TV 3.0 Project – Phase 3 - Over-the-air Physical Layer Field Tests

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Brazilian Digital Terrestrial Television System Forum

Brazilian Ministry of Communications

Brazilian National Education and Research Network (RNP, *Rede Nacional de Ensino e Pesquisa*)

Fluminense Federal University (UFF, *Universidade Federal Fluminense*)

State University of Maranhão (UEMA, *Universidade Estadual do Maranhão*)

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1 Introduction

The SBTVD Forum was created by the Brazilian Presidential Decree No. 5,820 / 2006, to advise the Brazilian Government regarding policies and technical issues related to the approval of technical innovations, specifications, development, and implementation of the Brazilian Digital Terrestrial Television System (SBTVD). The SBTVD Forum is composed of representatives of the broadcasting, academia, transmission, reception, and software industry sectors, and has the participation of Brazilian Government representatives as non-voting members.

Free-to-air terrestrial television is the main audiovisual distribution platform in Brazil, covering almost all Brazilian households and used in more than 70% of them. It secures to most of the Brazilian population a free-of-charge, universal and democratic access to information and entertainment, made by Brazilians for Brazilians. It is, therefore, an important social cohesion, national, and cultural identity factor.

For its first generation Digital Terrestrial Television system, after thorough testing and careful studies, the Brazilian Government adopted in June 2006 the ISDB-T standard, incorporating technological innovations that were deemed relevant, such as MPEG-4 AVC (H.264) video coding, MPEG-4 AAC audio coding, an appropriate closed caption character set for the Brazilian Portuguese, and a new middleware for interactive applications (Ginga).

The SBTVD Forum developed the first SBTVD standards, that were published in 2007, allowing the official opening of transmissions in that same year. Since then, the standards have been continuously revised and updated by the Forum. The technological innovations proposed by Brazil were incorporated into the International ISDB-T standard, which is currently adopted by 20 countries.

In 2016, Brazil started a safe and gradual analog TV switch-off process, that was designed to assure that no one would be deprived of the terrestrial free-to-air TV. The process was divided into two stages: in the first stage (2016 to 2019) the analog television switch-off was performed in all the state capitals, metropolitan areas, and other areas where it was required to release the 700 MHz band; on the second stage (up to 2023) the analog television switch-off would be performed in the remaining of the country. During the first stage, 1,362 cities in 47 different clusters were impacted, accounting for nearly 128 million people (62% of the population). More than 12 million Digital TV reception kits were distributed for low-income families. The analog switch-off had no significant impact on the free-to-air terrestrial TV audience. Regarding the second stage, the remaining 38% of the population (more than 79 million people) is distributed in 4,208 cities. After the implementation of Digital Terrestrial Television, Brazil adopted an industrial policy that determined that all flat-panel TVs manufactured from 2012 must have an integrated Digital TV receiver and from 2013 no more CRT TVs were manufactured. Therefore, it is anticipated, based on the expected product lifetimes, that by 2023 Brazil would have nearly all its TV sets already equipped with an integrated Digital TV receiver, thus facilitating the analog television switch-off without additional Digital TV reception kits distribution.

As the Brazilian digital television switch-over began, the SBTVD Forum started considering the next steps for the evolution of the Brazilian Television. The analog TV (that we conventionally call "TV 1.0"), which started in Brazil in 1950, was black and white with monophonic sound. Then, some backward-compatible improvements (that we conventionally call "TV 1.5"), such as color (in the 1970s), stereo sound and closed caption (in the 1980s) were added to it. From 2007, the first generation of Digital Terrestrial Television (that we conventionally call "TV 2.0") was introduced in Brazil, bringing high-definition video, surround sound, mobile reception, and interactivity. Since then, the technological landscape has changed a lot. The rhythm of development and introduction of innovations is increasingly accelerated. These innovations create new consumption habits and increase the expectations of technological services users regarding the quality and convenience of these services. Since the introduction of SBTVD, new immersive audio and video formats have

emerged, and are already present in the new TV sets available in the market. The TV sets currently available have resolution and contrast greater than those supported in the first generation SBTVD standard. That is the opposite of the market situation when Digital TV was launched in Brazil, as the HDTV sets offer was very low. The availability and the speed of Internet access in Brazil, especially in metropolitan areas, increased significantly, enabling the consumption of on-demand audiovisual content. This connectivity is already in use by TV sets (Smart TVs) and by broadcasters' Over-The-Top (OTT) offers. However, in the first generation SBTVD standard, there was not an integration between the broadcasting service and the Internet content offer. Furthermore, new techniques for signal coding, transport, and modulation were also developed, allowing greater efficiency in audiovisual transmission. Many Digital Terrestrial Television systems have also been evolving, including in this evolution not only enhancements in quality and efficiency but also new convergent services between the broadcasting and the Internet. Based on this technological landscape, the SBTVD Forum recognized the necessity to evolve the SBTVD. It also acknowledged that changes in the physical layer, the transport layer, and/or audiovisual coding would not be backward-compatible. Nevertheless, the transition to a new generation of Digital Terrestrial Television is a long process, based on the investments required for both broadcasters and consumers and the expected life span of TV transmitters and receivers. It was, therefore, deemed necessary to increase the life span of the existing Digital Terrestrial Television system as much as possible through a backward-compatible evolution (a project we called "TV 2.5") and to start the development of the next generation Digital Terrestrial Television system (the project we called "TV 3.0").

The "TV 2.5" project comprised two aspects: broadcast-broadband integration and audiovisual quality. The first aspect involved the development of a new receiver profile for the middleware Ginga (receiver profile D, a.k.a. "DTV Play"), addressing use cases such as on-demand video, synchronized companion device, audiovisual enhancement over the Internet, and targeted content. The second aspect was addressed through the introduction of three new optional immersive audio codecs (MPEG-H Audio, E-AC-3 JOC, and AC-4) while retaining MPEG-4 AAC main audio for backward-compatibility, and through the introduction of two new optional HDR video formats (SL-HDR1 dynamic metadata and HLG "preferred transfer characteristics" signaling) while keeping MPEG-4 AVC (H.264) / 8-bit / BT.709 / 1080i for backward-compatibility. The revision of the SBTVD standards containing both "TV 2.5" aspects has already been published (available at https://forumsbtvd.org.br/legislacao-e-normas-tecnicas/normas-tecnicas-da-tv-digital/english/).

For the "TV 3.0" project, the SBTVD Forum, after agreeing on its requirements (use cases and corresponding technical specifications), decided to release a Call for Proposals (available at https://forumsbtvd.org.br/wp-content/uploads/2020/07/SBTVDTV-3-0-CfP.pdf) for any interested organization to submit its proposed candidate technologies for any of the system components or sub-components. The new system is expected to start operating within the next few years, but based on the Brazilian experience on the transition from analog to digital television, the complete transition from the current SBTVD to the TV 3.0 is expected to last at least 15+ years.

As described in the aforementioned Call for Proposals document, the response to the Call for Proposals was divided into two phases.

Phase 1 responses comprised the identification of each proposed candidate technology and appropriate contact persons and filling the compliance form of the components or sub-components corresponding to the proposed candidate technology.

Phase 2 responses comprised providing the full specification of the proposed candidate technology, adhering to the SBTVD Forum Intellectual Property Rights Policy, and the additional requirements considering general information and resources needed for evaluating and comparing the proposed candidate technologies. The "TV 3.0 CfP Phase 2 / Testing and Evaluation" document (available at https://forumsbtvd.org.br/wp-

content/uploads/2021/03/SBTVD-TV_3_0-P2_TE_2021-03-15.pdf) provides further information on Phase 2, along with the test procedures for evaluating and comparing the proposals of candidate technologies.

The Call for Proposals was open from 17 July 2020 to 30 November 2020. It received in total, considering its 6 system components (Over-the-air Physical Layer, Transport Layer, Video Coding, Audio Coding, Captions, and Application Coding), 36 responses from 21 different organizations worldwide. Some similar proposals were merged for the sake of Phase 2 testing and evaluation, resulting in 30 candidate technologies.

Phase 2 tests were funded by the Brazilian Ministry of Communications through the Brazilian National Council for Scientific and Technological Development (CNPq, *Conselho Nacional de Desenvolvimento Científico e Tecnológico*). The Over-the-air Physical Layer candidate technologies were tested by the Mackenzie Presbyterian University (laboratory tests) and Fluminense Federal University (field tests) from 05 July 2021 to 03 December 2021. Phase 2 Over-the-air Physical Layer laboratory tests report is available at https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-PL-Lab-Report.pdf and field tests report is available at https://forumsbtvd.org.br/wp-content/uploads/2021/12/SBTVD-TV_3_0-PL-Field-Report.pdf.

At the end of Phase 2, the SBTVD Forum concluded that complementary laboratory and field tests would be needed in the Phase 3 to select the appropriate technology for the Over-the-air Physical Layer among the current candidate technologies (Advanced ISDB-T, ATSC 3.0 and 5G Broadcast – the DTMB-A proposal was withdrawn by the proponent). It was agreed that only the two candidate technologies that demonstrate the best fit with the specific requirements of the TV 3.0 Project in the laboratory tests would continue in the field tests. It also concluded that it was necessary to carry out a real-time video coding subjective quality assessment using the video coding technologies selected for the TV 3.0 Project (VVC and LCEVC) to determine the required bit rate for the Over-the-air Physical Layer to enable delivering audiovisual quality superior to that of the first-generation Brazilian DTTB system.

In April 2023, the Brazilian Presidential Decree No. 11,484, which provides the guidelines for the evolution of the Brazilian Digital Terrestrial Television System and for ensuring the availability of radio spectrum for its deployment, was published (available at http://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/decreto/D11484.htm, in Portuguese only).

It establishes that the next-generation Digital Terrestrial Television Broadcasting (DTTB) system in Brazil, called TV 3.0, shall have the following characteristics:

I. audiovisual quality superior to that of the first-generation Brazilian DTTB system;
II. fixed reception, with external and internal antenna, and mobile reception;
III. integration between contents transmitted by the broadcasting service and over the internet;
IV. app-based user interface;
V. content segmentation according to viewers' geographic location;
VI. customization of content according to viewers' preferences;
VII. optimized use of the radio frequency spectrum destined for terrestrial television broadcasting; and
VIII. new forms of access to cultural, educational, artistic, and informative contents.

The characteristics I, II, V and VII have a direct relationship with the Over-the-air Physical Layer and are in line with the requirements defined in the Call for Proposals.

The Phase 3 Over-the-air Physical Layer laboratory tests were carried out by Mackenzie Presbyterian University from April to September 2023 (report available at https://forumsbtvd.org.br/wp-content/uploads/2023/11/SBTVD-TV_3_0-P3-PL-Lab-Report.pdf), the real-time video coding subjective quality assessment was carried out at Brasilia University from June 2023 to January 2024 (report available at https://forumsbtvd.org.br/wp-content/uploads/2024/03/SBTVD-TV_3_0-P3-VC-Report.pdf) and the field tests were carried out by the Fluminense Federal University and the State University of Maranhão from December 2023 to May 2024 (this report). These tests, as well as Transport Layer and Application Coding R&D activities (from April 2023 to September 2024), are all being carried out under the coordination of the SBTVD Forum and funded by the Brazilian Ministry of Communications through the Brazilian National Education and Research Network (RNP, *Rede Nacional de Ensino e Pesquisa*).

Considering the Phase 3 physical layer laboratory results, the video bitrate requirements resulting from the Phase 3 real-time video coding subjective quality assessment, as well as the bitrate requirements of the other system components (audio, captions, sign language and applications) and the transport layer overhead, it was concluded that, under the current technology development status, it would not be possible to operate the TV 3.0 over-the-air physical layer with frequency reuse-1 for non-directional receiving antennas (that would require C/N < 0 dB) with enough capacity with a 6 MHz channel with 2x2 MIMO to ensure audiovisual quality higher than the maximum possible in the first-generation Brazilian DTTB system (with a 6 MHz channel with SISO).

It was then decided to test, for each of the candidate technologies (Advanced ISDB-T and ATSC 3.0) the most robust configuration (with the lowest C/N requirement) that would deliver at least 30 Mbps in a single Physical Layer Pipe (PLP) with a 6 MHz channel with 2x2 MIMO, 16K FFT and guard interval higher than 100 µs. This capacity is enough to carry one 8K HDR program service (the required bitrate for 8K was extrapolated from the subjective test results for 720p, 1,080p and 4K), or two 4K HDR program services, or three 1,080p HDR program services with audiovisual quality higher than the maximum possible in the first-generation Brazilian DTTB. It would also be possible to carry one 1,080p HDR program service and three 720p HDR program services, or five 720p HDR program services (in the case of 720p HDR program services, they would have, in the worst case, slightly lower subjective quality than the maximum possible with 1,080i in the first-generation Brazilian DTTB). The quantity and/or resolution of program services could be increased if the quality requirements are relaxed and/or with better VVC encoder performance (either with real-time encoder implementation improvement or using multi-pass or offline encoding). The use of 2x2 MIMO in a single Layer/PLP aims to minimize the C/N requirement for the desired capacity, in order to facilitate fixed indoor reception by minimizing the required field strength. The use of the 16K FFT seeks a balance between the spectral efficiency for fixed reception and the speed limit for mobile reception. The use of a guard interval higher than 100 µs is intended to allow SFN operation with the re-utilization of transmission sites currently operating on SFNs in Brazil.

The physical layer field test has two main objectives:

1. Comparison of candidate technologies; and

2. Measurement of the C/N requirement for indoor reception to be recommended to Anatel (Brazilian National Telecommunications Agency) for frequency planning purposes.

It should be noted that TV 3.0 standardization will not prescribe the physical layer configuration to be used by different broadcasters, but the C/N value adopted for frequency planning in Brazil may impose practical coverage and/or interference limitations on the use of configurations with higher C/N values.

Additional tests were also carried out on a subset of points, of a two-layer configuration with capacity ≥ 10 Mbps each (enough for at least one 1,080p HDR program service on each layer) with different C/N requirements, and of a two-layer reuse-1 configuration for comparison with the laboratory results.

Further information regarding the TV 3.0 Project can be obtained at: https://forumsbtvd.org.br/tv3_0/.

This document contains the results of the Phase 3 Over-the-air Physical Layer field tests to support (alongside the results of the other tests and the market and intellectual property assessments) the SBTVD Forum in recommending the appropriate technology for the Over-the-air Physical Layer of the next generation of digital terrestrial television in Brazil.

It is important to highlight that, in this process, the SBTVD Forum has a propositional role, with the Brazilian Government alone being responsible for making any decisions about the standards applicable to broadcasting service in Brazil.

2 Research Team

This report was developed by the following team of the Fluminense Federal University (UFF, *Universidade Federal Fluminense*) and the State University of Maranhão (UEMA, *Universidade Estadual do Maranhão*):

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Pollyana Notargiacomo Mustaro - Physical Layer & Transport Layer Workgroup, SBTVD Forum

As we used Globo's transmission infrastructure for the tests, we also counted with Globo's local support team for setting up the tests.

3 Partners

We thank Globo, for providing the transmission station, measuring vehicle, and support staff.

4 Glossary

AAC	Advanced Audio Coding
ABNT	*Associação Brasileira de Normas Técnicas* (Brazilian Technical Standards Association)
ATSC	Advanced Television System Committee
ATSC 3.0	Newest Version of Advanced Television System Committee Standard
A/V	Audio/Video
AVC	Advanced Video Coding
BCH	Bose–Chaudhuri–Hocquenghem
BER	Bit Error Rate
BNC	Bayonet Neill Concelman
CFP	Call for Proposals

CL	Core Layer
CNPq	*Conselho Nacional de Desenvolvimento Científico e Tecnológico* (National Council for Scientific and Technological Development)
C/N	Carrier-to-Noise Ratio
CRT	Cathode Ray Tube
DiBEG	Digital Broadcasting Experts Group
DTT	Digital Terrestrial Television
DTTB	Digital Terrestrial Television Broadcasting
DTV	Digital Television
E-AC-3	Enhanced AC-3
EIA	Engineering Industries Association
EL	Enhanced Layer
FER	Frame Error Rate
FFT	Fast Fourier Transform
GPS	Global Positioning System
HD	High Definition
HDR	High Dynamic Range
HLG	Hybrid Log-Gamma
IP	Internet Protocol
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ITU	International Telecommunications Union

ITU-R	ITU Radiocommunication Sector
JOC	Joint Object Coding
LA	Layer A
LB	Layer B
LCEVC	Low Complexity Enhancement Video Coding
LDM	Layered Division Multiplexing
MER	Modulation Error Rate
MIC	Ministry of Internal Affairs and Communications
MIMO	Multiple-Input and Multiple-Output
MPEG	Moving Picture Experts Group
NBR	*Norma Brasileira Regulamentadora* (Brazilian National Standard)
NHK	*Nippon Hōsō Kyōkai* (Japan Broadcasting Corporation)
NUC	Non-Uniform Constellation
OFDM	Orthogonal Frequency-Division Multiplexing
OTT	Over-The-Top
PC	Personal Computer
PER	Packet Error Rate
PL	Physical Layer
PPS	Pulse Per Second
PR	Protection Ratio

PUC-Rio	*Pontifícia Universidade Católica do Rio de Janeiro* (Pontifical Catholic University of Rio de Janeiro)
QEF	Quasi Error Free
reuse-1	The use of the same RF channel by independent stations covering adjacent service areas
RF	Radio Frequency
RMS	Root Mean Square
RNP	*Rede Nacional de Ensino e Pesquisa* (Brazilian National Education and Research Network)
SBTVD	*Sistema Brasileiro de Televisão Digital* (Brazilian Digital Television System)
SFN	Single Frequency Network
SL-HDR	Single-Layer HDR
STB	Set-Top Box
TOV	Threshold Of Visibility
TV	Television
UC	Uniform Constellation
UEMA	*Universidade Estadual do Maranhão* (State University of Maranhão)
UFF	*Universidade Federal Fluminense* (Fluminense Federal University)
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
VVC	Versatile Video Coding

5 TV 3.0 Architecture

The TV 3.0 system components described in this document reflect the reference TV 3.0 architecture, as depicted in Figure 5.1.

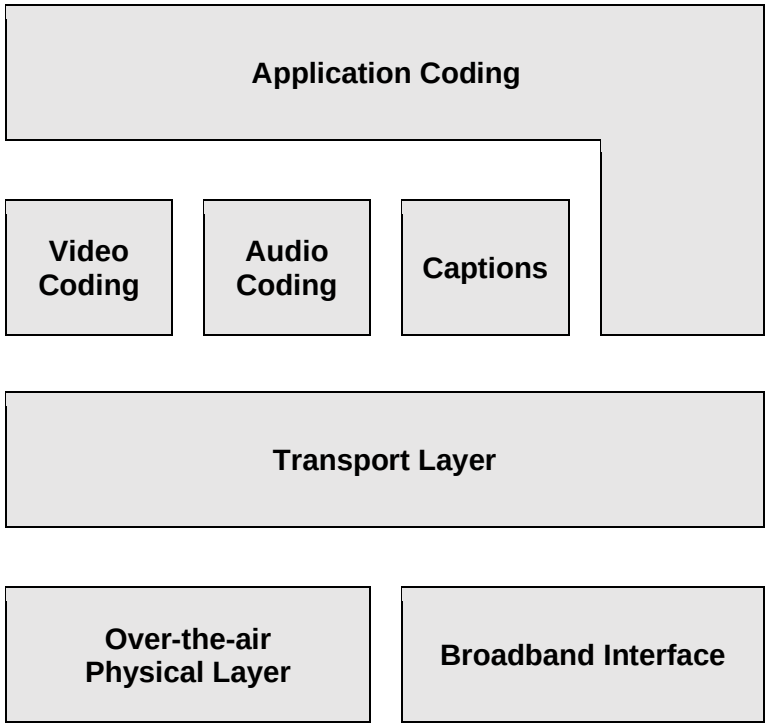


Figure 5.1 - TV 3.0 Architecture.

For further information about TV 3.0 architecture, please refer to the TV 3.0 Call for Proposals (CfP) document (available at https://forumsbtvd.org.br/wp-content/uploads/2020/07/SBTVDTV-3-0-CfP.pdf).

6 TV 3.0 Phase 3 Testing and Evaluation

Please refer to Section 4 of the "TV 3.0 CfP Phase 2 / Testing and Evaluation" document (available at https://forumsbtvd.org.br/wp-content/uploads/2021/03/SBTVD-TV_3_0-P2_TE_2021-03-15.pdf) for further information on the testing and evaluation procedures.

In Phase 3, the physical layer is validated with MIMO systems only. For the configurations considered in this field test, please refer to the Introduction section of this document.

7 TV 3.0 Phase 3 Testing and Evaluation Results

7.1 Testing Devices

A vehicle prepared for installing the equipment was used to collect the signals. The vehicle has a diesel generator independent of the vehicle's power system, used to supply electrical energy to the equipment, a telescopic mast whose maximum height is 10 meters on which the receiving antenna used in fixed measurements was installed.

At reception, the measurement system is composed of a panel antenna with two independent polarizations (horizontal and vertical), a pair of RF cables (with losses of 2.92 and 2.97 dB) whose terminations were connected to a set of filters, attenuators, power dividers, and low noise amplifiers.

Figure 7.1 presents the schematic diagram, and the actual implementation of the setup described in Section 6.2.2.1, which was called RF Box. SBTVD Forum developed the RF Box to facilitate the field measurement tests. This box contains a set of devices, forming two branches of inputs: A and B. Each branch has two inputs, totalizing four inputs, as follows:

• Signal Input A: this input connects to the Receiving antenna polarization V. We set an impedance matcher and a band-pass filter between the antenna and the RF Box signal input.

• Noise Input A: this input connects to a noise generator. There is a 1:2 splitter between the noise generator and the RF Box noise input.

• Signal Input B: this input connects to the Receiving antenna polarization H. We set an impedance matcher and a band-pass filter between the antenna and the RF Box signal input.

• Noise Input B: this input connects to a noise generator. There is a 1:2 splitter between the noise generator and the RF Box noise input.

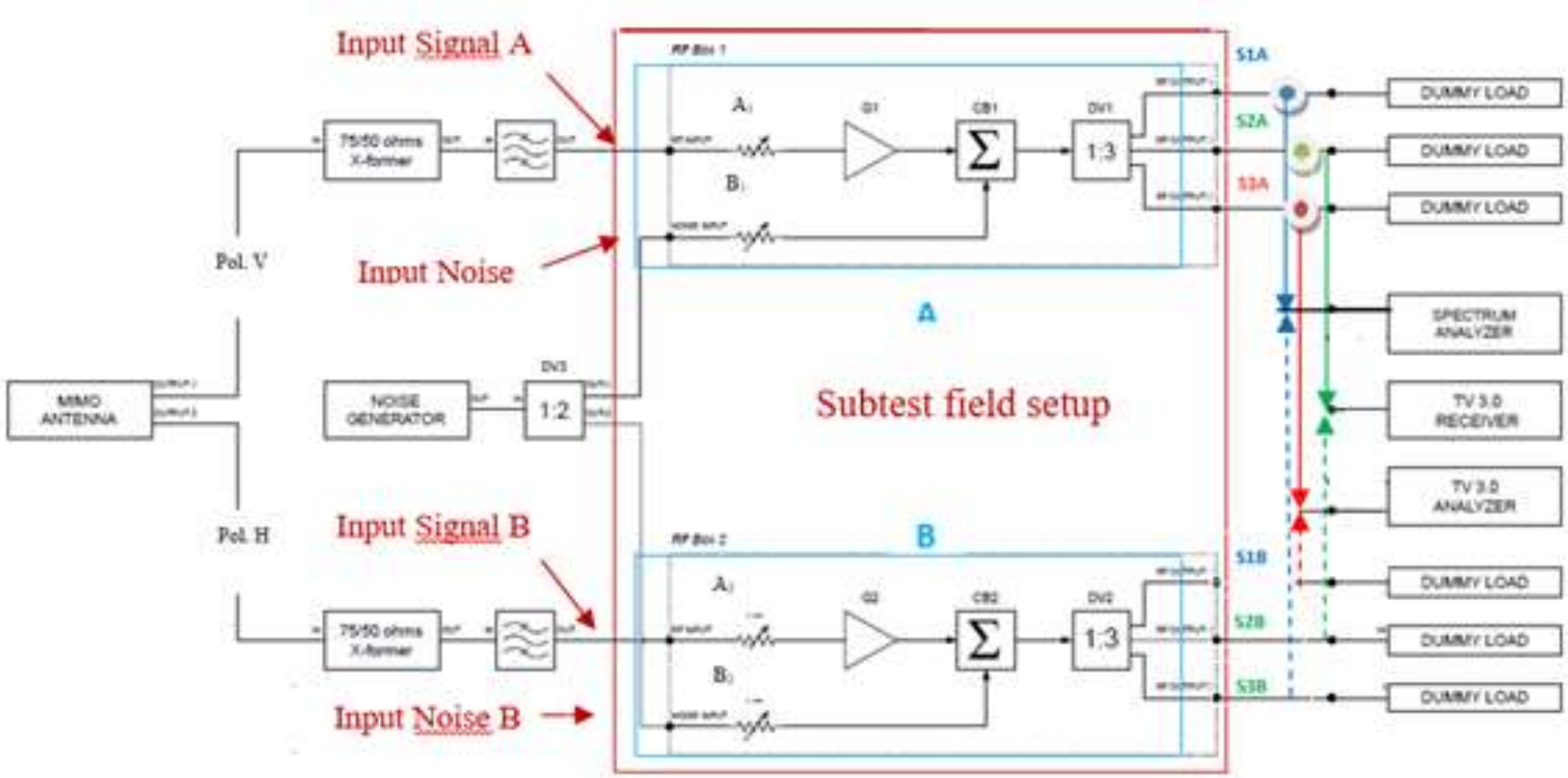


Figure 7.1 - Field test RF Box setup.

The 1:2 splitter divides the signal generated by the noise generator to inject this signal into both noise inputs. The filters before both signal inputs select the channel of interest. The impedance matcher matches the impedance between the cable from the antenna and the filter input.

In branches A and B, the signal input paths have the following steps:

- The input signal enters a variable attenuator that attenuates up to 60 dB, controlled via IP.
- The variable attenuator's output enters a Low Noise Amplifier (LNA) that nominally amplifies 25 dB.
- The LNA's output enters a 2:1 combiner that combines signal and noise.
- The combiner's output enters a 1:3 splitter that divides the input into three output signals, S1A, S1B, S2A, S2B, and S3A, S3B. These outputs allow three different equipment to show the received signal (for instance, Spectrum Analyzer, TV 3.0 receiver, and TV 3.0 Analyzer).

In branches A and B, the noise input paths have the following devices:

- Noise enters a variable attenuator that attenuates up to 60 dB, controlled via IP.
- The variable attenuator's output enters a 2:1 combiner that combines signal and noise.
- The combiner's output enters a 1:3 splitter that divides the input into three output signals, S1A, S1B, S2A, S2B, and S3A, S3B. These outputs allow three different equipment to show the received signal (for instance, Spectrum Analyzer, TV 3.0 receiver, and TV 3.0 Analyzer).

We used a DTU-315 Modulator and a PC with DekTec Stream Xpress software as a noise generator. We used the ISDB-T signal generation in an 8 MHz channel as noise. The software allows adjusting the signal level in the range of (-45, -25) dBm in 0.5 dB steps. This characteristic enables fine adjustment of the noise level in measurements of C/N at TOV.

7.1.1 Field equipment characterization

a) RF Box characterization

The frequency response of the 4 RF Box inputs was characterized using an arbitrary signal generator MG3700 from the brand Anritsu and a spectrum analyzer Tektronix RSA306, generating a continuous wave (CW) signal with an output power of -29 dBm whose output is connected to a cable with attenuation of 1.6 dB, in the bandwidth of 569 ± 3.96 MHz. For this characterization, the four input variable attenuators, one for each RF Box input, are set to 0 dB attenuation. The characterization procedure consists of injecting a -30.6 dBm signal into the measured input while matching the impedance of the remaining inputs. The impedance of the outputs not used in the test were matched to avoid interference. It is worth noting that the splitter utilized to divide the signals to branch A and branch B introduces a 3 dB loss to the signal generated by the noise generator.

i. Branch A

At first, a -30.6 dBm signal was injected into the Noise Input A. Then, we collected the level at the six outputs, S1A/B, S2A/B, and S3A/B, one at a time. The observed power is -44.8 dBm, which means the loss observed at the 569 MHz central frequency equals approximately 14.2 dB. The frequency response is very similar for all three outputs.

Next, a -30.6 dBm signal was injected into the Signal Input A and collected the level at branch A's LNA output. The observed power is -17.5 dBm on average, which means the gain observed at the 569 MHz central frequency equals approximately 13.1 dB in this branch.

ii. Branch B

At first, a -30.6 dBm signal was injected into the Noise Input B. Then, we collected the level at the six outputs, S1A/B, S2A/B, and S3A/B, one at a time. The observed power is -44.3 dBm, which means the loss observed at the 569 MHz central frequency equals approximately 13.7 dB. The frequency response is very similar for all three outputs.

Next, a -30.6 dBm signal was injected into the Signal Input A and collected the level at branch A's LNA output. The observed power is -17.2 dBm on average, which means the gain observed at the 569 MHz central frequency equals approximately 13.4 dB in this branch.

Signal branches A and B provided approximate gains of 13.1 dB and 13.4 dB from the signal input to the outputs S. The losses in A and B noise branches were 14.2 dB and 13.7 dB. The ZX60-112LN+ Low Noise Amplifier has a typical gain of 28 dB in 600 MHz. If we compare the loss in the noise input (without LNA) and the gain in the input signal (with LNA) the difference is about 27.3 dB.

The measurements at both branches' outputs are in Table 7.1.

Table 7.1 - Gains and Losses across the branches of the Subtest Field Setup.

	Signal (Gain)		Noise (Loss)	
Output	**A Branch(dB)**	**B Branch (dB)**	**A Branch (dB)**	**B Branch (dB)**
S1A	13.1		14.2	
S1B		13.4		13.7
S2A	13.1		14.0	
S2B		13.3		13.9
S3A	13		14.1	
S3B		13.2		13.8

b) Filter and cable losses

Using RF Box branch A, we also analyzed the losses external to the RF Box, specifically the filter, cable loss, and other accessories. We injected a signal in the system in two different configurations. We used a signal generator + RF Box branch A + analyzer in the first configuration. We used a signal generator + filter + RF Box branch A + analyzer in the second configuration. As a result, the attenuation of the filter is about 6.43 dB.

c) Attenuator characterization

Each branch corresponding to the desired signal is composed of a low-noise amplifier, a variable attenuator controlled via IP and a set of RF integrators used to insert noise into the desired signal. The two noise inputs (one for each polarization) each have a variable attenuator, used in the test to calculate the minimum signal-to-noise ratio at which the system can decode the signal without reaching the minimum bit error rate.

Tables 7.2 and 7.3 present the attenuation for each attenuator in 10 dB increments.

Table 7.2 - Attenuator loss characterization for signal input.

Attenuator 1 (dB)	Output			Attenuator 2 (dB)	Output		
	S1A (dB)	S2A (dB)	S3A (dB)		S2B (dB)	S2B (dB)	S2B (dB)
0	0.00	0.00	0.00	0	0.00	0.00	0.00
-10	-10.06	-10.13	-10.03	-10	-10.05	-10.01	-10.02
-20	-19.74	-19.87	-19.70	-20	-19.80	-19.77	-19.77
-30	-29.71	-29.81	-29.64	-30	-29.73	-29.69	-29.69
-40	-39.59	-39.72	-39.51	-40	-39.62	-39.56	-38.59
-50	-49.69	-49.86	-49.63	-50	-49.71	-49.73	-49.69
-60	-59.31	-59.60	-59.12	-60	-59.16	-59.16	-59.04

Table 7.3 - Attenuator loss characterization for noise input.

Attenuator 3 (dB)	Output S1A	Attenuator 4 (dB)	Output S1B
0	0.00	0	0.00
-10	-10.44	-10	-10.02
-20	-20.17	-20	-19.74
-30	-29.95	-30	-29.56
-40	-39.52	-40	-39.14
-50	-49.79	-50	-49.64
-60	-59.28	-60	-59.41

7.1.2 Antennas

We received 3 antennas models to perform field tests. One of them is a panel antenna with two entries, one for each polarization. This antenna was used for outdoor test and was installed at the mast of the mobile unit. The second antenna is a panel antenna too and was used for indoor test. The third is an omnidirectional antenna and was used to perform a drive test. Specifications are in Table 7.4.

Table 7.4 - Antennas specifications.

ANTENNA	Pattern	Operation Band (MHz)	Gain (dBi)	Z_{in} (W)	Polarization	Return Loss (dB)
Ideal	Panel	566-674	8.7	50	H/V	> 10
VH-PT00-5767	Panel	470-698	4	75	H/V	> 10
VH-SLDP-5767	Omni	470-698	0	50	H/V	> 10

7.2 Testing Sites

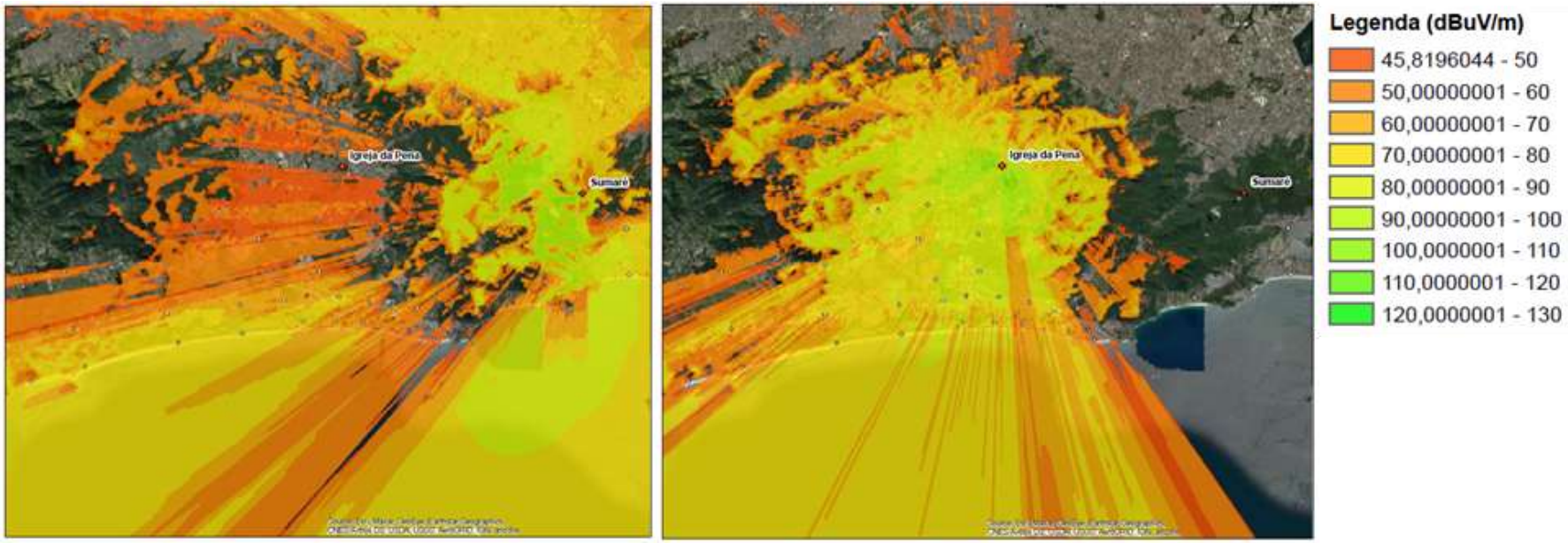
The field test sites are located in the districts of Jacarepaguá, Barra da Tijuca, and Recreio dos Bandeirantes, which are located in the western zone of Rio de Janeiro city. The main reasons for selecting this area are:

a) It's the most suitable area for implementing the standards of recommendation ITU-R SM.1875-3;

b) It allows the reuse of measurements considering Sumaré and Pena transmission sites;

c) Safety reasons.

We simulated the coverage prediction using PROGIRA software to provide the approximate values of the electric field strength in the test area. The software loads the topography and morphology of the environment. It calculates the electric field strength considering the phenomena of diffraction, tropospheric dispersion, reflection, refraction, and losses when entering the relief and constructions. The coverage area prediction from the transmitting antennas installed at the Sumaré and Penna stations and the expected electric field strength in dBµV/m are in Figure 7.2.



(a) Sumaré **(b) Penna**

Figure 7.2 - Coverage Predictions of broadcast stations.

Due to the region's topography, it was not possible to strictly follow the standards of ITU-R SM.1875-3 for choosing the measurement points. Due to time limitations, we selected a limited number of sites within the predicted coverage area with different population densities, traffic, terrain (rugged and flat, proximity or not to water bodies), and azimuth to the transmitters. Figure 7.3 shows the selected measurement locations. We have a total of 30 outdoor sites and nine indoor sites. Among the 30 outdoor sites, we included the outdoor measurements of each indoor site to compare the effects of the building over the reception in the area.

Concerning the indoor sites, they were selected considering the coverage area and the availability for the researcher team being for hours to perform the tests. Moreover, we need to return to the same place a few times to complete different technology configuration analyses.

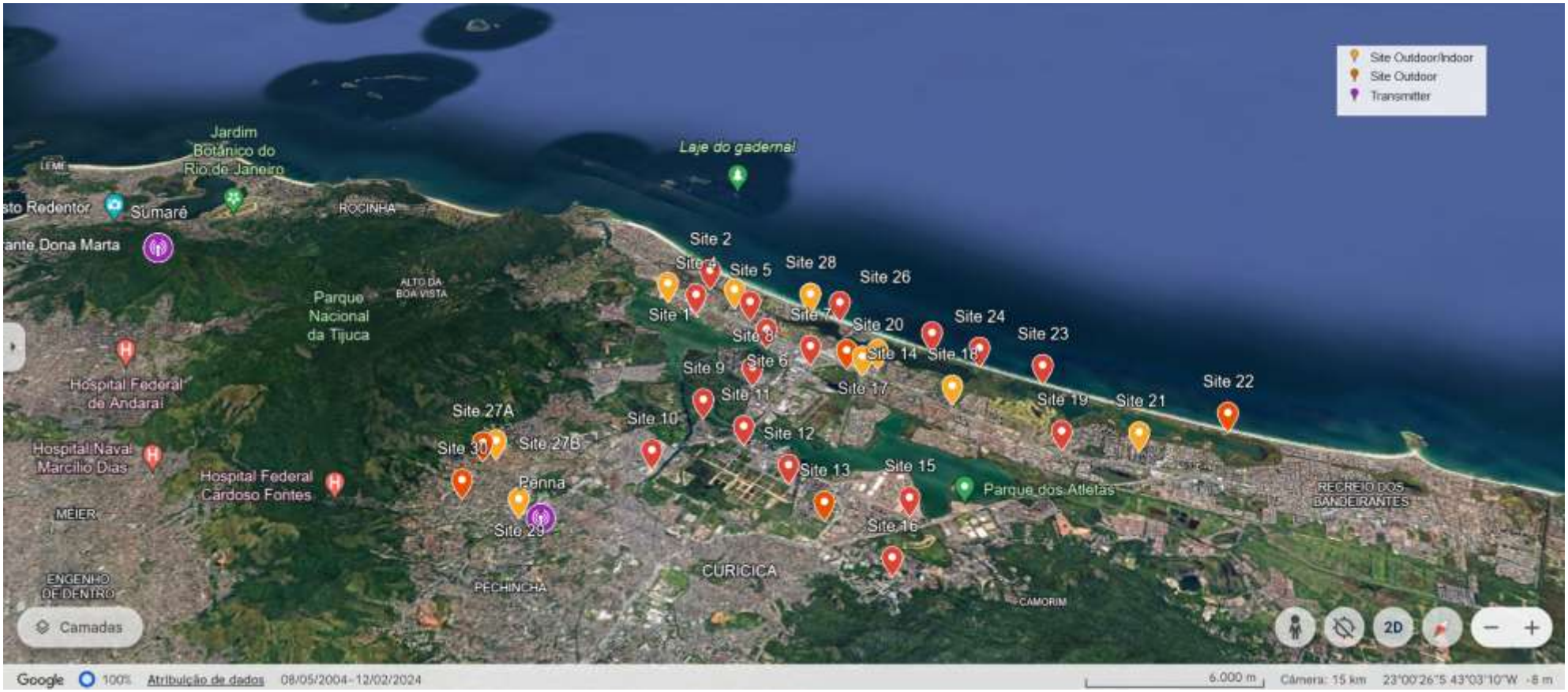


Figure 7.3 - Measurement sites.

In sum, we defined the number of tested areas based on the following assumptions:

a) terrain difference within and around the planned coverage area;

b) existence of necessary precision for coverage evaluation;

c) access availability;

d) availability of indoor site; and

c) maximum measurement effort possible, considering the project schedule, the size of the team, and the available measurement devices.

Table 7.5 shows the summarized information about each site. We specify which sites we used as outdoor and/or indoor sites, and the average channel power measured in vertical and horizontal polarization. We considered all the measurements performed in each site, considering that the number of measurements in each site varies, as some measurement campaigns used a subset of the sites due to schedule constraints.

It is important to note that the researcher team planned to perform a measurement campaign using all sites for the main configuration of each technology and a subset containing 20 outdoor sites and four indoor sites for extra configurations suggested by SBTVD Forum. Nevertheless, we had four test interruptions for vehicle maintenance, which impacted this initial planning. Hence, smaller subsets were used in the extra campaigns, as the tests were finished before initial subset completion due to schedule restrictions. We could not compensate for the lost days in car maintenance due to SBTVD Forum schedule restrictions. The extra configurations were requested by the SBTVD forum to perform extra campaigns. Thus, the extra measurement tests are optional and not essential for choosing the candidate technology to be the Brazilian TV 3.0 Standard.

Table 7.5 - Final selection of measurement sites.

Site	Latitude	Longitude	Address	Outdoor /Indoor	Distance to Penna (km)	Outdoor Average Channel Power -V (dBm)	Outdoor Average Channel Power - H (dBm)
1	-22.997507	-43.328922	Av. das Américas, 1650 - Barra da Tijuca, Rio de Janeiro - RJ, 22640-101	O+I	6.6	-39.71	-39.65
2	-23.006203	-43.333335	Av. Sen. Danton Jobim, 620 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-060	O	7.5	-71.45	-75.52
3	-23.00289	-43.342009	Av. Gastão Sengés, 185 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-280	O+I	7.0	-67.41	-67.42
4	-22.997372	-43.33625	R. Mario Melo - Barra da Tijuca, Rio de Janeiro - RJ, 22640-100	O	6.5	-62.15	-62.58
5	-23.001388	-43.347166	Av. Assis Chateaubriand, 301 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-320	O	6.7	-57.77	-57.39
6	-22.996291	-43.354979	Av. Luís Carlos Prestes - Barra da Tijuca, Rio de Janeiro - RJ, 22640-102	O	6.2	-65.29	-63.86
7	-22.99645	-43.365296	Av. das Américas, 5150 - Barra da Tijuca, Rio de Janeiro - RJ, 22640-102	O	6.5	-57.54	-55.08
8	-22.985899	-43.359167	Av. João Cabral de Mello Neto, 405 - Barra da Tijuca, Rio de Janeiro - RJ, 22775-057	O	5.1	-59.19	-58.14
9	-22.974372	-43.35656	Av. Projetada 3, Vila do Pan - Jacarepaguá, Rio de Janeiro - RJ, 22775-036	O	3.8	-36.52	-37.68
10	-22.959769	-43.356765	Av. Ayrton Senna, 6000 - Jacarepaguá, Rio de Janeiro - RJ, 22775-005	O	2.2	-33.75	-35.34
11	-22.972765	-43.367048	Av. Almirante Júlio de Sá Bierrenbach - Jacarepaguá, Rio de Janeiro - RJ, 22775-022	O	4.0	-51.17	-51.29
12	-22.969287	-43.379213	Av. José Wilker, Jacarepaguá, Rio de Janeiro - RJ	O	4.5	-41.46	-41.12
13	-22.965617	-43.389325	Av. Vice Pres. José Alencar, 7 - Jacarepaguá, Rio de Janeiro - RJ, 22775-033	O	5.0	-61.91	-61.76
14	-22.999160	-43.3719470	Av. das Américas, 6000 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-080	O	6.9	-44.10	-43.50
15	-22.974721	-43.400773	Av. Embaixador Abelardo Bueno, 5001 - Barra da Tijuca, Rio de Janeiro - RJ, 22775-039	O	6.5	-61.29	-62.74
16	-22.960635	-43.403654	Estr. de Curicica, 192-204 - Curicica, Rio de Janeiro - RJ, 22710-560	O	6.2	-51.50	-51.23
17	-22.998755	-43.375285	Av. das Américas, Nº 6120 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-080	O+I	7.0	-42.97	-42.85
18	-23.002504	-43.388385	Av. das Américas, 8445 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-081	O+I	8.1	-63.80	-52.32
19	-23.000793	-43.414506	Av. das Américas, 10605 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-082	O	9.6	-47.11	-46.97
20	-23.002602	-43.376897	Rua Ataulpho Coutinho, 80 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-520	O+I	7.4	-41.97	-41.62
21	-23.007774	-43.428911	Condomínio Barra Sul - Praça Sao Marcos, 10 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-36	O+I	11.0	-62.78	-62.11
22	-23.020473	-43.440157	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22620-170	O	13.0	-53.00	-52.37
23	-23.014799	-43.406583	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22795-006	O	10.1	-46.00	-46.13
24	-23.013019	-43.393763	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22630-012	O	9.3	-49.87	-50.38
25	-23.012123	-43.384085	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22620-170	O	8.7	-52.82	-52.60
26	-23.010459	-43.362609	Av. Lúcio Costa, 6388 - Barra da Tijuca, Rio de Janeiro - RJ, 22630-013	O	7.9	-51.55	-53.00
27A	-23.012123	-43.384085	R. Prof. Silvio Fialho - Jacarepaguá, Rio de Janeiro - RJ, 22750-470	O	2.0	-44.04	-41.99
27B	-22.94731	-43.33169	Rua Prof Fernando Raja Gabaglia, 217 - Anil, Jacarepaguá, Rio de Janeiro - RJ, 22750660	I	1.8	-	-
28	-23.010049	-43.356259	Av. Lúcio Costa, 6000 - Barra da Tijuca, Rio de Janeiro - RJ, 22630-012	O+I	7.6	-49.34	-50.10
29	-22.939926	-43.345226	Ladeira da Freguesia, 375 - Freguesia, Jacarepaguá, Rio de Janeiro - RJ, 22760-090	O+I	0.4	-58.66	-59.27
30	-22.938003	-43.333644	Estr. do Bananal, 400 - Freguesia (Jacarepaguá), Rio de Janeiro - RJ, 22750-013	O	1.6	-64.12	-63.88

7.2.1 Outdoor and Indoor fixed sites

In the following sections, we present a detailed description of each site. The site profile indicates causes for differences observed in measurements between sites.

7.2.1.1 Site 1

a) Outdoor

Table 7.6 - Site 1 outdoor profile.

Site Index	1 - ION Intelligent Center, Globo
Geographic coordinates	22°59'51.10"S 43°19'43.95"O
Address	Av. das Américas, 1650 - Barra da Tijuca, Rio de Janeiro - RJ, 22640-101
Distance between TX and RX	6.6 km
Average power reception	Vertical polarization: -36 dBm Horizontal polarization: -38 dBm
Area description	ION parking is an area with medium-height buildings and little vegetation, and it is close to Tijuca Lake, as shown in Figure 7.4.
Altitude profile	Transmission without interference from mountains, as shown in Figure 7.5.
Signal characterization	Good reception, with flat frequency fading and high signal level, as shown in Figure 7.6.

Figure 7.4 - Area around Site 1, showing the positioning of the measurement van.

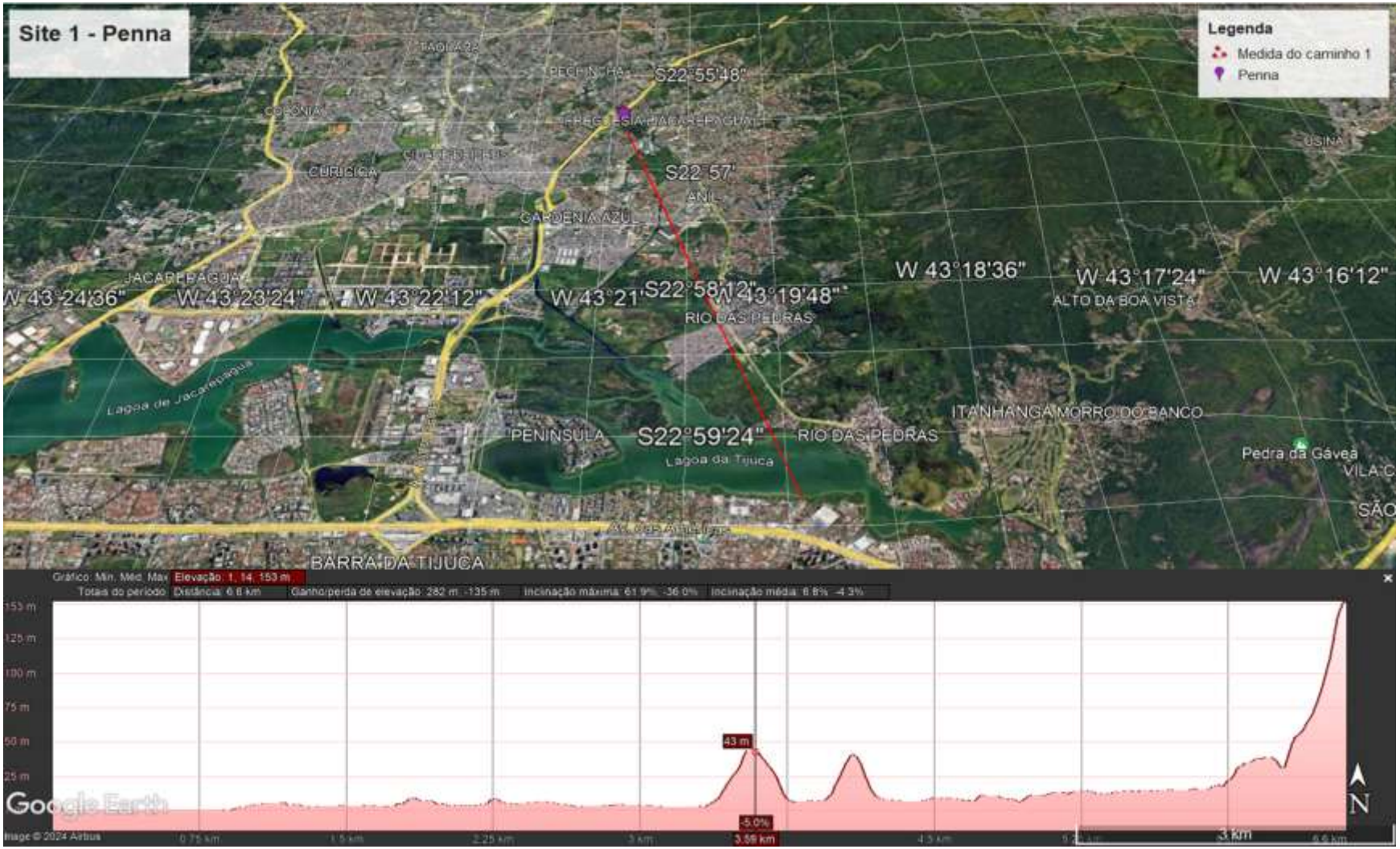


Figure 7.5 - Map showing the position of Site 1 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.6 - Example of the received signal at Site 1, with a 15 dB attenuation.

b) Indoor

We performed measurements in the building next to the outdoor site on the second floor. The antenna was near a closed window, as shown in Figure 7.7. The position was selected to maximize reception power. We observe approximately a 25 dB loss in channel power, compared to the outdoor site, and low impact on the fading pattern, as shown in Figure 7.8.

Figure 7.7 - Indoor area of Site 1, showing the antenna positioning.

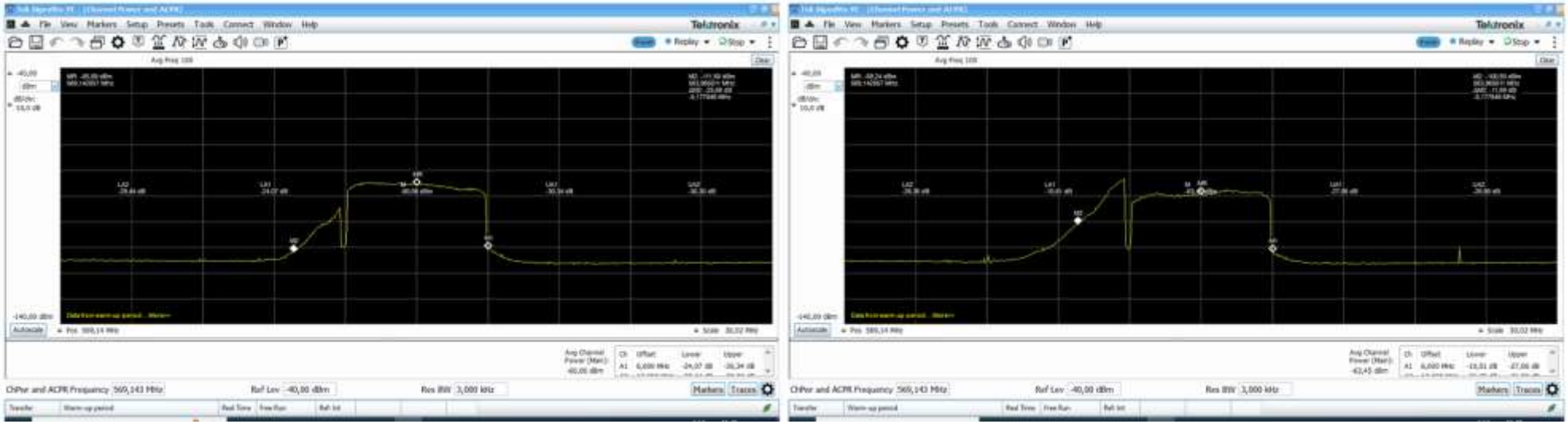


Figure 7.8 - Example of the indoor received signal at Site 1.

7.2.1.2 Site 2

a) Outdoor

Table 7.7 - Site 2 outdoor profile.

Site Index	2 - Condomínio Santa Lúcia
Geographic coordinates	23° 0'22.39"S 43°20'0.41"O
Address	Av. Sen. Danton Jobim, 620 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-060
Distance between TX and RX	7.5 km
Average power reception	Vertical polarization: -71 dBm Horizontal polarization: -76 dBm
Area description	Street has meager traffic and little vegetation and is close to the Marapendi Canal, as shown in Figure 7.9.
Altitude profile	Transmission with mountain interference, with impact on frequency fading selectivity, as shown in Figure 7.10.
Signal characterization	Selective frequency fading and low signal level, as shown in Figure 7.11.

Figure 7.9 - Area around Site 2, showing the positioning of the measurement van.

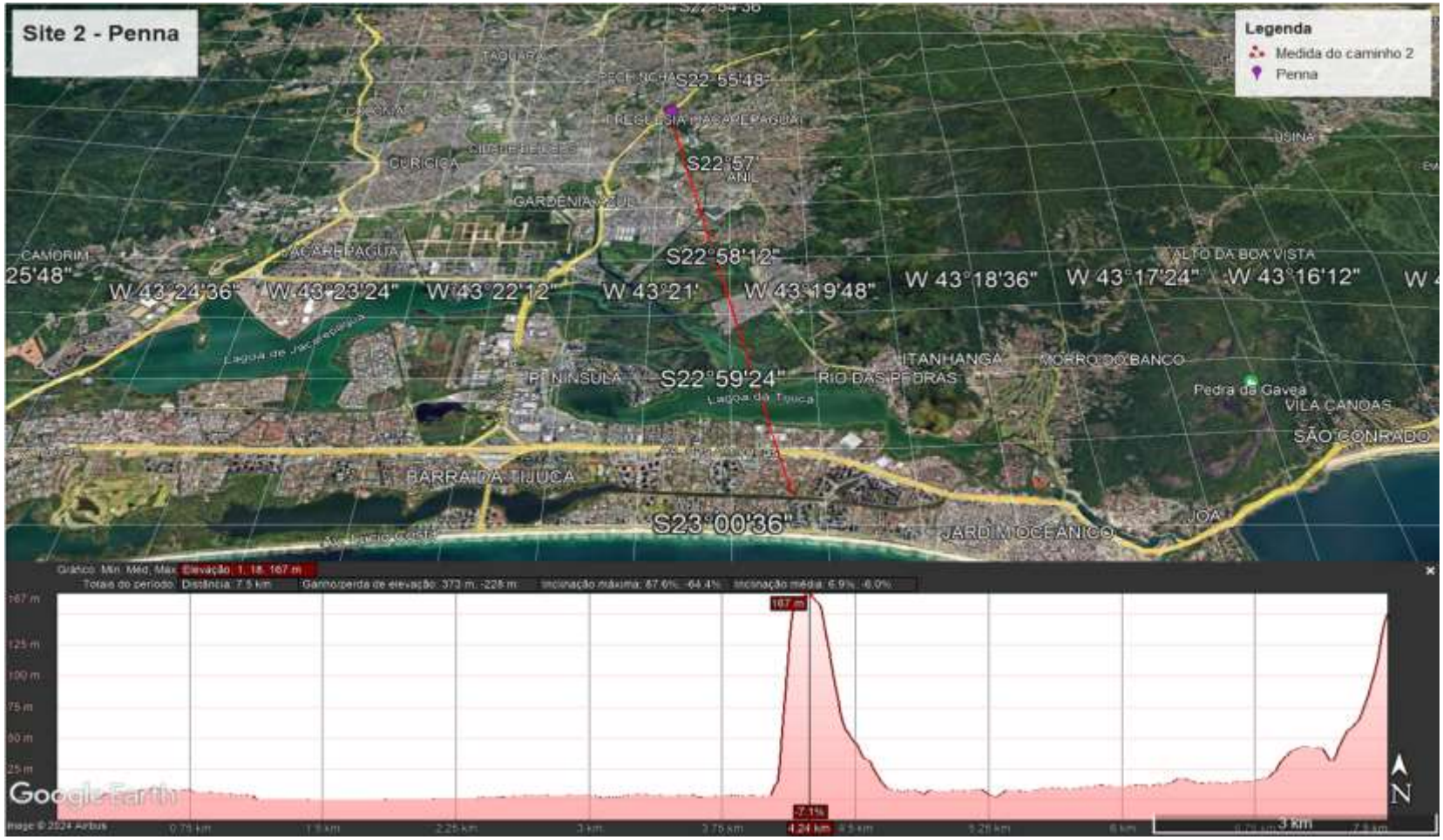


Figure 7.10 - Map showing the position of Site 2 relative to the Penna transmitter and the altitude profile of the path between these two points.

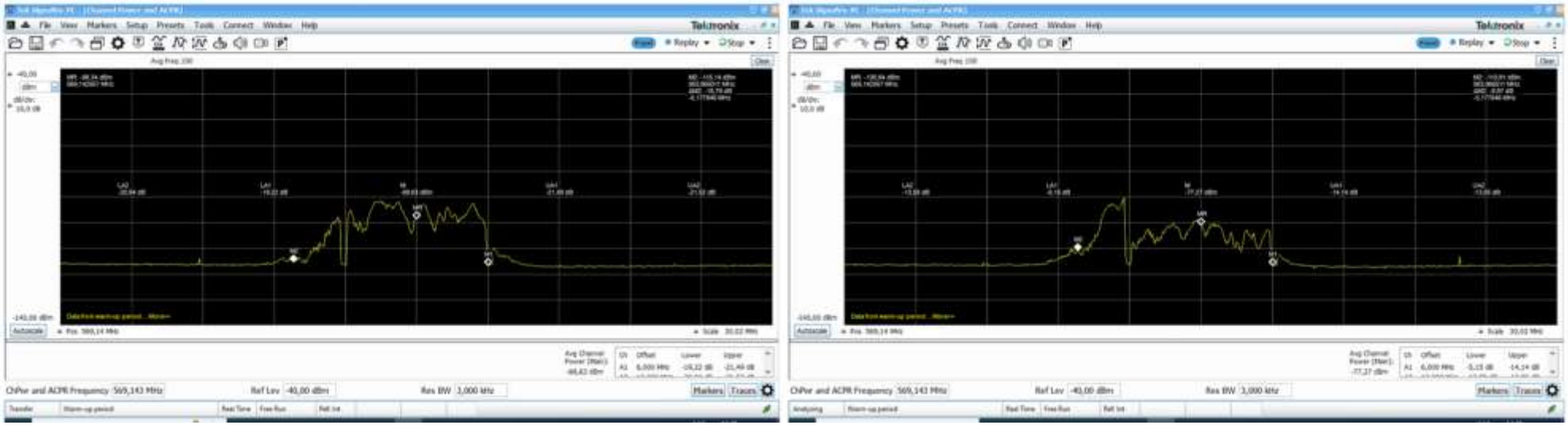


Figure 7.11 - Example of the received signal at Site 2.

7.2.1.3 Site 3

a) Outdoor

Table 7.8 - Site 3 outdoor profile.

Site Index	3 - Condomínio Mediterrâneo Flat
Geographic coordinates	23° 0'10.65"S 43°20'31.46"O
Address	Av. Gastão Sengés, 185 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-280
Distance between TX and RX	7.0 km
Average power reception	Vertical polarization: -67 dBm Horizontal polarization: -67 dBm
Area description	Street with meager traffic, little vegetation, and close to high buildings, as shown in Figure 7.12.
Altitude profile	Transmission with mountain interference and high impact on frequency fading selectivity, as shown in Figure 7.13.
Signal characterization	Good signal level reception, with selective frequency fading, as shown in Figure 7.14.

Figure 7.12 - Area around Site 3, showing the positioning of the measurement van.

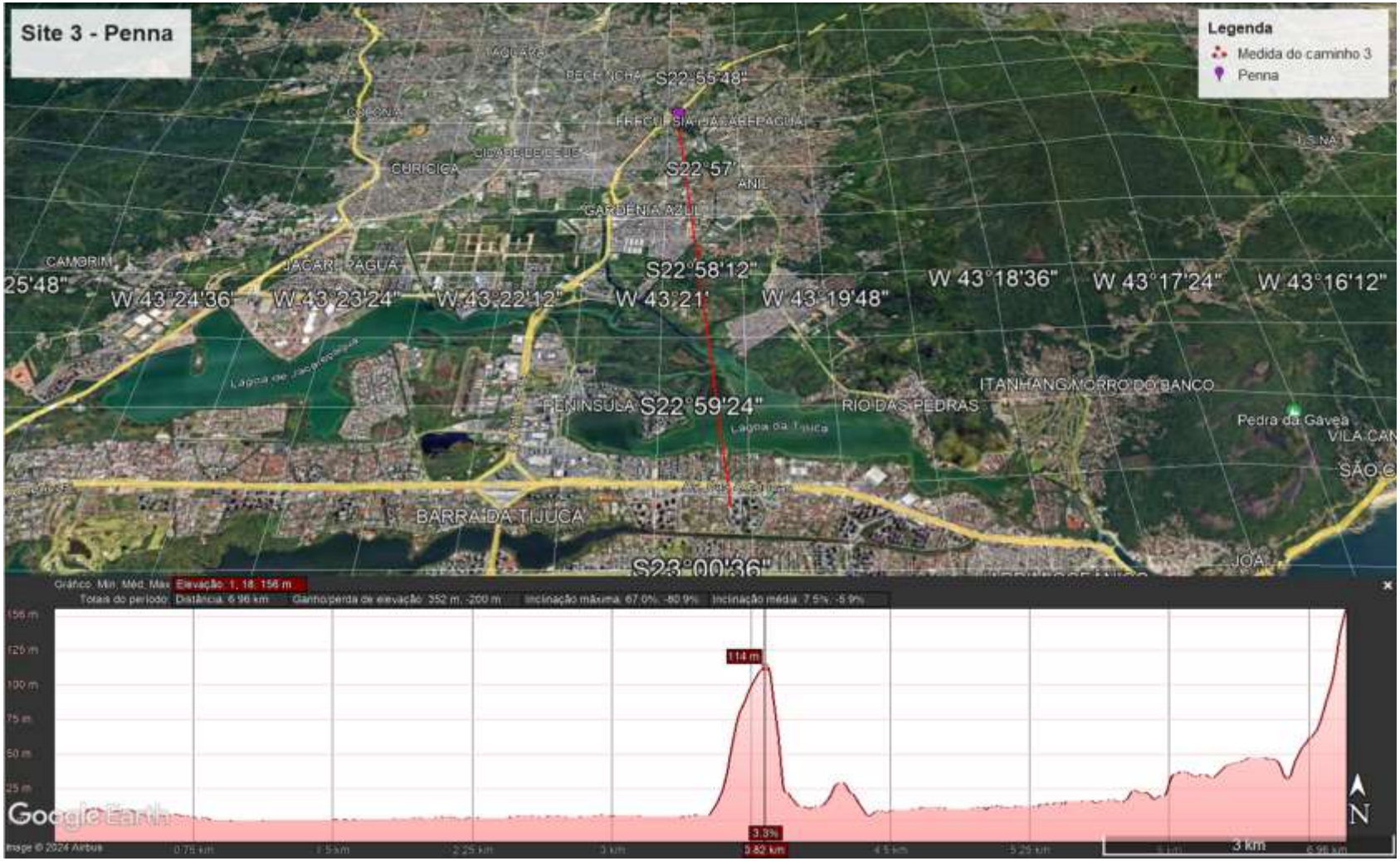


Figure 7.13 - Map showing the position of Site 3 relative to the Penna transmitter and the altitude profile of the path between these two points.

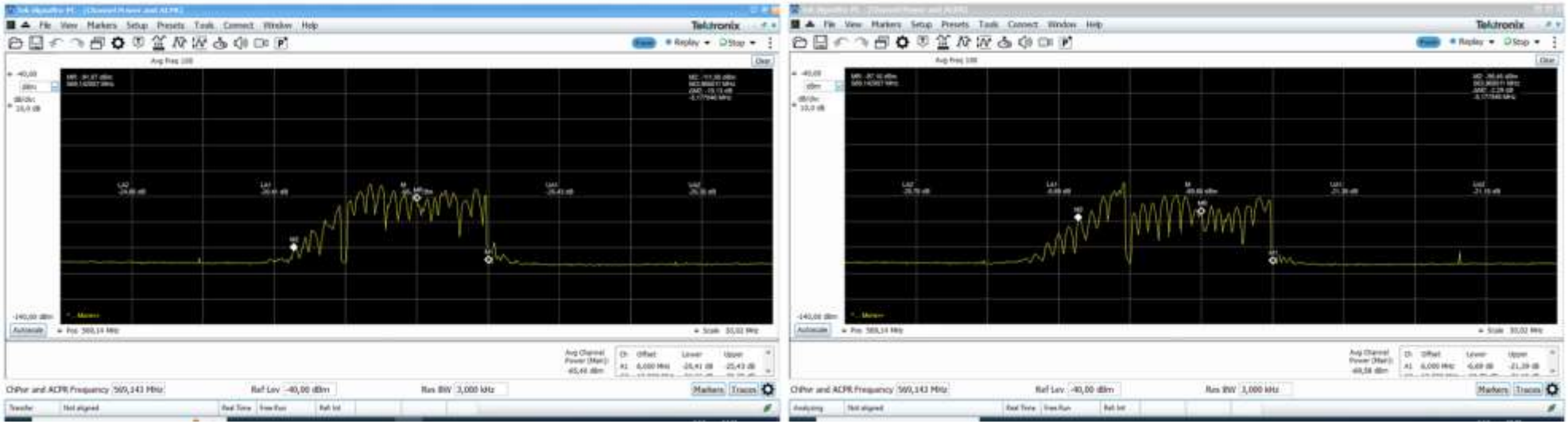


Figure 7.14 - Example of the received signal at Site 3.

b) Indoor

We performed measurements in the building next to the outdoor site on the seventh floor. The antenna was pointed to a wall near a closed window, as shown in Figure 7.15. The position was selected to maximize reception power. We observe approximately an increase of 5 dB on channel power, compared to the outdoor site, and an improvement on fading pattern, as shown in Figure 7.16. This increase is attributed to the much higher height than the outdoor point, with a view towards the antenna with less interference. This scenario compensates for the losses expected for an indoor scenario, when compared to an outdoor one.

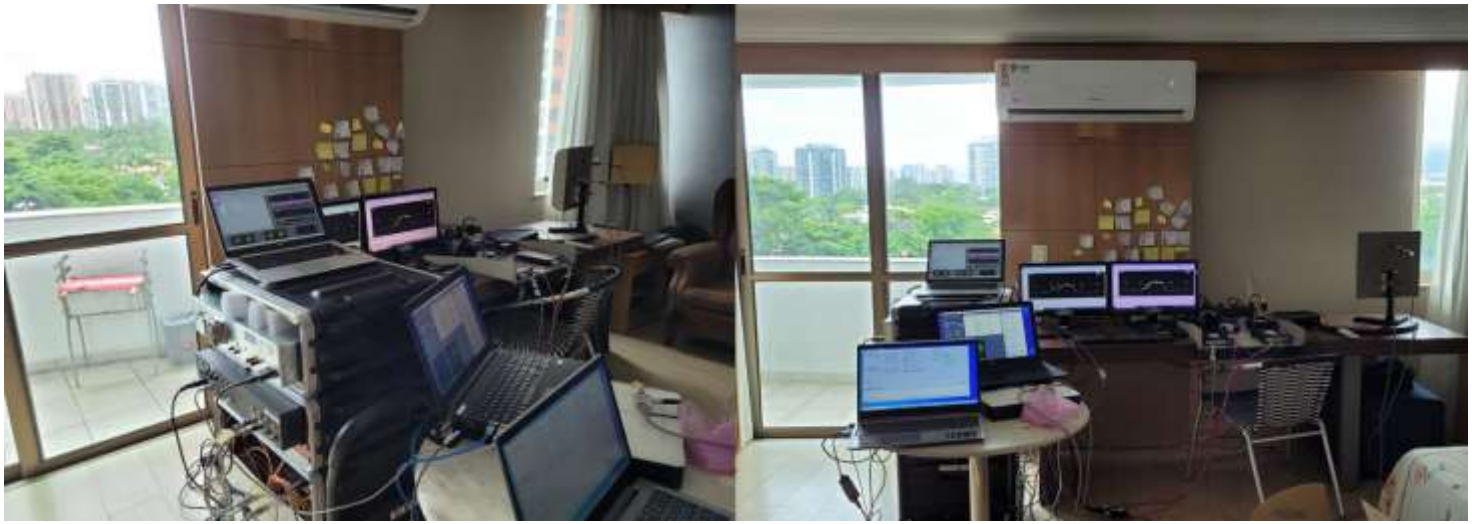


Figure 7.15 - Indoor area of Site 3, showing the antenna positioning.

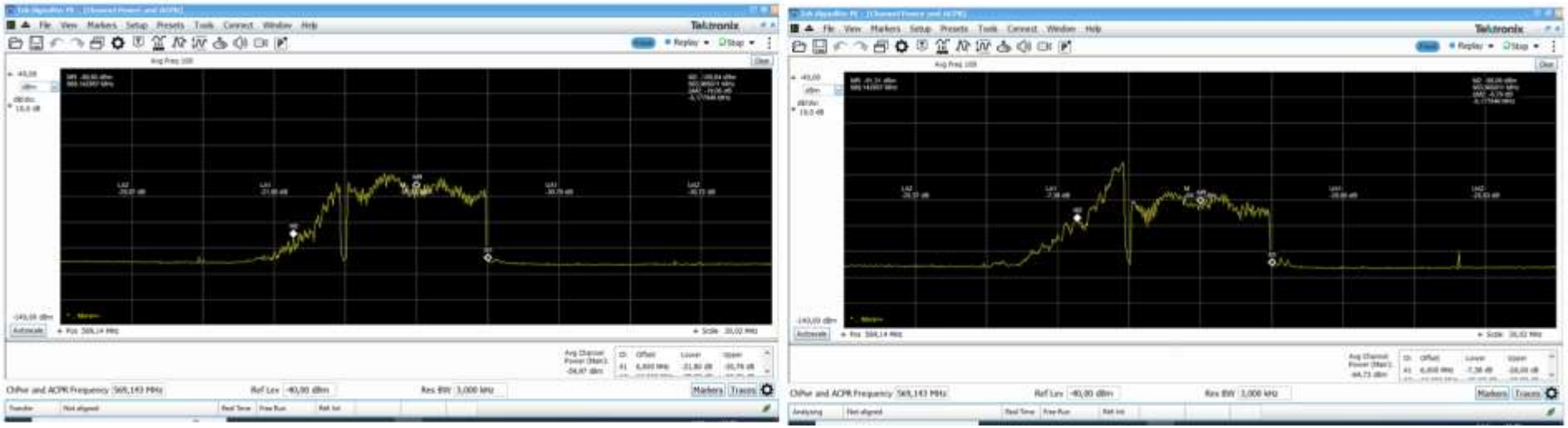


Figure 7.16 - Example of indoor received signal at Site 3.

7.2.1.4 Site 4

a) Outdoor

Table 7.9 - Site 4 outdoor profile.

Site Index	4 - Freeway supermarket
Geographic coordinates	22°59'51.16"S 43°20'10.63"O
Address	R. Mario Melo - Barra da Tijuca, Rio de Janeiro - RJ, 22640-100
Distance between TX and RX	6.5 km
Average power reception	Vertical polarization: -62 dBm Horizontal polarization: -63 dBm
Area description	Street with meager traffic, a little vegetation, and close to low buildings and Tijuca Lake, as shown in Figure 7.17.
Altitude profile	Transmission with mountain interference, and low impact on frequency fading selectivity, as shown in Figure 7.18.
Signal characterization	Good reception, with almost flat frequency fading, as shown in Figure 7.19.

Figure 7.17 - Area around Site 4, showing the positioning of the measurement van.

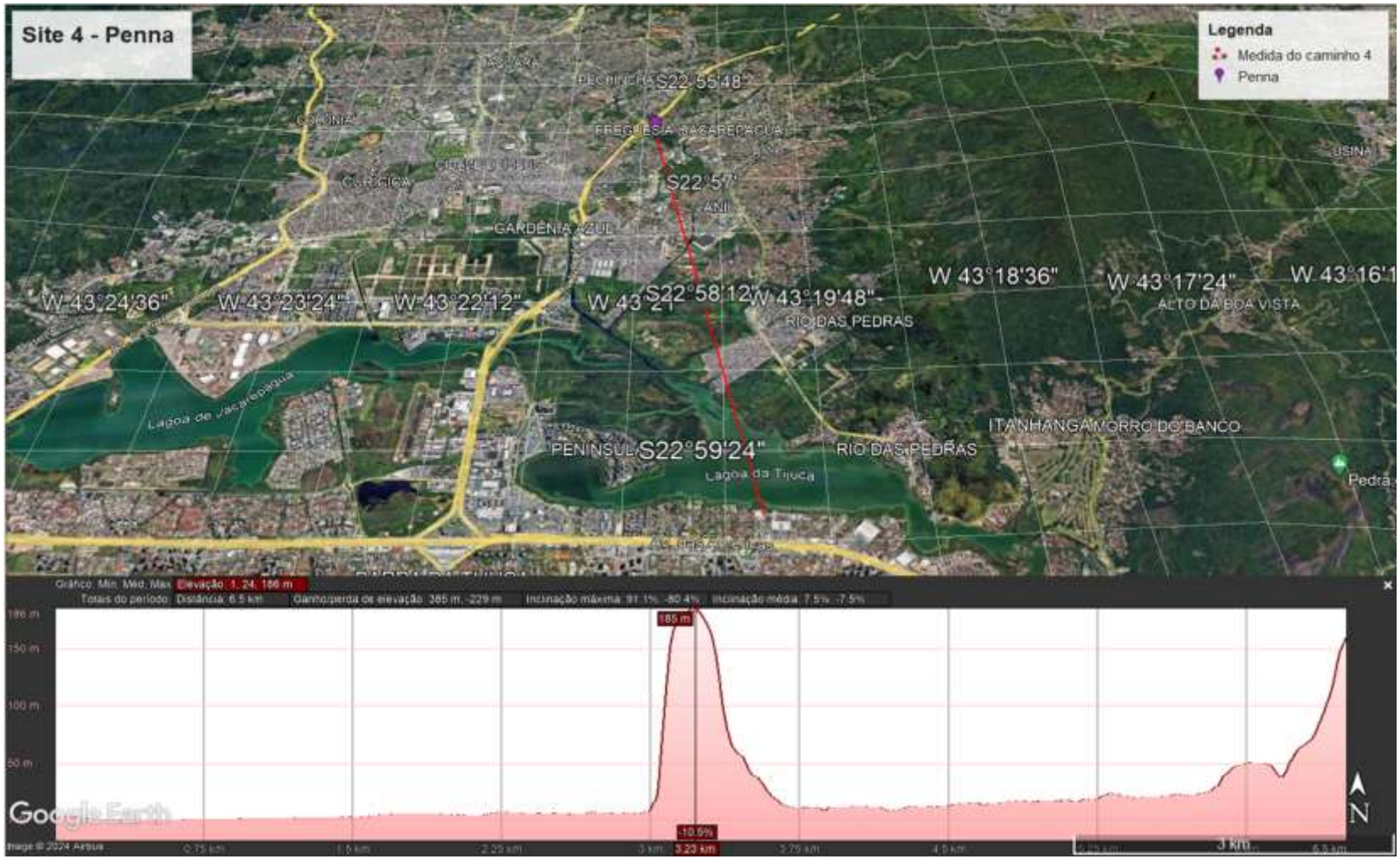


Figure 7.18 - Map showing the position of Site 4 relative to the Penna transmitter and the altitude profile of the path between these two points.

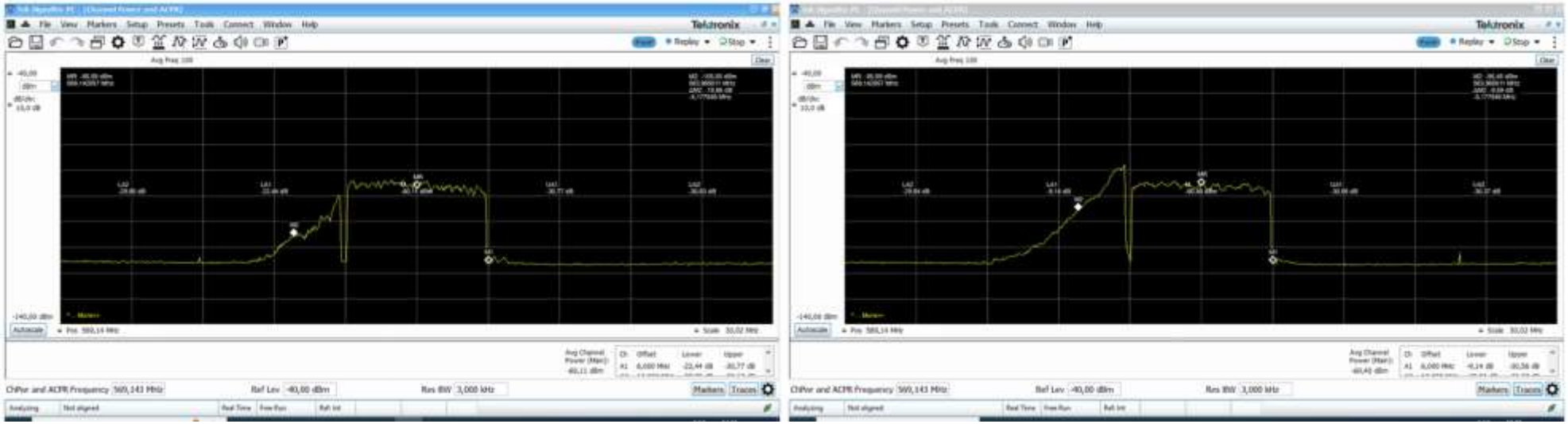


Figure 7.19 - Example of the received signal at Site 4.

7.2.1.5 Site 5

a) Outdoor

Table 7.10 - Site 5 outdoor profile.

Site Index	5 - Condomínio Blue Ship
Geographic coordinates	23° 0'5.01"S 43°20'49.79"O
Address	Av. Assis Chateaubriand, 301 - Barra da Tijuca, Rio de Janeiro - RJ, 22631-320
Distance between TX and RX	6.7 km
Average power reception	Vertical polarization: -58 dBm Horizontal polarization: -57 dBm
Area description	Street with meager traffic and a little vegetation, and close to a few buildings, as shown in Figure 7.20.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.21.
Signal characterization	Good reception, with almost flat frequency fading, as shown in Figure 7.22.

Figure 7.20 - Area around Site 5, showing the positioning of the measurement van.

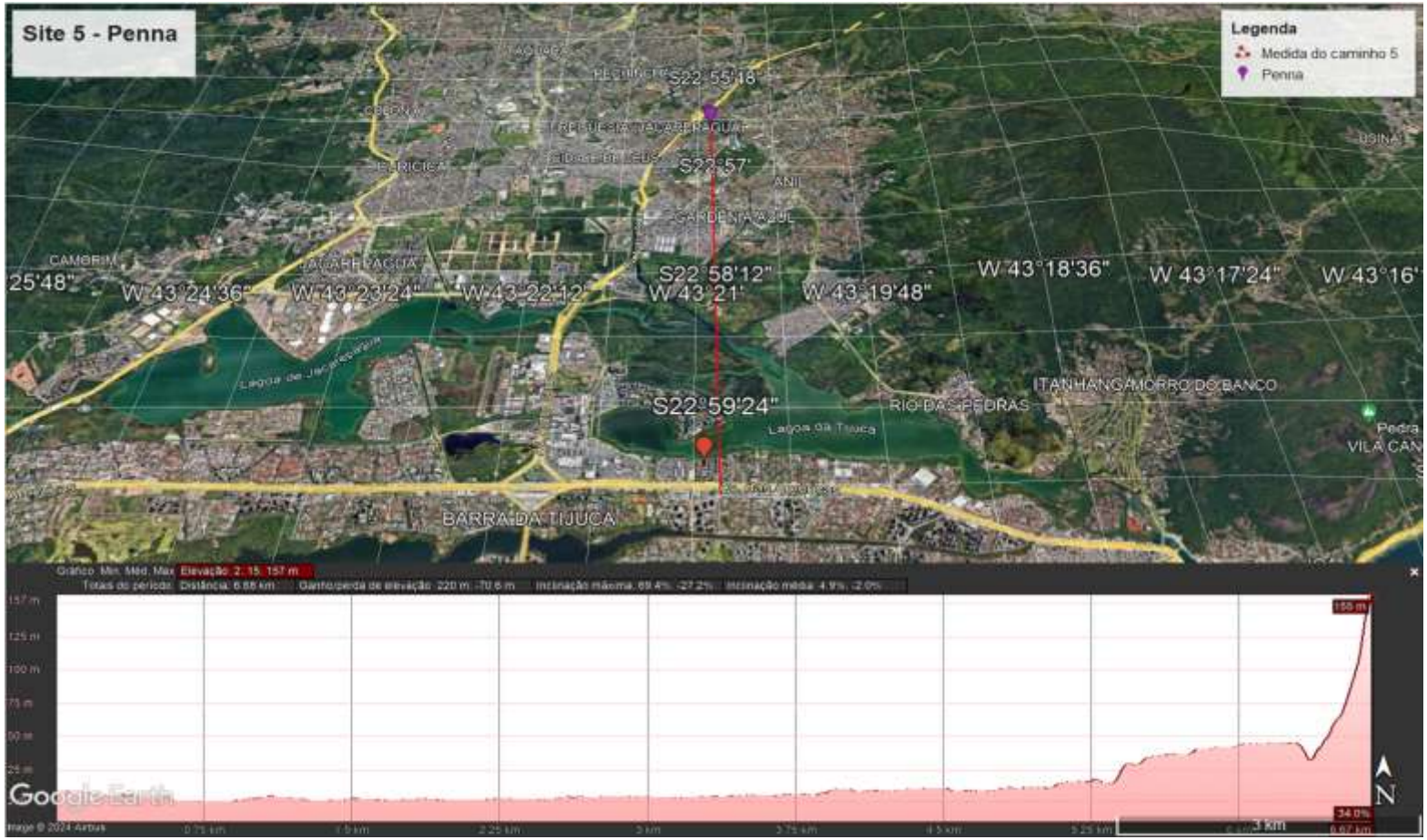


Figure 7.21 - Map showing the position of Site 5 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.22 - Example of the received signal at Site 5.

7.2.1.6 Site 6

a) Outdoor

Table 7.11 - Site 6 outdoor profile.

Site Index	6 – Fórum
Geographic coordinates	22°59'46"S 43°21'17"W
Address	Av. Luís Carlos Prestes - Barra da Tijuca, Rio de Janeiro - RJ, 22640-102
Distance between TX and RX	6.2 km
Average power reception	Vertical polarization: -65 dBm Horizontal polarization: -64 dBm
Area description	It is a street with meager traffic and little vegetation, close to Tijuca Lake, as shown in Figure 7.23.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.24.
Signal characterization	The signal has a good reception level but with selective frequency fading, as shown in Figure 7.25.

Figure 7.23 - Area around Site 6, showing the positioning of the measurement van.

Figure 7.24 - Map showing the position of Site 6 relative to the Penna transmitter and the altitude profile of the path between these two points.

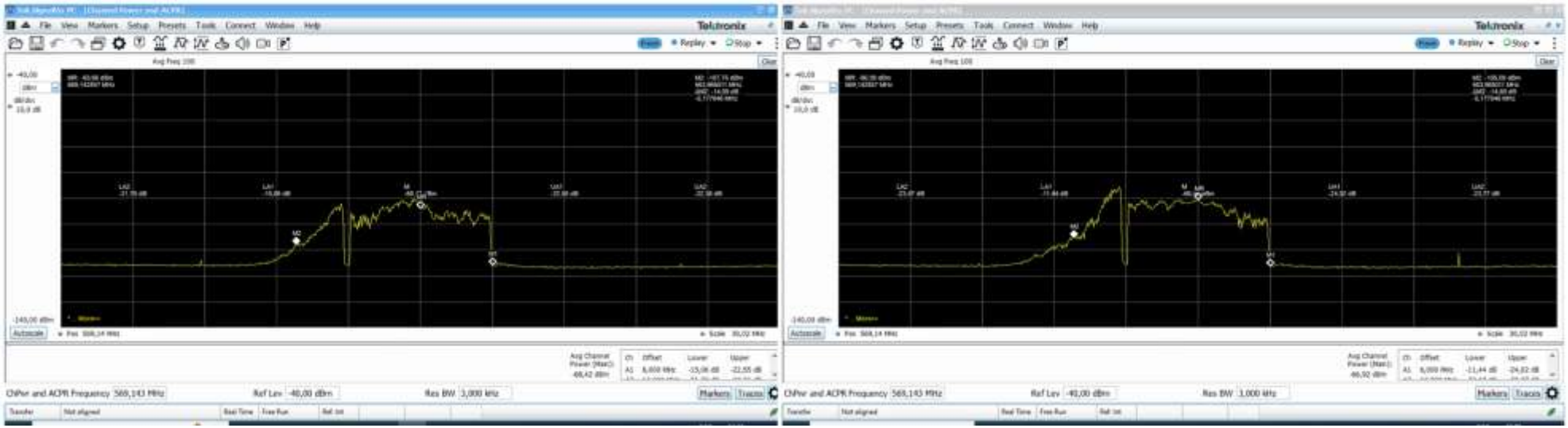


Figure 7.25 - Example of the received signal at Site 6.

7.2.1.7 Site 7

a) Outdoor

Table 7.12 - Site 7 outdoor profile.

Site Index	7 - Carrefour Supermarket
Geographic coordinates	22°59'47"S 43°21'54"W
Address	Av. das Américas, 5150 - Barra da Tijuca, Rio de Janeiro - RJ, 22640-102
Distance between TX and RX	6.5 km
Average power reception	Vertical polarization: -58 dBm Horizontal polarization: -55 dBm
Area description	The parking area is close to an avenue with high traffic, as shown in Figure 7.26.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.27.
Signal characterization	Signal with good reception level but with selective frequency fading in vertical polarization and flat frequency fading in horizontal polarization, as shown in Figure 7.28.

Figure 7.26 - Area around Site 7, showing the positioning of the measurement van.

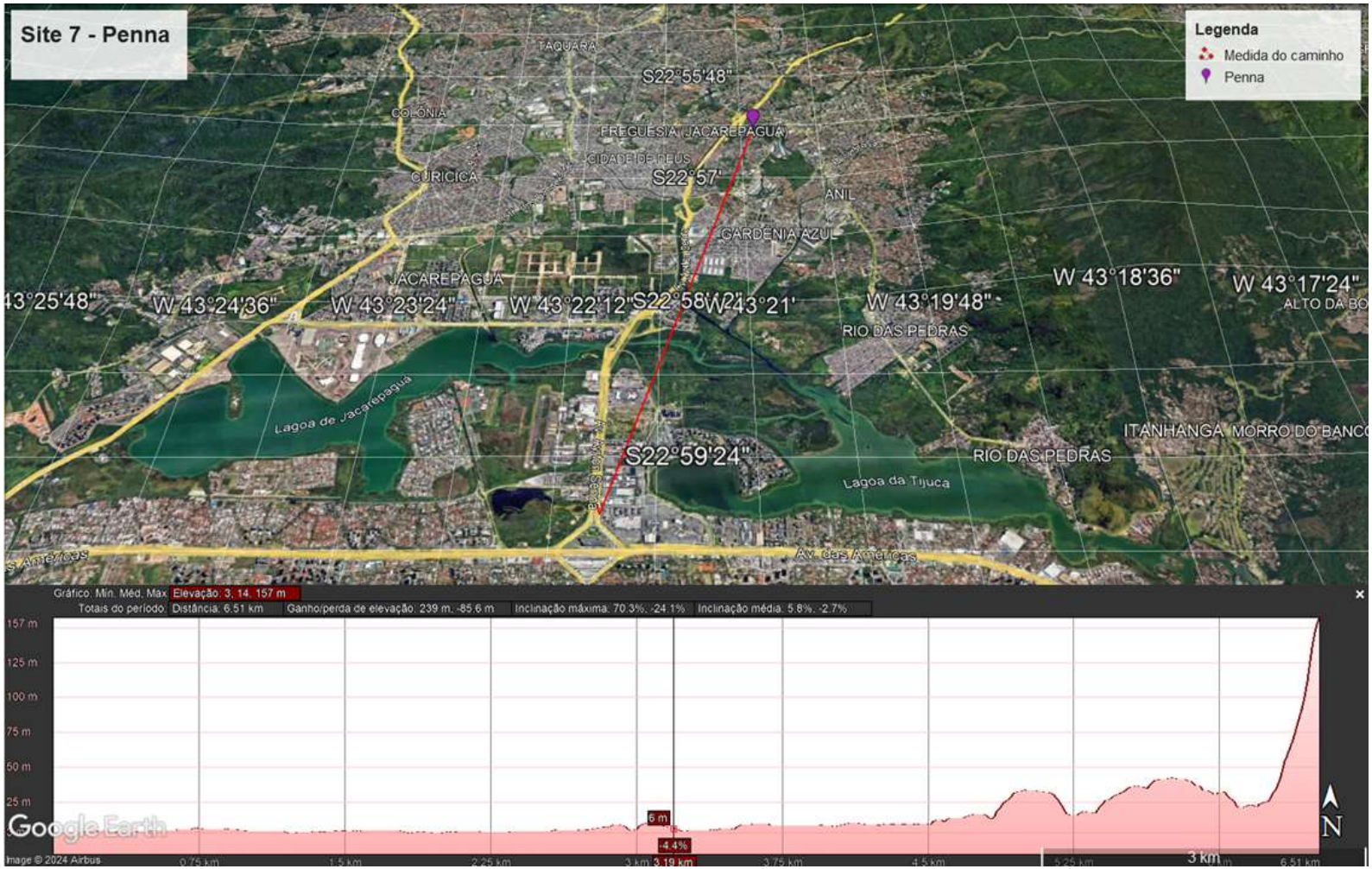


Figure 7.27 - Map showing the position of Site 7 relative to the Penna transmitter and the altitude profile of the path between these two points.

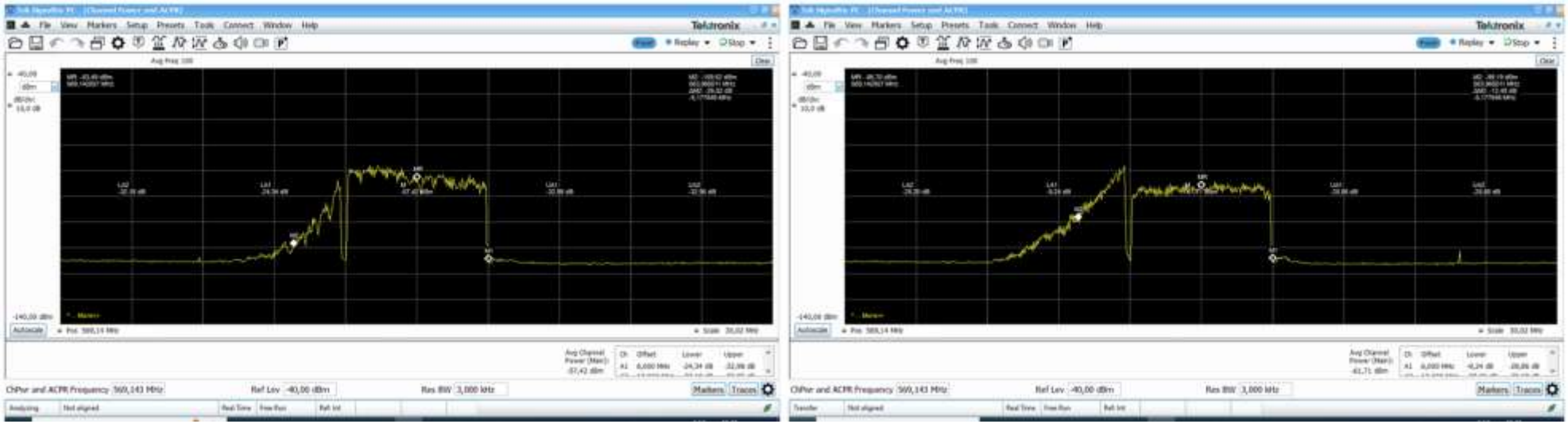


Figure 7.28 - Example of the received signal at Site 7.

7.2.1.8 Site 8

a) Outdoor

Table 7.13 - Site 8 outdoor profile.

Site Index	8 – CEO Business Building
Geographic coordinates	22°59'09"S 43°21'33"W
Address	Av. João Cabral de Mello Neto, 405 - Barra da Tijuca, Rio de Janeiro - RJ, 22775-057
Distance between TX and RX	5.1 km
Average power reception	Vertical polarization: -59 dBm Horizontal polarization: -58 dBm
Area description	Streets with low traffic, close to high buildings, and little vegetation are shown in Figure 7.29.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.30.
Signal characterization	The signal had a good reception level but was degraded with selective frequency fading, as shown in Figure 7.31.

Figure 7.29 - Area around Site 8, showing the positioning of the measurement van.

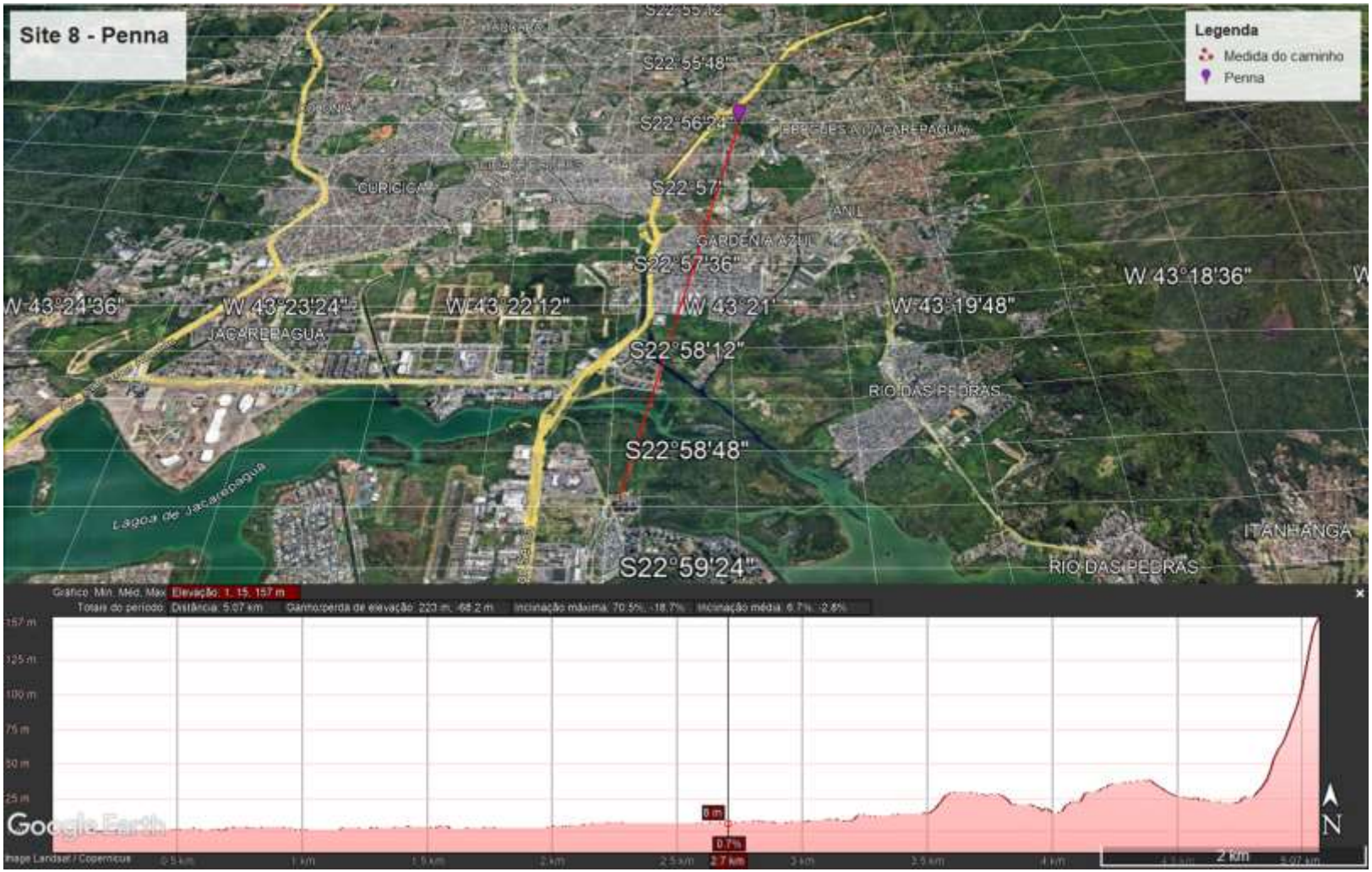


Figure 7.30 - Map showing the position of Site 8 relative to the Penna transmitter and the altitude profile of the path between these two points.

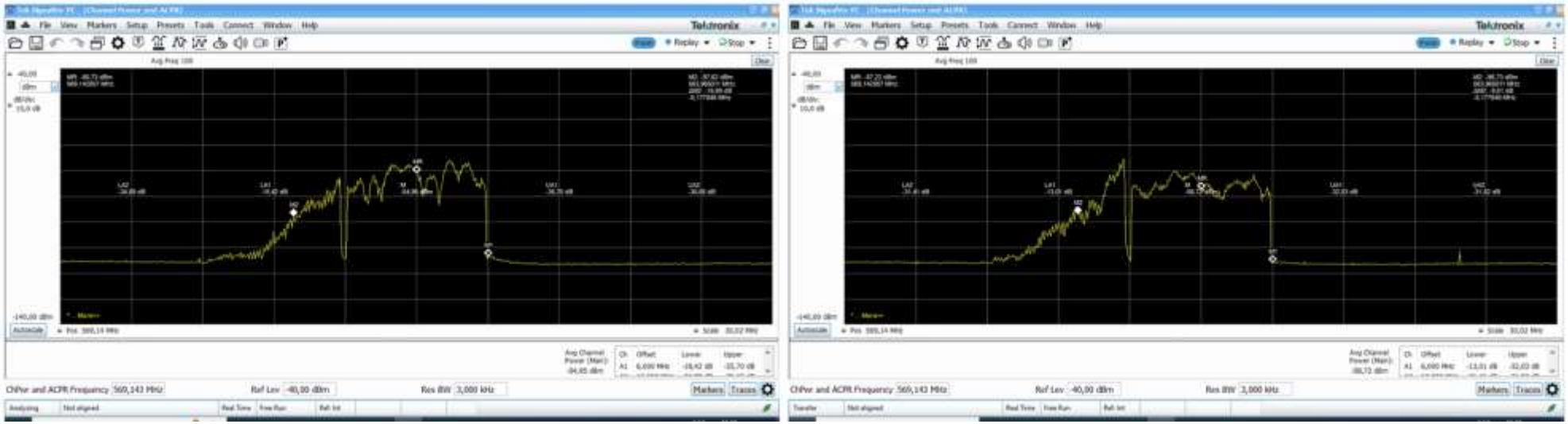


Figure 7.31 - Example of the received signal at Site 8.

7.2.1.9 Site 9

a) Outdoor

Table 7.14 - Site 9 outdoor profile.

Site Index	9 – Pan Village
Geographic coordinates	22°58'27"S 43°21'23"W
Address	Av. Projetada 3, Vila do Pan - Jacarepaguá, Rio de Janeiro - RJ, 22775-036
Distance between TX and RX	3.8 km
Average power reception	Vertical polarization: -37 dBm Horizontal polarization: -38 dBm
Area description	Street with low traffic and close to high buildings, a small canal, and little vegetation, as shown in Figure 7.32.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.33.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.34.

Figure 7.32 - Area around Site 9, showing the positioning of the measurement van.

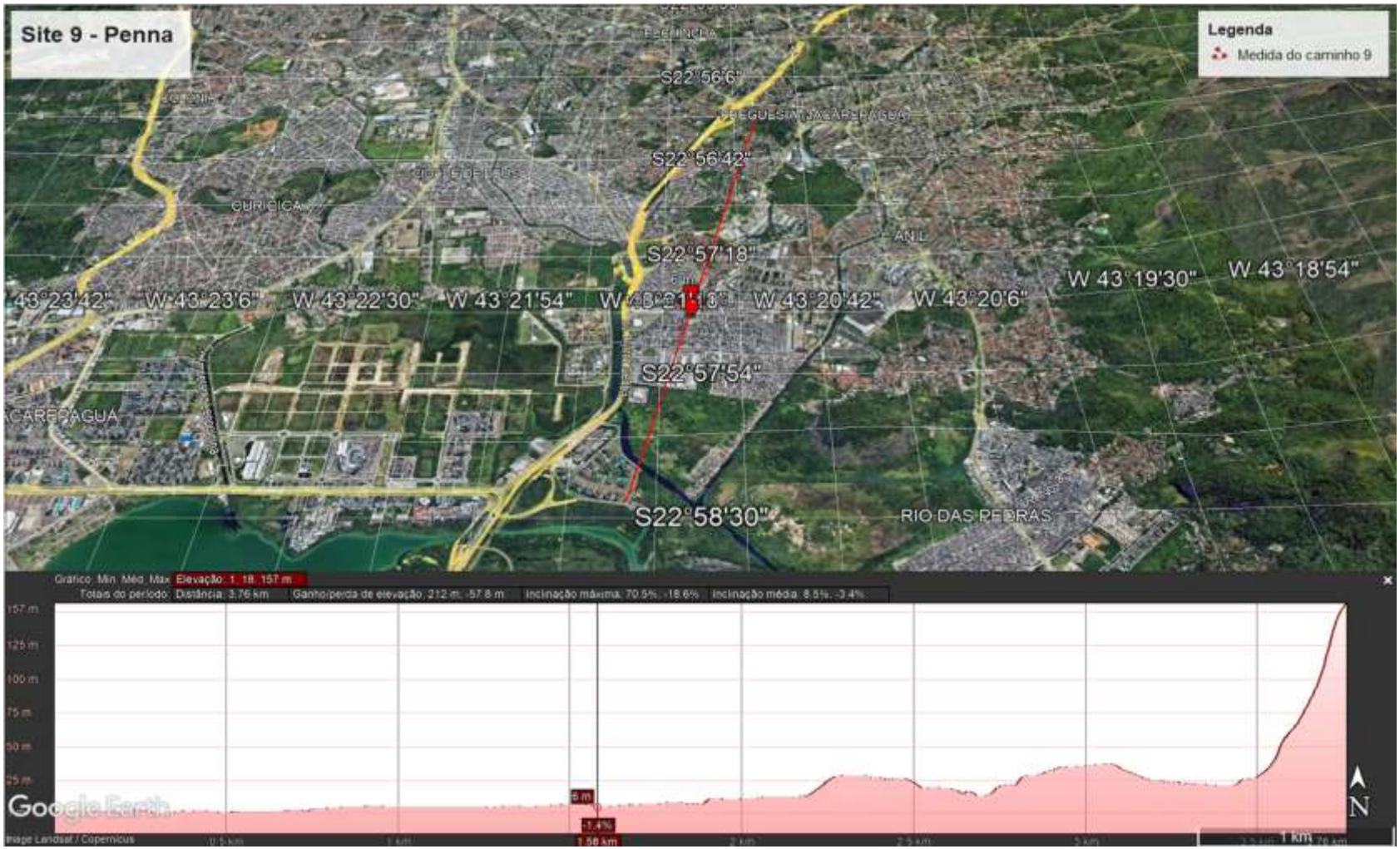


Figure 7.33 - Map showing the position of Site 9 relative to the Penna transmitter and the altitude profile of the path between these two points.

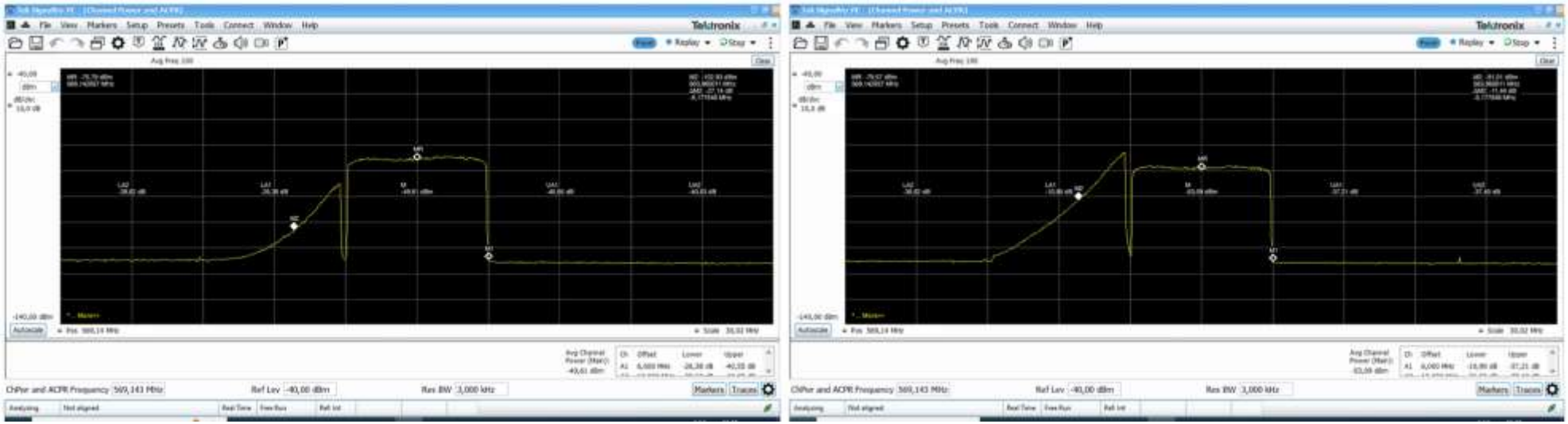


Figure 7.34 - Example of the received signal at Site 9, attenuated in 15 dB.

7.2.1.10 Site 10

a) Outdoor

Table 7.15 - Site 10 outdoor profile.

Site Index	10 – Assaí Atacadista Supermarket
Geographic coordinates	22°57'35"S 43°21'24"W
Address	Av. Ayrton Senna, 6000 - Jacarepaguá, Rio de Janeiro - RJ, 22775-005
Distance between TX and RX	2.2 km
Average power reception	Vertical polarization: -34 dBm Horizontal polarization: -35 dBm
Area description	Street with high traffic and close to high buildings, as shown in Figure 7.35.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.36.
Signal characterization	The signal has a good reception level but with selective frequency fading, as shown in Figure 7.37.

Figure 7.35 - Area around Site 10, showing the positioning of the measurement van.

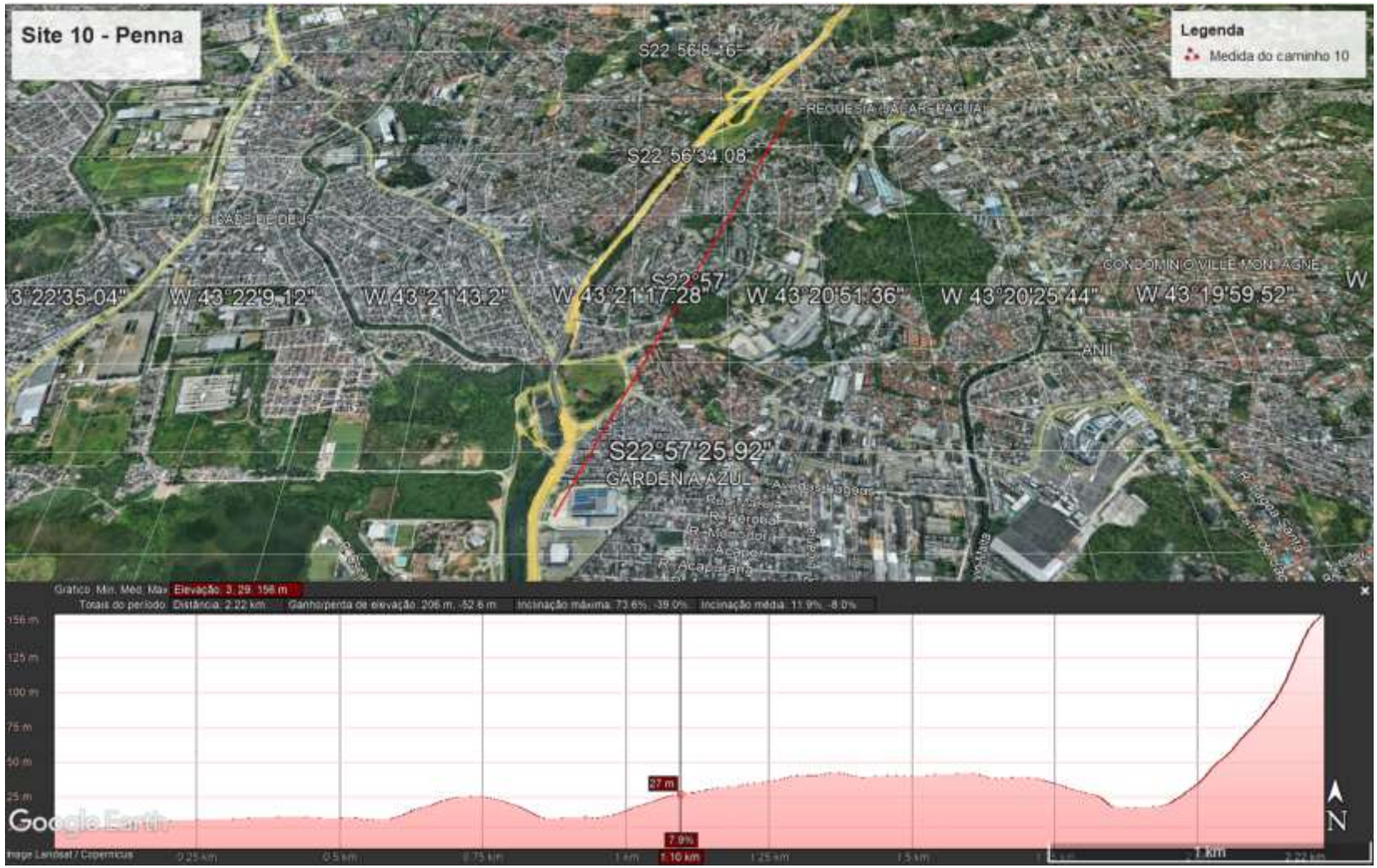


Figure 7.36 - Map showing the position of Site 10 relative to the Penna transmitter and the altitude profile of the path between these two points.

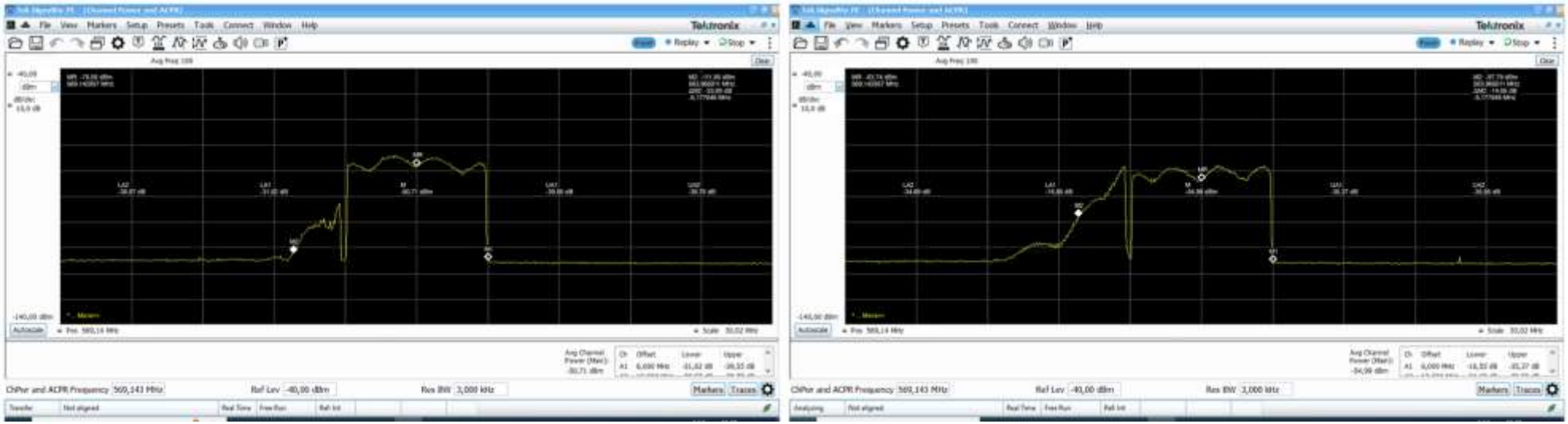


Figure 7.37 - Example of the received signal at Site 10, attenuated by 15 dB.

7.2.1.11 Site 11

a) Outdoor

Table 7.16 - Site 11 outdoor profile.

Site Index	11 – Cond. Worldwide Offices
Geographic coordinates	22°58'21"S 43°22'01"W
Address	Av. Almirante Júlio de Sá Bierrenbach - Jacarepaguá, Rio de Janeiro - RJ, 22775-022
Distance between TX and RX	4.0 km
Average power reception	Vertical polarization: -51 dBm Horizontal polarization: -51 dBm
Area description	Parking close to streets with high traffic and high buildings, as shown in Figure 7.38.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.39.
Signal characterization	Signal with good reception level, but degraded with selective frequency fading, as shown in Figure 7.40.

Figure 7.38 - Area around Site 11, showing the positioning of the measurement van.

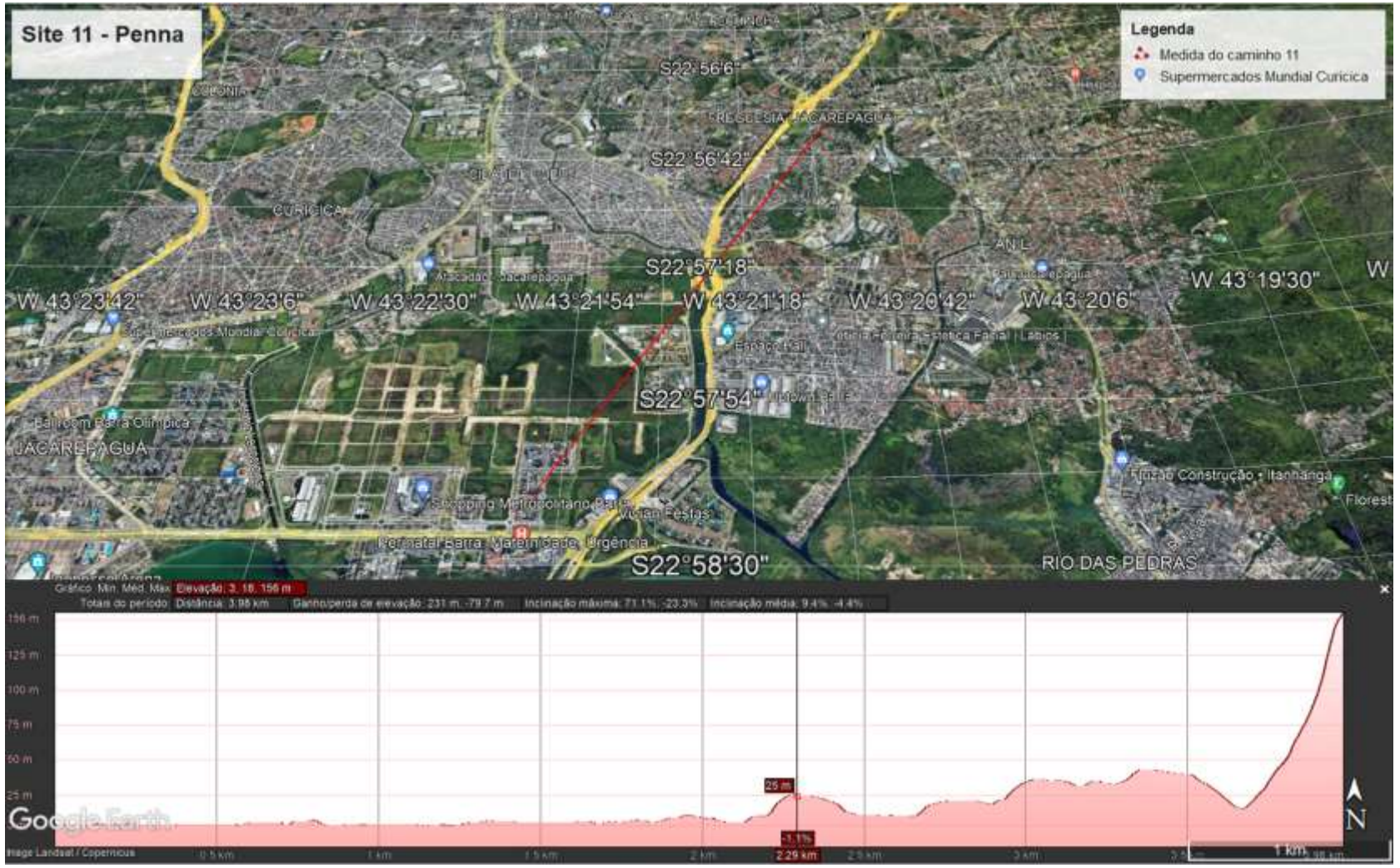


Figure 7.39 - Map showing the position of Site 11 relative to the Penna transmitter and the altitude profile of the path between these two points.

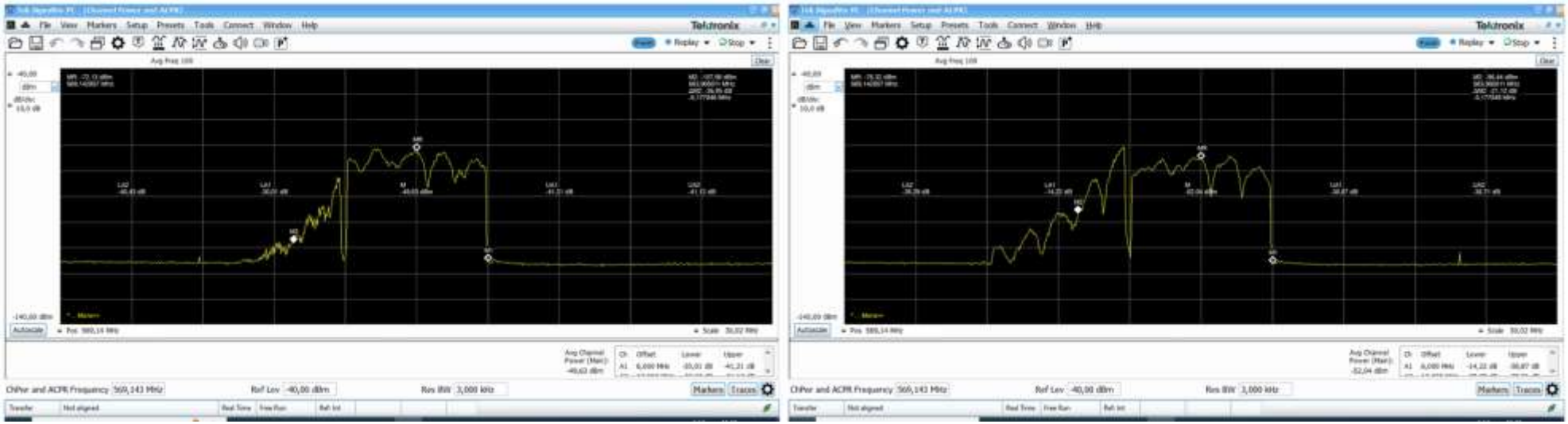


Figure 7.40 - Example of the received signal at Site 11.

7.2.1.12 Site 12

a) Outdoor

Table 7.17 - Site 12 outdoor profile.

Site Index	12 – SARA Hospital
Geographic coordinates	22°58'09"S 43°22'45"W
Address	Av. José Wilker, Jacarepaguá, Rio de Janeiro – RJ
Distance between TX and RX	4.5 km
Average power reception	Vertical polarization: -41 dBm Horizontal polarization: -41 dBm
Area description	Street with low traffic and little vegetation, as shown in Figure 7.41.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.42.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.43.

Figure 7.41 - Area around Site 12, showing the positioning of the measurement van.

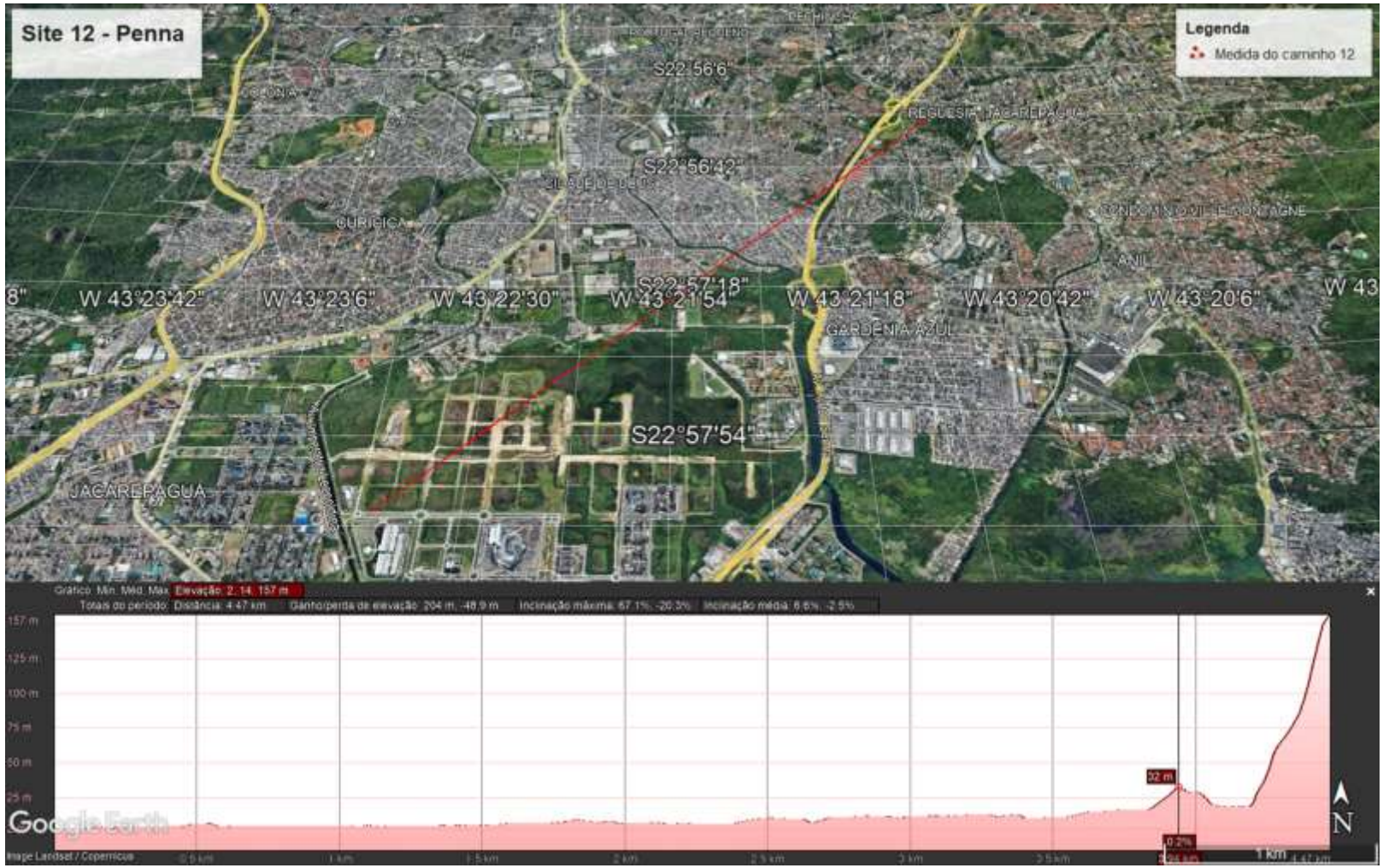


Figure 7.42 - Map showing the position of Site 12 relative to the Penna transmitter and the altitude profile of the path between these two points.

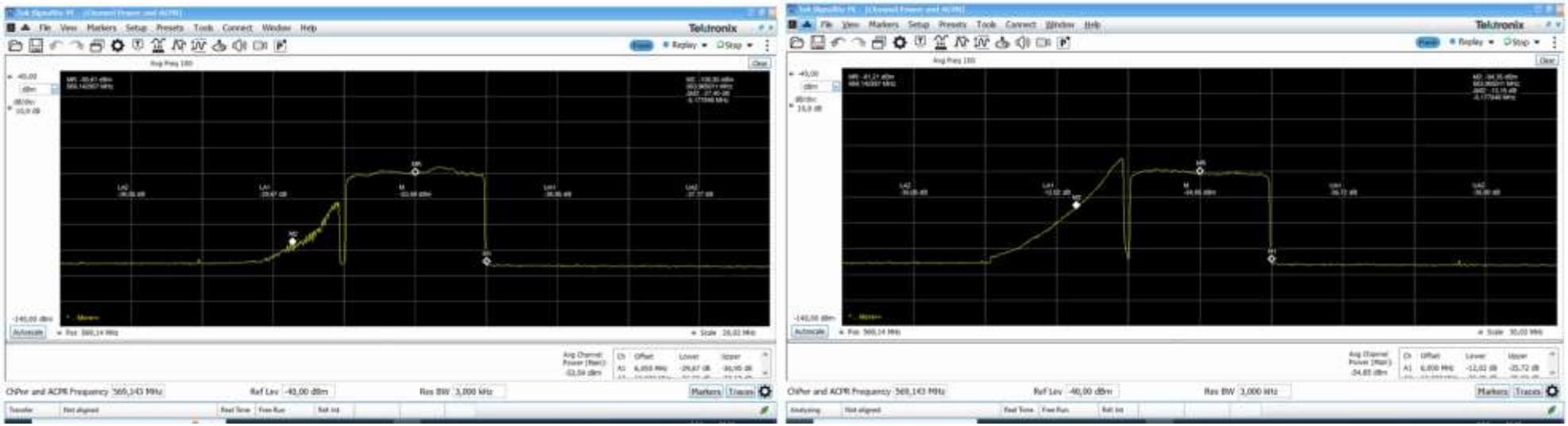


Figure 7.43 - Example of the received signal at Site 12, attenuated by 15 dB.

7.2.1.13 Site 13

a) Outdoor

Table 7.18 - Site 13 outdoor profile.

Site Index	13 – Cond. Cidade Jardim
Geographic coordinates	22°57'56"S 43°23'20"W
Address	Av. Vice Pres. José Alencar, 7 - Jacarepaguá, Rio de Janeiro - RJ, 22775-033
Distance between TX and RX	5.0 km
Average power reception	Vertical polarization: -62 dBm Horizontal polarization: -62 dBm
Area description	Street with low traffic and little vegetation, close to high buildings, as shown in Figure 7.44.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.45.
Signal characterization	Signal with good reception level, with selective frequency fading, as shown in Figure 7.46.

Figure 7.44 - Area around Site 13, showing the positioning of the measurement van.

Figure 7.45 - Map showing the position of Site 13 relative to the Penna transmitter and the altitude profile of the path between these two points.

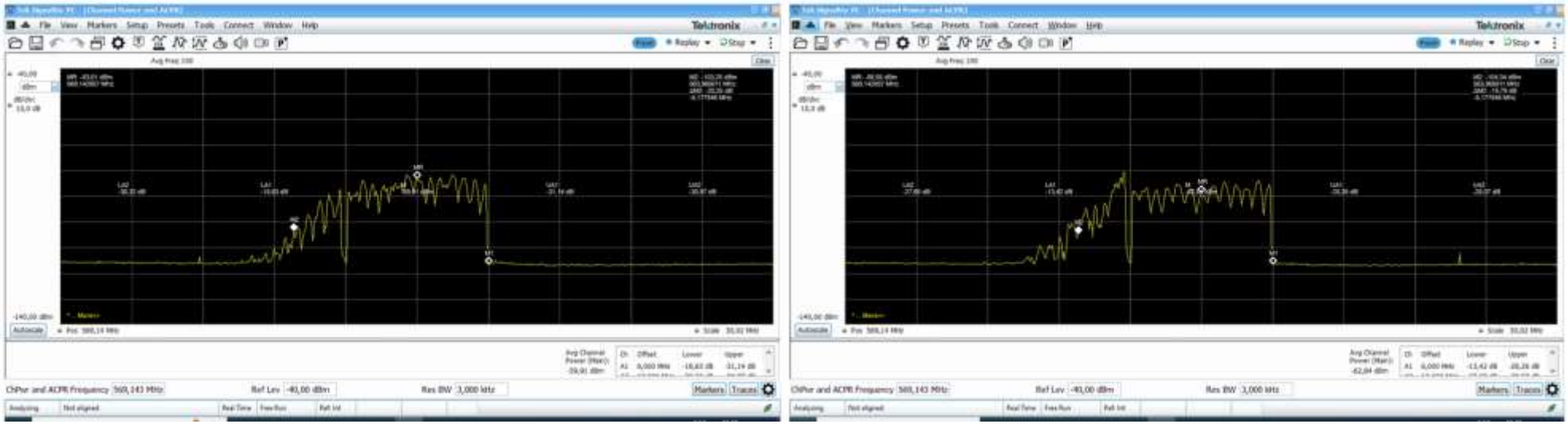


Figure 7.46 - Example of the received signal at Site 13.

7.2.1.14 Site 14

a) Outdoor

Table 7.19 - Site 14 outdoor profile.

Site Index	14 – Barra Forest
Geographic coordinates	22°59'57"S 43°22'19"W
Address	Av. das Américas, 6000 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-080
Distance between TX and RX	6.9 km
Average power reception	Vertical polarization: -44 dBm Horizontal polarization: -43 dBm
Area description	Parking of the forest, close to vegetation and a few low buildings, as shown in Figure 7.47.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.48.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.49.

Figure 7.47 - Area around Site 14, showing the positioning of the measurement van.

Figure 7.48 - Map showing the position of Site 14 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.49 - Example of the received signal at Site 14, attenuated by 15 dB.

7.2.1.15 Site 15

a) Outdoor

Table 7.20 - Site 15 outdoor profile.

Site Index	15 – Olympic City
Geographic coordinates	22°58'25"S 43°24'03"W
Address	Av. Embaixador Abelardo Bueno, 5001 - Barra da Tijuca, Rio de Janeiro - RJ, 22775-039
Distance between TX and RX	6.5 km
Average power reception	Vertical polarization: 61 dBm Horizontal polarization: 63 dBm
Area description	Parking of the Olympic City, close to some buildings and an avenue with a lot of traffic, as shown in Figure 7.50.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.51.
Signal characterization	Signal with good reception level, with flat frequency fading, but with some degradation on the vertical polarization, as shown in Figure 7.52.

Figure 7.50 - Area around Site 15, showing the positioning of the measurement van.

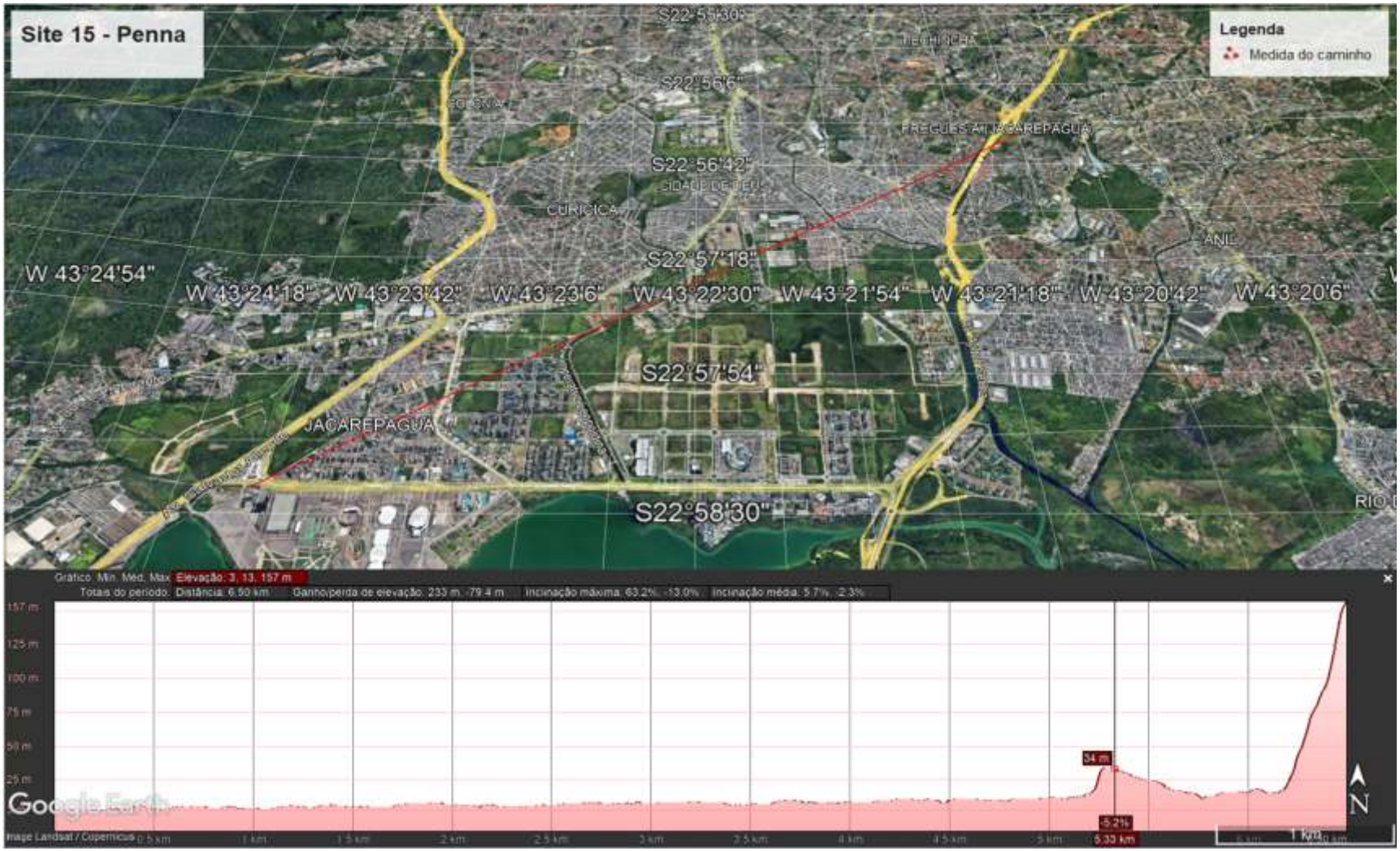


Figure 7.51 - Map showing the position of Site 15 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.52 - Example of the received signal at Site 15.

7.2.1.16 Site 16

a) Outdoor

Table 7.21 - Site 16 outdoor profile.

Site Index	16 – Globo Studios
Geographic coordinates	22°57'42"S 43°24'16"W
Address	Estr. de Curicica, 192-204 - Curicica, Rio de Janeiro - RJ, 22710-560
Distance between TX and RX	6.2 km
Average power reception	Vertical polarization: -52 dBm Horizontal polarization: -51 dBm
Area description	Wide parking area, close to low buildings and vegetation area, as shown in Figure 7.53.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.54.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.55.

Figure 7.53 - Area around Site 16, showing the positioning of the measurement van.

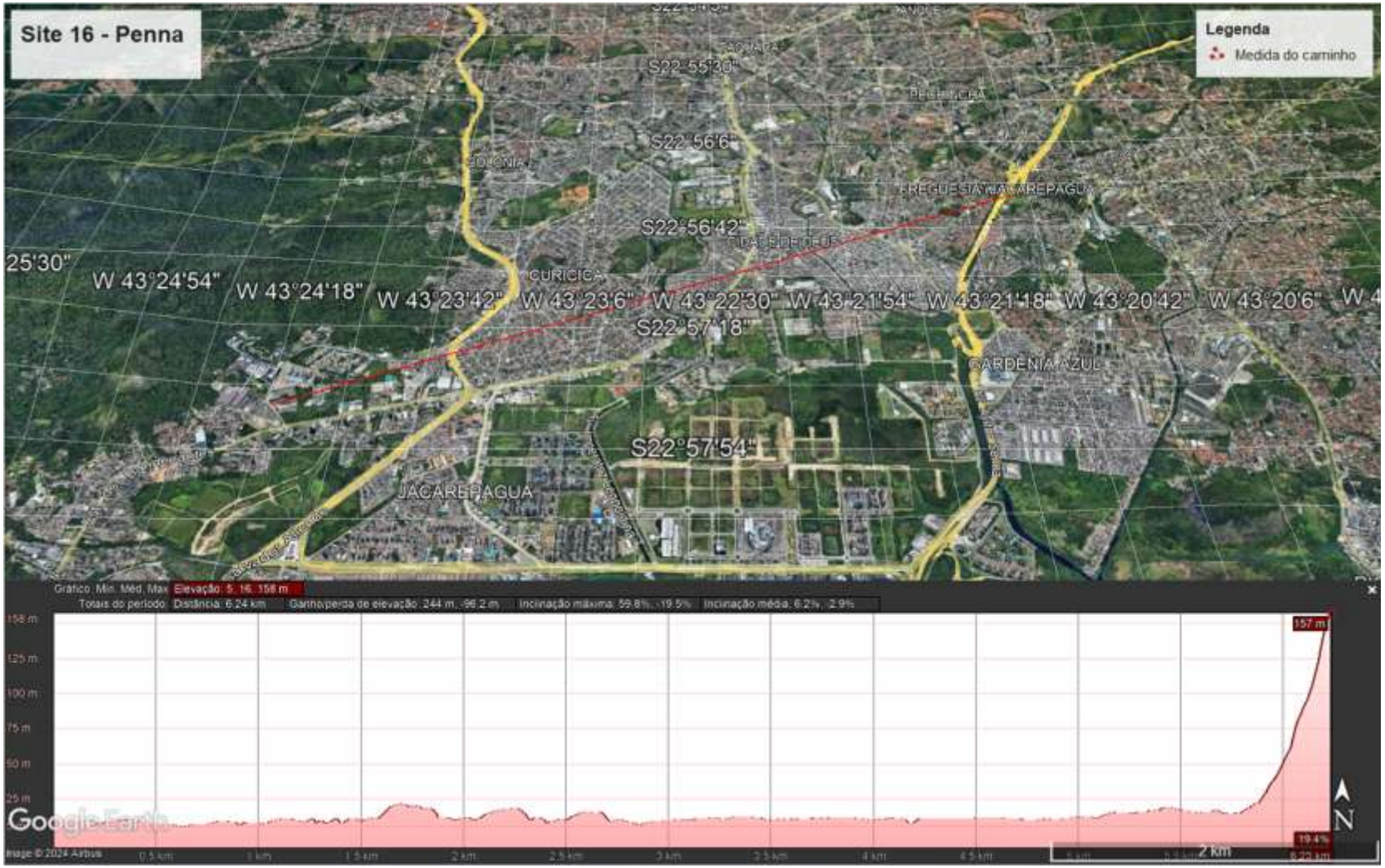


Figure 7.54 - Map showing the position of Site 16 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.55 - Example of the received signal at Site 16, attenuated by 15 dB.

7.2.1.17 Site 17

a) Outdoor

Table 7.22 - Site 17 outdoor profile.

Site Index	17 – Vicente Januzzi School
Geographic coordinates	22°59'57"S 43°22'31"W
Address	Av. das Américas, Nº 6120 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-080
Distance between TX and RX	7.0 km
Average power reception	Vertical polarization: -43 dBm Horizontal polarization: -43 dBm
Area description	Street with low traffic, close to low buildings, as shown in Figure 7.56.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.57.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.58. This site has an approximate 16 dB reception power difference between Penna and Sumaré transmitters. Hence, it was selected for the frequency reuse-1 test.

Figure 7.56 - Area around Site 17, showing the positioning of the measurement van.

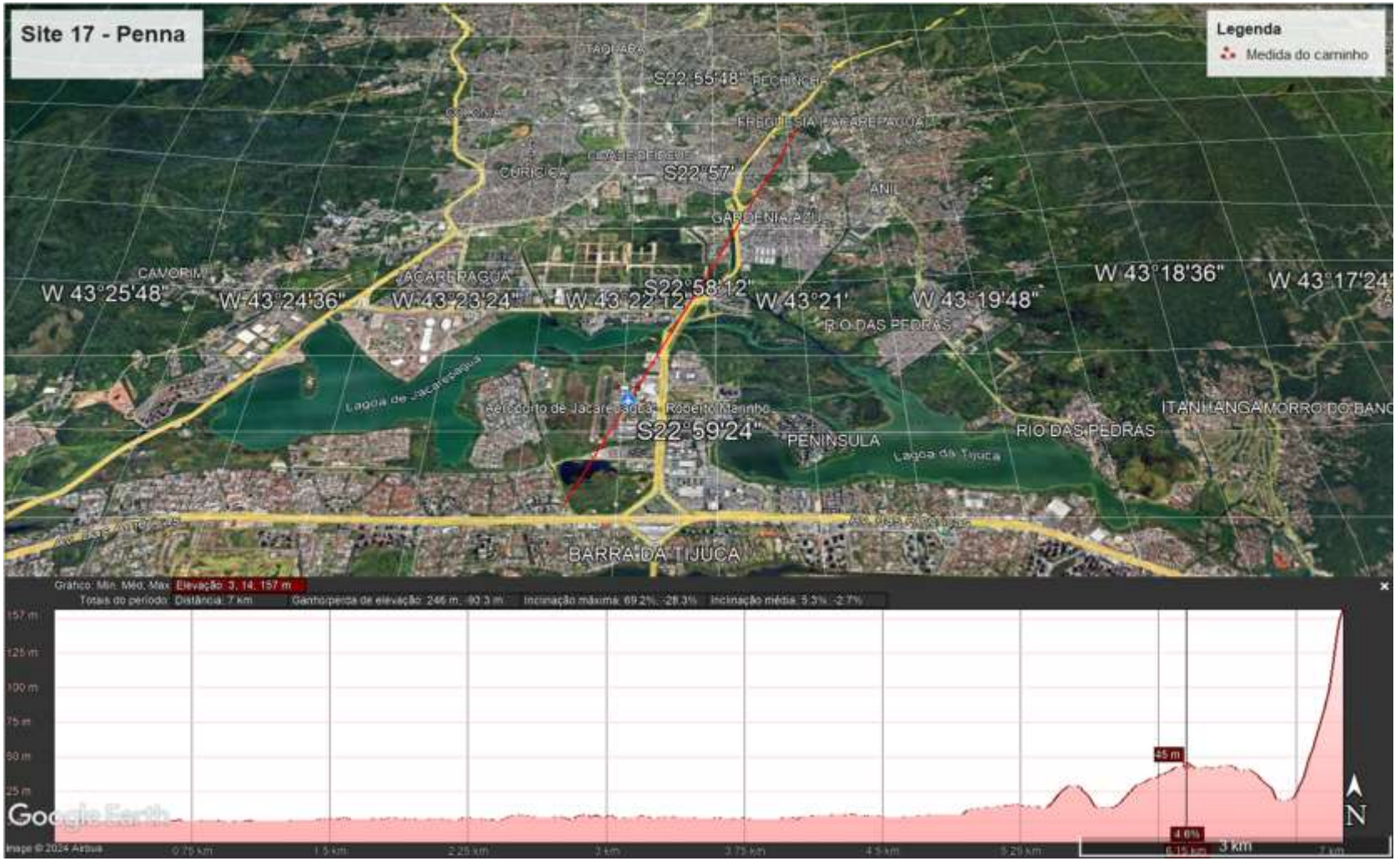


Figure 7.57 - Map showing the position of Site 17 relative to the Penna transmitter and the altitude profile of the path between these two points.

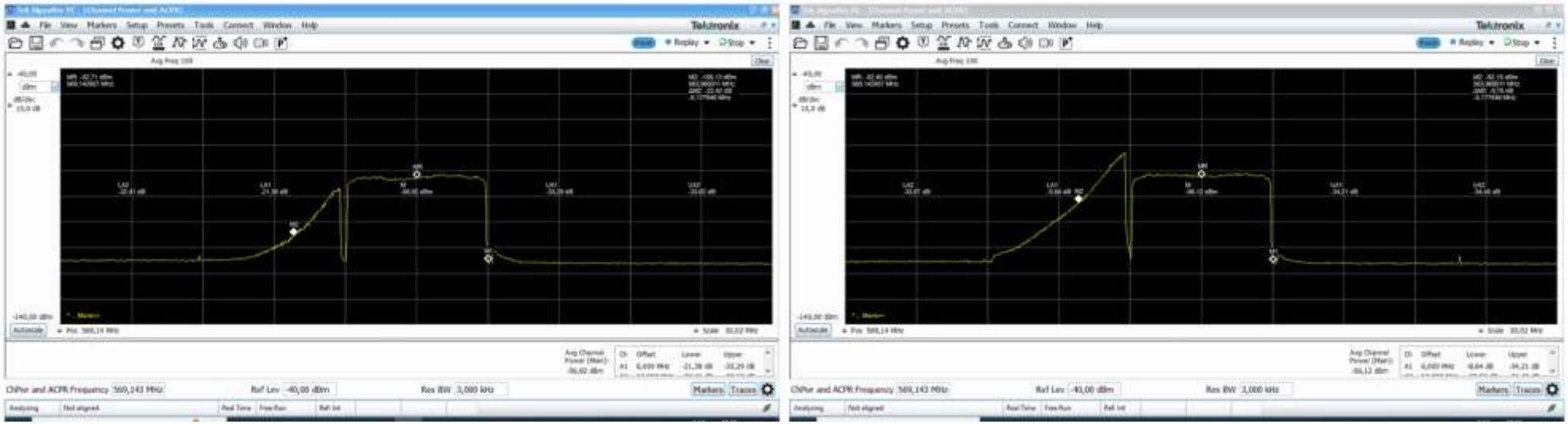


Figure 7.58 - Example of received signal at Site 17, attenuated by 15 dB.

b) Indoor

We performed measurements in the building next to the outdoor site, on the ground floor. The antenna was pointed to a wall and was near a window, as shown in Figure 7.59. The position was selected to maximize reception power. We observe an average decrease of 27 dB on channel power, compared to the outdoor site, and a similar fading pattern, as shown in Figure 7.60.

Figure 7.59 - Indoor area of Site 17, showing the antenna positioning.

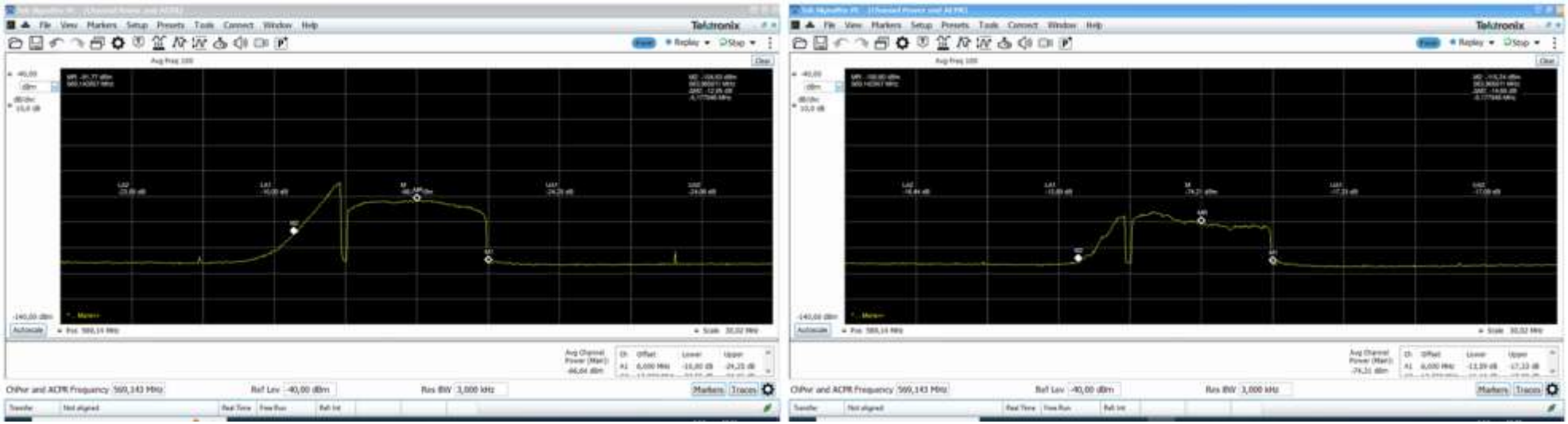


Figure 7.60 - Example of indoor received signal at Site 17.

7.2.1.18 Site 18

a) Outdoor

Table 7.23 - Site 18 outdoor profile.

Site Index	18 – Cond. Barra Tower
Geographic coordinates	23°00'03"S 43°23'38"W
Address	Av. das Américas, 8445 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-081
Distance between TX and RX	8.1 km
Average power reception	Vertical polarization: -64 dBm Horizontal polarization: -52 dBm
Area description	Street with low traffic, close to high buildings, as shown in Figure 7.61.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.62.
Signal characterization	Signal with good reception level, but with selective frequency fading, as shown in Figure 7.63. This site has approximately the same reception power from Penna and Sumaré transmitters. Hence, it was selected for the frequency reuse-1 test.

Figure 7.61 - Area around Site 18, showing the positioning of the measurement van.

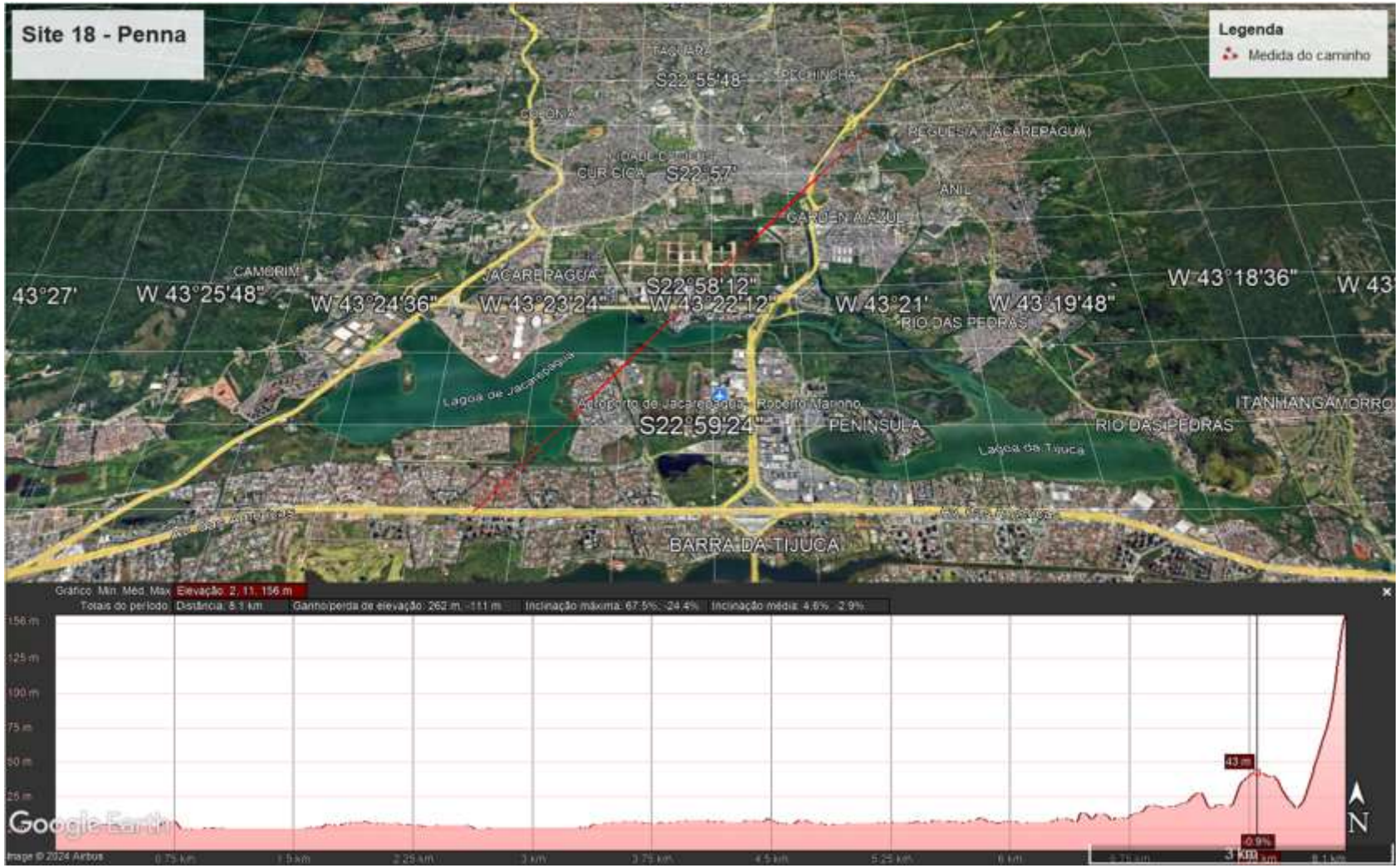


Figure 7.62 - Map showing the position of Site 18 relative to the Penna transmitter and the altitude profile of the path between these two points.

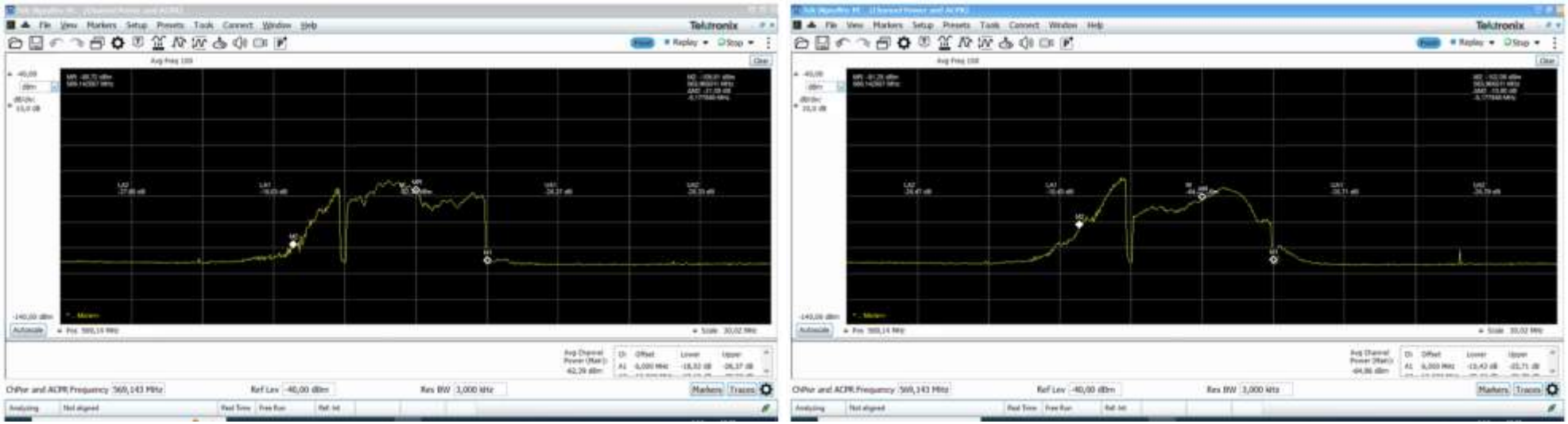


Figure 7.63 - Example of the indoor received signal at Site 18.

b) Indoor

We performed measurements in the building next to the outdoor site, on the terrace, on the fifteenth floor. The antenna was on the floor pointed to a hallway, as shown in Figure 7.64. The position was selected to maximize reception power. We observe a 6 dB decrease in channel power in vertical polarization and a 17 dB decrease in horizontal polarization compared to the outdoor site. We also note an improvement in the fading pattern, as shown in Figure 7.65. These changes are attributed to the much higher height than the outdoor point and the antenna opening area surrounded by walls.

Figure 7.64 - Indoor area of Site 18, showing the antenna positioning.

Figure 7.65 - Example of the indoor received signal at Site 18.

7.2.1.19 Site 19

a) Outdoor

Table 7.24 - Site 19 outdoor profile.

Site Index	19 - Fiat Italia store
Geographic coordinates	23°00'03"S 43°24'59"W
Address	Av. das Américas, 10605 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-082
Distance between TX and RX	9.6 km
Average power reception	Vertical polarization: -47 dBm Horizontal polarization: -47 dBm
Area description	Avenue with high traffic and close to buildings, as shown in Figure 7.66.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.67.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.68. This site has an approximate 16 dB reception power difference between Penna and Sumaré transmitters. Hence, it was selected for the frequency reuse-1 test.

Figure 7.66 - Area around Site 19, showing the positioning of the measurement van.

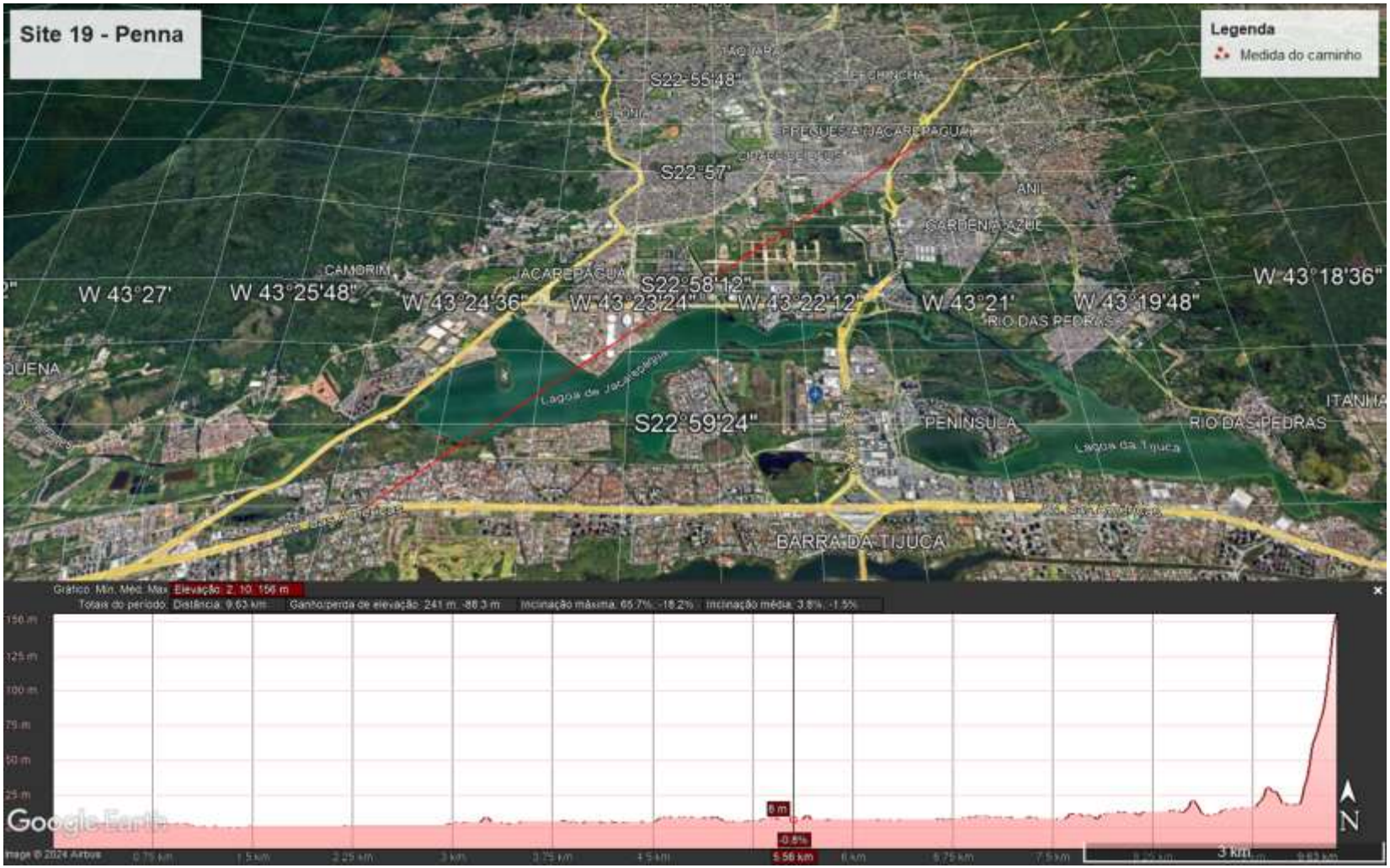


Figure 7.67 - Map showing the position of Site 19 relative to the Penna transmitter and the altitude profile of the path between these two points.

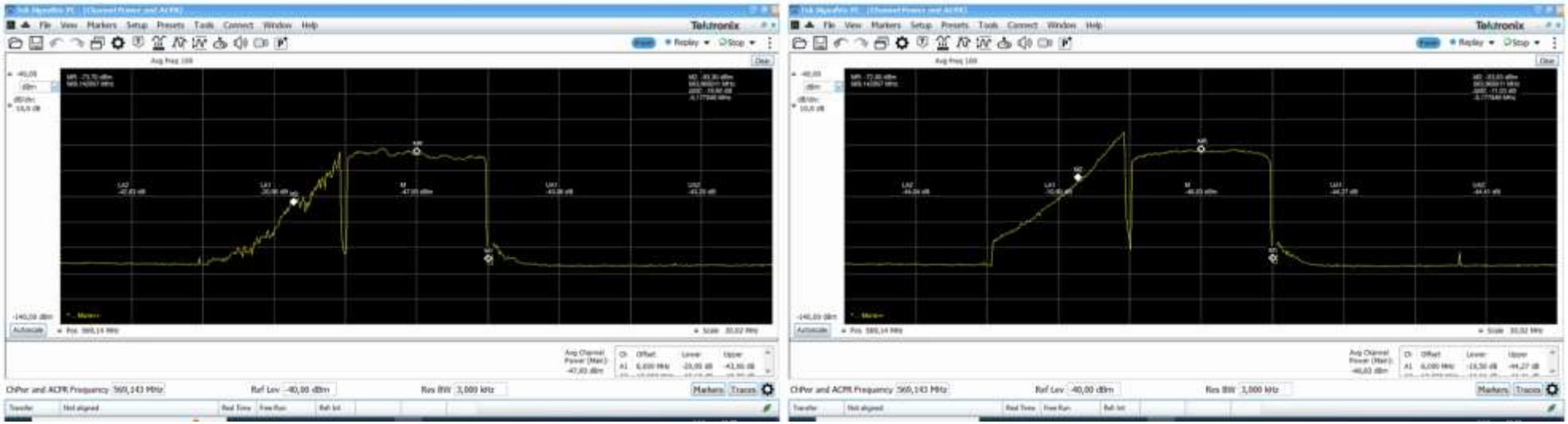


Figure 7.68 - Example of the received signal at Site 19.

7.2.1.20 Site 20

a) Outdoor

Table 7.25 - Site 20 outdoor profile.

Site Index	20 - Collaborator Apartment
Geographic coordinates	23°00'08"S 43°22'37"W
Address	Rua Ataulpho Coutinho, 80 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-520
Distance between TX and RX	7.4 km
Average power reception	Vertical polarization: -42 dBm Horizontal polarization: -42 dBm
Area description	Parking in a street with low traffic, with buildings and close to a square, as shown in Figure 7.69.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.70.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.71.

Figure 7.69 - Area around Site 20, showing the positioning of the measurement van.

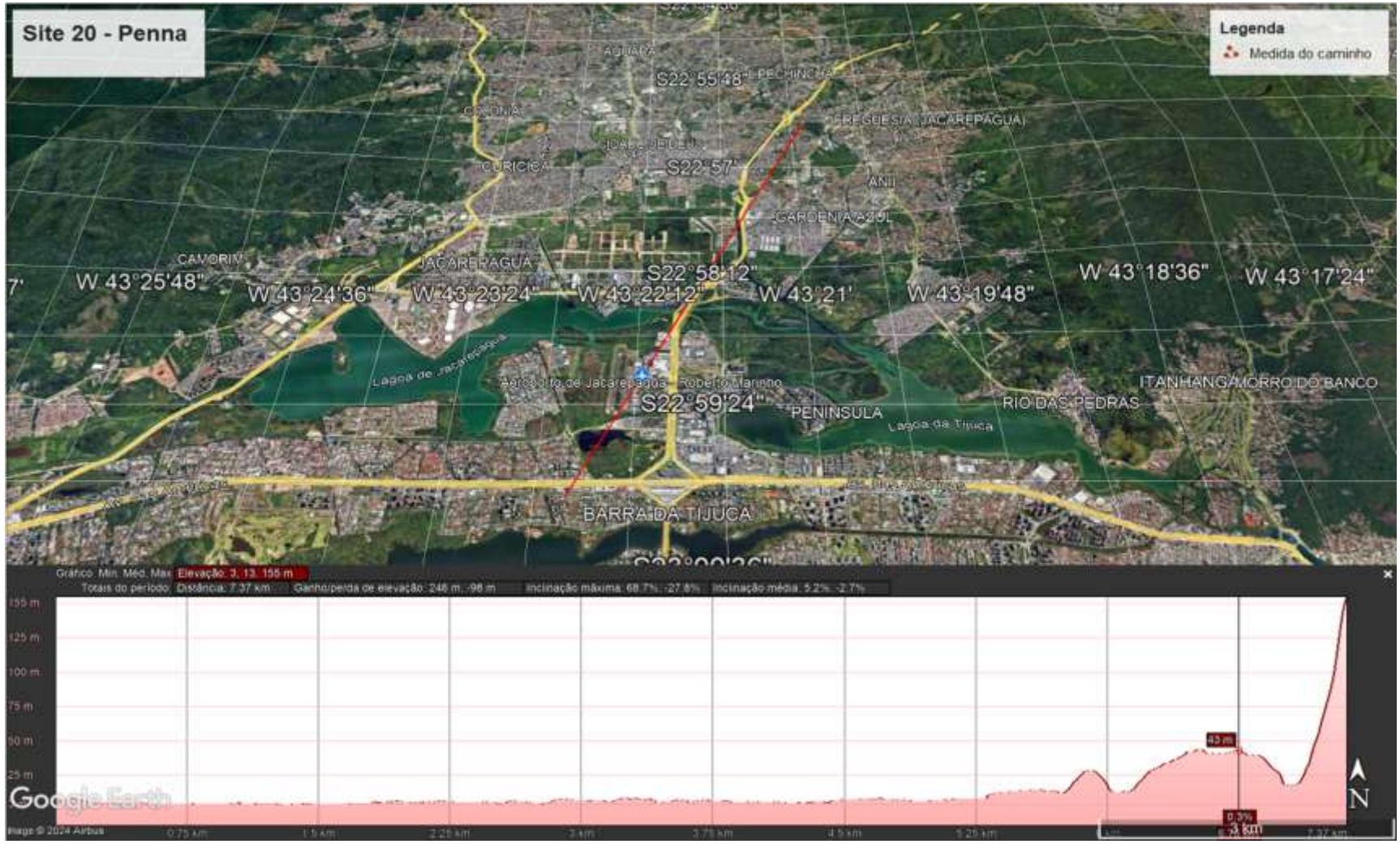


Figure 7.70 - Map showing the position of Site 20 relative to the Penna transmitter and the altitude profile of the path between these two points.

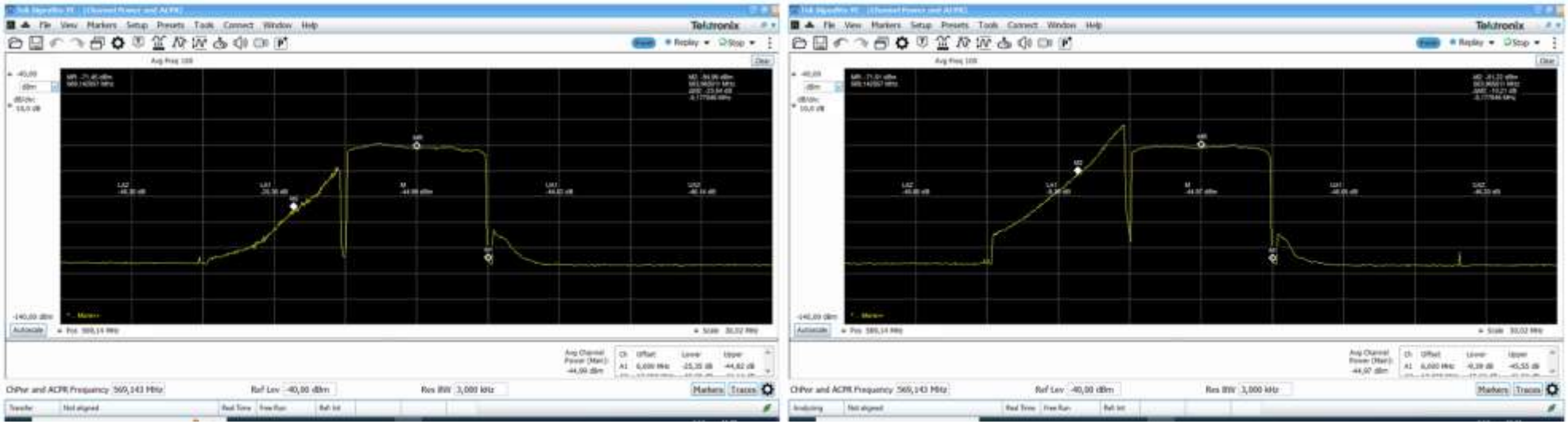


Figure 7.71 - Example of the received signal at Site 20, attenuated by 3 dB.

b) Indoor

We performed measurements in the building next to the outdoor site on the sixth floor. The antenna was pointed to a window, as shown in Figure 7.72. The position was selected to maximize reception power. We observe a loss of 10 dB on channel power compared to the outdoor site and a similar fading pattern, as shown in Figure 7.73.

Figure 7.72 - Indoor area of Site 20, showing the antenna positioning.

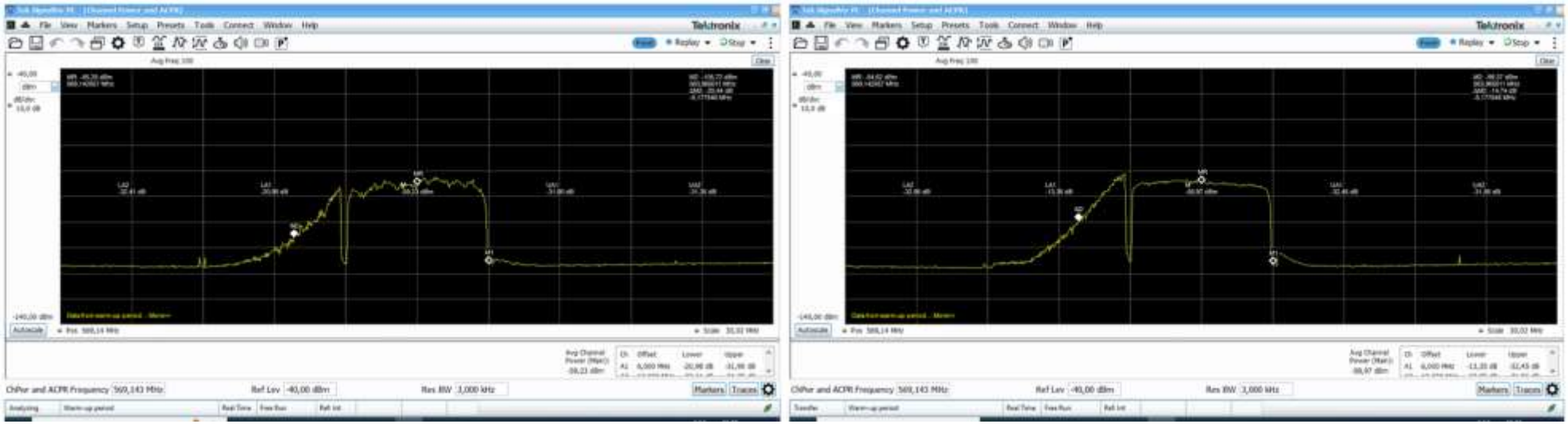


Figure 7.73 - Example of the indoor received signal at Site 20.

7.2.1.21 Site 21

a) Outdoor

Table 7.26 - Site 21 outdoor profile.

Site Index	21 - Saint Mark's Church
Geographic coordinates	23°00'27"S 43°25'42"W
Address	Condomínio Barra Sul - Praça São Marcos, 10 - Barra da Tijuca, Rio de Janeiro - RJ, 22793-360
Distance between TX and RX	11.0 km
Average power reception	Vertical polarization: -63 dBm Horizontal polarization: -62 dBm
Area description	Street with low traffic and low buildings, close to a square, as shown in Figure 7.74.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.75.
Signal characterization	Signal with good reception level and selective frequency fading, especially at vertical polarization, as shown in Figure 7.76.

Figure 7.74 - Area around Site 21, showing the positioning of the measurement van.

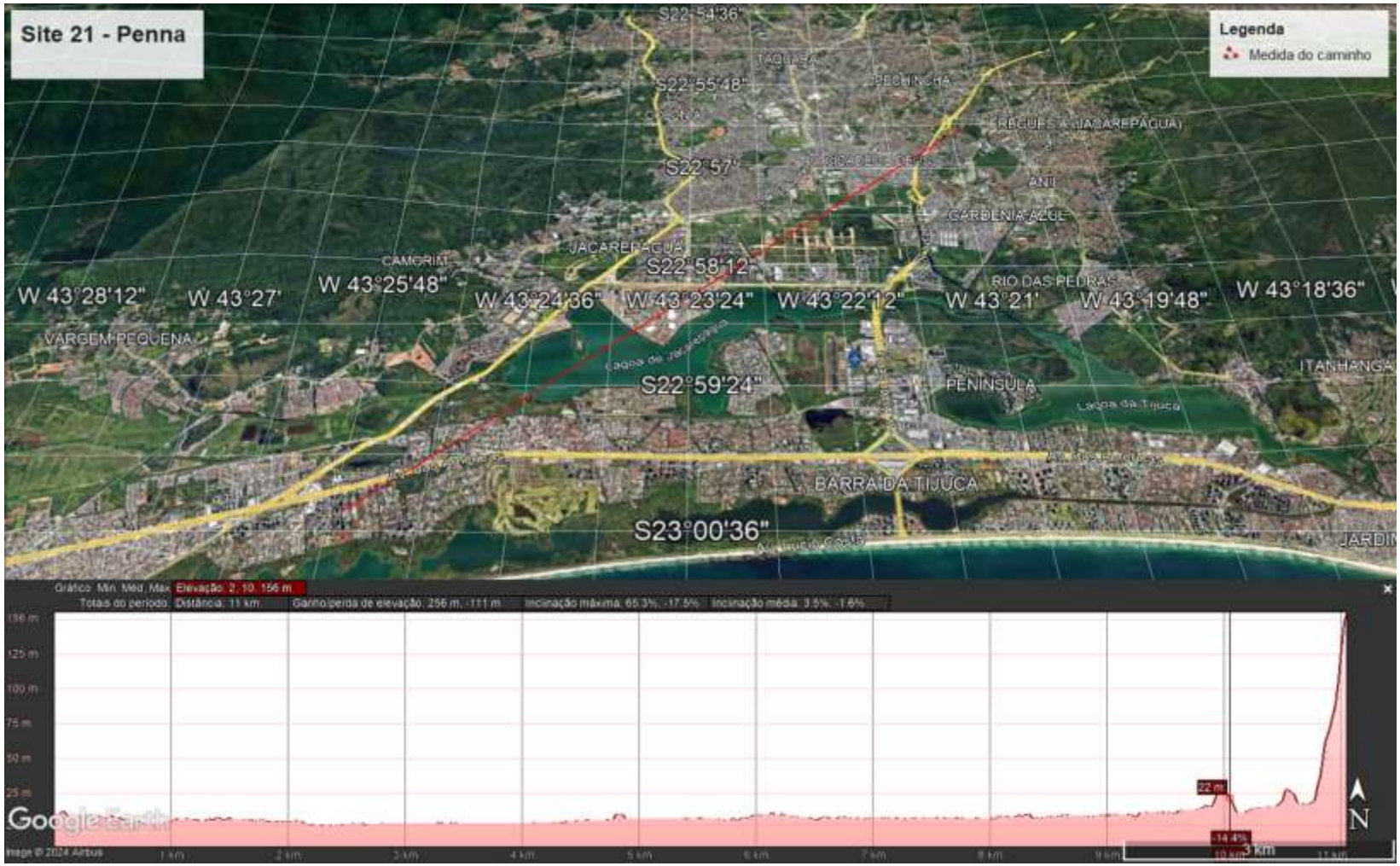


Figure 7.75 - Map showing the position of Site 21 relative to the Penna transmitter and the altitude profile of the path between these two points.

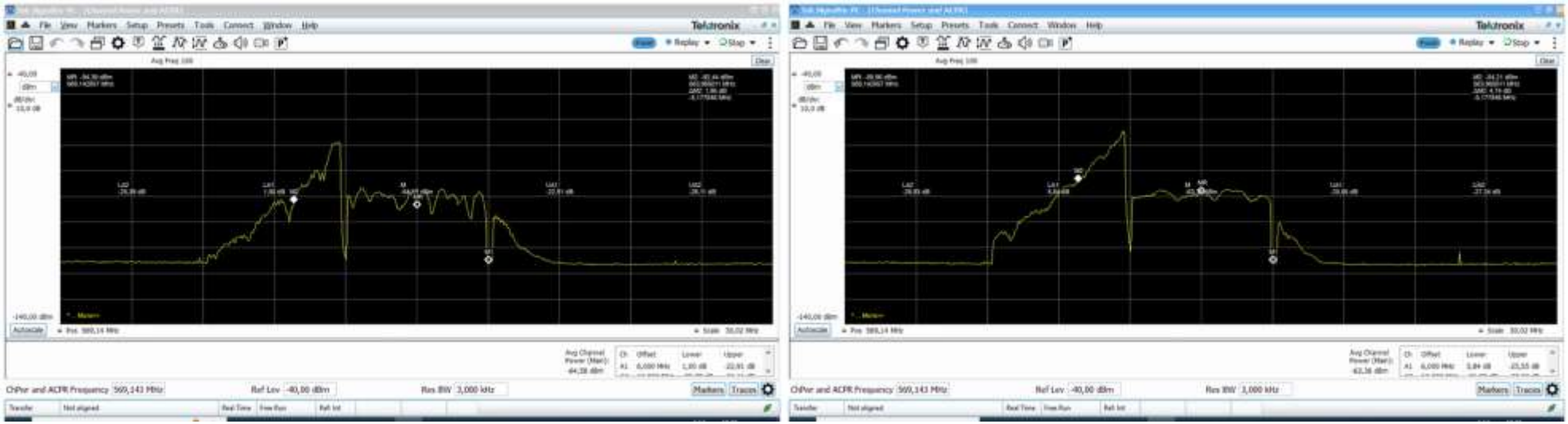


Figure 7.76 - Example of the received signal at Site 21.

b) Indoor

We performed measurements in the building next to the outdoor site on the second floor. The room presented a covered balcony, and the antenna was pointed to this balcony, as shown in Figure 7.77. The position was selected to maximize reception power. We observe an approximate 3 dB gain in the vertical polarization and a 6 dB loss in channel power on horizontal polarization compared to the outdoor site. Also, we note a degraded fading pattern, as shown in Figure 7.78.

Figure 7.77 - Indoor area of Site 21, showing the antenna positioning.

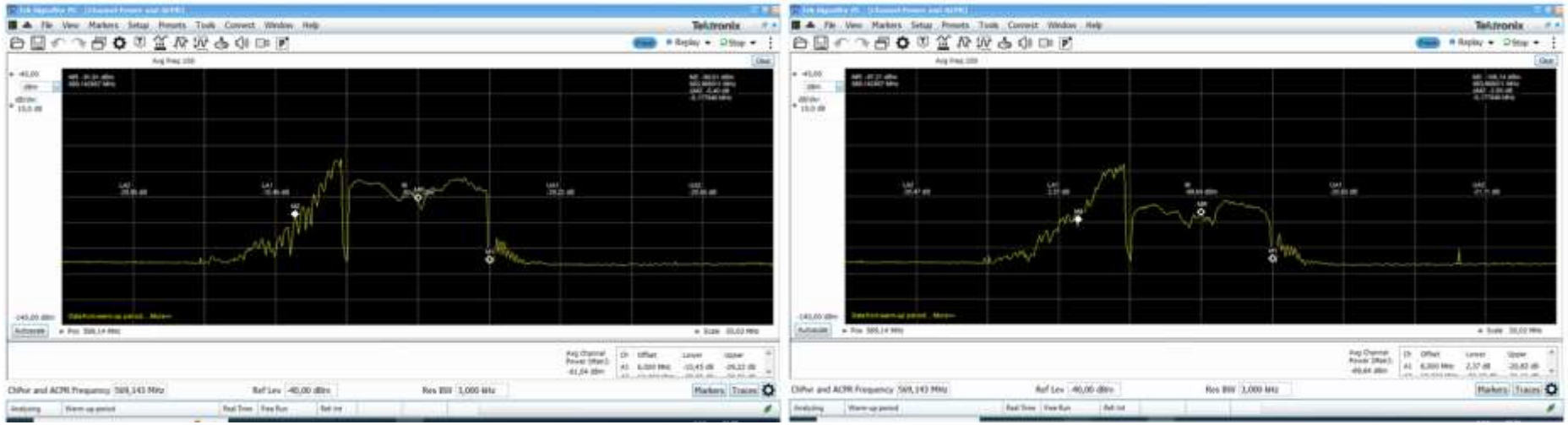


Figure 7.78 - Example of the indoor received signal at Site 21.

7.2.1.22 Site 22

a) Outdoor

Table 7.27 - Site 22 outdoor profile.

Site Index	22 - Reserva Beach
Geographic coordinates	23°01'14"S 43°26'25"W
Address	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22620-170
Distance between TX and RX	13.0 km
Average power reception	Vertical polarization: -53 dBm Horizontal polarization: -52 dBm
Area description	Avenue bordering the Reserve beach, with the beach on one side and a natural reserve area on the other, as shown in Figure 7.79. In the reserve area, there is a canal.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.80.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.81.

Figure 7.79 - Area around Site 22, showing the positioning of the measurement van.

Figure 7.80 - Map showing the position of Site 22 relative to the Penna transmitter and the altitude profile of the path between these two points.

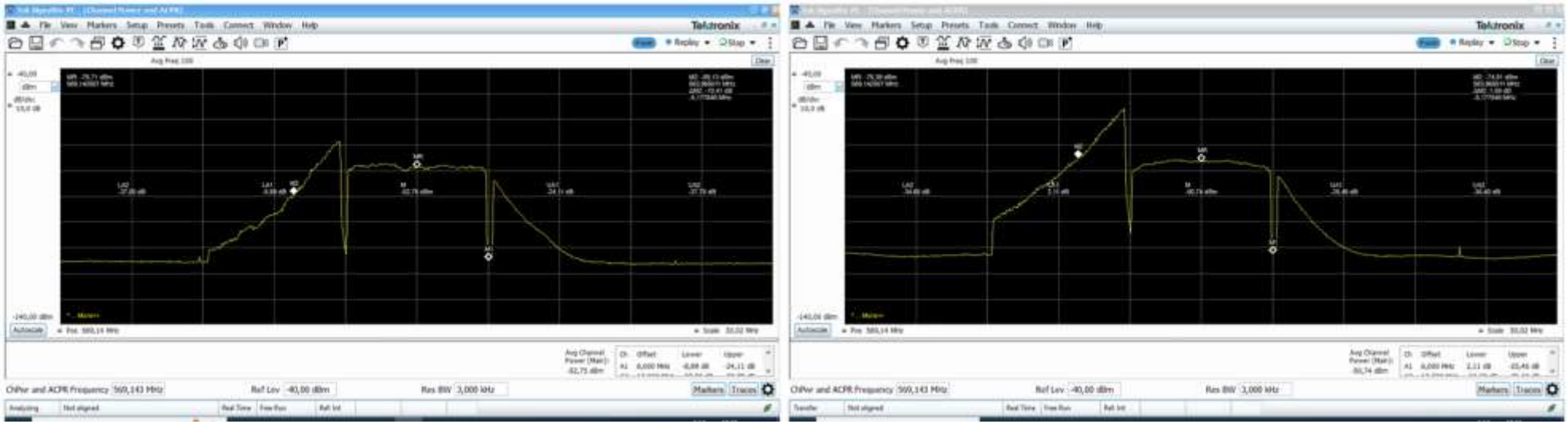


Figure 7.81 - Example of the received signal at Site 22.

7.2.1.23 Site 23

a) Outdoor

Table 7.28 - Site 23 outdoor profile.

Site Index	23 - Reserva Beach 2
Geographic coordinates	23°00'53"S 43°24'22"W
Address	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22795-006
Distance between TX and RX	10.1 km
Average power reception	Vertical polarization: -46 dBm Horizontal polarization: -46 dBm
Area description	Avenue bordering the Reserve beach, with beach on one side and natural reserve area on the other, as shown in Figure 7.82. In the reserve area, there is a canal.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.83.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.84.

Figure 7.82 - Area around Site 23, showing the positioning of the measurement van.

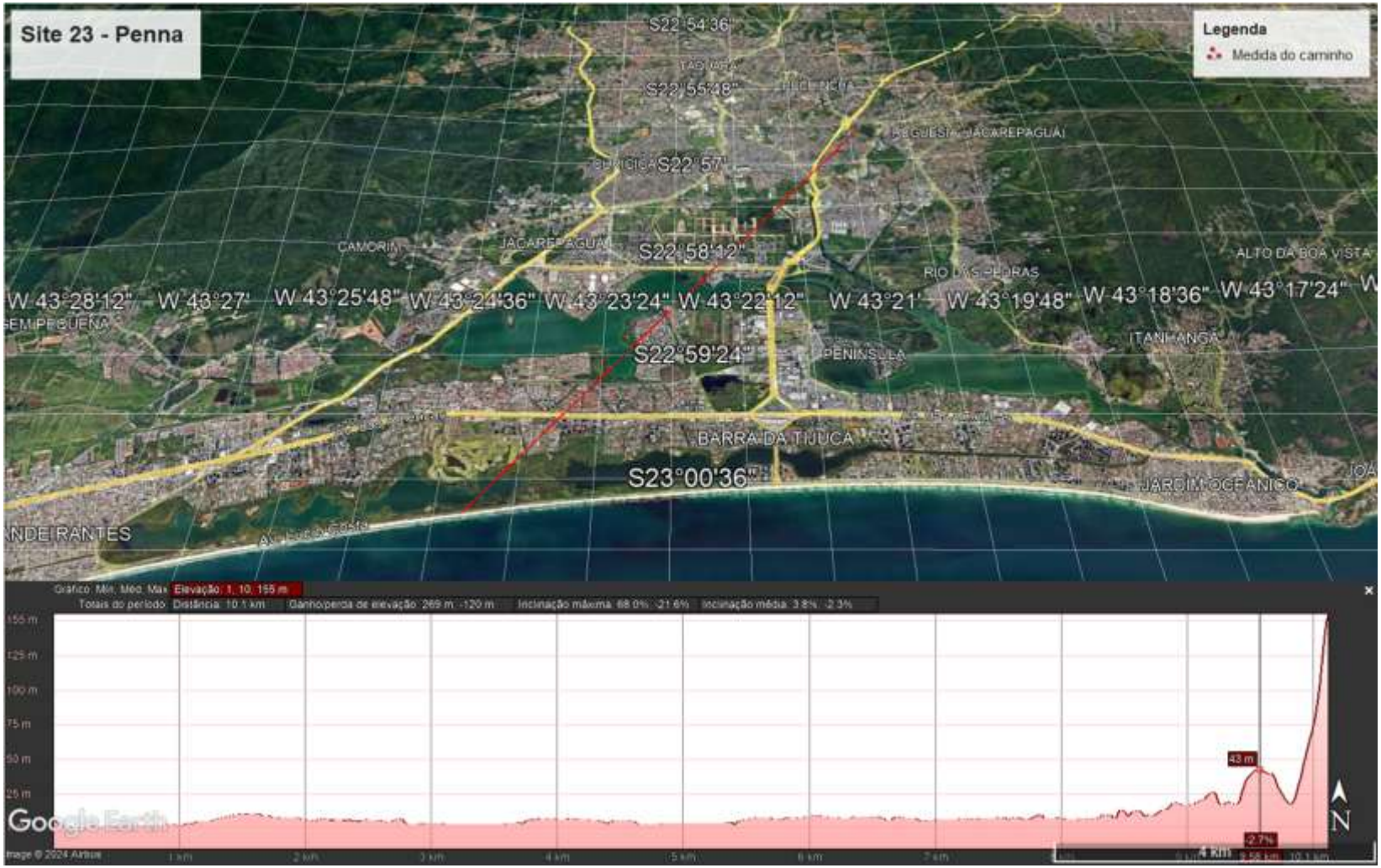


Figure 7.83 - Map showing the position of Site 23 relative to the Penna transmitter and the altitude profile of the path between these two points.

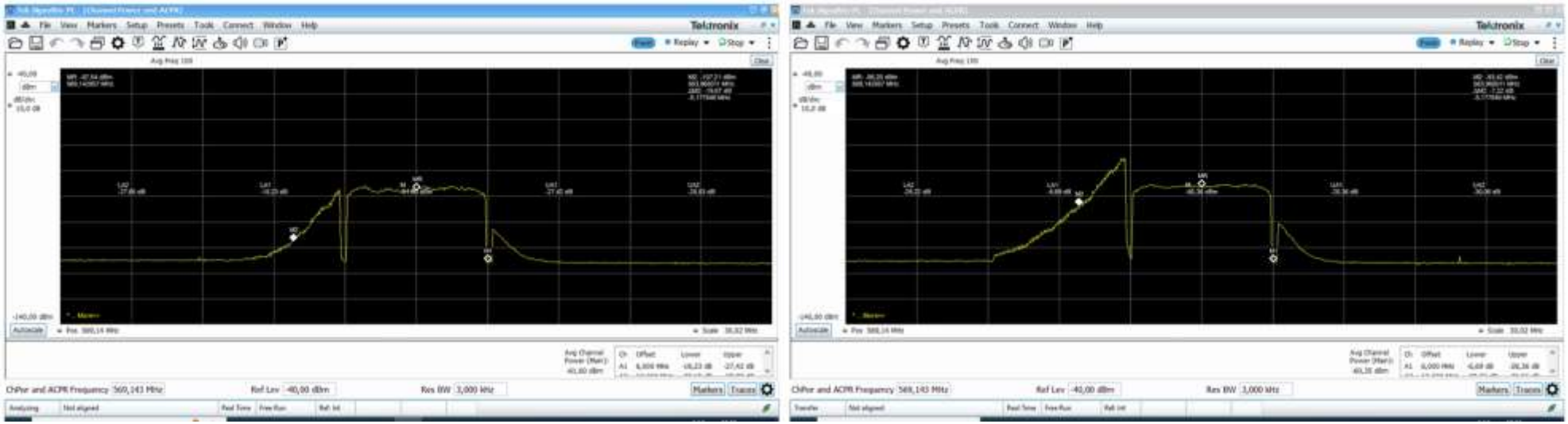


Figure 7.84 - Example of the received signal at Site 23, attenuated by 15 dB.

7.2.1.24 Site 24

a) Outdoor

Table 7.29 - Site 24 outdoor profile.

Site Index	24 - Reserva Beach 3
Geographic coordinates	23°00'46"S 43°23'37"W
Address	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22630-012
Distance between TX and RX	9.3 km
Average power reception	Vertical polarization: -50 dBm Horizontal polarization: -50 dBm
Area description	Avenue bordering the Reserve beach, with the beach on one side and a natural reserve area on the other, as shown in Figure 7.85. In the reserve area, there is a canal.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.86.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.87.

Figure 7.85 - Area around Site 24, showing the positioning of the measurement van.

Figure 7.86 - Map showing the position of Site 24 relative to the Penna transmitter and the altitude profile of the path between these two points.

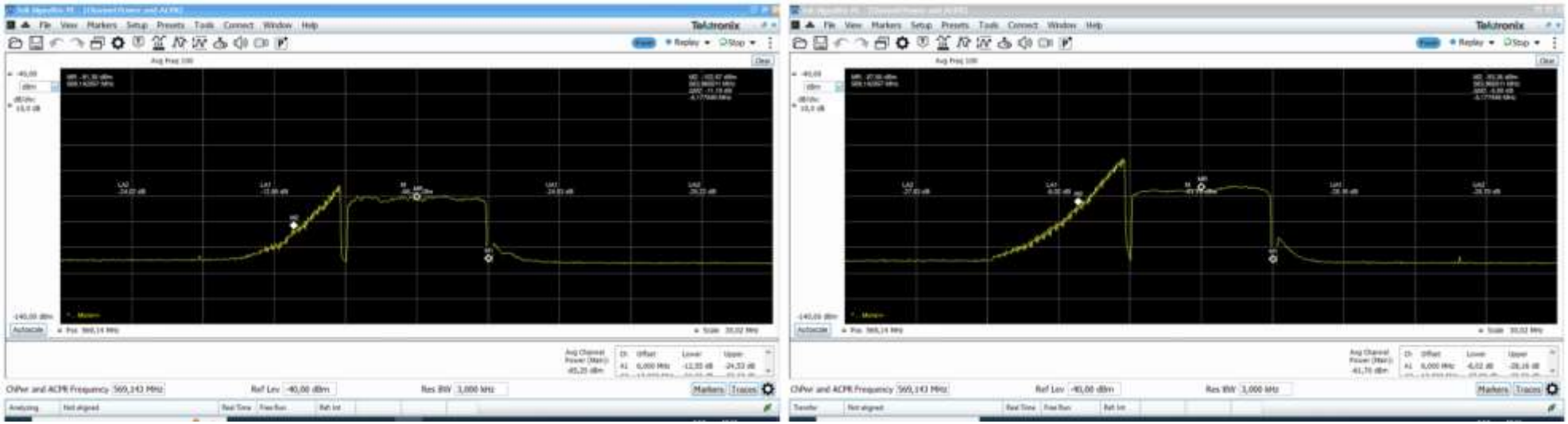


Figure 7.87 - Example of the received signal at Site 24, attenuated by 15 dB.

7.2.1.25 Site 25

a) Outdoor

Table 7.30 - Site 25 outdoor profile.

Site Index	25 - Reserva Beach 4
Geographic coordinates	23°00'43"S 43°23'00"W
Address	Av. Lúcio Costa, S/N - Barra da Tijuca, Rio de Janeiro - RJ, 22620-170
Distance between TX and RX	8.7 km
Average power reception	Vertical polarization: -53 dBm Horizontal polarization: -53 dBm
Area description	Avenue bordering the Reserve beach, with the beach on one side and a natural reserve area on the other, as shown in Figure 7.88. In the reserve area, there is a canal.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.89.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.90. This site has approximately the same reception power from Penna and Sumaré transmitters. Hence, it was selected for the frequency reuse-1 test.

Figure 7.88 - Area around Site 25, showing the positioning of the measurement van.

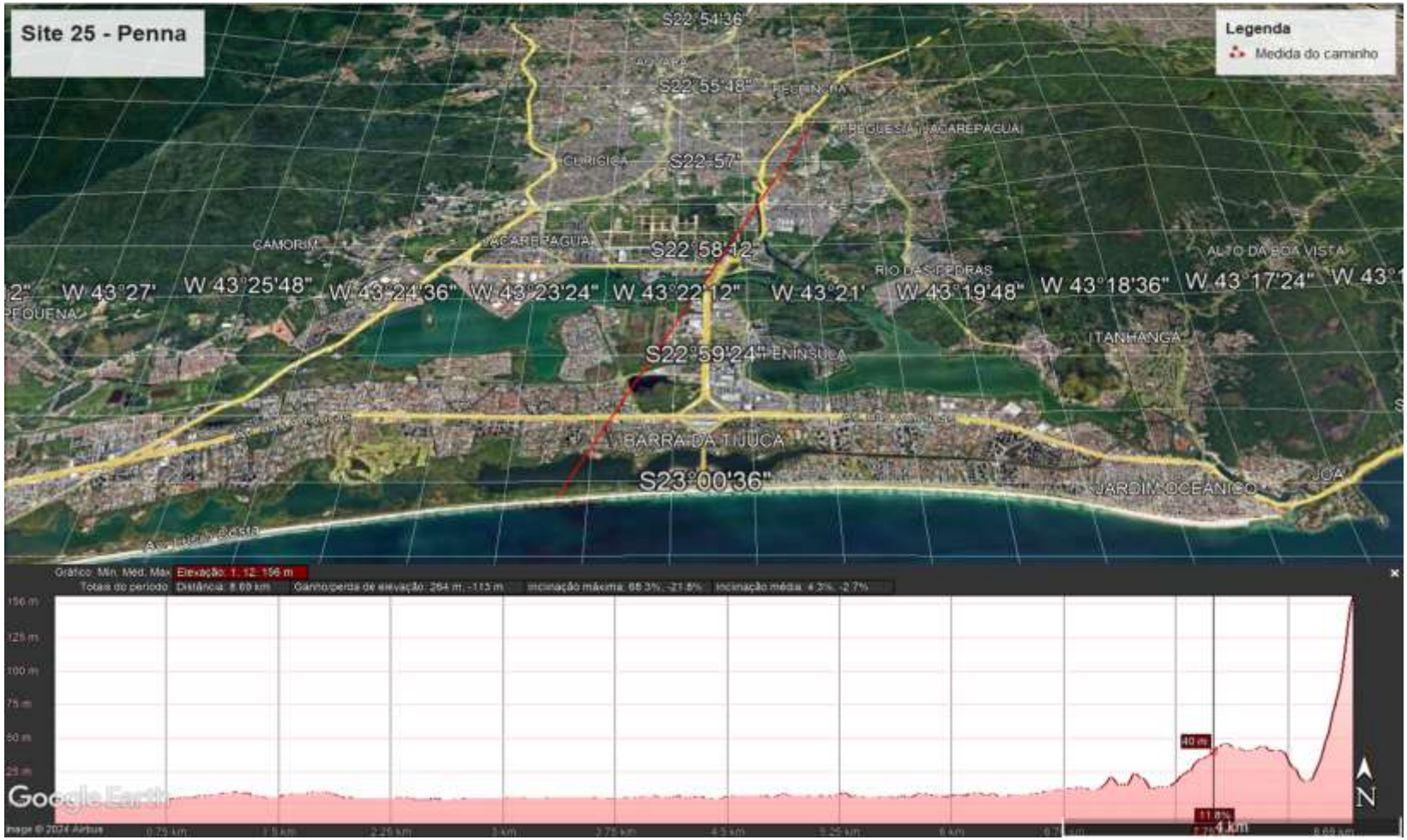


Figure 7.89 - Map showing the position of Site 25 relative to the Penna transmitter and the altitude profile of the path between these two points.

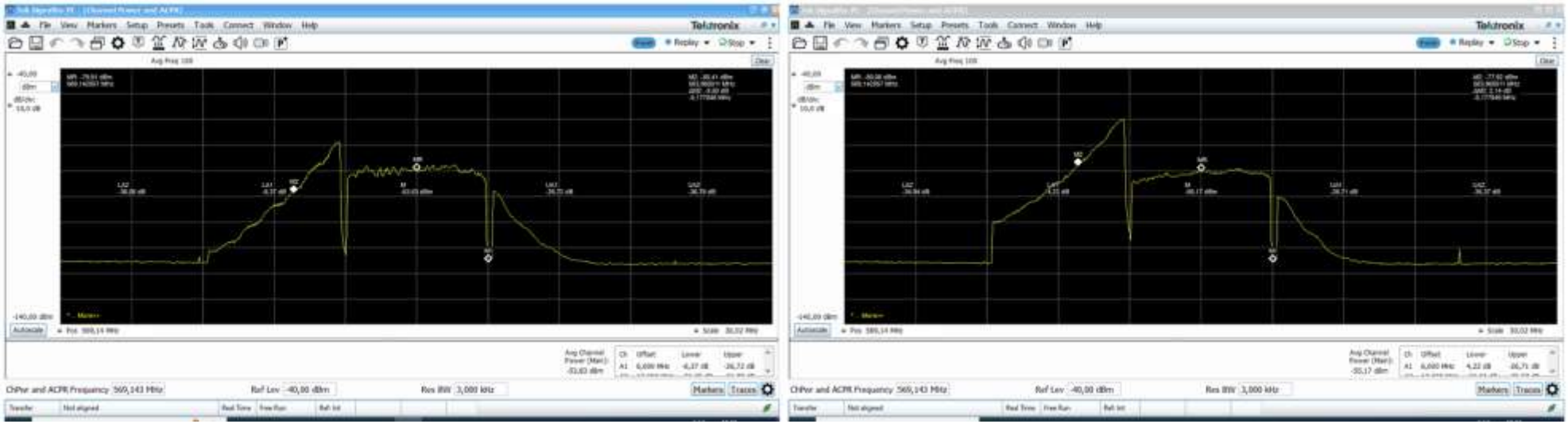


Figure 7.90 - Example of the received signal at Site 25.

7.2.1.26 Site 26

a) Outdoor

Table 7.31 - Site 26 outdoor profile.

Site Index	26 - Post 8, Barra Beach
Geographic coordinates	23°00'38"S 43°21'46"W
Address	Av. Lúcio Costa, 6388 - Barra da Tijuca, Rio de Janeiro - RJ, 22630-013
Distance between TX and RX	7.9 km
Average power reception	Vertical polarization: -52 dBm Horizontal polarization: -53 dBm
Area description	Avenue bordering the Barra beach, with the beach on one side and high buildings on the other, as shown in Figure 7.91. The avenue presents heavy traffic.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.92.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.93.

Figure 7.91 - Area around Site 26, showing the positioning of the measurement van.

Figure 7.92 - Map showing the position of Site 26 relative to the Penna transmitter and the altitude profile of the path between these two points.

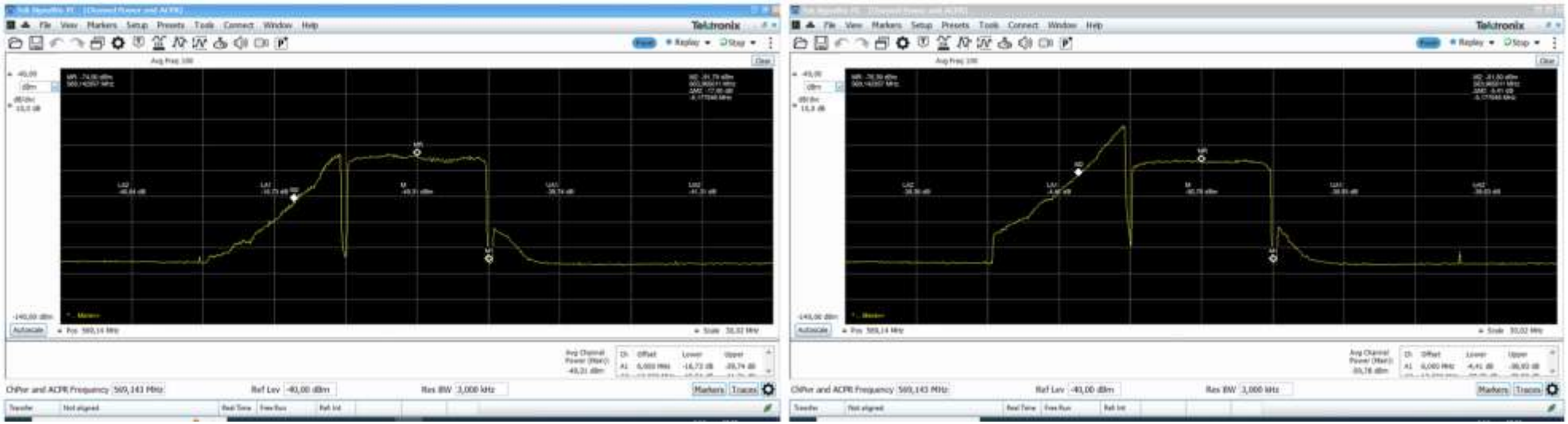


Figure 7.93 - Example of the received signal at Site 26.

7.2.1.27 Site 27

a) Outdoor

Table 7.32 - Site 27 outdoor profile.

Site Index	27 - Collaborator house, Cond. Eldorado
Geographic coordinates	22°56'44"S 43°19'48"W
Address	R. Prof. Silvio Fialho - Jacarepaguá, Rio de Janeiro - RJ, 22750-470
Distance between TX and RX	2.0 km
Average power reception	Vertical polarization: -44 dBm Horizontal polarization: -42 dBm
Area description	The residential area is surrounded by houses and mountains, as shown in Figure 7.94. The street presents light traffic.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.95.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.96.

Figure 7.94 - Area around Site 27, showing the positioning of the measurement van.

Figure 7.95 - Map showing the position of Site 27 relative to the Penna transmitter and the altitude profile of the path between these two points.

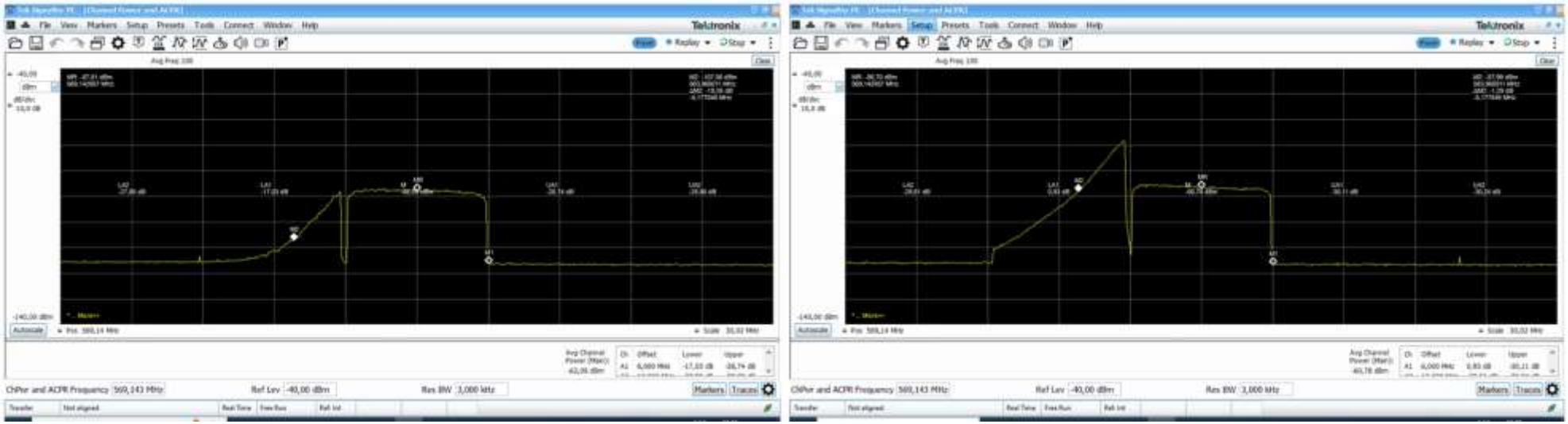


Figure 7.96 - Example of the received signal at Site 27, attenuated by 3 dB.

b) Indoor

We performed measurements in a house close to the outdoor site, as shown in Figure 7.97. It was impossible to set the outdoor site in front of the house due to the presence of trees. The house is higher than the outdoor site because the street is on a slope.

The measurements were performed in the garage. The antenna was pointed to the back wall, as shown in Figure 7.98. The position was selected to maximize reception power. We observe approximately a 17 dB loss in channel power, compared to the outdoor site, and a degradation in fading pattern, as shown in Figure 7.99. The losses are attributed to the walls between the antenna and the transmitter.

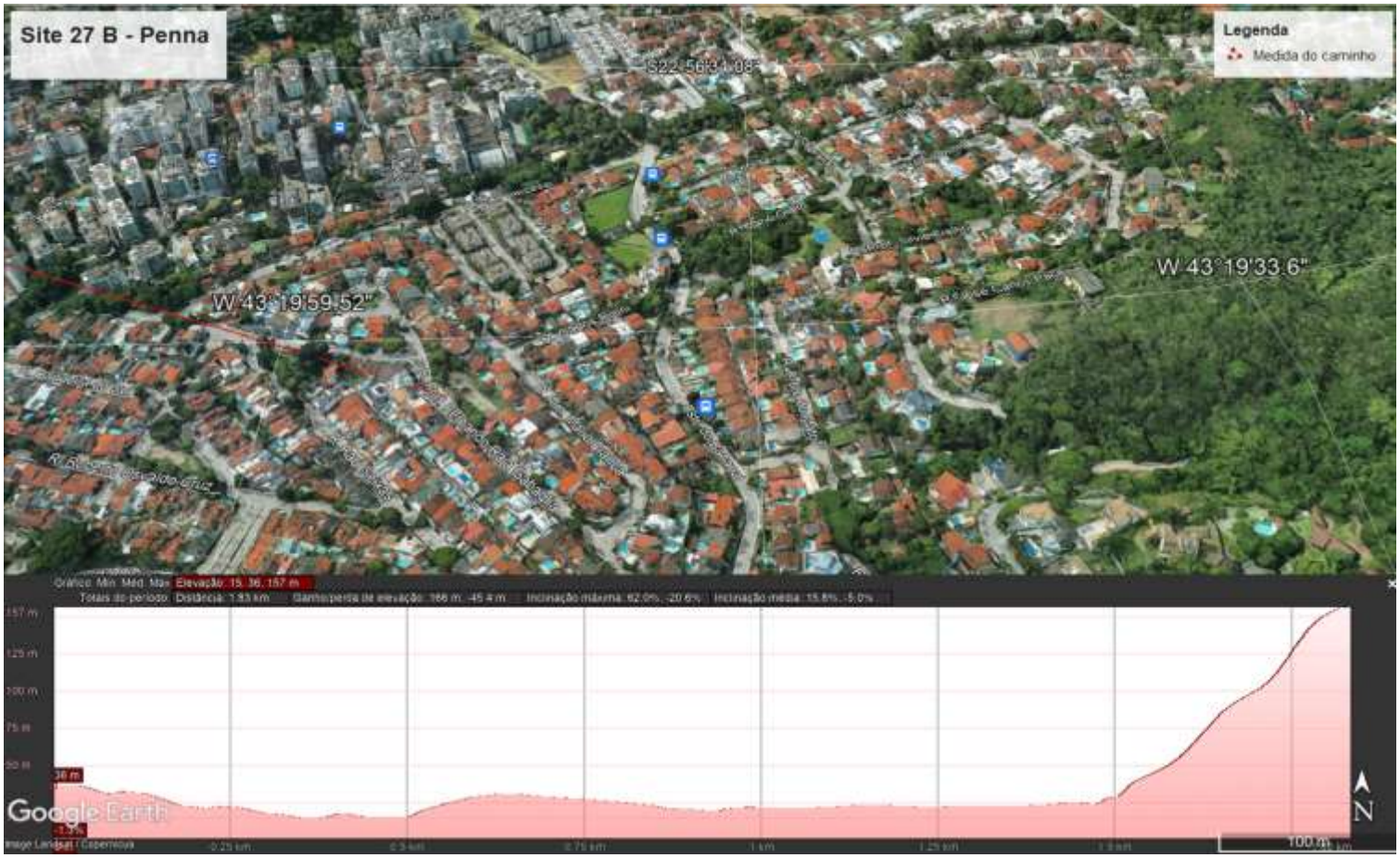


Figure 7.97 - Map showing the position of indoor measurement of Site 27 relative to the Penna transmitter and the altitude profile of the path between these two points.

Figure 7.98 - Indoor area of Site 27, showing the antenna positioning.

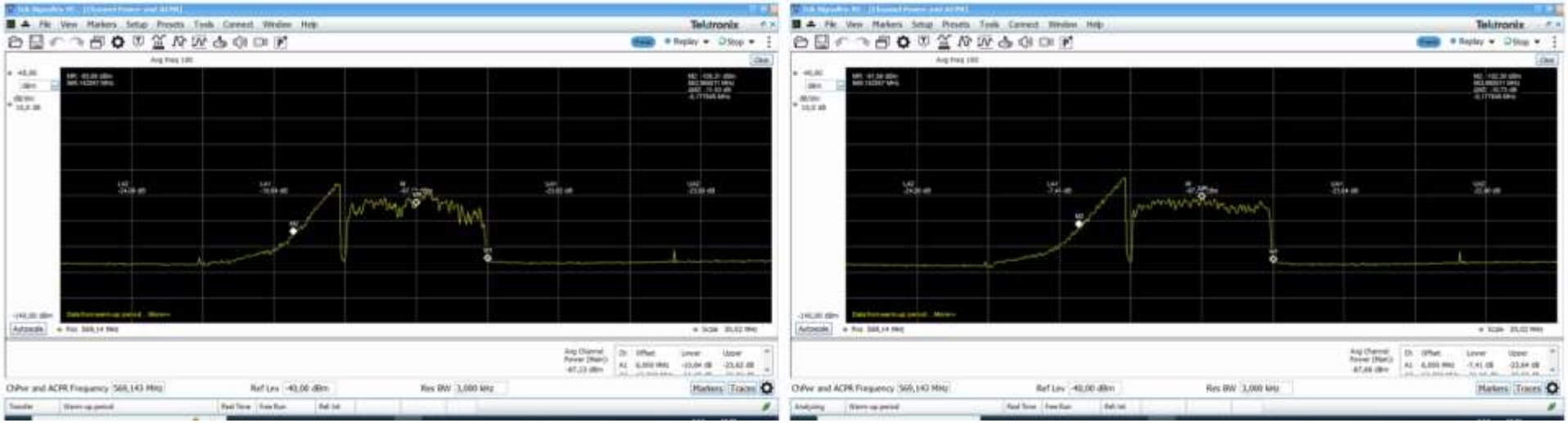


Figure 7.99 - Example of the indoor received signal at Site 27.

7.2.1.28 Site 28

a) Outdoor

Table 7.33 - Site 28 outdoor profile.

Site Index	28 - Collaborator apartment 2
Geographic coordinates	23°00'35"S 43°21'22"W
Address	Av. Lúcio Costa, 6000 - Barra da Tijuca, Rio de Janeiro - RJ, 22630-012
Distance between TX and RX	7.6 km
Average power reception	Vertical polarization: -49 dBm Horizontal polarization: -50 dBm
Area description	Avenue bordering the Barra beach, with the beach on one side and high buildings on the other, as shown in Figure 7.100. The avenue presents heavy traffic.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.101.
Signal characterization	Signal with good reception level, with flat frequency fading, as shown in Figure 7.102.

Figure 7.100 - Area around Site 28, showing the positioning of the measurement van.

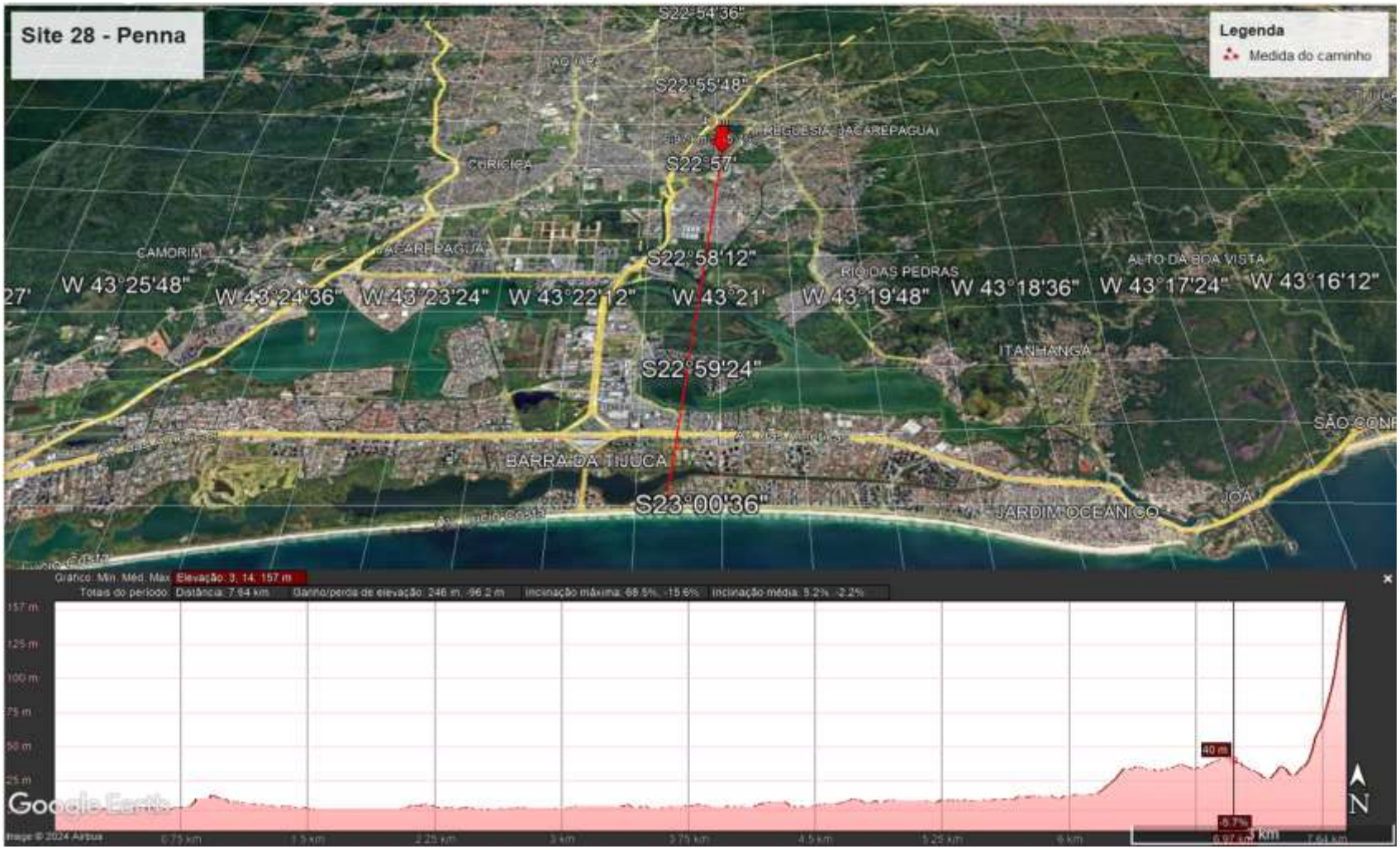


Figure 7.101 - Map showing the position of Site 28 relative to the Penna transmitter and the altitude profile of the path between these two points.

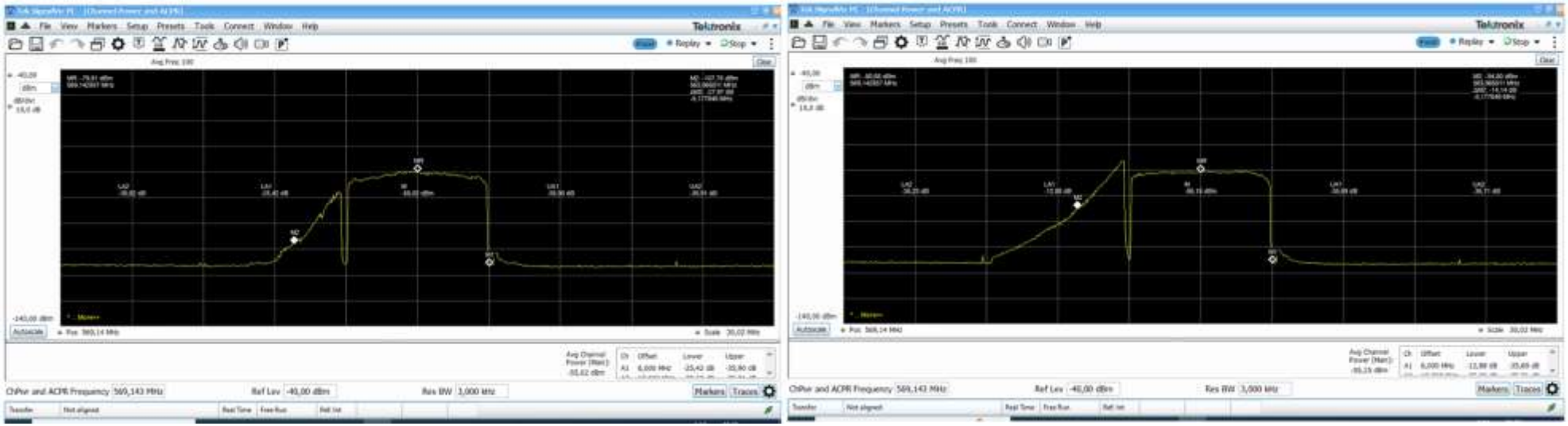


Figure 7.102 - Example of the received signal at Site 28.

b) Indoor

We performed measurements in the building next to the outdoor site on the fifth floor. The antenna was pointed to a window, as shown in Figure 7.103. The position was selected to maximize reception power. Compared to the outdoor site, we observe an approximate 16 dB loss in channel power and a more degraded fading, especially on the vertical polarization, as shown in Figure 7.104.

Figure 7.103 - Indoor area of Site 28.

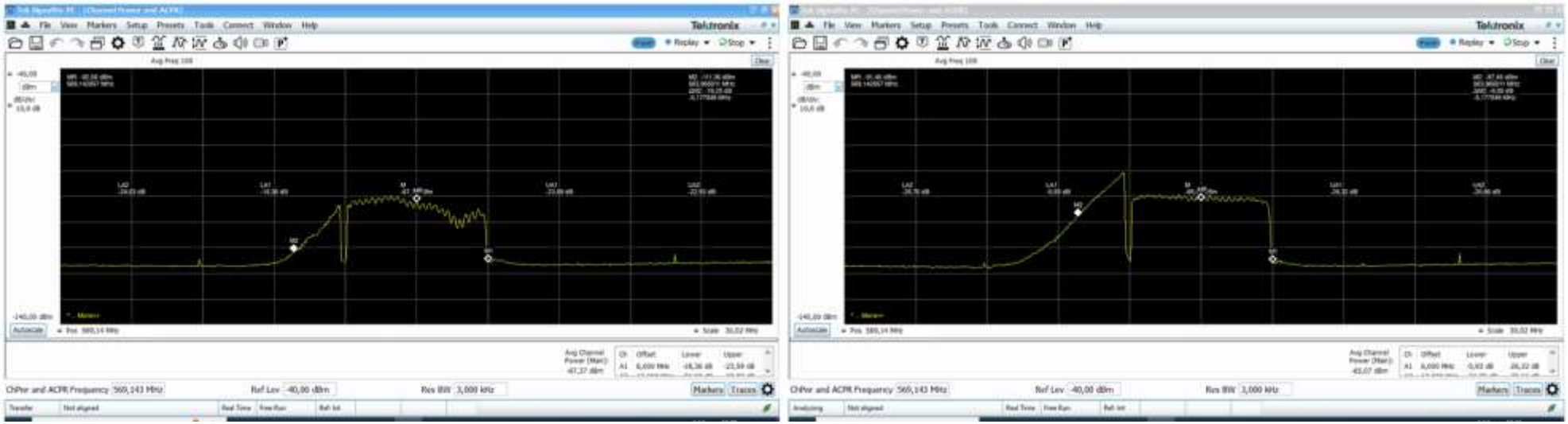


Figure 7.104 - Example of the indoor received signal at Site 28.

7.2.1.29 Site 29

a) Outdoor

Table 7.34 - Site 29 outdoor profile.

Site Index	29 - Church of Our Lady of Loreto
Geographic coordinates	22°56'22"S 43°20'41"W
Address	Ladeira da Freguesia, 375 - Freguesia, Jacarepaguá, Rio de Janeiro - RJ, 22760-090
Distance between TX and RX	0.4 km
Average power reception	Vertical polarization: -59 dBm Horizontal polarization: -59 dBm
Area description	The location is at the foot of the hill with the Penna transmitter, as shown in Figure 7.105.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.106.
Signal characterization	Signal with good reception level, but selective frequency fading, as shown in Figure 7.107.

Figure 7.105 - Area around Site 29, showing the positioning of the measurement van.

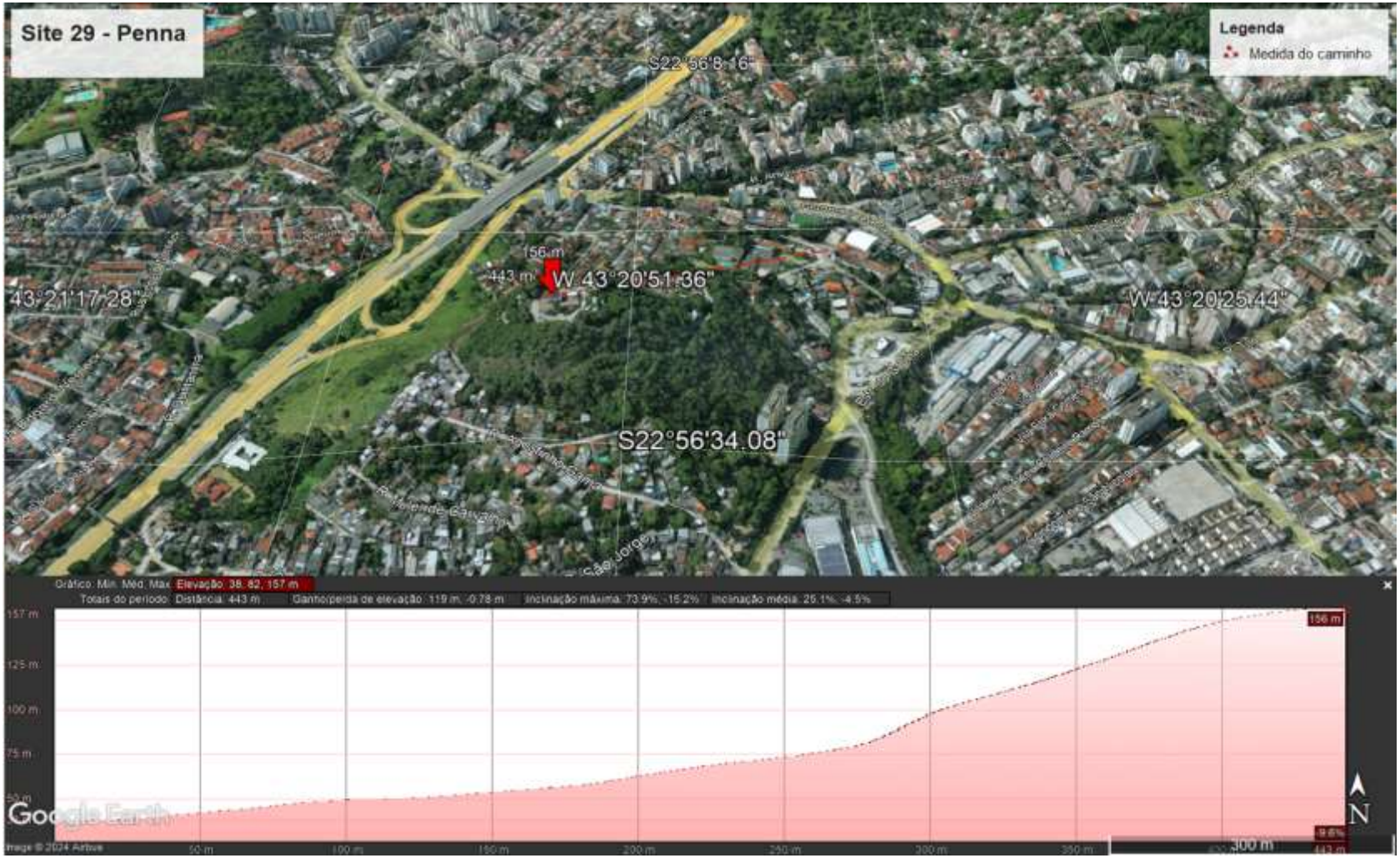


Figure 7.106 - Map showing the position of Site 29 relative to the Penna transmitter and the altitude profile of the path between these two points.

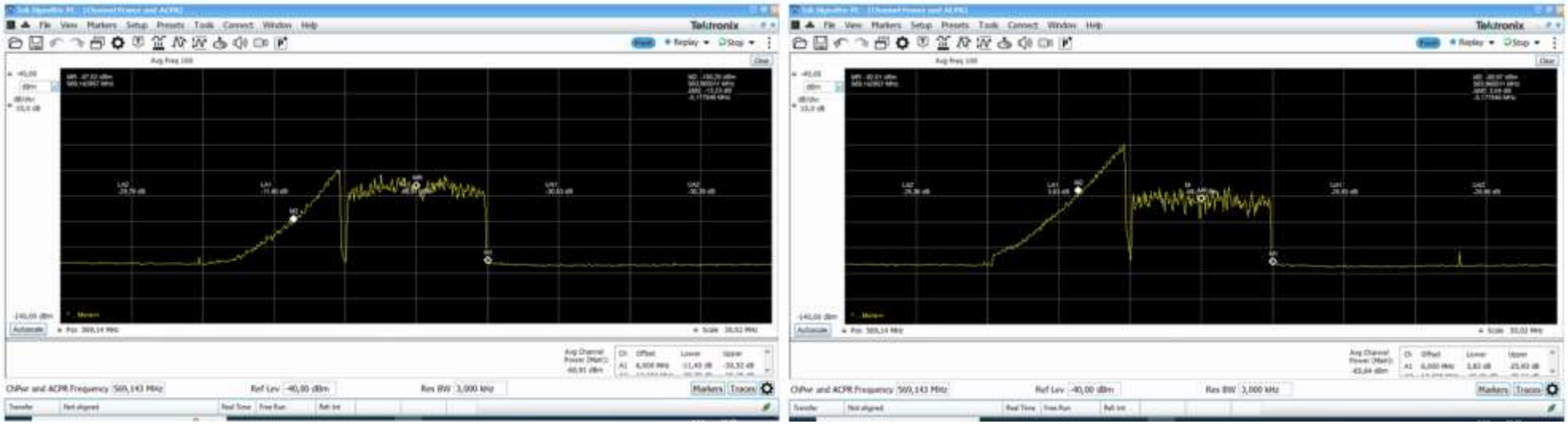


Figure 7.107 - Example of the received signal at Site 29.

b) Indoor

We performed measurements in the building next to the outdoor site, which is in a higher level than the outdoor site. The antenna was pointed to a window, as shown in Figure 7.108. The position was selected to maximize reception power. We observe a loss close to 20 dB on channel power, compared to the outdoor site. The fading pattern is also degraded, as shown in Figure 7.109.

Figure 7.108 - Indoor area of Site 29, showing the antenna positioning.

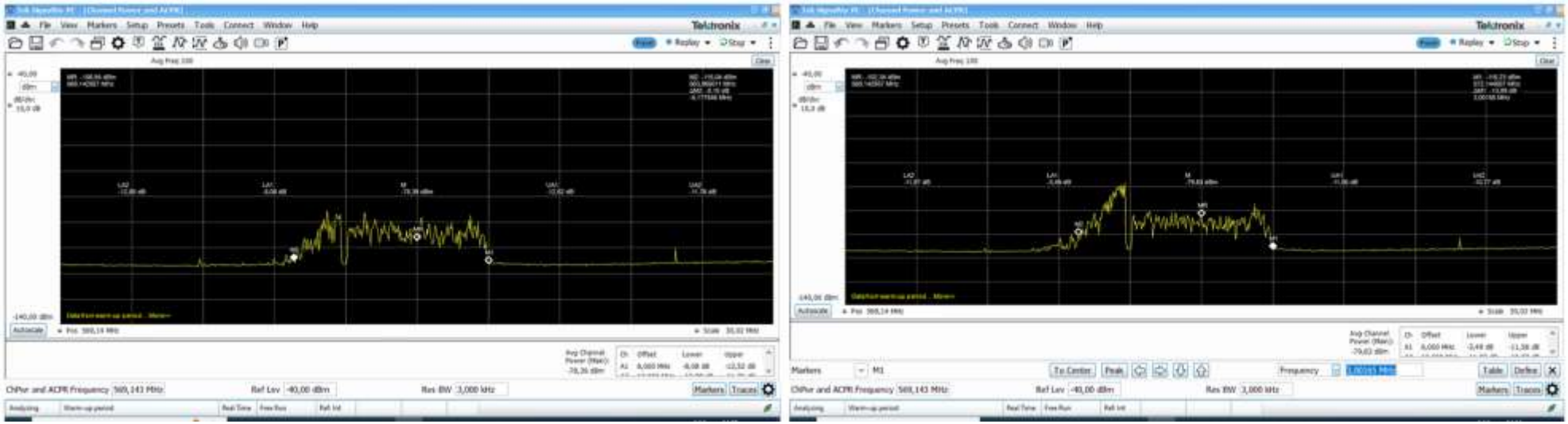


Figure 7.109 - Example of indoor received signal at Site 29.

7.2.1.30 Site 30

a) Outdoor

Table 7.35 - Site 30 outdoor profile.

Site Index	30 - Vianense Supermarket
Geographic coordinates	22°56'16"S 43°20'00"W
Address	Estr. do Bananal, 400 - Freguesia (Jacarepaguá), Rio de Janeiro - RJ, 22750-013
Distance between TX and RX	1.6 km
Average power reception	Vertical polarization: -64 dBm Horizontal polarization: -64 dBm
Area description	Street with a lot of movement of people and cars, with medium-height buildings, as shown in Figure 7.110.
Altitude profile	Transmission without mountain interferences, as shown in Figure 7.111.
Signal characterization	Signal with good reception level, but selective frequency fading, especially on the vertical polarization, as shown in Figure 7.112.

Figure 7.110 - Area around Site 30.

Figure 7.111 - Map showing the position of Site 30 relative to the Penna transmitter and the altitude profile of the path between these two points.

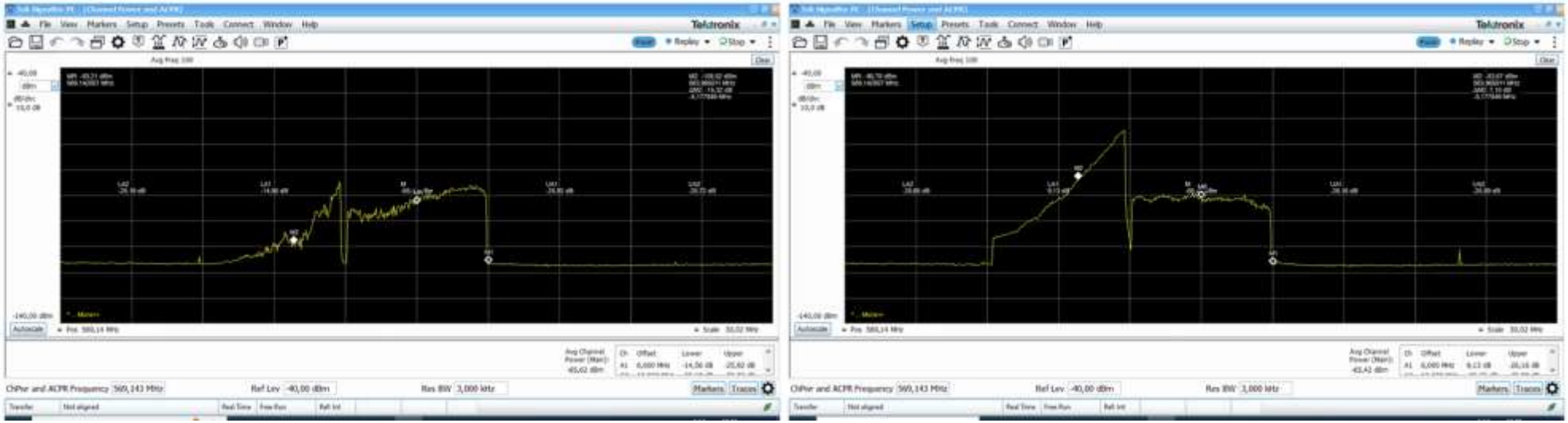


Figure 7.112 - Example of received signal at Site 30.

7.2.2 Reuse-1 test

The reuse-1 test evaluates the use of the same RF channel by independent stations covering adjacent service areas. We divided the signal into two layers. Hence, we considered two cases:

- Layer A / Core Layer: This layer must present a configuration that allows the receiver to work in the condition of C/N ≤ 0 dB. This means the reception is successful even when both transmitters present the same power in a certain location. The receiver must lock on one of the transmitters and receive the signal without errors for at least 30 minutes to declare a successful test in this layer.
- Layer B / Enhanced Layer: In this case, we assume that the transmitters should work considering the traditional recommendation for directivity discrimination of antennas in the reception of television broadcasting, defined by Recommendation ITU-R BT.419. Hence, considering the reception power of each transmitter differs by at least 16 dB using a directive antenna, the receiver must be able to receive the signal of the selected transmitter without errors. Then, this layer must present a configuration that allows the receiver to work in the condition of C/N ≤ 16 dB. The receiver must lock on the selected transmitter and receive the signal without errors for at least 30 minutes to declare a successful test in this layer.

We selected different sites to test the frequency reuse-1 for both layers. We selected sites where Penna and Sumaré have similar reception power in vertical and horizontal polarization for Layer A / Core Layer tests. For Layer B / Enhanced Layer tests, we selected sites where Penna reception power surpasses Sumaré reception power by 16 dB in vertical and horizontal polarization. Each layer is tested separately. We begin the test using the configuration in which reuse-1 worked for the technology in the laboratory tests. Then, in case of reception errors in the tested layer, we increase the signal robustness by decreasing the FEC and repeating the test. The final result shows the layer configuration where the reuse-1 works for that site and the corresponding data rate.

For the sites where we test the reuse-1 using Layer A / Core Layer, we do not expect Layer B / Enhanced Layer to work, as it uses a less robust mod-code scheme. Hence, we do not test Layer B / Enhanced Layer in these sites. Also, for the sites where we test the frequency reuse-1 using Layer B / Enhanced Layer, we do not test Layer A / Core Layer, as it is expected to work, as Layer A / Core Layer modulation was projected to work considering C/N ≤ 0 dB. It is important to notice reuse-1 tests are very time consuming and the test schedule was restricted, so we disregarded unnecessary measurements. Moreover, considering all possible antenna azimuths, we could not find a site where there was an azimuth in which both Penna and Sumaré transmitters presented the same channel power for both polarization (C/N ≤ 0 dB) as well as an azimuth in which a 16 dB difference was found between transmitters. Hence, Layer A / Core Layer and Layer B /Enhanced Layer reuse-1 tests were performed in different places.

7.2.3 Drive test

The drive test was conducted with the measurement van moving around the field test area. The measurement van was mounted with a MIMO Omnidirectional antenna to receive the transmitted signal, and a GPS antenna fixed securely above the vehicle, and connected to the respective Receiver and laptop with receiver software, inside the vehicle. The transmitter's configuration used for both candidates uses a single layer with approximately 30 Mbps transmission rate. The details for each candidate technology are shown in Sections 7.4.1.2.2 and 7.5.1.2.2.

We performed the drive test in 5 routes, varying the speed, at the west zone of Rio de Janeiro, as shown in Figure 7.113. The received signal and GPS signal were stored at a rate of at least 1 register per second. Route 1 comprises a high-speed route that begins at Av. das Américas and finishes near the Penna Station transmission site. This route includes a highway, namely Linha Amarela. Route 2 comprises a medium to high-speed route that begins near the Penna Station transmission site and finishes at Av. Embaixador Abelardo Bueno. This route includes Linha Amarela Highway and a medium-speed avenue with several traffic lights. Route 3 is repeated thrice with different speeds of 20, 40, and 60 km/h. This route is almost free of traffic, but it has two roundabouts, reducing the speed. This route comprises Av. José Wilker. Route 4 comprises a medium to high-speed route, starting at Av. José Wilker and finishing at Av. Pref. Dulcídio Cardoso. It is common to have traffic jams on this route. Finally, Route 5 is a low to medium-speed route that starts at Av. Pref. Dulcídio Cardoso and finishes at ION Intelligent Center. This route has traffic lights, traffic jams, and U-turns.

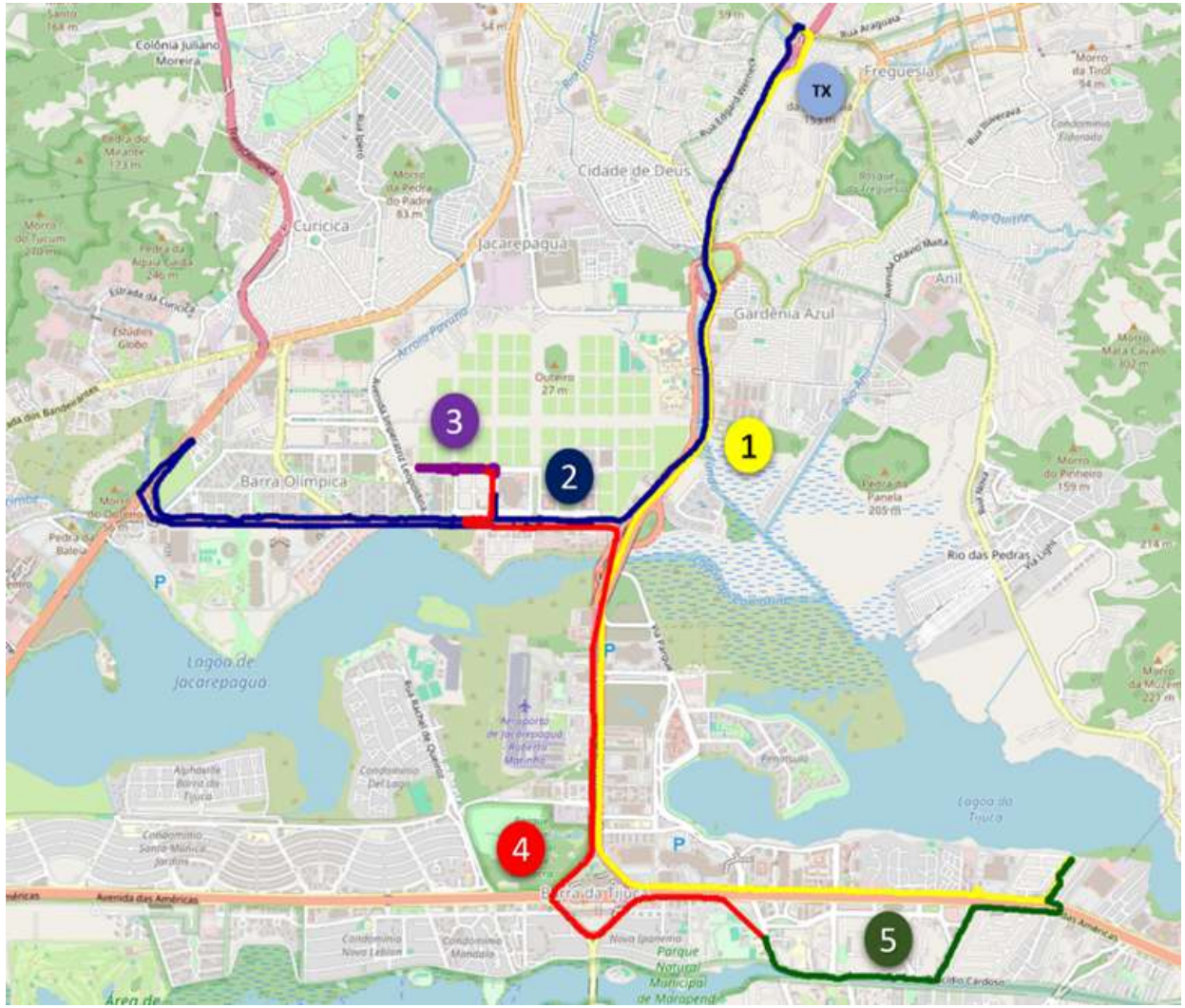


Figure 7.113 - Map showing the drive test routes.

7.3 Identification of the candidate technologies

Throughout this report the candidate technologies are referred to by letters "A" and "B". Table 7.36 shows the correspondence with their real names.

Table 7.36 - Candidate Technologies

Candidate Technology A	Advanced ISDB-T
Candidate Technology B	ATSC 3.0

7.4 Candidate Technology A

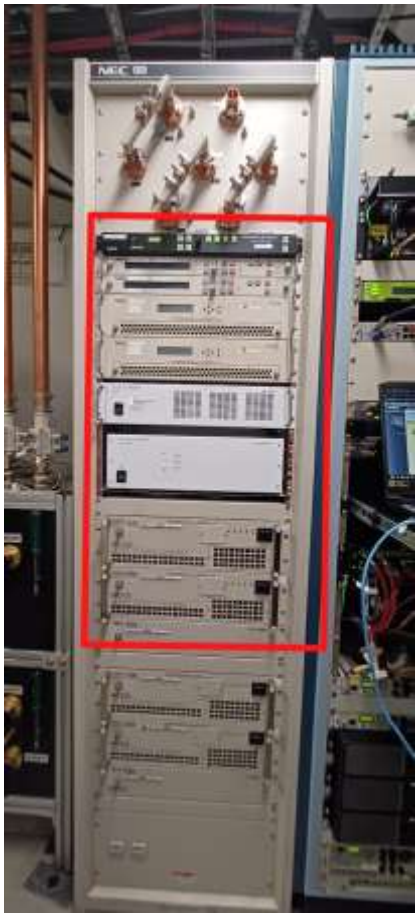
We received the Advanced ISDB-T equipment in Rio de Janeiro by 30 November 2023. From 04 December 2023 up to 09 January 2024, we performed the Advanced ISDB-T software configuration and hardware installation on the van as well as both Sumaré and Penna stations assembling. The pre-test measurements and tools verification took from 10 January 2024 to 16 January 2024. It is also important to emphasize that the proponents of this candidate technology were in Rio de Janeiro from 10 January 2024 up to 18 January 2024 to check and validate the installation of measurement equipment and software used in indoor and outdoor campaigns. The Advanced ISDB-T equipment was validated to operate in SFN, but the field test was not conducted in this network mode. The field test window was from 19 January 2024 until 15 March 2024.

The devices received for the test are described in Table 7.37. The setup photos are in Figure 7.114.

Table 7.37 - Advanced ISDB-T devices for field tests.

Description	Type	Manufacturer	Quantity (Sets)
4K Encoder (HEVC)	YE-9300/MF4400	NEC	2
Re-Multiplexer	0416A-003	Eiden	2
Modulator	0428A	Eiden	2
Up Converter (Noise Generator)	1908A	Eiden	4
Exciter	HPC-1990	NEC	4
Exciter	HPC-1990	NEC	2
TX CONT Light	HPC-1427C	NEC	4
Demodulator	SC1502A-B03	Socionext	2
Stream Divider	OTH001	Turbo System	1
Stream Combiner	OTH001	Turbo System	1
MMT/TLV Station	1708A-101	Eiden	1

Description	Type	Manufacturer	Quantity (Sets)
Packet Analyzer	7709C	Eiden	1
RF Capture (MIMO) comprising:			
RF Capture (MIMO)	4422A	Eiden	1
HDD	EM352B31-12T02	Eiden	1
4K Decoder (HEVC)	4K XJive MMT Player	Turbo Systems	1
GPS Receiver with SG comprising:			1
Master Clock	5601MSC+2PS+GP+T	Evertz	2
GPS Cable	WA-T11	Evertz	2
GPS Antenna	106406-00	Evertz	2
Note PC comprising:			1
Note PC	Dell Latitude 3500 CTO	Dell	1
HUB	LGB2126A	Black Box	1
VDA	C10DA	AJA	1
Speaker Panel	SP105-12G-32	Consmic	1
GOP Generator	NS-G8600	NEC	2
Advanced Analyzer	6950A	Nittsuki	1
Receiving Antenna comprising:			
Indoor Antenna Standard	VH-PT00-5767	Nippon Antenna	2
Indoor Antenna 45 degree	VH-PT45-5767	Nippon Antenna	2
Omnidirectional Antenna	VH-SLDP-575	Nippon Antenna	2



a) Setup at Penna station.

b) Setup inside the measuring van.

Figure 7.114 - Advanced ISDB-T field test setup.

The configurations applied to the transmitter are in Tables 7.38 and 7.39 for configurations 1 (main configuration) and 3 (extra configuration), respectively. We use PRBS to perform all tests. The quality threshold indicated by the proponent was the absence of BCH errors in the reception.

Table 7.38 - Advanced ISDB-T transmission parameters for the main configuration, called Config. 1.

Modulation	64-QAM
Constellation	Non-Uniform Constellation
Error correction	LDPC + BCH (8/16)
FFT	16K
GI ratio	800/16384 (126 µs)
Pilot pattern	Dx=6, Dy=2
Time interleaving	I=3
Layer	Layer-A, 35 segments
Useful Bandwidth	5.83 MHz
Bitrate	30.9 Mbps

Table 7.39 - Advanced ISDB-T transmission parameters for the extra configuration, called Config. 3.

Modulation	Layer-A, 16-QAM Layer-B, 64-QAM
Constellation	Layer-A, Uniform Constellation Layer-B, Non-Uniform Constellation
Error correction	Layer-A, LDPC+BCH (6/16) Layer-B, LDPC+BCH (10/16)
FFT	16K
GI ratio	800/16384
Pilot pattern	Dx=6, Dy=2
Time interleaving	I=3
Layer	Layer-A, 25 segments Layer-B, 10 segments
Useful Bandwidth	5.83 MHz
Bitrate	10.5+10.5 Mbps

7.4.1 Test Results

Configurations 1 and 3 were chosen by the SBTVD Forum in order to provide typical services in digital television broadcasting. Specifically, Configuration 1 can provide sufficient data rate for supporting 4K UHD video, while Configuration 3 can support two HD video broadcasting simultaneously.

7.4.1.1 Coverage Measurement

7.4.1.1.1 Methodology

For the main configuration, we performed the tests in all 30 outdoor and 9 indoor sites. Indoor measurements are much more time-consuming and labor-intensive than outdoor measurements, as the former requires the equipment to be dismantled from the measurement van, moved from the van to the indoor environment, and installed again. Further, due to the owners' restrictions, we had restricted time windows to access the indoor sites, making the measurement logistics difficult.

The Channel Power was measured in horizontal and vertical polarizations with the Tektronix Spectrum Analyzer. We used an average of 100 samples in sequence since the instantaneous values varied continuously due to the variability of the radio channel. At this time, values of MER were recorded for each polarization as well. When considering all measuring sites, the components in each branch had a maximum difference of 7.7 dB due to path diversity.

After that, we measured the system margin. We attenuated the input RF signal using attenuators until there were almost no BCH errors (BCHERR_A). At this moment, we decrease the attenuation by 0.5 dB until we observe no BCH errors for three minutes. Then, we noted the values of the attenuators and saved data from RF Capture, Socionext Demodulator, and Tektronix Spectrum Analyzer.

The last test measured the C/N ratio in the threshold. We must notice that we use SISO spectrum analyzers, so they do not provide a MIMO signal view. We combined the received signal with the artificially generated noise, with variable attenuators set to zero. We controlled the random noise level from -25 dBm to -45 dBm using the software. When necessary, we attenuated noise levels. We increased the noise level until there were almost no BCH errors. Then, we reduced the noise level by 0.5 dB until we observed no BCH errors for at least three minutes. Finally, we wrote down the values of the attenuators and recorded the C/N signal by 1 minute. After that, we also collected data from all the monitoring devices for the signal, the noise, and the signal+noise combination.

7.4.1.1.2 Results

7.4.1.1.2.1 Outdoor sites

Table 7.40 shows the main results of the coverage test for linear polarization schemes in Config. 1. A detailed view of all site measurements is in Appendix I.

Table 7.40 - Outdoor measured sites and main parameters of coverage and service (Config. 1).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -53.96 V: -51.74	31.28 33.12	-78.79 -76.59	H: 11.50 V: 13.59	11.50
2 (H) 2 (V)	H: -77.08 V: -69.45	11.71 17.17	-79.43 -71.79	H: 11.60 V: 18.94	11.60
3 (H) 3 (V)	H: -69.73 V: -65.48	14.93 17.80	-76.87 -73.53	H: 13.09 V: 17.28	13.09
4 (H) 4 (V)	H: -60.35 V: -60.10	26.75 26.23	-77.92 -77.69	H: 12.54 V: 12.45	12.45
5 (H) 5 (V)	H: -57.06 V: -56.43	27.42 28.15	-73.70 -73.06	H: 14.08 V: 14.32	14.08
6 (H) 6 (V)	H: -66.12 V: -69.62	18.27 15.18	-72.87 -73.34	H: 21.63 V: 21.35	21.35
7 (H) 7 (V)	H: -61.56 V: -57.31	22.18 22.13	-77.38 -73.39	H: 14.94 V: 19.17	14.94
8 (H) 8 (V)	H: -58.85 V: -55.05	22.36 24.88	-75.93 -72.69	H: 14.53 V: 17.34	14.53
9 (H) 9 (V)	H: -53.38 V: -49.95	32.93 35.46	-79.32 -76.03	H: 11.28 V: 14.53	11.28
10 (H) 10 (V)	H: -54.82 V: -50.69	31.29 33.92	-79.12 -75.33	H: 11.71 V: 15.35	11.71
11 (H) 11 (V)	H: -51.92 V: -49.48	28.12 32.70	-77.67 -74.80	H: 13.42 V: 15.71	13.42
12 (H) 12 (V)	H: -54.85 V: -53.55	31.58 31.84	-78.44 -77.18	H: 12.51 V: 13.50	12.51
13 (H) 13 (V)	H: -62.83 V: -59.98	17.20 19.65	-75.58 -72.41	H: 15.18 V: 17.79	15.18
14 (H) 14 (V)	H: -57.70 V: -58.79	27.86 29.12	-77.25 -78.52	H: 13.66 V: 12.08	12.08
15 (H) 15 (V)	H: -64.12 V: -61.41	27.71 28.01	-77.15 -77.16	H: 13.05 V: 12.86	12.86
16 (H) 16 (V)	H: -68.17 V: -64.73	19.44 22.93	-79.08 -75.36	H: 12.04 V: 15.80	12.04
17 (H) 17 (V)	H: -56.13 V: -56.93	29.96 28.98	-77.64 -78.25	H: 13.42 V: 12.36	12.36
18 (H) 18 (V)	H: -64.95 V: -62.58	15.53 15.53	-71.15 -69.04	H: 19.95 V: 21.97	19.95

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
19 (H) 19 (V)	H: -46.79 V: -47.93	34.74 32.57	-77.56 -78.65	H: 14.19 V: 13.02	13.02
20 (H) 20 (V)	H: -44.99 V: -44.97	37.60 36.80	-78.56 -78.63	H: 13.56 V: 13.23	13.23
21 (H) 21 (V)	H: -63.23 V: -64.54	20.96 22.59	-76.42 -77.73	H: 14.51 V: 12.71	12.71
22 (H) 22 (V)	H: -50.78 V: -52.74	30.37 31.26	-75.98 -77.79	H: 14.29 V: 12.04	12.04
23 (H) 23 (V)	H: -60.35 V: -61.52	25.42 23.18	-76.88 -78.06	H: 12.86 V: 11.14	11.14
24 (H) 24 (V)	H: -61.69 V: -65.22	24.41 21.43	-75.94 -79.28	H: 13.75 V: 9.69	9.69
25 (H) 25 (V)	H: -55.19 V: -53.86	27.98 30.71	-77.83 -76.28	H: 12.75 V: 13.84	12.75
26 (H) 26 (V)	H: -50.77 V: -49.31	33.77 35.51	-78.39 -77.01	H: 6.38 V: 13.49	6.38
27 (H) 27 (V)	H: -44.99 V: -44.97	37.60 36.80	-78.56 -78.63	H: 13.56 V: 13.23	13.23
28 (H) 28 (V)	H: -51.17 V: -49.53	34.92 35.90	-78.42 -76.88	H: 13.37 V: 14.49	13.37
29 (H) 29 (V)	H: -65.57 V: -60.96	16.61 17.12	-74.12 -69.79	H: 16.04 V: 20.35	16.04
30 (H) 30 (V)	H: -65.74 V: -64.70	16.17 17.70	-75.15 -75.46	H: 16.33 V: 14.29	14.29
MEDIAN C/N Minimum (dB)					12.81

Table 7.41 shows the main results of the coverage test for linear polarization schemes in Config. 3. As Config 3 is an extra measurement, it was expected to have a subset of 20 sites for outdoor and 4 sites for indoor measurements, besides a drive test. Nevertheless, due to mechanical issues in the measurement vehicle, we had a reduced number of outdoor sites, and we did not perform the drive test. A detailed view of all site measurements is in Appendix V.

Table 7.41 - Outdoor measured sites and main parameters of coverage and service (Config. 3).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	CN (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -53.83 V: -56.29	LA: -1.33; LB: 29.11 LA: -1.67; LB: 32.08	LA: -81.40; LB: -74.13 LA: -83.86; LB: -76.98	H(LA): 8.64; V(LA): 5.87 H(LB): 16.19; V(LB): 13.44	LA: 5.87 LB: 13.44
3 (H) 3 (V)	H: -67.83 V: -68.53	LA: -1.94; LB: 15.50 LA: -1.80; LB: 14.36	LA: -80.65; LB: -70.74 LA: -81.71; LB: -71.97	H(LA): 11.11; V(LA): 9.89 H(LB): 19.80; V(LB): 18.57	LA: 9.89 LB: 18.57

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	CN (dB)	C/N Minimum (dB)
4 (H) 4 (V)	H: -64.98 V: -65.27	LA: -1.60; LB: 21.14 LA: -1.63; LB: 21.53	LA: -81.86; LB: -74.30 LA: -81.92; LB: -74.44	H(LA): 8.55; V(LA): 7.69 H(LB): 18.81; V(LB): 17.82	LA: 7.69 LB: 17.82
6 (H) 6 (V)	H: -61.00 V: -62.57	LA: -1.68; LB: 21.40 LA: -1.42; LB: 20.74	LA: -78.39; LB: -68.24 LA: -81.34; LB: -70.30	H(LA): 12.77; V(LA): 10.55 H(LB): 21.18; V(LB): 18.84	LA: 10.55 LB: 18.84
7 (H) 7 (V)	H: -50.60 V: -54.13	LA: -1.44; LB: 29.40 LA: -1.40; LB: 33.29	LA: -80.58; LB: -73.40 LA: -83.54; LB: -76.83	H(LA): 10.93; V(LA): 6.87 H(LB): 18.78; V(LB): 14.65	LA: 6.87 LB: 14.65
8 (H) 8 (V)	H: -59.00 V: -62.10	LA: -1.71; LB: 18.95 LA: -1.53; LB: 21.11	LA: -78.65; LB: -68.62 LA: -82.13; LB: -72.37	H(LA): 11.19; V(LA): 8.24 H(LB): 20.98; V(LB): 17.83	LA: 8.24 LB: 17.83
12 (H) 12 (V)	H: -55.92 V: -57.64	LA: -1.31; LB: 28.88 LA: -1.39; LB: 30.19	LA: -82.35; LB: -74.33 LA: -83.69; LB: -76.17	H(LA): 16.51; V(LA): 14.99 H(LB): 7.51; V(LB): 6.14	LA: 14.99 LB: 6.14
17 (H) 17 (V)	H: -57.62 V: -58.00	LA: -1.36; LB: 28.08 LA: -1.33; LB: 28.92	LA: -83.36; LB: -75.25 LA: -83.59; LB: -75.50	H(LA): 7.49; V(LA): 6.81 H(LB): 15.45; V(LB): 14.64	LA: 6.81 LB: 14.64
18 (H) 18 (V)	H: -61.51 V: -61.42	LA: -1.58; LB: 23.94 LA: -1.79; LB: 16.45	LA: -80.96; LB: -71.15 LA: -80.58; LB: -71.23	H(LA): 10.27; V(LA): 10.11 H(LB): 20.16; V(LB): 19.84	LA: 10.11 LB: 19.84
24 (H) 24 (V)	H: -57.39 V: -51.28	LA: -1.27; LB: 34.02 LA: -1.34; LB: 27.41	LA: -85.53; LB: -77.71 LA: -80.59; LB: -72.16	H(LA): 3.09; V(LA): 8.94 H(LB): 12.39; V(LB): 18.26	LA: 3.09 LB: 12.39
28 (H) 28 (V)	H: -55.44 V: -55.38	LA: -1.19; LB: 30.42 LA: -1.43; LB: 29.94	LA: -82.01; LB: -74.56 LA: -81.48; LB: -74.00	H(LA): 8.90; V(LA): 8.71 H(LB): 18.36; V(LB): 18.07	LA: 8.71 LB: 18.07
MEDIAN C/N Minimum (dB)					LA: 8.24 LB: 17.82

7.4.1.1.2.2 Indoor sites

Table 7.42 shows the main results of the coverage test for linear polarization schemes in Config. 1. A detailed view of all site measurements is in Appendix II.

Table 7.42 - Indoor measured sites and main parameters of coverage and service (Config. 1).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -62.77 V: -59.69	18.79 21.38	-77.03 -74.46	H: 12.80 V: 16.40	12.80
3 (H) 3 (V)	H: -64.66 V: -59.95	19.46 22.46	-76.88 -72.33	H: 13.19 V: 17.36	13.19
17 (H) 17 (V)	H: -73.93 V: -67.12	17.40 14.30	-76.12 -70.94	H: 12.62 V: 20.31	12.62
18 (H) 18 (V)	H: -69.33 V: -70.33	16.92 16.30	-74.14 -75.06	H: 15.42 V: 14.19	14.19

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
20 (H) 20 (V)	H: -60.75 V: -56.72	23.06 29.21	-79.21 -75.17	H: 12.38 V: 15.64	12.38
21 (H) 21 (V)	H: -69.67 V: -61.95	9.31 17.38	-76.88 -68.48	H: 14.93 V: 23.05	14.93
27 (H) 27 (V)	H: -63.36 V: -67.19	18.60 15.60	-70.80 -74.29	H: 20.92 V: 15.94	15.94
28 (H) 28 (V)	H: -66.35 V: -66.76	17.3 17.9	-72.42 -73.15	H: 21.63 V: 21.72	21.63
29 (H) 29 (V)	H: -73.20 V: -75.75	11.78 10.68	-73.36 -76.06	H: 17.48 V: 14.40	14.40
MEDIAN C/N Minimum (dB)					14.19

Table 7.43 shows the main results of the coverage test for linear polarization schemes in Config. 3. MER, system margin, and C/N at threshold are provided in function of polarization and layer. We highlight that, as an extra measurement campaign, we selected a subset of the indoor sites, due to schedule restrictions. A detailed view of all site measurements is in Appendix VI.

Table 7.43 - Indoor measured sites and main parameters of coverage and service (Config. 3).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -63.43 V: -62.66	LA: -1.76; LB: 18.03 LA: -1.88; LB: 15.58	LA: -81.03; LB: -72.22 LA: -80.56; LB: -71.63	H(LA): 8.82; V(LA): 9.04 H(LB): 12.29; V(LB): 13.06	LA: 8.82 LB: 12.29
3 (H) 3 (V)	H: -63.60 V: -59.93	LA: -1.58; LB: 19.24 LA: -1.80; LB: 18.39	LA: -82.05; LB: -73.83 LA: -78.98; LB: -70.38	H(LA): 7.04; V(LA): 10.22 H(LB): 15.84; V(LB): 18.88	LA: 7.04 LB: 15.84
17 (H) 17 (V)	H: -57.62 V: -58.00	LA: -1.36; LB: 28.08 LA: -1.33; LB: 28.92	LA: -83.36; LB: -75.25 LA: -83.59; LB: -75.50	H(LA): 7.49; V(LA): 6.81 H(LB): 15.45; V(LB): 14.64	LA: 6.81 LB: 14.64
18 (H) 18 (V)	H: -70.08 V: -69.07	LA: -1.91; LB: 16.53 LA: -1.77; LB:17.83	LA: -81.79; LB: -74.88 LA: -81.03; LB: -73.87	H(LA): 7.33; V(LA): 8.09 H(LB): 15.96; V(LB): 16.67	LA: 7.33 LB: 15.96
21 (H) 21 (V)	H: -69.39 V: -63.47	LA: -1.70; LB: 16.03 LA: -1.64; LB: 19.81	LA: -83.45; LB: -75.61 LA: -78.31; LB: -70.38	H(LA): 6.42; V(LA): 11.64 H(LB): 15.71; V(LB): 20.89	LA: 6.42 LB: 15.71
MEDIAN C/N Minimum (dB)					LA: 7.04 LB: 15.71

7.4.1.2 Service Measurement

We conducted Service Measurement in parallel to the Coverage Measurement. A detailed report of each site's measurements is in our Appendixes.

We measured the noise floor by a marker on the Spectrum Analyzer screen in the channel power condition in each site. It was not possible to turn off the transmitter at each site to measure the channel power of the noise itself. The Rintaro provided delay profile and cross-polarization analysis data.

Concerning the service provision, as previously explained, when the reception conditions in the site were not good and errors occurred even without any attenuation or noise, we could measure neither C/N at TOV nor system margin. These situations happened with signals generally below -85 dBm. In those cases, the BCHerr flag indicated error rates, and the bit recovery became impracticable. The more delayed versions of the signal are responsible for the distortion leading to selective fading.

We could not perform video and audio measurements, as we used PRBS for the tests.

We didn’t test channel bonding because of transmission site and time constraints.

7.4.1.2.1 Reuse-1 test

We ran this test on 4 sites, most of them on a sunny day, and there was traffic on the street.

7.4.1.2.1.1 Test methodology

The objective of the test is to evaluate the condition under reuse-1 in threshold conditions. Hence, we want to verify the performance of the system under two different scenarios. First, we want to assess whether the system can keep tuned to one transmitter when another transmitter has similar reception power at a specific channel coding rate. The idea is that the receiver must be able to keep tuned to one transmitter even if more than one transmitter covering the same area has similar power in that place. The C/N ≤ 0 dB under a frame error rate threshold given by the BCHerror flag guarantees that the system can operate even in the presence of high interference, which is a condition for reuse-1, but it does not guarantee that the system will be able to deliver a regular lock to a single transmitter. We observed the Carrier Error in the demodulator software in order to observe the transmitter lock. The software presented a Carrier Error positive for one transmitter and negative for the other.

In the second scenario, a Site and azimuth were sought so that the difference of the received signal of each base station was approximately 16 dB. As defined in the standard, the idea is to check the performance of the system where the transmitters use directional antennas.

Hence, we performed the test rotating the antenna on the pole, at ~10 m from the floor, as shown in Figure 7.115. We rotated the antenna considering azimuths from 0º to 360º, covering both transmitters’ reception areas in the test location. We took note of the channel power at each azimuth, viewing, first, only Penna station transmission and then, only Sumaré station transmission, using two Tektronix Spectrum Analyzer (RSA306B) with the configuration on Table 7.44, one for each polarization. We used this procedure to find an azimuth for each polarization in which both Penna and Sumaré presented similar channel power, simulating the threshold condition of reuse-1.

Figure 7.115 - Arrangement of antenna in the reuse-1 test in both polarization schemes.

Table 7.44 - Tektronix Spectrum Analyzer (RSA306B) parameters.

Parameter	Value
Reference level	-40.0 dBm
Attenuation	0 dBm
RBW	3 kHz
VBW	1 kHz
Channel bandwidth	6 MHz
Center frequency	569.143 MHz
Span	30 MHz

After the scan, we positioned the antenna in the selected azimuths and rechecked the received power. The idea is to guarantee that the receiver would tune to a single station. After that, we turned on both transmitters simultaneously. In our scenario, the receiver tuned to Penna station. It is important to highlight that for this test an offset of 386 Hz was included in the transmission of the Penna station (569.143243 MHz), in relation to the transmission frequency of Sumaré station (569.142857 MHz).

We consider the test successful if the receiver remains connected to one transmitter without reception errors verified by the BCHerror flag available at the Socionext software for at least half hour. If the BCHerror flag returned “error” during the test or Carrier Error indicated a change in the transmission station, the channel coding rate was modified to a more robust one, and the test started again with the new configuration. The channel code rates that have been considered were 4/16, 3/16 and 2/16 for Layer A tests and 8/16 and 4/16 for Layer B. We highlight that the layers were tested separately, in different sites, as we consider the threshold condition of C/N ≤ 0 dB for Layer A and C/N ≤ 16 dB for Layer B. This means that both transmitters present similar channel power in the site for Layer A and the difference between channel powers is 16 dB for Layer B.

According to the previous results from laboratory tests for Advanced ISDB-T (see the Phase 3 Over-the-air Physical Layer laboratory tests report, available at https://forumsbtvd.org.br/wp-content/uploads/2023/11/SBTVD-TV_3_0-P3-PL-Lab-Report.pdf), we used the following transmitter configuration, as summarized in Table 7.45.

Table 7.45 - Advanced ISDB-T configuration for the reuse-1 test.

Parameter	LA	LB
Useful bandwidth	5.83 MHz	
Modulation	QPSK	256-QAM
Constellation	UC	NUC
Error Correction	LDPC+BCH	LDPC+BCH
FEC	4/16	8/16
IFFT Size	16384	
GI Ratio	800/16384 (126 μS)	
Dx	6	
Dy	2	
Time Interleaving	I=3	
Number of Segments	25	10
Bitrate (Mbps)	3.48	11.23

7.4.1.2.1.2 Results

Table 7.46 shows the configuration of each site in terms of layer, FEC, azimuth, and channel power for each station transmitting separately and both transmitting at the same time when the reuse-1 condition is met. It can be observed that, in the four tested Sites (17, 18, 19 and 25), it was possible to find a half-hour window without errors in all the tests conducted by increasing the signal robustness. For the C/N around 0 dB tests, in Layer A, the highest achievable rates were using FEC 2/16 and 3/16 while for Layer B tests, at the point where the C/N was around 16 dB, the best rates were using FEC 8/16 and 4/16.

In the next subsections, for each evaluated site, we show the channel power of the received signal for Sumaré transmitter (Penna is off), for Penna transmitter (Sumaré is off), and both signals combined. We also show the results presented by the receiver (Socionext software) in each case, which also shows the resulting constellation and the status of the flag BCH for each layer. The results of this measurement campaign are depicted in Figures 7.116 to 7.145.

Table 7.46 - Advanced ISDB-T results for the reuse-1 test.

Site	Layer	FEC	Polarization	Azimuth	TX1 - Sumaré channel power (dBm)	TX2 - Penna channel power (dBm)	Difference (TX1- TX2) (dB)	Channel power with reuse-1 (dBm)
17	B	4/16	Vertical	10º	-78.40	-62.00	-16.4	-63.39
			Horizontal		-73.70	-57.30	-16.4	-56.19
18	A	3/16	Vertical	240º	-76.01	-74.10	-1.91	-71.92
			Horizontal		-73.68	-73.18	-0.50	-70.79
19	B	8/16	Vertical	160º	-65.55	-49.72	-15.83	-49.61
			Horizontal		-64.10	-48.04	-16.00	-48.09
25	A	2/16	Vertical	190º	-57.73	-56.94	-0.79	-54.44
			Horizontal		-52.07	-53.28	1.21	-50.21

a) Site 17 - Layer B Test

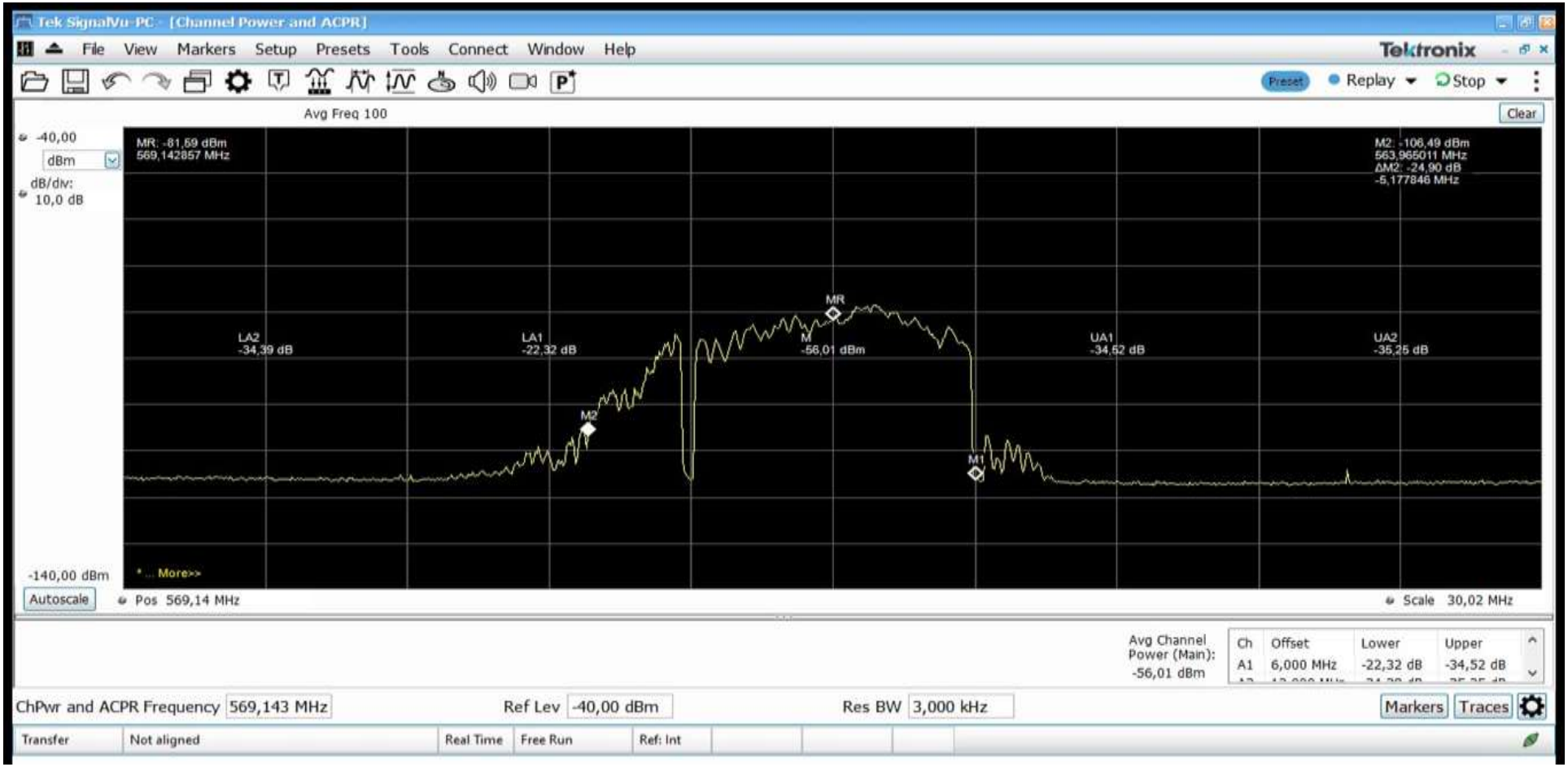


Figure 7.116 - Site 17, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

Figure 7.117 - Site 17, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

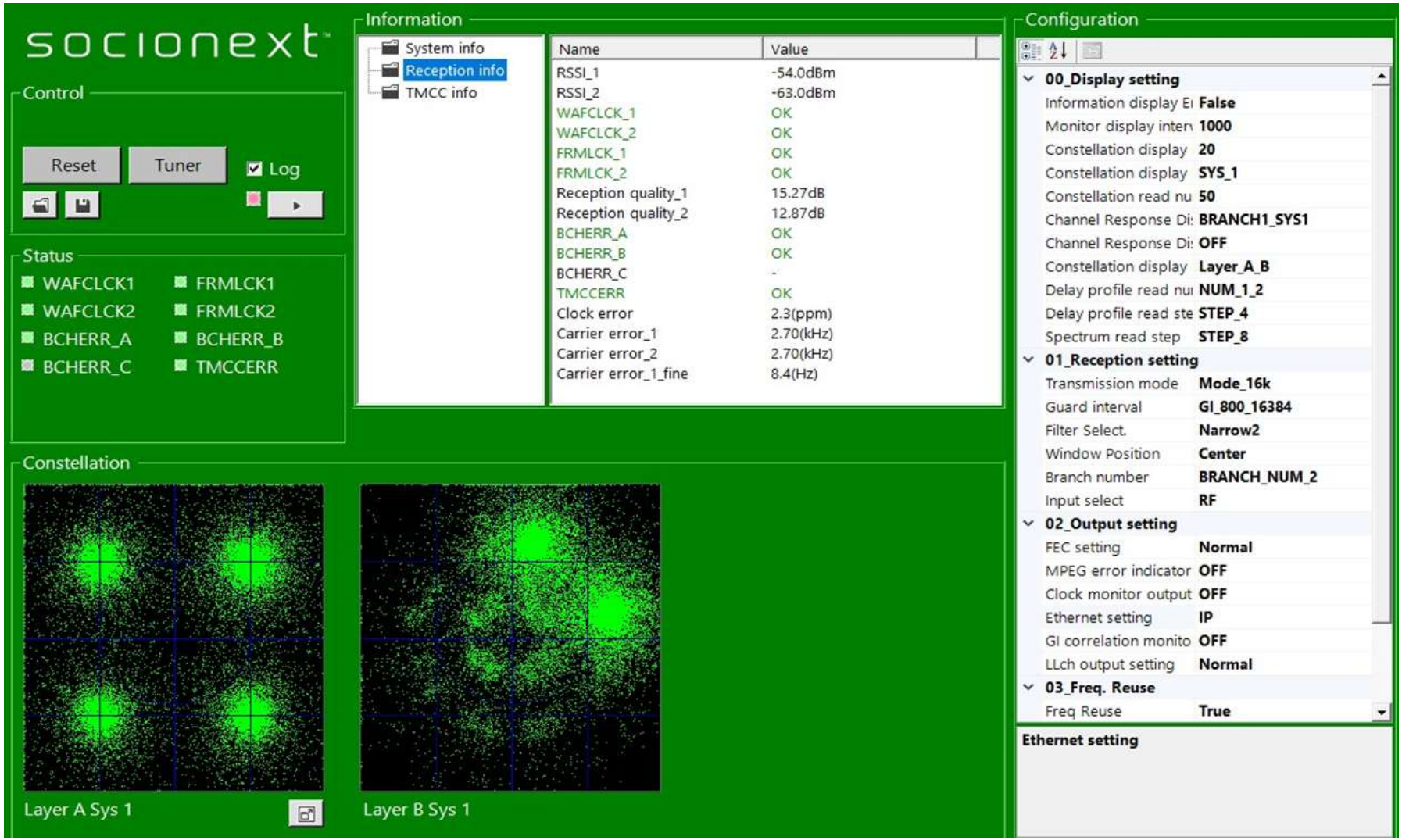


Figure 7.118 - Site 17, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna and Sumaré stations.

b) Site 18 - Layer A

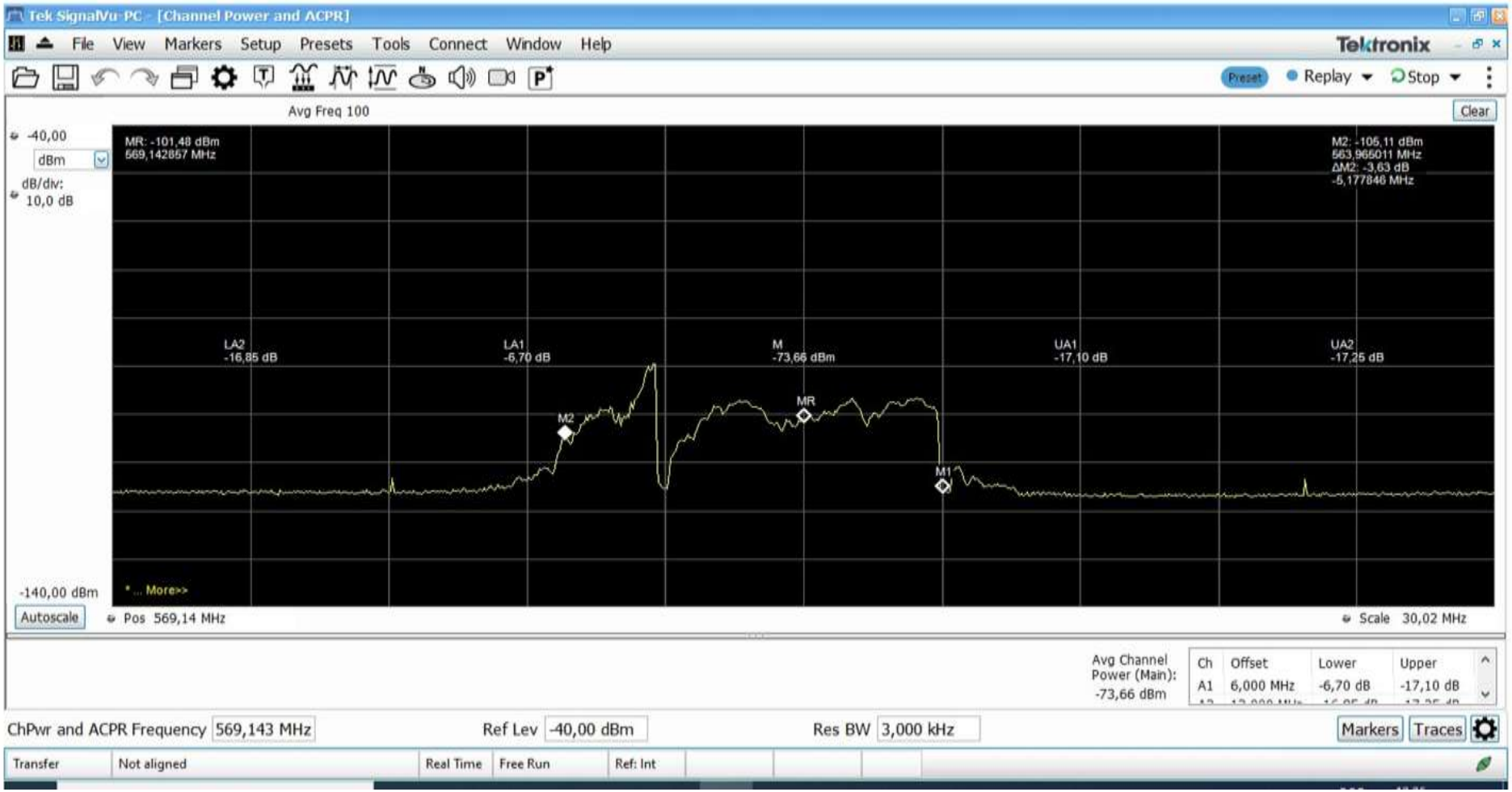


Figure 7.119 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

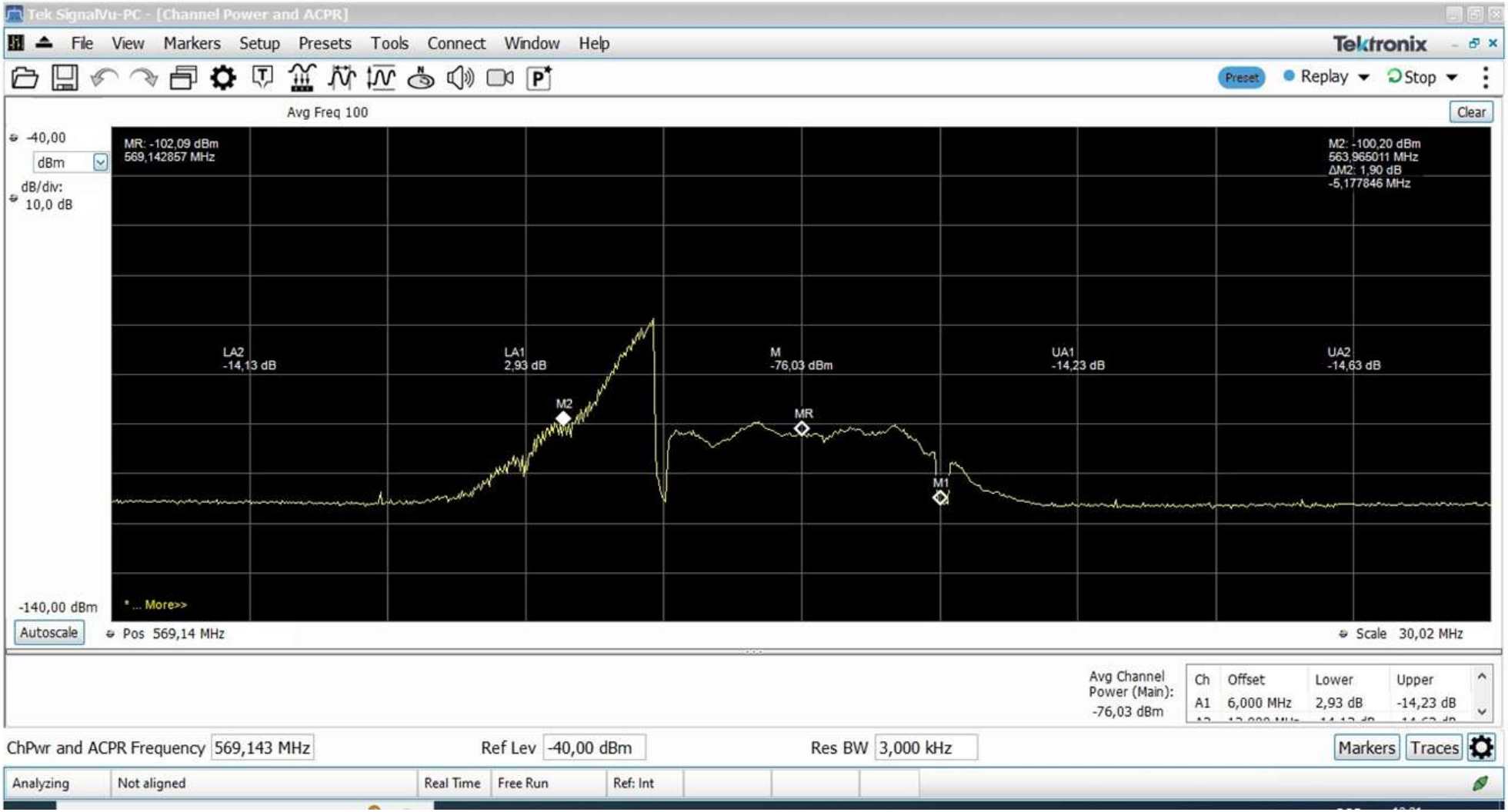


Figure 7.120 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

Figure 7.121 - Site 18, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Sumaré station.

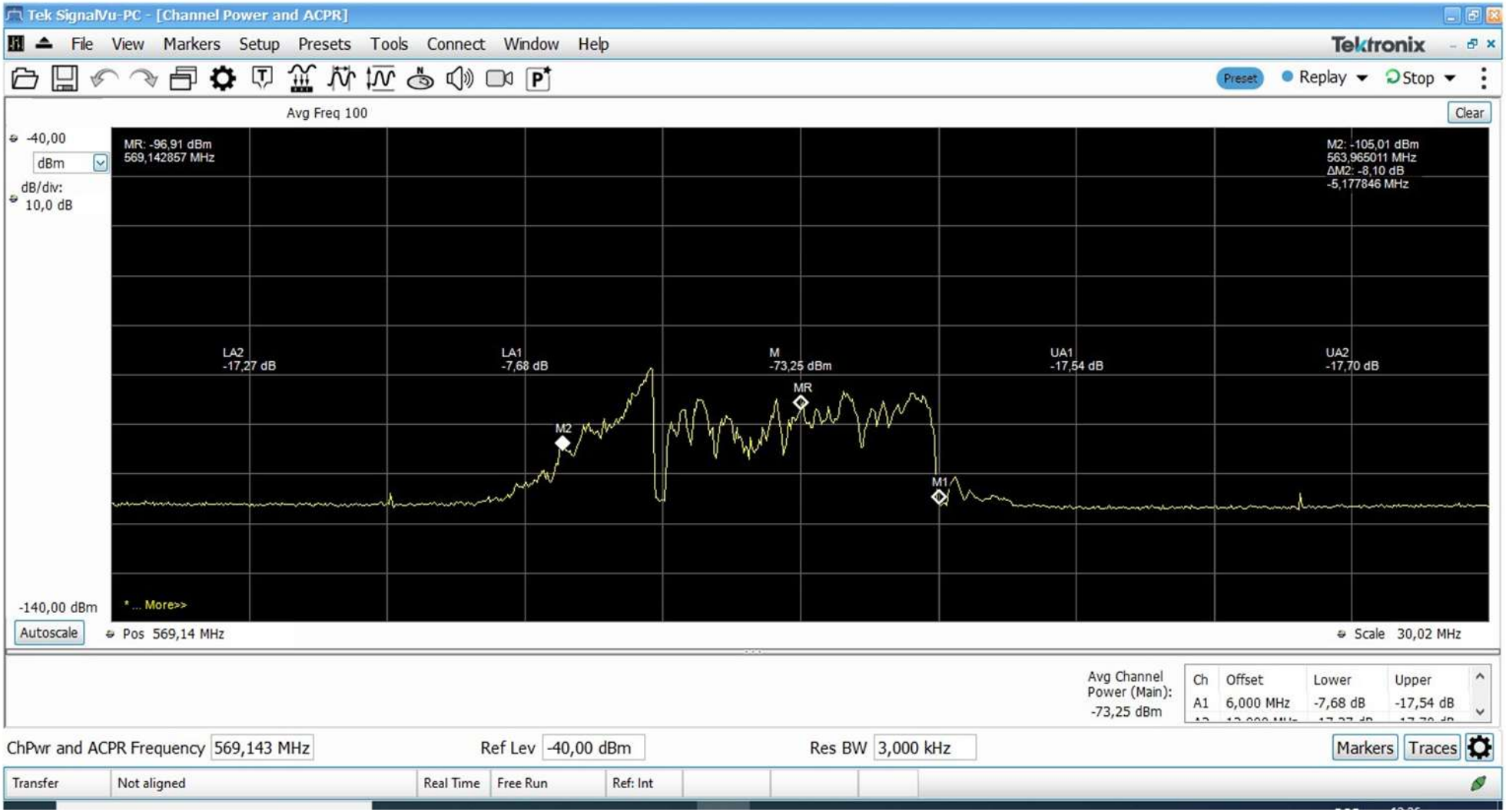


Figure 7.122 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

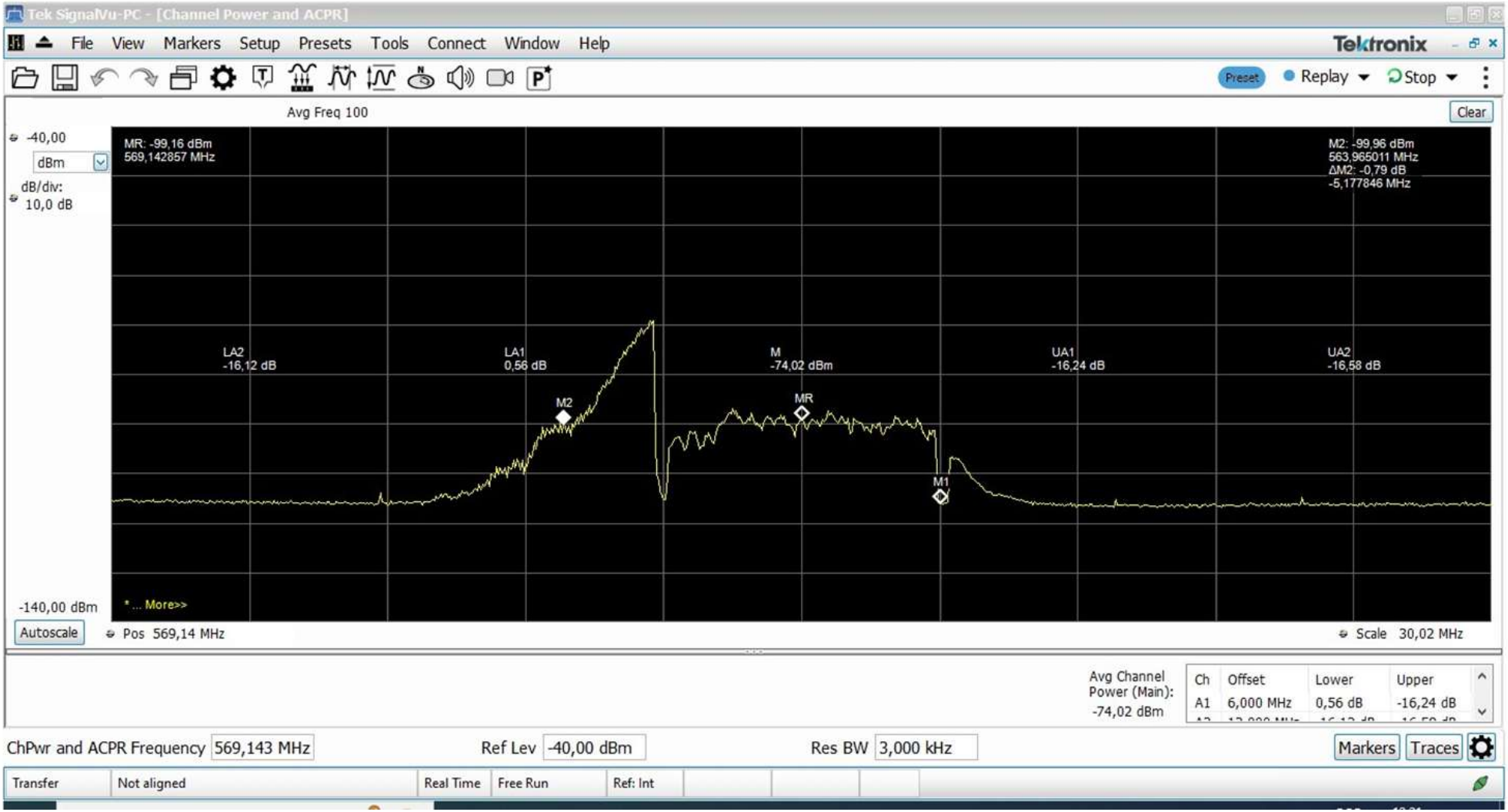


Figure 7.123 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

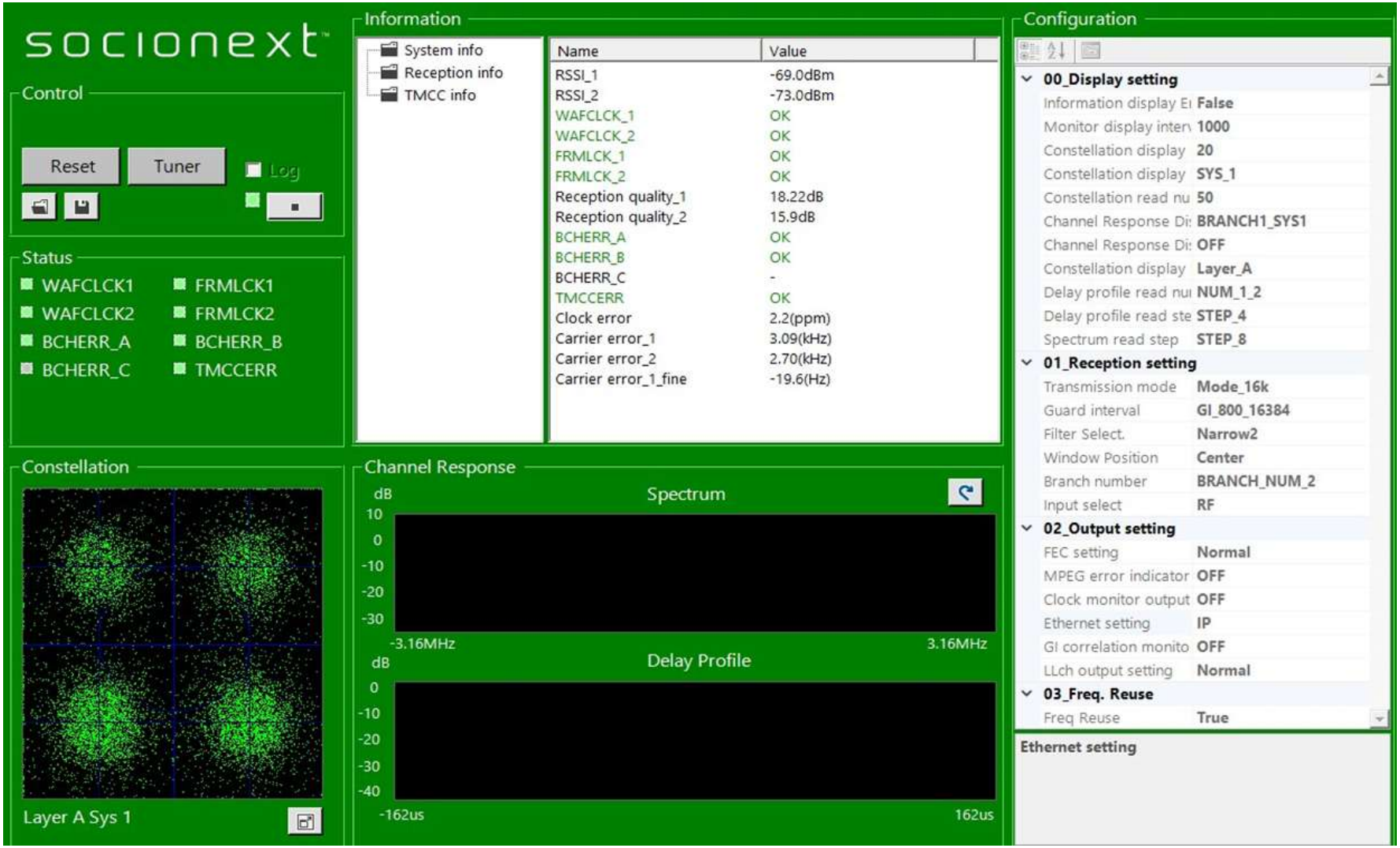


Figure 7.124 - Site 18, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna station.

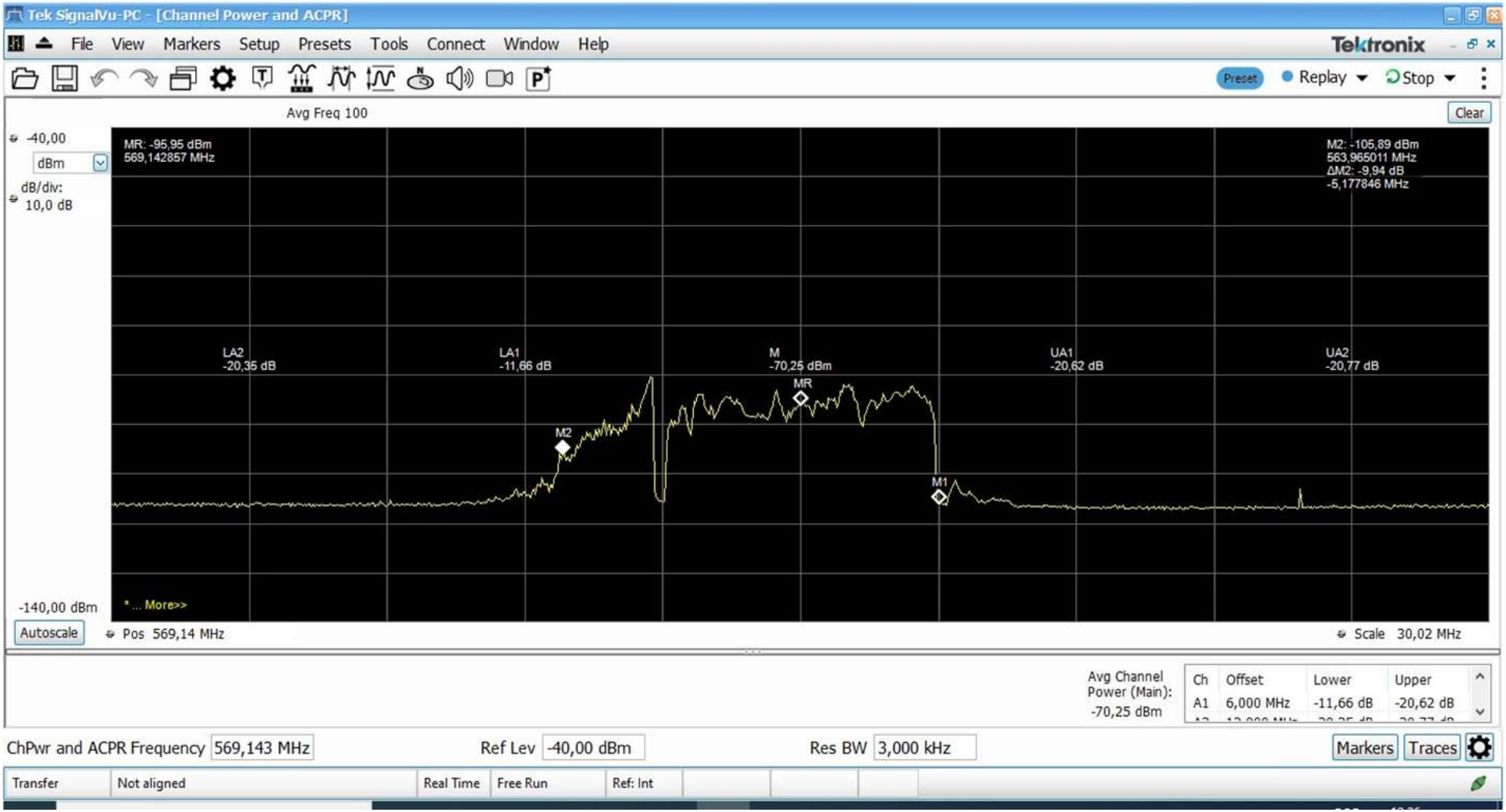


Figure 7.125 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

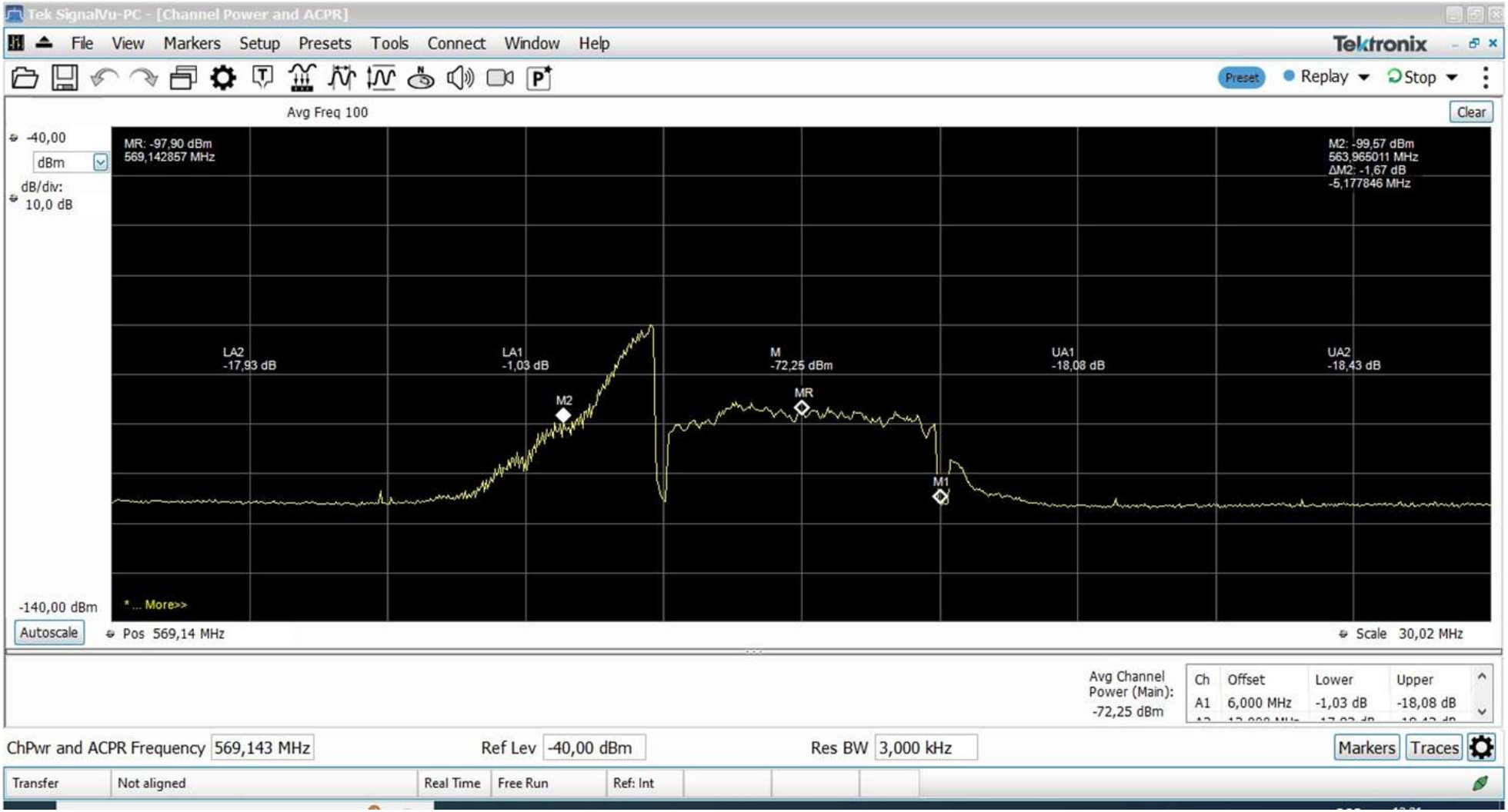


Figure 7.126 - Site 18, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

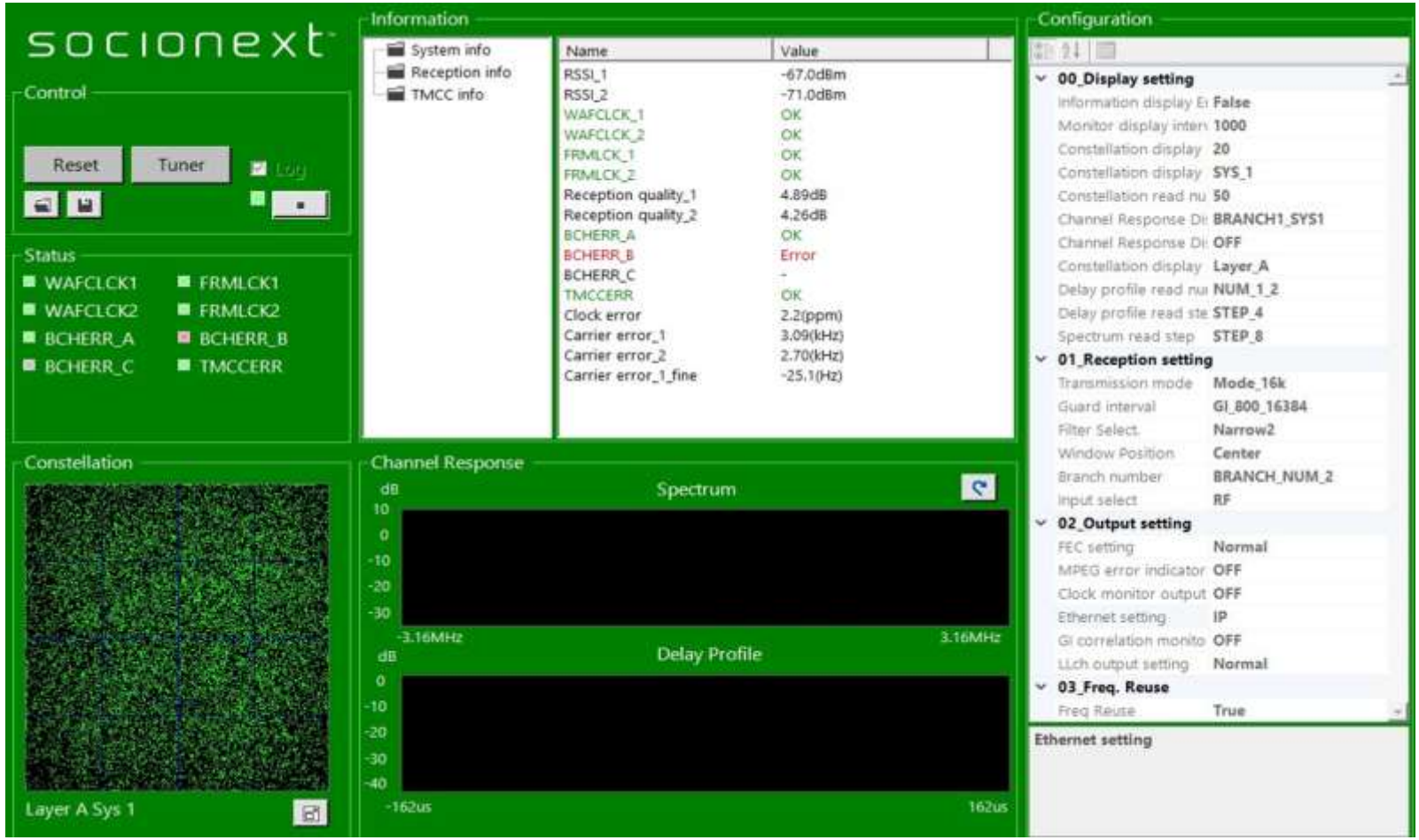


Figure 7.127 - Site 18, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna and Sumaré stations.

c) Site 19 - Layer A

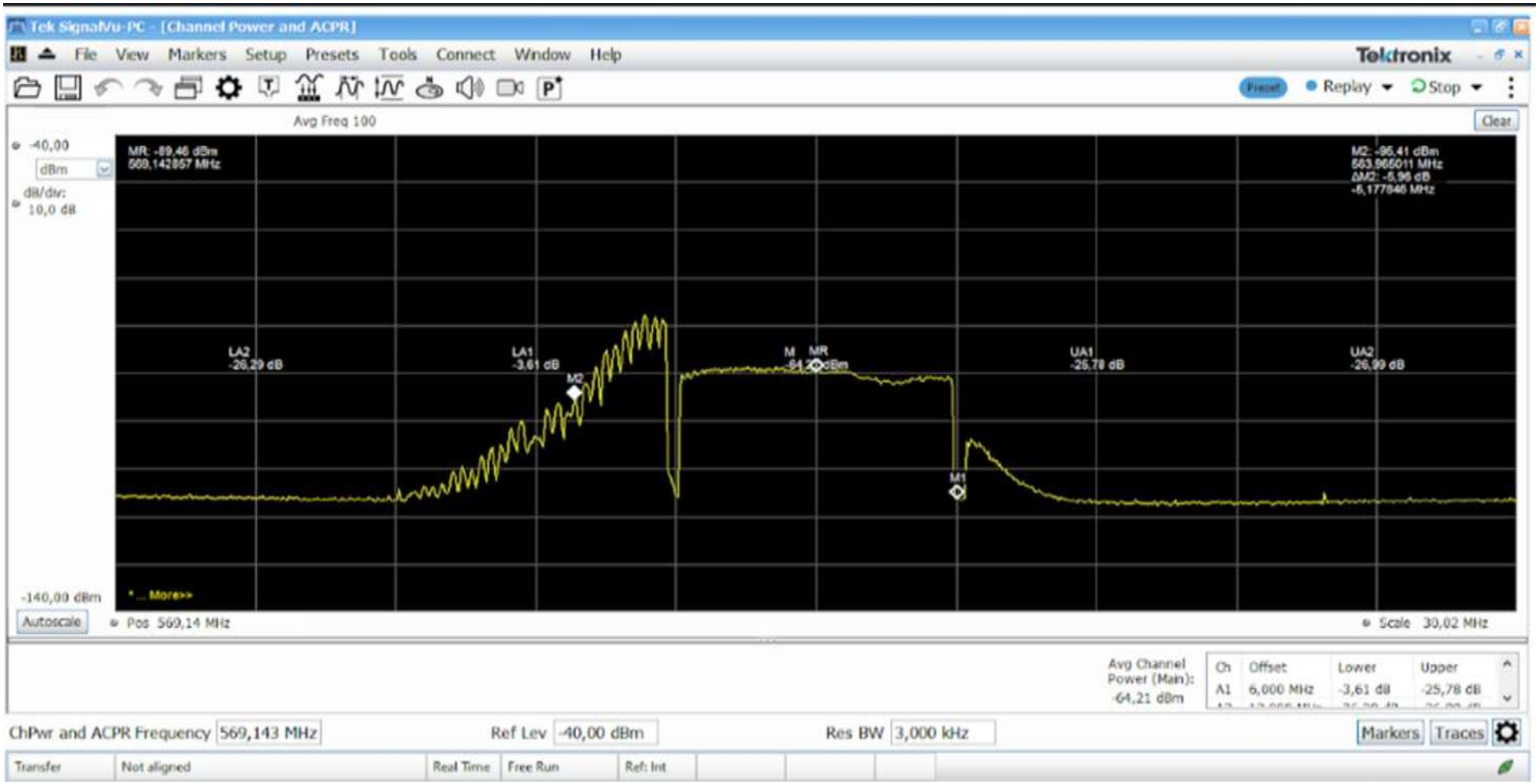


Figure 7.128 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

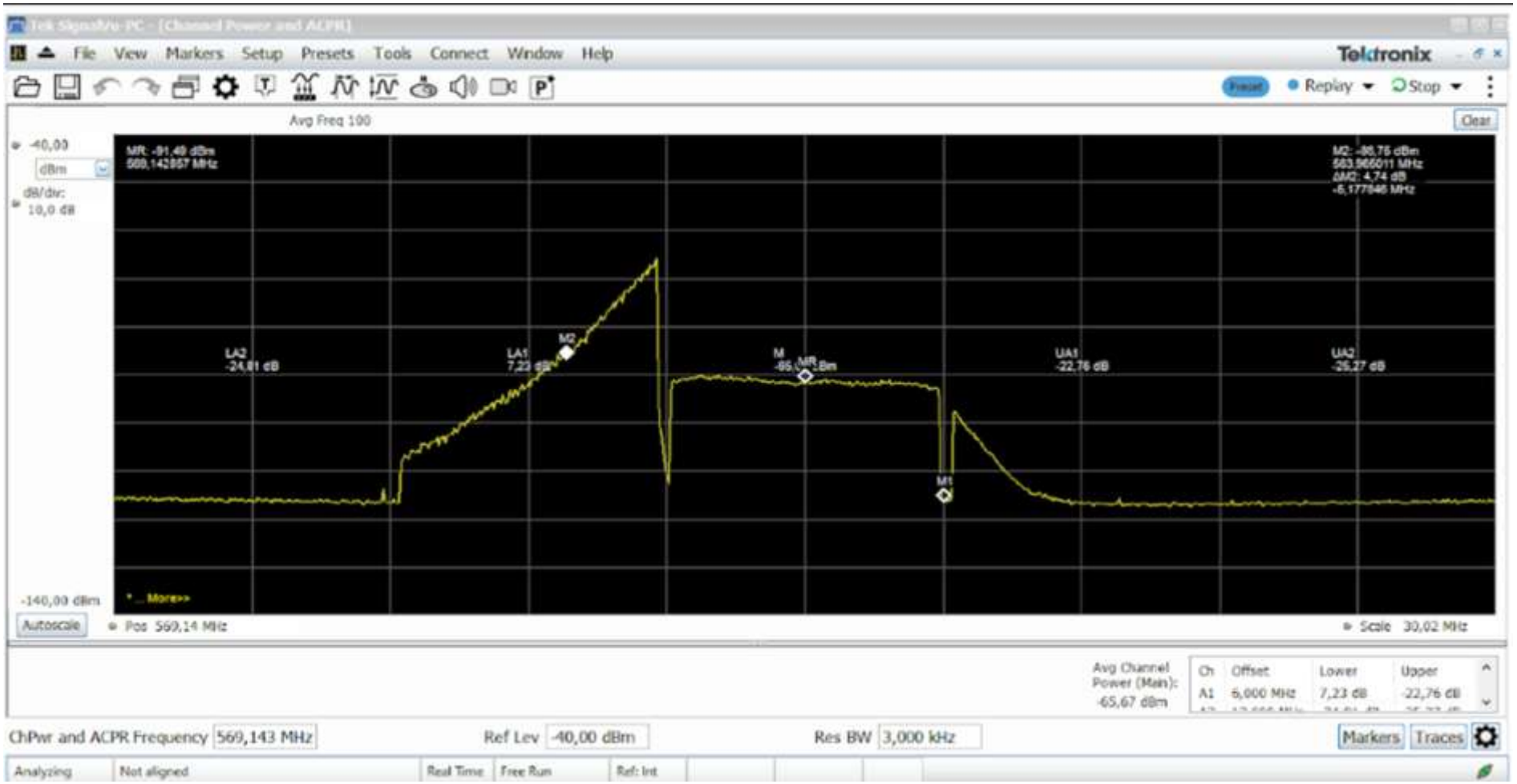


Figure 7.129 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

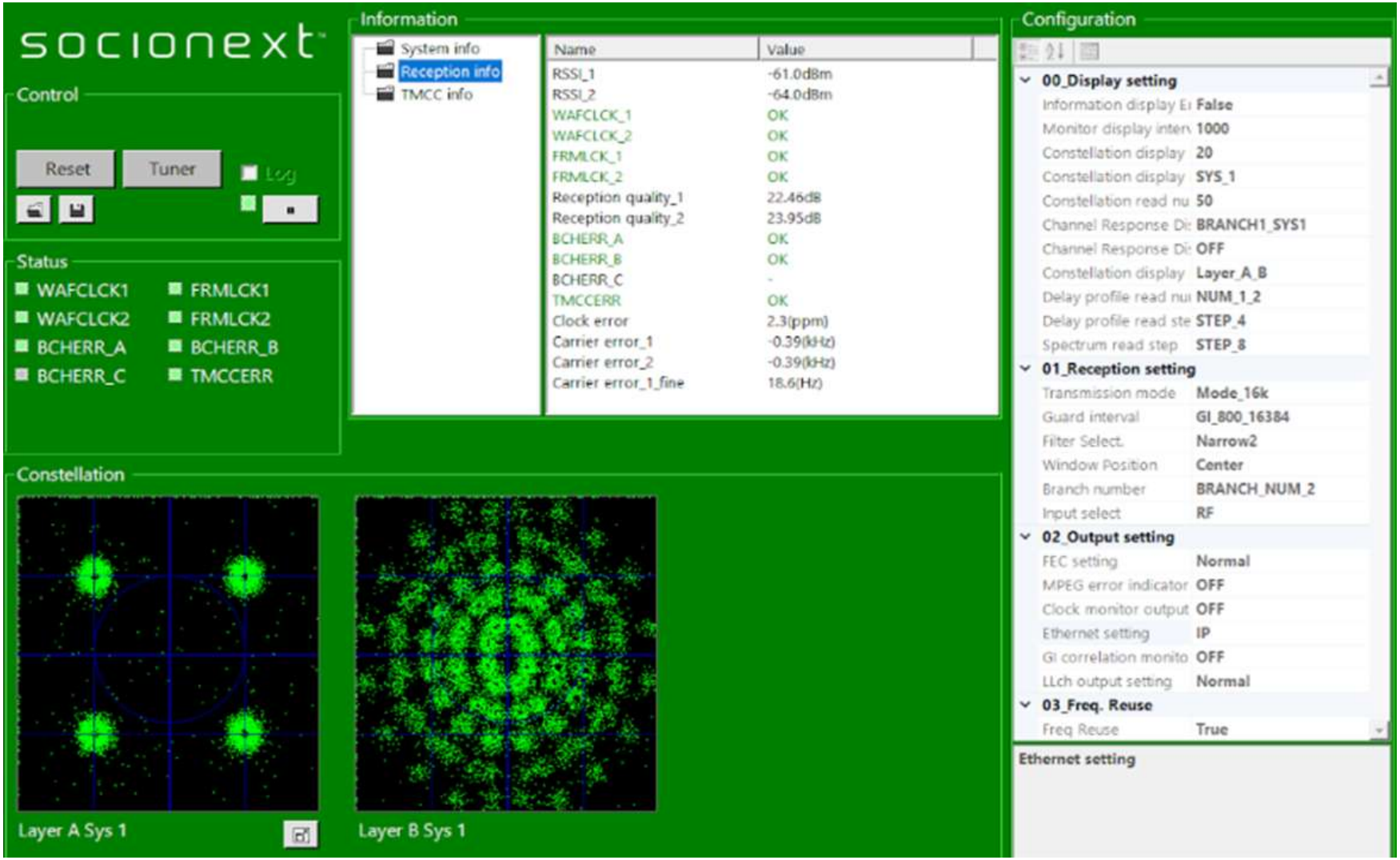


Figure 7.130 - Site 19, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Sumaré station.

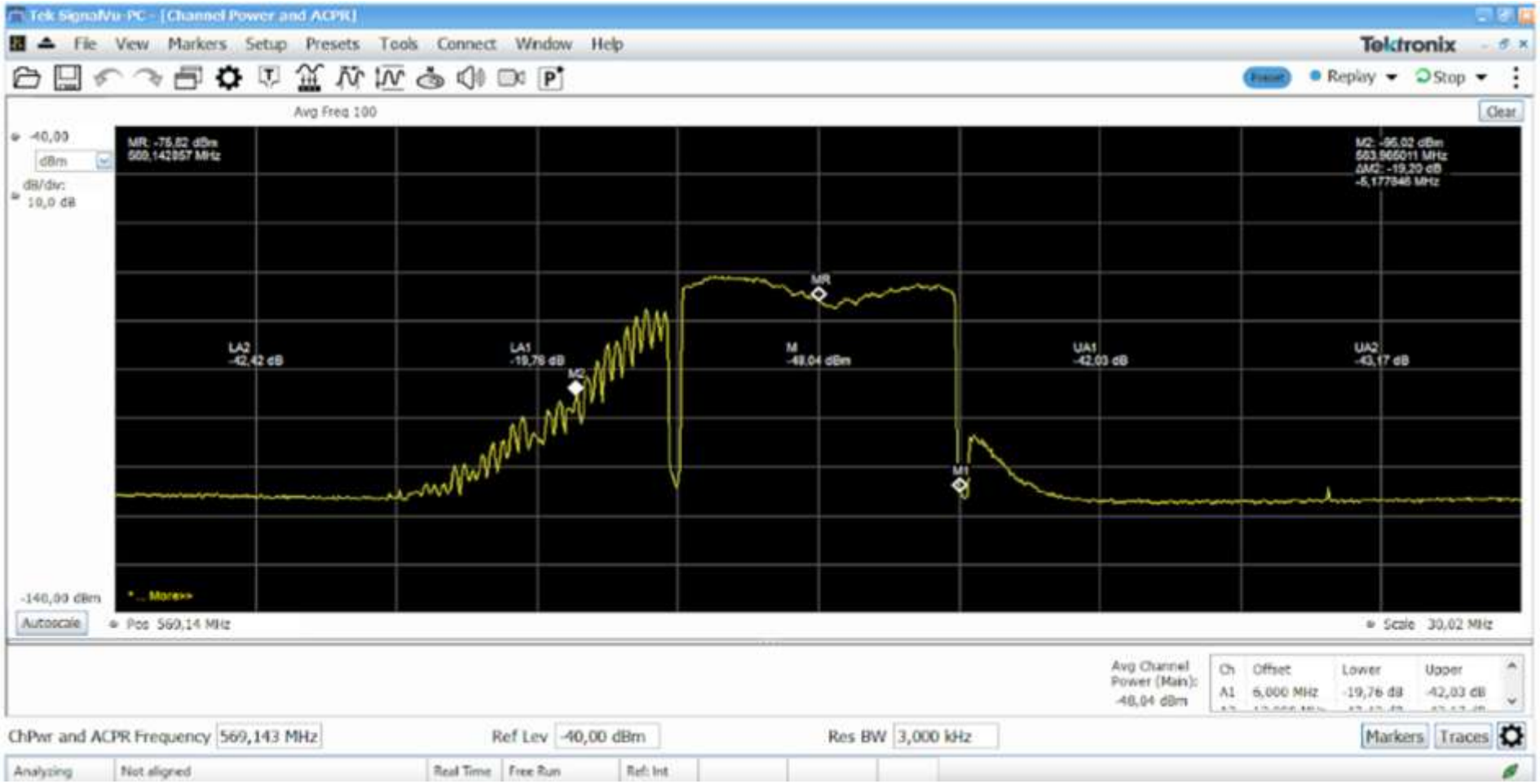


Figure 7.131 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

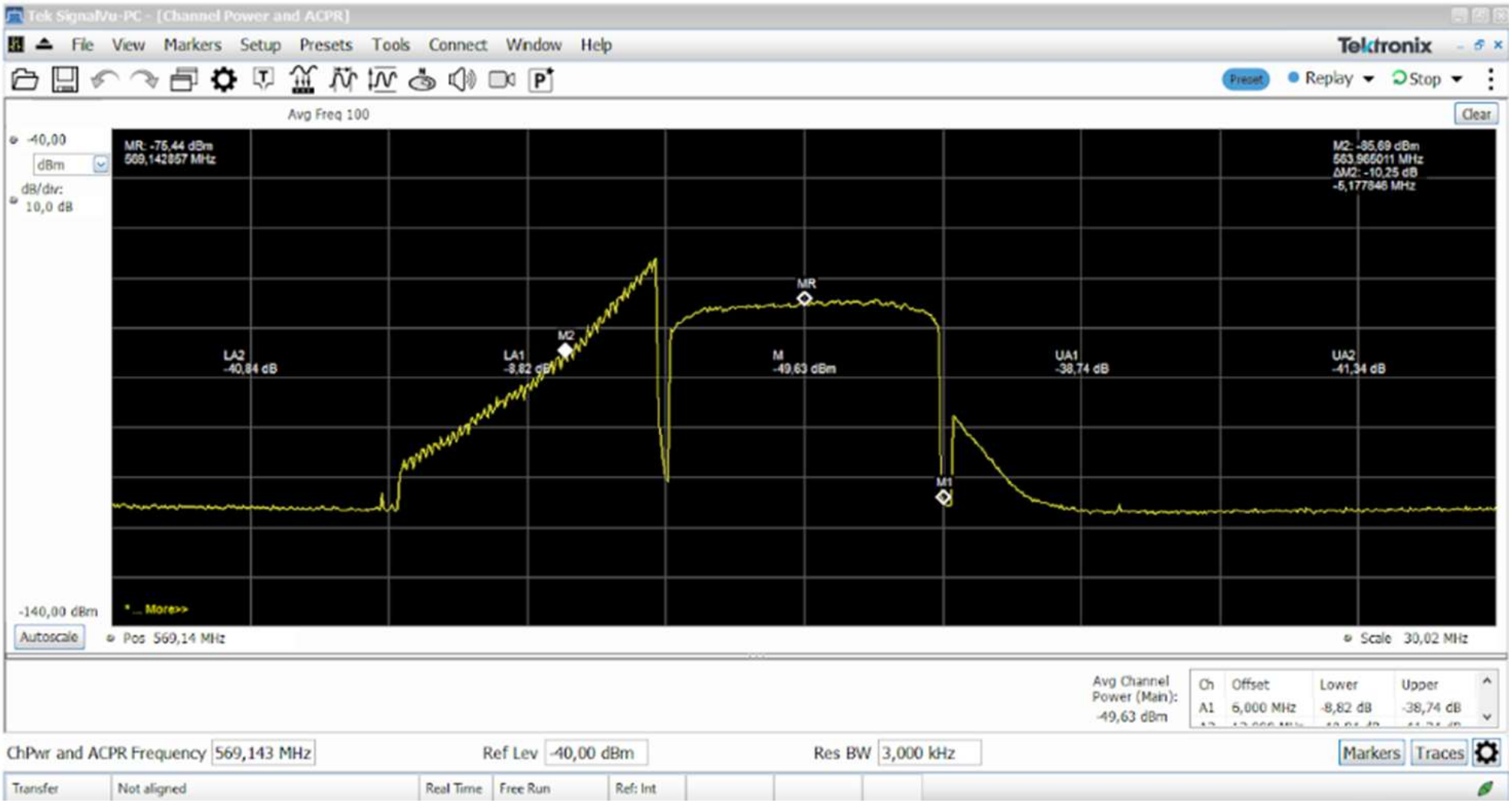


Figure 7.132 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

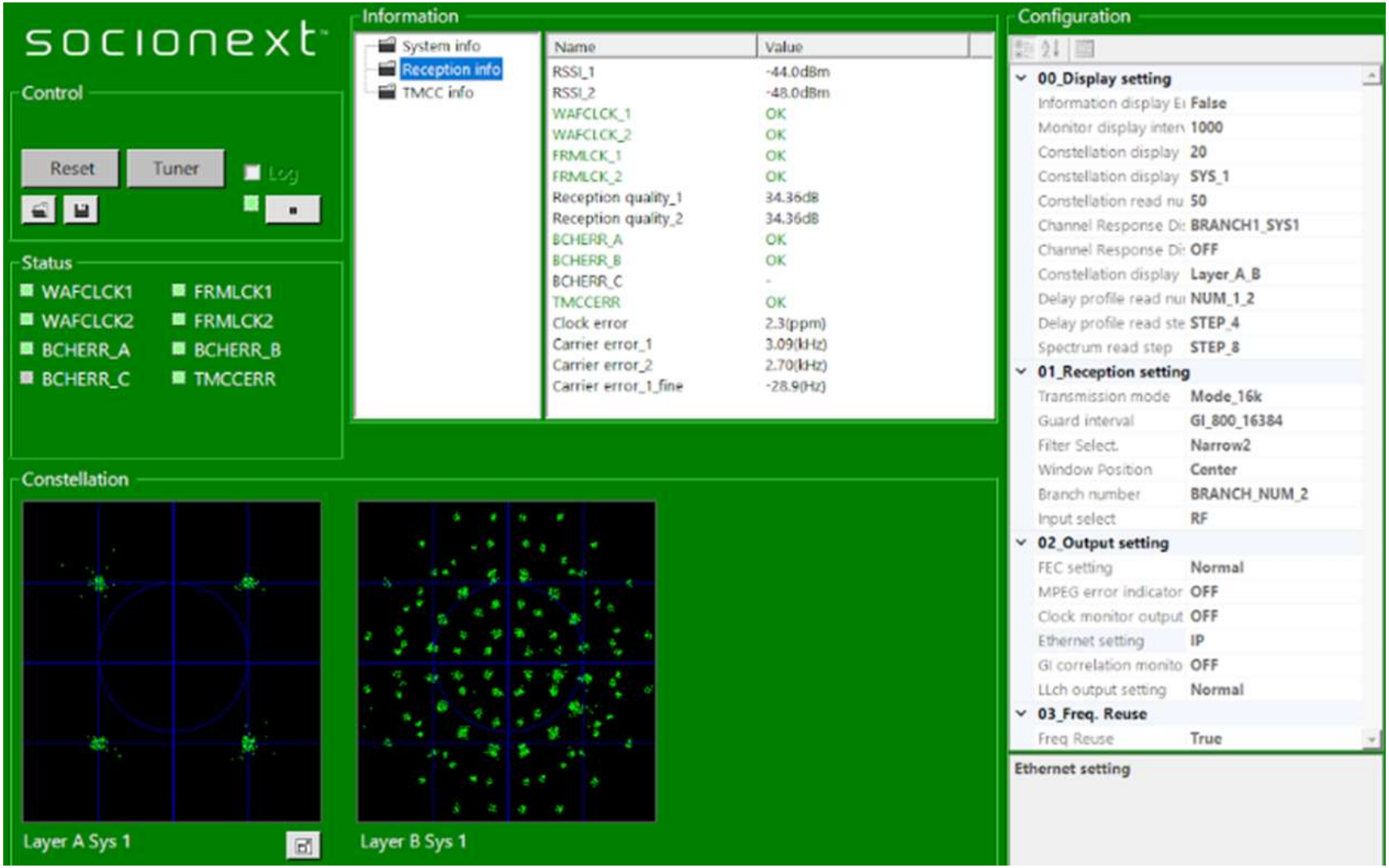


Figure 7.133 - Site 19, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna station.

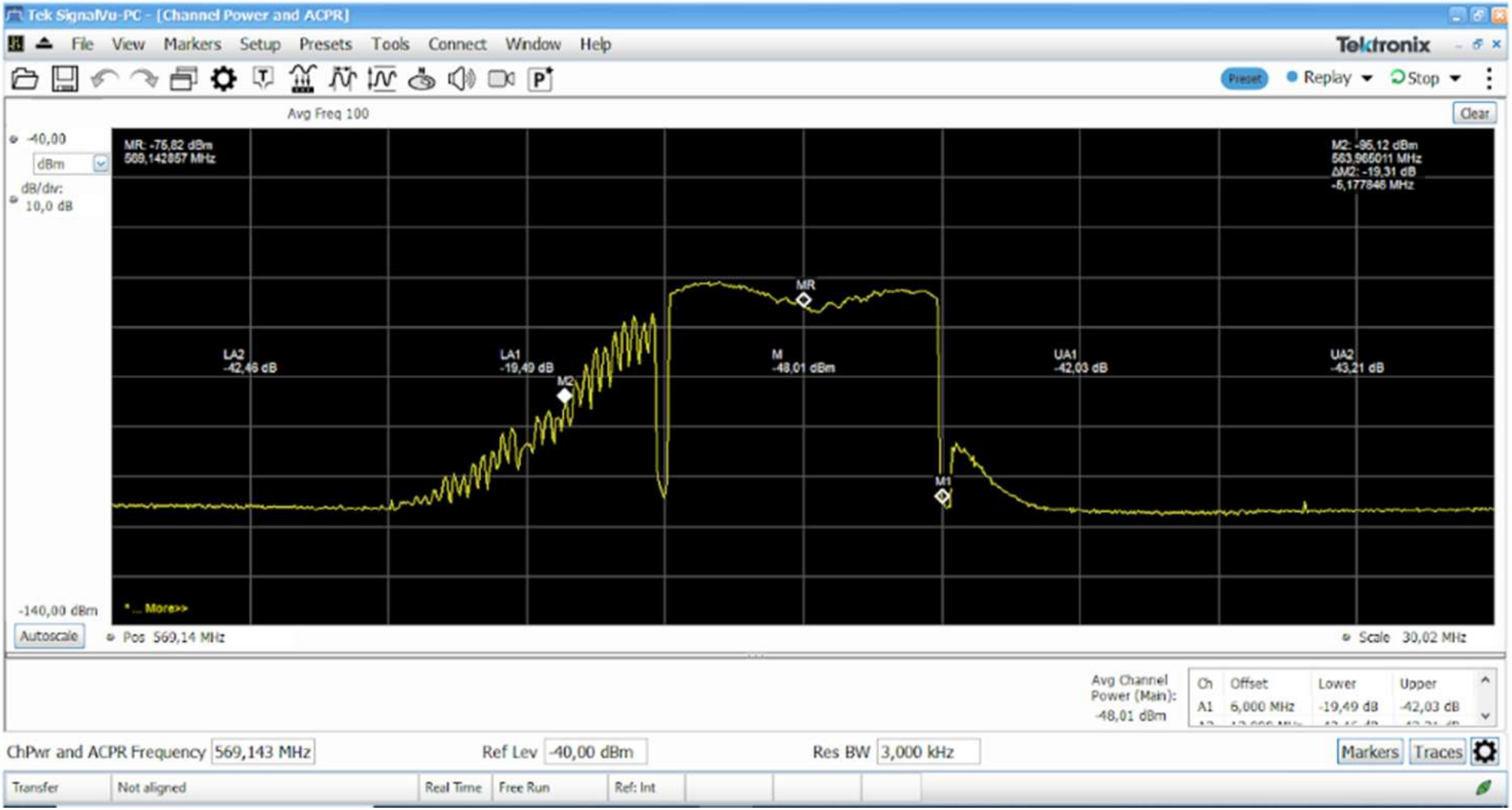


Figure 7.134 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

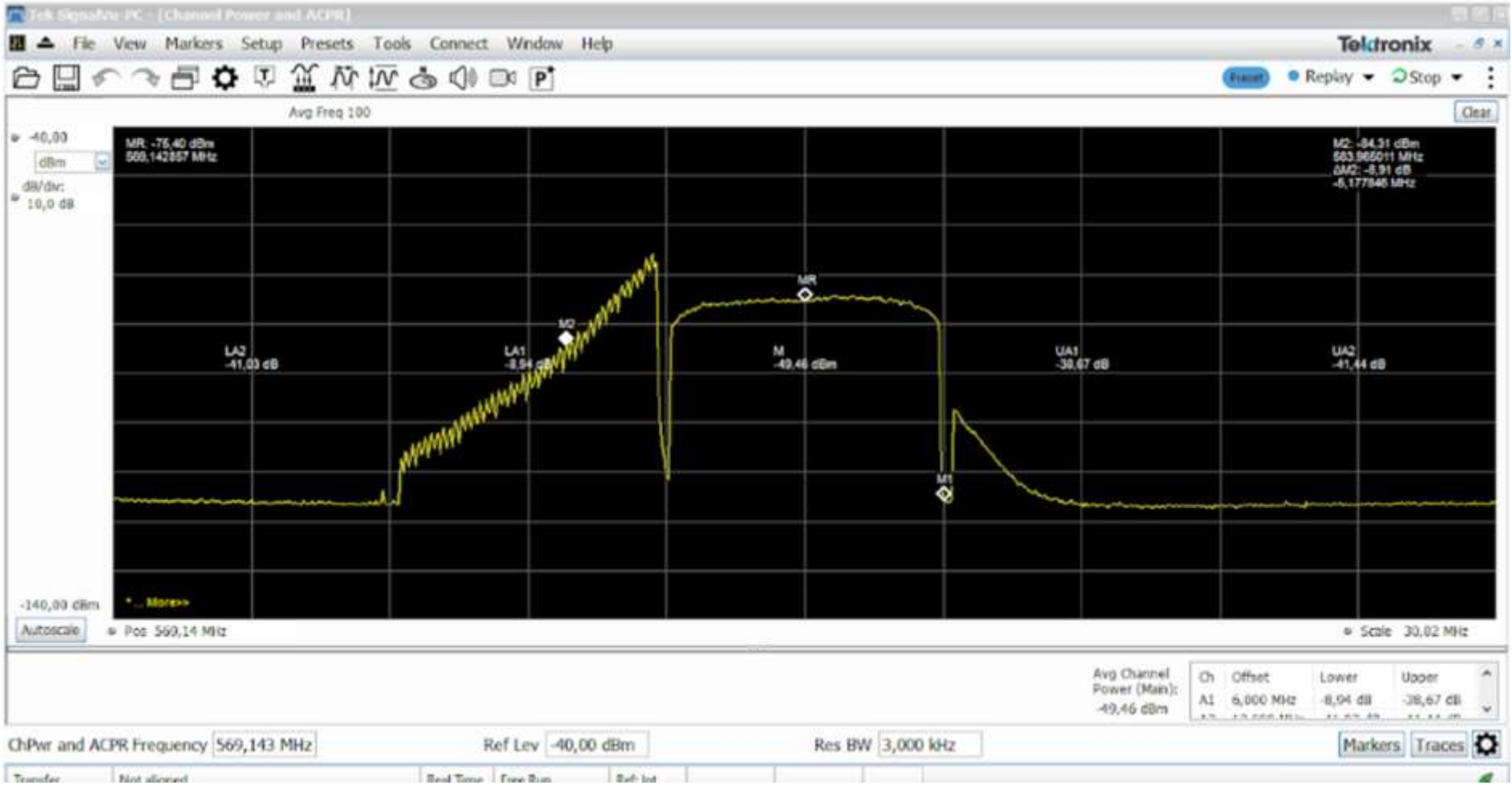


Figure 7.135 - Site 19, Advanced ISDB-T reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

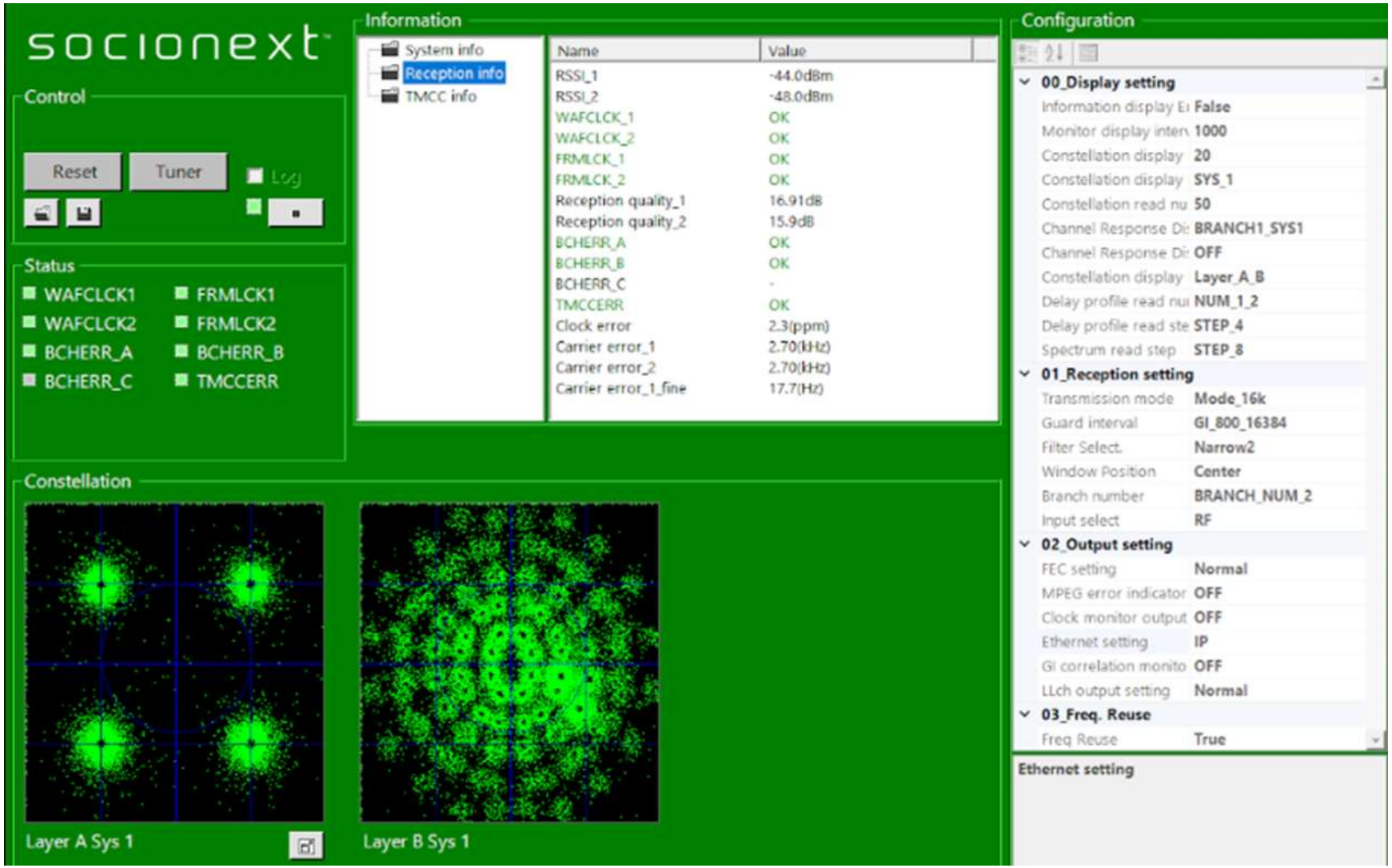


Figure 7.136 - Site 19, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna and Sumaré stations.

d) Site 25 - Layer B

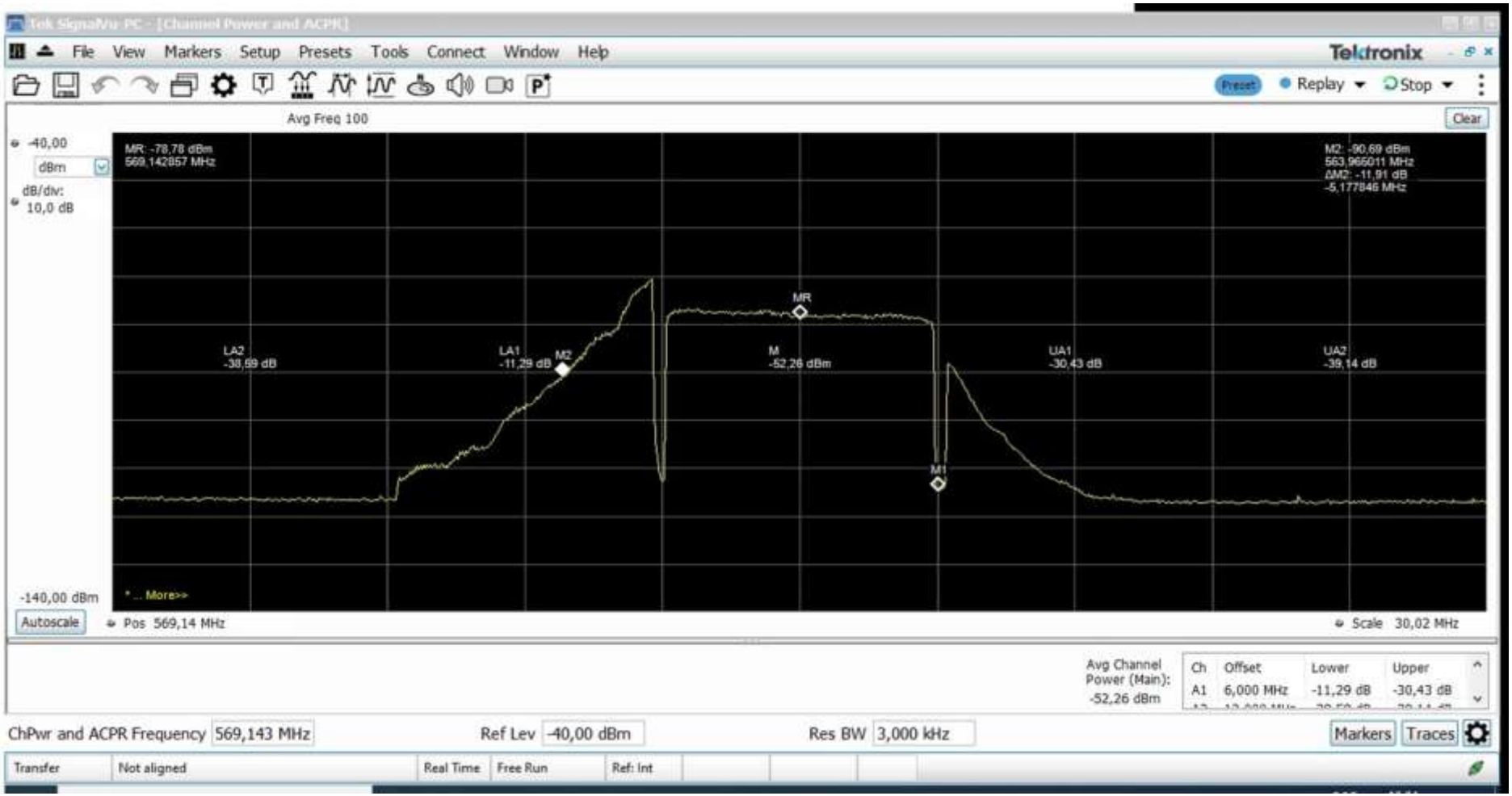


Figure 7.137 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

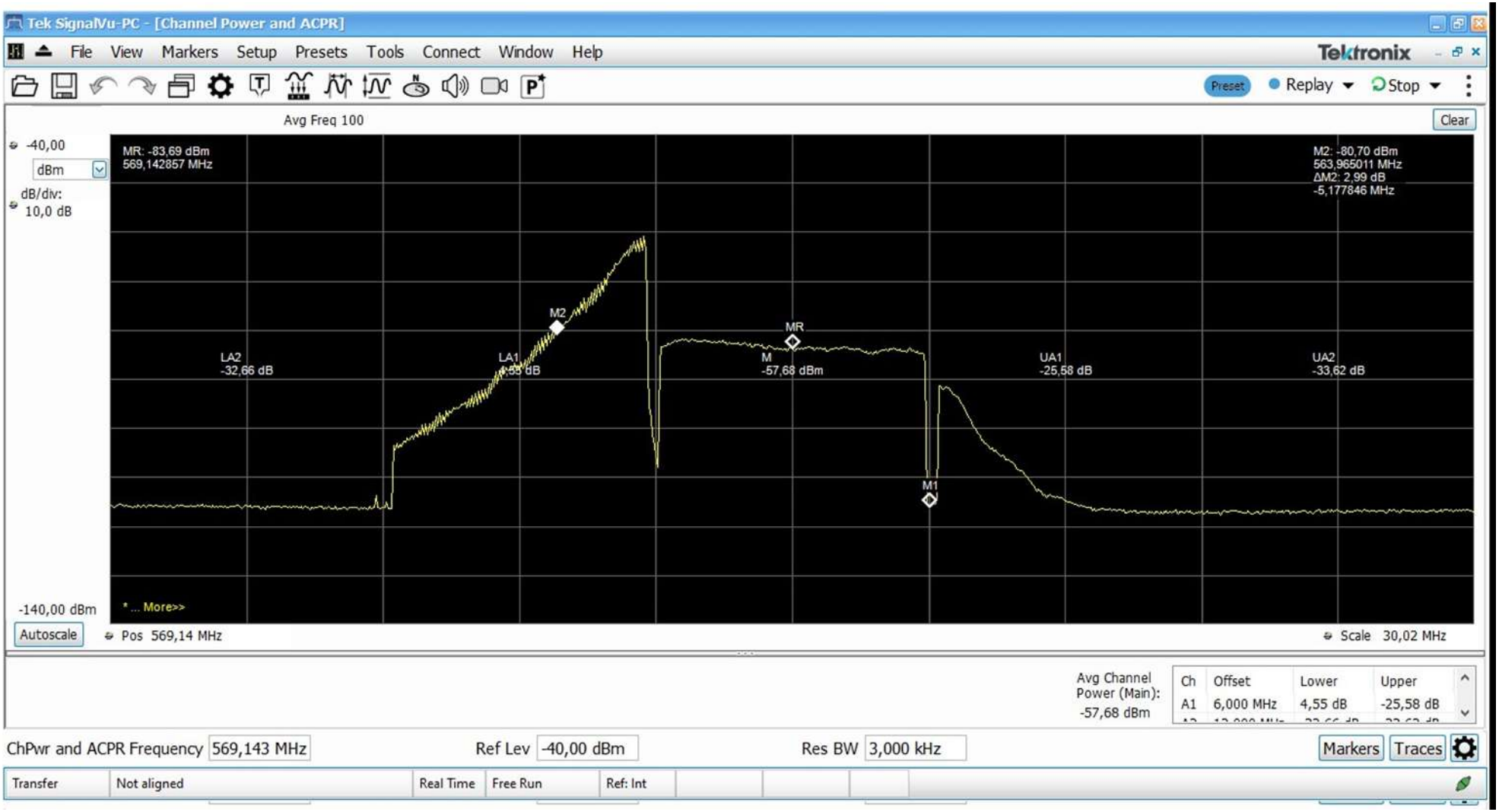


Figure 7.138 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

Figure 7.139 - Site 25, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Sumaré station.

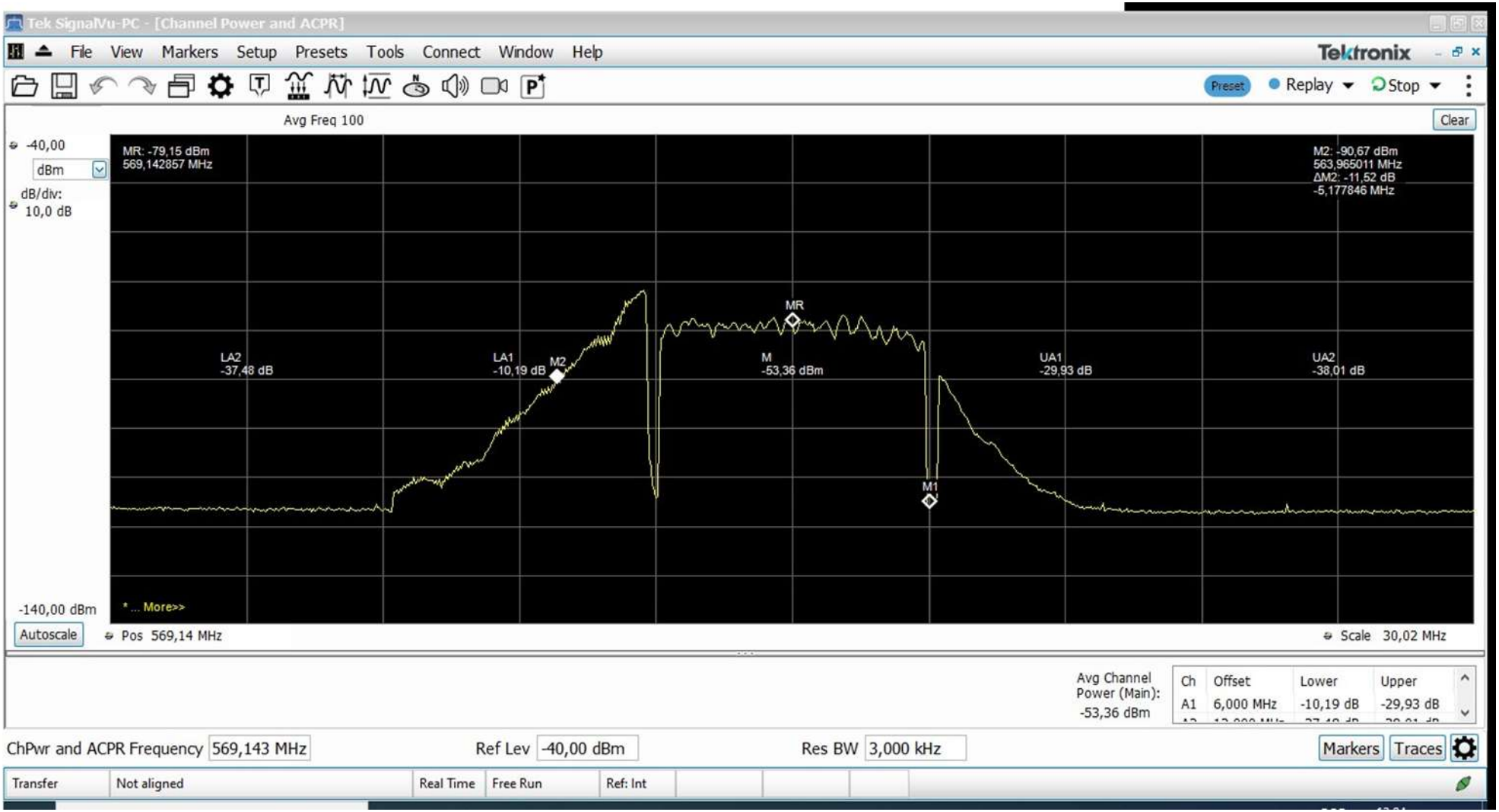


Figure 7.140 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

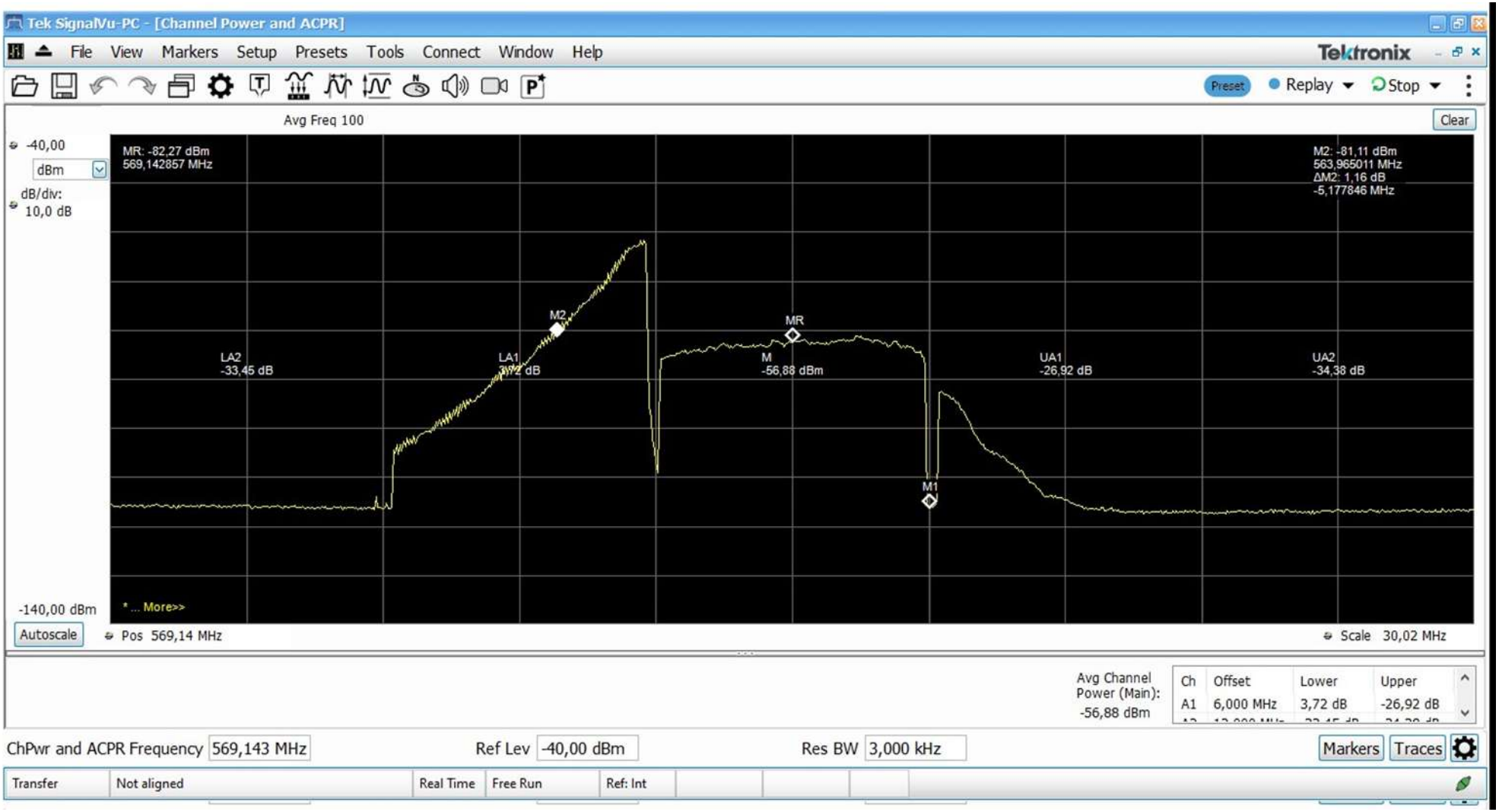


Figure 7.141 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

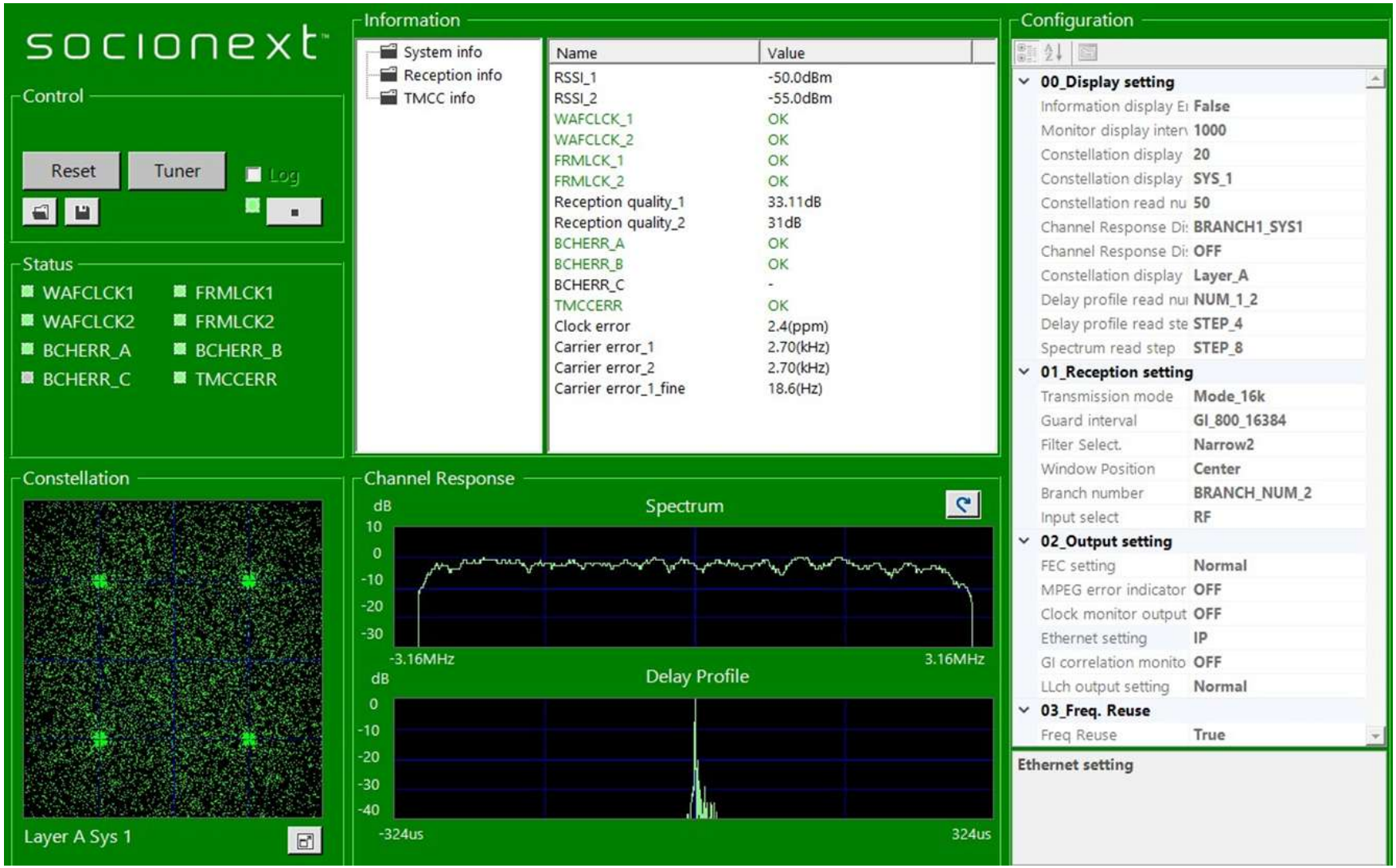


Figure 7.142 – Site 25, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna station.

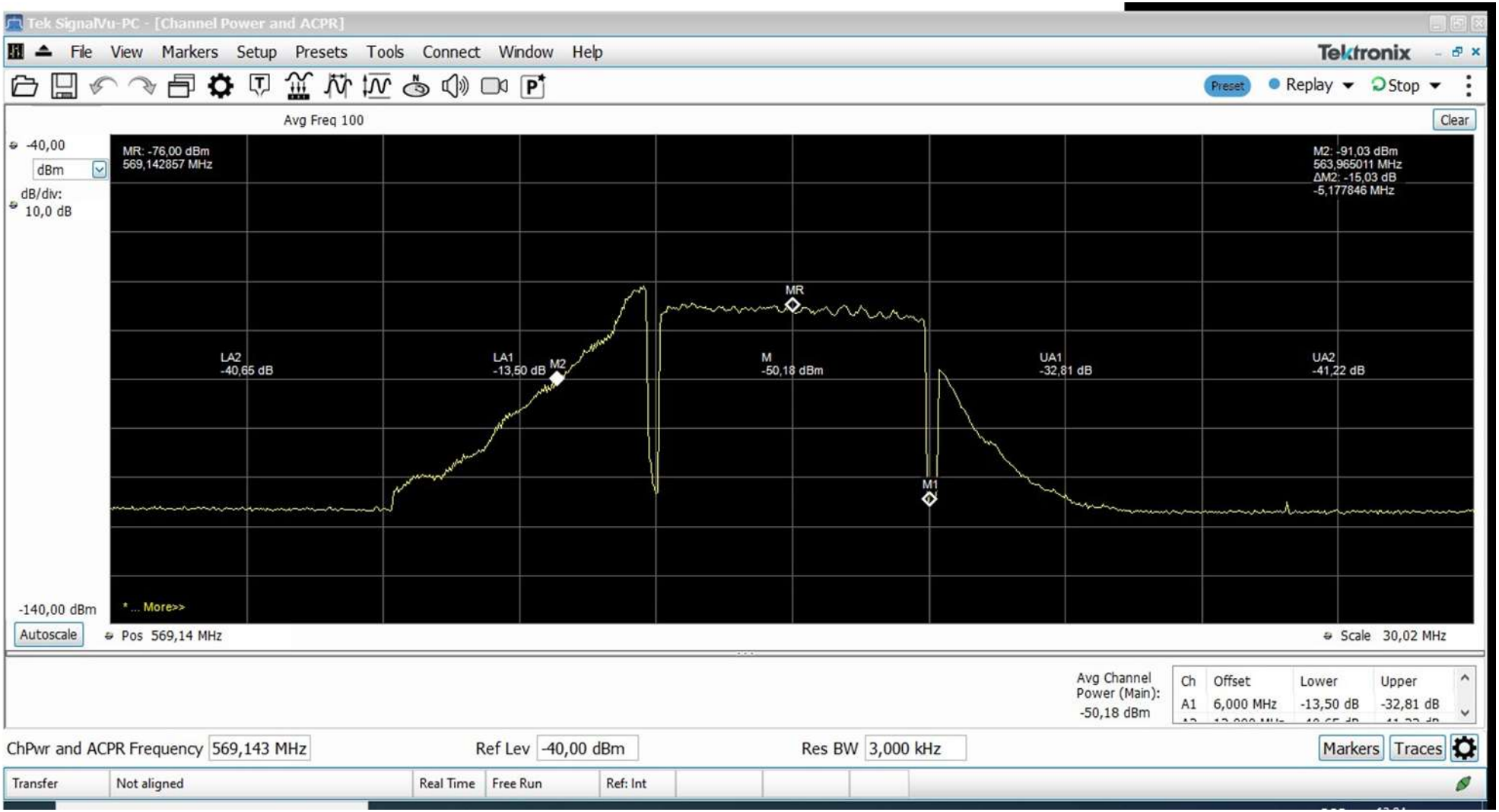


Figure 7.143 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

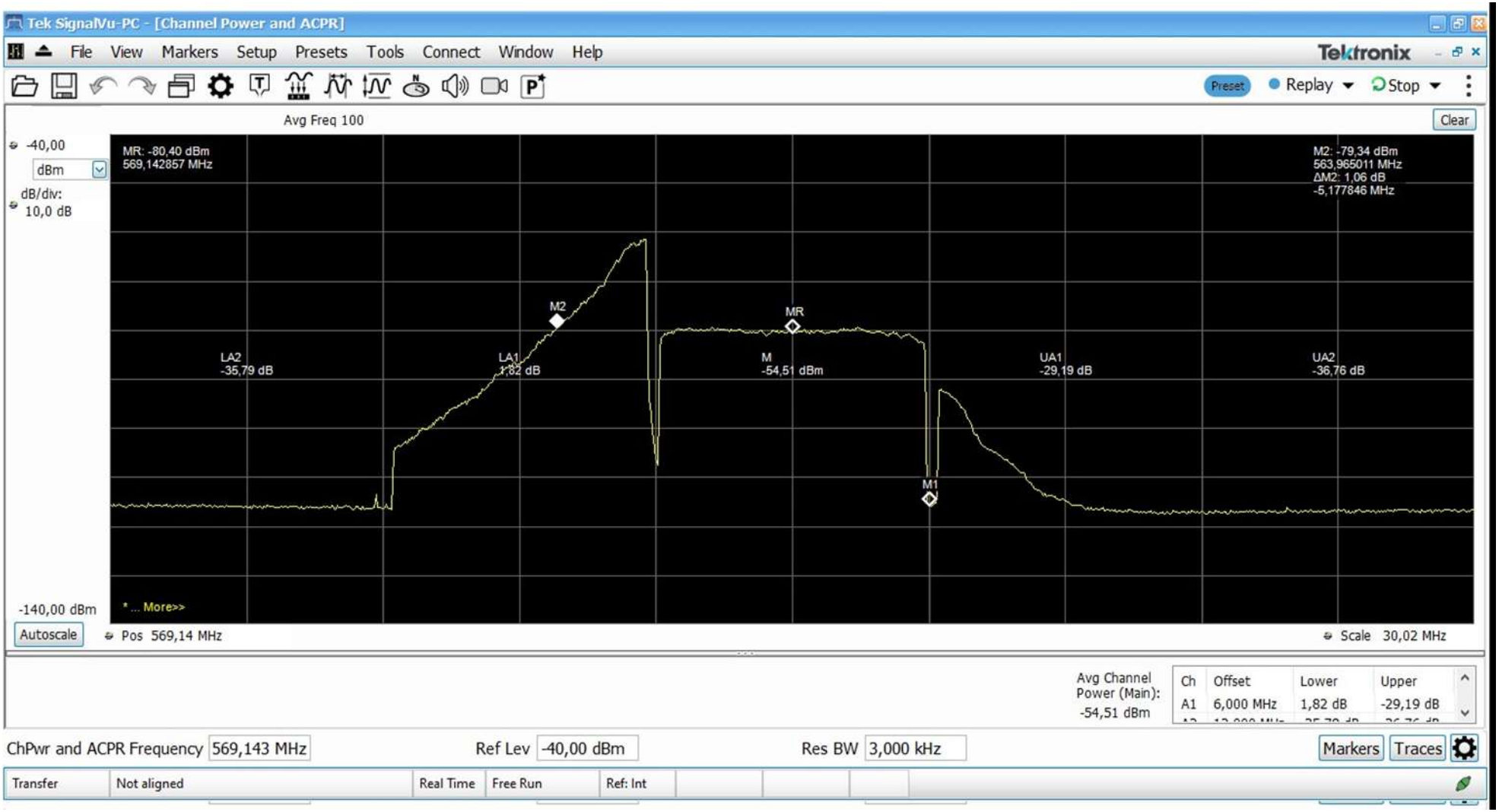


Figure 7.144 - Site 25, Advanced ISDB-T reuse-1, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

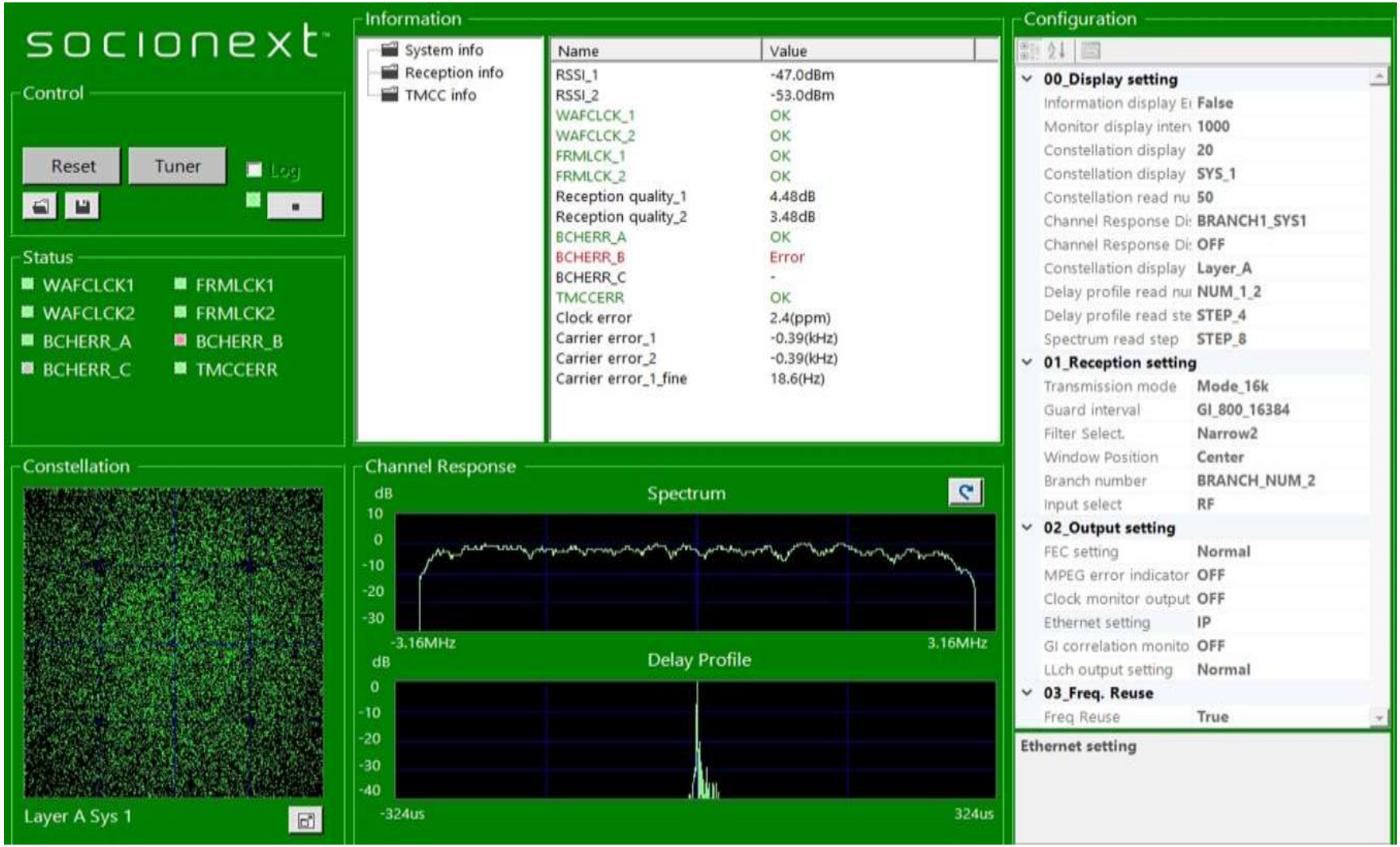


Figure 7.145 - Site 25, Advanced ISDB-T reuse-1 test, Socionext (demodulator) measurement, Penna and Sumaré stations.

7.4.1.2.2 Drive Test

7.4.1.2.2.1 Test methodology

The drive test was conducted with a test vehicle equipped with the reception setup. This setup used MIMO Automotive Omnidirectional Antenna for Advanced ISDB-T on horizontal and vertical polarization. The antenna was fixed on the top of the vehicle and connected to the RF box. A GPS antenna was fixed on the top of the vehicle and connected to the reception software. Two equipment were provided by the proponent to analyze the reception data, the MIMO Channel Analyzer and the Socionext Demodulator. Both equipment were connected to the RF Box used in all field tests. The drive test was divided in five routes, as shown in Figure 7.146. Along all the routes, it is possible to find different environmental characteristics. The route passes near all the sites where the outdoor measurements were performed. Due to vehicle traffic, the speed was not kept constant during the drive test. Only on route 3 it was possible to maintain constant speed. Therefore, this route was run three times with different speeds (20 km/h, 40 km/h and 60 km/h). The transmitter location is also shown in Figure 7.146. During the test, the received signal strength indication (RSSI), channel to noise ratio (C/N) and BHC error were collected. The proponent also provided a BER Tester, however, due to device problems, it was not possible to use it. Thus, no MER and BER data were captured during the drive test. The configuration used for this test is detailed in Table 7.35 (Config 1).

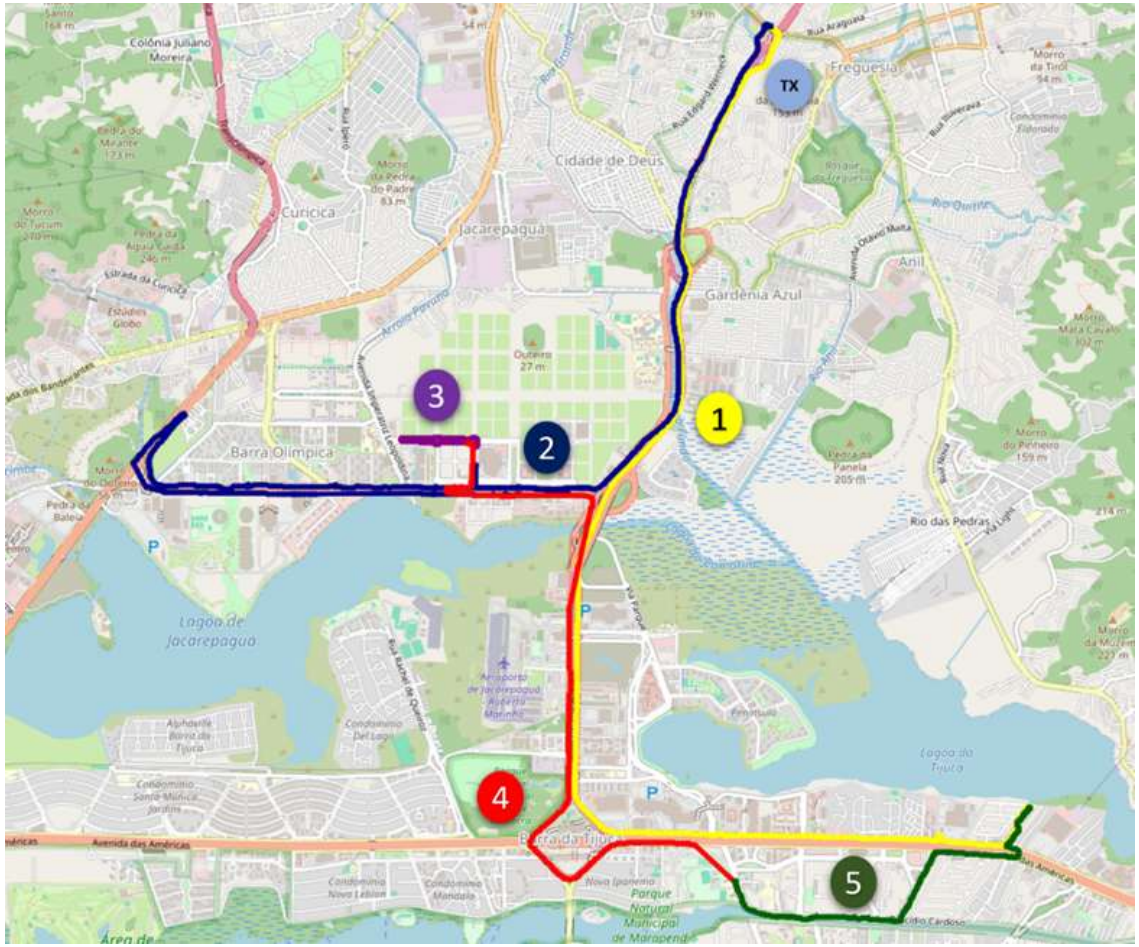


Figure 7.146 - Map showing the drive test routes for Advanced ISDB-T.

7.4.1.2.2.2 Test results

The proponent provided a Socionext demodulator and a laptop with a software able to verify RF characteristics of the received signal, such as the BCH error. Also, the RF box was connected to two spectrum analyzes, one for each polarization. From this equipment, the RSSI and C/N information were collected. The C/N was collected using the function upper A (UA2, in the spectrum analyzer figures).

7.4.1.2.2.2.1 Speed and distance to transmitter profiles

The drive test speed profile is shown in Figures 7.147 and 7.148. The car achieved up to 60 km/h and variations are caused by traffic lights and traffic jams. We could control the speed only on Route 3. Therefore, we repeated Route 3 three times, using the speeds 20 km/h, 40 km/h, and 60 km/h each time. The average speed was approximately 32.5 km/h, 25.07 km/h, 28.62 km/h, 22.74 km/h for routes 1, 2, 4, and 5 respectively. The distance between the vehicle and the transmitter was also calculated over time and it is shown in Figures 7.149 and 7.150.

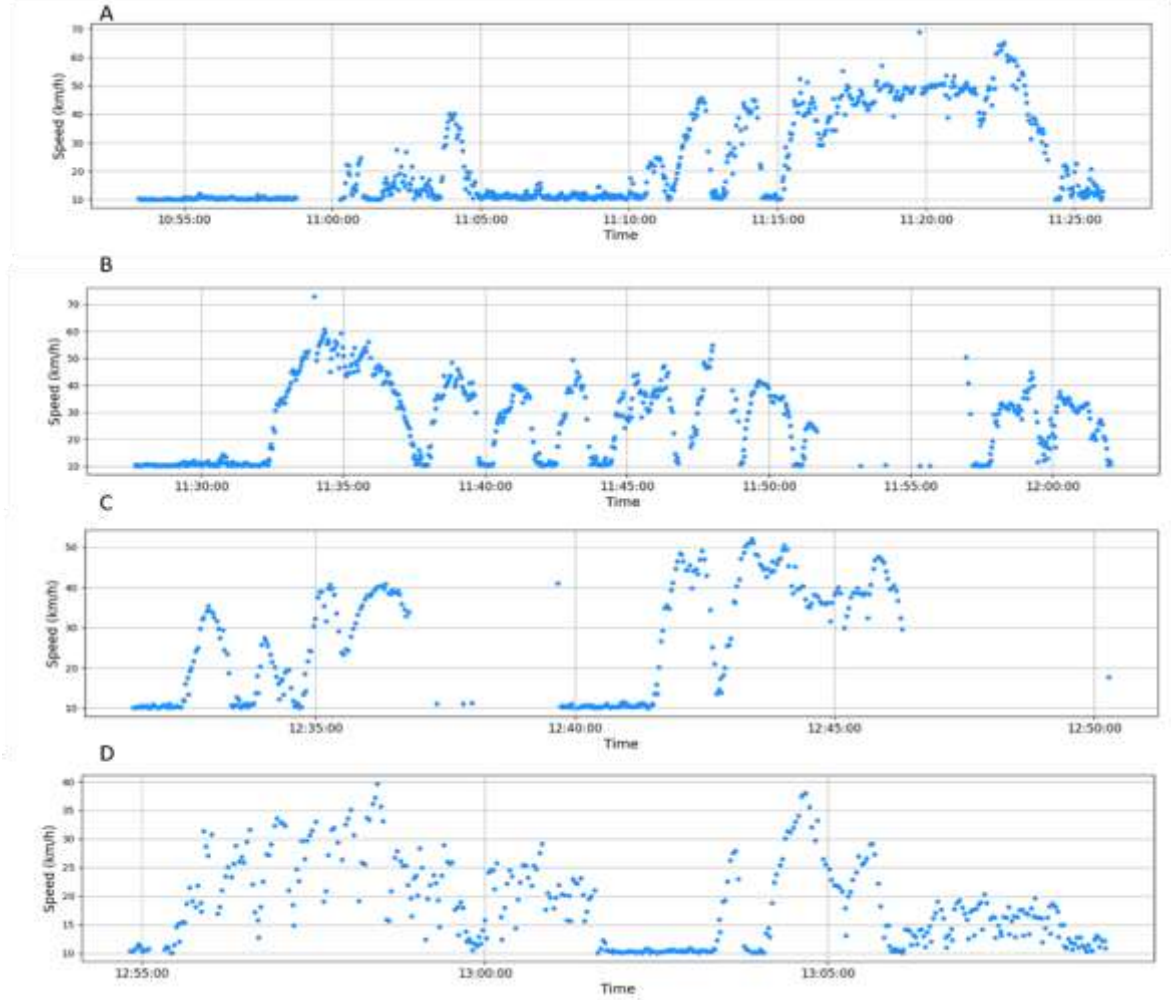


Figure 7.147 - Speed over time for routes A) 1; B) 2; C) 4; and D) 5.

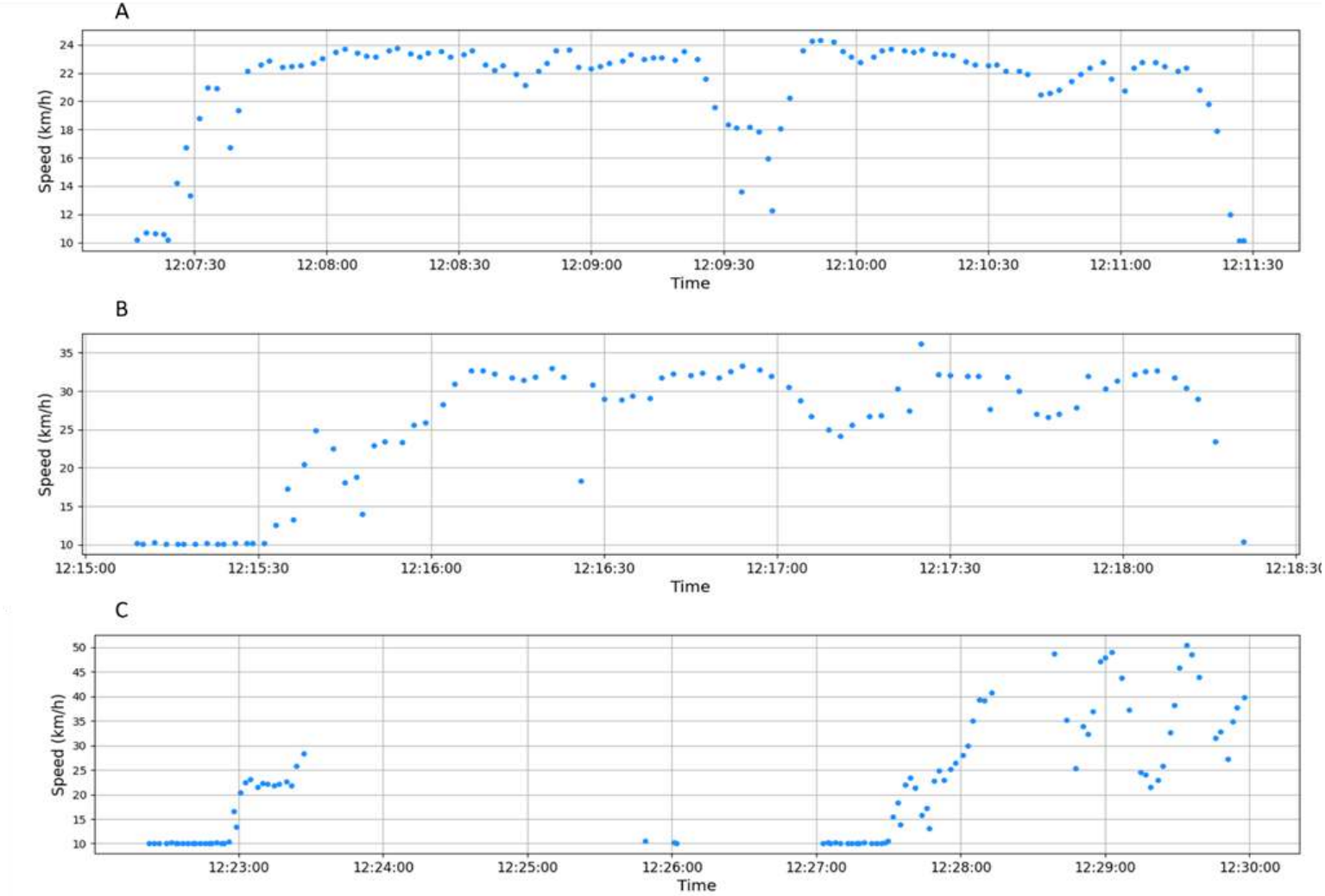


Figure 7.148 - Speed over time for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

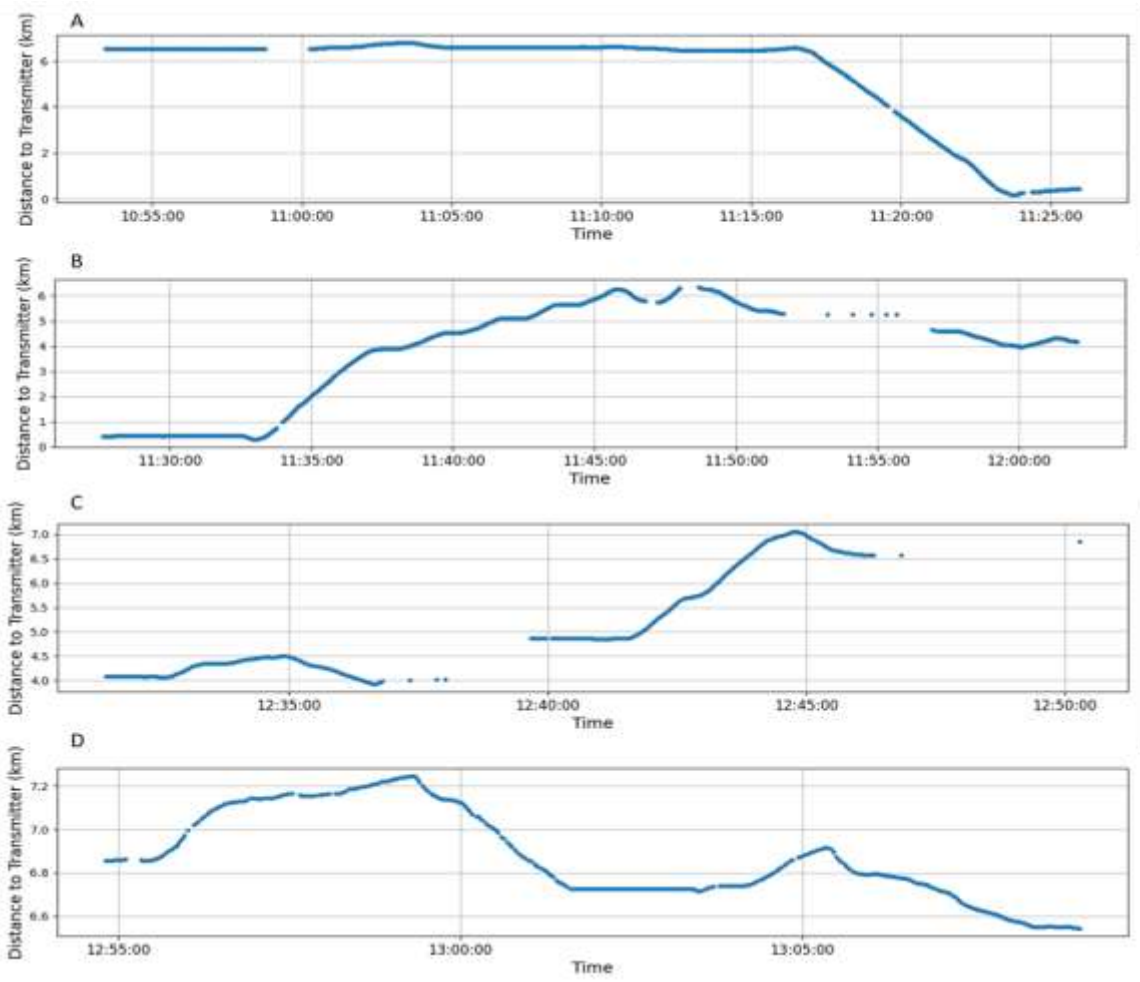


Figure 7.149 - Distance to transmitter over time for routes A) 1; B) 2; C) 4; and D) 5.

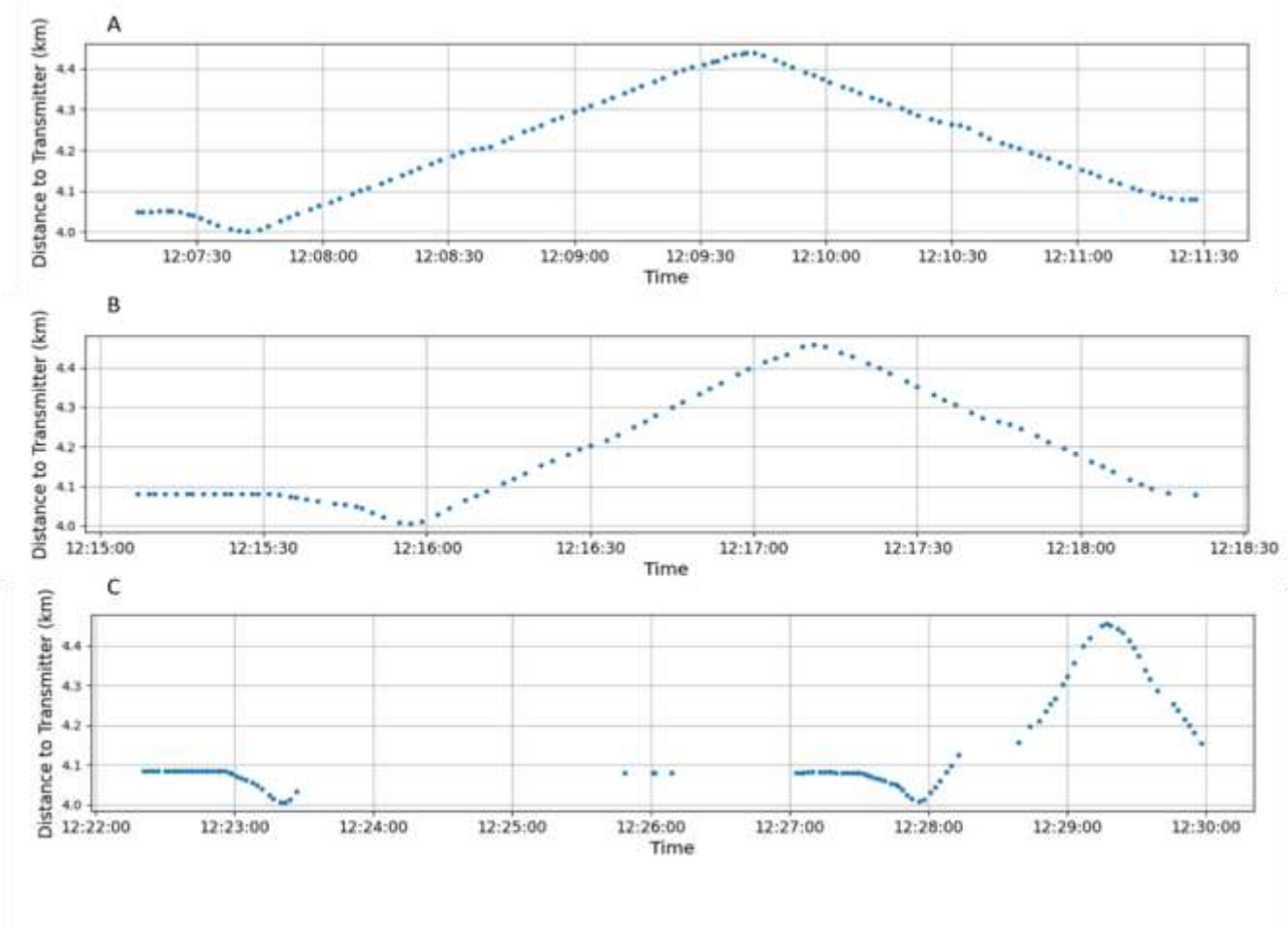


Figure 7.150 - Distance to transmitter over time for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.4.1.2.2.2.2 Received signal strength indicator (RSSI)

The RSSI was captured using two identical spectrum analyzers, one for each polarization. The evolution of RSSI over distance to transmitter is shown in Figures 7.151 and 7.152. The values varied from -34 dBm to -89 dBm approximately in all routes. It is possible to notice that the RSSI value decreases slowly up to 4 km. After this distance, this value tends to suffer greater losses due to the characteristics of the environment. There are mountains and buildings that can pose stronger interference on the signal propagation at distances greater than 4 km.

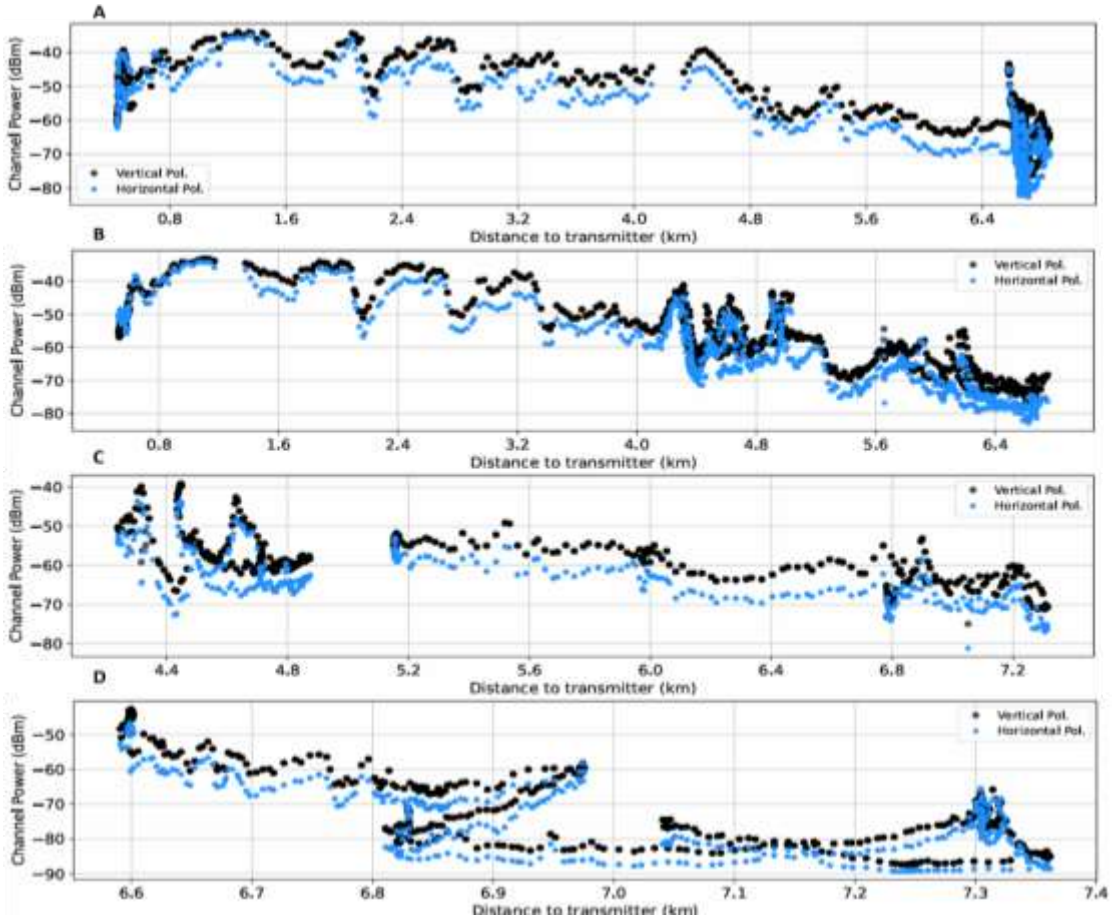


Figure 7.151 - Channel power over distance to transmitter for routes A) 1; B) 2; C) 4; and D) 5.

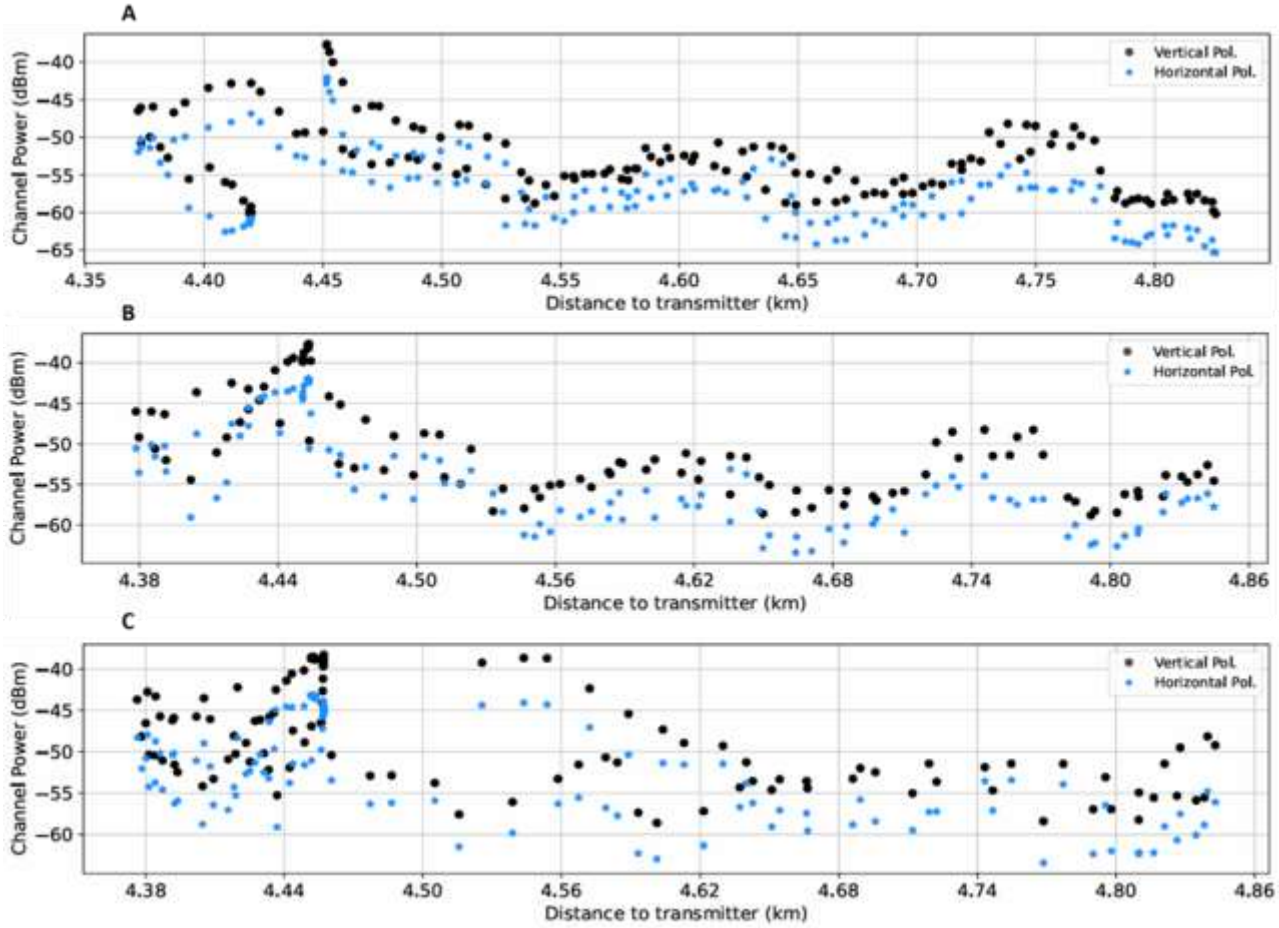


Figure 7.152 - Channel power over distance to transmitter for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

Carrier to noise ratio

Carrier to noise rate (C/N) was obtained with two identical spectral analyzers and were evaluated over the distance to the transmitter. Figures 7.153 and 7.154 show the data collected. On Routes 1 and 2, even for small distances to the transmitter of up to 1 km, it is possible to notice low values for C/N. This behavior probably happened due to the environment's characteristics and to the transmitter antenna azimuth. Near the transmitter, the car passed not only through the front antenna opening area, experiencing good reception levels, but also through the rear antenna opening area, experiencing poor reception levels in these areas. The antenna points approximately in the direction of the beaches and, in Figure 7.146, it can be seen that the car leaves the antenna opening at the final points of Routes 1 and 2, which are very close to the transmitter.

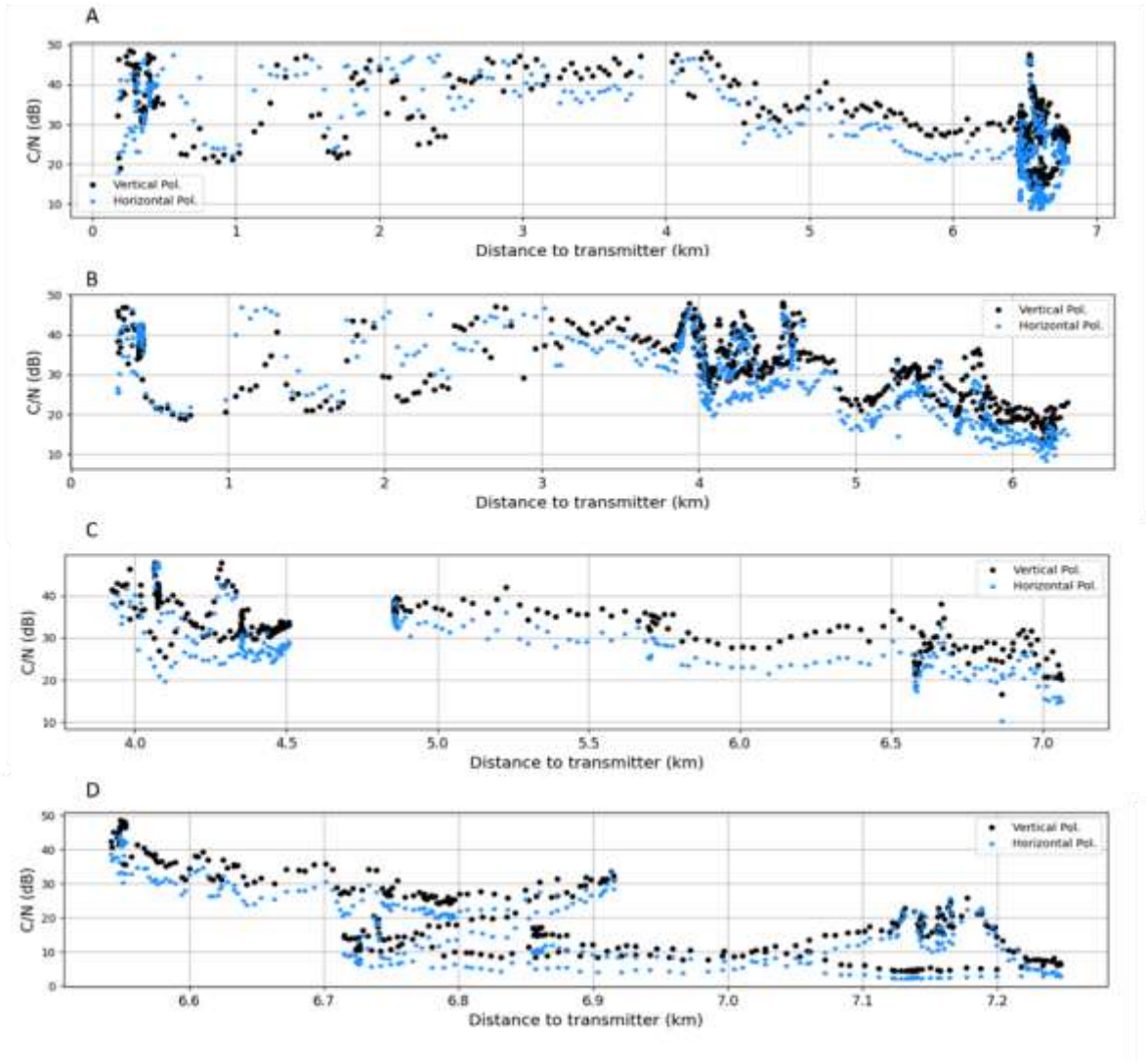


Figure 7.153 - Carrier to noise ratio over distance to transmitter for routes A) 1; B) 2; C) 4; and D) 5.

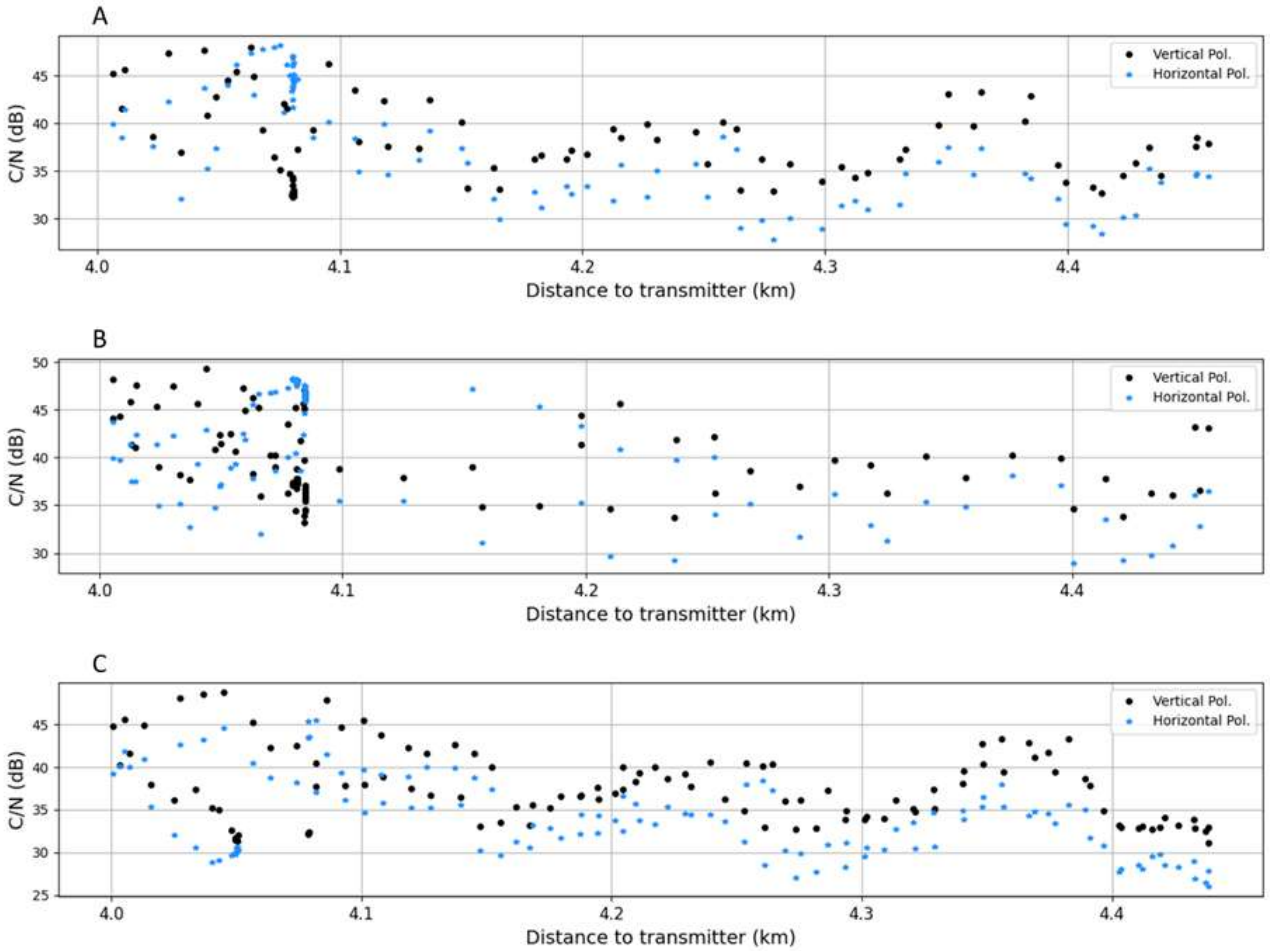


Figure 7.154 - Carrier to noise ratio over distance to transmitter for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.4.1.2.2.2.3 BCH error rate

BCH error was collected using Socionext software provided by the proponent. The software is connected to the demodulator, and it shows whether there are BCH errors along time. The number of BCH errors was evaluated over C/N ratio and is shown in Figures 7.155 and 7.156. Even with a good C/N ratio (around 40 dB), it is possible to see that there are some BCH errors during the test, probably due to fast fading caused by objects and cars around the receiver. However, the number of BHC errors increases when the C/N ratio is around 15 dB.

The number of BCH errors was also evaluated over RSSI, and the results are shown in Figures 7.157 and 7.158. The BCH error increases when RSSI is below -75 dBm approximately. Also, for higher speeds on Route 3, the number of BHC errors also increased.

The number of BCH errors was also evaluated over speed during all routes and the results are shown in Figures 7.159 and 7.160.

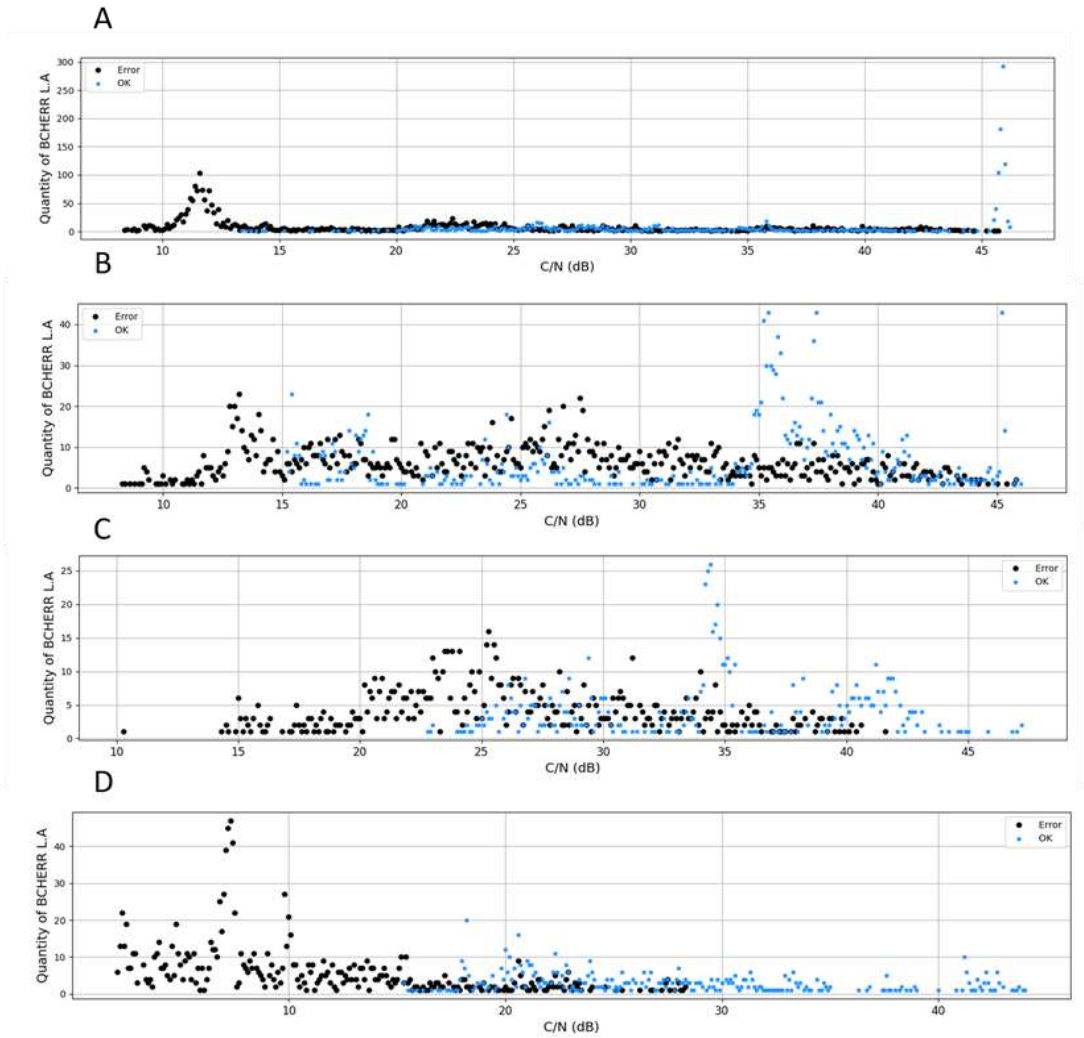


Figure 7.155 - Quantity of BCH errors over C/N for A) route 1; B) route 2 C) route 4; and D) route 5.

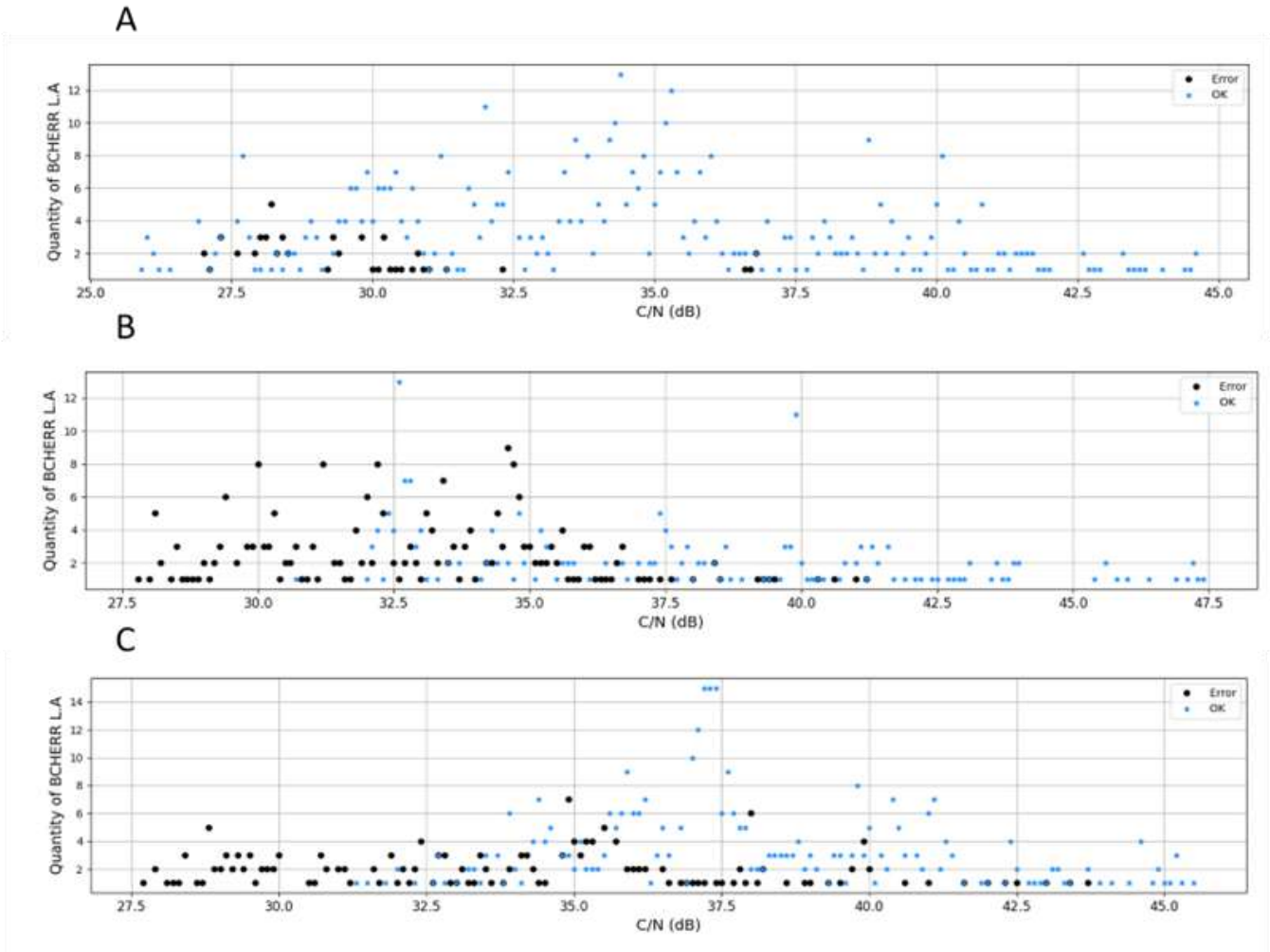


Figure 7.156 - Quantity of BCH errors over C/N for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

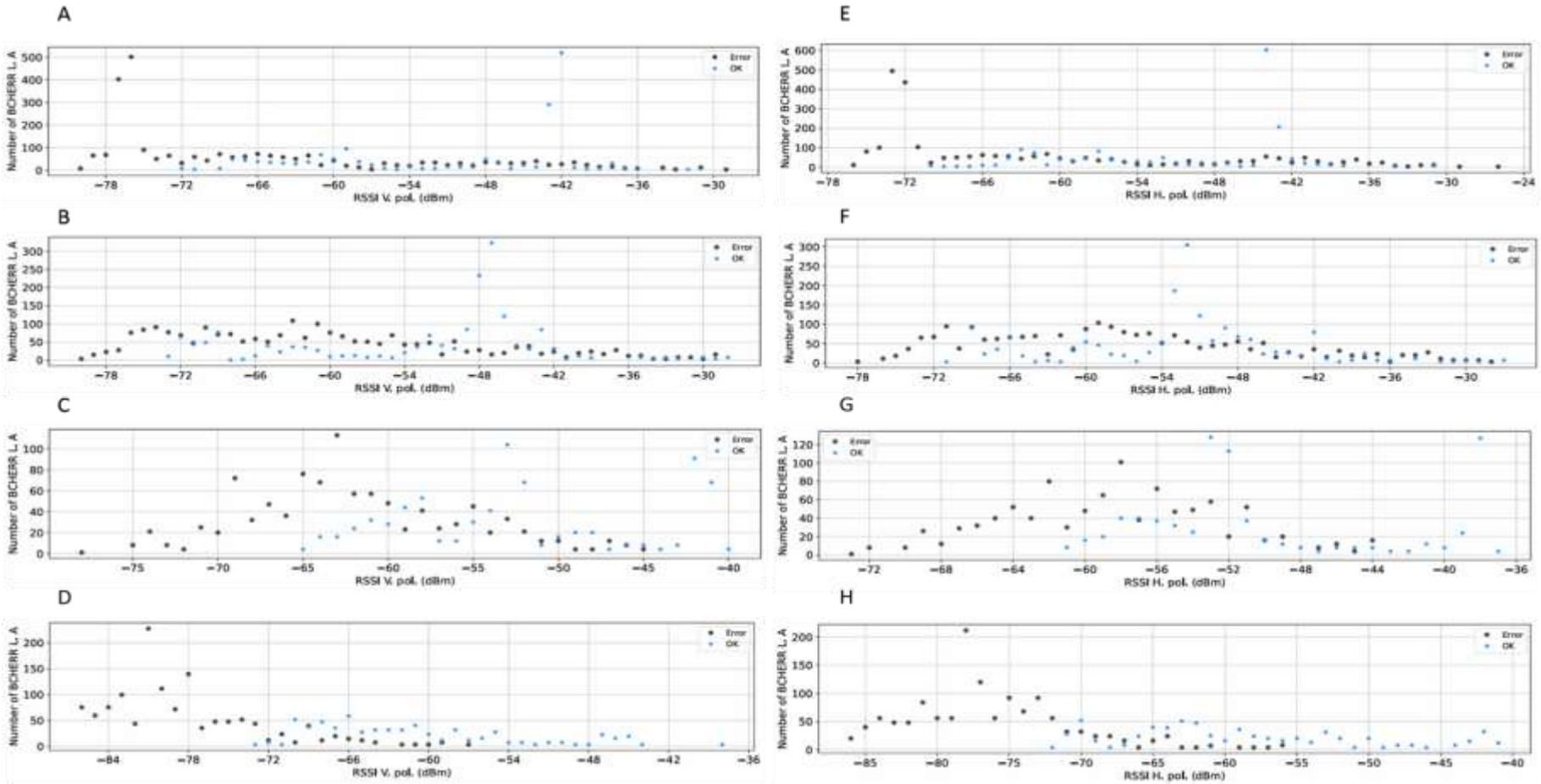


Figure 7.157 - Quantity of BCH errors over RSSI for A) route 1, vertical Pol. B) route 2, Vertical Pol. C) route 4, Vertical Pol. d) route 5, Vertical Pol. E) route 1, Horizontal Pol. F) route 2, Horizontal Pol. G) route 4, Horizontal Pol. H) route 5, Horizontal Pol.

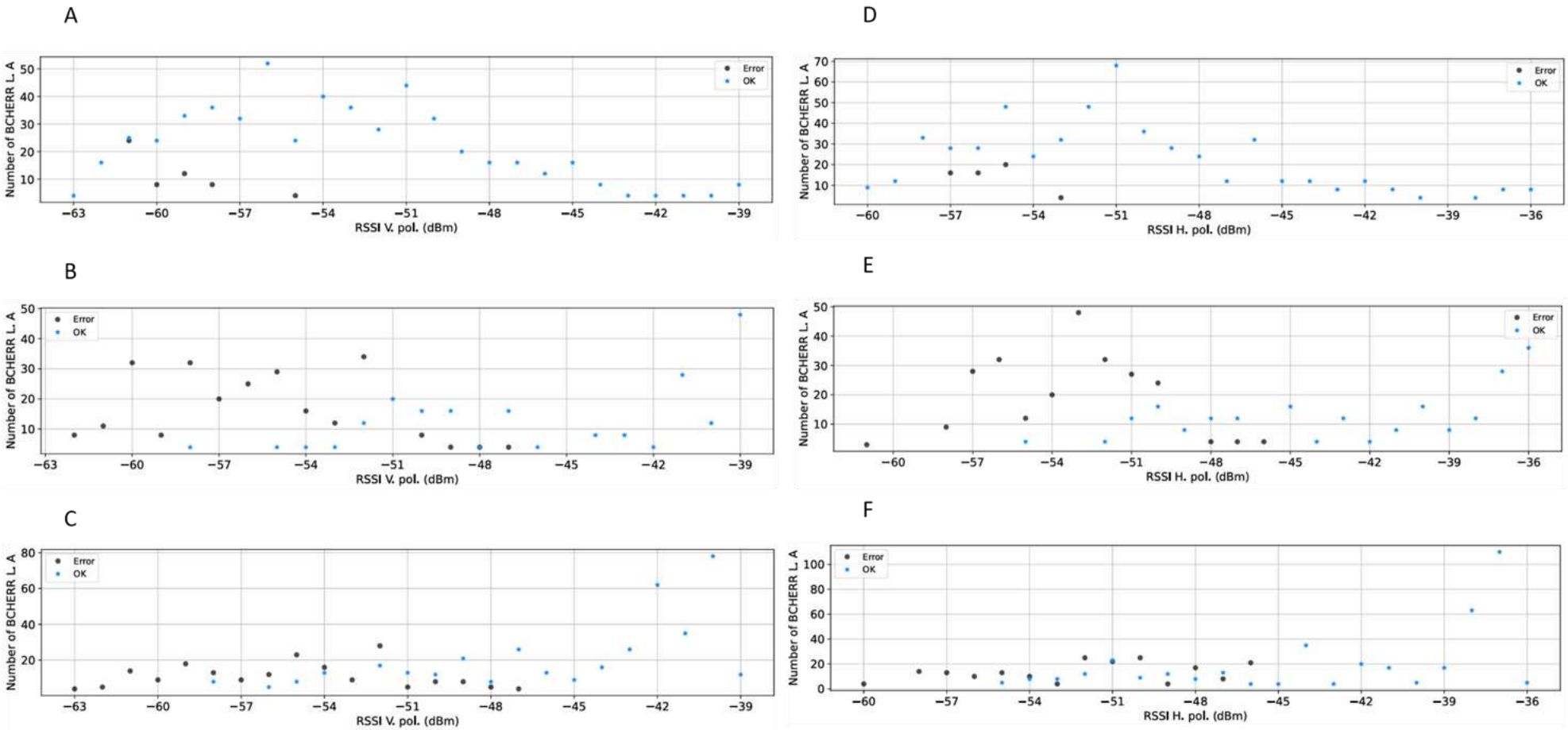


Figure 7.158 - Quantity of BCH errors over RSSI for route 3 at A) 20 km/h, Vertical Pol. B) 40 km/h, Vertical Pol. C) 60 km/h, Vertical Pol. D) 20 km/h, Horizontal Pol. E) 40 km/h, Horizontal Pol. F) 60 km/h, Horizontal Pol.

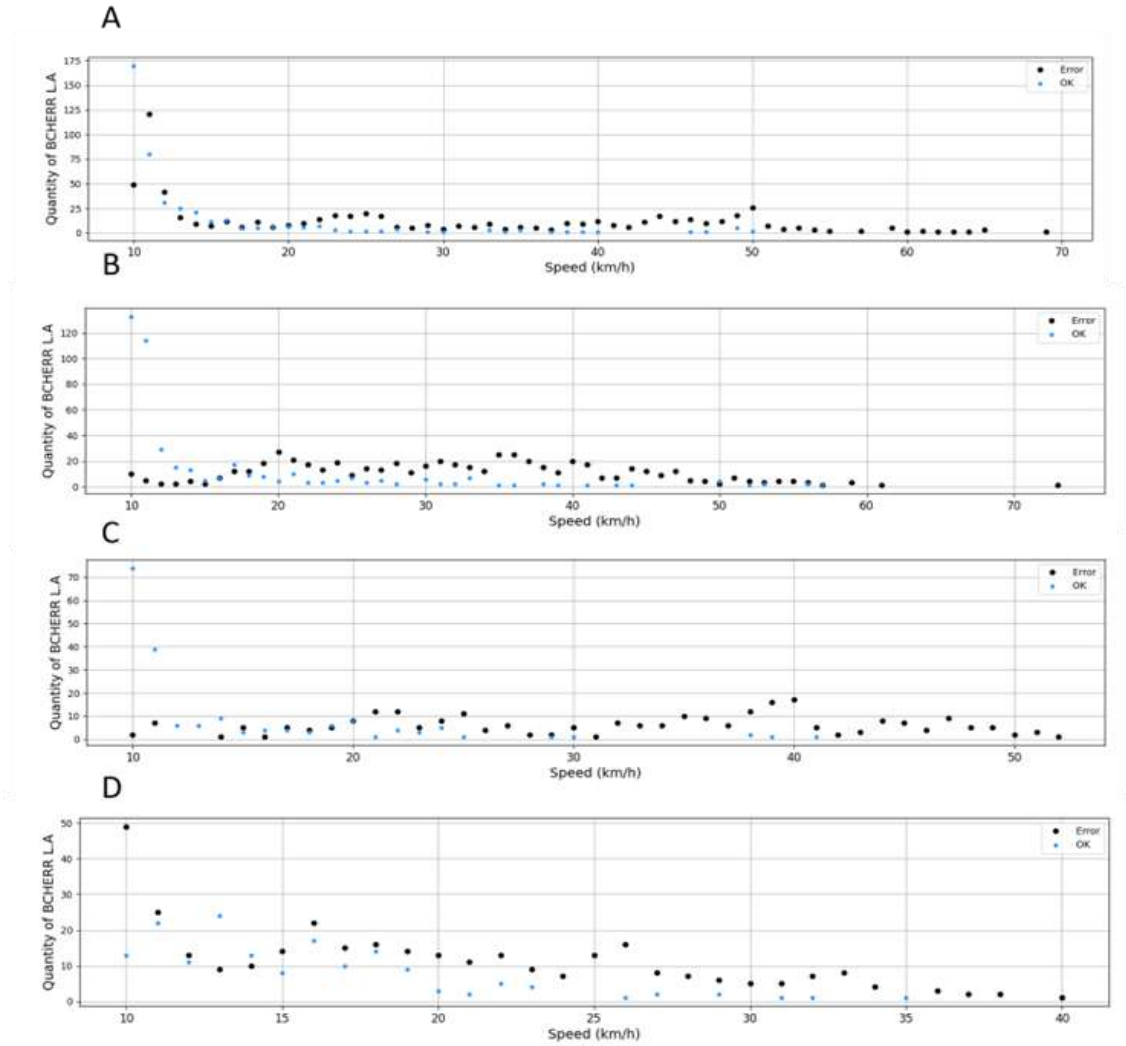


Figure 7.159 - Quantity of BCH errors over Speed for A) route 1; B) route 2 C) route 4; and D) route 5.

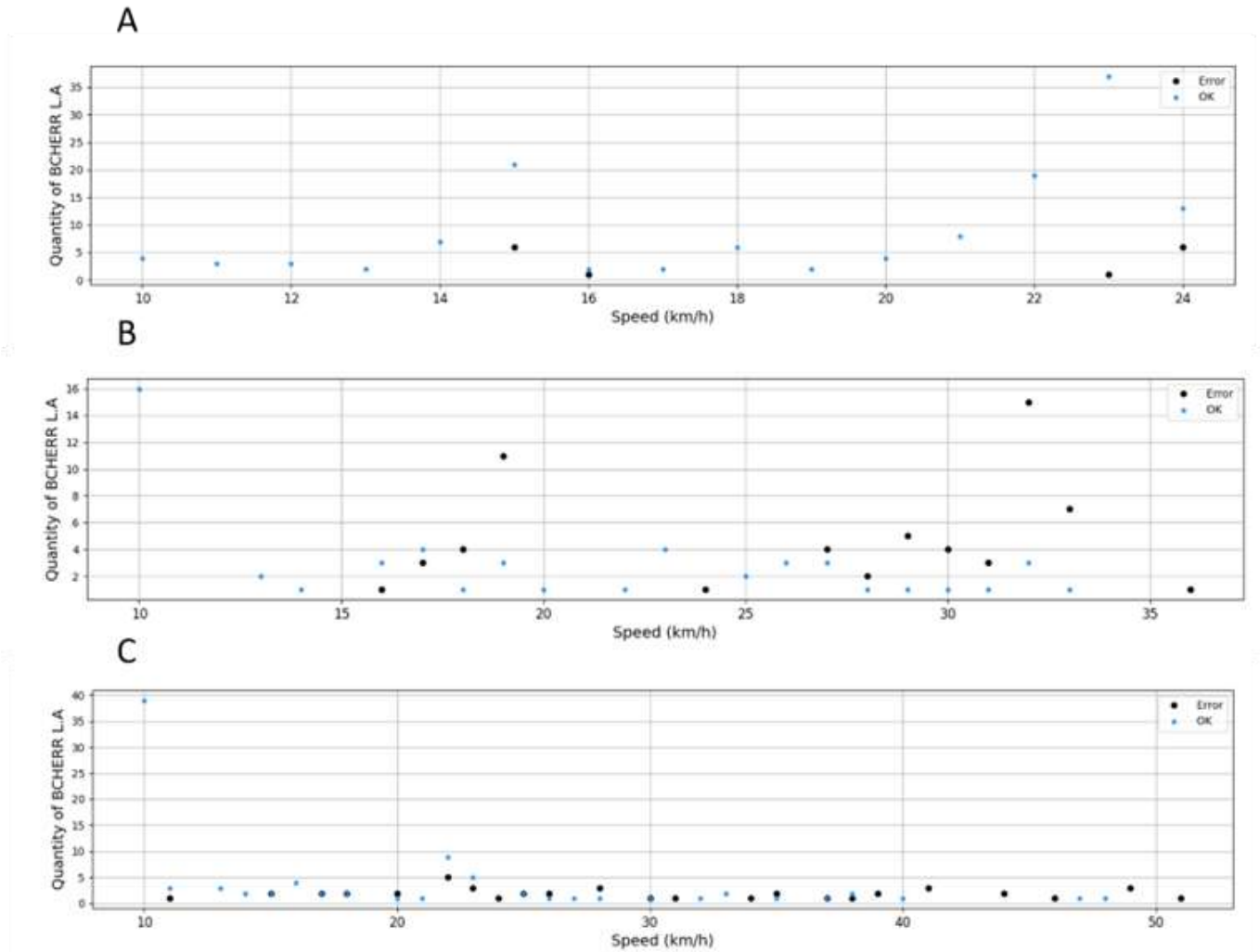


Figure 7.160 - Quantity of BCH errors over speed for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.4.2 Summary of Test Results

The measurements for Advanced ISDB-T technology were performed in three different configurations. The Advanced ISDB-T tests for Configuration 1 yielded robust results across multiple metrics, as shown in Table 7.47. Utilizing a useful bandwidth of 97% (5.83 MHz), the system implemented MIMO 2x2 spatial multiplexing with a carrier spacing of 386 Hz (FFT 16K) and an effective symbol duration of 2592 µs. The guard interval was 126 µs (4.88%), and the pilot pattern was Dx=6, Dy=4. The modulation scheme employed was 64-QAM NUC (6 bits per symbol) with an LDPC+BCH 8/16 (0.500) FEC rate, achieving a bitrate of 30.9 Mbps. The tests were successful at 30 outdoor points and 9 indoor points. The median carrier-to-noise ratio (C/N) required for outdoor reception was 12.81 dB, while indoor reception required a median C/N of 14.19 dB.

Table 7.47 - Table referring to configuration 1 of the Advanced ISDB-T. One layer with capacity ≥ 30 Mbps.

Features	Advanced ISDB-T
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	386 Hz (FFT 16K)
Effective Symbol Duration	2,592 µs
Guard Interval	126 µs (800/16384 = 4.88%)
Pilot Pattern	Dx=6, Dy=4
Outdoor points successfully tested	30
Indoor points successfully tested	9
Modulation	64-QAM NUC (6 bits / symbol)
FEC (Forward Error Correction)	LDPC+BCH 8/16 (0.500)
Bitrate	30.9 Mbps
Median C/N required for outdoor reception	12.8 dB
Median C/N required for indoor reception	14.2 dB

The Advanced ISDB-T tests for Configuration 2 demonstrated the following performance metrics, shown in Table 7.48. The system utilized a useful bandwidth of 97% (5.83 MHz) and employed MIMO 2x2 spatial multiplexing with a carrier spacing of 386 Hz using an FFT of 16K. The effective symbol duration was measured at 2,592 µs, with a guard interval of 126 µs (4.88%). The pilot pattern was configured as Dx=6, Dy=2. Multiplexing was achieved through FDM, with Layer A using 25 segments (4.16 MHz) and Layer B using 10 segments (1.67 MHz). In outdoor points with C/N < 0 dB, Layer A successfully tested on two sites: one site presented a successful reuse-1 using QPSK UC with LDPC+BCH 3/16 (yielding a bitrate of 2.6 Mbps), while the other site depended on a more robust configuration, using LDPC+BCH 2/16 (yielding 1.7 Mbps). Similarly, for outdoor points with C/N < 16 dB, Layer B successfully tested 256-QAM NUC with two FEC rates: LDPC+BCH 8/16 (yielding 11.2 Mbps) in one site and LDPC+BCH 4/16 (yielding 5.6 Mbps) in another site with less signal quality.

Table 7.48 - Table referring to configuration 2 of the Advanced ISDB-T. Reuse-1 with two layers.

Features	Advanced ISDB-T
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	386 Hz (FFT 16K)
Effective Symbol Duration	2,592 µs
Guard Interval	126 µs (800/16384 = 4.88%)
Pilot Pattern	Dx=6, Dy=2
Multiplexing	FDM (Layer A = 25 segments / 4.16 MHz, Layer B = 10 segments / 1.67 MHz)
Layer A (C/N < 0 dB): Successfully Tested Outdoor Points	2
Layer A (C/N < 0 dB): Modulation	QPSK UC (2 bits / symbol)
Layer A (C/N < 0 dB): FEC	LDPC+BCH 3/16 (0.188) (1 point), LDPC+BCH 2/16 (0.125) (1 point)
Layer A (C/N < 0 dB): Bitrate	2.6 Mbps (FEC 3/16), 1.7 Mbps (FEC 2/16)
Layer B (C/N < 16 dB): Successfully Tested Outdoor Points	2
Layer B (C/N < 16 dB): Modulation	256-QAM NUC (8 bits / symbol)
Layer B (C/N < 16 dB): FEC	LDPC+BCH 8/16 (0.500) (1 point), LDPC+BCH 4/16 (0.250) (1 point)
Layer B (C/N < 16 dB): Bitrate	11.2 Mbps (FEC 8/16), 5.6 Mbps (FEC 4/16)

For the extra measurement campaign, called Config. 3, shown in Table 7.49, the system has useful bandwidth of 97% (5.83 MHz), utilizes spatial multiplexing MIMO 2x2, with 386 Hz carrier spacing and 2,592 µs symbol duration, and FDM multiplexing for segments of 4.16 MHz and 1.67 MHz. Eight outdoor and five indoor points were successfully tested. For Layer A, with modulation 16-QAM UC (4 bits/symbol) and FEC LDPC+BCH 6/16 (0.375), the bitrate is 10.5 Mbps. The median C/N required for reception for Layer A is 8.24 dB in outdoor sites and 7.04 dB in indoor sites. Layer B uses 64-QAM NUC (6 bits / symbol) and FEC LDPC+BCH 10/16 (0.625), achieving a bitrate of 10.5 Mbps. The median C/N required is 17.82 dB in outdoor sites and 15.71 dB in indoor sites.

Table 7.49 - Table referring to configuration 3 of the Advanced ISDB-T. Two layers with capacity ≥ 10 Mbps each.

Features	Advanced ISDB-T
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	386 Hz (FFT 16K)
Effective Symbol Duration	2,592 µs
Guard Interval	126 µs (800/16384 = 4.88%)
Pilot Pattern	Dx=6, Dy=2
Multiplexing	FDM (Layer A = 25 segments / 4.16 MHz, Layer B = 10 segments / 1.67 MHz)
Successfully Tested Outdoor Points in Both Technologies	5
Successfully Tested Indoor Points in Both Technologies	2
Layer A: Modulation	16-QAM UC (4 bits / symbol)
Layer A: FEC	LDPC+BCH 6/16 (0.375)
Layer A: Bitrate	10.5 Mbps
Layer A: Median C/N Required for Outdoor Reception	8.2 dB
Layer A: Median C/N Required for Indoor Reception	7.0 dB
Layer B: Modulation	64-QAM NUC (6 bits / symbol)
Layer B: FEC	LDPC+BCH 10/16 (0.625)
Layer B: Bitrate	10.5 Mbps
Layer B: Median C/N Required for Outdoor Reception	17.8 dB
Layer B: Median C/N Required for Indoor Reception	15.7 dB

Tables 7.50 and 7.51 summarize the results obtained with the technology.

Table 7.50 - Summarized results using Advanced ISDB-T for fixed reception.

	Config 1	Config 3	
Fixed Reception	**LA**	**LA**	**LB**
Number of outdoor sites	30	11	11
Number of outdoor sites without reception errors	30	11	11
Percentages of success in outdoor sites	100%	100%	100%
Median carrier-to-noise ratio (C/N) required for outdoor reception	12.81 dB	8.24 dB	17.82 dB
Max carrier-to-noise ratio (C/N) required for outdoor reception	21.35 dB	14.99 dB	19.84 dB
Min carrier-to-noise ratio (C/N) required for outdoor reception	6.38 dB	3.09 dB	6.14 dB
Median system margin for outdoor sites	H: -77.47 dBm	H: -81.17 dBm	H: -73.75 dBm
	V: -76.43 dBm	V: -81.92 dBm	V: -74.00 dBm
Max system margin for outdoor sites	H: -71.15 dBm	H: -78.39 dBm	H: -68.24 dBm
	V: -69.04 dBm	V: -80.58 dBm	V: -70.30 dBm
Min system margin for outdoor sites	H: -79.43 dBm	H: -85.53 dBm	H: -77.71 dBm
	V: -79.28 dBm	V: -83.86 dBm	V: -76.98 dBm
Number of indoor sites	9	5	5
Number of indoor sites without reception errors	9	5	5
Percentages of success in indoor sites	100%	100%	100%
Median carrier-to-noise ratio (C/N) required for indoor reception	14.19 dB	7.04 dB	15.71 dB
Max carrier-to-noise ratio (C/N) required for indoor reception	21.63 dB	8.82 dB	15.96 dB
Min carrier-to-noise ratio (C/N) required for indoor reception	12.38 dB	6.42 dB	12.29 dB

	Config 1	Config 3	
Fixed Reception	**LA**	**LA**	**LB**
Median system margin for indoor sites	H: -76.48 dBm	H: -82.05 dBm	H: -74.88 dBm
	V: -74.37 dBm	V: -80.56 dBm	V: -71.63 dBm
Max system margin for indoor sites	H: -70.80 dBm	H: -81.00 dBm	H: -72.22 dBm
	V: -68.48 dBm	V: -78.31 dBm	V: -70.38 dBm
Min system margin for indoor sites	H: -79.21 dBm	H: -83.45 dBm	H: -75.61 dBm
	V: -76.06 dBm	V: -83.59 dBm	V: -75.5 dBm

Table 7.51 - Summarized results using Advanced ISDB-T for mobile reception.

Mobile Reception – Routes	1	2	3 - 20 km/h	3 - 40 km/h	3 - 60 km/h	4	5
Number of measured points in drive test	1,072	979	147	113	133	431	490
Number of points without reception errors	423	427	133	52	89	182	163
Reception success rate in range [1 km/h ,10 km/h]	80	100	100	100	100	100	100
Reception success rate in range]10 km/h ,20 km/h]	56.29	79.36	88.52	61.22	86.88	83.06	42.21
Reception success rate in range [20 km/h ,30 km/h]	20.80	21.94	91.86	57.14	55	22.58	15.12
Reception success rate in range]30 km/h ,40 km/h]	15.58	9.64	-	16.66	50	3.48	8.33
Reception success rate in range]40 km/h ,50 km/h]	5.88	2.94	-	-	18.18	1.75	-
Reception success rate in range]50 km/h ,60 km/h]	2.27	25.64	-	-	0	0	-
Reception success rate in range]60 km/h ,70 km/h]	0	0	-	-	-	-	-
Reception success rate in range]70 km/h ,80 km/h]	-	0	-	-	-	-	-

7.5 Candidate Technology B

We received the ATSC 3.0 equipment in Rio de Janeiro by 06 March 2024. From 11 March 2024 up to 22 March 2024, we performed the ATSC 3.0 software configuration and hardware installation on the van as well as both Sumaré and Penna stations assembling. It is also important to emphasize that, from 11 March 2024 to 19 March 2024, the proponents of this candidate technology checked and validated the installation of measurement equipment and software used in indoor and outdoor campaigns. The ATSC 3.0 equipment was validated to operate in SFN, but the field test was not conducted in this network mode. The field test window was from 26 March 2024 until 07 May 2024.

The devices received for the ATSC 3.0 test are described in Table 7.52.

Table 7.52 - ATSC 3.0 devices for field tests.

Description	Type	Quantity (Sets)
ATSC 3.0 Modulator Channel Bonding	CLA3-CB1000T	1
ATSC 3.0 Demodulator Channel Bonding	CLA3-CB1000R	1
ATSC 3.0 Modulator MIMO	CLA3-MM1000T	2
ATSC 3.0 Demodulator MIMO	CLA3-MM1000R	2
Cables and Adapters: 2x USB AC ETH Power adapter USB adapter to 4 pins 4 pins cable	CLA3-MM1000T	Set
Cables and Adapters: 2x USB AC ETH USB adapter for RS232 4 pins adapter	CLA3-MM1000R	Set

The configurations applied to the transmitter are in Tables 53 and 54, for Configs. 1 (main measurement campaign) and 3 (extra measurement campaign), respectively. We use PRBS to perform all tests. The quality threshold adopted was FEC Error Rate < 2×10^{-4}. The extra configuration was requested by the SBTVD forum to perform extra measurements.

Table 7.53 - ATSC 3.0 transmission parameters (Config. 1 - Main measurement).

Modulation	64-QAM
Constellation	Non-Uniform Constellation
Error correction	LDPC + BCH (8/15)
FFT	16K
GI ratio	768/16384 (111 μs)
Time interleaving	CTI 1024
Pilot pattern	Dx=8, Dy=2
Useful Bandwidth	5.83 MHz
Bitrate	32.2 Mbps

Table 7.54 - ATSC 3.0 transmission parameters (Config. 3 - Extra measurement).

Modulation	Core Layer, 16-QAM Enhanced Layer, QPSK
Constellation	Core Layer, Non-Uniform Constellation Enhanced Layer, Uniform Constellation
Error correction	Core Layer, LDPC+BCH (4/15) Enhanced Layer, LDPC+BCH (8/15)
LDM injection level	9 dB
FFT	16K
GI ratio	768/16384 (111 μs)
Interleaver	CTI 1024
Pilot pattern	Dx=8, Dy=2
Useful Bandwidth	5.83 MHz
Bit rate	10.7 + 10.7 Mbps

7.5.1 Test Results

Note that Configurations 1 and 3 were chosen by the SBTV Forum in order to provide typical services in digital television broadcasting. Specifically, Configuration 1 can provide sufficient data rate for supporting 4K UHD video, while Configuration 3 can support two HD video broadcasting simultaneously.

7.5.1.1 Coverage Measurement

7.5.1.1.1 Methodology

The methodology for measuring the channel reception power, MER, Margin, and C/N at the threshold in MIMO were the same as in AISDBT. A brief explanation is given as follows

The first step of the test was to capture and analyze signal reception. Along with the measurements, some sites had a very low signal level, so we could not measure system margin and C/N at the threshold, as the system was already beyond its margin. These sites have 'N/A' in the 'C/N at threshold in MIMO' column in the following tables.

The Channel Power was measured in horizontal and vertical polarizations with the Tektronix Spectrum Analyzer. We used an average of 100 samples in sequence since the instantaneous values varied continuously due to the variability of the radio channel. At this time, values of MER were recorded for each polarization as well. When considering all measuring sites, the components in each branch had a maximum difference of 8.7 dB due to path diversity.

Next, we measured the system margin. We attenuated the input RF signal using attenuators until the FEC Error Rate < 2×10^{-4}. At this moment, we decreased the attenuation by 0.5 dB until the FEC Error Rate < 2×10^{-4} for three minutes. Then, we noted the values of the attenuators, recorded the margin signal for one minute, and saved data from the IMAS Demodulator and Tektronix Spectrum Analyzer.

The last test measured the C/N ratio in the threshold. It is essential to notice that this is a SISO spectrum analyzer, so it does not provide a MIMO signal view. We combined the received signal with the artificially generated noise, with variable attenuators set to zero. We controlled the random noise level from -25 dBm to -45 dBm using the software. When necessary, we attenuated noise levels. We increased the noise level until the FEC Error Rate < 2×10^{-4}. Then, we reduced the noise level by 0.5 dB until the FEC Error Rate < 2×10^{-4} for at least three minutes. Finally, we wrote down the values of the attenuators and recorded the C/N signal by 1 minute. After that, we also collected data from all the monitoring devices for the signal, the noise, and the signal+noise combination.

7.5.1.1.2 Results

7.5.1.1.2.1 Outdoor sites

Table 7.56 shows the main results of the coverage test for linear polarization schemes in Config. 1. The term "N/A" is used whenever the measurement was not possible on the site, as the reception was already lower than the system margin. A detailed view of all site measurements is in Appendix III.

Table 7.56 - Outdoor measured sites and main parameters of coverage and service (Config. 1).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -41.46 V: -40.73	V/H: 37.7	-78.81 -78.03	H: 13.26 V: 13.01	13.01
2 (H) 2 (V)	H: -74.37 V: -75.29	V/H: 14.3	N/A N/A	N/A N/A	N/A
3 (H) 3 (V)	H: -65.77 V: -66.78	V/H: 17.2	-68.71 -69.55	H: 21.90 V: 20.45	20.45
4 (H) 4 (V)	H: -63.76 V: -62.94	V/H: 23.5	-78.23 -77.42	H: 13.21 V: 13.41	13.21
5 (H) 5 (V)	H: -57.74 V: -59.73	V/H: 28.2	-75.51 -77.55	H: 16.18 V: 13.55	13.55
6 (H) 6 (V)	H: -65.32 V: -65.91	V/H: 21.3	-71.30 -71.78	H: 19.07 V: 18.47	18.47
7 (H) 7 (V)	H: -59.57 V: -59.56	V/H: 25.2	-74.58 -75.68	H: 16.48 V: 15.64	15.64
8 (H) 8 (V)	H: -57.72 V: -61.26	V/H: 19.4	-66.70 -70.12	H: 21.93 V: 17.90	17.90
9 (H) 9 (V)	H: -37.07 V: -39.00	V/H: 37.9	-76.24 -78.20	H: 15.24 V: 12.74	12.74
10 (H) 10 (V)	H: -43.18 V: -42.42	V/H: 36.9	-78.10 -77.35	H: 12.15 V: 12.89	12.15
11 (H) 11 (V)	H: -50.74 V: -53.96	V/H: 26.3	-70.55 -73.65	H: 21.35 V: 17.48	17.48
12 (H) 12 (V)	H: -40.21 V: -41.73	V/H: 35.4	-76.89 -78.38	H: 15.02 V: 12.86	12.86
13 (H) 13 (V)	H: -60.91 V: -65.49	V/H: 14.0	-69.11 -74.08	H: 22.09 V: 17.19	17.19
14 (H) 14 (V)	H: -44.47 V: -44.44	V/H: 34.4	-77.24 -77.14	H: 12.99 V: 12.09	12.09
15 (H) 15 (V)	H: -61.69 V: -61.17	V/H: 23.1	-75.43 -74.68	H: 16.41 V: 16.63	16.41
16 (H) 16 (V)	H: -49.90 V: -54.54	V/H: 29.6	-75.21 -78.90	H: 15.66 V: 11.30	11.30
17 (H) 17 (V)	H: -59.05 V: -58.45	V/H: 29.5	-78.53 -77.79	H: 13.41 V: 13.41	13.41
18 (H) 18 (V)	H: -66.34 V: -68.02	V/H: 19.1	-70.74 -72.02	H: 19.61 V: 17.25	17.25

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
19 (H) 19 (V)	H: -47.15 V: -46.42	V/H: 32.4	-78.90 -77.76	H: 13.47 V: 13.55	13.47
20 (H) 20 (V)	H: -41.28 V: -41.98	V/H: 36.8	-77.90 -78.46	H: 13.05 V: 11.84	11.84
21 (H) 21 (V)	H: -59.66 V: -60.74	V/H: 25.2	-75.38 -76.27	H: 15.63 V: 14.15	14.15
22 (H) 22 (V)	H: -54.91 V: -53.27	V/H: 26.2	-77.69 -76.15	H: 12.95 V: 13.93	12.95
23 (H) 23 (V)	H: -45.33 V: -44.80	V/H: 30.2	-78.37 -77.88	H: 12.88 V: 12.94	12.88
24 (H) 24 (V)	H: -48.83 V: -46.18	V/H: 33.2	-79.47 -76.93	H: 11.52 V: 13.48	11.52
25 (H) 25 (V)	H: -56.19 V: -55.83	V/H: 29.2	-75.92 -75.55	H: 14.00 V: 13.67	13.67
26 (H) 26 (V)	H: -57.83 V: -56.42	V/H: 29.9	-77.12 -75.76	H: 13.30 V: 14.30	13.30
27 (H) 27 (V)	H: -47.60 V: -48.16	V/H: 34.0	-77.49 -77.47	H: 14.62 V: 13.92	13.92
28 (H) 28 (V)	H: -54.38 V: -54.96	V/H: 32.5	-76.80 -77.21	H: 16.26 V: 15.28	15.28
29 (H) 29 (V)	H: -63.82 V: -64.18	V/H: 9.5	N/A N/A	H: N/A V: N/A	N/A
30 (H) 30 (V)	H: -62.58 V: -63.60	V/H: 21.9	-72.24 -73.73	H: 16.21 V: 15.10	15.10
MEDIAN					13.51

Table 7.57 shows the main outdoor results of the coverage test for linear polarization schemes in Config. 3. We highlight that we expected to measure the same sites with both technologies in the extra measurements, completing a subset of 20 outdoor sites. Nevertheless, during the measurement campaign, the vehicle presented mechanical issues at the end of the measurement schedule. As a consequence, we could not complete the whole subset of 20 sites nor perform the drive test using the extra configuration. A detailed view of all site measurements is in Appendix VII.

In Table 7.57, the term “N/A” is used whenever the measurement was not possible in the site, as the reception was already lower than the system margin. Also, the MER values in these tables are equivalent to the combined MER of the two polarizations (V and H), since the MER of each polarization was not available on the IMAS software. The same occurs for the indoor sites in config. 3, within Table 60.

Table 7.57 - Outdoor measured sites and main parameters of coverage and service (Config. 3).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -39.61 V: -40.00	V/H (CL): 10.0 V/H (EL): 28.3	CL: -84.95; EL: -77.28 CL: -84.89; EL: -77.61	H(CL): 6.74; V(CL): 5.92 H(EL): 15.18; V(EL): 14.13	CL: 5.92 EL: 14.13
4 (H) 4 (V)	H: -62.87 V: -61.86	V/H (CL): 10.0 V/H (EL): 16.3	CL: -85.06; EL: -77.95 CL: -84.29; EL: -77.00	H(CL): 6.38; V(CL): 6.55 H(EL): 13.37; V(EL): 13.65	CL: 6.38 EL: 13.37
6 (H) 6 (V)	H: -62.95 V: -64.94	V/H (CL): 9.9 V/H (EL): 11.4	CL: -89.89; EL: -68.76 CL: -81.57; EL: -71.88	H(CL): 13.62; V(CL): 10.61 H(EL): 20.81; V(EL): 18.63	CL: 10.61 EL: 18.63
7 (H) 7 (V)	H: -57.29 V: -56.15	V/H (CL): 10.0 V/H (EL): 17.7	CL: -80.65; EL: -72.66 CL: -81.44; EL: -74.08	H(CL): 11.11; V(CL): 7.74 H(EL): 19.64; V(EL): 16.00	CL: 7.74 EL: 16.00
8 (H) 8 (V)	H: -56.67 V: -64.08	V/H (CL): 9.8 V/H (EL): 13.2	CL: -77.65; EL: -68.65 CL: -84.01; EL: -75.86	H(CL): 14.76; V(CL): 7.47 H(EL): 23.30; V(EL): 15.41	CL: 7.47 EL: 15.41
23 (H) 23 (V)	H: -48.35 V: -46.99	V/H (CL): 10.0 V/H (EL): 17.6	CL: -84.76; EL: -78.31 CL: -83.50; EL: -76.88	H(CL): 6.12; V(CL): 6.81 H(EL): 13.13; V(EL): 13.62	CL: 6.12 EL: 13.13
25 (H) 25 (V)	H: -49.56 V: -50.48	V/H (CL): 10.0 V/H (EL): 23.9	CL: -84.46; EL: -77.34 CL: -85.04; EL: -78.39	H(CL): 6.97; V(CL): 5.54 H(EL): 14.44; V(EL): 12.74	CL: 5.54 EL: 12.74
28 (H) 28 (V)	H: -48.21 V: -46.61	V/H (CL): 10.1 V/H (EL): 12.4	CL: -85.57; EL: -78.25 CL: -84.34; EL: -76.69	H(CL): 6.00; V(CL): 6.61 H(EL): 12.44; V(EL): 13.32	CL: 6.00 EL: 12.44
MEDIAN					CL: 6.25 EL: 13.75

7.5.1.1.2.2 Indoor sites

Table 7.59 shows the main results of the coverage test for linear polarization schemes in Config. 1. A detailed view of all site measurements is in Appendix IV.

Table 7.59 - Indoor measured sites and main parameters of coverage and service (Config. 1).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -63.95 V: -61.04	V/H: 20.2	-63.83 -61.93	H: 13.98 V: 16.04	13.98
3 (H) 3 (V)	H: -60.94 V: -62.77	V/H: 19.2	-70.27 -72.06	H: 21.29 V: 18.67	18.67
17 (H) 17 (V)	H: -70.36 V: -74.11	V/H: 16.7	-73.78 -73.62	H: 17.73 V: 16.62	16.62
18 (H) 18 (V)	H: -72.38 V: -72.37	V/H: 16.9	-75.31 -76.25	H: 15.38 V: 14.49	14.49
20 (H) 20 (V)	H: -59.06 V: -59.22	V/H: 24.7	-71.79 -71.80	H: 15.78 V: 15.21	15.21
21 (H) 21 (V)	H: -76.52 V: -67.79	V/H: 9.3	N/A	N/A	N/A
27 (H) 27 (V)	H: -67.78 V: -67.16	V/H: 15.0	-70.72 -69.64	H: 20.89 V: 20.89	20.89
28 (H) 28 (V)	H: -65.03 V: -67.42	V/H: 21.1	-73.96 -76.83	H: 18.10 V: 14.65	14.65
29 (H) 29 (V)	H: -79.61 V: -78.36	V/H: 8.8	N/A	N/A	N/A
MEDIAN					15.21

Table 7.60 shows the main results of the coverage test for linear polarization schemes in the extra measurement using Config. 3. A detailed view of all site measurements is in Appendix VIII.

Table 7.60 - Indoor measured sites and main parameters of coverage and service (Config. 3).

Site (Polarization)	Channel Power (dBm)	MER	MARGIN (dBm)	C/N (dB)	C/N Minimum (dB)
1 (H) 1 (V)	H: -62.65 V: -66.71	V/H (CL): 9.3 V/H (EL): 10.3	CL: -81.07; EL: -73.94 CL: -84.21; EL: -77.53	H(CL): 9.59; V(CL): 5.79 H(EL): 17.65; V(EL): 13.97	CL: 5.79 EL: 13.97
17 (H) 17 (V)	H: -73.22 V: -74.23	V/H (CL): 9.7 V/H (EL): 6.0	CL: -82.40; EL: N/A CL: -82.17; EL: N/A	H(CL): 12.66; V(CL): 9.38 H(EL): N/A; V(EL): N/A	CL: 9.38 EL: N/A
18 (H) 18 (V)	H: -67.75 V: -68.85	V/H (CL): 9.9 V/H (EL): 8.7	CL: -73.47; EL: -82.18 CL: -74.65; EL: -83.08	H(CL): 9.18; V(CL): 7.52 H(EL): 17.76; V(EL): 15.66	CL: 7.52 EL: 15.66
21 (H) 21 (V)	H: -71.25 V: -65.24	V/H (CL): 7.5 V/H (EL): 5.9	CL: -80.09; EL: N/A CL: -74.49; EL: N/A	H(CL): 13.11; V(CL): 18.19 H(EL): N/A; V(EL): N/A	CL: 13.11 EL: N/A
MEDIAN					CL: 8.45 EL: 14.82

7.5.1.2 Service Measurement

We conducted service measurement in parallel to the Coverage Measurement. A detailed report of each site's measurements is in the Appendixes.

We measured the noise floor by a marker on the Spectrum Analyzer screen in the channel power condition in each site. It was not possible to turn off the transmitter at each site to measure the channel power of the noise itself. Concerning the service provision, as previously explained, when the reception conditions in the site were not good and errors occurred even without any attenuation or noise, we could measure neither C/N at TOV nor system margin. These situations happened with signals generally below -85 dBm. In those cases, the FEC Error Rate measured by the IMAS software was higher than 2×10^{-4}. The more delayed versions of the signal are responsible for the distortion leading to selective fading.

We could not perform video and audio measurements, as we used PRBS for the tests.

We didn’t test channel bonding because of transmission site and time constraints. Channel Bonding was assessed only in laboratory tests.

7.5.1.2.1.1 Reuse-1 test

We ran this test on 4 sites, most of them on a sunny day, and there was traffic on the street.

7.5.1.2.1.2 Test methodology

The objective of the test is to evaluate the condition under reuse-1 in threshold conditions. Hence, we want to verify the performance of the system under two different scenarios. First, we want to assess whether the system can keep tuned to one transmitter when another transmitter has similar reception power at a specific channel coding rate. The idea is that the receiver must be able to keep tuned to one transmitter even if more than one transmitter covering the same area has similar power in that place. The C/N ≤ 0 dB under a FEC Error Rate threshold given by the value of 2×10^{-4} guarantees that the system can operate even in the presence of high interference, which is a condition for reuse-1, but it does not guarantee that the system will be able to deliver a regular lock to a single transmitter. We observed the TxID in the receiver in order to observe the transmitter lock. The software presented a TxID equal to 2,000 for one or 1,000 for the other. In the second scenario, a Site and azimuth were sought so that the difference of the received signal of each base station was approximately 16 dB. As defined in the standard, the idea is to check the performance of the system where the transmitters use directional antennas.

Hence, we performed the test rotating the antenna on the pole, at ~10 m from the floor, as shown in Figure 7.161. We rotated the antenna considering azimuths from 0º to 360º, covering both transmitters’ reception areas in the test location. We took note of the channel power at each azimuth, viewing, first, only Penna station transmission and then, only Sumaré station transmission, using two Tektronix Spectrum Analyzer (RSA306B) with the configuration on Table 7.62, one for each polarization. We used this procedure to find an azimuth for each polarization in which both Penna and Sumaré presented similar channel power, simulating the threshold condition of reuse-1.

Figure 7.161 - Arrangement of antenna in the reuse-1 test in both polarization schemes.

Table 7.62 - Tektronix Spectrum Analyzer (RSA306B) parameters.

Parameter	Value
Reference level	-40.0 dBm
Attenuation	0 dBm
RBW	3 kHz
VBW	1 kHz
Channel bandwidth	6 MHz
Center frequency	569.143
Span	30 MHz

After the scan, we positioned the antenna in the selected azimuths and rechecked the received power. After that, we turned on both transmitters simultaneously. We consider the test successful if the receiver remains connected to one transmitter without a considerable number of reception errors verified by the FEC Error Rate available at the IMAS Test software for at least half hour. If the FEC Error Rate ended the test higher than 2×10^{-4}, the channel coding rate was modified to a more robust one, and the test started again with the new configuration. The channel code rates that have been considered were 2/15 and 3/15 for Core Layer tests and 6/15, 7/15 and 8/15 for Enhanced Layer. The idea is to guarantee that the receiver would tune to one of the transmitters. In our test, it locked to Penna station.

According to the previous results from laboratory tests for ATSC 3.0 (see Physical Layer – Laboratory Results Report), we used the following transmitter configuration, as summarized in Table 7.63.

Table 7.63 - ATSC 3.0 configuration for the reuse-1 test.

Parameter	Core layer	Enhanced layer
Useful bandwidth	5.83 MHz	
Modulation	QPSK	16-QAM
Constellation	UC	NUC
Error Correction	64K LDPC+BCH	64K LDPC+BCH
FEC	3/15	8/15
LDM Injection Level	6 dB	
IFFT Size	16K	
GI Ratio	111 µs	
Pilot Pattern	MP8_2	
Pilot Encoding	Null Pilot	
Num of OFDM Symbols	98	
Time Interleaving	CTI 1024	
Bitrate (Mbps)	4.0	21.4
TxID	Penna station: 2000 Sumaré station: 1000	

7.5.1.2.1.3 Results

Table 7.64 shows the measurement results of each site, in terms of layer, channel code rate, azimuth, channel power for each station transmitting separately and both transmitting at the same time. It can be observed that, in one (18) of the four tested Sites (17, 18, 19 and 25), it was not possible to find a half-hour window with a FEC Error Rate ≤ 2 x 10^{-4} in all the tests conducted. For the C/N around 0 dB tests, Core Layer, the highest achievable rate was using FEC 2/15 while for Enhanced Layer tests, at the point where the C/N was around 16 dB, the best rates were using FEC of 6/15 in a site and 8/15 in the other.

In the next subsections, for each evaluated site, we show the channel power of the received signal for Sumaré transmitter (Penna is off), for Penna transmitter (Sumaré is off), and both signals combined. We also show the results presented by the receiver (IMAS software) in each case, which also shows the resulting constellation and the status of the FEC Error Rate. The sites where it was possible to find a half-hour measurement window with FEC below 2 x 10^{-4} have screen photos representing the correct results. The sites where it was not possible to find a satisfactory measurement window have the results of all the configurations tested. The results of this measurement campaign are depicted in Figures 7.162 to 7.197.

Table 7.64 - ATSC 3.0 results for the reuse-1 test.

Site	Layer	FEC	Polarization	Azimuth	Tx1 - Sumaré channel power (dBm)	Tx2 - Penna channel power (dBm)	Difference (Tx1 - Tx2) (dB)	Channel power with reuse-1 (dBm)
17	Enhanced	6/15	Vertical	35º	-70.76	-55.32	15.44	-55.20
			Horizontal		-67.76	-51.39	16.37	-51.15
18	Core	Could not be found	Vertical	70º	-72.76	-71.13	1.63	-68.63
			Horizontal		-69.46	-67.59	1.87	-65.23
19	Enhanced	8/15	Vertical	210º	-64.37	-48.20	16.17	-47.94
			Horizontal		-62.34	-46.69	15.65	-46.62
25	Core	2/15	Vertical	37º	-60.76	-57.43	3.33	-55.70
			Horizontal		-53.94	-57.04	3.10	-52.11

a) Site 17 - Enhanced Layer - C/N ≤ 16 dB

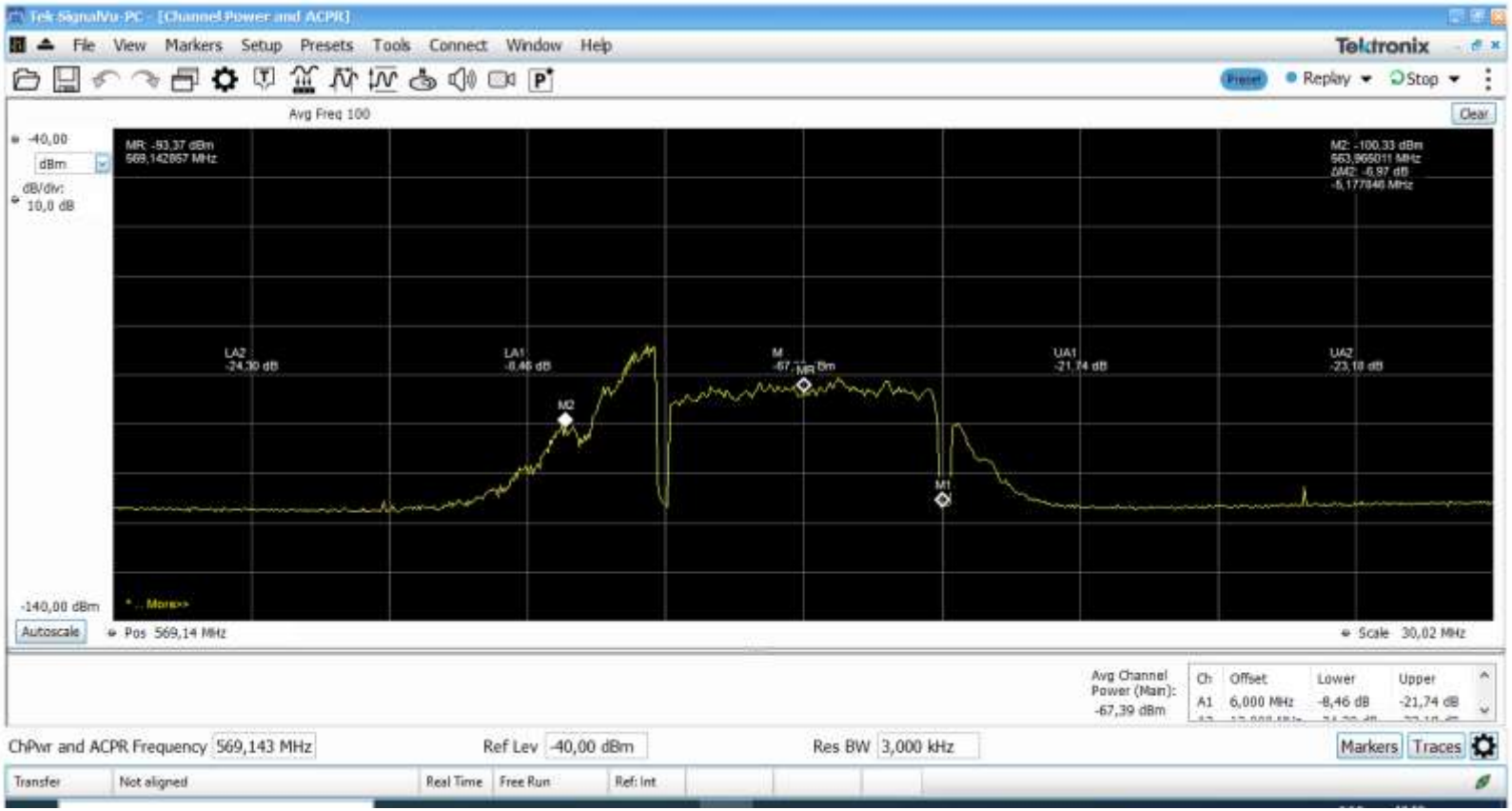


Figure 7.162 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

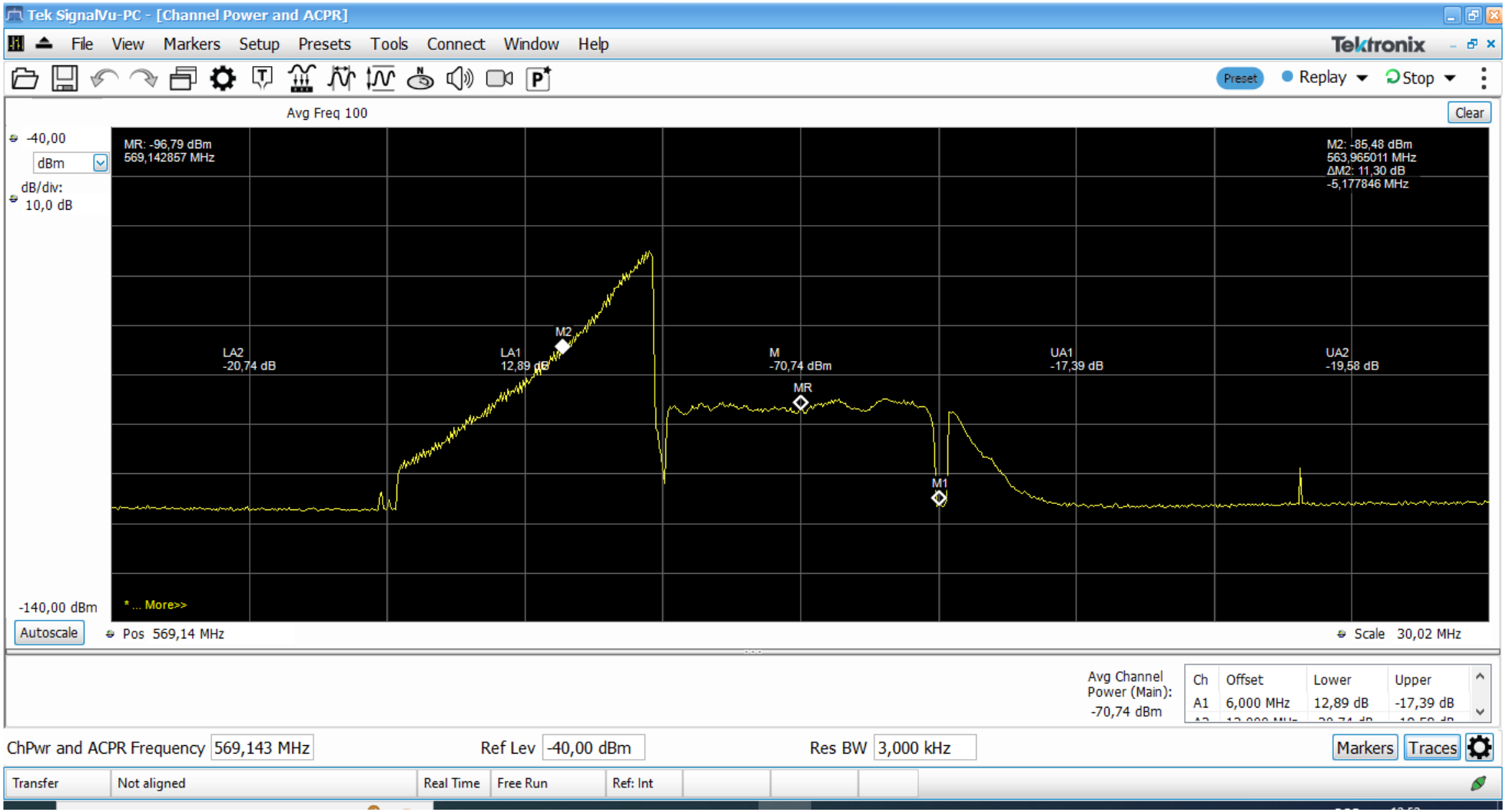


Figure 7.163 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

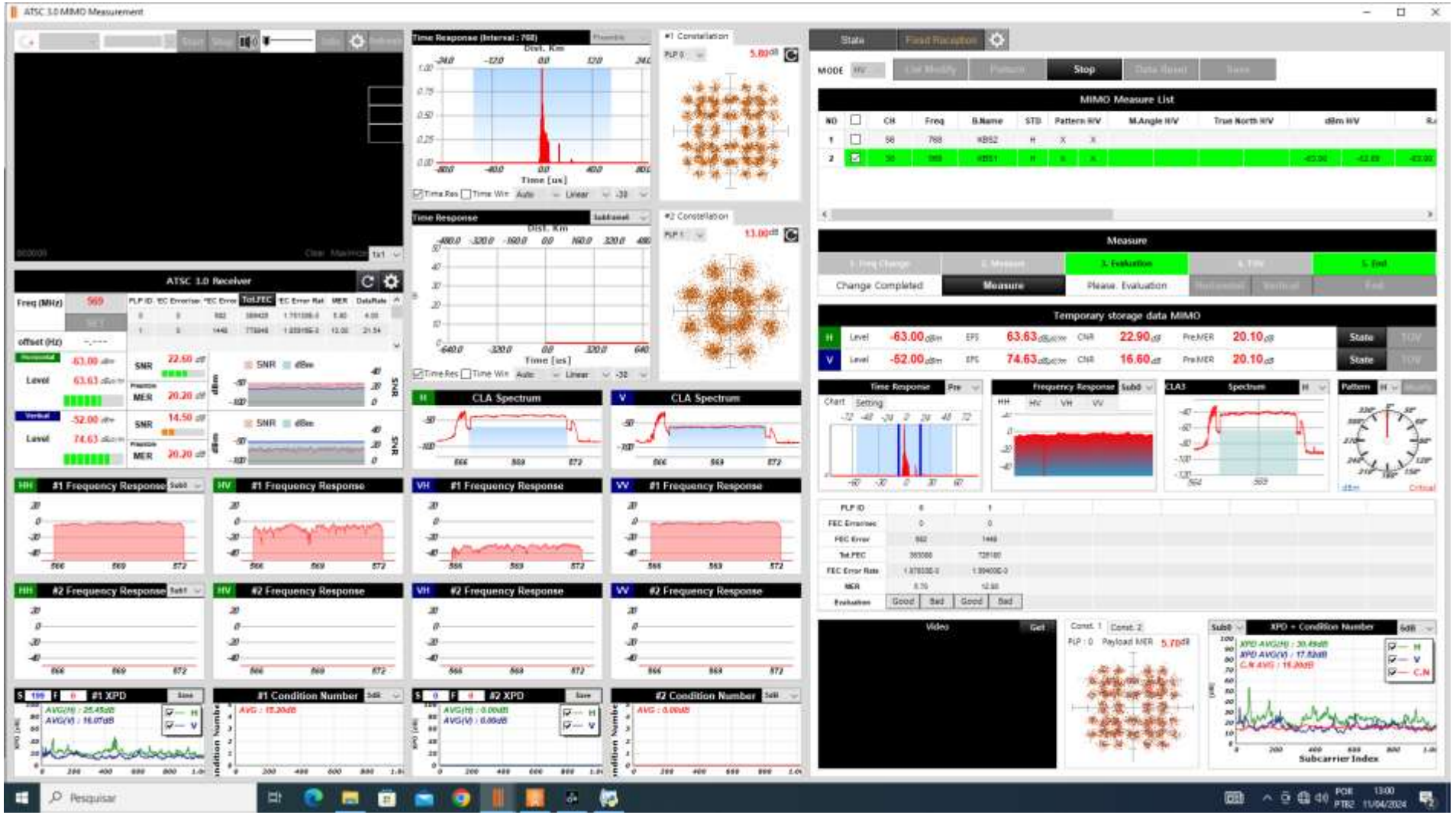


Figure 7.164 - Site 17, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Sumaré station.

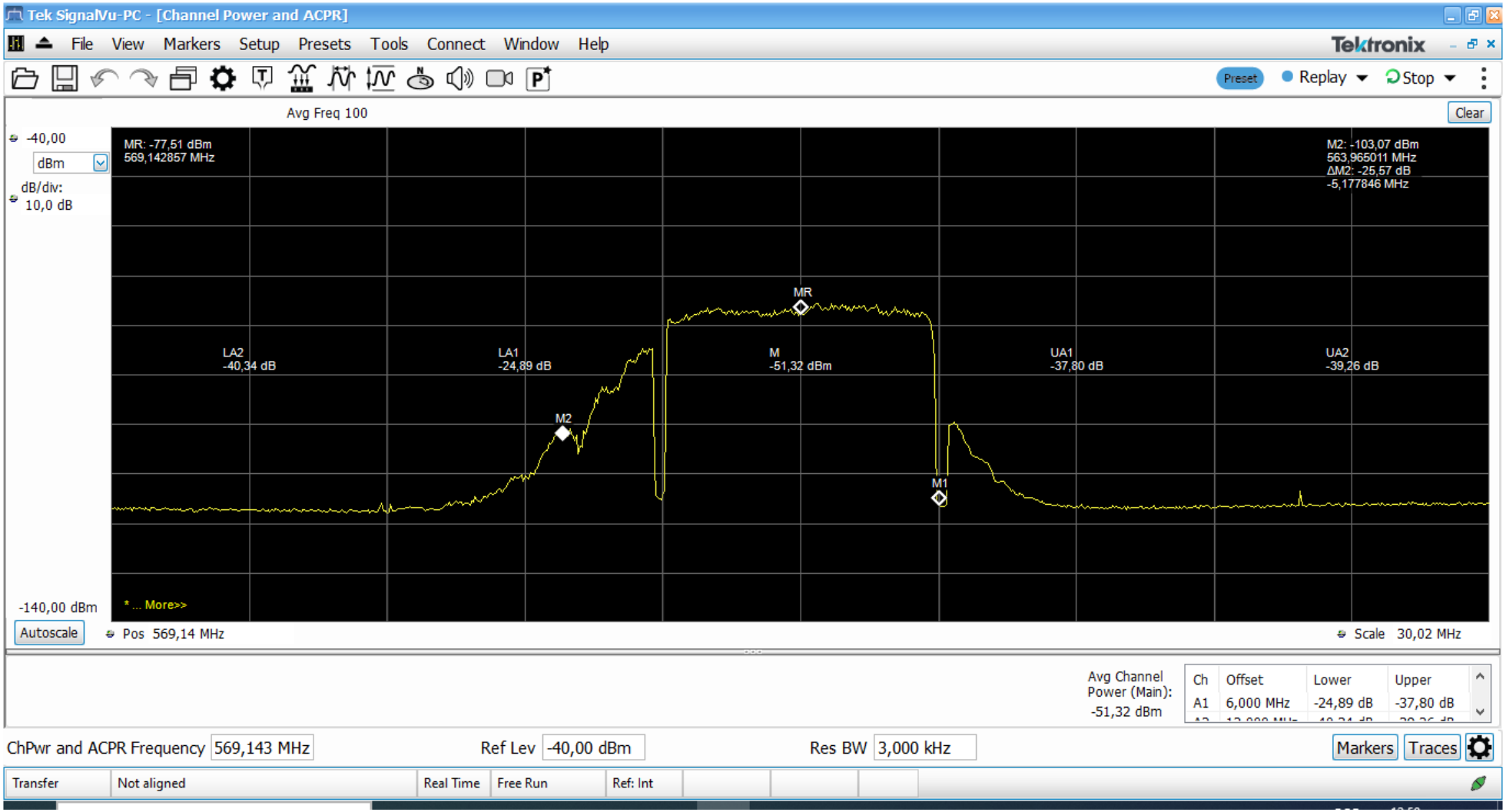


Figure 7.165 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

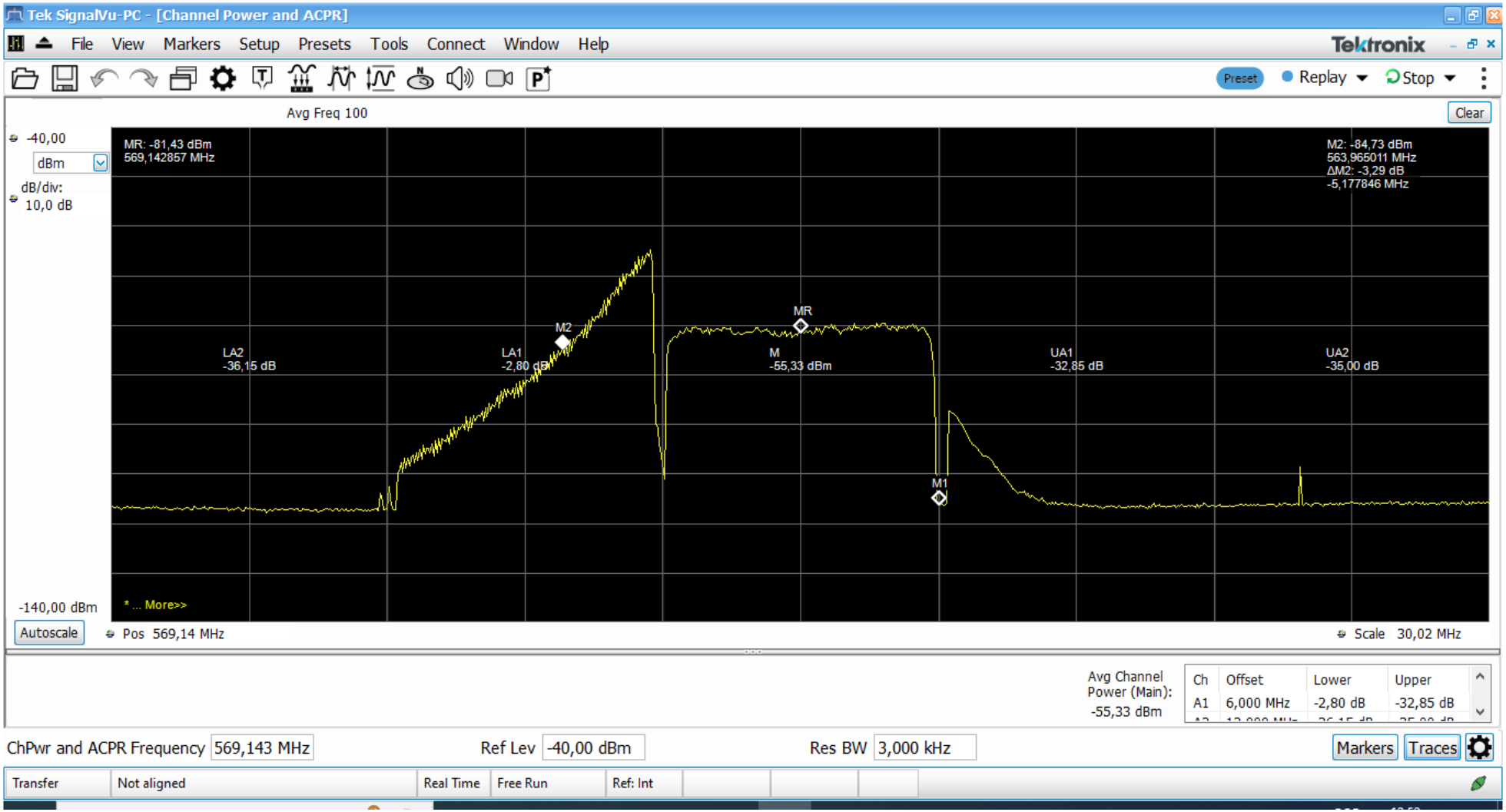


Figure 7.166 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

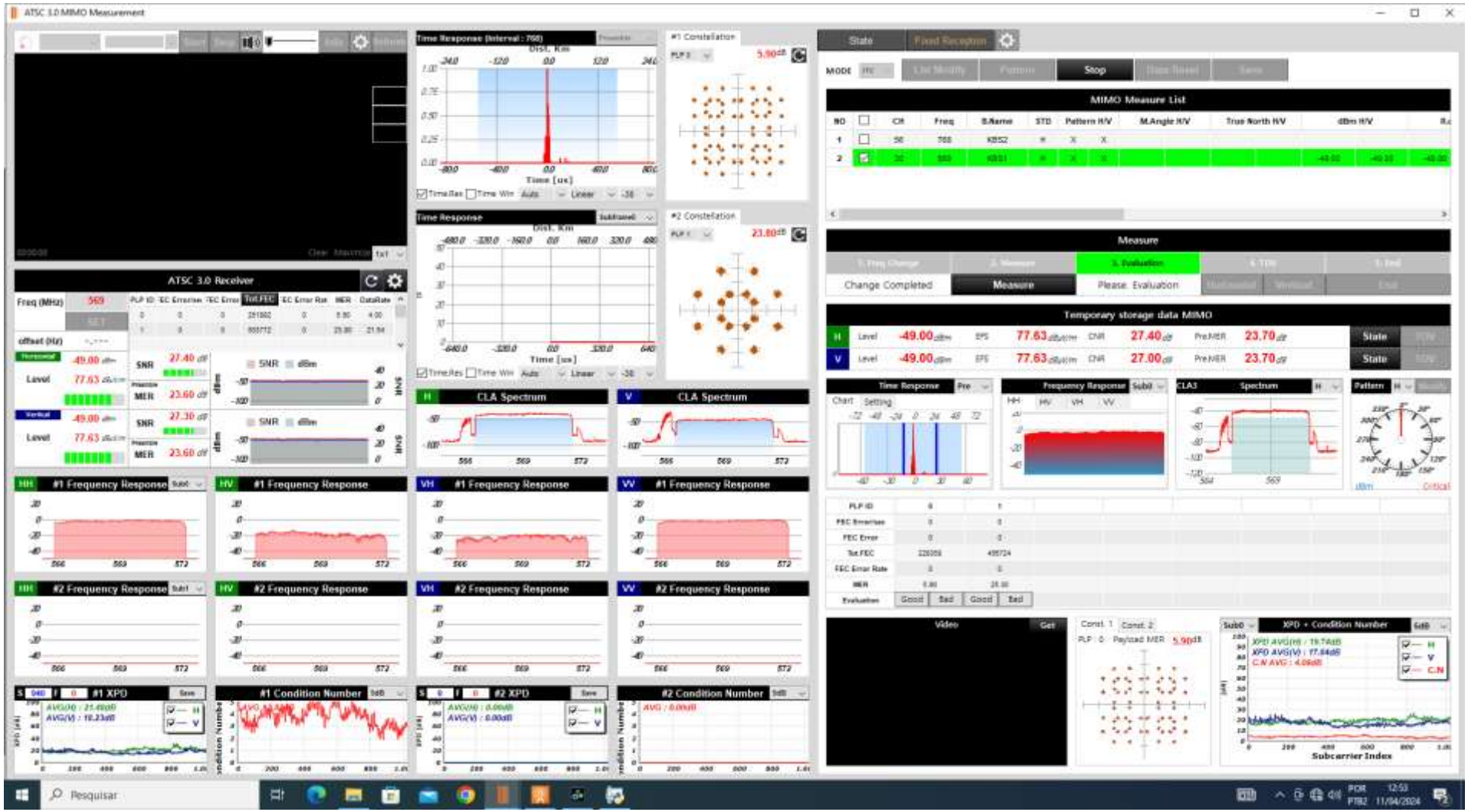


Figure 7.167 - Site 17, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Penna station.

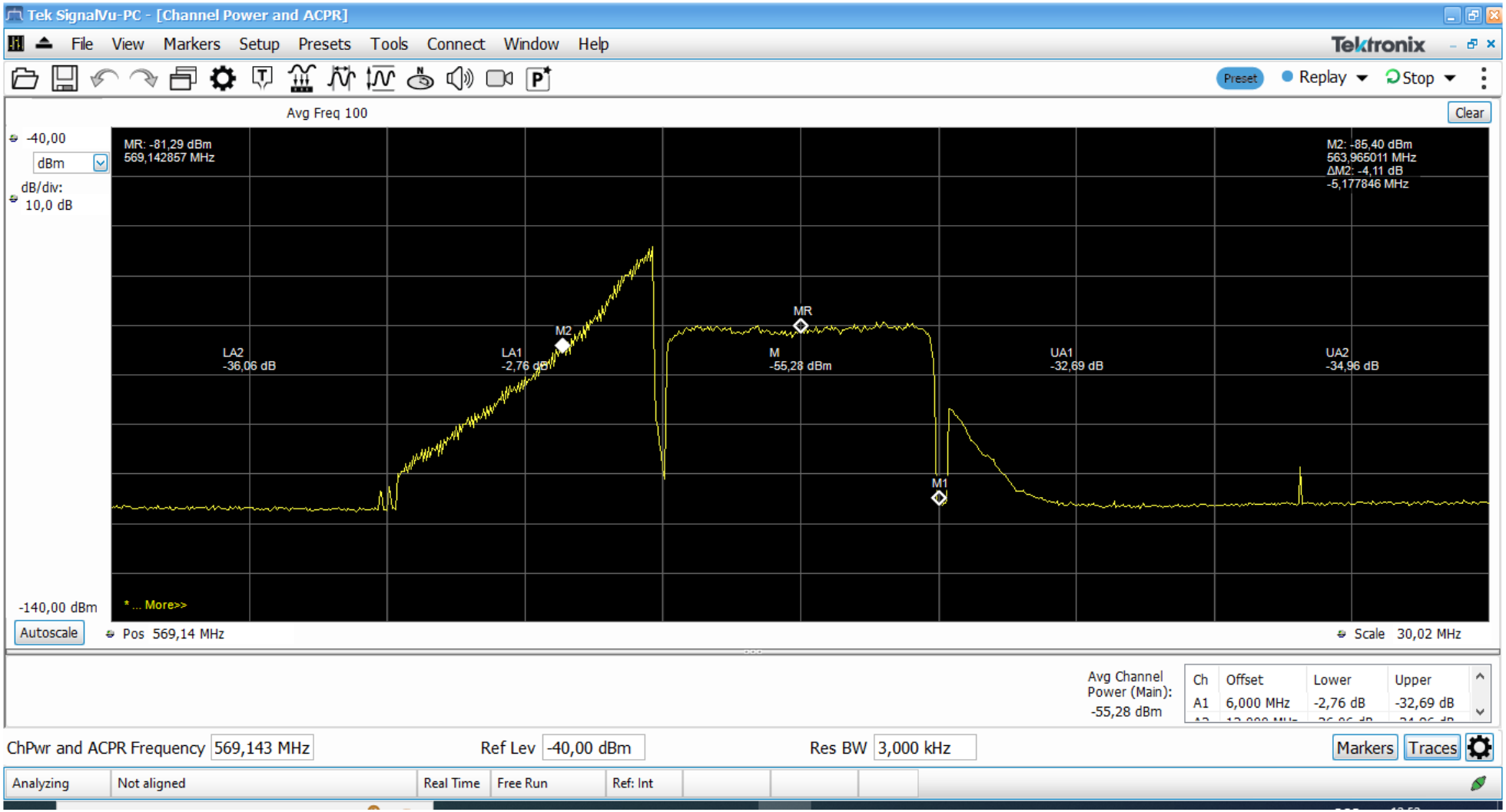


Figure 7.168 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

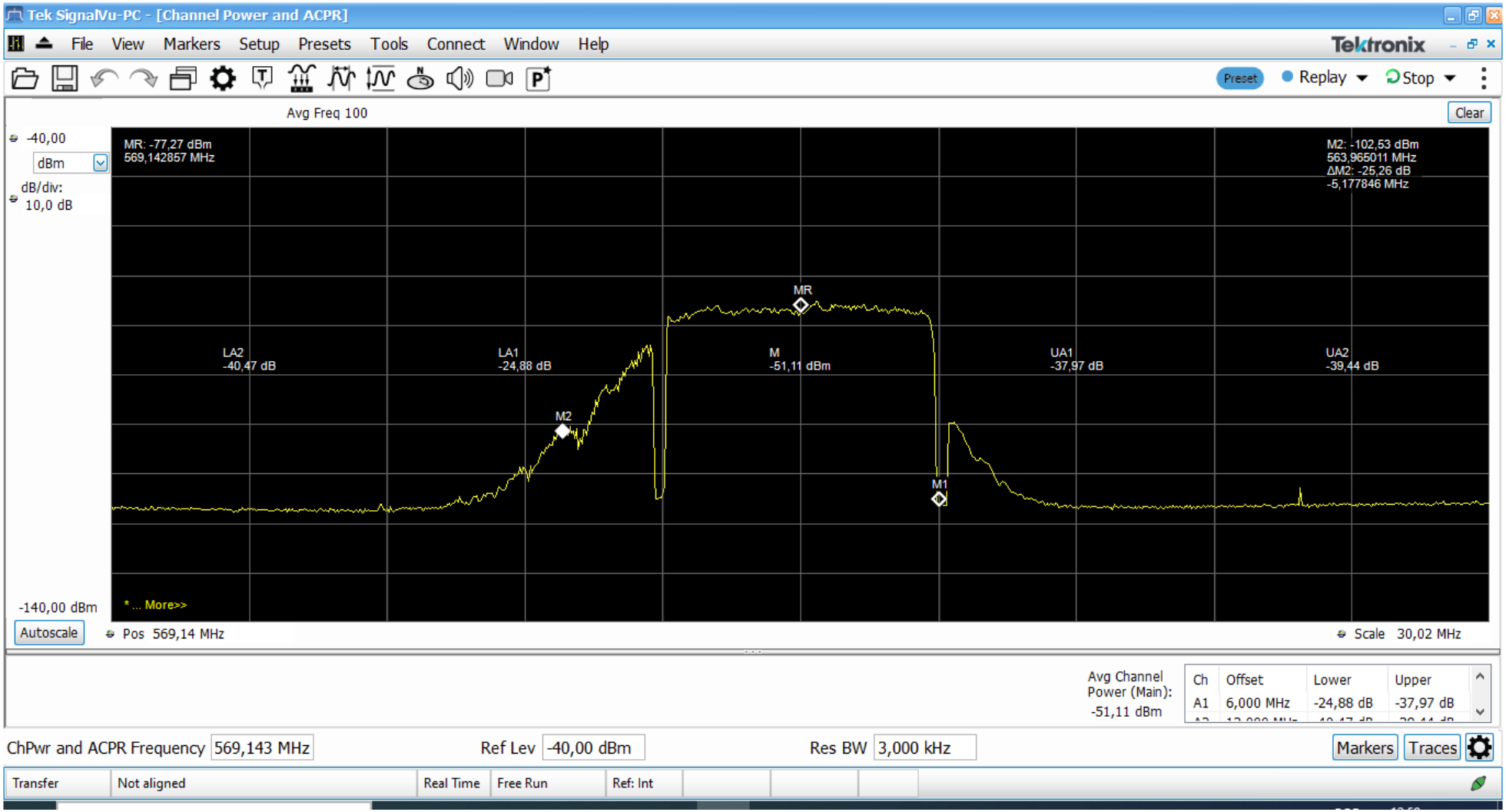


Figure 7.169 - Site 17, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

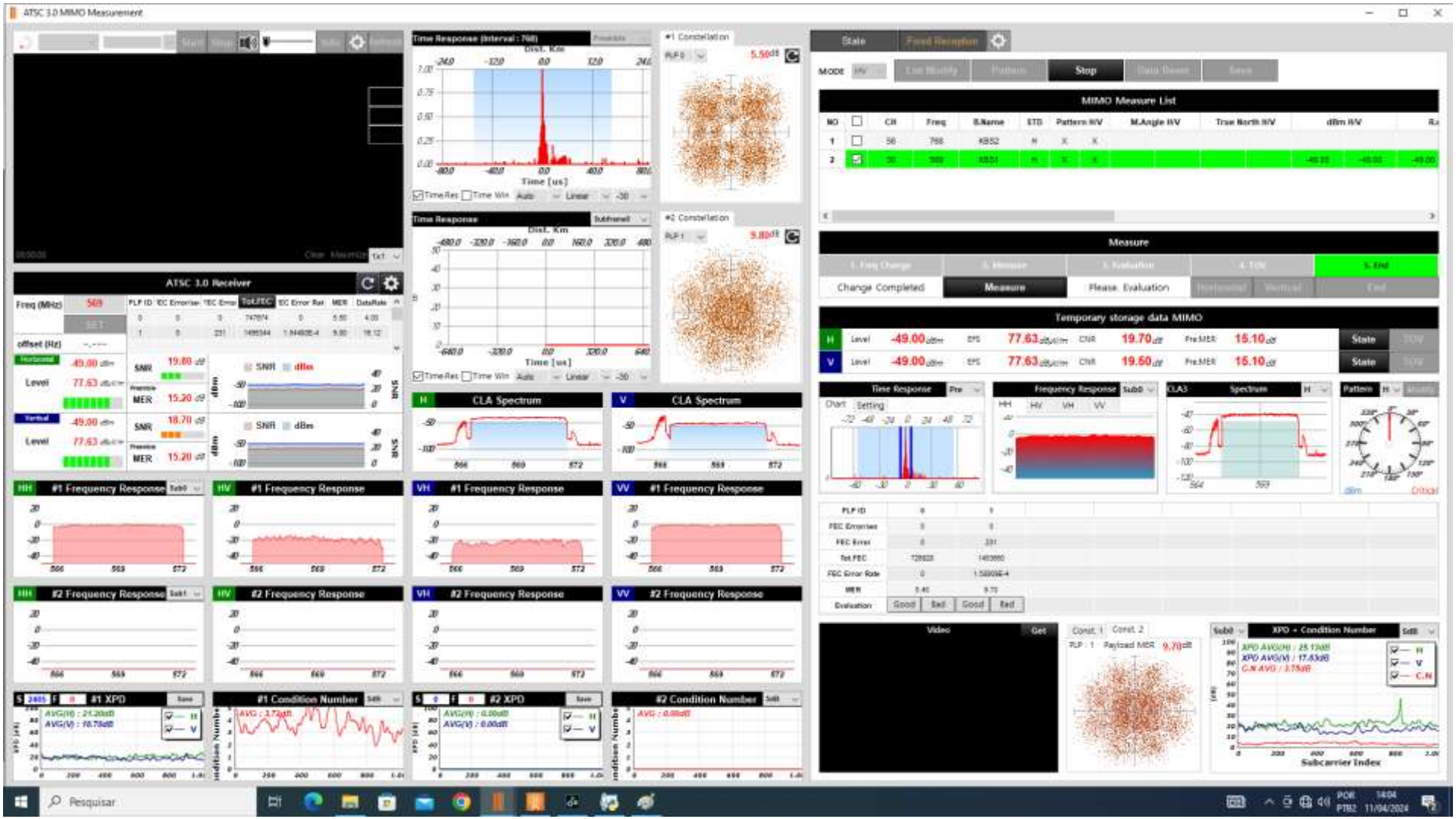


Figure 7.170 - Site 17, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Sumaré and Penna stations.

b) Site 18 - Core Layer - C/N ≤ 0 dB

i) FEC 3/15

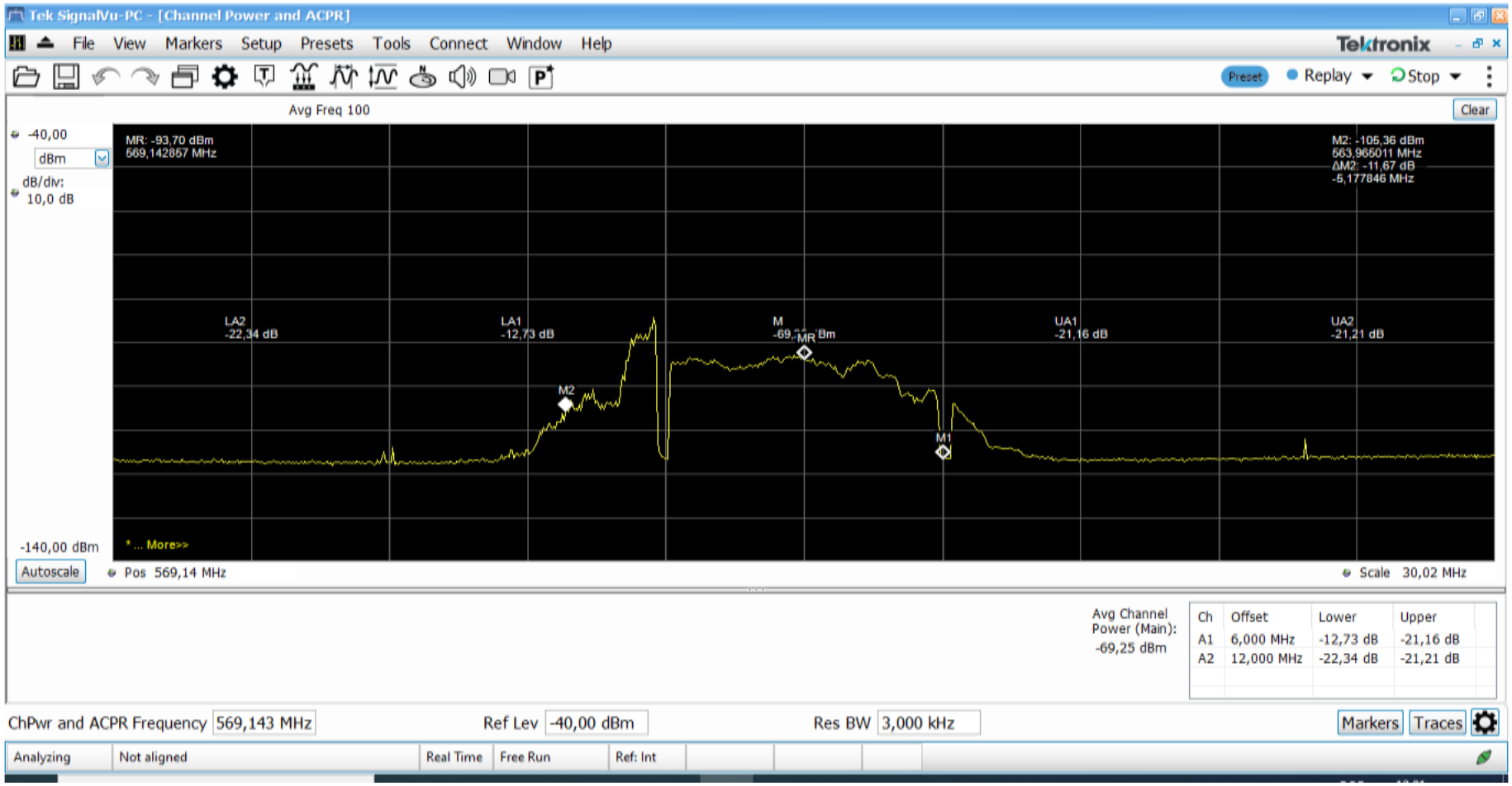


Figure 7.171 - Site 18, ATSC 3.0 reuse-1 test, Core layer code rate 3/15, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

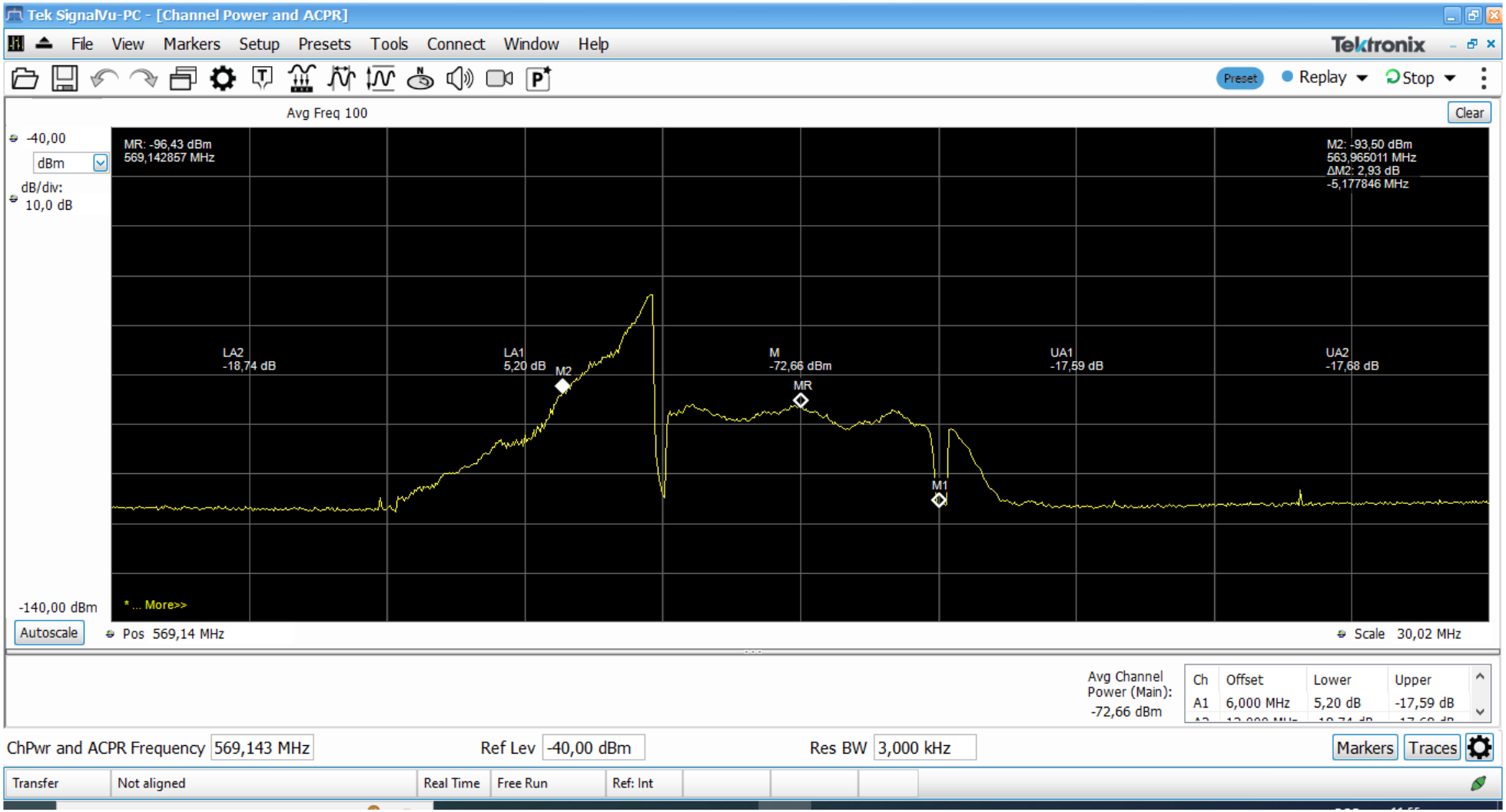


Figure 7.172 - Site 18, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

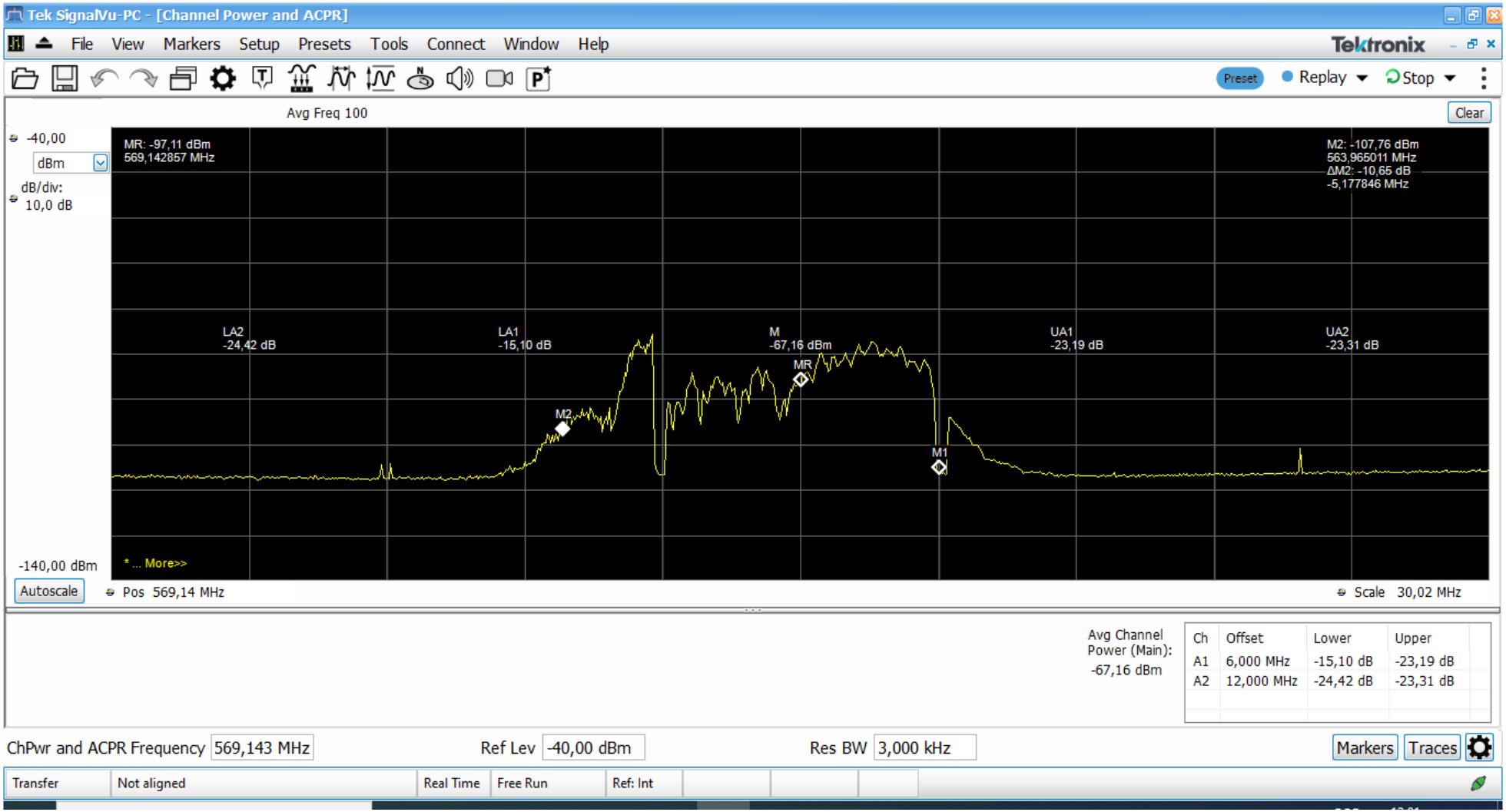


Figure 7.172 - Site 18, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

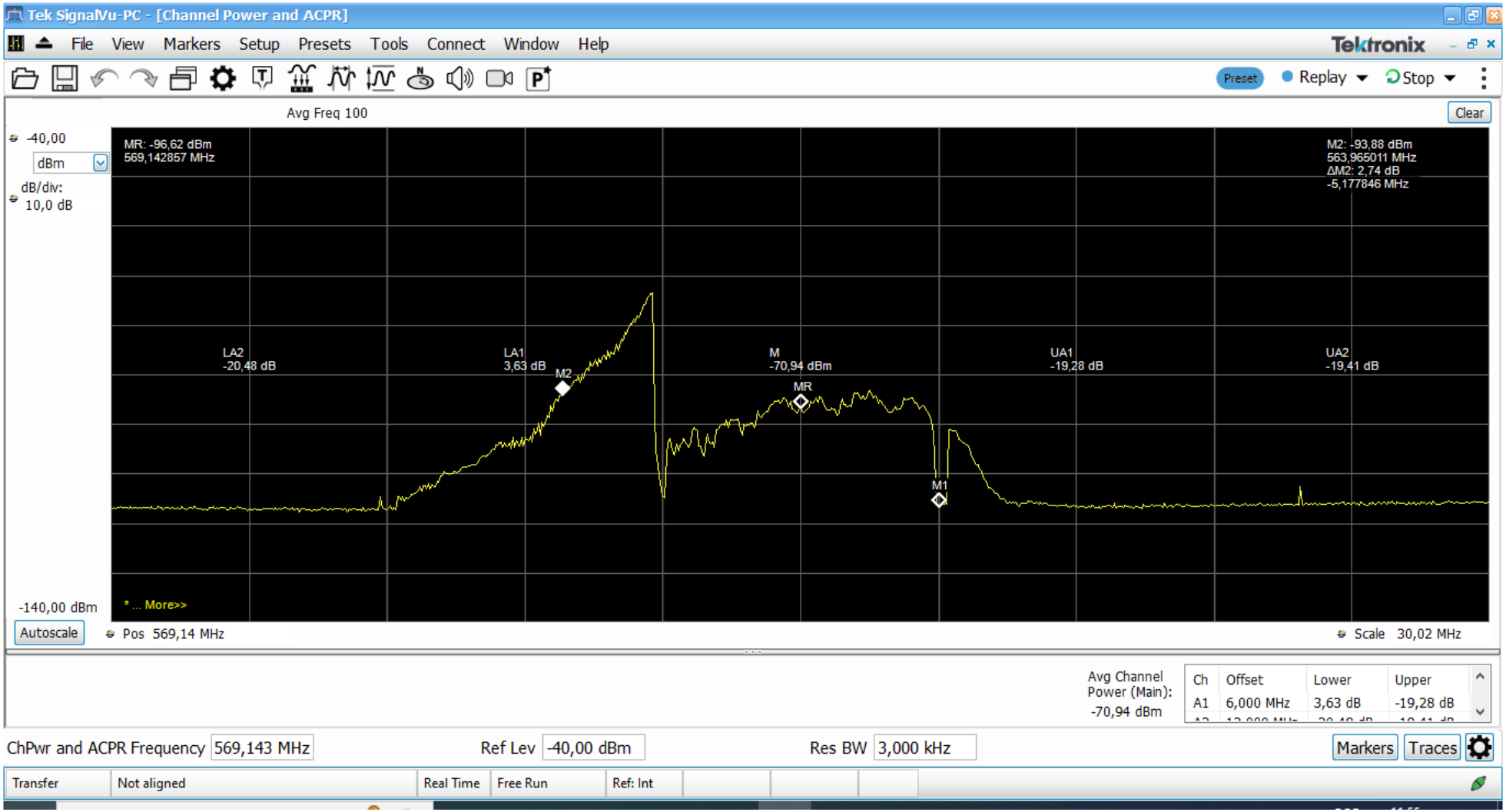


Figure 7.173 - Site 18, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

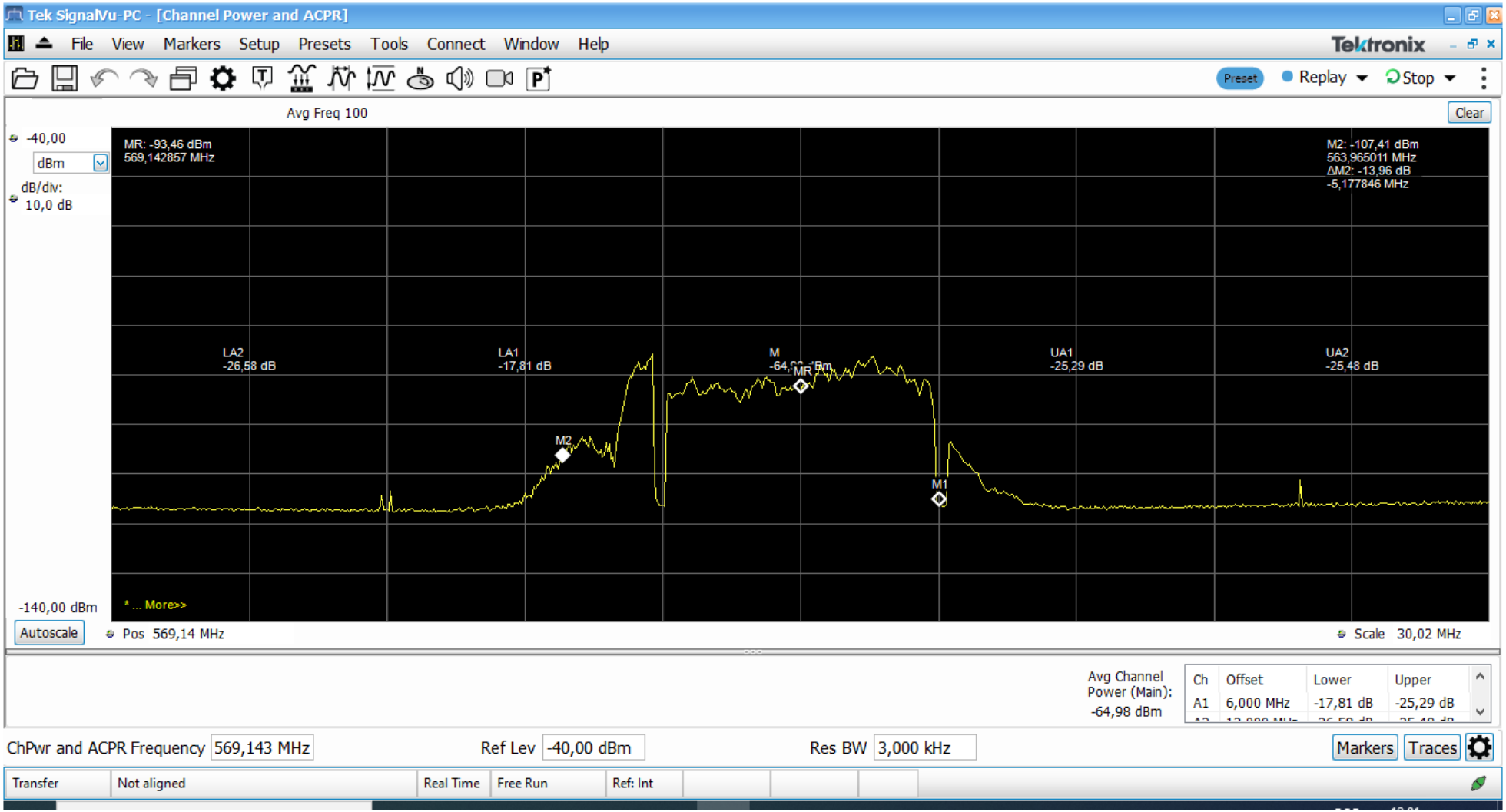


Figure 7.174 - Site 18, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

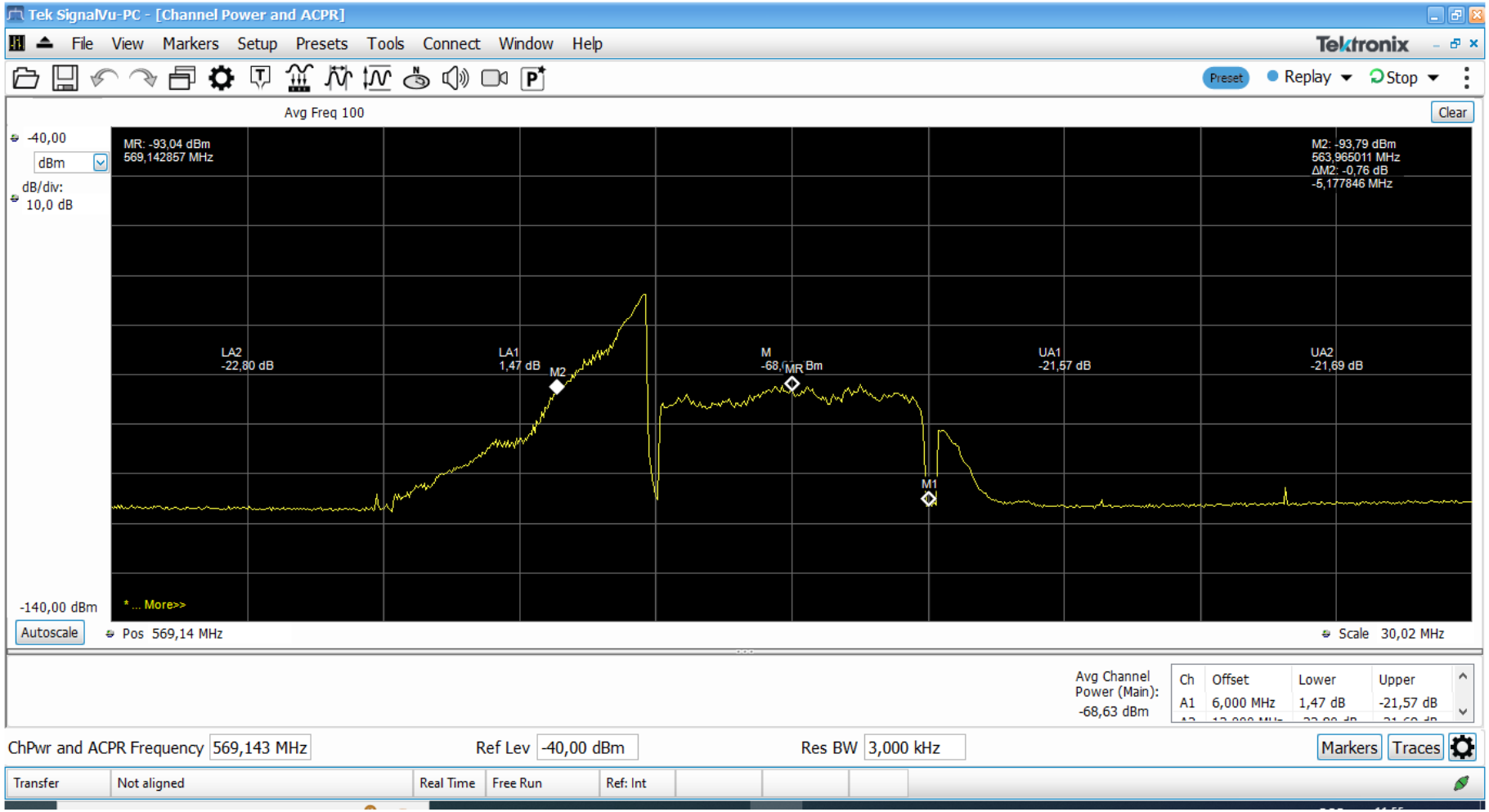


Figure 7.175 - Site 18, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

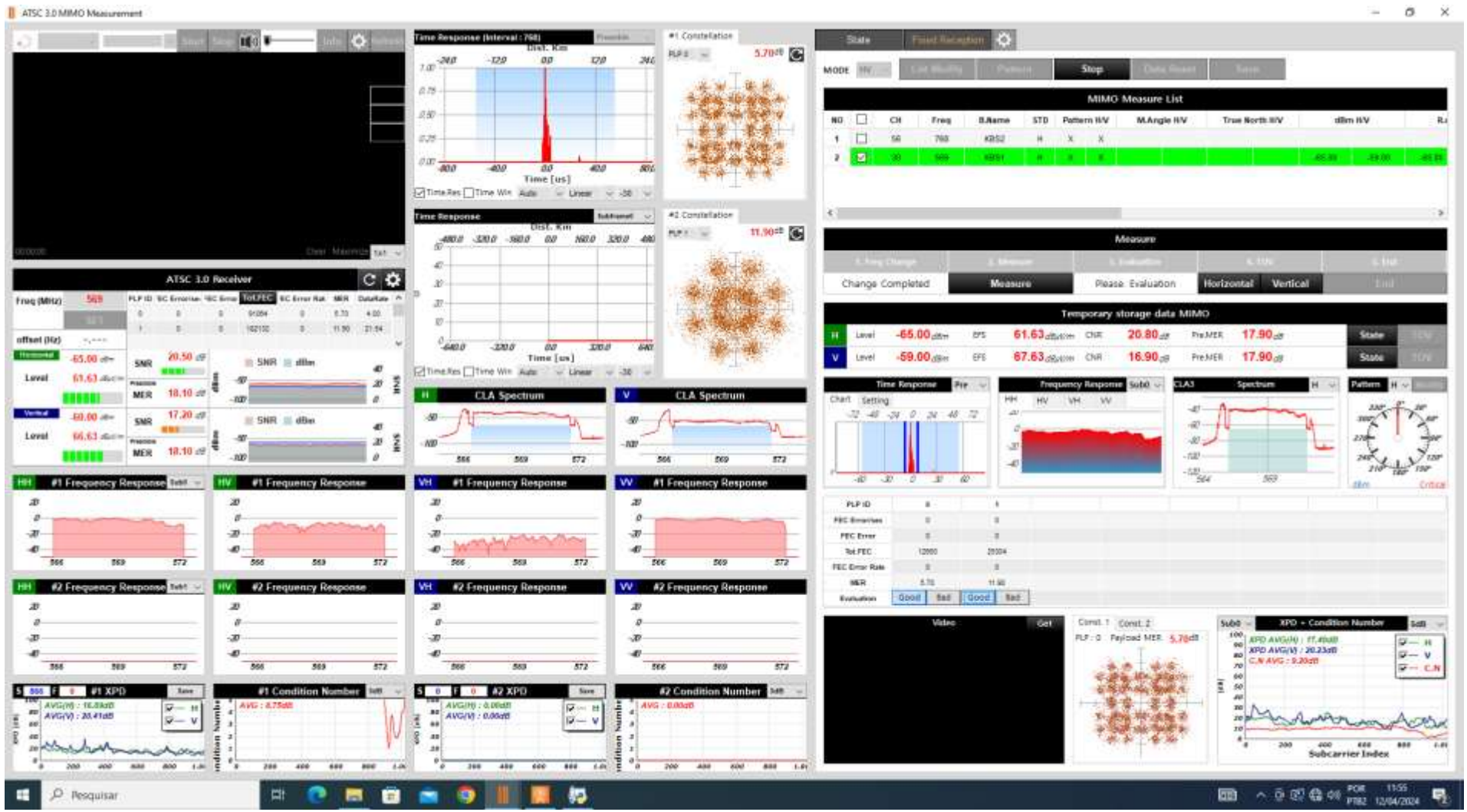


Figure 7.176 - Site 18, ATSC 3.0 reuse-1 test, Core layer code rate 3/15, IMAS (demodulator) measurement, Sumaré station.

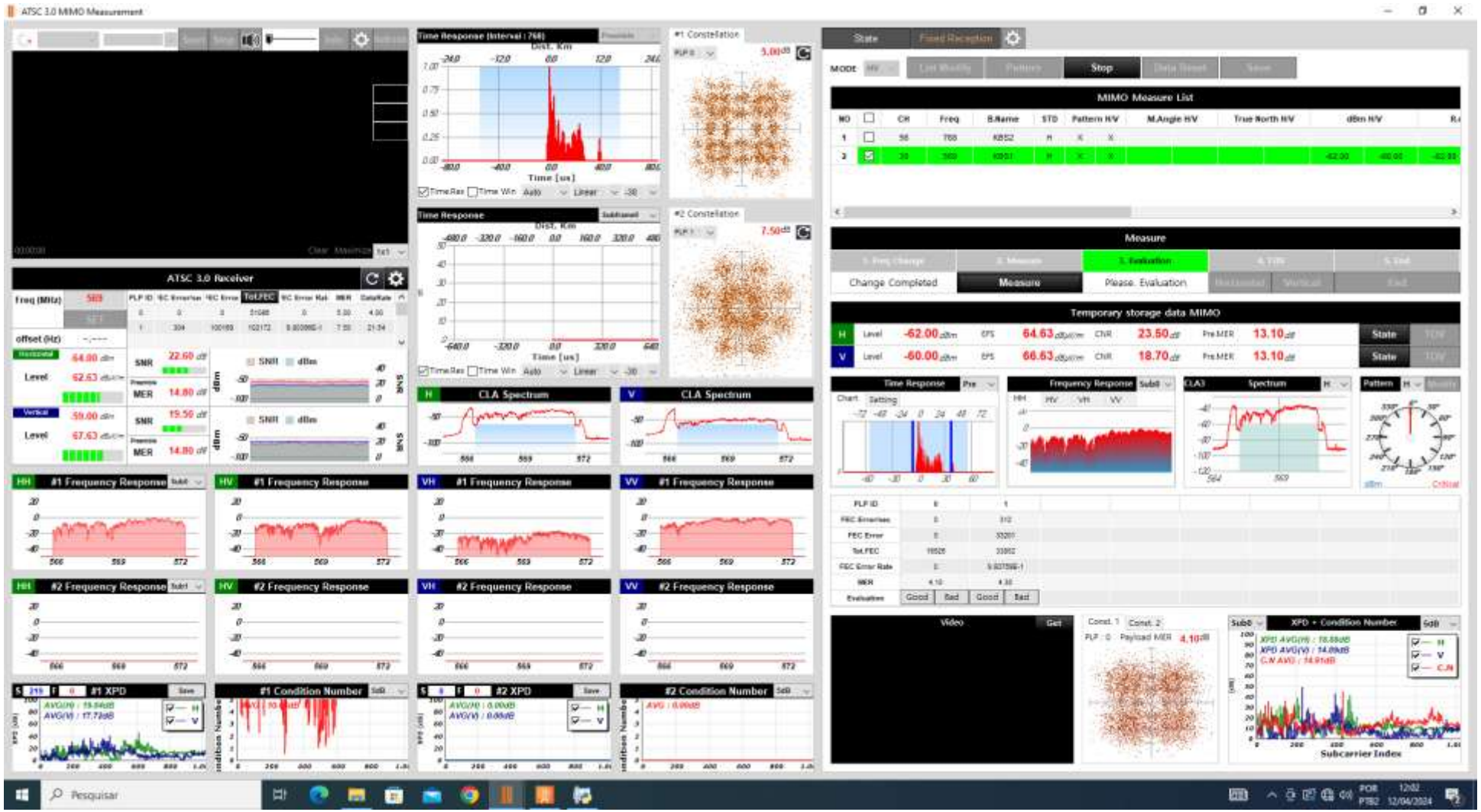


Figure 7.177 - Site 18, ATSC 3.0 reuse-1 test, Core layer code rate 3/15, IMAS (demodulator) measurement, Penna station.

II) Site 18 - Core layer - Code rate 3/15

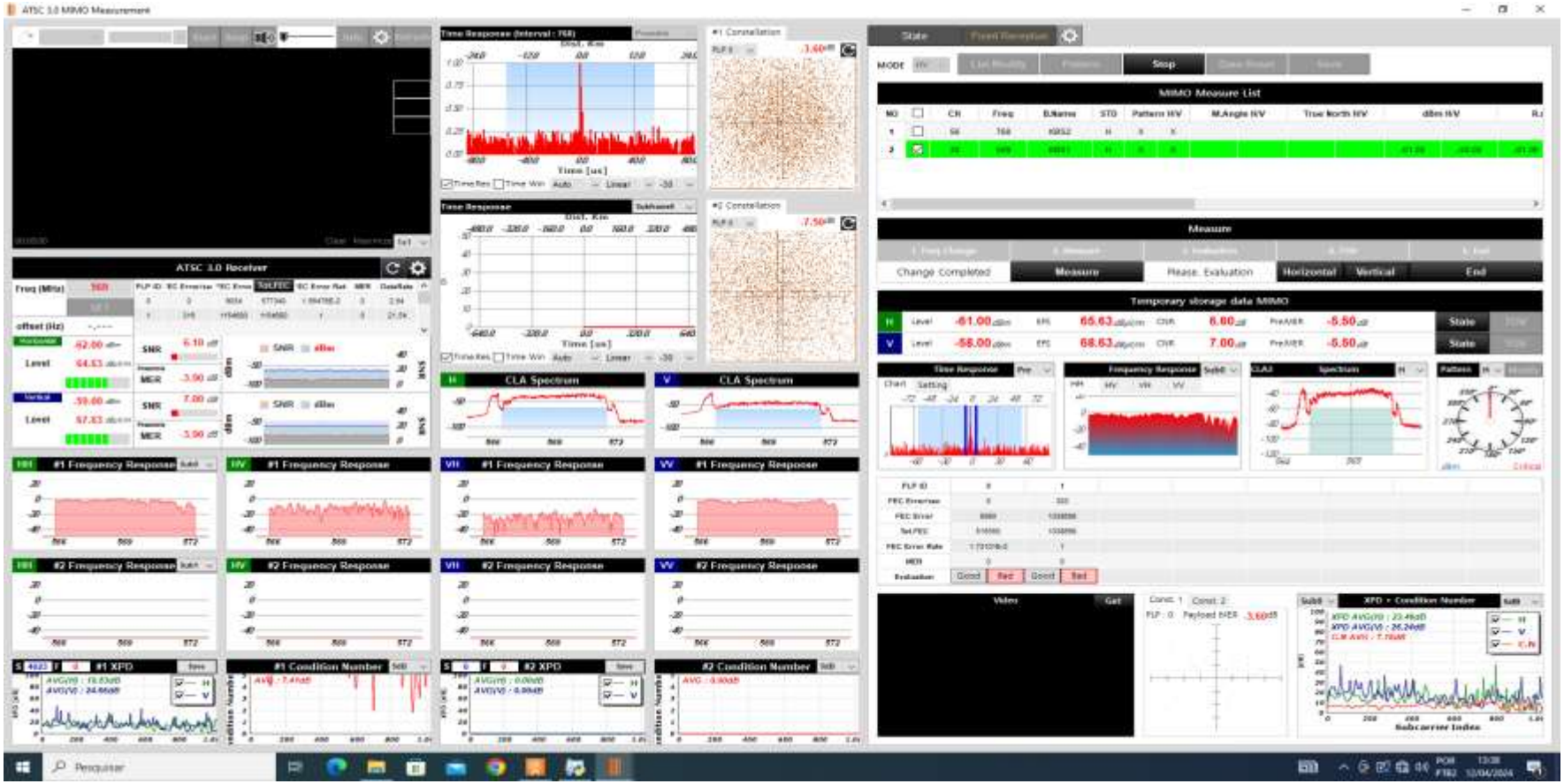


Figure 7.178 - Site 18, ATSC 3.0 reuse-1 test, Core layer code rate 3/15, IMAS (demodulator) measurement, Sumaré and Penna stations.

III) Site 18 - Core layer - Code rate 2/15

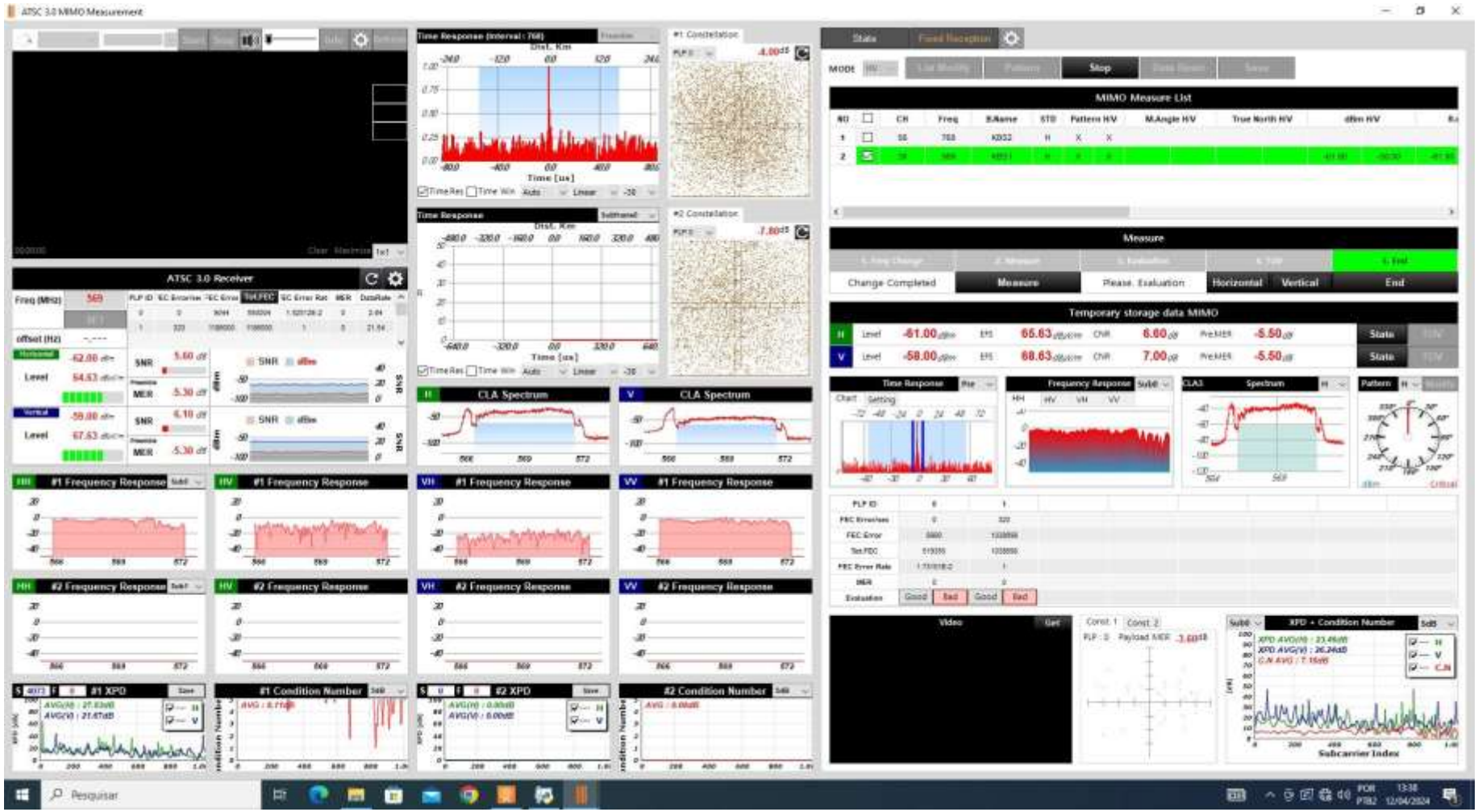


Figure 7.179 - Site 18, ATSC 3.0 reuse-1 test, Core layer code rate 2/15, IMAS (demodulator) measurement, Sumaré and Penna stations.

c) Site 19 - Enhanced Layer - C/N ≤ 16 dB

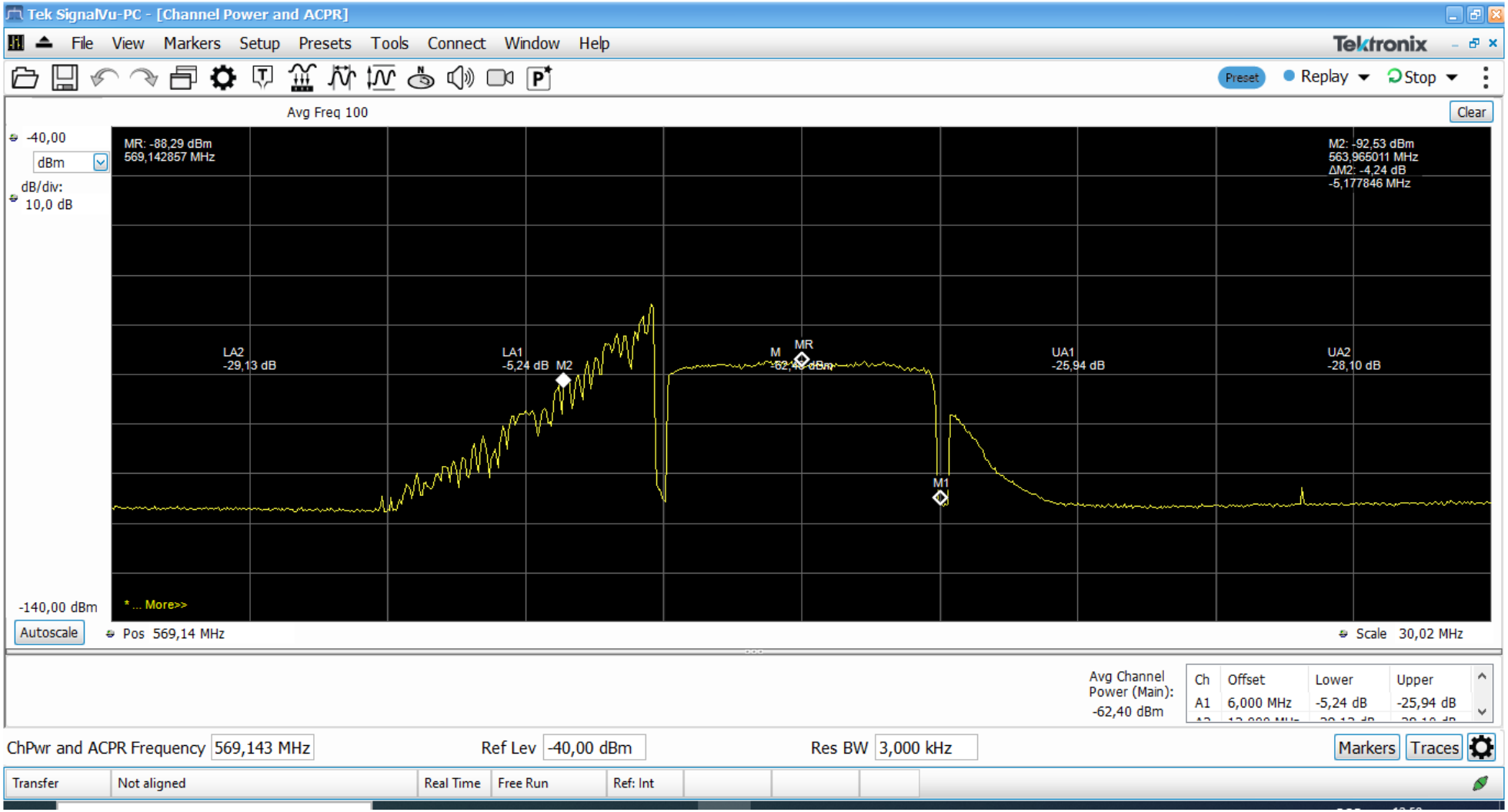


Figure 7.180 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

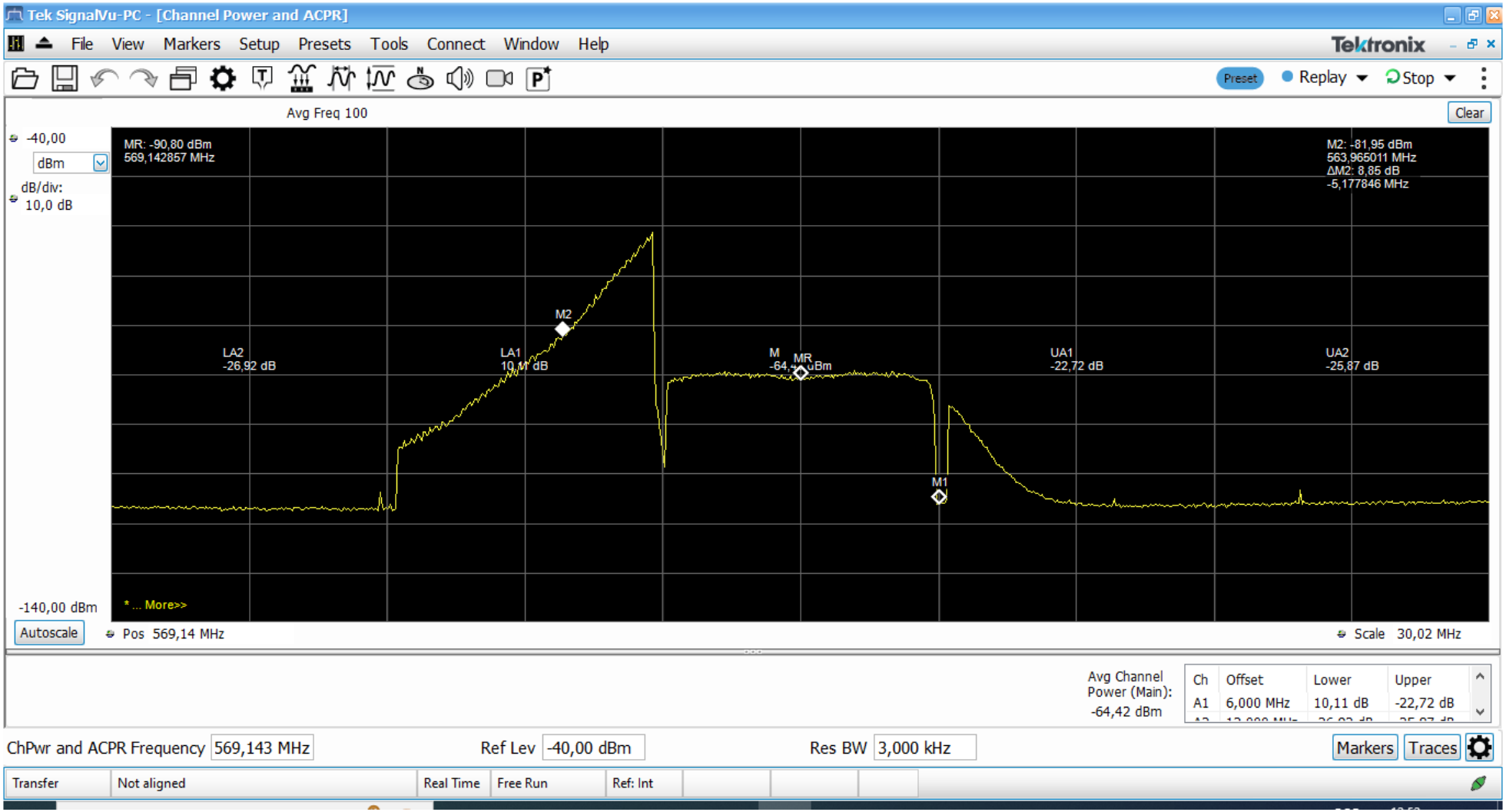


Figure 7.181 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

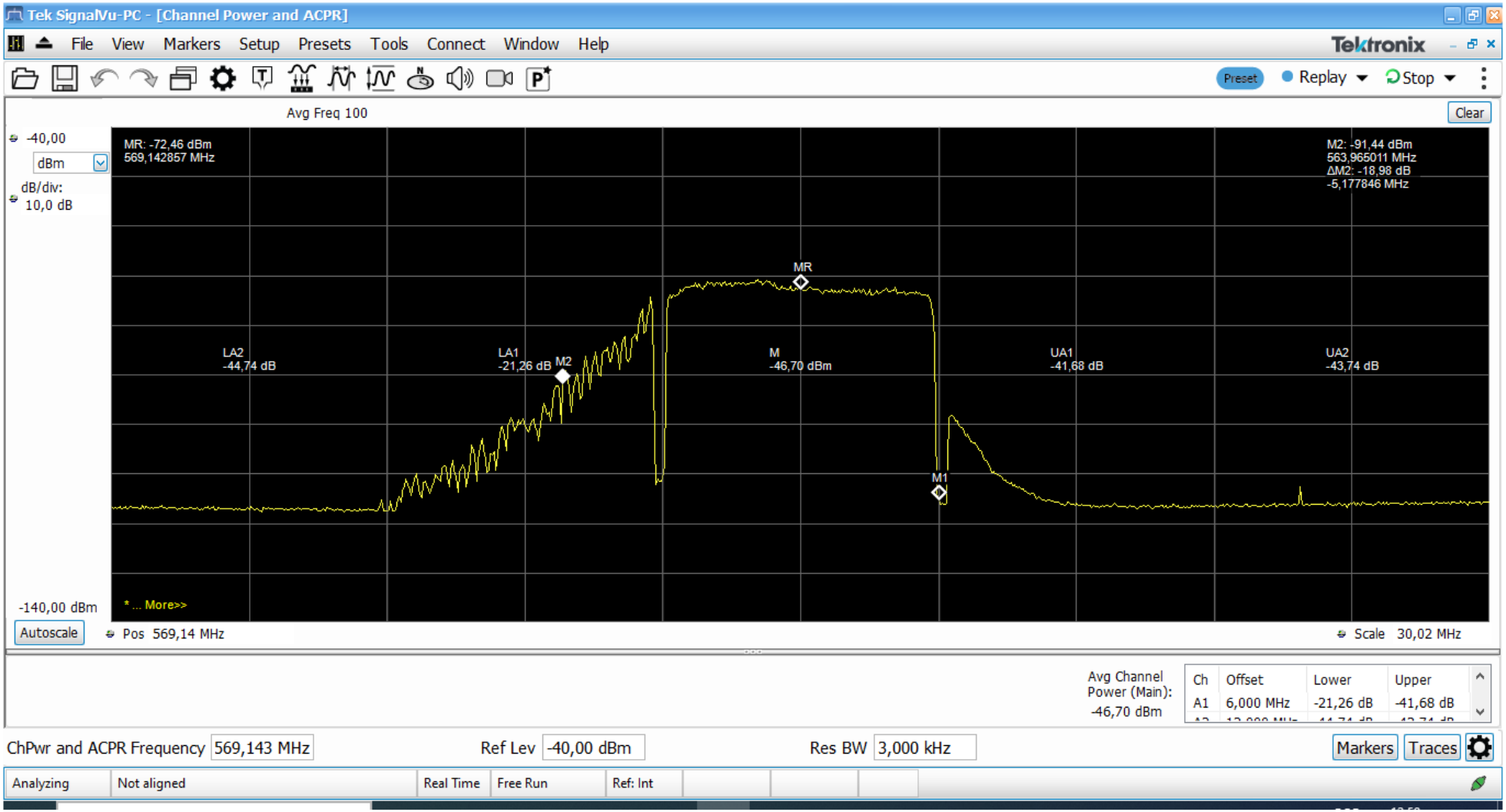


Figure 7.182 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

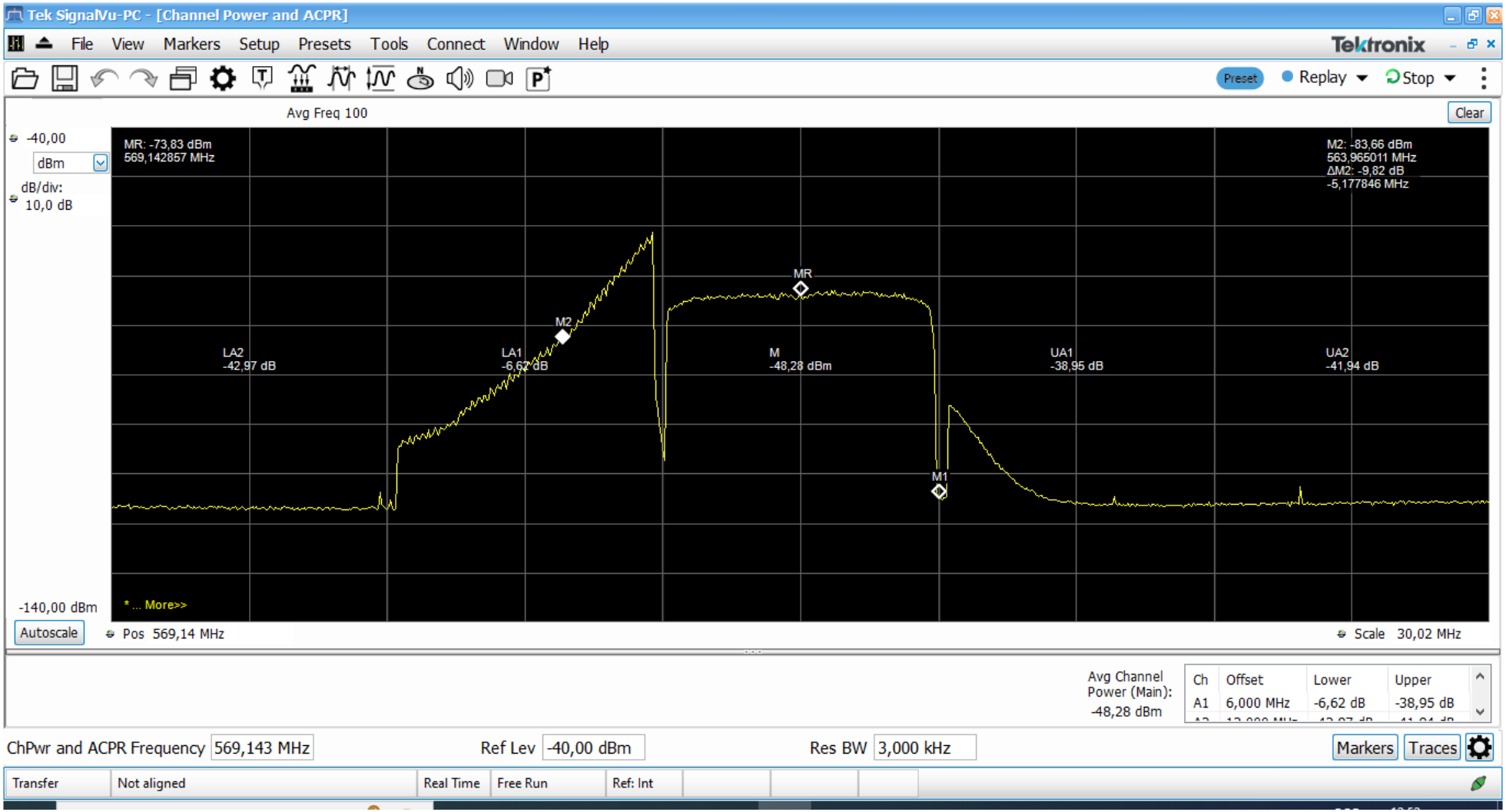


Figure 7.183 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

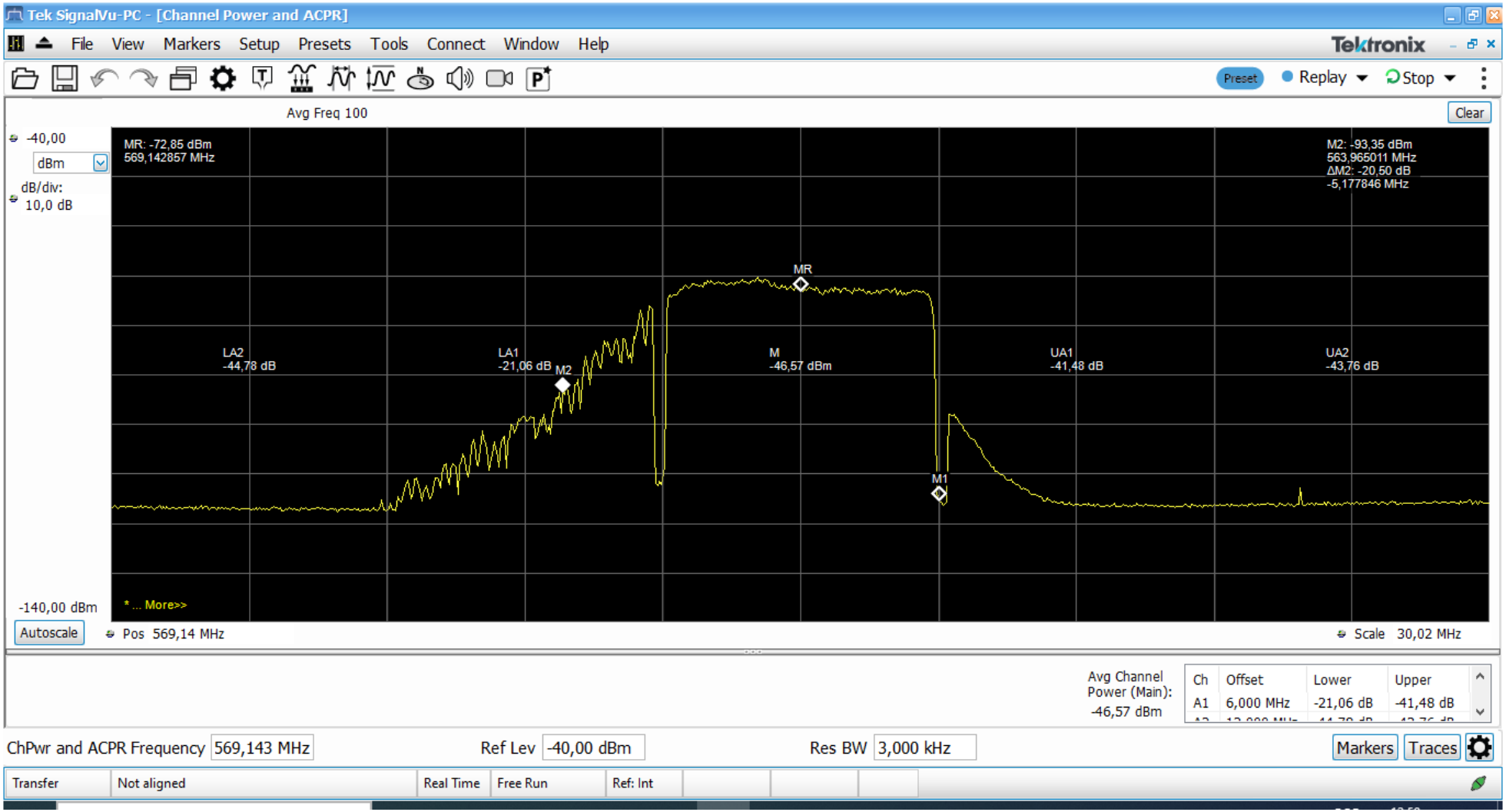


Figure 7.184 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

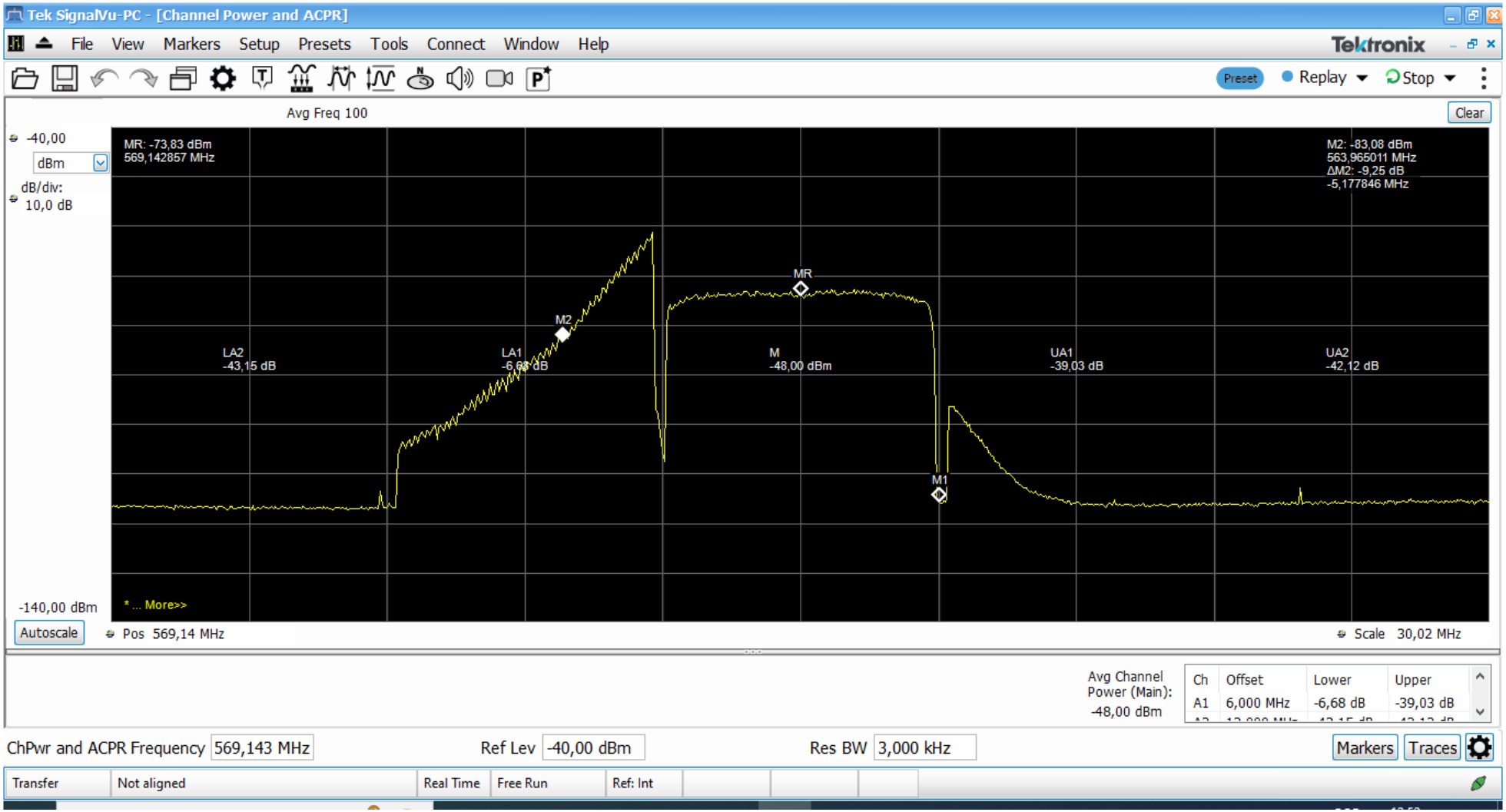


Figure 7.185 - Site 19, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

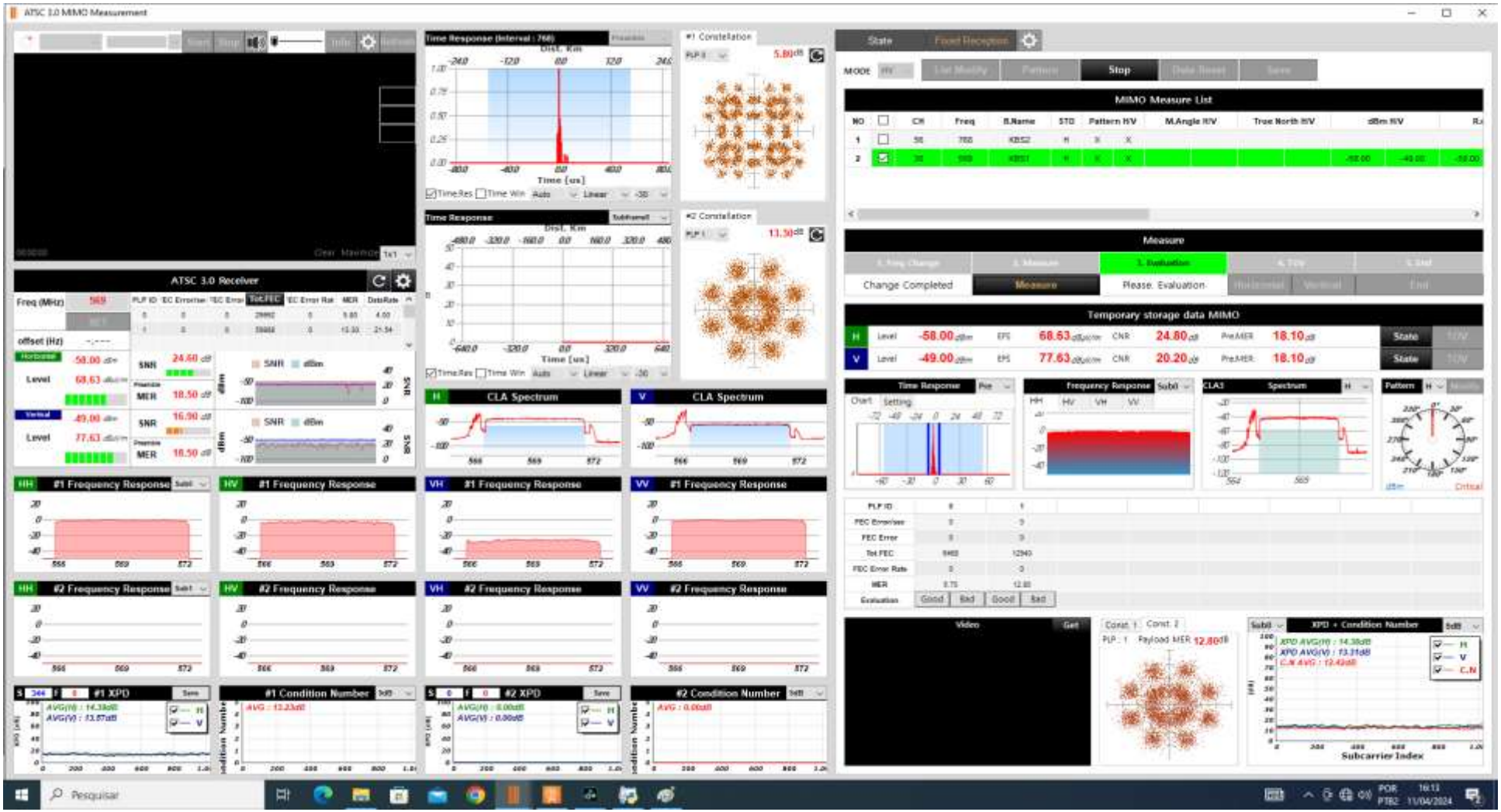


Figure 7.186 - Site 19, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Sumaré station.

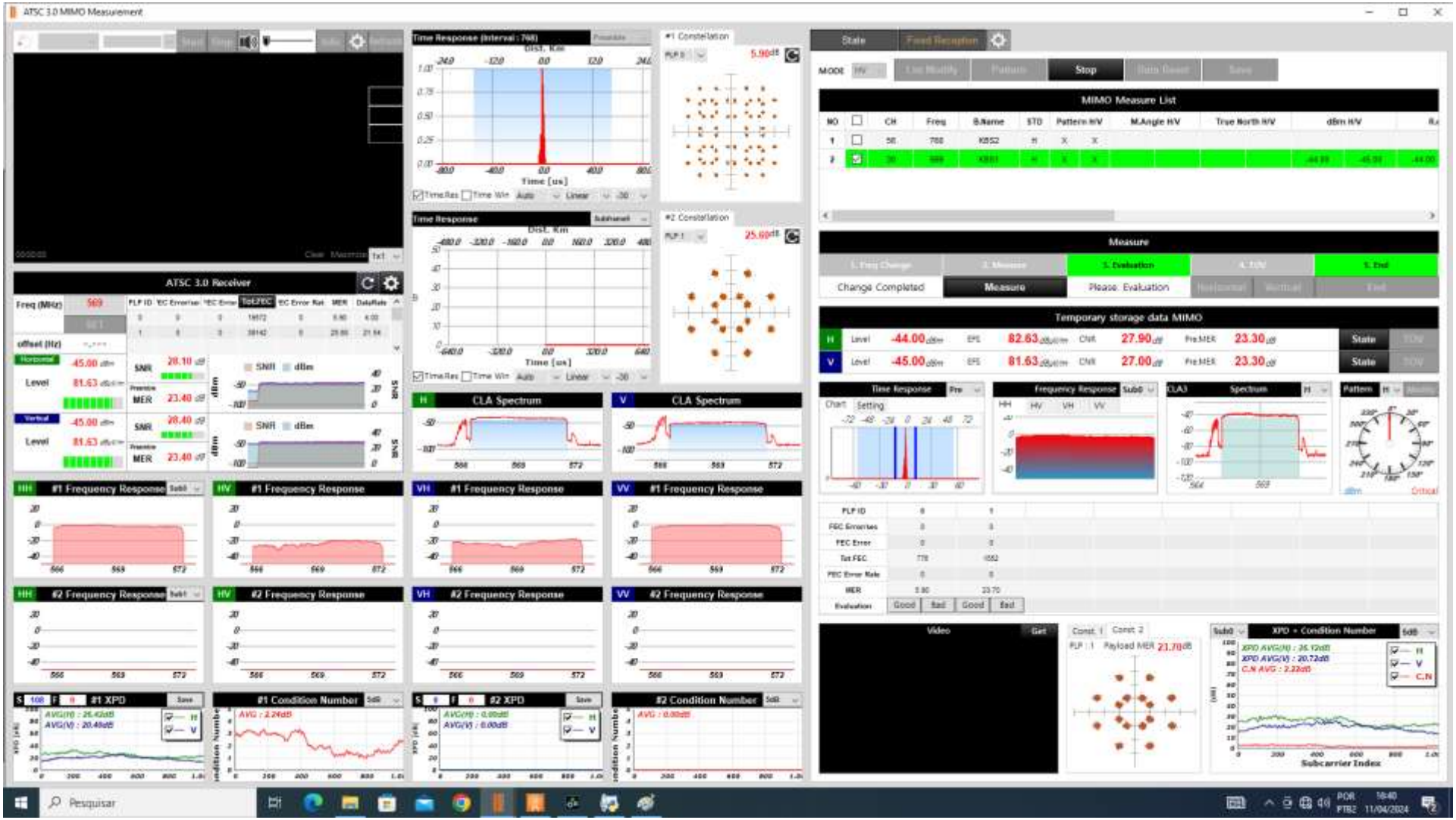


Figure 7.187 - Site 19, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Penna station.

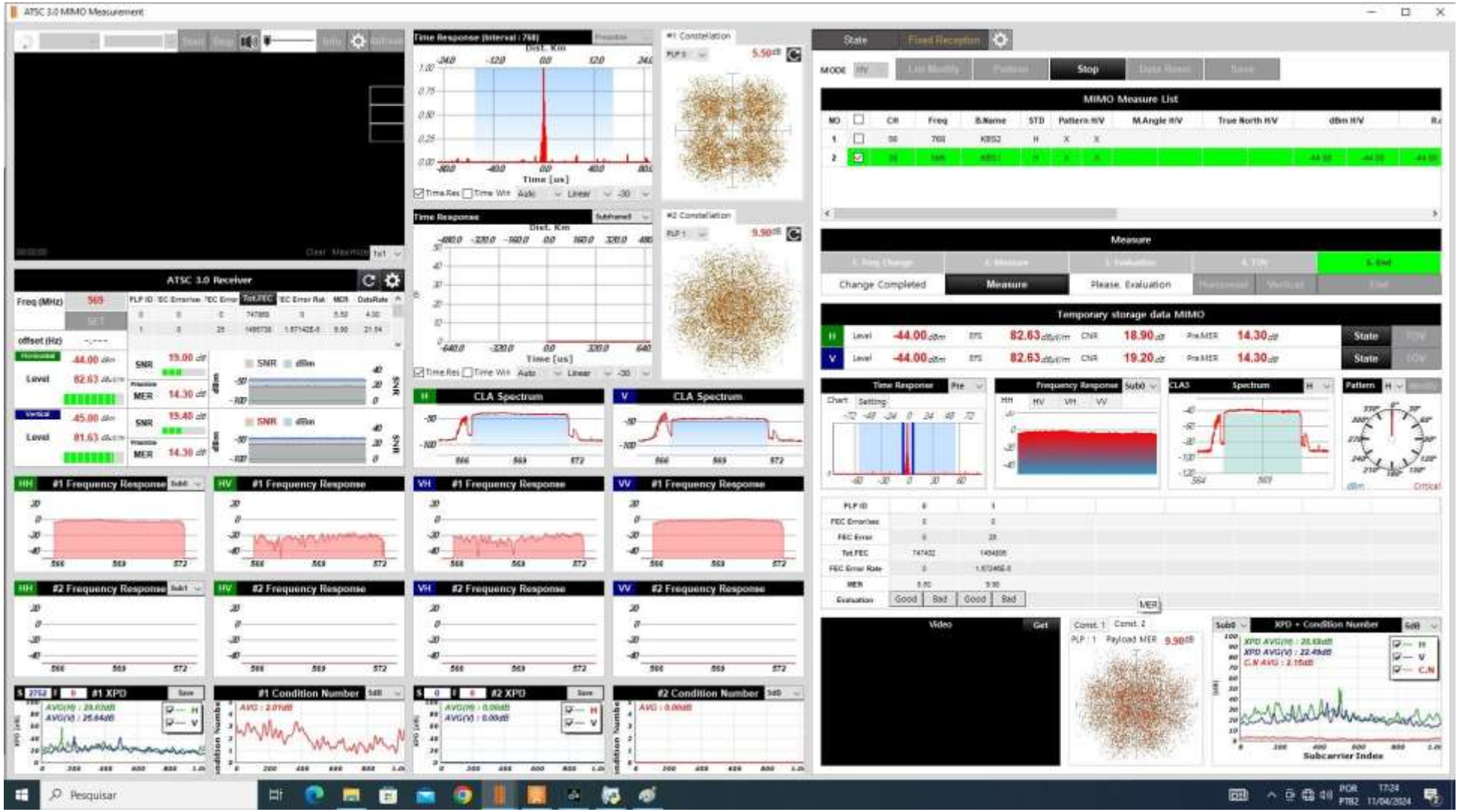


Figure 7.188 - Site 19, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Sumaré and Penna stations.

d) Site 25 - Core Layer - C/N ≤ 0 dB

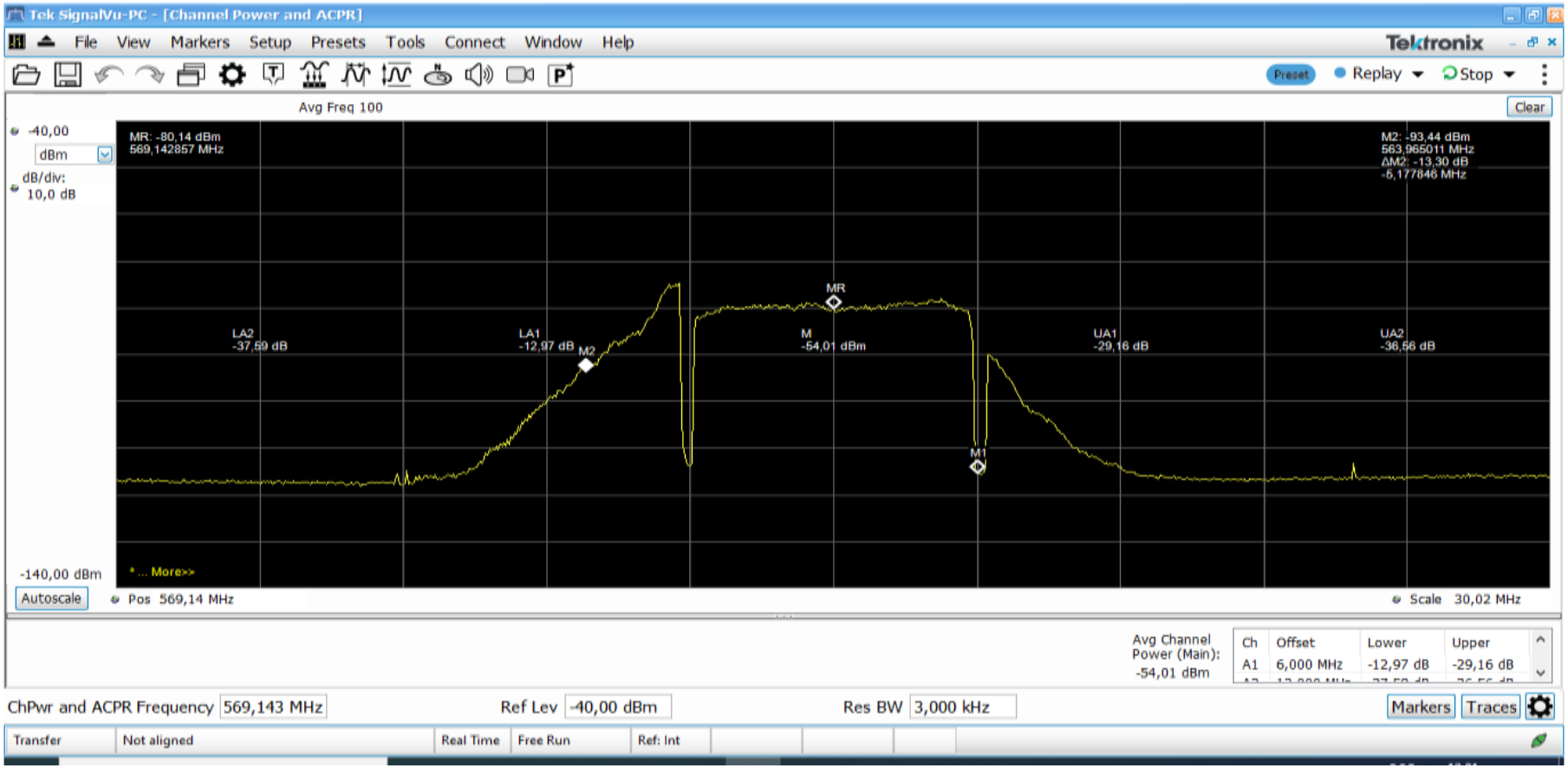


Figure 7.189 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Sumaré station.

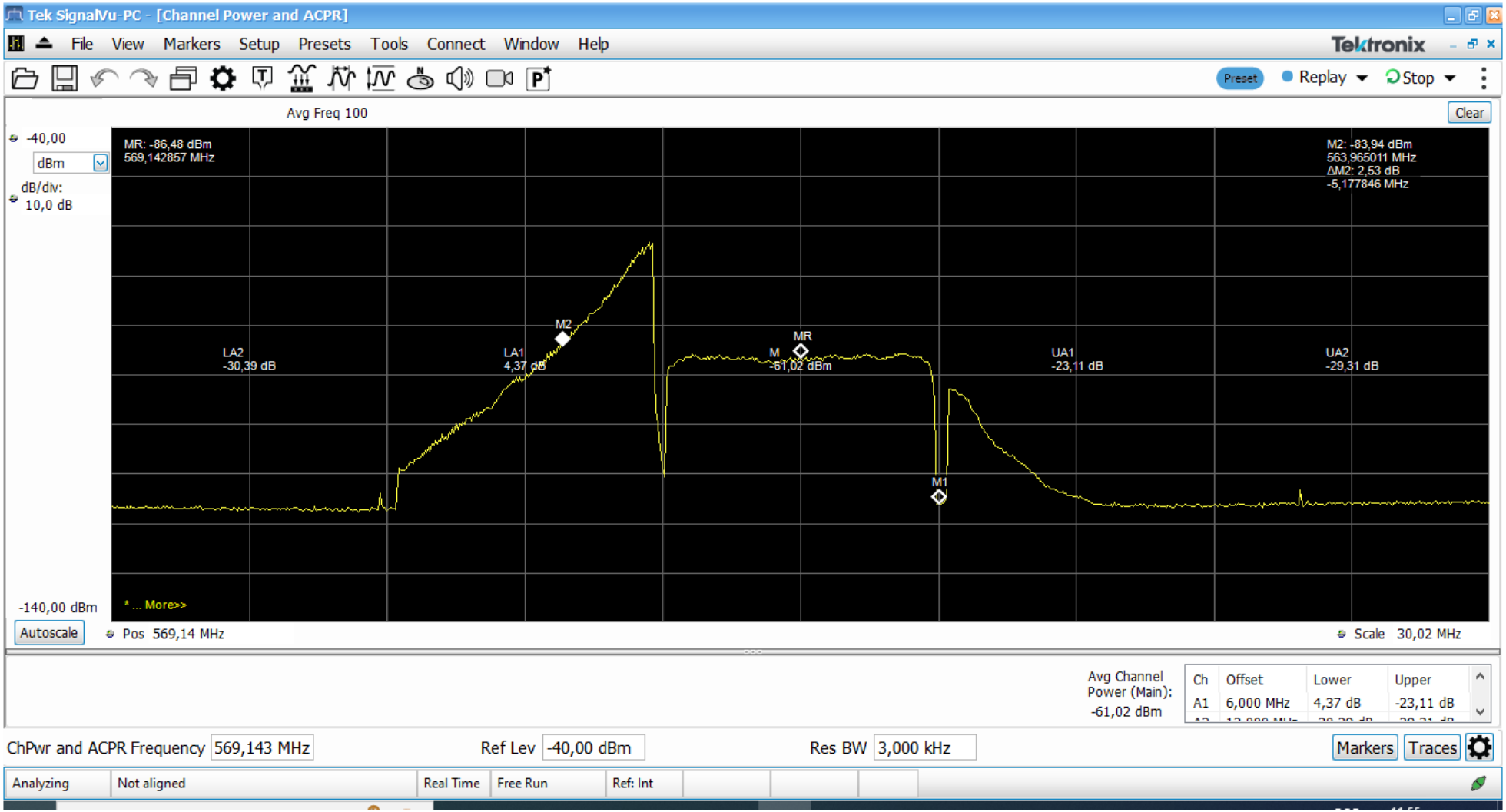


Figure 7.190 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Sumaré station.

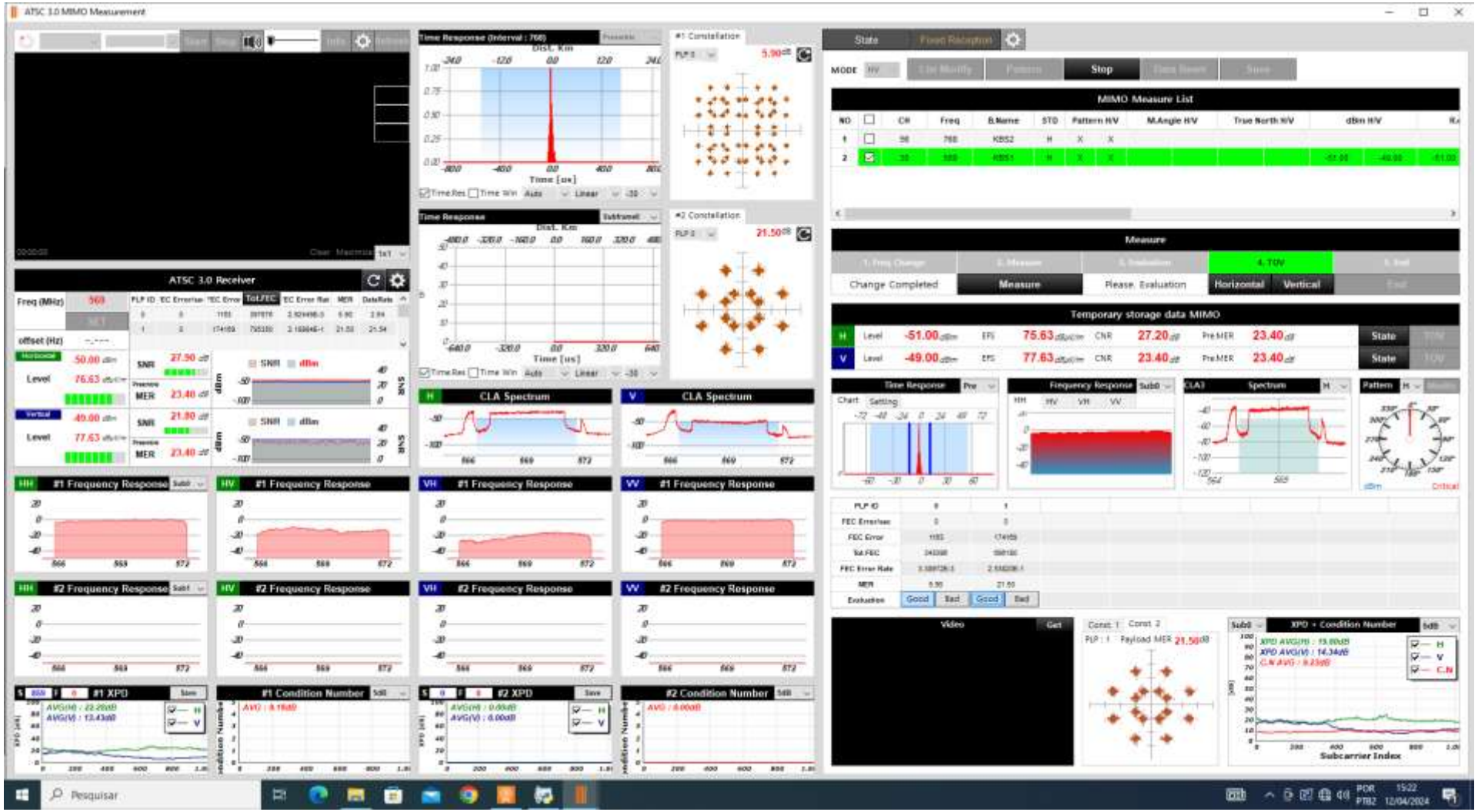


Figure 7.191 - Site 25, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Sumaré station.

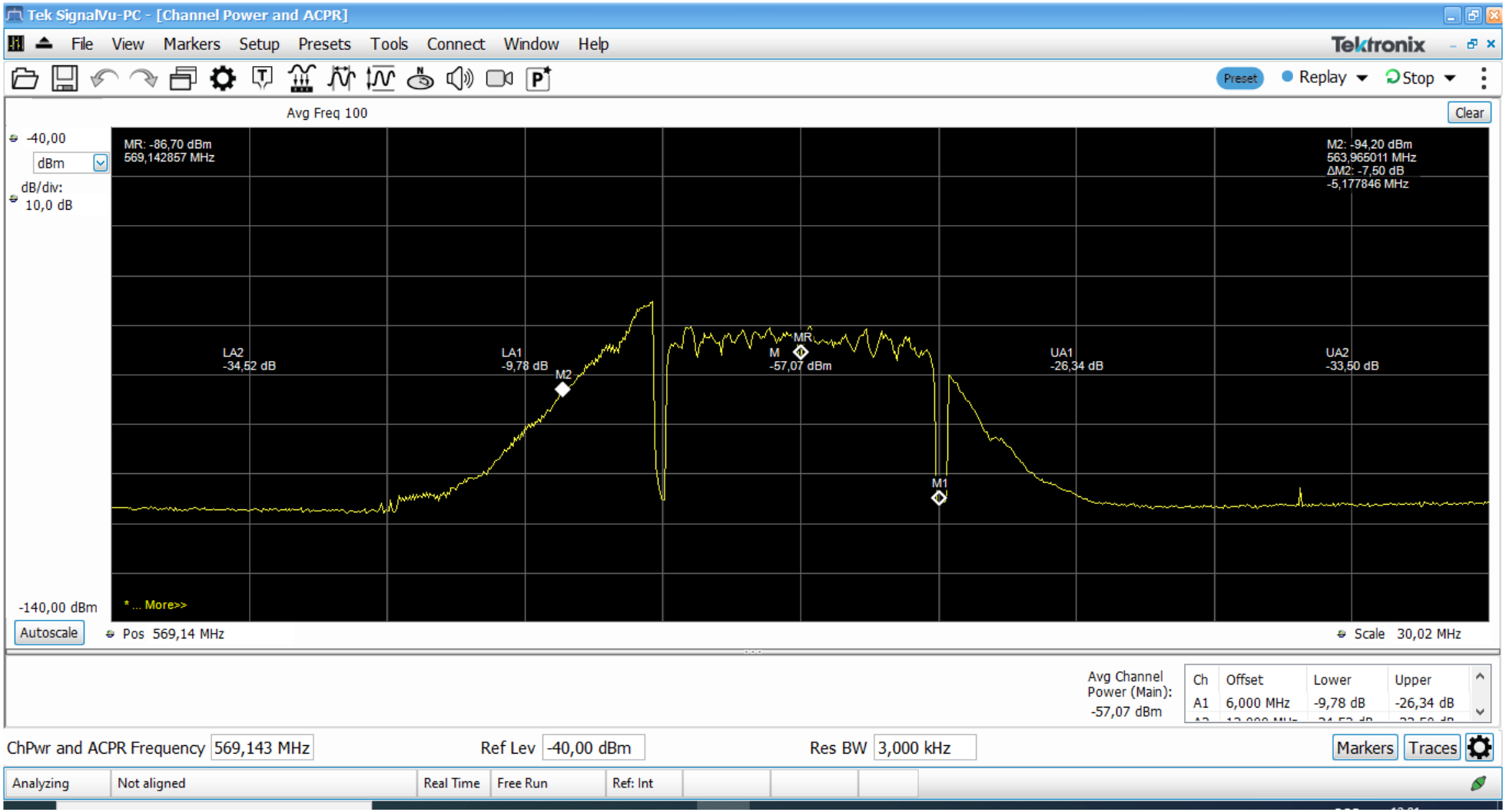


Figure 7.192 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna station.

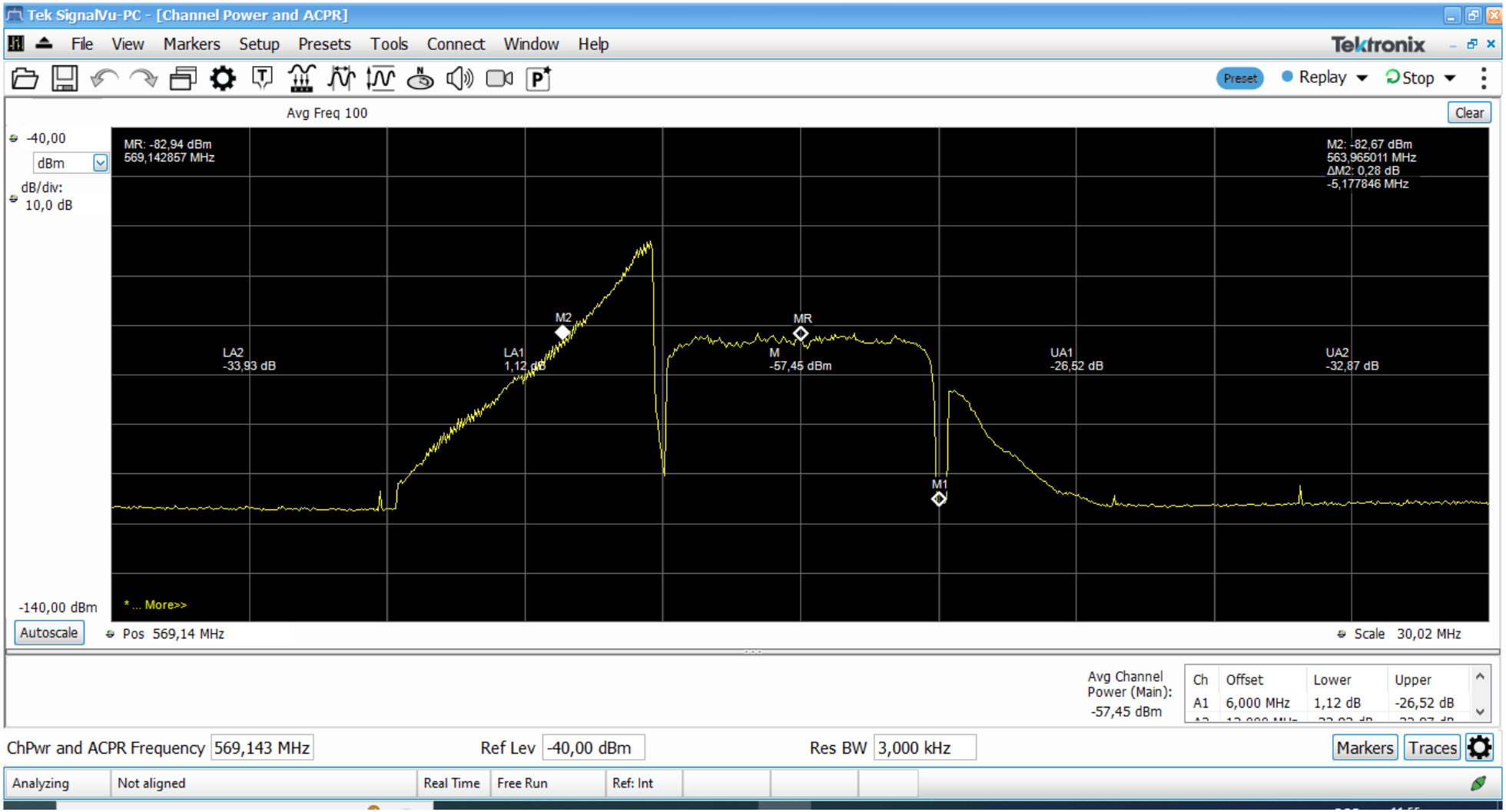


Figure 7.193 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna station.

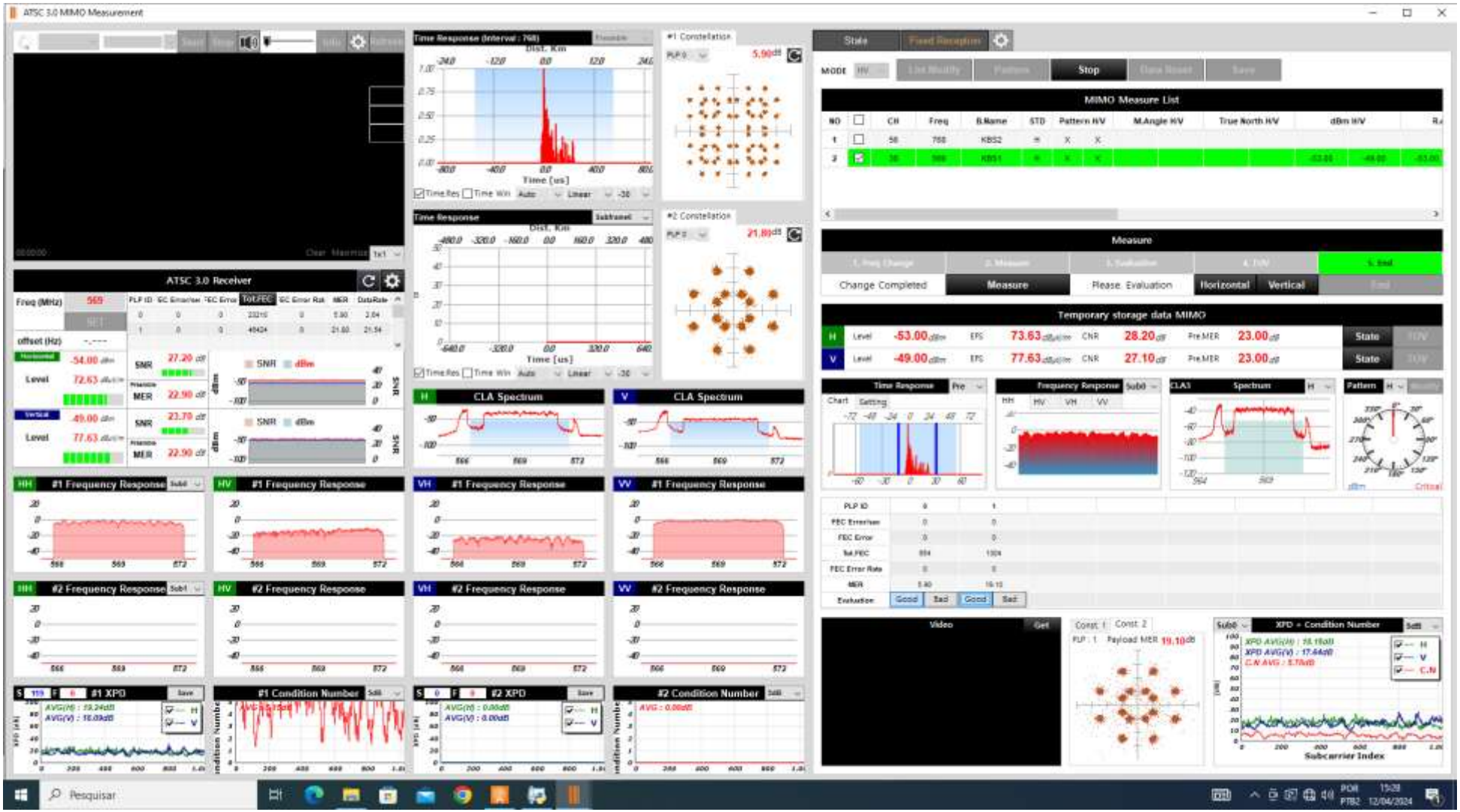


Figure 7.194 - Site 25, ATSC 3.0 reuse-1 test, IMAS (demodulator) measurement, Penna station.

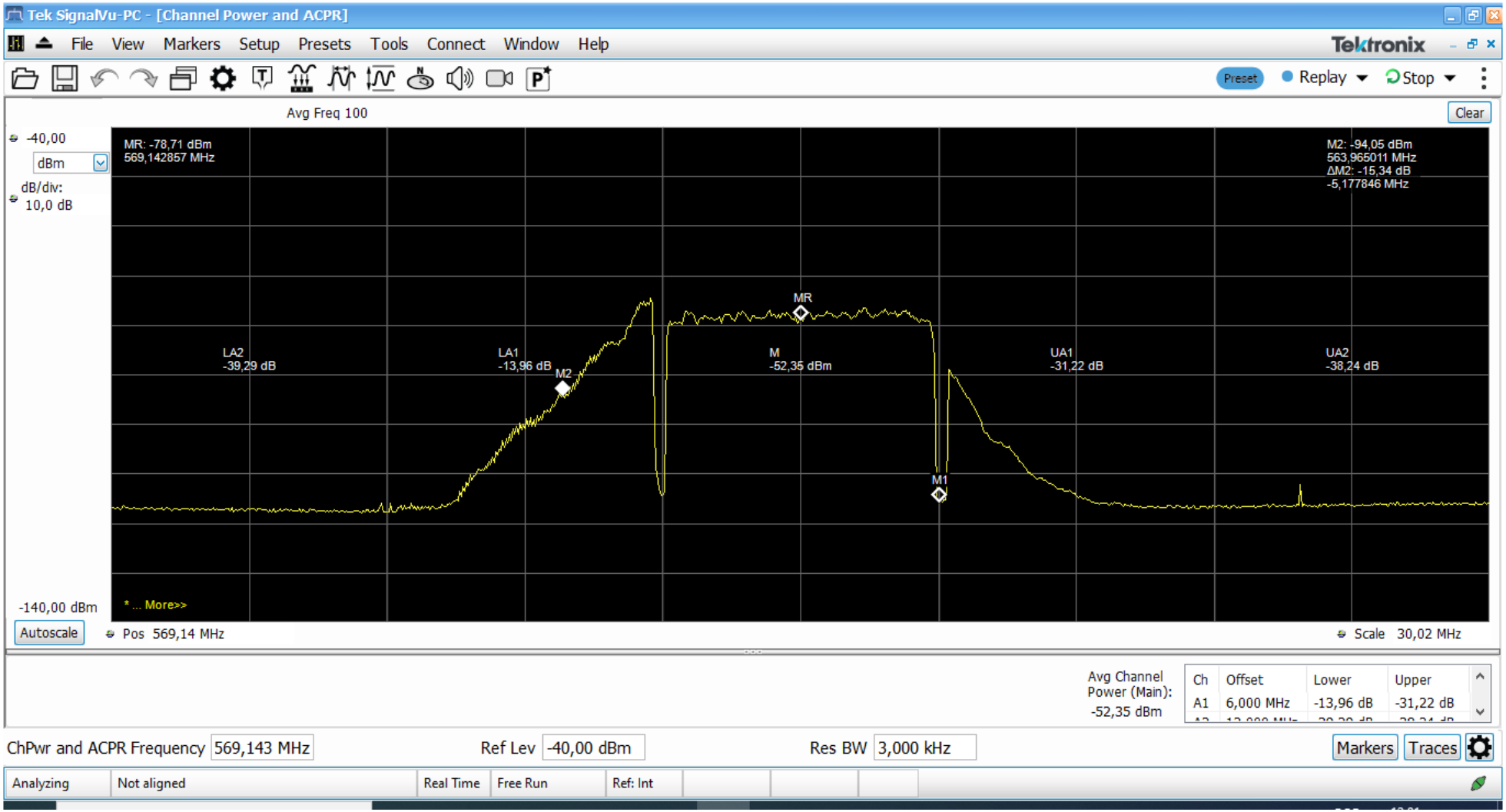


Figure 7.195 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, horizontal polarization, Penna and Sumaré stations.

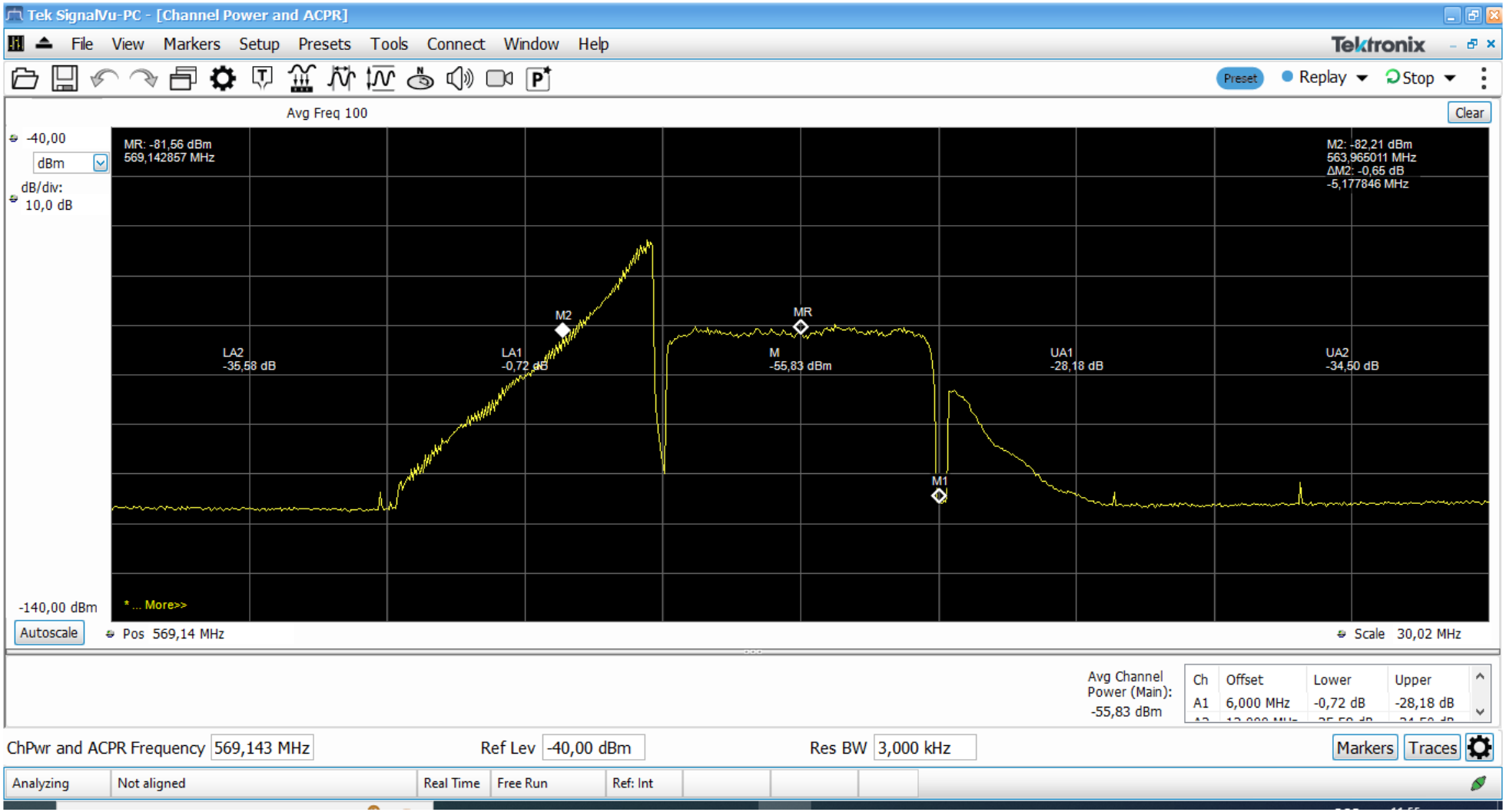


Figure 7.196 - Site 25, ATSC 3.0 reuse-1 test, avg. channel power measurement by Tektronix spectrum analyzer, vertical polarization, Penna and Sumaré stations.

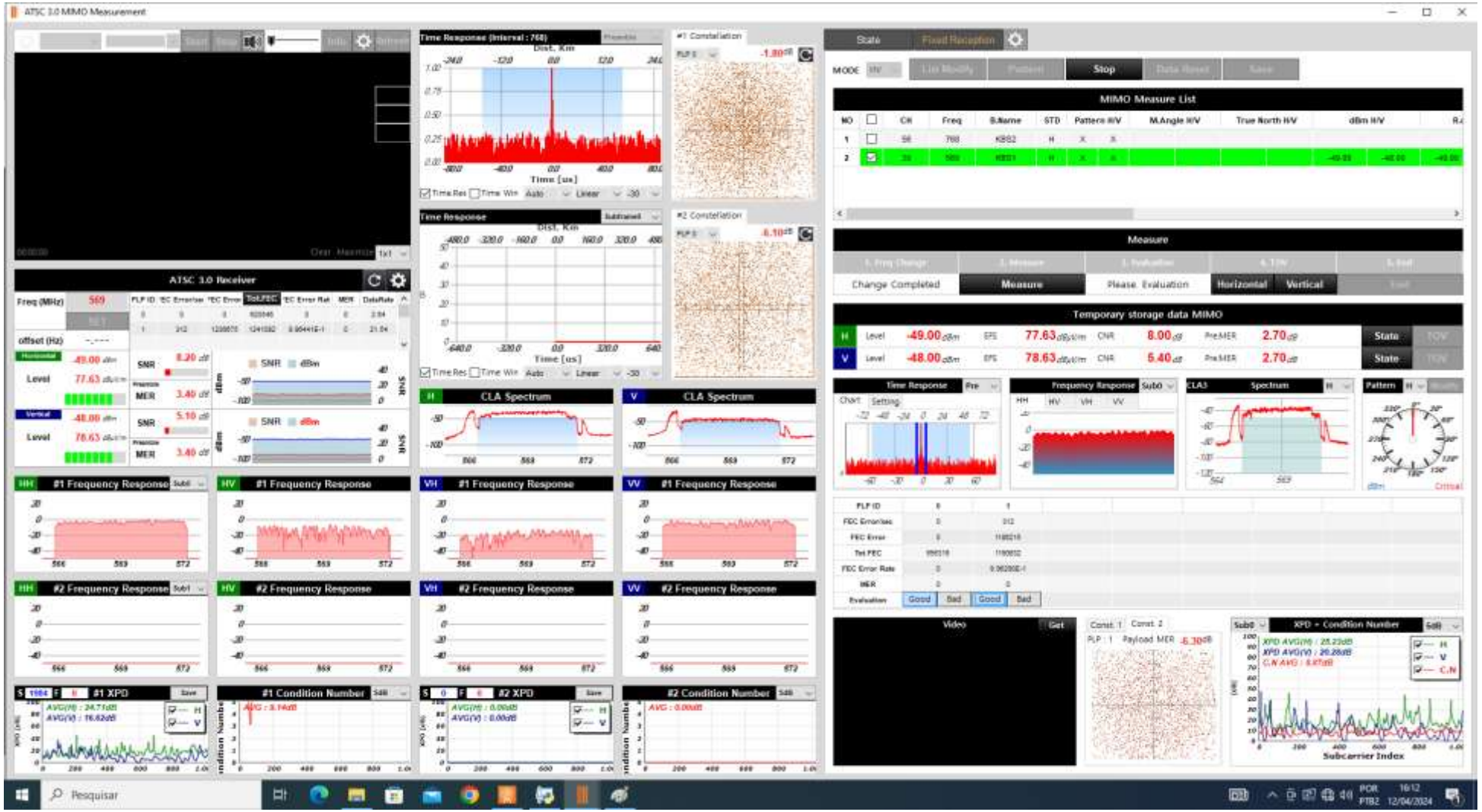


Figure 7.197 - Site 25, ATSC 3.0 reuse-1 test, Core layer code rate 2/15, IMAS (demodulator) measurement, Sumaré and Penna stations.

7.5.1.2.2 Drive Test

7.5.1.2.2.1 Test methodology

The drive test was conducted with a test vehicle equipped with the reception setup. This setup used MIMO Automotive Omnidirectional Antenna for Advanced ISDB-T on horizontal and vertical polarization. The antenna was fixed on the top of the vehicle and connected to the RF box. A GPS antenna was fixed on the top of the vehicle and connected to the reception software. One Demodulator was provided by the proponent to analyze the reception data. IMAS software also provided by the proponent was installed in a desktop computer to extract reception data. The demodulator was connected to the RF Box used in all field tests. The drive test was divided into four routes, as shown in Figure 7.198. Along all the routes, it is possible to find different environmental characteristics. The route passes near all the sites where the outdoor measurements were performed. Due to vehicle traffic, the speed was not kept constant during the drive test. Only on route 3 it was possible to maintain constant speed. Therefore, this route was run three times with different speeds (20 km/h, 40 km/h and 60 km/h) each time. The transmitter location is also shown in the Figure. During the testing, the received signal strength indication (RSSI), channel to noise ratio (C/N), and FEC Error Rate were collected. The configuration used for this test is detailed in Table 7.53.

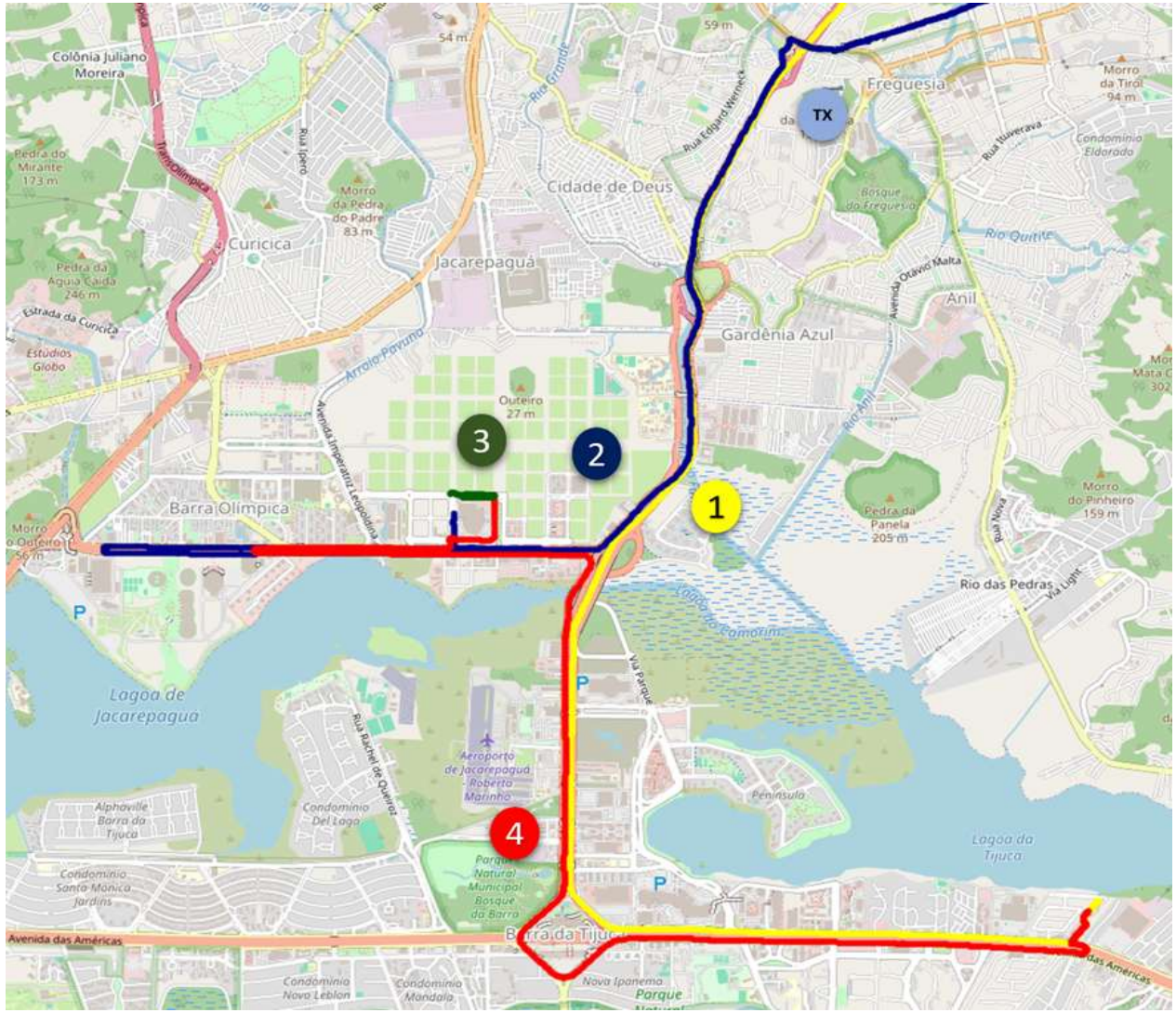


Figure 7.198 - Map showing the drive test routes.

7.5.1.2.2.2 Test results

The proponent provided a Demodulator and IMAS software, in which as possible to verify RF characteristics of the received signal. Also, the RF box was connected to two spectrum analyzes, one for each polarization. From this equipment, the RSSI and C/N information were collected.

7.5.1.2.2.2.1 Speed and distance to transmitter profiles

The drive test performed on horizontal and vertical polarizations was conducted with the speed profile shown in Figures 7.199 and 7.200. The speed achieved up to 90 km/h and variations are caused by traffic lights and traffic jam. Route 3 was the only one possible to control the speed all the way. Therefore, it was measured 3 times at speeds 20 km/h, 40 km/h and 60 km/h. The average speed was approximately 39.2 km/h, 35.5 km/h, 32.4 km/h, for routes 1, 2 and 4 respectively. The distance between the vehicle and the transmitter was also calculated over time and it is shown in Figures 7.201 and 7.202.

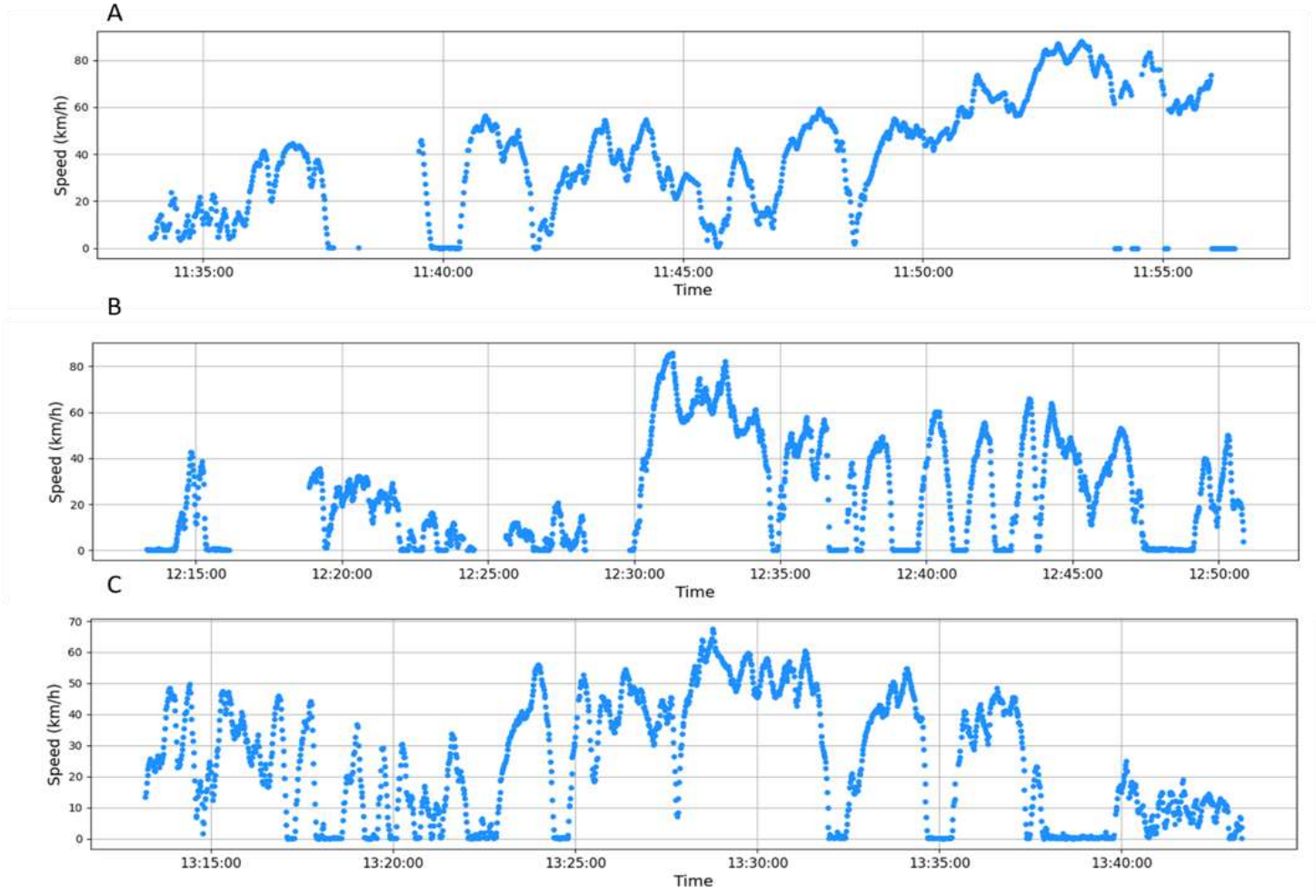


Figure 7.199 - Speed over time for routes A) 1; B) 2 and C) 4.

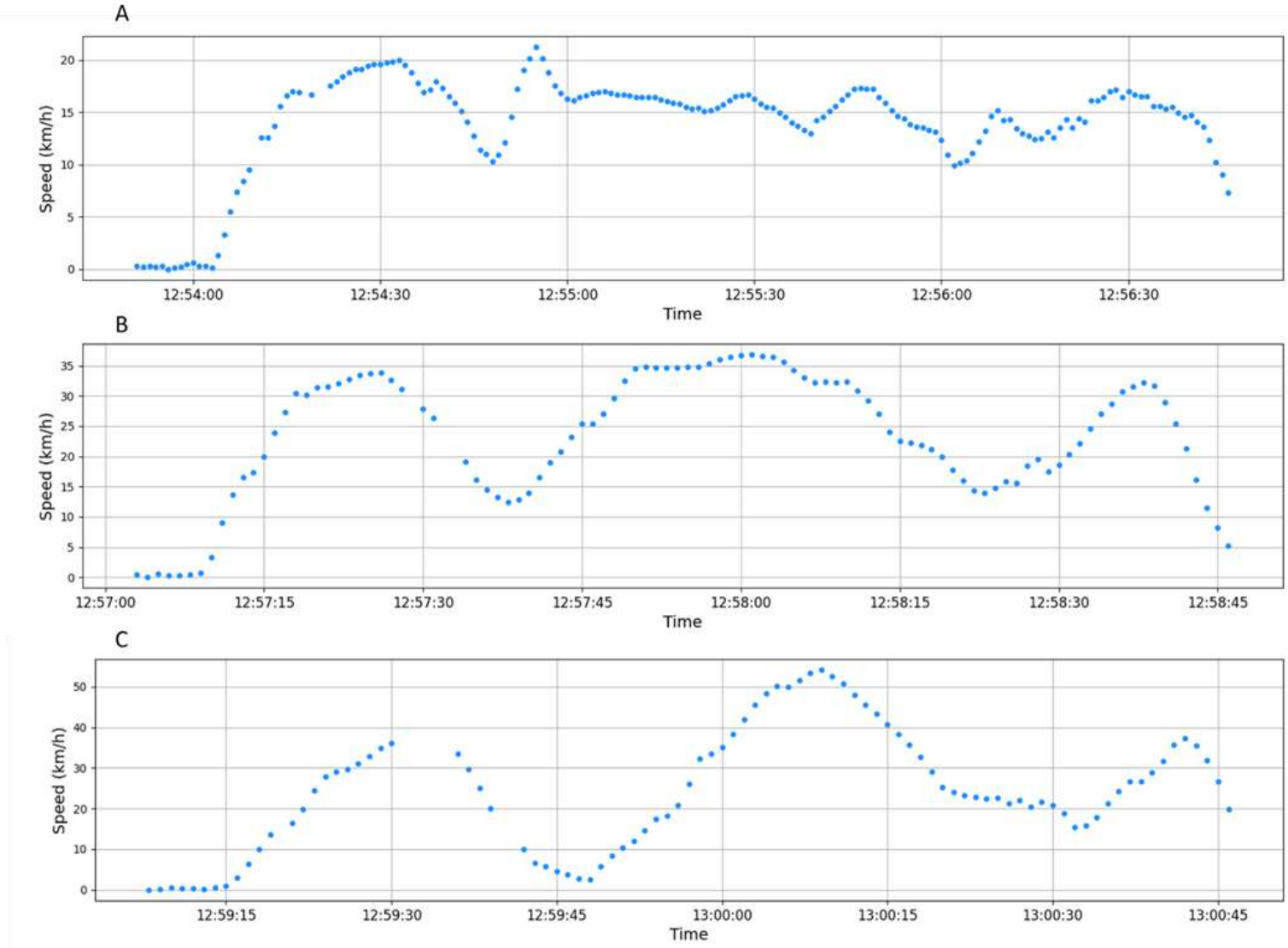


Figure 7.200 - Speed over time for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

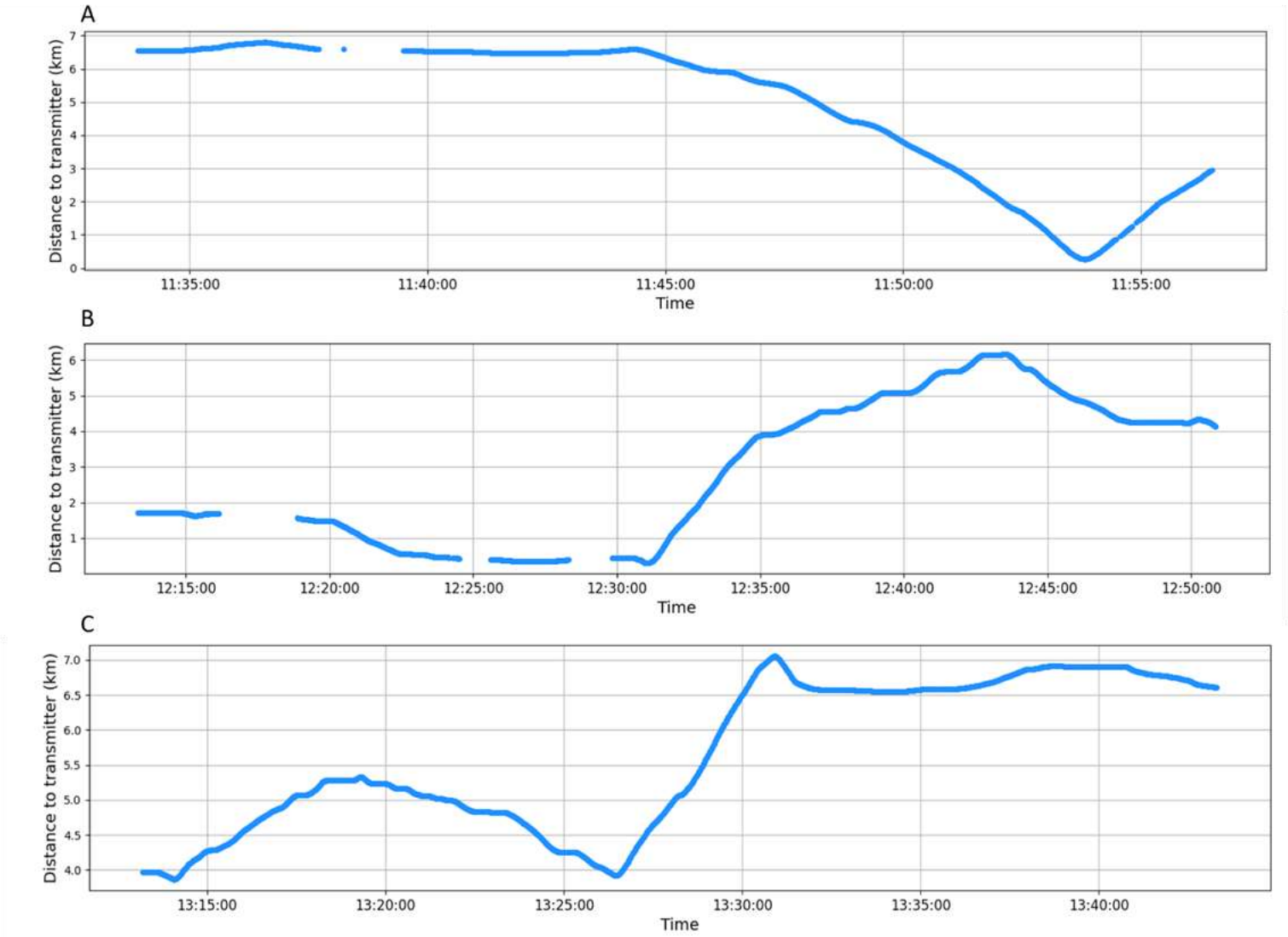


Figure 7.201 - Distance to transmitter over time for routes A) 1; B) 2 and C) 4.

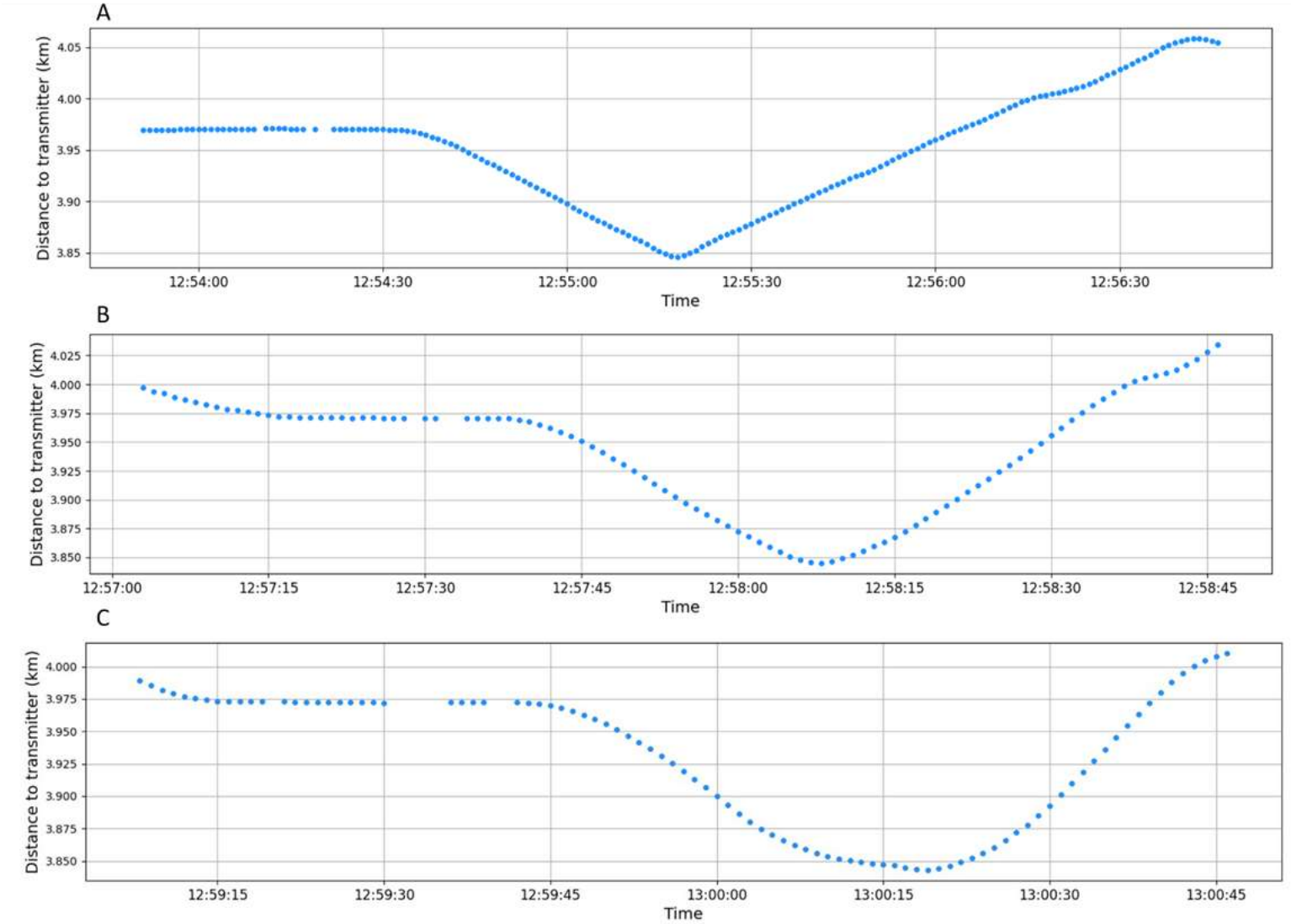


Figure 7.202 - Distance to transmitter over time for route 3 ate A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.5.1.2.2.2.2 Received signal strength indicator (RSSI)

The RSSI was captured using two identical spectrum analyzers, one for each polarization. The evolution of RSSI over distance to transmitter is shown in Figures 7.203 and 7.204. The values varied from -36 dBm to -90 dBm approximately in all routes. It is possible to notice that the RSSI value decreases slowly up to 4 km. After this distance, this value tends to suffer greater losses due to the characteristics of the environment. There are mountains and buildings that can pose stronger interference on the signal propagation at distances greater than 4 km. Furthermore, it is possible to note that there are 2 RSSI values for distances up to 3 km on routes 1 and 2. This is explained due to the path taken on the route, which bypassed the transmitter (Tx) on both sides.

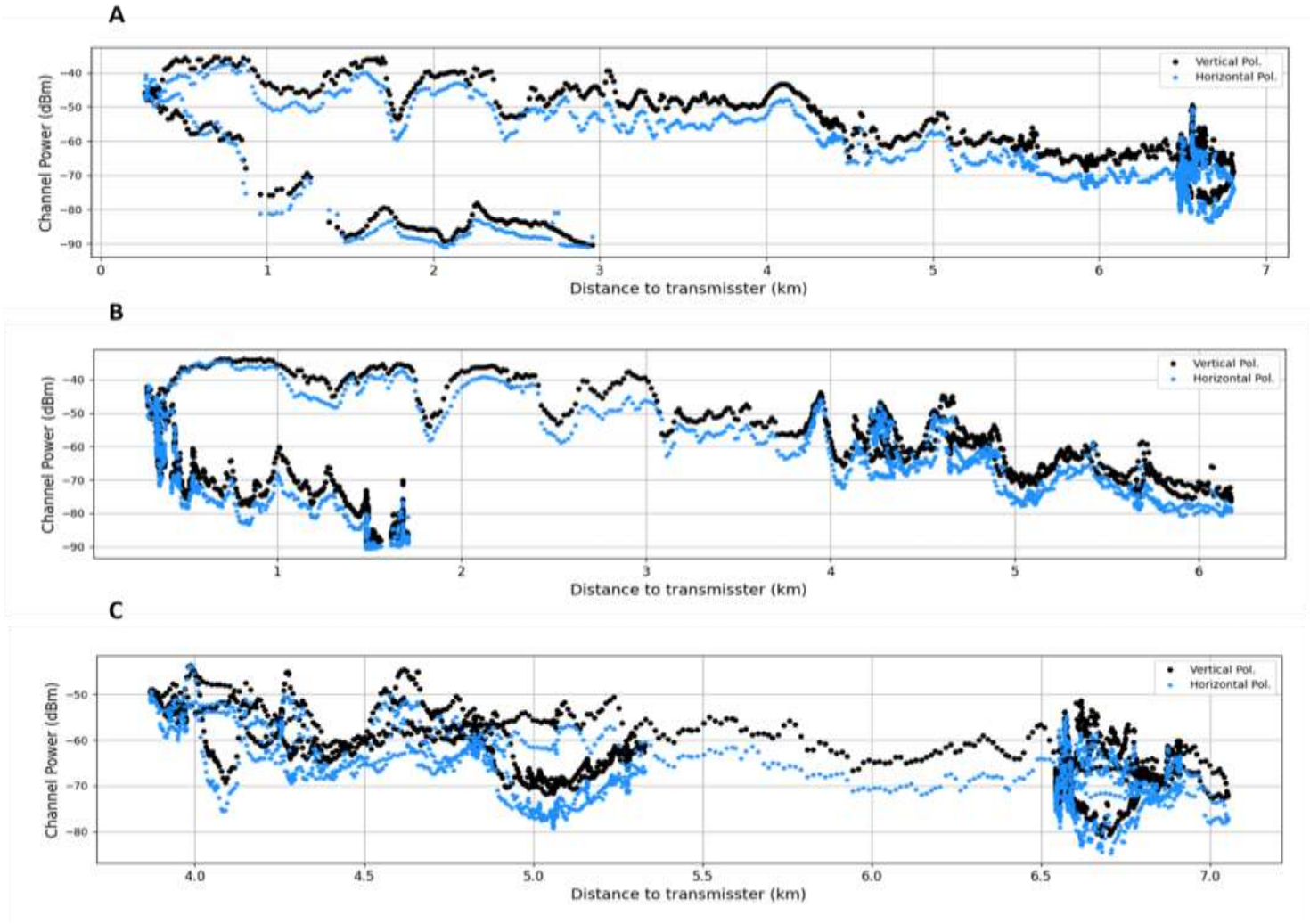


Figure 7.203 - Channel power over distance to transmitter for routes A) 1; B) 2 and C) 4.

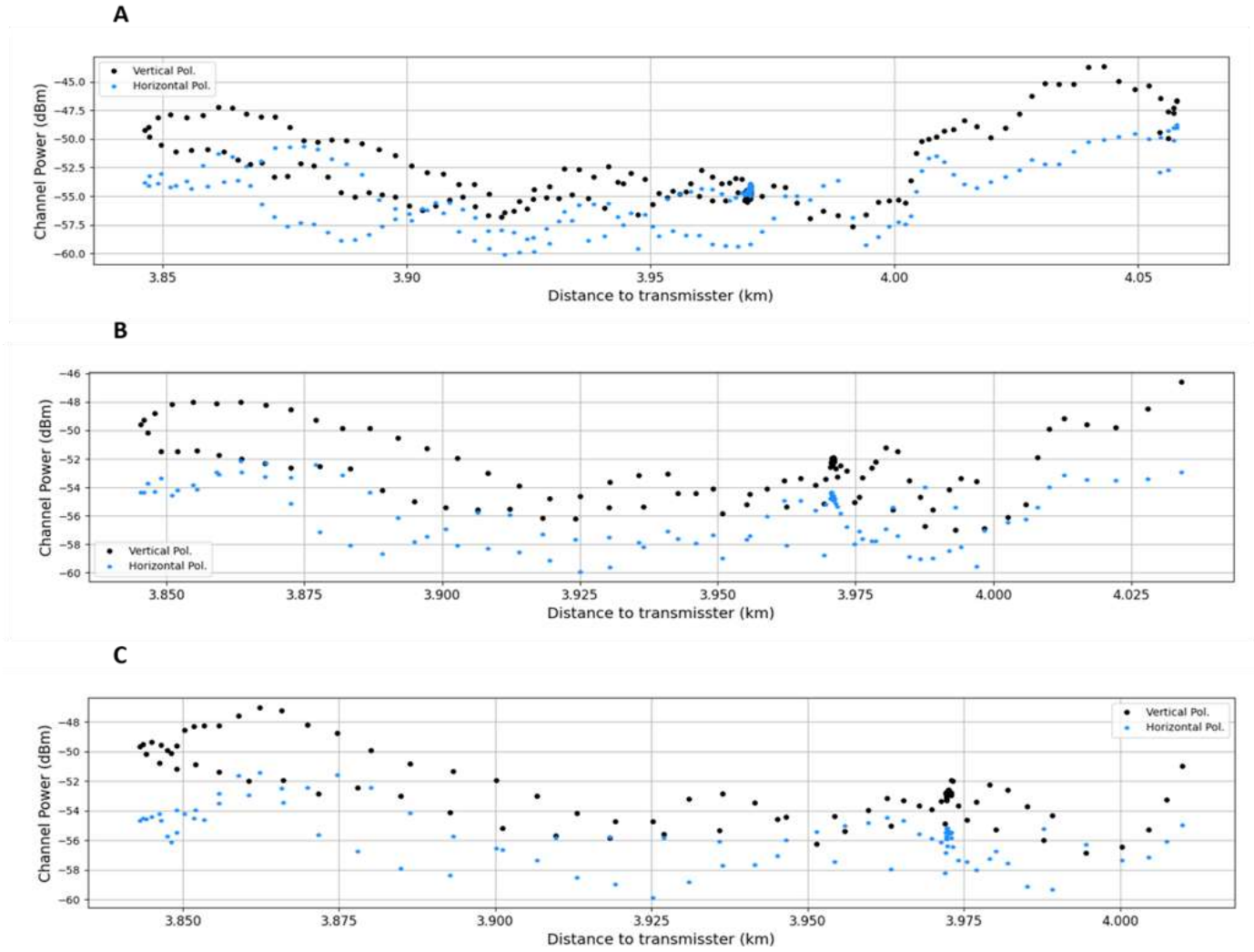


Figure 7.204 - Channel power over distance to transmitter for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.5.1.2.2.2.3 Carrier-to-interference-and-noise ratio (CINR)

Carrier to noise rate (C/N) was obtained with two identical spectral analyzers and were evaluated over the distance to the transmitter. The Figures 7.205 and 7.206 show the data collected. On routes 1, 2, even for small distances up to 3 km, it is possible to notice lower values for C/N. This behavior probably happened due to the environment's characteristics. Close to the transmitter, there are mountains and buildings that can pose stronger interference on the signal propagation, lowering the C/N ratio at small distances. For route 3, C/N values tend to decrease slowly when speed increases.

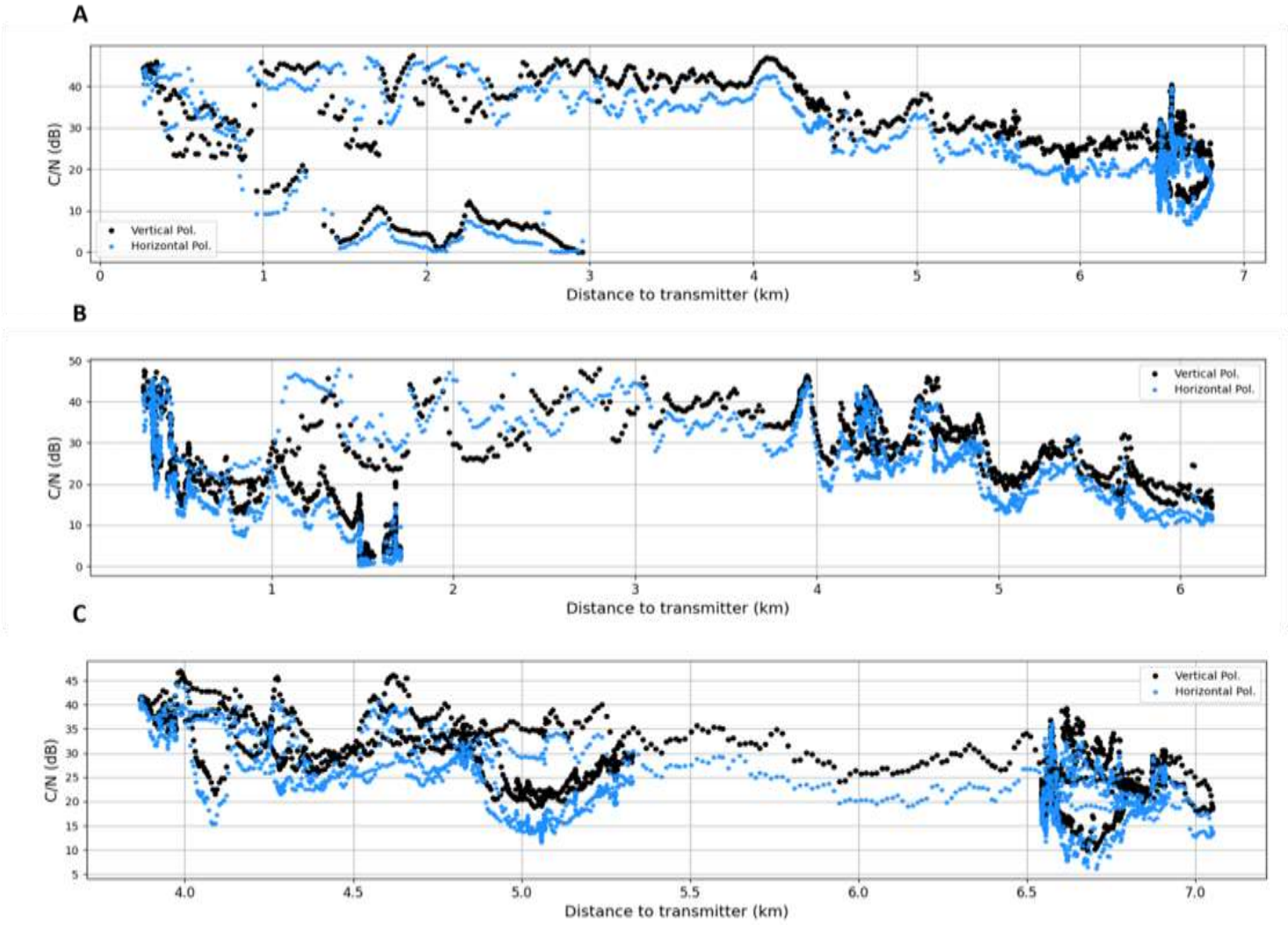


Figure 7.205 - Carrier to noise ratio over distance to transmitter for routes A) 1; B) 2 and C) 4.

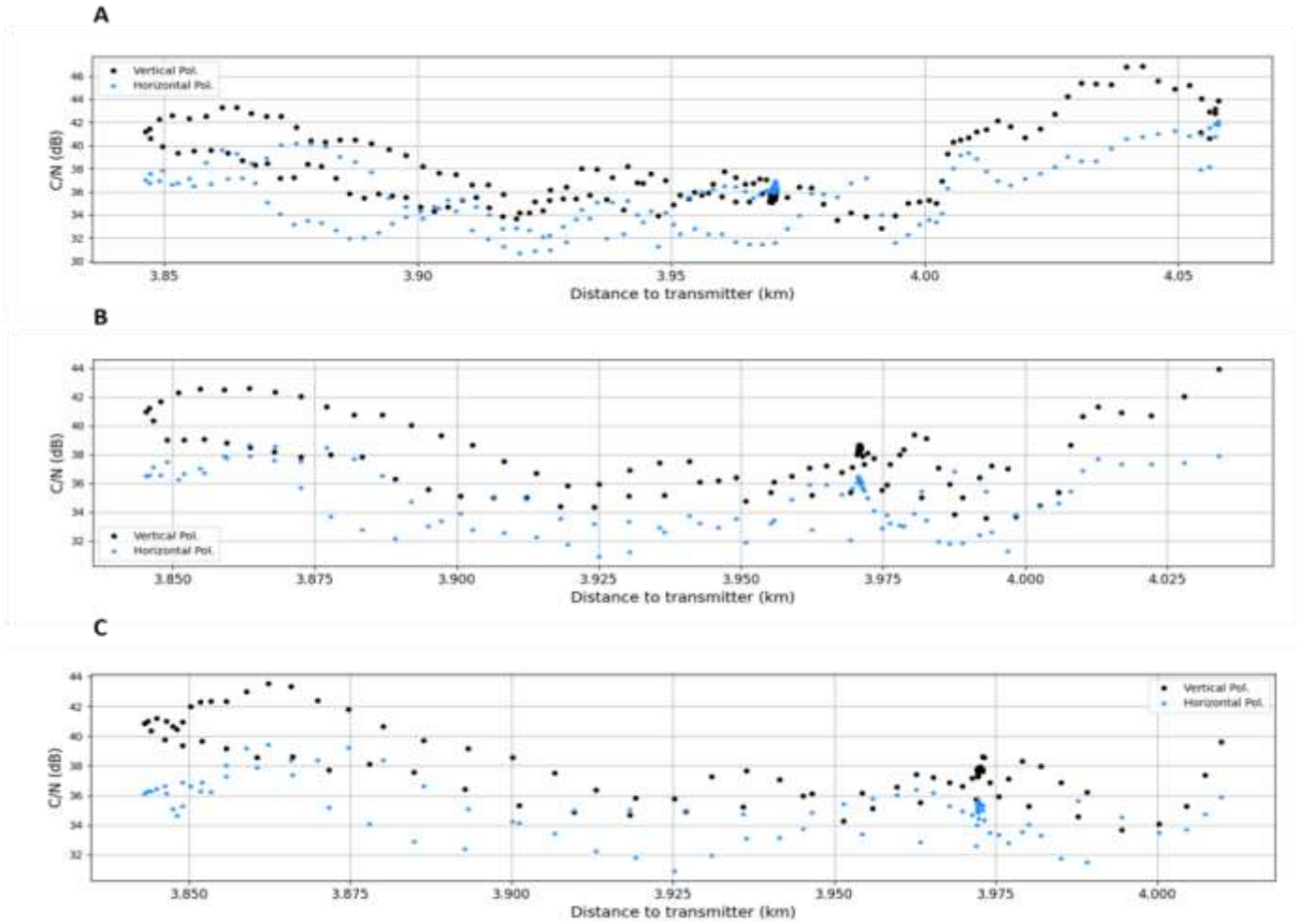


Figure 7.206 - Carrier to noise ratio over distance to transmitter for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.5.1.2.2.2.4 PLP0 error rate

PLP0 error was collected using IMAS software provided by the proponent. The software is connected to the demodulator, and it shows whether there are PLP0 errors along time. The number of PLP0 errors was evaluated over C/N ratio and is shown in Figures 7.207 and 7.208. Even with a good C/N ratio (around 40 dB), it is possible to see that there are some errors during the test, probably due to fast fading caused by objects and cars around the receiver. However, the number of PLP0 errors increases when the C/N ratio is around 20 dB. The number of PLP0 errors was also evaluated over RSSI and the results are shown in Figures 7.209 and 7.210. The PLP0 error increases when RSSI is below -70 dBm approximately.

The number of PLP0 errors was also evaluated over speed during all routes and the results are shown in Figures 7.211 and 7.212.

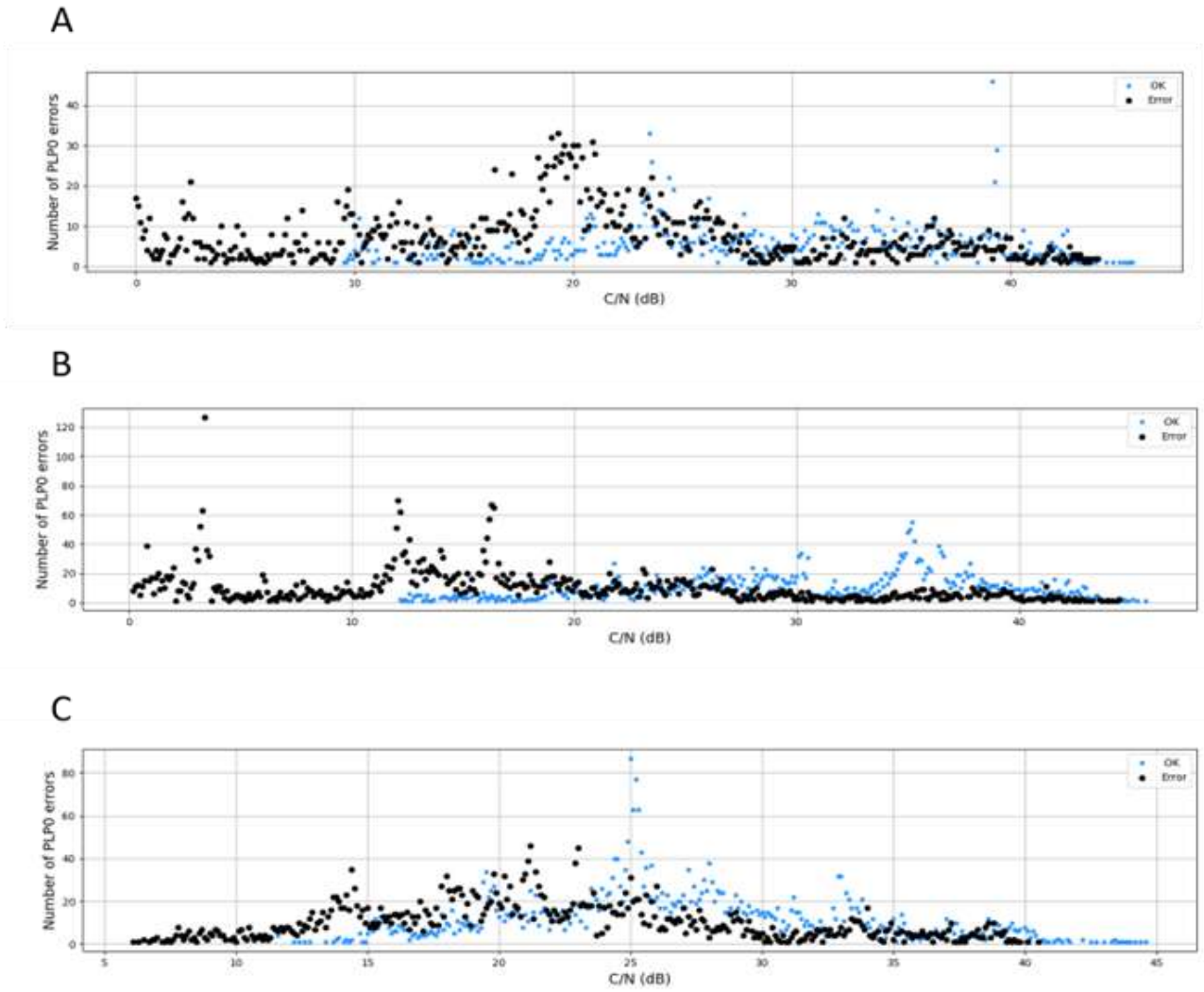


Figure 7.207 - Quantity of PLP0 errors over C/N for A) route 1; B) route 2; and C) route 4.

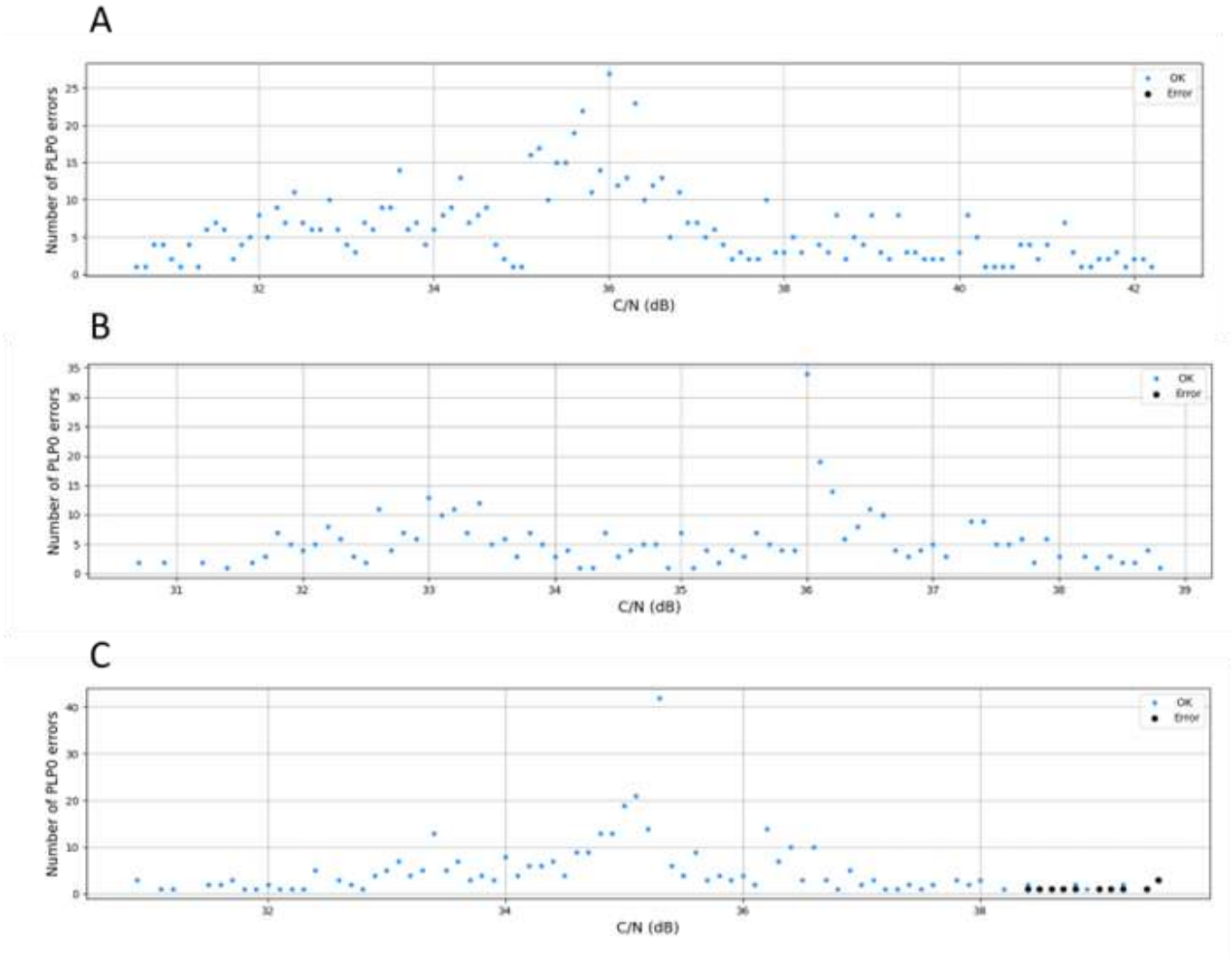


Figure 7.208 - Quantity of PLP0 errors over C/N for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

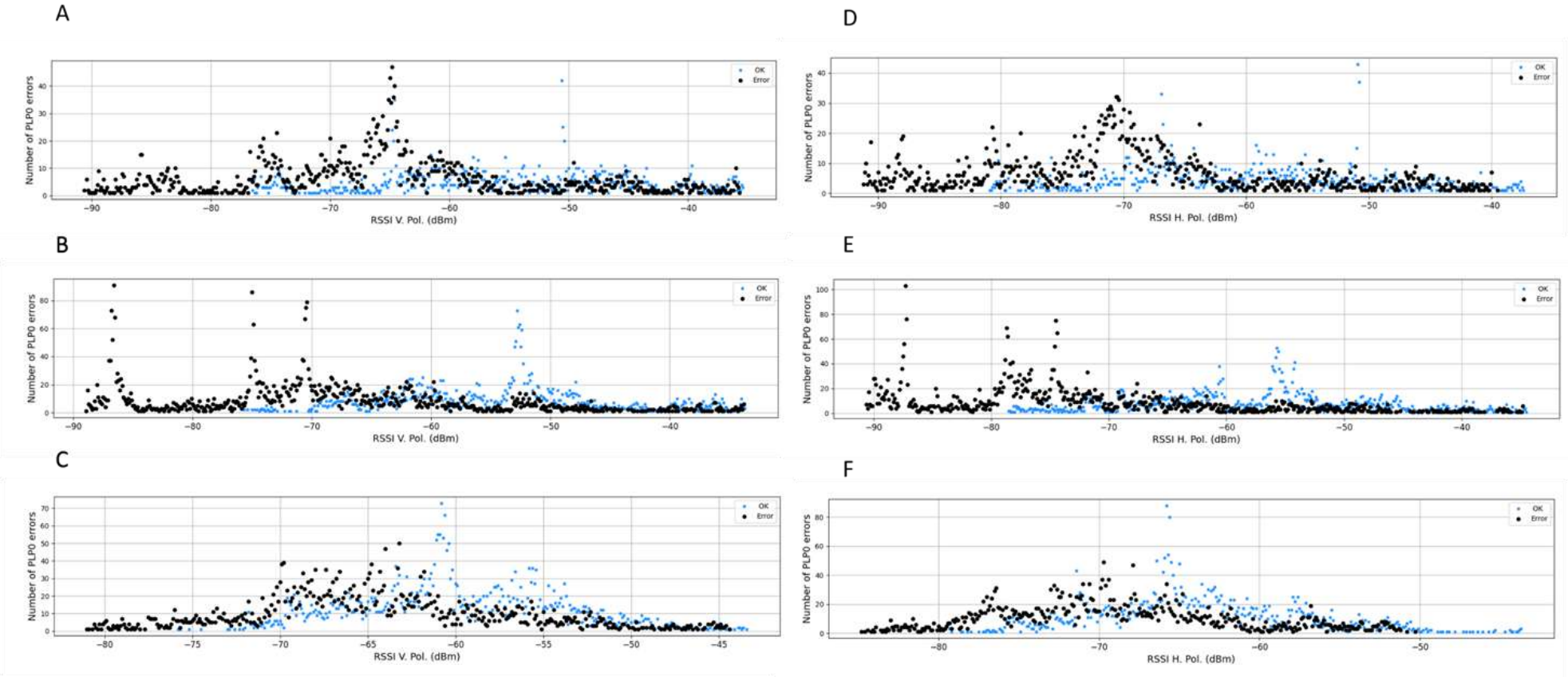


Figure 7.209 - Quantity of PLP0 errors over RSSI for A) route 1, vertical Pol. B) route 2, Vertical Pol. C) route 4, Vertical Pol. D) route 1, Horizontal Pol. E) route 2, Horizontal Pol. F) route 4, Horizontal Pol.

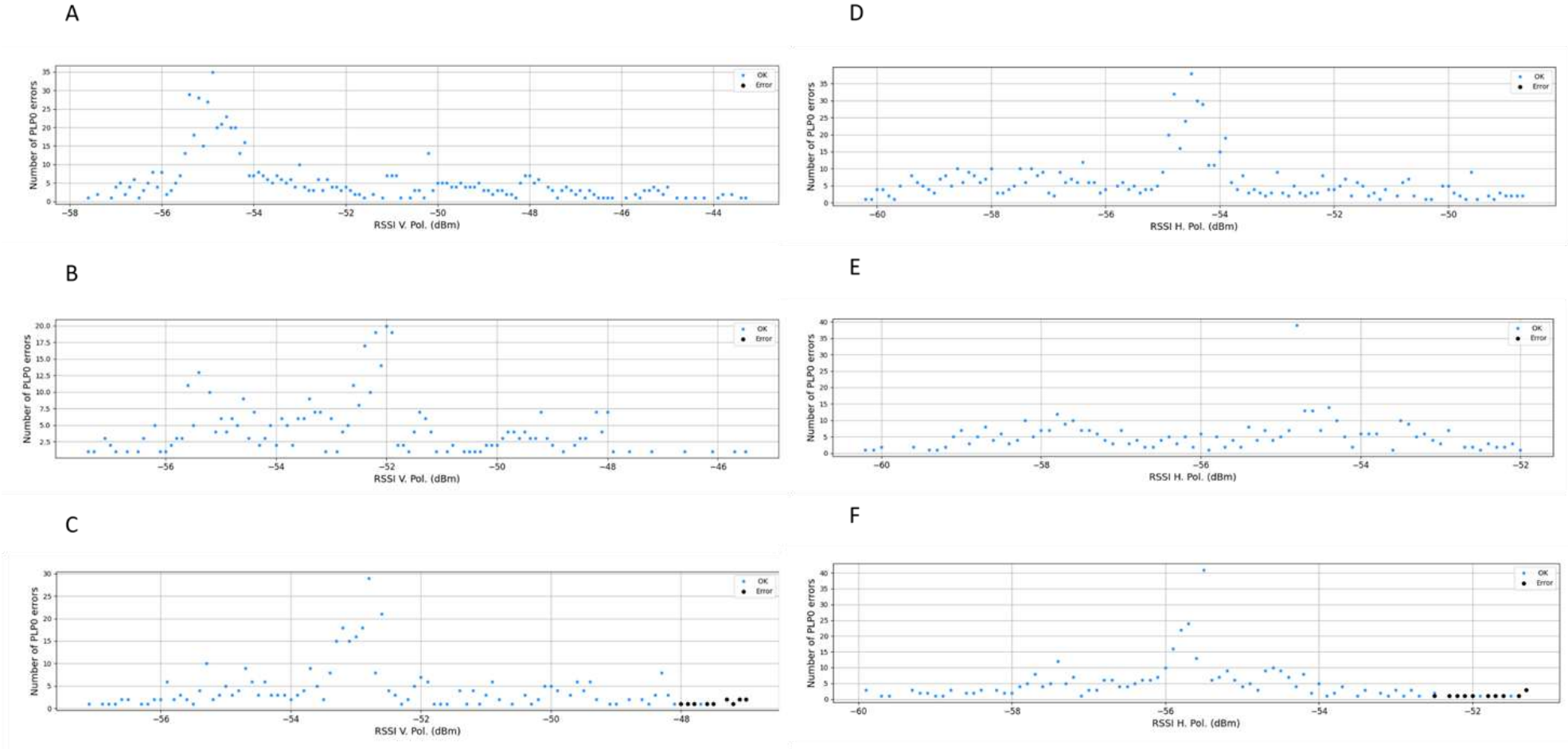


Figure 7.210 - Quantity of PLP0 errors over RSSI for route 3 at A) 20 km/h, Vertical Pol. B) 40 km/h, Vertical Pol. C) 60 km/h, Vertical Pol. D) 20 km/h, Horizontal Pol. E) 40 km/h, Horizontal Pol. F) 60 km/h, Horizontal Pol.

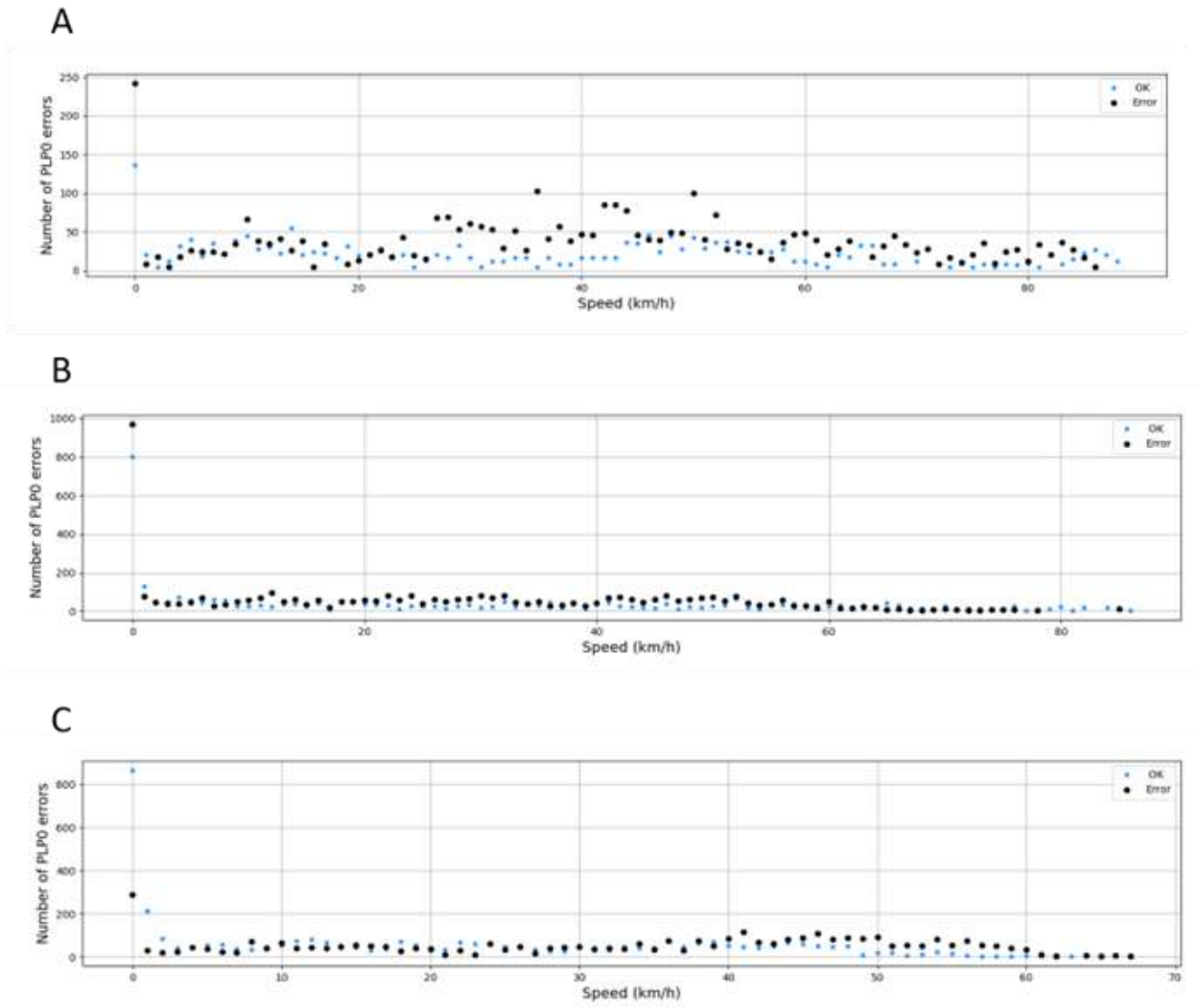


Figure 7.211 - Quantity of PLP0 errors over speed for A) route 1; B) route 2; and C) route 4.

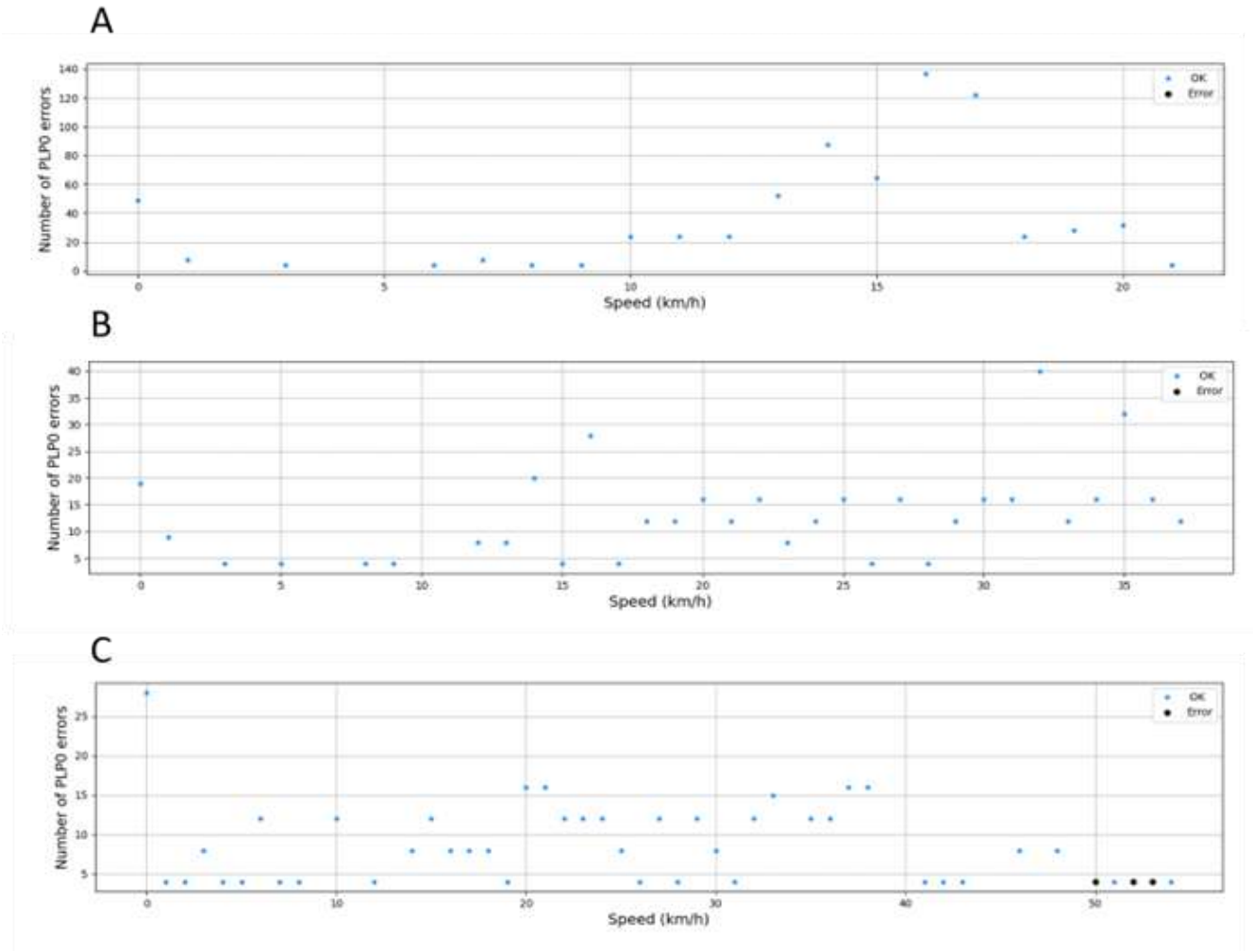


Figure 7.212 - Quantity of PLP0 errors over speed for route 3 at A) 20 km/h; B) 40 km/h; and C) 60 km/h.

7.5.2 Summary of Test Results

The results for Configuration 1 of ATSC 3.0, which includes one layer with a capacity of at least 30 Mbps, are shown in Table 7.65. The bandwidth was measured at 97% with a value of 5.83 MHz, employing MIMO 2x2 and spatial multiplexing techniques. Carrier spacing was set at 422 Hz with an FFT of 16K, while the effective symbol duration was 2,370 µs, and the guard interval was 111 µs, accounting for 4.69% of the total symbol duration. The pilot pattern utilized Dx=8 and Dy=2. Outdoor testing yielded successful reception at 28 out of 30 sites, whereas indoor reception was successful at 7 out of 9 sites. Modulation was achieved through 64-QAM NUC with 6 bits per symbol, accompanied by LDPC+BCH 8/15 Forward Error Correction with an efficiency of 0.533. The resulting bitrate was measured at 32.2 Mbps. Median Carrier-to-Noise ratios of 13.55 dB and 15.21 dB were required for outdoor and indoor reception, respectively.

Table 7.65 - Table referring to configuration 1 of the ATSC 3.0. One layer with capacity ≥ 30 Mbps.

Features	ATSC 3.0
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	422 Hz (FFT 16K)
Effective Symbol Duration	2,370 µs
Guard Interval	111 µs (768/16384 = 4.69%)
Pilot Pattern	Dx=8, Dy=2
Outdoor sites successfully tested	28
Indoor sites successfully tested	7
Modulation	64-QAM NUC (6 bits / symbol)
FEC (Forward Error Correction)	LDPC+BCH 8/15 (0.533)
Bitrate	32.2 Mbps
Median C/N required for outdoor reception	13.5 dB
Median C/N required for indoor reception	15.2 dB

The results for Configuration 2 of ATSC 3.0, which employs reuse-1 with two layers, are shown in Table 7.66. The bandwidth remained consistent at 97% with a value of 5.83 MHz, utilizing MIMO 2x2 and spatial multiplexing techniques. Carrier spacing was set at 422 Hz with an FFT of 16K, while the effective symbol duration and guard interval mirrored those of Configuration 1. The pilot pattern employed Dx=8 and Dy=2. Multiplexing was achieved through LDM with an injection level of 6 dB. For Core Layer (CL), which operates at Carrier-to-Noise ratios below 0 dB, outdoor testing revealed successful reception at one point. Modulation for Core Layer was achieved through QPSK UC with 2 bits per symbol, employing LDPC+BCH 2/15 Forward Error Correction with an efficiency of 0.133, resulting in a bitrate of 2.6 Mbps. Two outdoor points demonstrated successful reception for Enhanced Layer (EL), operating at Carrier-to-Noise ratios below 16 dB. Modulation for Enhanced Layer included 16-QAM NUC 8/15 with 4 bits per symbol. FEC for the Enhanced Layer varied, with LDPC+BCH 8/15 utilized for one point and LDPC+BCH 6/15 for another, resulting in bitrates of 21.4 Mbps and 16.0 Mbps, respectively.

Table 7.66 - Table referring to Configuration 2 of the ATSC 3.0. Reuse-1 with two layers.

Features	ATSC 3.0
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	422 Hz (FFT 16K)
Effective Symbol Duration	2,370 µs
Guard Interval	111 µs (768/16384 = 4.69%)
Pilot Pattern	Dx=8, Dy=2
Multiplexing	LDM (Injection level = 6 dB)
Core Layer (C/N < 0 dB): Successfully Tested Outdoor Points	1
Core Layer (C/N < 0 dB): Modulation	QPSK UC (2 bits / symbol)
Core Layer (C/N < 0 dB): FEC	LDPC+BCH 2/15 (0.133)
Core Layer (C/N < 0 dB): Bitrate	2.6 Mbps
Enhanced Layer (C/N < 16 dB): Successfully Tested Outdoor Points	2
Enhanced Layer (C/N < 16 dB): Modulation	16-QAM NUC 8/15 (4 bits / symbol)
Enhanced Layer (C/N < 16 dB): FEC	LDPC+BCH 8/15 (0.533) (1 point) LDPC+BCH 6/15 (0.400) (1 point)
Enhanced Layer (C/N < 16 dB): Bitrate	21.4 Mbps (FEC 8/15) 16.0 Mbps (FEC 6/15)

Configuration 3 of ATSC 3.0 involves two layers with a capacity of at least 10 Mbps each, and the test results are shown in Table 7.67. The bandwidth remains at 97% with a value of 5.83 MHz, utilizing MIMO 2x2 and spatial multiplexing. Carrier spacing, symbol duration, guard interval, and pilot pattern are consistent with previous configurations. Multiplexing is achieved through LDM with an injection level of 9 dB. Outdoor testing resulted in successful reception at 8 out of 8 sites for both Core Layer and Enhanced Layer, while indoor testing yielded success at 4 out of 4 sites for the Core Layer and 2 out of 4 sites for the Enhanced Layer. For the Core Layer, modulation is accomplished with 16-QAM NUC, offering 4 bits per symbol, with LDPC+BCH 4/15 FEC providing an efficiency of 0.267 and a bitrate of 10.7 Mbps. Median Carrier-to-Noise ratios required for outdoor and indoor reception are 6.2 dB and 8.4 dB, respectively. For the Enhanced Layer, modulation is achieved through QPSK UC with 2 bits per symbol, accompanied by LDPC+BCH 8/15 FEC with an efficiency of 0.533, also resulting in a bitrate of 10.7 Mbps. Median Carrier-to-Noise ratios required for outdoor and indoor reception for the Enhanced Layer are 13.7 dB and 14.8 dB, respectively.

Table 7.67 - Table referring to configuration 3 of the ATSC 3.0. Two layers with capacity ≥ 10 Mbps each.

Features	ATSC 3.0
Useful Bandwidth	97% (5.83 MHz)
MIMO 2x2	Spatial Multiplexing
Carrier Spacing	422 Hz (FFT 16K)
Effective Symbol Duration	2,370 µs
Guard Interval	111 µs (768/16384 = 4.69%)
Pilot Pattern	Dx=8, Dy=2
Multiplexing	LDM (Injection level = 9 dB)
Outdoor sites successfully tested	8
Indoor sites successfully tested	2
Core Layer: Modulation	16-QAM NUC (4 bits / symbol)
Core Layer: FEC	LDPC+BCH 4/15 (0.267)
Core Layer: Bitrate	10.7 Mbps
Core Layer: Median C/N Required for Outdoor Reception	6.2 dB
Core Layer: Median C/N Required for Indoor Reception	13.7 dB
Enhanced Layer: Modulation	QPSK UC (2 bits / symbol)
Enhanced Layer: FEC	LDPC+BCH 8/15 (0.533)
Enhanced Layer: Bitrate	10.7 Mbps
Enhanced Layer: Median C/N Required for Outdoor Reception	13.7 dB
Enhanced Layer: Median C/N Required for Indoor Reception	14.8 dB

Tables 7.68 and 7.69 summarize the results obtained with the technology.

Table 7.68 - Summarized results using ATSC 3.0 for fixed reception, where CL=Core Layer and EL=Enhanced Layer.

	Config 1	Config 3	
Fixed Reception	**CL**	**CL**	**EL**
Number of outdoor sites	30	8	8
Number of outdoor sites without reception errors	28	8	8
Percentage of success in outdoor sites	93%	100%	100%
Median carrier-to-noise ratio (C/N) required for outdoor reception	13.51 dB	6.25 dB	13.75 dB
Max carrier-to-noise ratio (C/N) required for outdoor reception	20.45 dB	10.61 dB	18.63 dB
Min carrier-to-noise ratio (C/N) required for outdoor reception	11.30 dB	5.54 dB	12.44 dB
Median system margin for outdoor sites	H: -76.51 dBm	H: -84.61 dBm	H: -77.31 dBm
	V: -77.03 dBm	V: -84.15 dBm	V: -76.78 dBm
Max system margin for outdoor sites	H: -66.70 dBm	H: -77.65 dBm	H: -68.65 dBm
	V: -69.55 dBm	V: -81.44 dBm	V: -71.88 dBm
Min system margin for outdoor sites	H: -79.47 dBm	H: -85.57 dBm	H: -78.31 dBm
	V: -78.90 dBm	V: -85.04 dBm	V: -78.39 dBm
Number of indoor sites	9	4	4
Number of indoor sites without reception errors	7	4	2
Percentage of success in indoor sites	78%	100%	50%
Median carrier-to-noise ratio (C/N) required for indoor reception	15.21 dB	8.45 dB	14.82 dB
Max carrier-to-noise ratio (C/N) required for indoor reception	20.89 dB	13.11 dB	15.66 dB

	Config 1	Config 3	
Fixed Reception	**CL**	**CL**	**EL**
Min carrier-to-noise ratio (C/N) required for indoor reception	13.98 dB	5.79 dB	13.97 dB
Median system margin for indoor sites	H: -71.79 dBm	H: -80.55 dBm	H: -76.34 dBm
	V: -72.06 dBm	V: -76.95 dBm	V: -79.47 dBm
Max system margin for indoor sites	H: -63.83 dBm	H: -73.47 dBm	H: -73.94 dBm
	V: -61.93 dBm	V: -74.49 dBm	V: -77.53 dBm
Min system margin for indoor sites	H: -75.31 dBm	H: -82.40 dBm	H: -82.18 dBm
	V: -76.83 dBm	V: -84.21 dBm	V: -83.08 dBm

Table 7.69 - Summarized results using ATSC 3.0 for mobile reception using Config 1.

Mobile Reception - Routes	1	2	3 - 20 km/h	3 - 40 km/h	3 - 60 km/h	4
Number of measured points in drive test	5039	7692	705	416	395	7081
Number of points without reception errors	1843	3324	705	416	383	3651
Reception success rate in range [1km/h ,10km/h]	45.38	49.05	100	100	100	70.04
Reception success rate in range]10km/h ,20km/h]	52.45	38.49	100	100	100	56.64
Reception success rate in range [20km/h ,30km/h]	33.81	30.55	100	100	100	57.09
Reception success rate in range]30km/h ,40km/h]	16.91	39.47	-	100	87.5	49.3
Reception success rate in range]40km/h ,50km/h]	34.66	29.54	-	-	66.66	35.10
Reception success rate in range]50km/h ,60km/h]	37.66	42.36	-	-	-	16.03
Reception success rate in range]60km/h ,70km/h]	33.72	59.79	-	-	-	46.25
Reception success rate in range]70km/h ,80km/h]	23.34	73.17	-	-	-	-
Reception success rate in range]80km/h ,90km/h]	48.48	86.95	-	-	-	-

Appendix I. Advanced ISDB-T - Outdoor Sites - Configuration 1 - Single Layer: 64-QAM NUC, FEC 8/16, Bitrate 30.9 Mbps

Chapter 1. Site 1

a) Channel Power

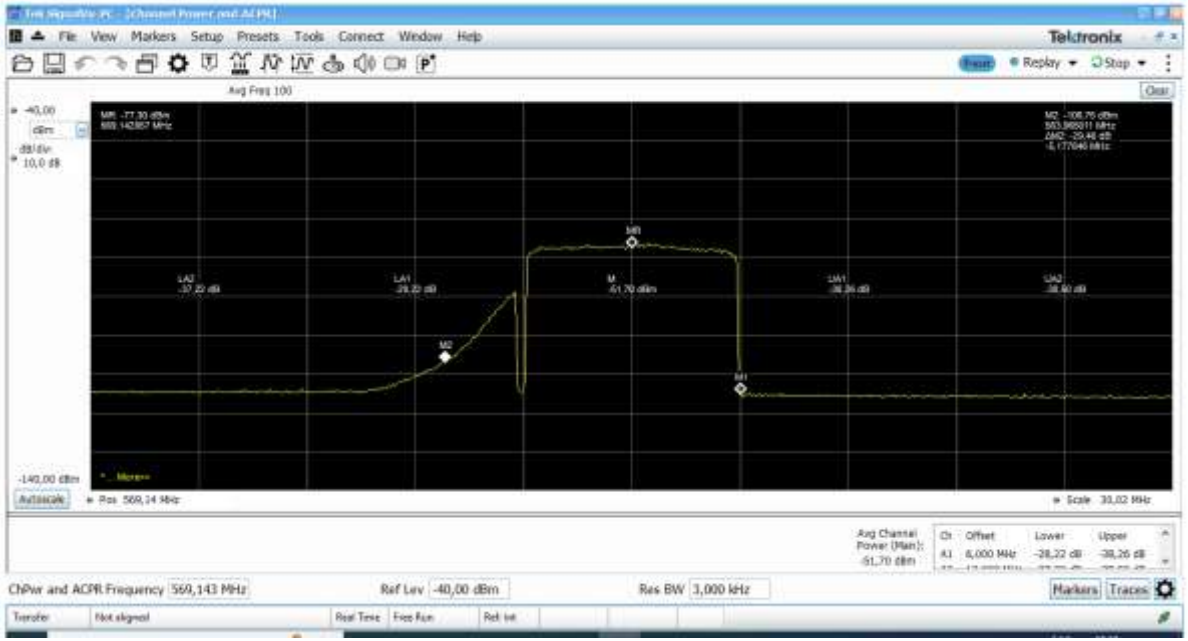


Figure 1.1 - Vertical

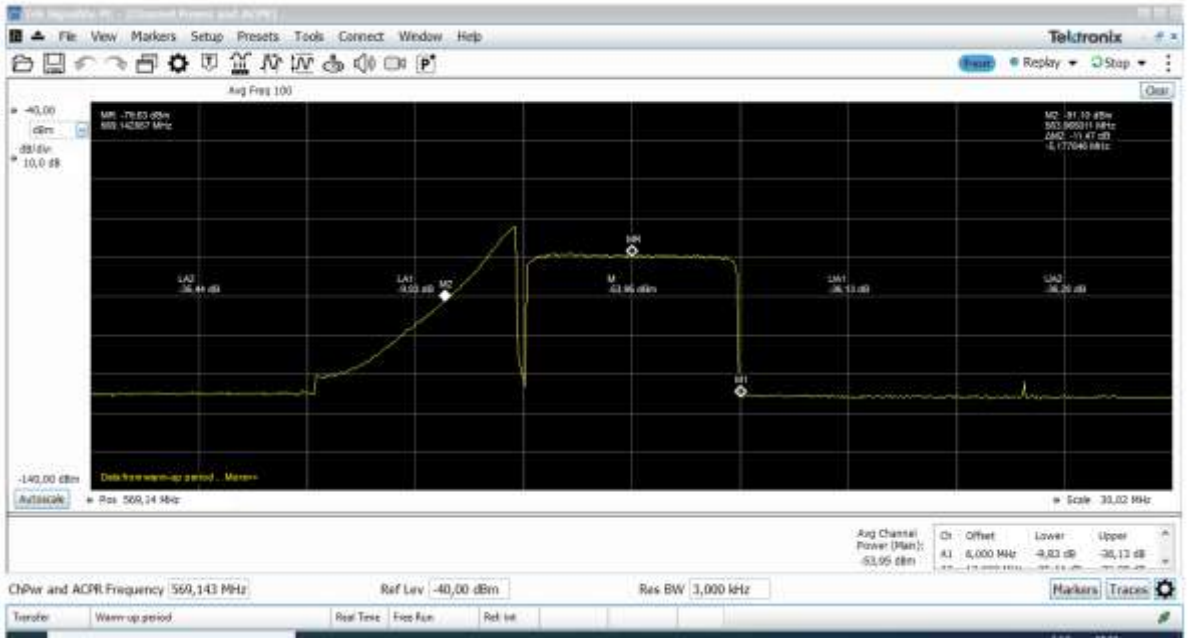


Figure 1.2 - Horizontal

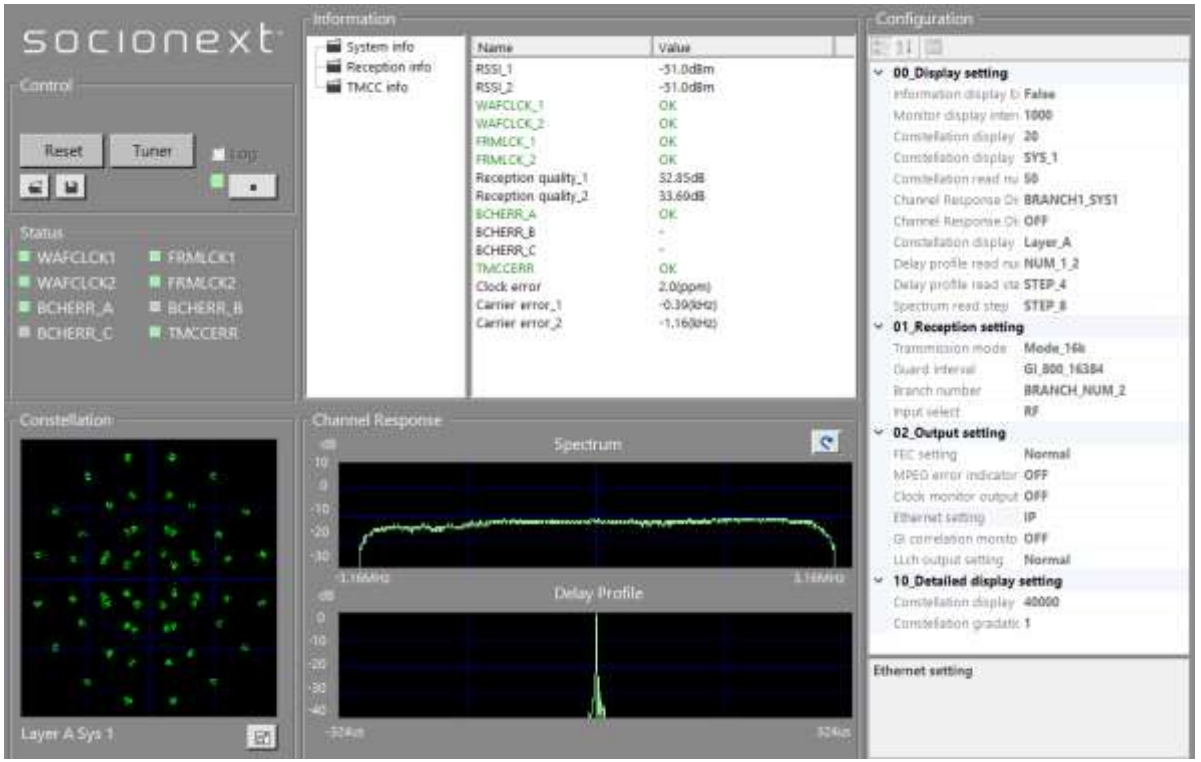


Figure 1.3 - Socionext Screen

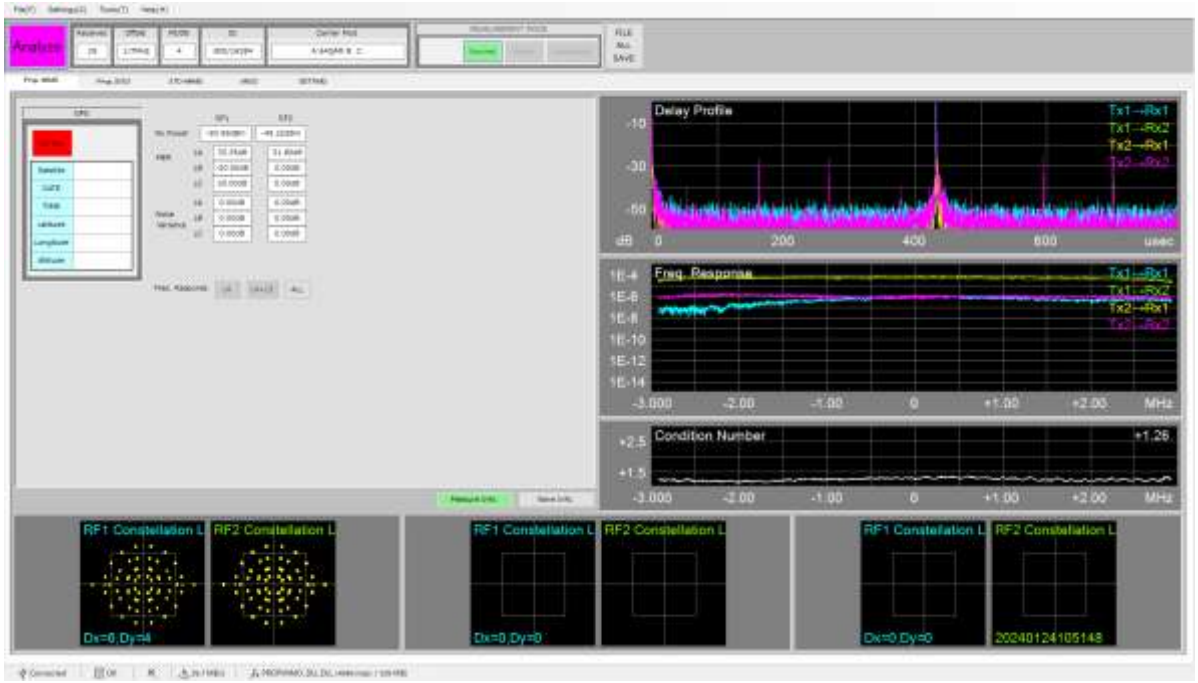


Figure 1.4 - Rintaro Screen

b) AWGN Power

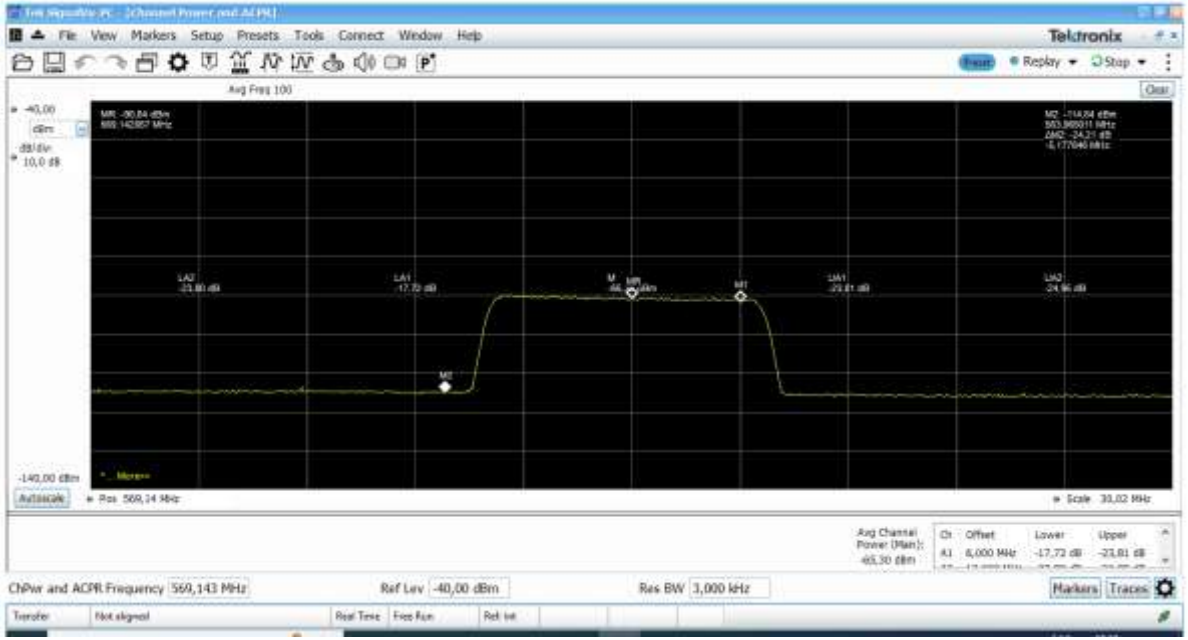


Figure 1.5 - Vertical

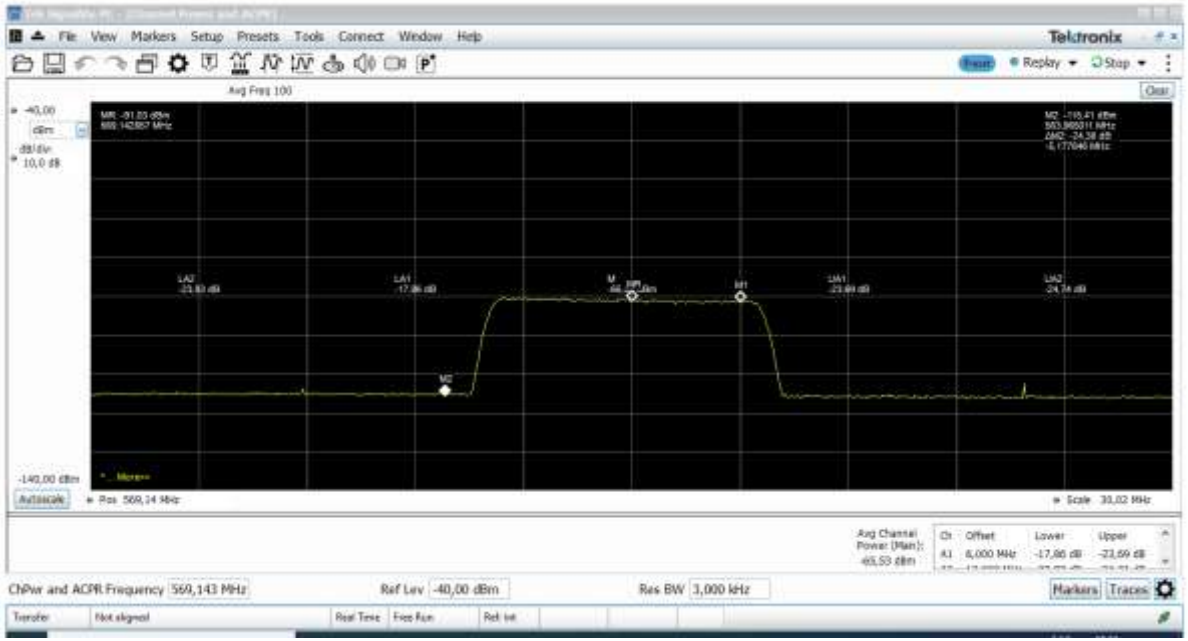


Figure 1.6 - Horizontal

c) C/N Threshold

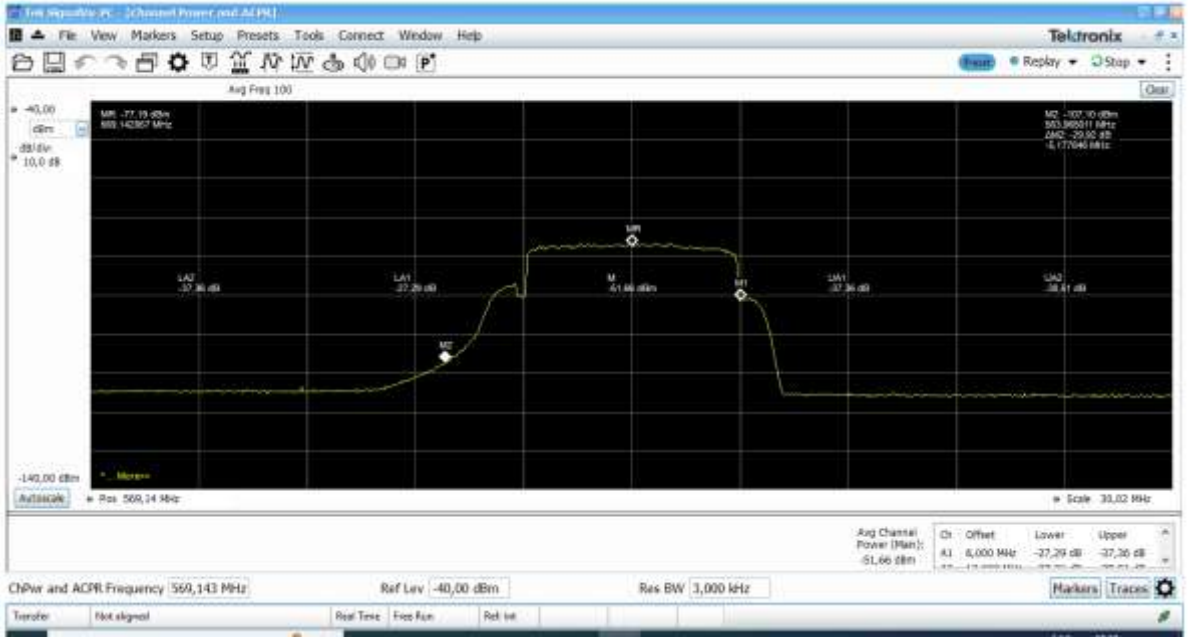


Figure 1.7 - Vertical

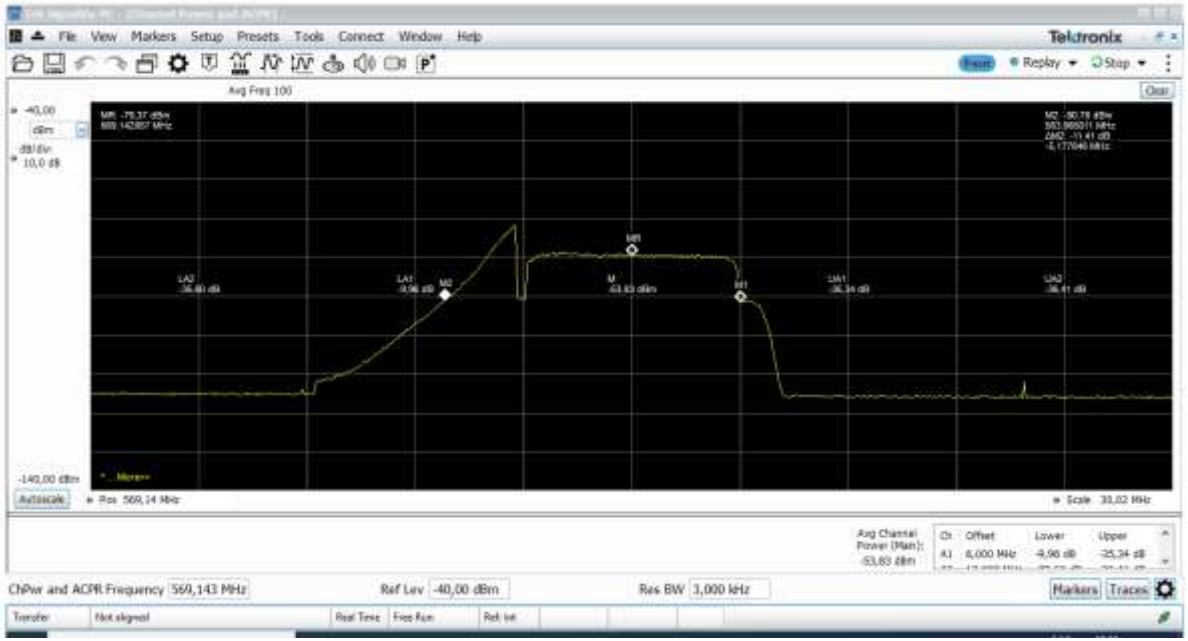


Figure 1.8 - Horizontal

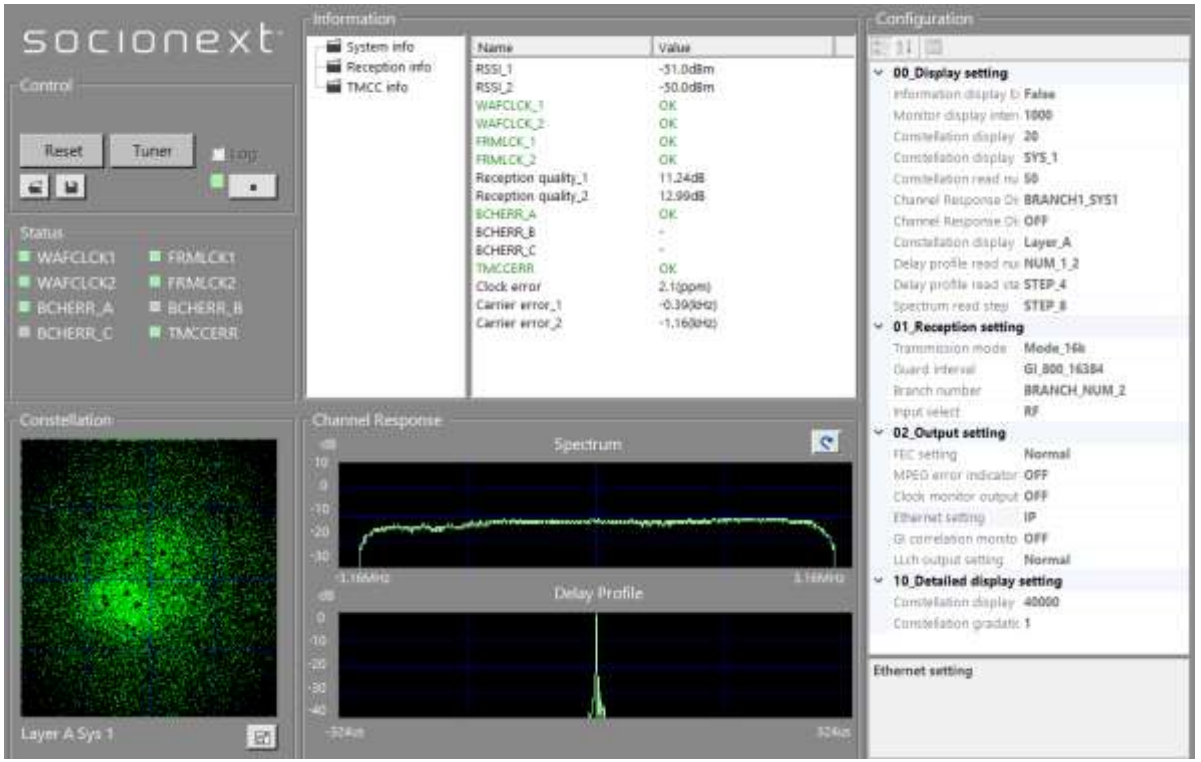


Figure 1.9 - Socionext Screen

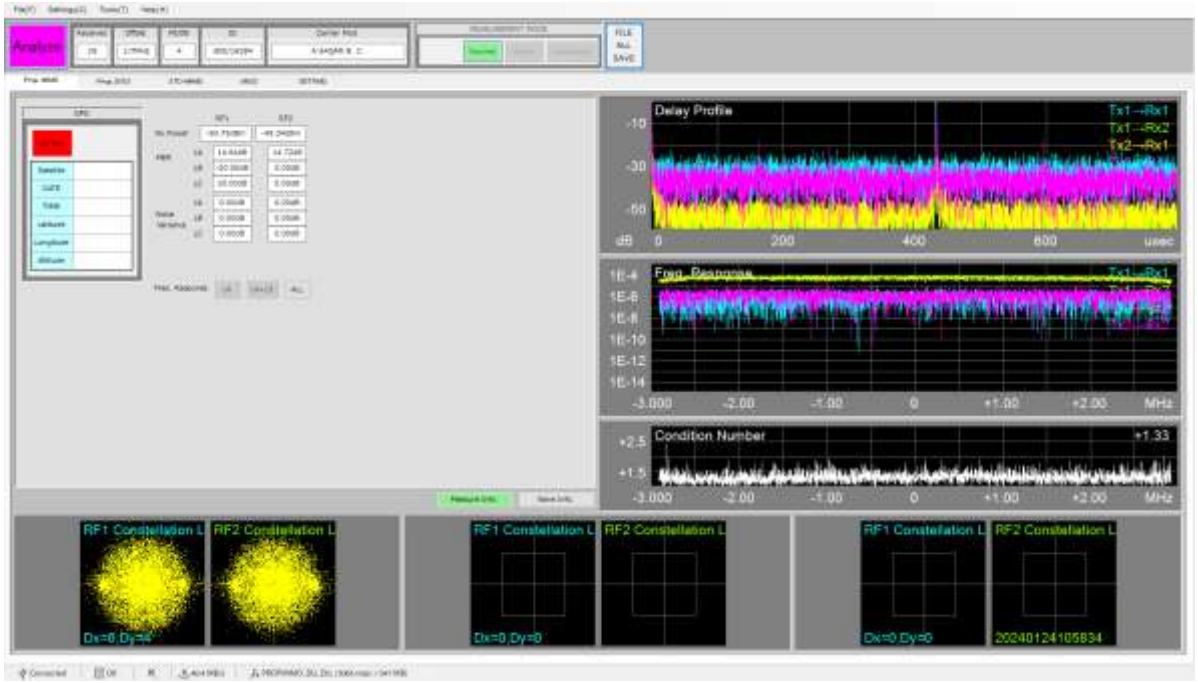


Figure 1.10 - Rintaro Screen

d) Reception Threshold

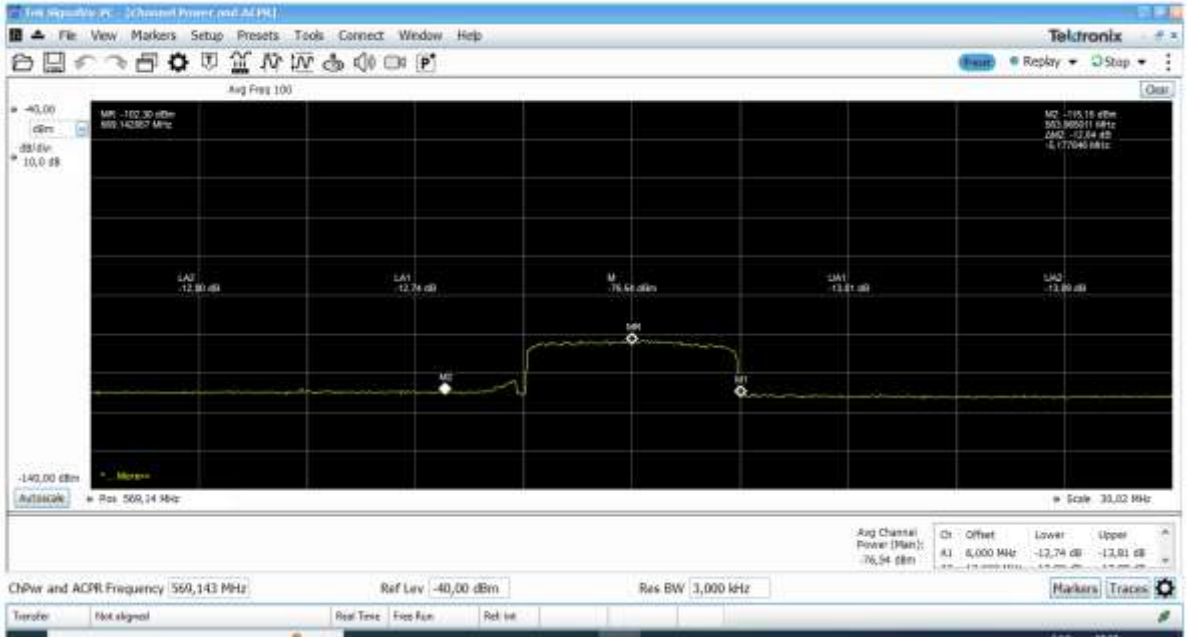


Figure 1.11 - Vertical

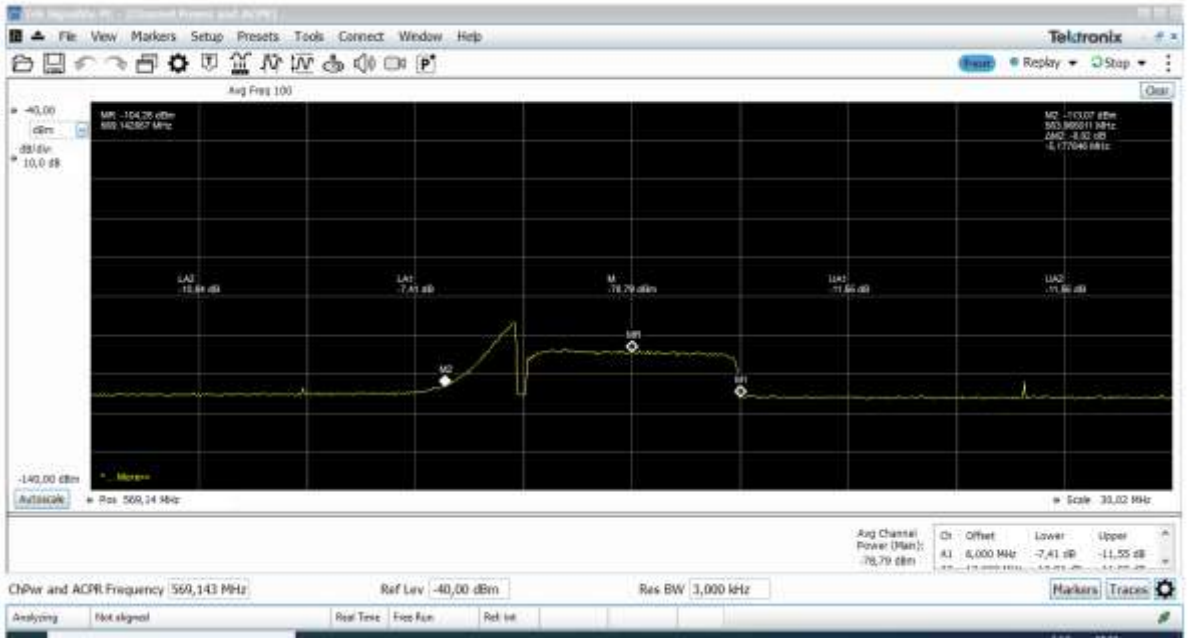


Figure 1.12 - Horizontal

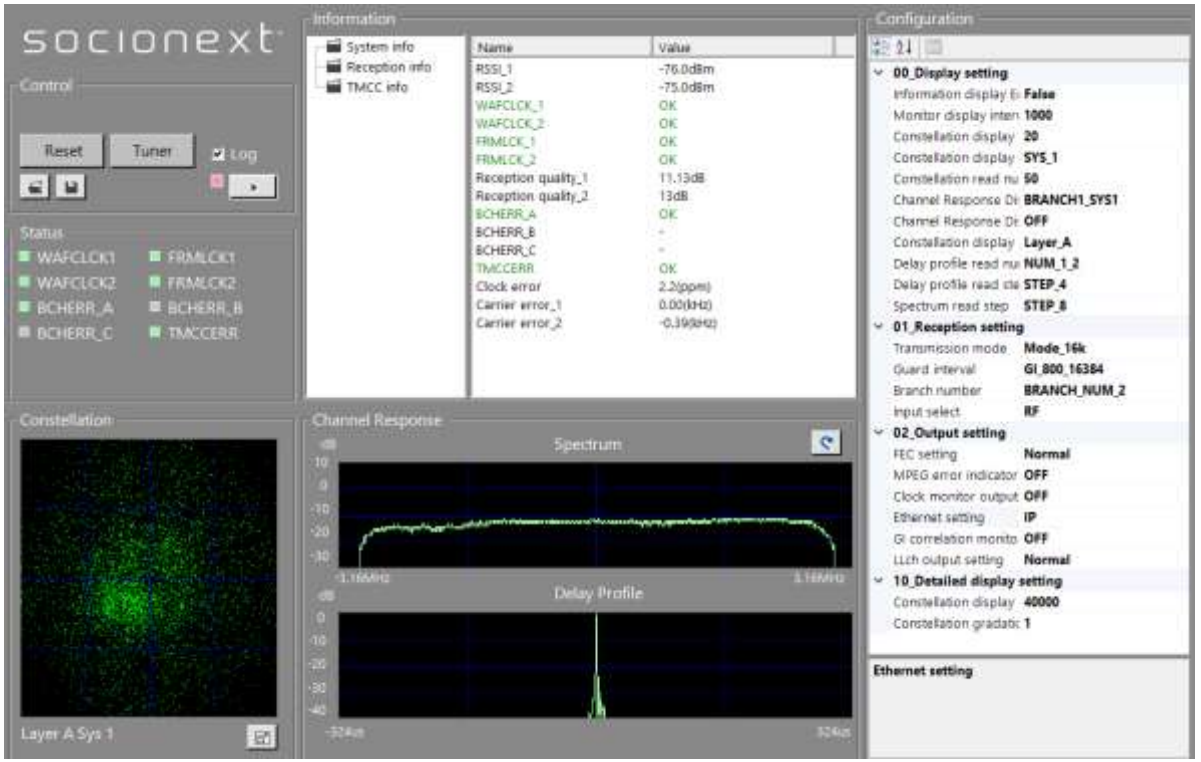


Figure 1.13 - Socionext Screen

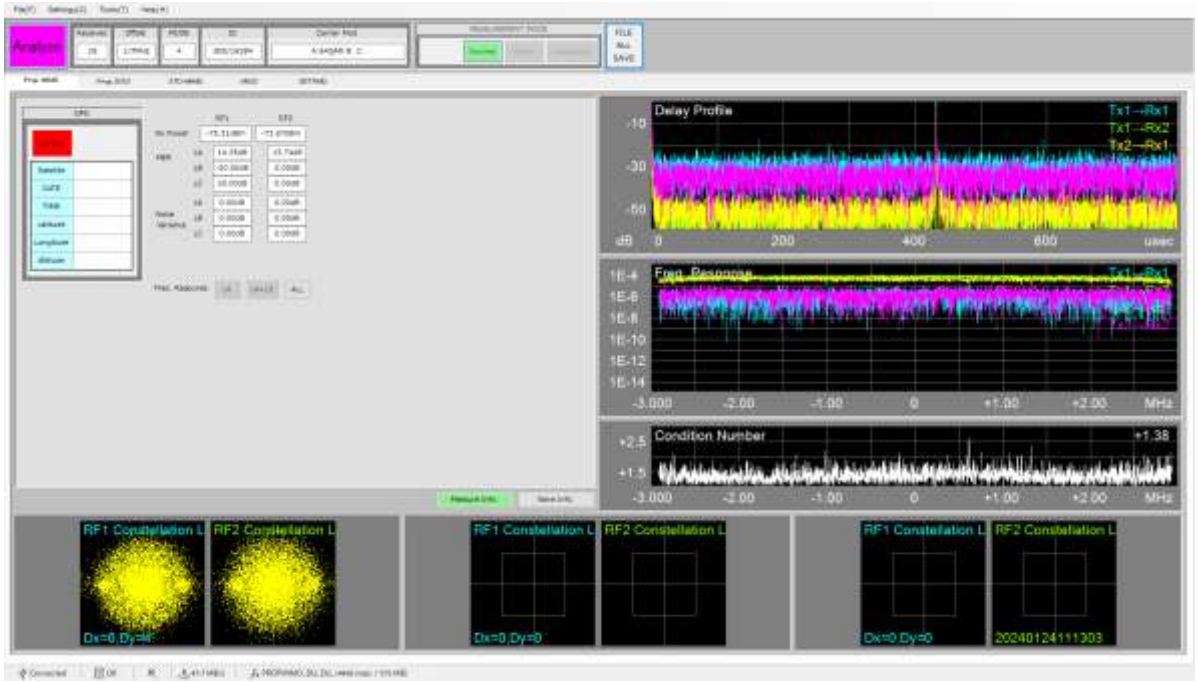


Figure 1.14 - Rintaro Screen

Chapter 2. Site 2

a) Channel Power

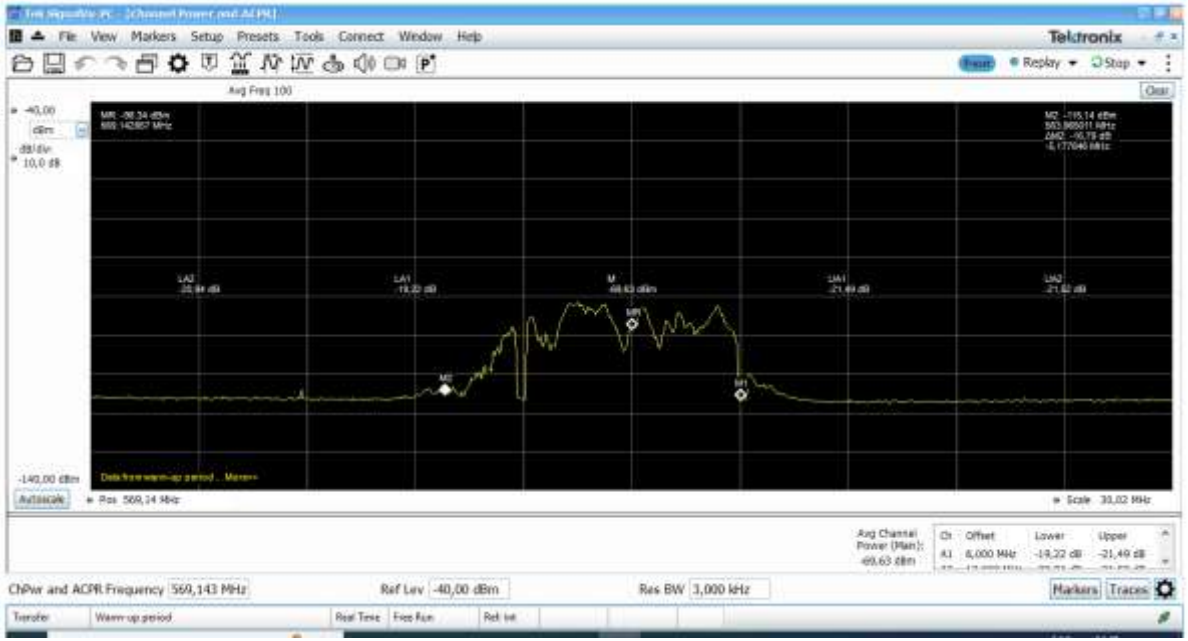


Figure 2.1 - Vertical

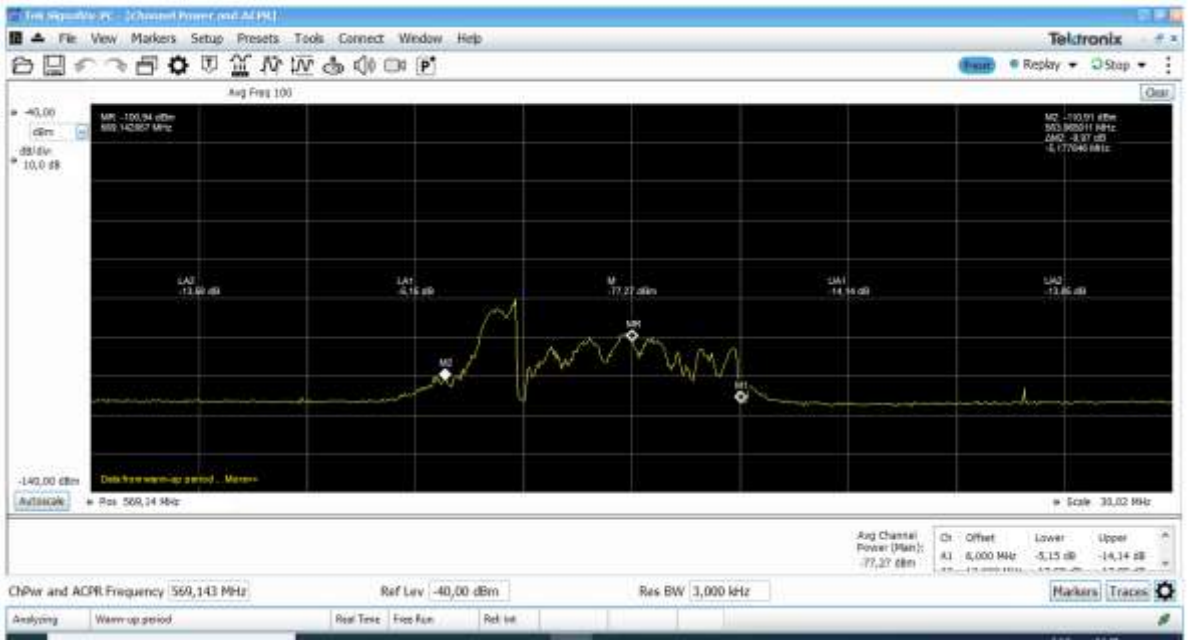


Figure 2.2 - Horizontal

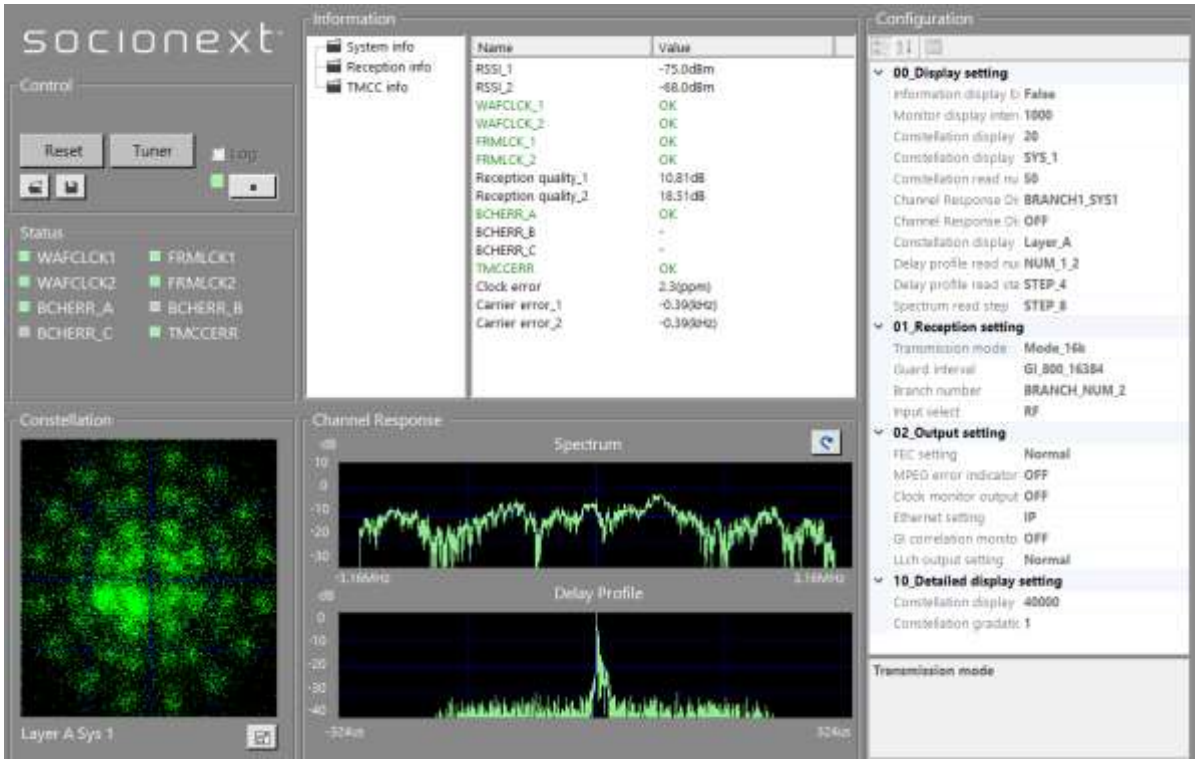


Figure 2.3 - Socionext Screen

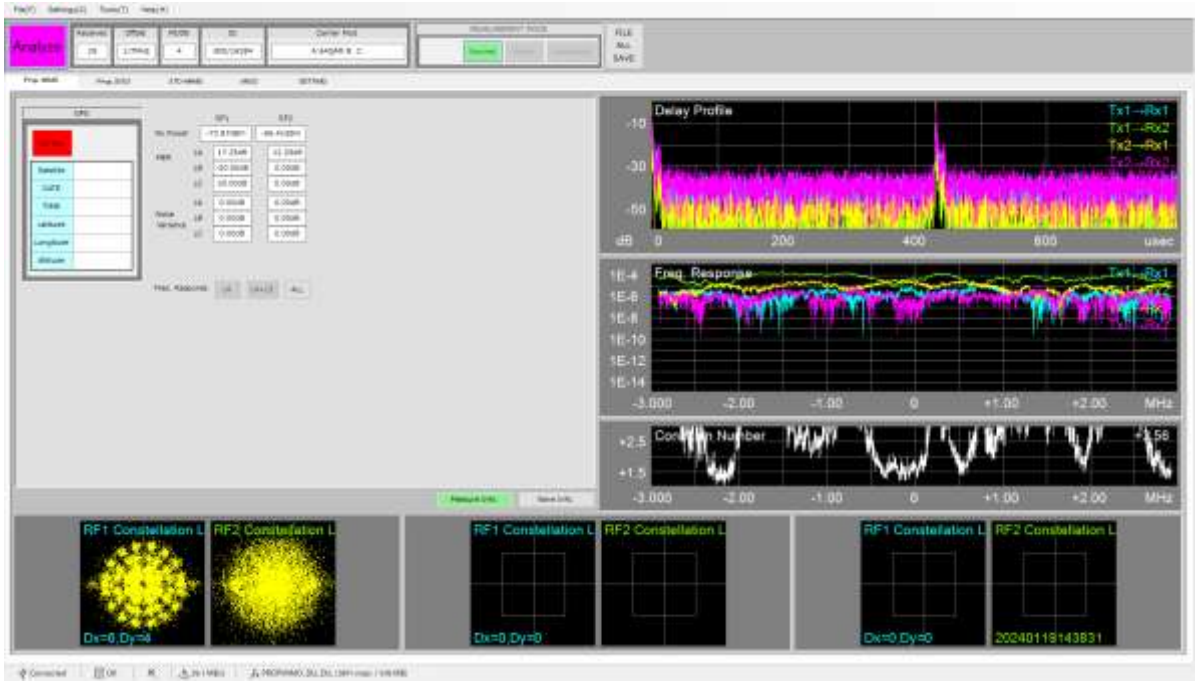


Figure 2.4 - Rintaro Screen

b) AWGN Power

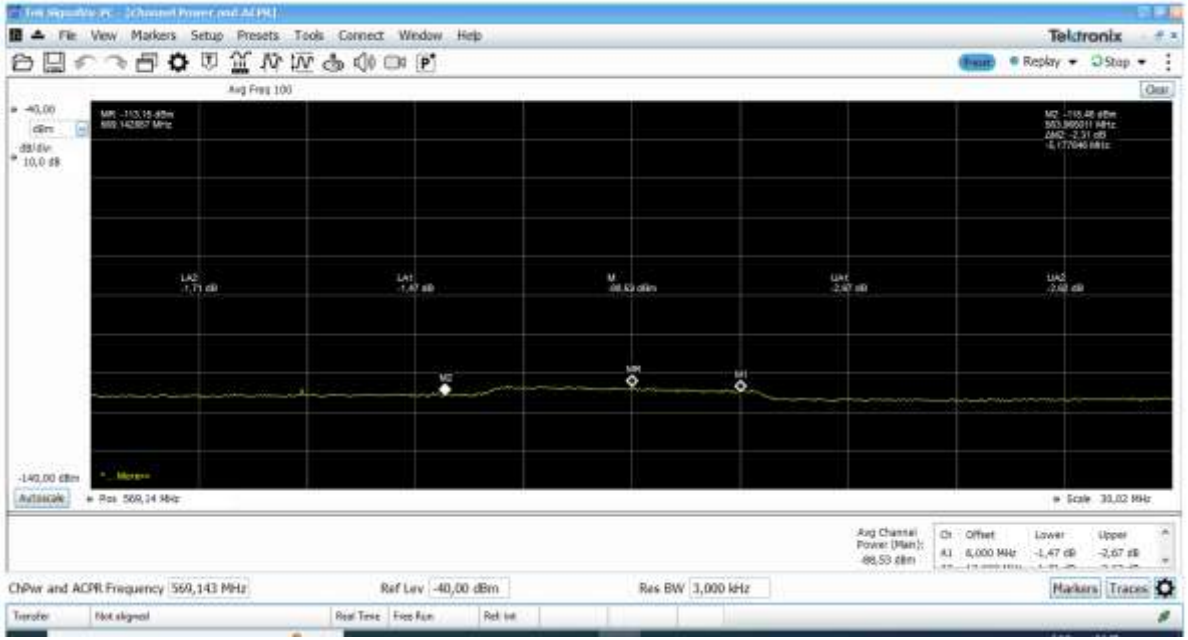


Figure 2.5 - Vertical

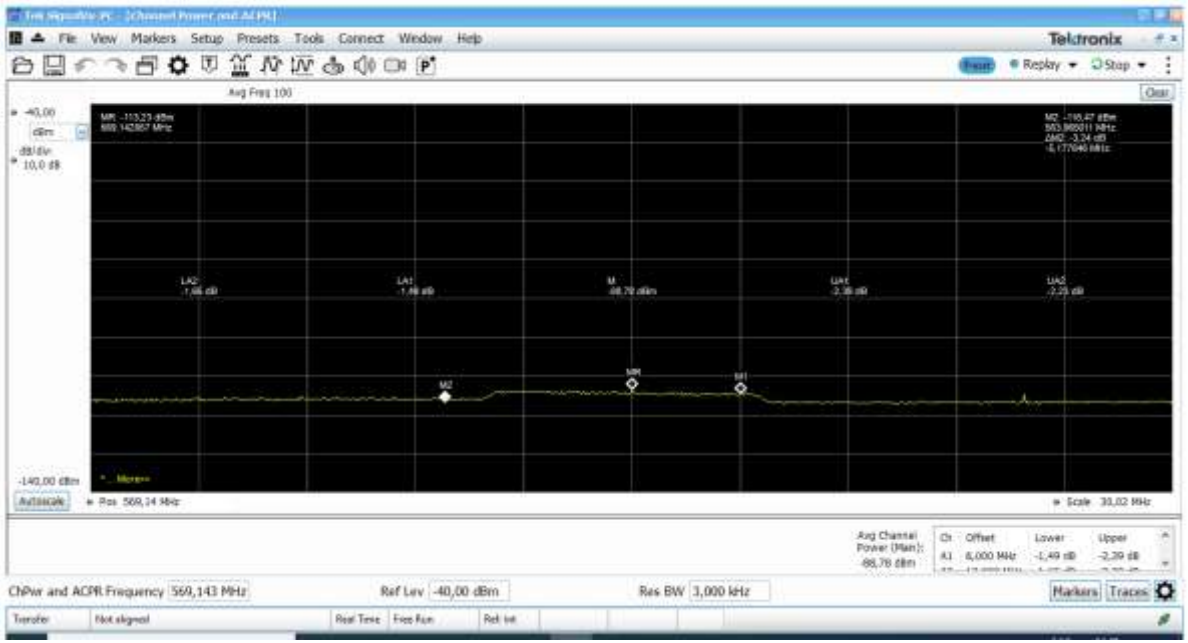


Figure 2.6 - Horizontal

c) C/N Threshold

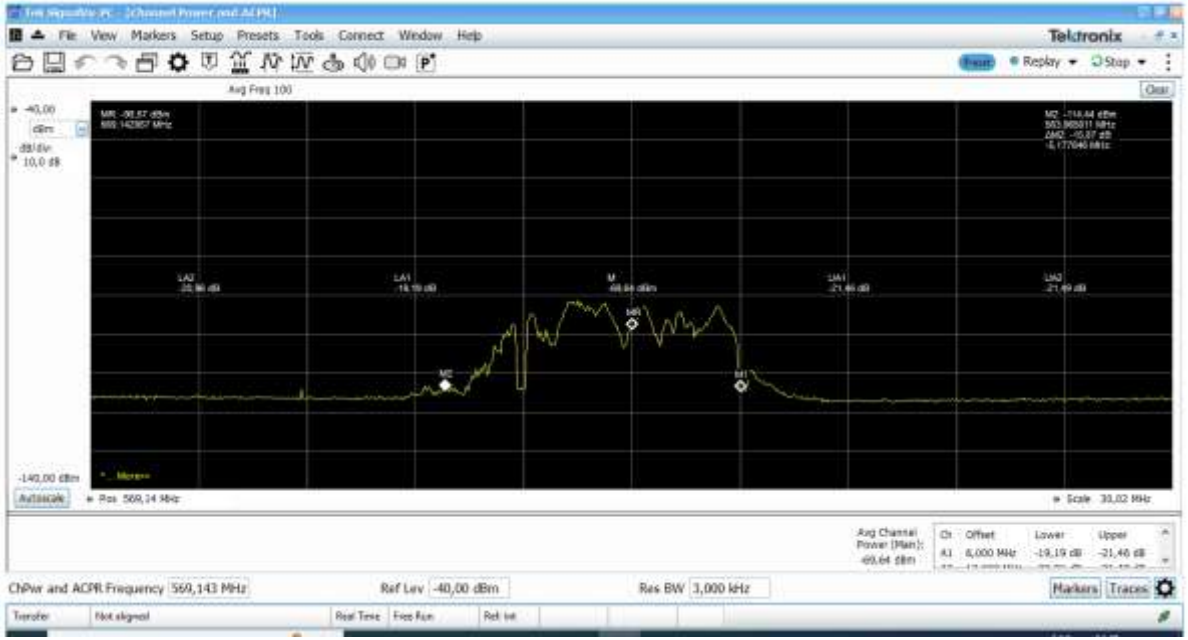


Figure 2.7 - Vertical

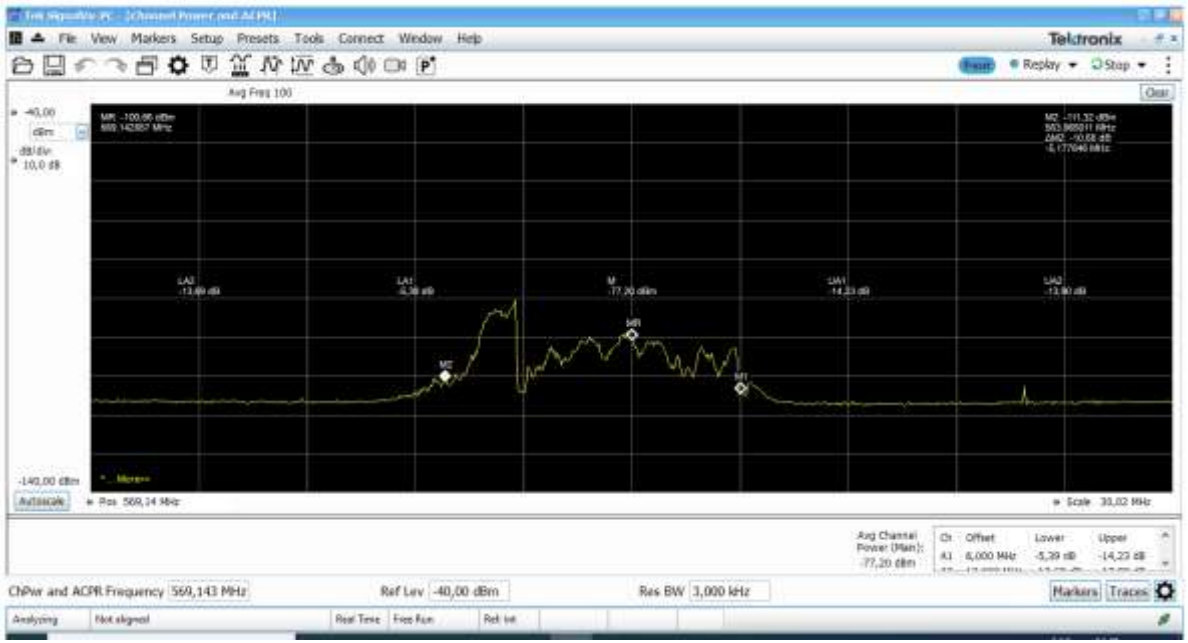


Figure 2.8 - Horizontal

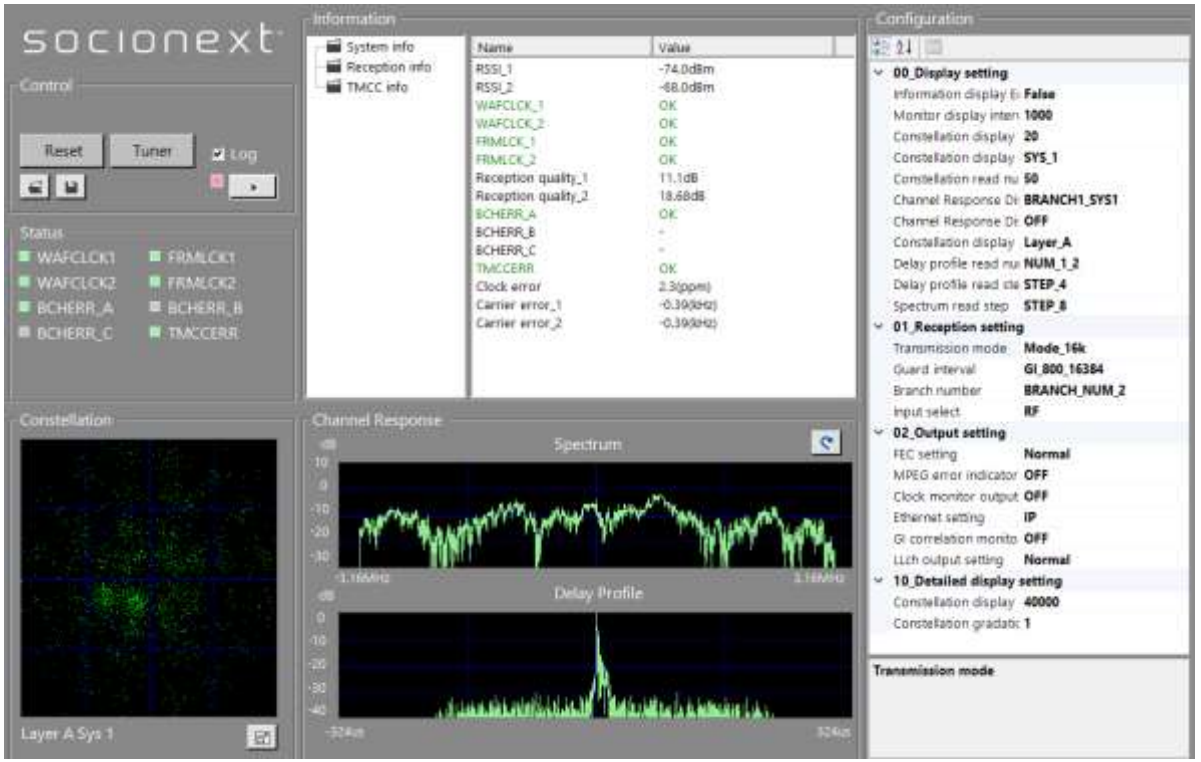


Figure 2.9 - Socionext Screen

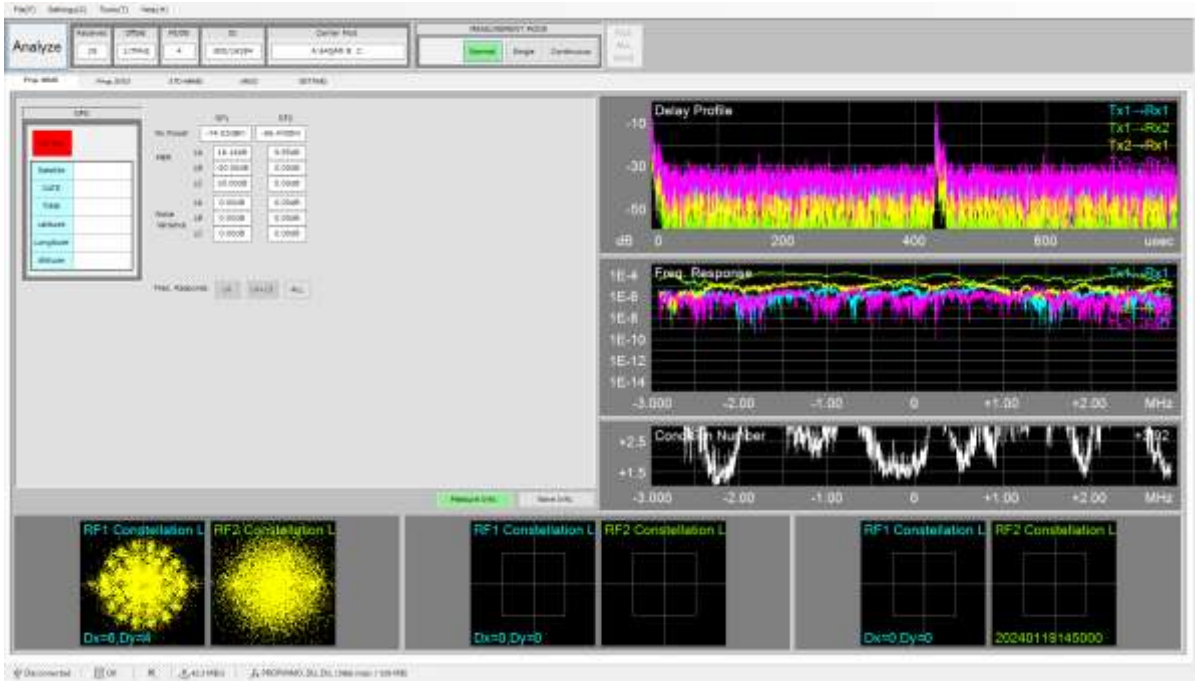


Figure 2.10 - Rintaro Screen

d) Reception Threshold

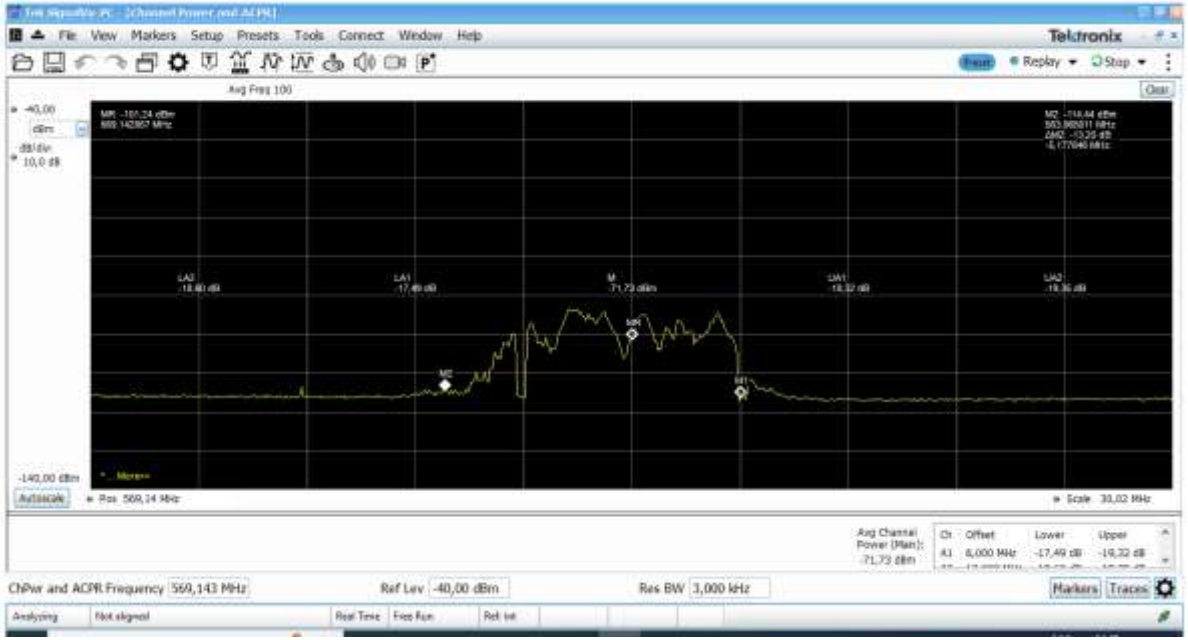


Figure 2.11 - Vertical

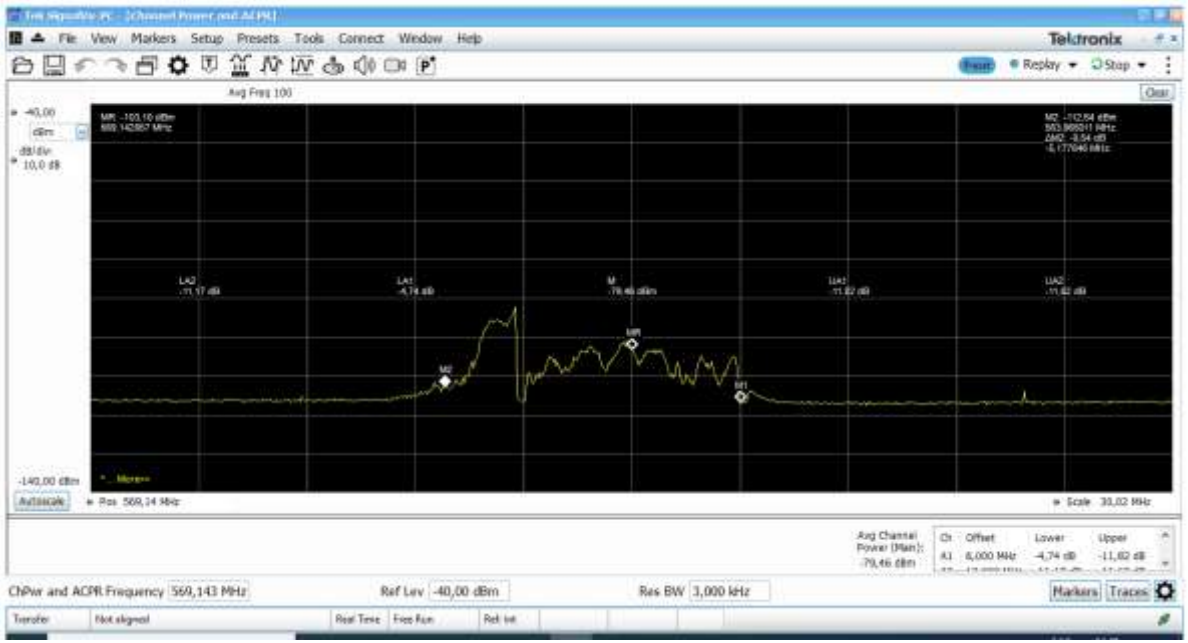


Figure 2.12 - Horizontal

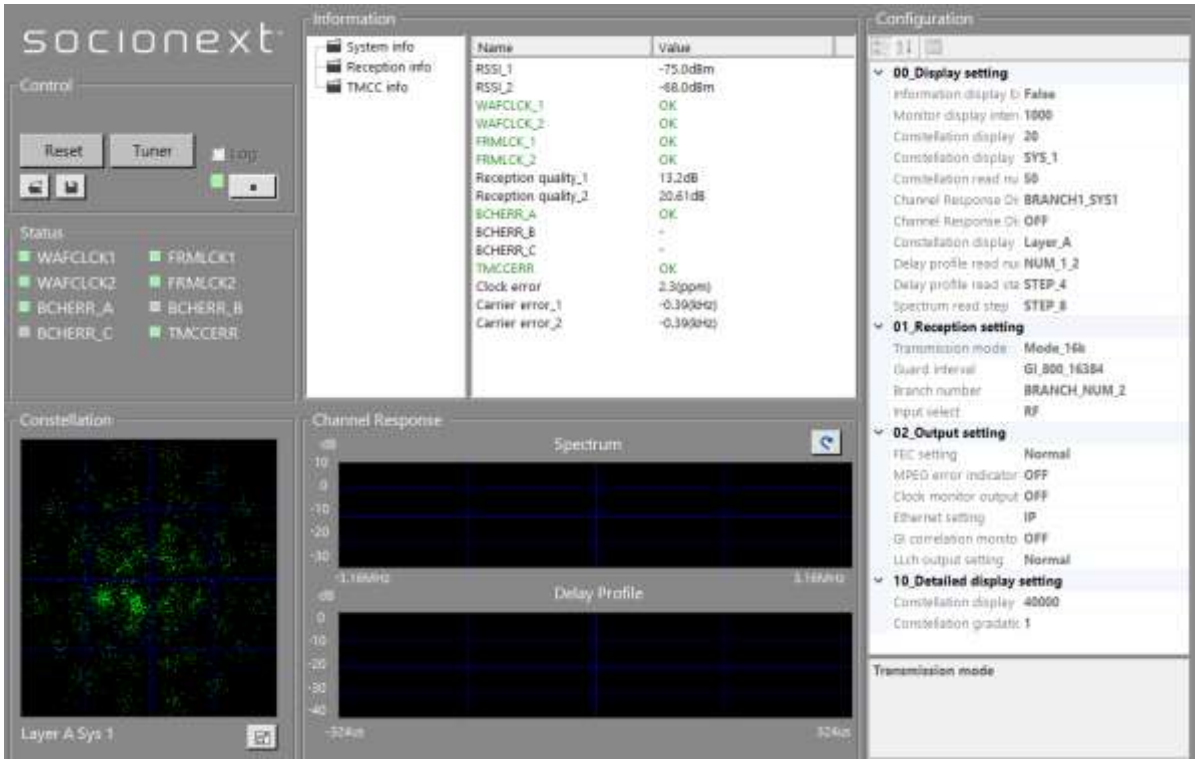


Figure 2.13 - Socionext Screen

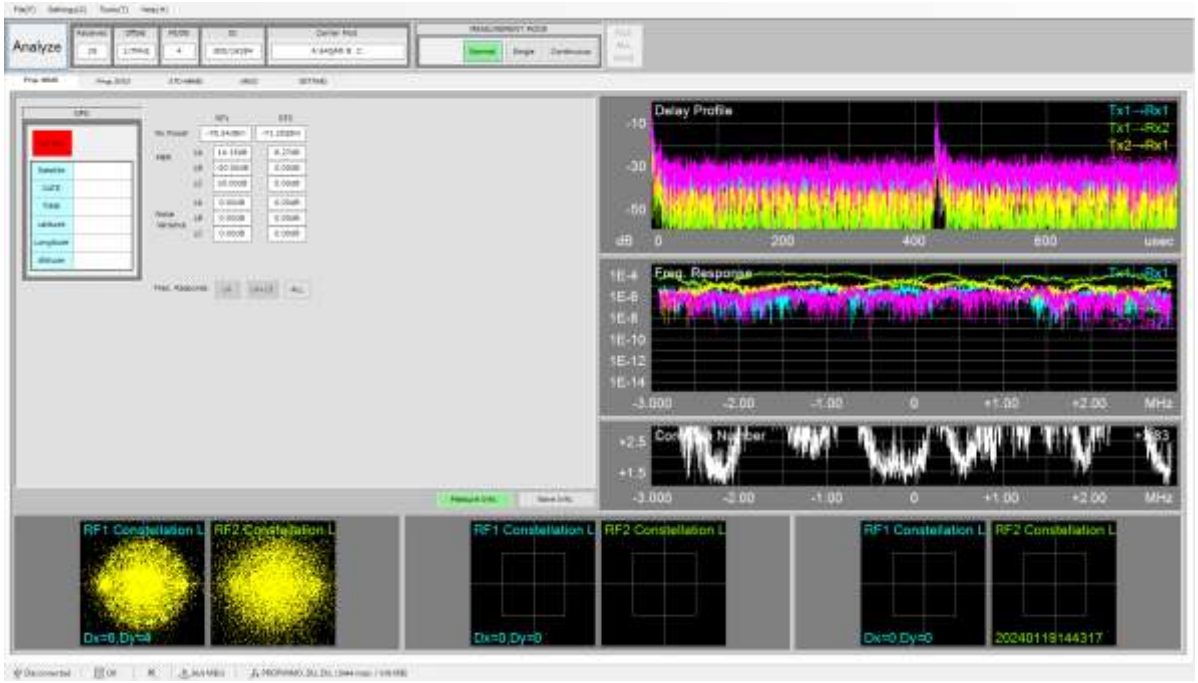


Figure 2.14 - Rintaro Screen

Chapter 3. Site 3

a) Channel Power

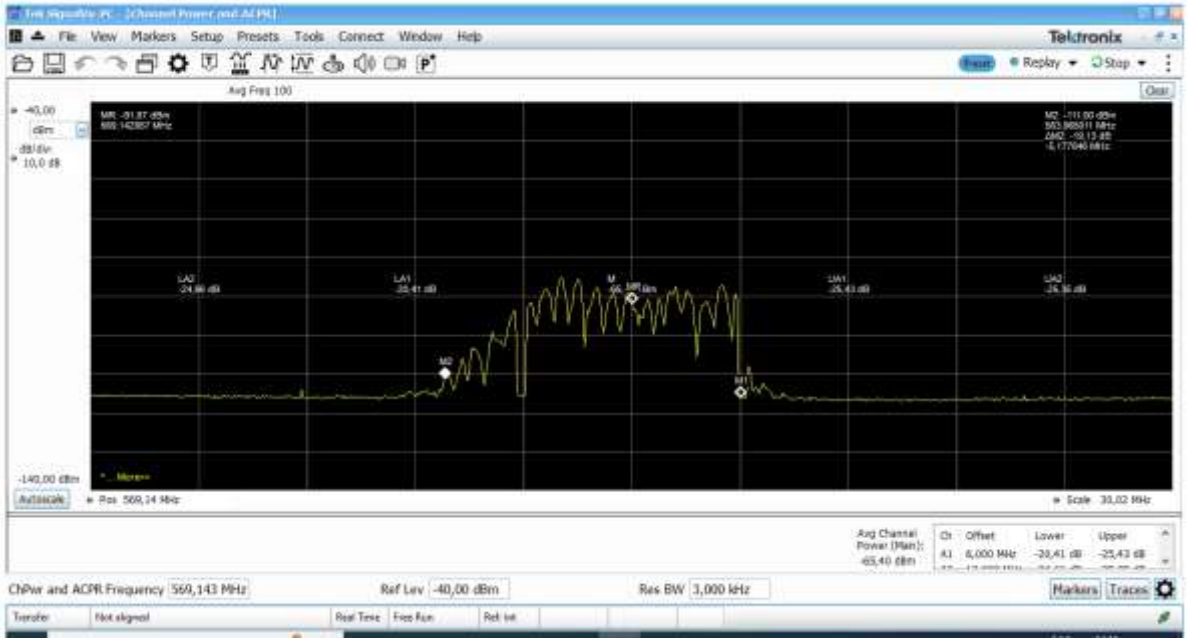


Figure 3.1 - Vertical

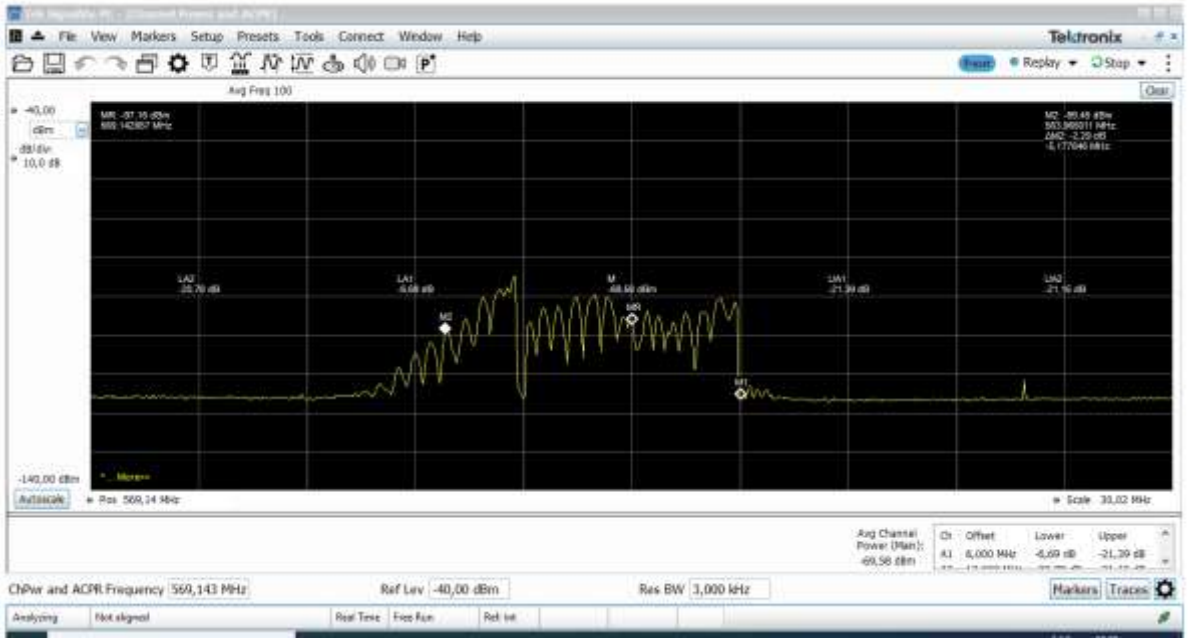


Figure 3.2 - Horizontal

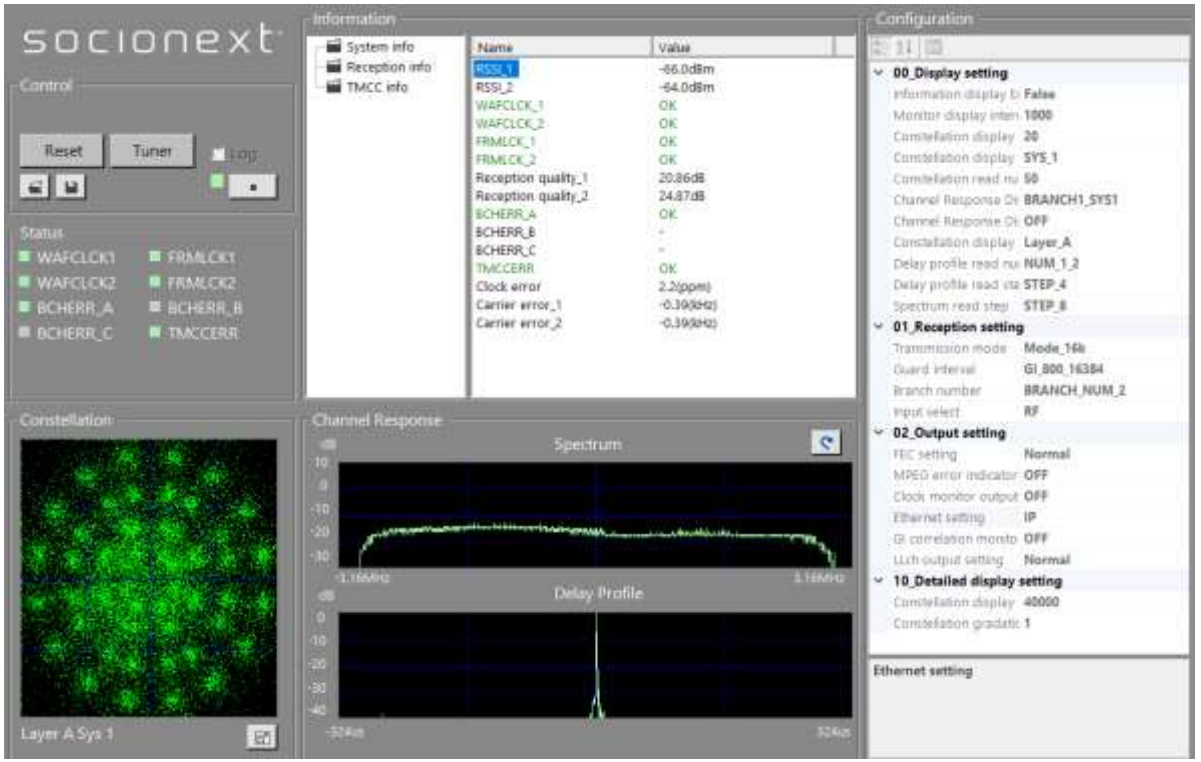


Figure 3.3 - Socionext Screen

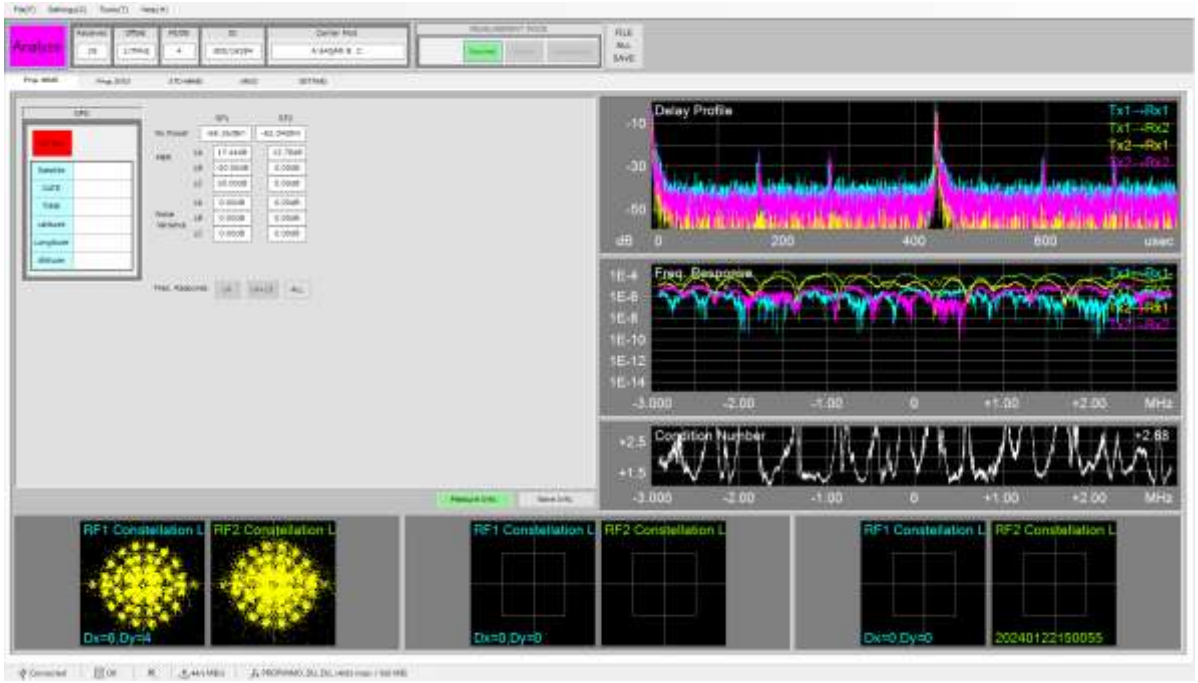


Figure 3.4 - Rintaro Screen

b) AWGN Power

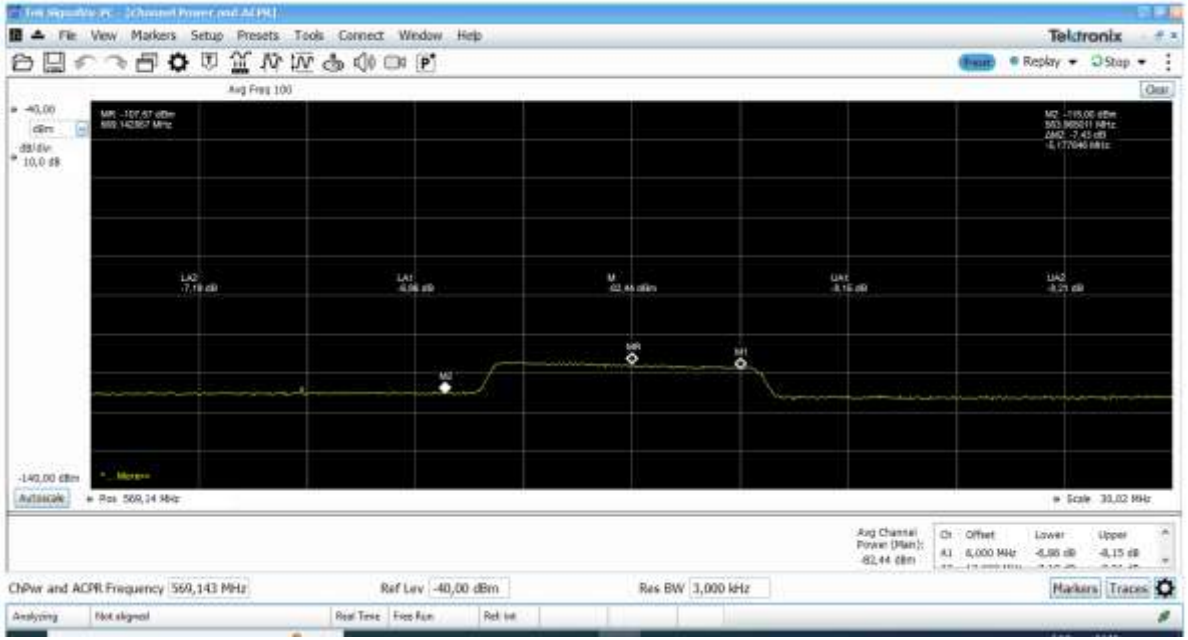


Figure 3.5 - Vertical

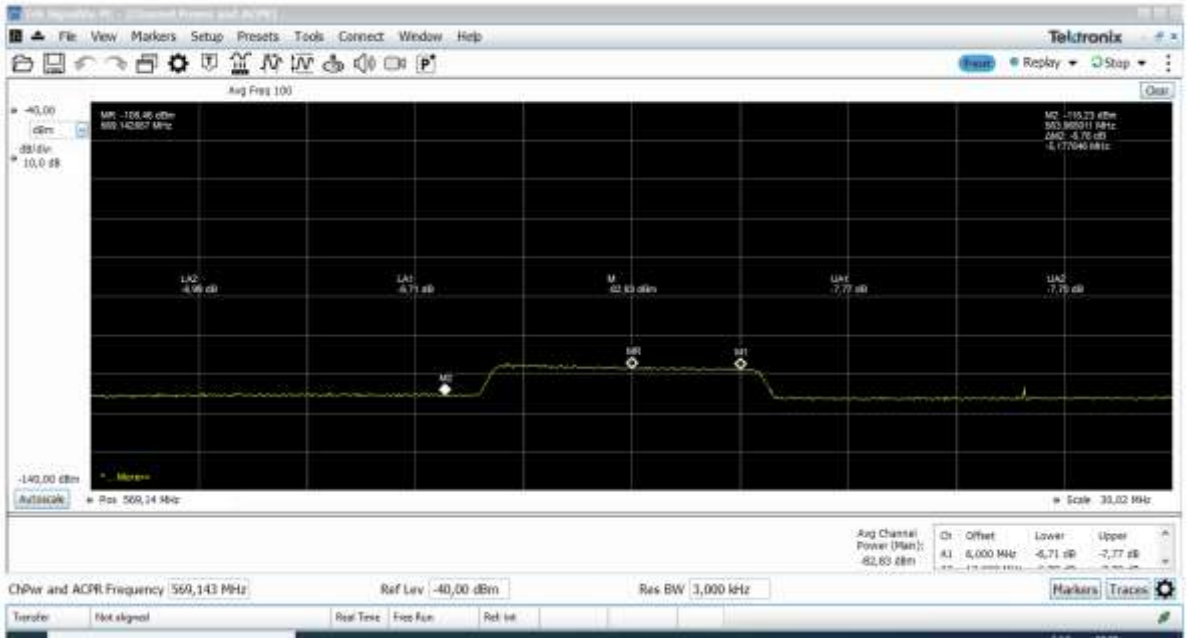


Figure 3.6 - Horizontal

c) C/N Threshold

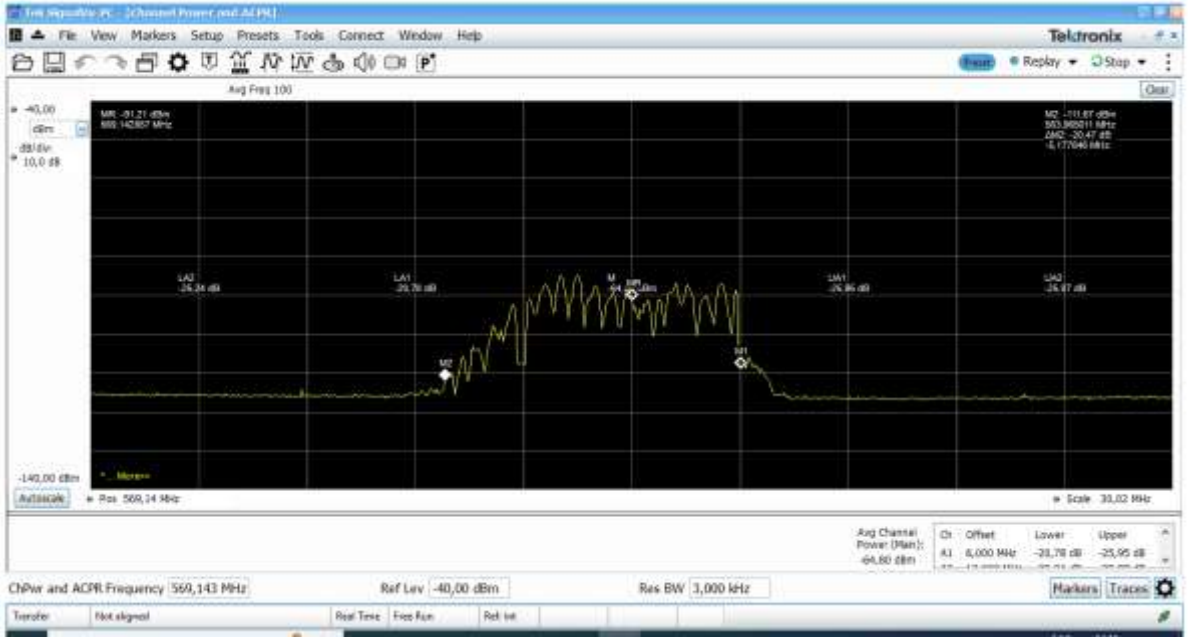


Figure 3.7 - Vertical

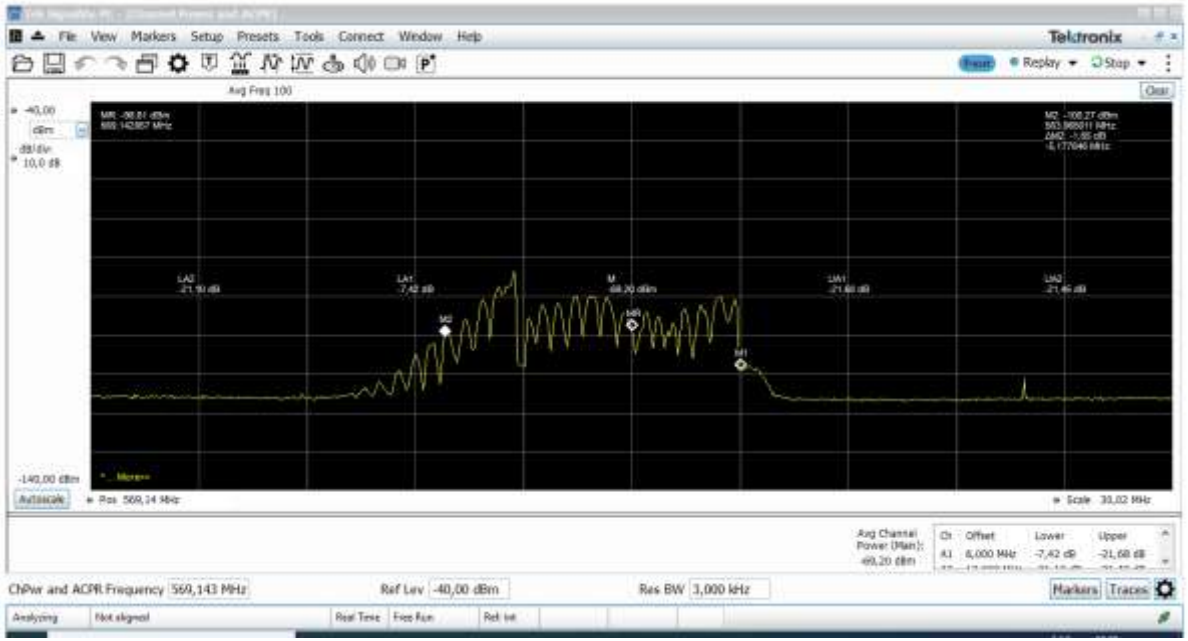


Figure 3.8 - Horizontal

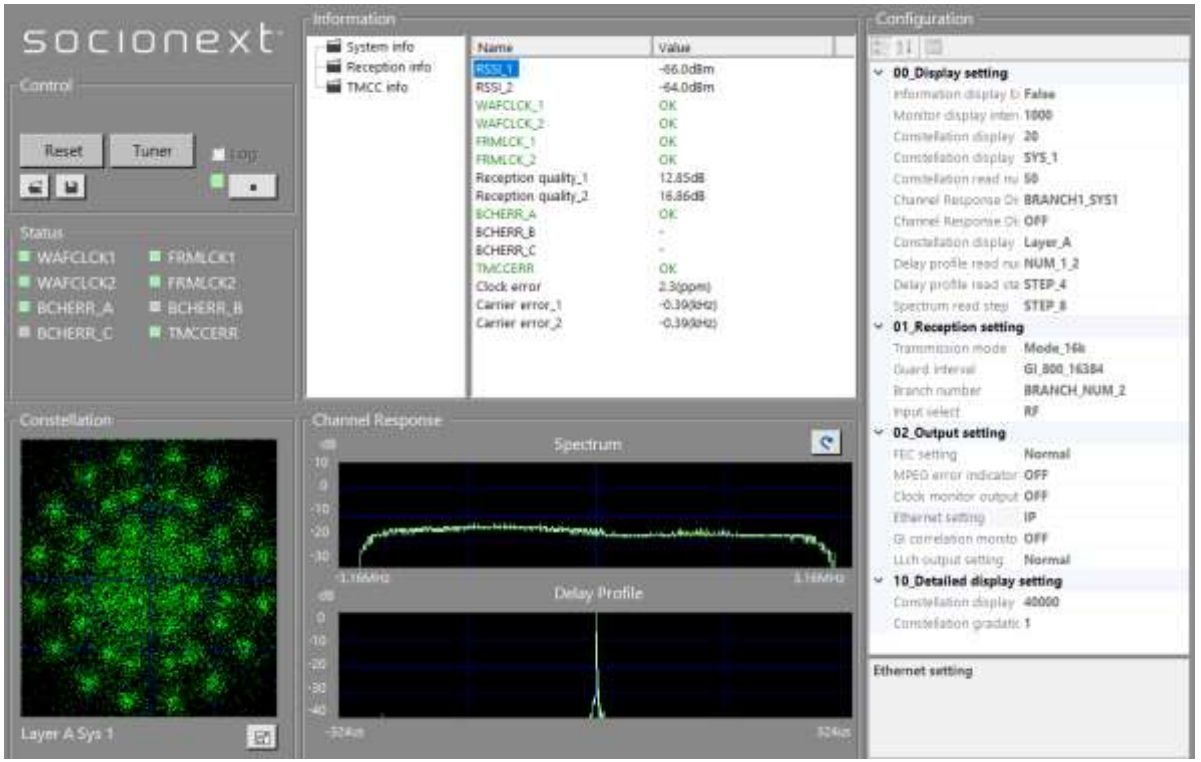


Figure 3.9 - Socionext Screen

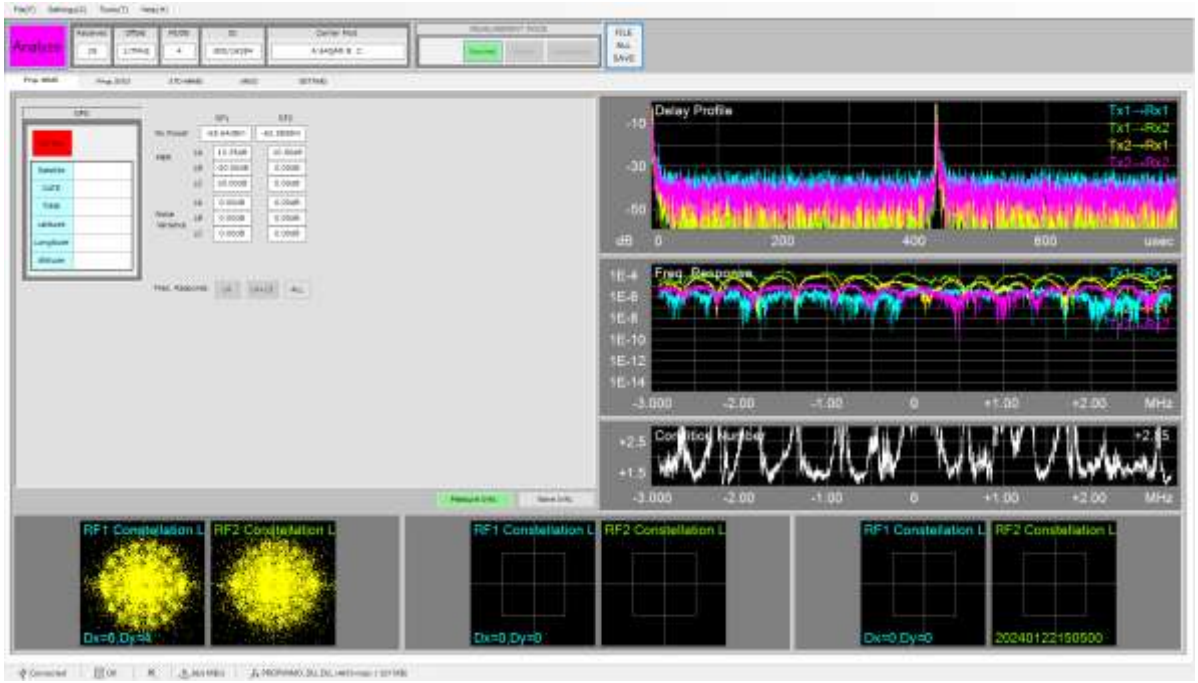


Figure 3.10 - Rintaro Screen

d) Reception Threshold

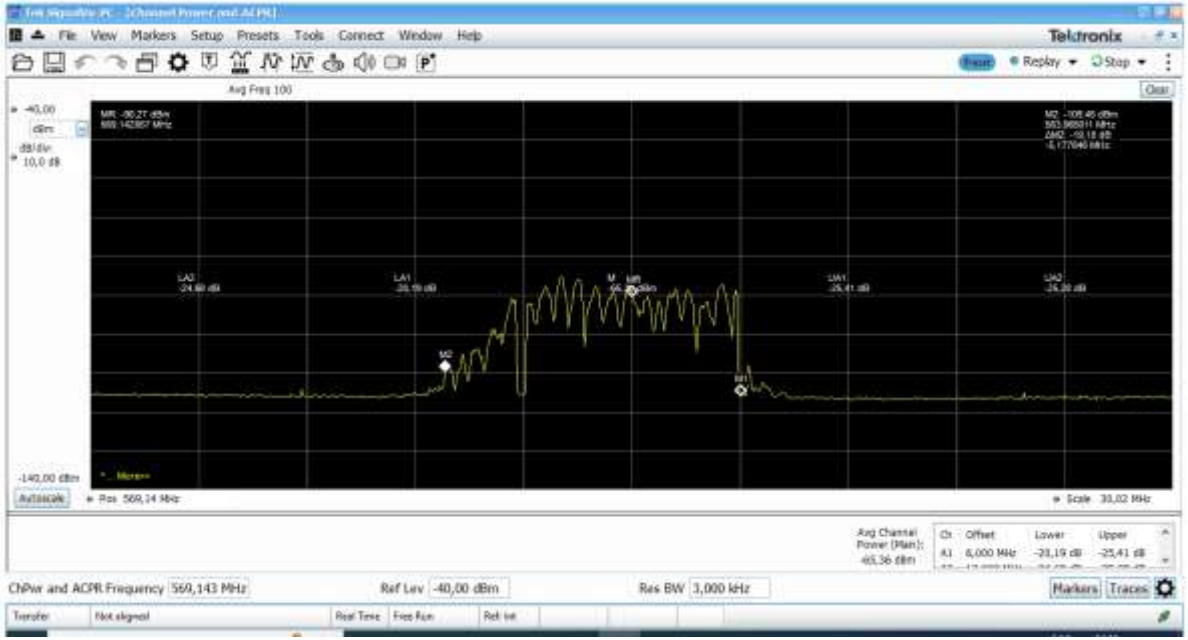


Figure 3.11 - Vertical

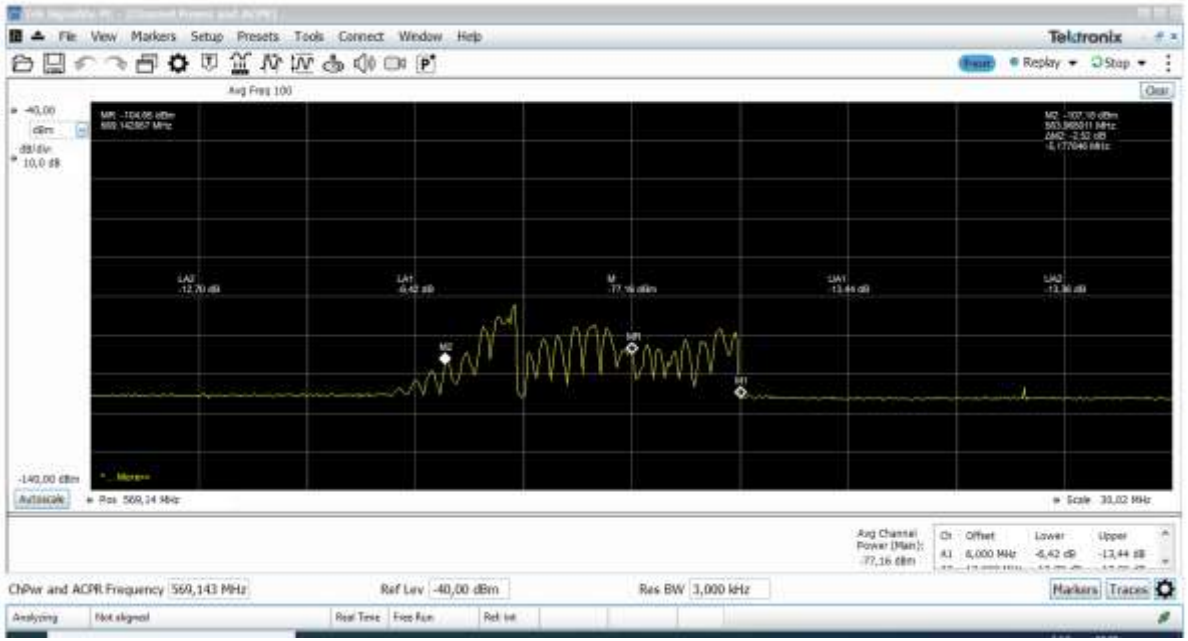


Figure 3.12 - Horizontal

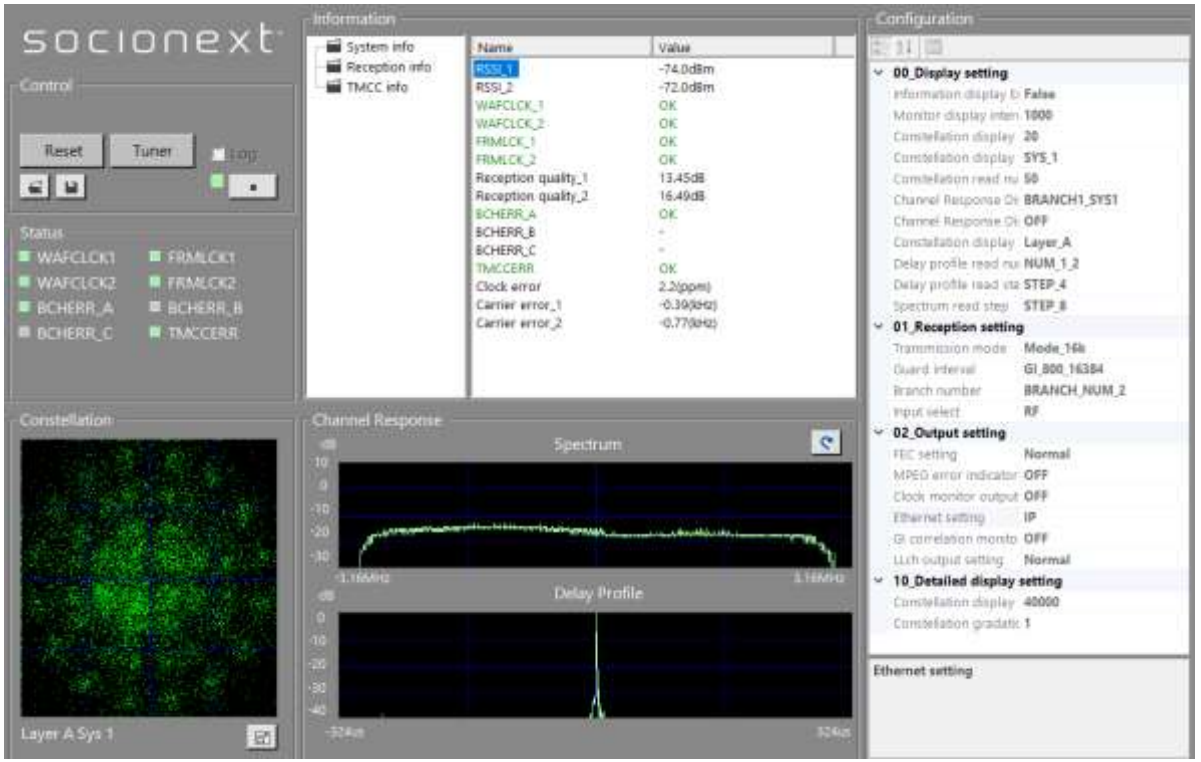


Figure 3.13 - Socionext Screen

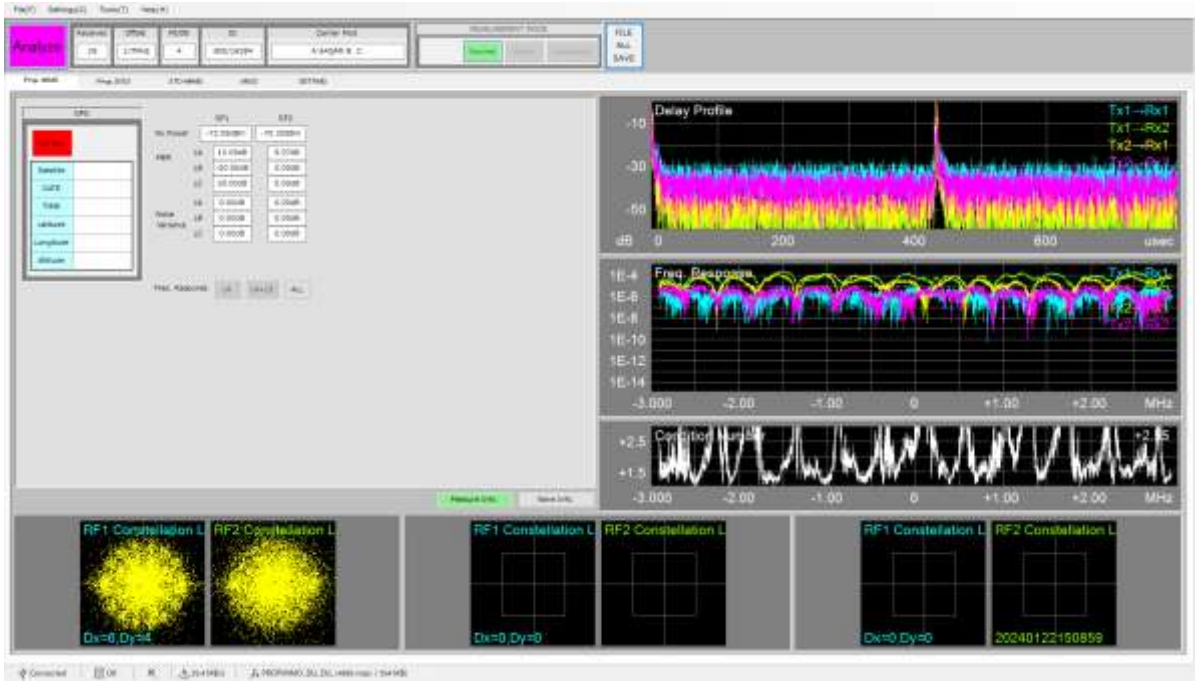


Figure 3.14 - Rintaro Screen

Chapter 4. Site 4

a) Channel Power

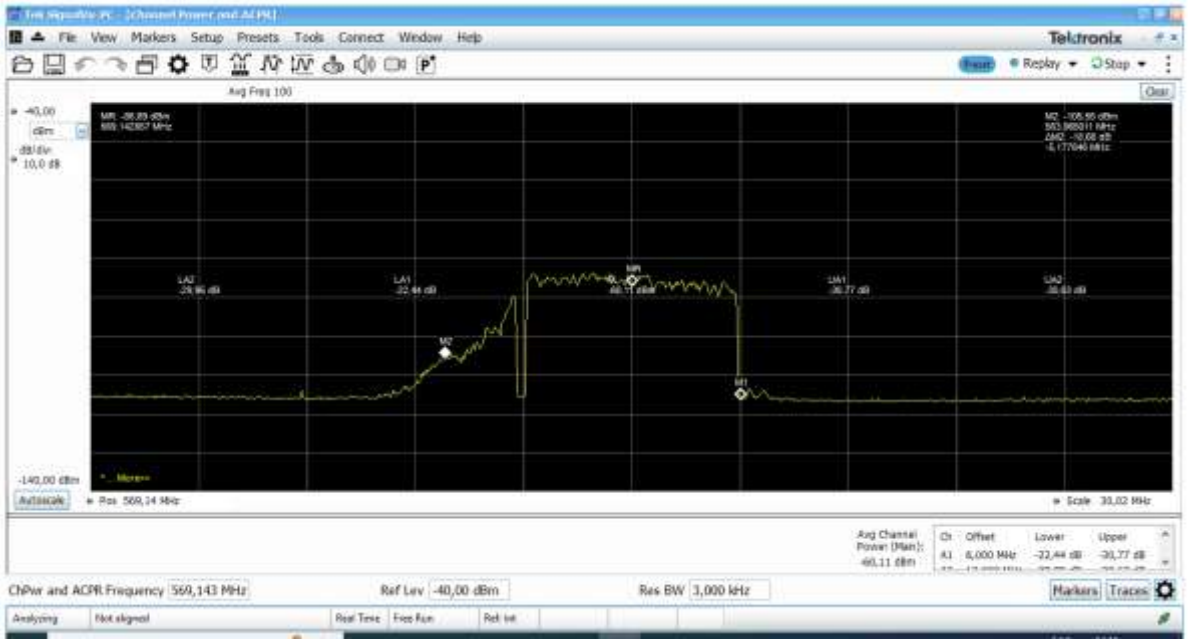


Figure 4.1 - Vertical

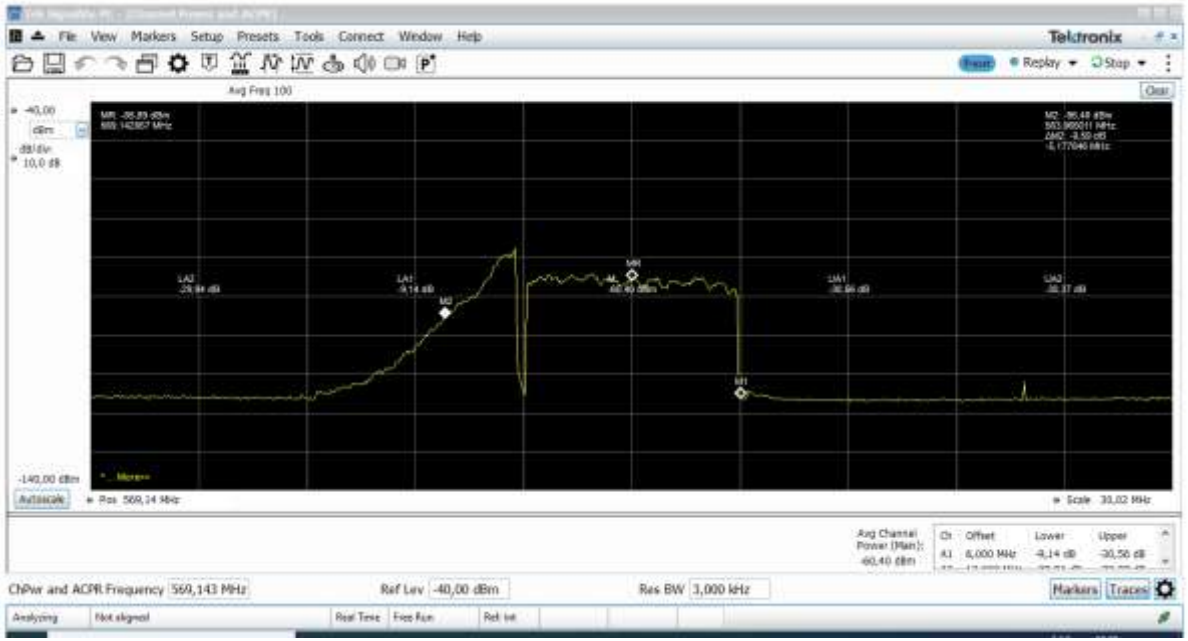


Figure 4.2 - Horizontal

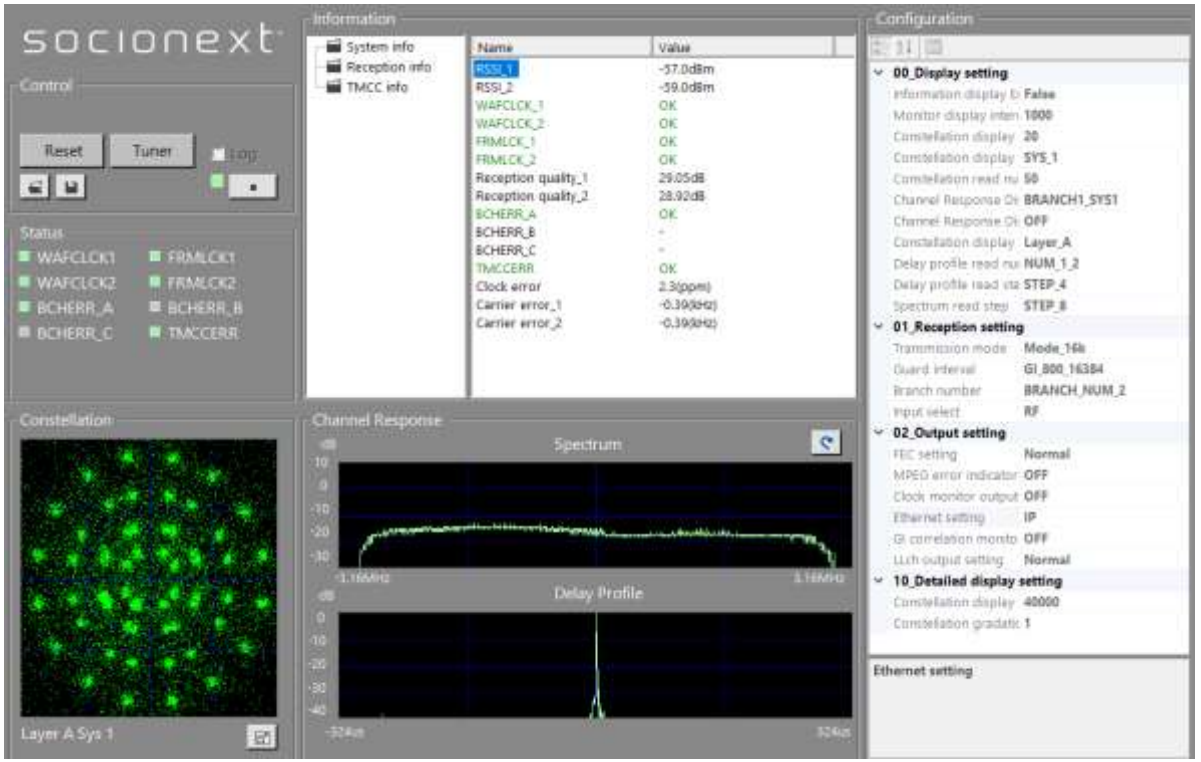


Figure 4.3 - Socionext Screen

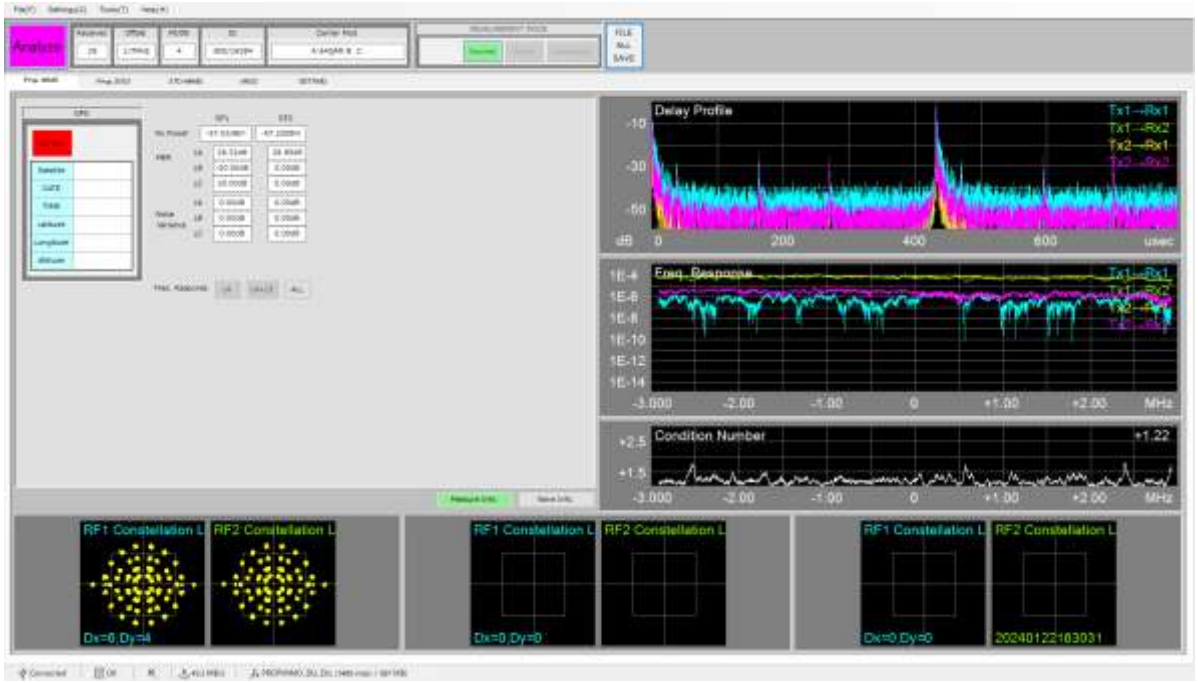


Figure 4.4 - Rintaro Screen

b) AWGN Power

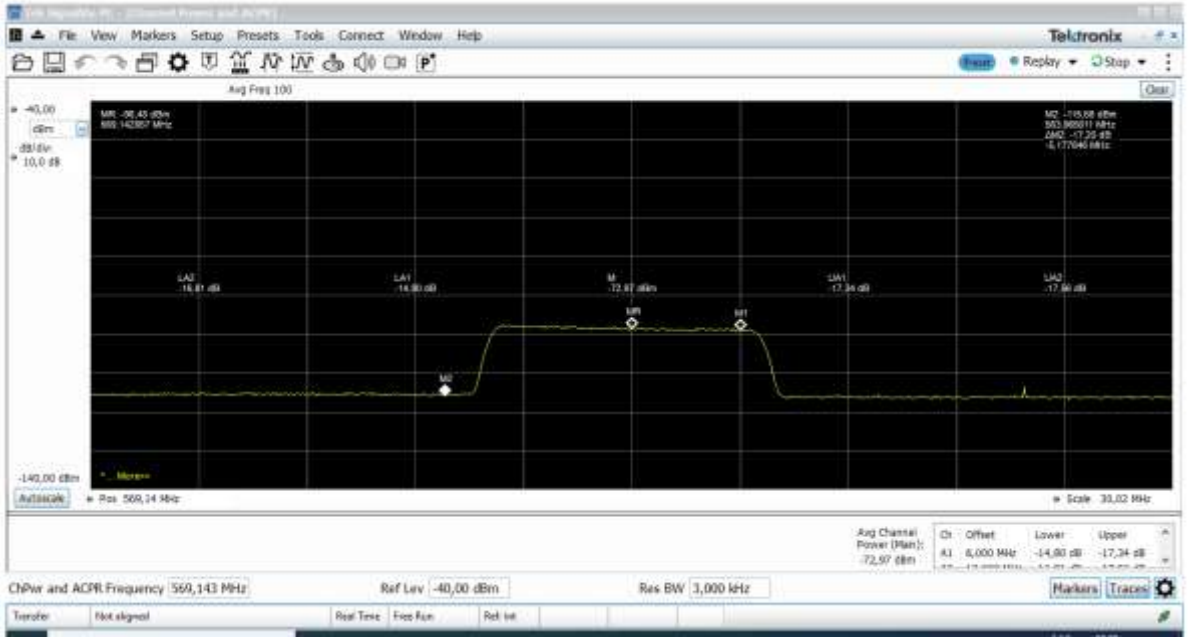


Figure 4.5 - Vertical

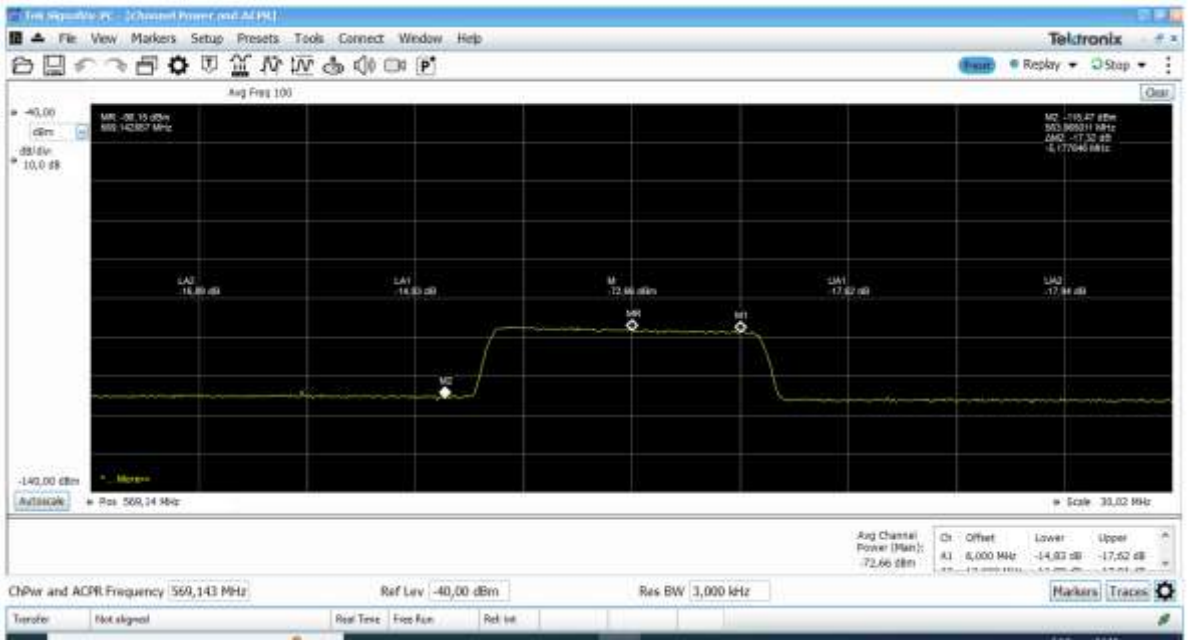


Figure 4.6 - Horizontal

c) C/N Threshold

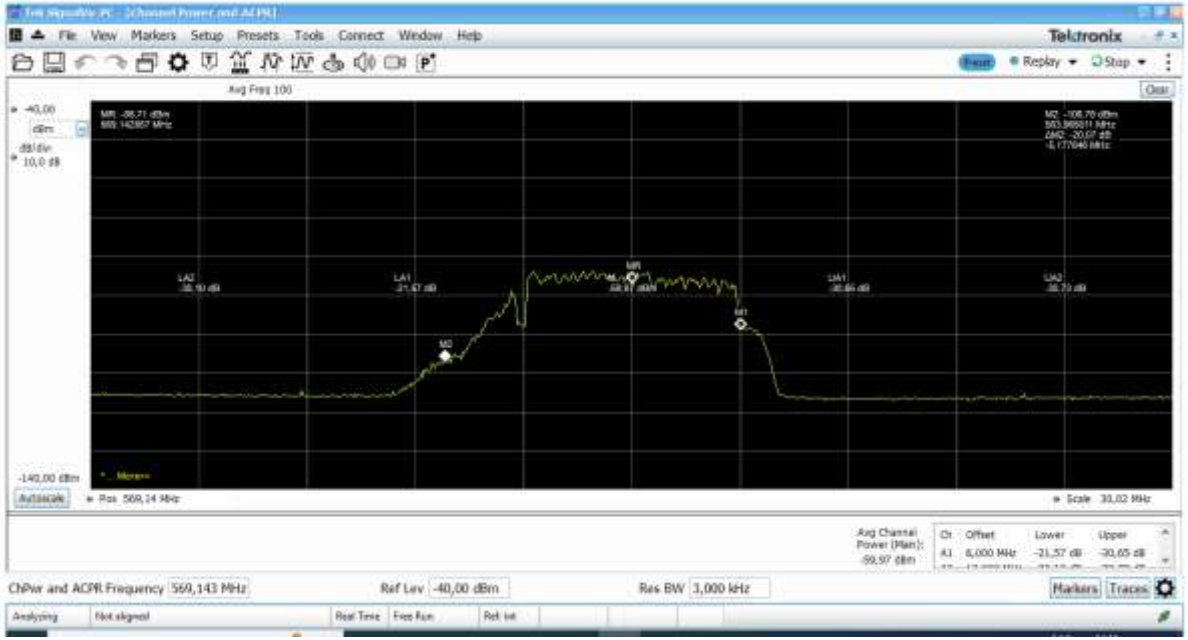


Figure 4.7 - Vertical

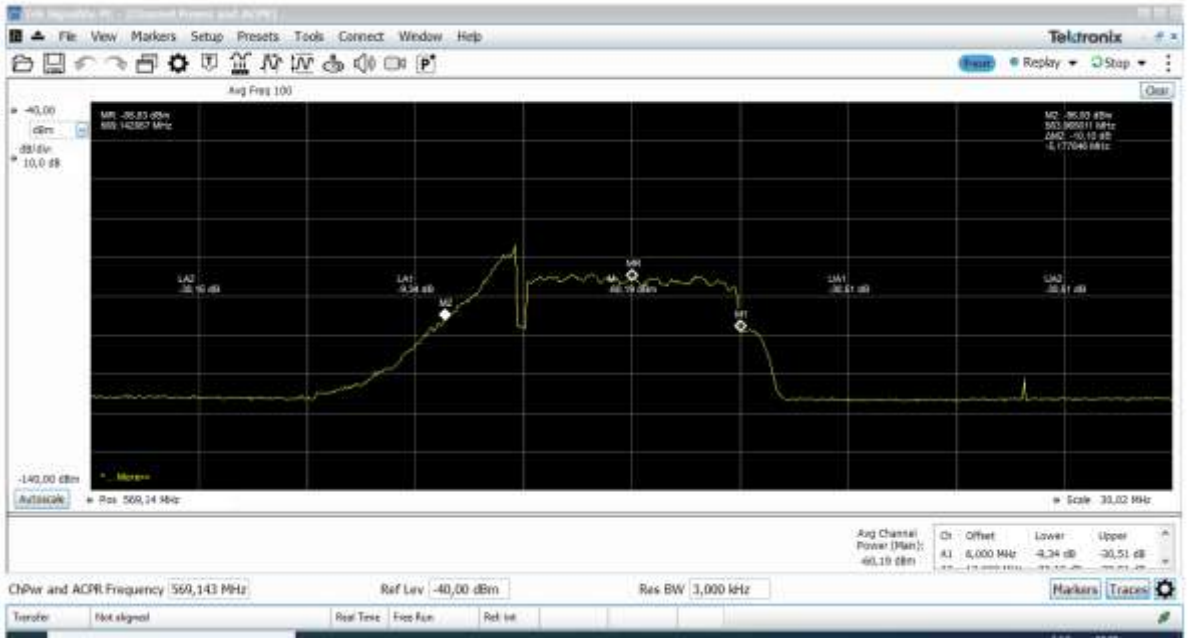


Figure 4.8 - Horizontal

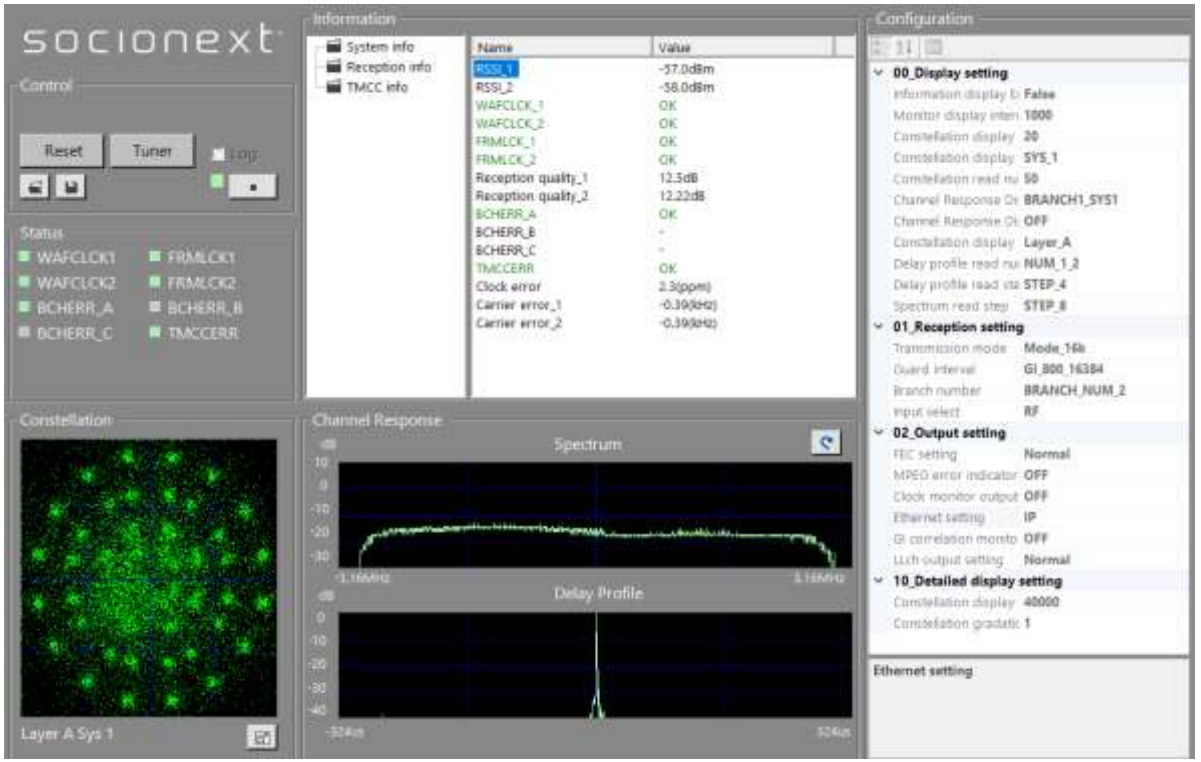


Figure 4.9 - Socionext Screen

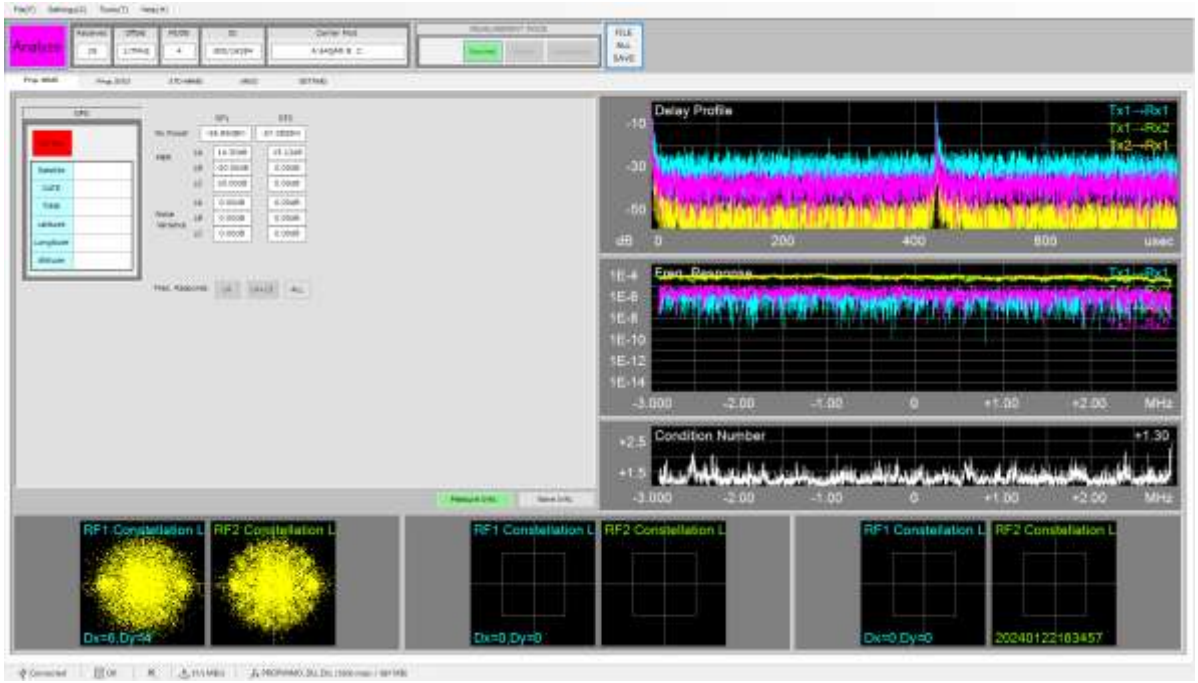


Figure 4.10 - Rintaro Screen

d) Reception Threshold

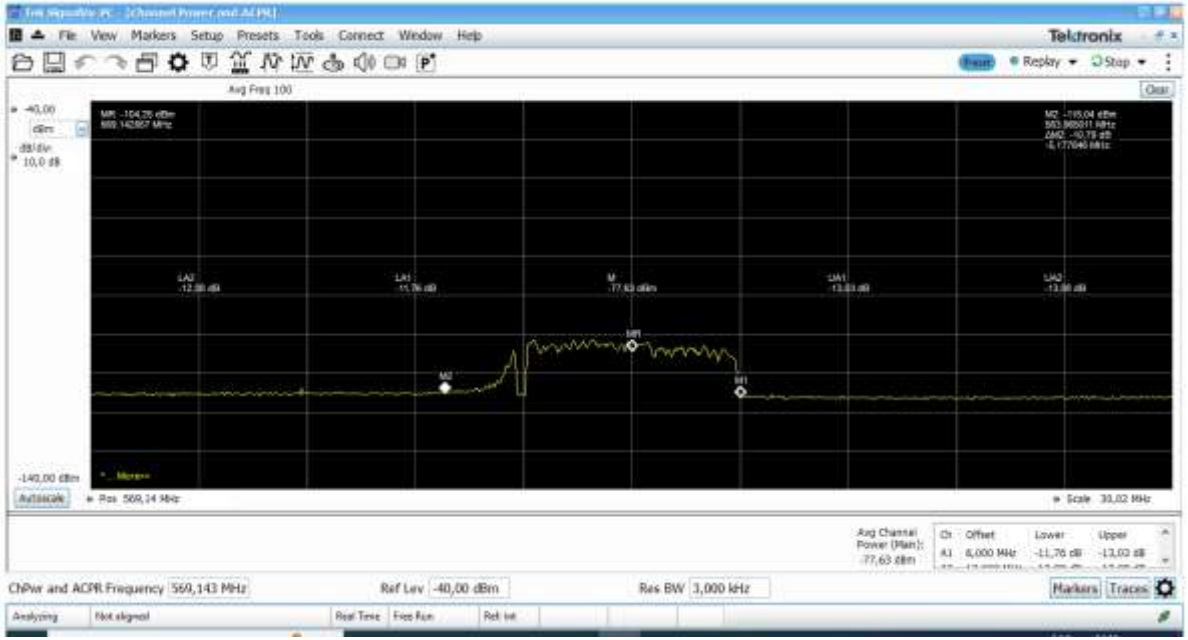


Figure 4.11 - Vertical

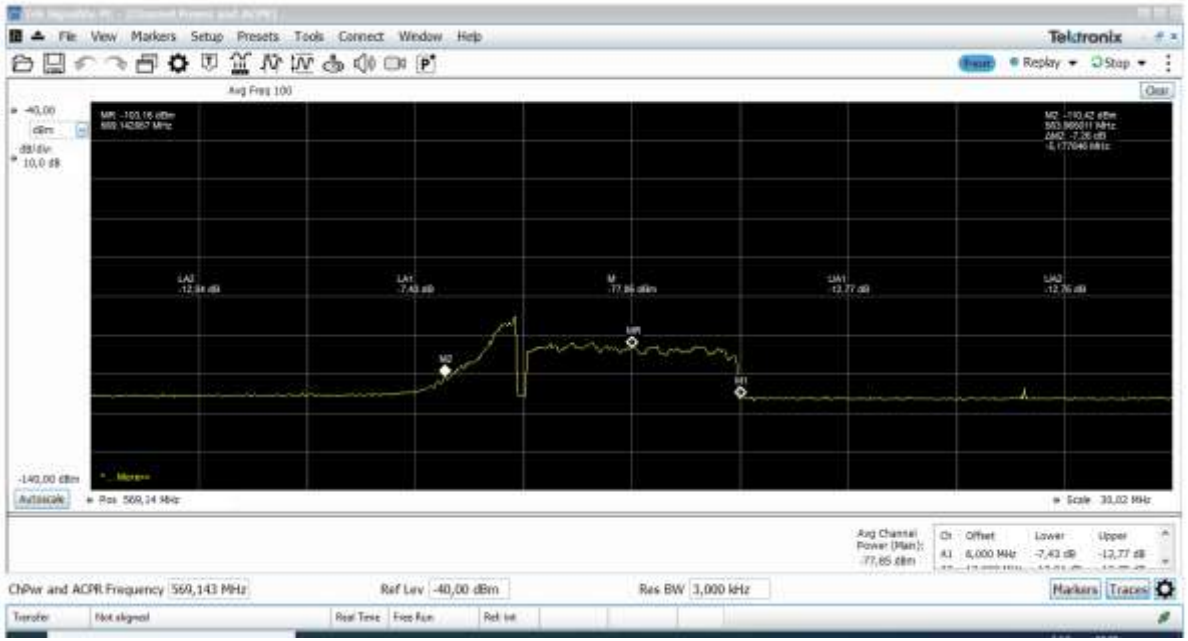


Figure 4.12 - Horizontal

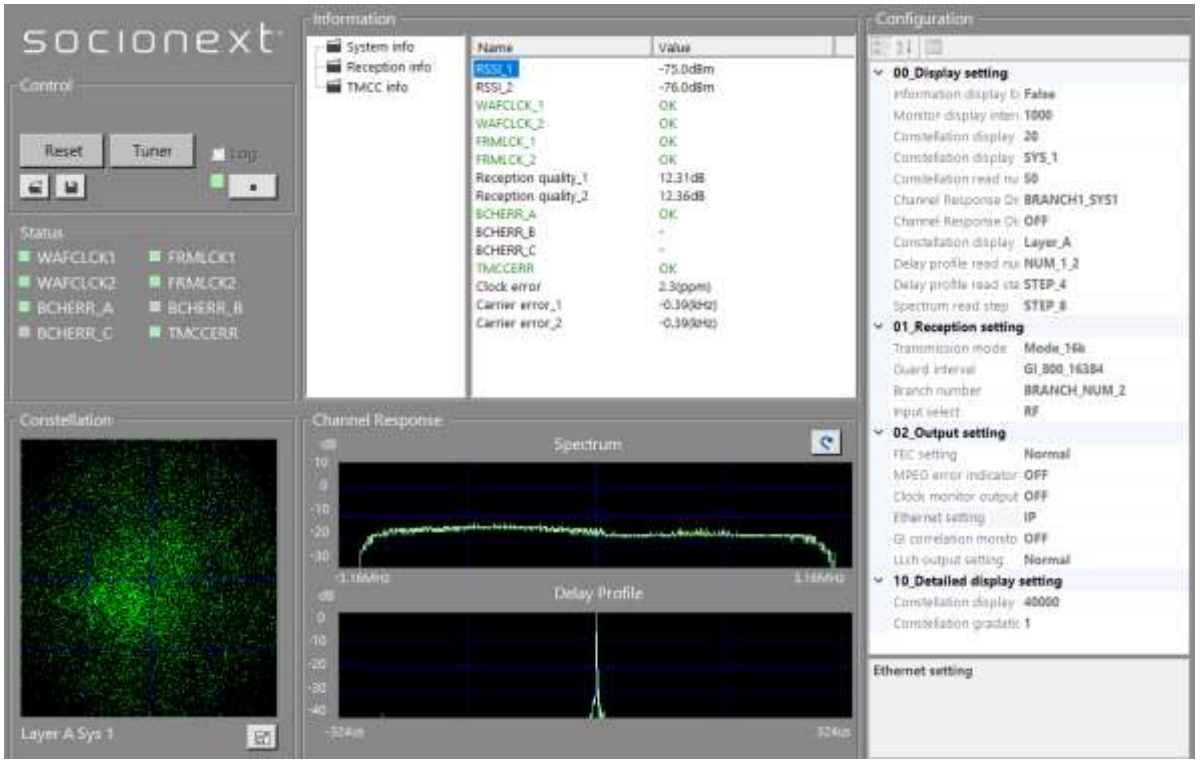


Figure 4.13 - Socionext Screen

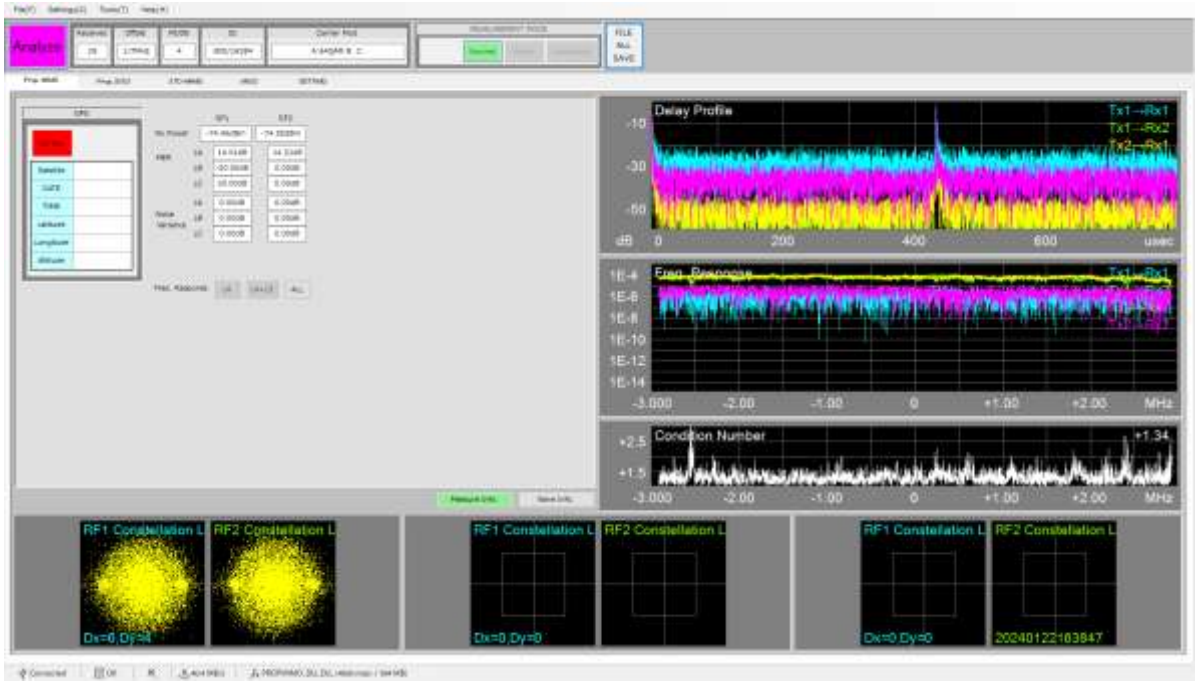


Figure 4.14 - Rintaro Screen

Chapter 5. Site 5

a) Channel Power

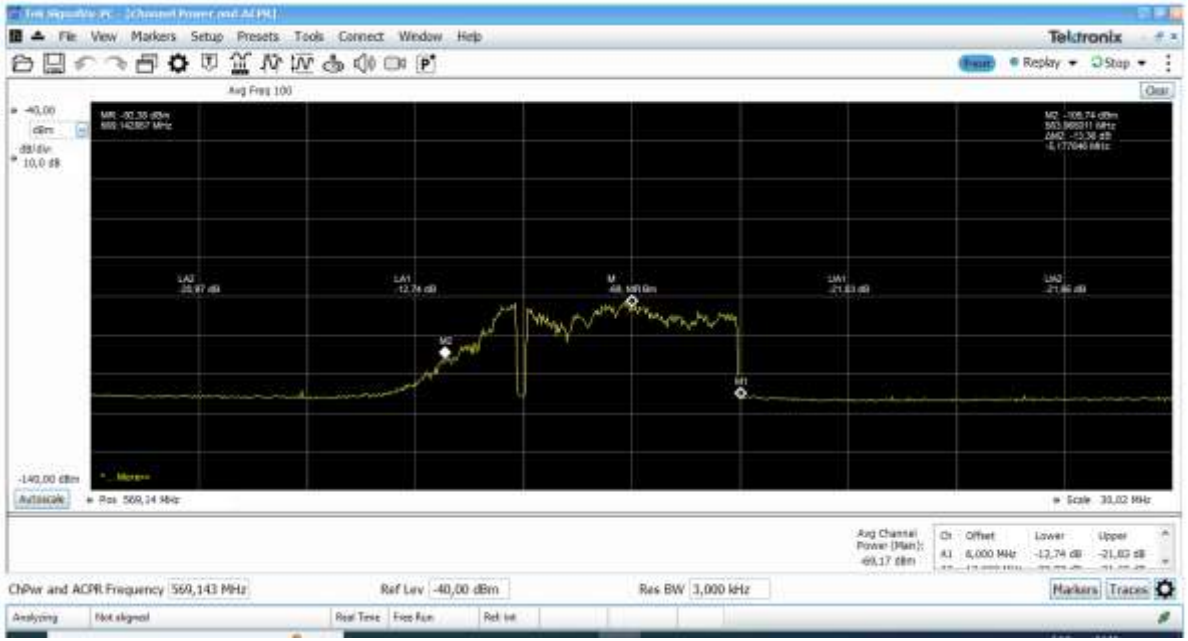


Figure 5.1 - Vertical

Figure 5.2 - Horizontal

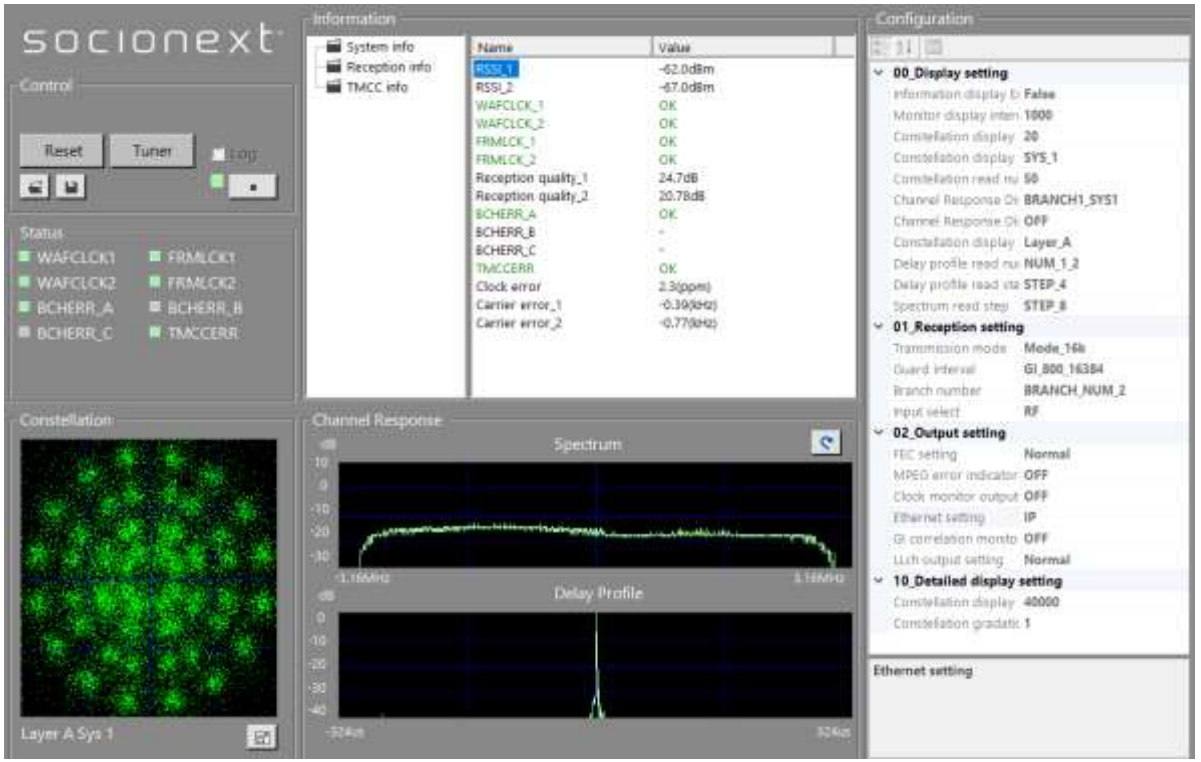


Figure 5.3 - Socionext Screen

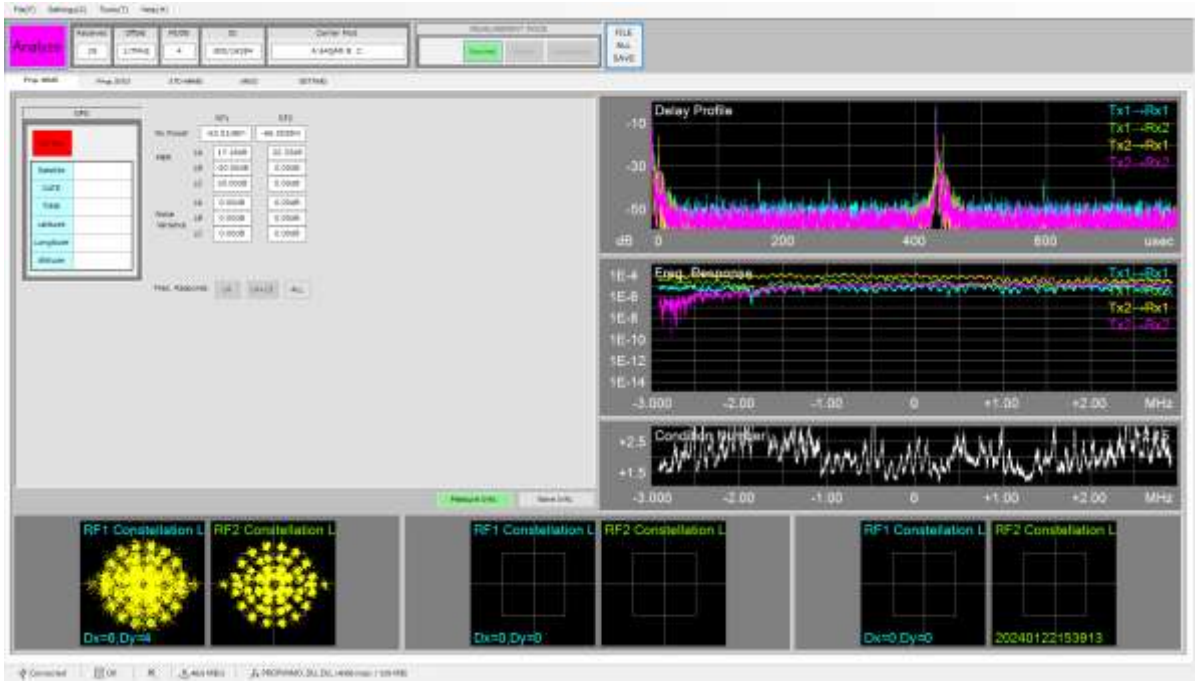


Figure 5.4 - Rintaro Screen

b) AWGN Power

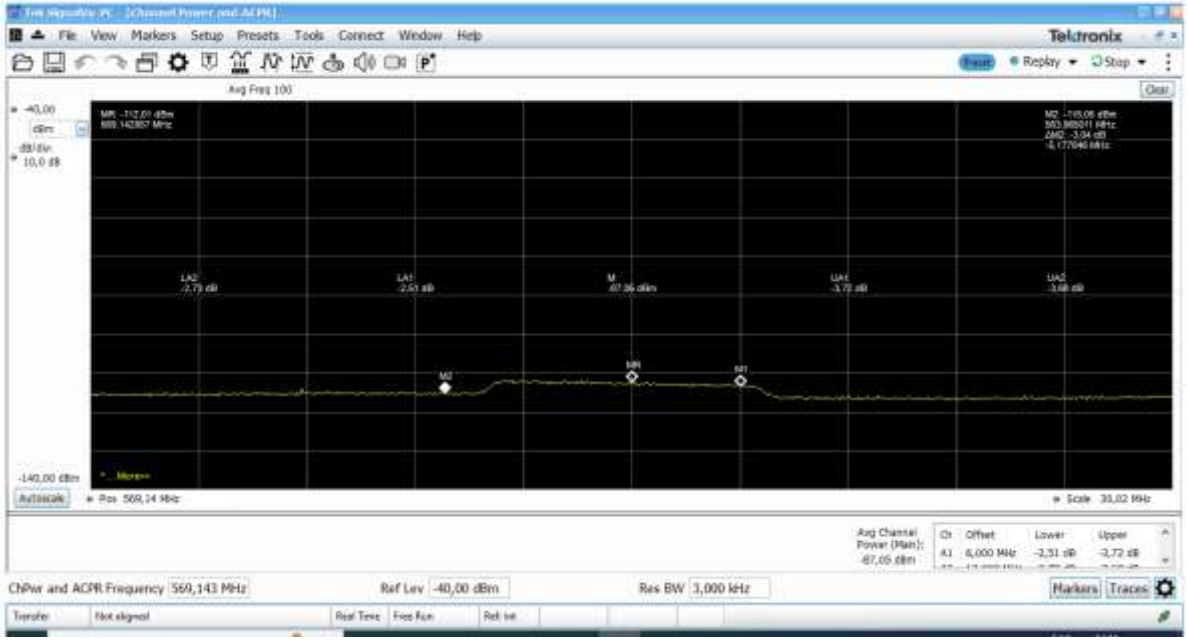


Figure 5.5 - Vertical

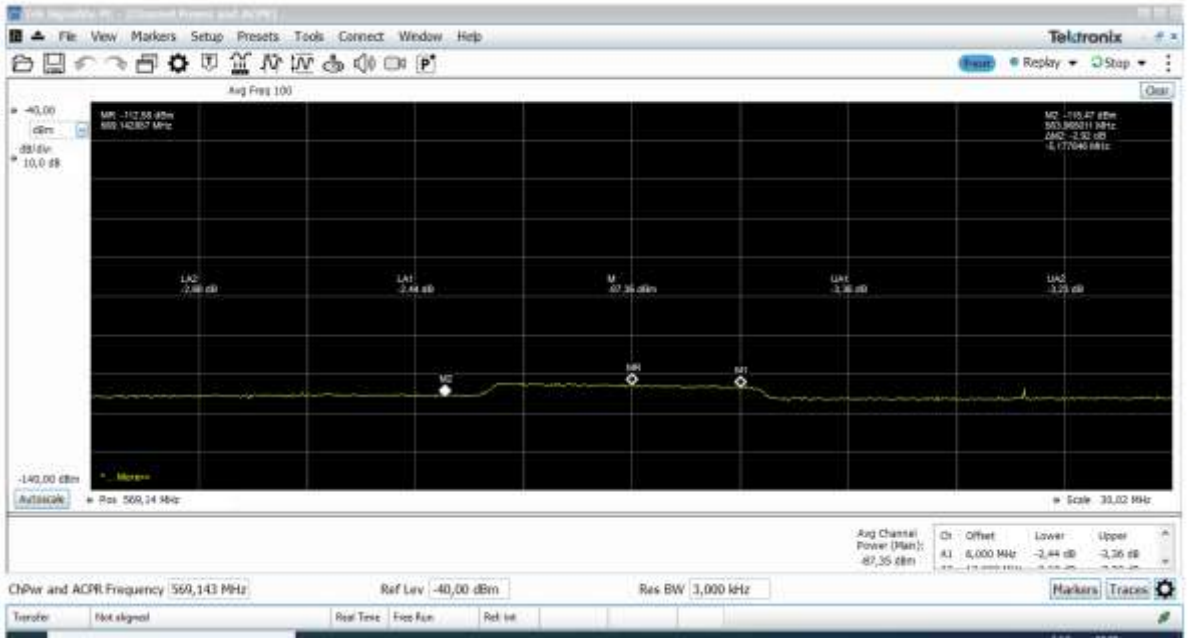


Figure 5.6 - Horizontal

c) C/N Threshold

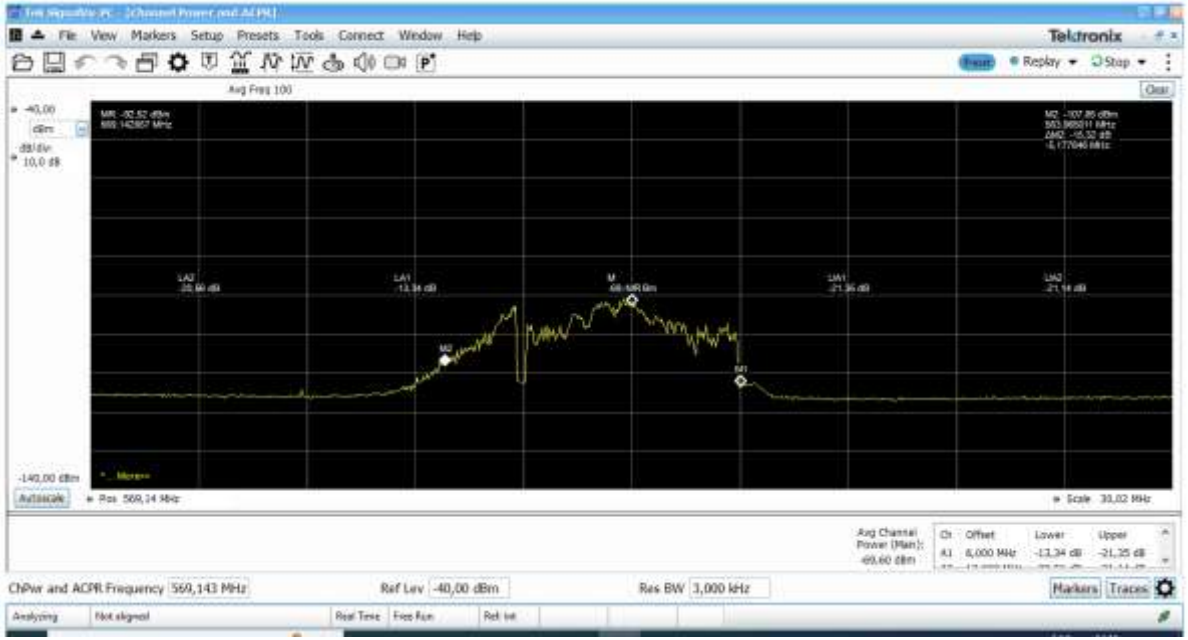


Figure 5.7 - Vertical

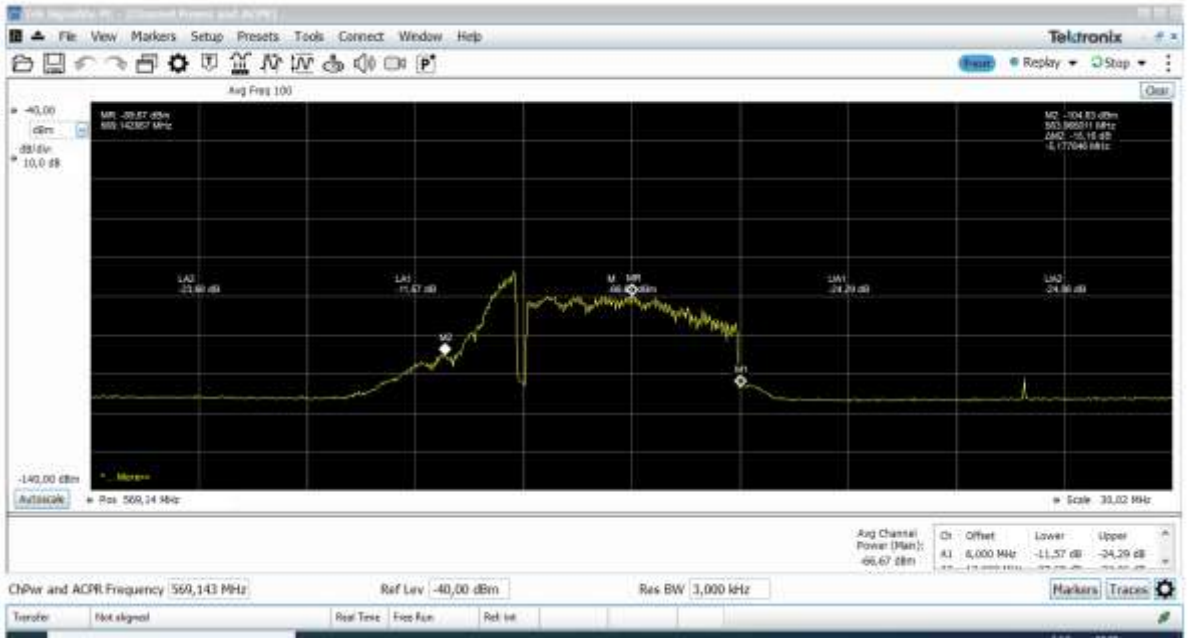


Figure 5.8 - Horizontal

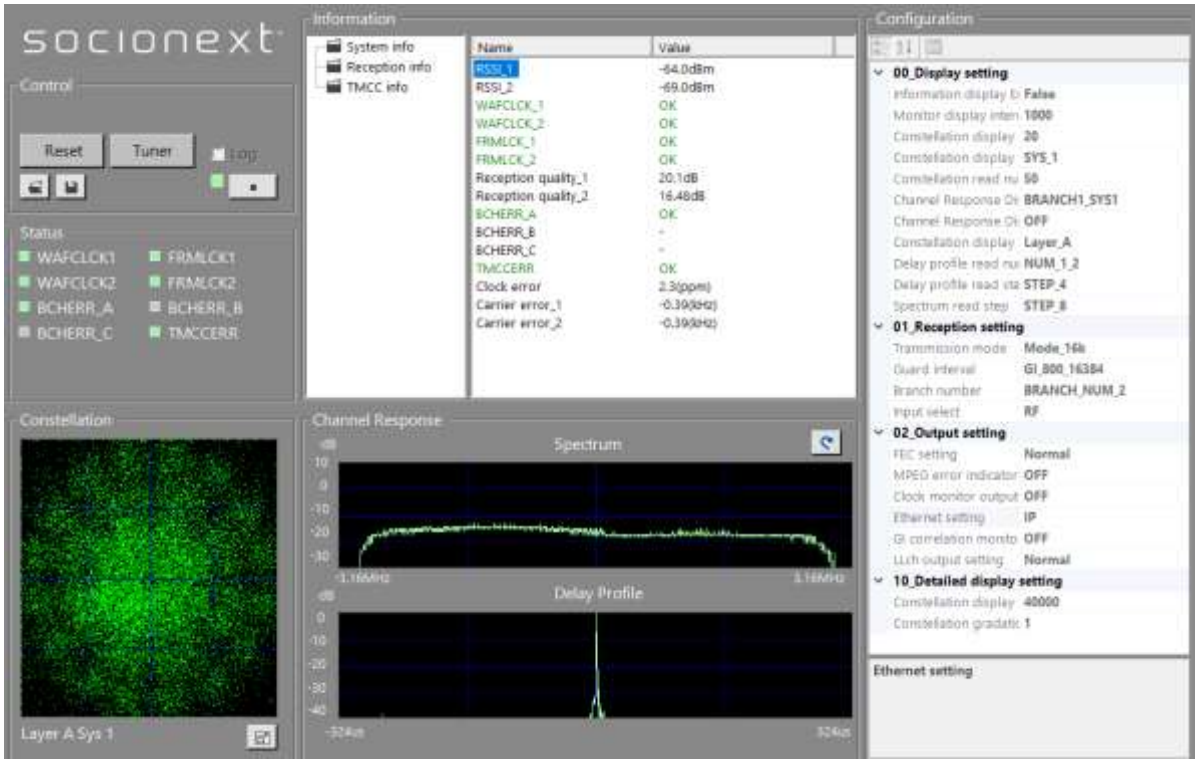


Figure 5.9 - Socionext Screen

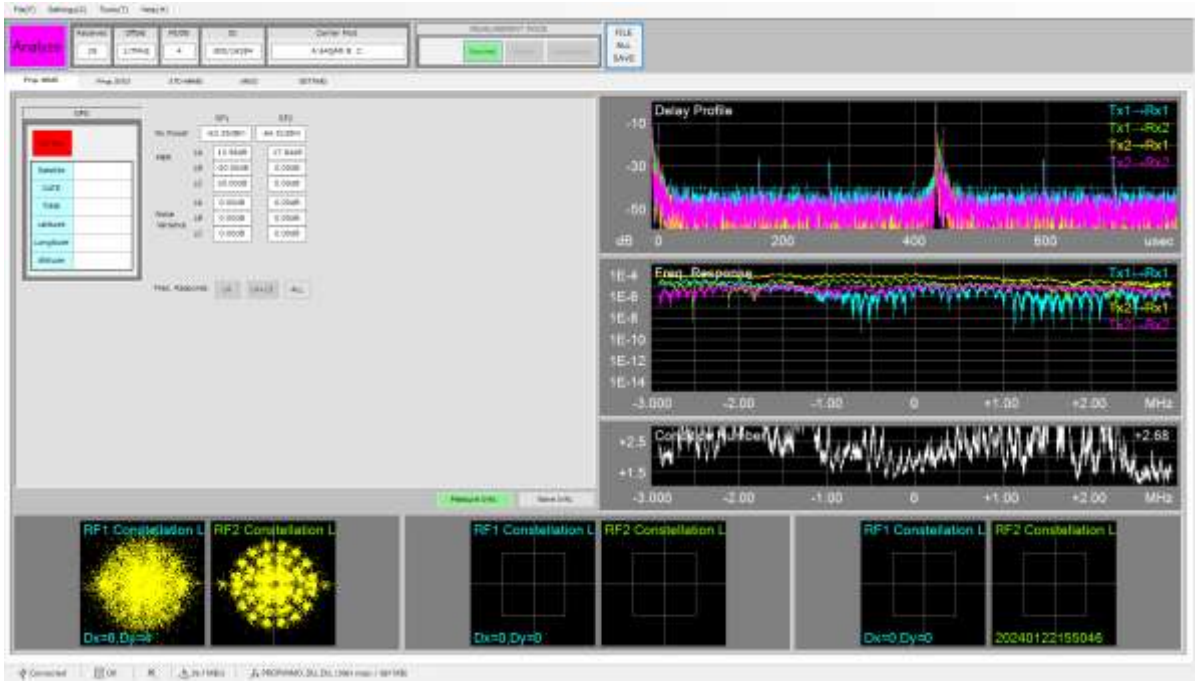


Figure 5.10 - Rintaro Screen

d) Reception Threshold

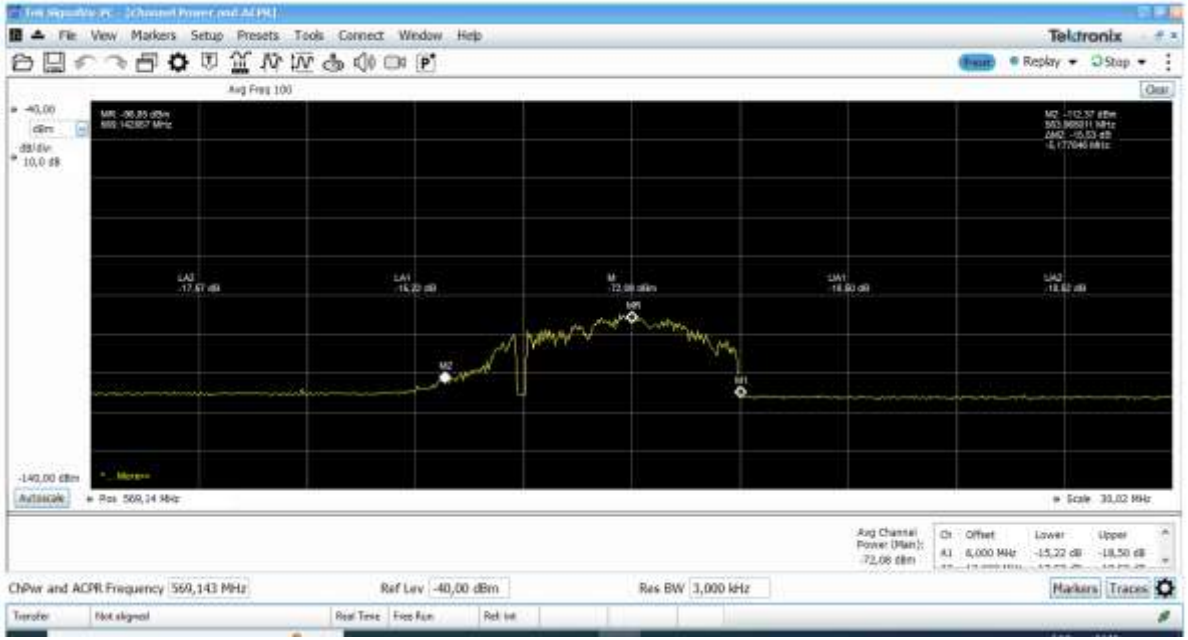


Figure 5.11 - Vertical

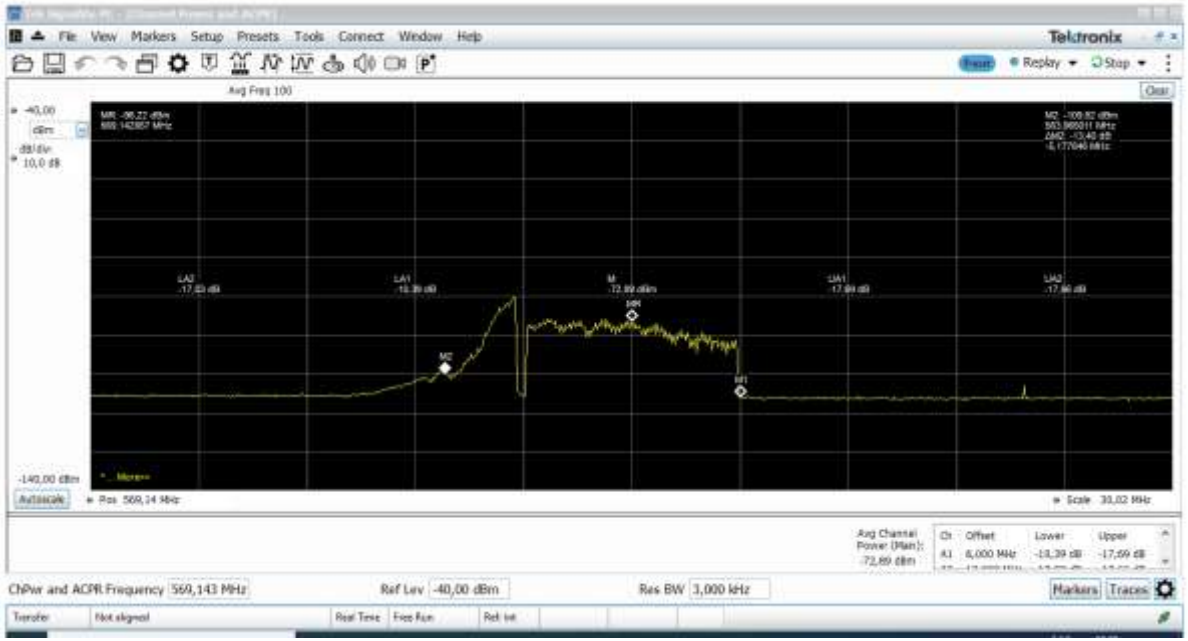


Figure 5.12 - Horizontal

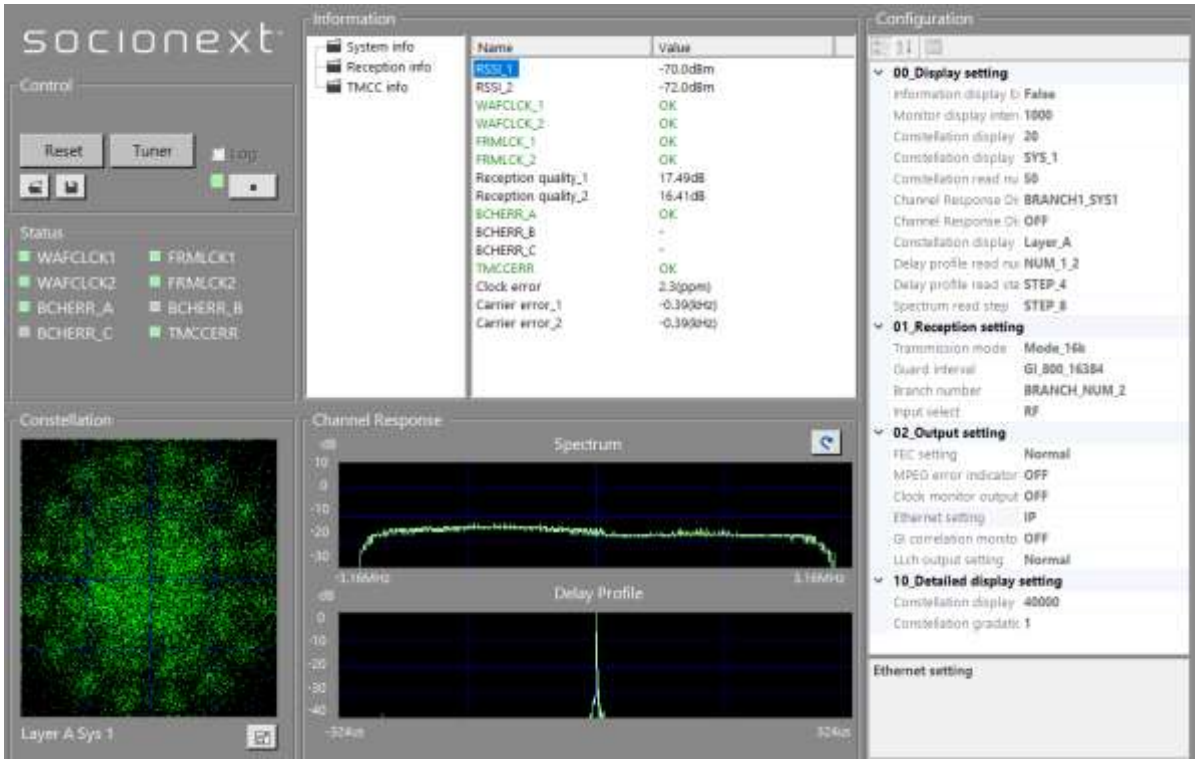


Figure 5.13 - Socionext Screen

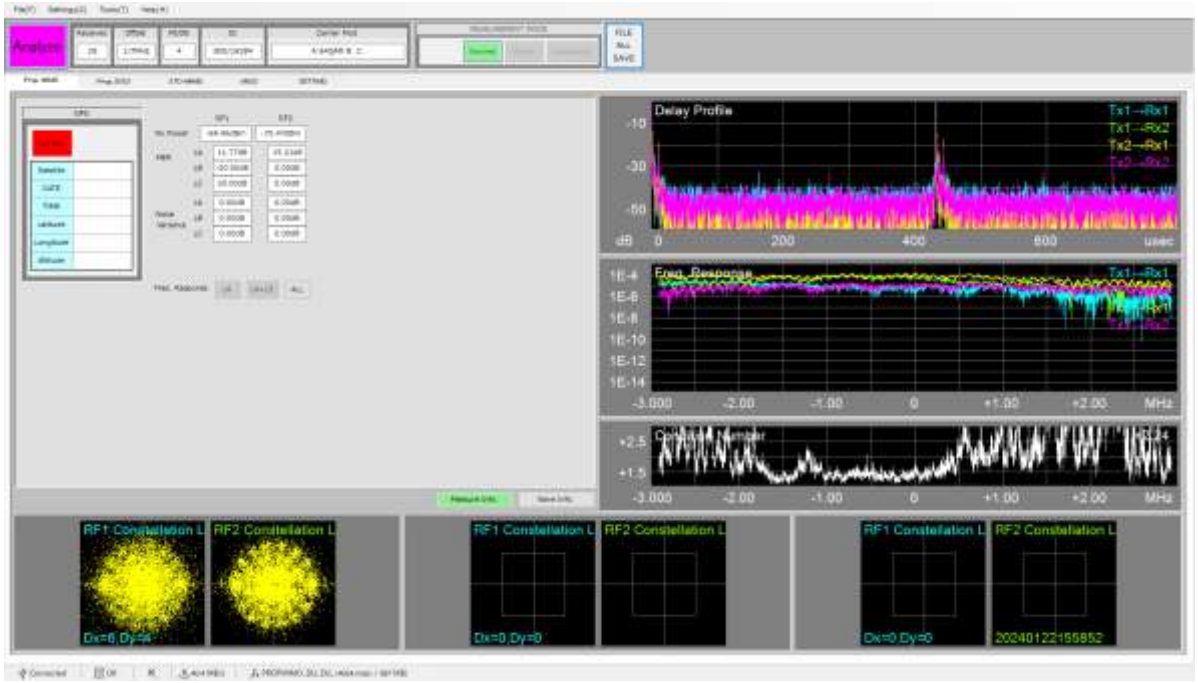


Figure 5.14 - Rintaro Screen

Chapter 6. Site 6

a) Channel Power

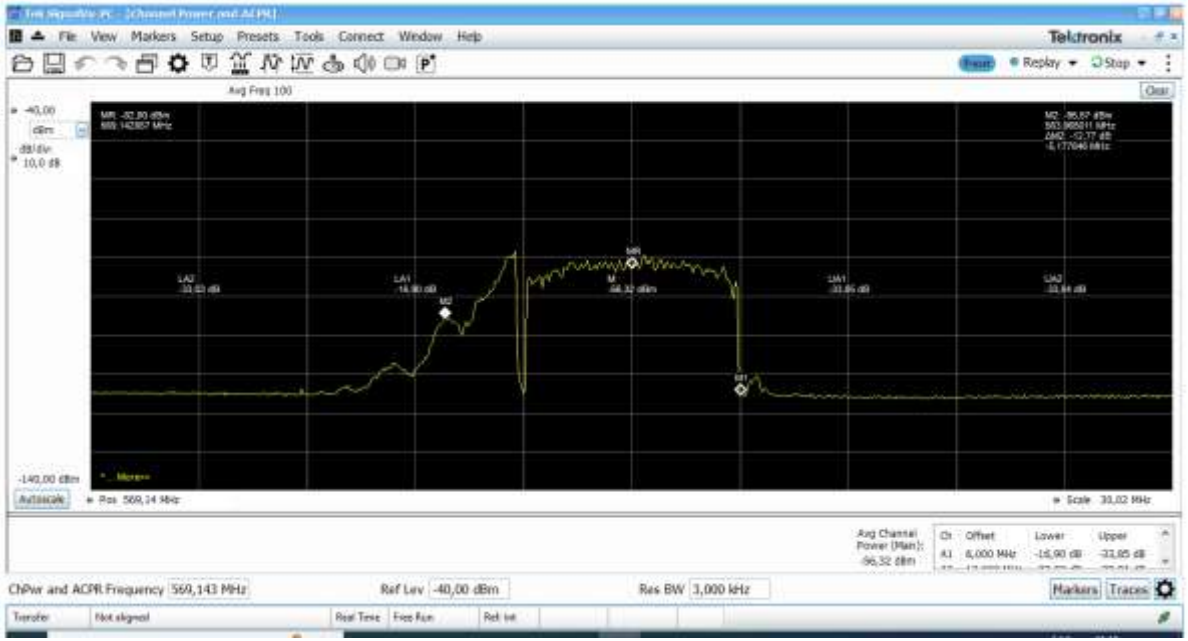


Figure 6.1 - Vertical

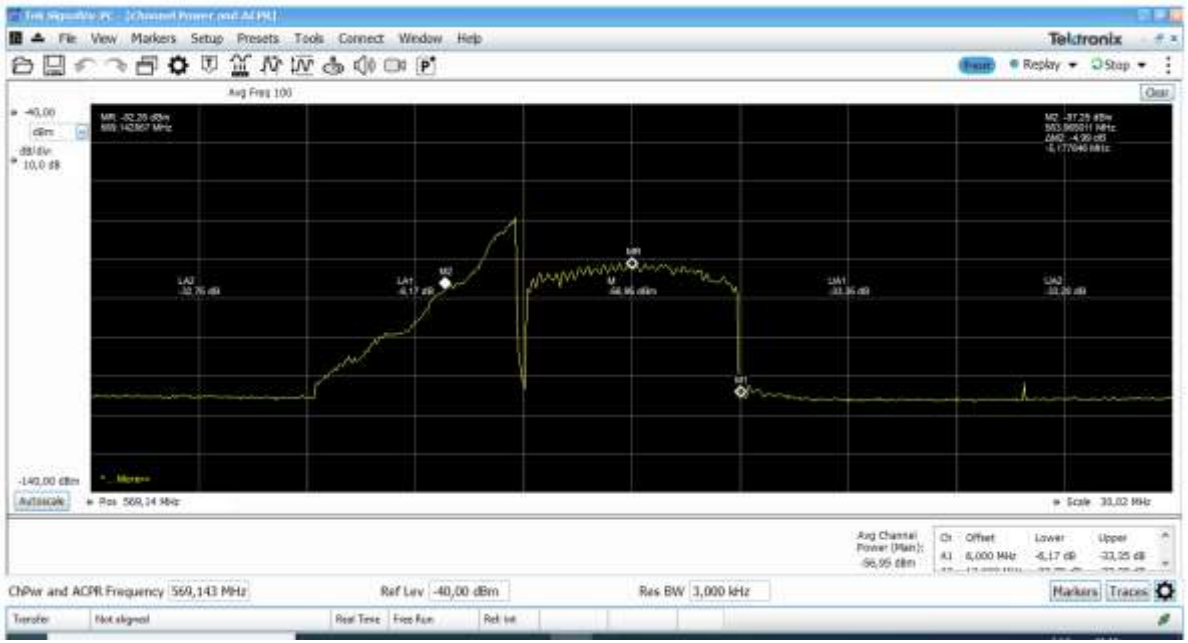


Figure 6.2 - Horizontal

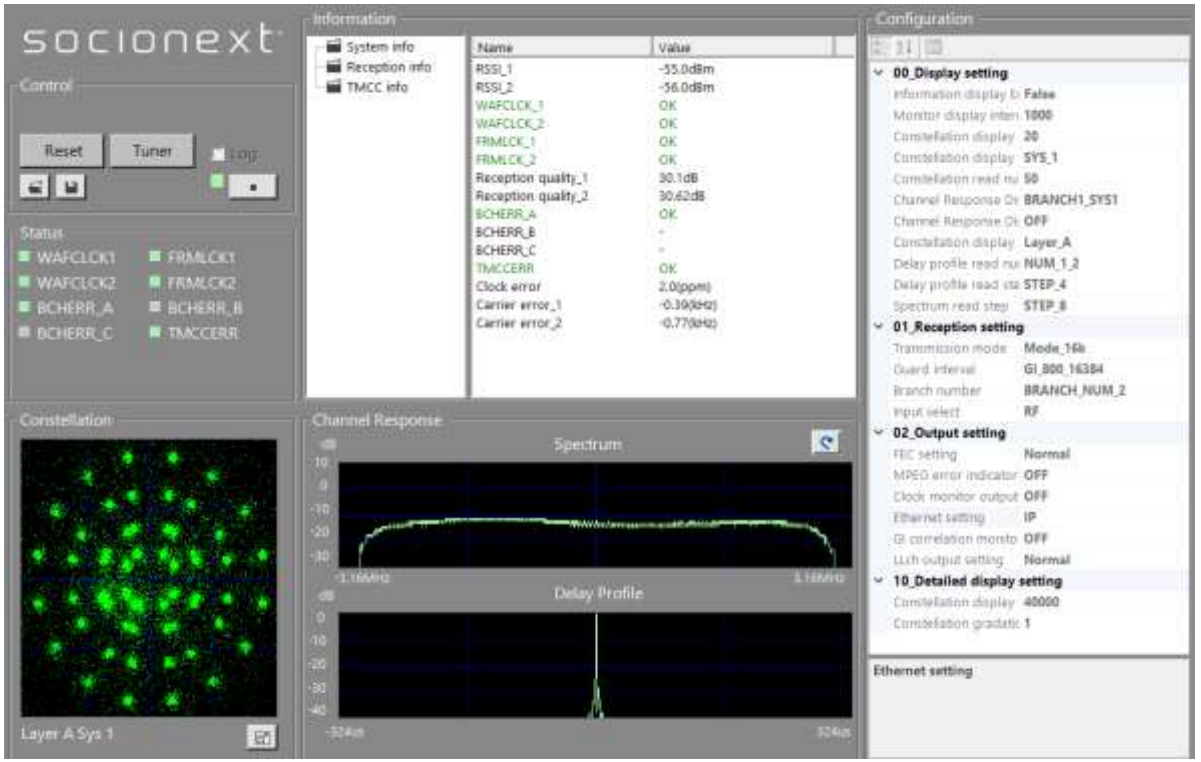


Figure 6.3 - Socionext Screen

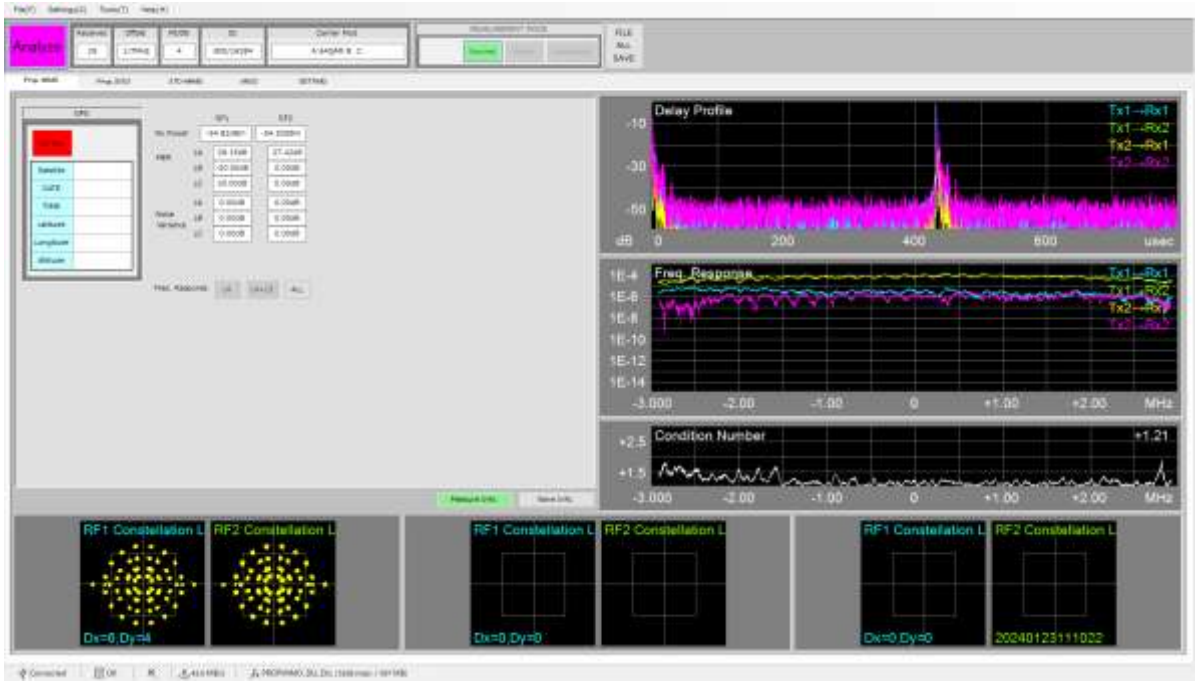


Figure 6.4 - Rintaro Screen

b) AWGN Power

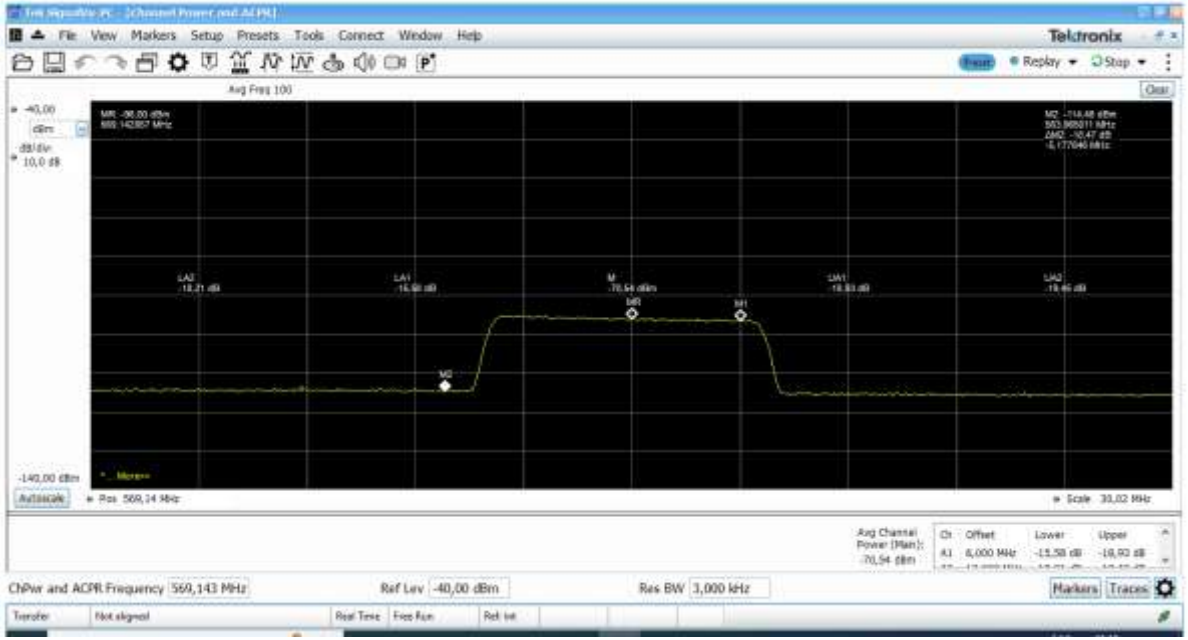


Figure 6.5 - Vertical

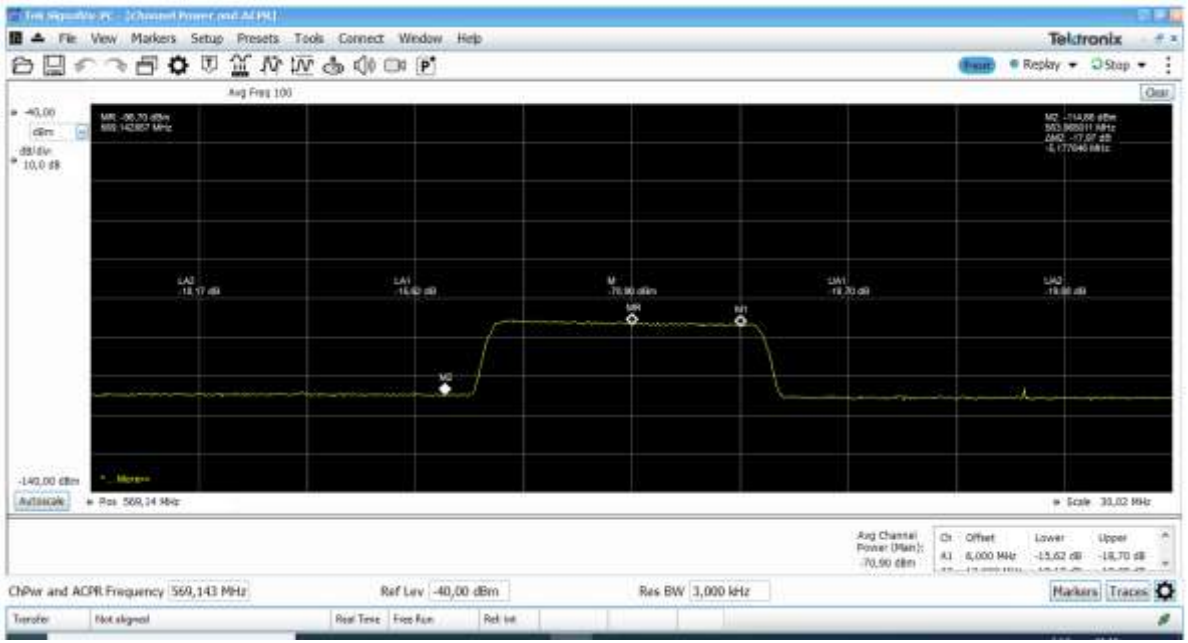


Figure 6.6 - Horizontal

c) C/N Threshold

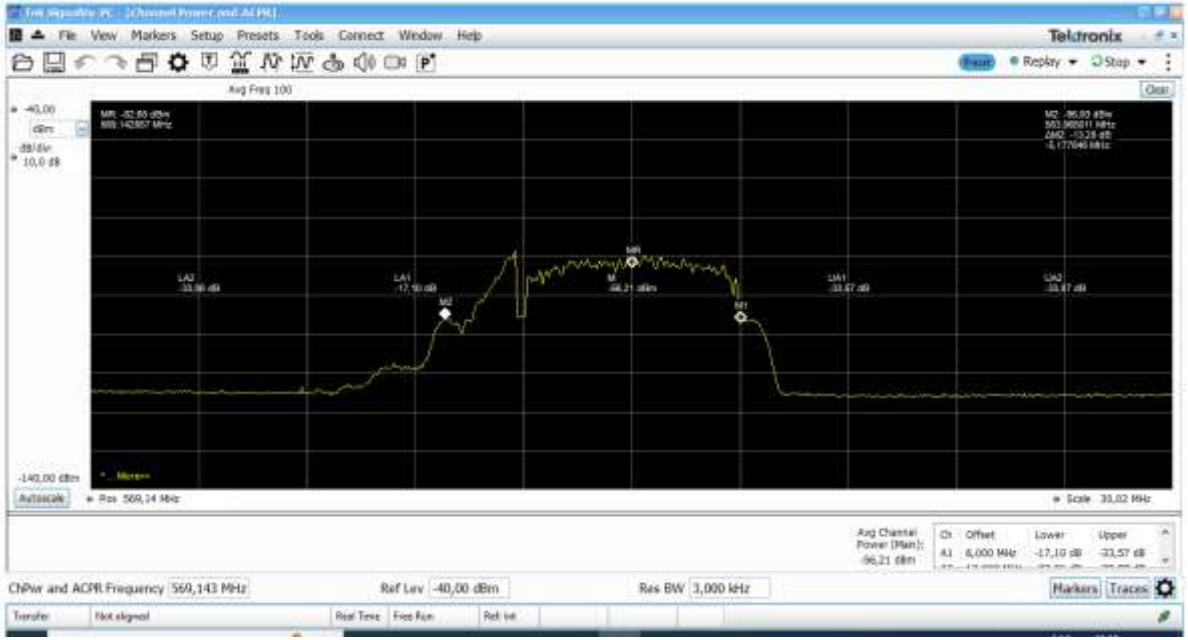


Figure 6.7 - Vertical

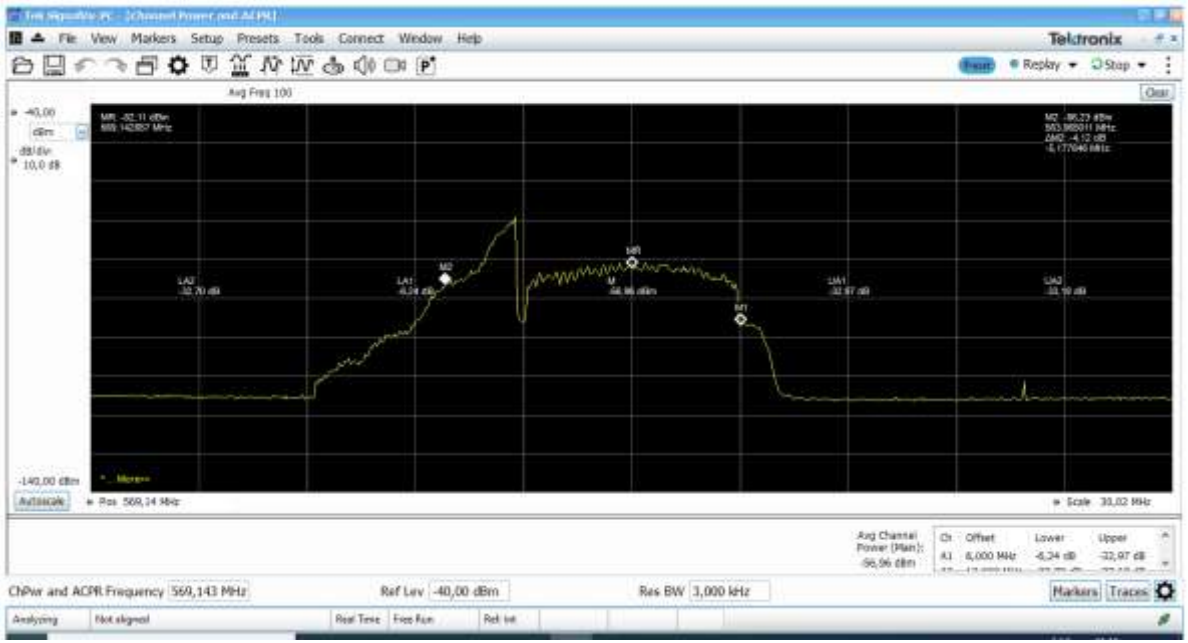


Figure 6.8 - Horizontal

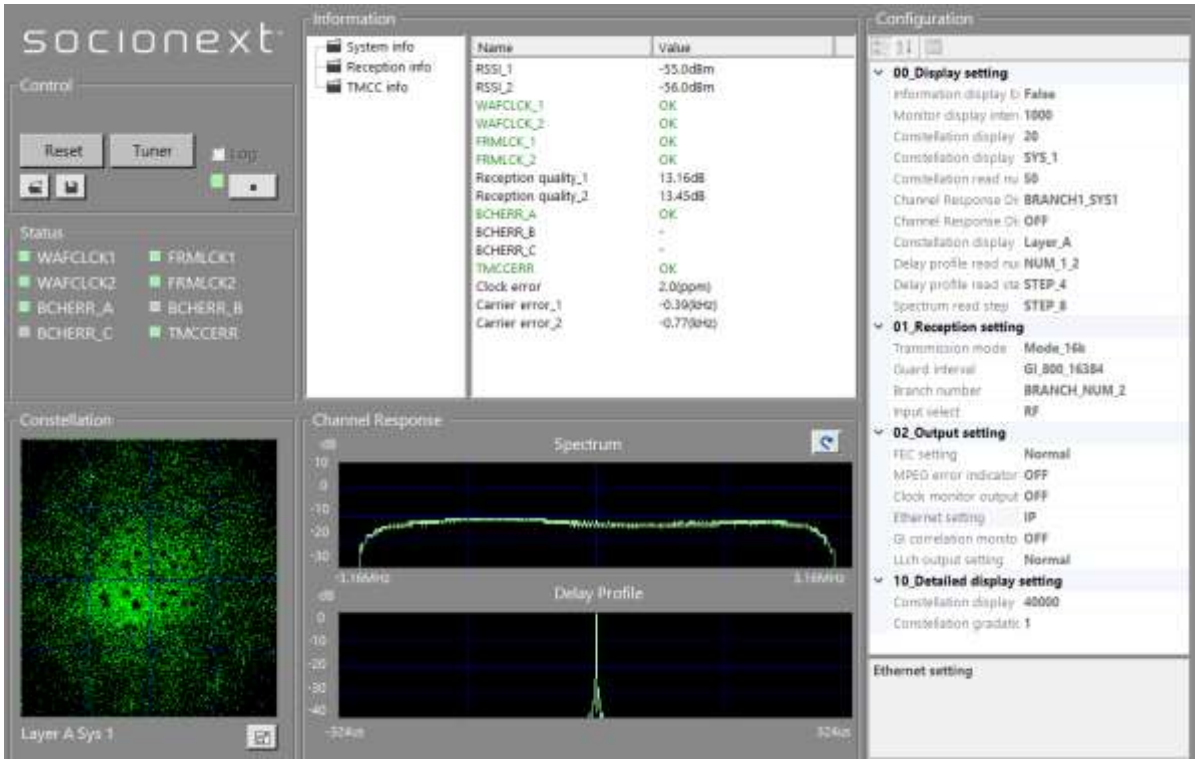


Figure 6.9 - Socionext Screen

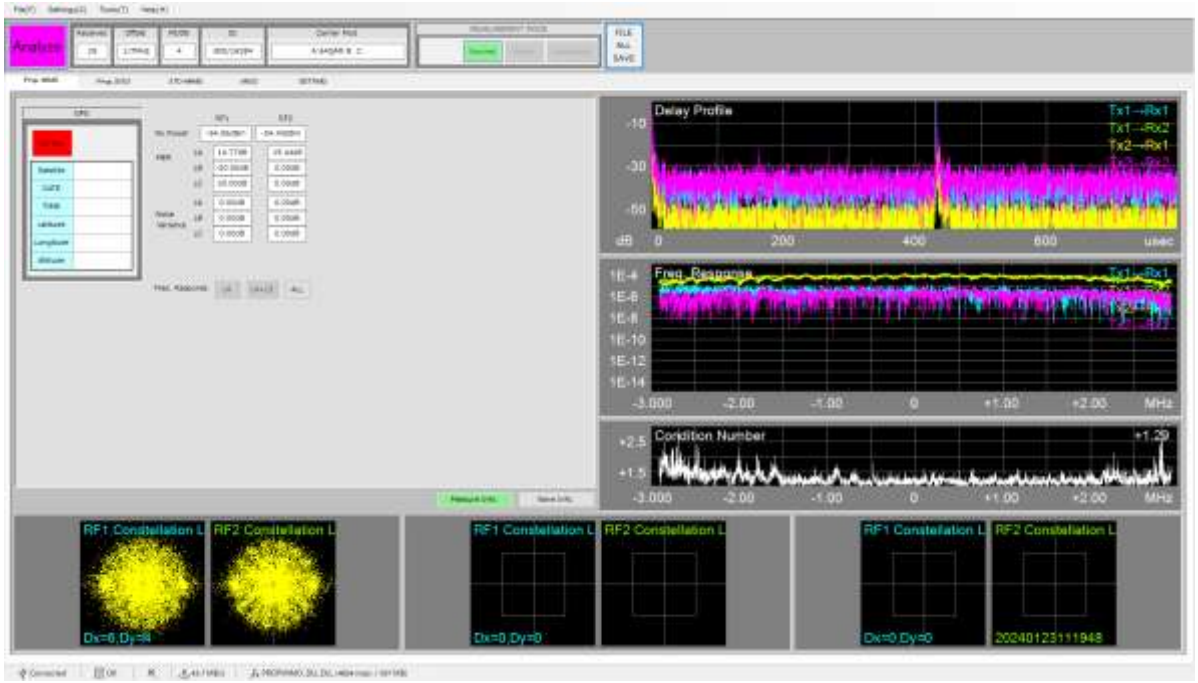


Figure 6.10 - Rintaro Screen

d) Reception Threshold

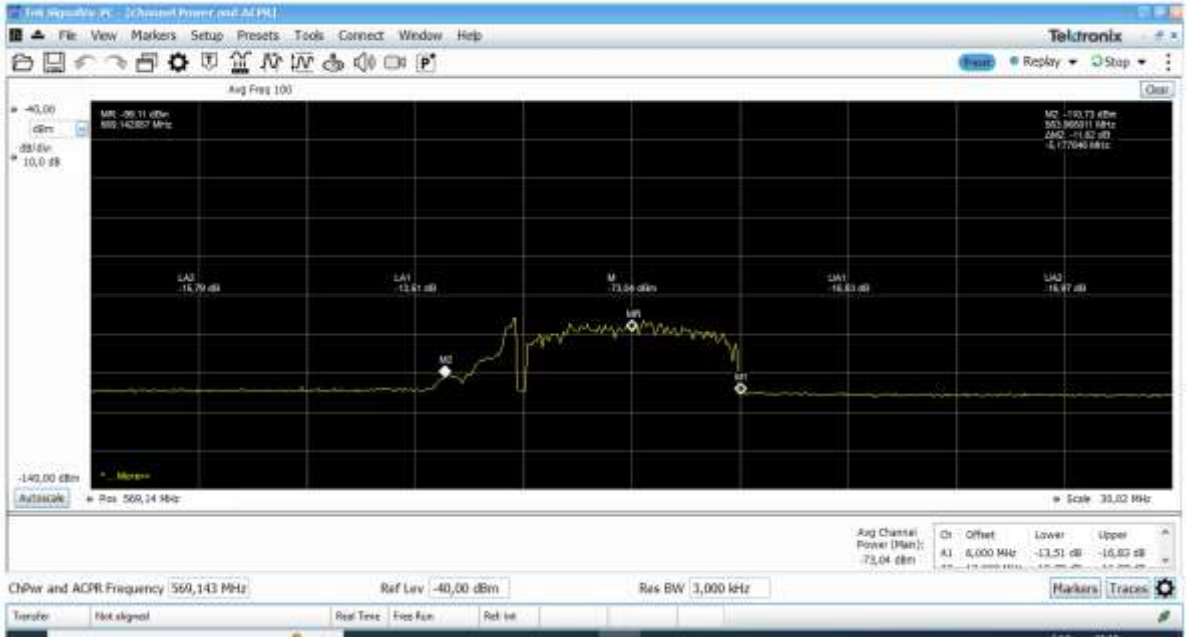


Figure 6.11 - Vertical

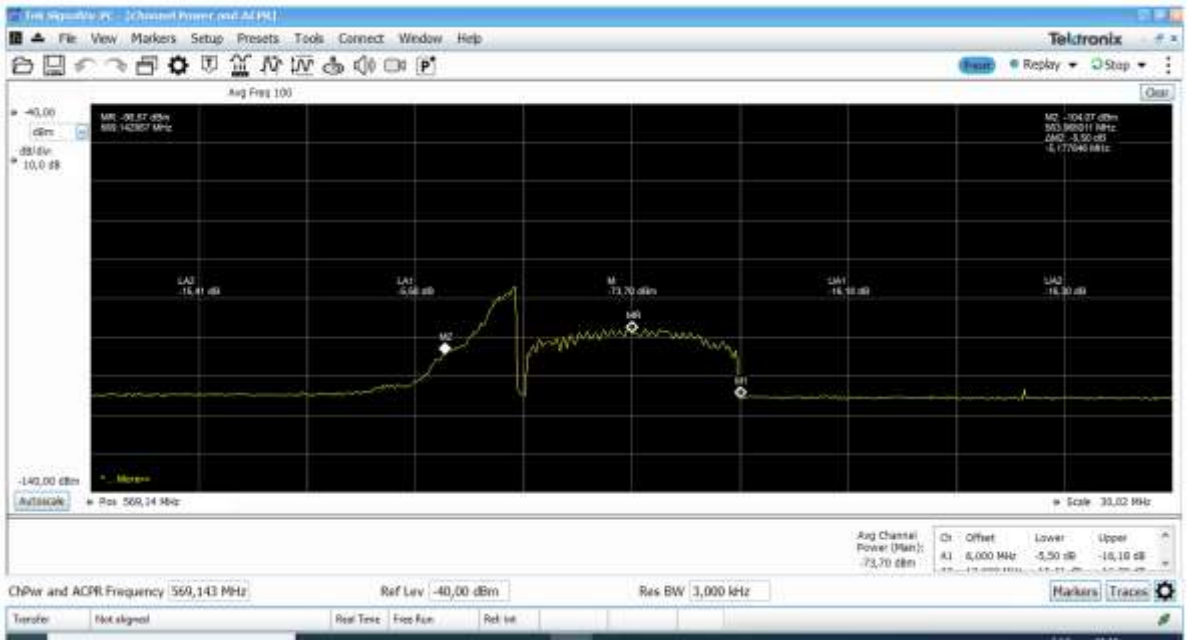


Figure 6.12 - Horizontal

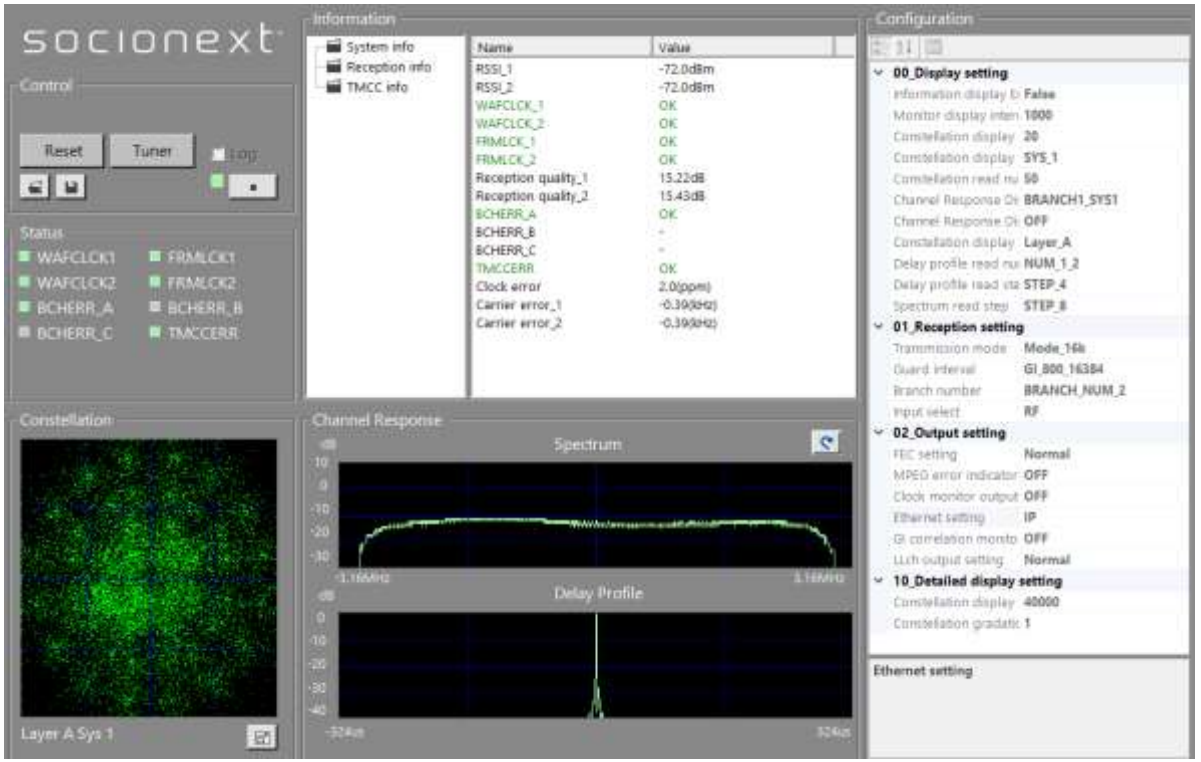


Figure 6.13 - Socionext Screen

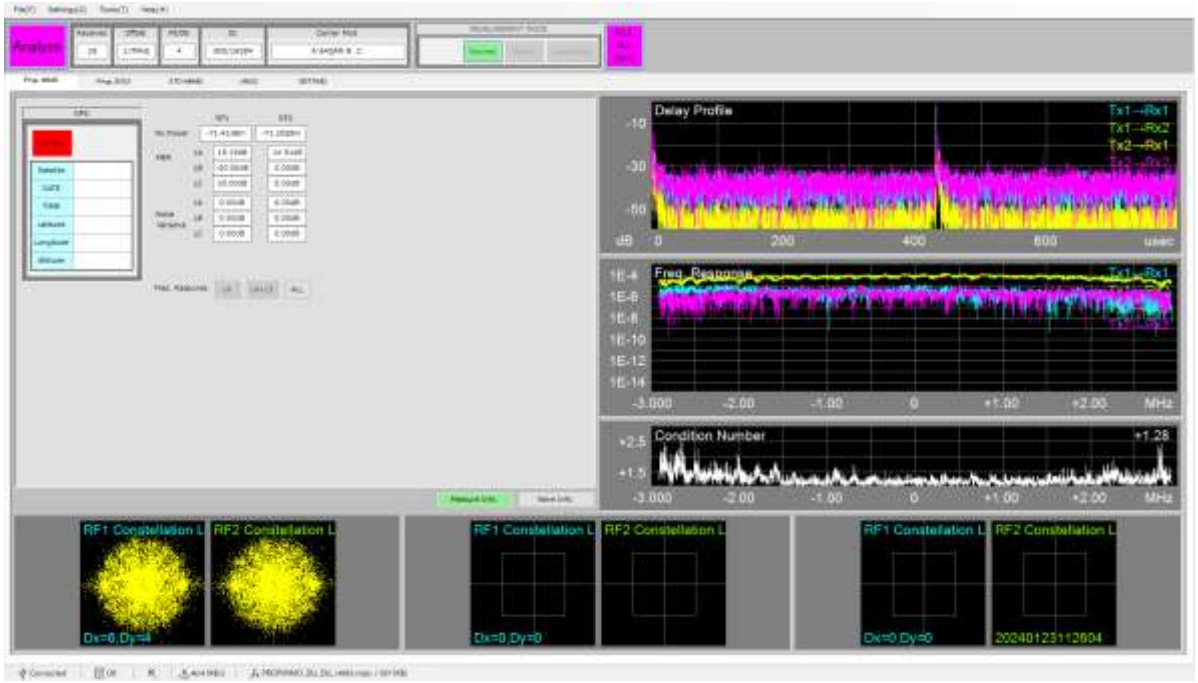


Figure 6.14 - Rintaro Screen

Chapter 7. Site 7

a) Channel Power

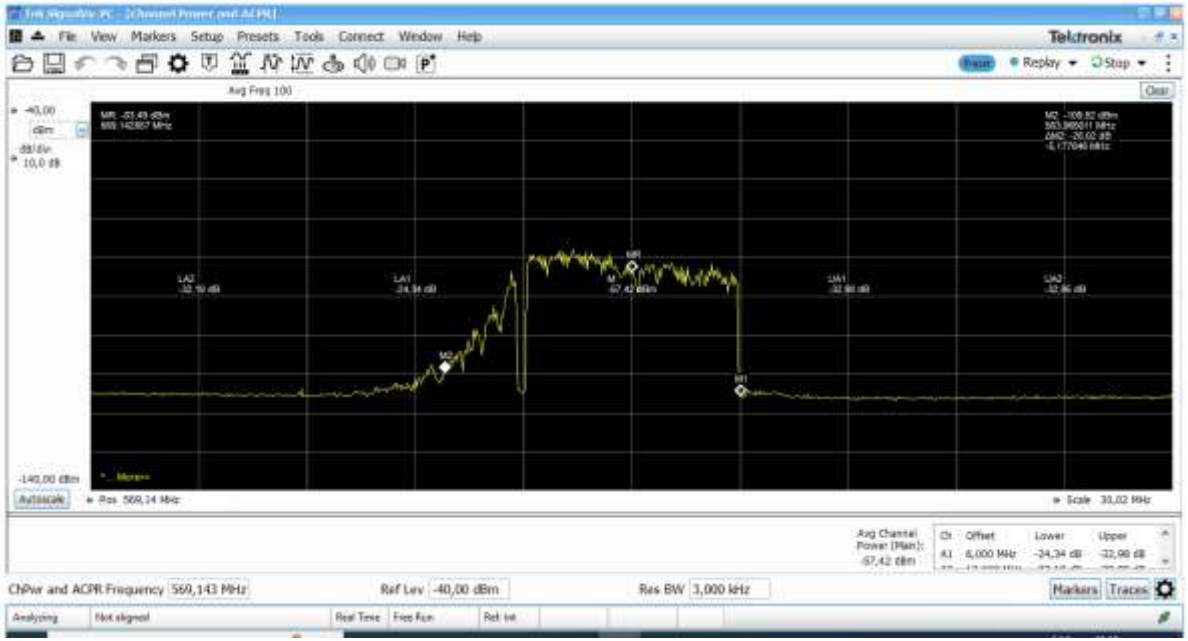


Figure 7.1 - Vertical

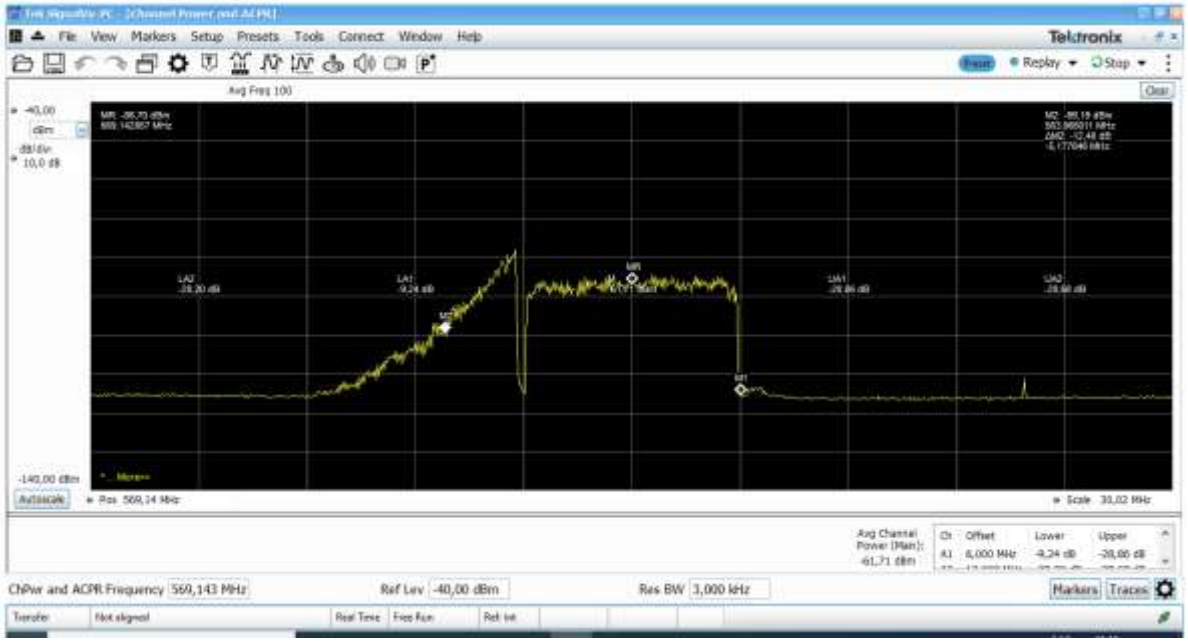


Figure 7.2 - Horizontal

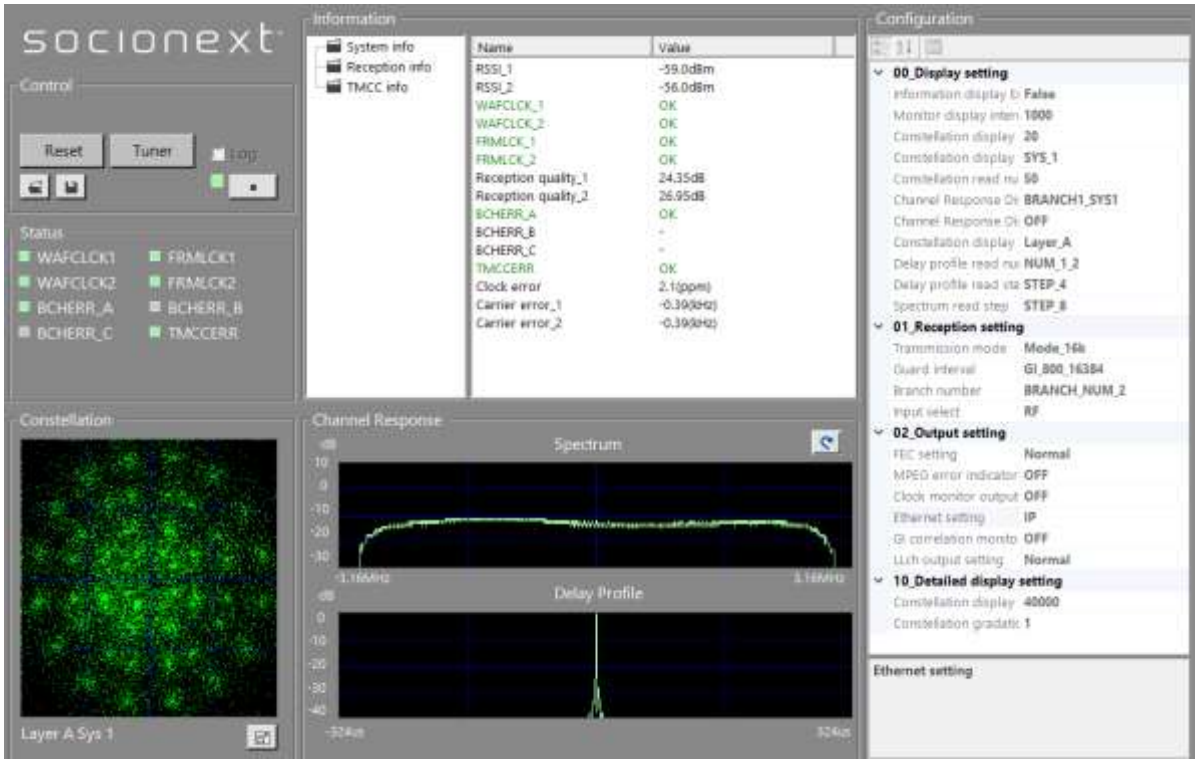


Figure 7.3 - Socionext Screen

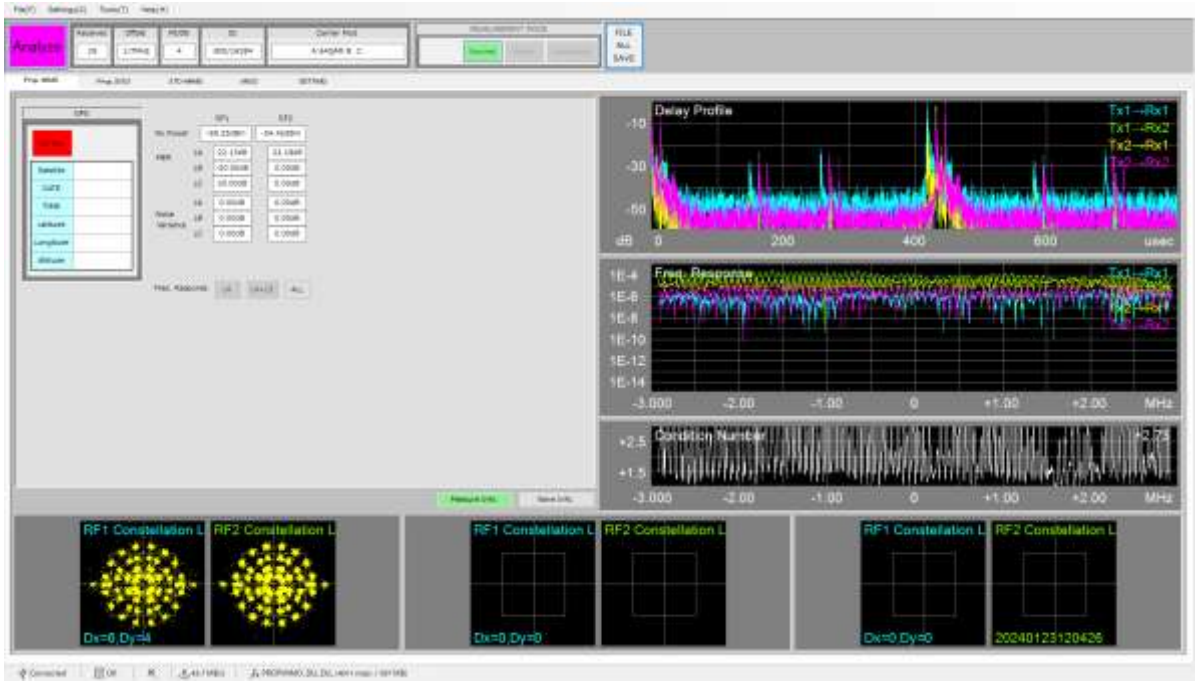


Figure 7.4 - Rintaro Screen

b) AWGN Power

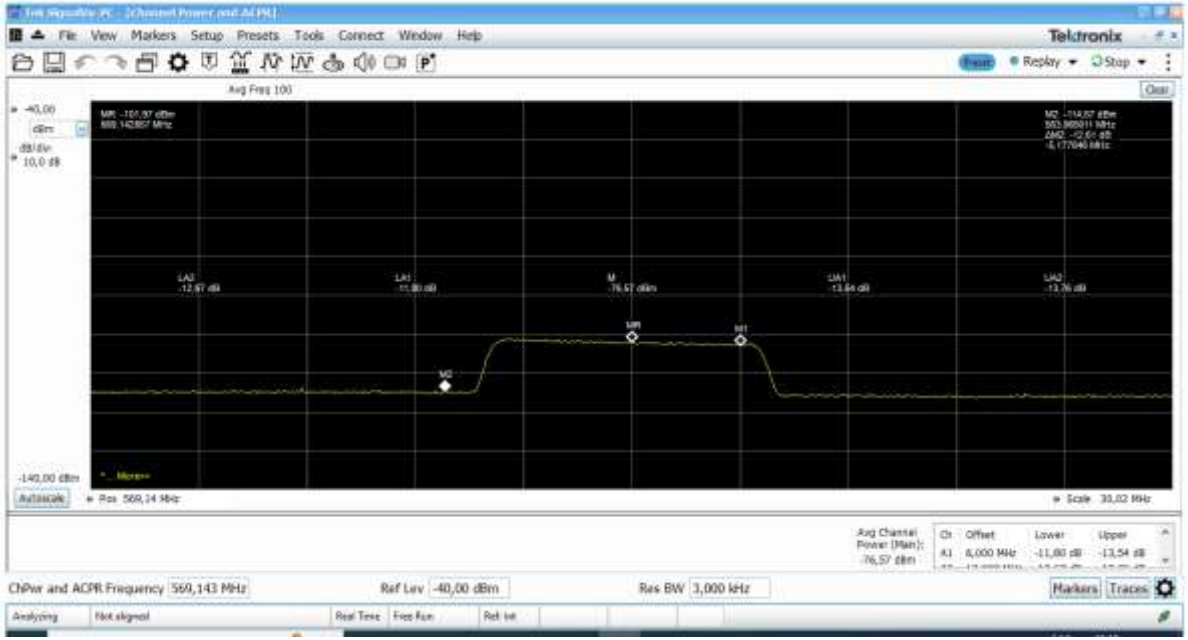


Figure 7.5 - Vertical

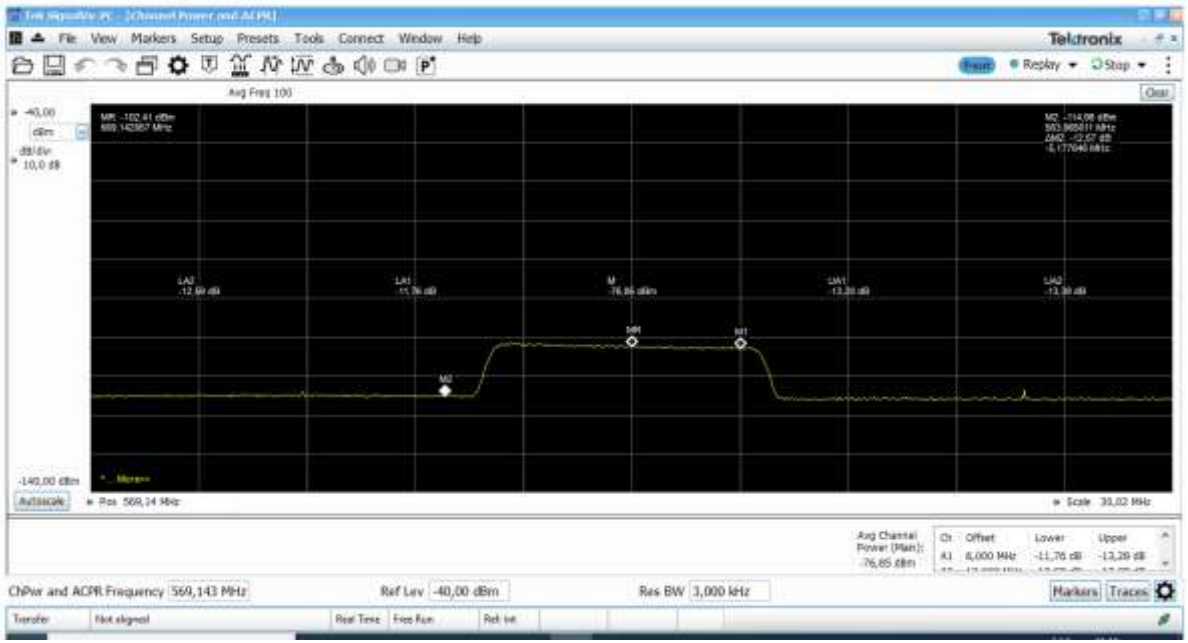


Figure 7.6 - Horizontal

c) C/N Threshold

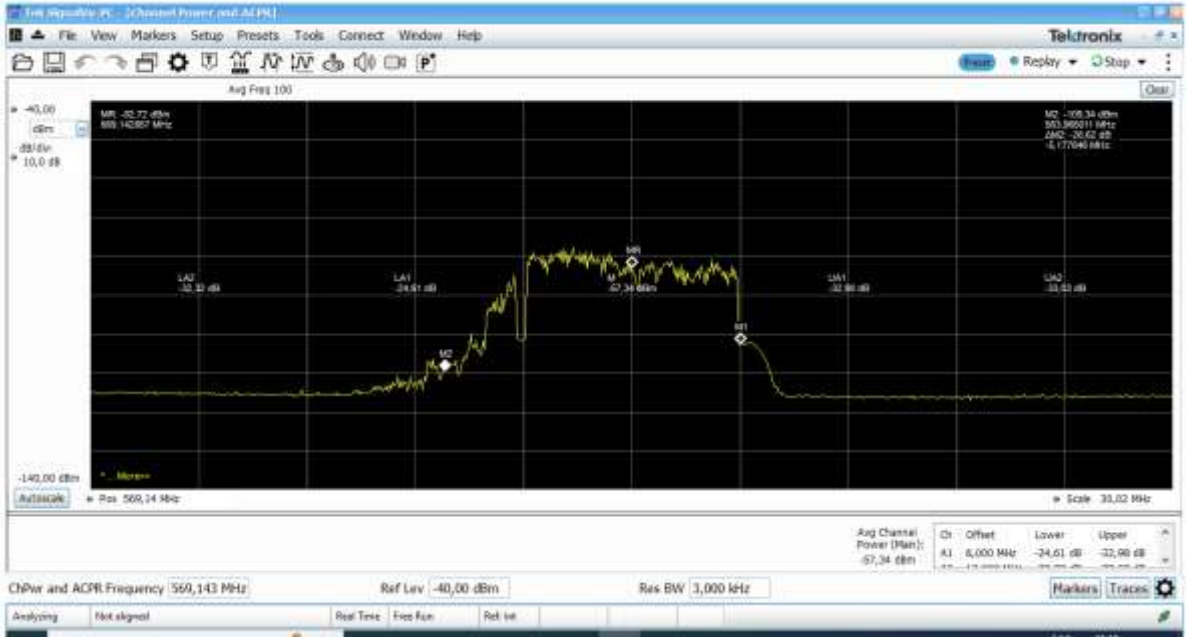


Figure 7.7 - Vertical

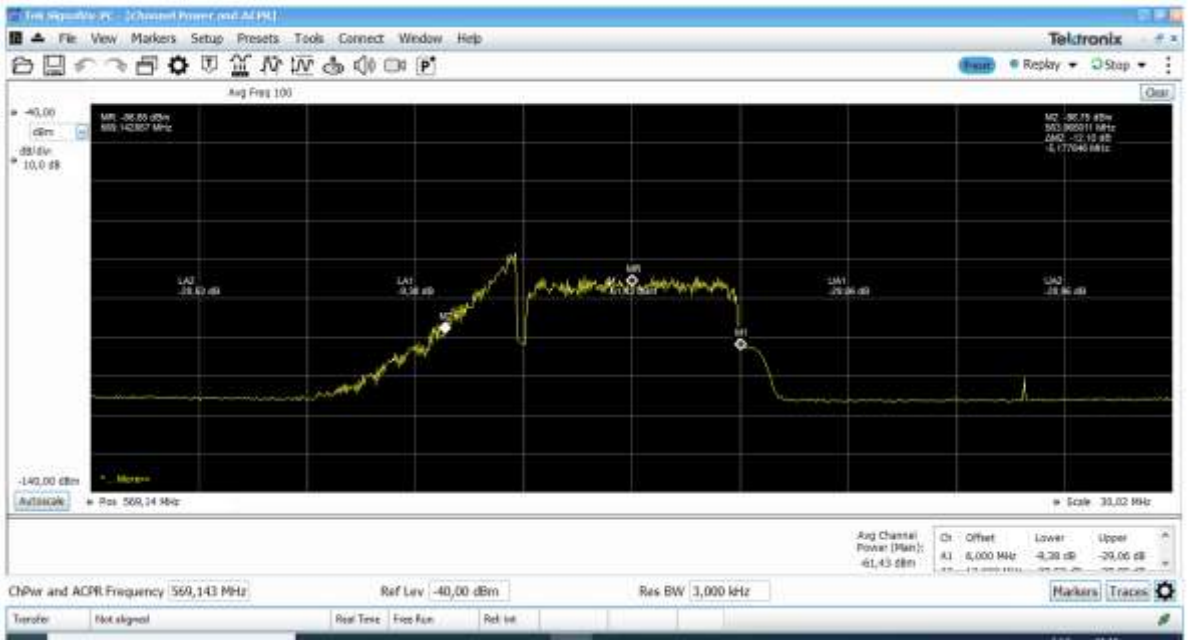


Figure 7.8 - Horizontal

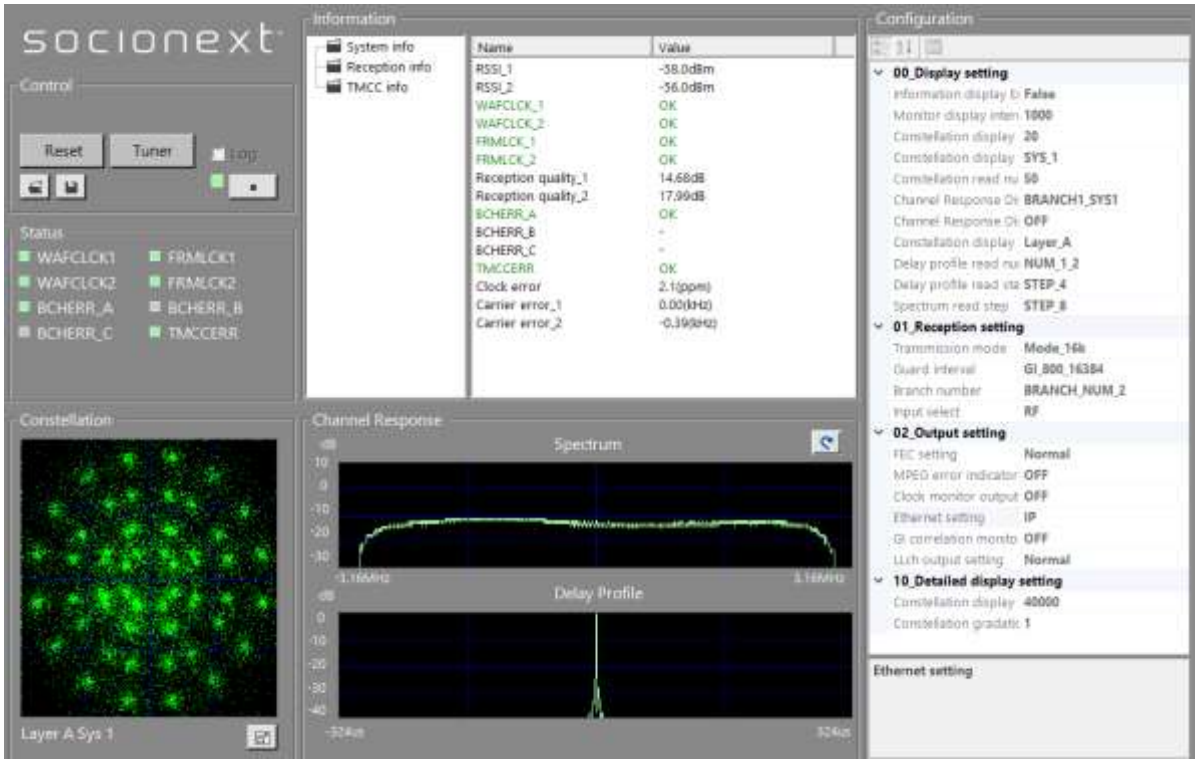


Figure 7.9 - Socionext Screen

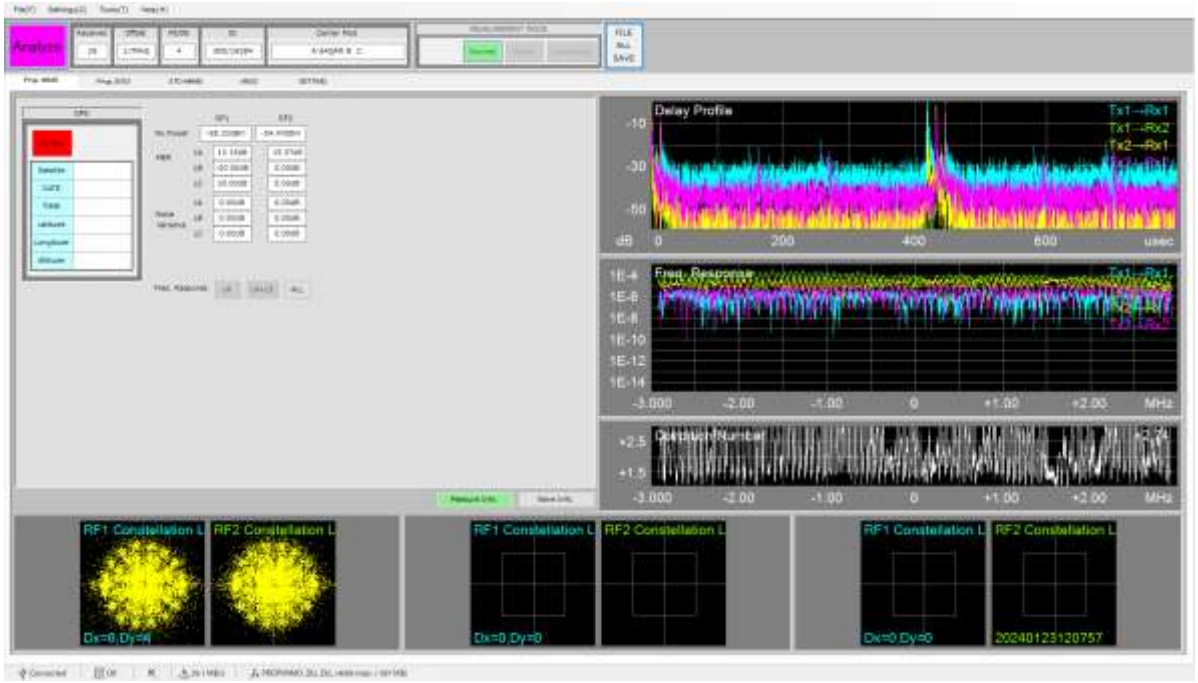


Figure 7.10 - Rintaro Screen

d) Reception Threshold

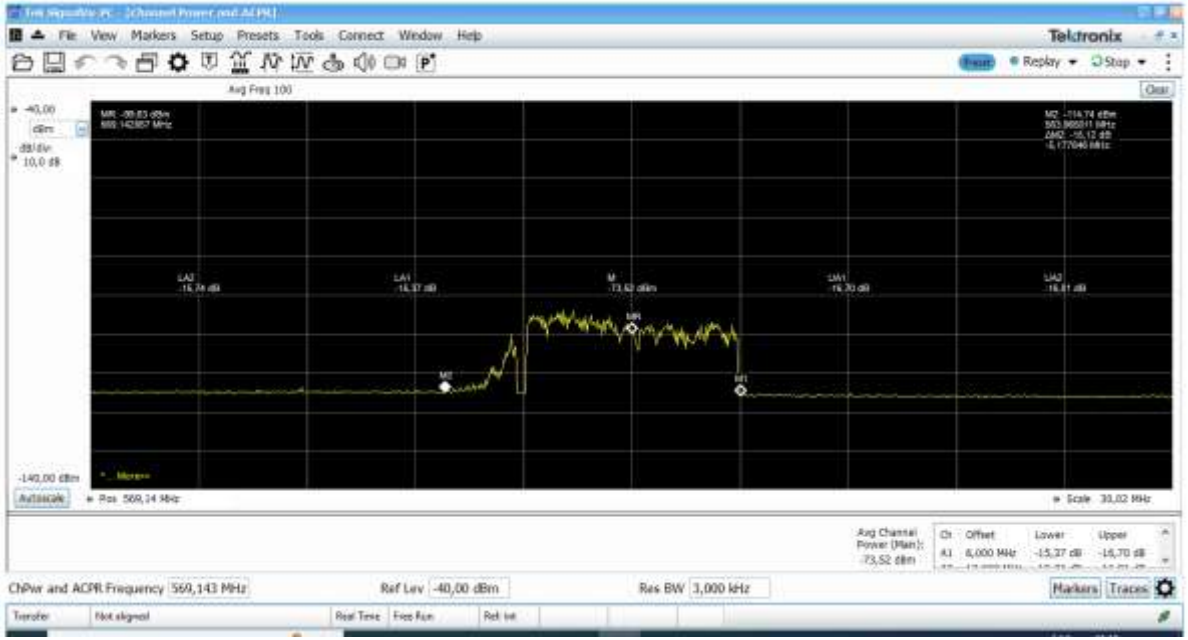


Figure 7.11 - Vertical

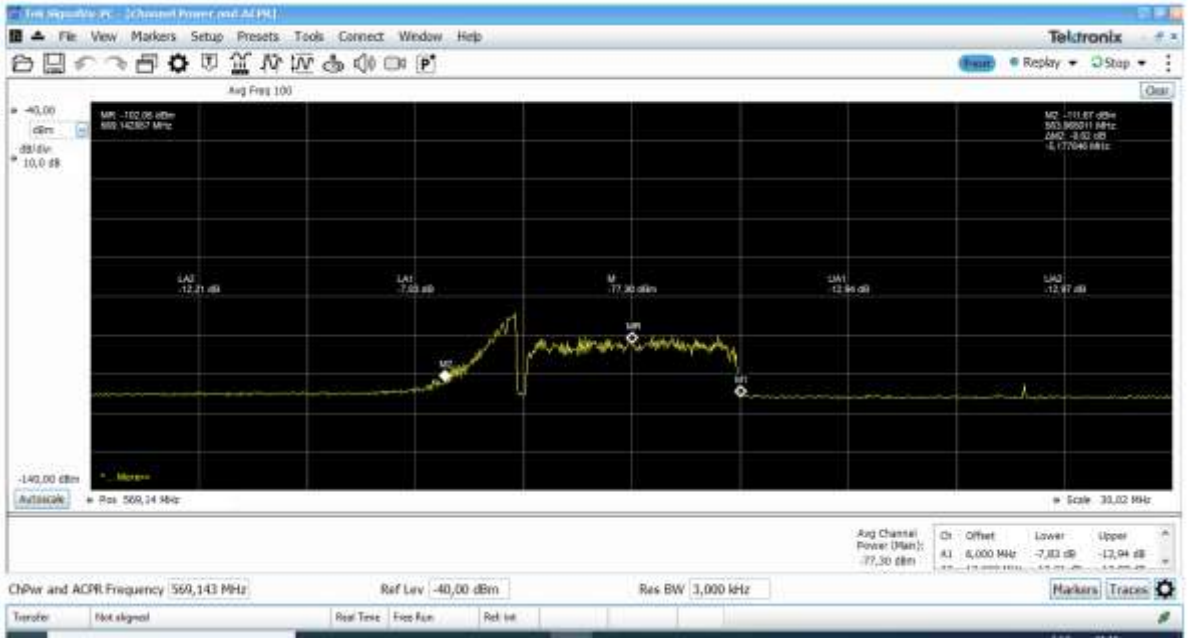


Figure 7.12 - Horizontal

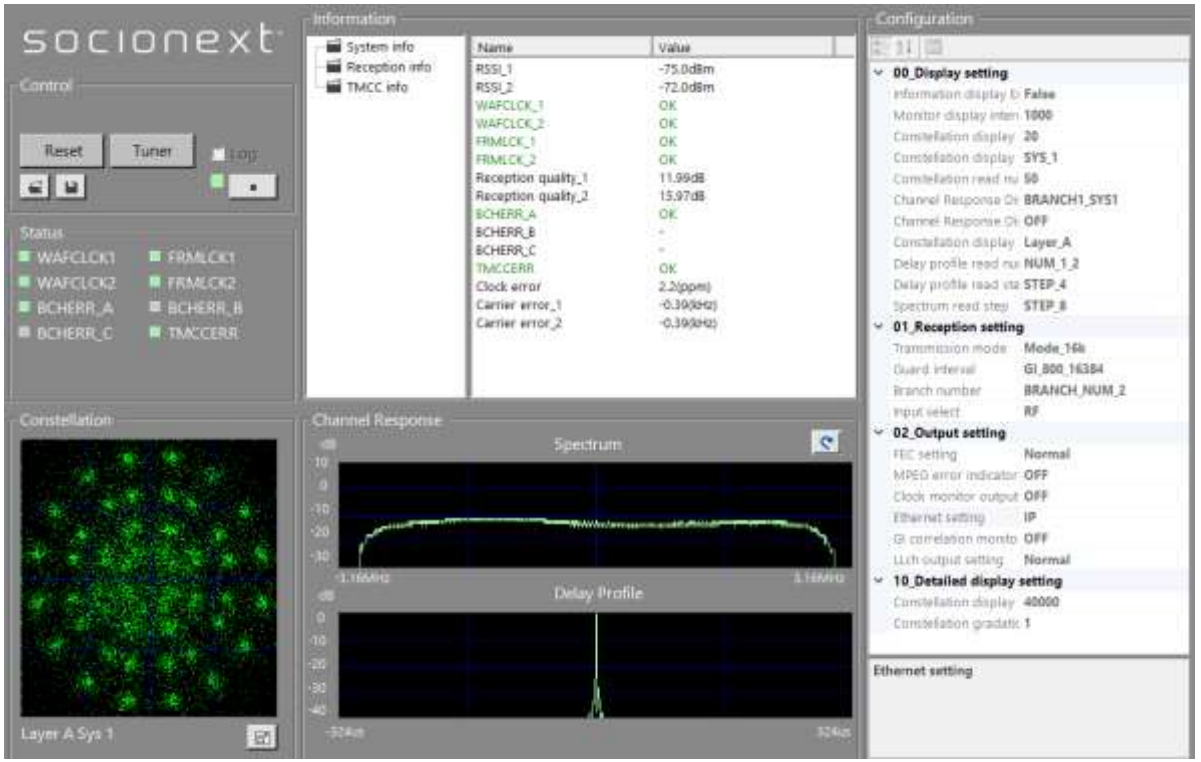


Figure 7.13 - Socionext Screen

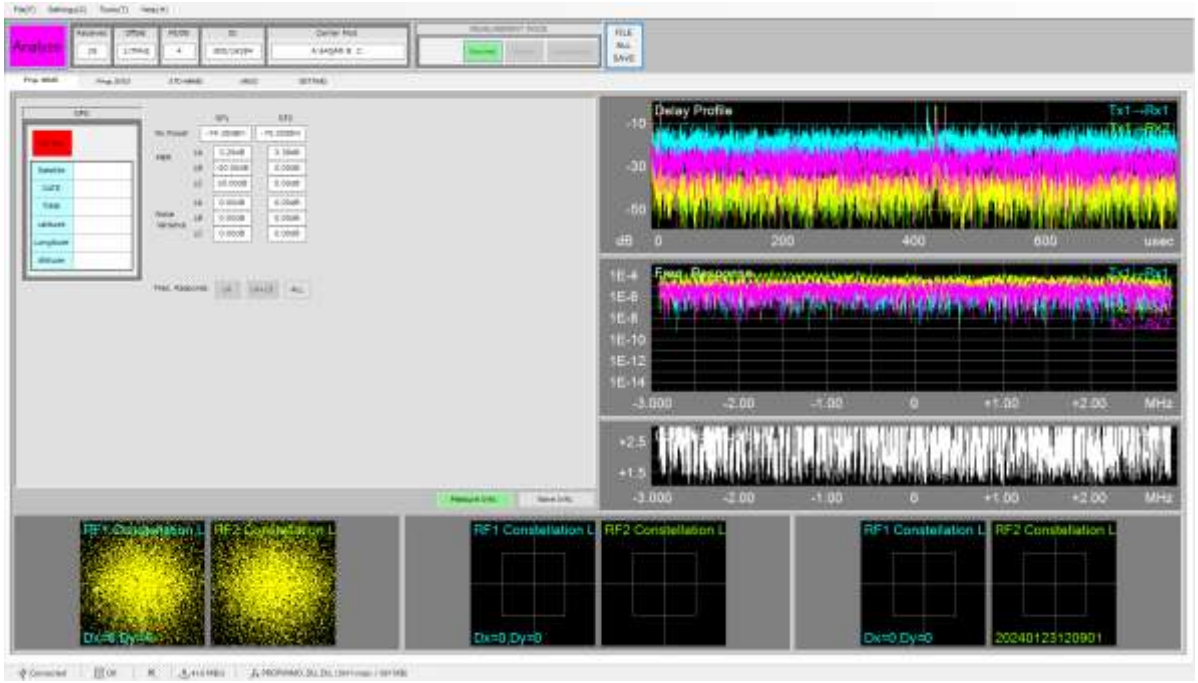


Figure 7.14 - Rintaro Screen

Chapter 8. Site 8

a) Channel Power

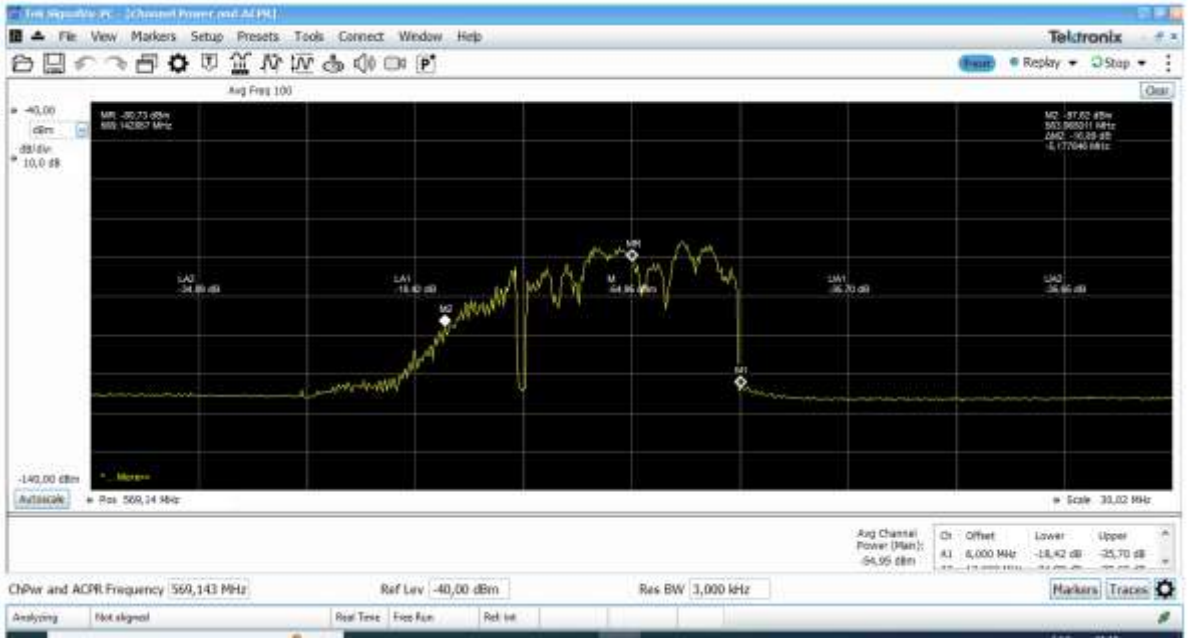


Figure 8.1 - Vertical

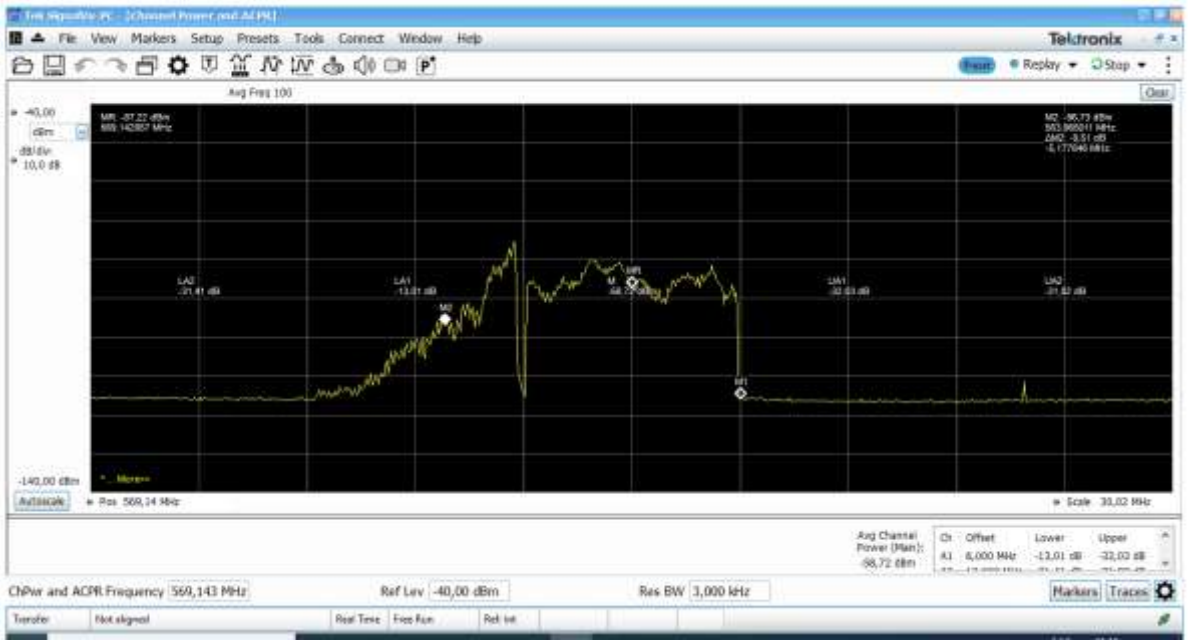


Figure 8.2 - Horizontal

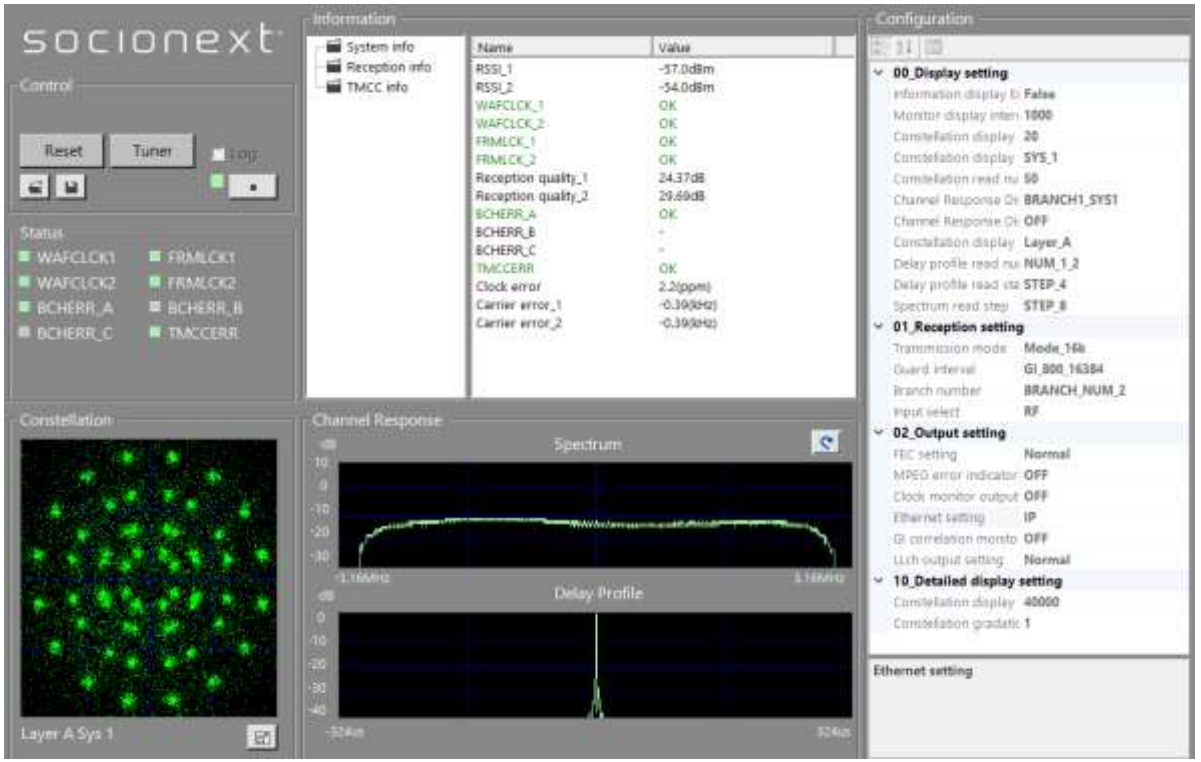


Figure 8.3 - Socionext Screen

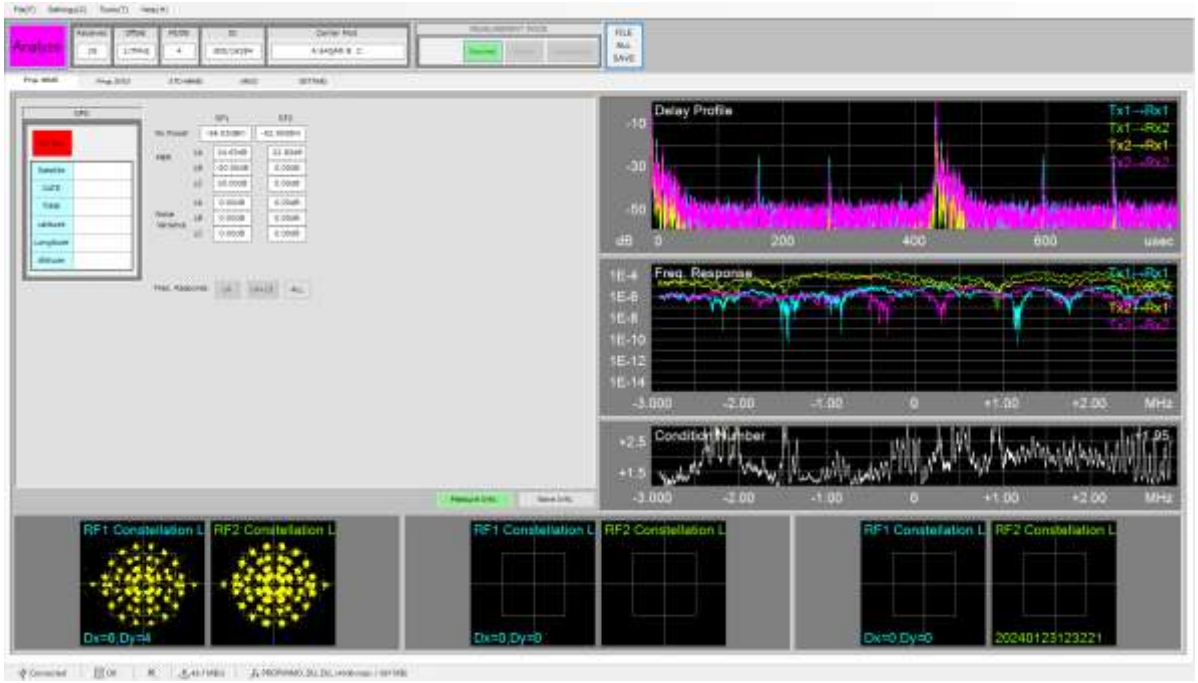


Figure 8.4 - Rintaro Screen

b) AWGN Power

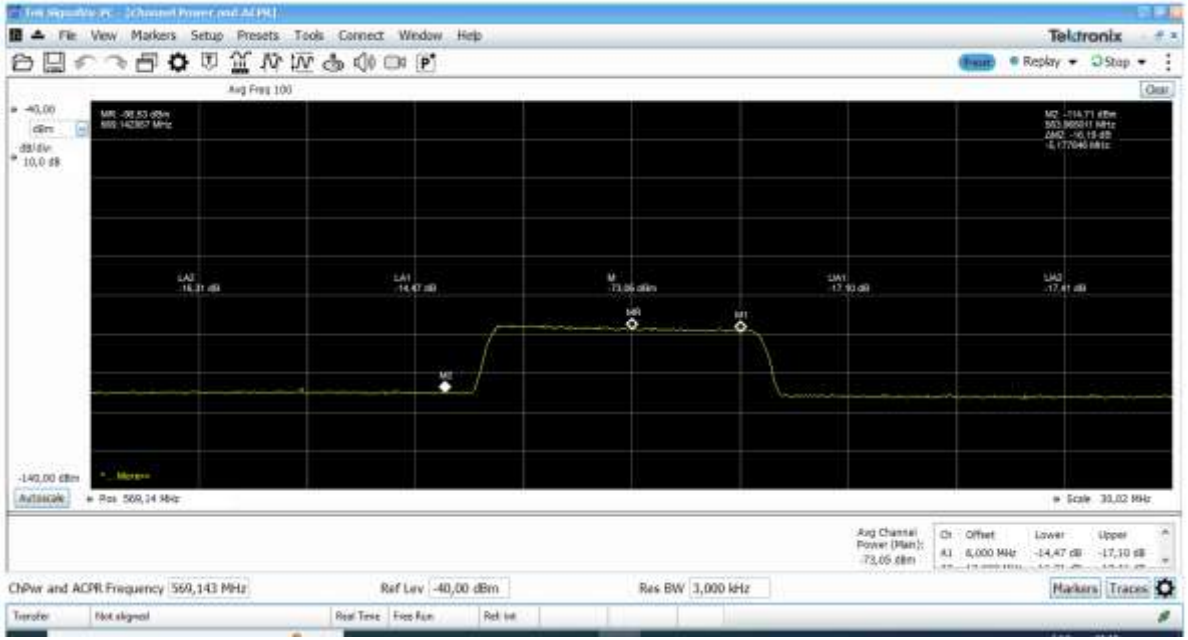


Figure 8.5 - Vertical

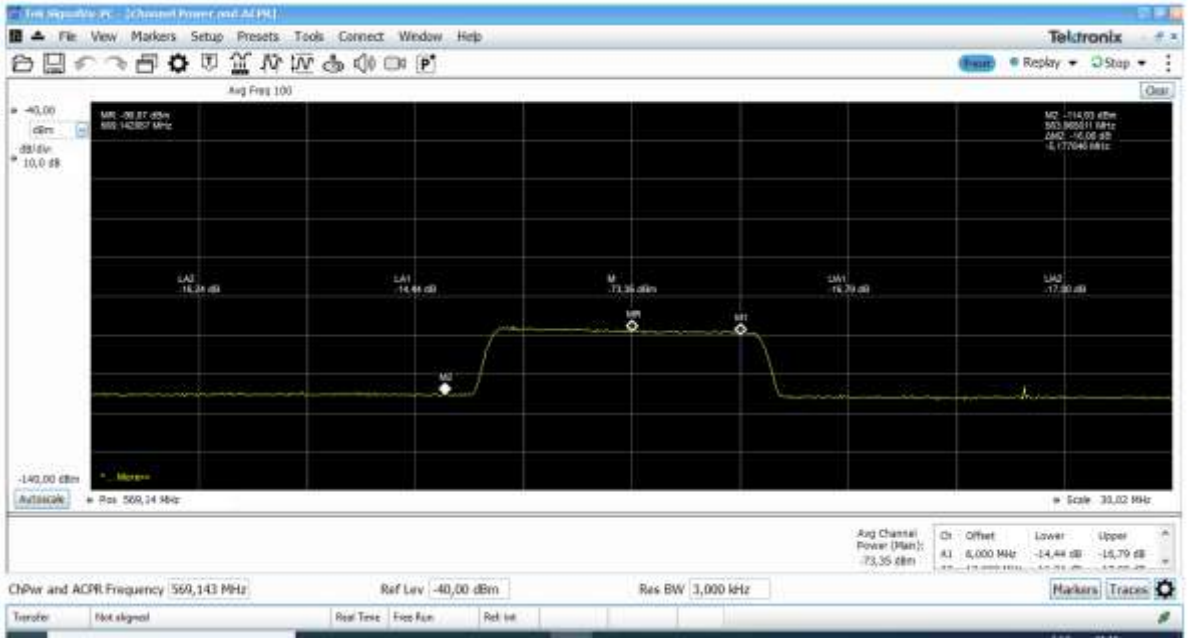


Figure 8.6 - Horizontal

c) C/N Threshold

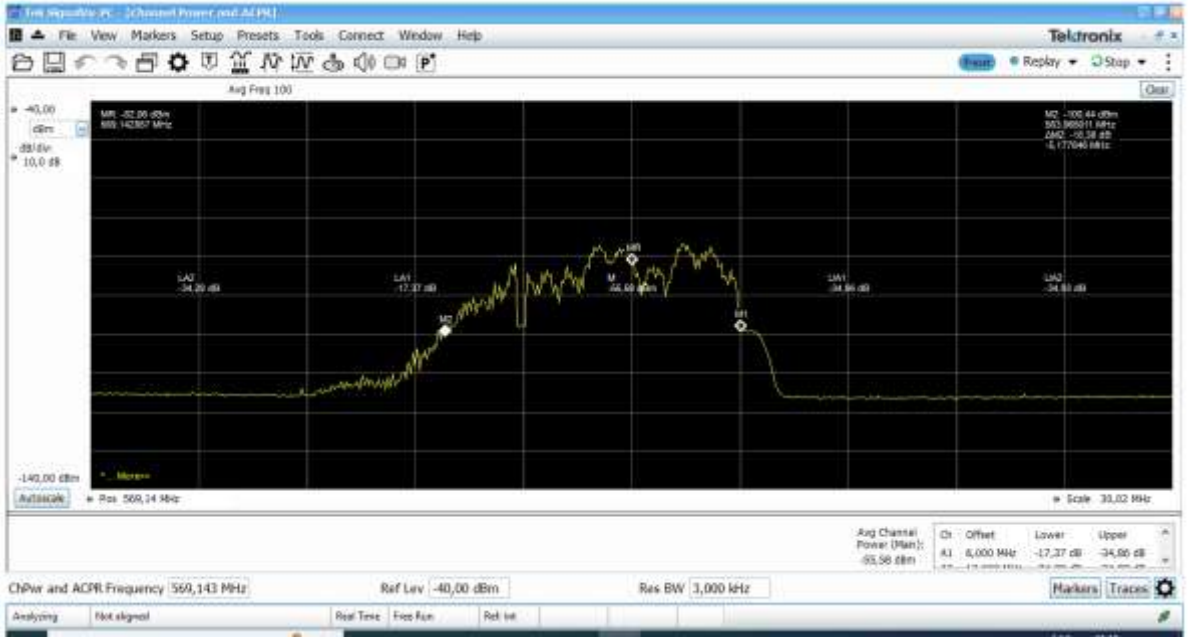


Figure 8.7 - Vertical

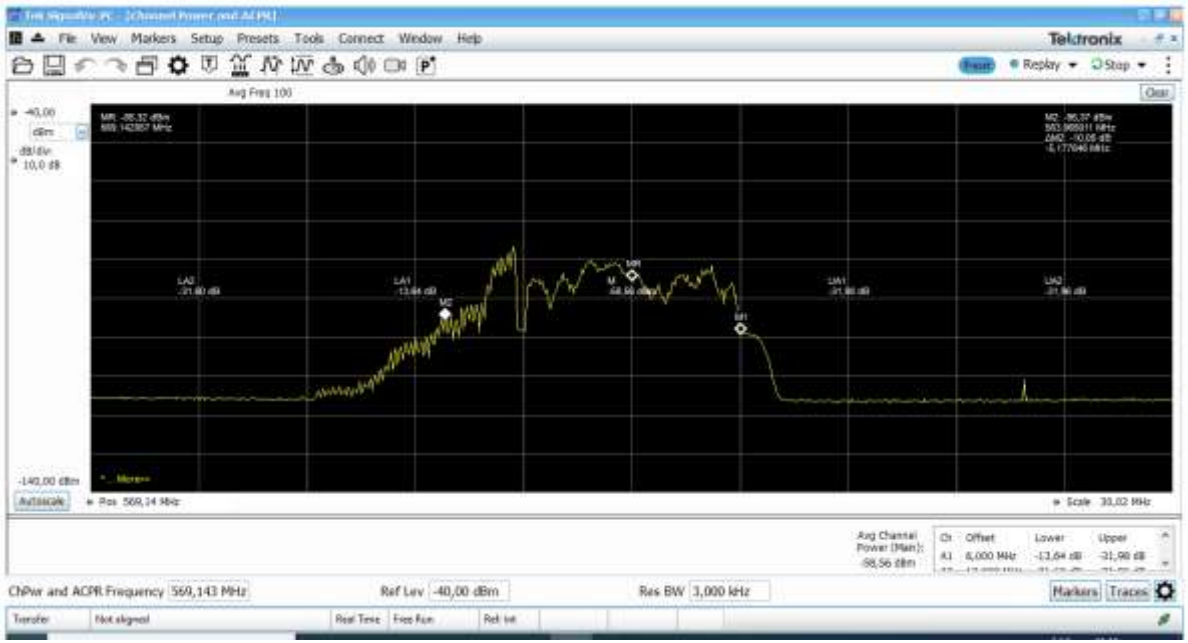


Figure 8.8 - Horizontal

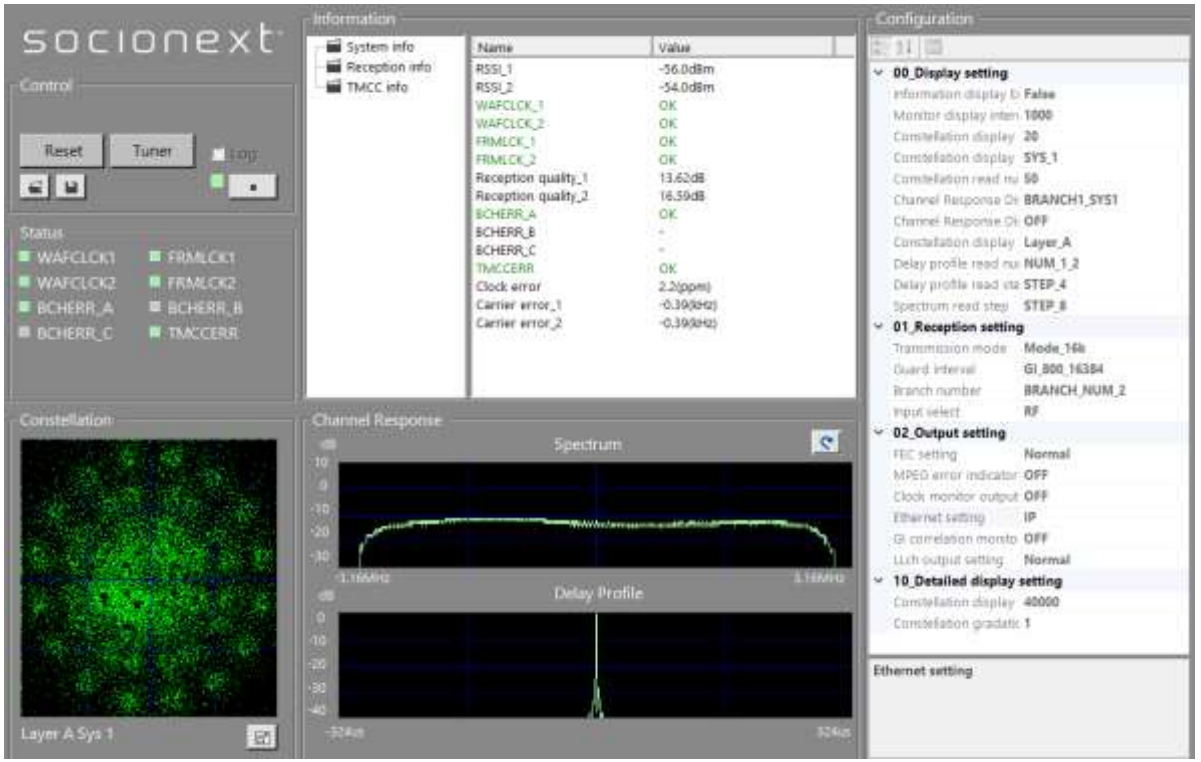


Figure 8.9 - Socionext Screen

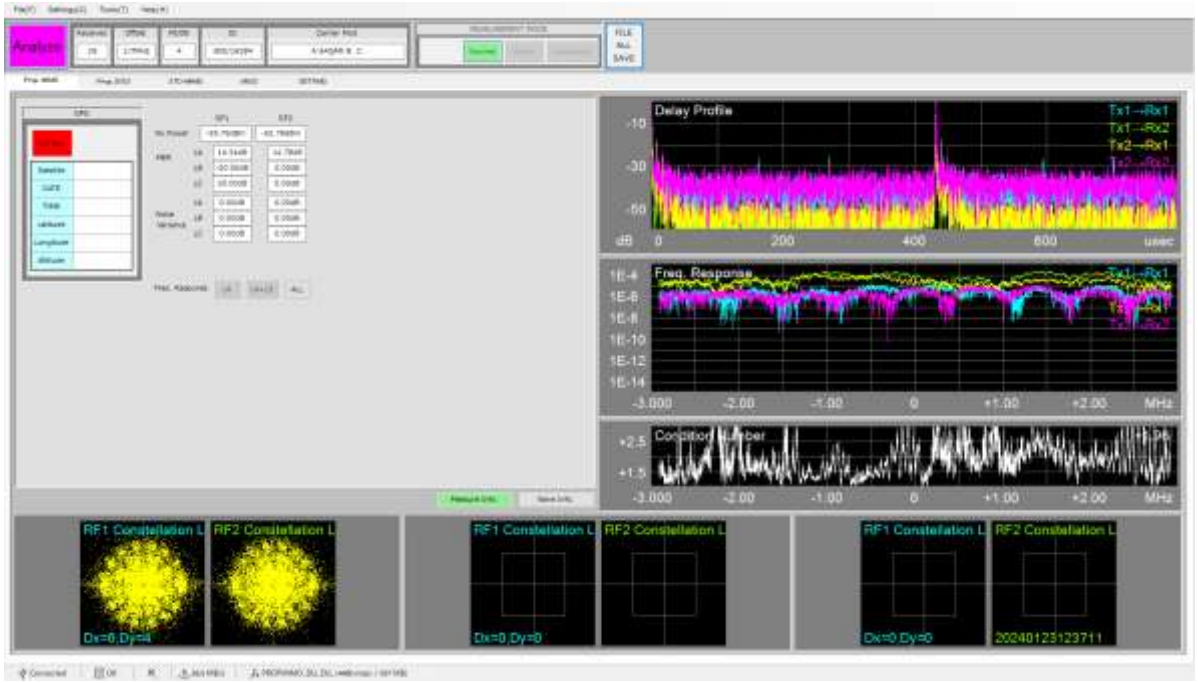


Figure 8.10 - Rintaro Screen

d) Reception Threshold

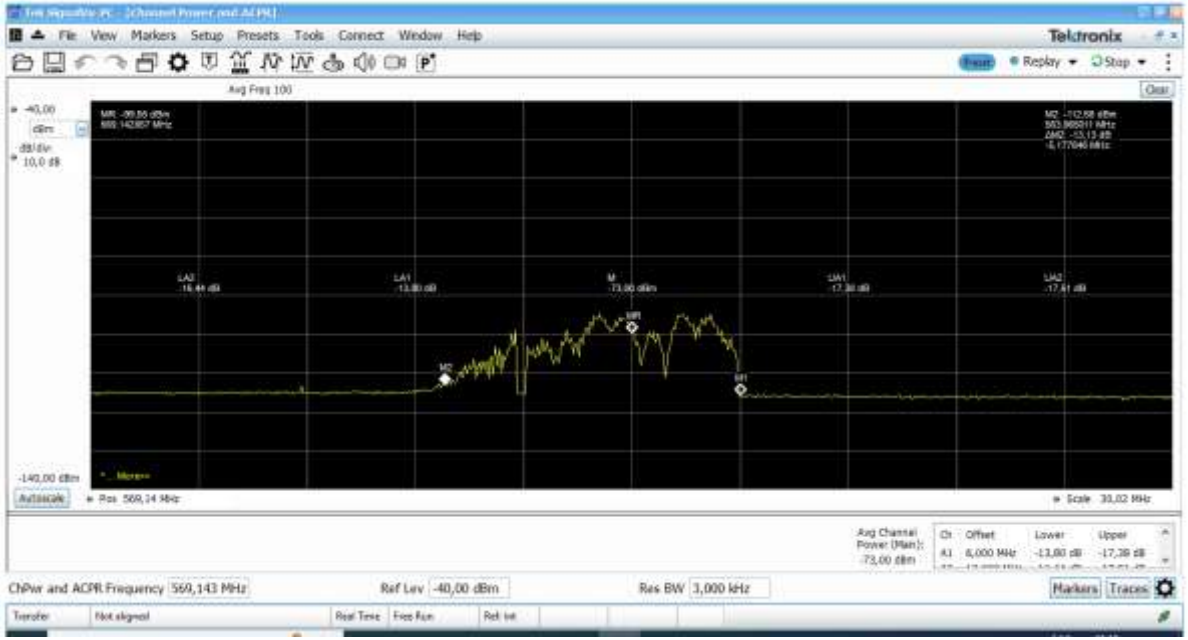


Figure 8.11 - Vertical

Figure 8.12 - Horizontal

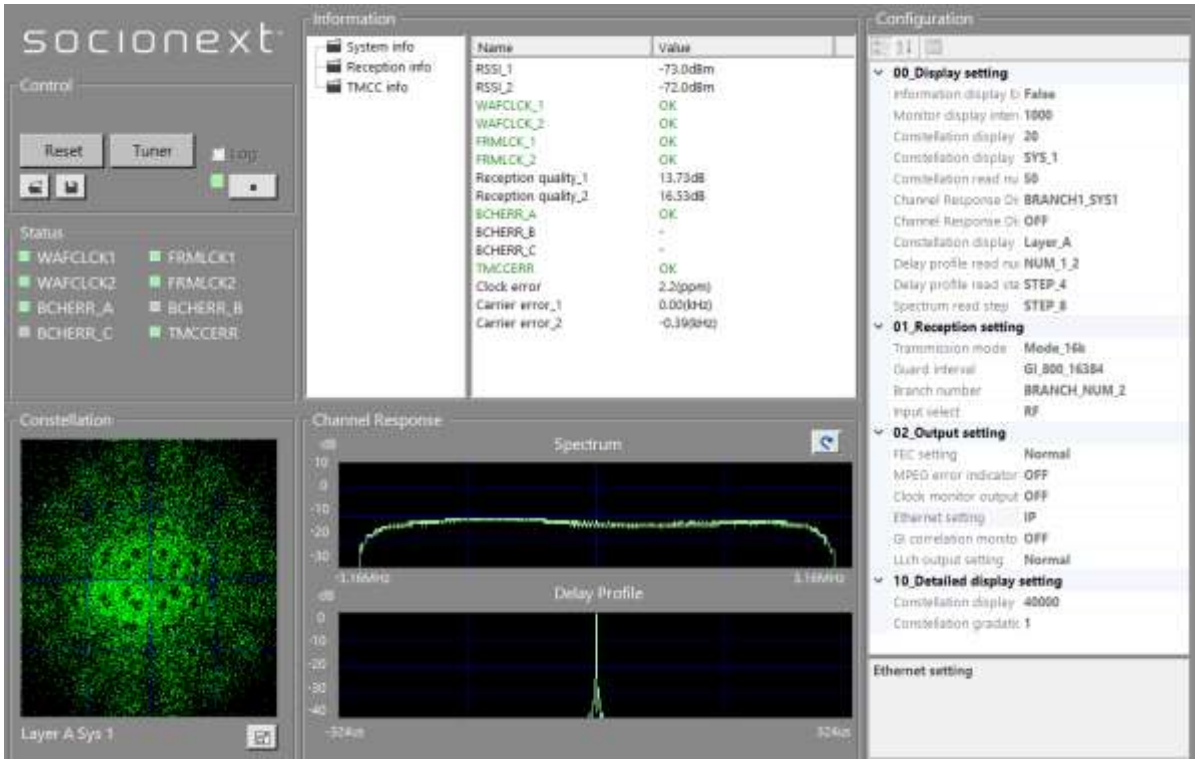


Figure 8.13 - Socionext Screen

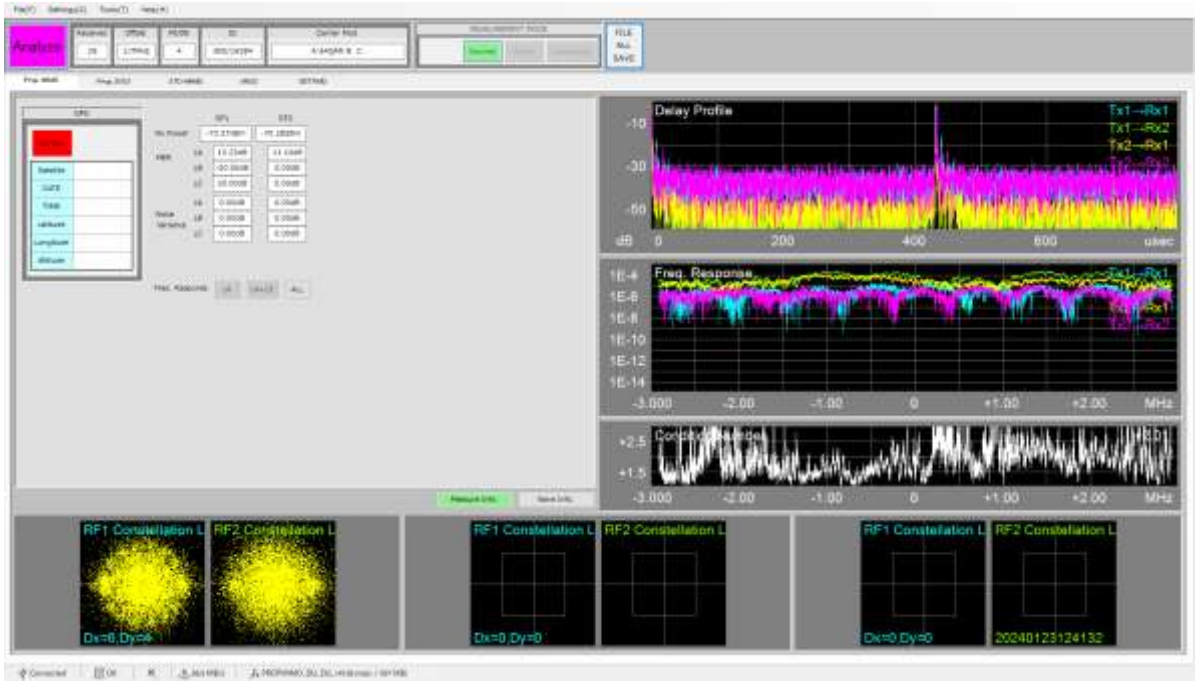


Figure 8.14 - Rintaro Screen

Chapter 9. Site 9

a) Channel Power

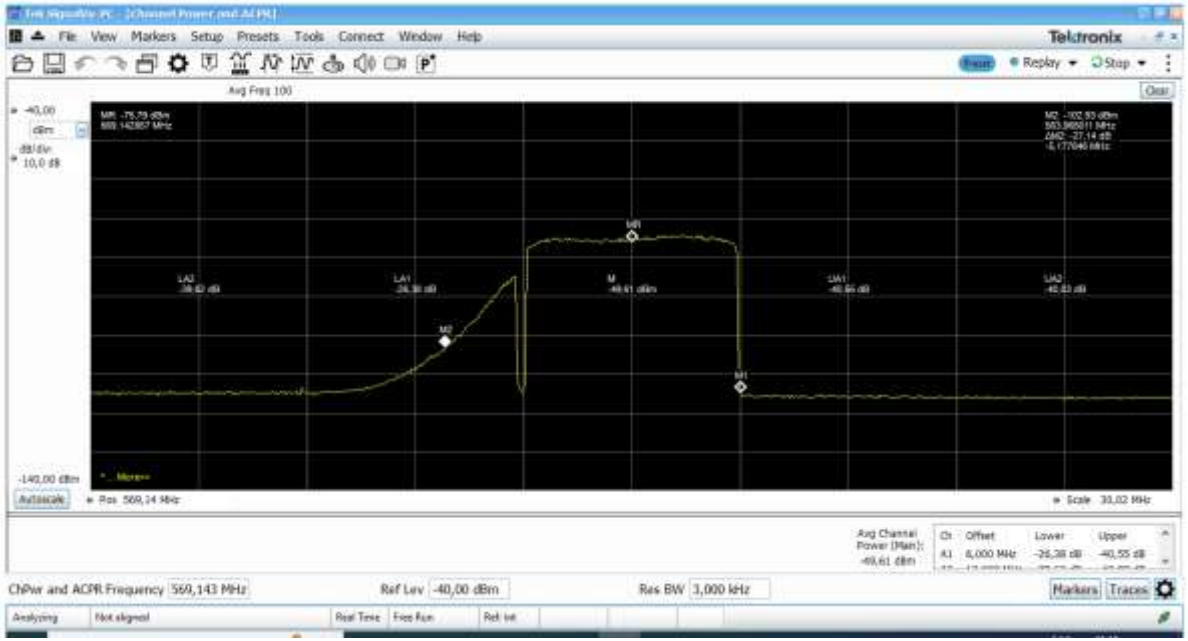


Figure 9.1 - Vertical

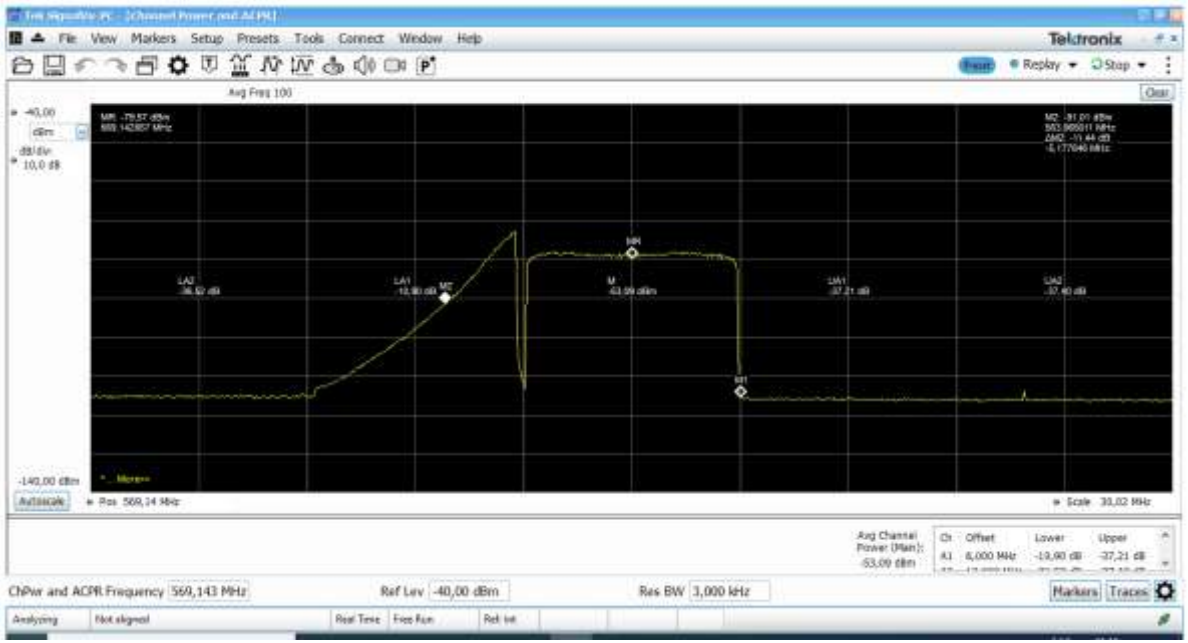


Figure 9.2 - Horizontal

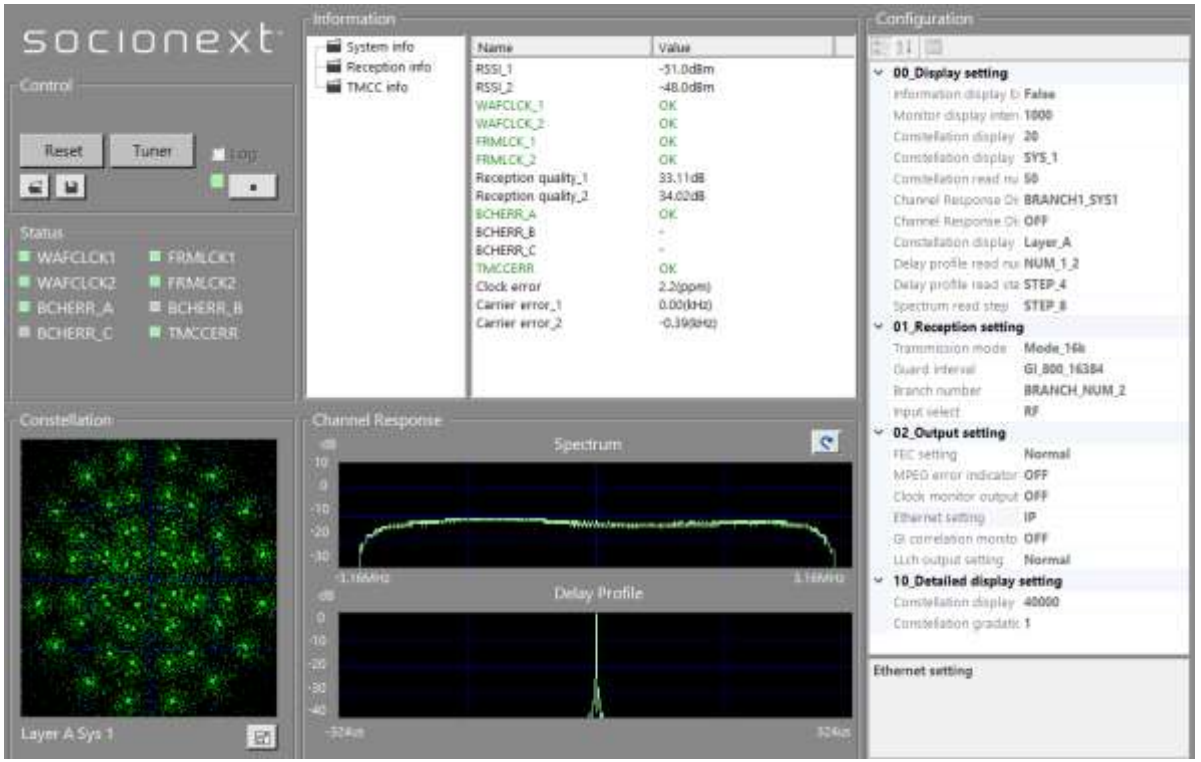


Figure 9.3 - Socionext Screen

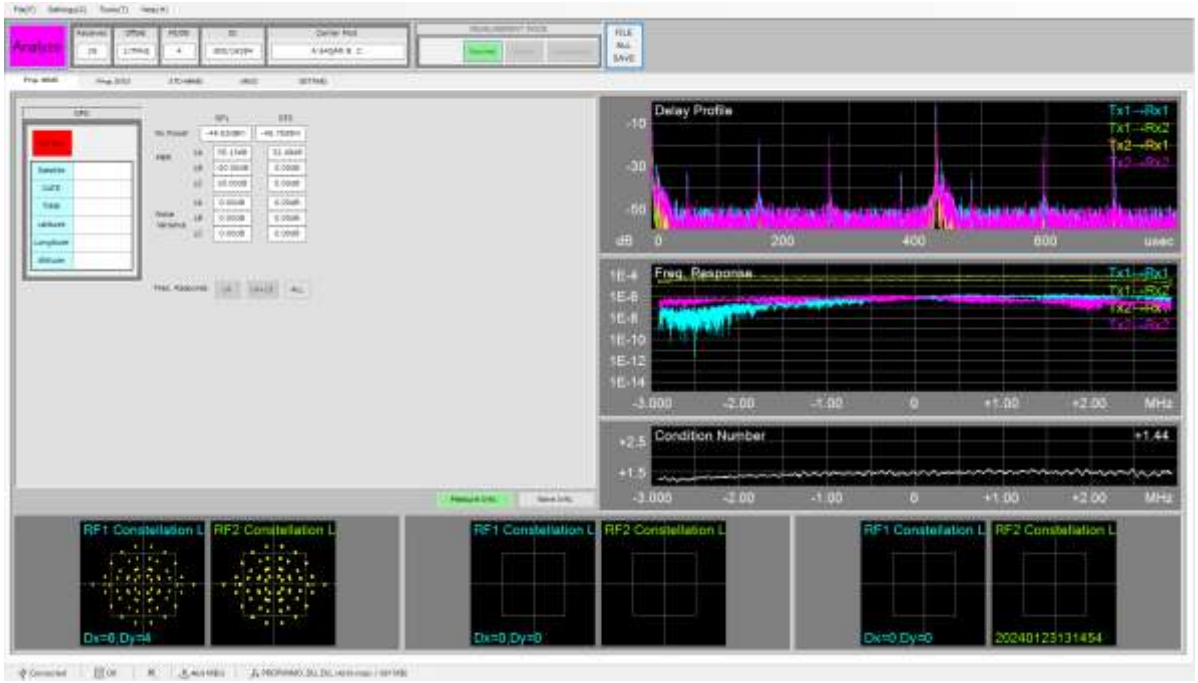


Figure 9.4 - Rintaro Screen

b) AWGN Power

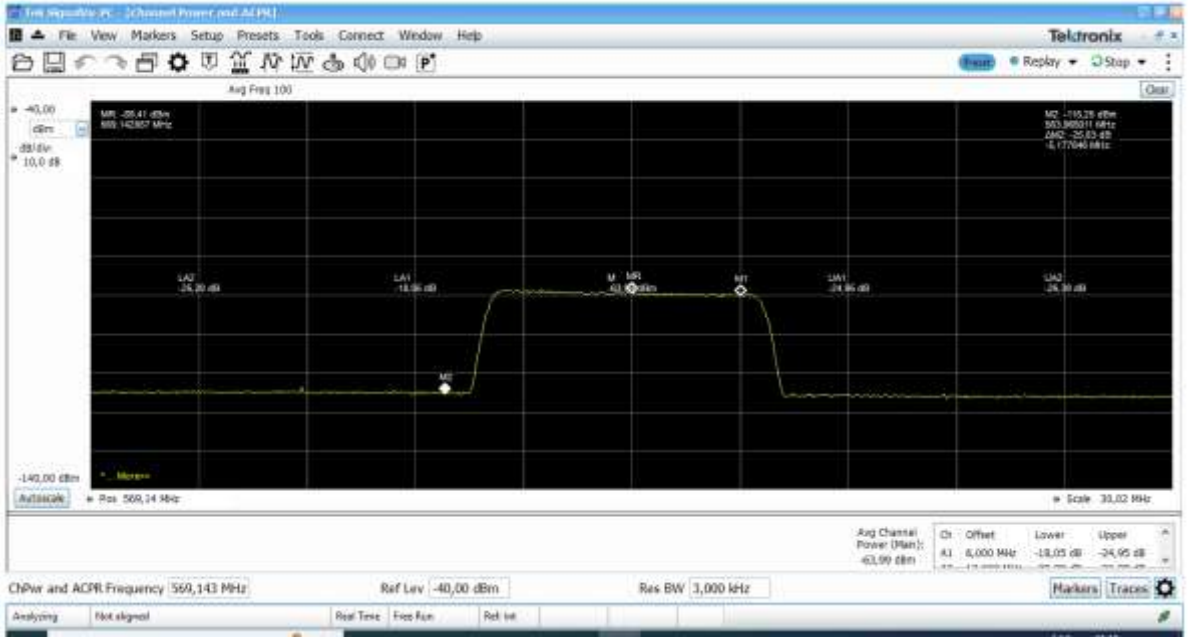


Figure 9.5 - Vertical

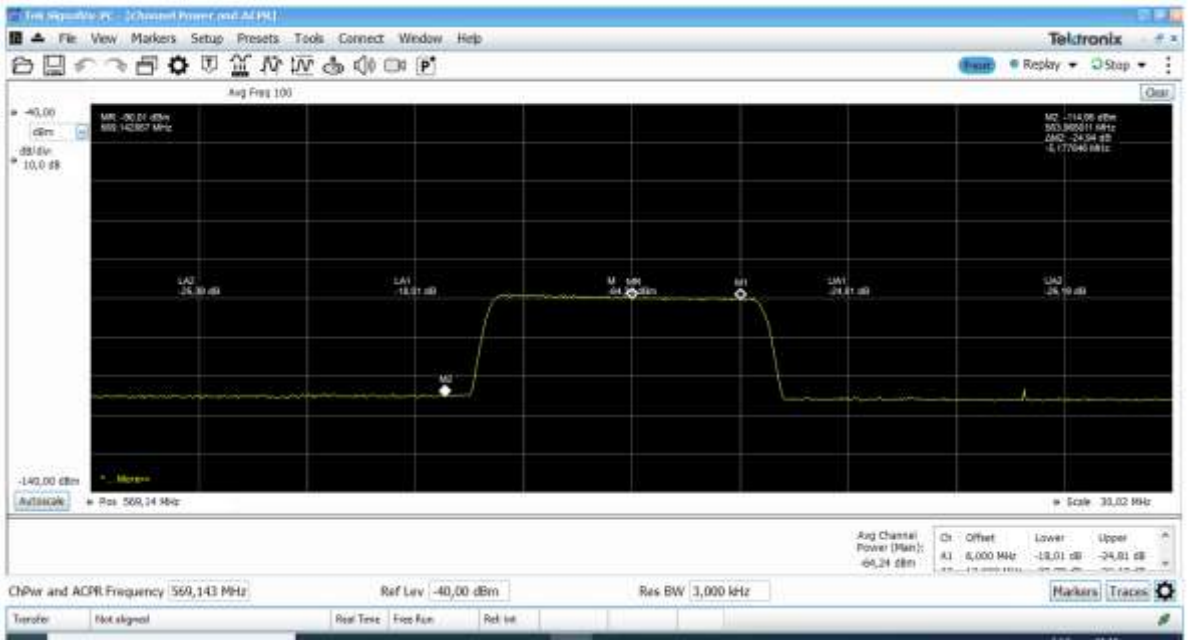


Figure 9.6 - Horizontal

c) C/N Threshold

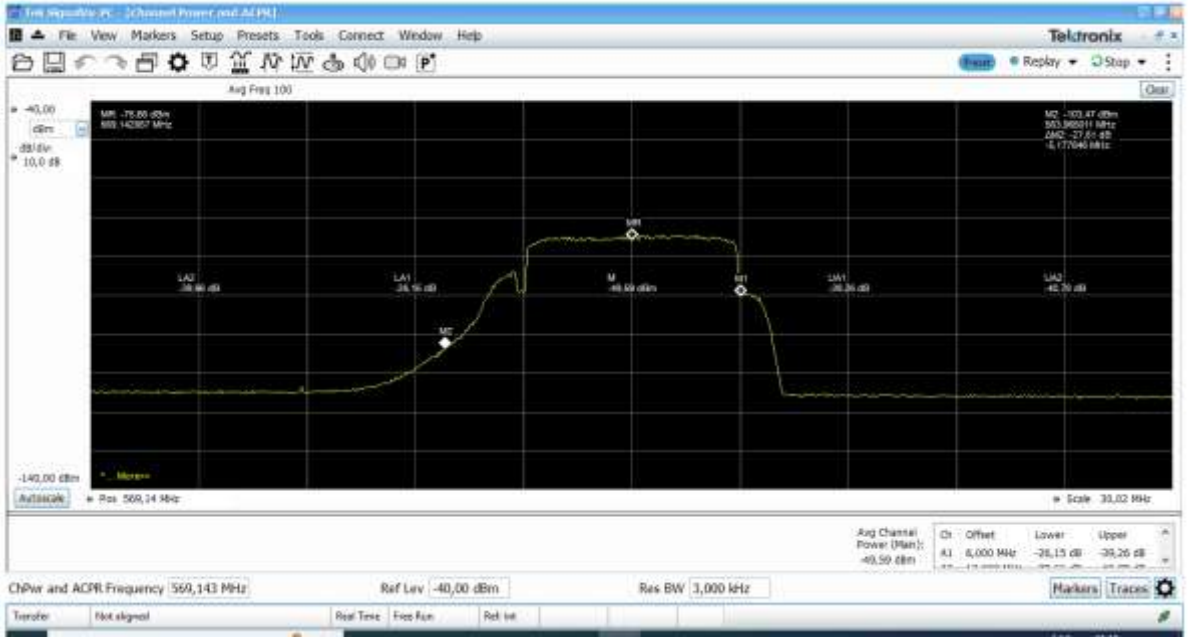


Figure 9.7 - Vertical

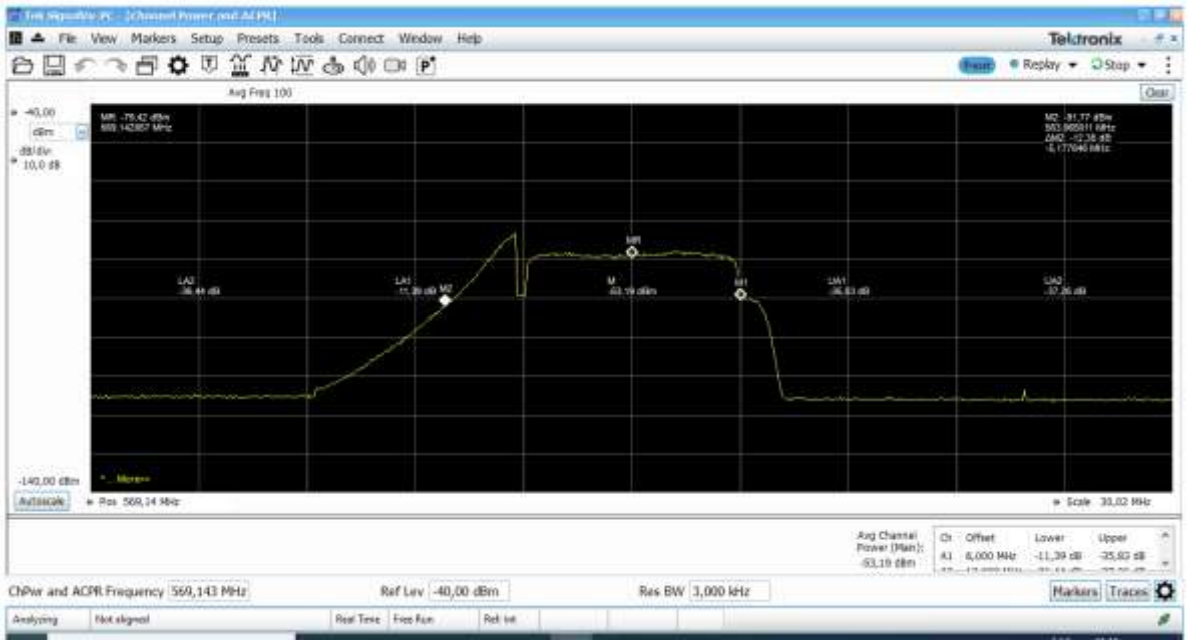


Figure 9.8 - Horizontal

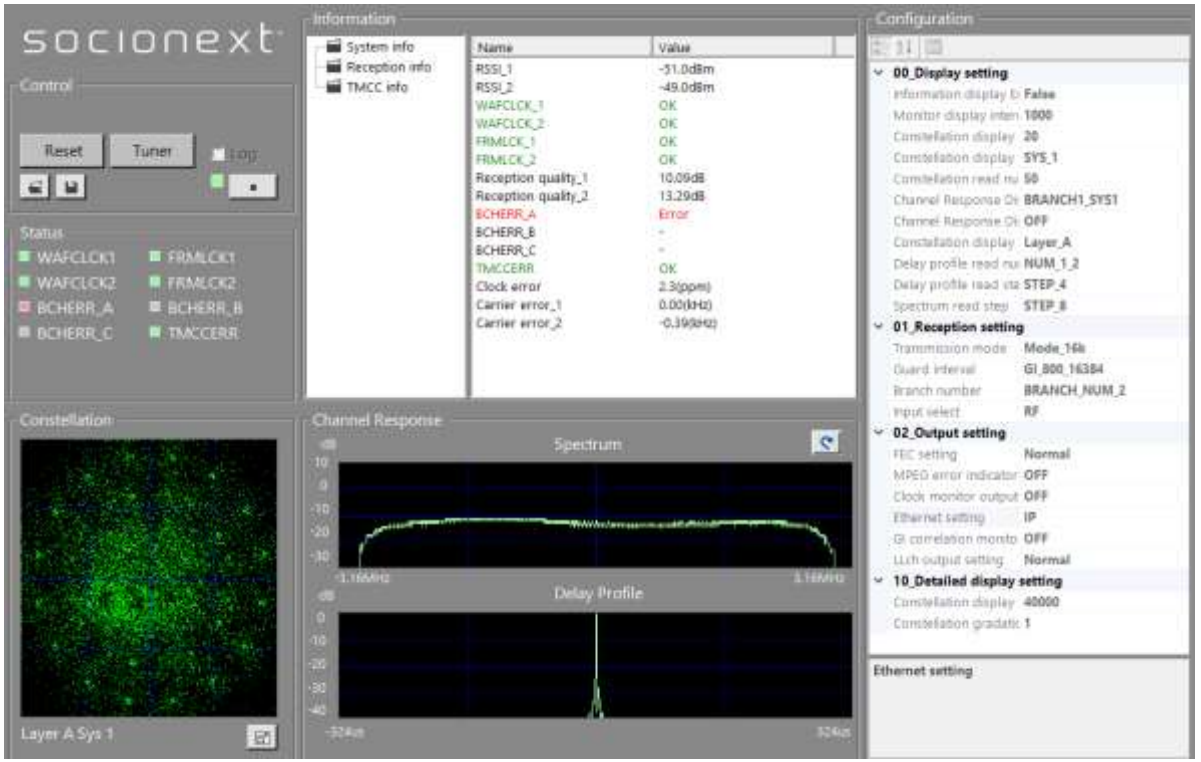


Figure 9.9 - Socionext Screen

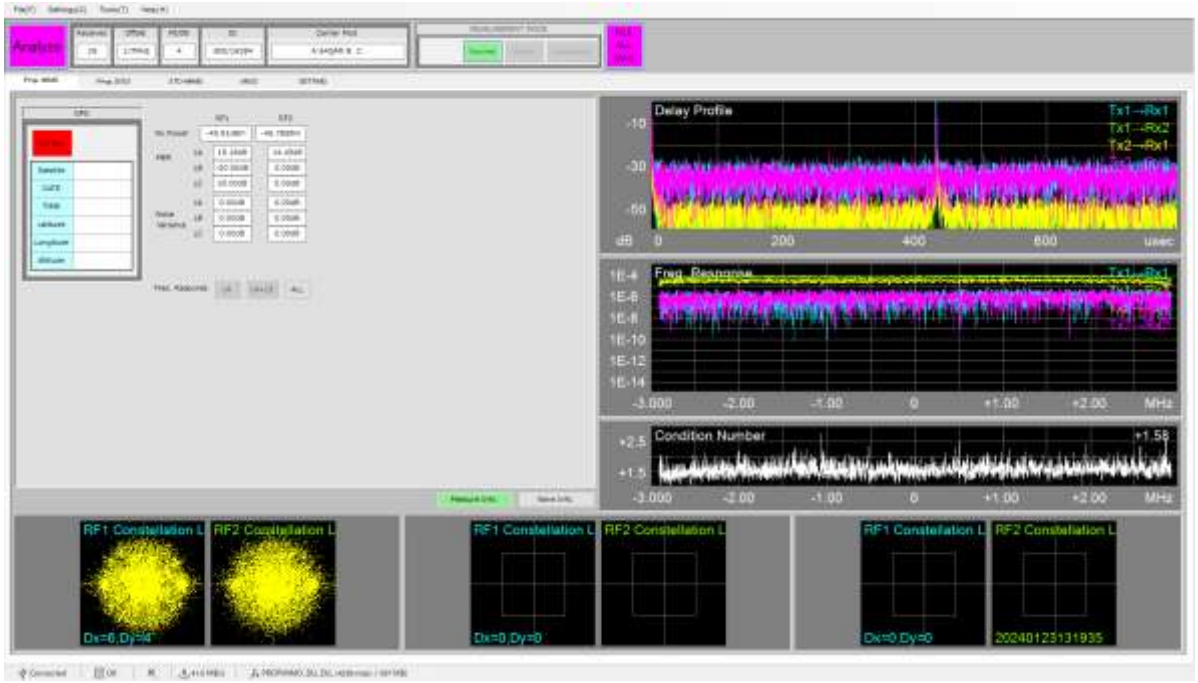


Figure 9.10 - Rintaro Screen

d) Reception Threshold

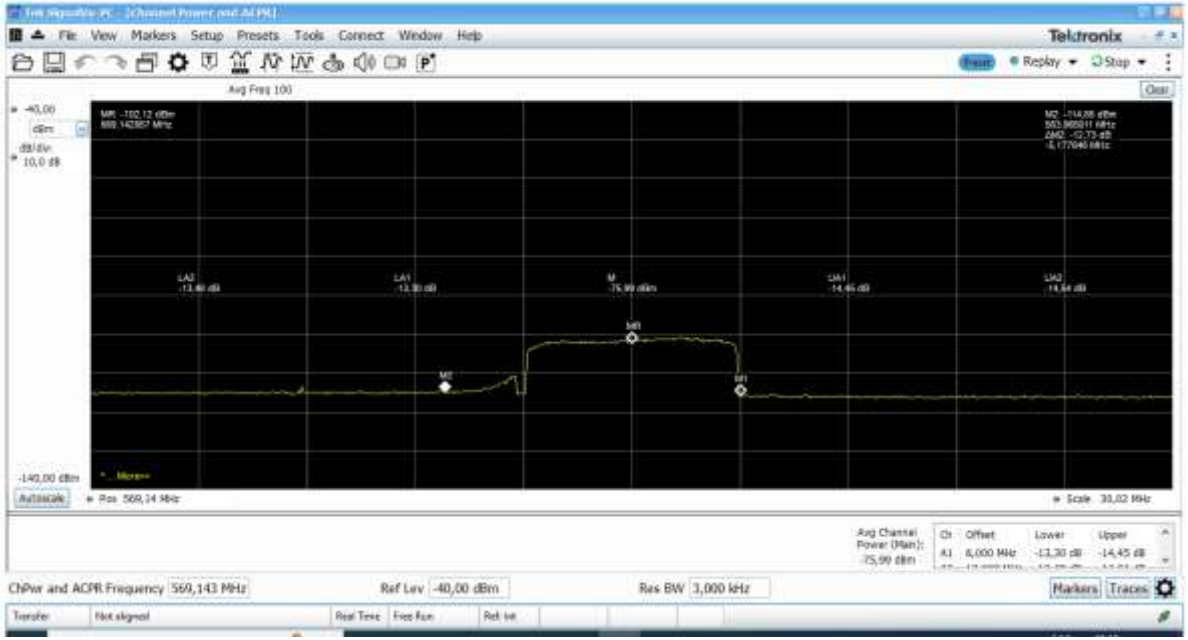


Figure 9.11 - Vertical

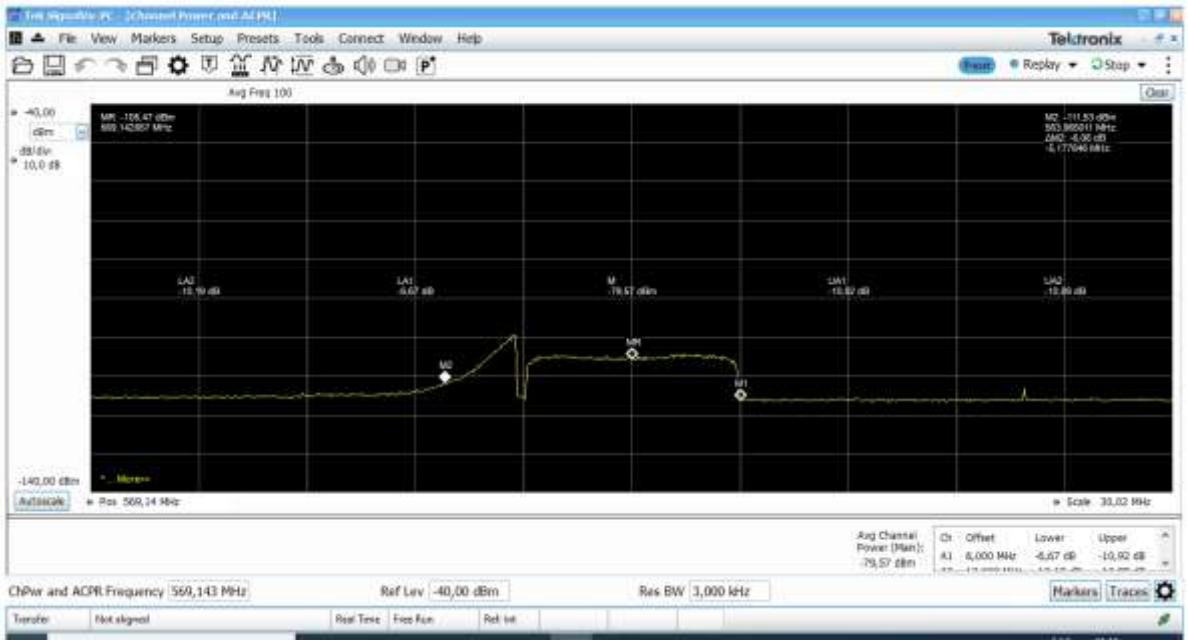


Figure 9.12 - Horizontal

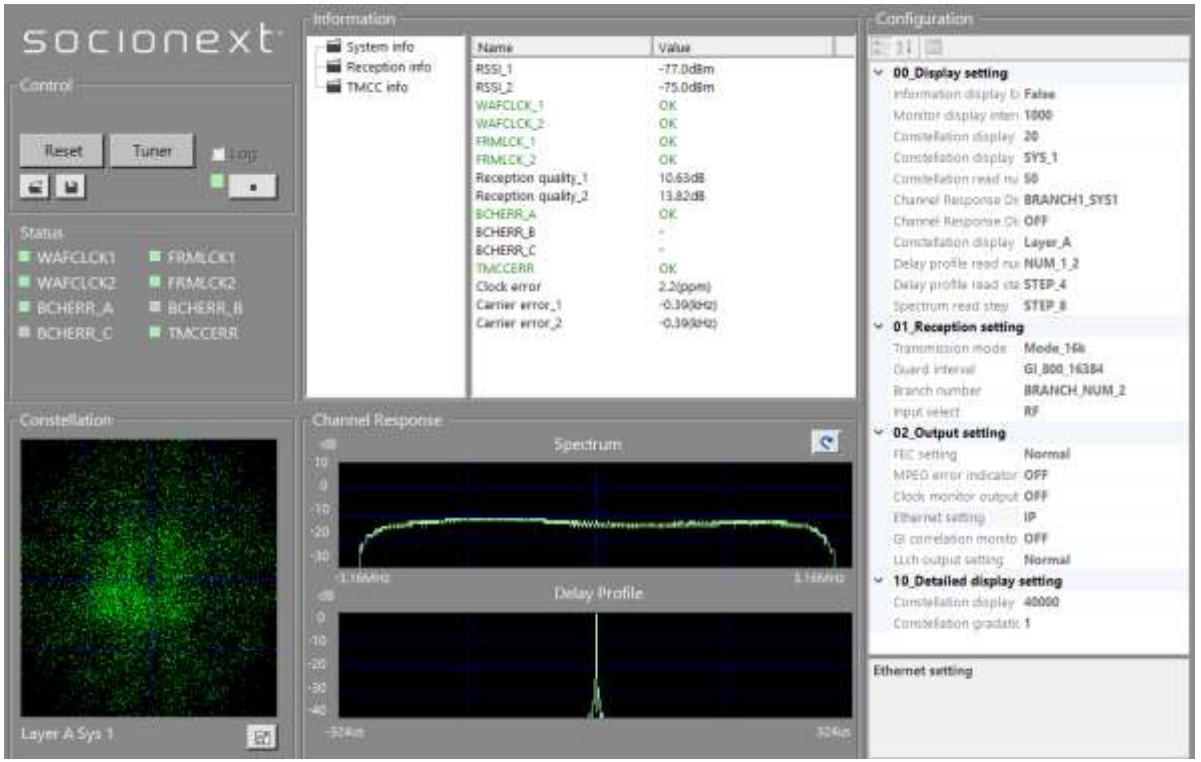


Figure 9.13 - Socionext Screen

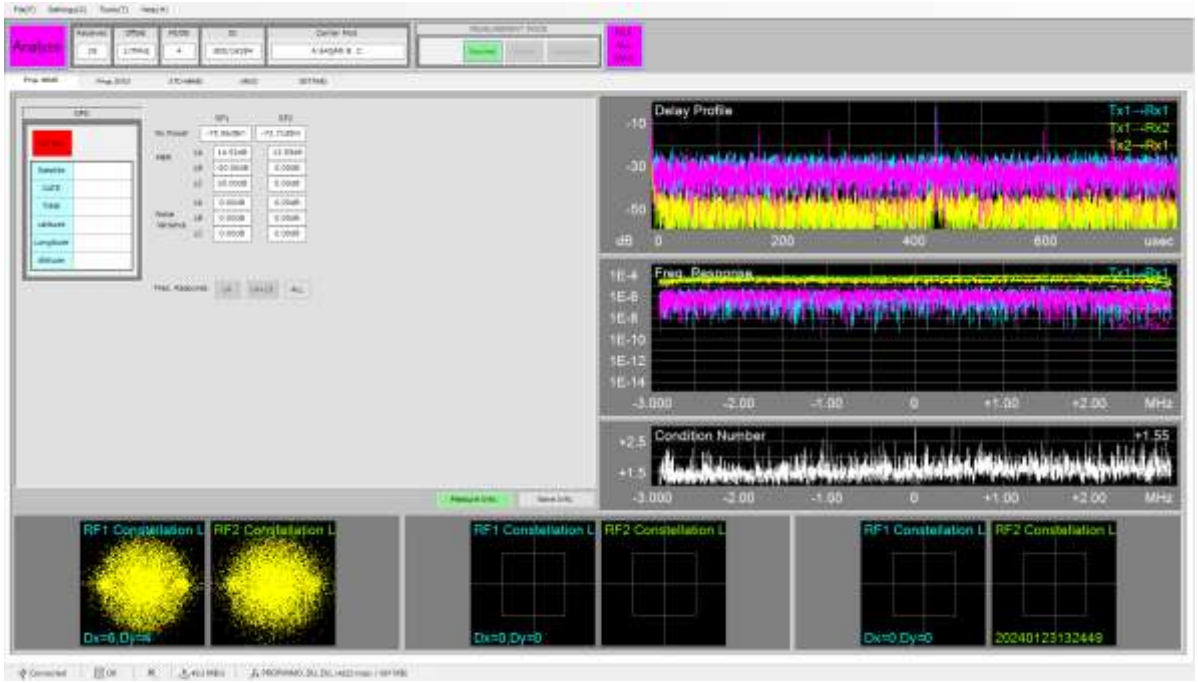


Figure 9.14 - Rintaro Screen

Chapter 10. Site 10

a) Channel Power

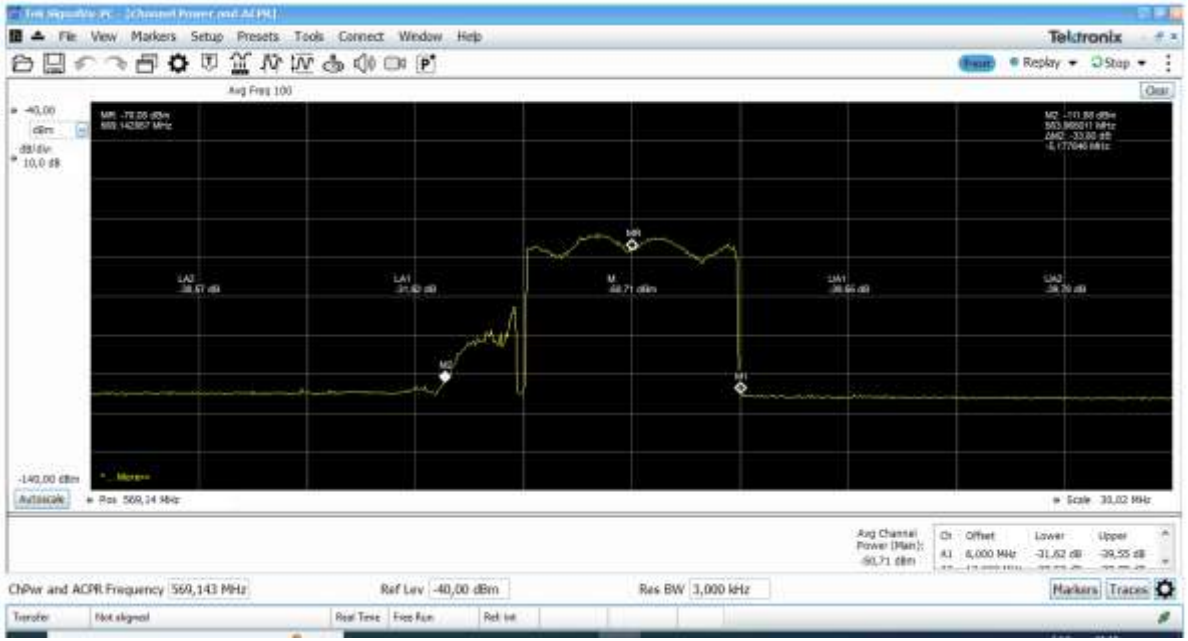


Figure 10.1 - Vertical

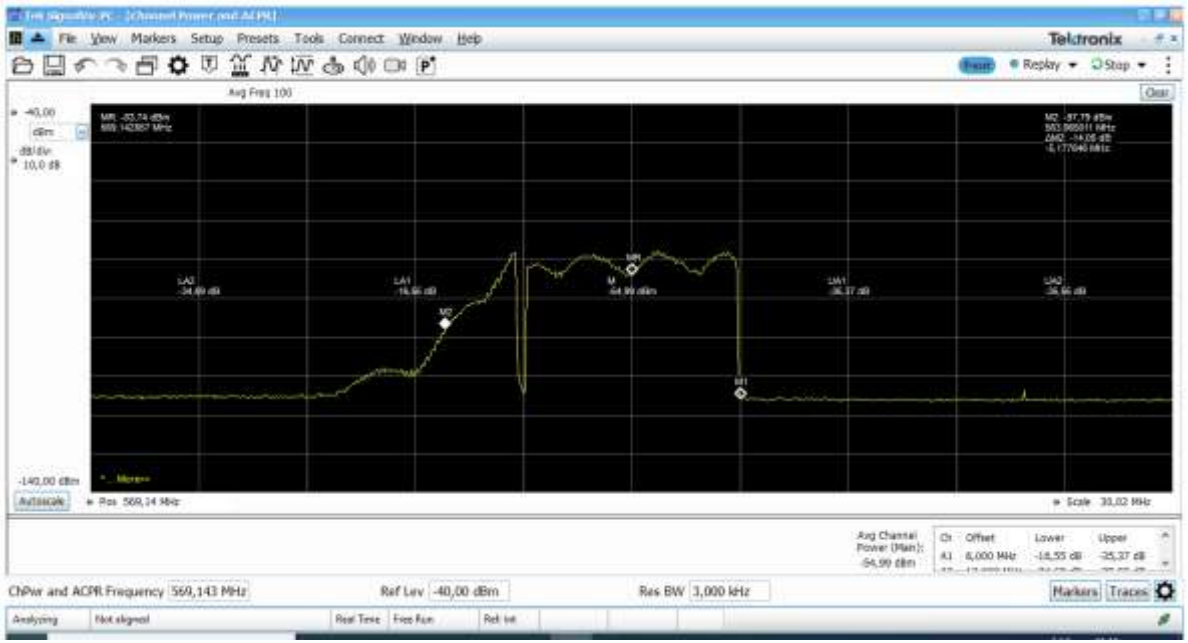


Figure 10.2 - Horizontal

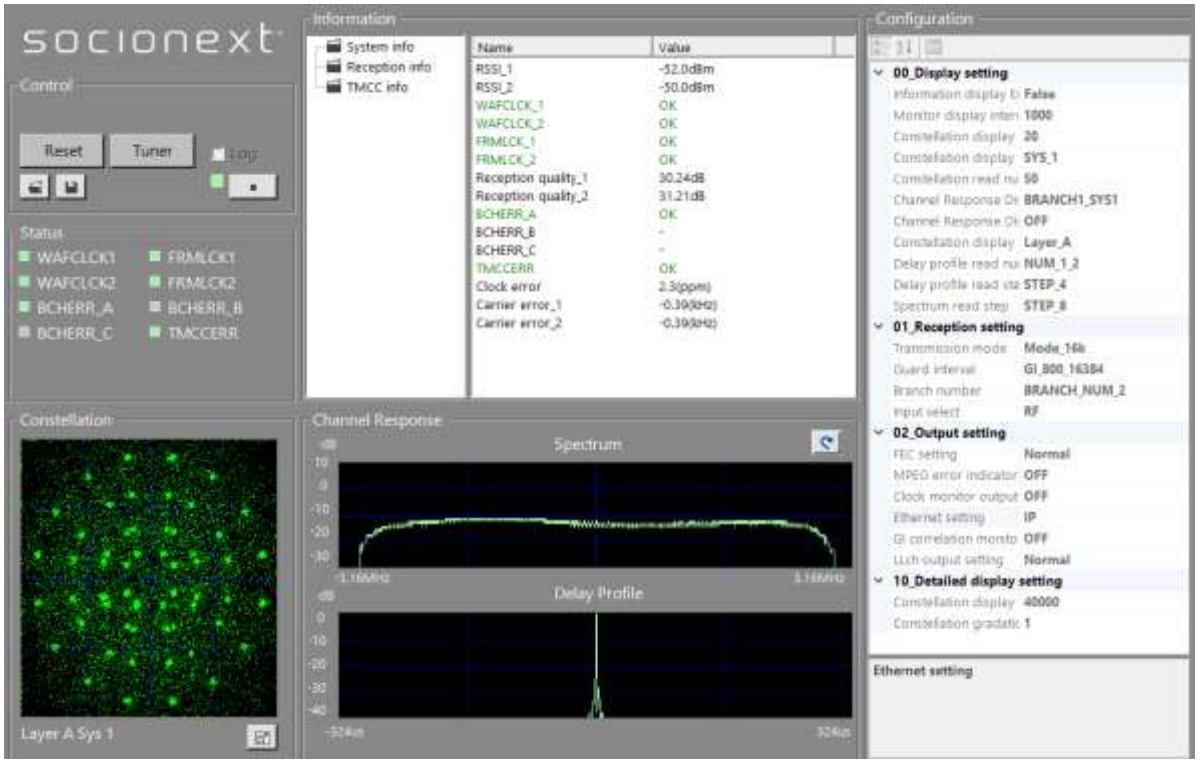


Figure 10.3 - Socionext Screen

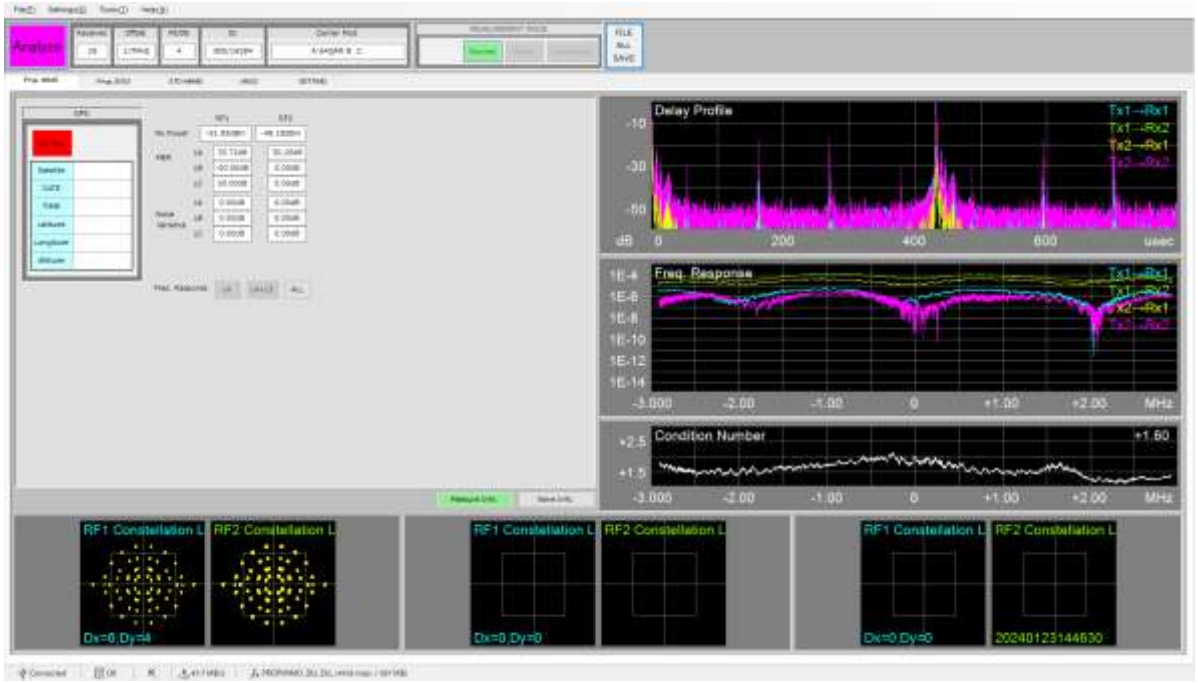


Figure 10.4 - Rintaro Screen

b) AWGN Power

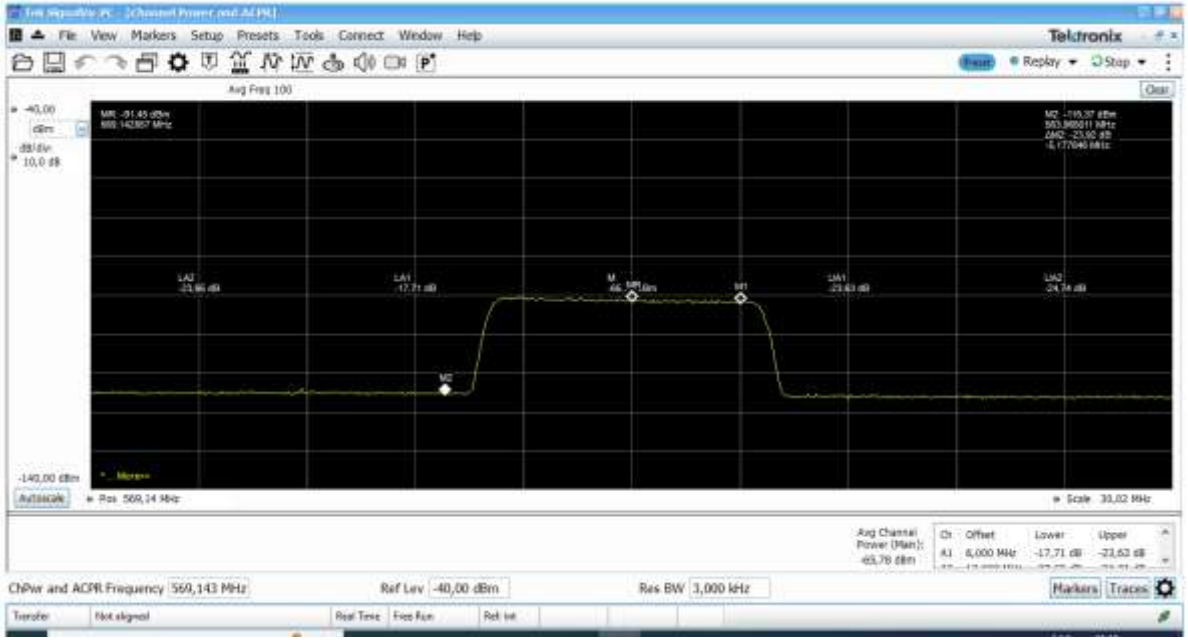


Figure 10.5 - Vertical

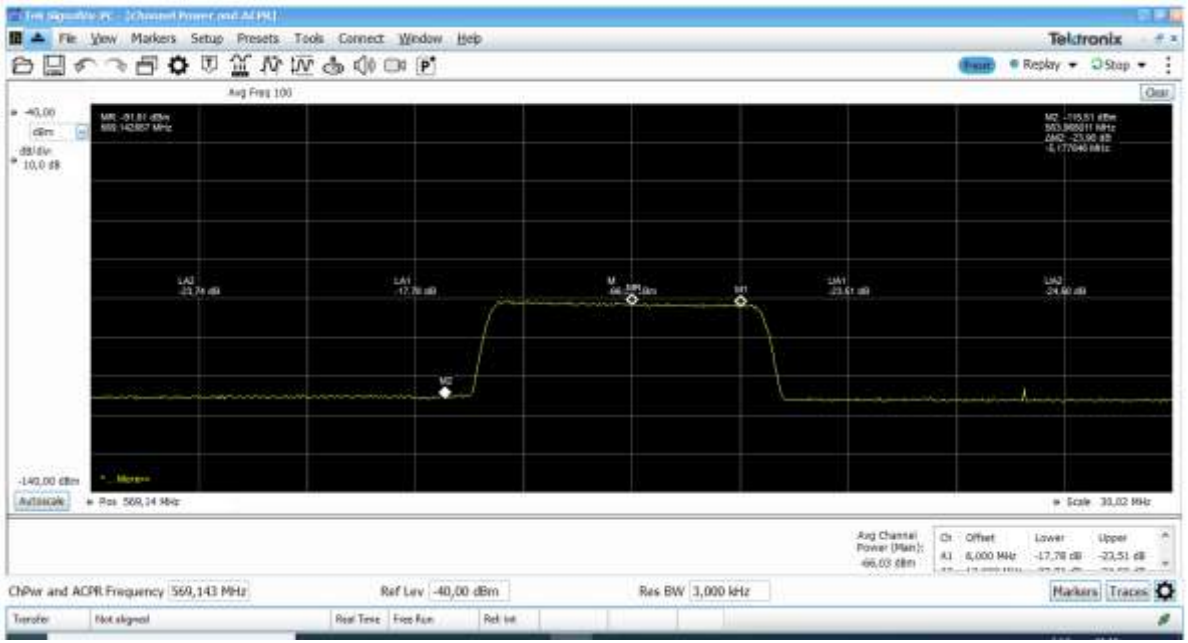


Figure 10.6 - Horizontal

c) C/N Threshold

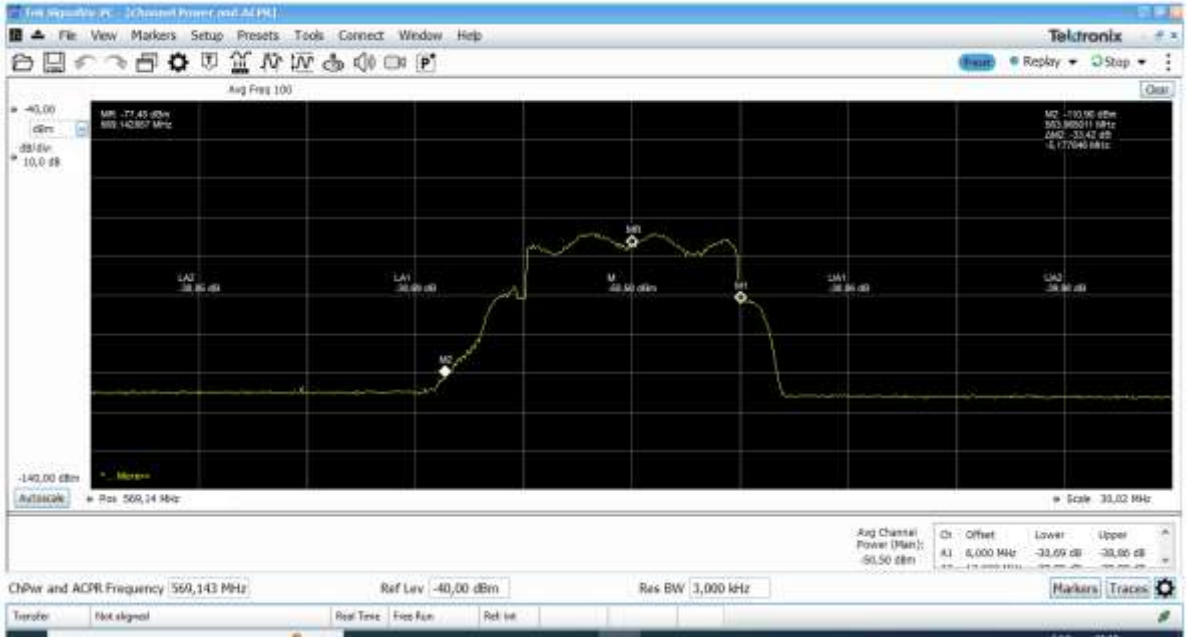


Figure 10.7 - Vertical

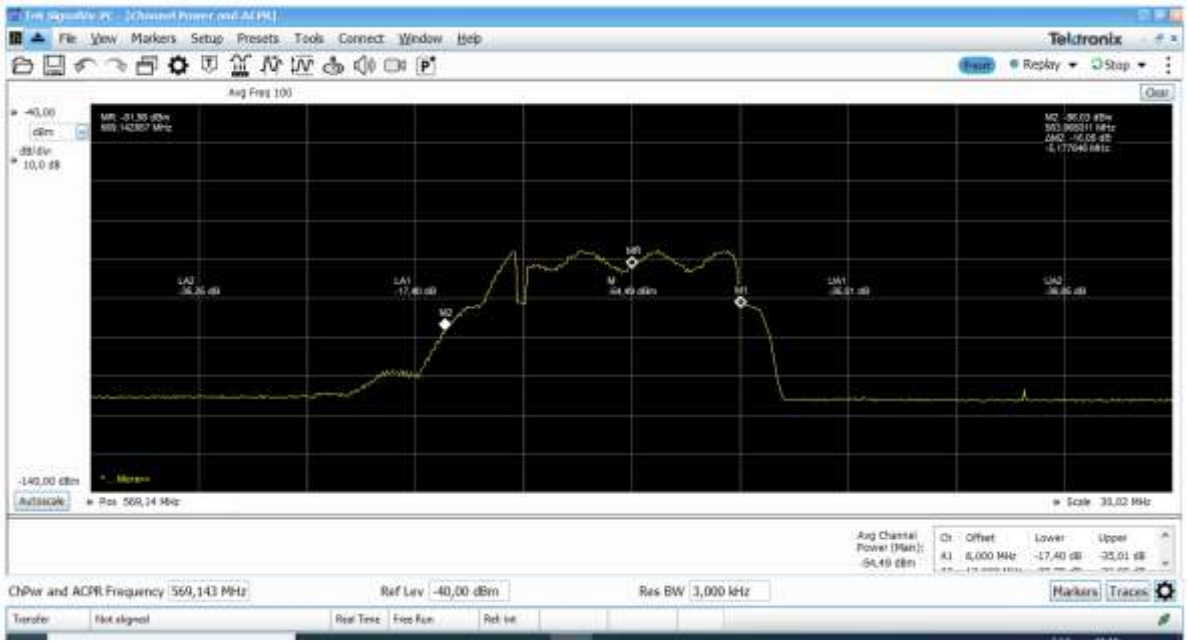


Figure 10.8 - Horizontal

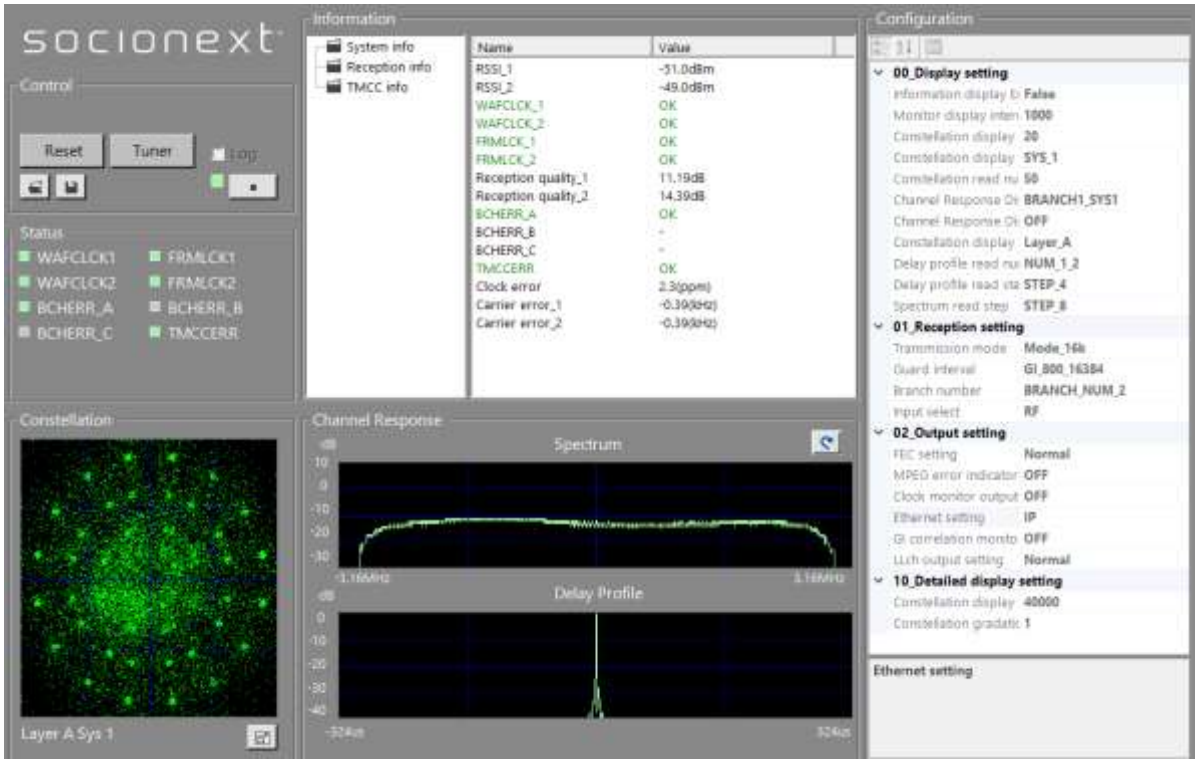


Figure 10.9 - Socionext Screen

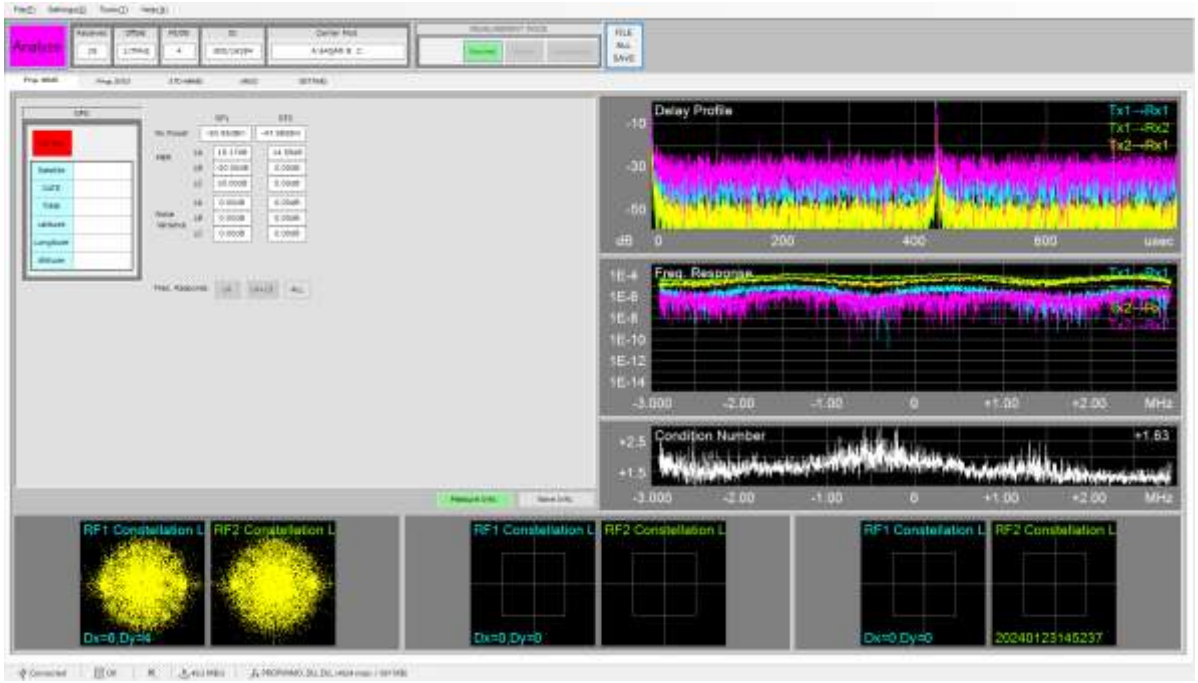


Figure 10.10 - Rintaro Screen

d) Reception Threshold

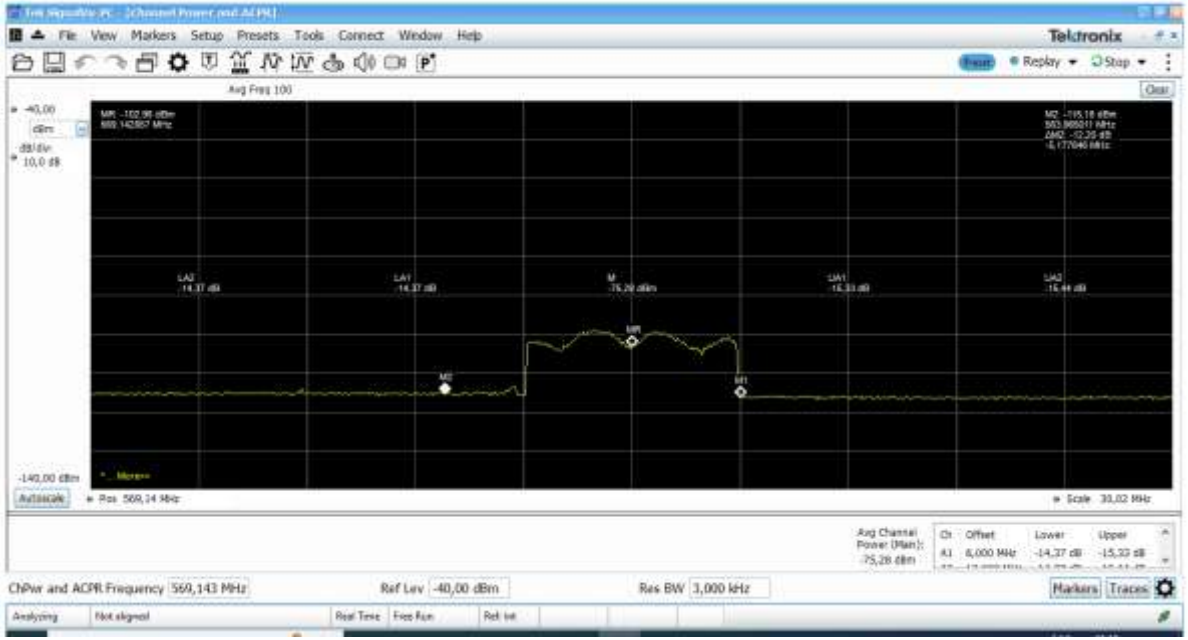


Figure 10.11 - Vertical

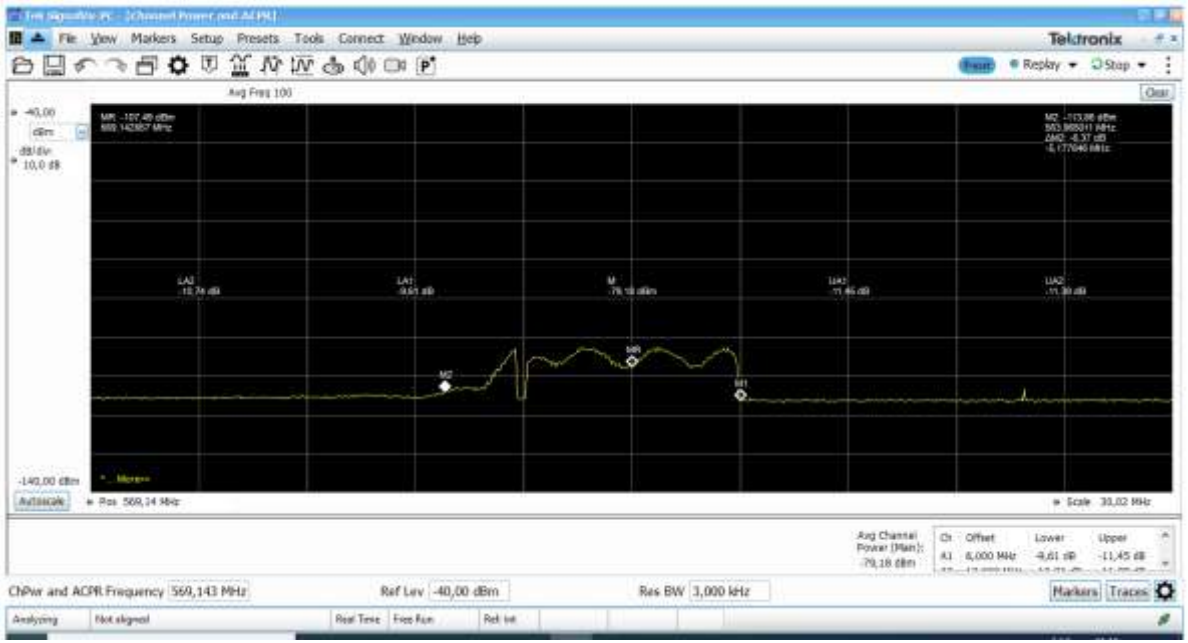


Figure 10.12 - Horizontal

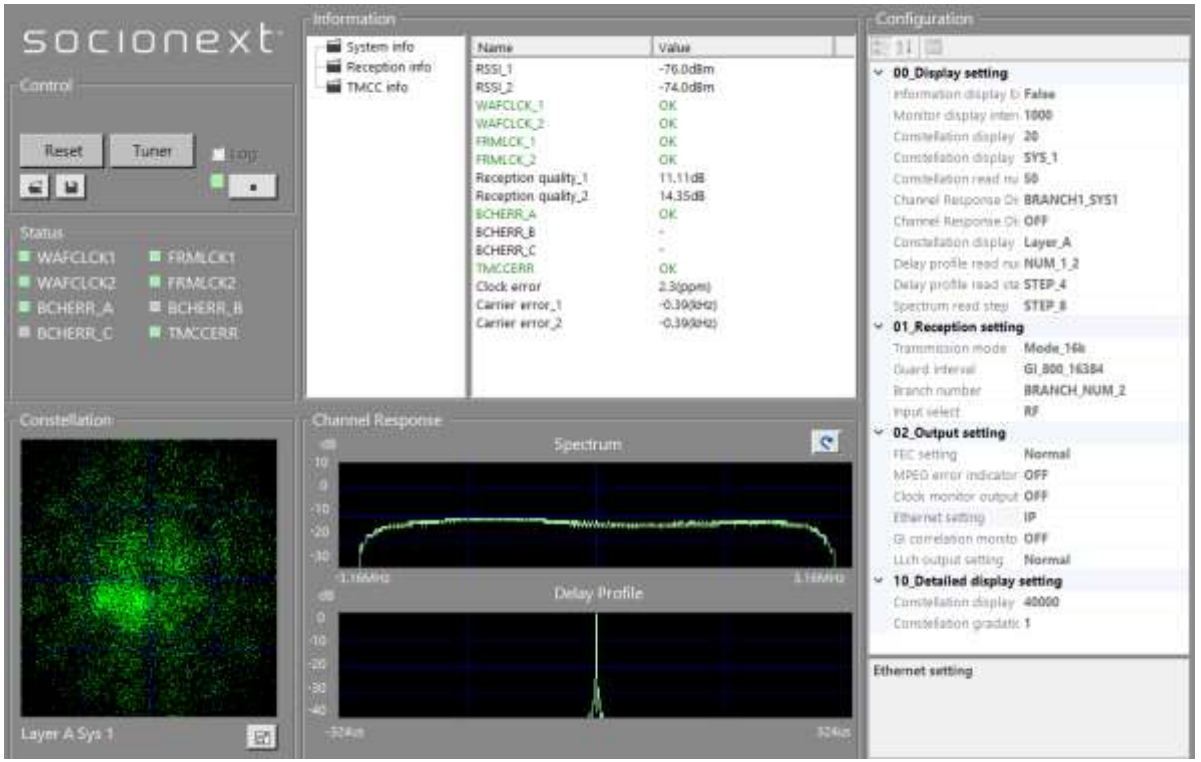


Figure 10.13 - Socionext Screen

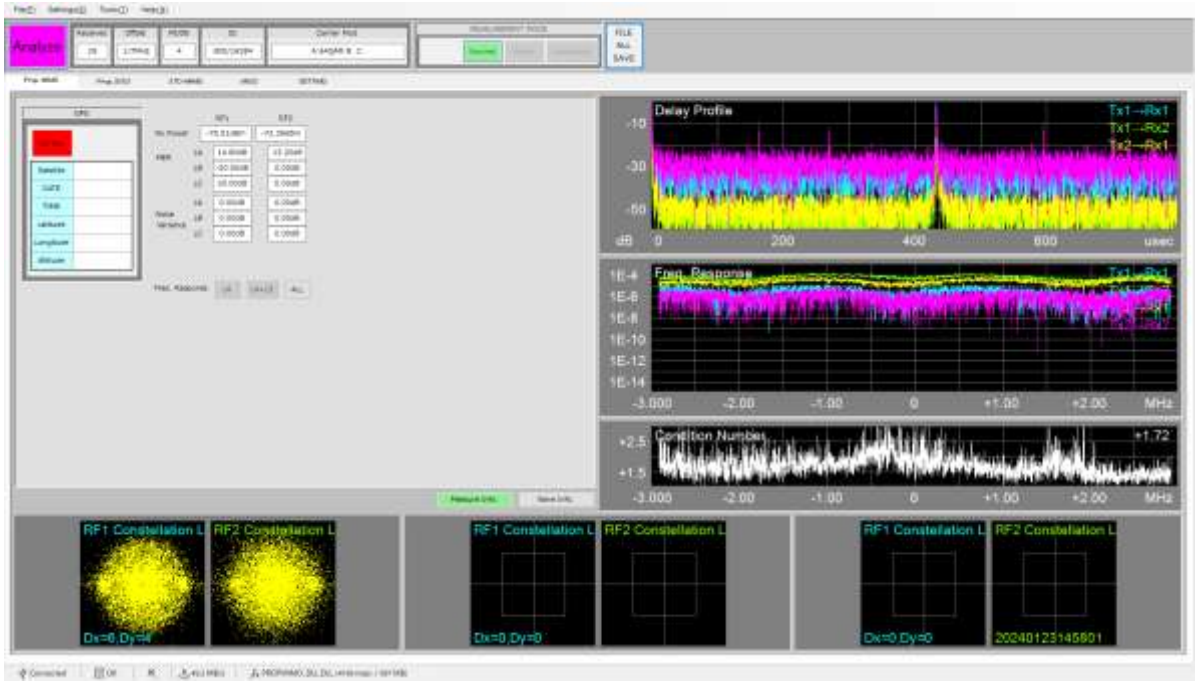


Figure 10.14 - Rintaro Screen

Chapter 11 - Site 11

a) Channel Power

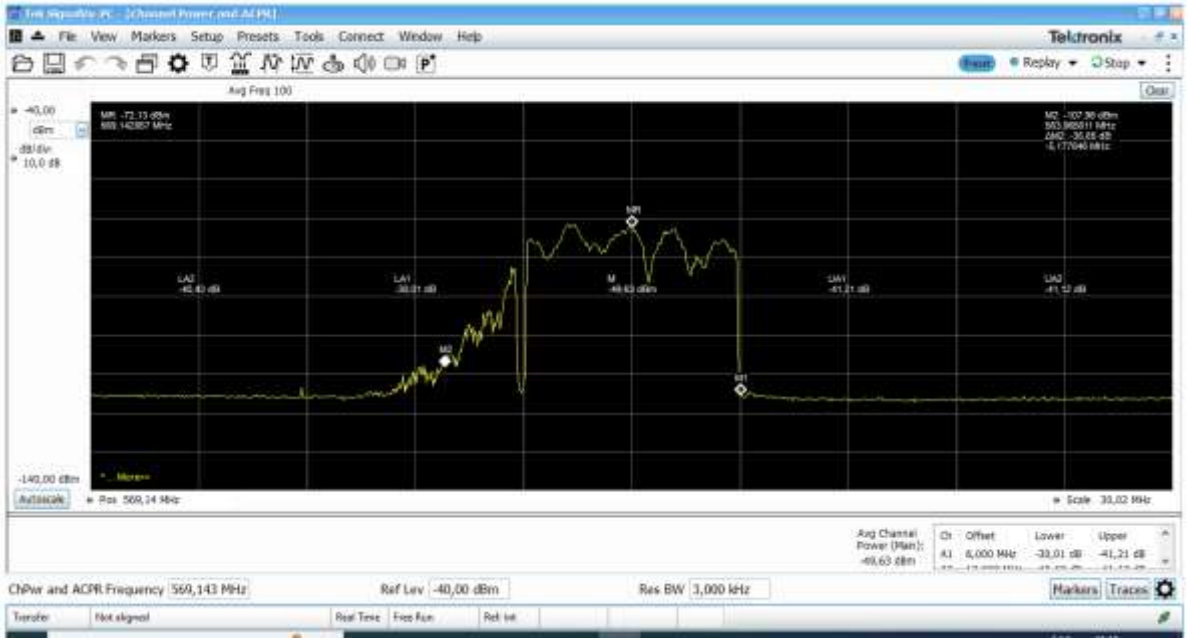


Figure 11.1 - Vertical

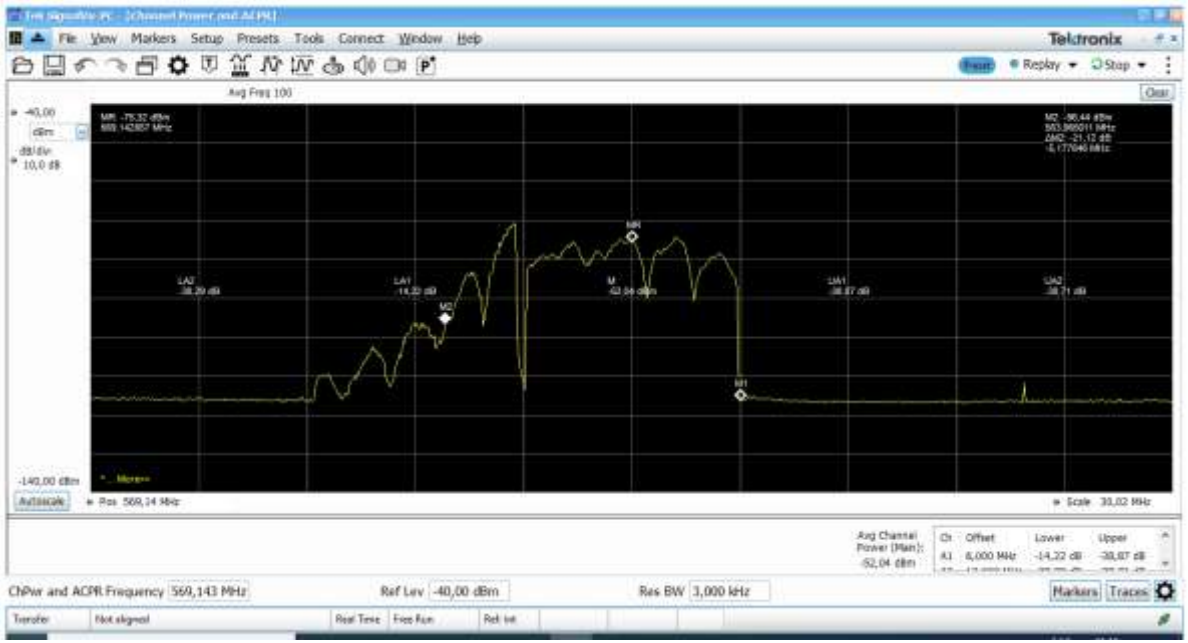


Figure 11.2 - Horizontal

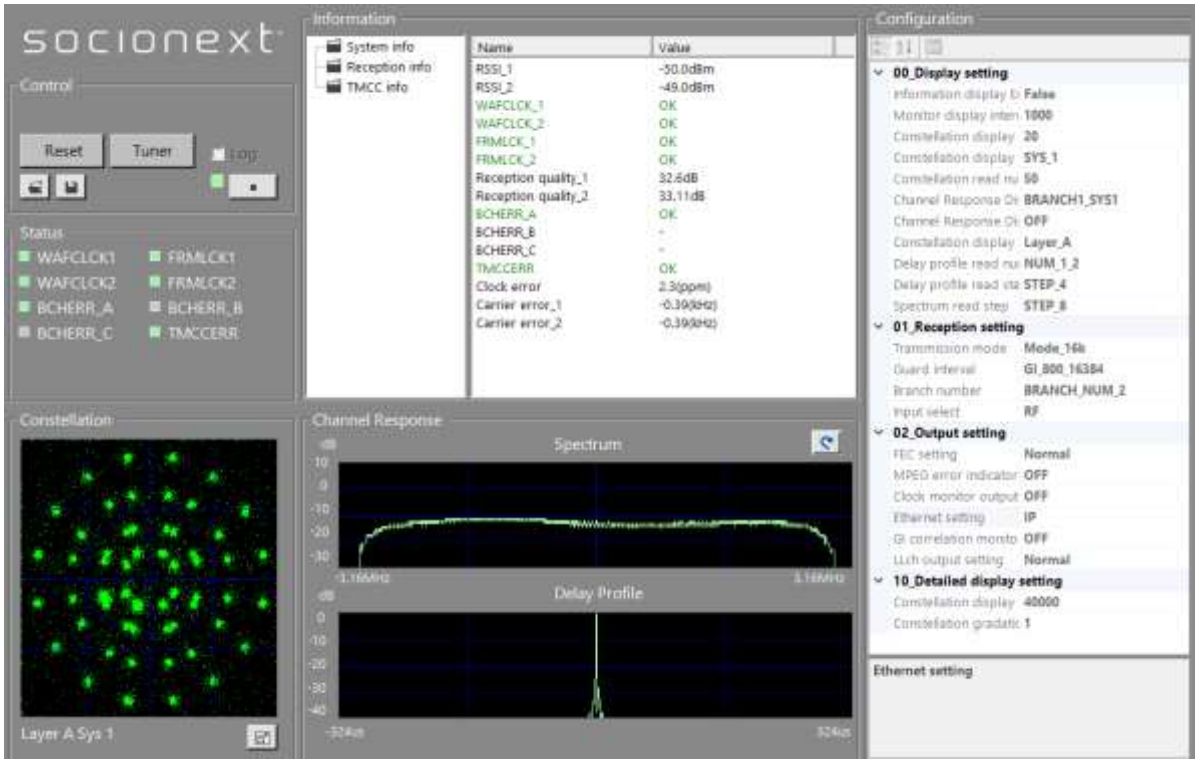


Figure 11.3 - Socionext Screen

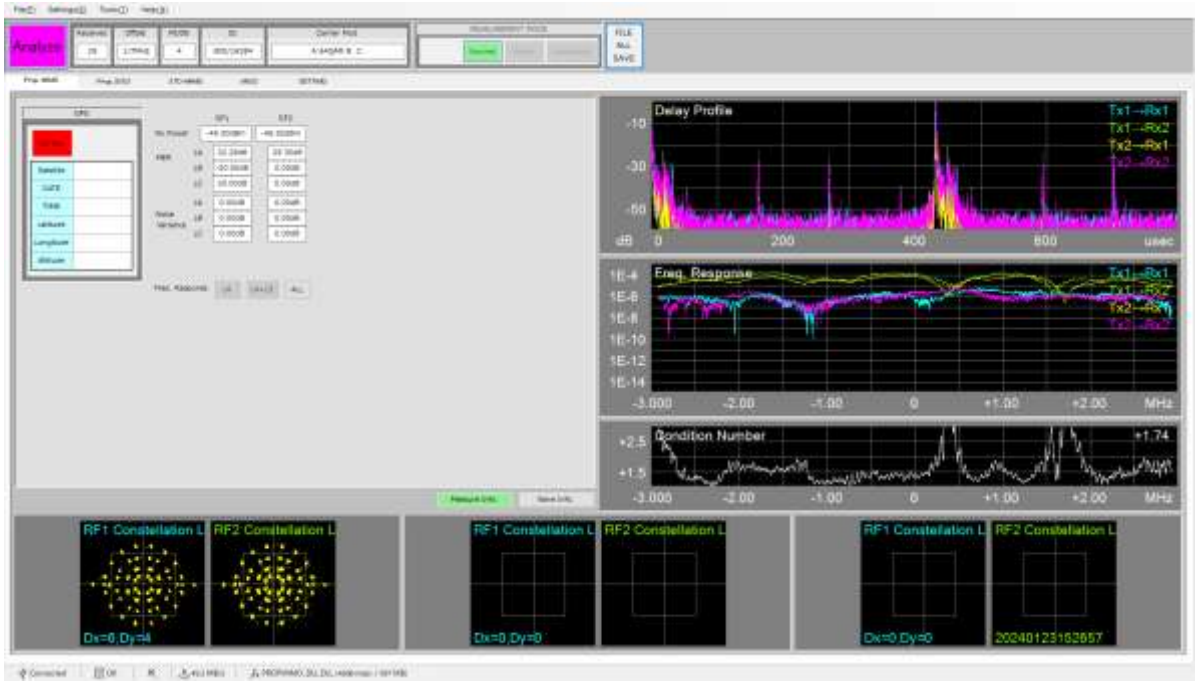


Figure 11.4 - Rintaro Screen

b) AWGN Power

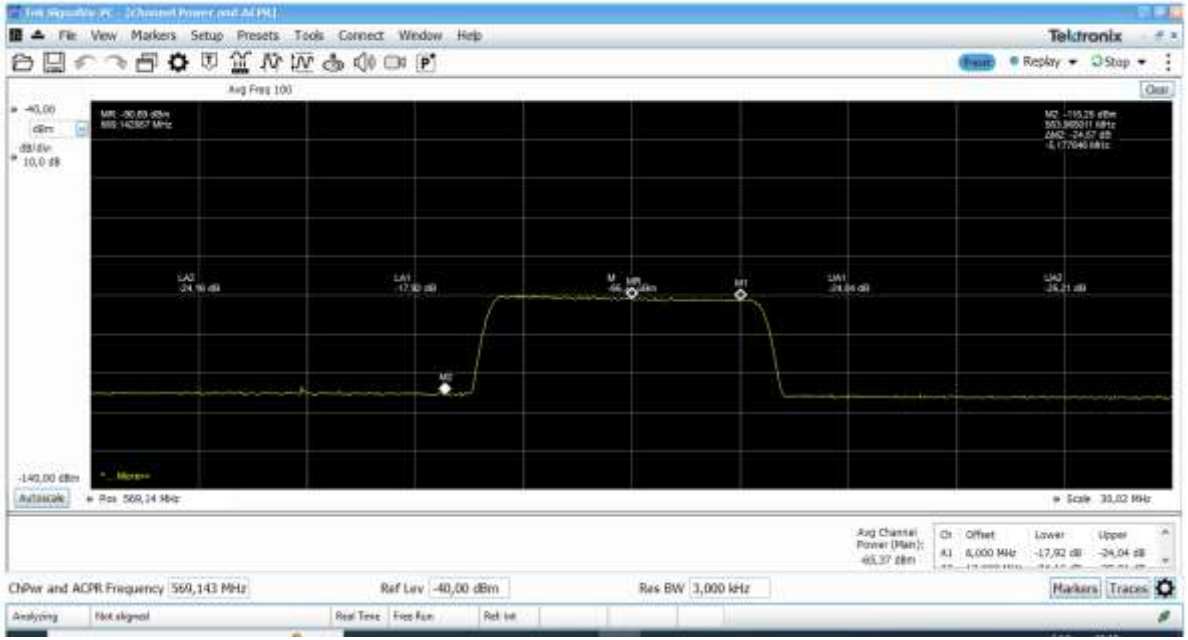


Figure 11.5 - Vertical

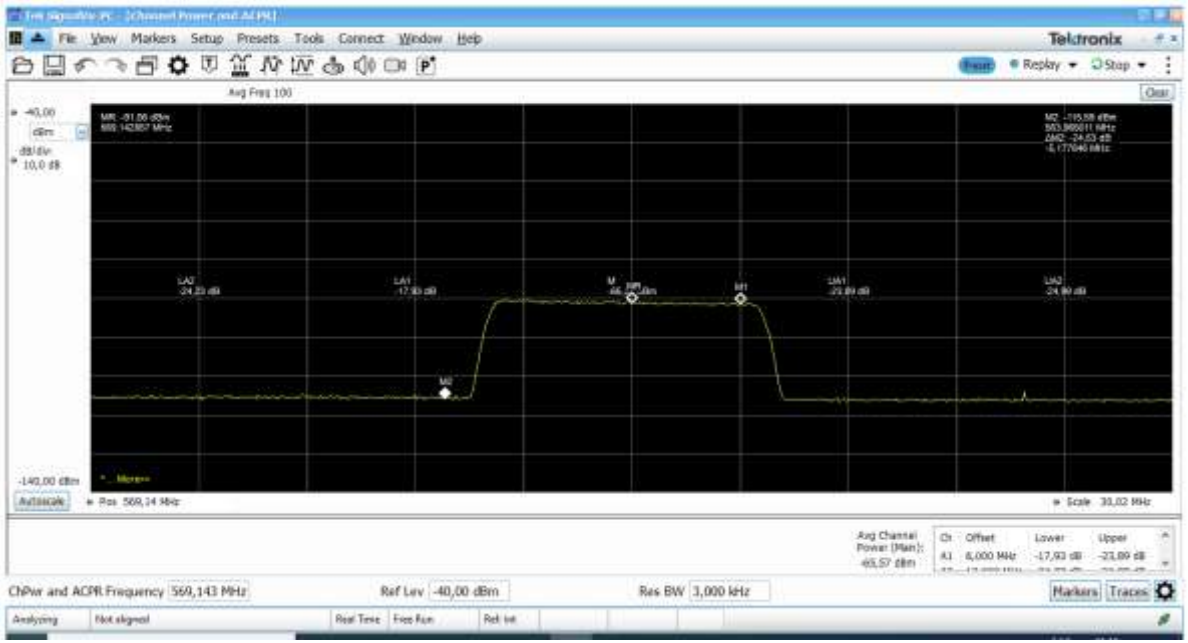


Figure 11.6 - Horizontal

c) C/N Threshold

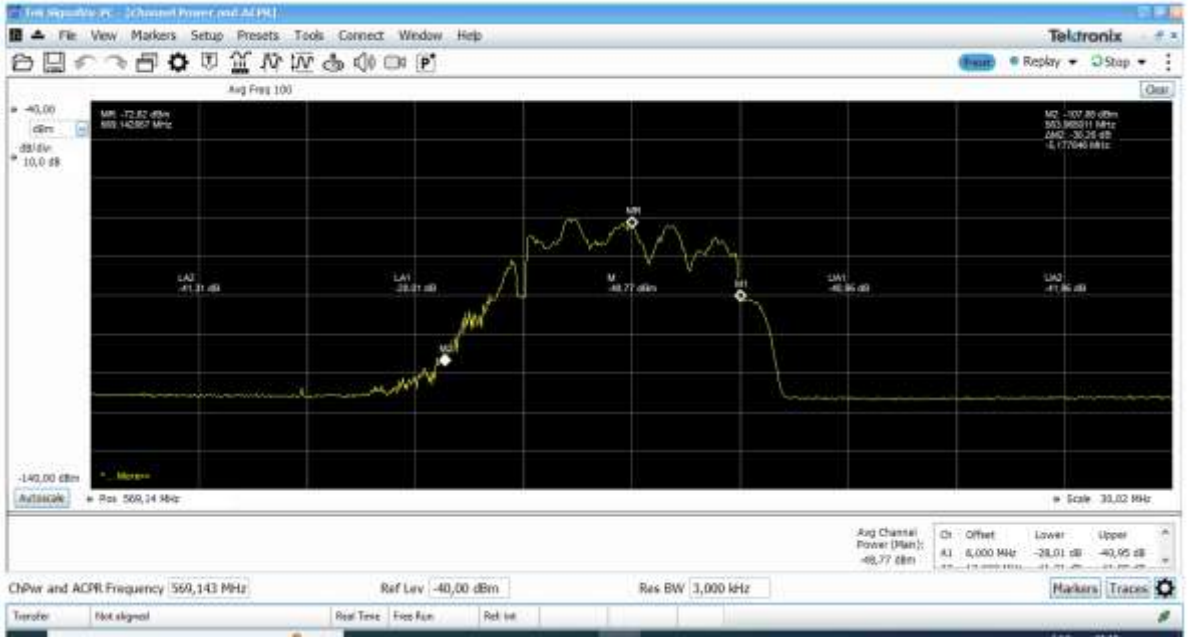


Figure 11.7 - Vertical

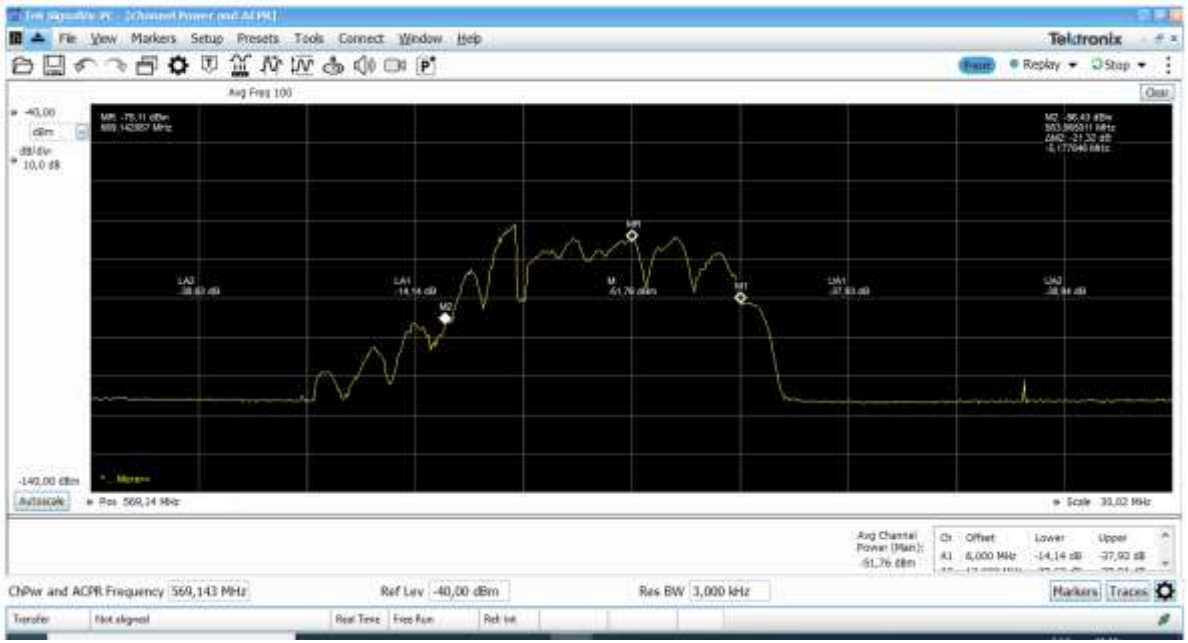


Figure 11.8 - Horizontal

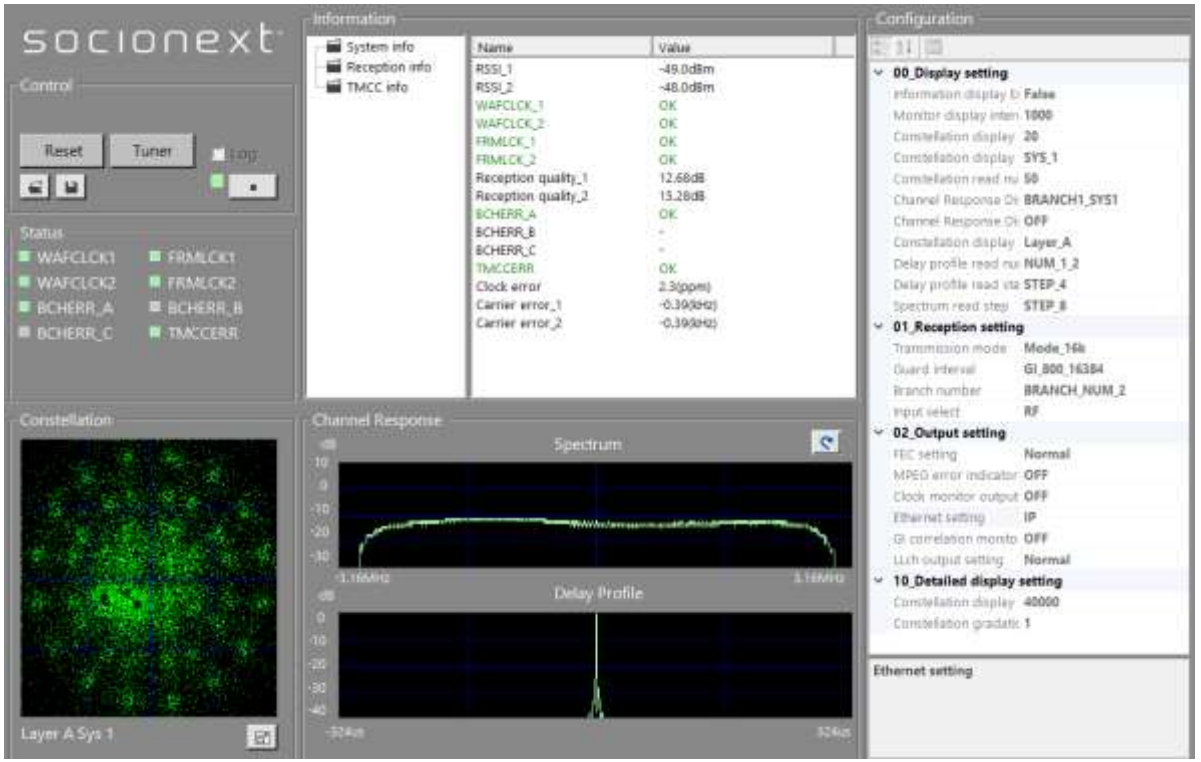


Figure 11.9 - Socionext Screen

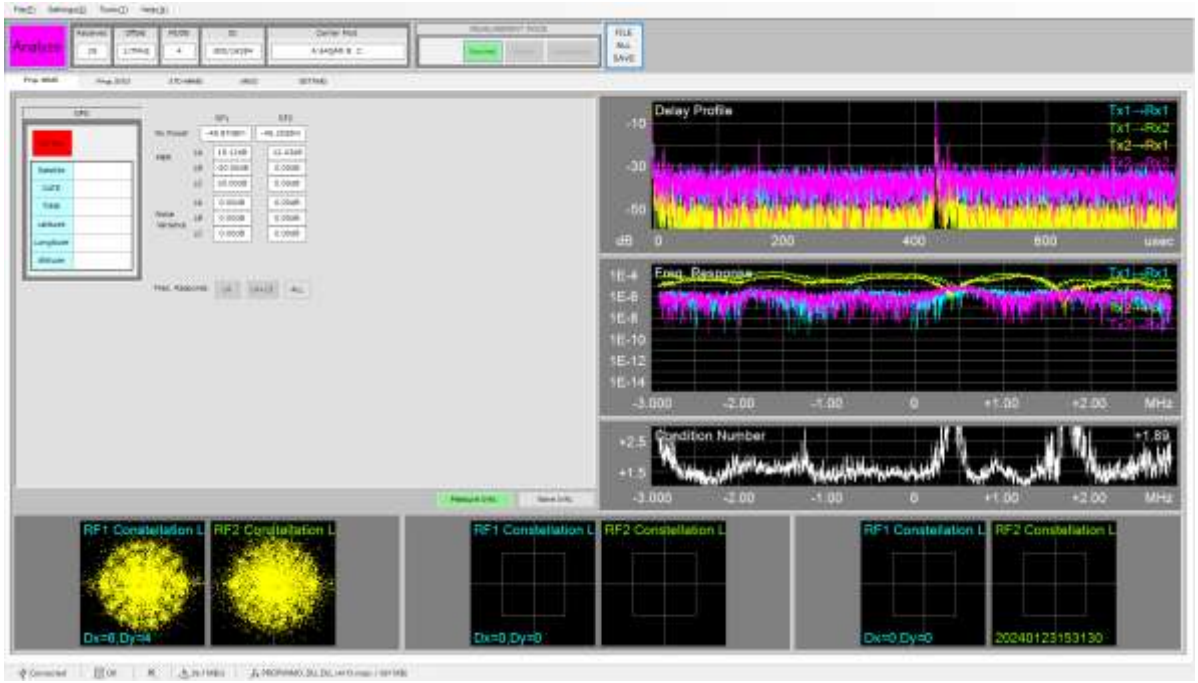


Figure 11.10 - Rintaro Screen

d) Reception Threshold

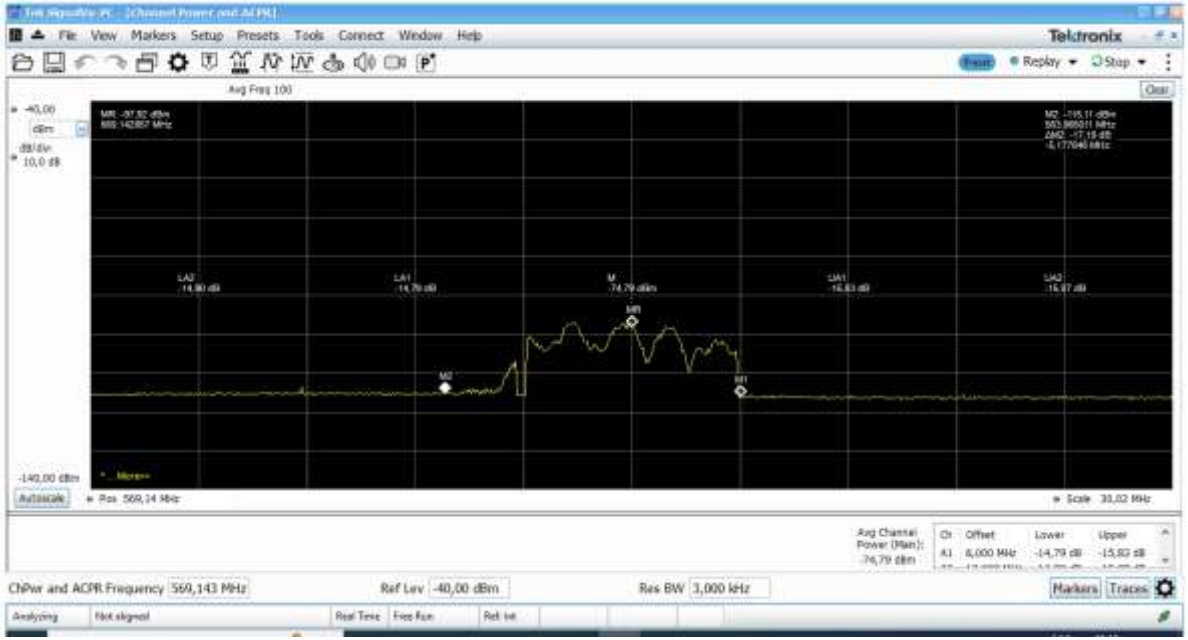


Figure 11.11 - Vertical

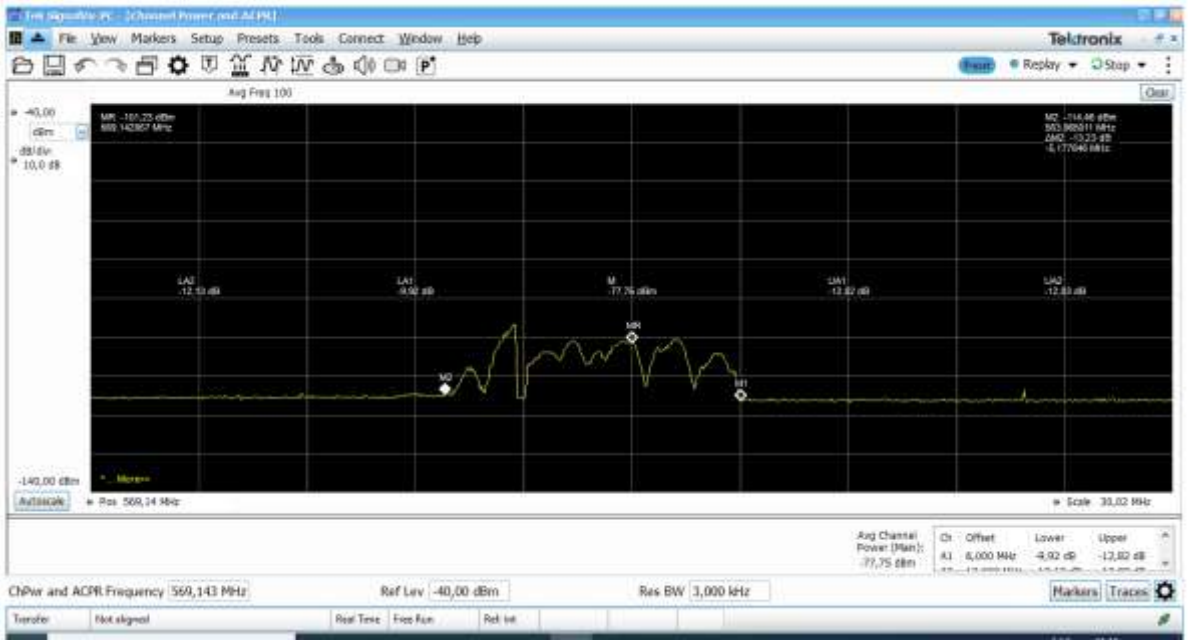


Figure 11.12 - Horizontal

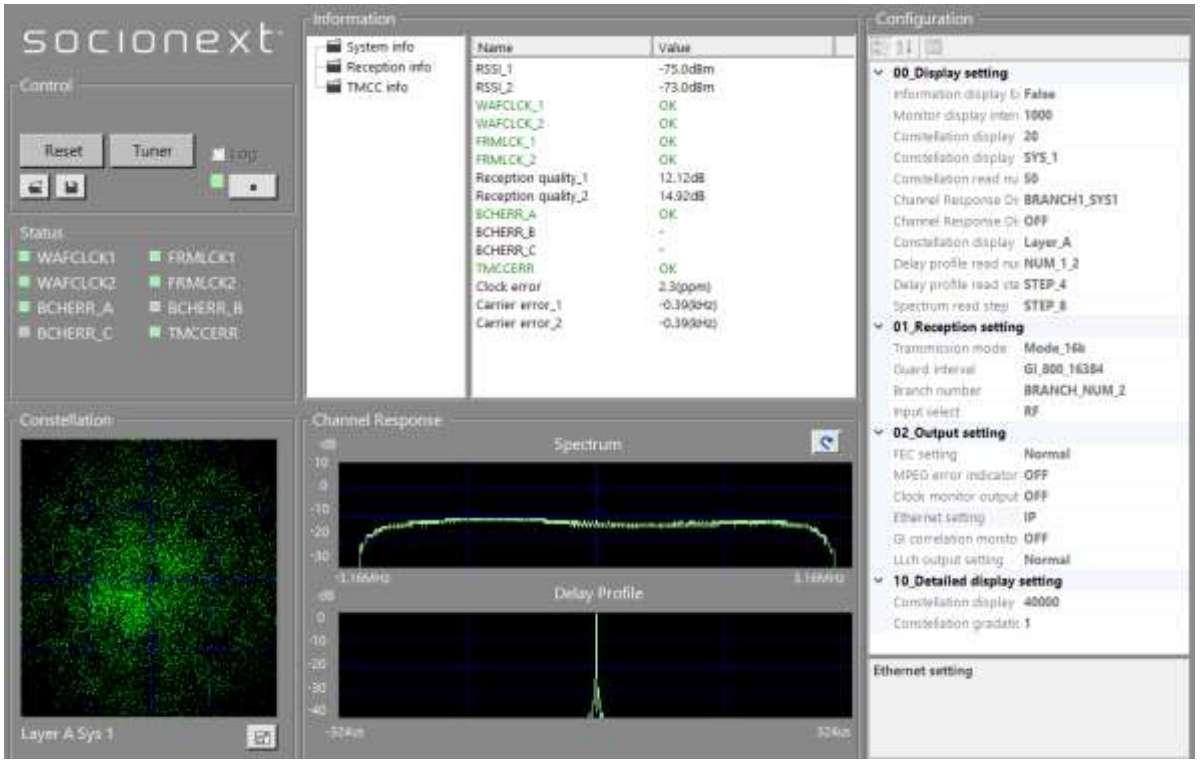


Figure 11.13 - Socionext Screen

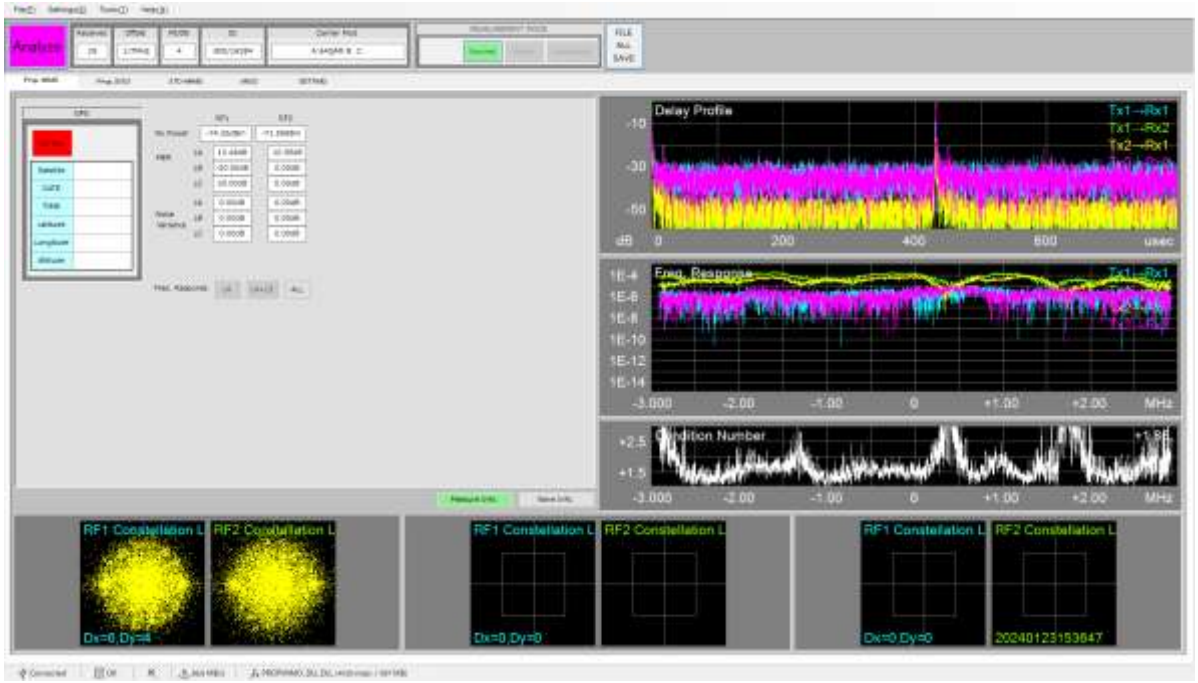


Figure 11.14 - Rintaro Screen

Chapter 12. Site 12

a) Channel Power

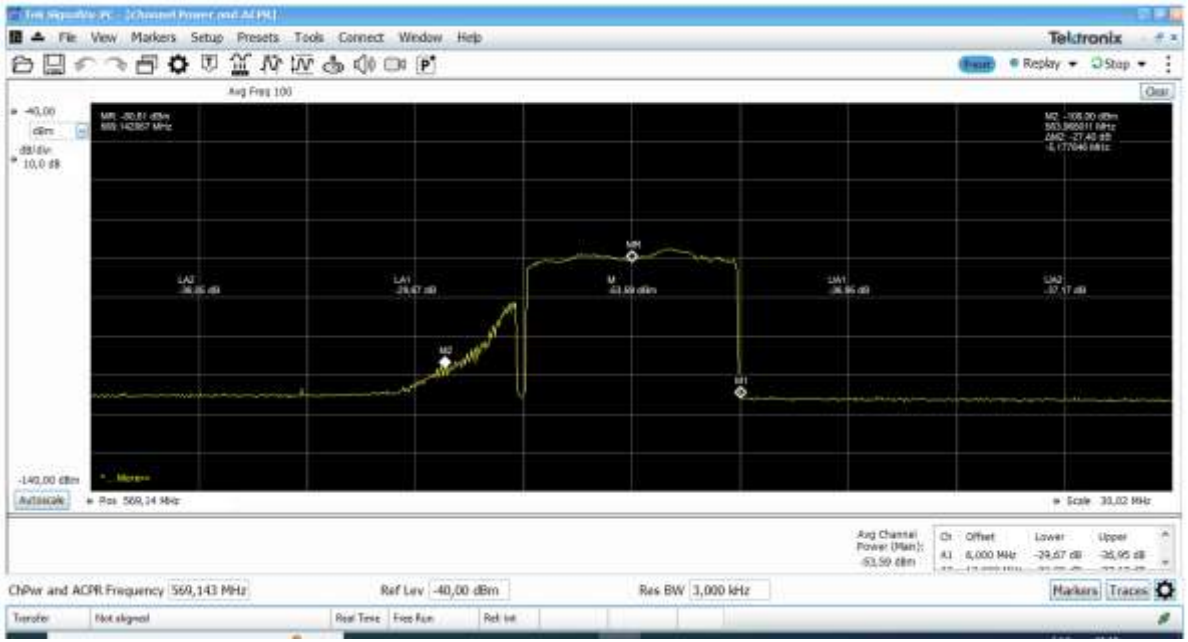


Figure 12.1 - Vertical

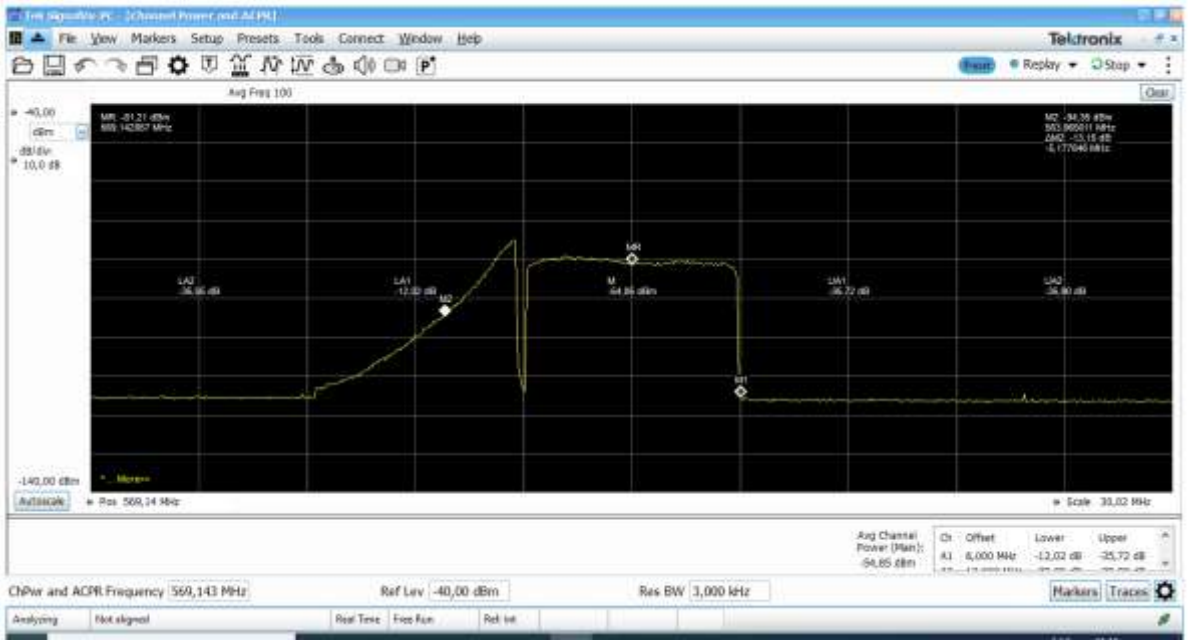


Figure 12.2 - Horizontal

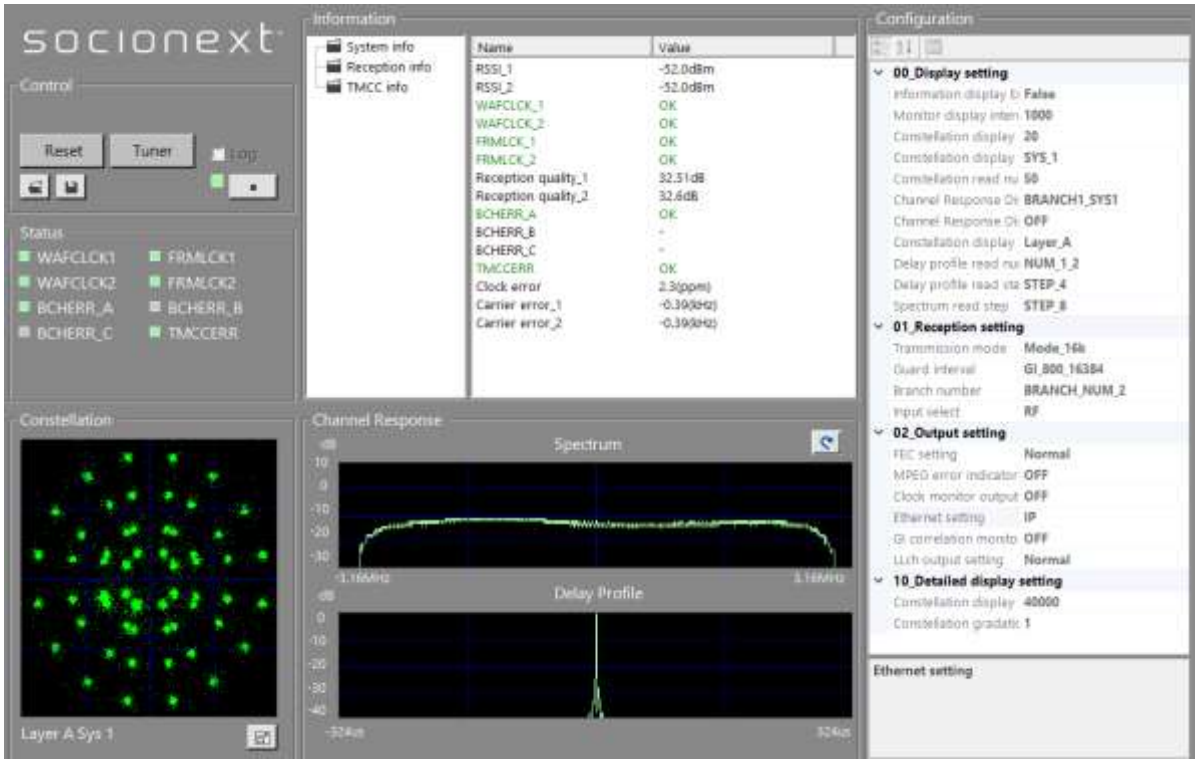


Figure 12.3 - Socionext Screen

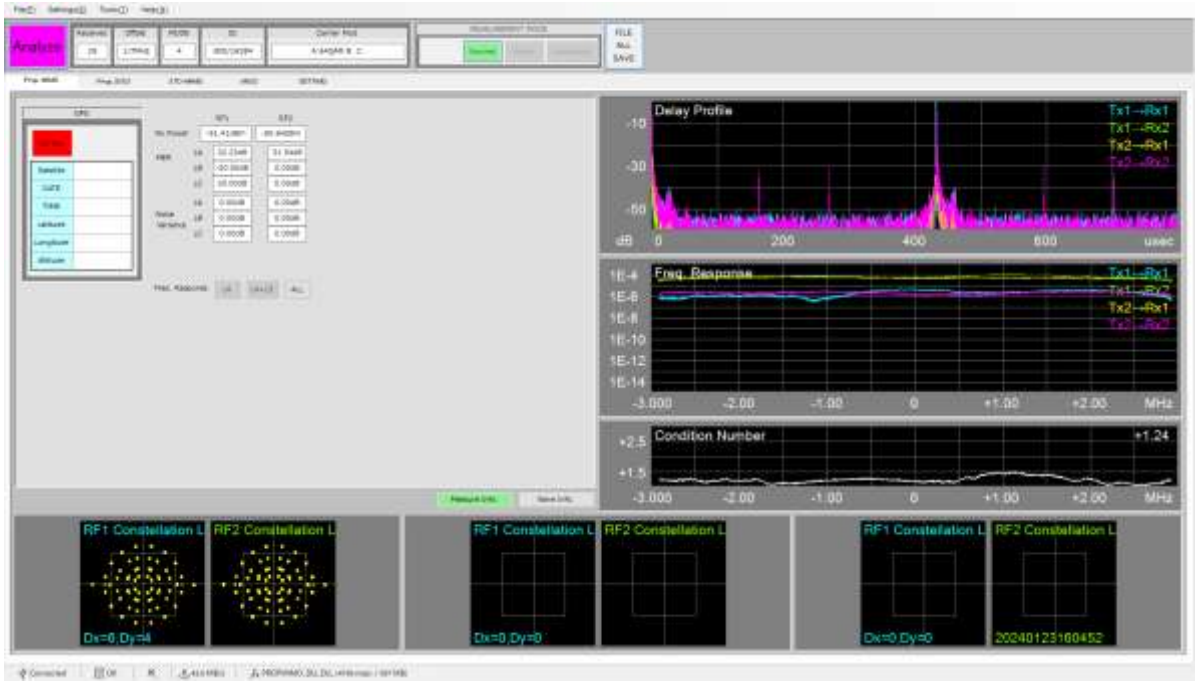


Figure 12.4 - Rintaro Screen

b) AWGN Power

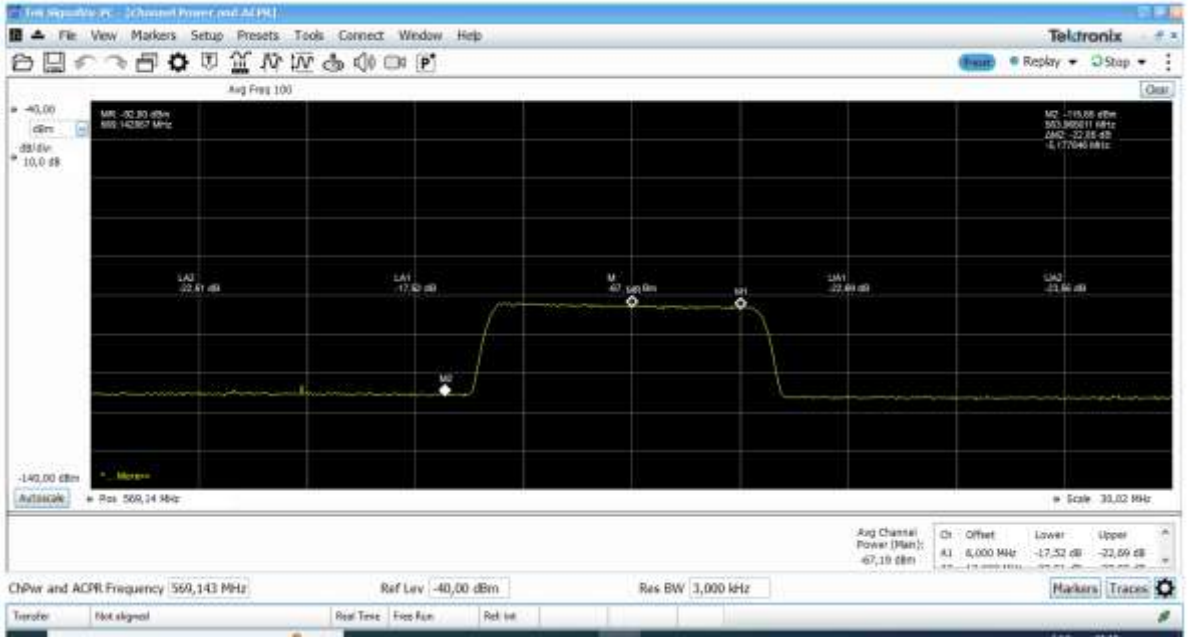


Figure 12.5 - Vertical

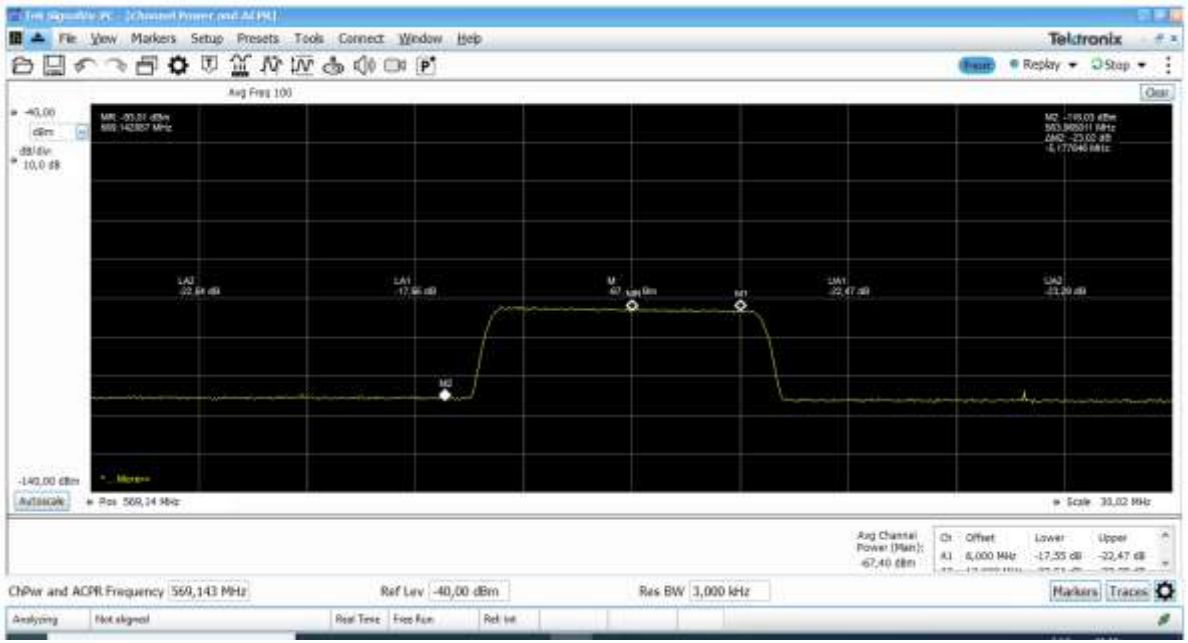


Figure 12.6 - Horizontal

c) C/N Threshold

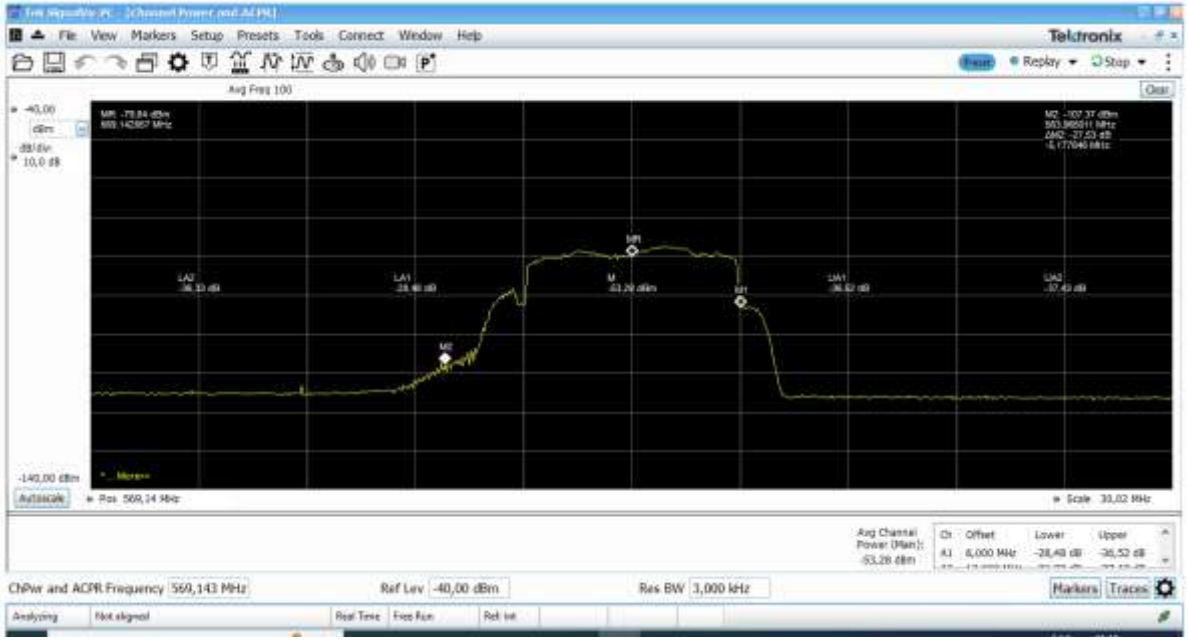


Figure 12.7 - Vertical

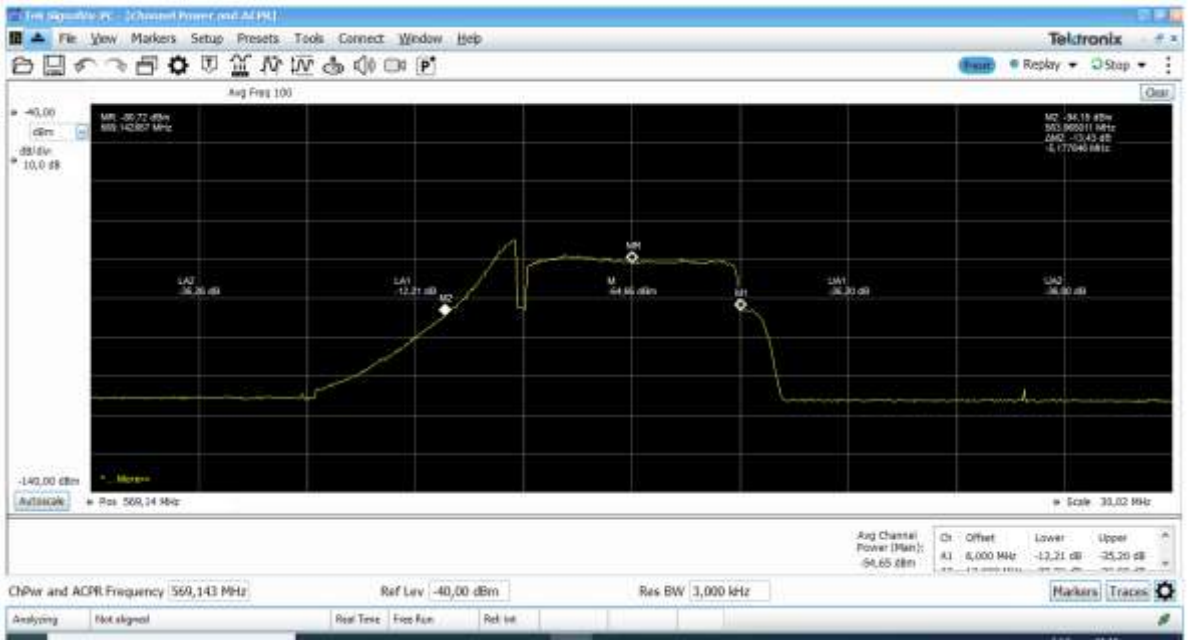


Figure 12.8 - Horizontal

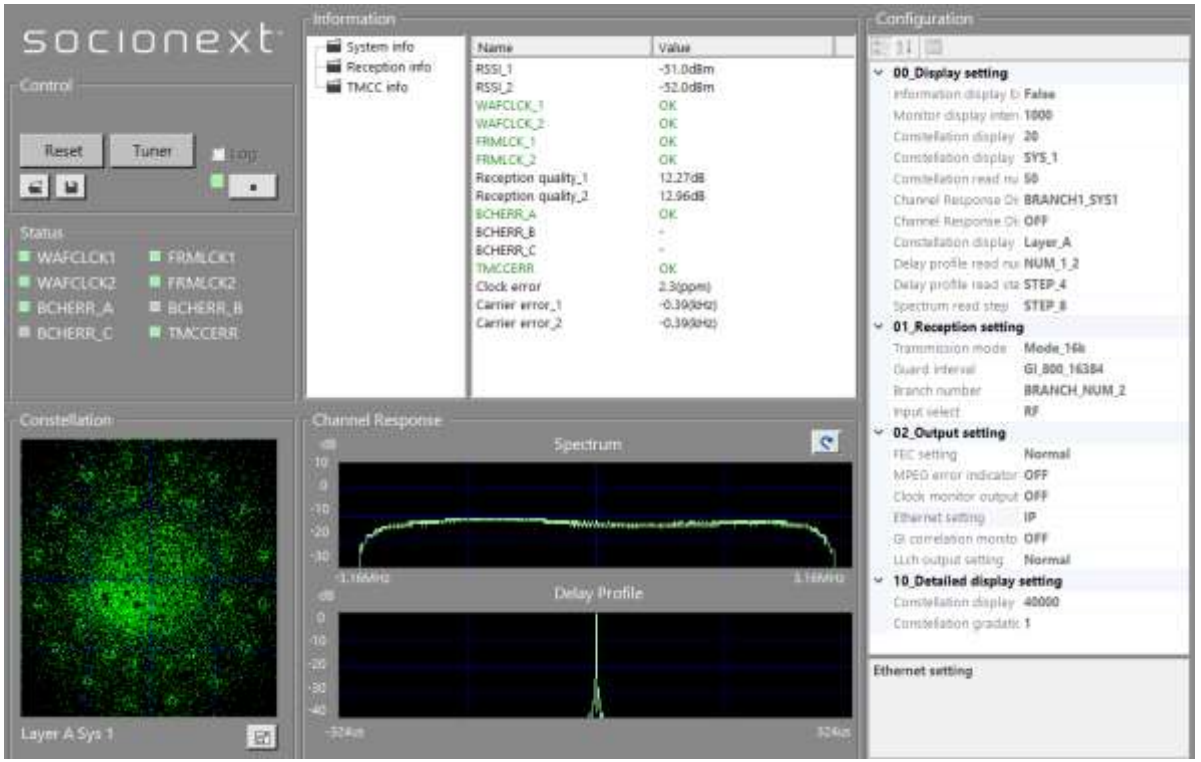


Figure 12.9 - Socionext Screen

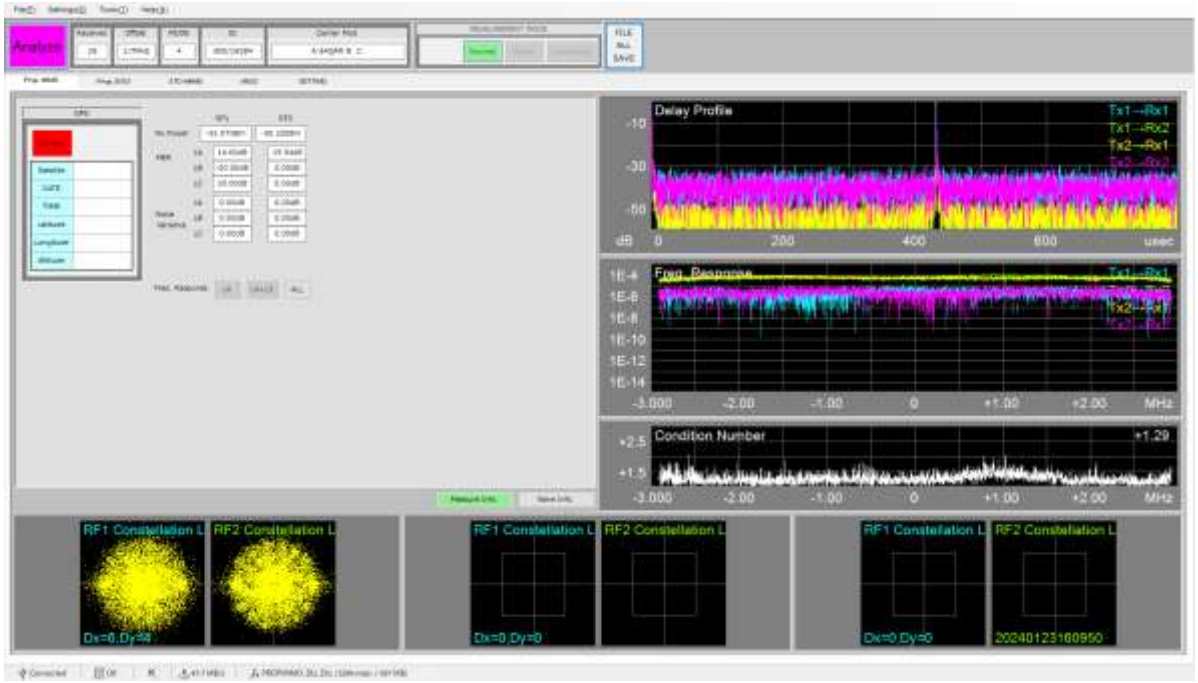


Figure 12.10 - Rintaro Screen

d) Reception Threshold

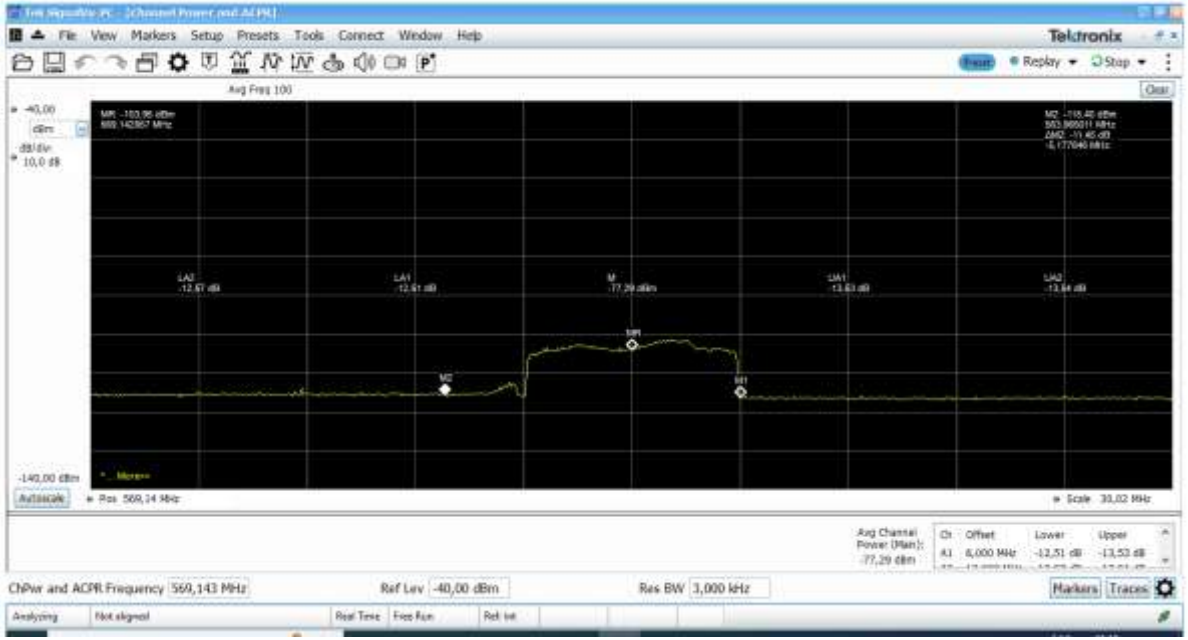


Figure 12.11 - Vertical

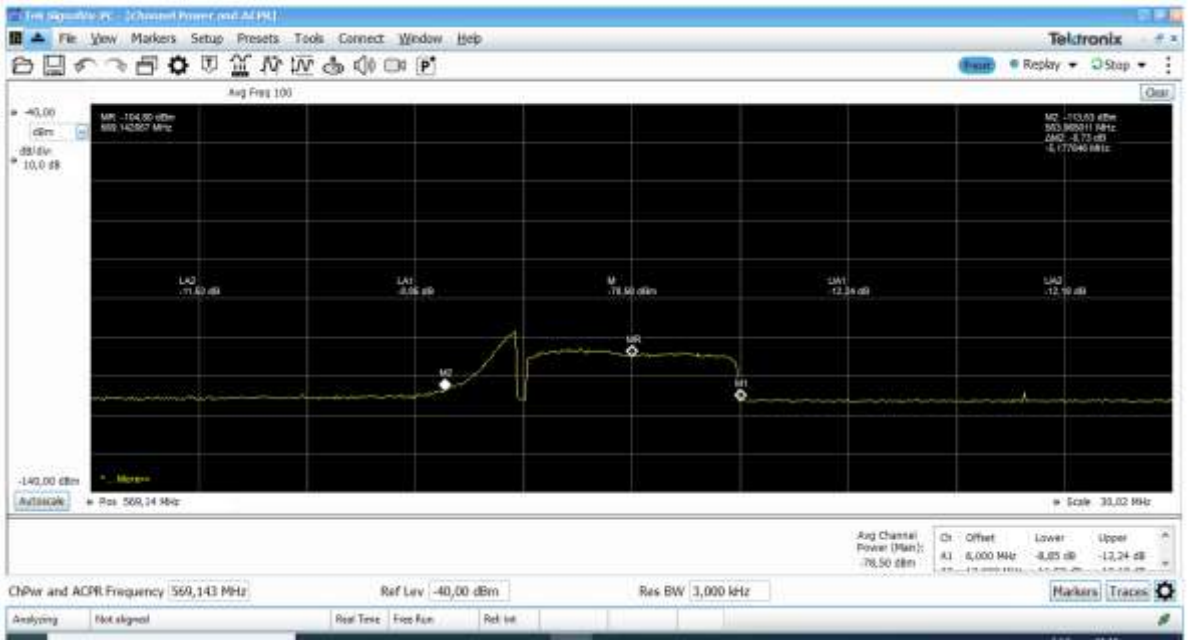


Figure 12.12 - Horizontal

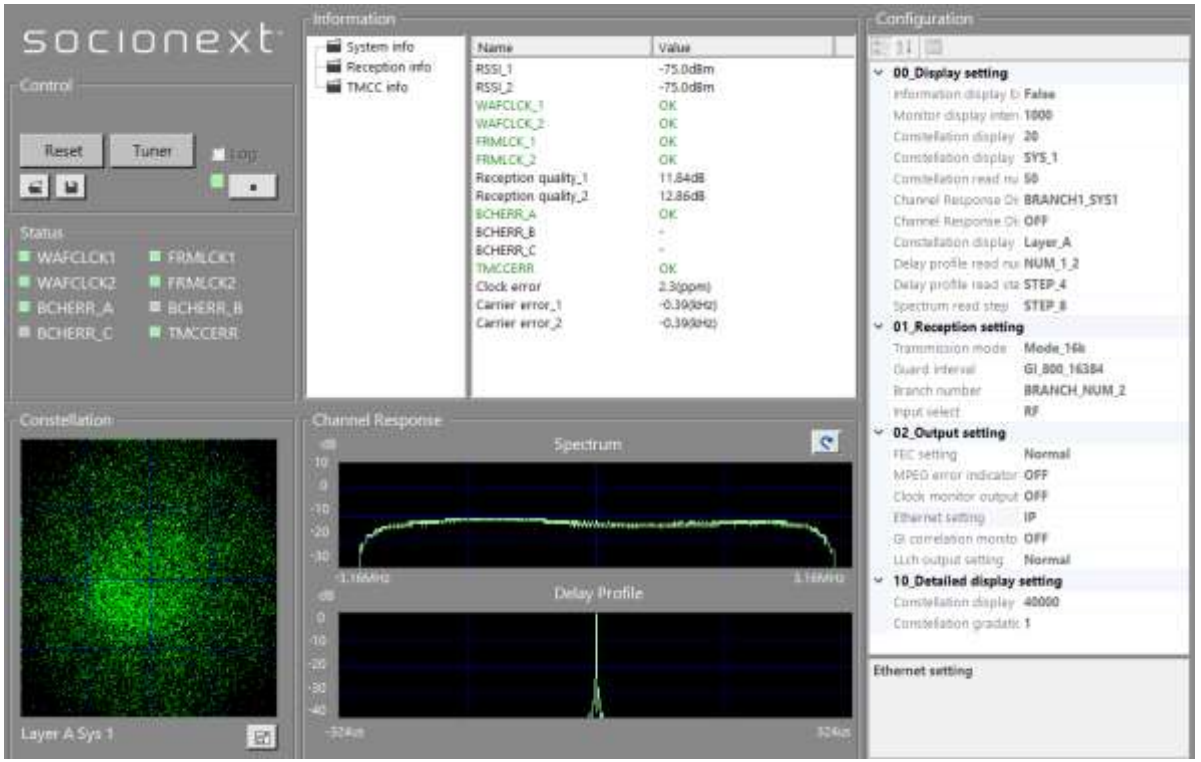


Figure 12.13 - Socionext Screen

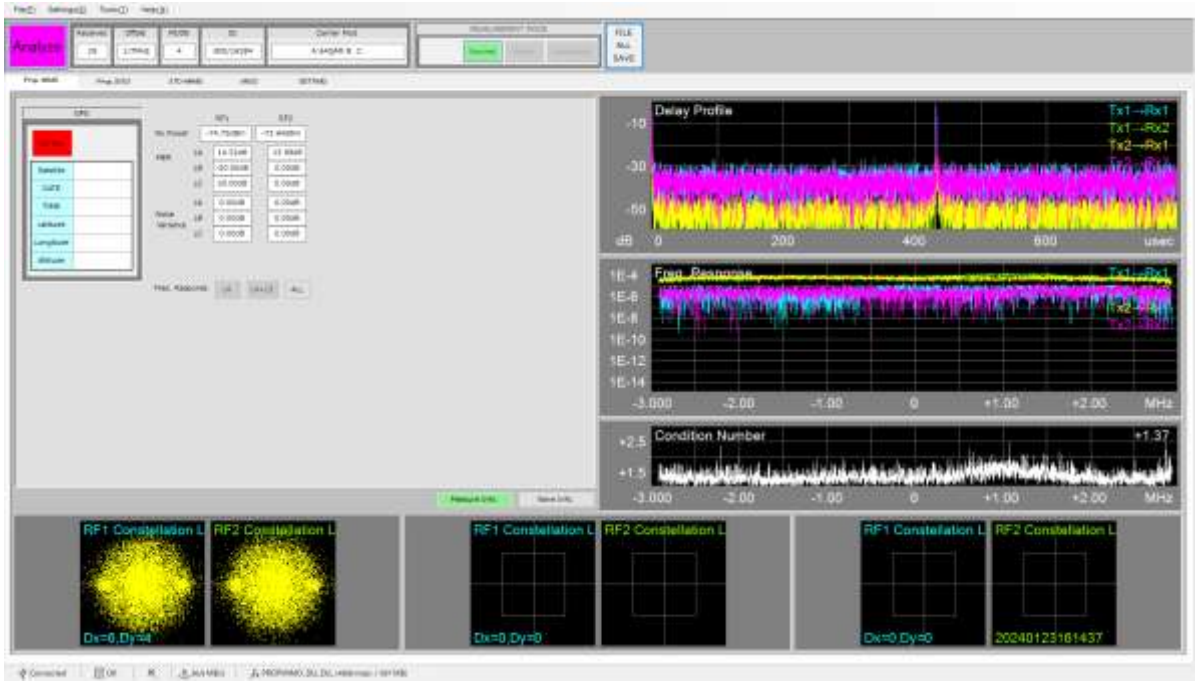


Figure 12.14 - Rintaro Screen

Chapter 13. Site 13

a) Channel Power

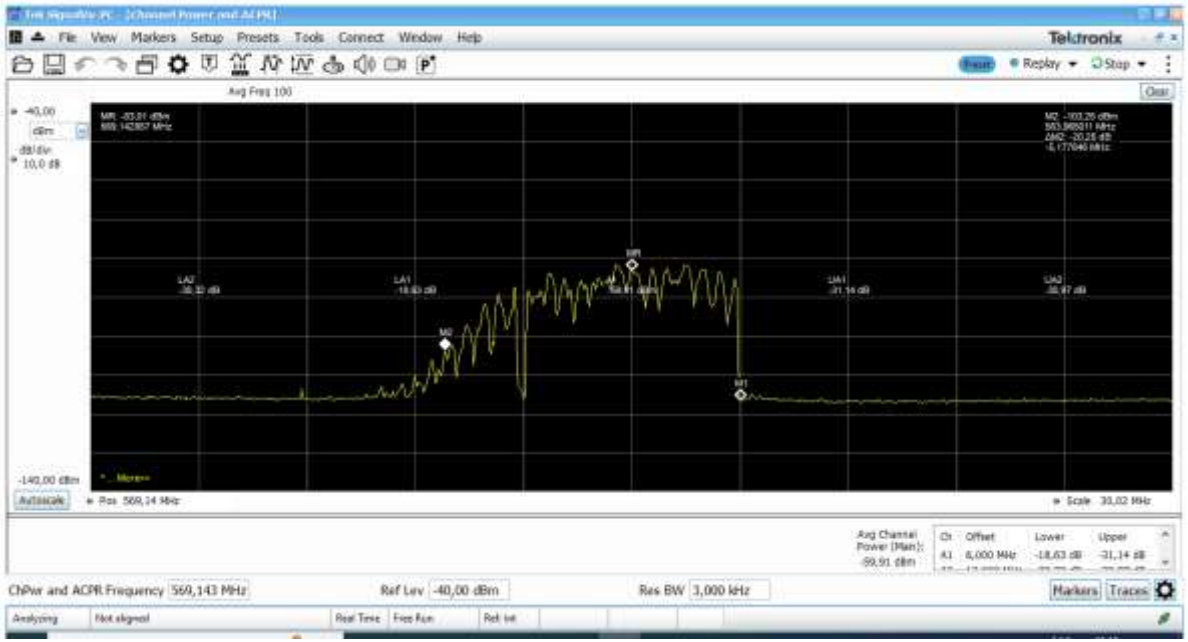


Figure 13.1 - Vertical

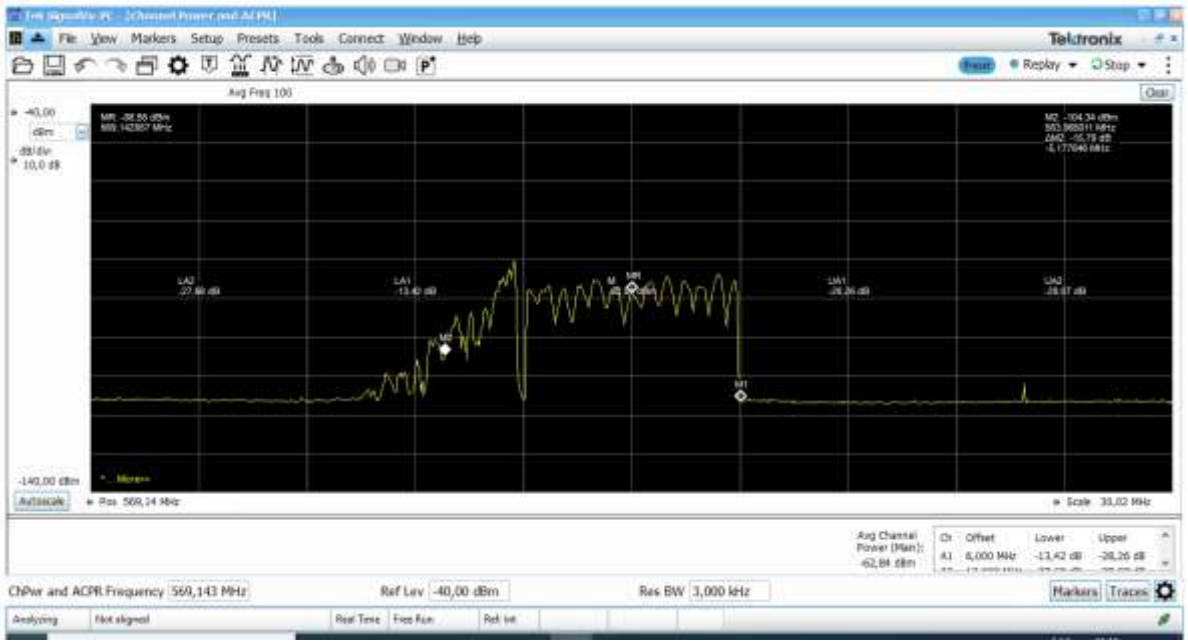


Figure 13.2 - Horizontal

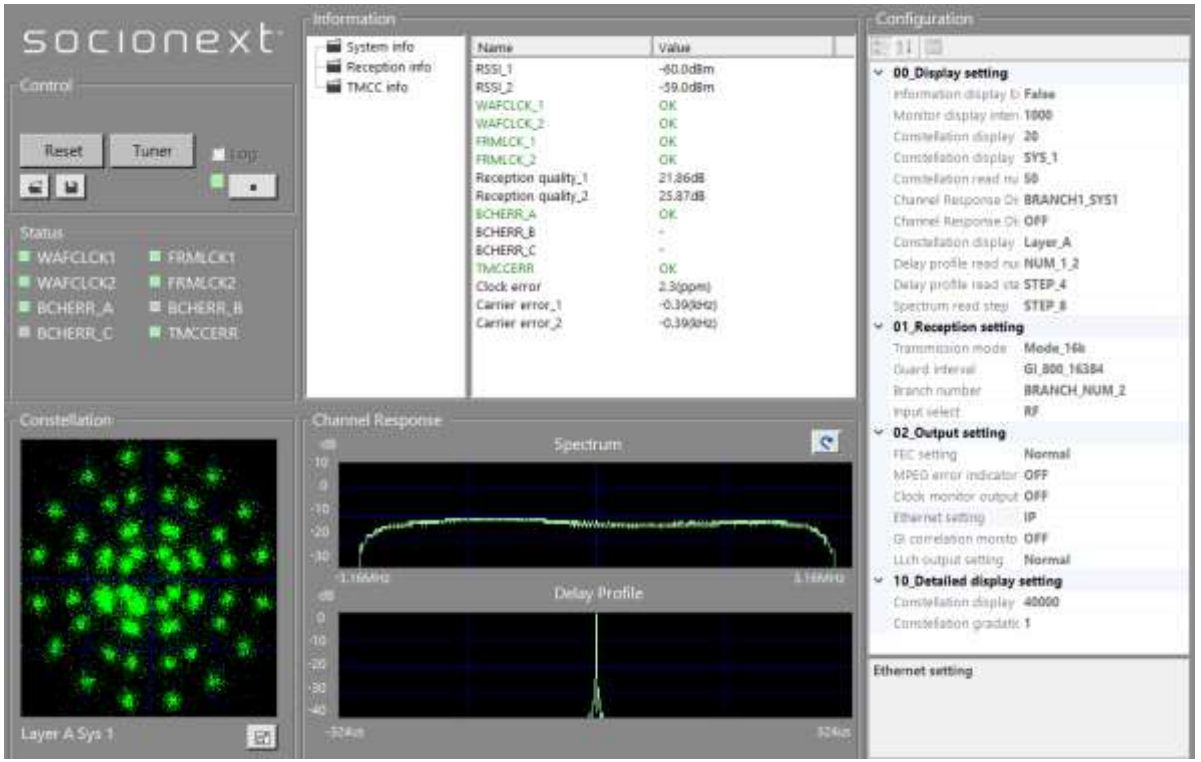


Figure 13.3 - Socionext Screen

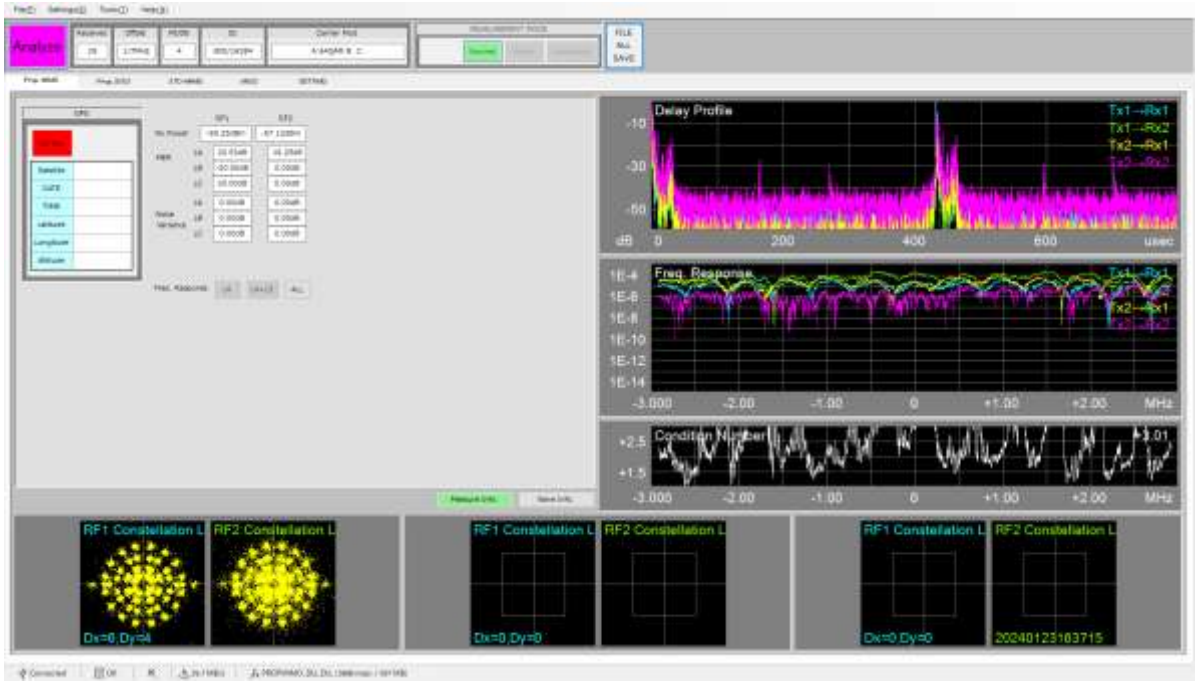


Figure 13.4 - Rintaro Screen

b) AWGN Power

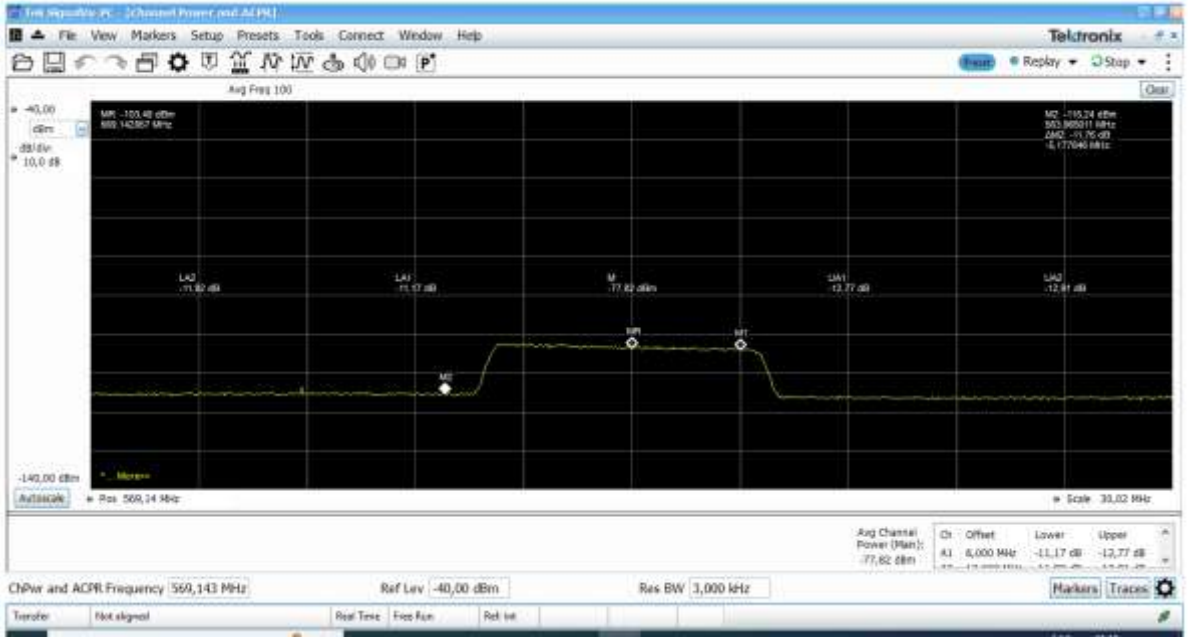


Figure 13.5 - Vertical

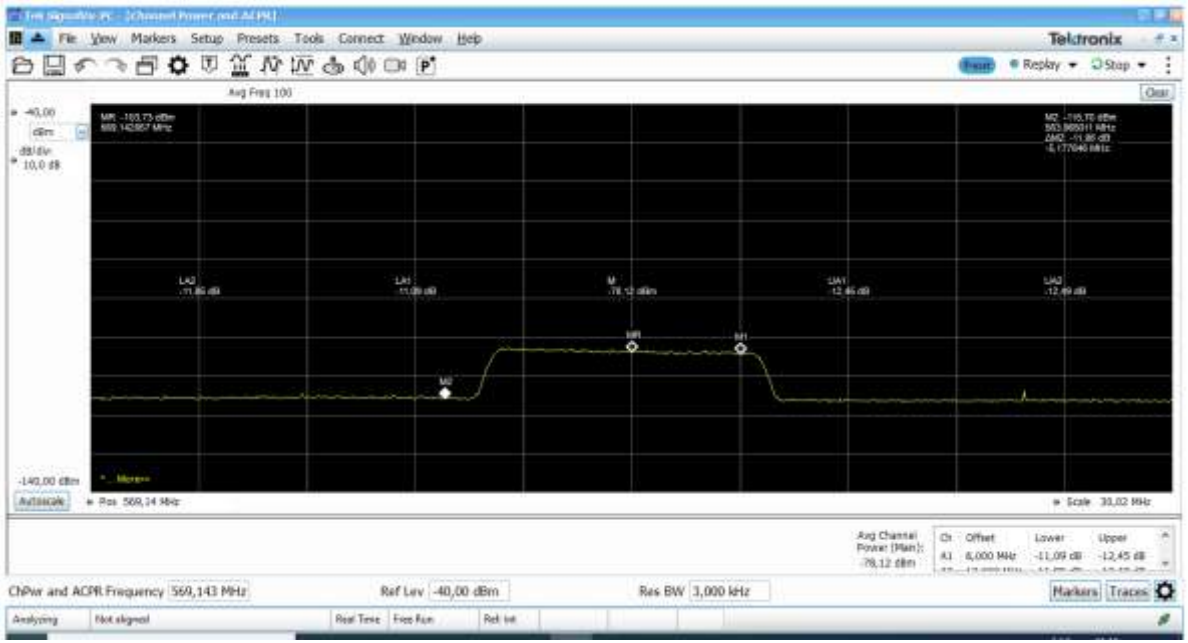


Figure 13.6 - Horizontal

c) C/N Threshold

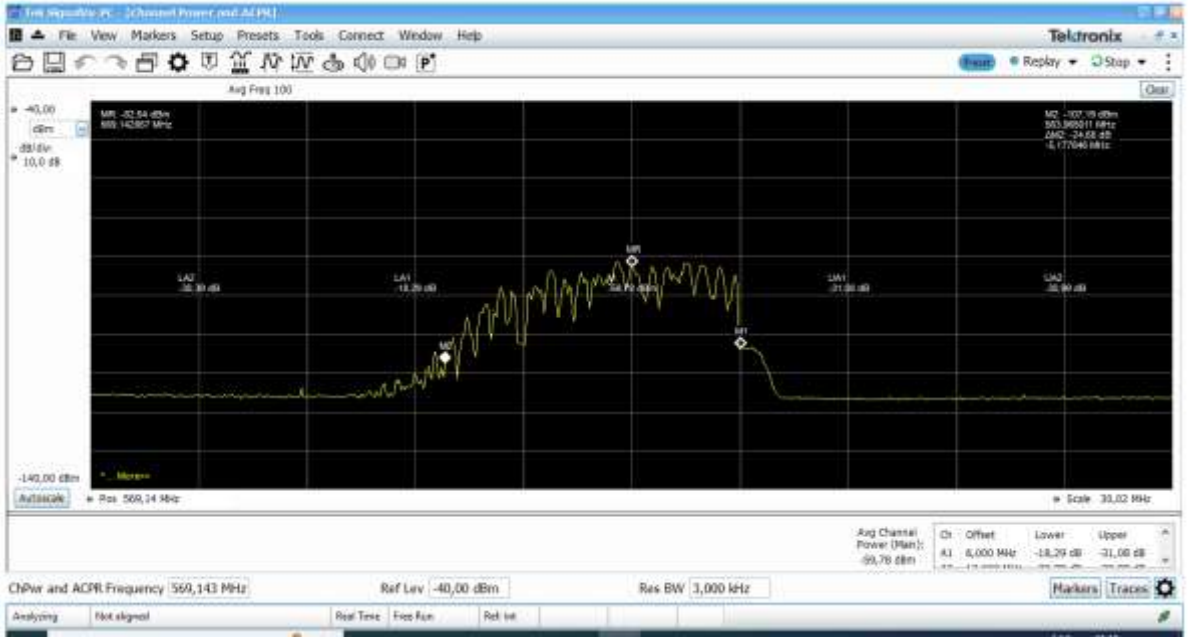


Figure 13.7 - Vertical

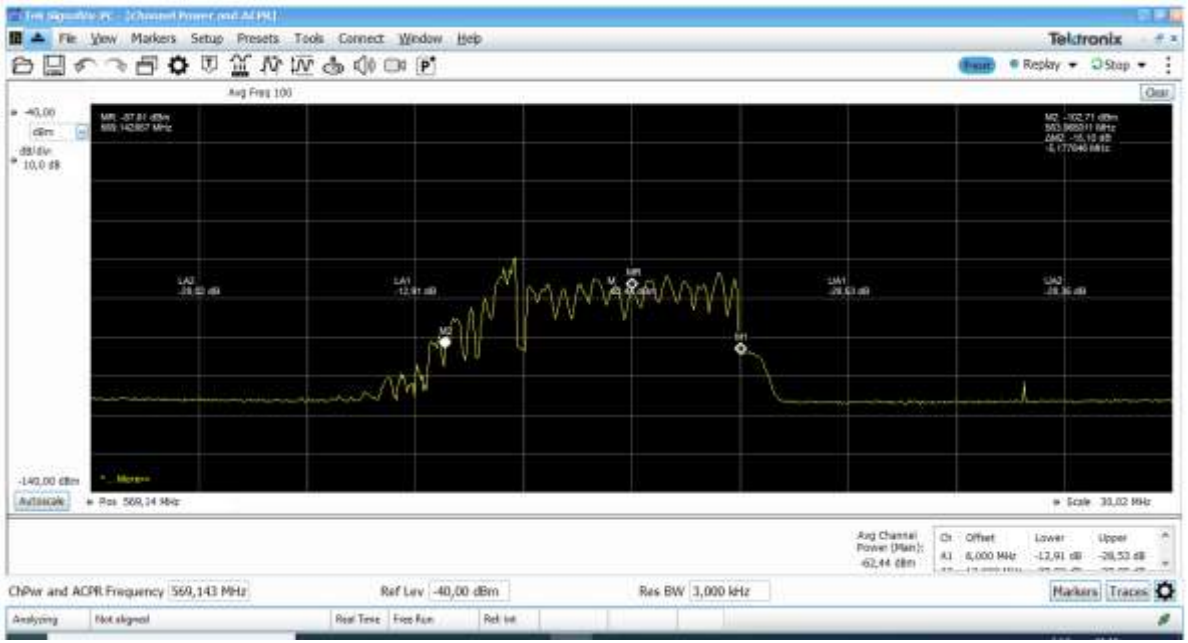


Figure 13.8 - Horizontal

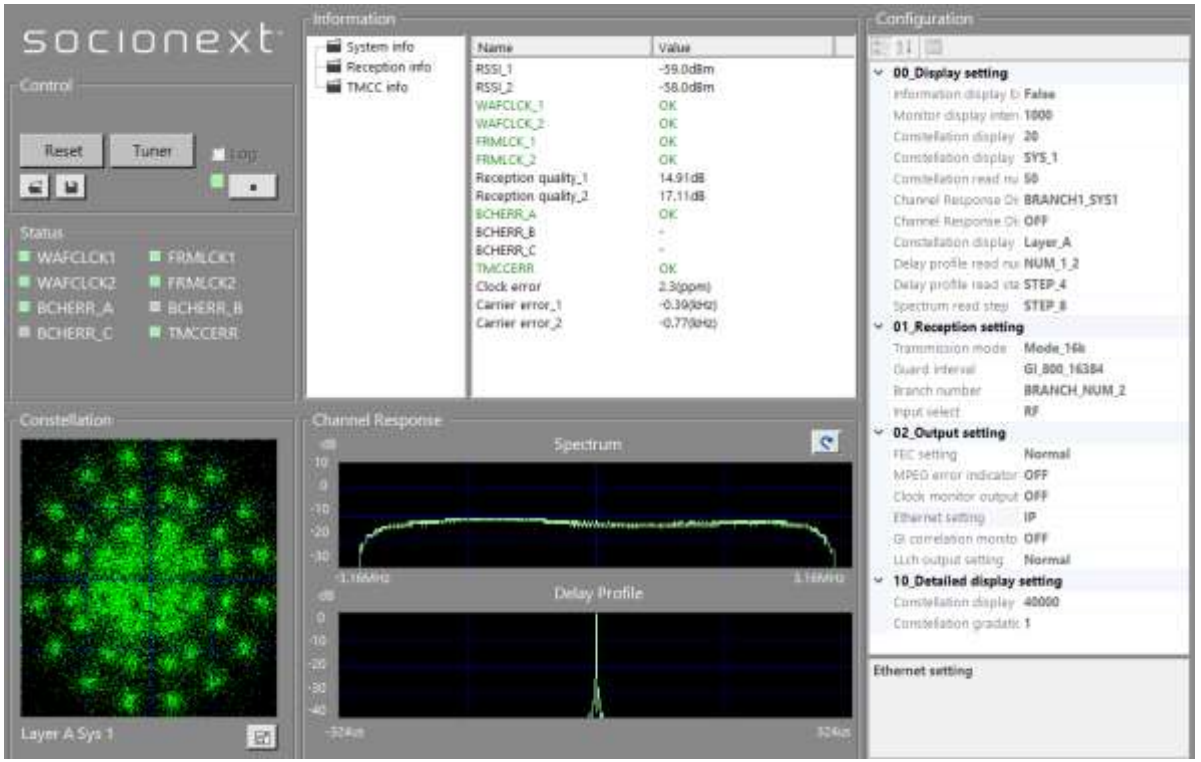


Figure 13.9 - Socionext Screen

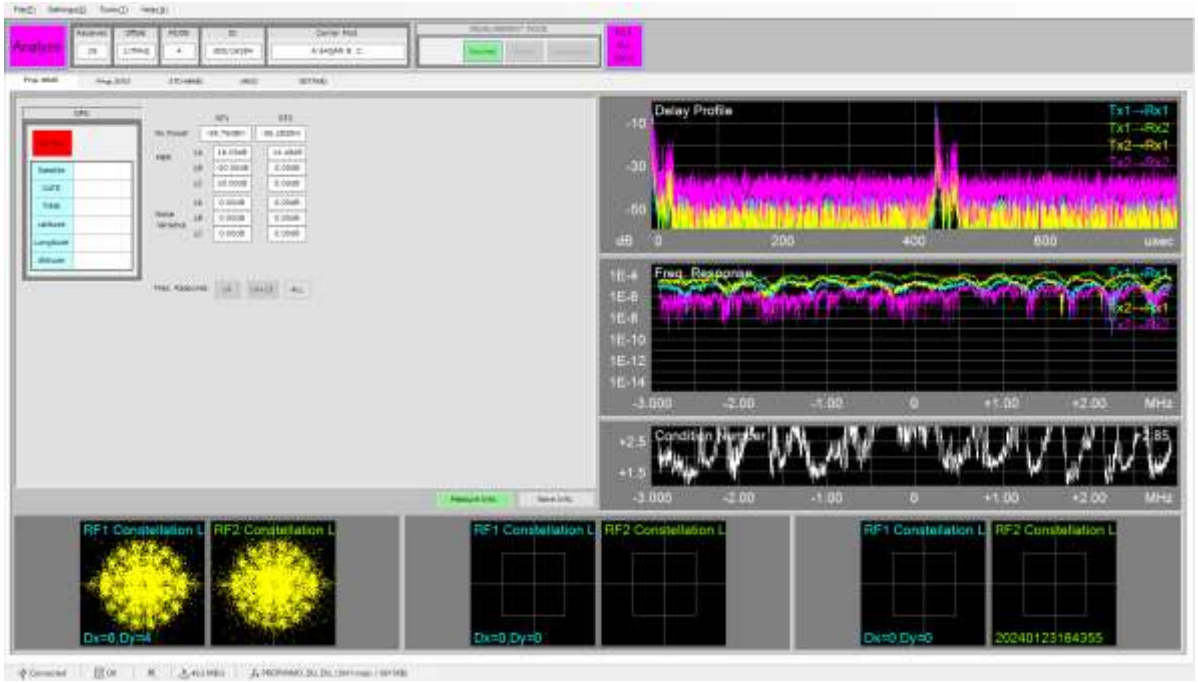


Figure 13.10 - Rintaro Screen

d) Reception Threshold

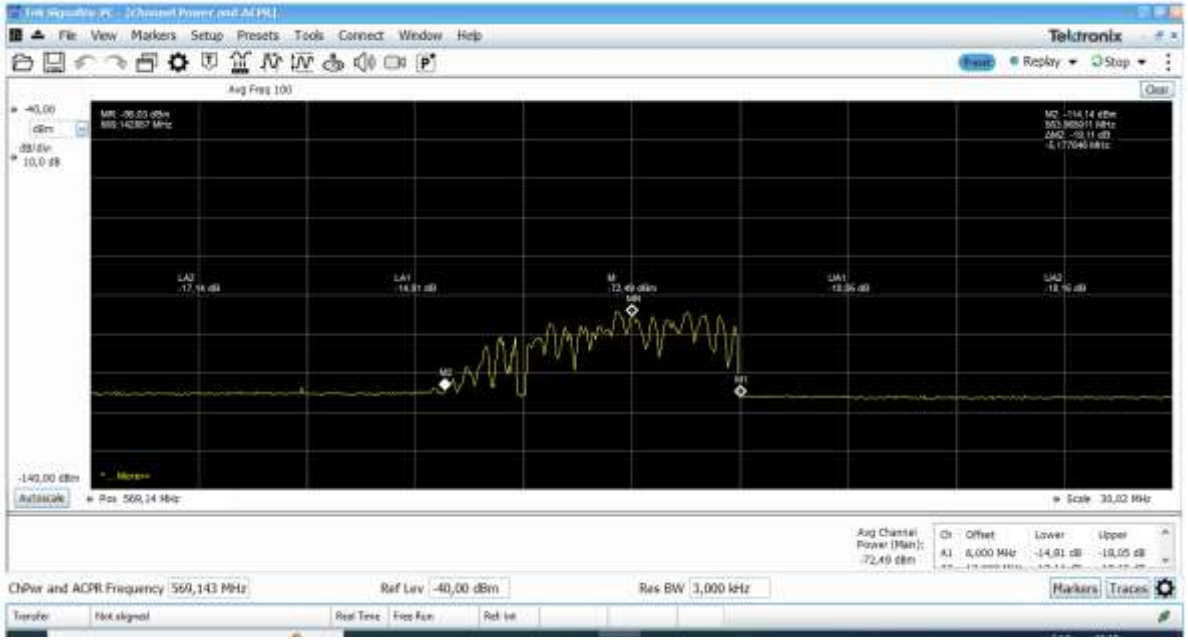


Figure 13.11 - Vertical

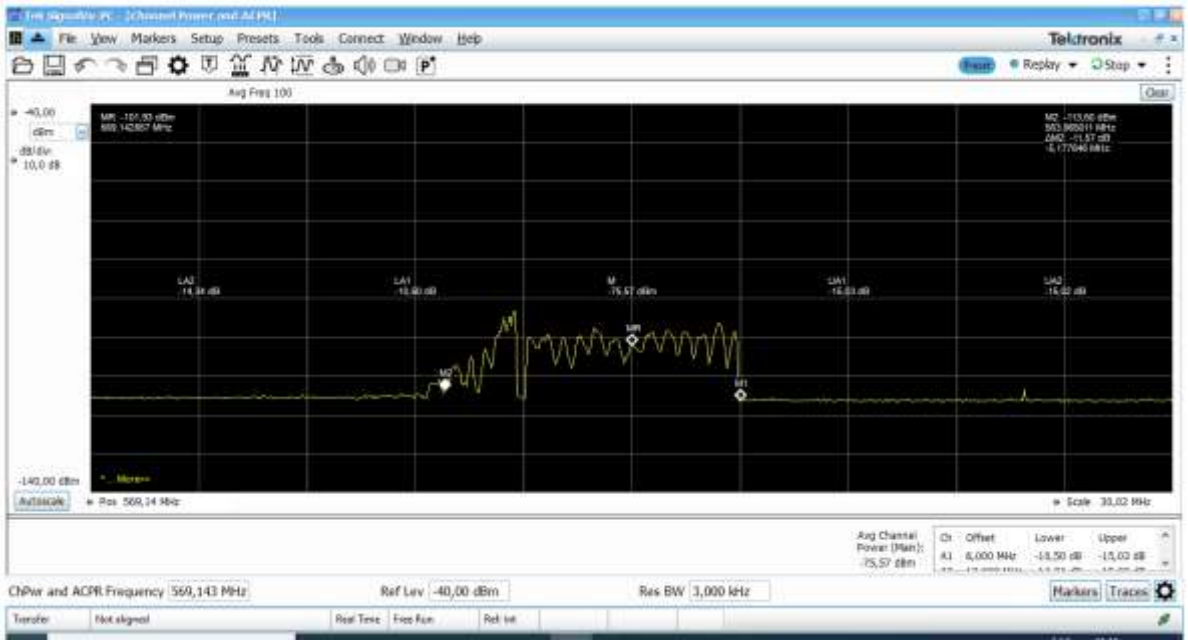


Figure 13.12 - Horizontal

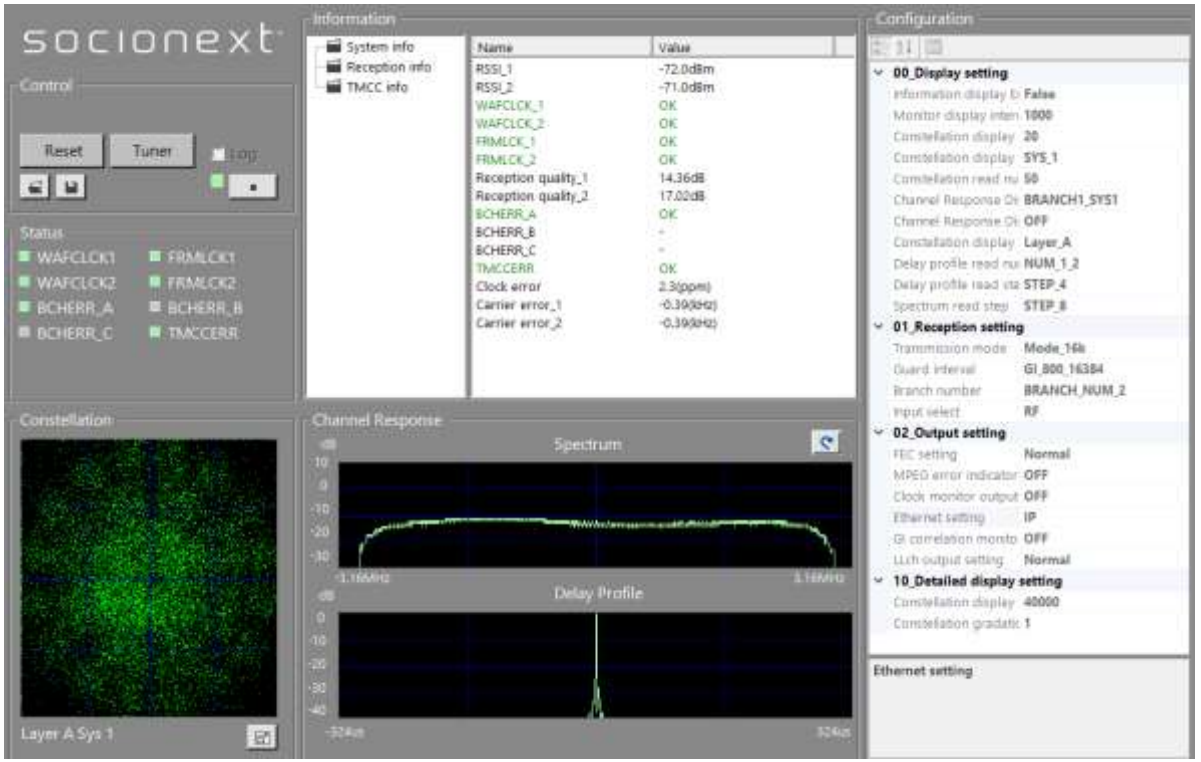


Figure 13.13 - Socionext Screen

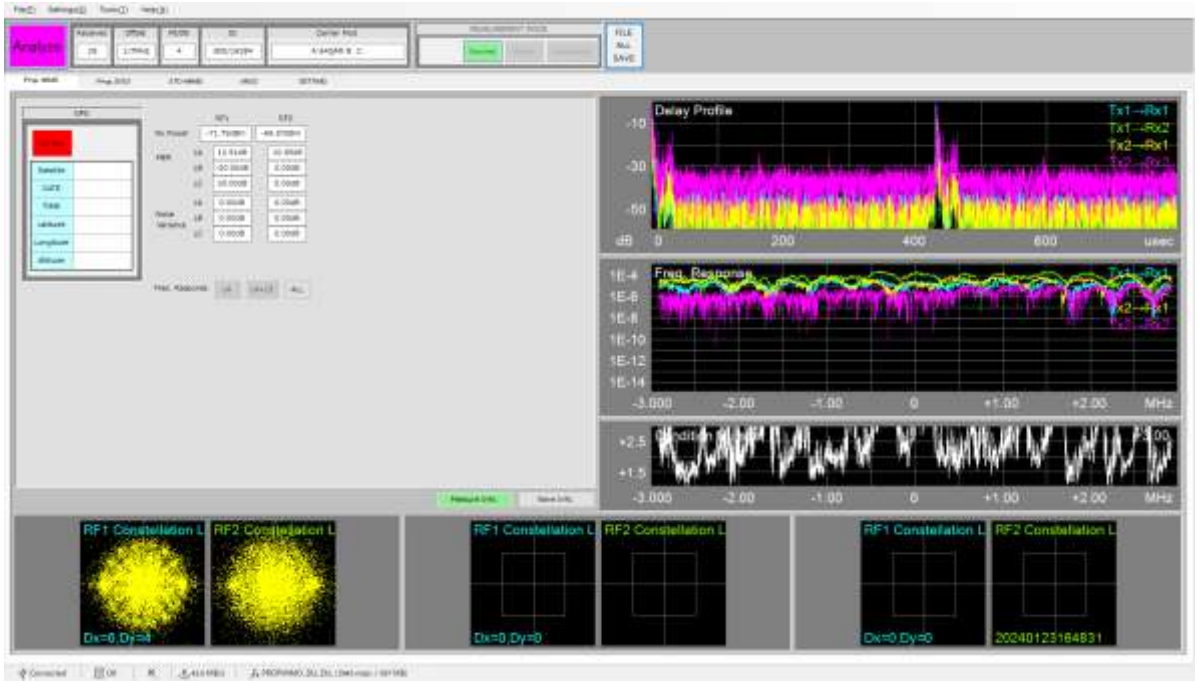


Figure 13.14 - Rintaro Screen

Chapter 14. Site 14

a) Channel Power

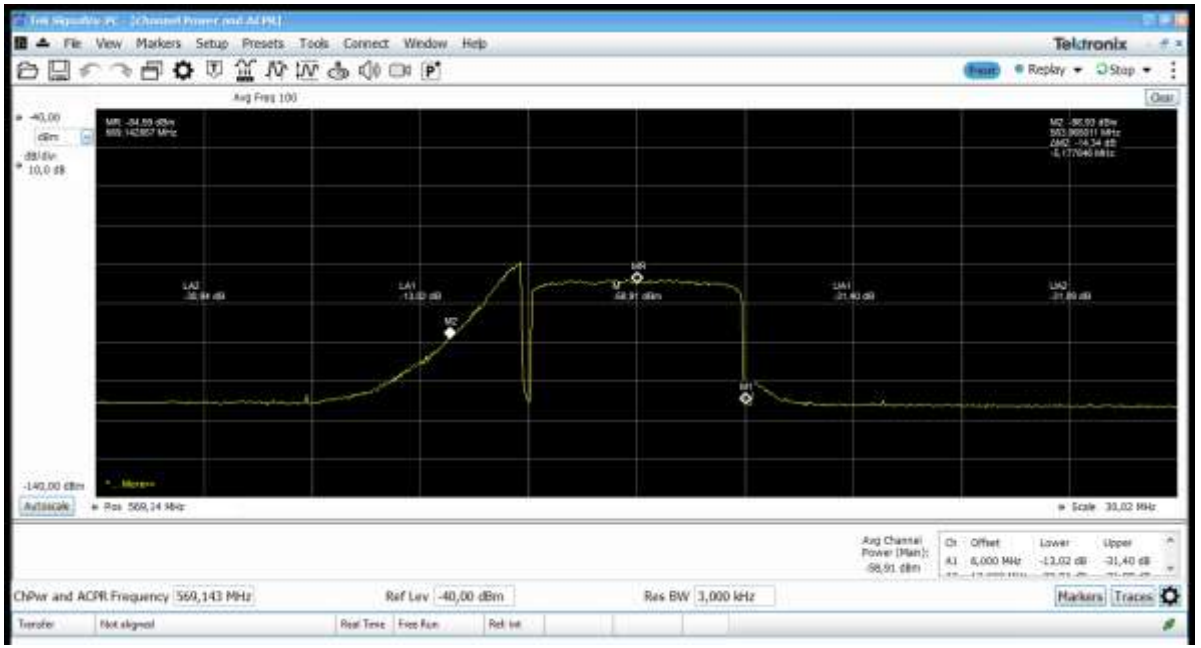


Figure 14.1 - Vertical

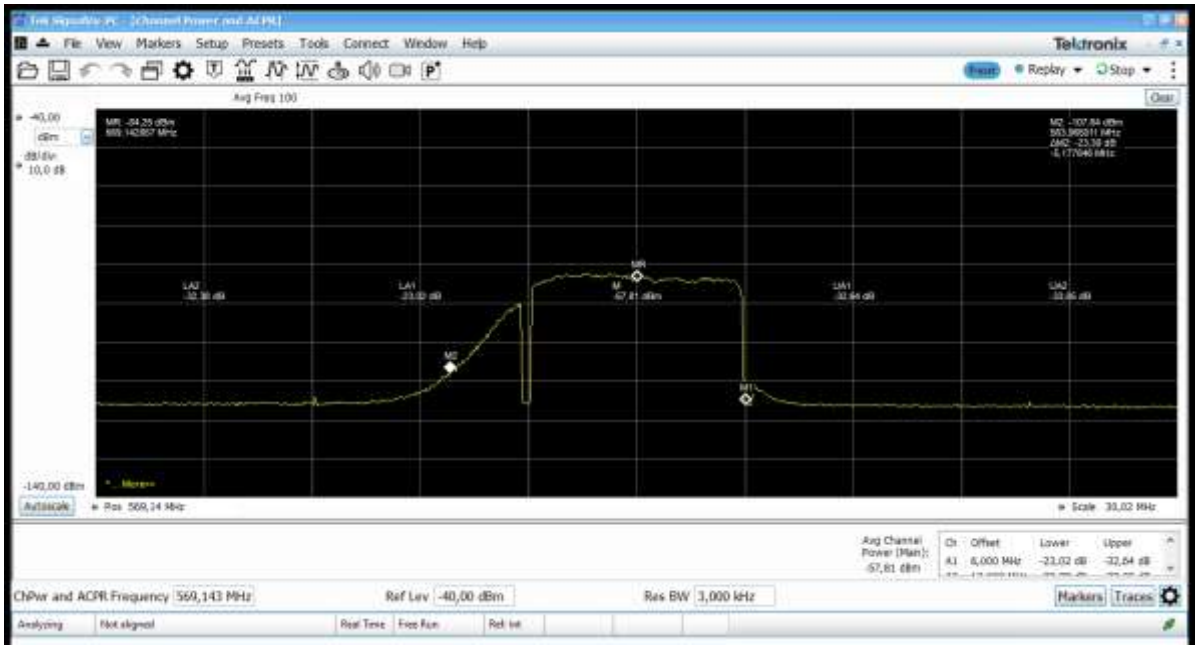


Figure 14.2 - Horizontal

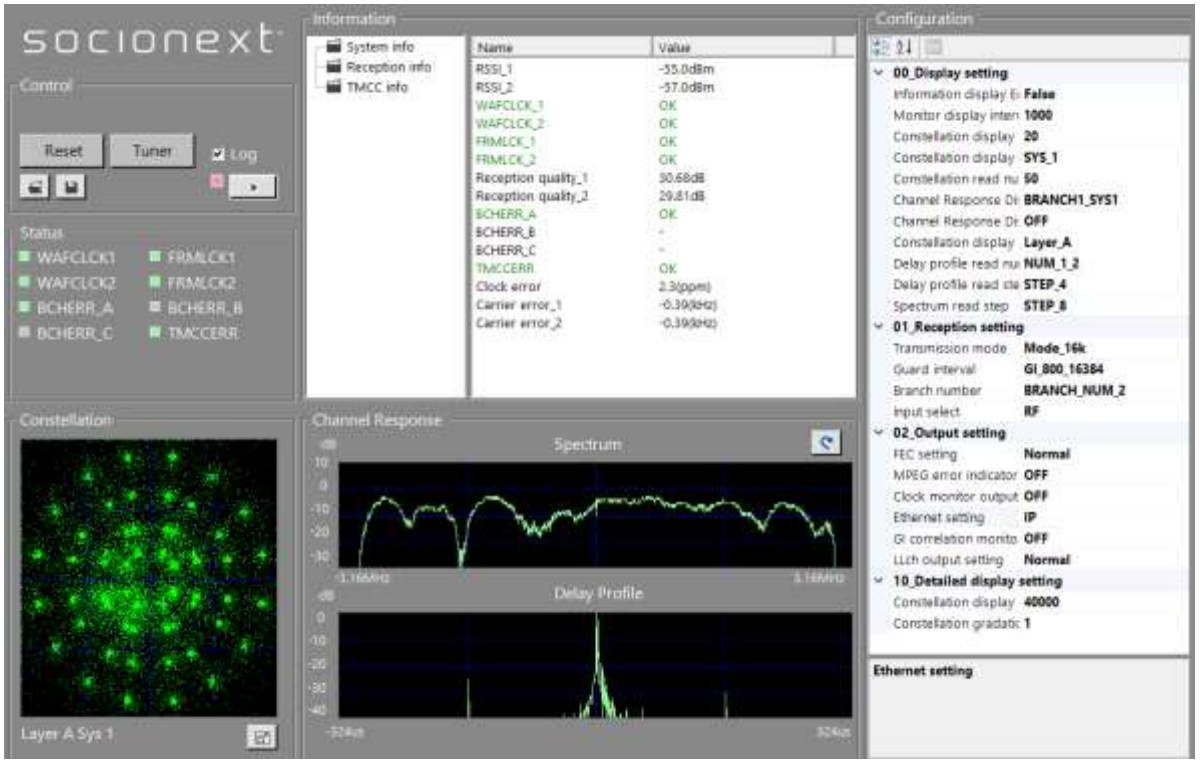


Figure 14.3 - Socionext Screen

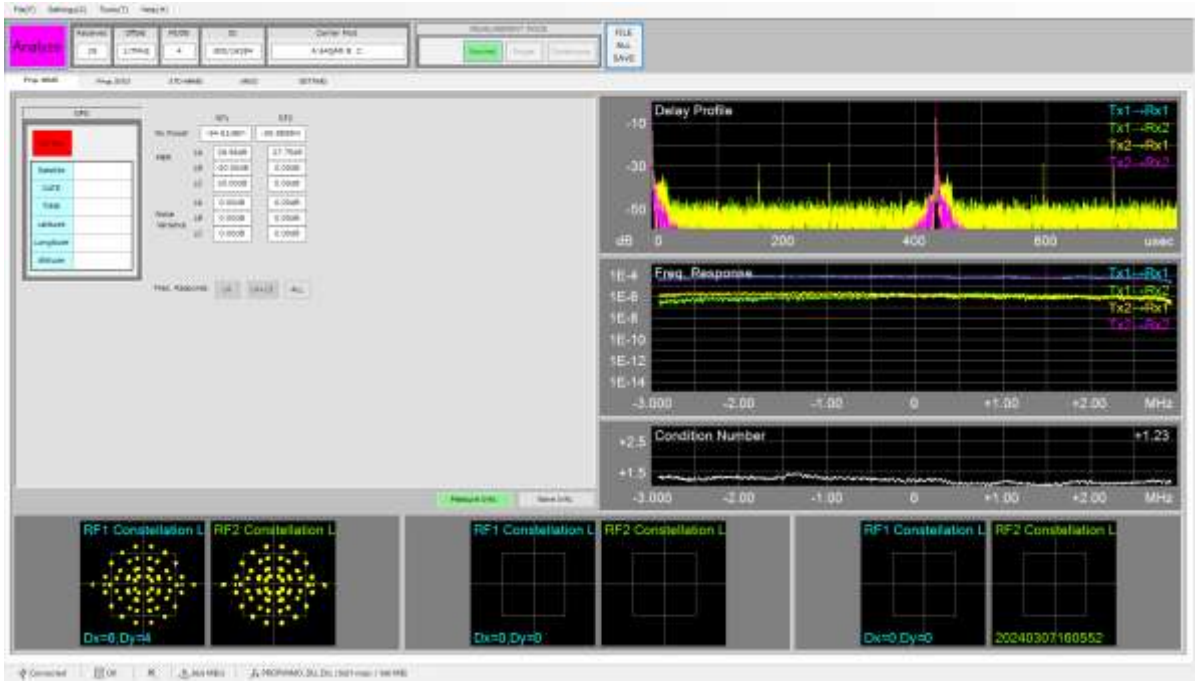


Figure 14.4 - Rintaro Screen

b) AWGN Power

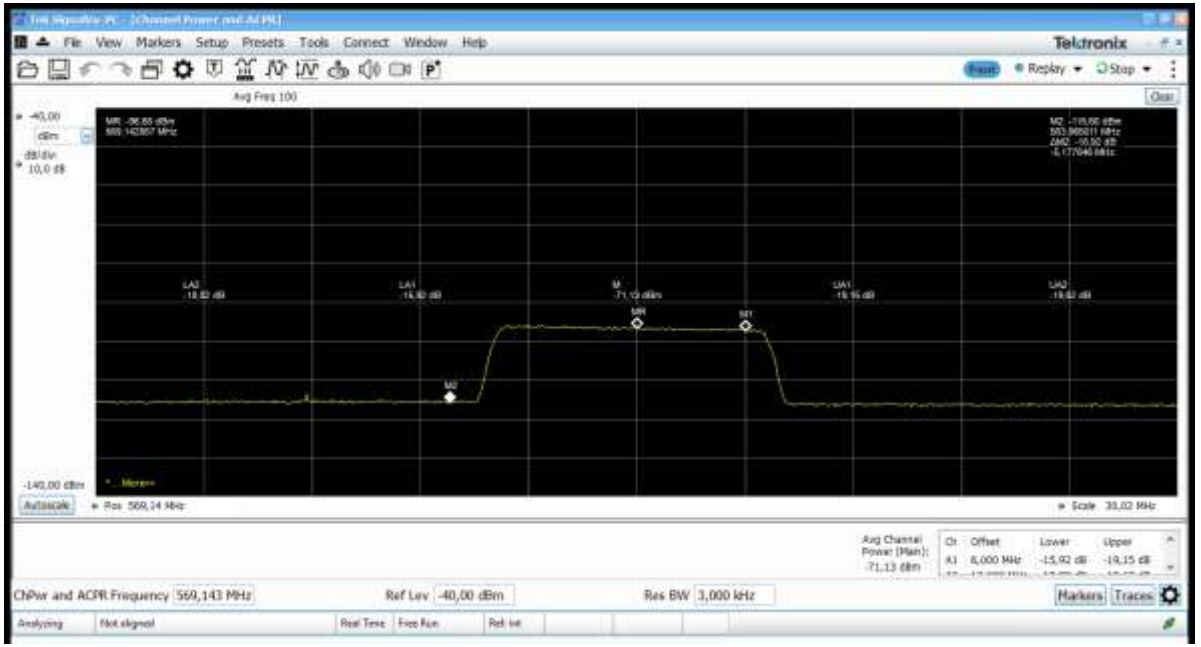


Figure 14.5 - Vertical

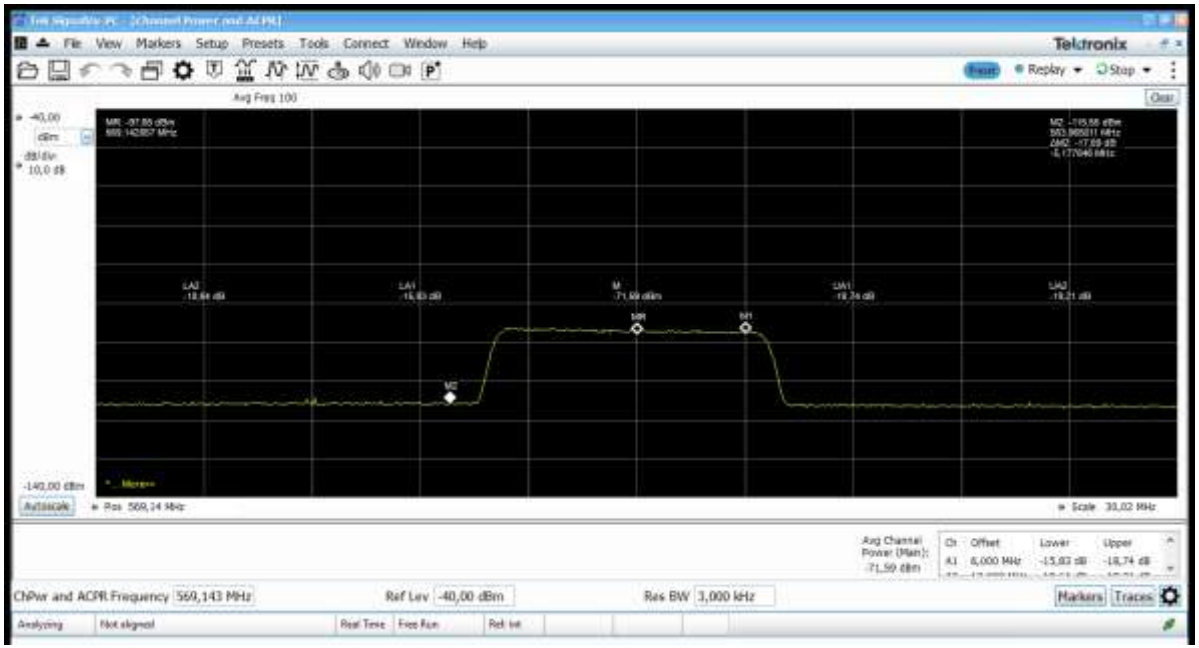


Figure 14.6 - Horizontal

c) C/N Threshold

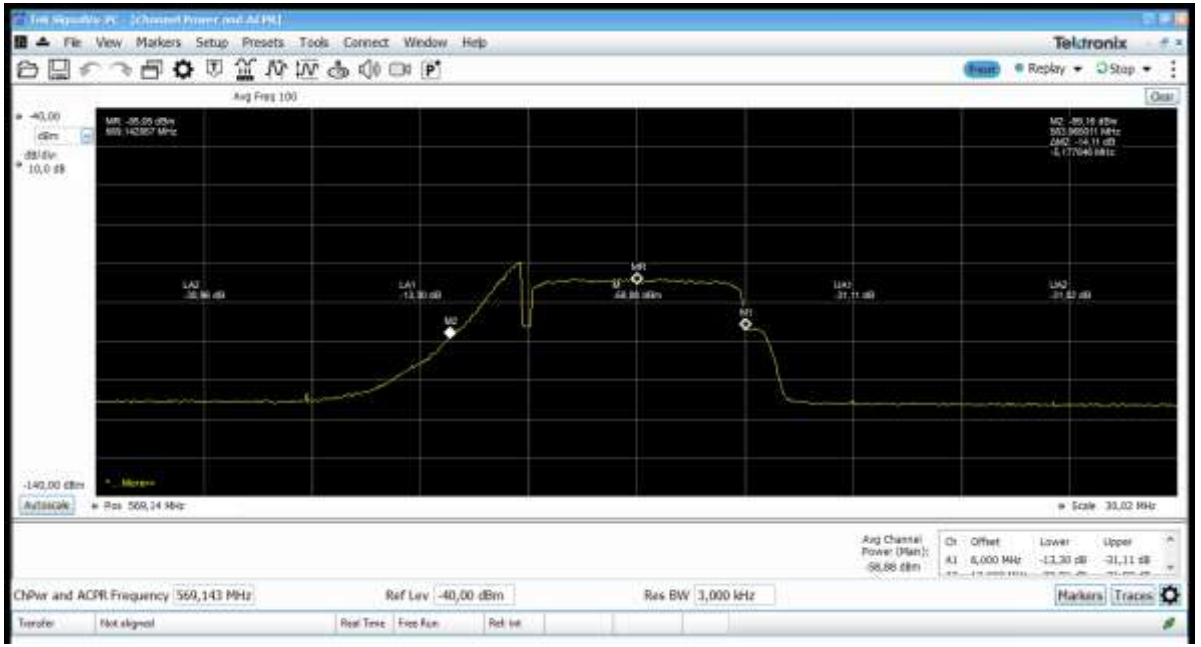


Figure 14.7 - Vertical

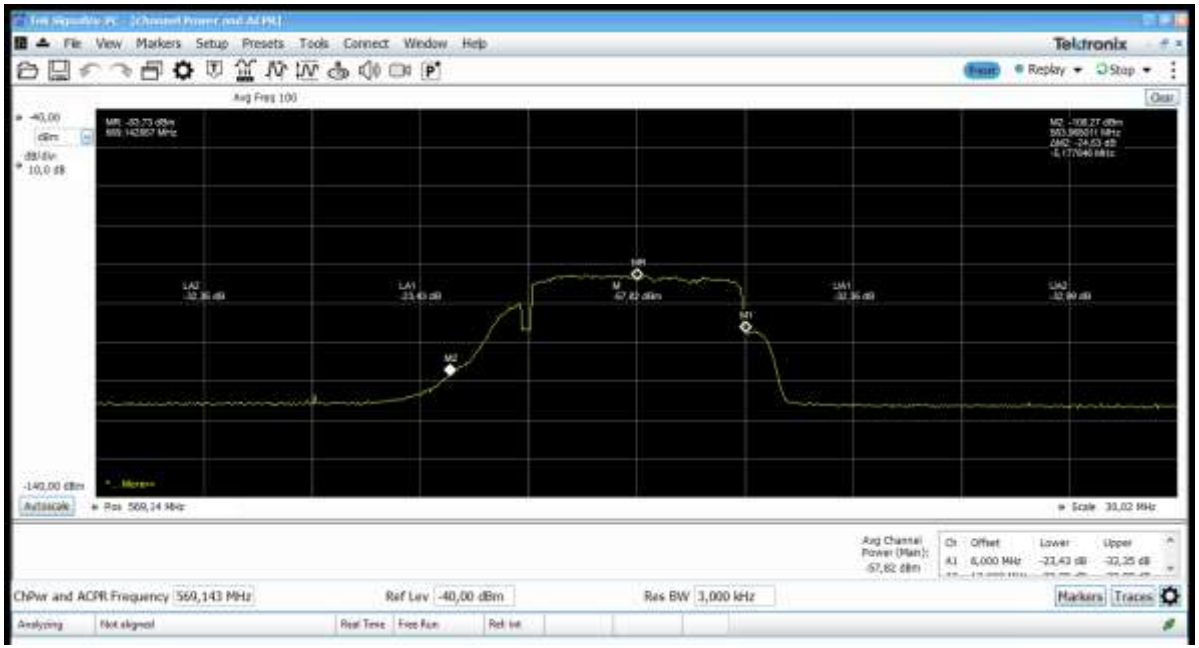


Figure 14.8 - Horizontal

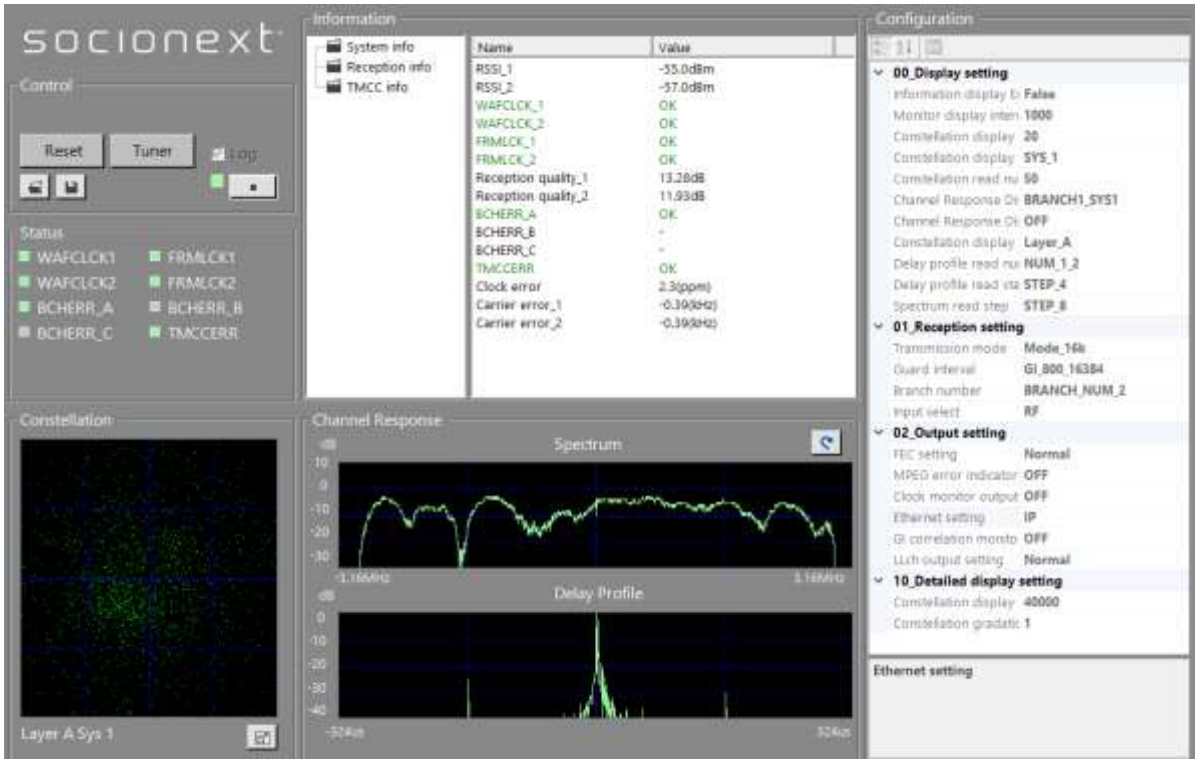


Figure 14.9 - Socionext Screen

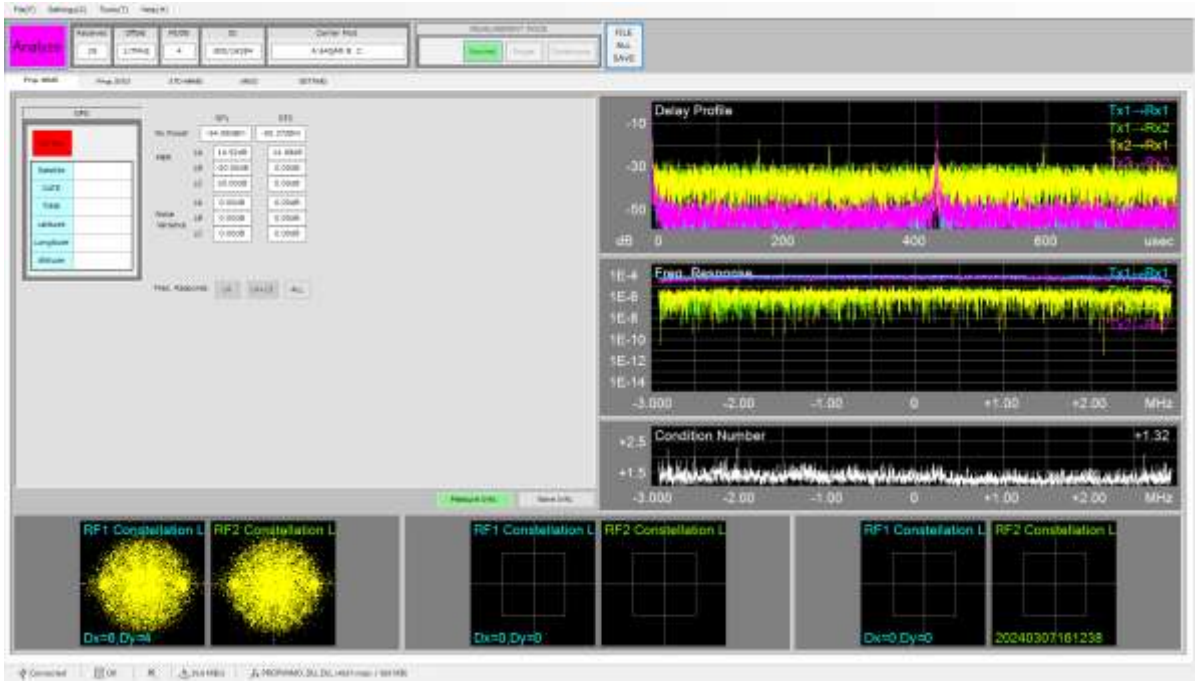


Figure 14.10 - Rintaro Screen

d) Reception Threshold

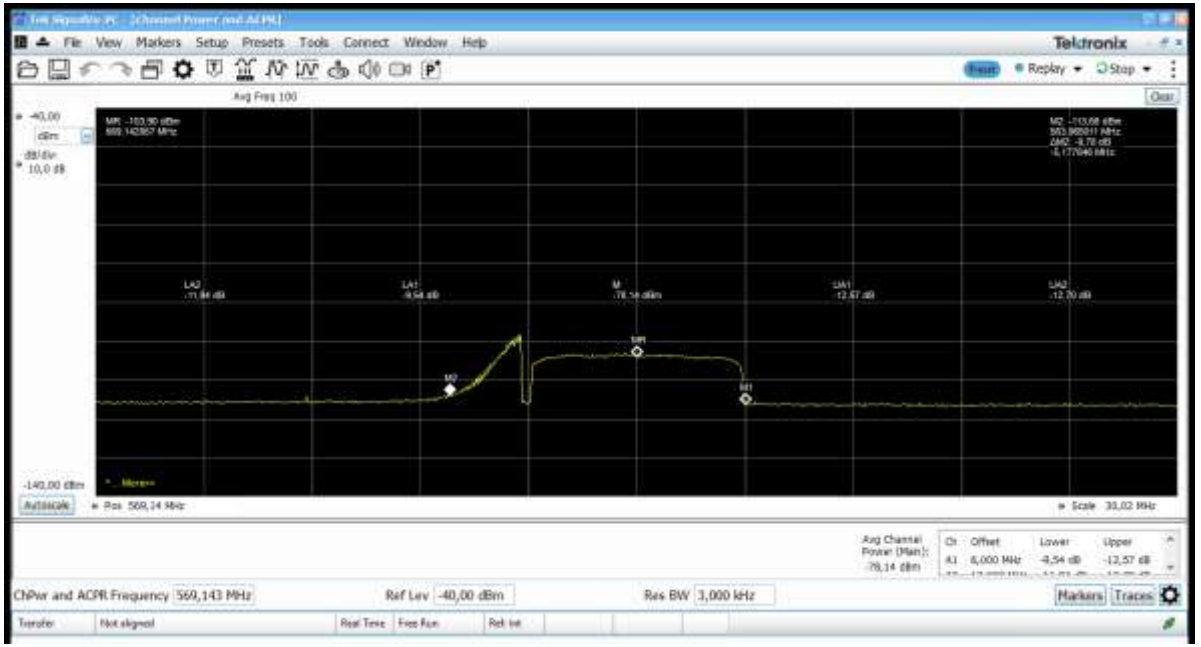


Figure 14.11 - Vertical

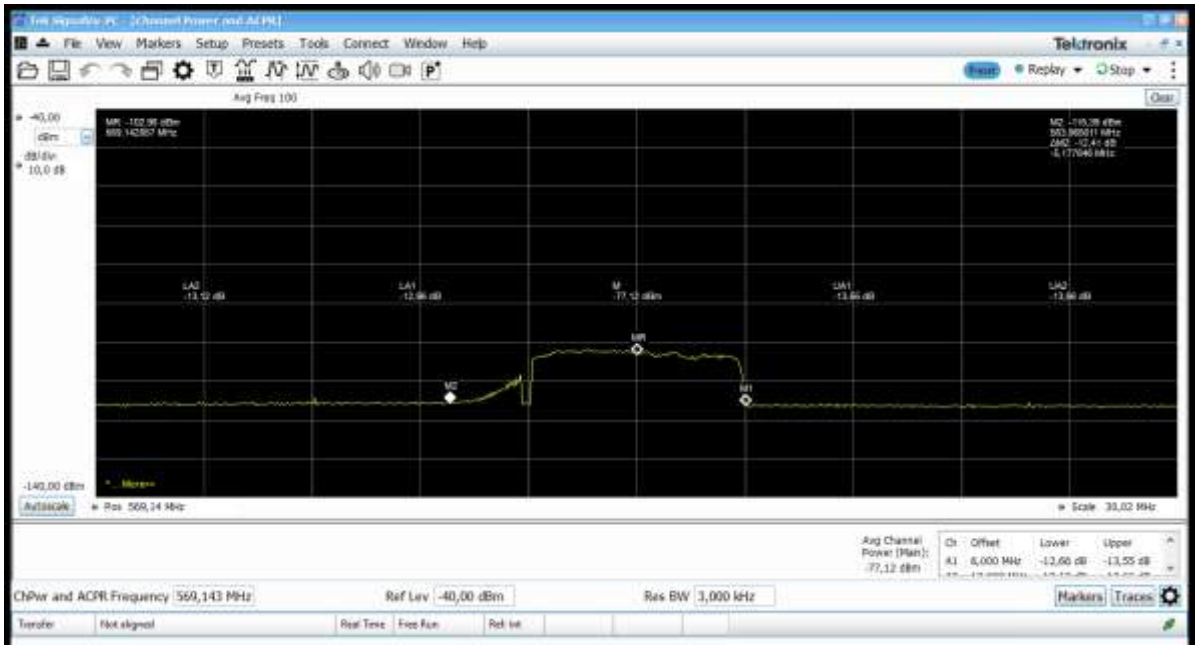


Figure 14.12 - Horizontal

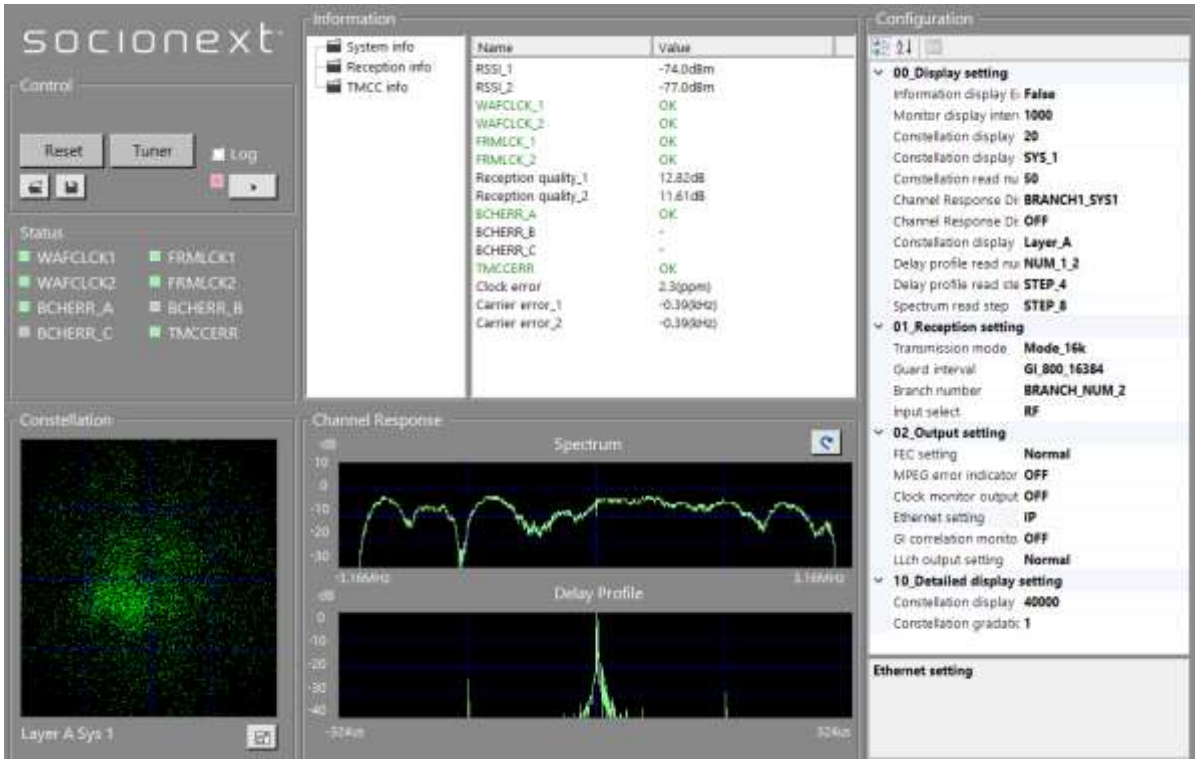


Figure 14.13 - Socionext Screen

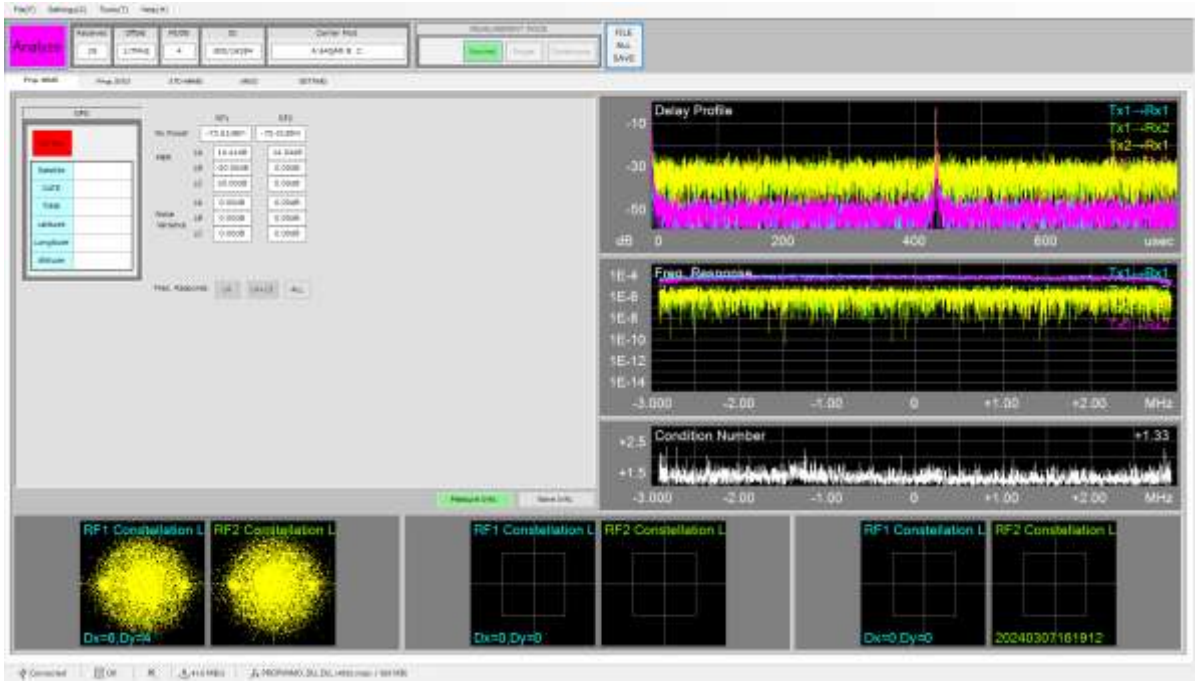


Figure 14.14 - Rintaro Screen

Chapter 15. Site 15

a) Channel Power

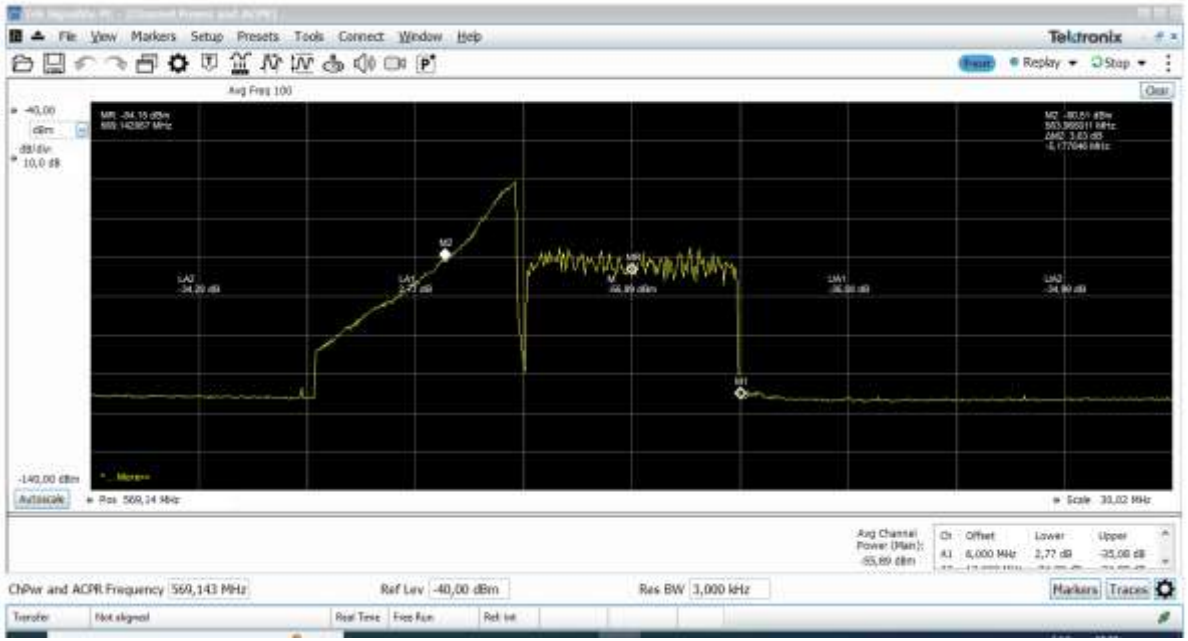


Figure 15.1 - Vertical

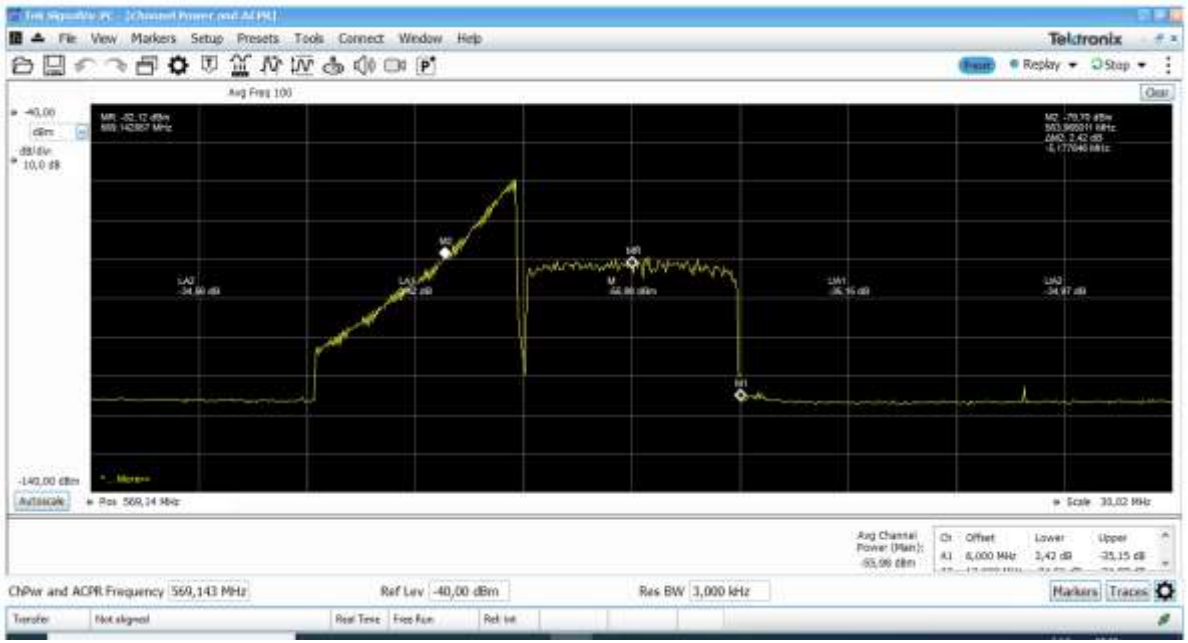


Figure 15.2 - Horizontal

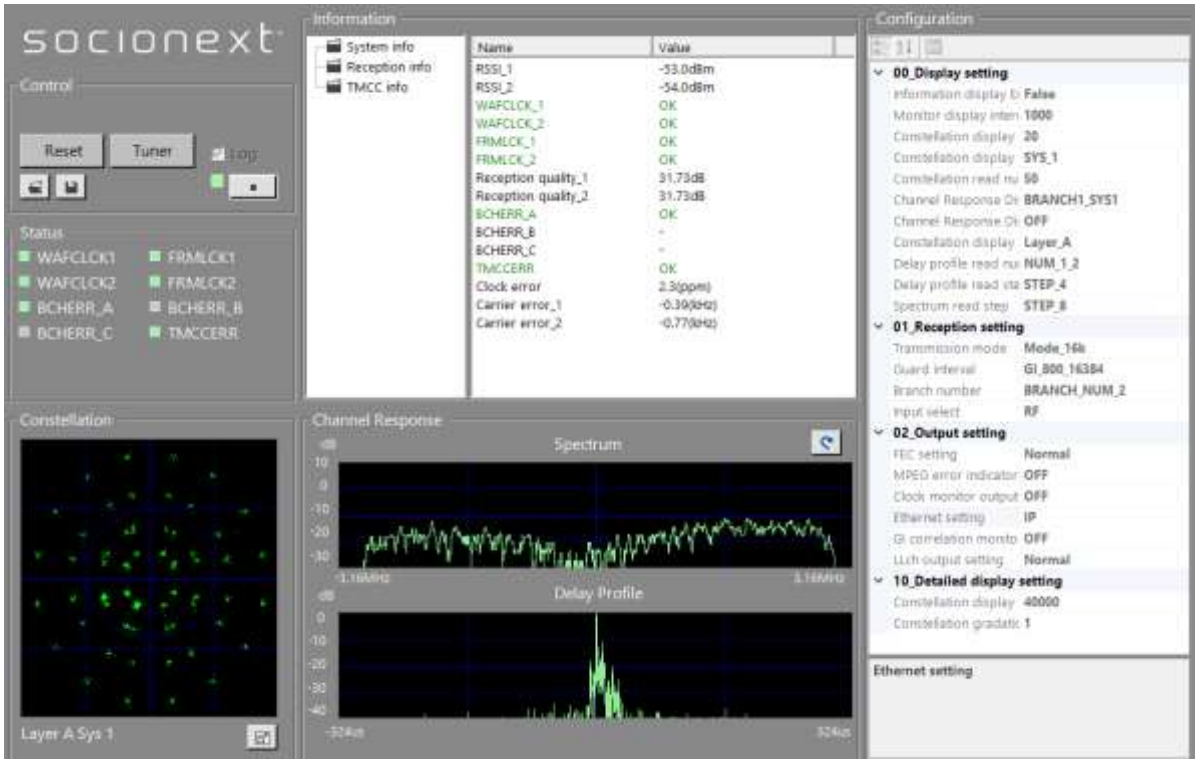


Figure 15.3 - Socionext Screen

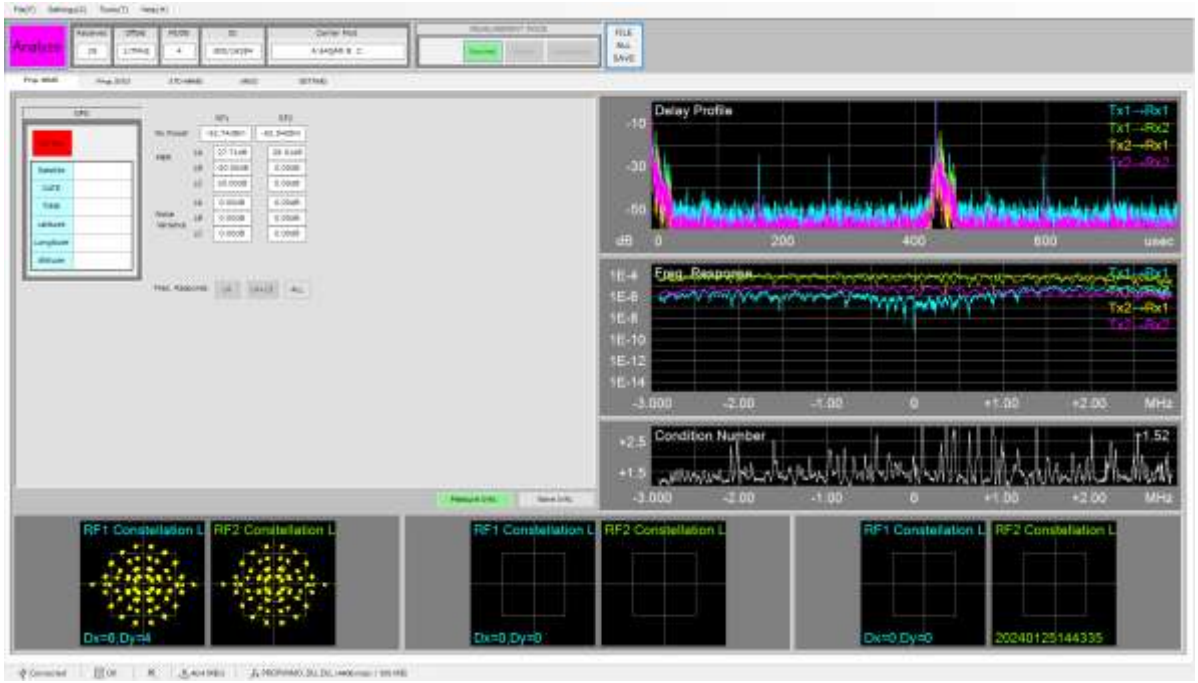


Figure 15.4 - Rintaro Screen

b) AWGN Power

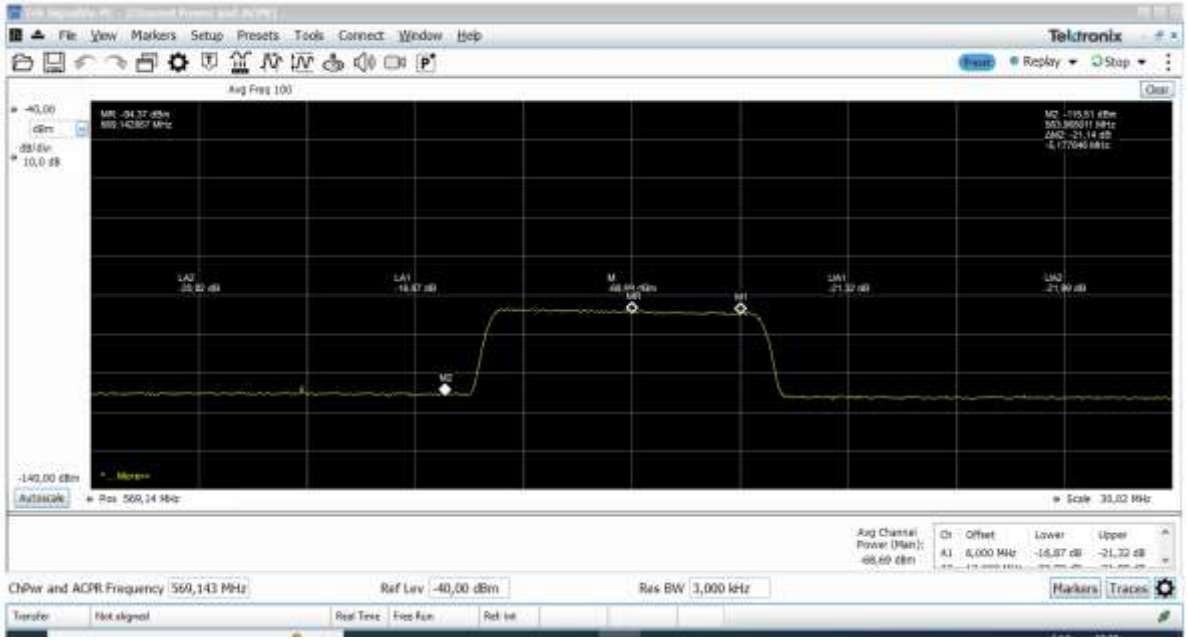


Figure 15.5 - Vertical

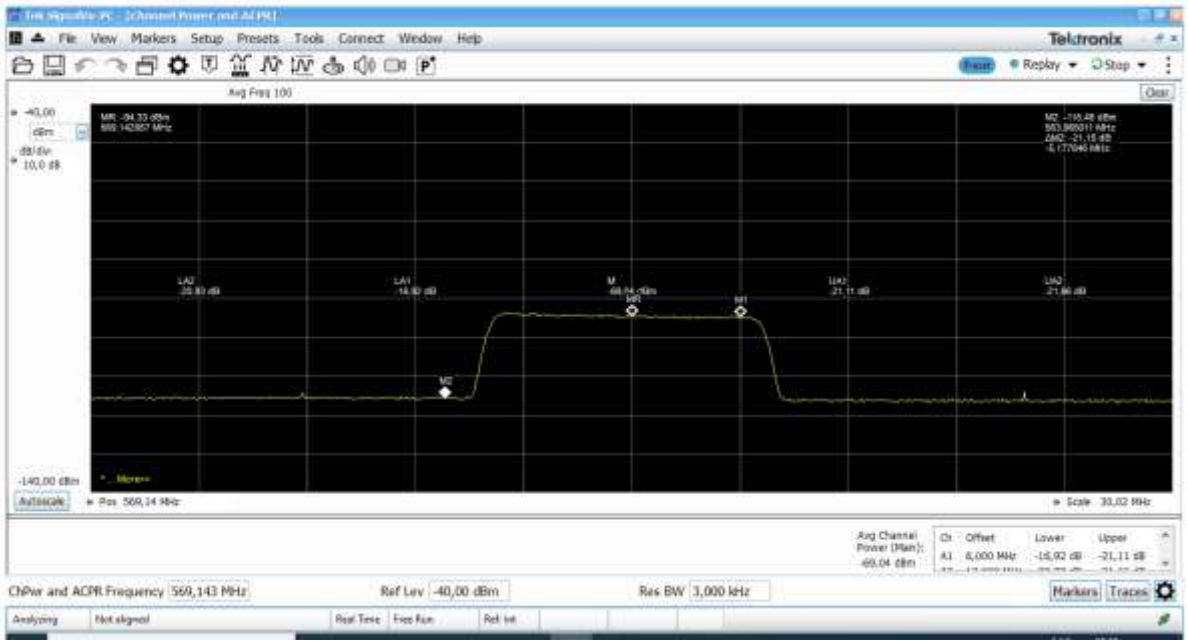


Figure 15.6 - Horizontal

c) C/N Threshold

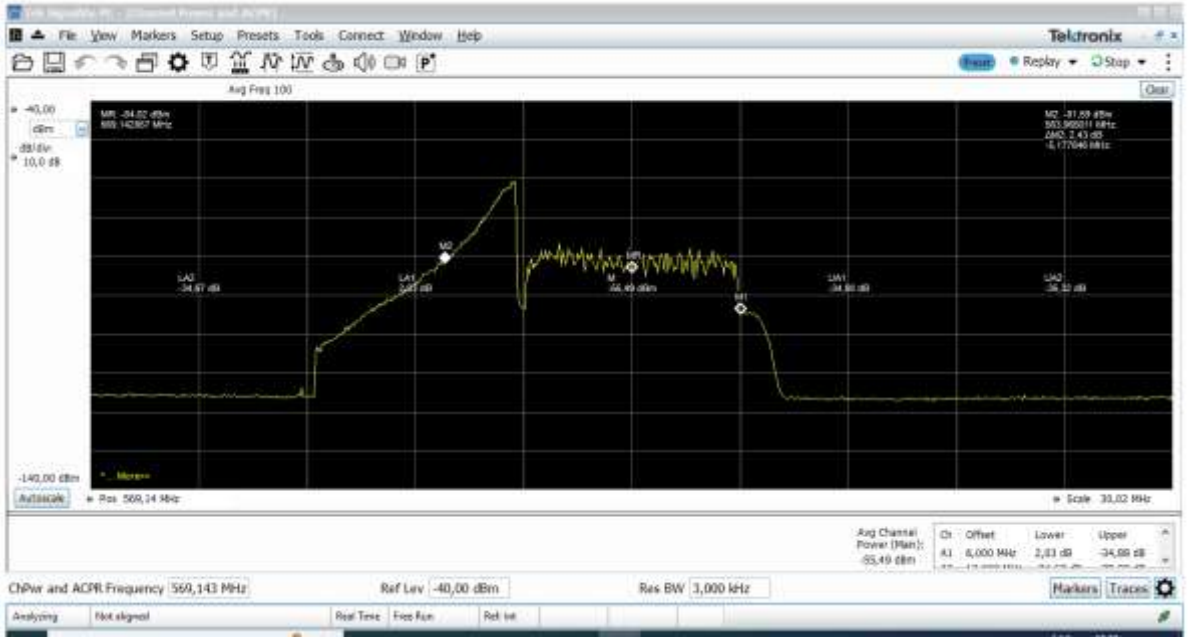


Figure 15.7 - Vertical

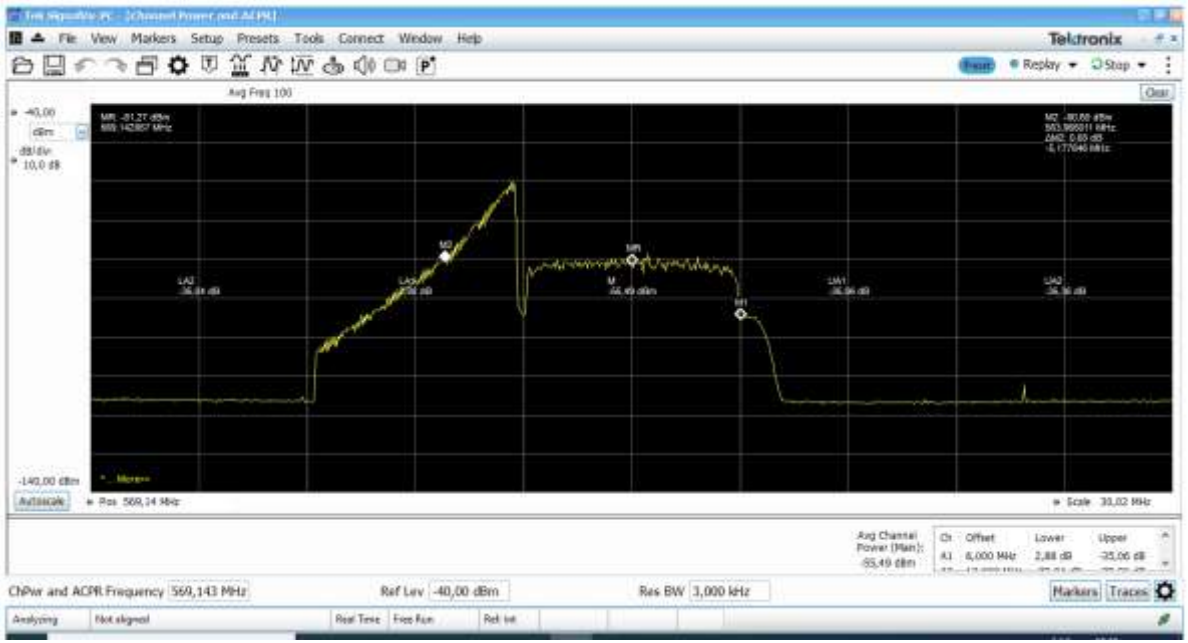


Figure 15.8 - Horizontal

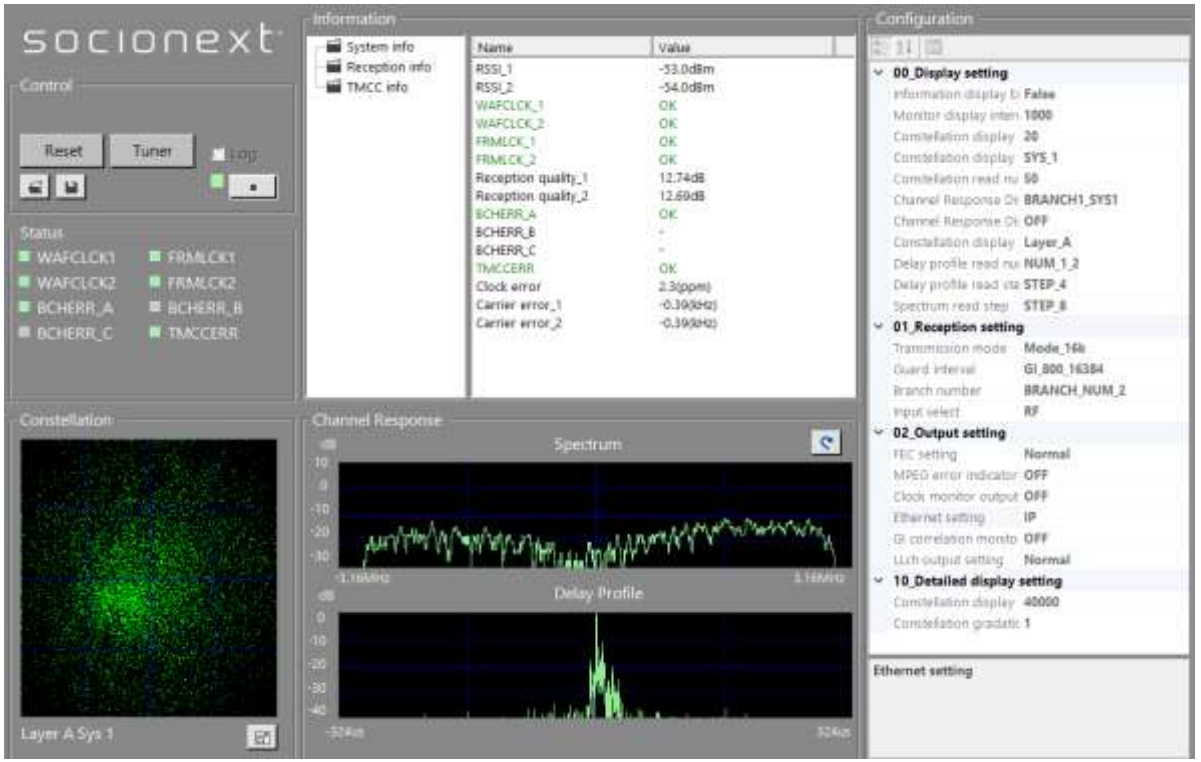


Figure 15.9 - Socionext Screen

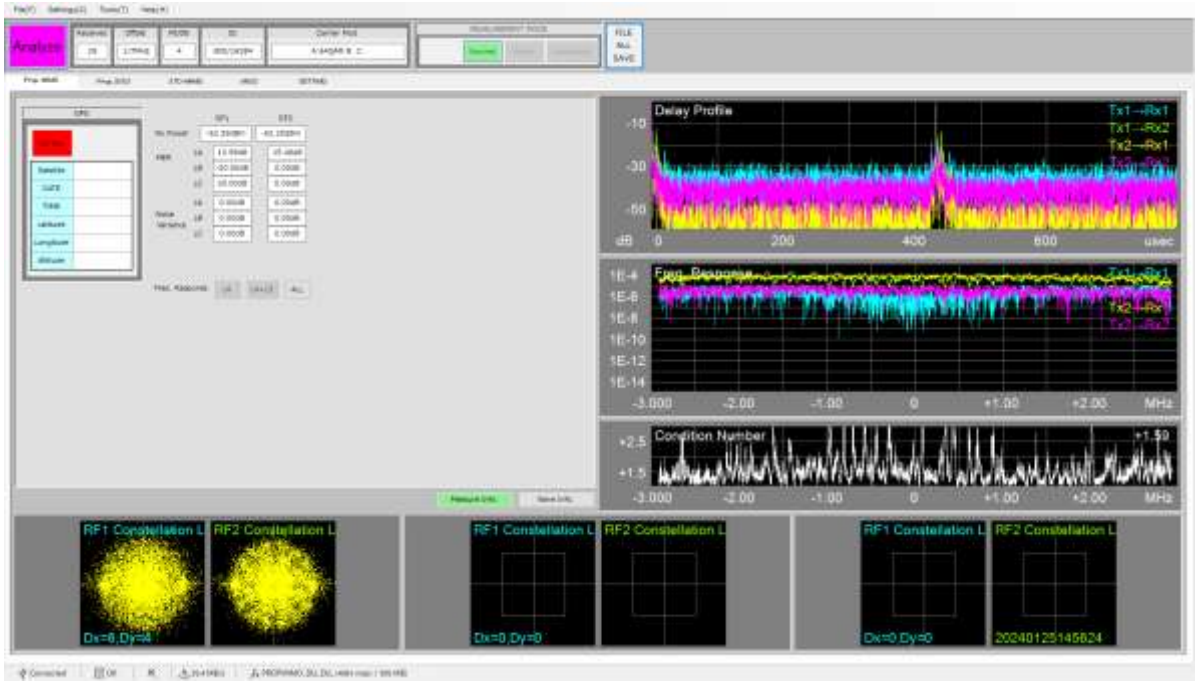


Figure 15.10 - Rintaro Screen

d) Reception Threshold

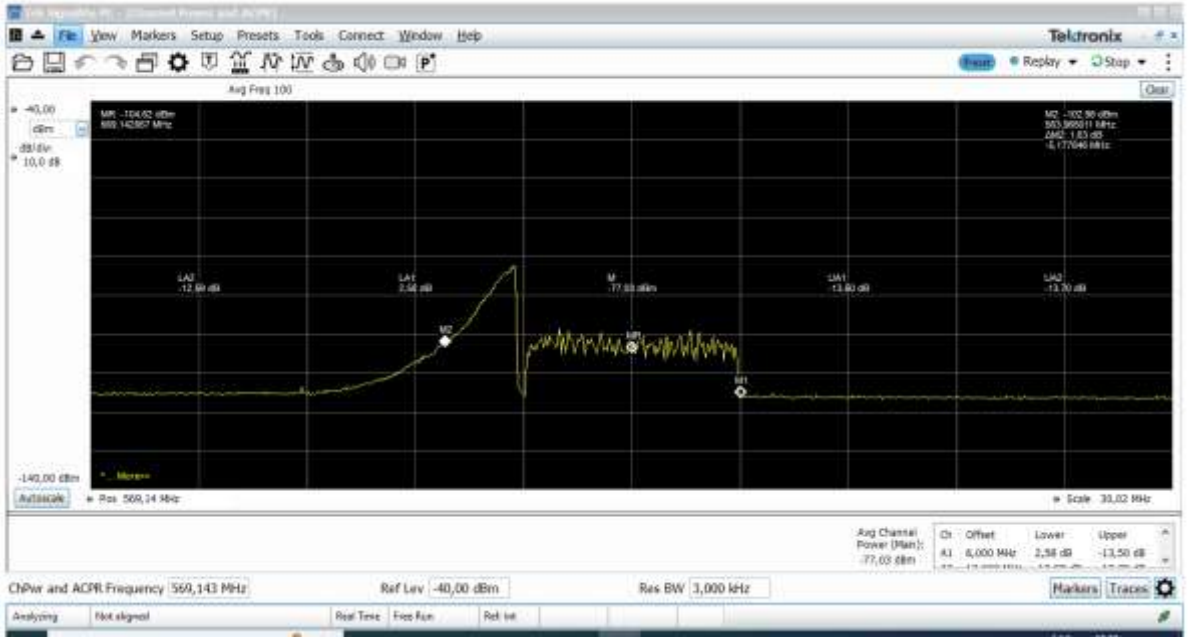


Figure 15.11 - Vertical

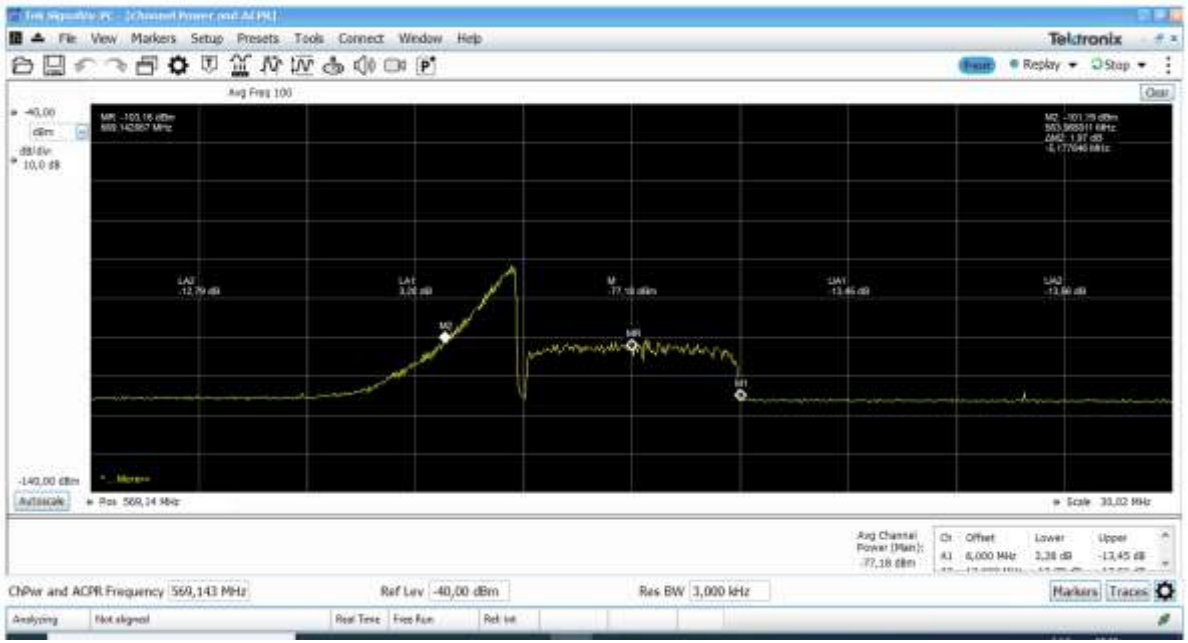


Figure 15.12 - Horizontal

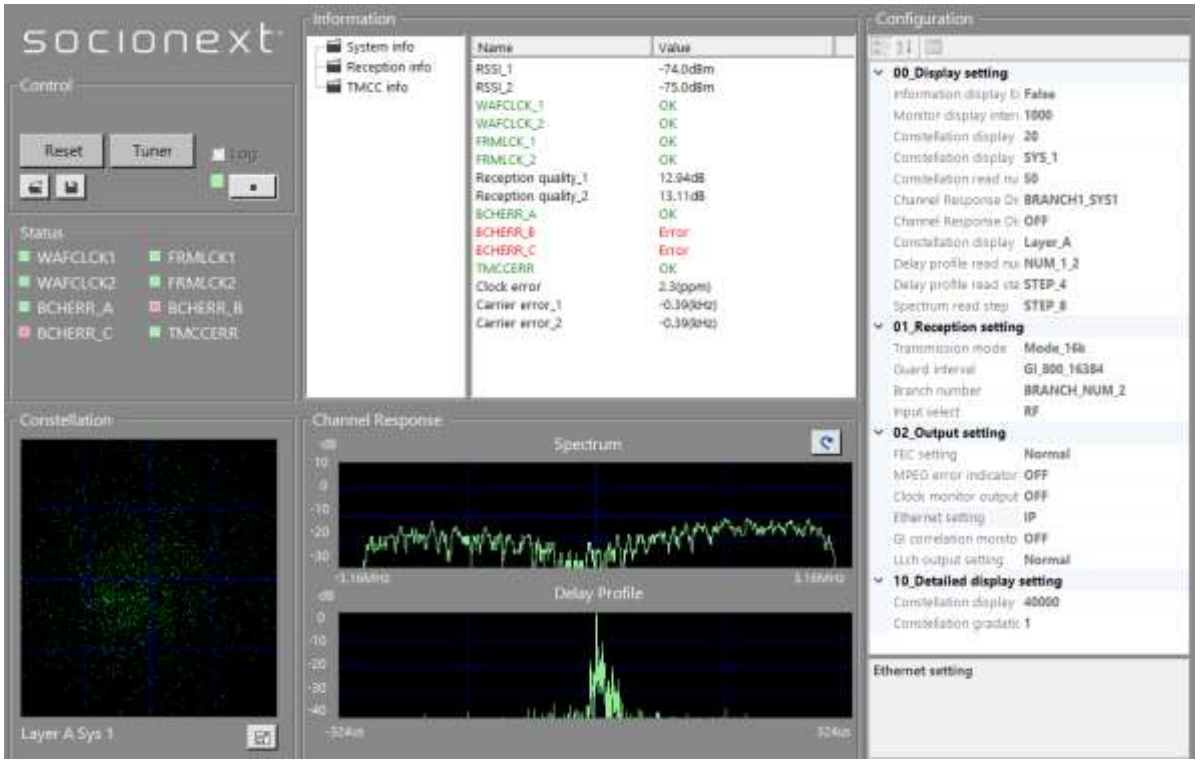


Figure 15.13 - Socionext Screen

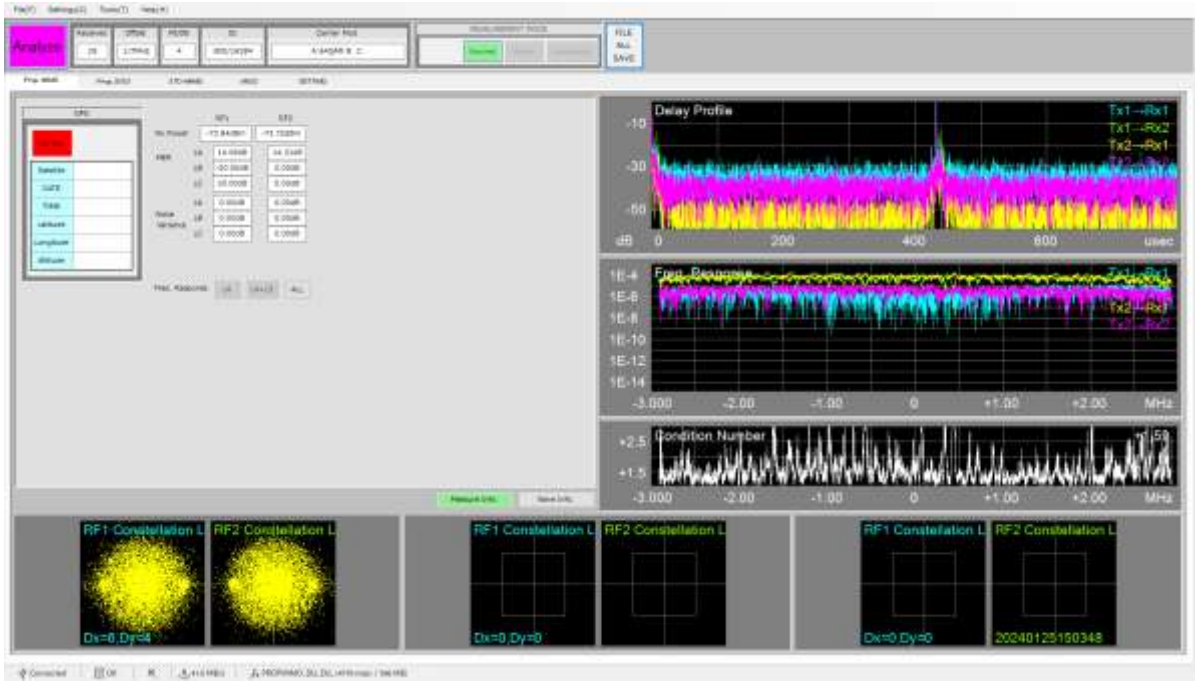


Figure 15.14 - Rintaro Screen

Chapter 16. Site 16

a) Channel Power

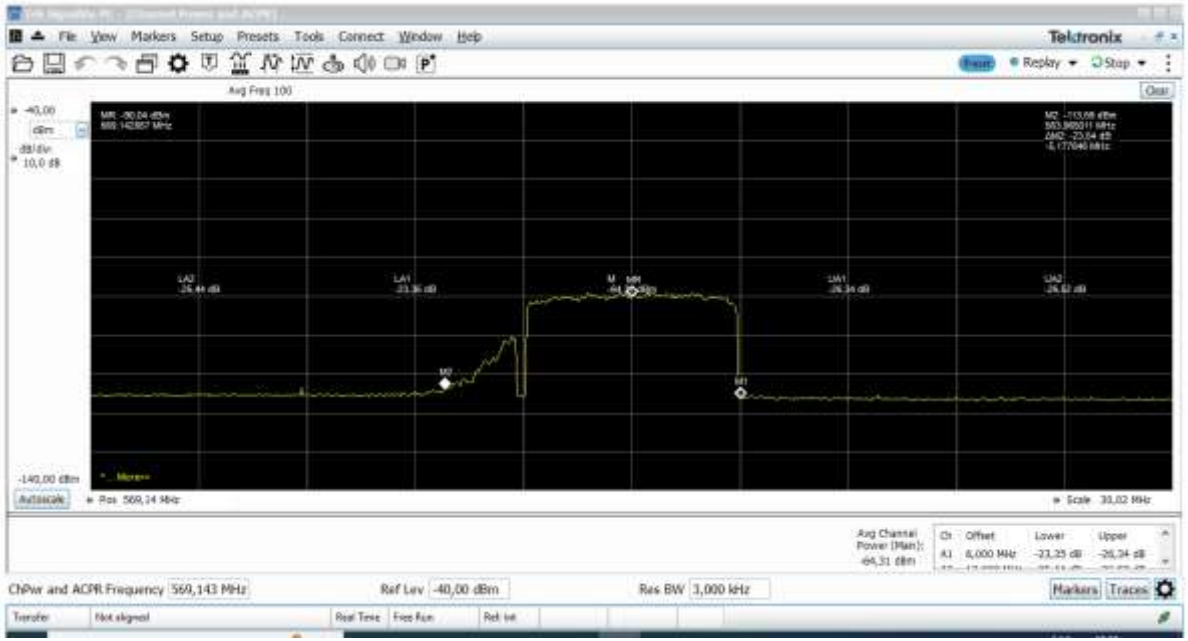


Figure 16.1 - Vertical

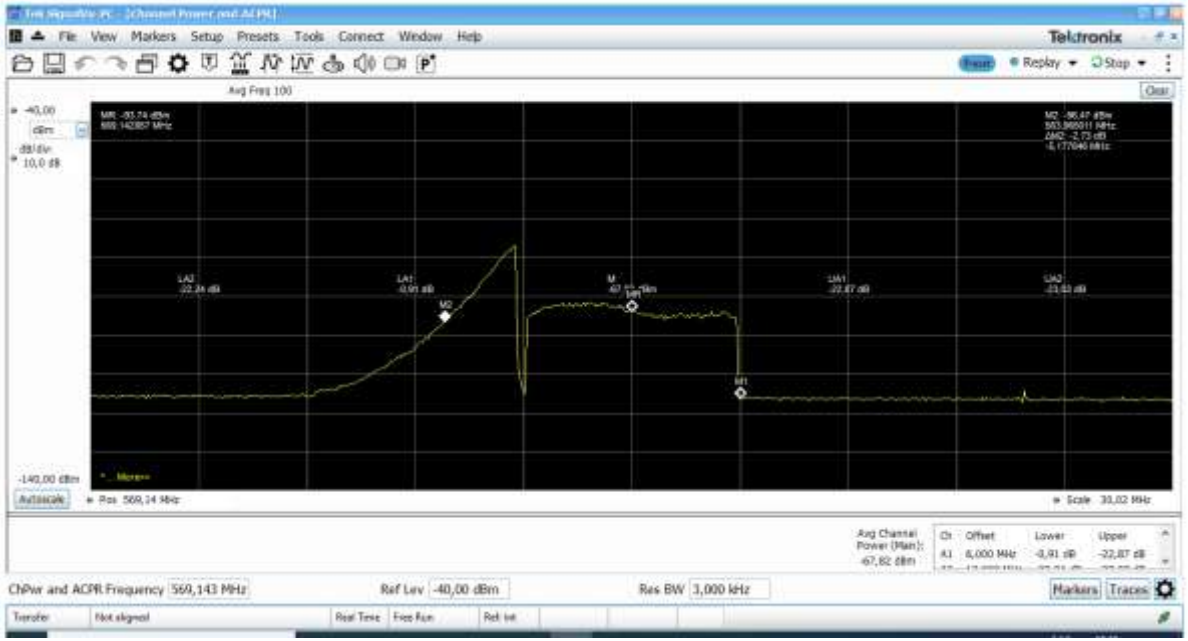


Figure 16.2 - Horizontal

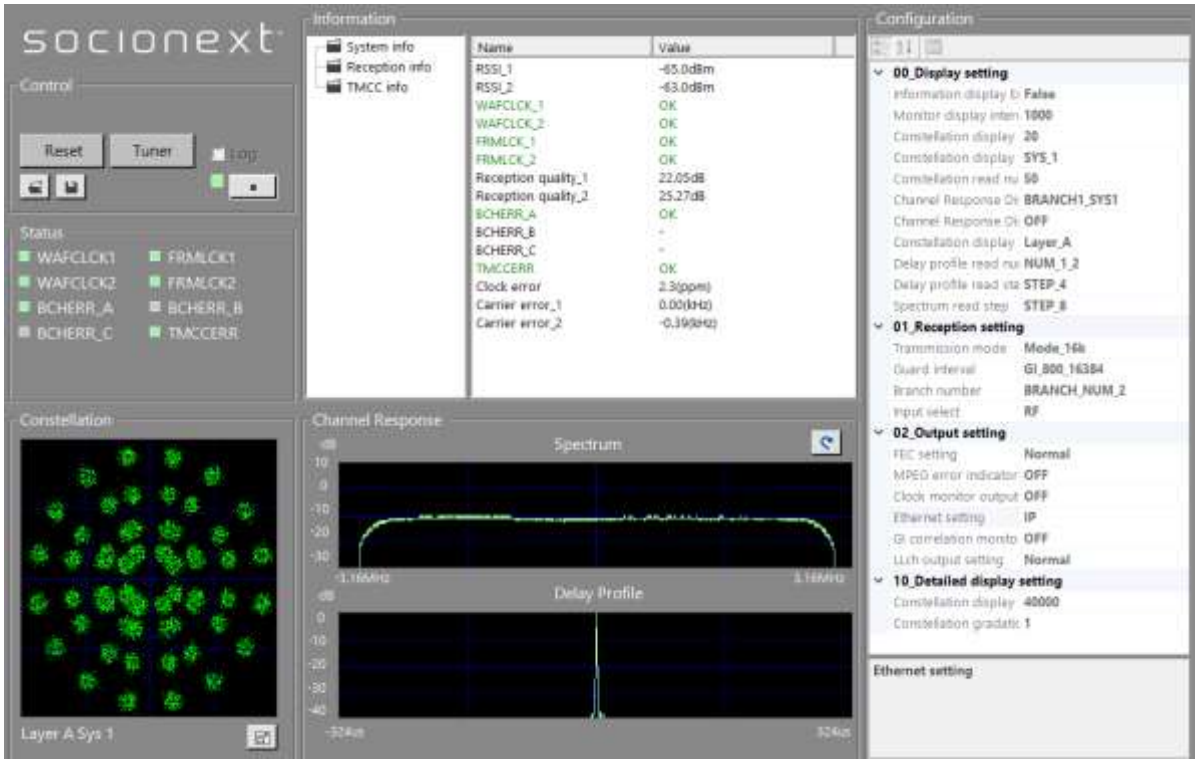


Figure 16.3 - Socionext Screen

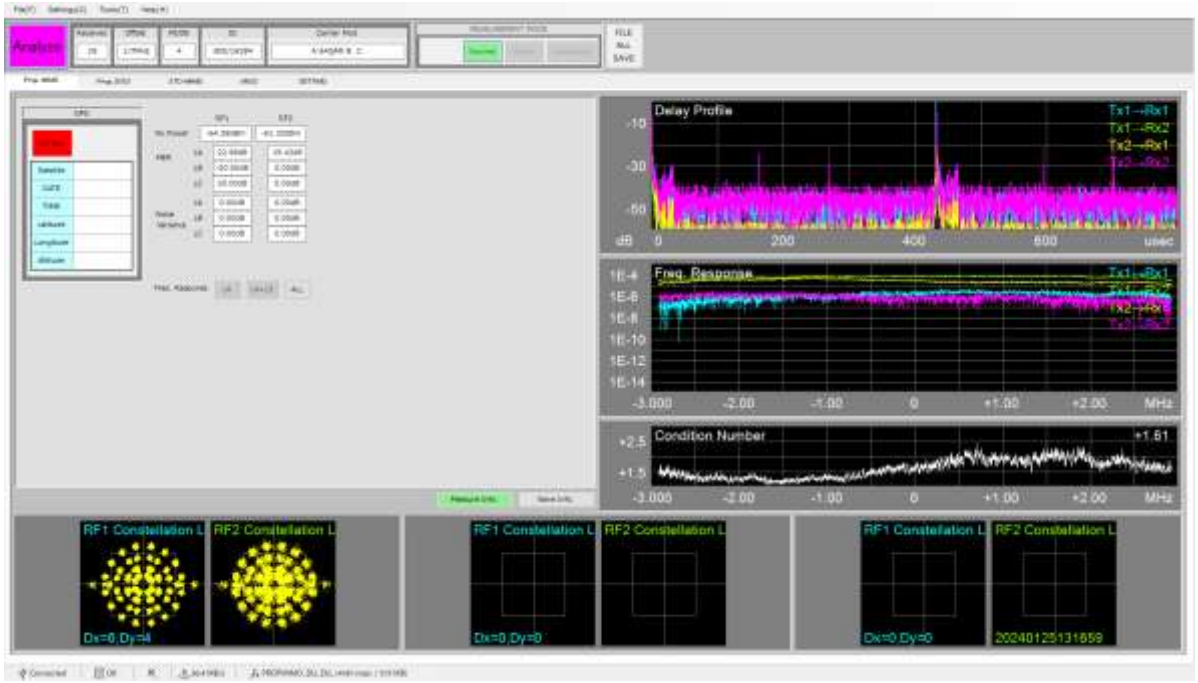


Figure 16.4 - Rintaro Screen

b) AWGN Power

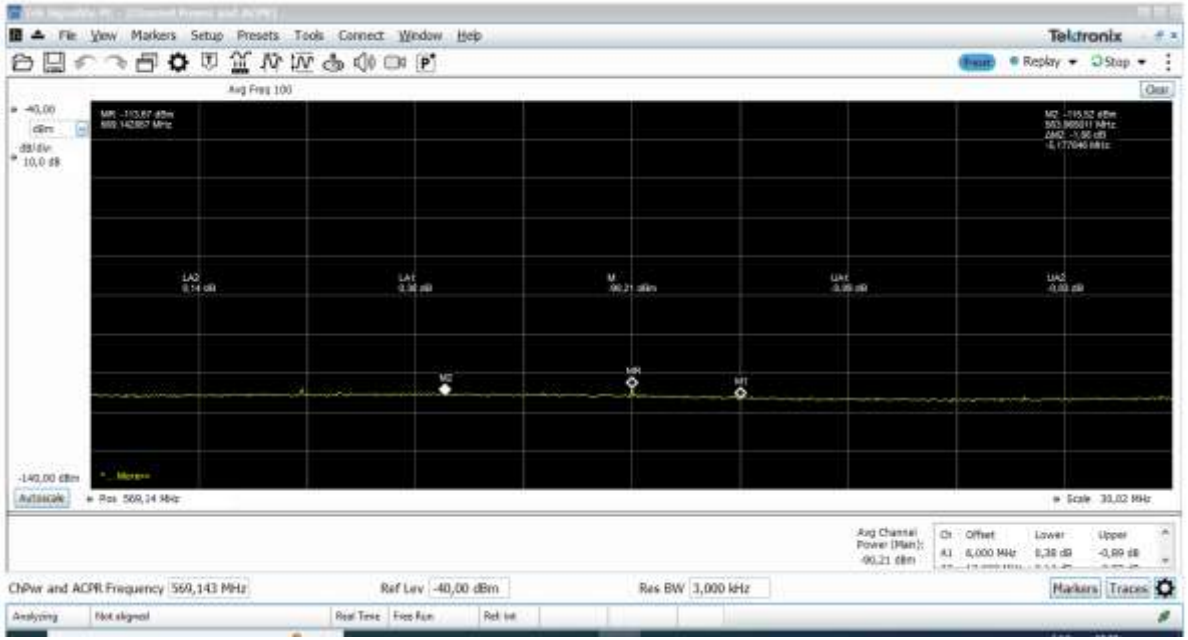


Figure 16.5 - Vertical

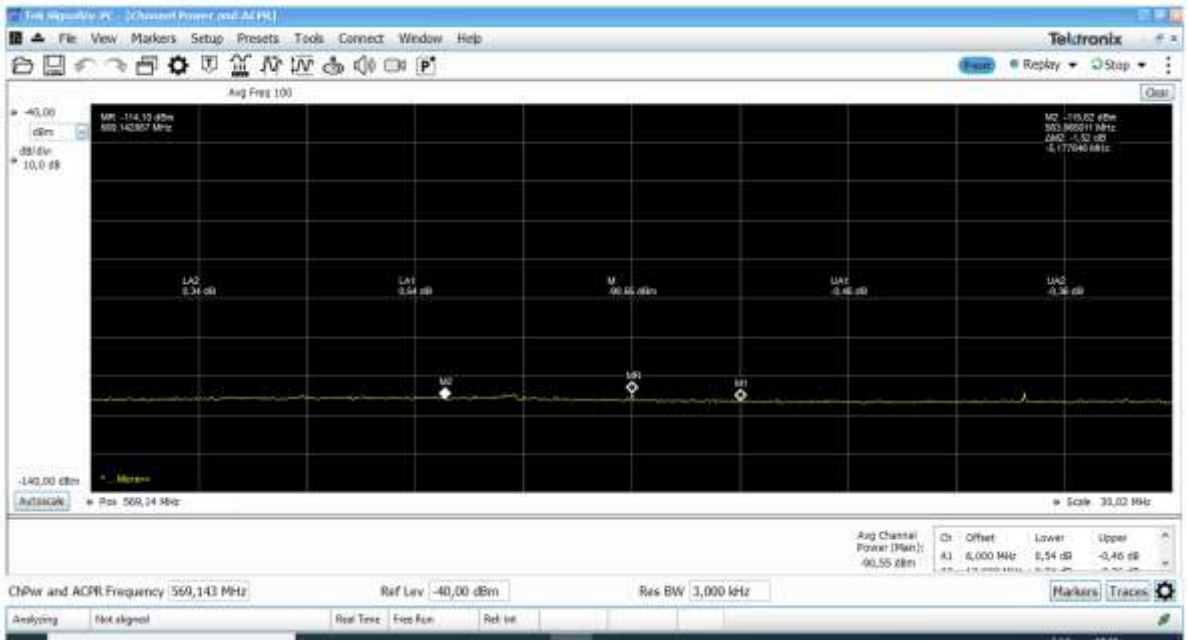


Figure 16.6 - Horizontal

c) C/N Threshold

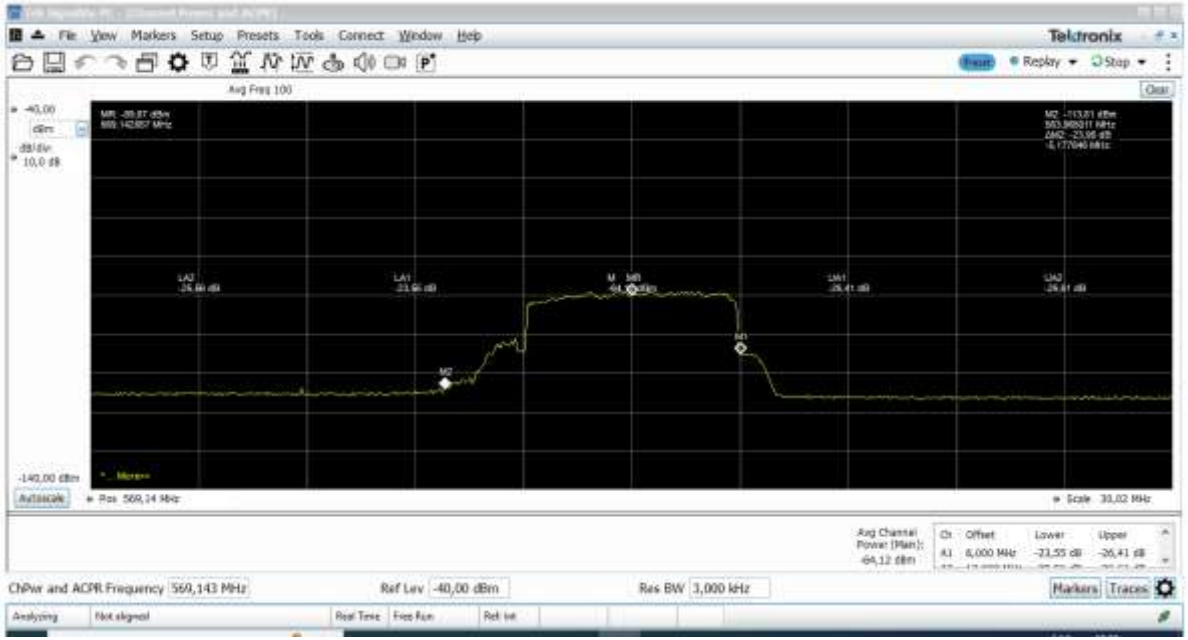


Figure 16.7 - Vertical

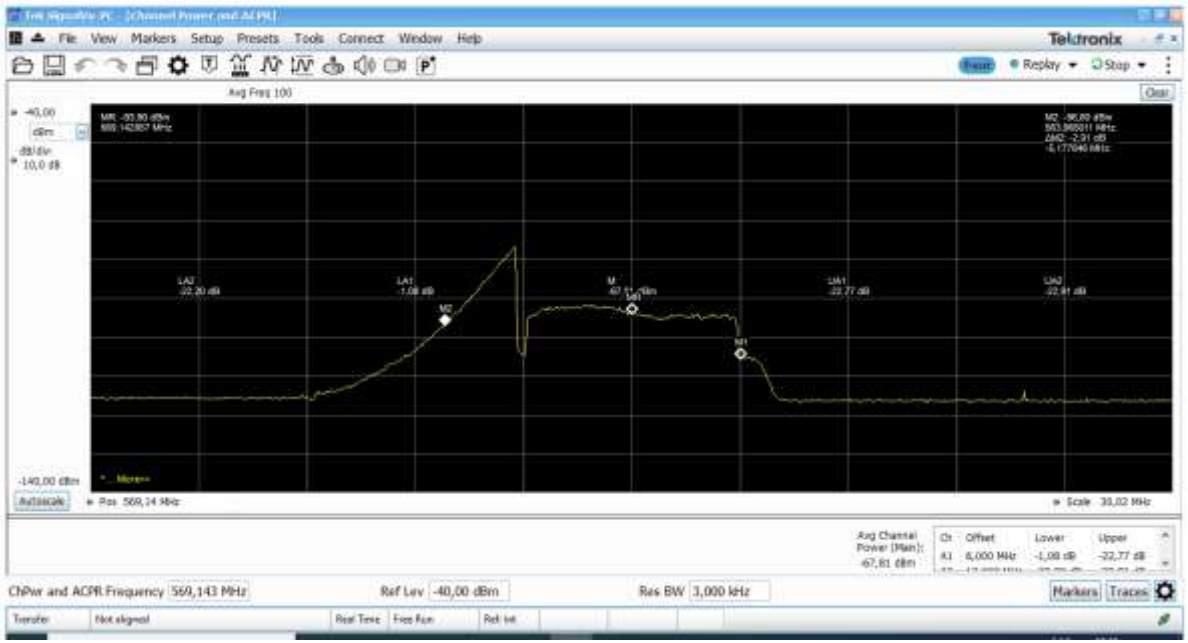


Figure 16.8 - Horizontal

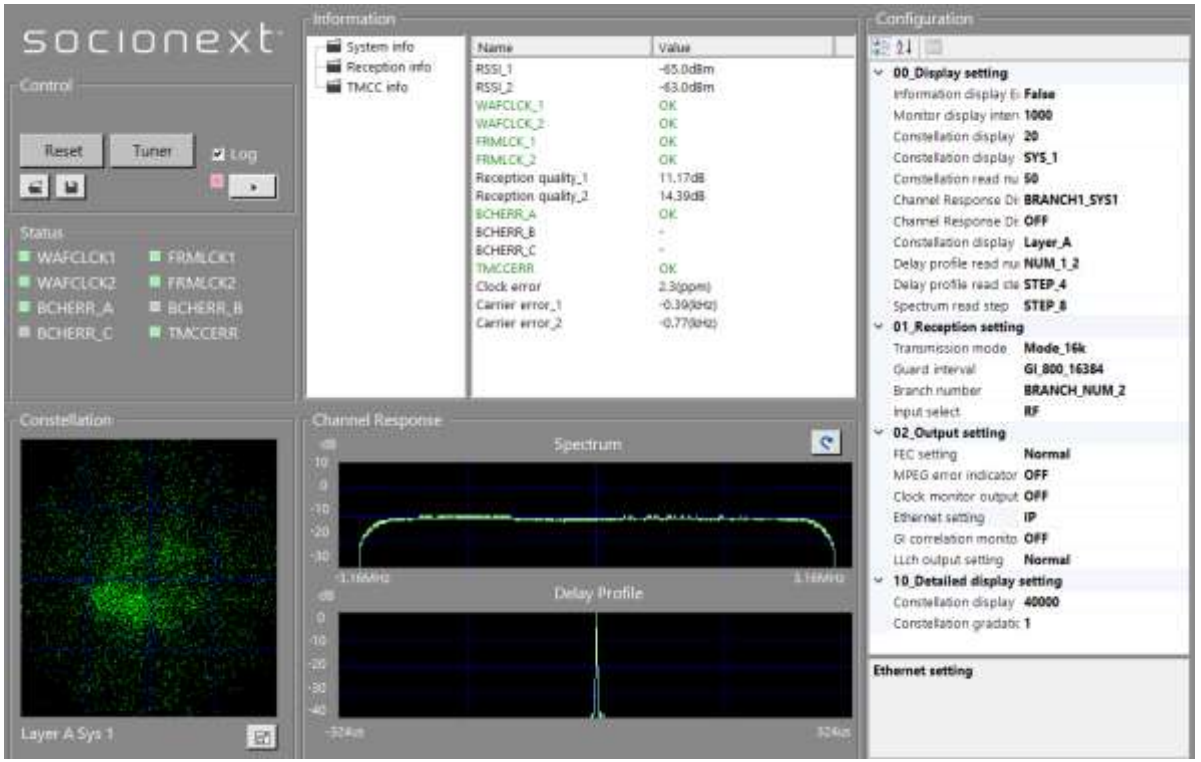


Figure 16.9 - Socionext Screen

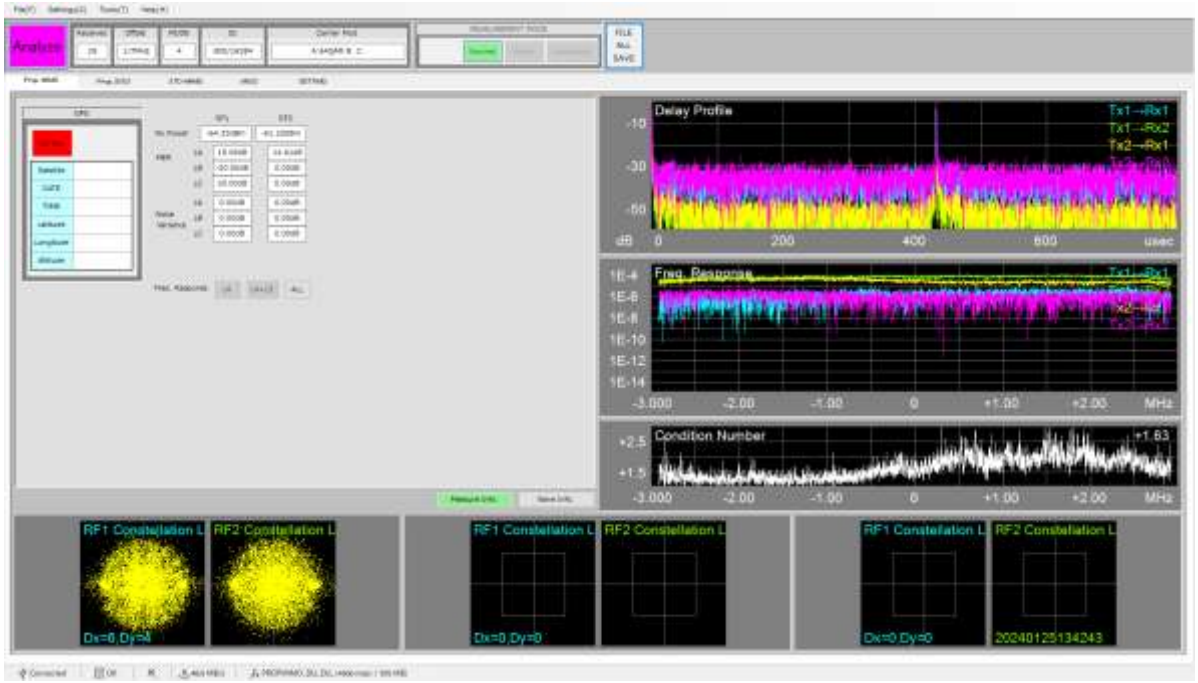


Figure 16.10 - Rintaro Screen

d) Reception Threshold

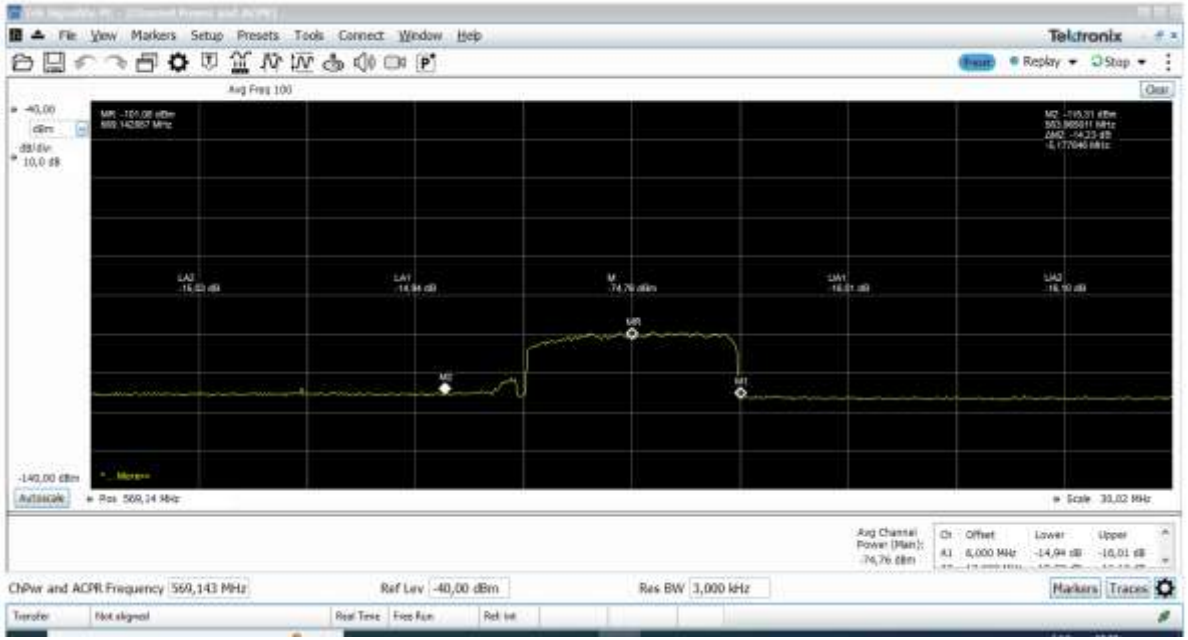


Figure 16.11 - Vertical

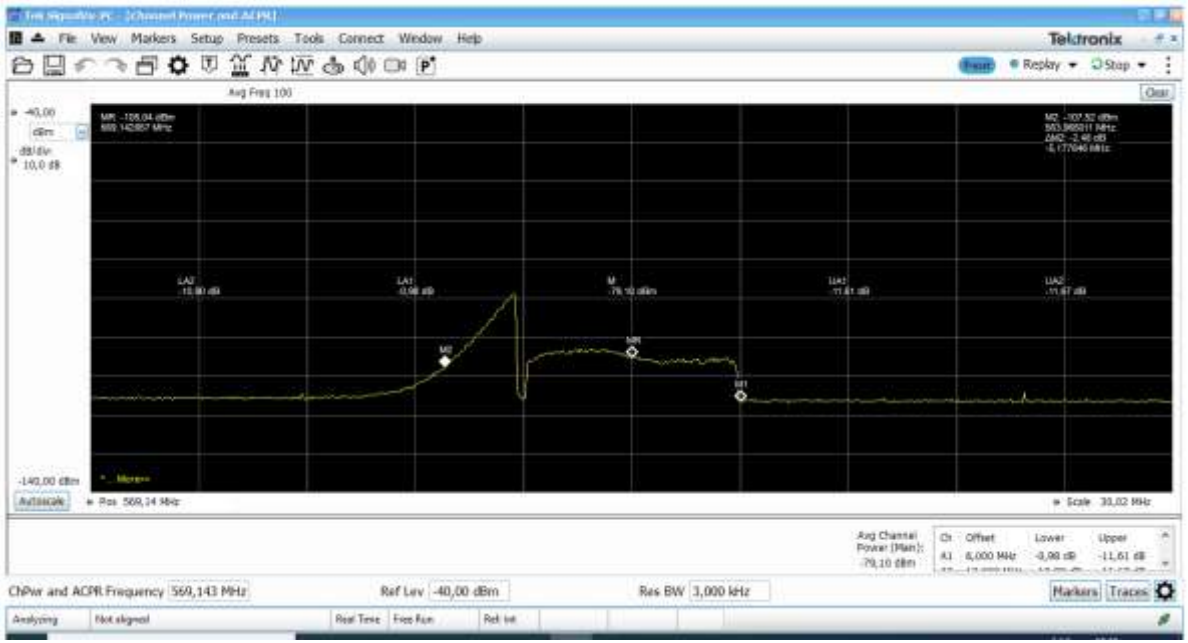


Figure 16.12 - Horizontal

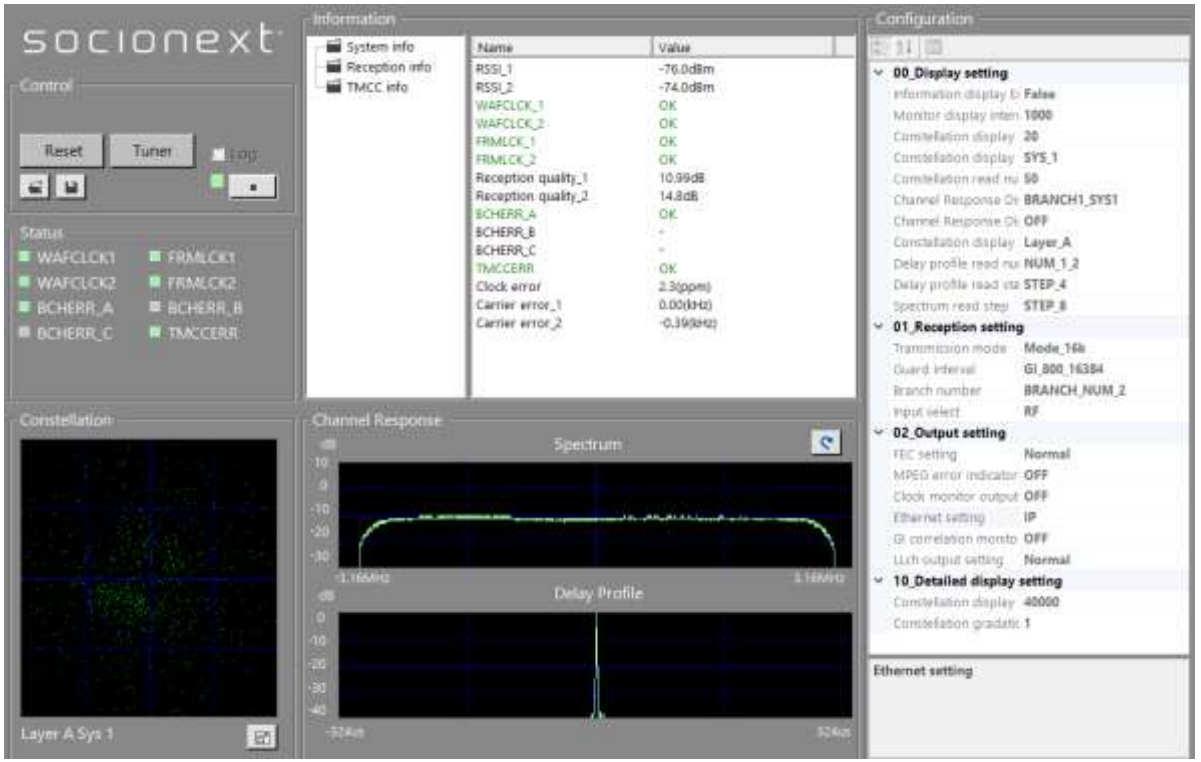


Figure 16.13 - Socionext Screen

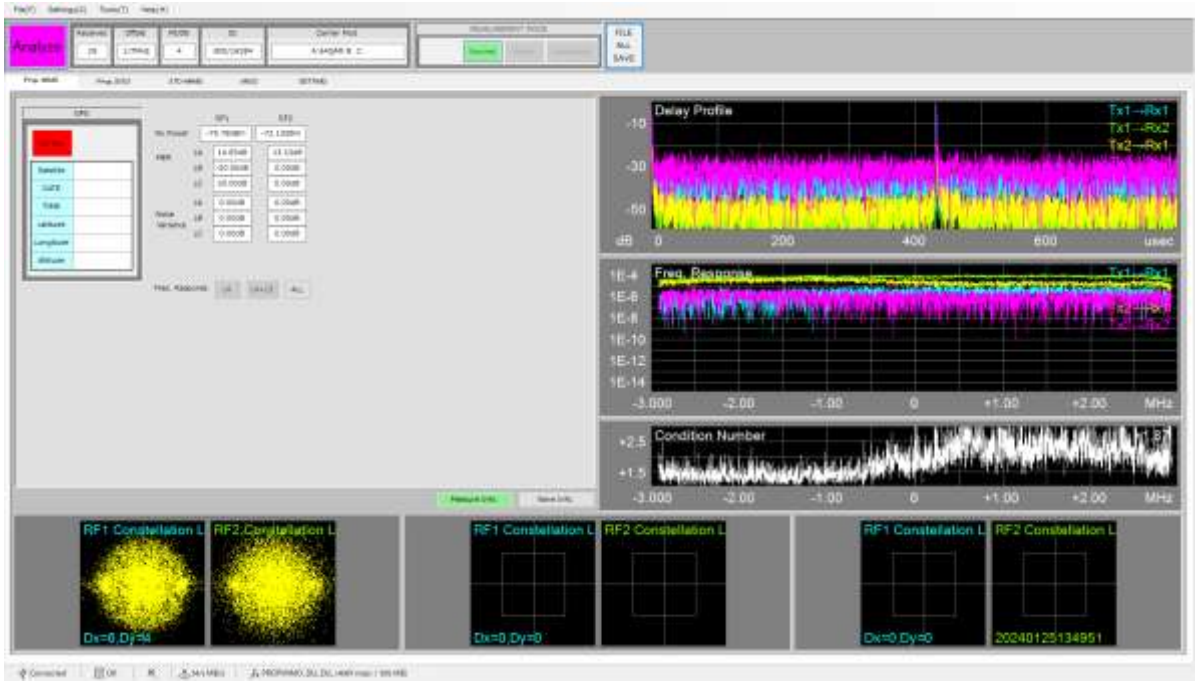


Figure 16.14 - Rintaro Screen

Chapter 17. Site 17

a) Channel Power

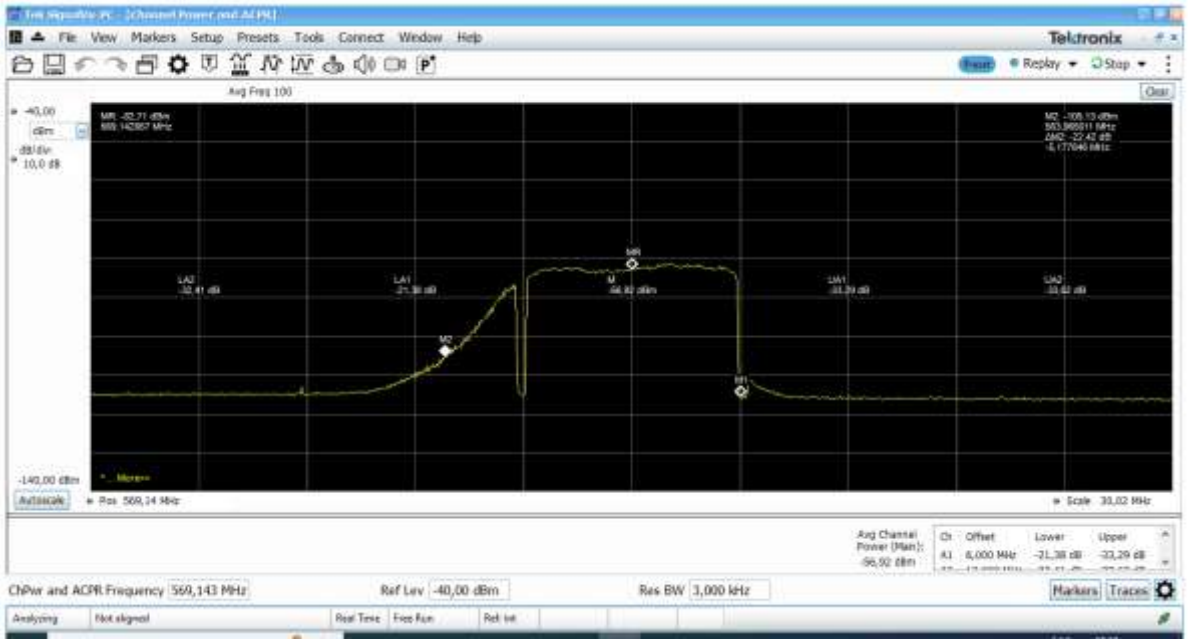


Figure 17.1 - Vertical

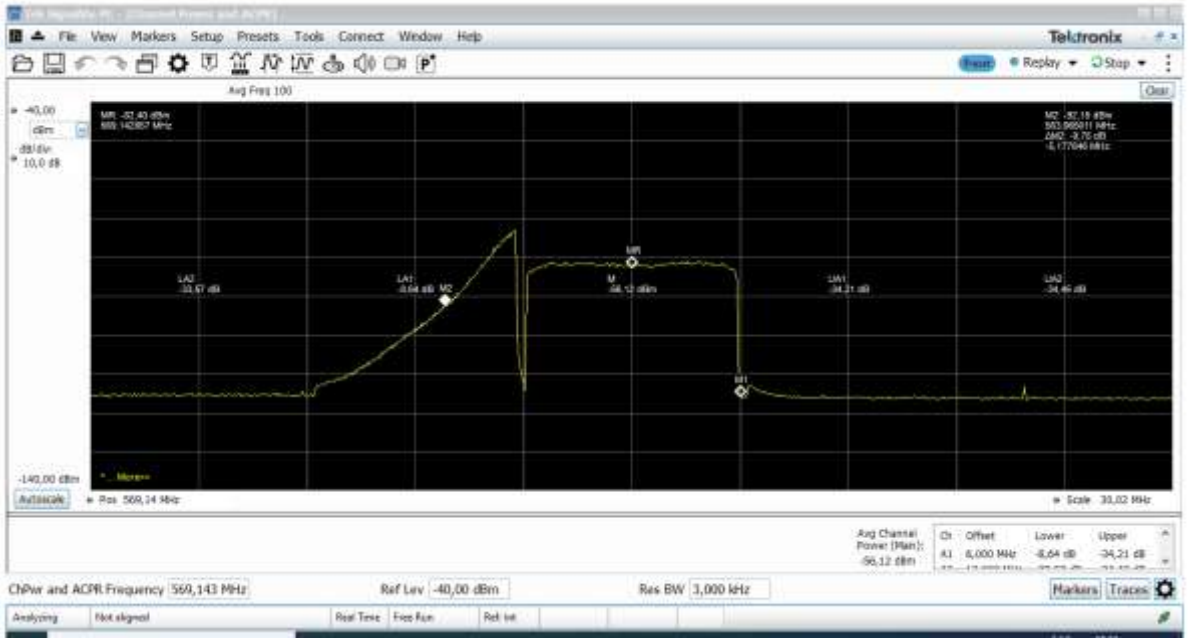


Figure 17.2 - Horizontal

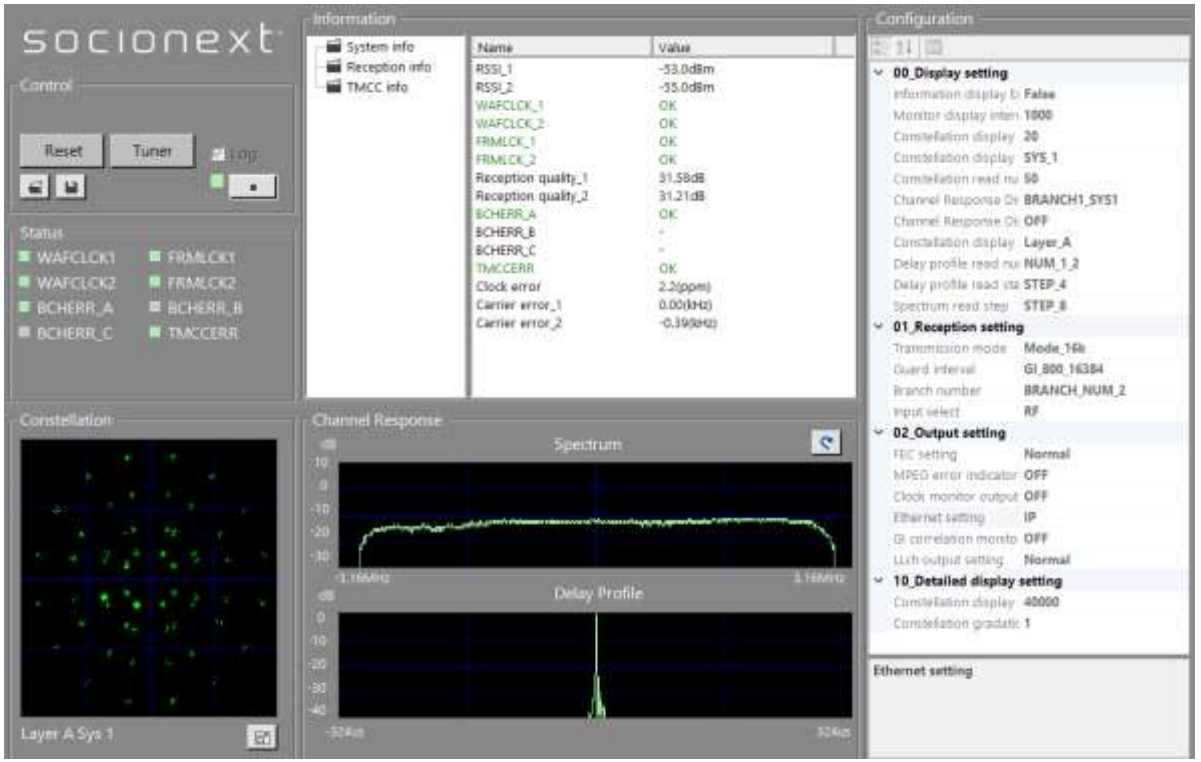


Figure 17.3 - Socionext Screen

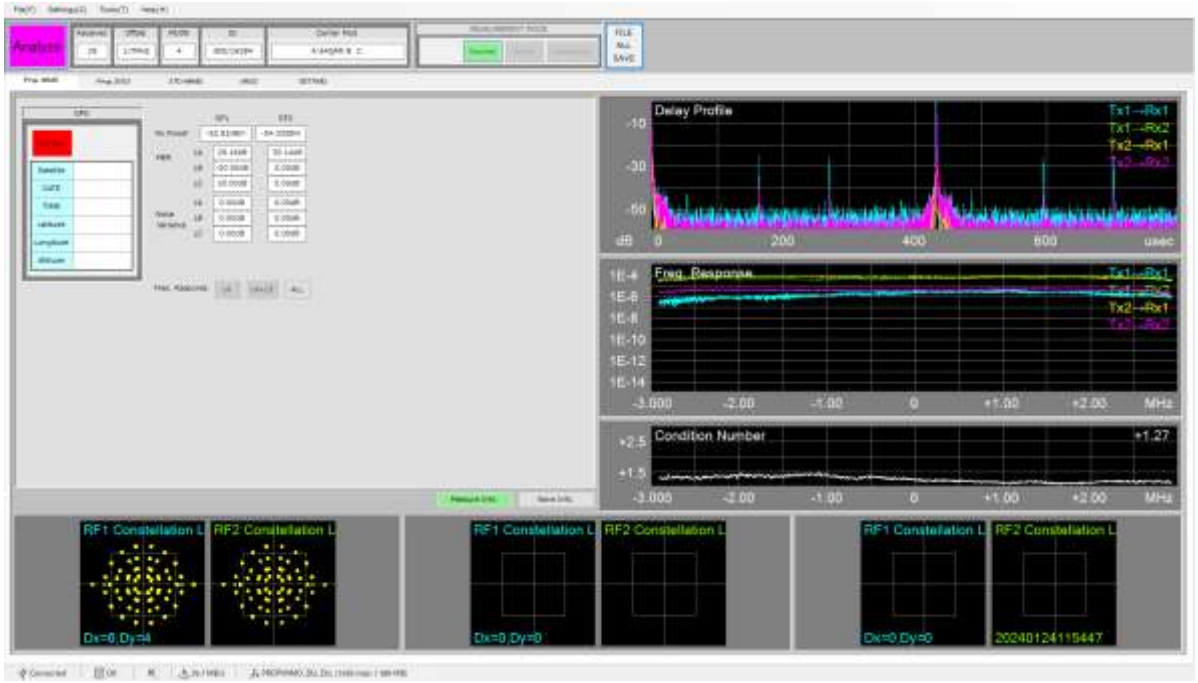


Figure 17.4 - Rintaro Screen

b) AWGN Power

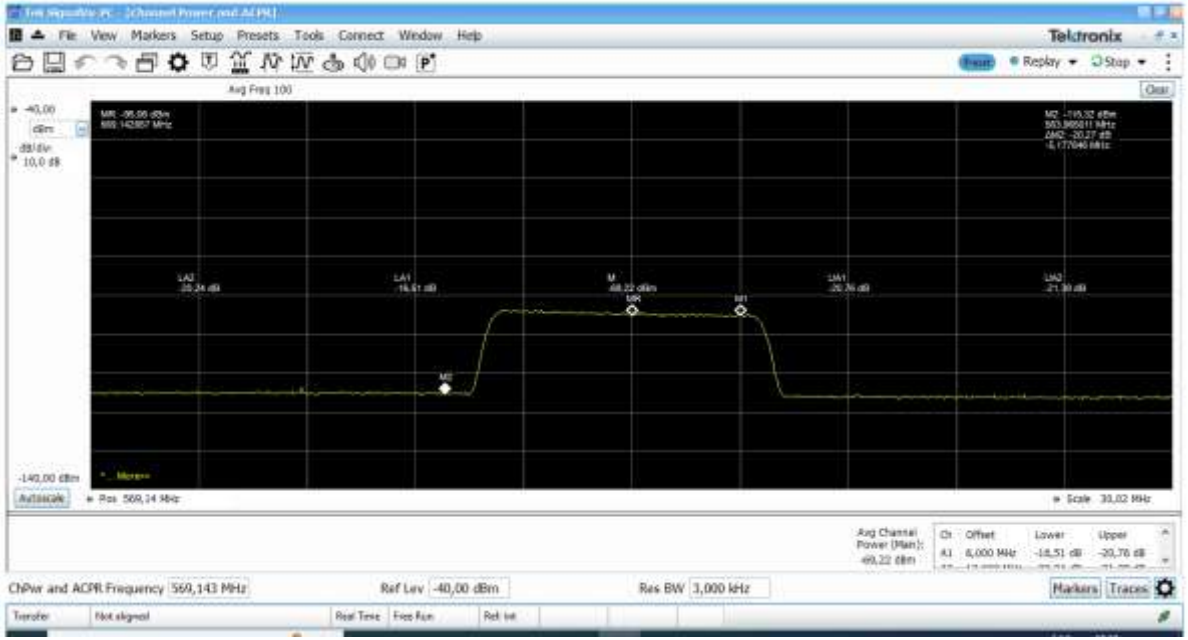


Figure 17.5 - Vertical

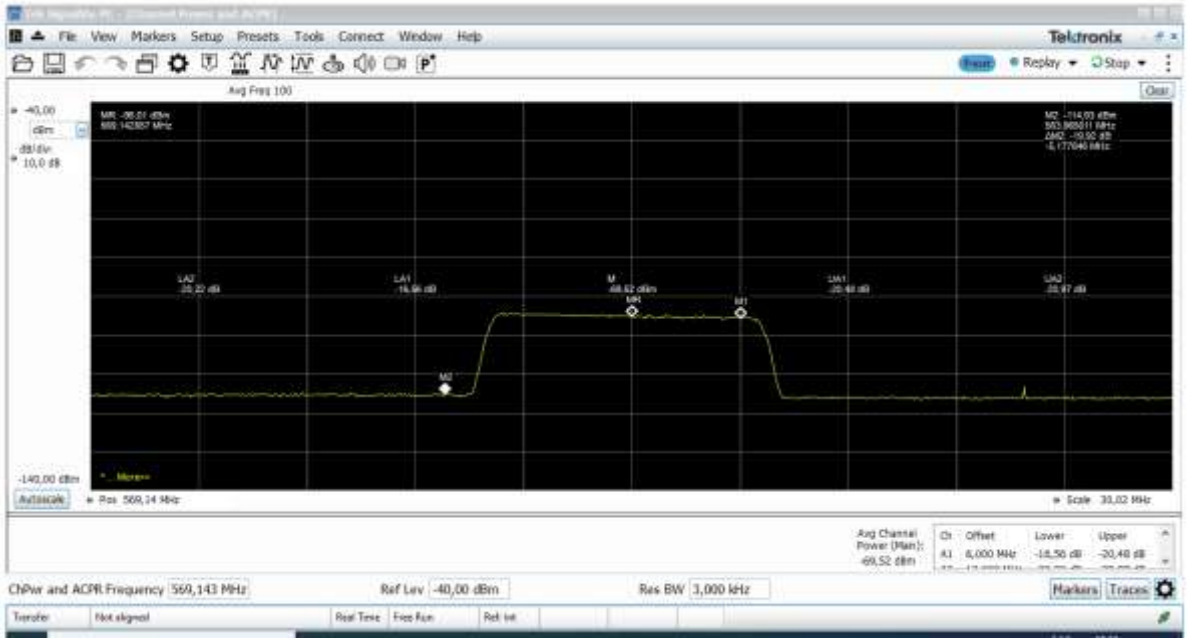


Figure 17.6 - Horizontal

c) C/N Threshold

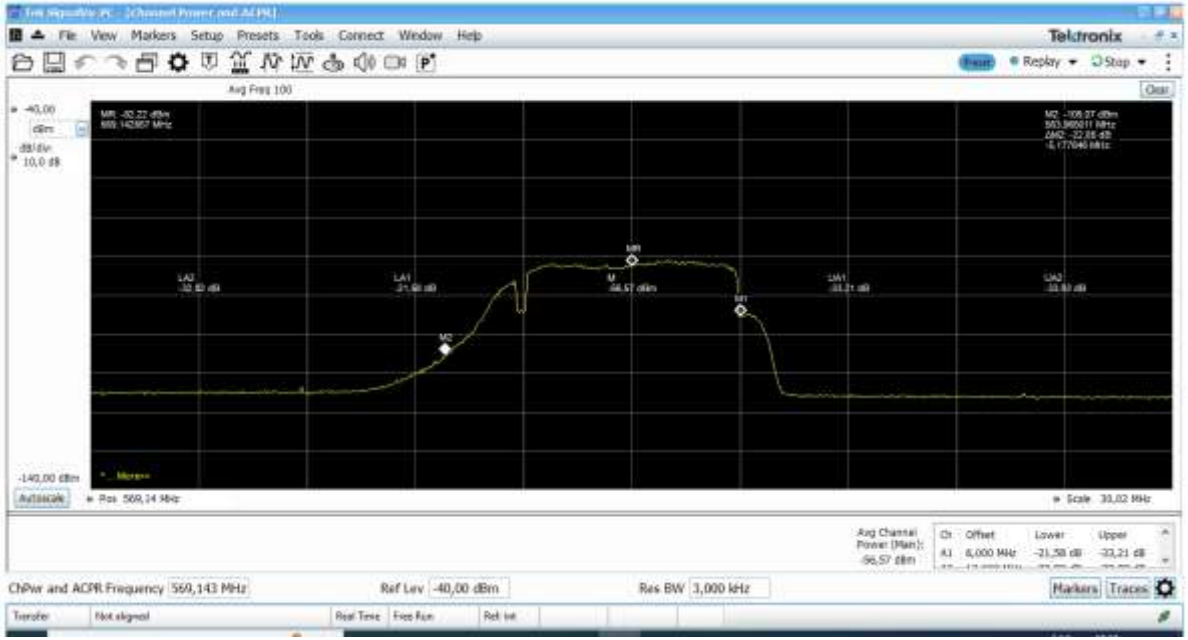


Figure 17.7 - Vertical

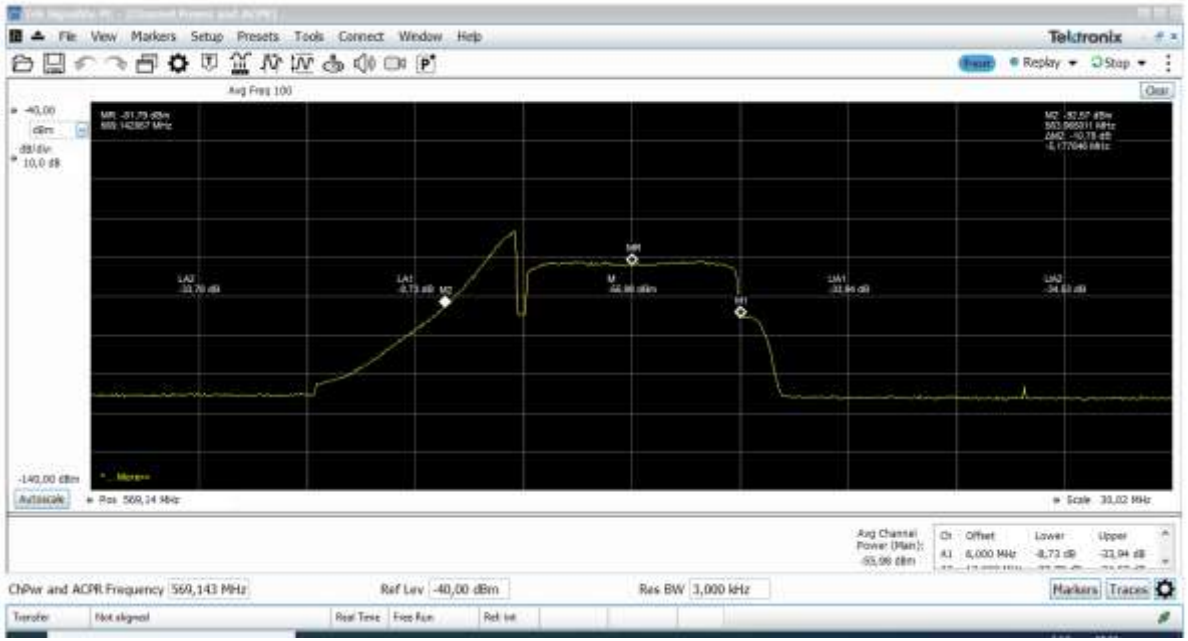


Figure 17.8 - Horizontal

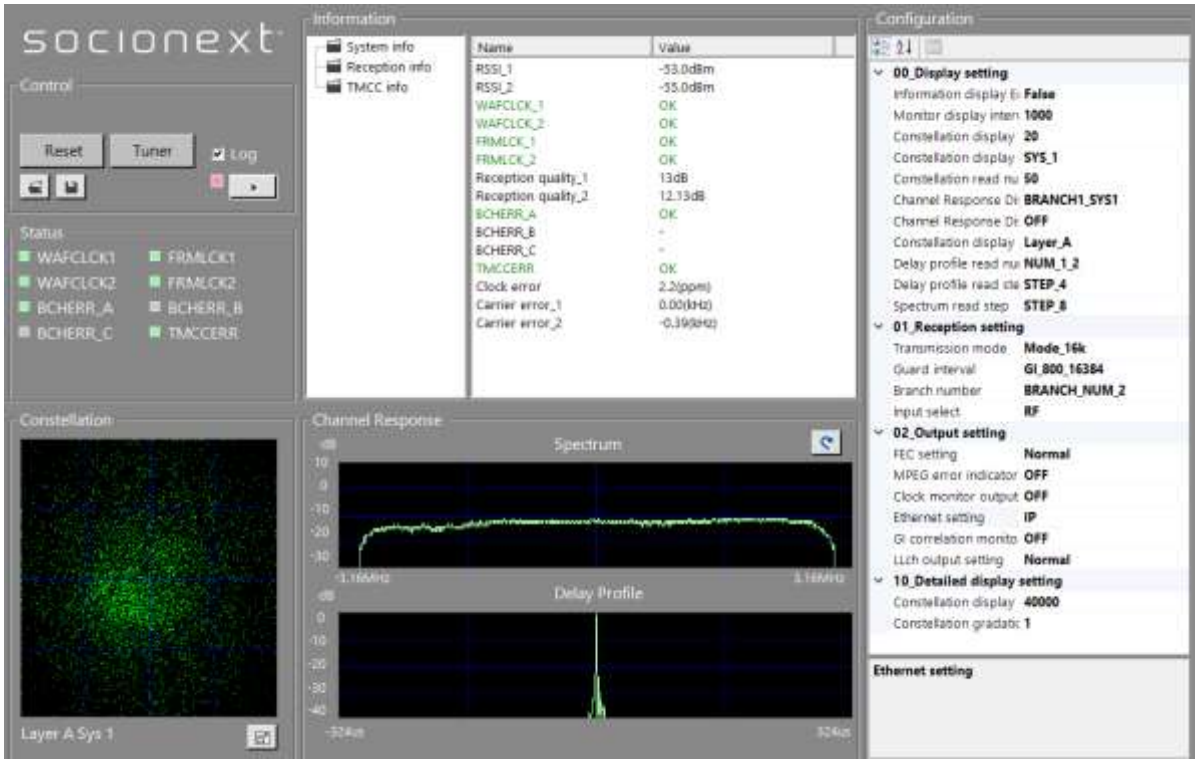


Figure 17.9 - Socionext Screen

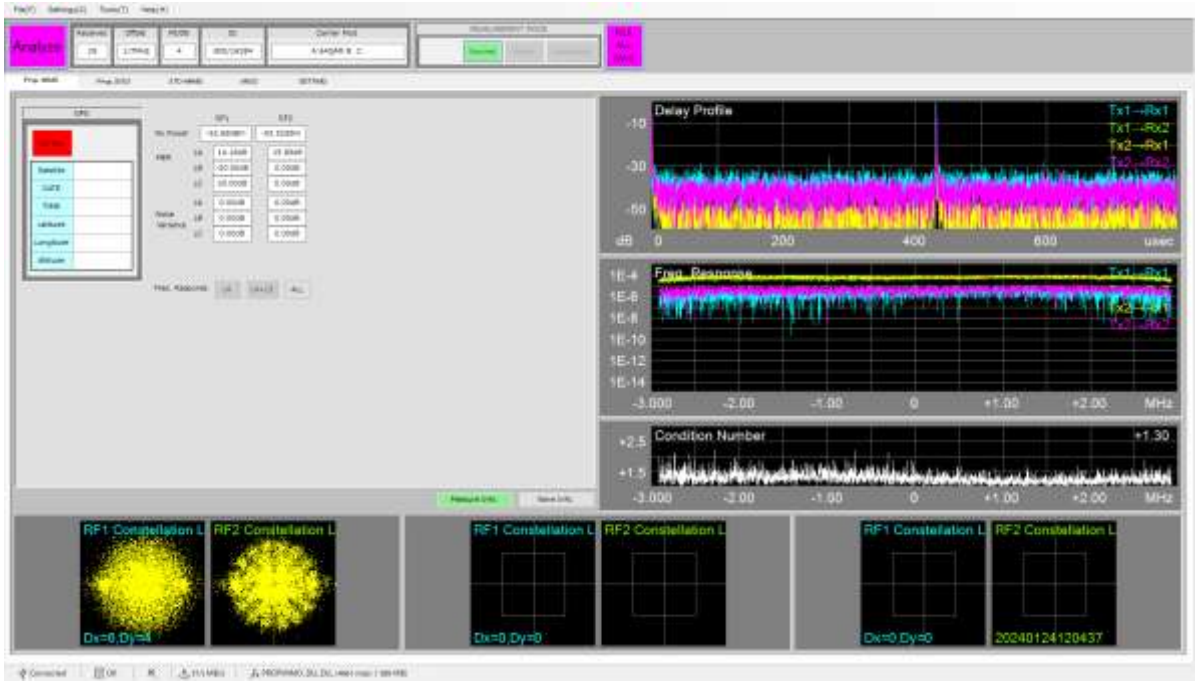


Figure 17.10 - Rintaro Screen

d) Reception Threshold

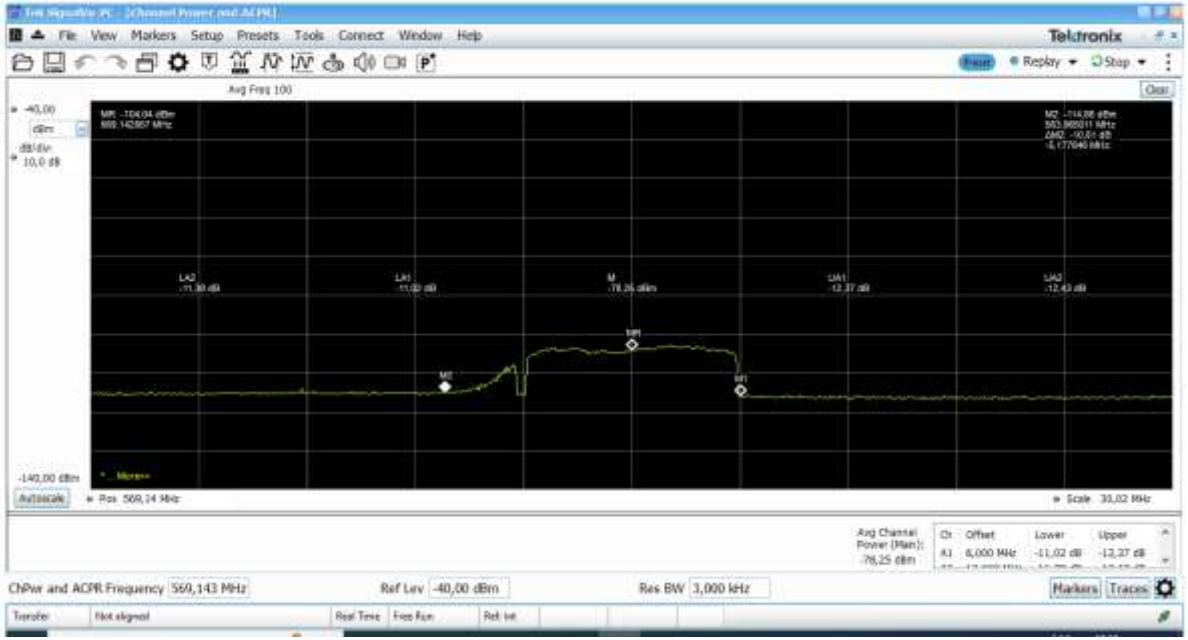


Figure 17.11 - Vertical

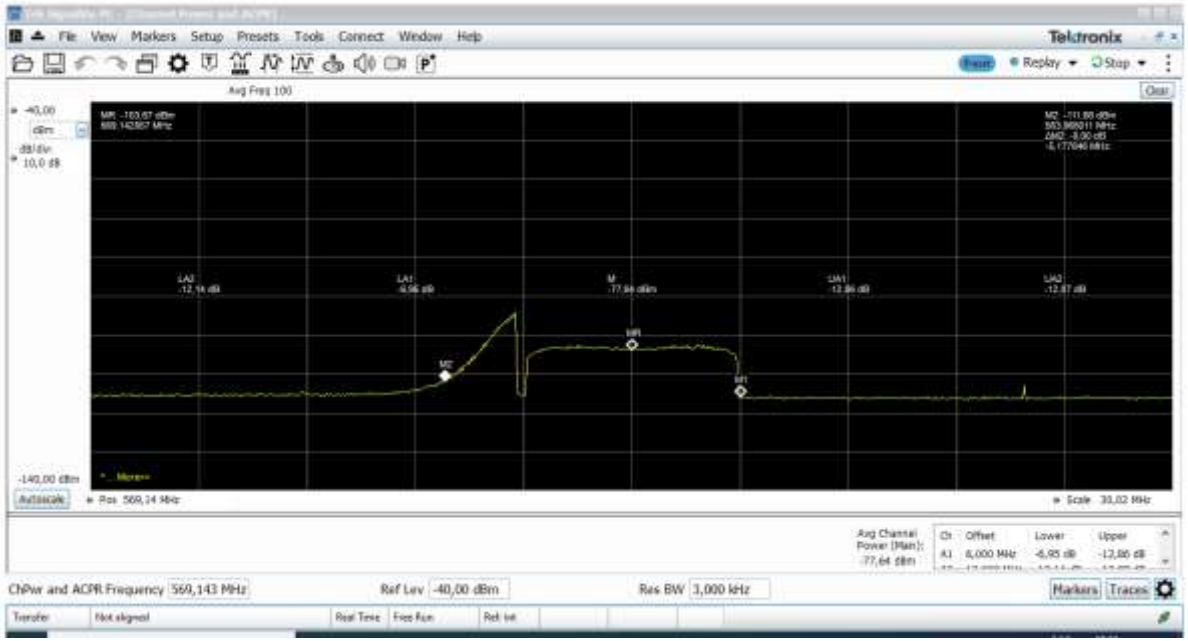


Figure 17.12 - Horizontal

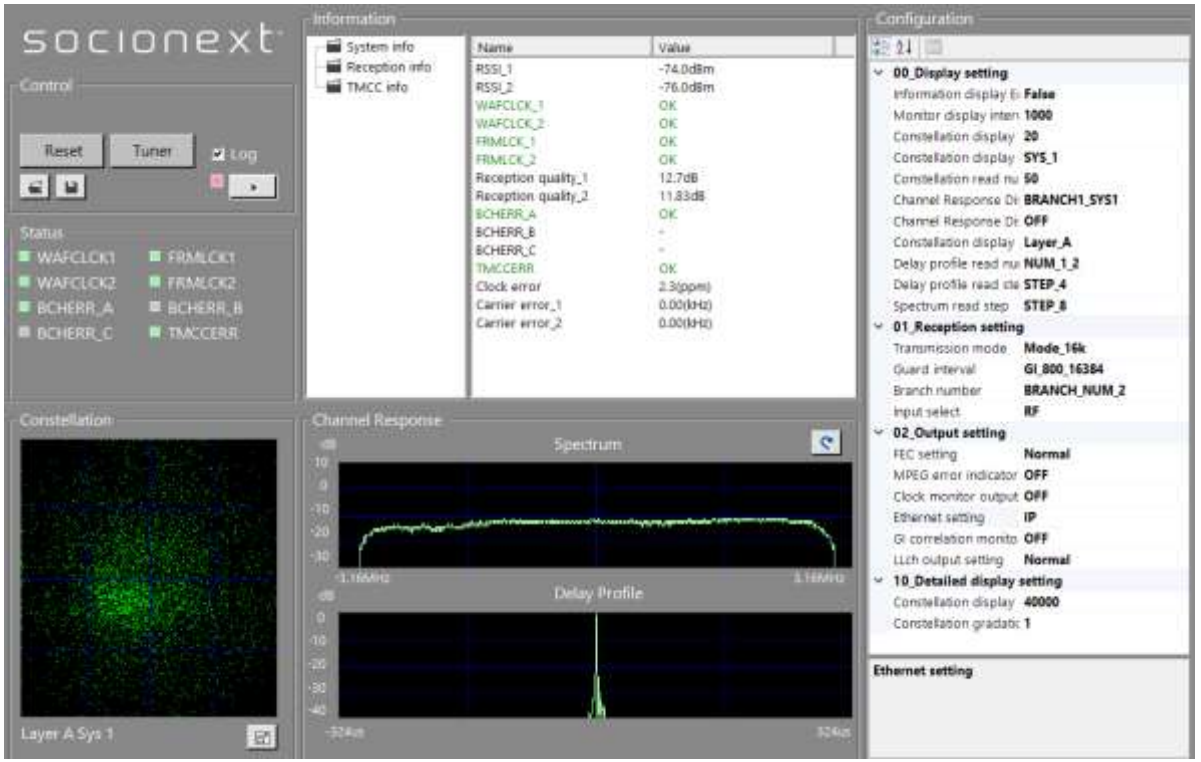


Figure 17.13 - Socionext Screen

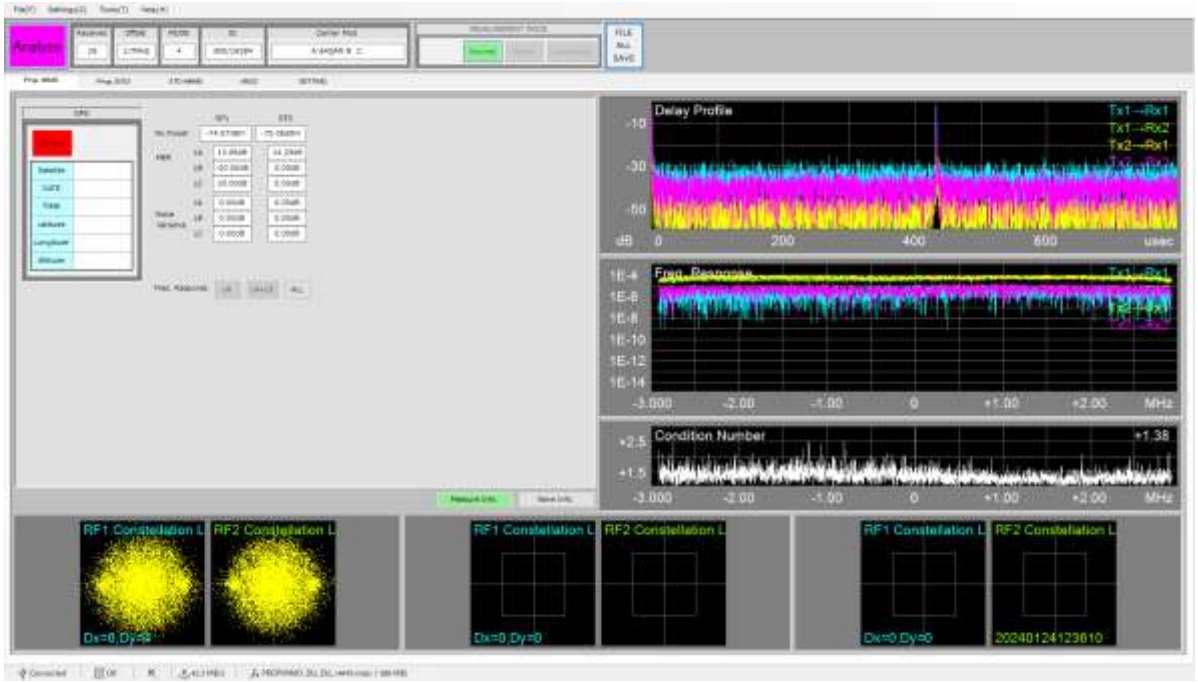


Figure 17.14 - Rintaro Screen

Chapter 18. Site 18

a) Channel Power

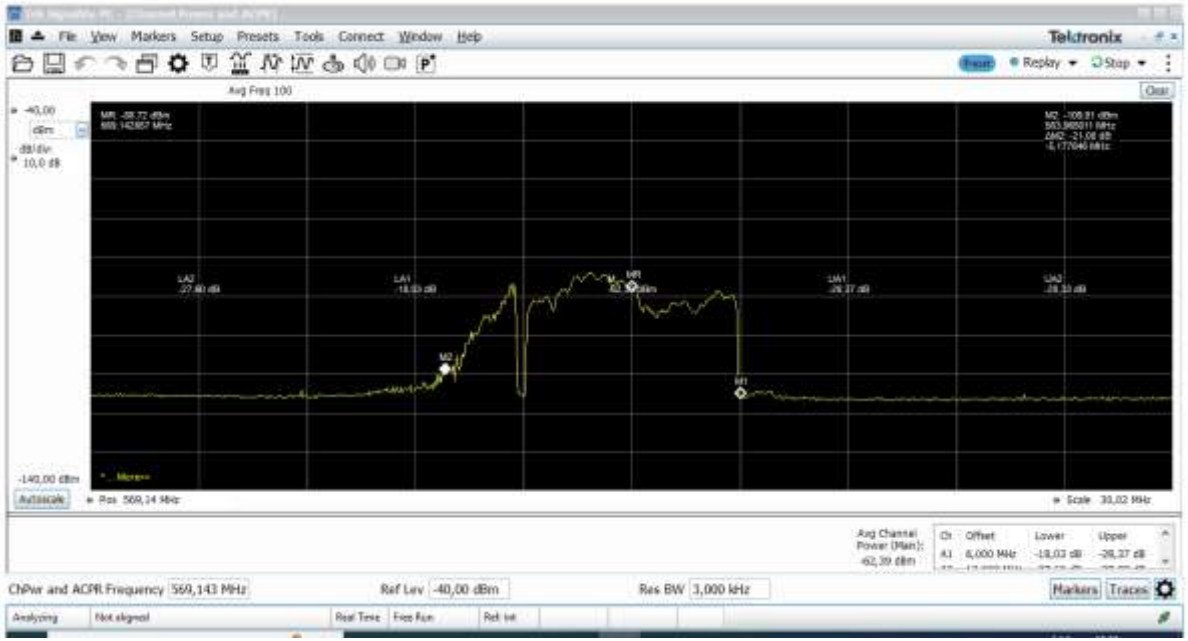


Figure 18.1 - Vertical

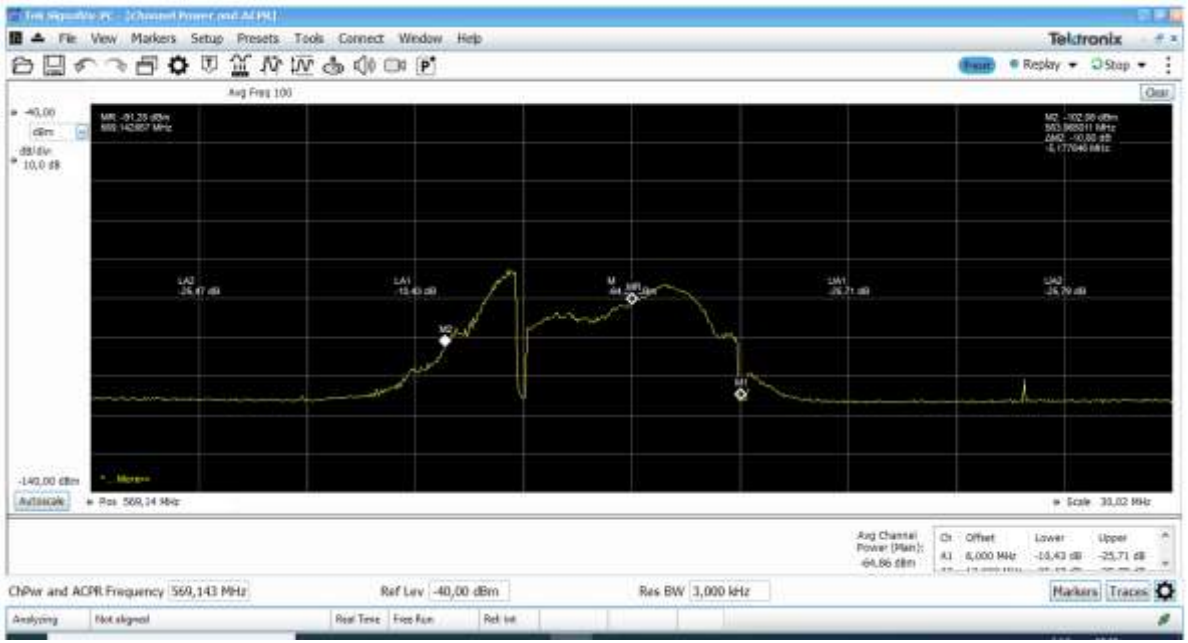


Figure 18.2 - Horizontal

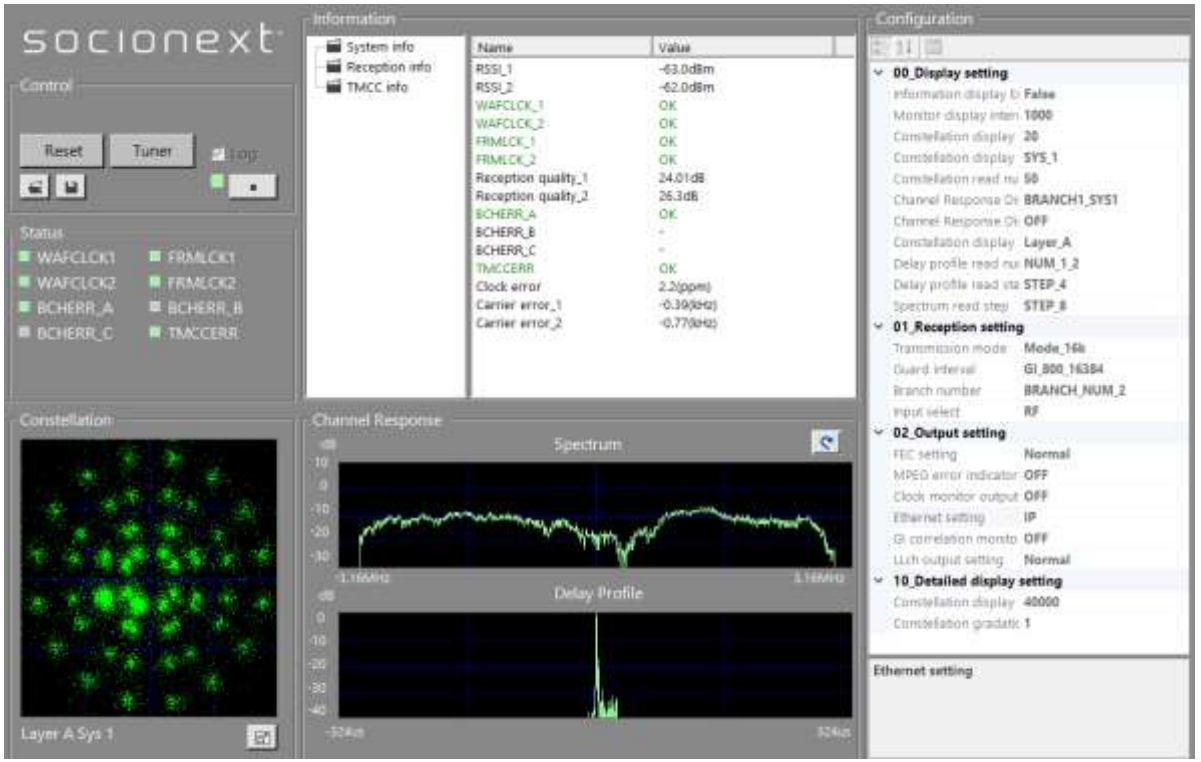


Figure 18.3 - Socionext Screen

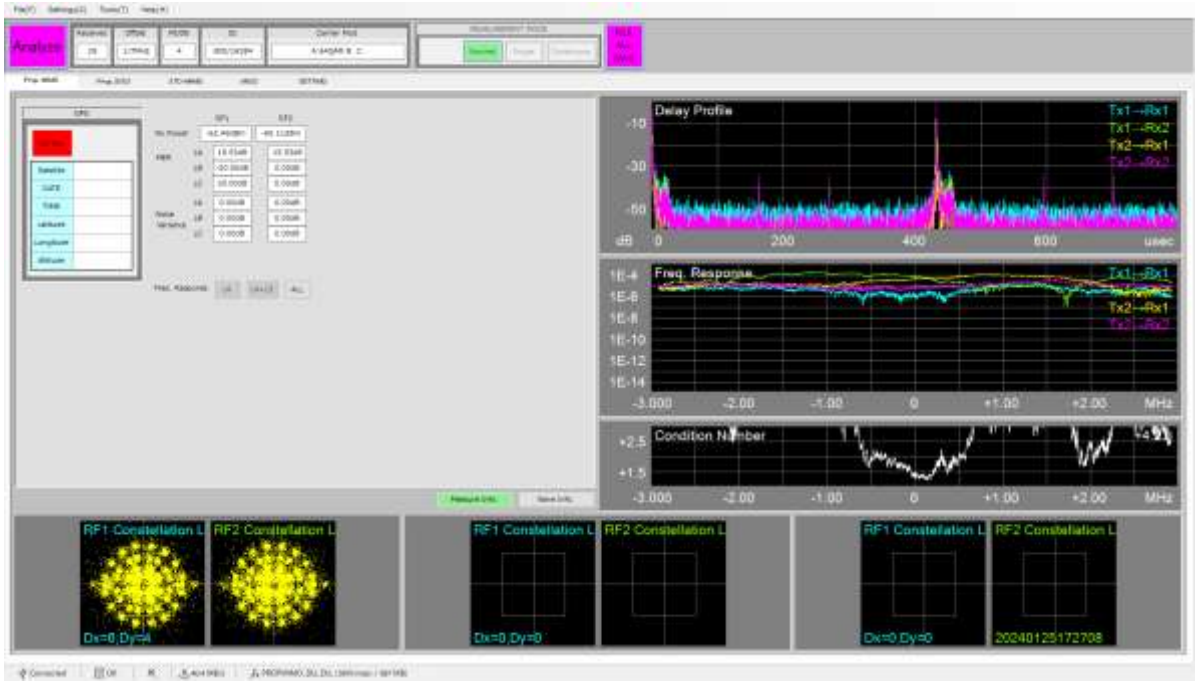


Figure 18.4 - Rintaro Screen

b) AWGN Power

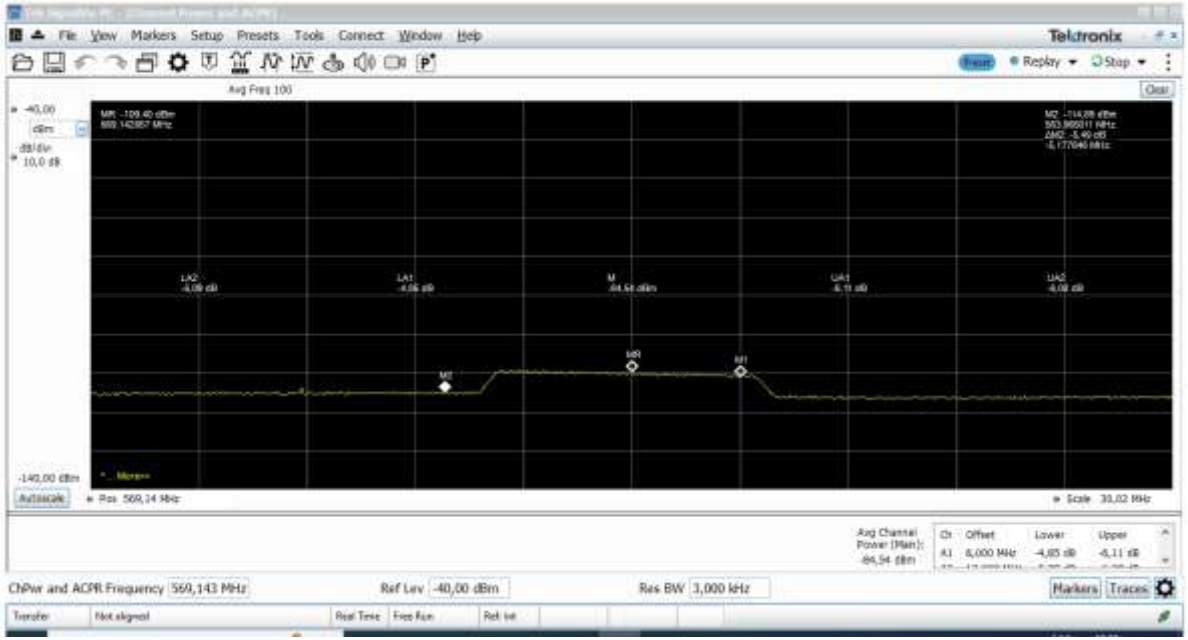


Figure 18.5 - Vertical

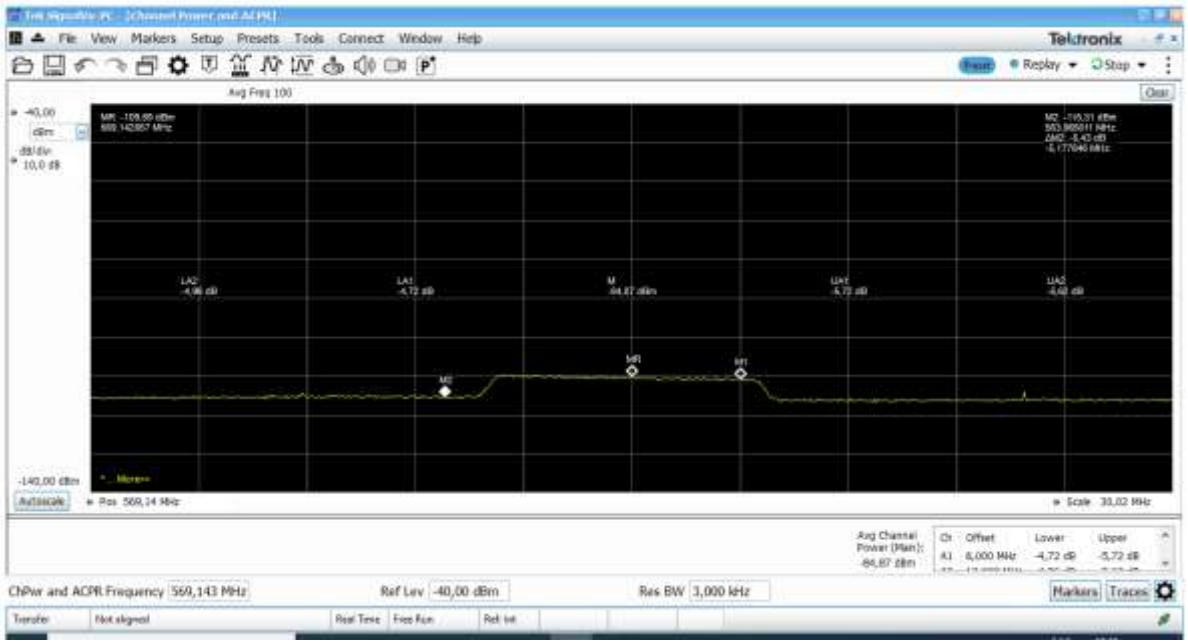


Figure 18.6 - Horizontal

c) C/N Threshold

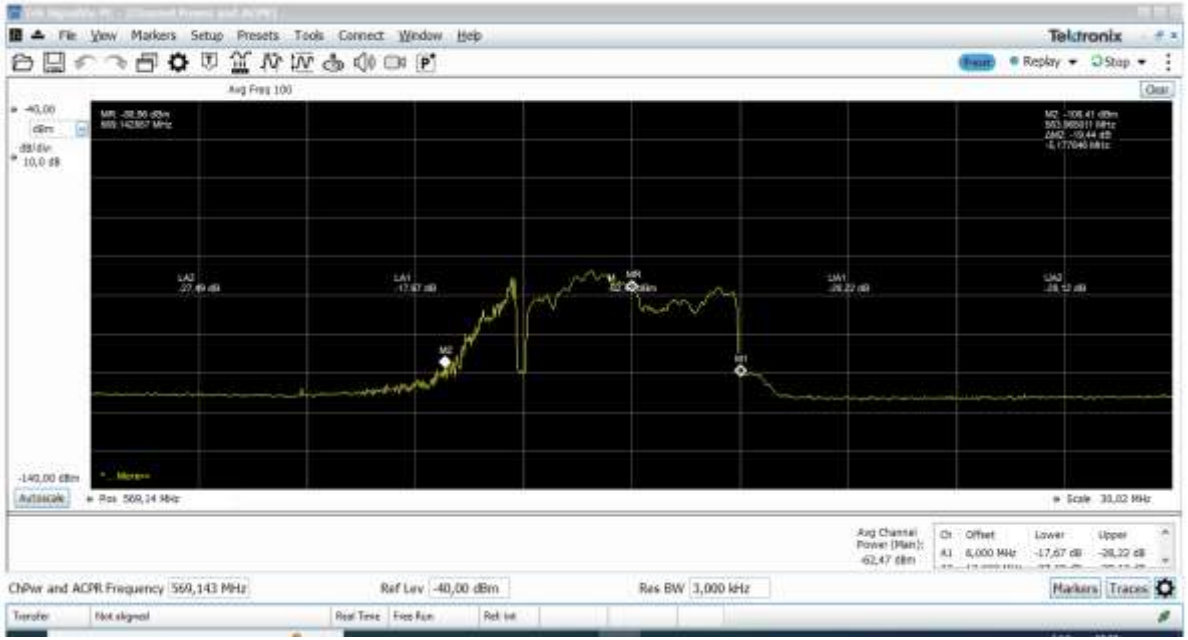


Figure 18.7 - Vertical

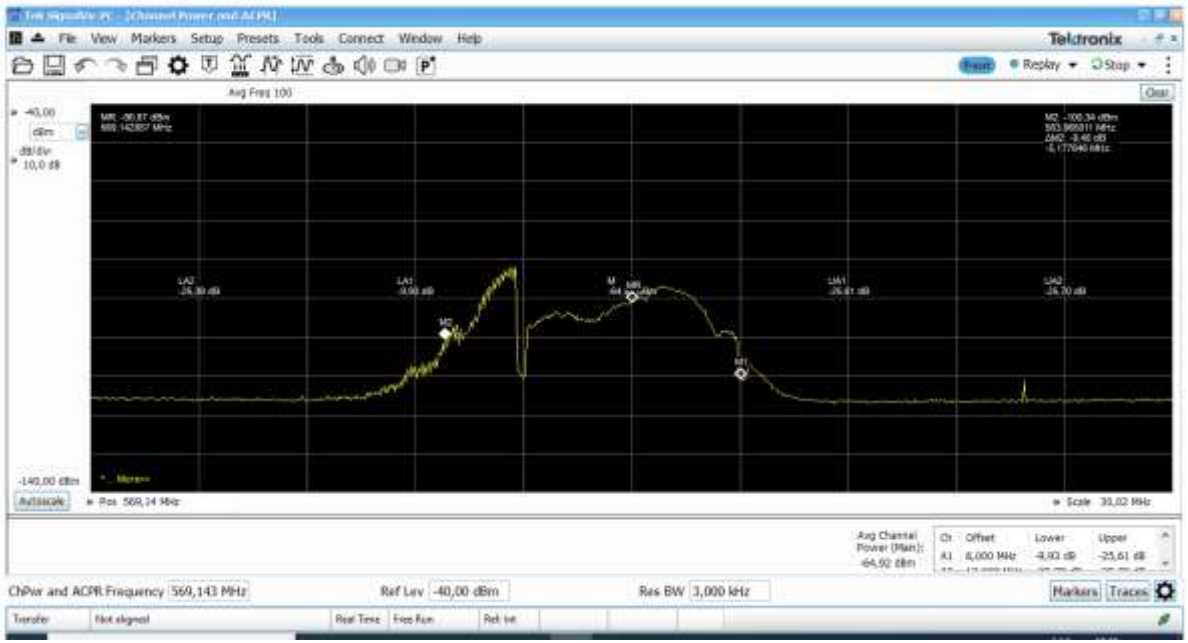


Figure 18.8 - Horizontal

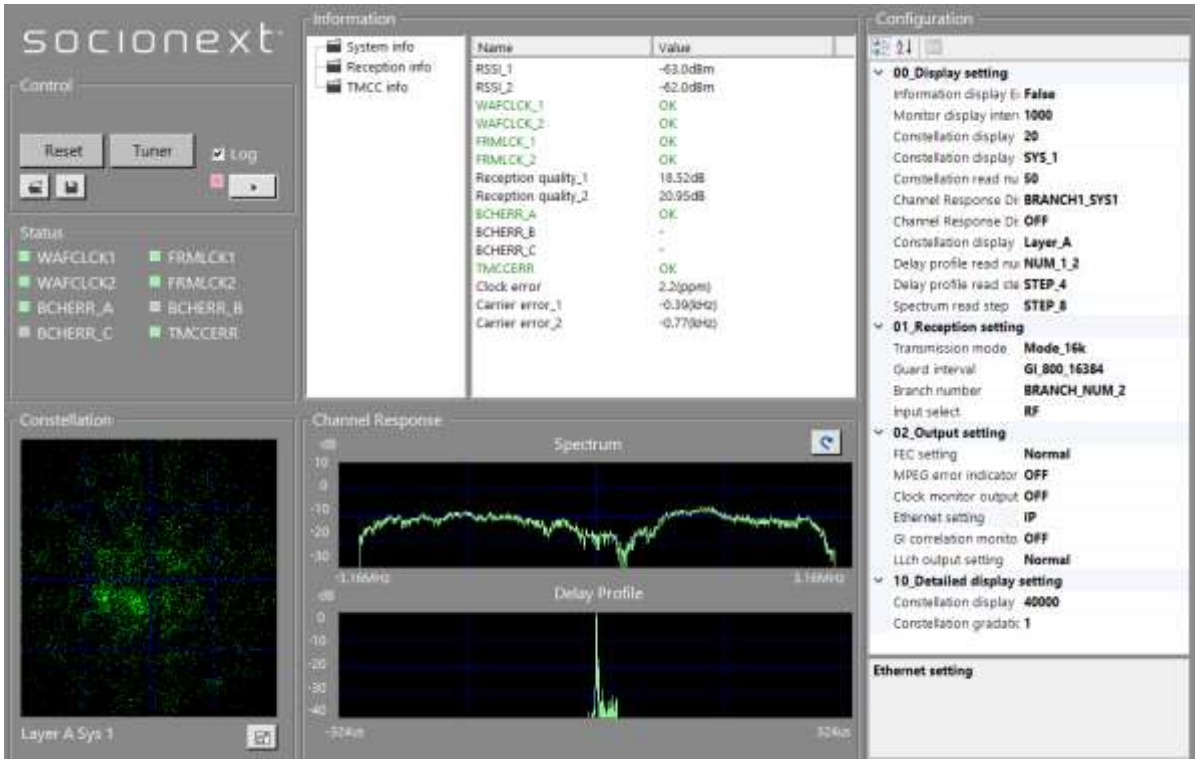


Figure 18.9 - Socionext Screen

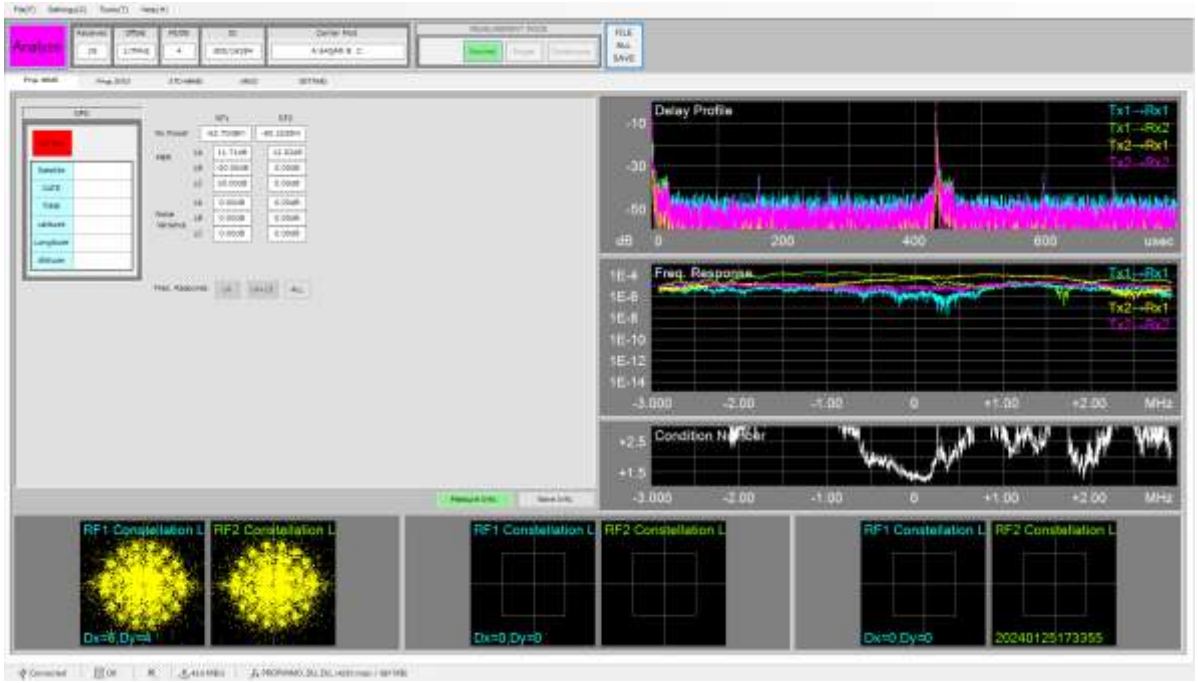


Figure 18.10 - Rintaro Screen

d) Reception Threshold

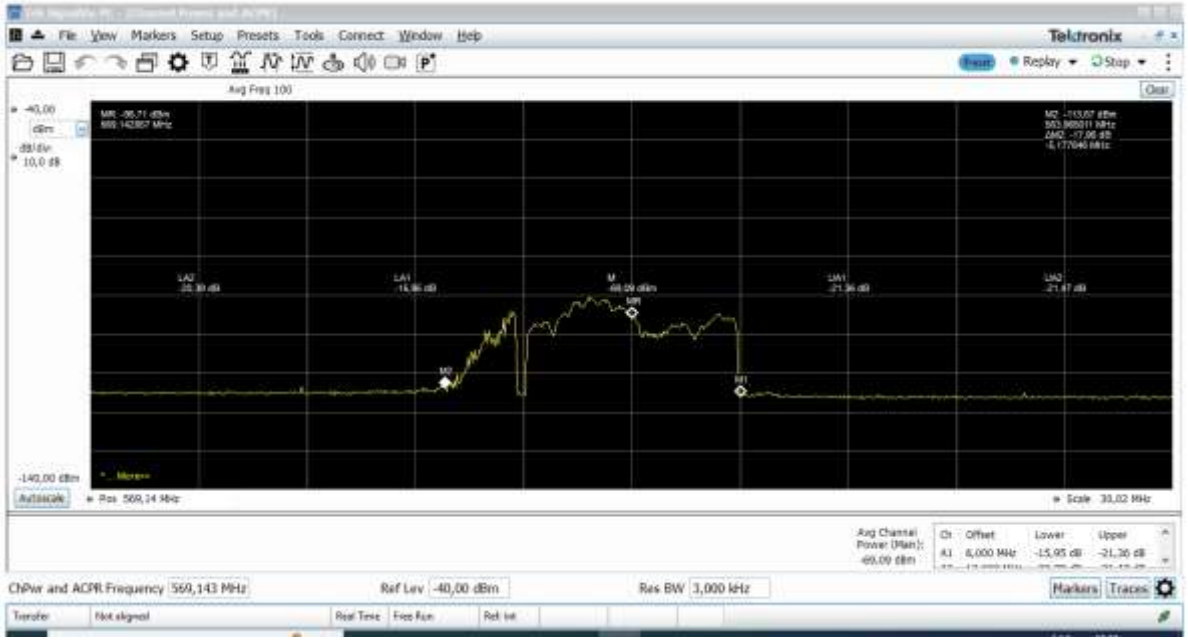


Figure 18.11 - Vertical

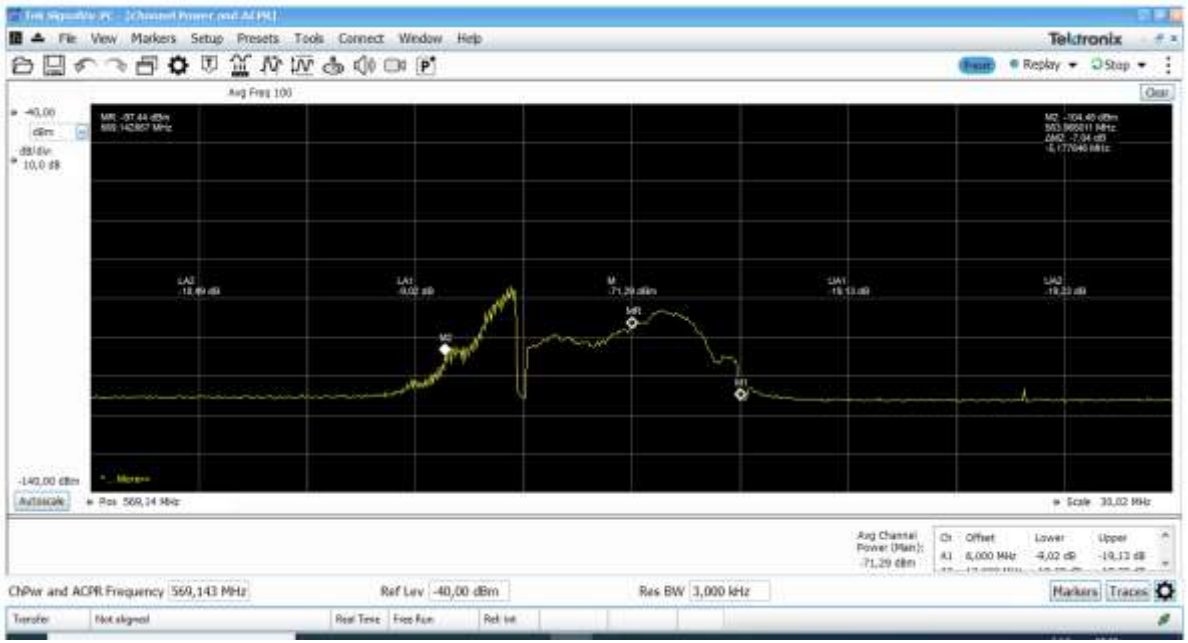


Figure 18.12 - Horizontal

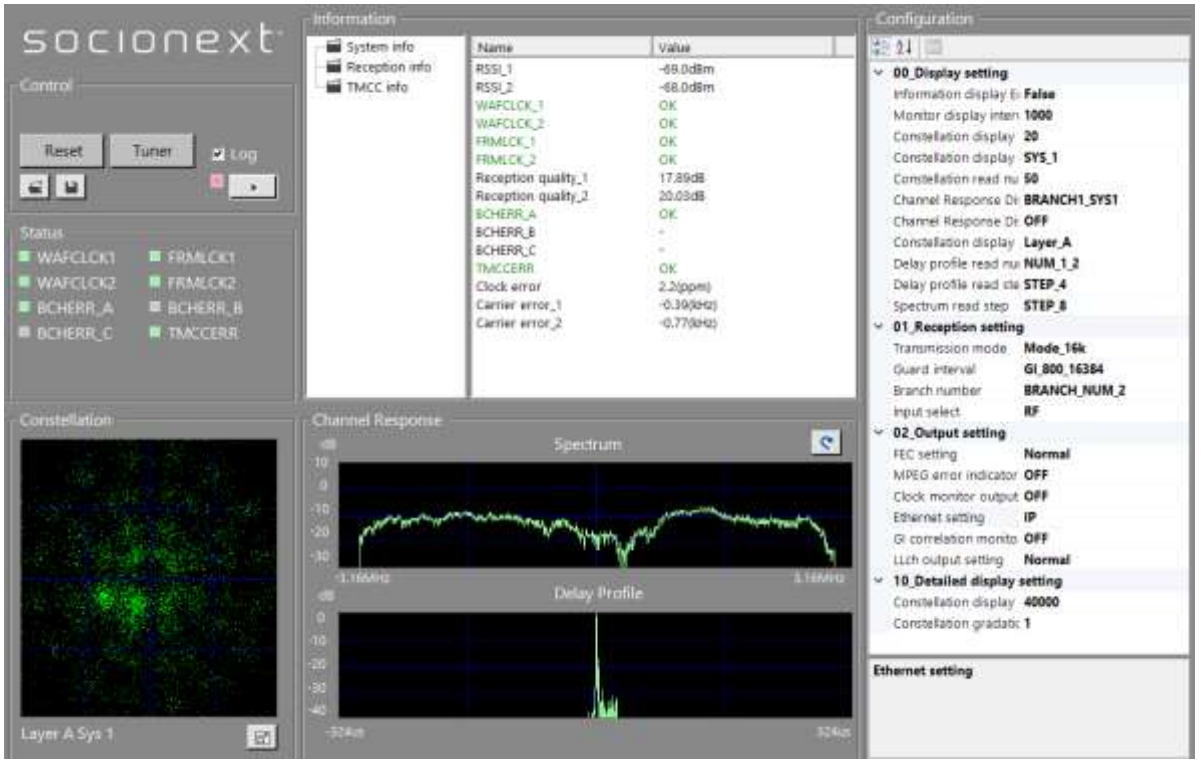


Figure 18.13 - Socionext Screen

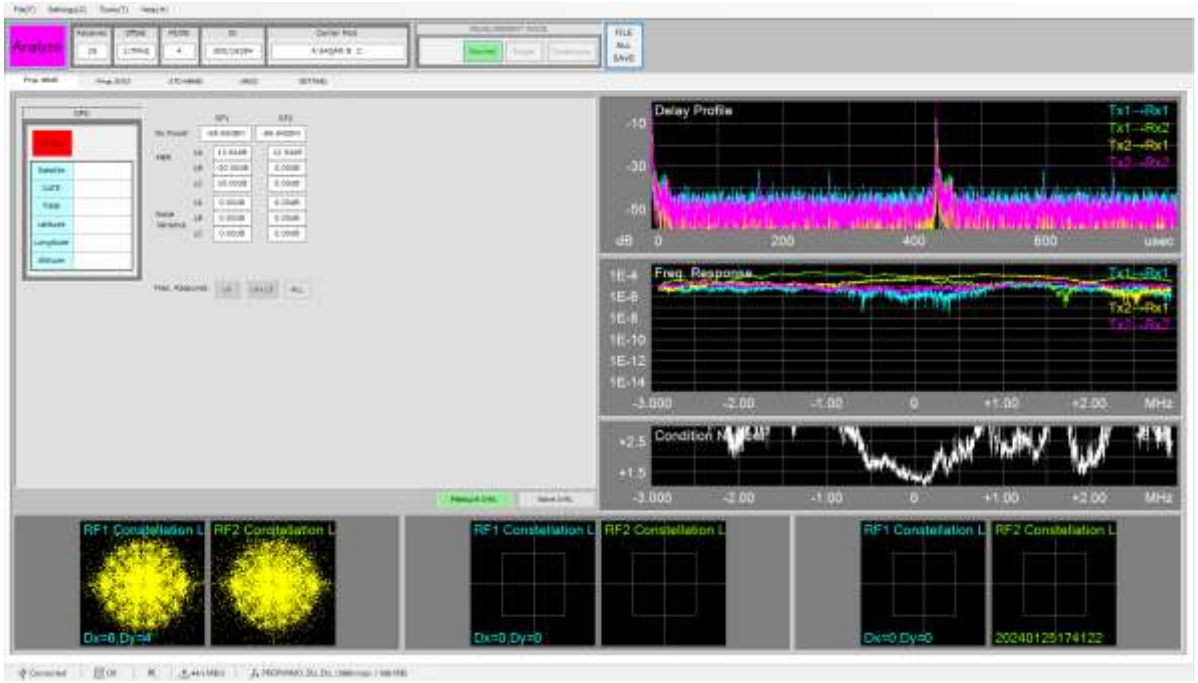


Figure 18.14 - Rintaro Screen

Chapter 19. Site 19

a) Channel Power

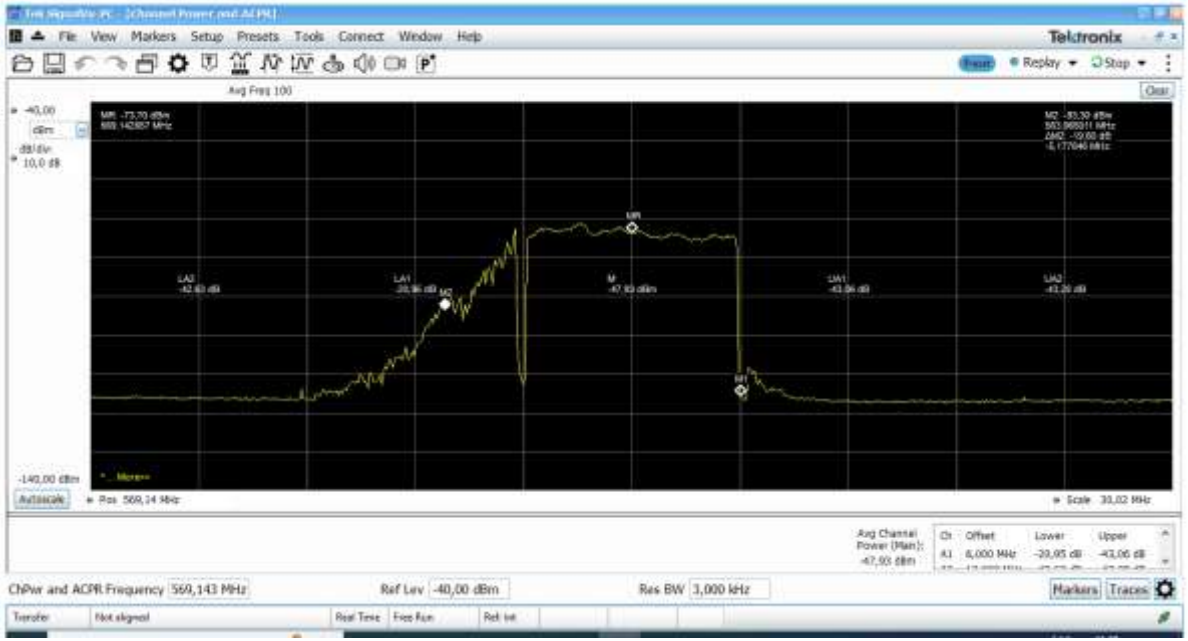


Figure 19.1 - Vertical

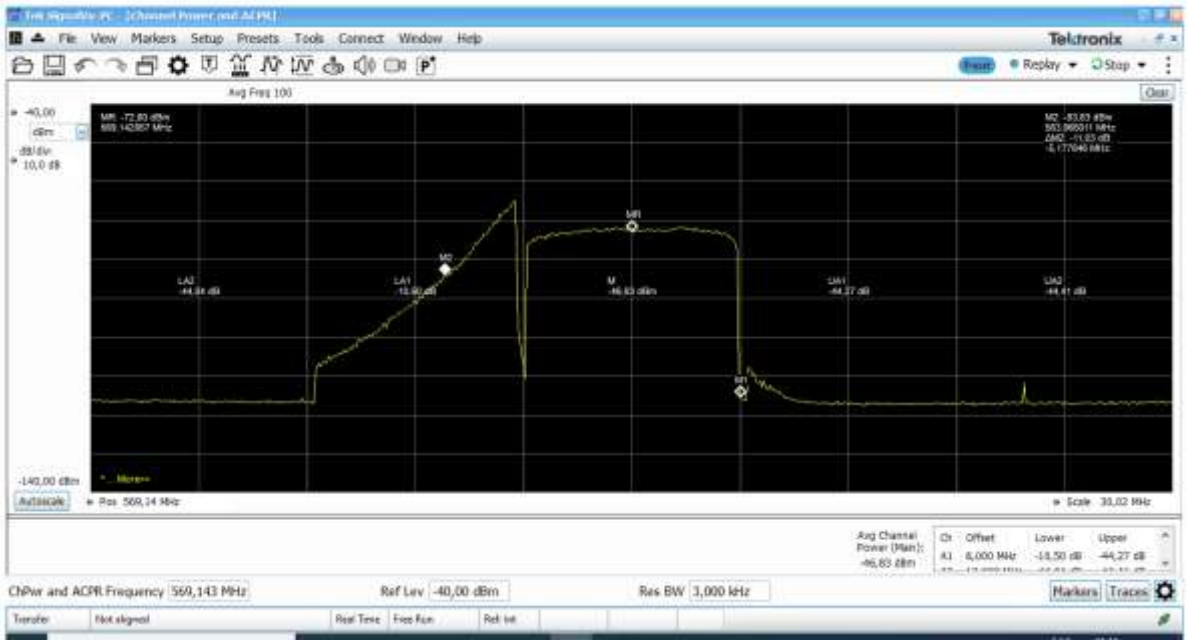


Figure 19.2 - Horizontal

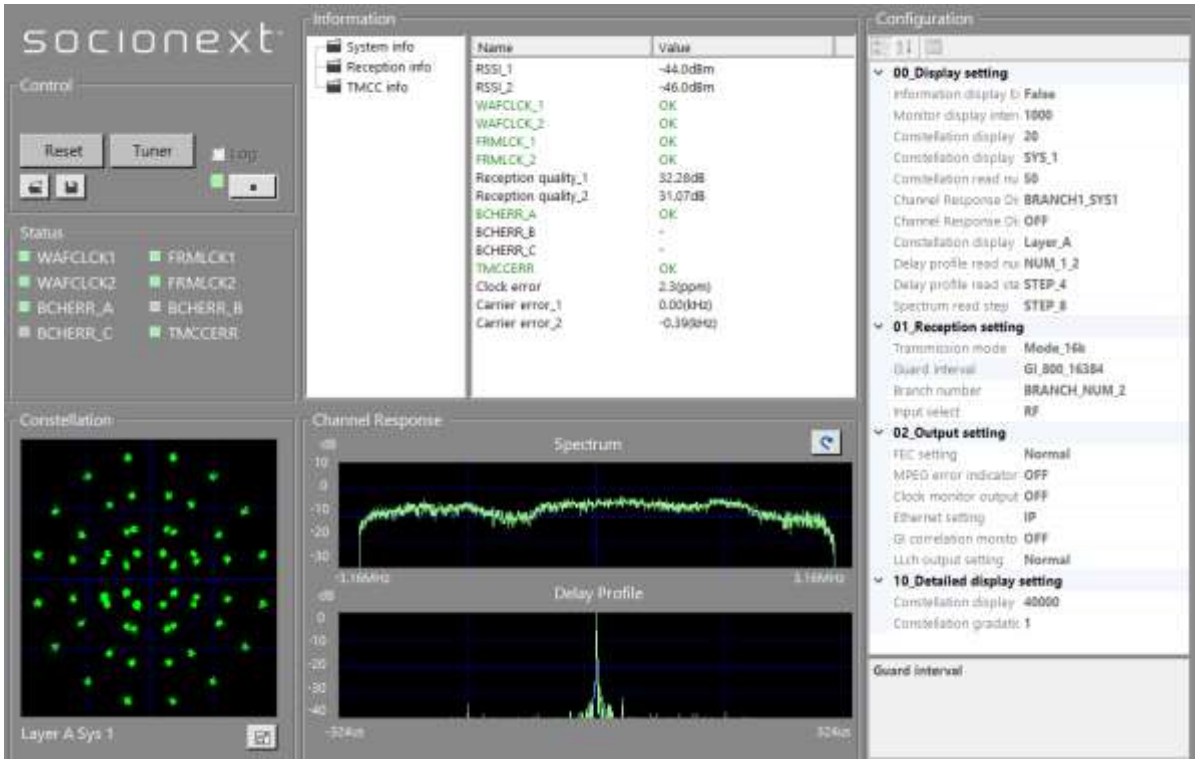


Figure 19.3 - Socionext Screen

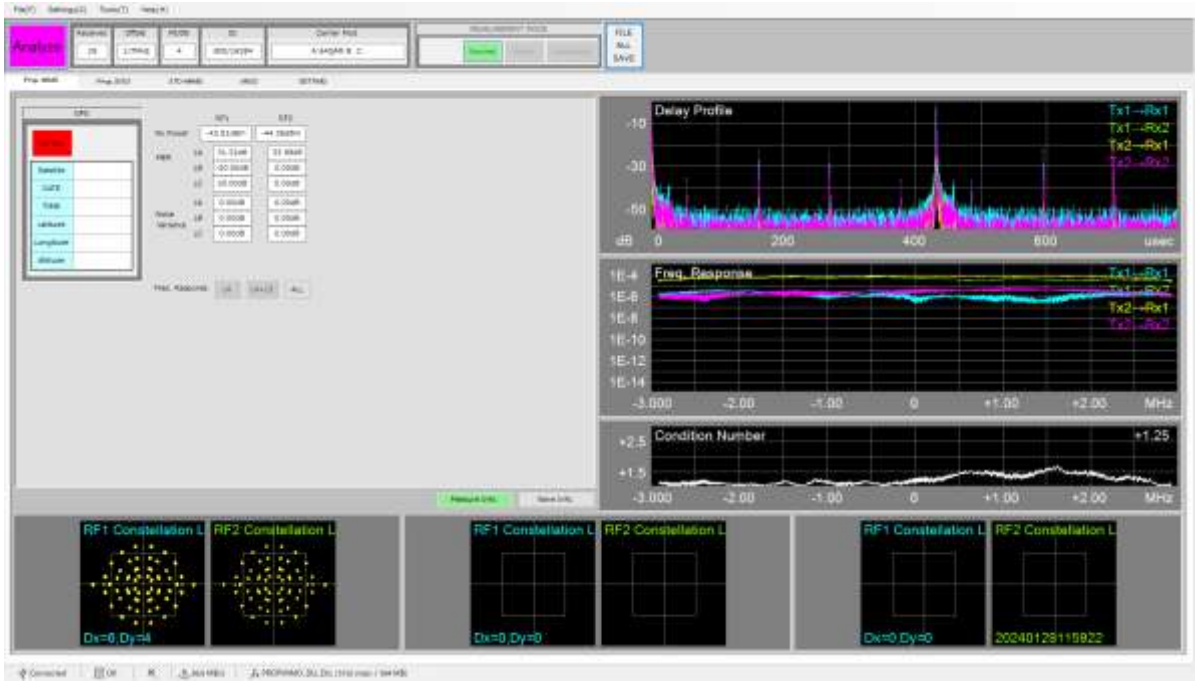


Figure 19.4 - Rintaro Screen

b) AWGN Power

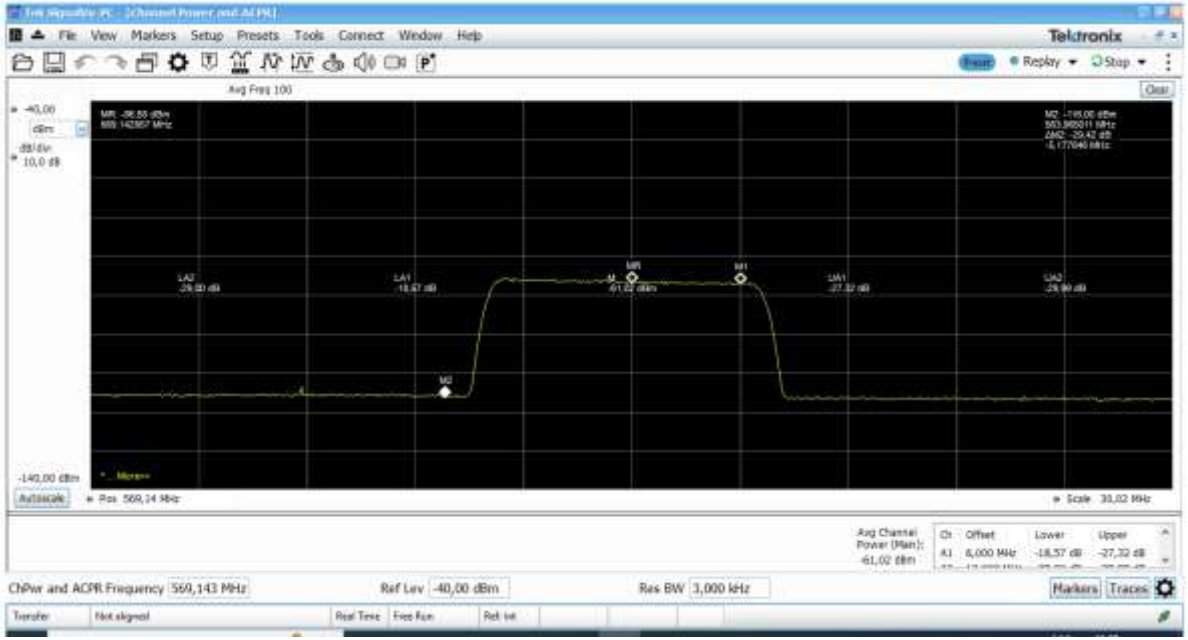


Figure 19.5 - Vertical

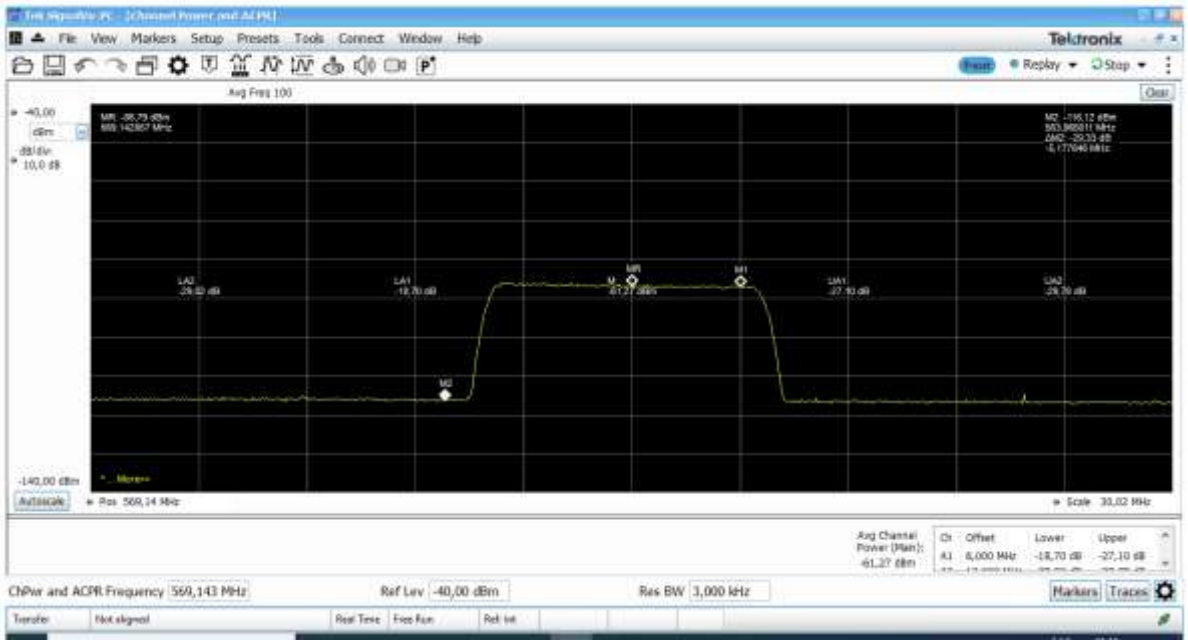


Figure 19.6 - Horizontal

c) C/N Threshold

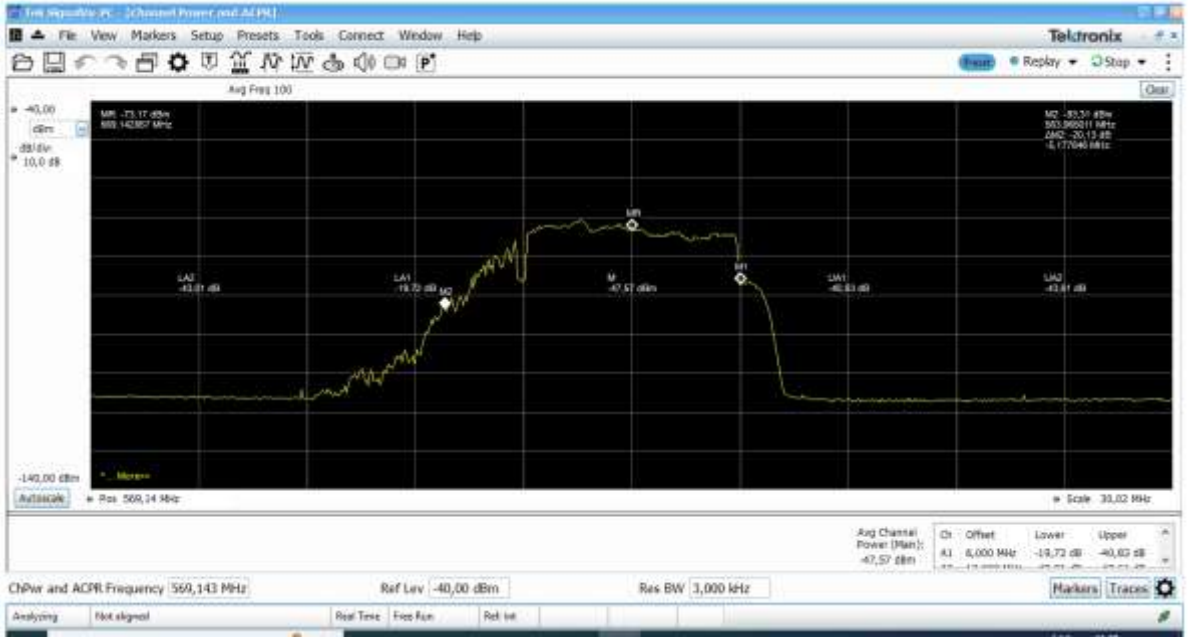


Figure 19.7 - Vertical

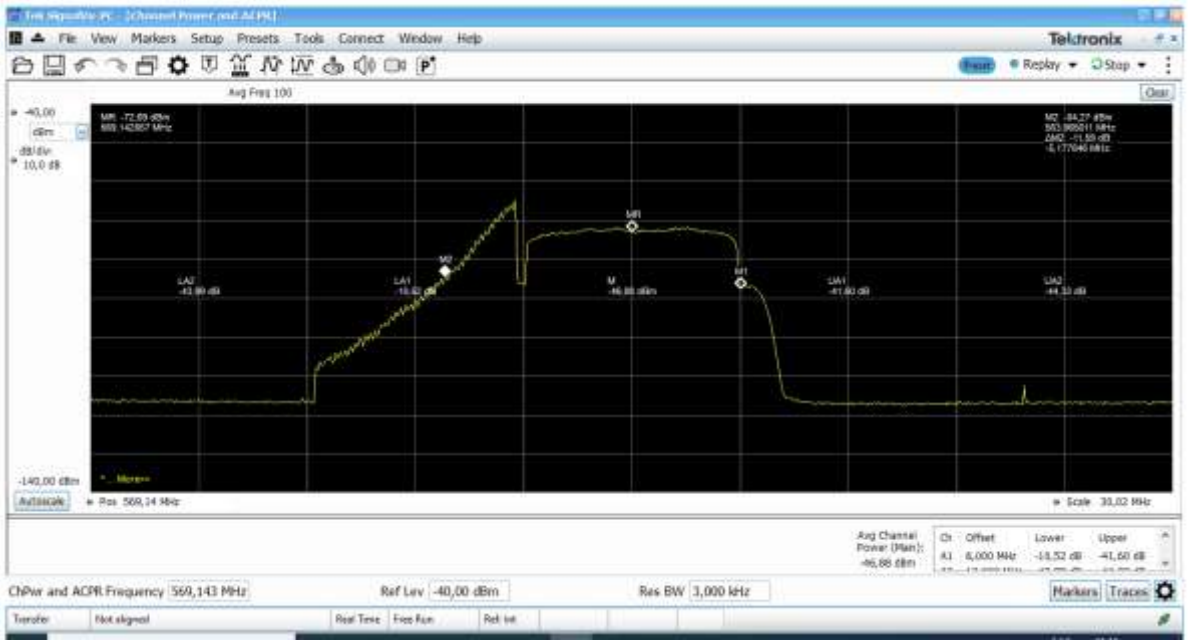


Figure 19.8 - Horizontal

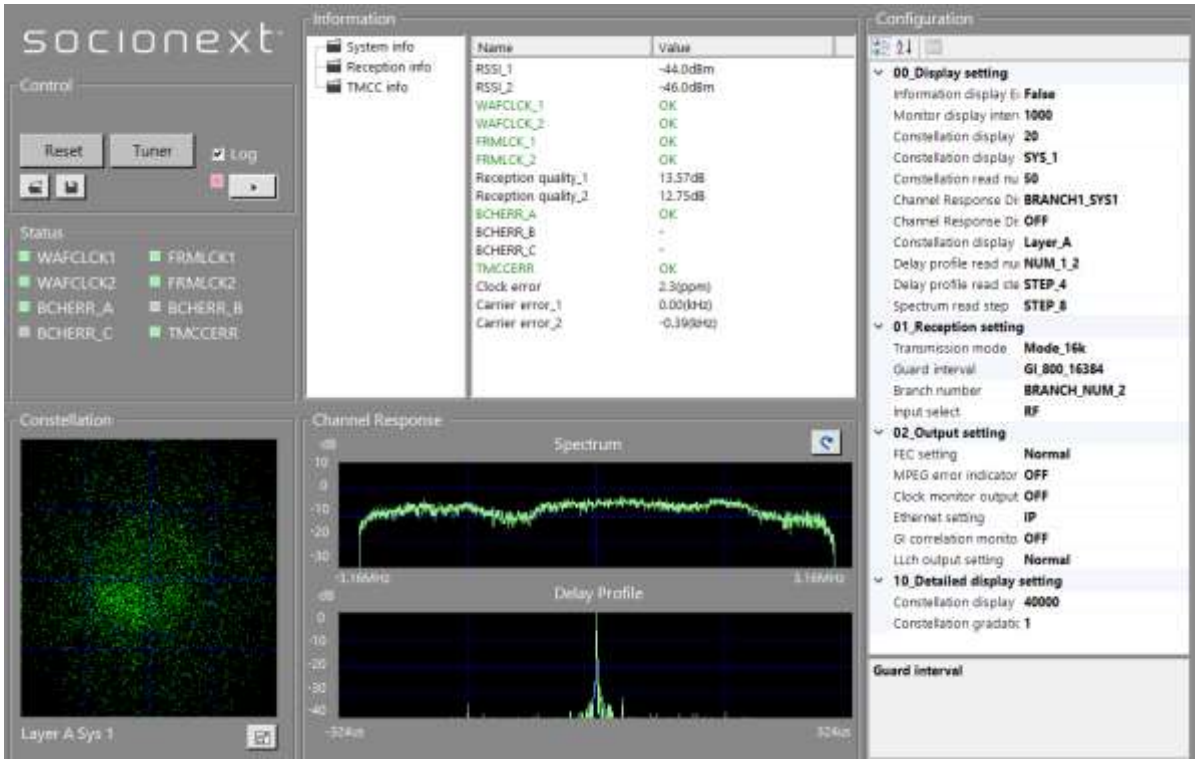


Figure 19.9 - Socionext Screen

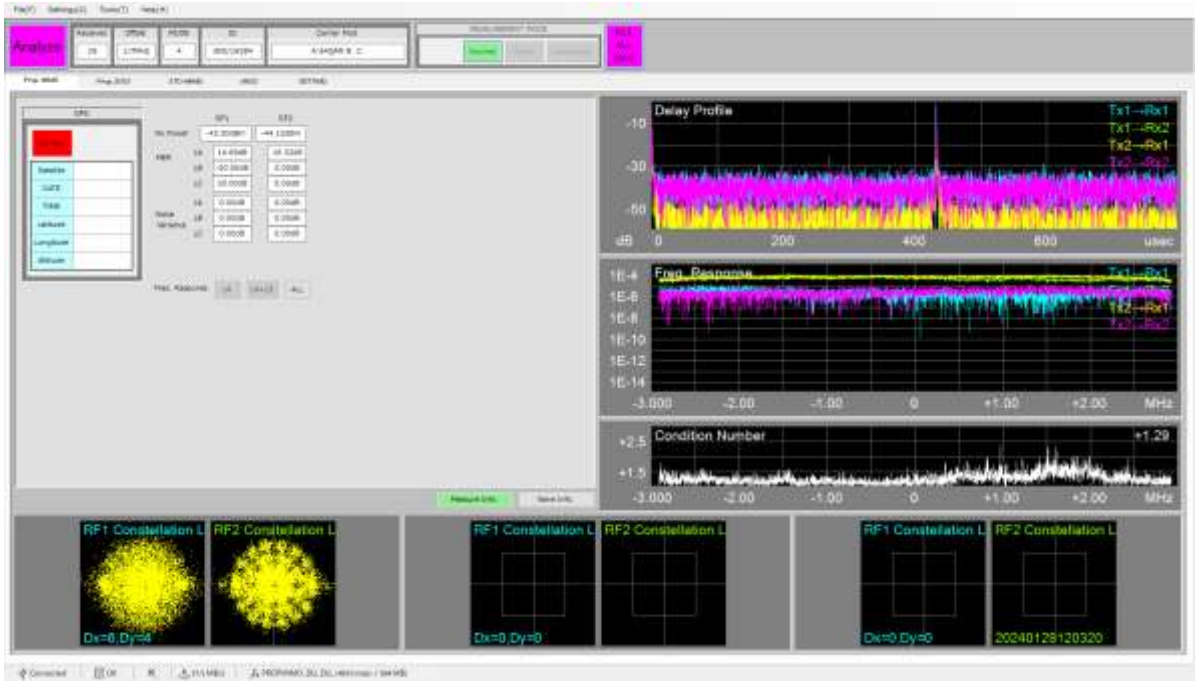


Figure 19.10 - Rintaro Screen

d) Reception Threshold

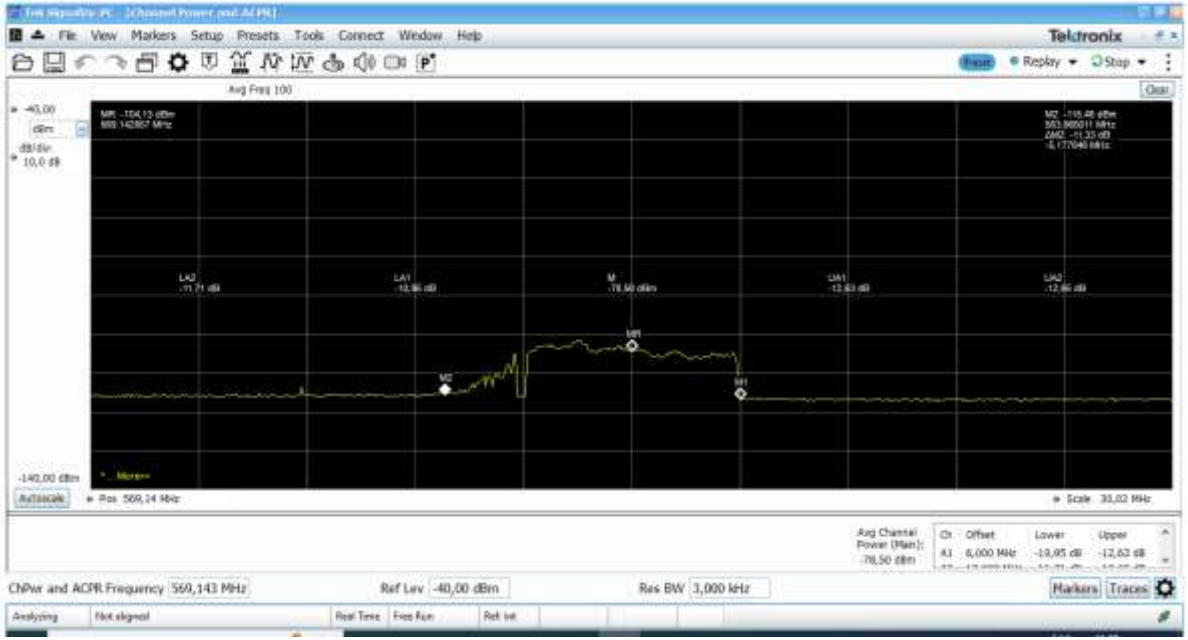


Figure 19.11 - Vertical

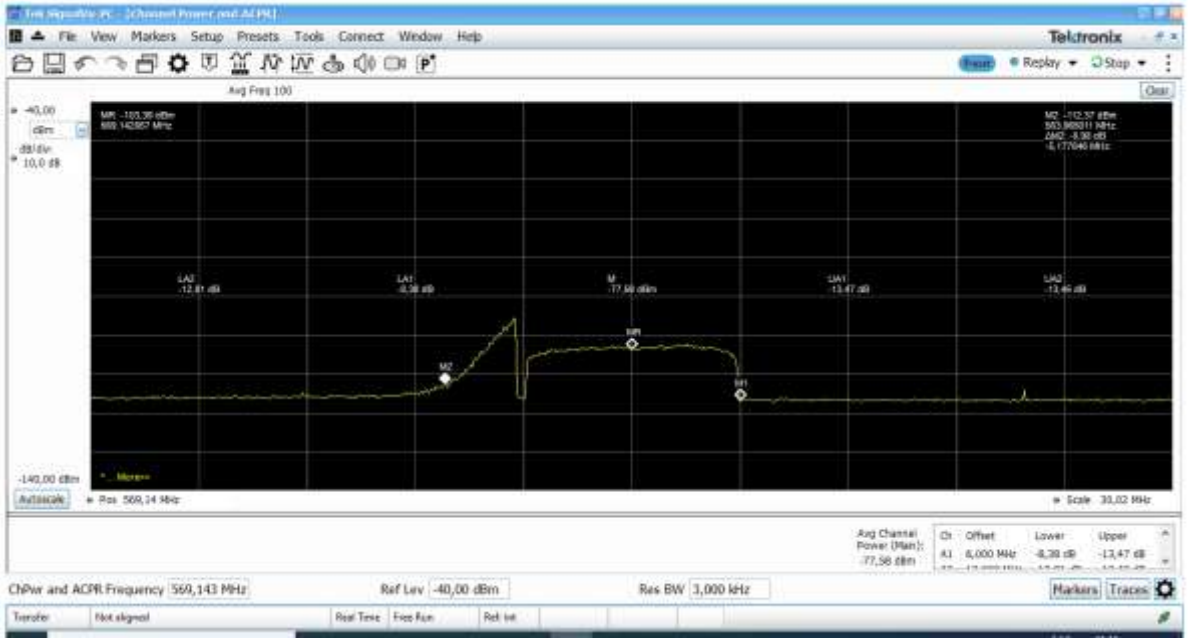


Figure 19.12 - Horizontal

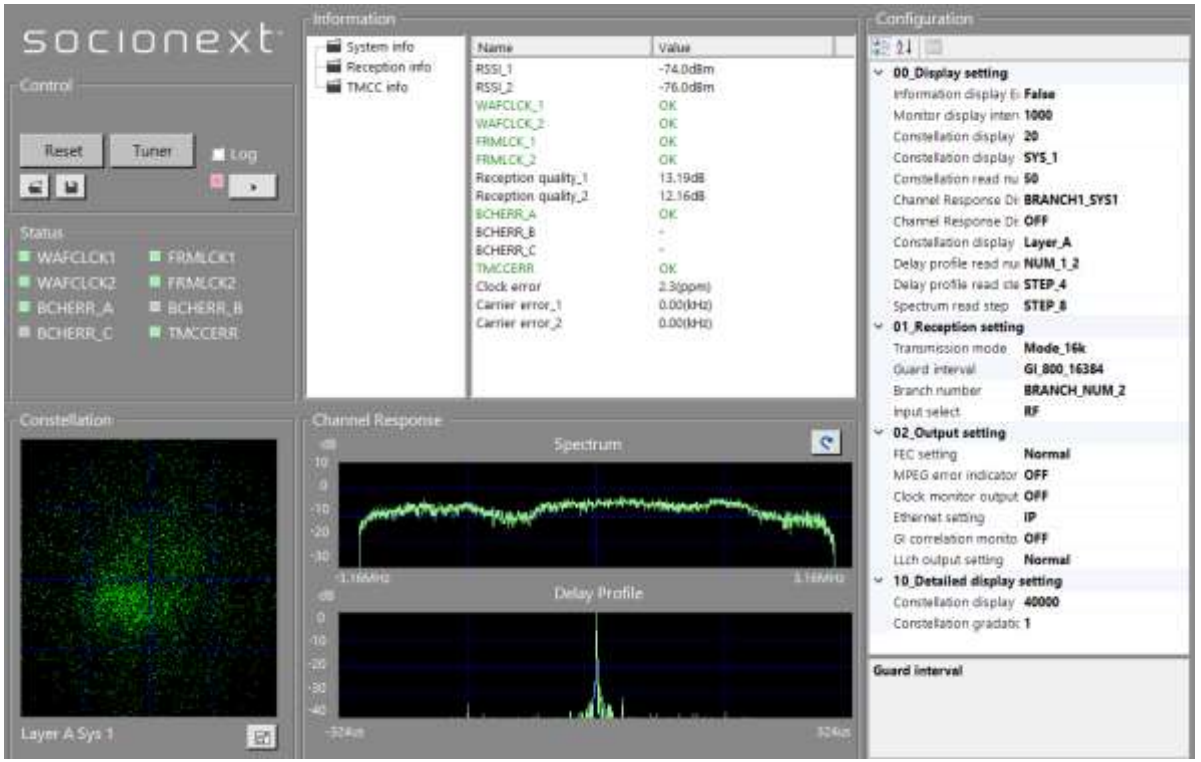


Figure 19.13 - Socionext Screen

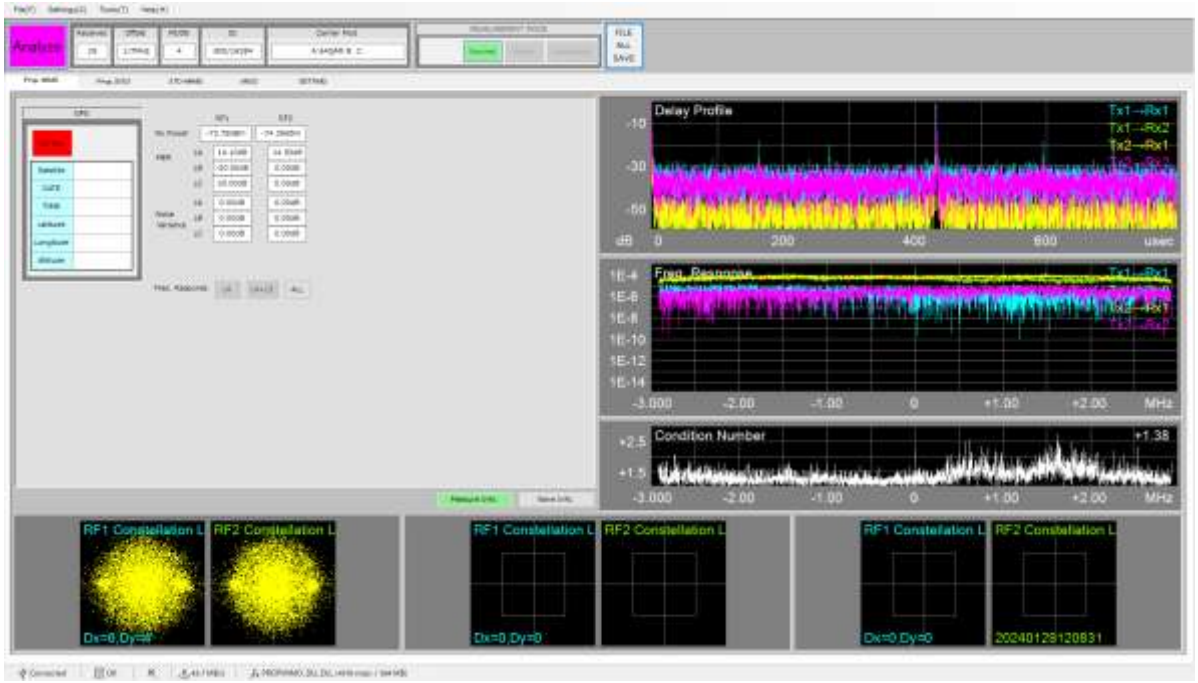


Figure 19.14 - Rintaro Screen

Chapter 20. Site 20

a) Channel Power

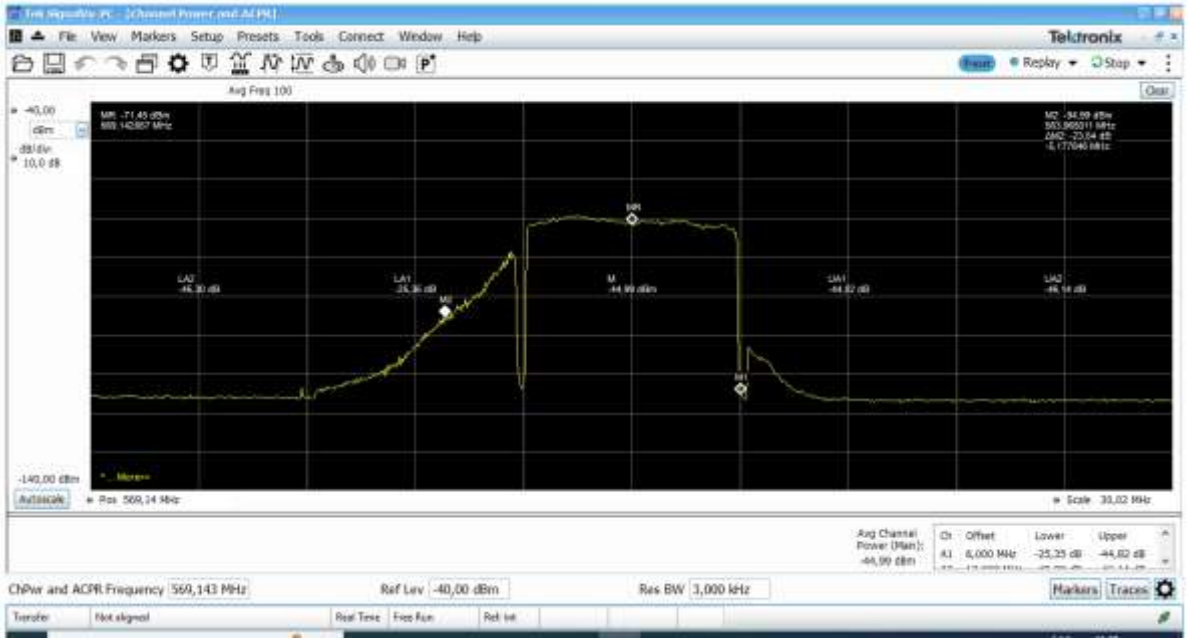


Figure 20.1 - Vertical

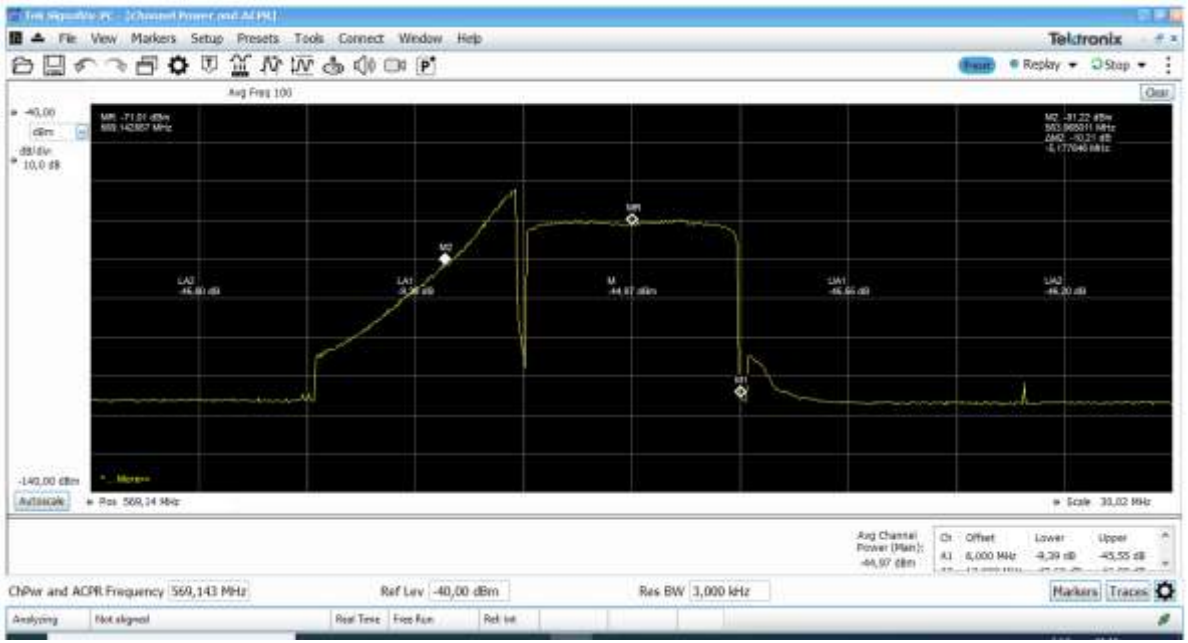


Figure 20.2 - Horizontal

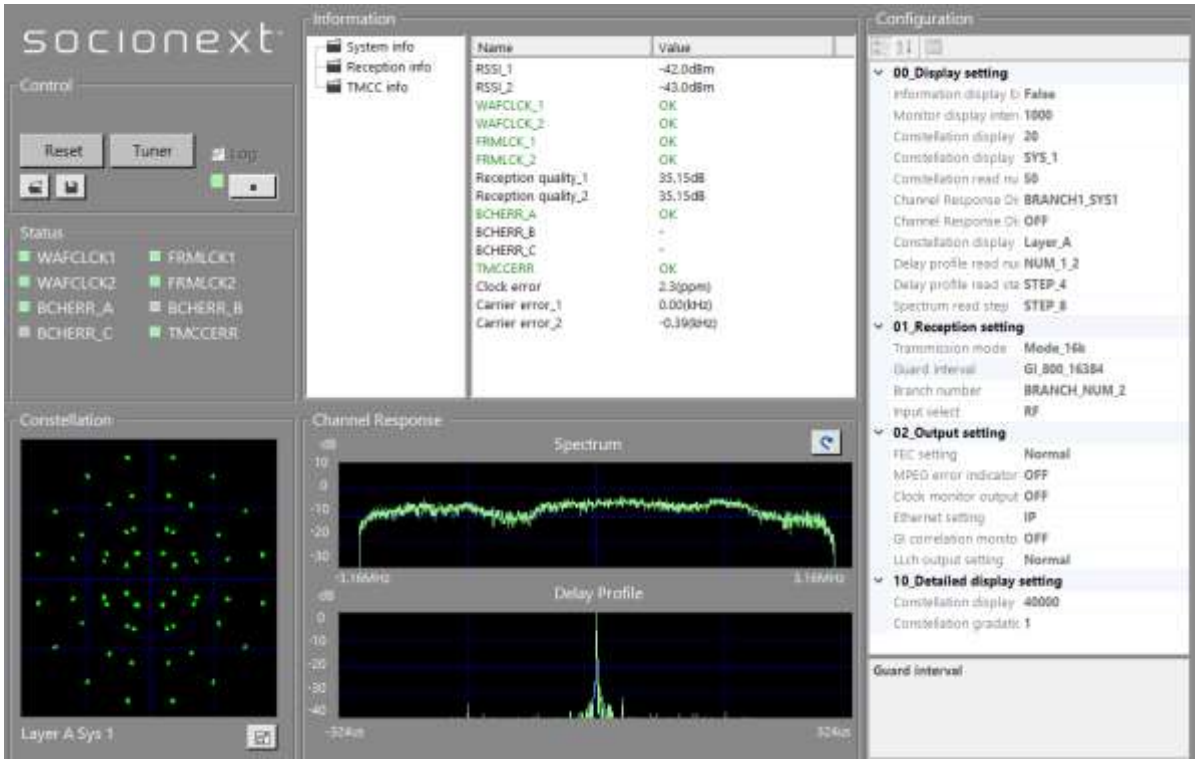


Figure 20.3 - Socionext Screen

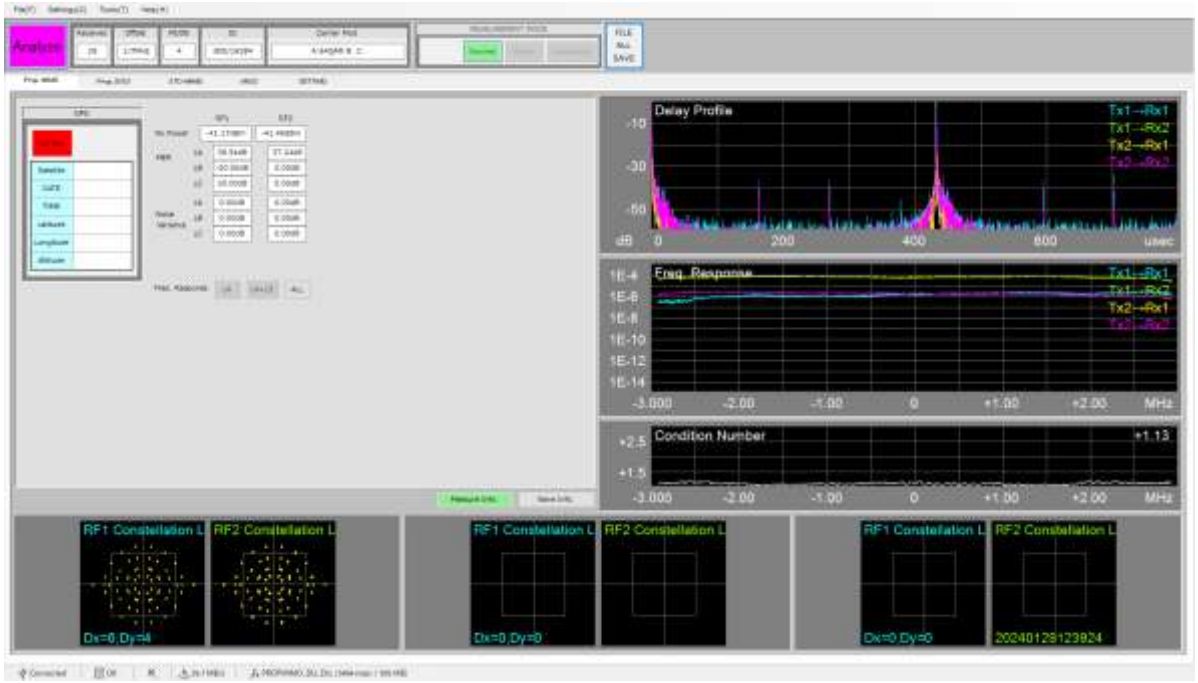


Figure 20.4 - Rintaro Screen

b) AWGN Power

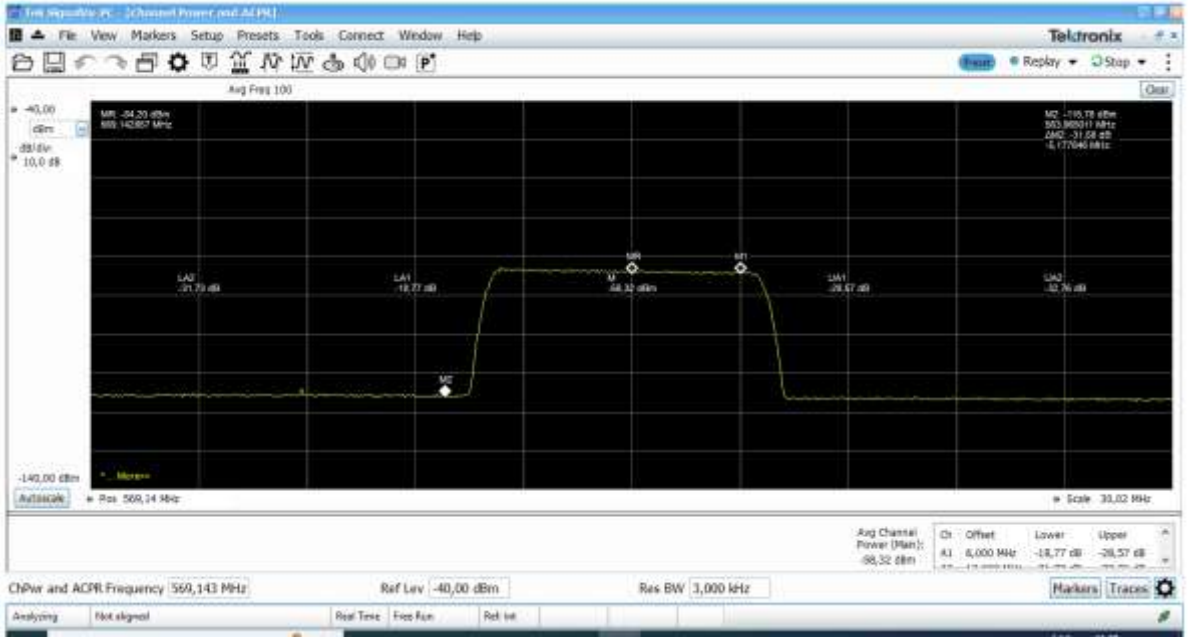


Figure 20.5 - Vertical

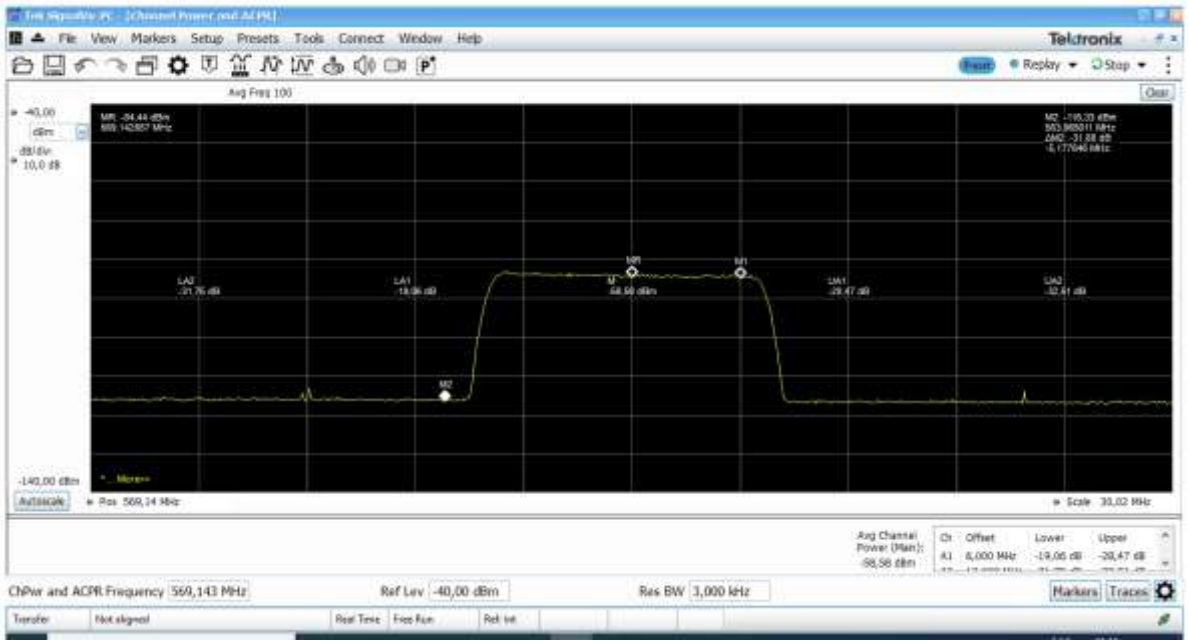


Figure 20.6 - Horizontal

c) C/N Threshold

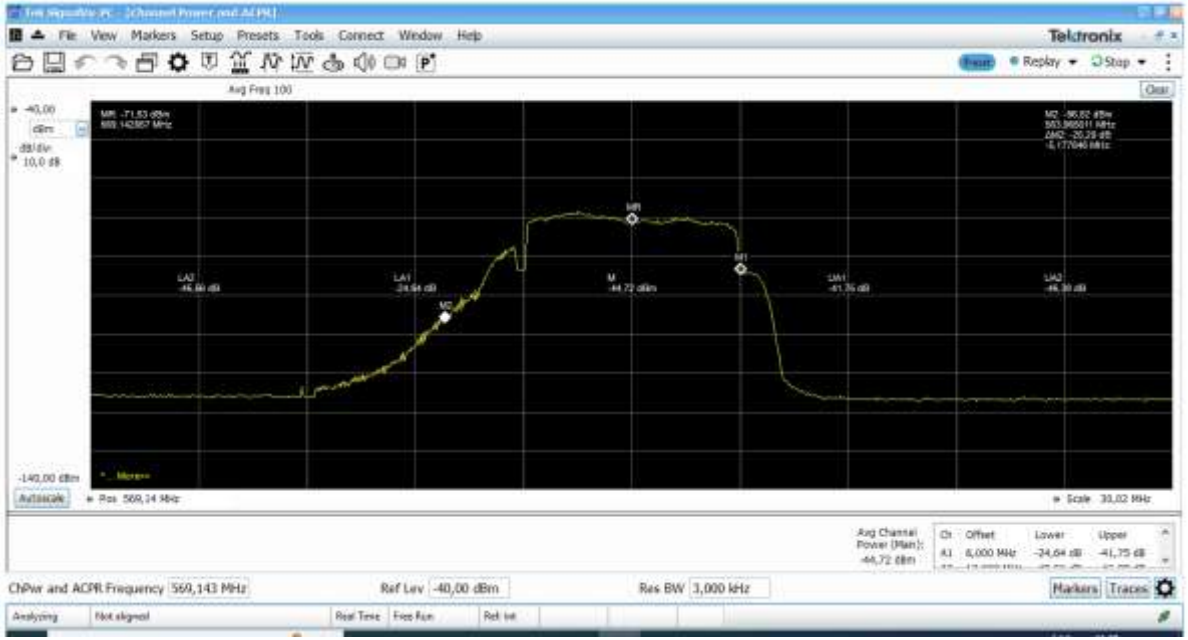


Figure 20.7 - Vertical

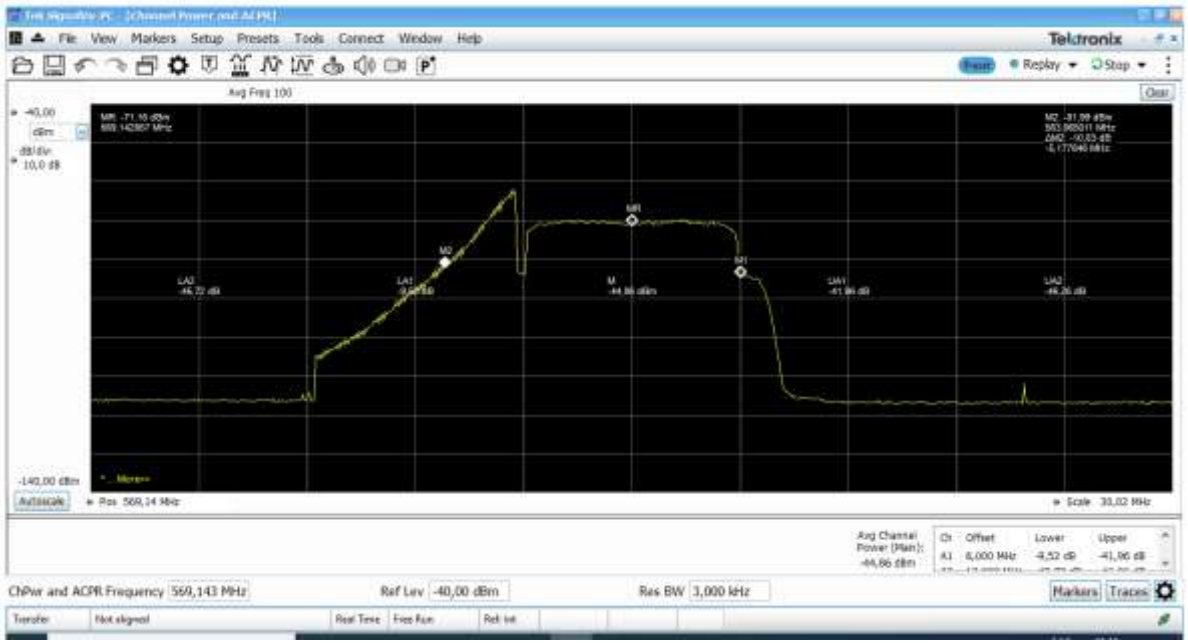


Figure 20.8 - Horizontal

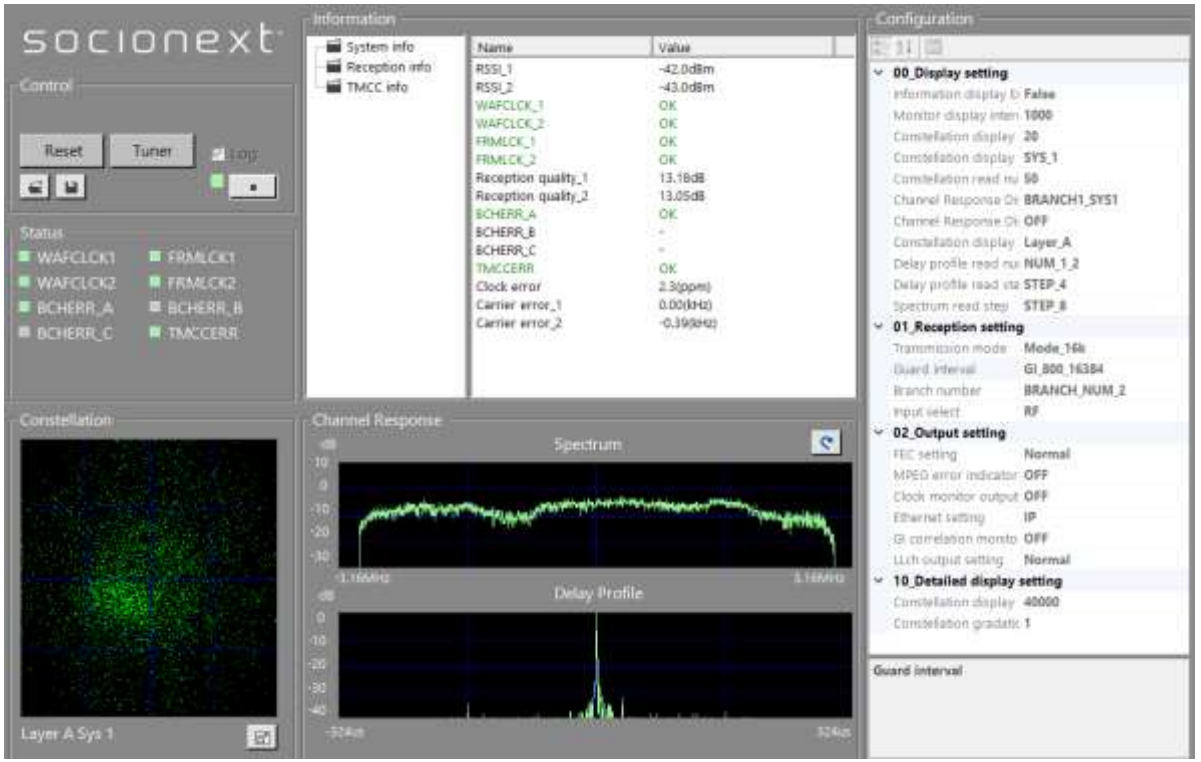


Figure 20.9 - Socionext Screen

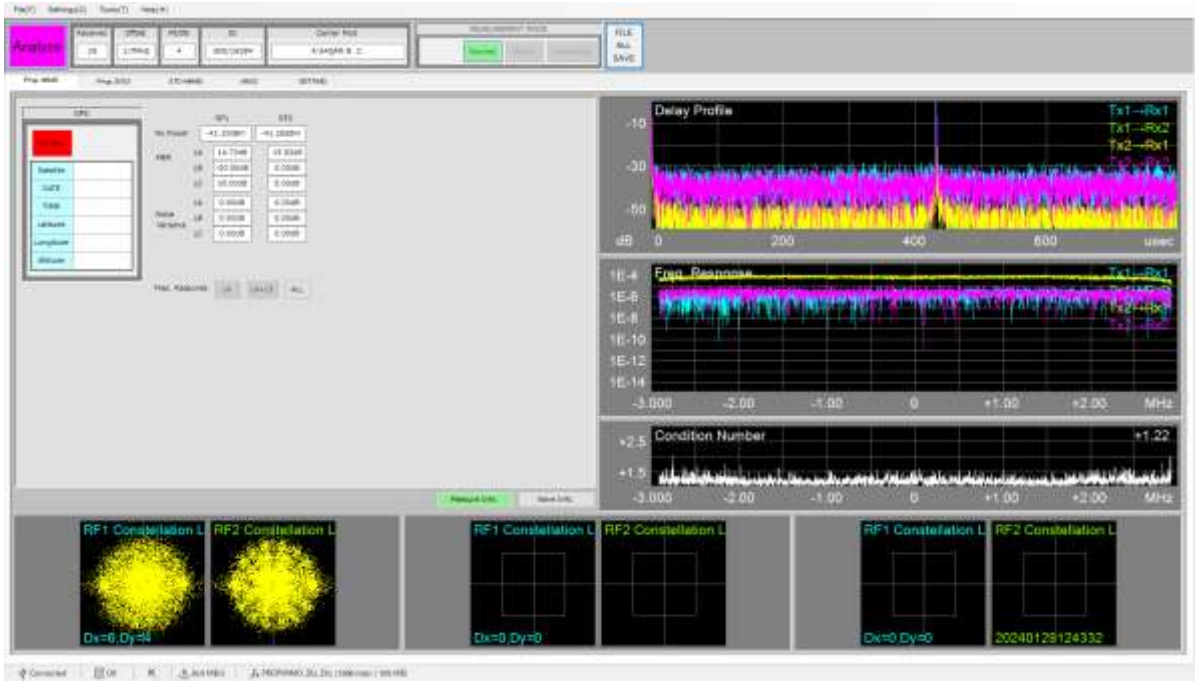


Figure 20.10 - Rintaro Screen

d) Reception Threshold

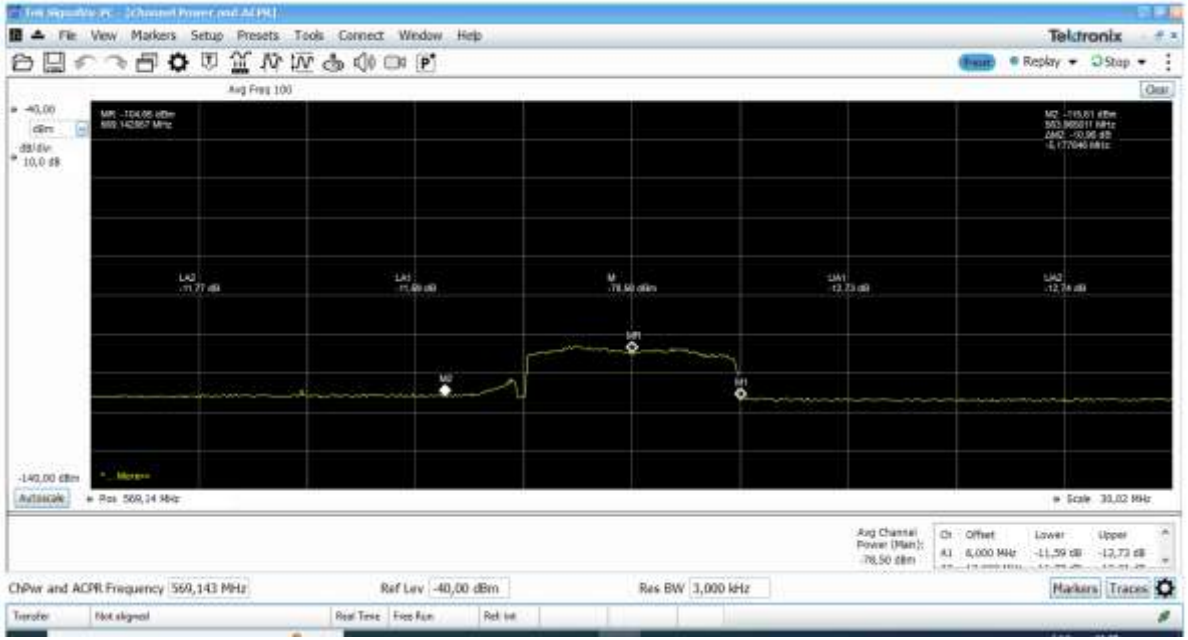


Figure 20.11 - Vertical

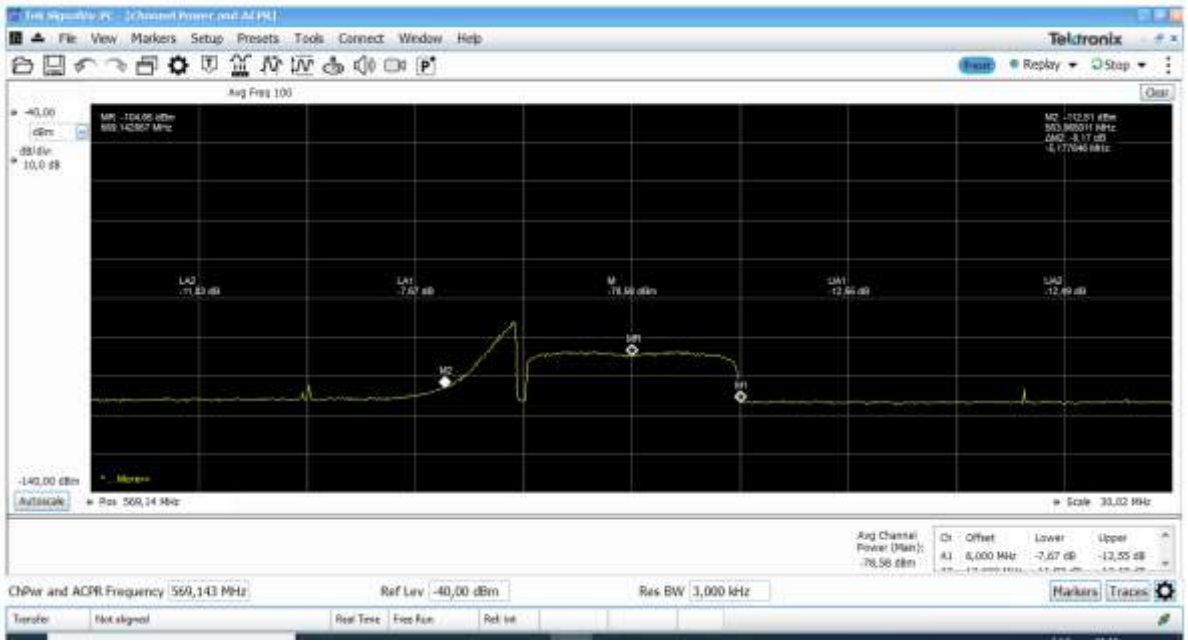


Figure 20.12 - Horizontal

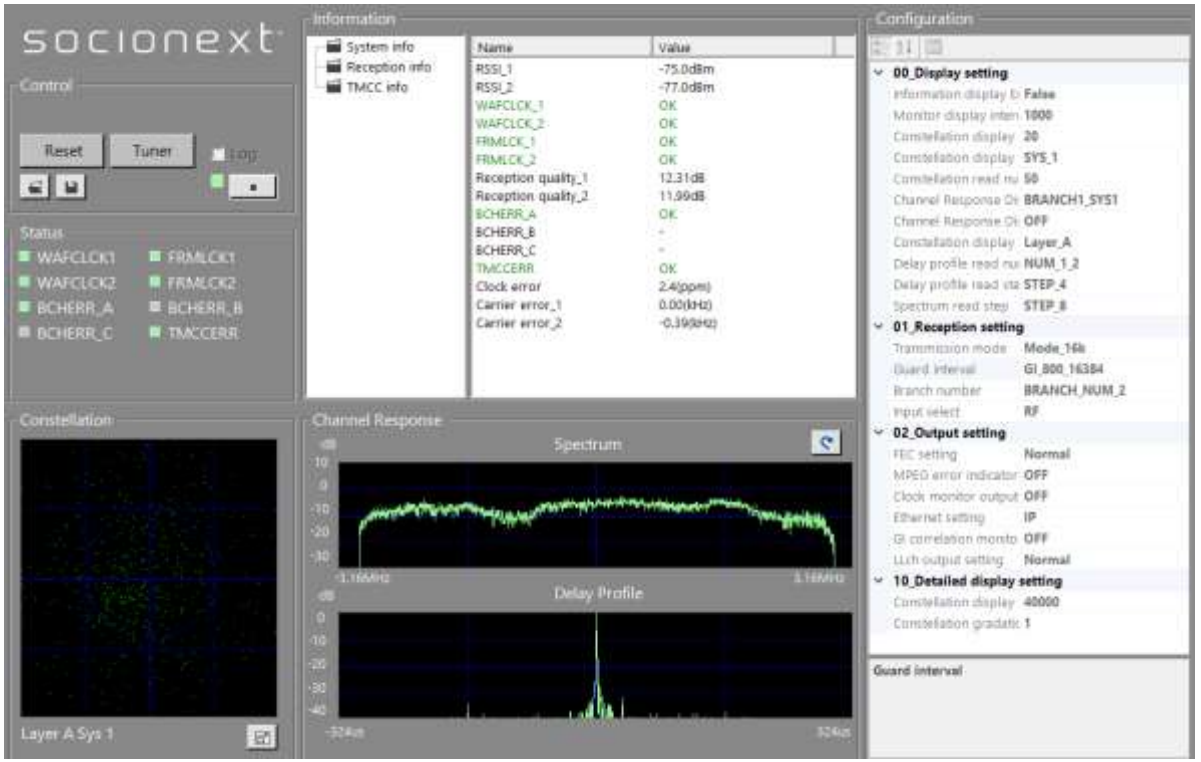


Figure 20.13 - Socionext Screen

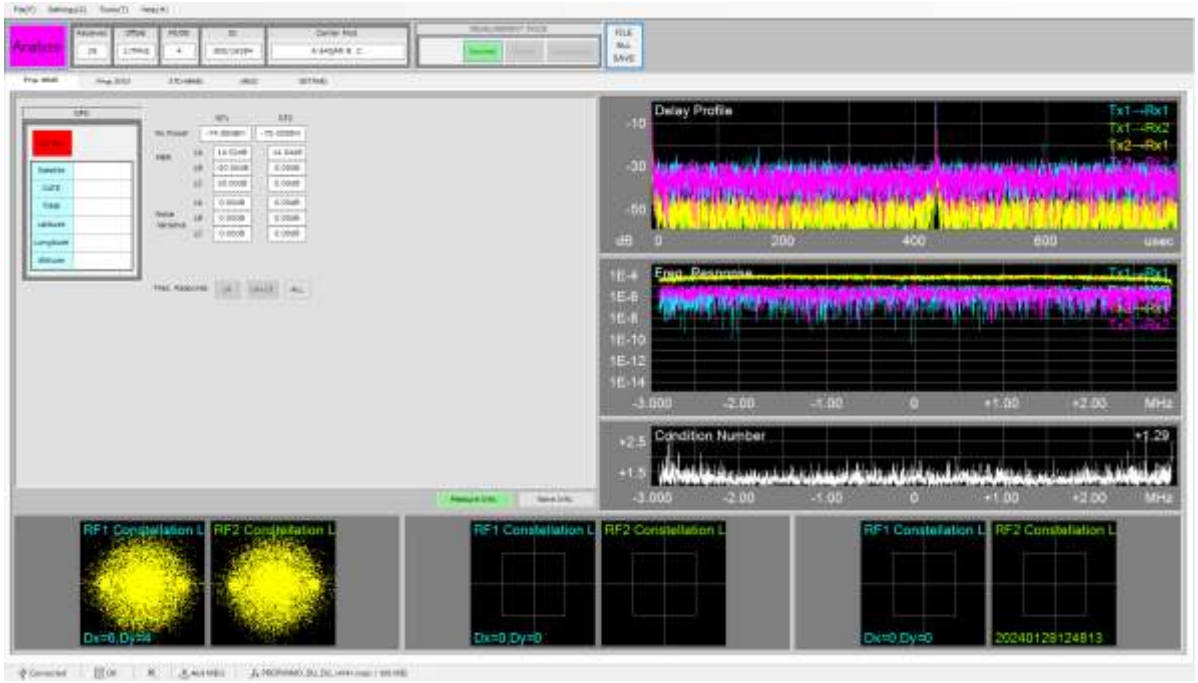


Figure 20.14 - Rintaro Screen

Chapter 21. Site 21

a) Channel Power

Figure 21.1 - Vertical

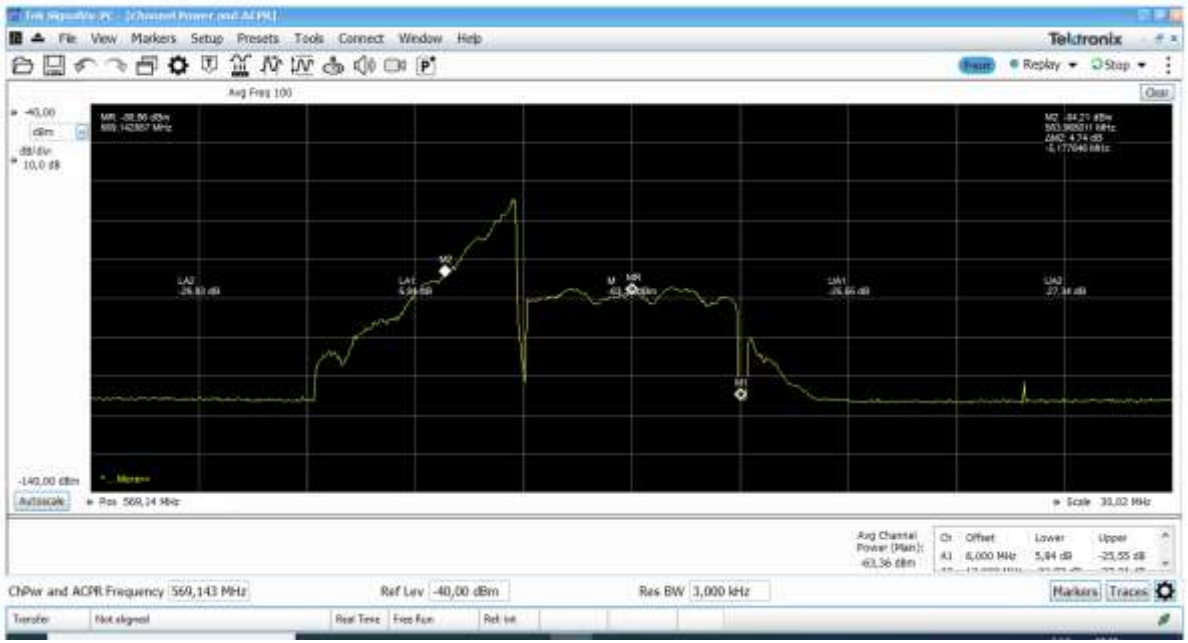


Figure 21.2 - Horizontal

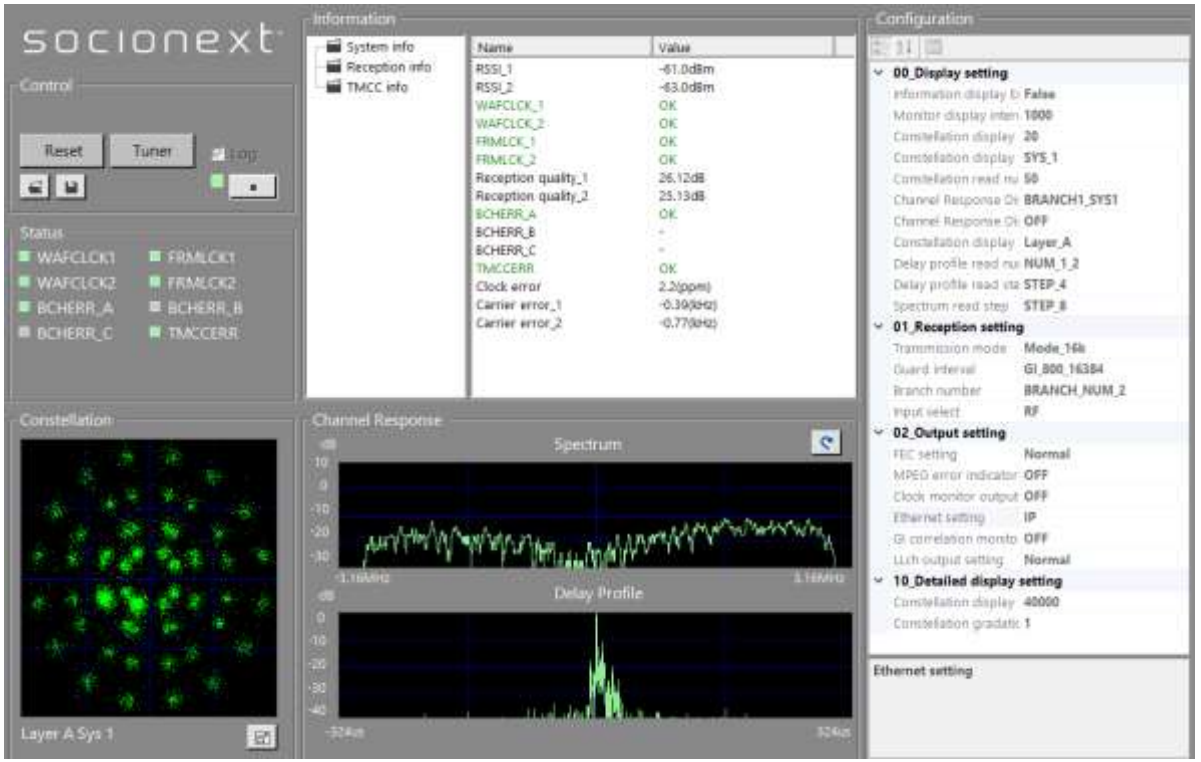


Figure 21.3 - Socionext Screen

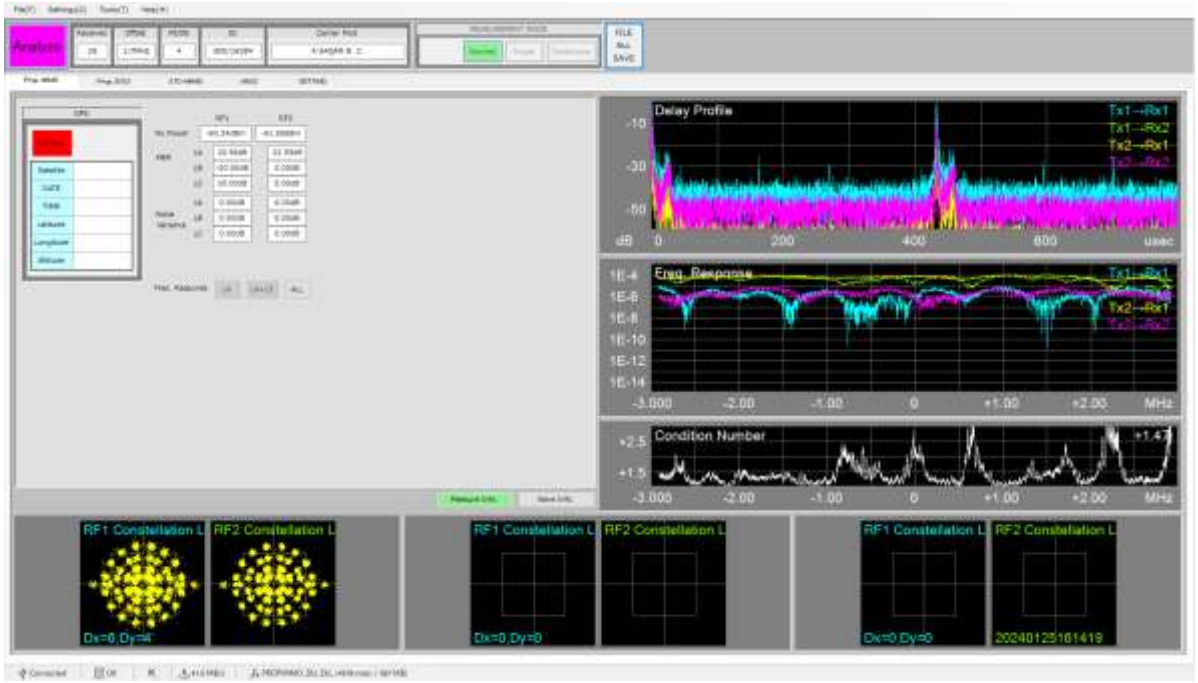


Figure 21.4 - Rintaro Screen

b) AWGN Power

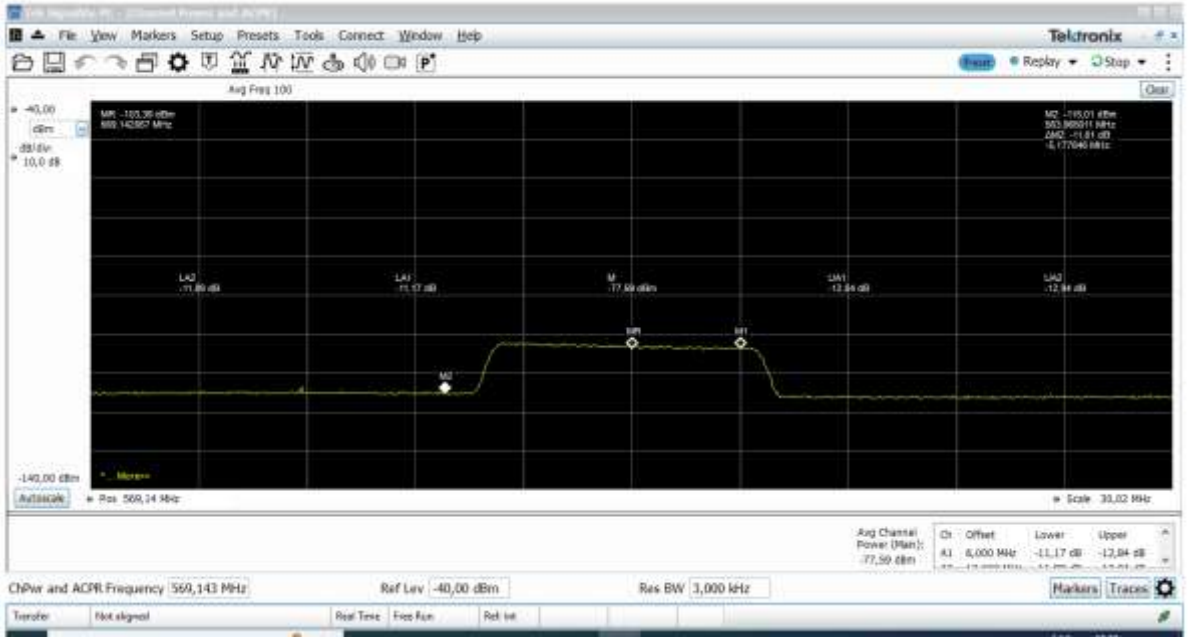


Figure 21.5 - Vertical

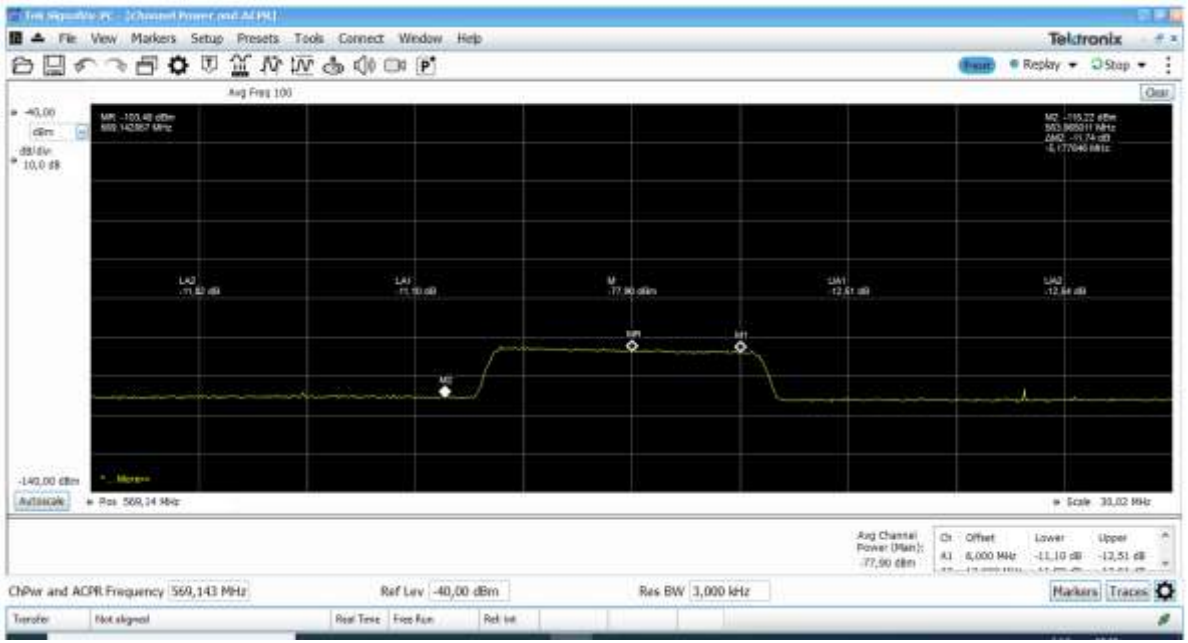


Figure 21.6 - Horizontal

c) C/N Threshold

Figure 21.7 - Vertical

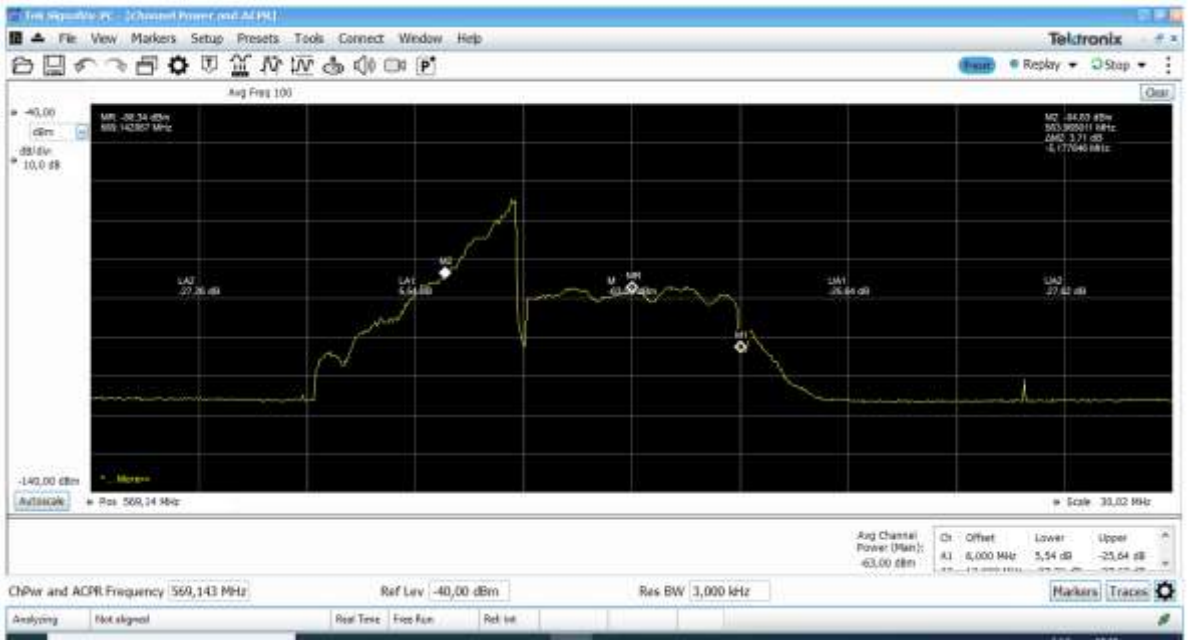


Figure 21.8 - Horizontal

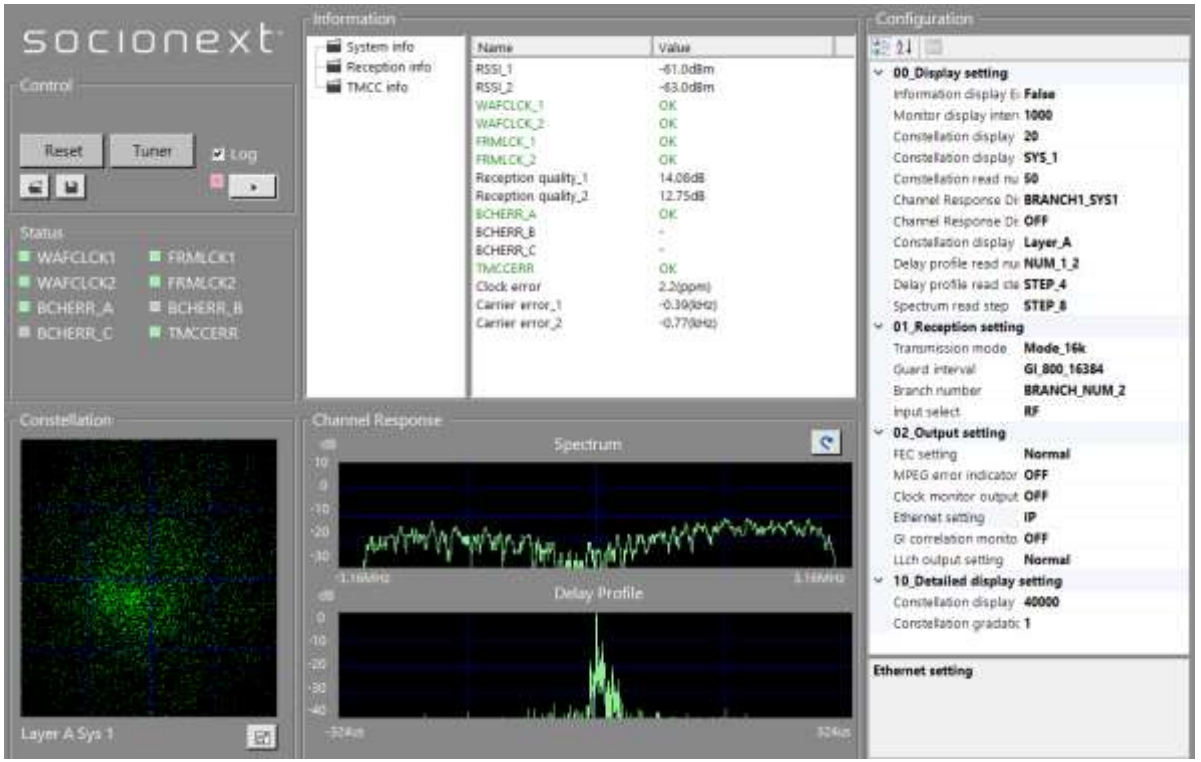


Figure 21.9 - Socionext Screen

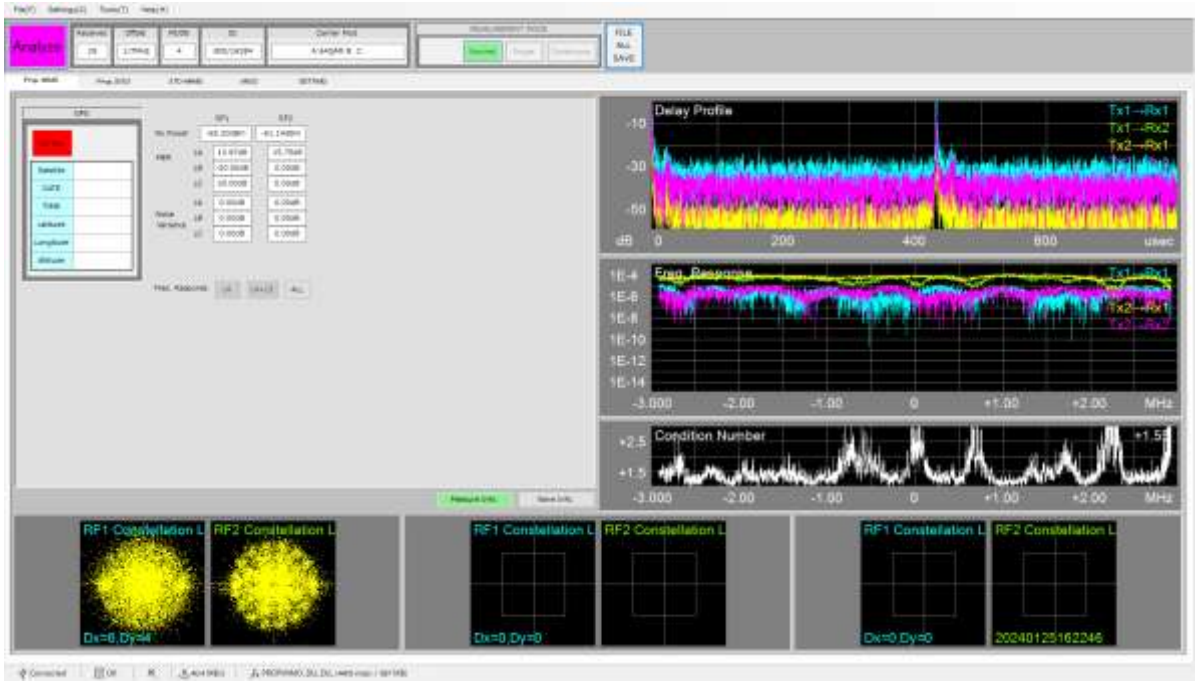


Figure 21.10 - Rintaro Screen

d) Reception Threshold

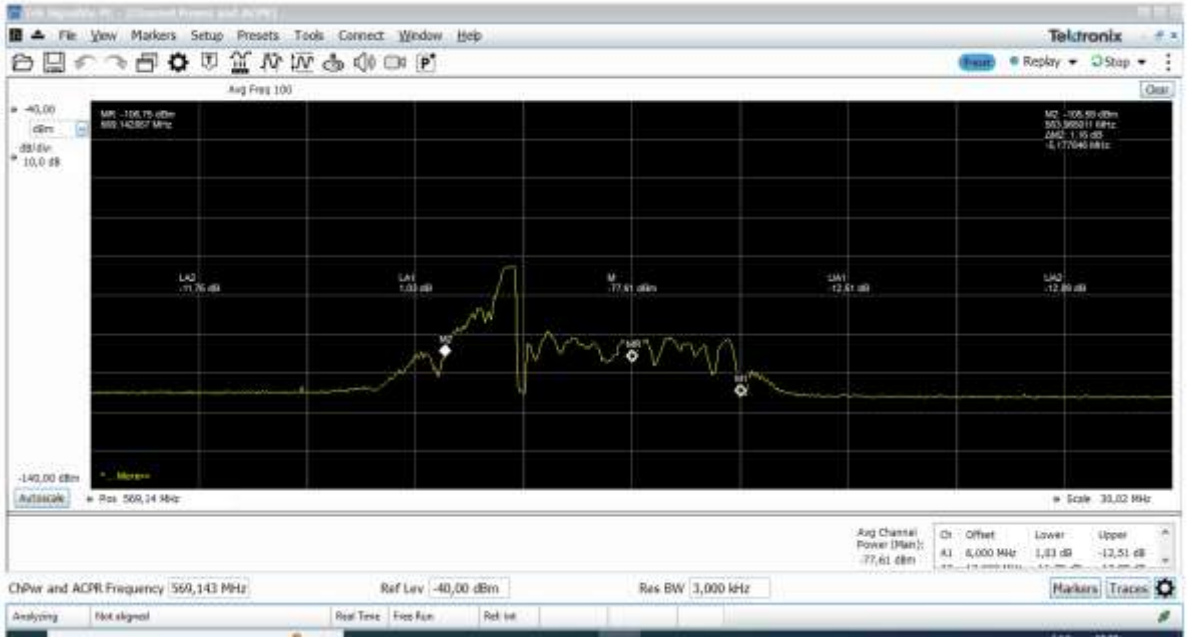


Figure 21.11 - Vertical

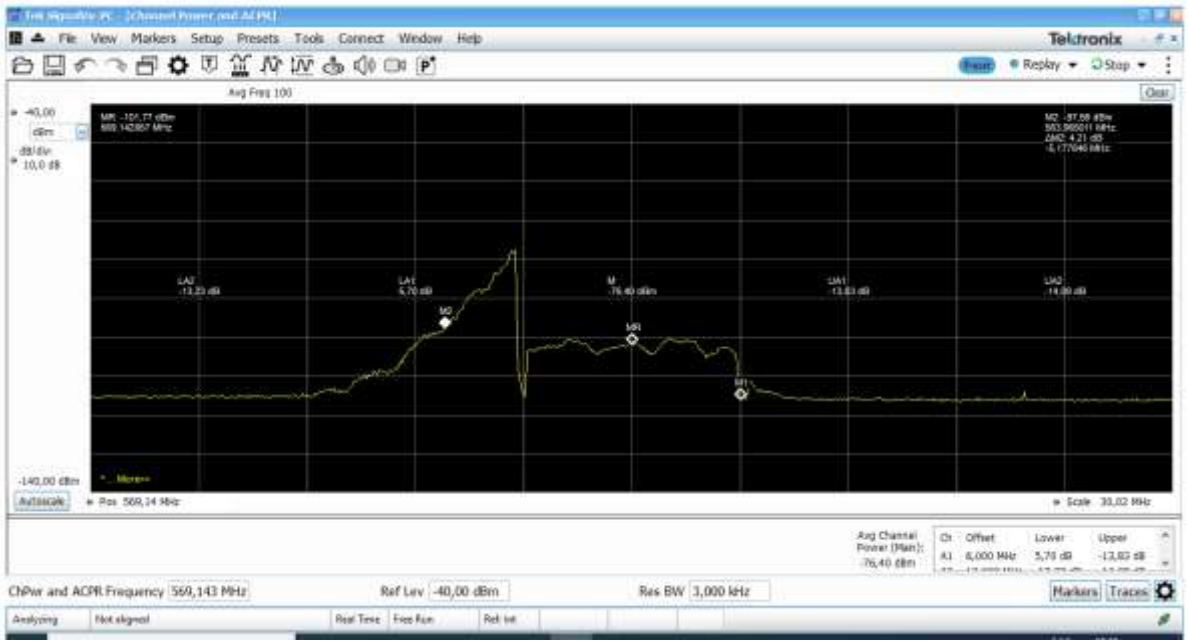


Figure 21.12 - Horizontal

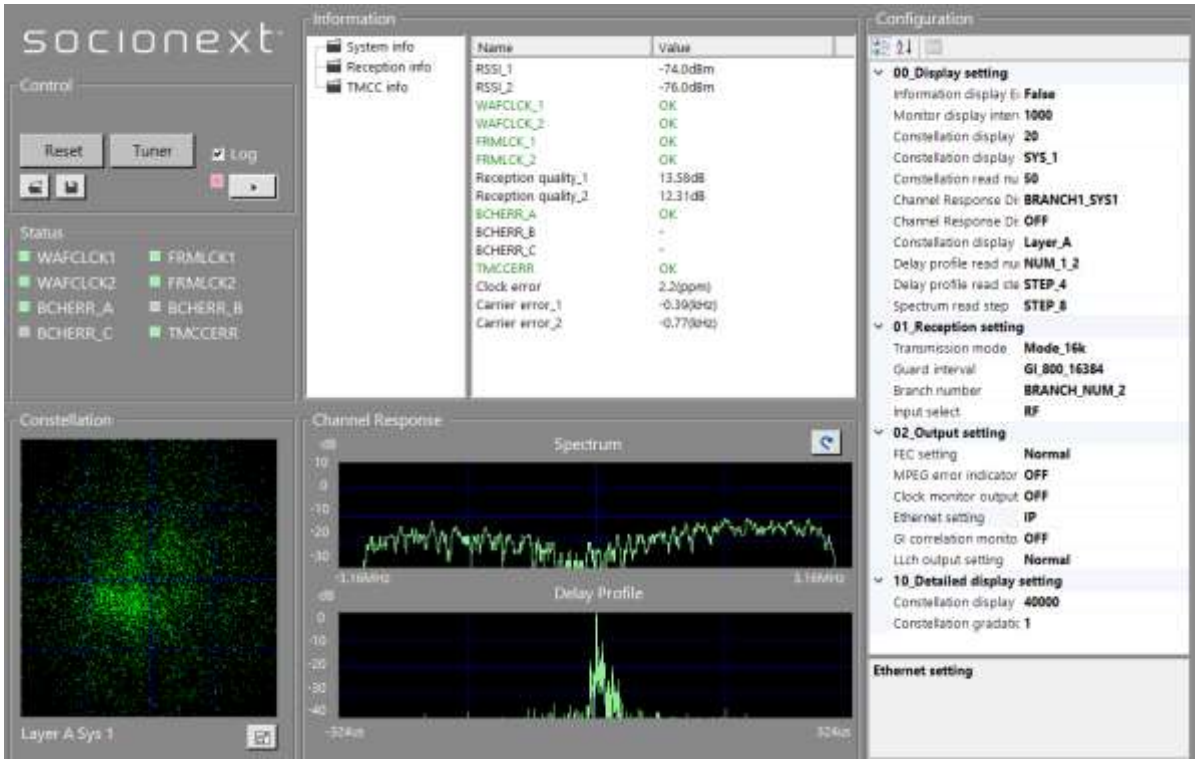


Figure 21.13 - Socionext Screen

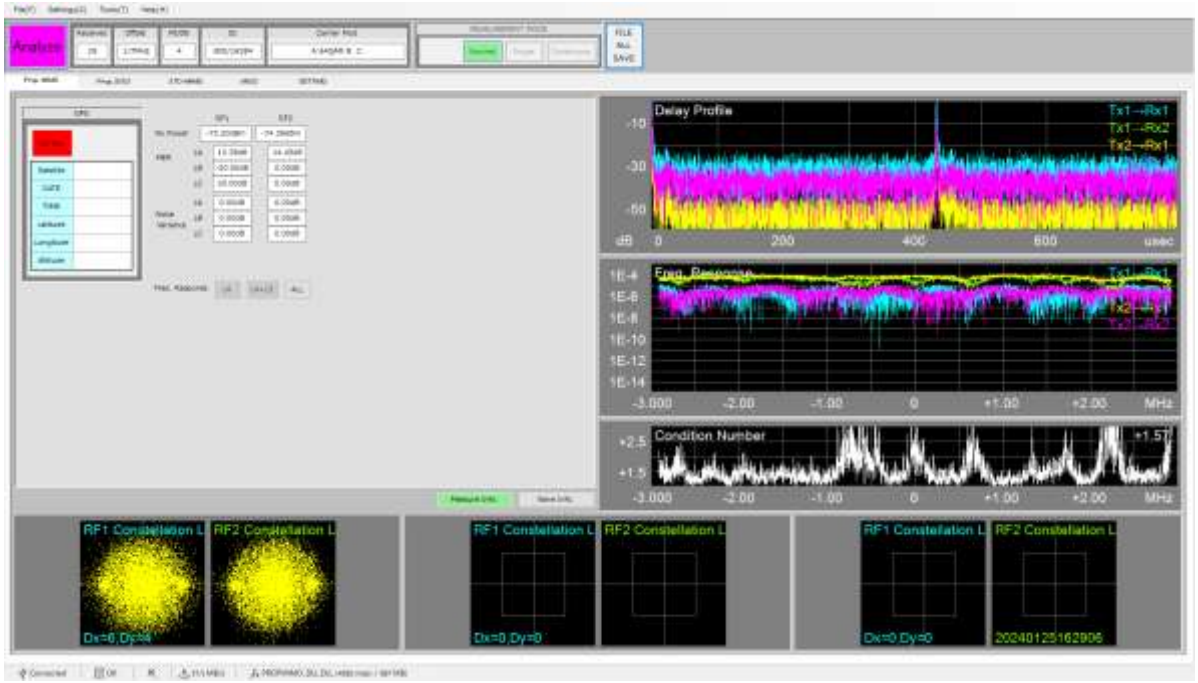


Figure 21.14 - Rintaro Screen

Chapter 22. Site 22

a) Channel Power

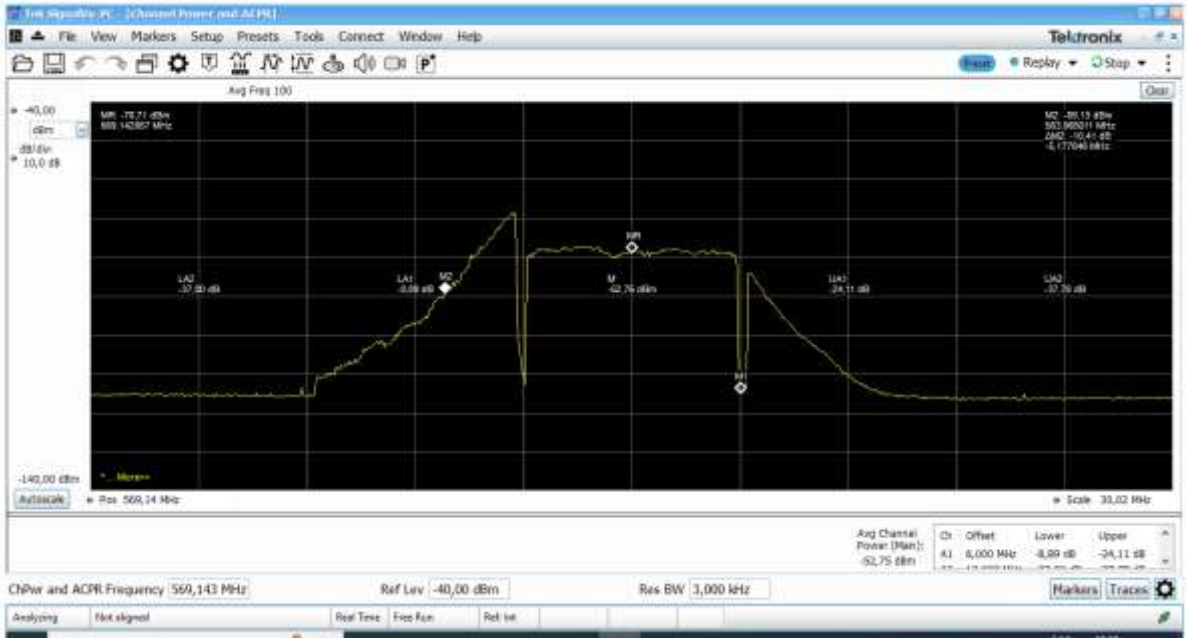


Figure 22.1 - Vertical

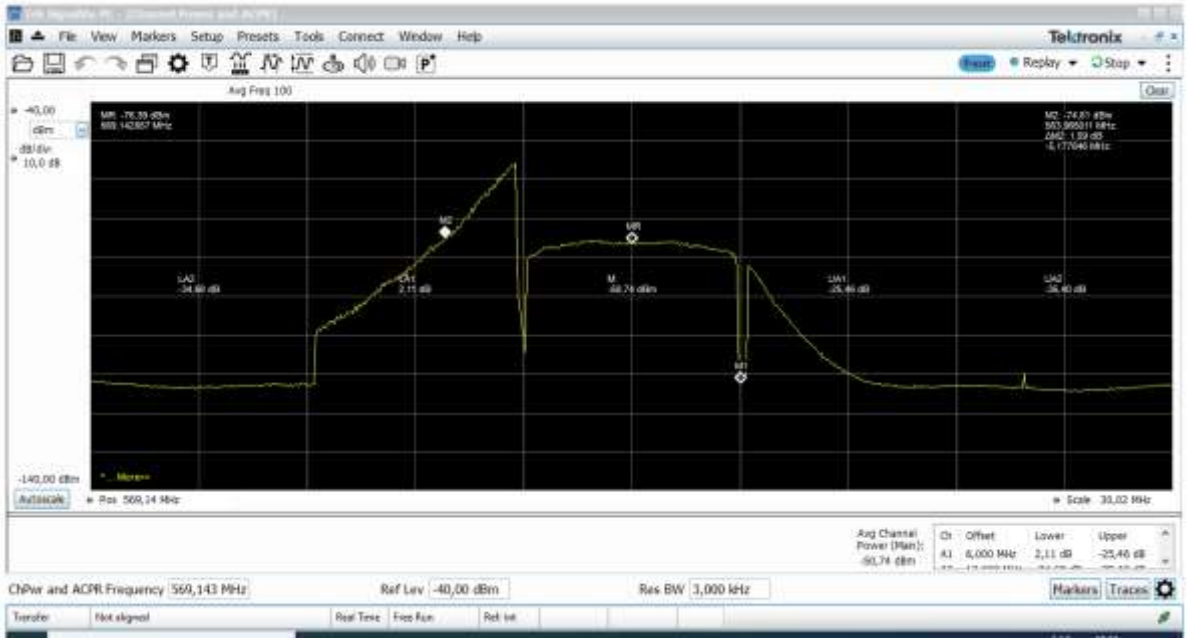


Figure 22.2 - Horizontal

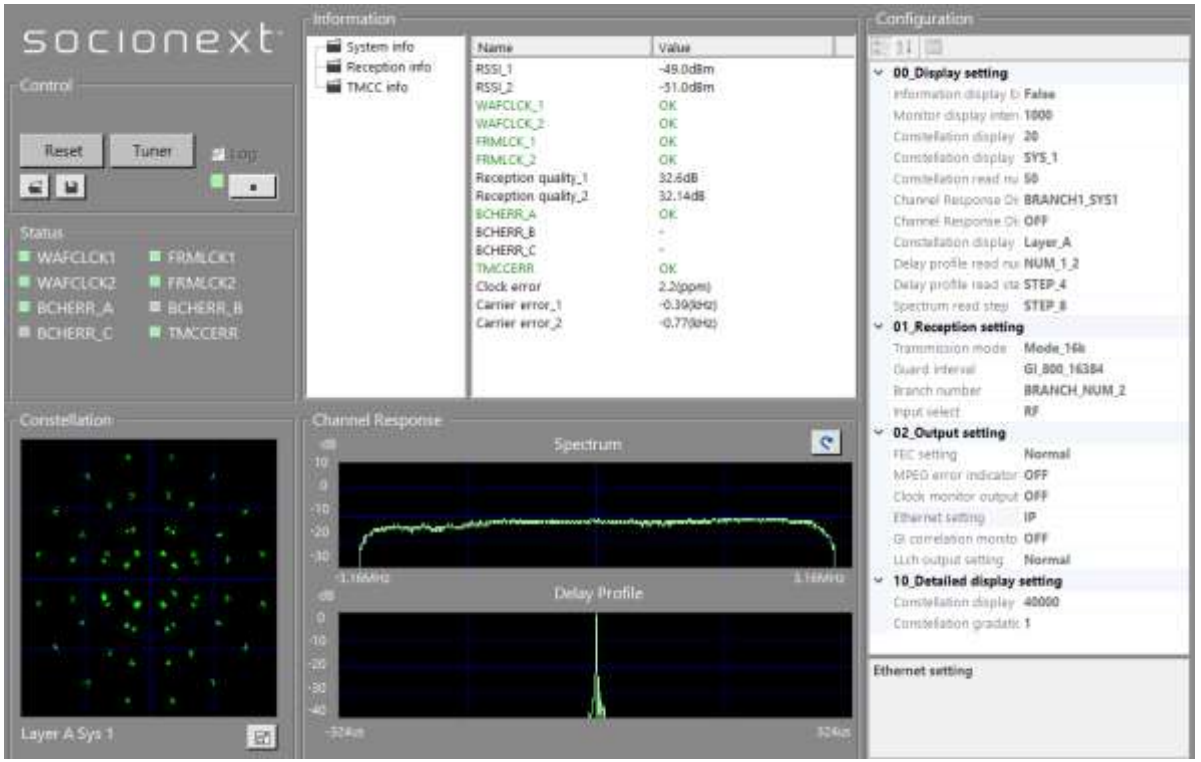


Figure 22.3 - Socionext Screen

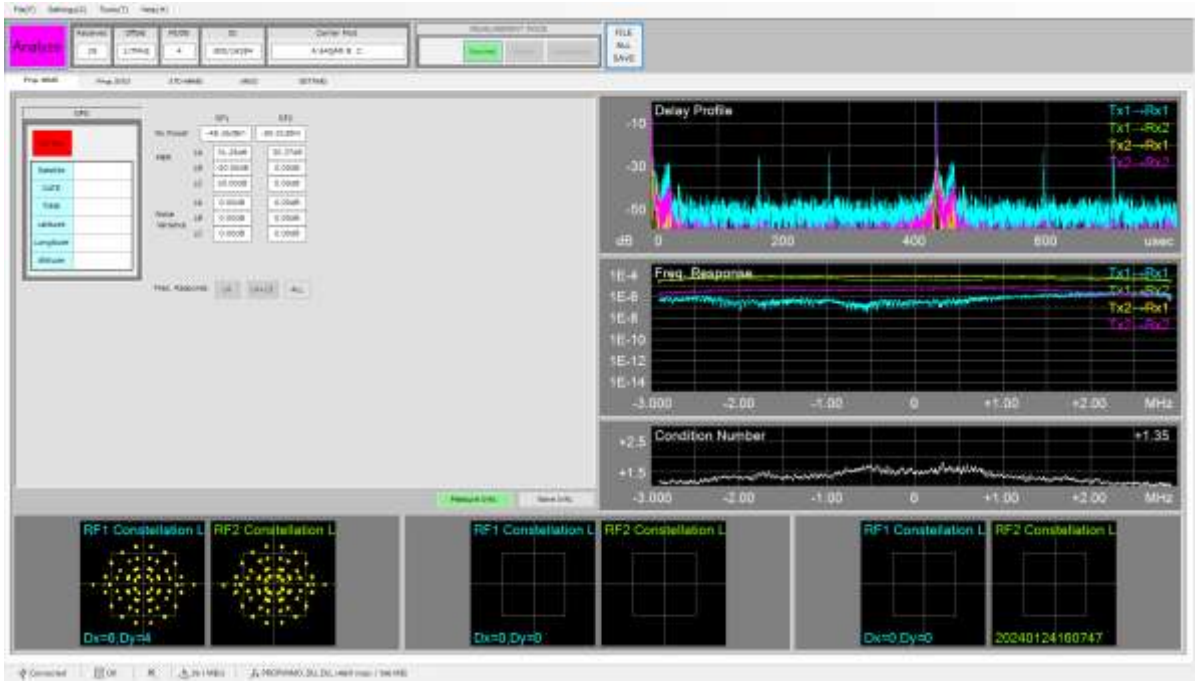


Figure 22.4 - Rintaro Screen

b) AWGN Power

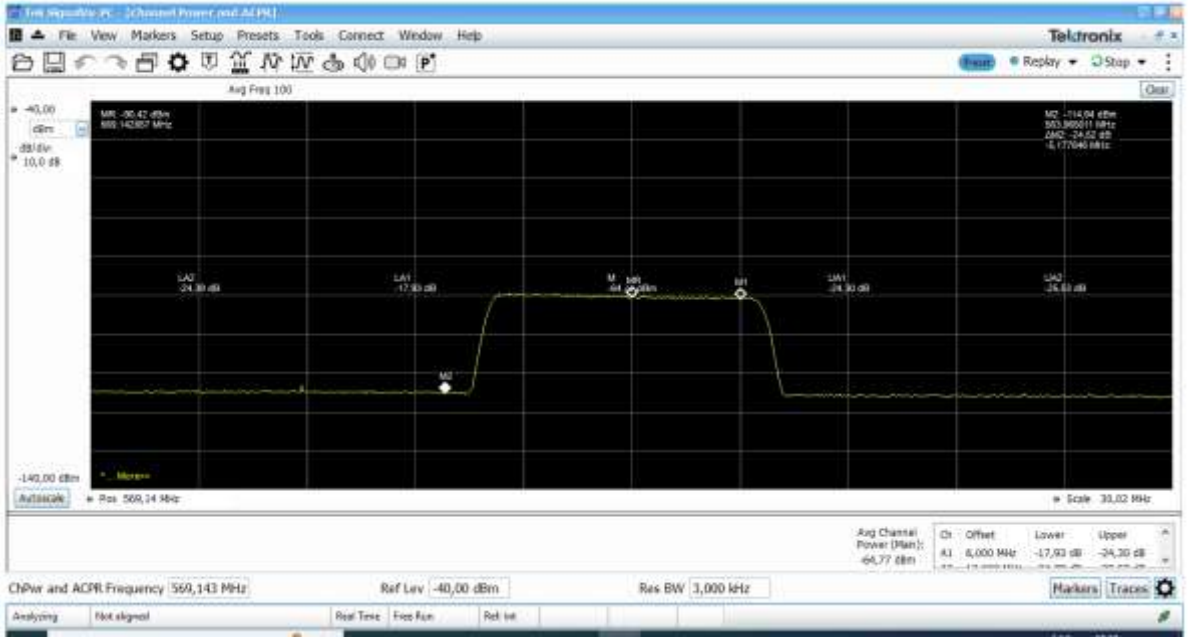


Figure 22.5 - Vertical

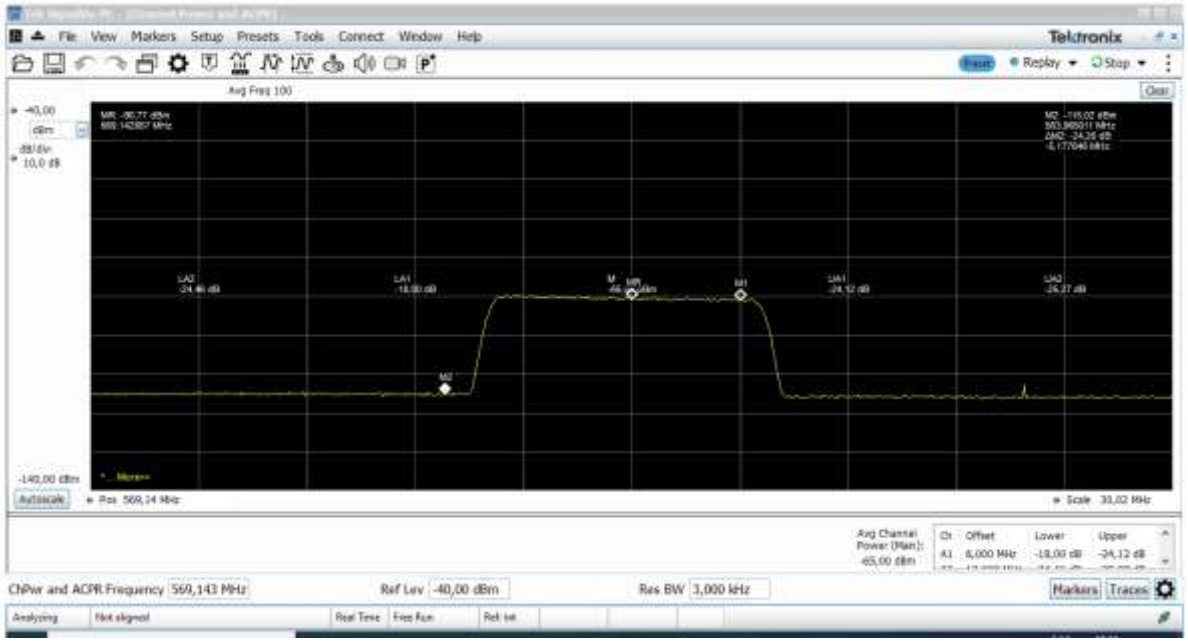


Figure 22.6 - Horizontal

c) C/N Threshold

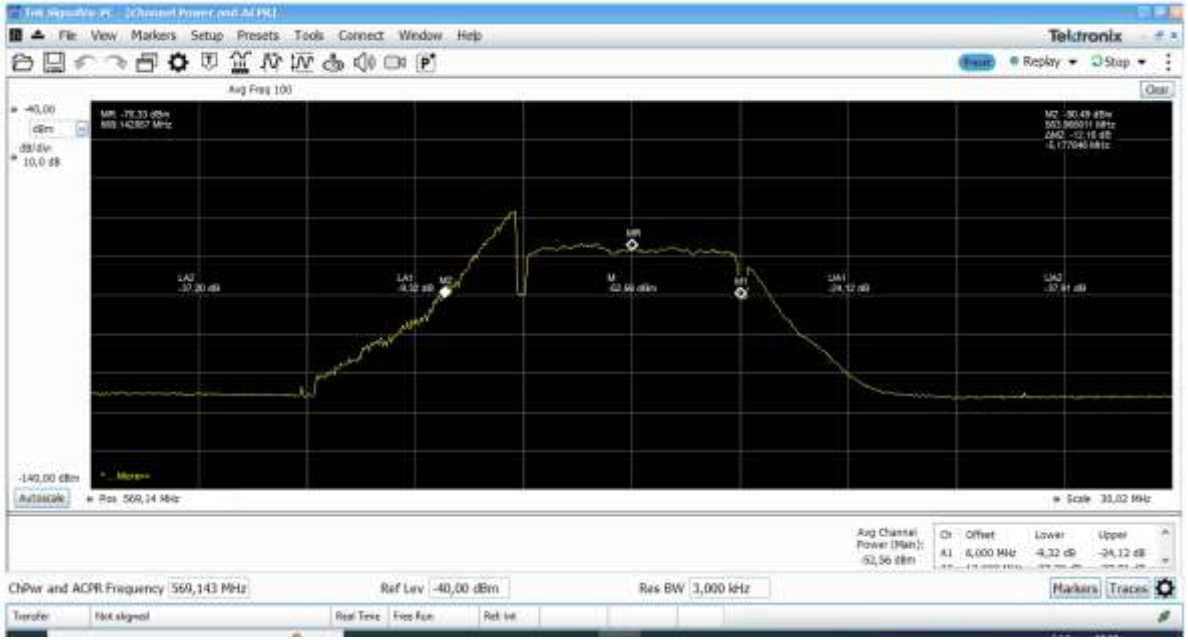


Figure 22.7 - Vertical

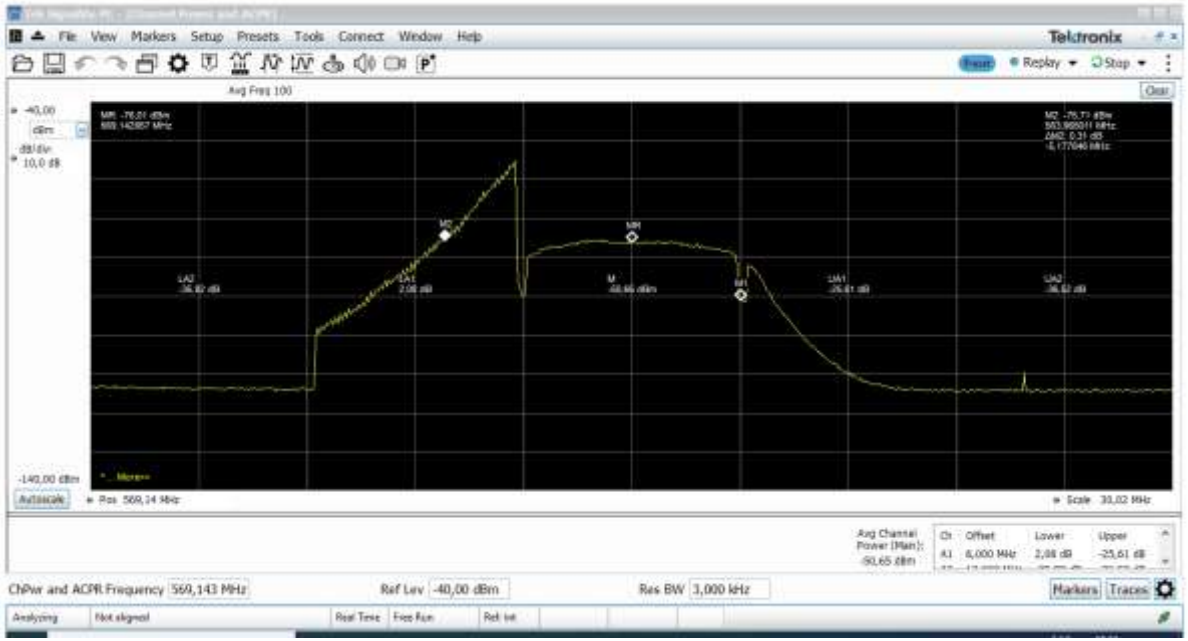


Figure 22.8 - Horizontal

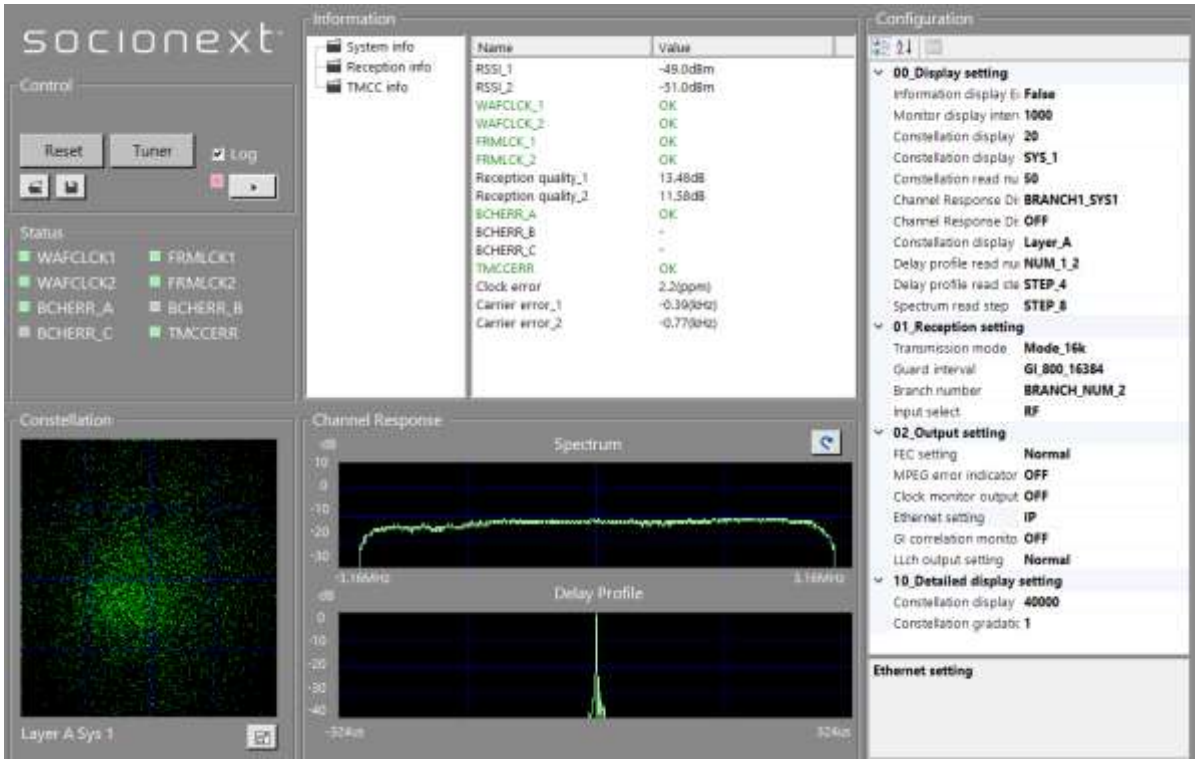


Figure 22.9 - Socionext Screen

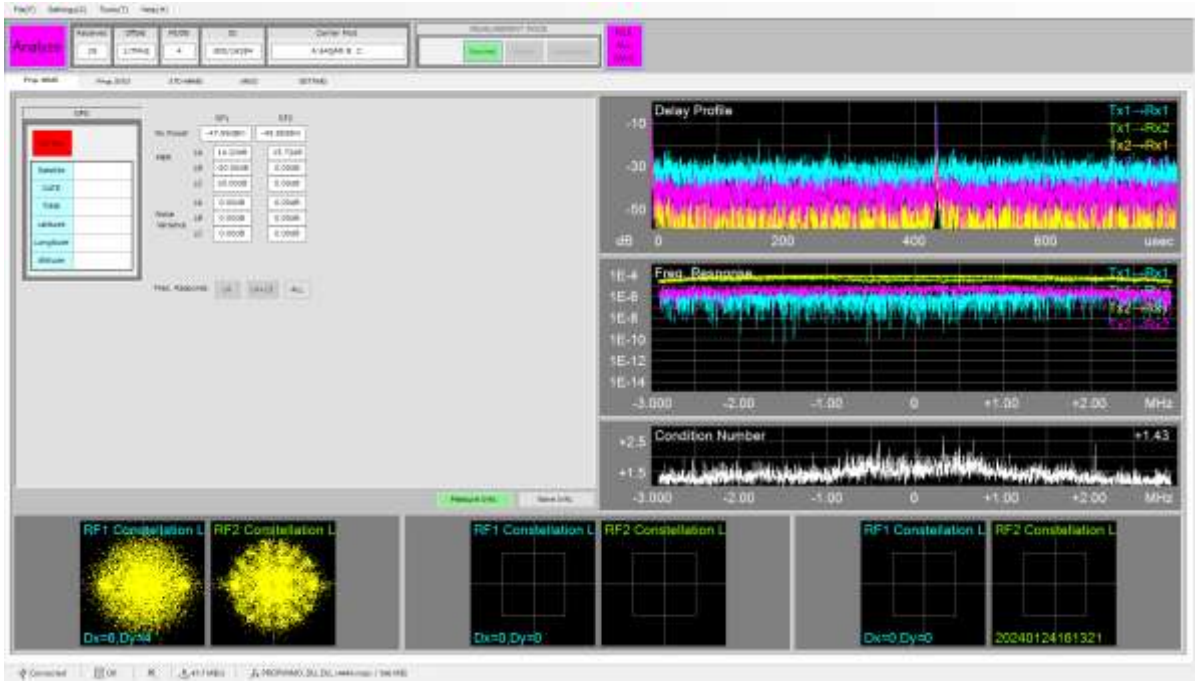


Figure 22.10 - Rintaro Screen

d) Reception Threshold

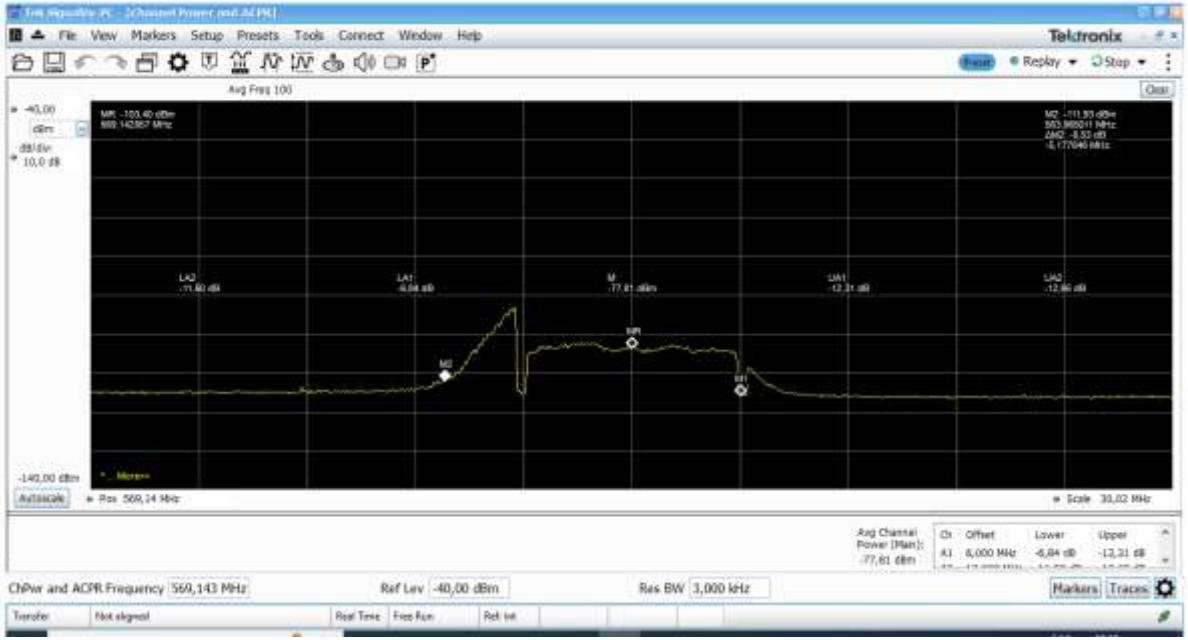


Figure 22.11 - Vertical

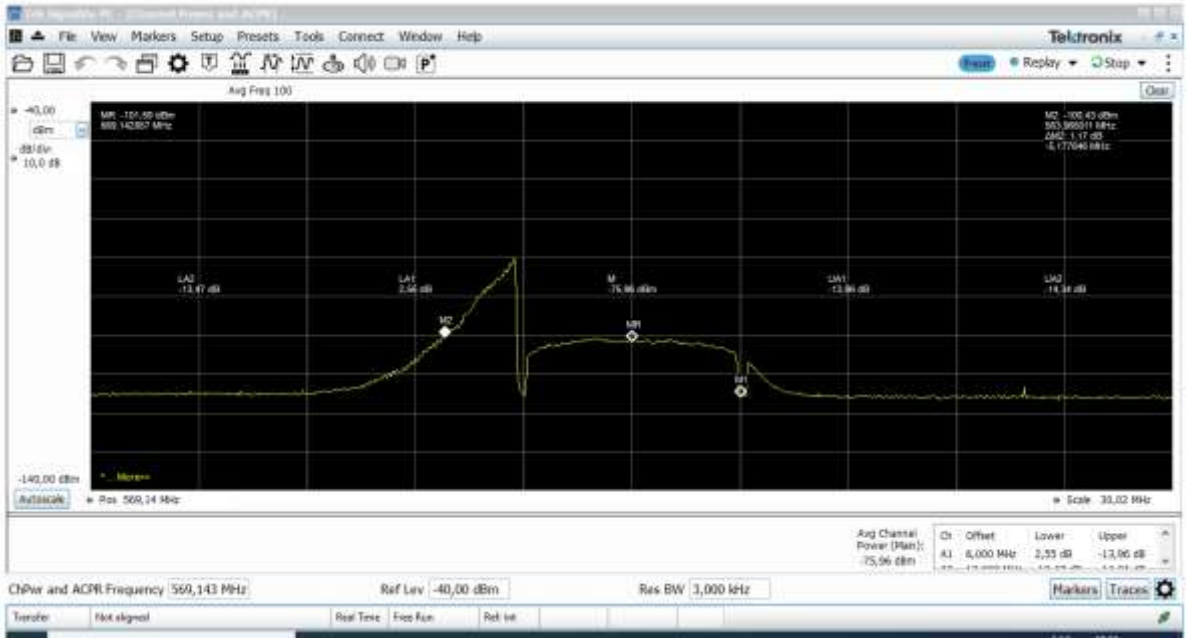


Figure 22.12 - Horizontal

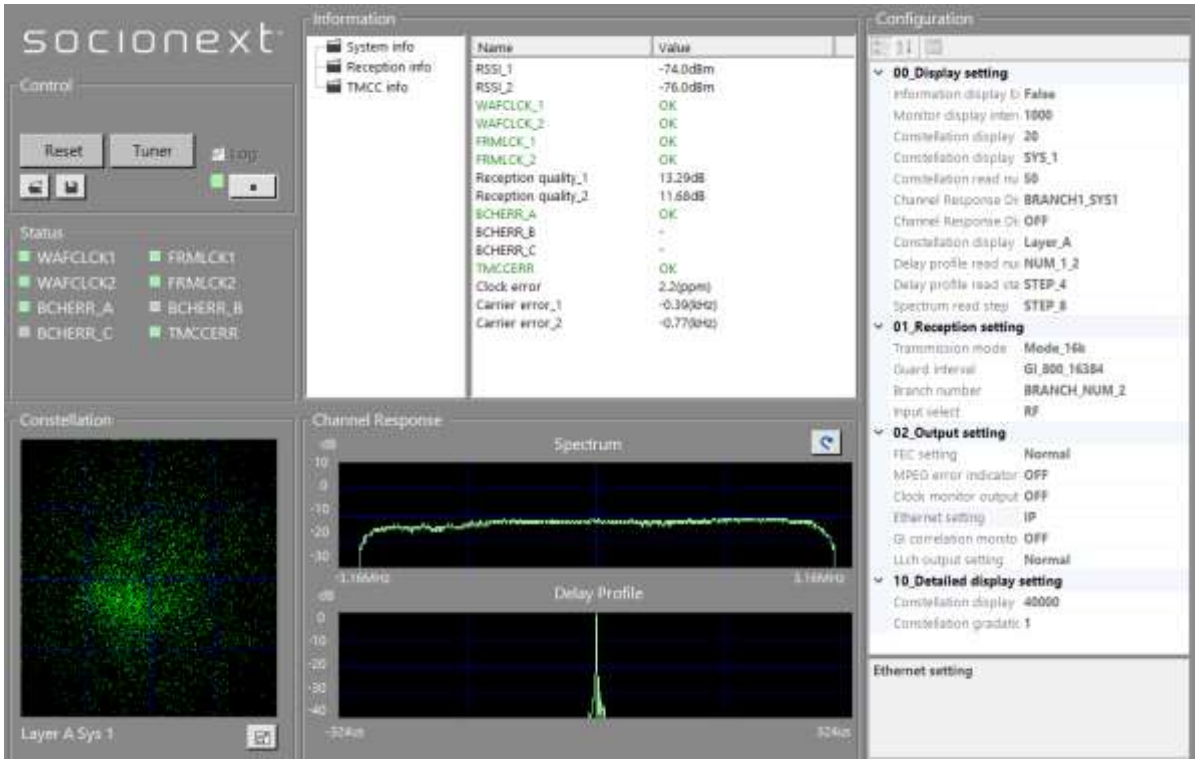


Figure 22.13 - Socionext Screen

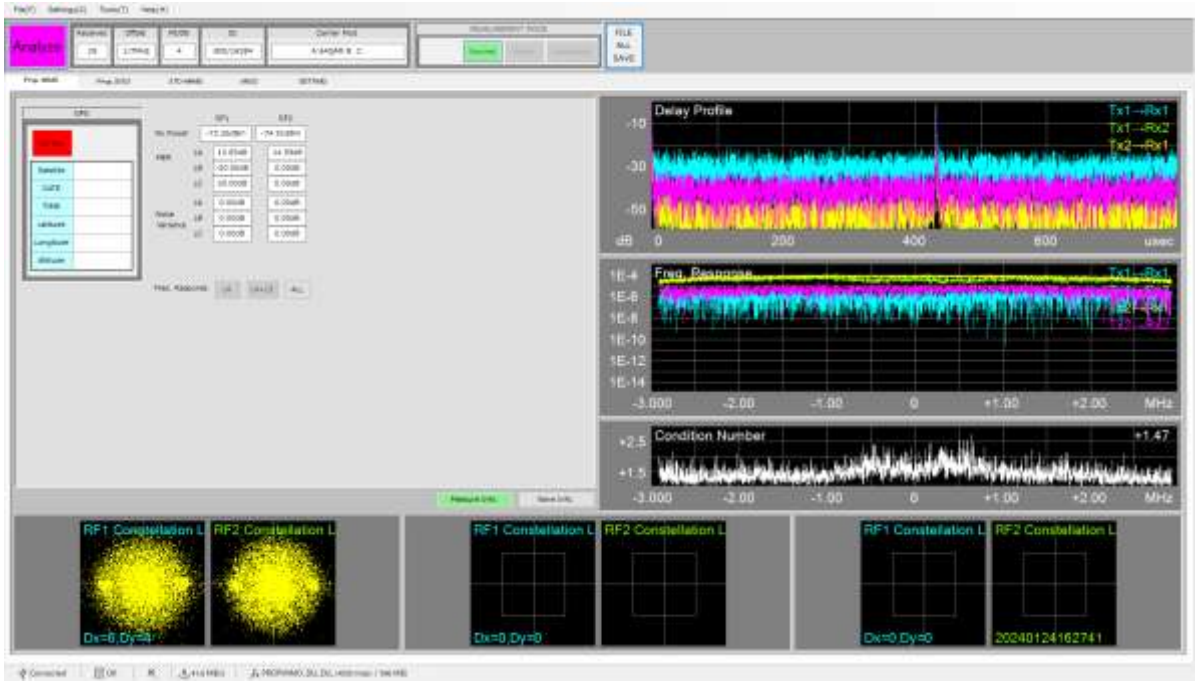


Figure 22.14 - Rintaro Screen

Chapter 23. Site 23

a) Channel Power

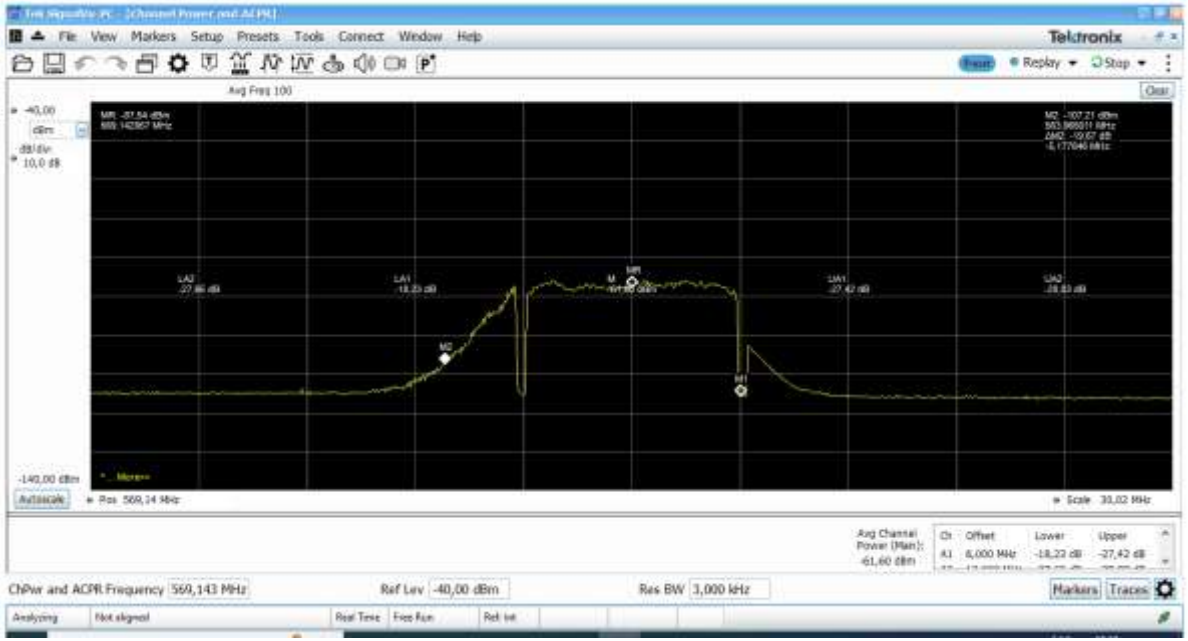


Figure 23.1 - Vertical

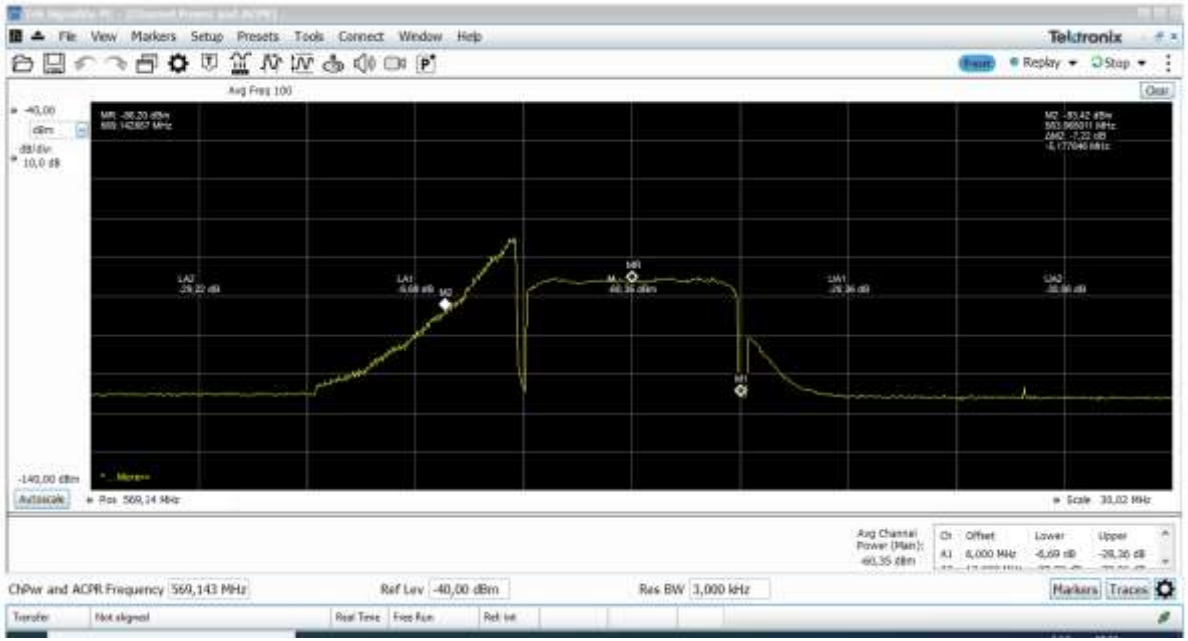


Figure 23.2 - Horizontal

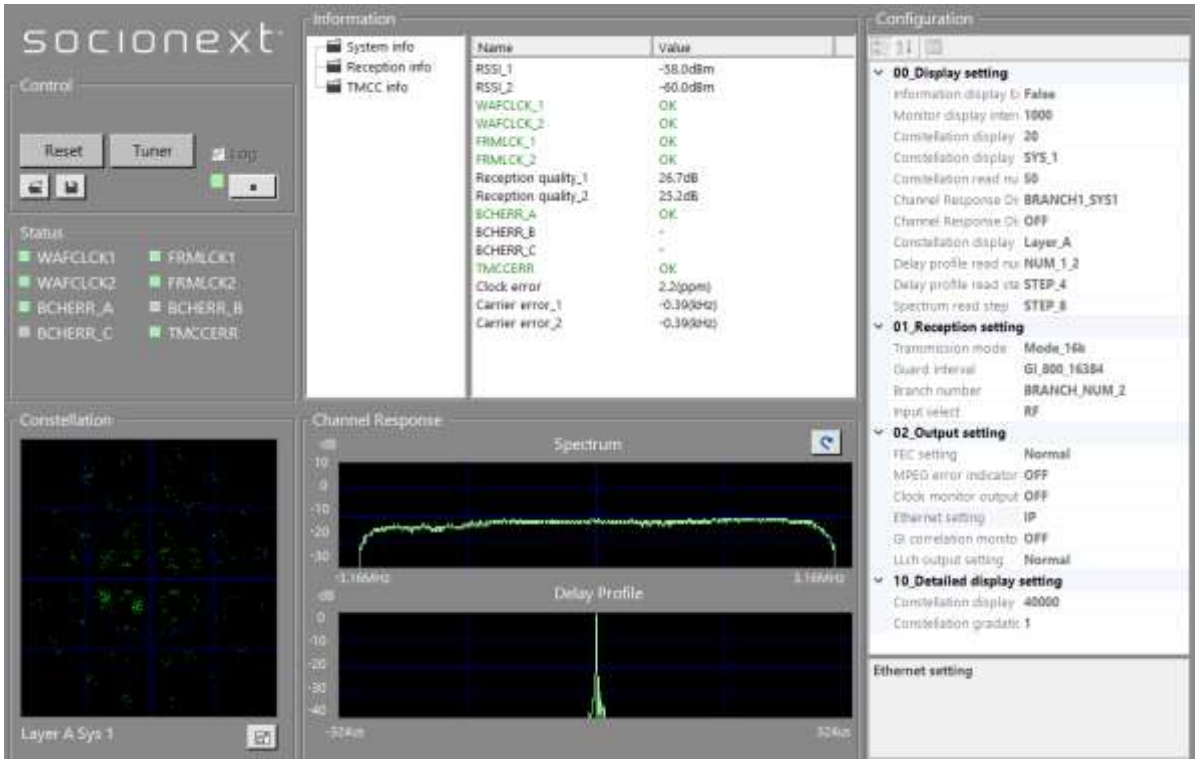


Figure 23.3 - Socionext Screen

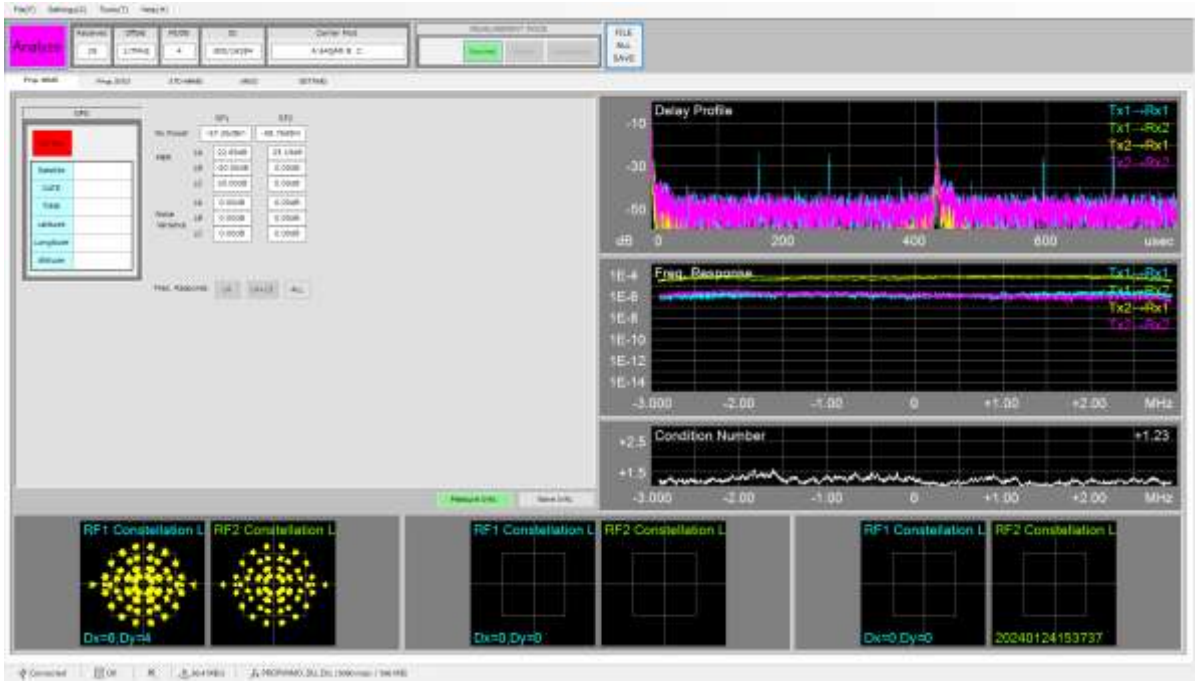


Figure 23.4 - Rintaro Screen

b) AWGN Power

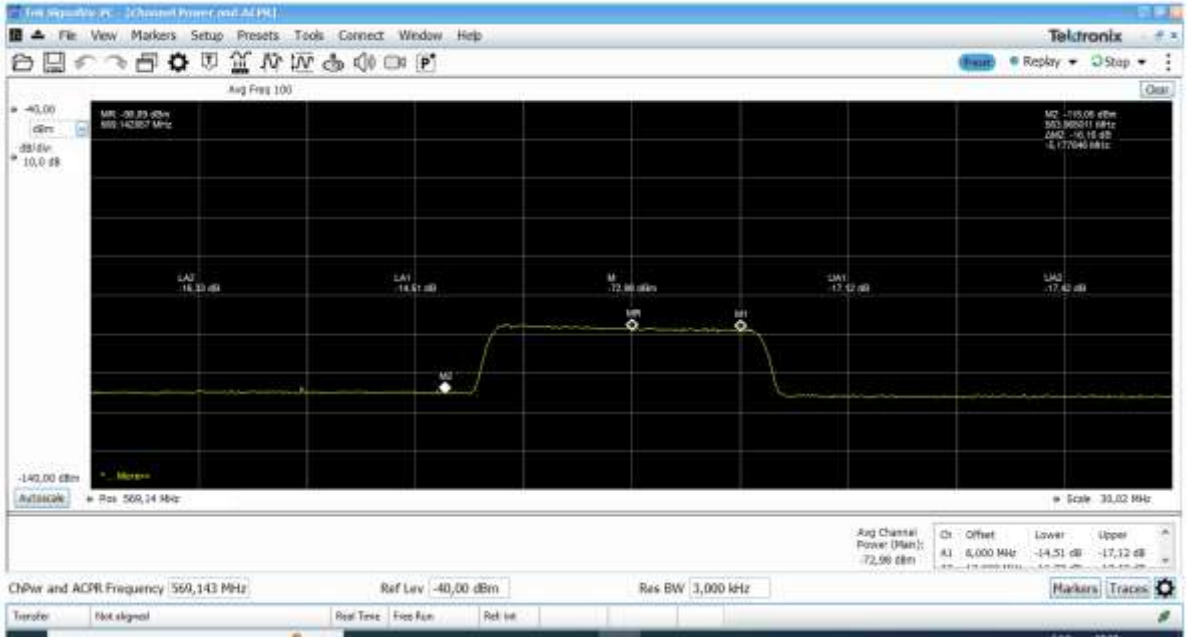


Figure 23.5 - Vertical

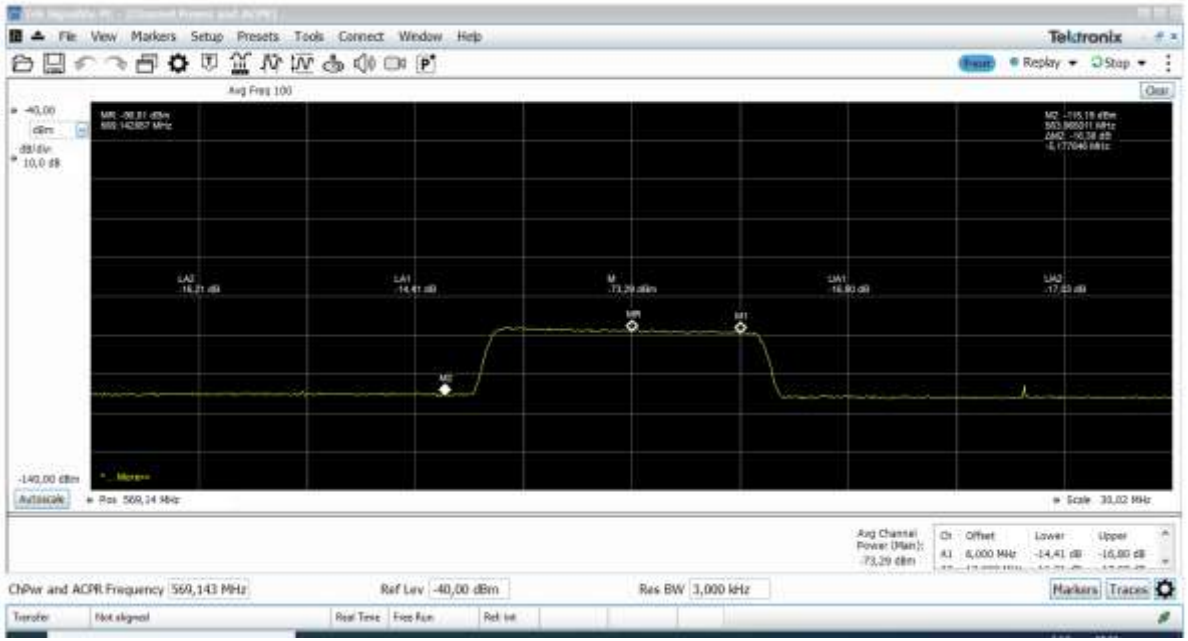


Figure 23.6 - Horizontal

c) C/N Threshold

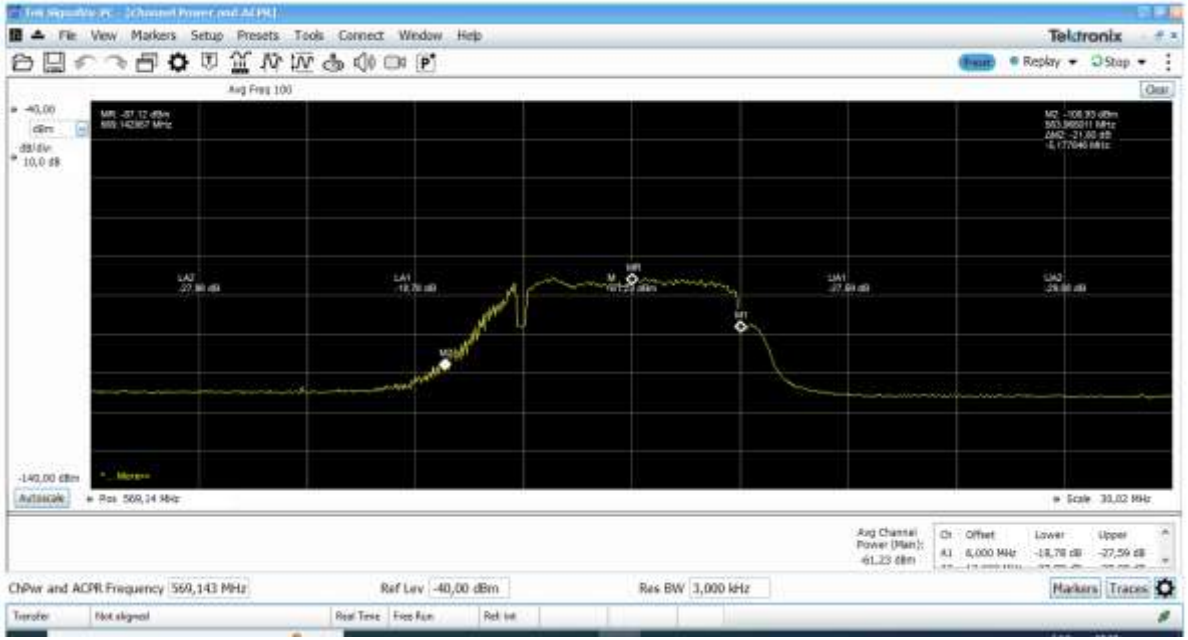


Figure 23.7 - Vertical

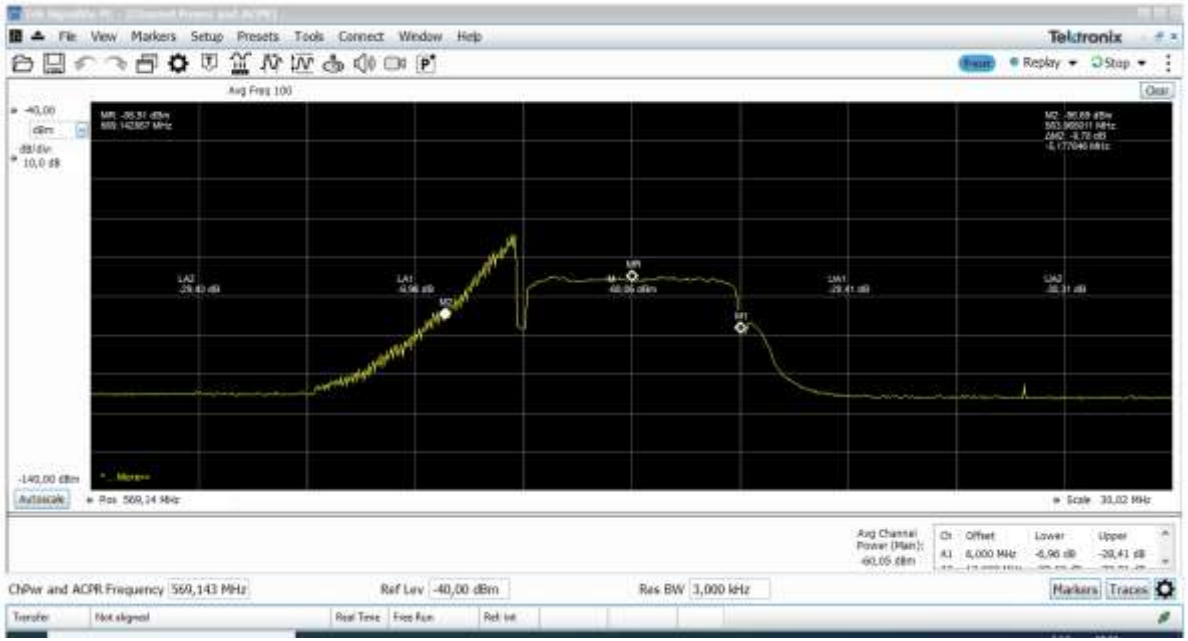


Figure 23.8 - Horizontal

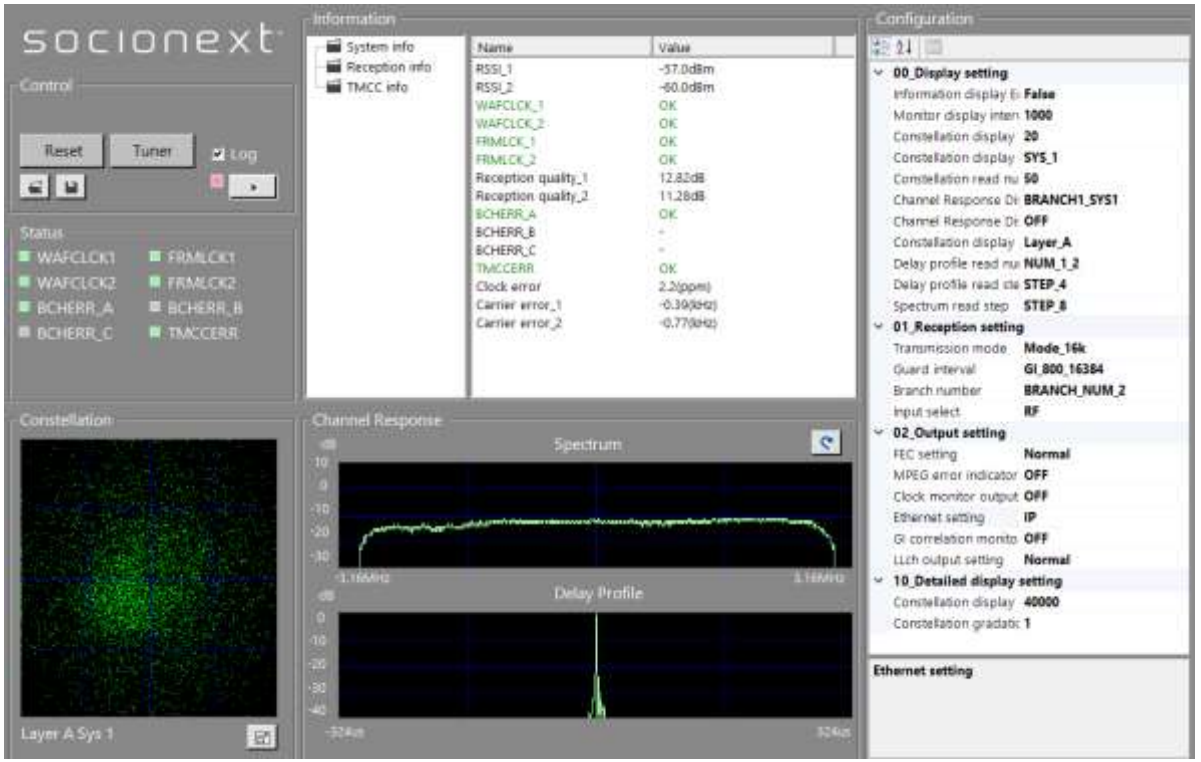


Figure 23.9 - Socionext Screen

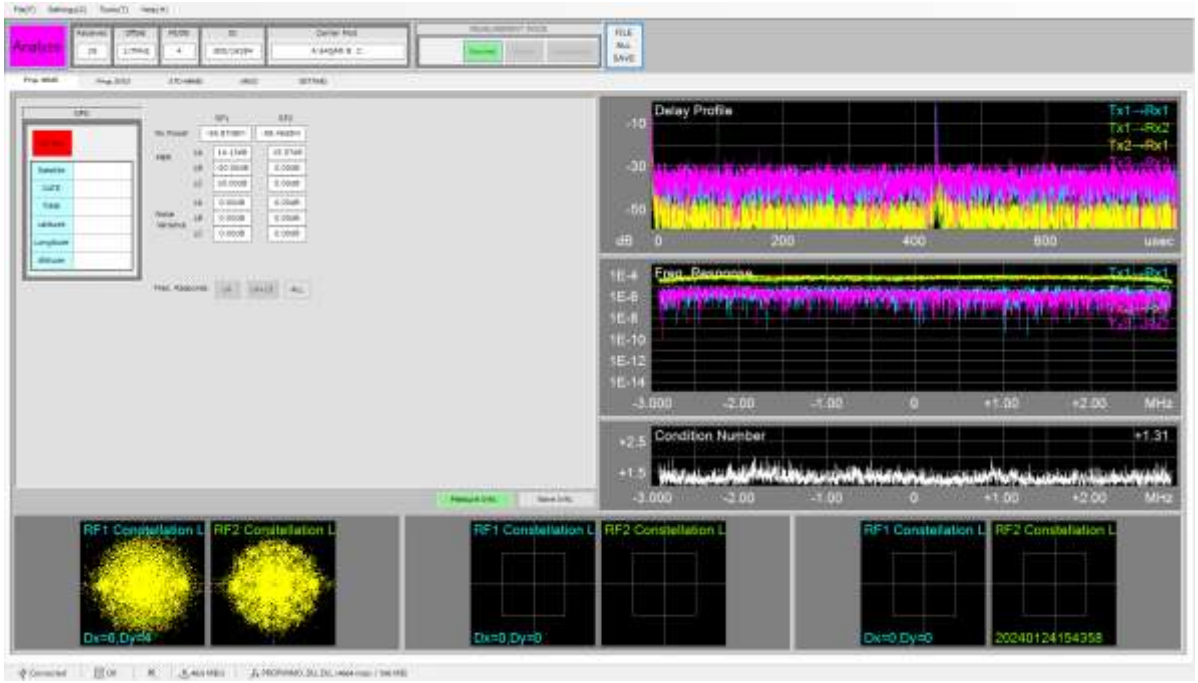


Figure 23.10 - Rintaro Screen

d) Reception Threshold

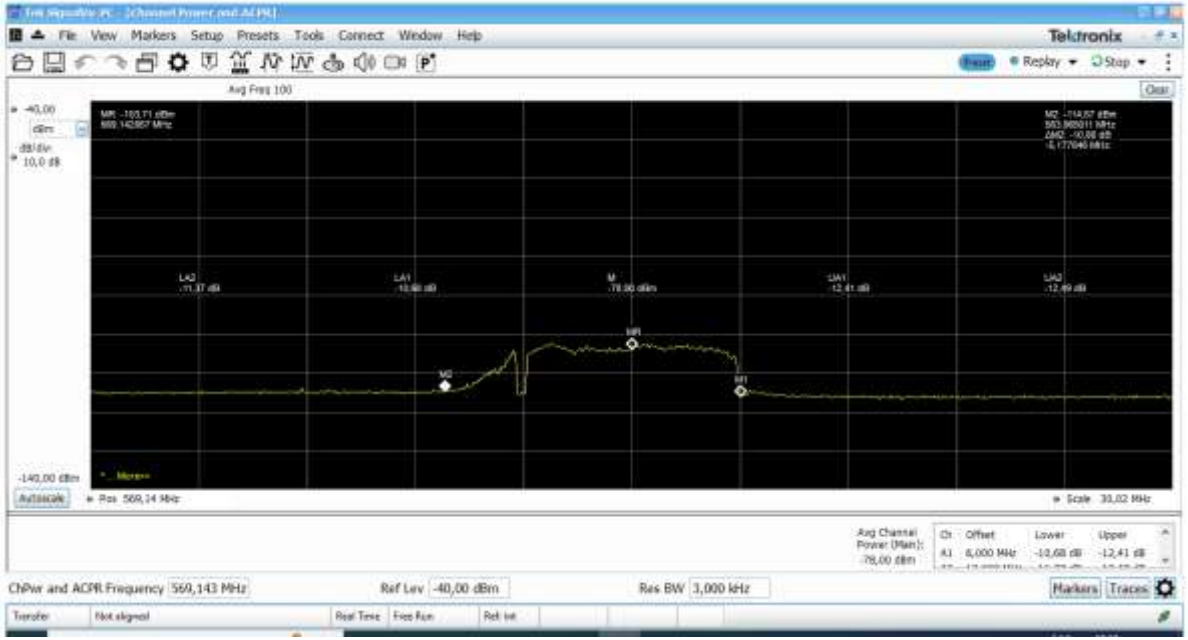


Figure 23.11 - Vertical

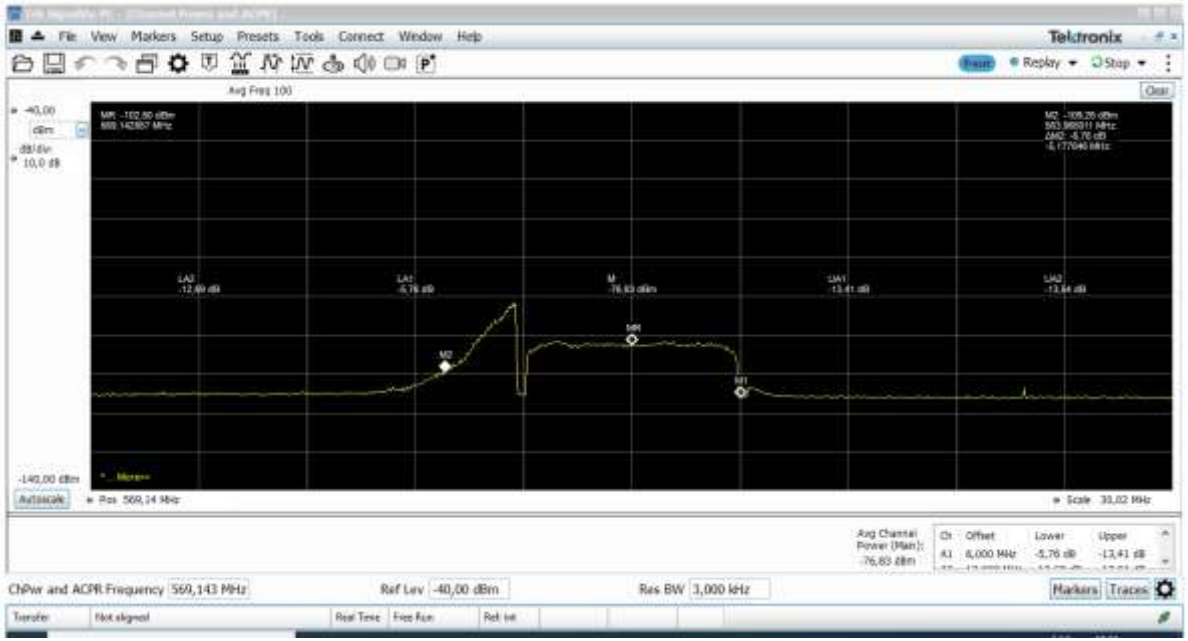


Figure 23.12 - Horizontal

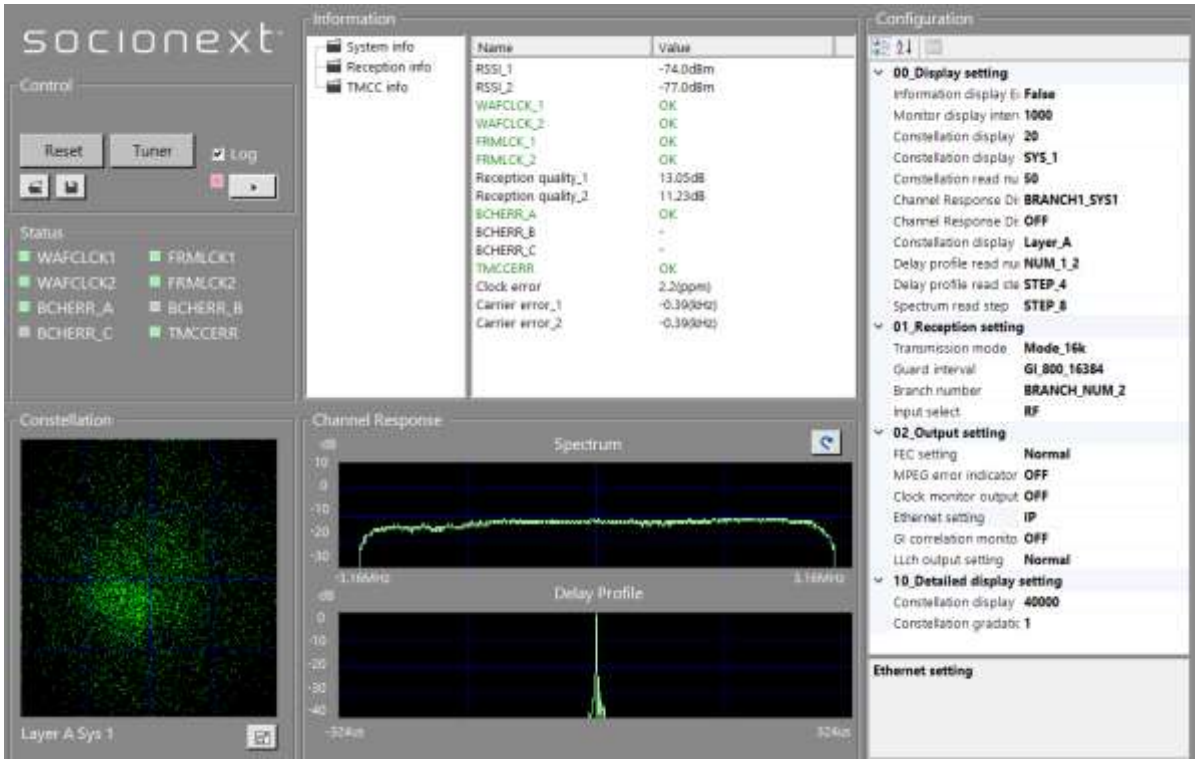


Figure 23.13 - Socionext Screen

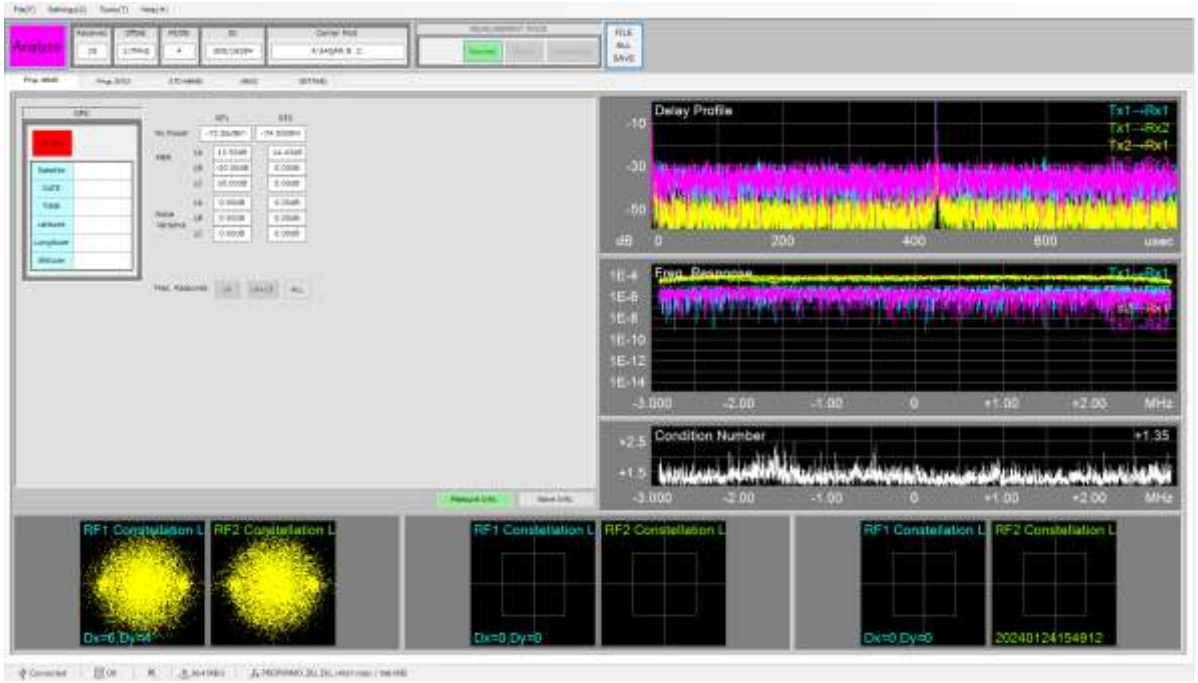


Figure 23.14 - Rintaro Screen

Chapter 24. Site 24

a) Channel Power

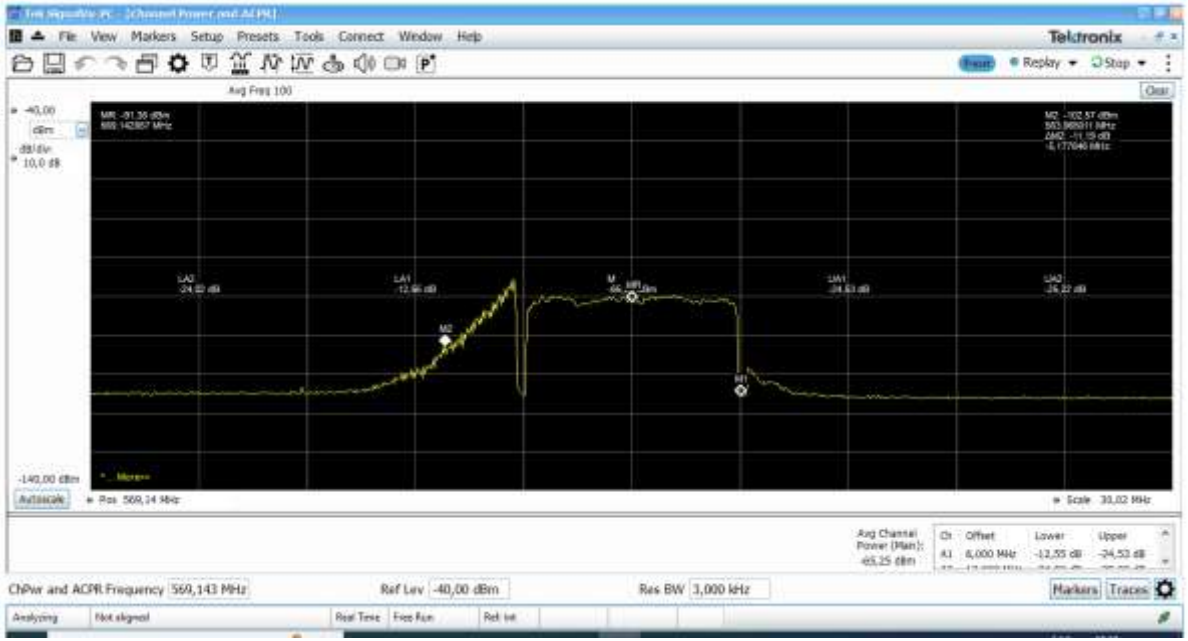


Figure 24.1 - Vertical

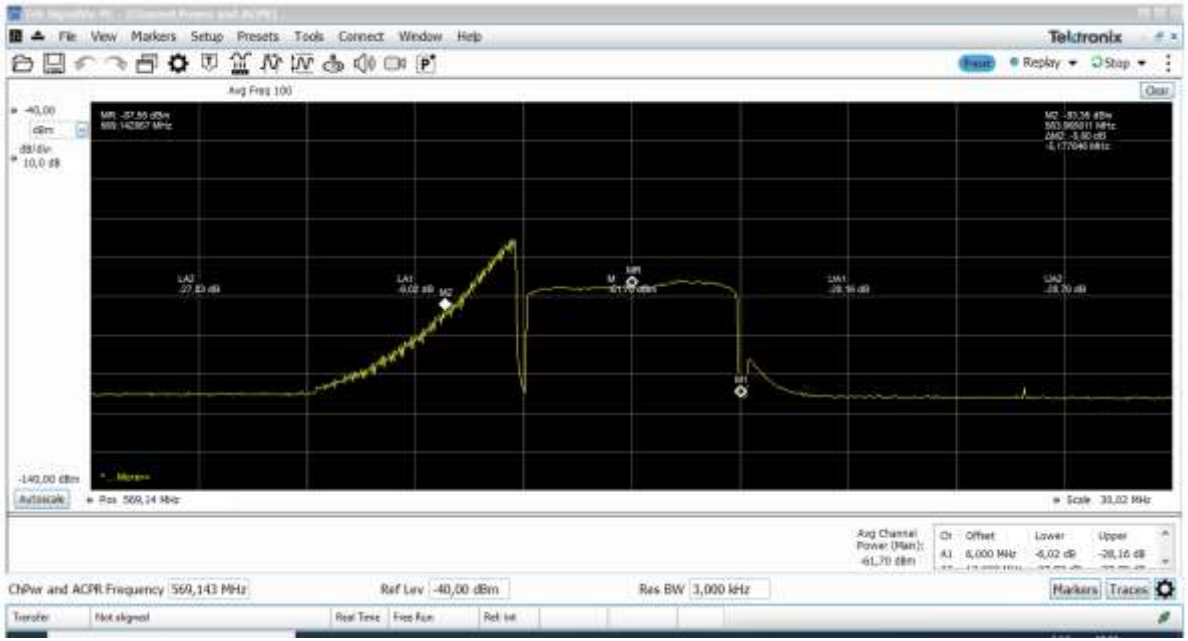


Figure 24.2 - Horizontal

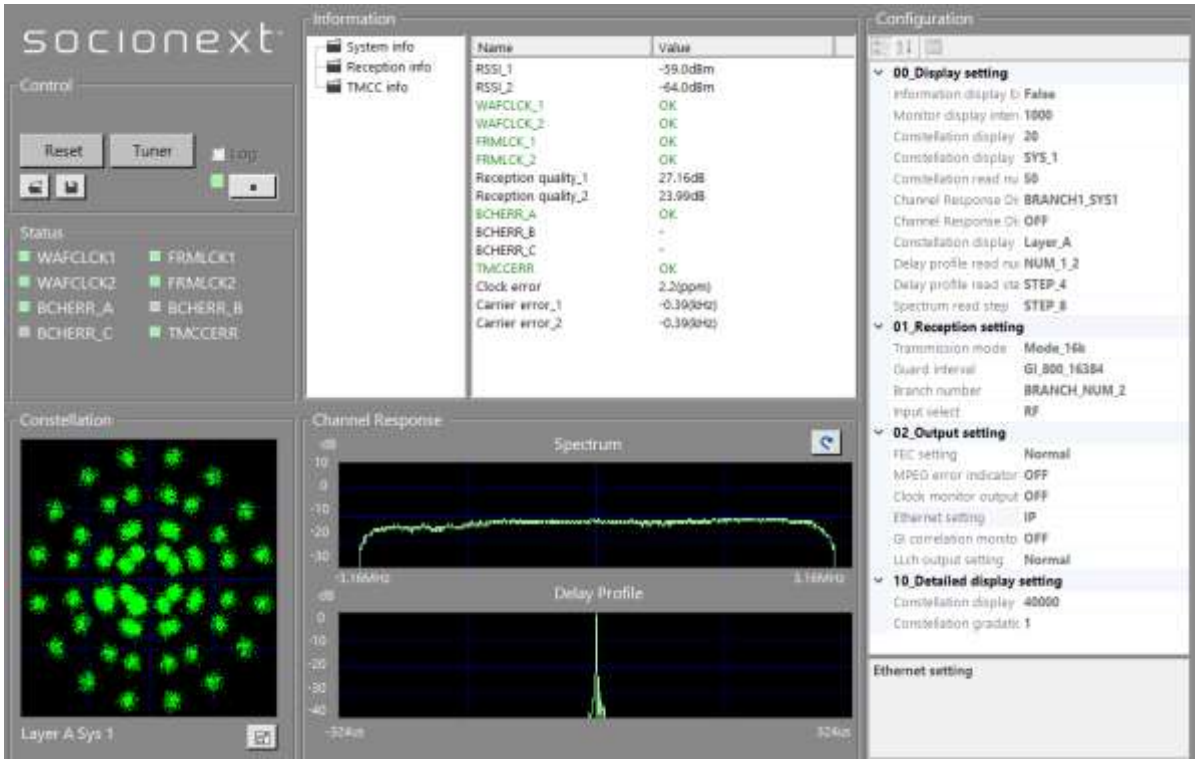


Figure 24.3 - Socionext Screen

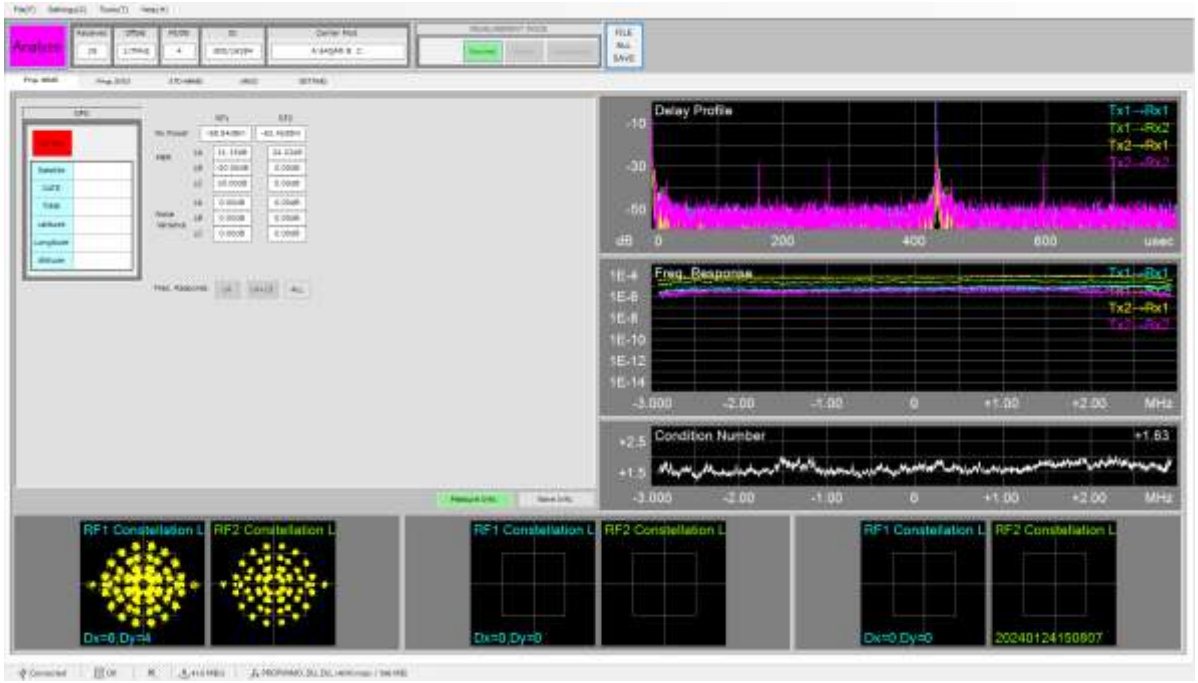


Figure 24.4 - Rintaro Screen

b) AWGN Power

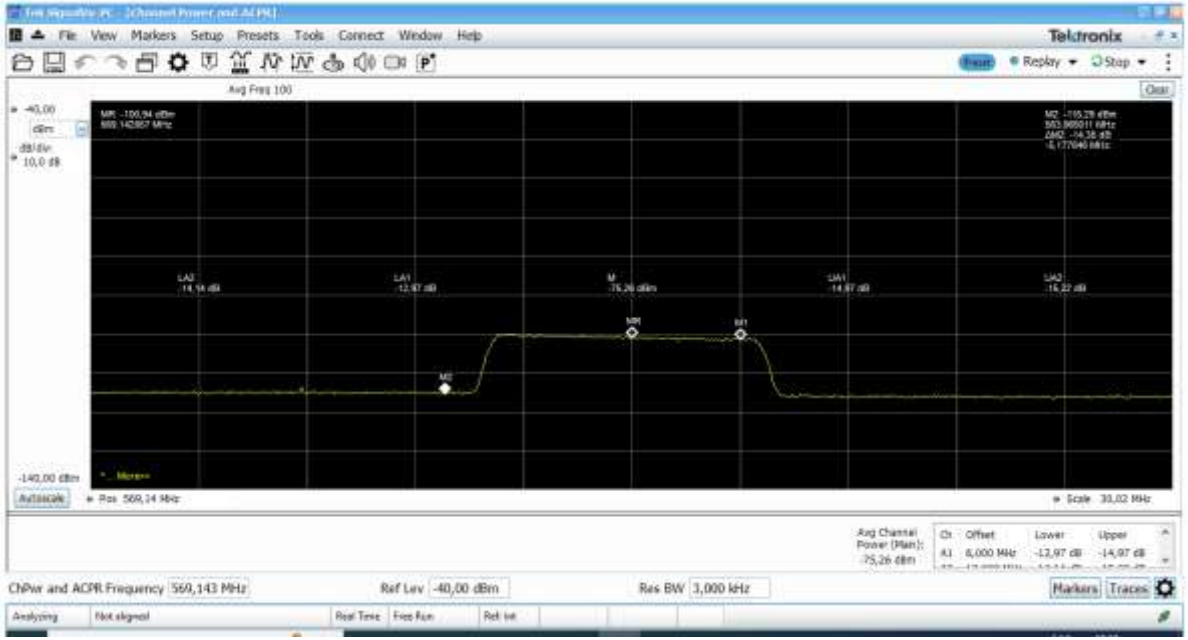


Figure 24.5 - Vertical

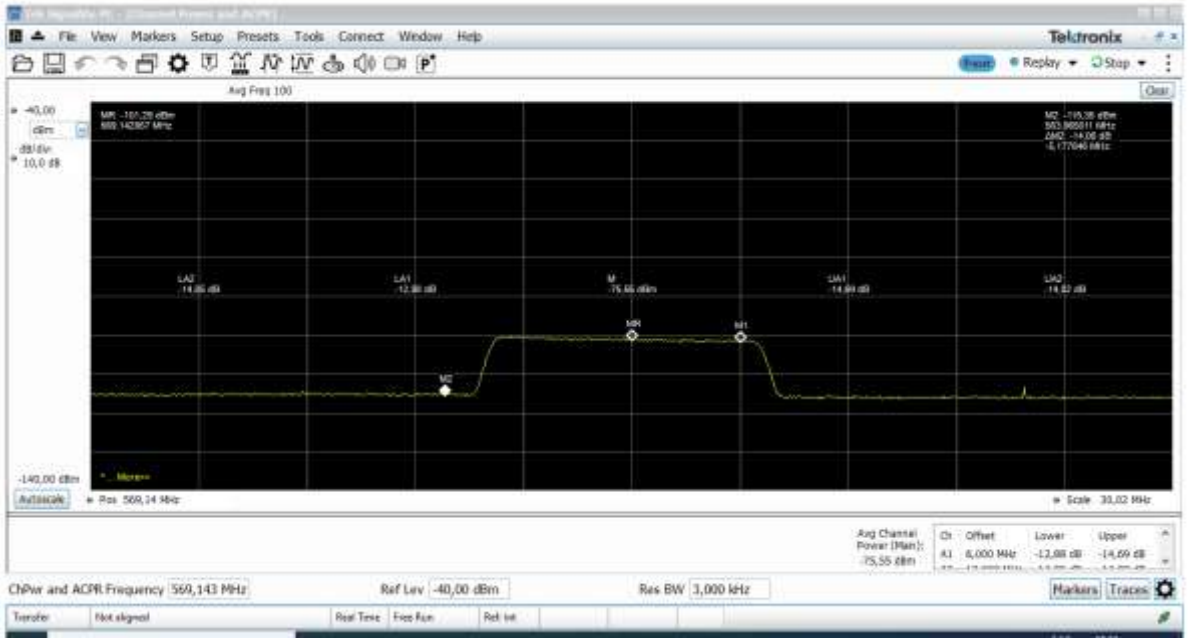


Figure 24.6 - Horizontal

c) C/N Threshold

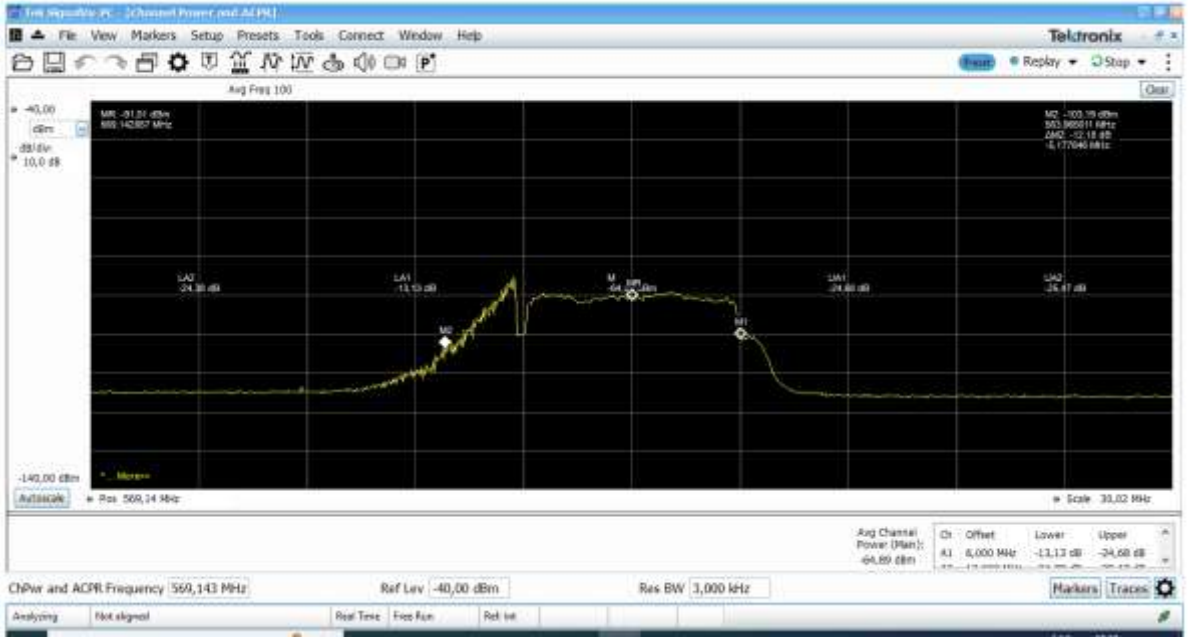


Figure 24.7 - Vertical

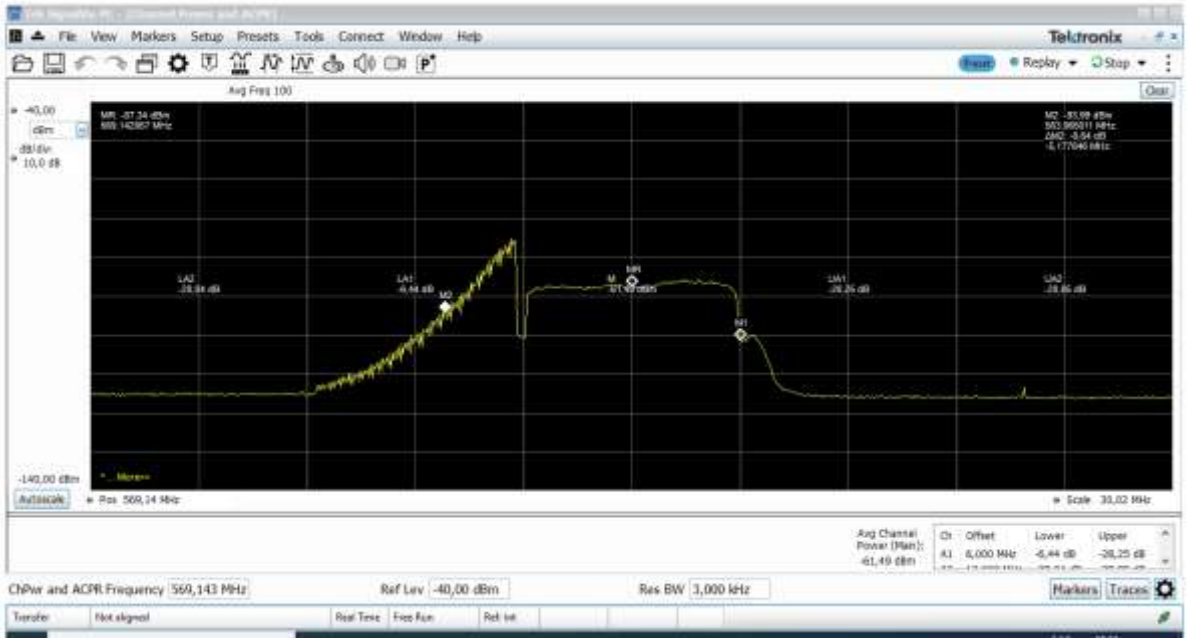


Figure 24.8 - Horizontal

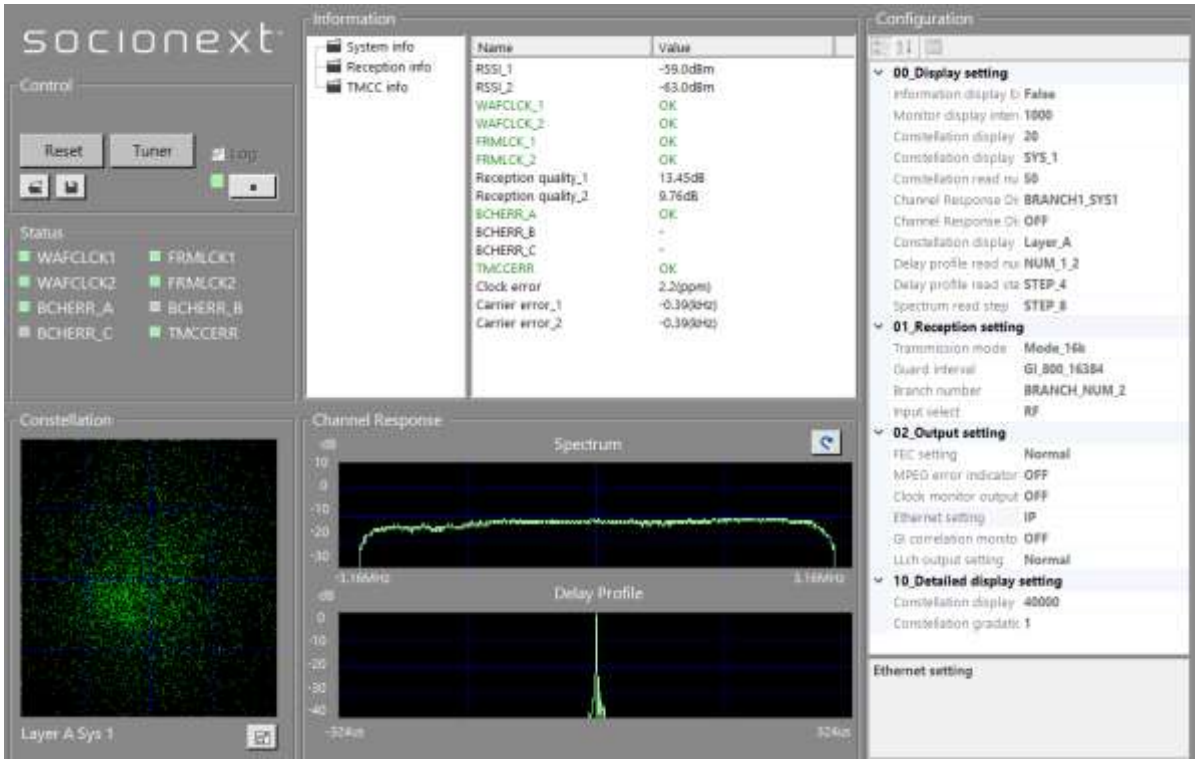


Figure 24.9 - Socionext Screen

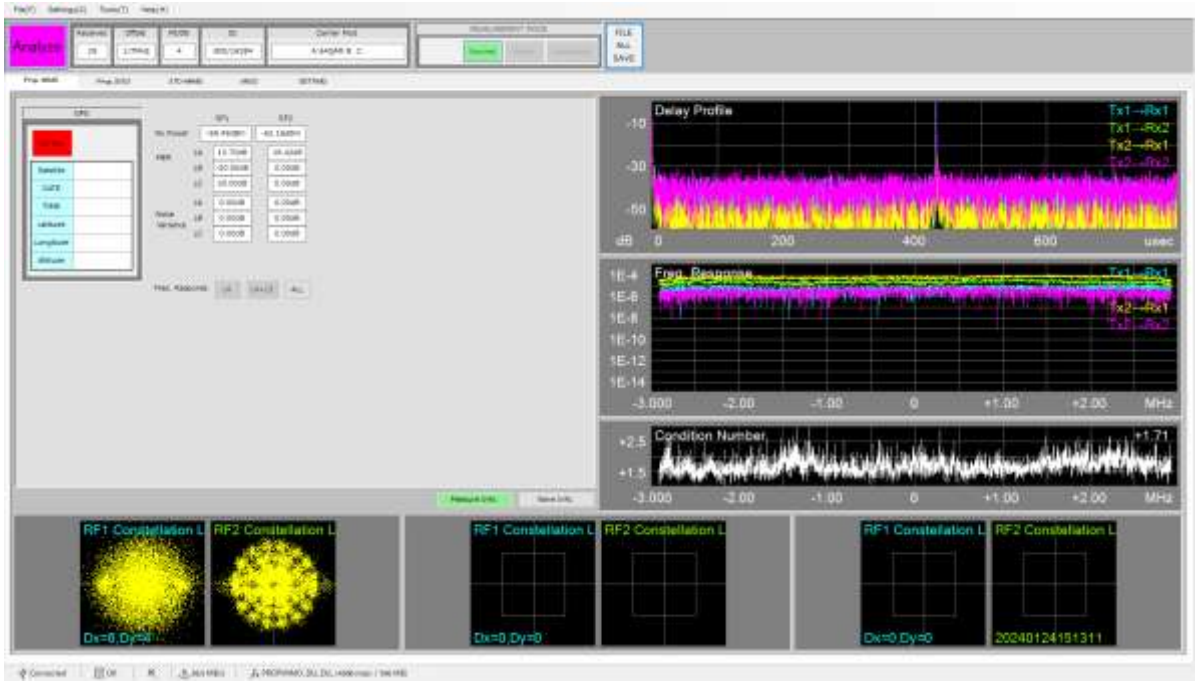


Figure 24.10 - Rintaro Screen

d) Reception Threshold

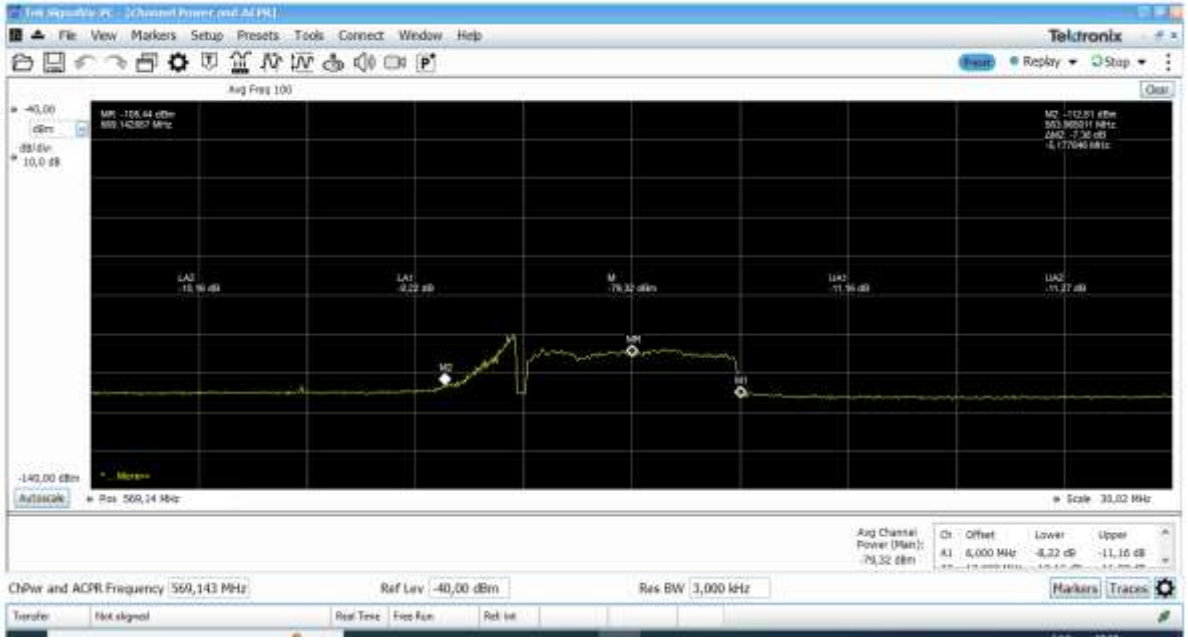


Figure 24.11 - Vertical

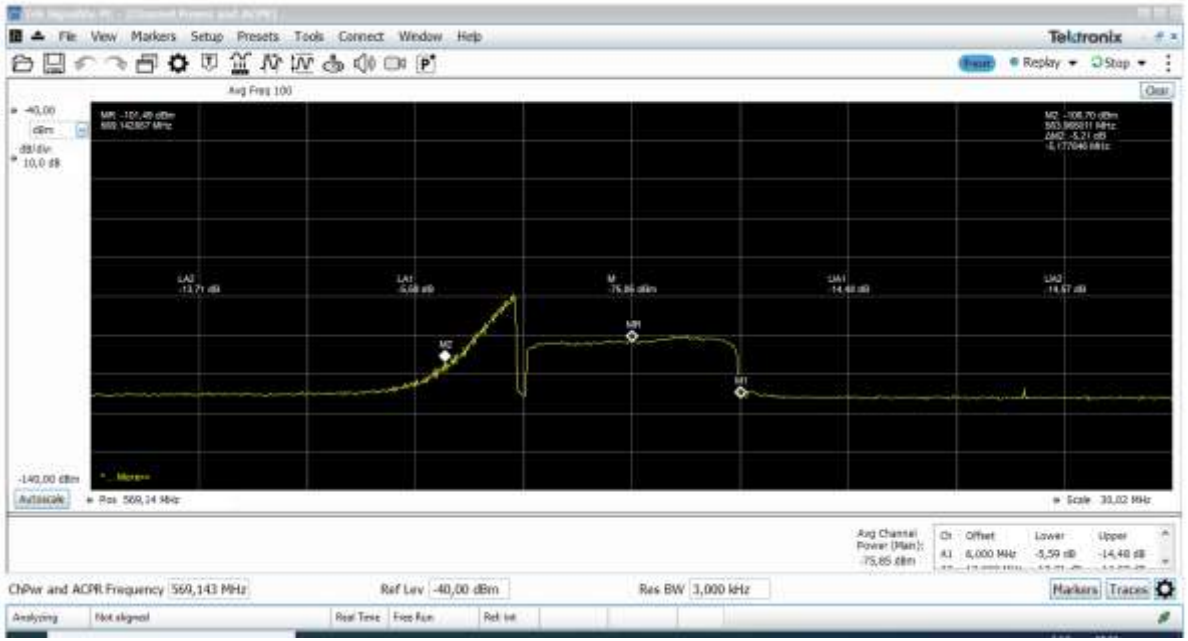


Figure 24.12 - Horizontal

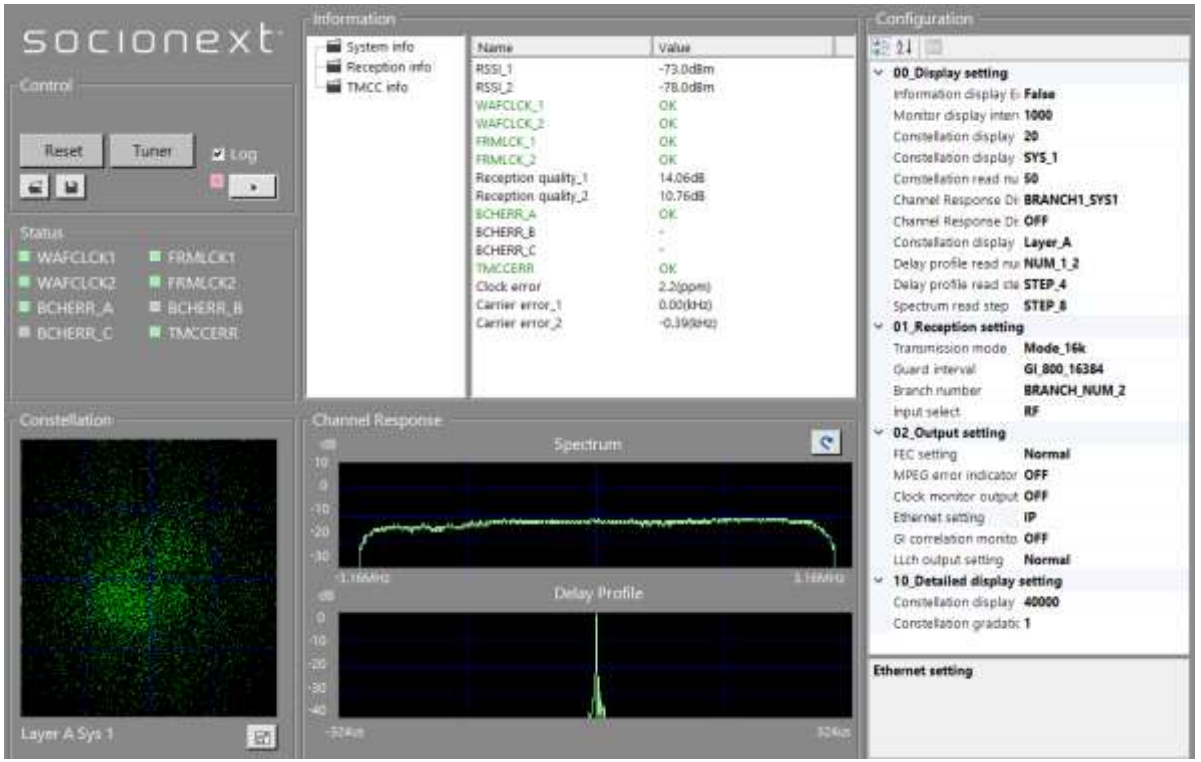


Figure 24.13 - Socionext Screen

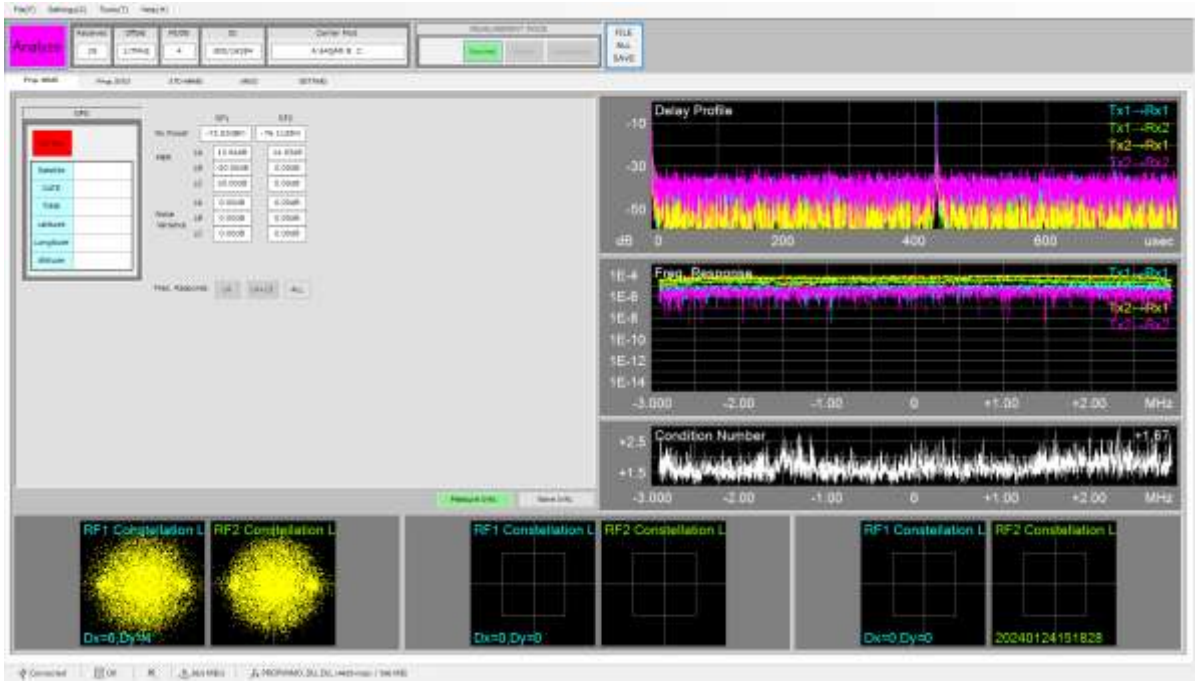


Figure 24.14 - Rintaro Screen

Chapter 25. Site 25

a) Channel Power

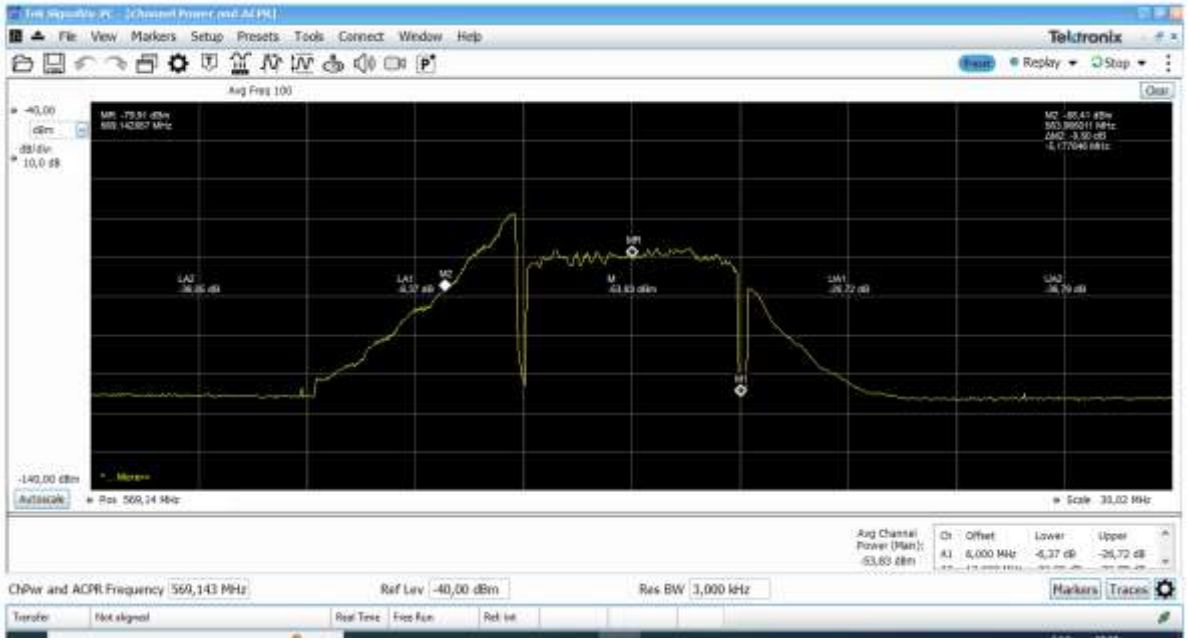


Figure 25.1 - Vertical

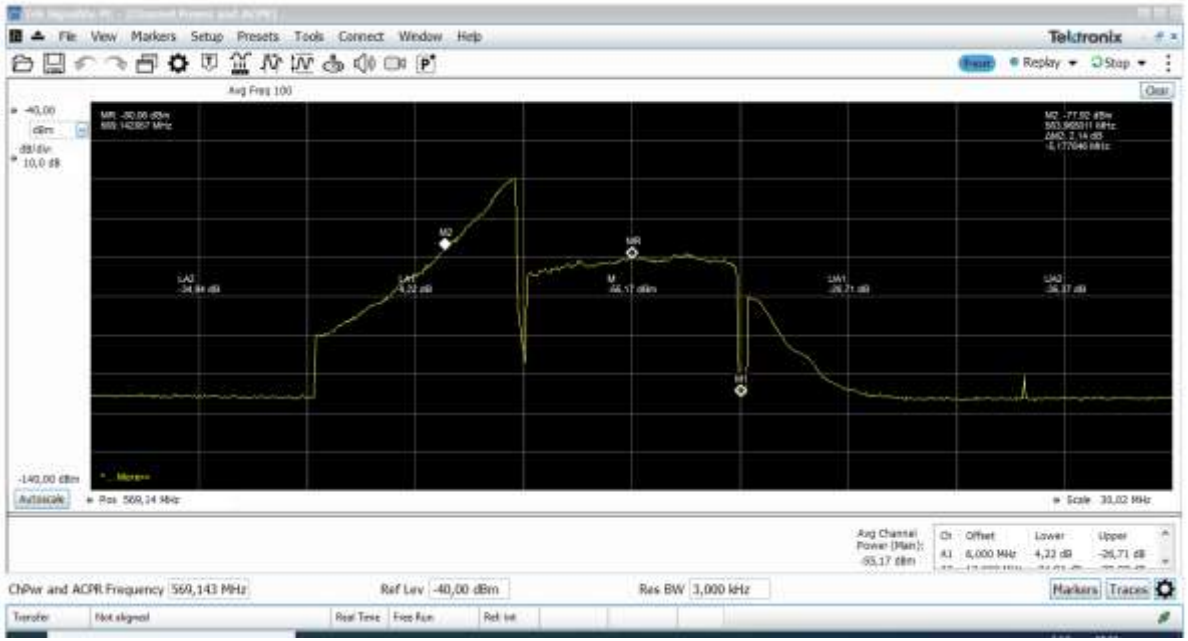


Figure 25.2 - Horizontal

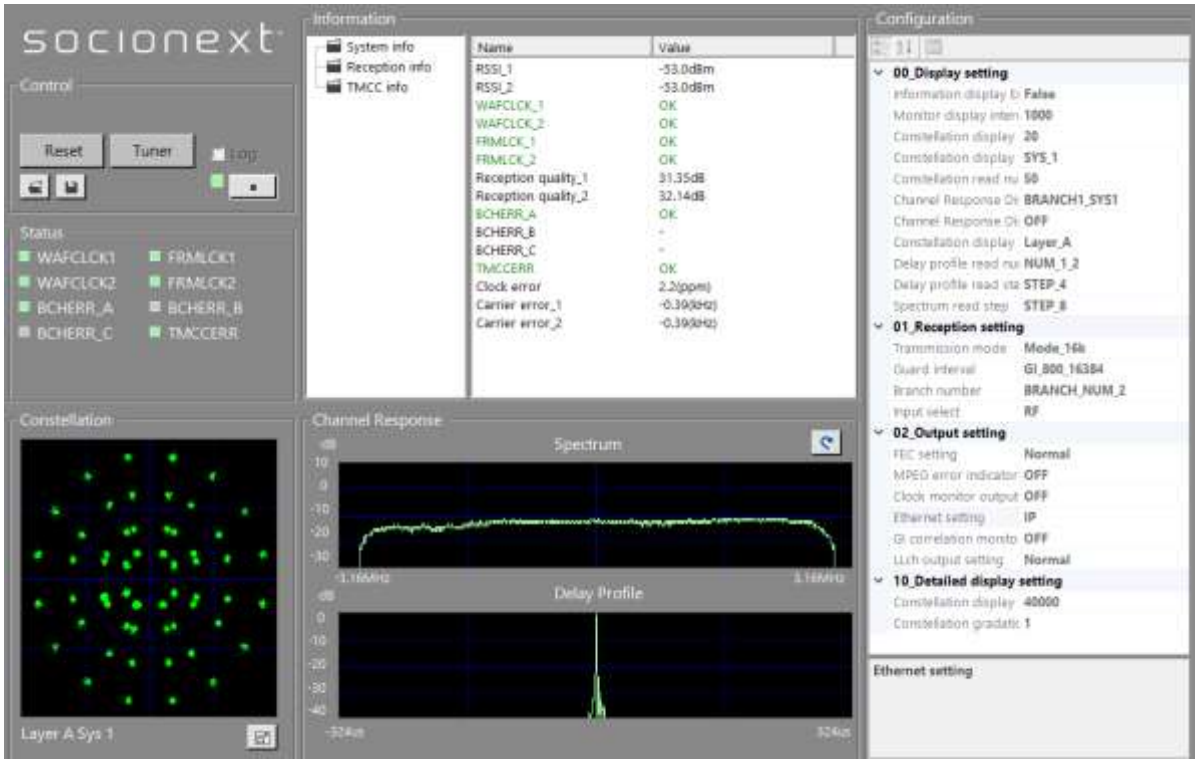


Figure 25.3 - Socionext Screen

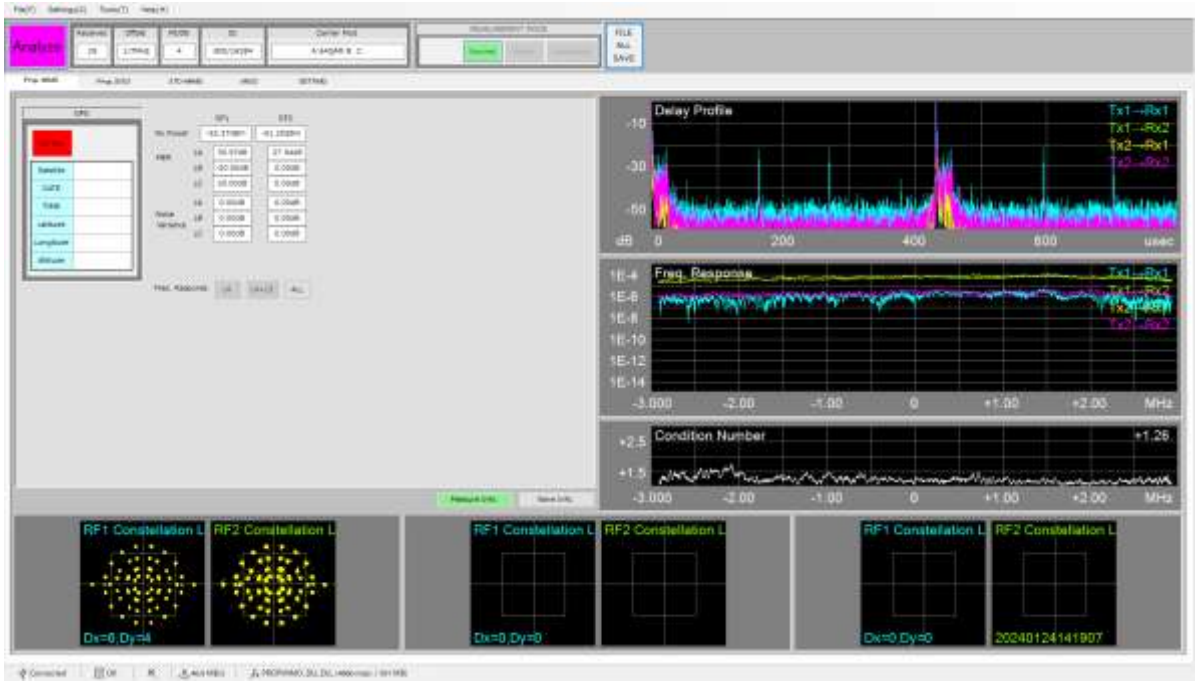


Figure 25.4 - Rintaro Screen

b) AWGN Power

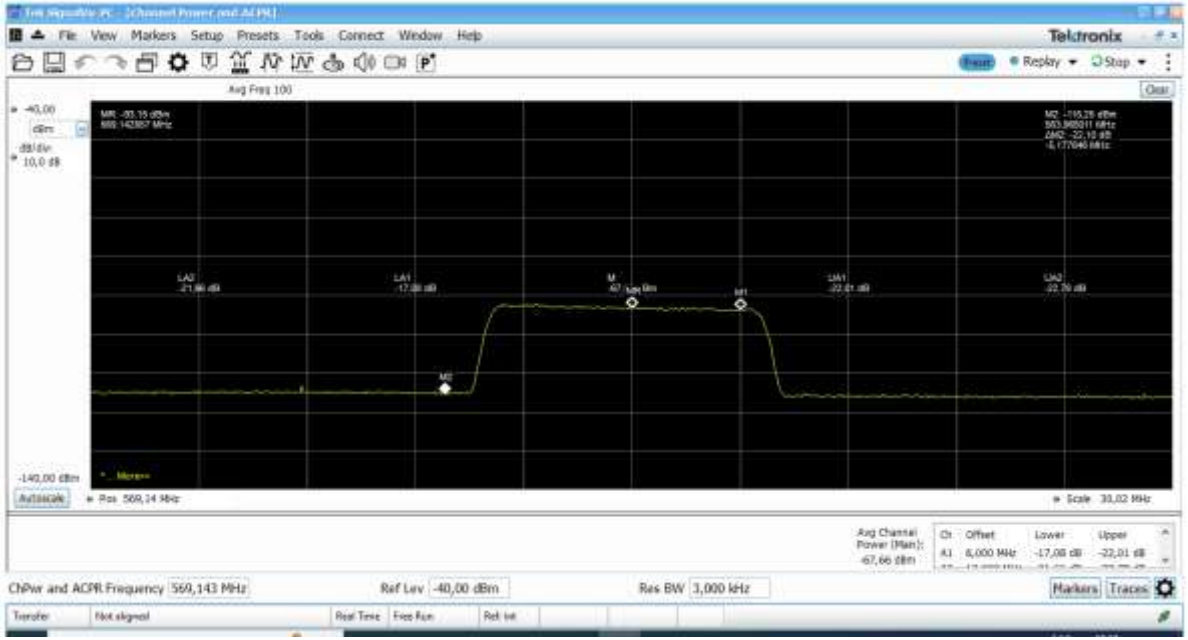


Figure 25.5 - Vertical

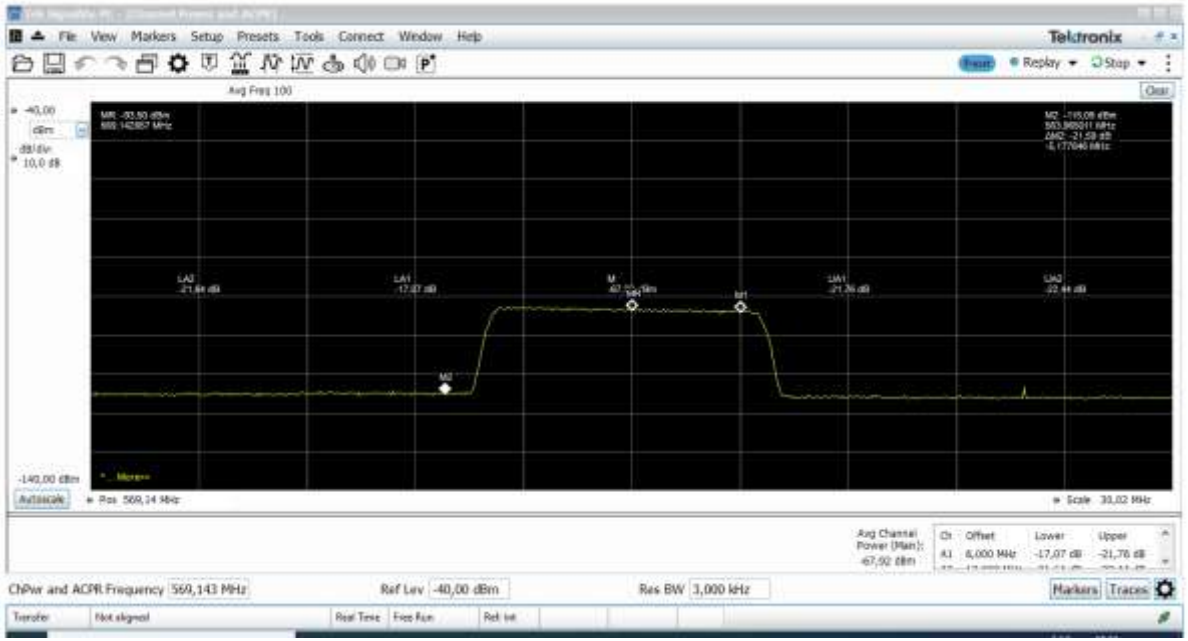


Figure 25.6 - Horizontal

c) C/N Threshold

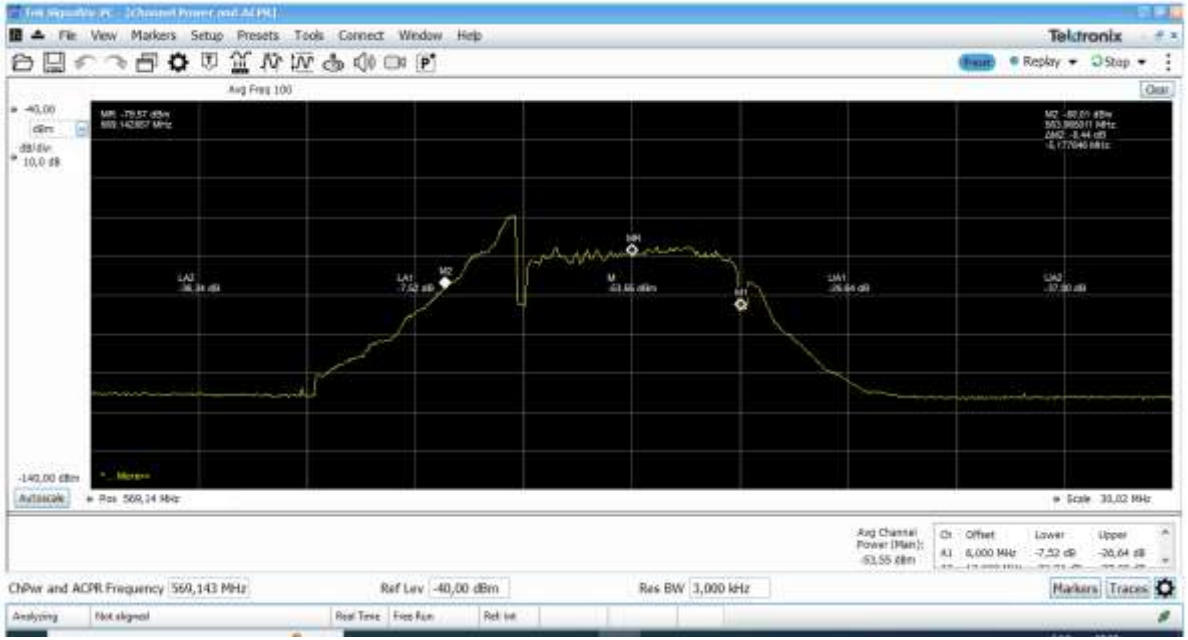


Figure 25.7 - Vertical

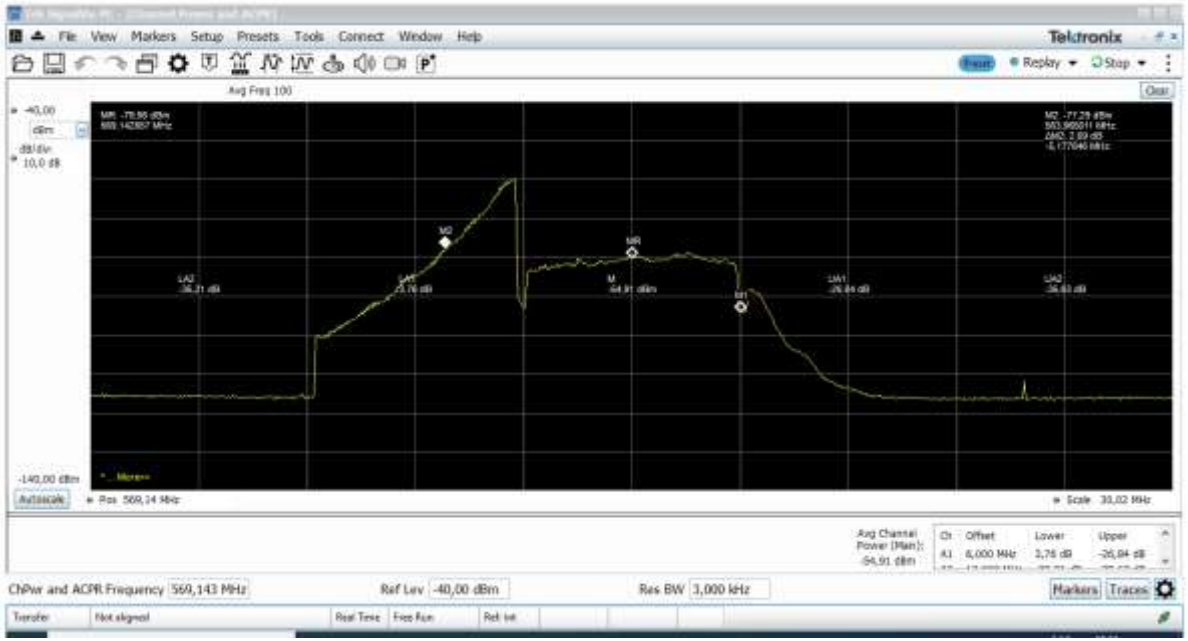


Figure 25.8 - Horizontal

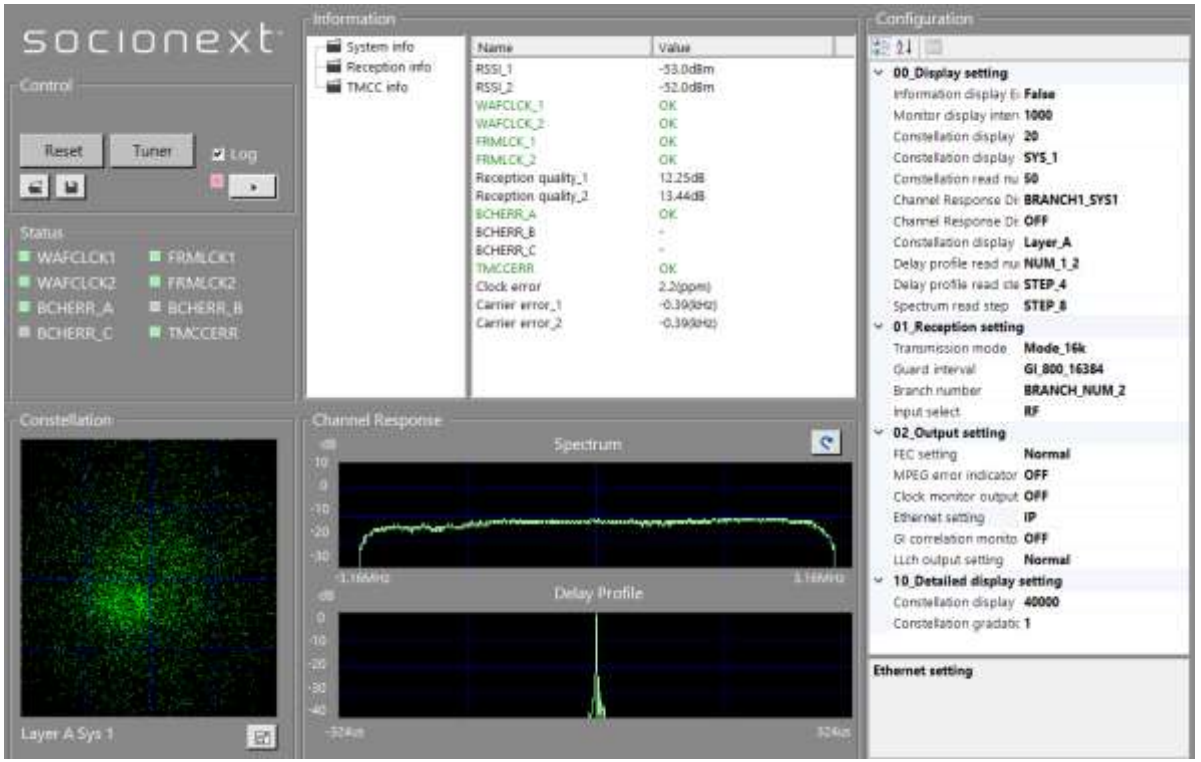


Figure 25.9 - Socionext Screen

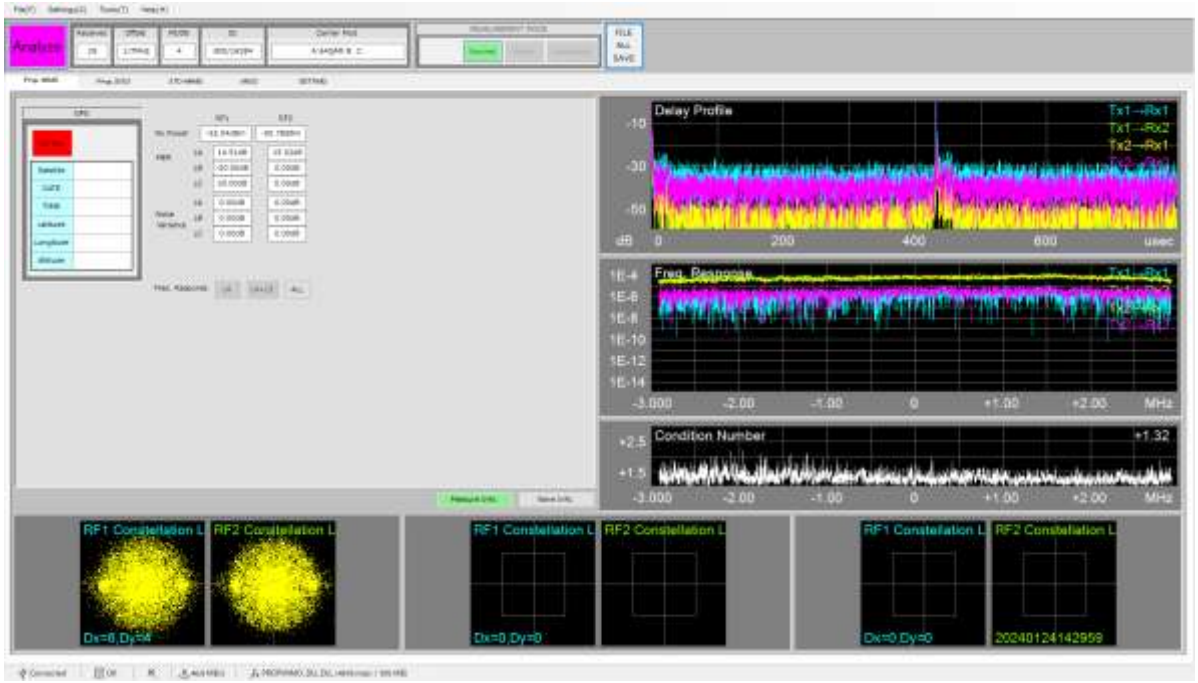


Figure 25.10 - Rintaro Screen

d) Reception Threshold

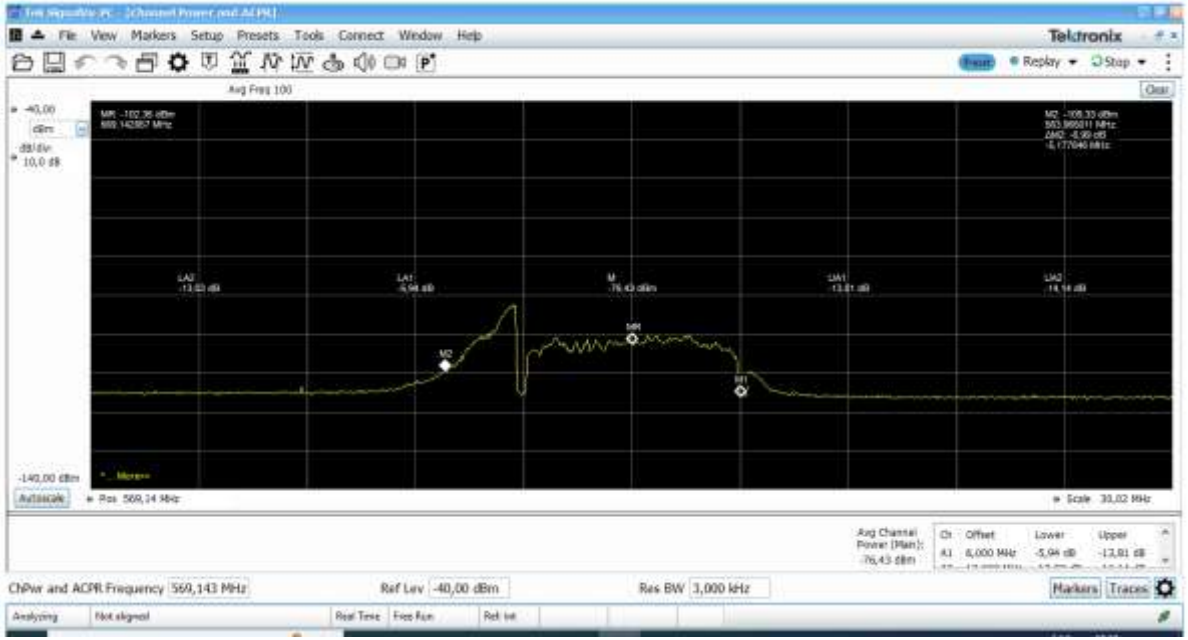


Figure 25.11 - Vertical

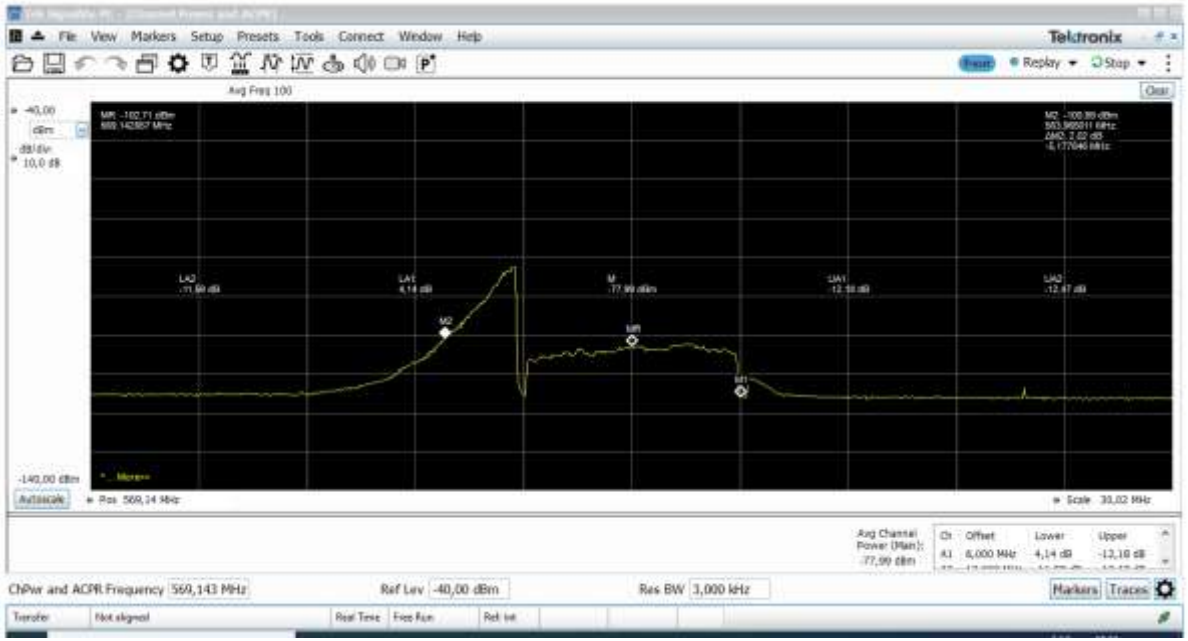


Figure 25.12 - Horizontal

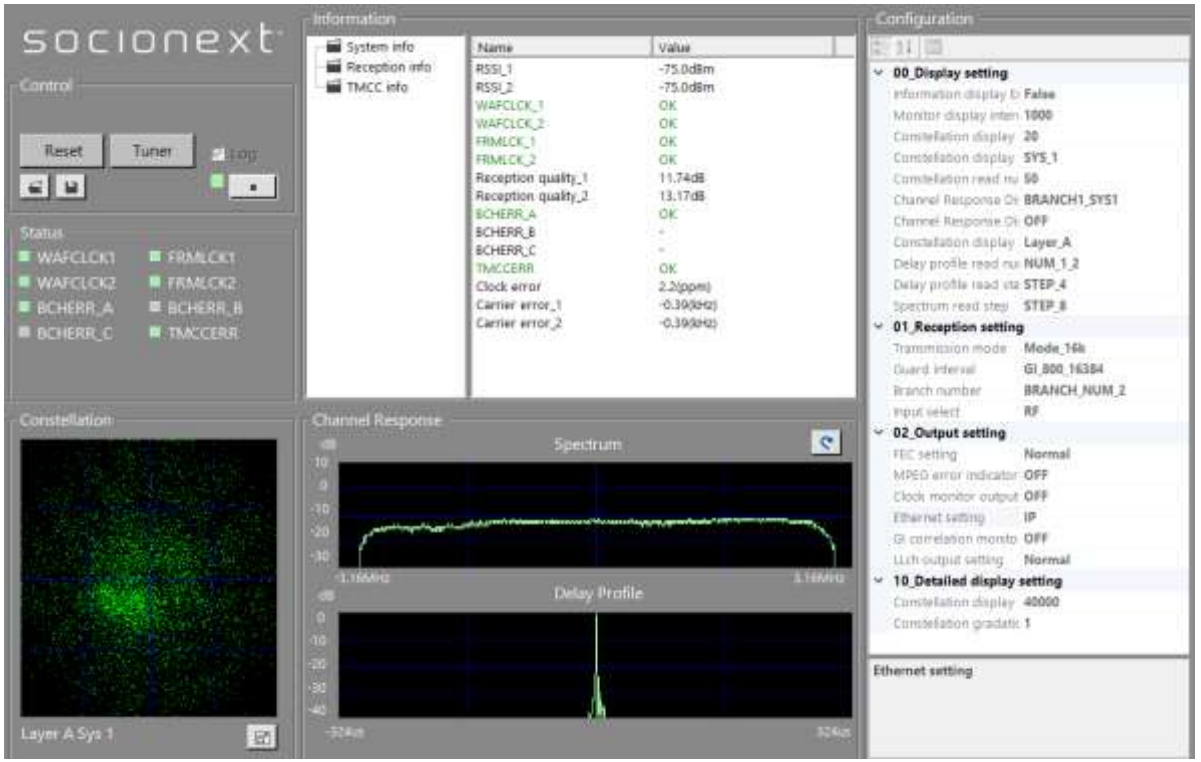


Figure 25.13 - Socionext Screen

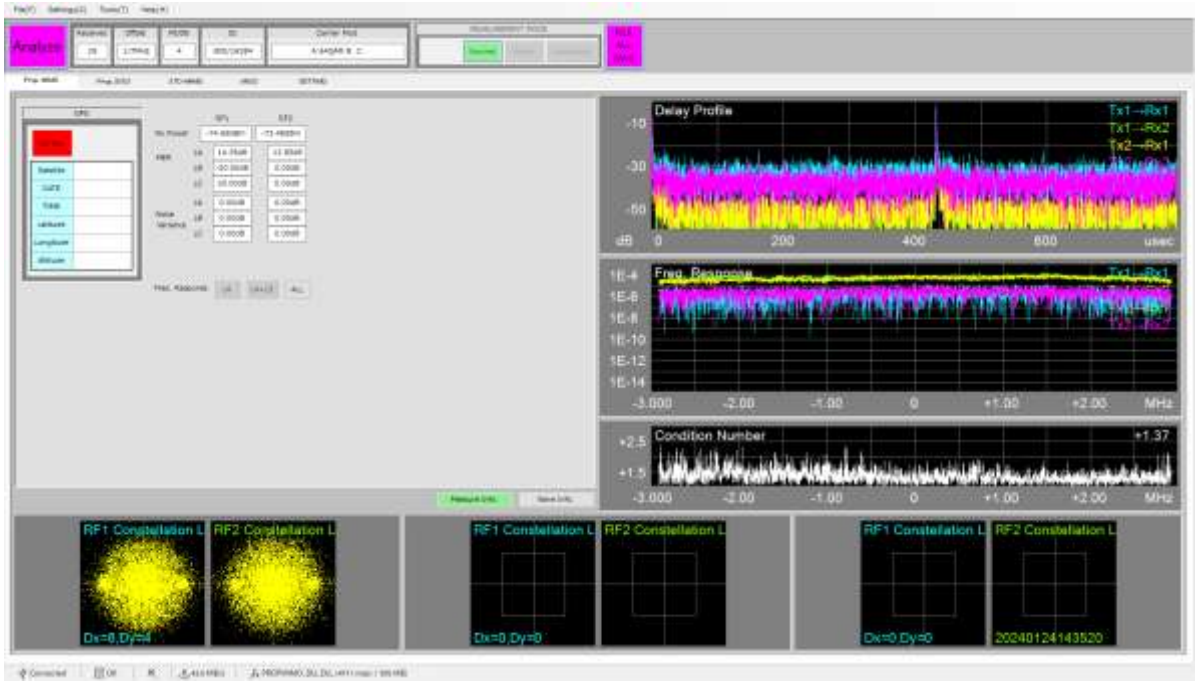


Figure 25.14 - Rintaro Screen

Chapter 26. Site 26

a) Channel Power

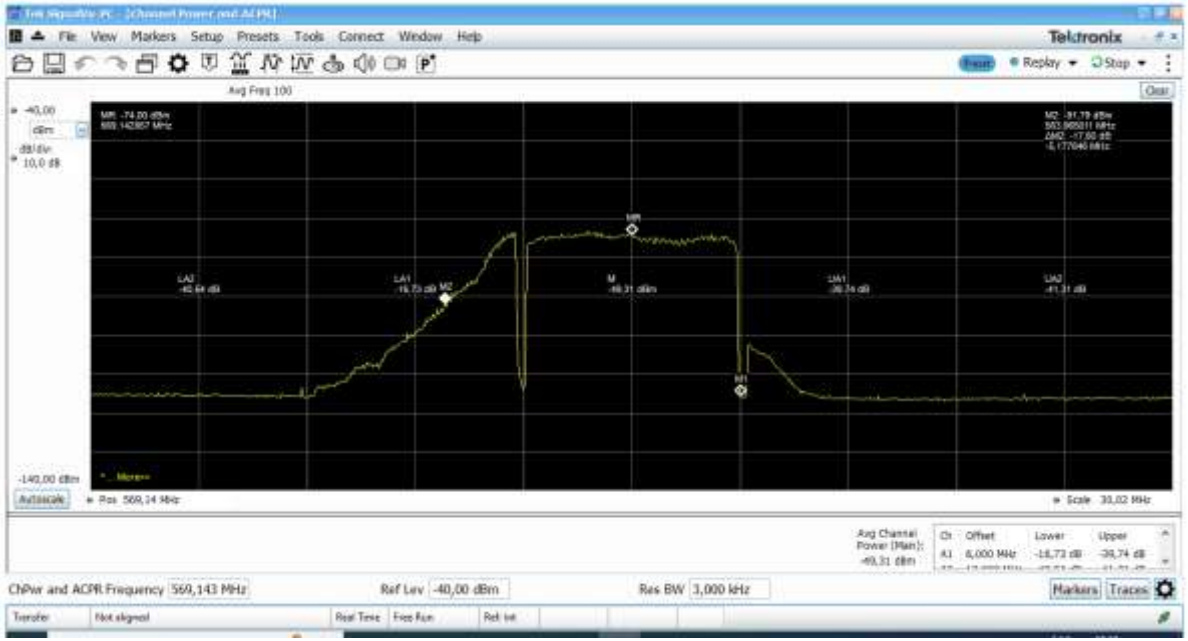


Figure 26.1 - Vertical

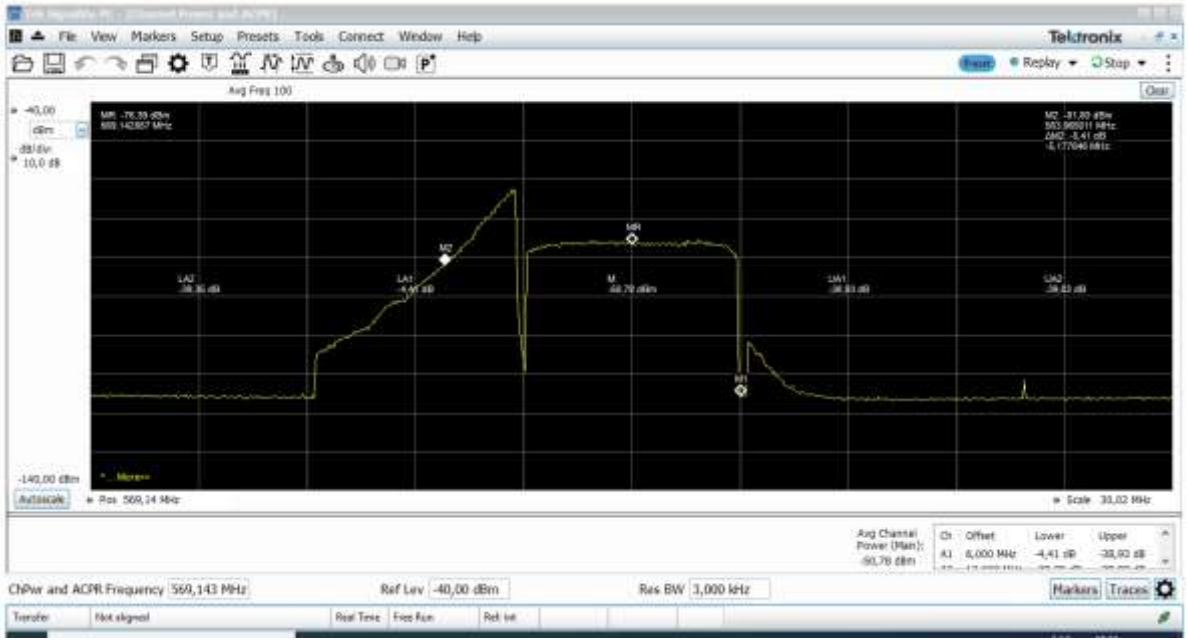


Figure 26.2 - Horizontal

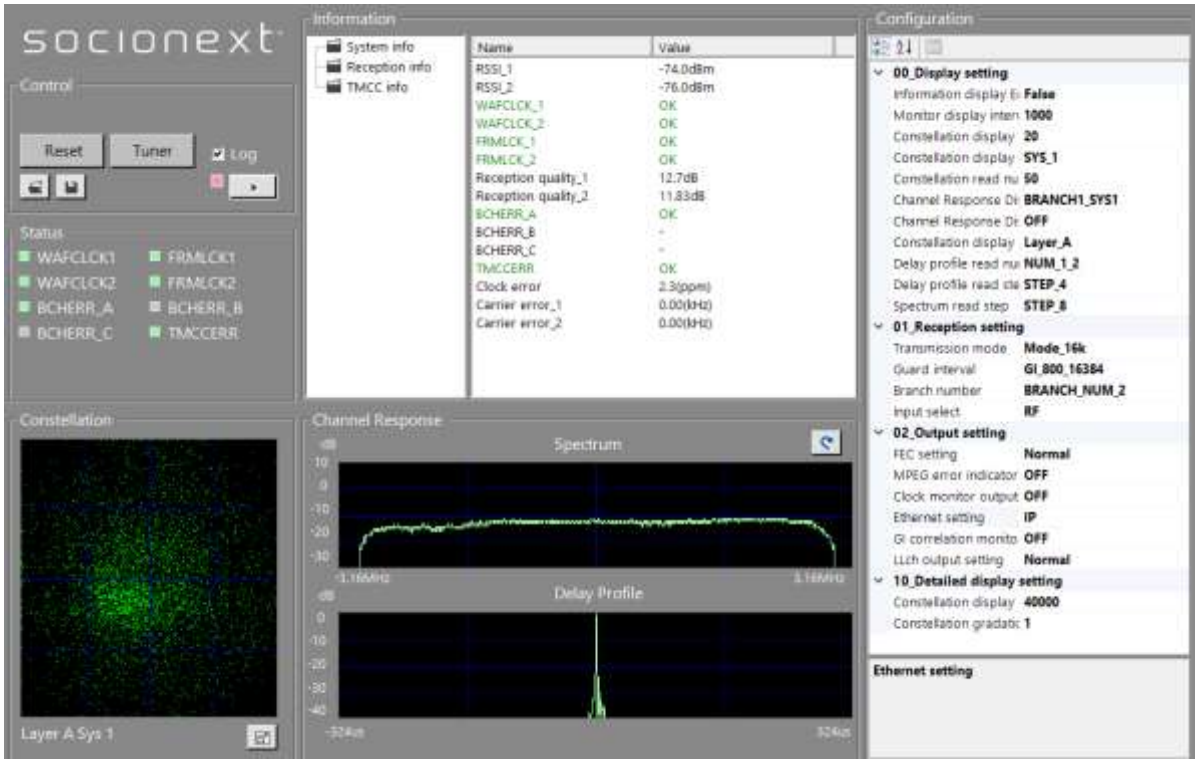


Figure 26.3 - Socionext Screen

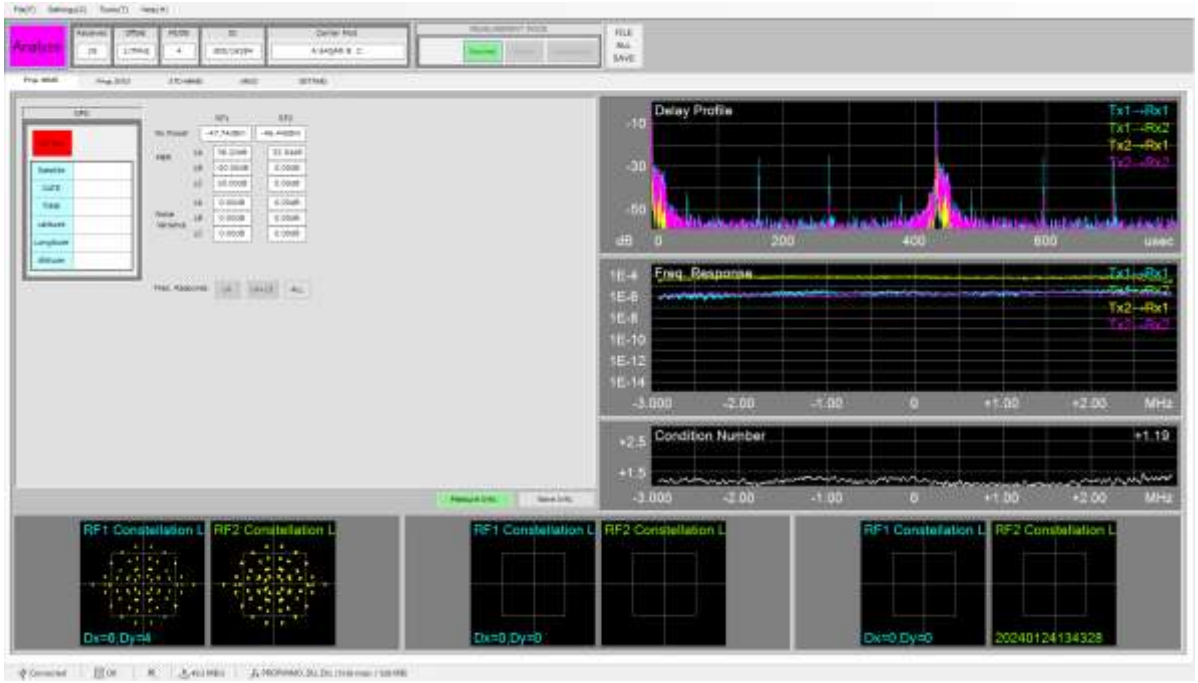


Figure 26.4 - Rintaro Screen

b) AWGN Power

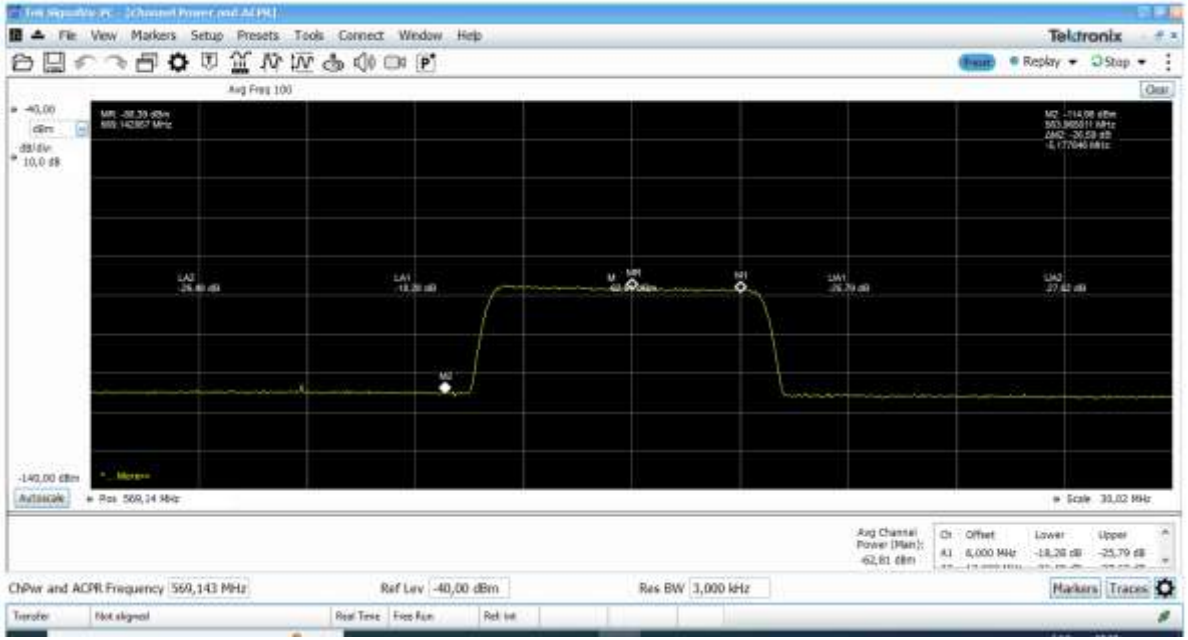


Figure 26.5 - Vertical

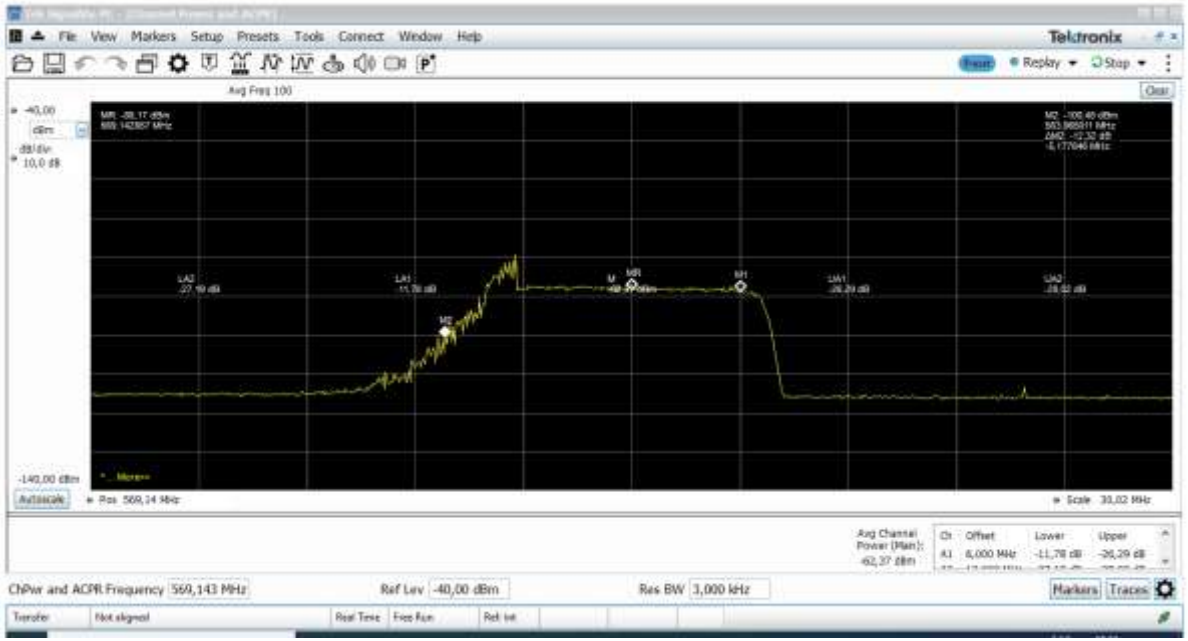


Figure 26.6 - Horizontal

c) C/N Threshold

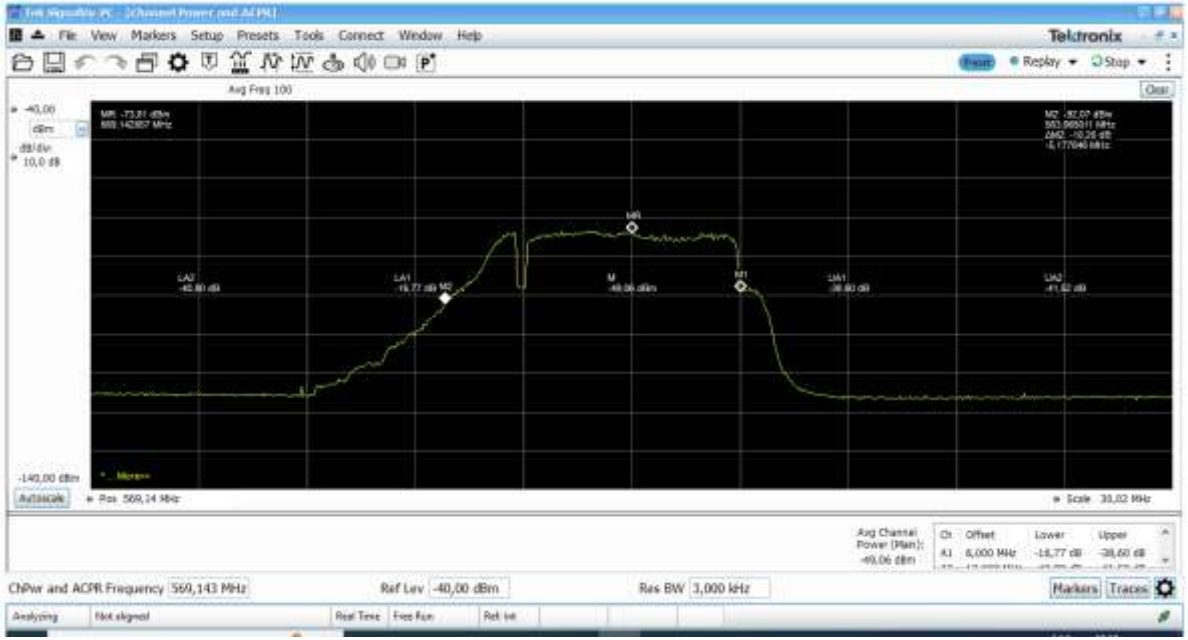


Figure 26.7 - Vertical

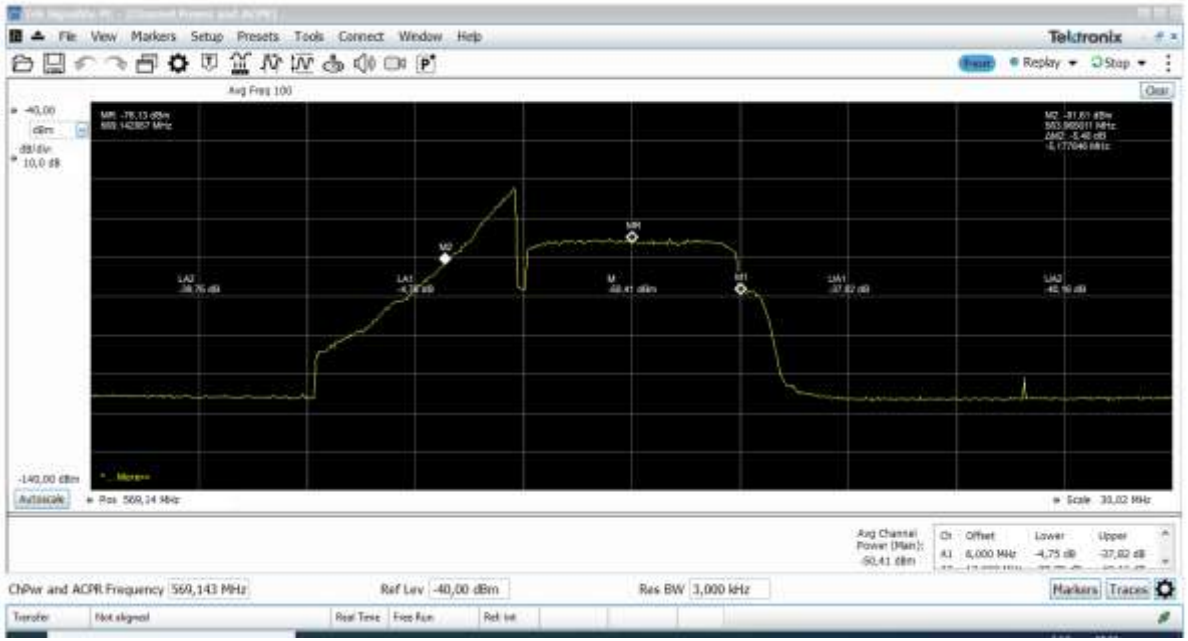


Figure 26.8 - Horizontal

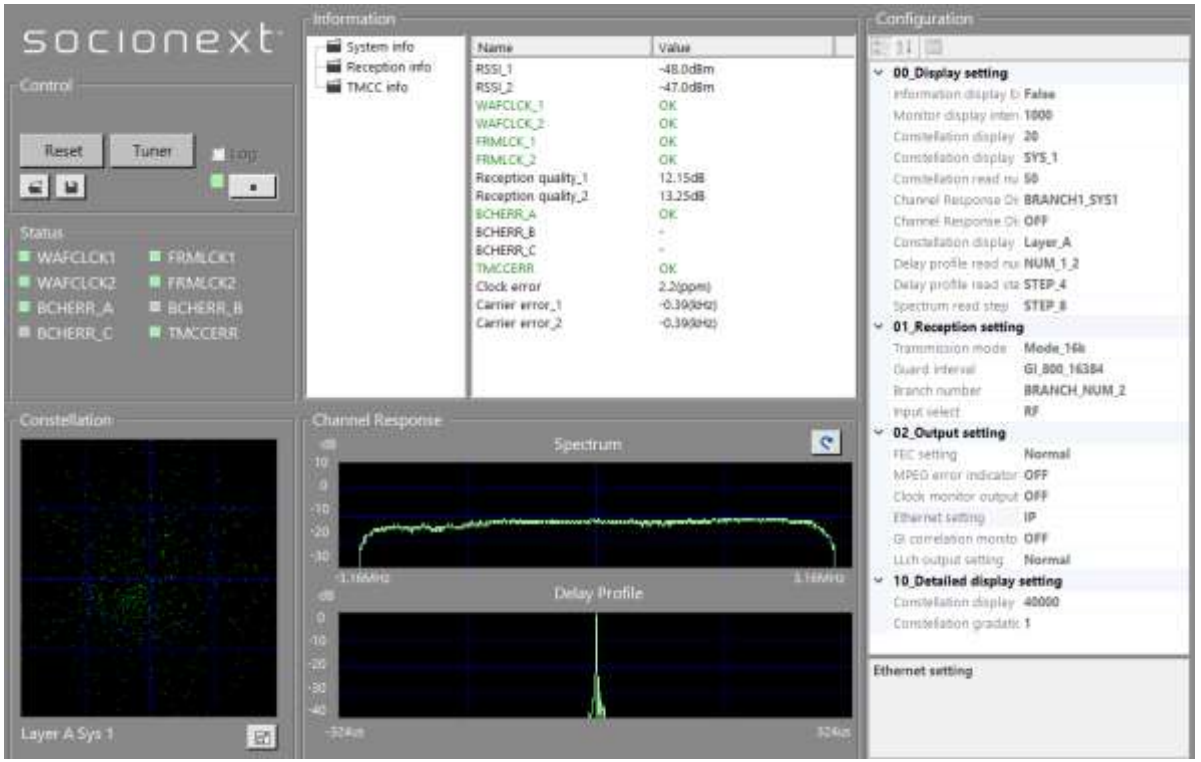


Figure 26.9 - Socionext Screen

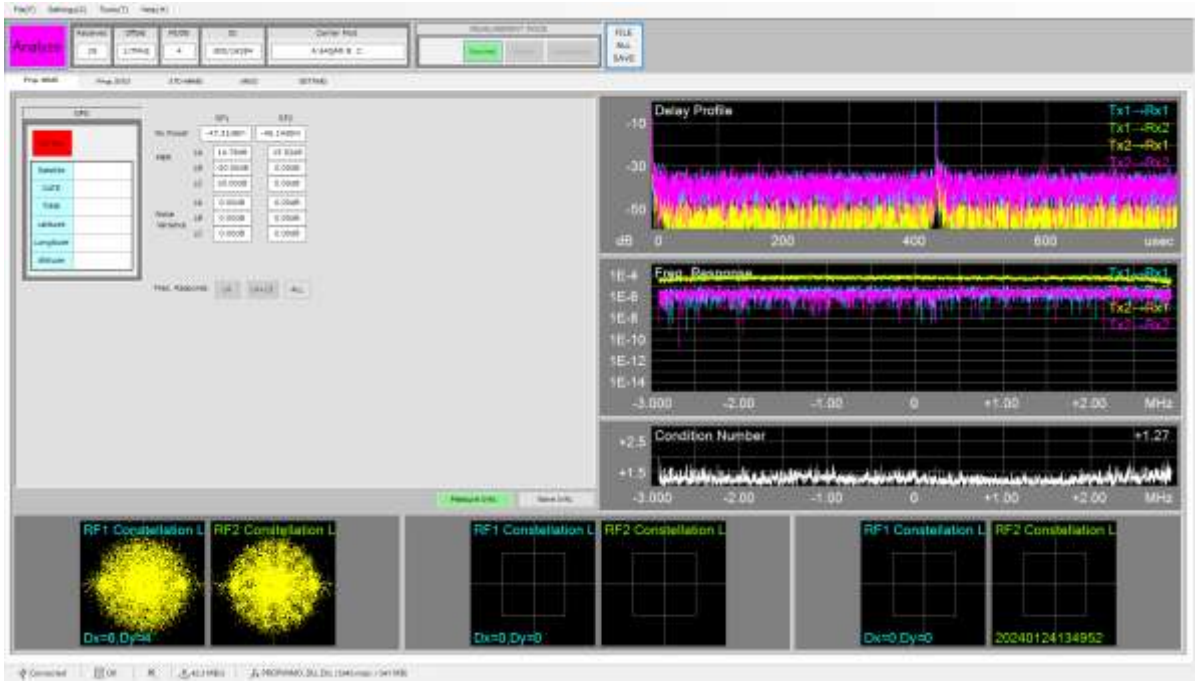


Figure 26.10 - Rintaro Screen

d) Reception Threshold

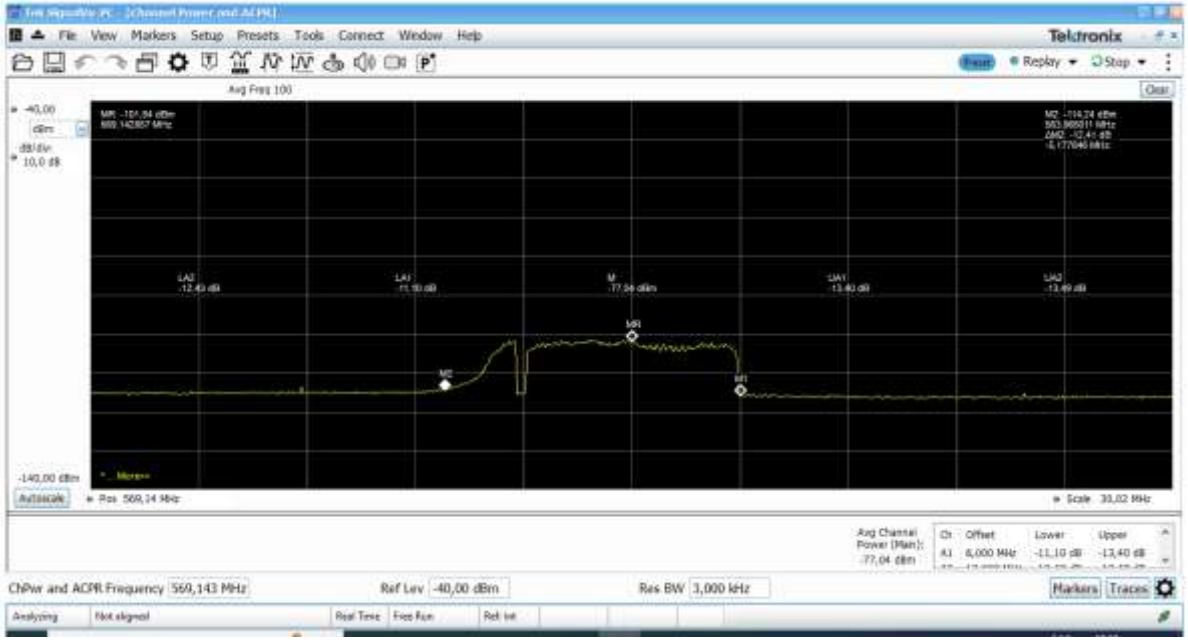


Figure 26.11 - Vertical

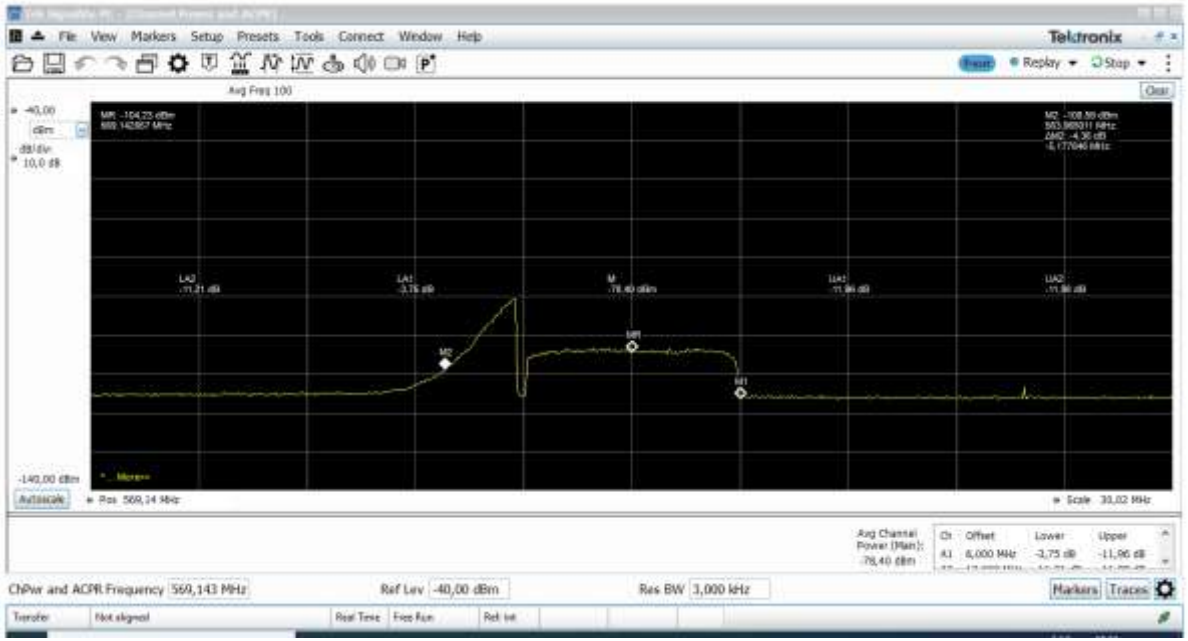


Figure 26.12 - Horizontal

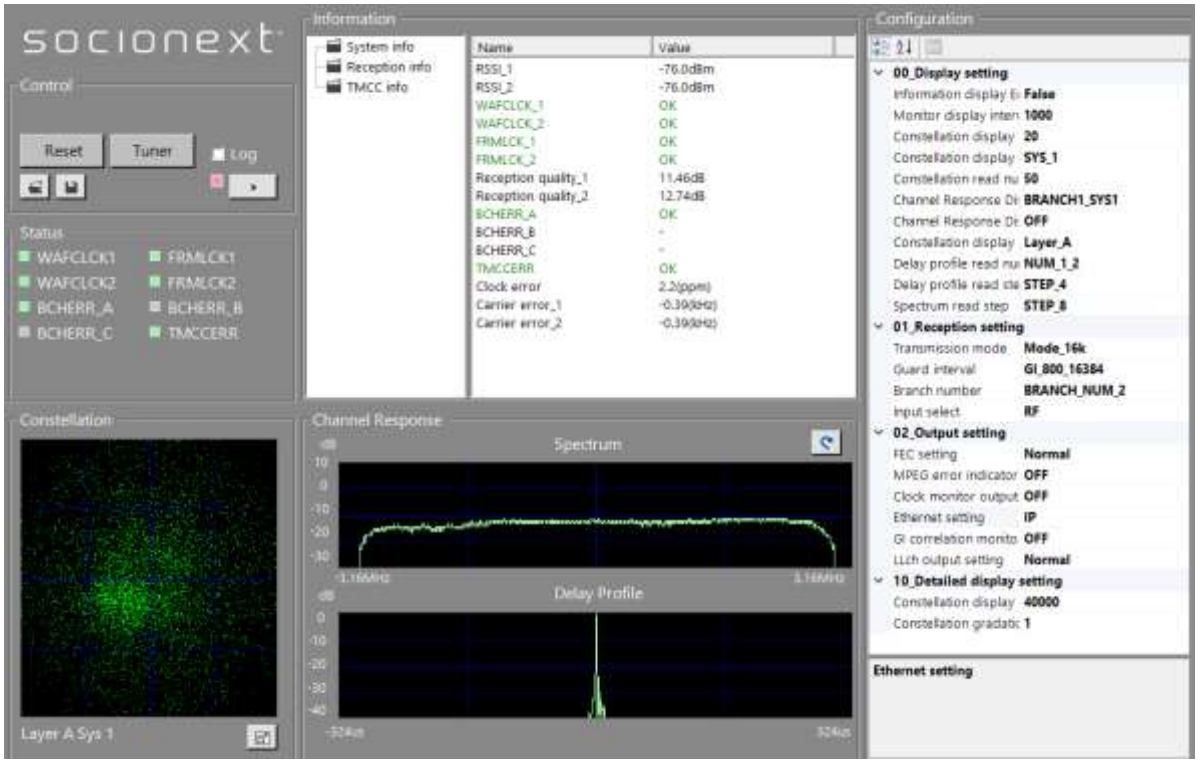


Figure 26.13 - Socionext Screen

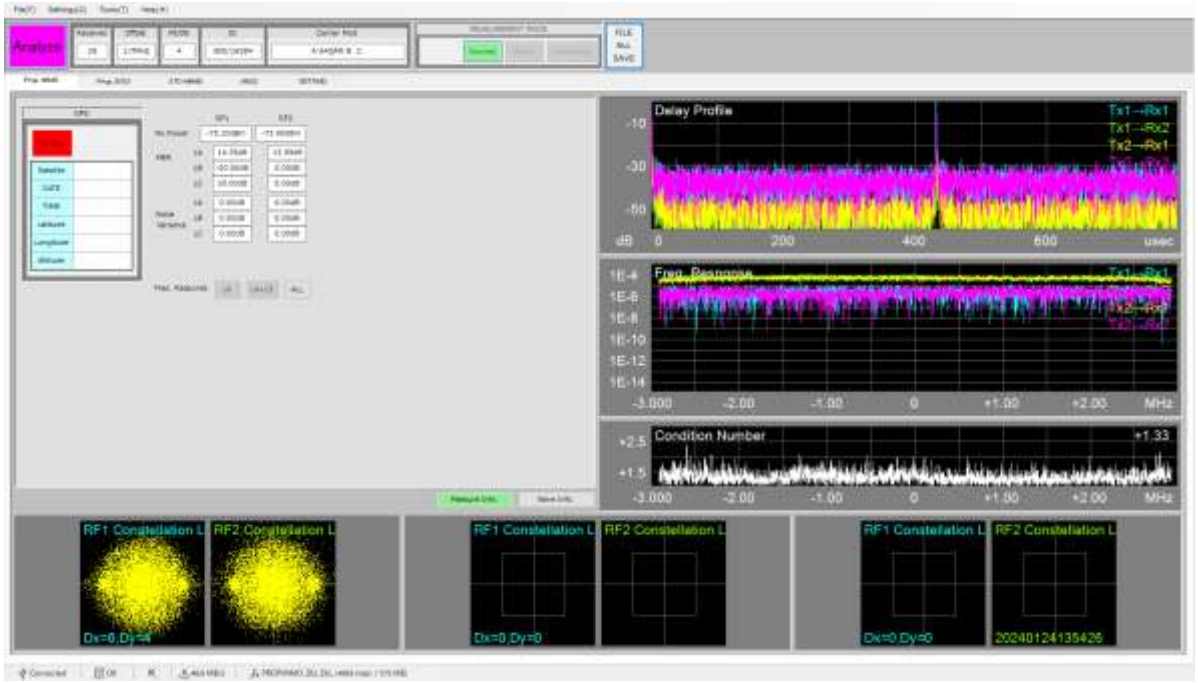


Figure 26.14 - Rintaro Screen

Chapter 27. Site 27

a) Channel Power

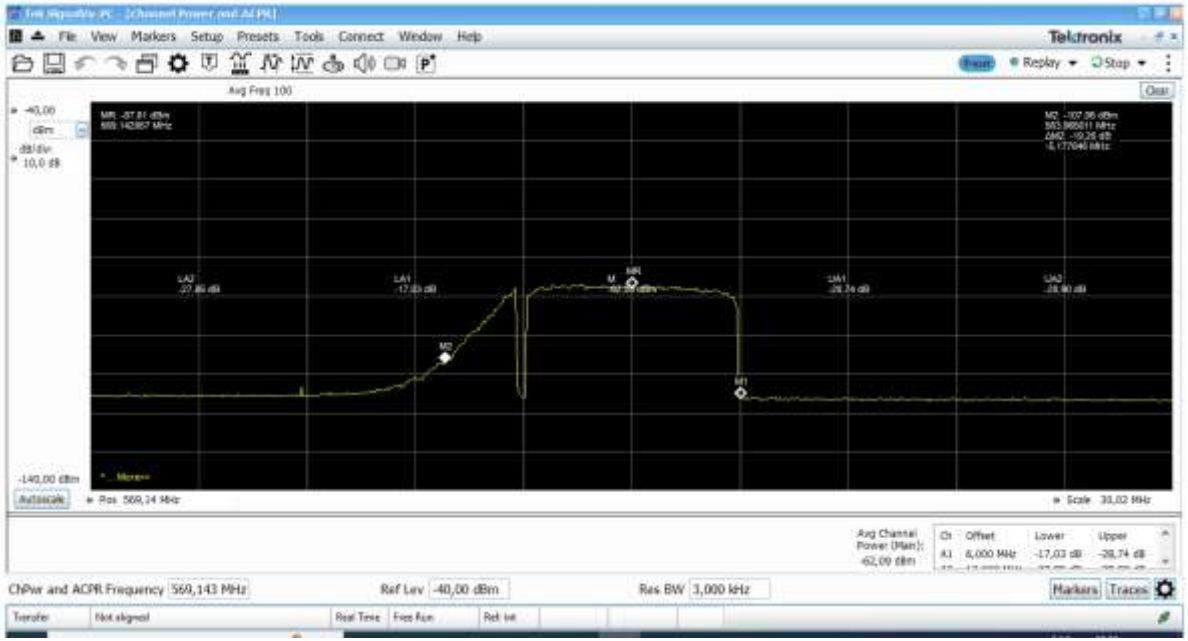


Figure 27.1 - Vertical

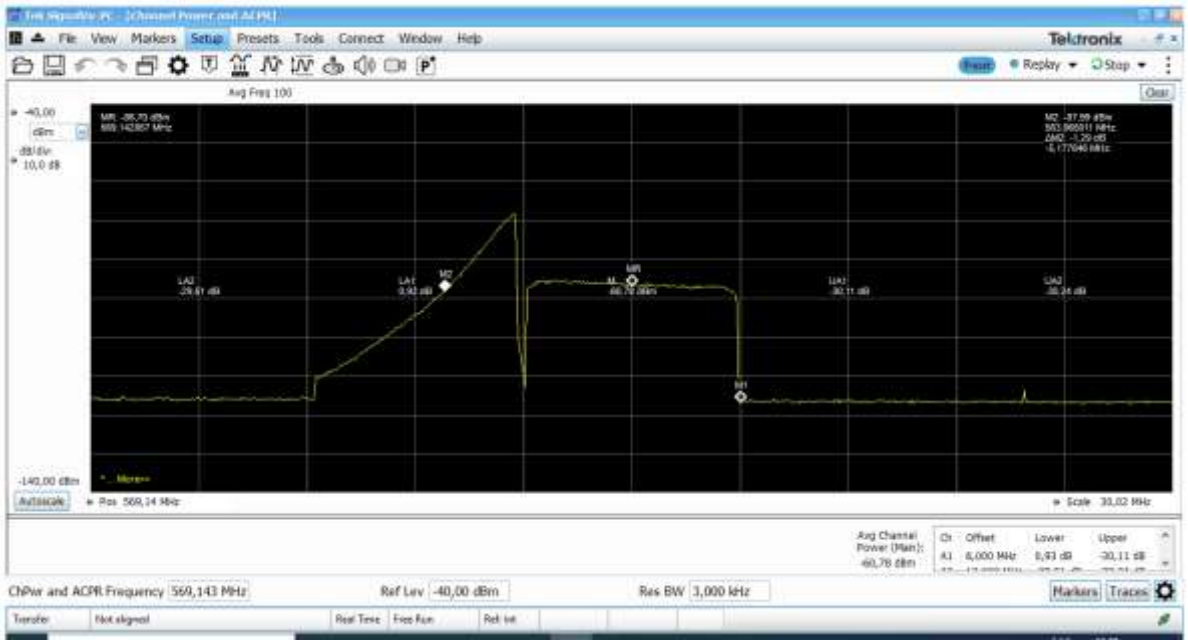


Figure 27.2 - Horizontal

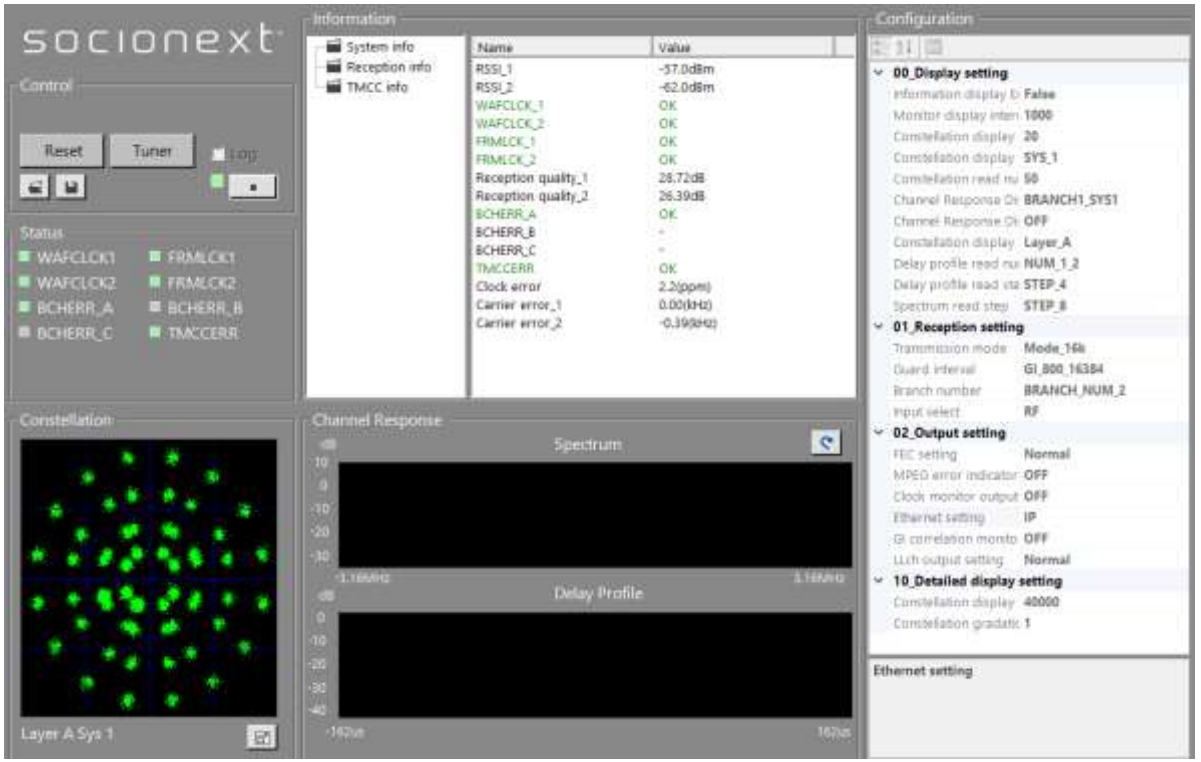


Figure 27.3 - Socionext Screen

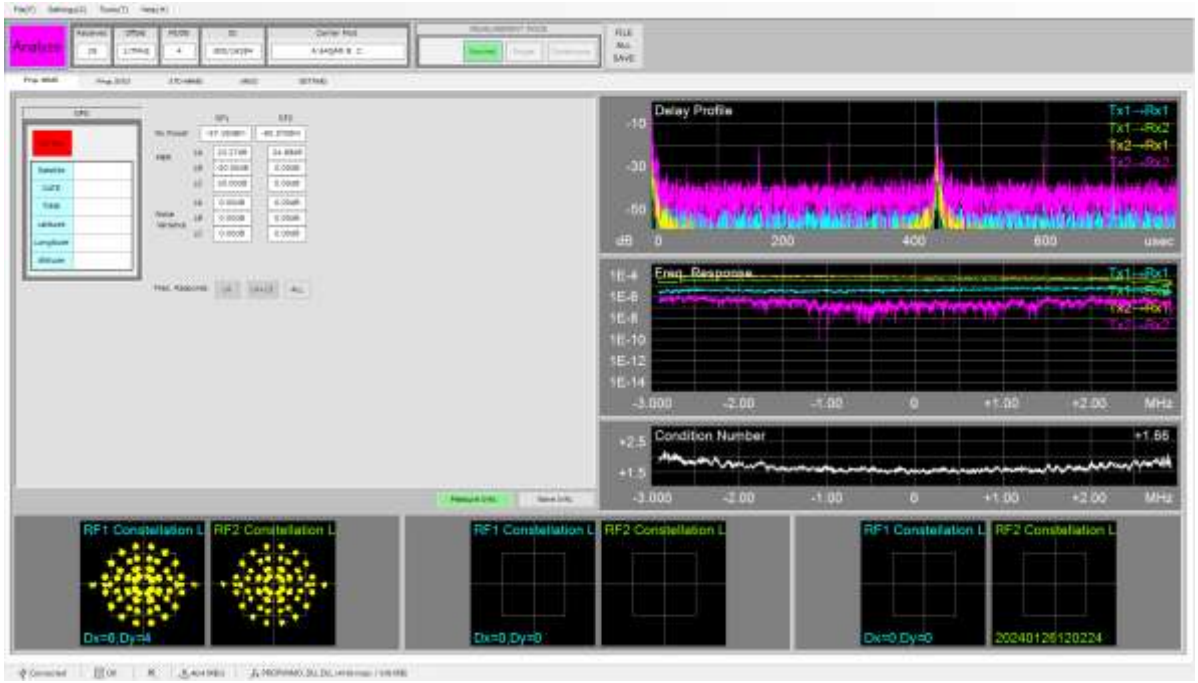


Figure 27.4 - Rintaro Screen

b) AWGN Power

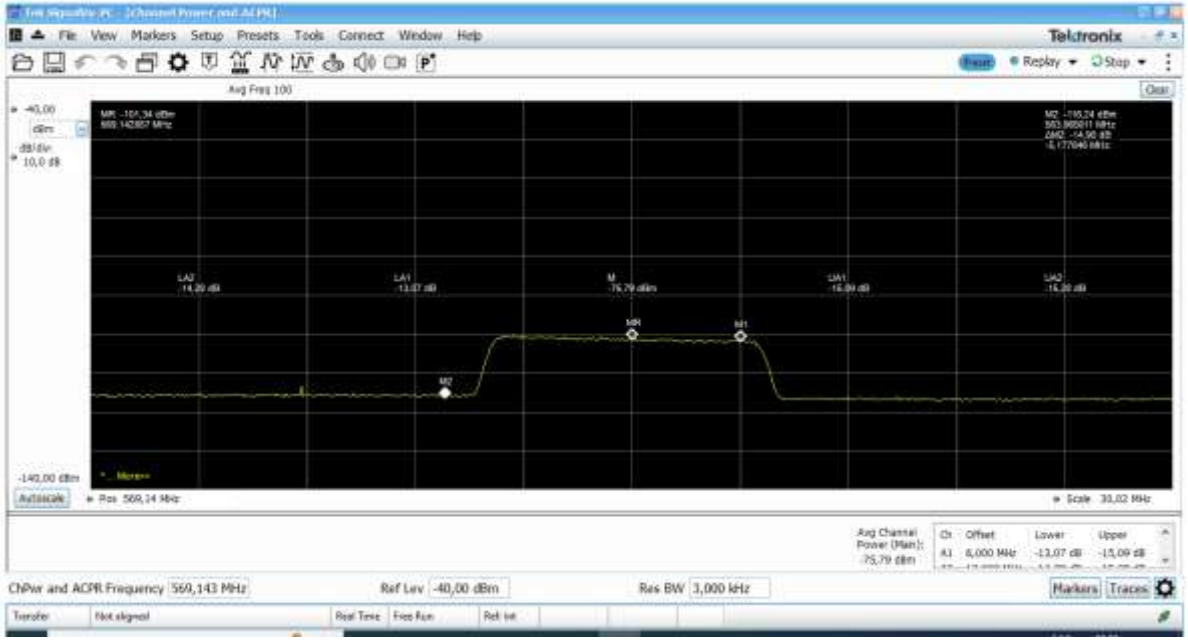


Figure 27.5 - Vertical

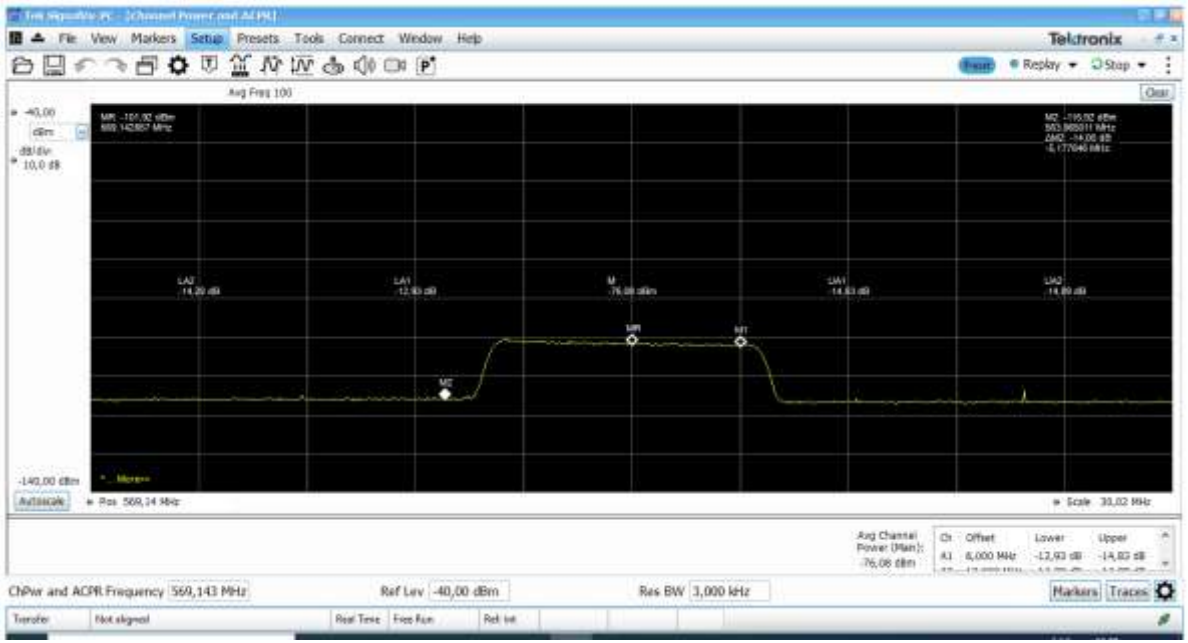


Figure 27.6 - Horizontal

c) C/N Threshold

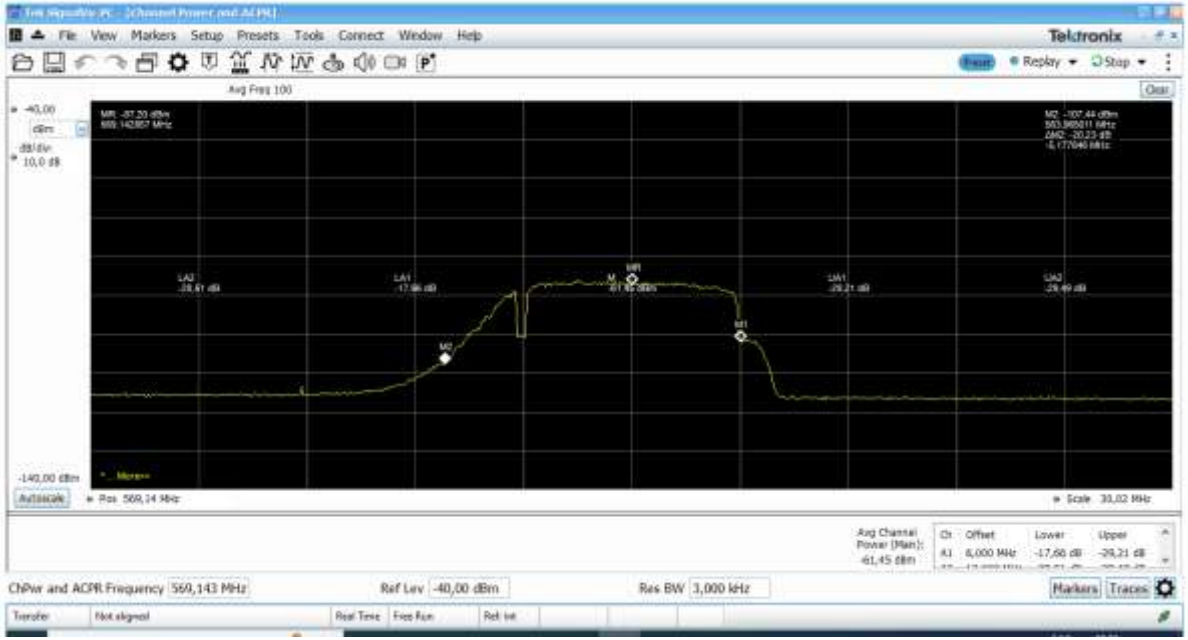


Figure 27.7 - Vertical

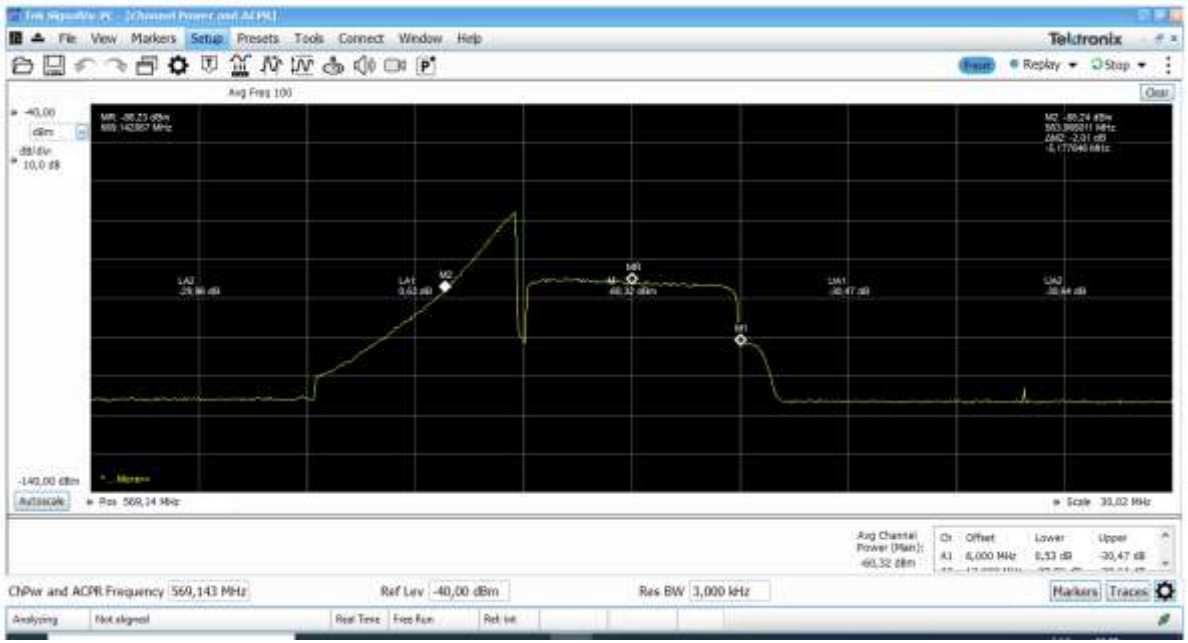


Figure 27.8 - Horizontal

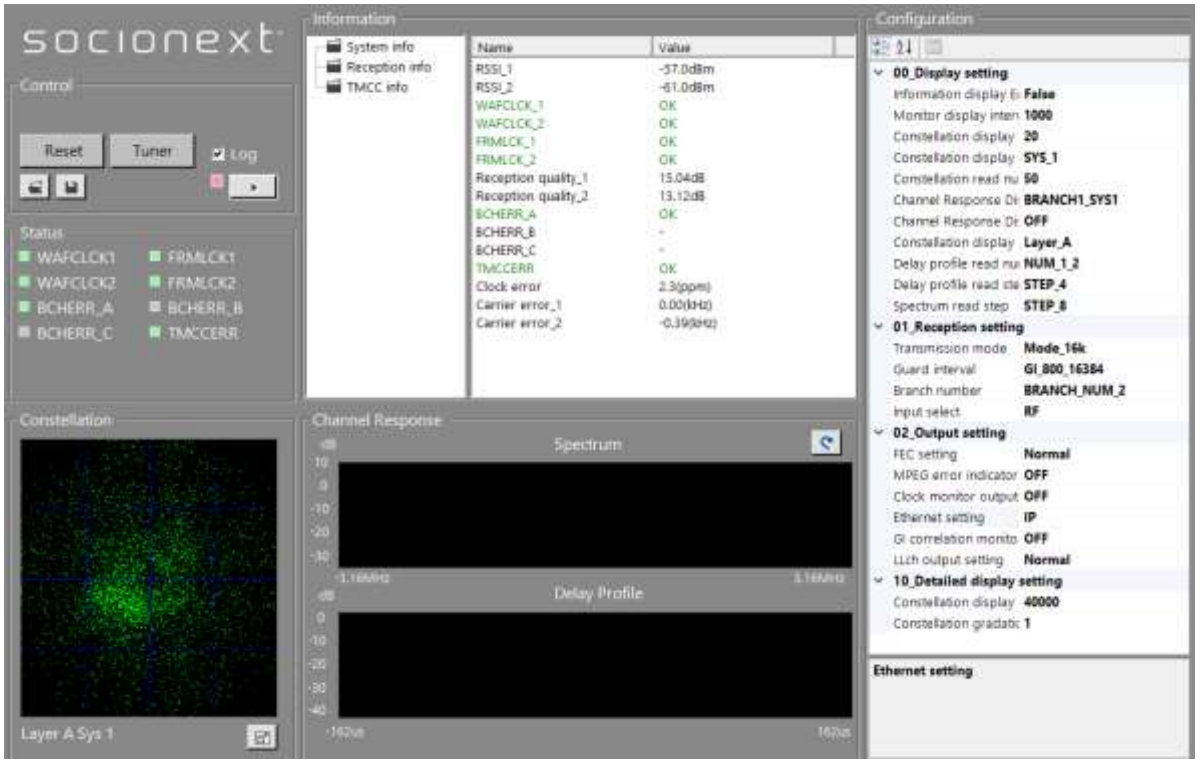


Figure 27.9 - Socionext Screen

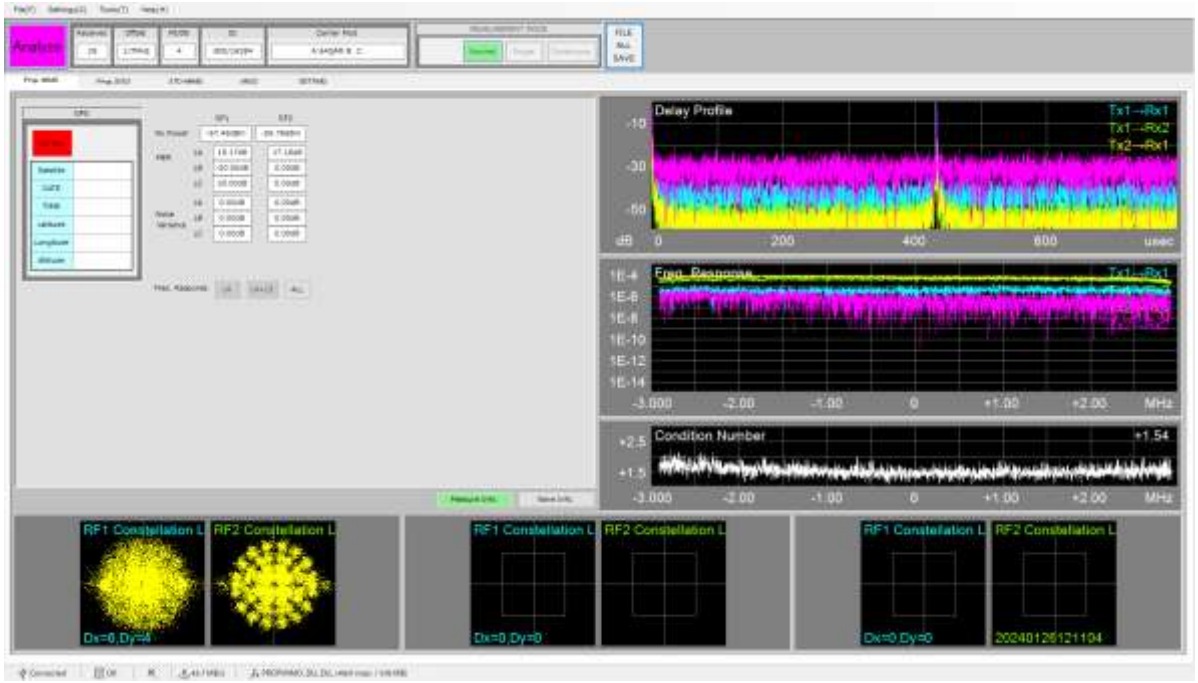


Figure 27.10 - Rintaro Screen

d) Reception Threshold

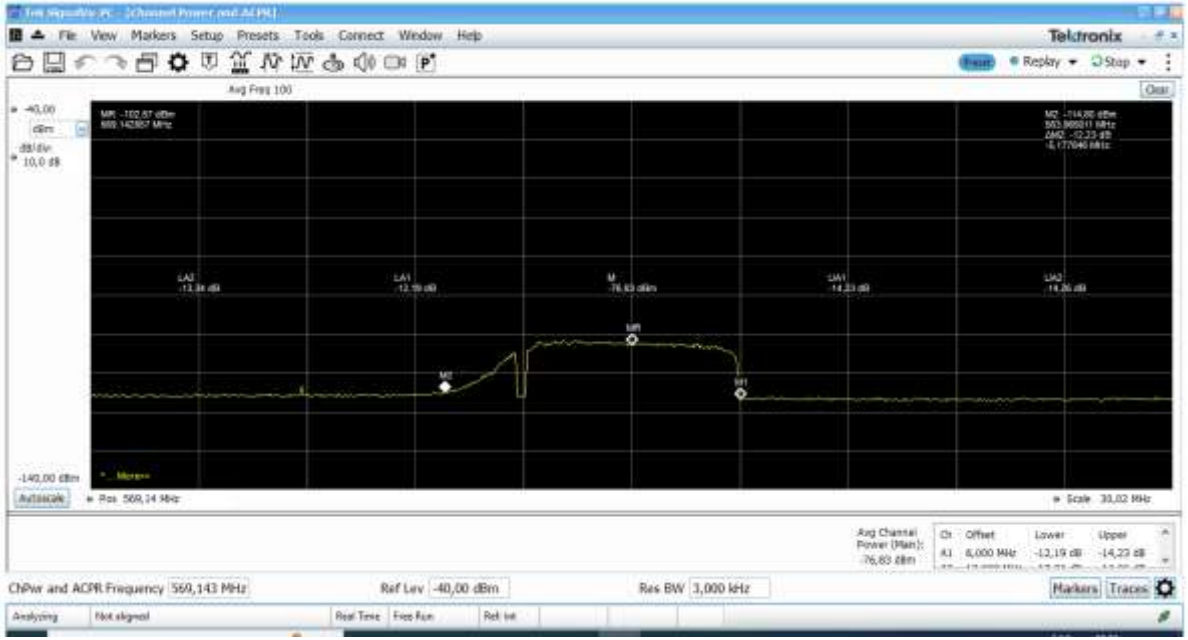


Figure 27.11 - Vertical

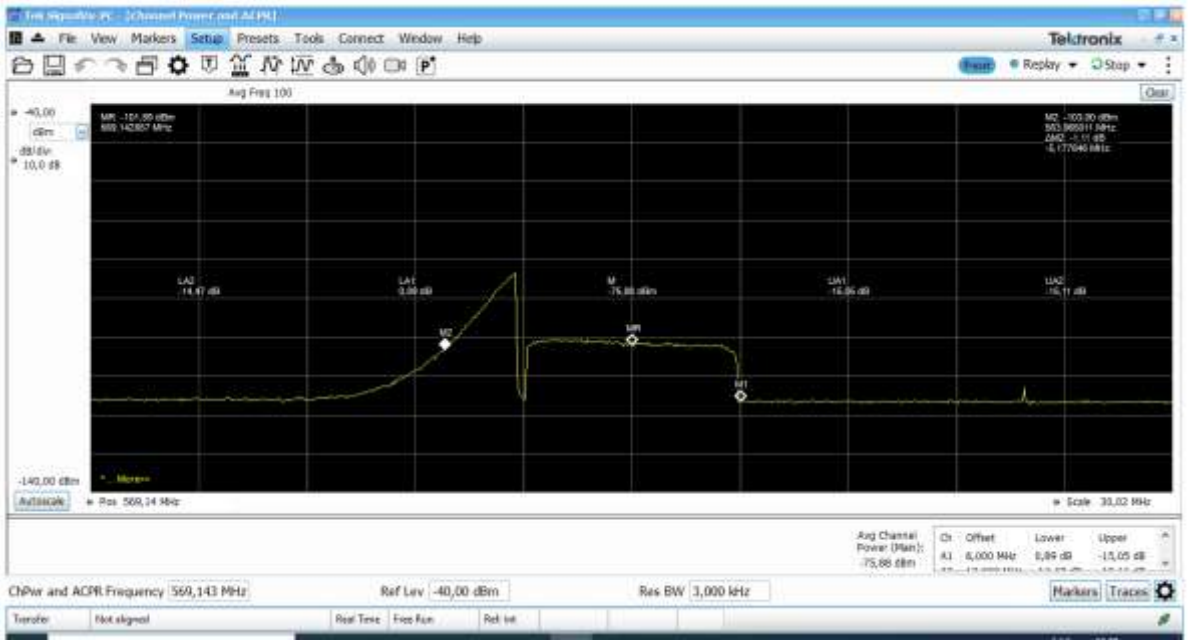


Figure 27.12 - Horizontal

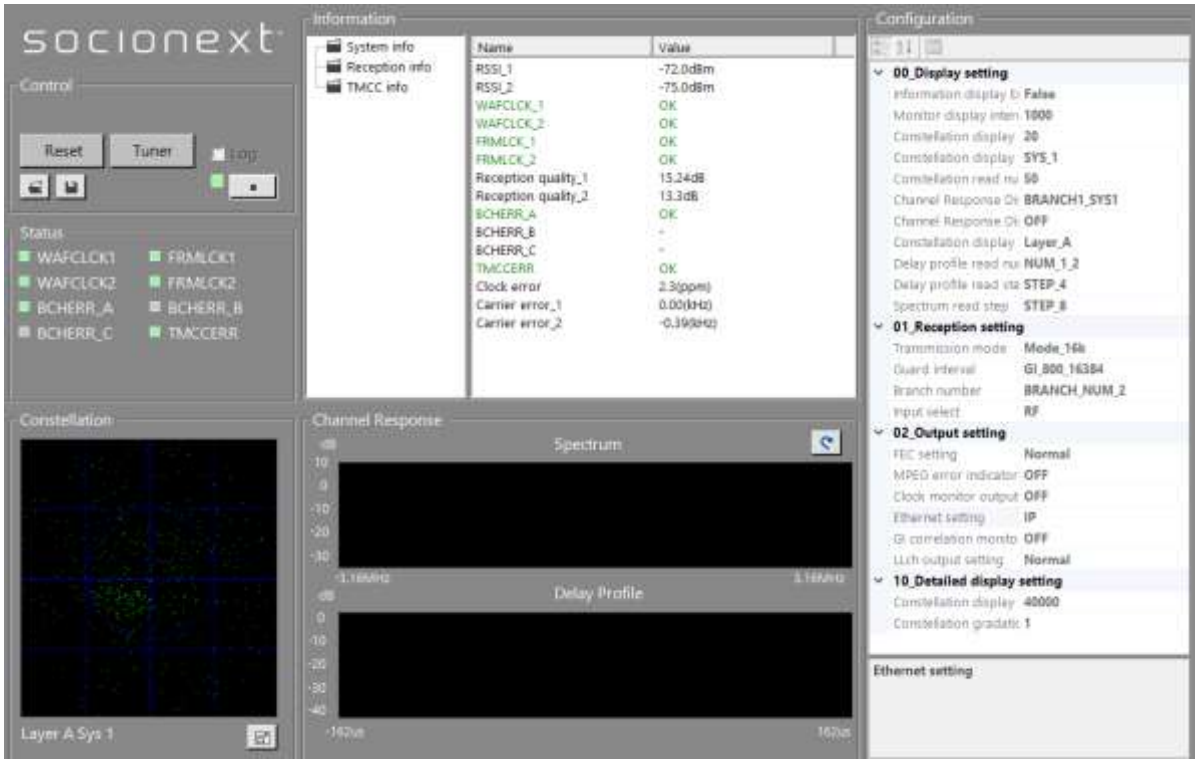


Figure 27.13 - Socionext Screen

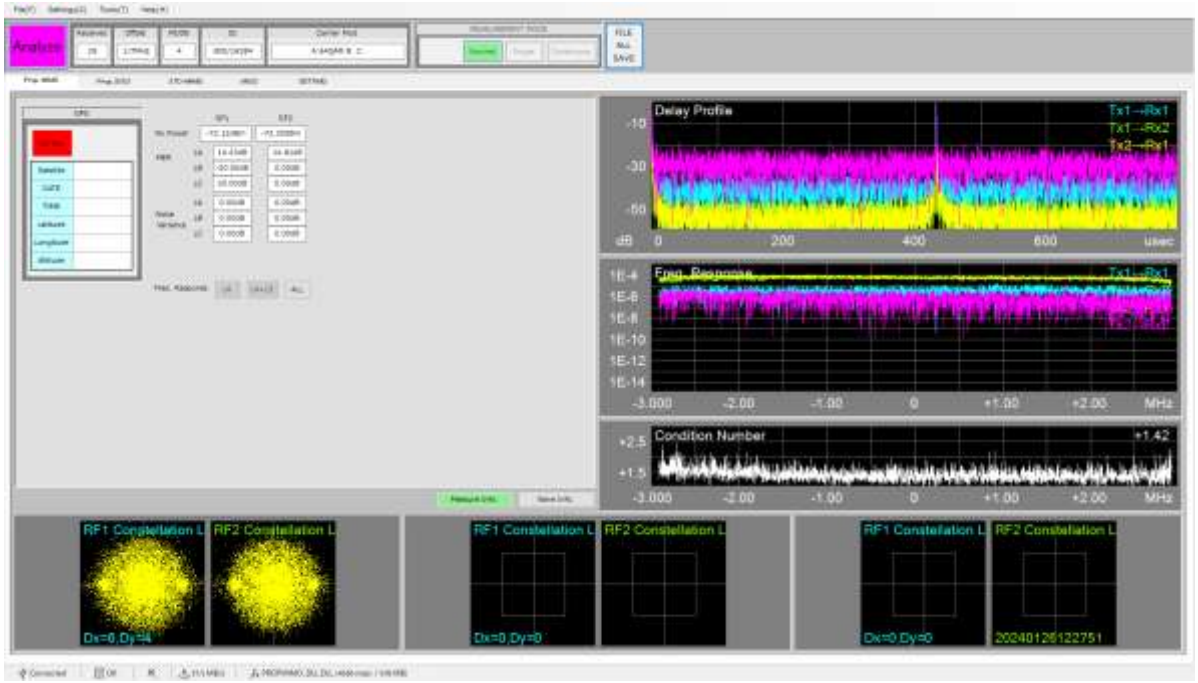


Figure 27.14 - Rintaro Screen

Chapter 28. Site 28

a) Channel Power

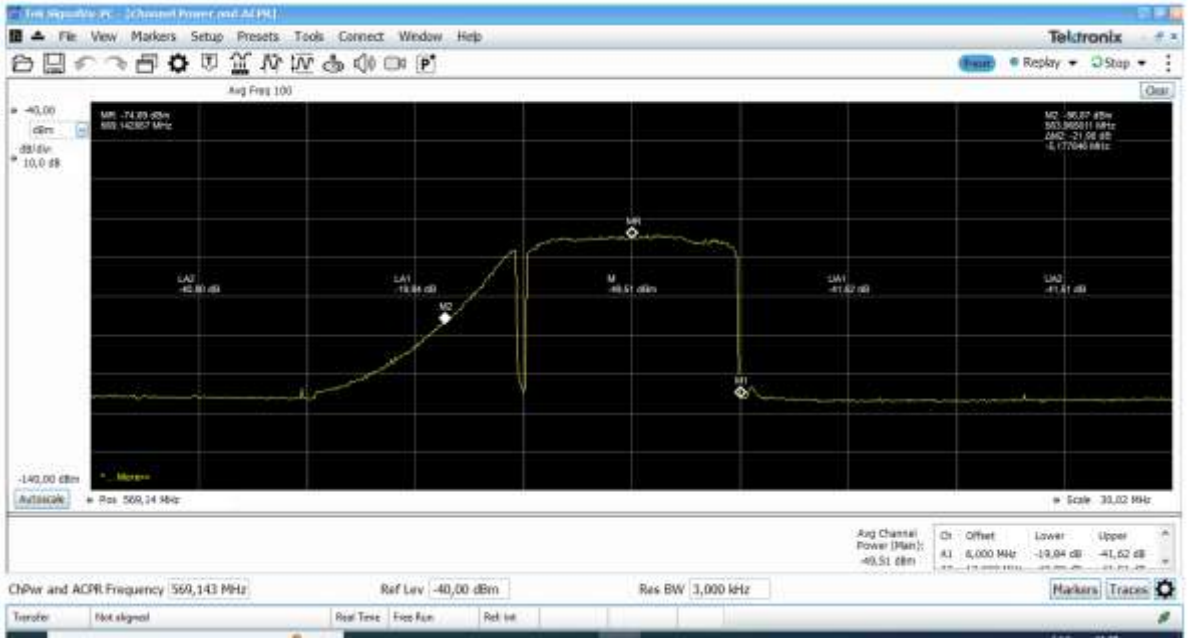


Figure 28.1 - Vertical

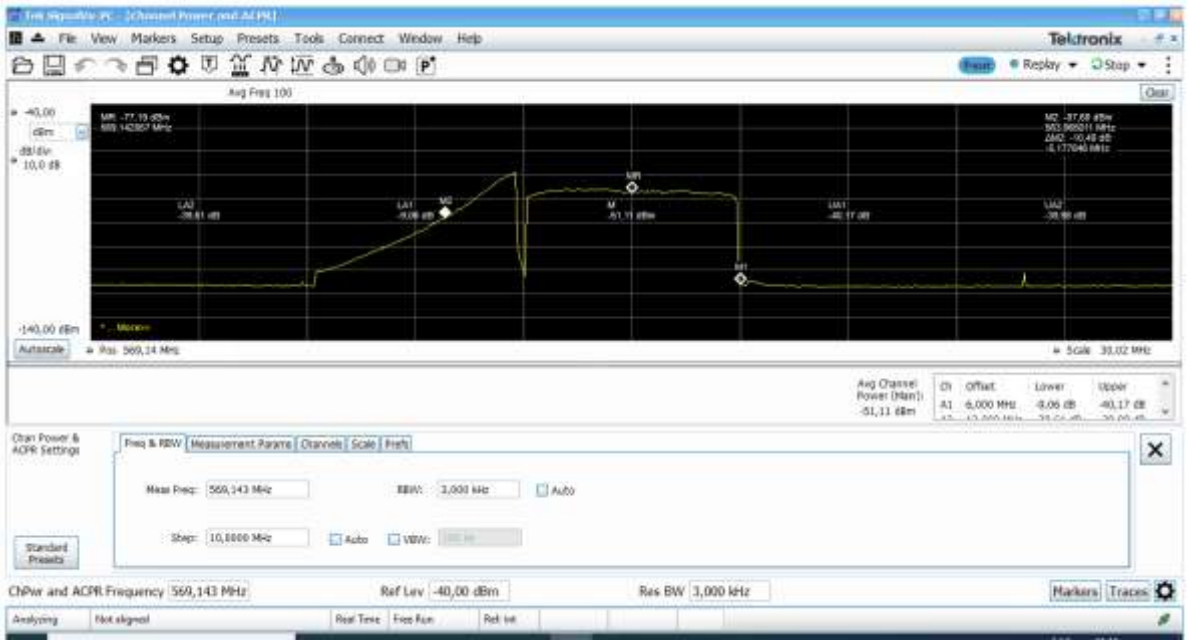


Figure 28.2 - Horizontal

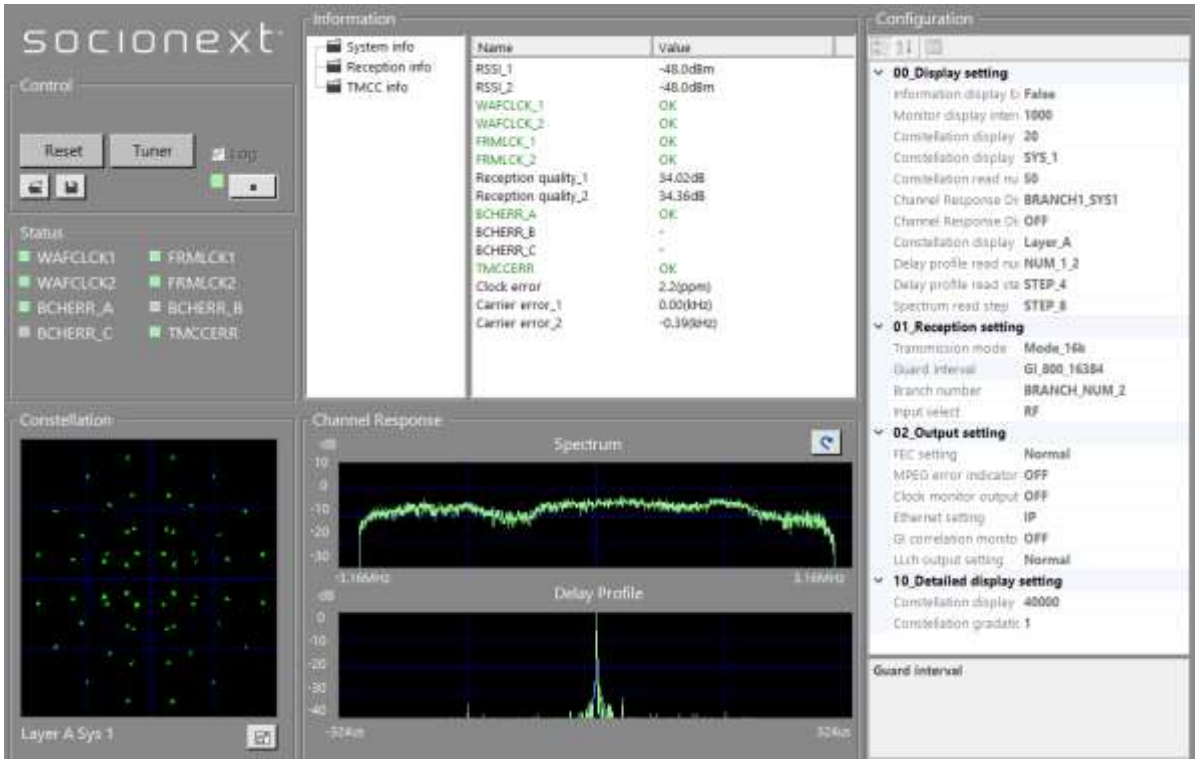


Figure 28.3 - Socionext Screen

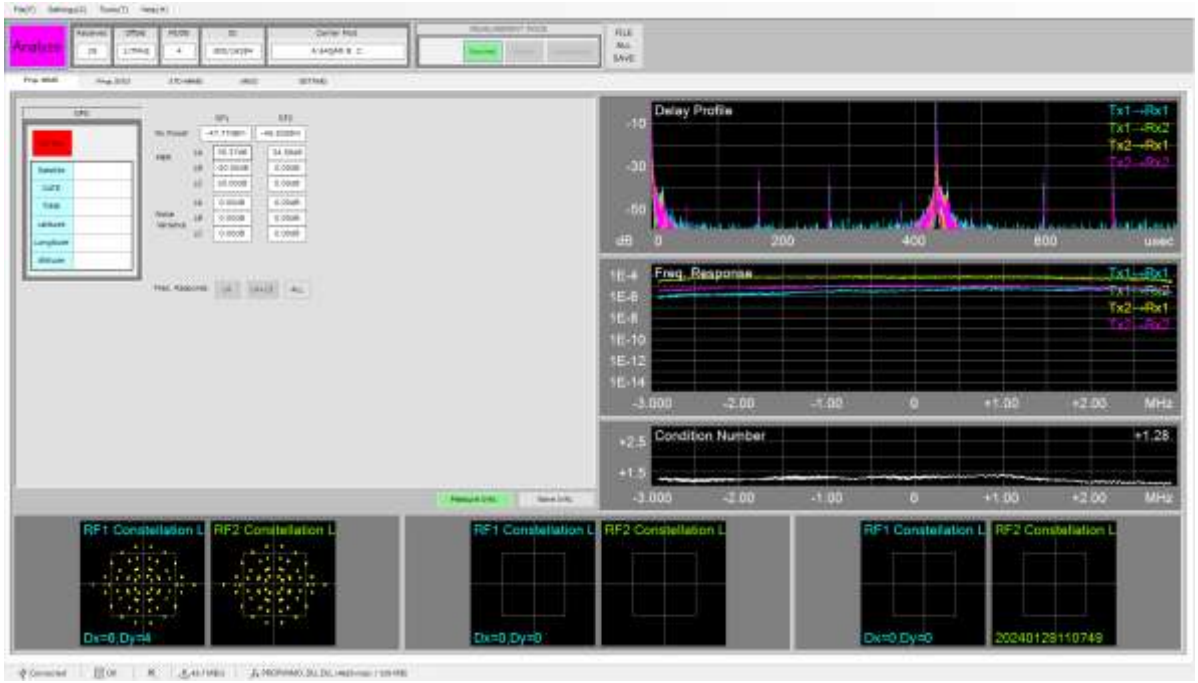


Figure 28.4 - Rintaro Screen

b) AWGN Power

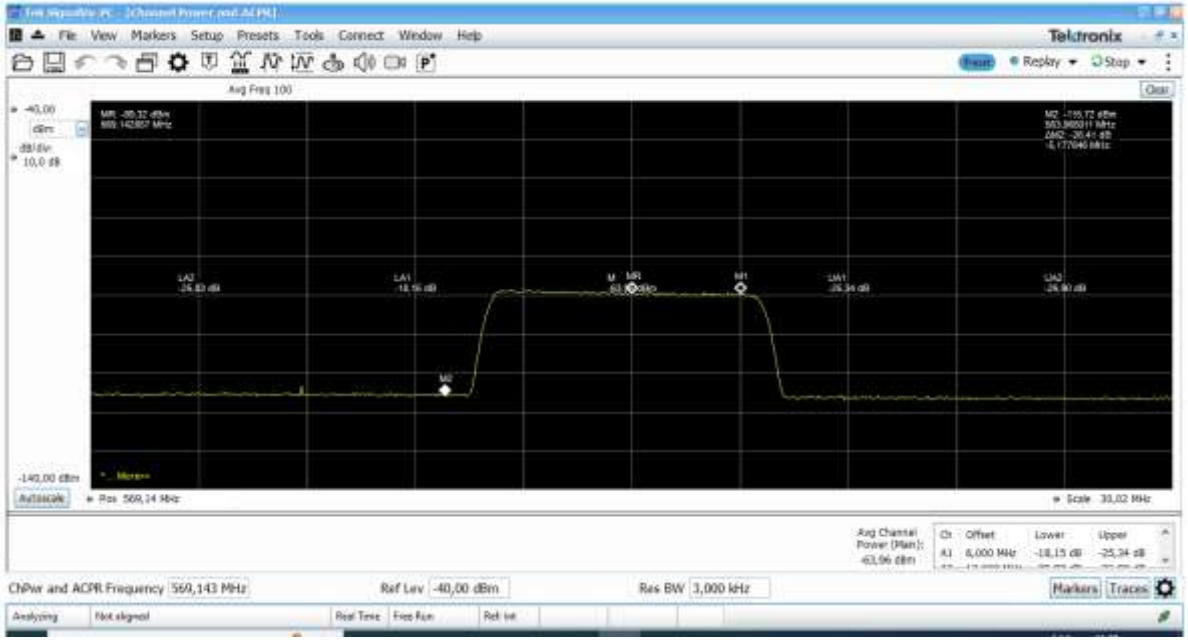


Figure 28.5 - Vertical

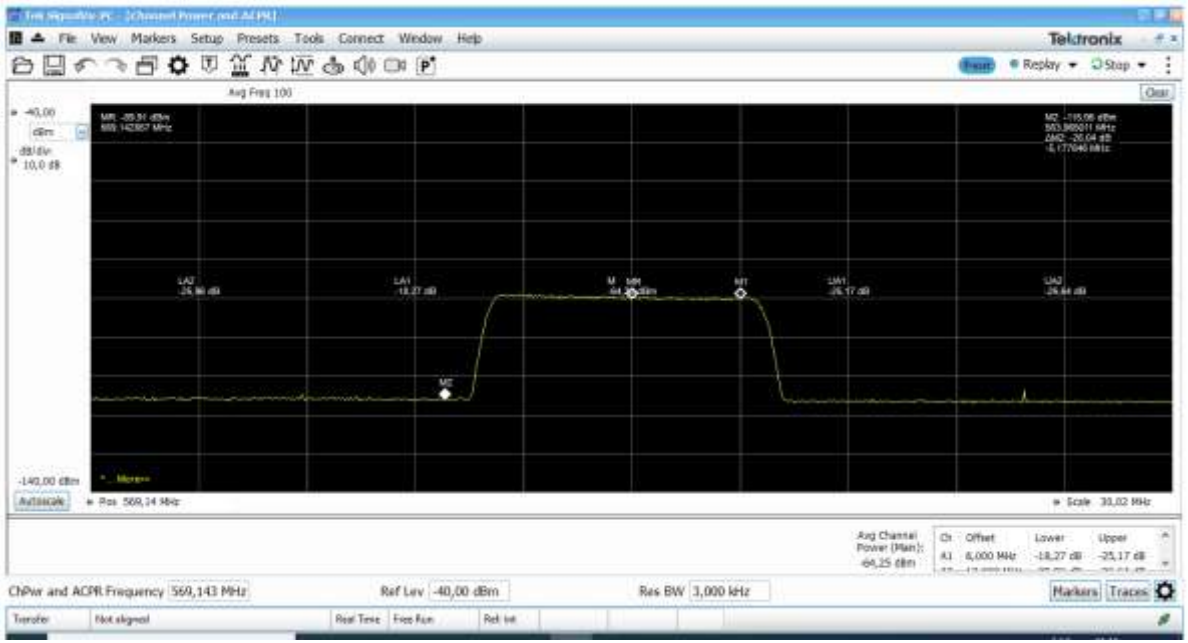


Figure 28.6 - Horizontal

c) C/N Threshold

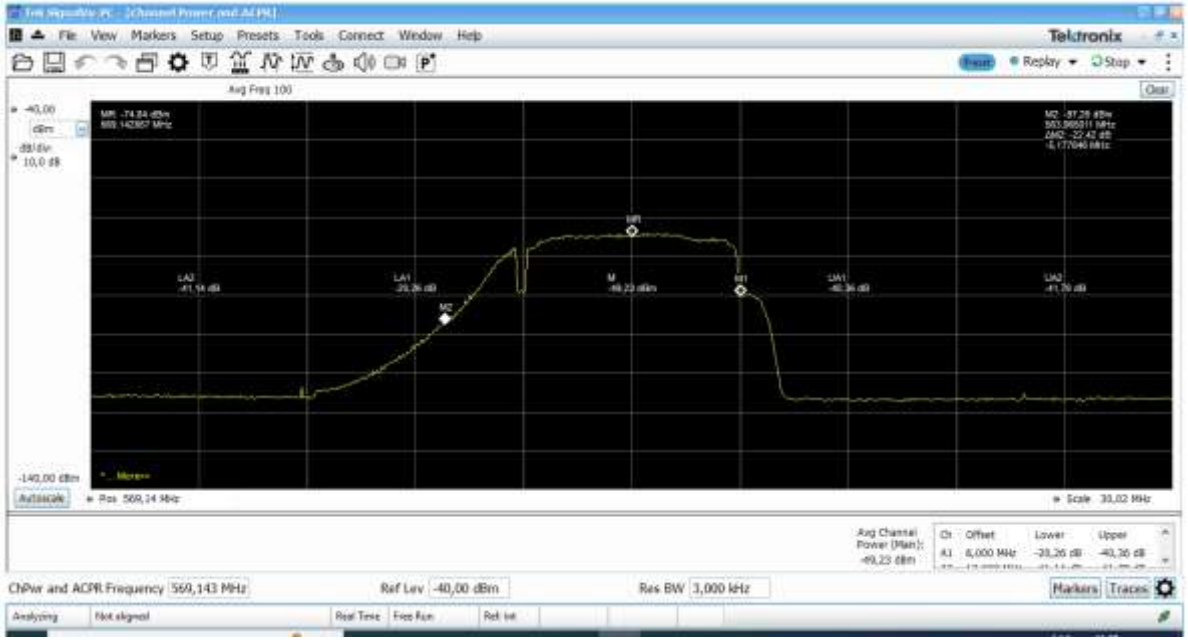


Figure 28.7 - Vertical

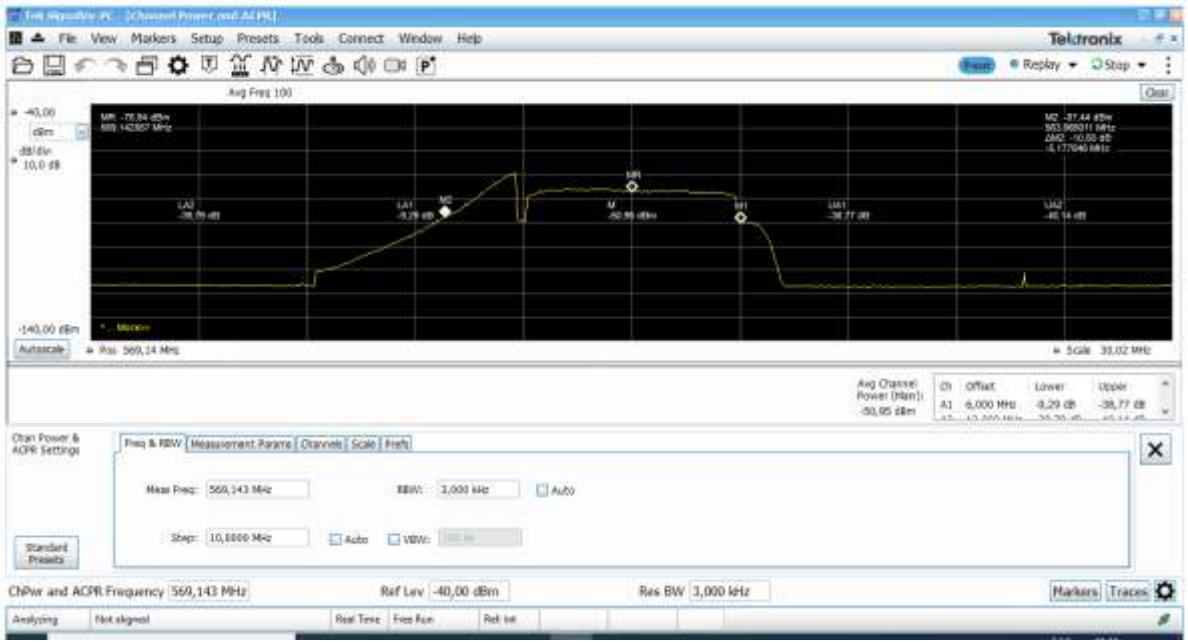


Figure 28.8 - Horizontal

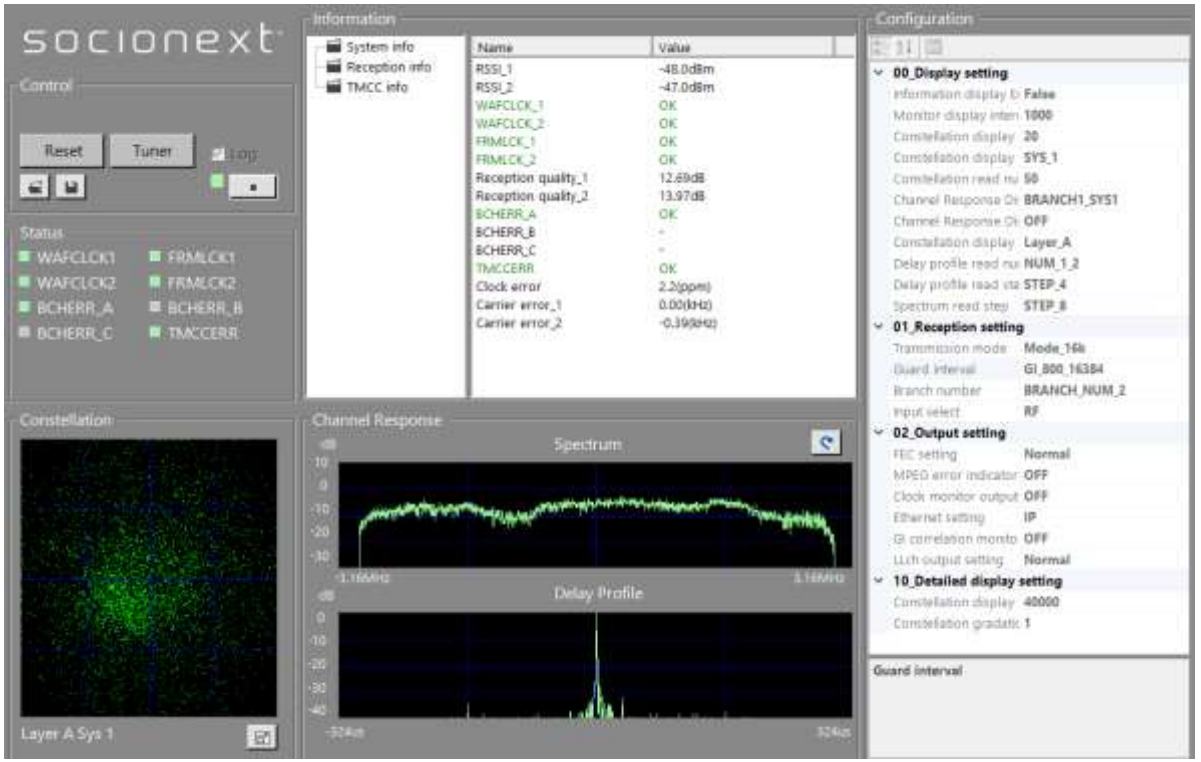


Figure 28.9 - Socionext Screen

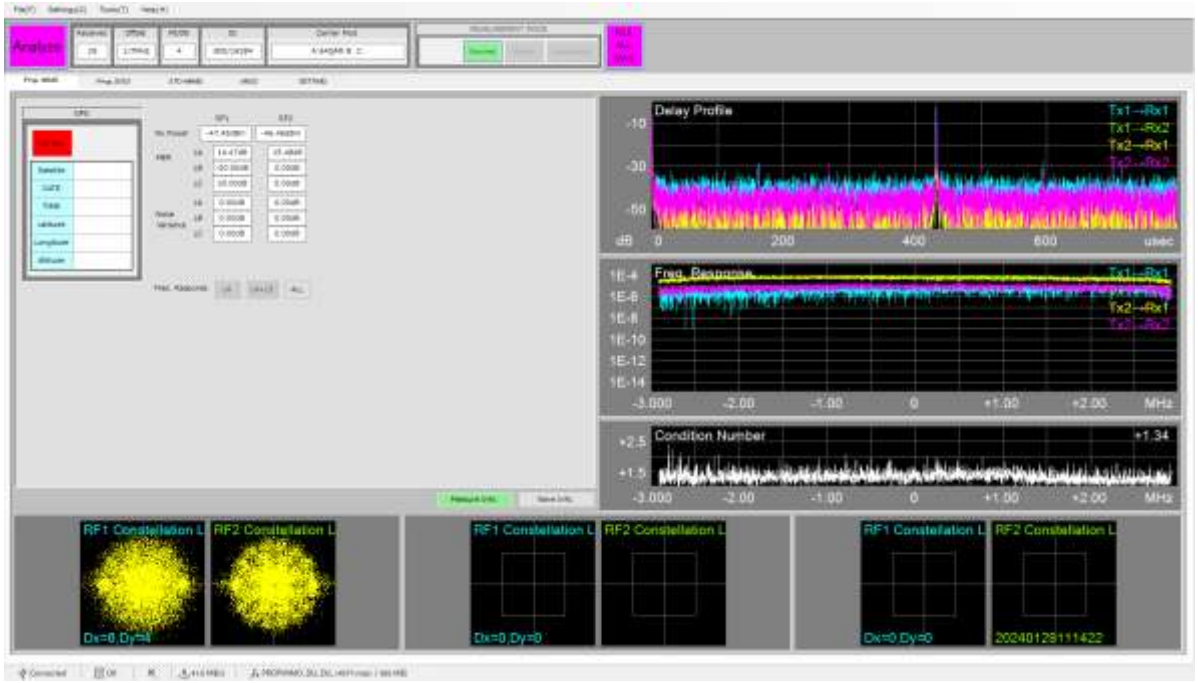


Figure 28.10 - Rintaro Screen

d) Reception Threshold

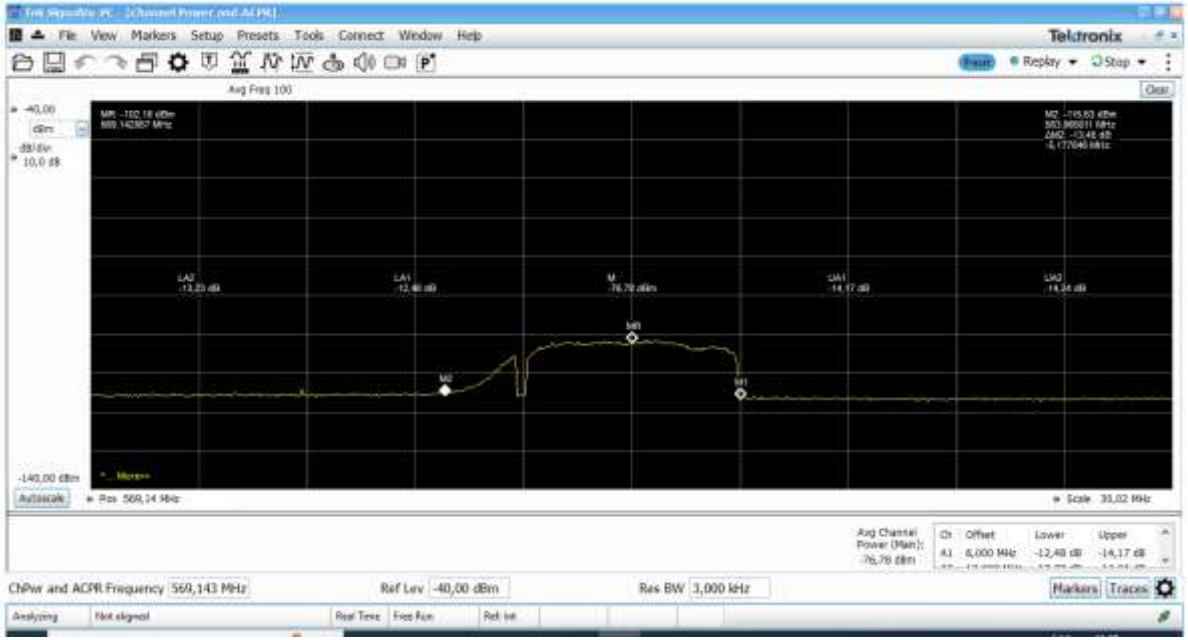


Figure 28.11 - Vertical

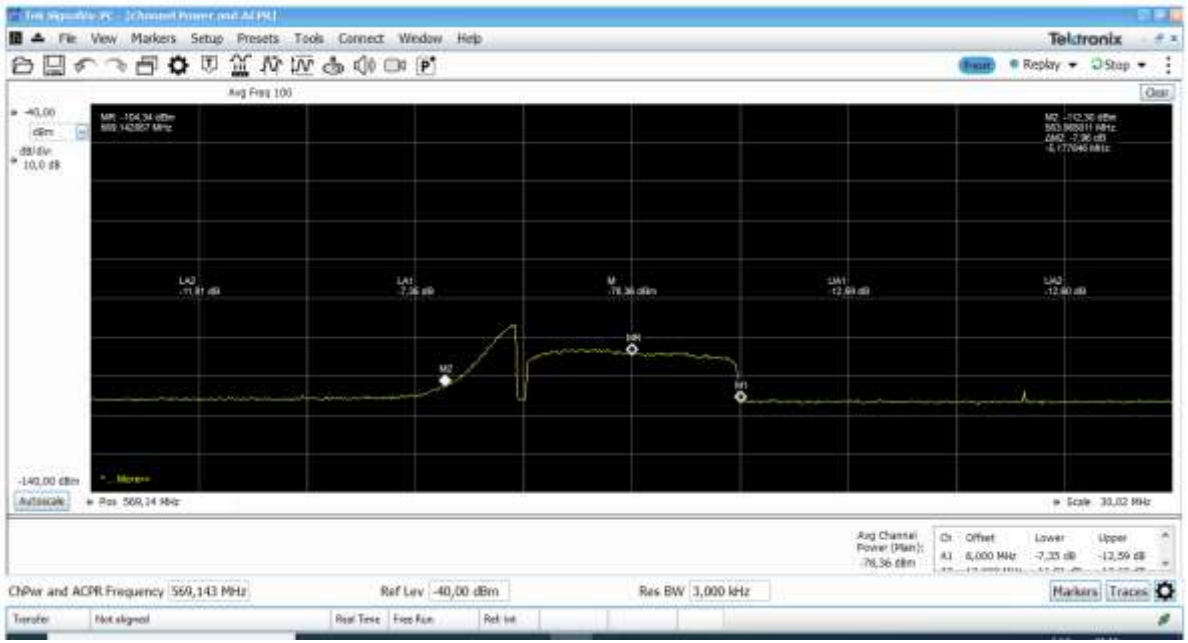


Figure 28.12 - Horizontal

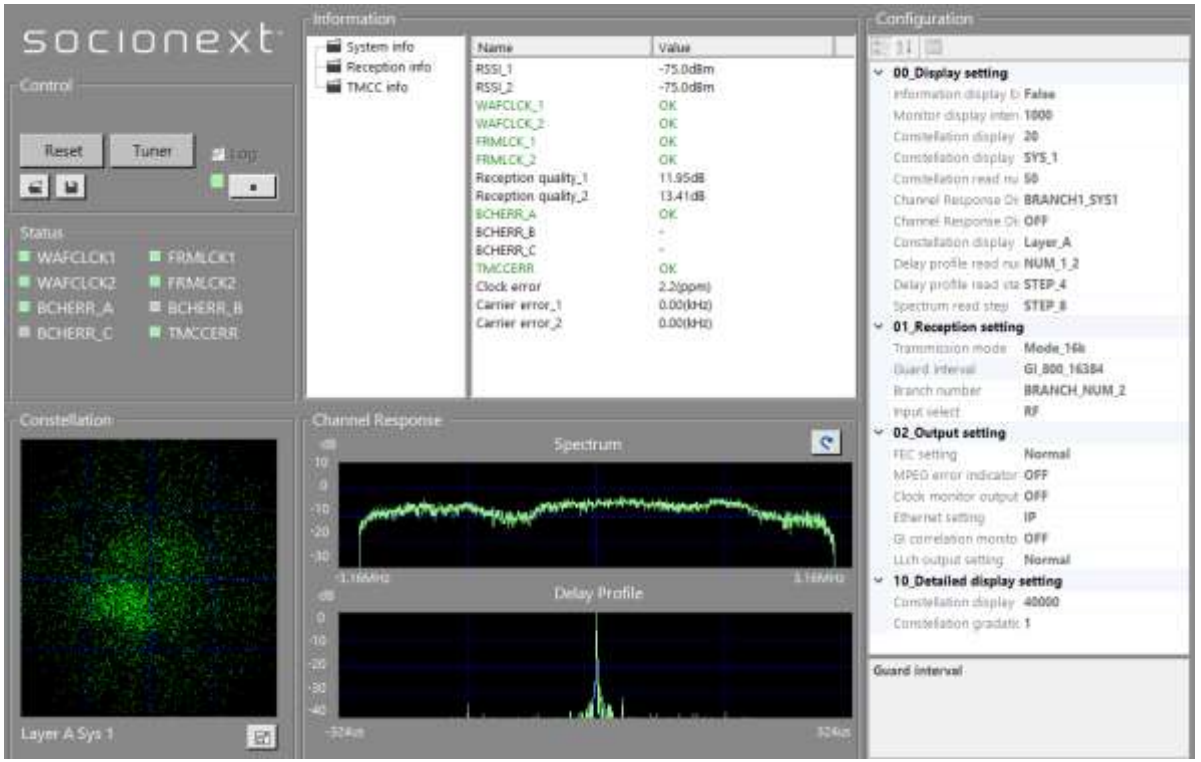


Figure 28.13 - Socionext Screen

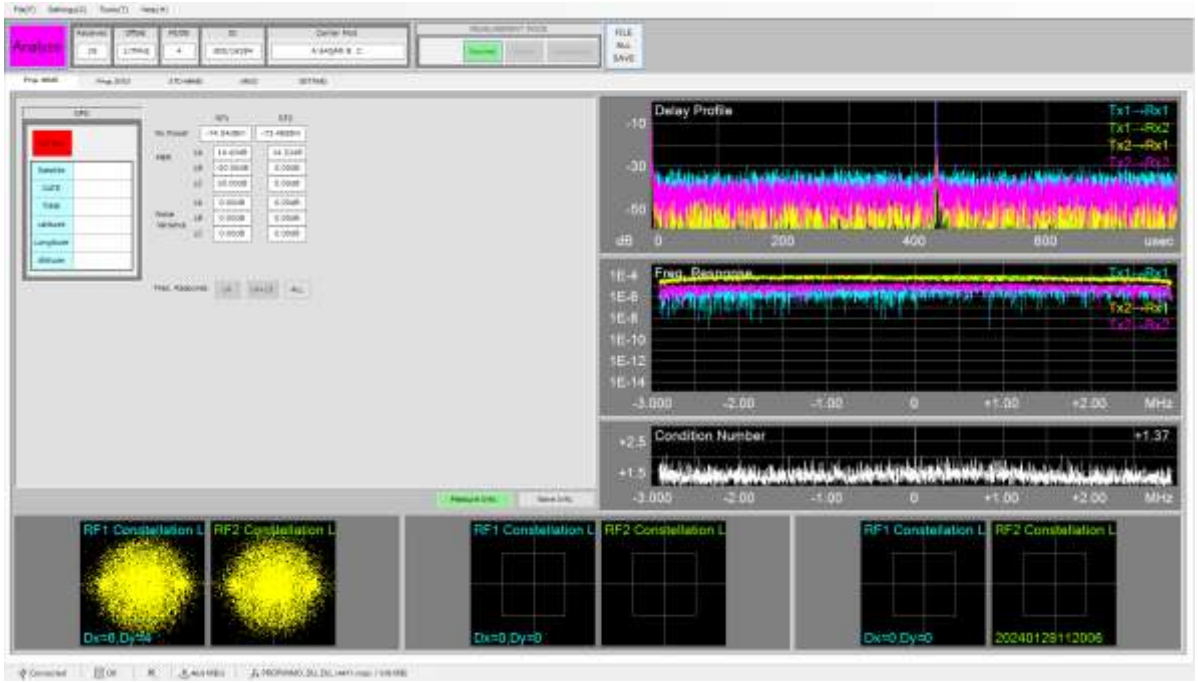


Figure 28.14 - Rintaro Screen

Chapter 29. Site 29

a) Channel Power

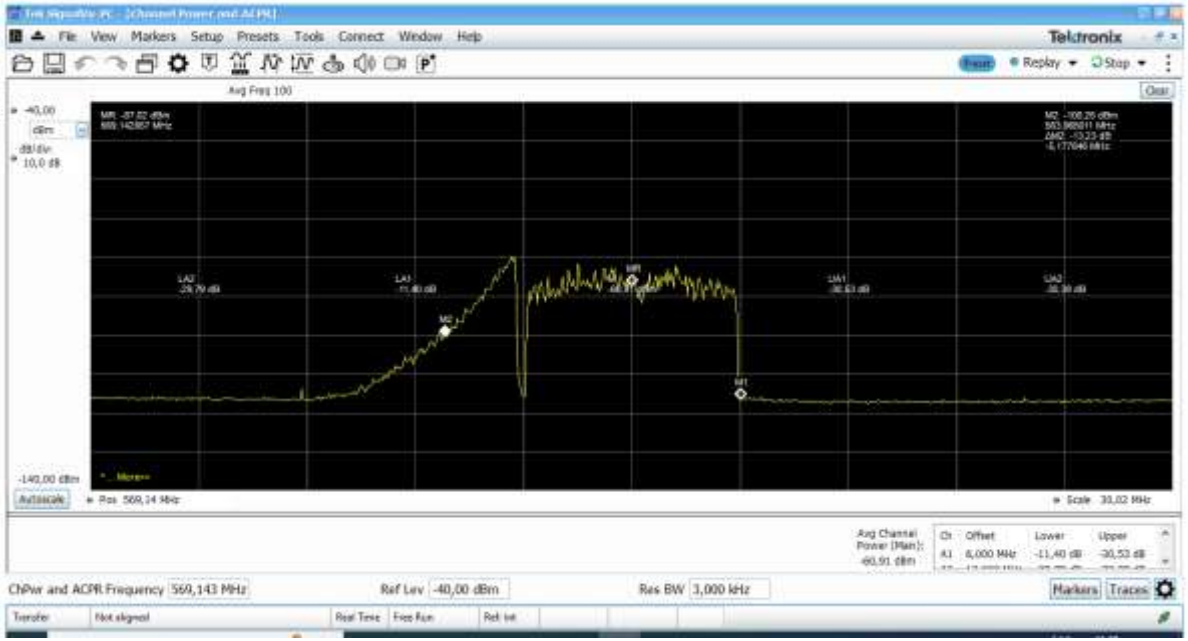


Figure 29.1 - Vertical

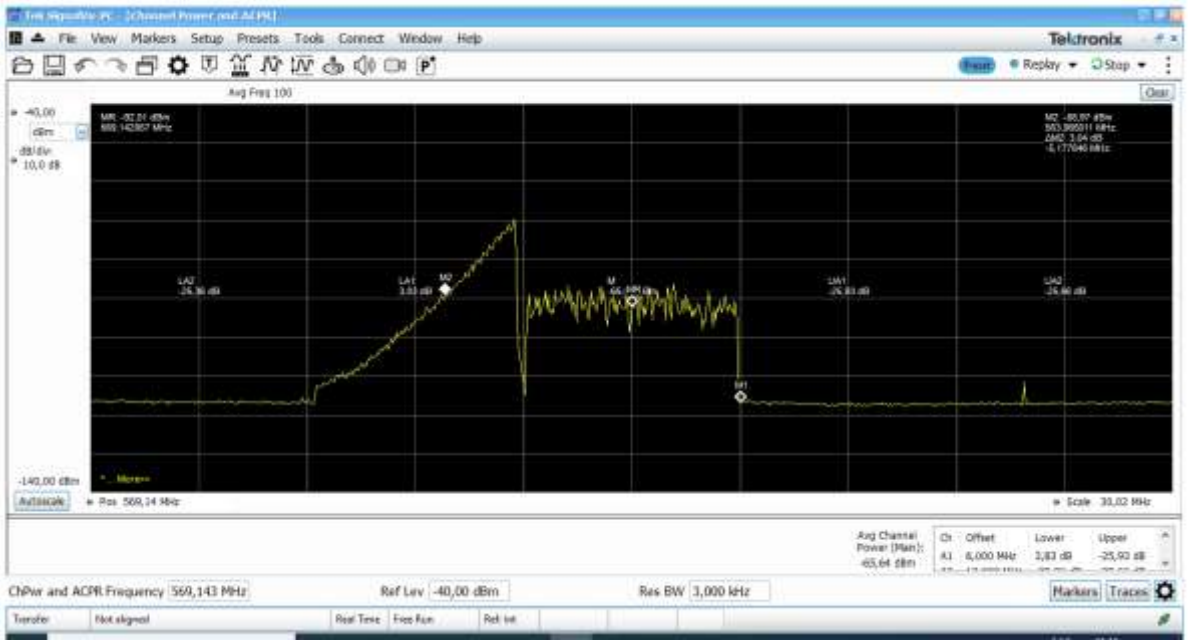


Figure 29.2 - Horizontal

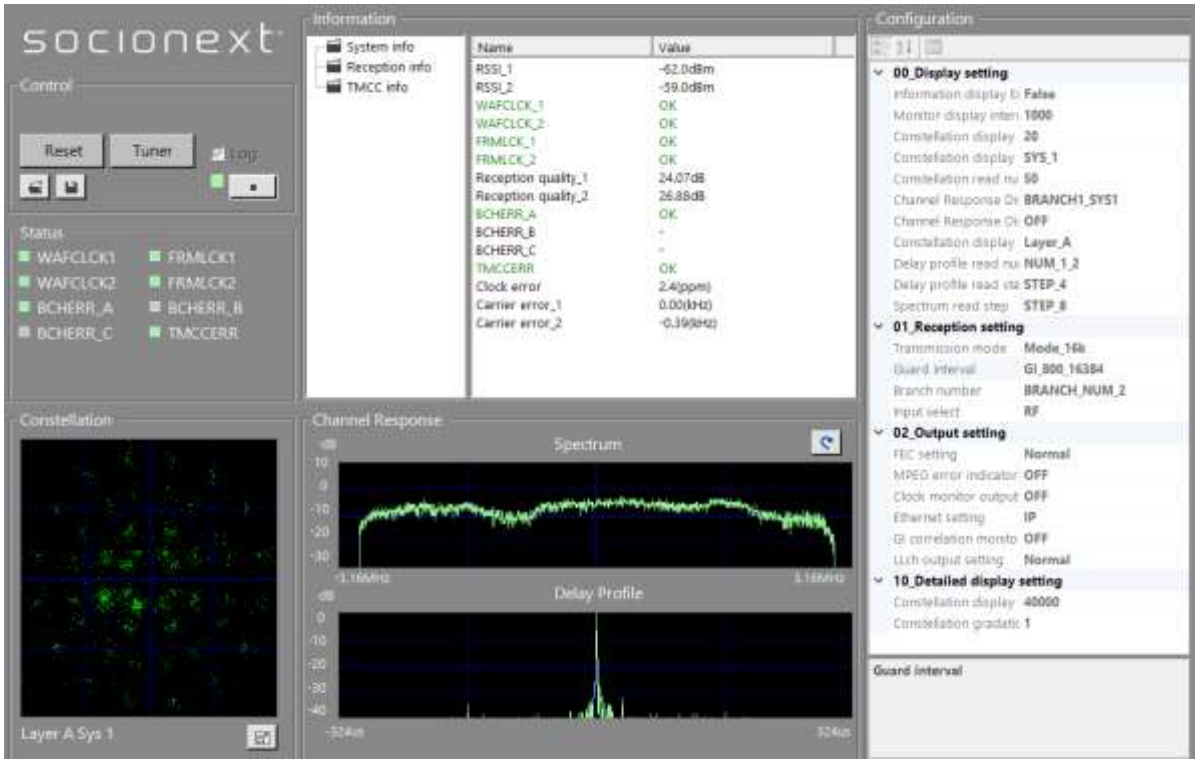


Figure 29.3 - Socionext Screen

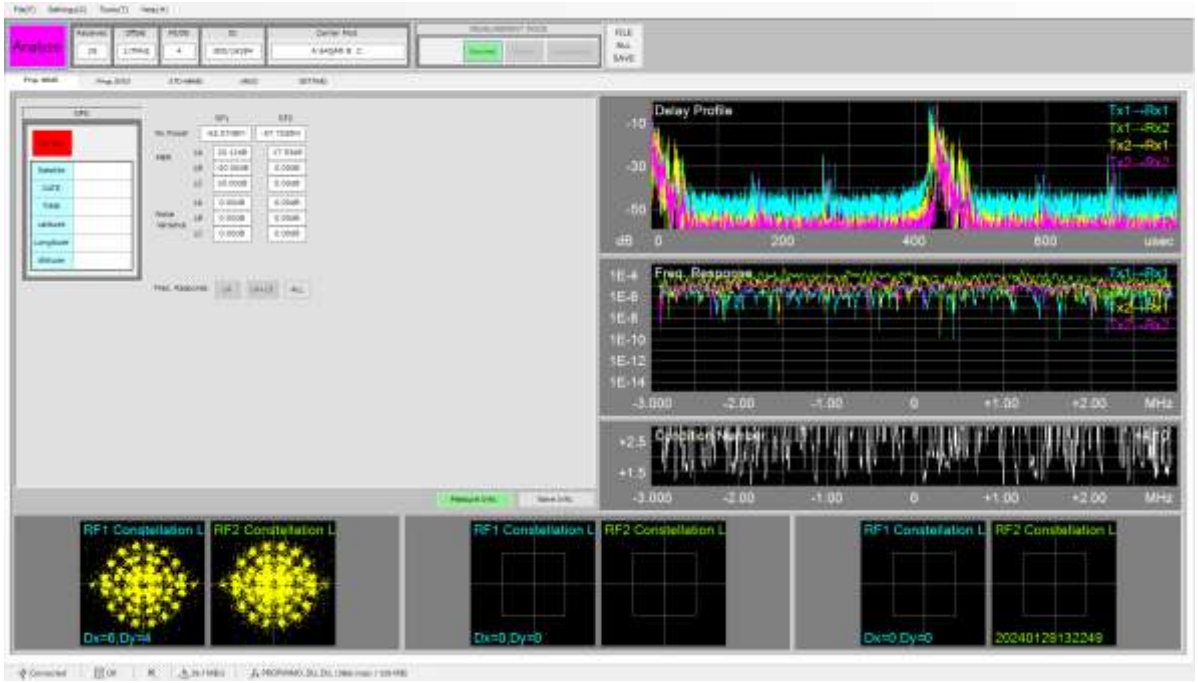


Figure 29.4 - Rintaro Screen

b) AWGN Power

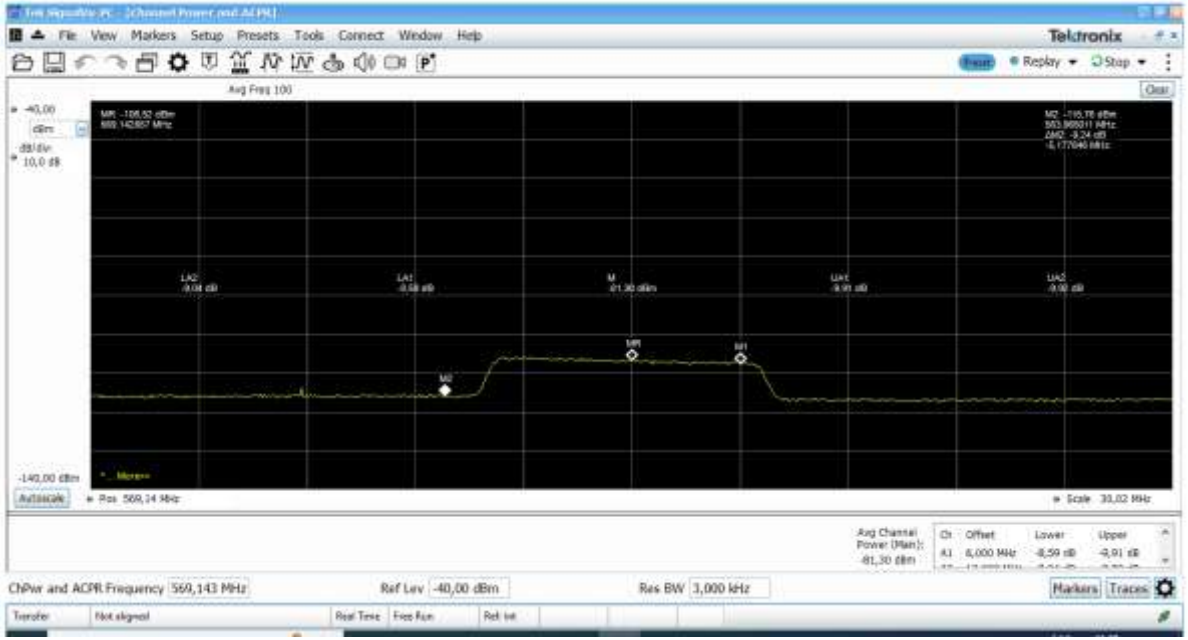


Figure 29.5 - Vertical

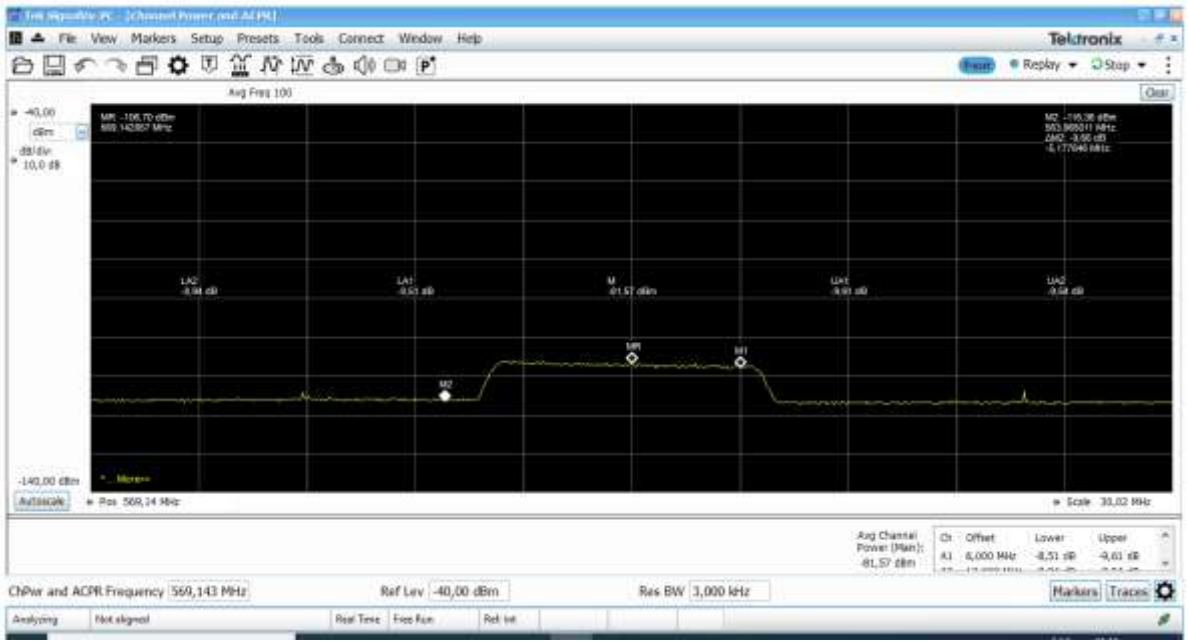


Figure 29.6 - Horizontal

c) C/N Threshold

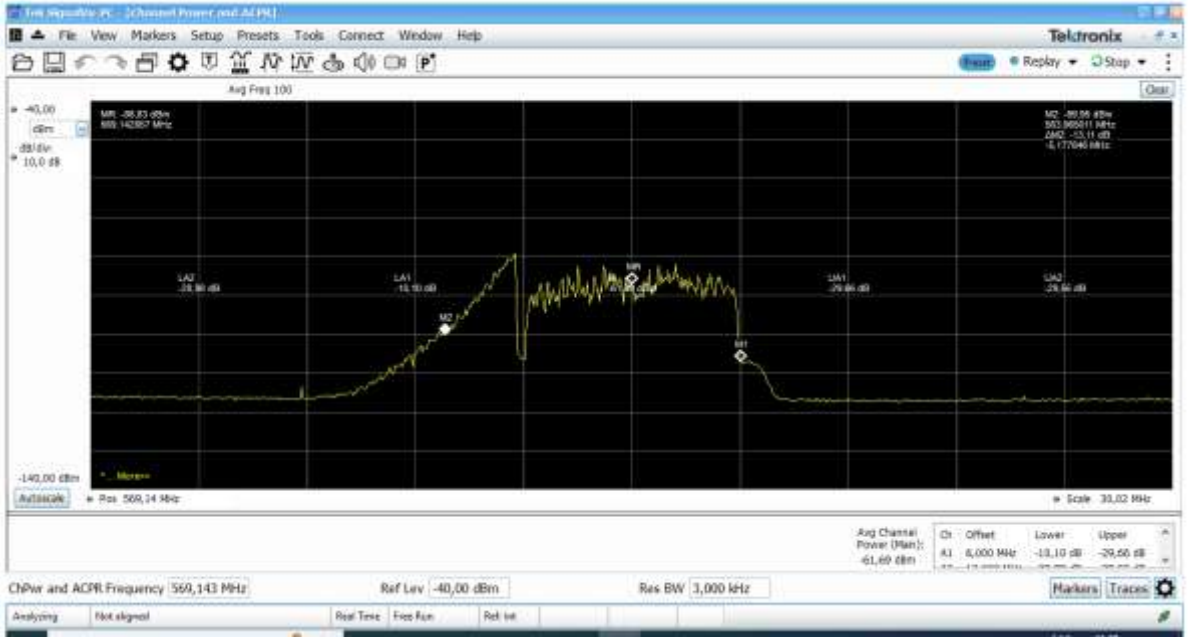


Figure 29.7 - Vertical

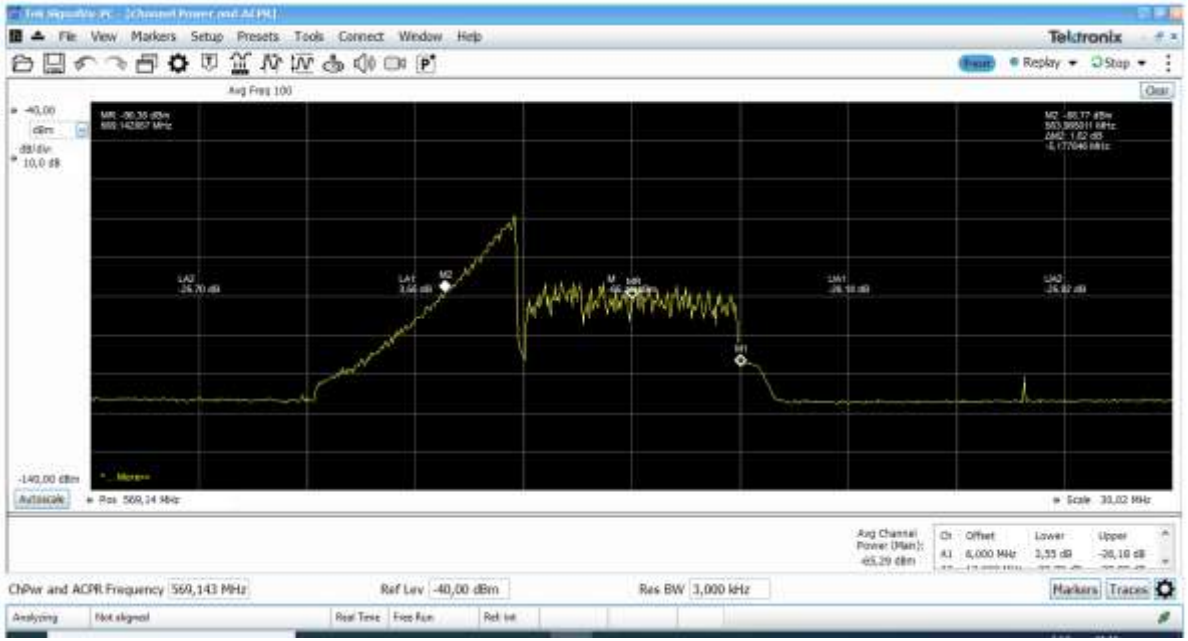


Figure 29.8 - Horizontal

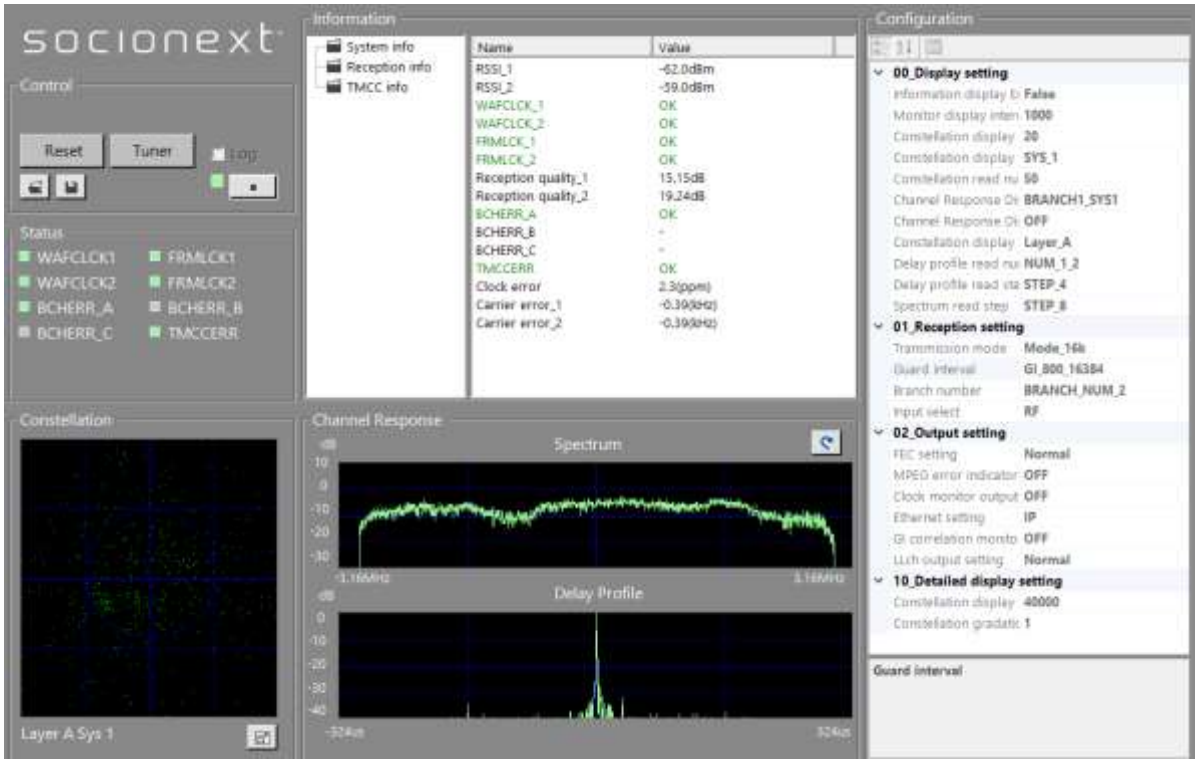


Figure 29.9 - Socionext Screen

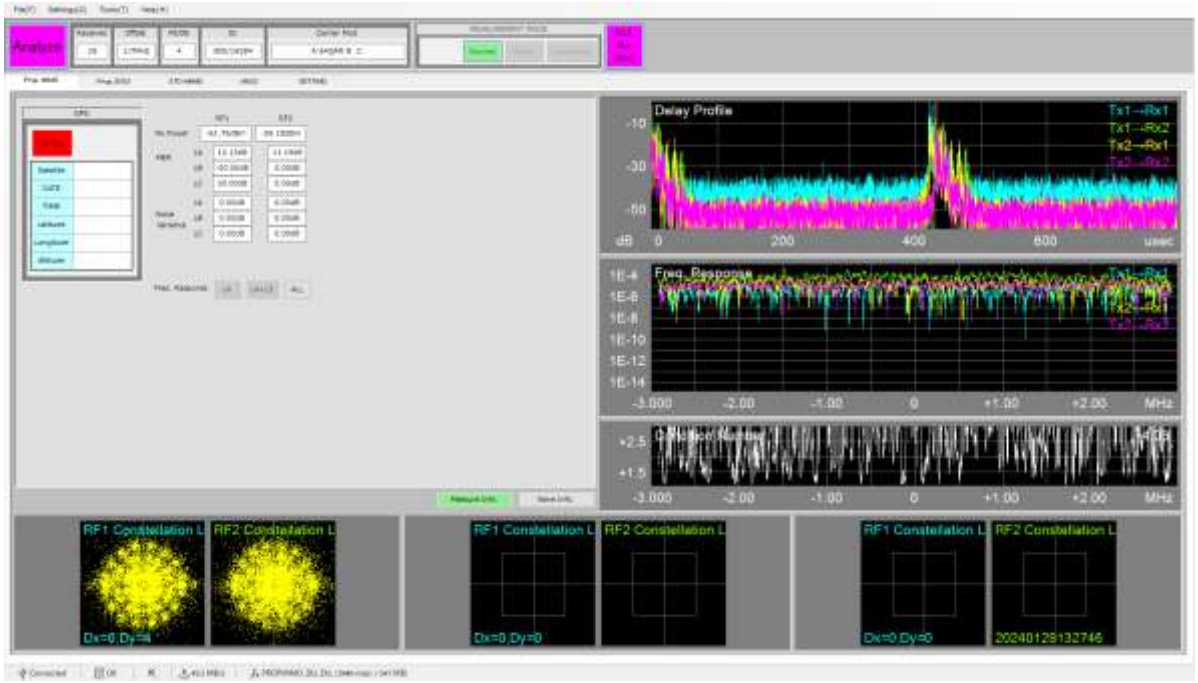


Figure 29.10 - Rintaro Screen

d) Reception Threshold

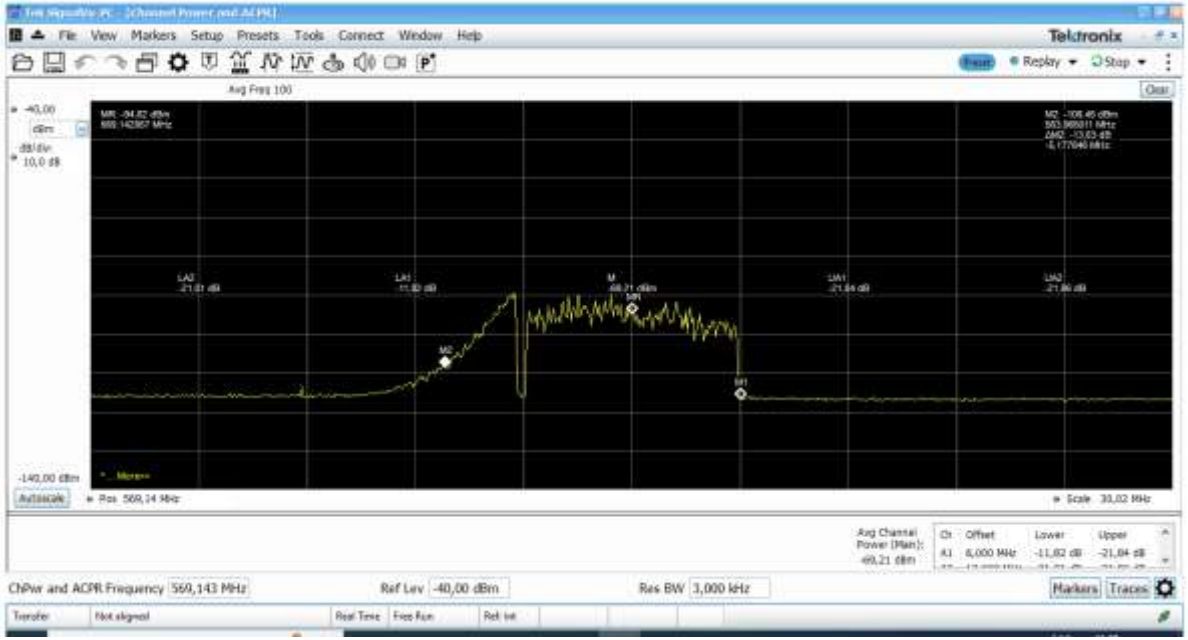


Figure 29.11 - Vertical

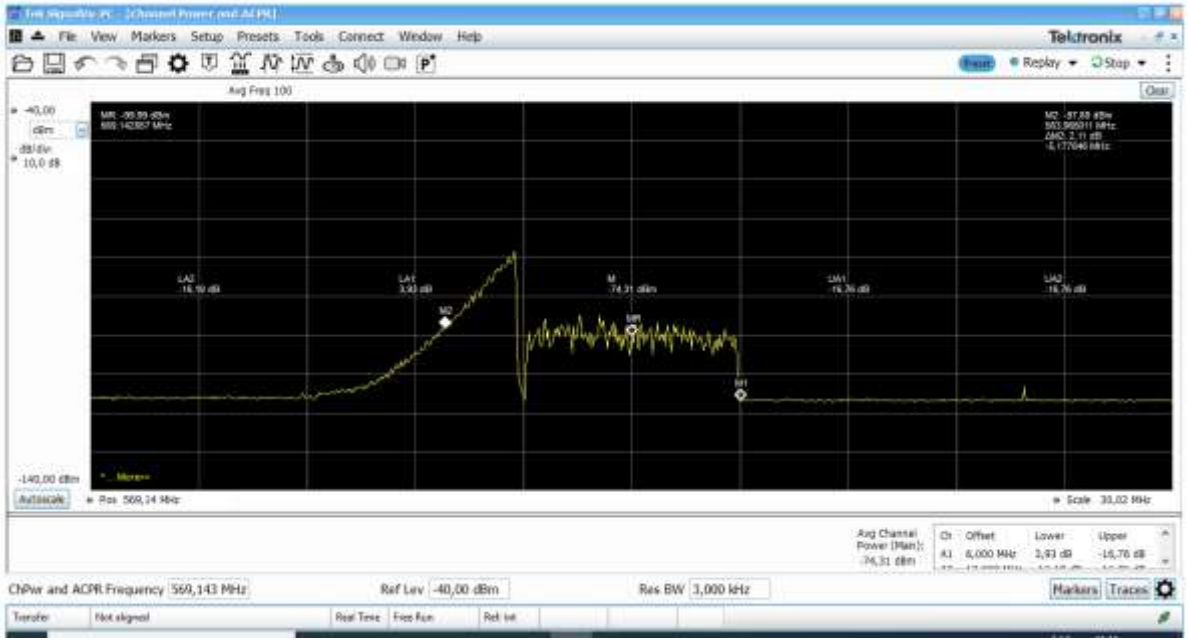


Figure 29.12 - Horizontal

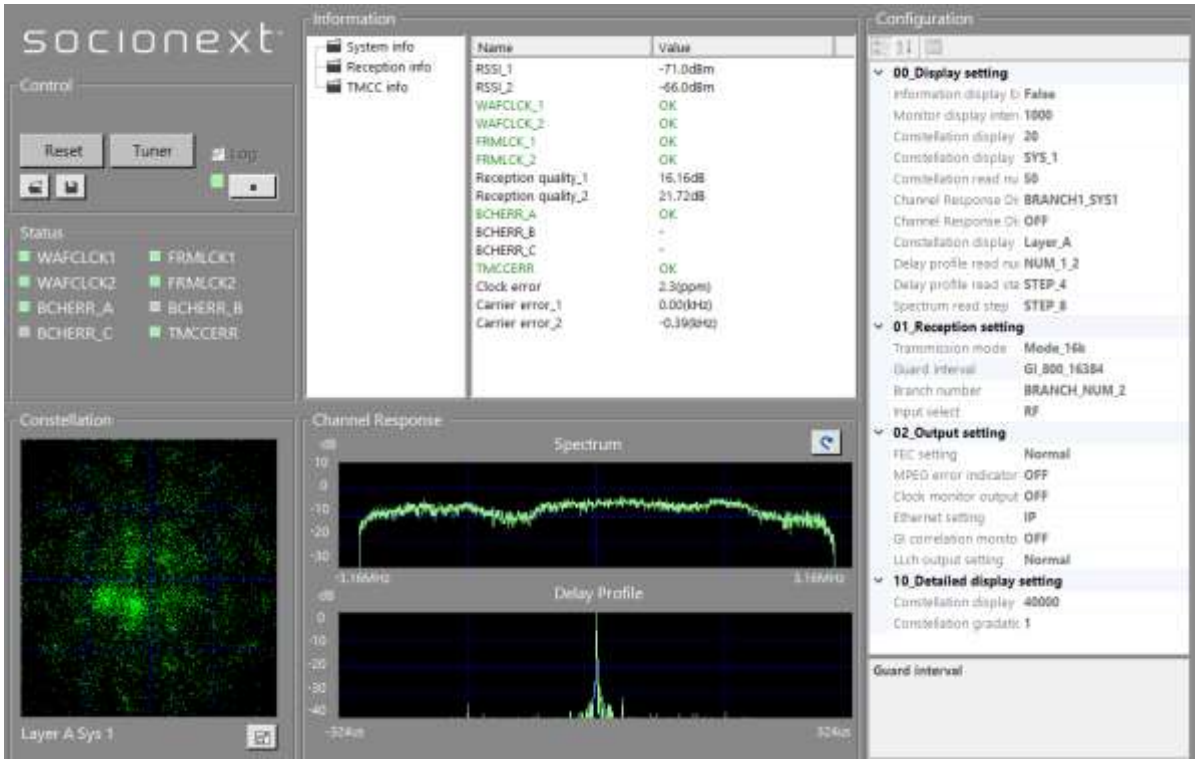


Figure 29.13 - Socionext Screen

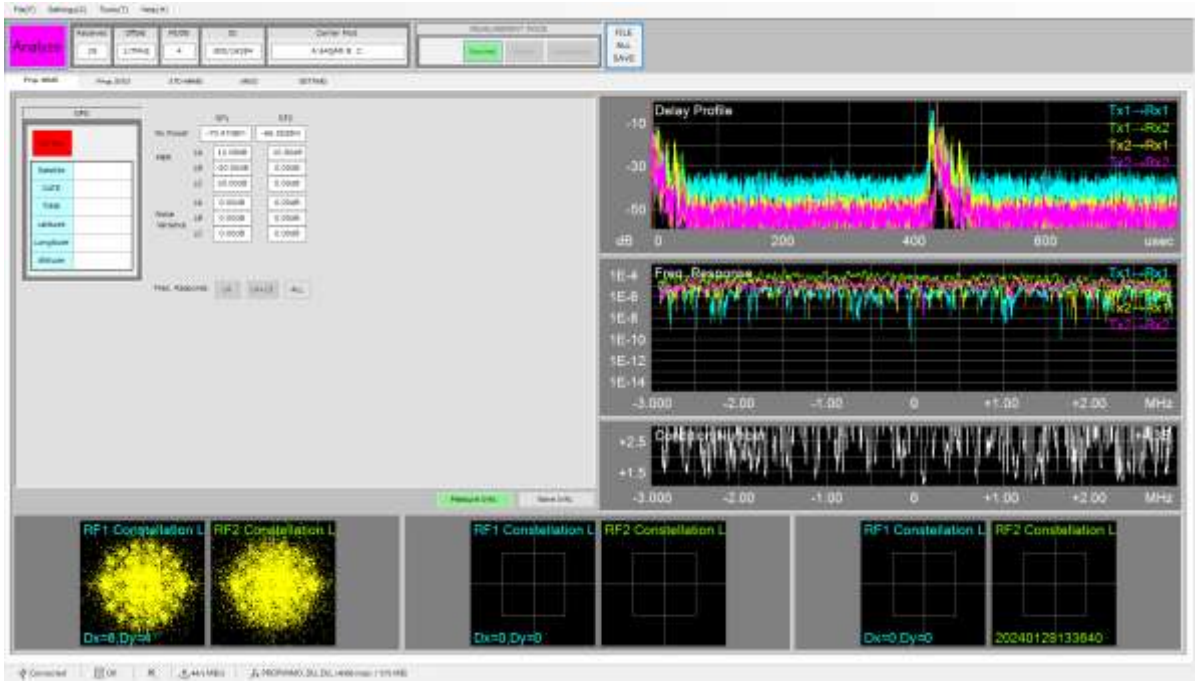


Figure 29.14 - Rintaro Screen

Chapter 30. Site 30

a) Channel Power

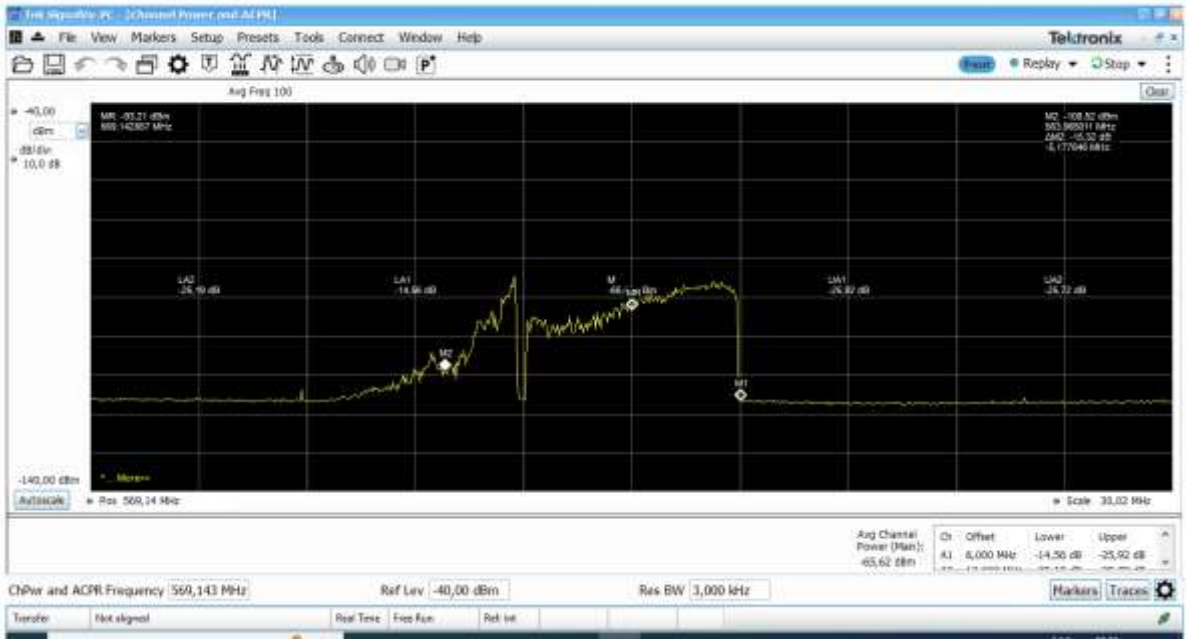


Figure 30.1 - Vertical

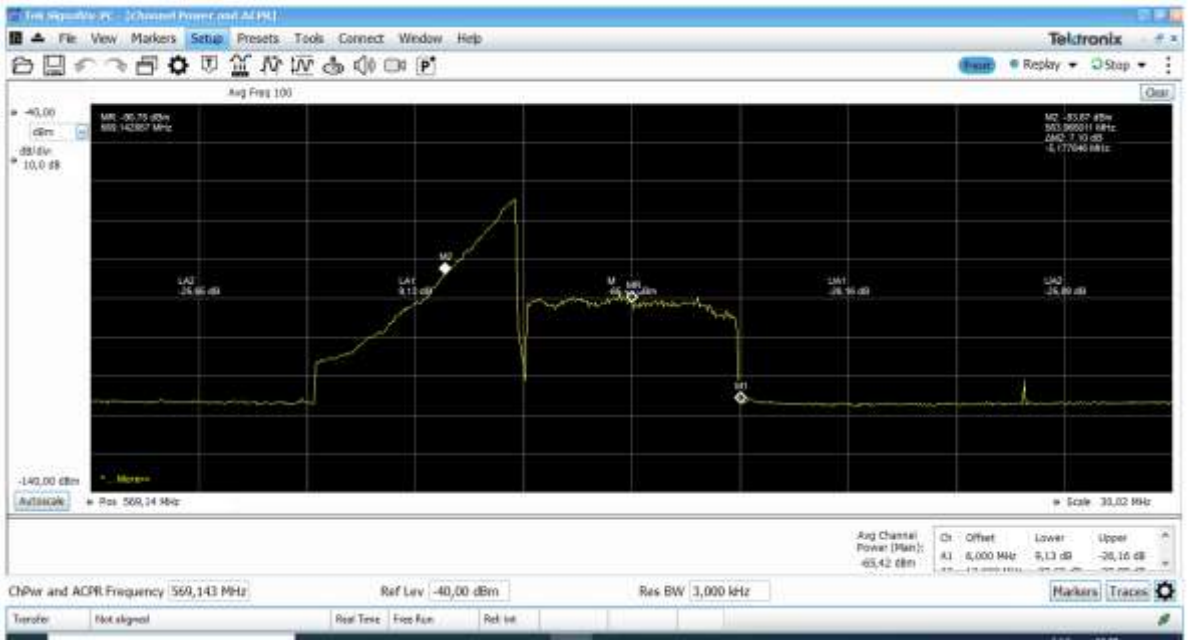


Figure 30.2 - Horizontal

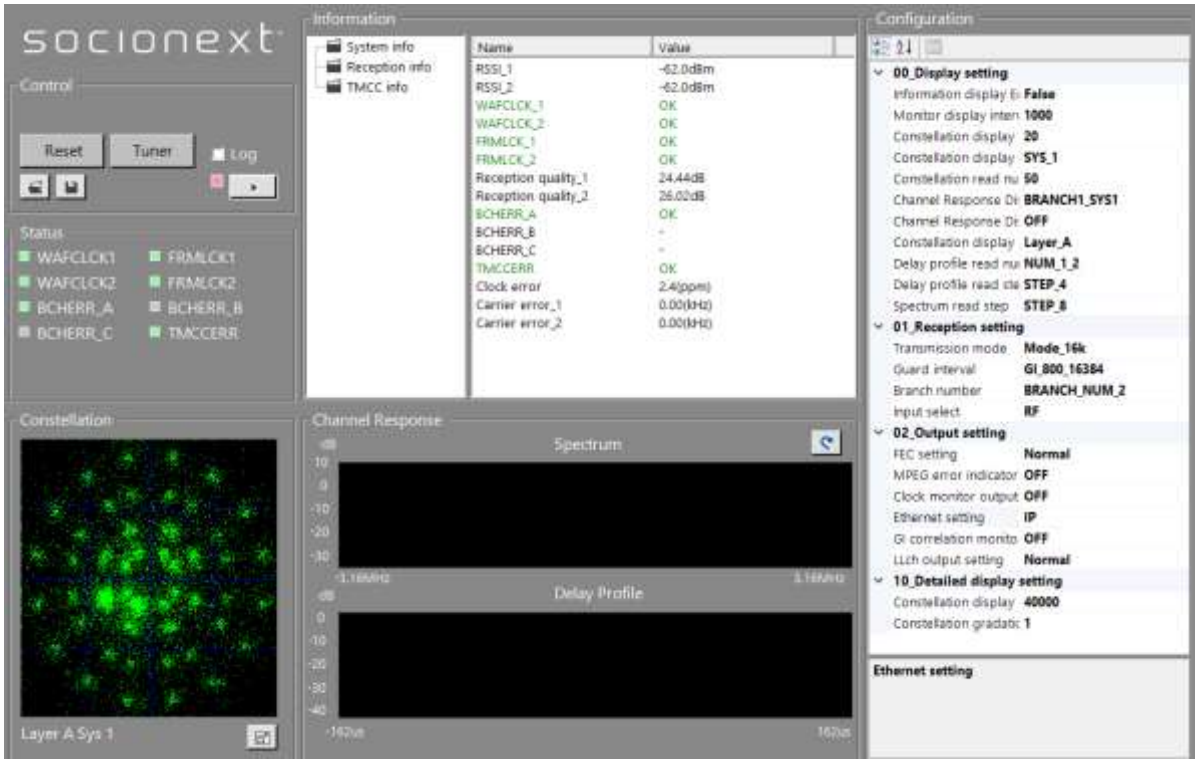


Figure 30.3 - Socionext Screen

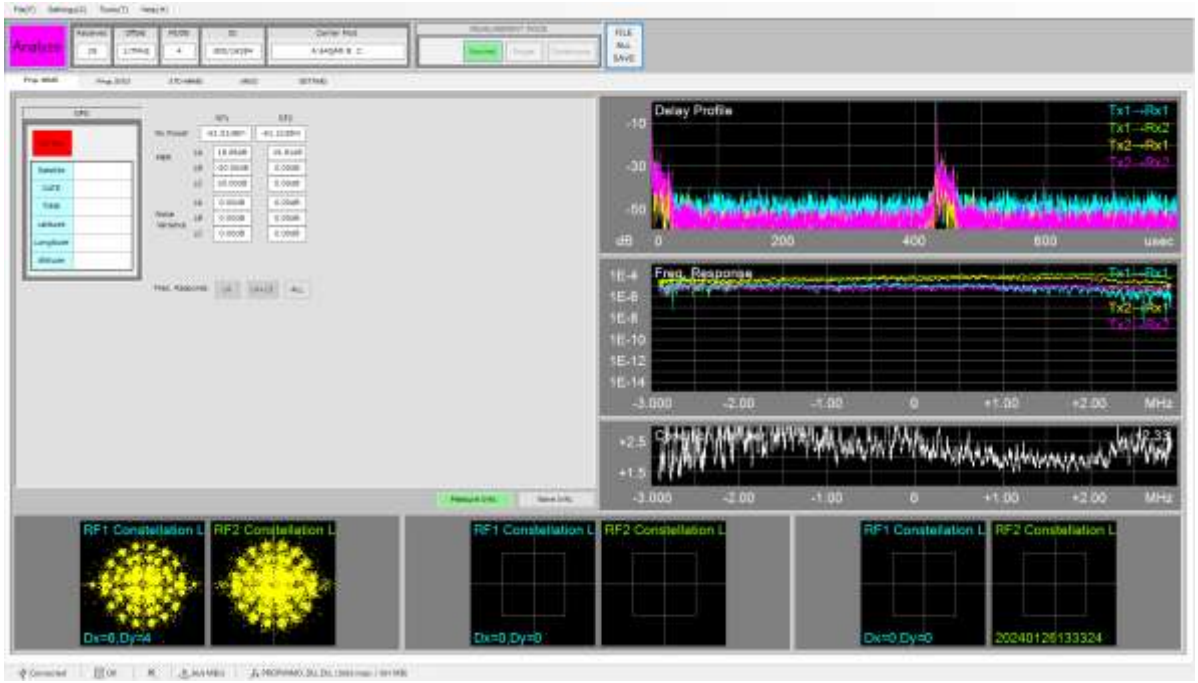


Figure 30.4 - Rintaro Screen

b) AWGN Power

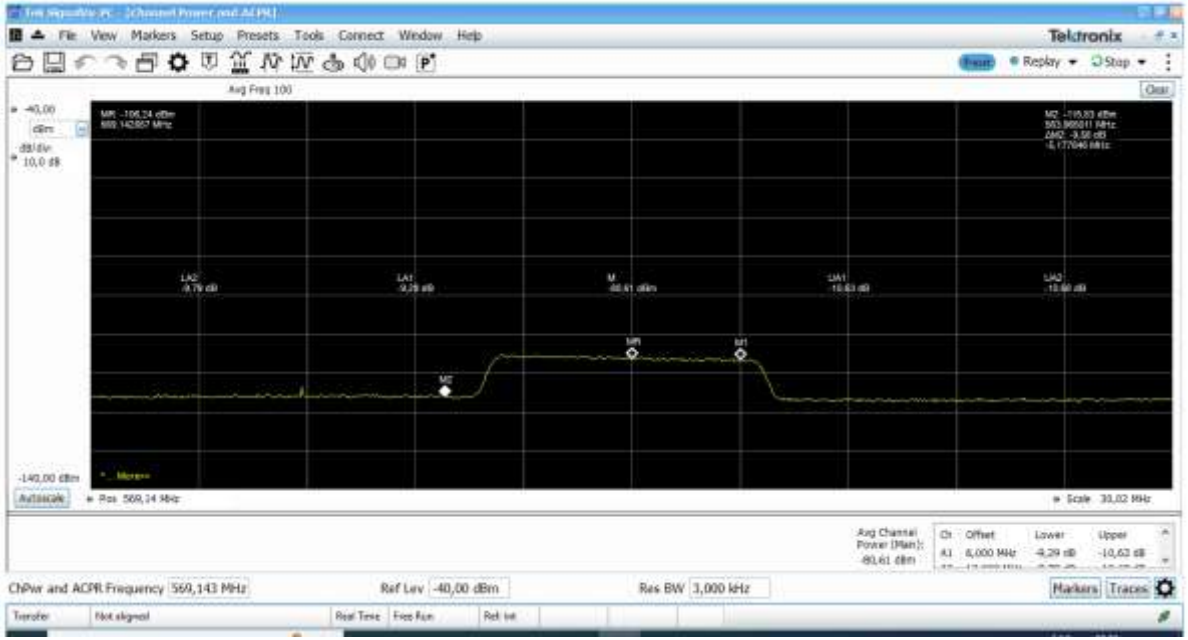


Figure 30.5 - Vertical

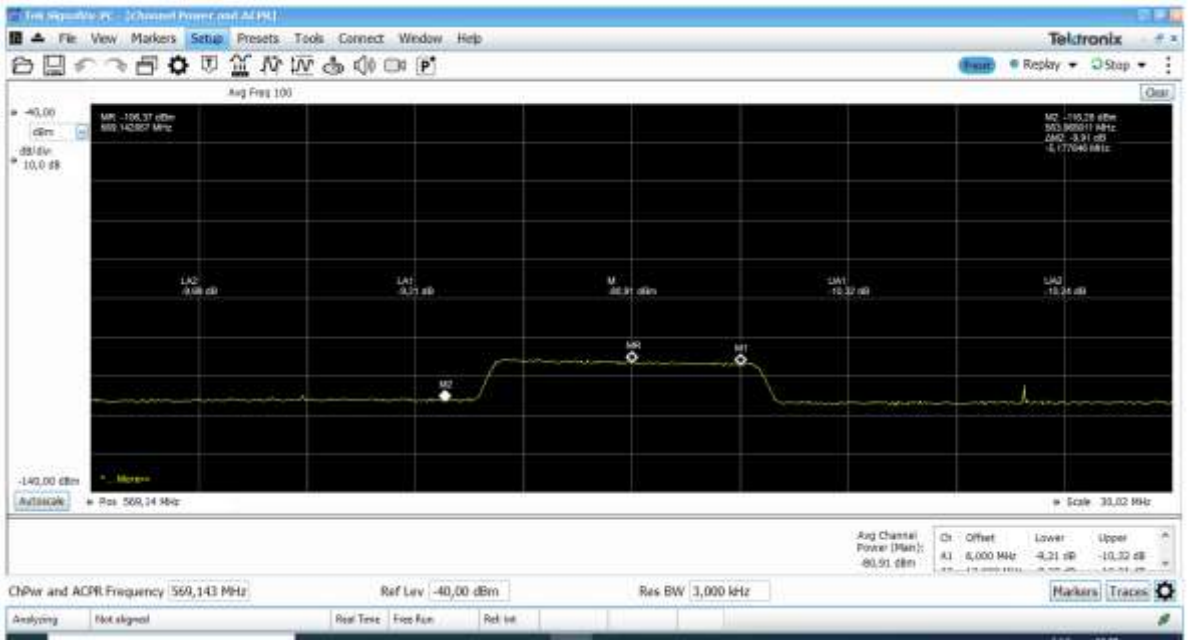


Figure 30.6 - Horizontal

c) C/N Threshold

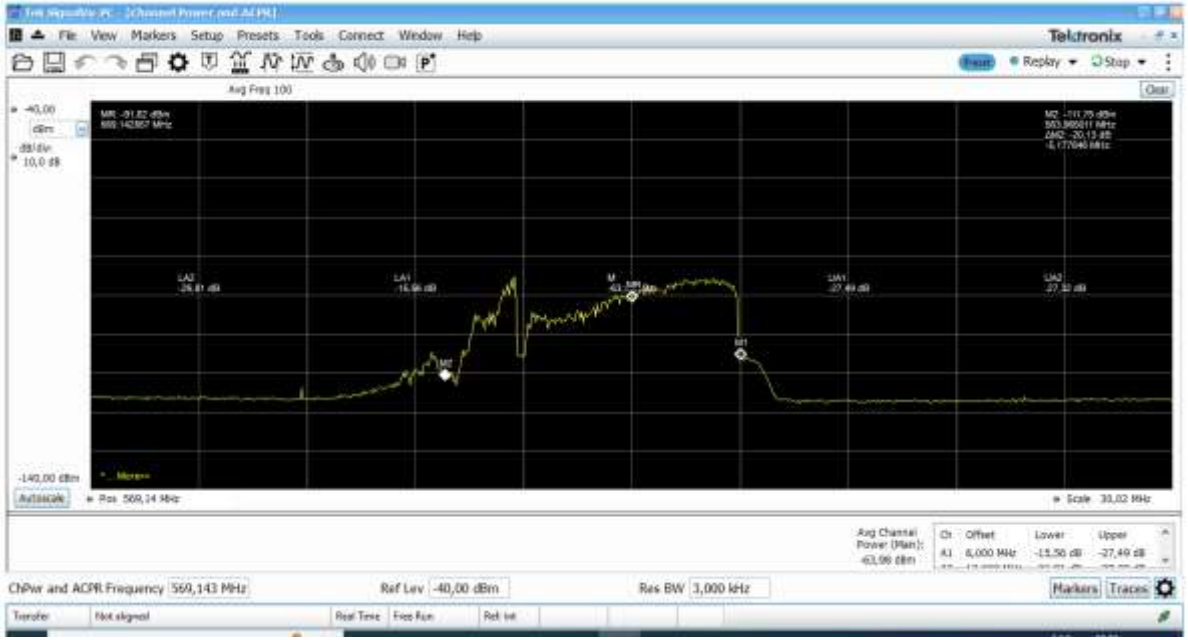


Figure 30.7 - Vertical

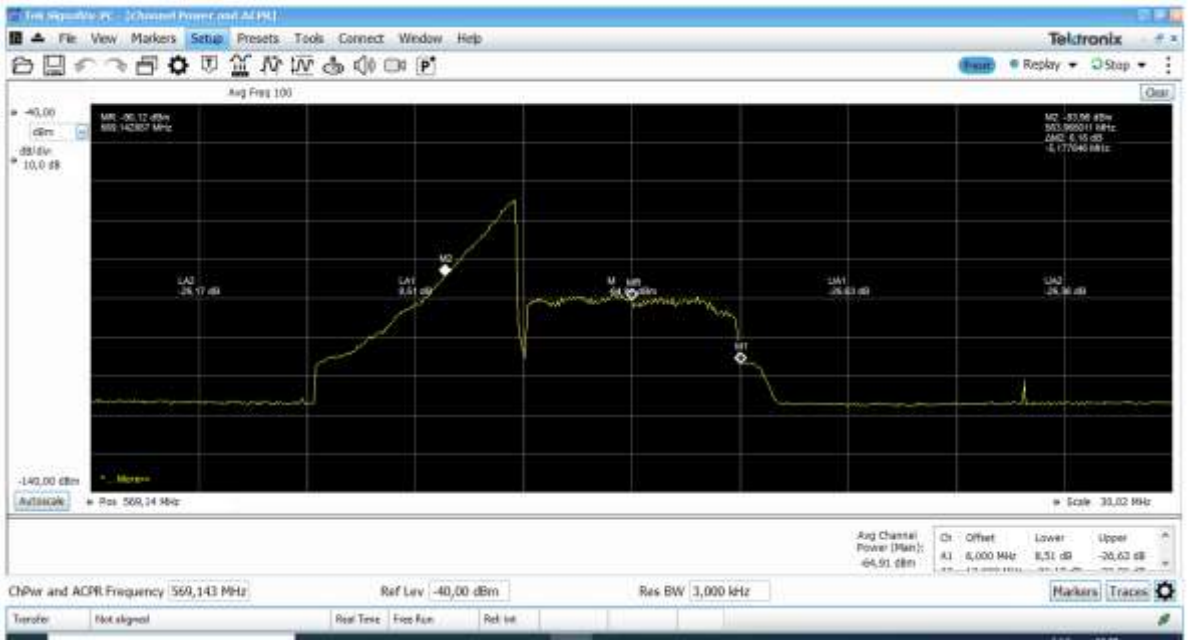


Figure 30.8 - Horizontal

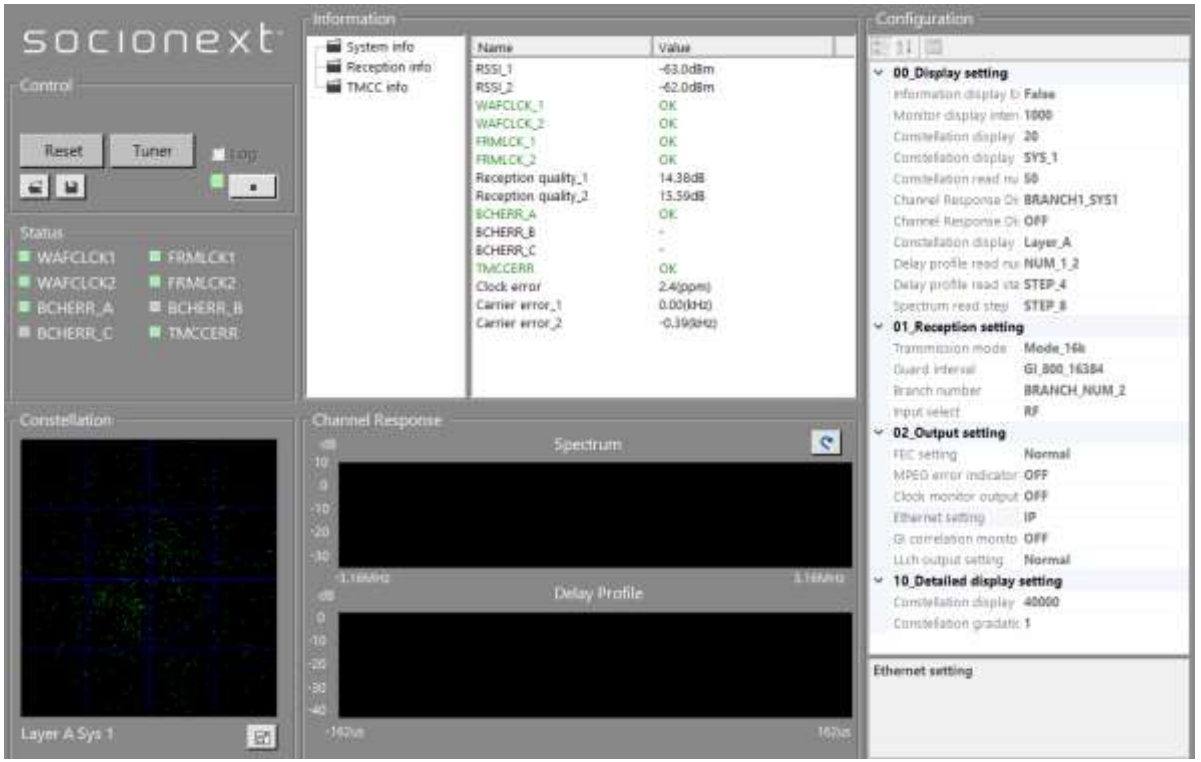


Figure 30.9 - Socionext Screen

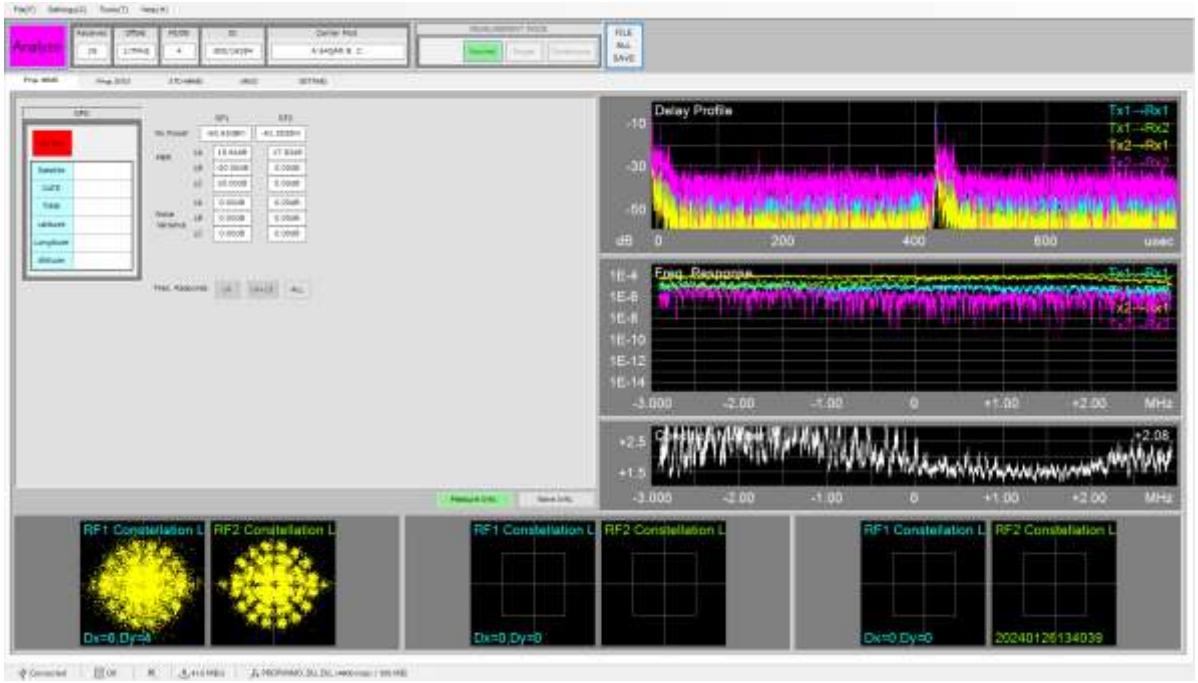


Figure 30.10 - Rintaro Screen

d) Reception Threshold

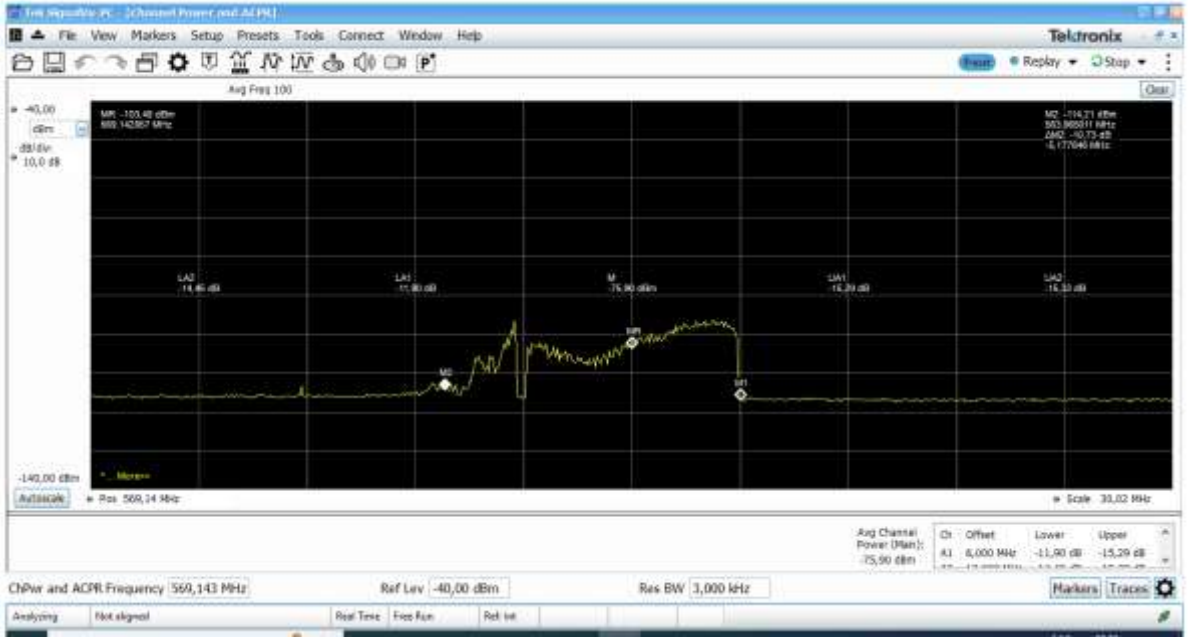


Figure 30.11 - Vertical

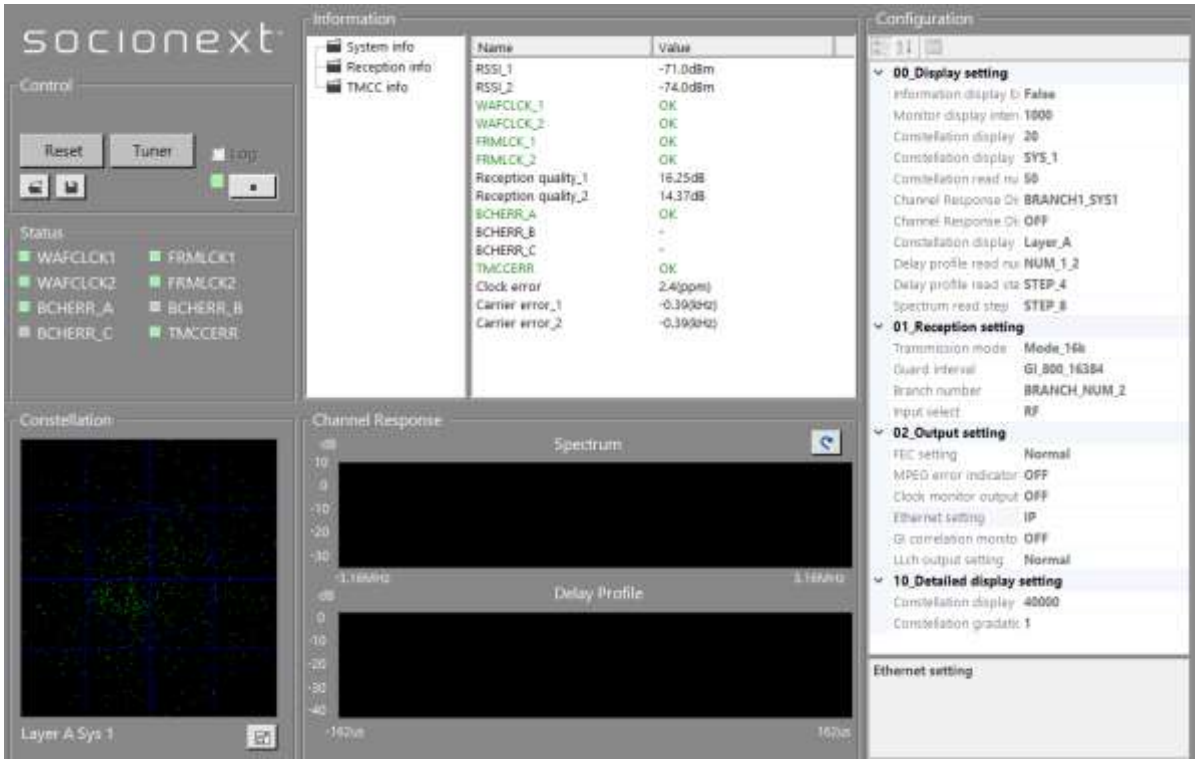


Figure 30.12 - Socionext Screen

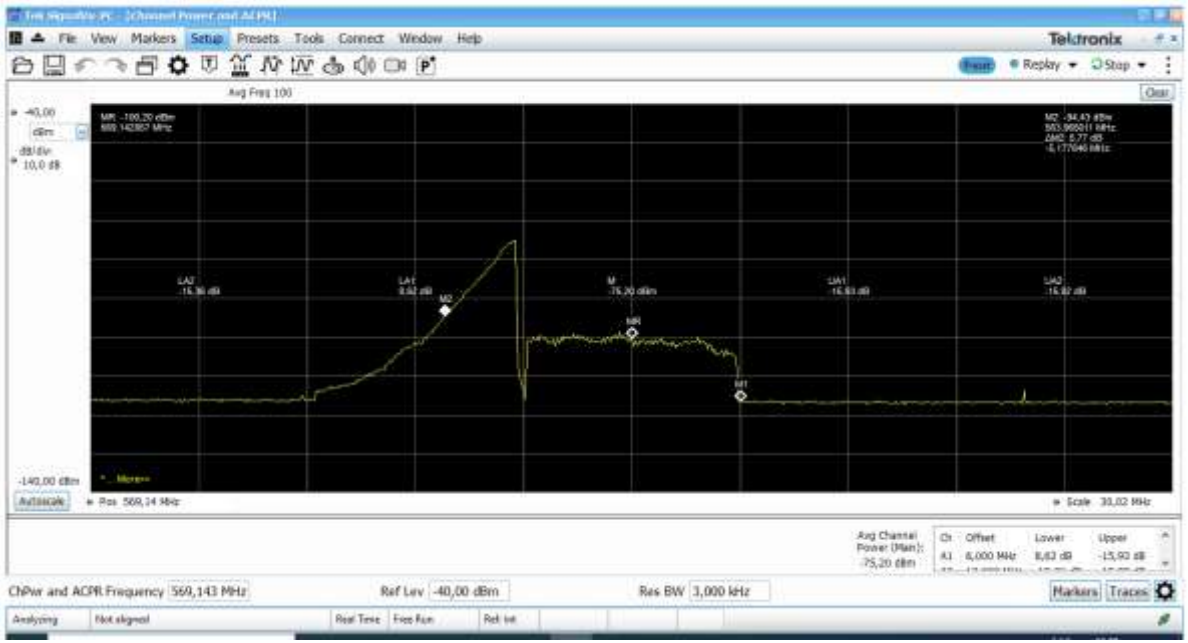


Figure 30.13 - Horizontal

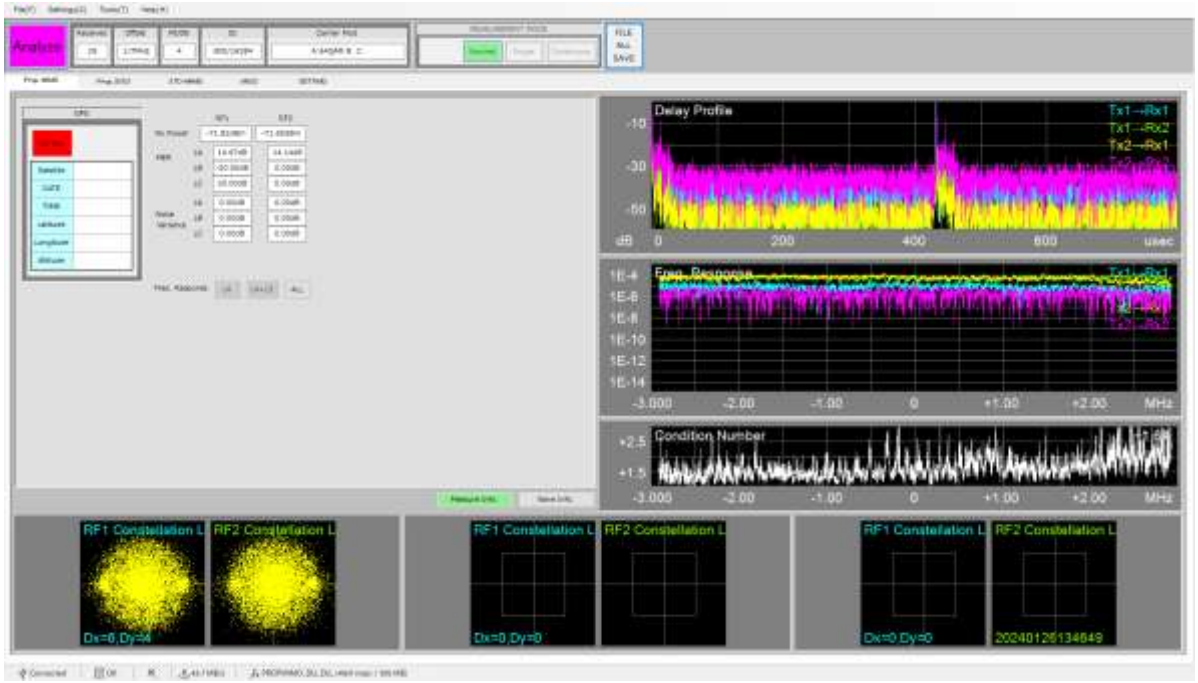


Figure 30.14 - Rintaro Screen

Appendix II. Advanced ISDB-T - Indoor Sites - Configuration 1 - Single Layer: 64-QAM NUC, FEC 8/16, Bitrate 30.9 Mbps

Chapter 1. Site 1

a) Channel Power

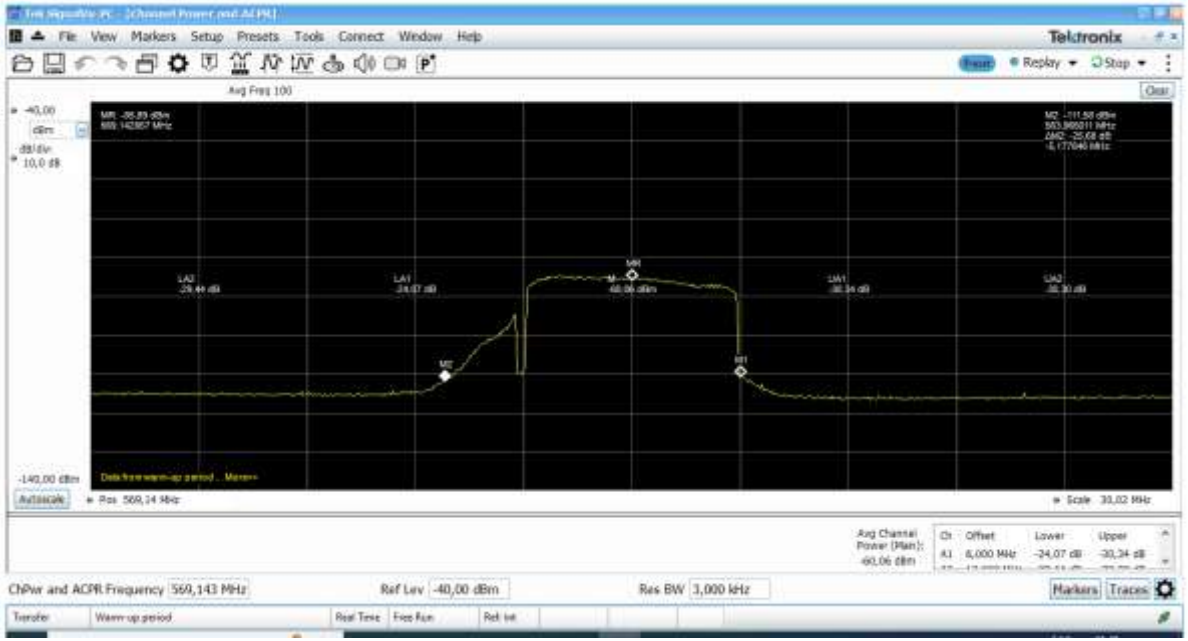


Figure 1.1 - Vertical

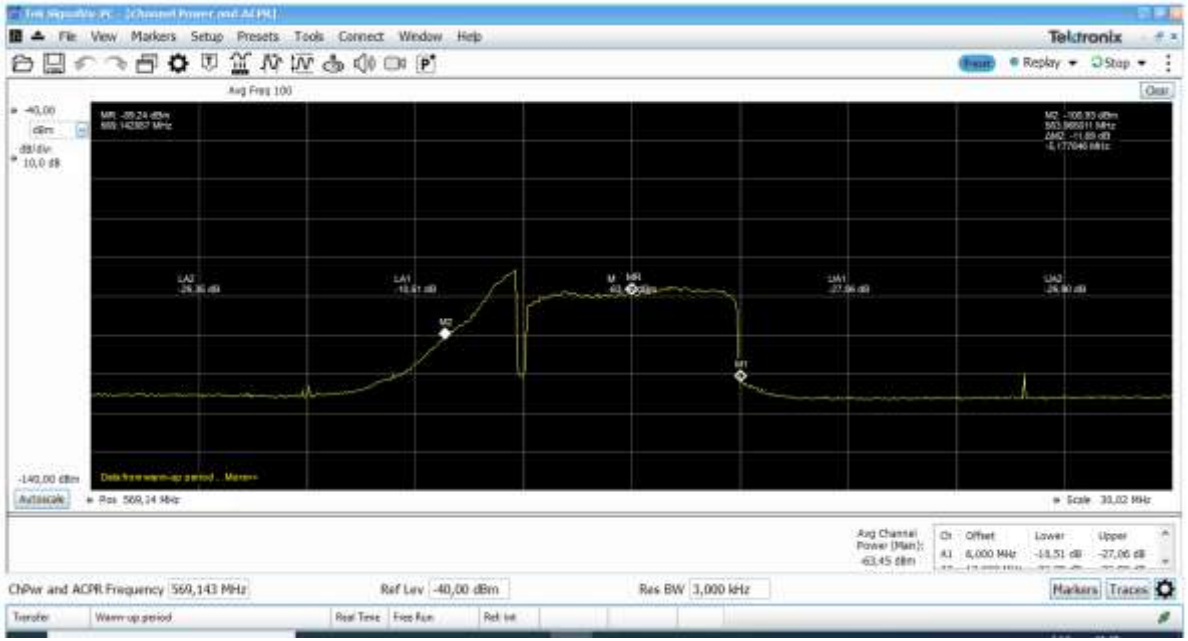


Figure 1.2 - Horizontal

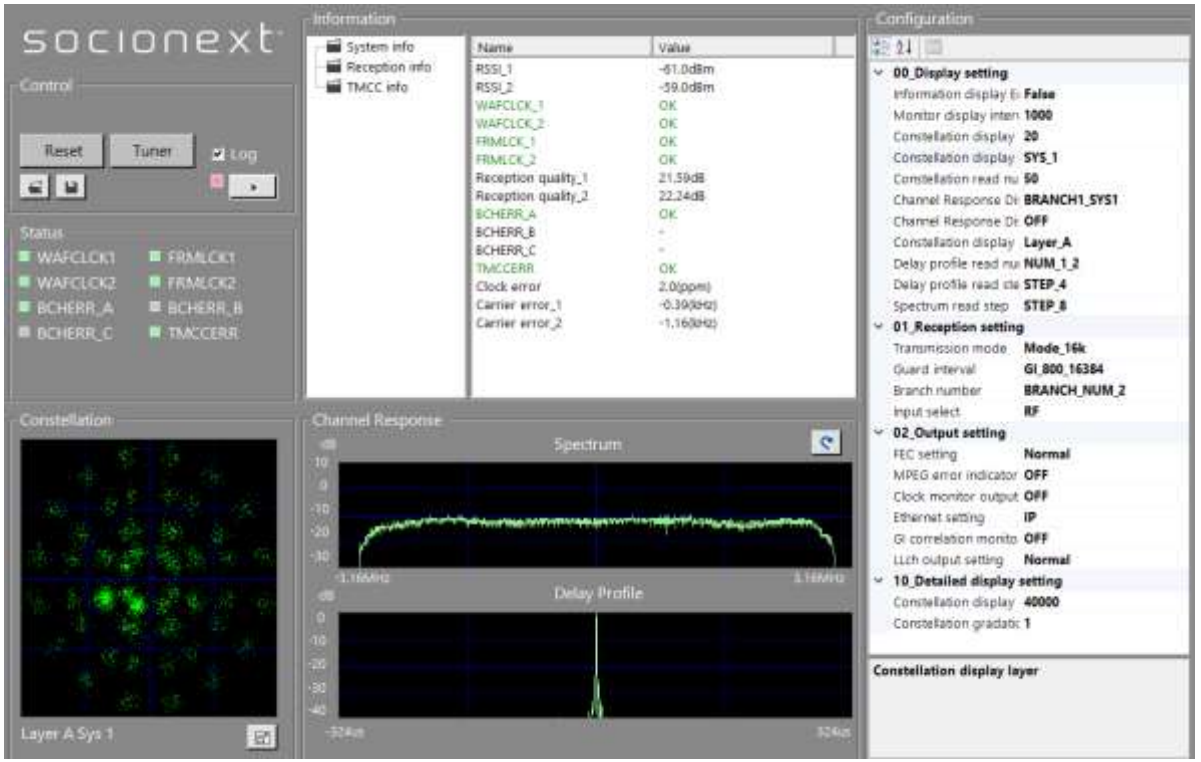


Figure 1.3 - Socionext Screen

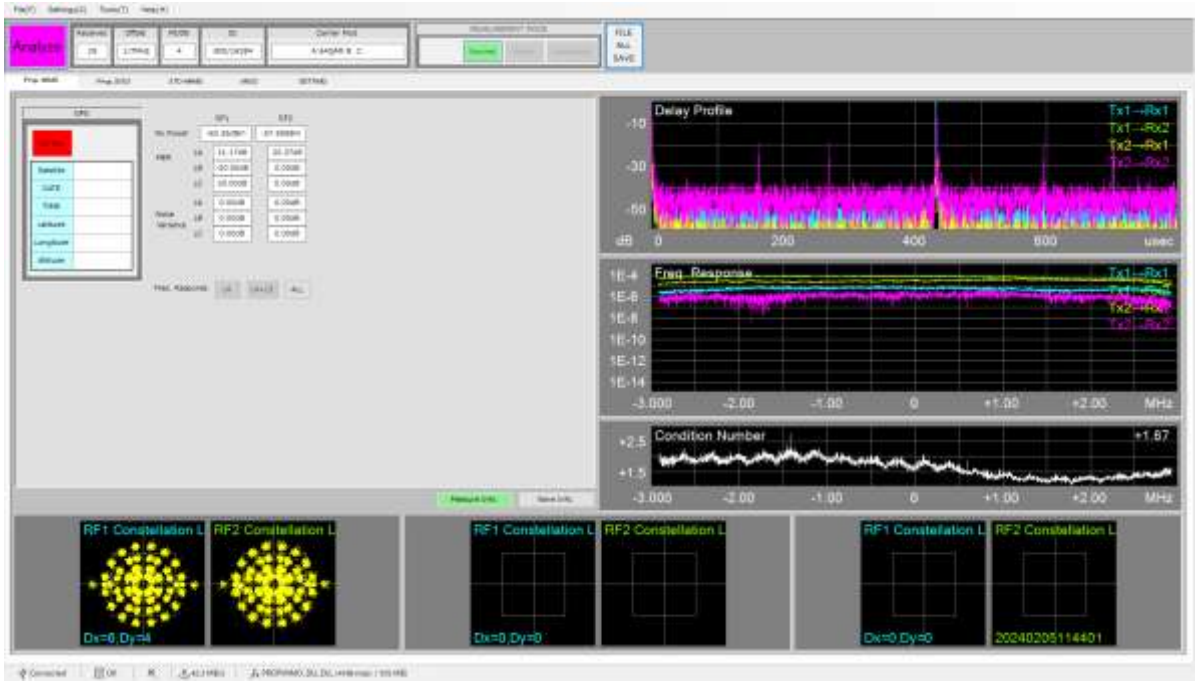


Figure 1.4 - Rintaro Screen

b) AWGN Power

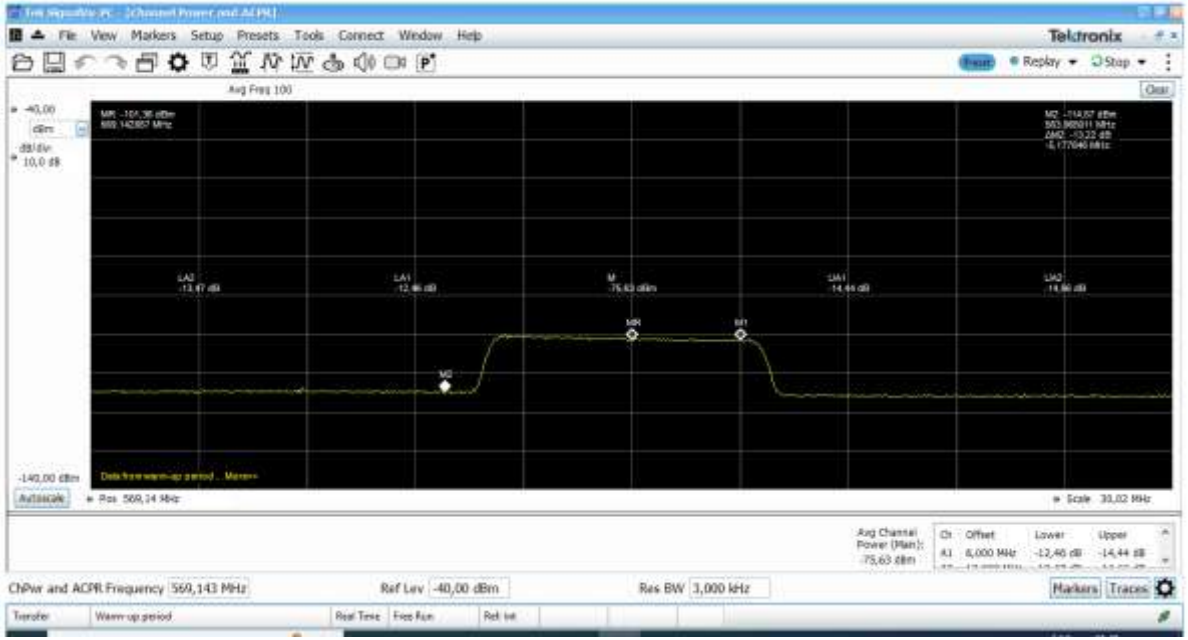


Figure 1.5 - Vertical

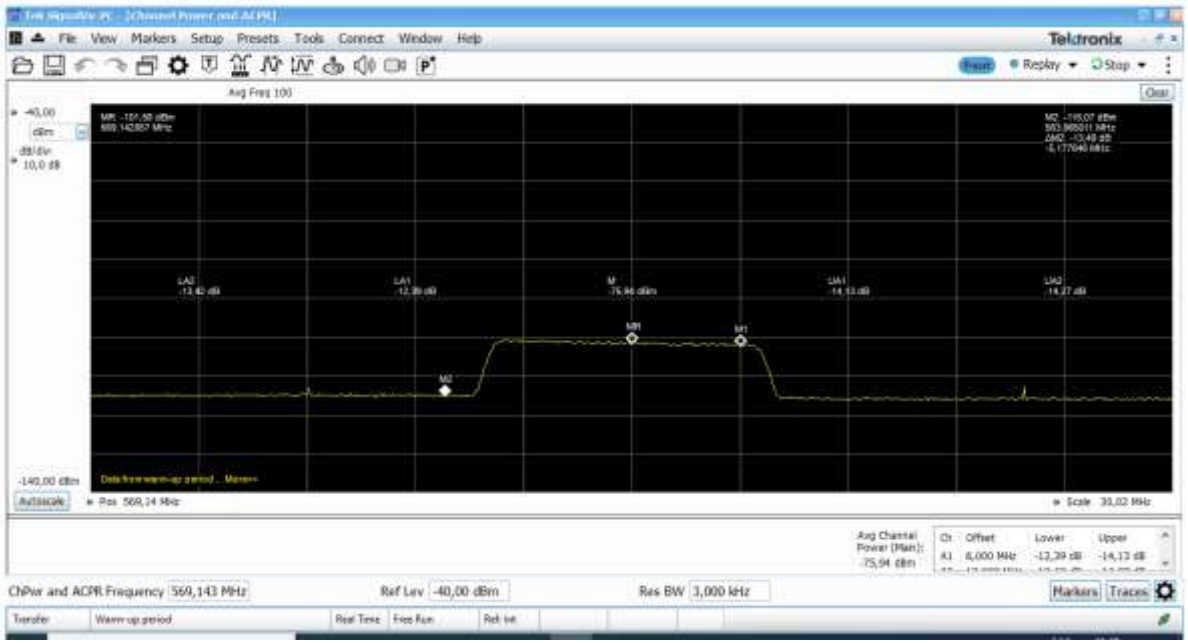


Figure 1.6 - Horizontal

c) C/N Threshold

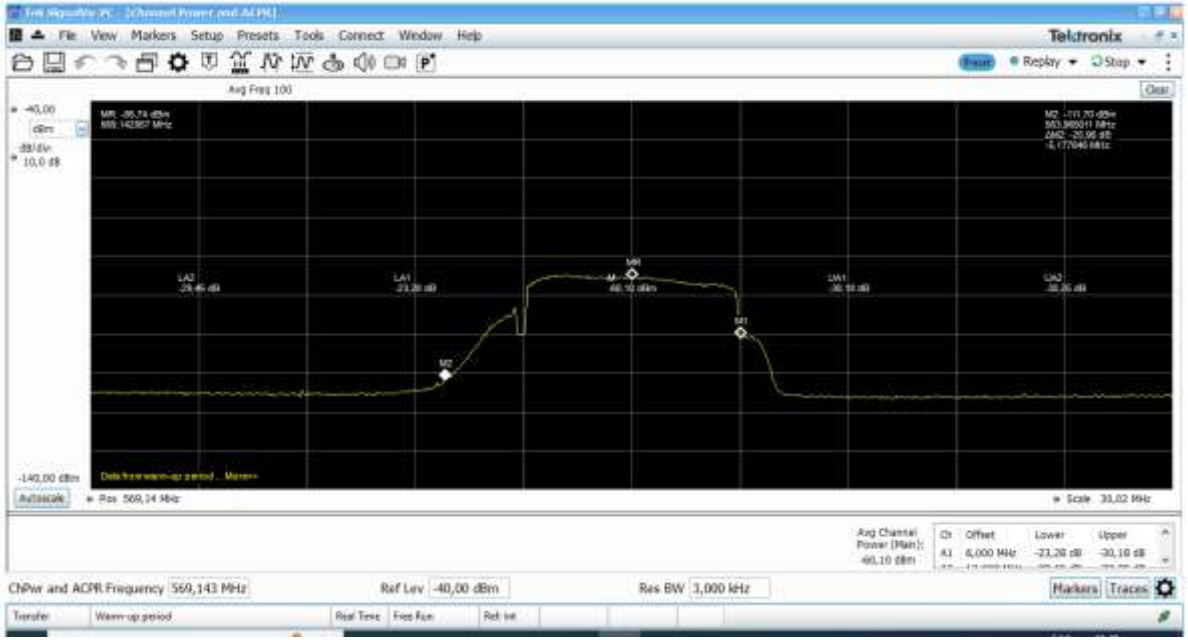


Figure 1.7 - Vertical

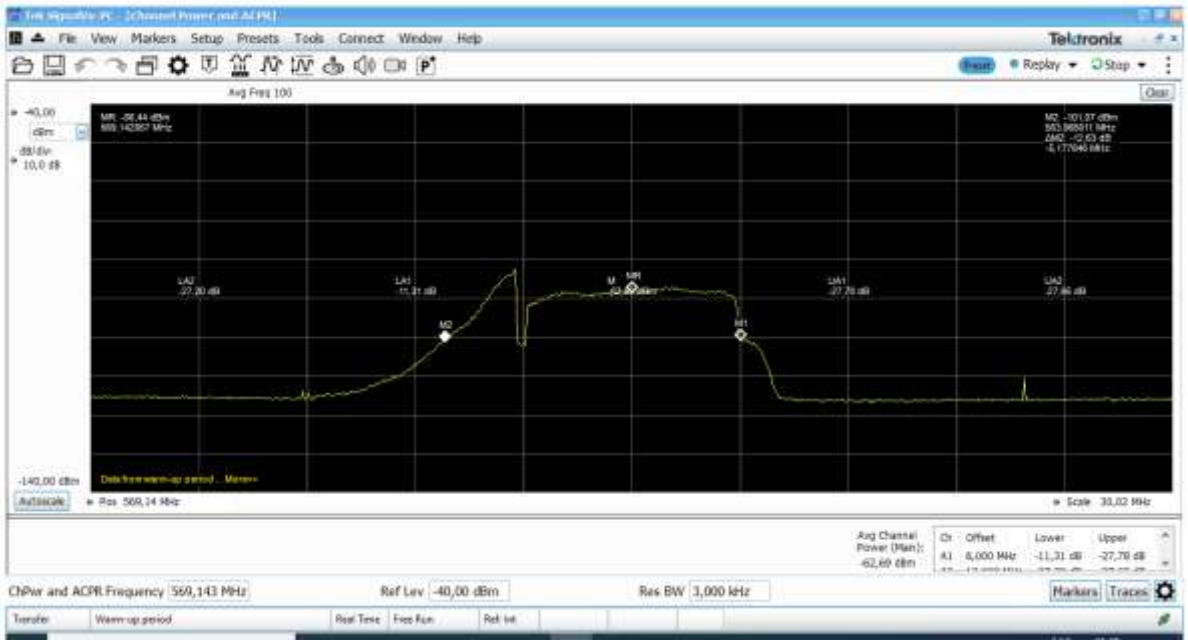


Figure 1.8 - Horizontal

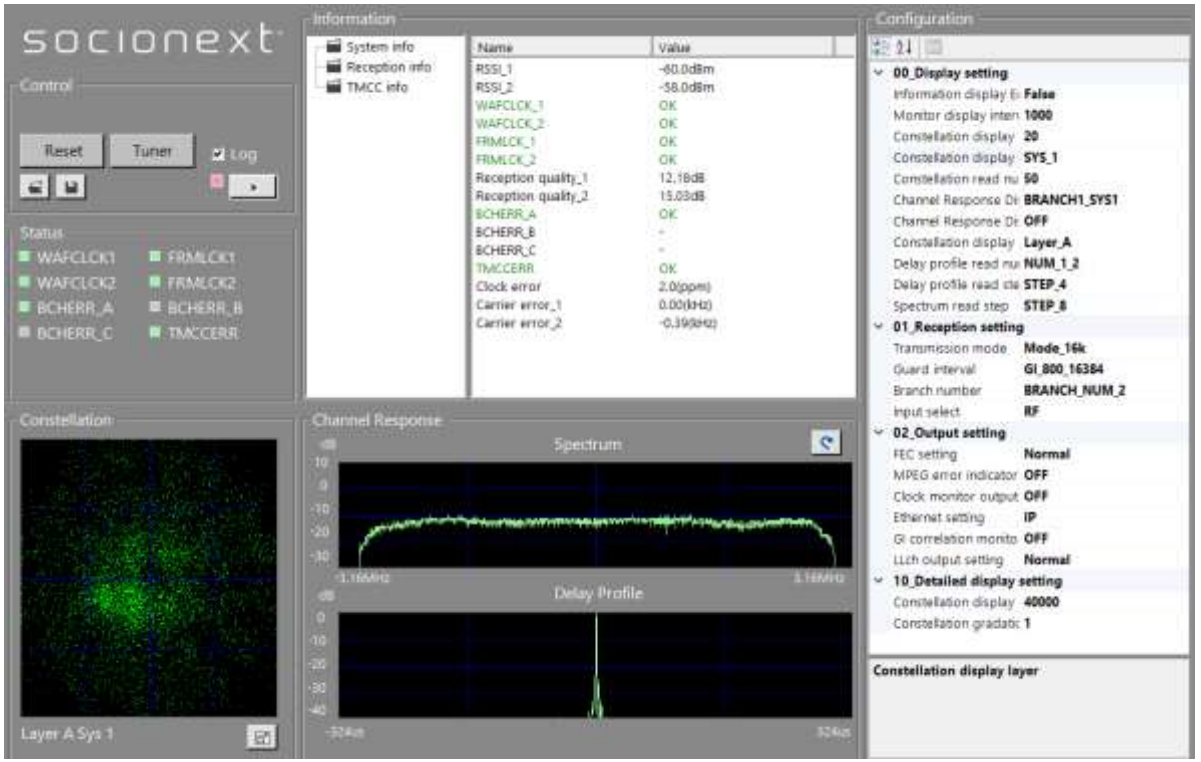


Figure 1.9 - Socionext Screen

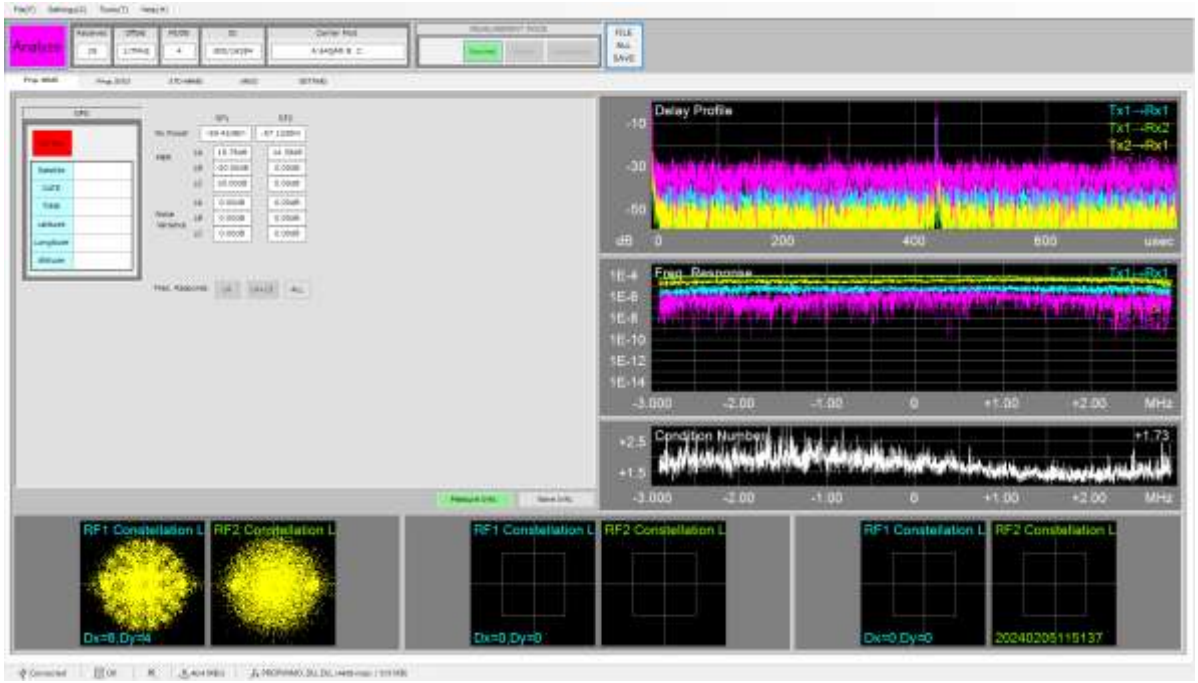


Figure 1.10 - Rintaro Screen

d) Reception Threshold

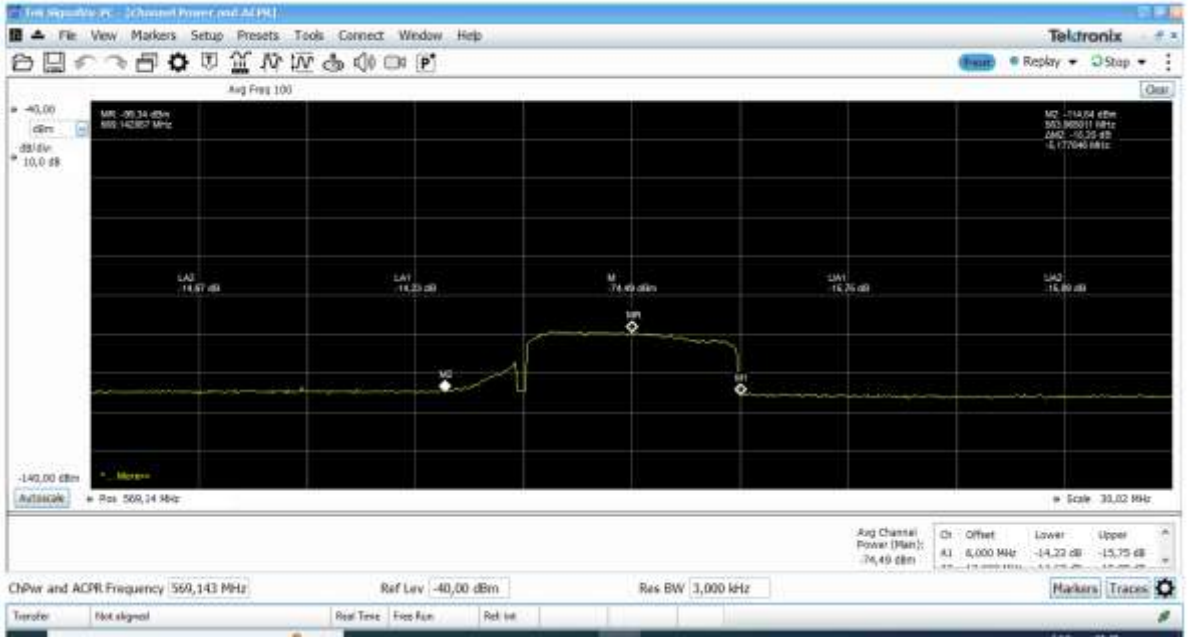


Figure 1.11 - Vertical

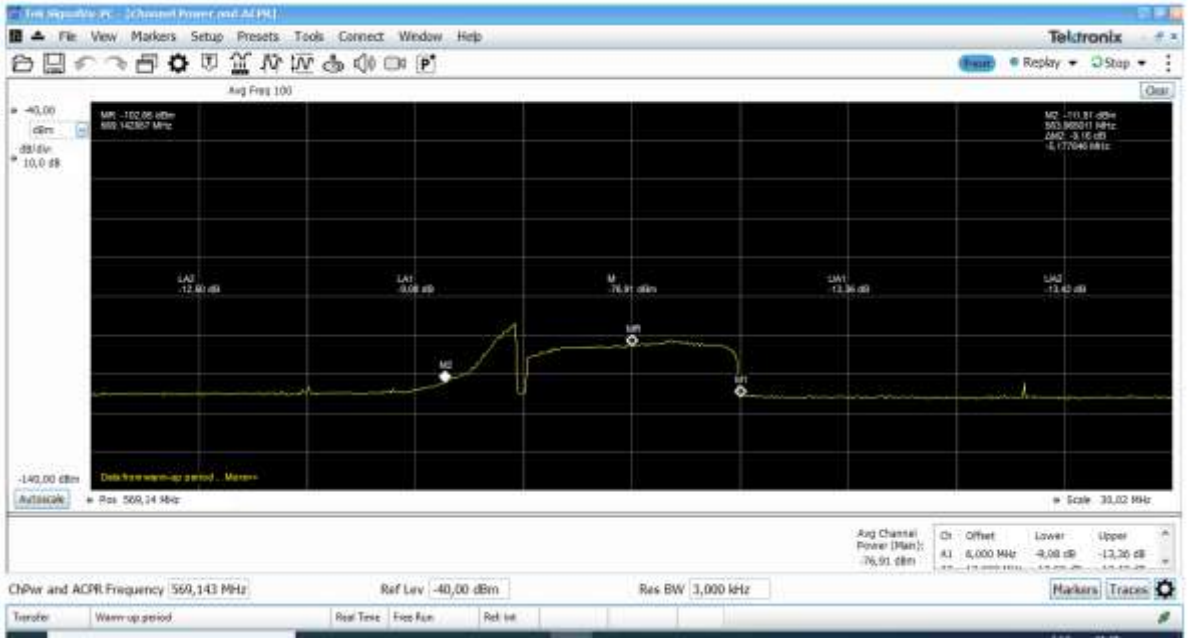


Figure 1.12 - Horizontal

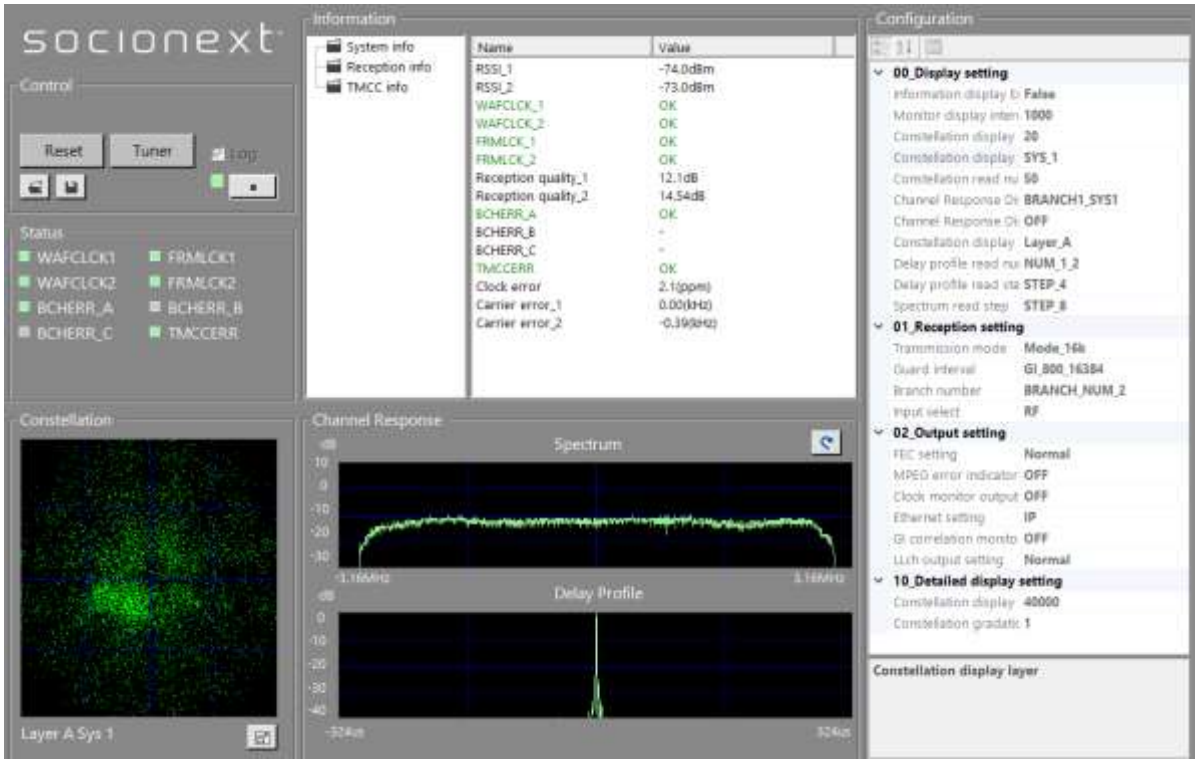


Figure 1.13 - Socionext Screen

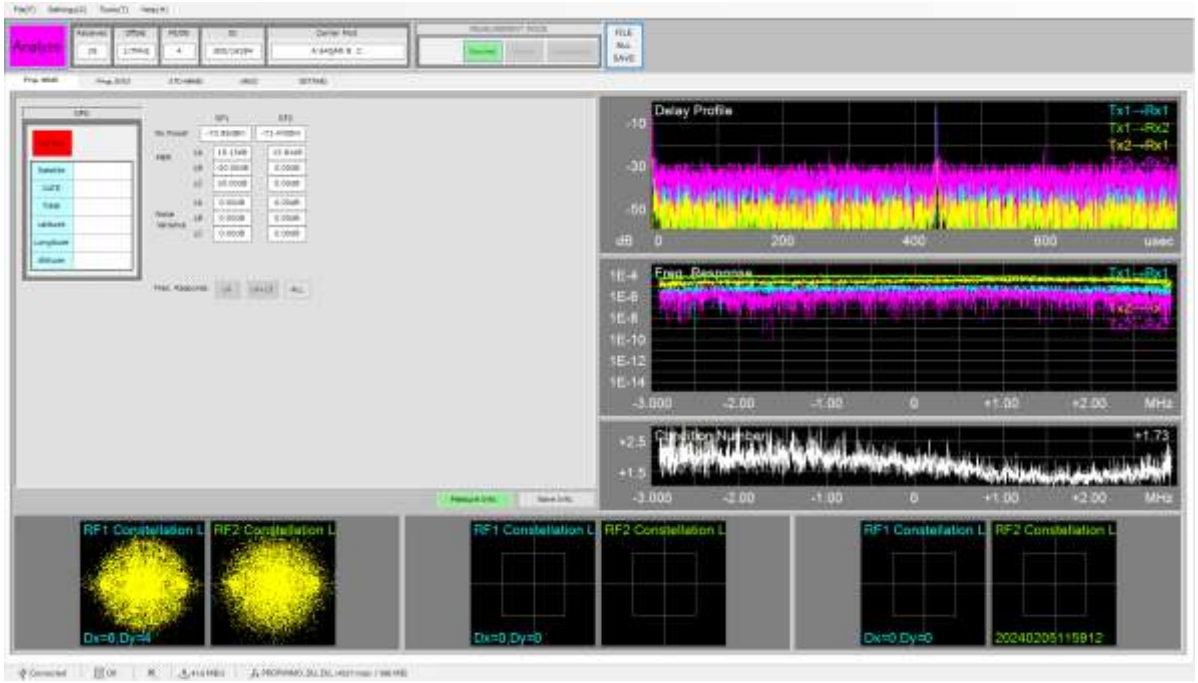


Figure 1.14 - Rintaro Screen

Chapter 2. Site 3

a) Channel Power

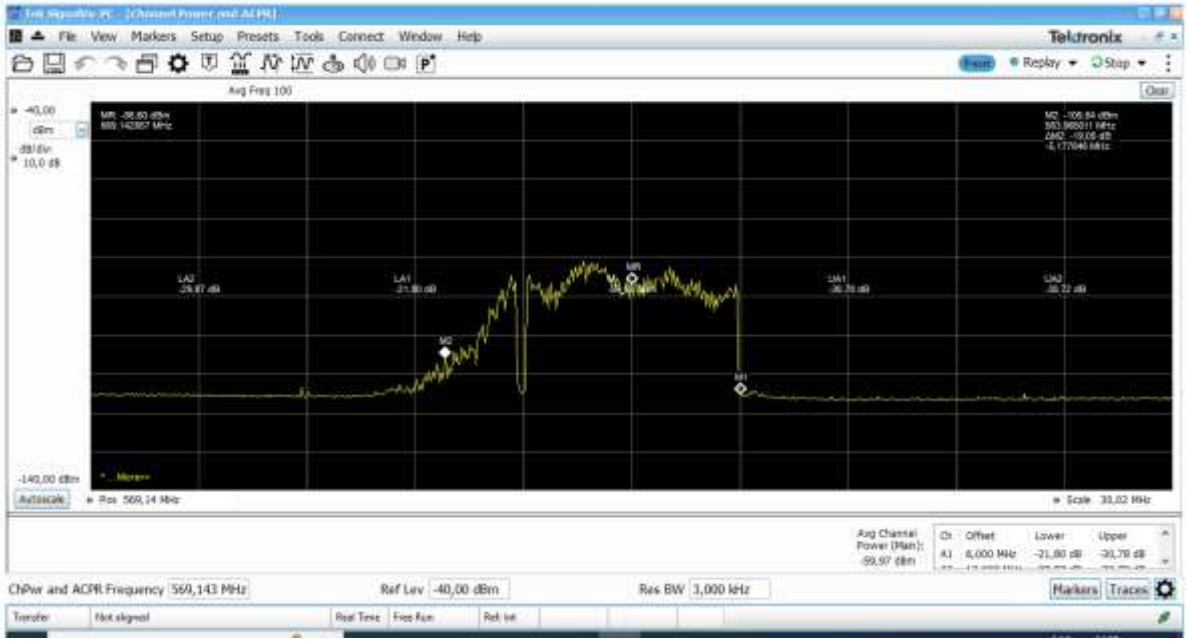


Figure 2.1 - Vertical

Figure 2.2 - Horizontal

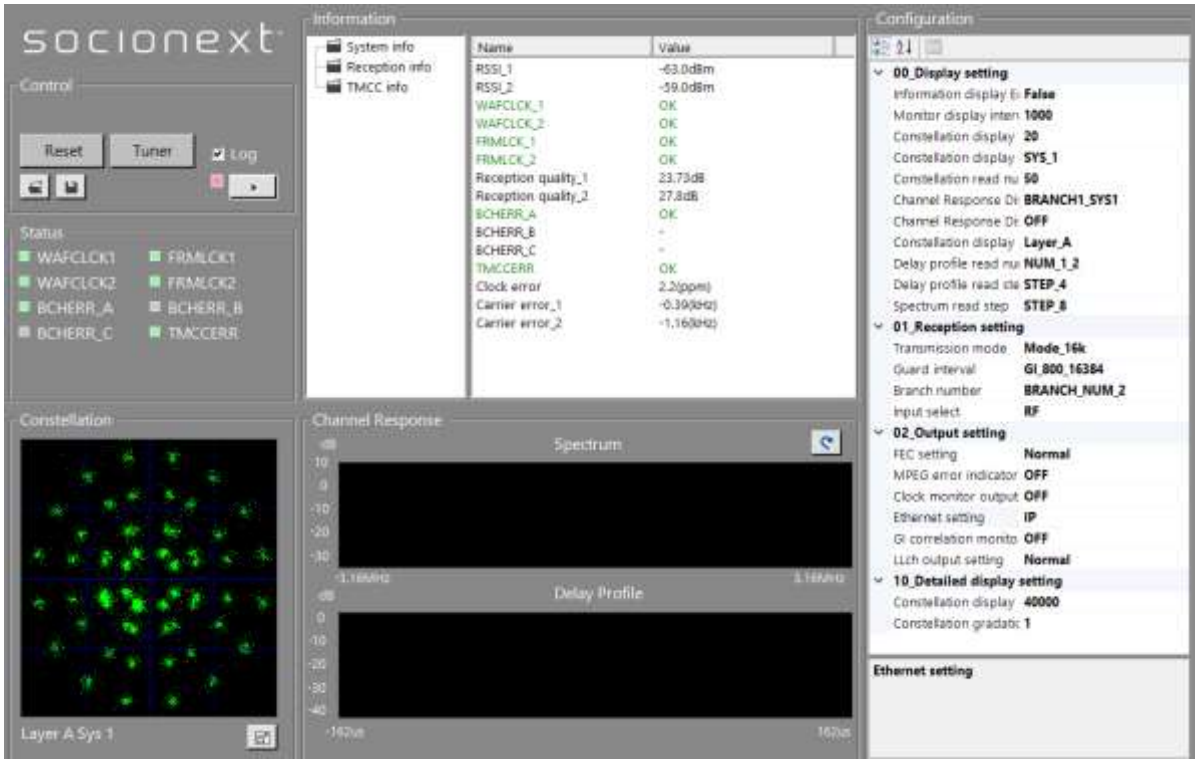


Figure 2.3 - Socionext Screen

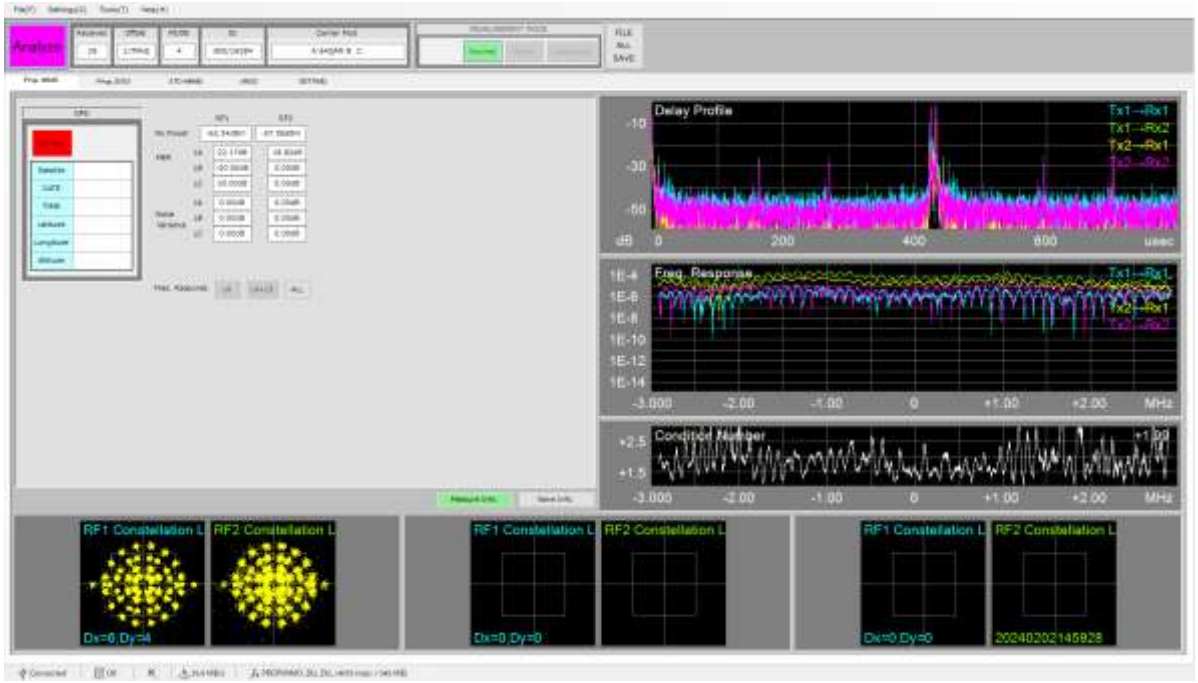


Figure 2.4 - Rintaro Screen

b) AWGN Power

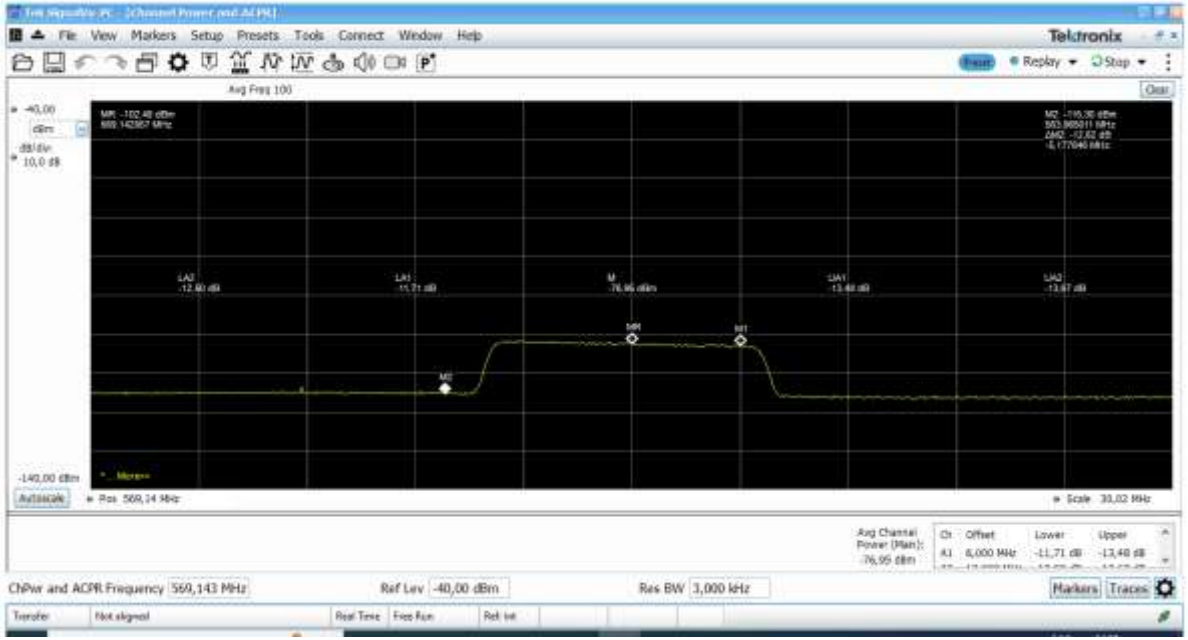


Figure 2.5 - Vertical

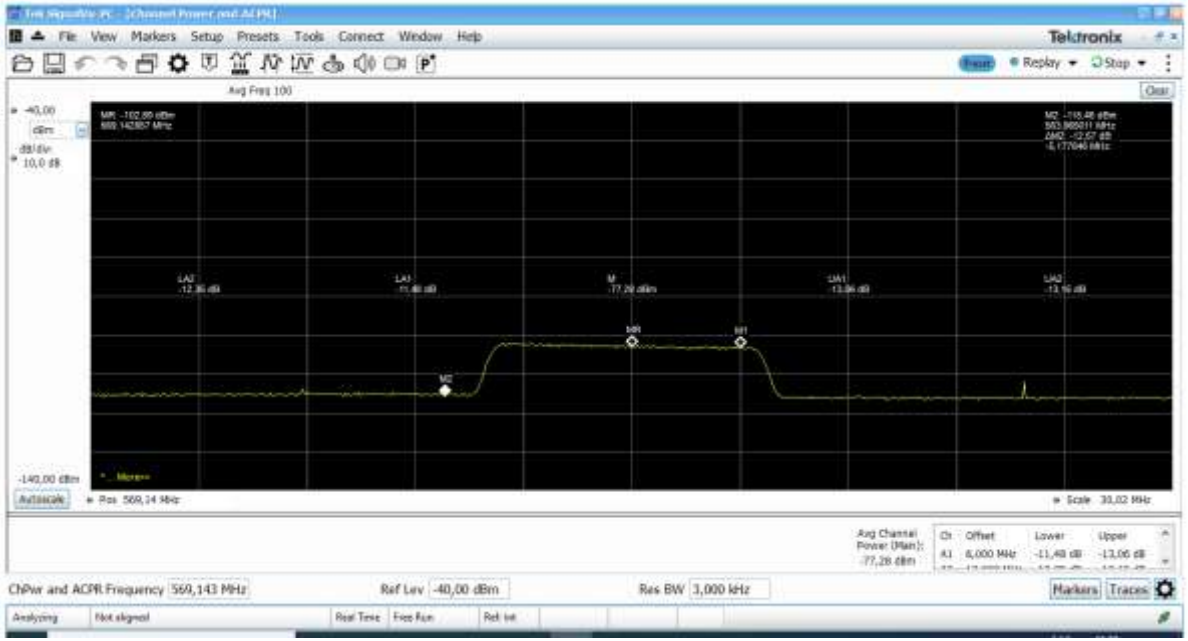


Figure 2.6 - Horizontal

c) C/N Threshold

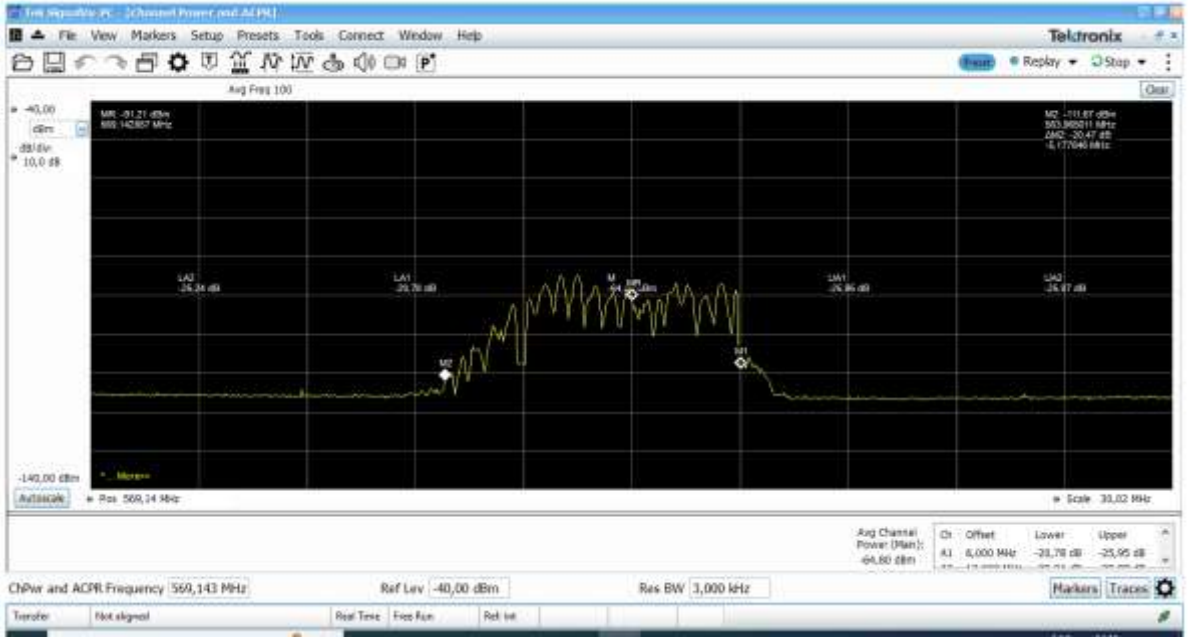


Figure 2.7 - Vertical

Figure 2.8 - Horizontal

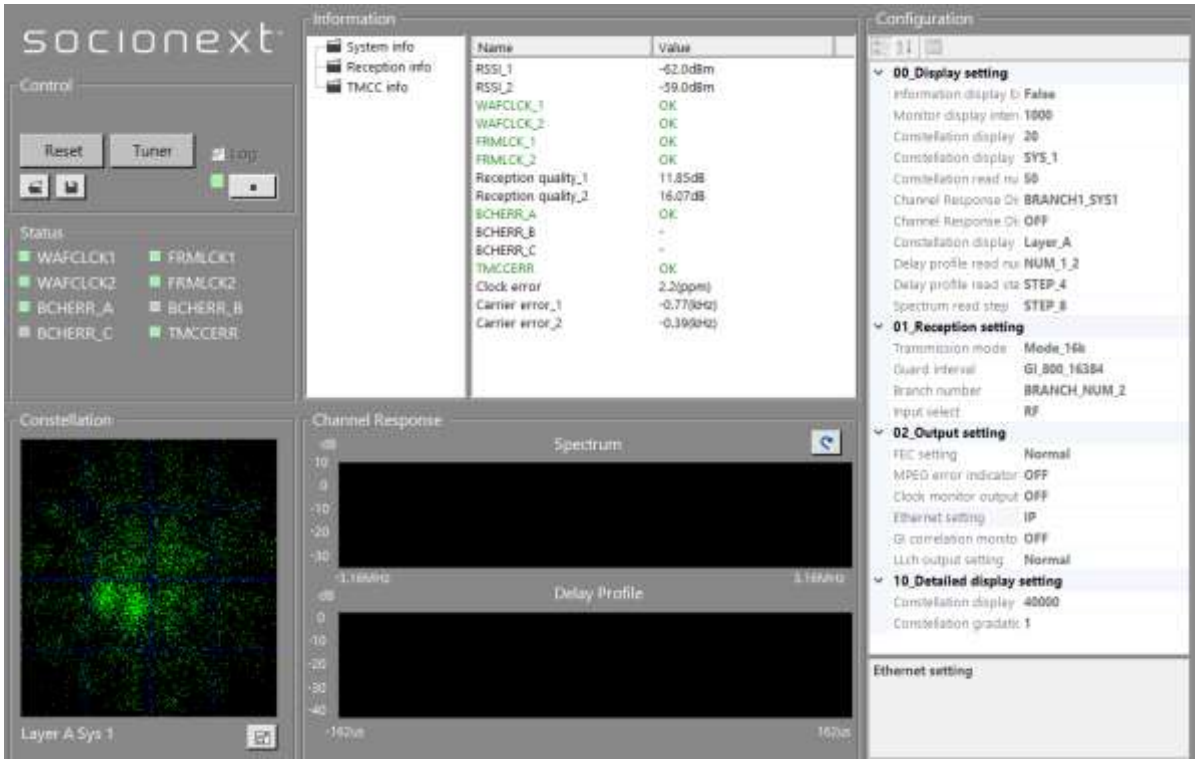


Figure 2.9 - Socionext Screen

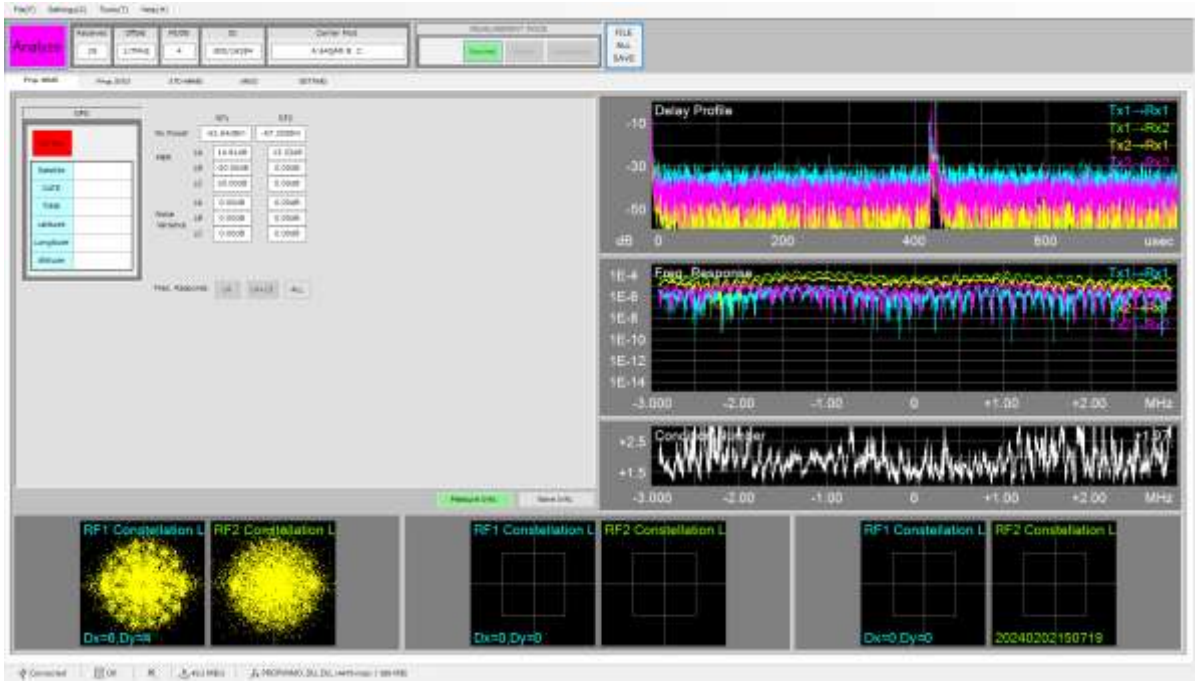


Figure 2.10 - Rintaro Screen

d) Reception Threshold

Figure 2.11 - Vertical

Figure 2.12 - Horizontal

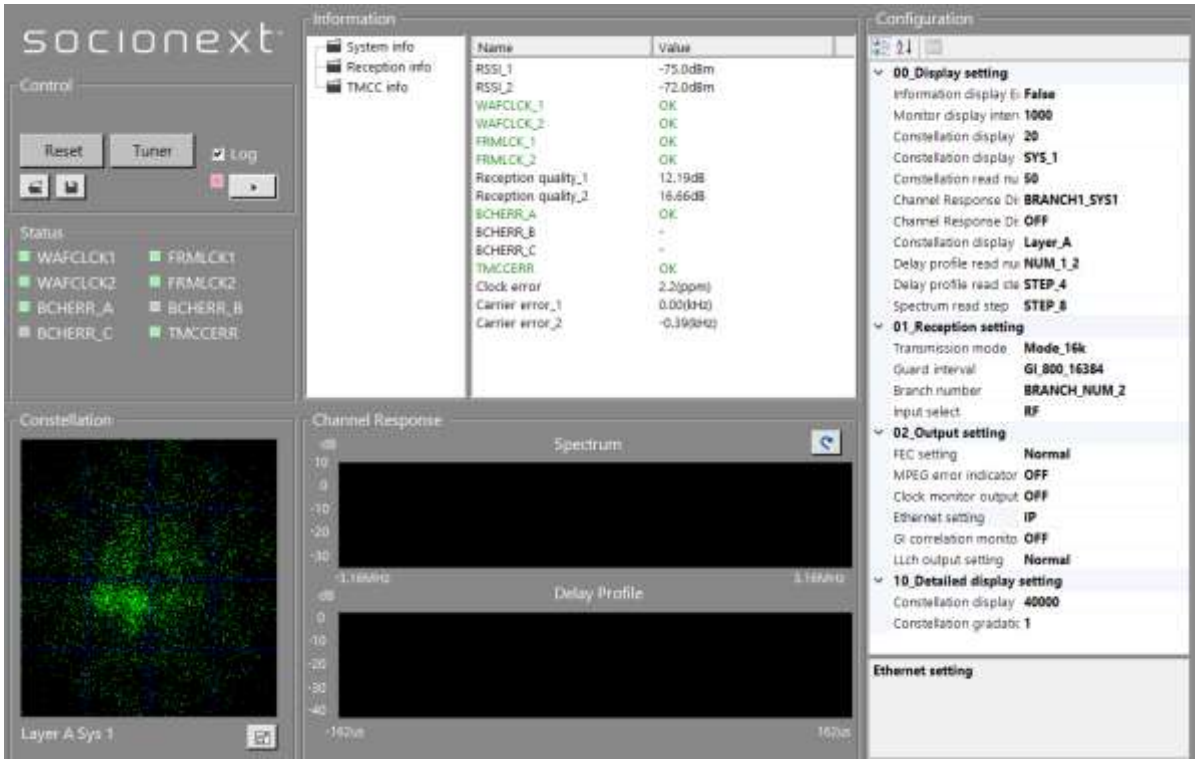


Figure 2.13 - Socionext Screen

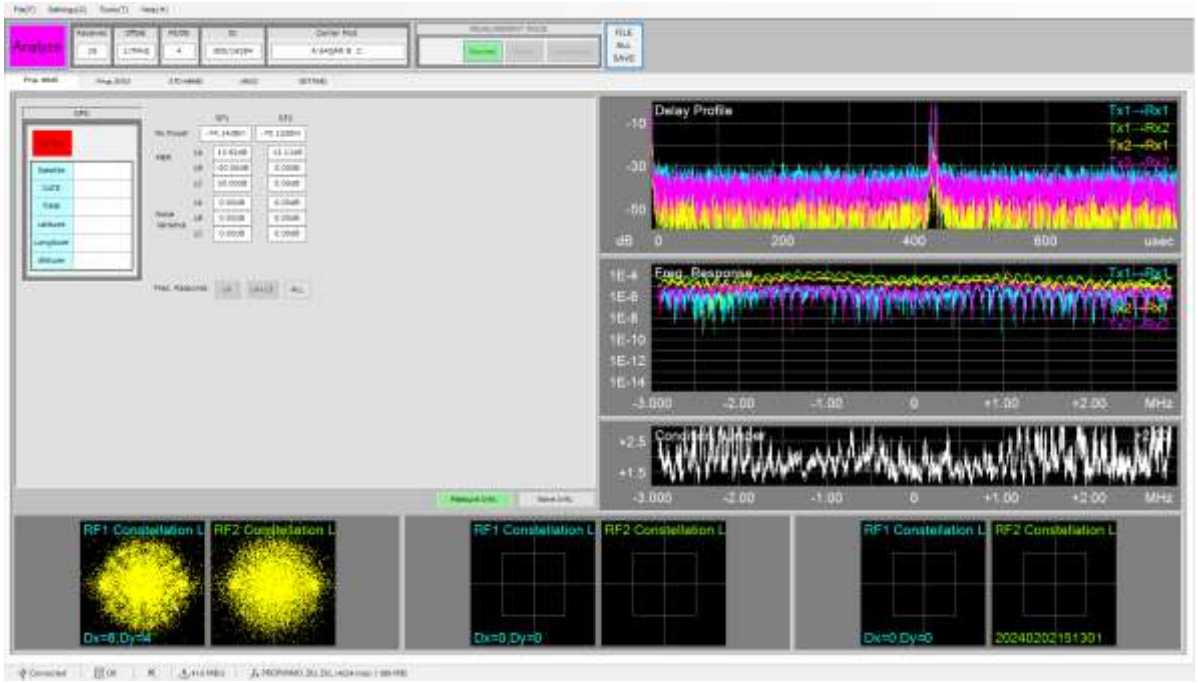


Figure 2.14 - Rintaro Screen

Chapter 3. Site 17

a) Channel Power

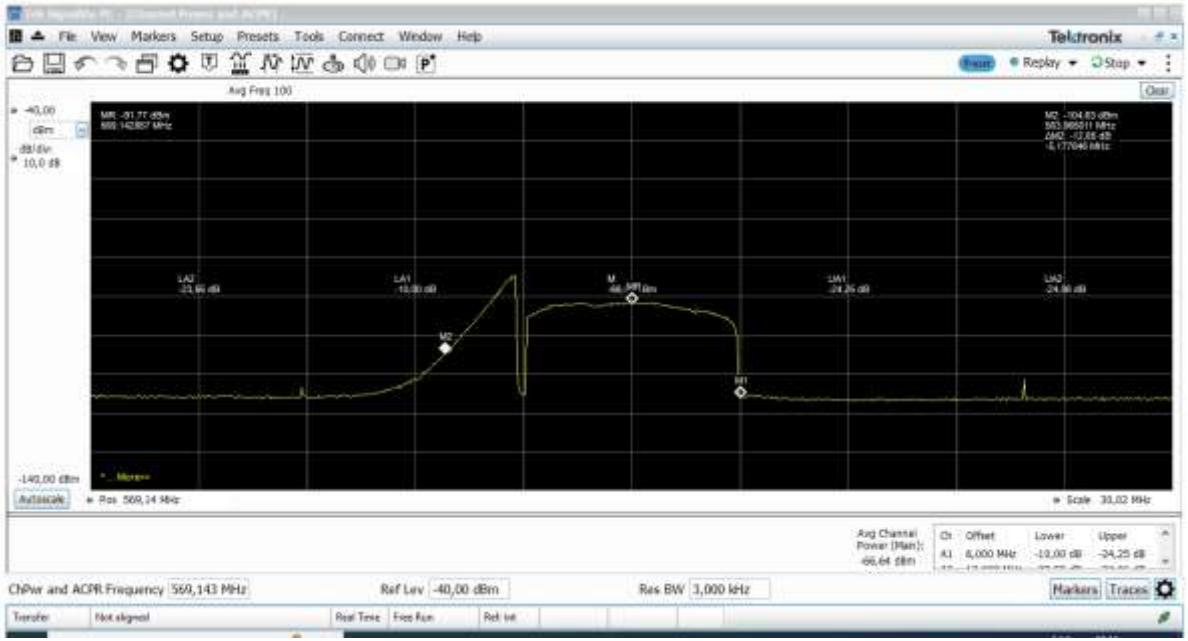


Figure 3.1 - Vertical

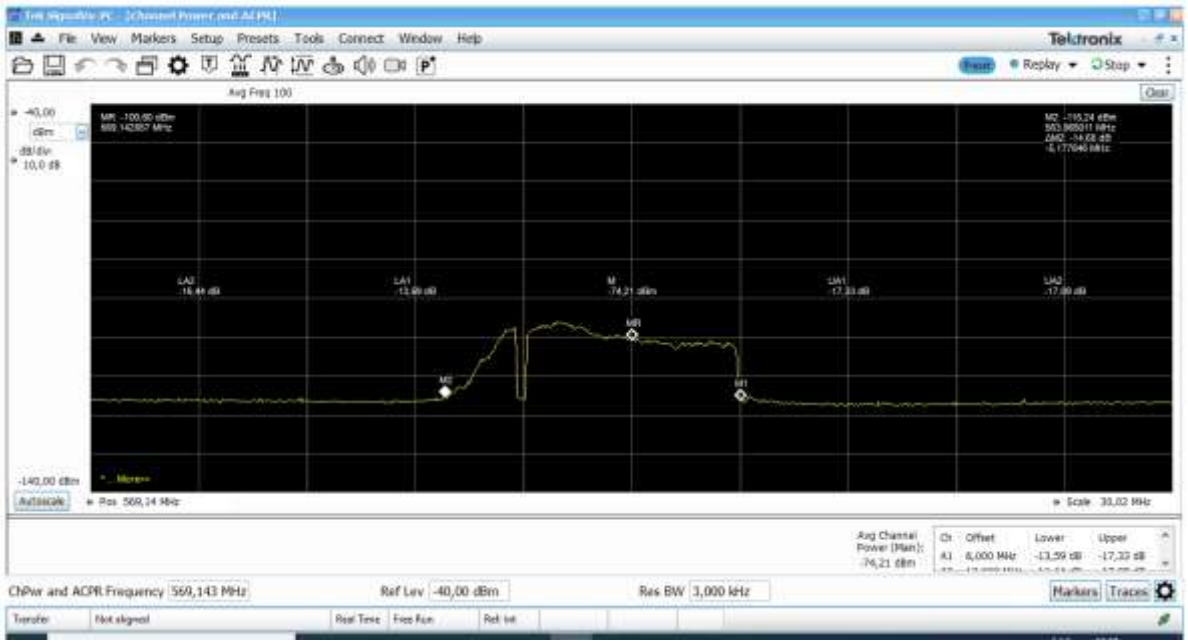


Figure 3.2 - Horizontal

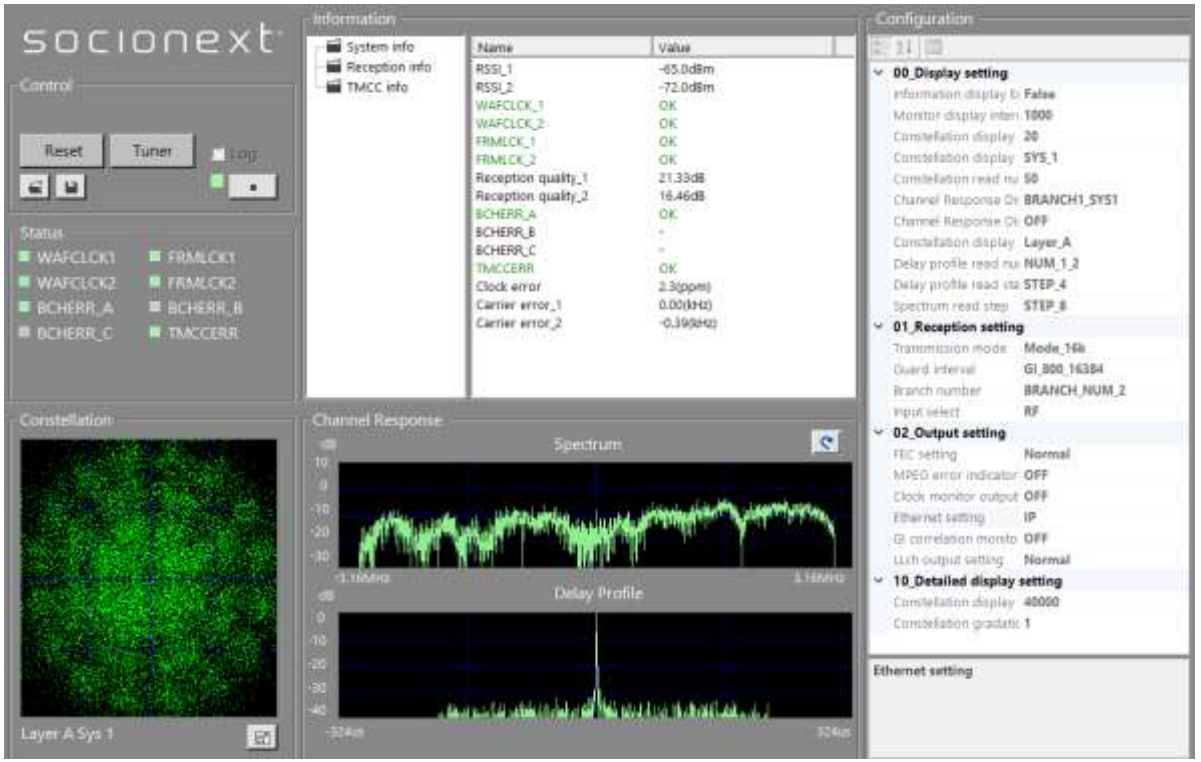


Figure 3.3 - Socionext Screen

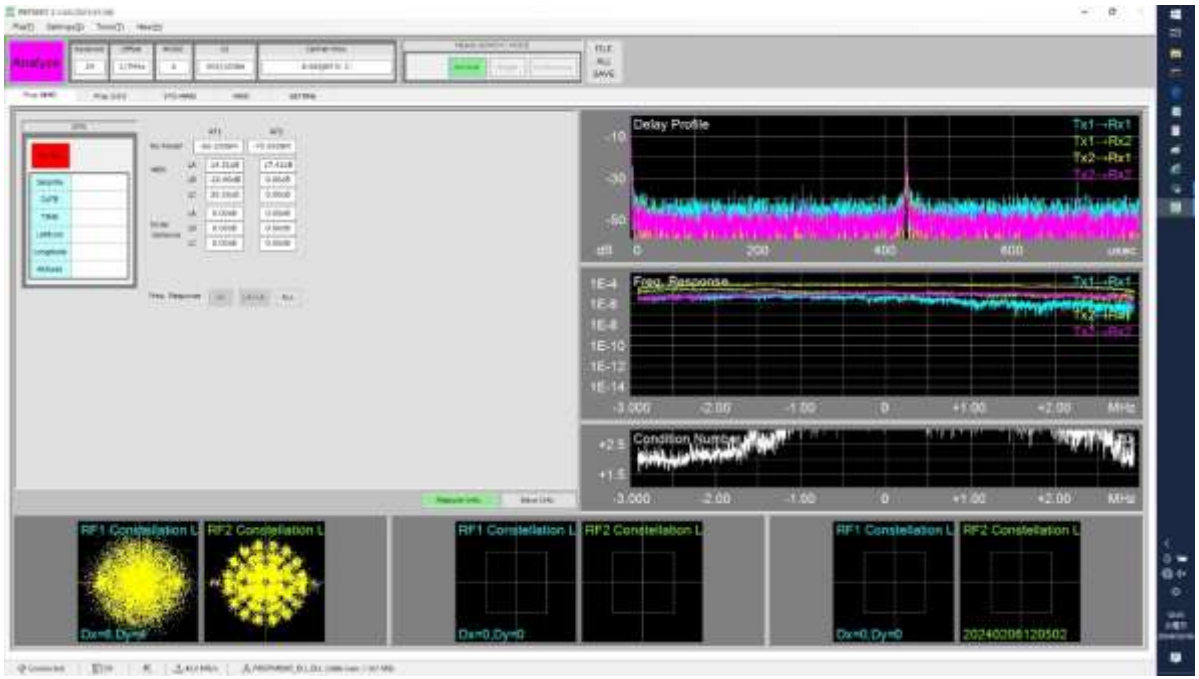


Figure 3.4 - Rintaro Screen

b) AWGN Power

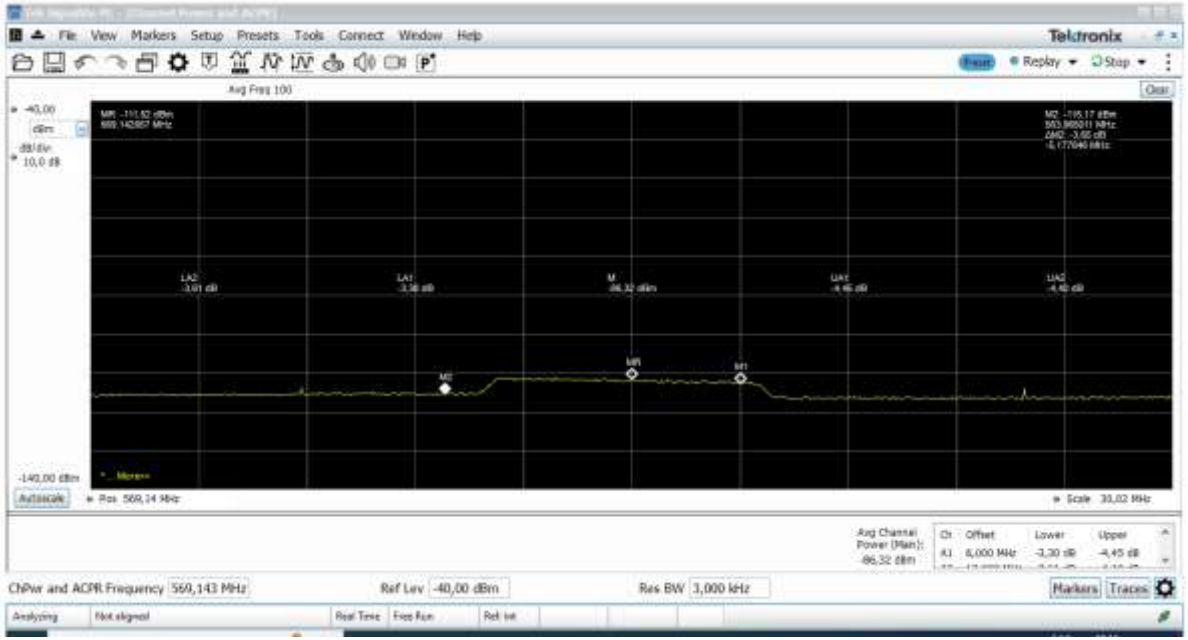


Figure 3.5 - Vertical

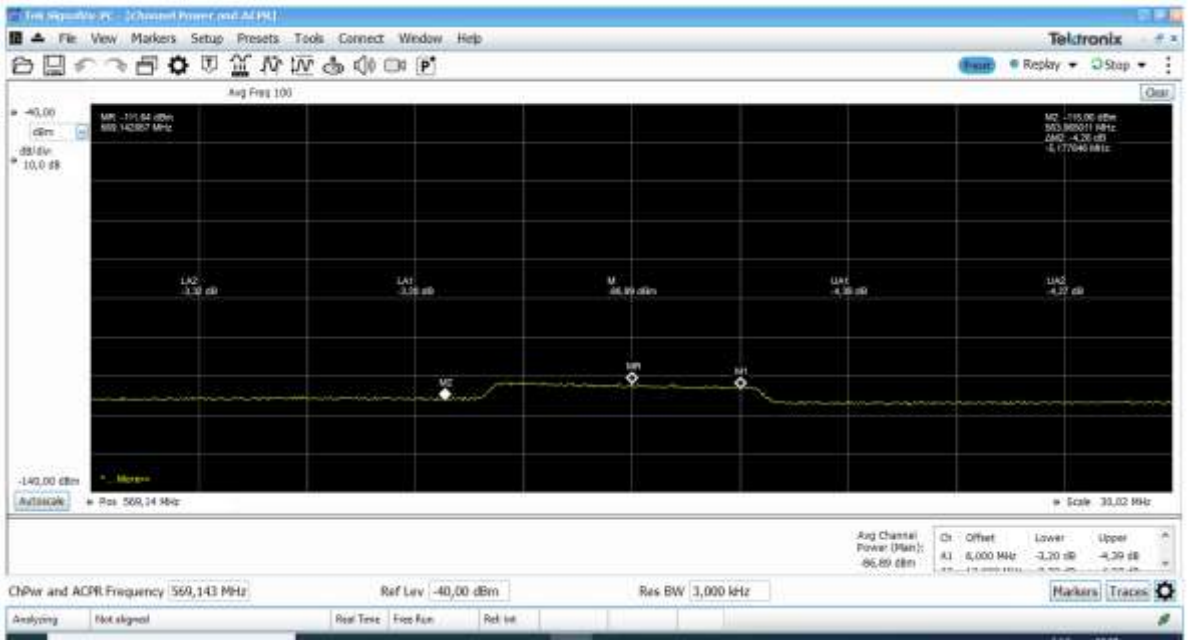


Figure 3.6 - Horizontal

c) C/N Threshold

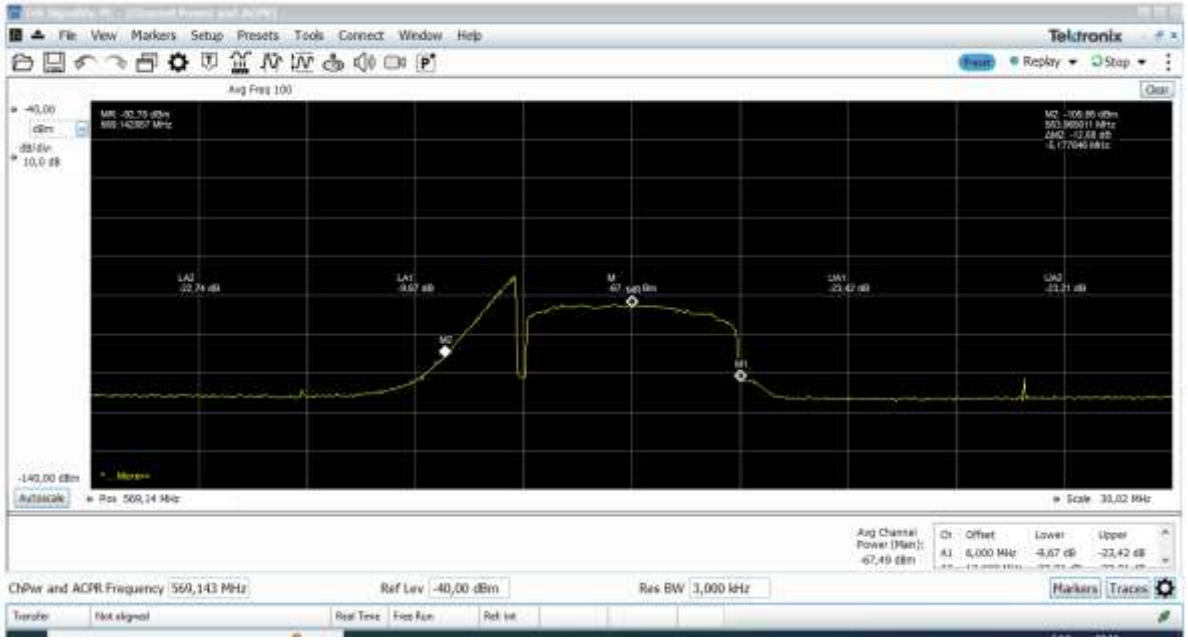


Figure 3.7 - Vertical

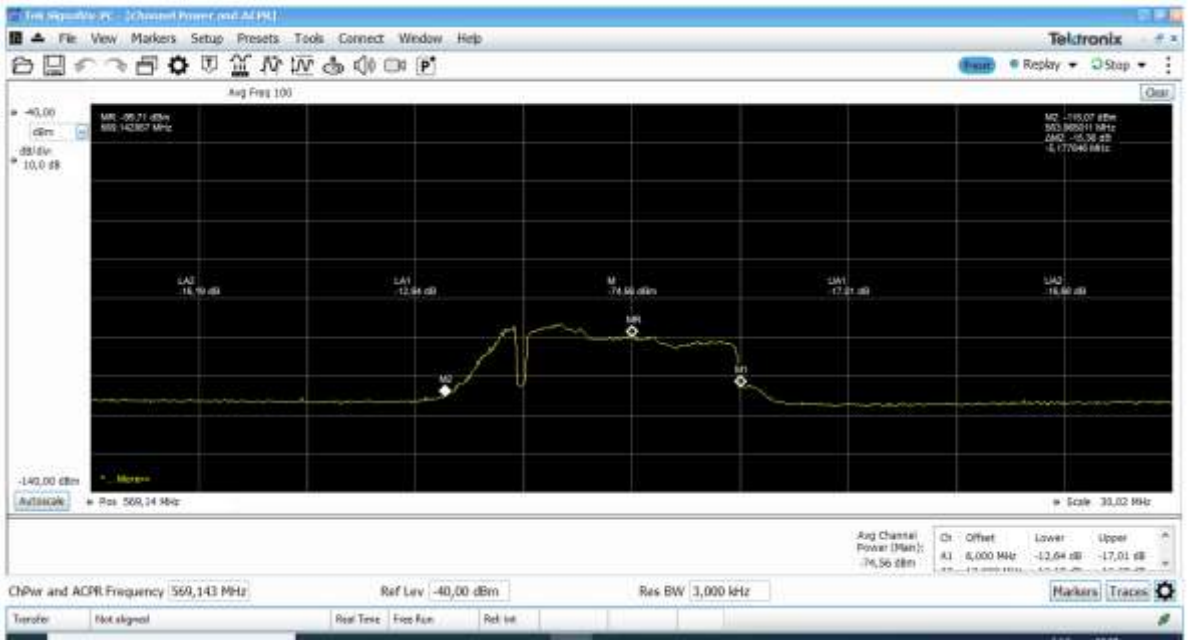


Figure 3.8 - Horizontal

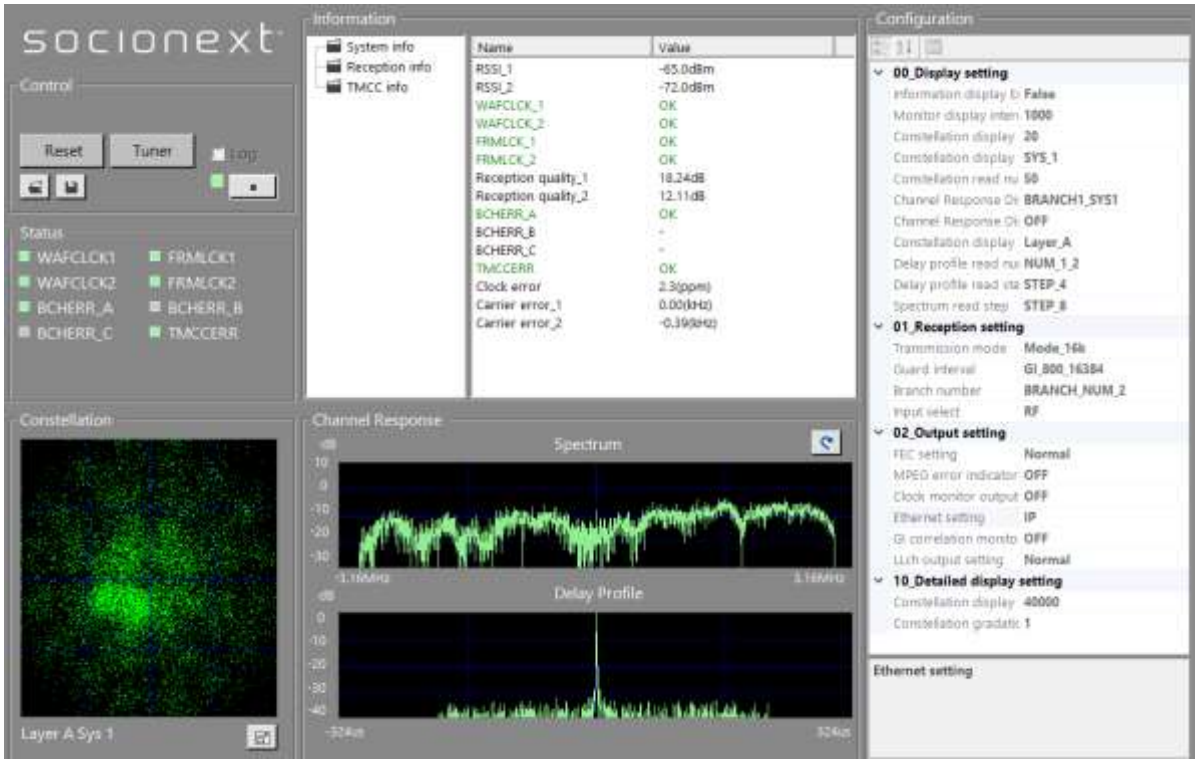


Figure 3.9 - Socionext Screen

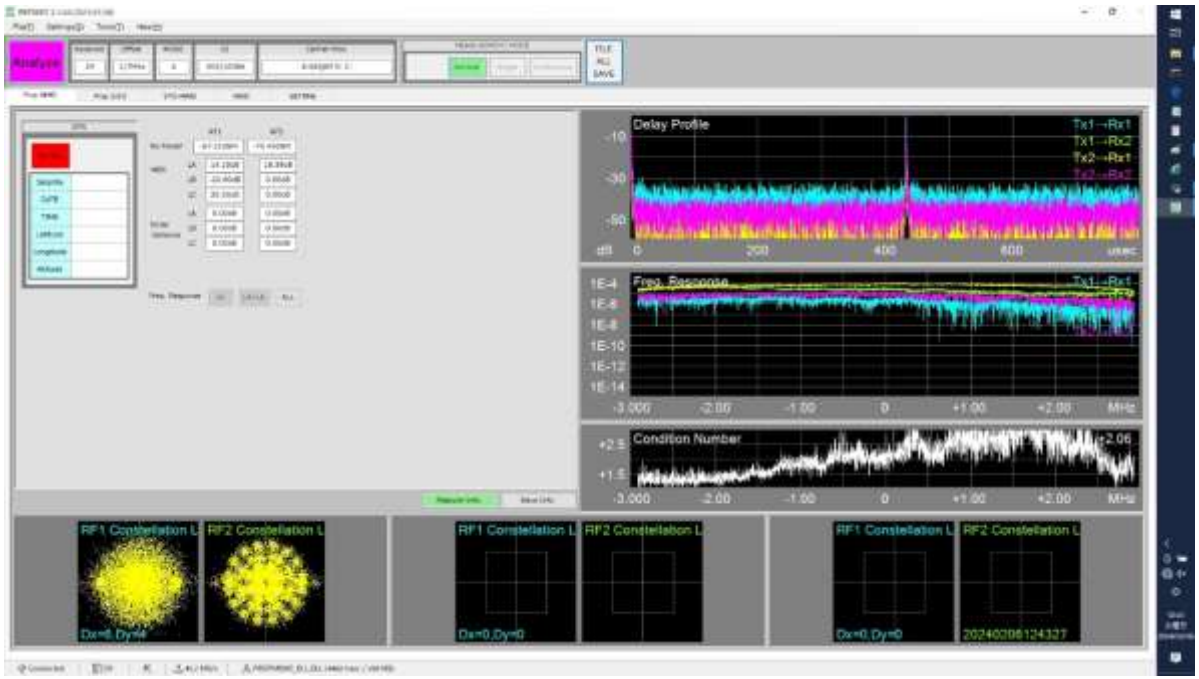


Figure 3.10 - Rintaro Screen

d) Reception Threshold

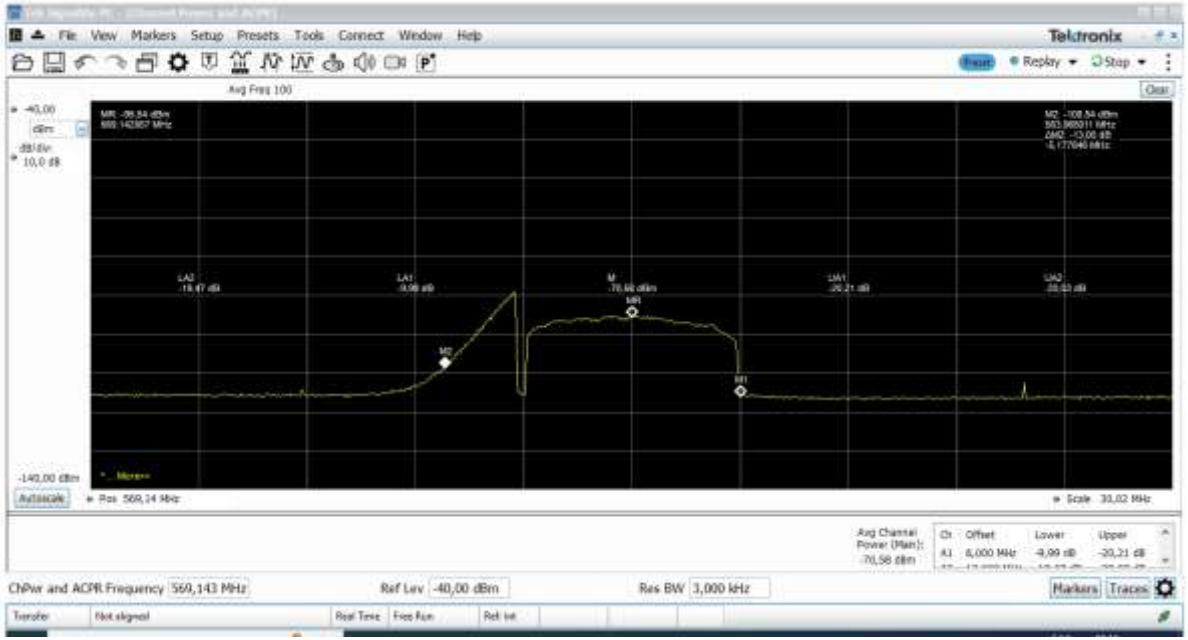


Figure 3.11 - Vertical

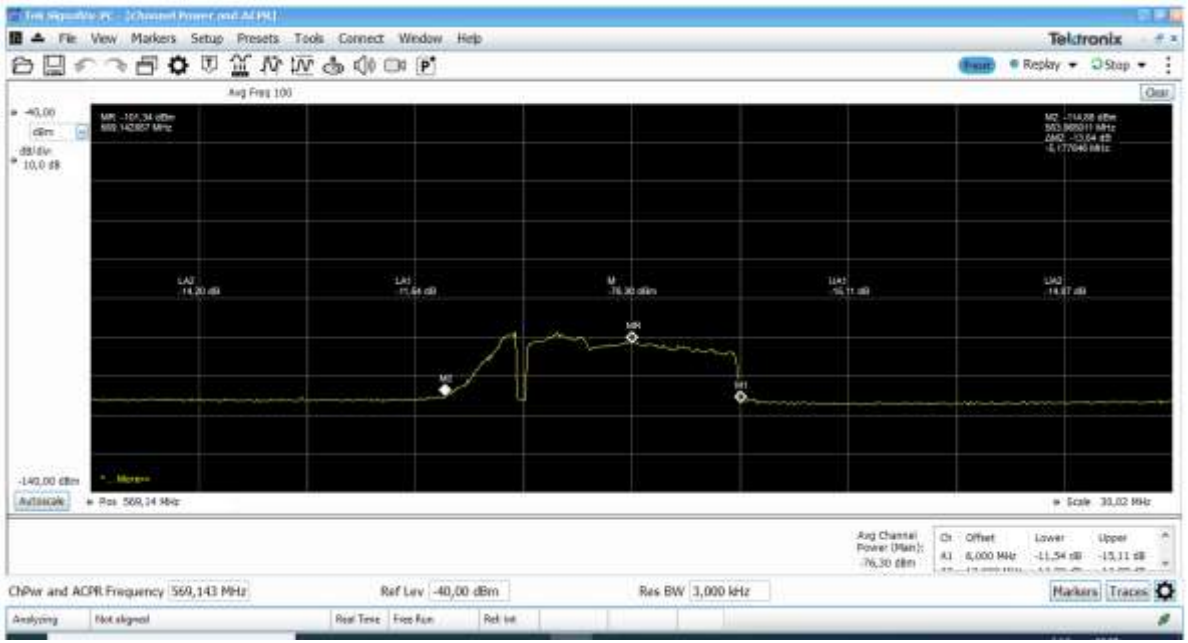


Figure 3.12 - Horizontal

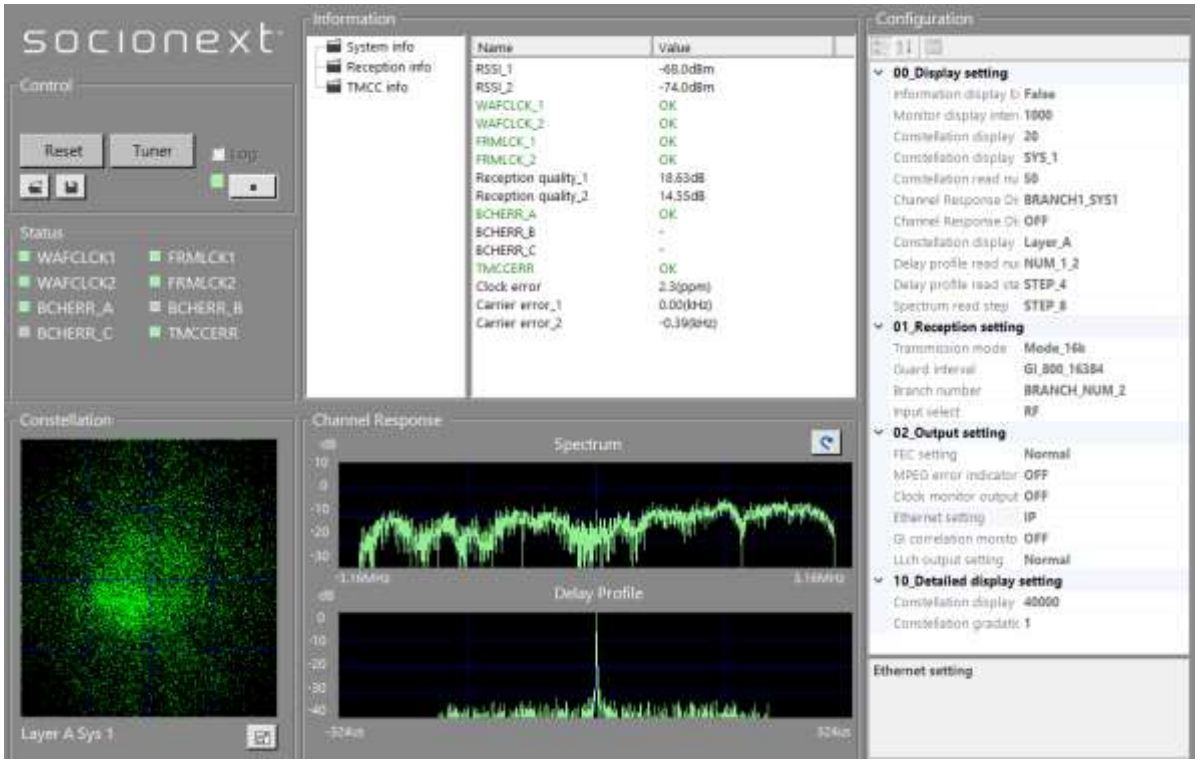


Figure 3.13 - Socionext Screen

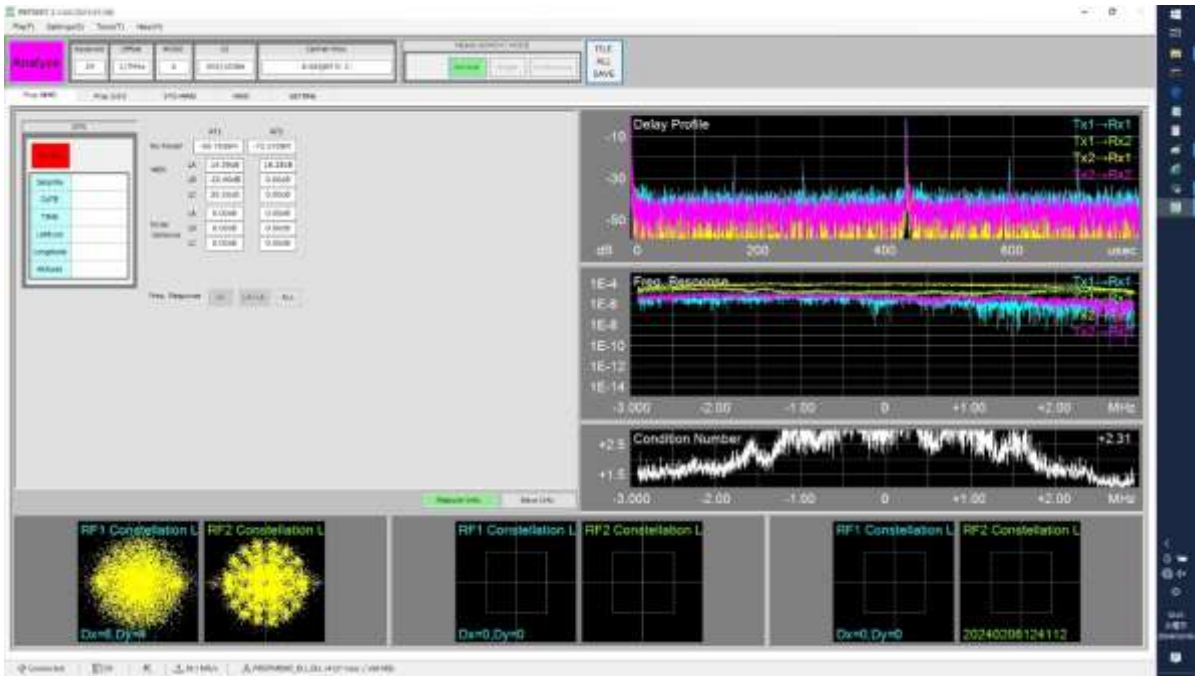


Figure 3.14 - Rintaro Screen

Chapter 4. Site 18

a) Channel Power

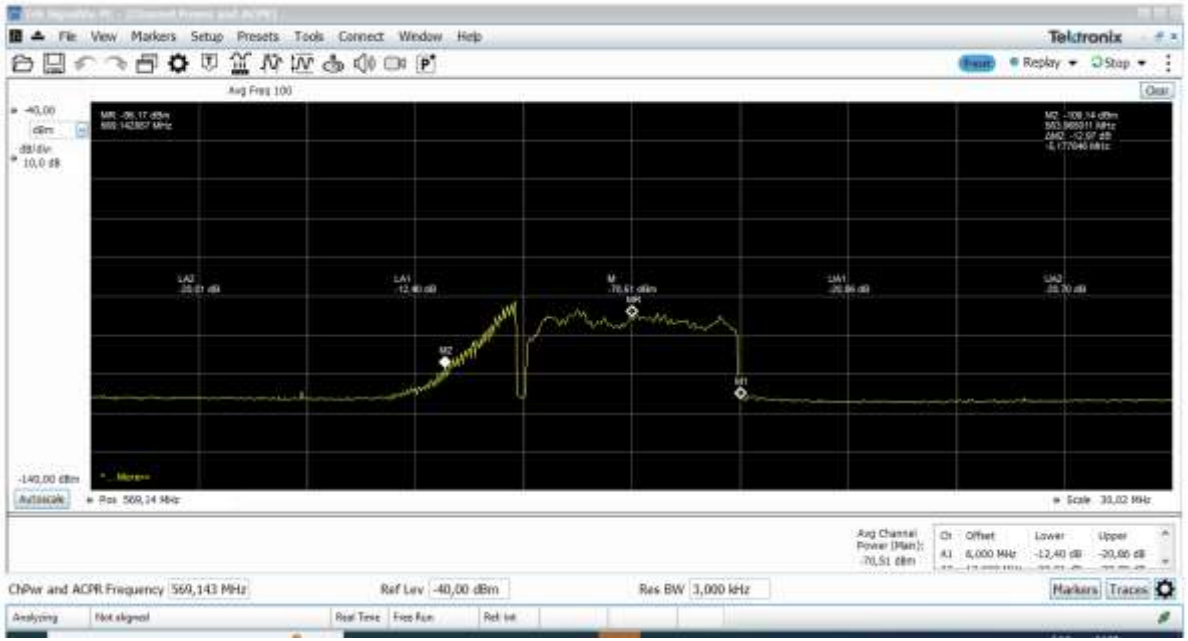


Figure 4.1 - Vertical

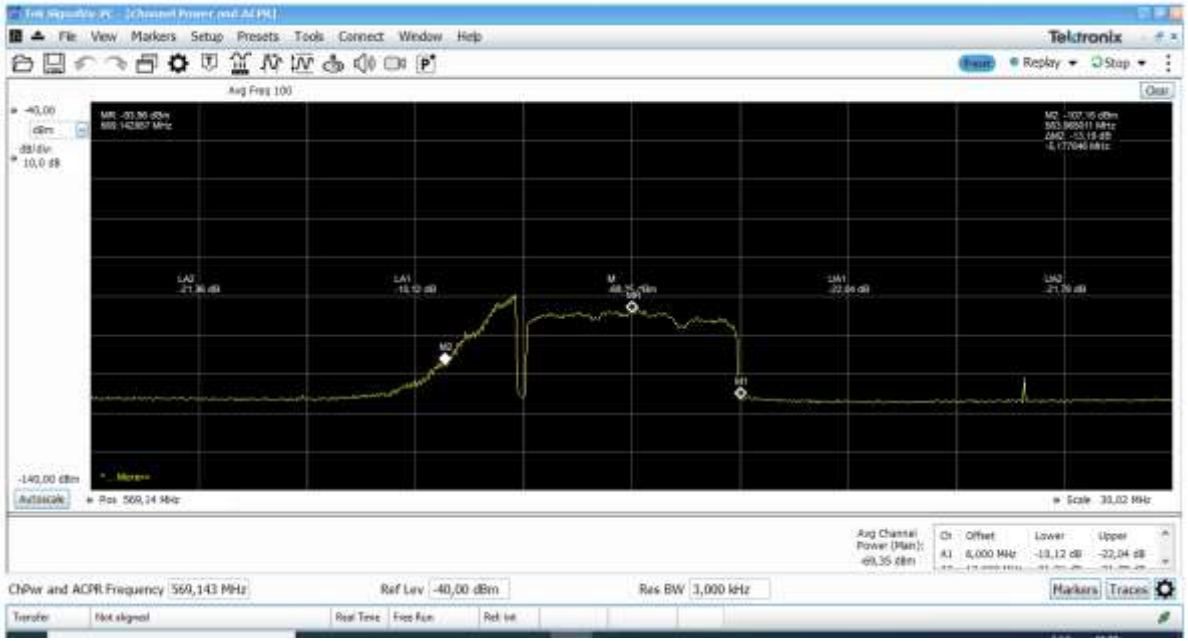


Figure 4.2 - Horizontal

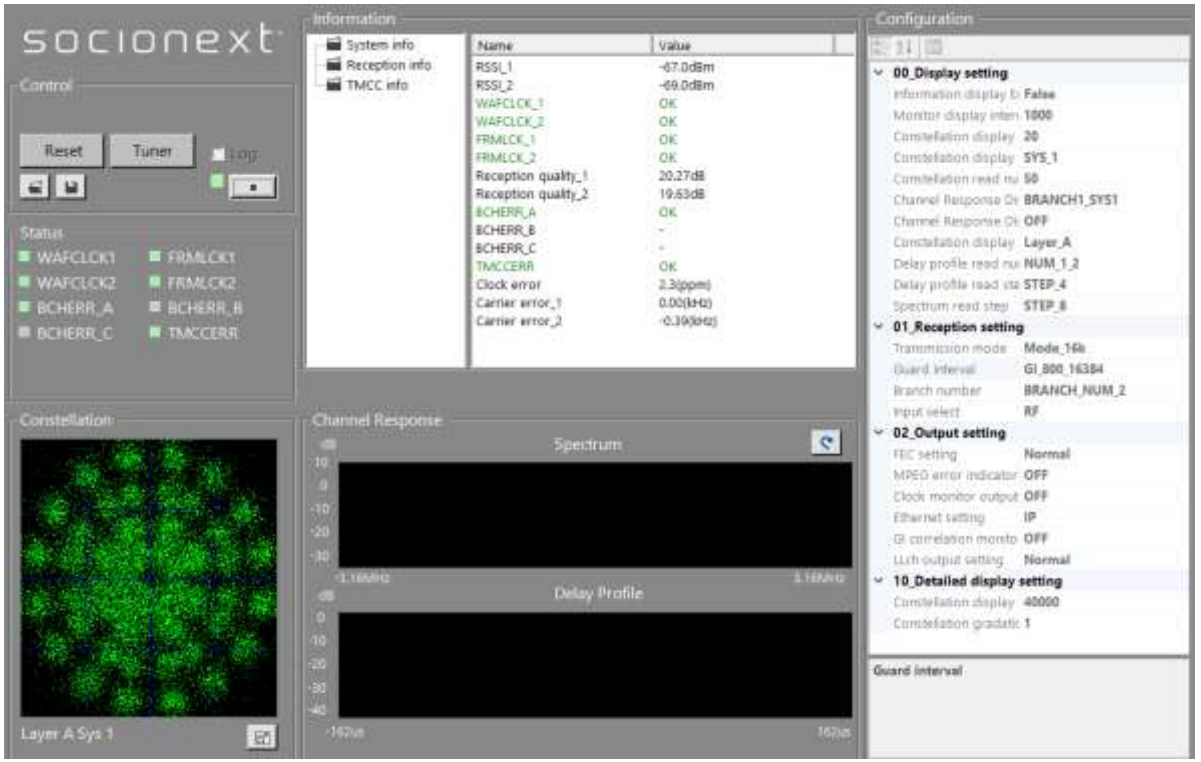


Figure 4.3 - Socionext Screen

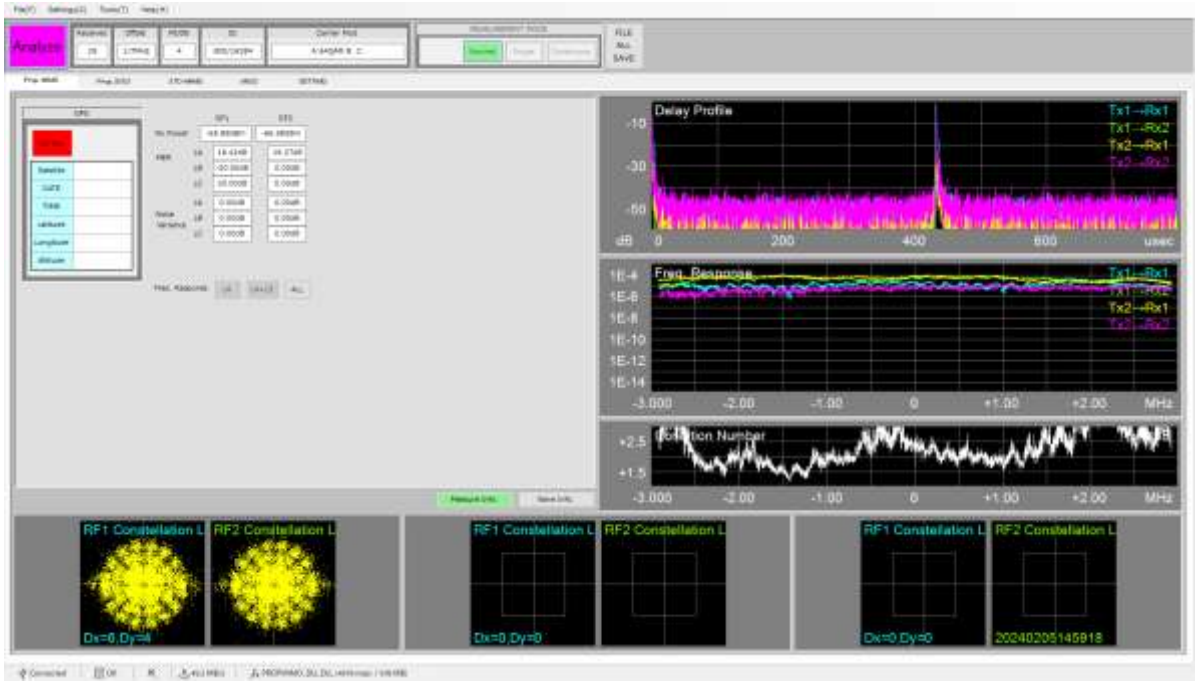


Figure 4.4 - Rintaro Screen

b) AWGN Power

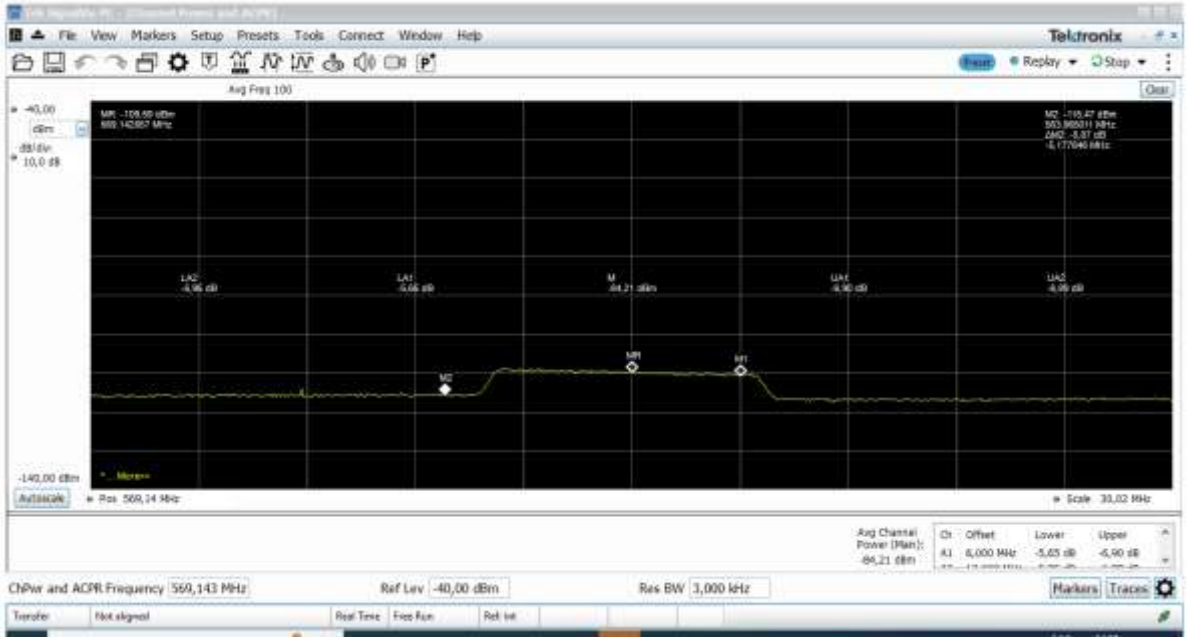


Figure 4.5 - Vertical

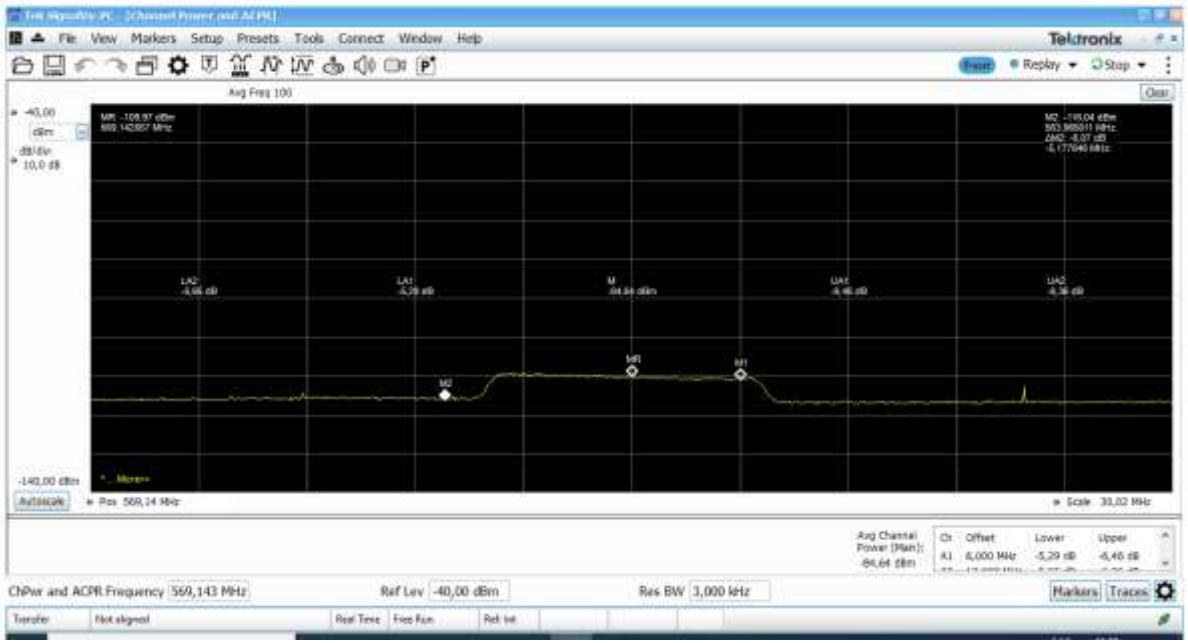


Figure 4.6 - Horizontal

c) C/N Threshold

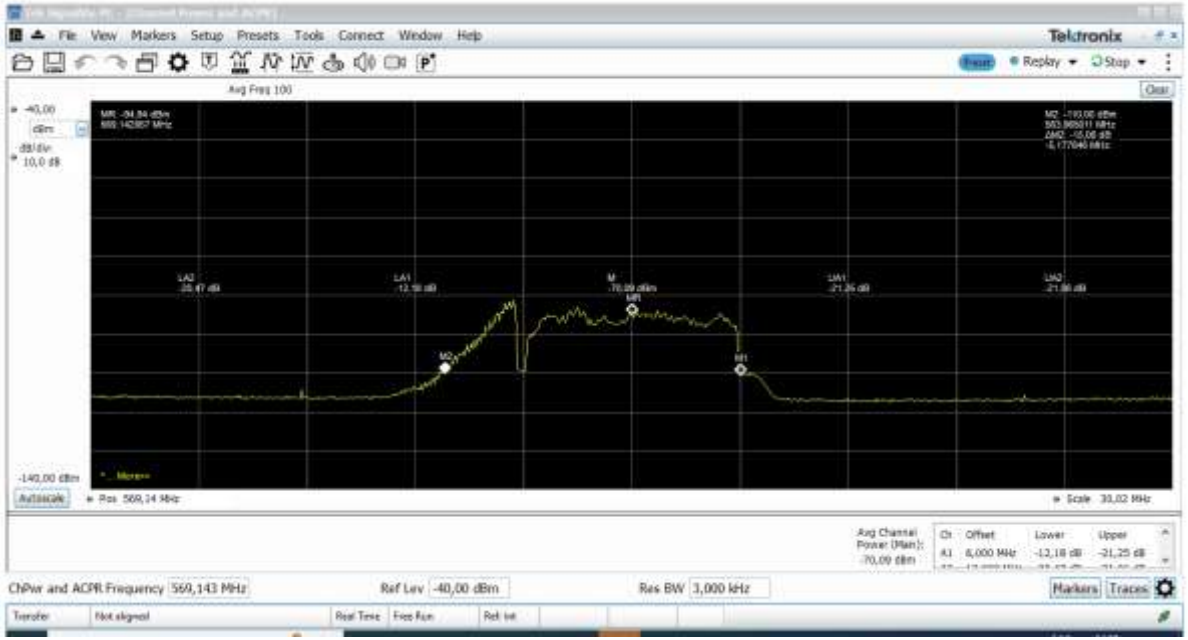


Figure 4.7 - Vertical

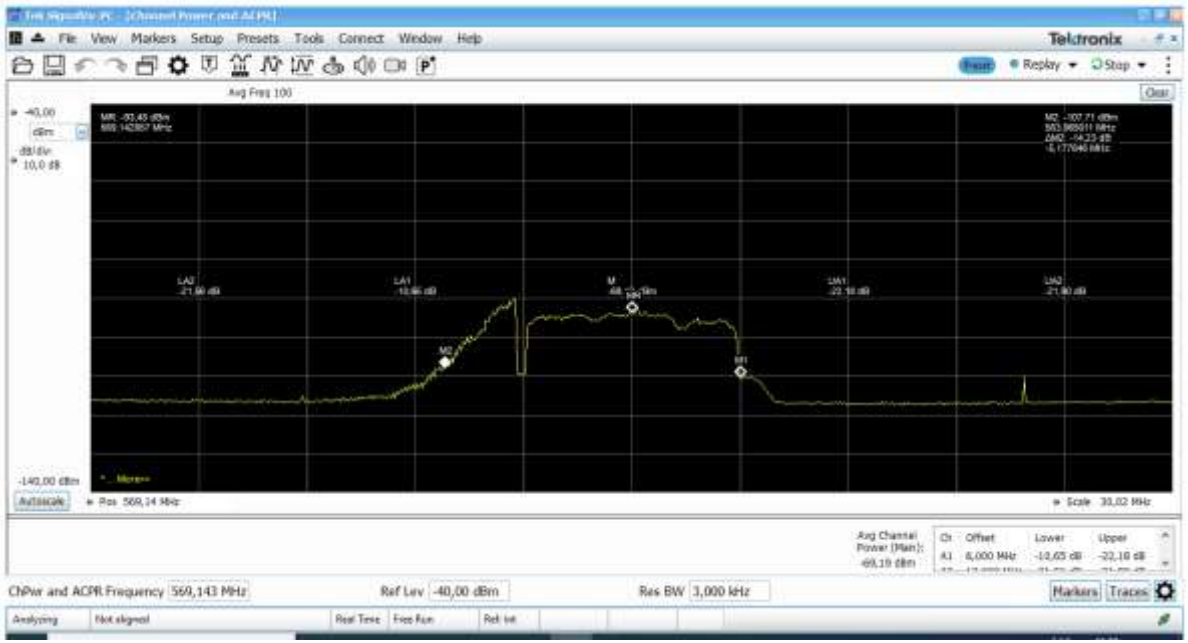


Figure 4.8 - Horizontal

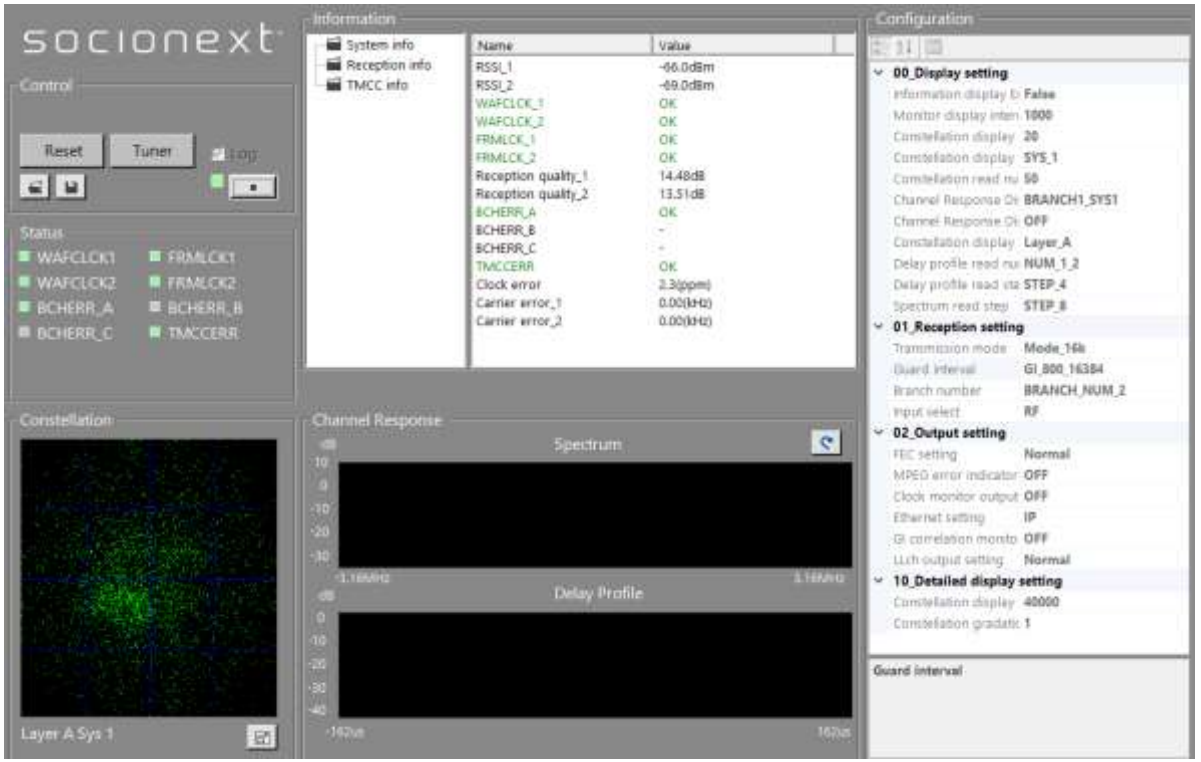


Figure 4.9 - Socionext Screen

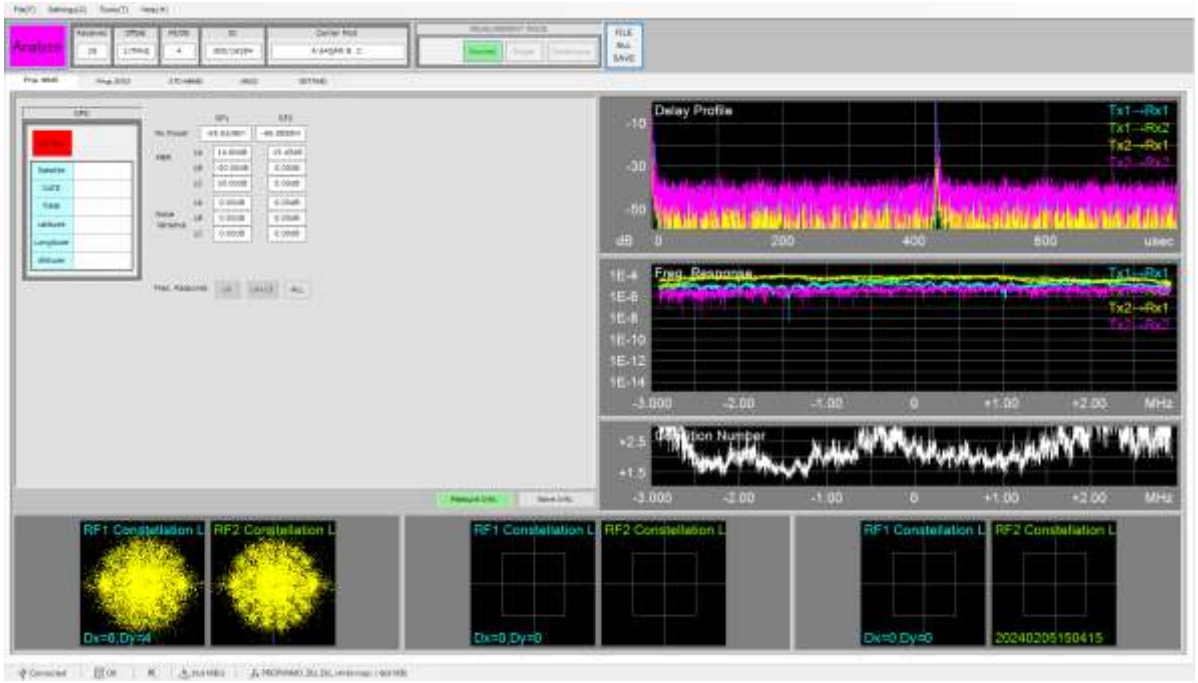


Figure 4.10 - Rintaro Screen

d) Reception Threshold

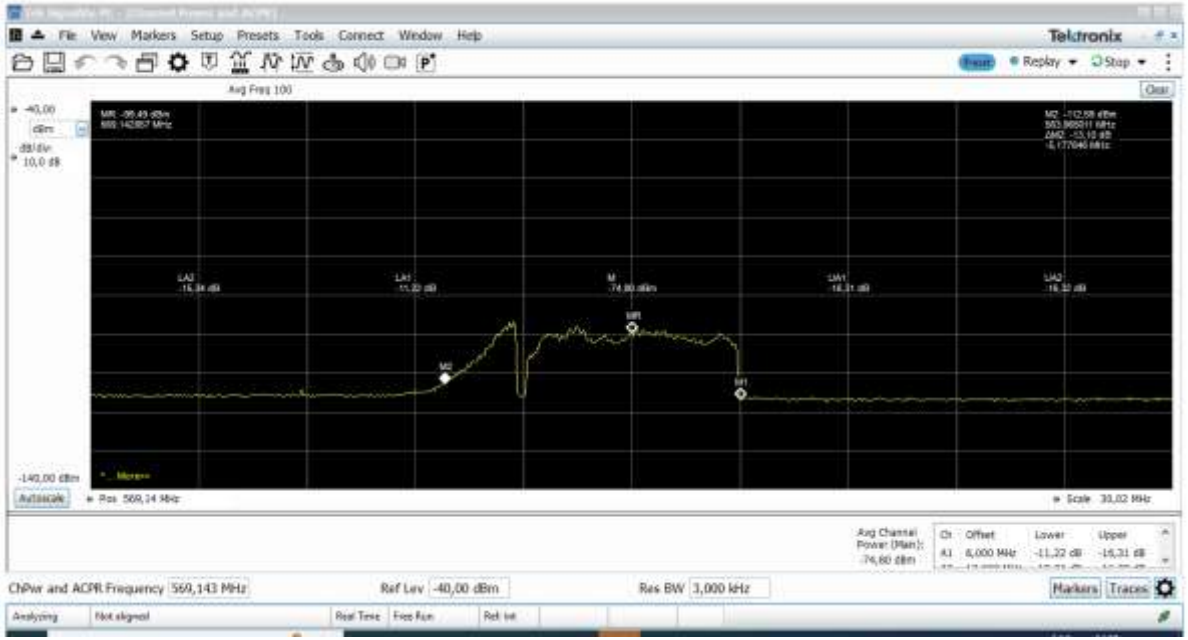


Figure 4.11 - Vertical

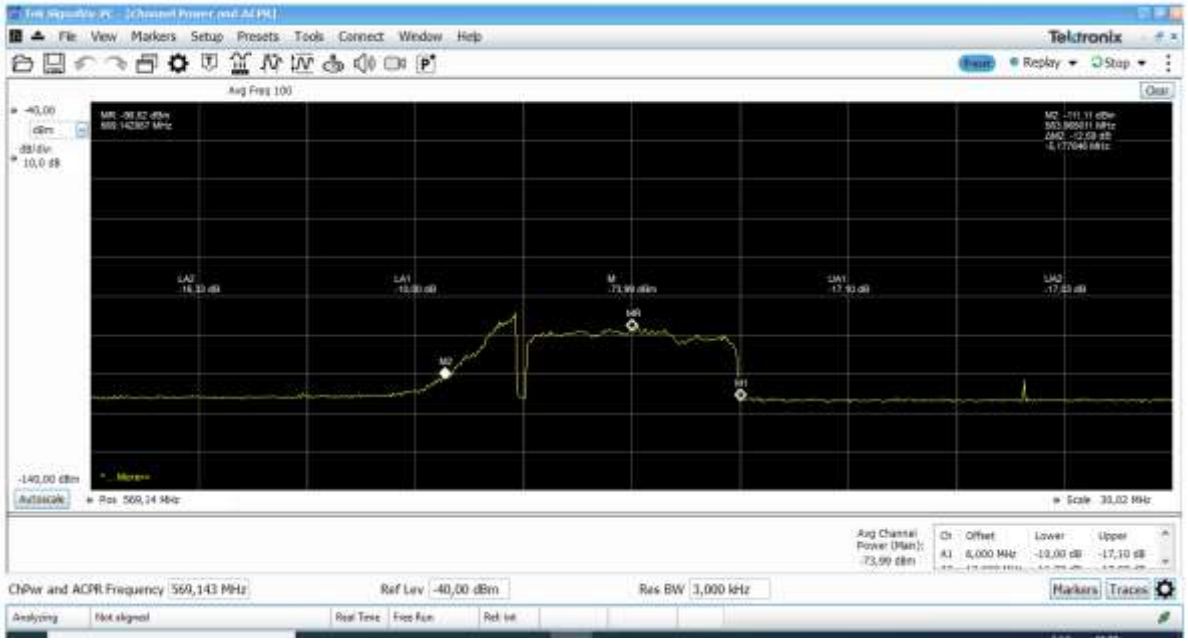


Figure 4.12 - Horizontal

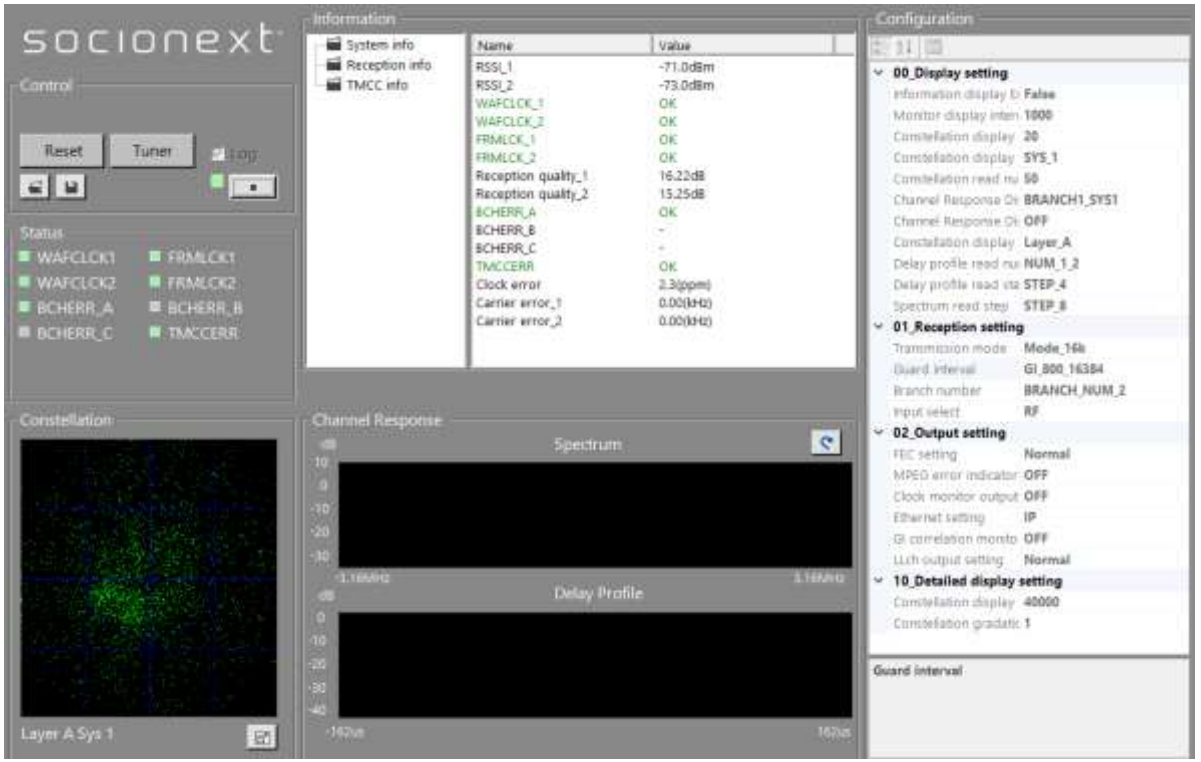


Figure 4.13 - Socionext Screen

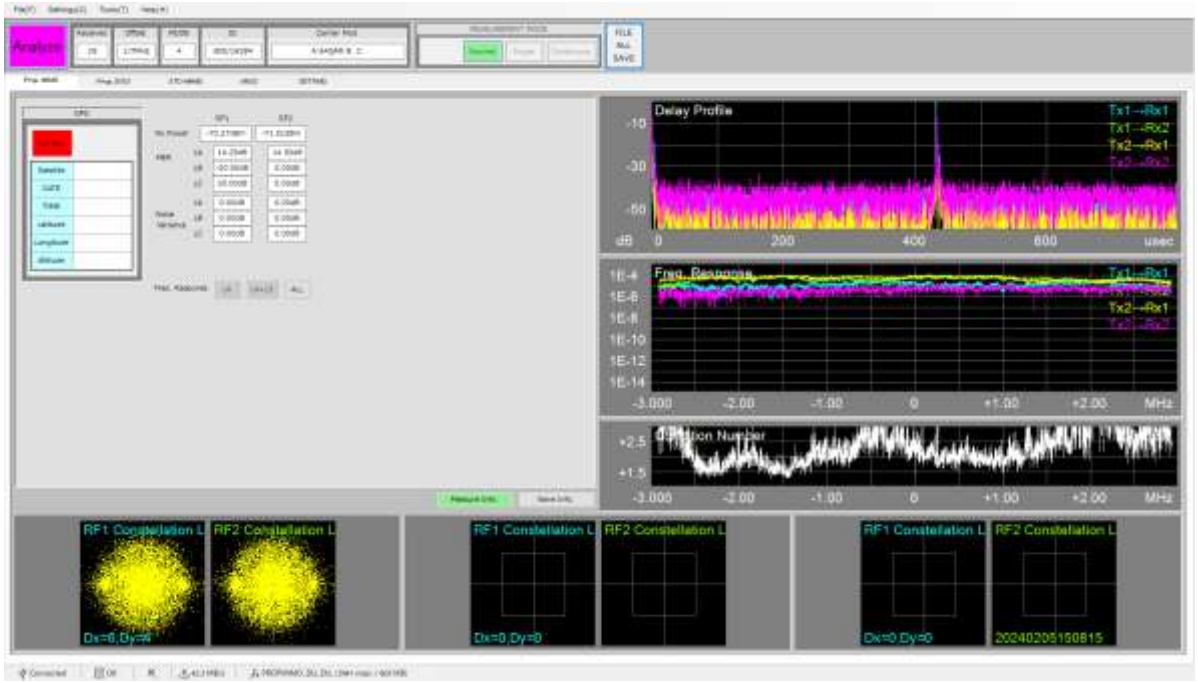


Figure 4.14 - Rintaro Screen

Chapter 5. Site 20

a) Channel Power

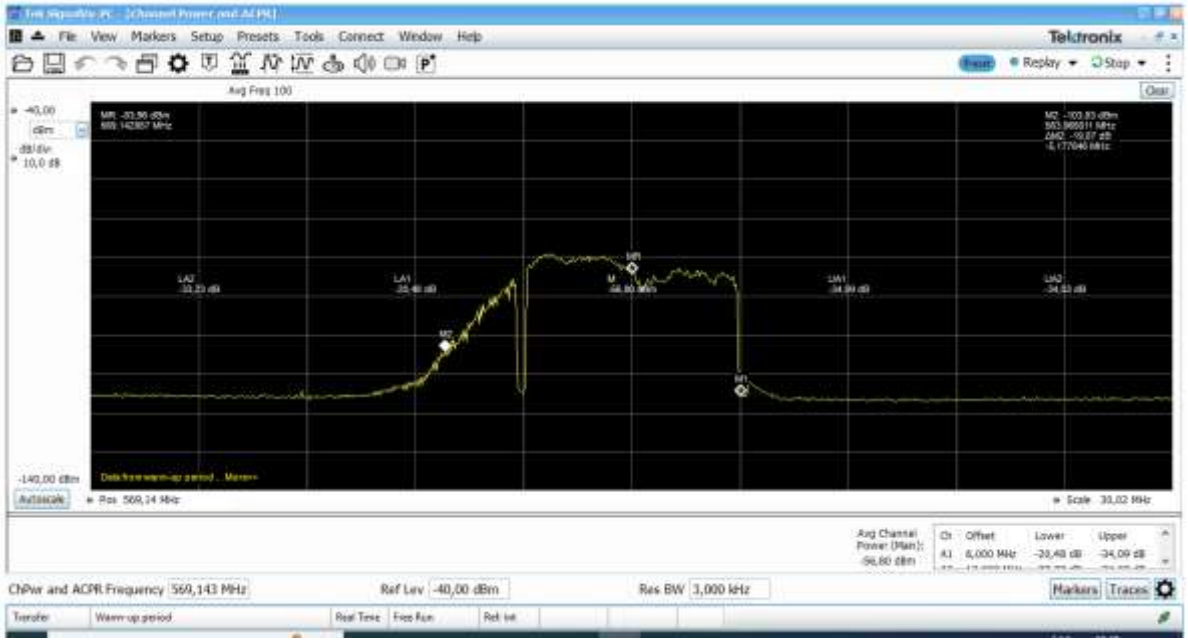


Figure 5.1 - Vertical

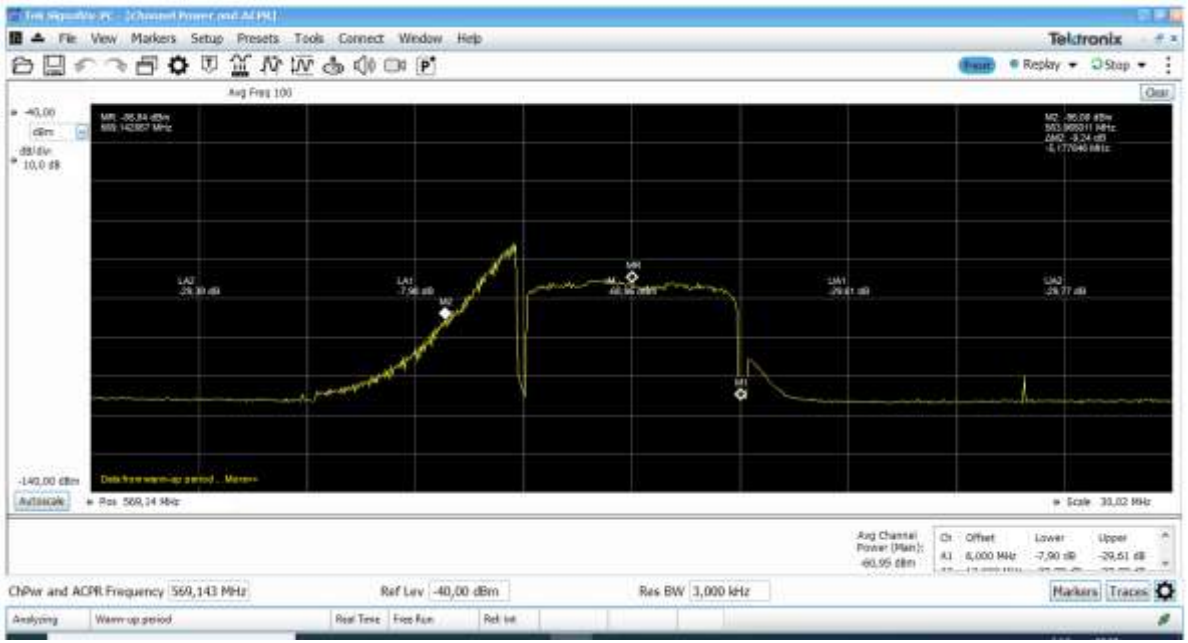


Figure 5.2 - Horizontal

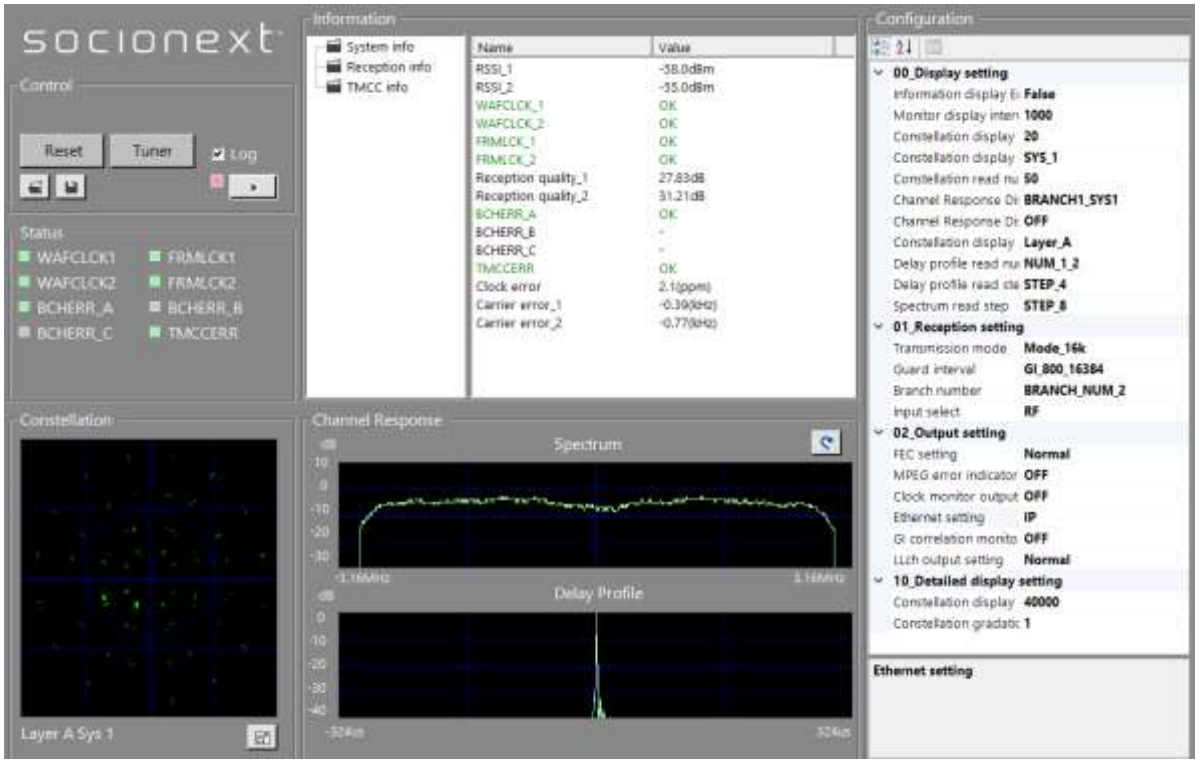


Figure 5.3 - Socionext Screen

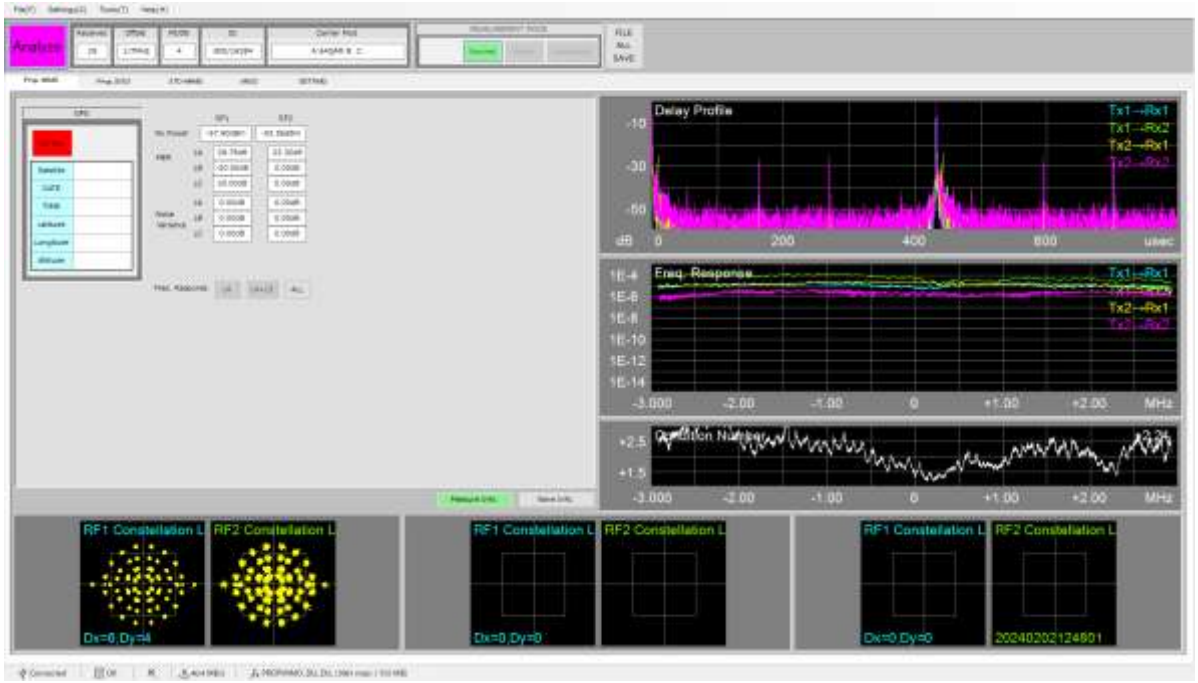


Figure 5.4 - Rintaro Screen

b) AWGN Power

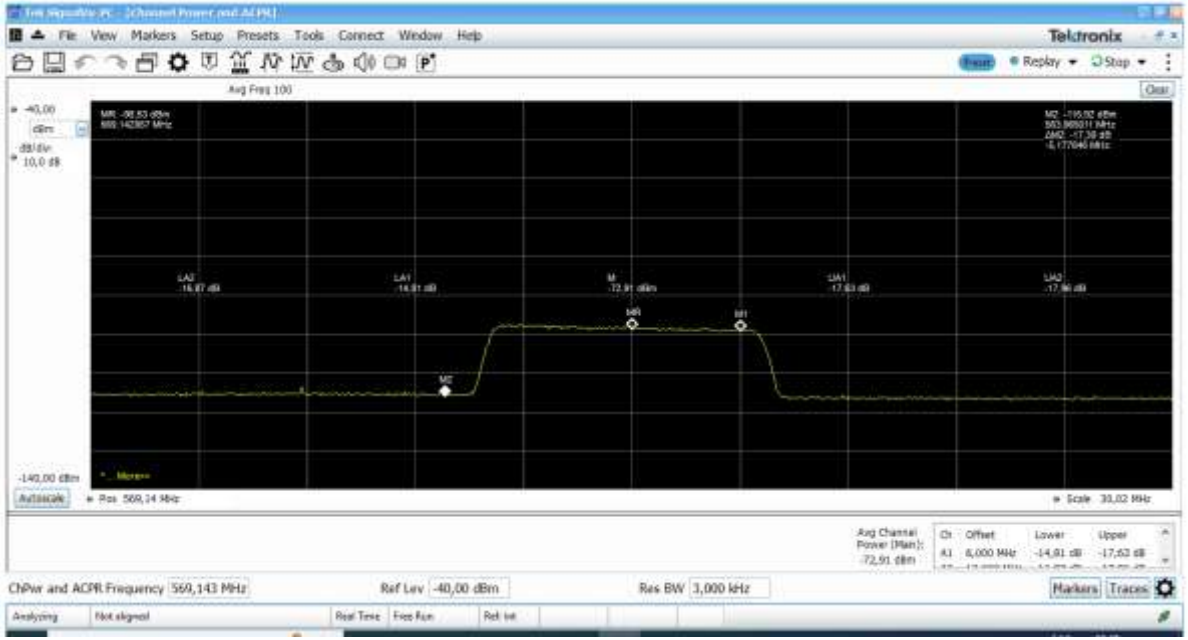


Figure 5.5 - Vertical

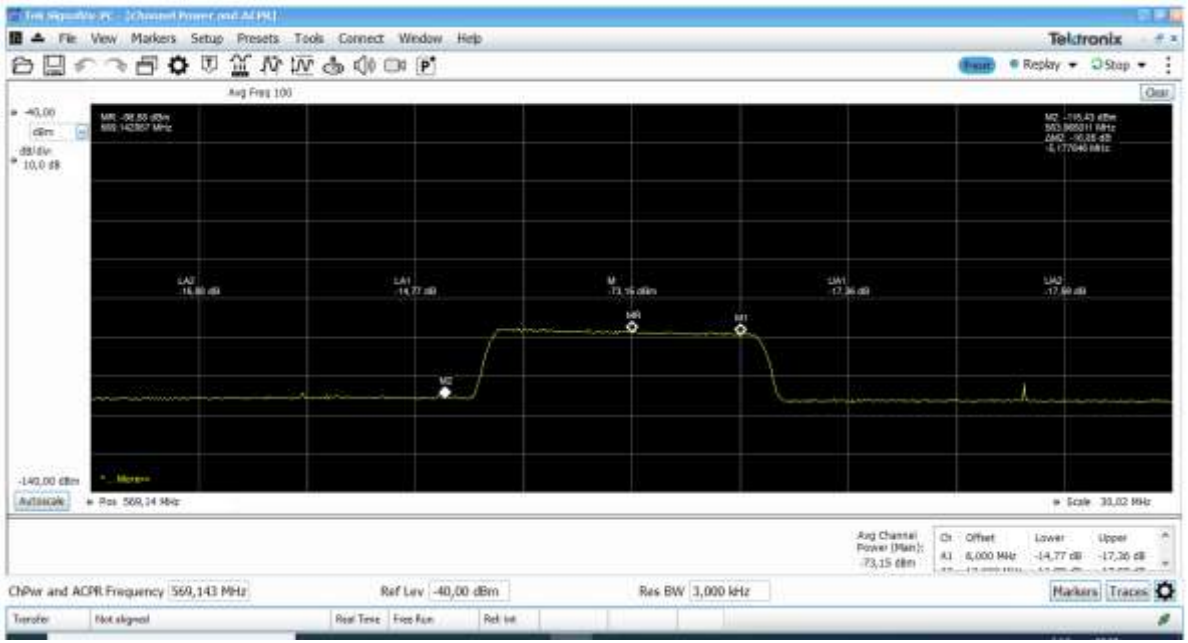


Figure 5.6 - Horizontal

c) C/N Threshold

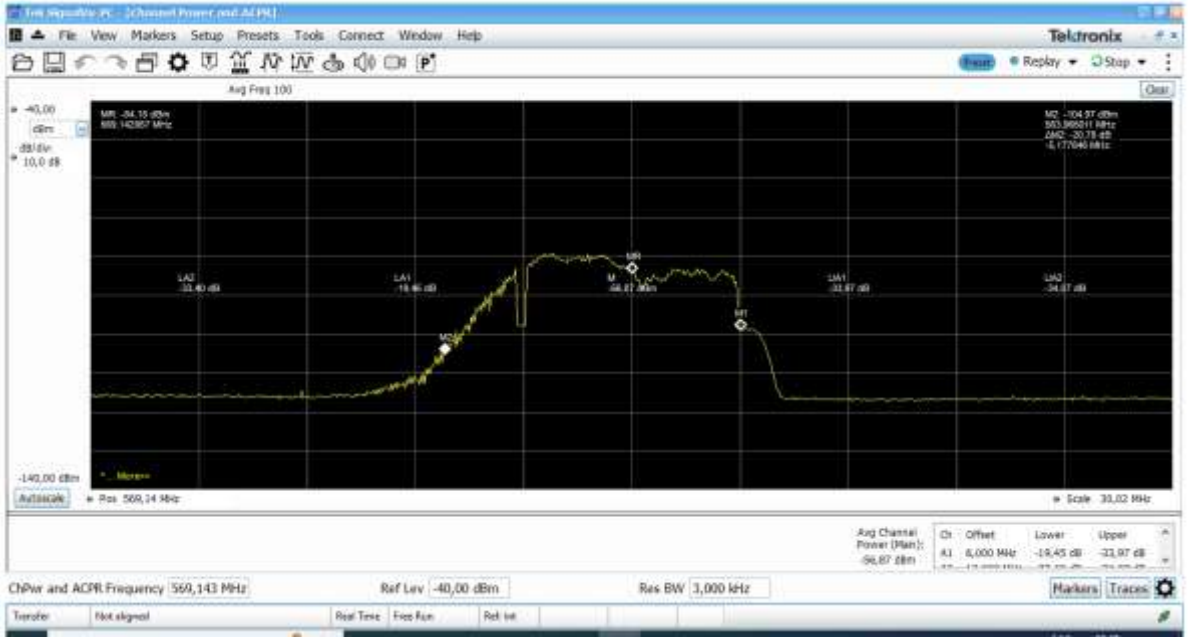


Figure 5.7 - Vertical

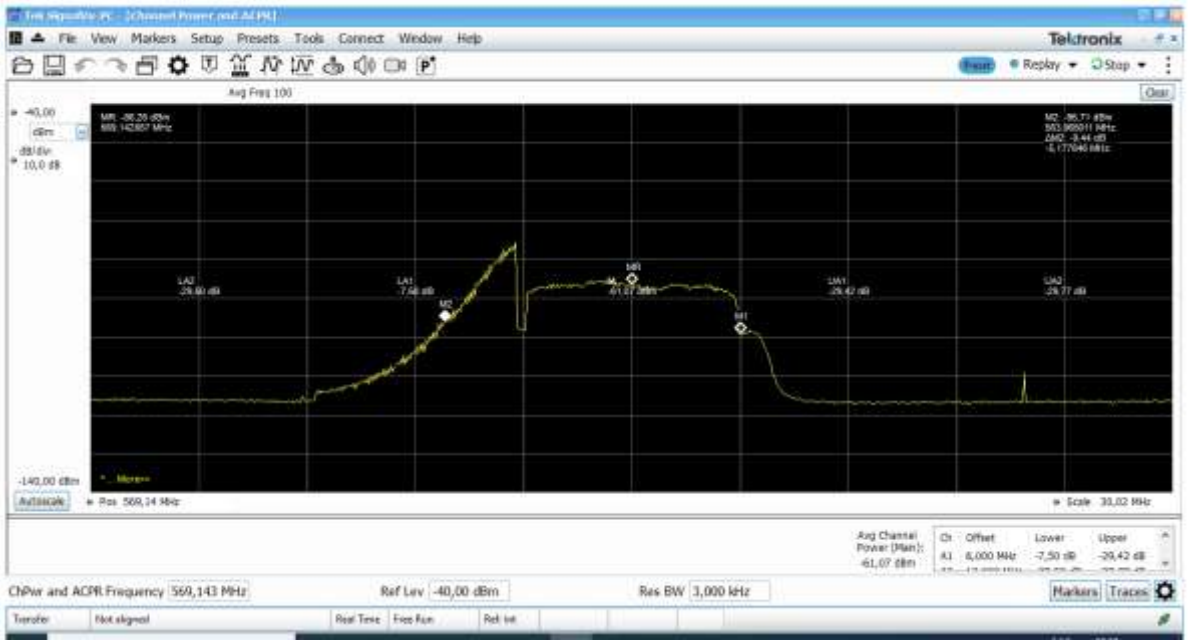


Figure 5.8 - Horizontal

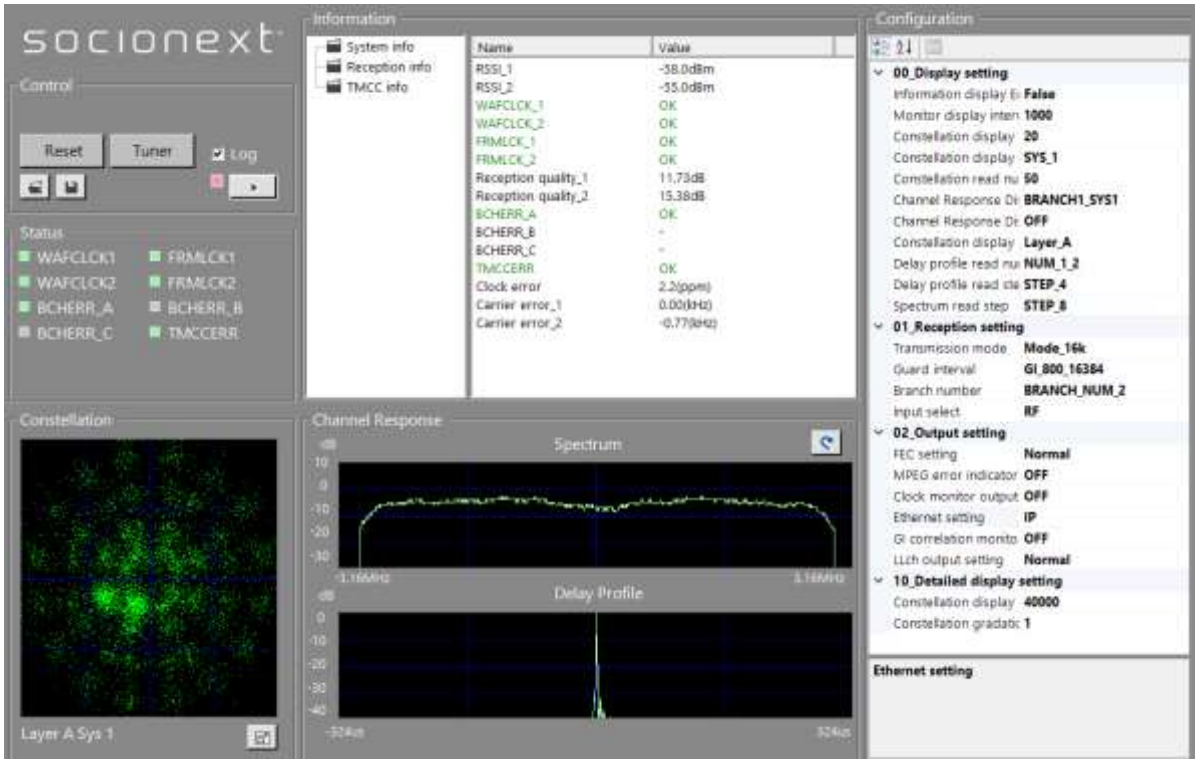


Figure 5.9 - Socionext Screen

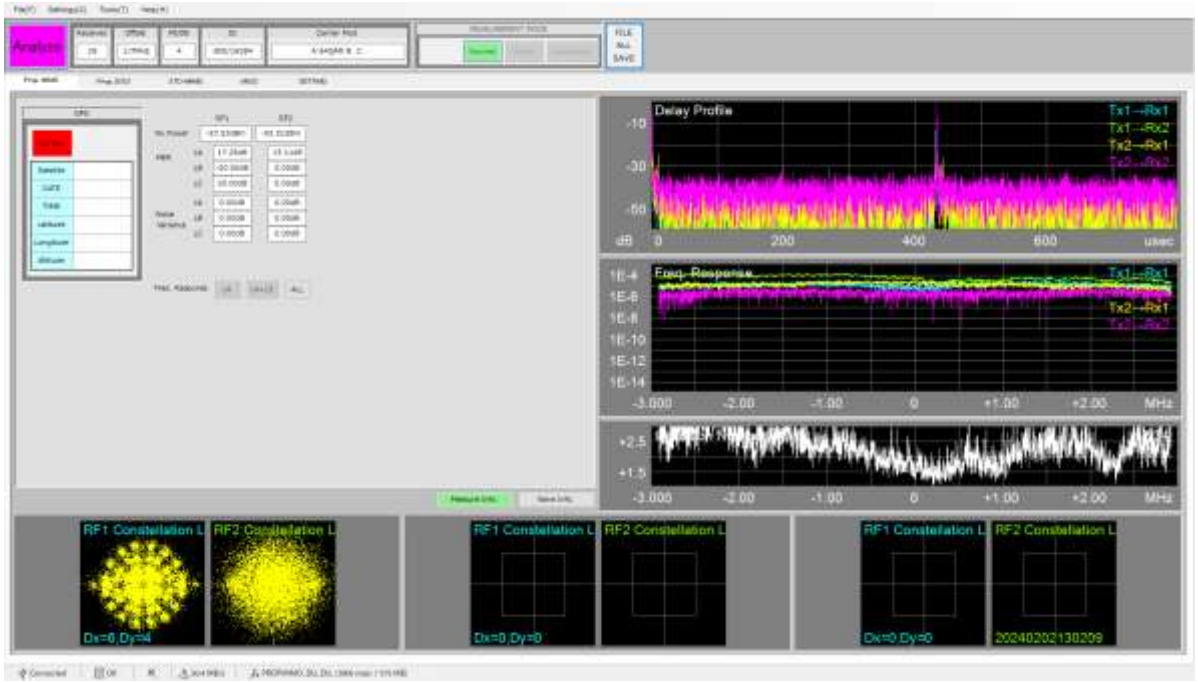


Figure 5.10 - Rintaro Screen

d) Reception Threshold

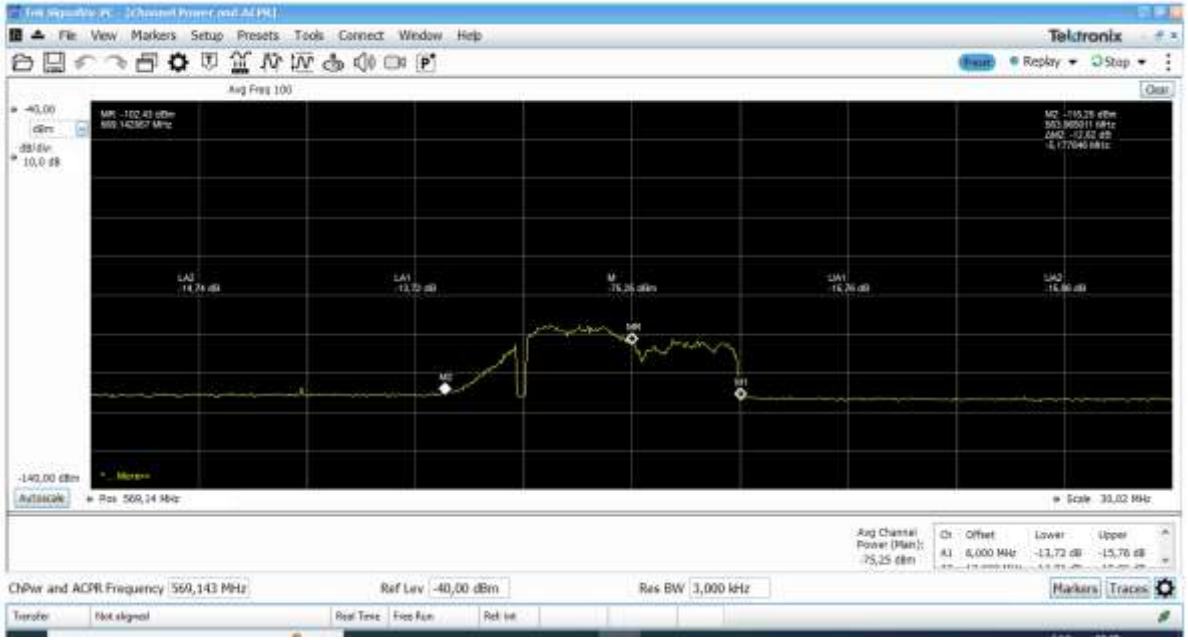


Figure 5.11 - Vertical

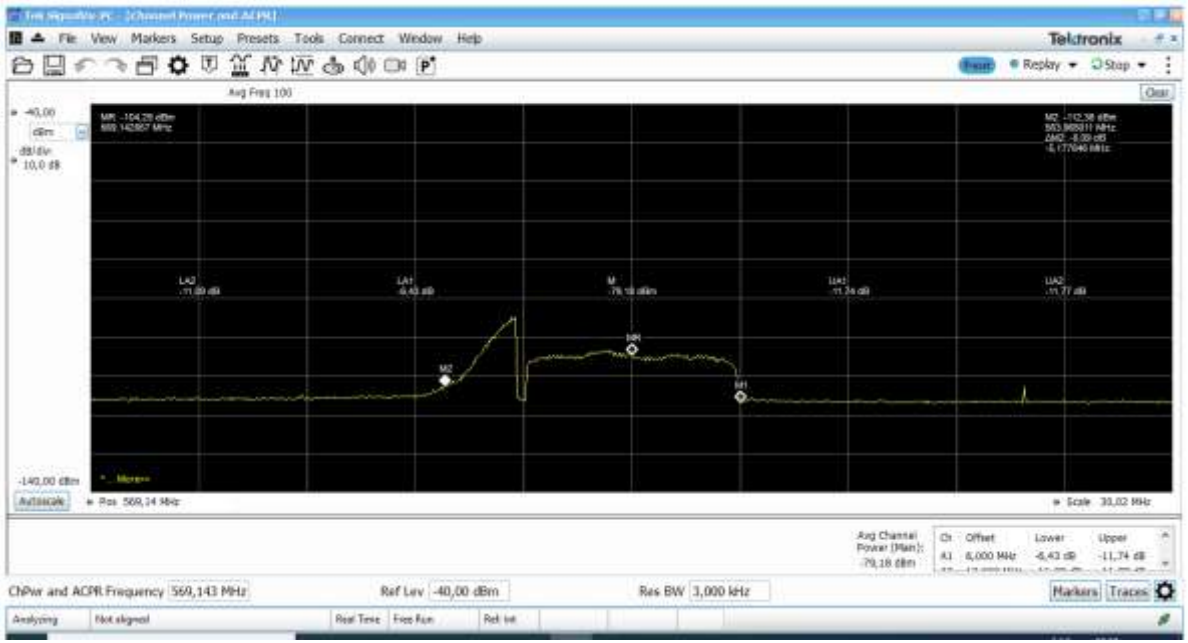


Figure 5.12 - Horizontal

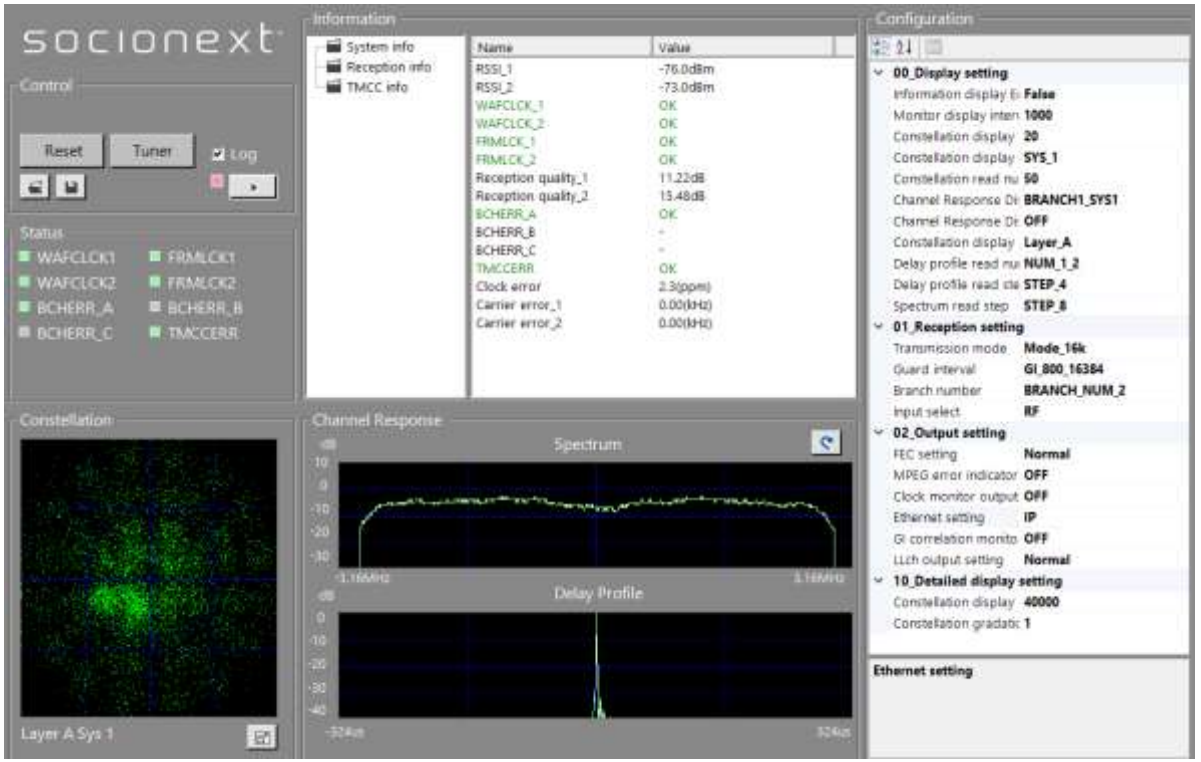


Figure 5.13 - Socionext Screen

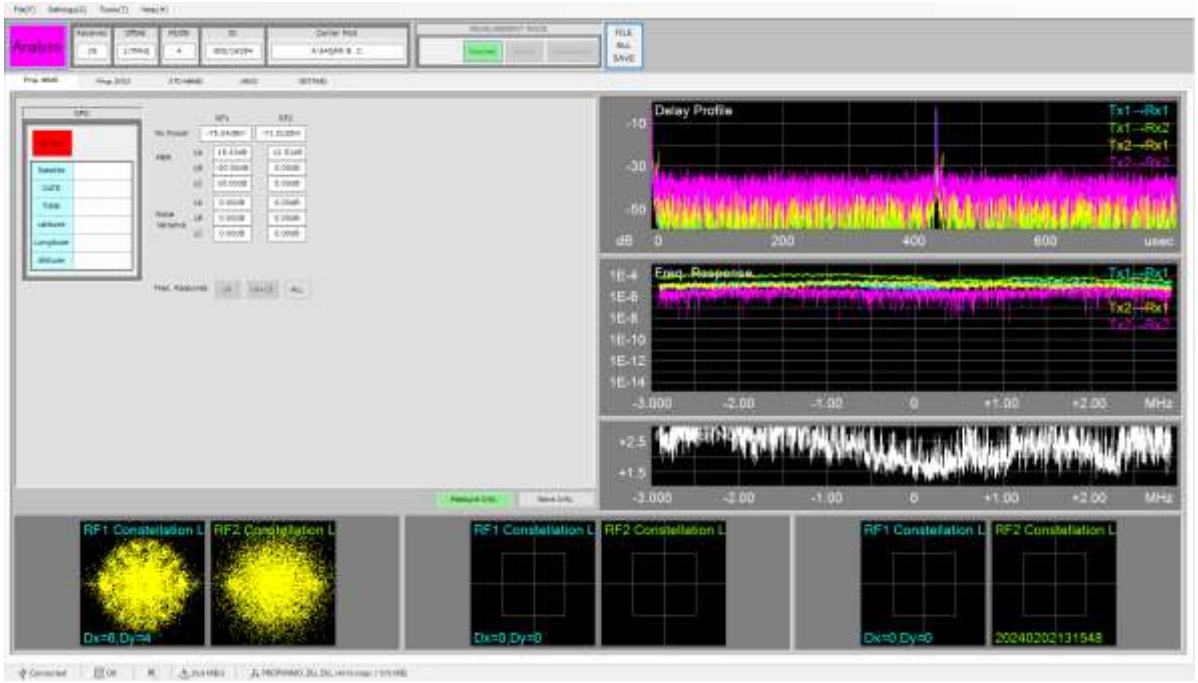


Figure 5.14 - Rintaro Screen

Chapter 6. Site 21

a) Channel Power

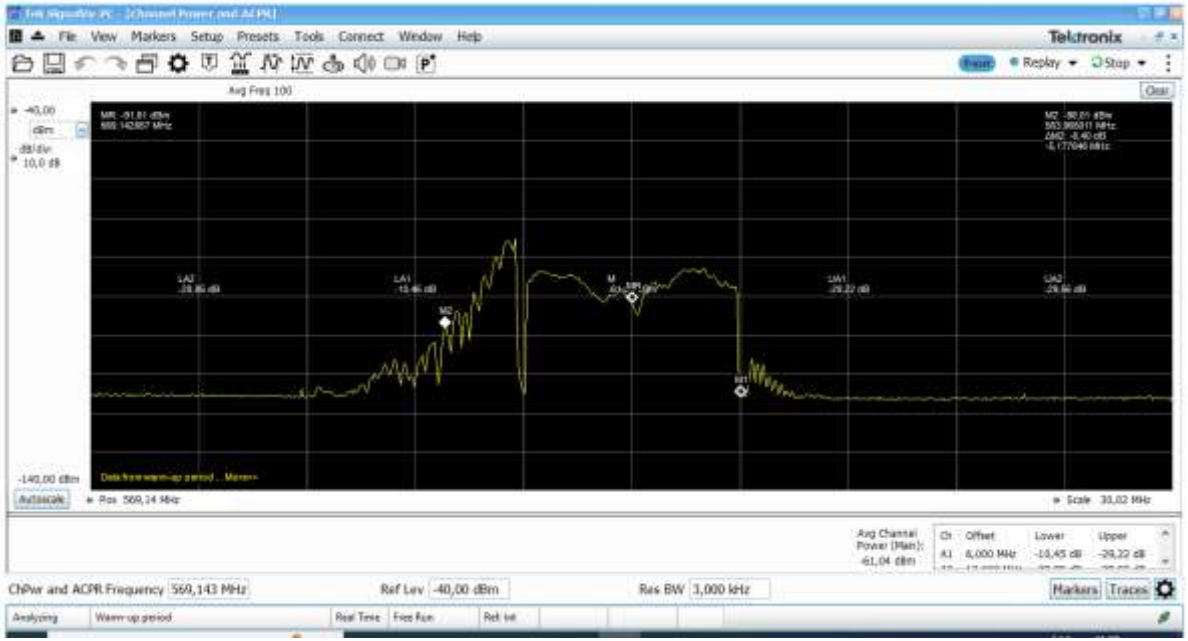


Figure 6.1 - Vertical

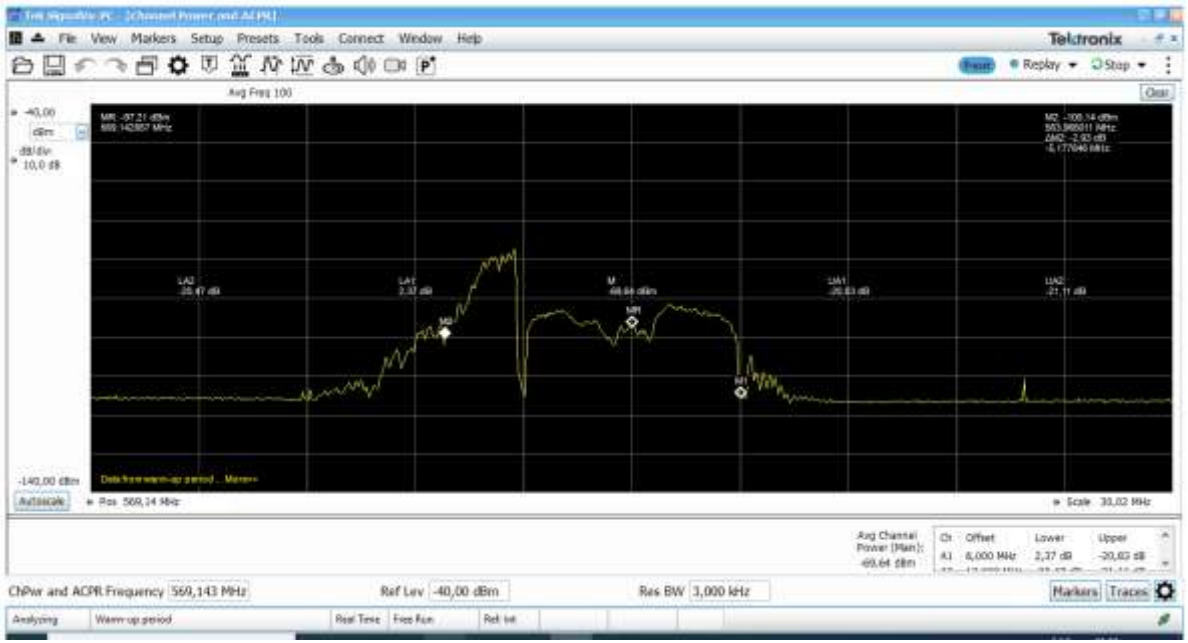


Figure 6.2 - Horizontal

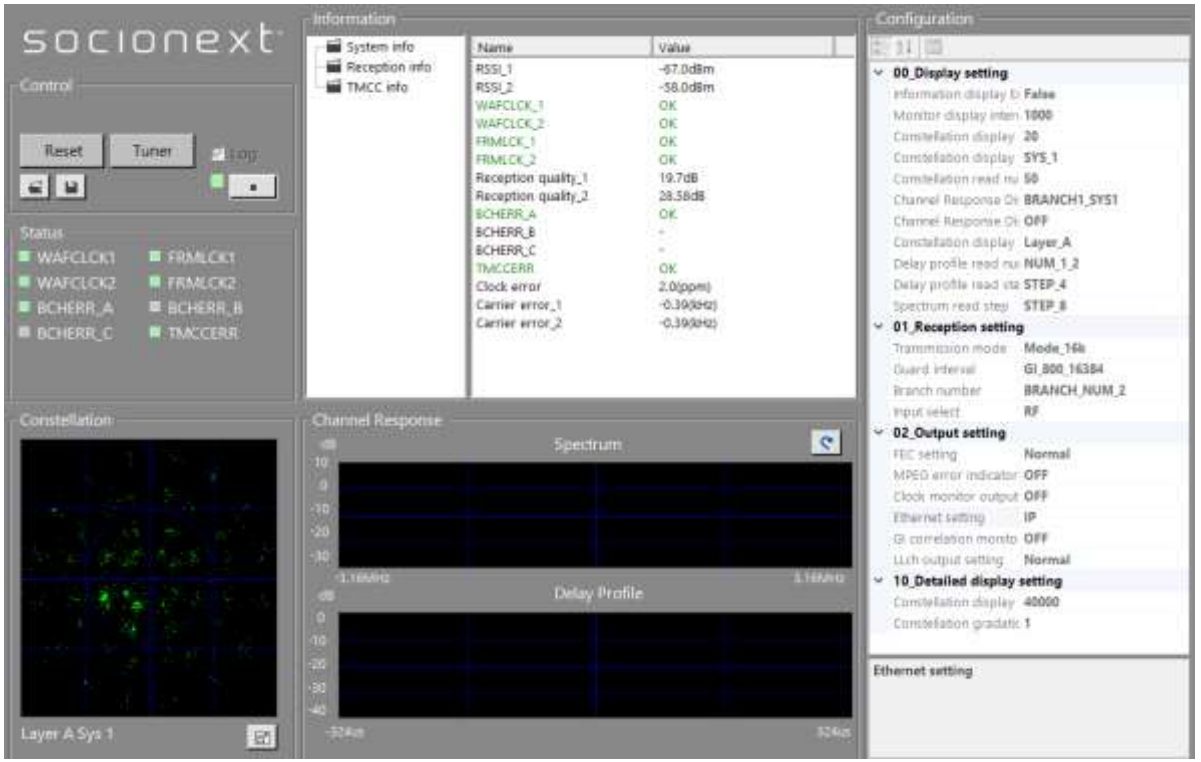


Figure 6.3 - Socionext Screen

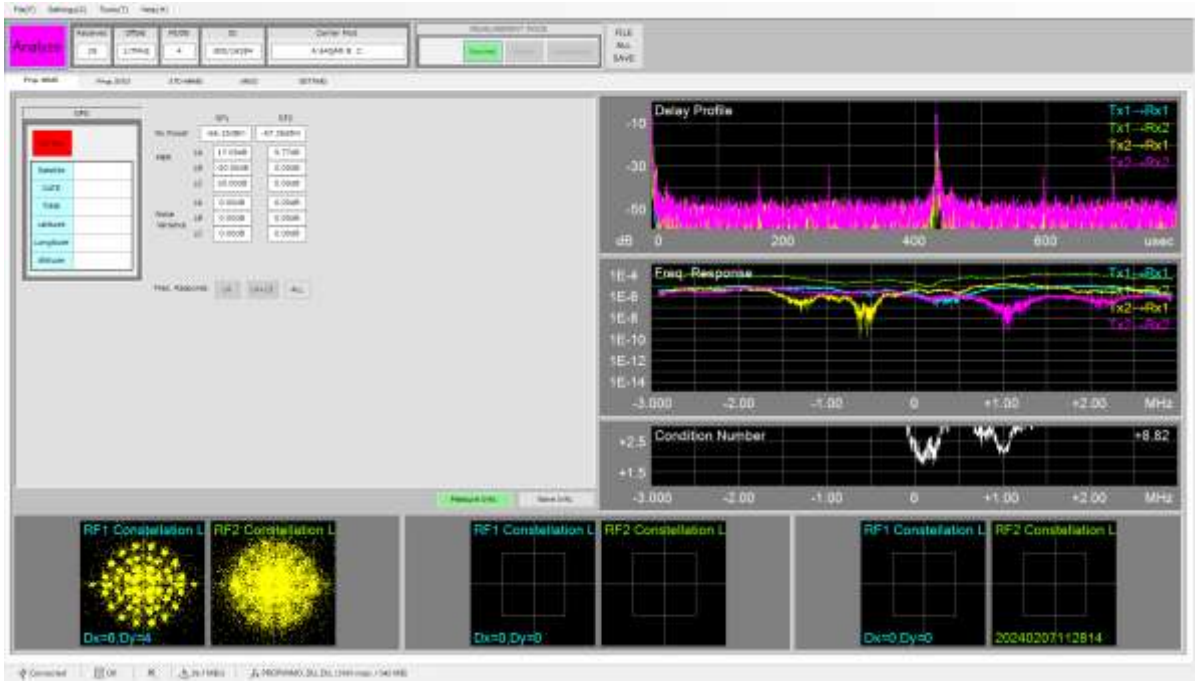


Figure 6.4 - Rintaro Screen

b) AWGN Power

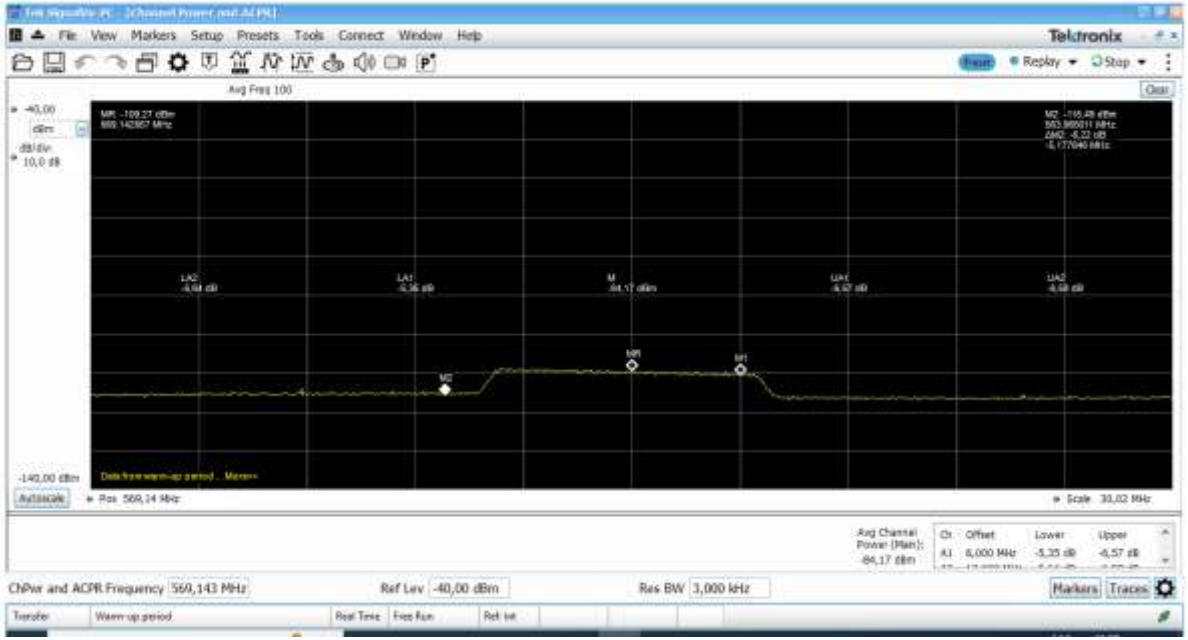


Figure 6.5 - Vertical

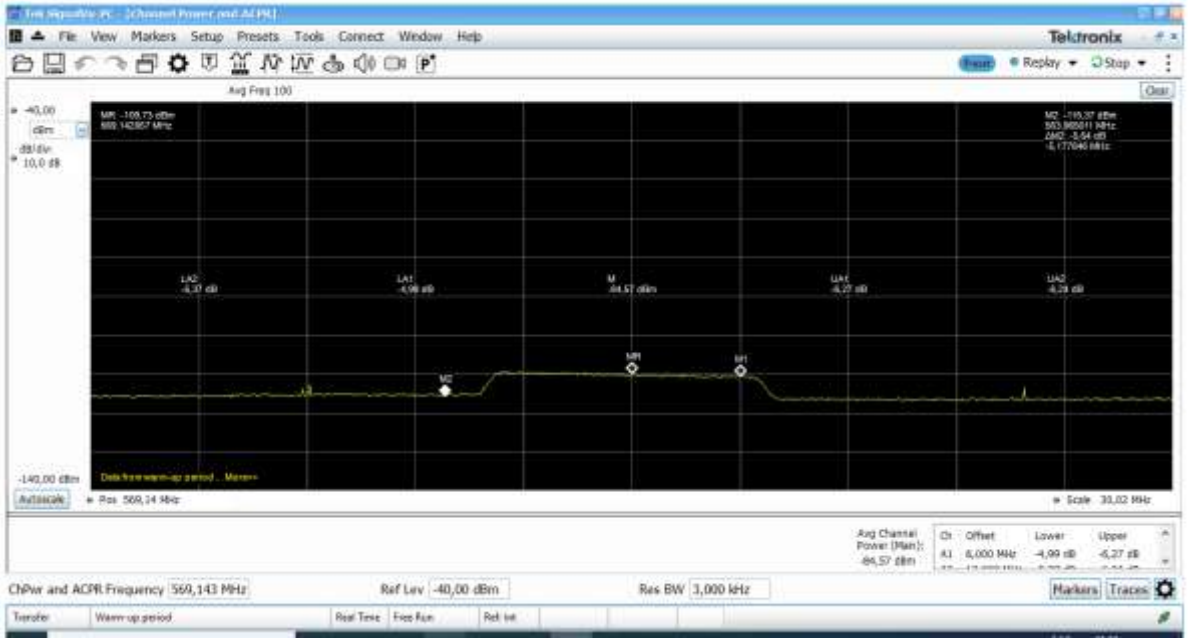


Figure 6.6 - Horizontal

c) C/N Threshold

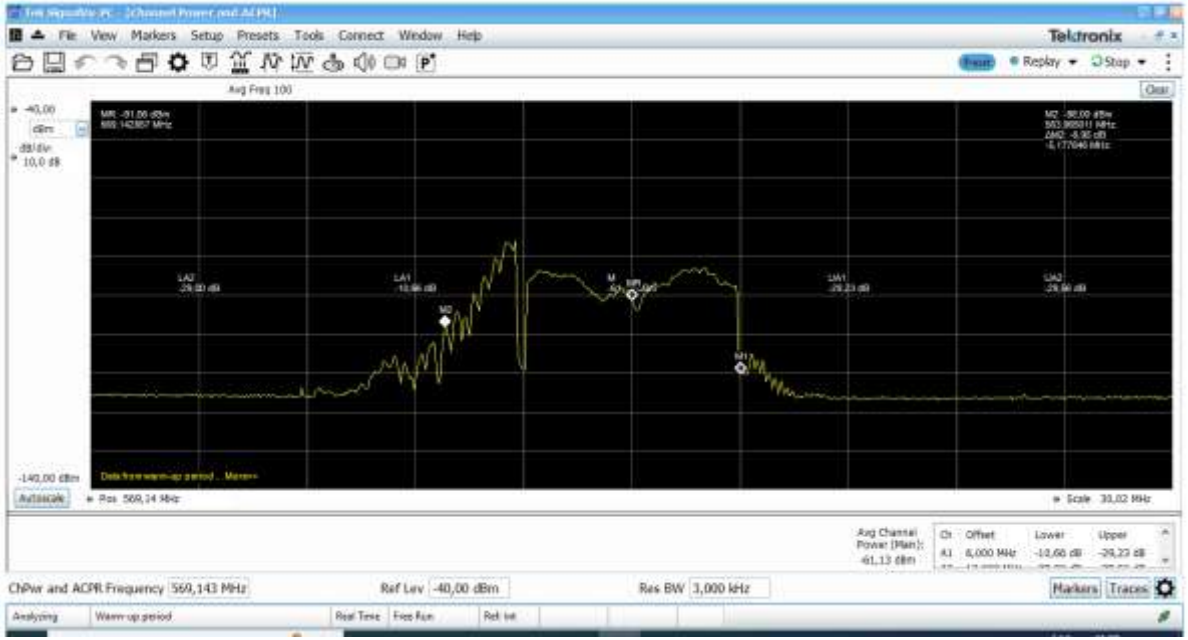


Figure 6.7 - Vertical

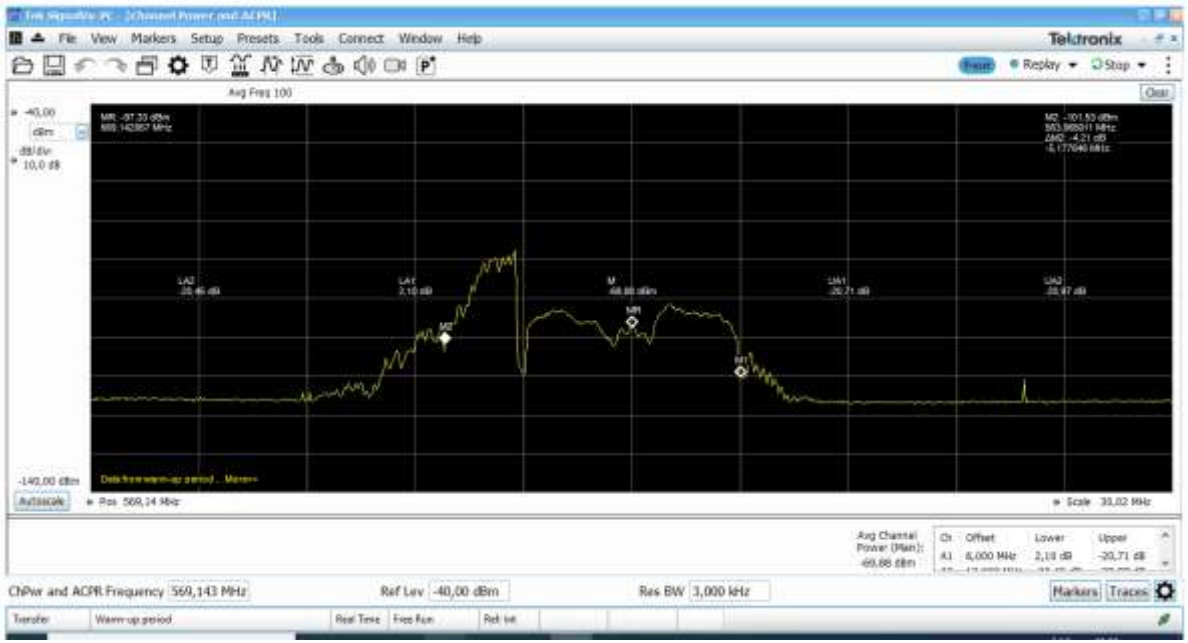


Figure 6.8 - Horizontal

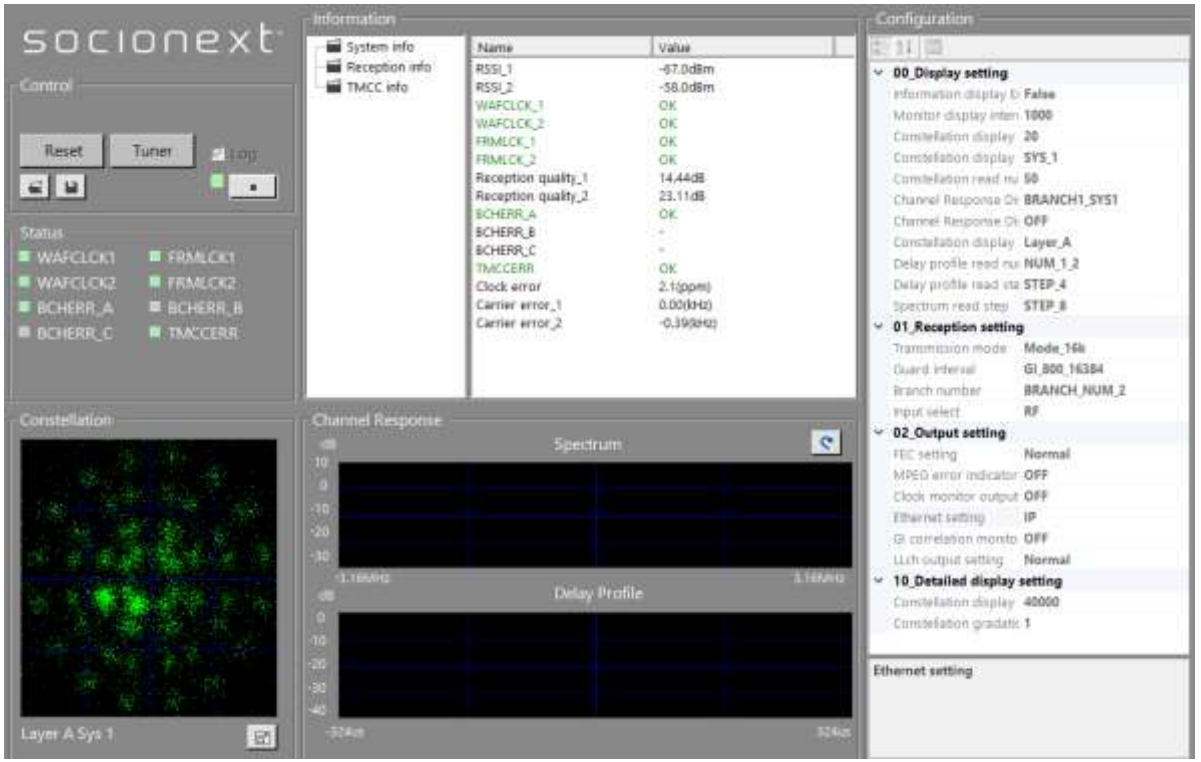


Figure 6.9 - Socionext Screen

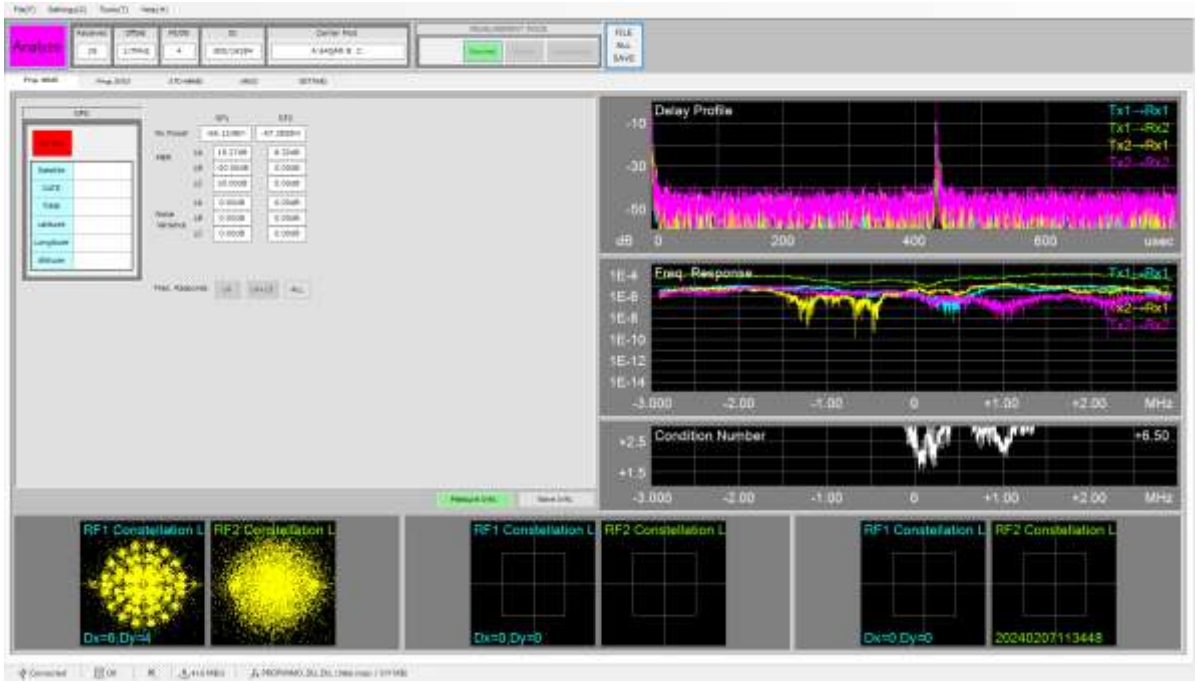


Figure 6.10 - Rintaro Screen

d) Reception Threshold

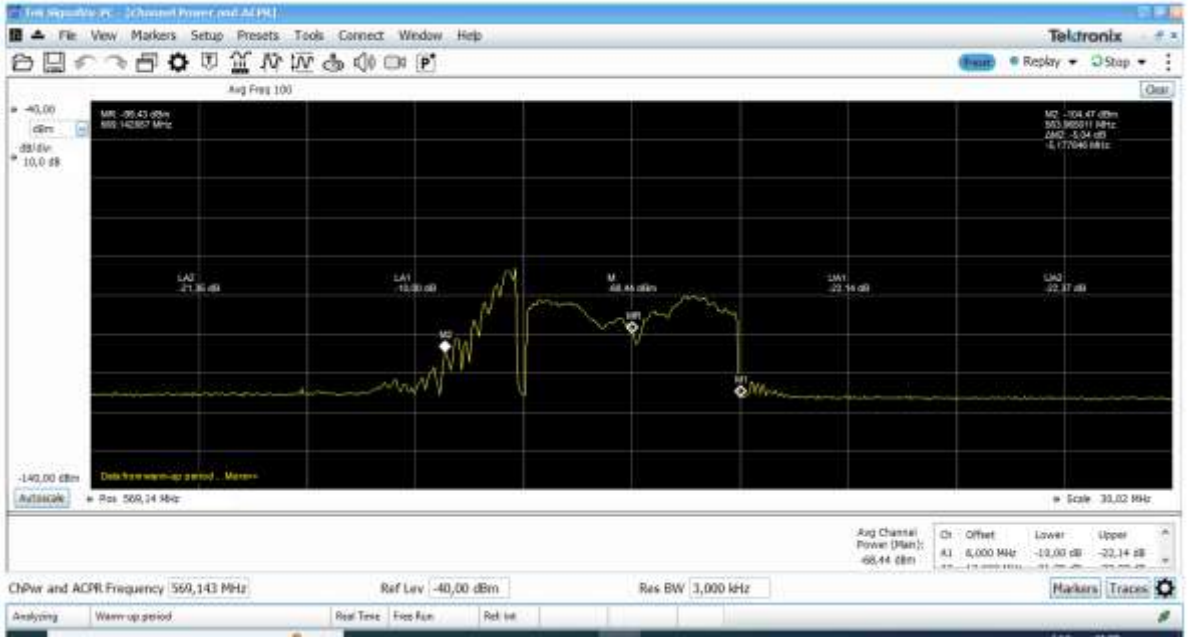


Figure 6.11 - Vertical

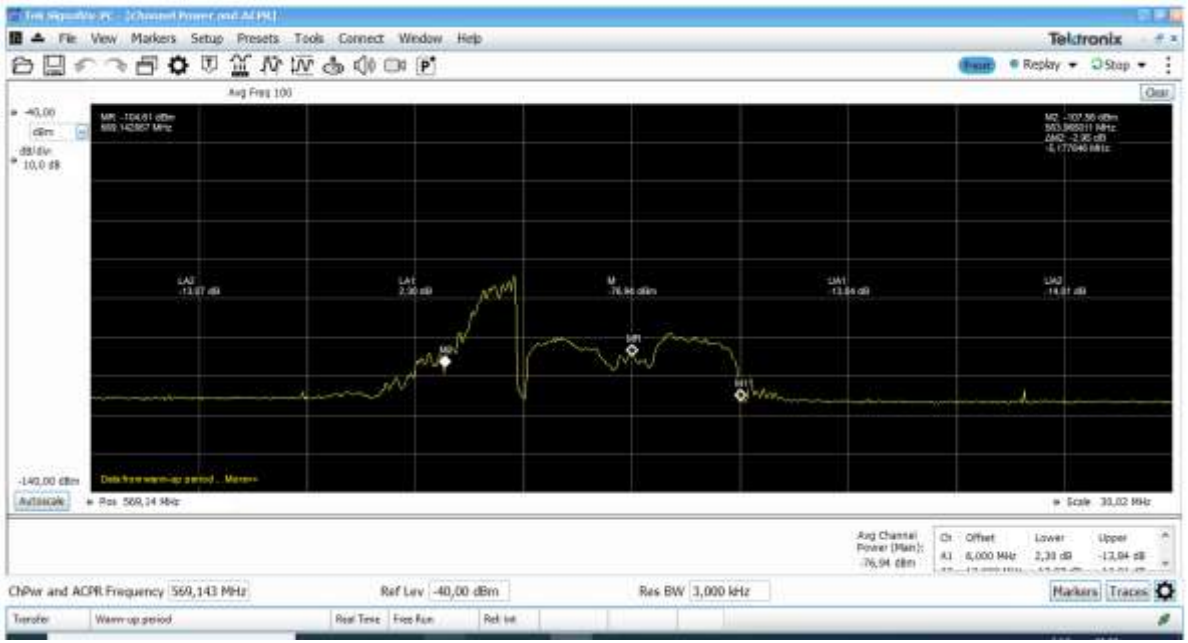


Figure 6.12 - Horizontal

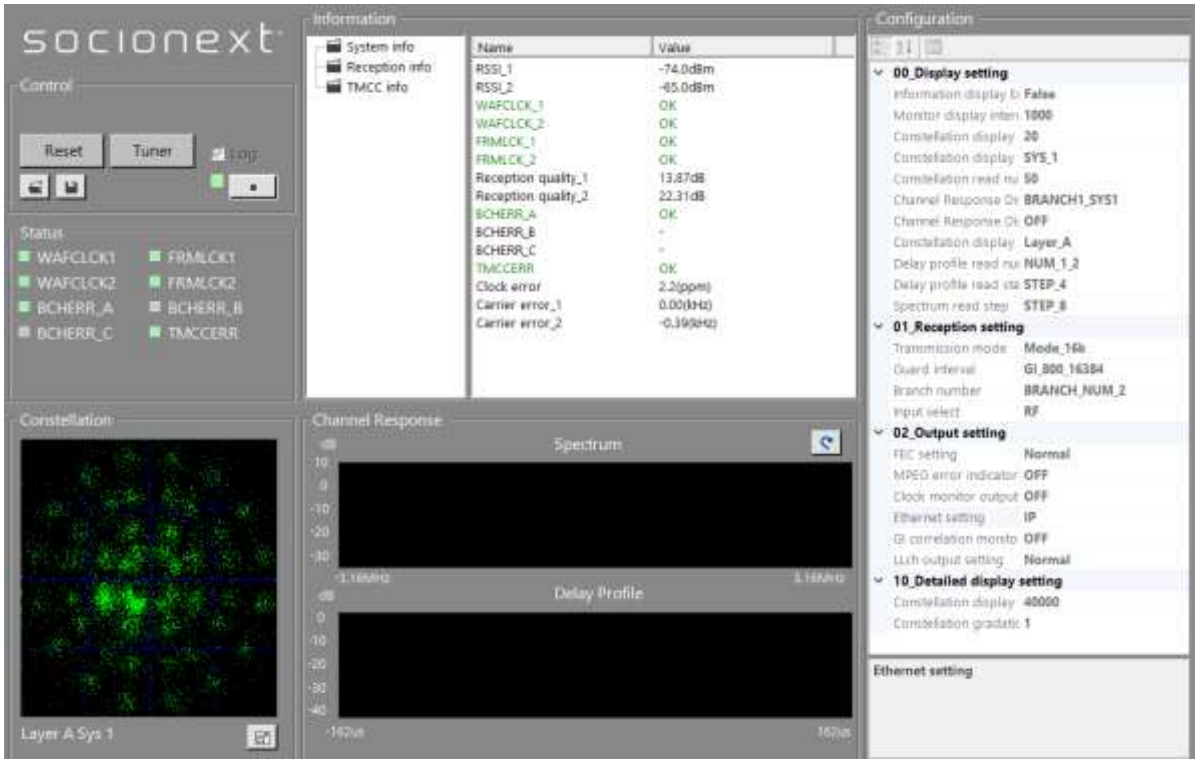


Figure 6.13 - Socionext Screen

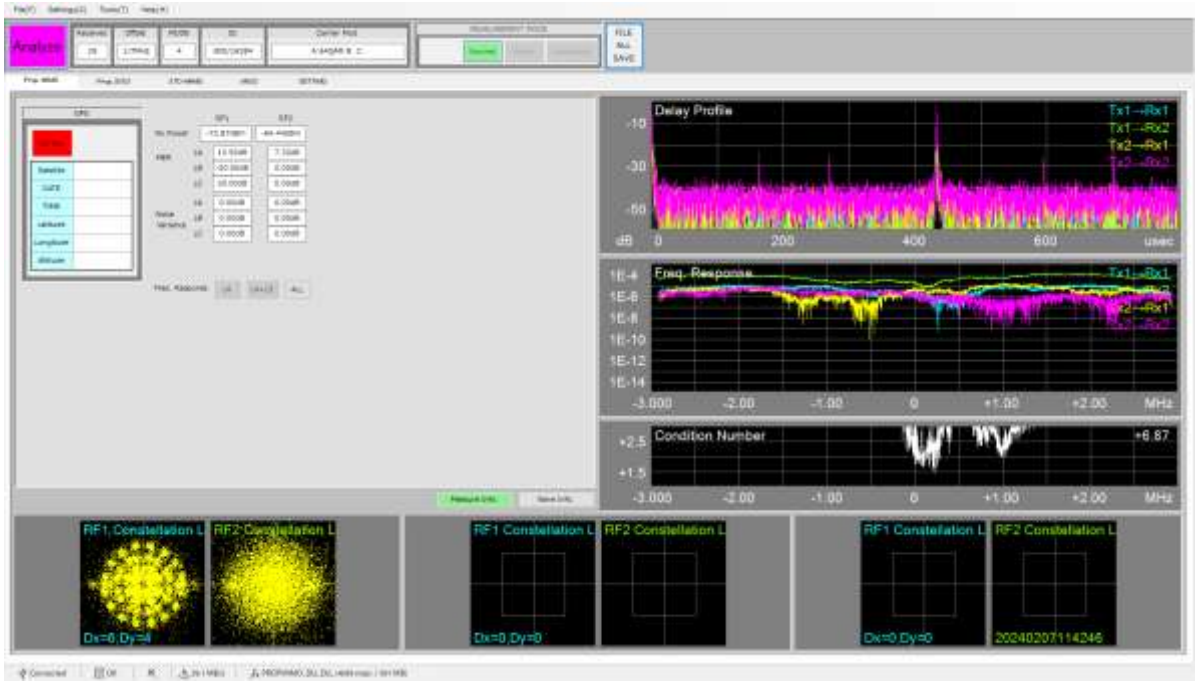


Figure 6.14 - Rintaro Screen

Chapter 7. Site 27

a) Channel Power

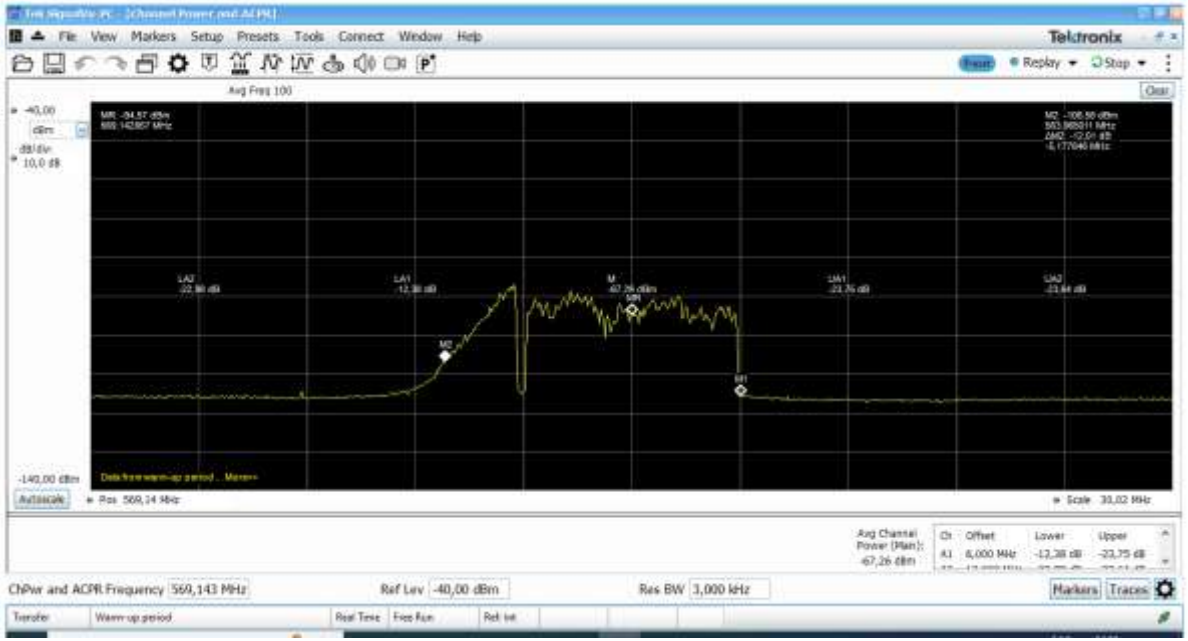


Figure 7.1 - Vertical

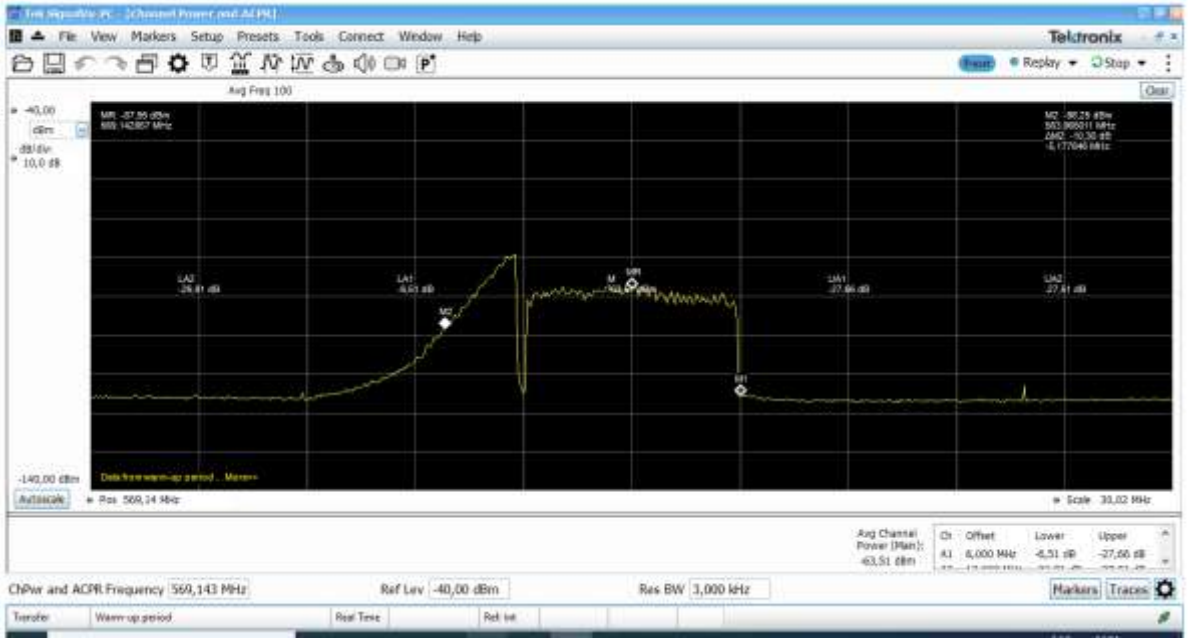


Figure 7.2 - Horizontal

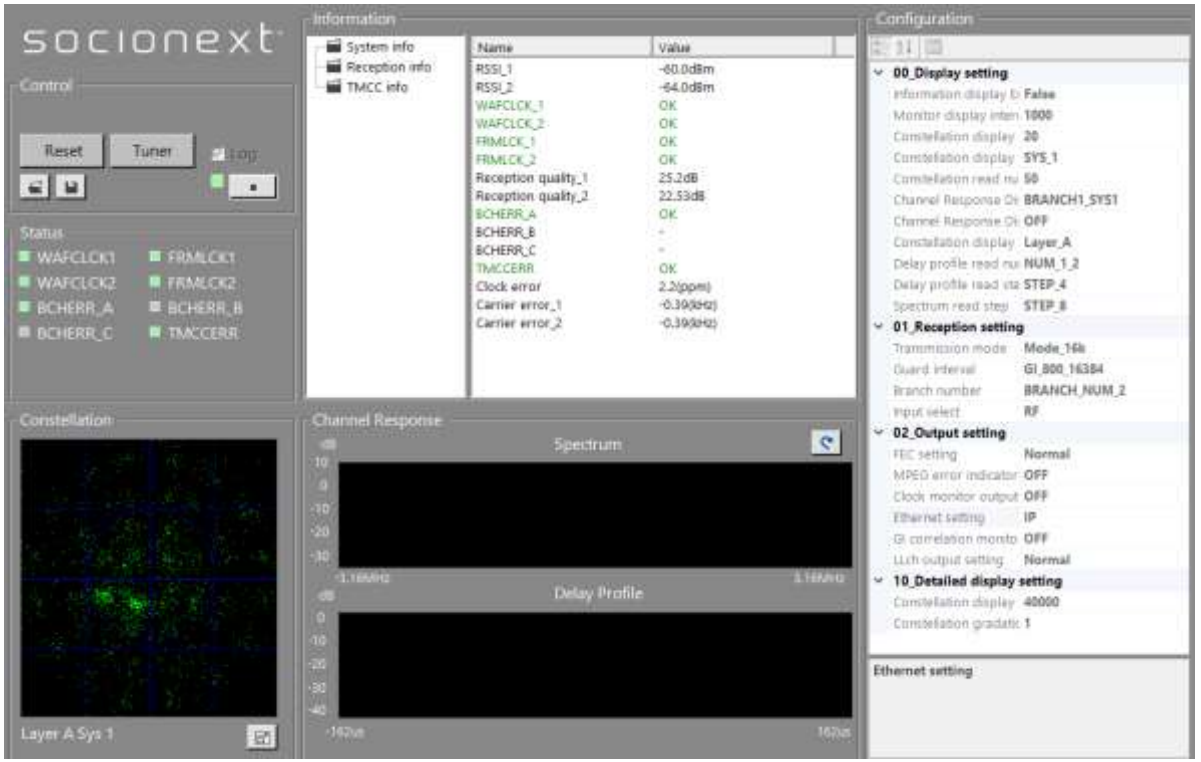


Figure 7.3 - Socionext Screen

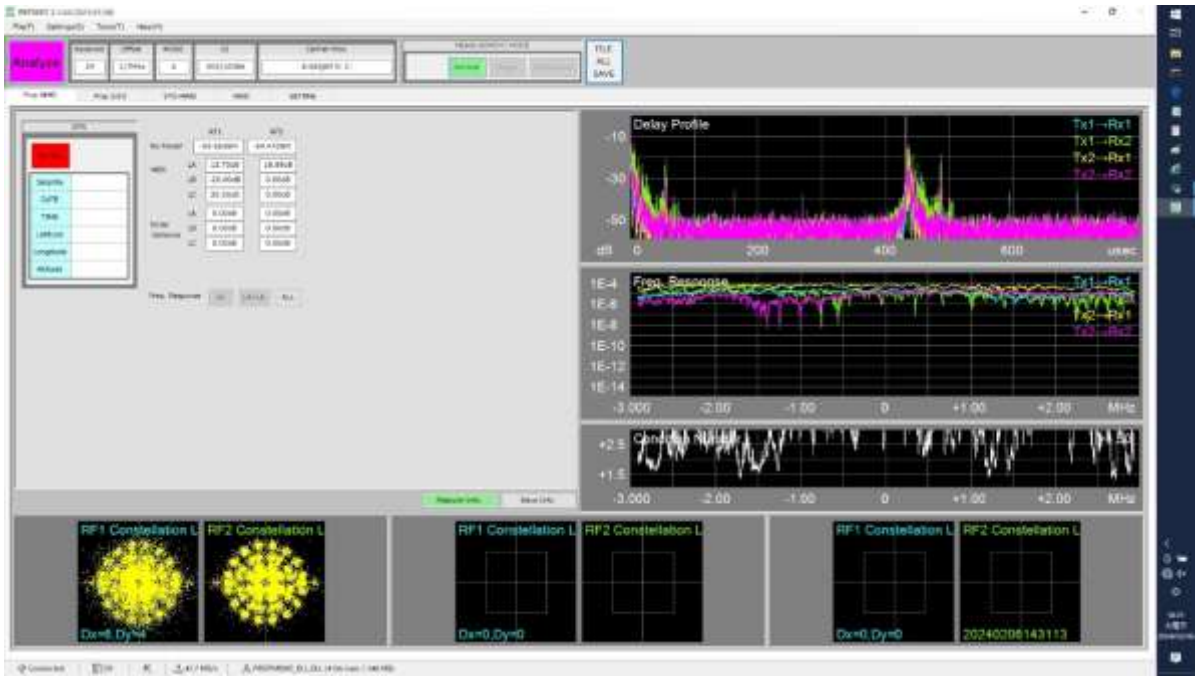


Figure 7.4 - Rintaro Screen

b) AWGN Power

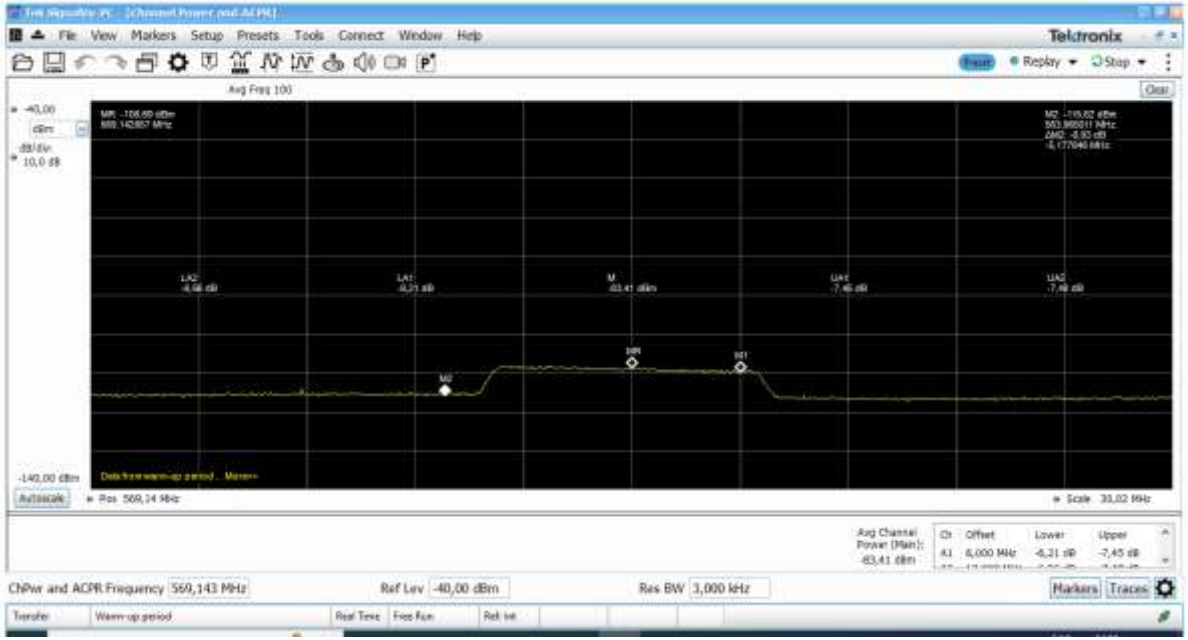


Figure 7.5 - Vertical

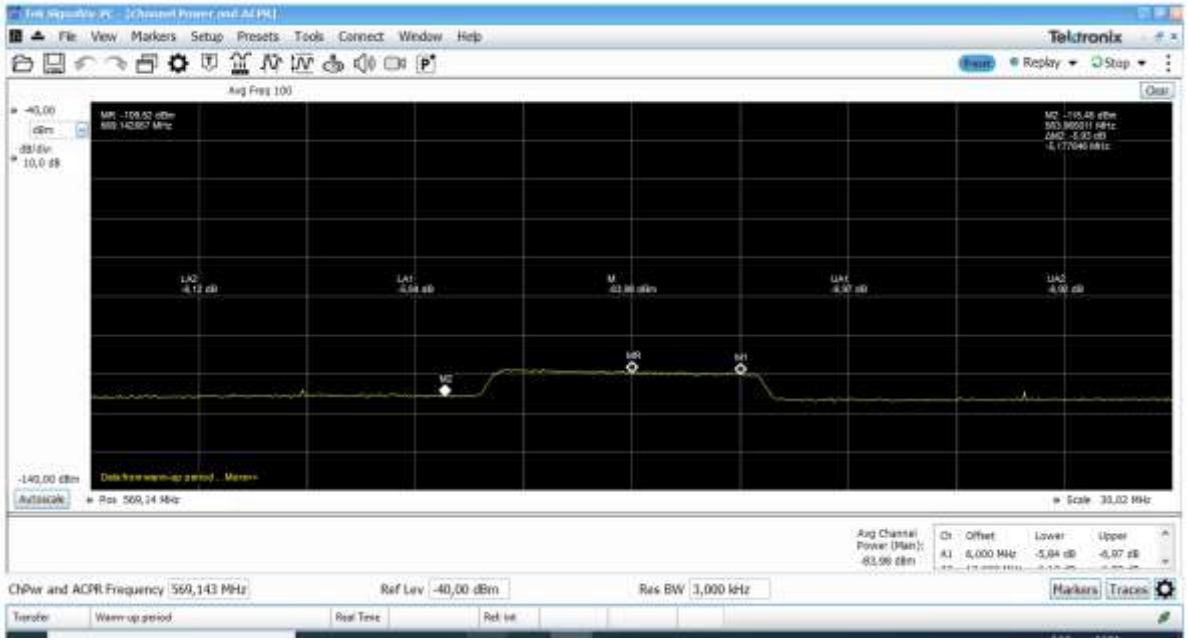


Figure 7.6 - Horizontal

c) C/N Threshold

Figure 7.7 - Vertical

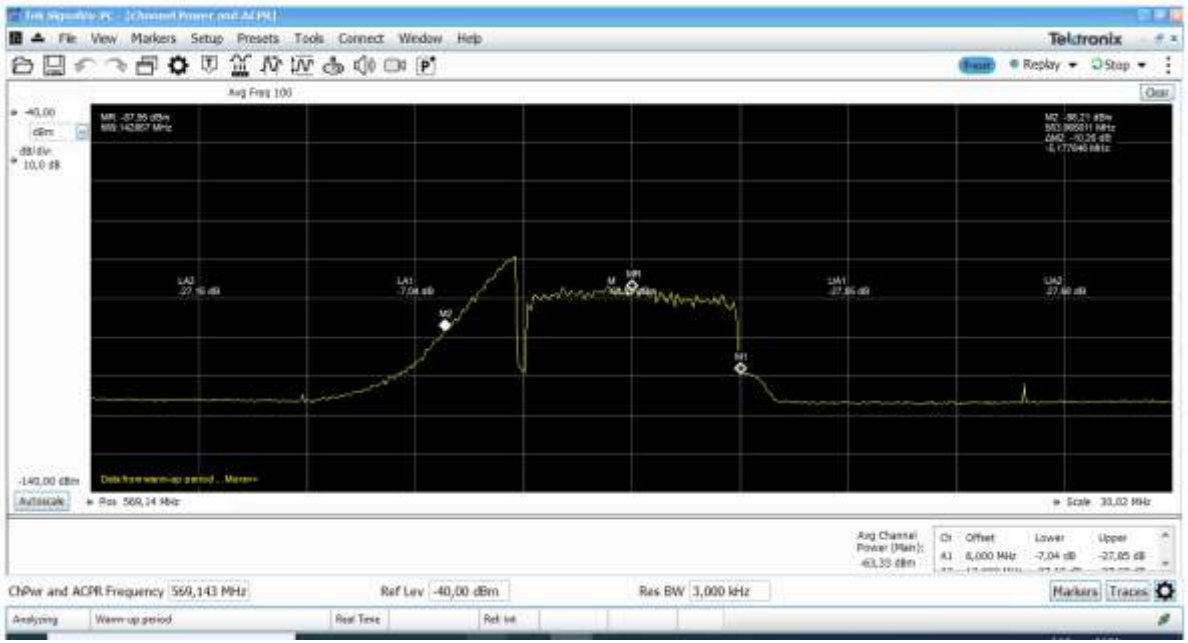


Figure 7.8 - Horizontal

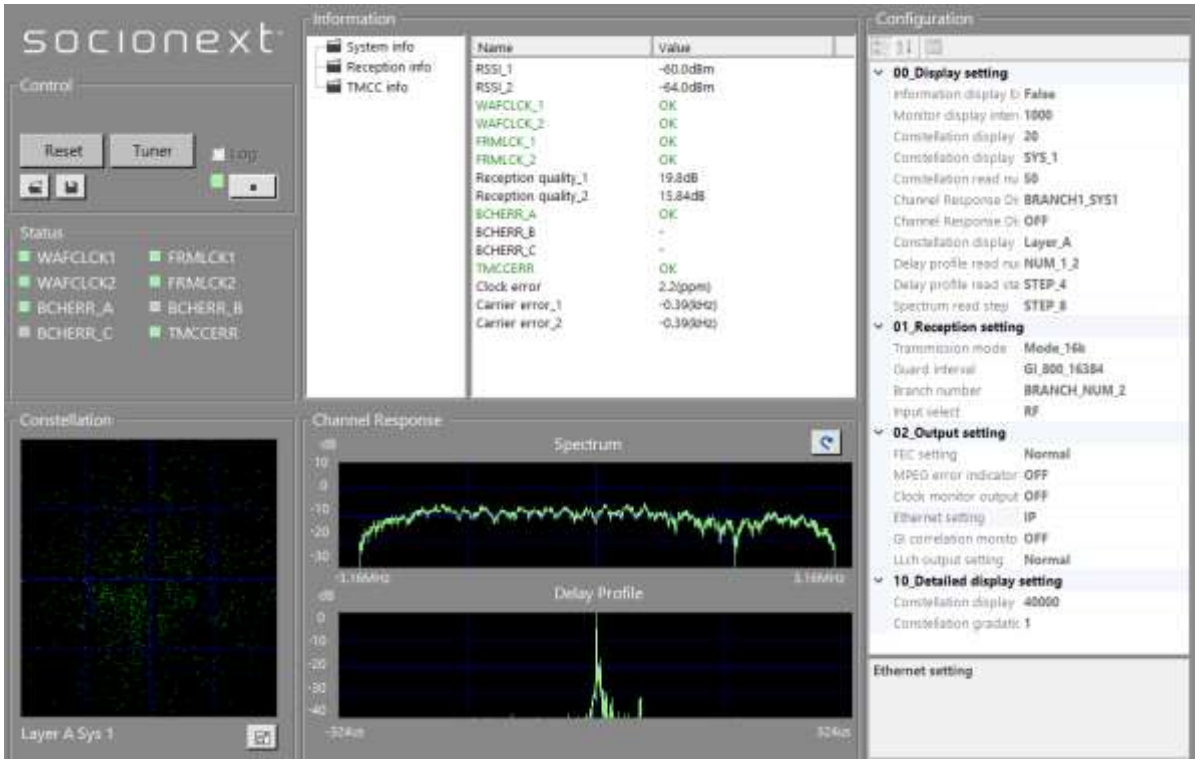


Figure 7.9 - Socionext Screen

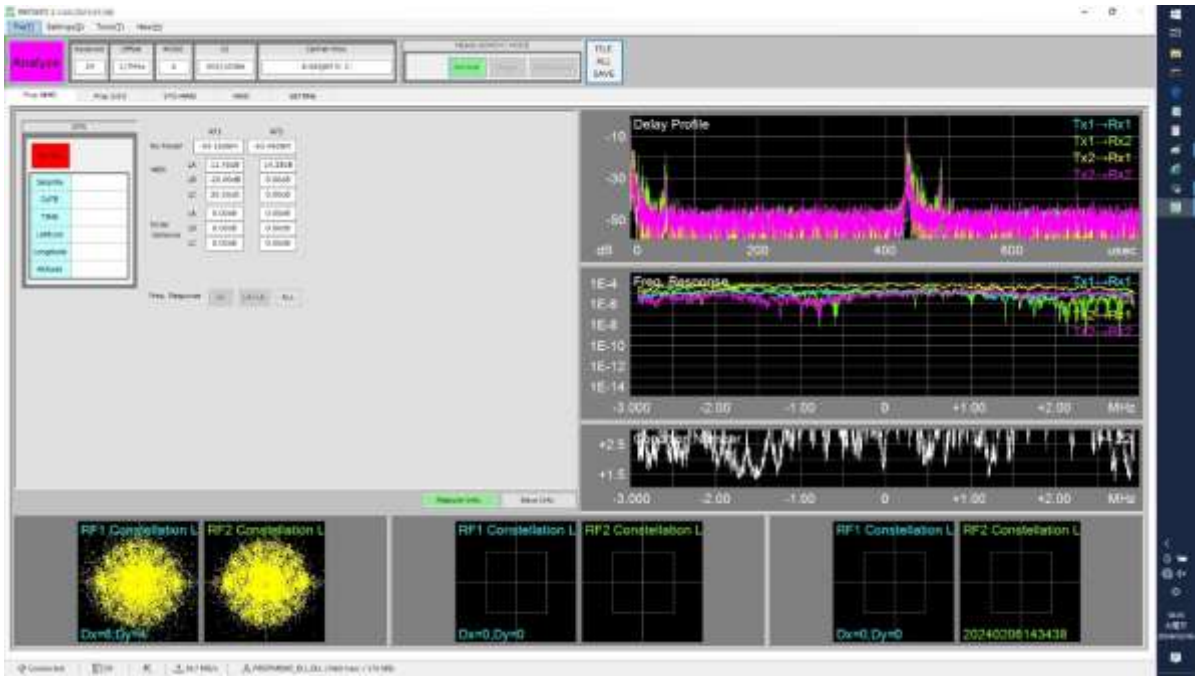


Figure 7.10 - Rintaro Screen

d) Reception Threshold

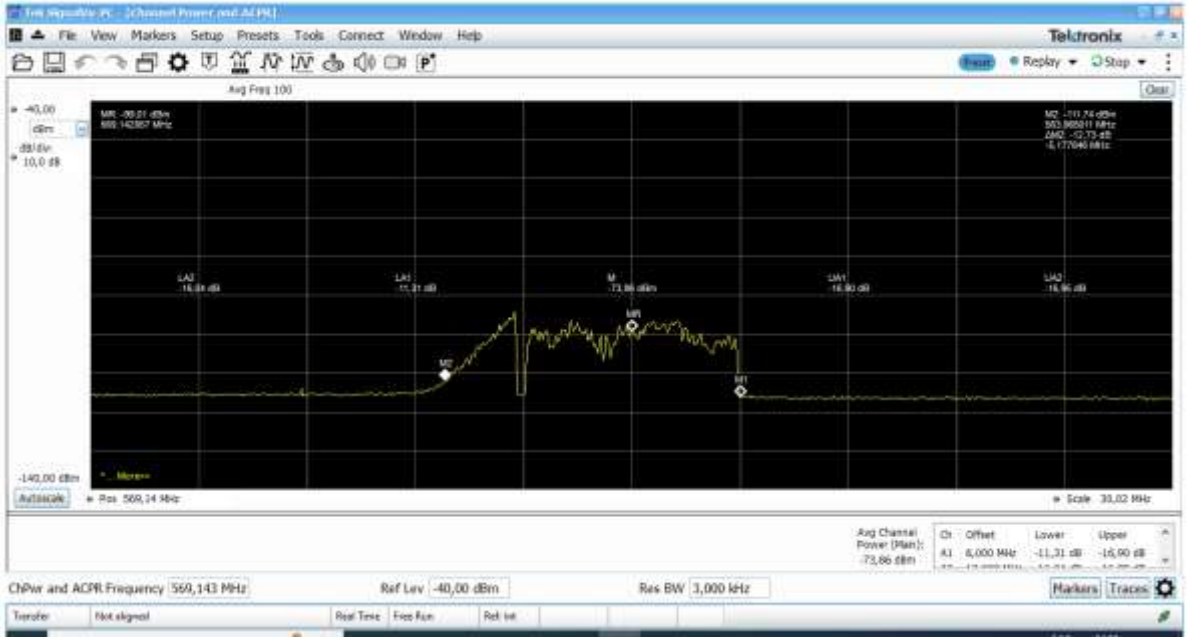


Figure 7.11 - Vertical

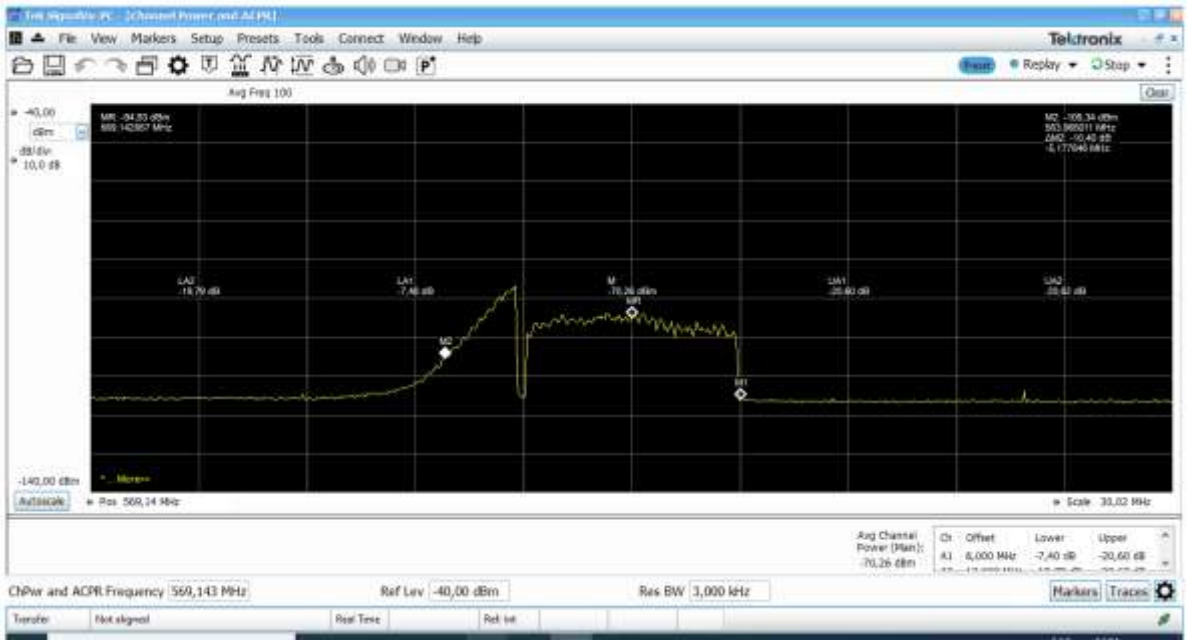


Figure 7.12 - Horizontal

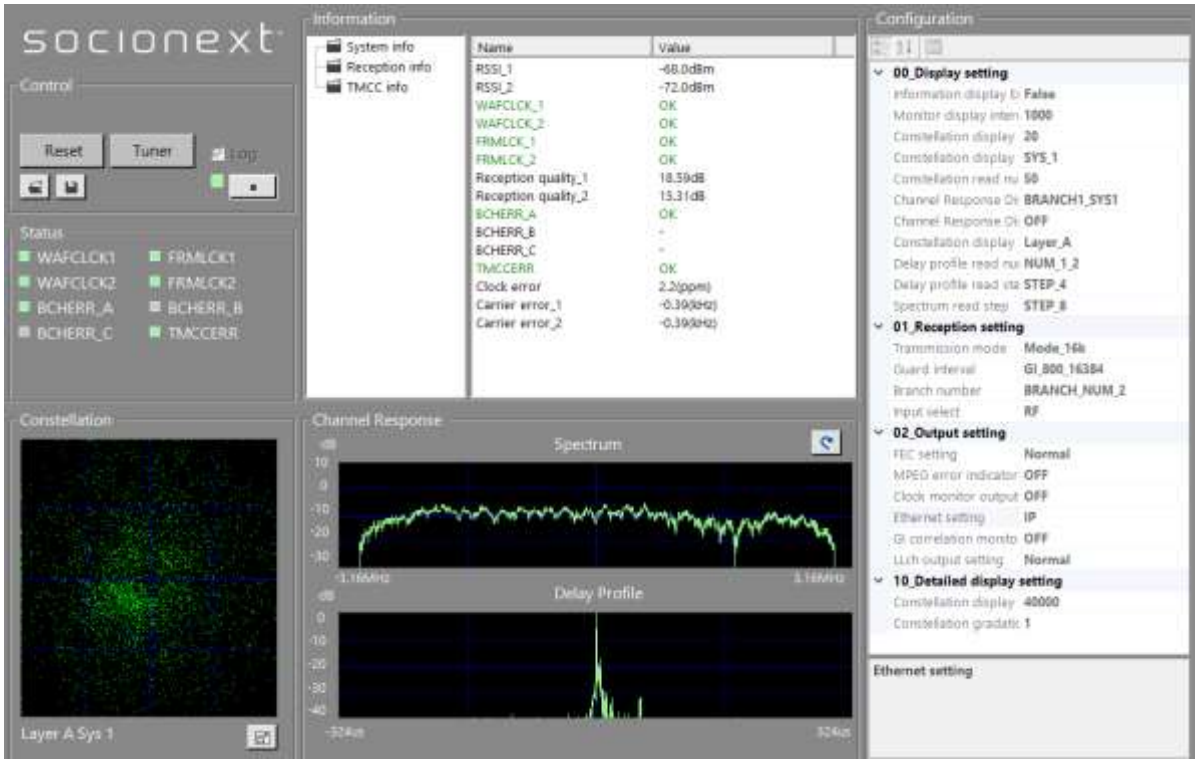


Figure 7.13 - Socionext Screen

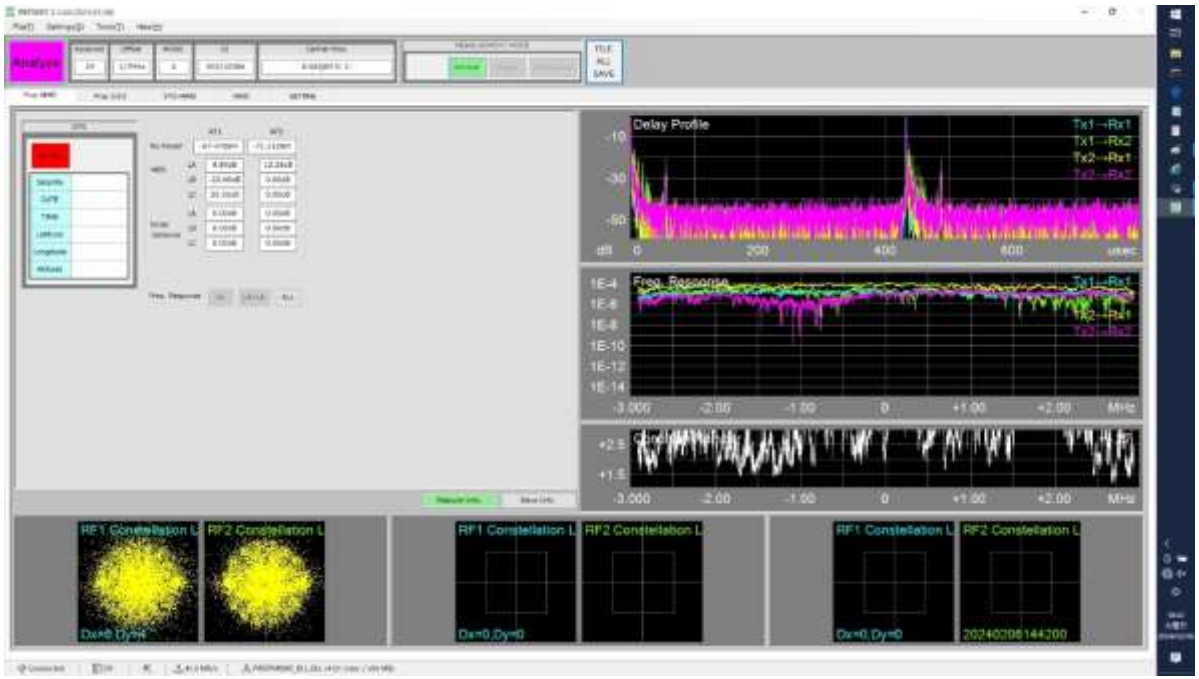


Figure 7.14 - Rintaro Screen

Chapter 8. Site 28

a) Channel Power

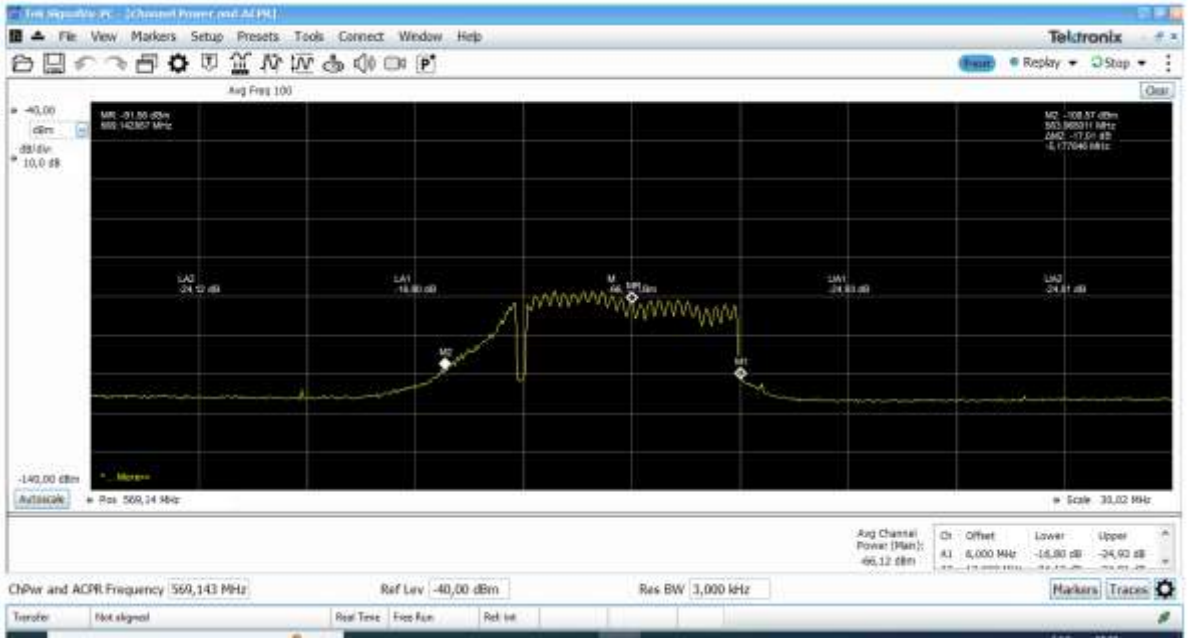


Figure 8.1 - Vertical

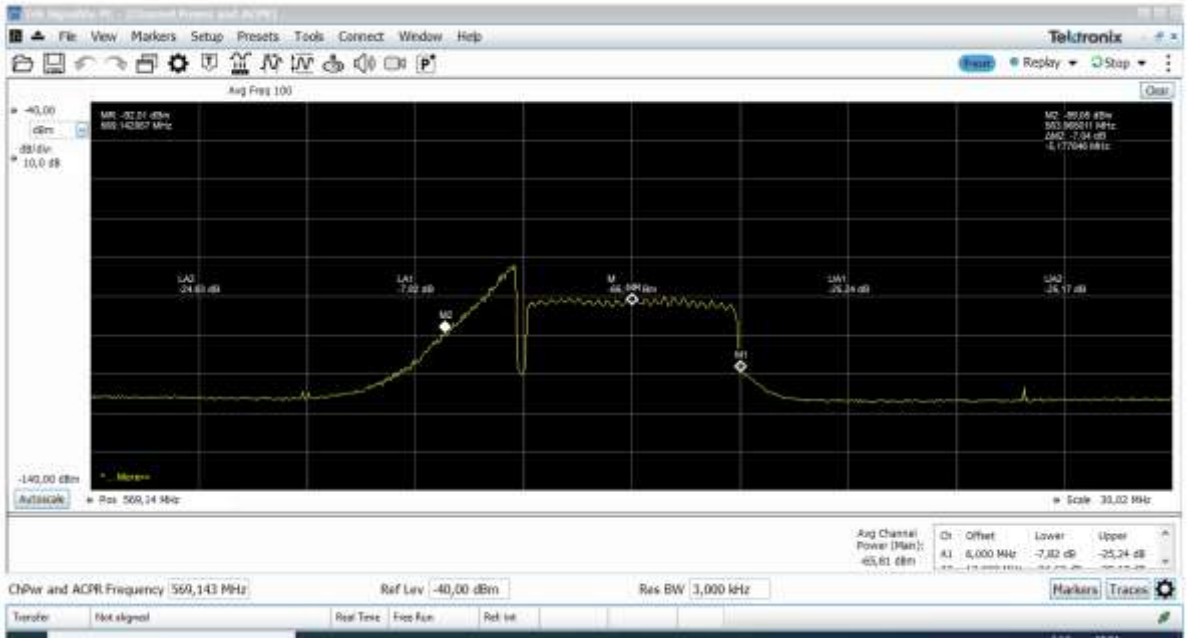


Figure 8.2 - Horizontal

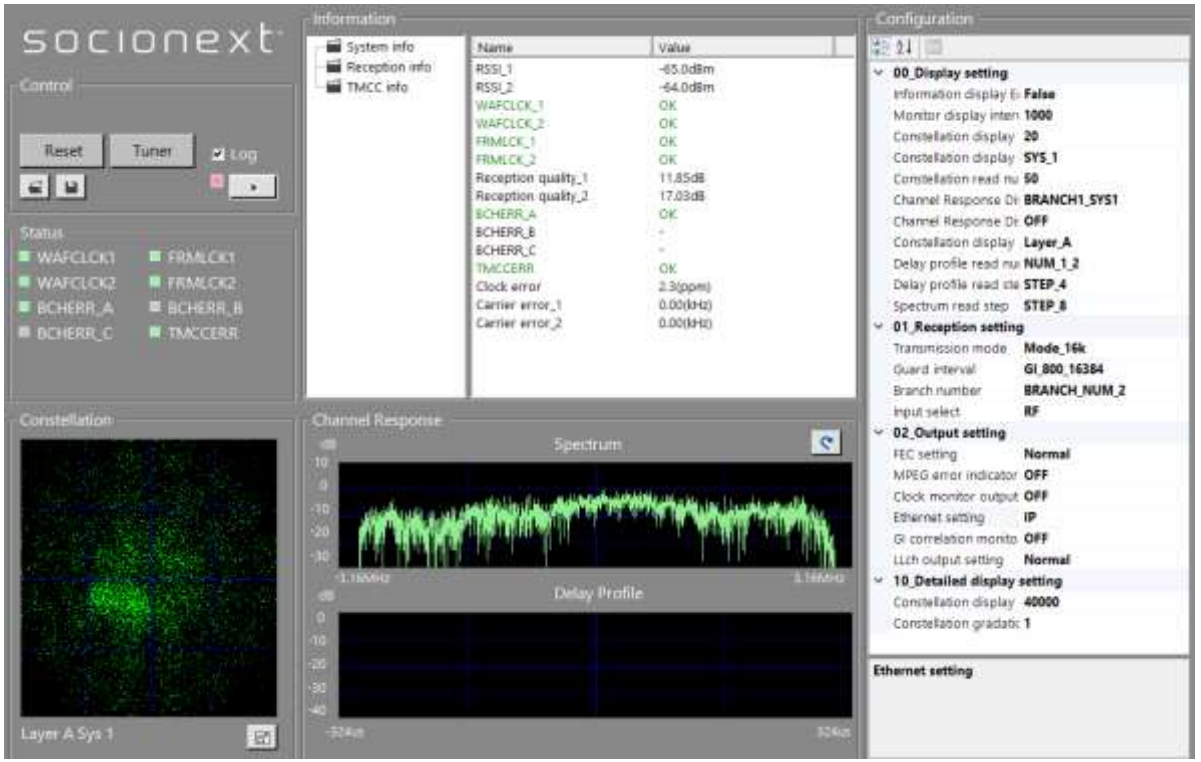


Figure 8.3 - Socionext Screen

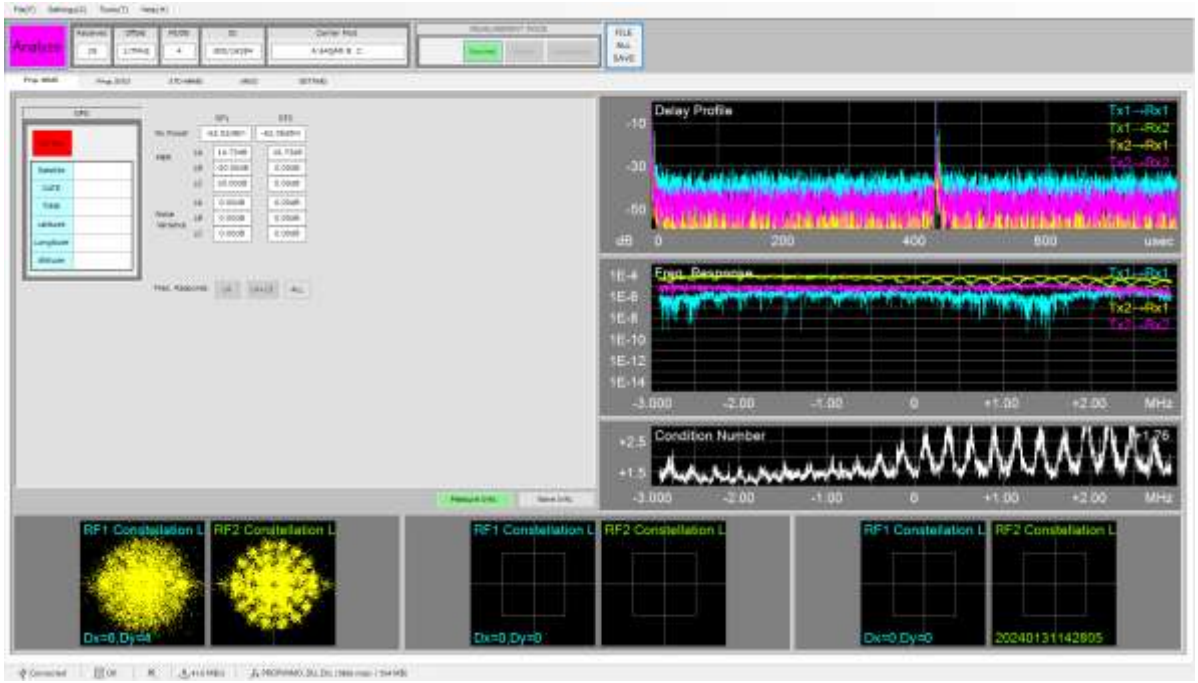


Figure 8.4 - Rintaro Screen

b) AWGN Power

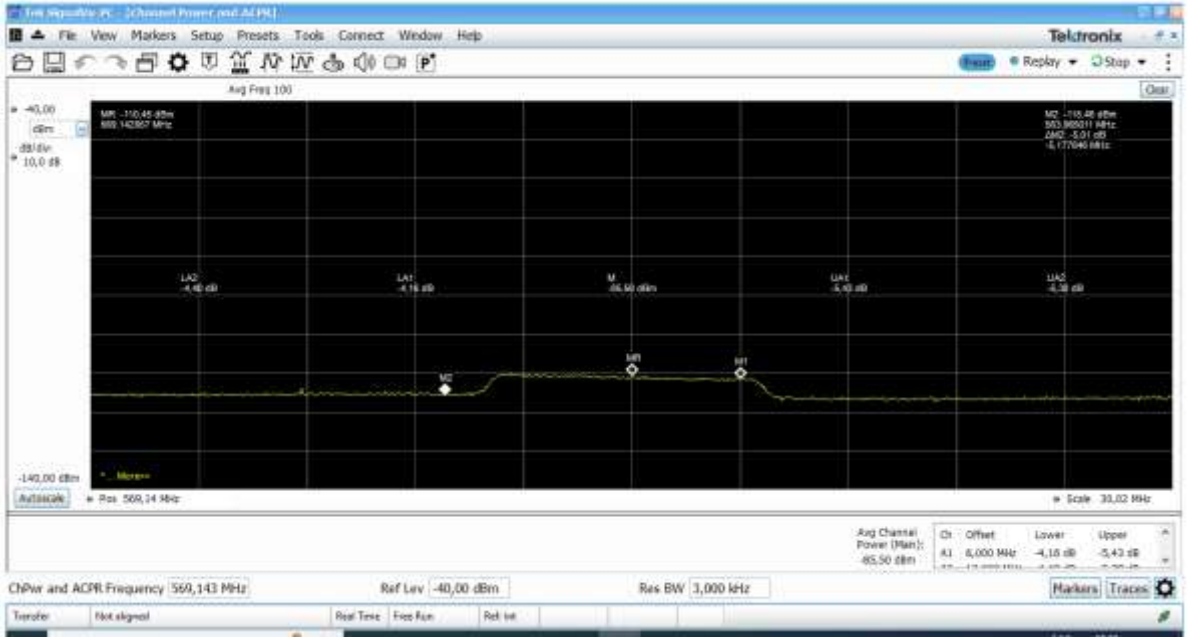


Figure 8.5 - Vertical

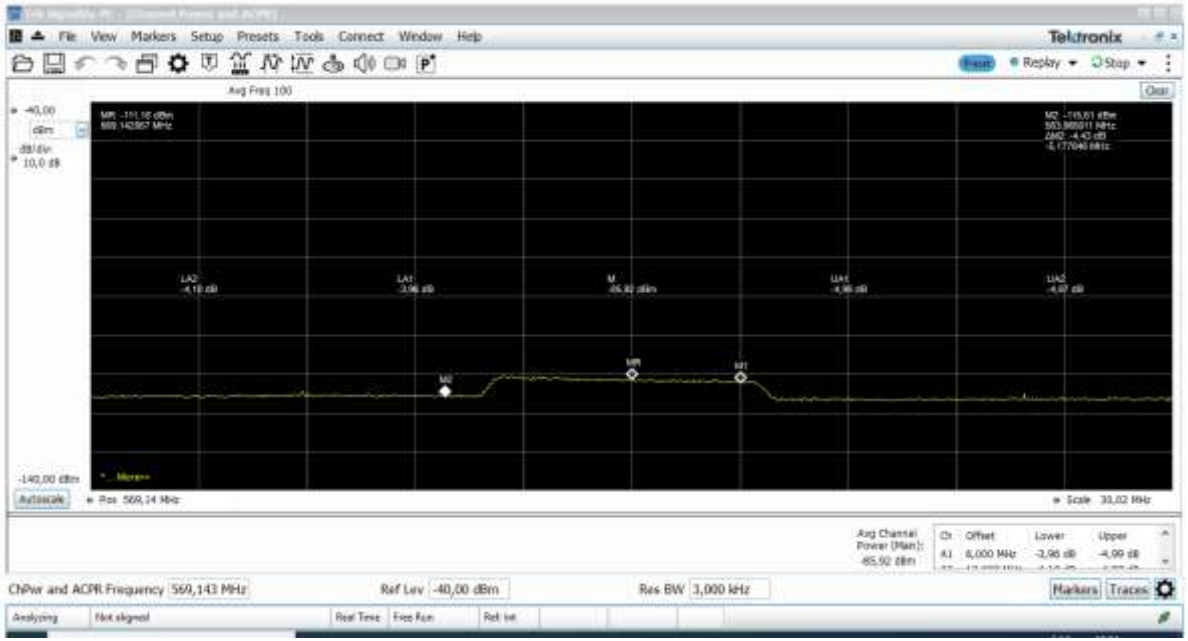


Figure 8.6 - Horizontal

c) C/N Threshold

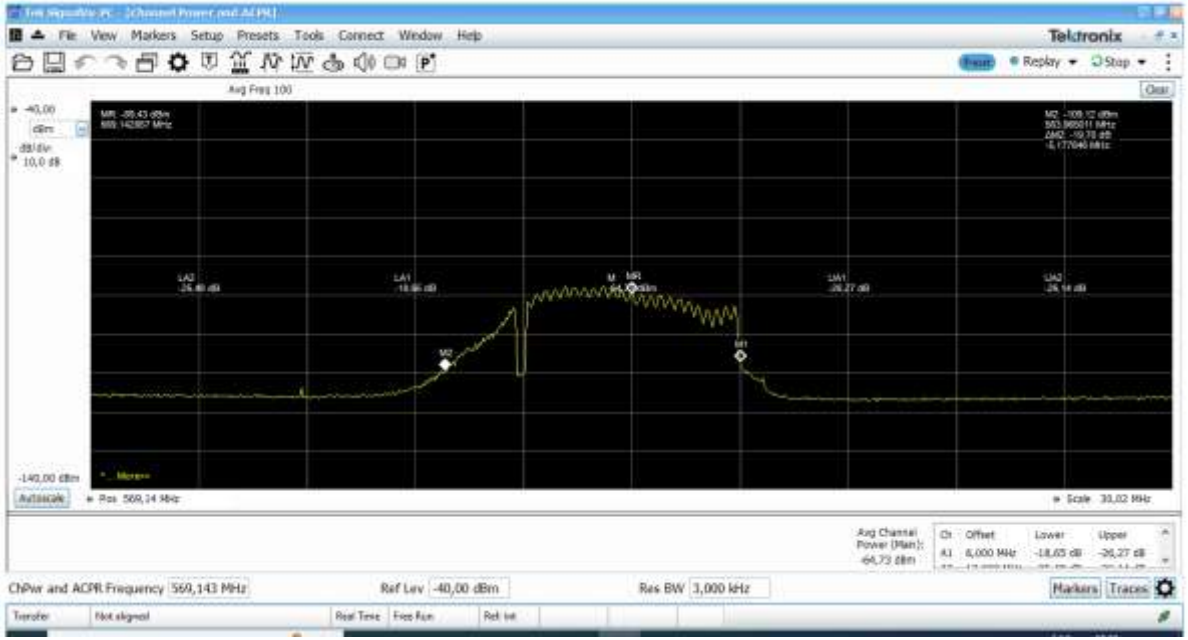


Figure 8.7 - Vertical

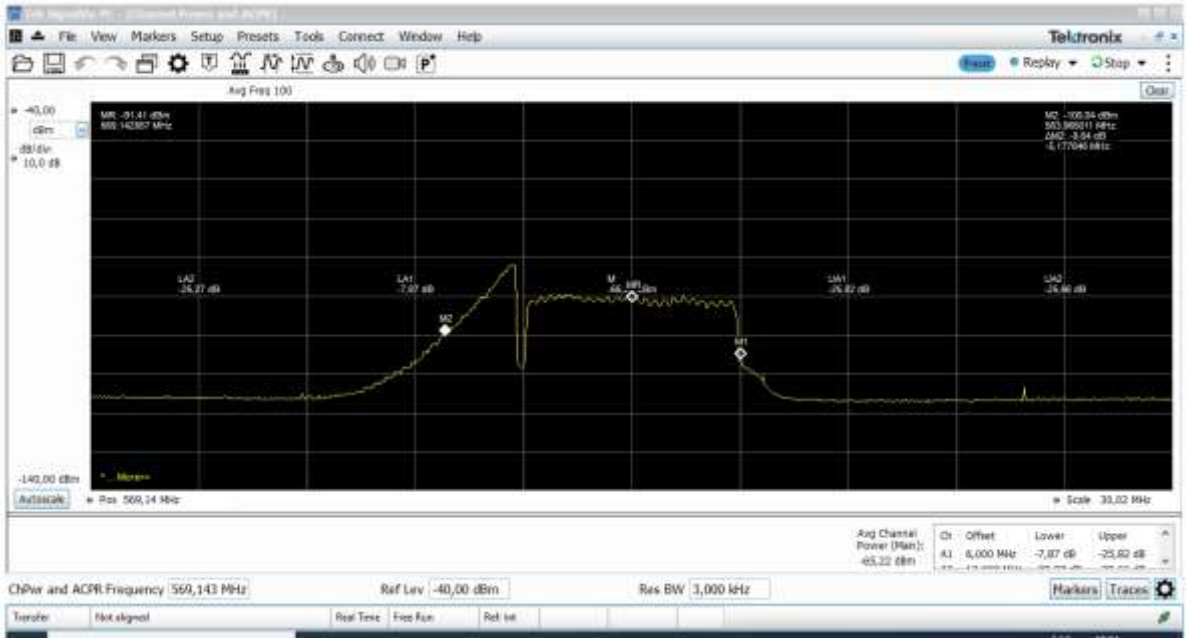


Figure 8.8 - Horizontal

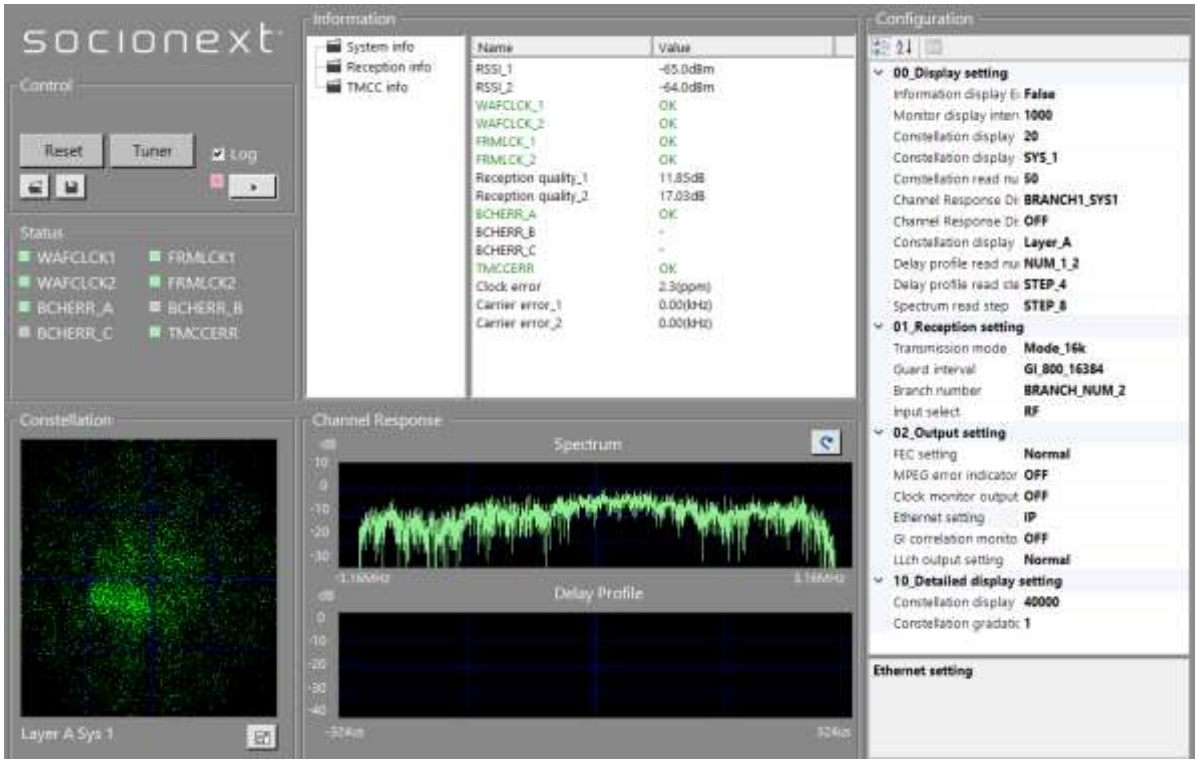


Figure 8.9 - Socionext Screen

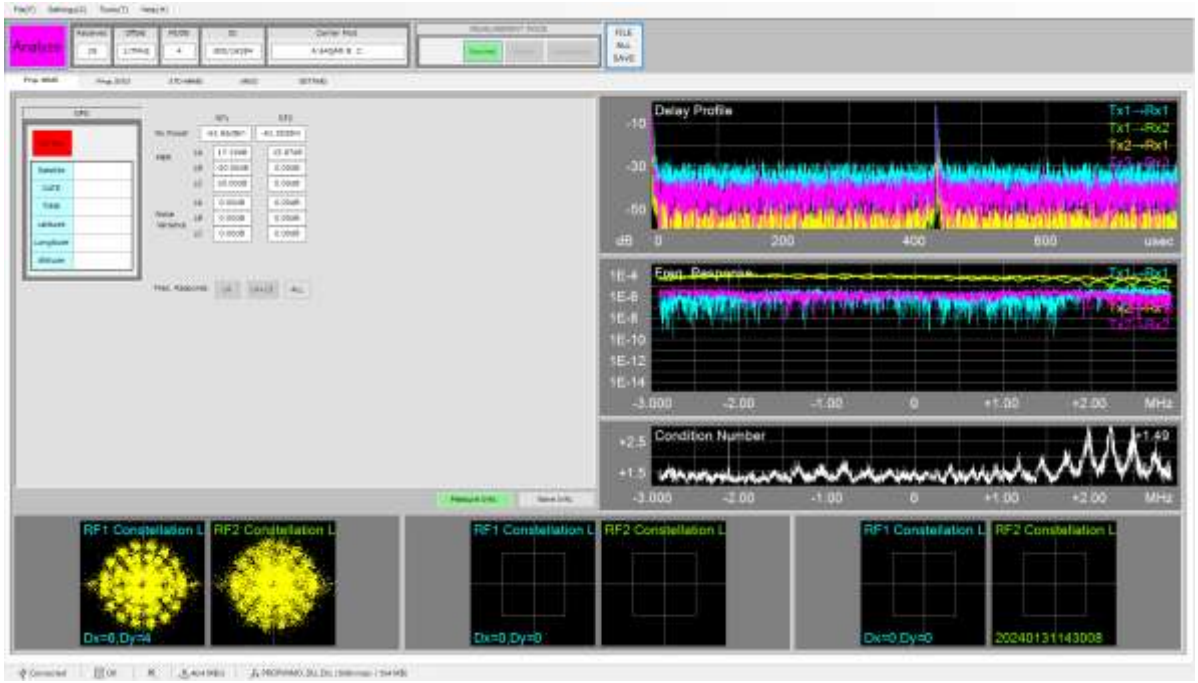


Figure 8.10 - Rintaro Screen

d) Reception Threshold

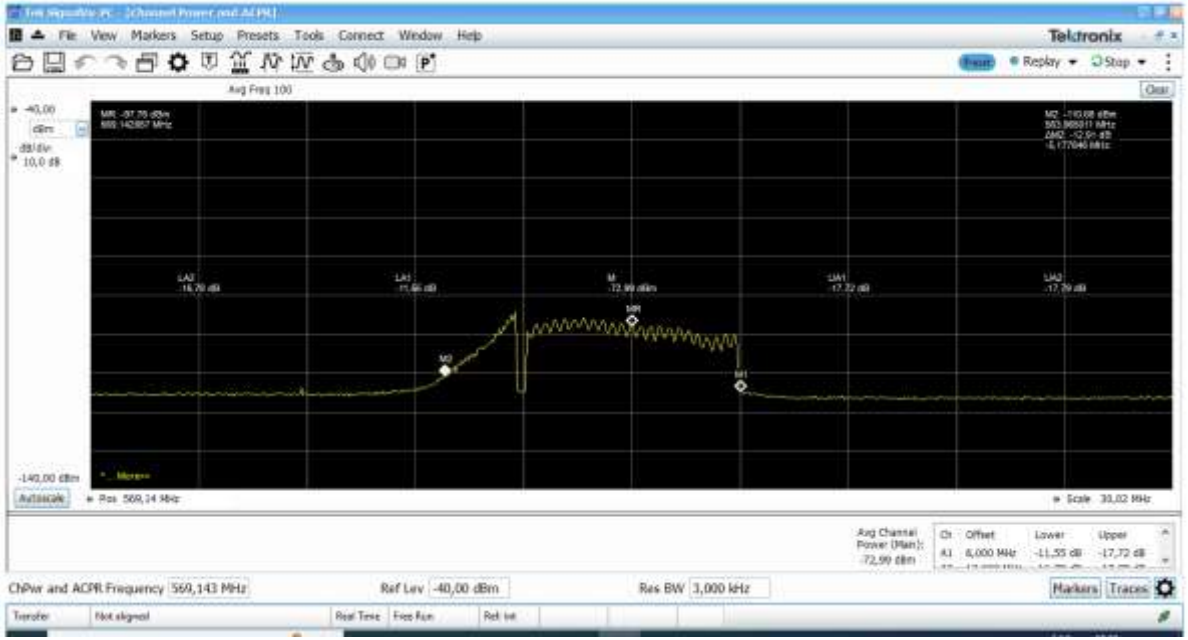


Figure 8.11 - Vertical

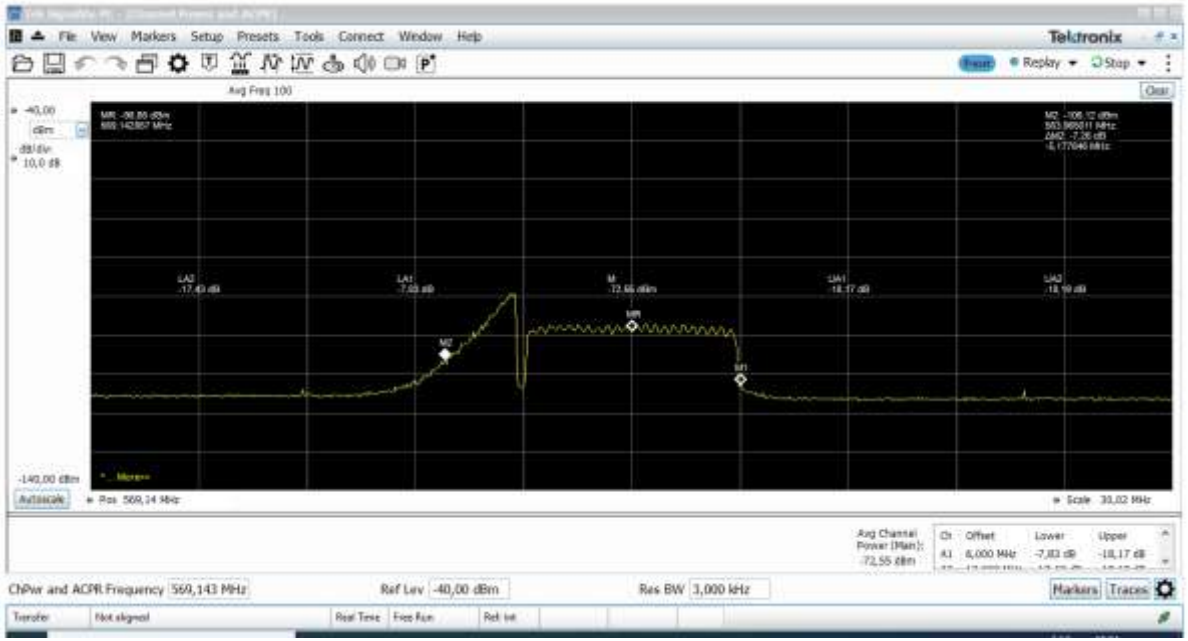


Figure 8.12 - Horizontal

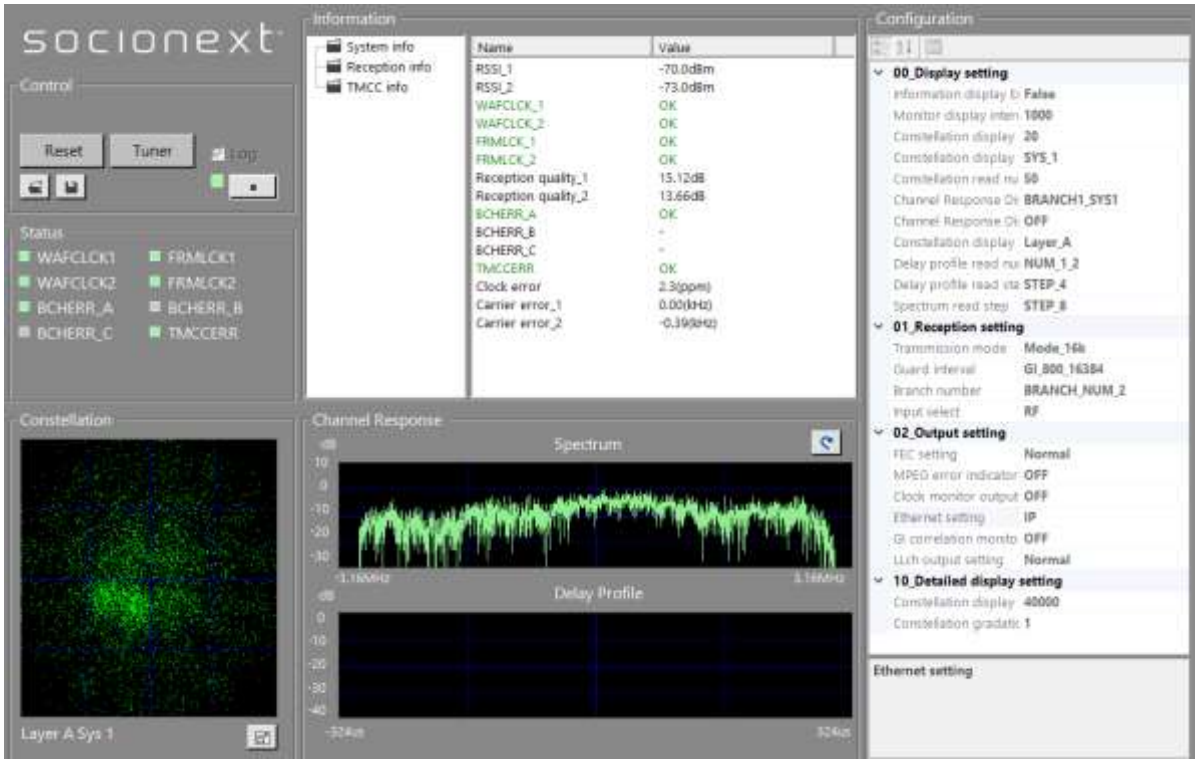


Figure 8.13 - Socionext Screen

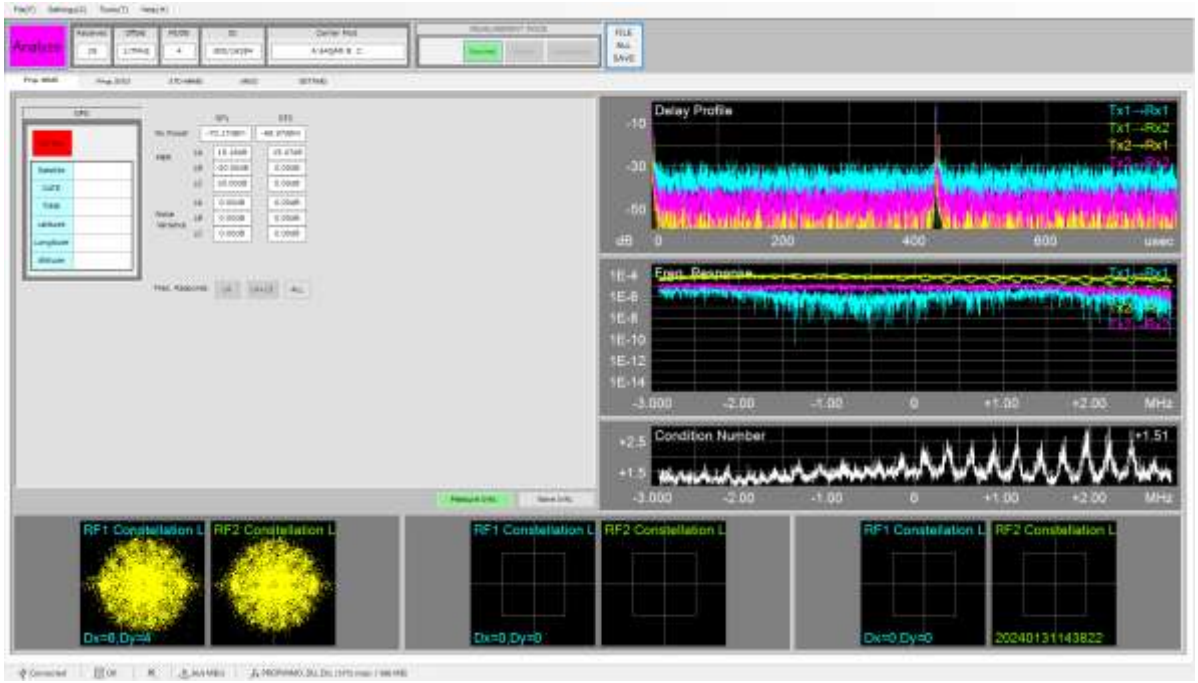


Figure 8.14 - Rintaro Screen

Chapter 9. Site 29

a) Channel Power

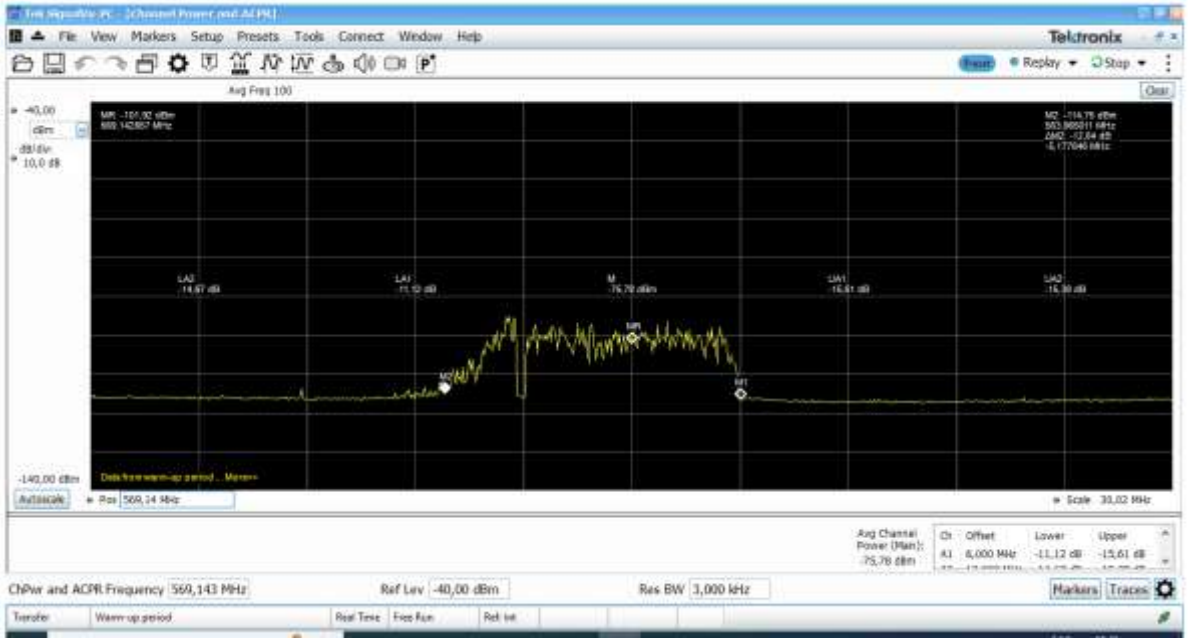


Figure 9.1 - Vertical

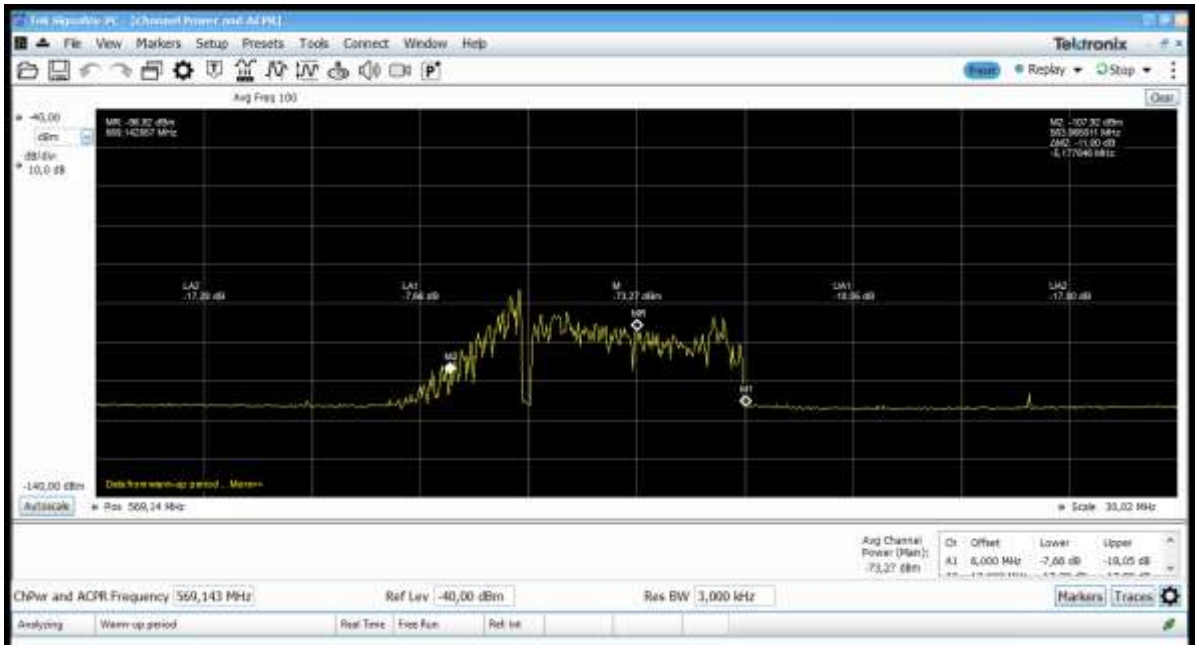


Figure 9.2 - Horizontal

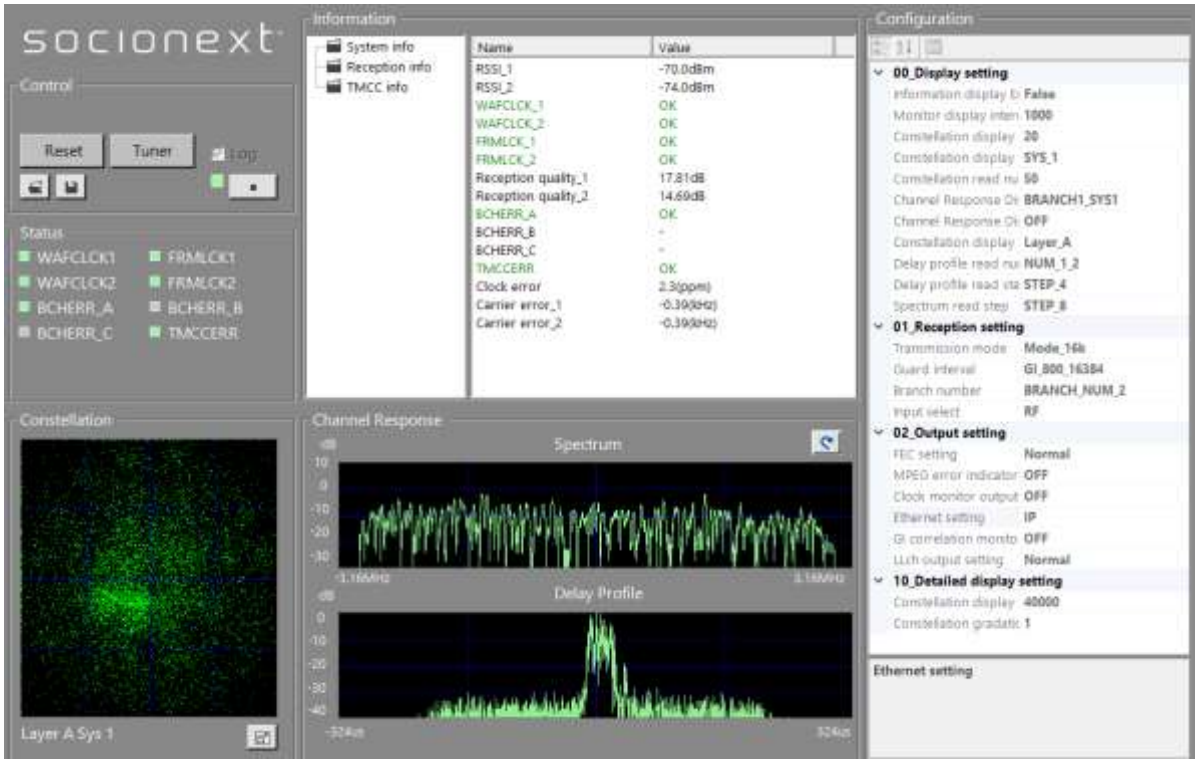


Figure 9.3 - Socionext Screen

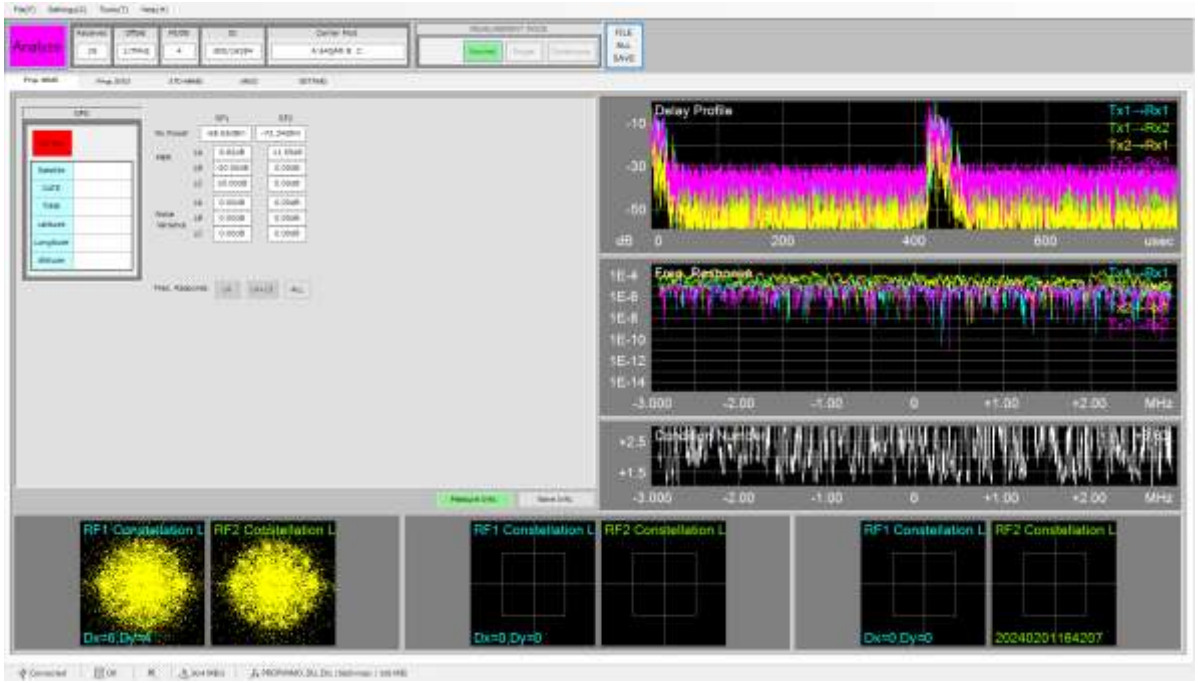


Figure 9.4 - Rintaro Screen

b) AWGN Power

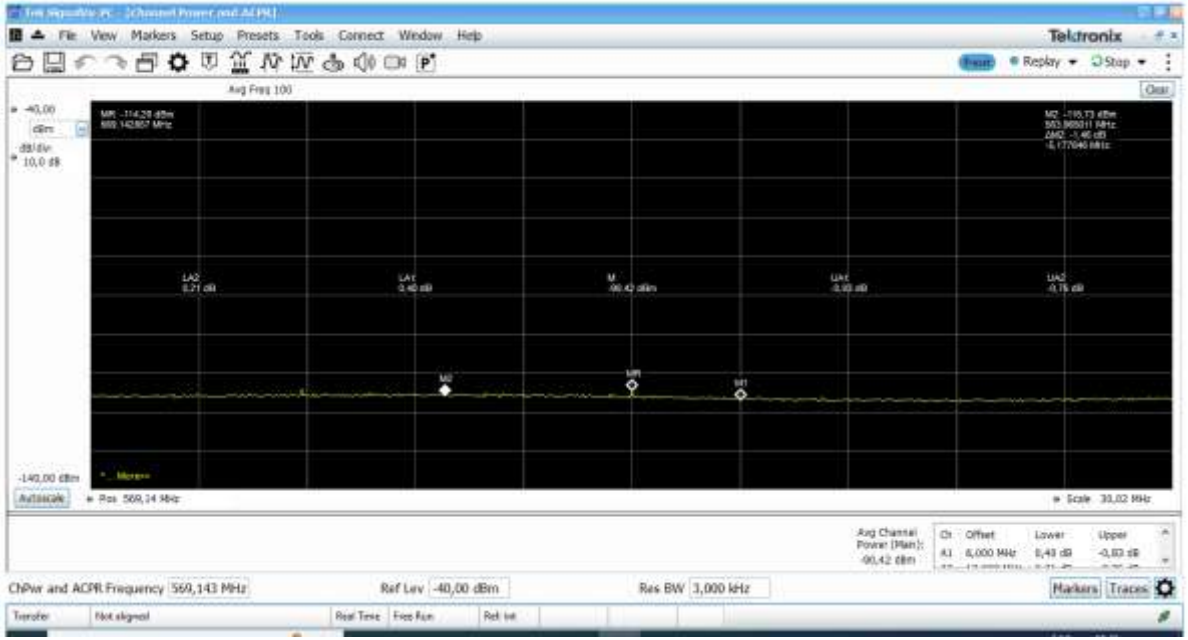


Figure 9.5 - Vertical

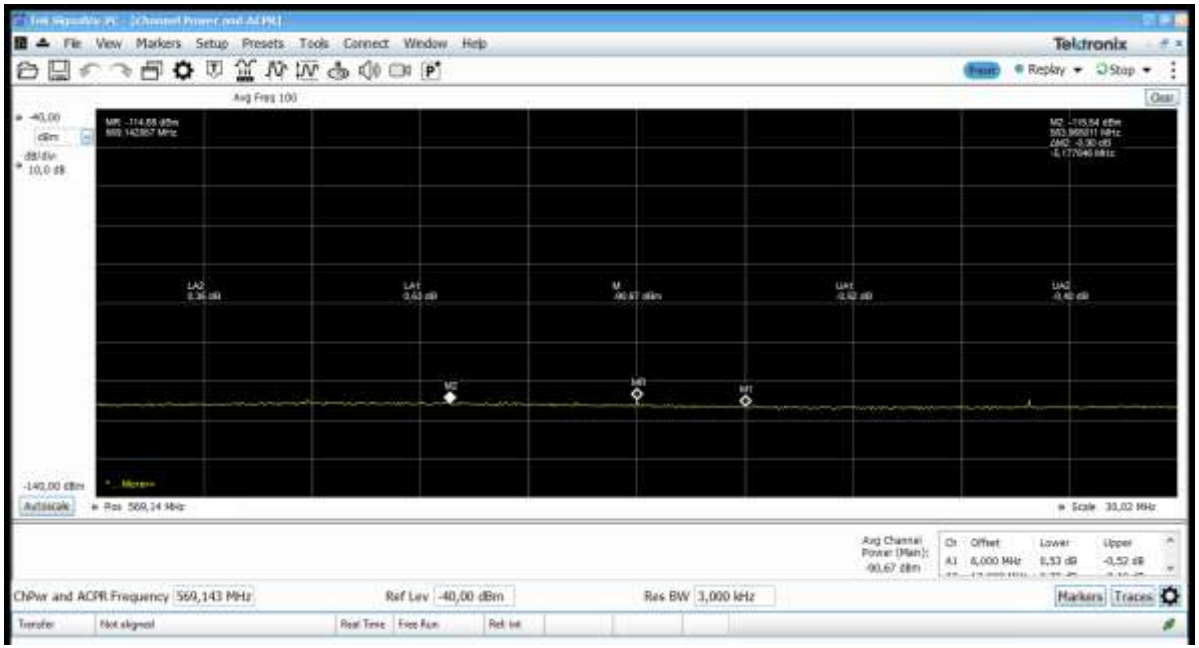


Figure 9.6 - Horizontal

c) C/N Threshold

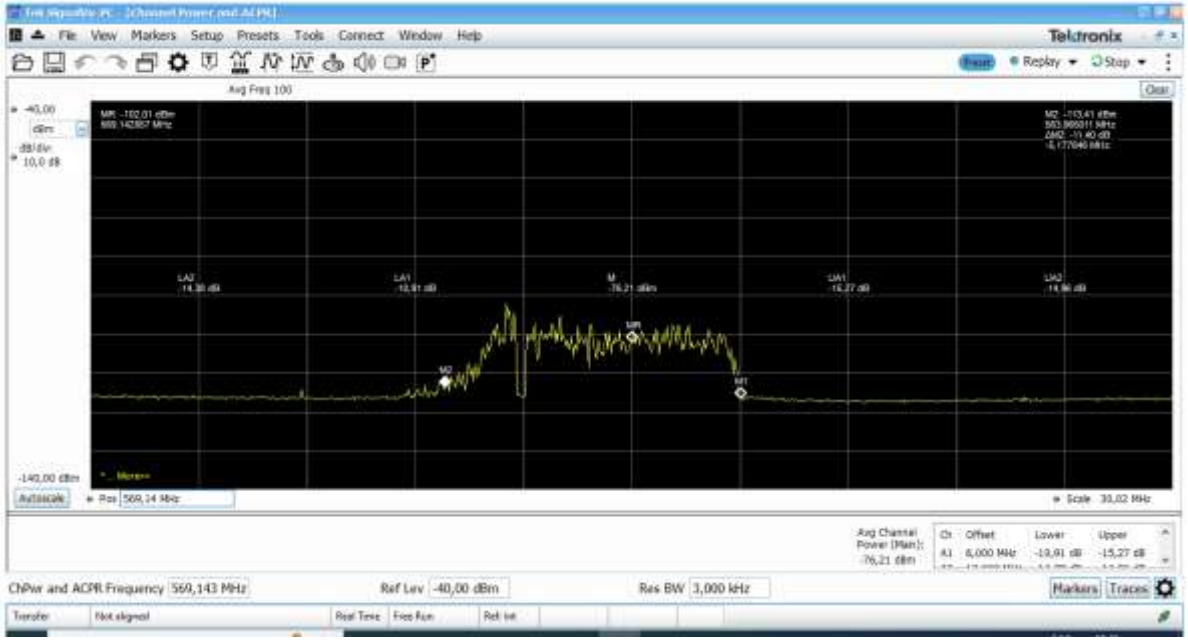


Figure 9.7 - Vertical

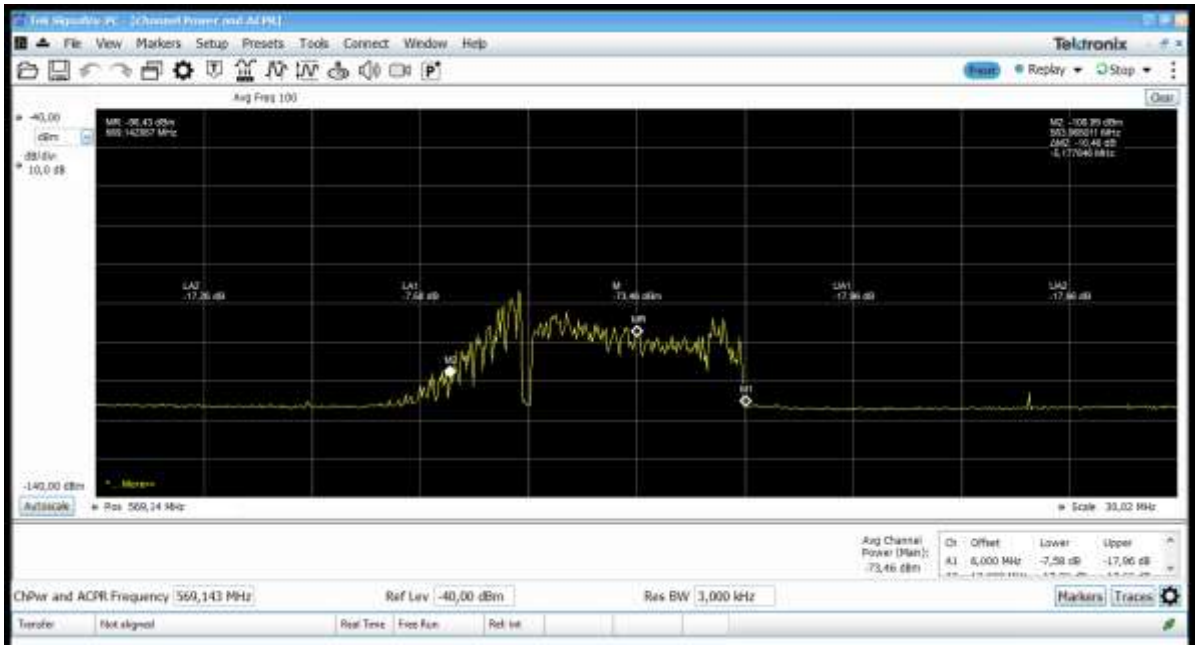


Figure 9.8 - Horizontal

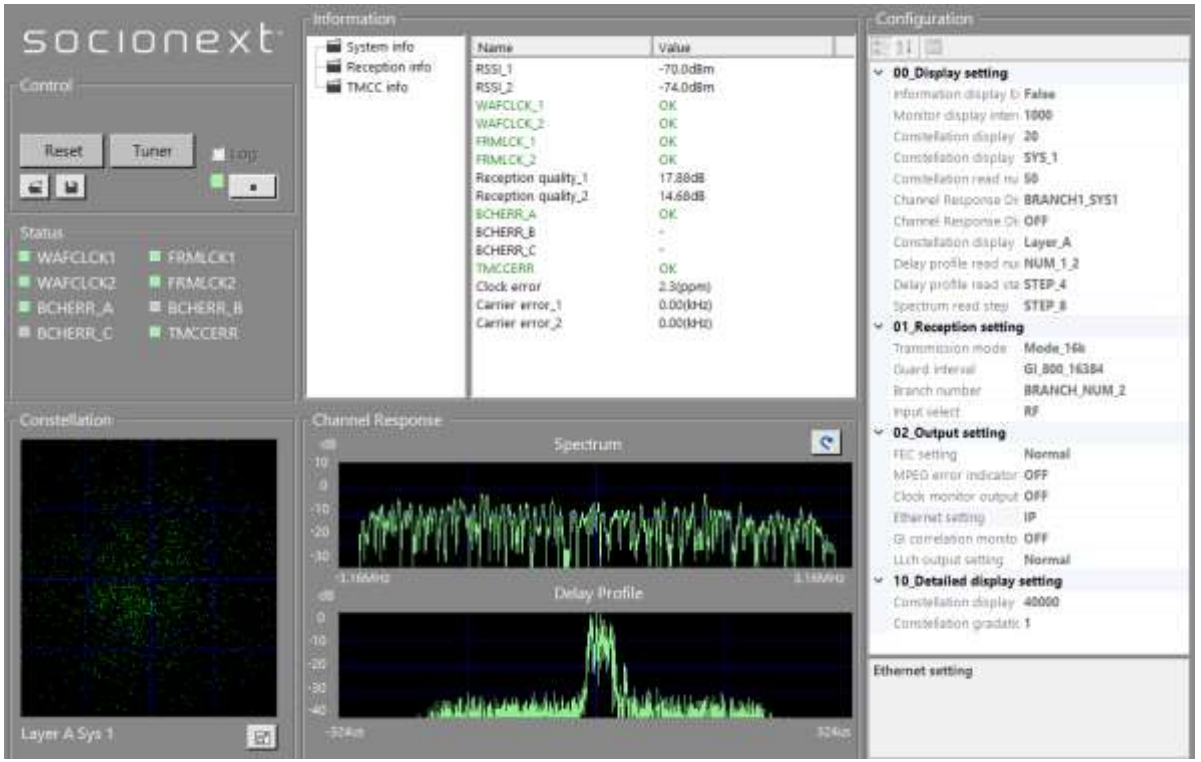


Figure 9.9 - Socionext Screen

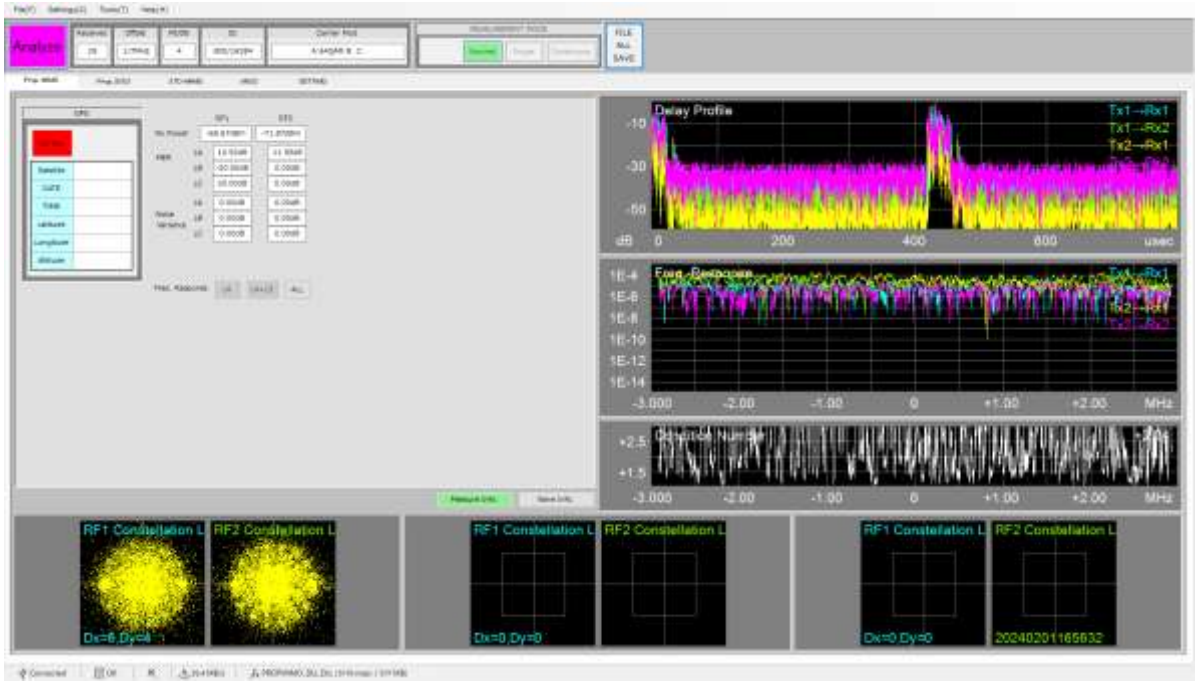


Figure 9.10 - Rintaro Screen

d) Reception Threshold

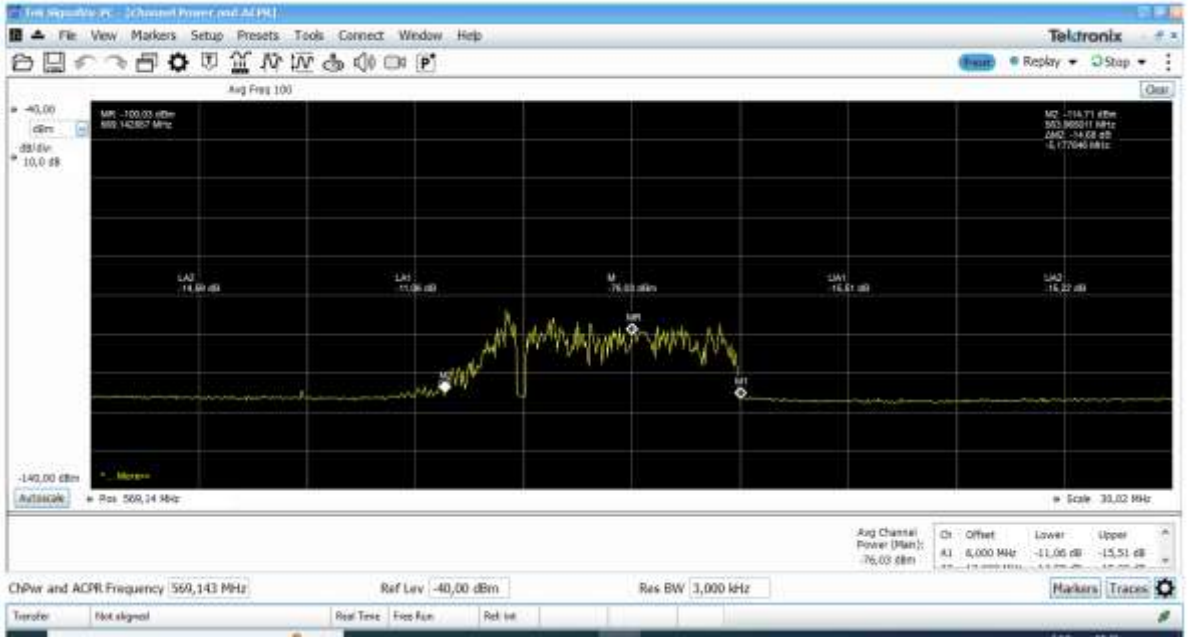


Figure 9.11 - Vertical

Figure 9.12 - Horizontal

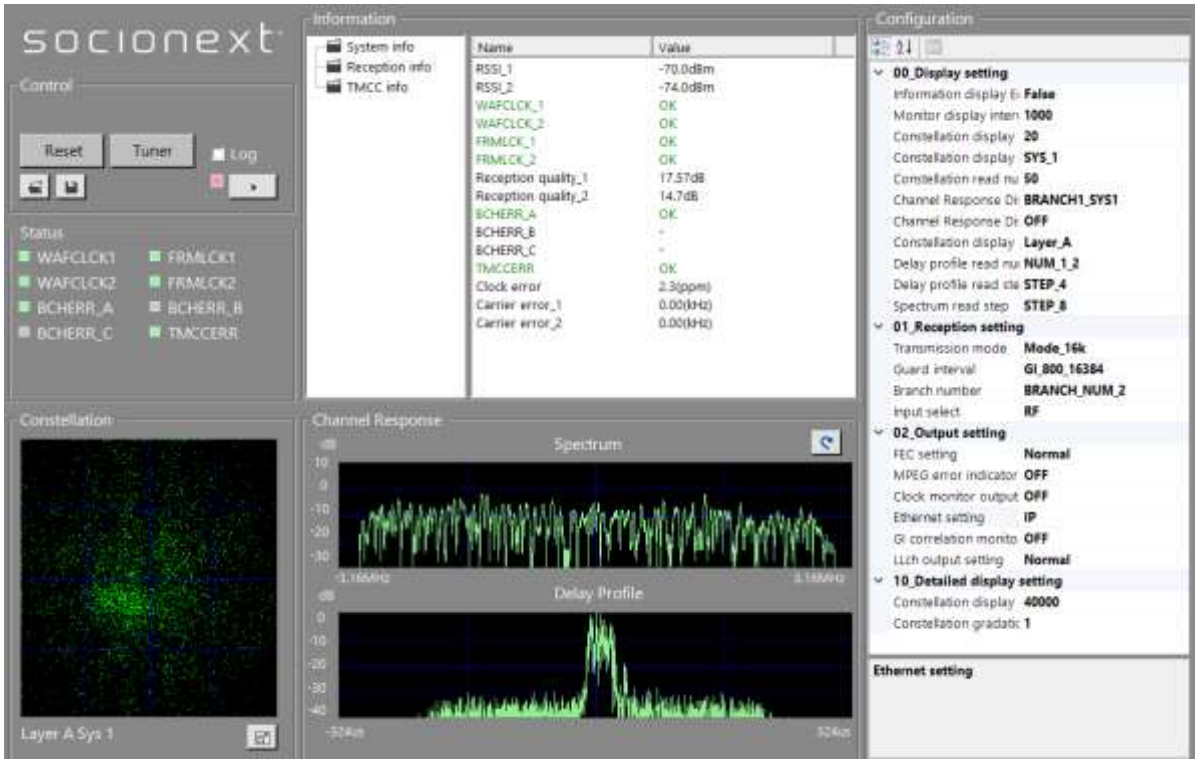


Figure 9.13 - Socionext Screen

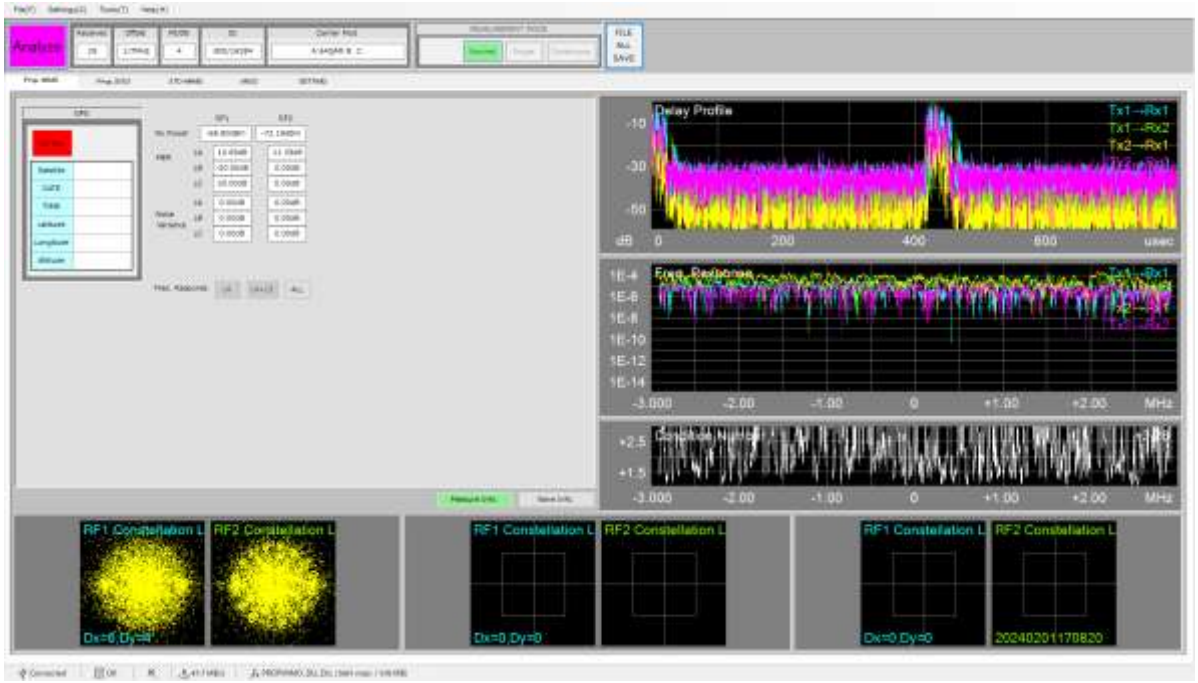


Figure 9.14 - Rintaro Screen

Appendix III. ATSC 3.0 - Outdoor Sites - Configuration 1 - Single Layer: 64-QAM NUC, FEC 8/15, Bitrate 32.2 Mbps

Chapter 1. Site 1

a) Channel Power

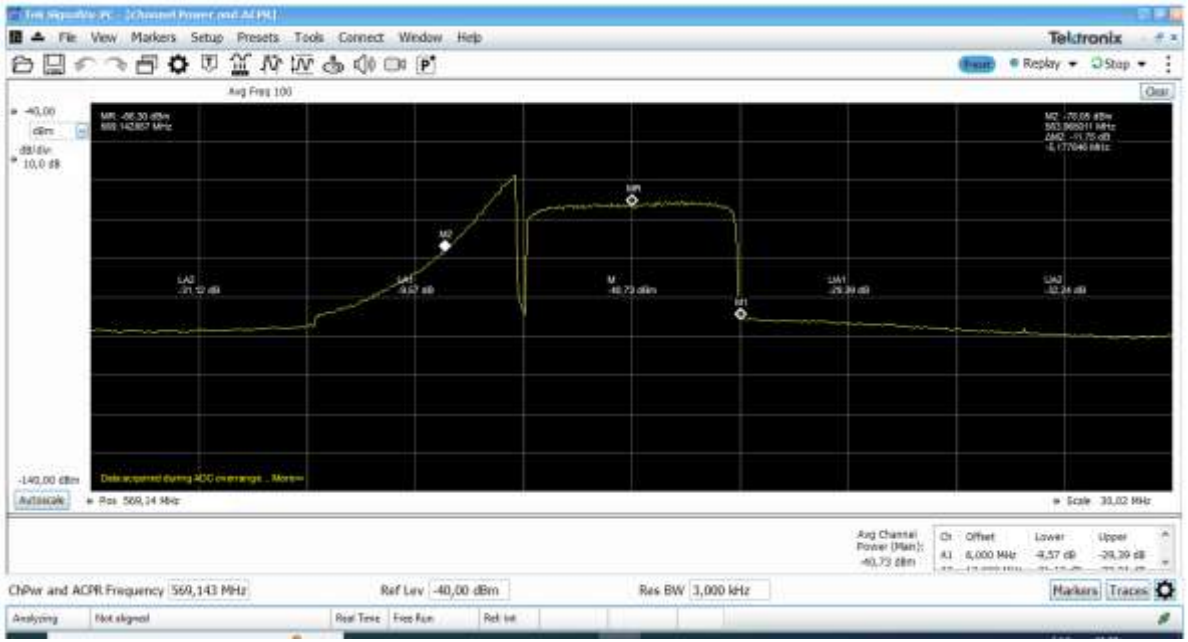


Figure 1.1 - Vertical

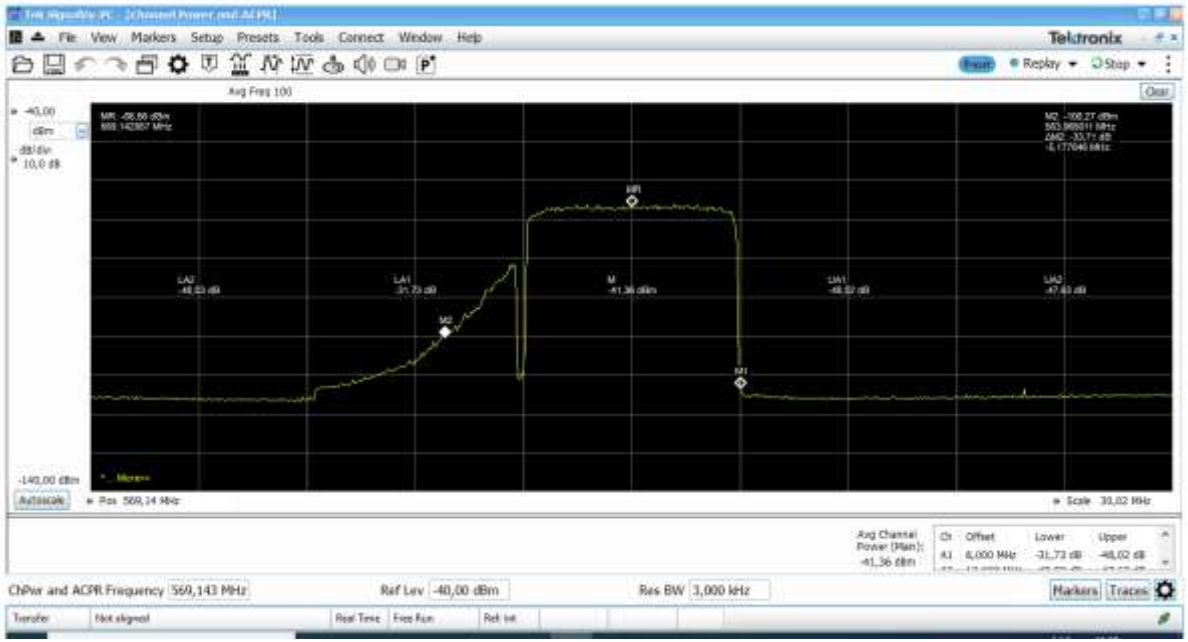


Figure 1.2 - Horizontal

Figure 1.3 - IMAS Screen

b) AWGN Power

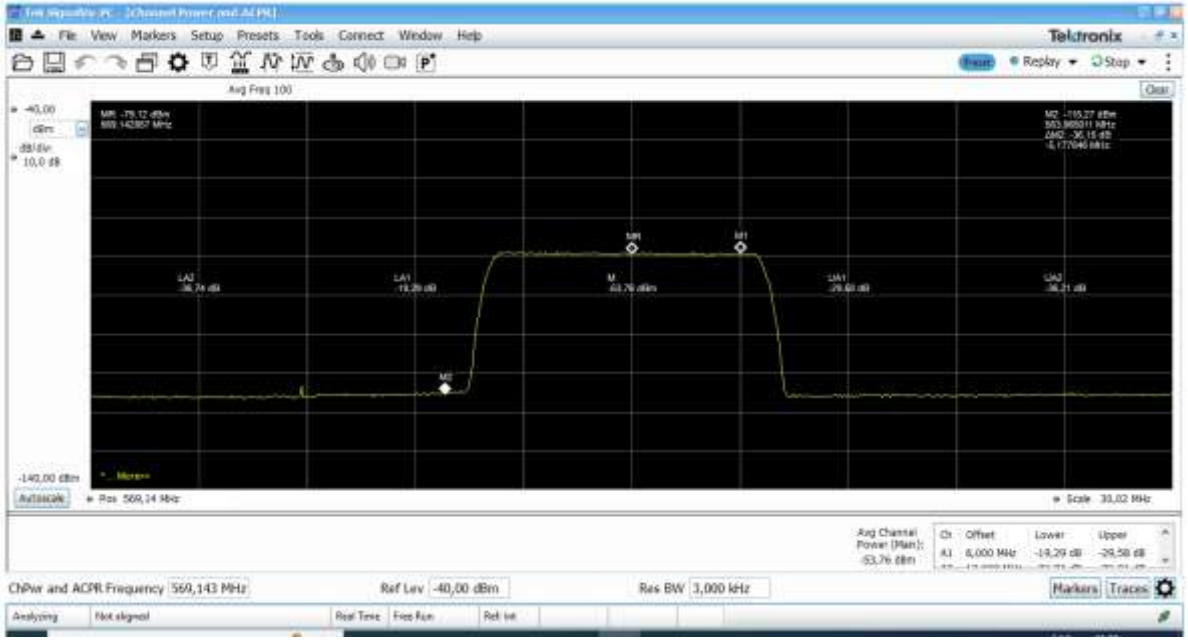


Figure 1.4 - Vertical

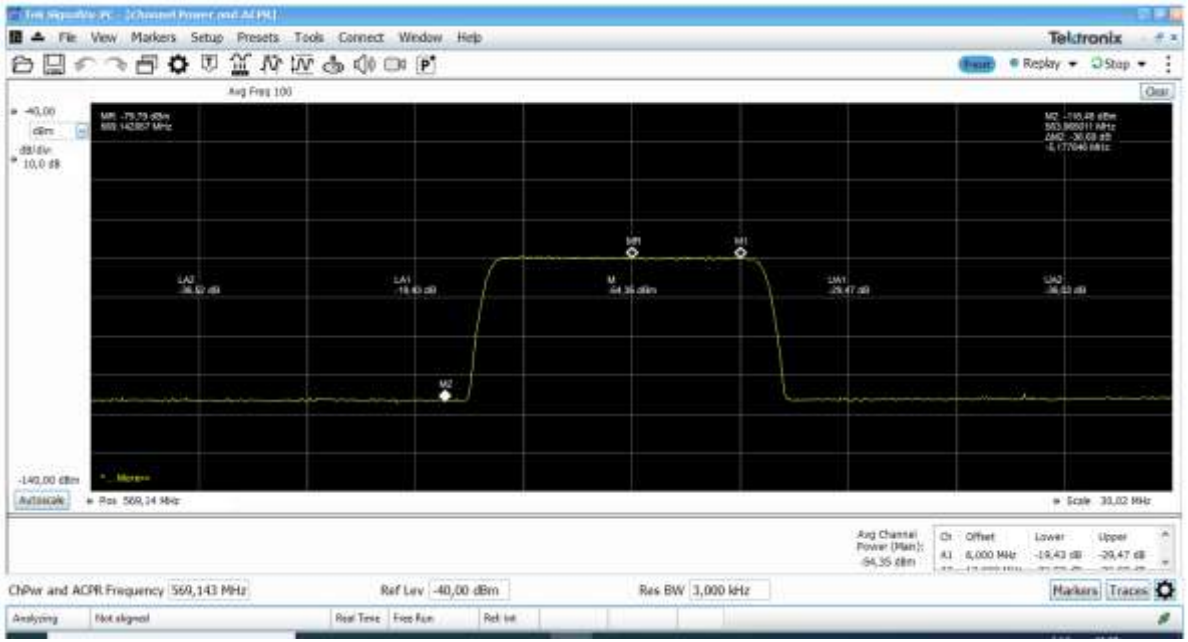


Figure 1.5 - Horizontal

c) C/N Threshold

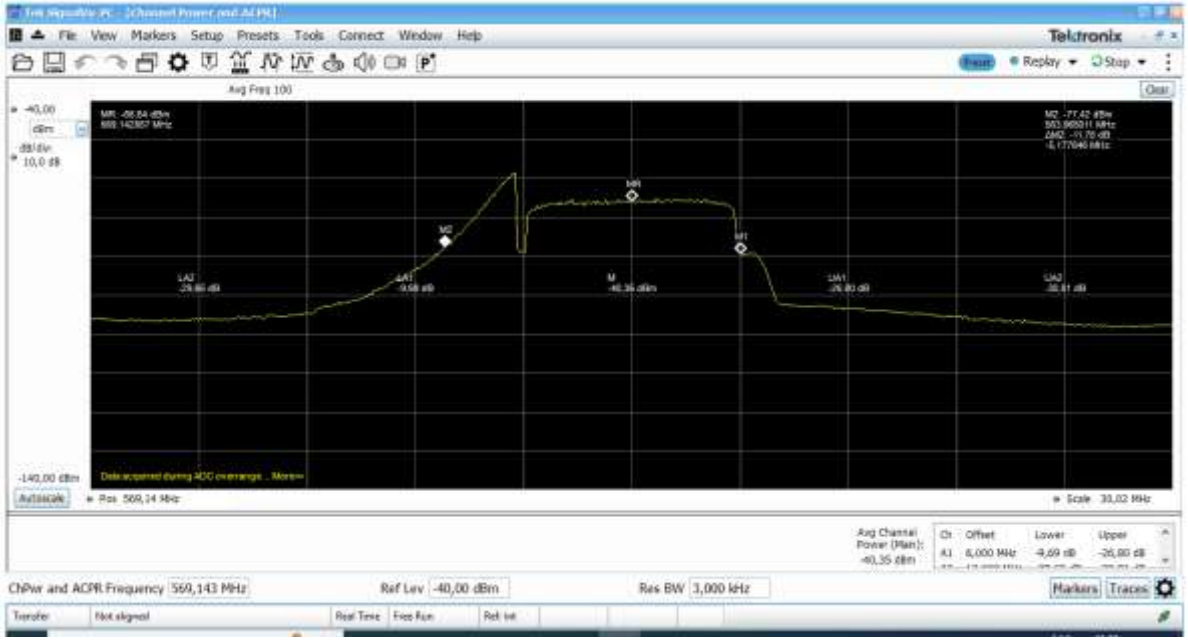


Figure 1.6 - Vertical

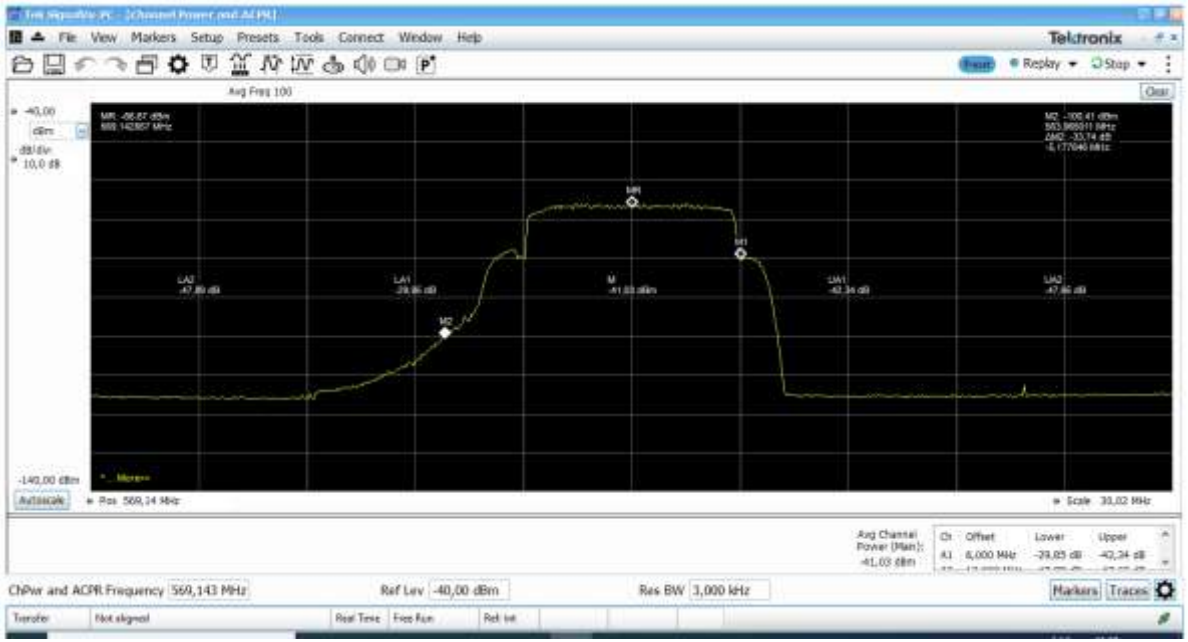


Figure 1.7 - Horizontal

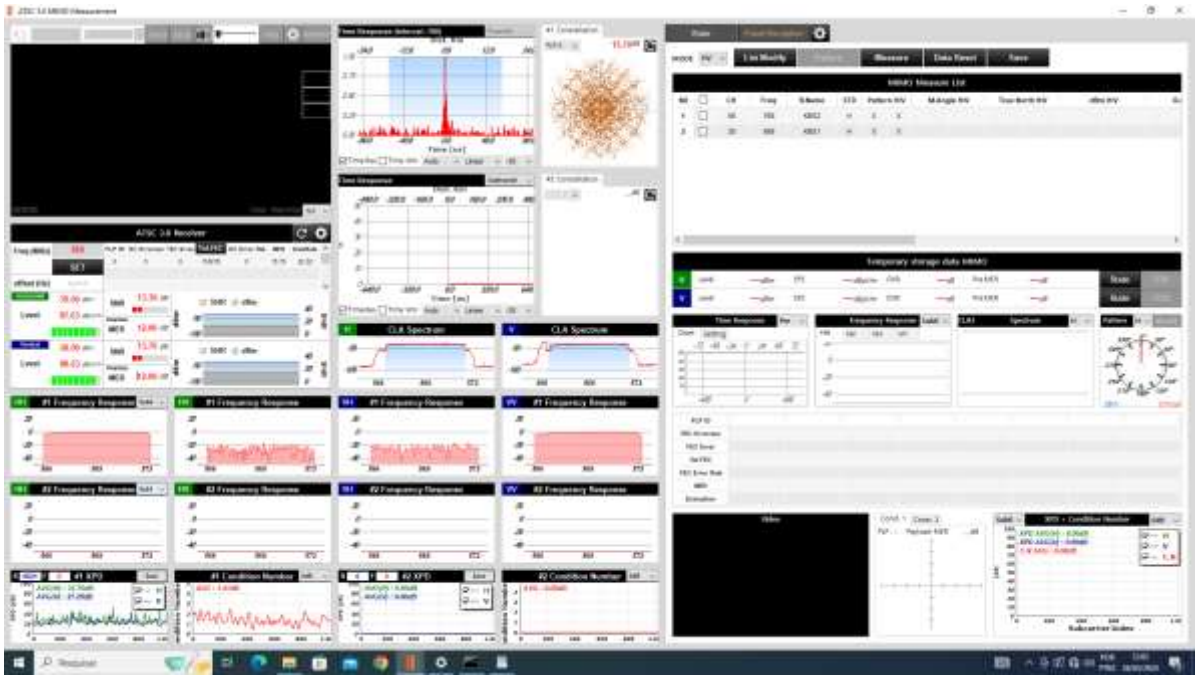


Figure 1.8 - IMAS Screen

d) Reception Threshold

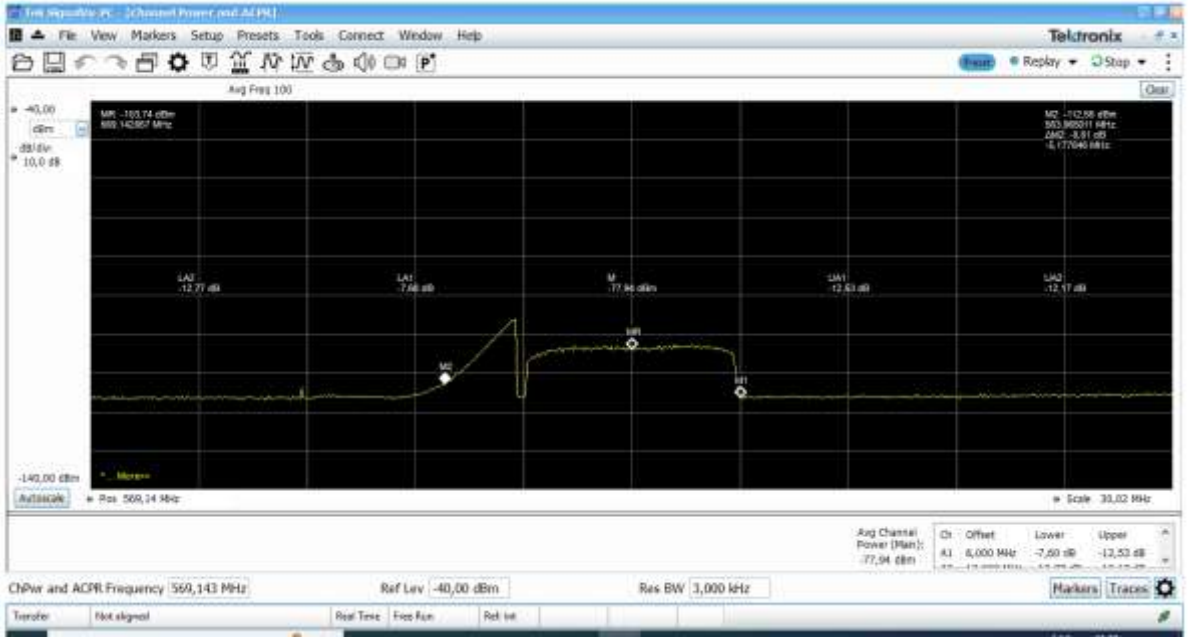


Figure 1.9 - Vertical

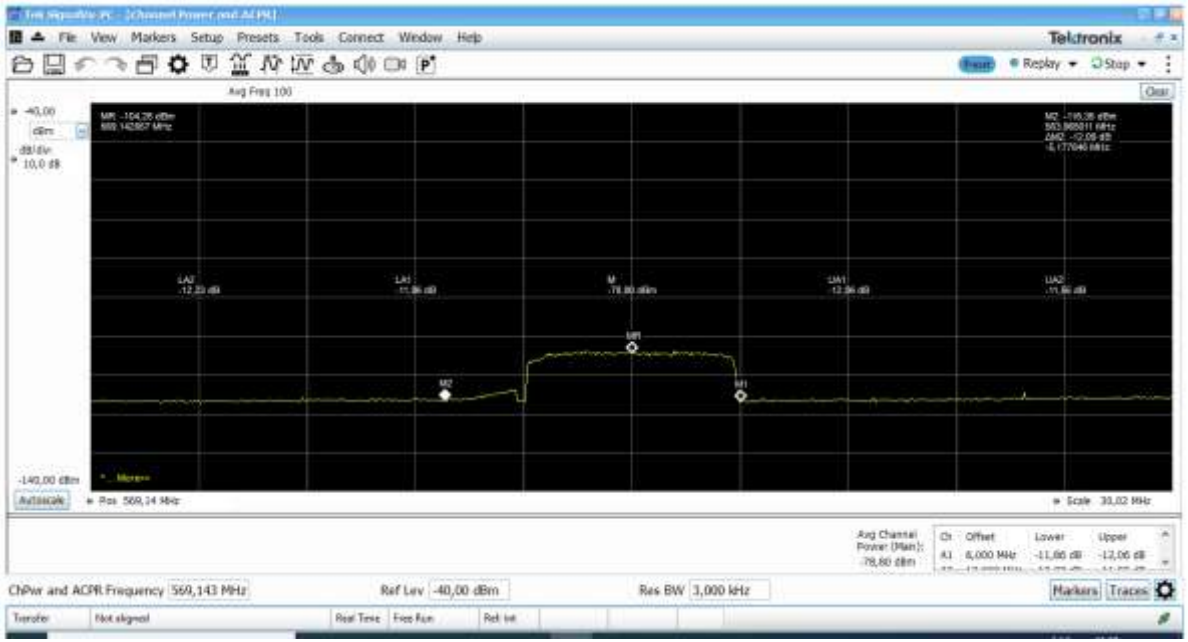


Figure 1.10 - Horizontal

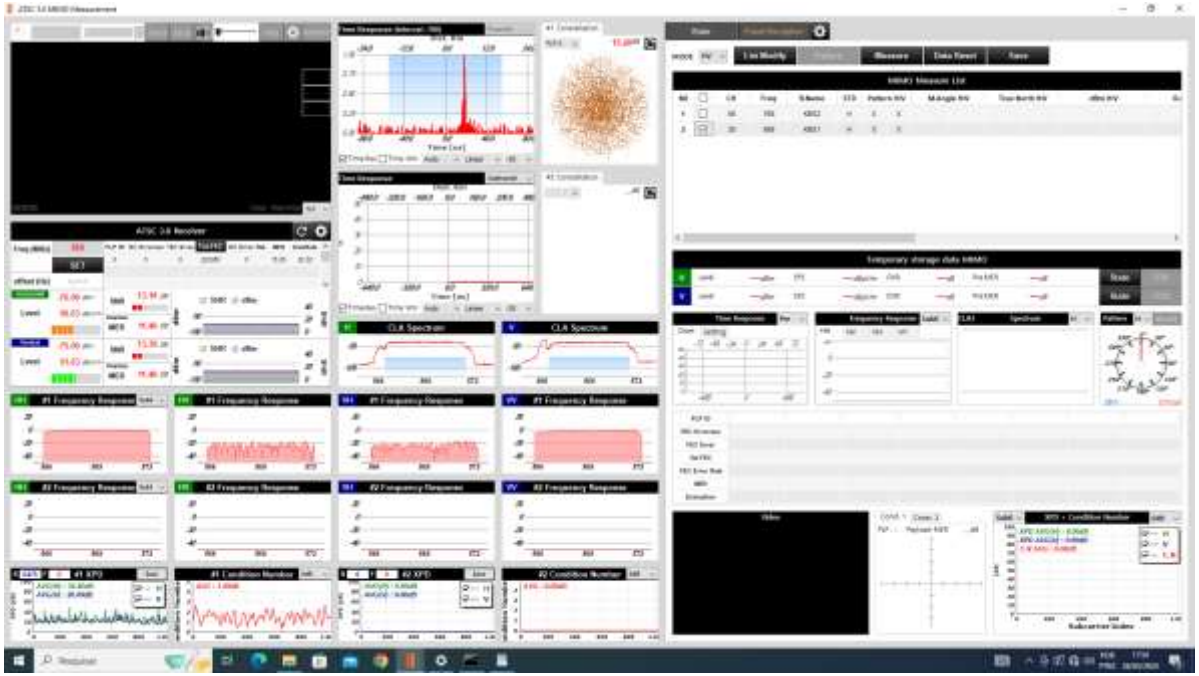


Figure 1.11 - IMAS Screen

Chapter 2. Site 2

a) Channel Power

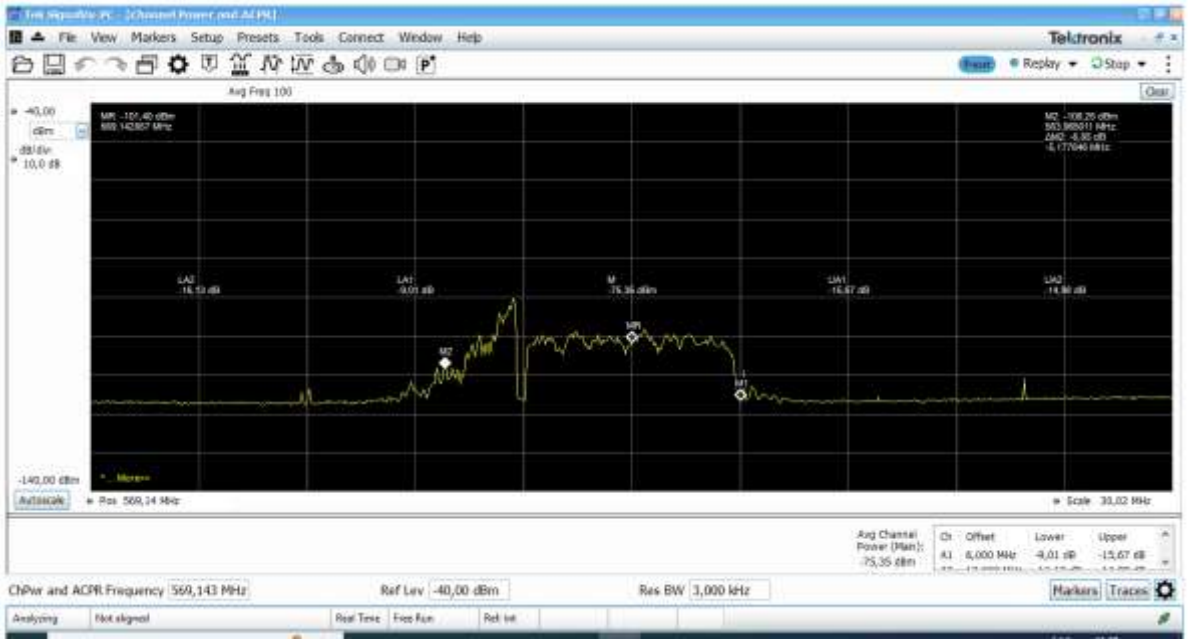


Figure 2.1 - Vertical

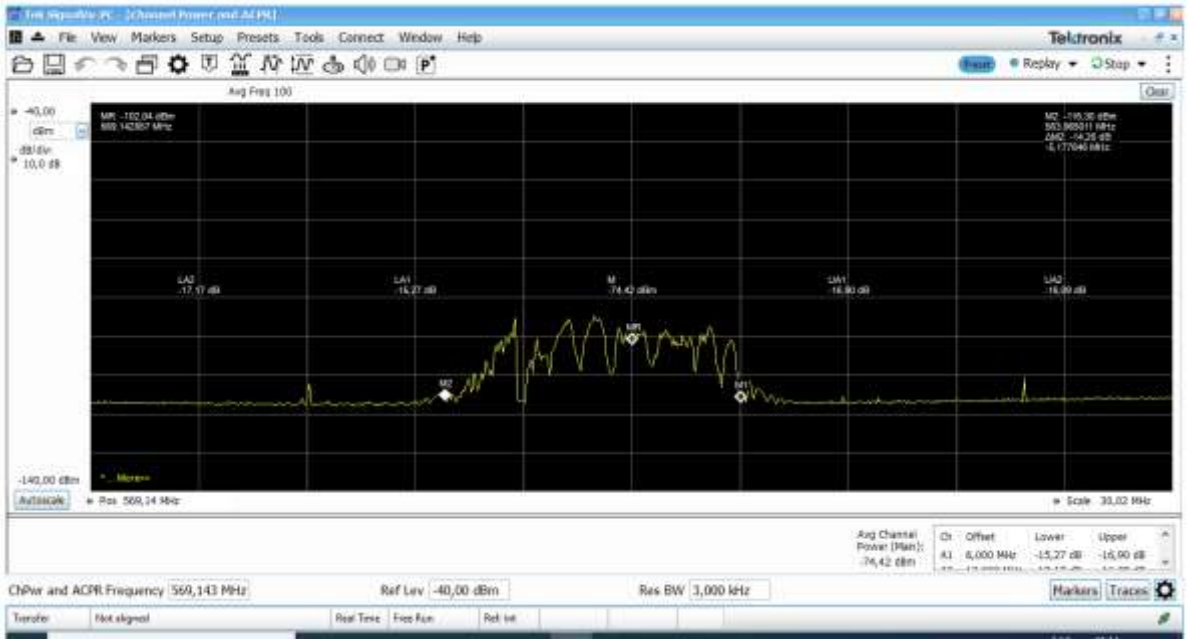


Figure 2.2 - Horizontal

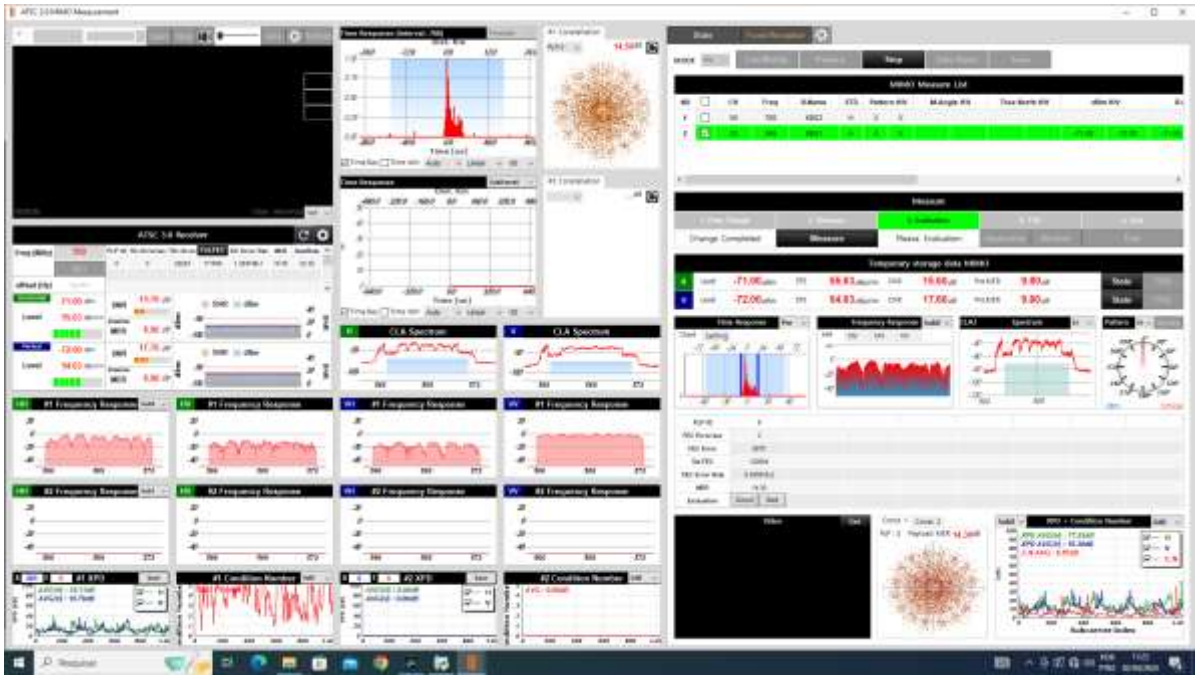


Figure 2.3 - IMAS Screen

b) AWGN Power

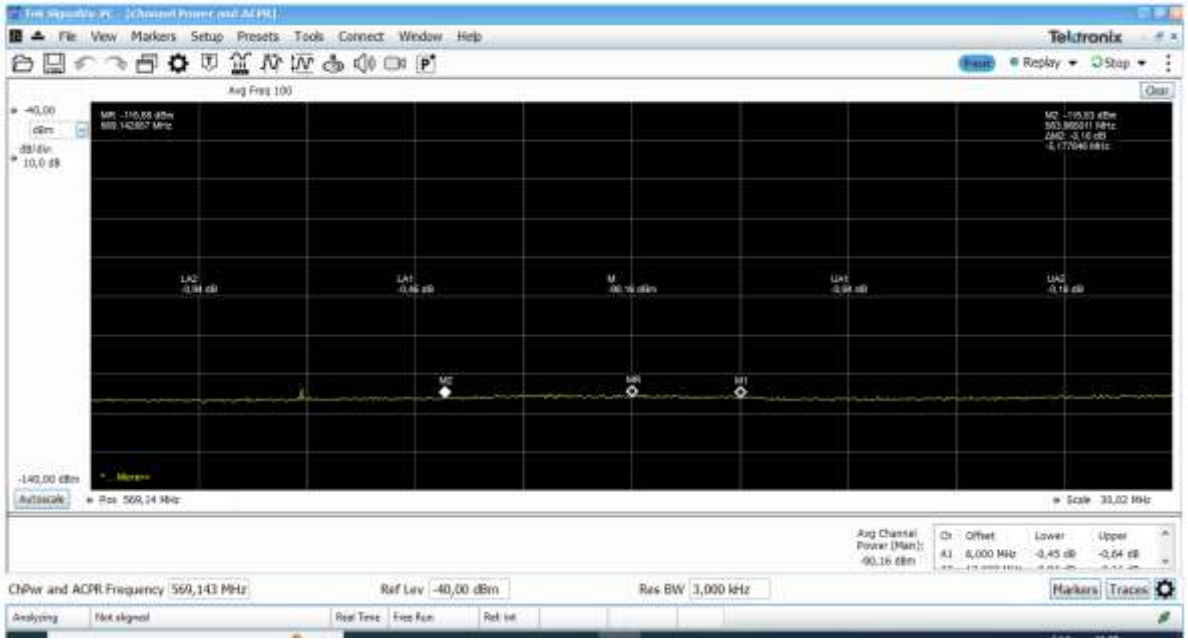


Figure 2.4 - Vertical

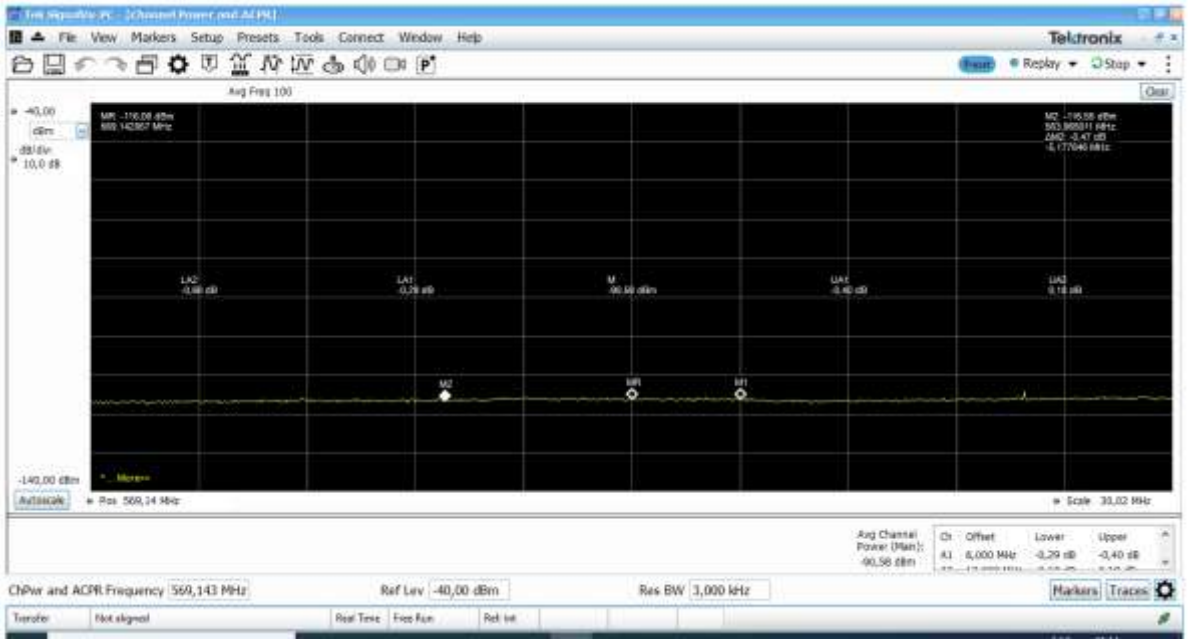


Figure 2.5 - Horizontal

c) C/N Threshold

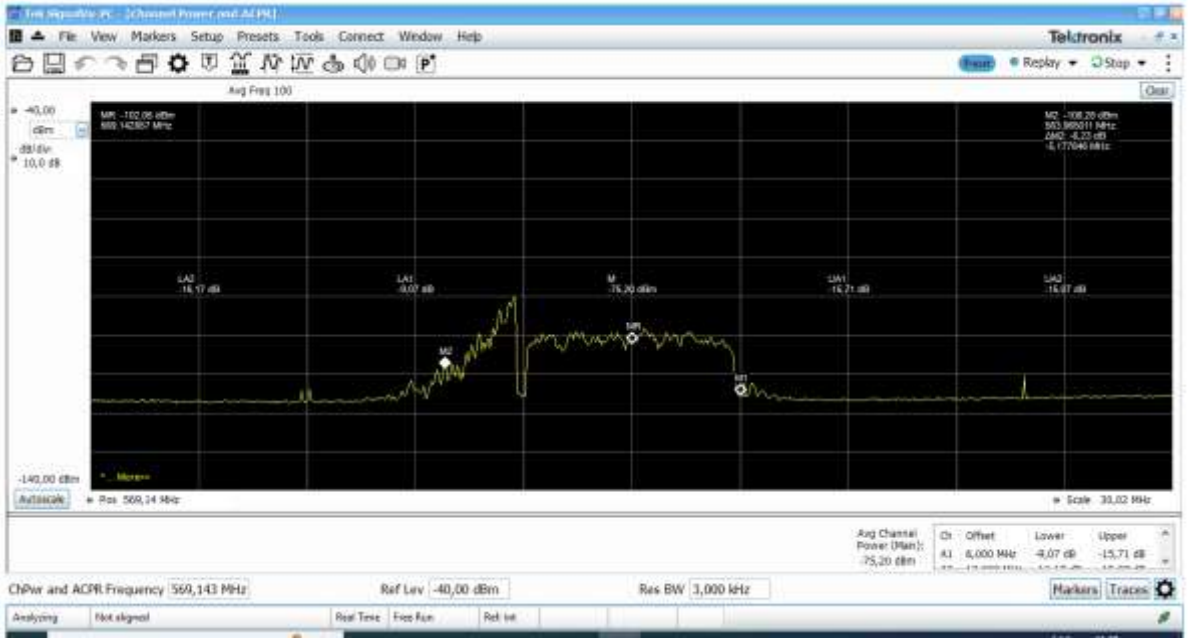


Figure 2.6 - Vertical

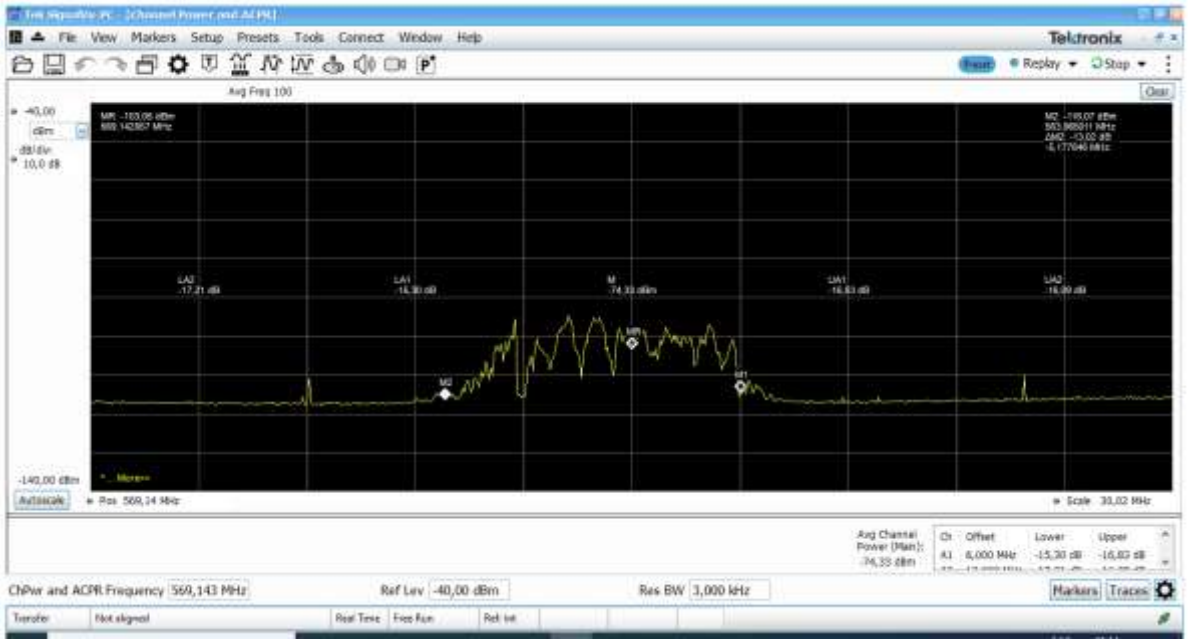


Figure 2.7 - Horizontal

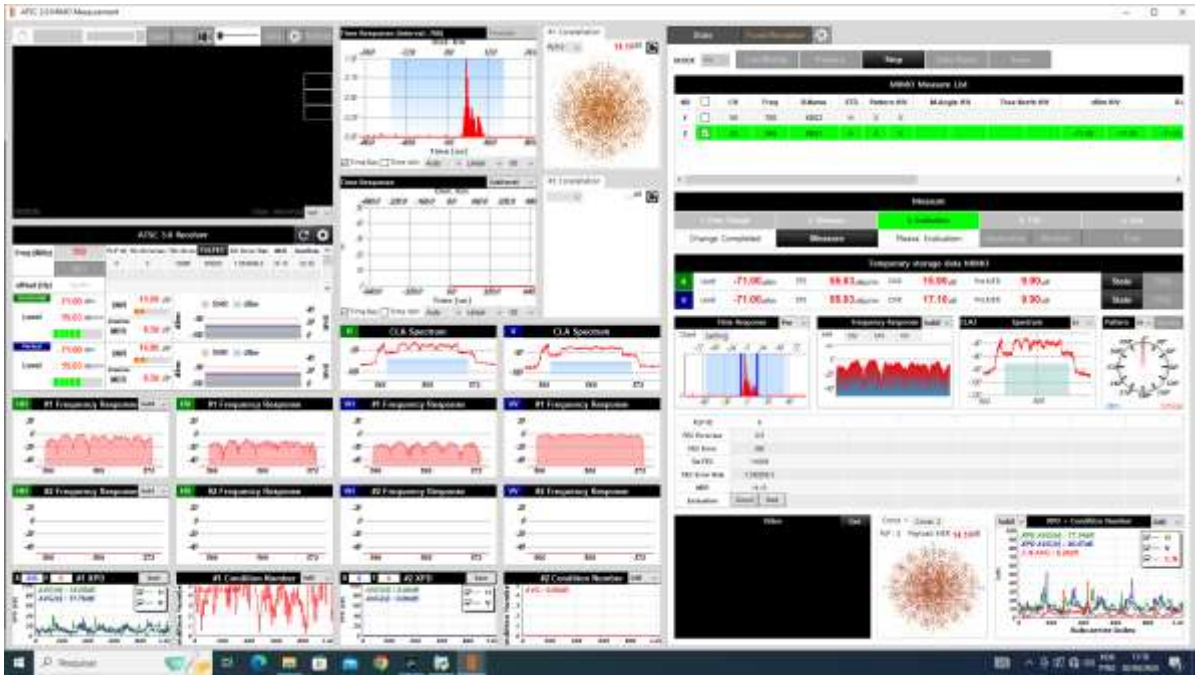


Figure 2.8 - IMAS Screen

Chapter 3. Site 3

a) Channel Power

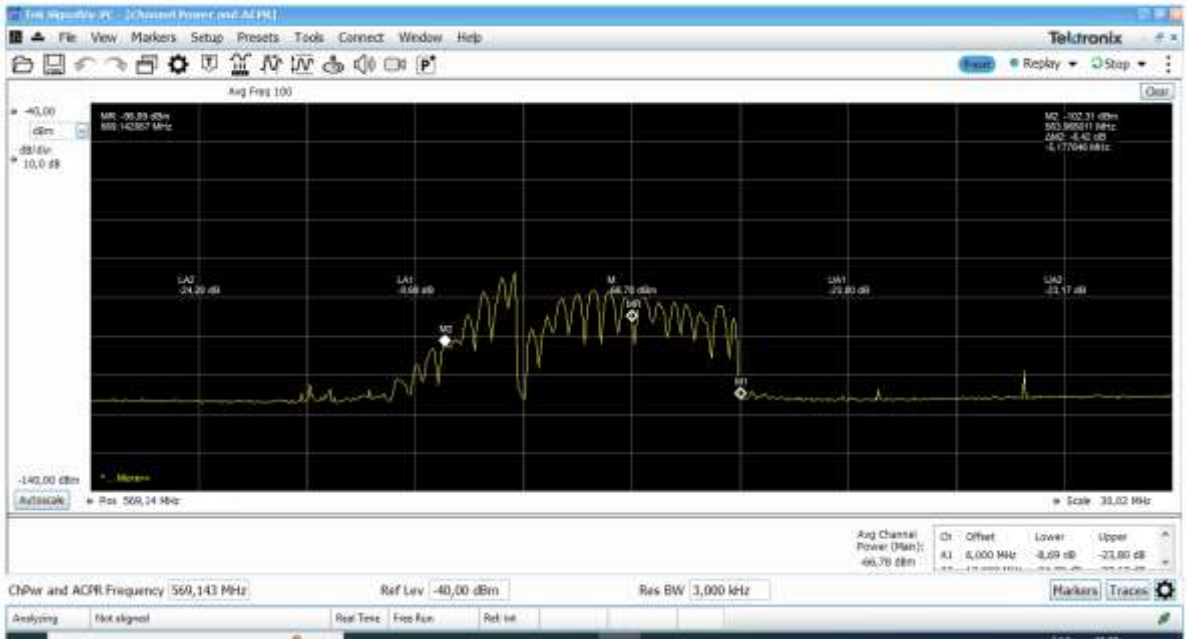


Figure 3.1 - Vertical

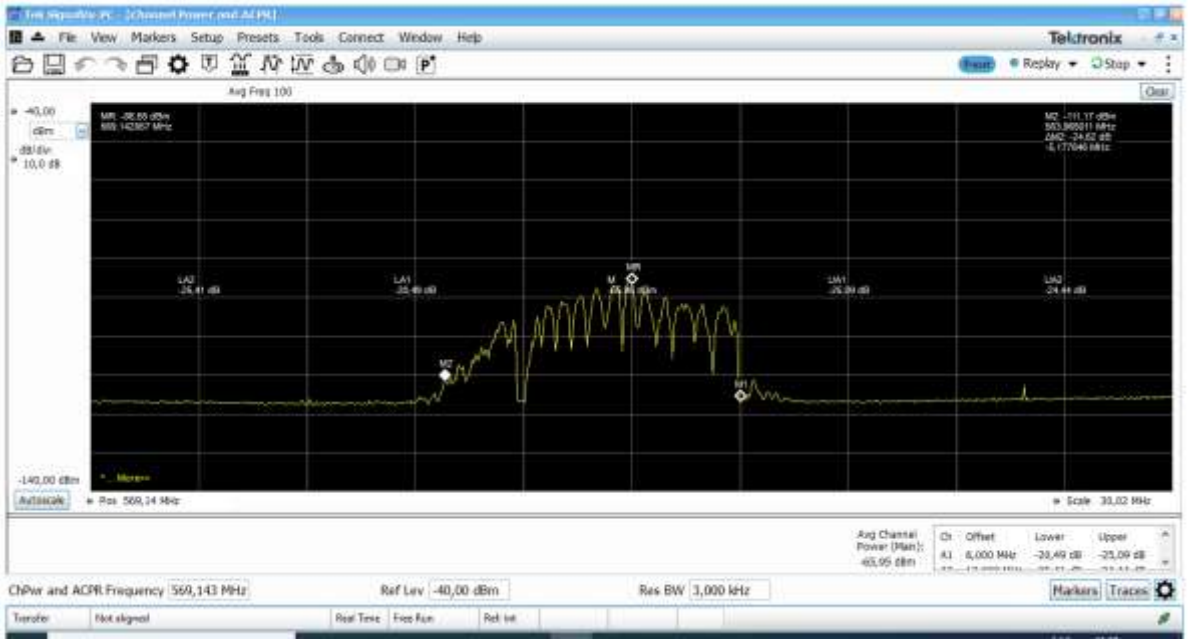


Figure 3.2 - Horizontal

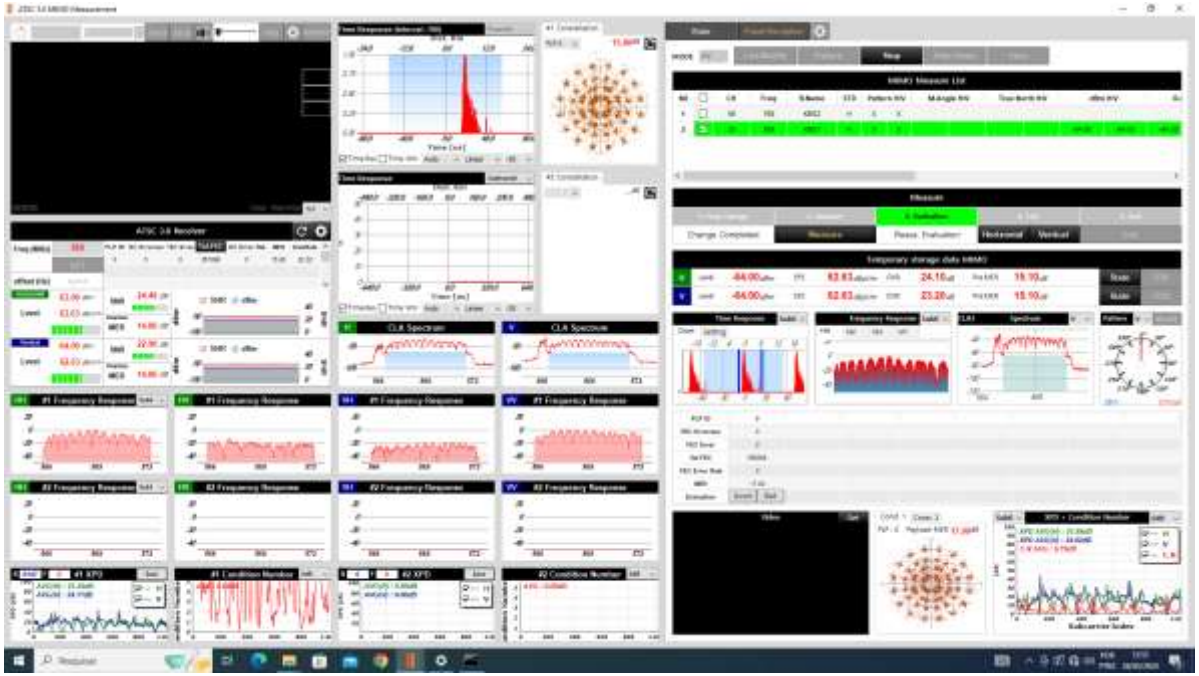


Figure 3.3 - IMAS Screen

Chapter 4. Site 4

a) Channel Power

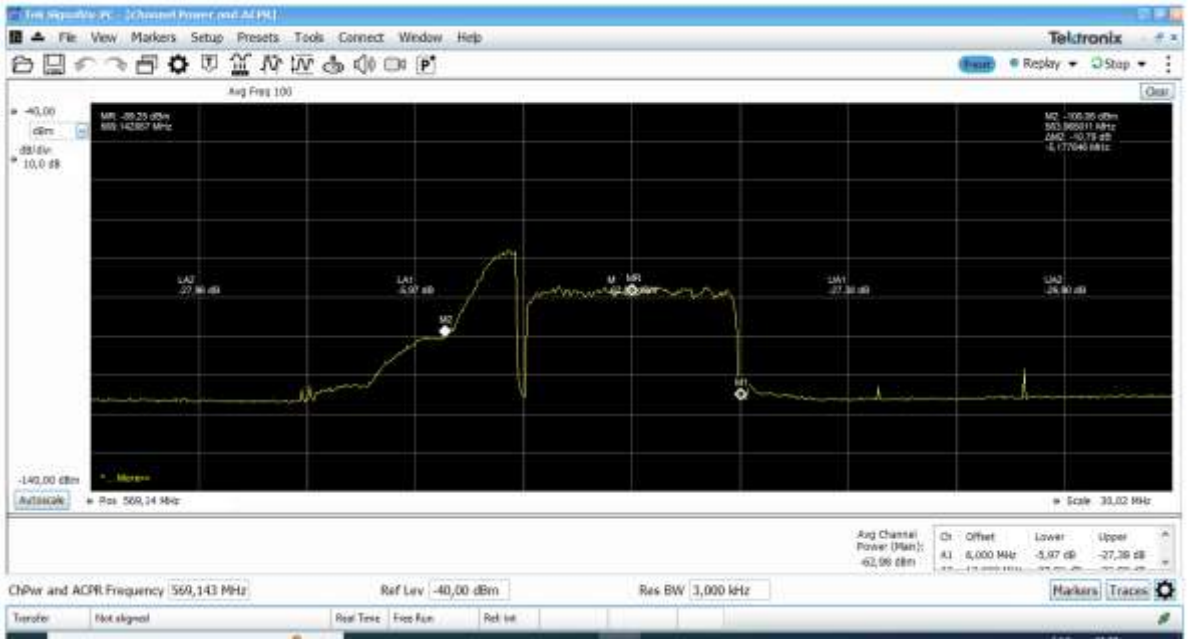


Figure 4.1 - Vertical

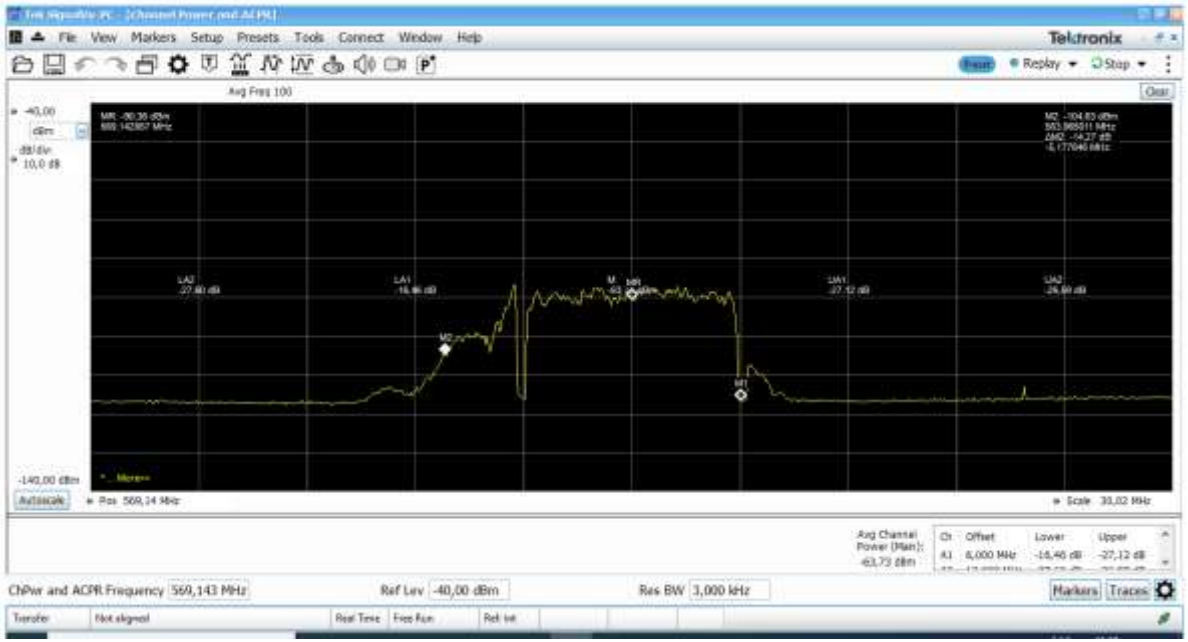


Figure 4.2 - Horizontal

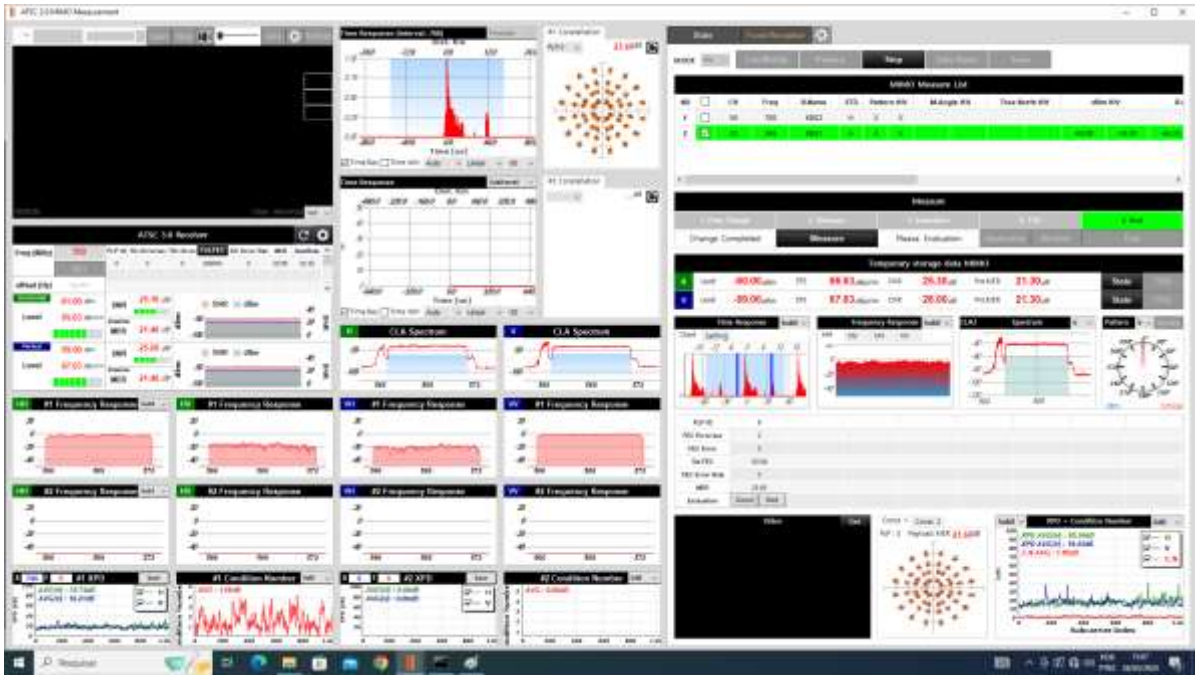


Figure 4.3 - IMAS Screen

b) AWGN Power

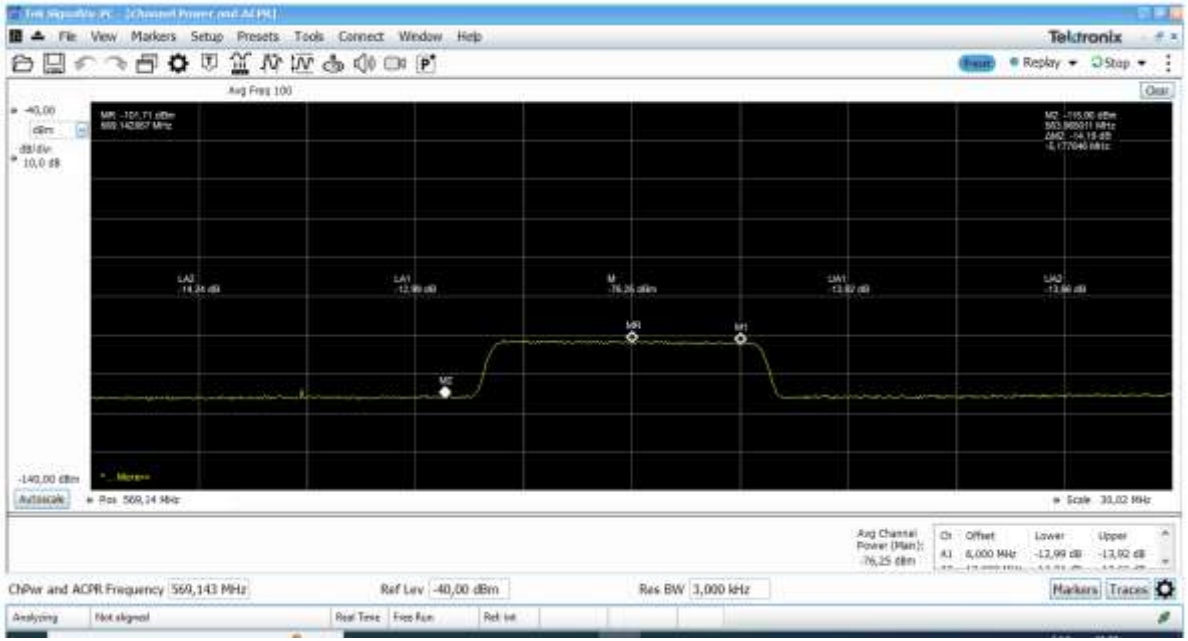


Figure 4.4 - Vertical

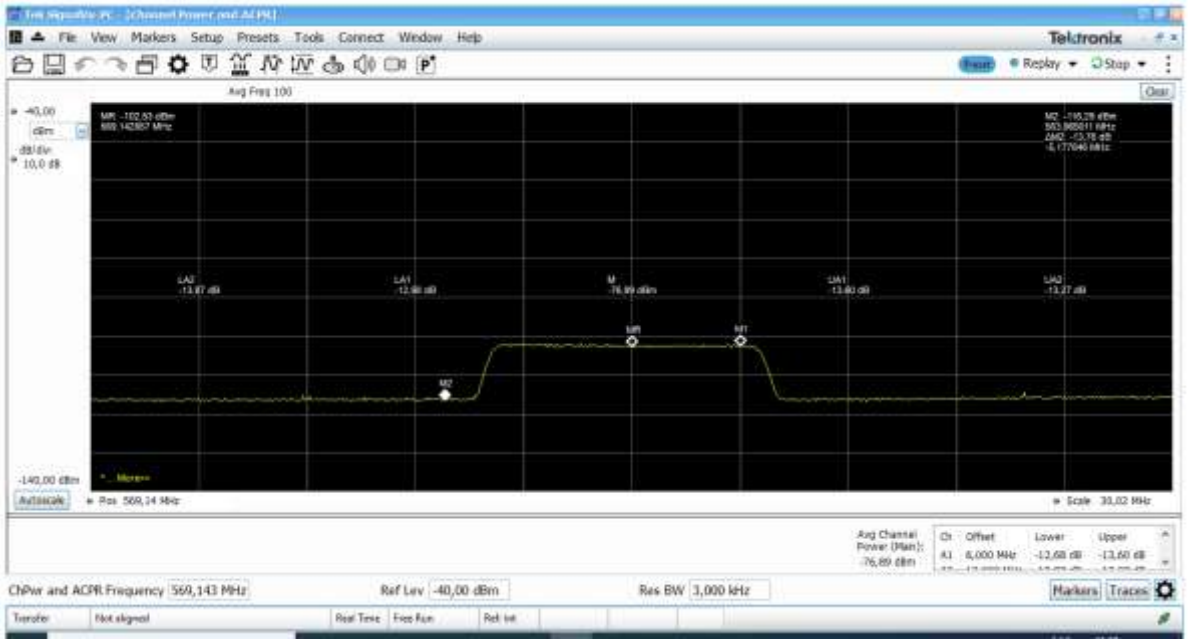


Figure 4.5 - Horizontal

c) C/N Threshold

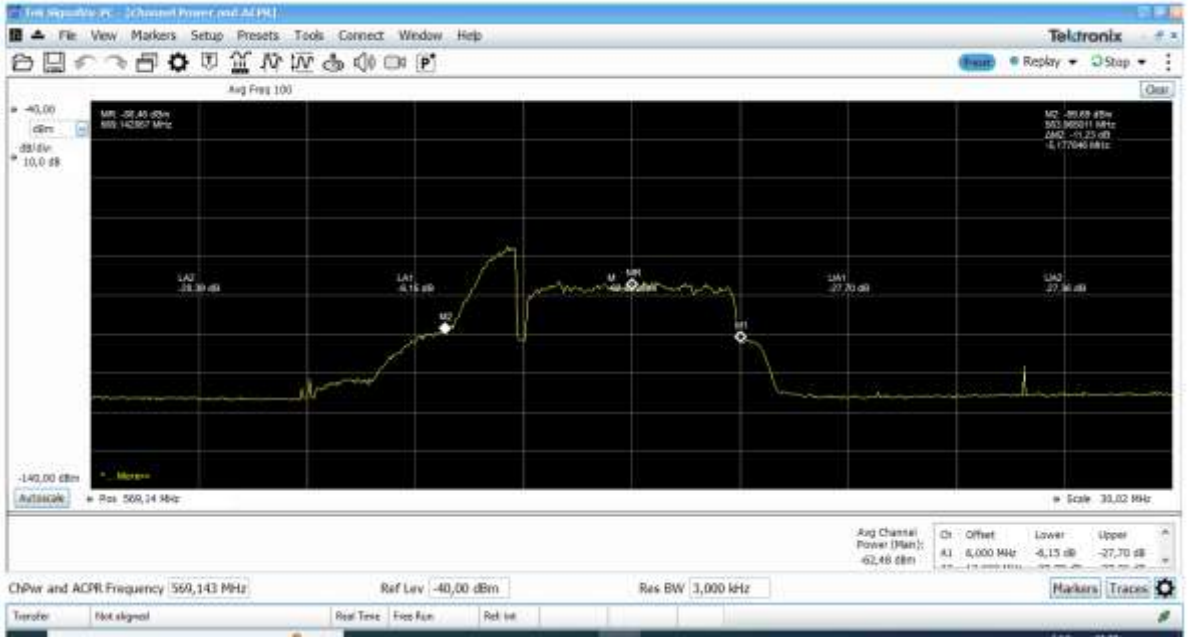


Figure 4.6 - Vertical

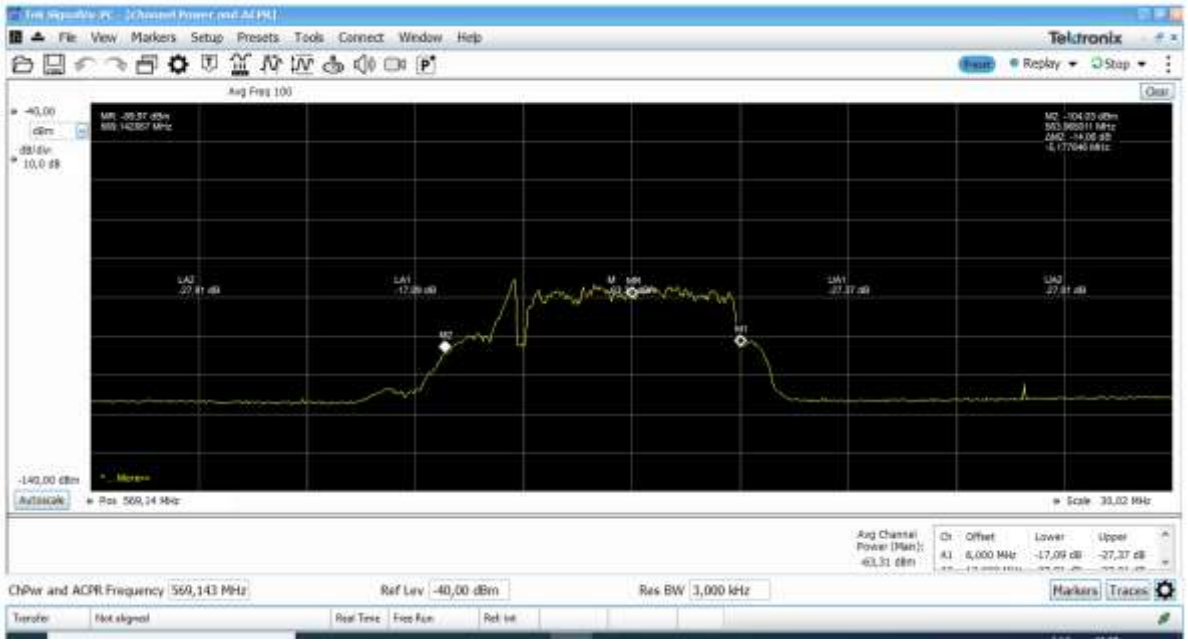


Figure 4.7 - Horizontal

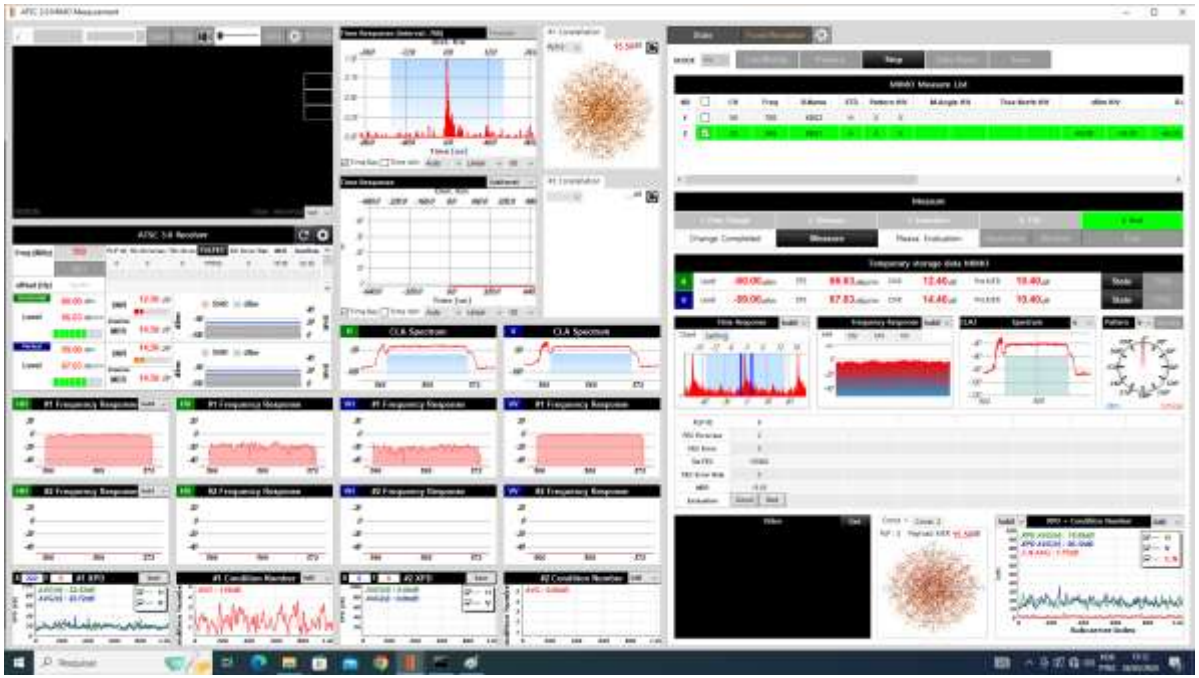


Figure 4.8 - IMAS Screen

d) Reception Threshold

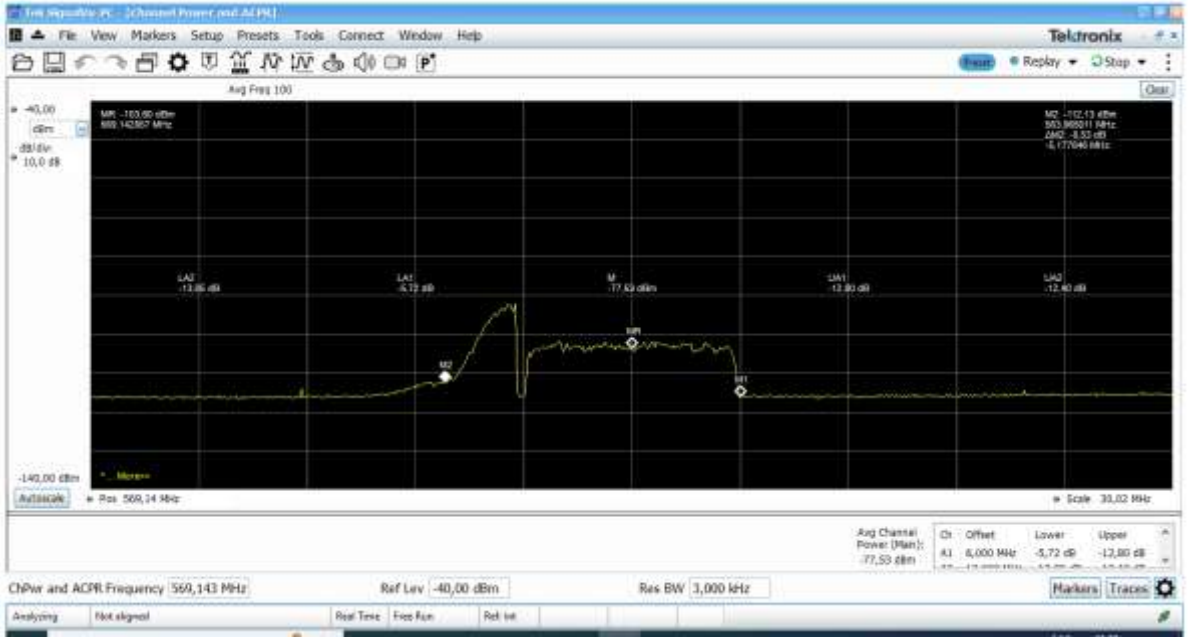


Figure 4.9 - Vertical

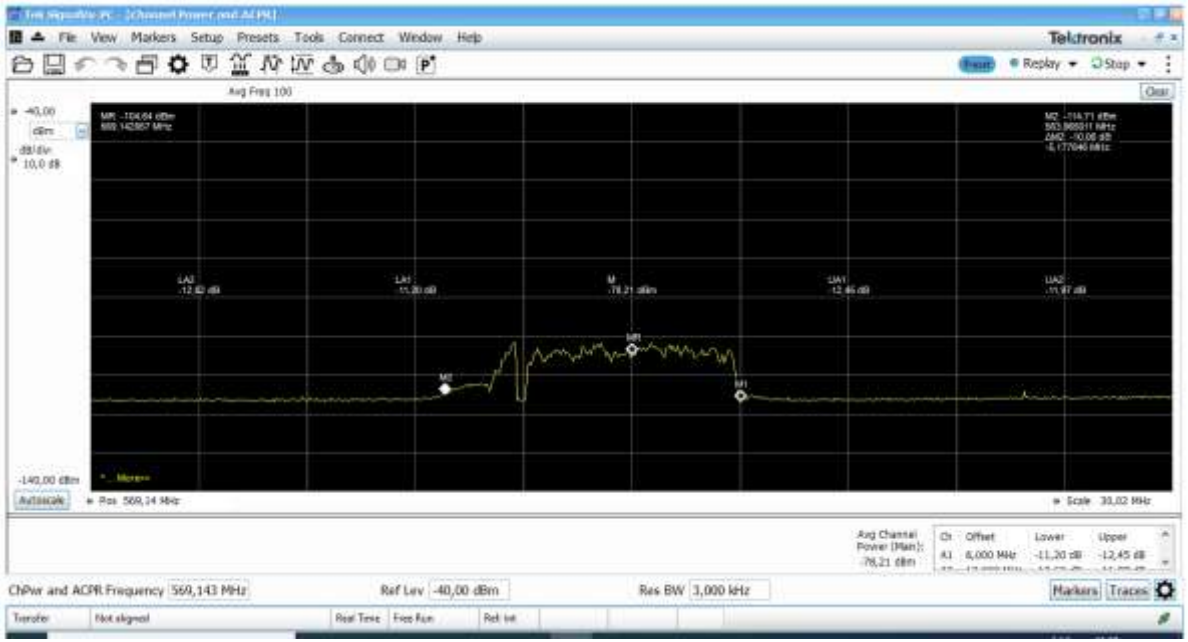


Figure 4.10 - Horizontal

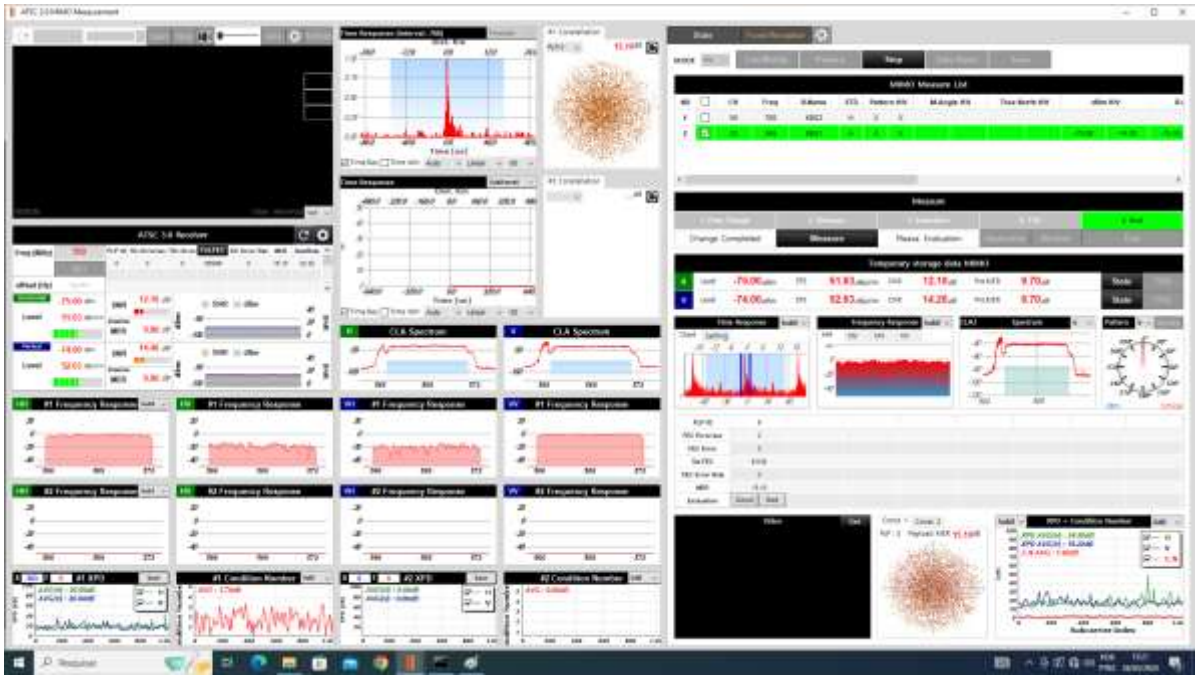


Figure 4.11 - IMAS Screen

Chapter 5. Site 5

a) Channel Power

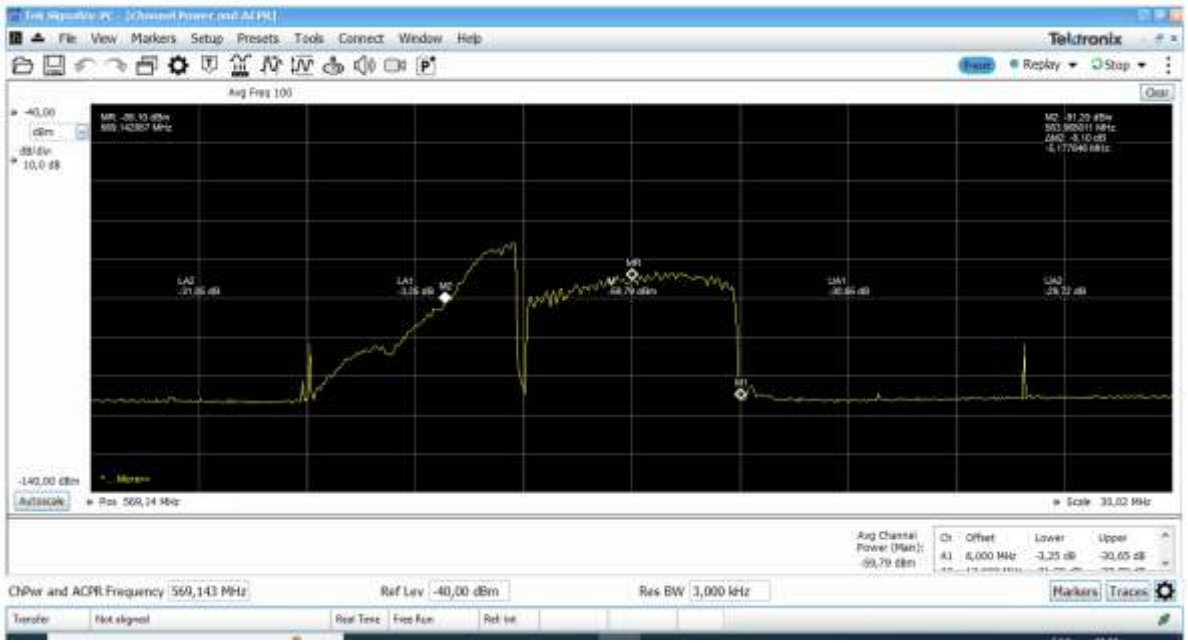


Figure 5.1 - Vertical

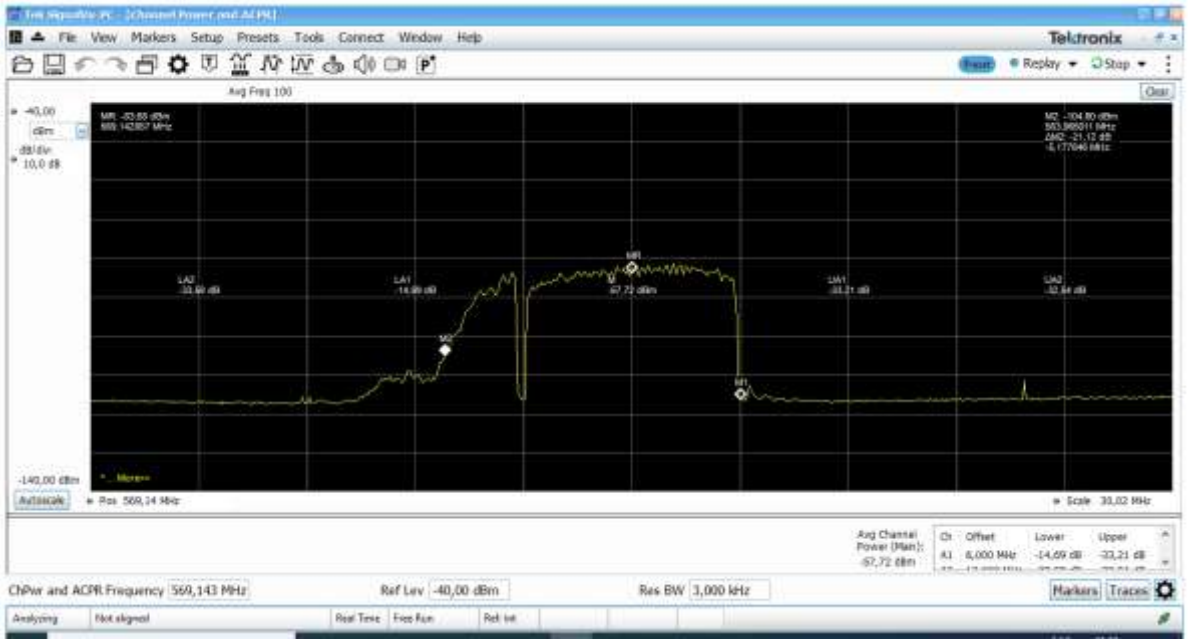


Figure 5.2 - Horizontal

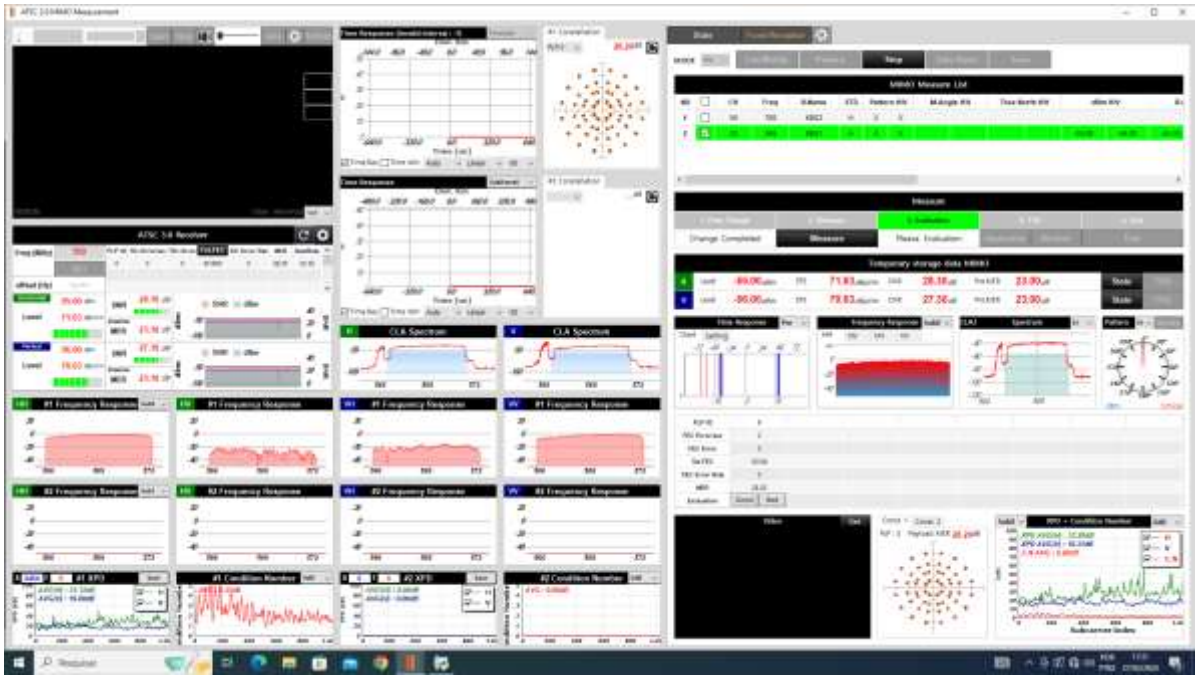


Figure 5.3 - IMAS Screen

b) AWGN Power

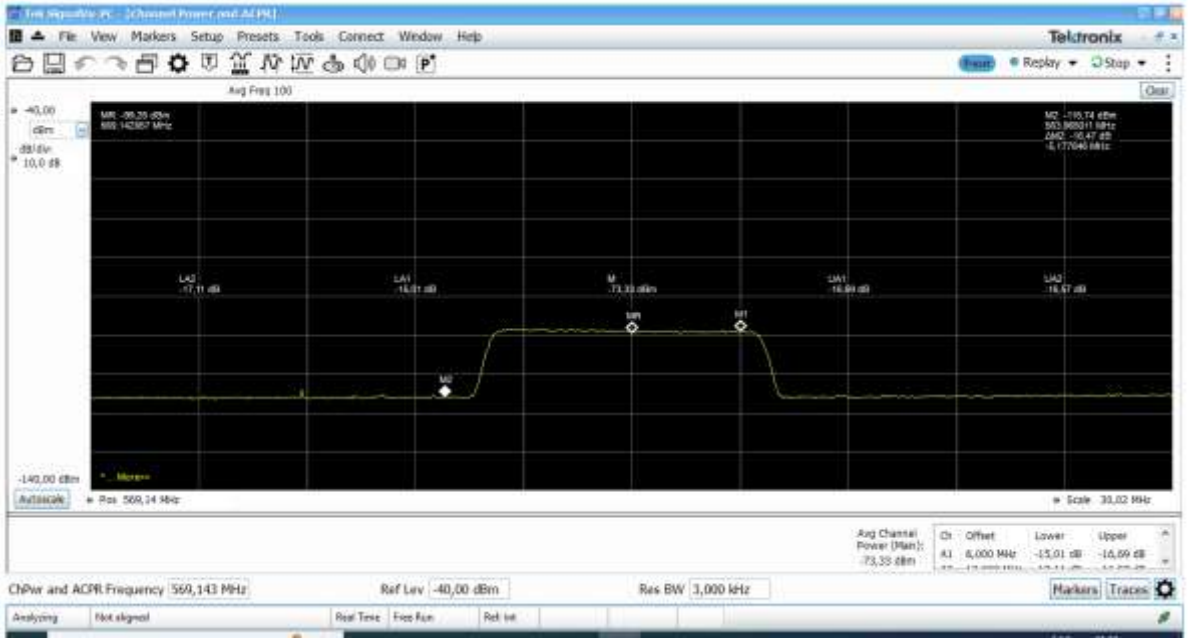


Figure 5.4 - Vertical

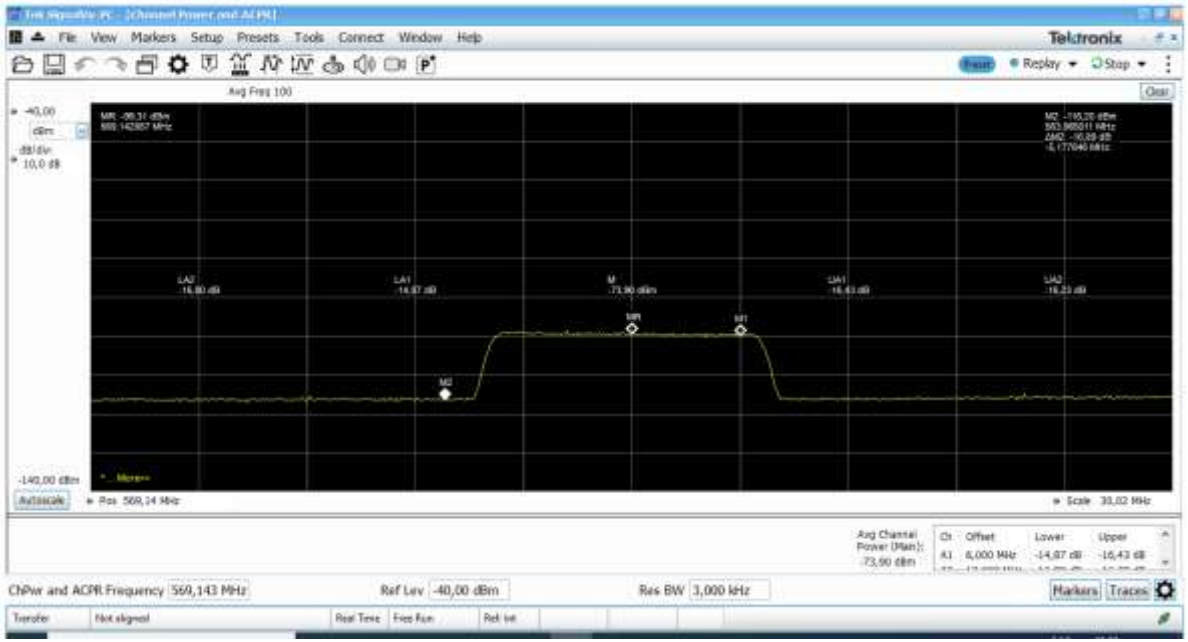


Figure 5.5 - Horizontal

c) C/N Threshold

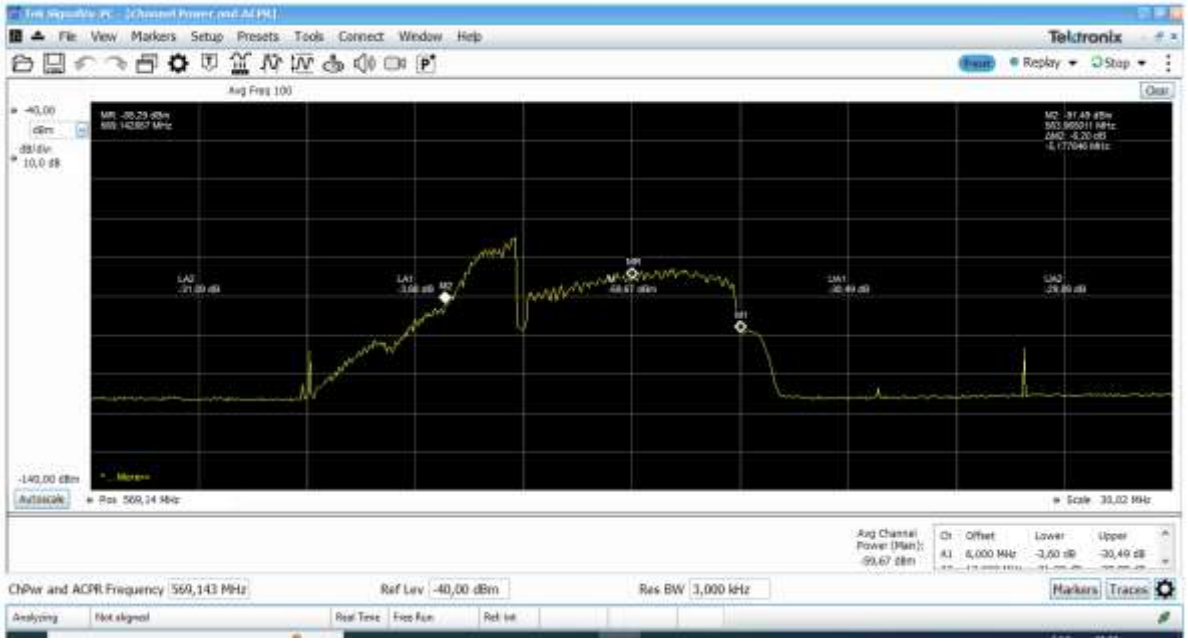


Figure 5.6 - Vertical

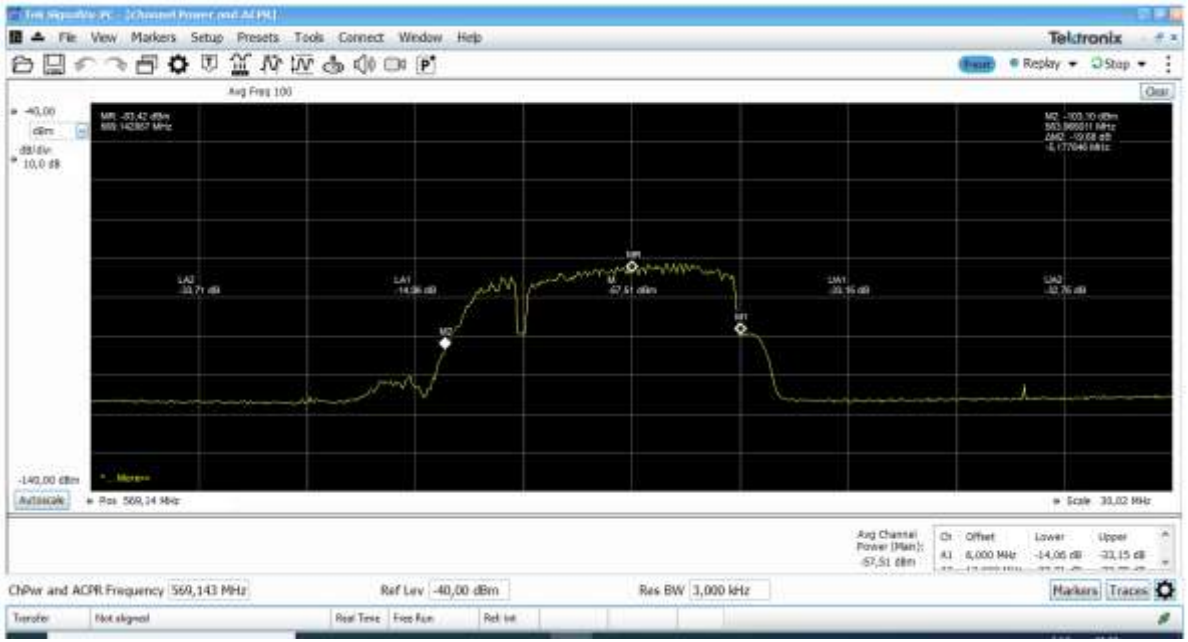


Figure 5.7 - Horizontal

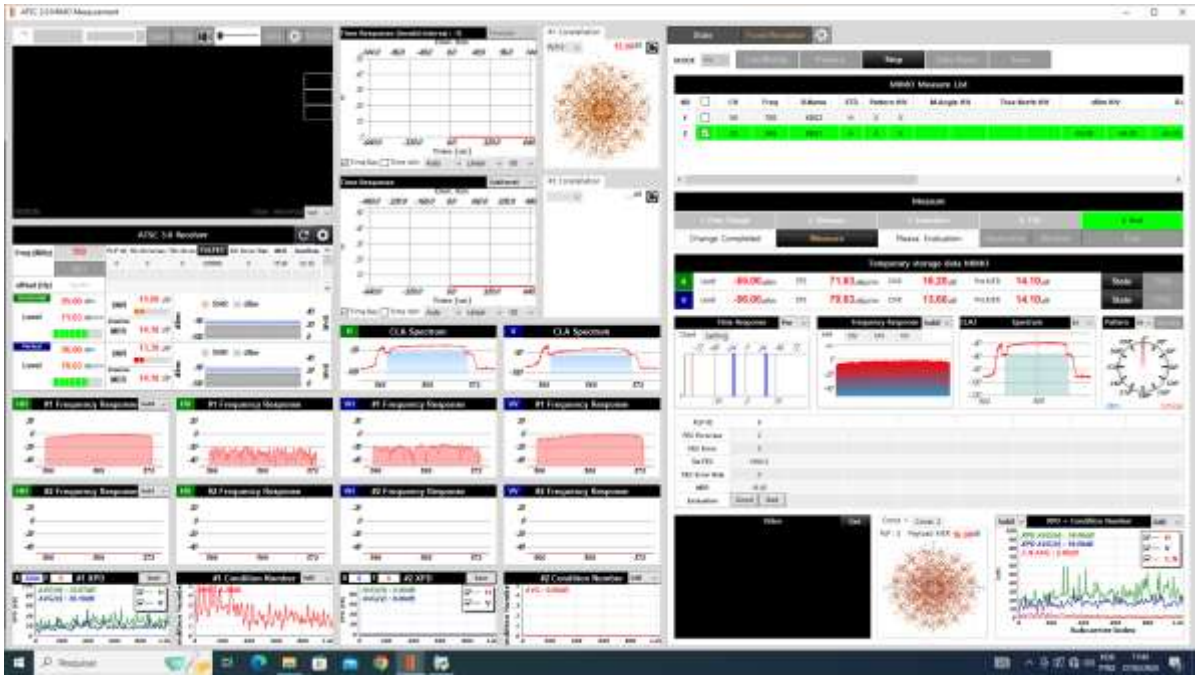


Figure 5.8 - IMAS Screen

d) Reception Threshold

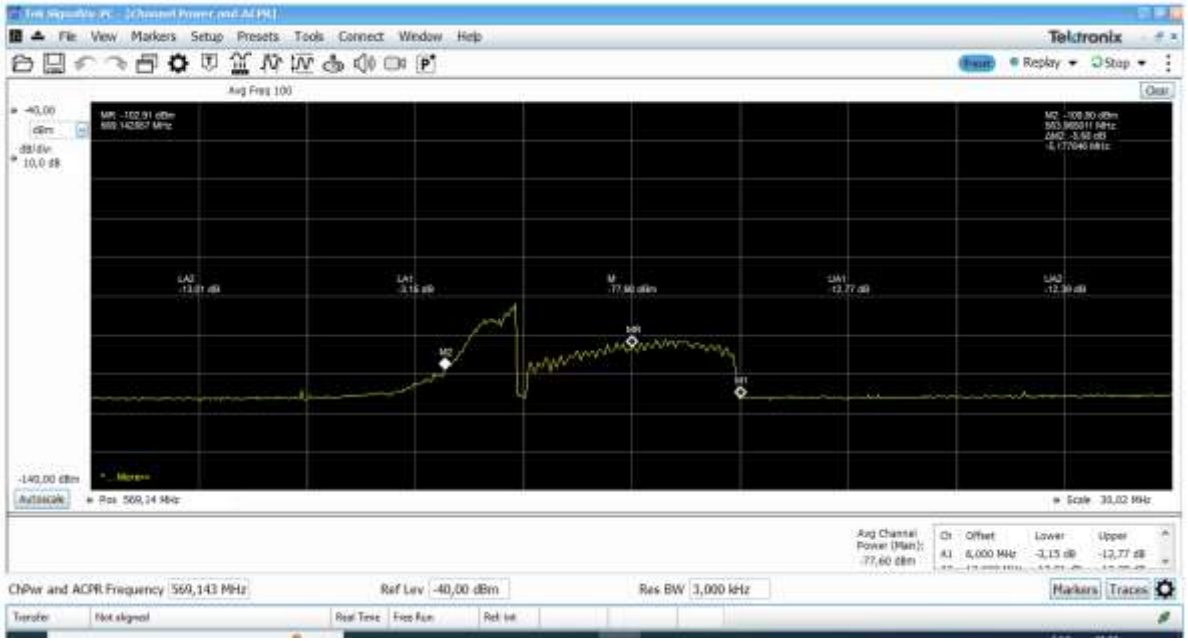


Figure 5.9 - Vertical

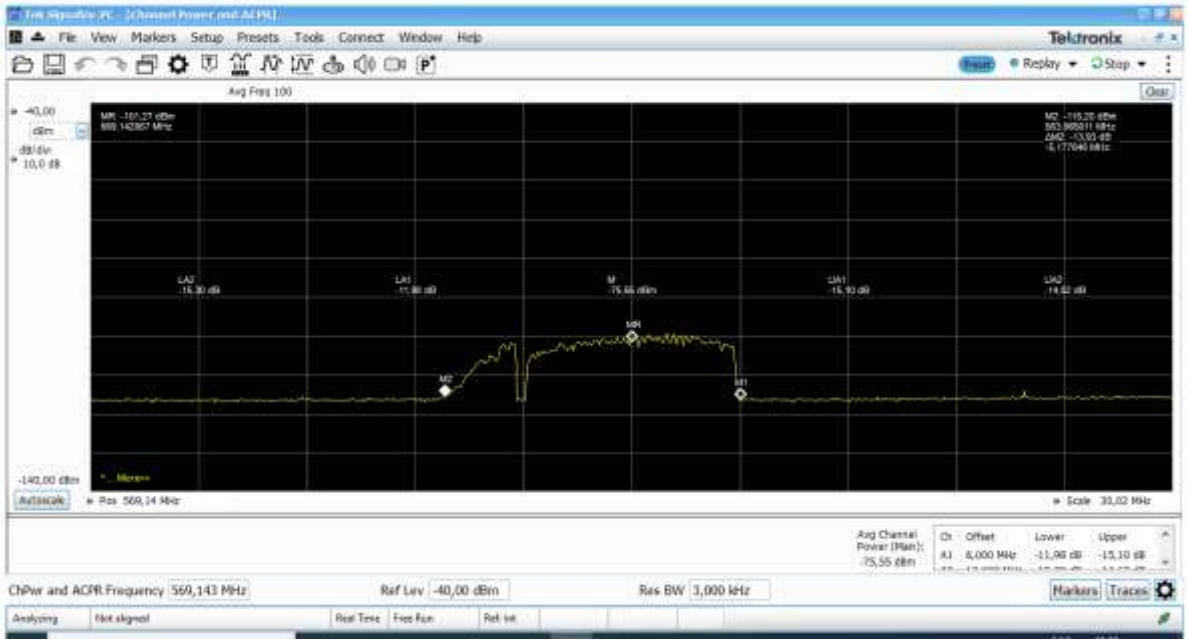


Figure 5.10 - Horizontal

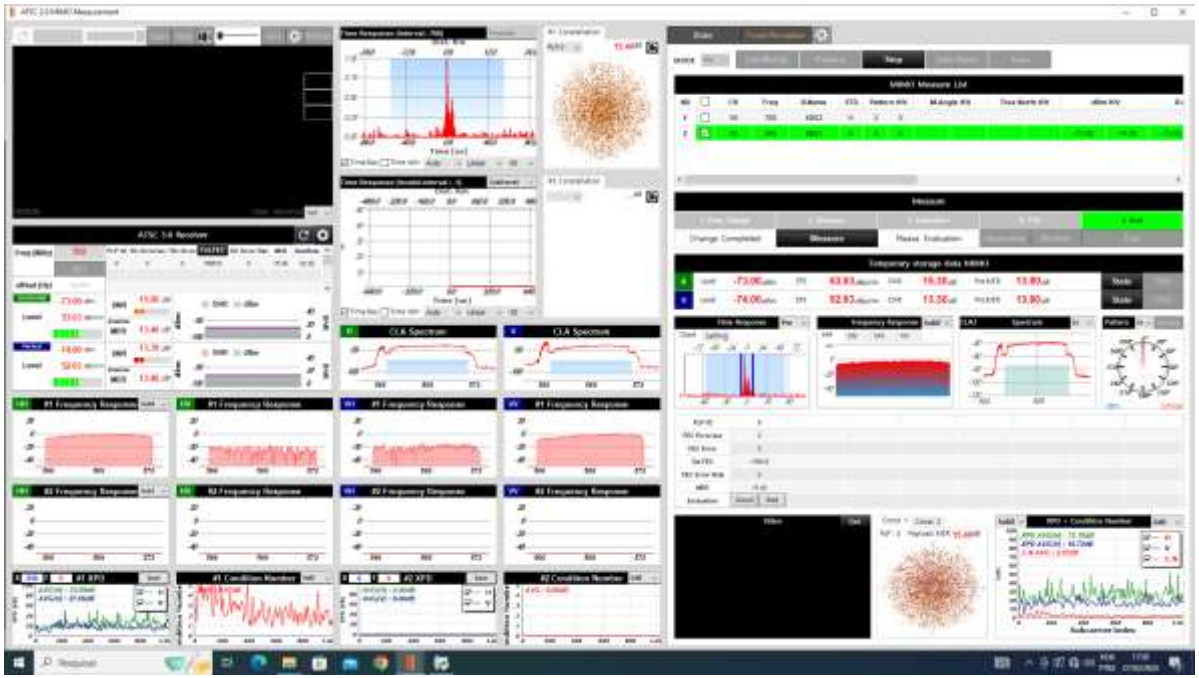


Figure 5.11 - IMAS Screen

Chapter 6. Site 6

a) Channel Power

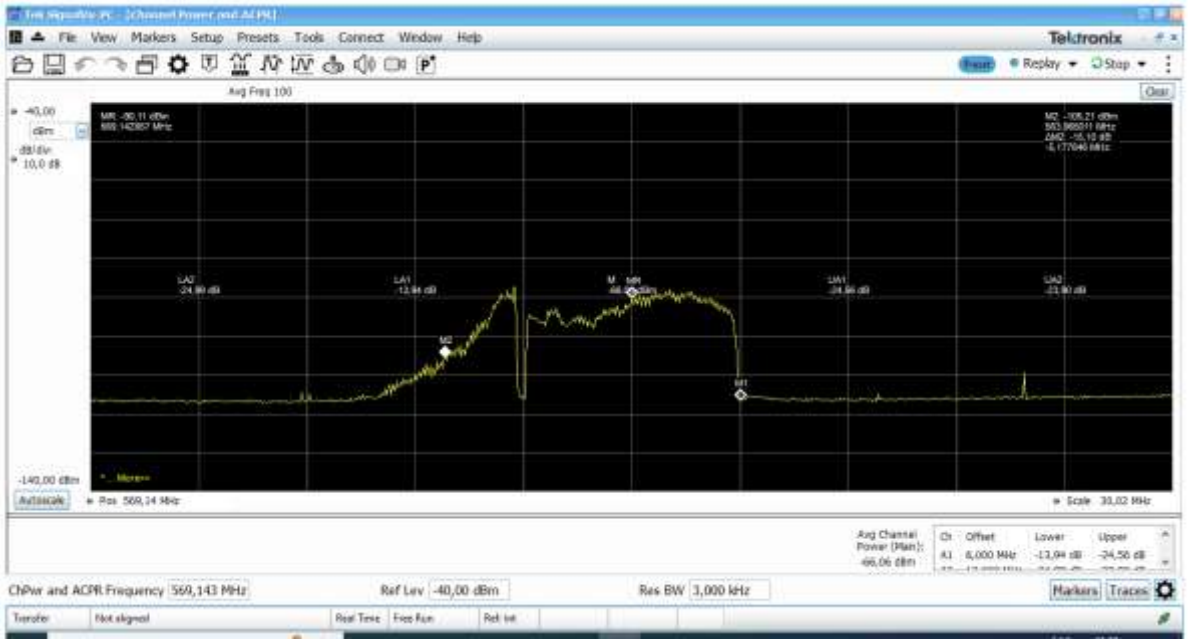


Figure 6.1 - Vertical

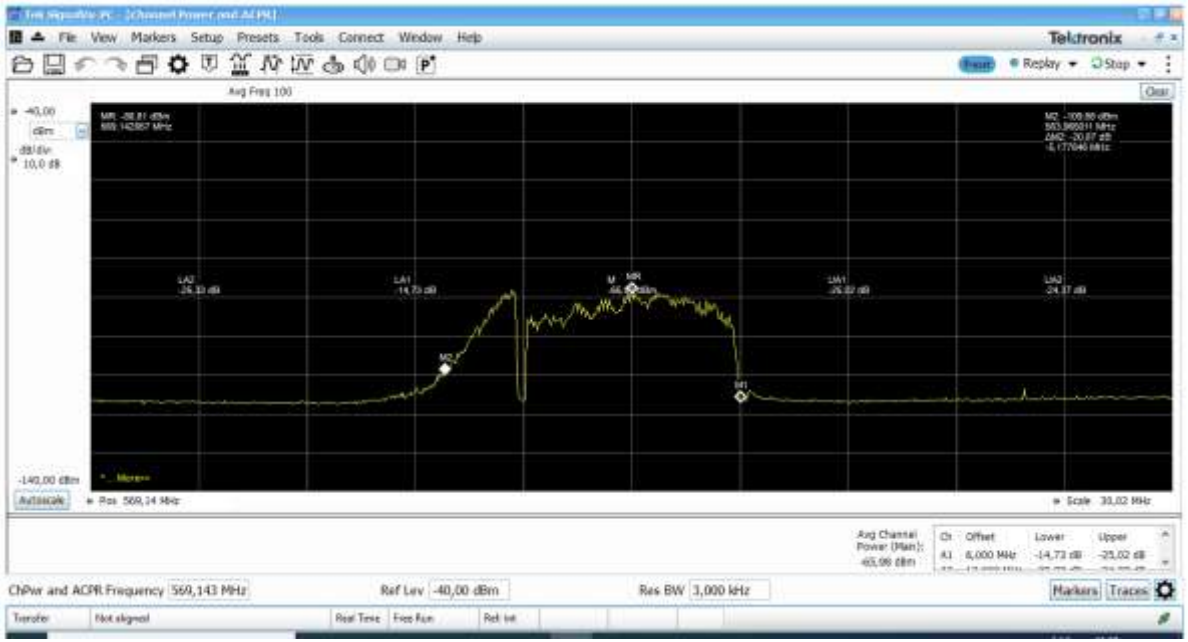


Figure 6.2 - Horizontal

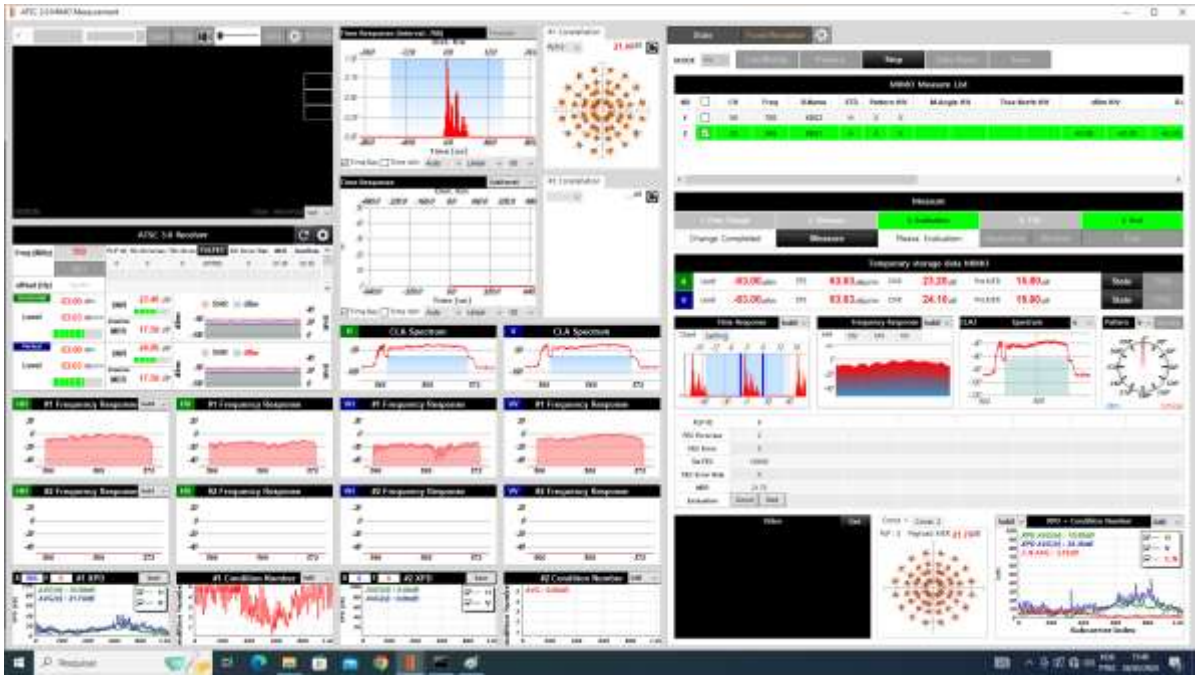


Figure 6.3 - IMAS Screen

b) AWGN Power

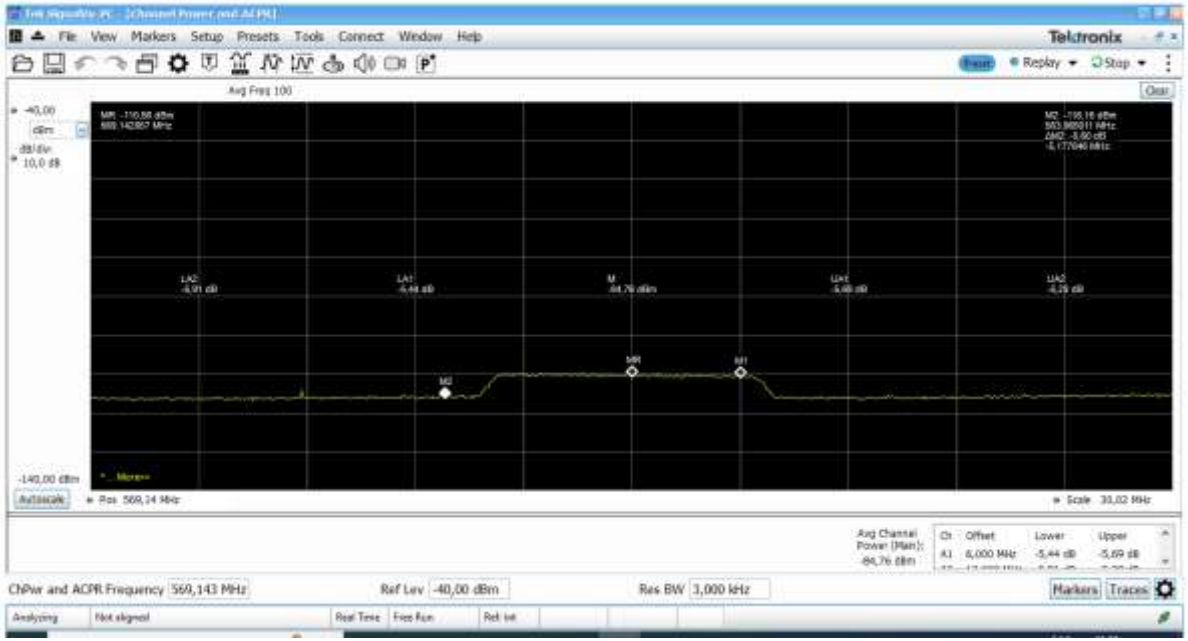


Figure 6.4 - Vertical

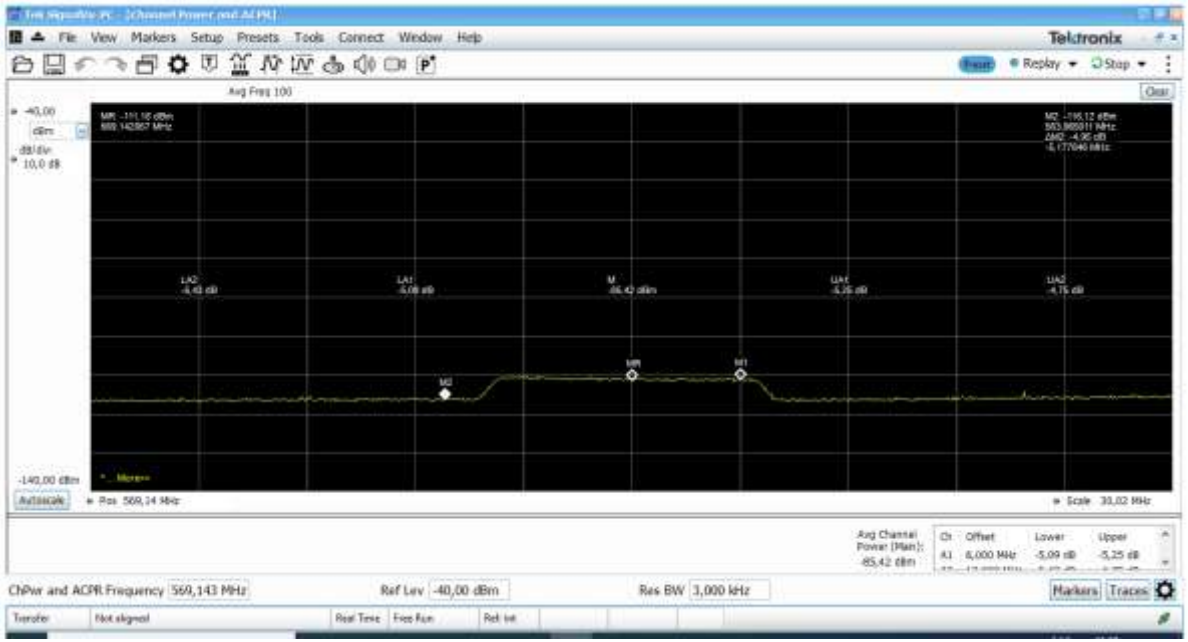


Figure 6.5 - Horizontal

c) C/N Threshold

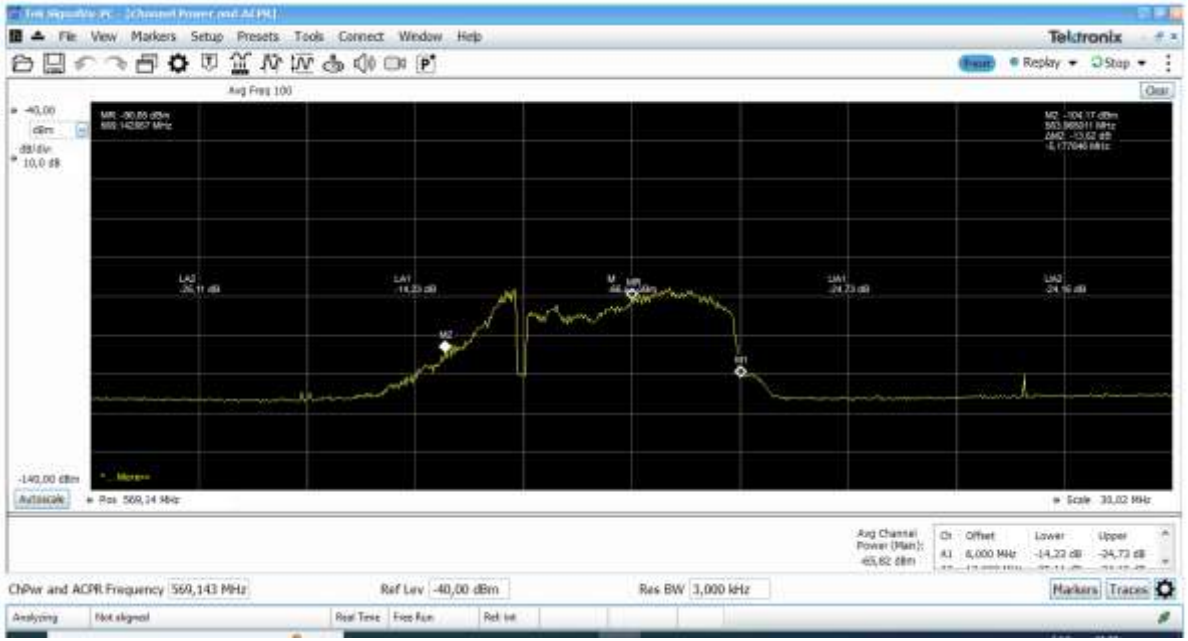


Figure 6.6 - Vertical

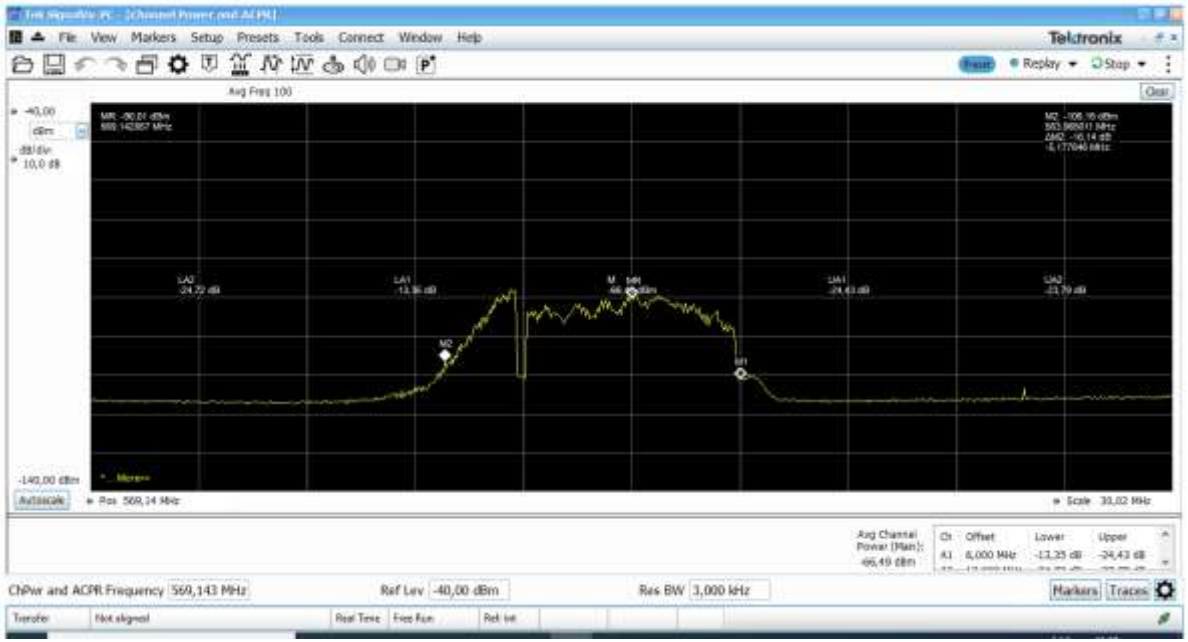


Figure 6.7 - Horizontal

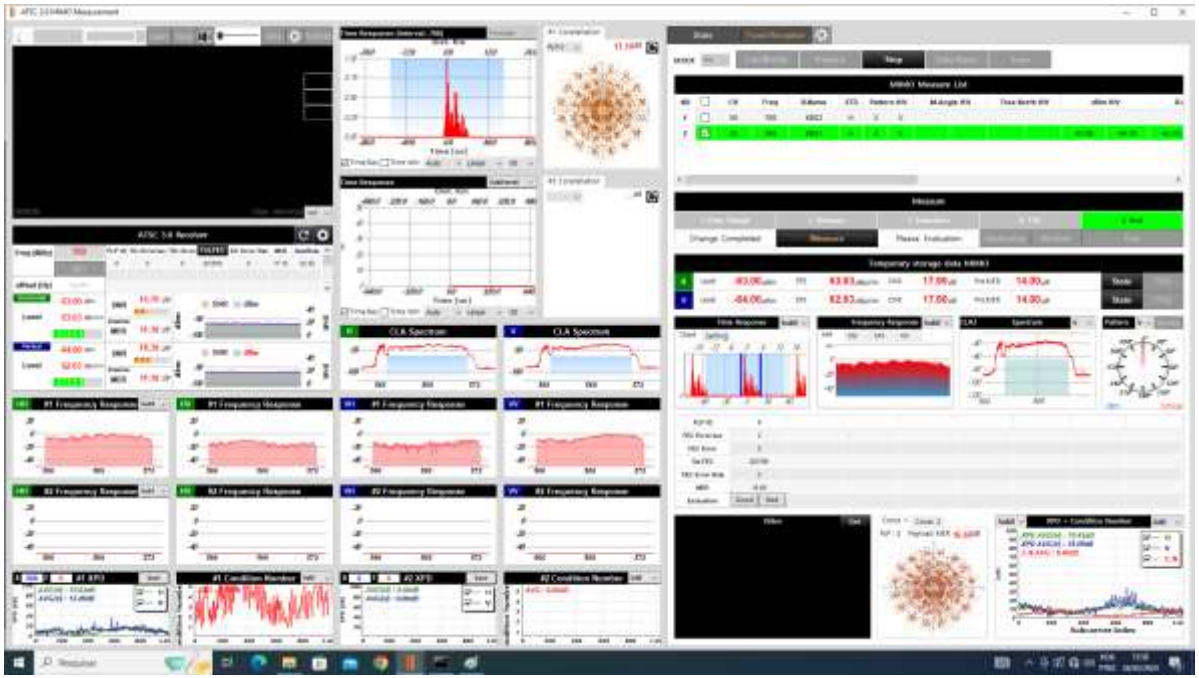


Figure 6.8 - IMAS Screen

d) Reception Threshold

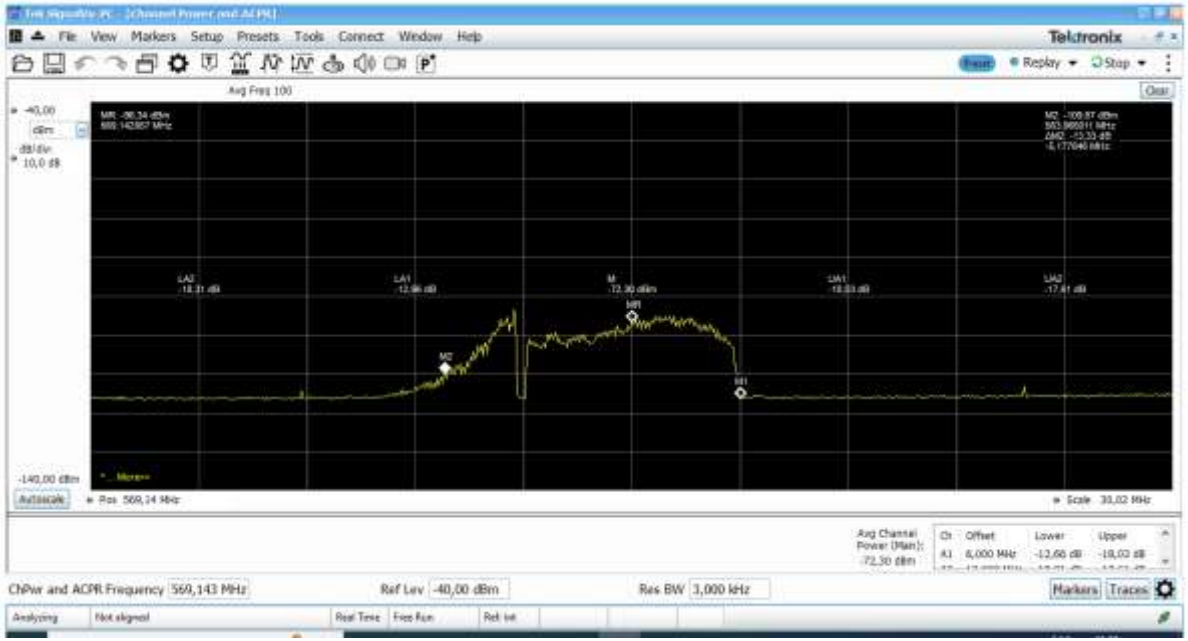


Figure 6.9 - Vertical

Figure 6.10 - Horizontal

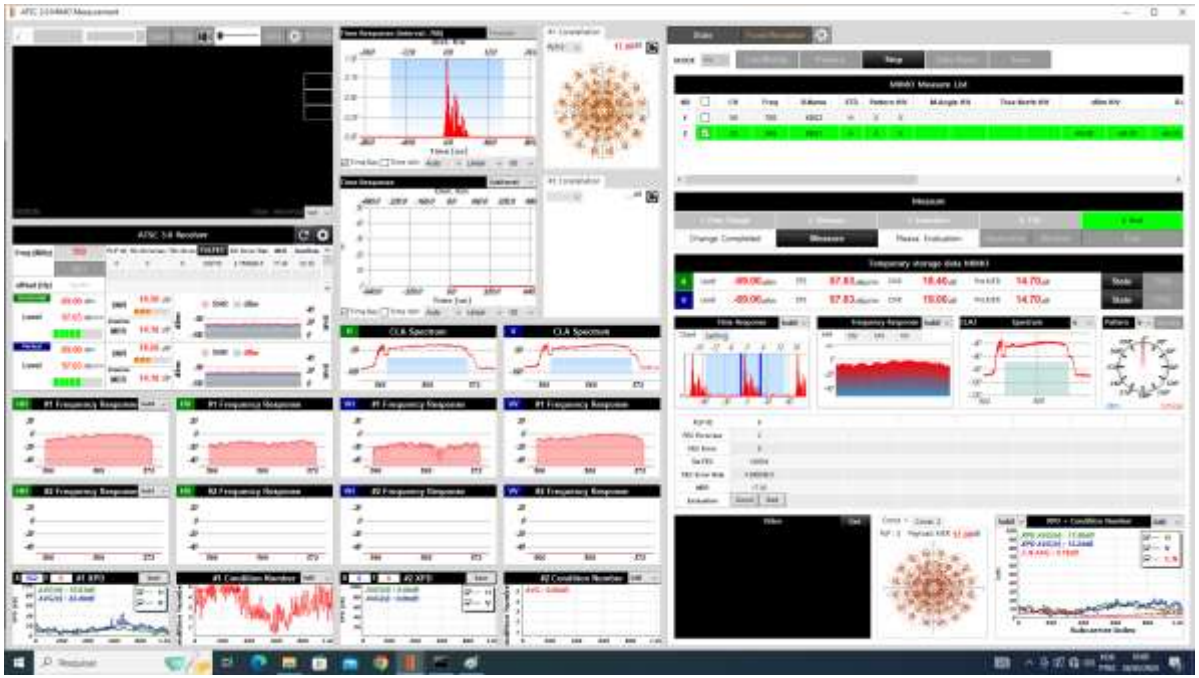


Figure 6.11 - IMAS Screen

Chapter 7. Site 7

a) Channel Power

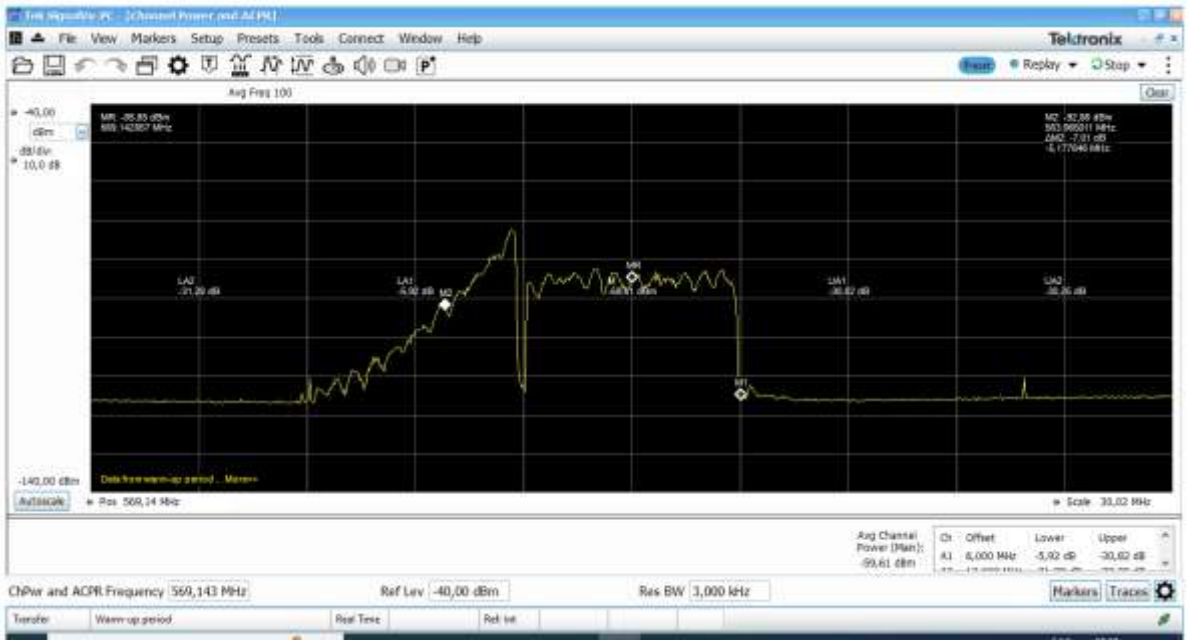


Figure 7.1 - Vertical

Figure 7.2 - Horizontal

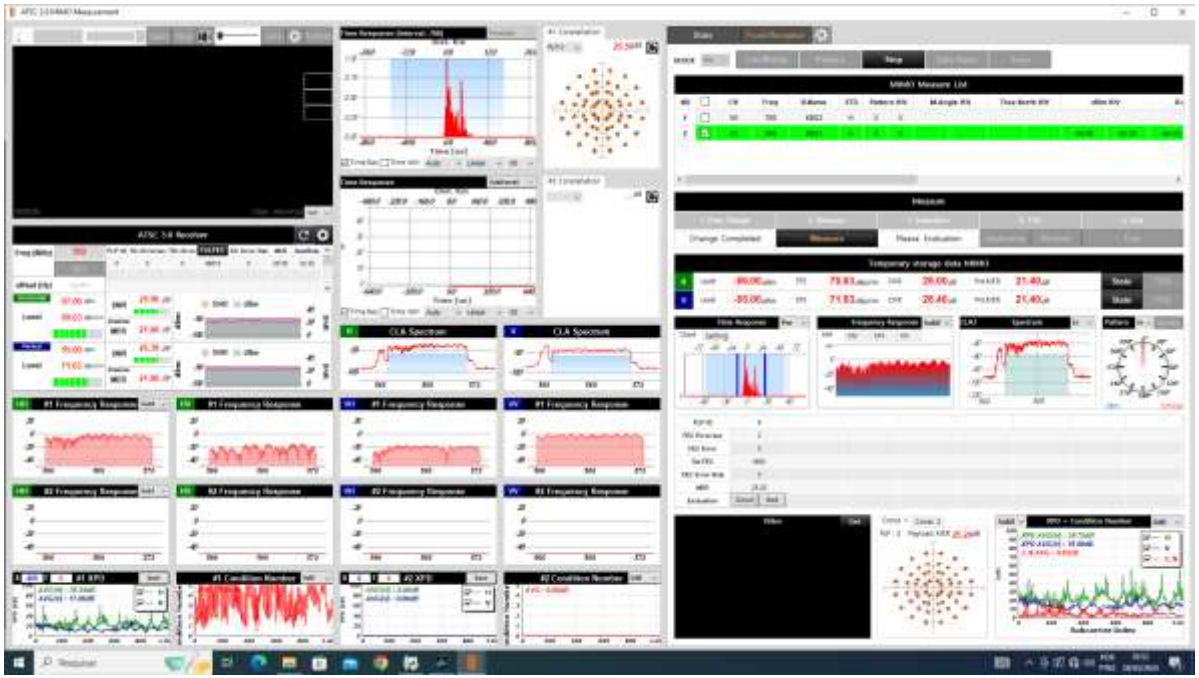


Figure 7.3 - IMAS Screen

b) AWGN Power

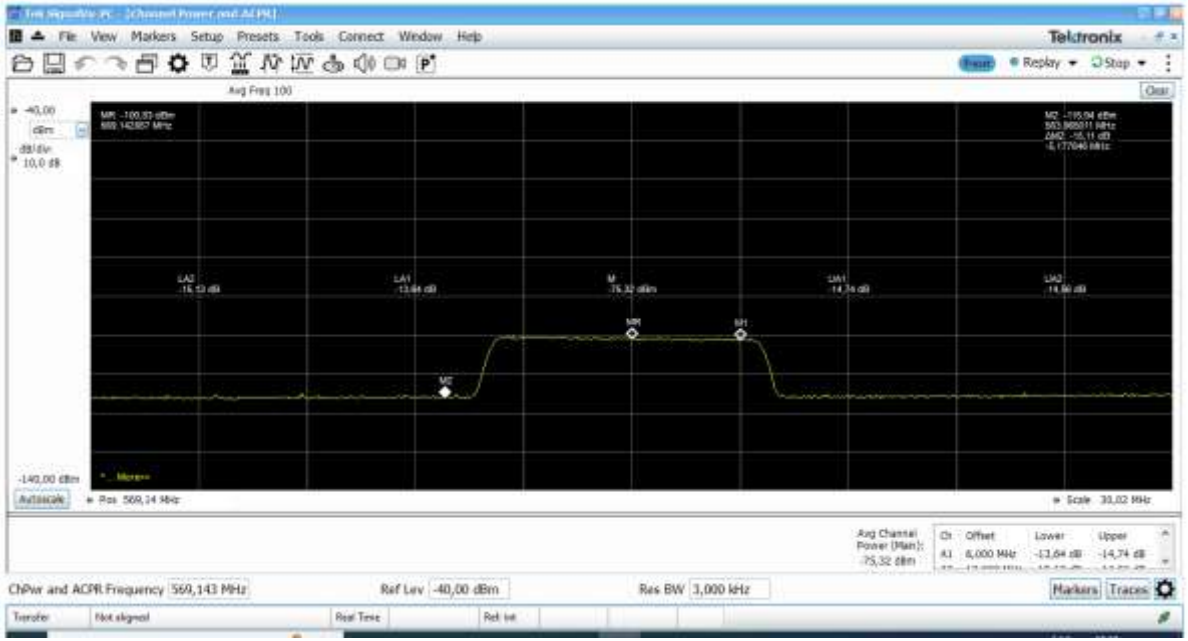


Figure 7.4 - Vertical

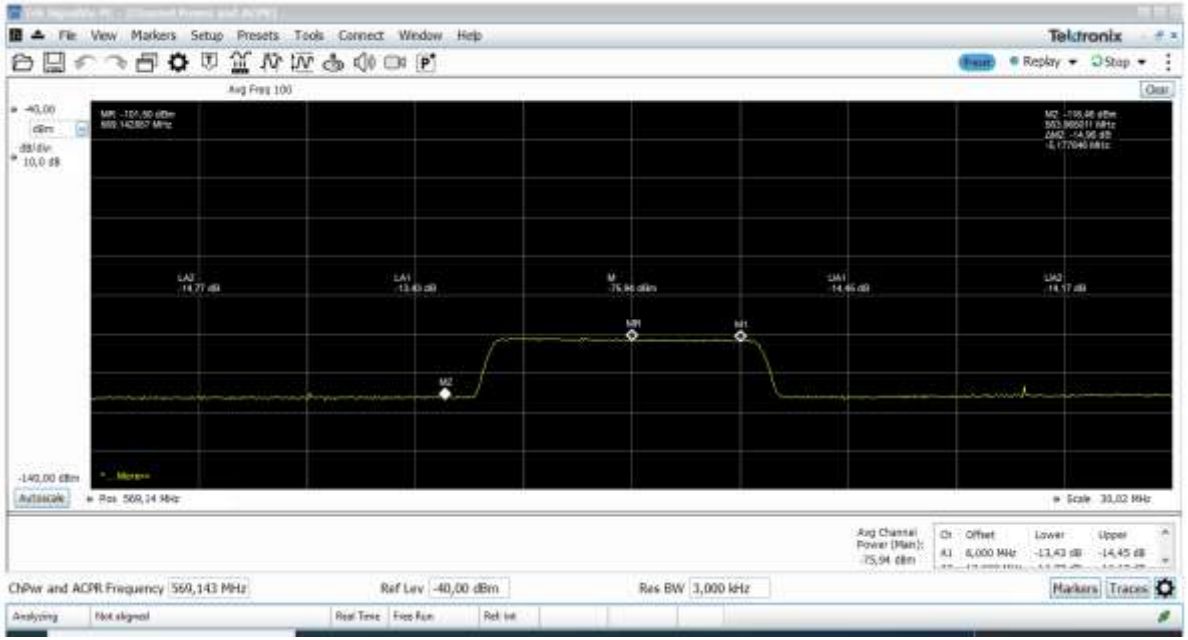


Figure 7.5 - Horizontal

c) C/N Threshold

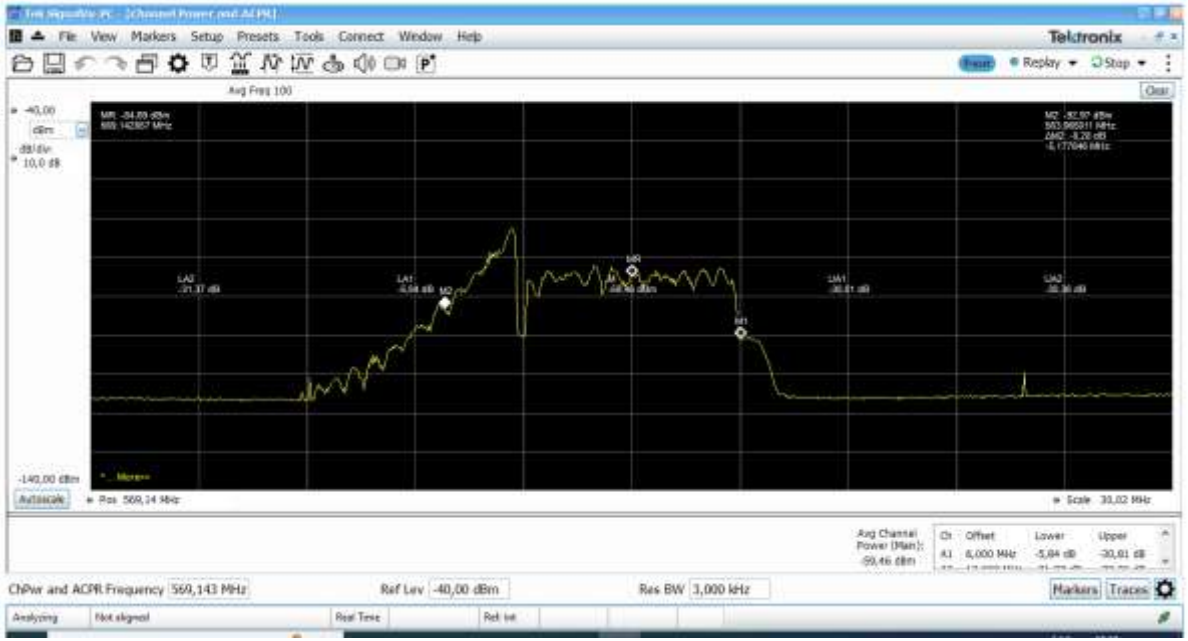


Figure 7.6 - Vertical

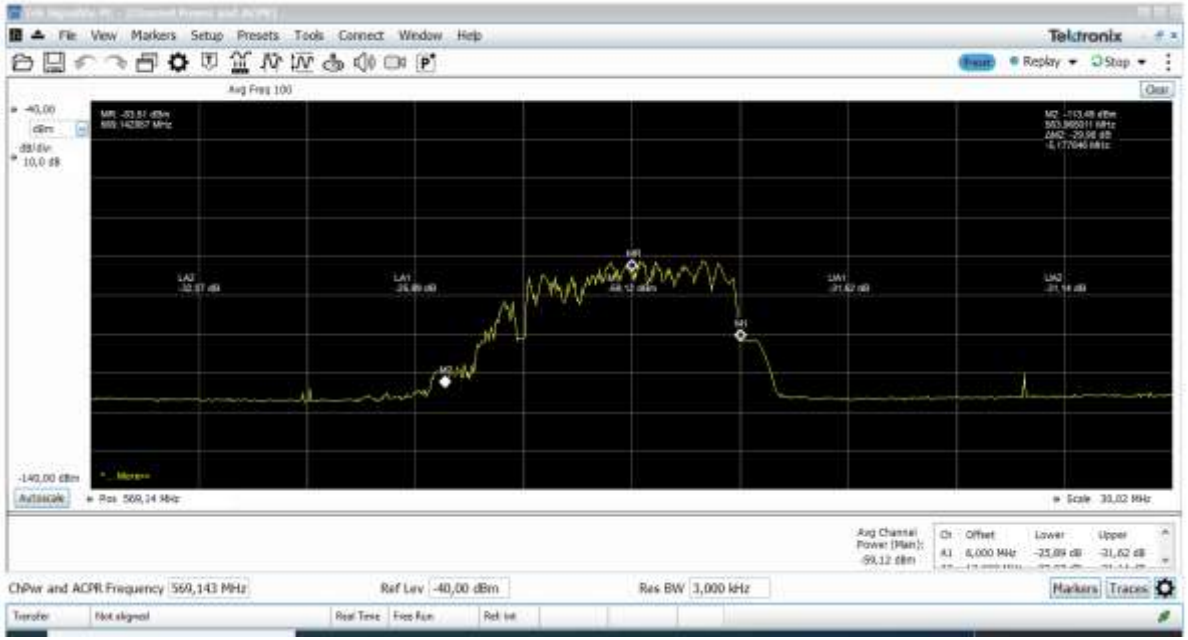


Figure 7.7 - Horizontal

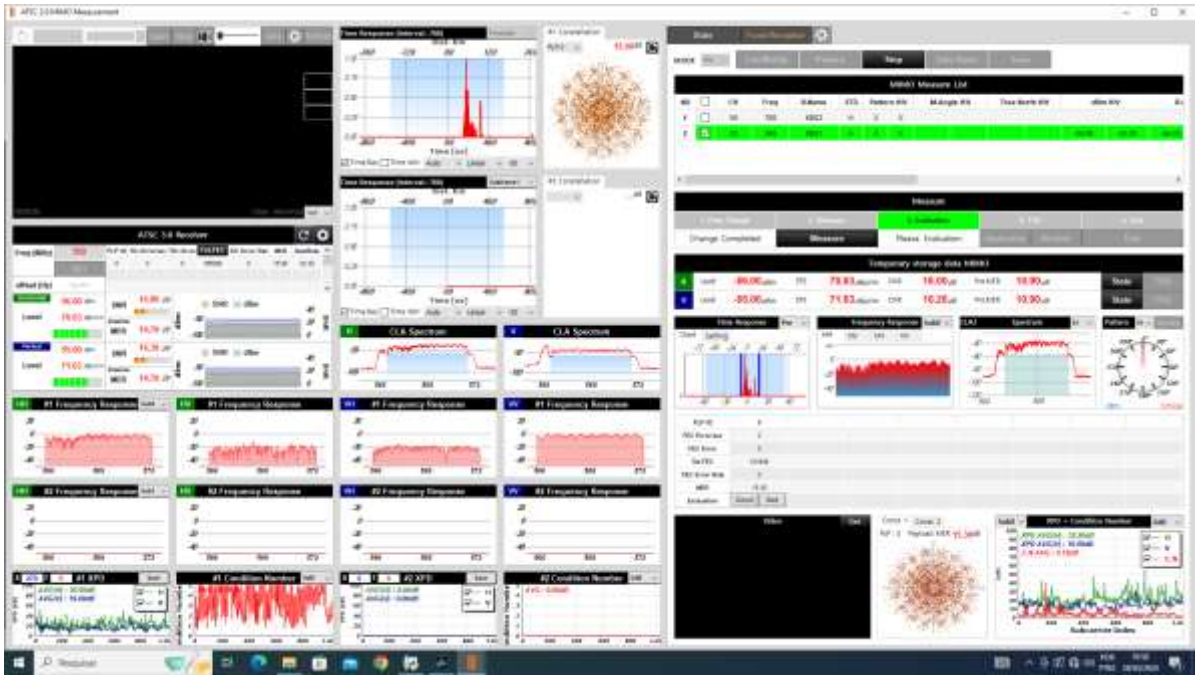


Figure 7.8 - IMAS Screen

d) Reception Threshold

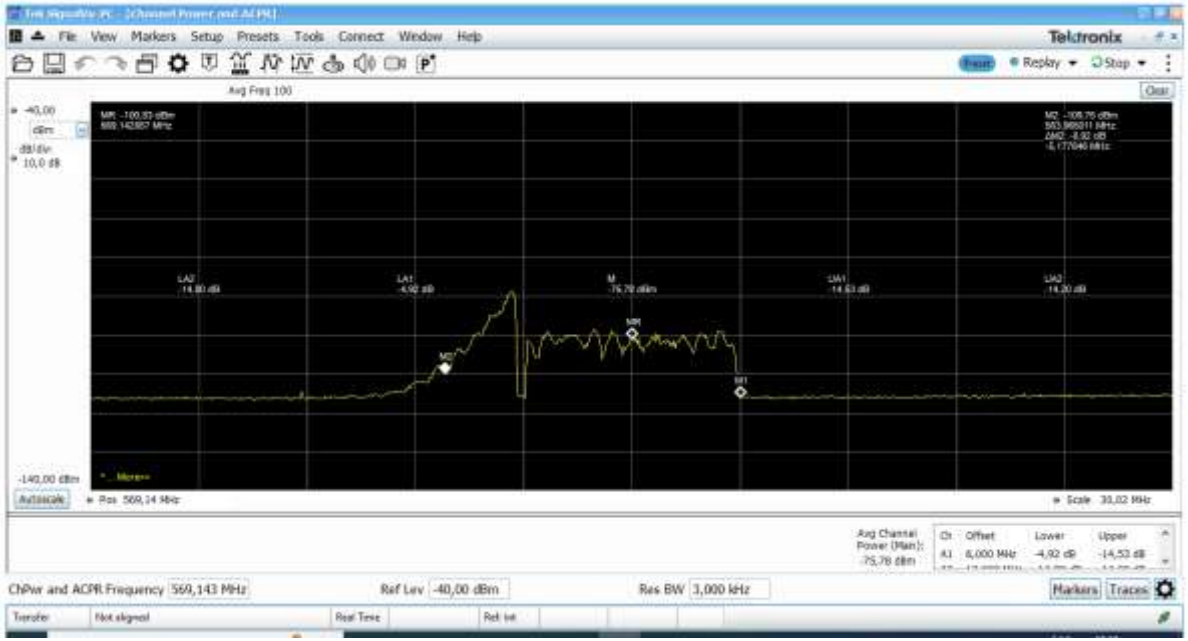


Figure 7.9 - Vertical

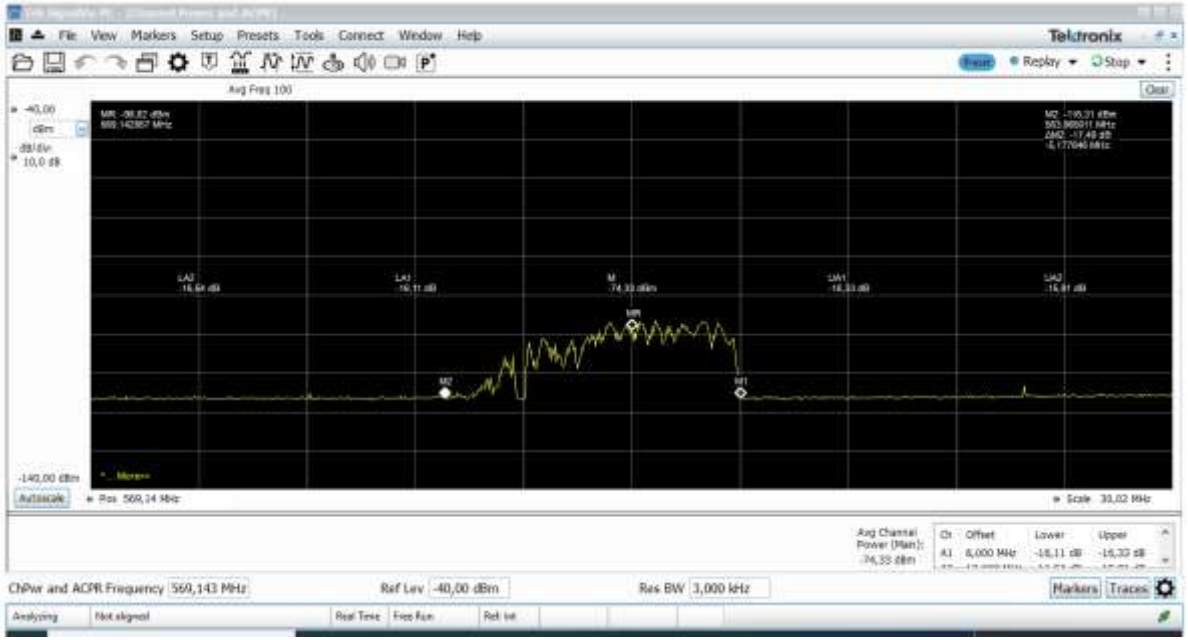


Figure 7.10 - Horizontal

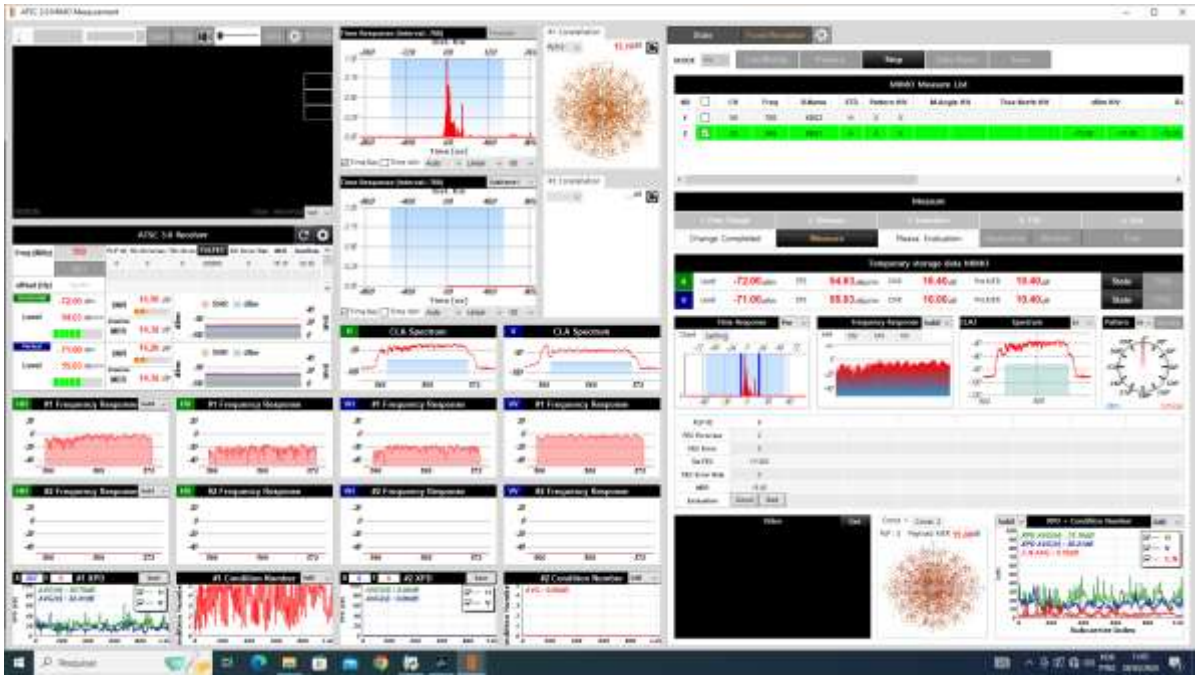


Figure 7.11 - IMAS Screen

Chapter 8. Site 8

a) Channel Power

Figure 8.1 - Vertical

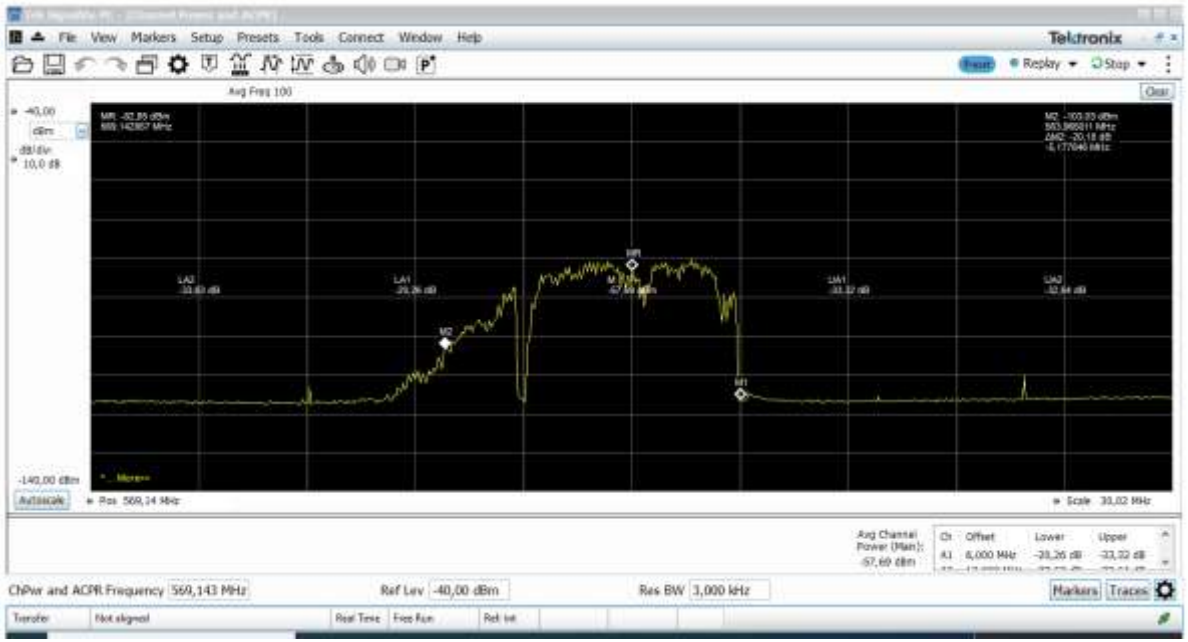


Figure 8.2 - Horizontal

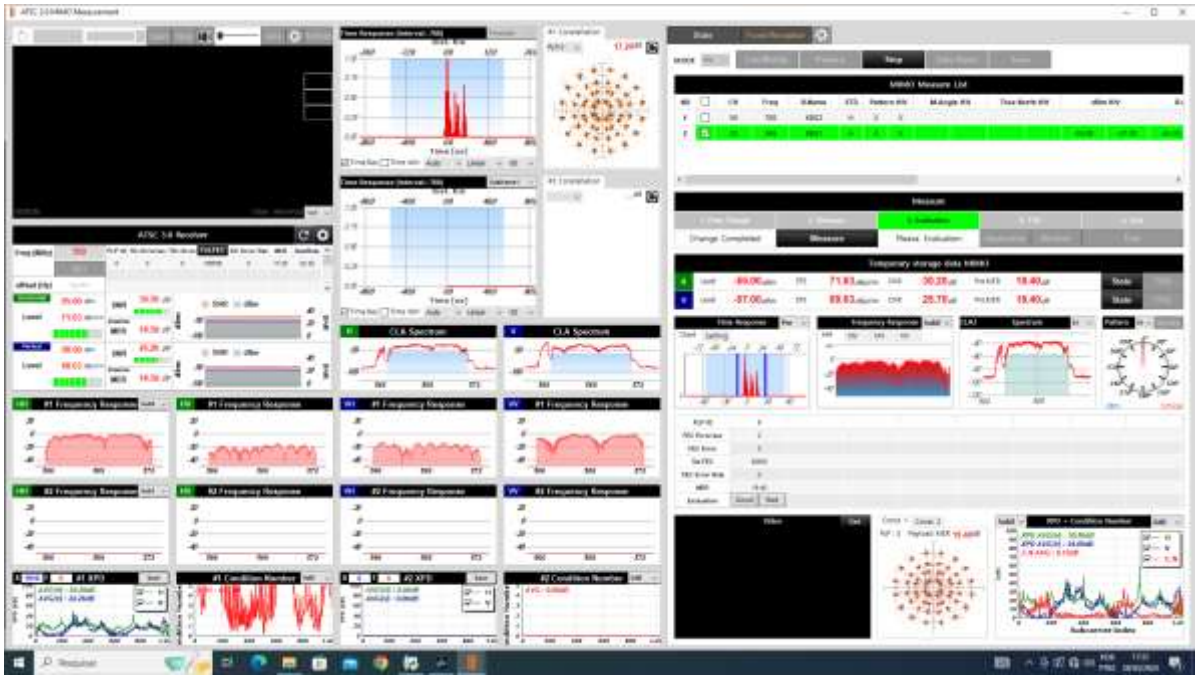


Figure 8.3 - IMAS Screen

b) AWGN Power

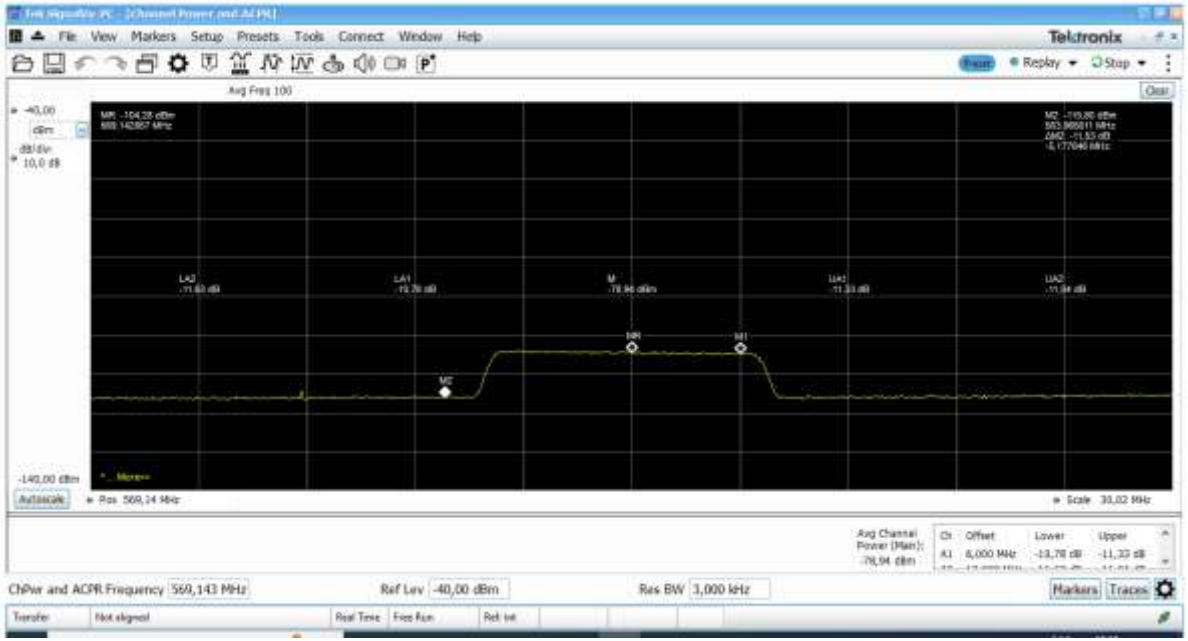


Figure 8.4 - Vertical

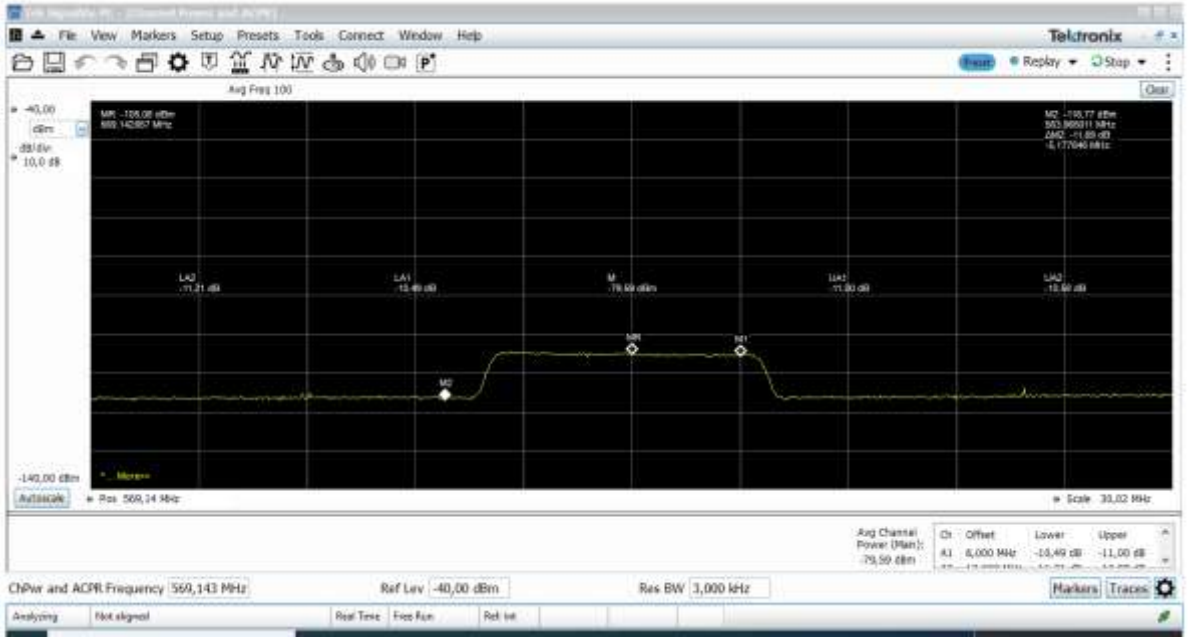


Figure 8.5 - Horizontal

c) C/N Threshold

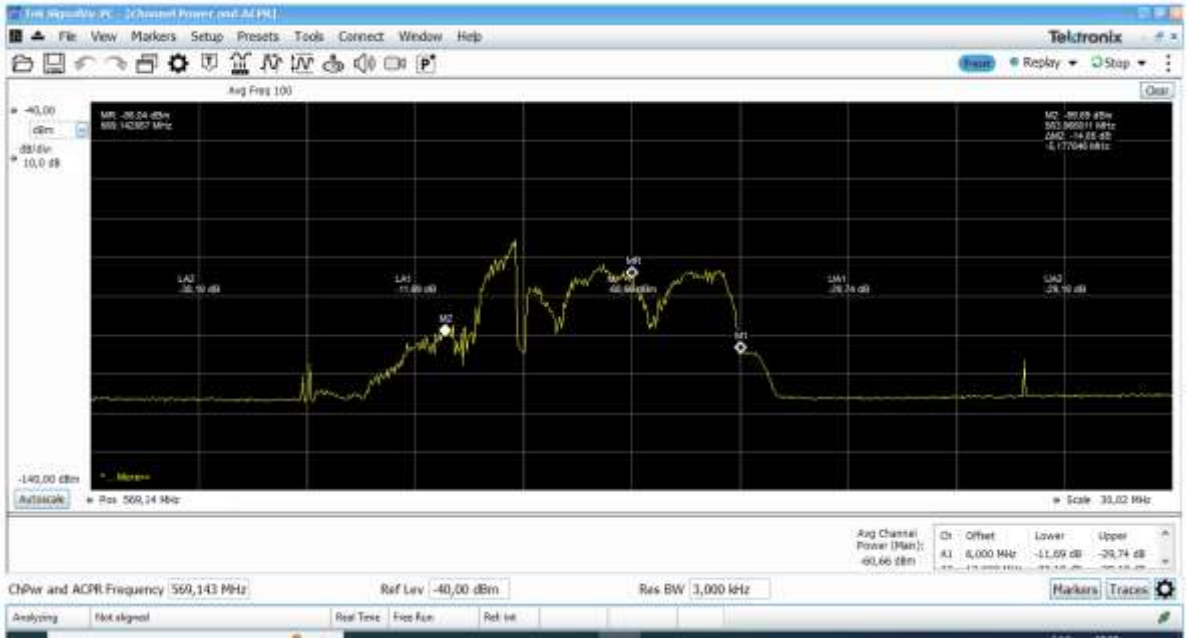


Figure 8.6 - Vertical

Figure 8.7 - Horizontal

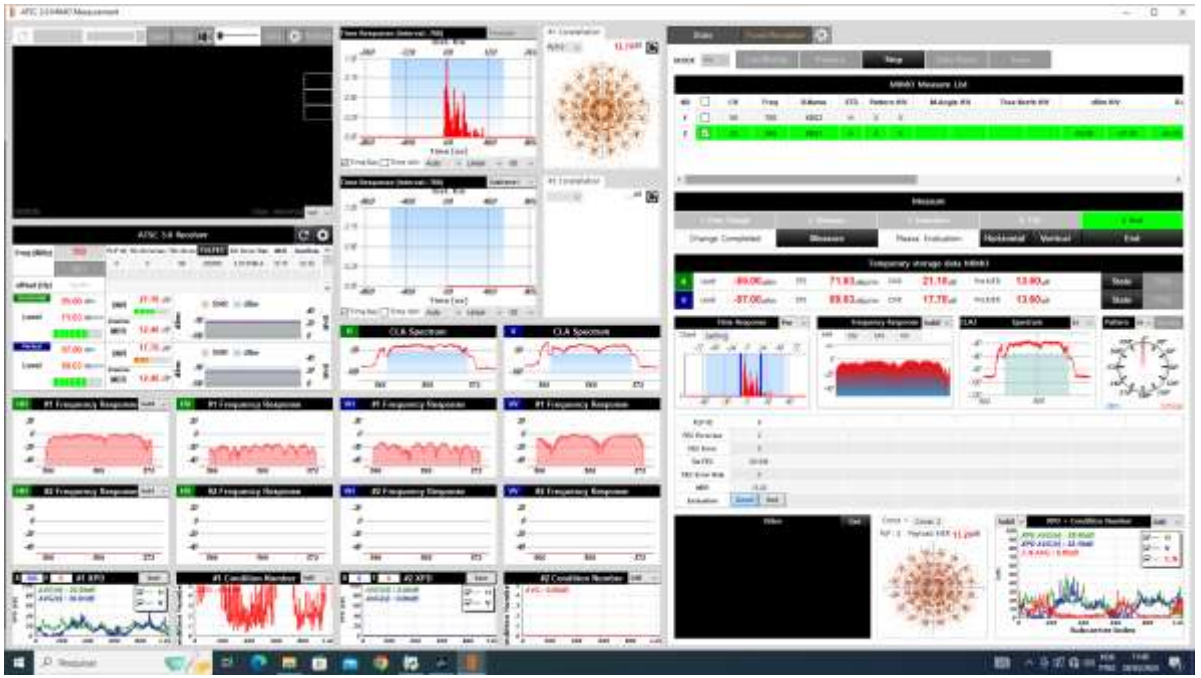


Figure 8.8 - IMAS Screen

d) Reception Threshold

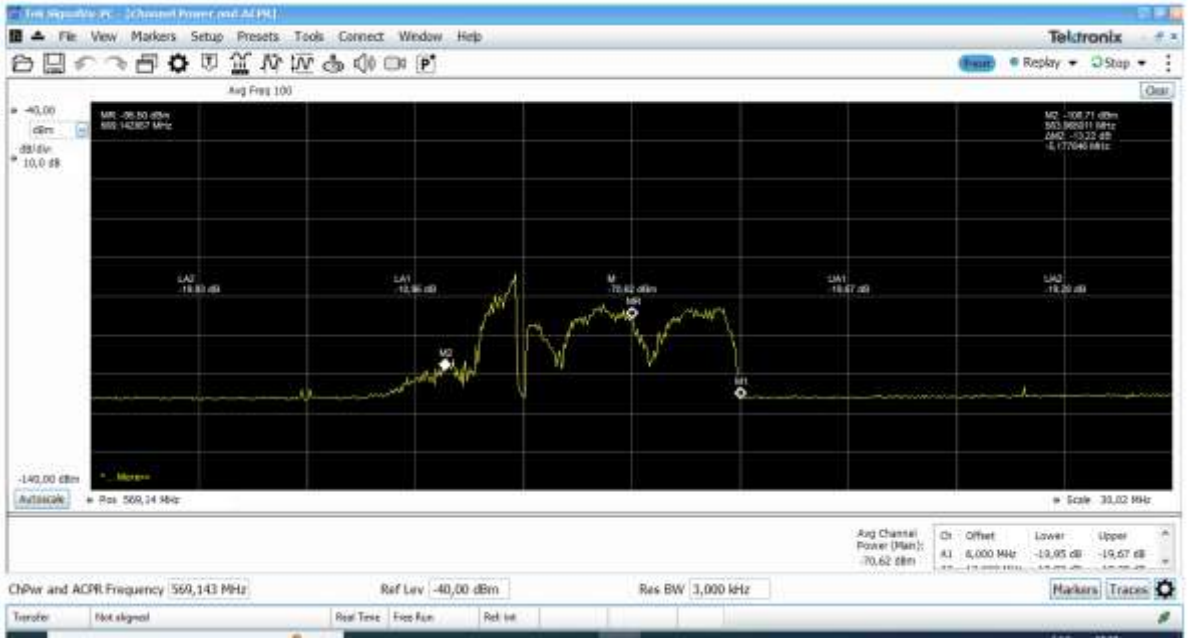


Figure 8.9 - Vertical

Figure 8.10 - Horizontal

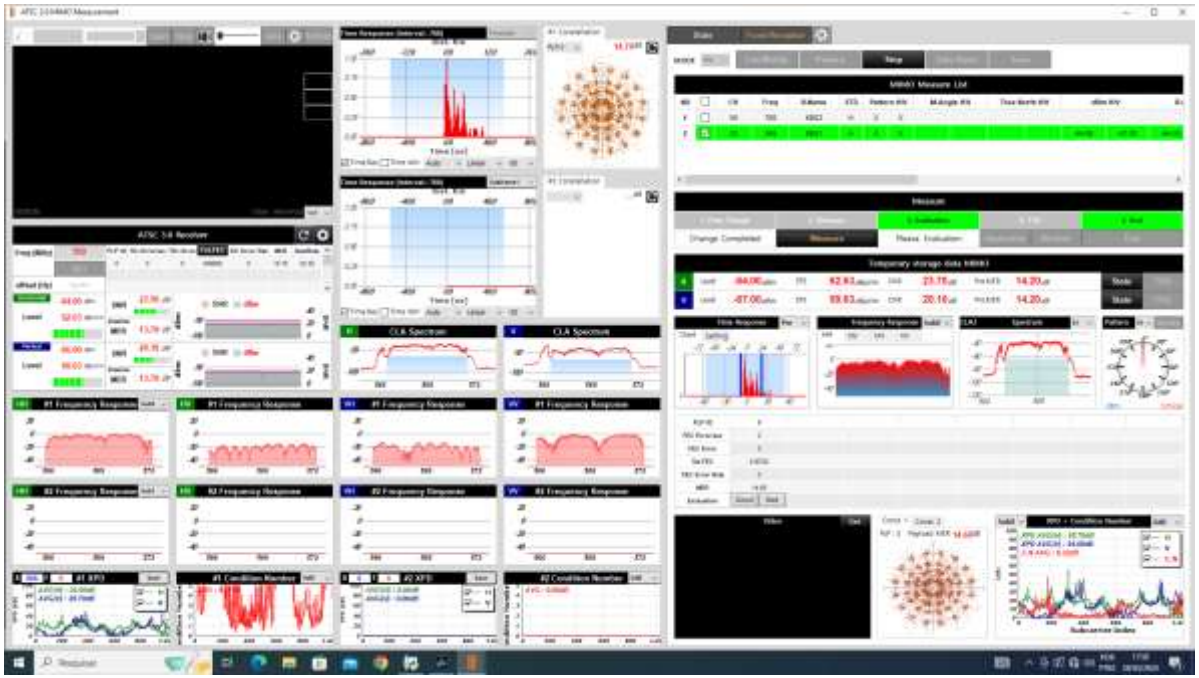


Figure 8.11 - IMAS Screen

Chapter 9. Site 9

a) Channel Power

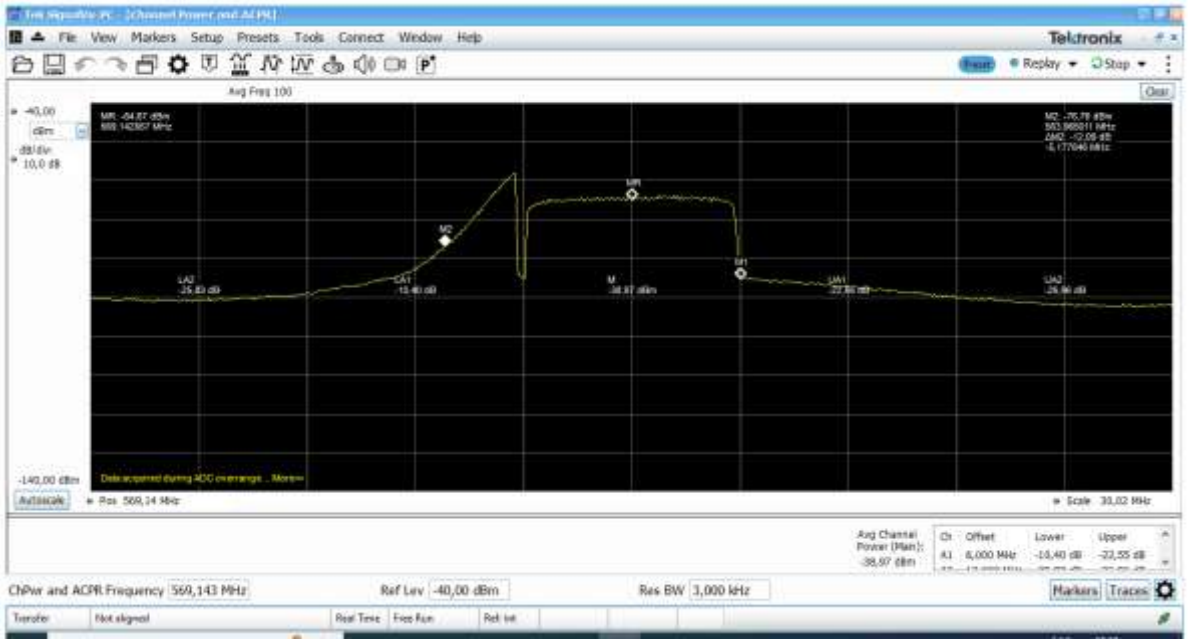


Figure 9.1 - Vertical

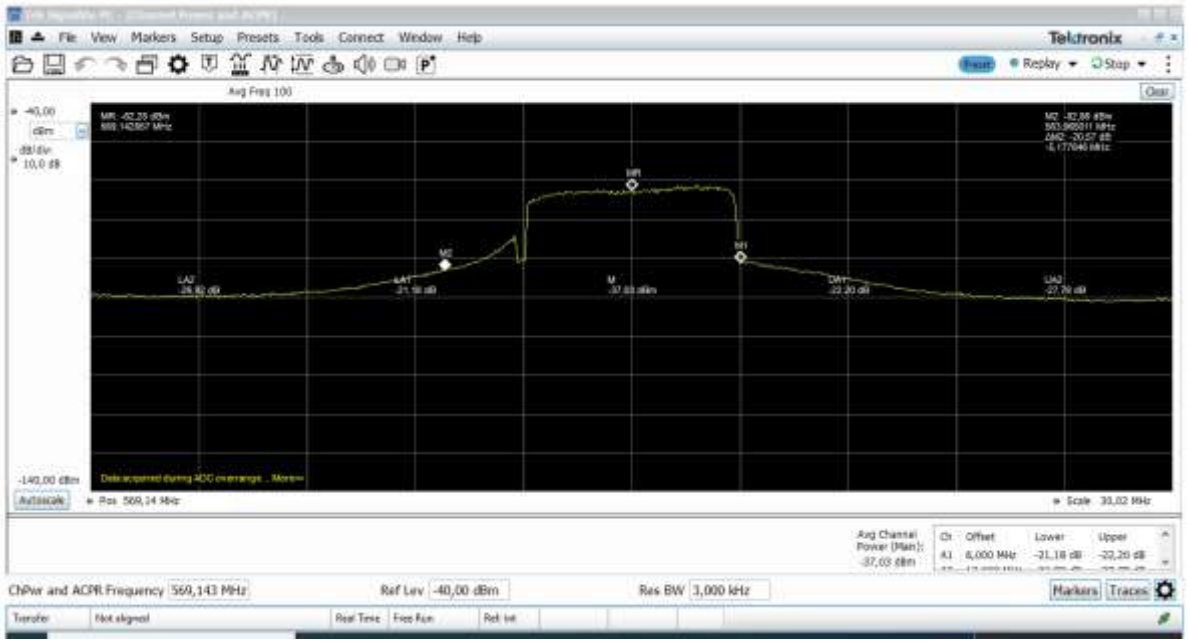


Figure 9.2 - Horizontal

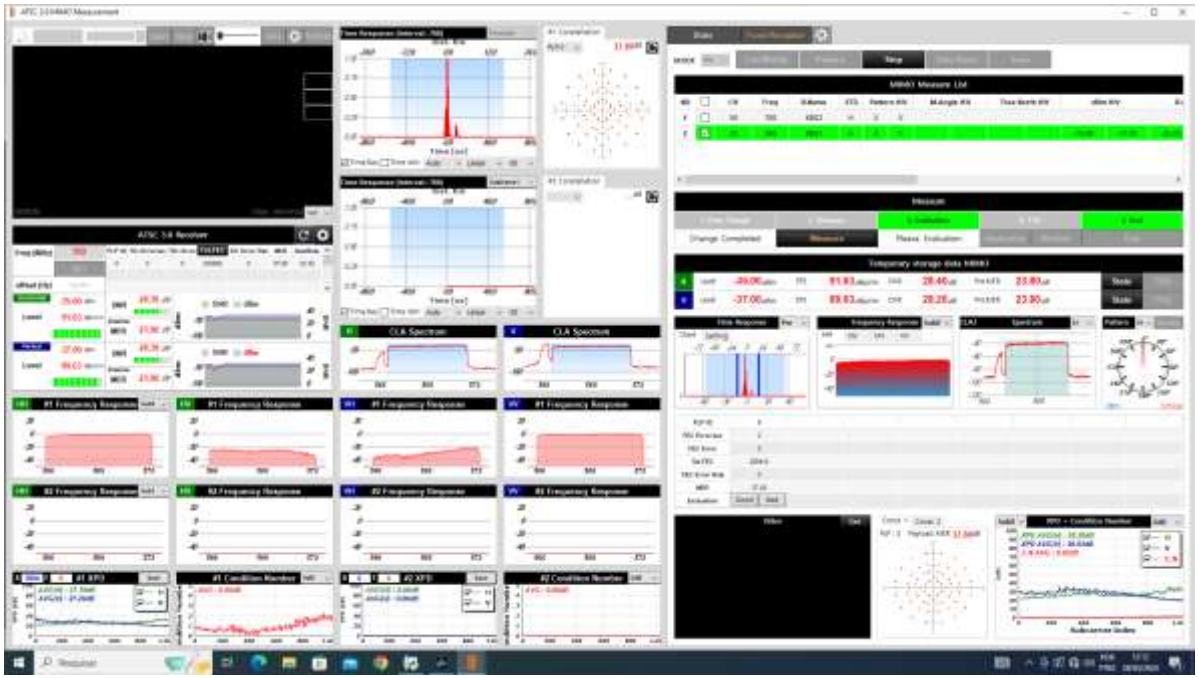


Figure 9.3 - IMAS Screen

b) AWGN Power

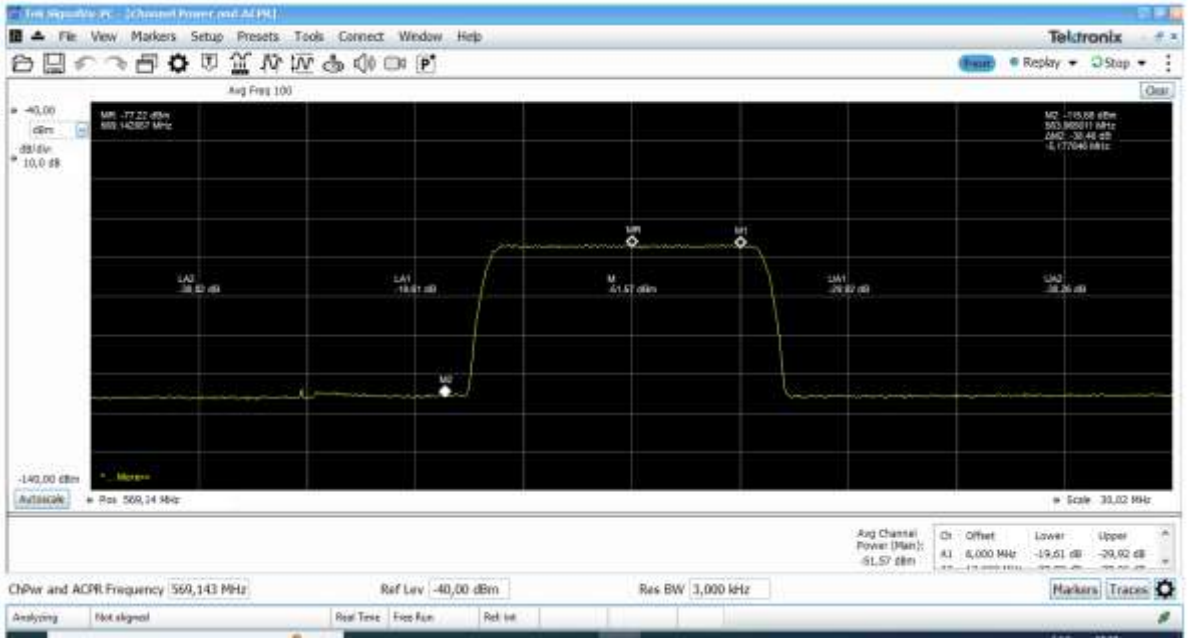


Figure 9.4 - Vertical

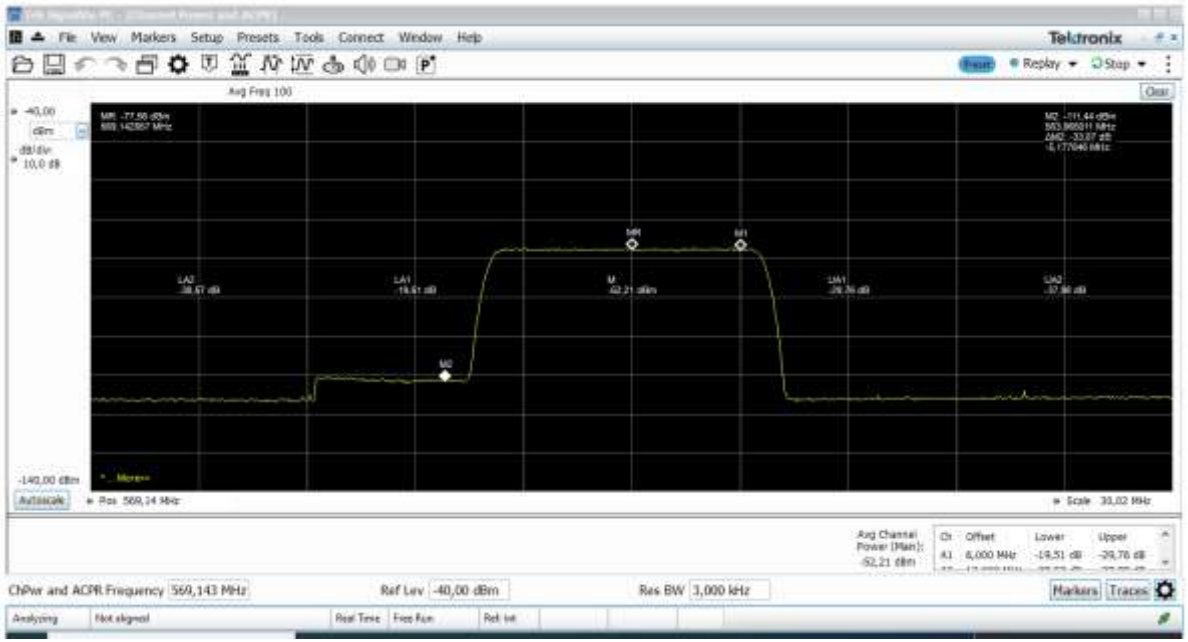


Figure 9.5 - Horizontal

c) C/N Threshold

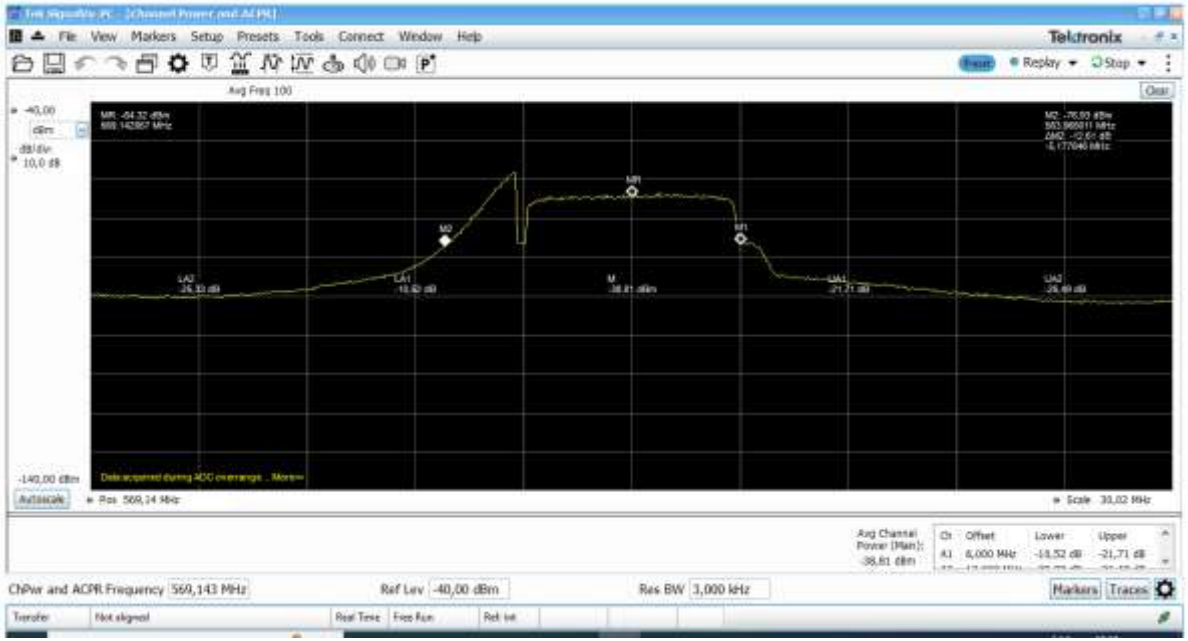


Figure 9.6 - Vertical

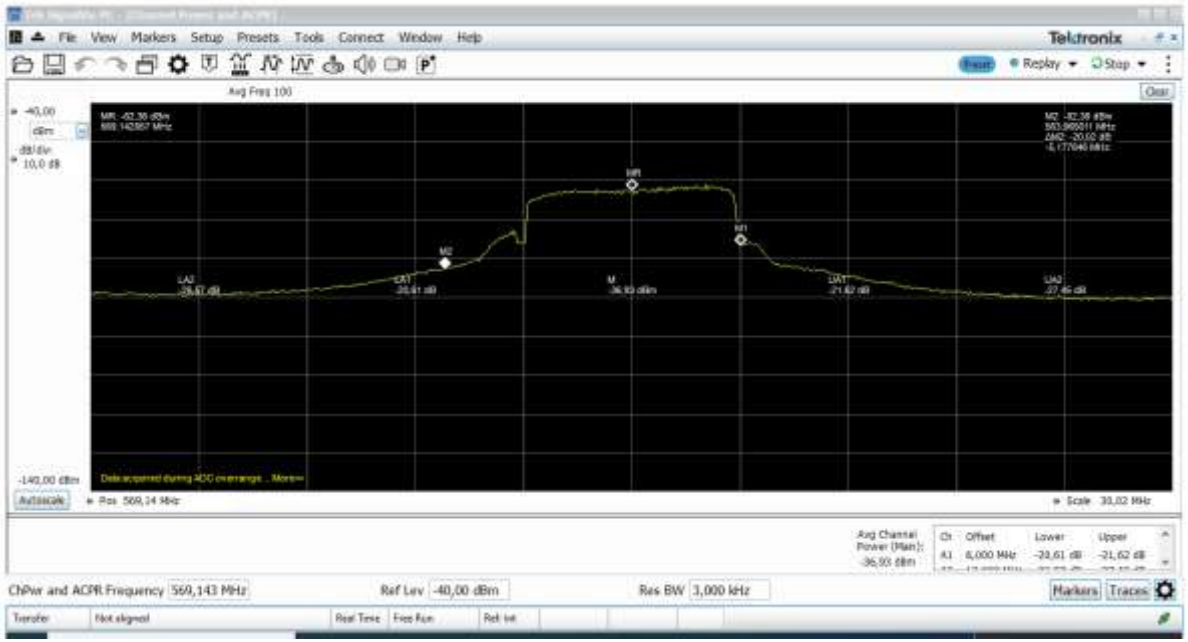


Figure 9.7 - Horizontal

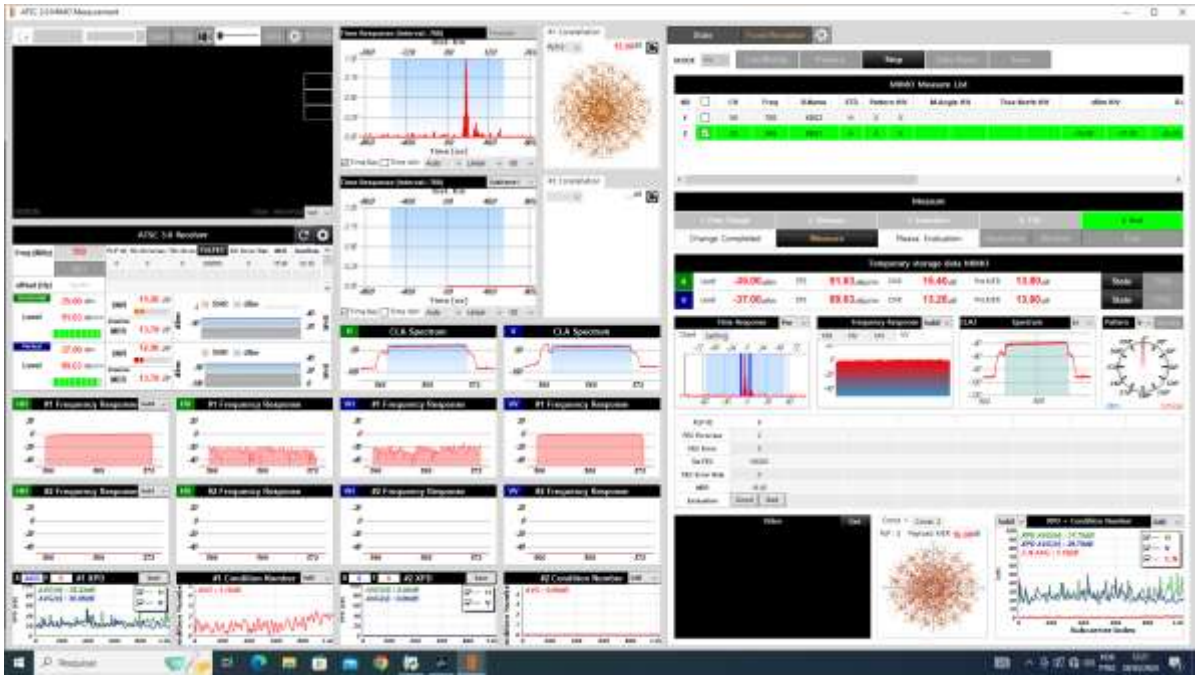


Figure 9.8 - IMAS Screen

d) Reception Threshold

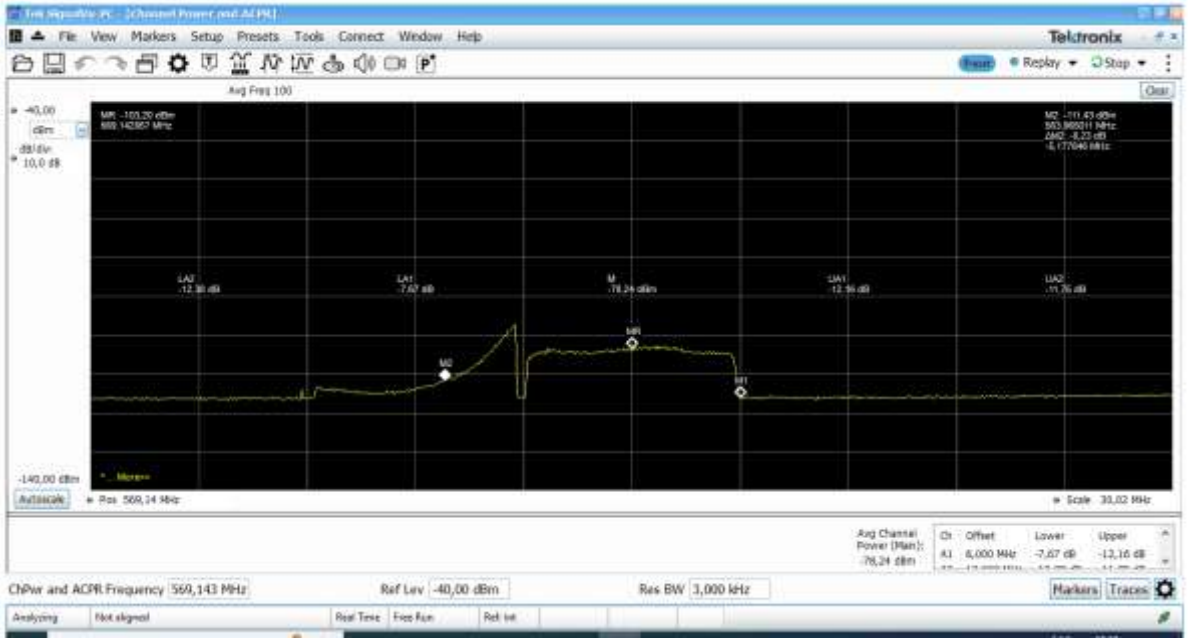


Figure 9.9 - Vertical

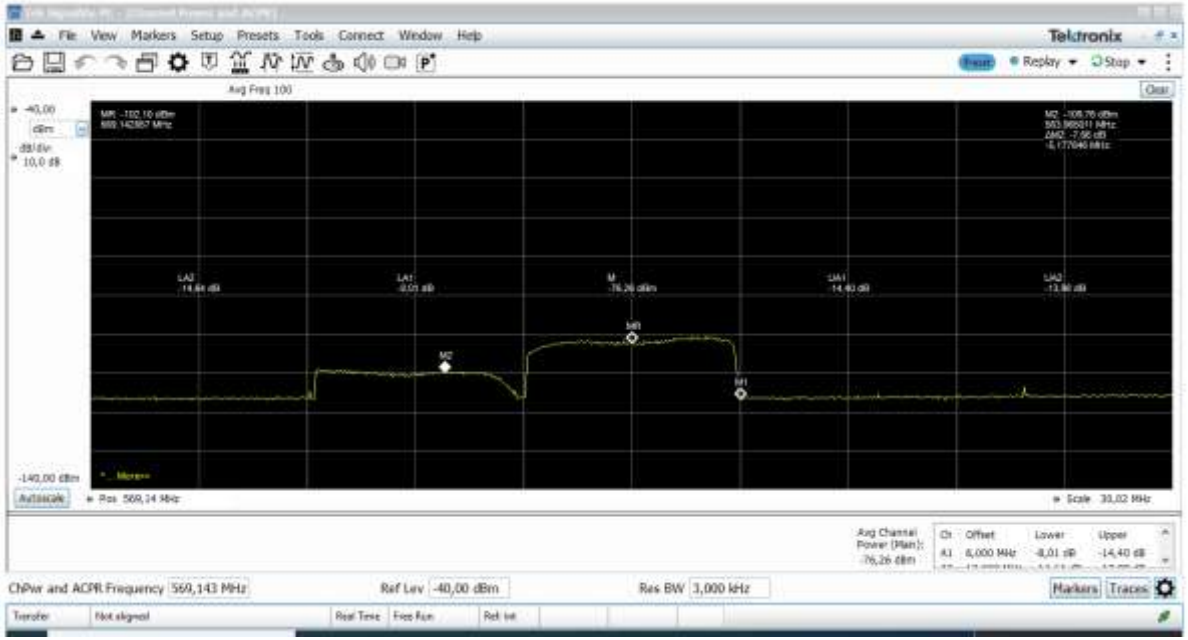


Figure 9.10 - Horizontal

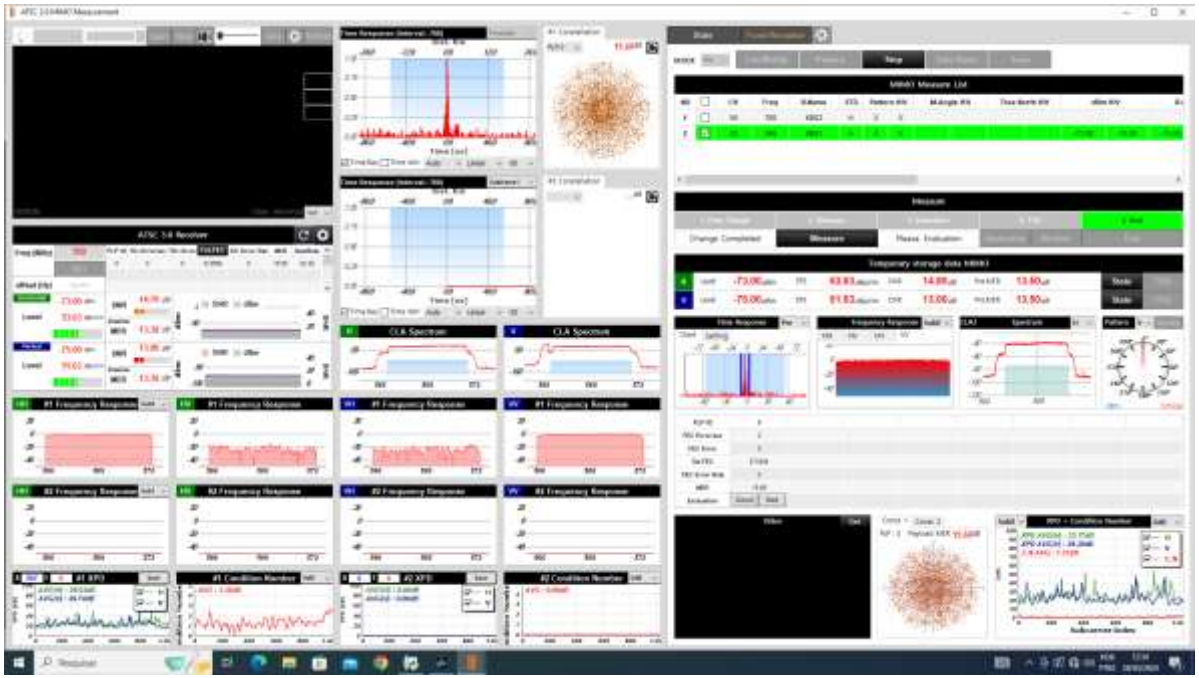


Figure 9.11 - IMAS Screen

Chapter 10. Site 10

a) Channel Power

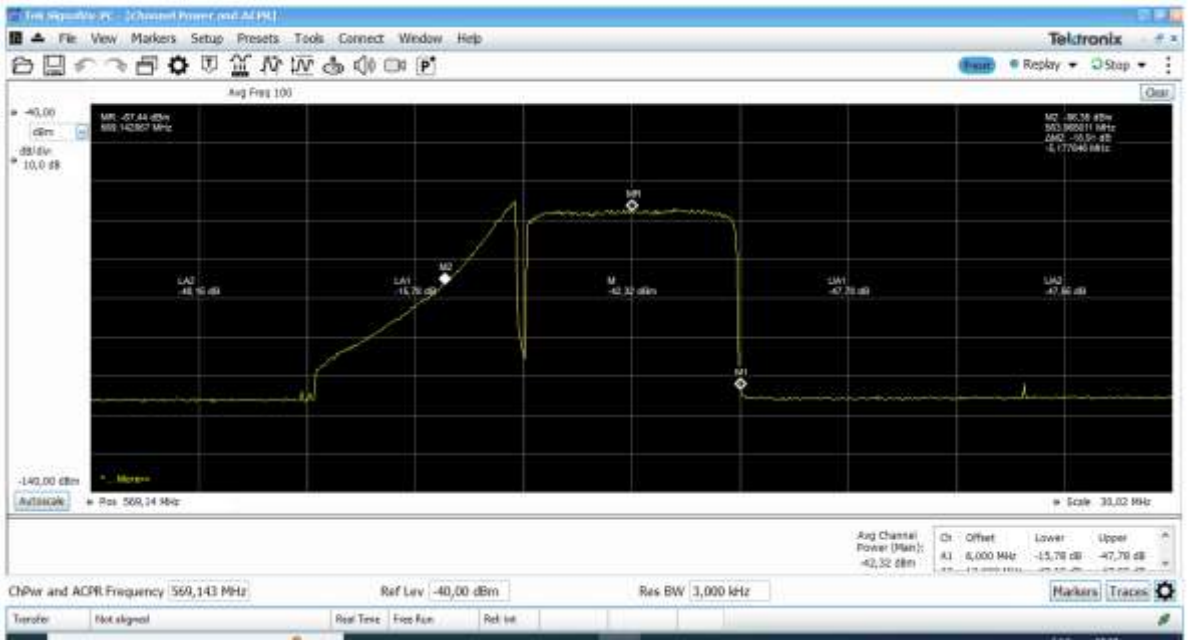


Figure 10.1 - Vertical

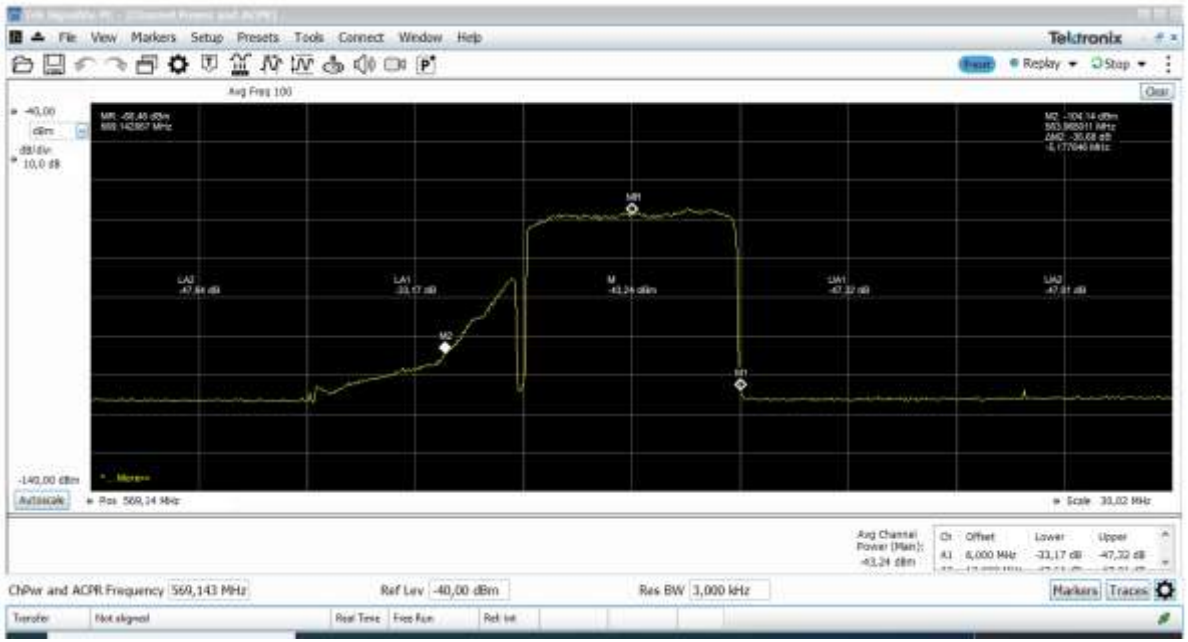


Figure 10.2 - Horizontal

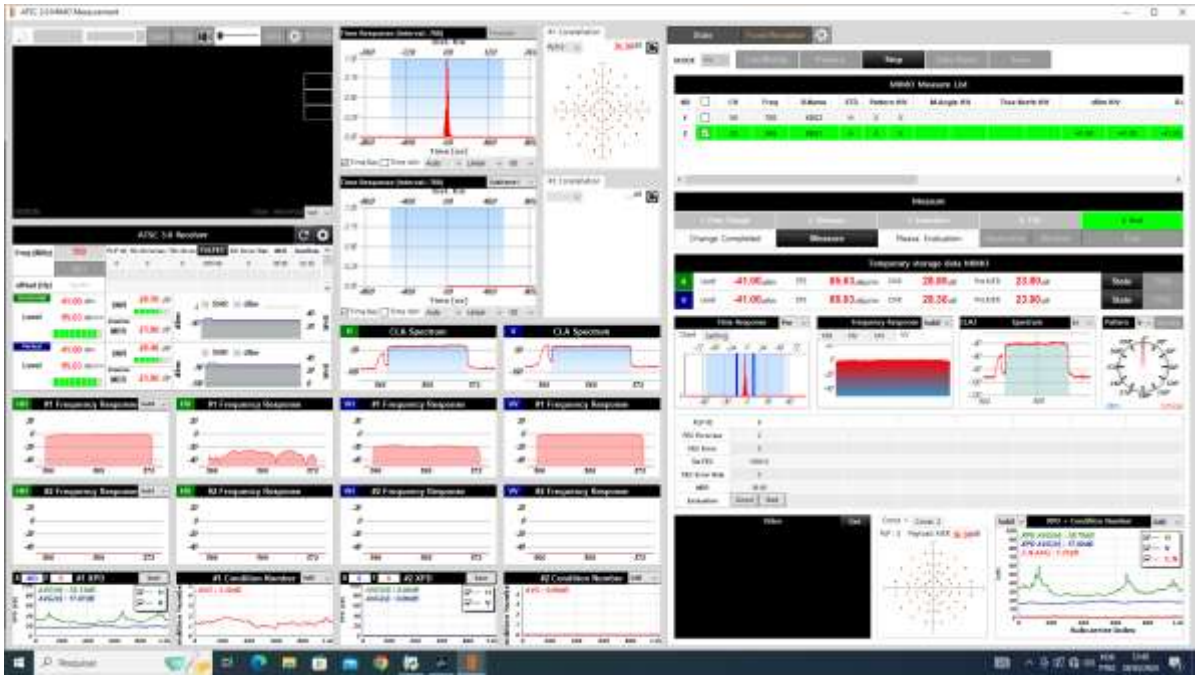


Figure 10.3 - IMAS Screen

b) AWGN Power

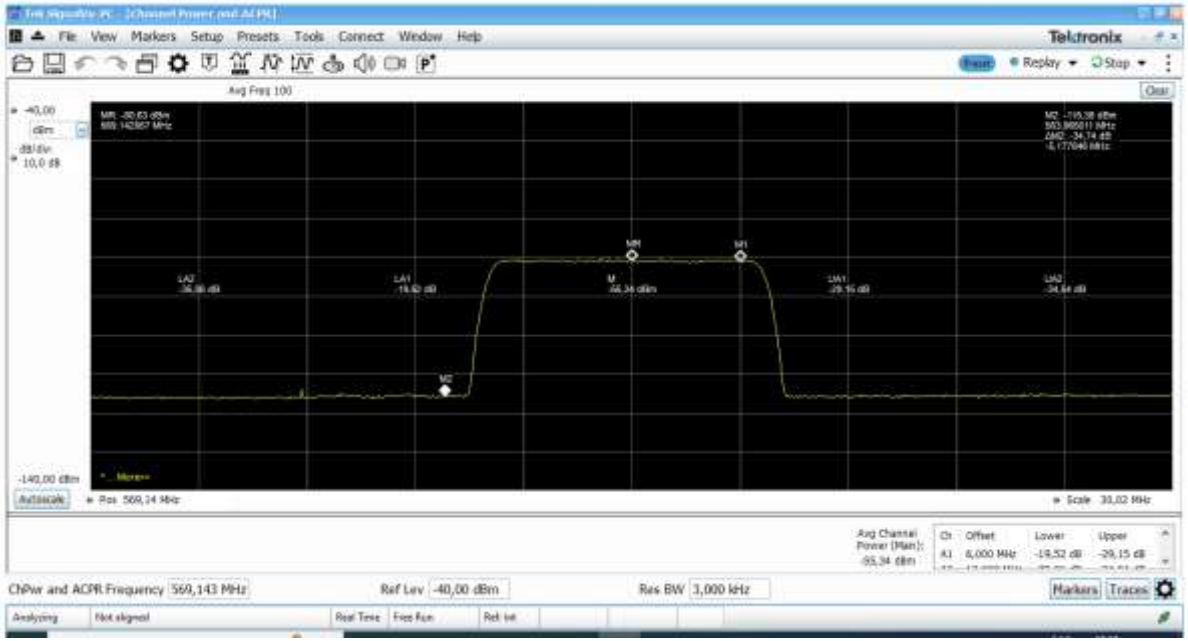


Figure 10.4 - Vertical

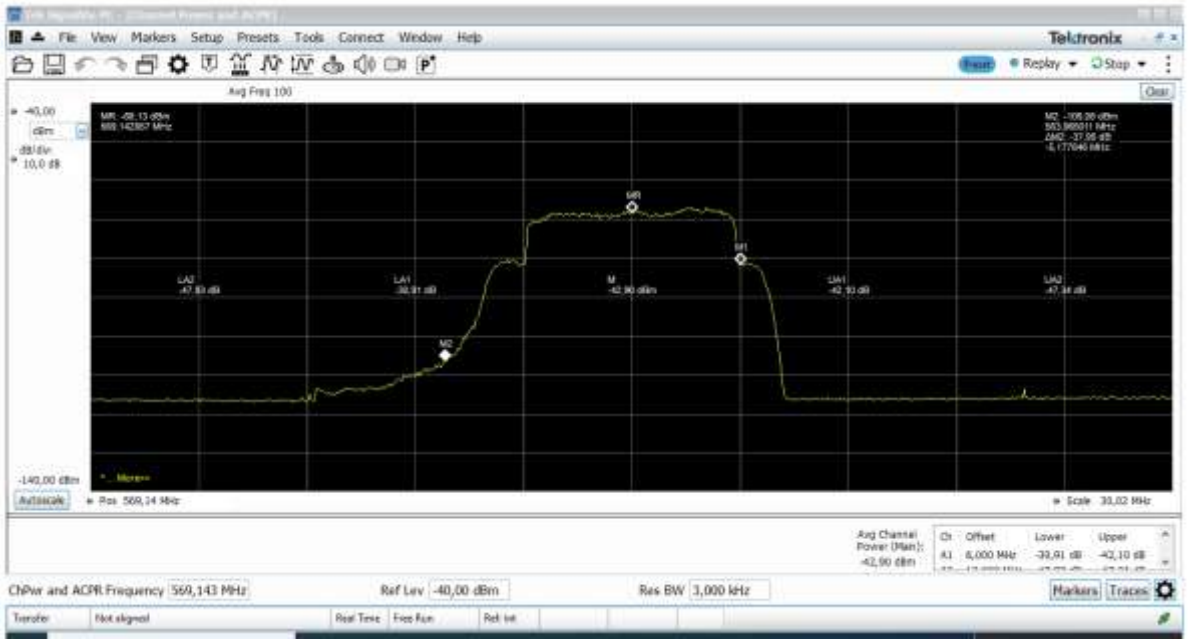


Figure 10.5 - Horizontal

c) C/N Threshold

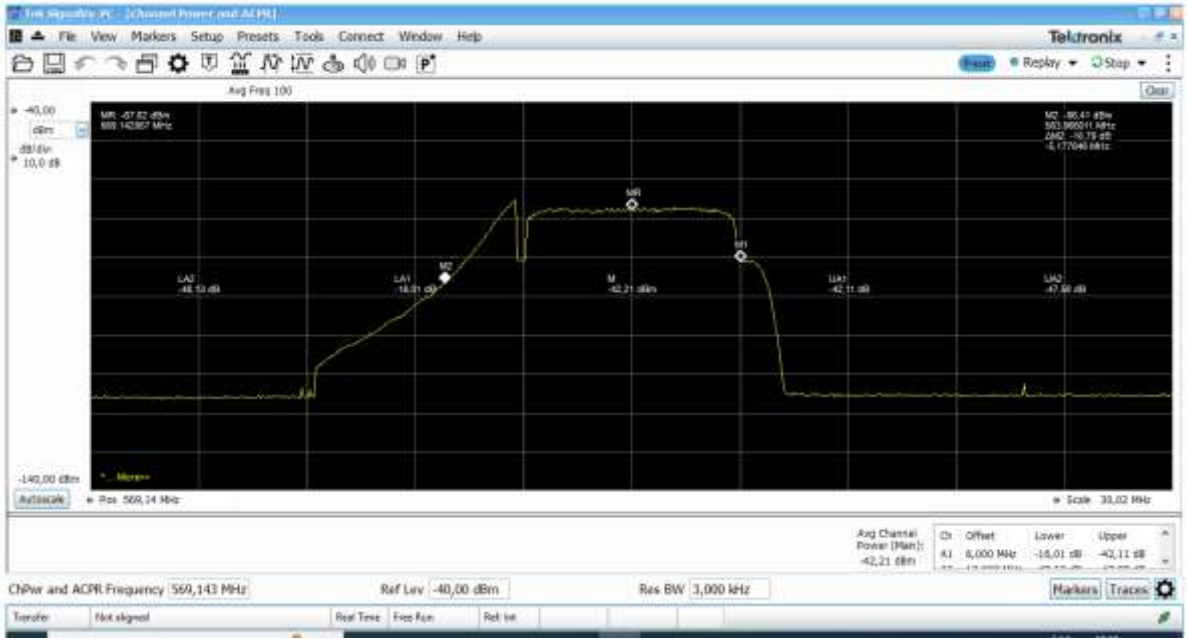


Figure 10.6 - Vertical

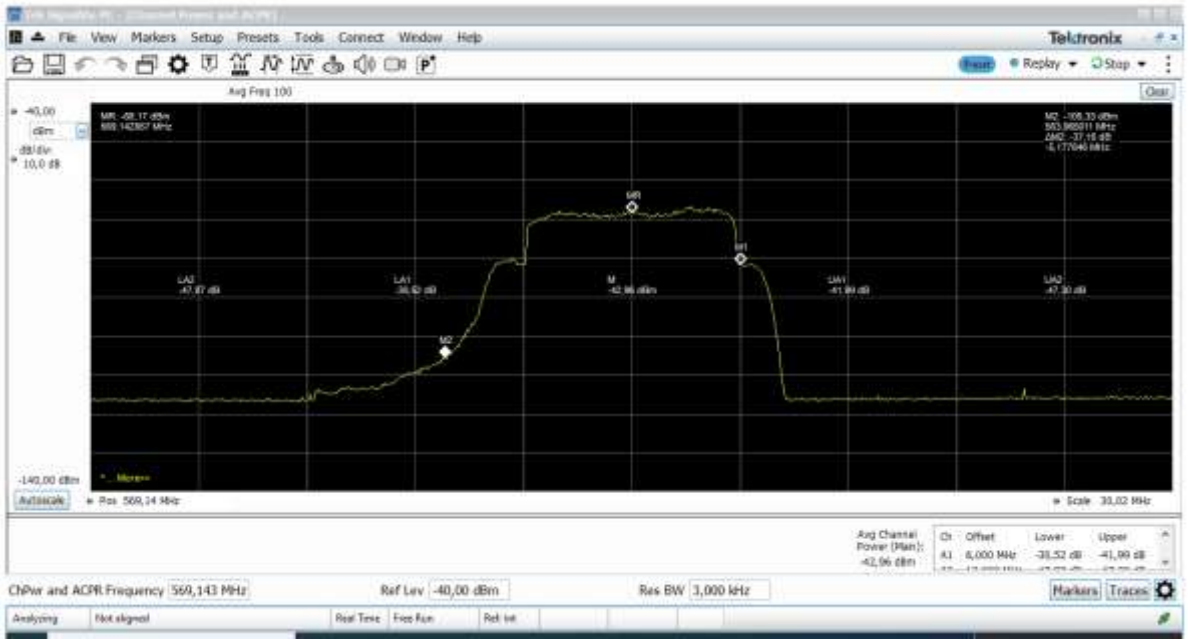


Figure 10.7 - Horizontal

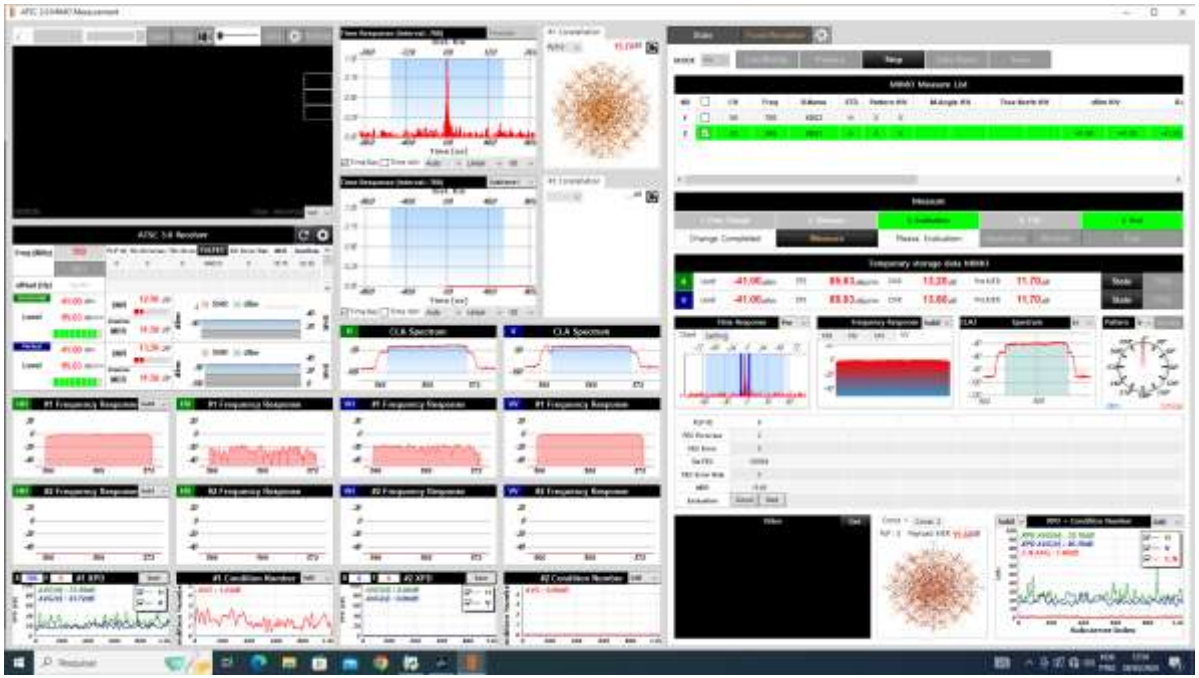


Figure 10.8 - IMAS Screen

d) Reception Threshold

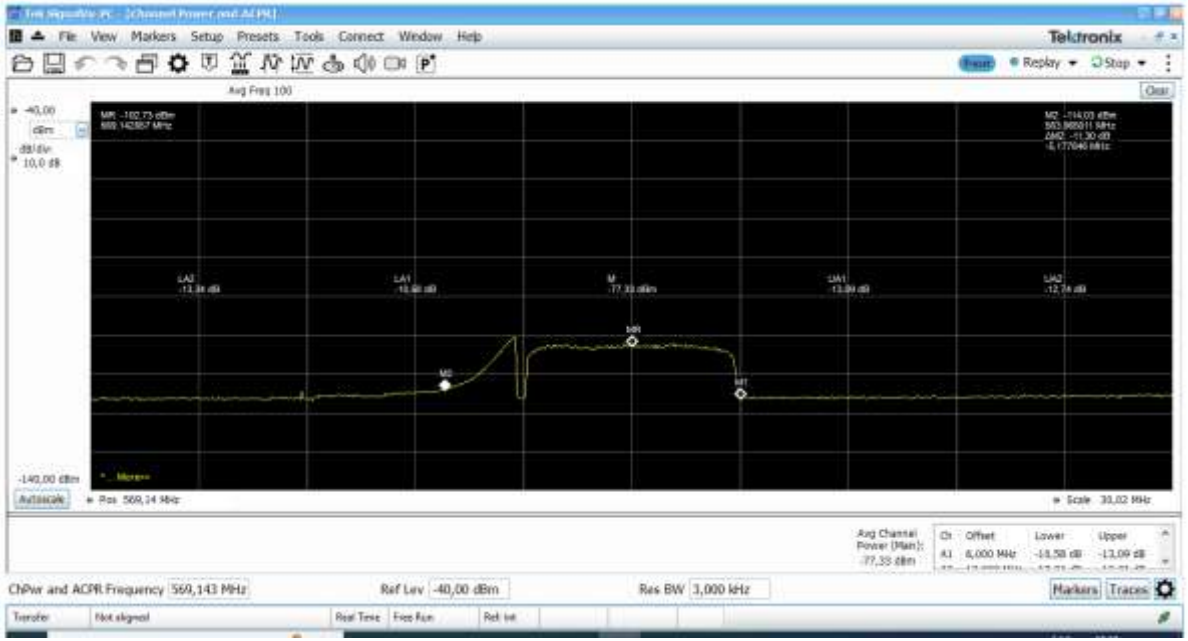


Figure 10.9 - Vertical

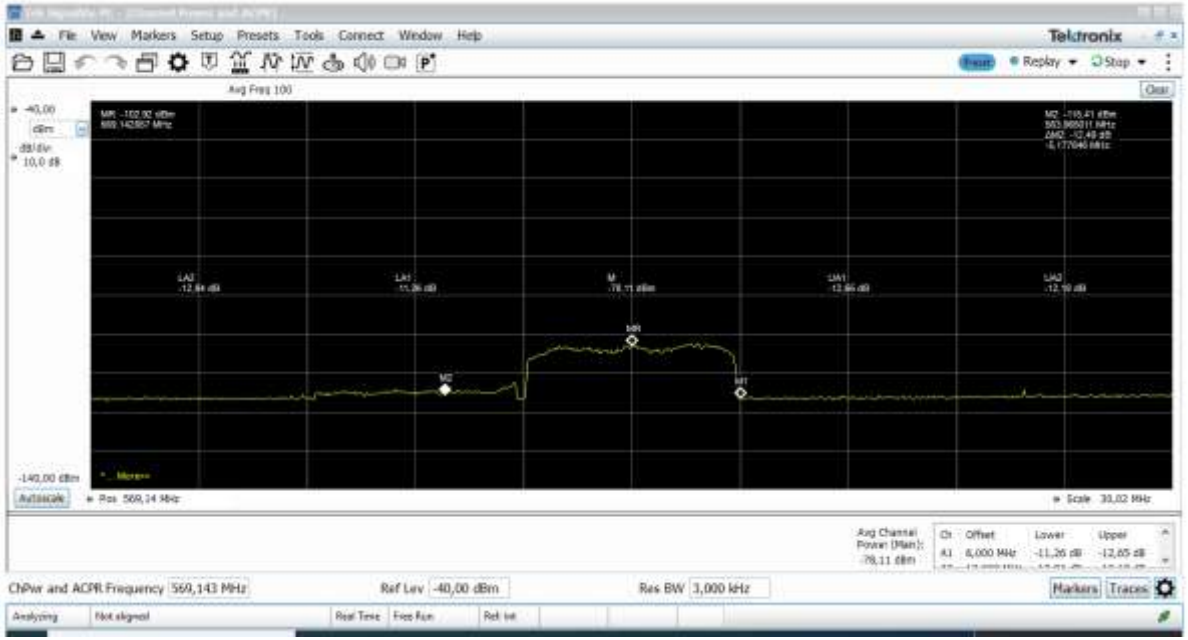


Figure 10.10 - Horizontal

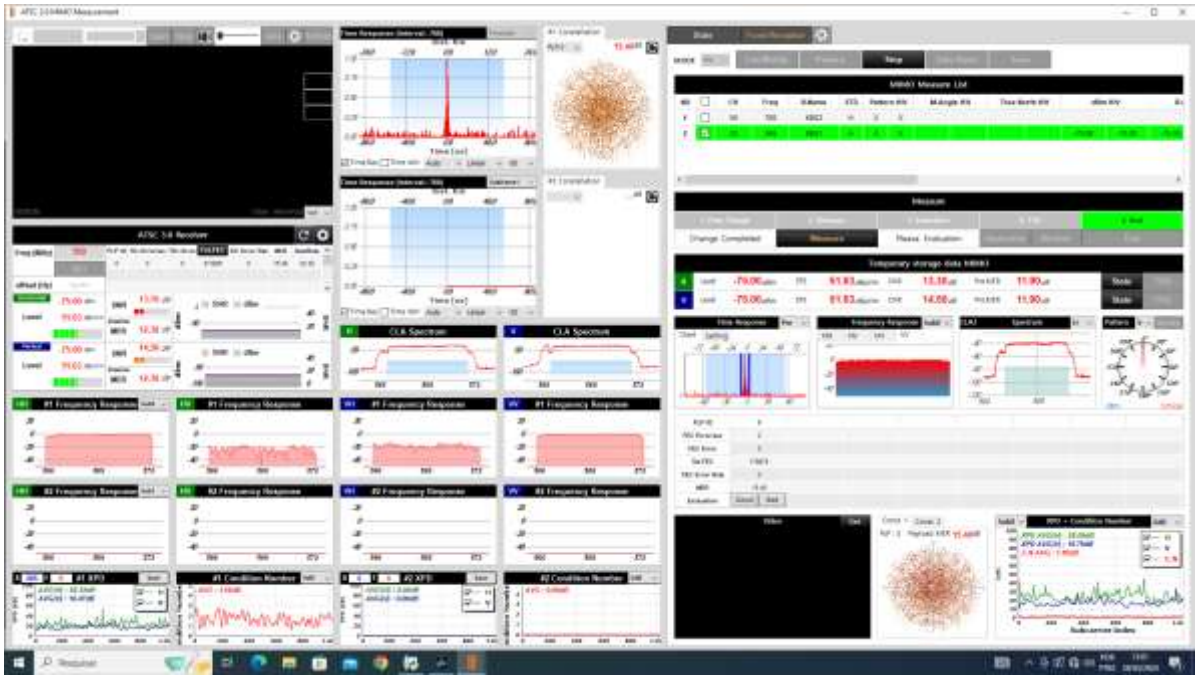


Figure 10.11 - IMAS Screen

Chapter 11. Site 11

a) Channel Power

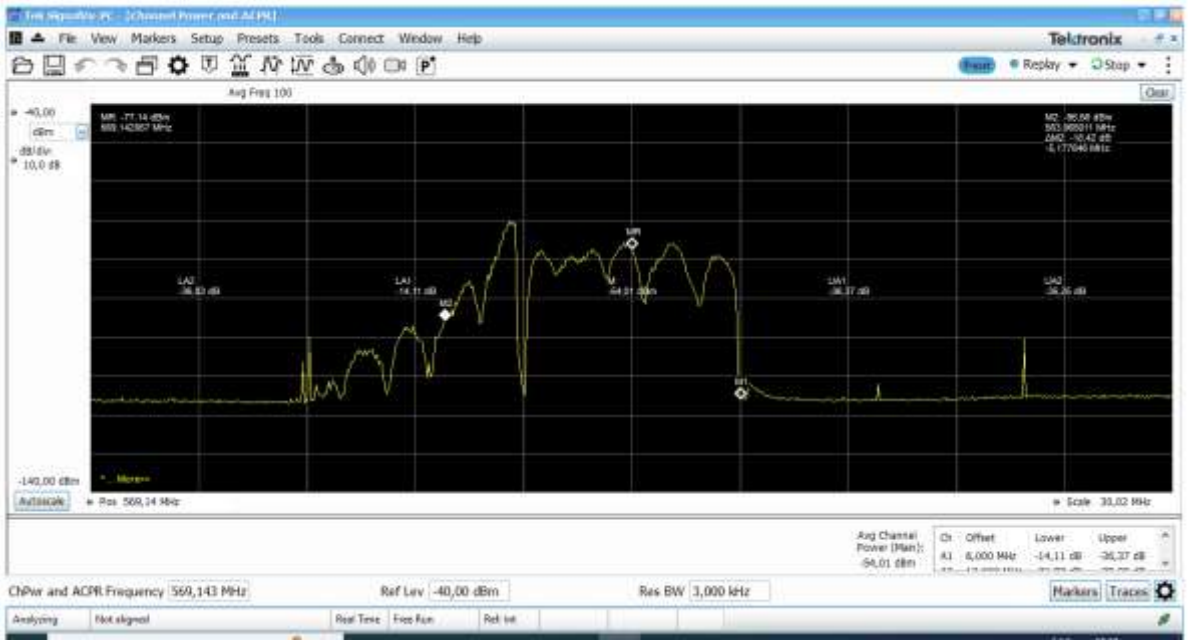


Figure 11.1 - Vertical

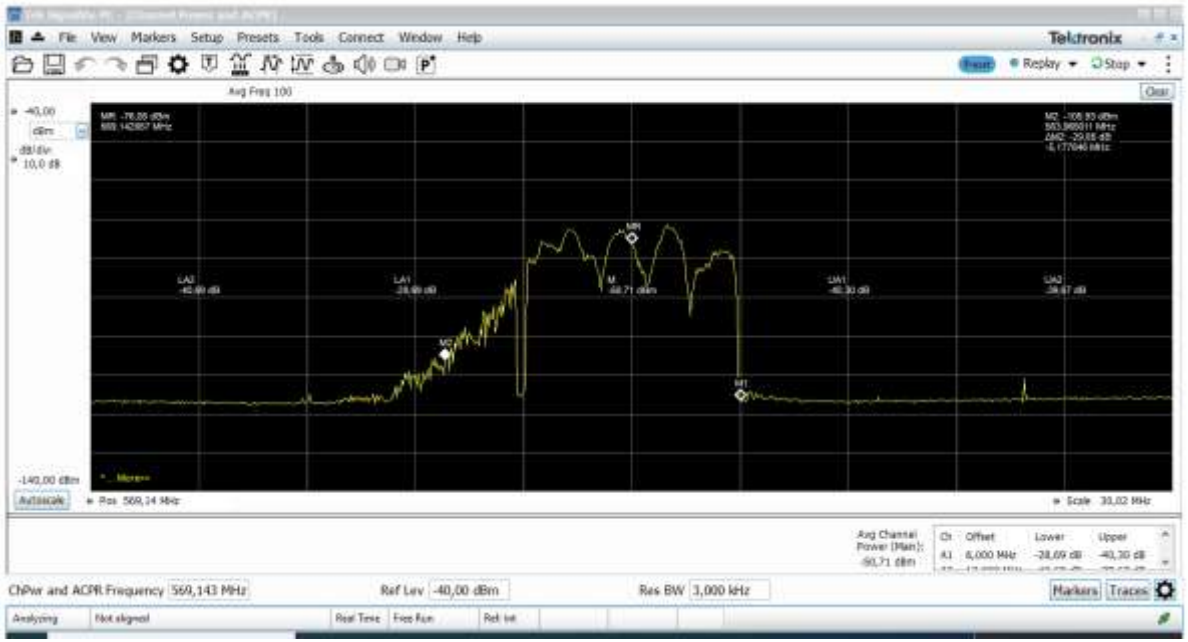


Figure 11.2 - Horizontal

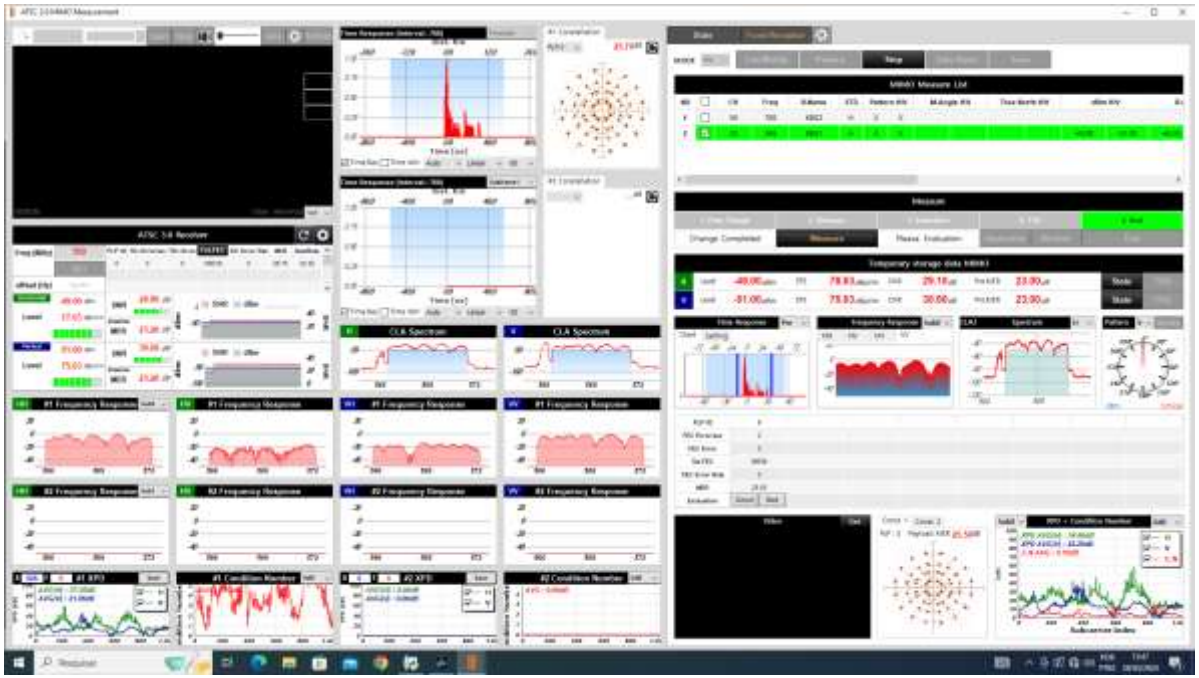


Figure 11.3 - IMAS Screen

b) AWGN Power

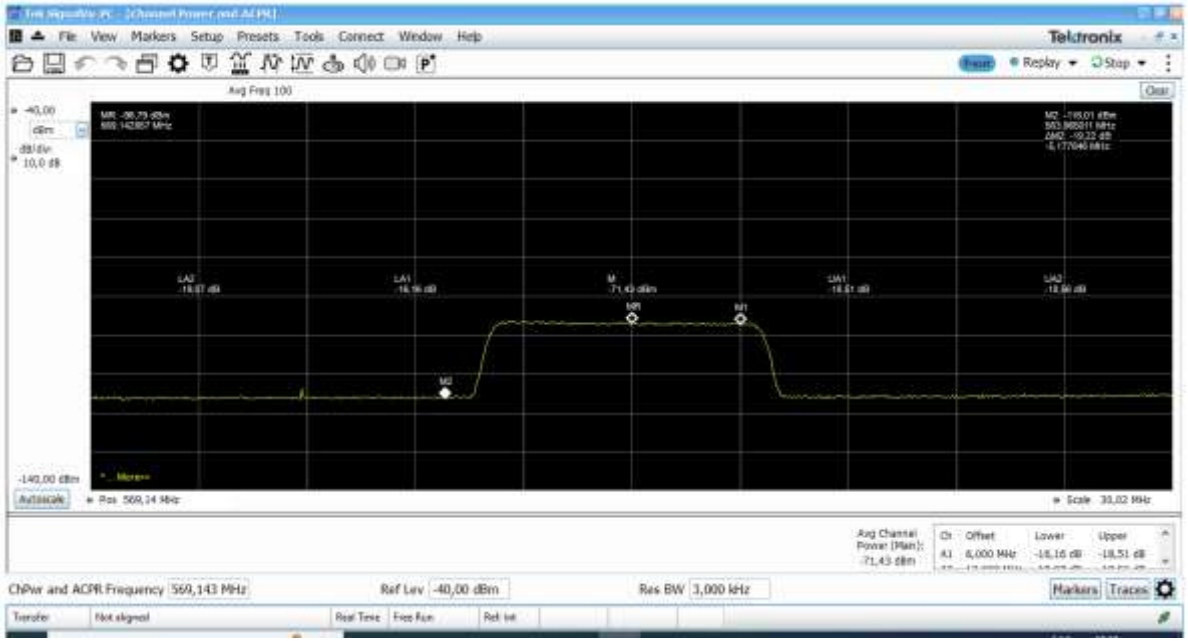


Figure 11.4 - Vertical

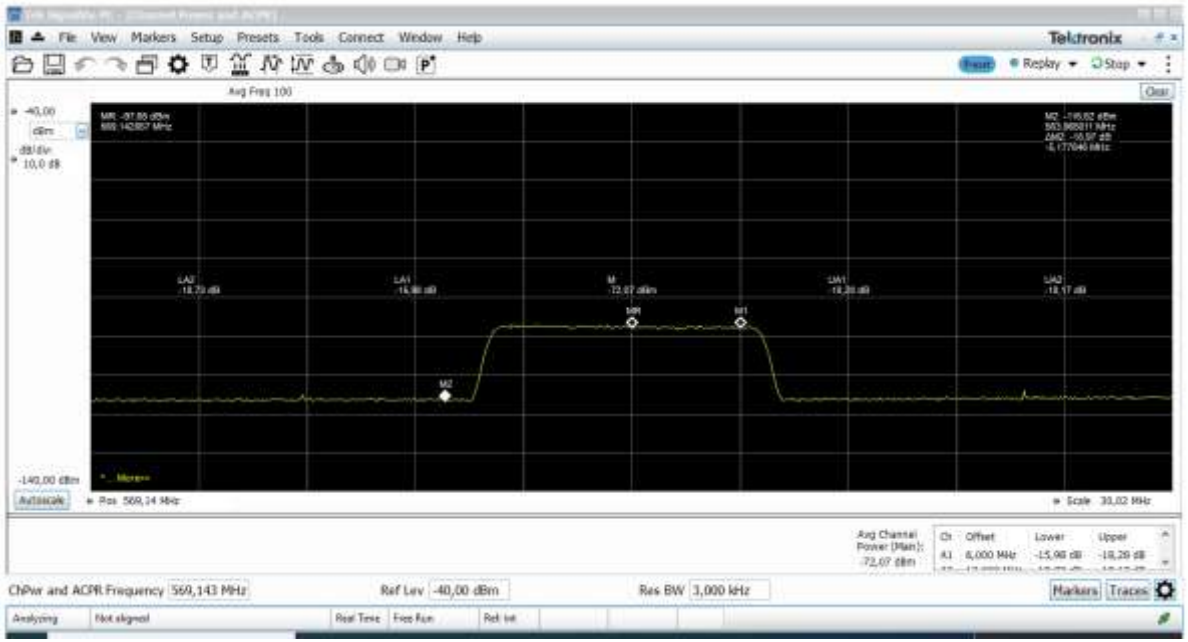


Figure 11.5 - Horizontal

c) C/N Threshold

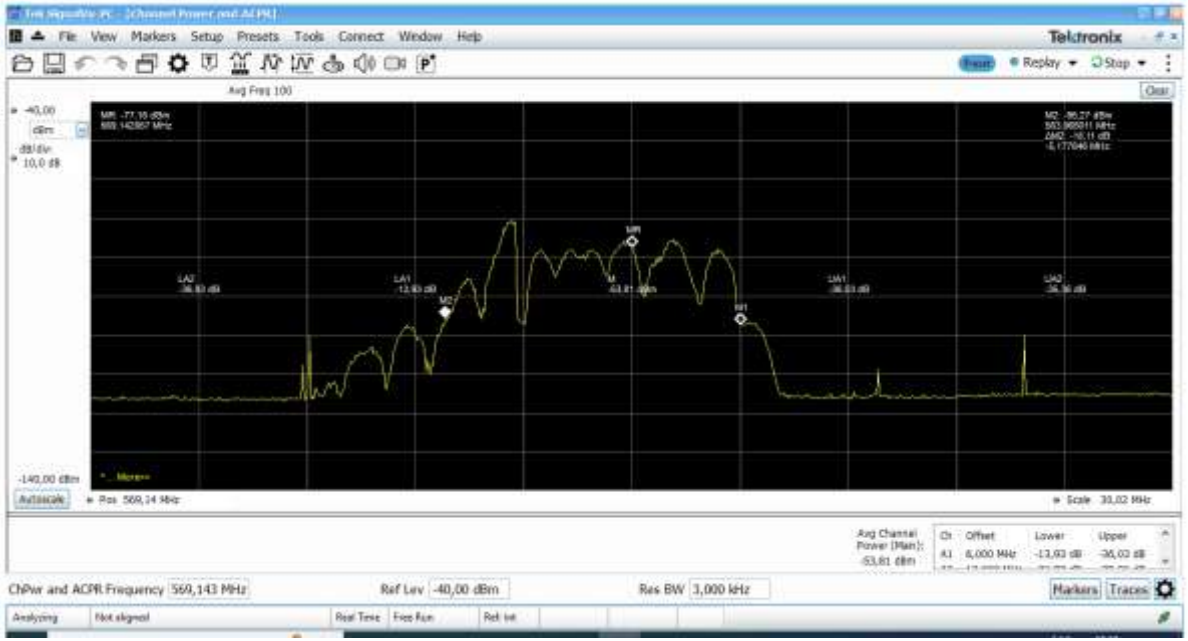


Figure 11.6 - Vertical

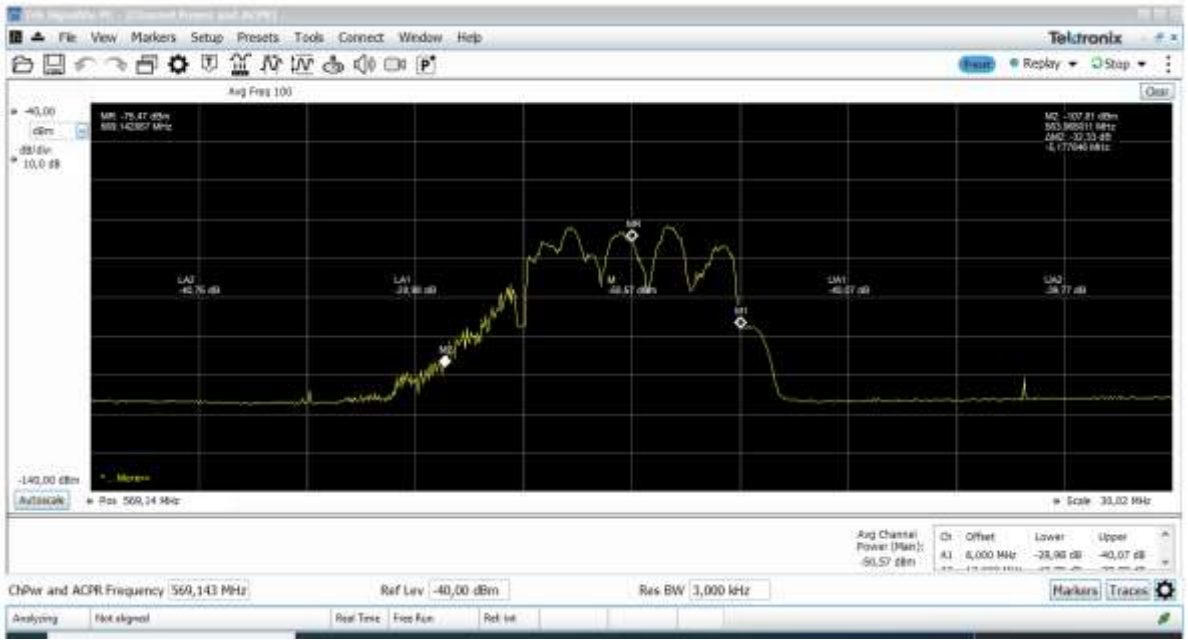


Figure 11.7 - Horizontal

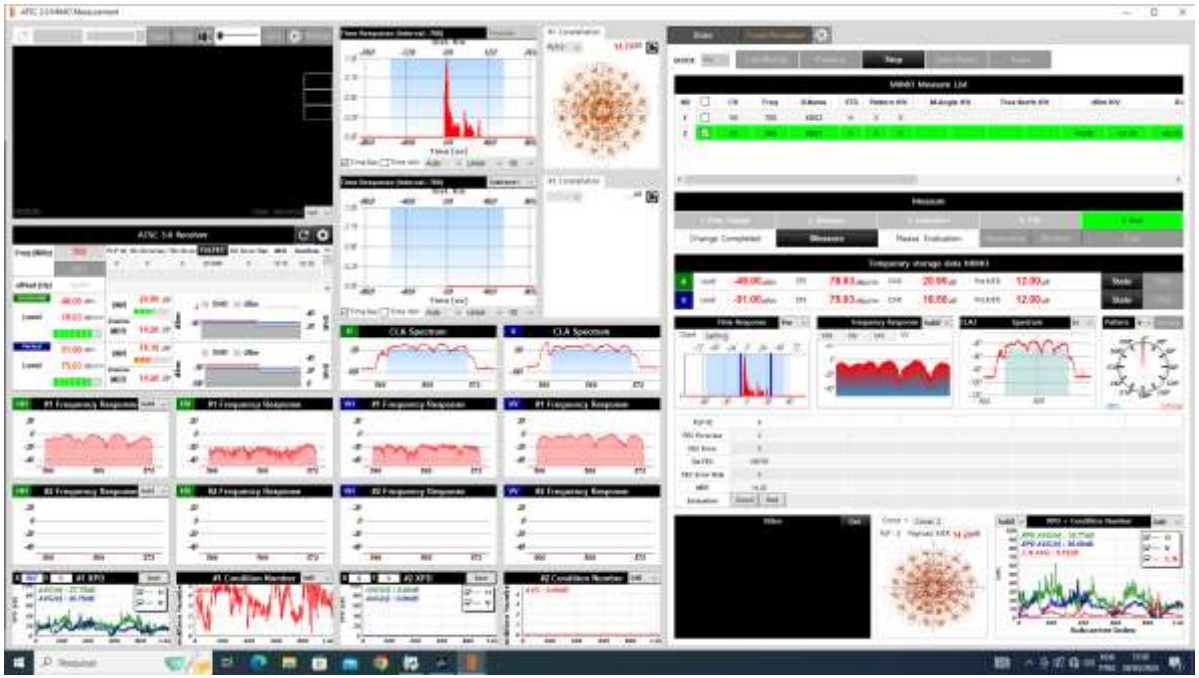


Figure 11.8 - IMAS Screen

d) Reception Threshold

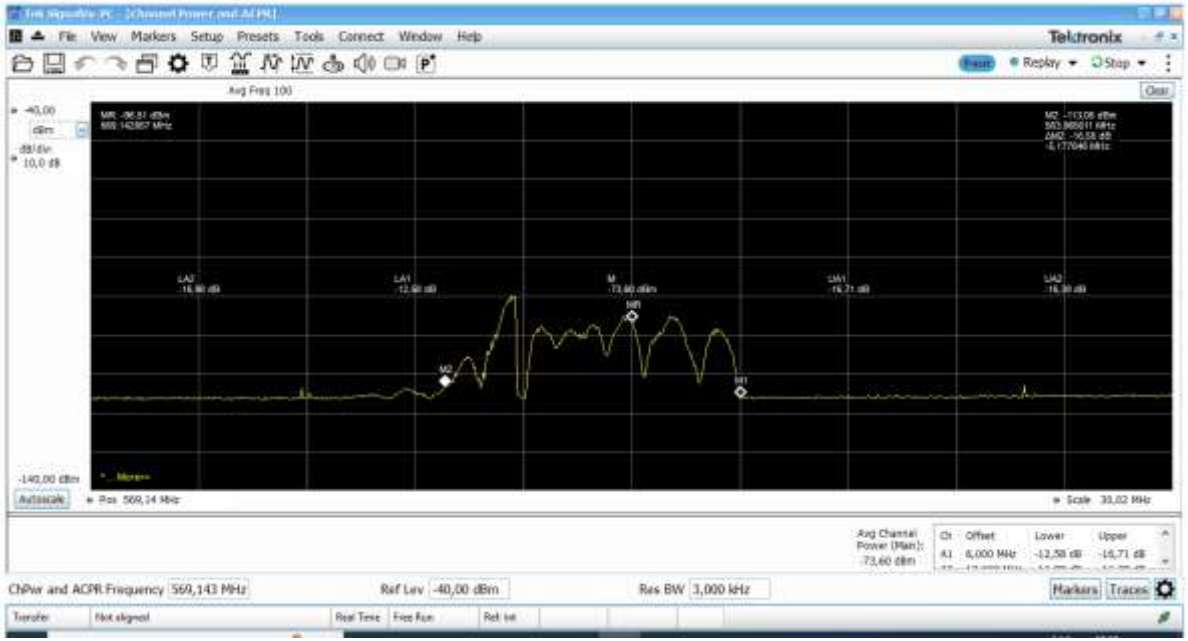


Figure 11.9 - Vertical

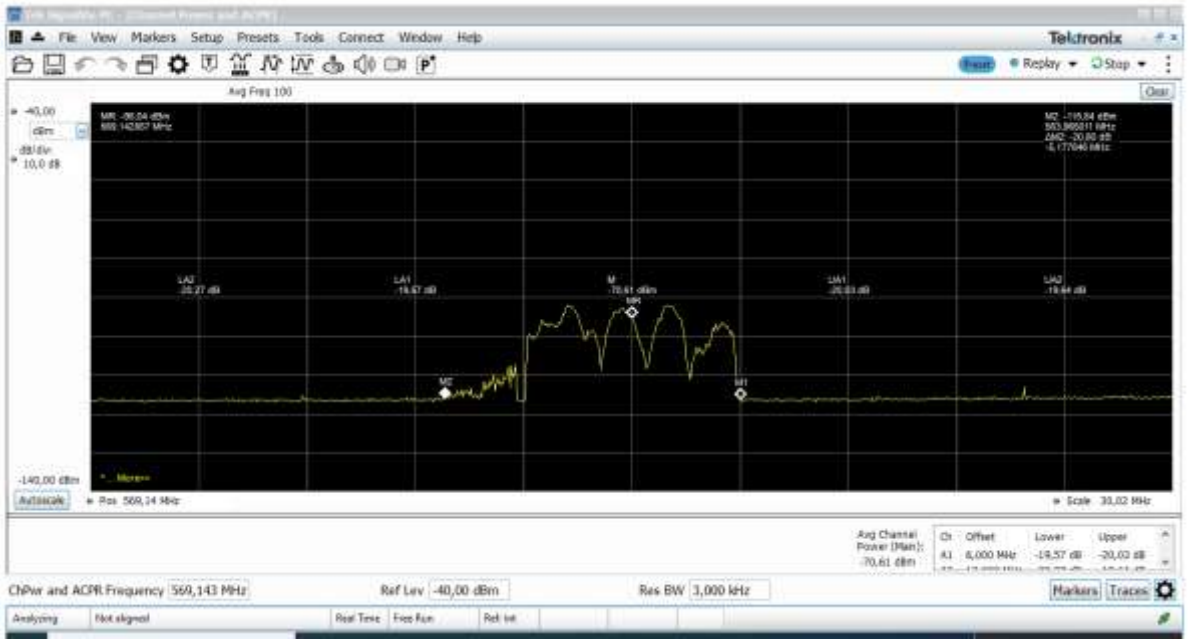


Figure 11.10 - Horizontal

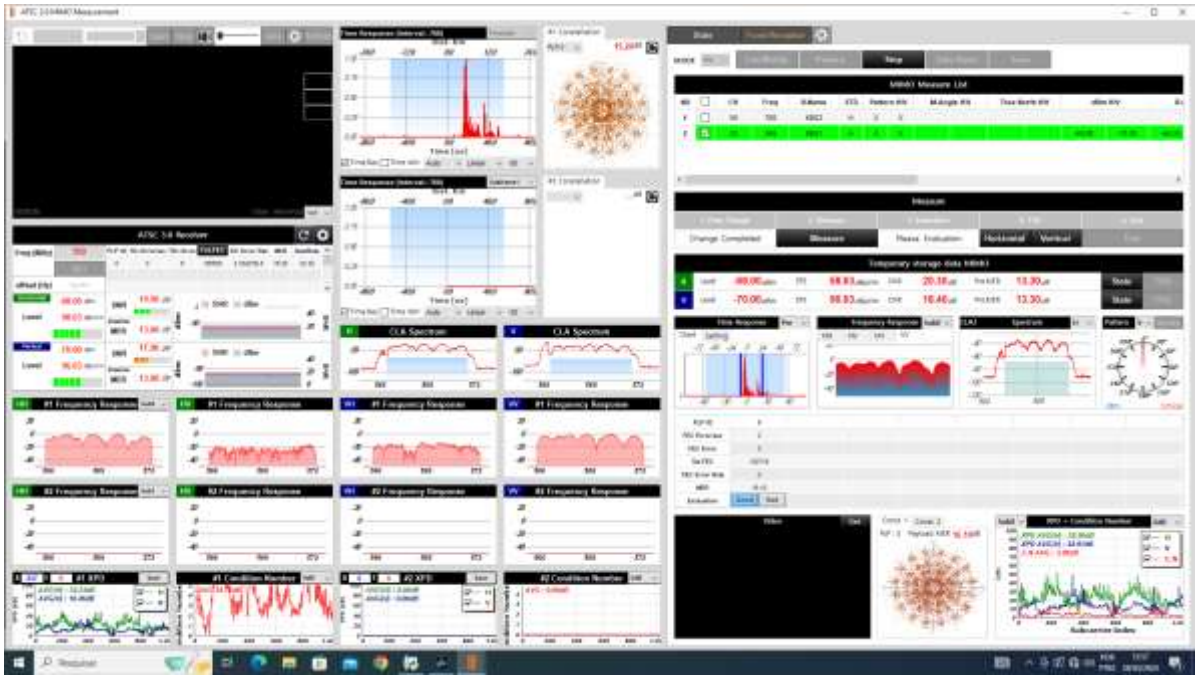


Figure 11.11 - IMAS Screen

Chapter 12. Site 12

a) Channel Power

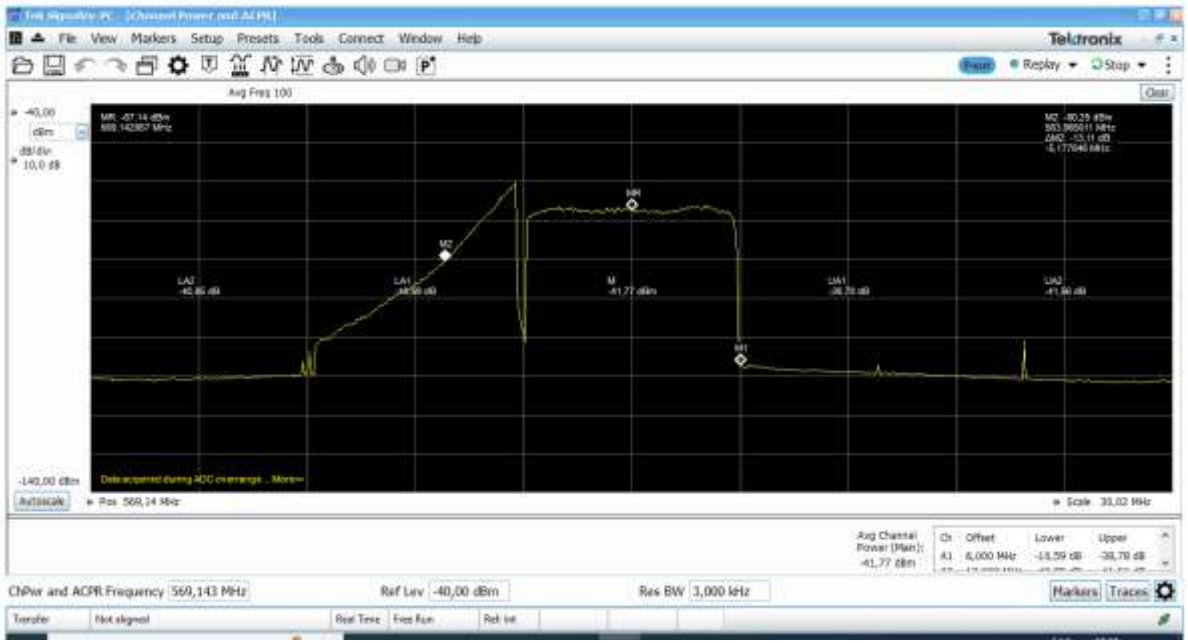


Figure 12.1 - Vertical

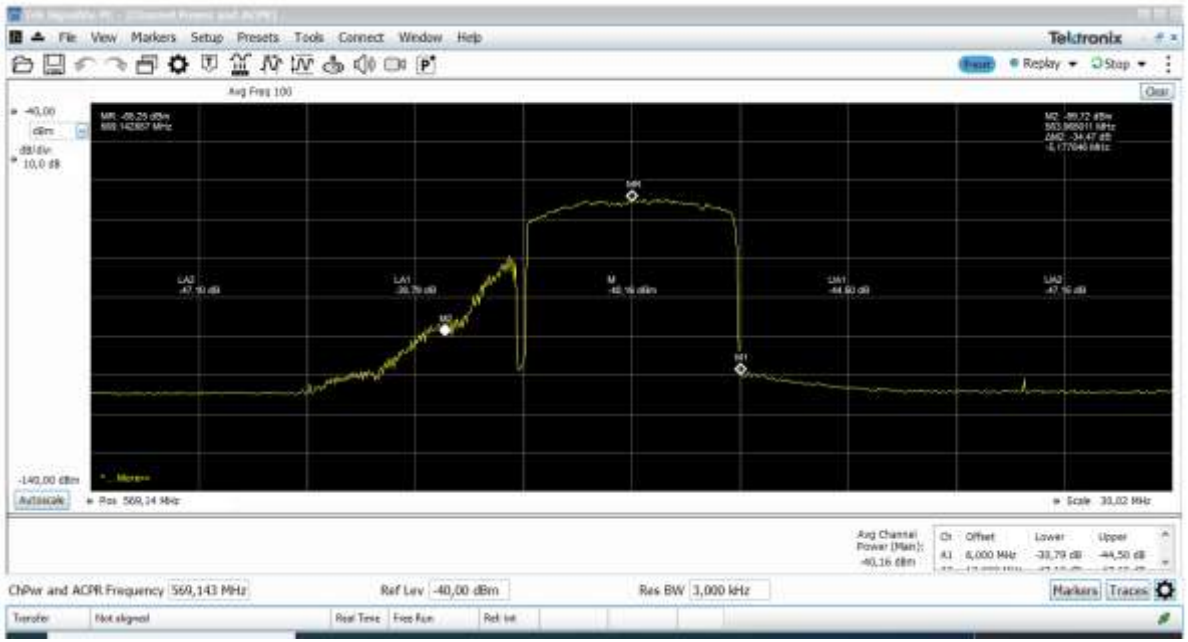


Figure 12.2 - Horizontal

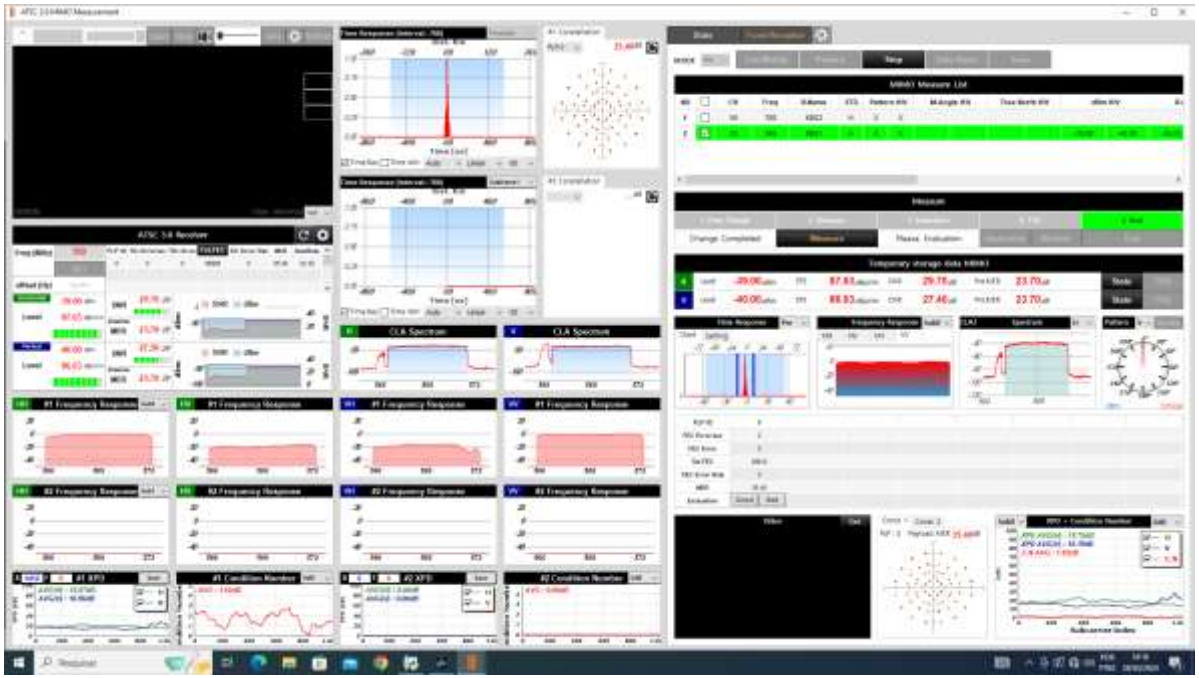


Figure 12.3 - IMAS Screen

b) AWGN Power

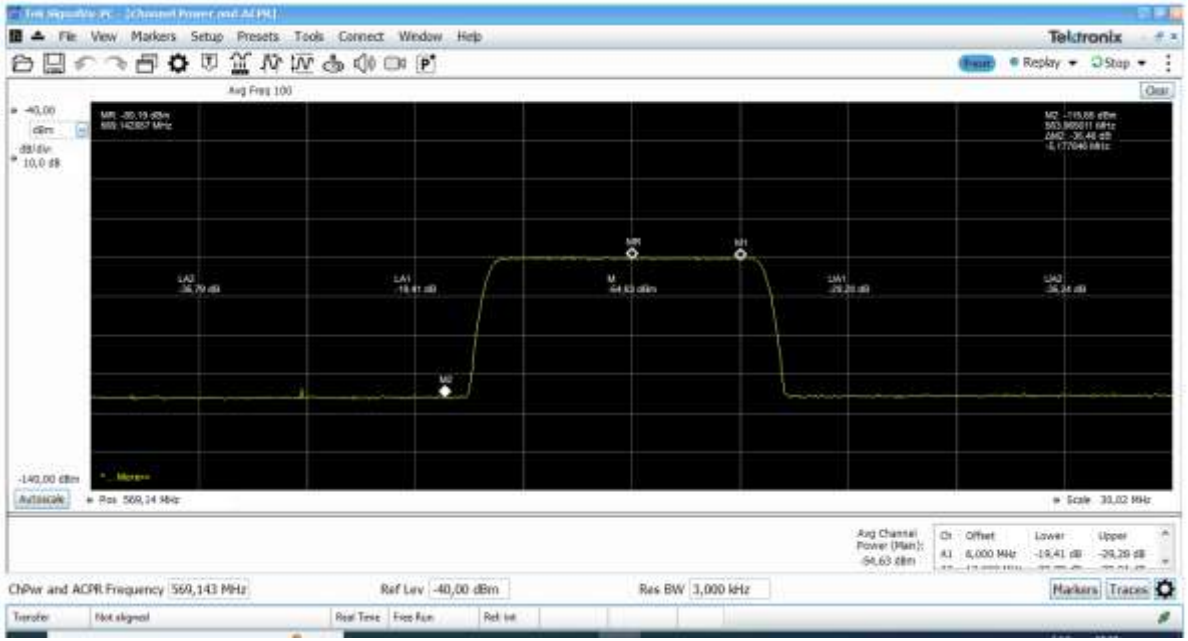


Figure 12.4 - Vertical

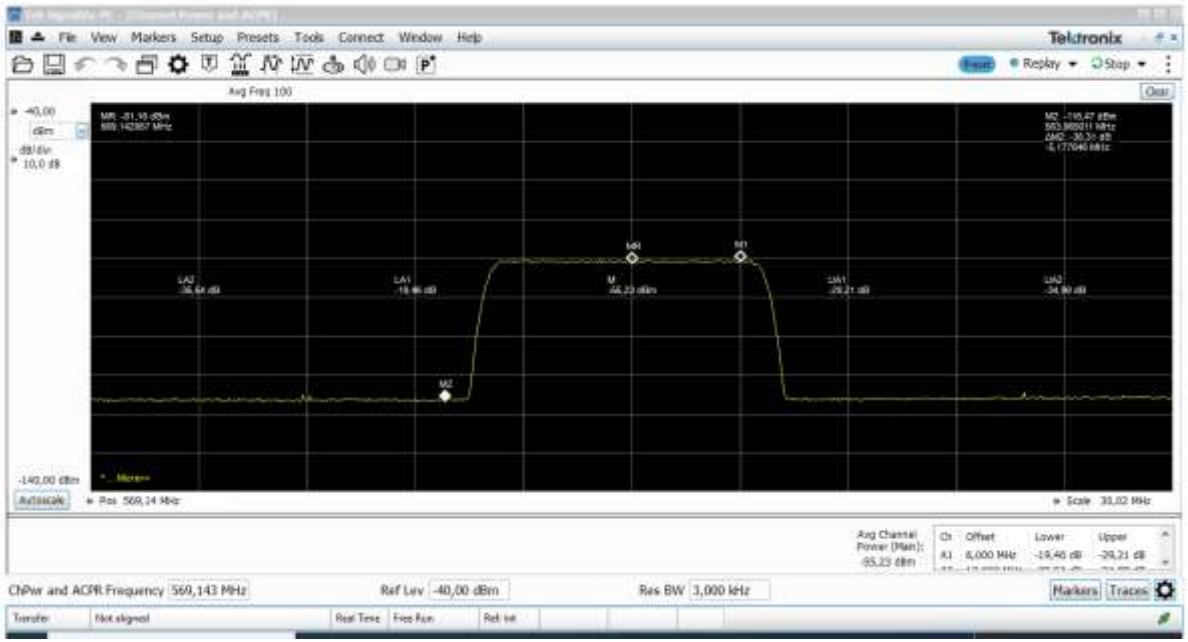


Figure 12.5 - Horizontal

c) C/N Threshold

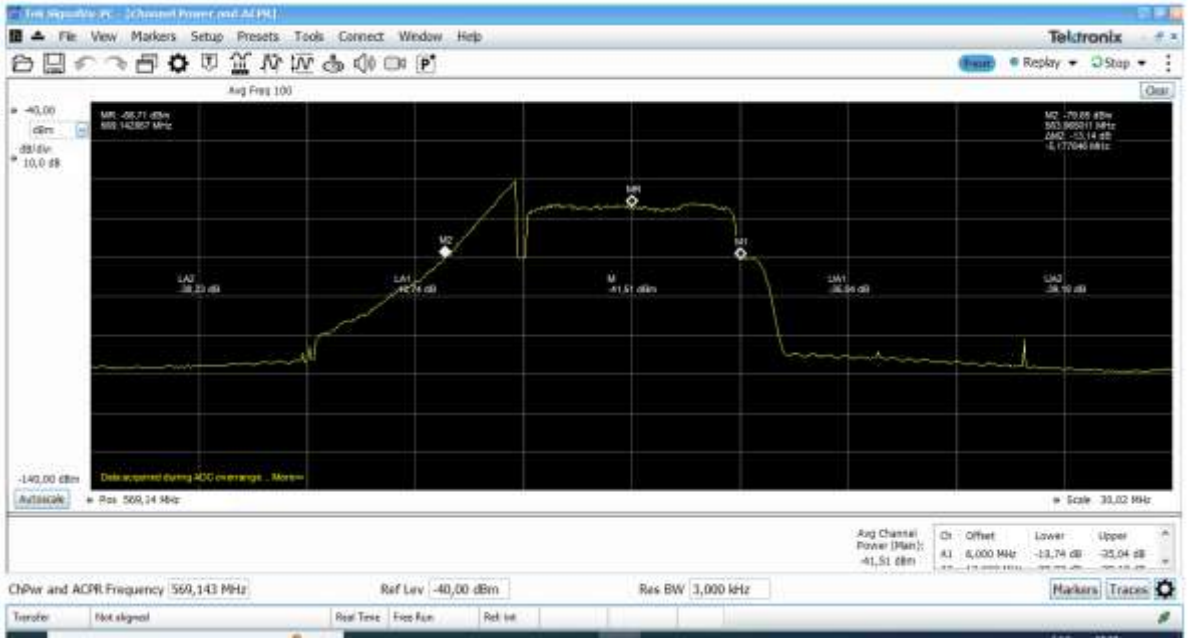


Figure 12.6 - Vertical

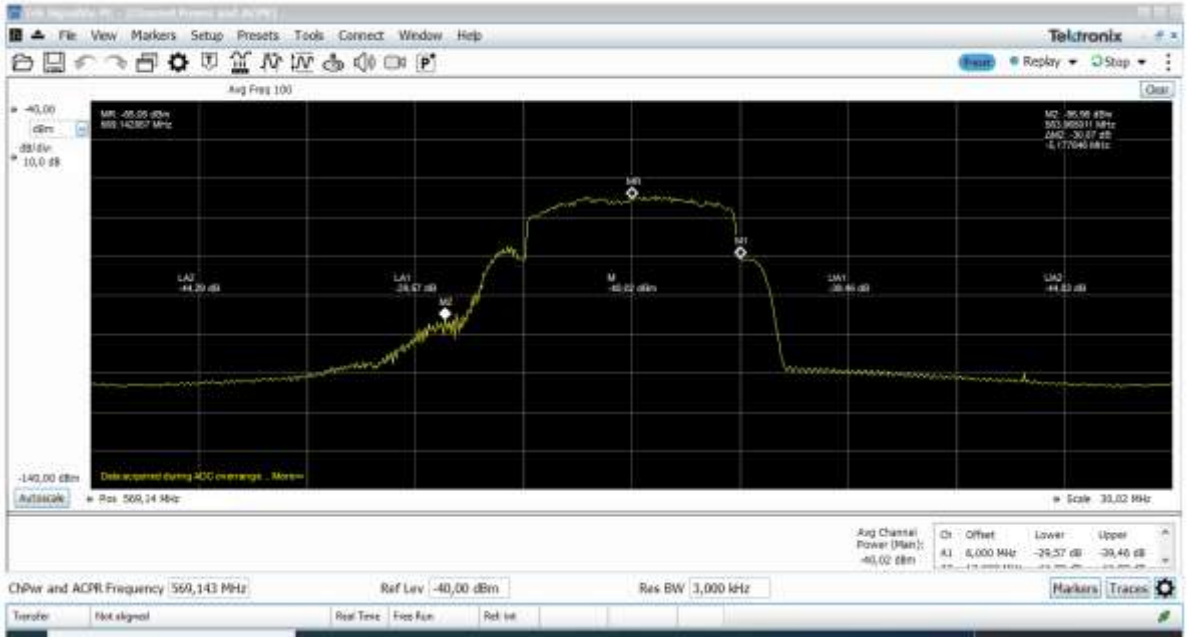


Figure 12.7 - Horizontal

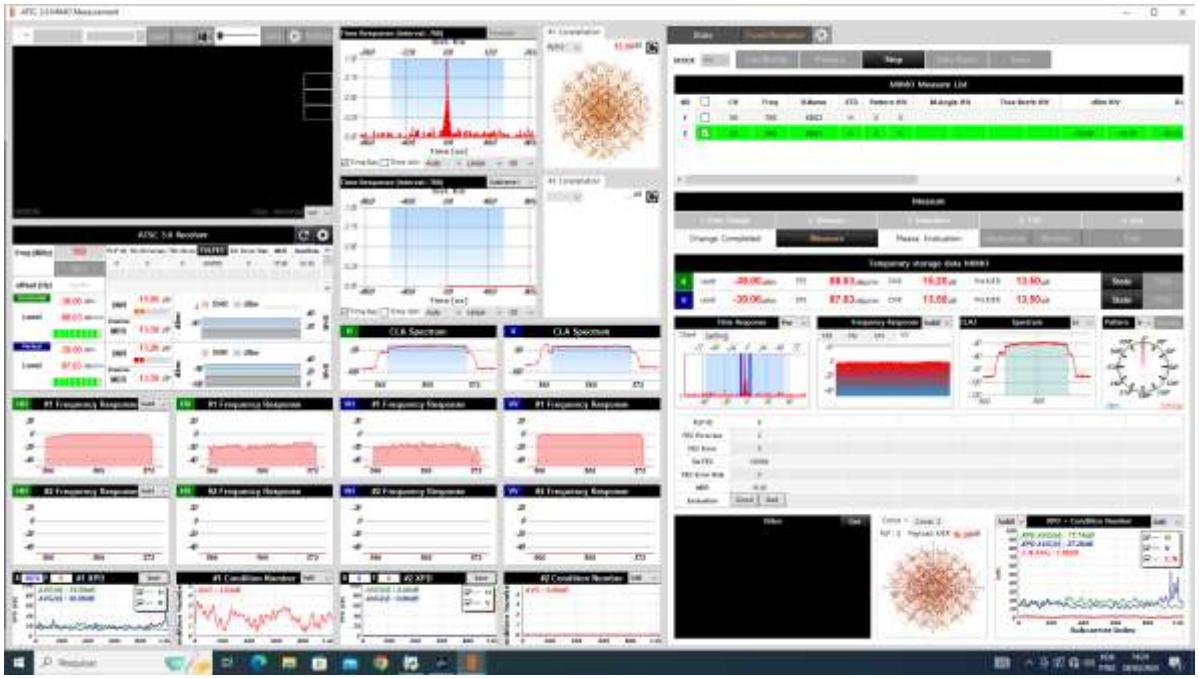


Figure 12.8 - IMAS Screen

d) Reception Threshold

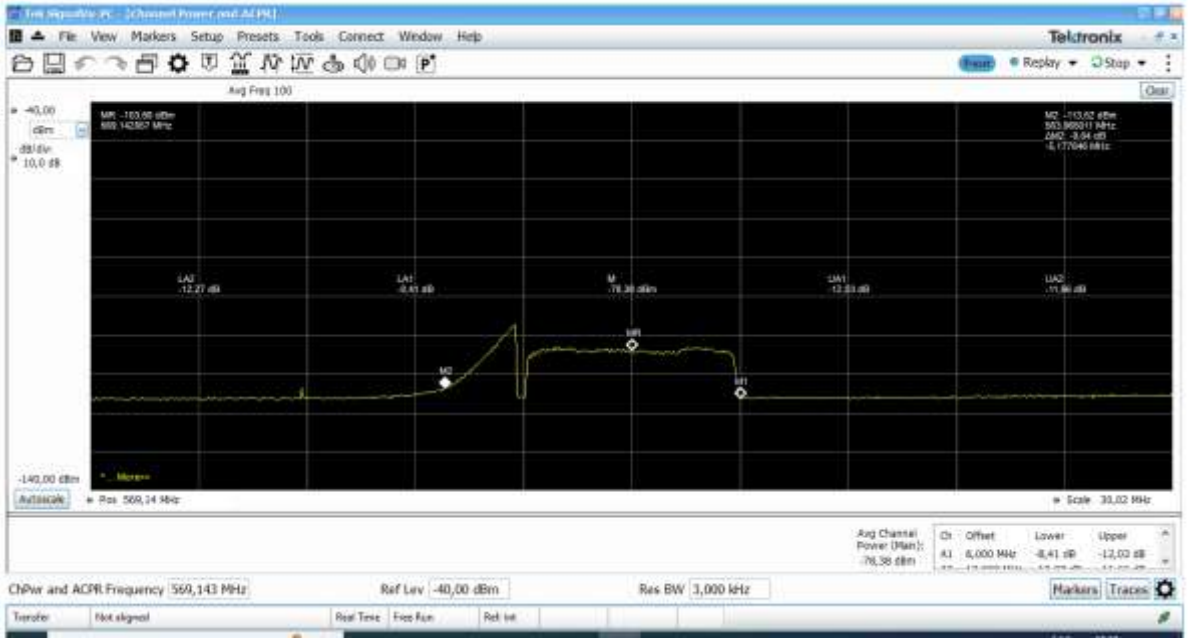


Figure 12.9 - Vertical

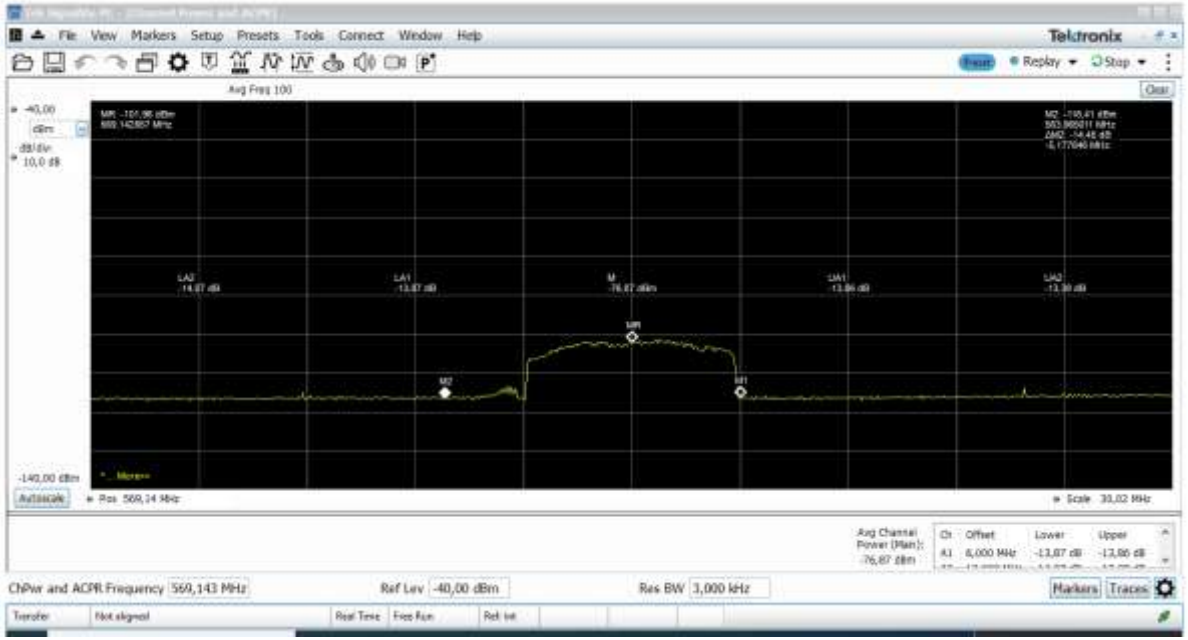


Figure 12.10 - Horizontal

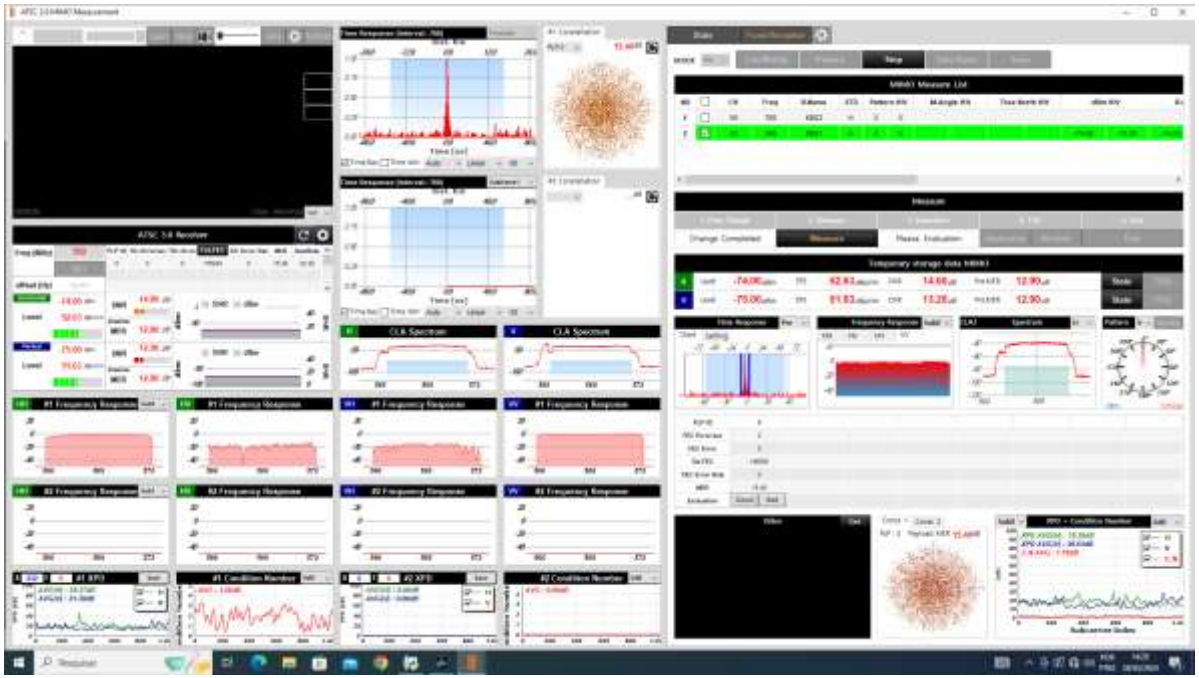


Figure 12.11 - IMAS Screen

Chapter 13. Site 13

a) Channel Power

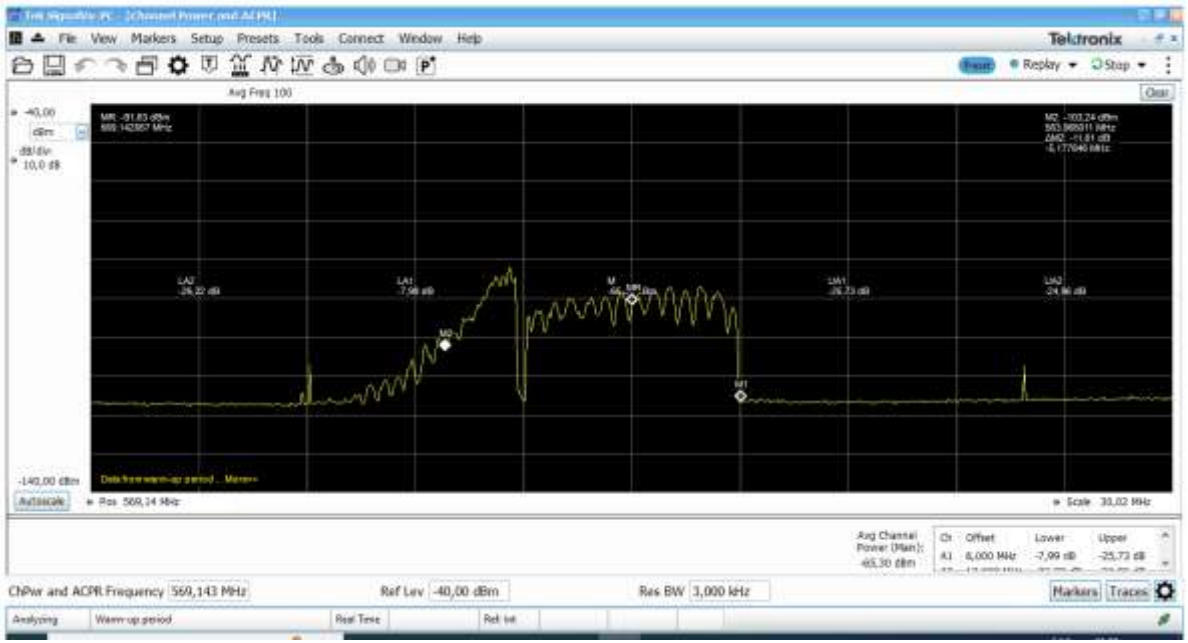


Figure 13.1 - Vertical

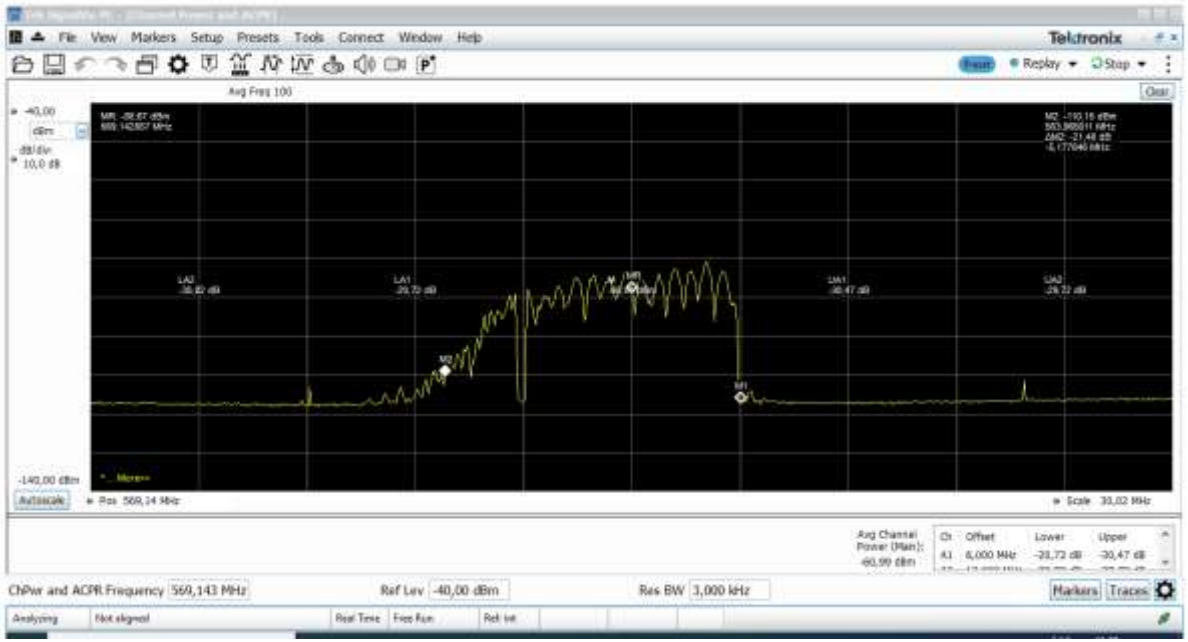


Figure 13.2 - Horizontal

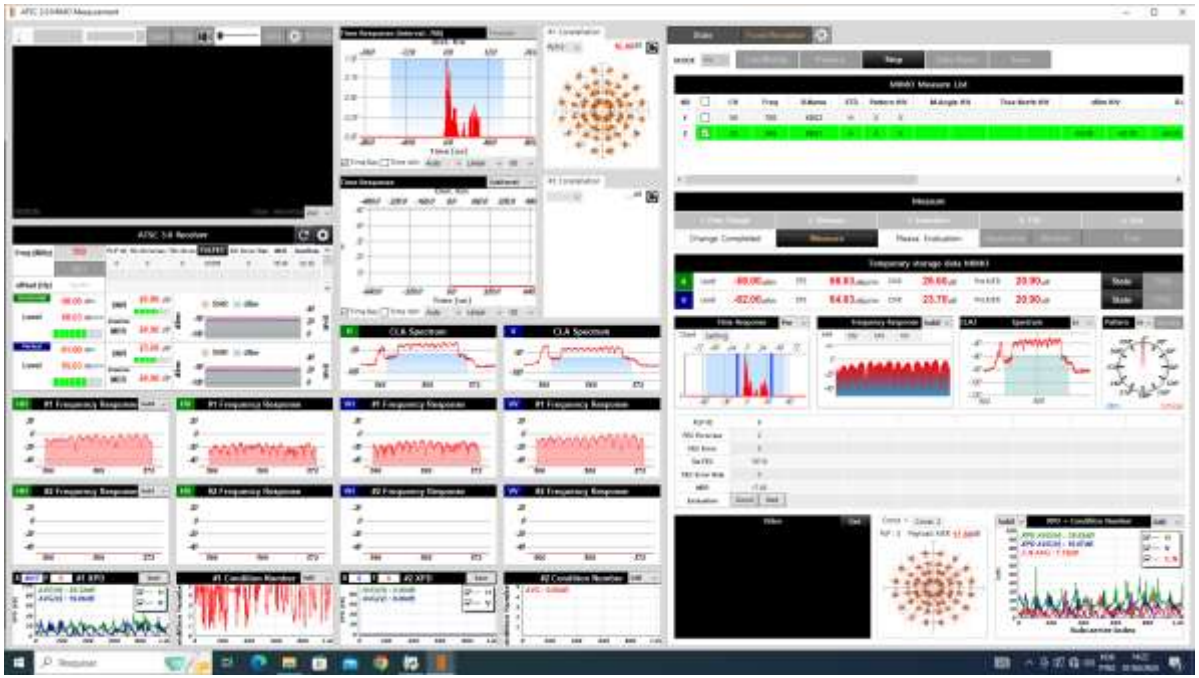


Figure 13.3 - IMAS Screen

b) AWGN Power

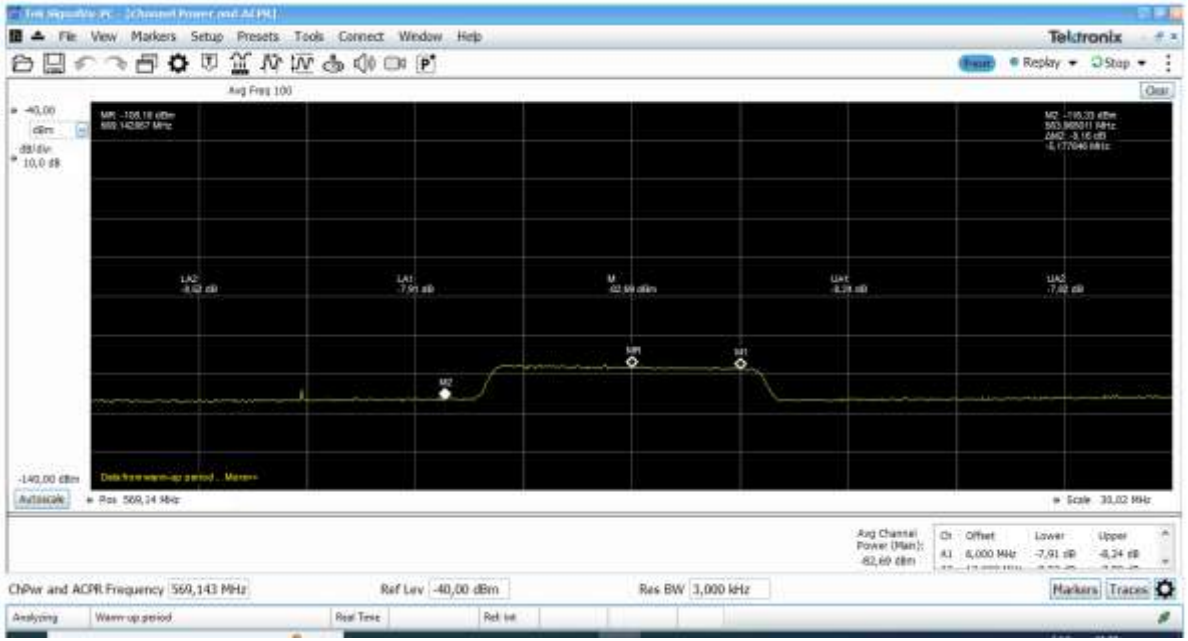


Figure 13.4 - Vertical

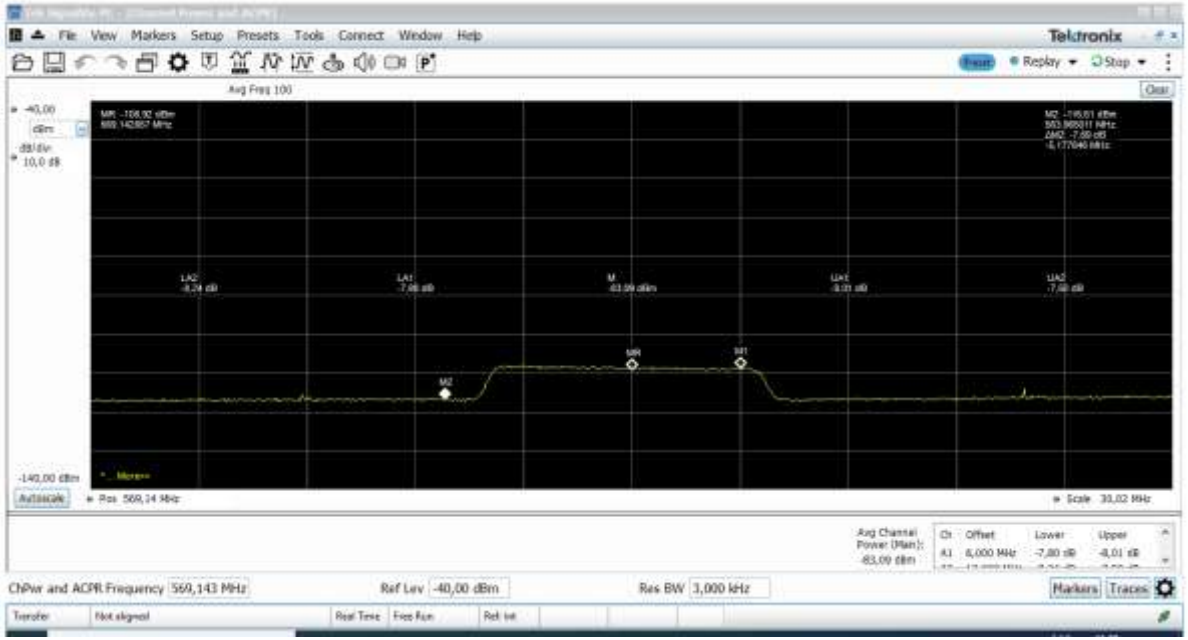


Figure 13.5 - Horizontal

c) C/N Threshold

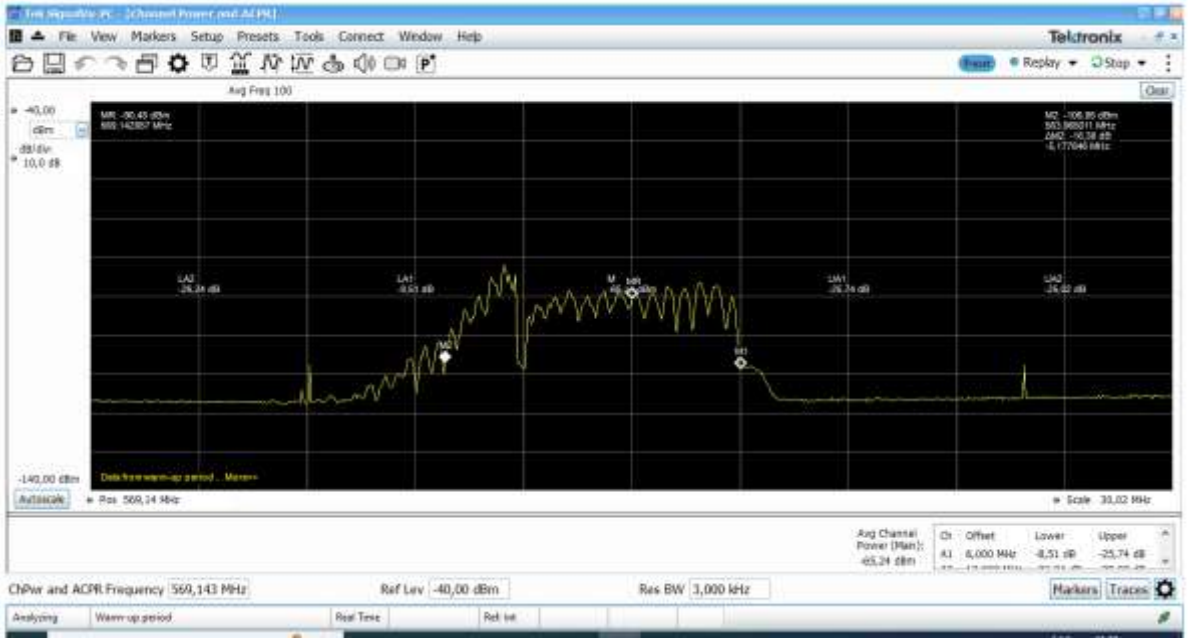


Figure 13.6 - Vertical

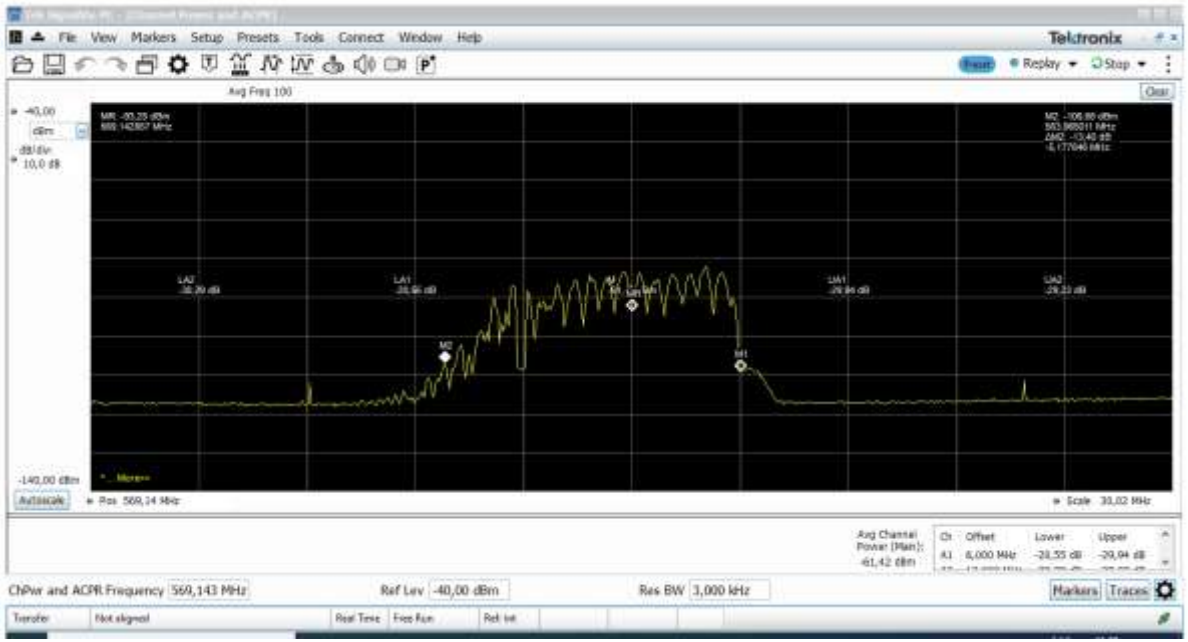


Figure 13.7 - Horizontal

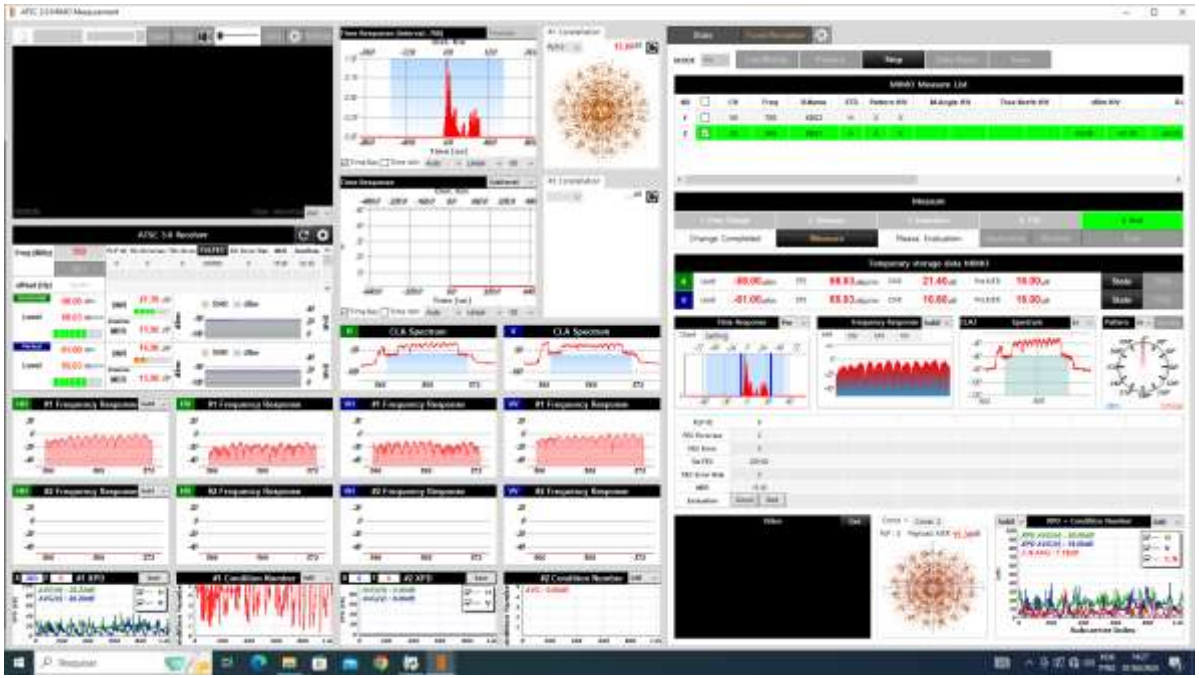


Figure 13.8 - IMAS Screen

d) Reception Threshold

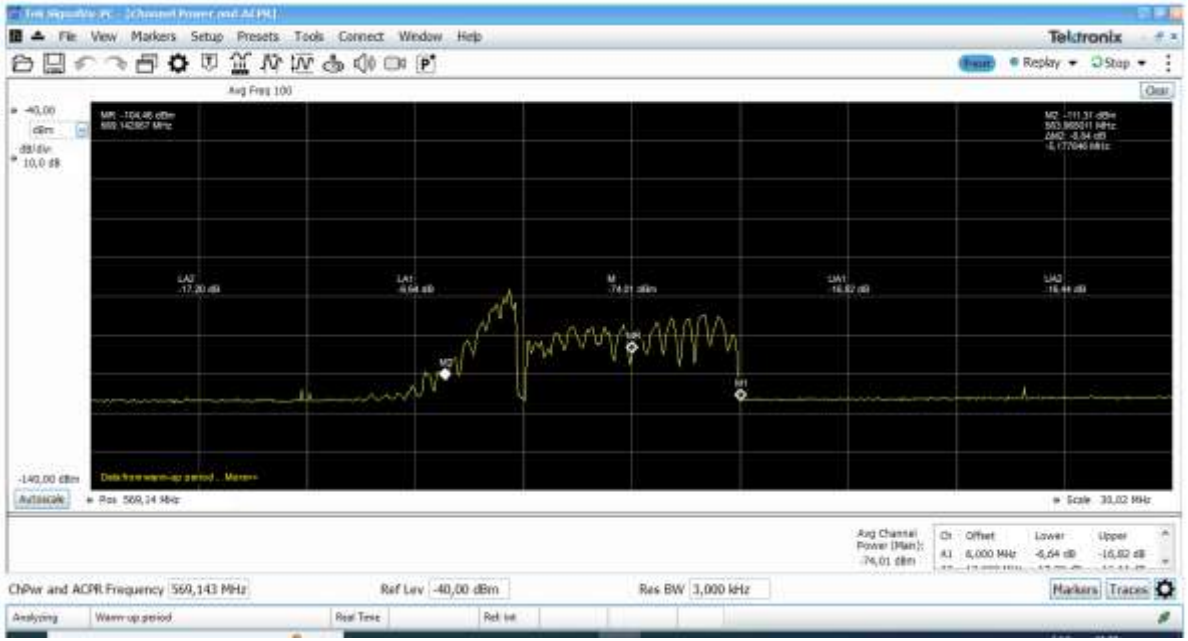


Figure 13.9 - Vertical

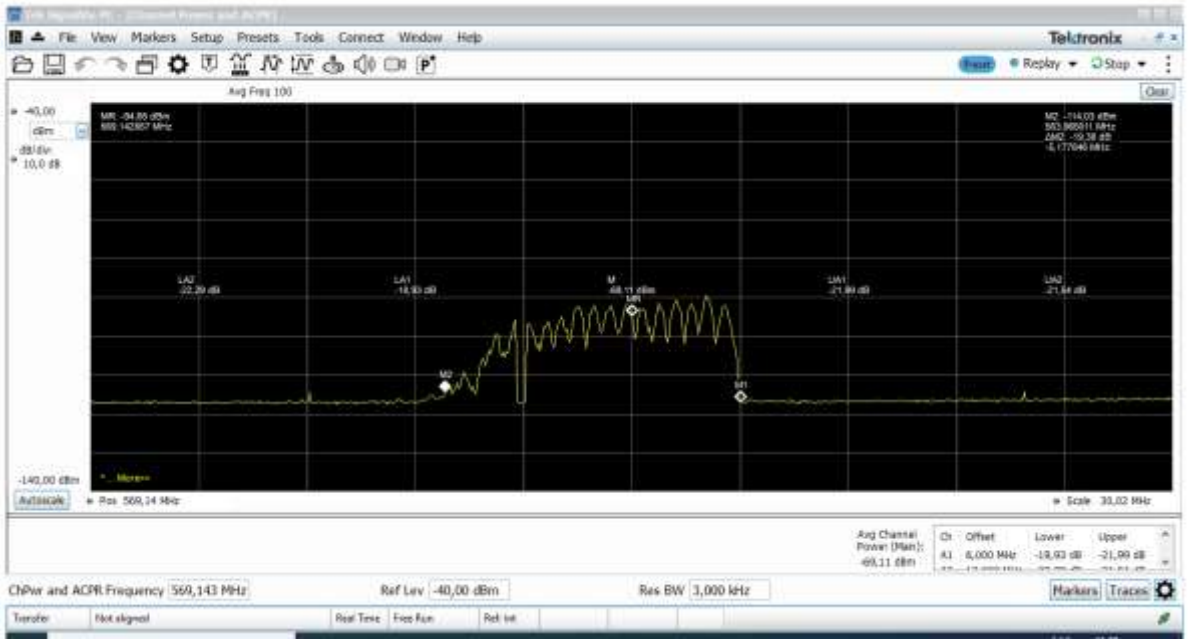


Figure 13.10 - Horizontal

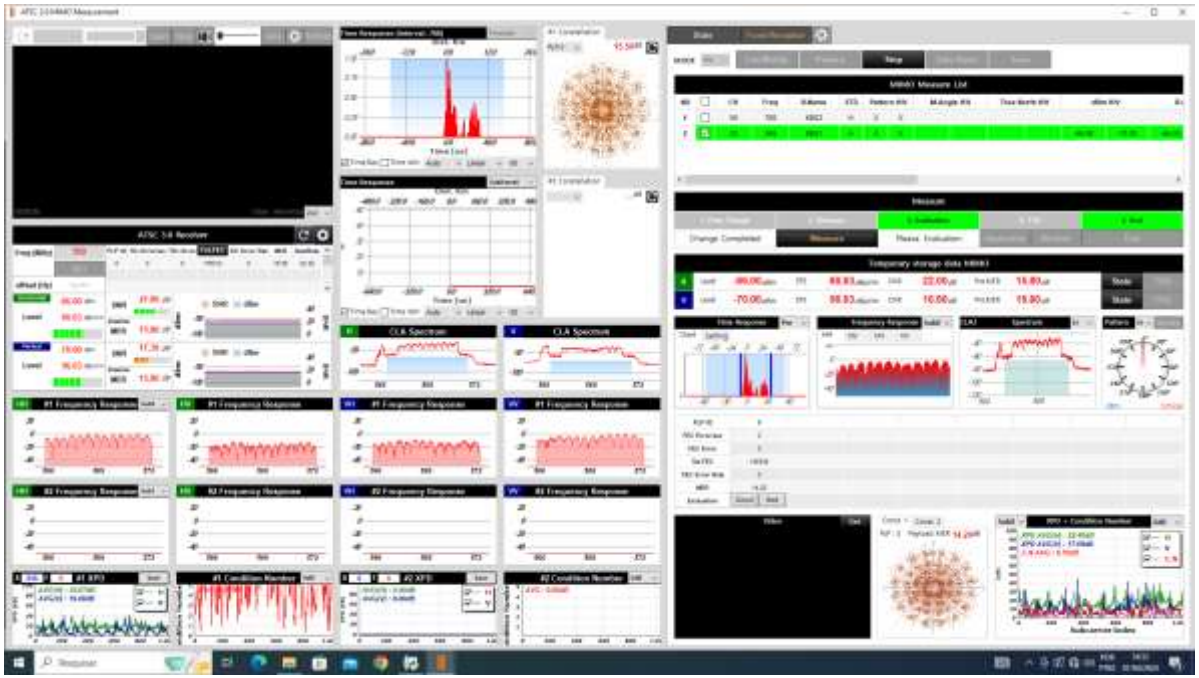


Figure 13.11 - IMAS Screen

Chapter 14. Site 14

a) Channel Power

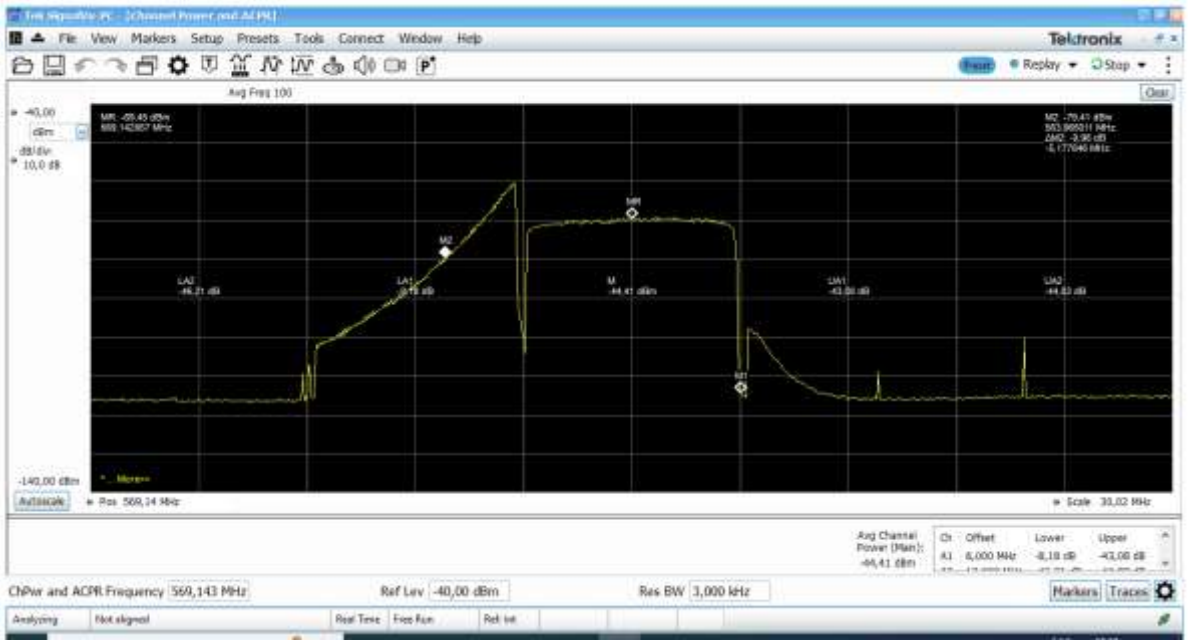


Figure 14.1 - Vertical

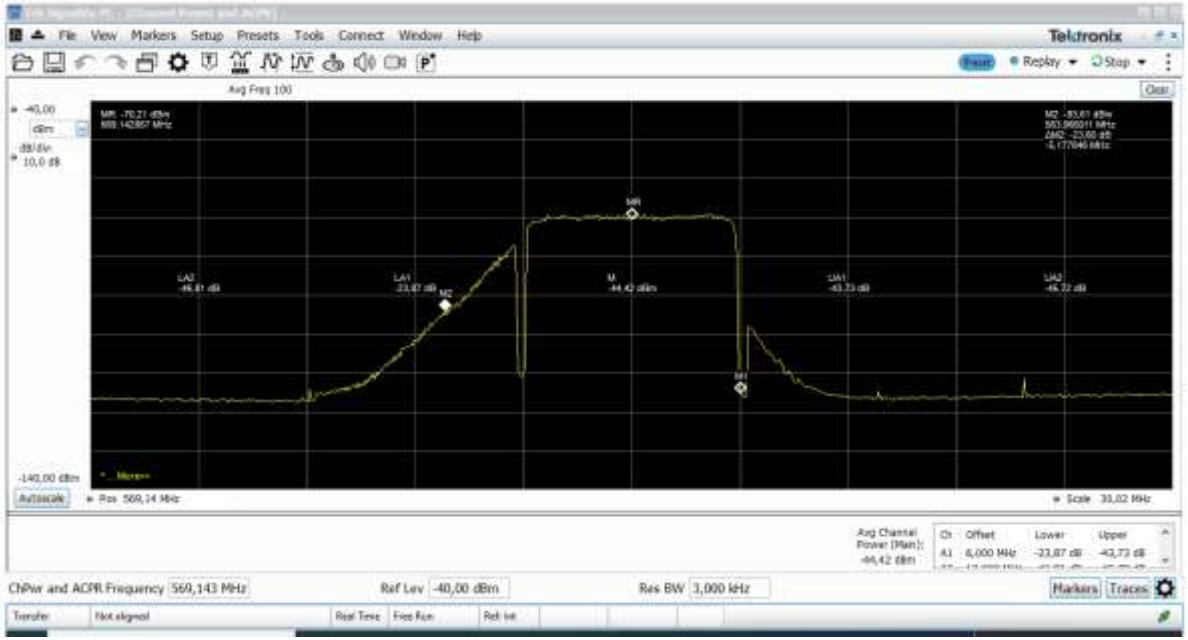


Figure 14.2 - Horizontal

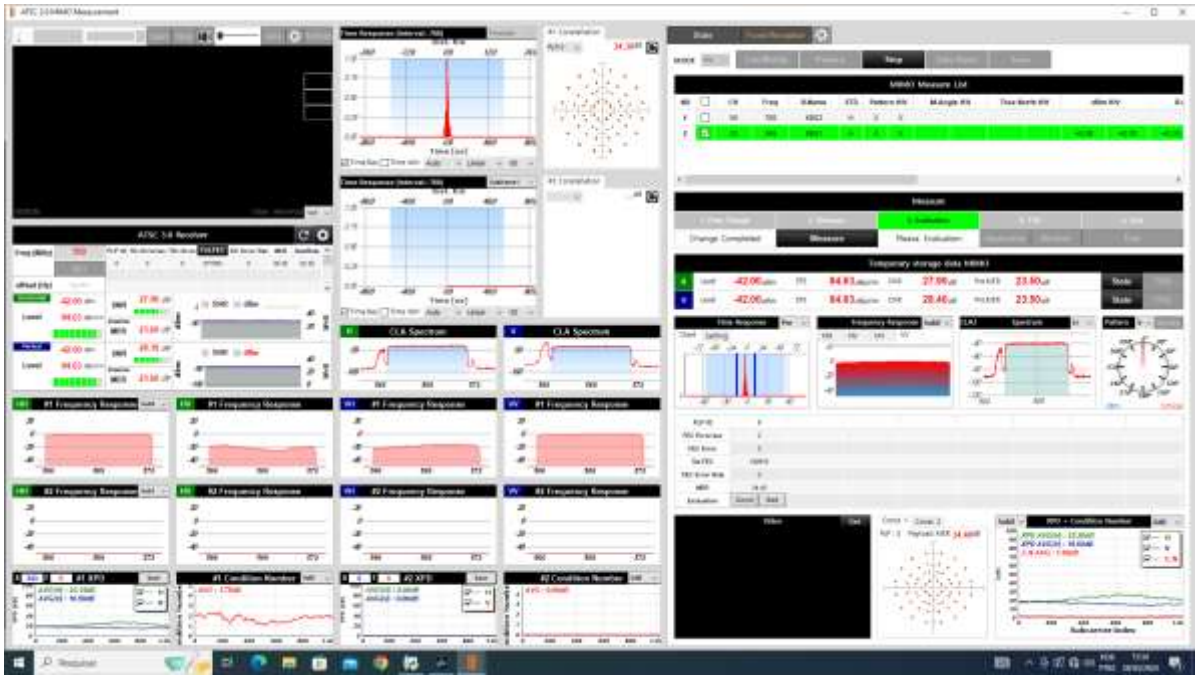


Figure 14.3 - IMAS Screen

b) AWGN Power

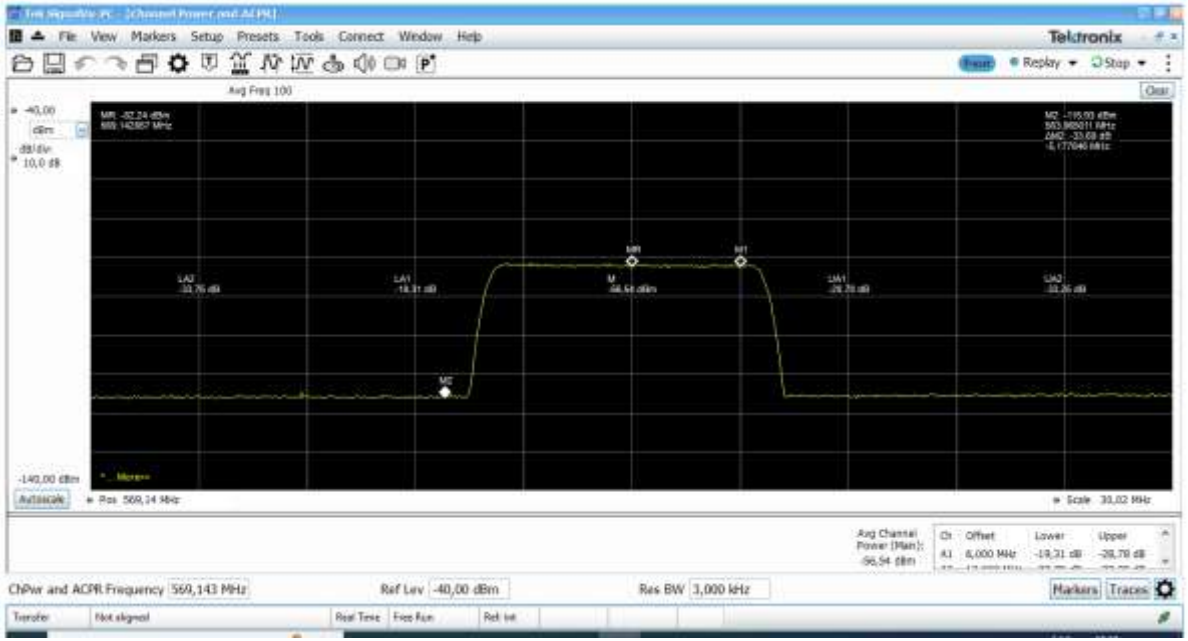


Figure 14.4 - Vertical

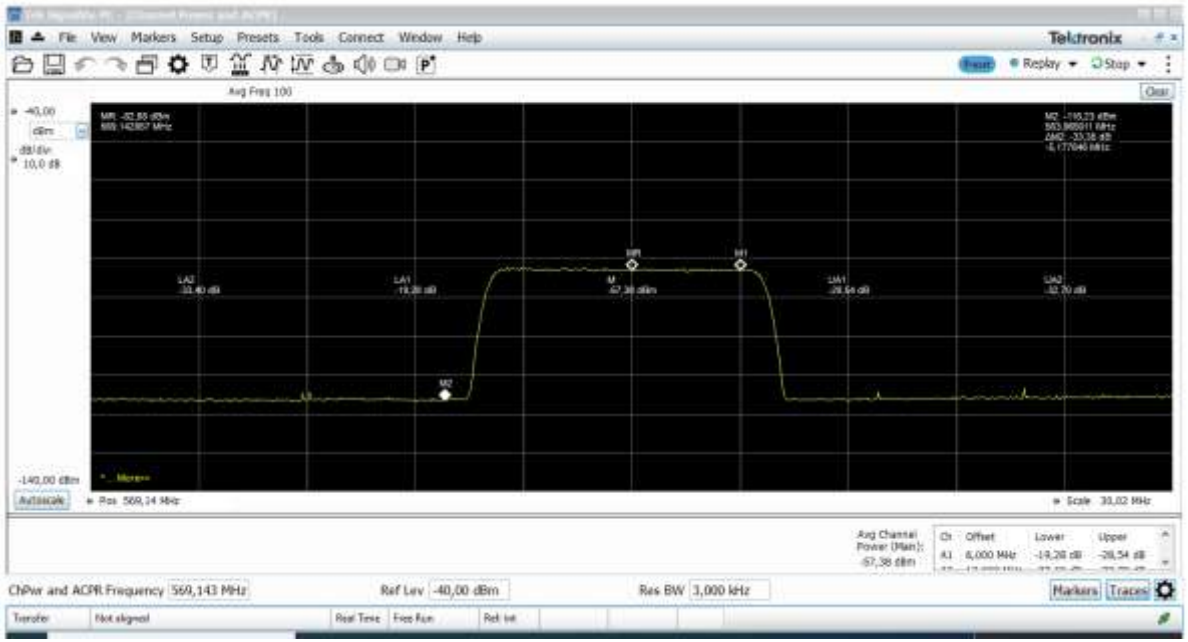


Figure 14.5 - Horizontal

c) C/N Threshold

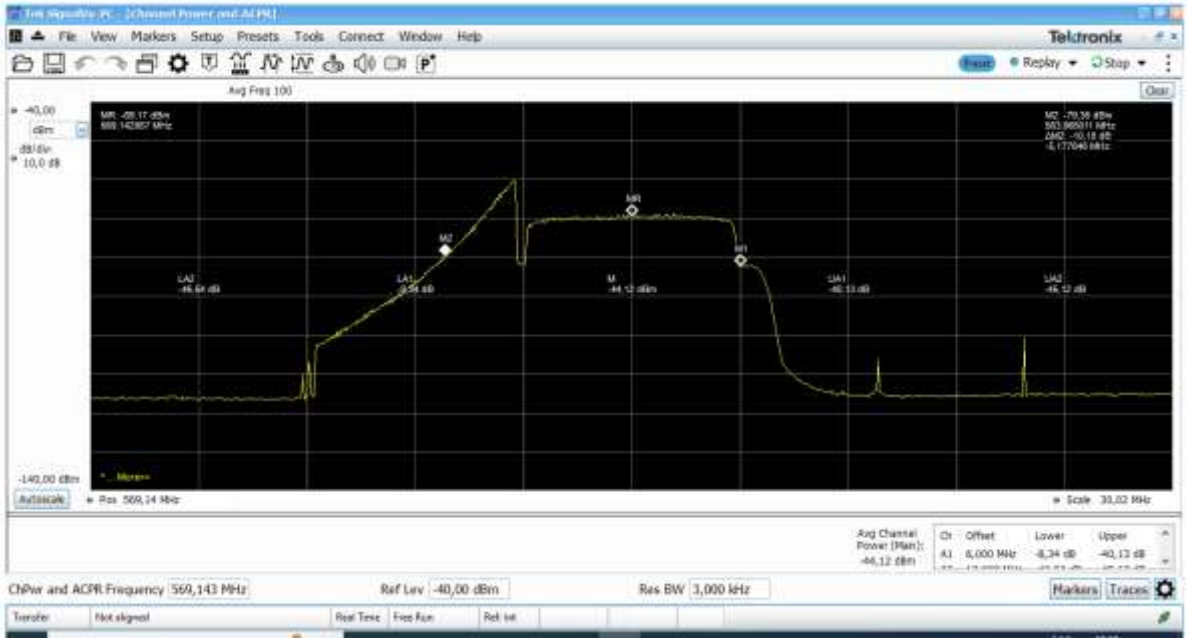


Figure 14.6 - Vertical

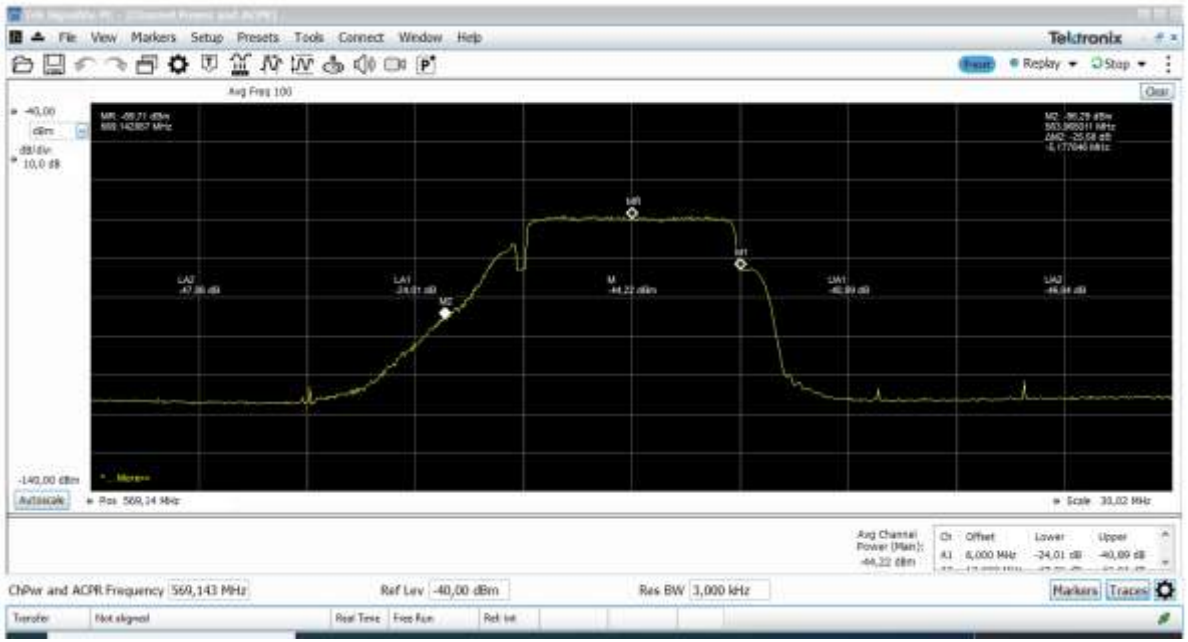


Figure 14.7 - Horizontal

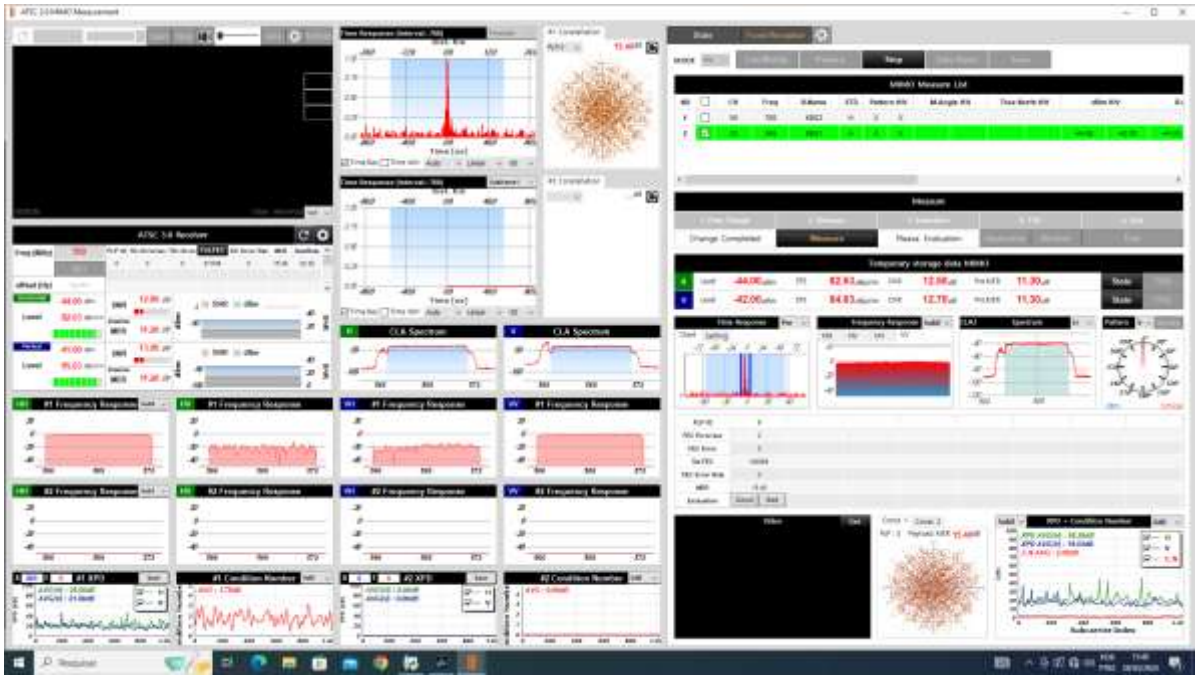


Figure 14.8 - IMAS Screen

d) Reception Threshold

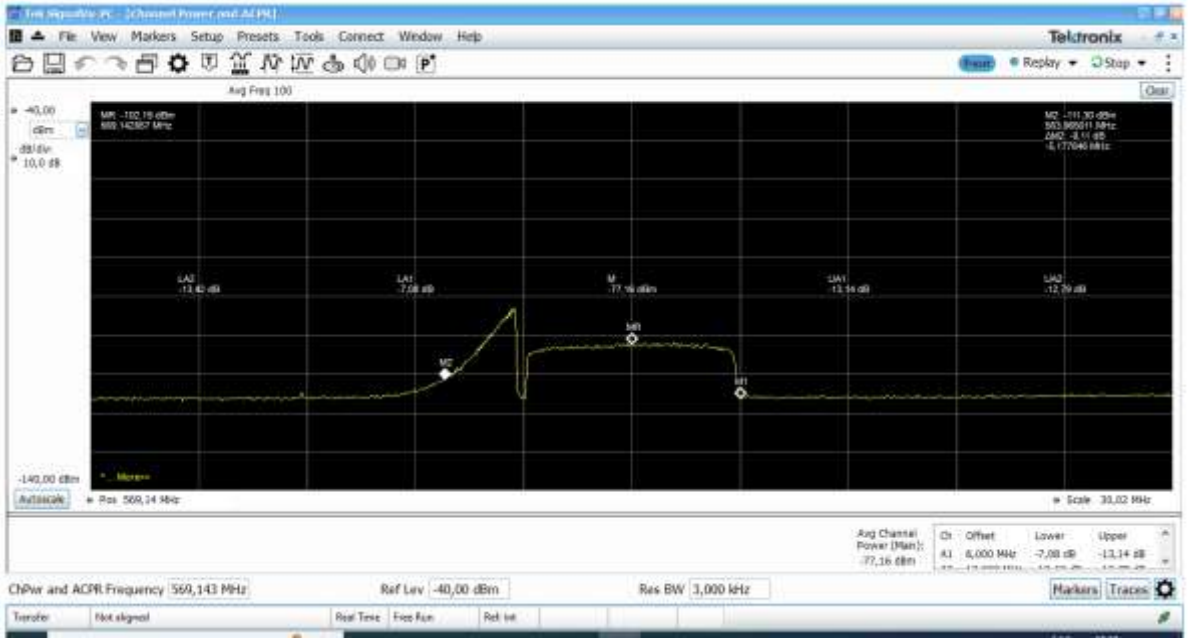


Figure 14.9 - Vertical

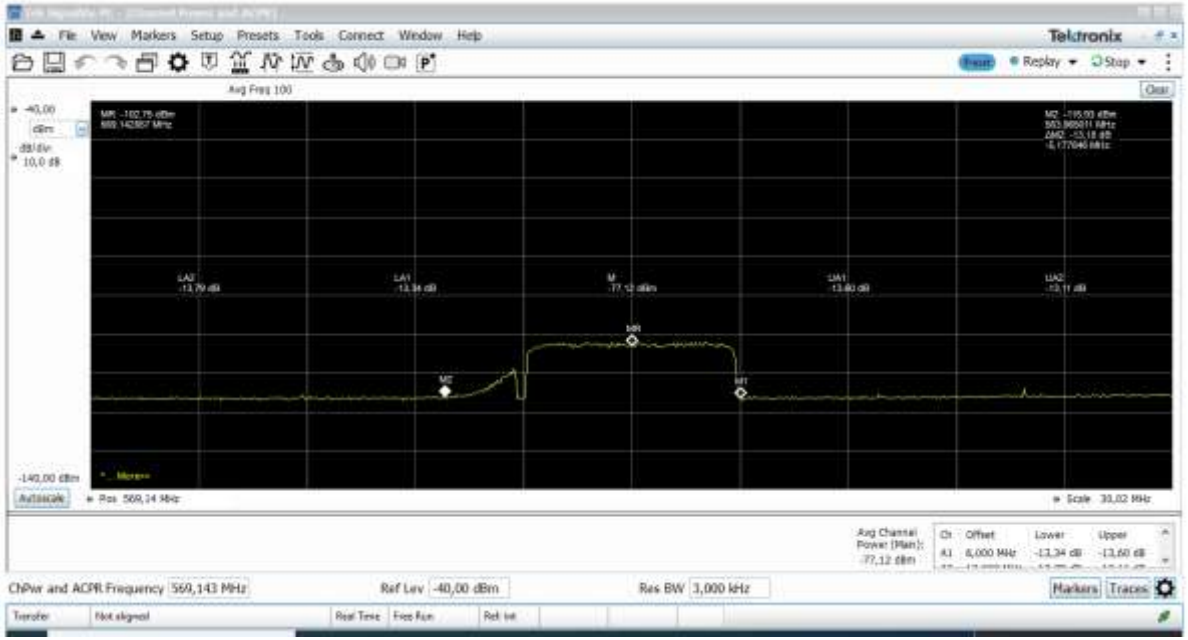


Figure 14.10 - Horizontal

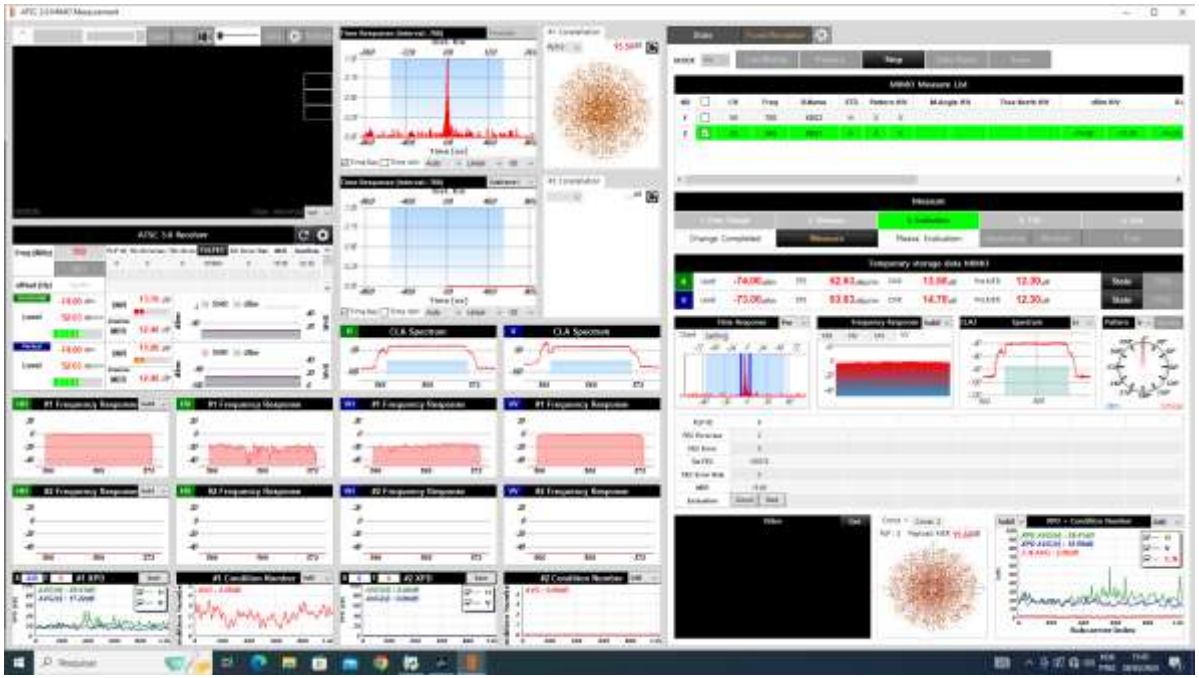


Figure 14.11 - IMAS Screen

Chapter 15. Site 15

a) Channel Power

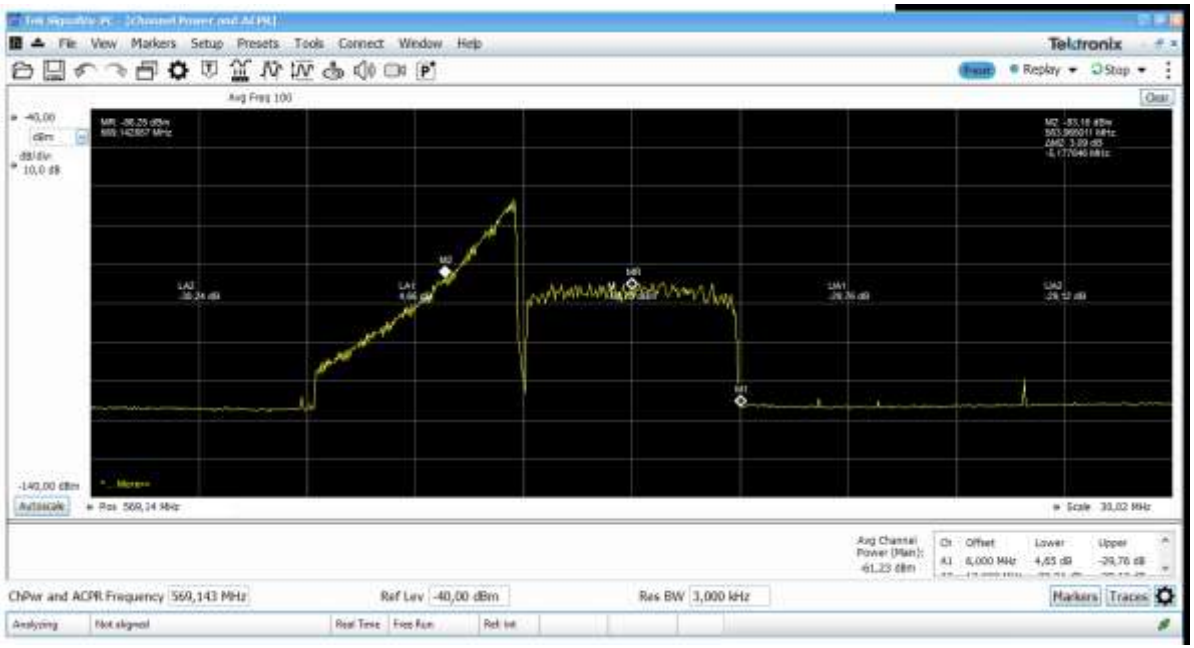


Figure 15.1 - Vertical

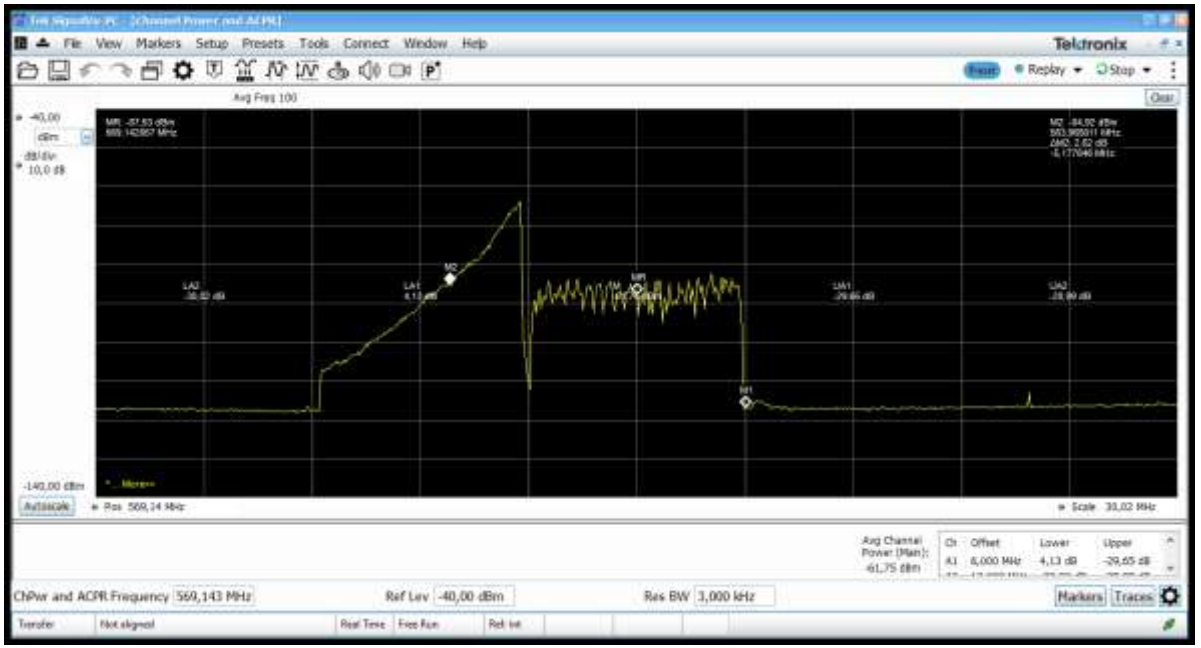


Figure 15.2 - Horizontal

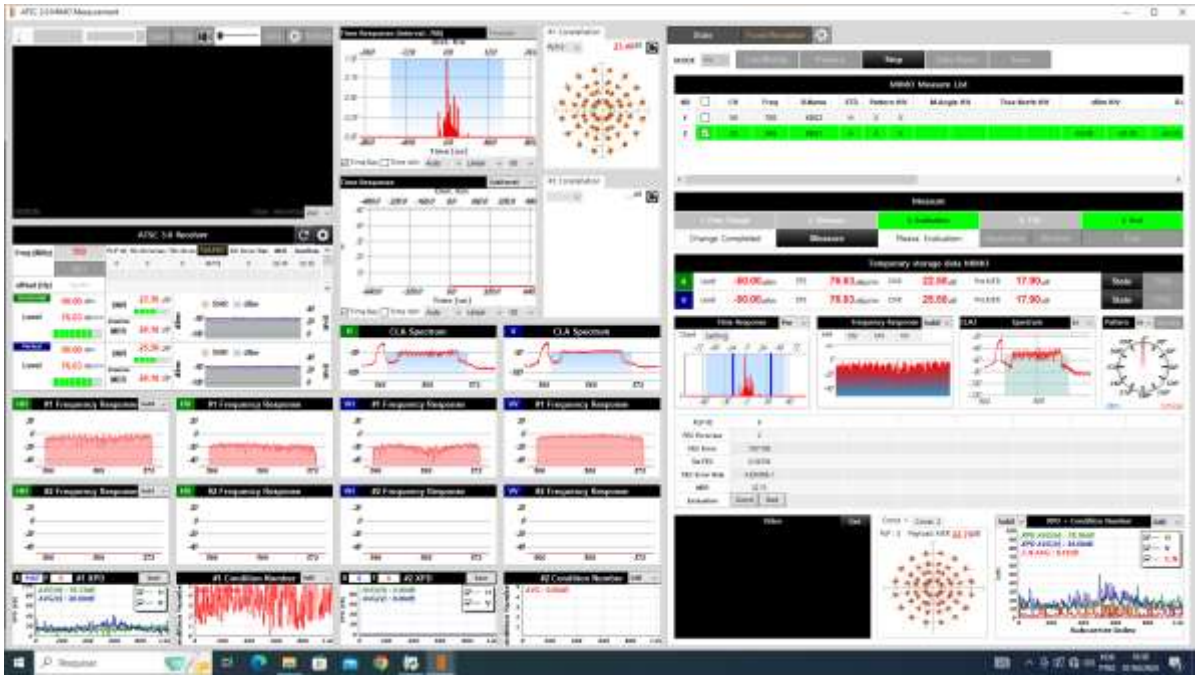


Figure 15.3 - IMAS Screen

b) AWGN Power

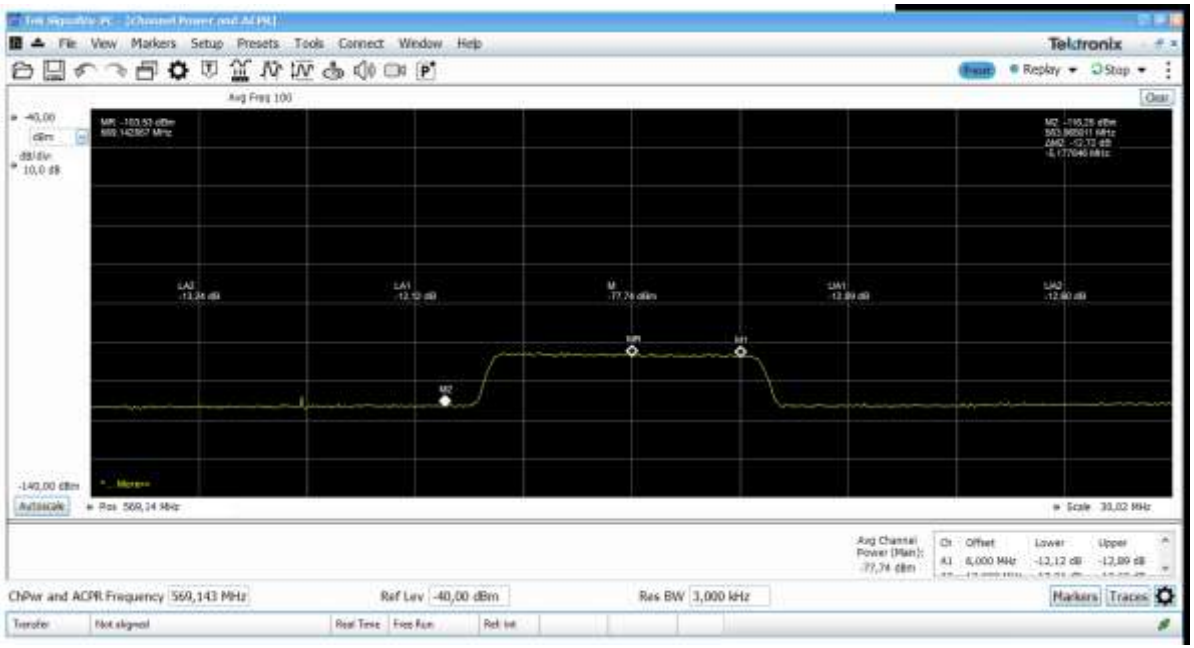


Figure 15.4 - Vertical

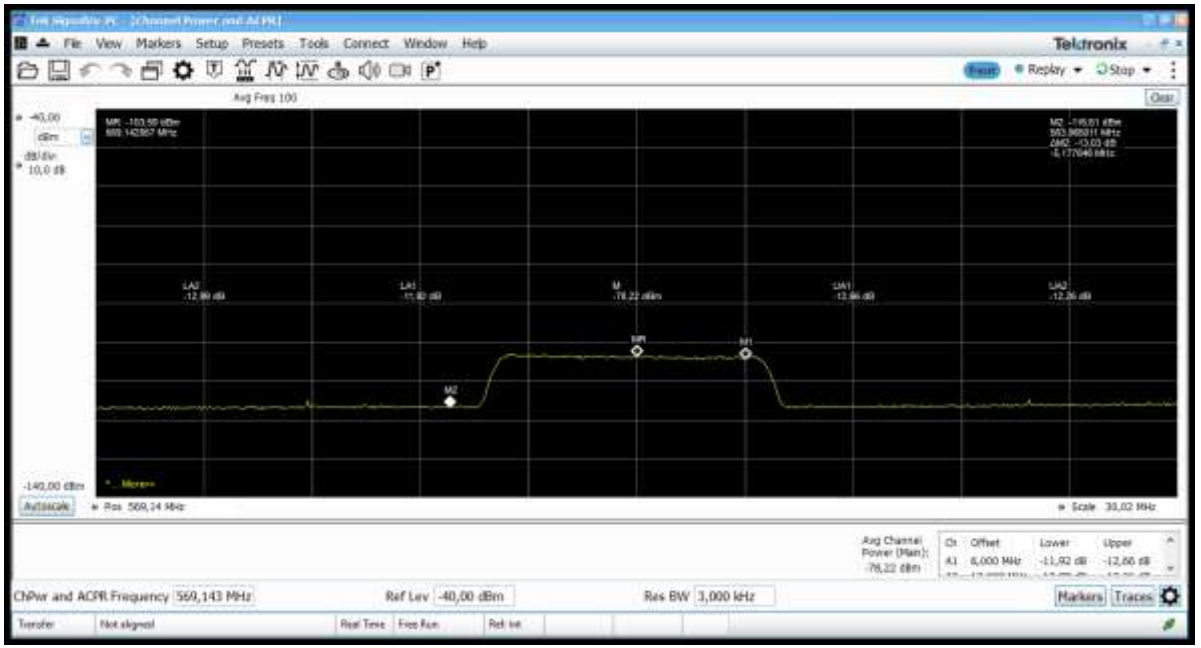


Figure 15.5 - Horizontal

c) C/N Threshold

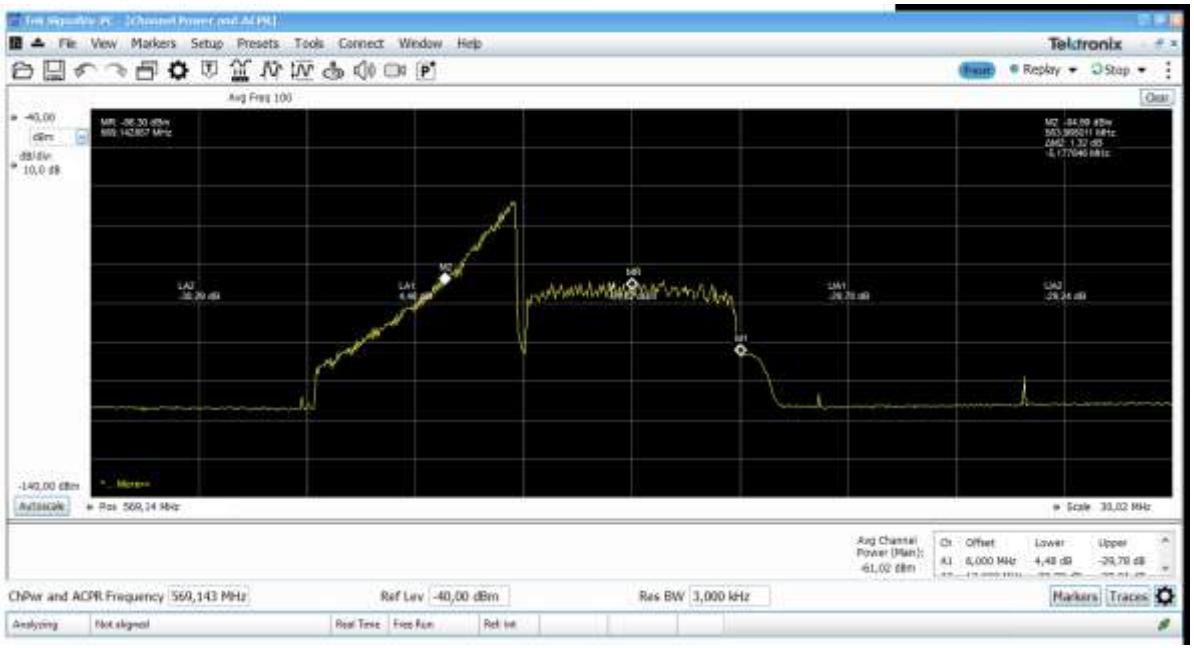


Figure 15.6 - Vertical

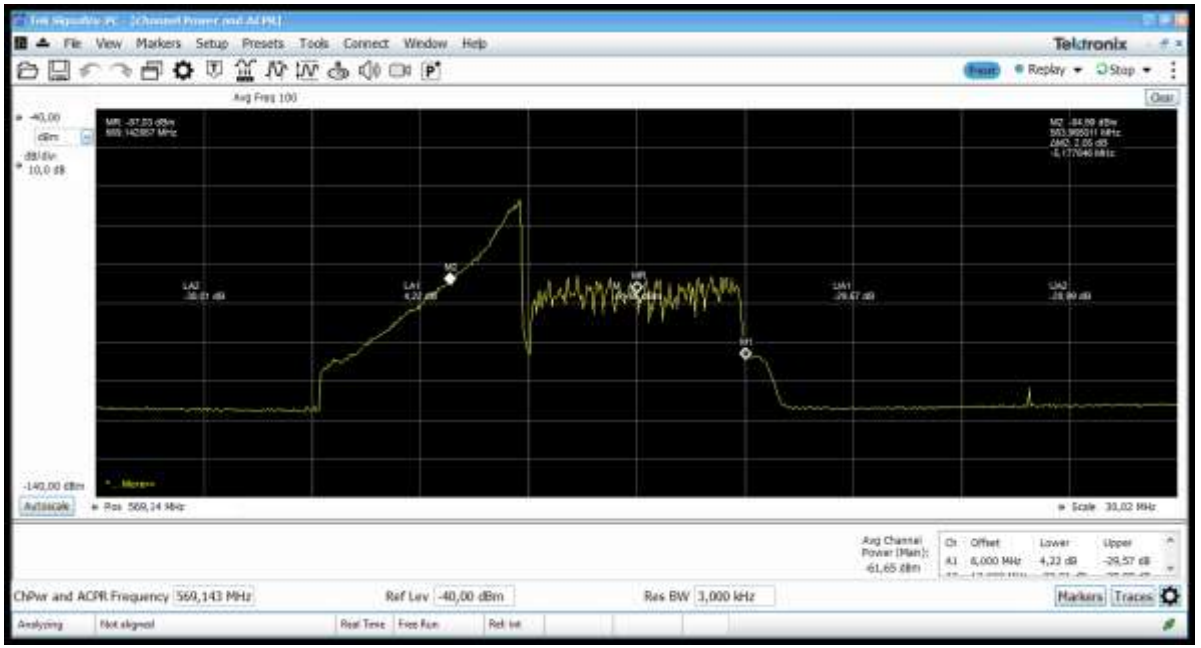


Figure 15.7 - Horizontal

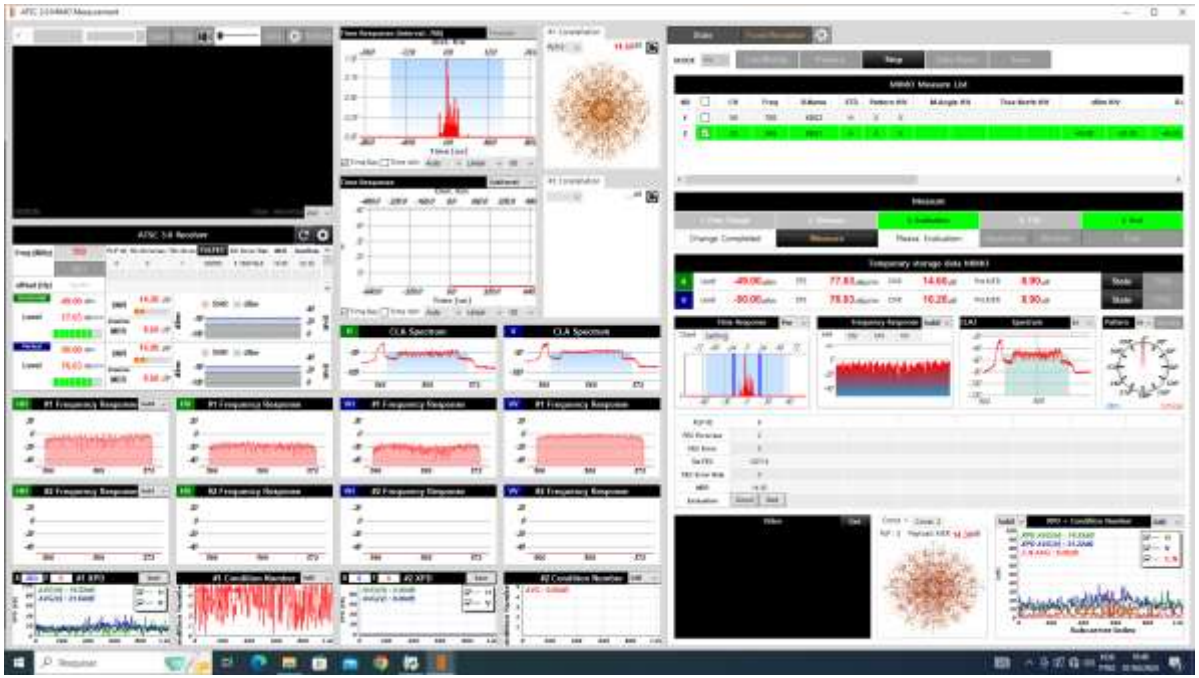


Figure 15.8 - IMAS Screen

d) Reception Threshold

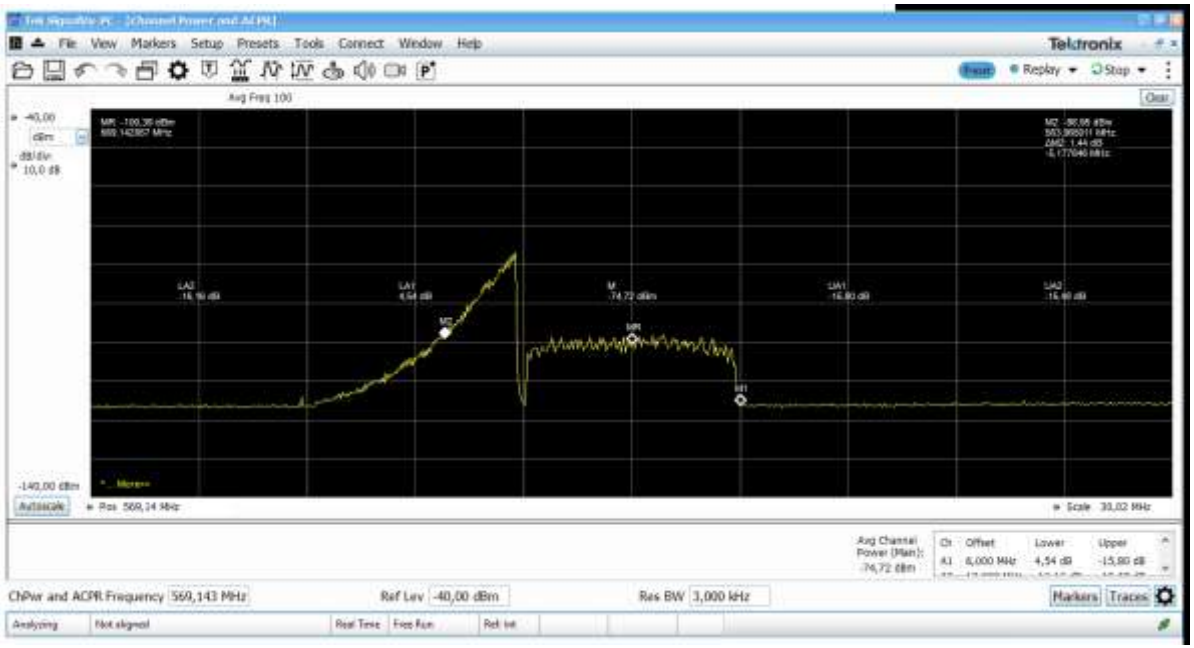


Figure 15.9 - Vertical

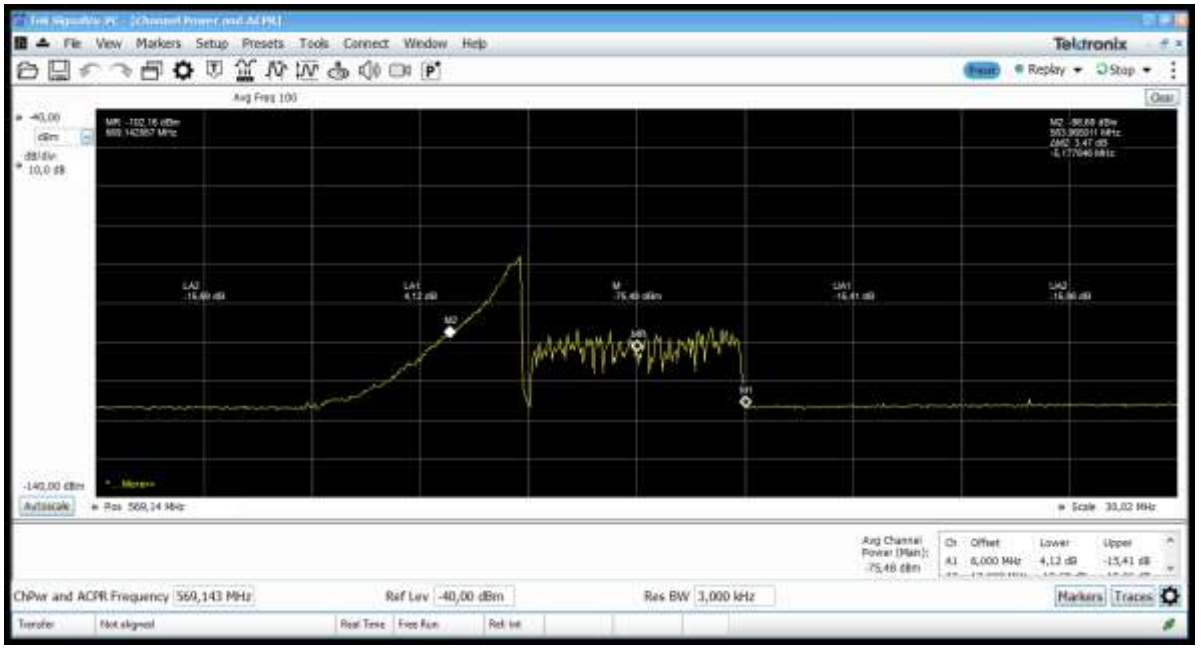


Figure 15.10 - Horizontal

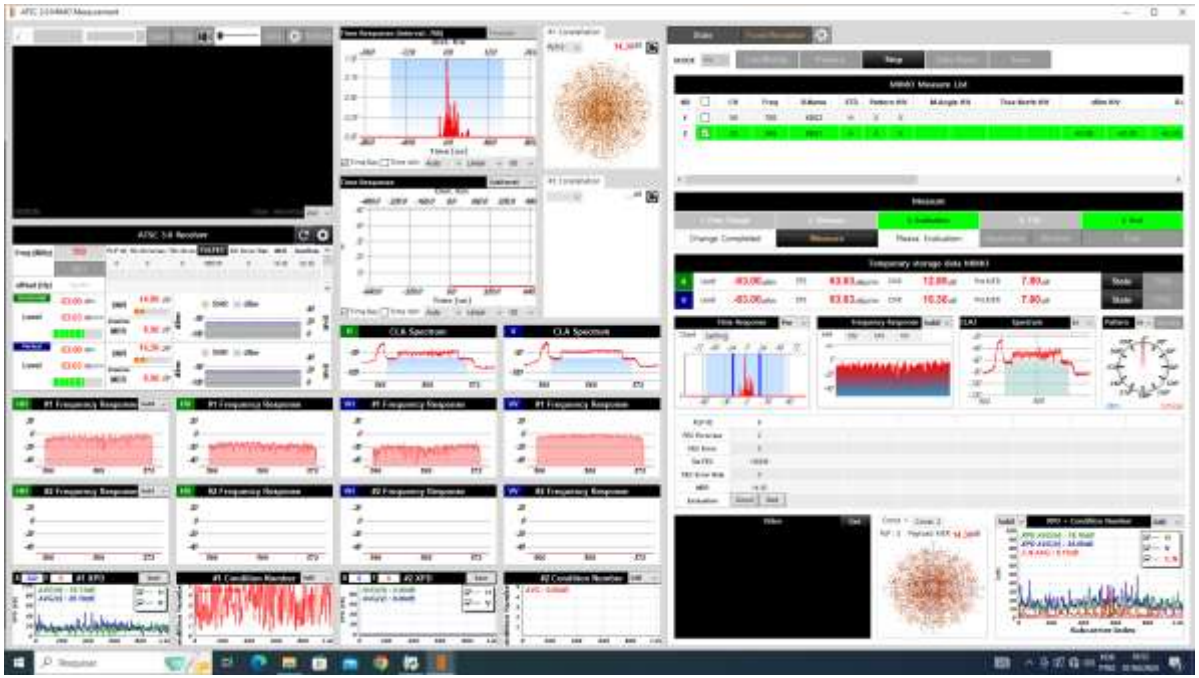


Figure 15.11 - IMAS Screen

Chapter 16. Site 16

a) Channel Power

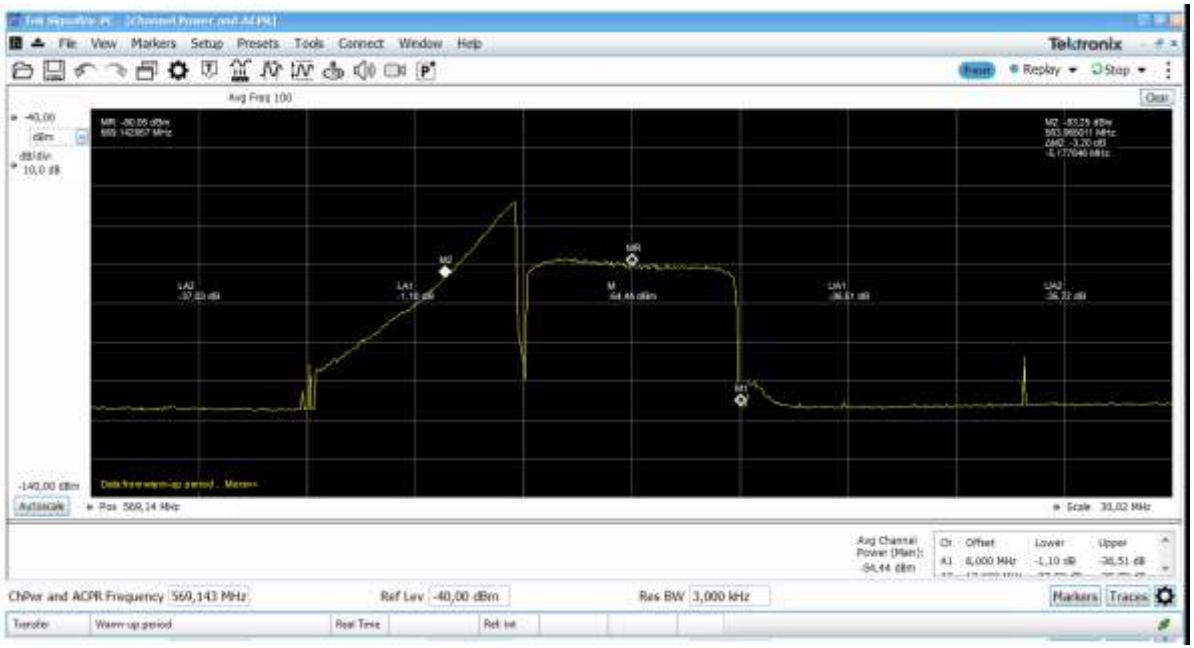


Figure 16.1 - Vertical

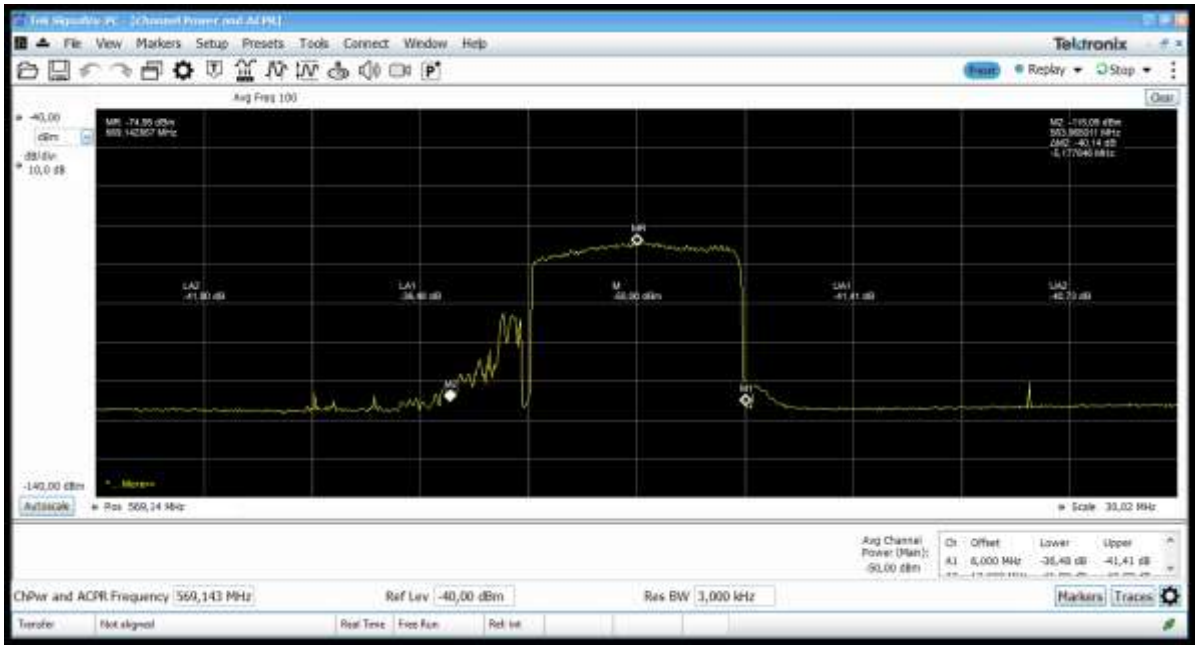


Figure 16.2 - Horizontal

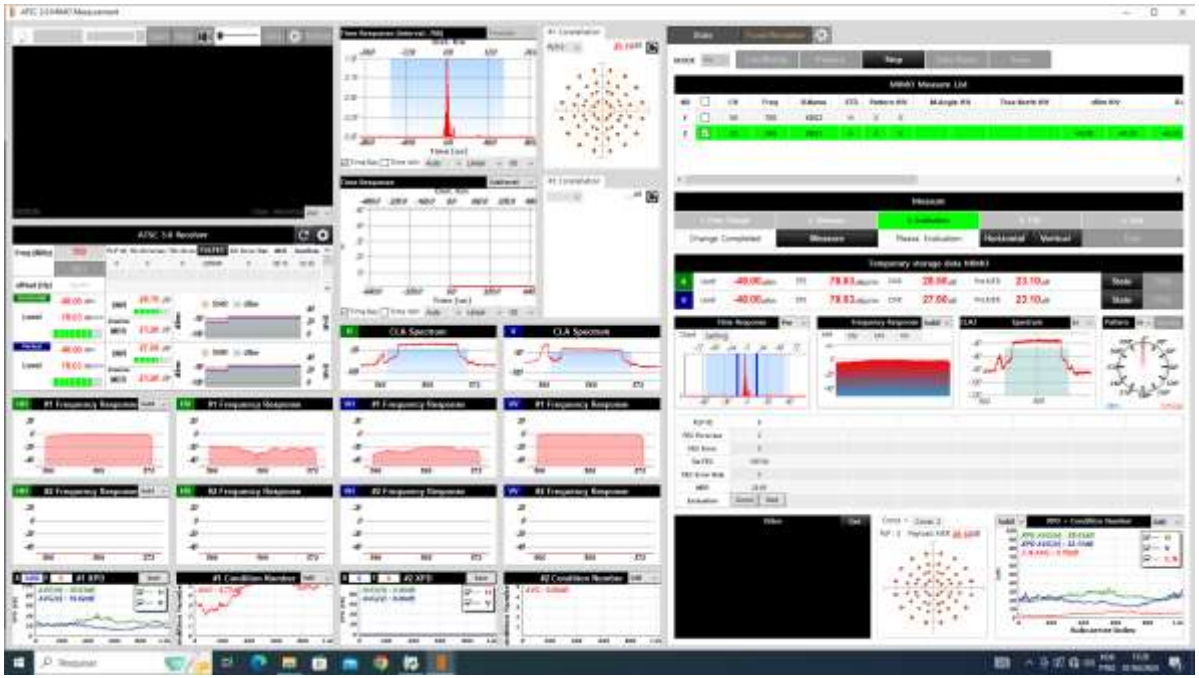


Figure 16.3 - IMAS Screen

b) AWGN Power

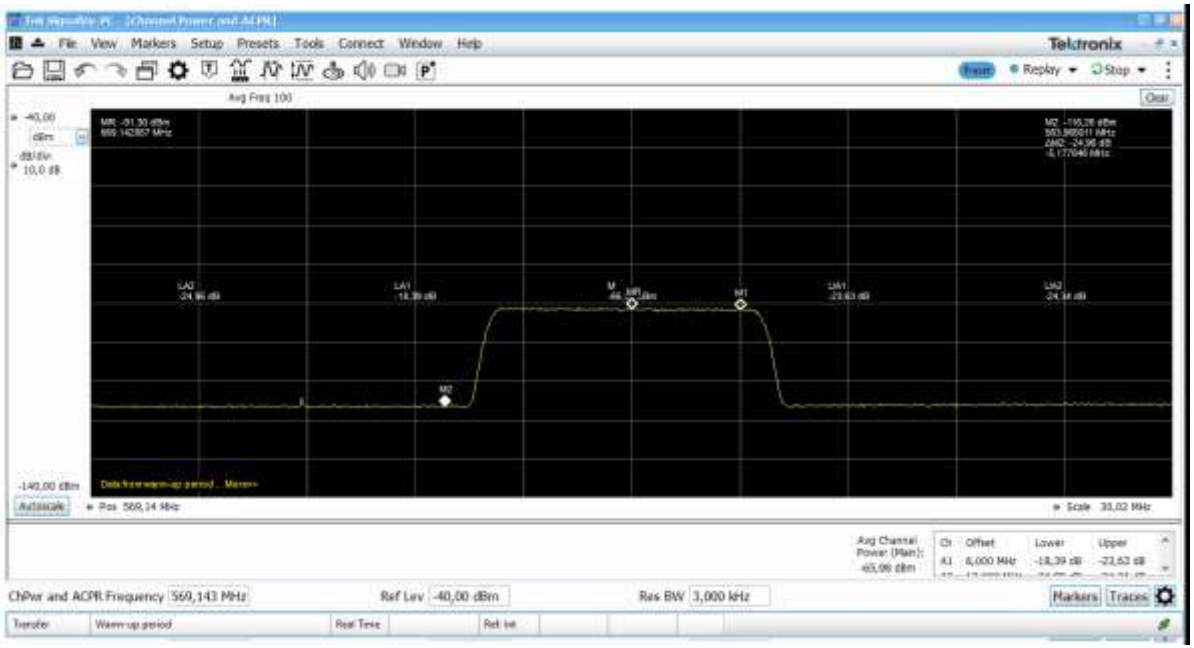


Figure 16.4 - Vertical

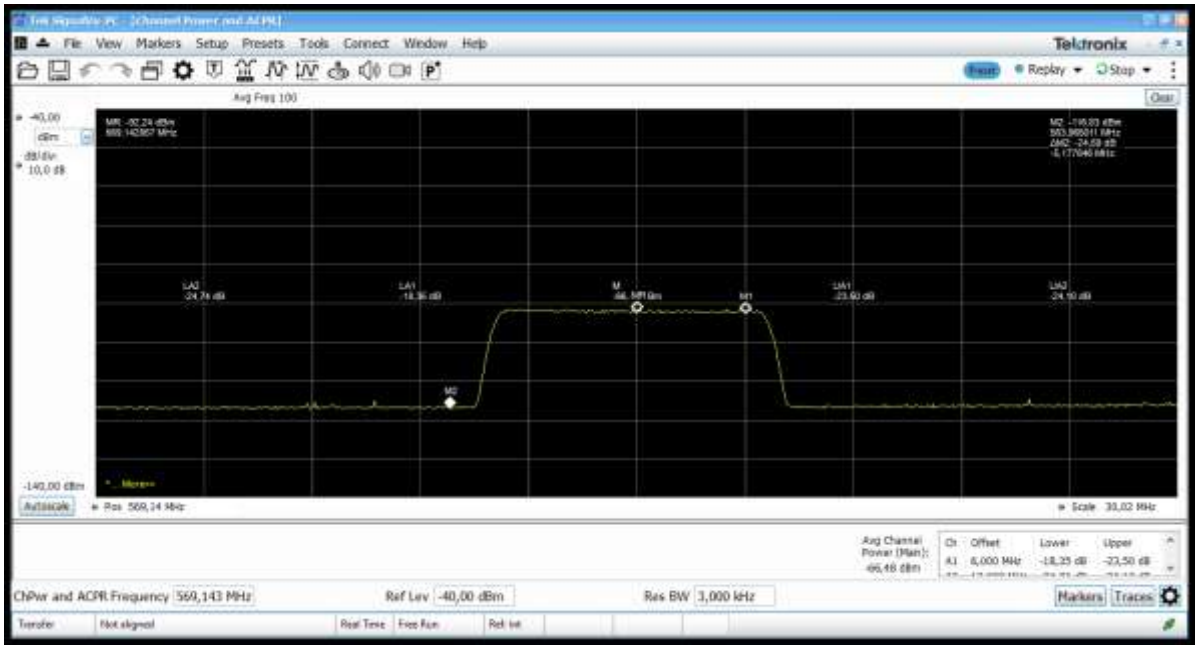


Figure 16.5 - Horizontal

c) C/N Threshold

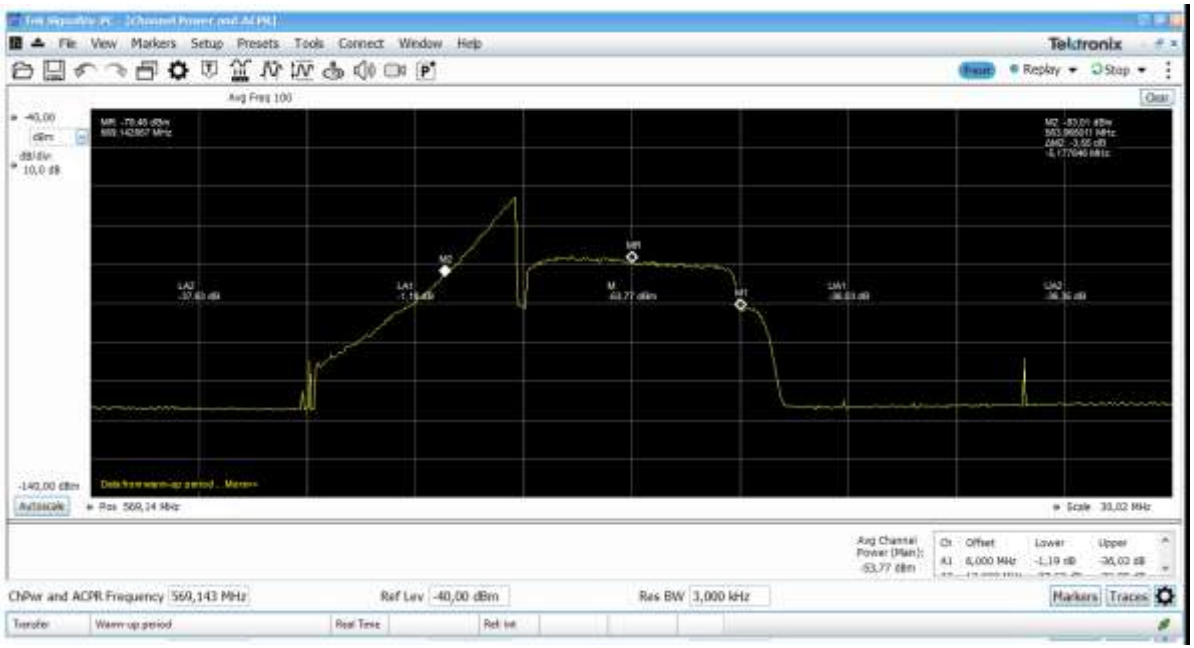


Figure 16.6 - Vertical

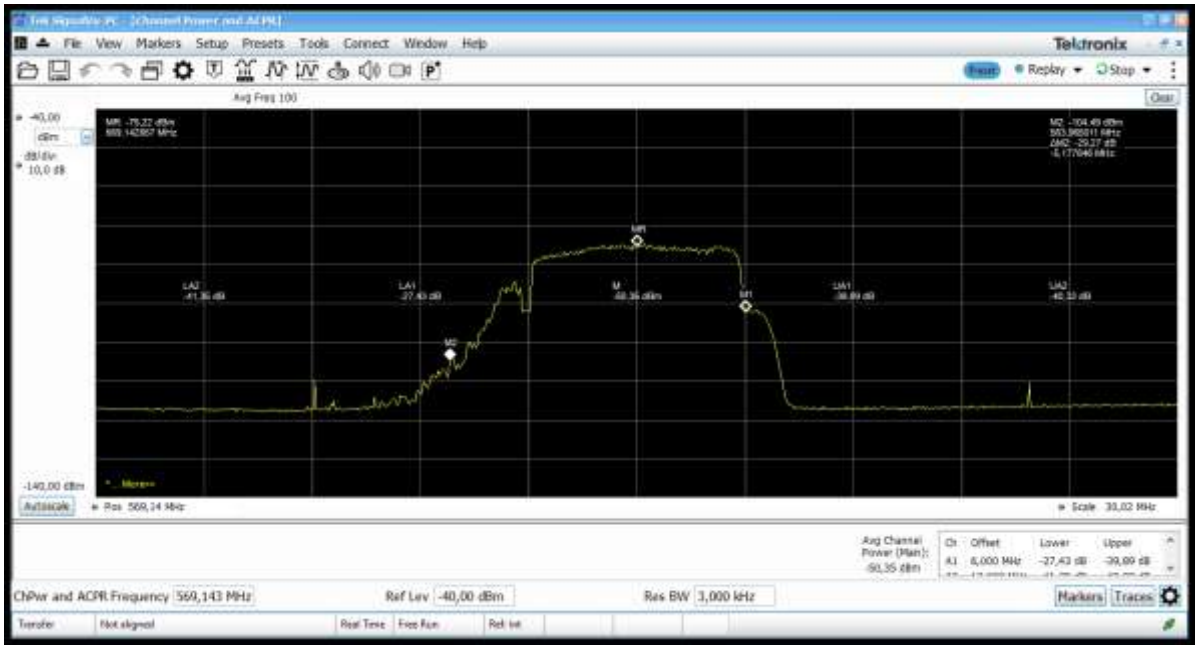


Figure 16.7 - Horizontal

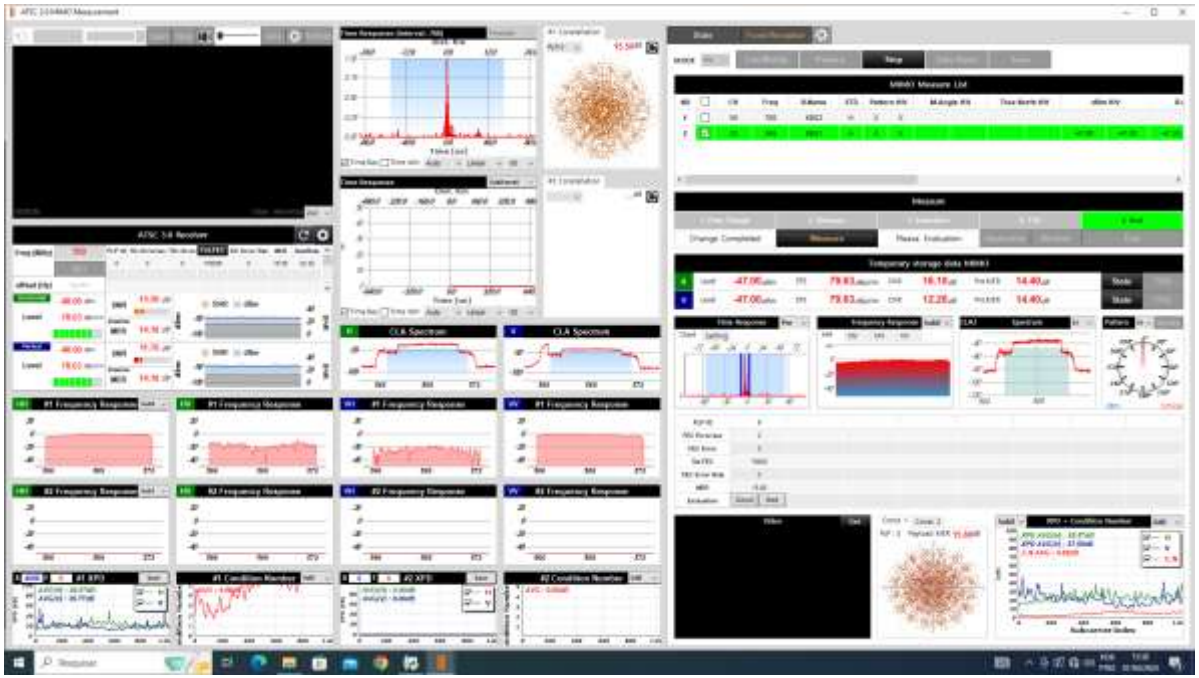


Figure 16.8 - IMAS Screen

d) Reception Threshold

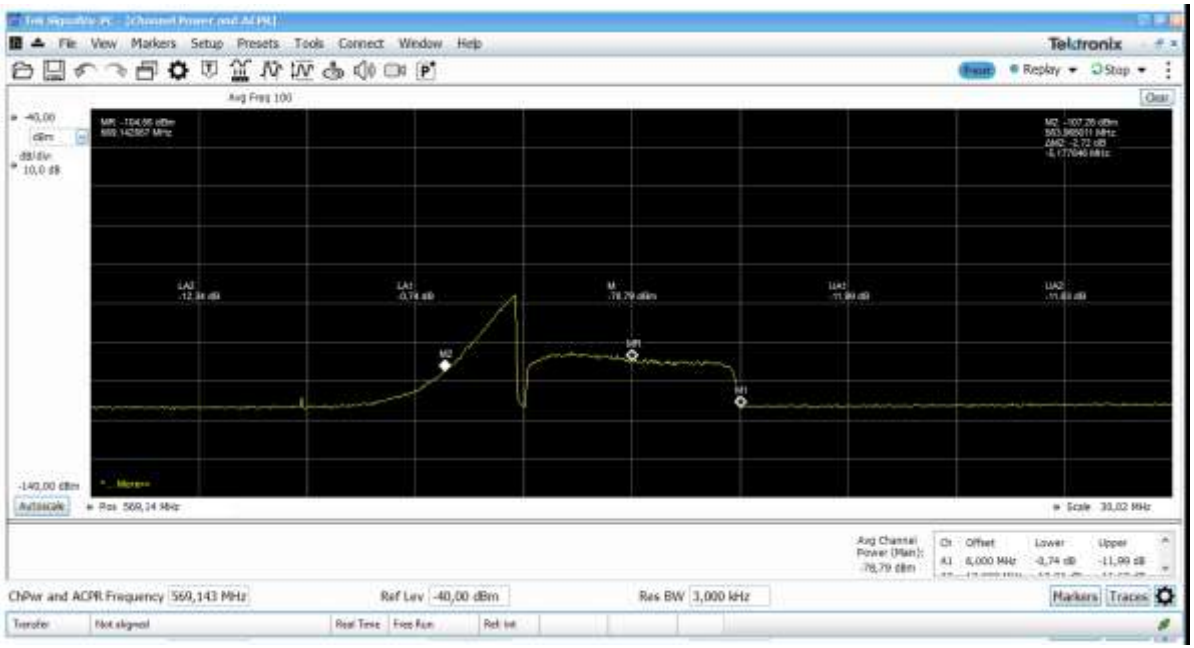


Figure 16.9 - Vertical

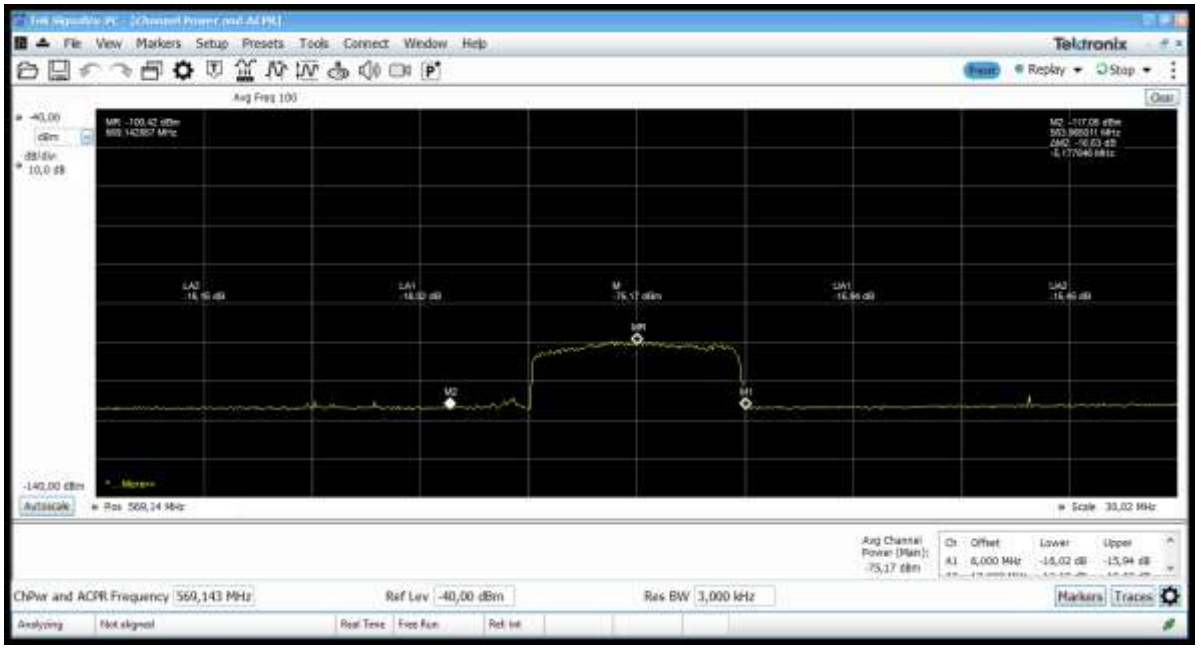


Figure 16.10 - Horizontal

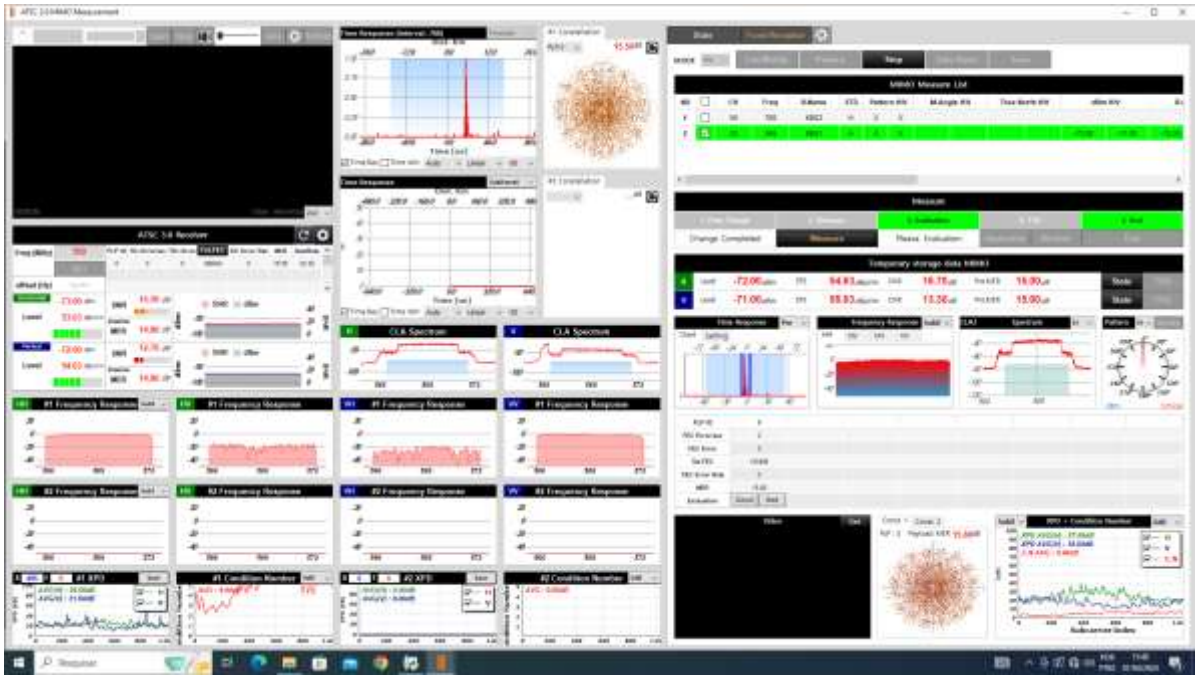


Figure 16.11 - IMAS Screen

Chapter 17. Site 17

a) Channel Power

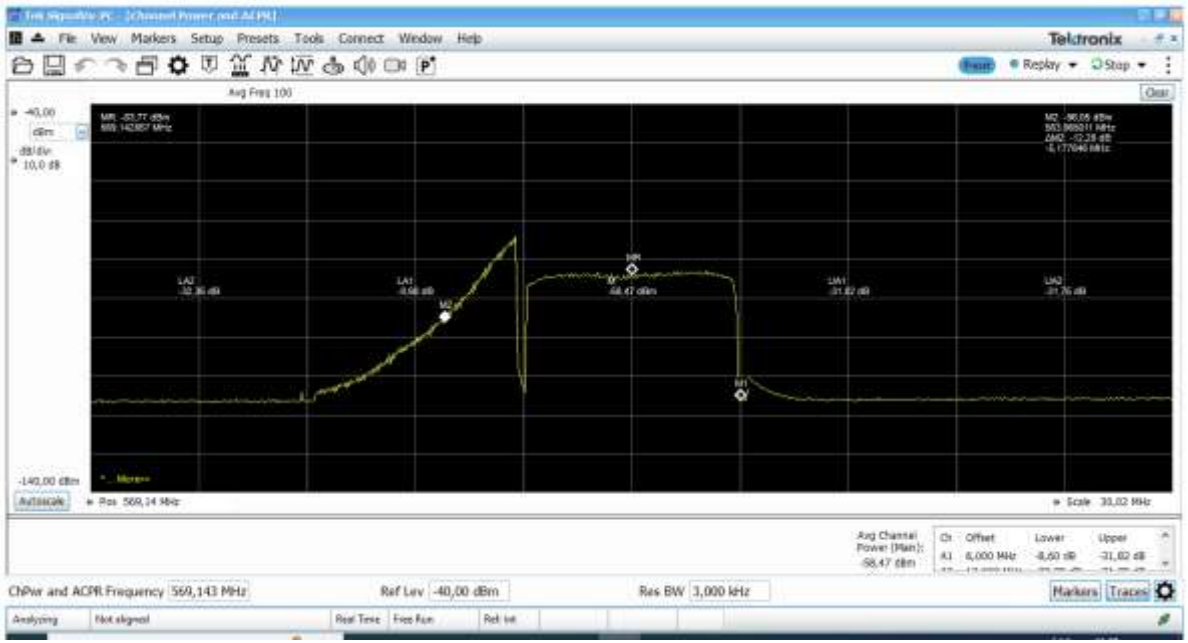


Figure 17.1 - Vertical

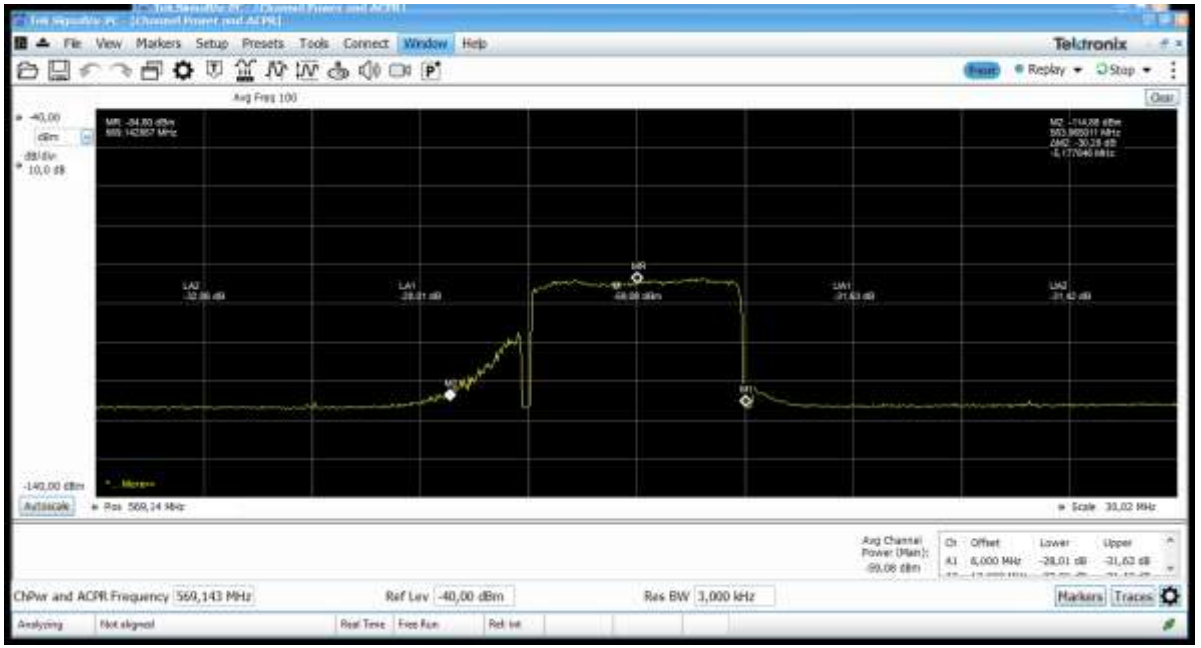


Figure 17.2 - Horizontal

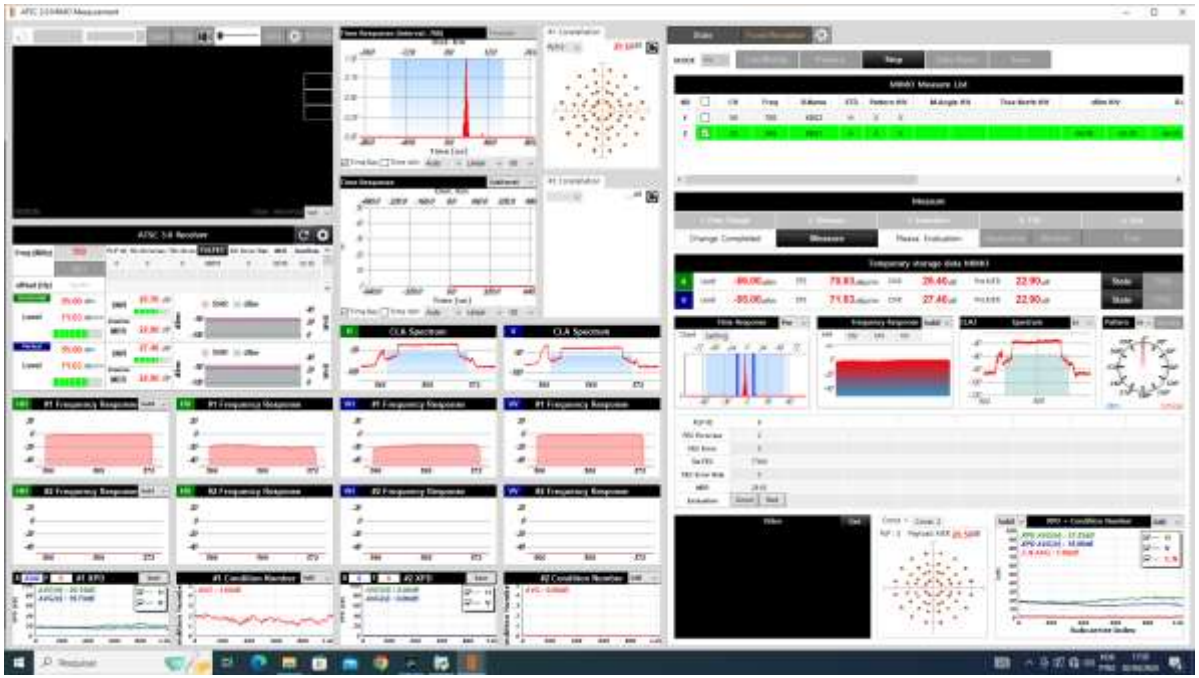


Figure 17.3 - IMAS Screen

b) AWGN Power

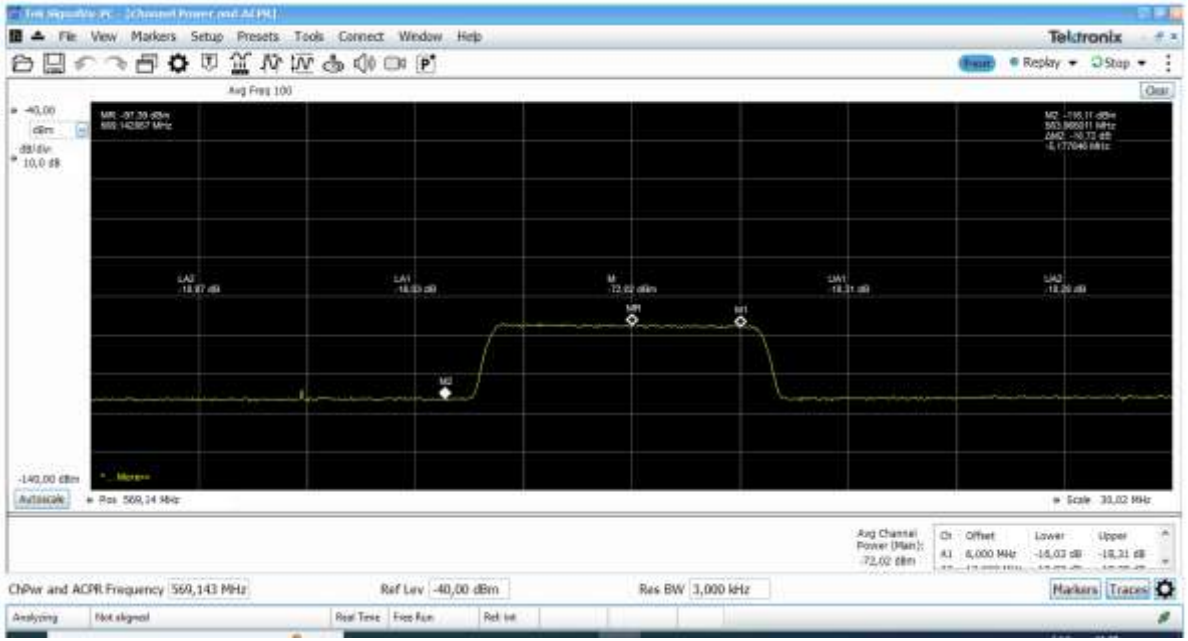


Figure 17.4 - Vertical

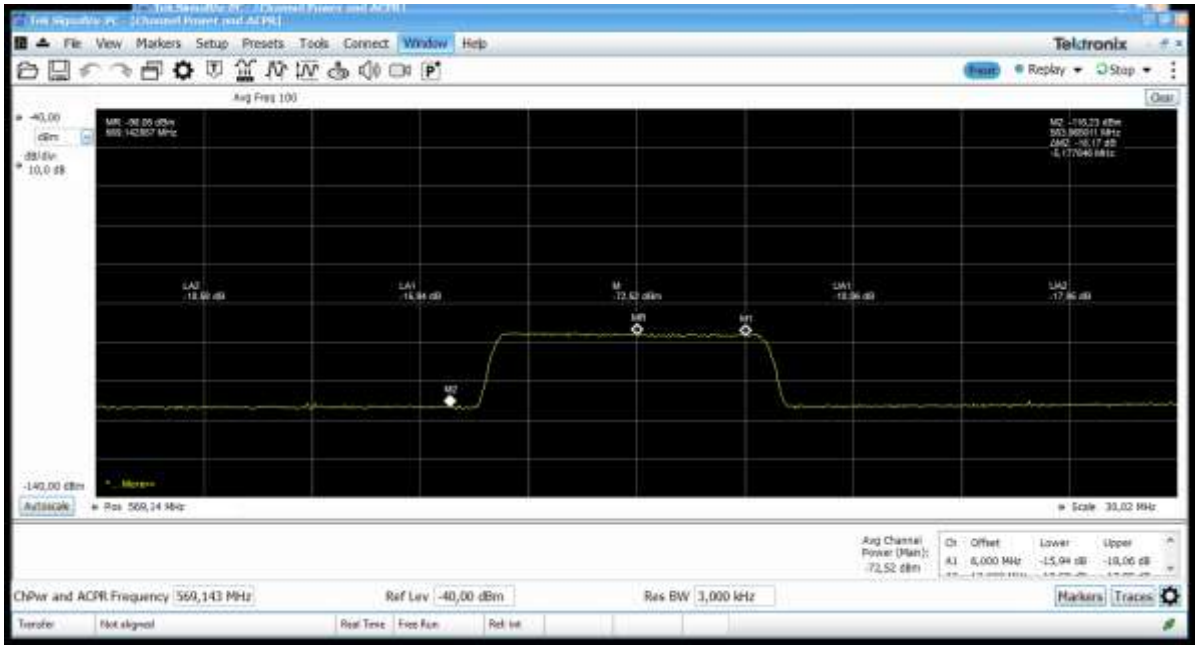


Figure 17.5 - Horizontal

c) C/N Threshold

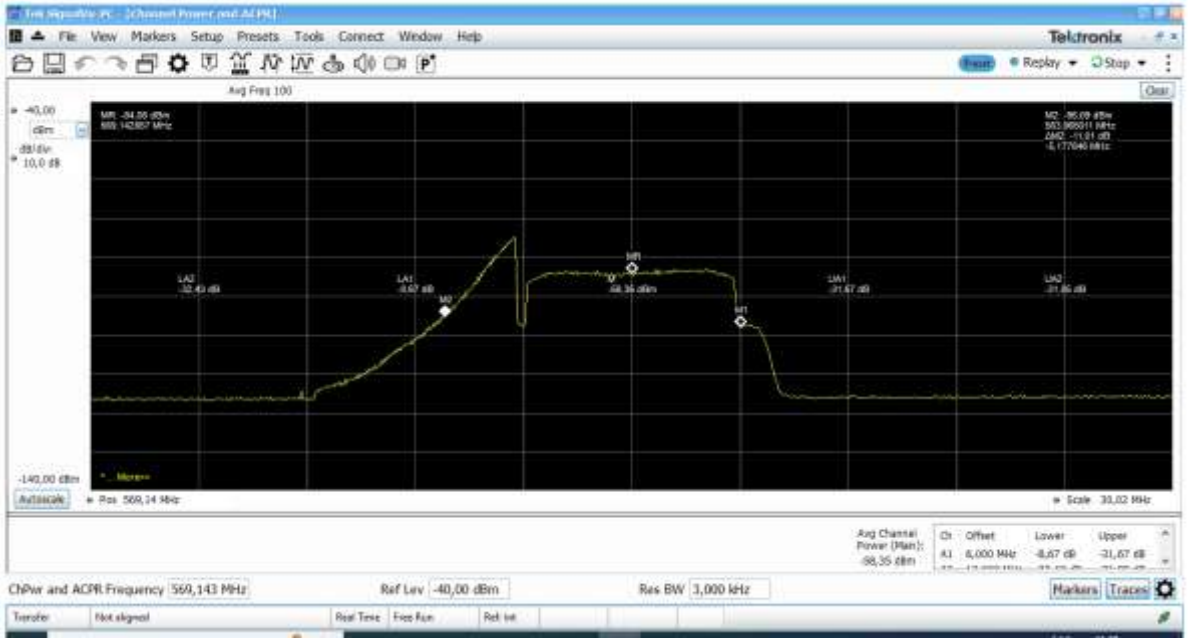


Figure 17.6 - Vertical

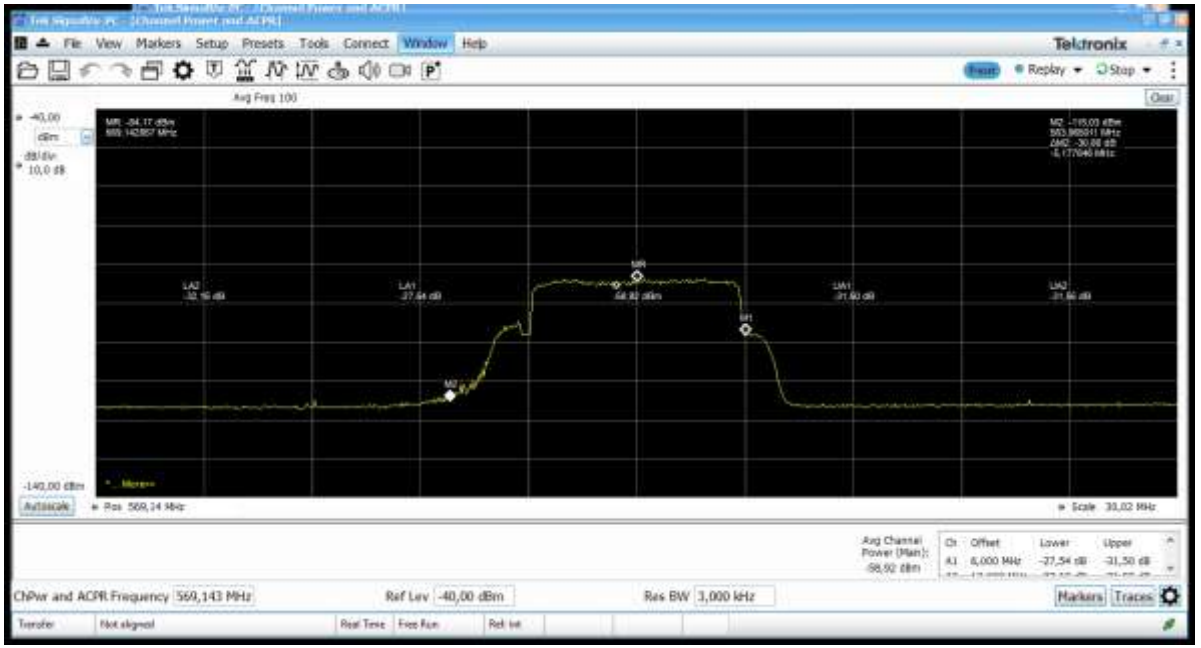


Figure 17.7 - Horizontal

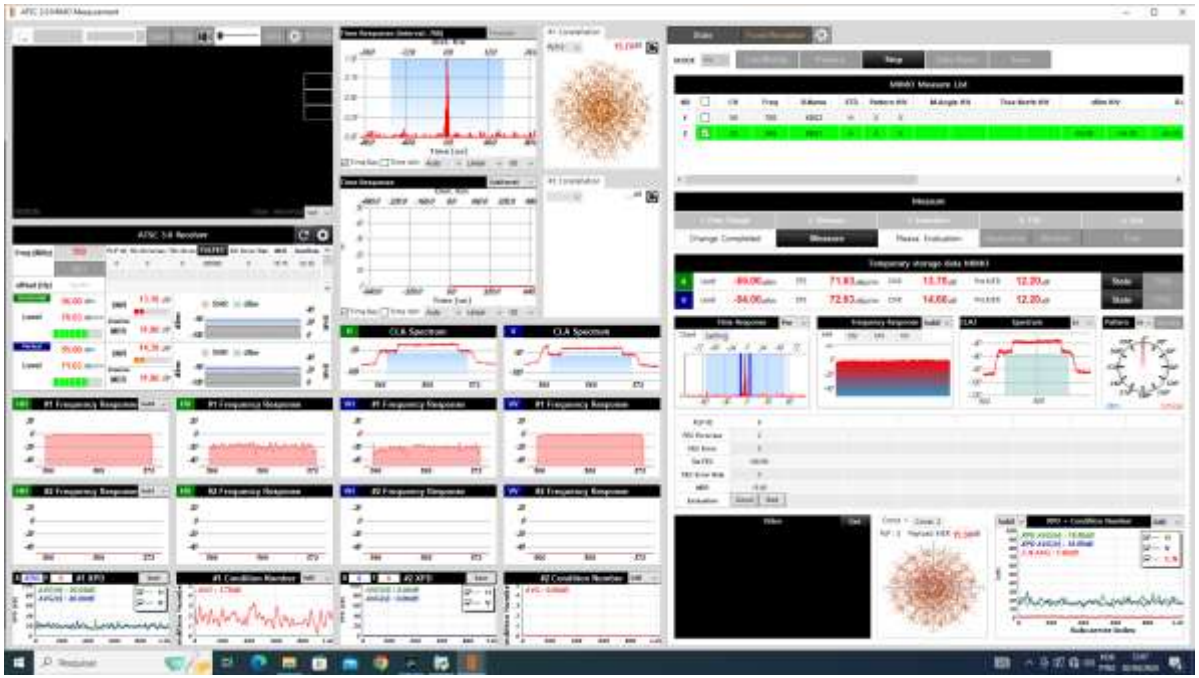


Figure 17.8 - IMAS Screen

d) Reception Threshold

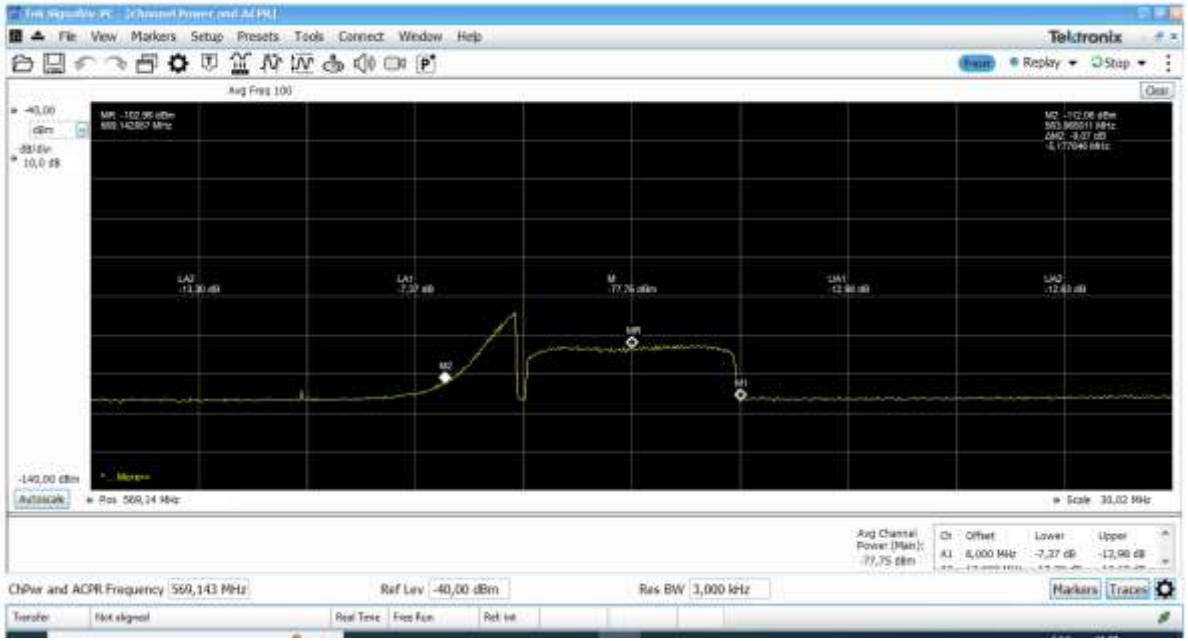


Figure 17.9 - Vertical

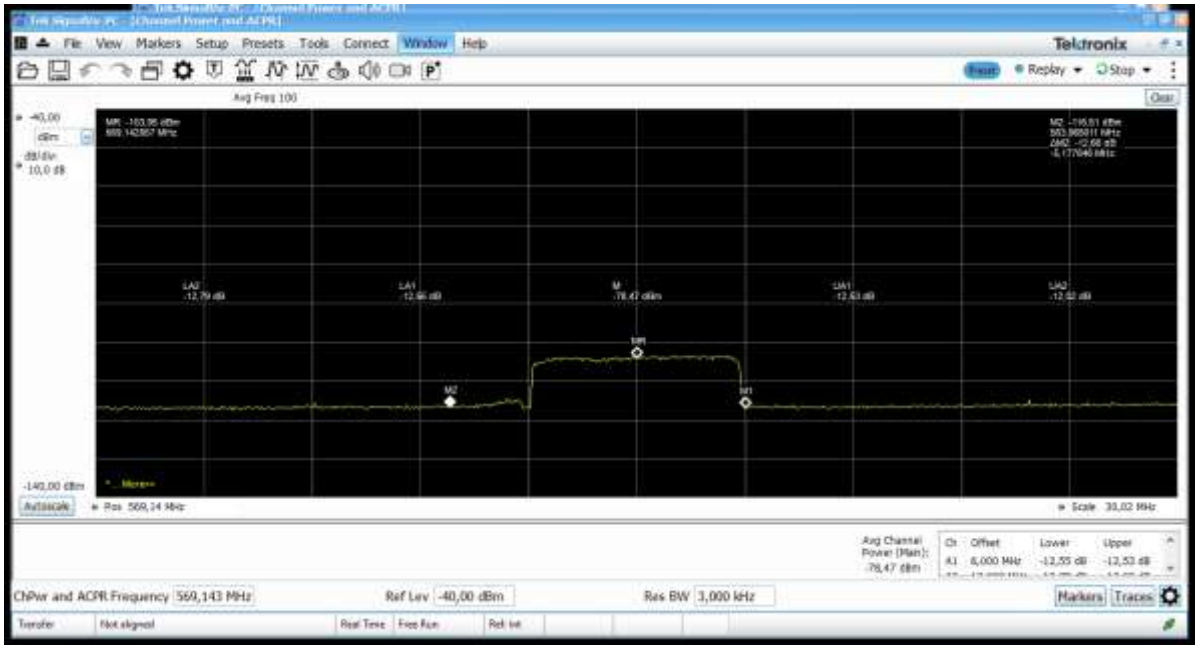


Figure 17.10 - Horizontal

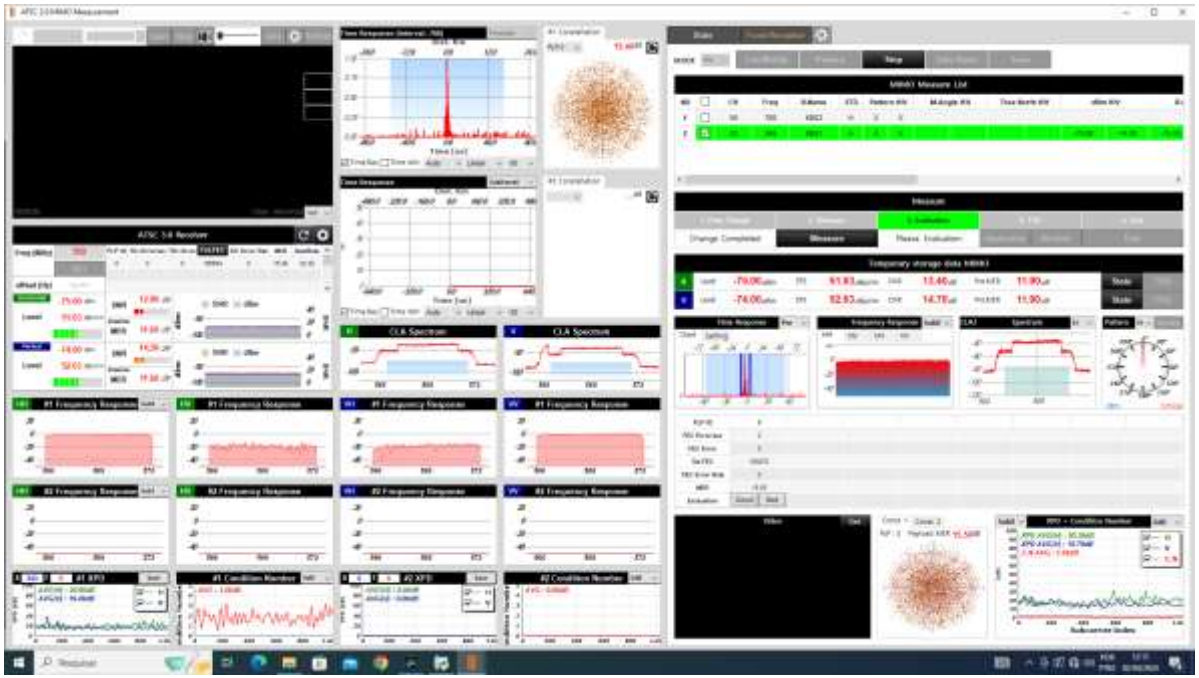


Figure 17.11 - IMAS Screen

Chapter 18. Site 18

a) Channel Power

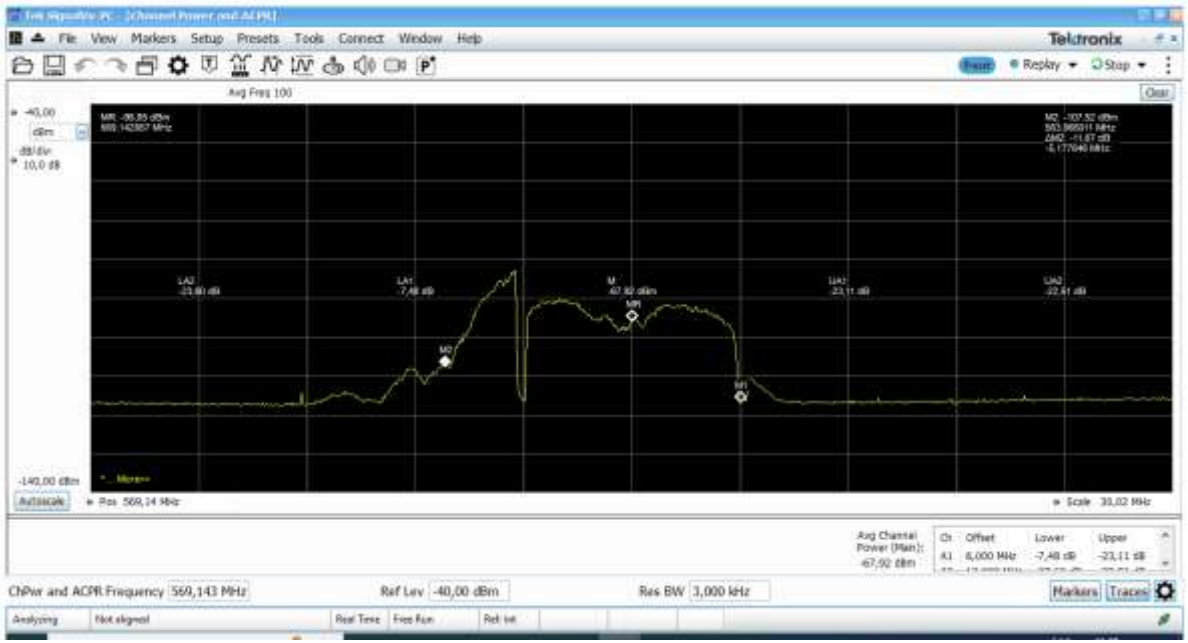


Figure 18.1 - Vertical

Figure 18.2 - Horizontal

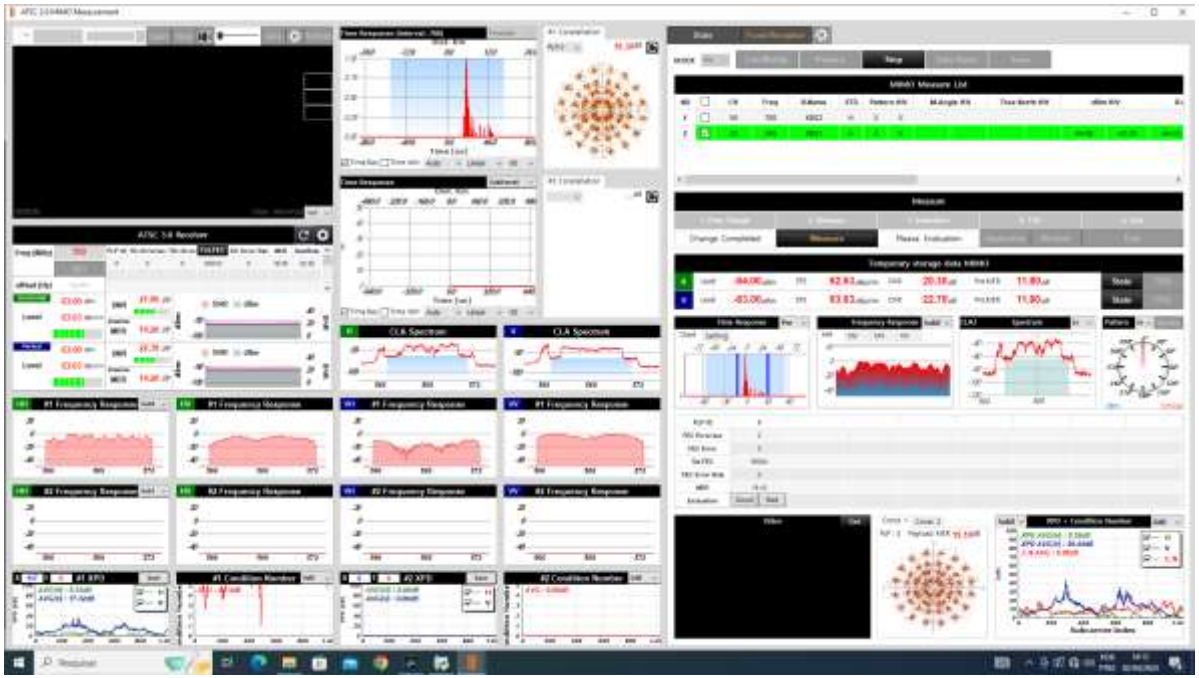


Figure 18.3 - IMAS Screen

b) AWGN Power

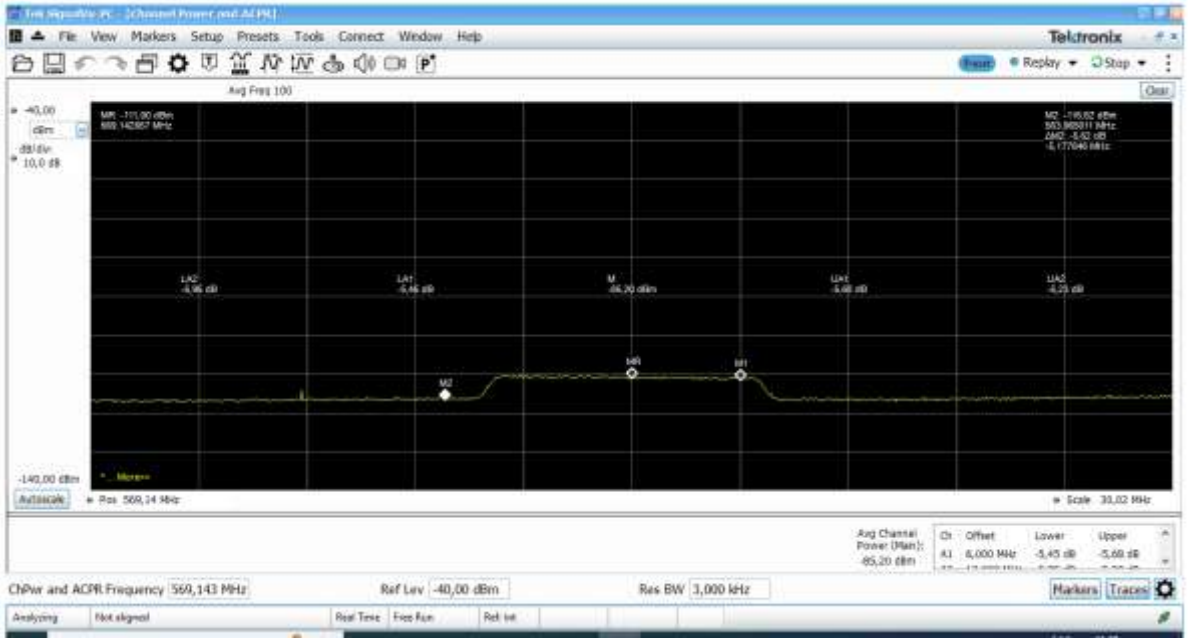


Figure 18.4 - Vertical

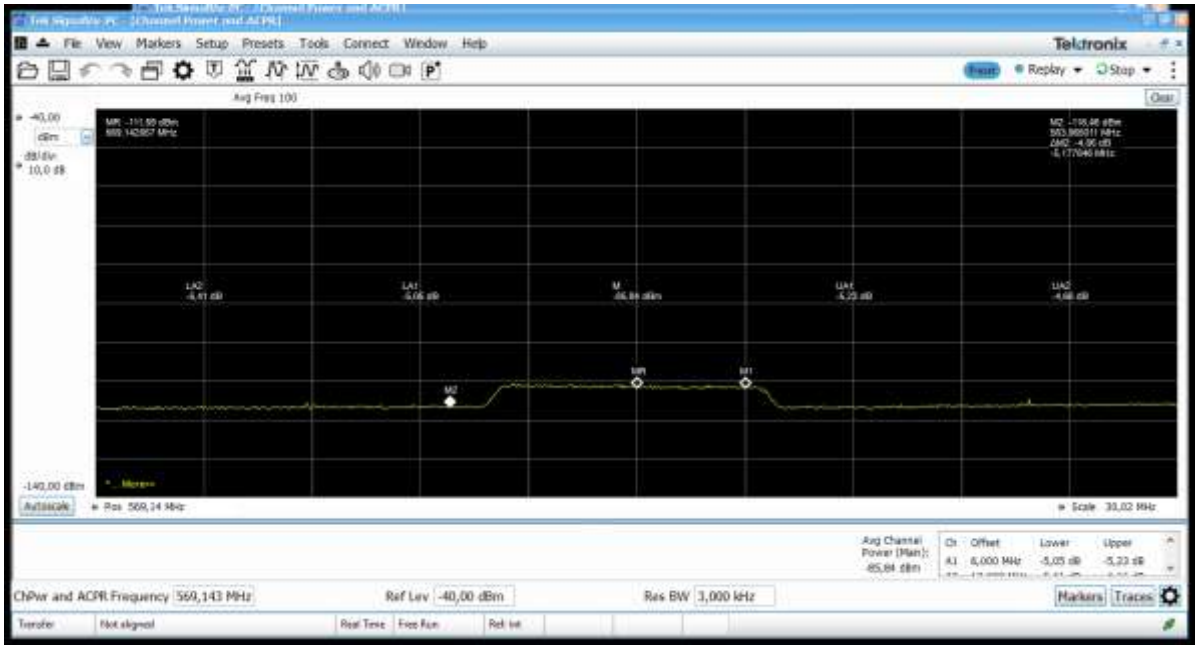


Figure 18.5 - Horizontal

c) C/N Threshold

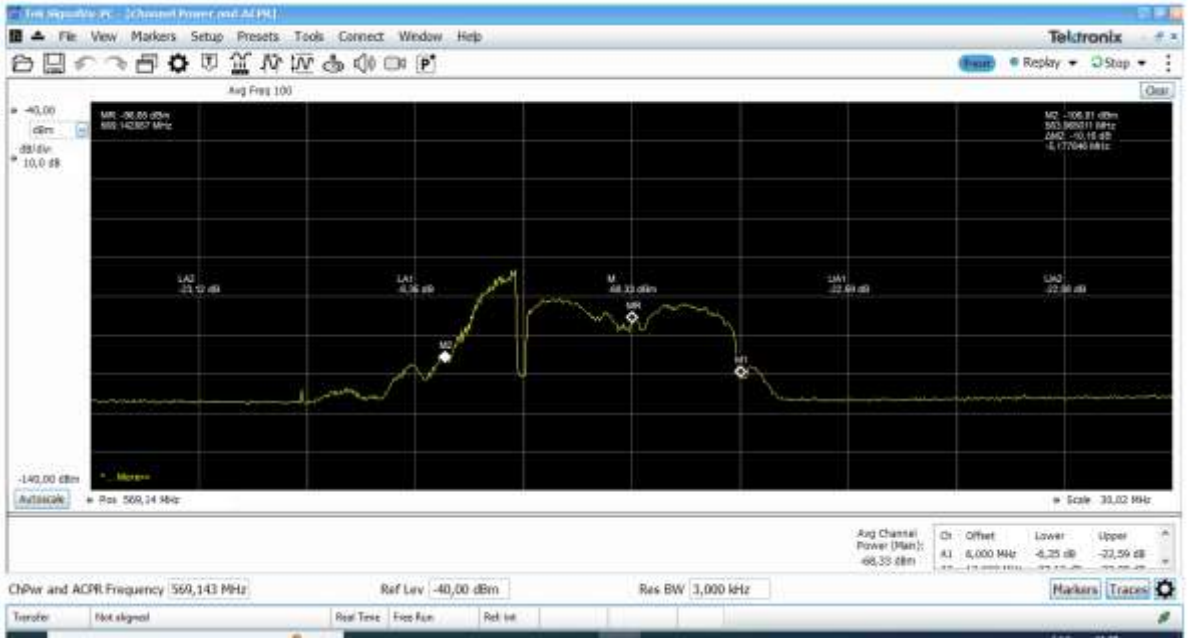


Figure 18.6 - Vertical

Figure 18.7 - Horizontal

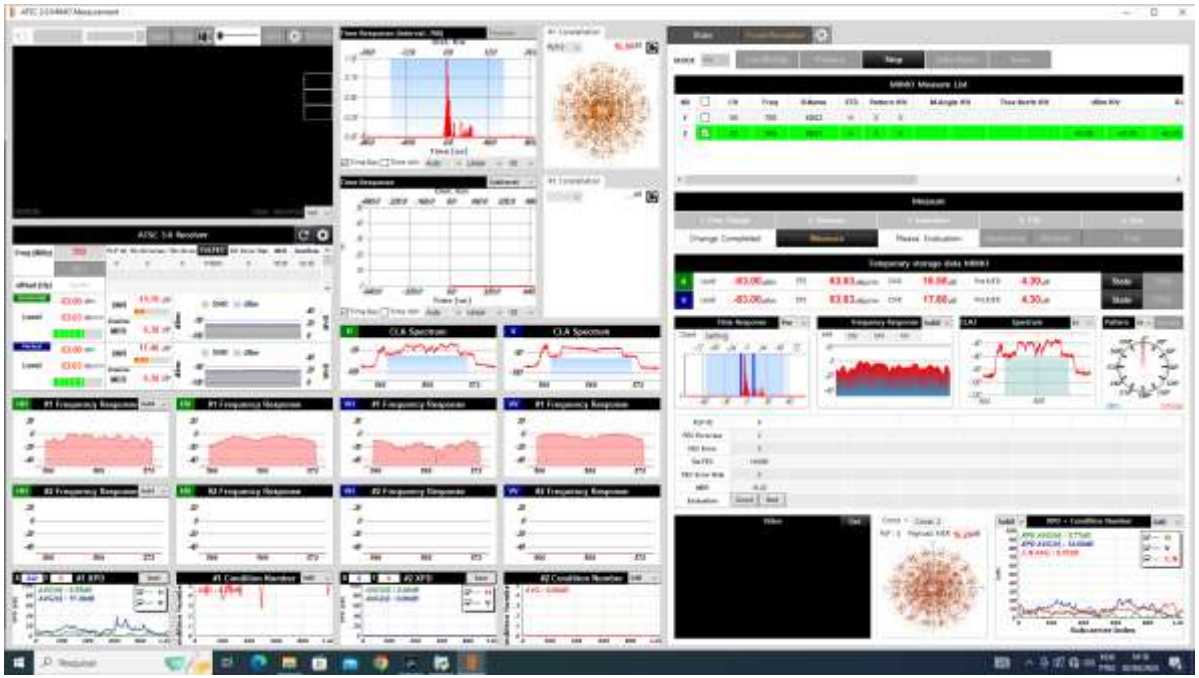


Figure 18.8 - IMAS Screen

d) Reception Threshold

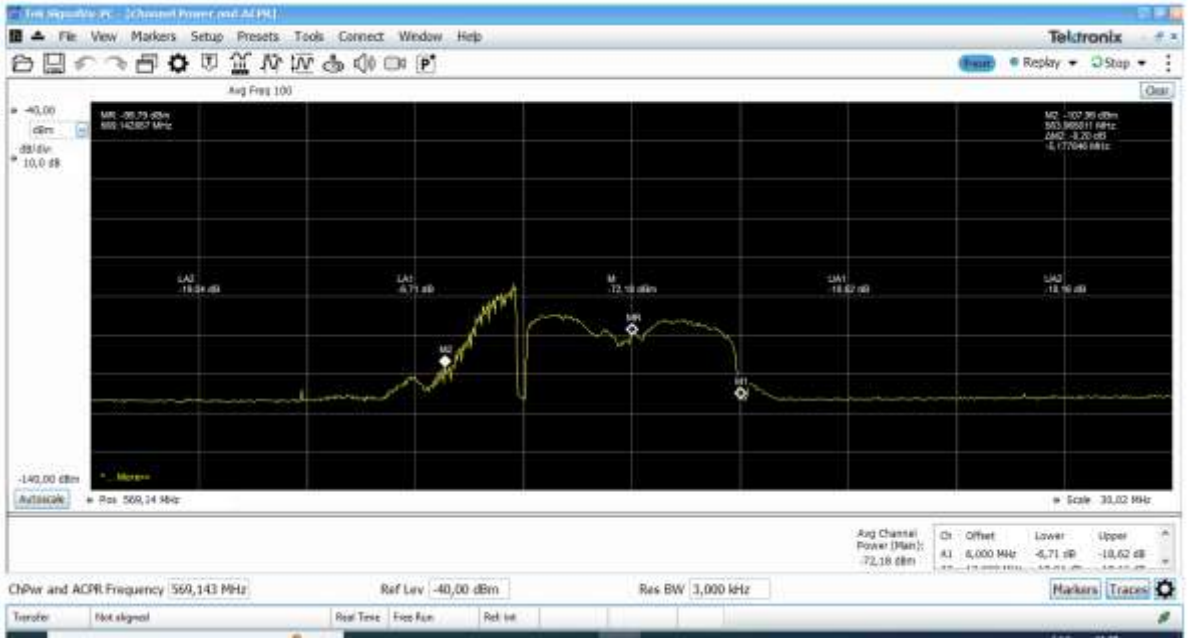


Figure 18.9 - Vertical

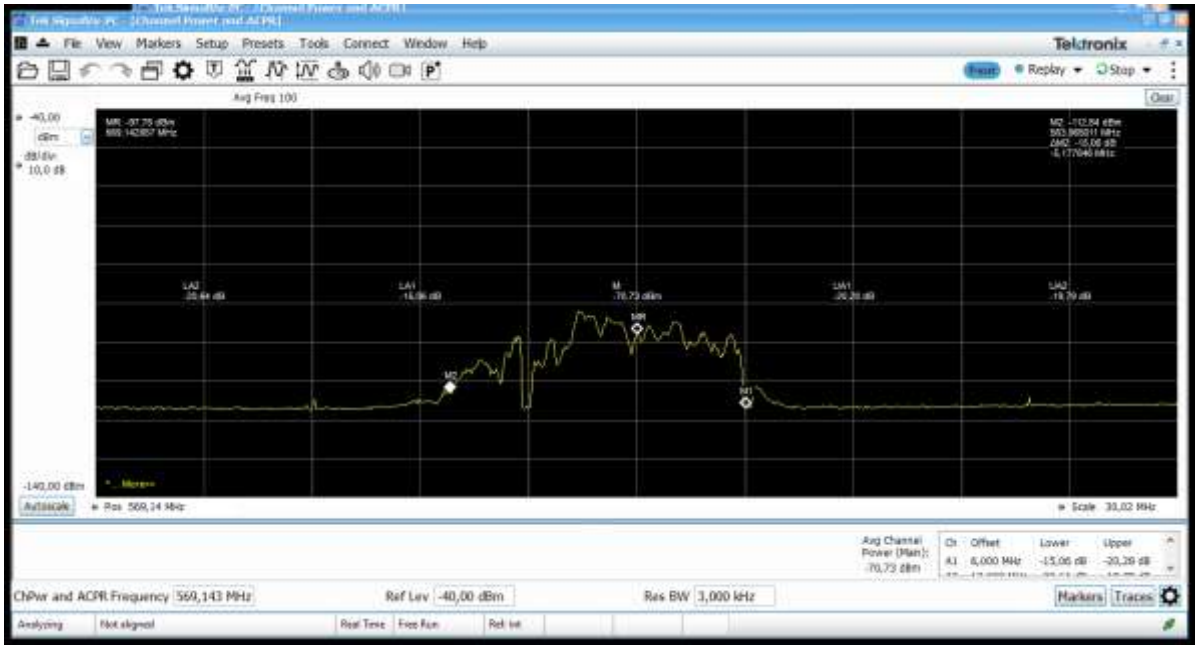


Figure 18.10 - Horizontal

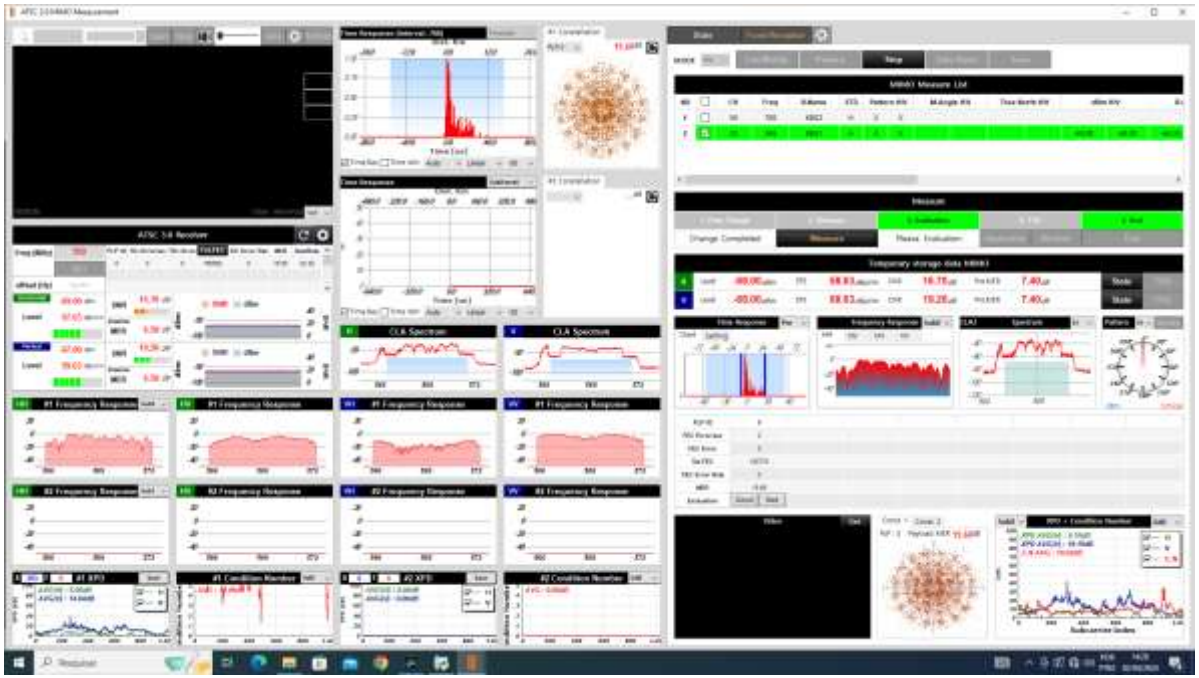


Figure 18.11 - IMAS Screen

Chapter 19. Site 19

a) Channel Power

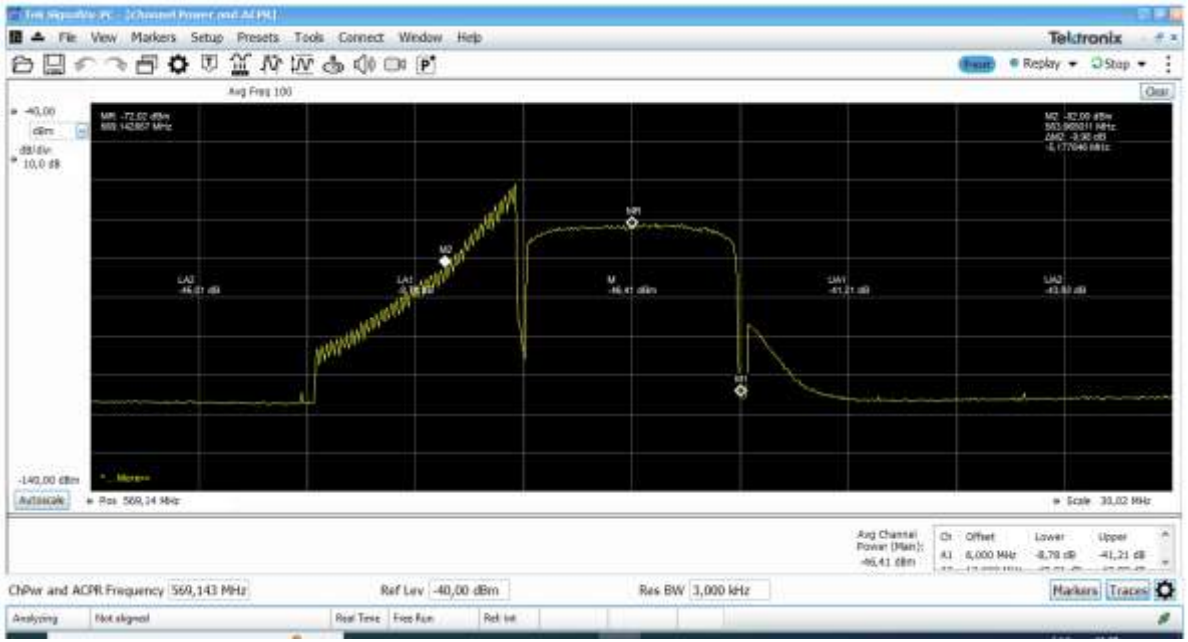


Figure 19.1 - Vertical

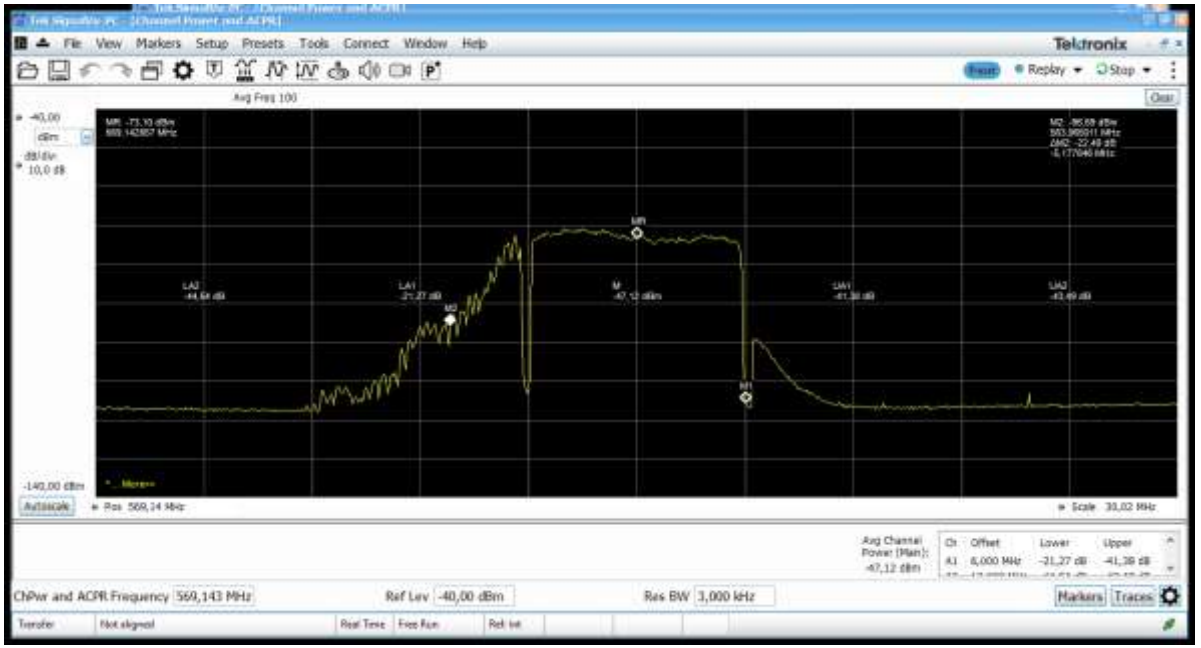


Figure 19.2 - Horizontal

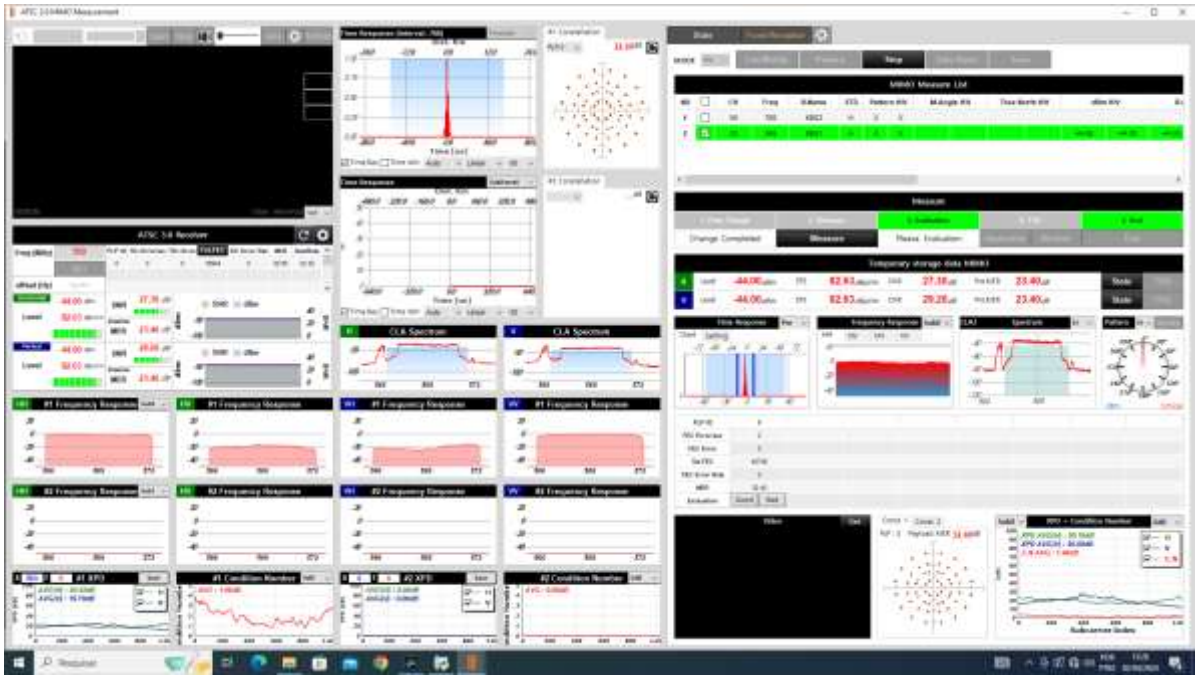


Figure 19.3 - IMAS Screen

b) AWGN Power

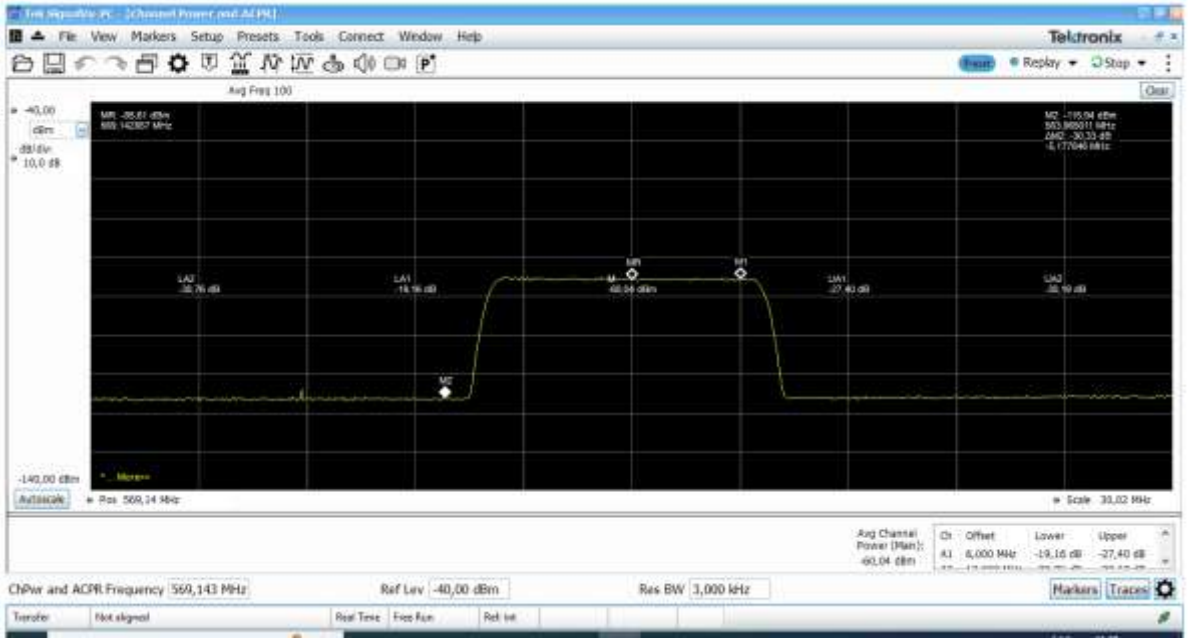


Figure 19.4 - Vertical

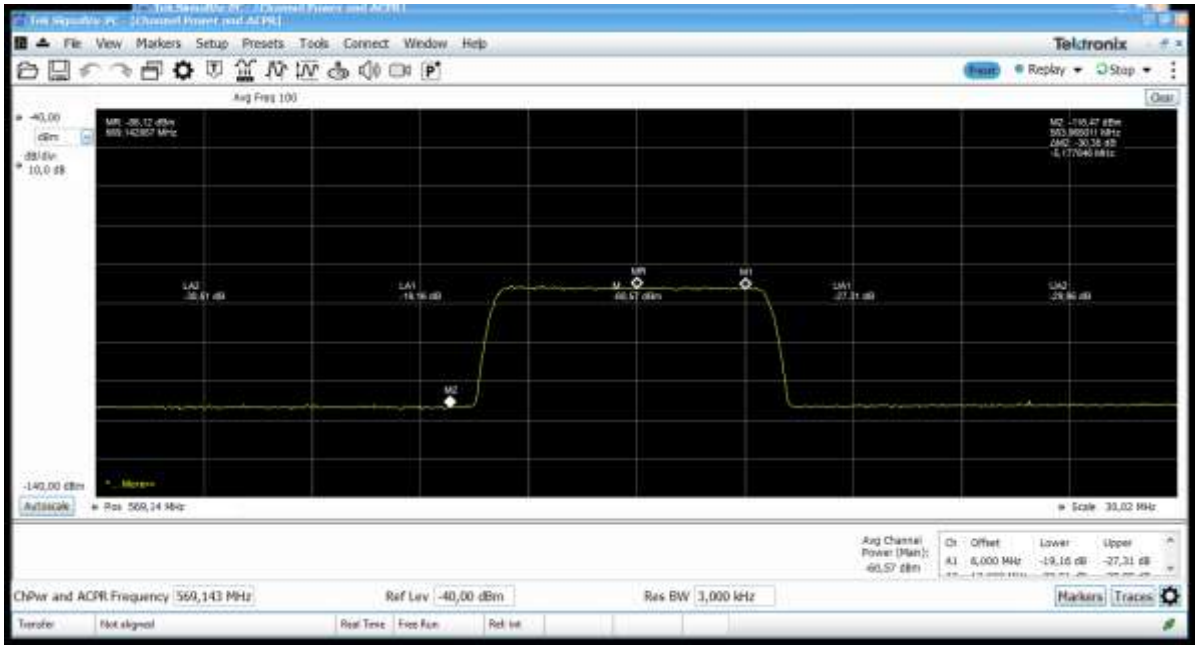


Figure 19.5 - Horizontal

c) C/N Threshold

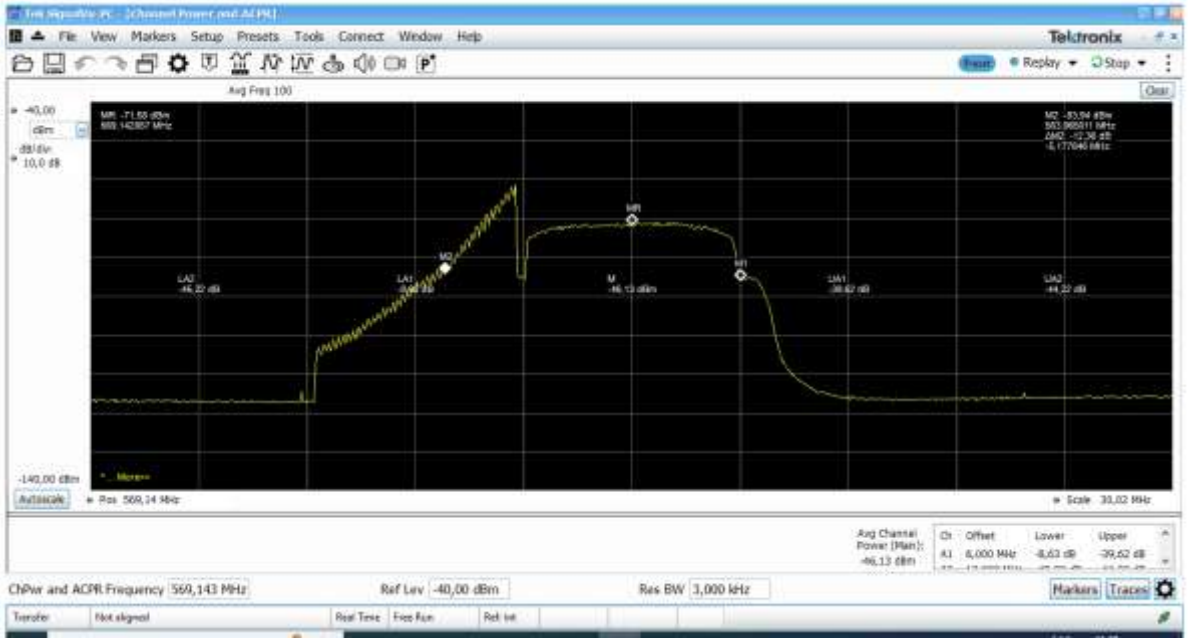


Figure 19.6 - Vertical

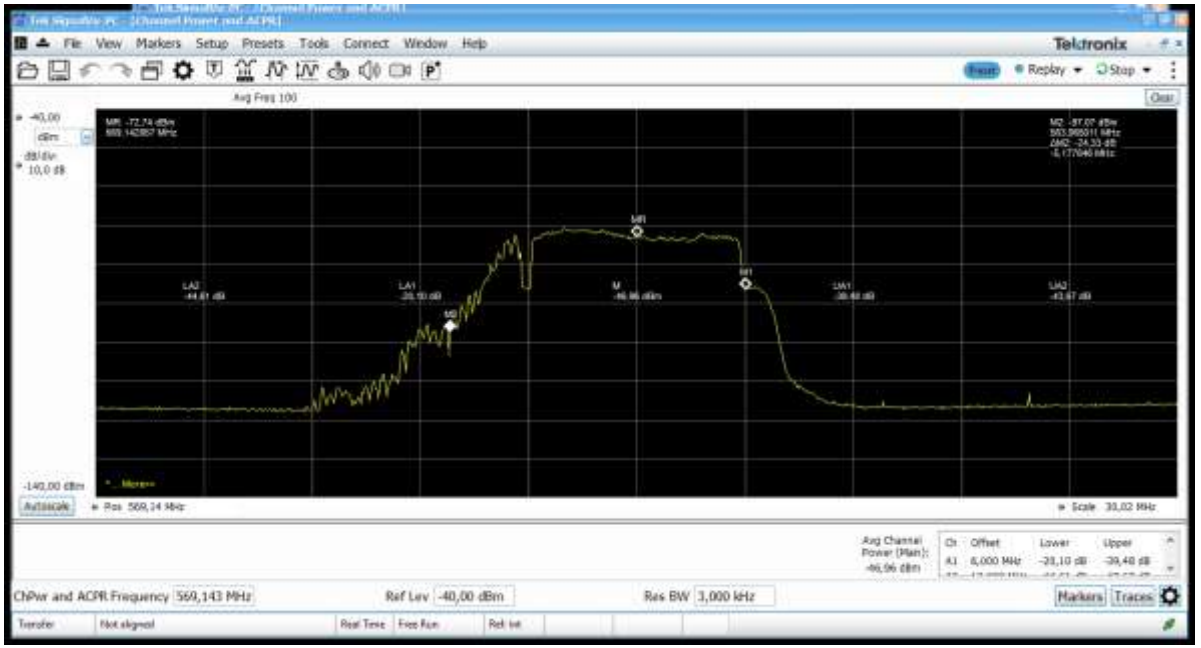


Figure 19.7 - Horizontal

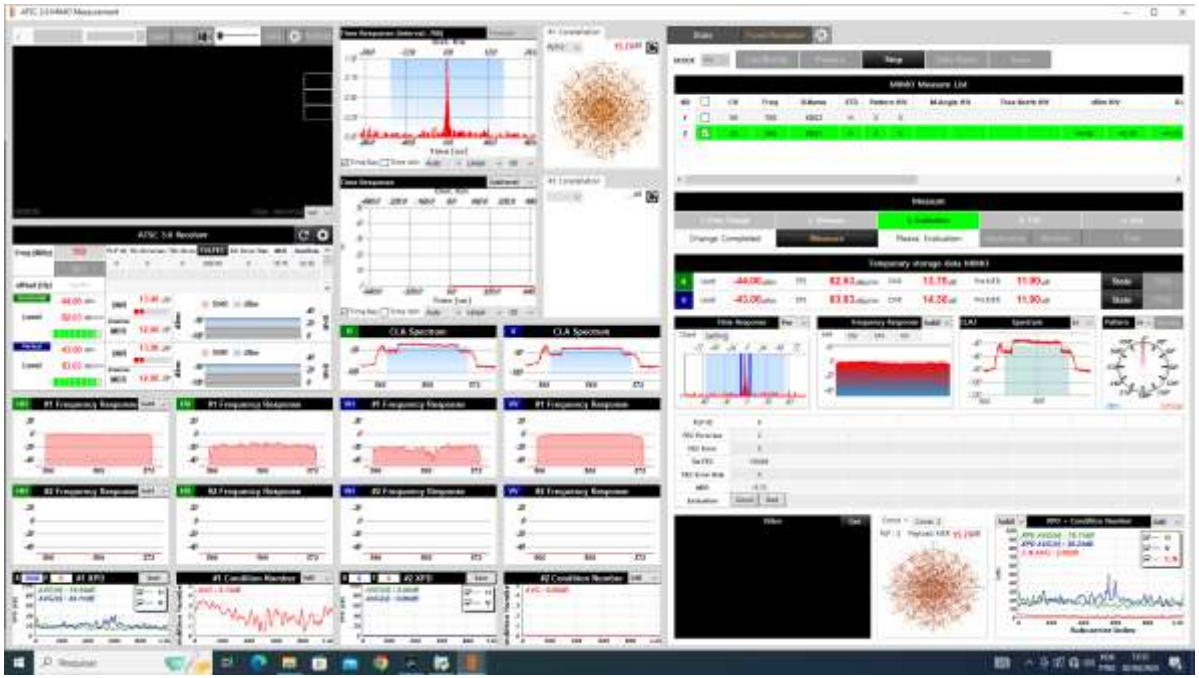


Figure 19.8 - IMAS Screen

d) Reception Threshold

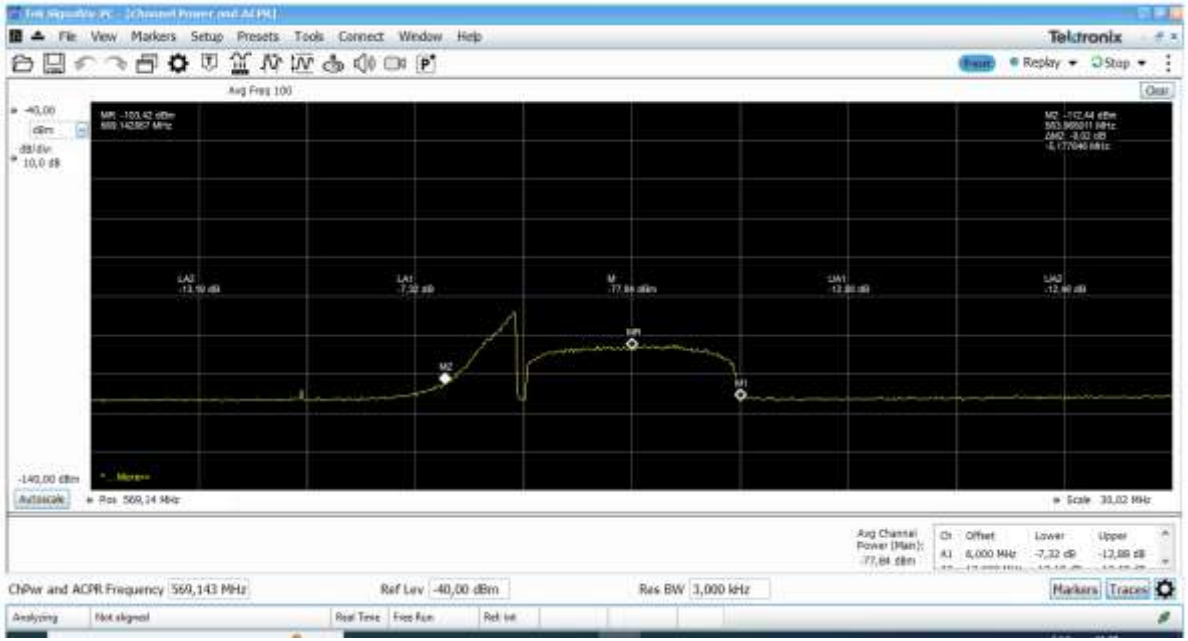


Figure 19.9 - Vertical

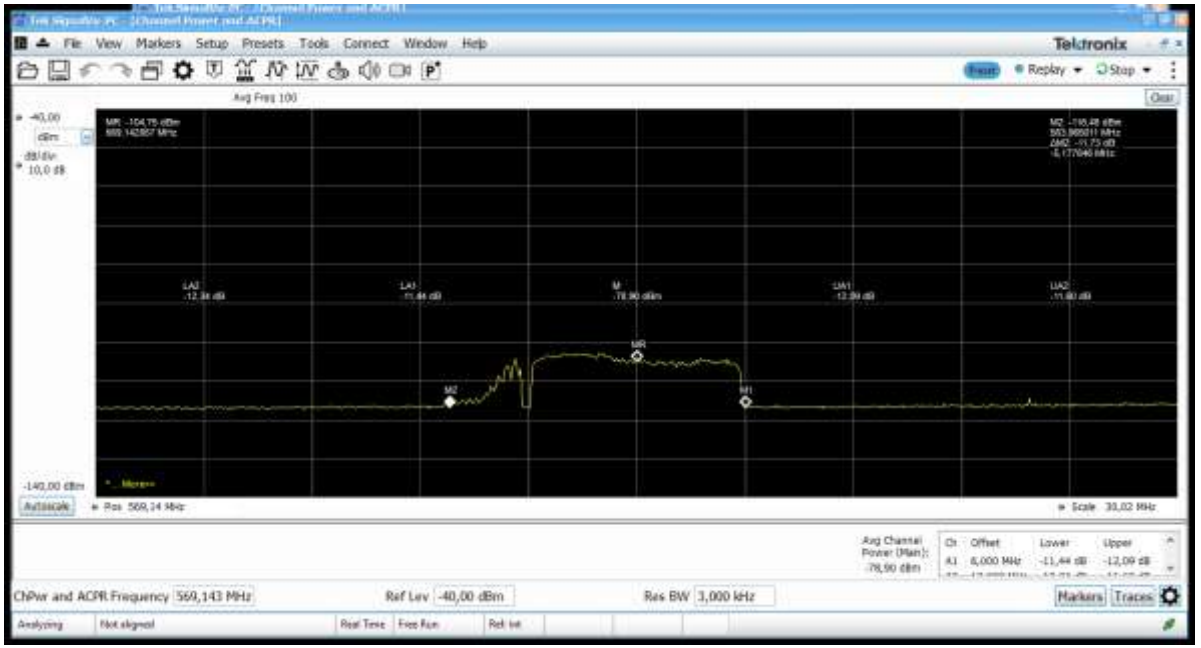


Figure 19.10 - Horizontal

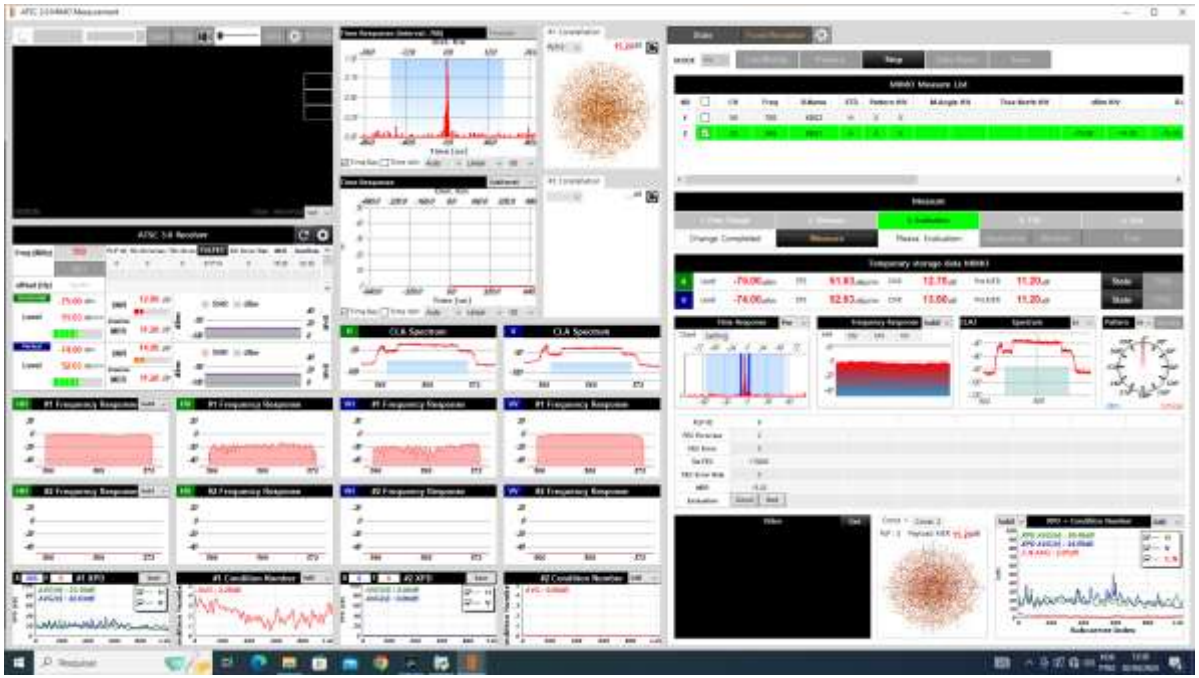


Figure 19.11 - IMAS Screen

Chapter 20. Site 20

a) Channel Power

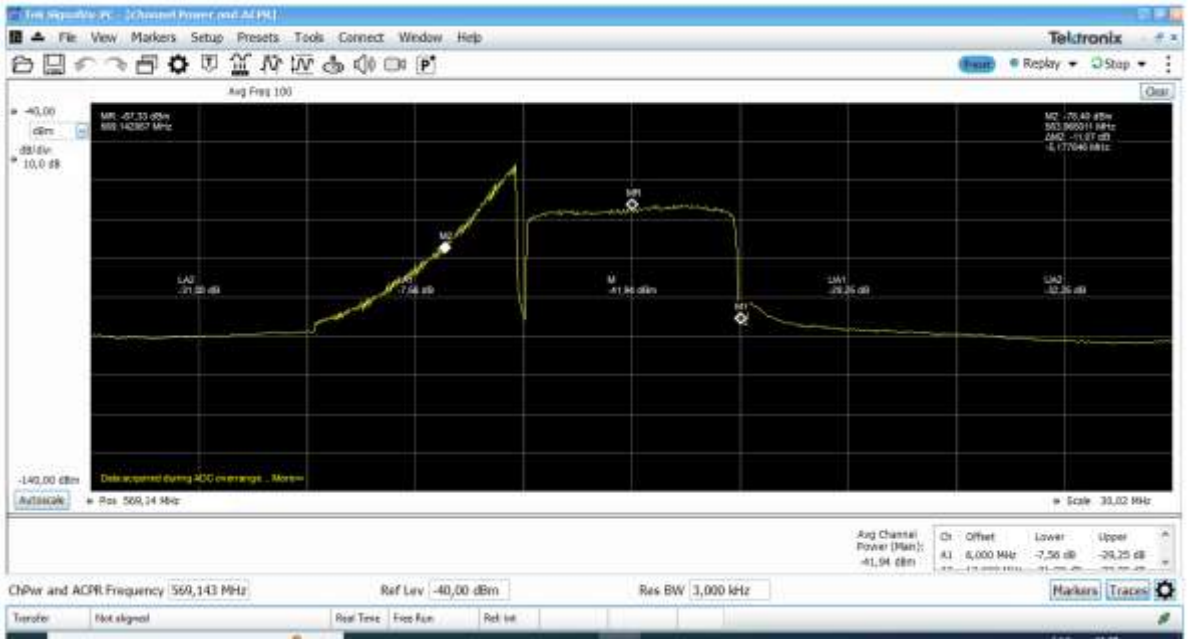


Figure 20.1 - Vertical

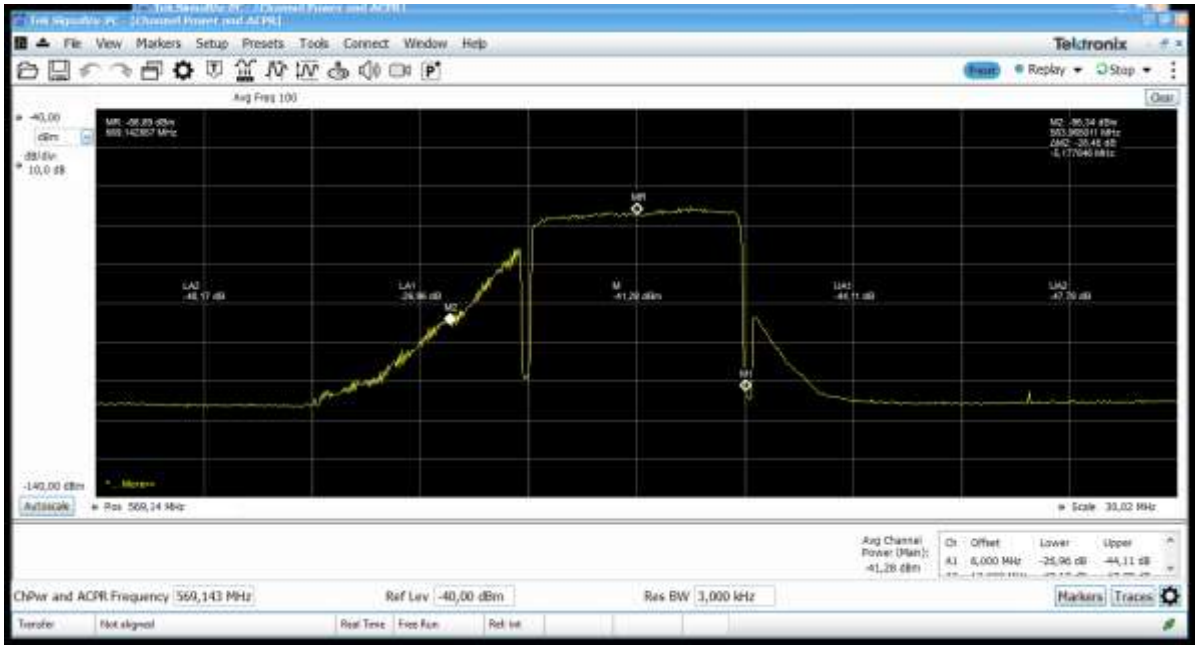


Figure 20.2 - Horizontal

Figure 20.3 - IMAS Screen

b) AWGN Power

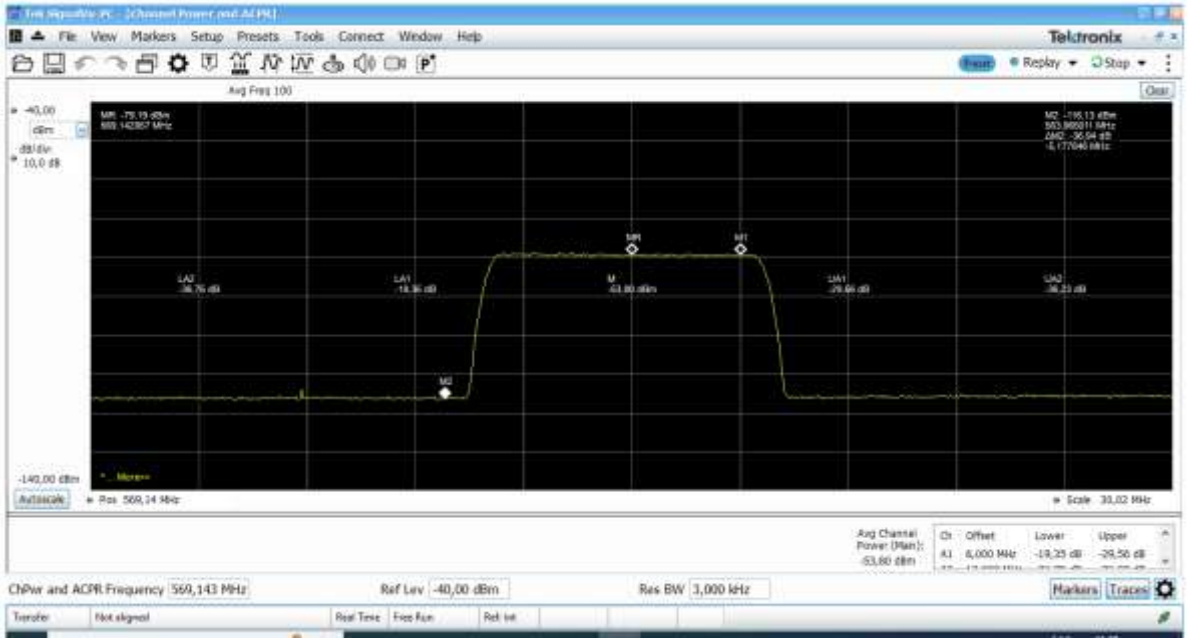


Figure 20.4 - Vertical

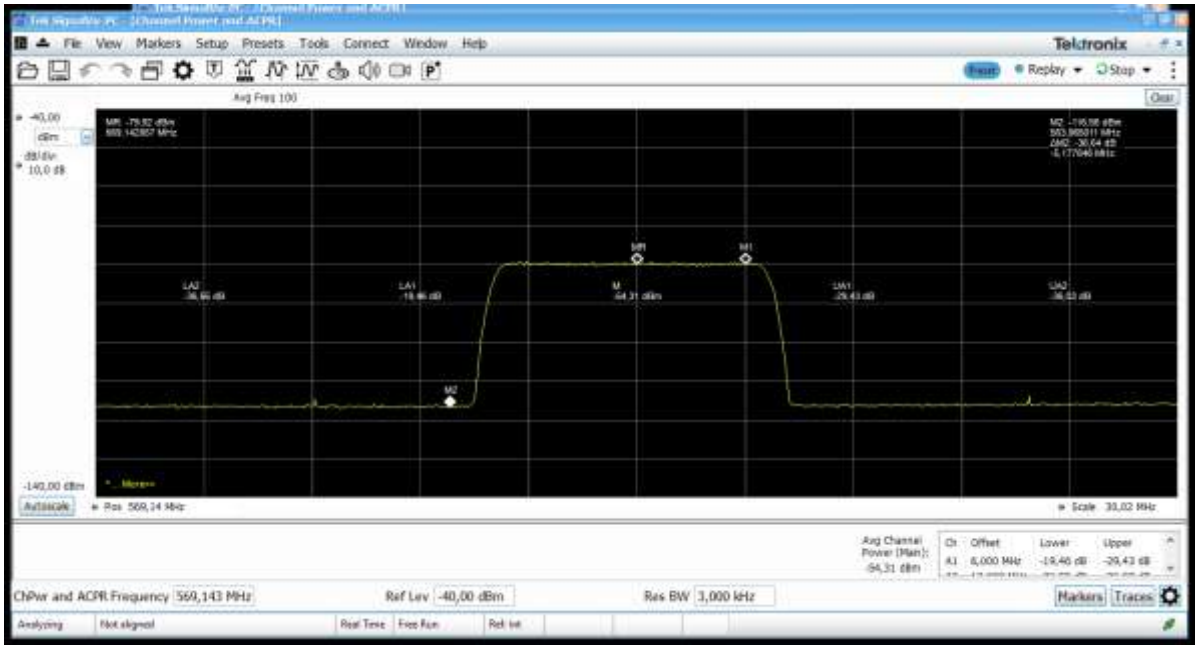


Figure 20.5 - Horizontal

c) C/N Threshold

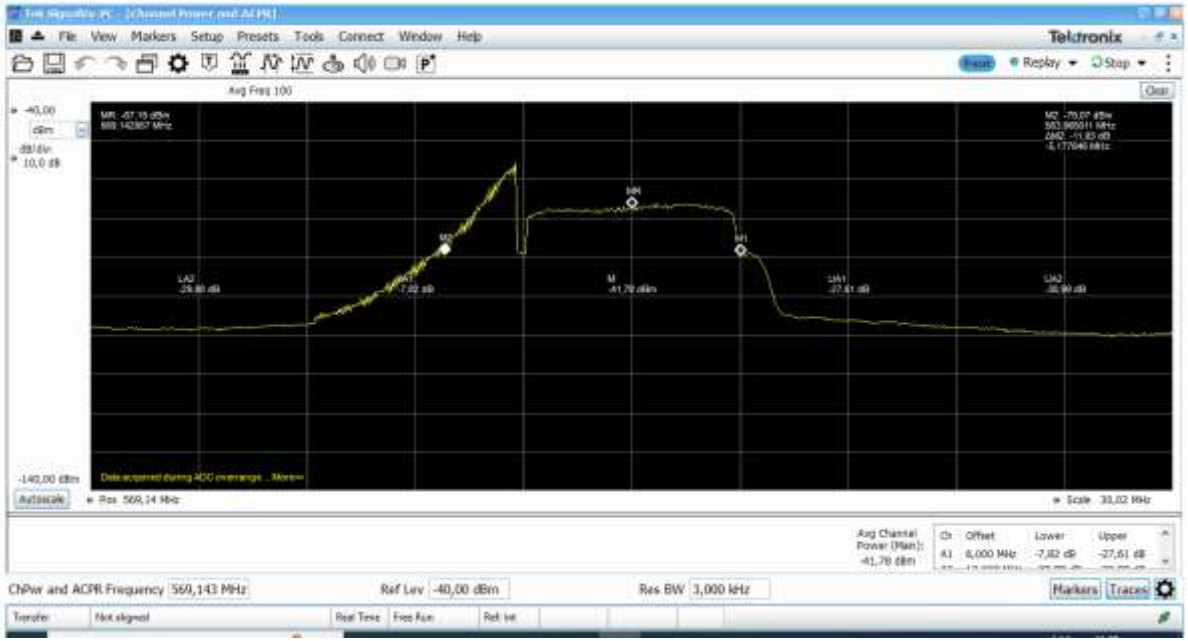


Figure 20.6 - Vertical

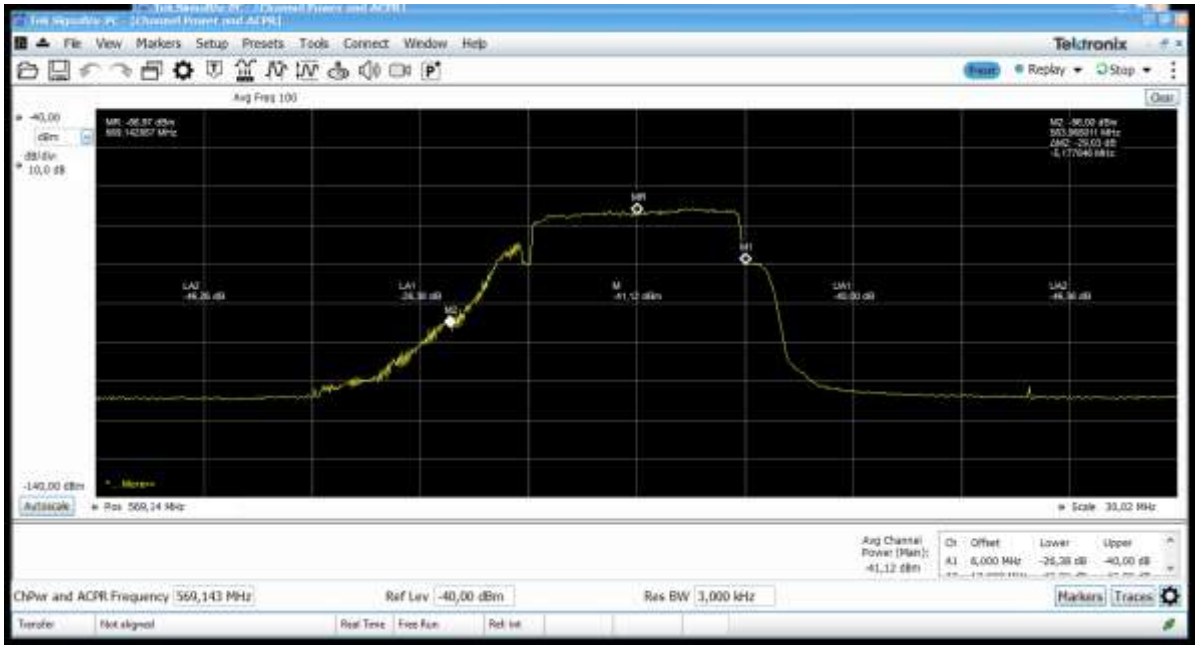


Figure 20.7 - Horizontal

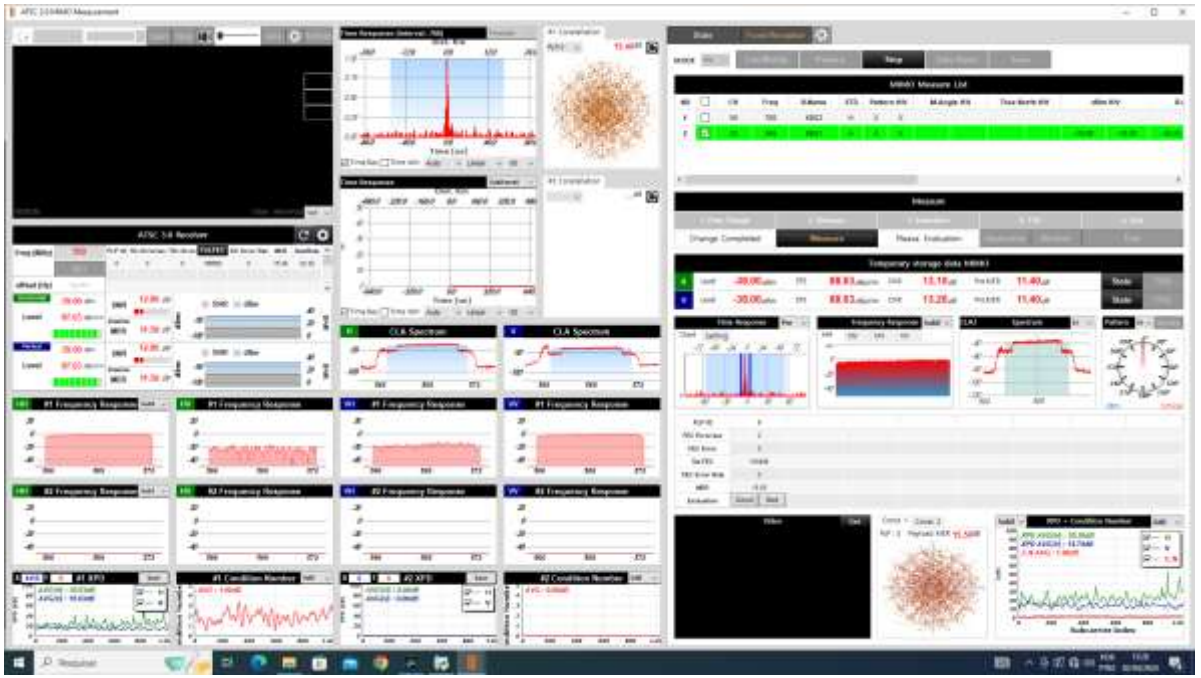


Figure 20.8 - IMAS Screen

d) Reception Threshold

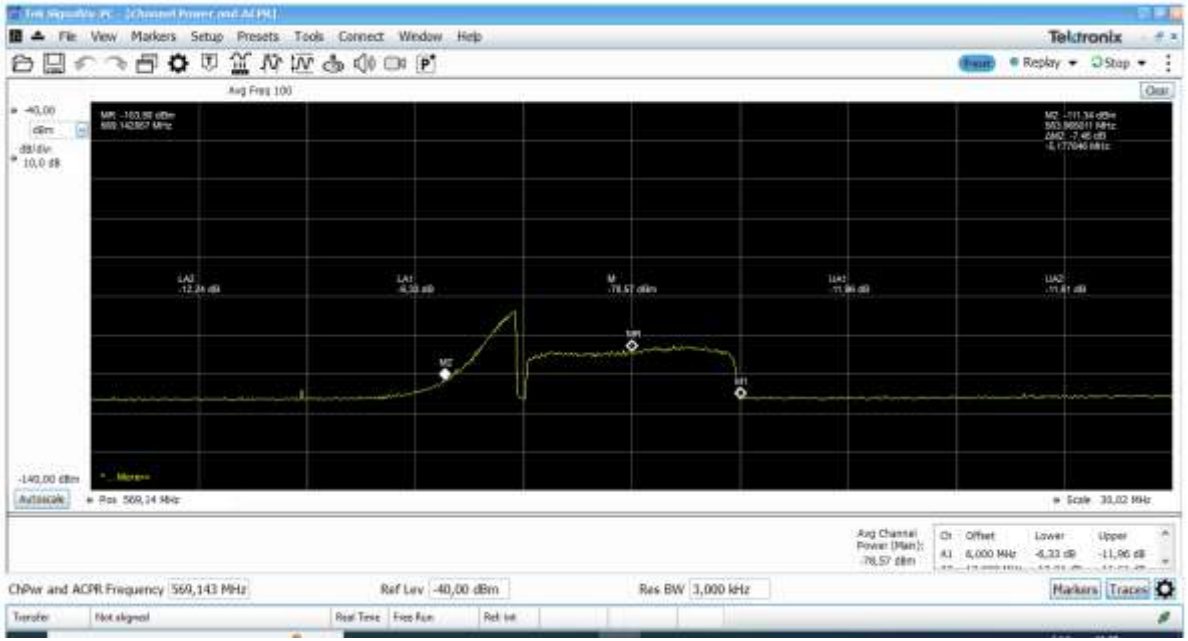


Figure 20.9 - Vertical

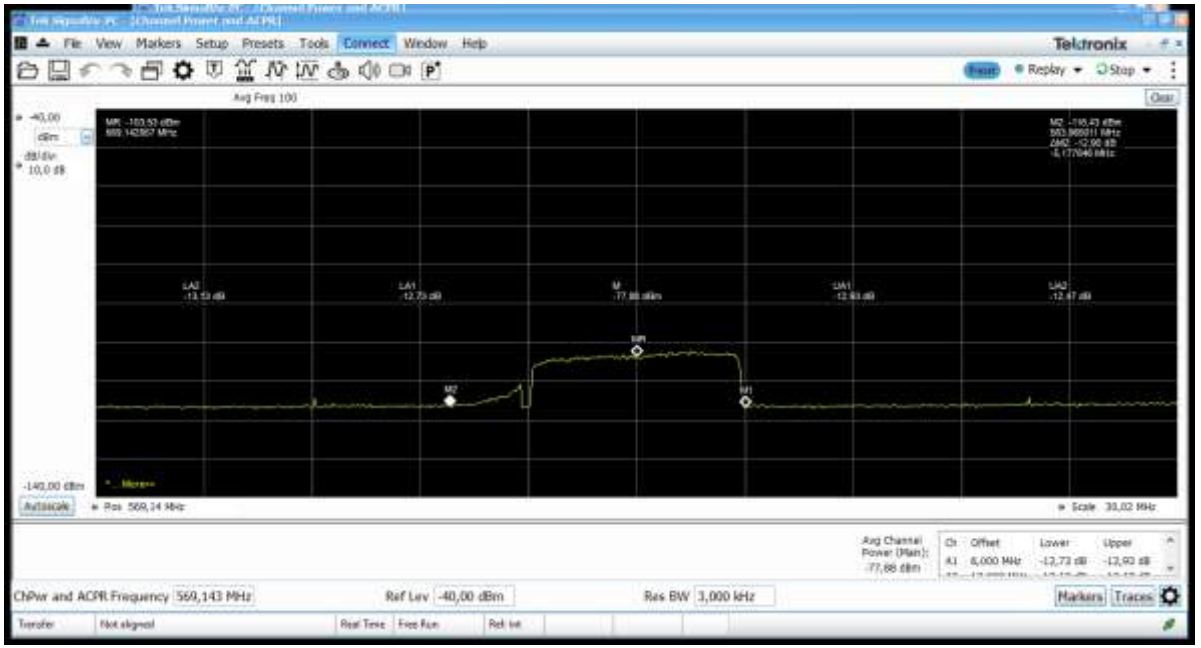


Figure 20.10 - Horizontal

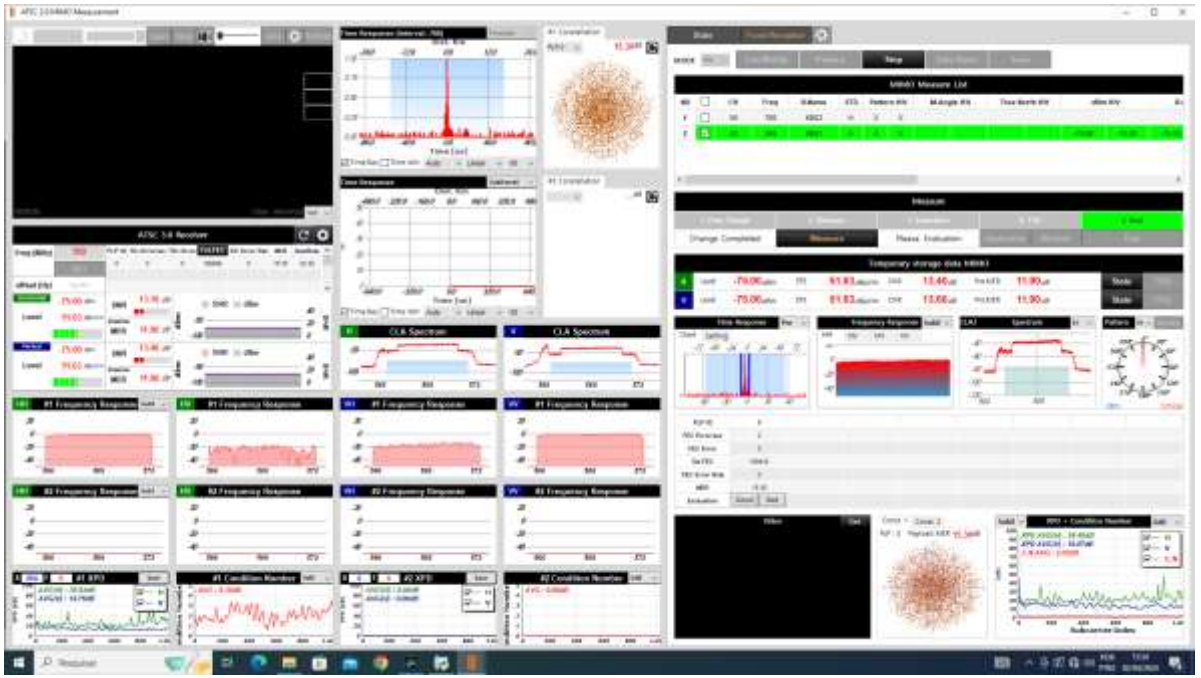


Figure 20.11 - IMAS Screen

Chapter 21. Site 21

a) Channel Power

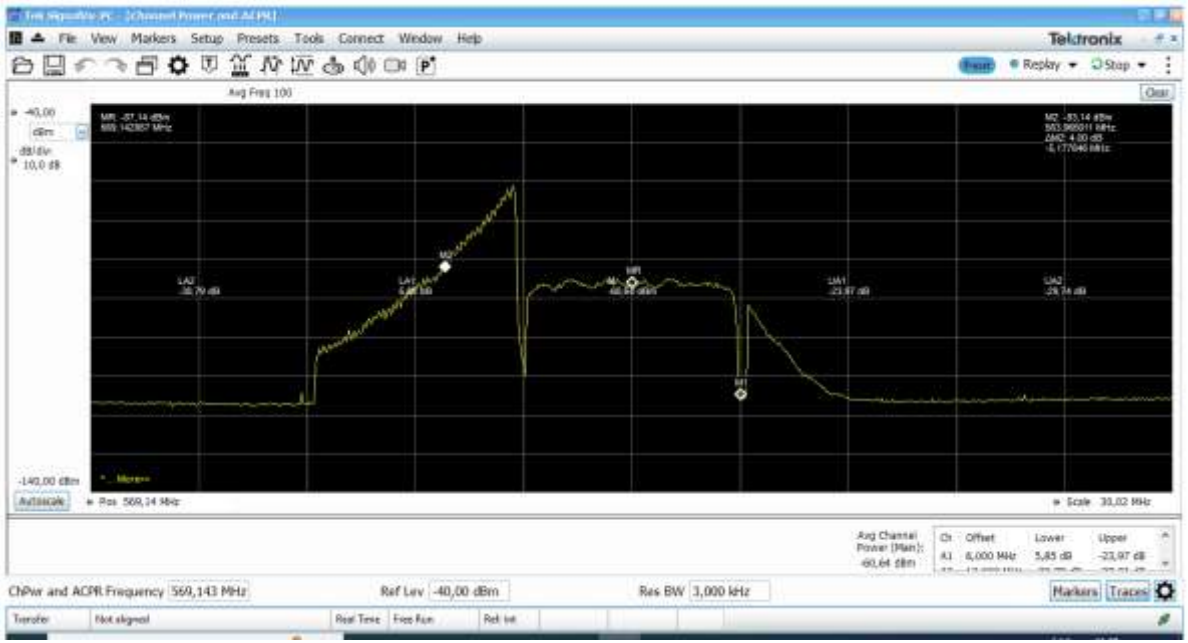


Figure 21.1 - Vertical

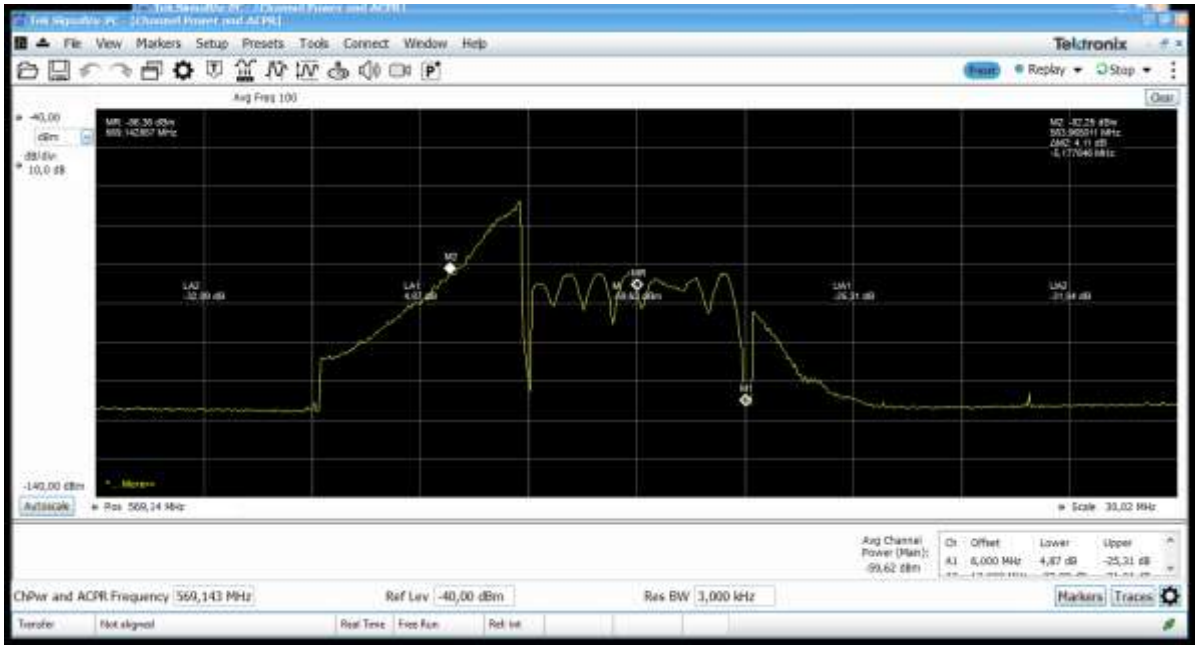


Figure 21.2 - Horizontal

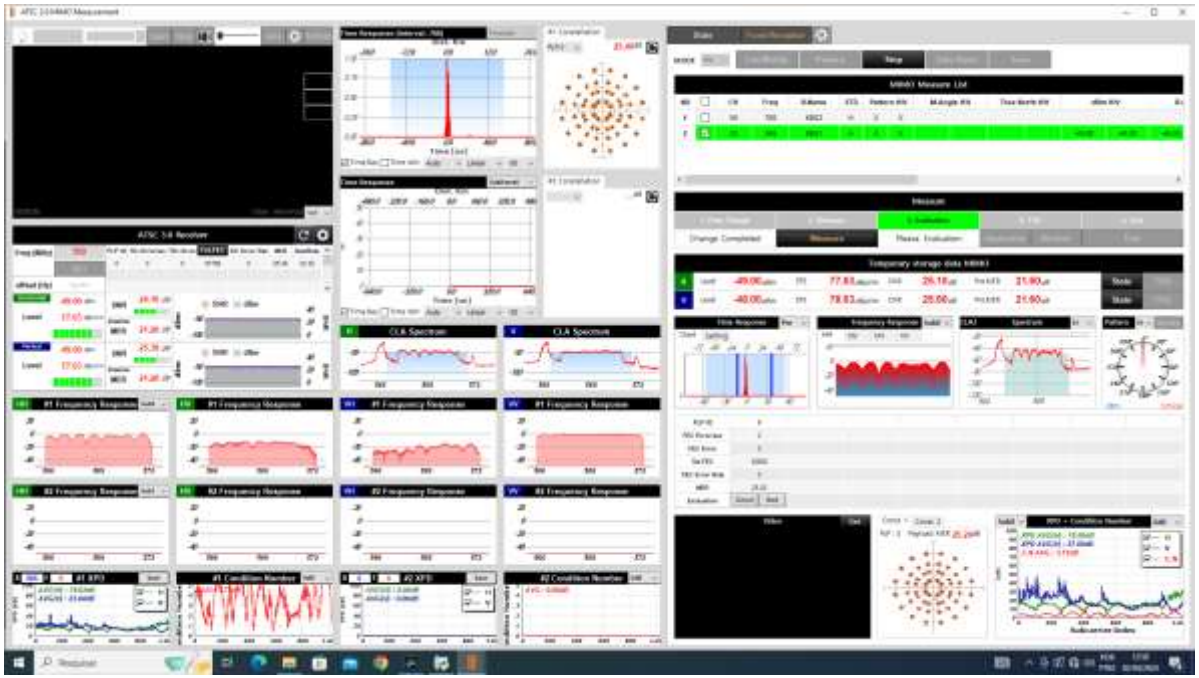


Figure 21.3 - IMAS Screen

b) AWGN Power

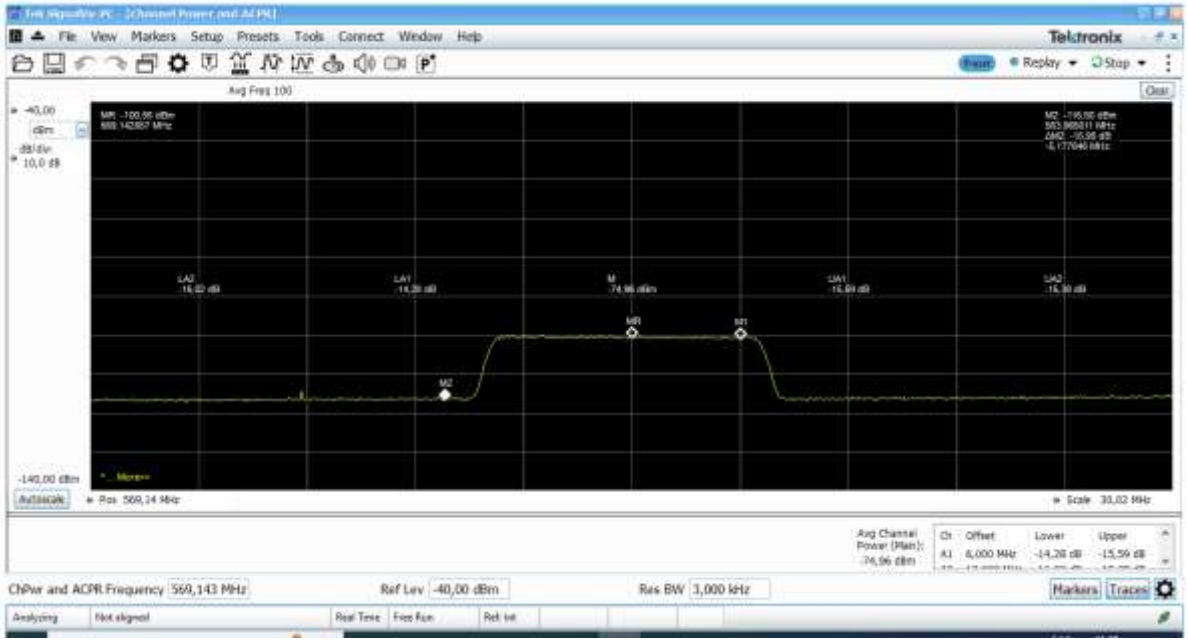


Figure 21.4 - Vertical

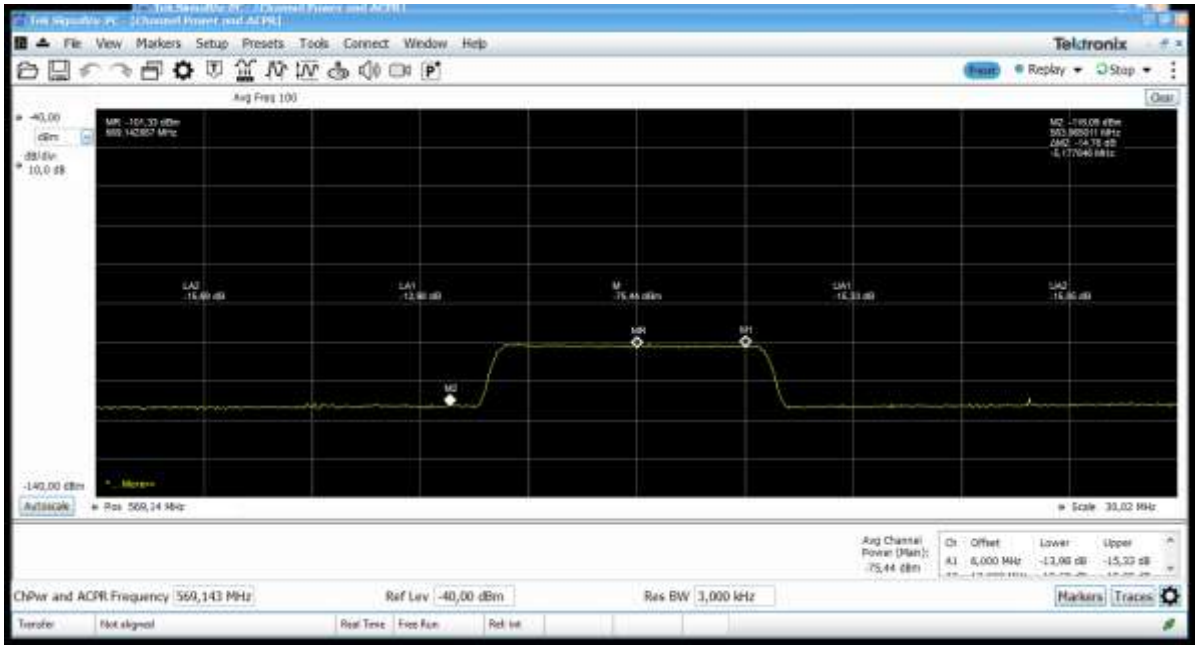


Figure 21.5 - Horizontal

c) C/N Threshold

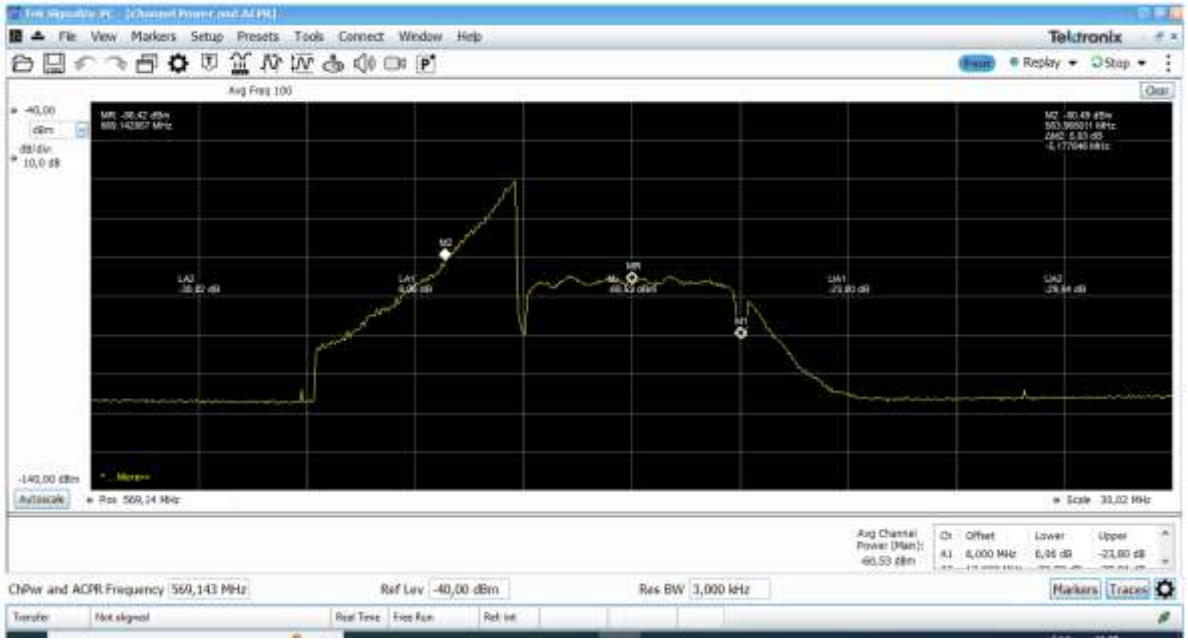


Figure 21.6 - Vertical

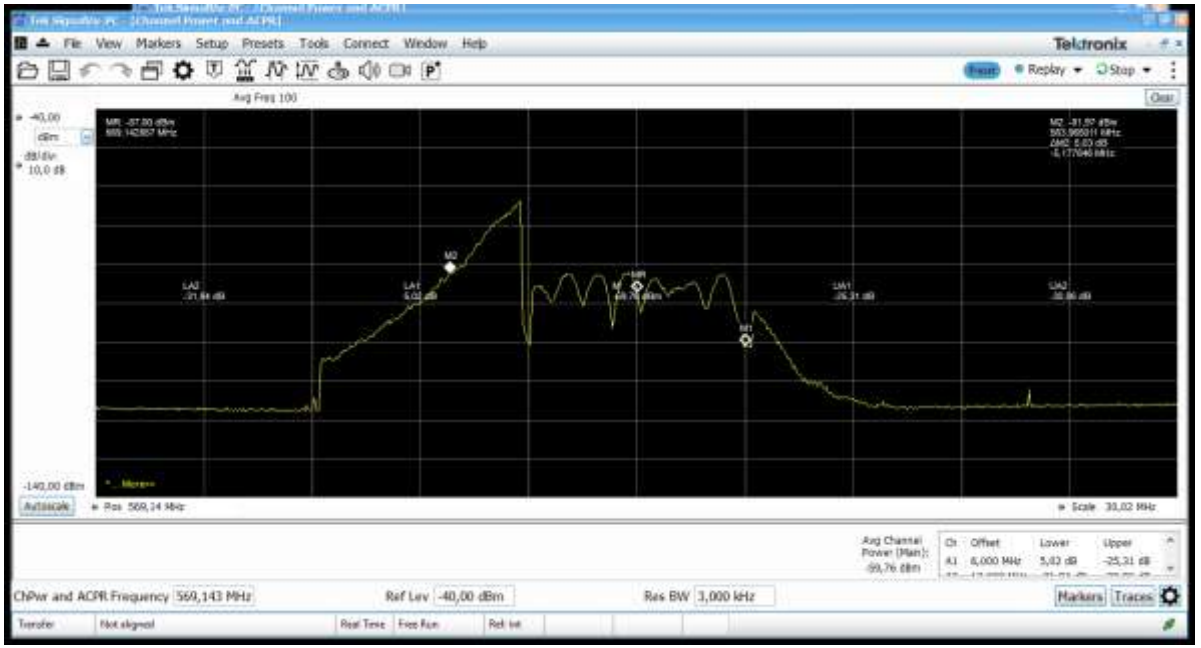


Figure 21.7 - Horizontal

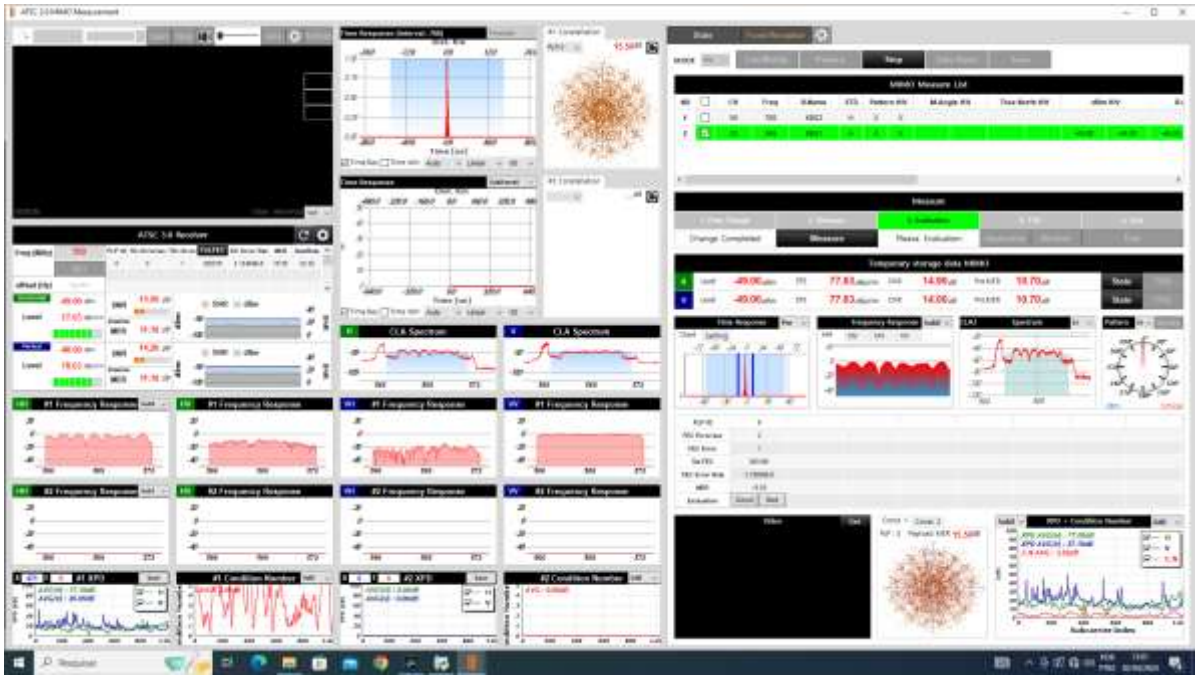


Figure 21.8 - IMAS Screen

d) Reception Threshold

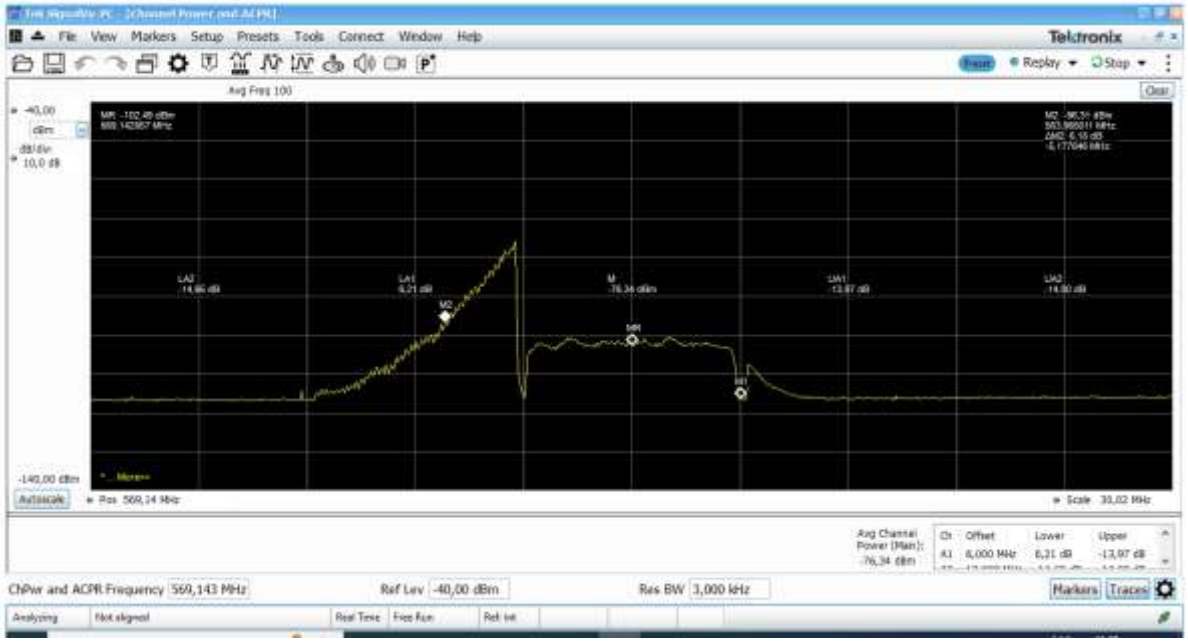


Figure 21.9 - Vertical

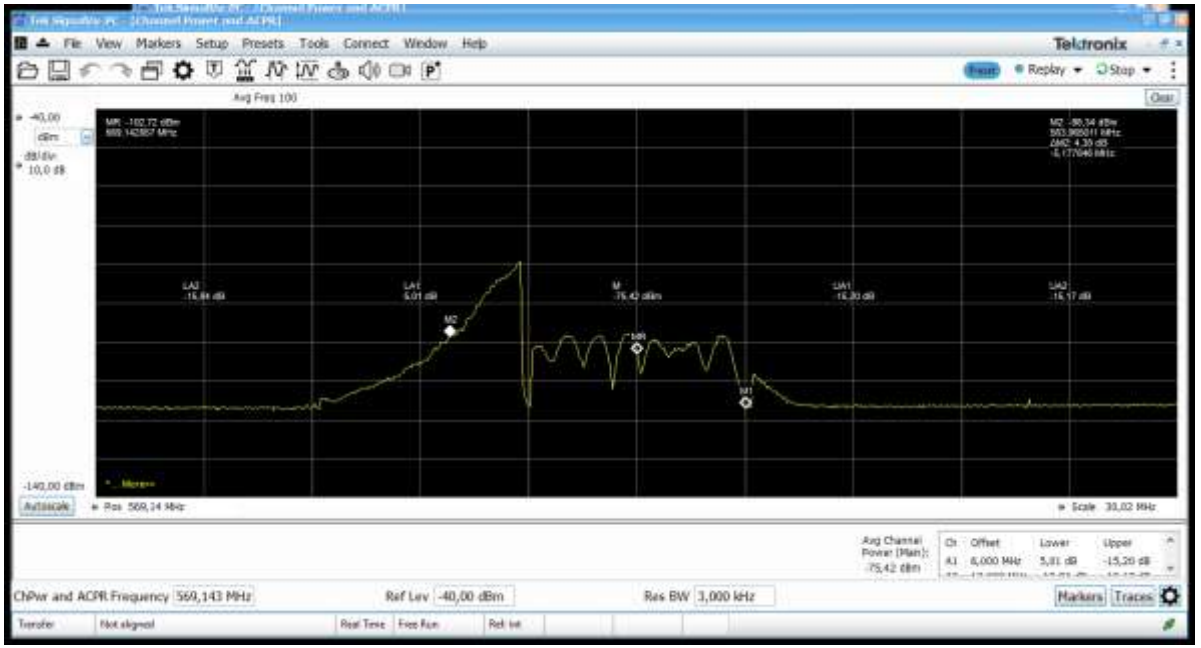


Figure 21.10 - Horizontal

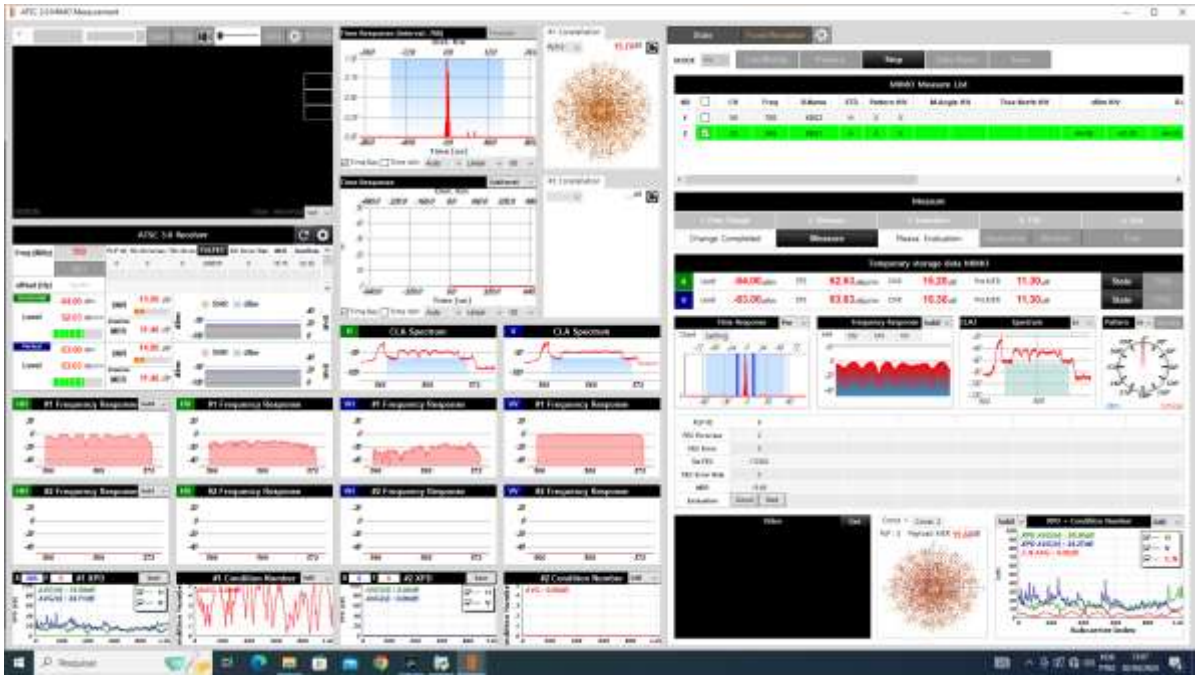


Figure 21.11 - IMAS Screen

Chapter 22. Site 22

a) Channel Power

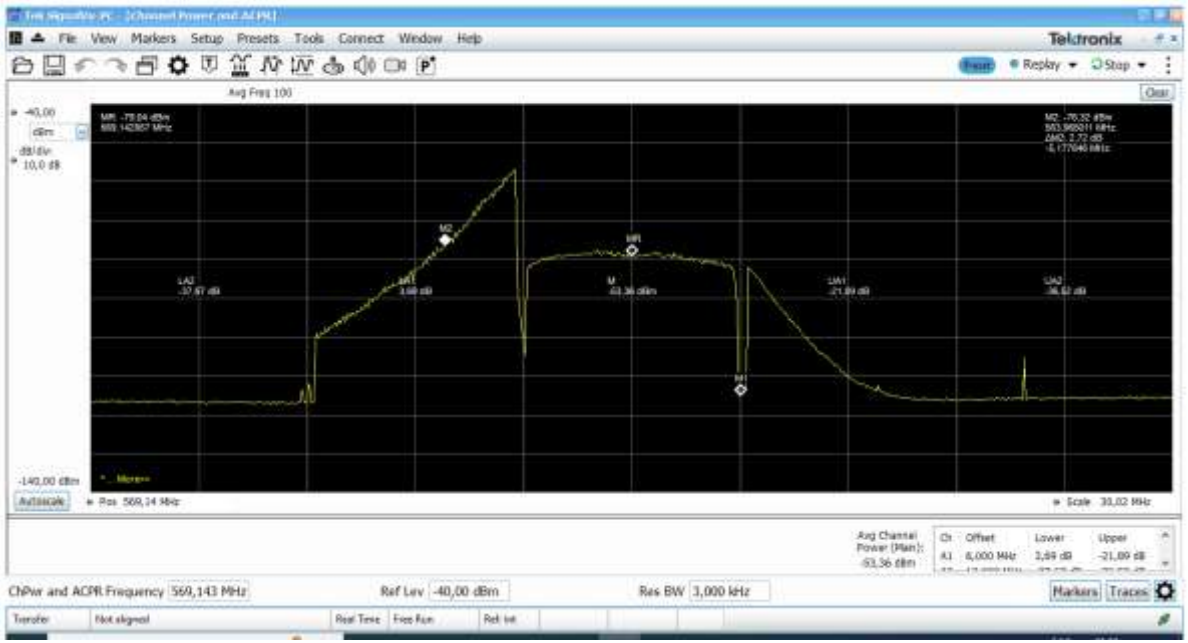


Figure 22.1 - Vertical

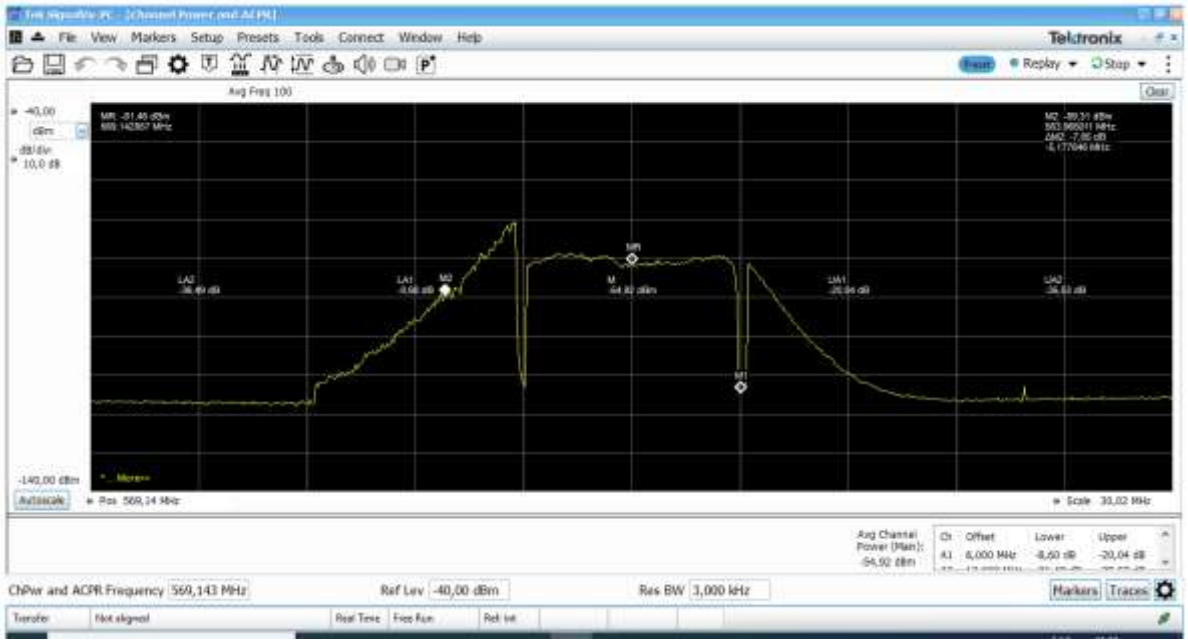


Figure 22.2 - Horizontal

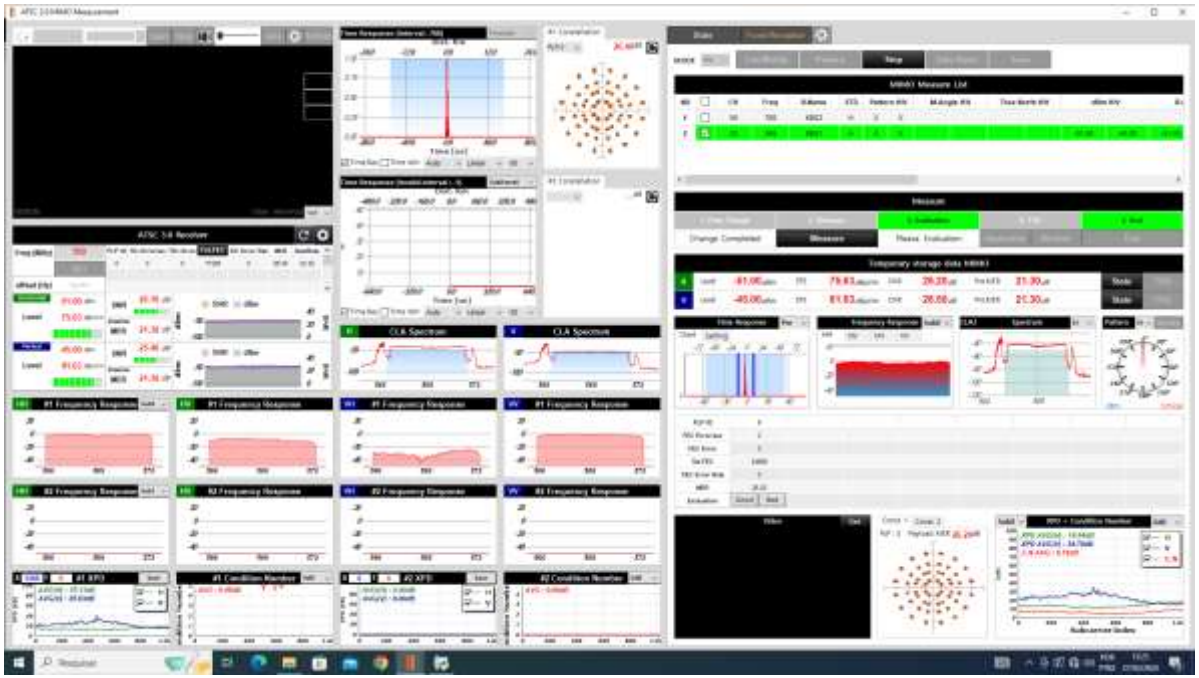


Figure 22.3 - IMAS Screen

b) AWGN Power

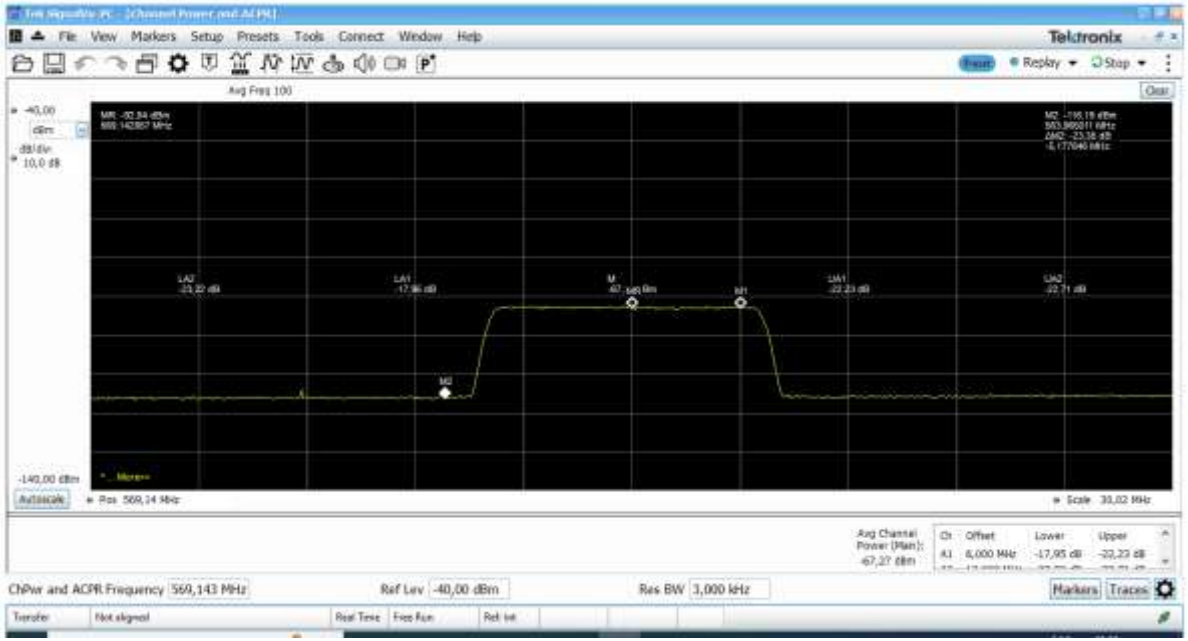


Figure 22.4 - Vertical

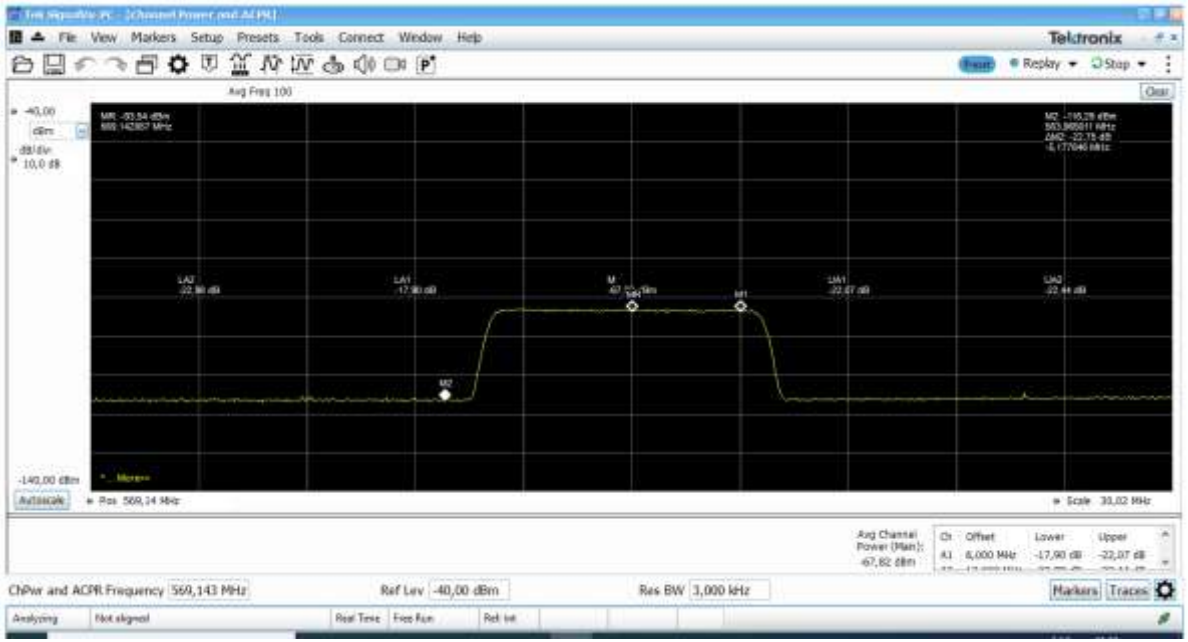


Figure 22.5 - Horizontal

c) C/N Threshold

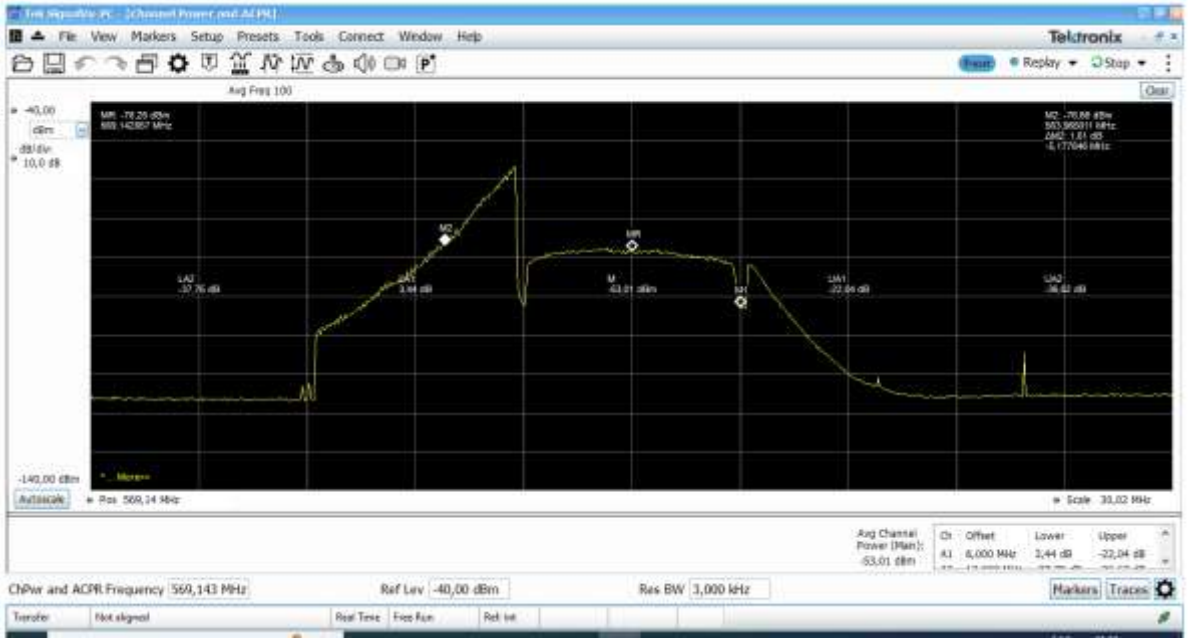


Figure 22.6 - Vertical

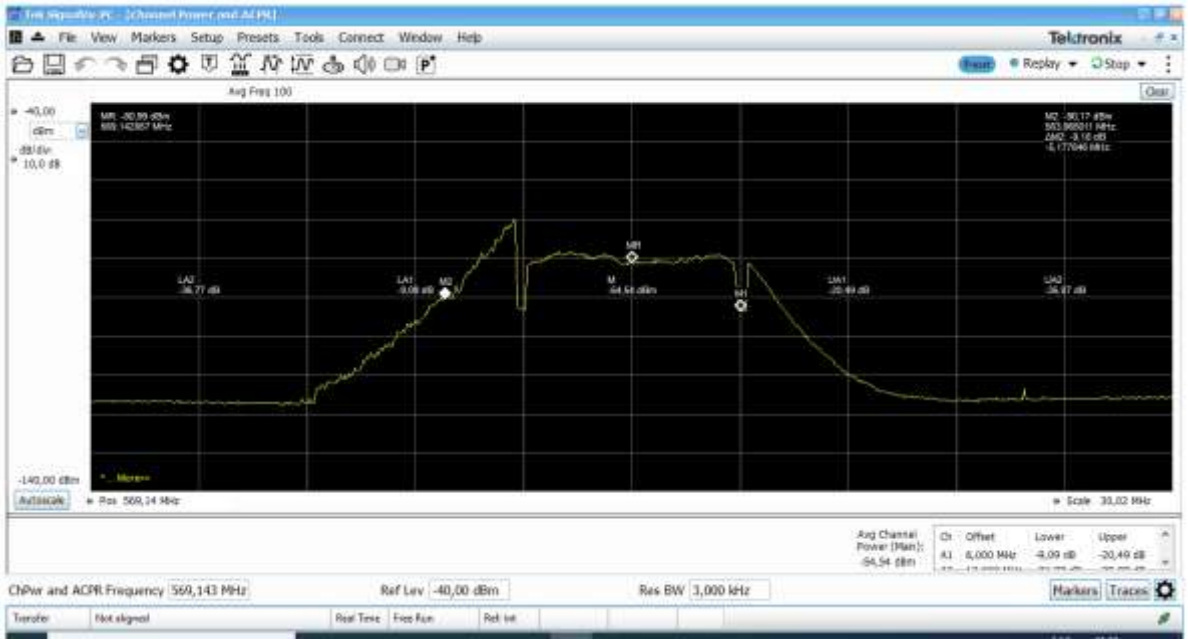


Figure 22.7 - Horizontal

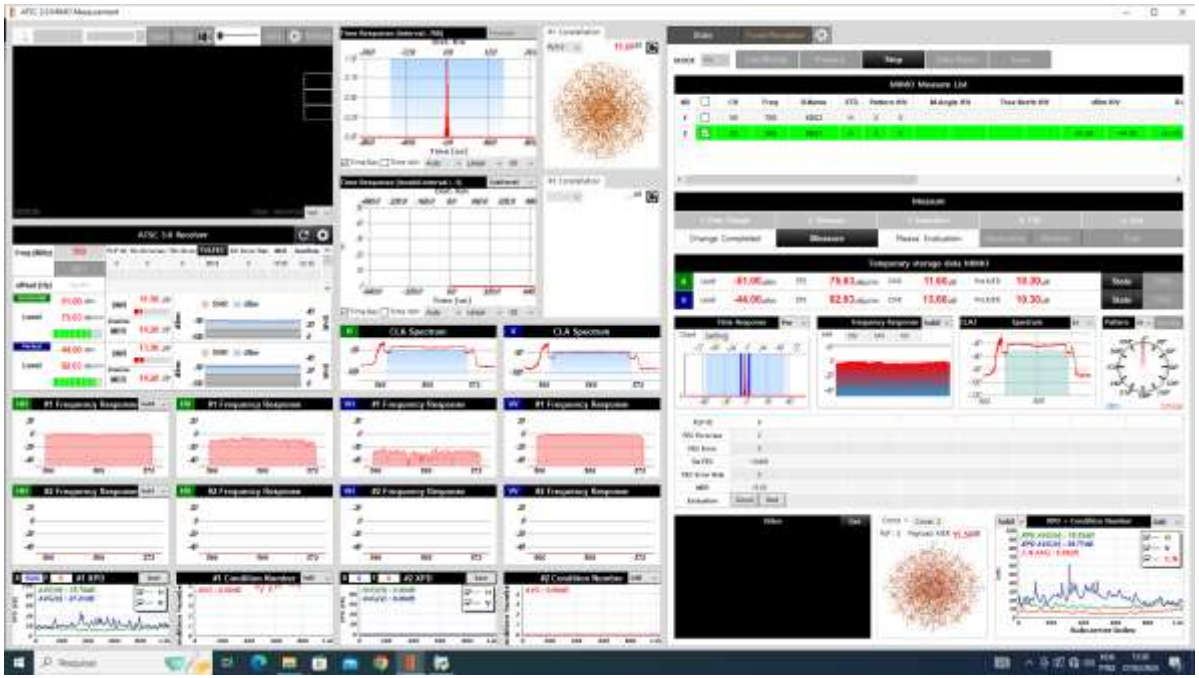


Figure 22.8 - IMAS Screen

d) Reception Threshold

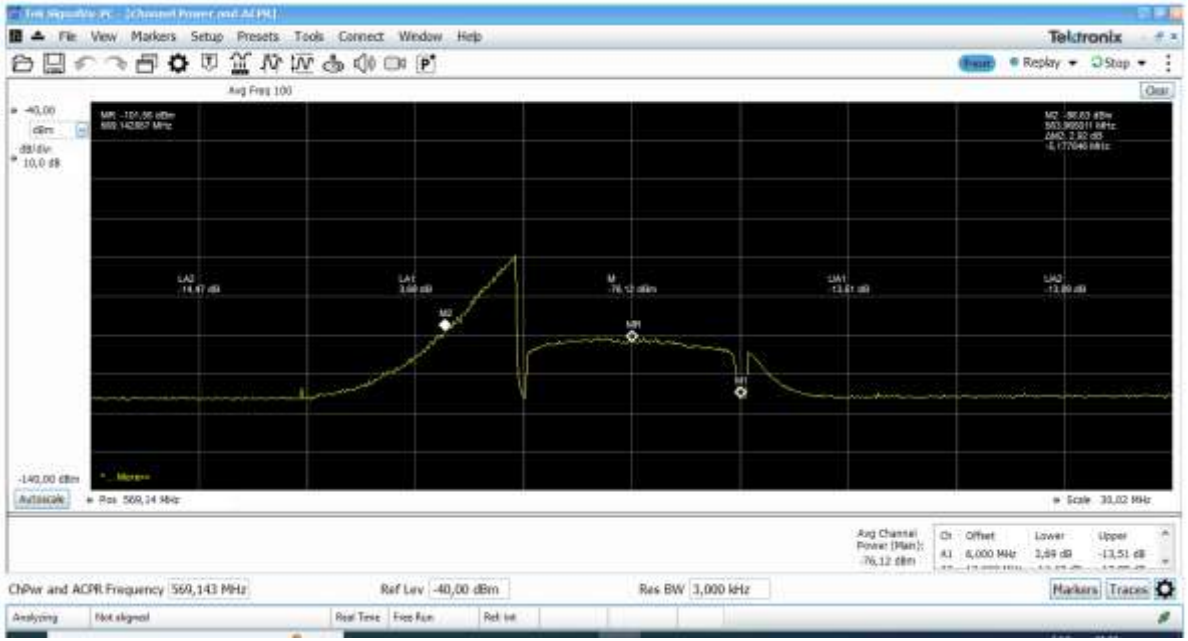


Figure 22.9 - Vertical

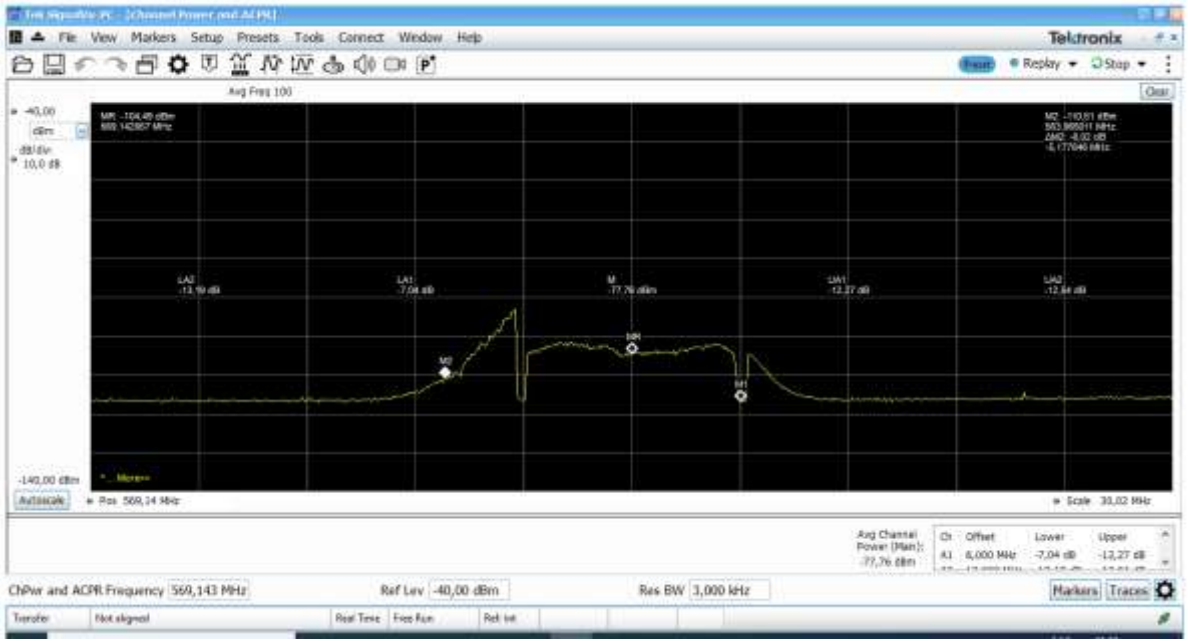


Figure 22.10 - Horizontal

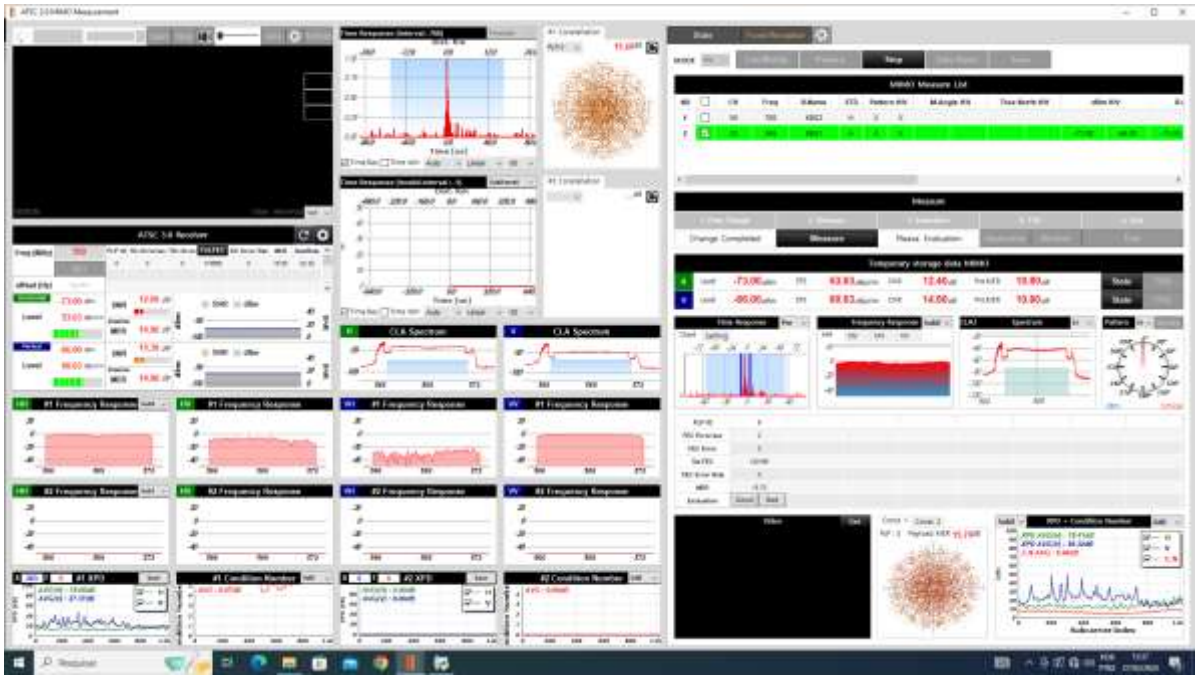


Figure 22.11 - IMAS Screen

Chapter 23. Site 23

a) Channel Power

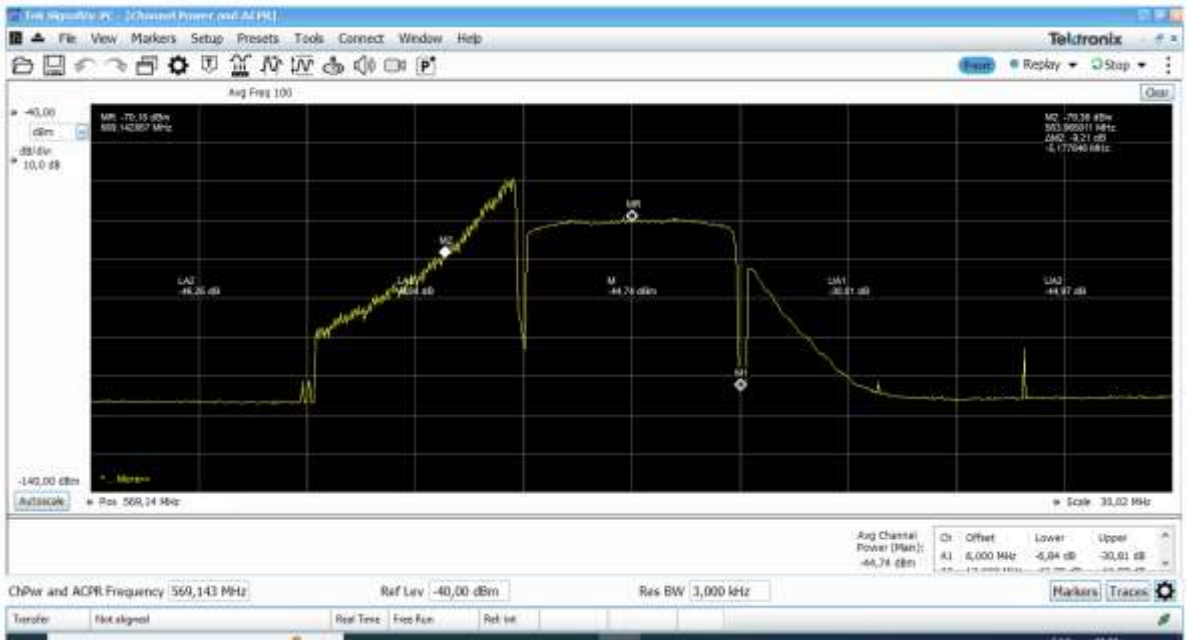


Figure 23.1 - Vertical

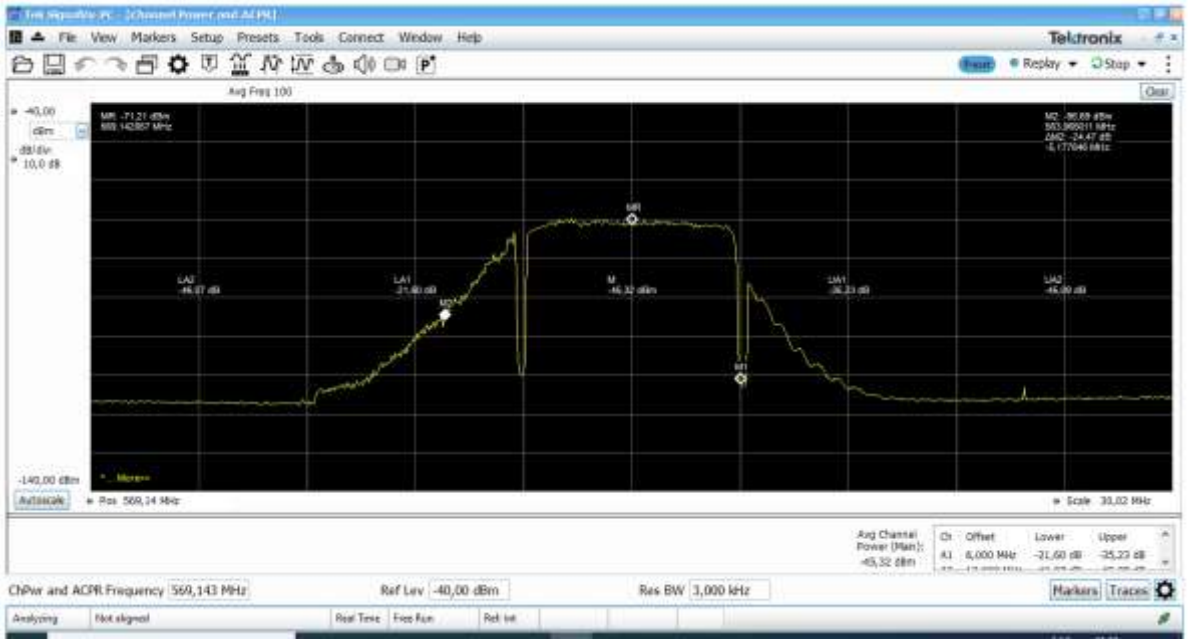


Figure 23.2 - Horizontal

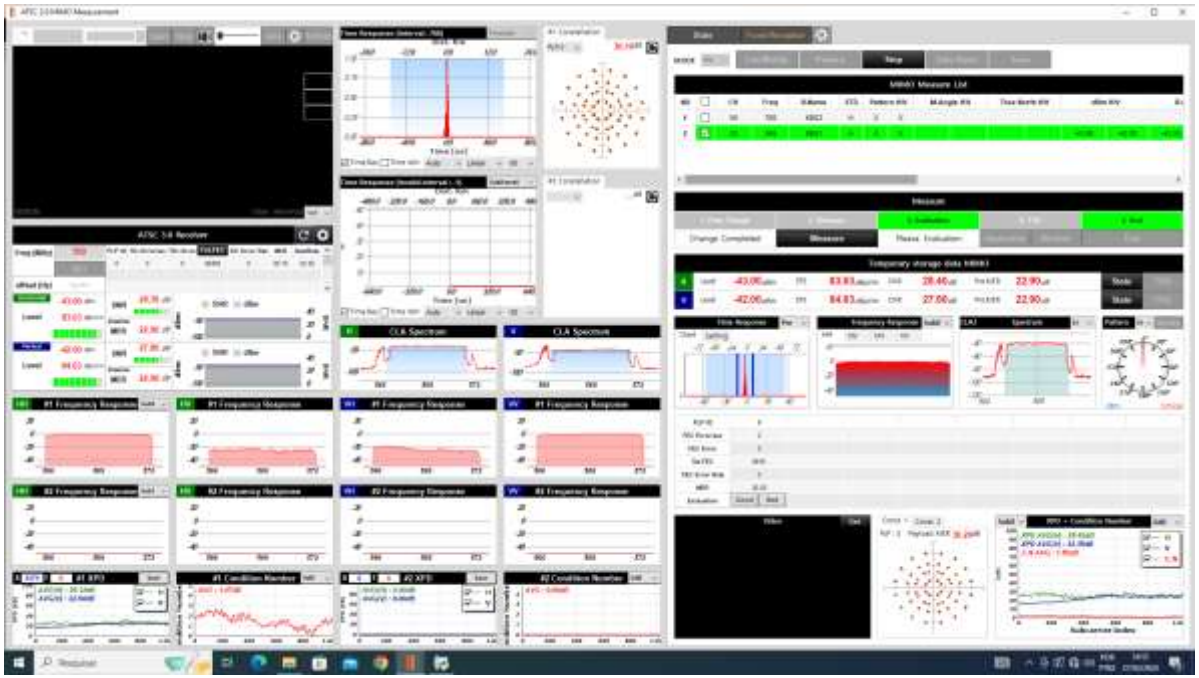


Figure 23.3 - IMAS Screen

b) AWGN Power

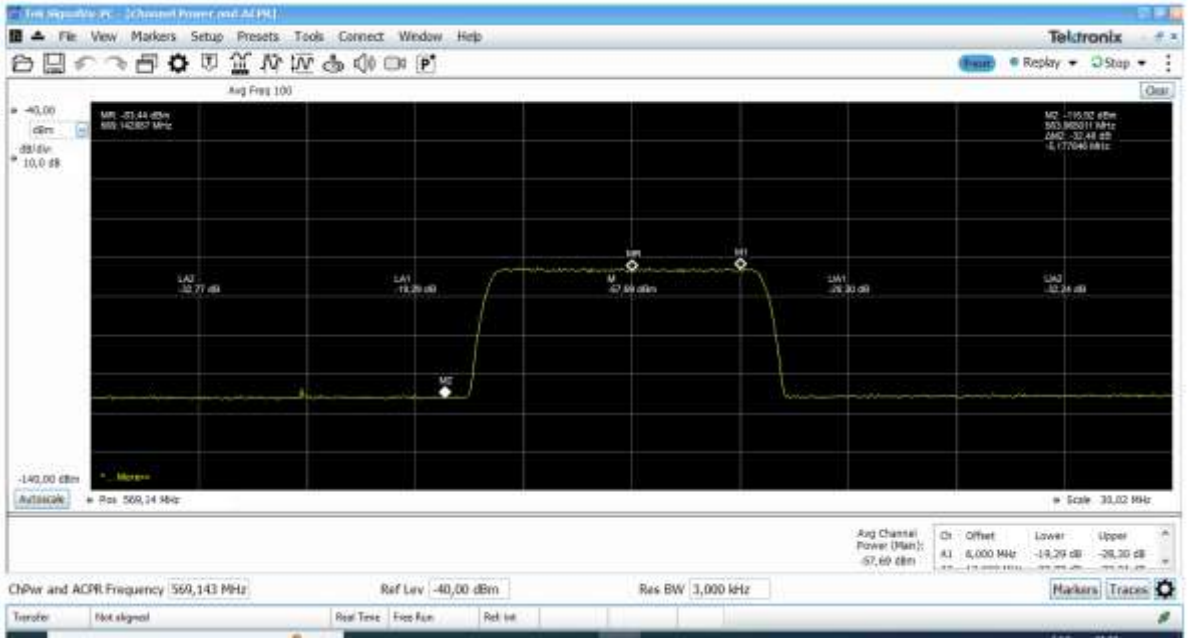


Figure 23.4 - Vertical

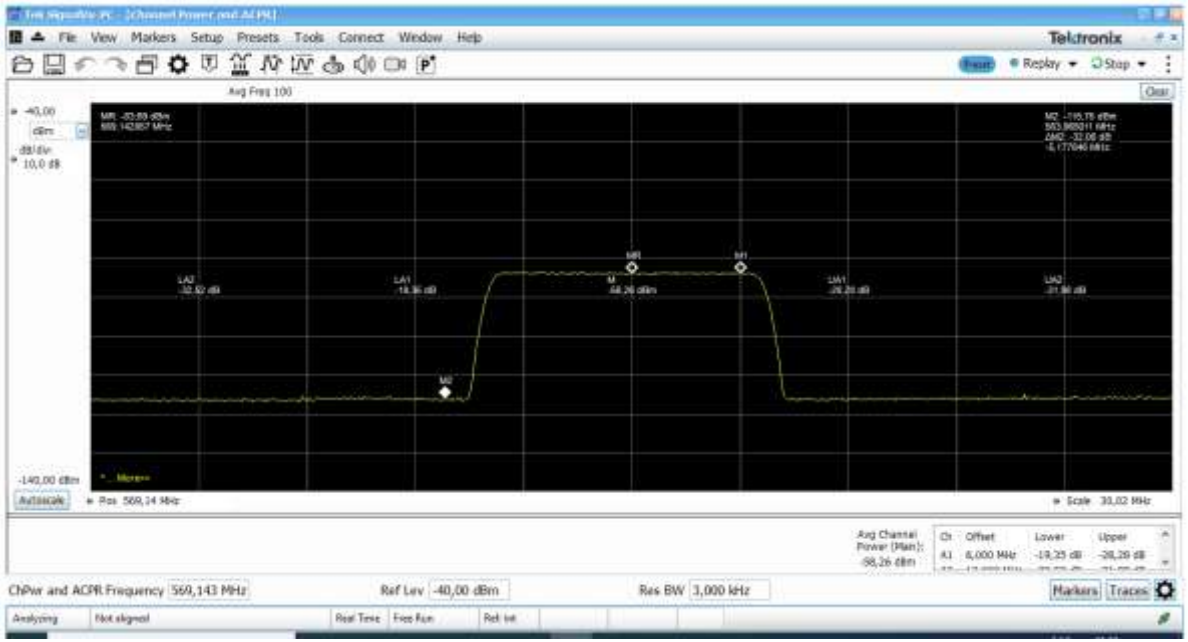


Figure 23.5 - Horizontal

c) C/N Threshold

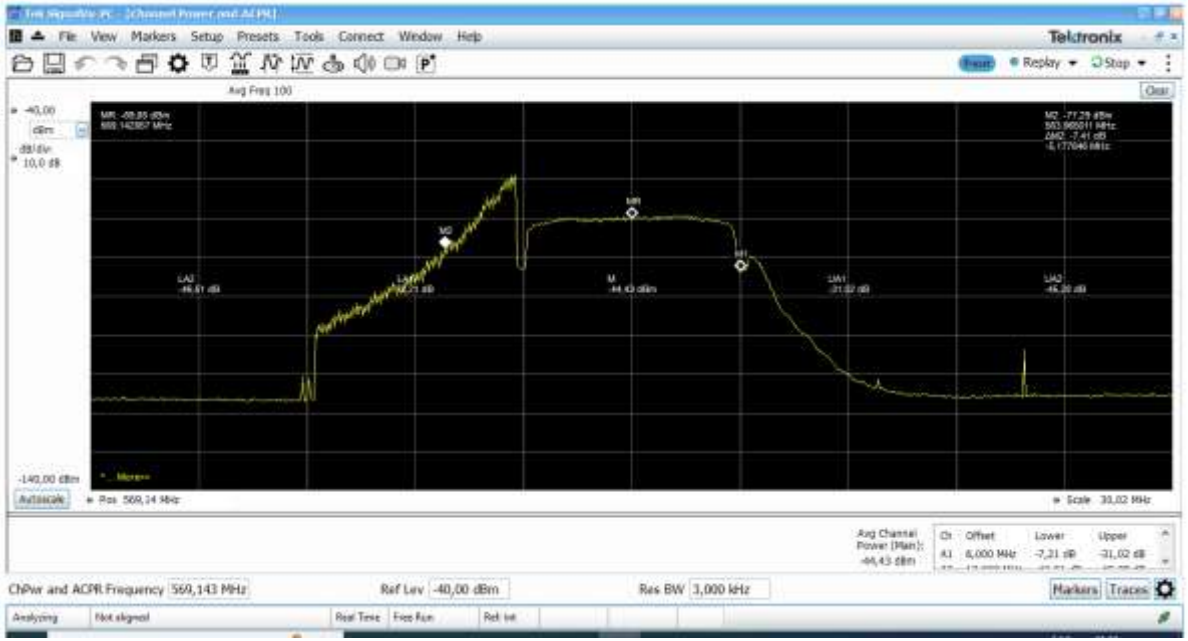


Figure 23.6 - Vertical

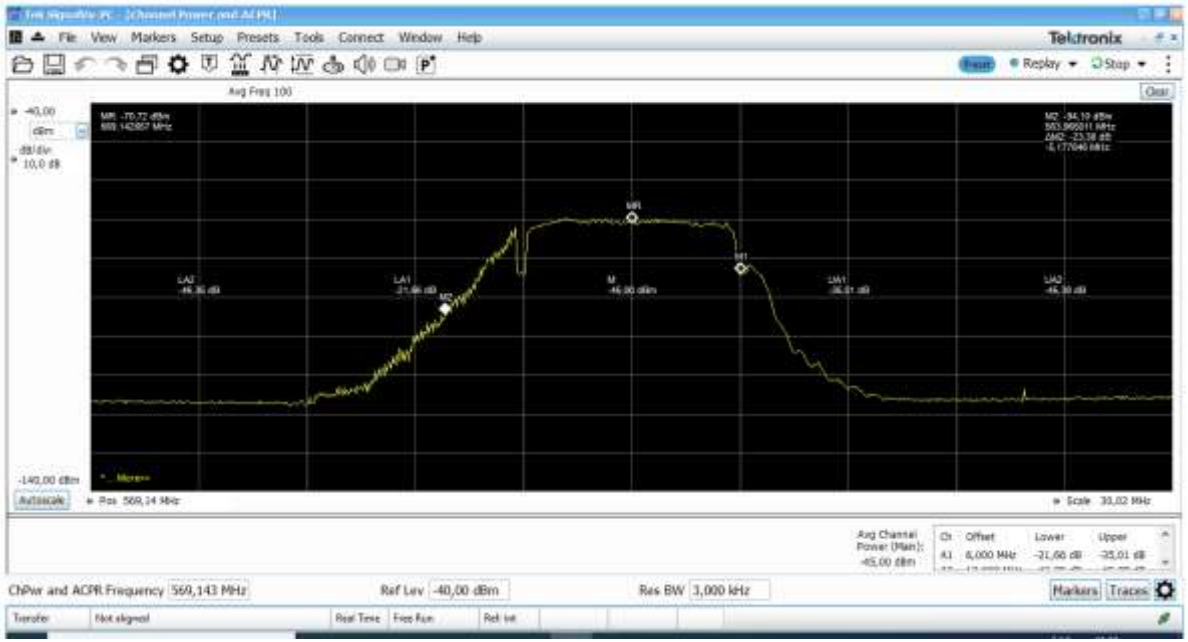


Figure 23.7 - Horizontal

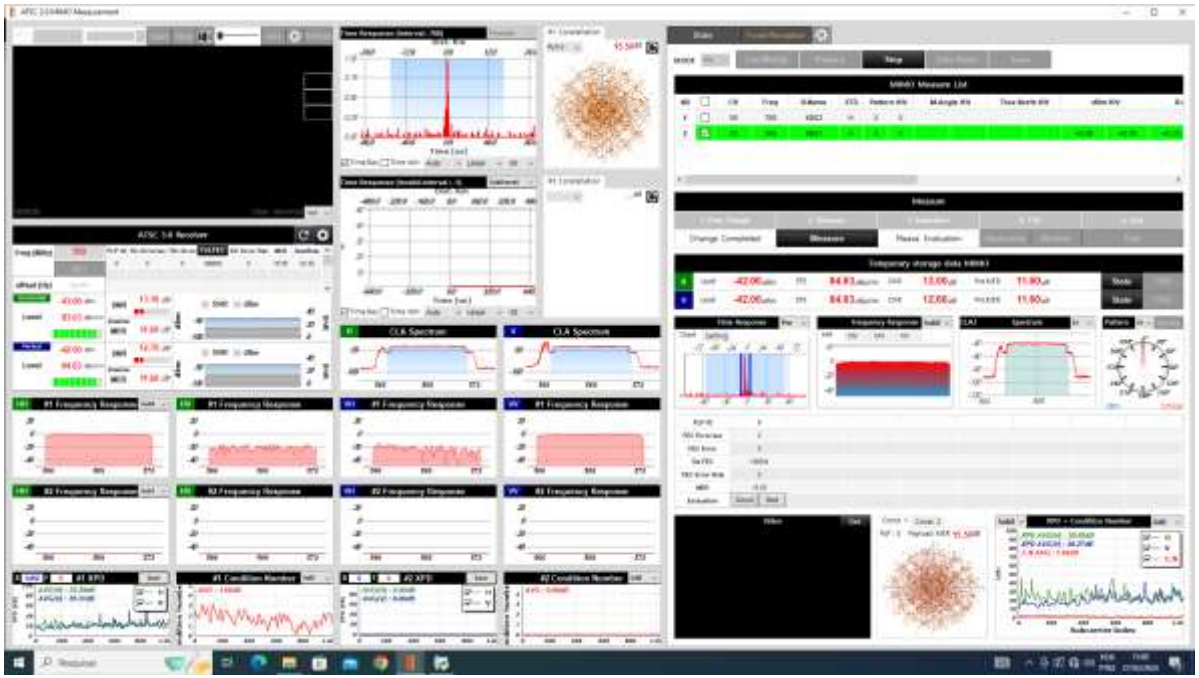


Figure 23.8 - IMAS Screen

d) Reception Threshold

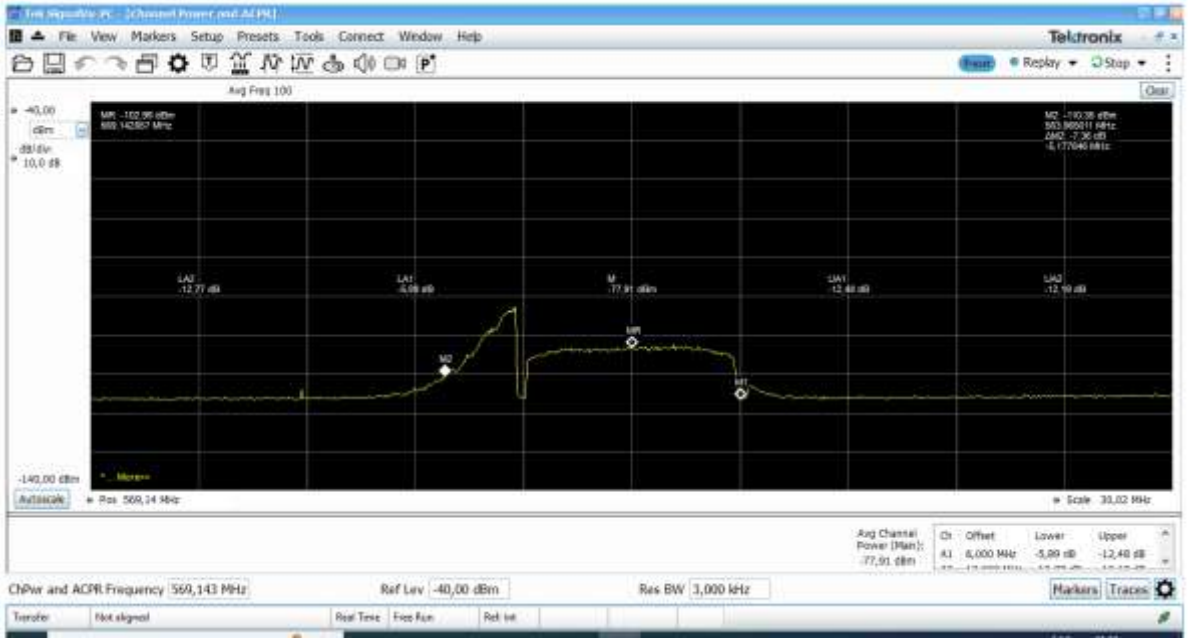


Figure 23.9 - Vertical

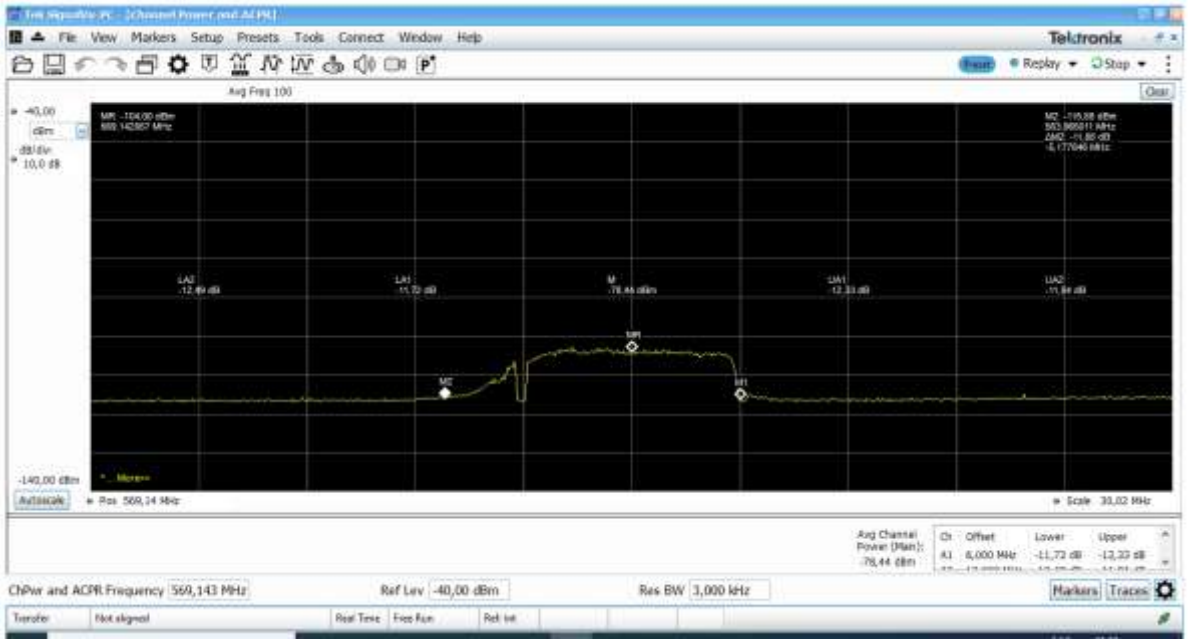


Figure 23.10 - Horizontal

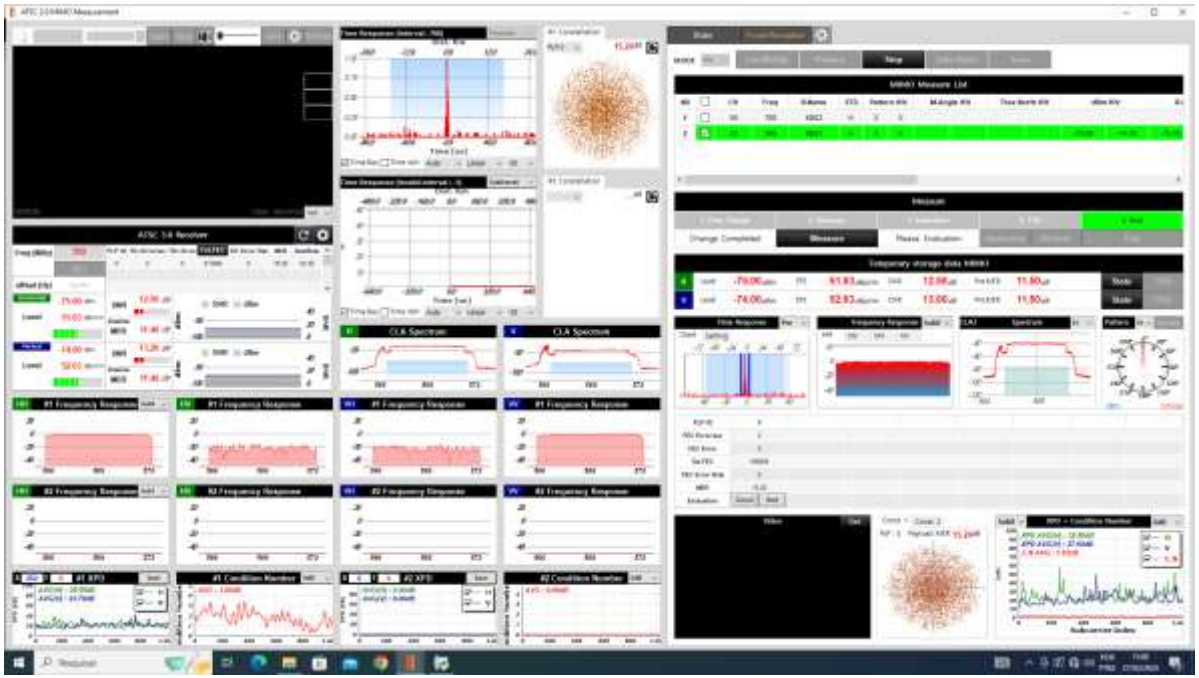


Figure 23.11 - IMAS Screen

Chapter 24. Site 24

a) Channel Power

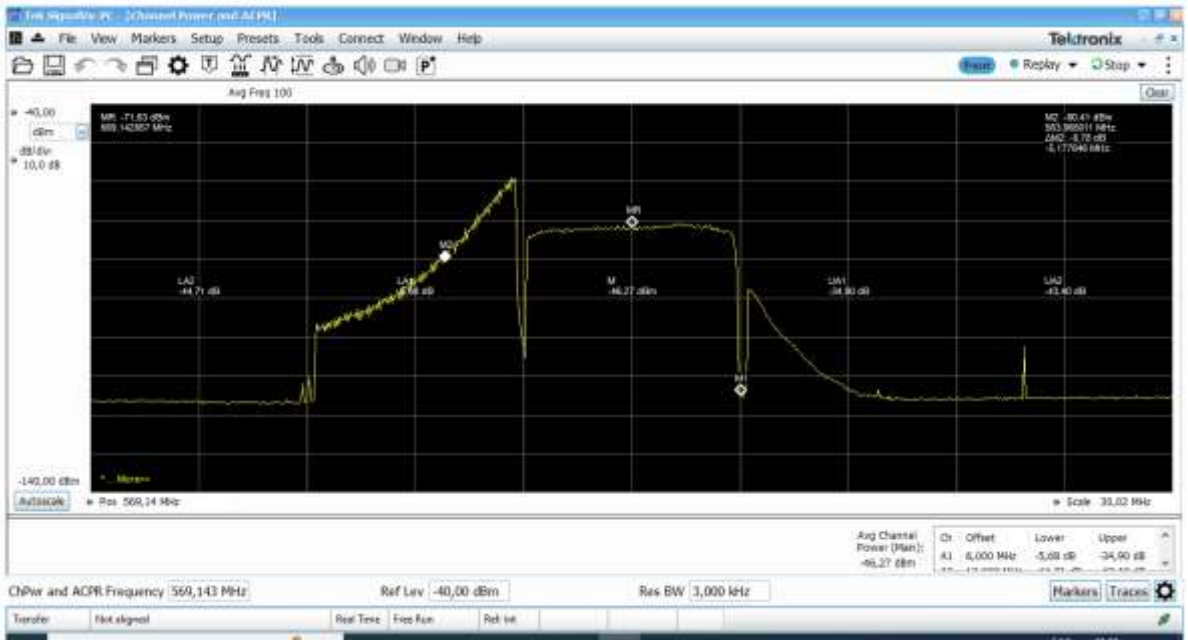


Figure 24.1 - Vertical

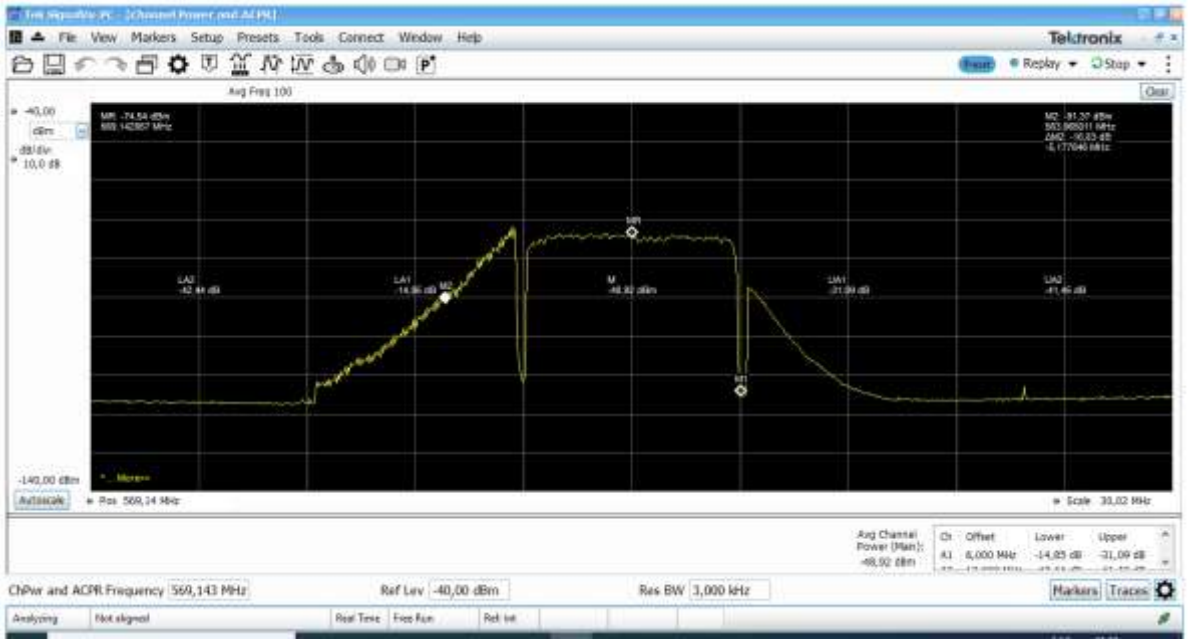


Figure 24.2 - Horizontal

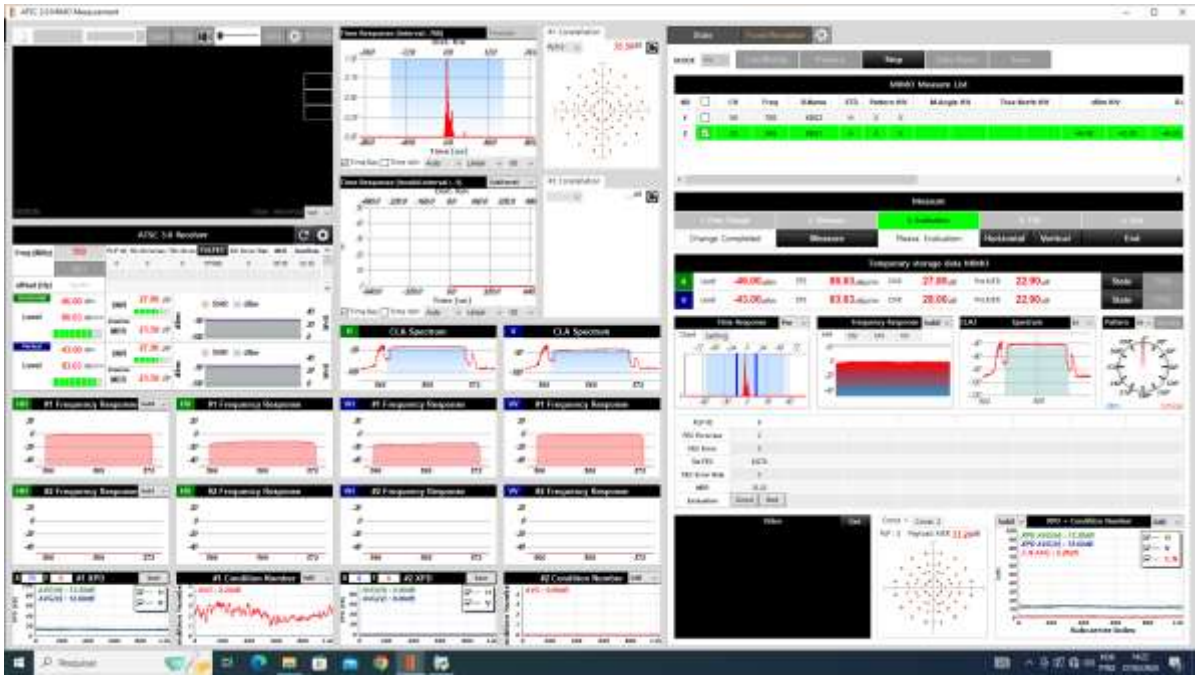


Figure 24.3 - IMAS Screen

b) AWGN Power

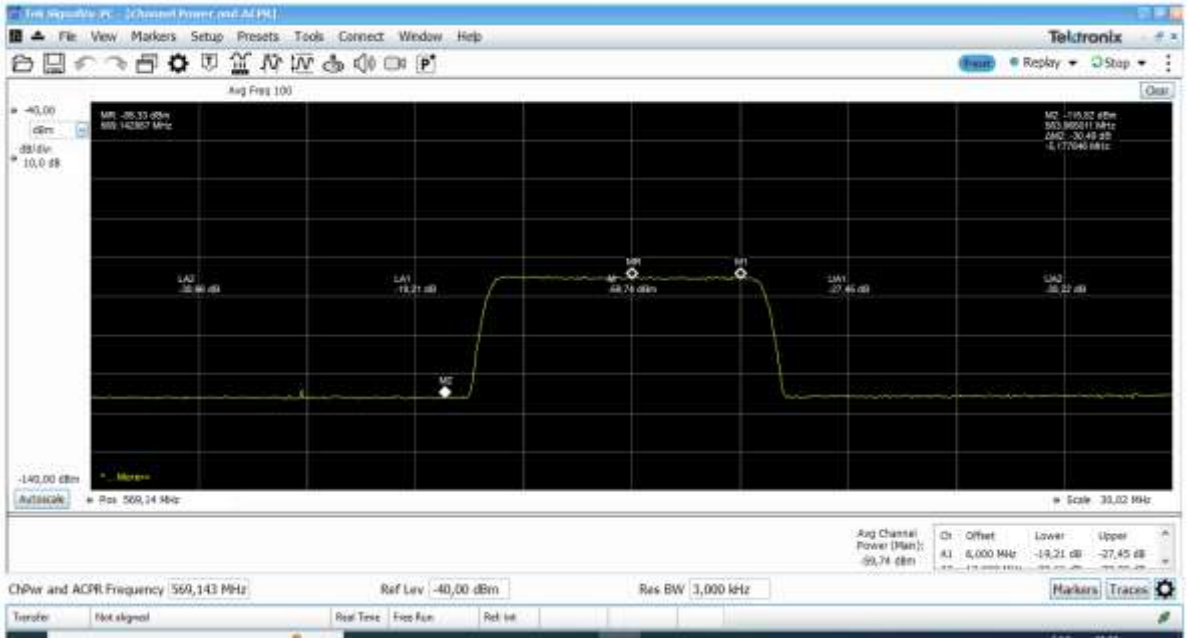


Figure 24.4 - Vertical

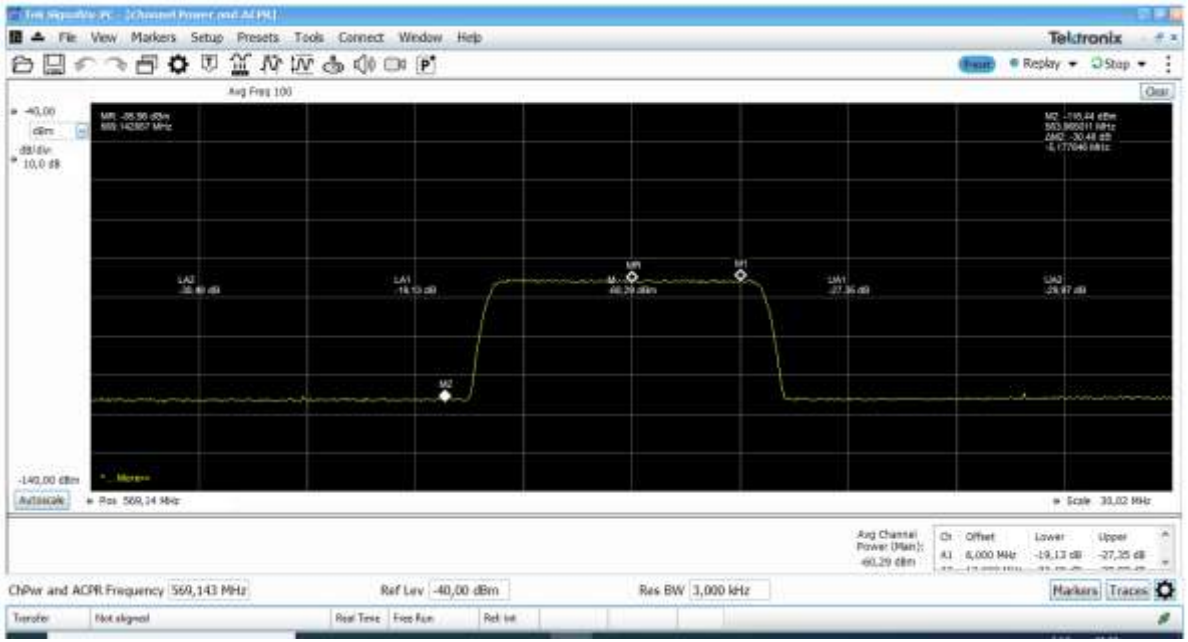


Figure 24.5 - Horizontal

c) C/N Threshold

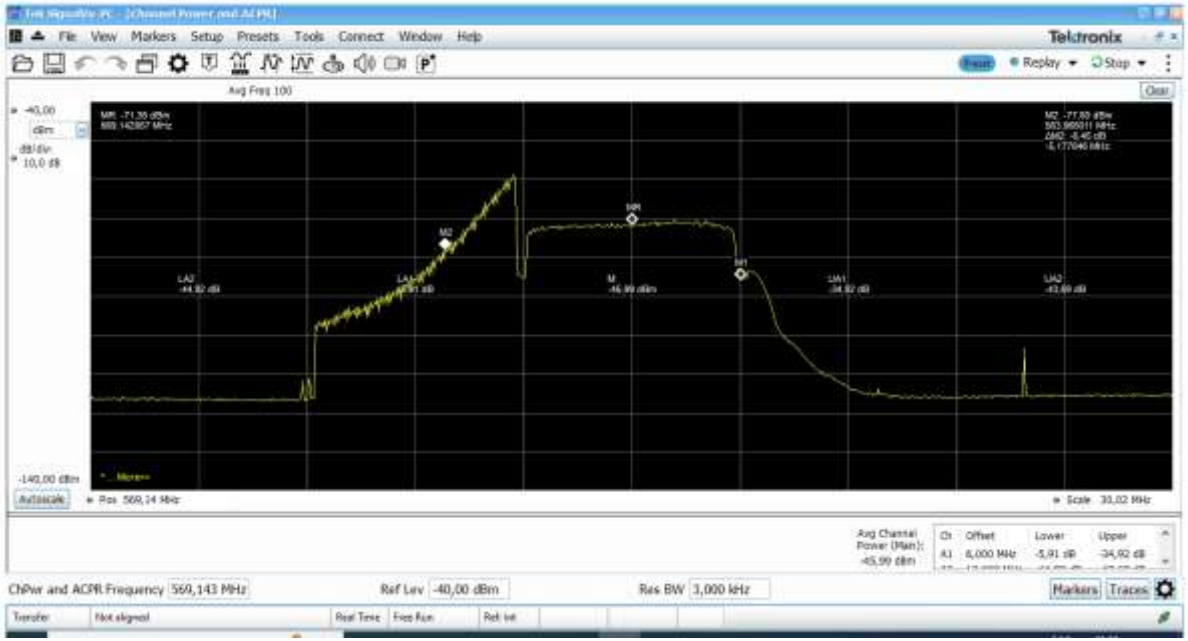


Figure 24.6 - Vertical

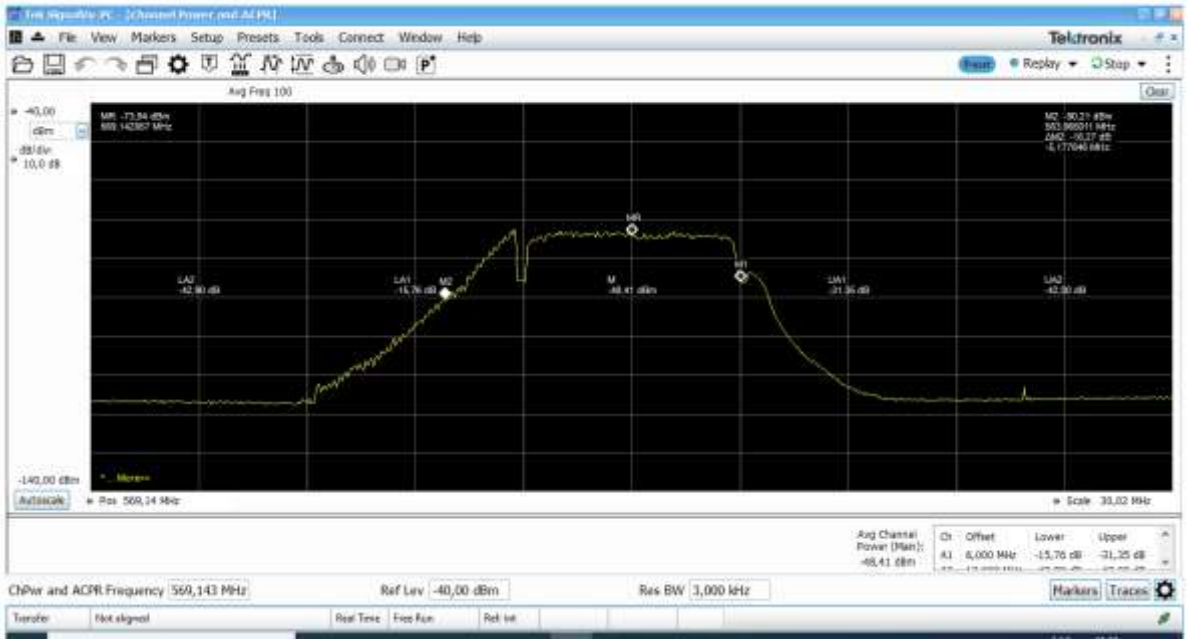


Figure 24.7 - Horizontal

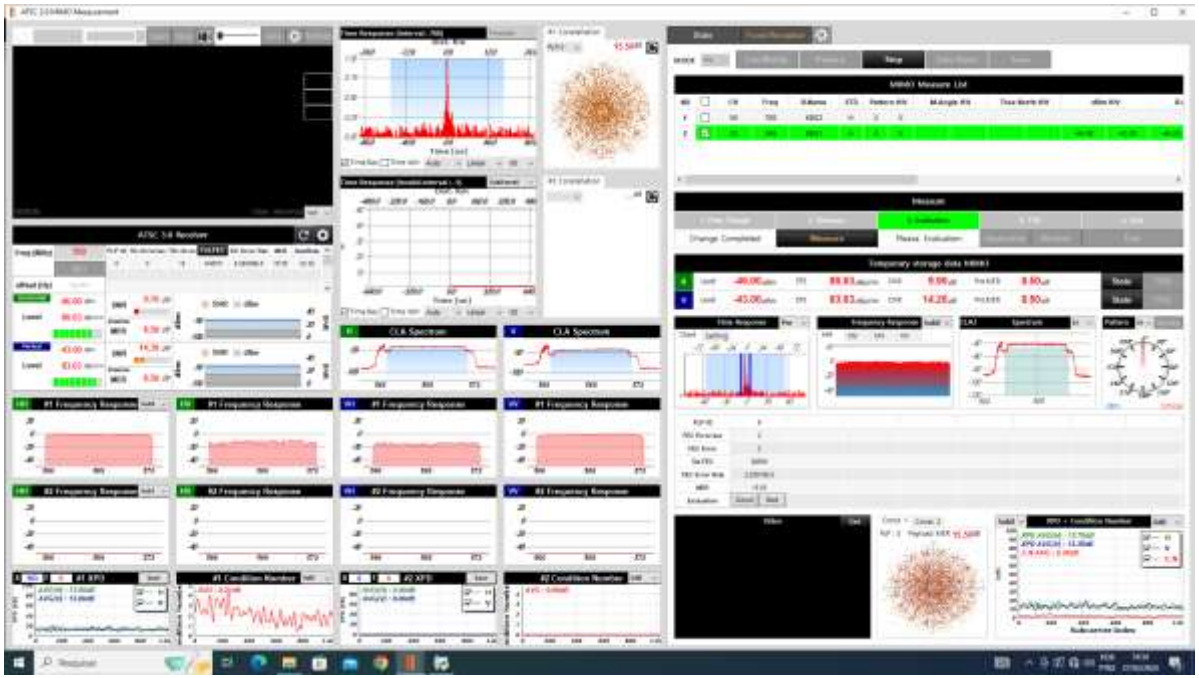


Figure 24.8 - IMAS Screen

d) Reception Threshold

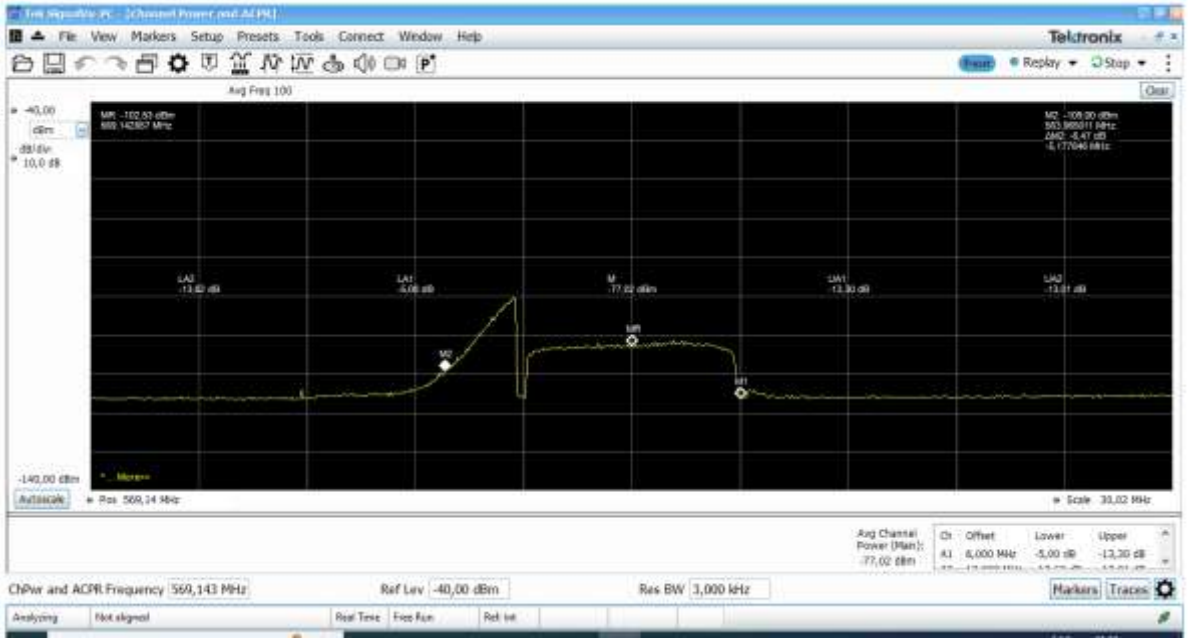


Figure 24.9 - Vertical

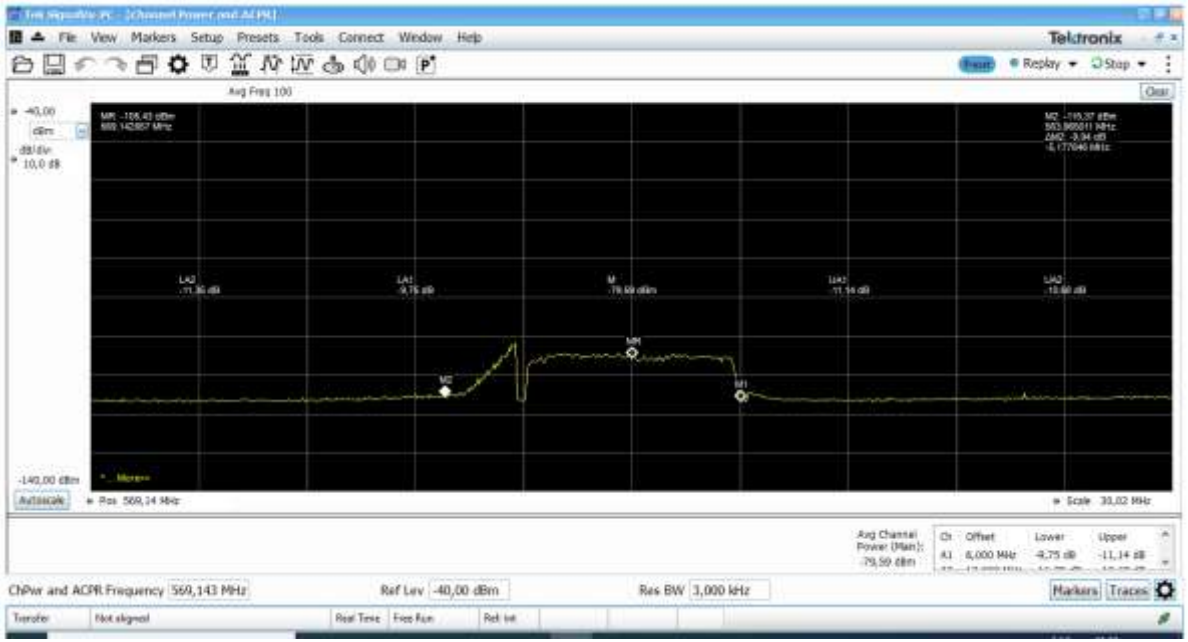


Figure 24.10 - Horizontal

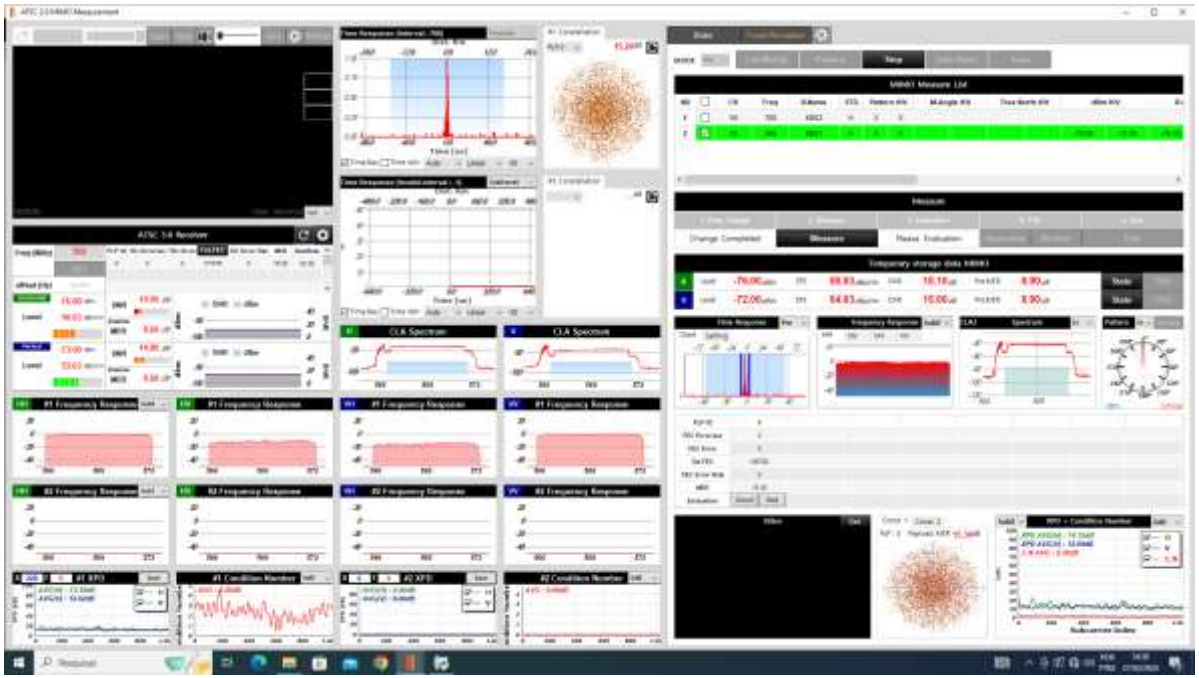


Figure 24.11 - IMAS Screen

Chapter 25. Site 25

a) Channel Power

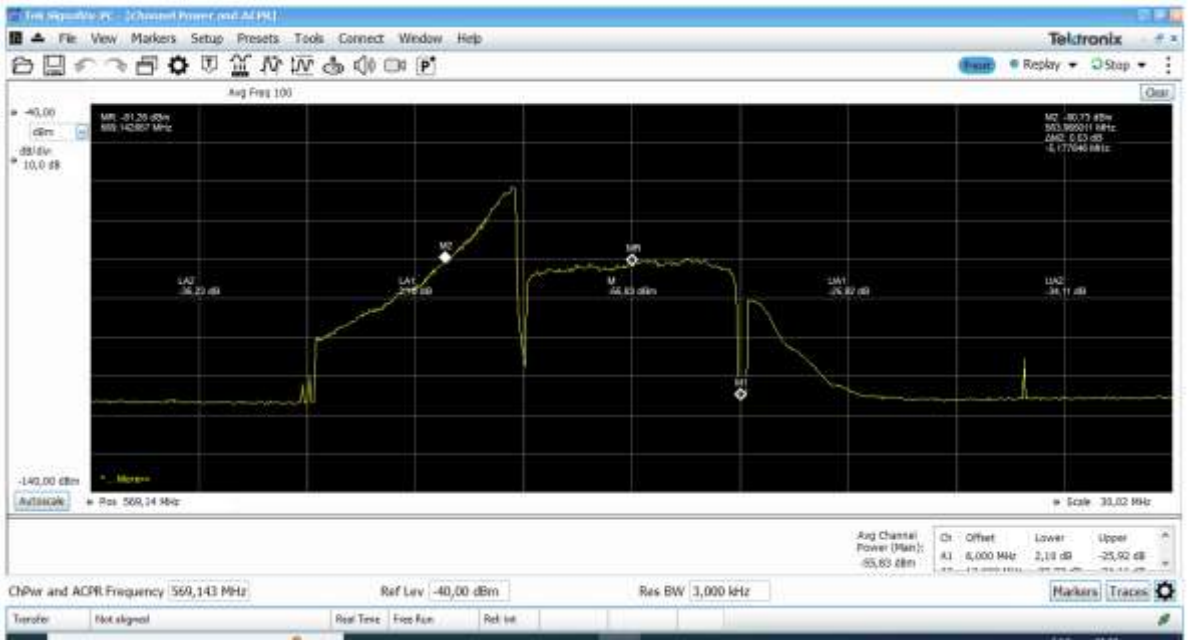


Figure 25.1 - Vertical

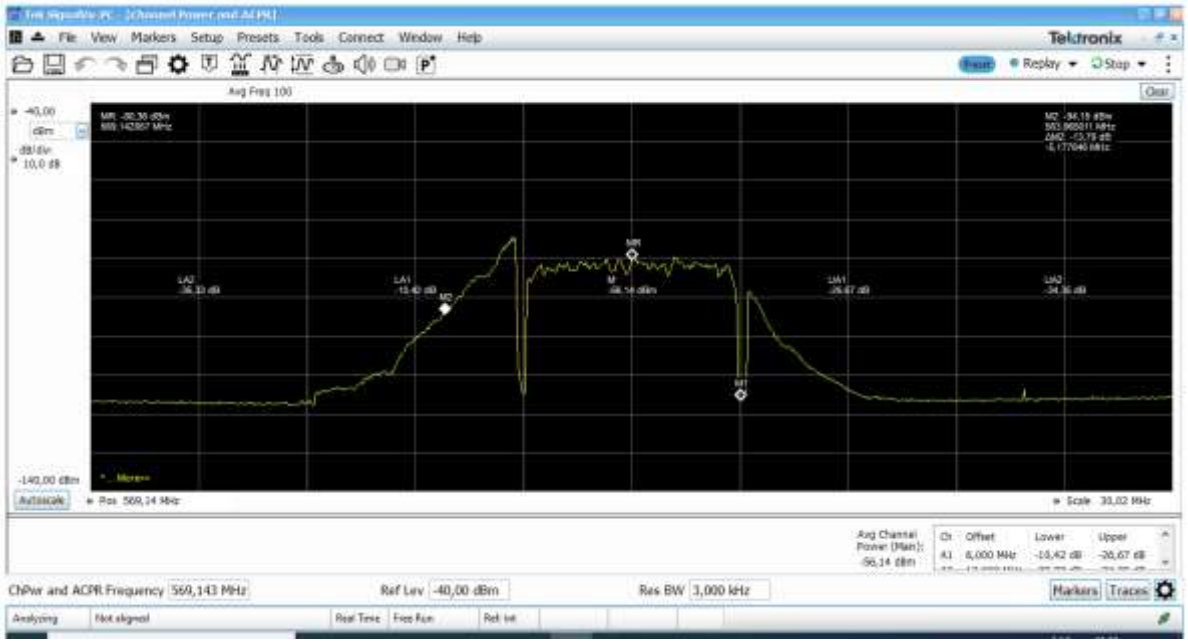


Figure 25.2 - Horizontal

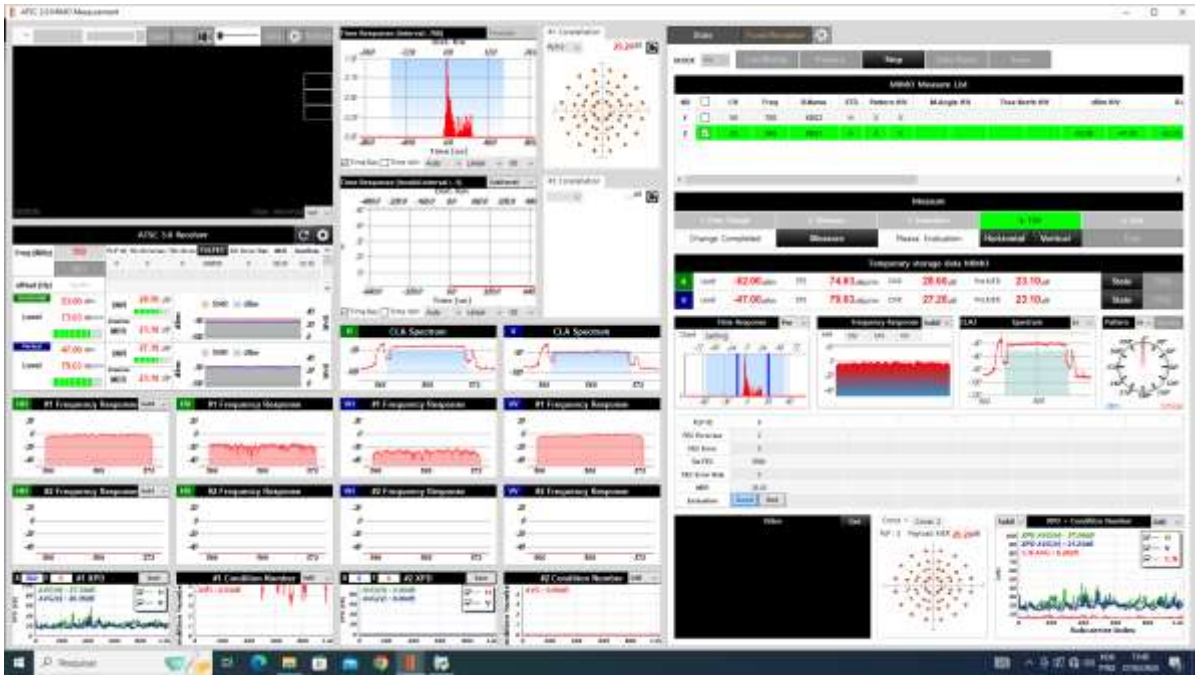


Figure 25.3 - IMAS Screen

b) AWGN Power

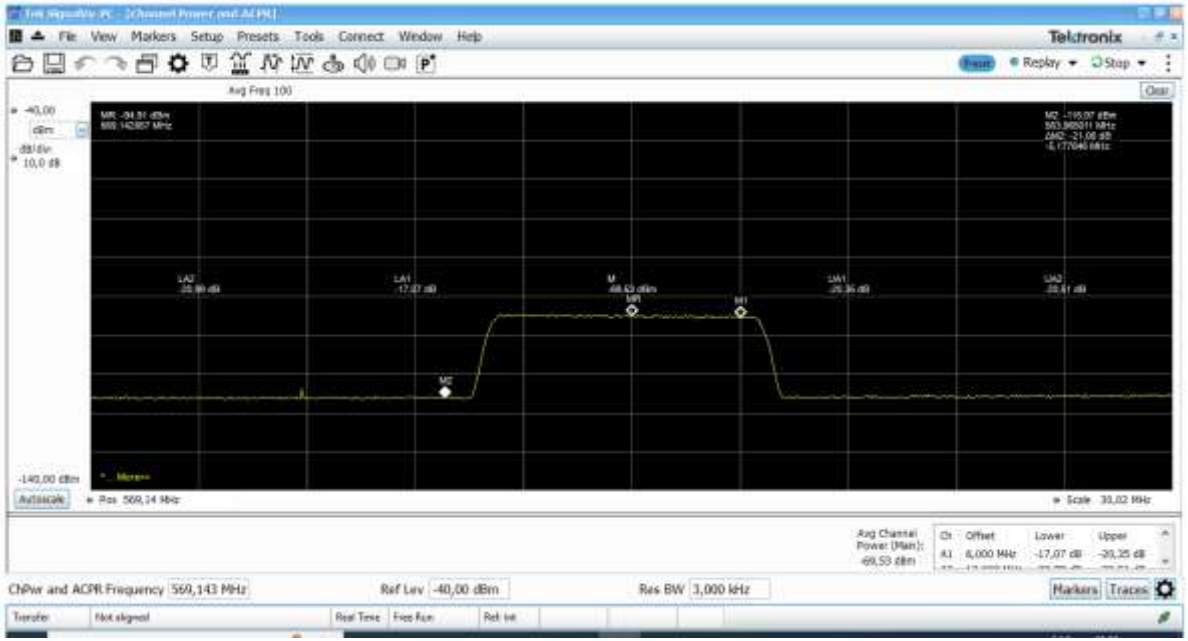


Figure 25.4 - Vertical

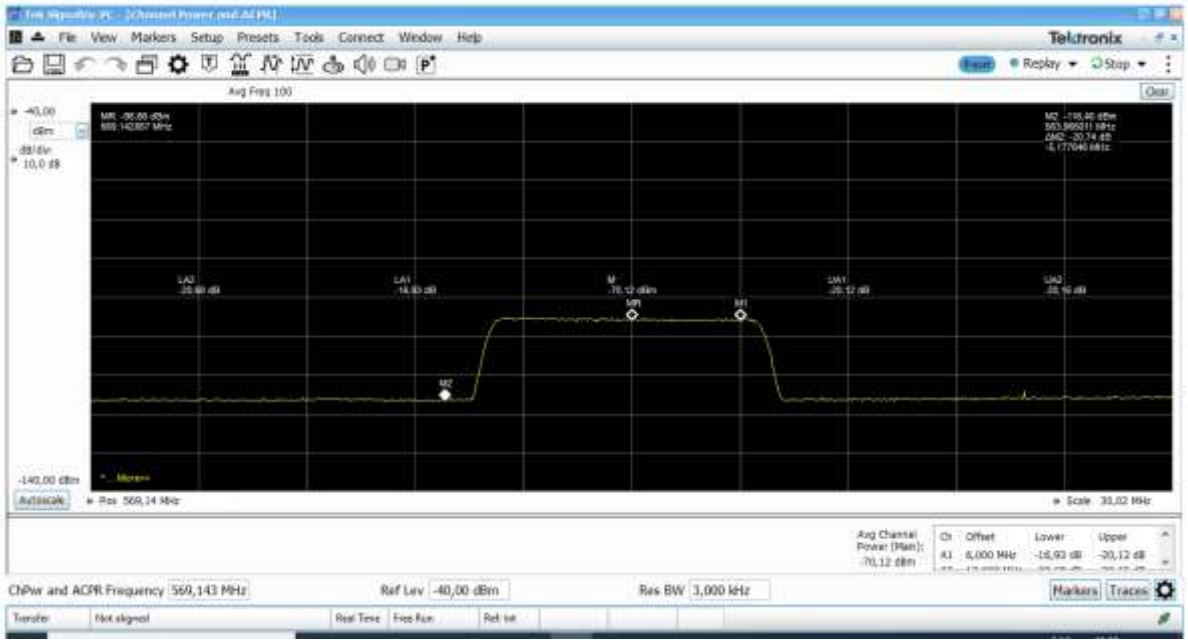


Figure 25.5 - Horizontal

c) C/N Threshold

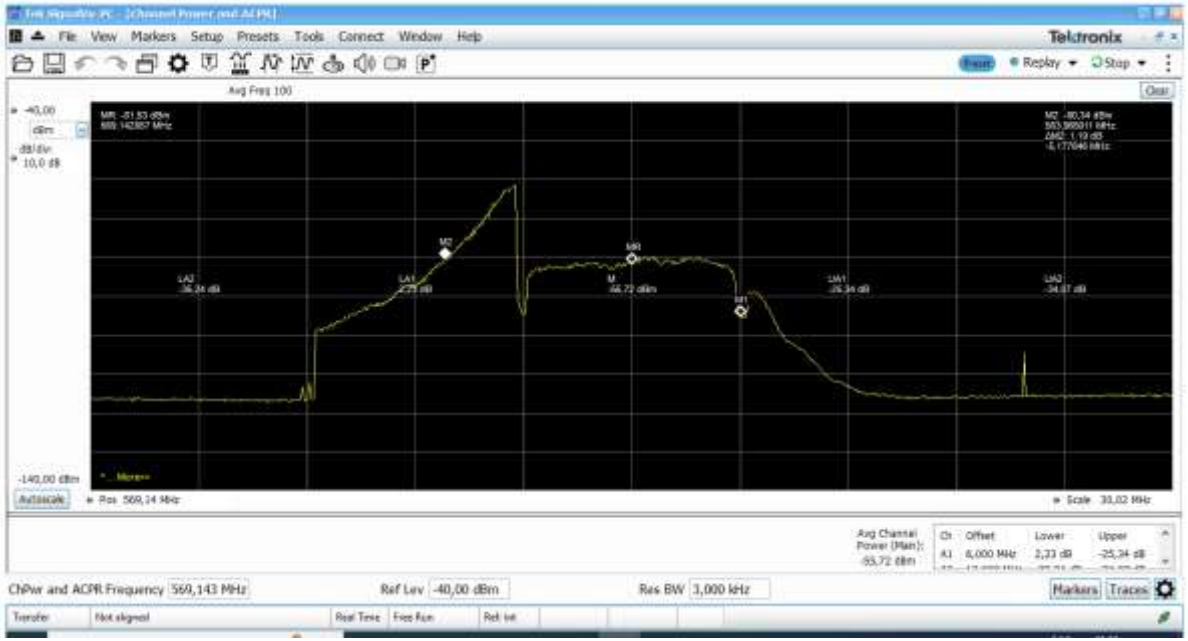


Figure 25.6 - Vertical

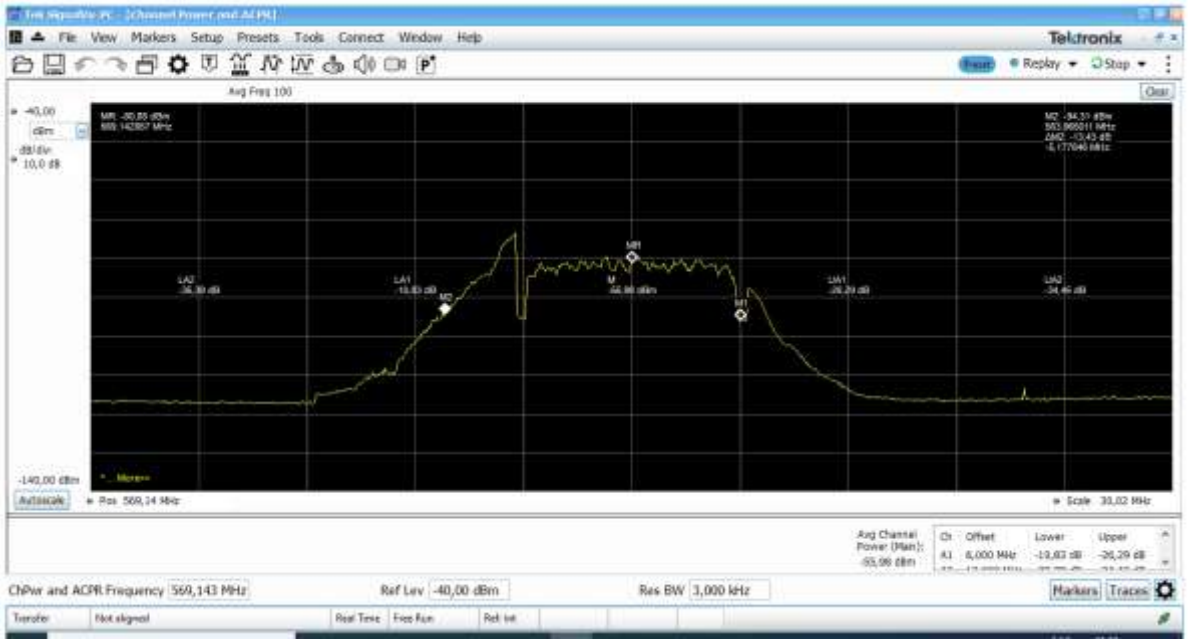


Figure 25.7 - Horizontal

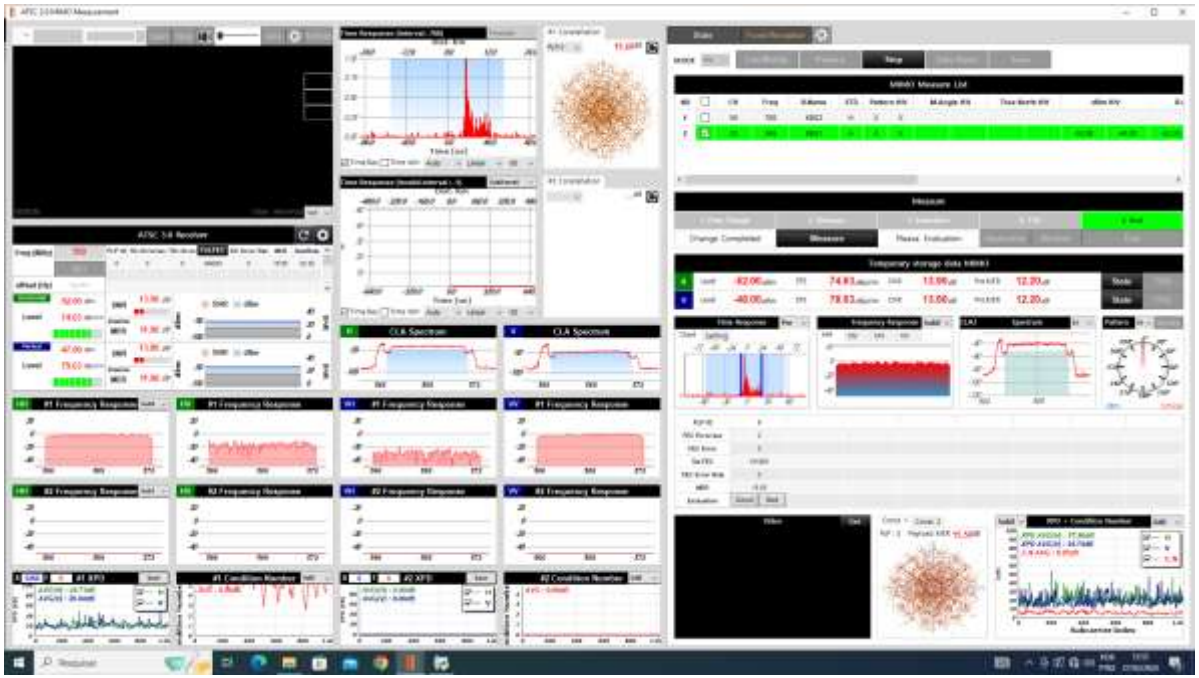


Figure 25.8 - IMAS Screen

d) Reception Threshold

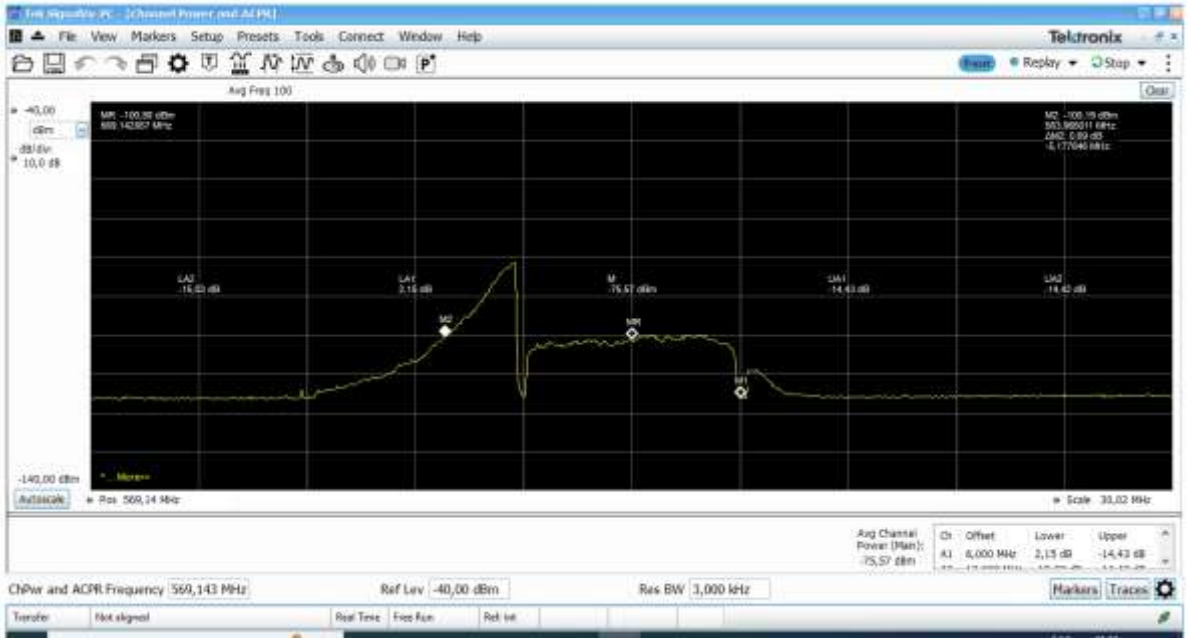


Figure 25.9 - Vertical

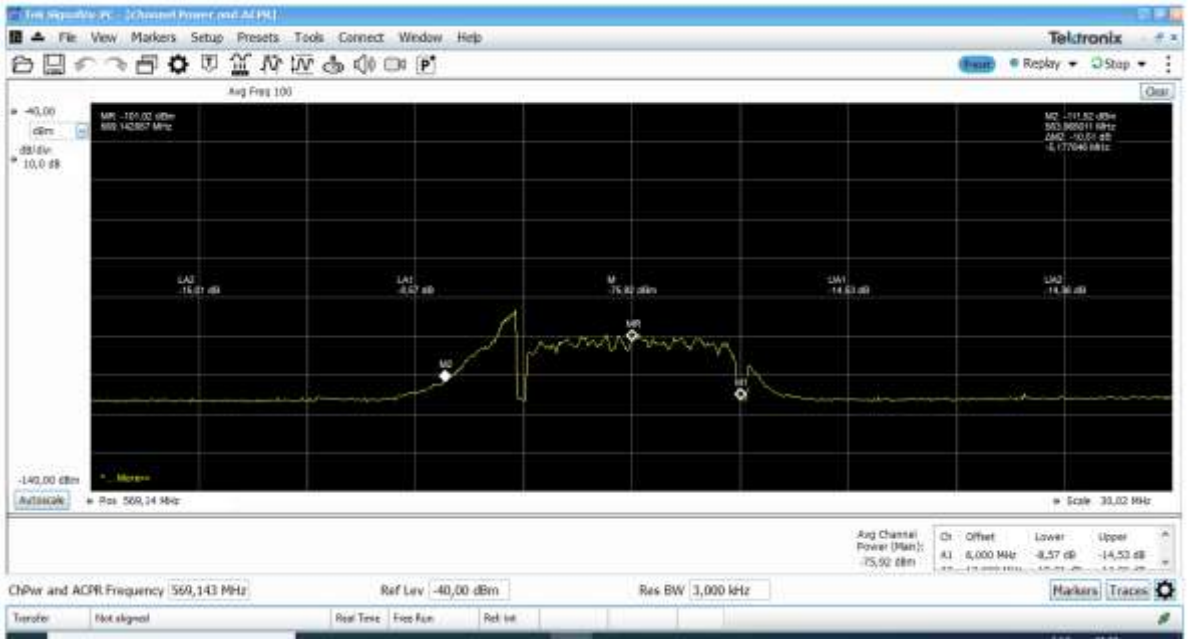


Figure 25.10 - Horizontal

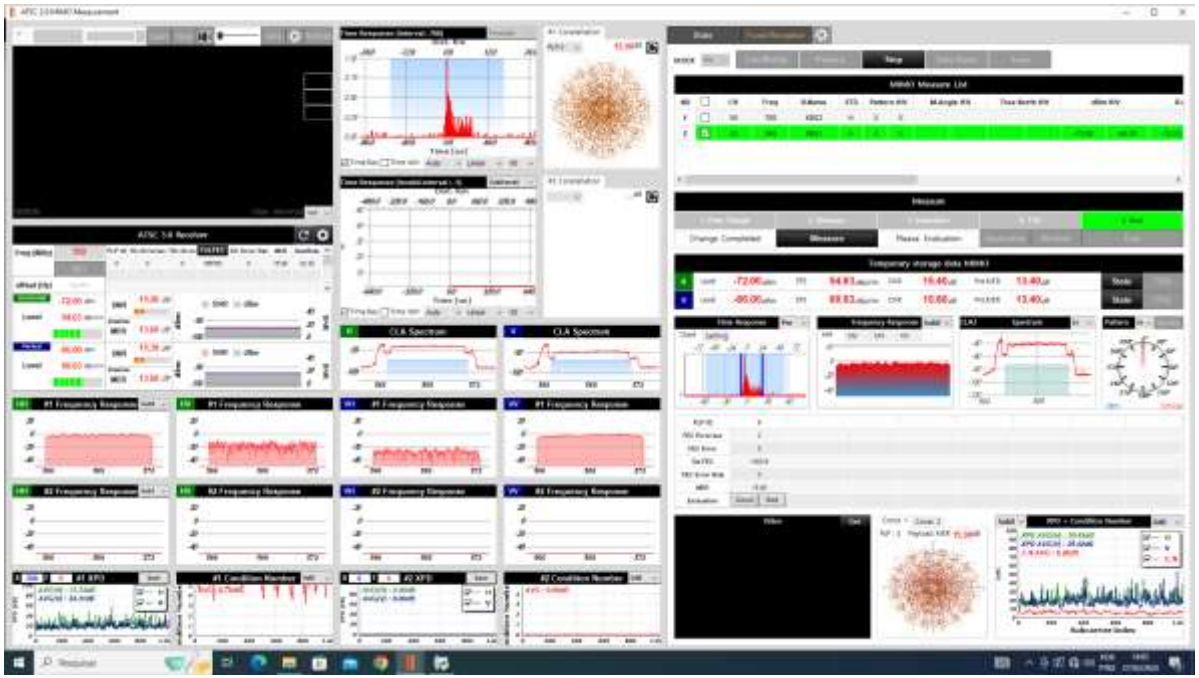


Figure 25.11 - IMAS Screen

Chapter 26. Site 26

a) Channel Power

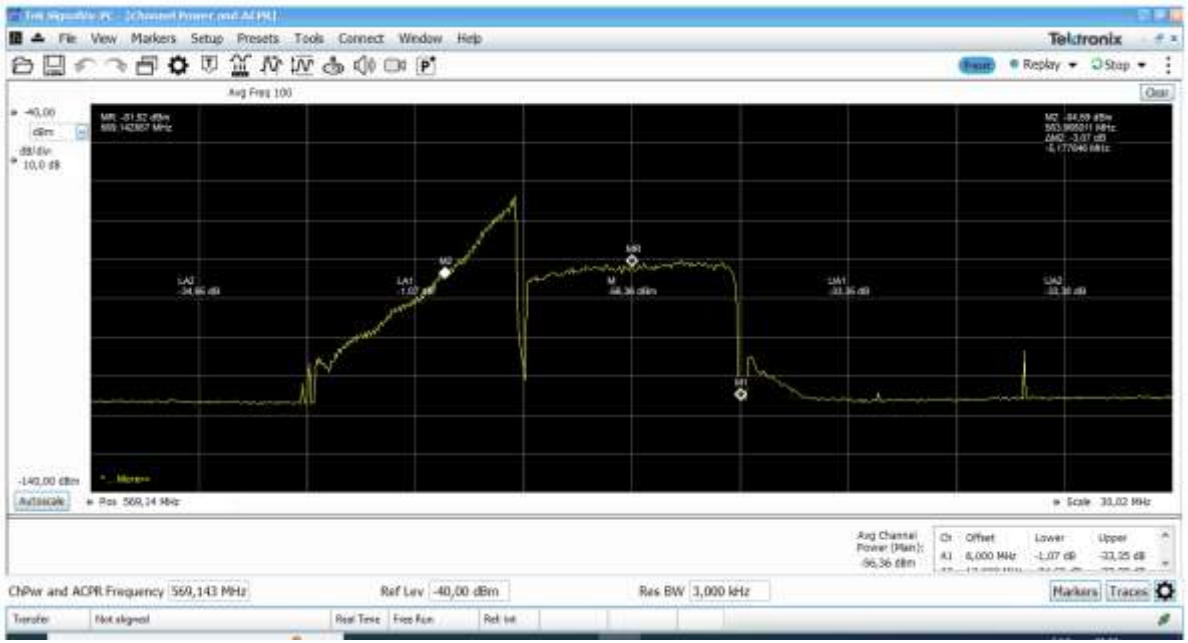


Figure 26.1 - Vertical

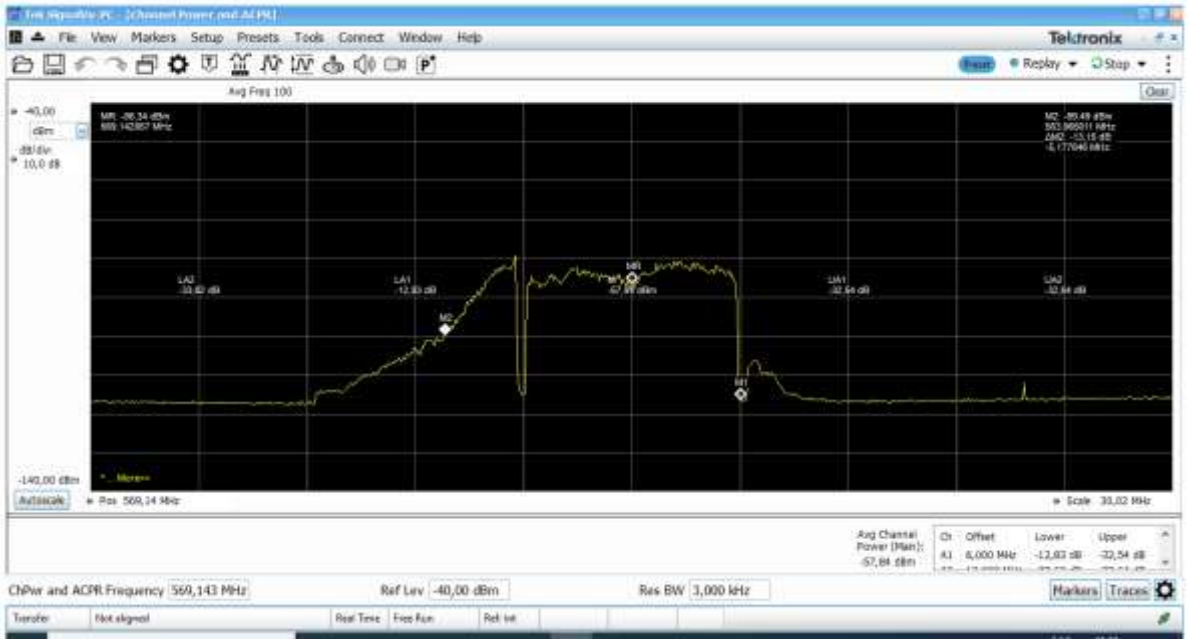


Figure 26.2 - Horizontal

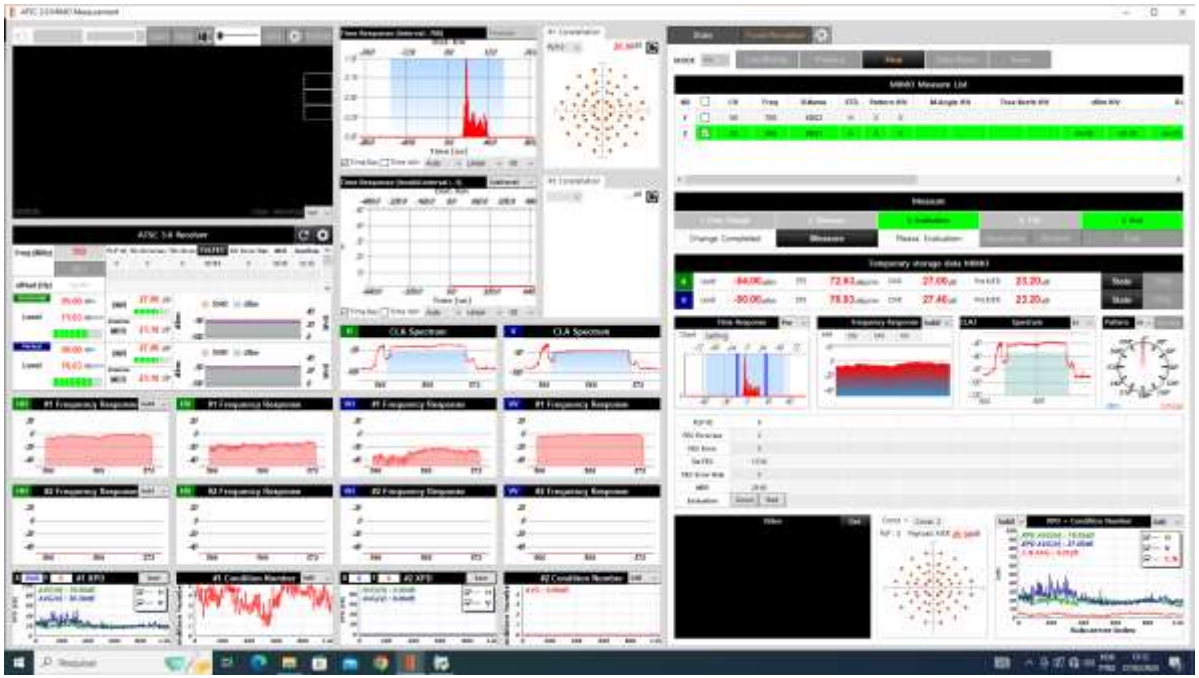


Figure 26.3 - IMAS Screen

b) AWGN Power

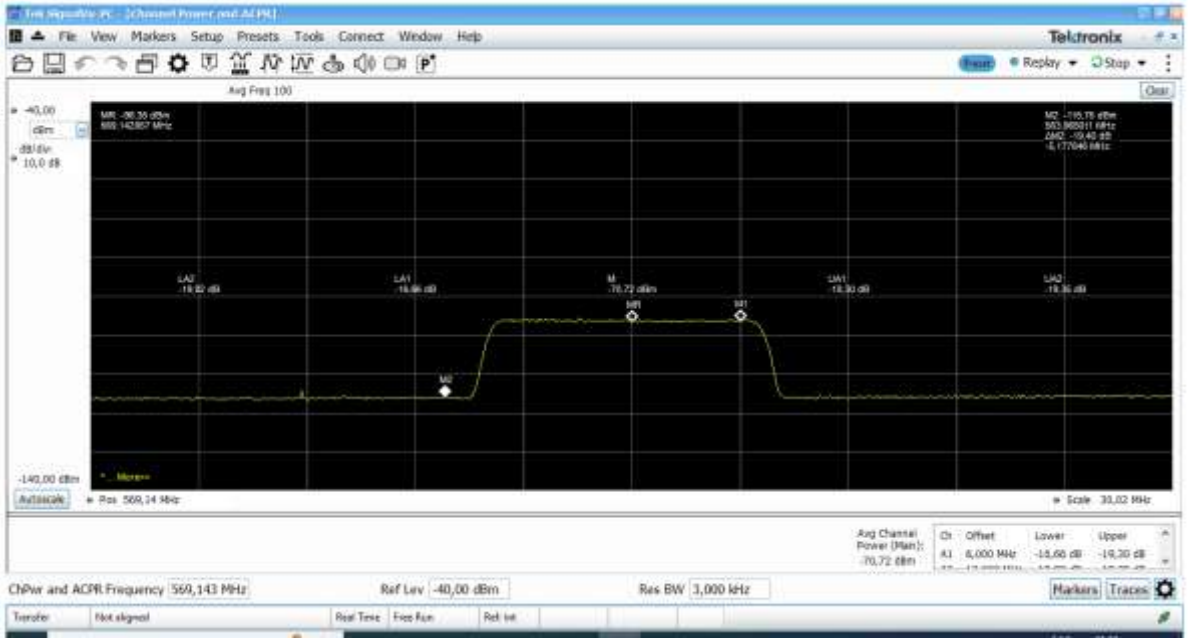


Figure 26.4 - Vertical

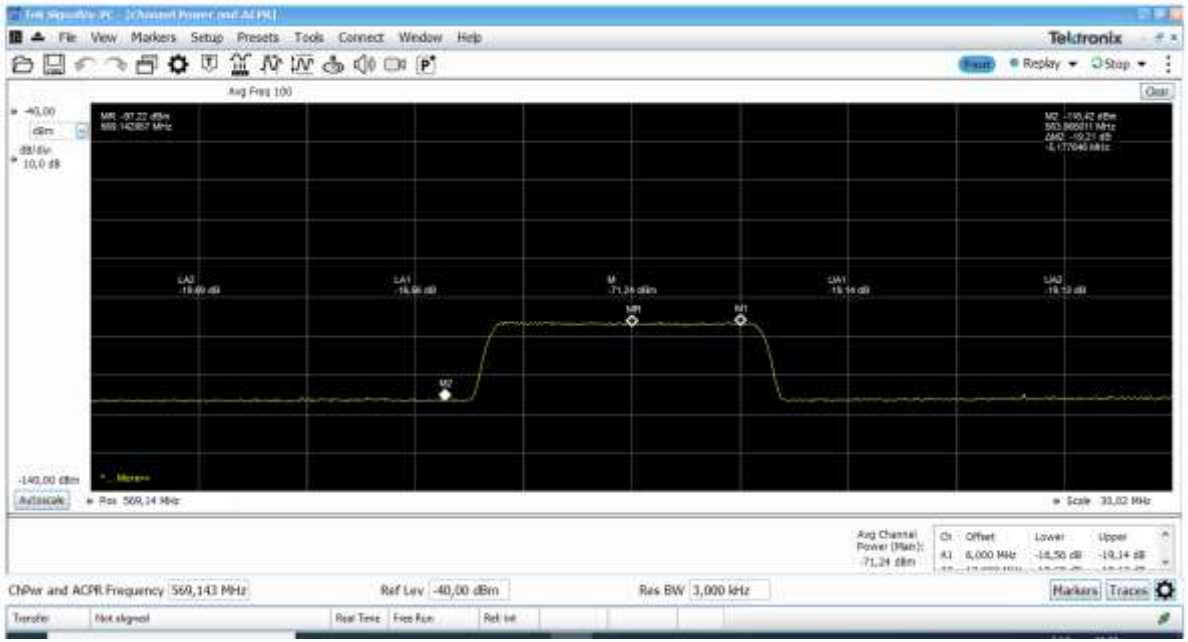


Figure 26.5 - Horizontal

c) C/N Threshold

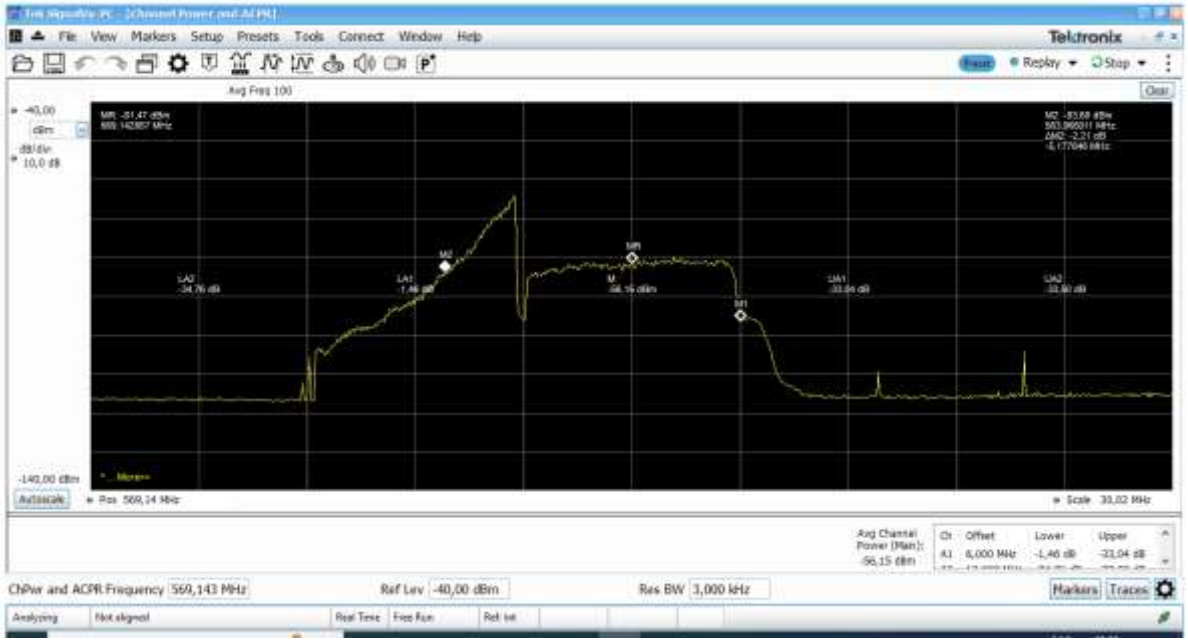


Figure 26.6 - Vertical

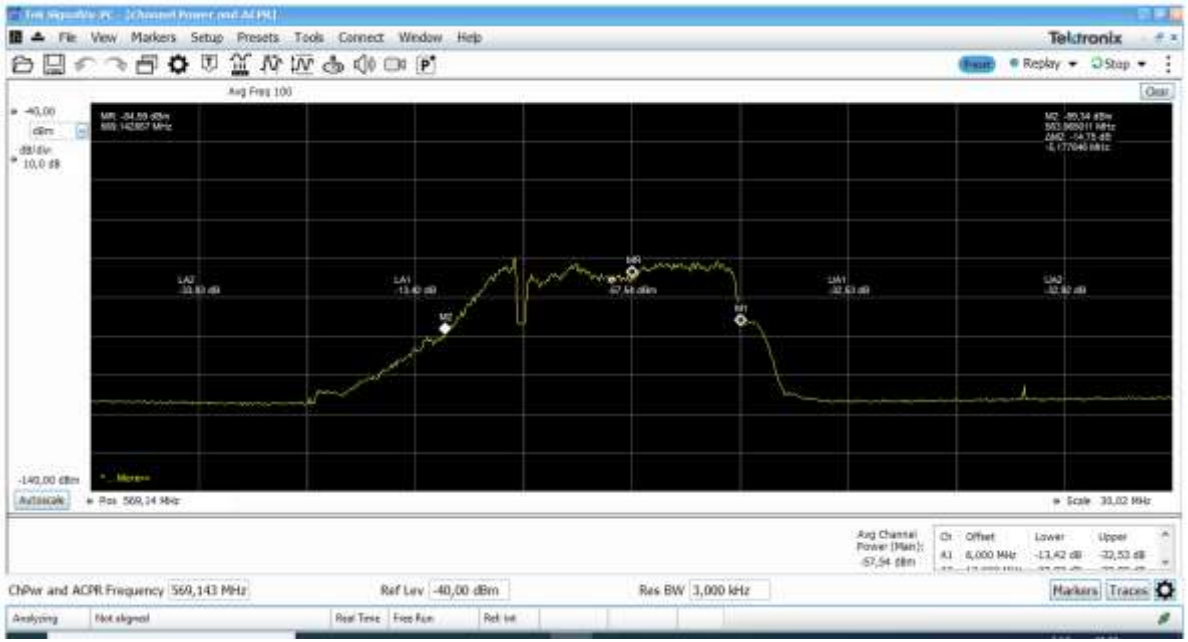


Figure 26.7 - Horizontal

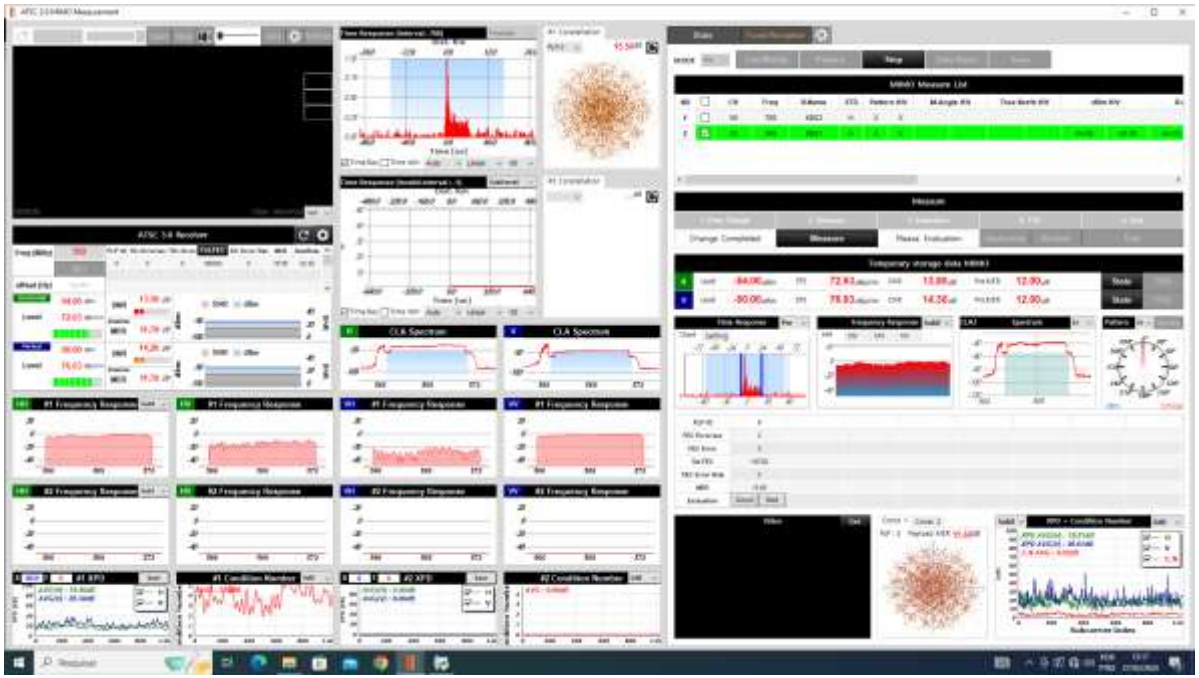


Figure 26.8 - IMAS Screen

d) Reception Threshold

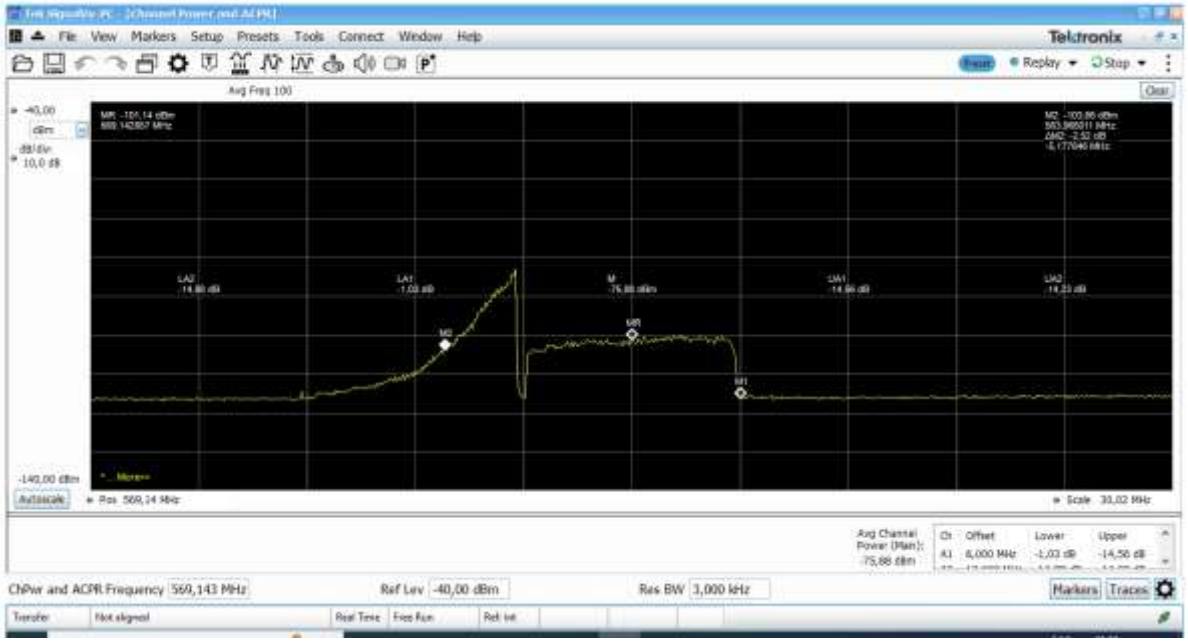


Figure 26.9 - Vertical

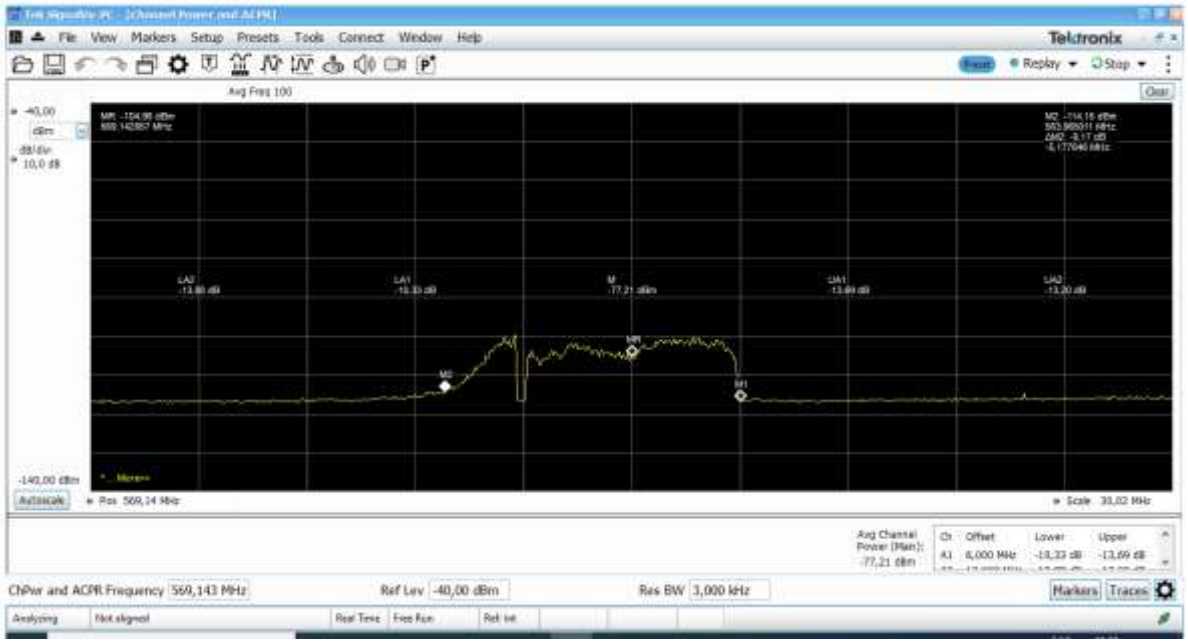


Figure 26.10 - Horizontal

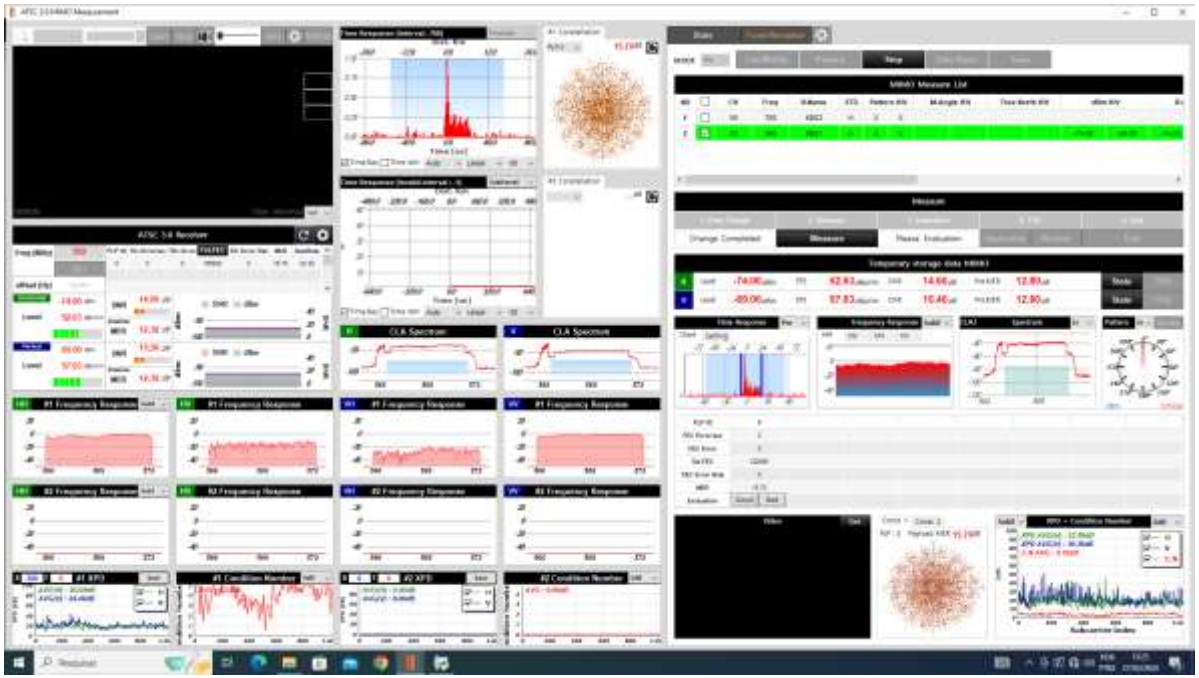


Figure 26.11 - IMAS Screen

Chapter 27. Site 27

a) Channel Power

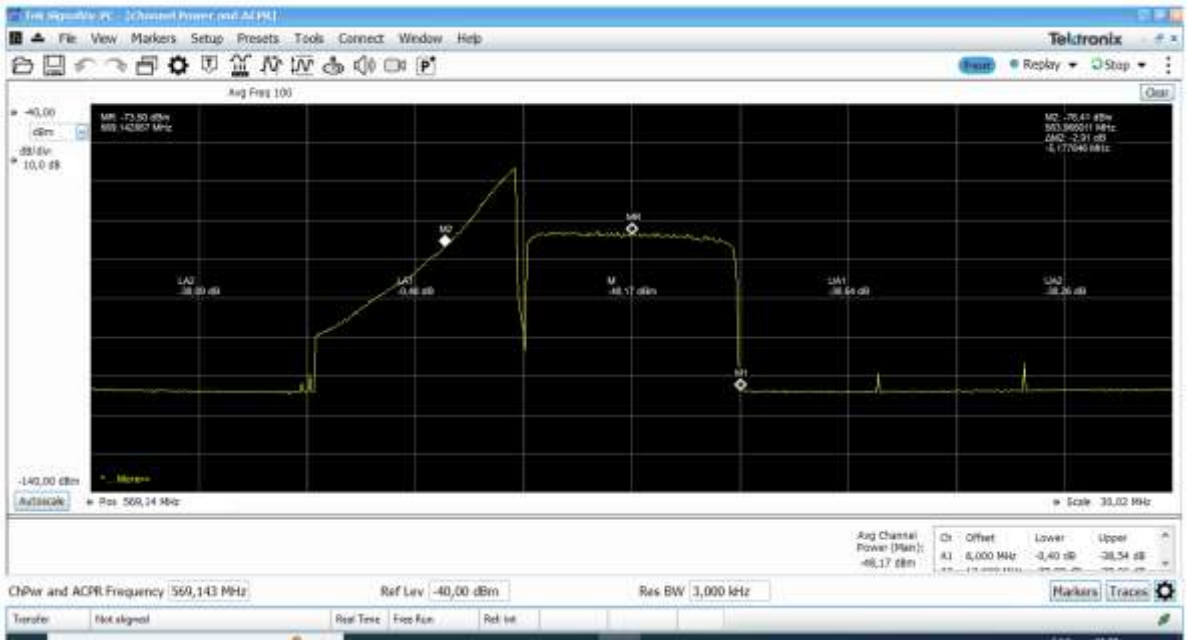


Figure 27.1 - Vertical

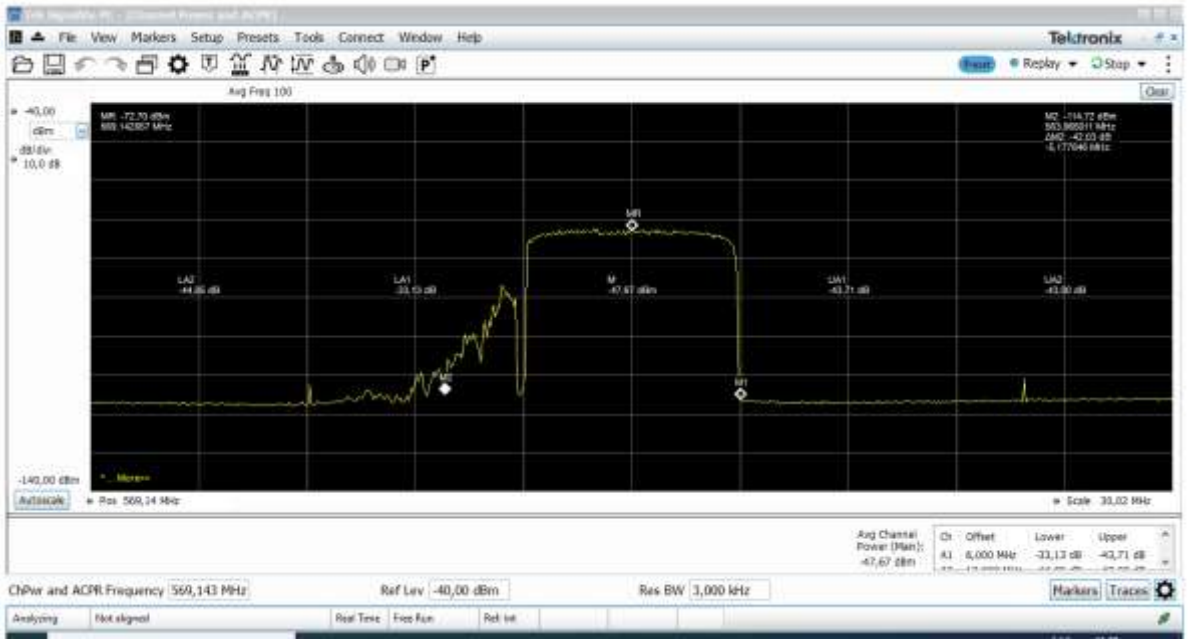


Figure 27.2 - Horizontal

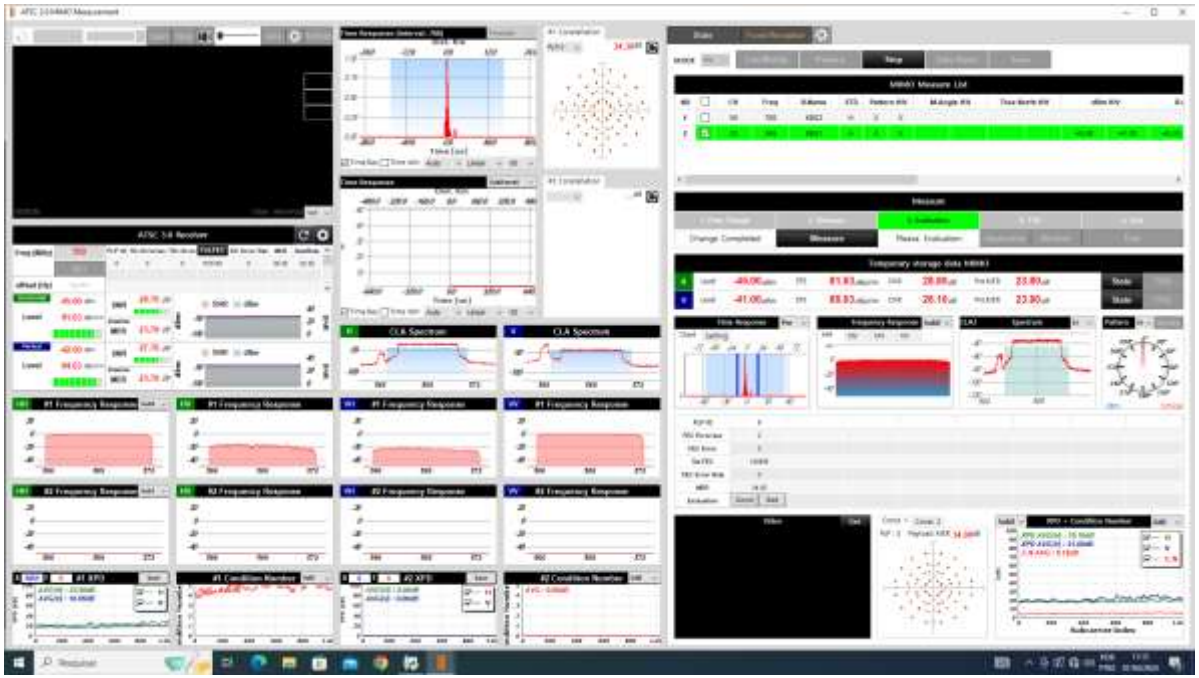


Figure 27.3 - IMAS Screen

b) AWGN Power

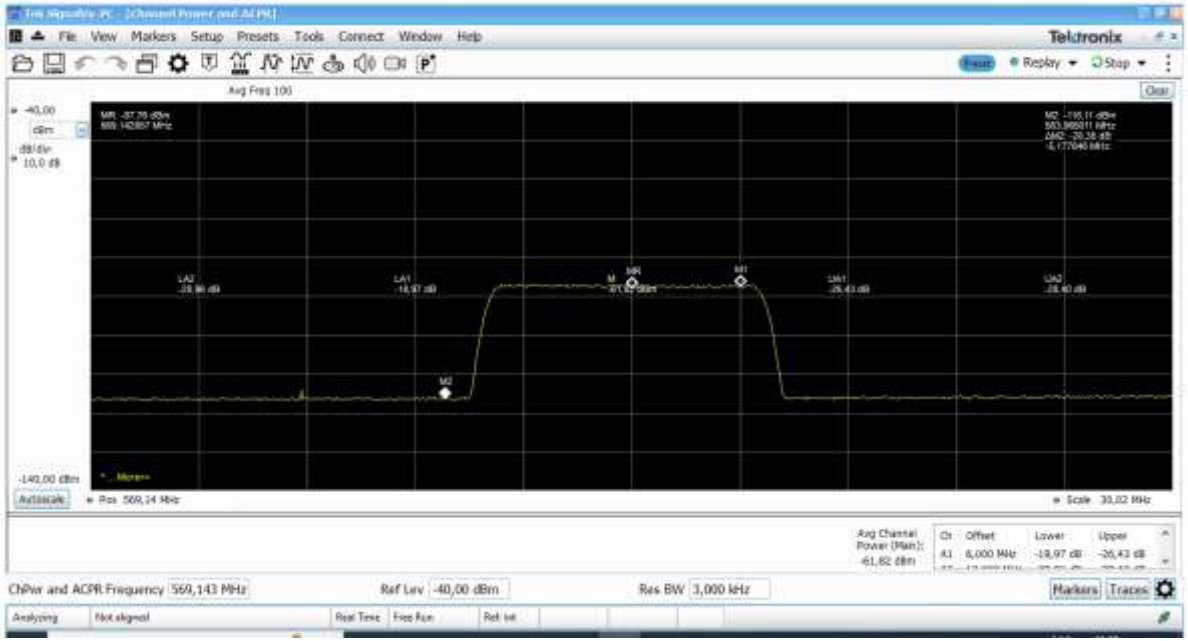


Figure 27.4 - Vertical

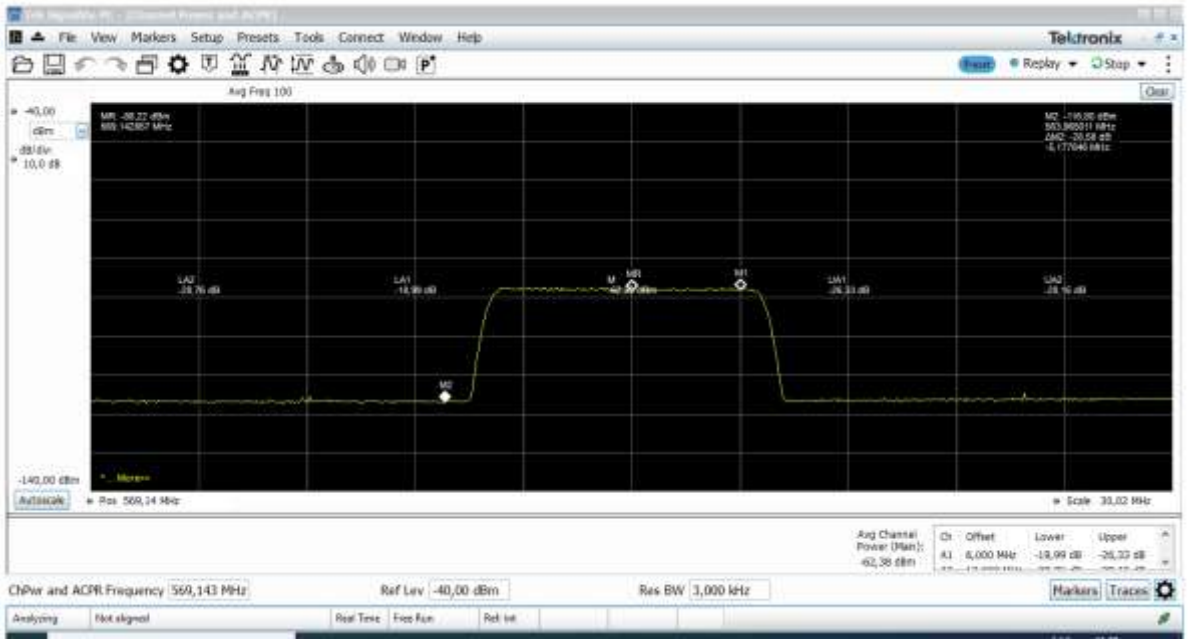


Figure 27.5 - Horizontal

c) C/N Threshold

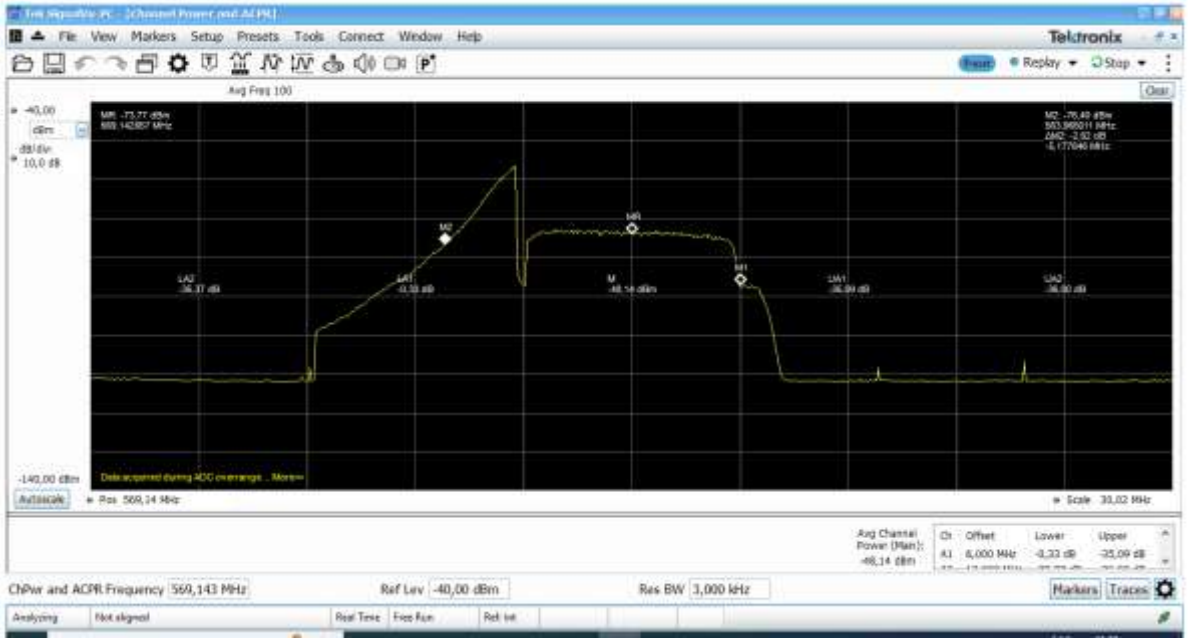


Figure 27.6 - Vertical

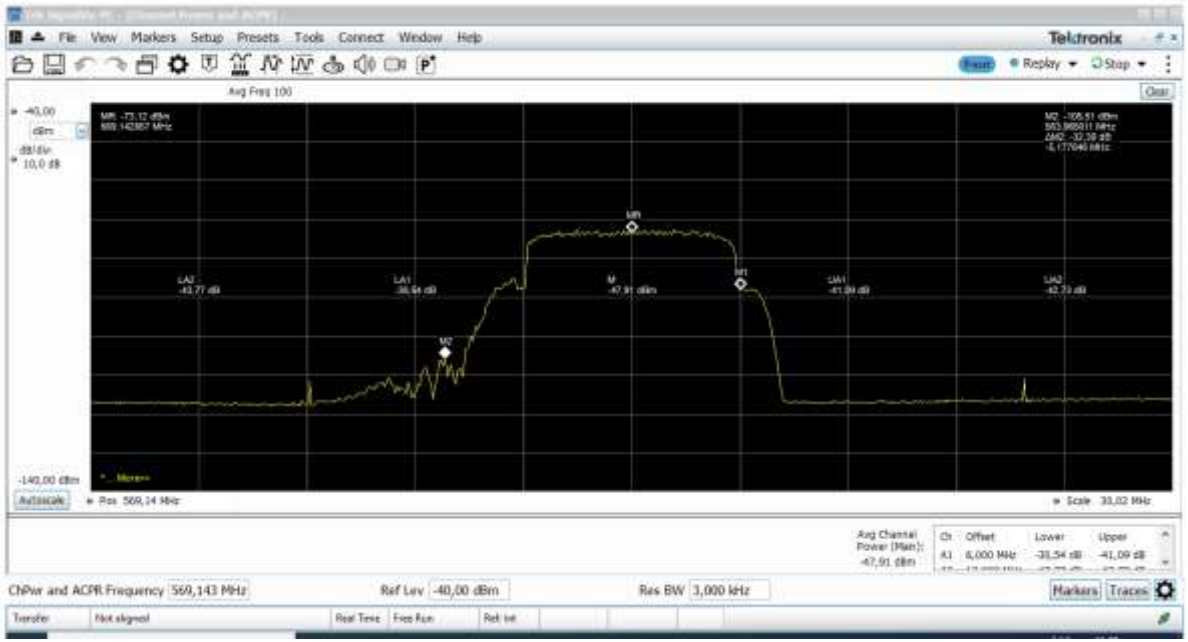


Figure 27.7 - Horizontal

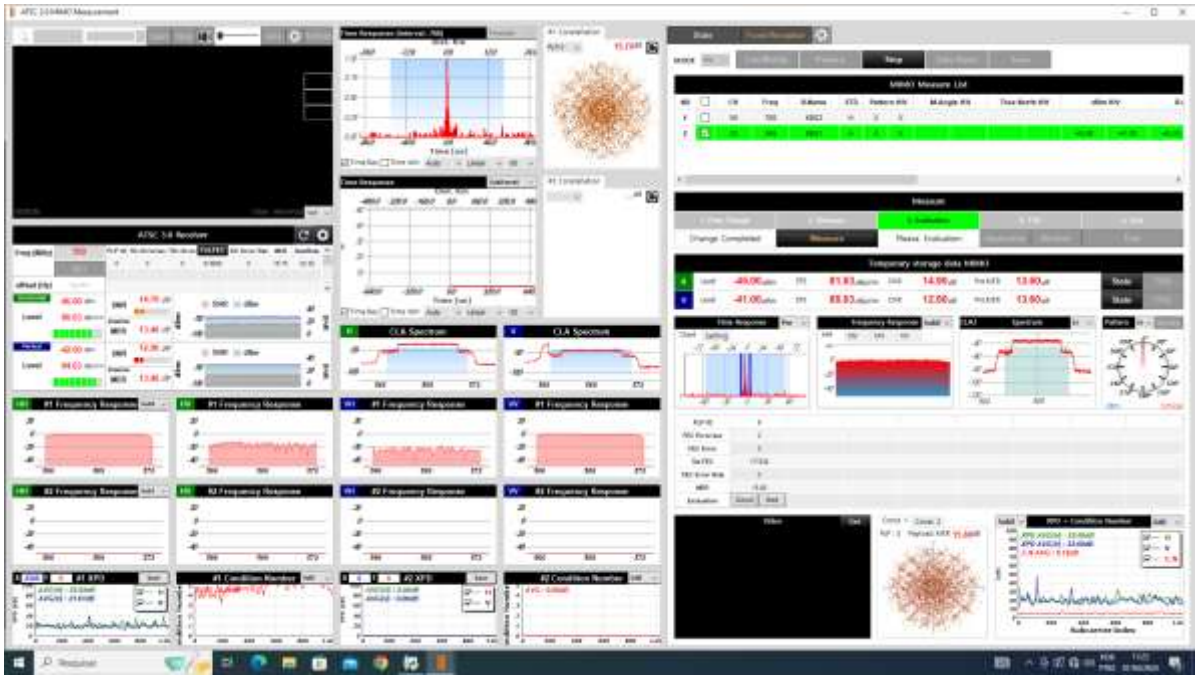


Figure 27.8 - IMAS Screen

d) Reception Threshold

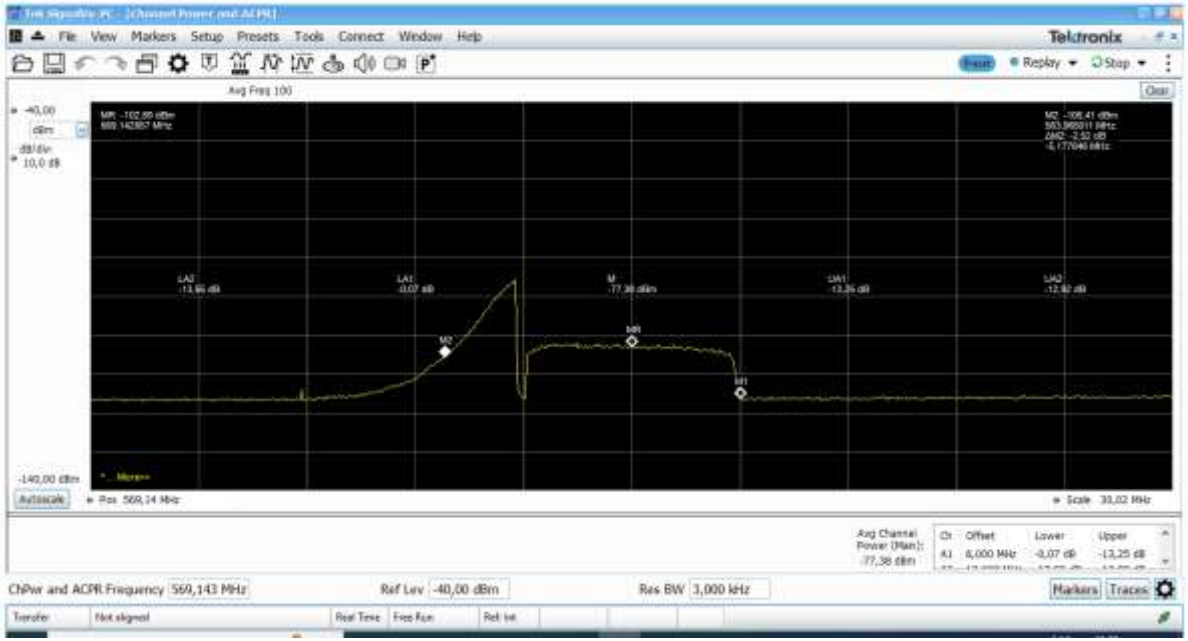


Figure 27.9 - Vertical

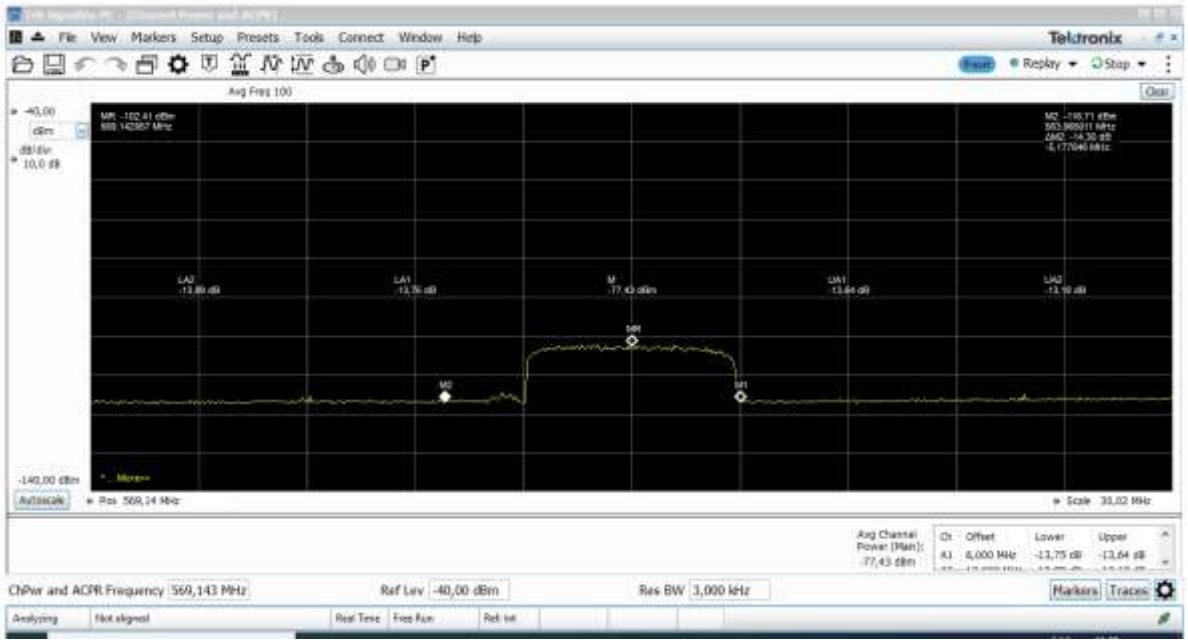


Figure 27.10 - Horizontal

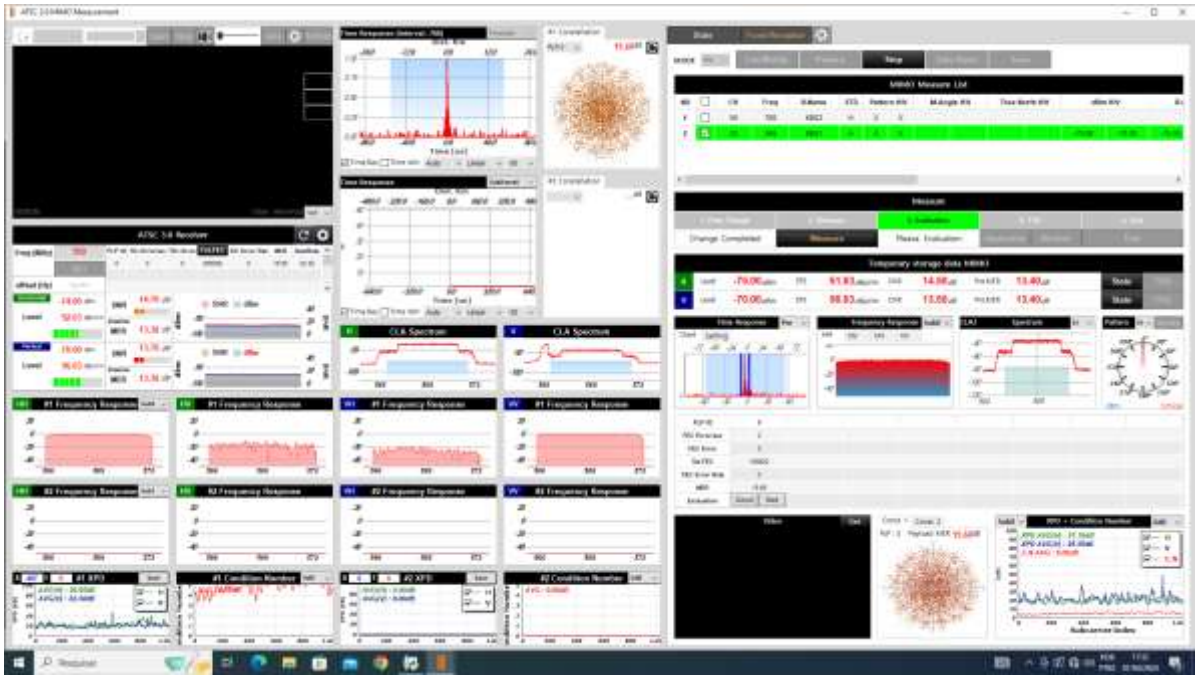


Figure 27.11 - IMAS Screen

Chapter 28. Site 28

a) Channel Power

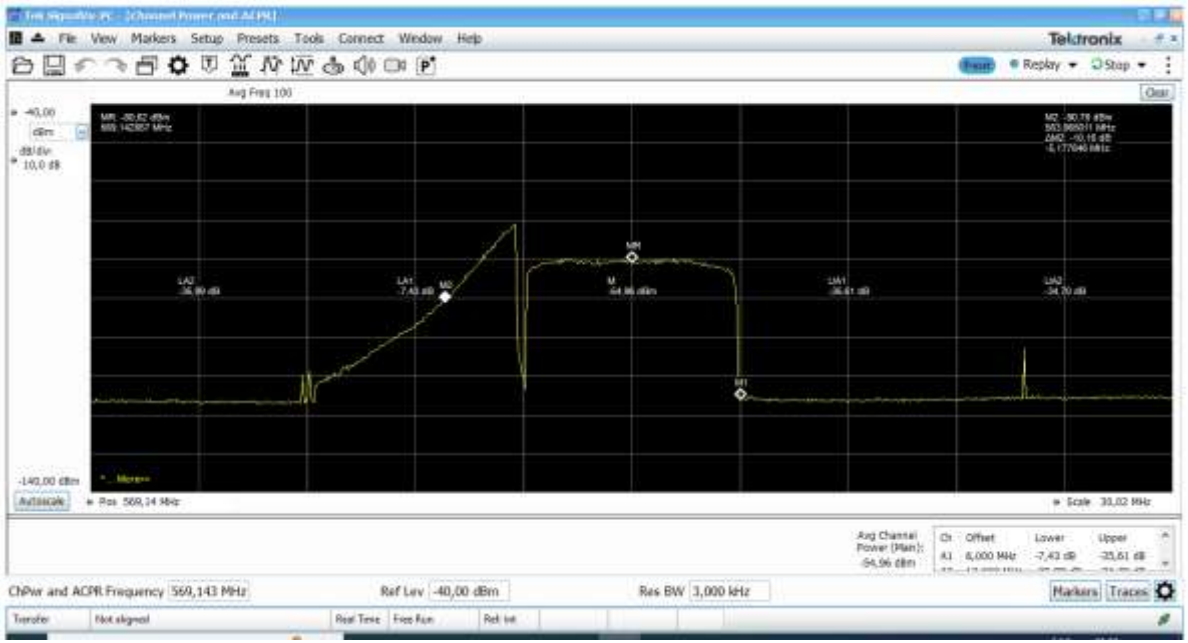


Figure 28.1 - Vertical

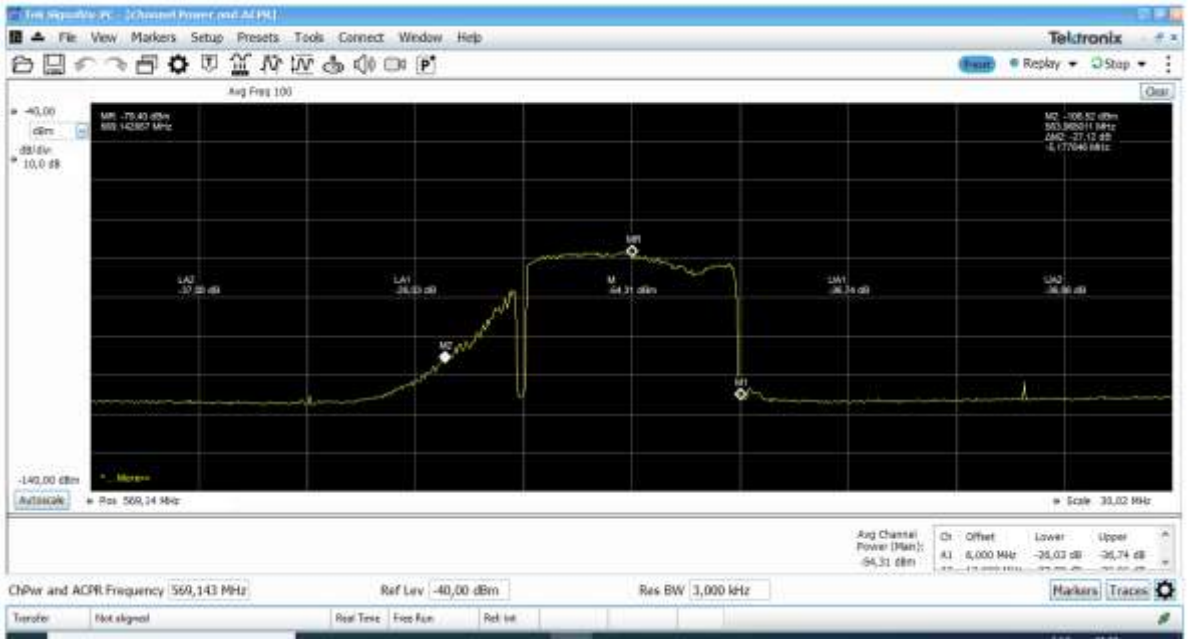


Figure 28.2 - Horizontal

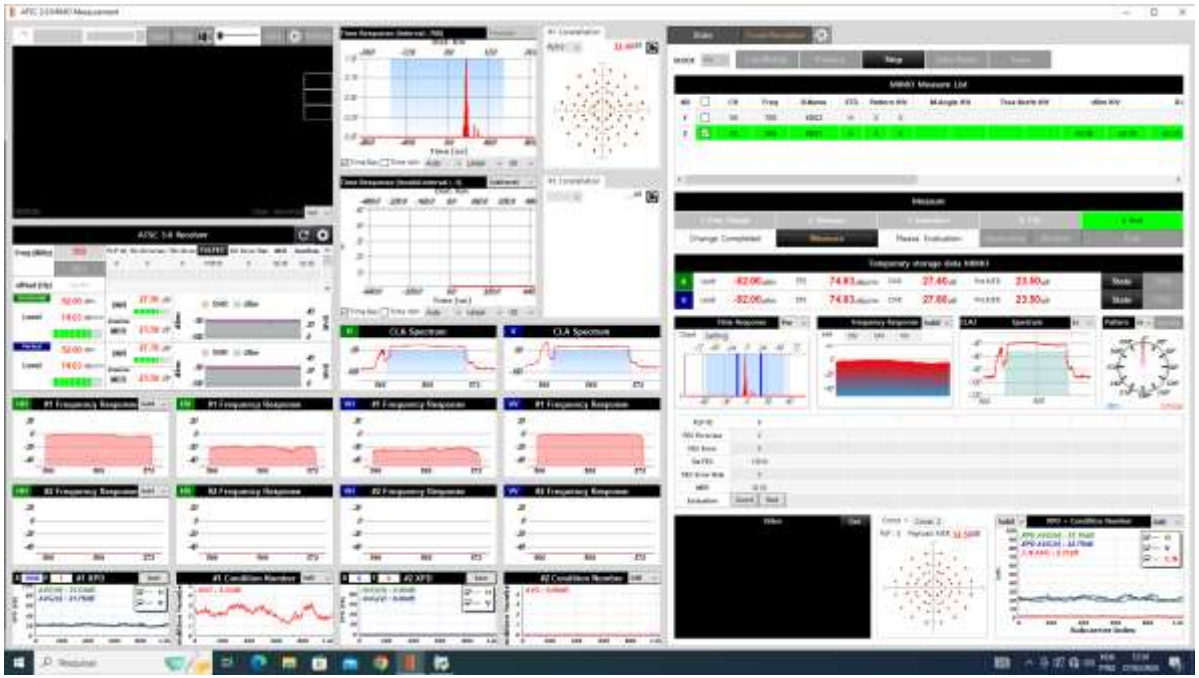


Figure 28.3 - IMAS Screen

b) AWGN Power

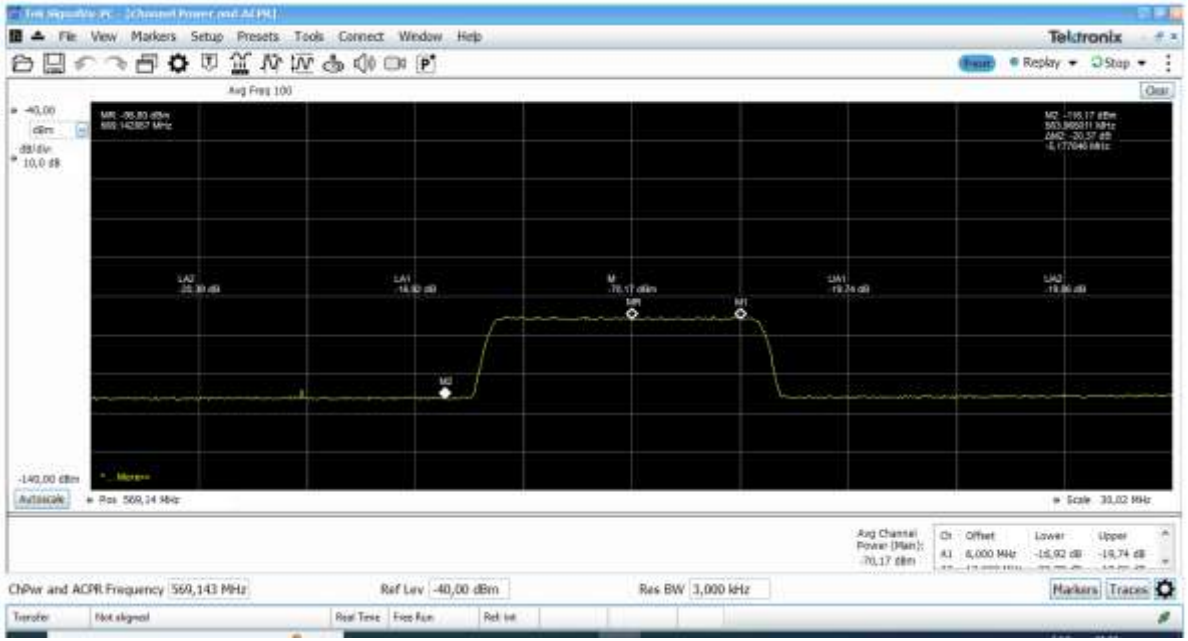


Figure 28.4 - Vertical

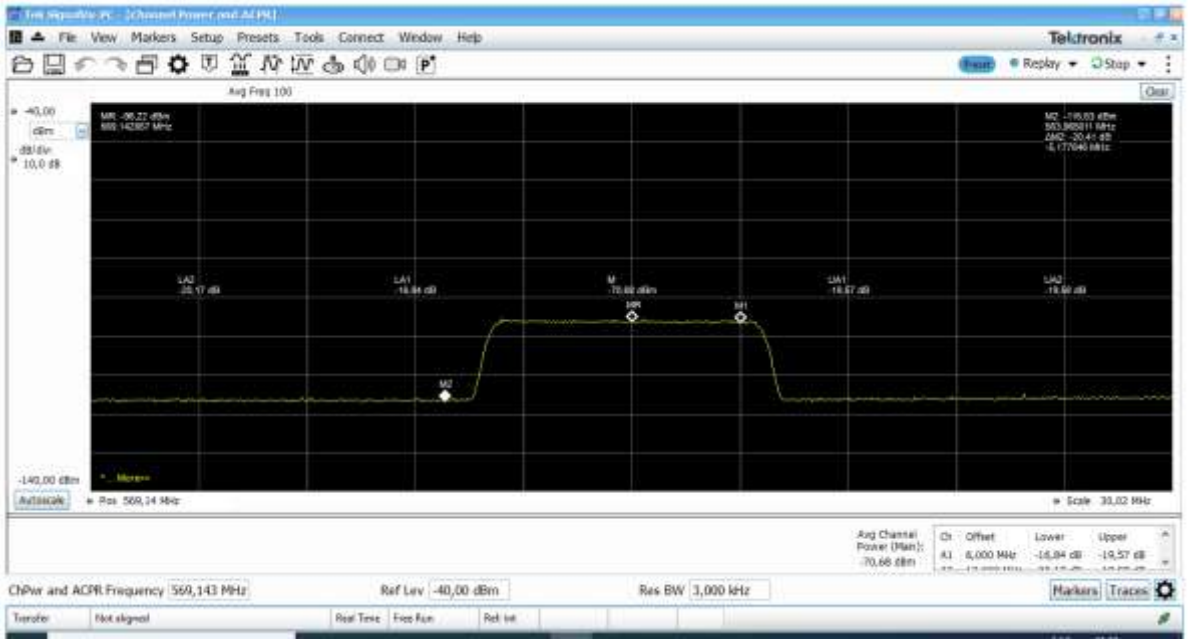


Figure 28.5 - Horizontal

c) C/N Threshold

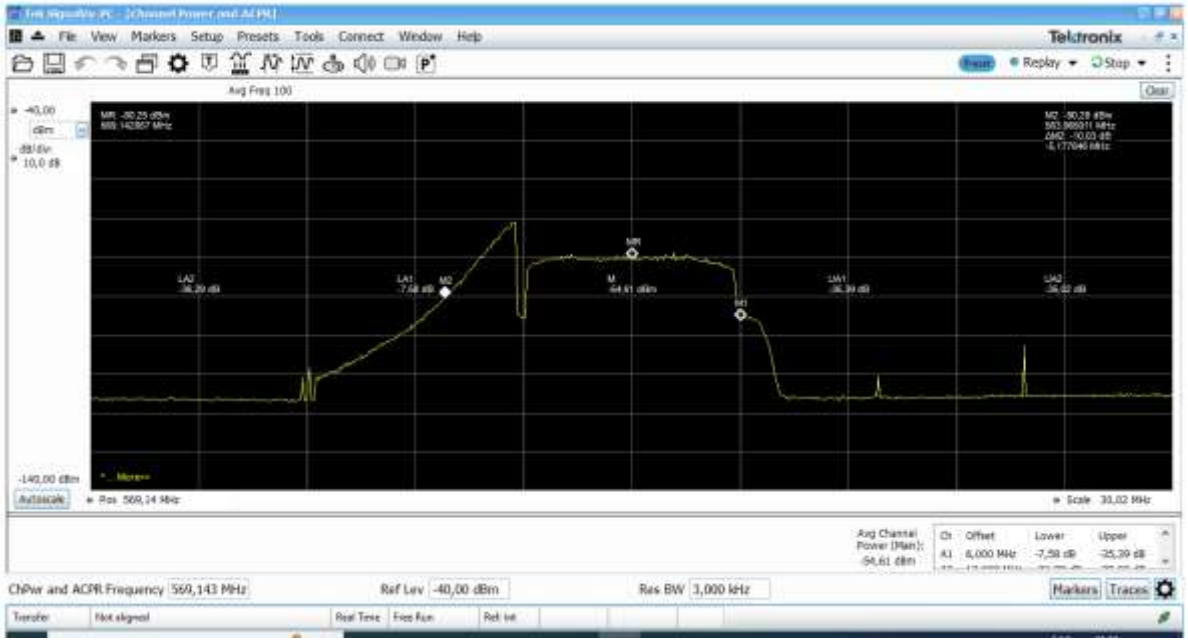


Figure 28.6 - Vertical

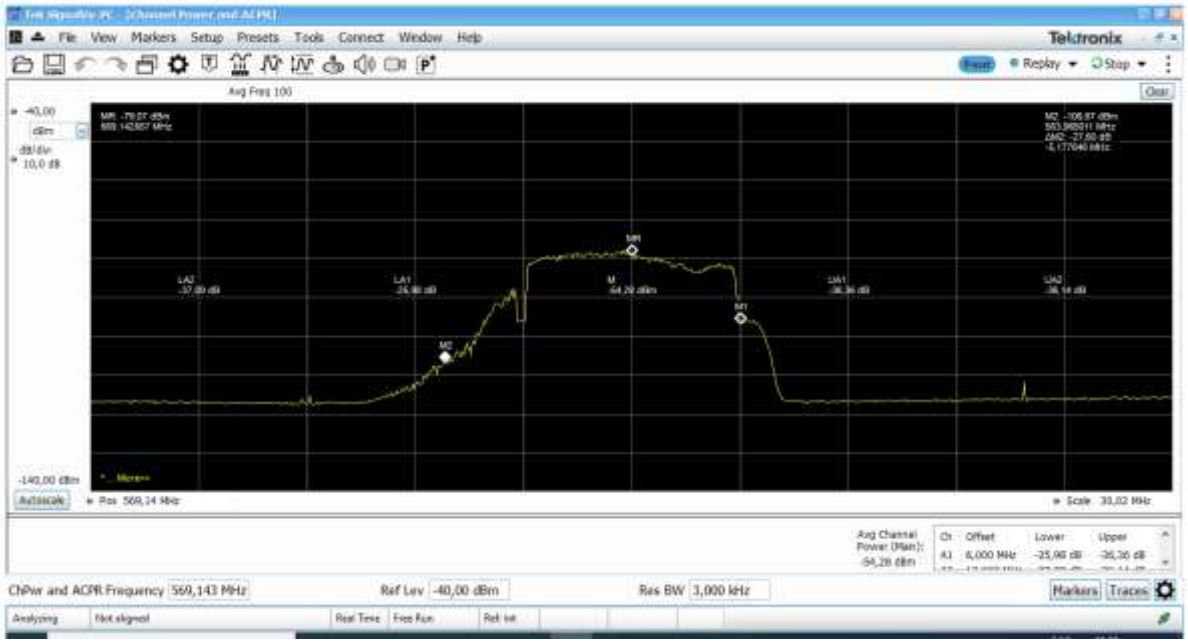


Figure 28.7 - Horizontal

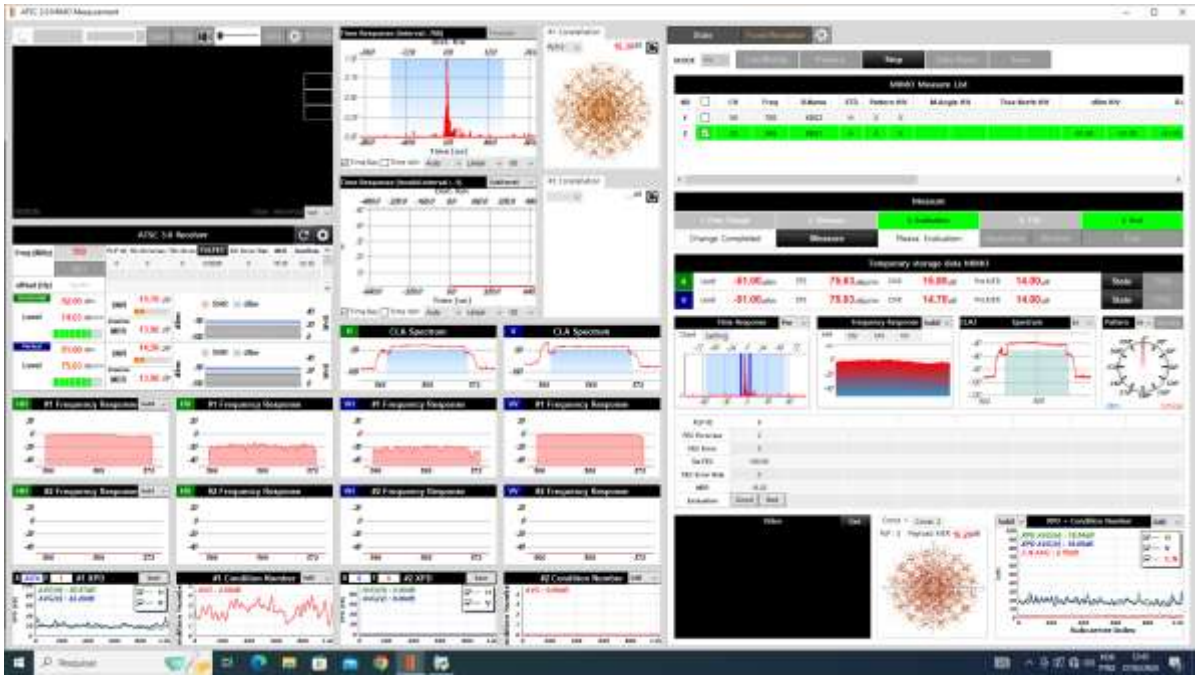


Figure 28.8 - IMAS Screen

d) Reception Threshold

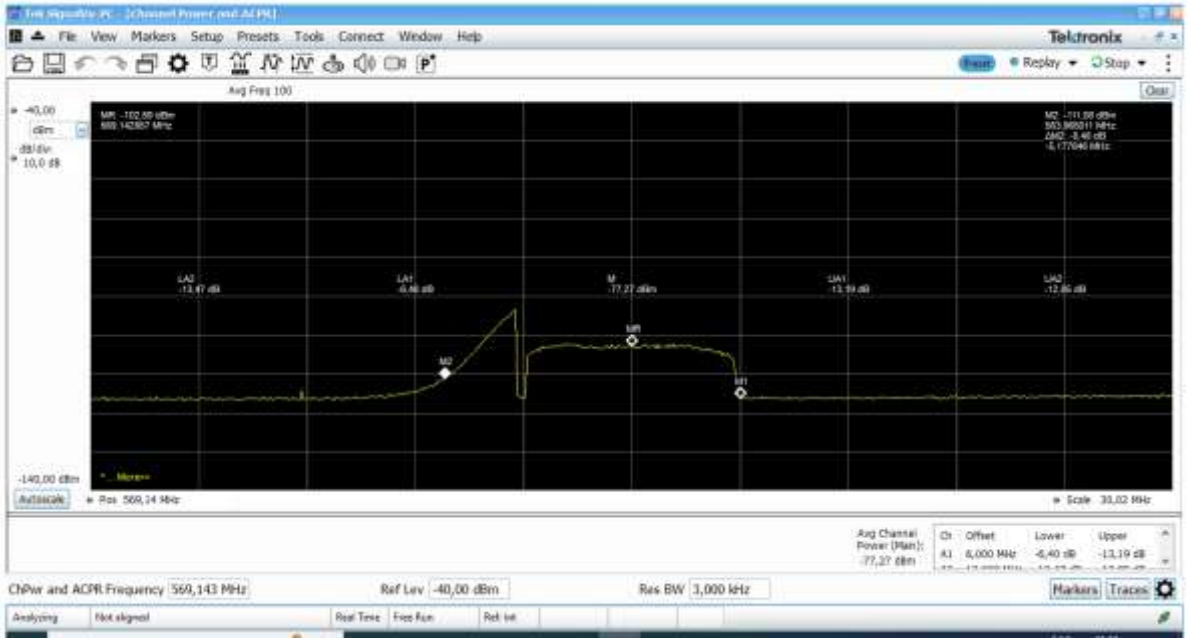


Figure 28.9 - Vertical

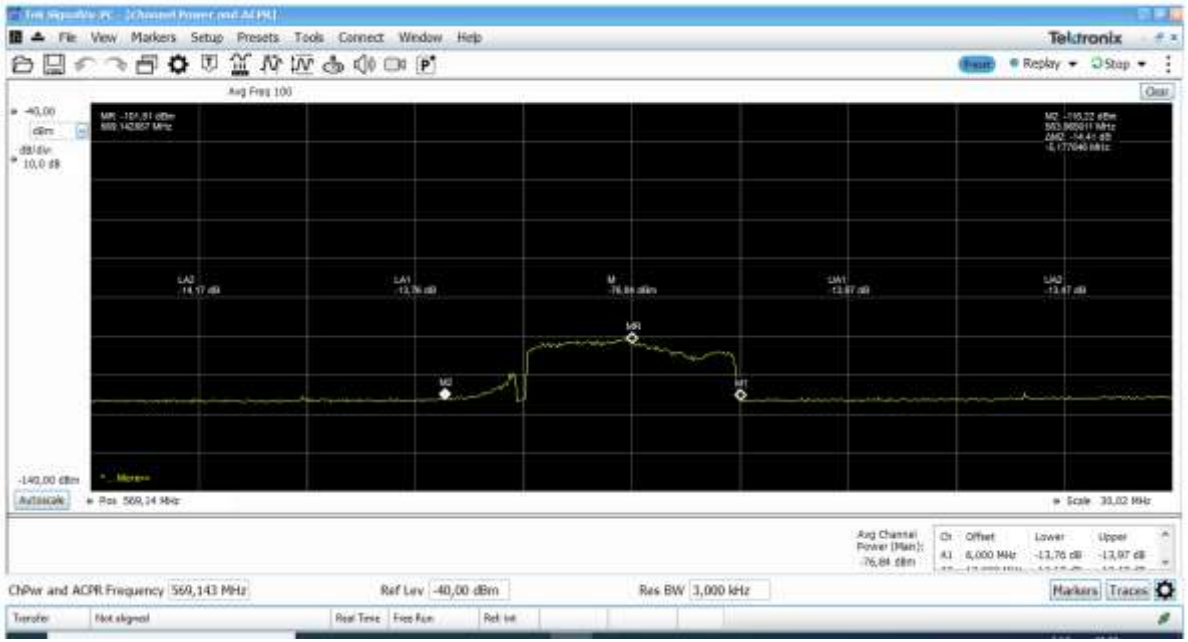


Figure 28.10 - Horizontal

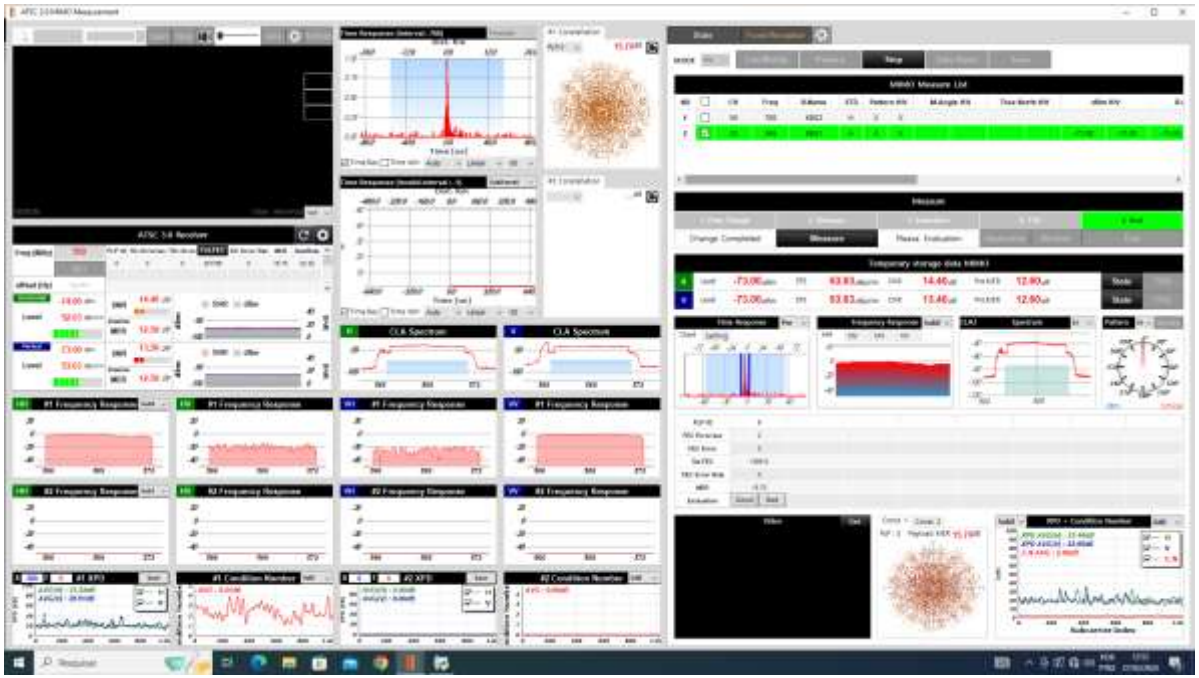


Figure 28.11 - IMAS Screen

Chapter 29. Site 29

a) Channel Power

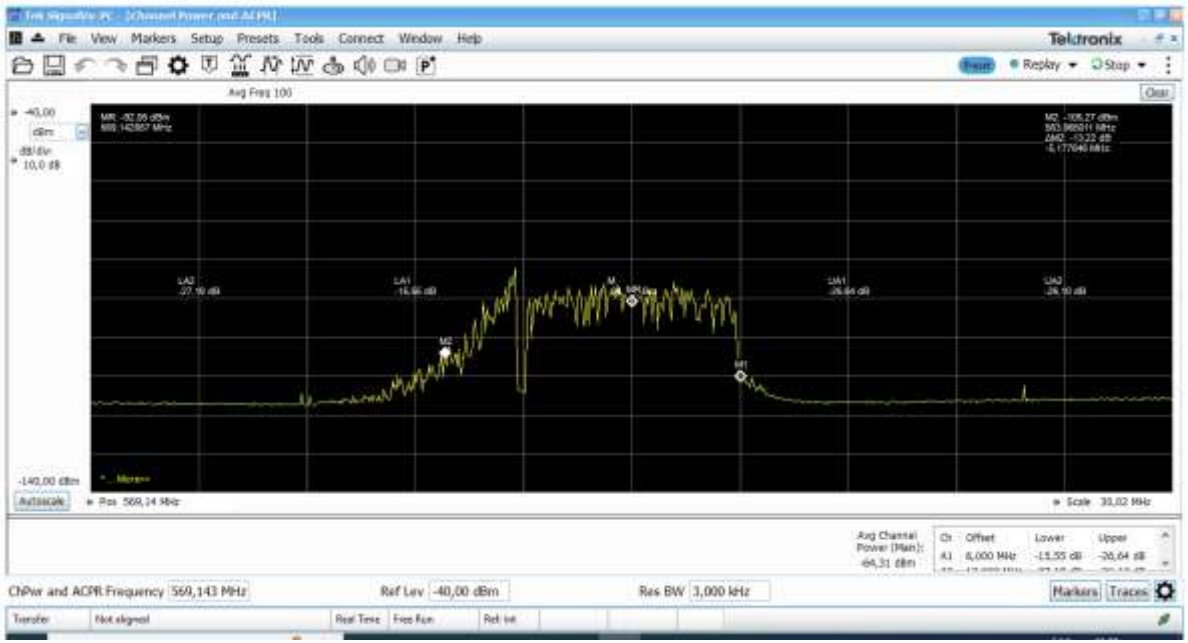


Figure 29.1 - Vertical

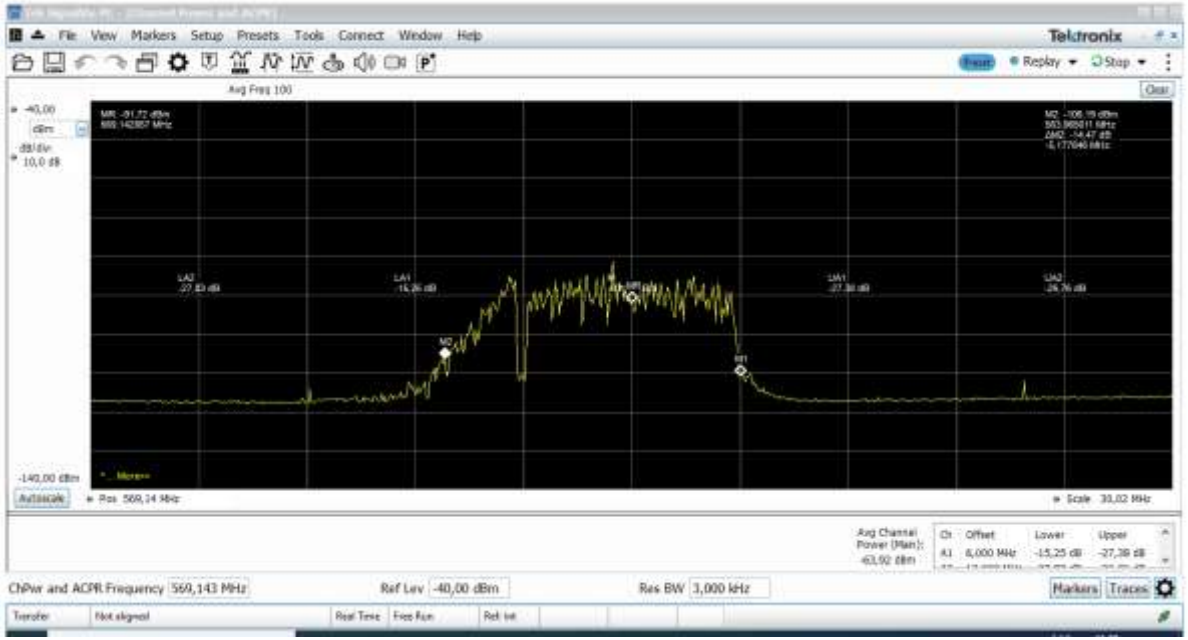


Figure 29.2 - Horizontal

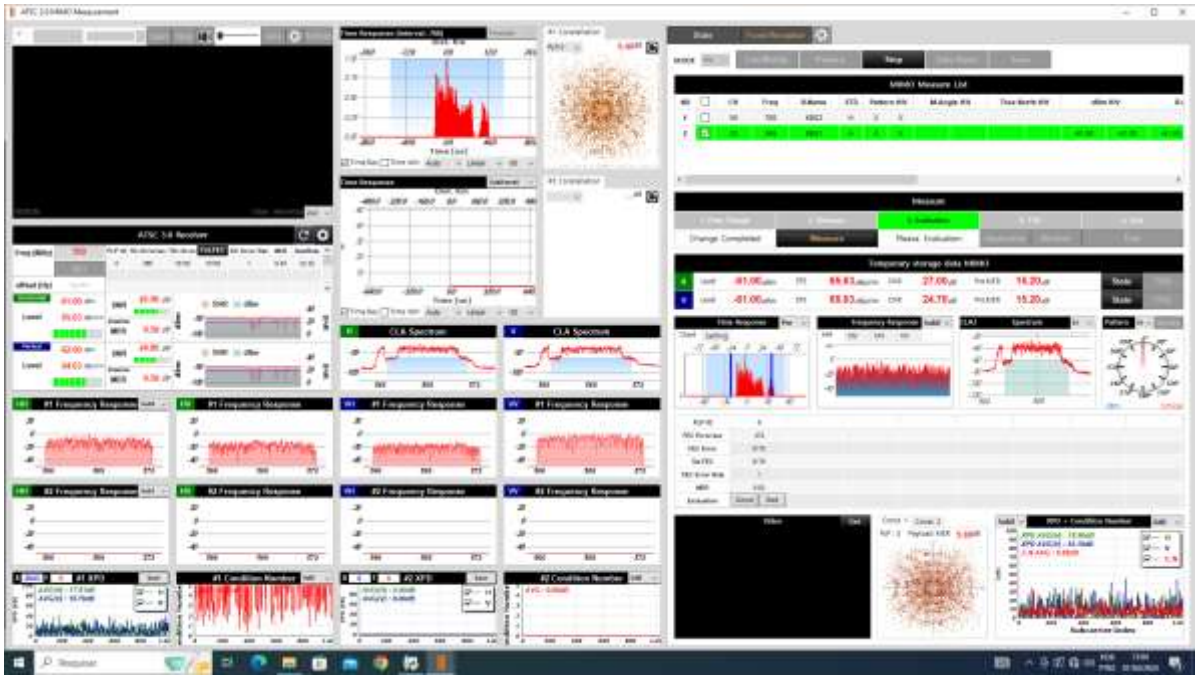


Figure 29.3 - IMAS Screen

b) C/N Threshold

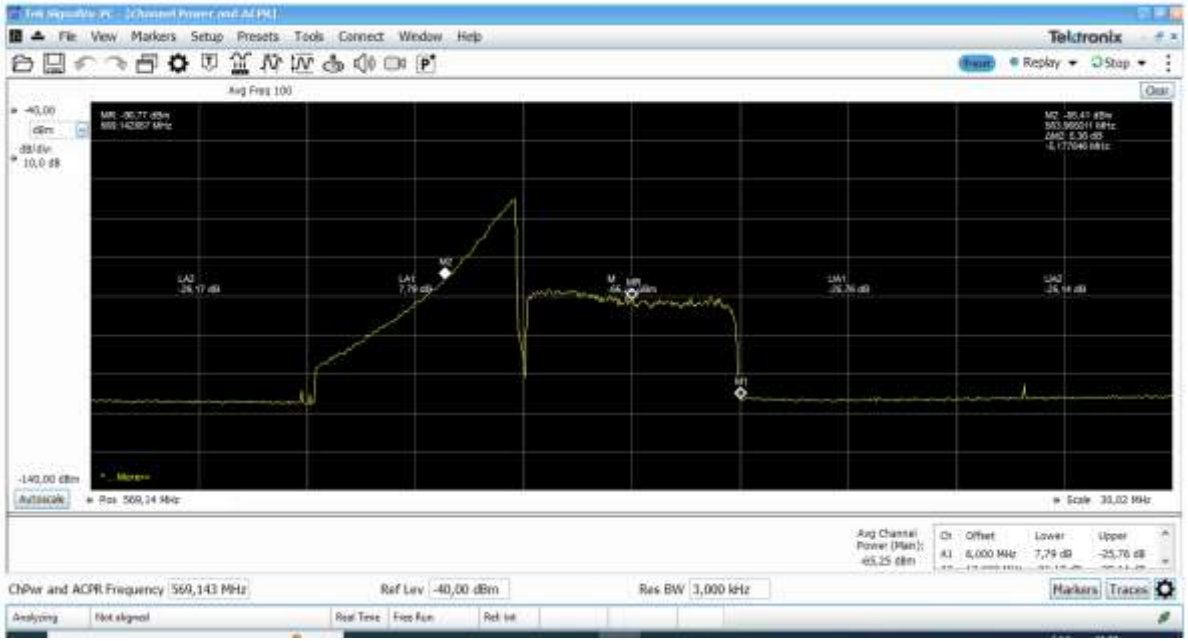


Figure 29.4 - Vertical

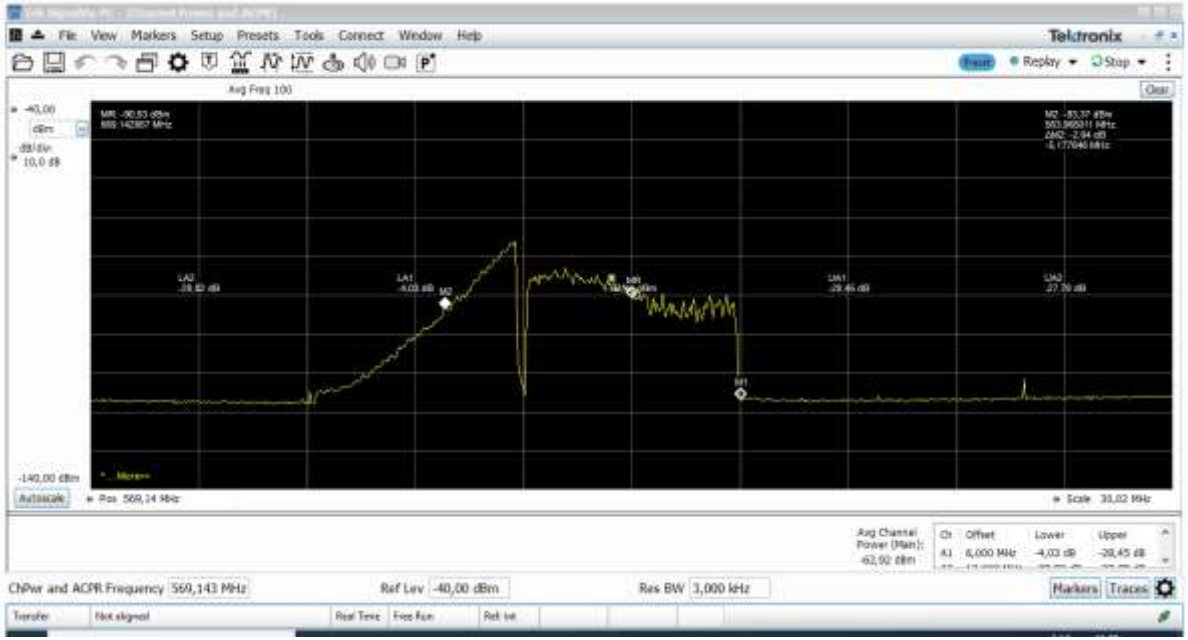


Figure 29.5 - Horizontal

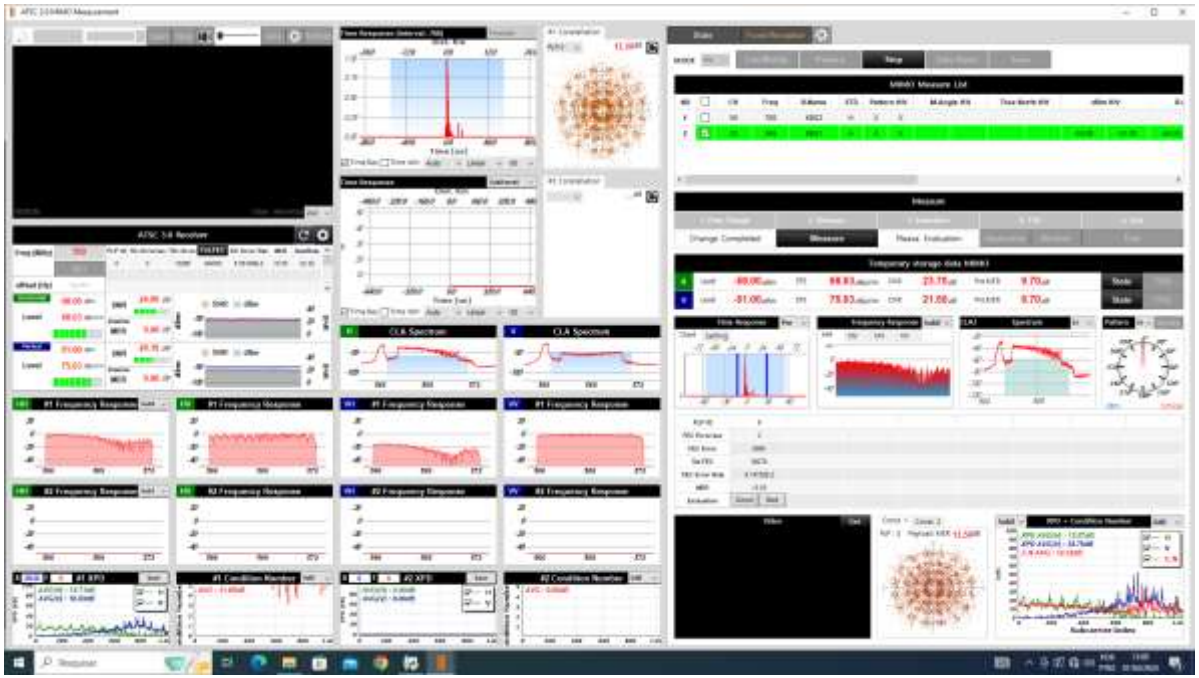


Figure 29.6 - IMAS Screen

Chapter 30. Site 30

a) Channel Power

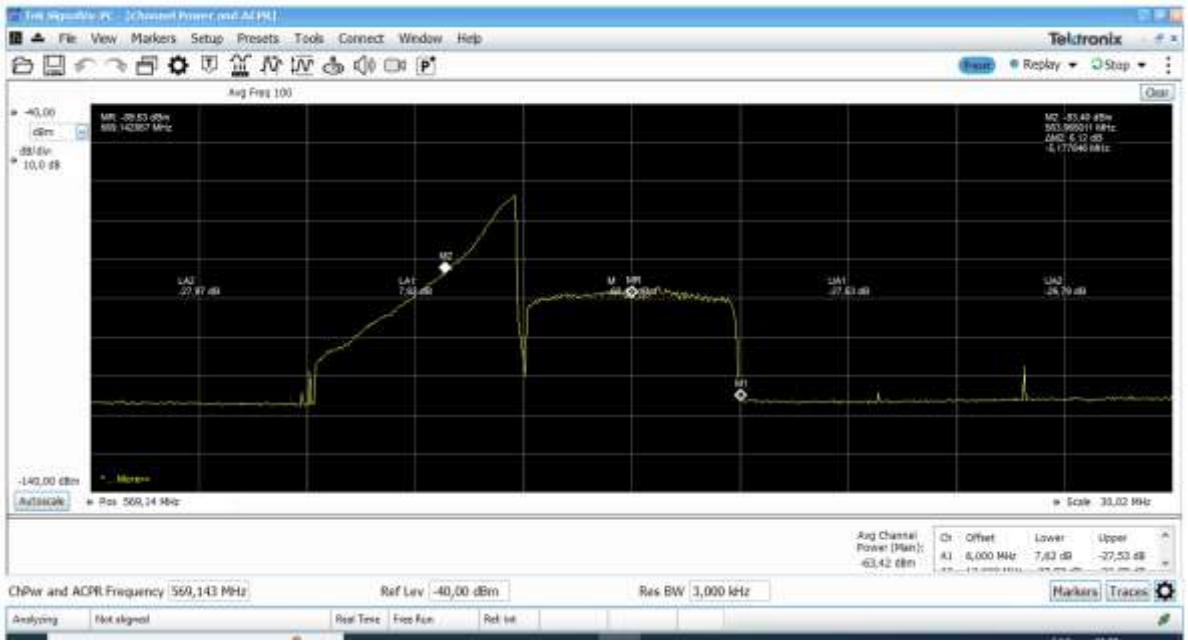


Figure 30.1 - Vertical

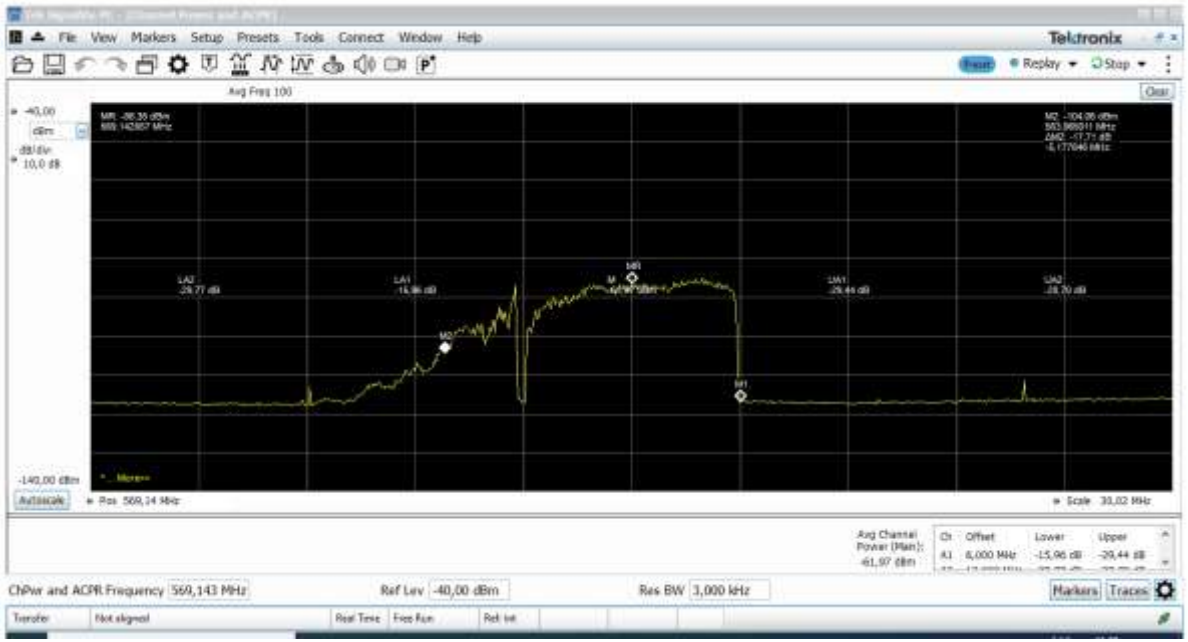


Figure 30.2 - Horizontal

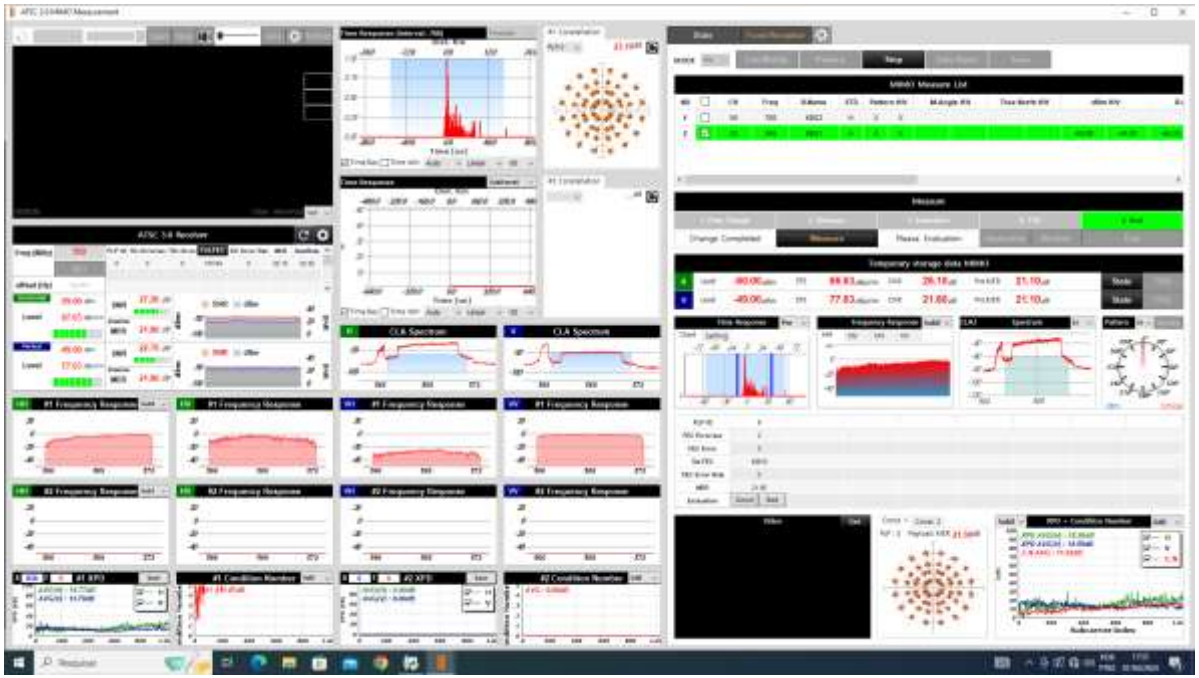


Figure 30.3 - IMAS Screen

b) AWGN Power

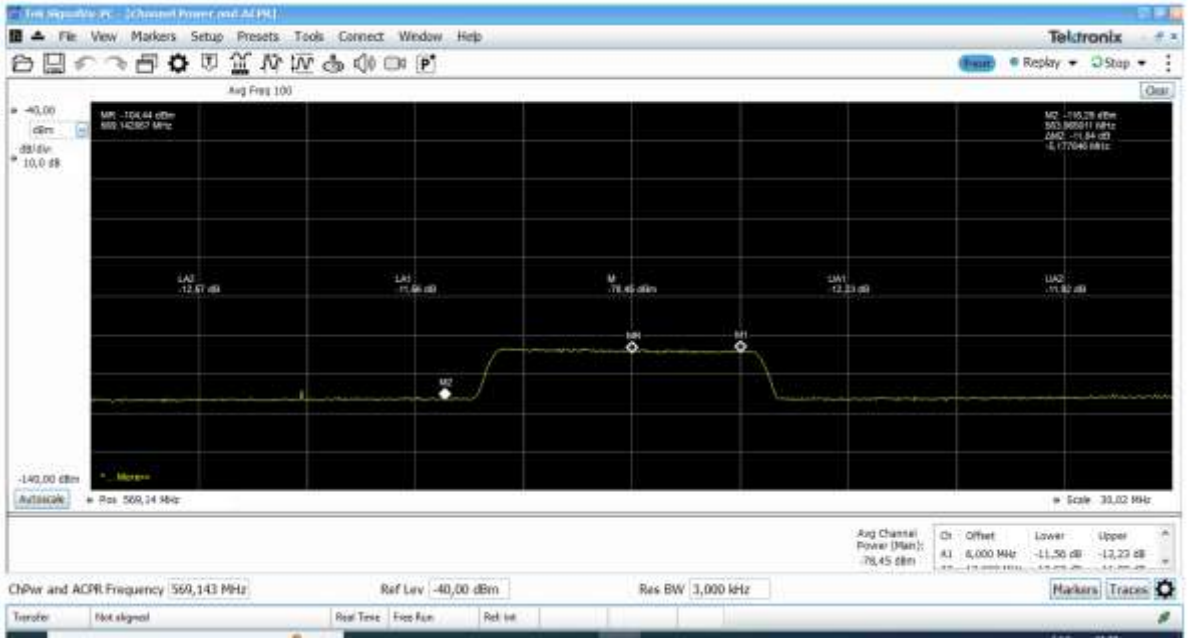


Figure 30.4 - Vertical

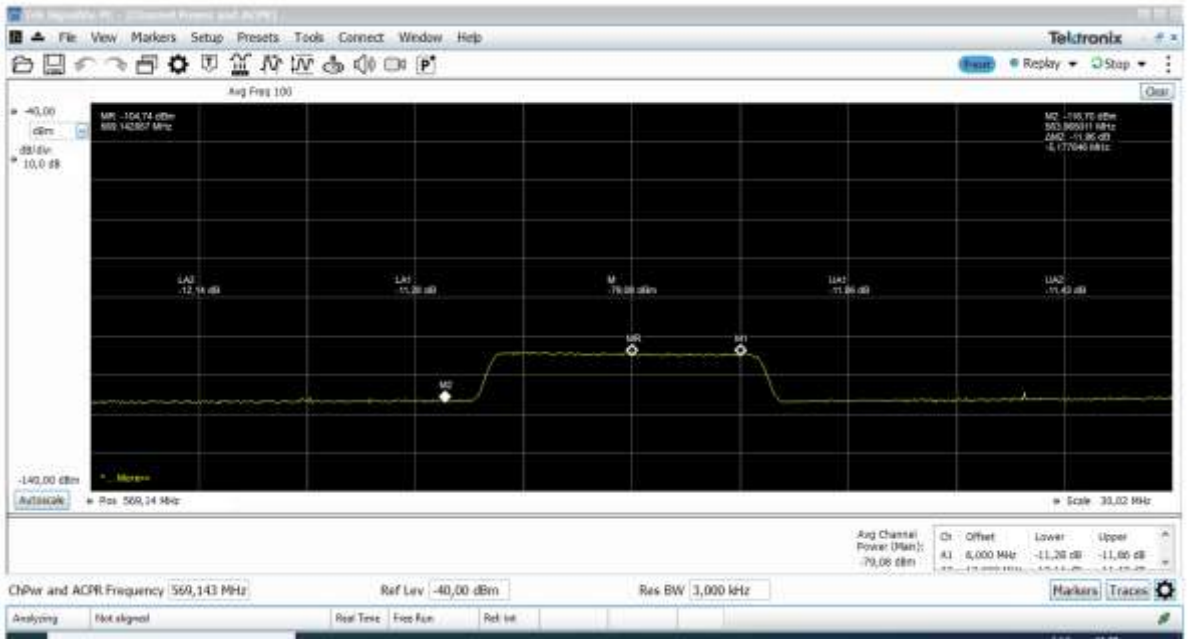


Figure 30.5 - Horizontal

c) C/N Threshold

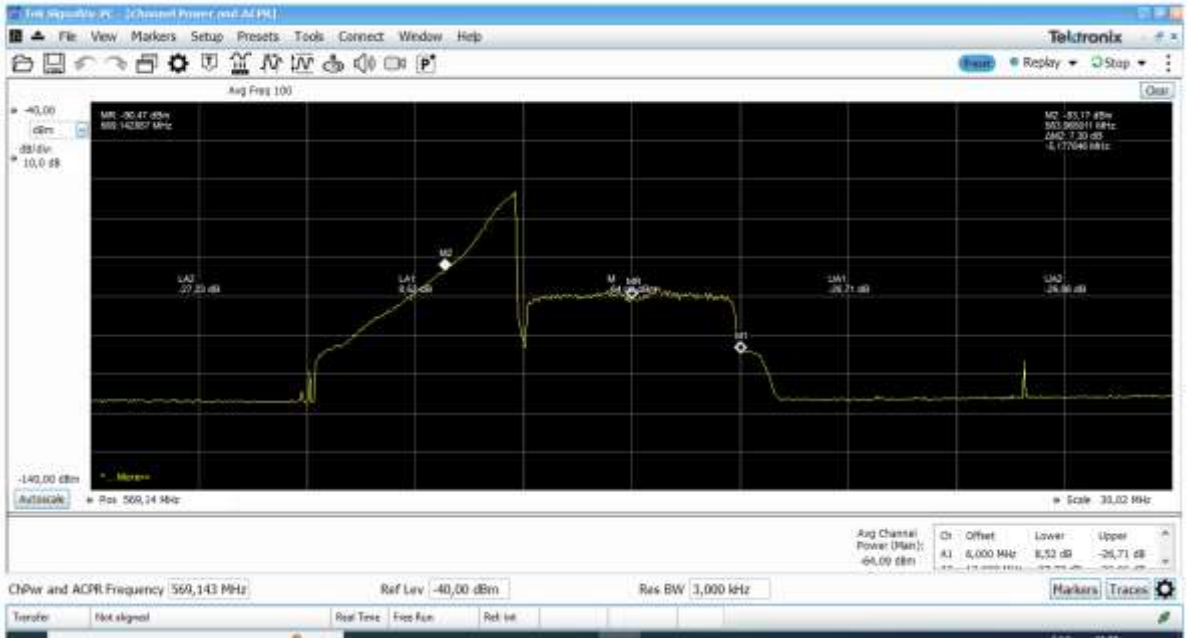


Figure 30.6 - Vertical

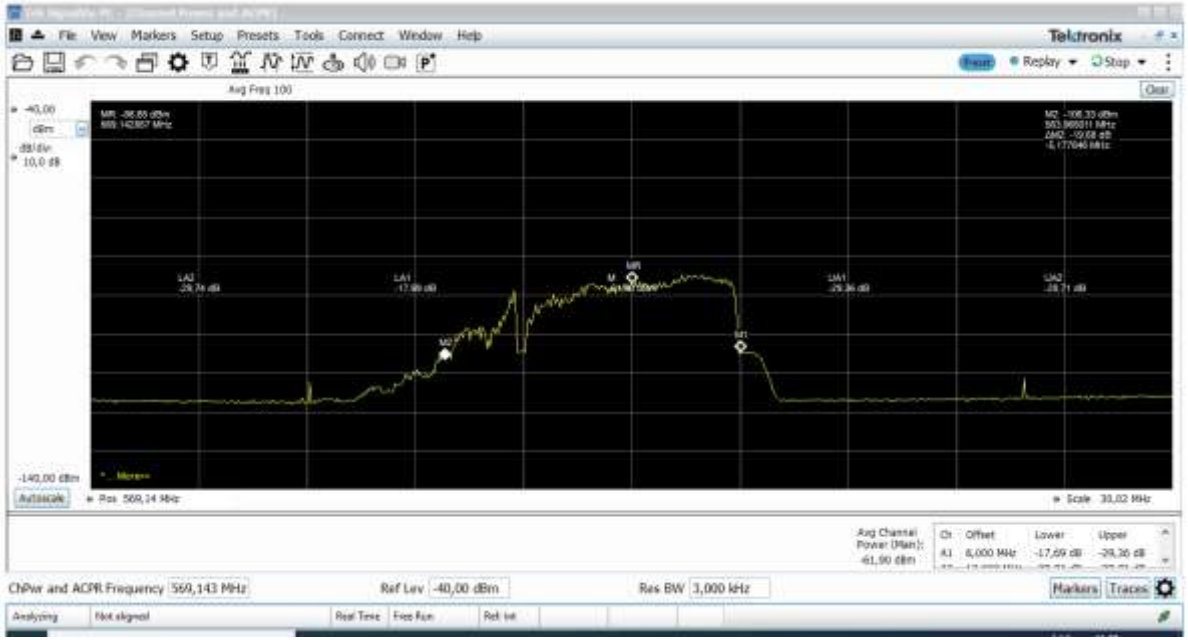


Figure 30.7 - Horizontal

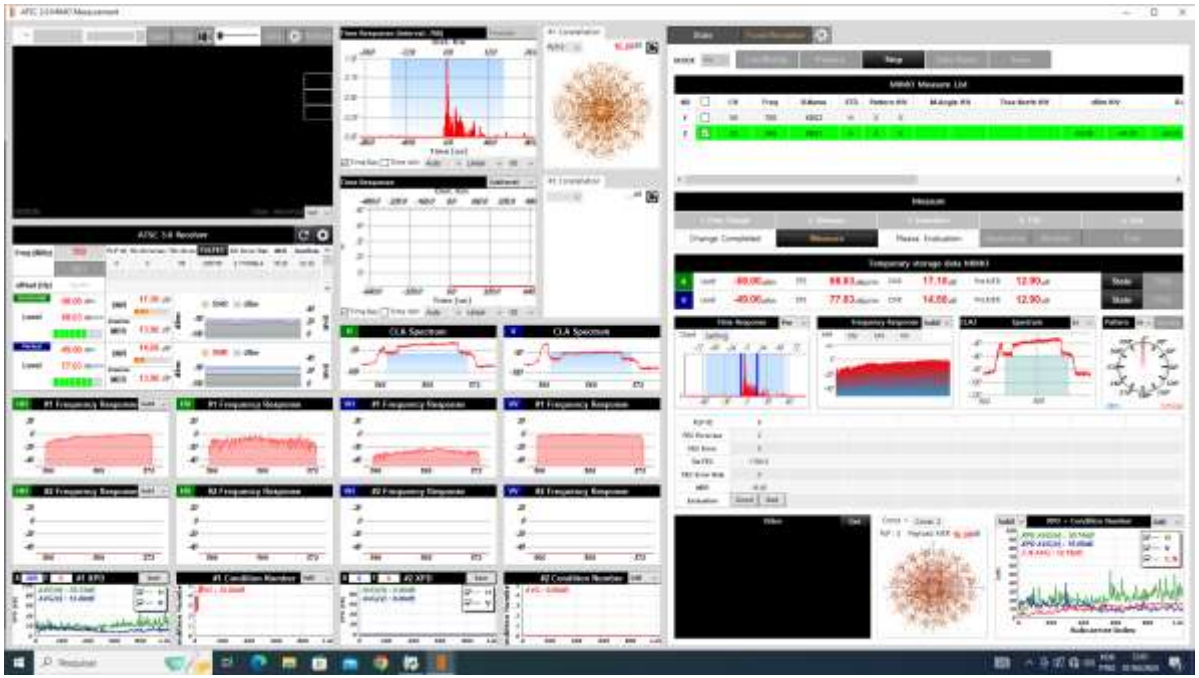


Figure 30.8 - IMAS Screen

d) Reception Threshold

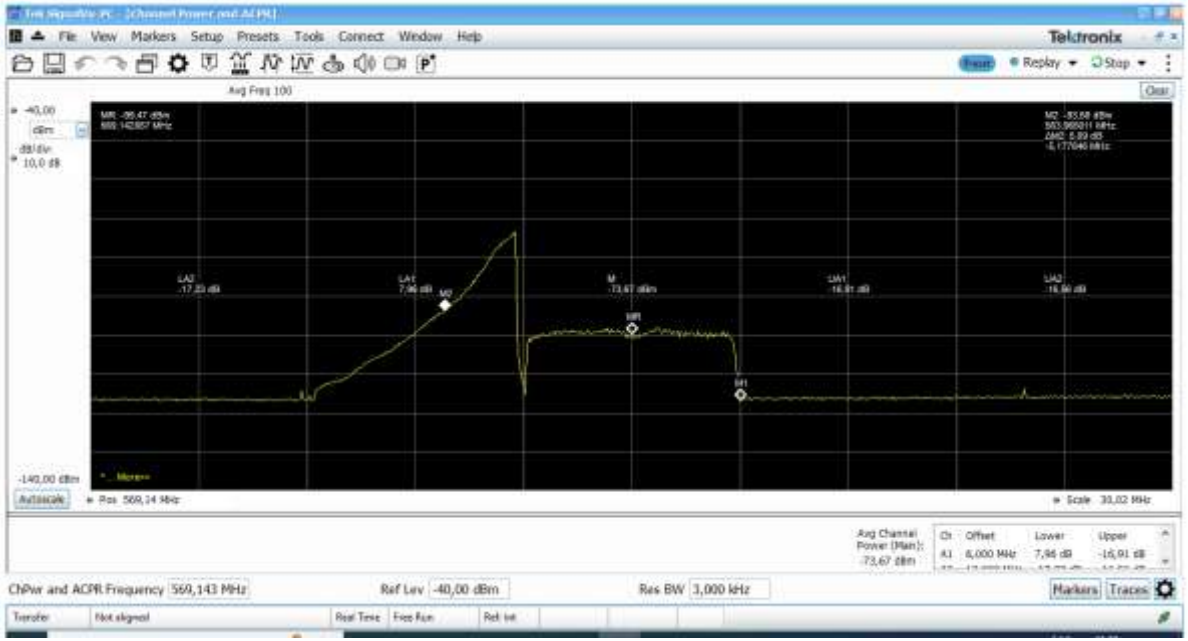


Figure 30.9 - Vertical

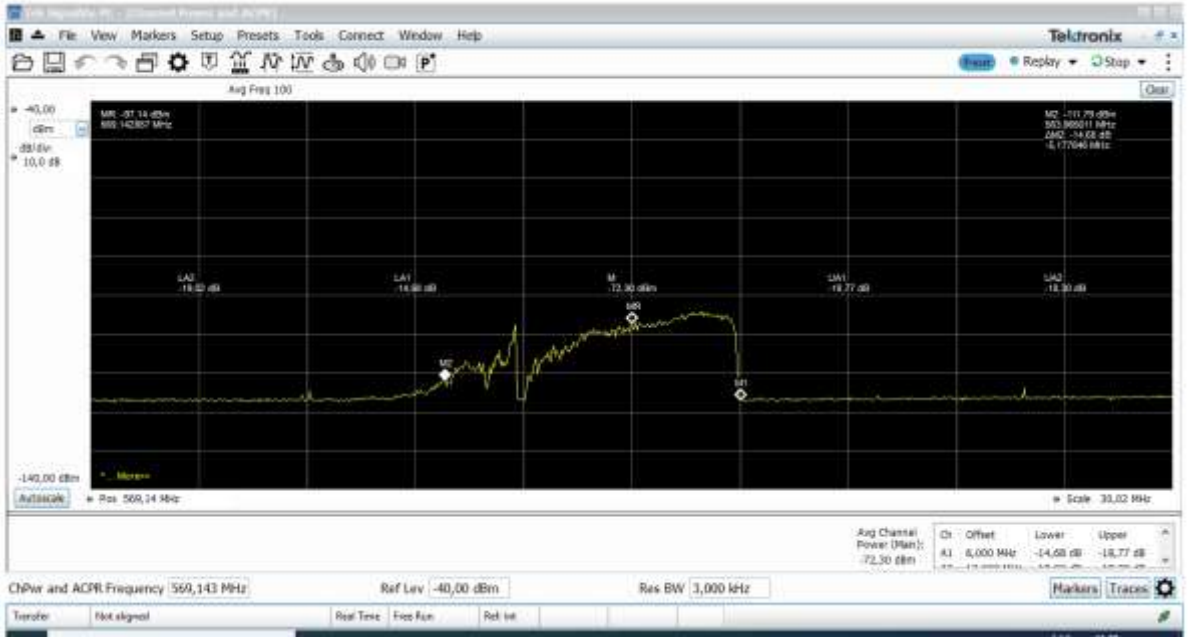


Figure 30.10 - Horizontal

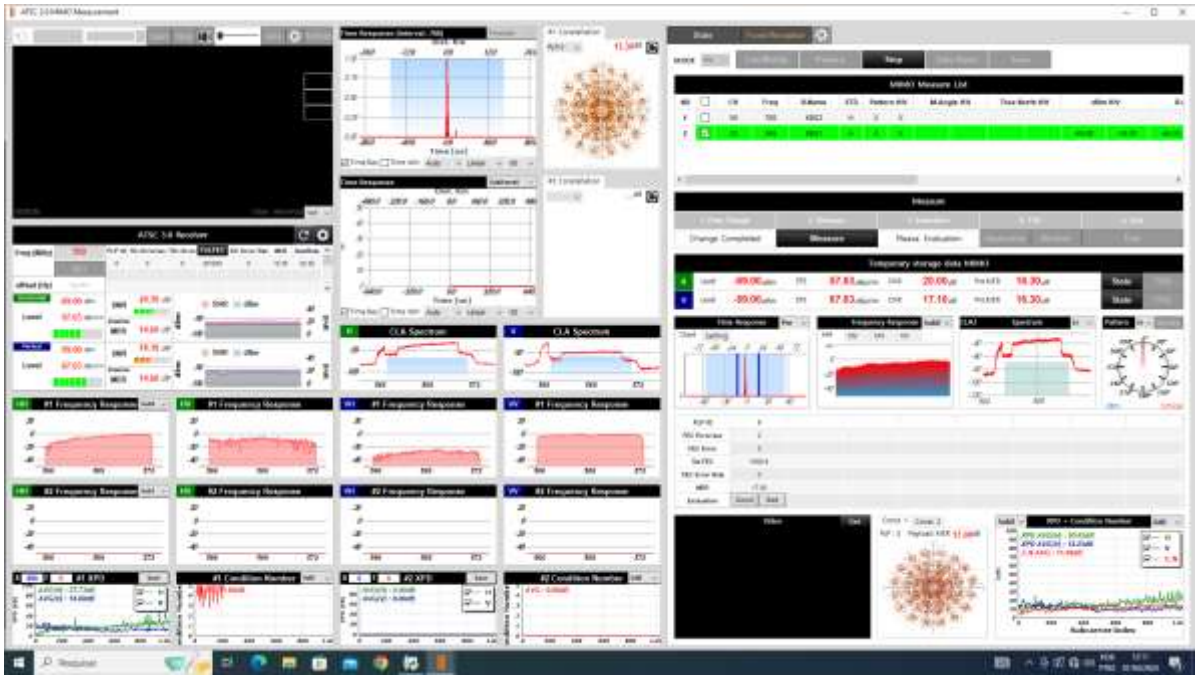


Figure 30.11 - IMAS Screen

Appendix IV. ATSC 3.0 - Indoor Sites - Configuration 1 - Single Layer: 64-QAM NUC, FEC 8/15, Bitrate 32.2 Mbps

Chapter 1. Site 1

a) Channel Power

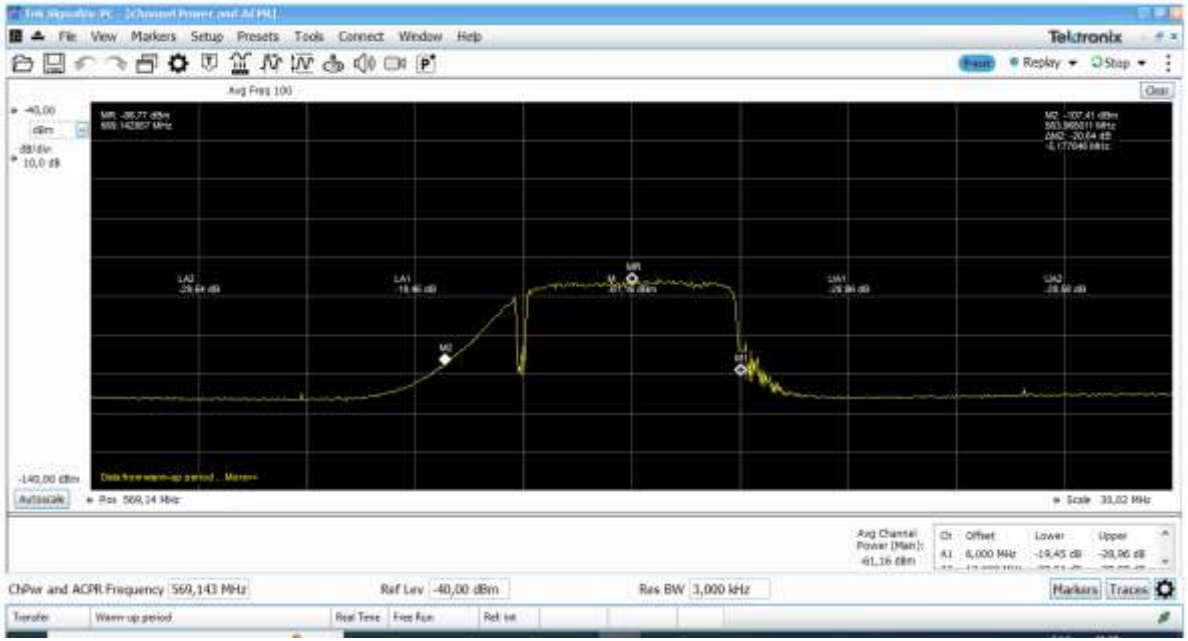


Figure 1.1 - Vertical

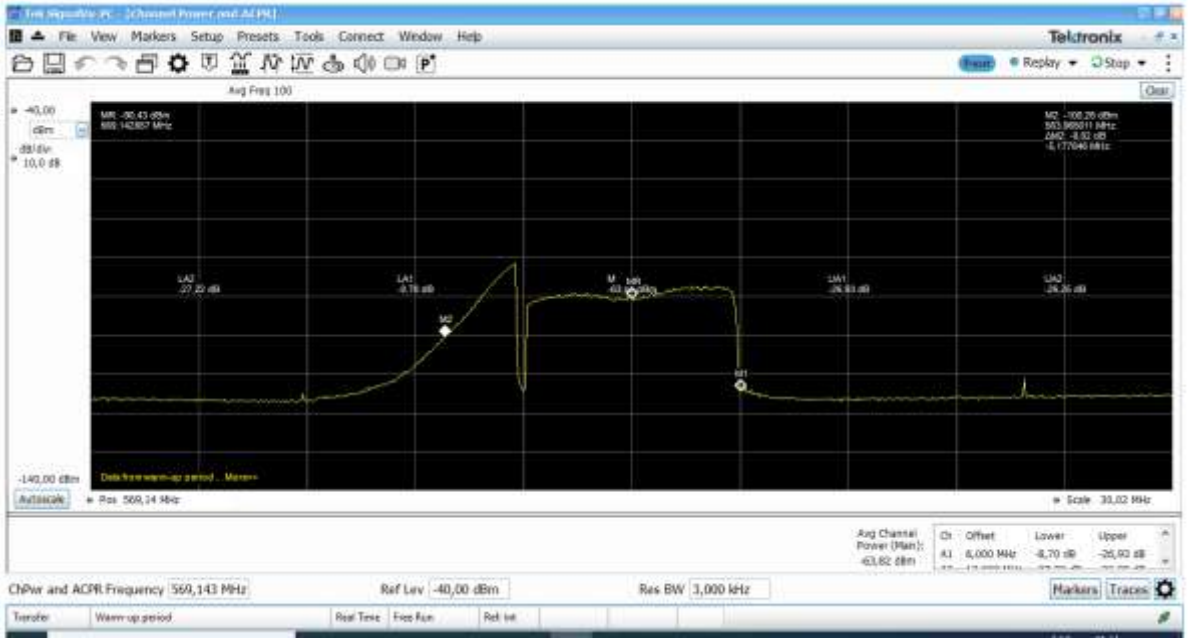


Figure 1.2 - Horizontal

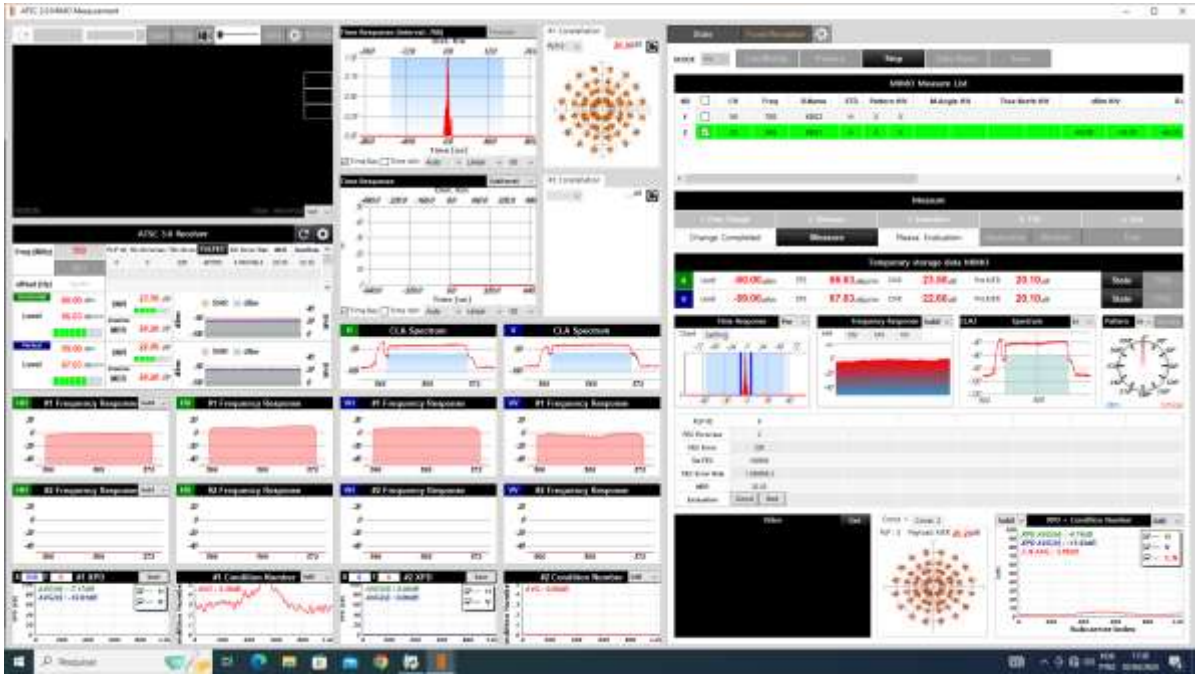


Figure 1.3 - IMAS Screen

b) AWGN Power

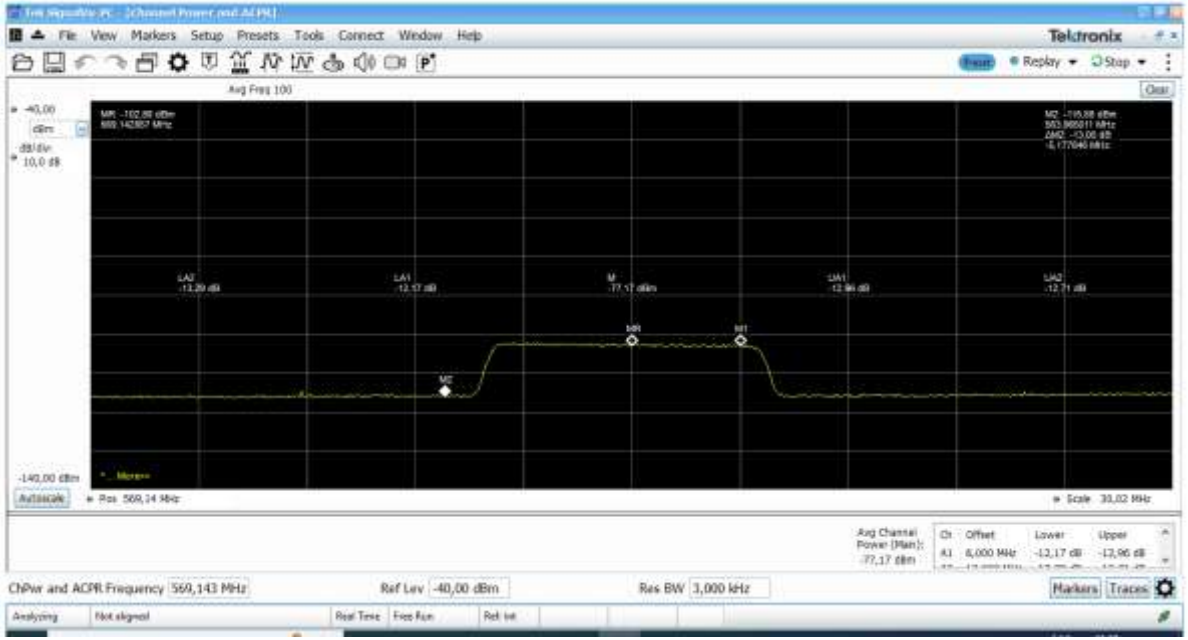


Figure 1.4 - Vertical

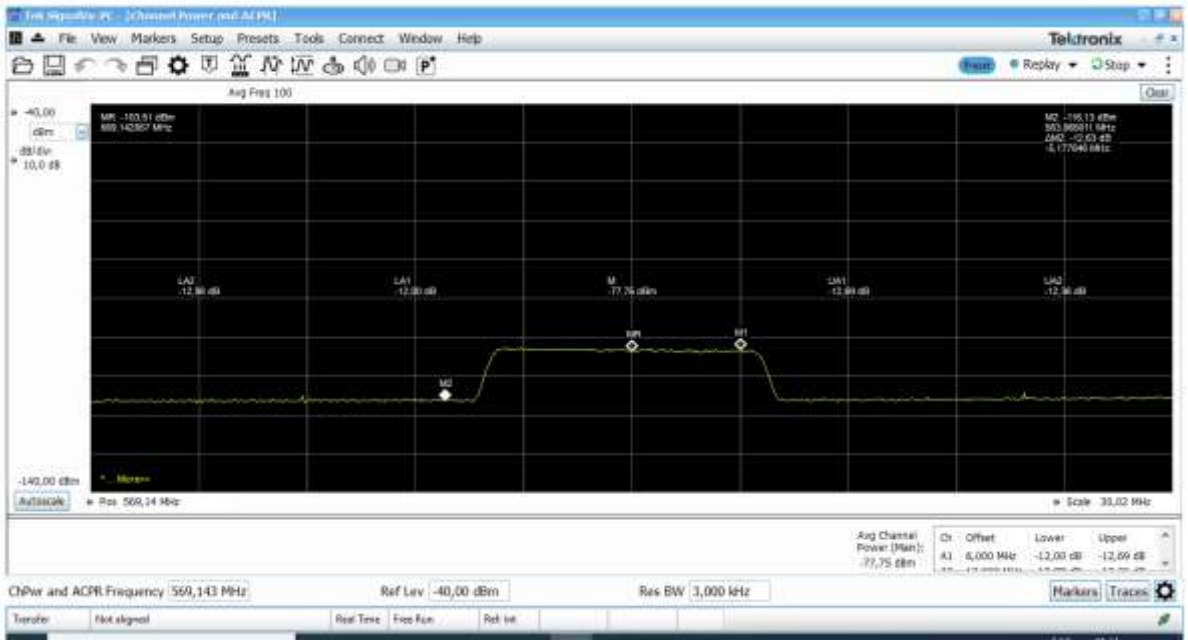


Figure 1.5 - Horizontal

c) C/N Threshold

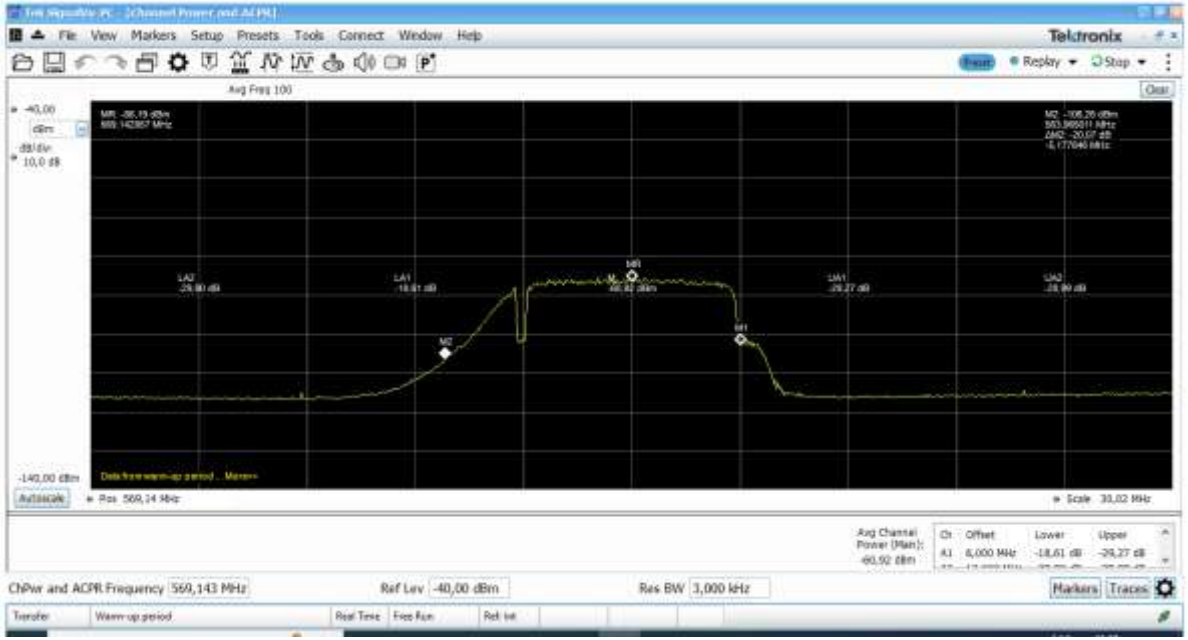


Figure 1.6 - Vertical

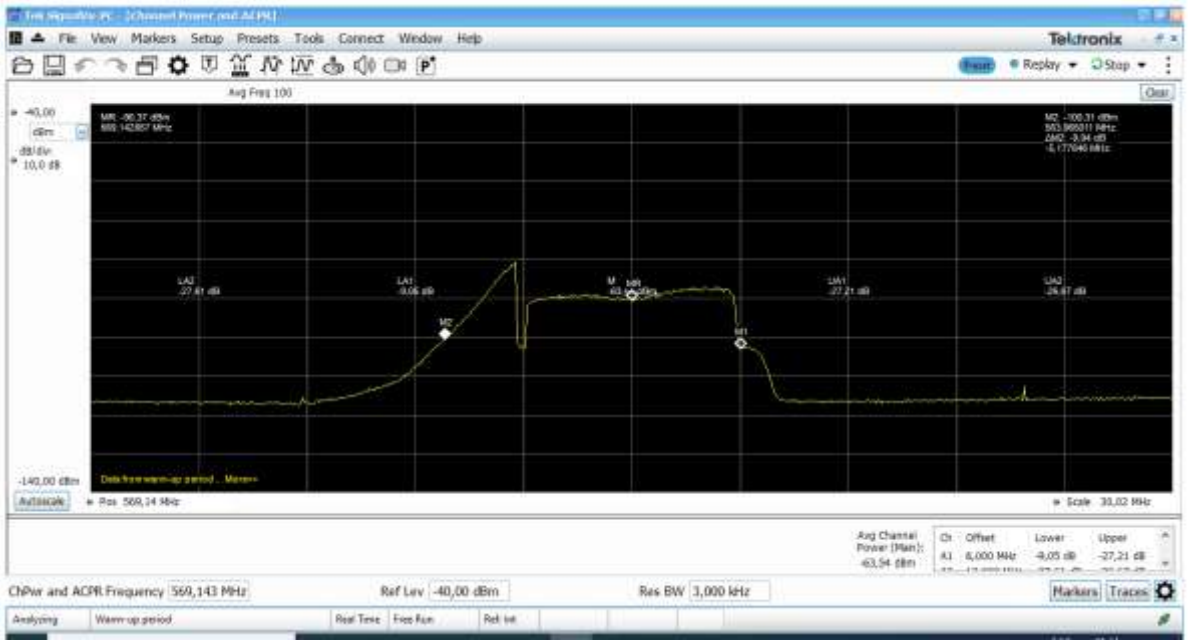


Figure 1.7 - Horizontal

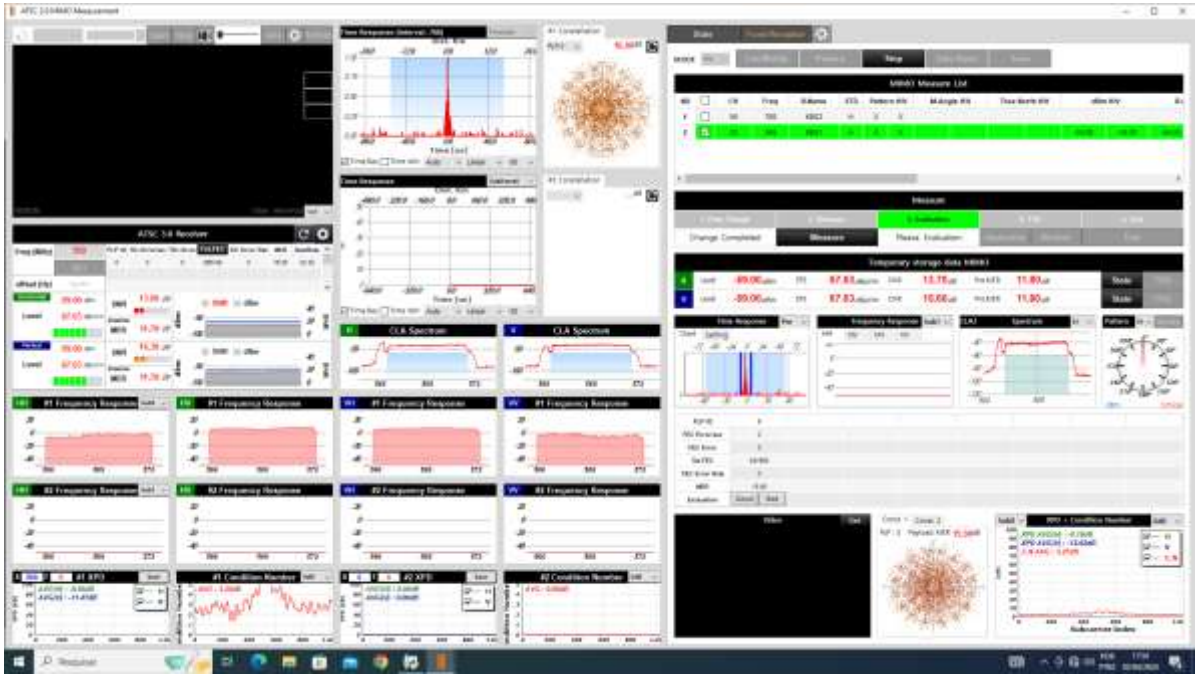


Figure 1.8 - IMAS Screen

d) Reception Threshold

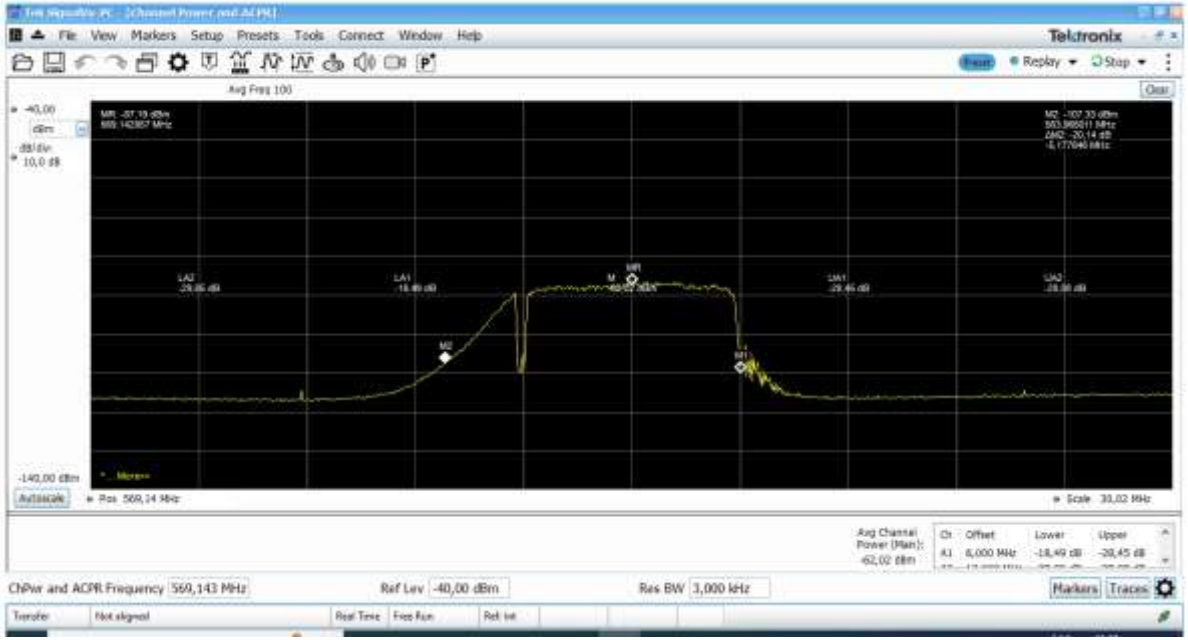


Figure 1.9 - Vertical

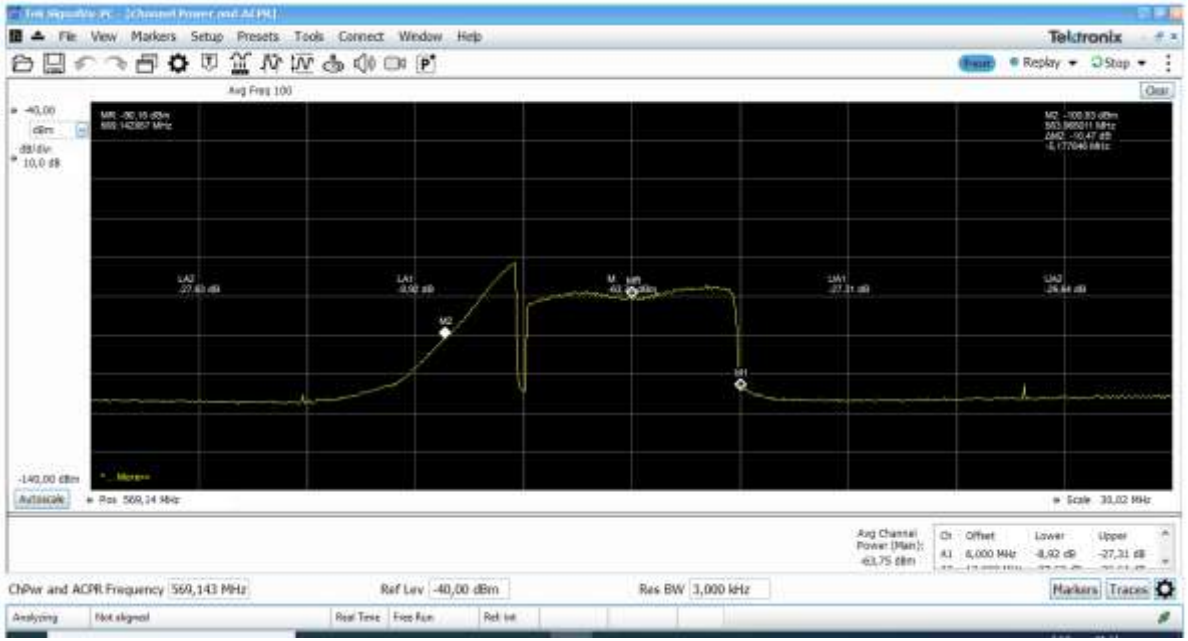


Figure 1.10 - Horizontal

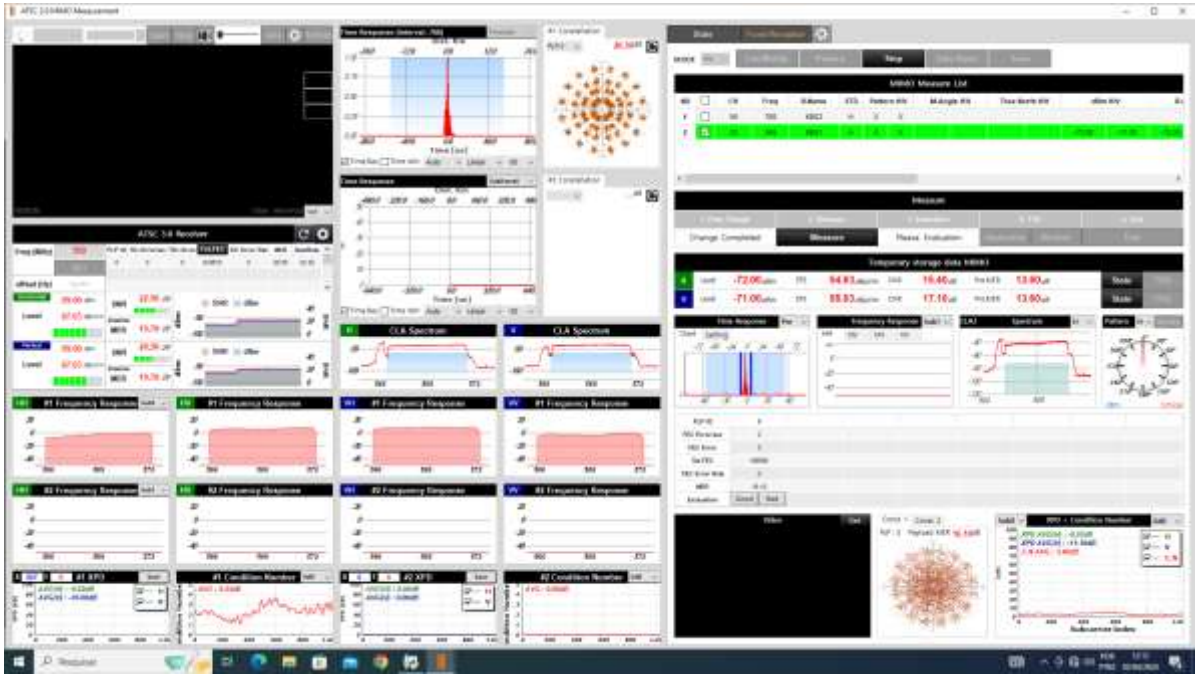


Figure 1.11 - IMAS Screen

Chapter 2. Site 3

a) Channel Power

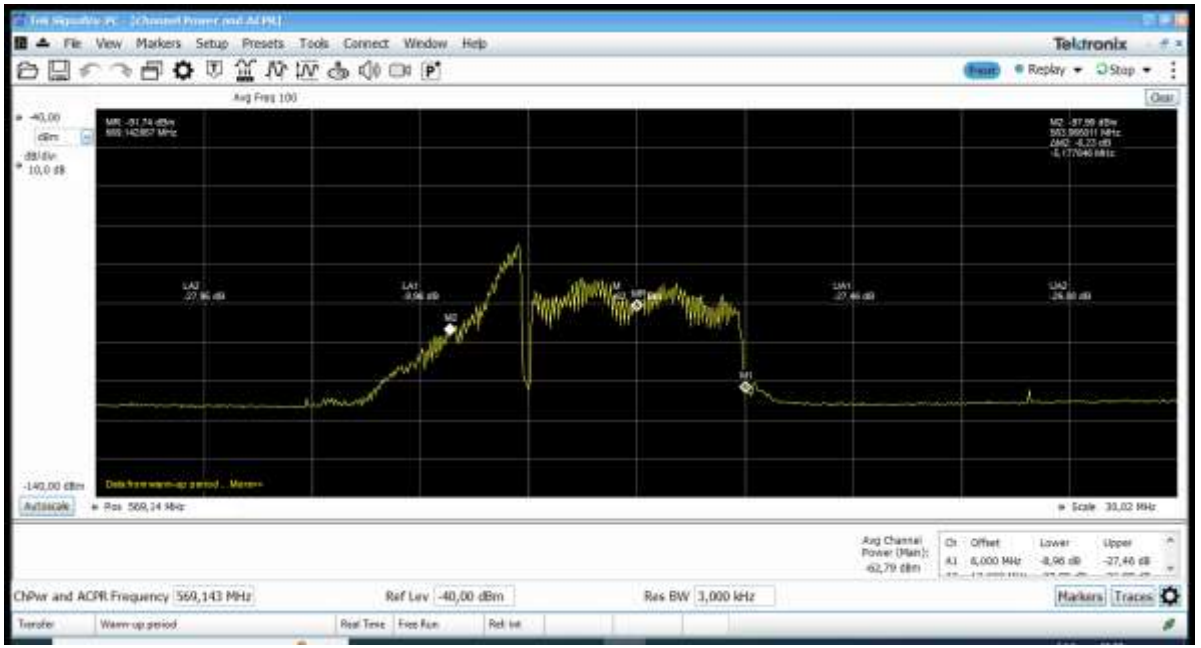


Figure 2.1 - Vertical

Figure 2.2 - Horizontal

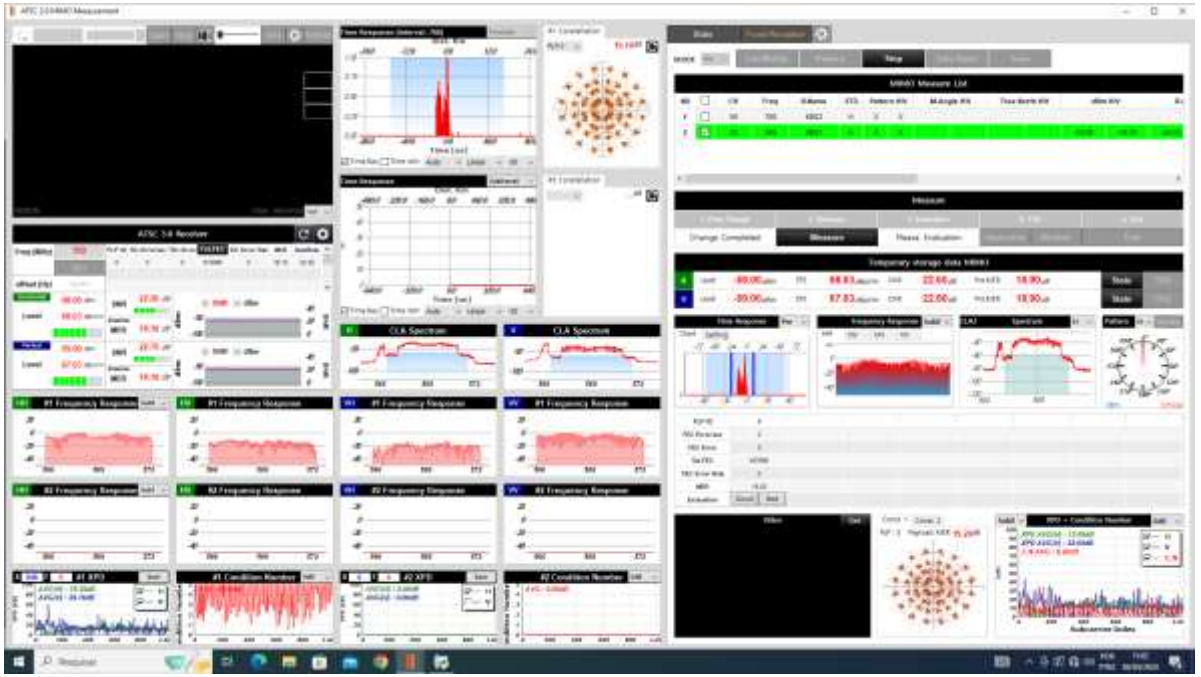


Figure 2.3 - IMAS Screen

b) AWGN Power

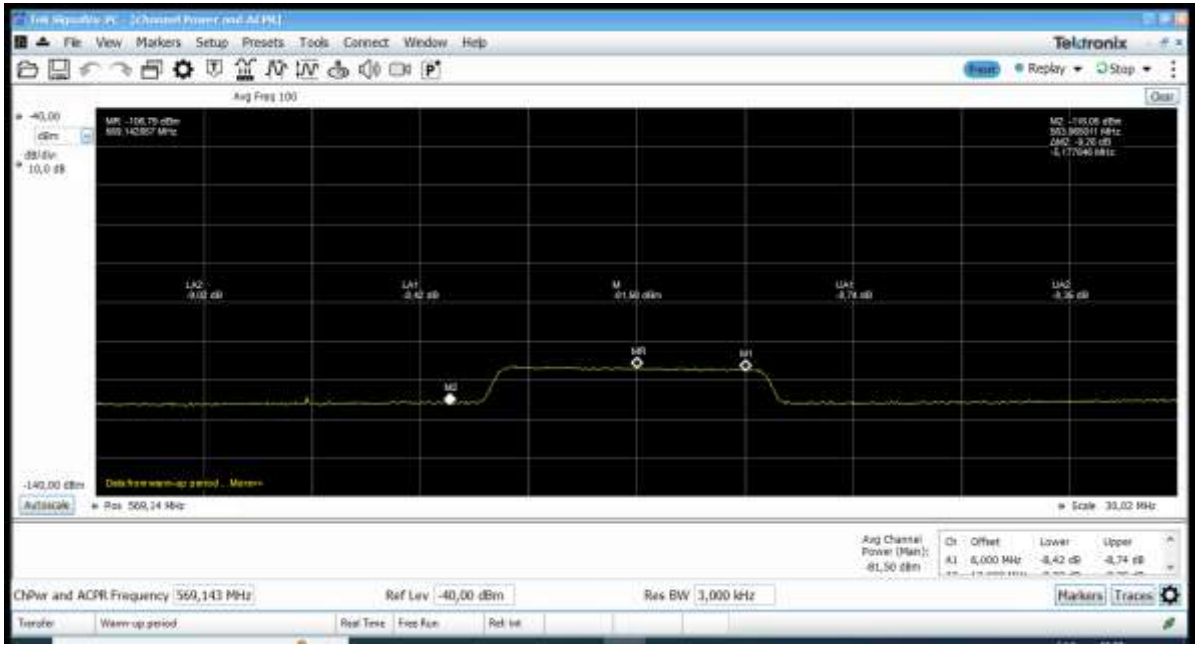


Figure 2.4 - Vertical

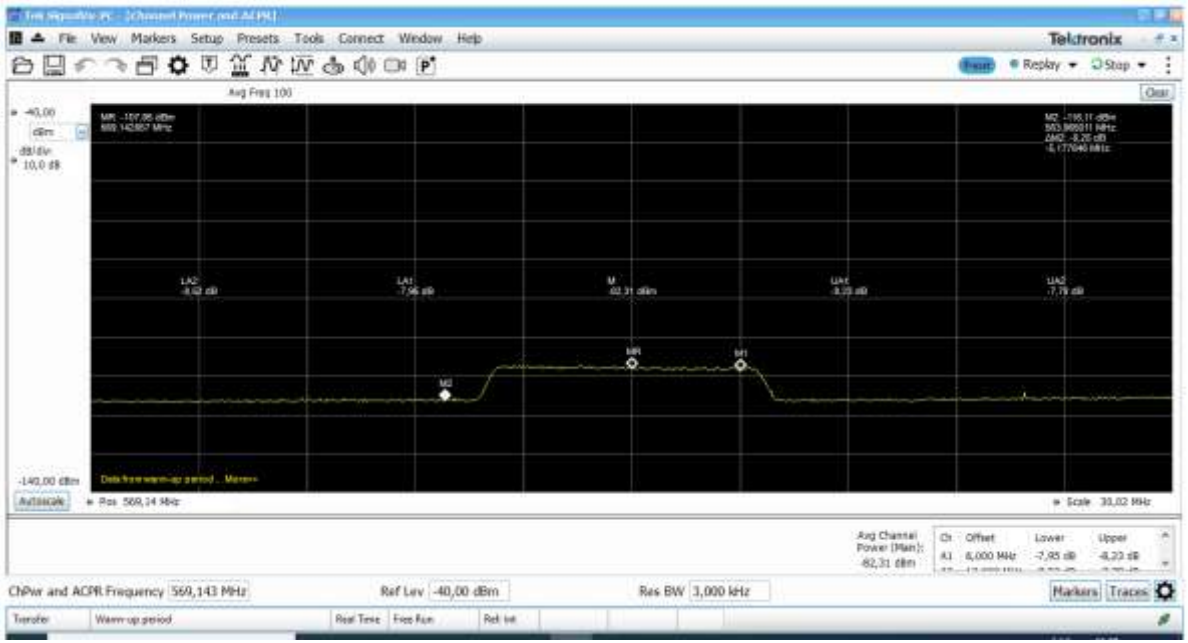


Figure 2.5 - Horizontal

c) C/N Threshold

Figure 2.6 - Horizontal

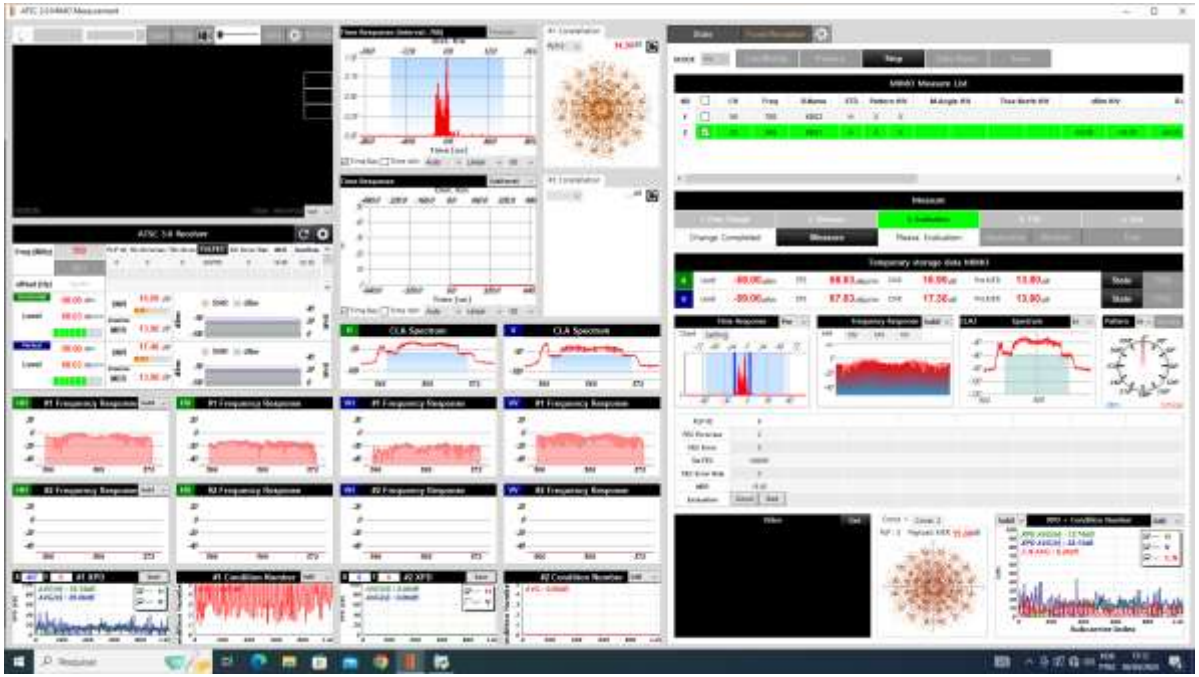


Figure 2.7 - IMAS Screen

d) Reception Threshold

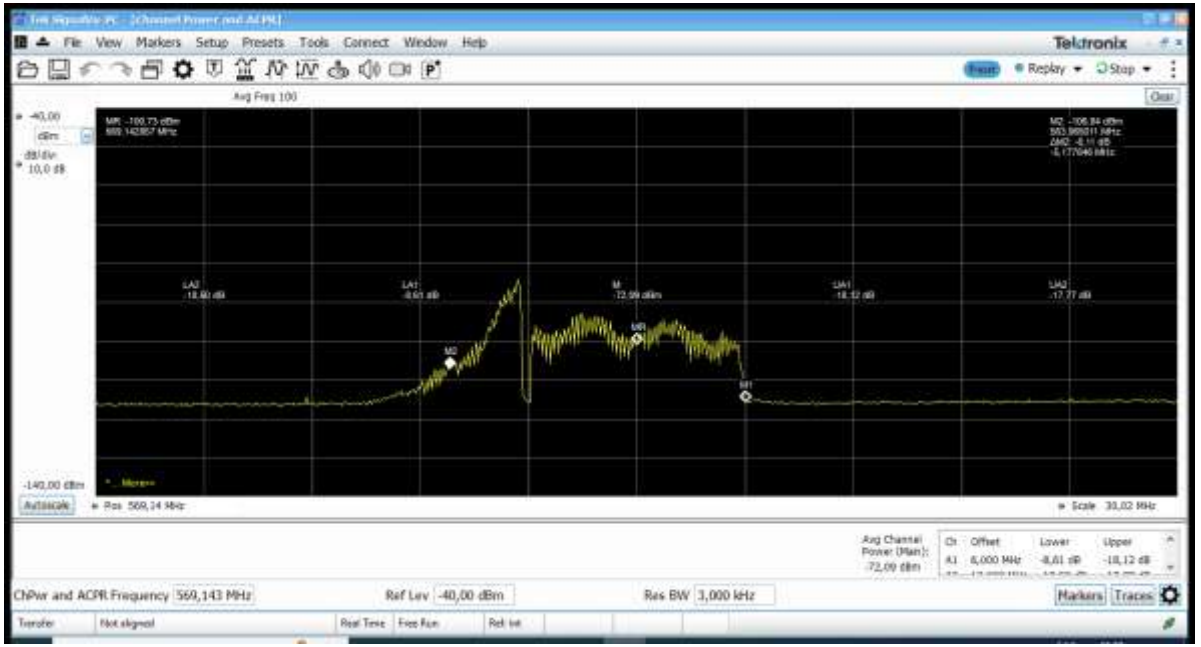


Figure 2.8 - Vertical

Figure 2.9 - Horizontal

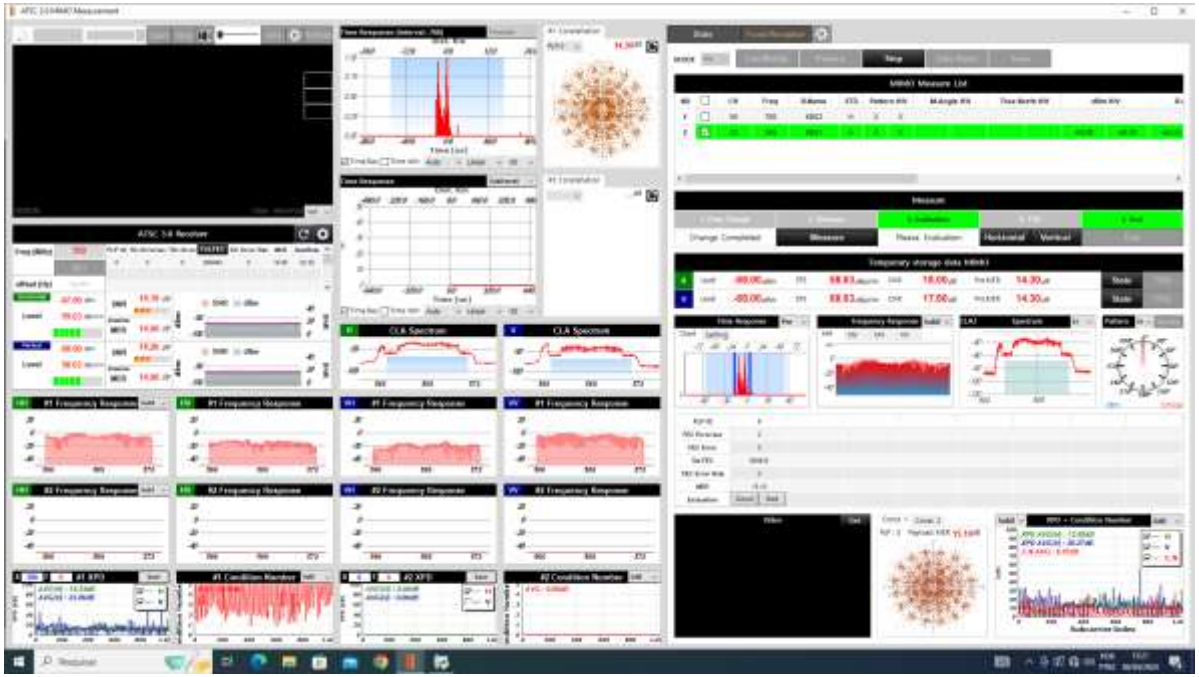


Figure 2.10 - IMAS Screen

Chapter 3. Site 17

a) Channel Power

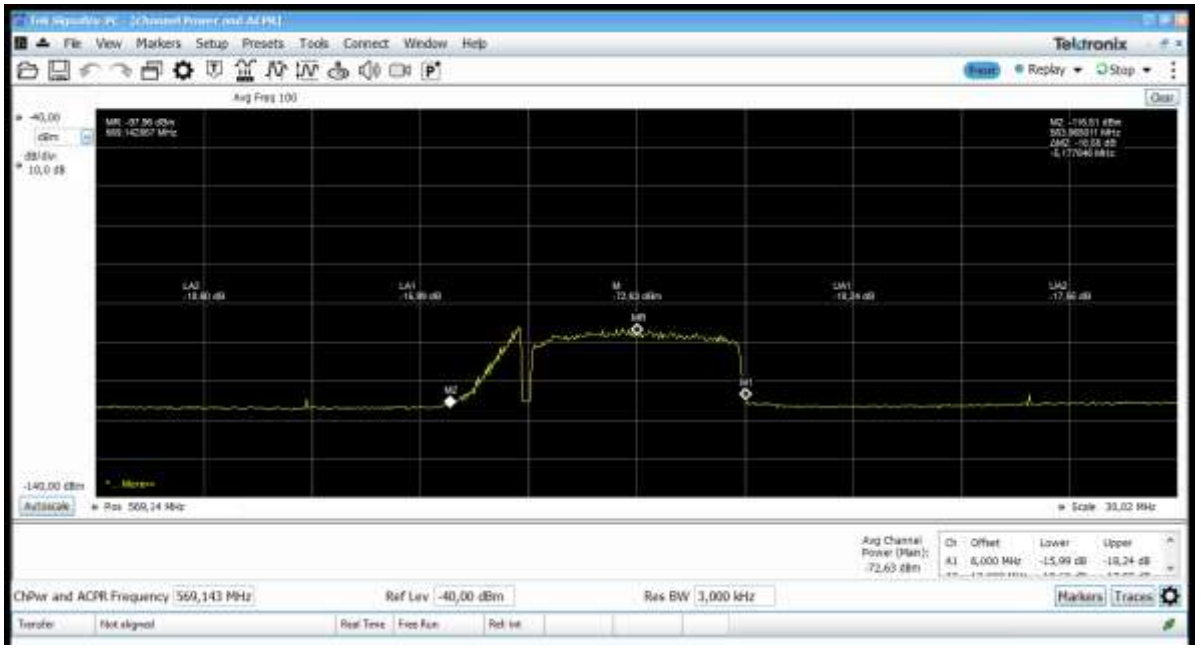


Figure 3.1 - Vertical

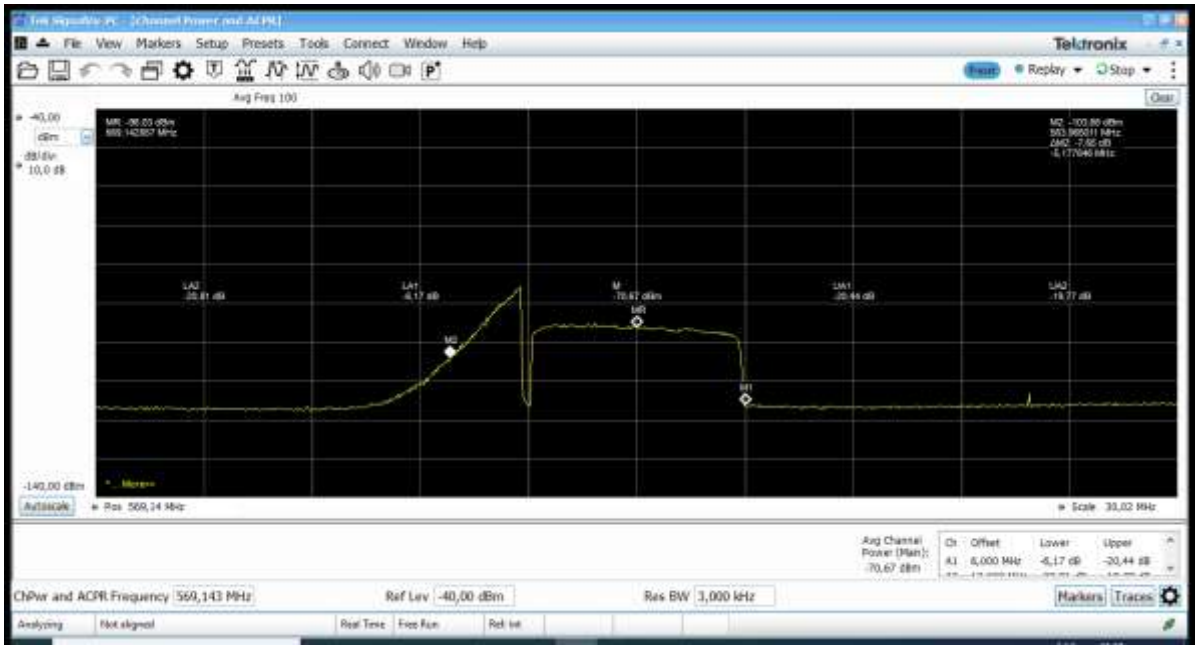


Figure 3.2 - Horizontal

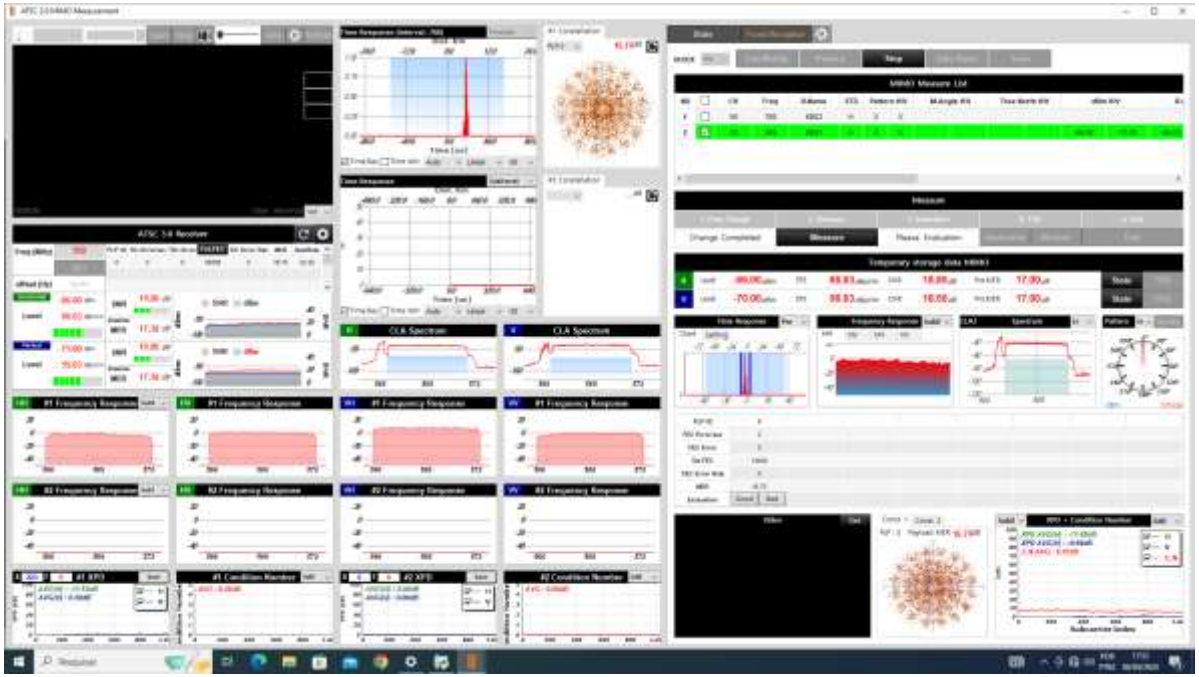


Figure 3.3 - IMAS Screen

b) AWGN Power

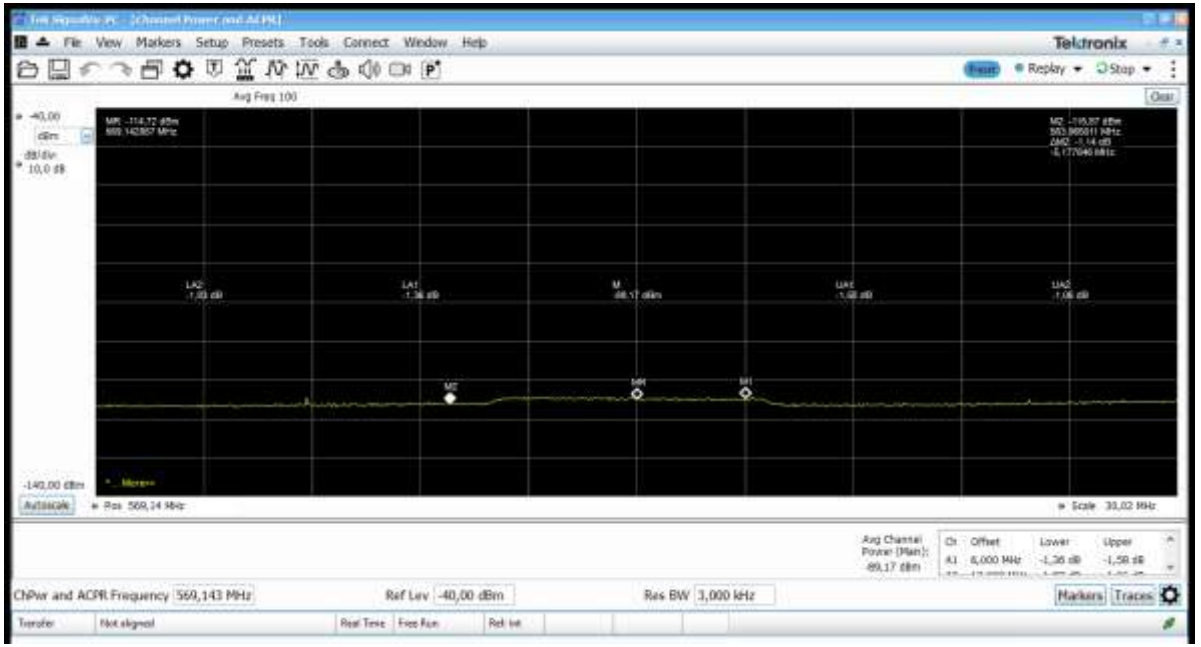


Figure 3.4 - Vertical

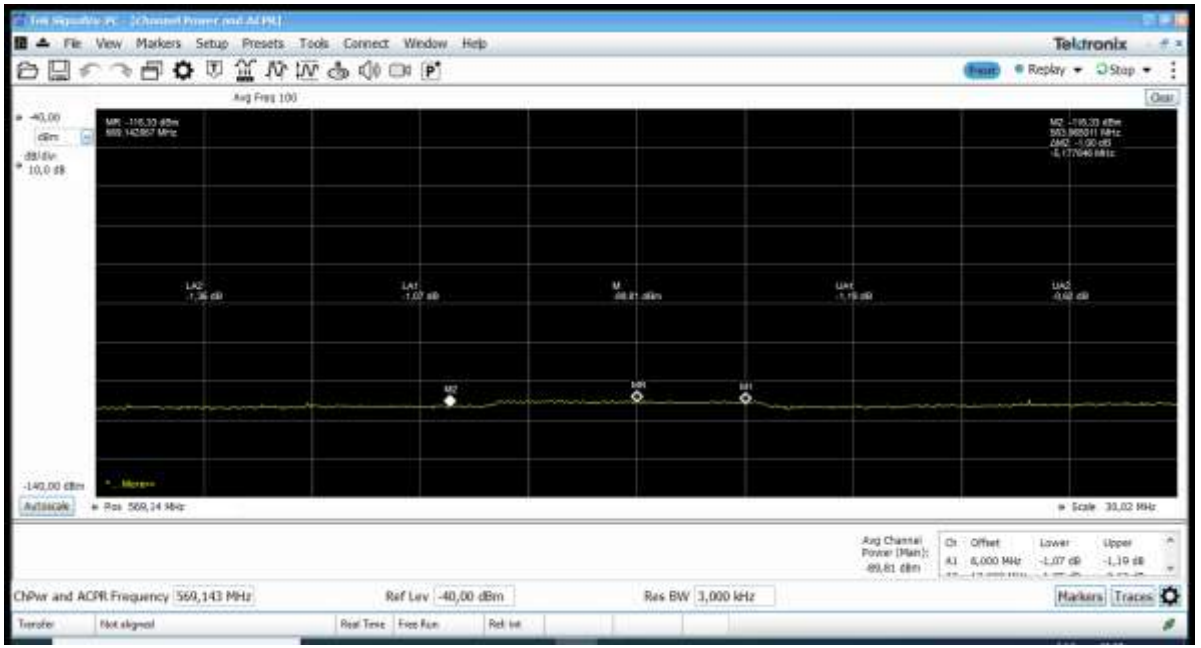


Figure 3.5 - Horizontal

c) C/N Threshold

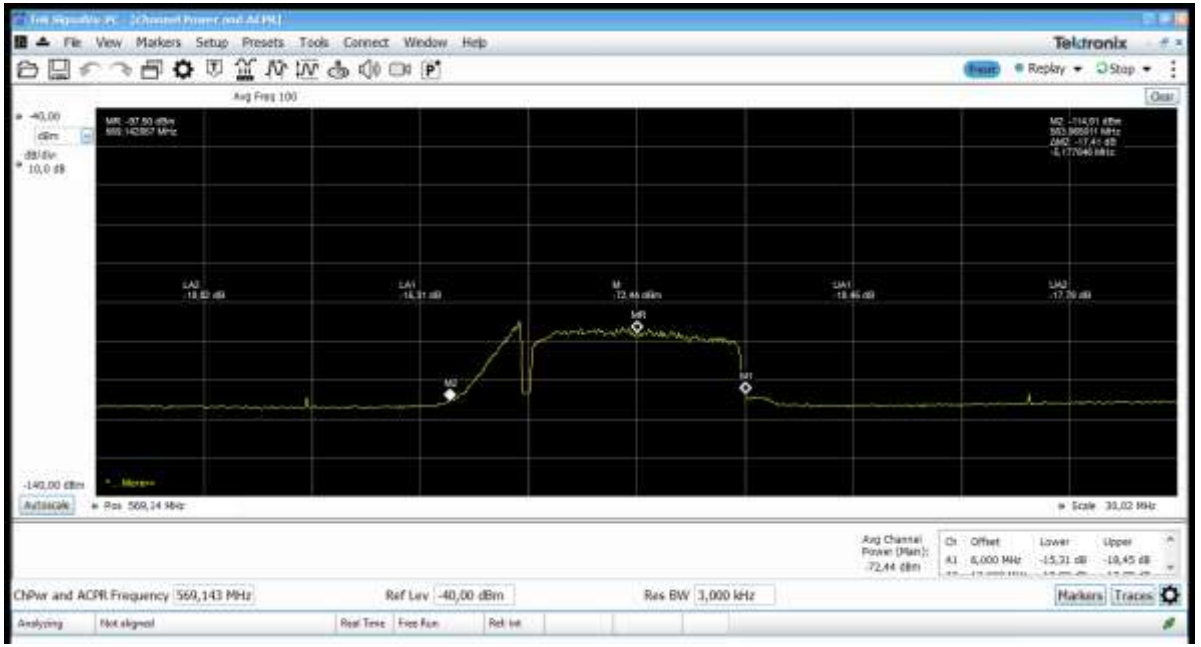


Figure 3.6 - Vertical

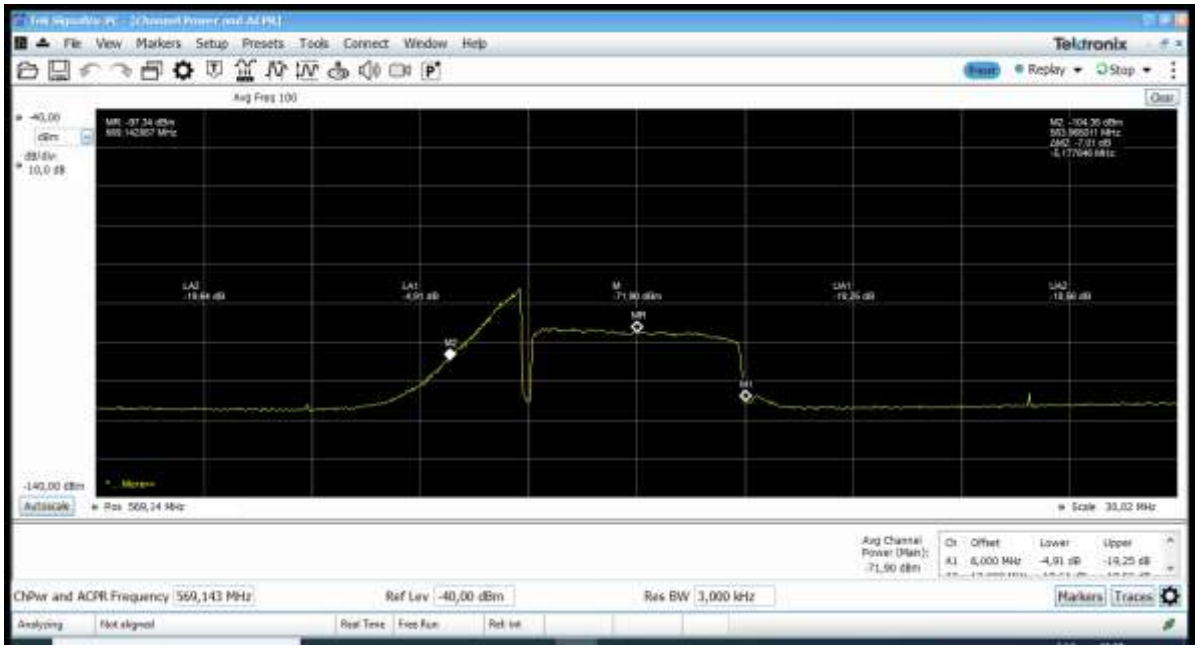


Figure 3.7 - Horizontal

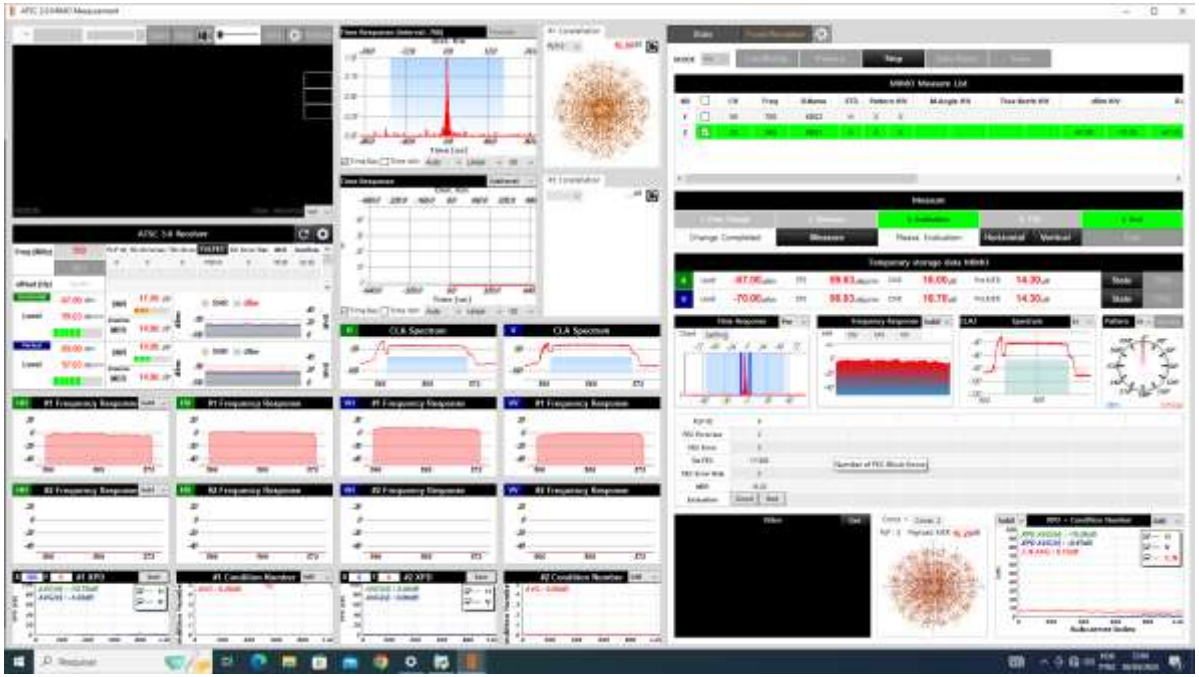


Figure 3.8 - IMAS Screen

d) Reception Threshold

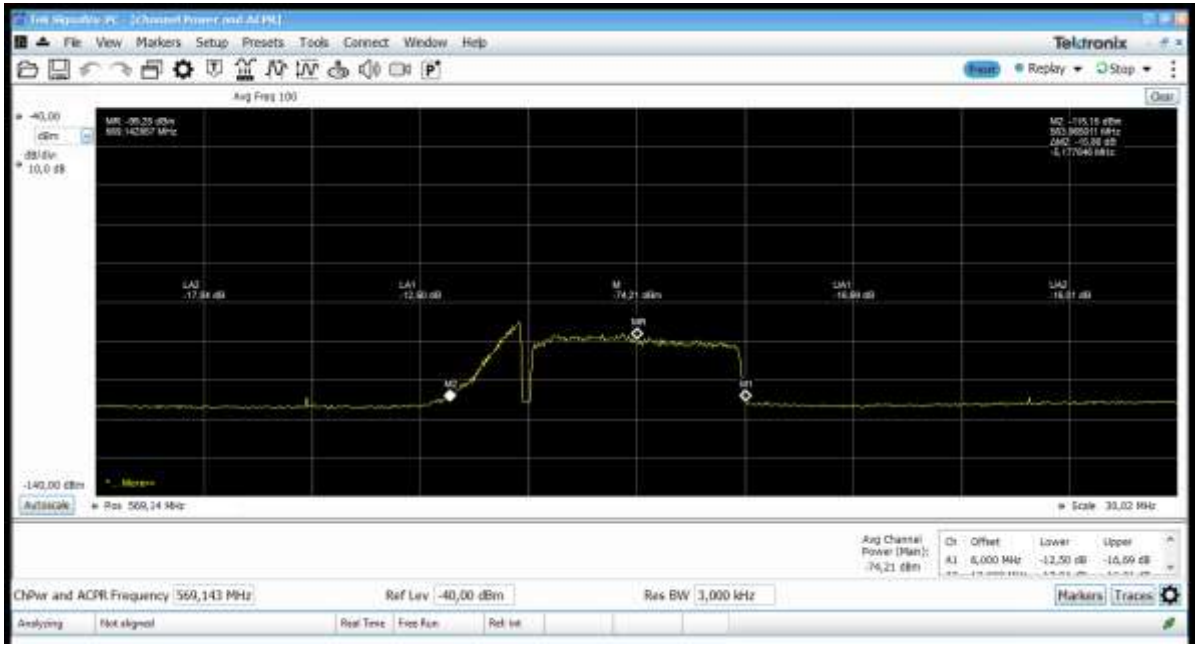


Figure 3.9 - Vertical

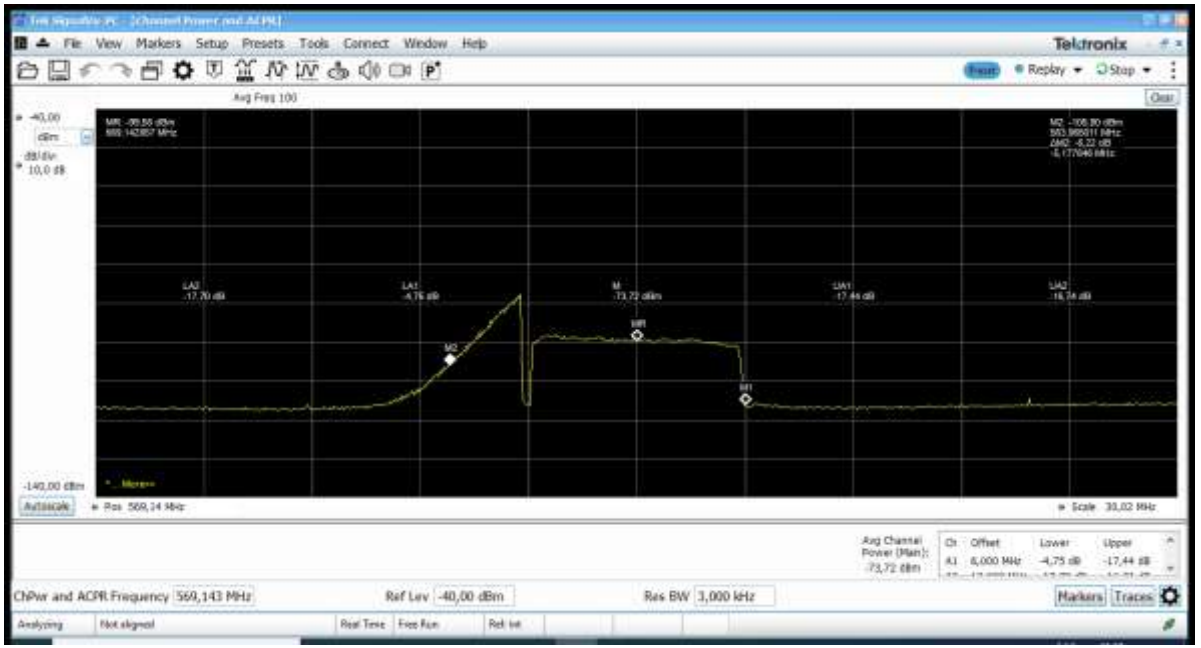


Figure 3.10 - Horizontal

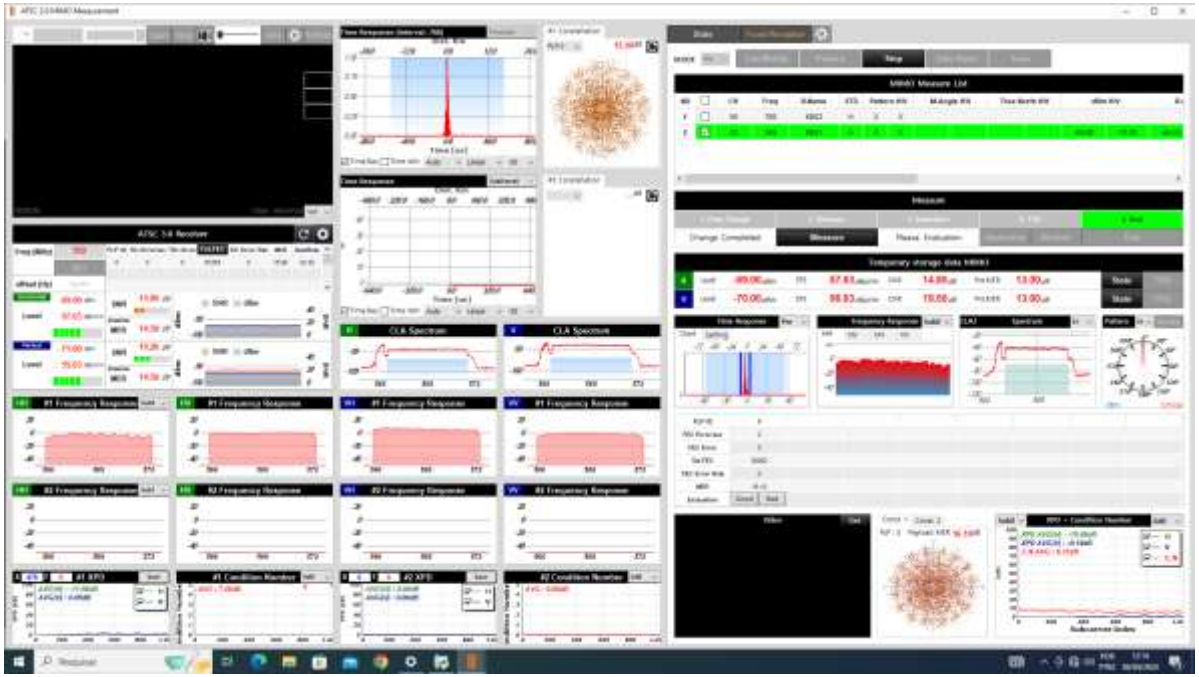


Figure 3.11 - IMAS Screen

Chapter 4. Site 18

a) Channel Power

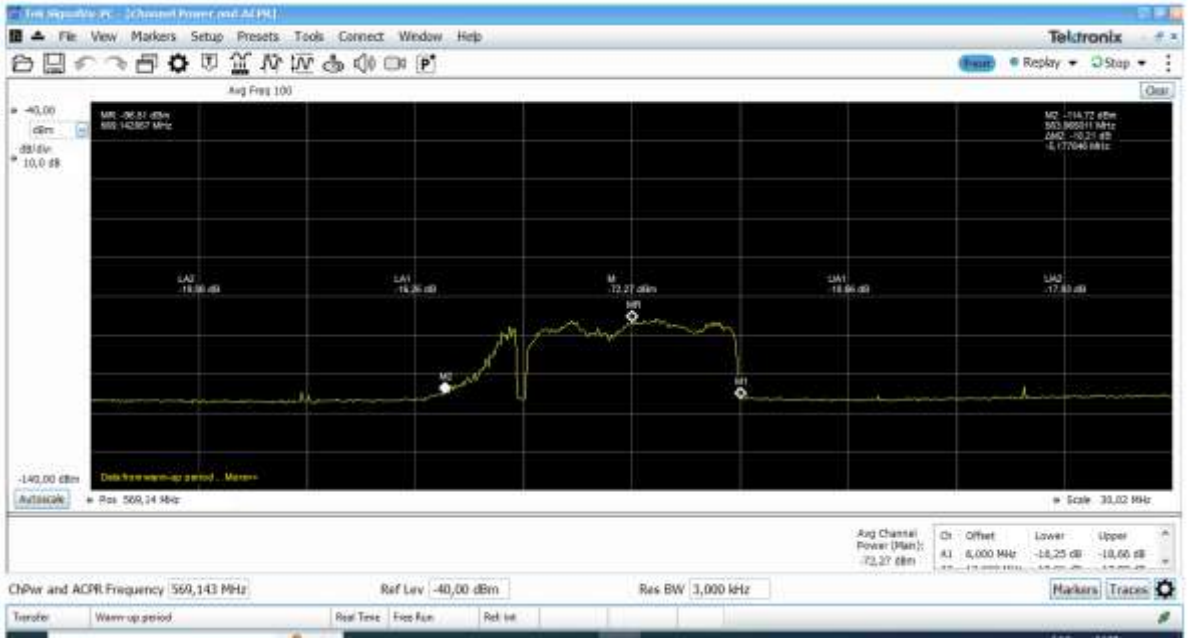


Figure 4.1 - Vertical

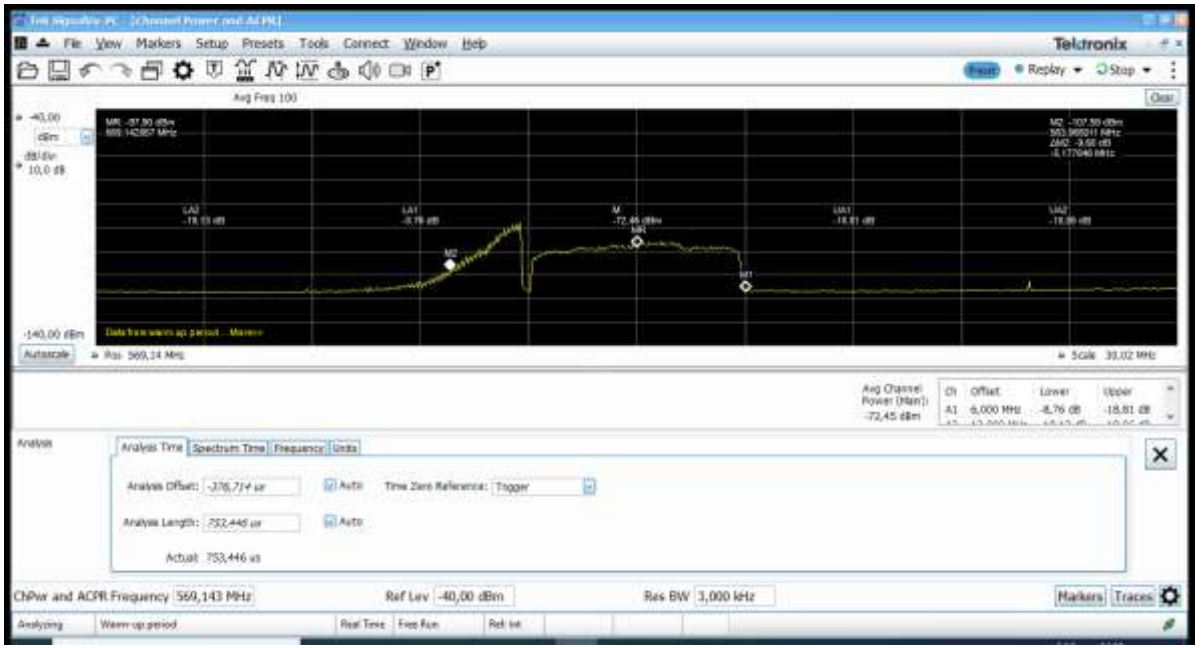


Figure 4.2 - Horizontal

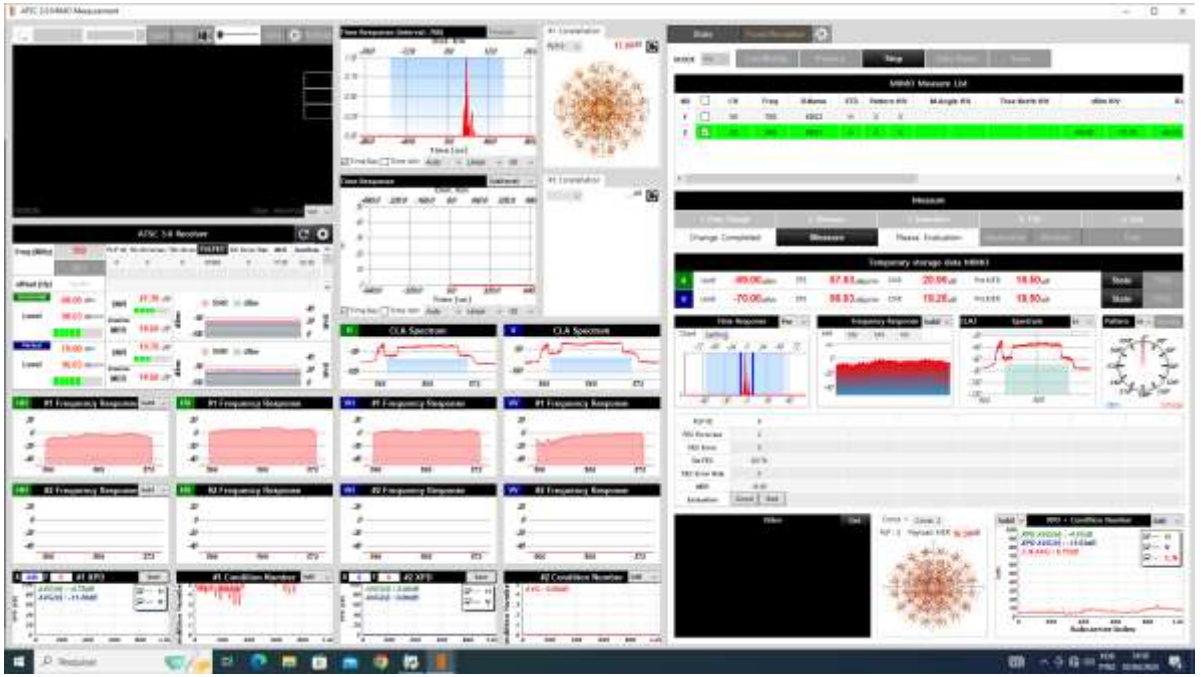


Figure 4.3 - IMAS Screen

b) AWGN Power

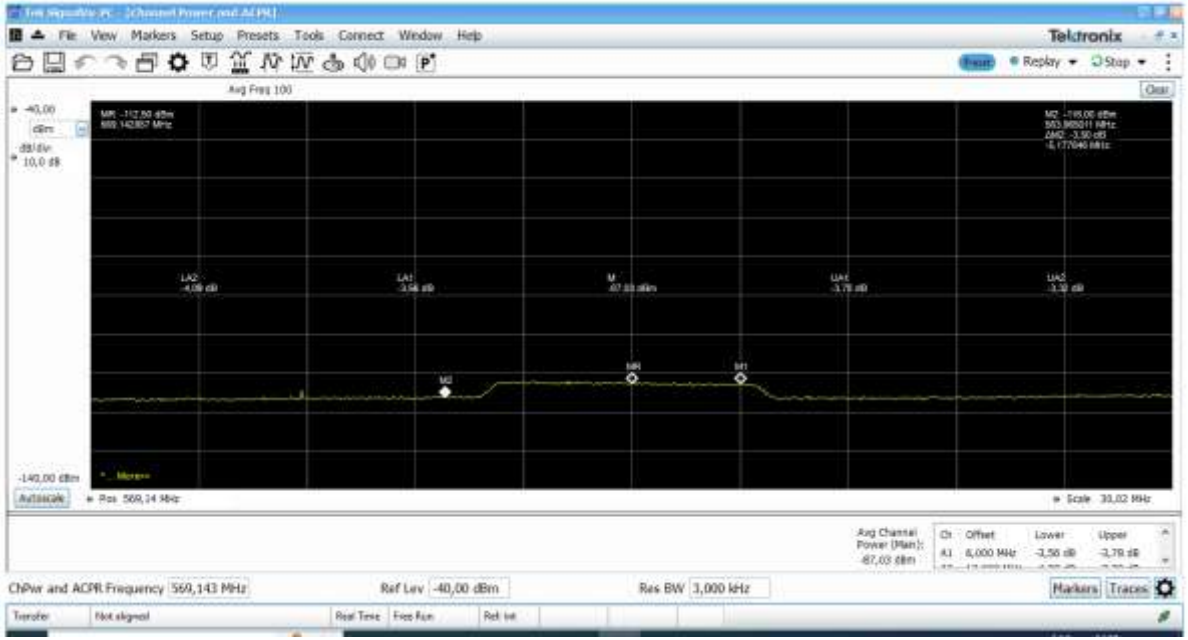


Figure 4.4 - Vertical

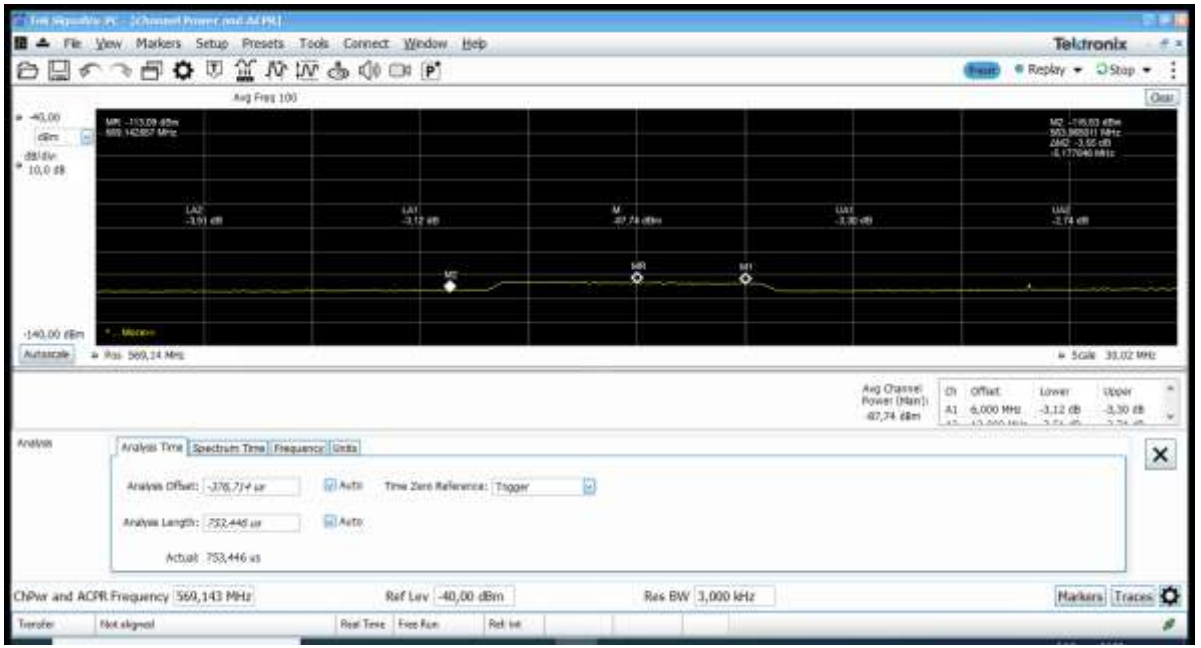


Figure 4.5 - Horizontal

c) C/N Threshold

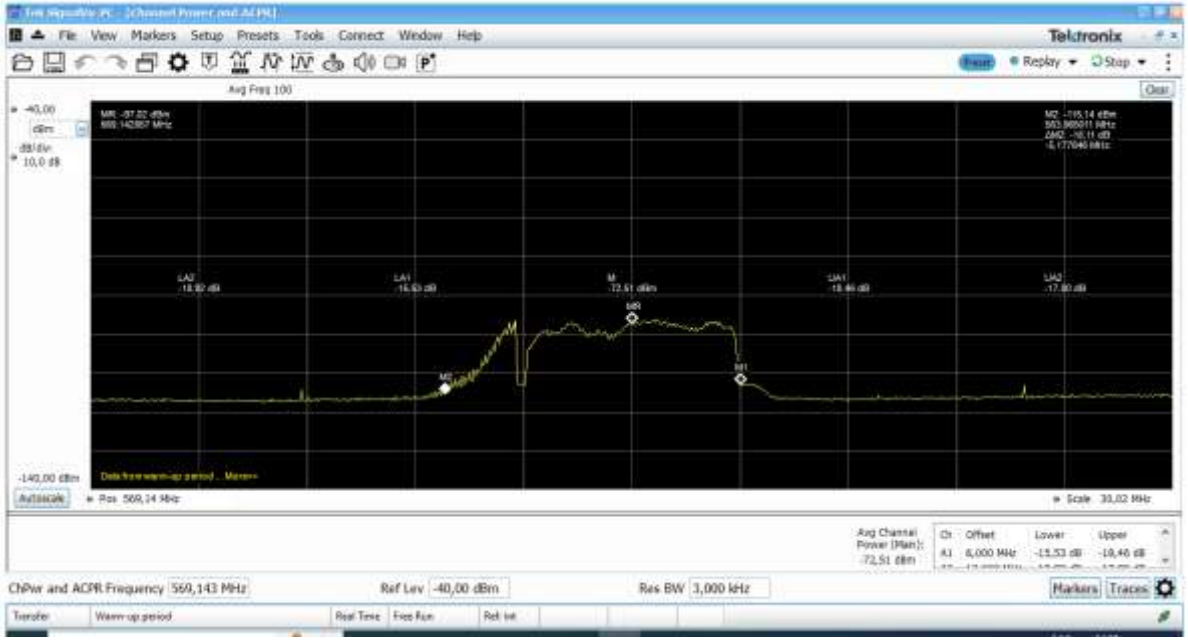


Figure 4.6 - Vertical

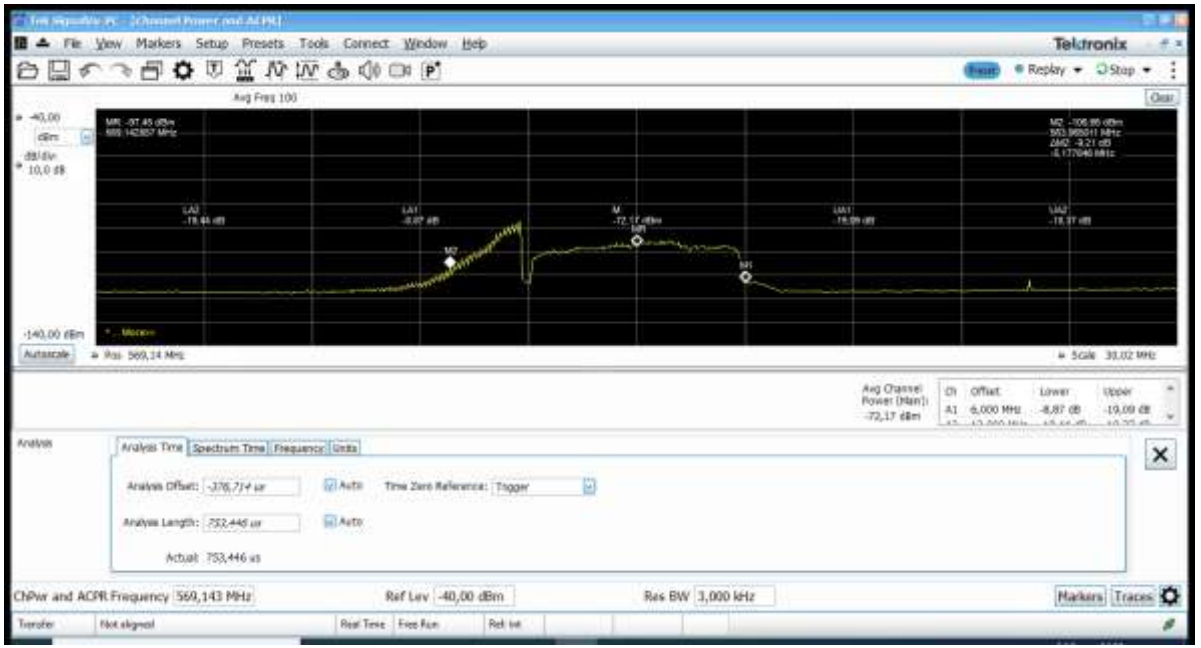


Figure 4.7 - Horizontal

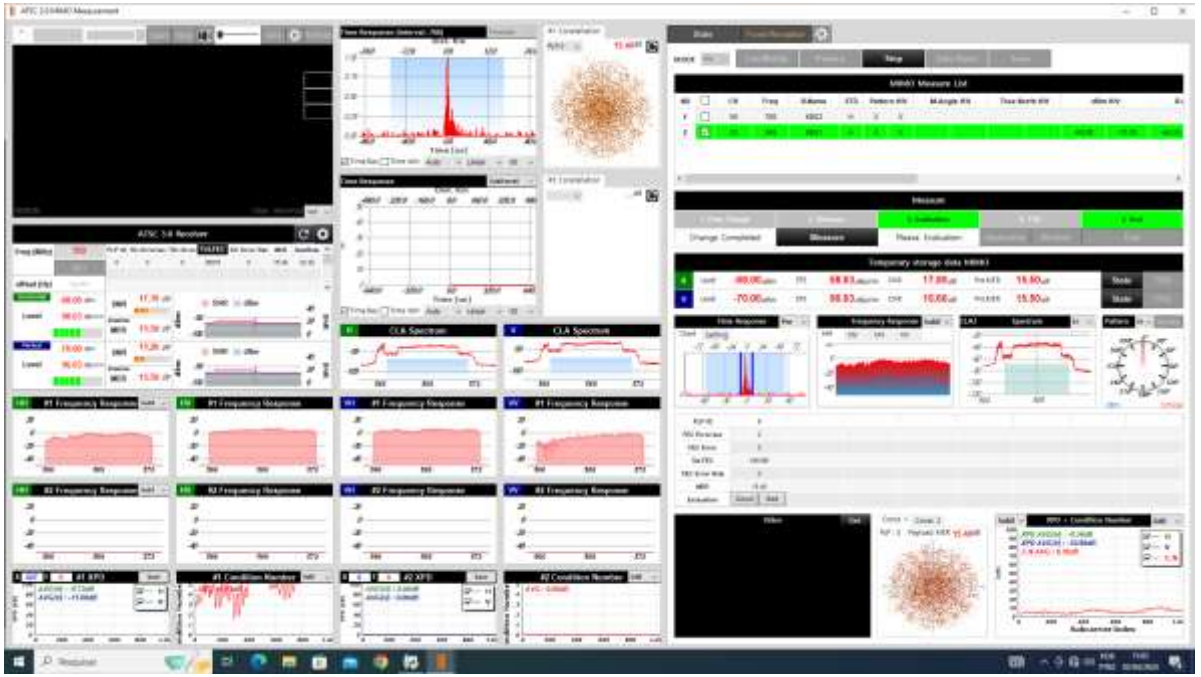


Figure 4.8 - IMAS Screen

d) Reception Threshold

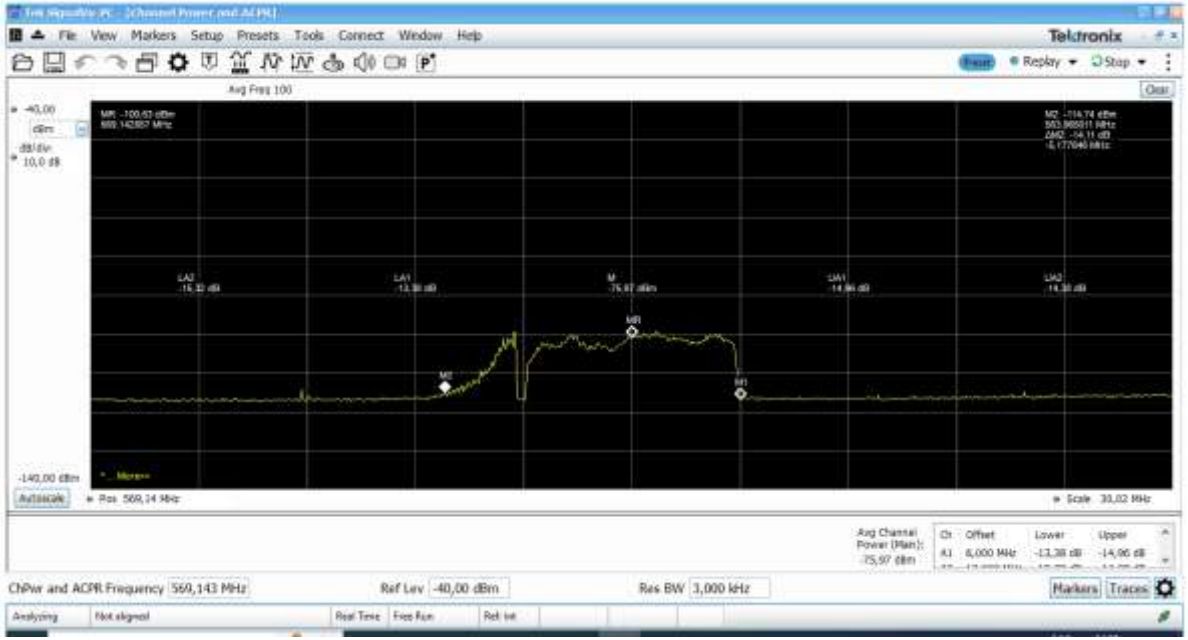


Figure 4.9 - Vertical

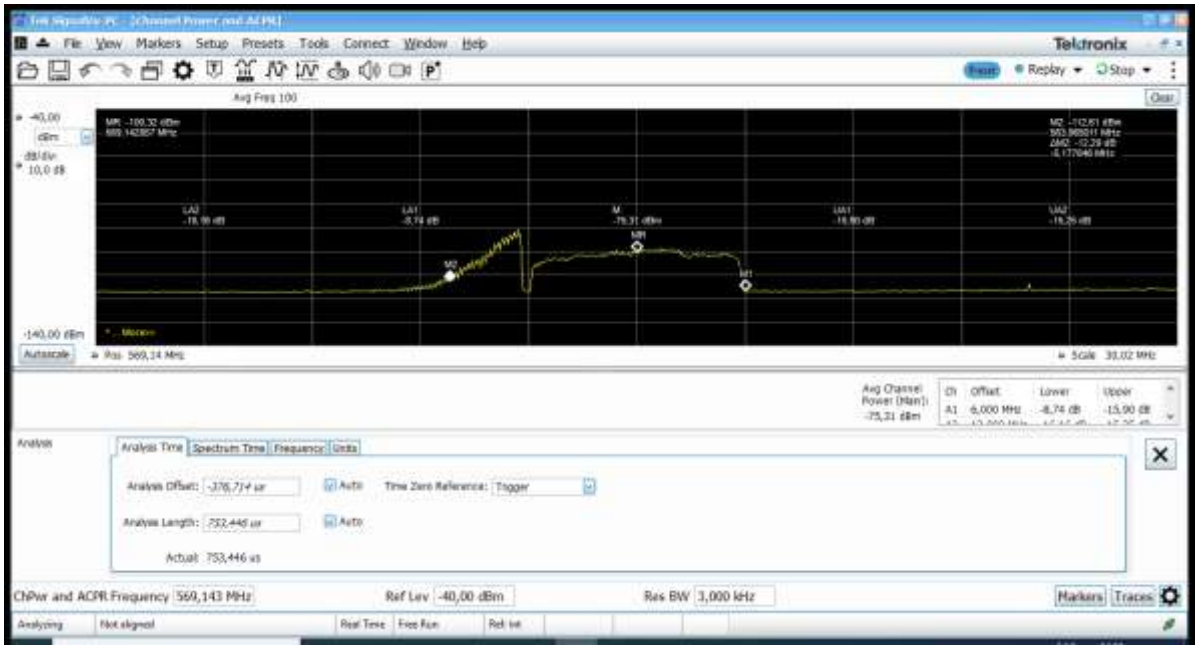


Figure 4.10 - Horizontal

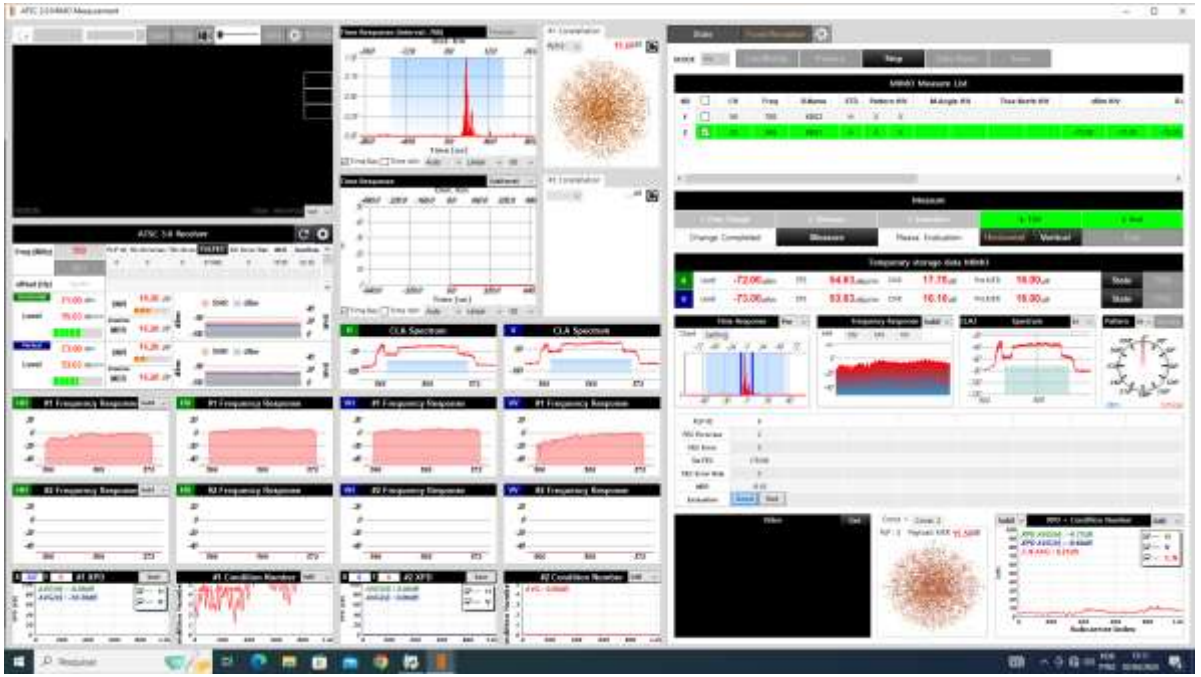


Figure 4.11 - IMAS Screen

Chapter 5. Site 20

a) Channel Power

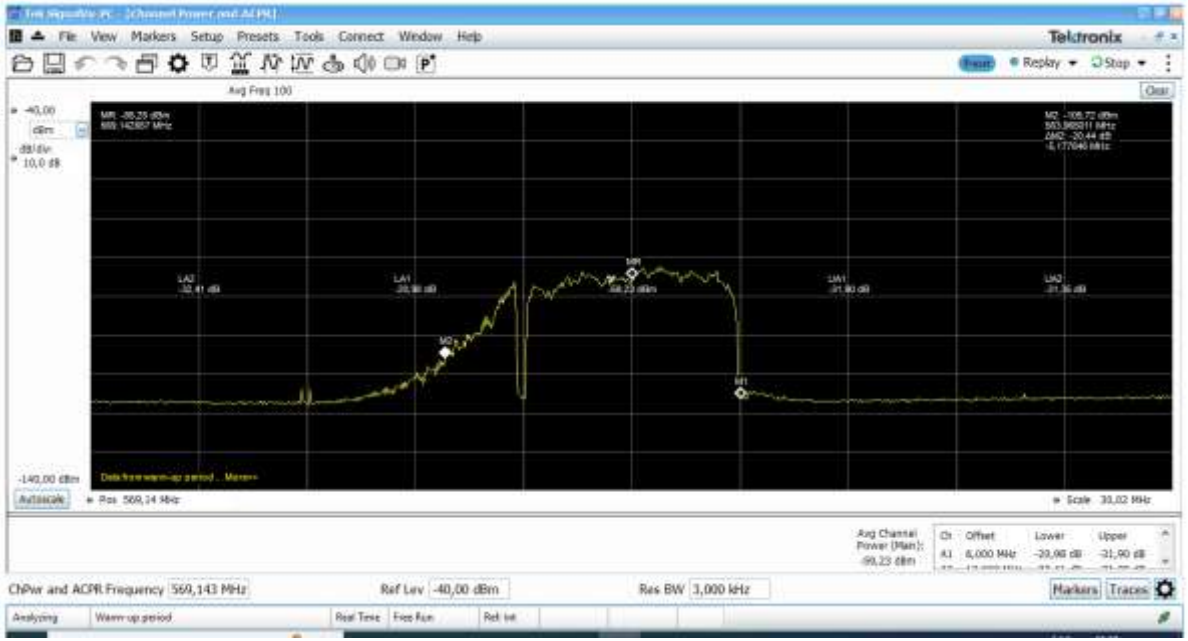


Figure 5.1 - Vertical

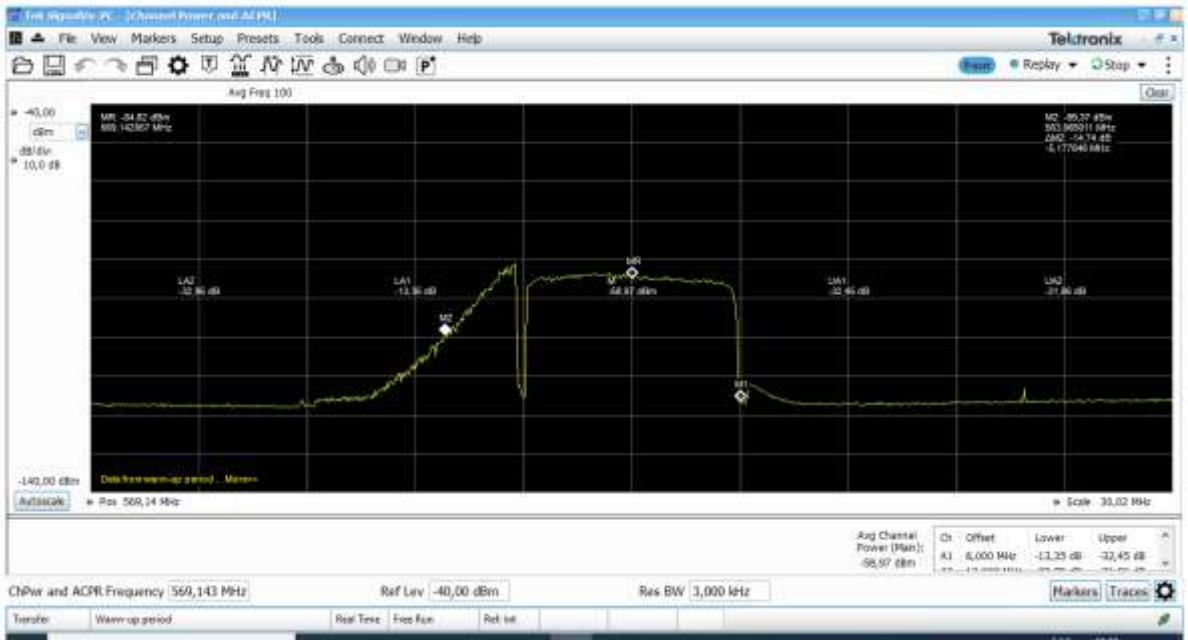


Figure 5.2 - Horizontal

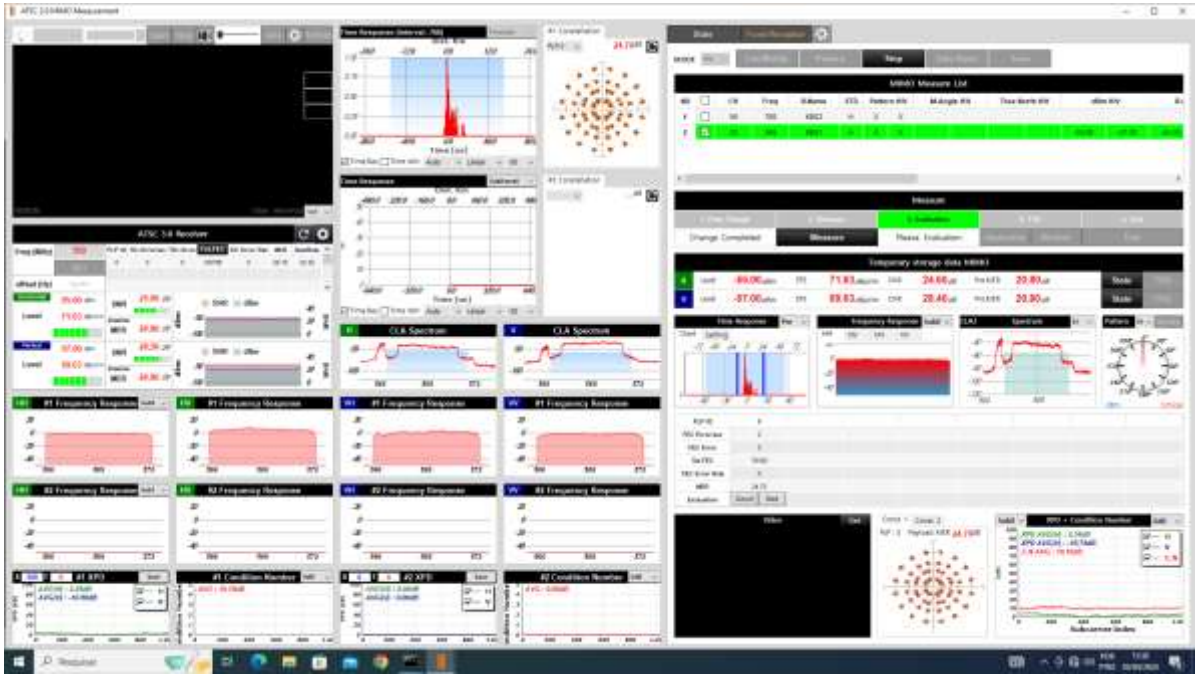


Figure 5.3 - IMAS Screen

b) AWGN Power

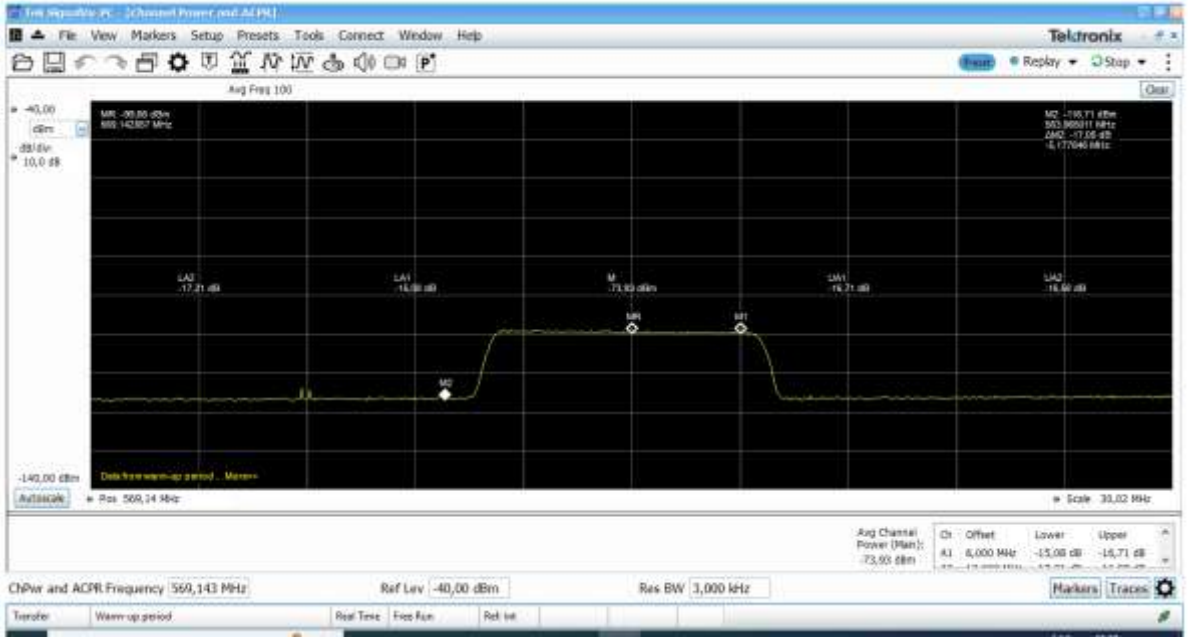


Figure 5.4 - Vertical

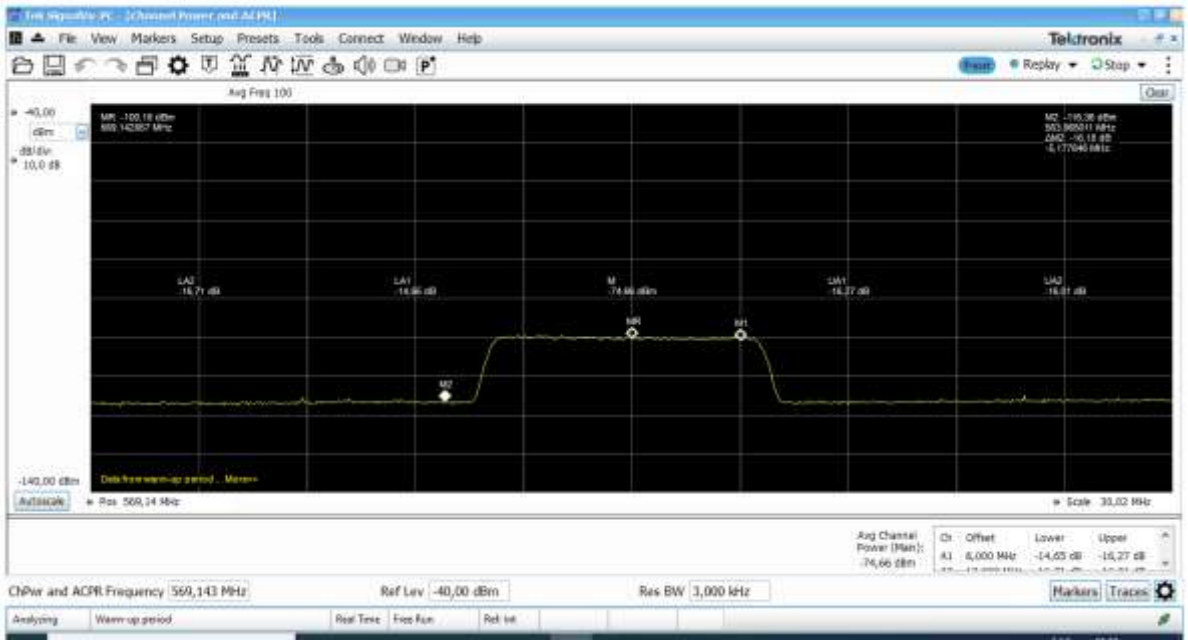


Figure 5.5 - Horizontal

c) C/N Threshold

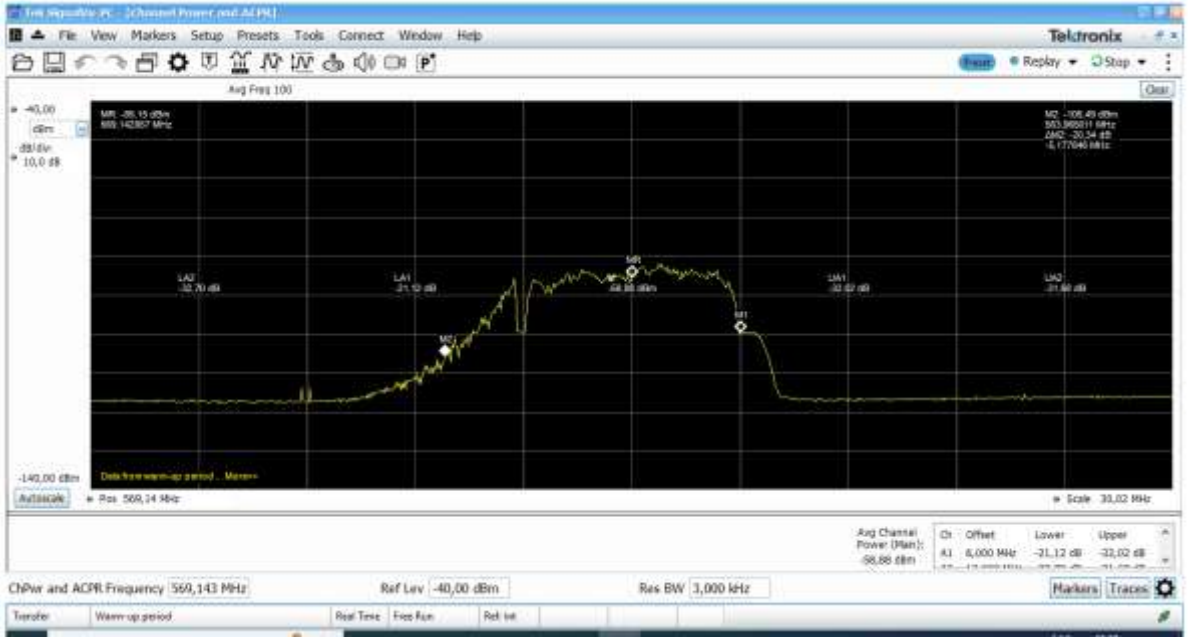


Figure 5.6 - Vertical

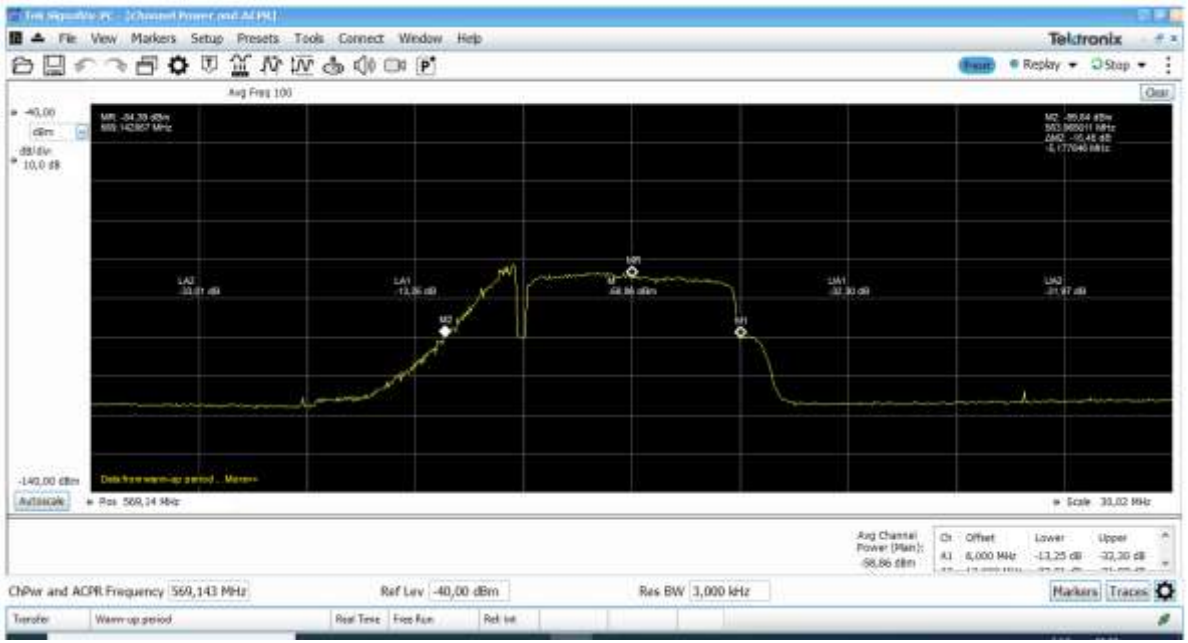


Figure 5.7 - Horizontal

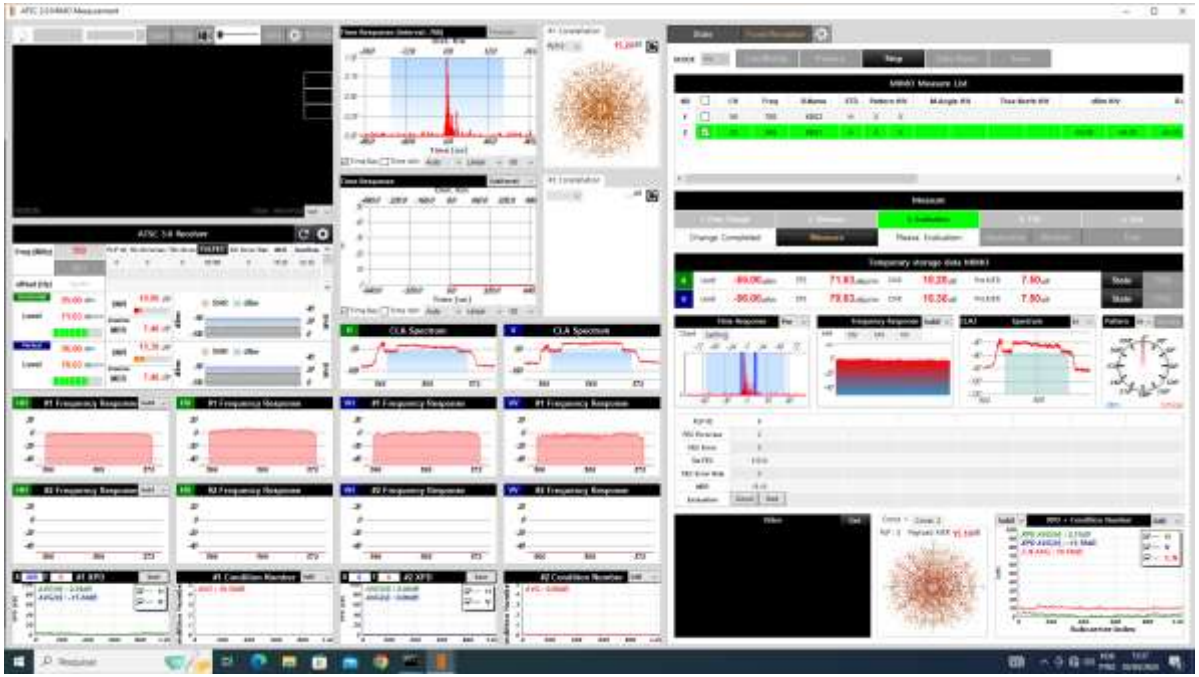


Figure 5.8 - IMAS Screen

d) Reception Threshold

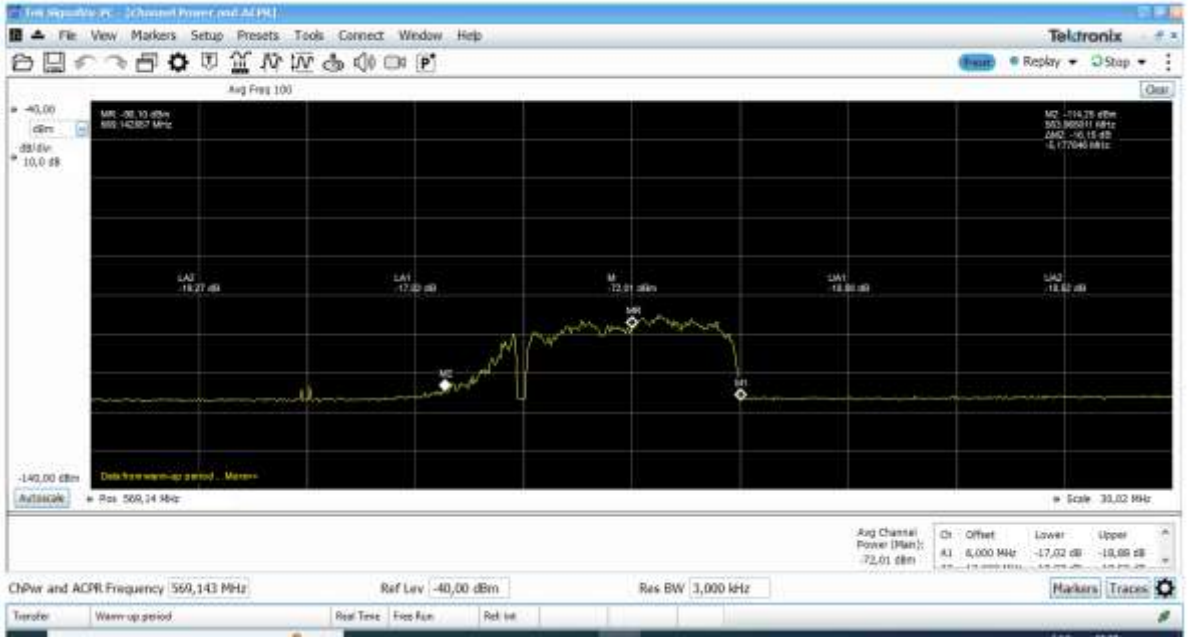


Figure 5.9 - Vertical

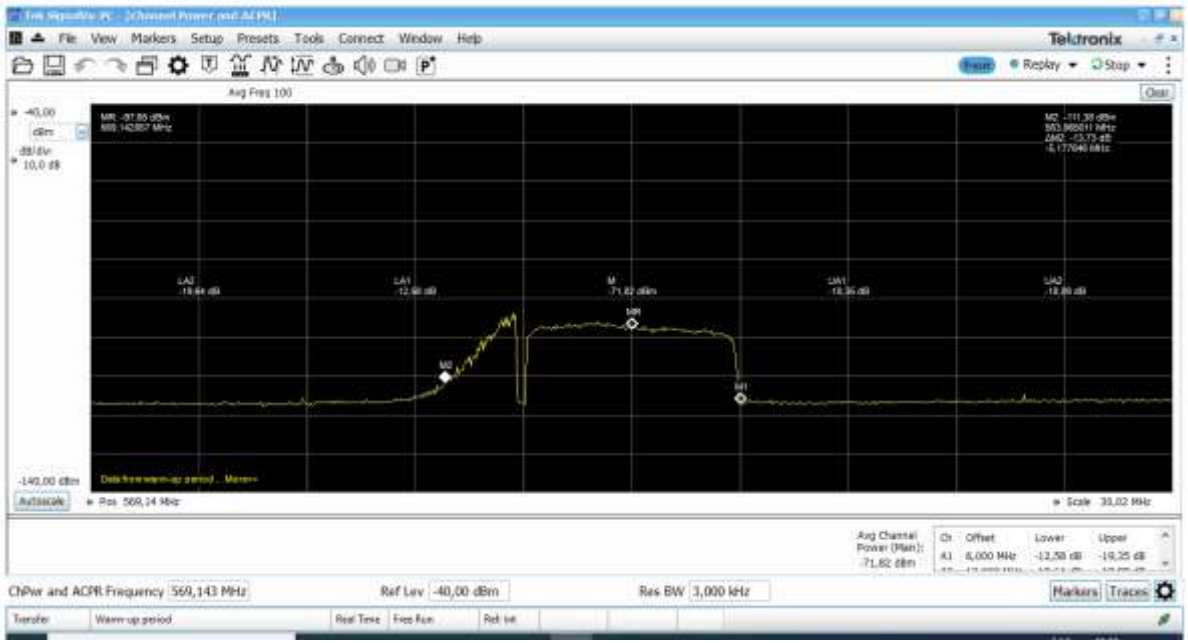


Figure 5.10 - Horizontal

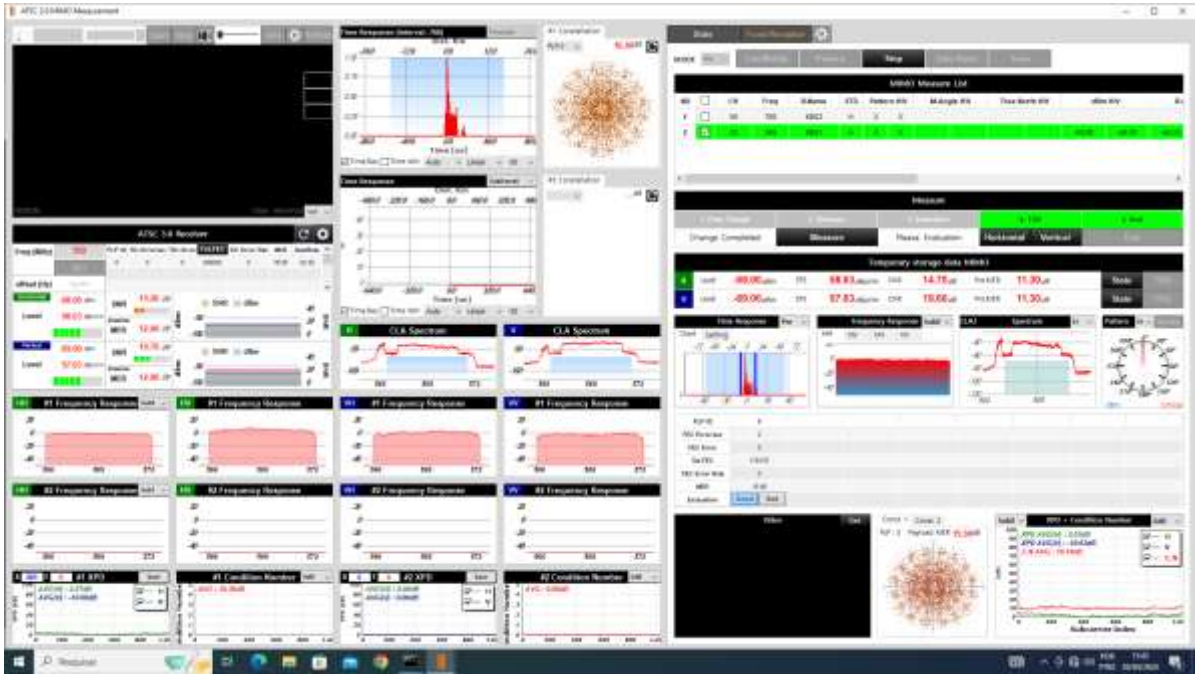


Figure 5.11 - IMAS Screen

Chapter 6. Site 21

a) Channel Power

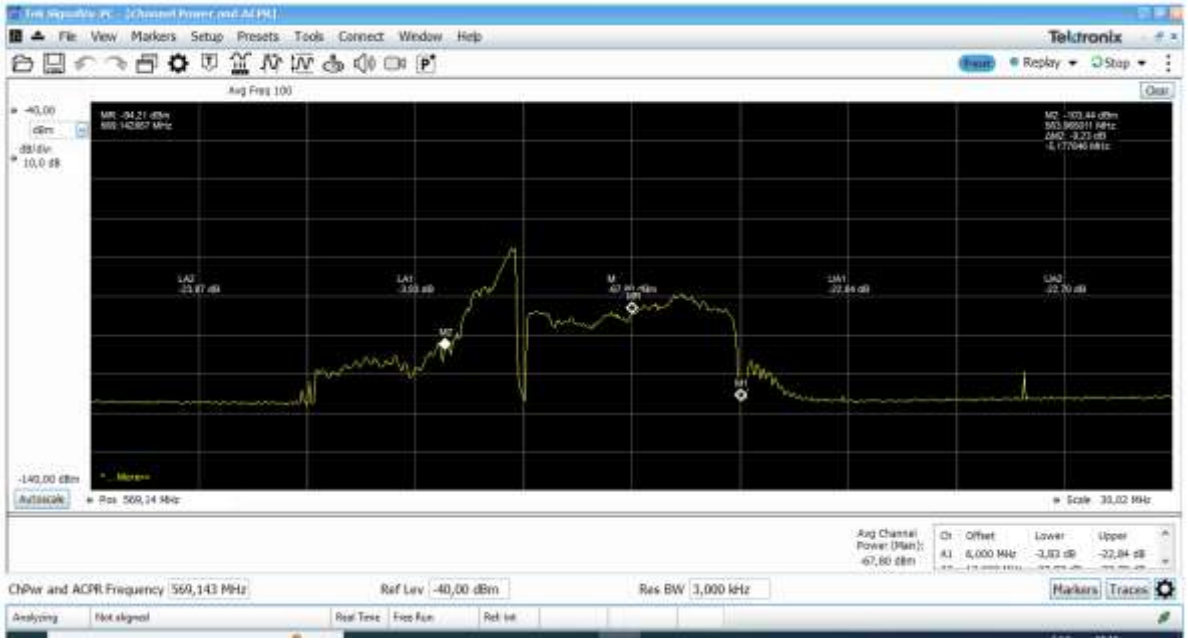


Figure 6.1 - Vertical

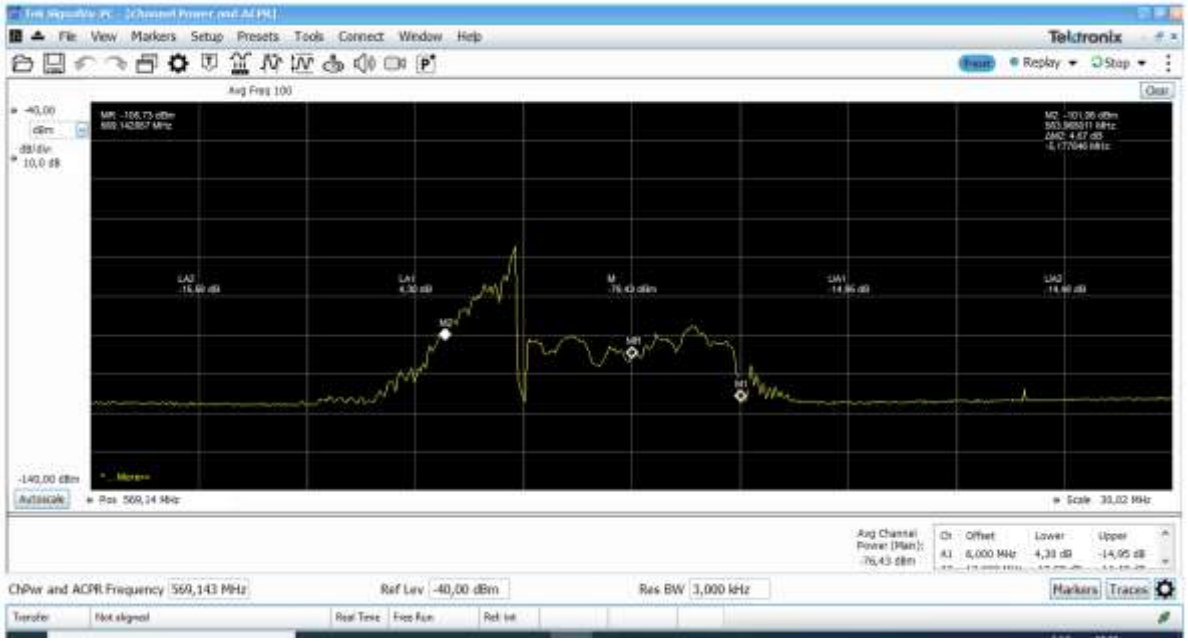


Figure 6.2 - Horizontal

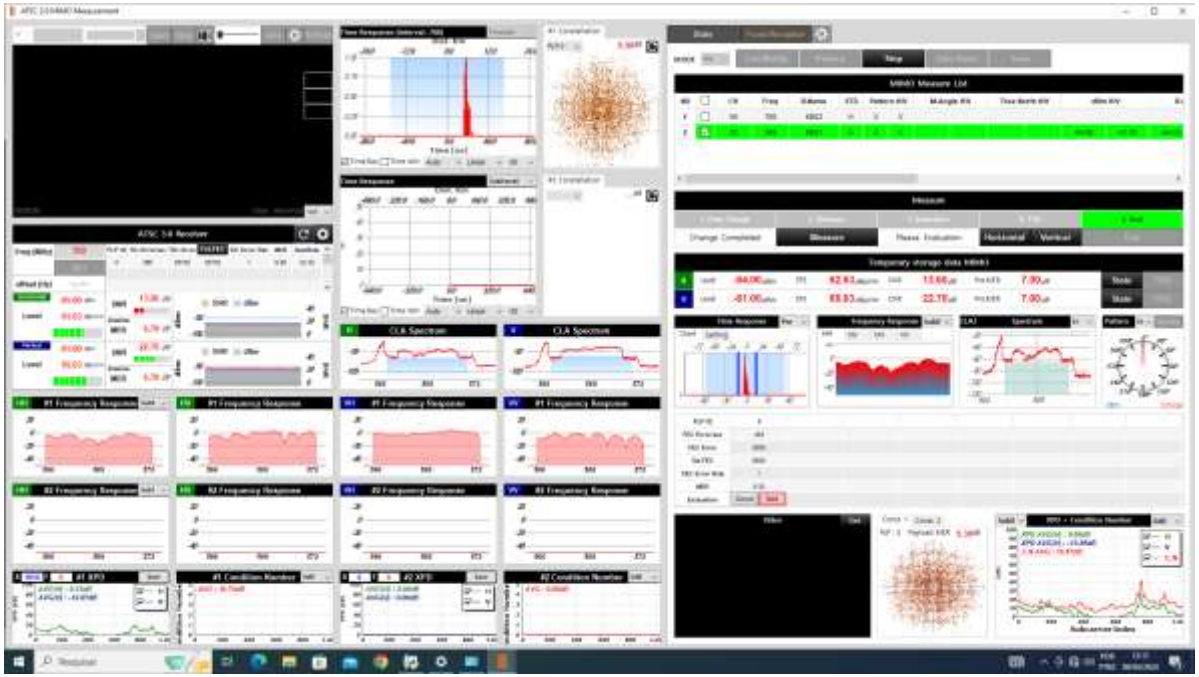


Figure 6.3 - IMAS Screen

Chapter 7. Site 27

a) Channel Power

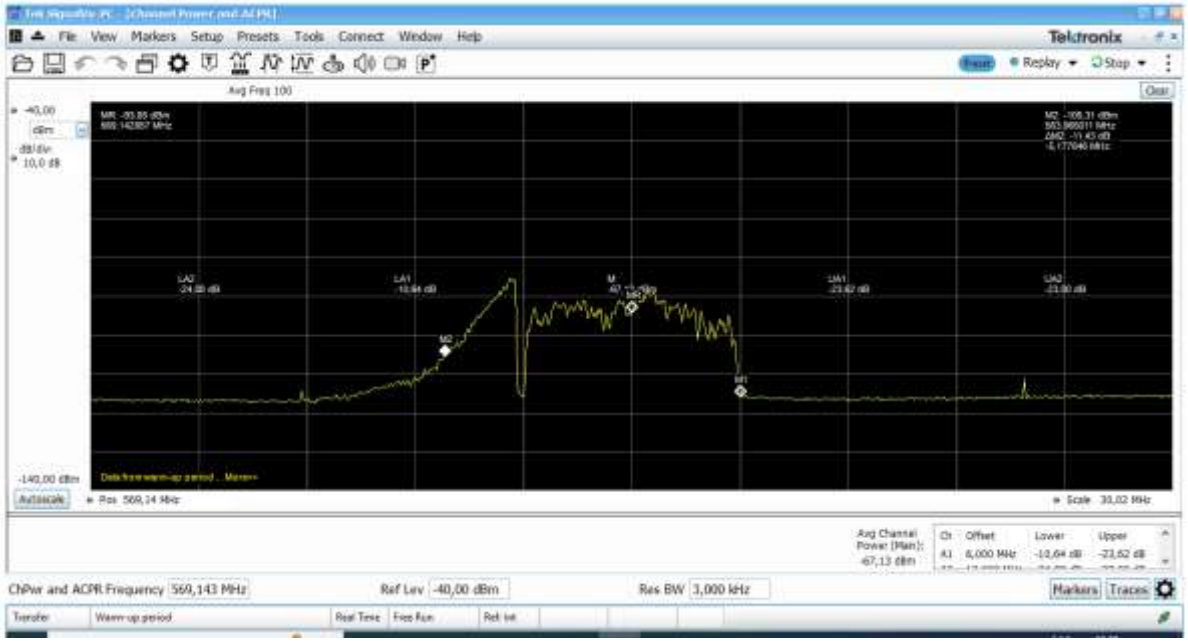


Figure 7.1 - Vertical

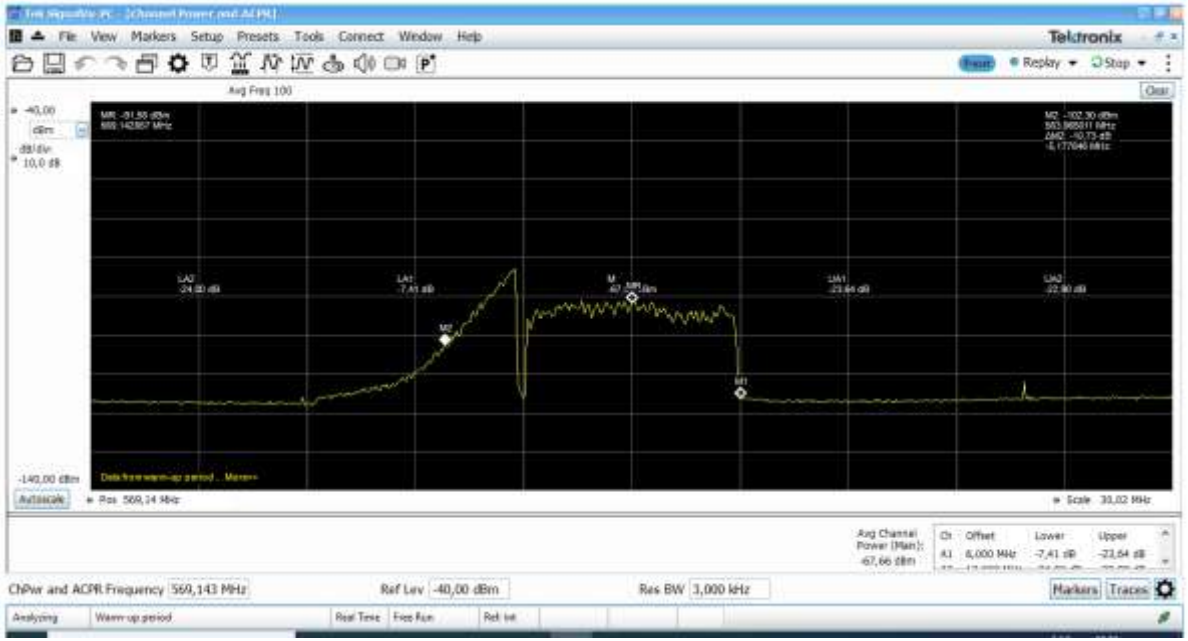


Figure 7.2 - Horizontal

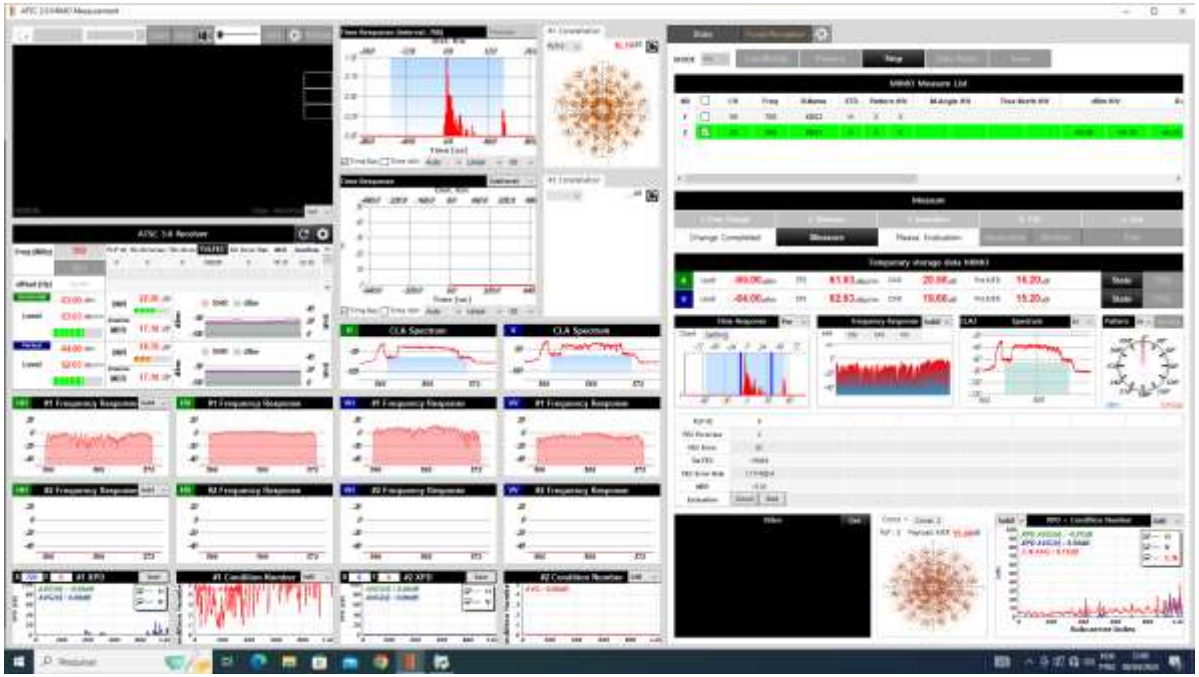


Figure 7.3 - IMAS Screen

b) AWGN Power

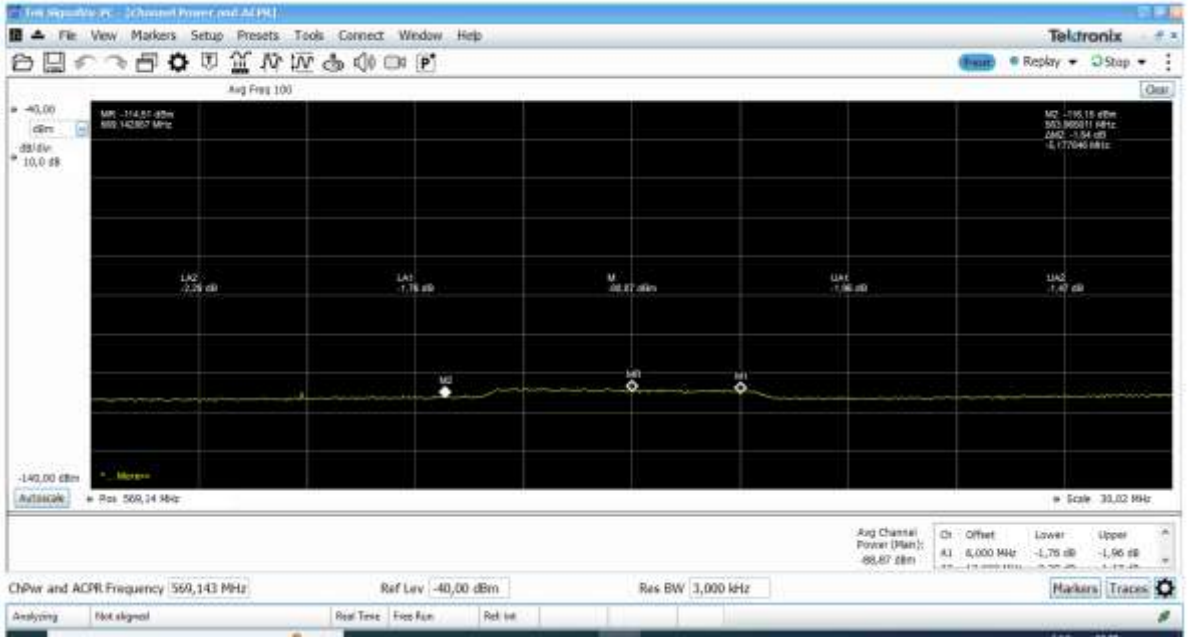


Figure 7.4 - Vertical

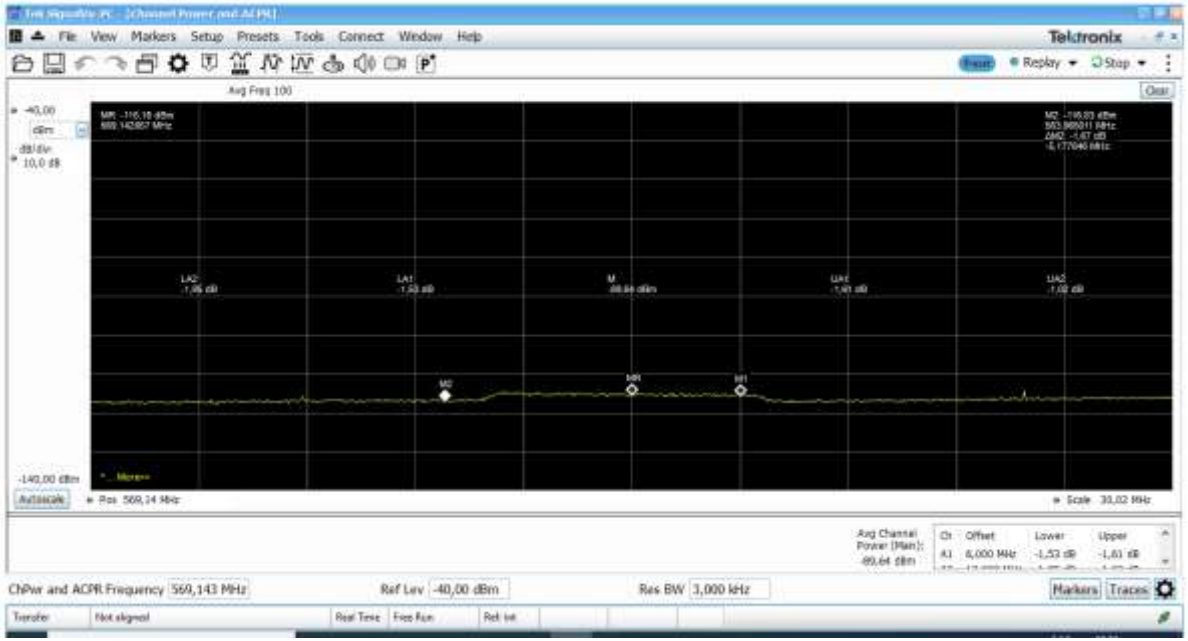


Figure 7.5 - Horizontal

c) C/N Threshold

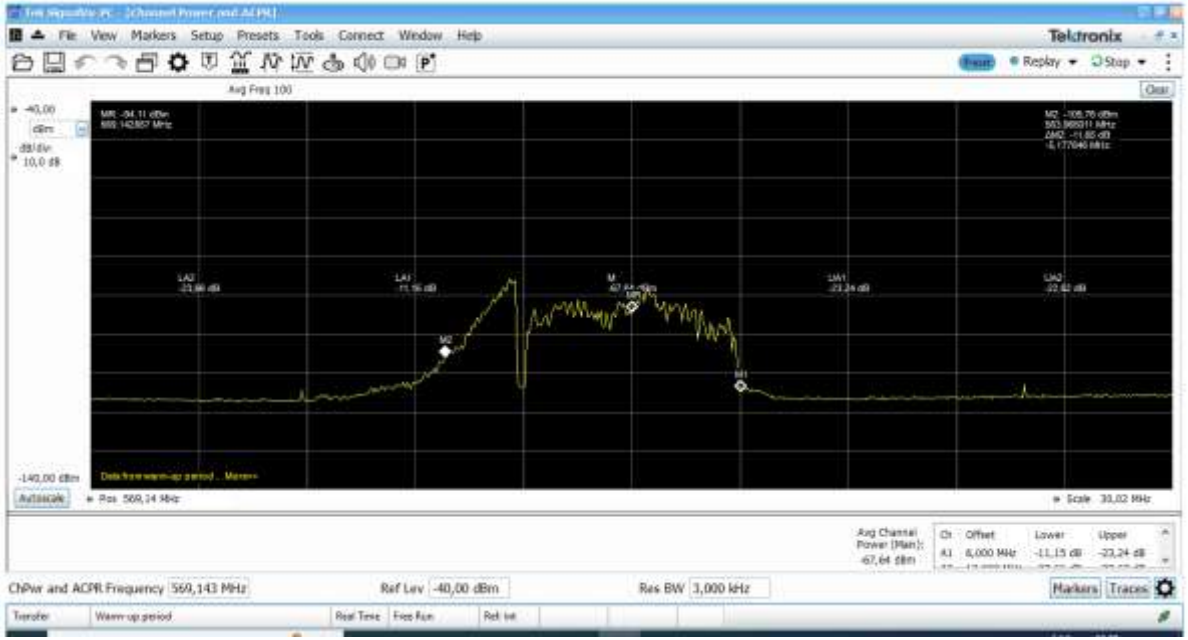


Figure 7.6 - Vertical

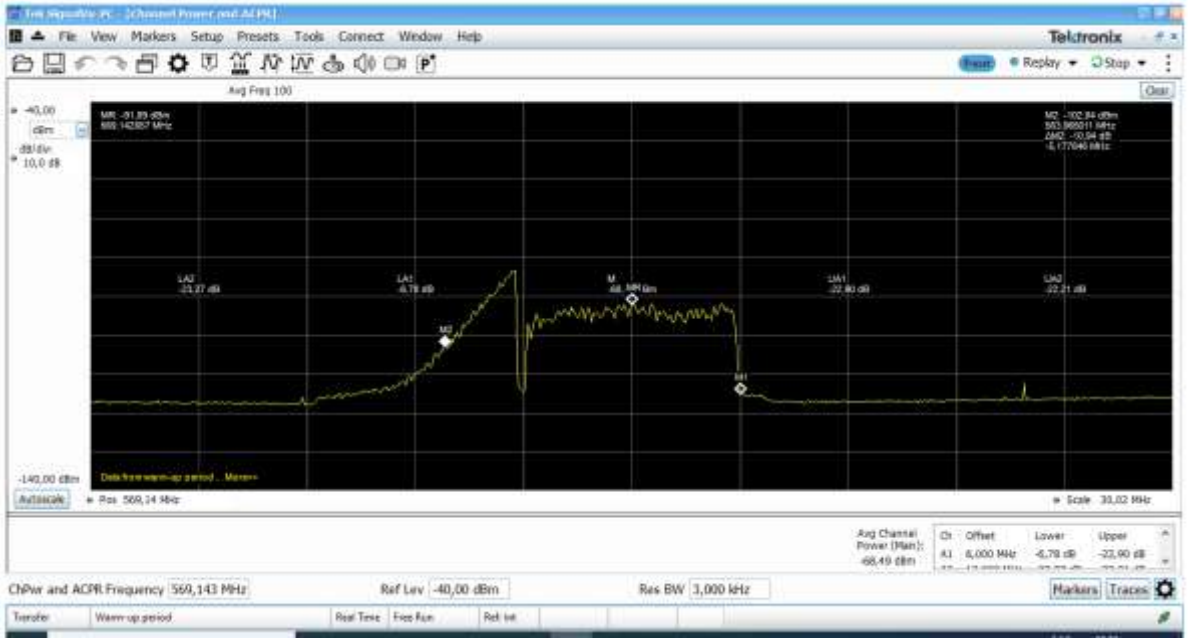


Figure 7.7 - Horizontal

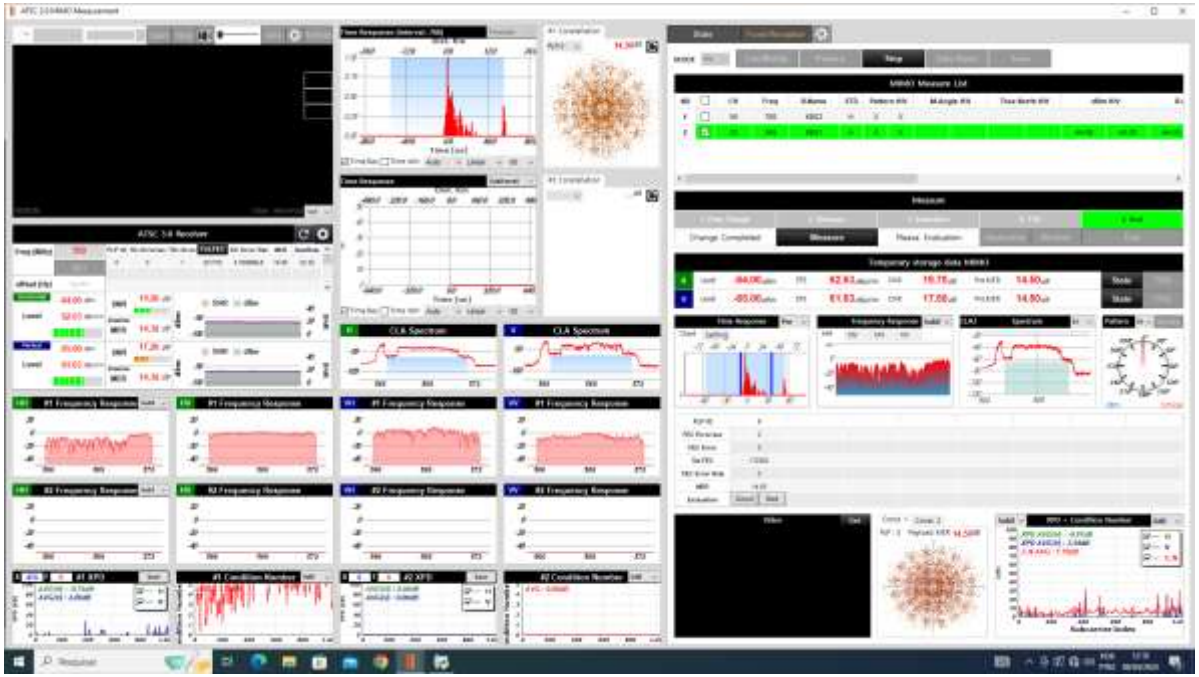


Figure 7.8 - IMAS Screen

d) Reception Threshold

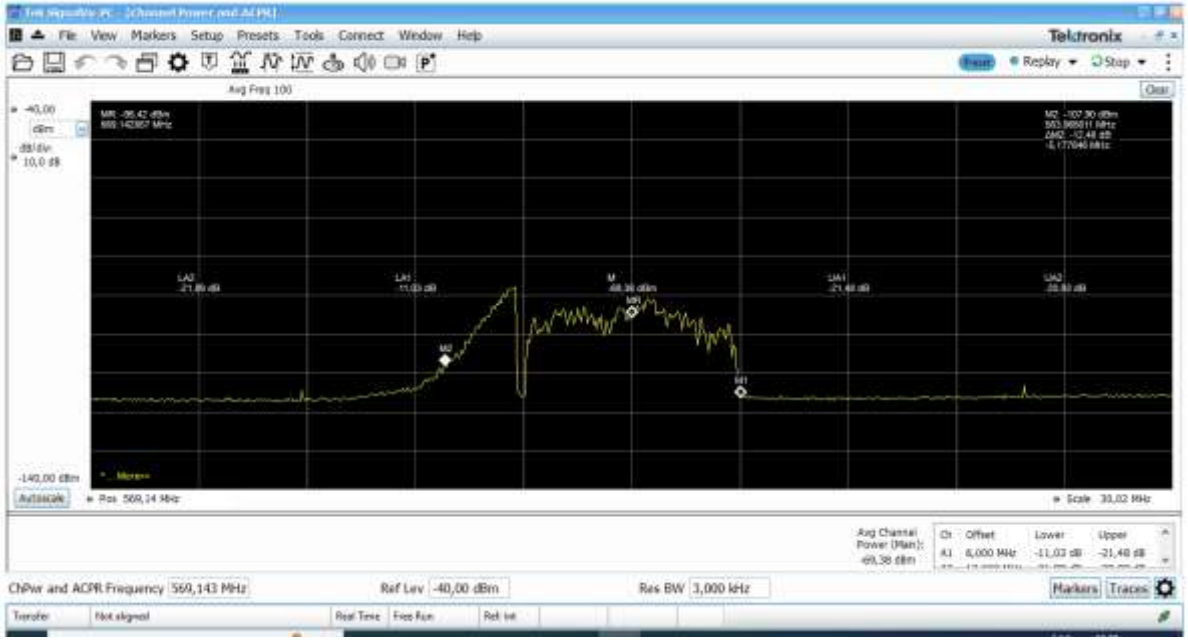


Figure 7.9 - Vertical

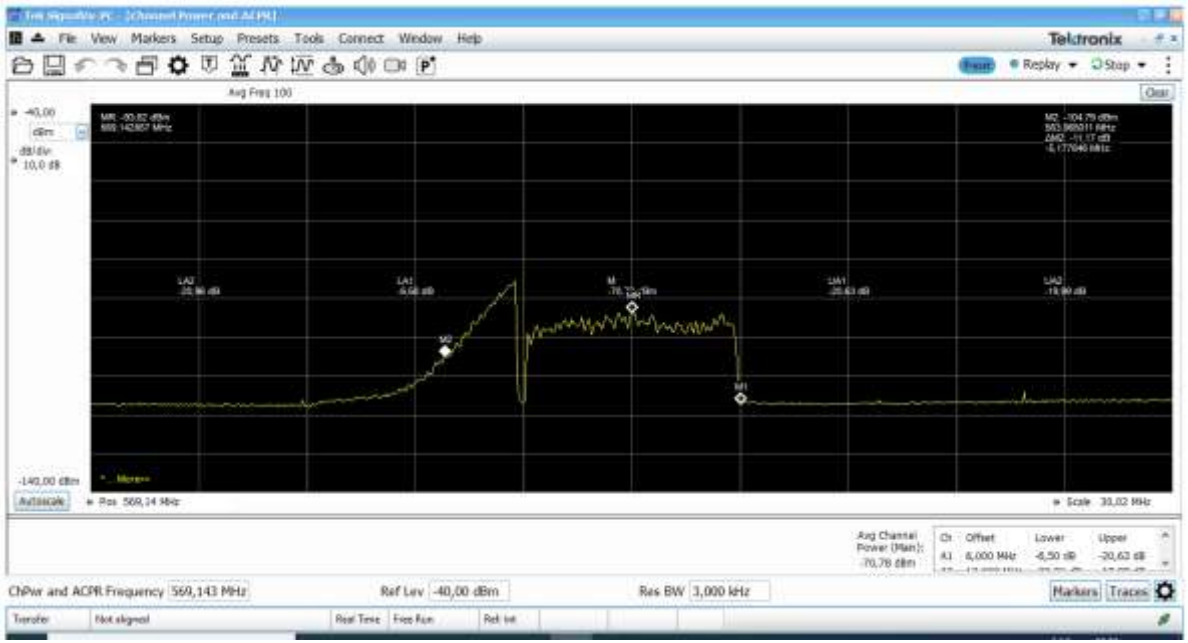


Figure 7.10 - Horizontal

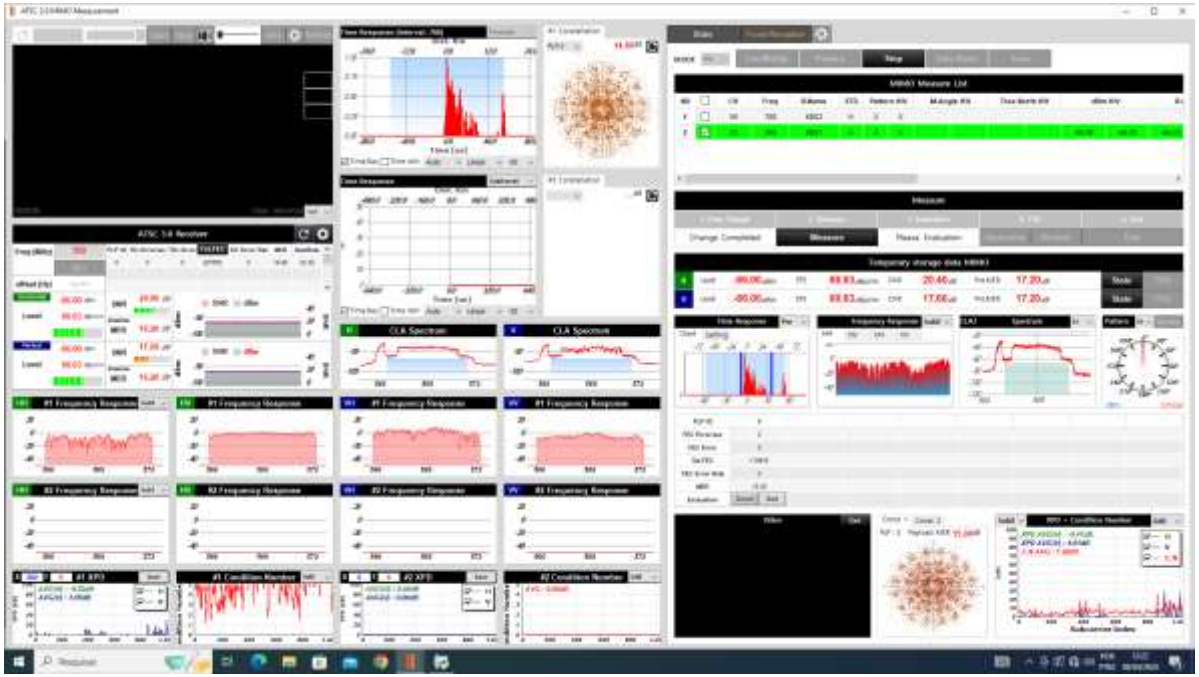


Figure 7.11 - IMAS Screen

Chapter 8. Site 28

a) Channel Power

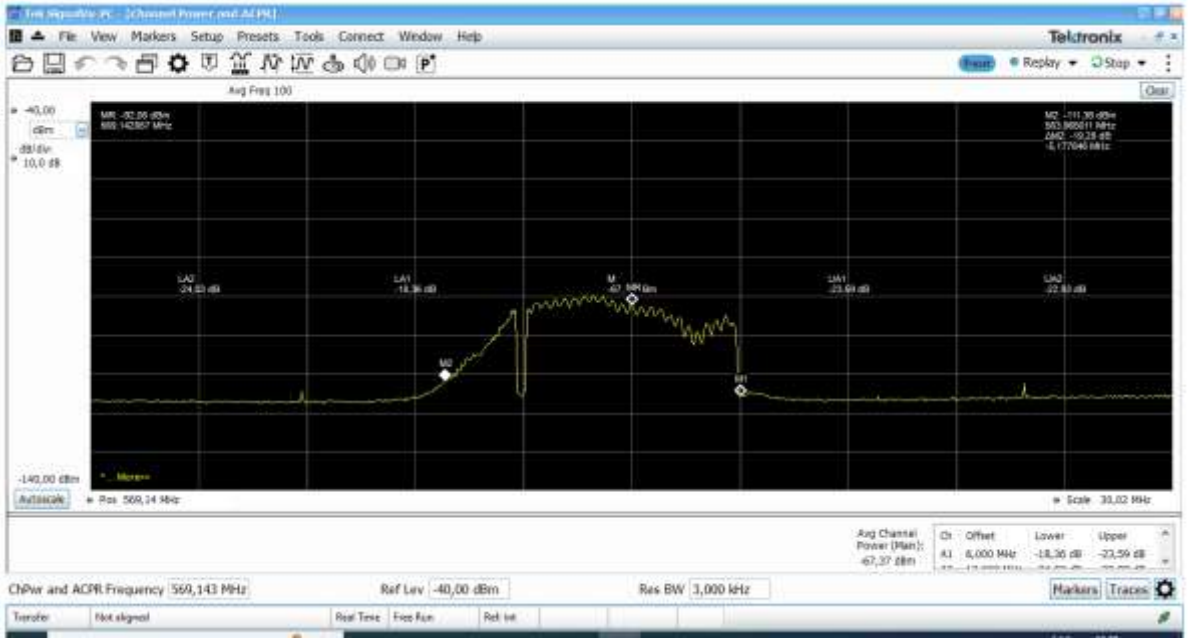


Figure 8.1 - Vertical

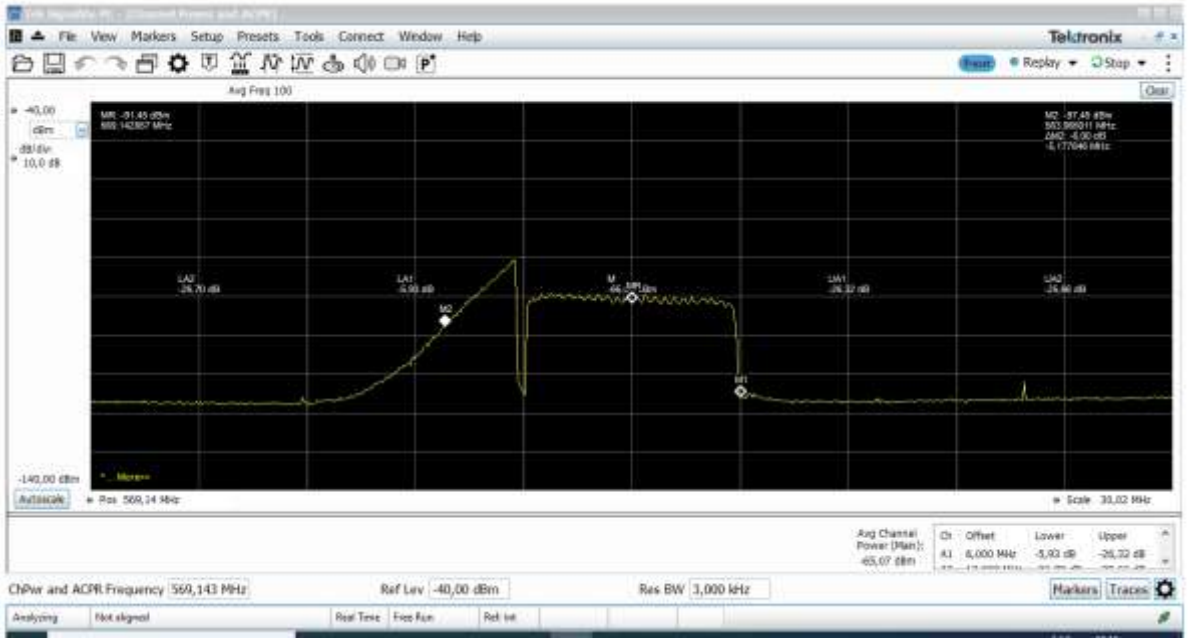


Figure 8.2 - Horizontal

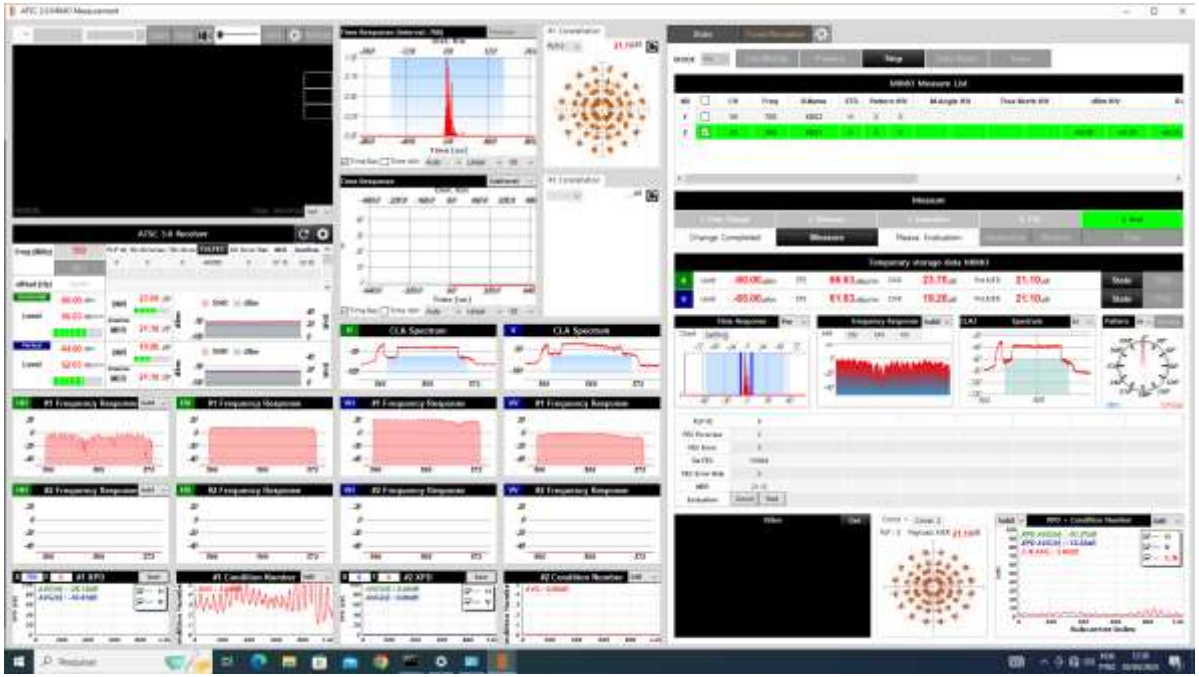


Figure 8.3 - IMAS Screen

b) AWGN Power

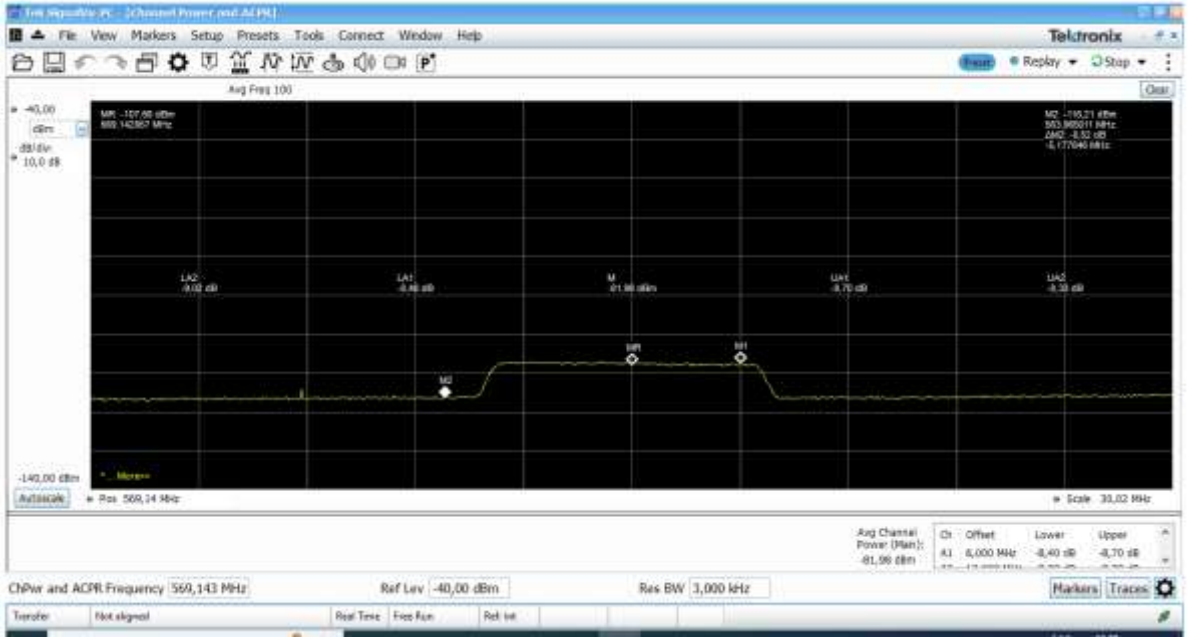


Figure 8.4 - Vertical

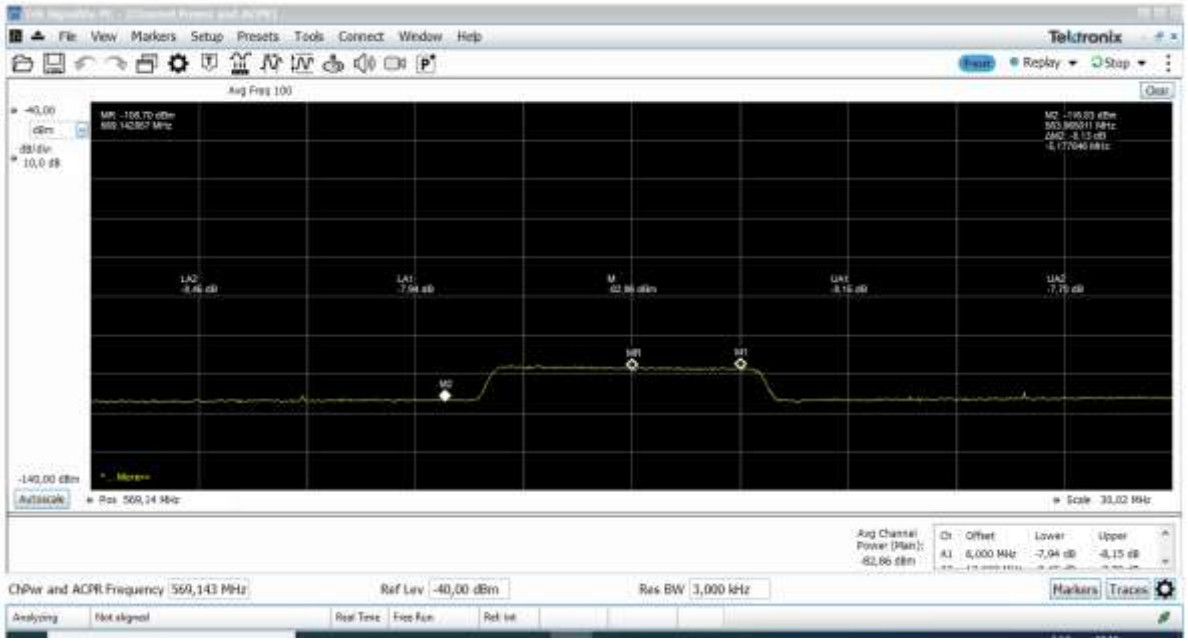


Figure 8.5 - Horizontal

c) C/N Threshold

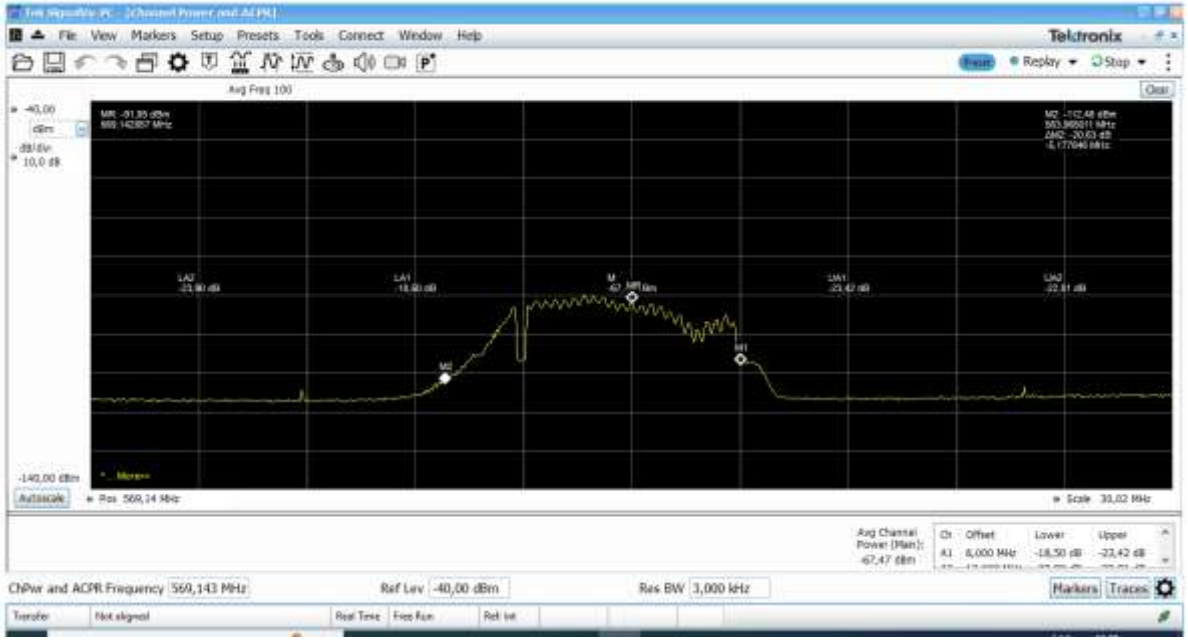


Figure 8.6 - Vertical

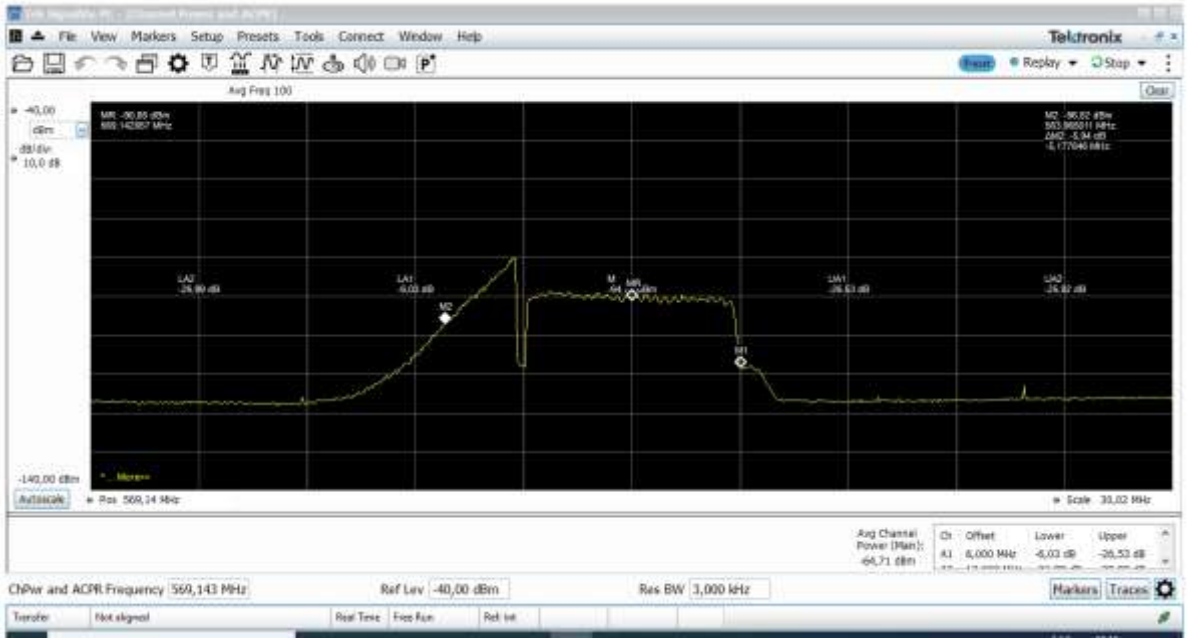


Figure 8.7 - Horizontal

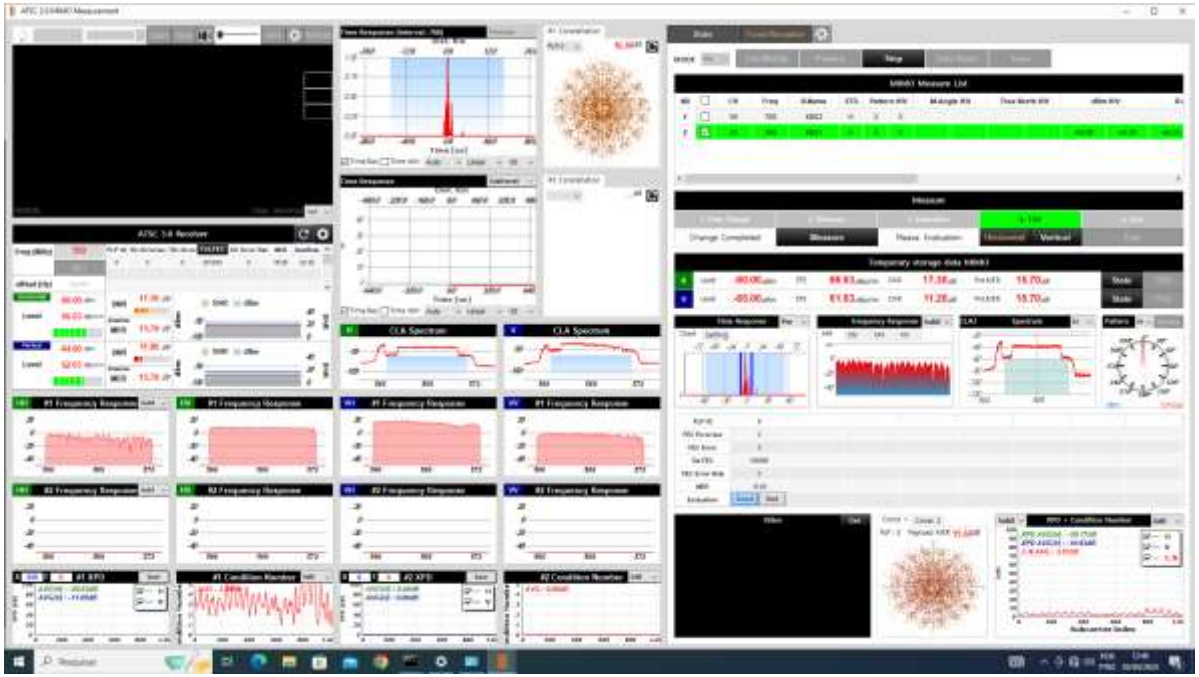


Figure 8.8 - IMAS Screen

d) Reception Threshold

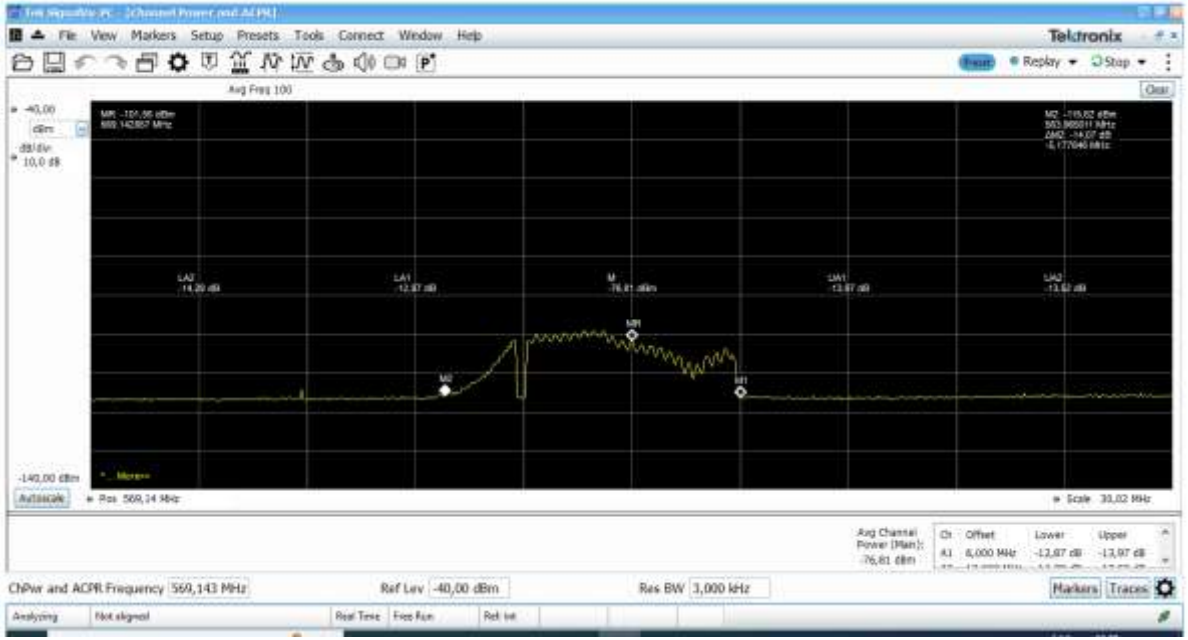


Figure 8.9 - Vertical

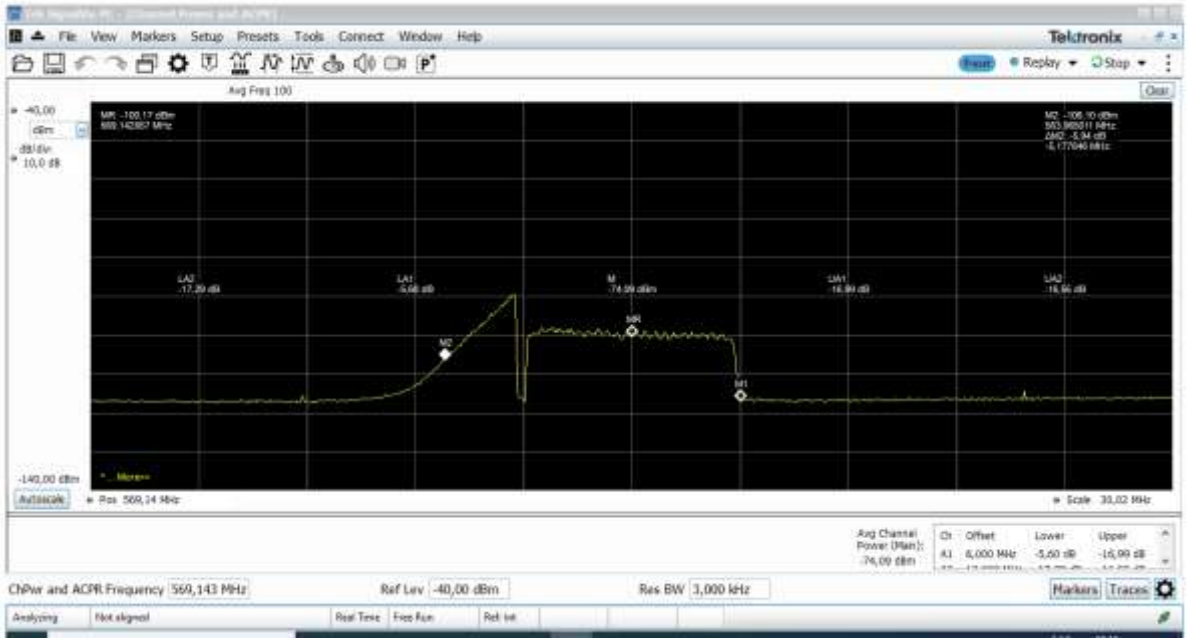


Figure 8.10 - Horizontal

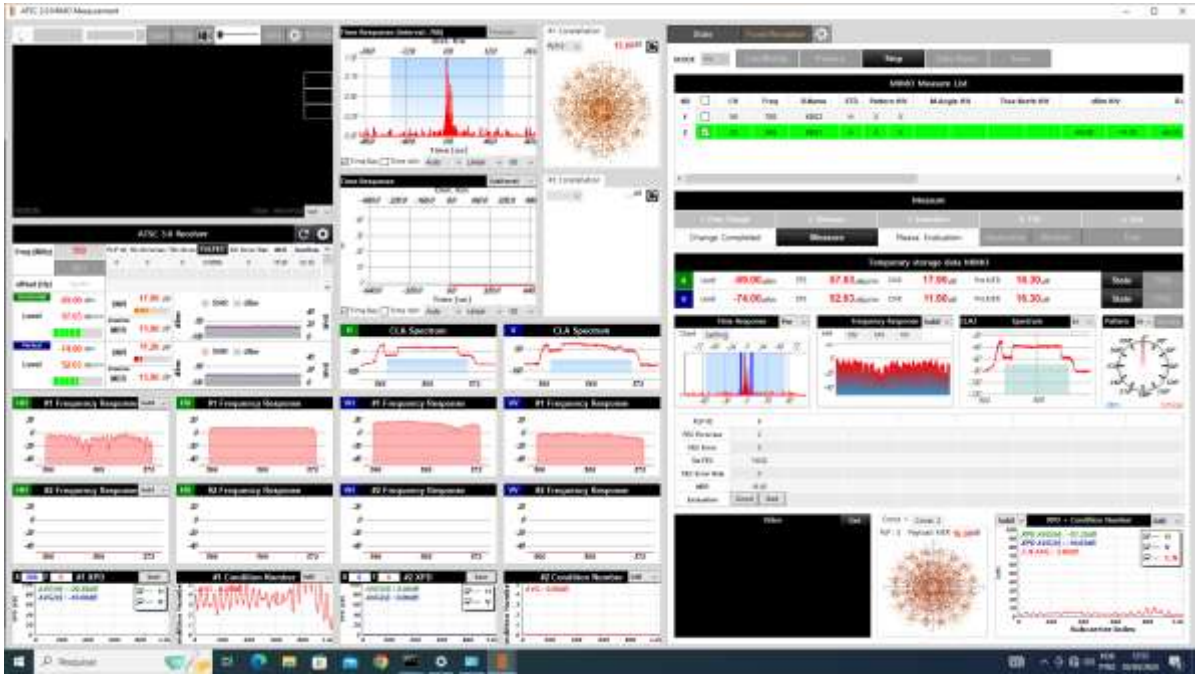


Figure 8.11 - IMAS Screen

Appendix V. Extra outdoor measurements using Advanced ISDB-T - Configuration 3 - Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps; Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

Chapter 1. Site 1

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

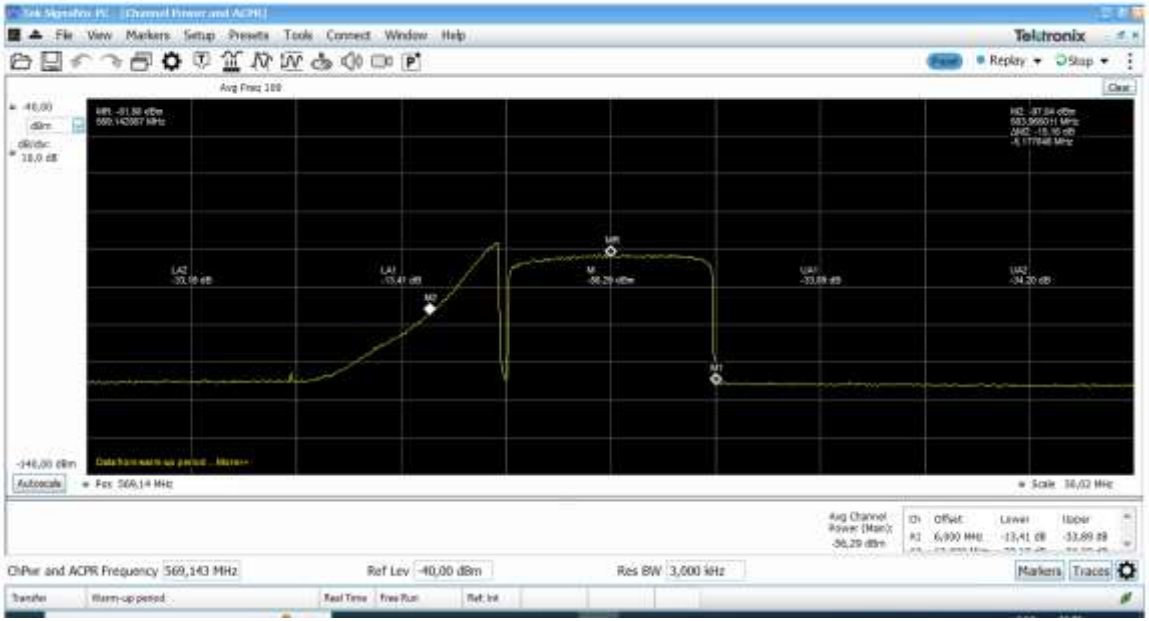


Figure 1.1 - Vertical

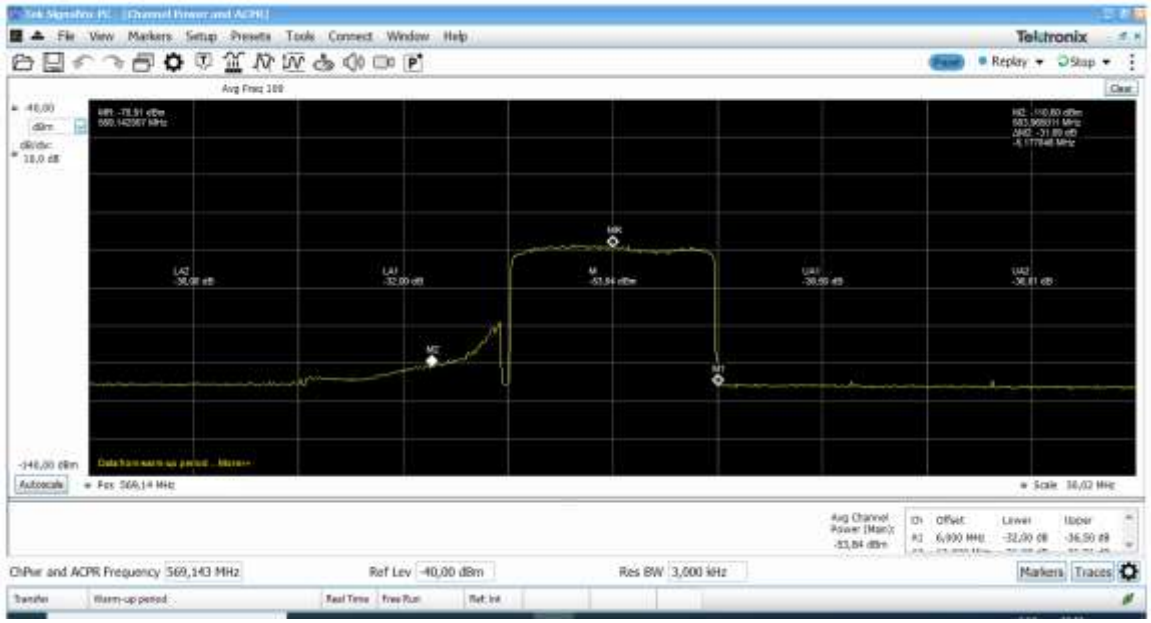


Figure 1.2 - Horizontal

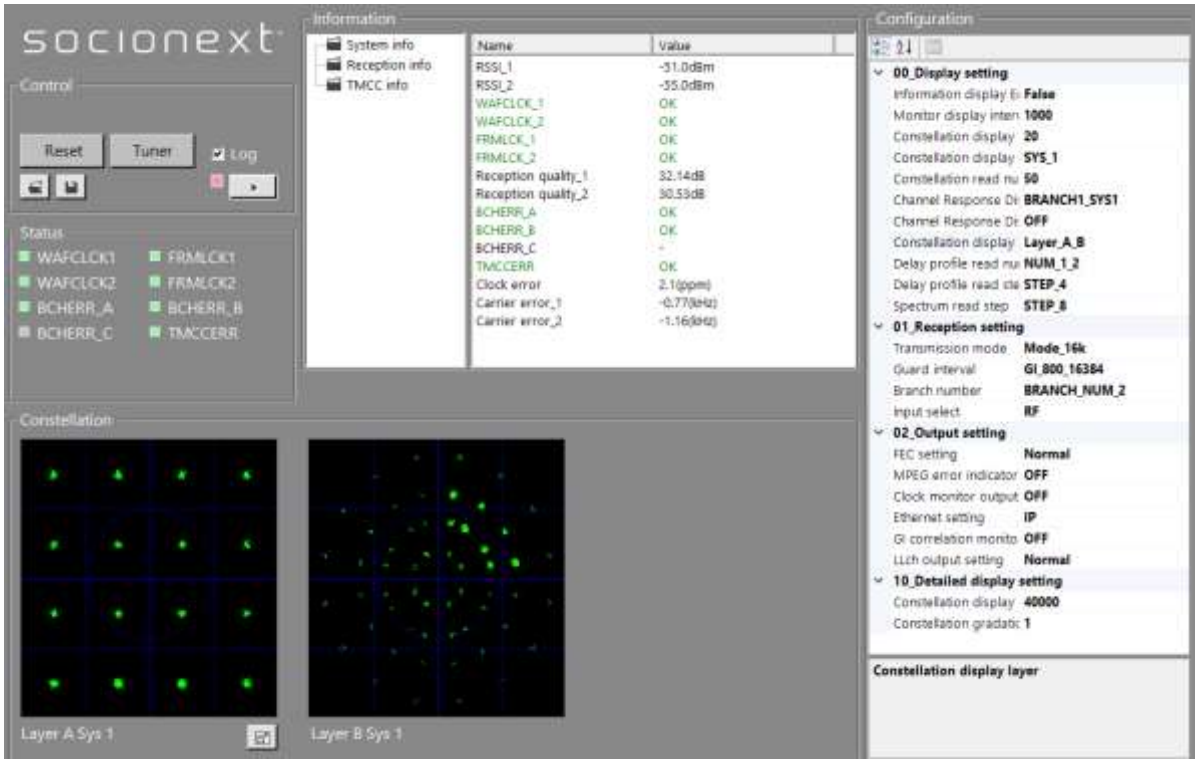


Figure 1.3 - Socionext Screen

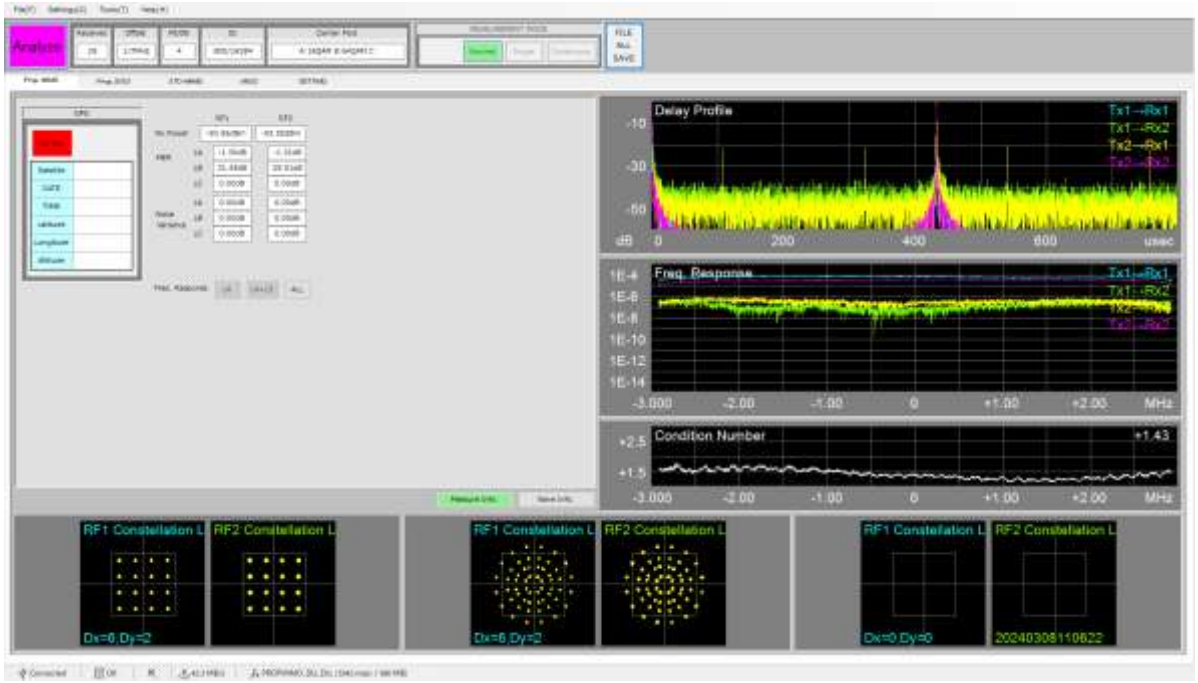


Figure 1.4 - Rintaro Screen

b) AWGN Power

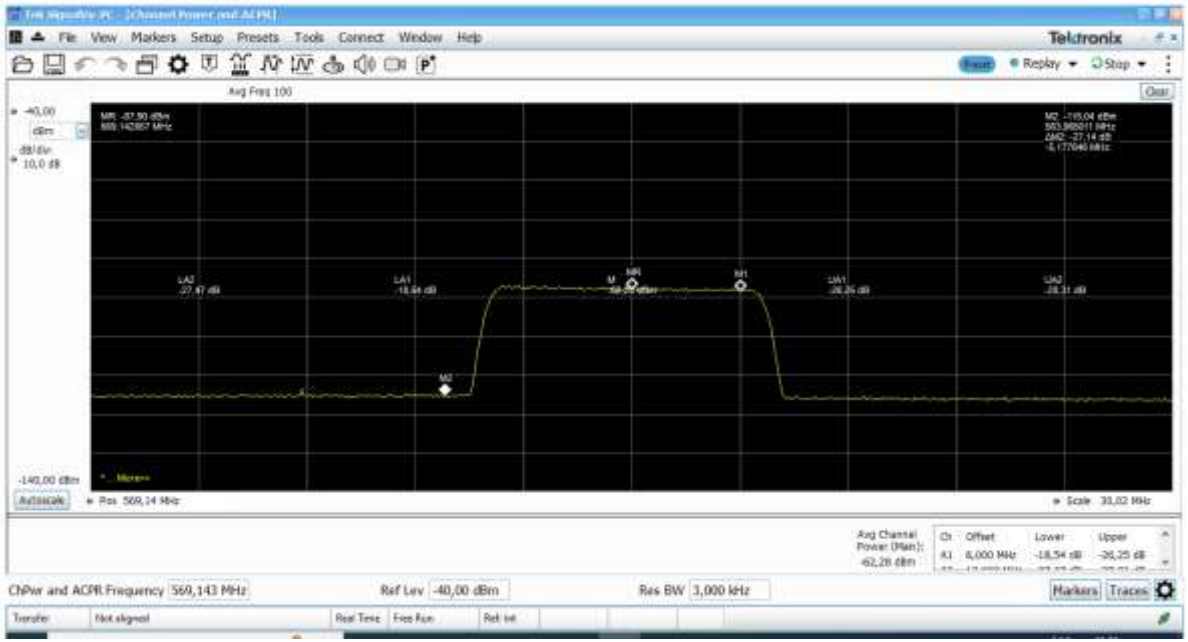


Figure 1.5 - Vertical

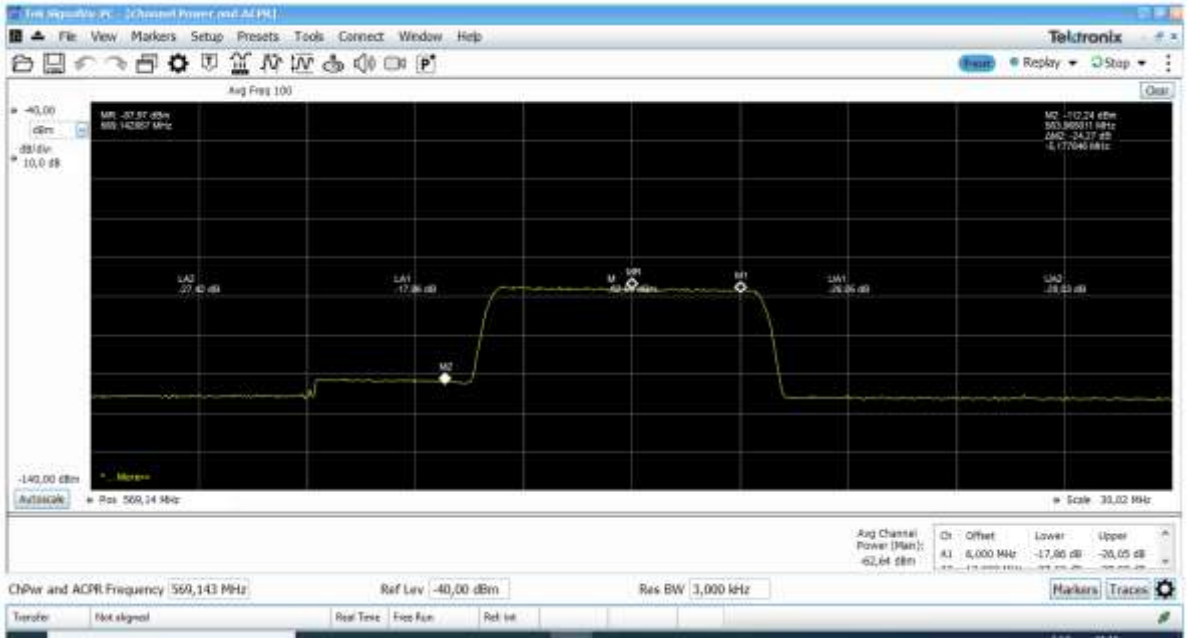


Figure 1.6 - Horizontal

c) C/N Threshold

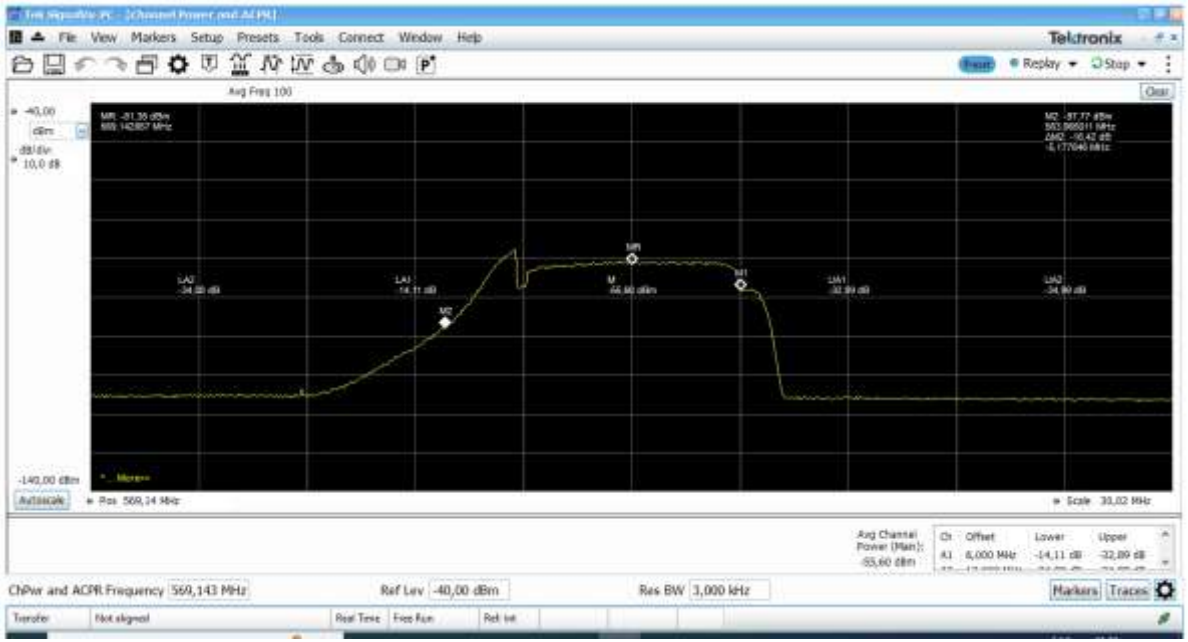


Figure 1.7 - Vertical

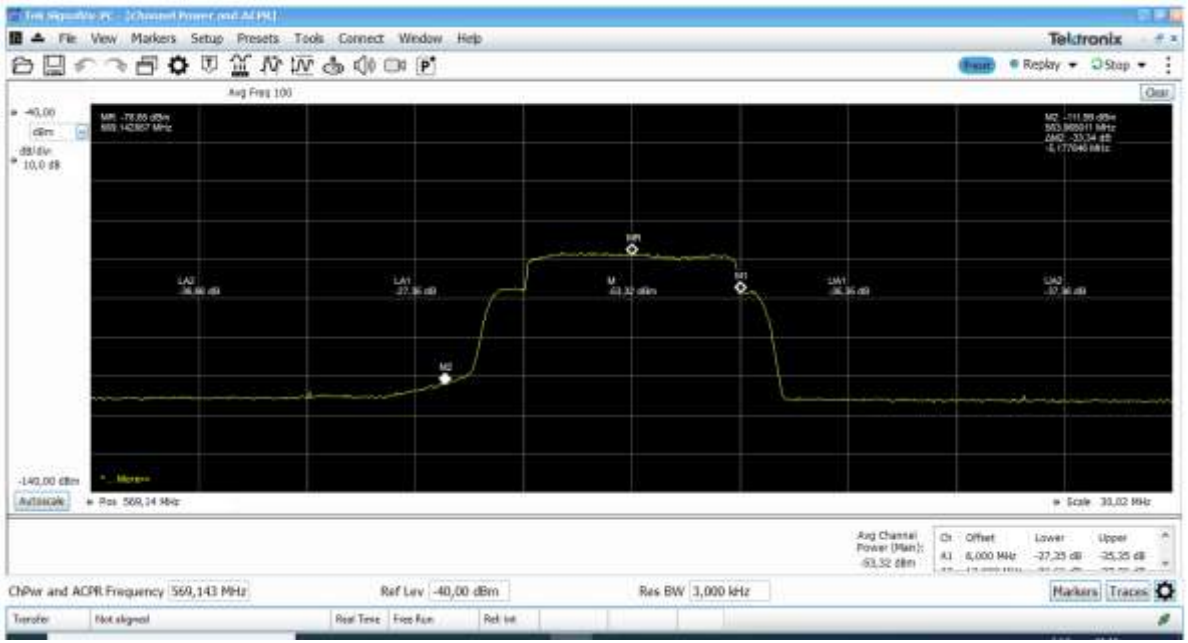


Figure 1.8 - Horizontal

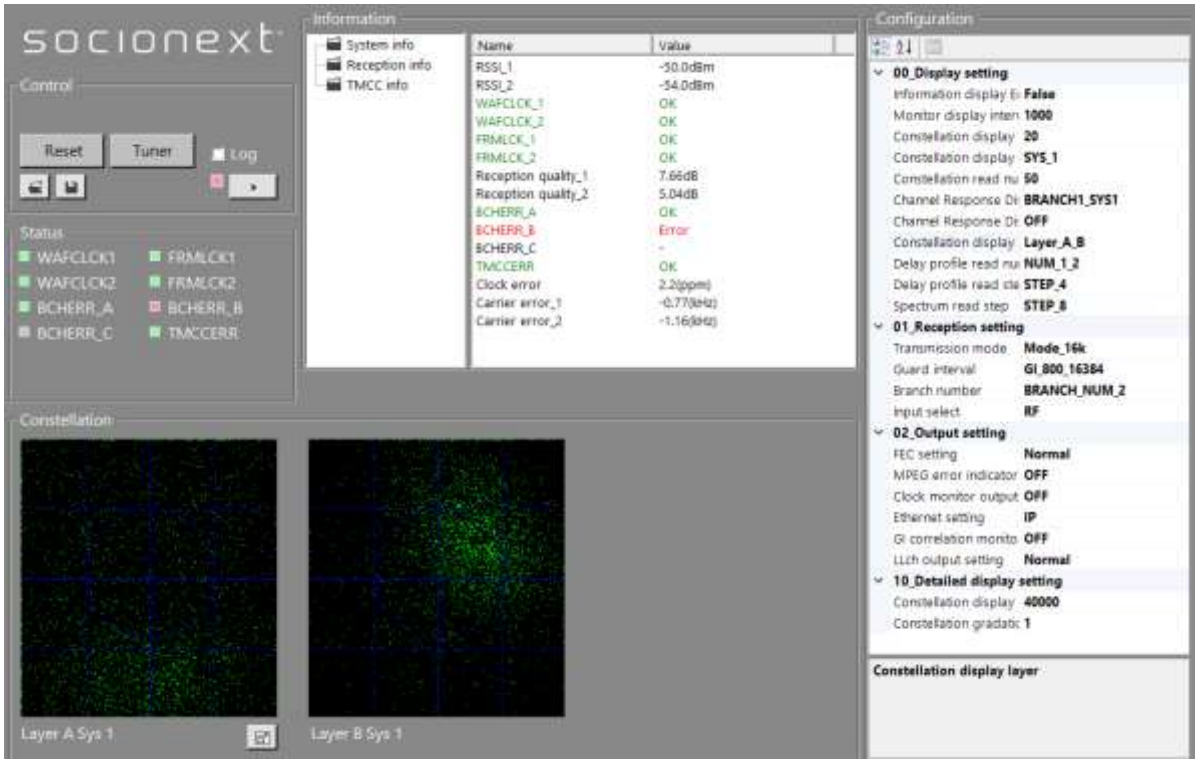


Figure 1.9 - Socionext Screen

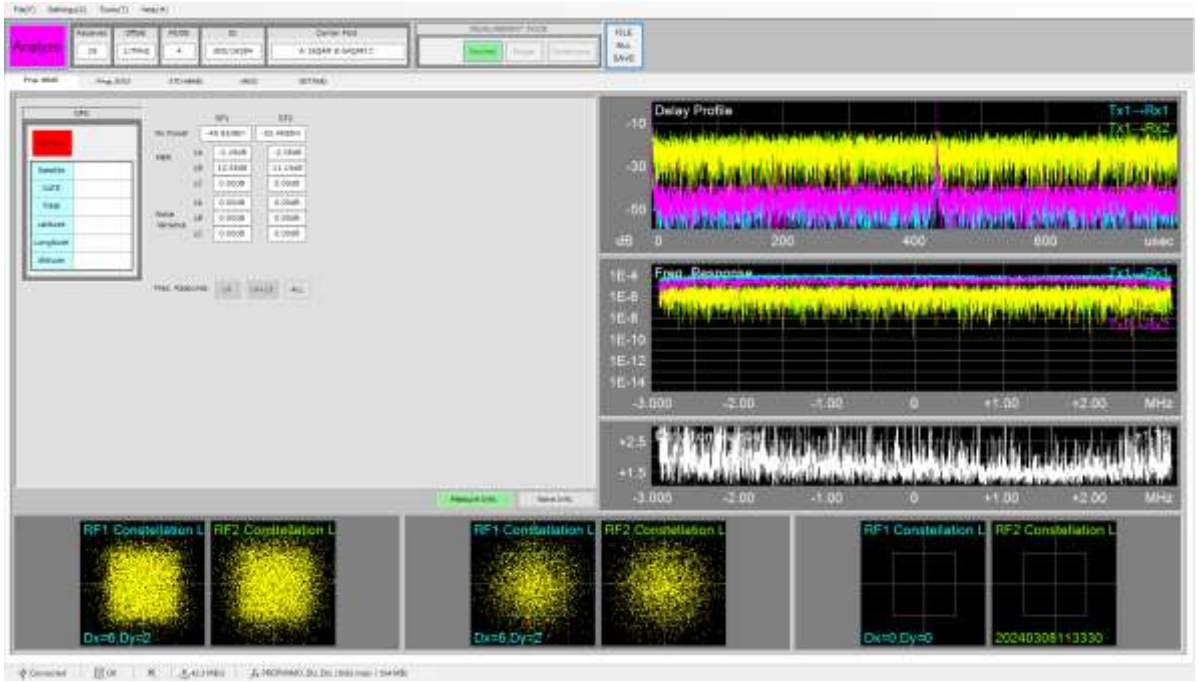


Figure 1.10 - Rintaro Screen

d) Reception Threshold

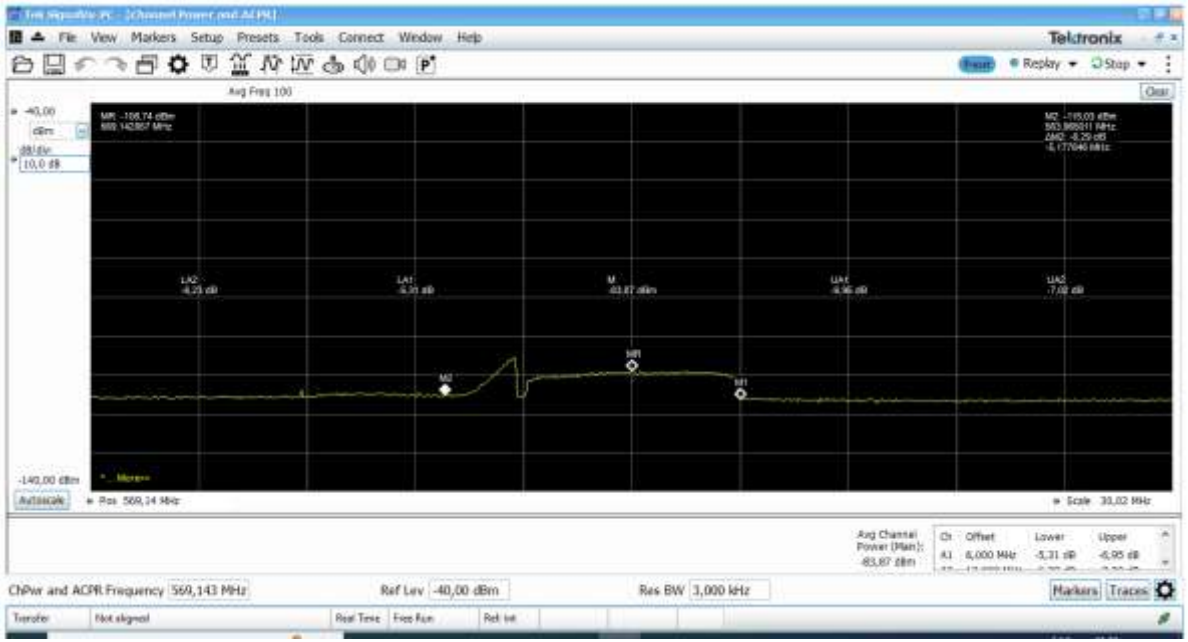


Figure 1.11 - Vertical

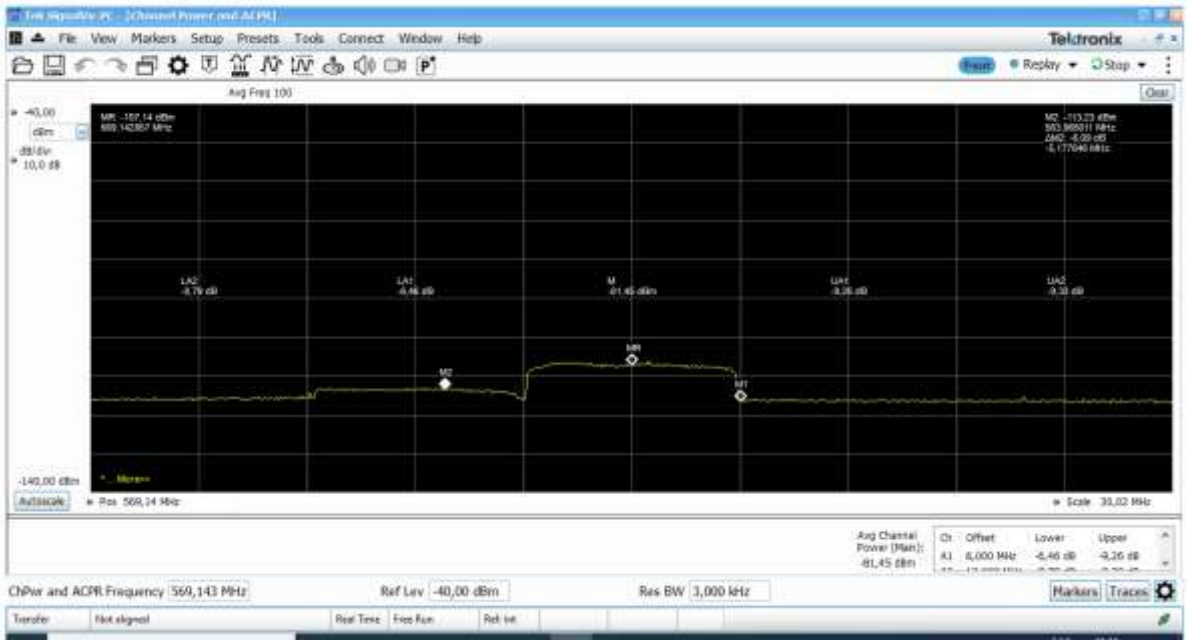


Figure 1.12 - Horizontal

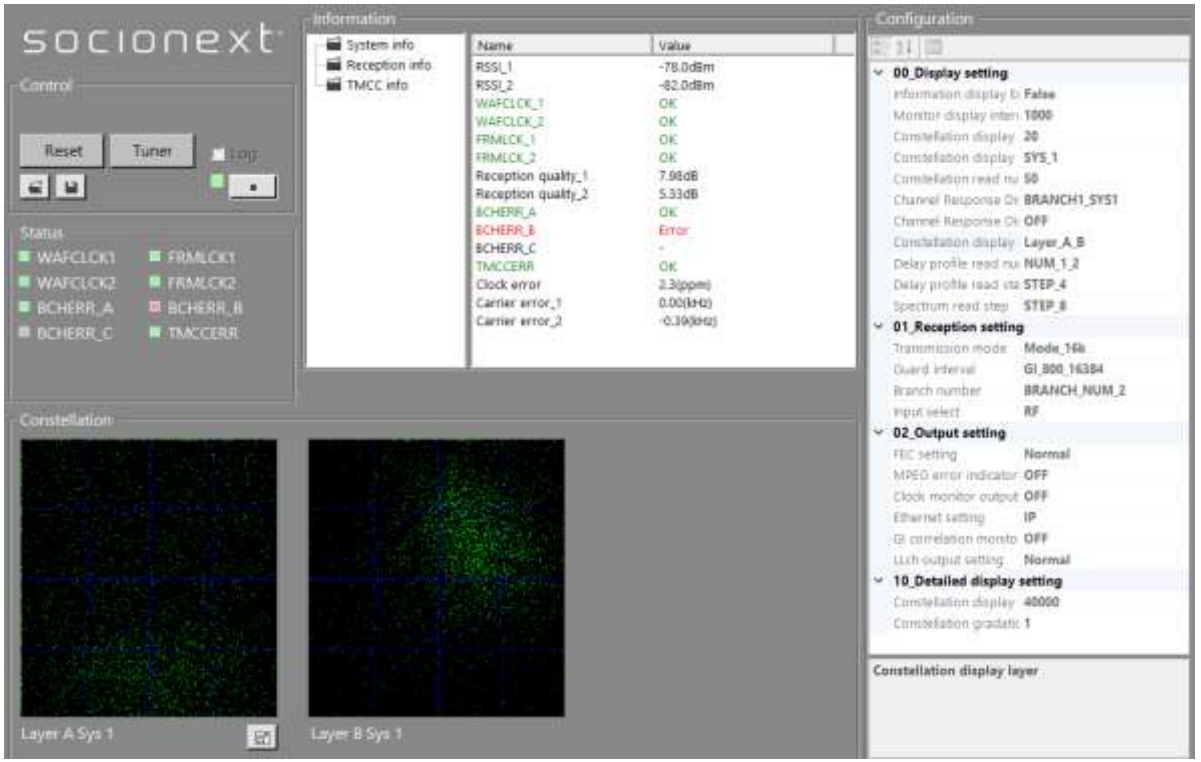


Figure 1.13 - Socionext Screen

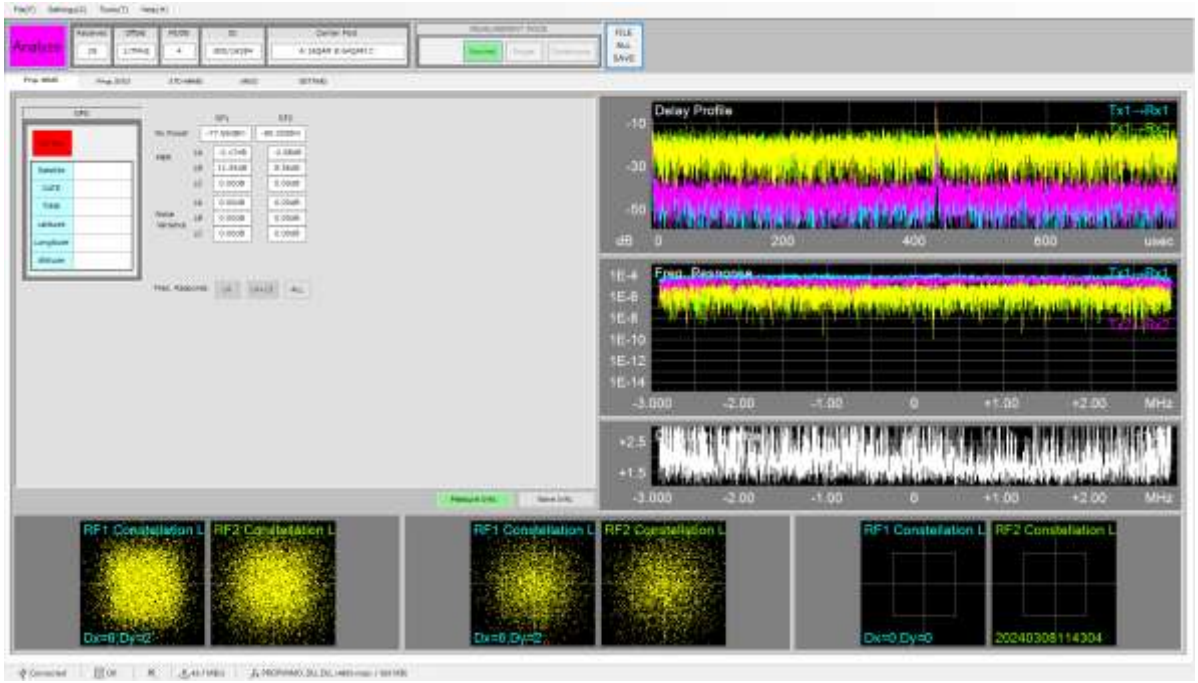


Figure 1.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

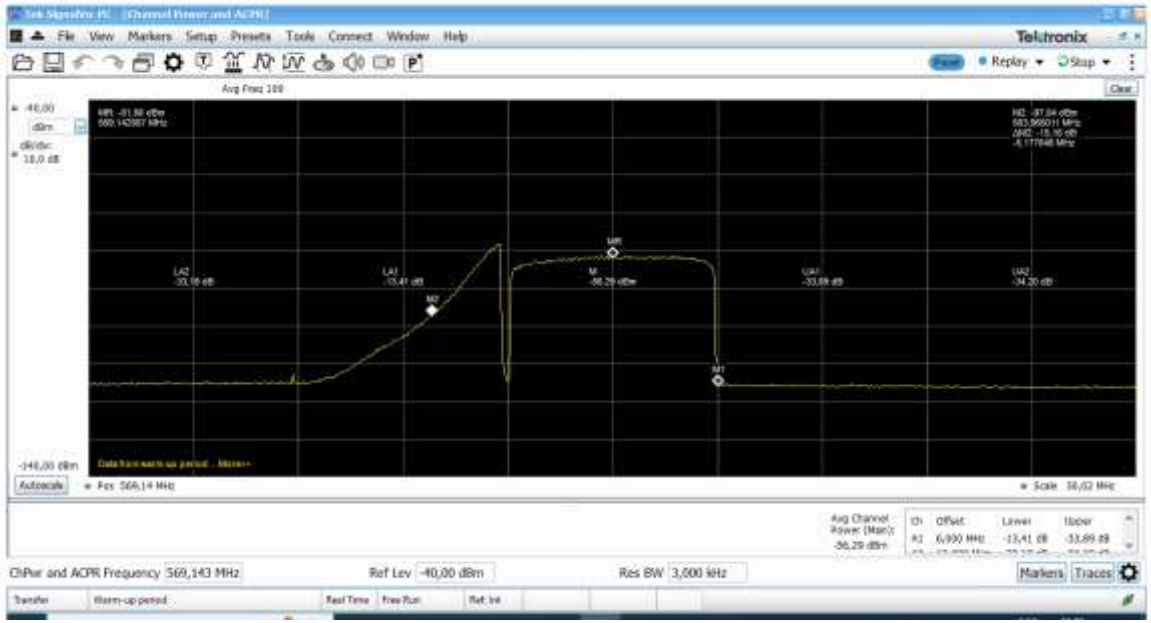


Figure 1.15 - Vertical

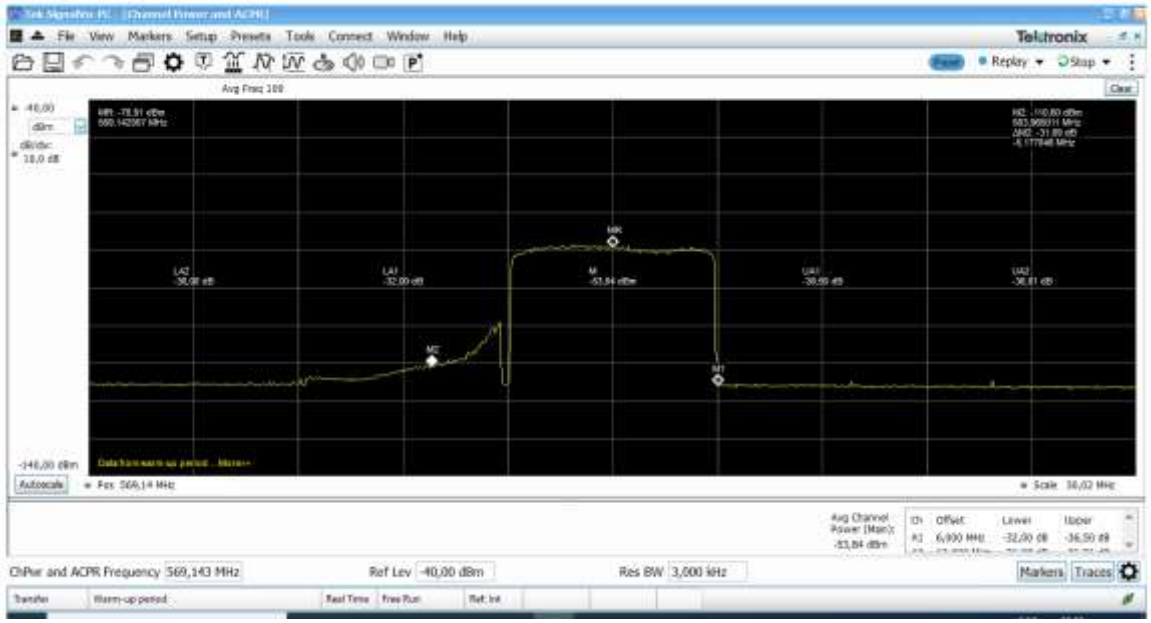


Figure 1.16 - Horizontal

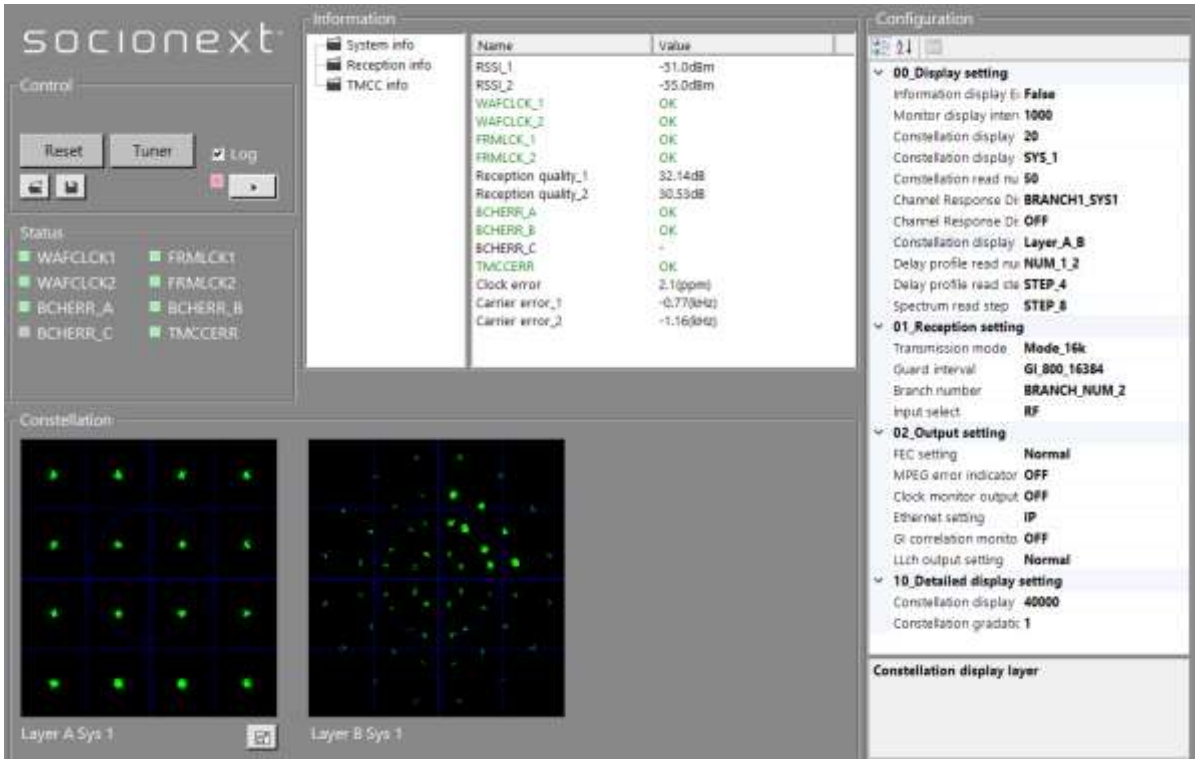


Figure 1.17 - Socionext Screen

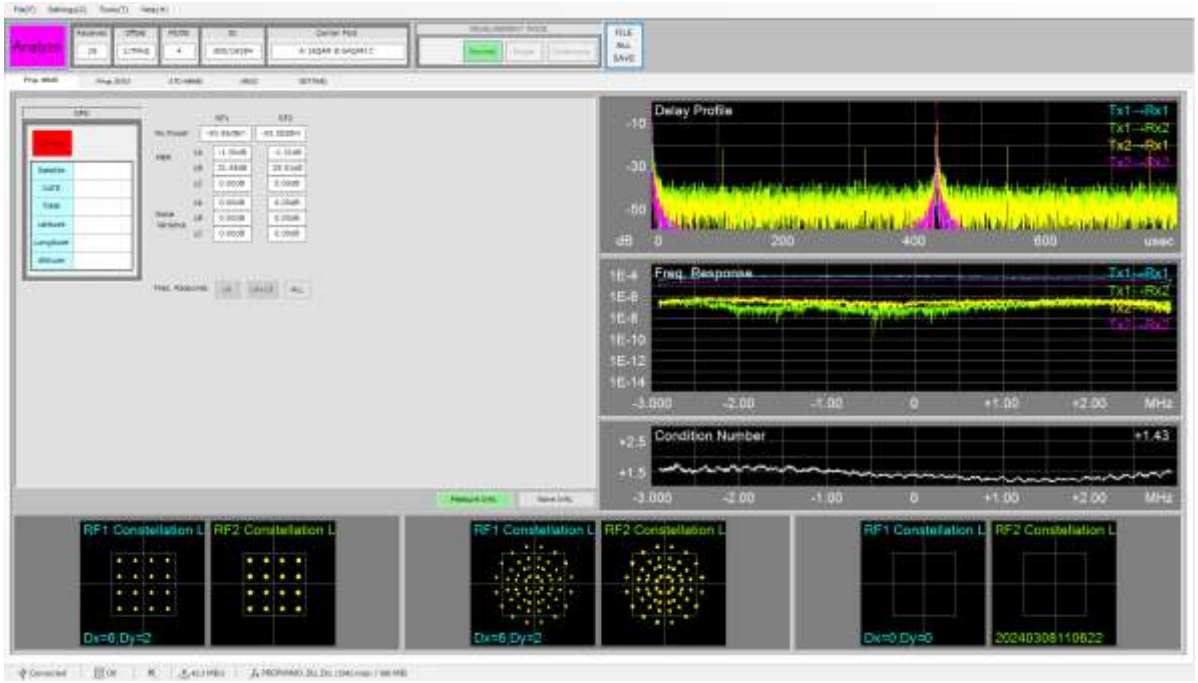


Figure 1.18 - Rintaro Screen

b) AWGN Power

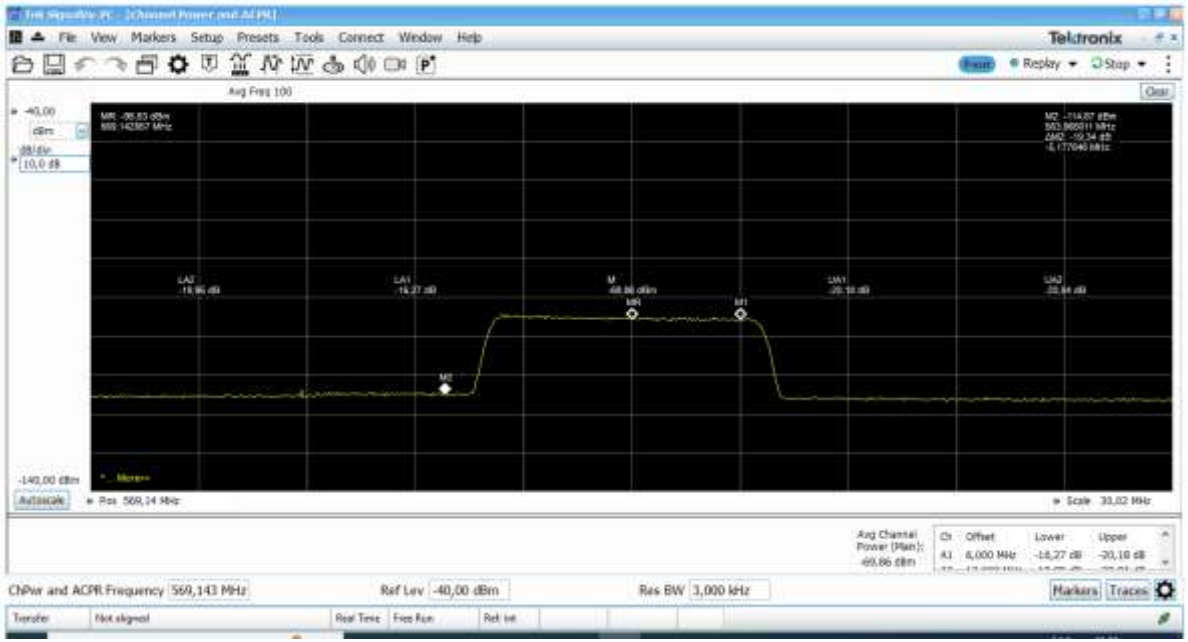


Figure 1.19 - Vertical

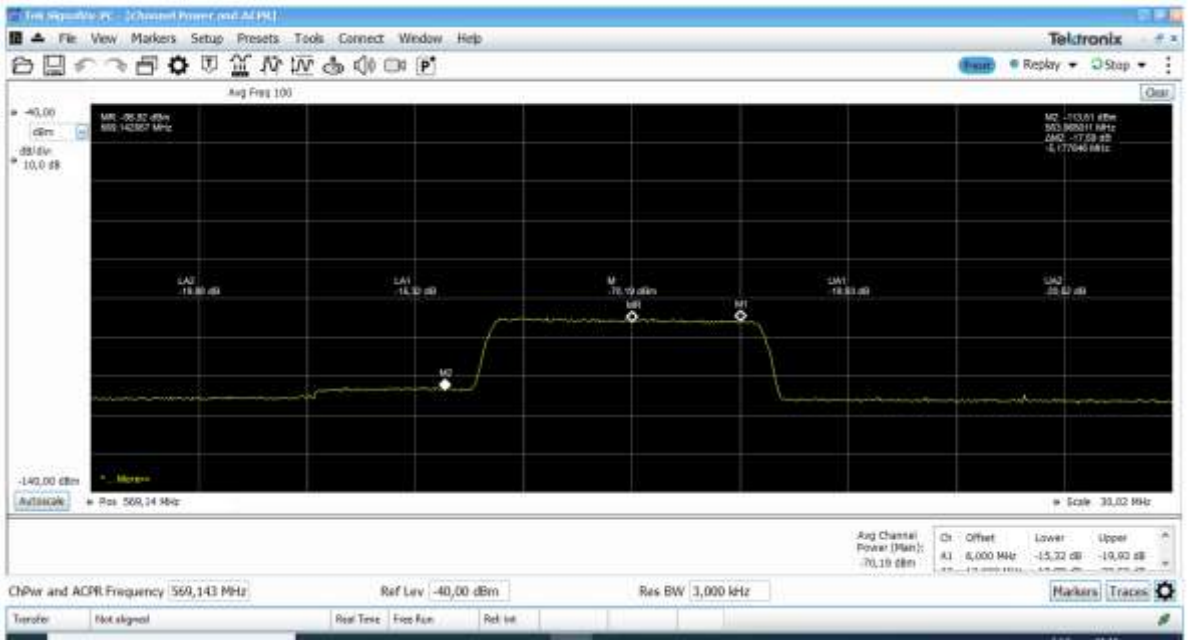


Figure 1.20 - Horizontal

c) C/N Threshold

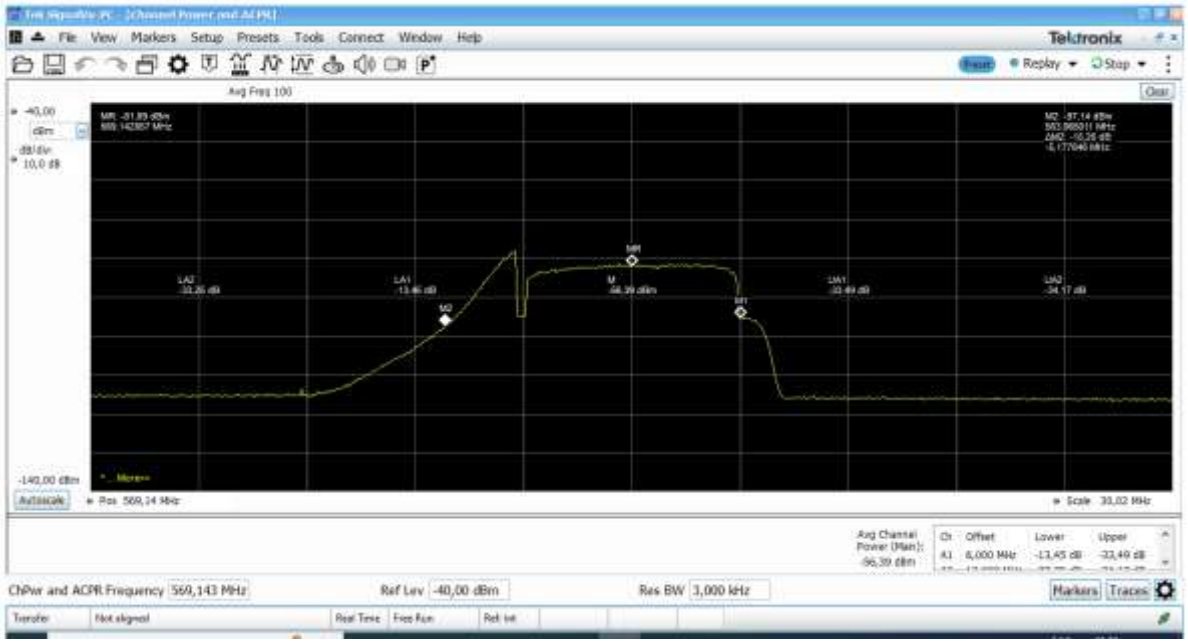


Figure 1.21 - Vertical

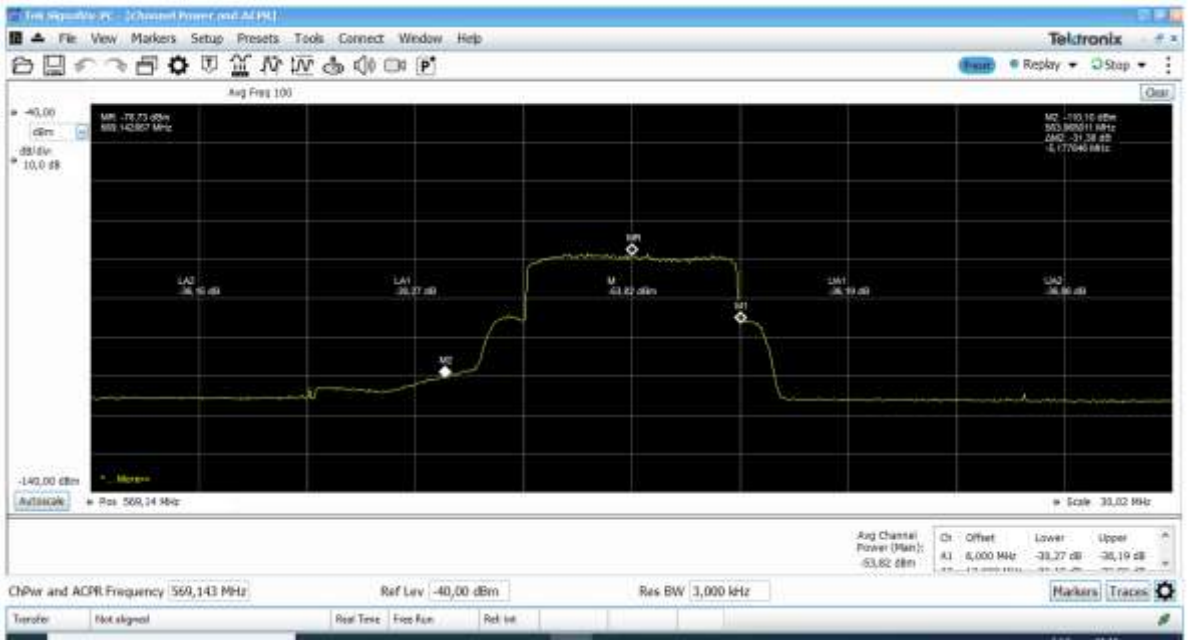


Figure 1.22 - Horizontal

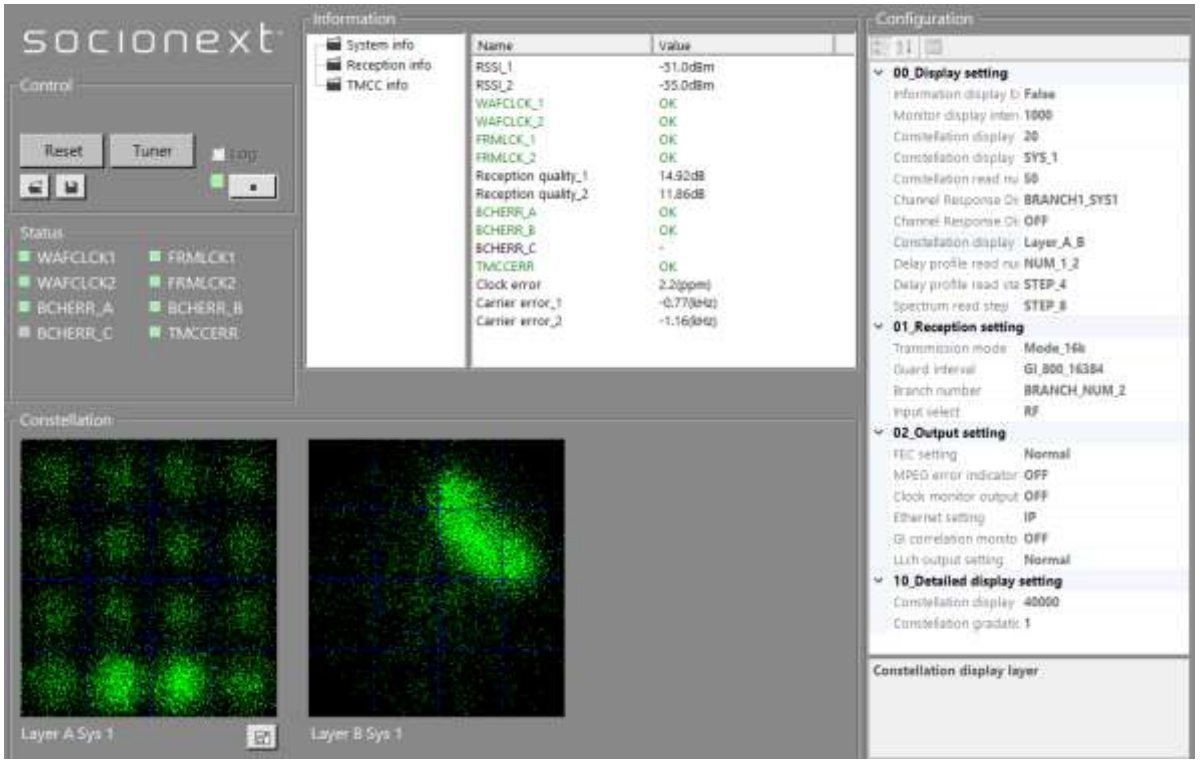


Figure 1.23 - Socionext Screen

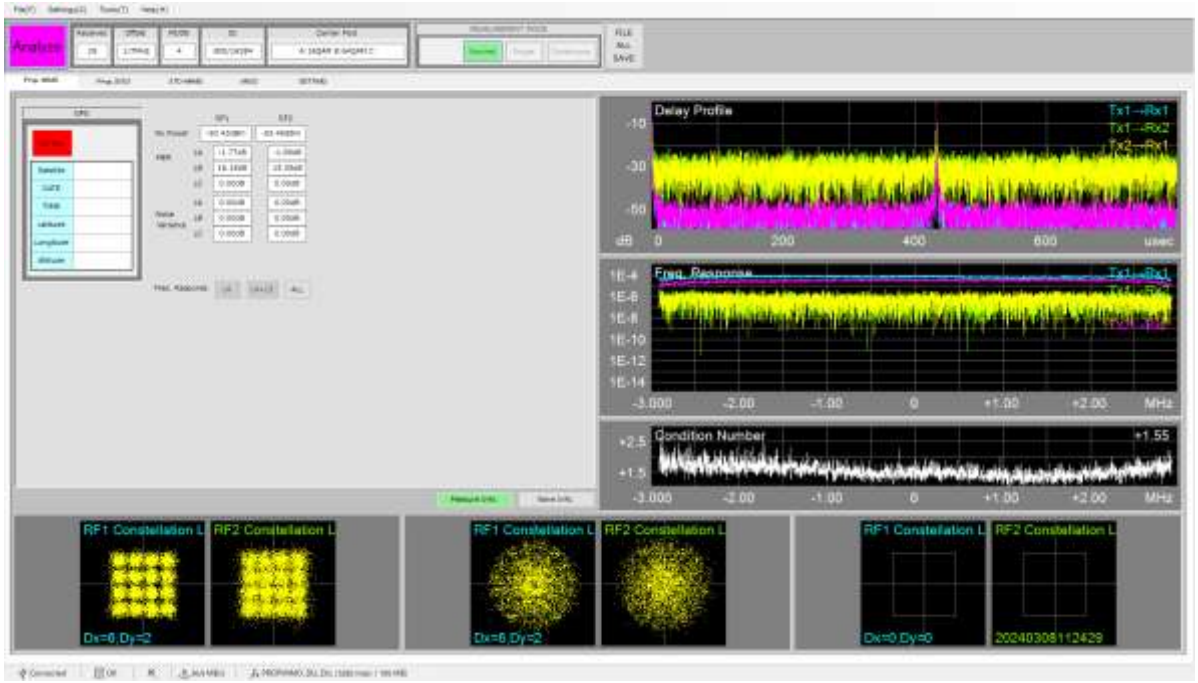


Figure 1.24 - Rintaro Screen

d) Reception Threshold

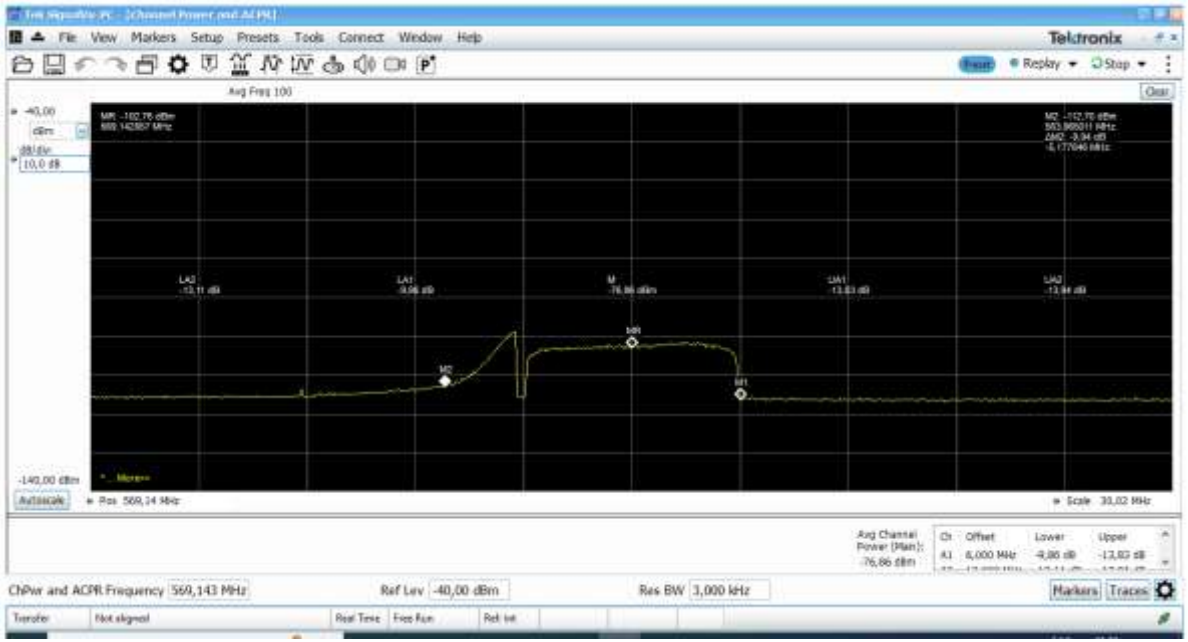


Figure 1.25 - Vertical

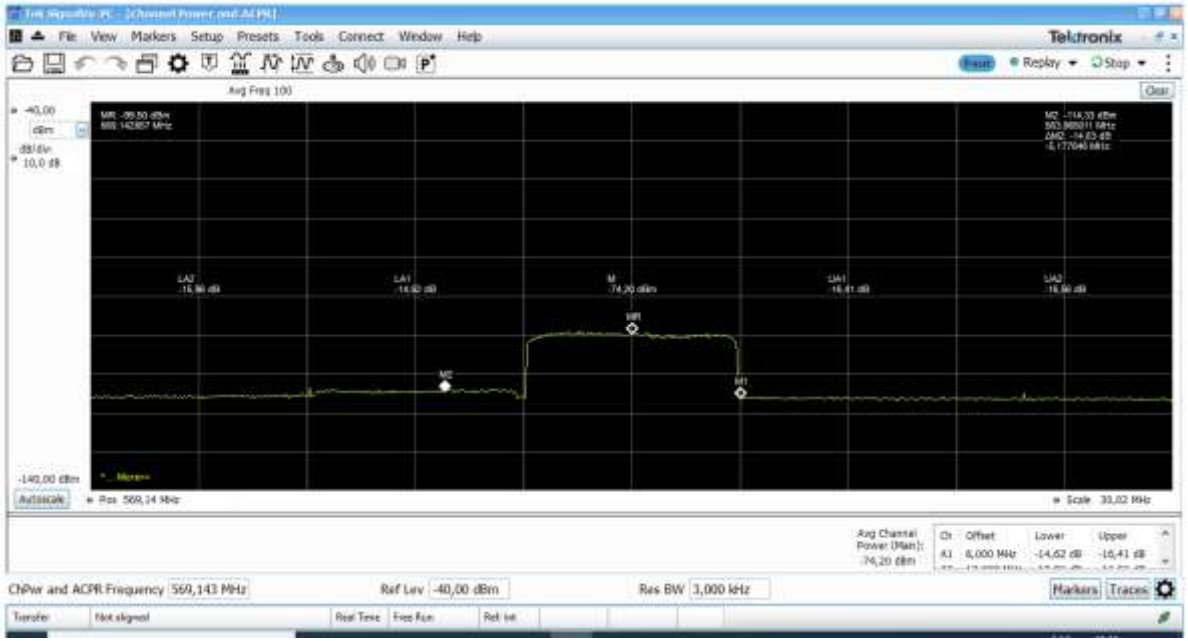


Figure 1.26 - Horizontal

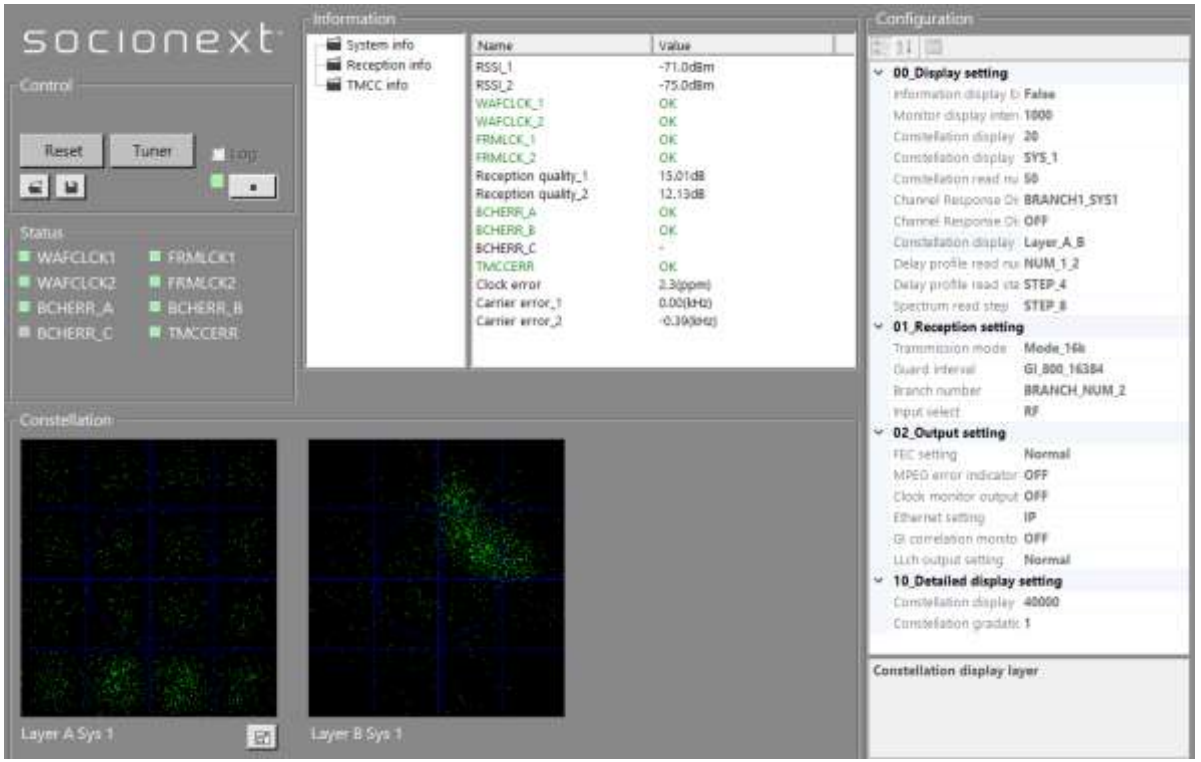


Figure 1.27 - Socionext Screen

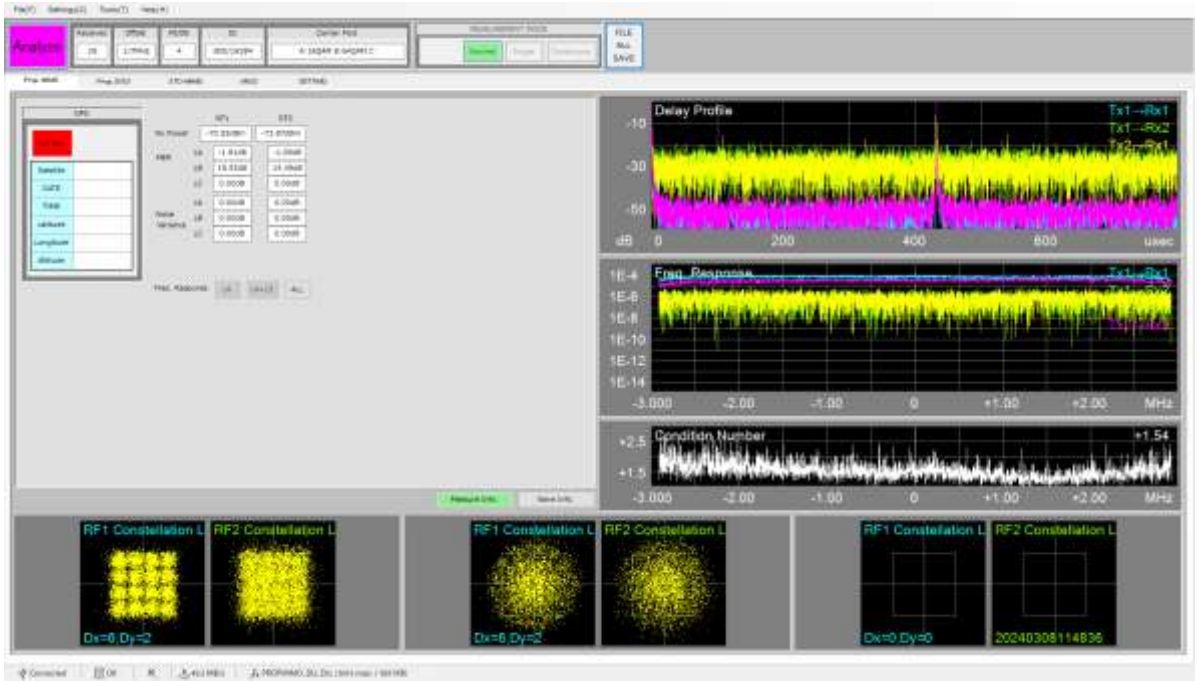


Figure 1.28 - Rintaro Screen

Chapter 2. Site 3

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

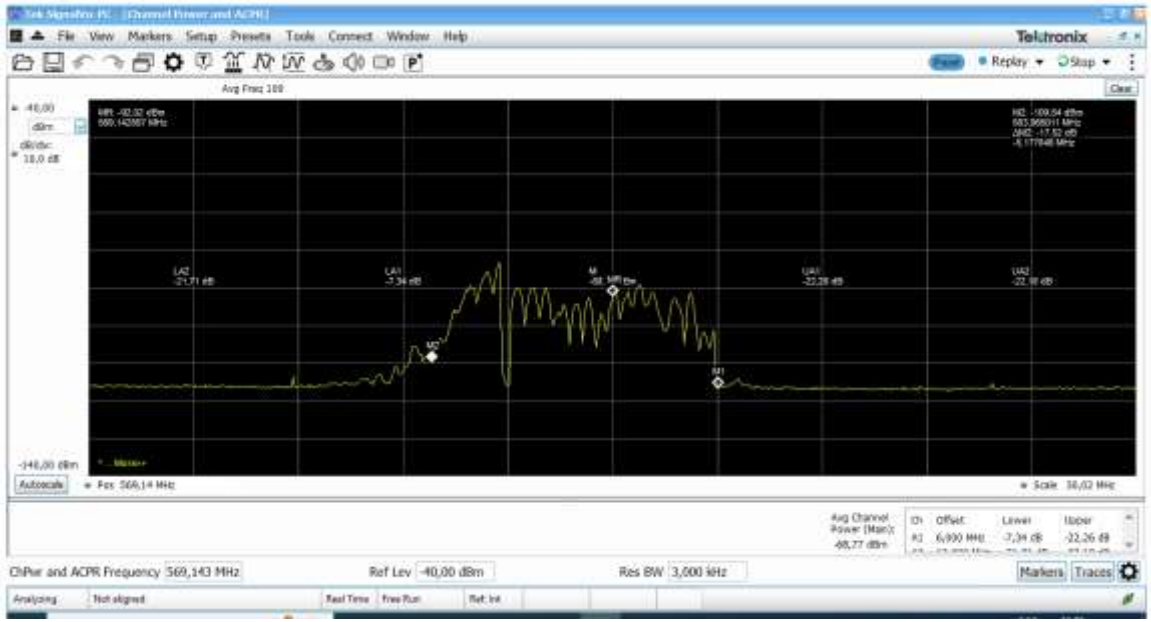


Figure 2.1 - Vertical

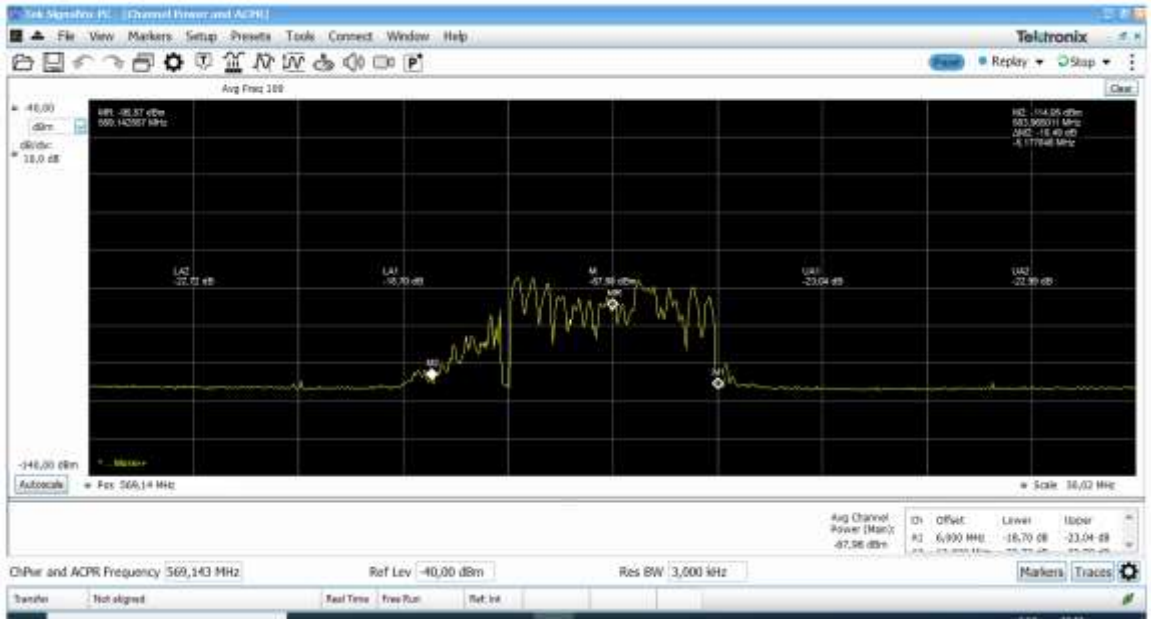


Figure 2.2 - Horizontal

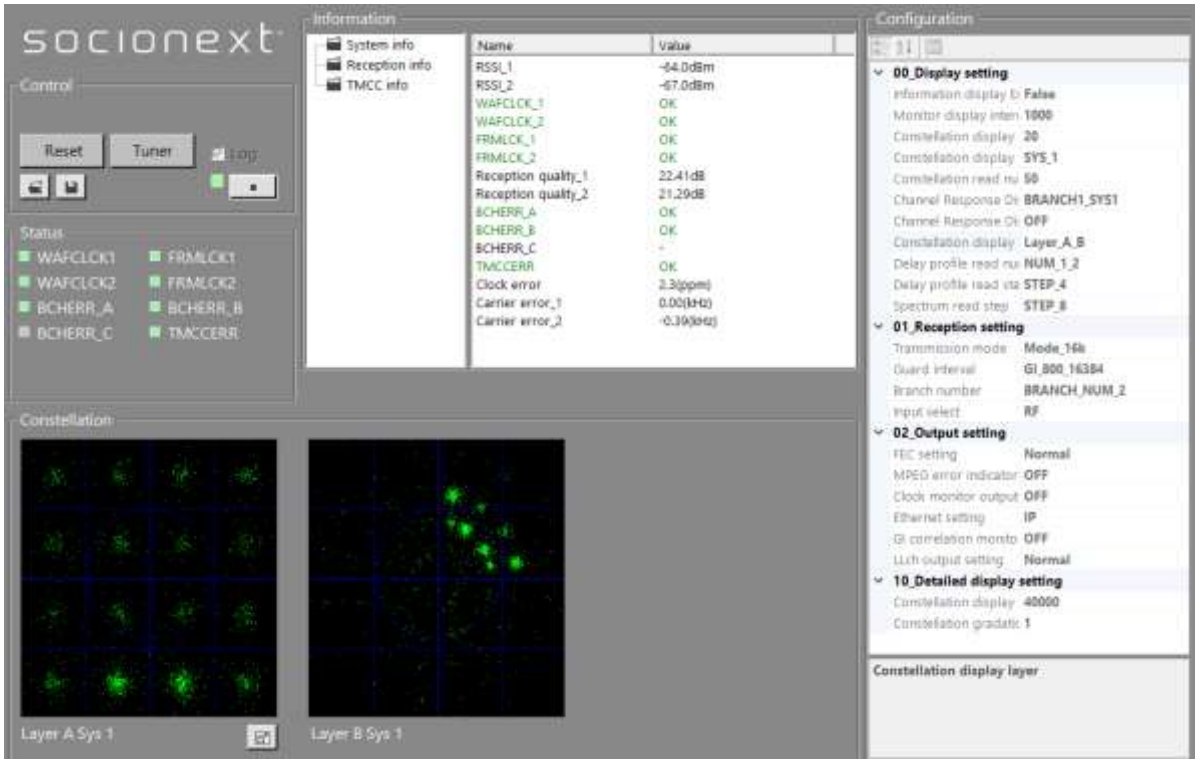


Figure 2.3 - Socionext Screen

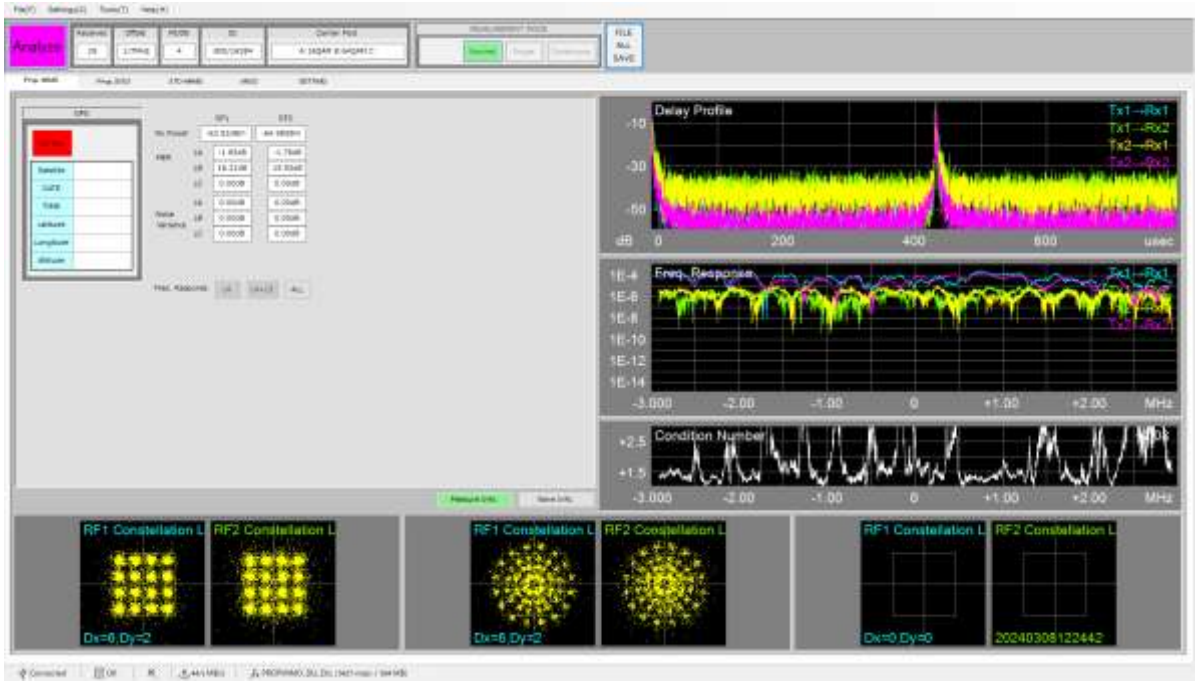


Figure 2.4 - Rintaro Screen

b) AWGN Power

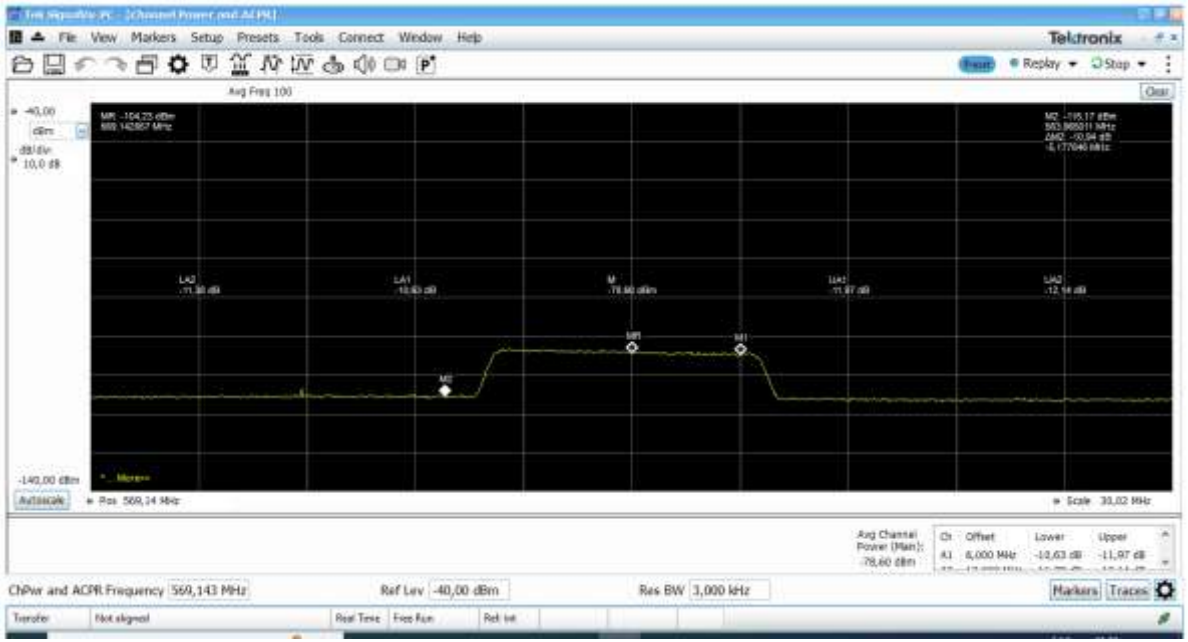


Figure 2.5 - Vertical

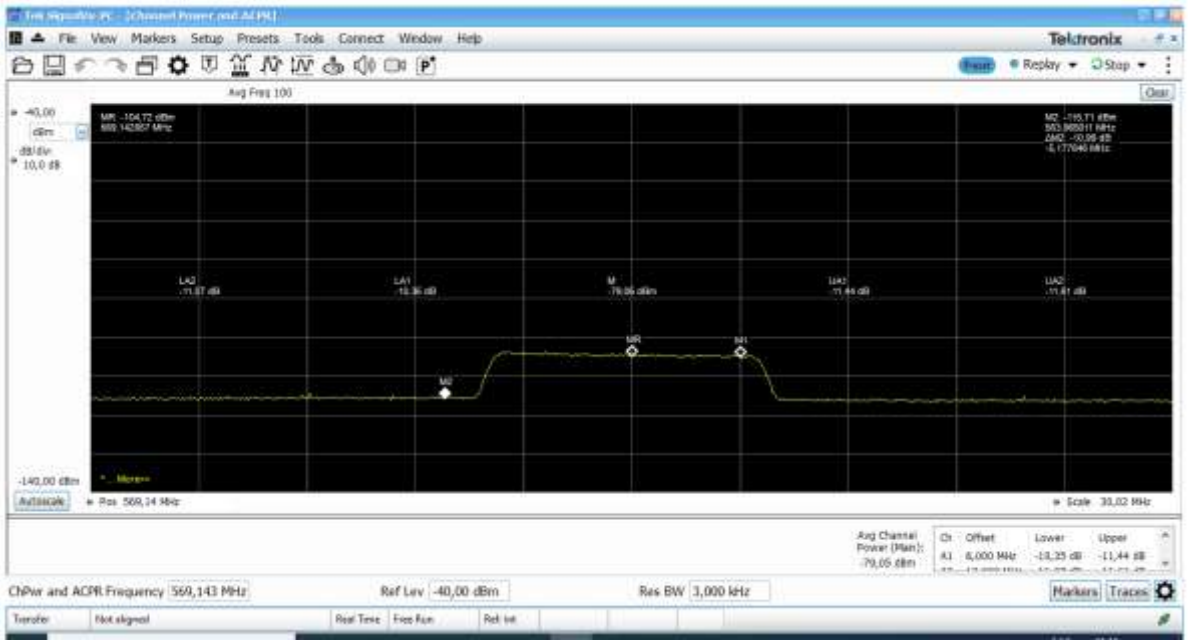


Figure 2.6 - Horizontal

c) C/N Threshold

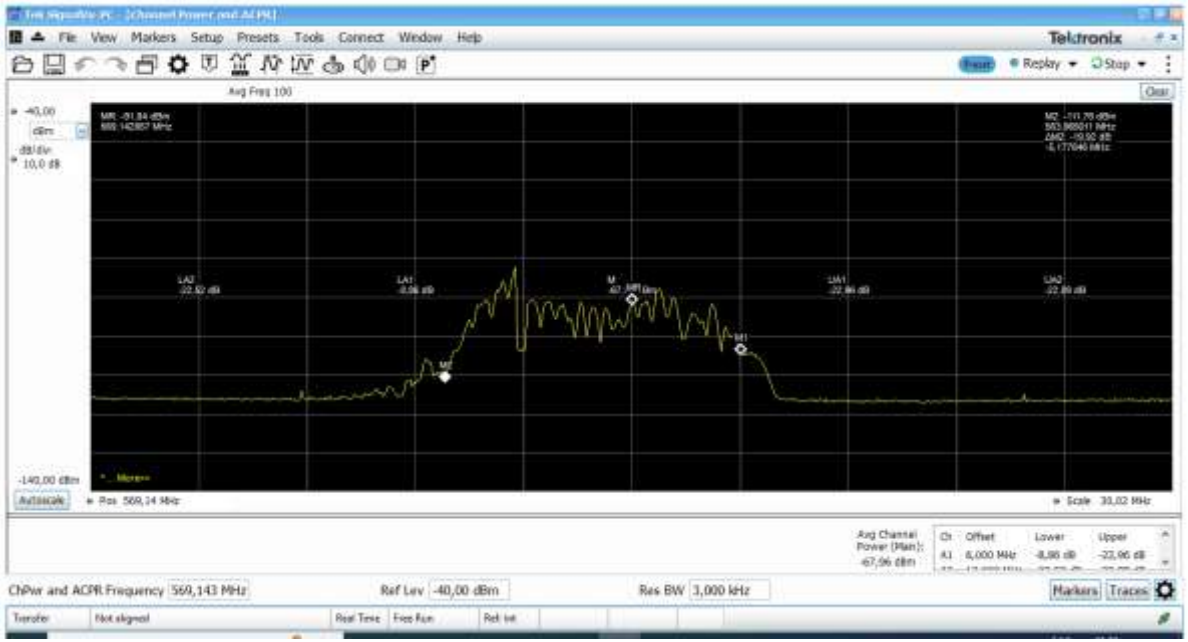


Figure 2.7 - Vertical

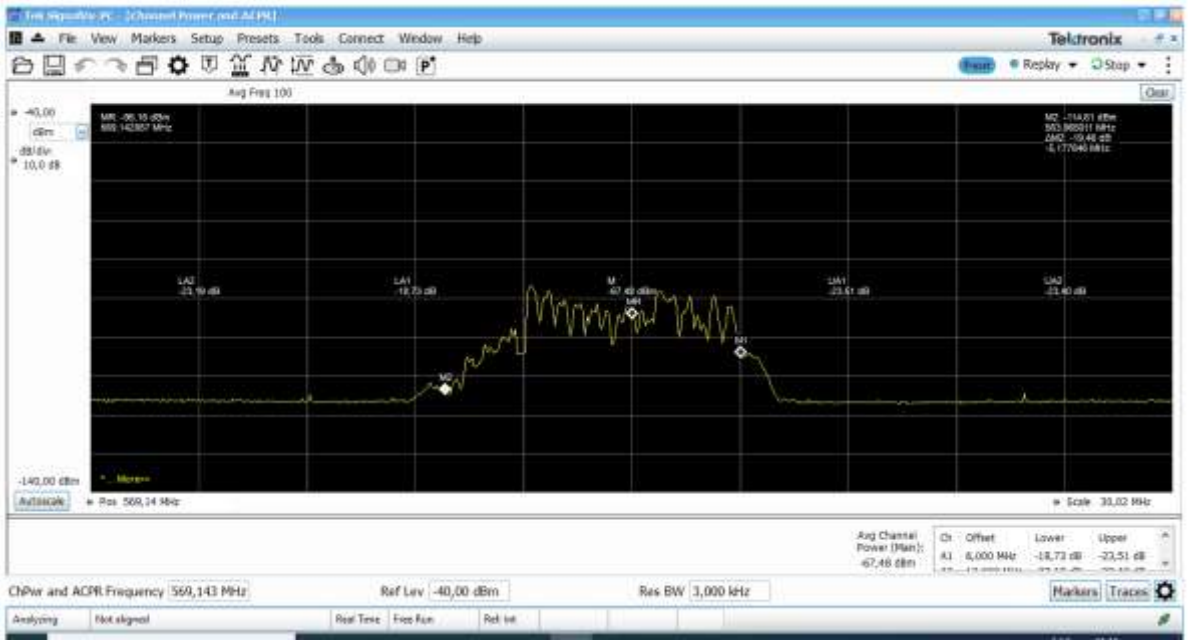


Figure 2.8 - Horizontal

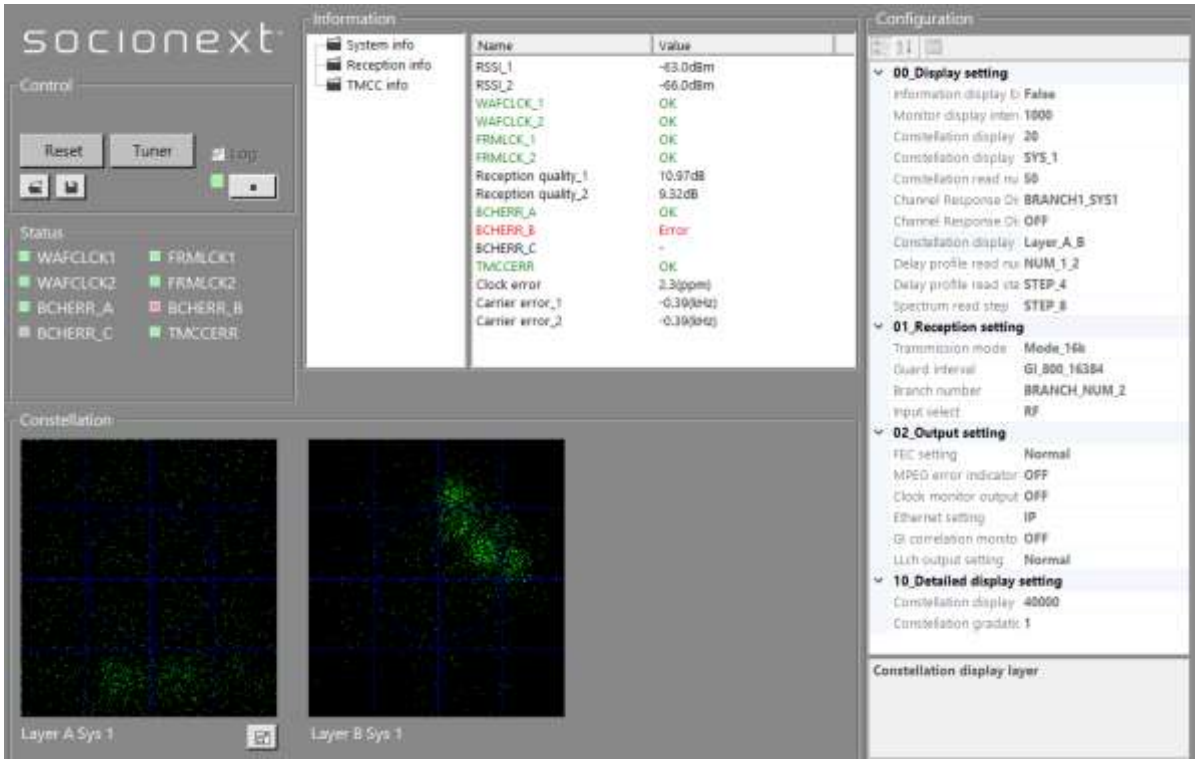


Figure 2.9 - Socionext Screen

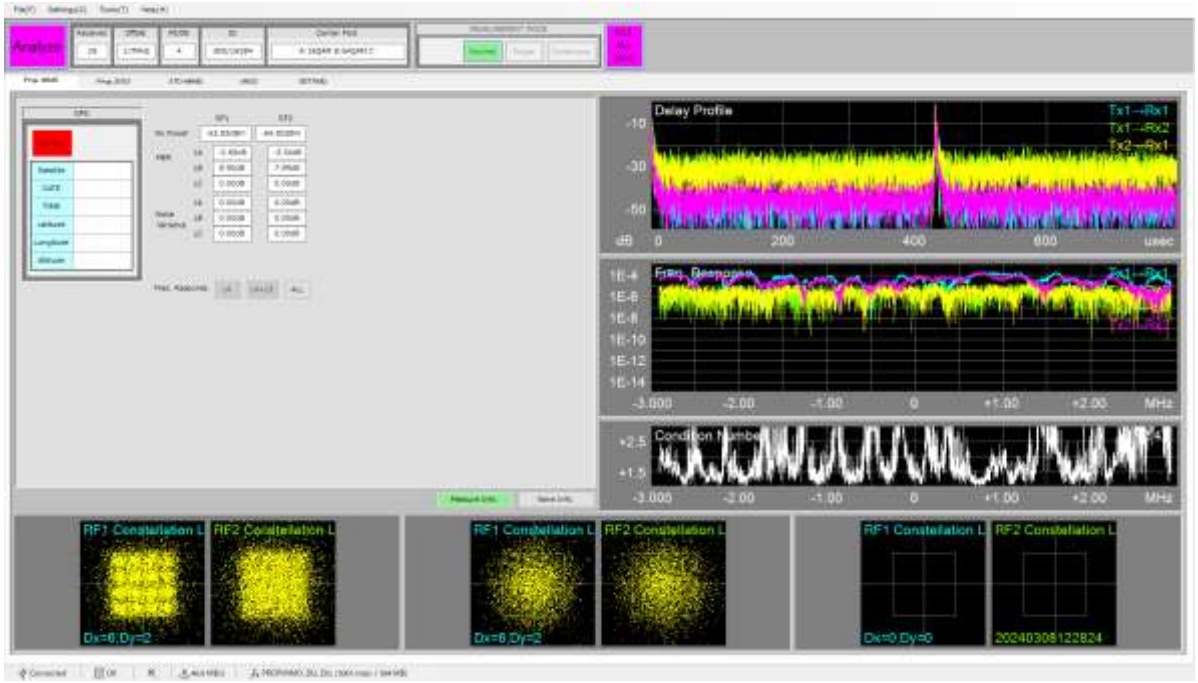


Figure 2.10 - Rintaro Screen

d) Reception Threshold

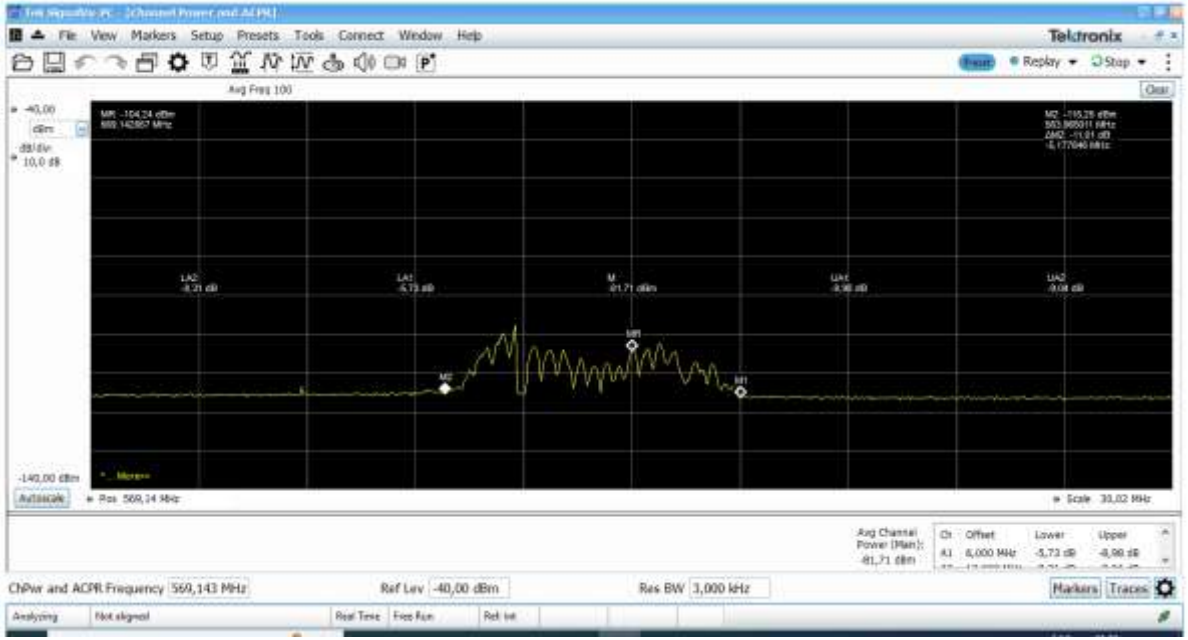


Figure 2.11 - Vertical

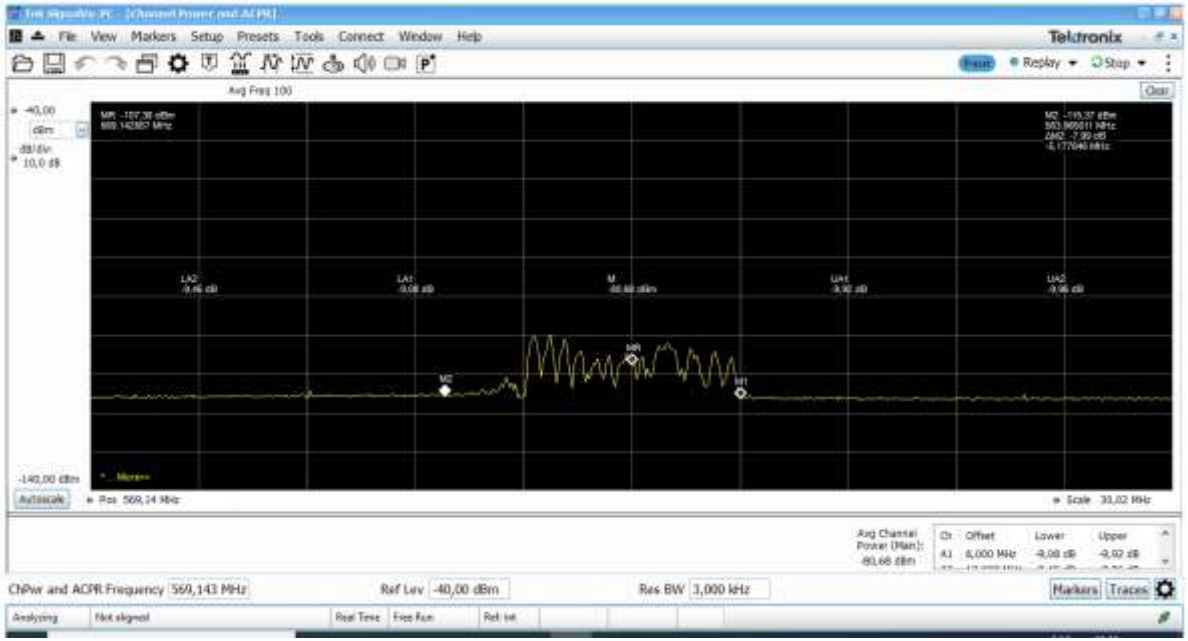


Figure 2.12 - Horizontal

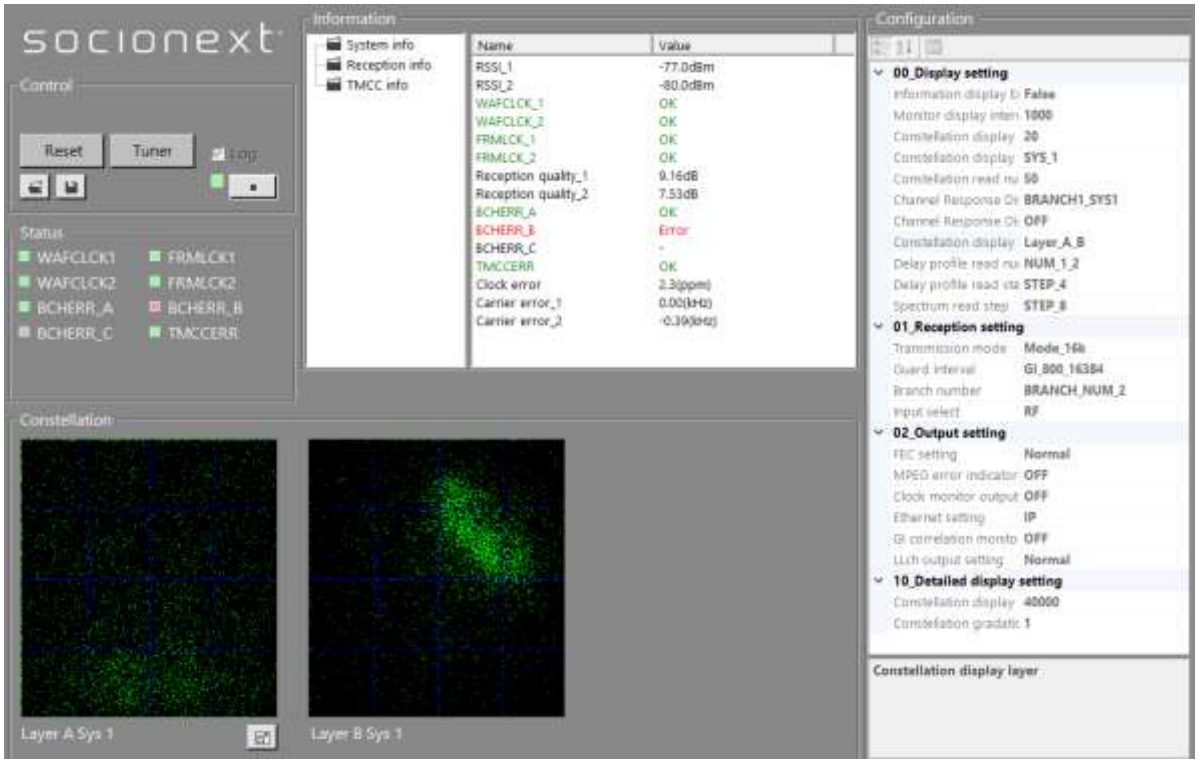


Figure 2.13 - Socionext Screen

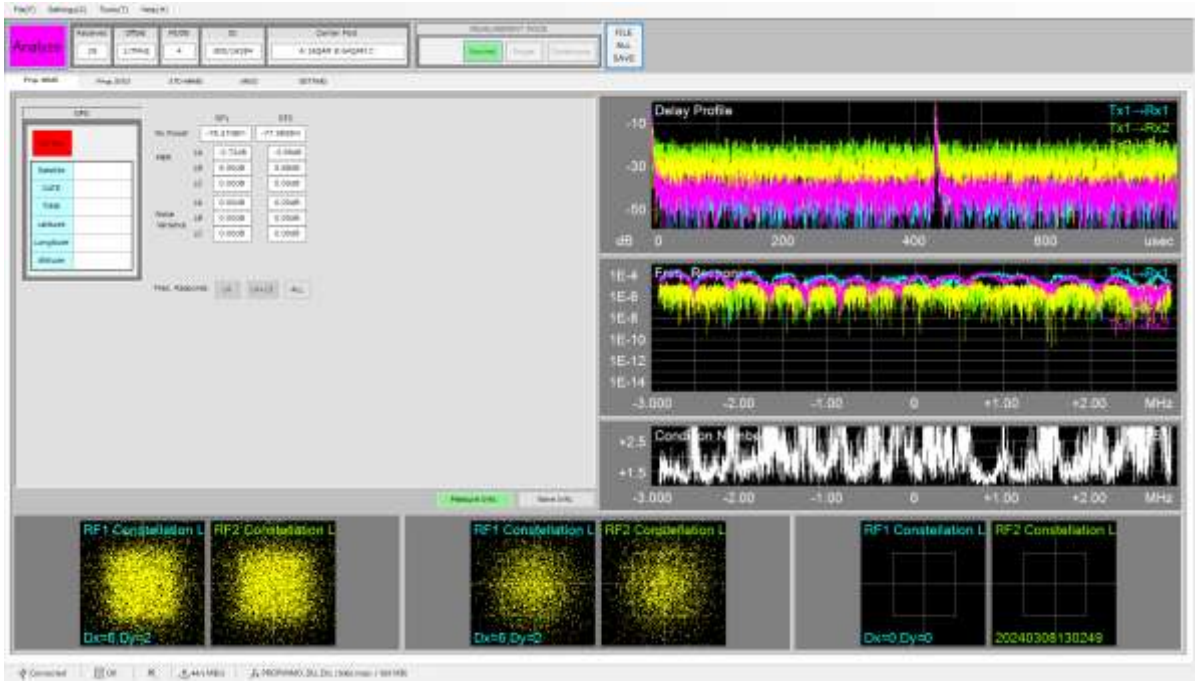


Figure 2.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

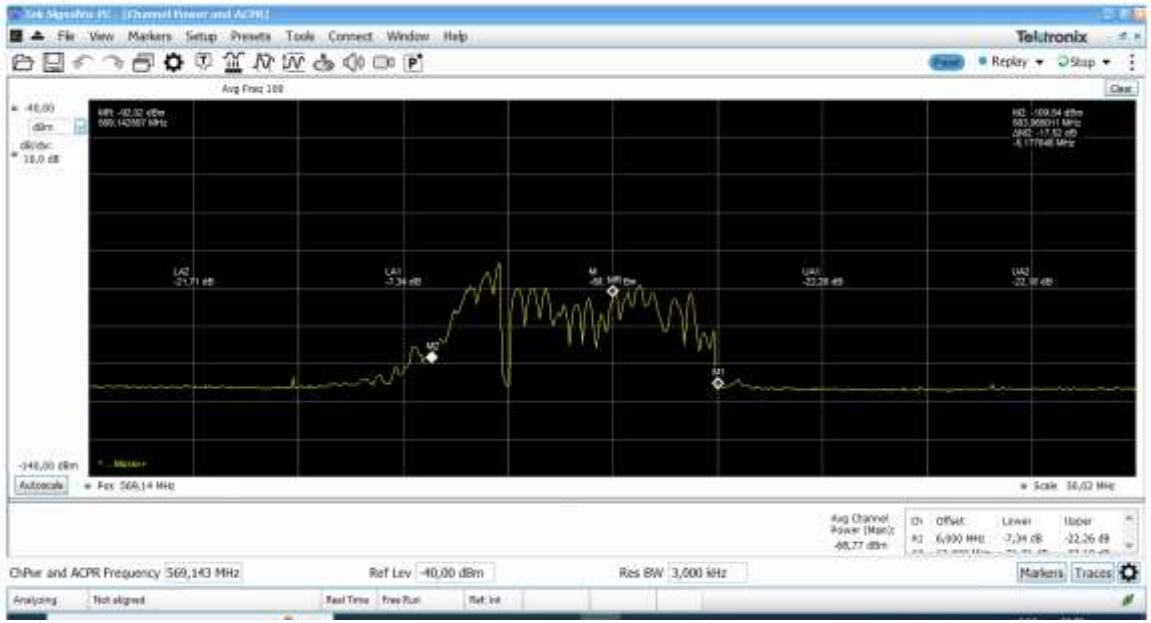


Figure 2.15 - Vertical

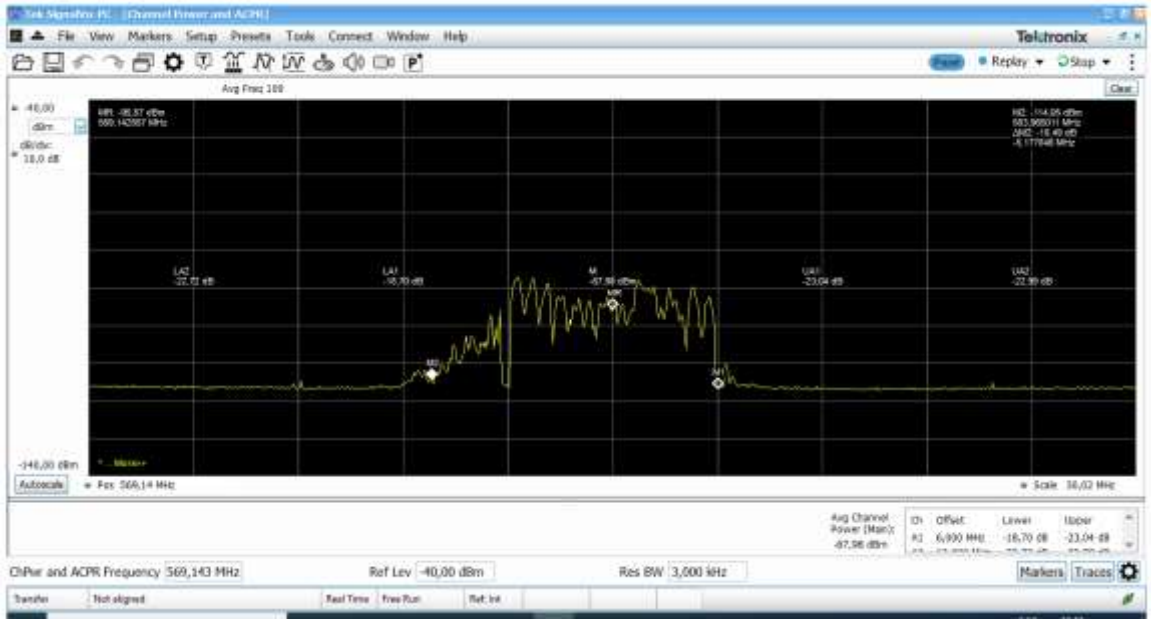


Figure 2.16 - Horizontal

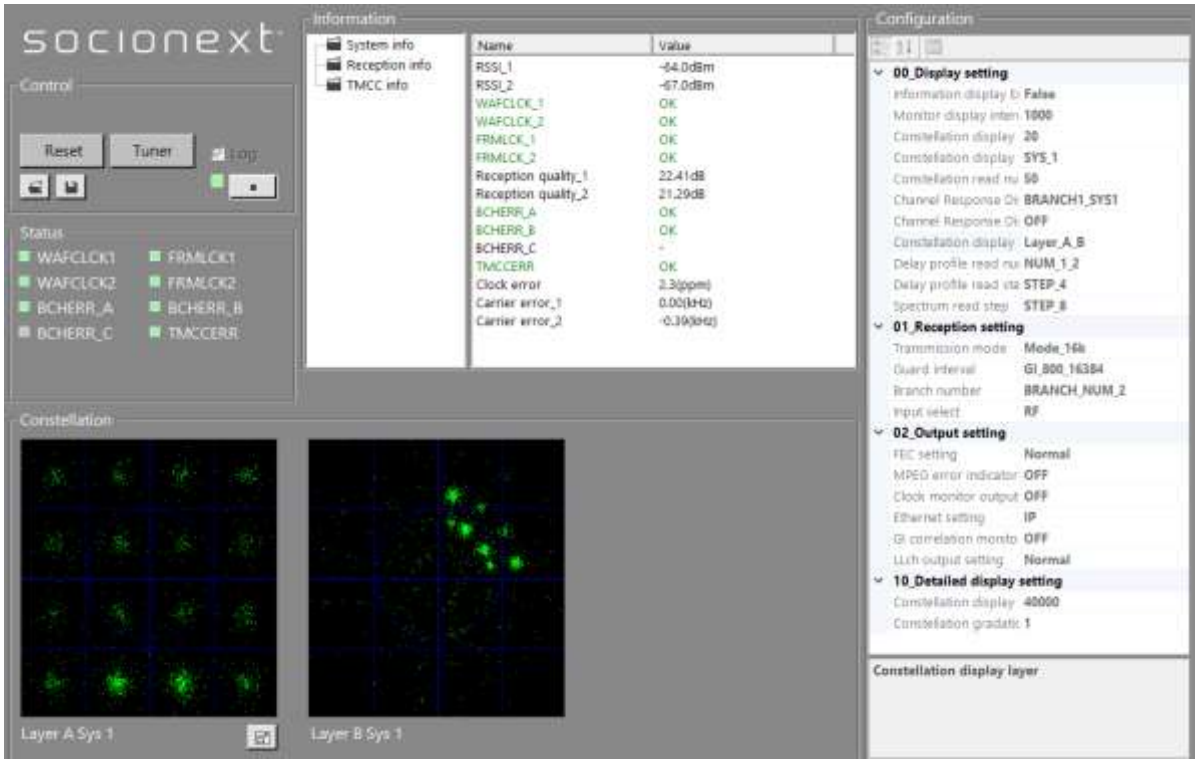


Figure 2.17 - Socionext Screen

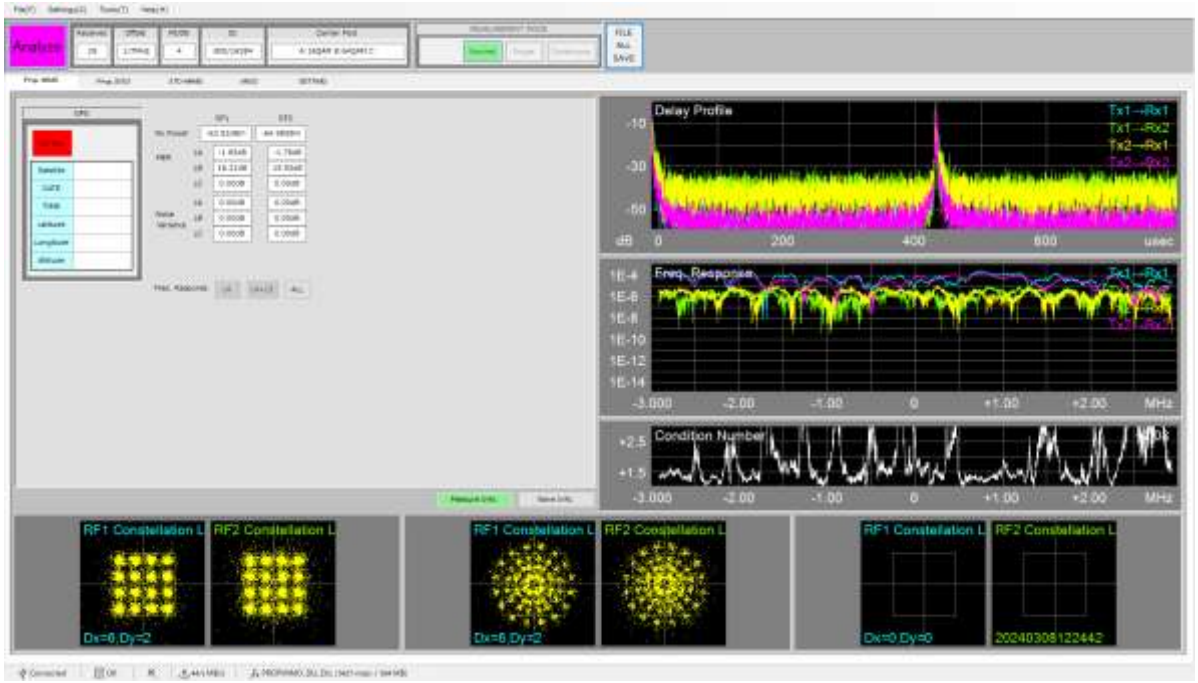


Figure 2.18 - Rintaro Screen

b) AWGN Power

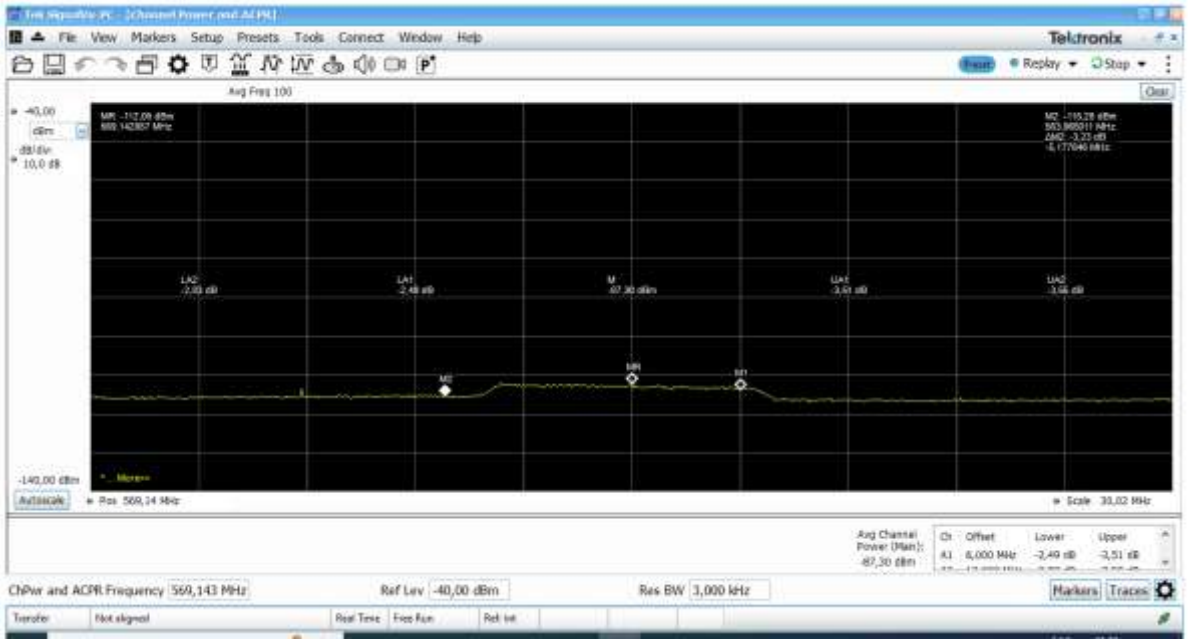


Figure 2.19 - Vertical

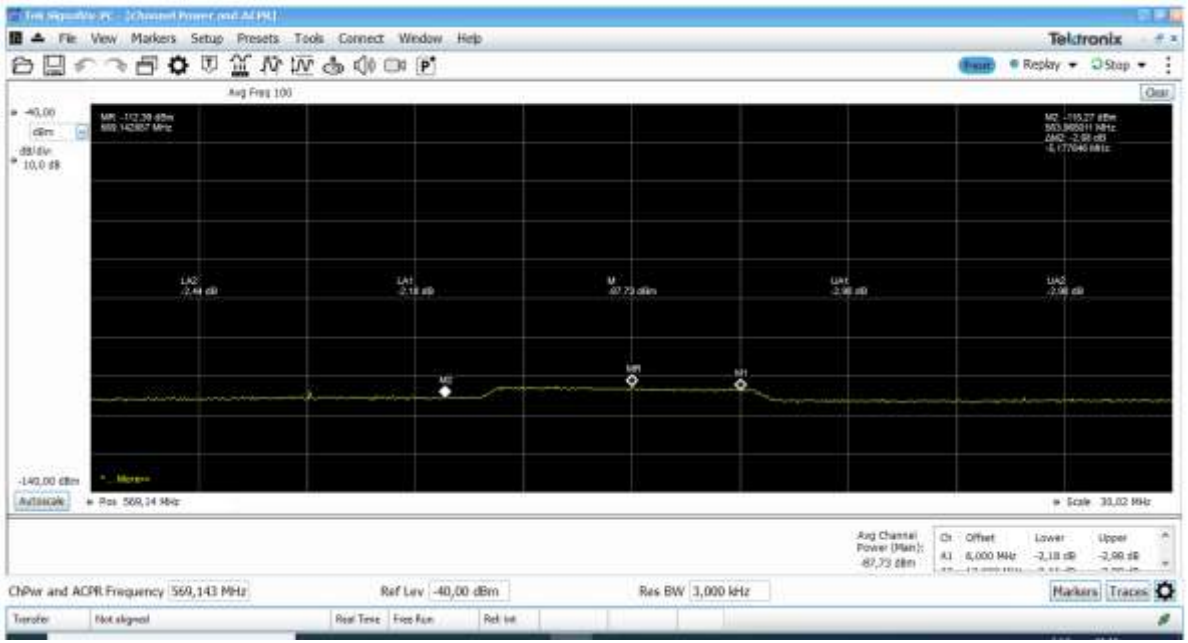


Figure 2.20 - Horizontal

c) C/N Threshold

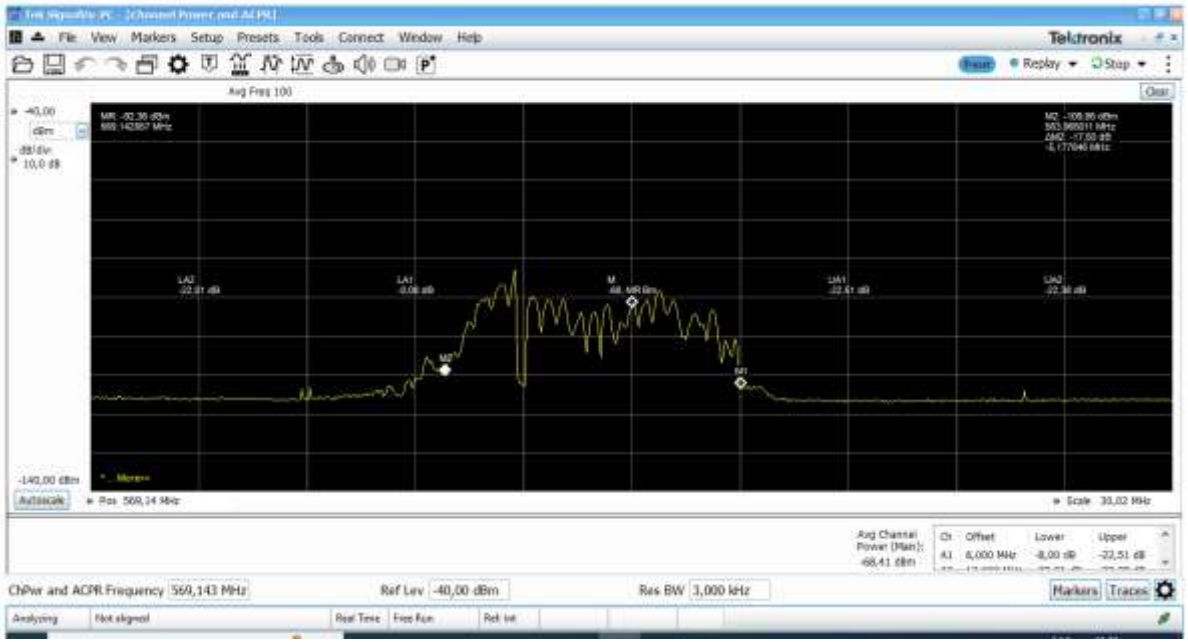


Figure 2.21 - Vertical

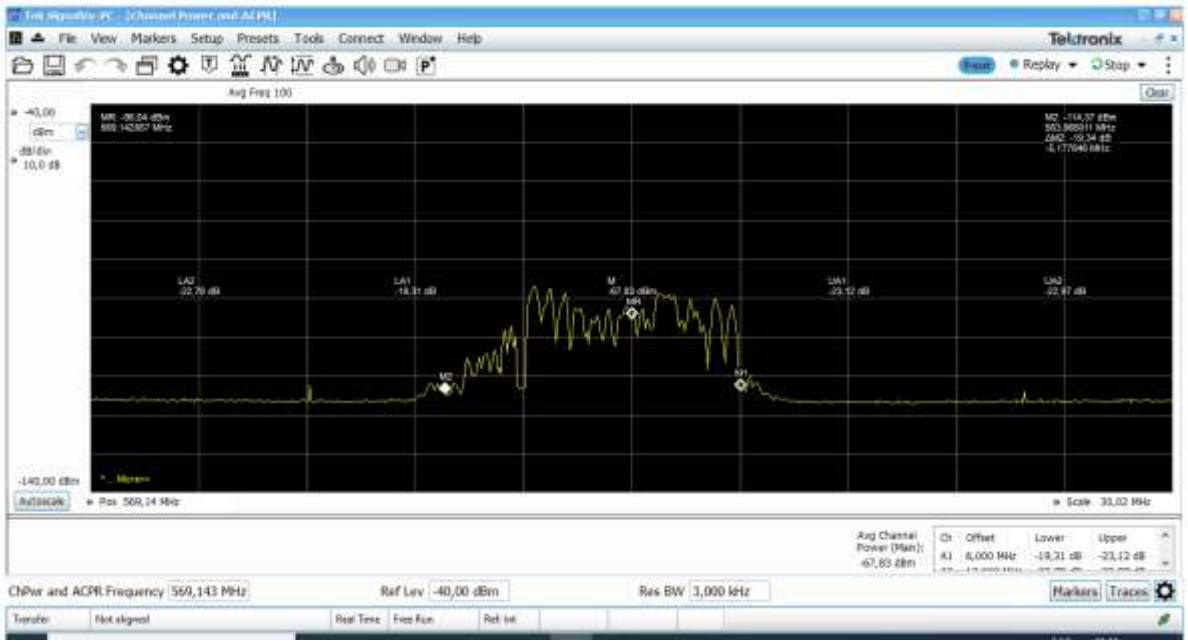


Figure 2.22 - Horizontal

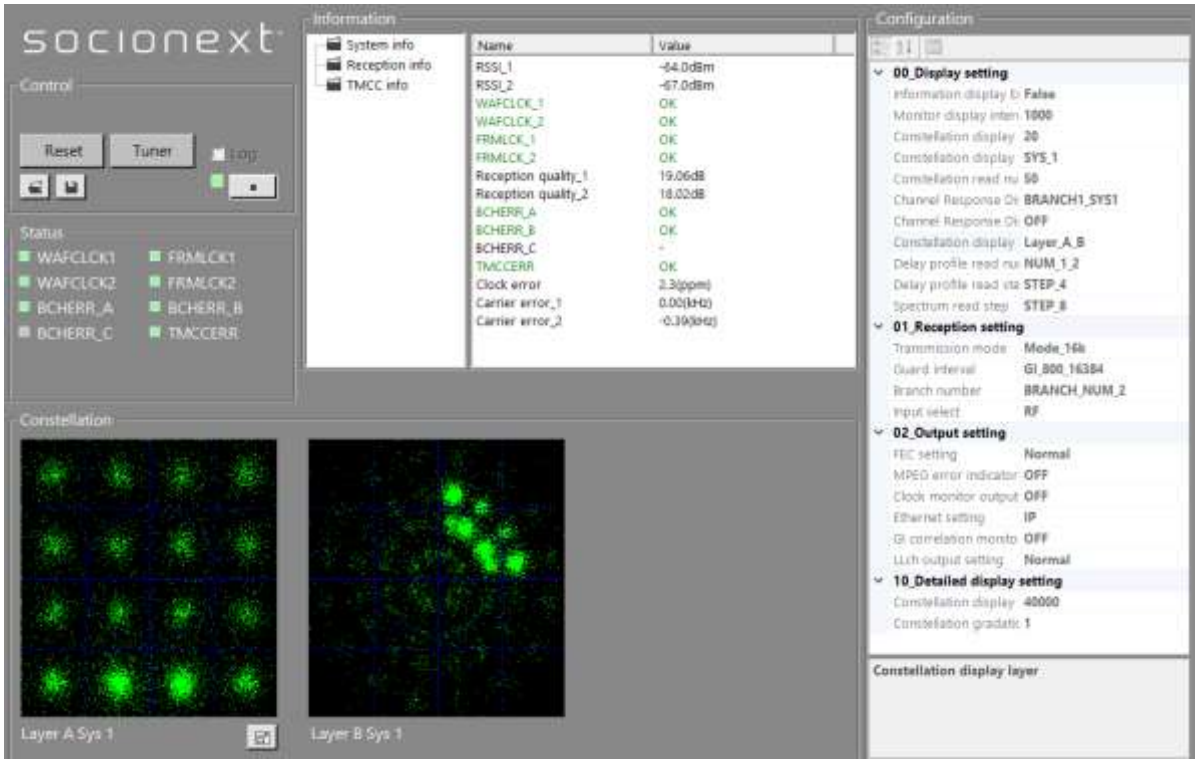


Figure 2.23 - Socionext Screen

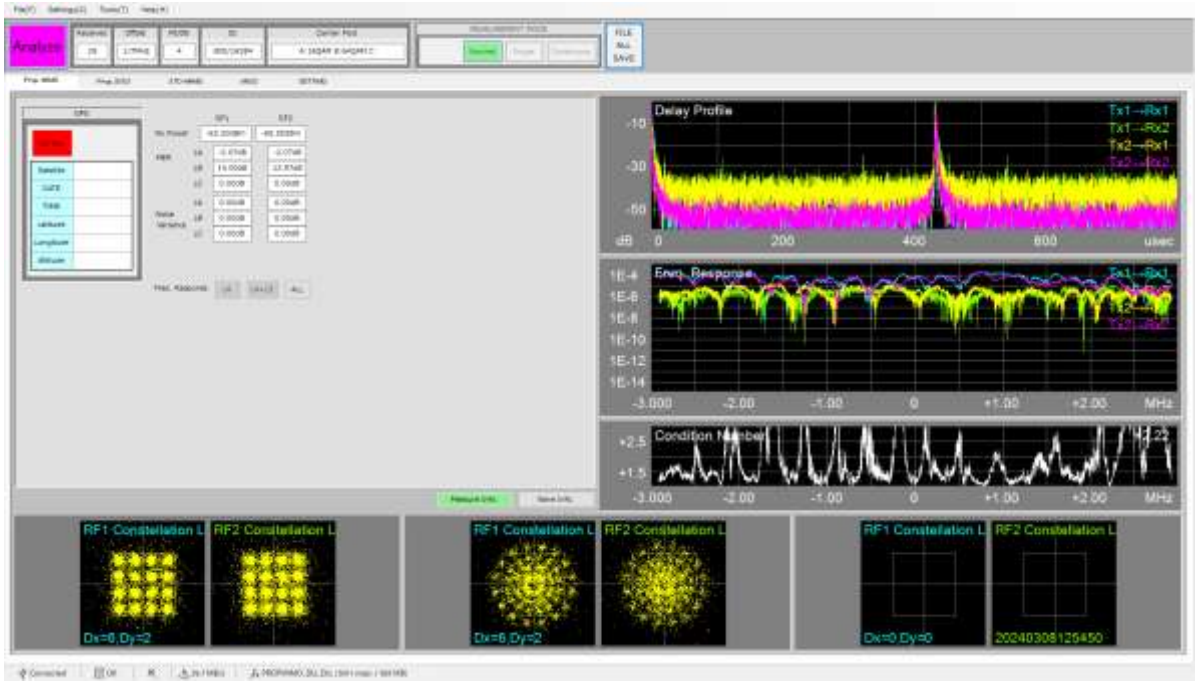


Figure 2.24 - Rintaro Screen

d) Reception Threshold

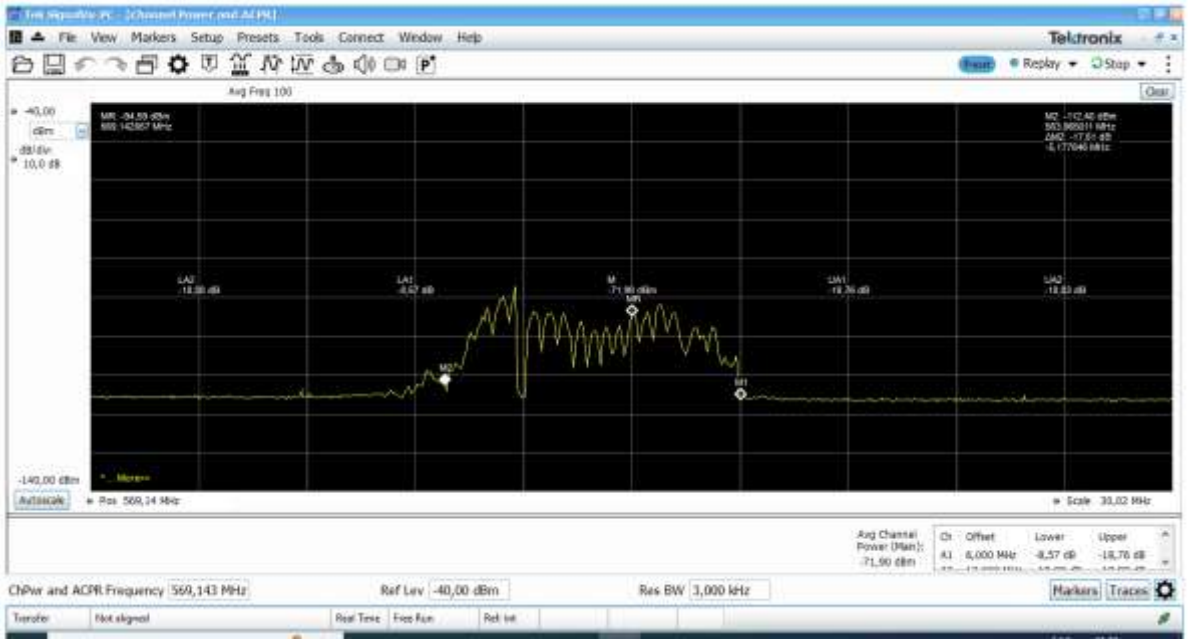


Figure 2.25 - Vertical

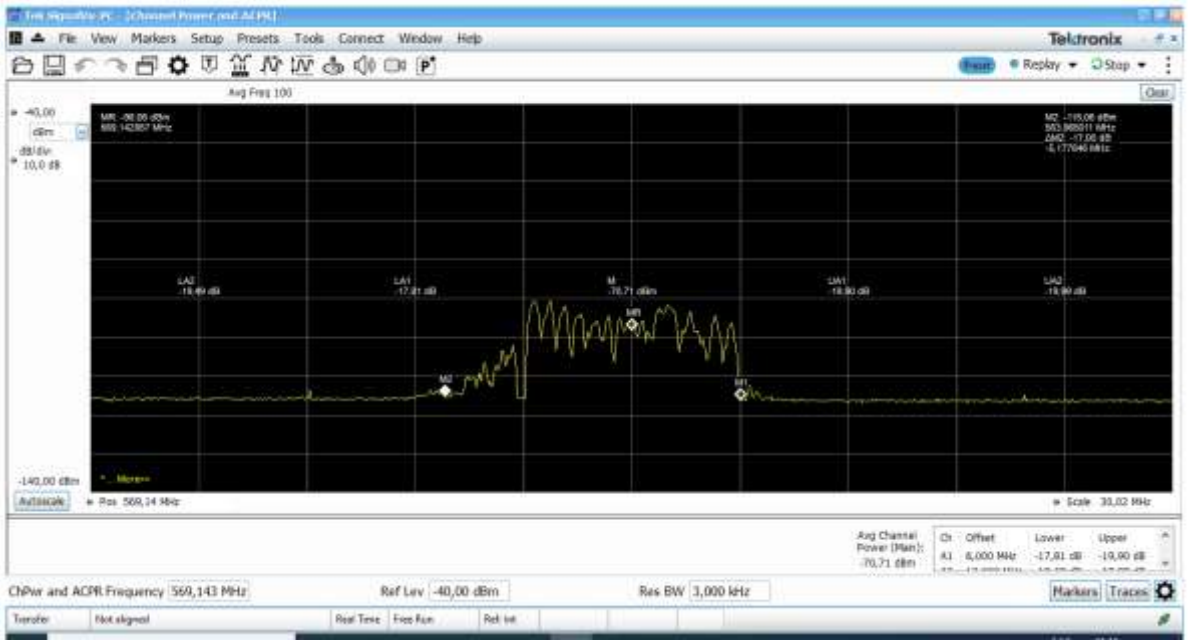


Figure 2.26 - Horizontal

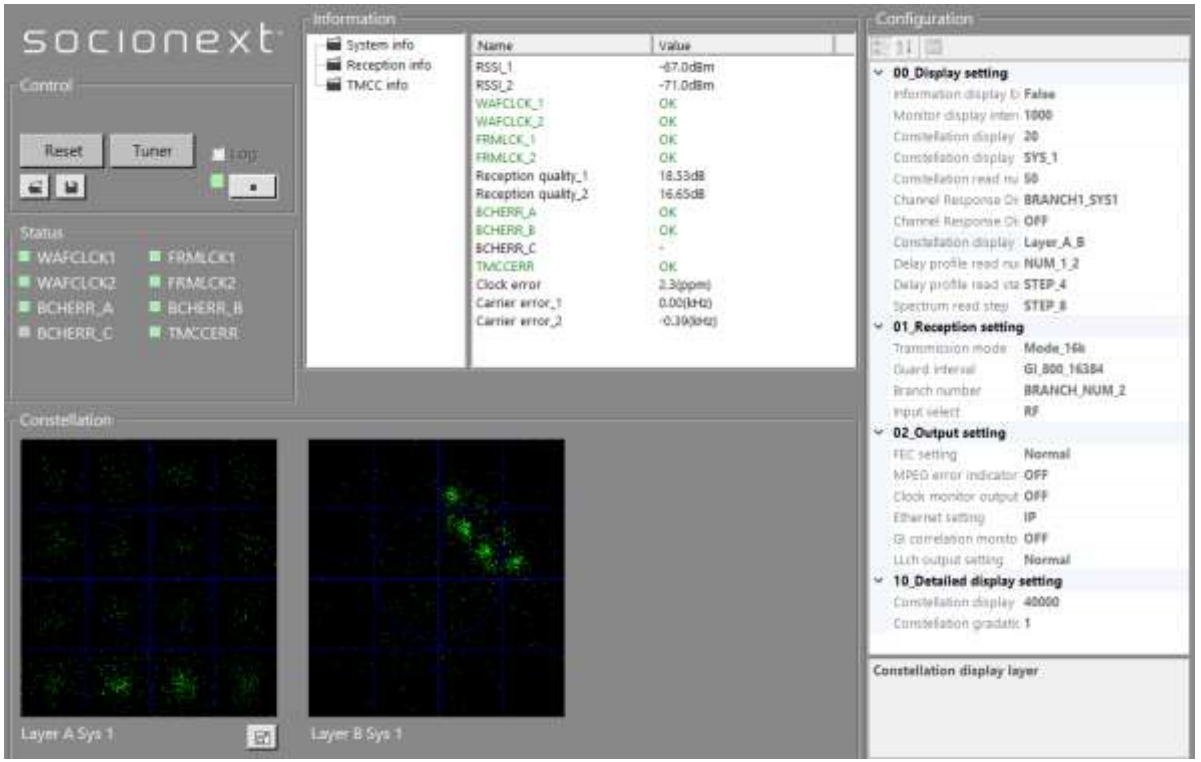


Figure 2.27 - Socionext Screen

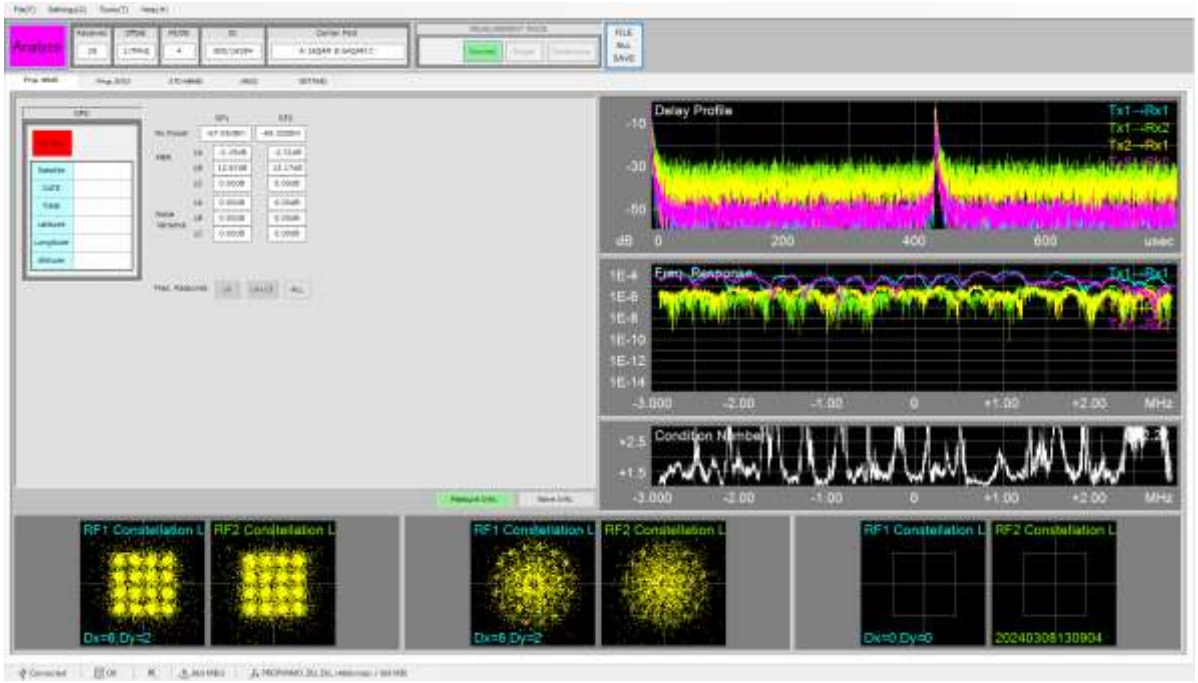


Figure 2.28 - Rintaro Screen

Chapter 3. Site 4

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

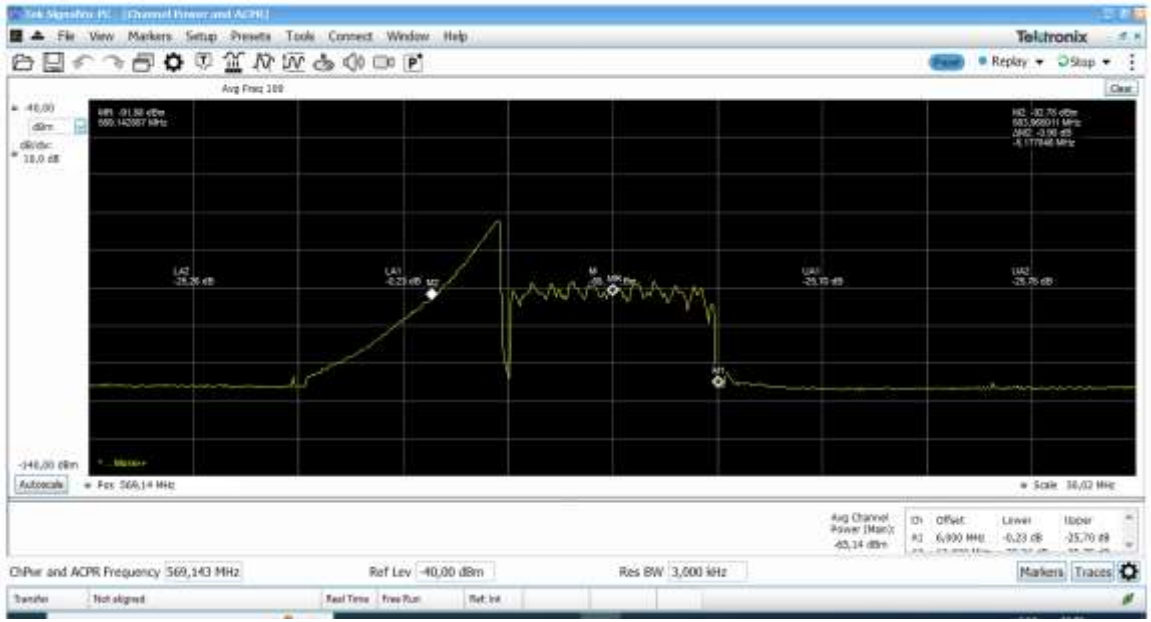


Figure 3.1 - Vertical

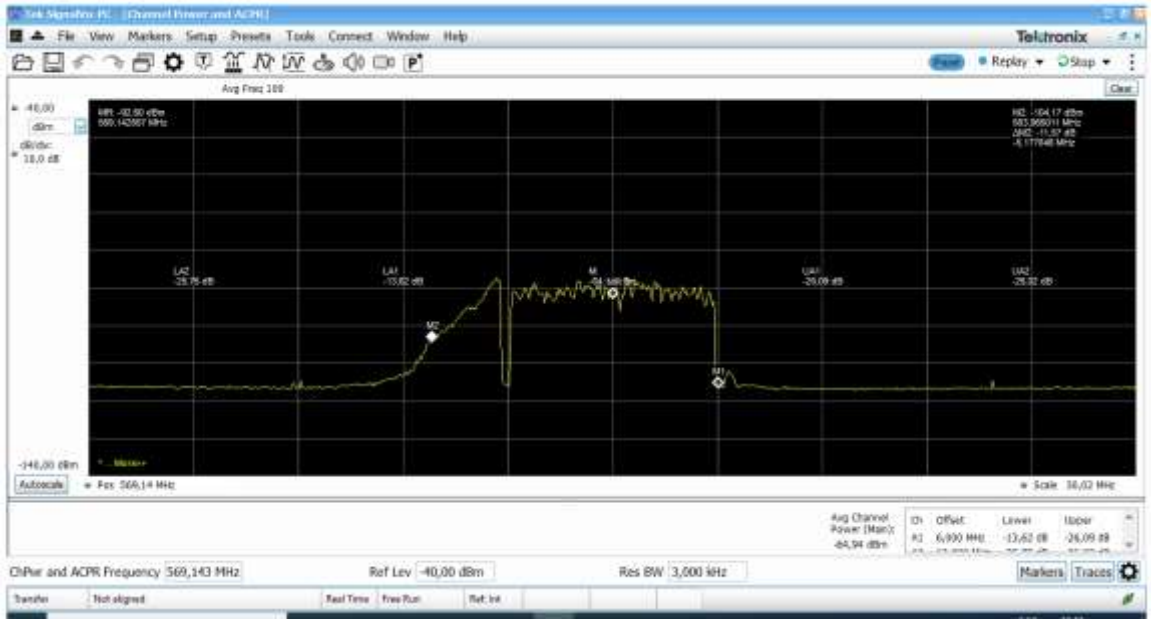


Figure 3.2 - Horizontal

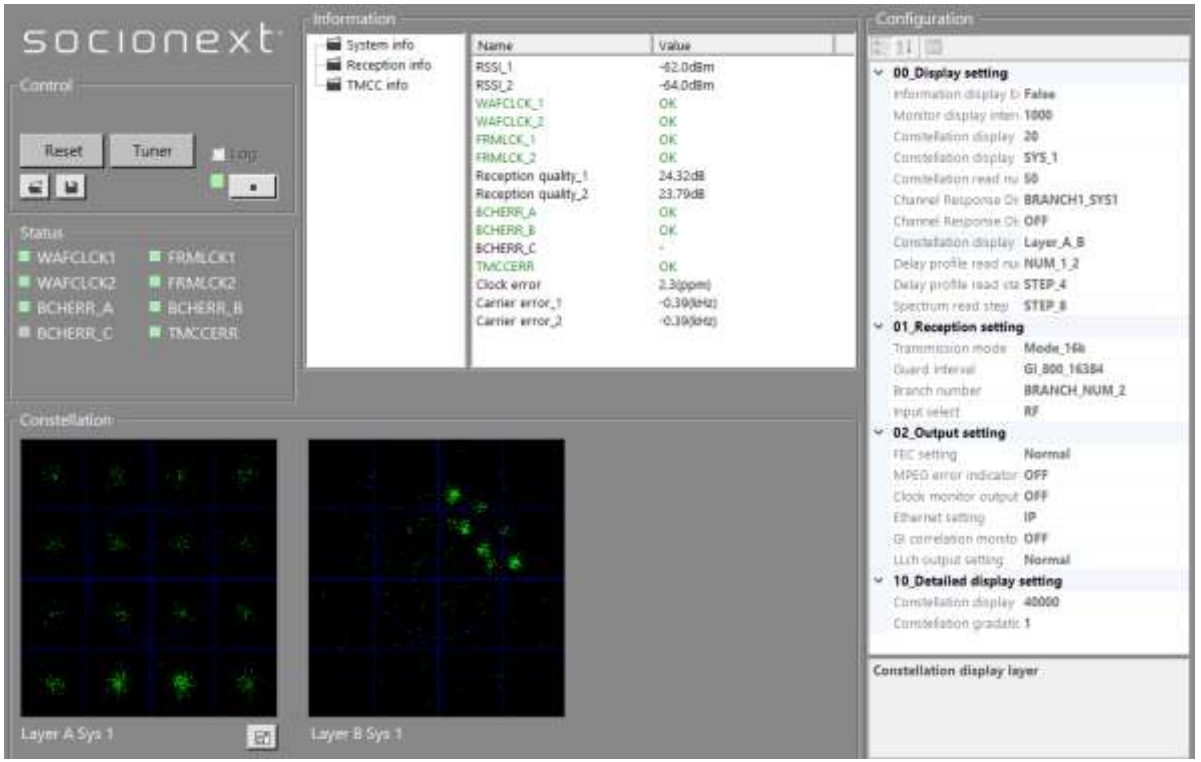


Figure 3.3 - Socionext Screen

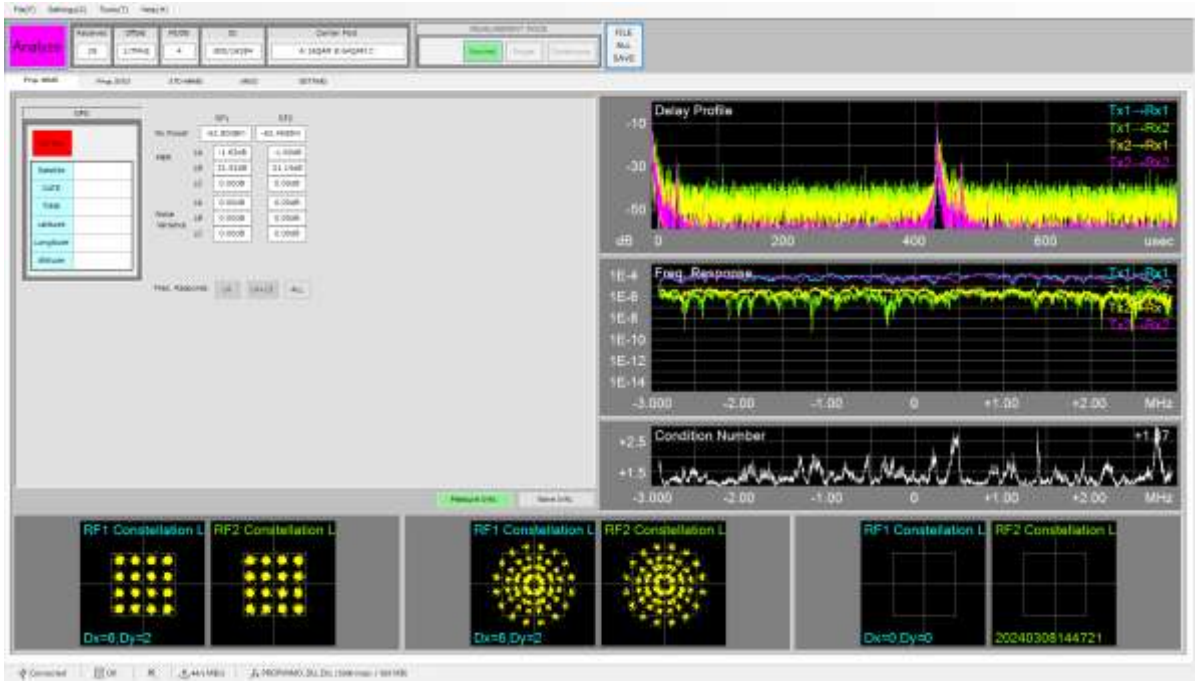


Figure 3.4 - Rintaro Screen

b) AWGN Power

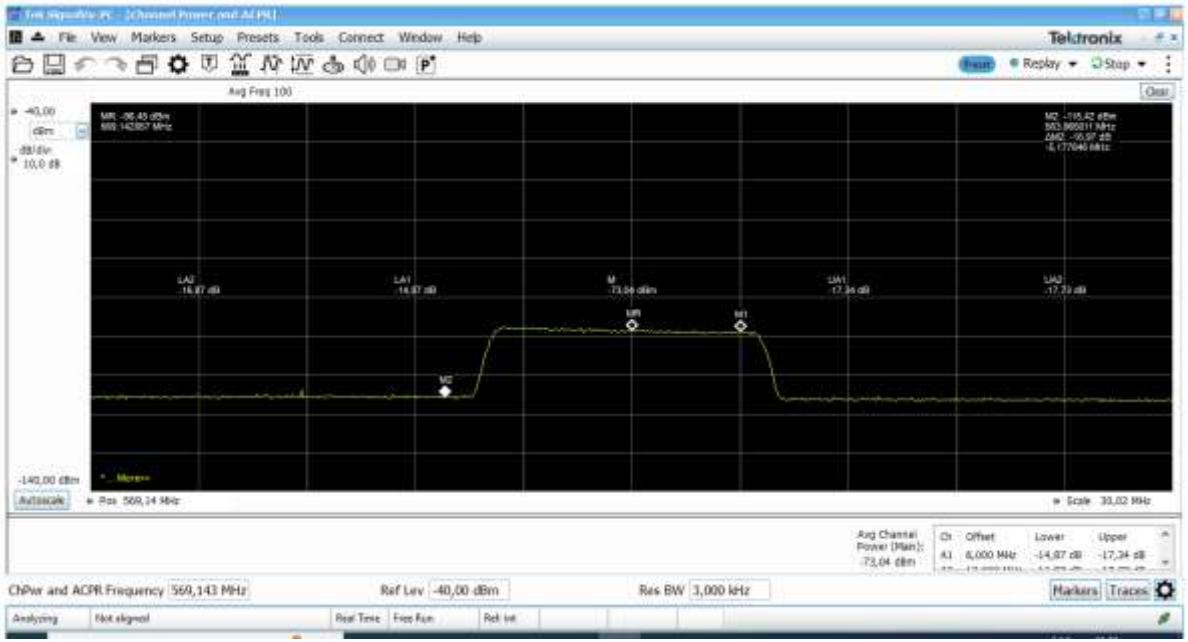


Figure 3.5 - Vertical

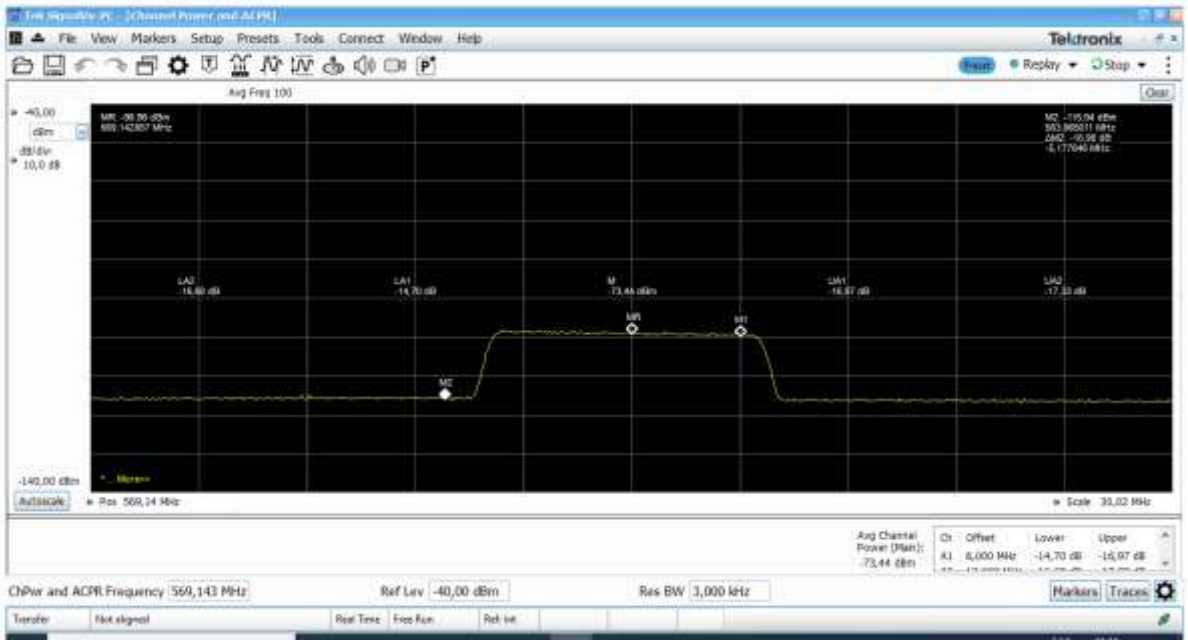


Figure 3.6 - Horizontal

c) C/N Threshold

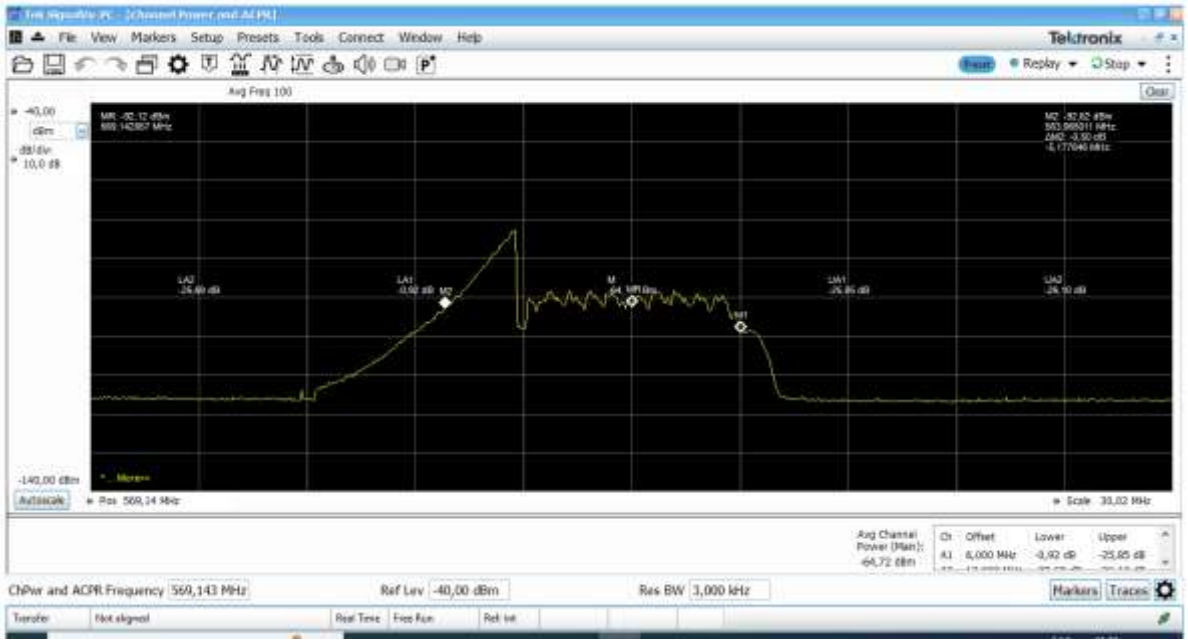


Figure 3.7 - Vertical

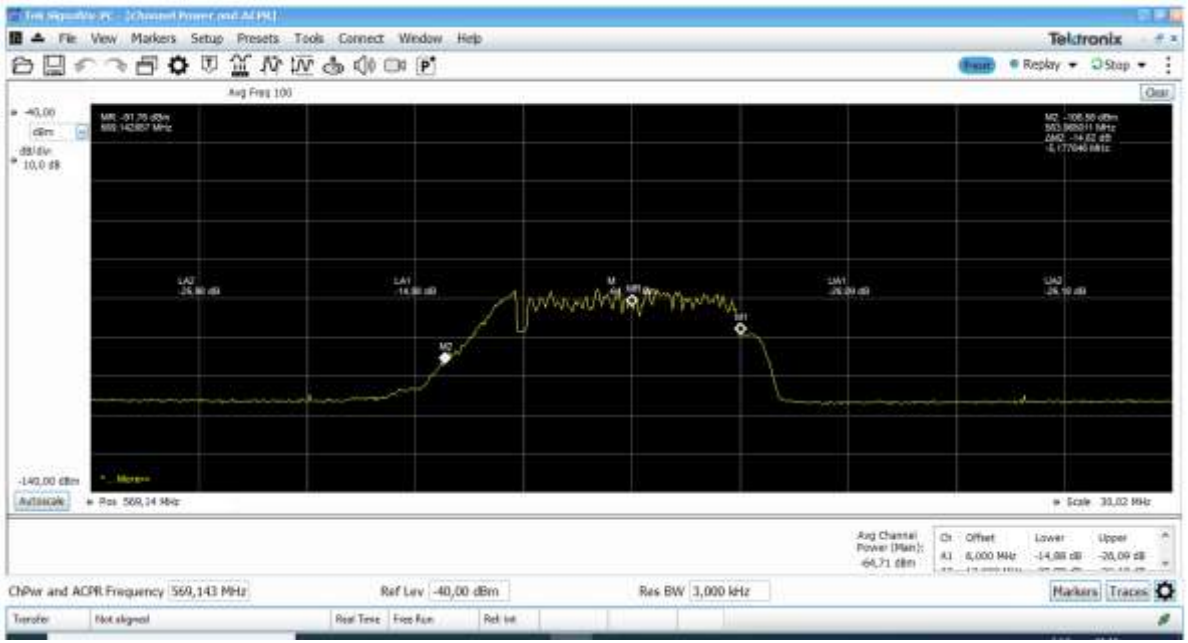


Figure 3.8 - Horizontal

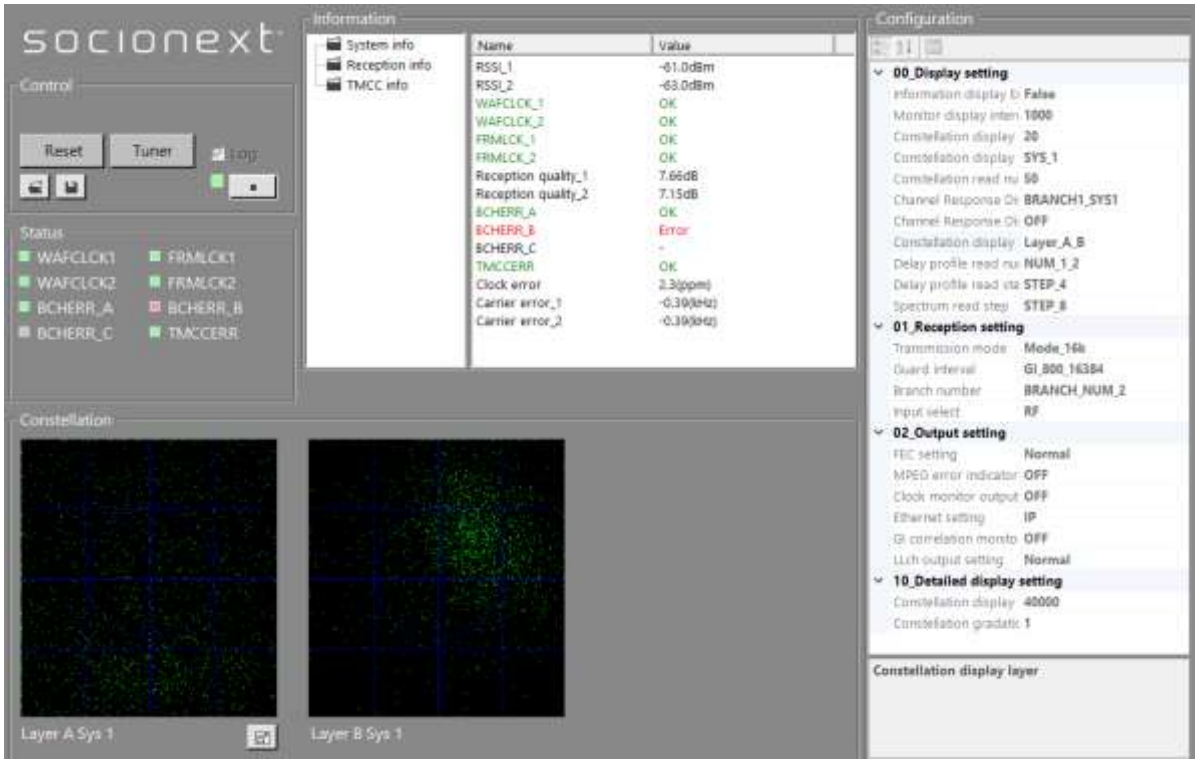


Figure 3.9 - Socionext Screen

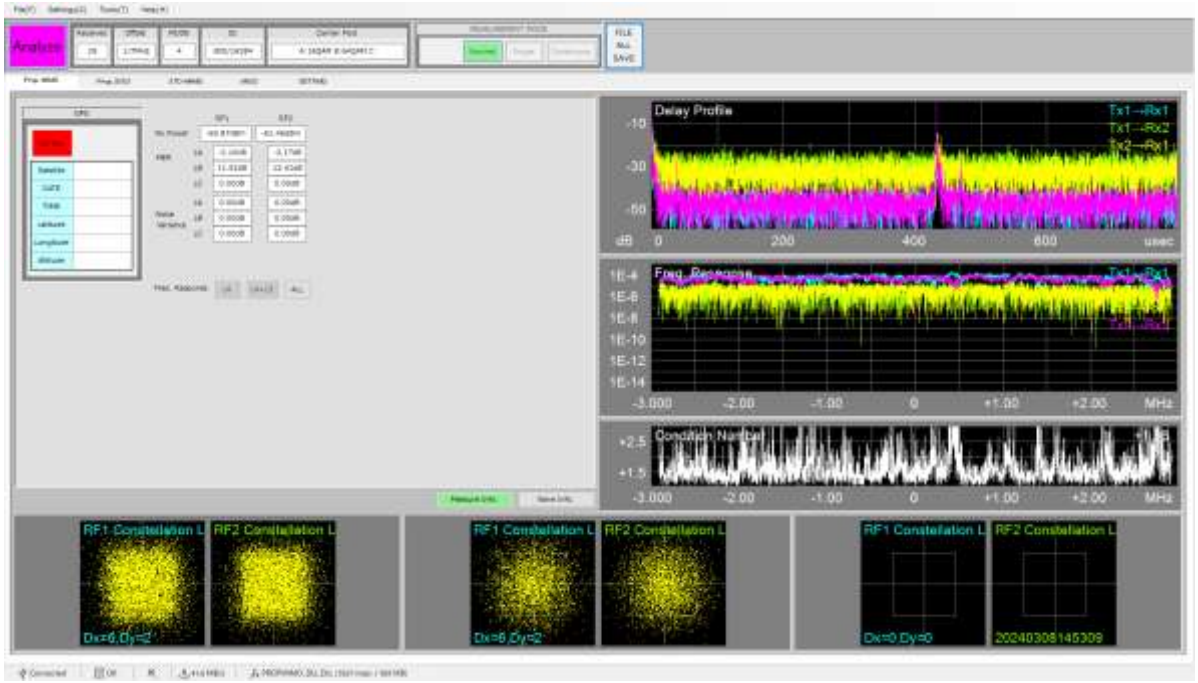


Figure 3.10 - Rintaro Screen

d) Reception Threshold

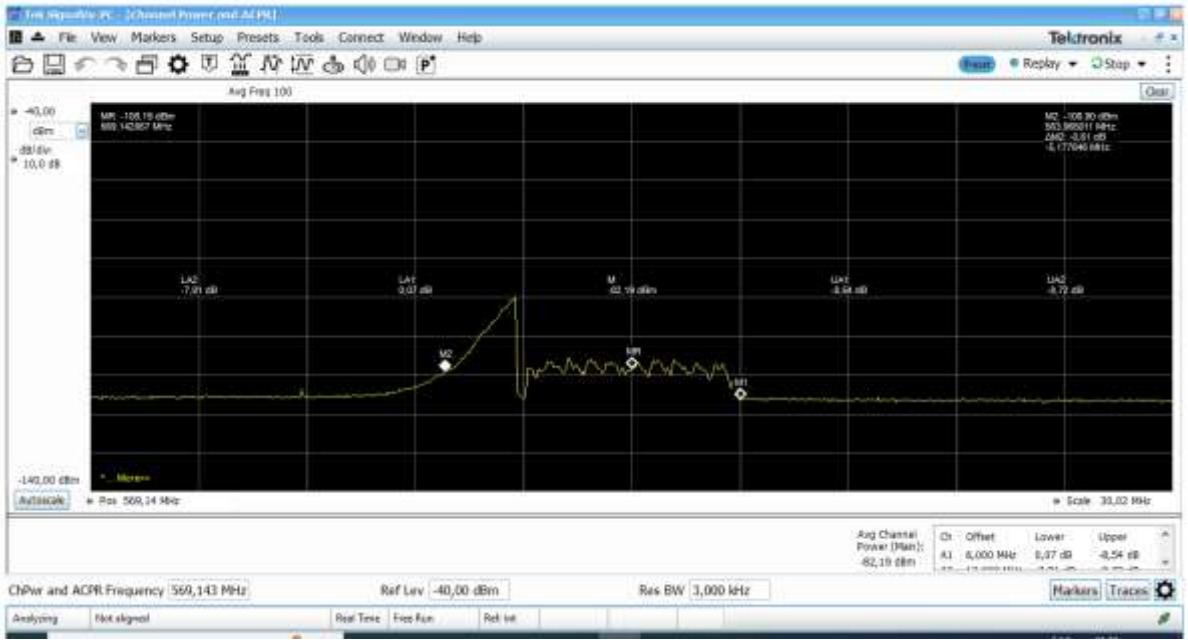


Figure 3.11 - Vertical

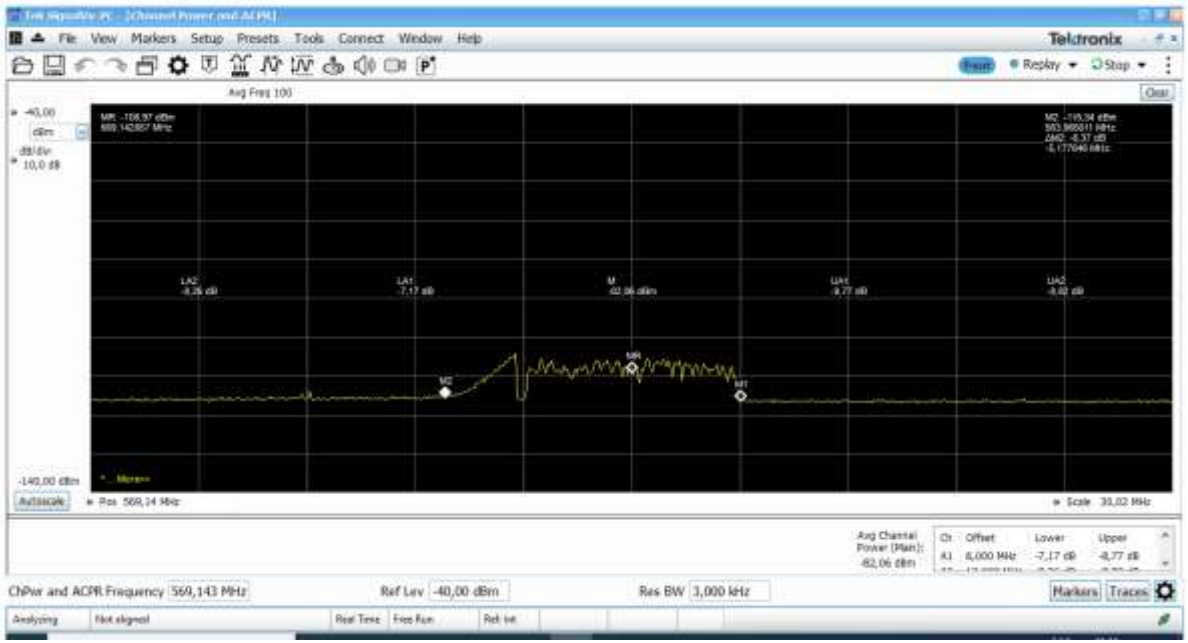


Figure 3.12 - Horizontal

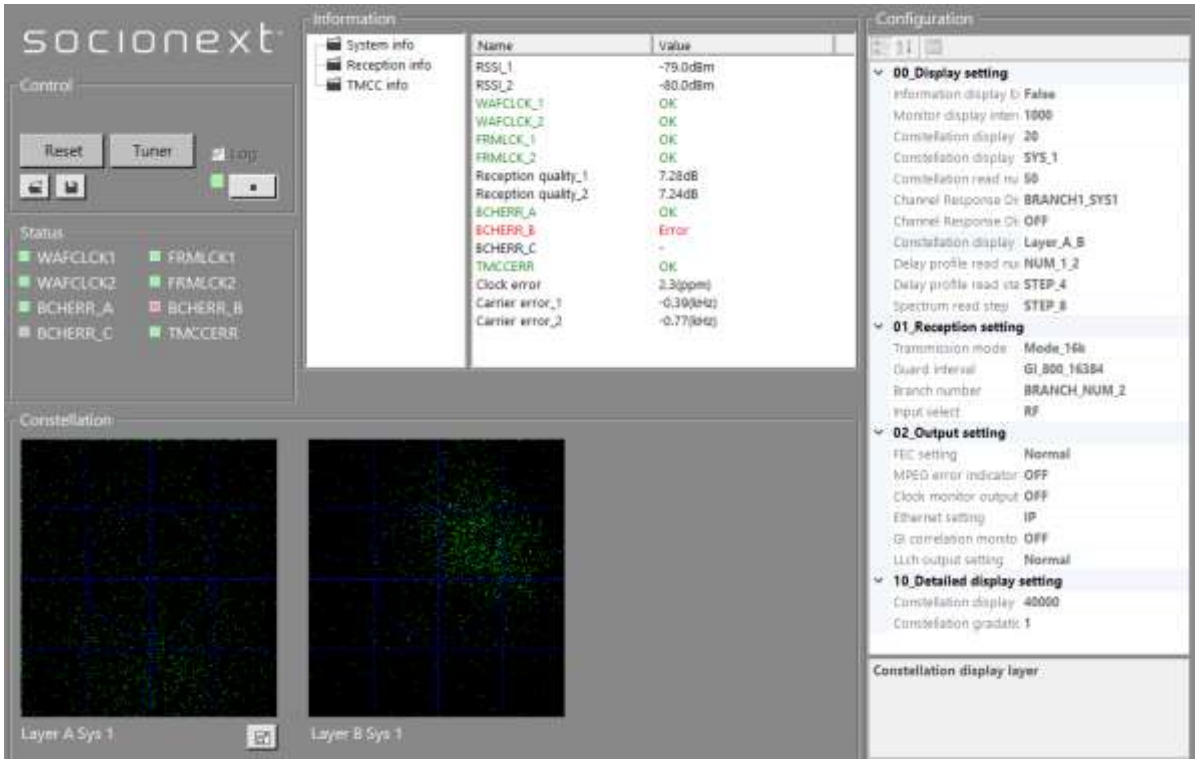


Figure 3.13 - Socionext Screen

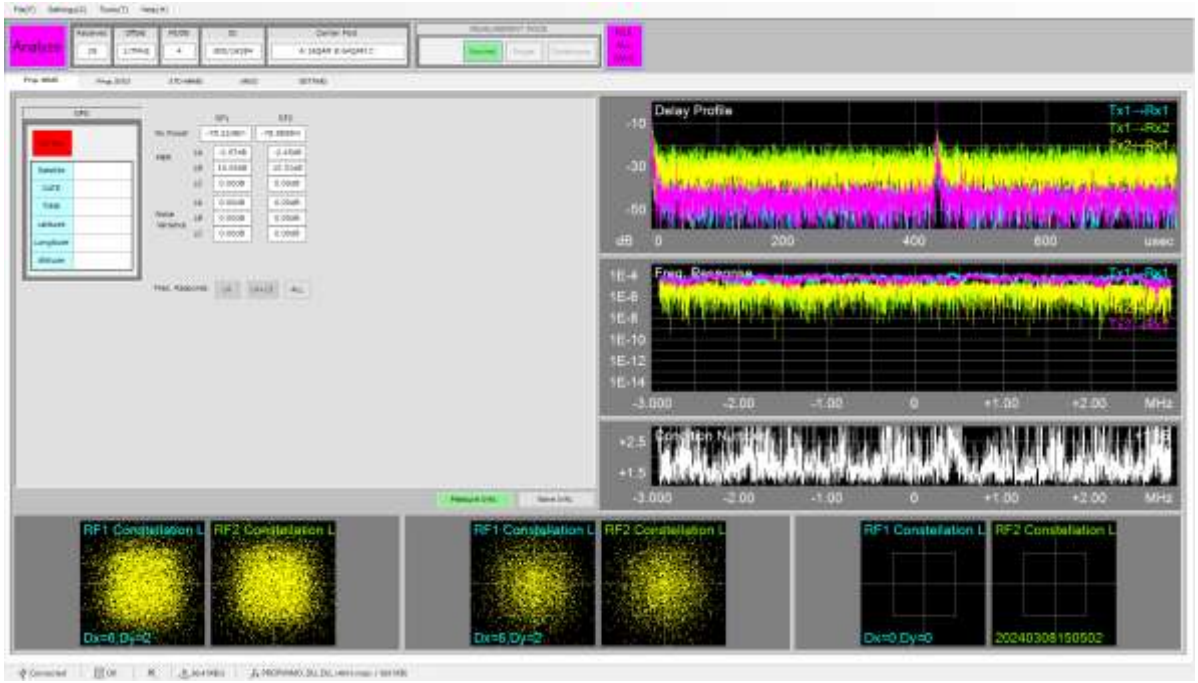


Figure 3.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

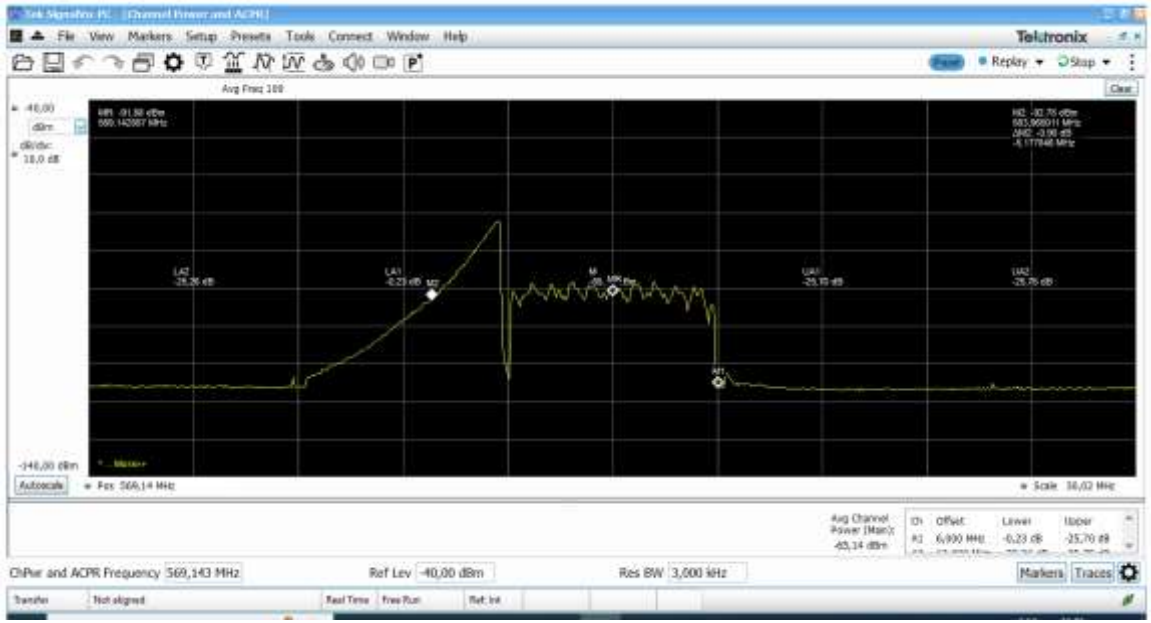


Figure 3.15 - Vertical

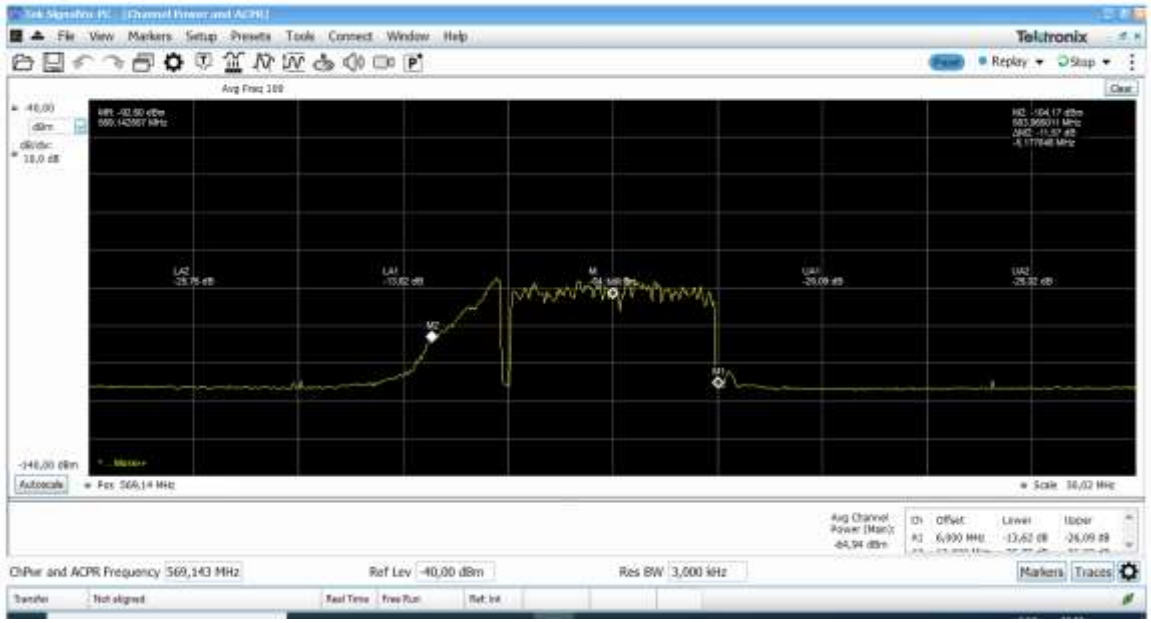


Figure 3.16 - Horizontal

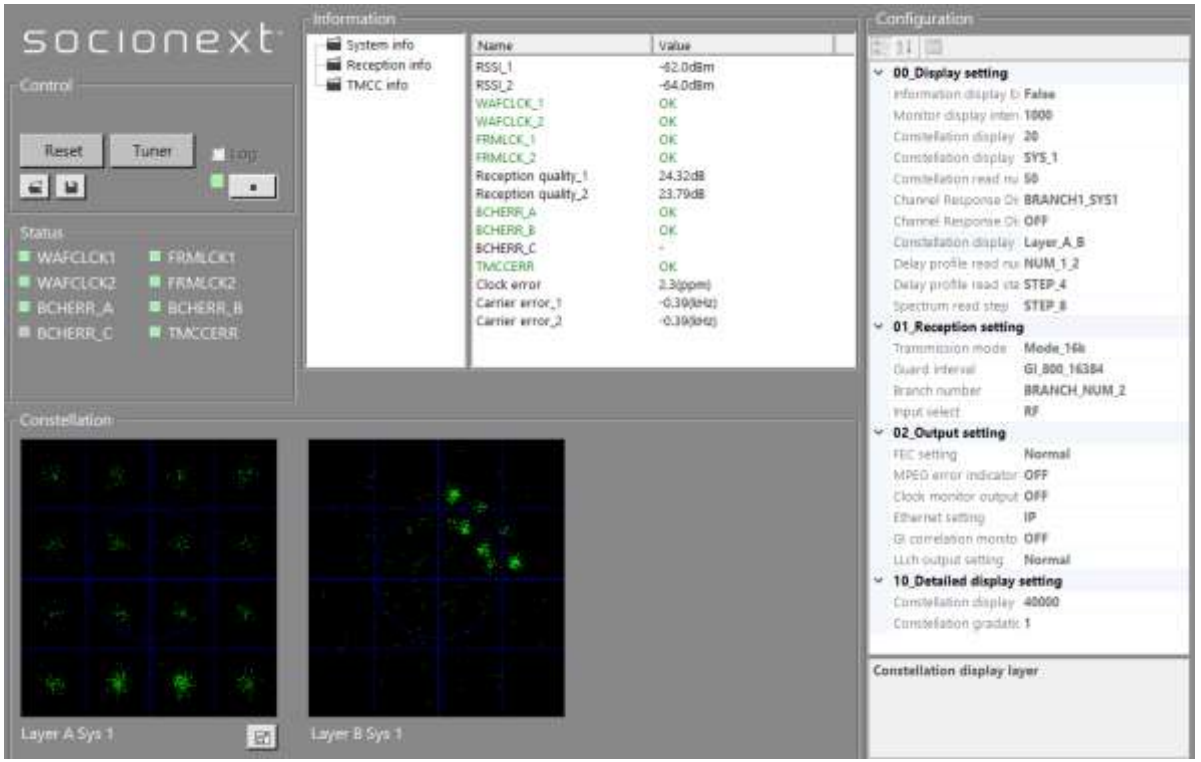


Figure 3.17 - Socionext Screen

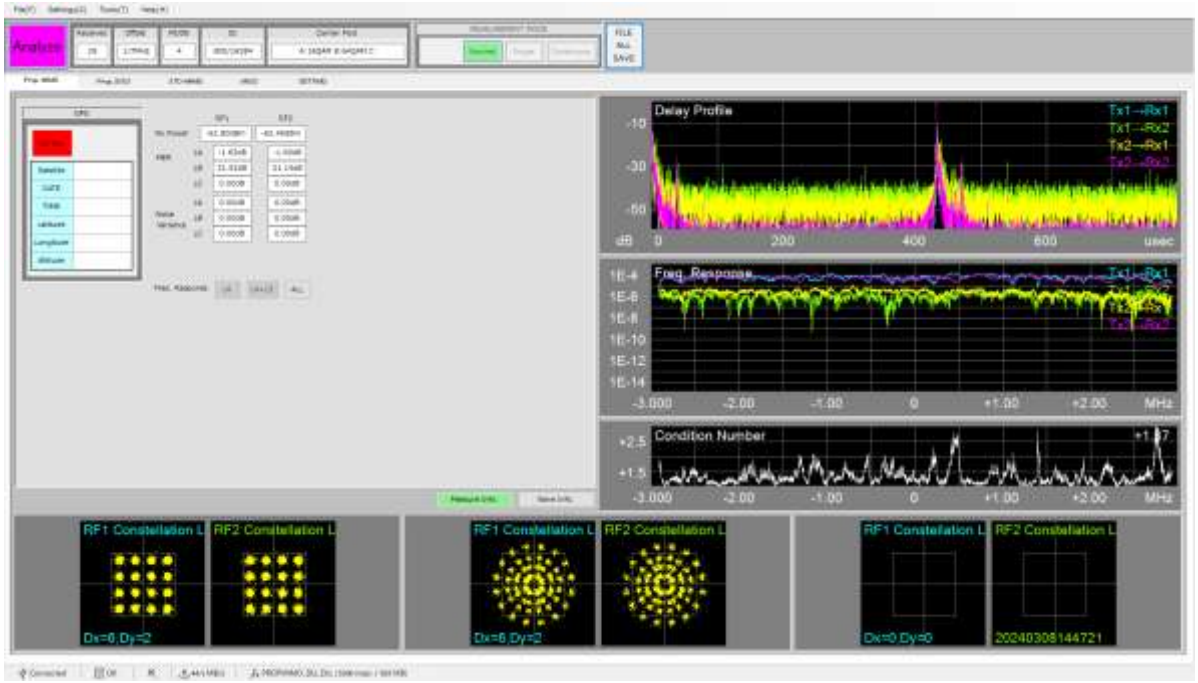


Figure 3.18 - Rintaro Screen

b) AWGN Power

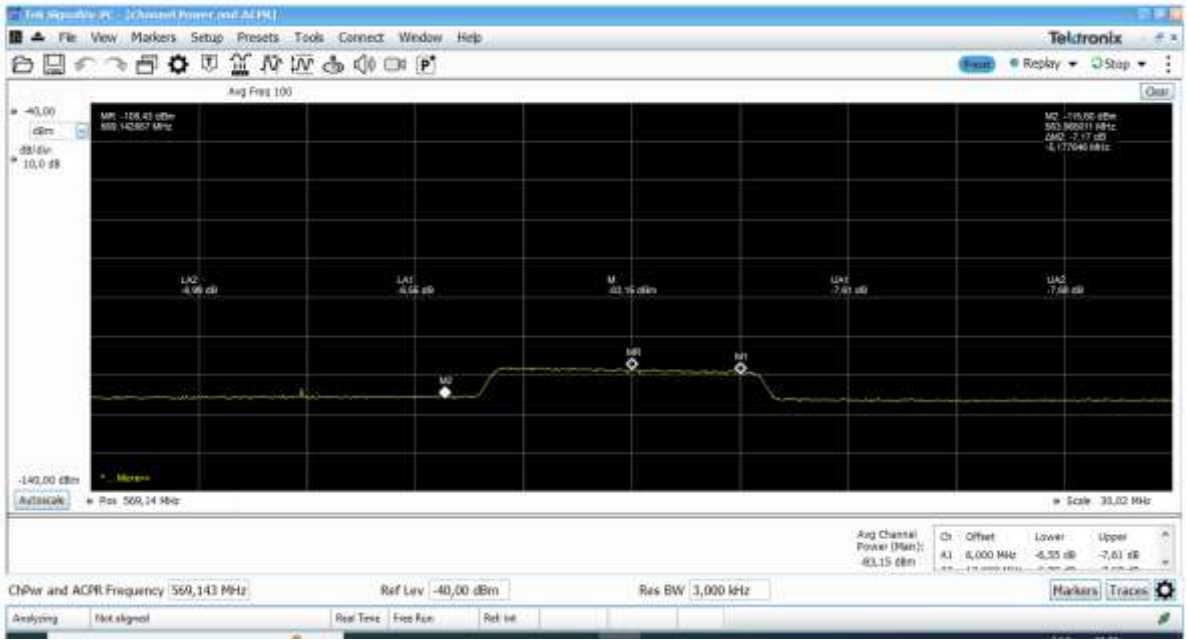


Figure 3.19 - Vertical

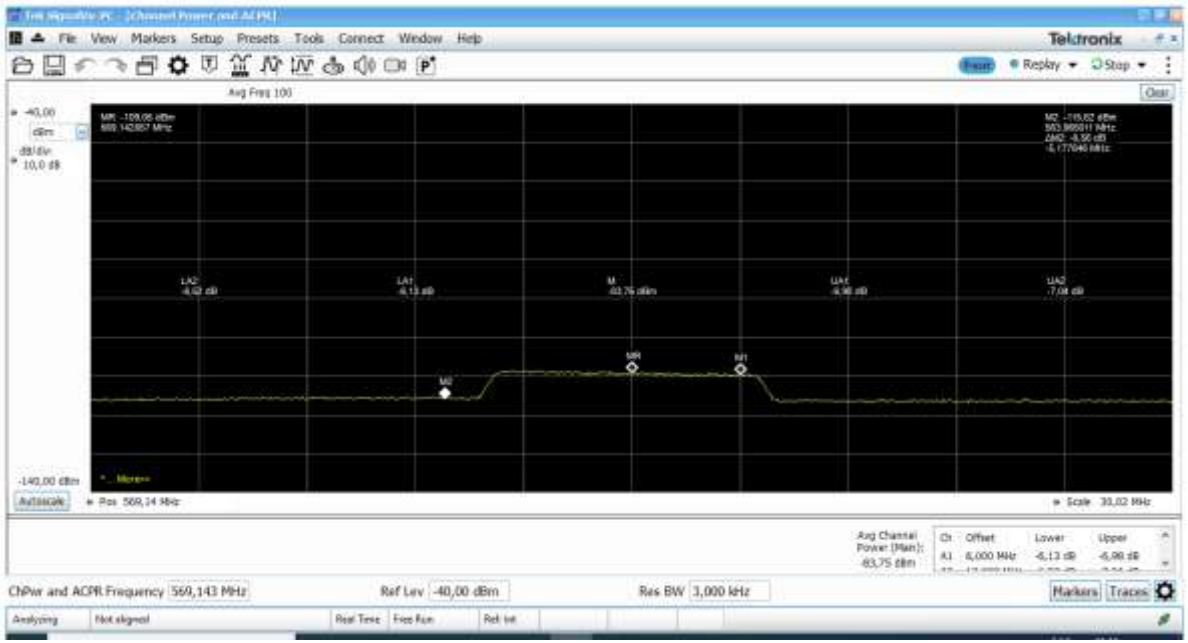


Figure 3.20 - Horizontal

c) C/N Threshold

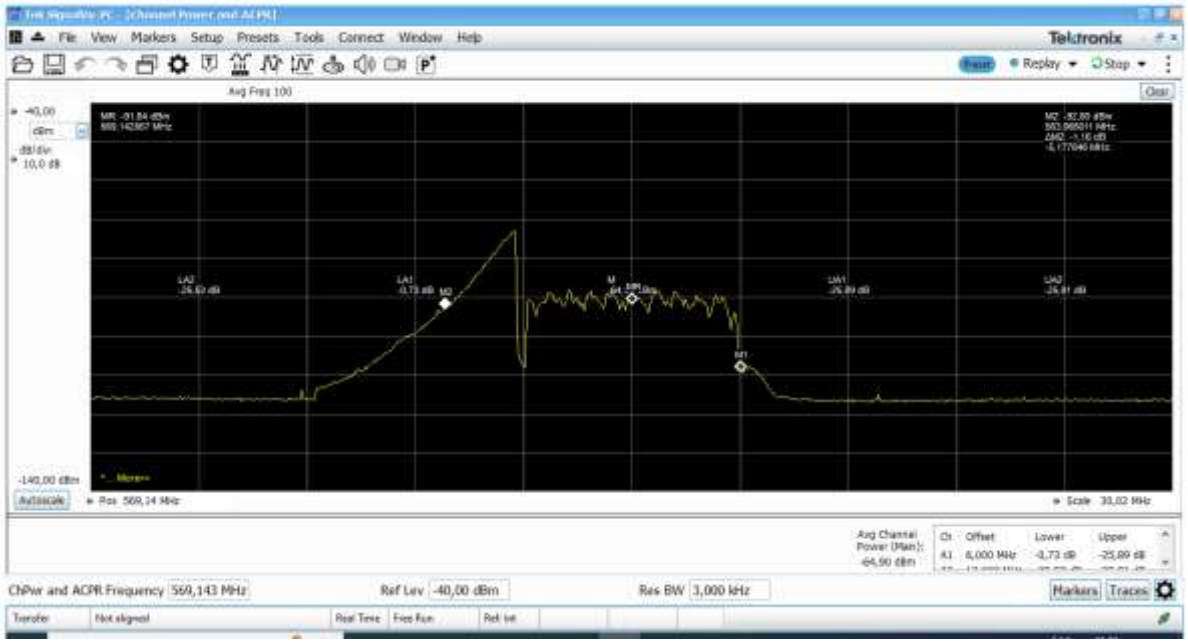


Figure 3.21 - Vertical

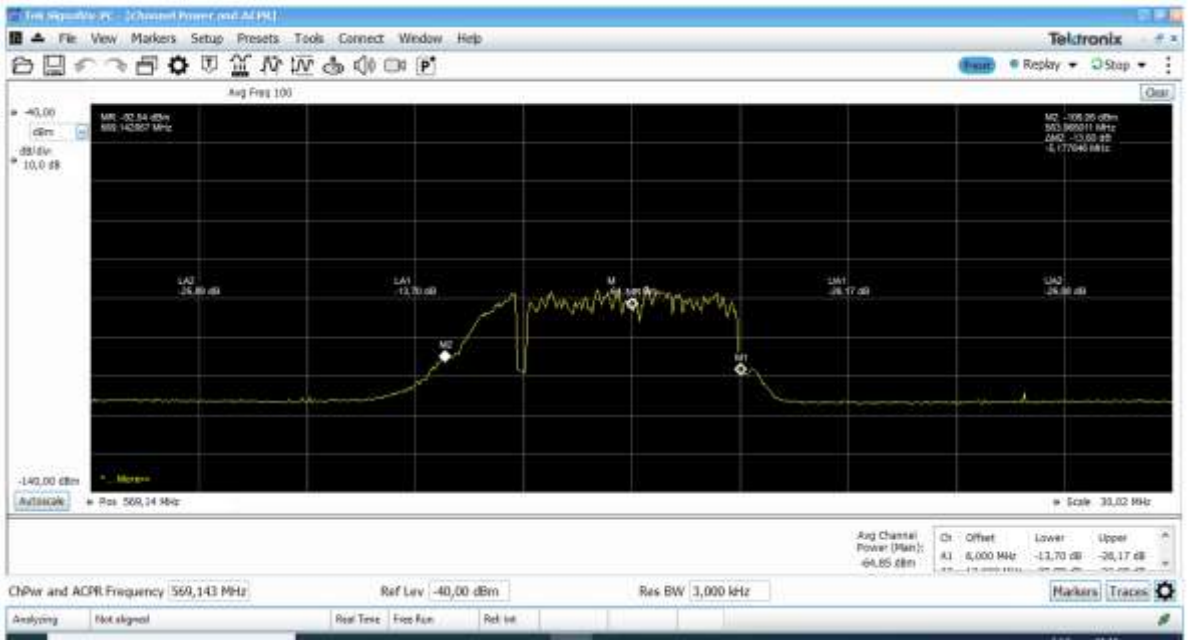


Figure 3.22 - Horizontal

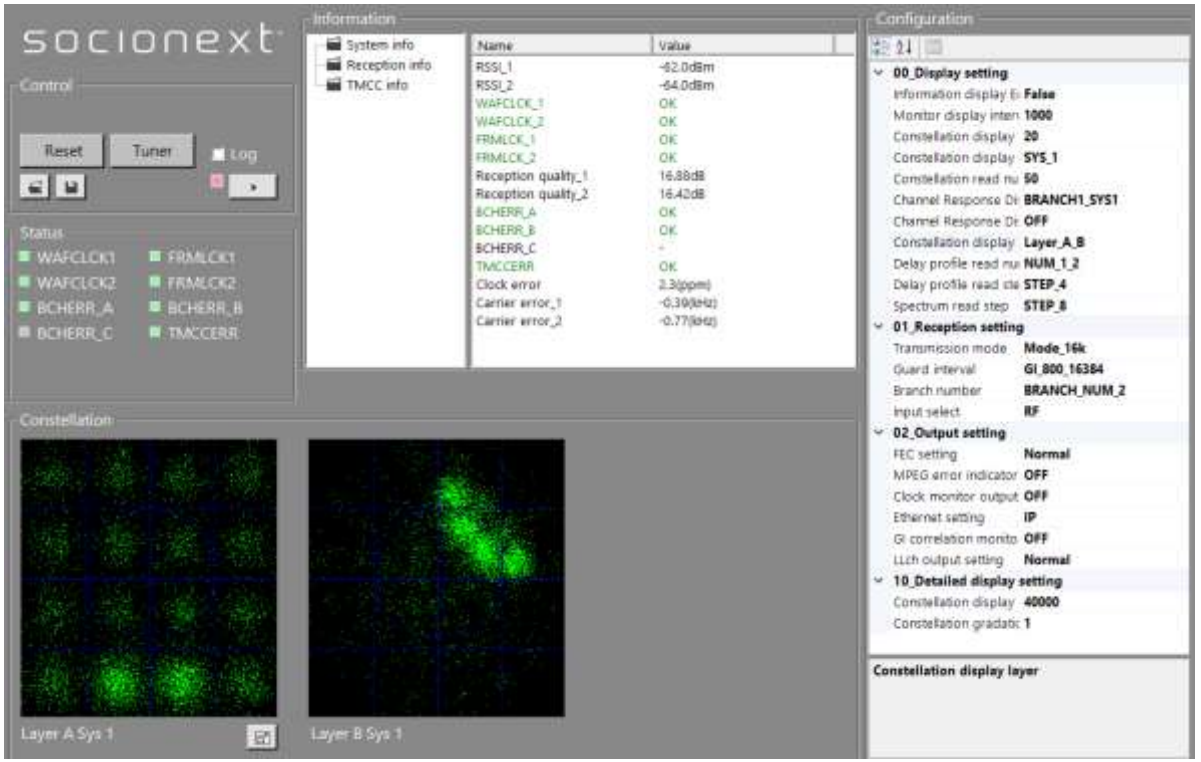


Figure 3.23 - Socionext Screen

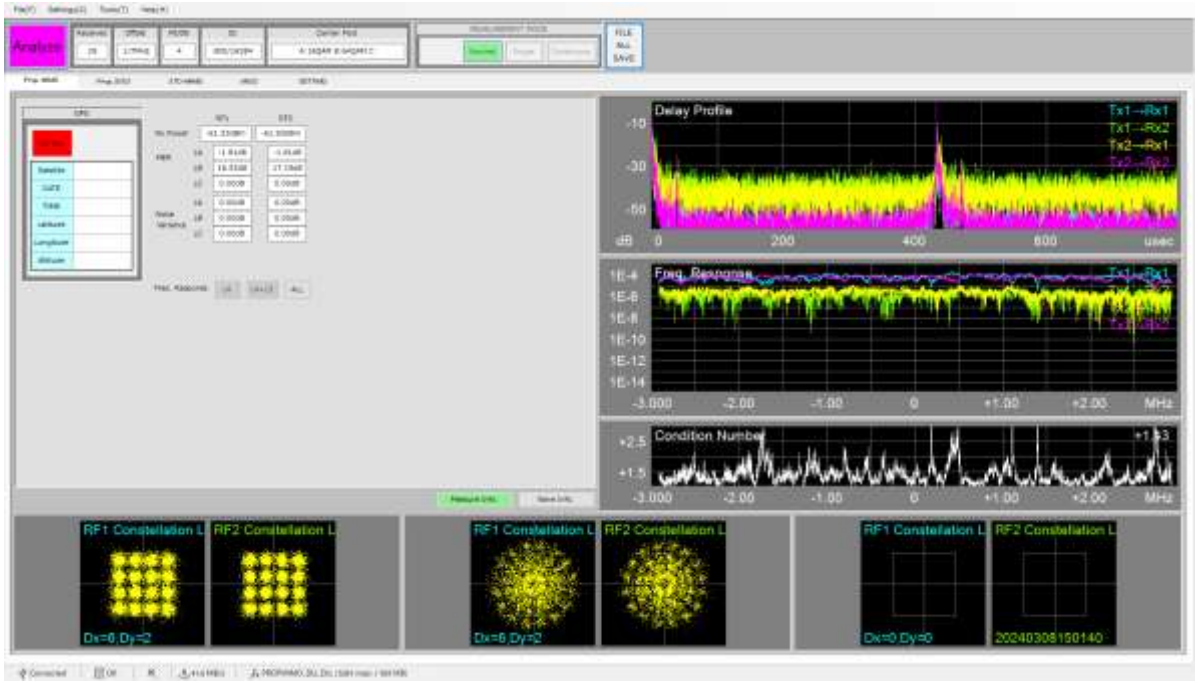


Figure 3.24 - Rintaro Screen

d) Reception Threshold

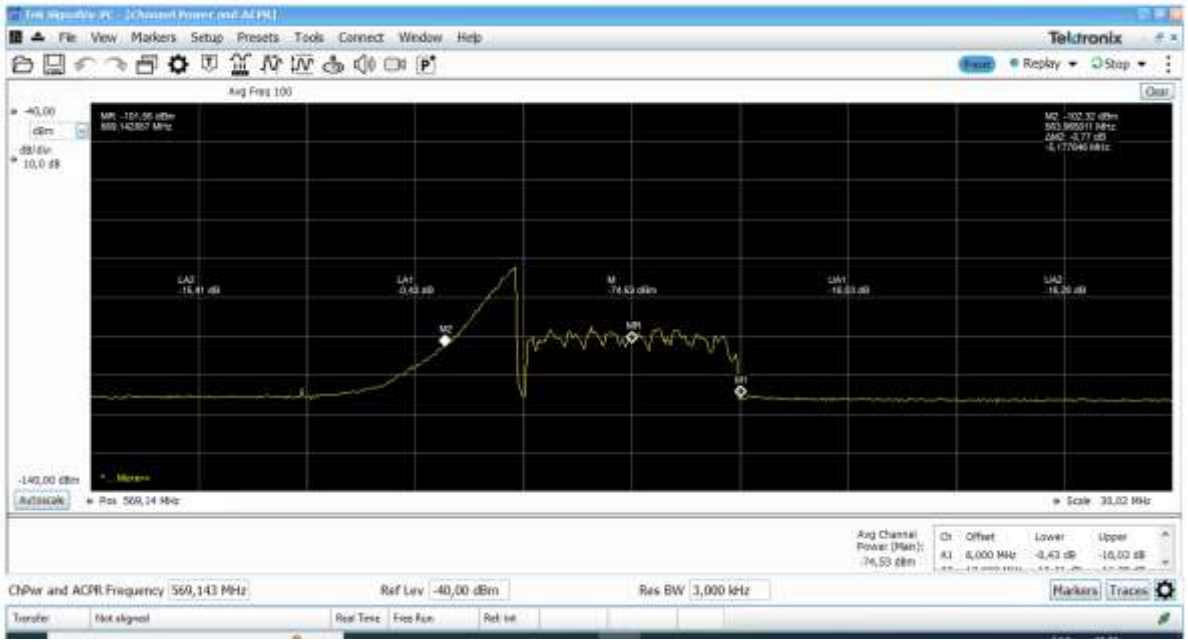


Figure 3.25 - Vertical

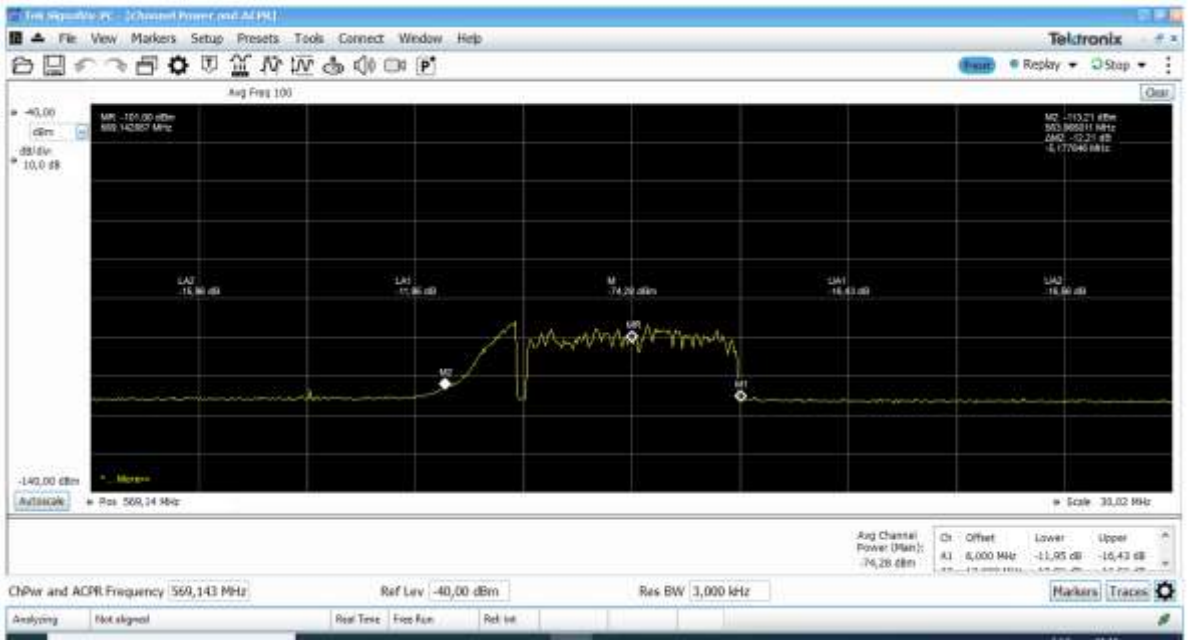


Figure 3.26 - Horizontal

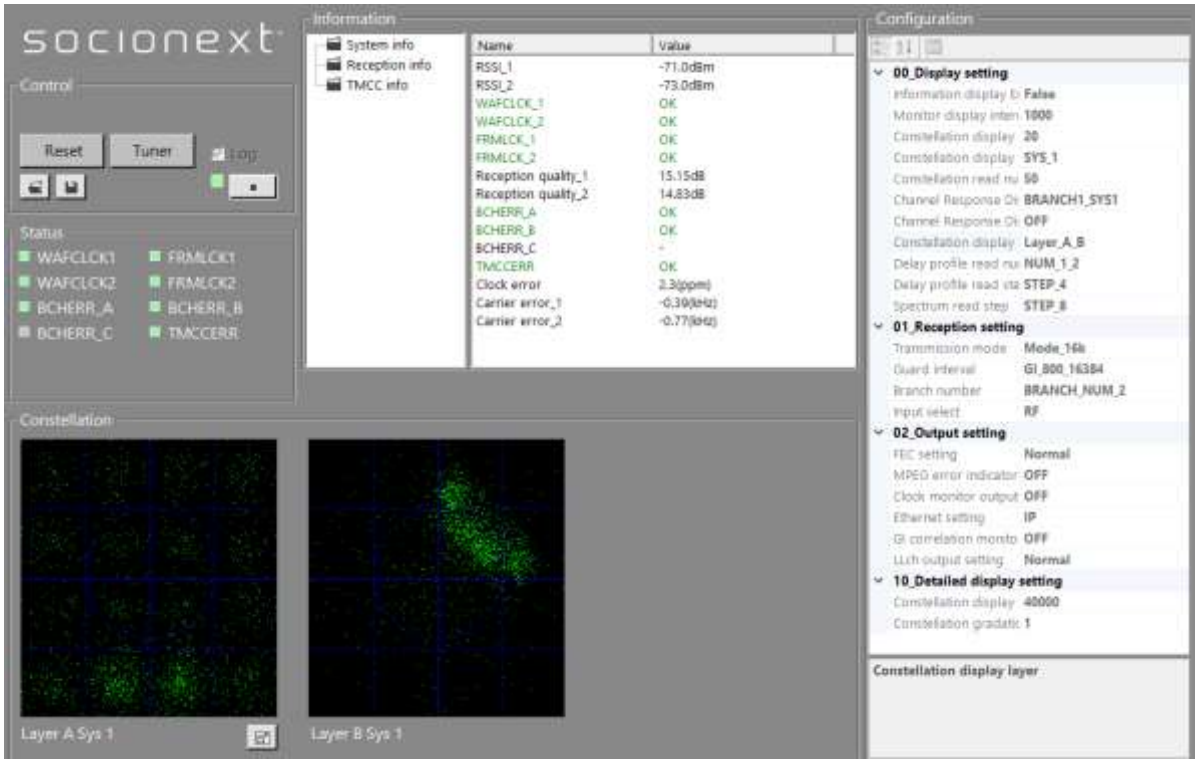


Figure 3.27 - Socionext Screen

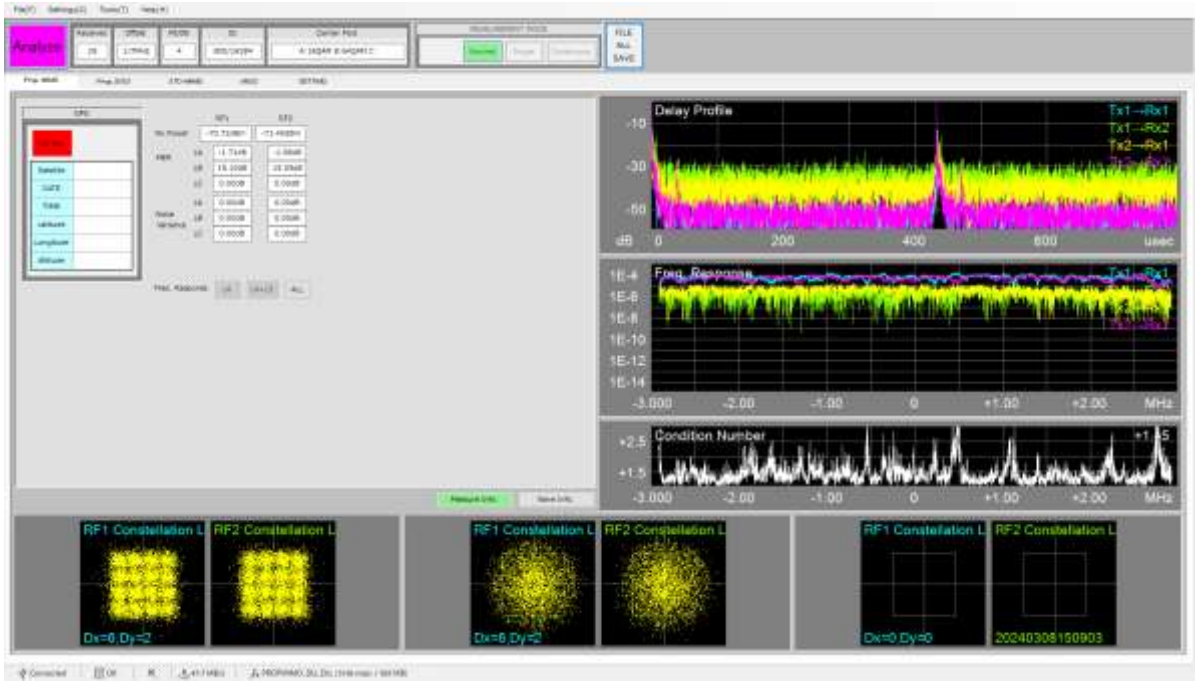


Figure 3.28 - Rintaro Screen

Chapter 4. Site 6

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

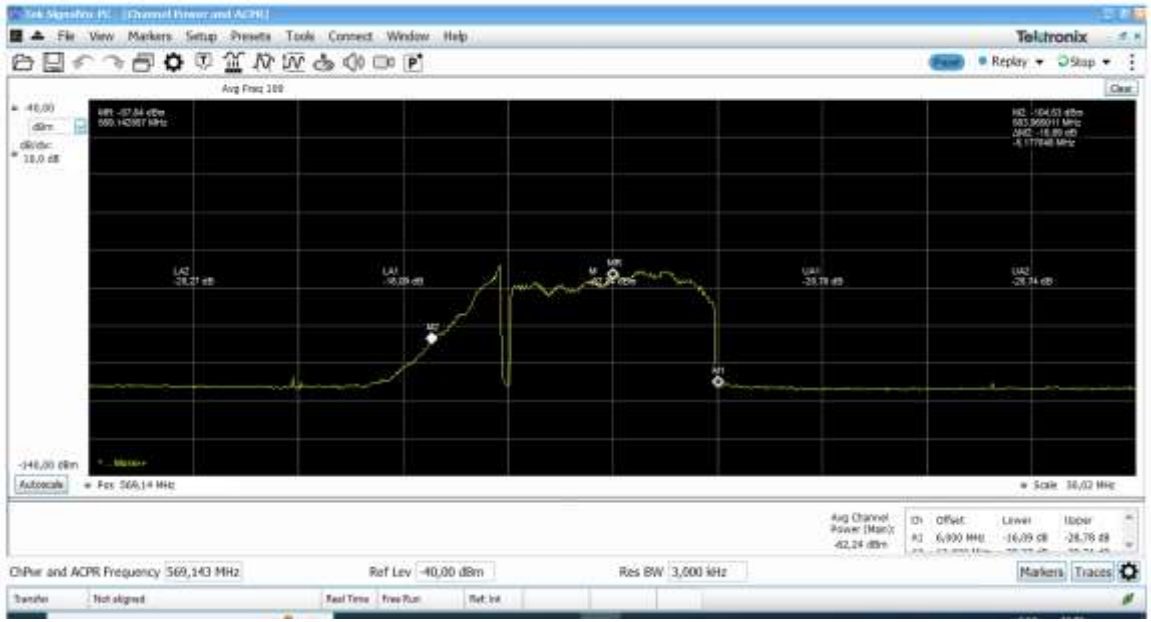


Figure 4.1 - Vertical

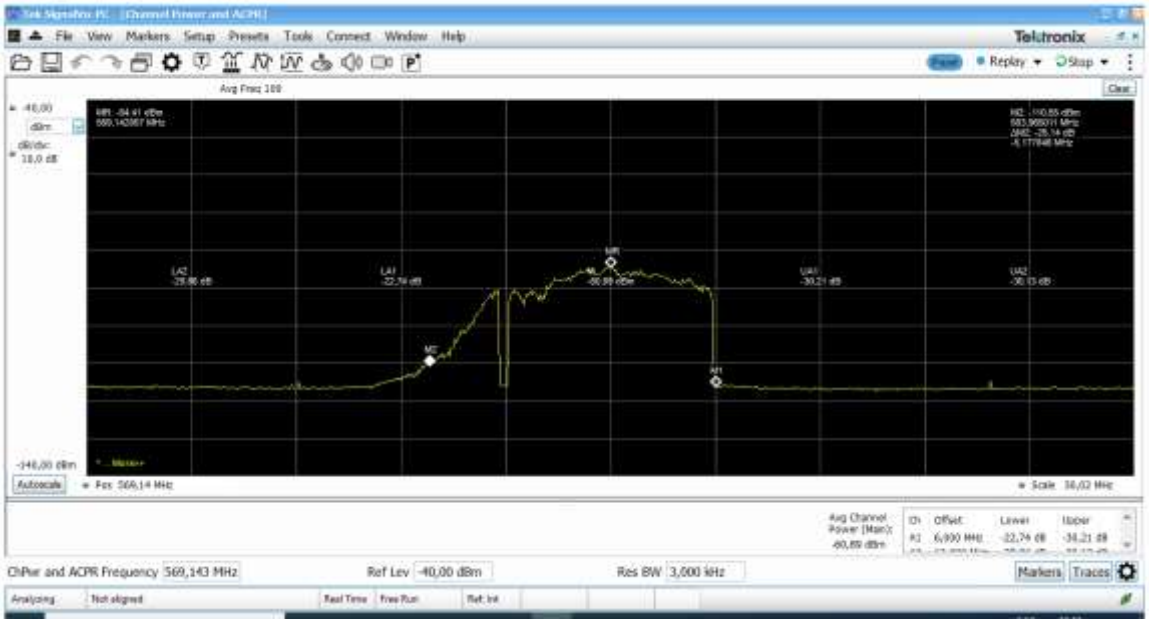


Figure 4.2 - Horizontal

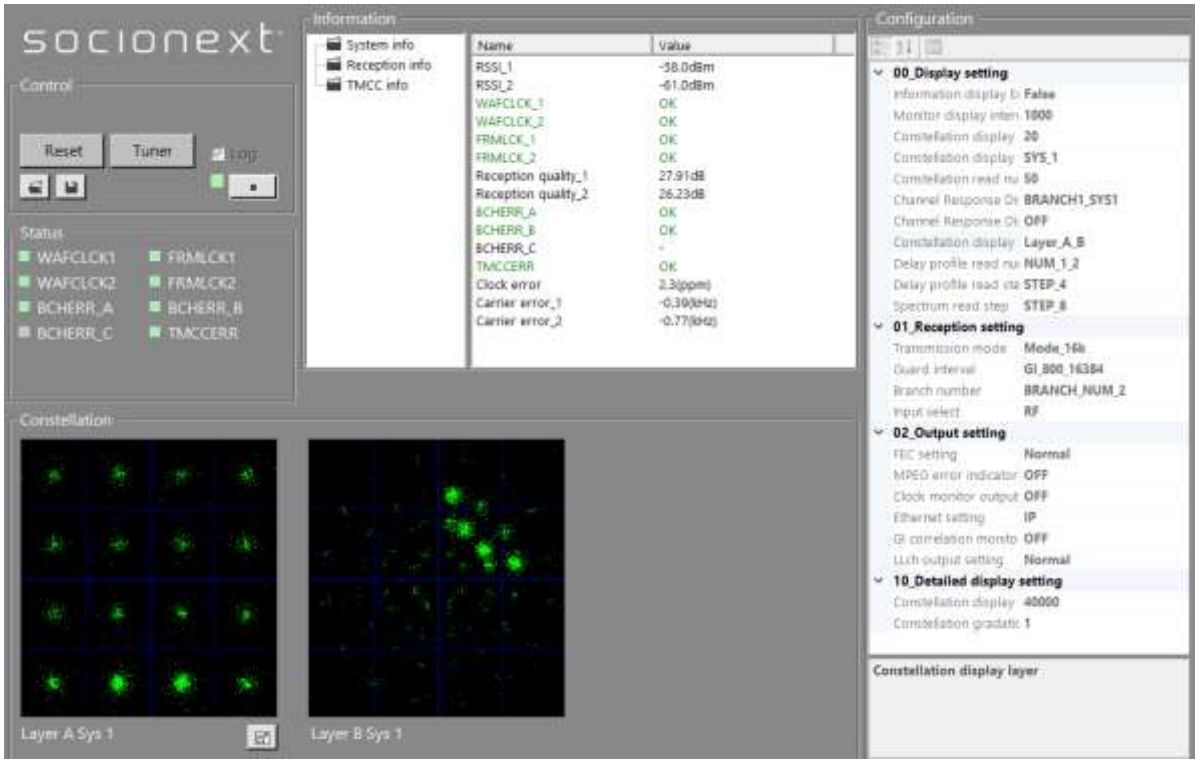


Figure 4.3 - Socionext Screen

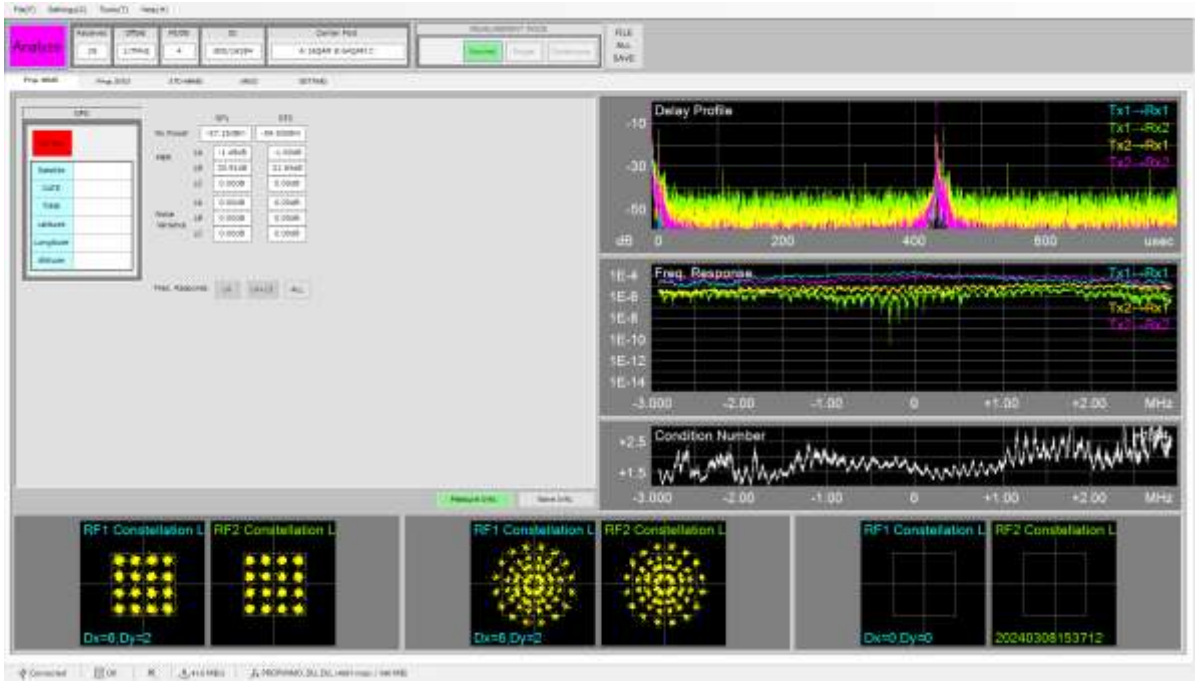


Figure 4.4 - Rintaro Screen

b) AWGN Power

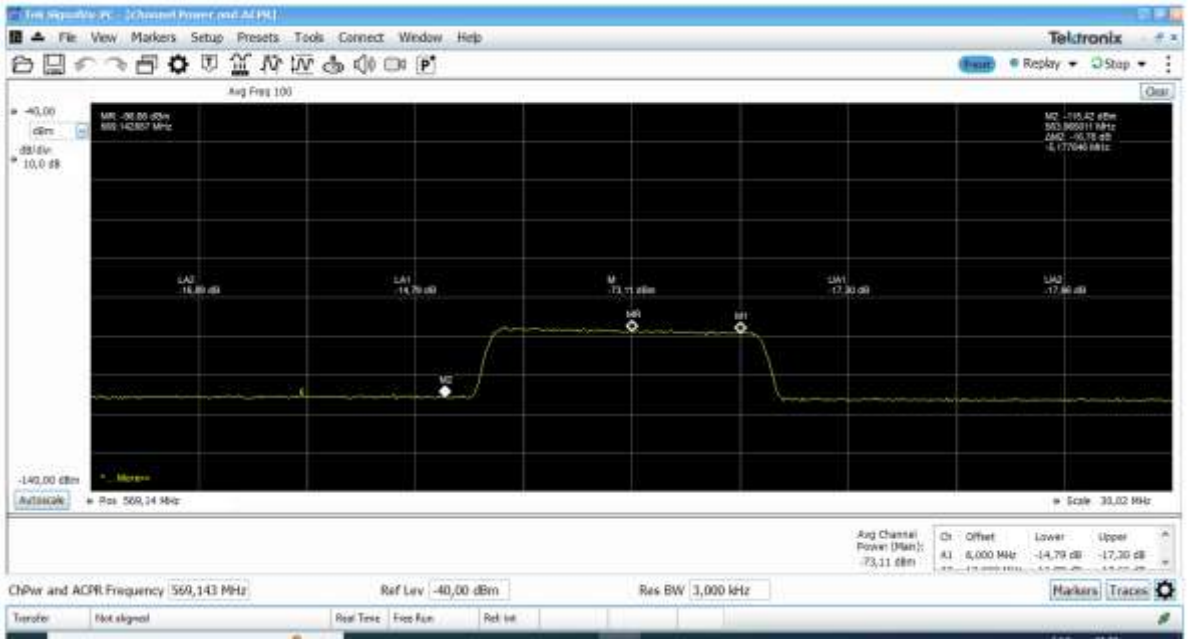


Figure 4.5 - Vertical

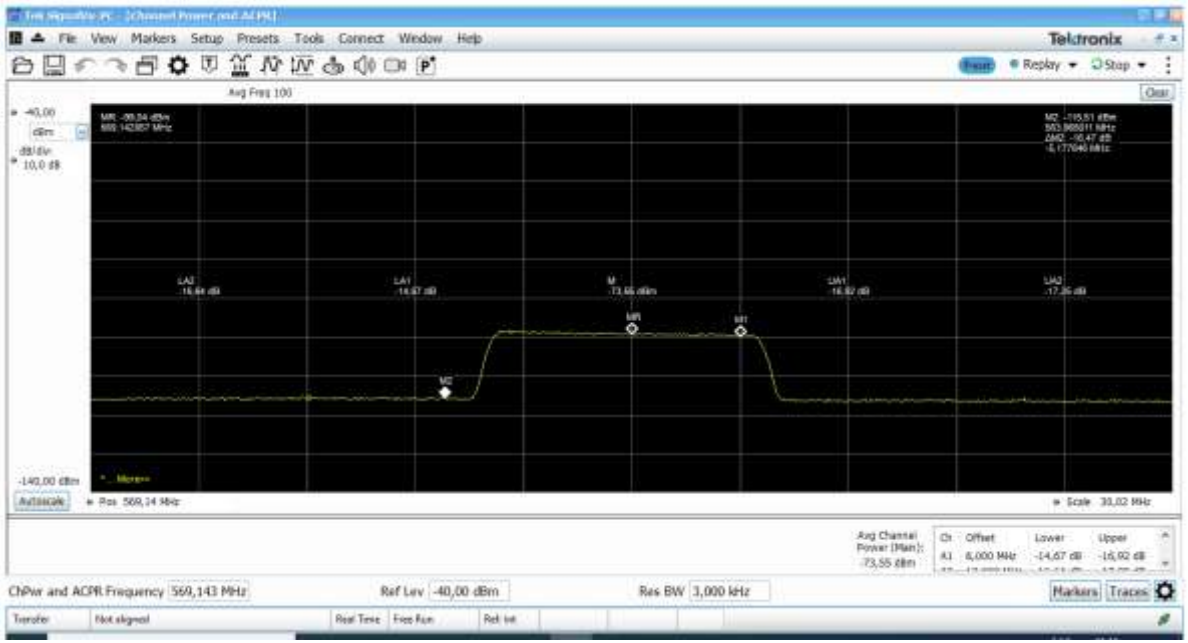


Figure 4.6 - Horizontal

c) C/N Threshold

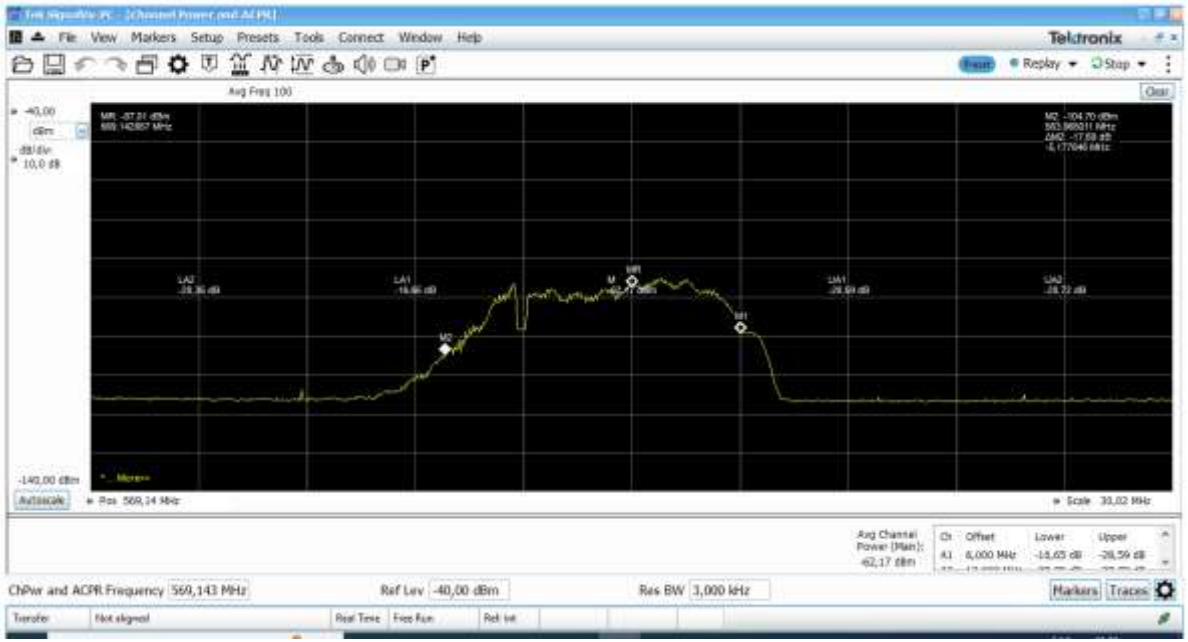


Figure 4.7 - Vertical

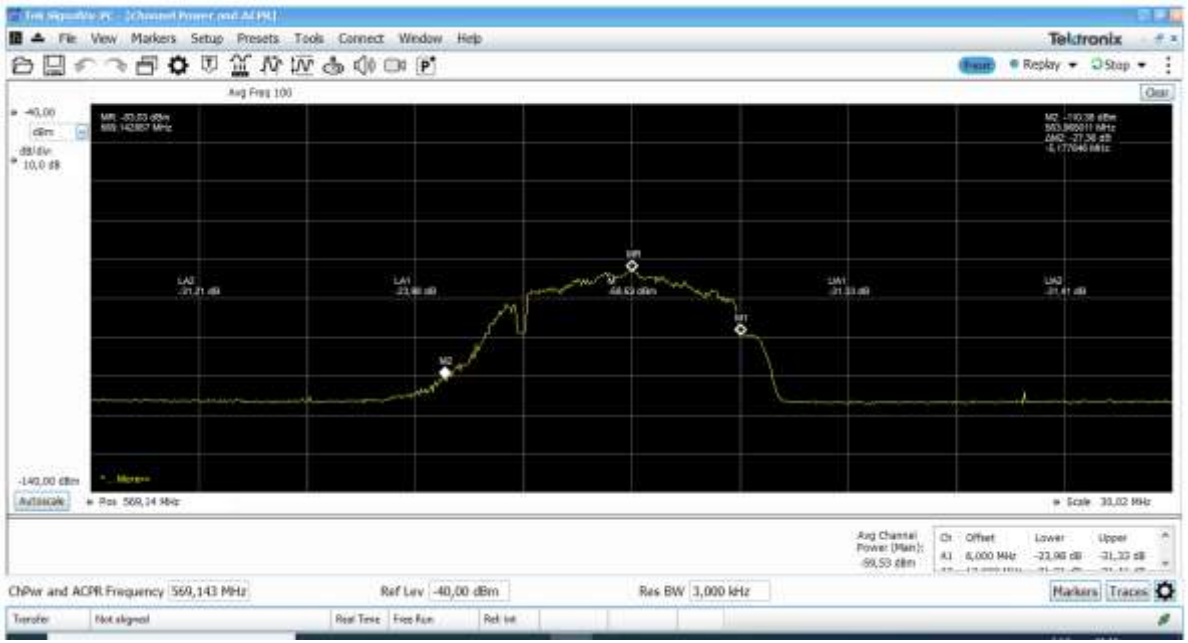


Figure 4.8 - Horizontal

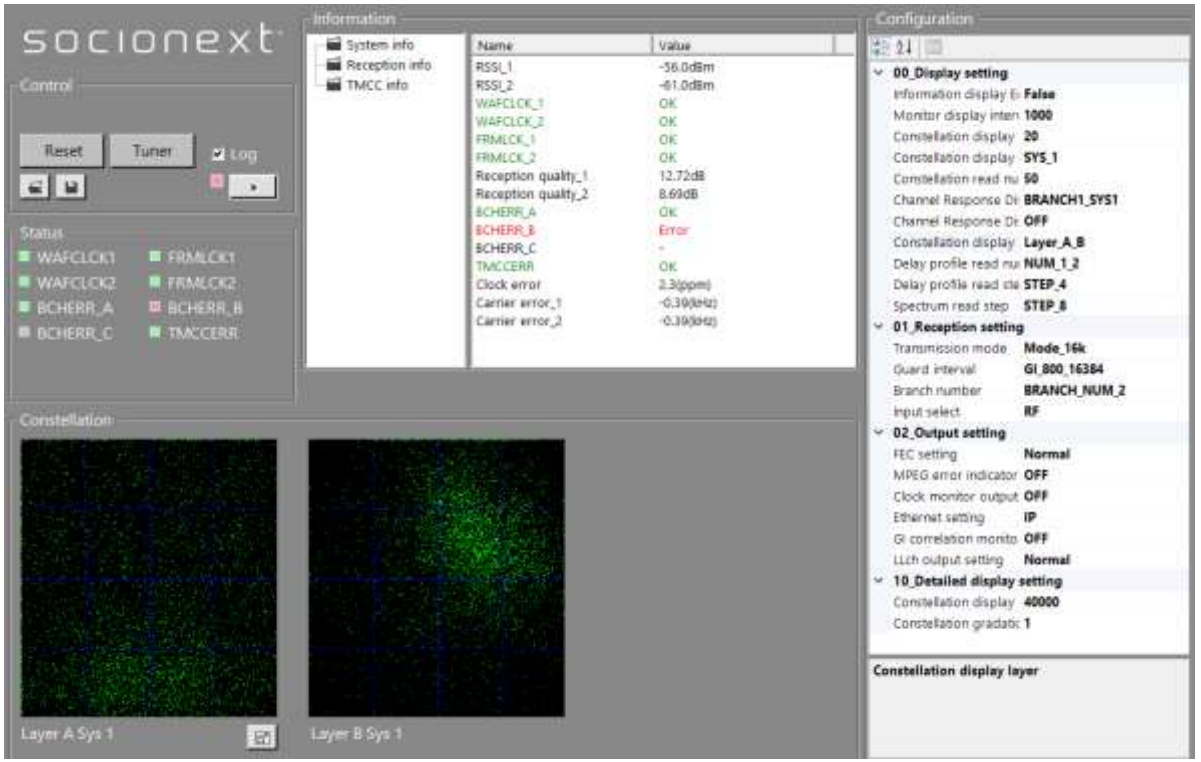


Figure 4.9 - Socionext Screen

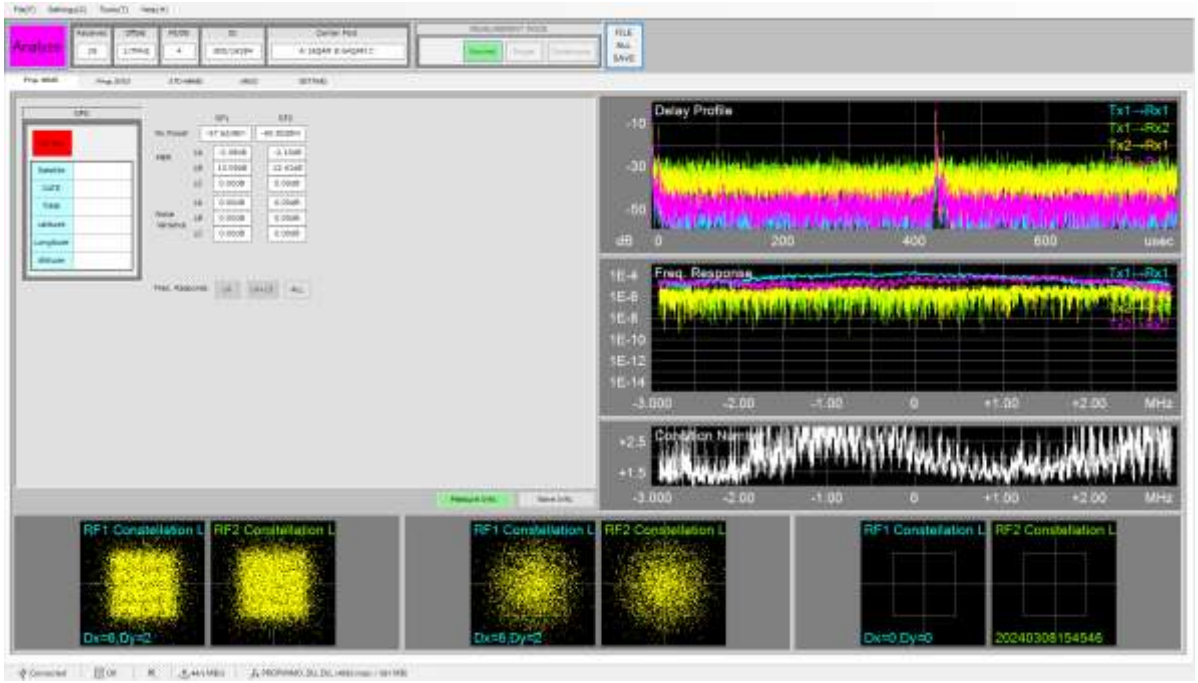


Figure 4.10 - Rintaro Screen

d) Reception Threshold

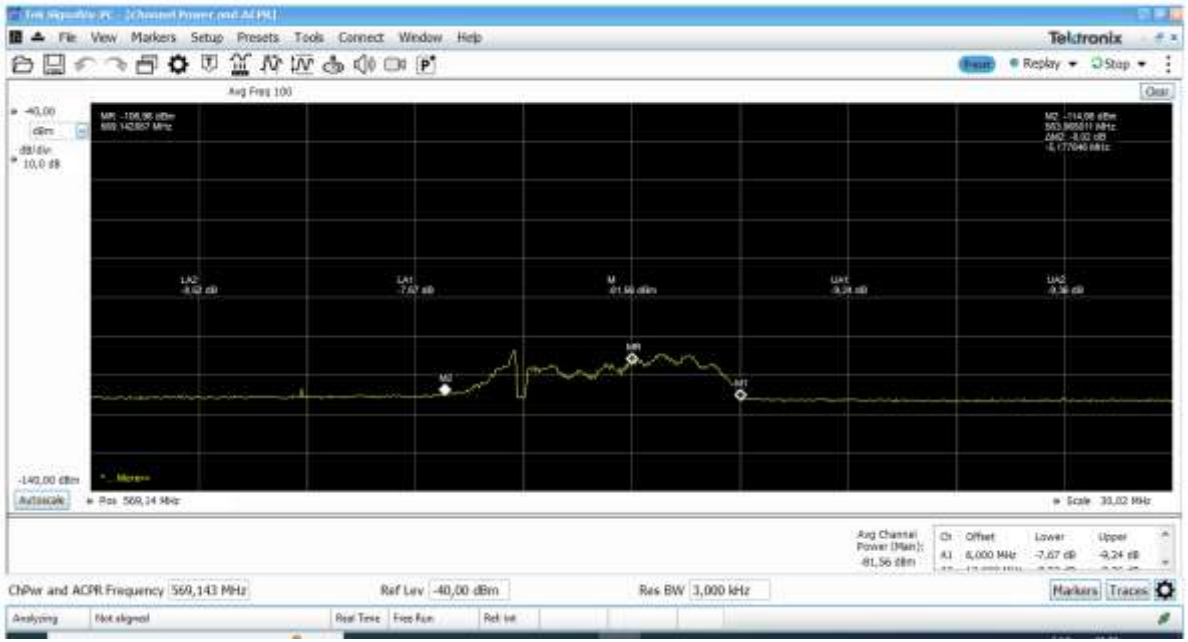


Figure 4.11 - Vertical

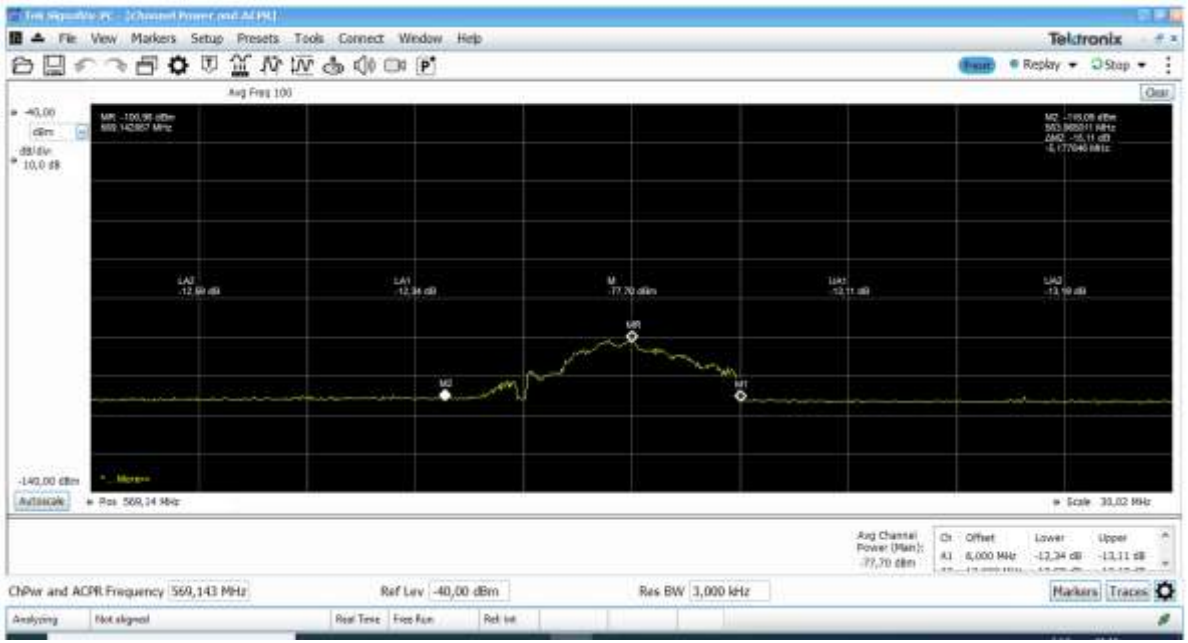


Figure 4.12 - Horizontal

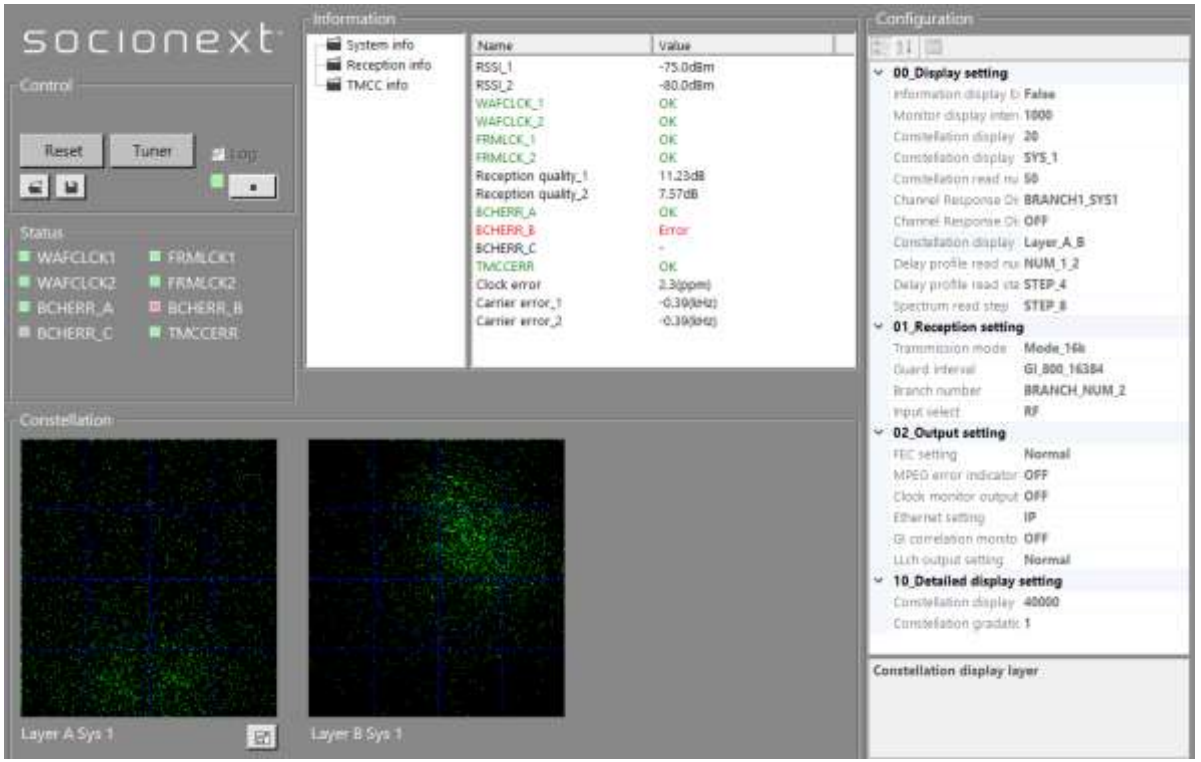


Figure 4.13 - Socionext Screen

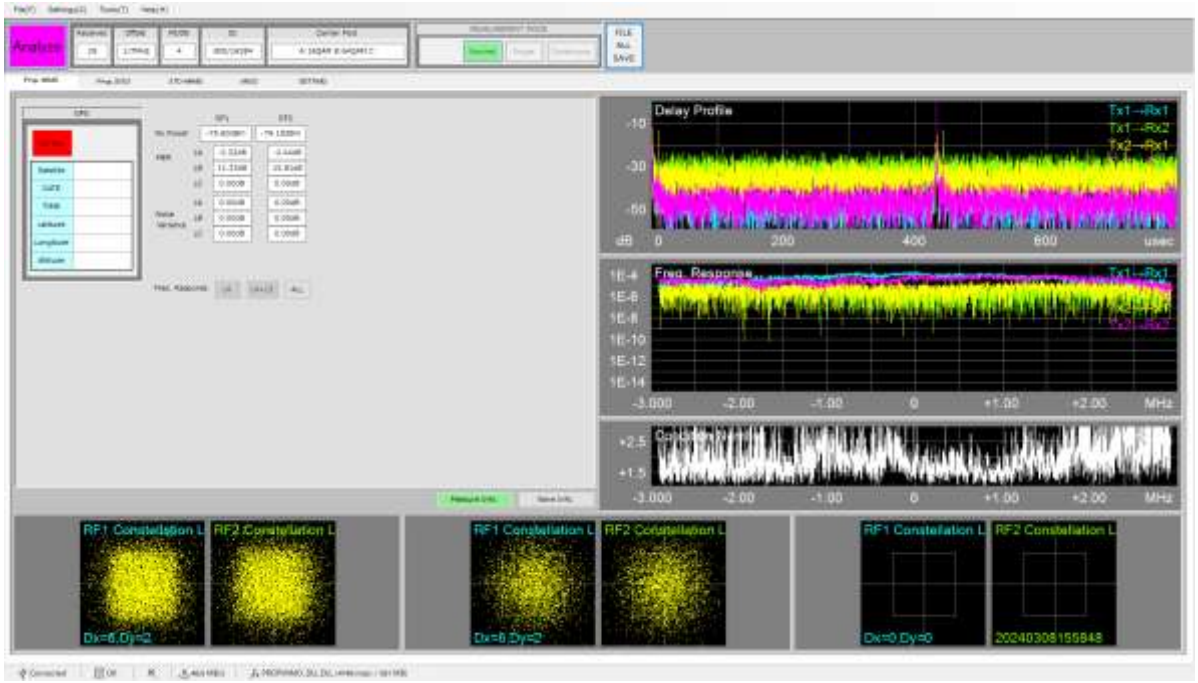


Figure 4.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

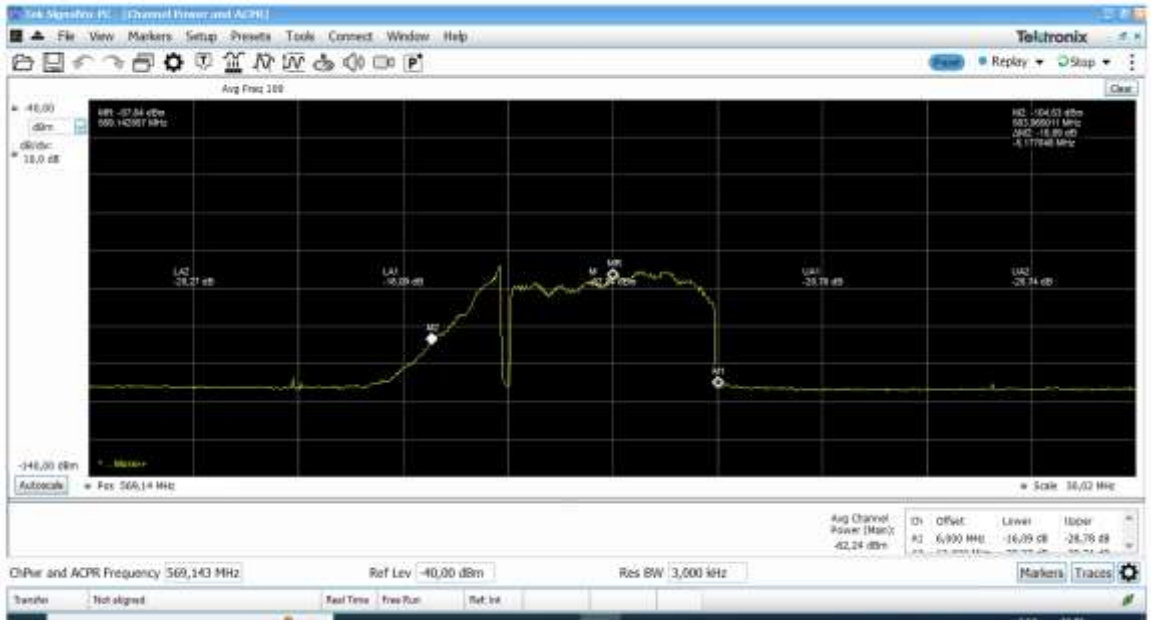


Figure 4.15 - Vertical

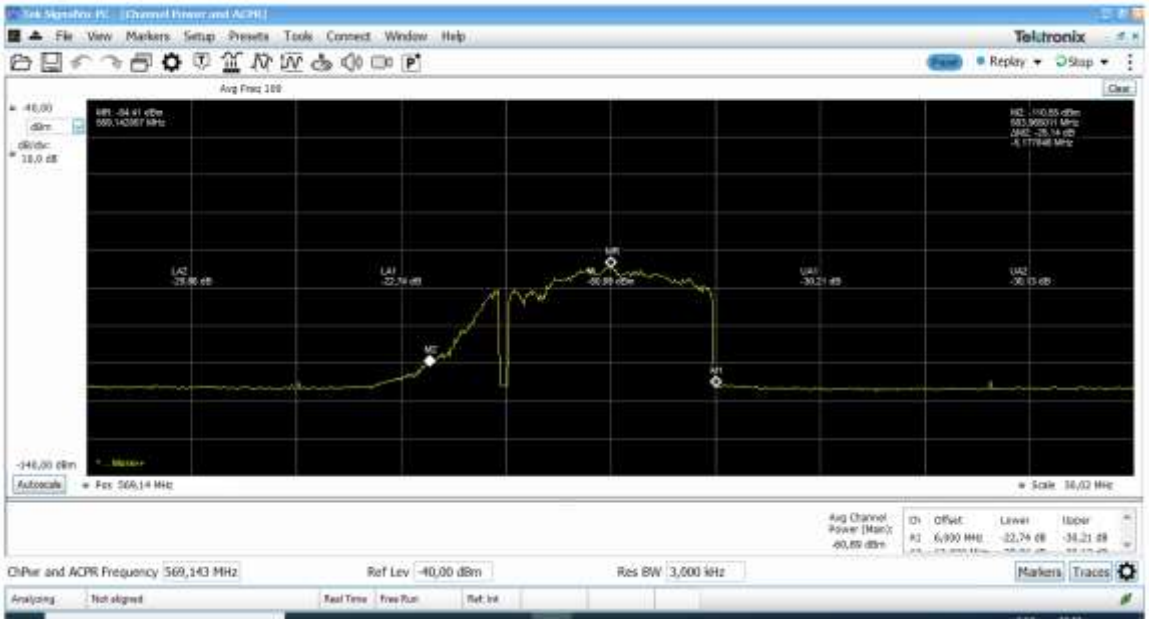


Figure 4.16 - Horizontal

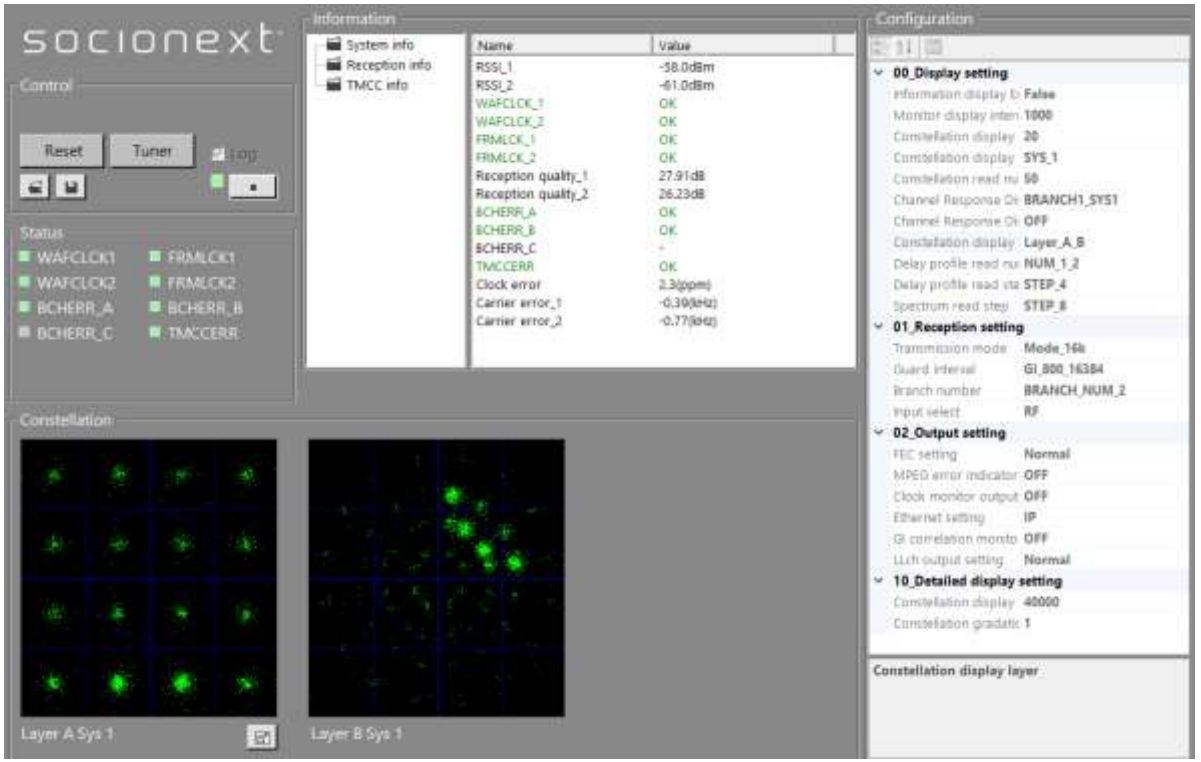


Figure 4.17 - Socionext Screen

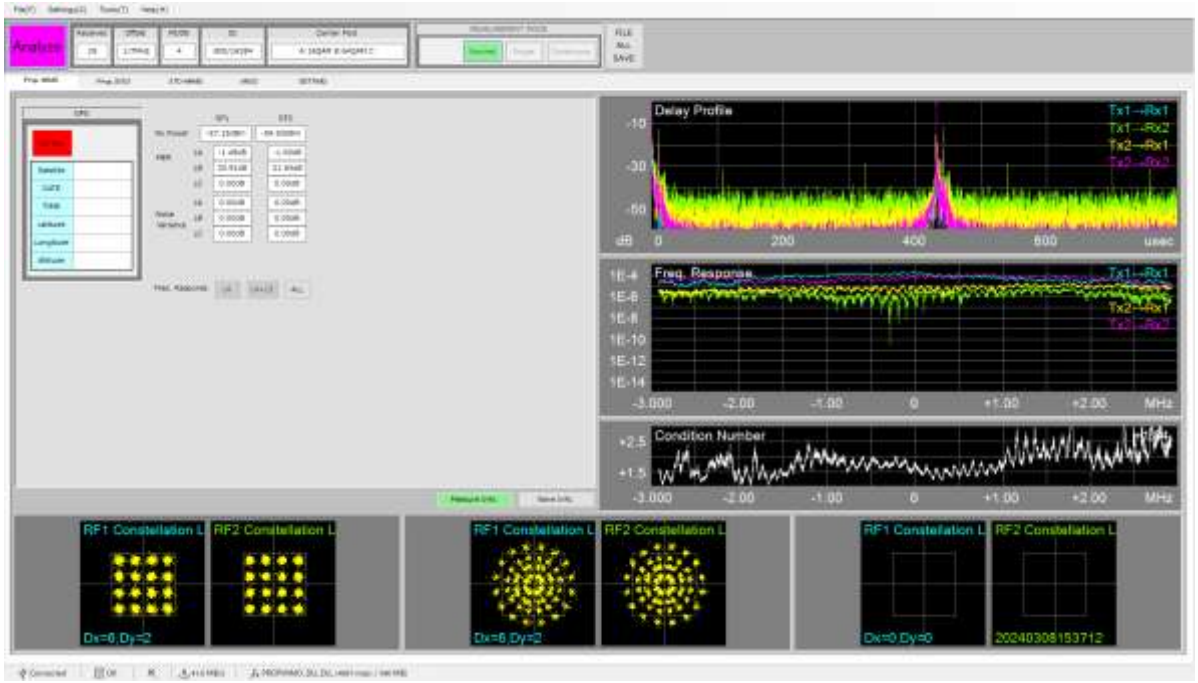


Figure 4.18 - Rintaro Screen

b) AWGN Power

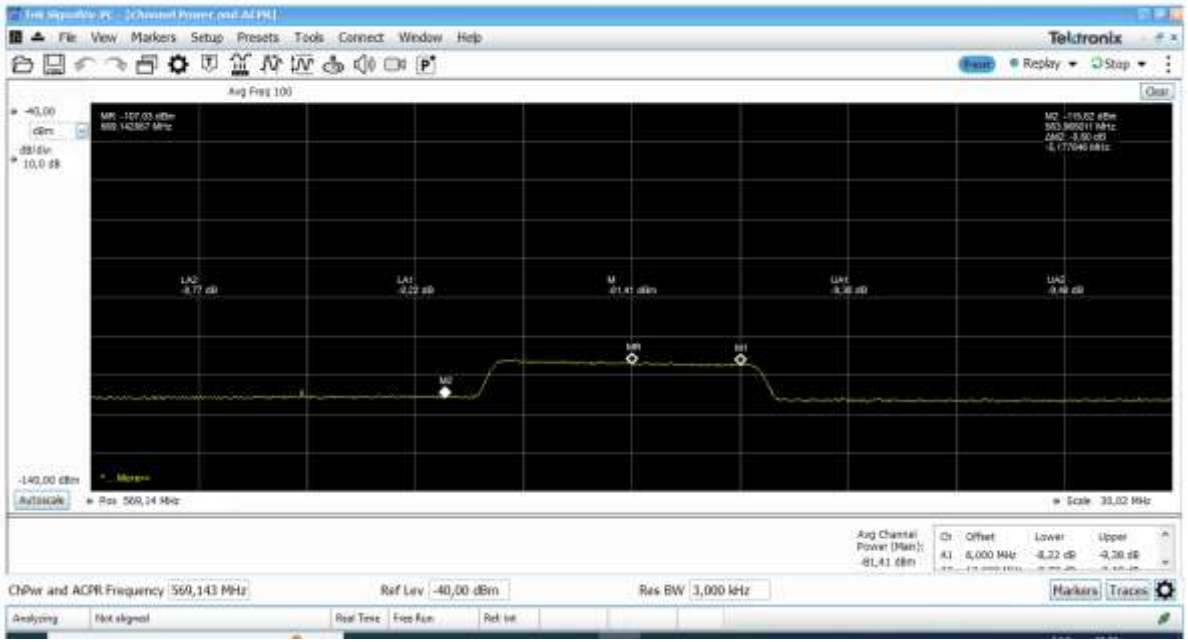


Figure 4.19 - Vertical

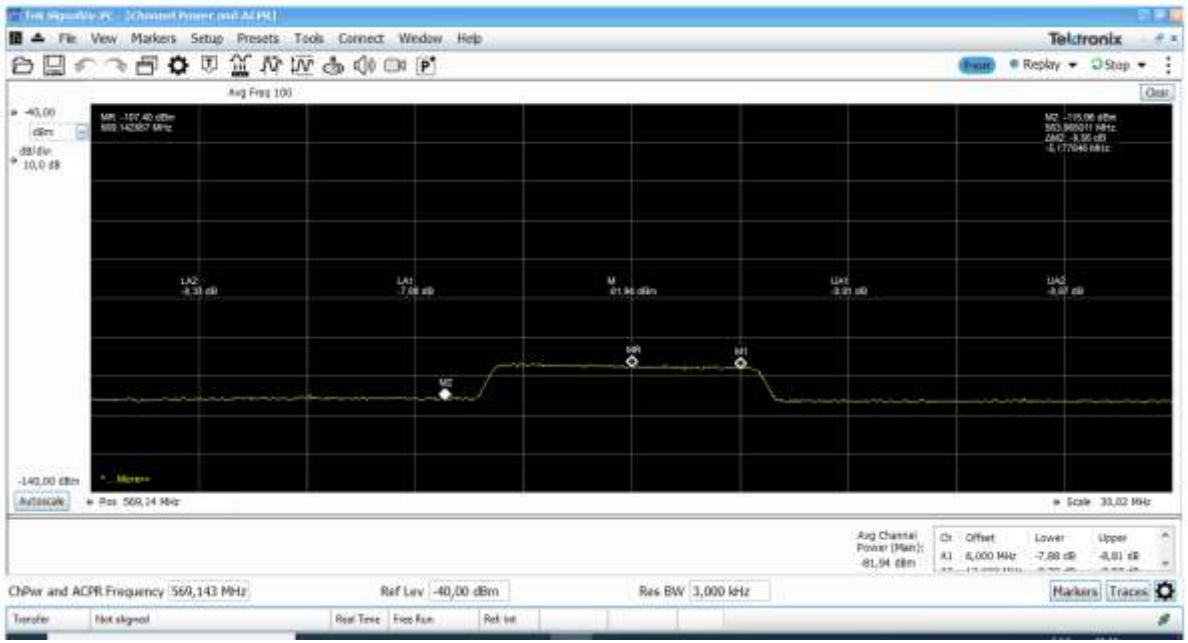


Figure 4.20 - Horizontal

c) C/N Threshold

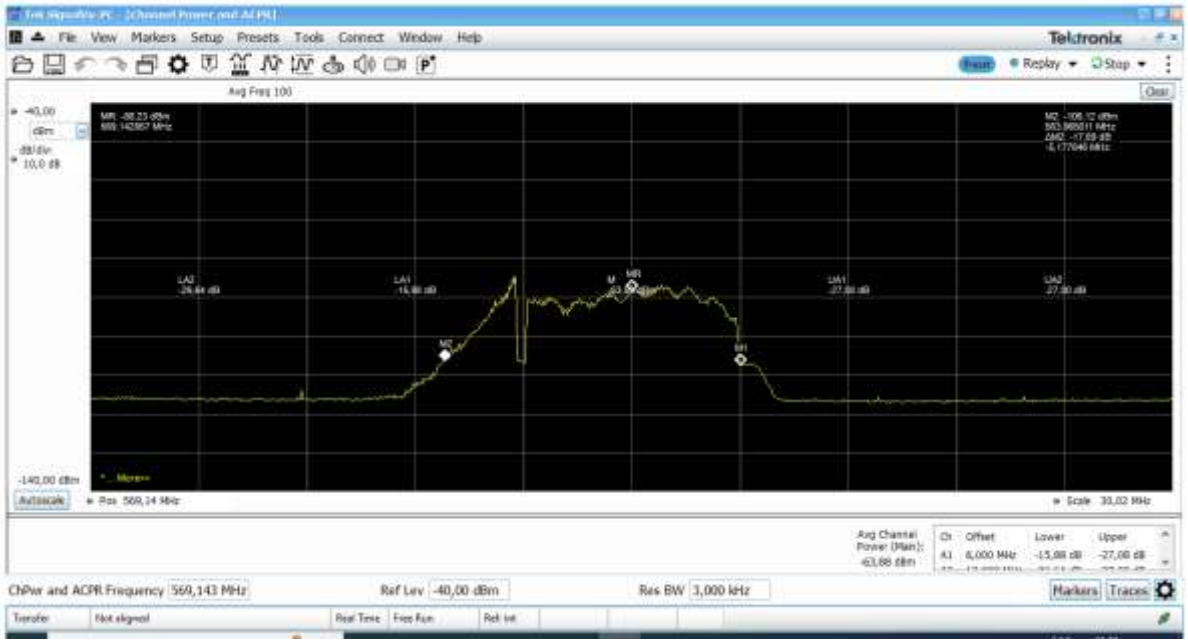


Figure 4.21 - Vertical

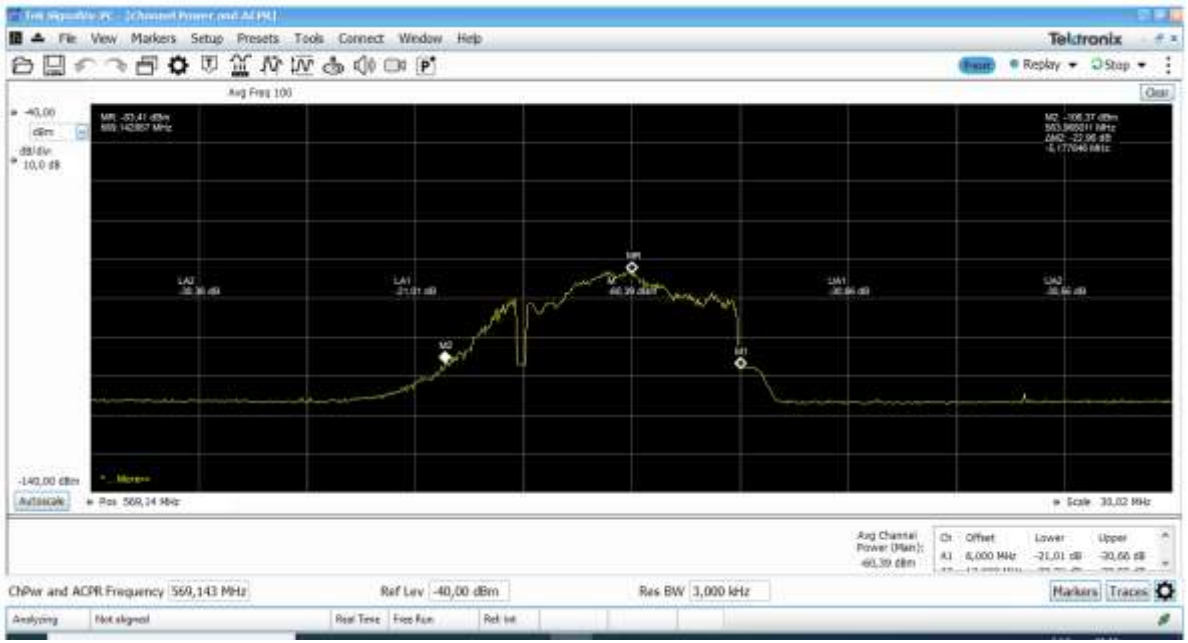


Figure 4.22 - Horizontal

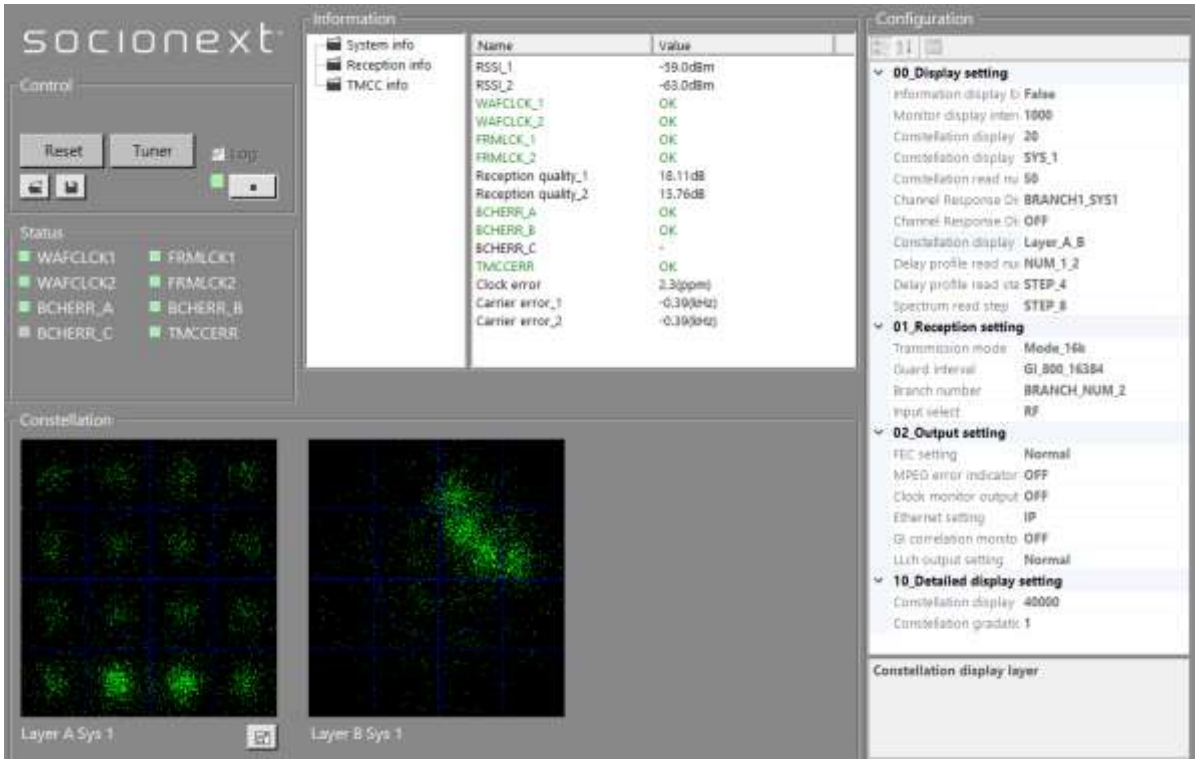


Figure 4.23 - Socionext Screen

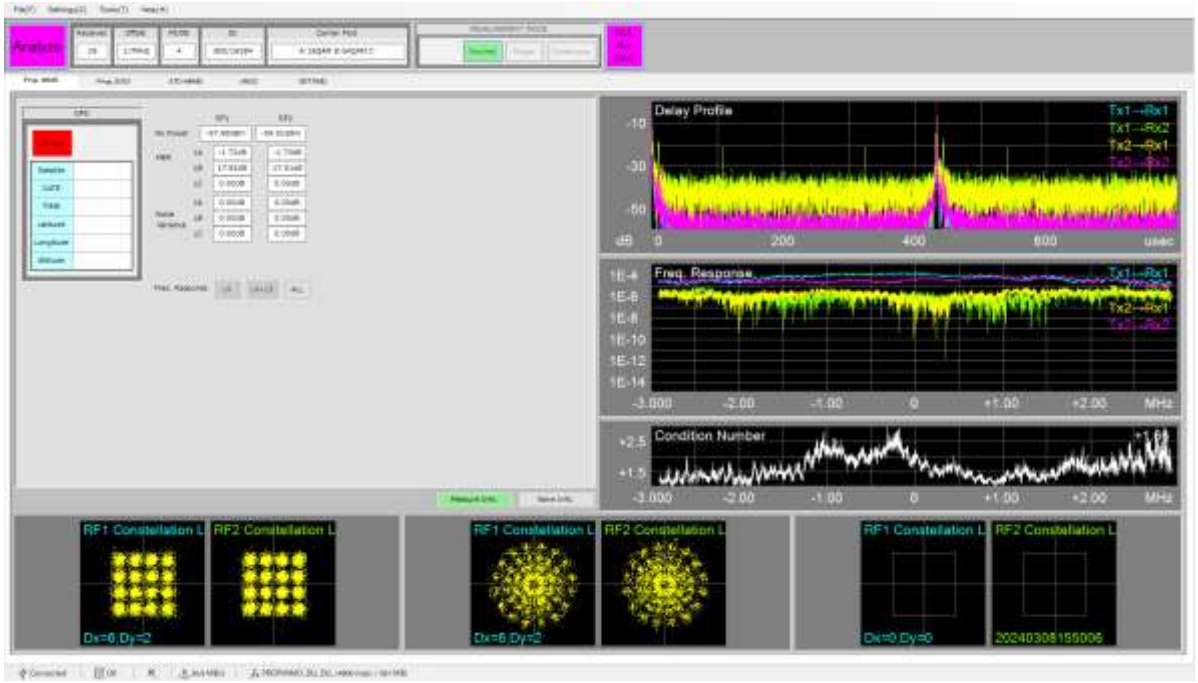


Figure 4.24 - Rintaro Screen

d) Reception Threshold

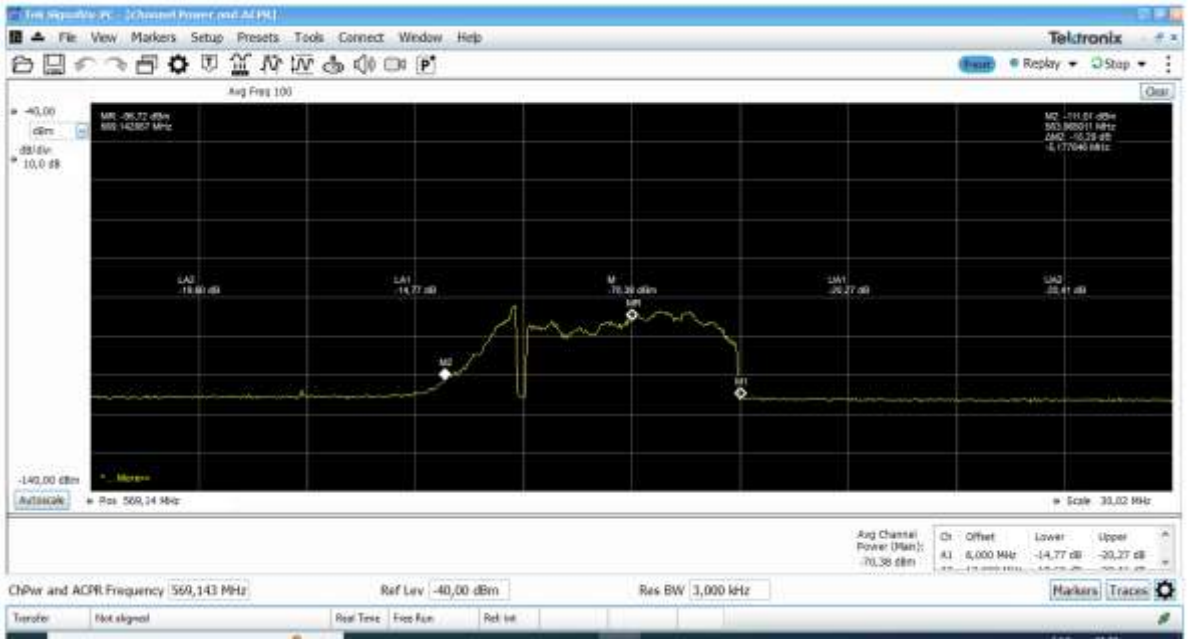


Figure 4.25 - Vertical

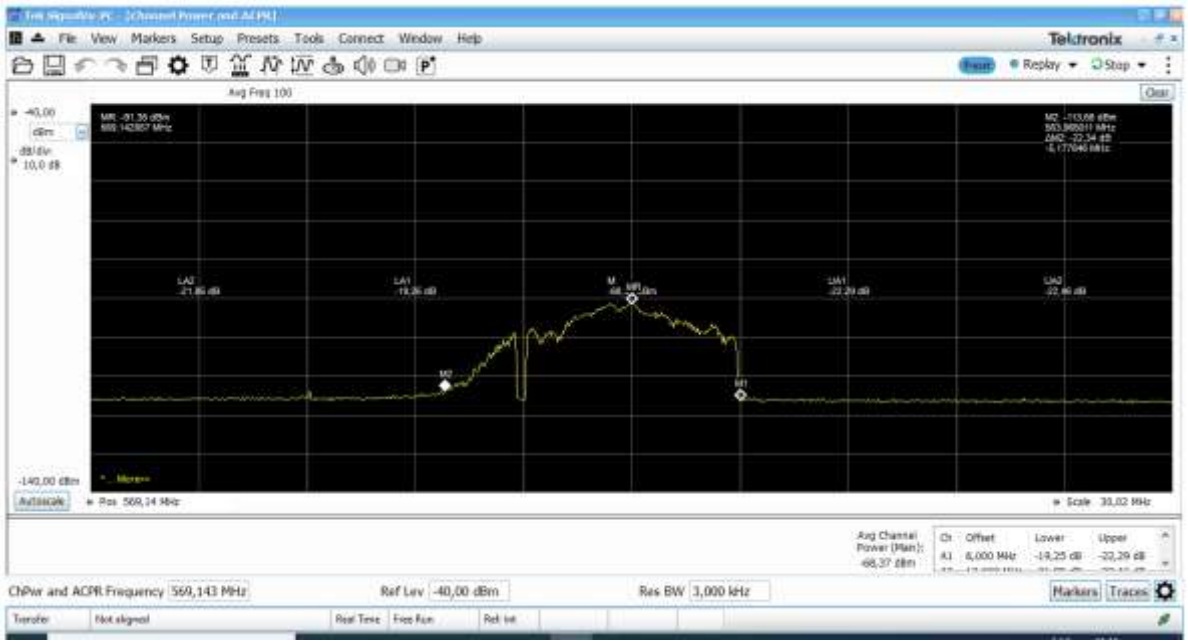


Figure 4.26 - Horizontal

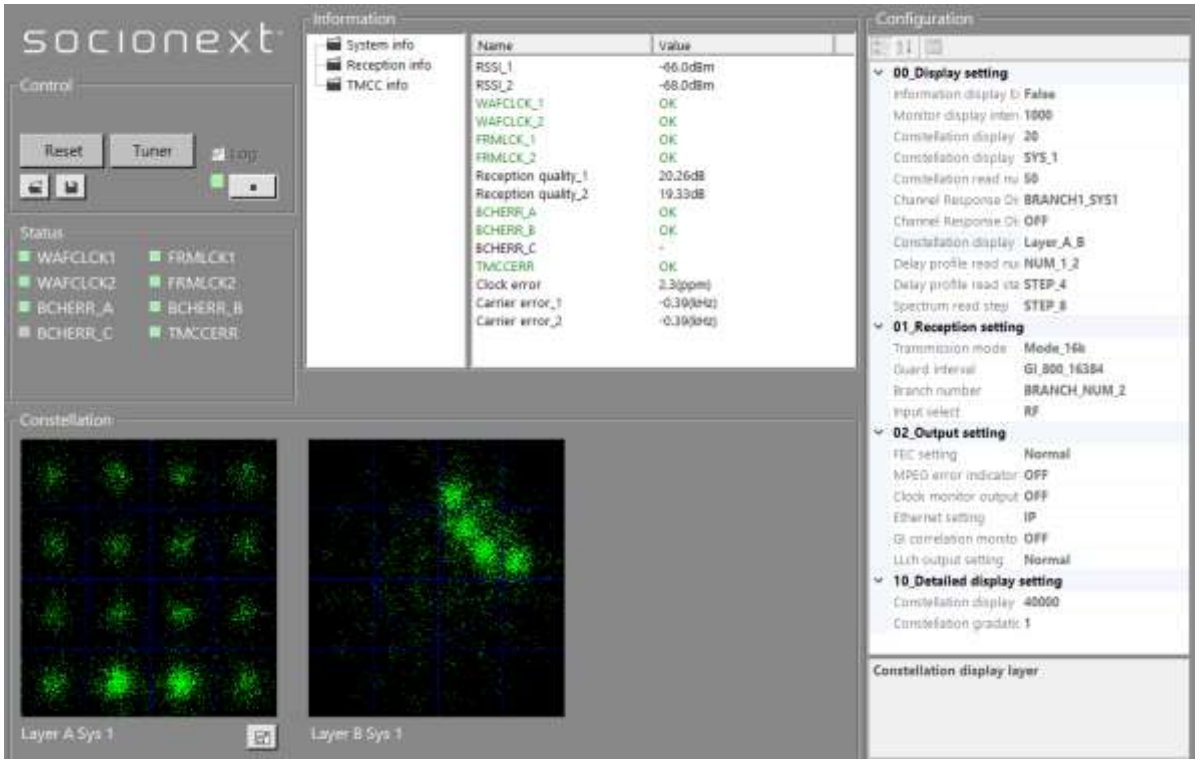


Figure 4.27 - Socionext Screen

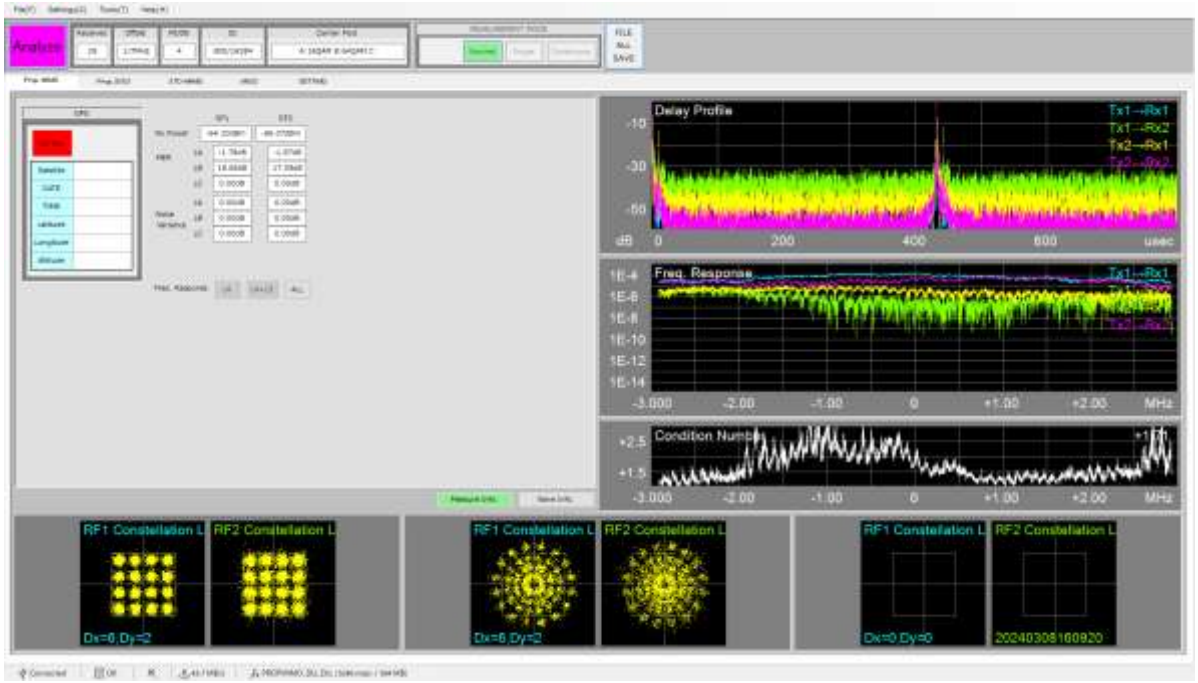


Figure 4.28 - Rintaro Screen

Chapter 5. Site 7

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

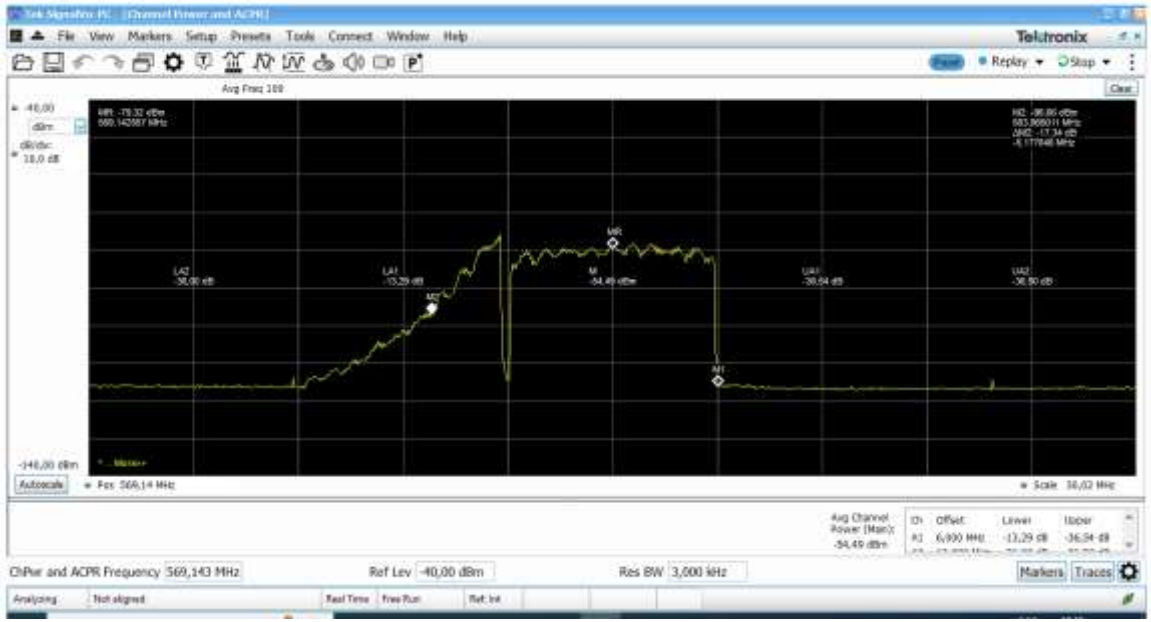


Figure 5.1 - Vertical

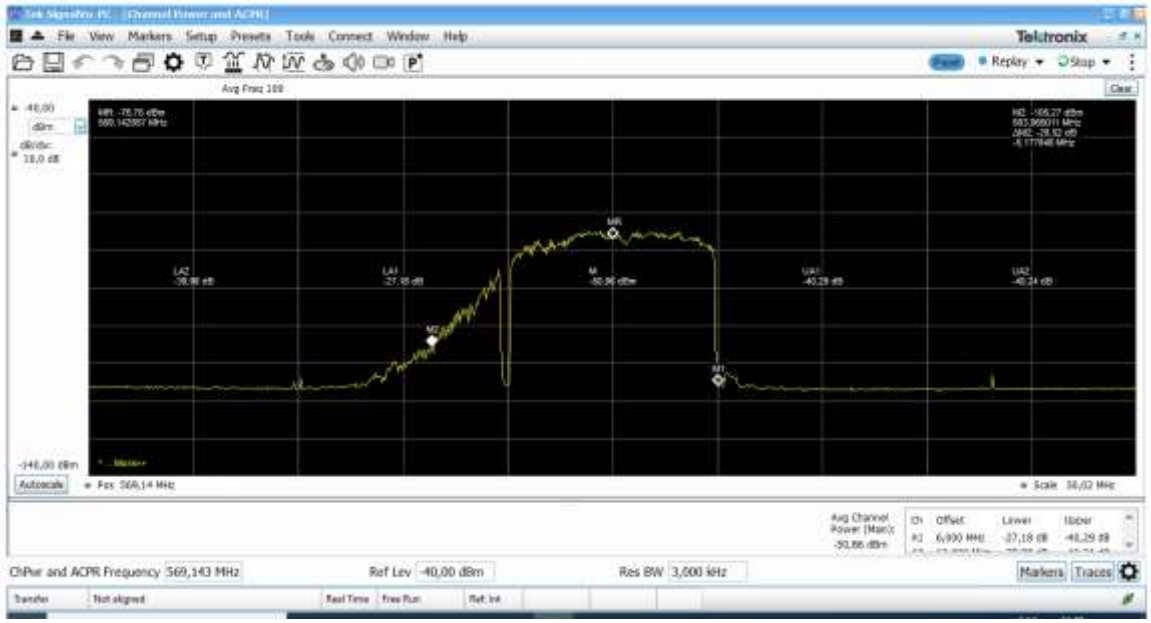


Figure 5.2 - Horizontal

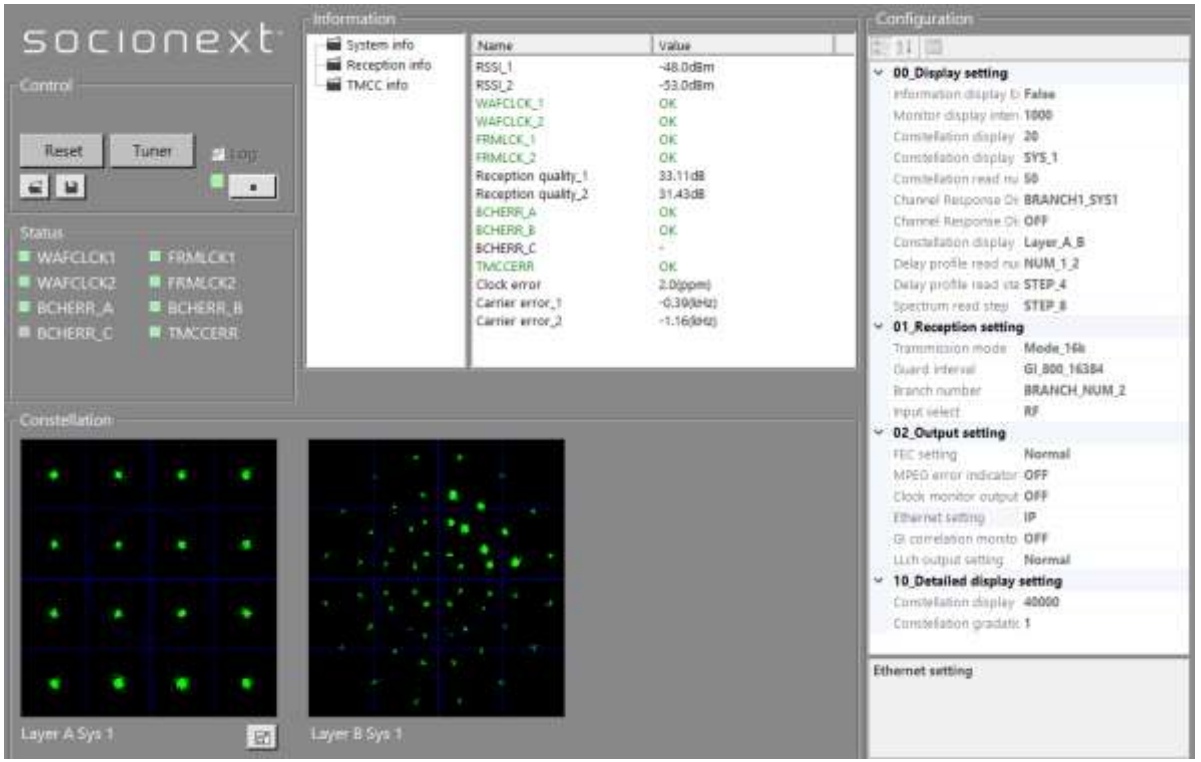


Figure 5.3 - Socionext Screen

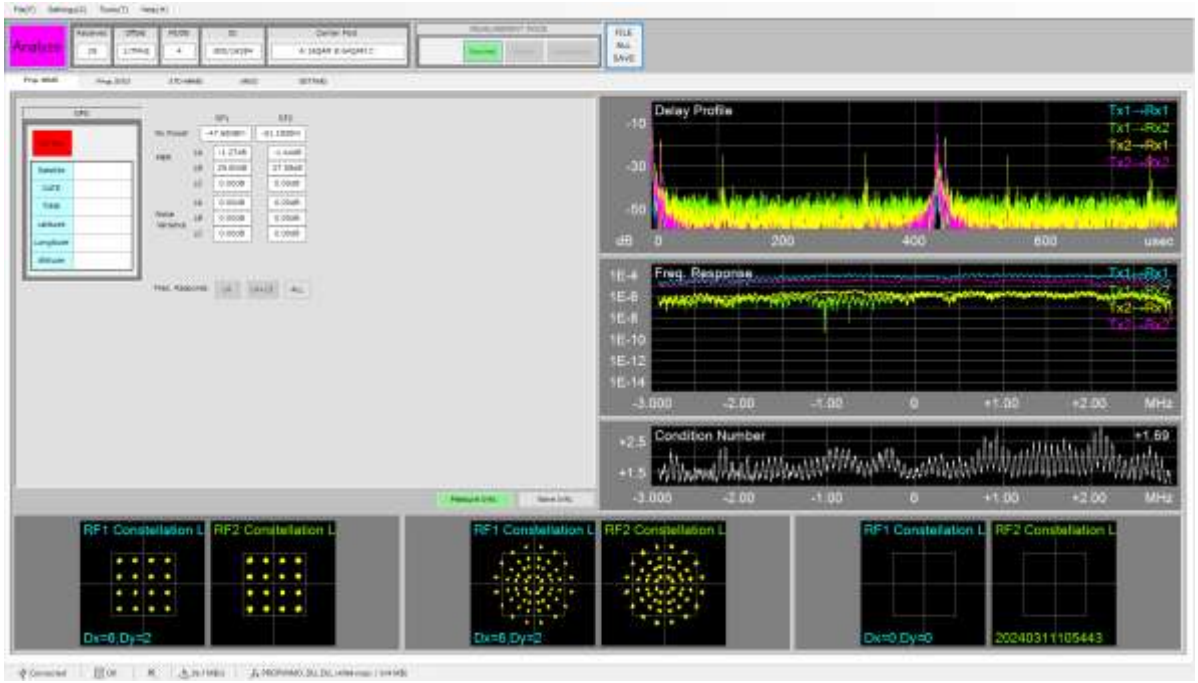


Figure 5.4 - Rintaro Screen

b) AWGN Power

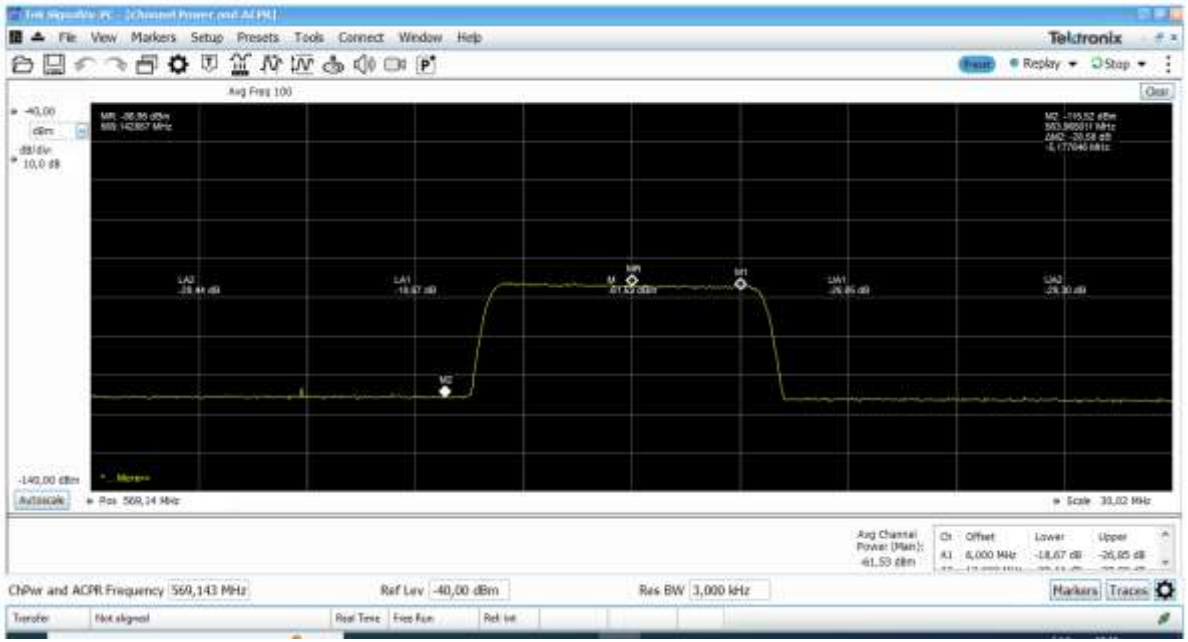


Figure 5.5 - Vertical

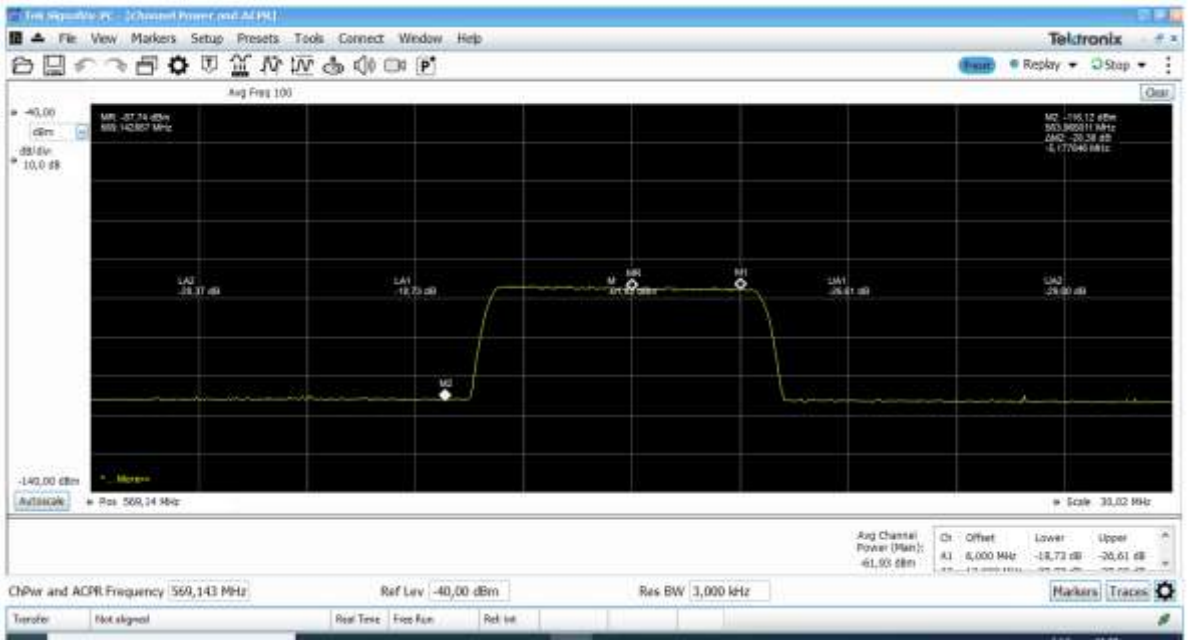


Figure 5.6 - Horizontal

c) C/N Threshold

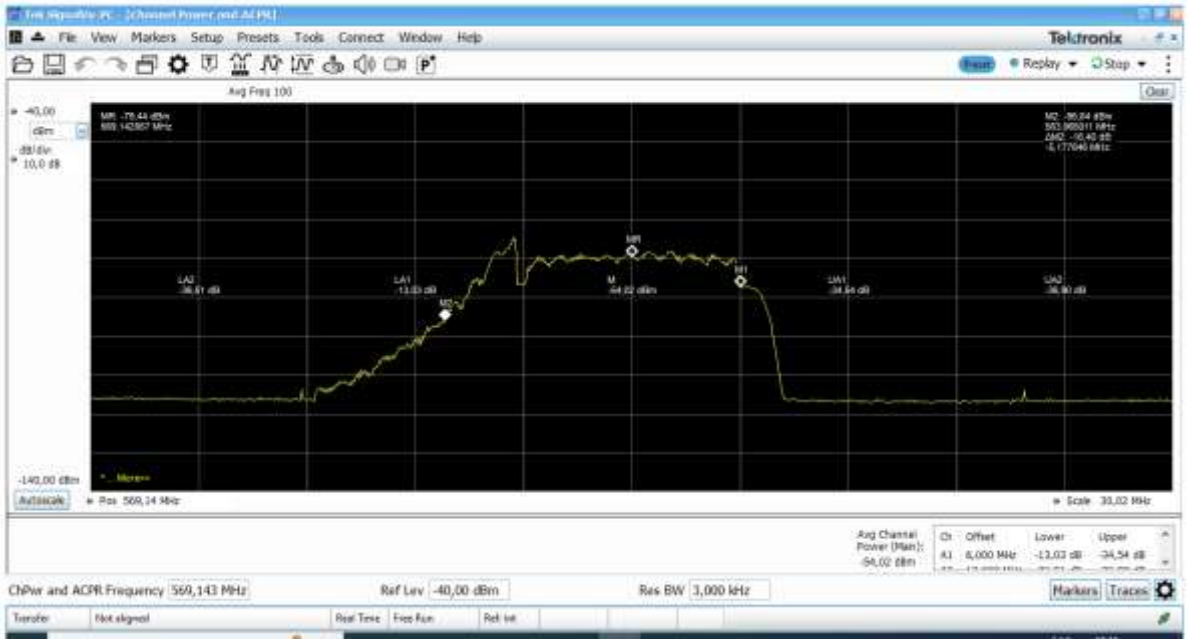


Figure 5.7 - Vertical

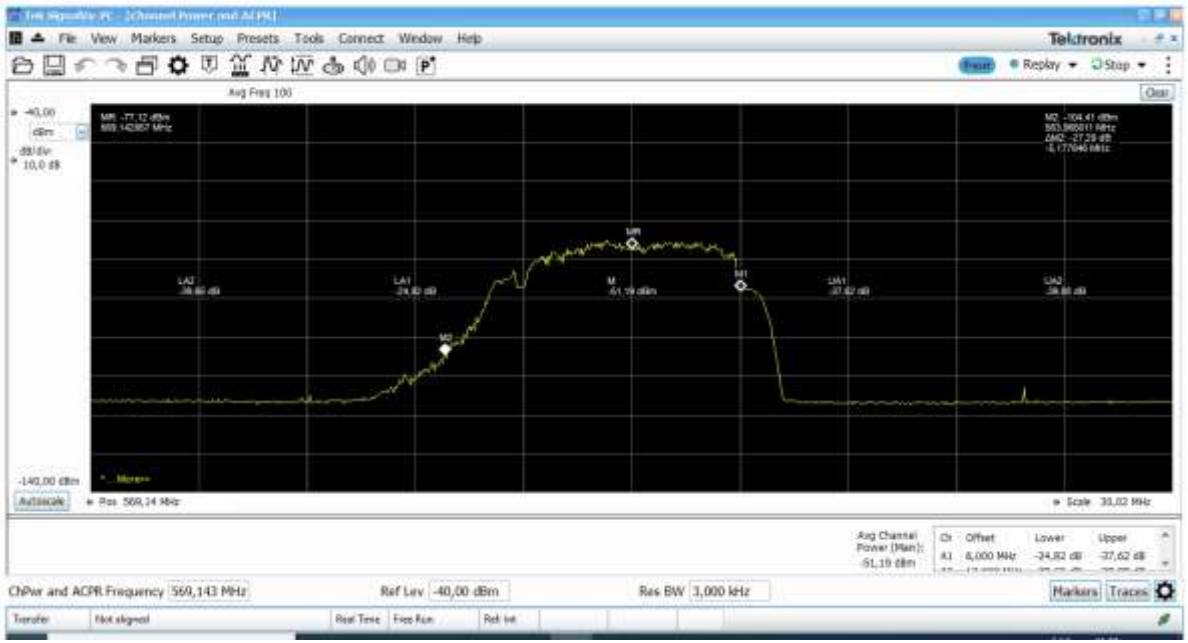


Figure 5.8 - Horizontal

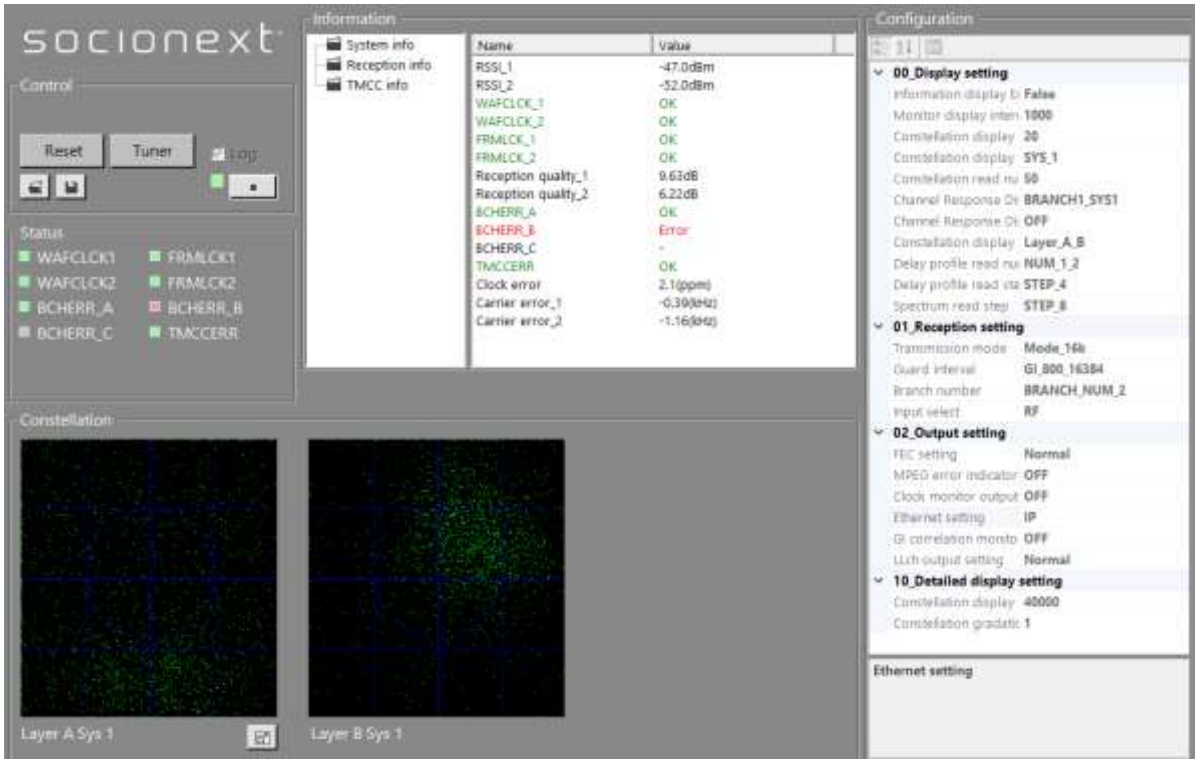


Figure 5.9 - Socionext Screen

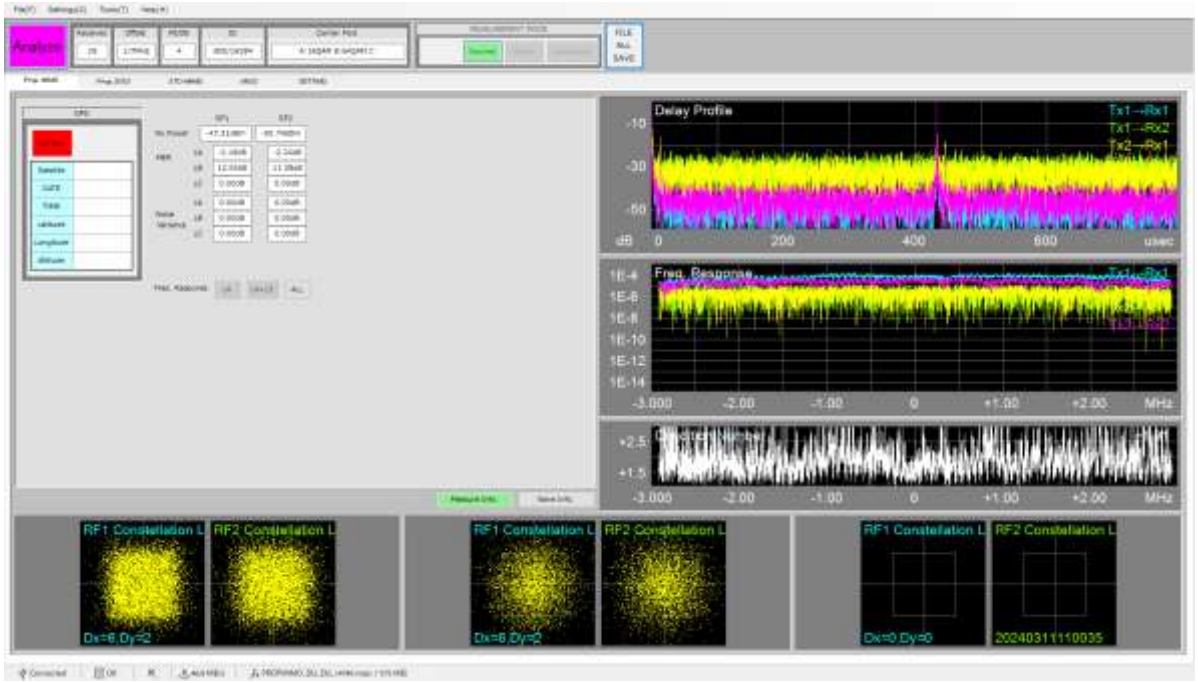


Figure 5.10 - Rintaro Screen

d) Reception Threshold

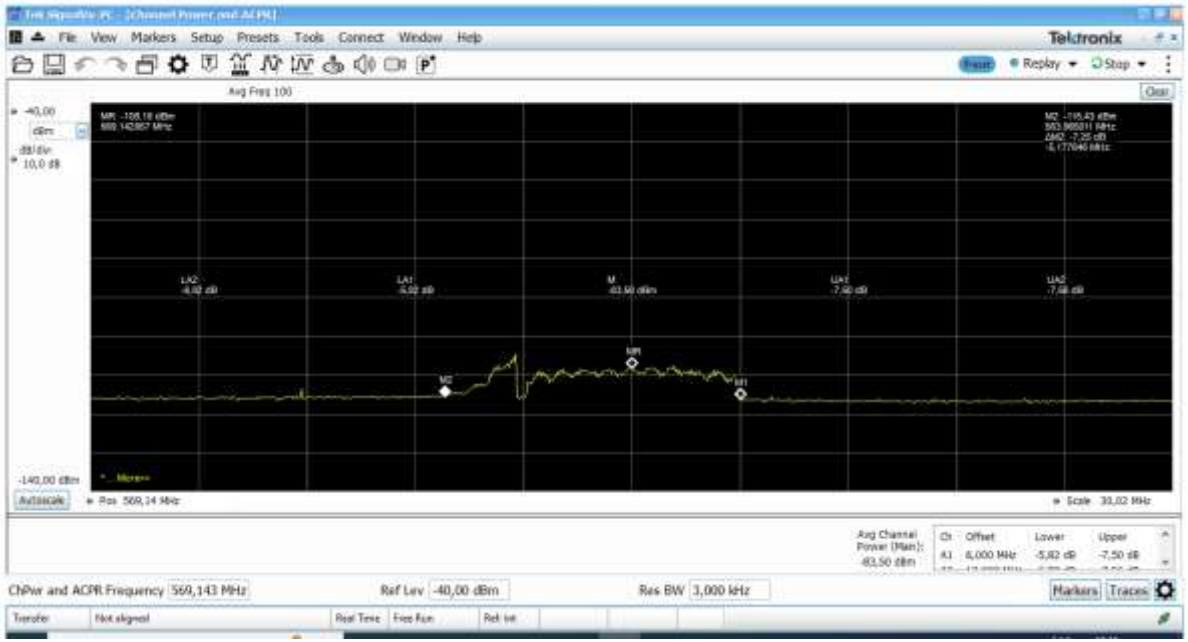


Figure 5.11 - Vertical

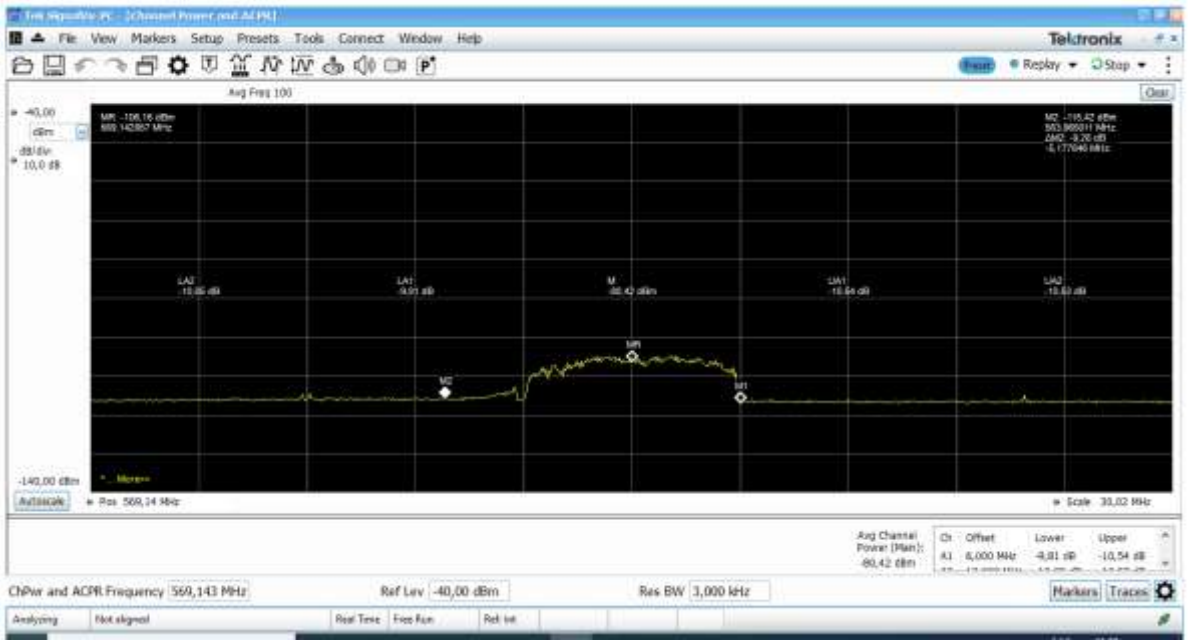


Figure 5.12 - Horizontal

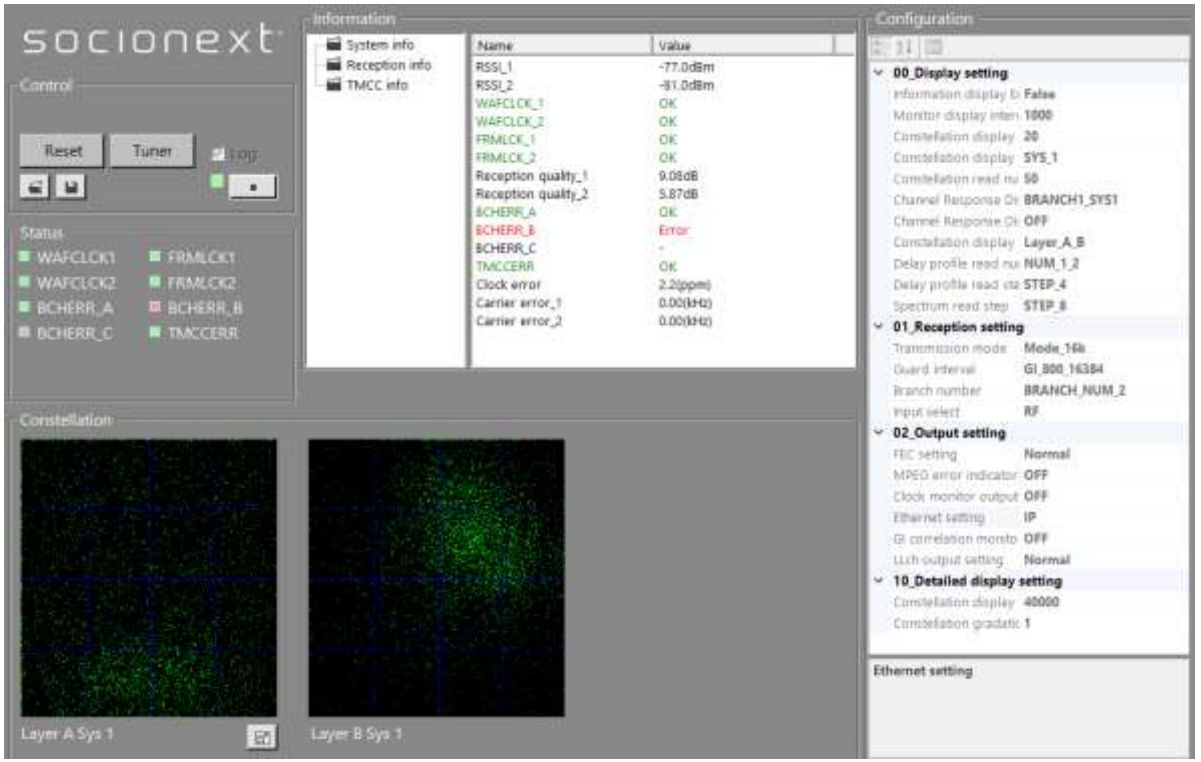


Figure 5.13 - Socionext Screen

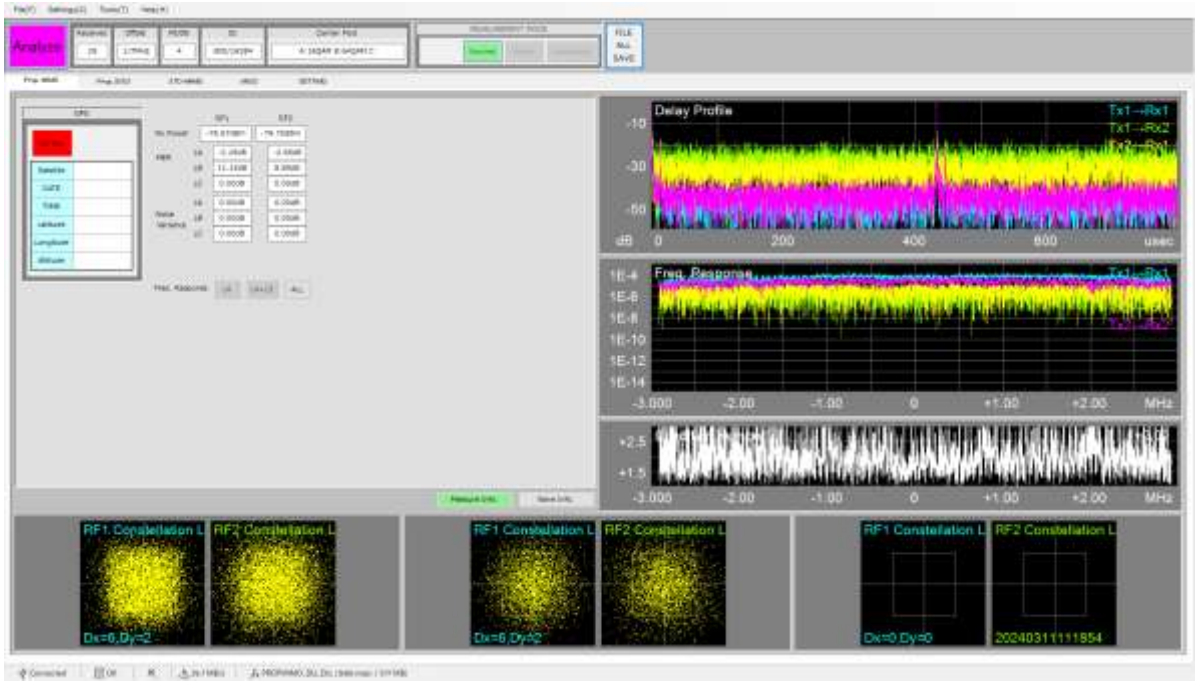


Figure 5.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

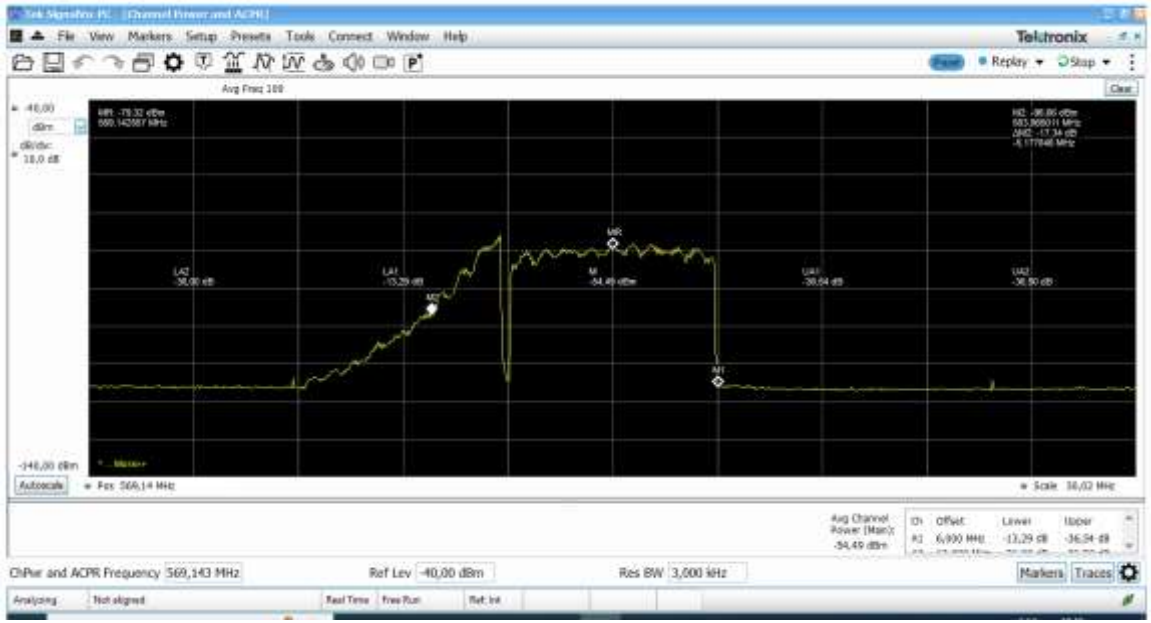


Figure 5.15 - Vertical

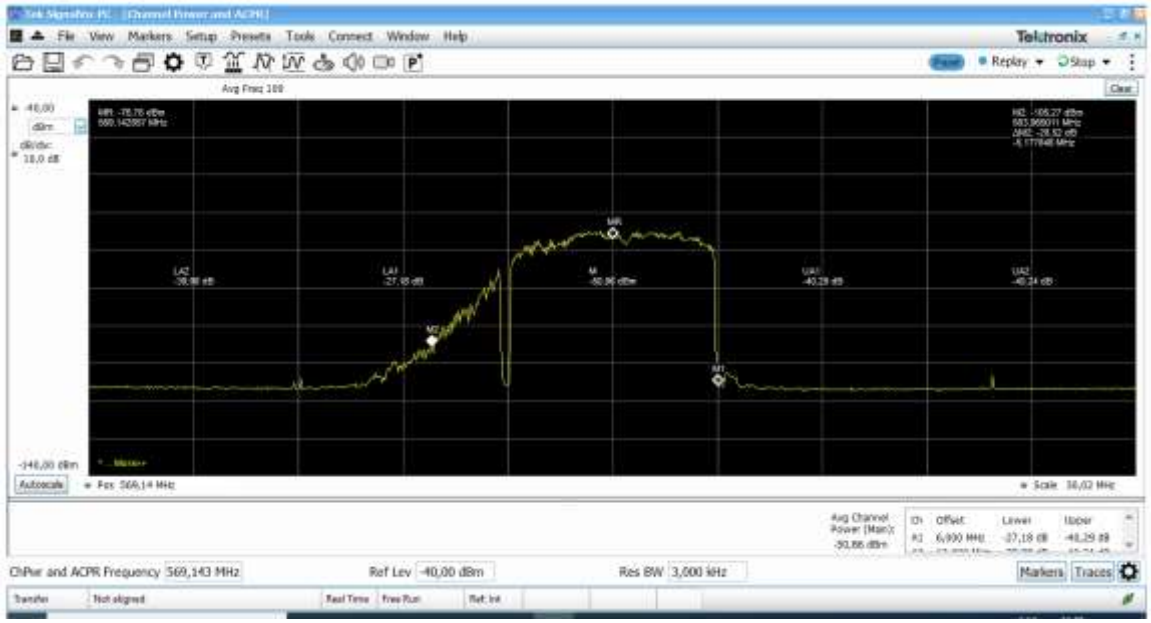


Figure 5.16 - Horizontal

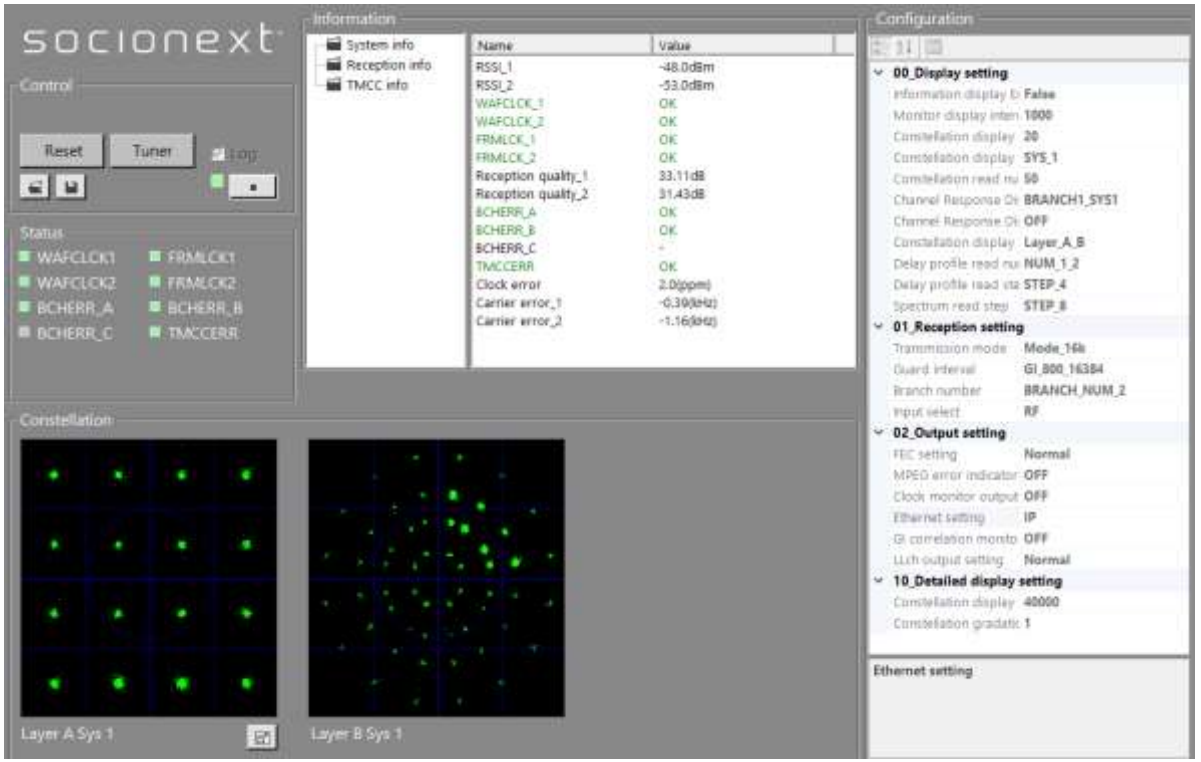


Figure 5.17 - Socionext Screen

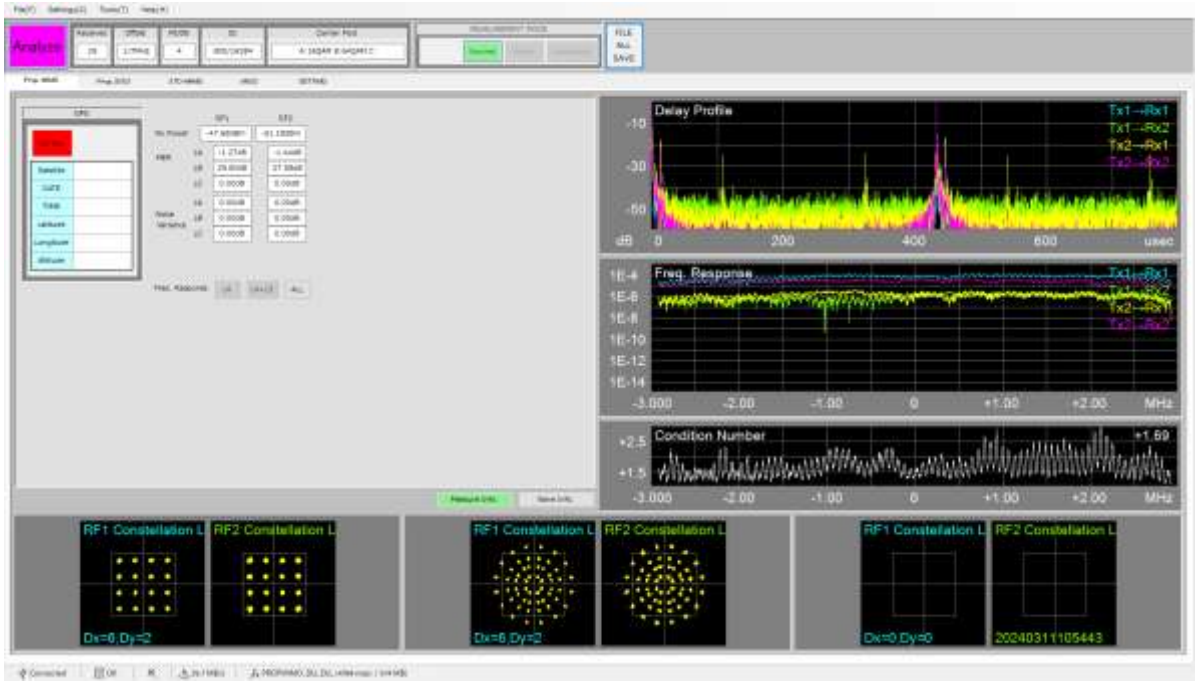


Figure 5.18 - Rintaro Screen

b) AWGN Power

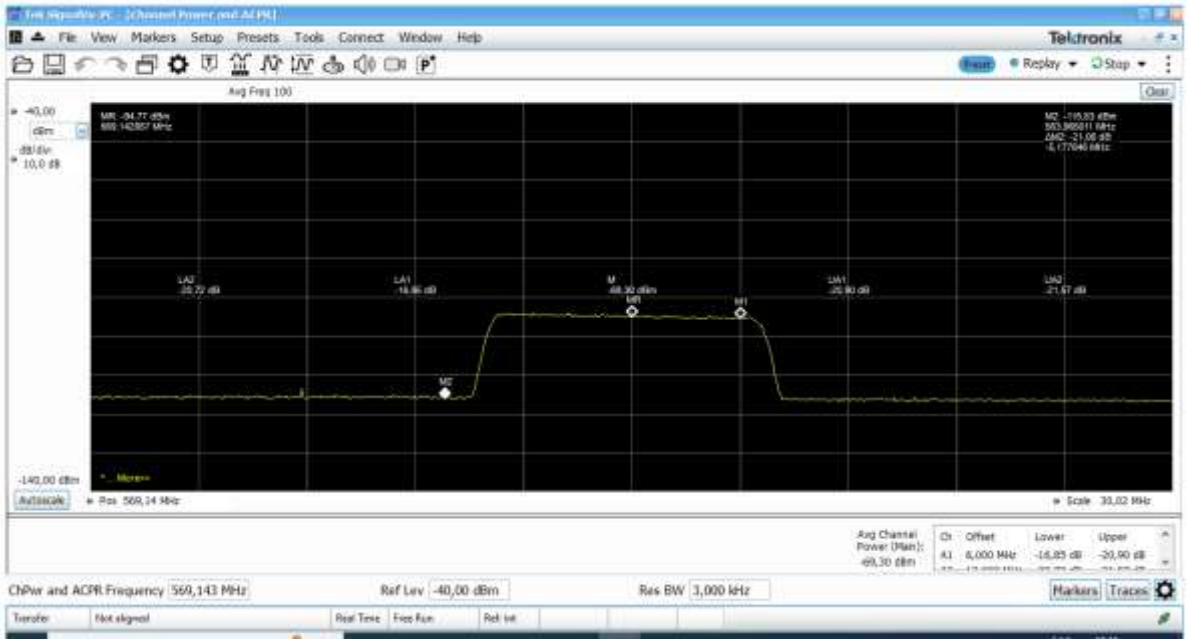


Figure 5.19 - Vertical

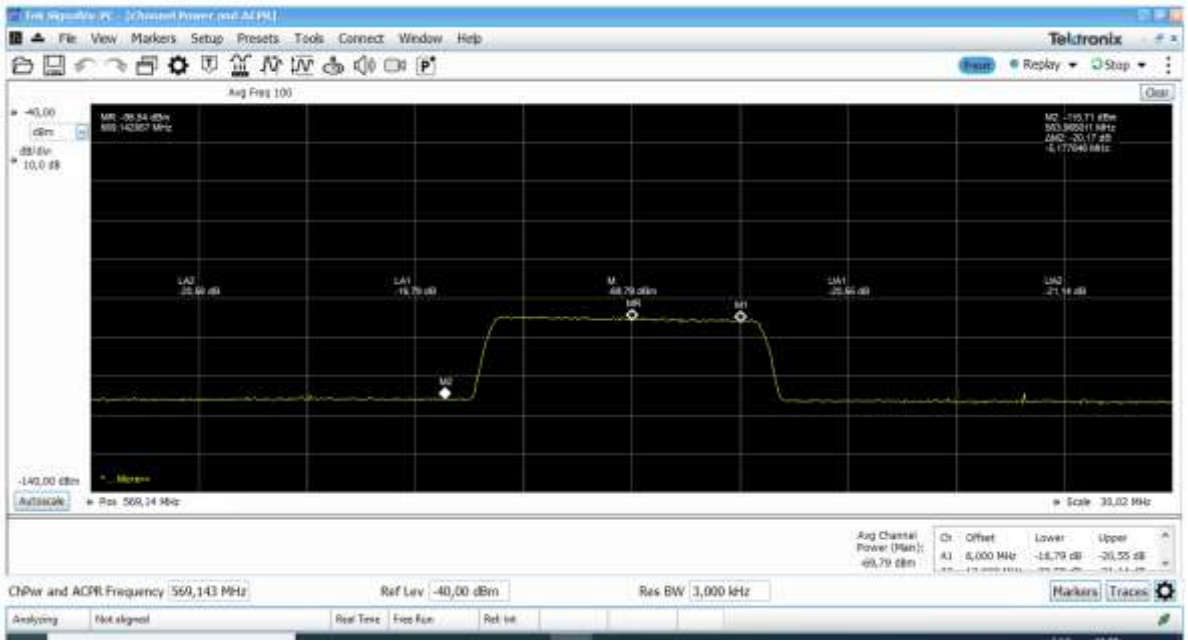


Figure 5.20 - Horizontal

c) C/N Threshold

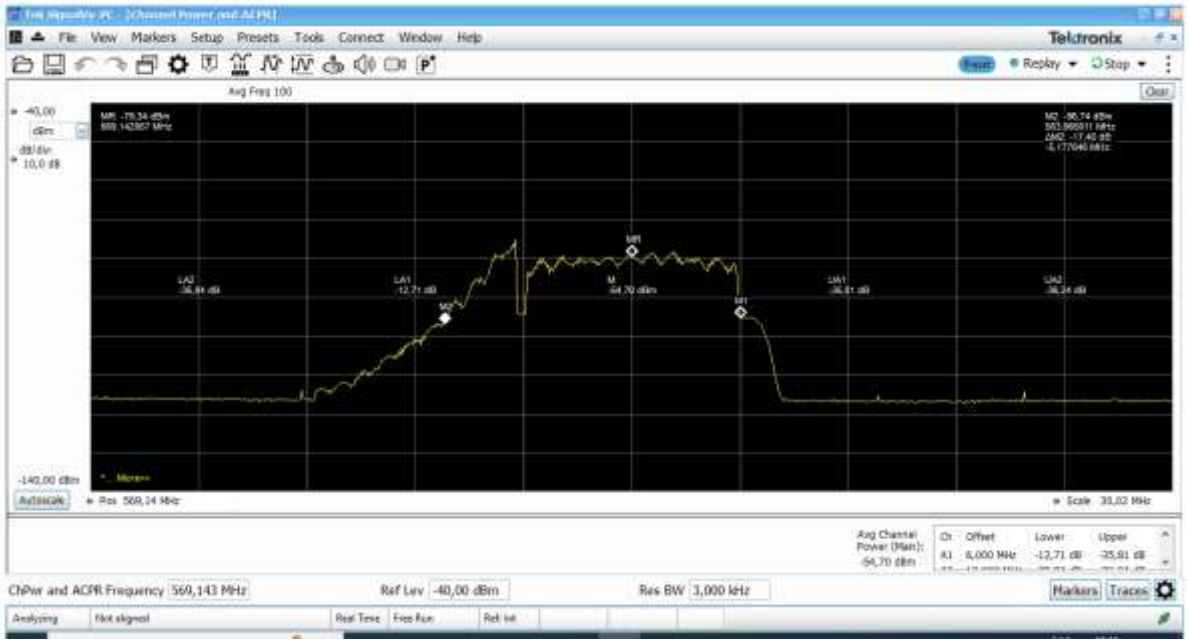


Figure 5.21 - Vertical

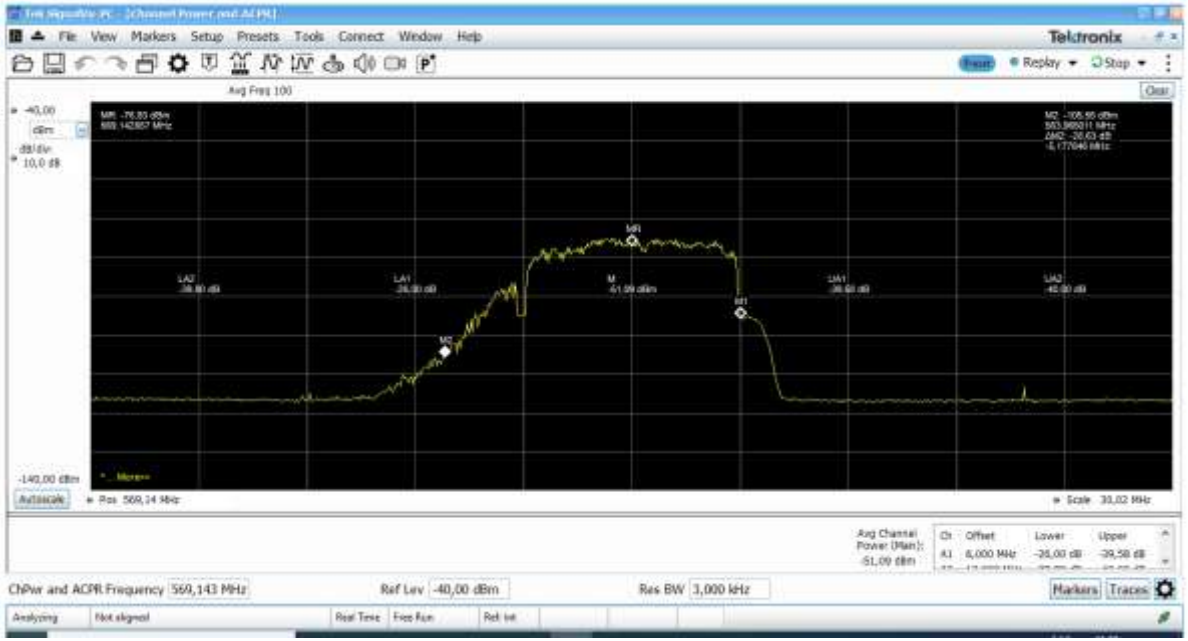


Figure 5.22 - Horizontal

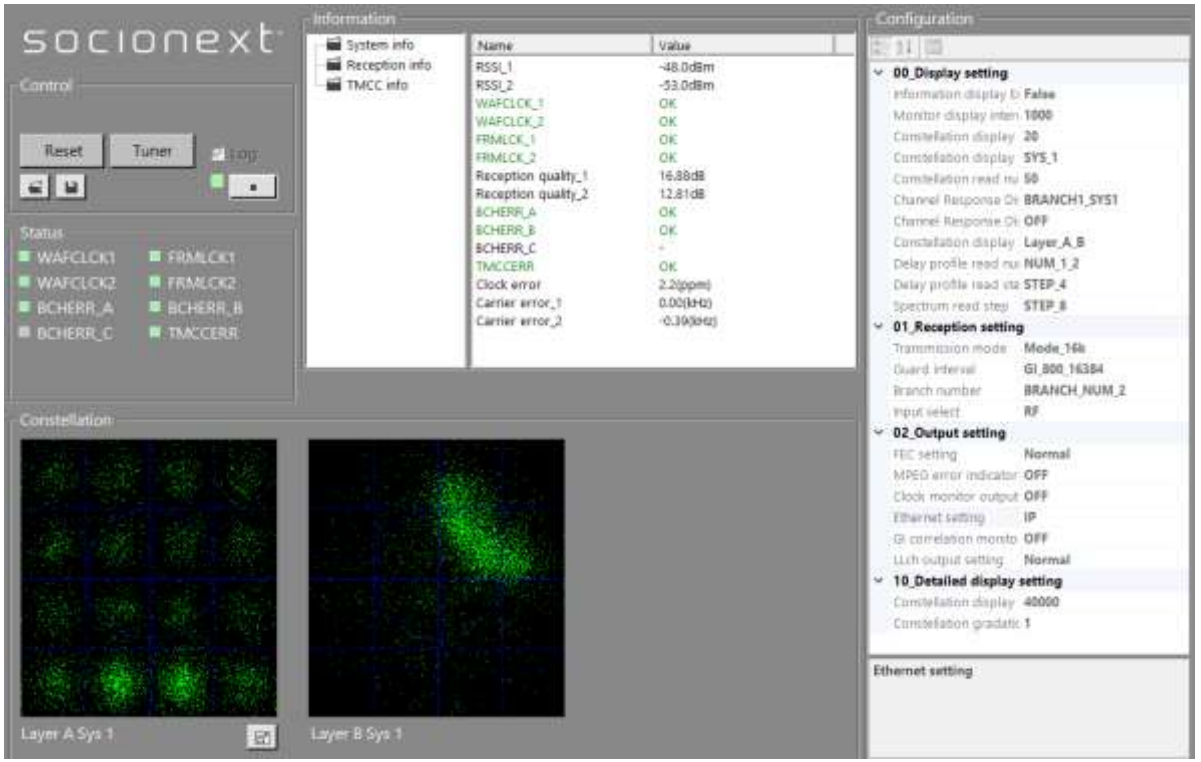


Figure 5.23 - Socionext Screen

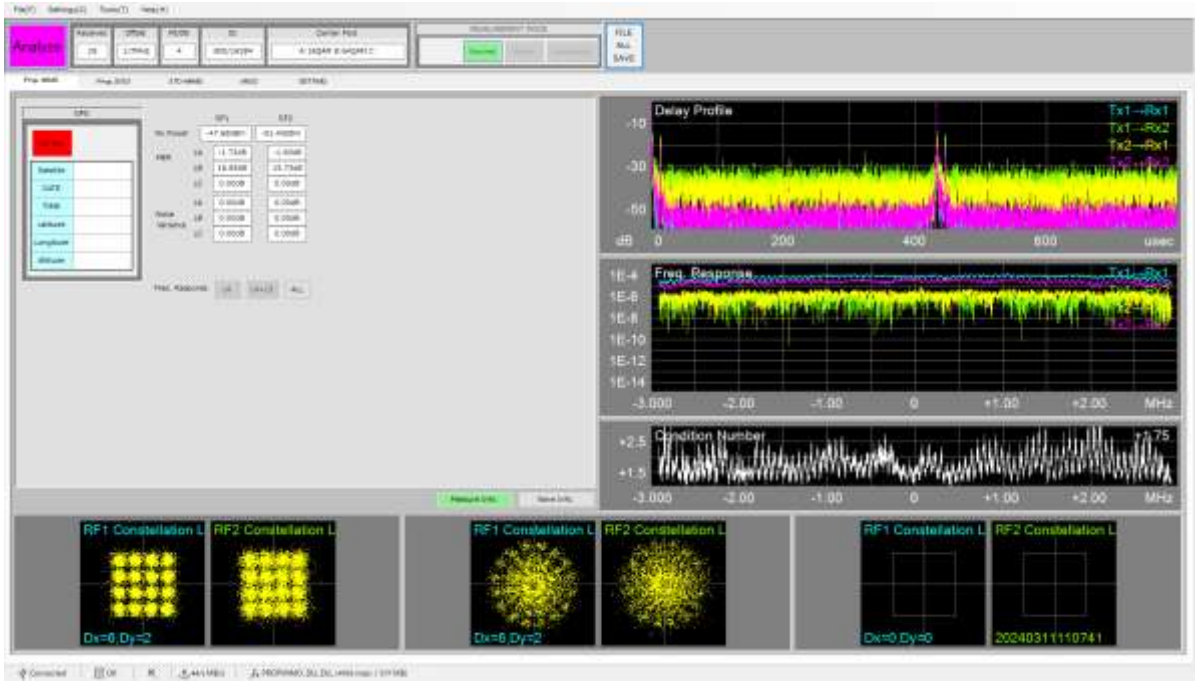


Figure 5.24 - Rintaro Screen

d) Reception Threshold

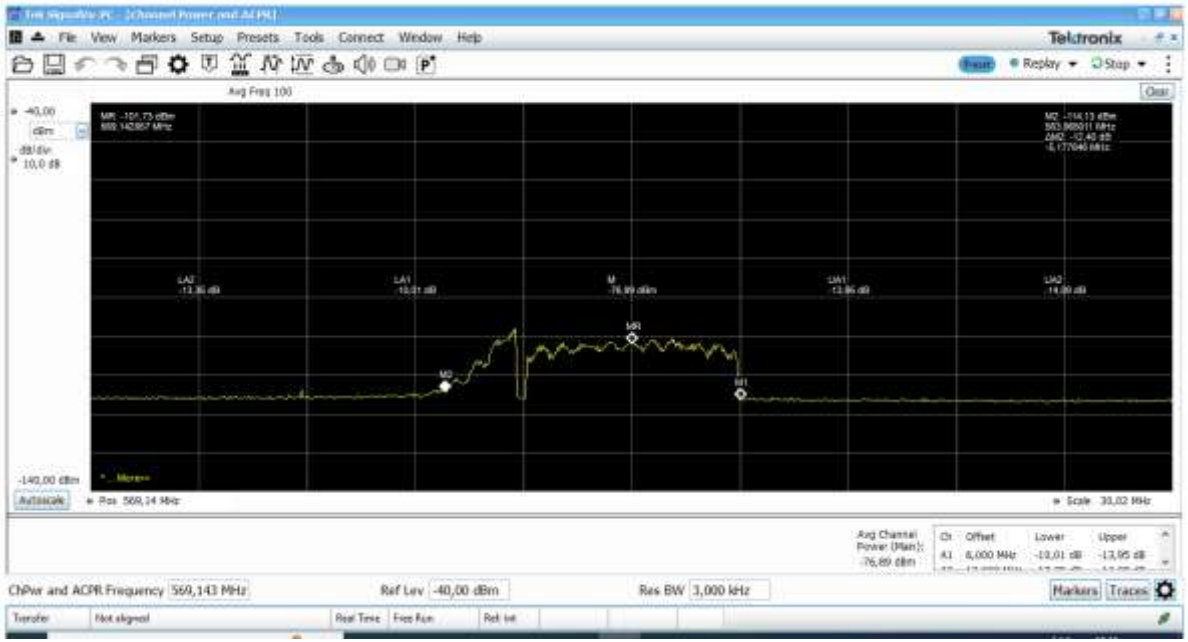


Figure 5.25 - Vertical

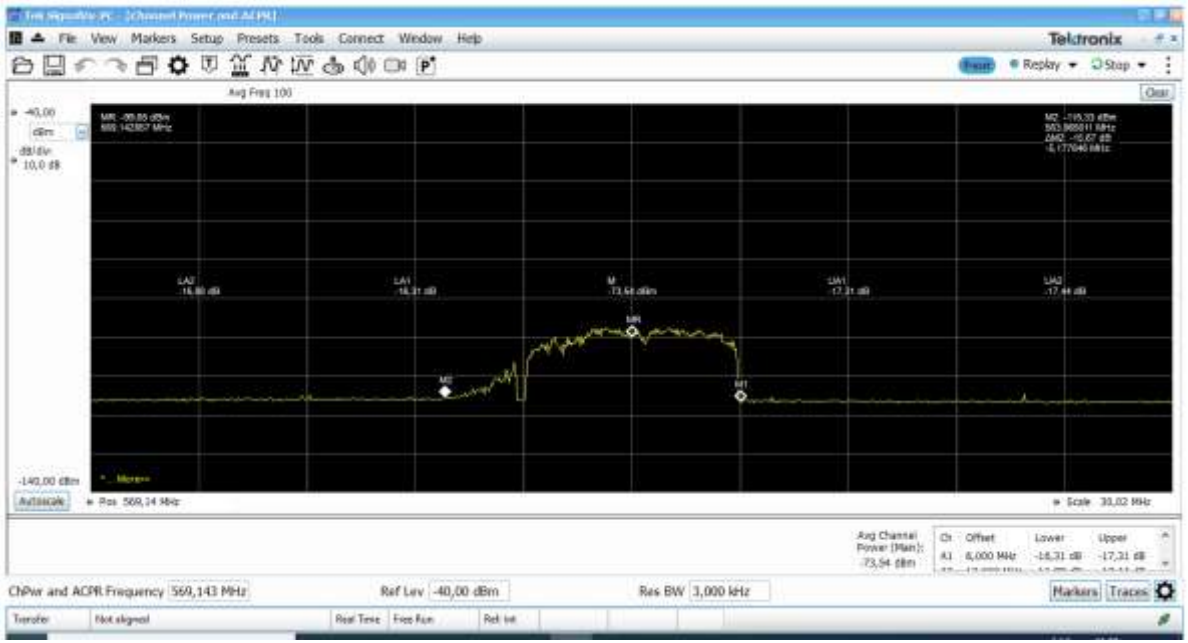


Figure 5.26 - Horizontal

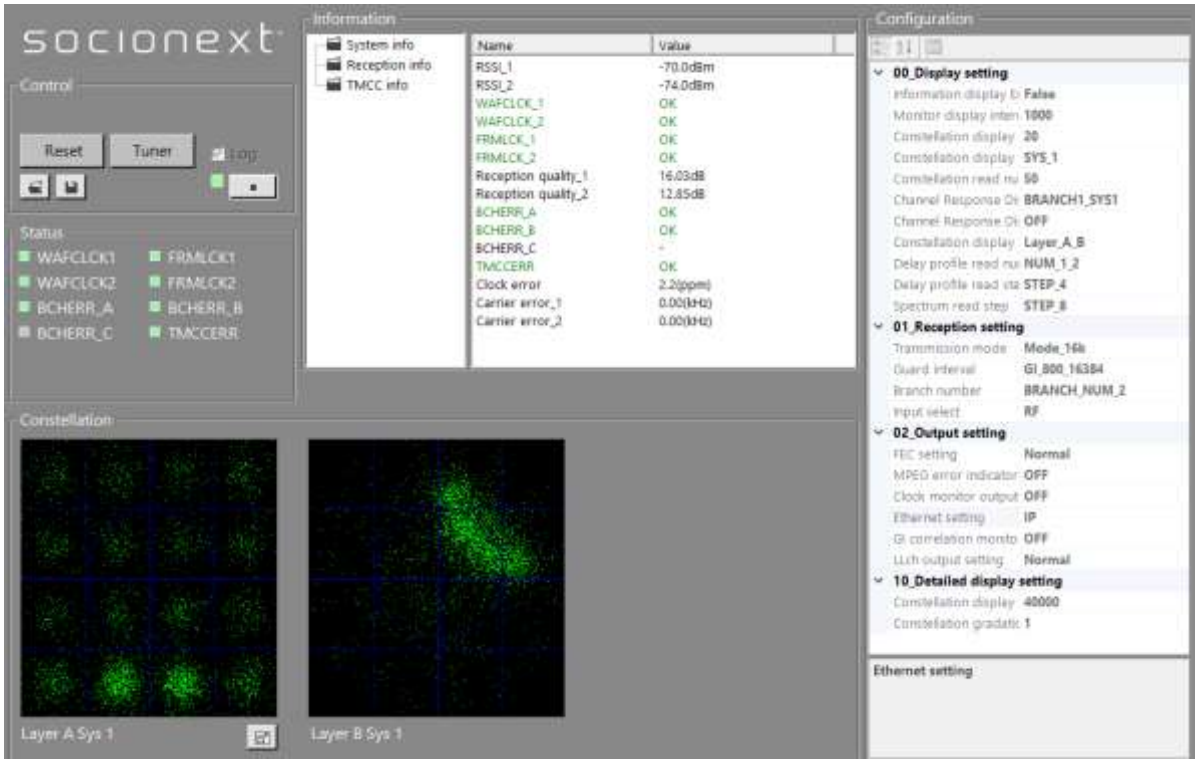


Figure 5.27 - Socionext Screen

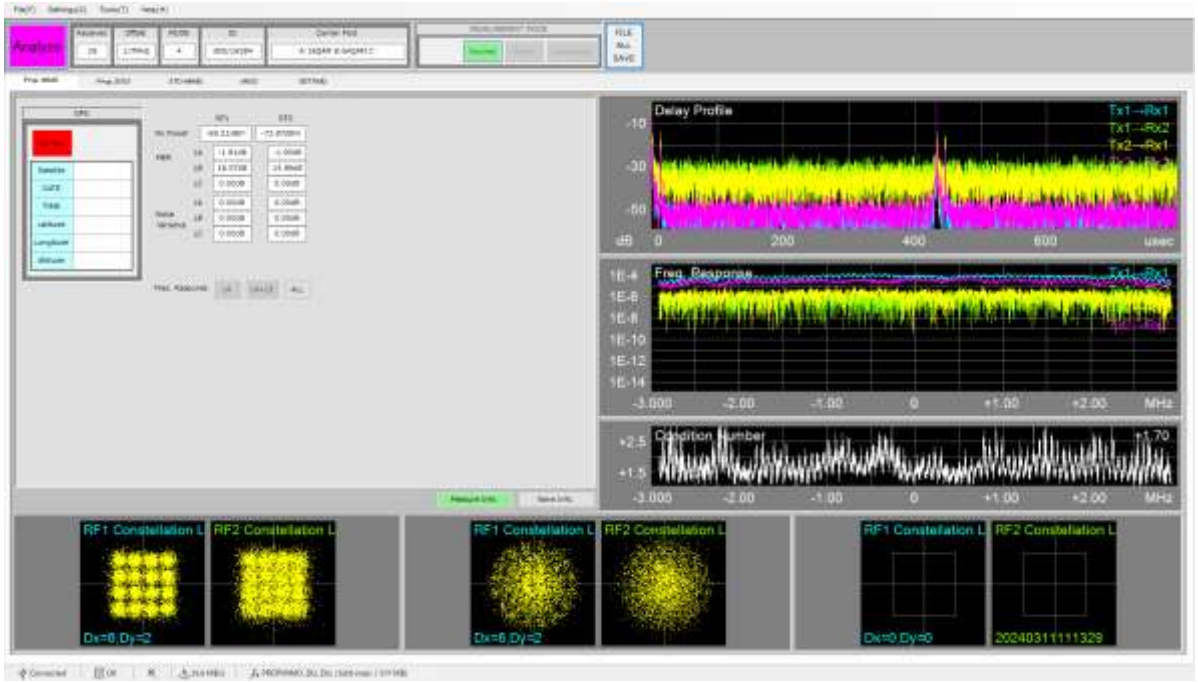


Figure 5.28 - Rintaro Screen

Chapter 6. Site 8

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

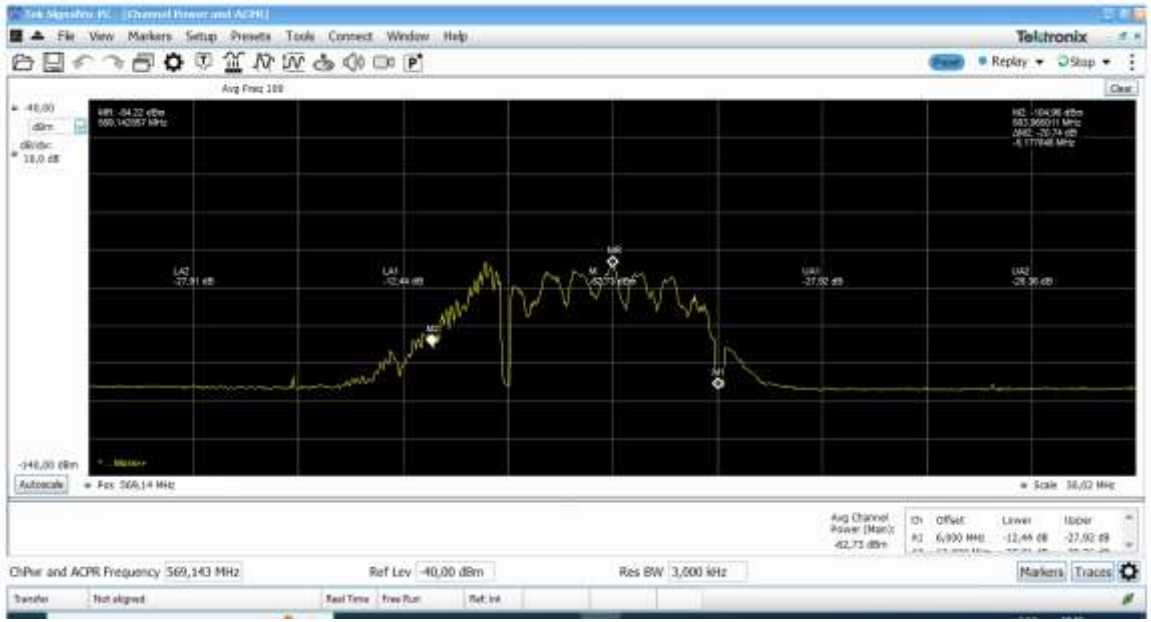


Figure 6.1 - Vertical

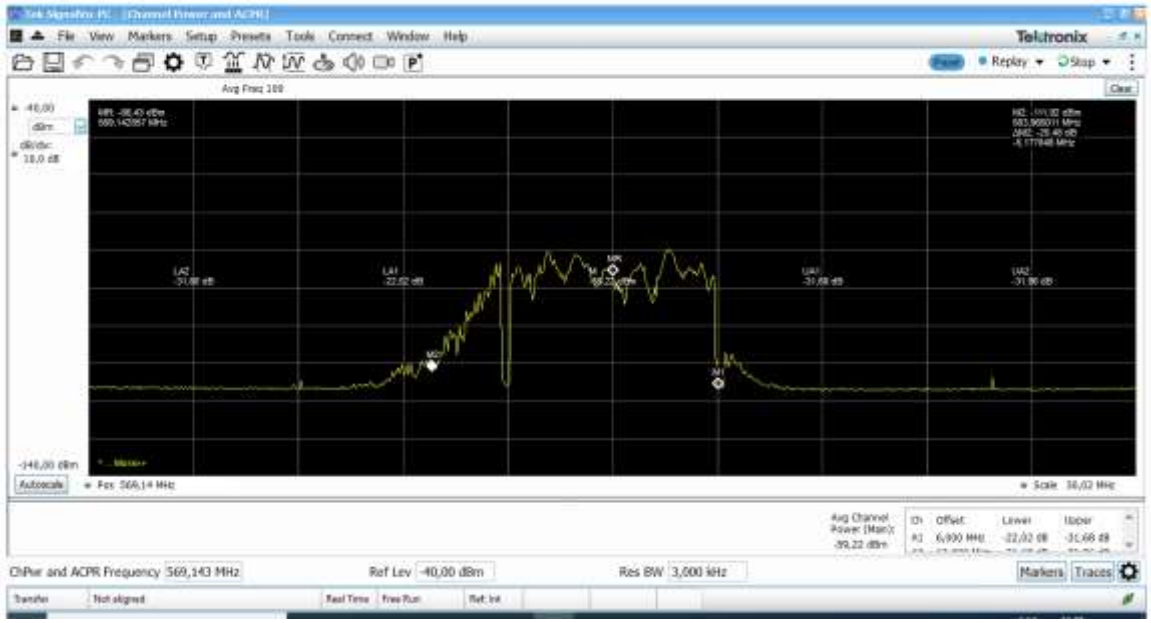


Figure 6.2 - Horizontal

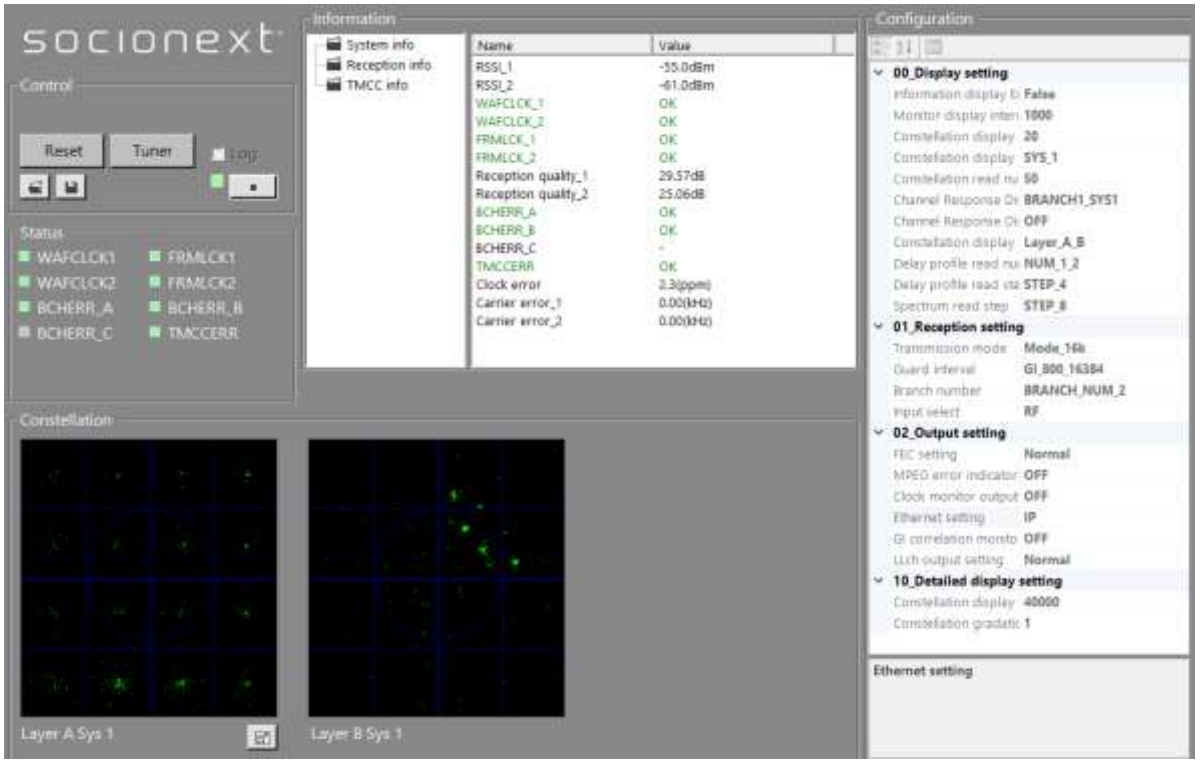


Figure 6.3 - Socionext Screen

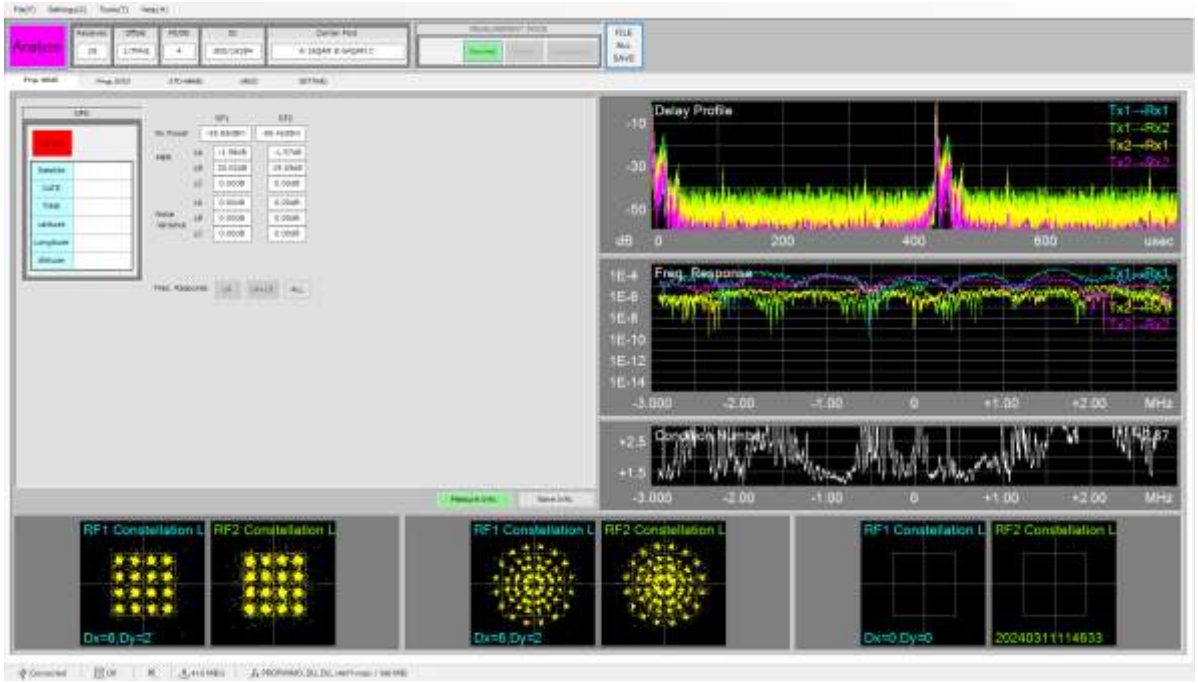


Figure 6.4 - Rintaro Screen

b) AWGN Power

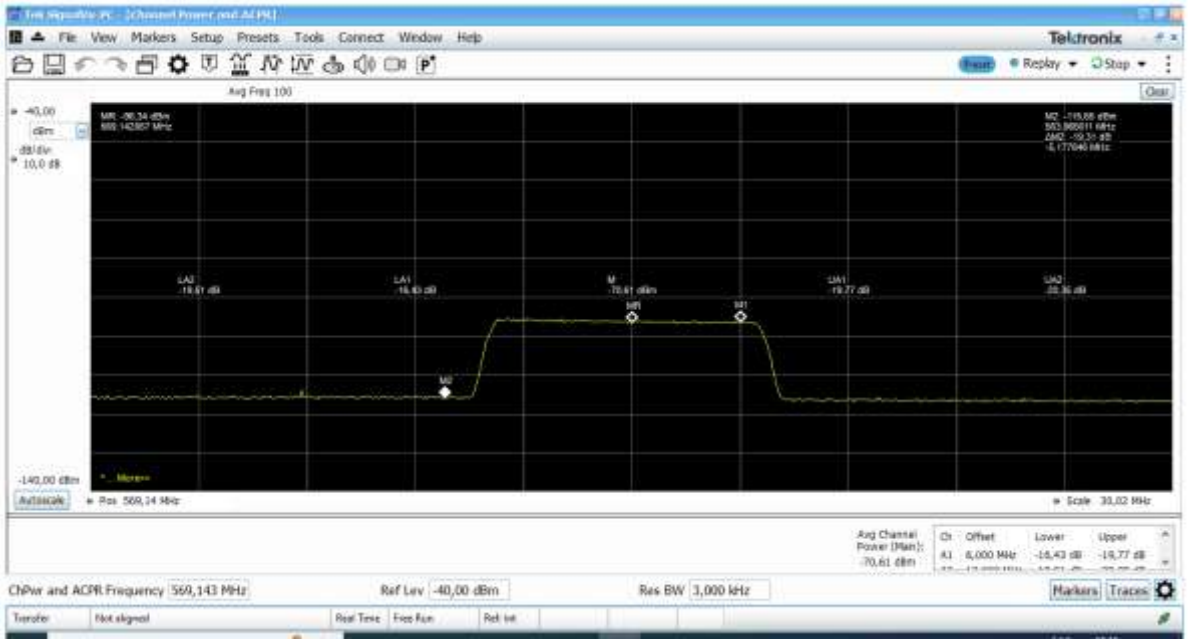


Figure 6.5 - Vertical

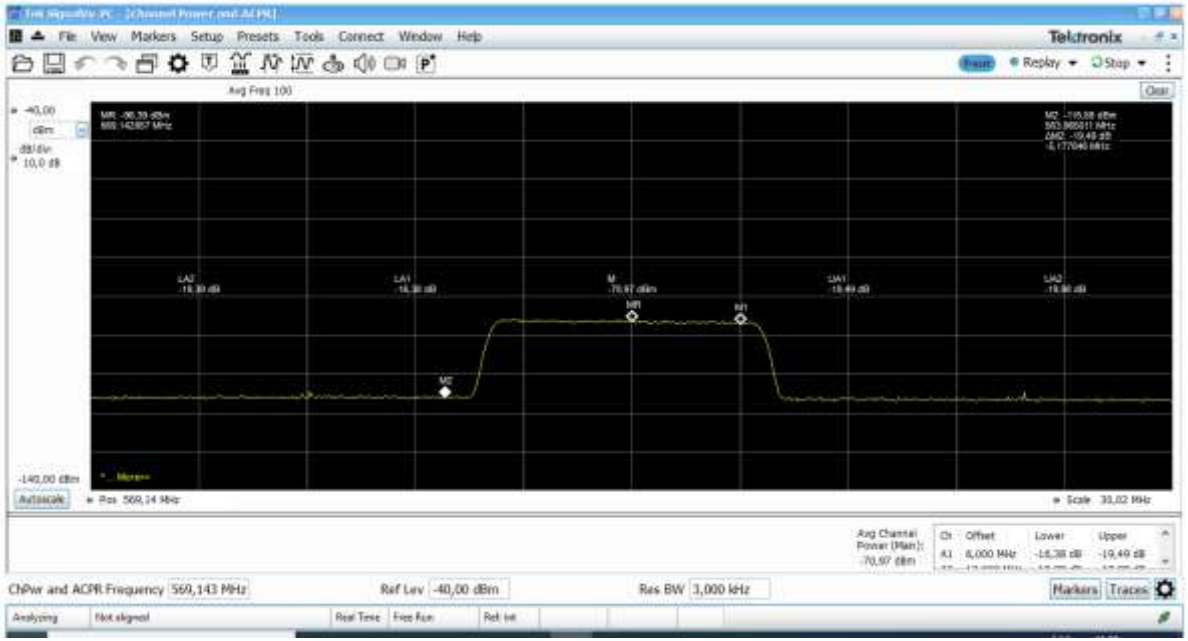


Figure 6.6 - Horizontal

c) C/N Threshold

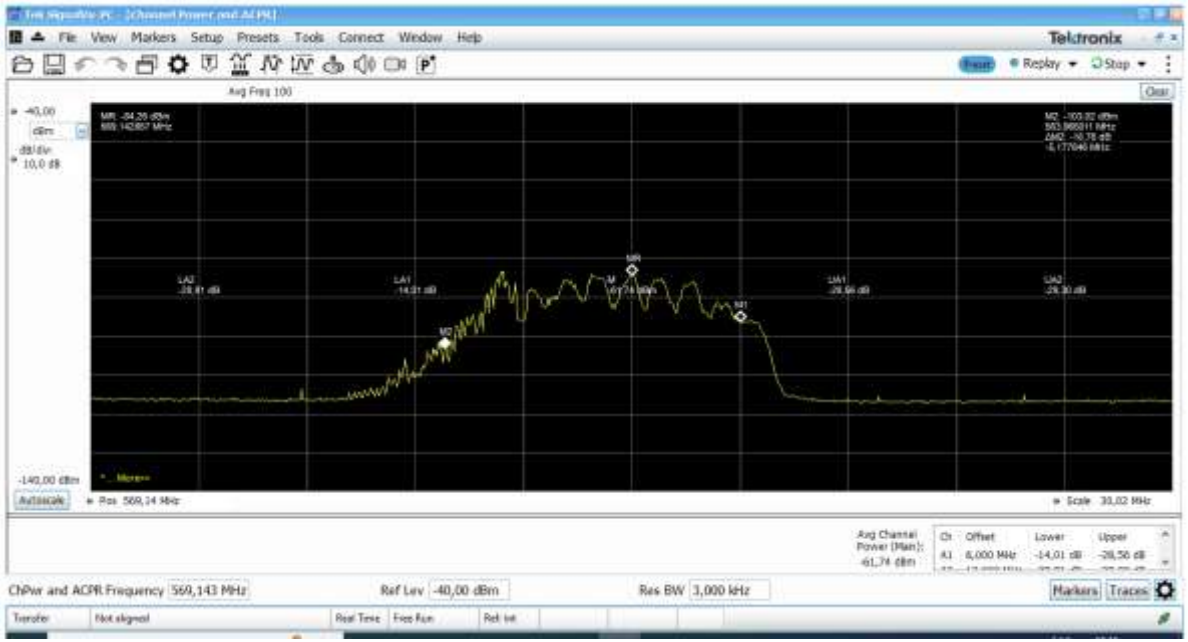


Figure 6.7 - Vertical

Figure 6.8 - Horizontal

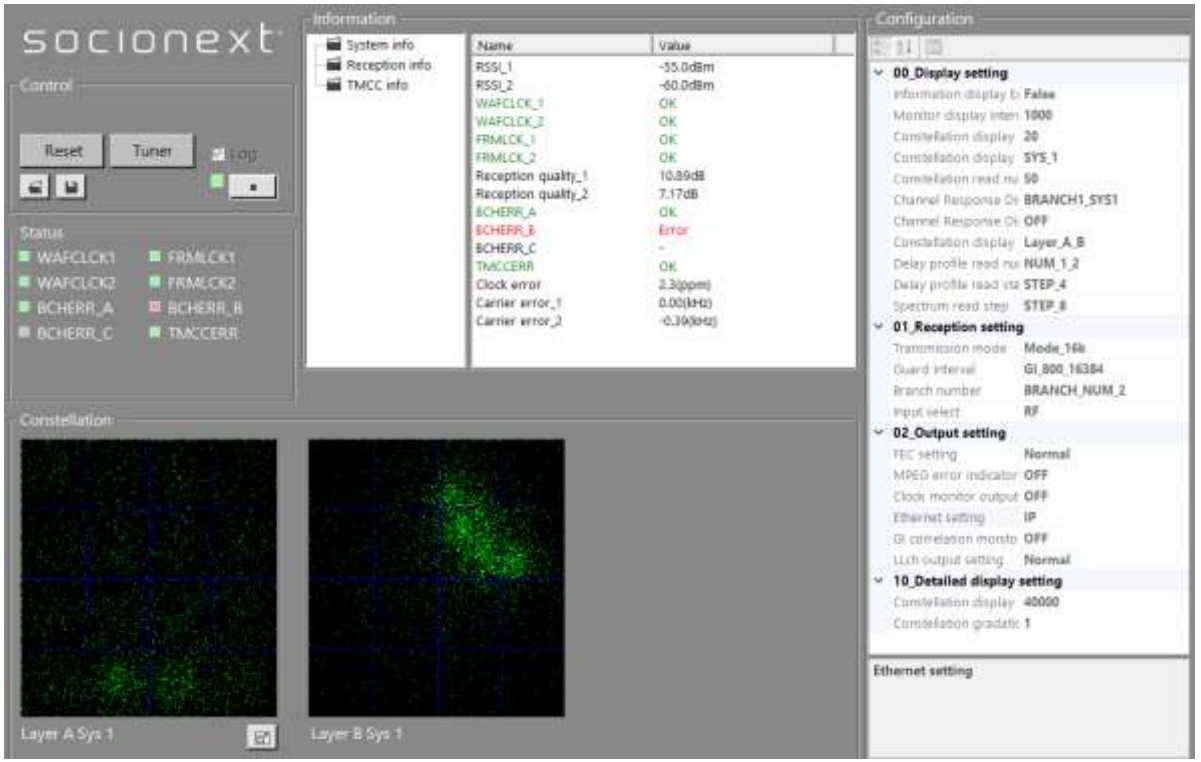


Figure 6.9 - Socionext Screen

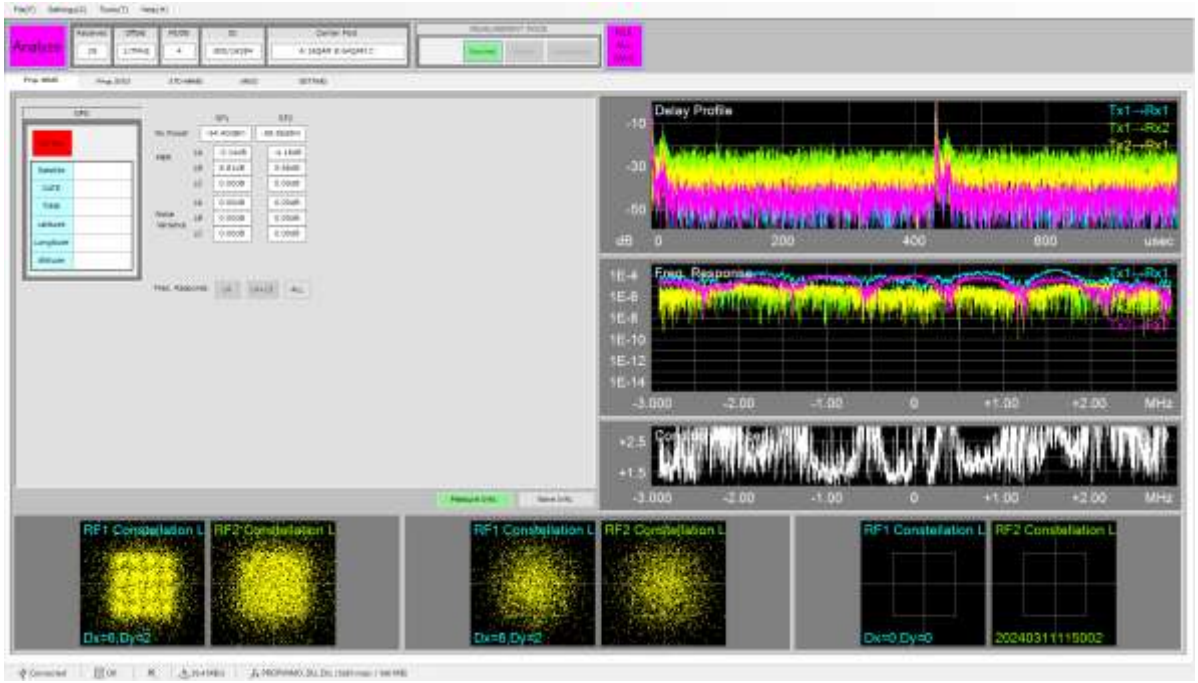


Figure 6.10 - Rintaro Screen

d) Reception Threshold

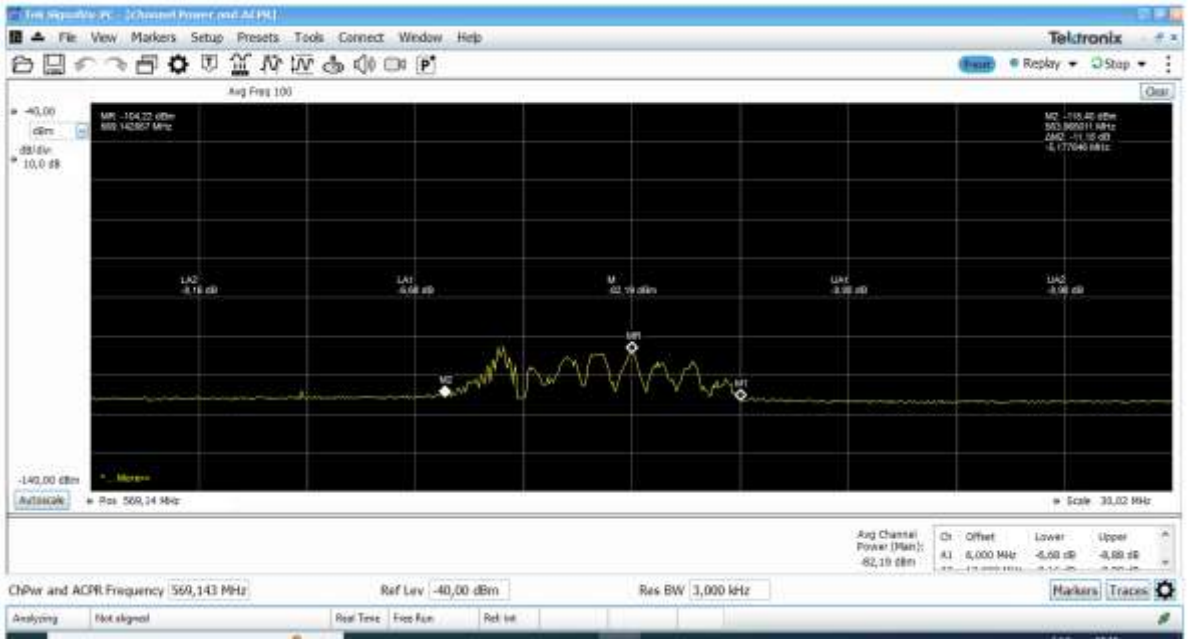


Figure 6.11 - Vertical

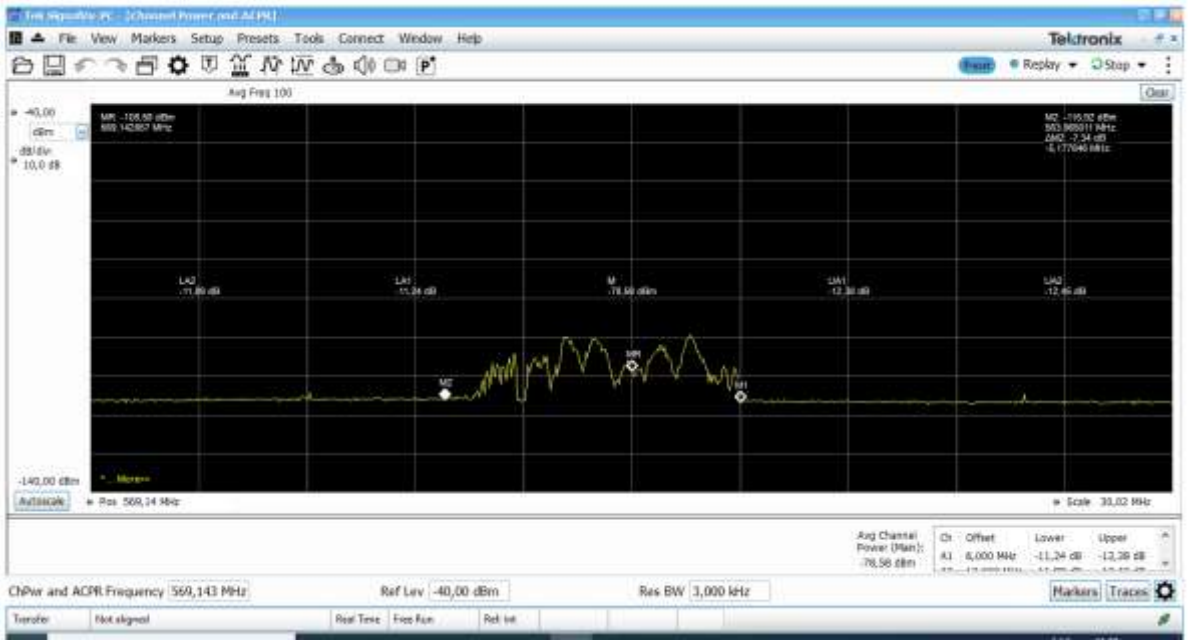


Figure 6.12 - Horizontal

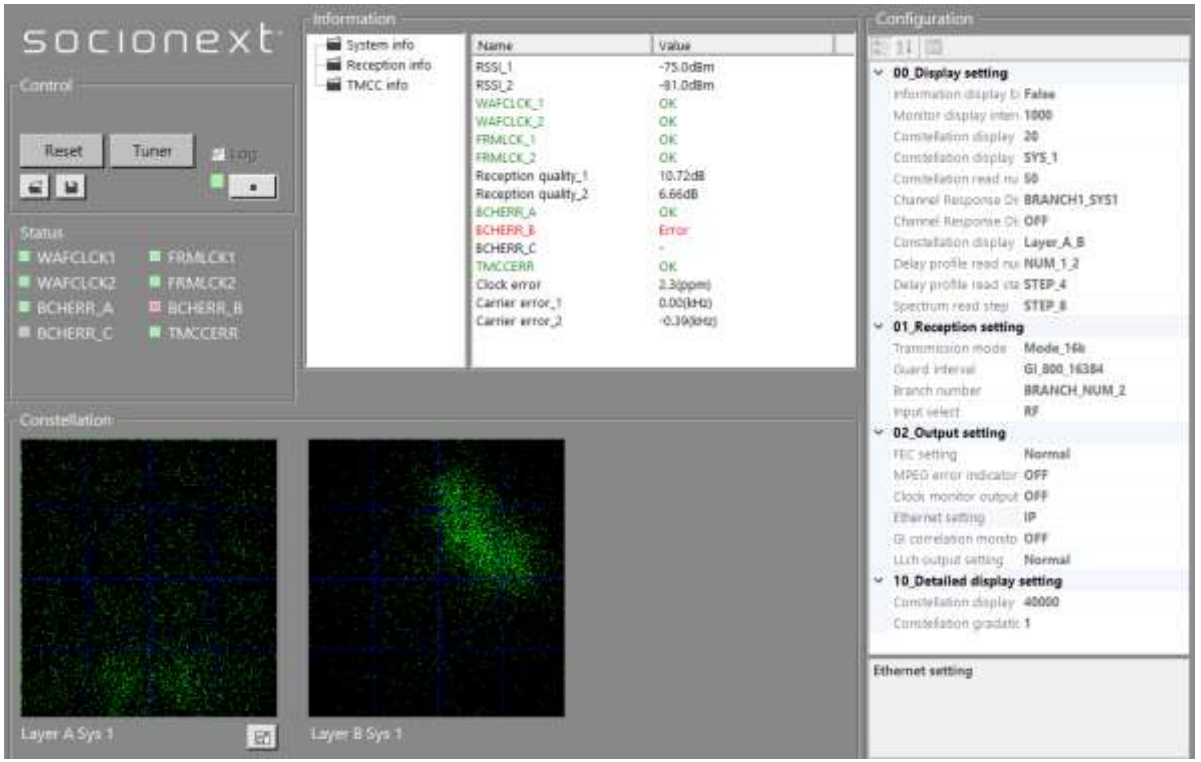


Figure 6.13 - Socionext Screen

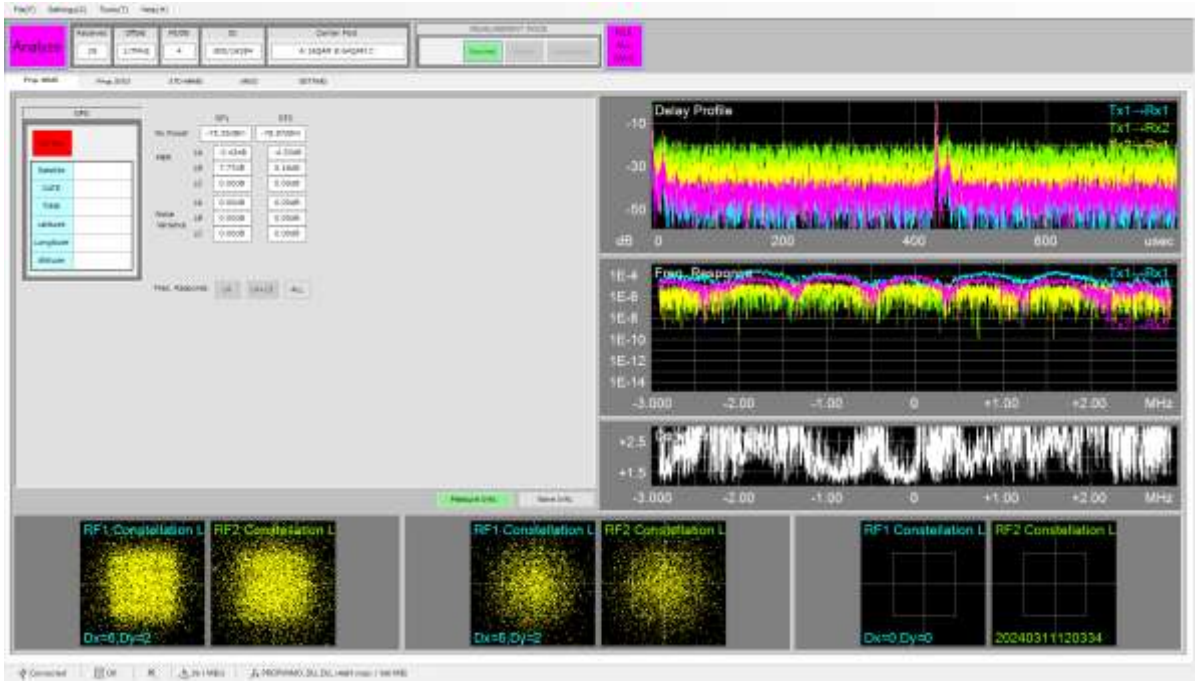


Figure 6.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

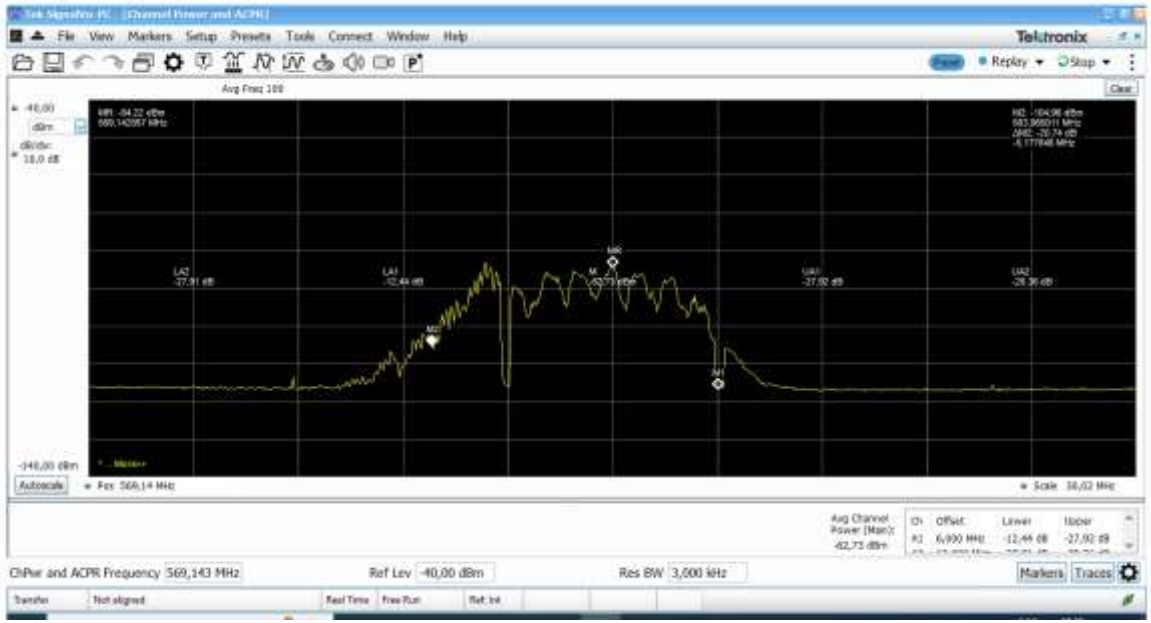


Figure 6.15 - Vertical

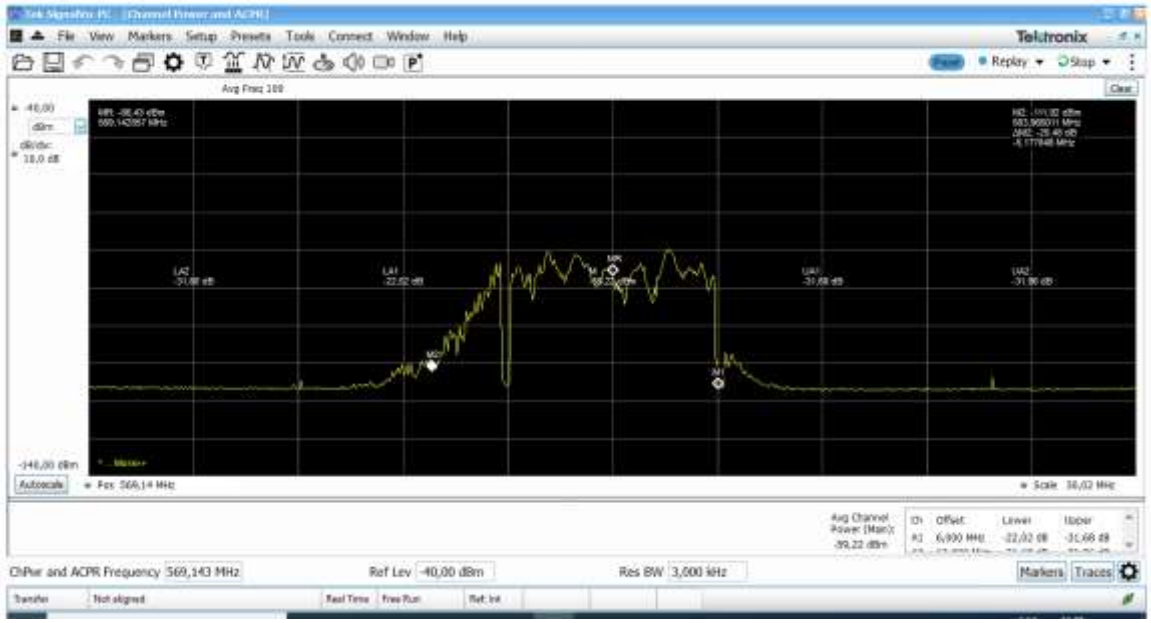


Figure 6.16 - Horizontal

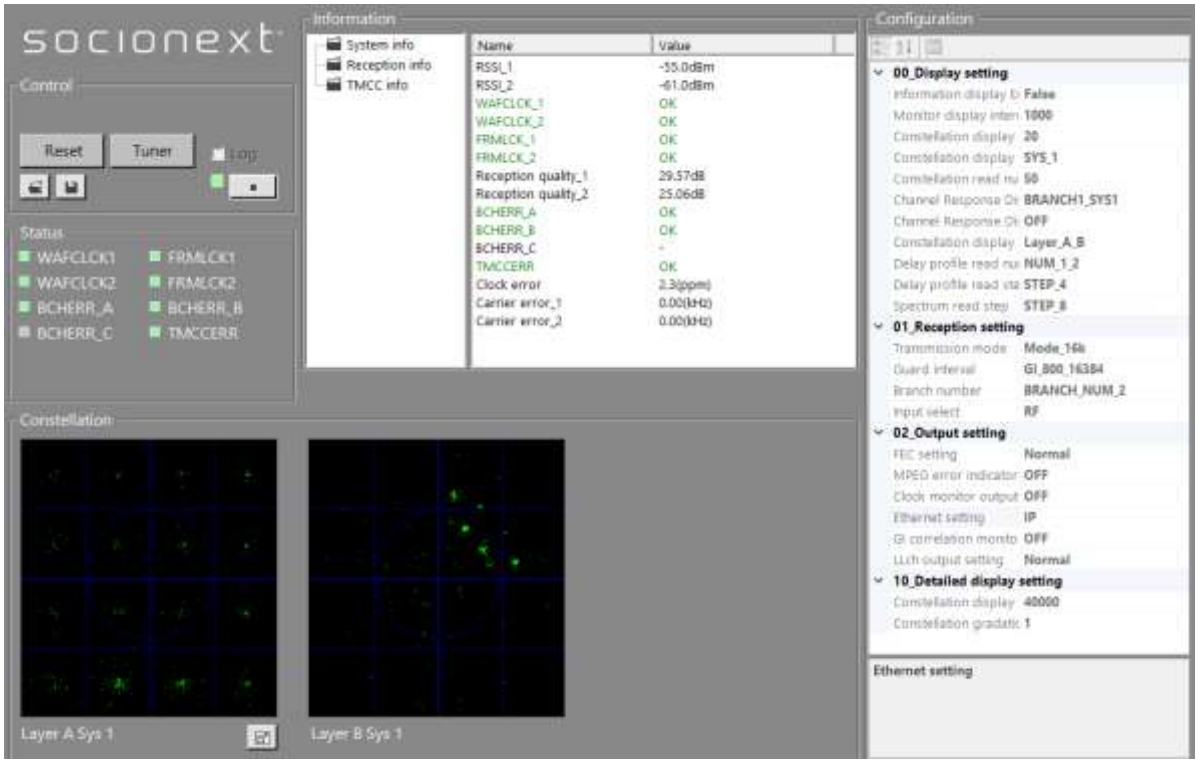


Figure 6.17 - Socionext Screen

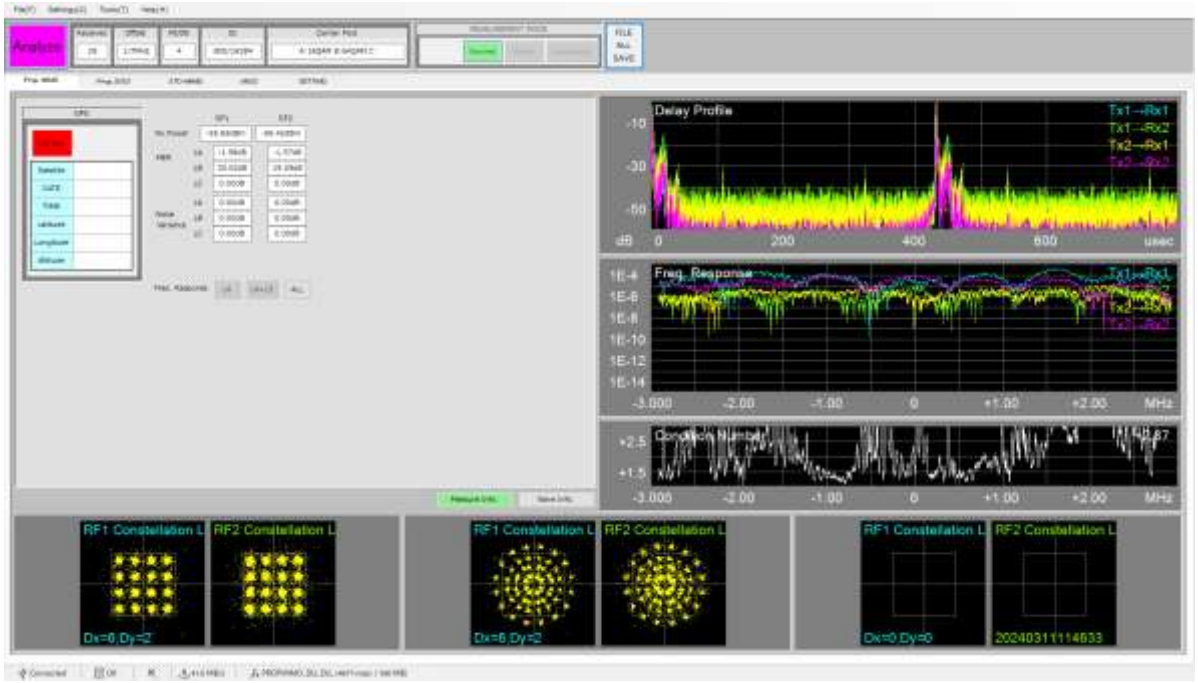


Figure 6.18 - Rintaro Screen

b) AWGN Power

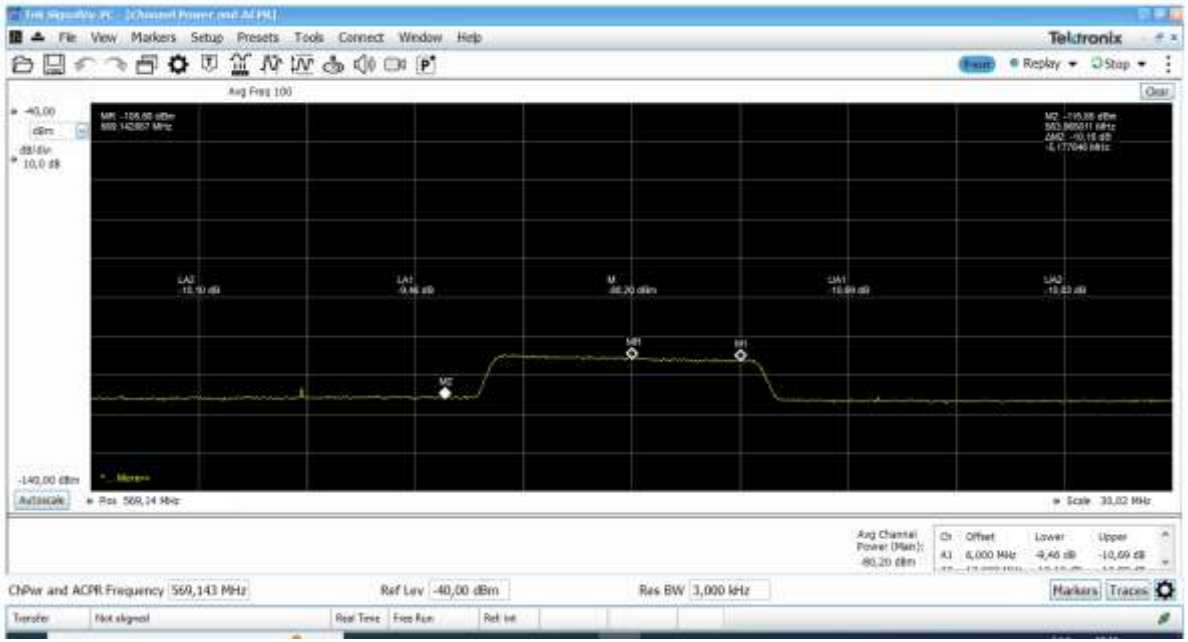


Figure 6.19 - Vertical

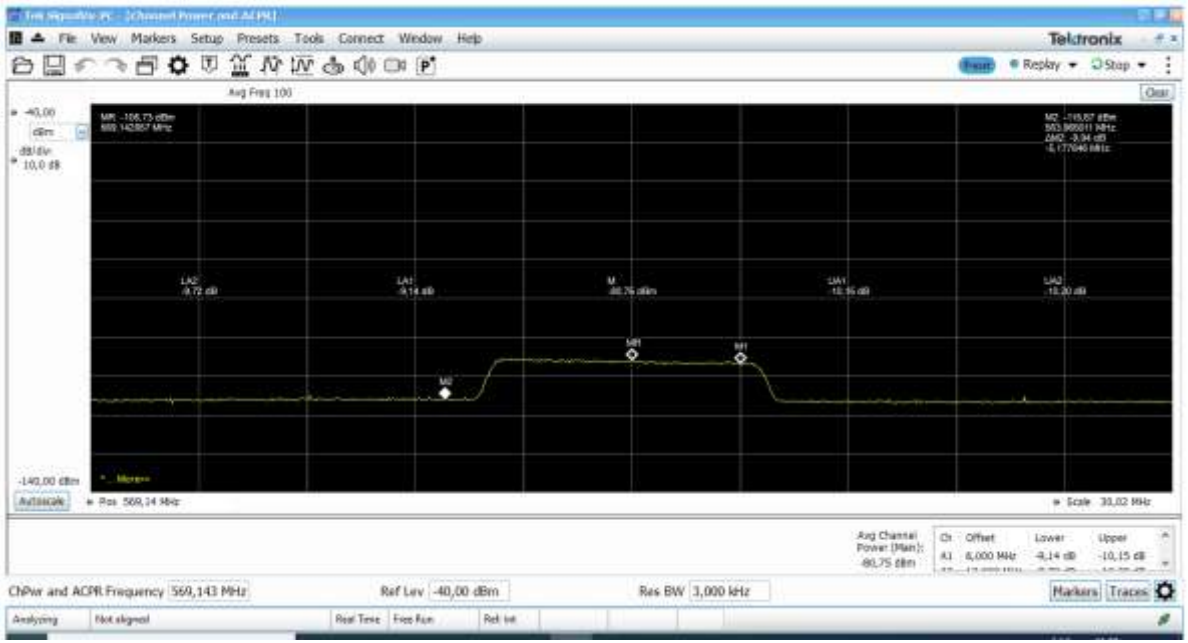


Figure 6.20 - Horizontal

c) C/N Threshold

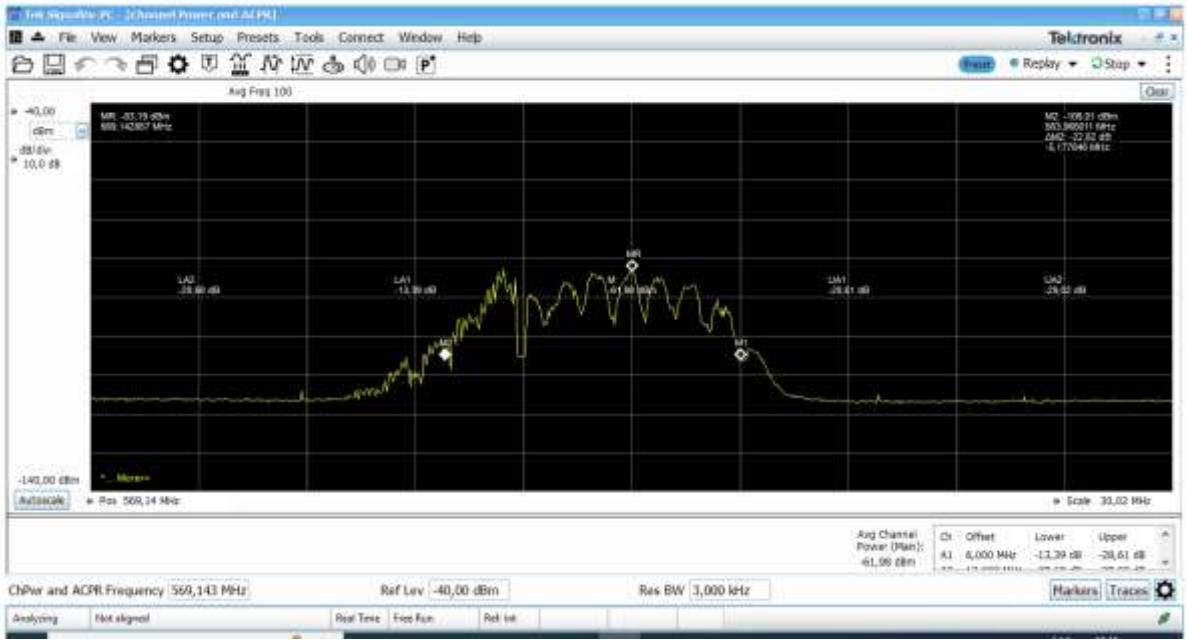


Figure 6.21 - Vertical

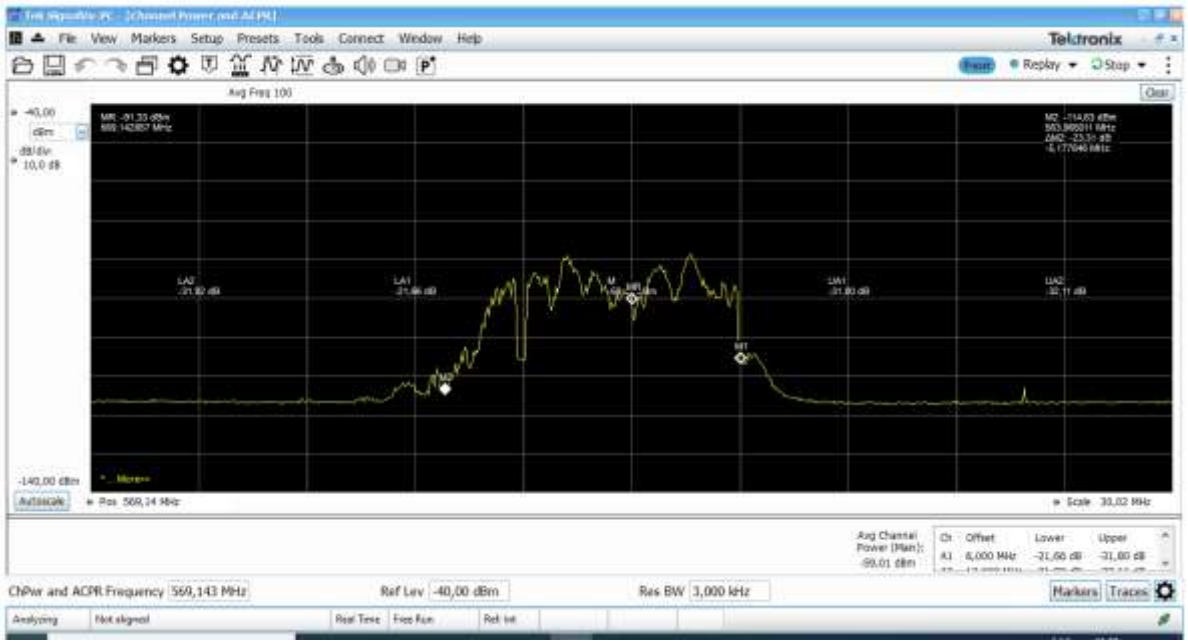


Figure 6.22 - Horizontal

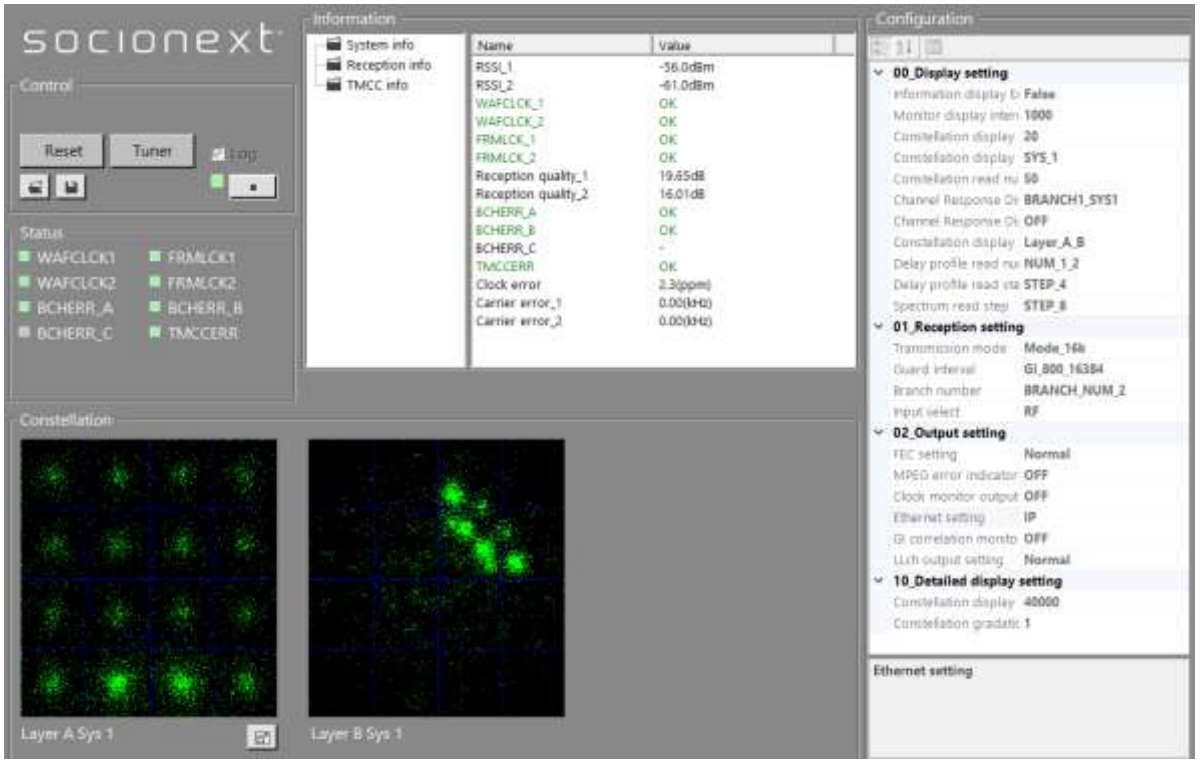


Figure 6.23 - Socionext Screen

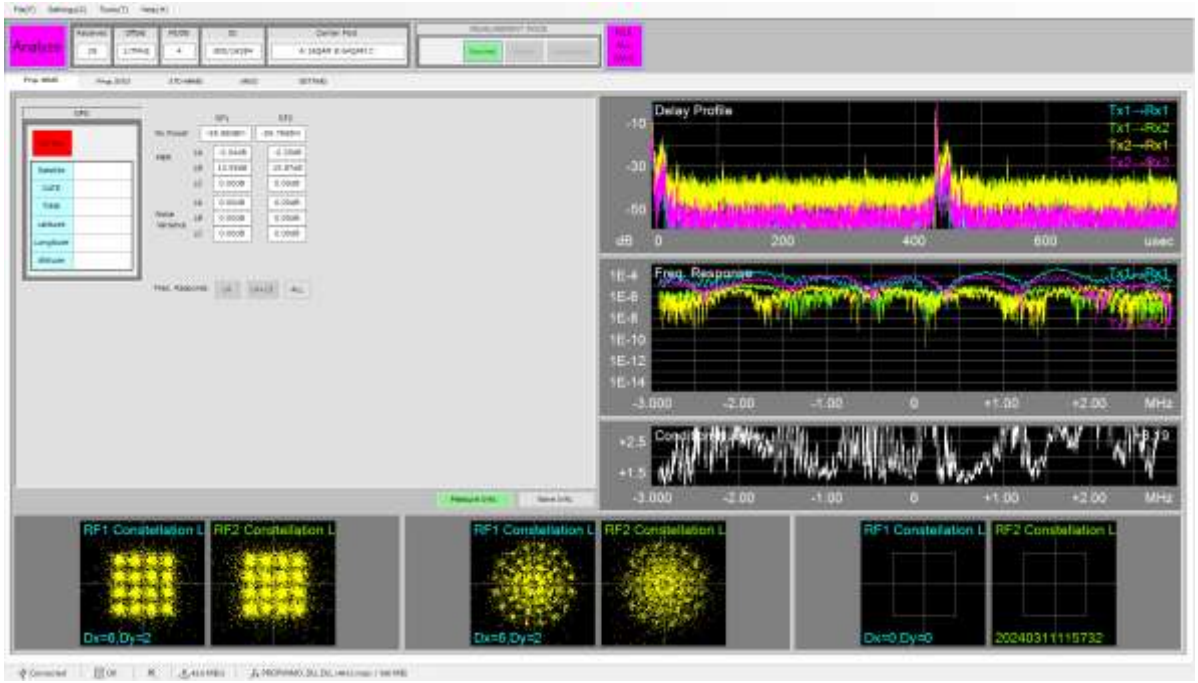


Figure 6.24 - Rintaro Screen

d) Reception Threshold

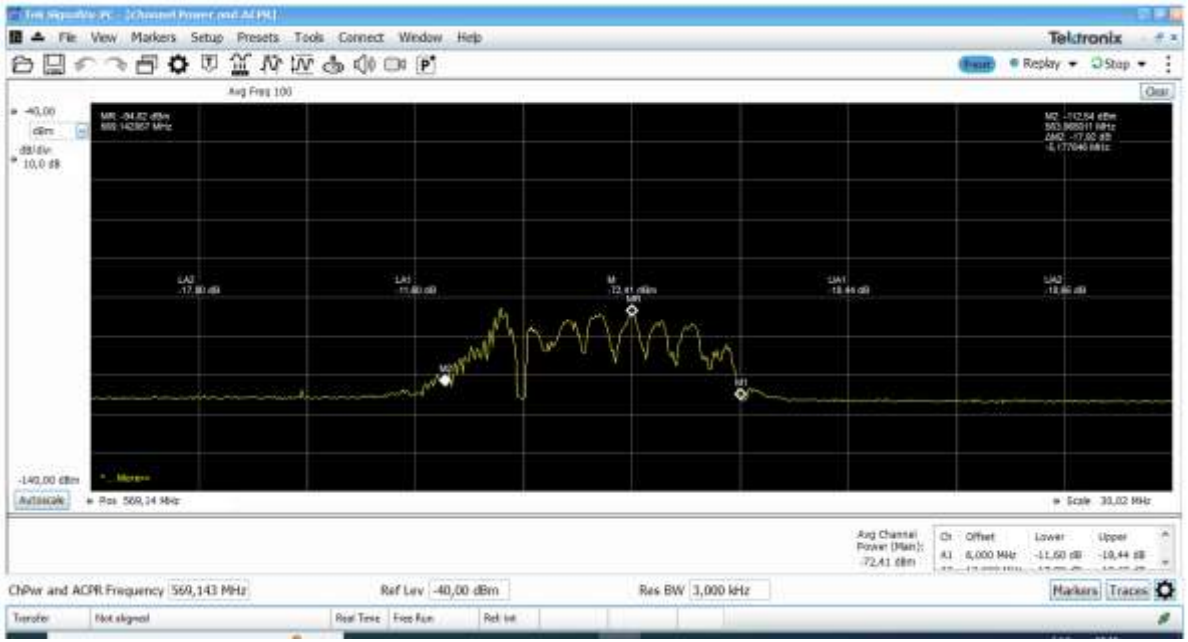


Figure 6.25 - Vertical

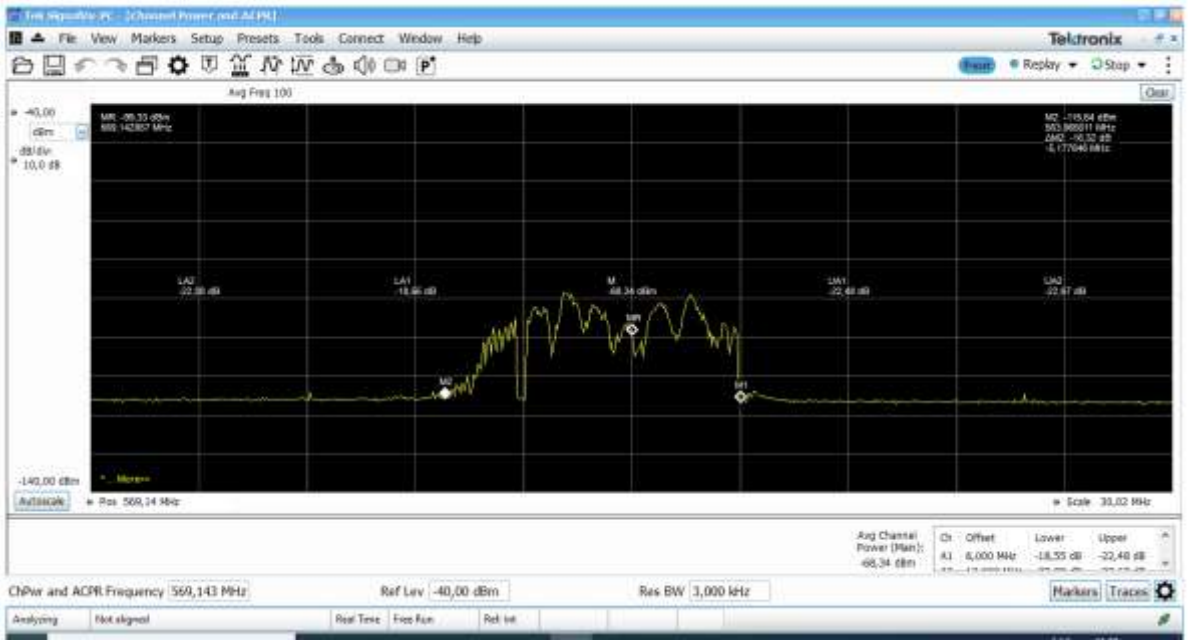


Figure 6.26 - Horizontal

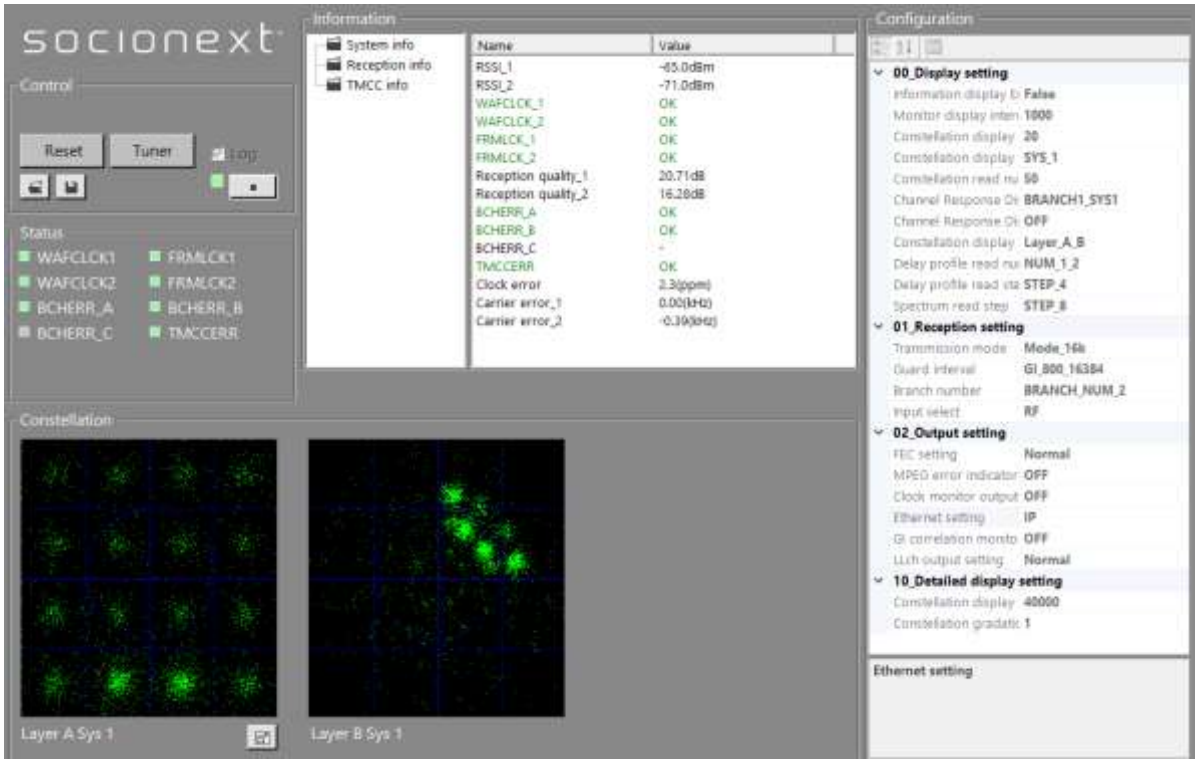


Figure 6.27 - Socionext Screen

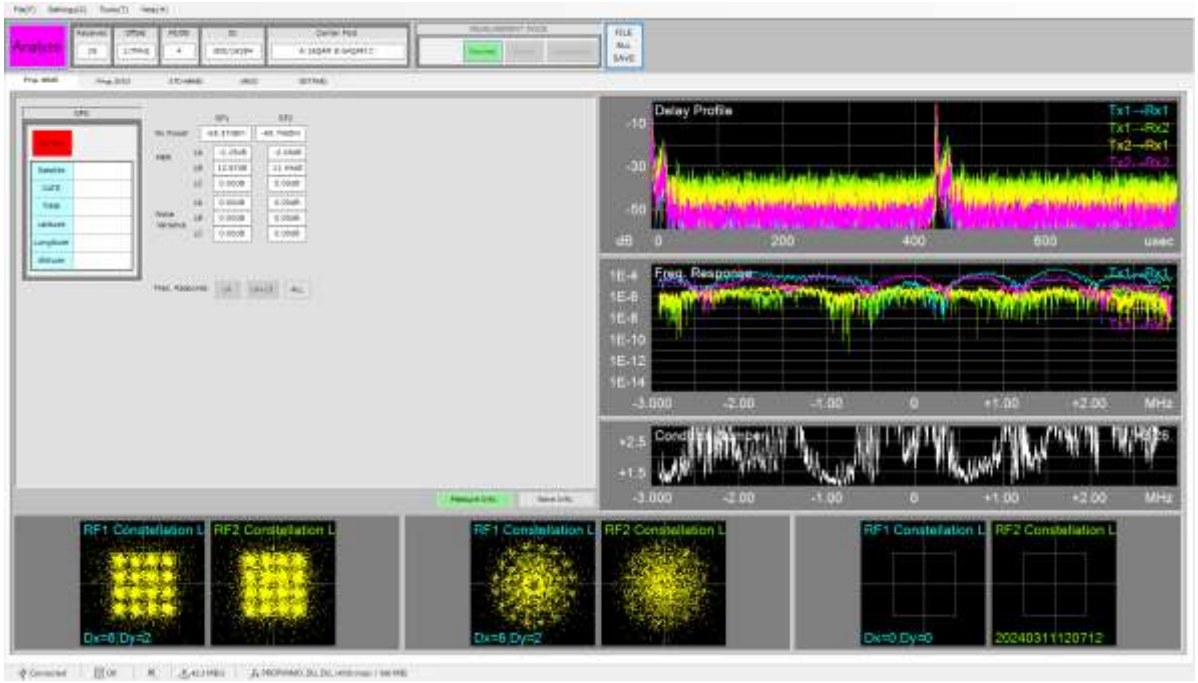


Figure 6.28 - Rintaro Screen

Chapter 7. Site 12

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

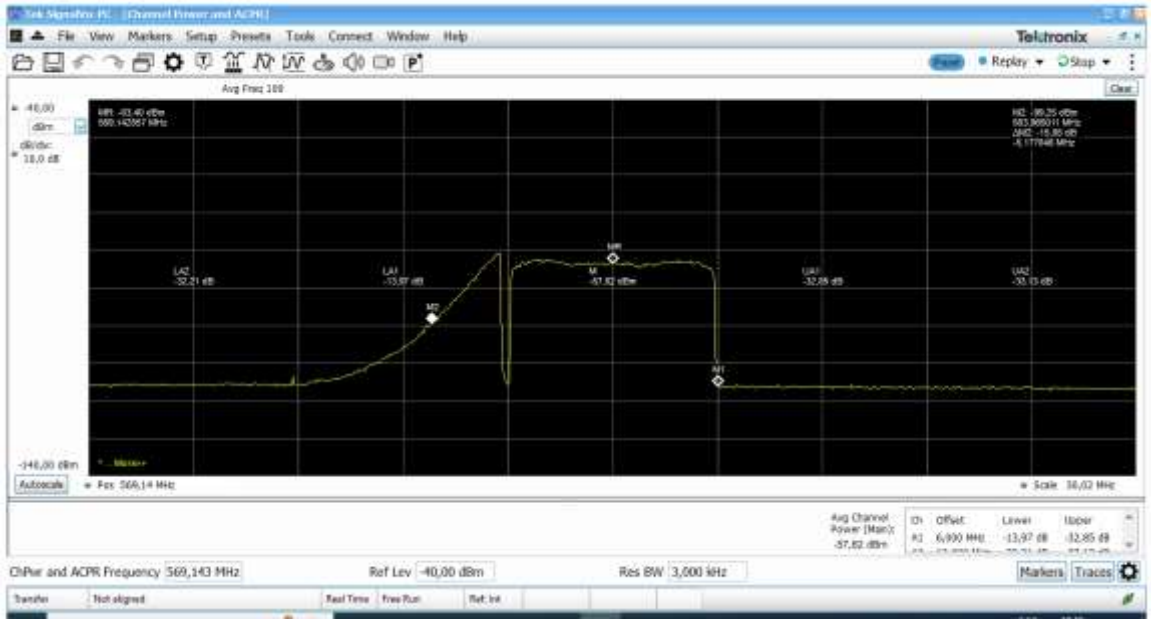


Figure 7.1 - Vertical

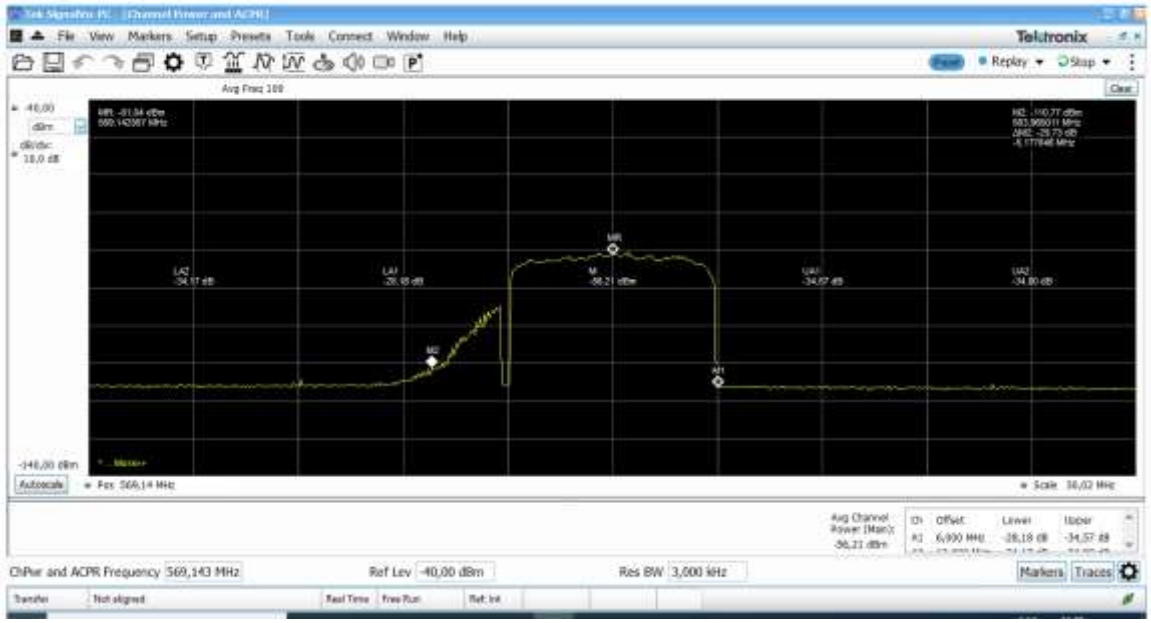


Figure 7.2 - Horizontal

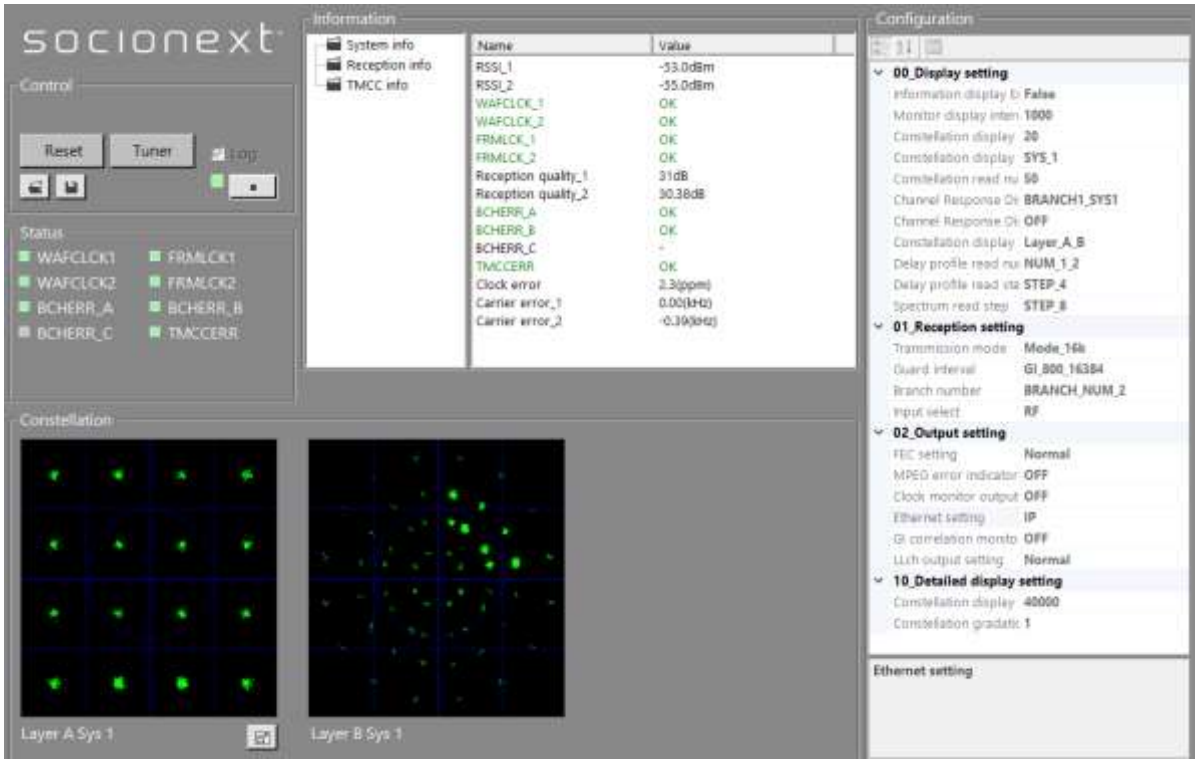


Figure 7.3 - Socionext Screen

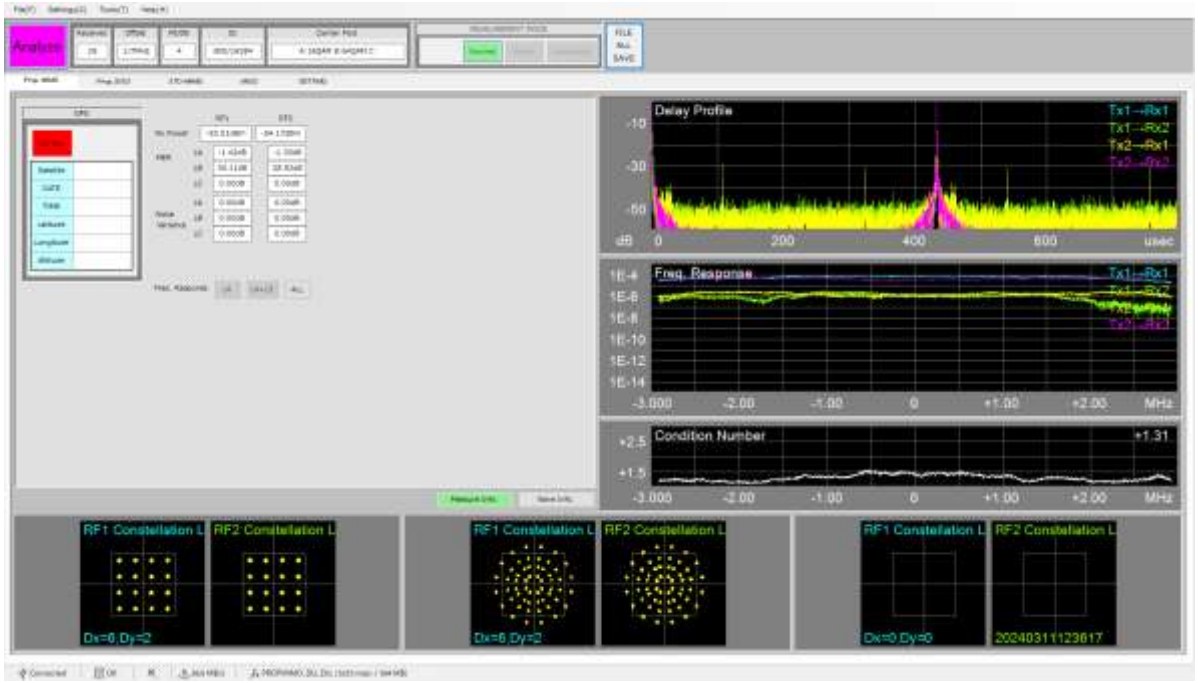


Figure 7.4 - Rintaro Screen

b) AWGN Power

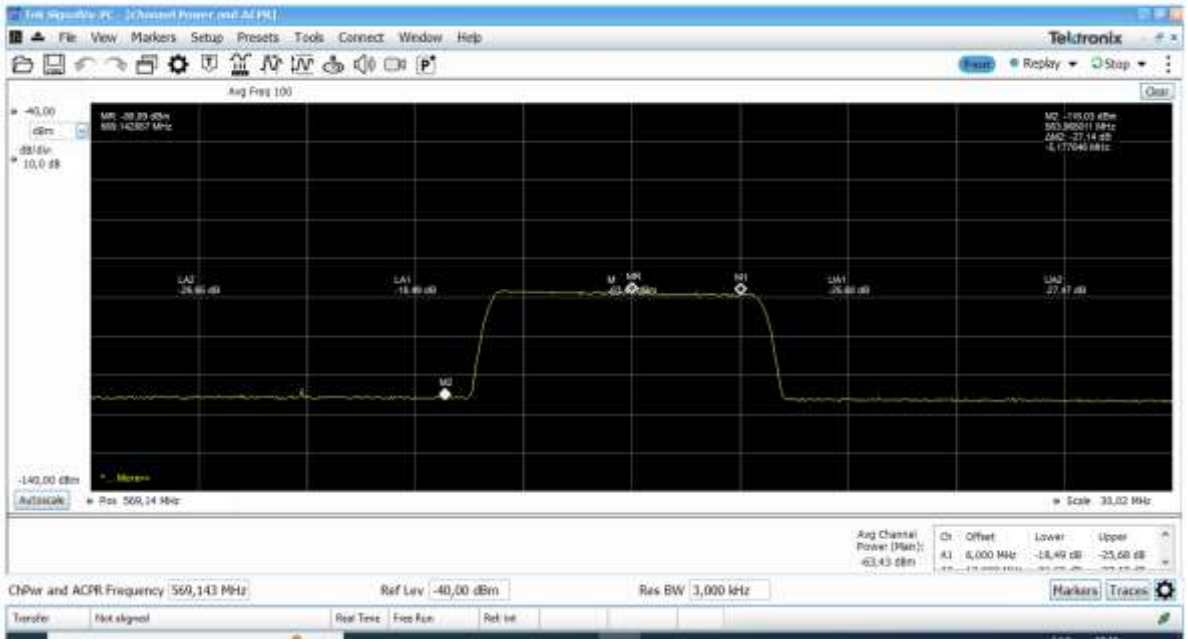


Figure 7.5 - Vertical

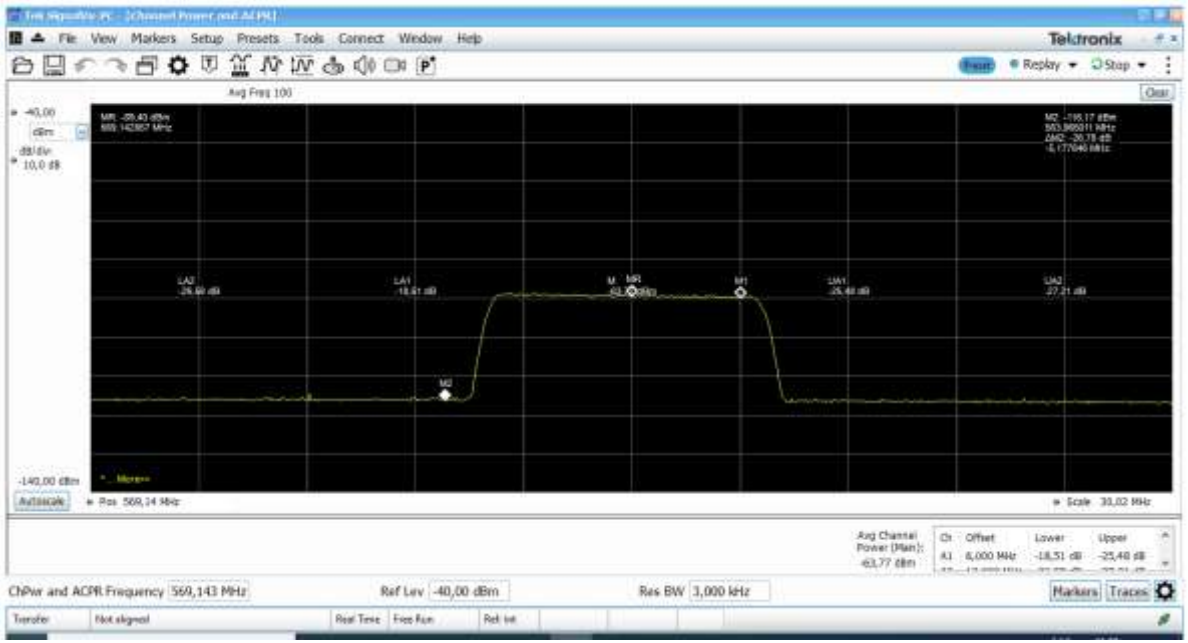


Figure 7.6 - Horizontal

c) C/N Threshold

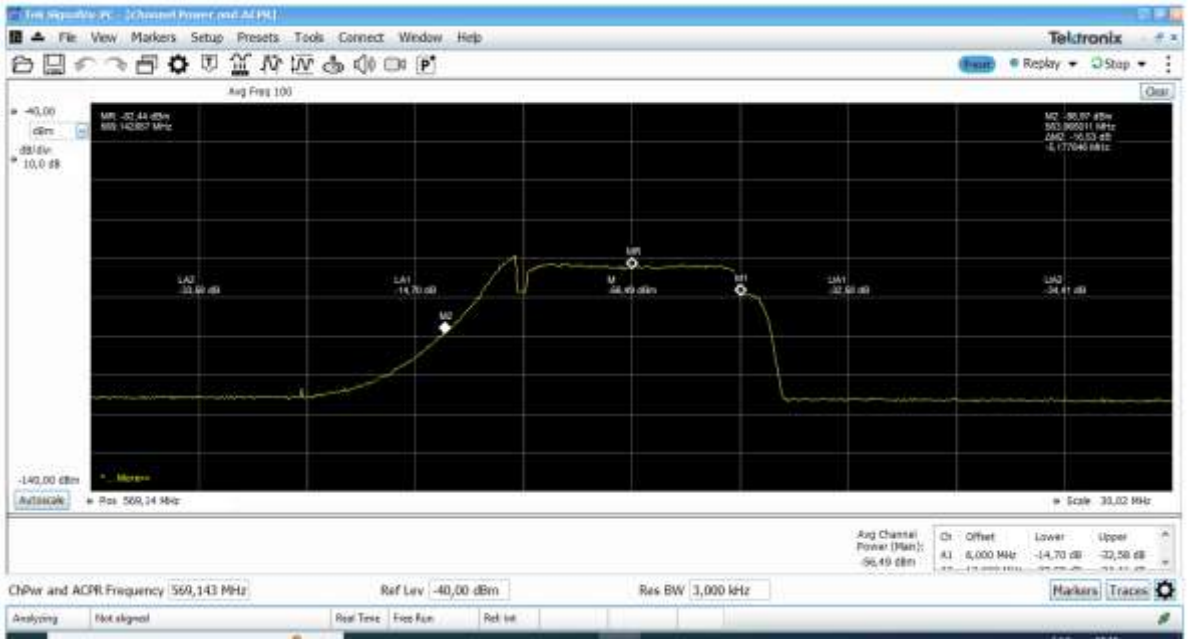


Figure 7.7 - Vertical

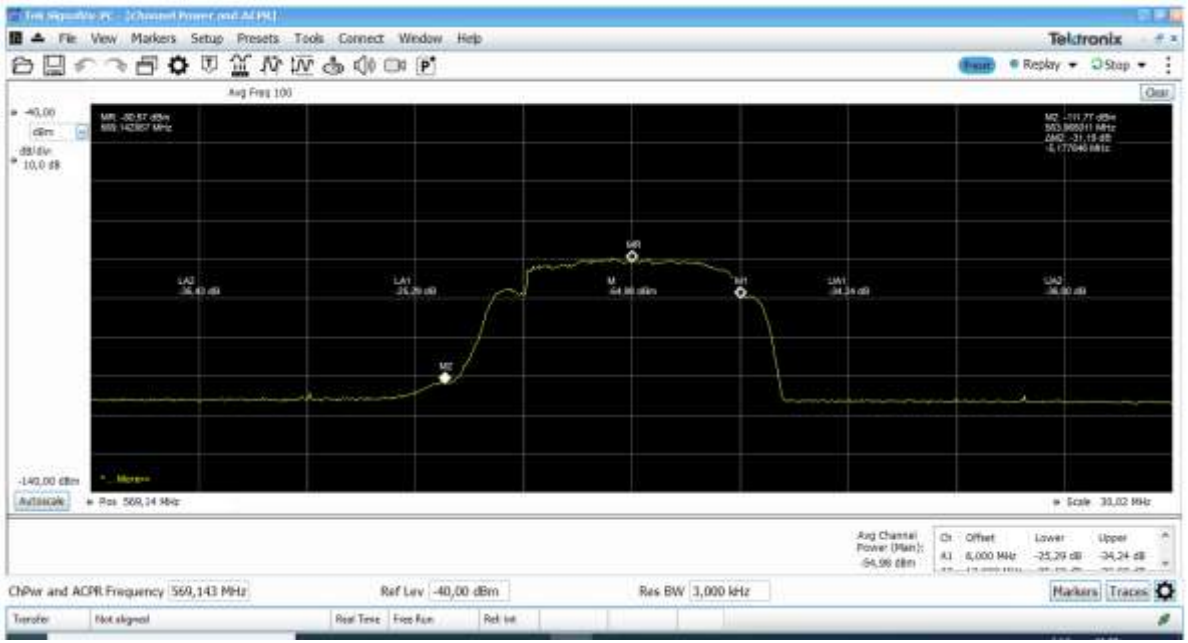


Figure 7.8 - Horizontal

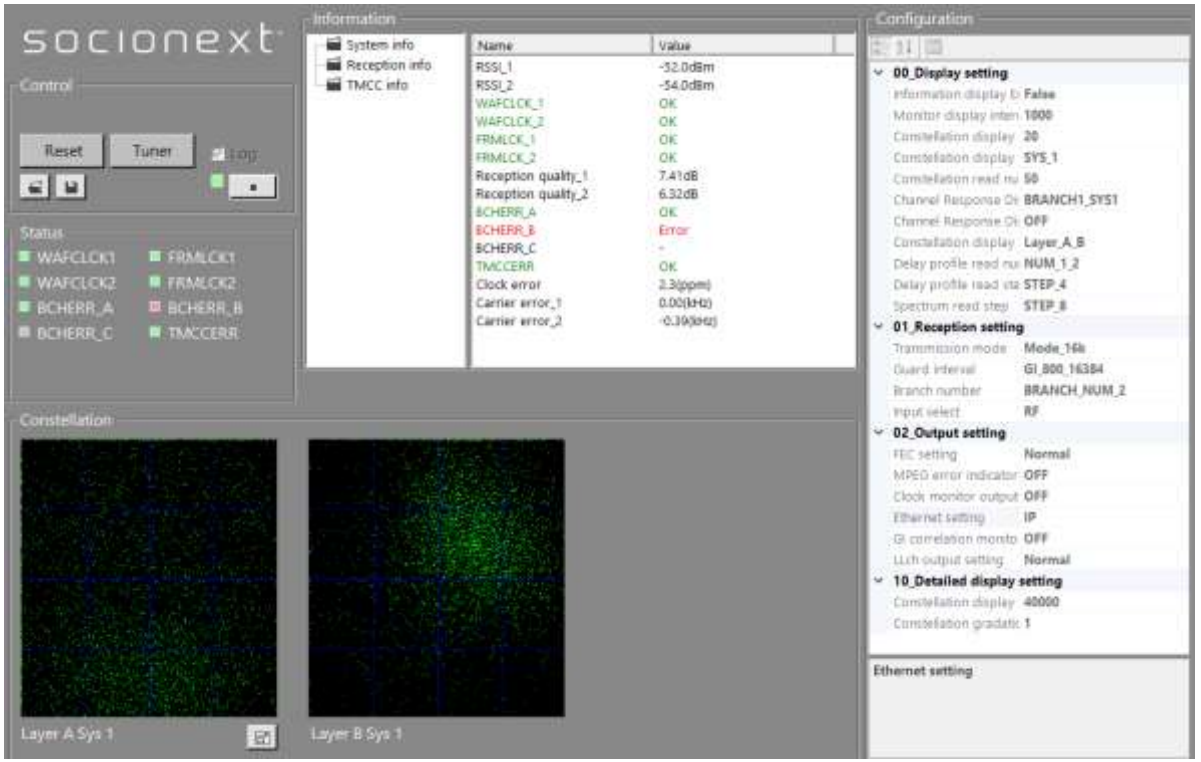


Figure 7.9 - Socionext Screen

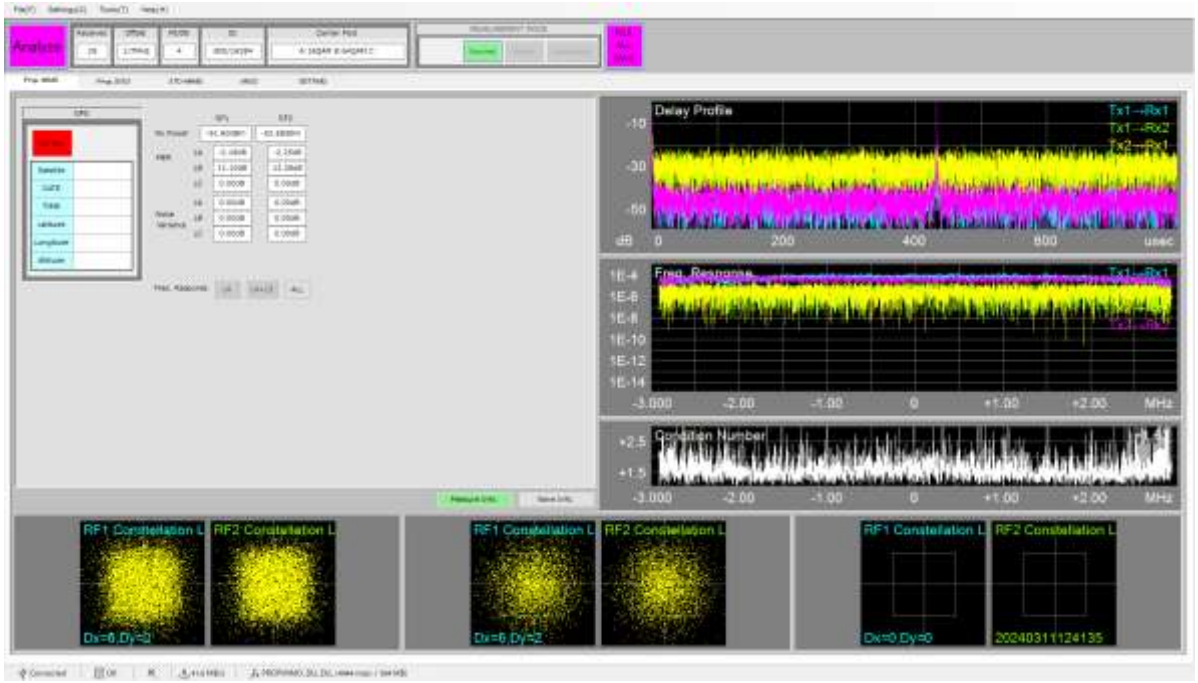


Figure 7.10 - Rintaro Screen

d) Reception Threshold

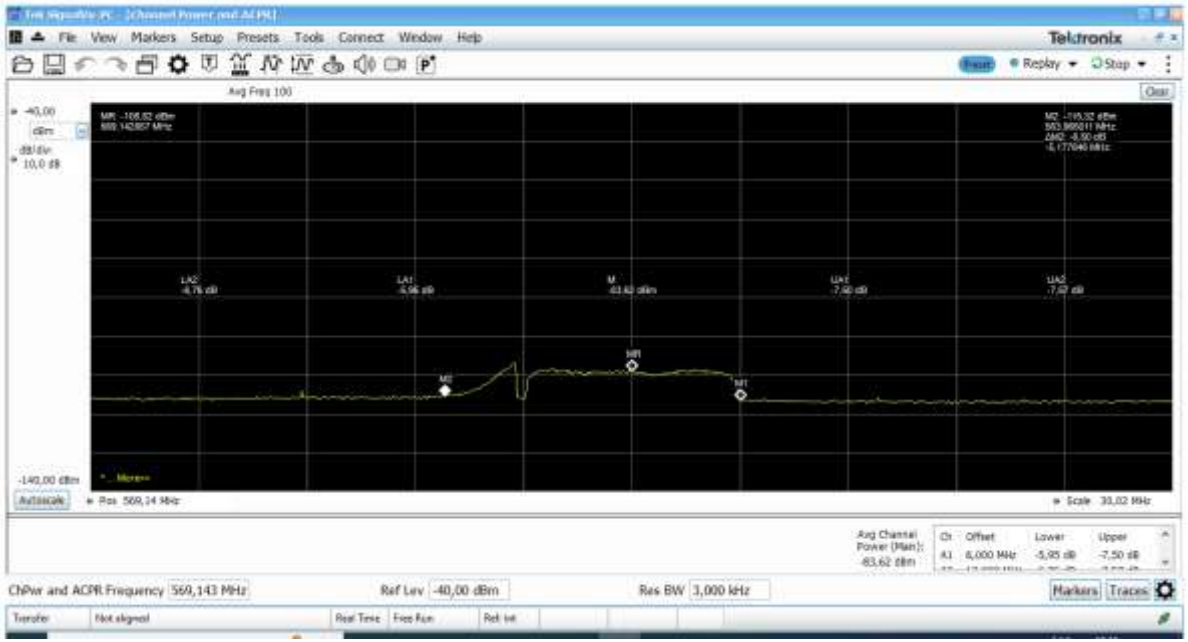


Figure 7.11 - Vertical

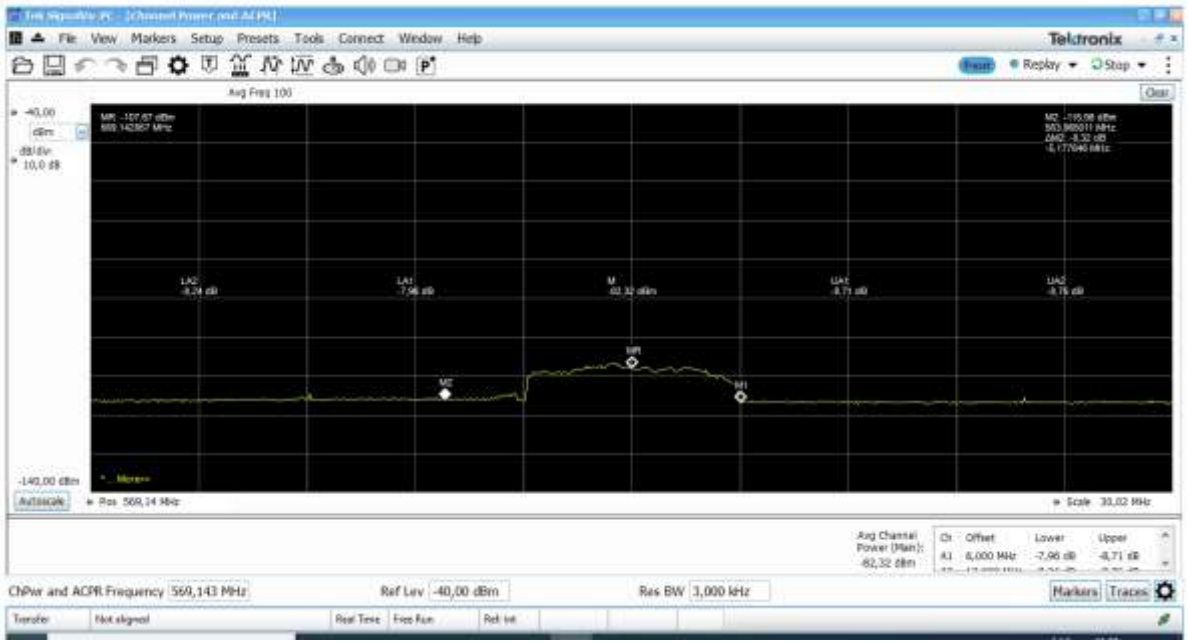


Figure 7.12 - Horizontal

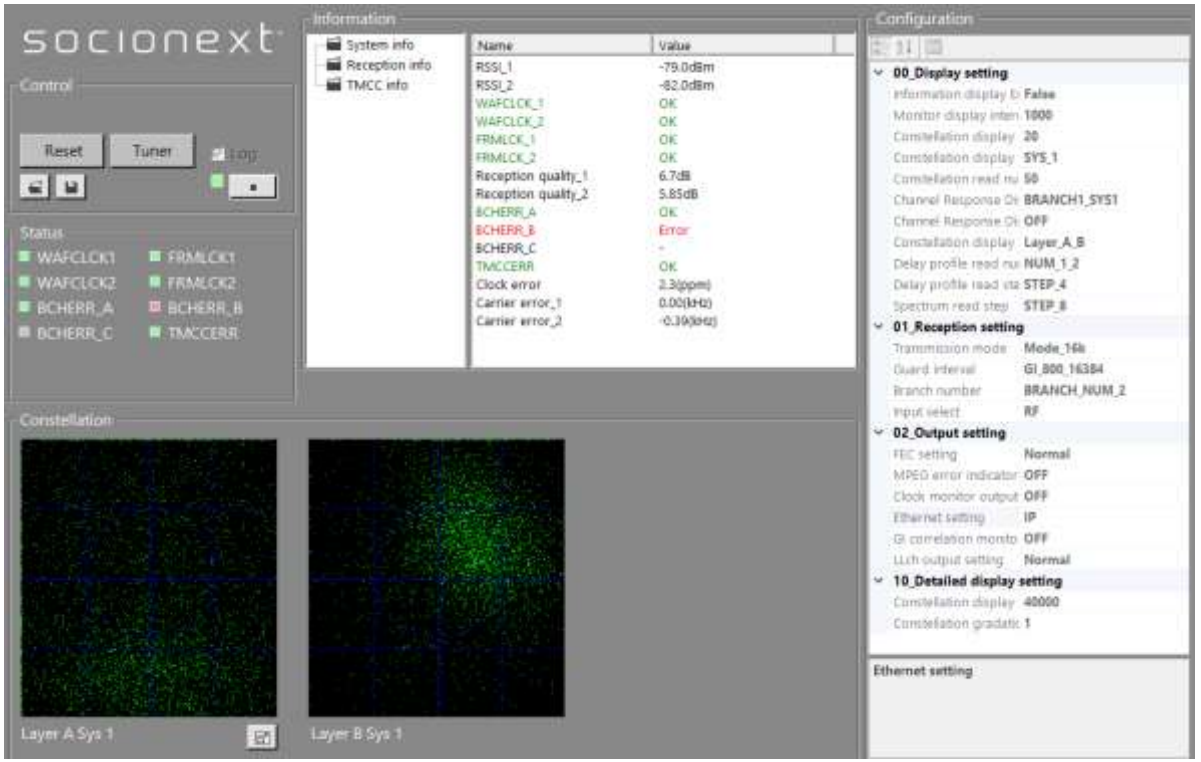


Figure 7.13 - Socionext Screen

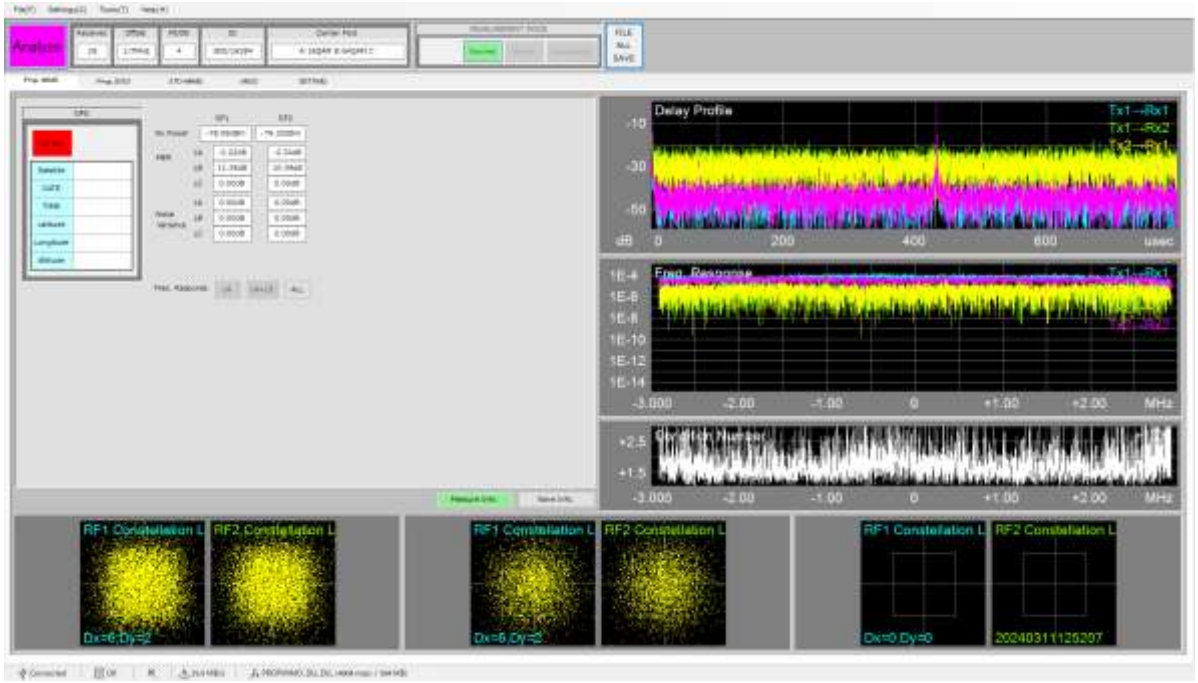


Figure 7.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

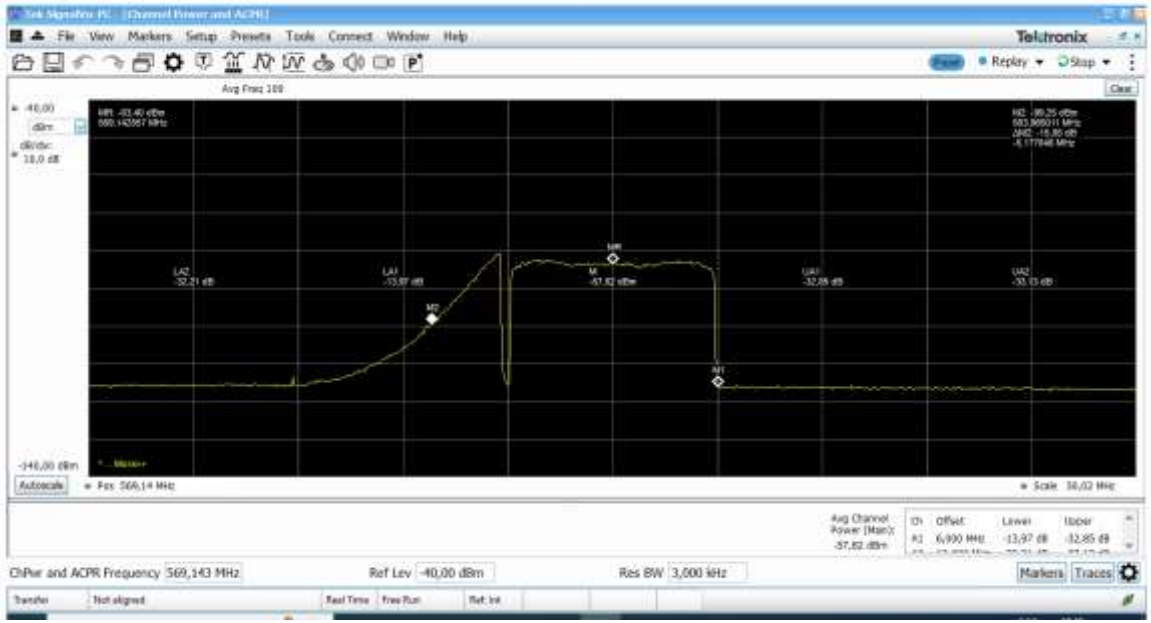


Figure 7.15 - Vertical

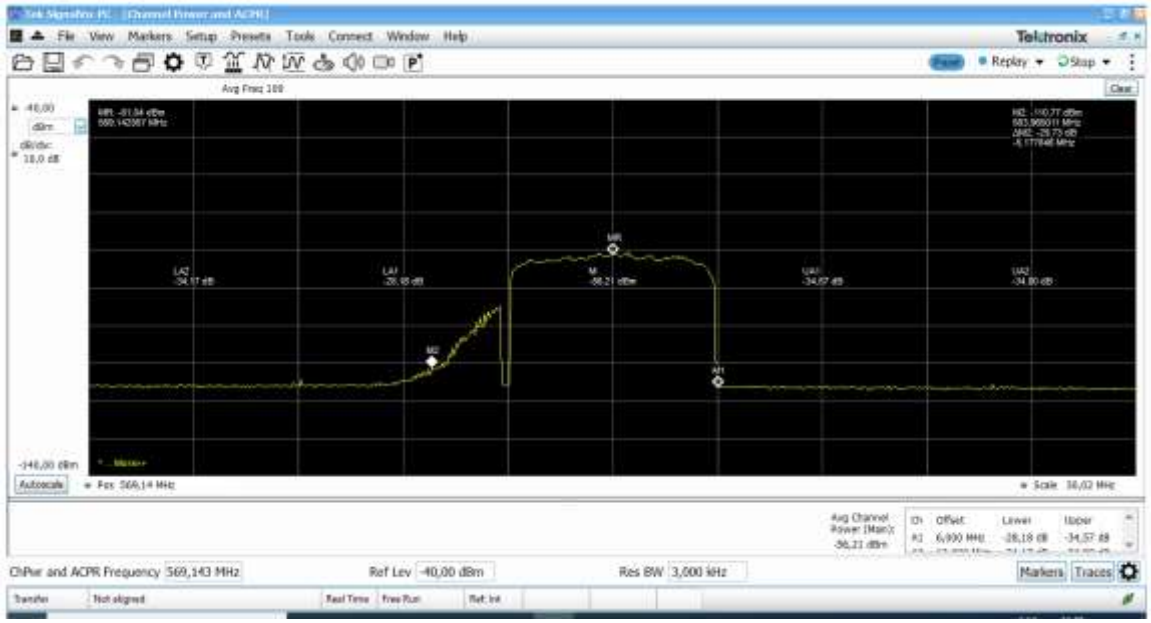


Figure 7.16 - Horizontal

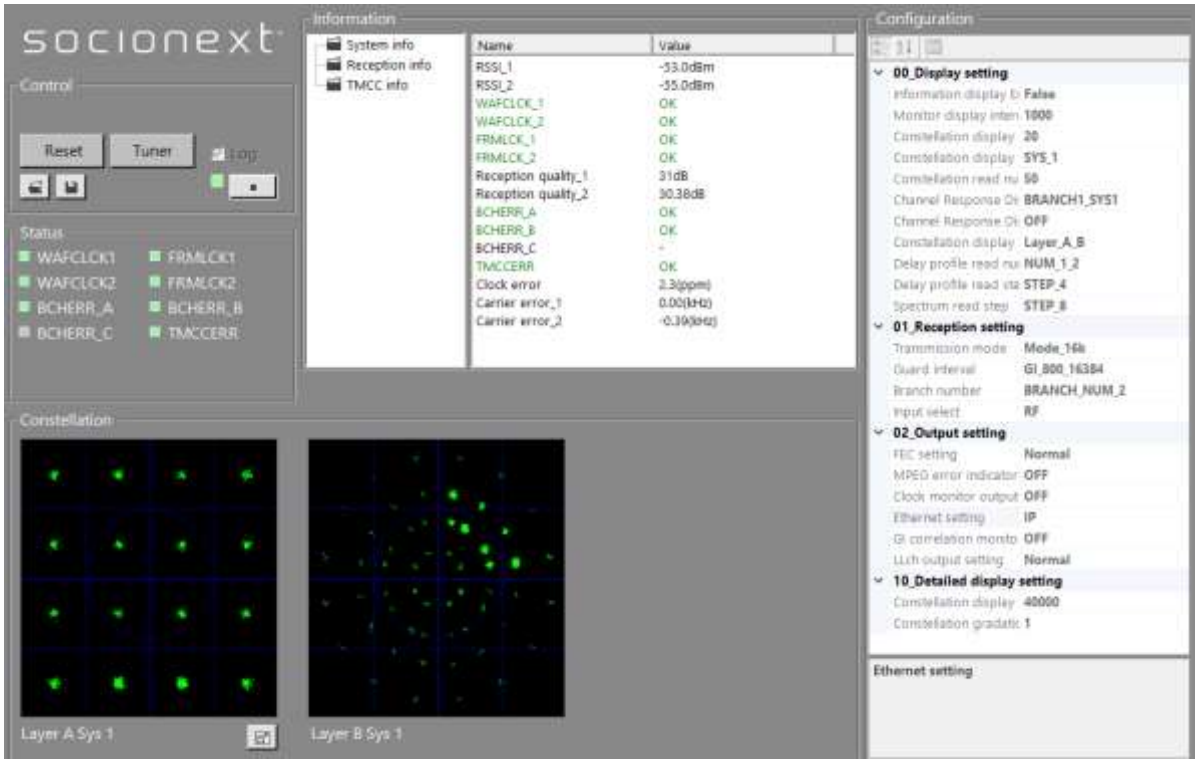


Figure 7.17 - Socionext Screen

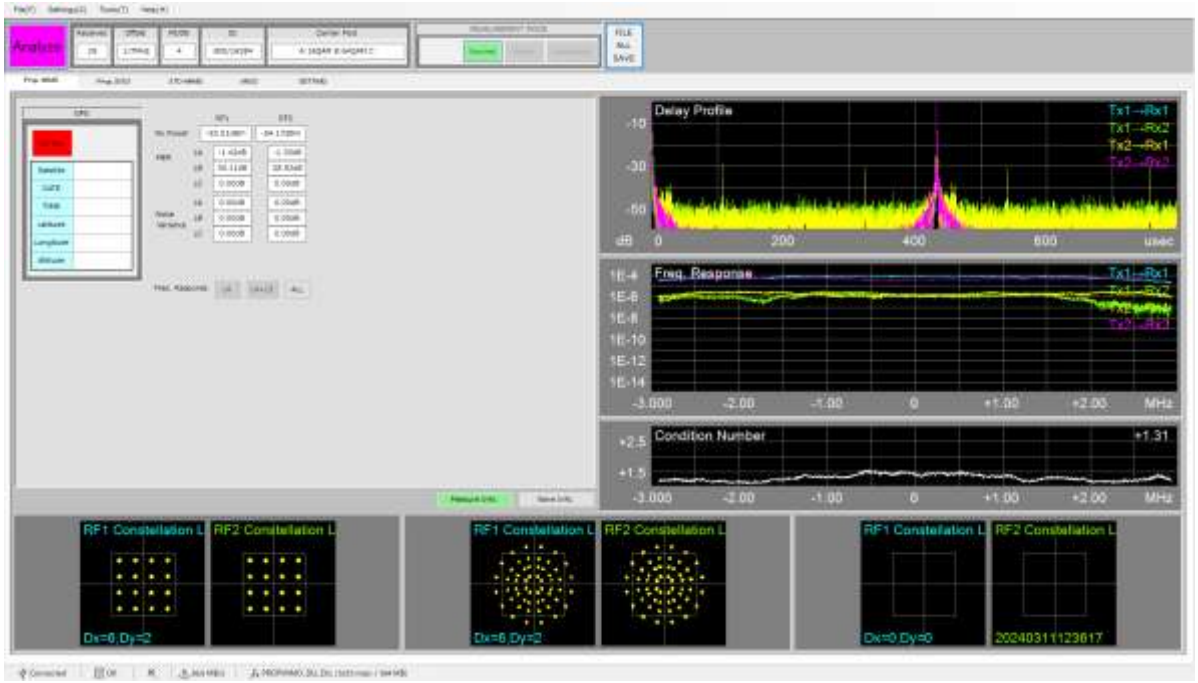


Figure 7.18 - Rintaro Screen

b) AWGN Power

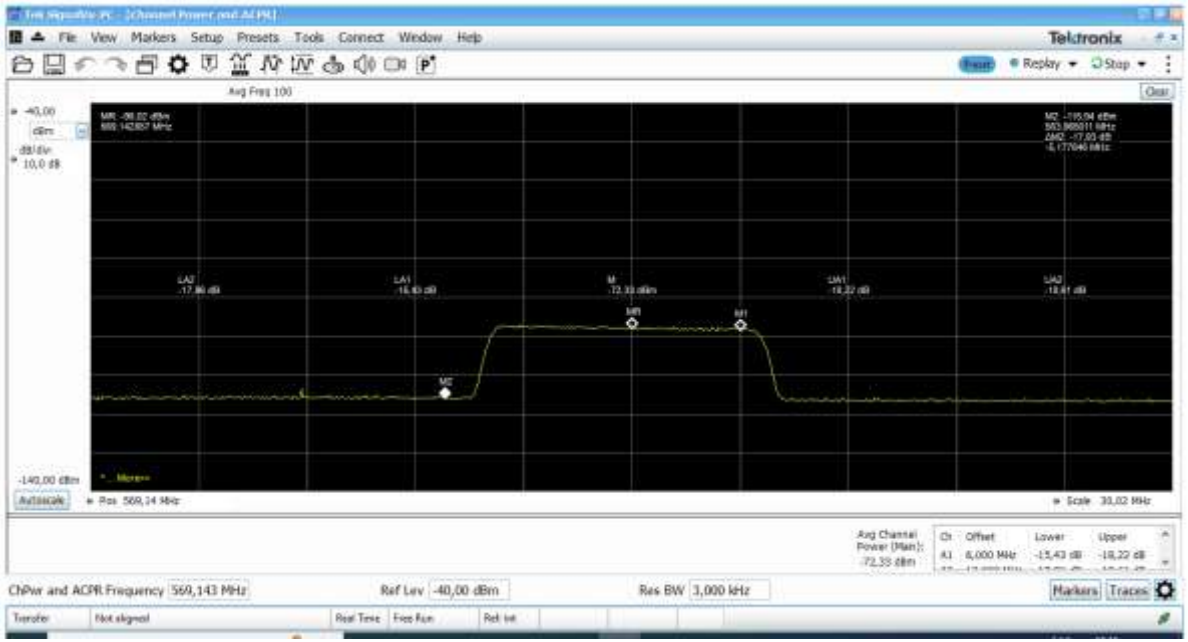


Figure 7.19 - Vertical

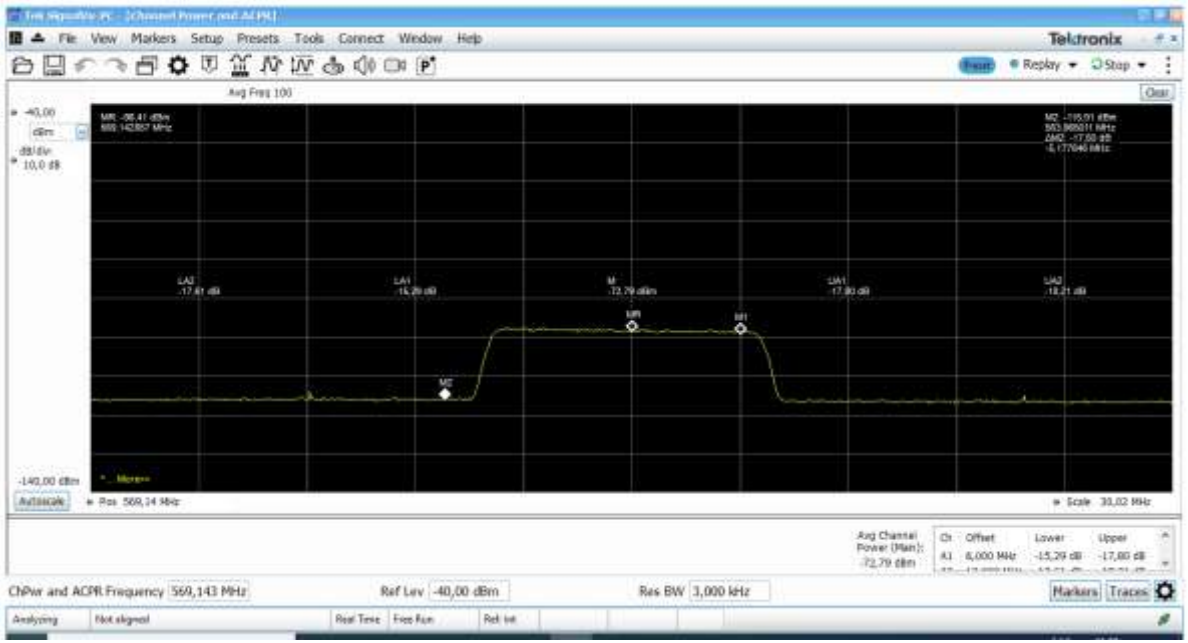


Figure 7.20 - Horizontal

c) C/N Threshold

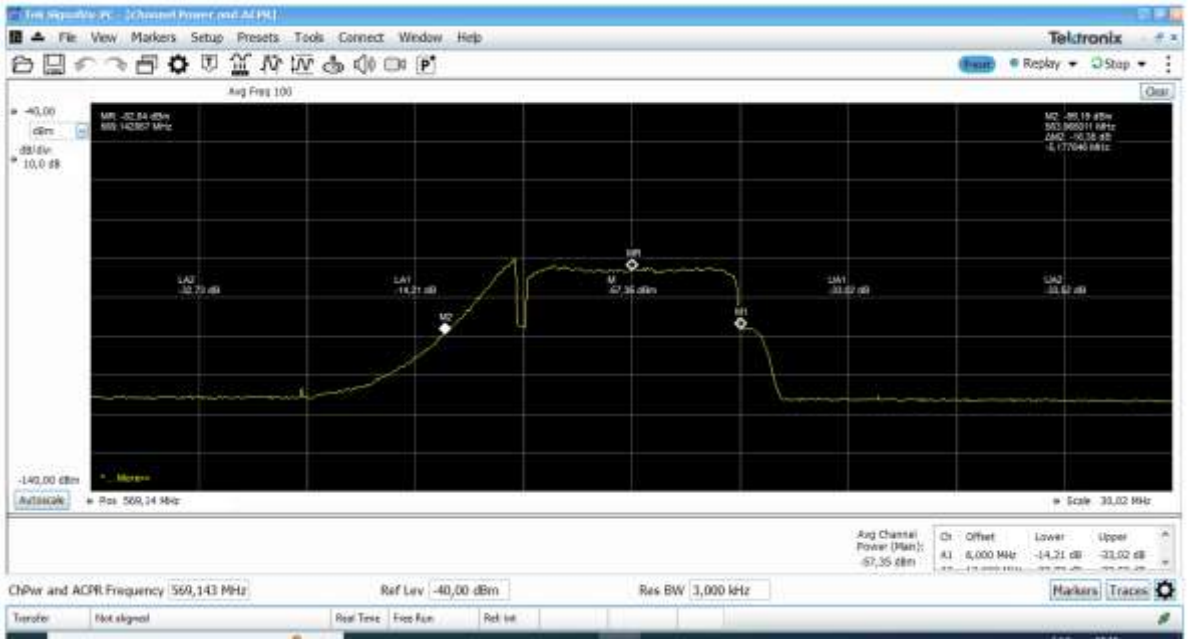


Figure 7.21 - Vertical

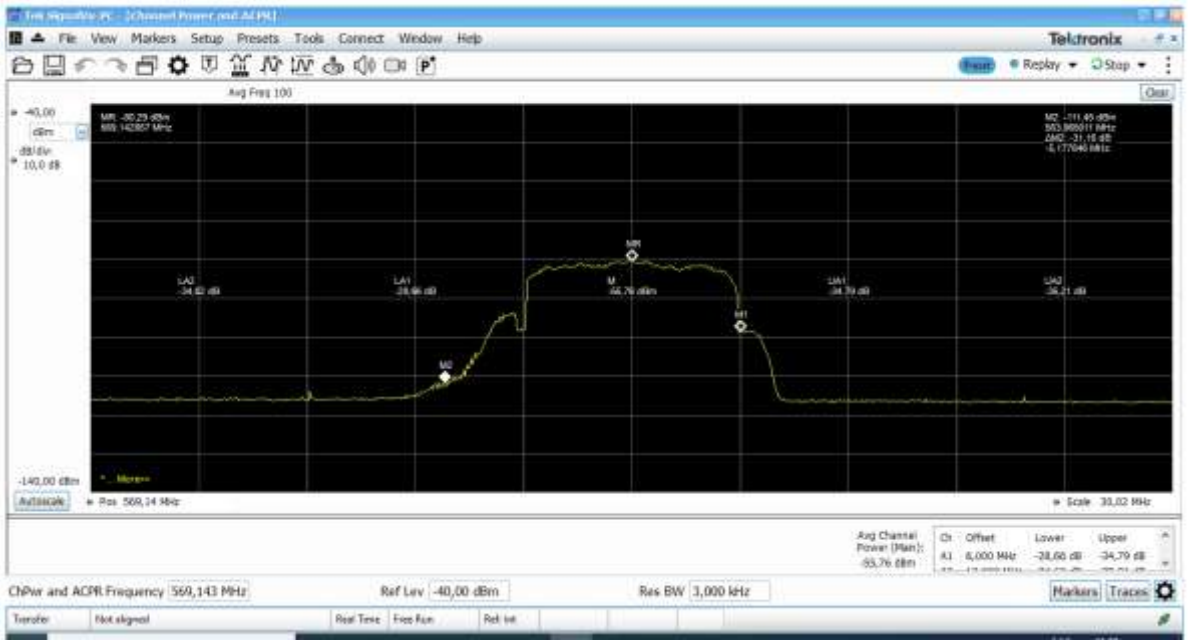


Figure 7.22 - Horizontal

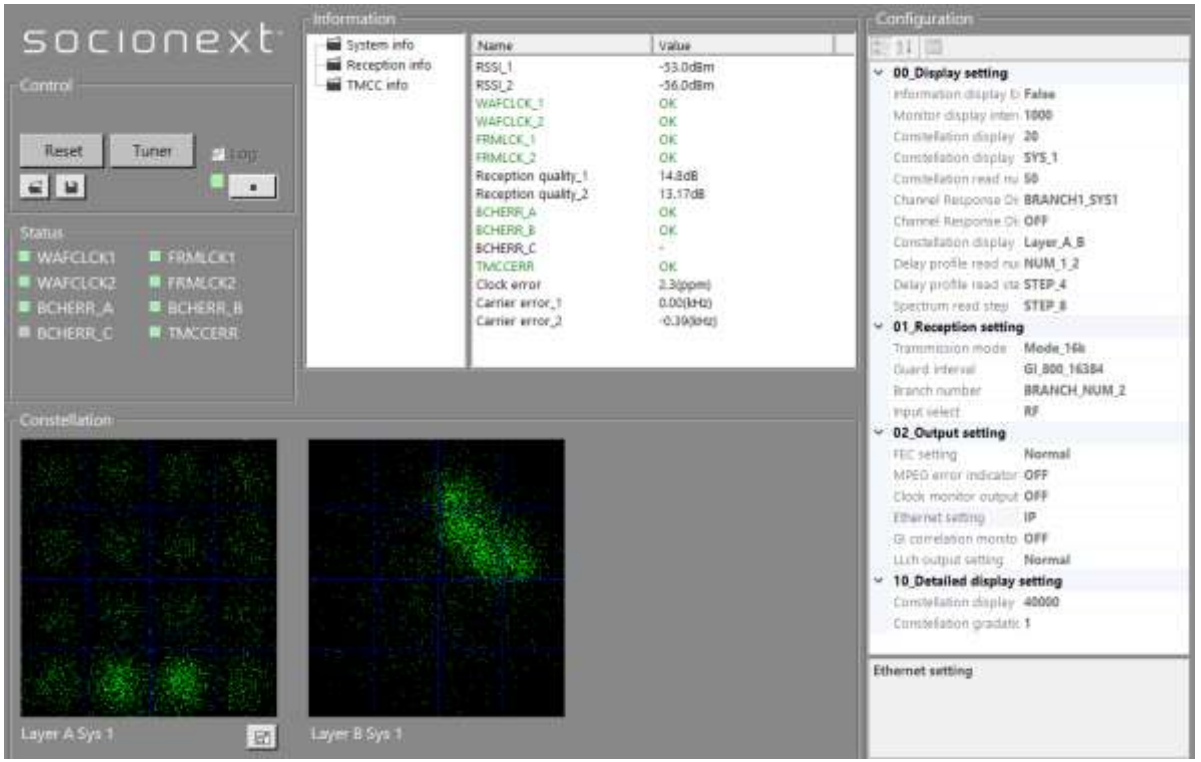


Figure 7.23 - Socionext Screen

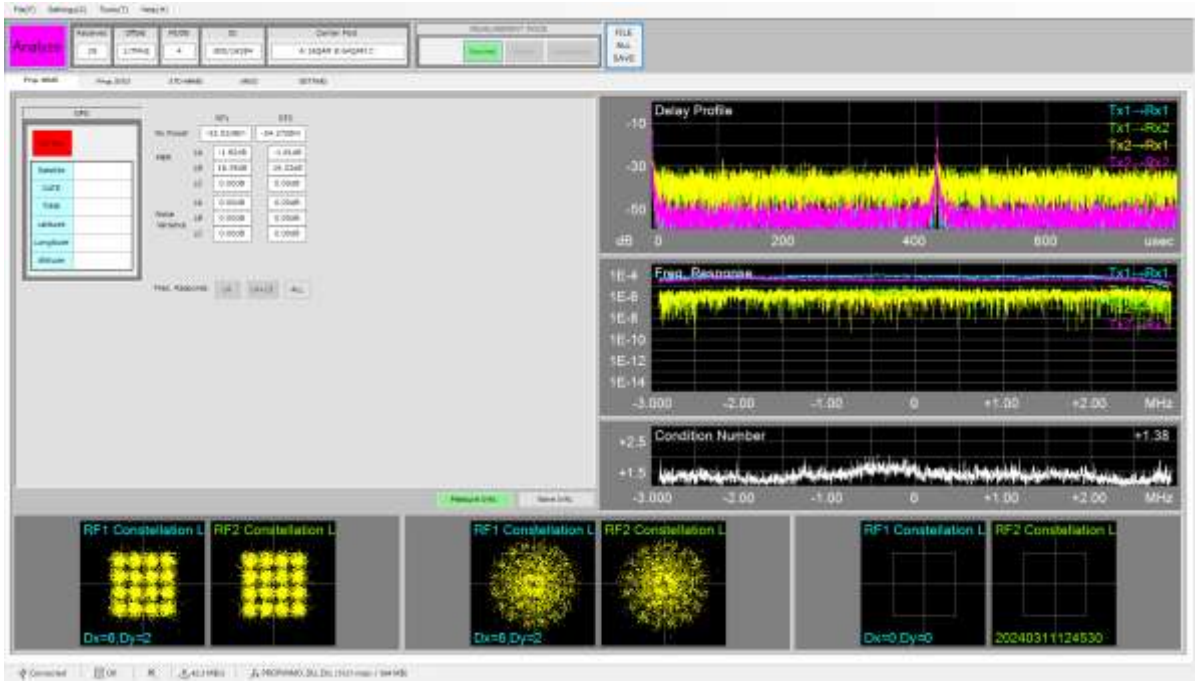


Figure 7.24 - Rintaro Screen

d) Reception Threshold

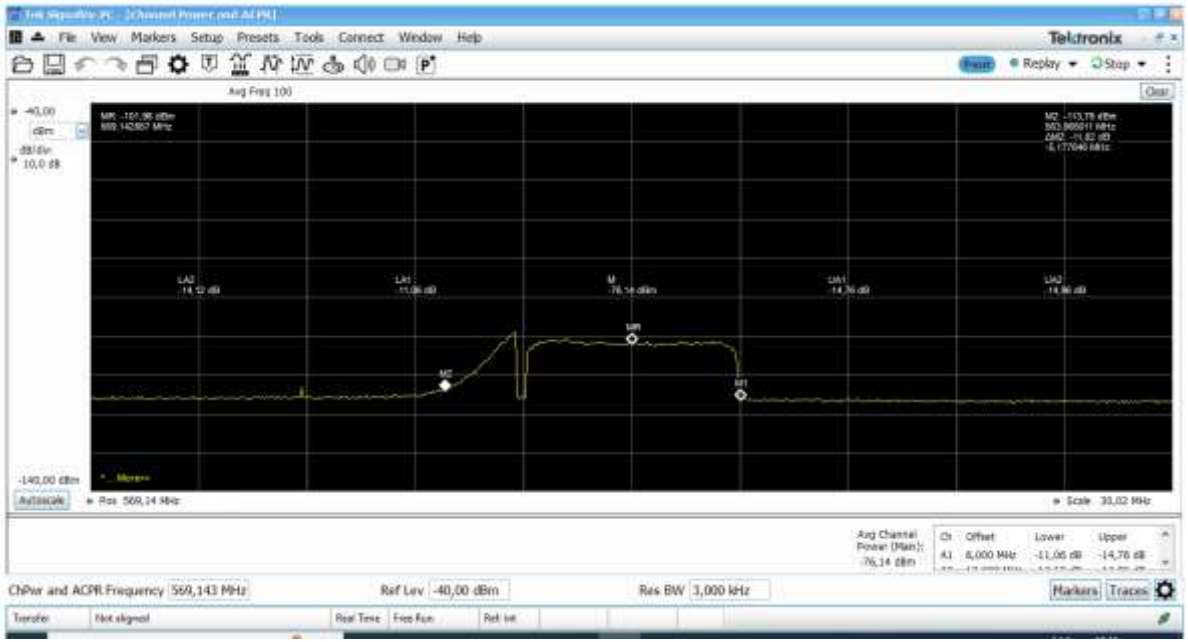


Figure 7.25 - Vertical

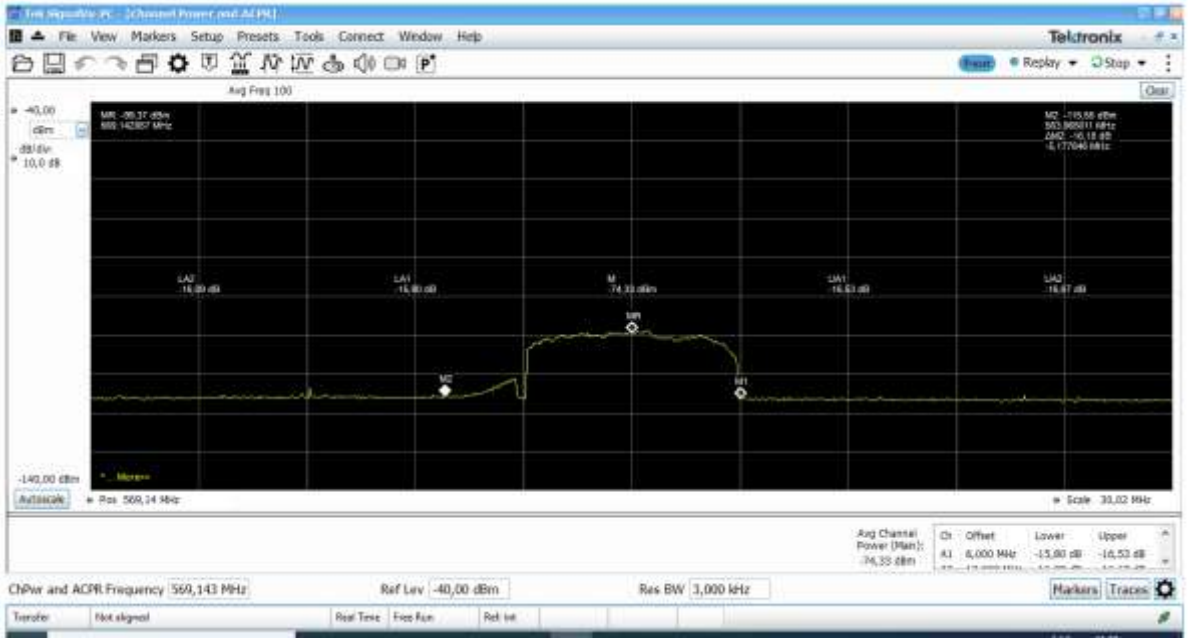


Figure 7.26 - Horizontal

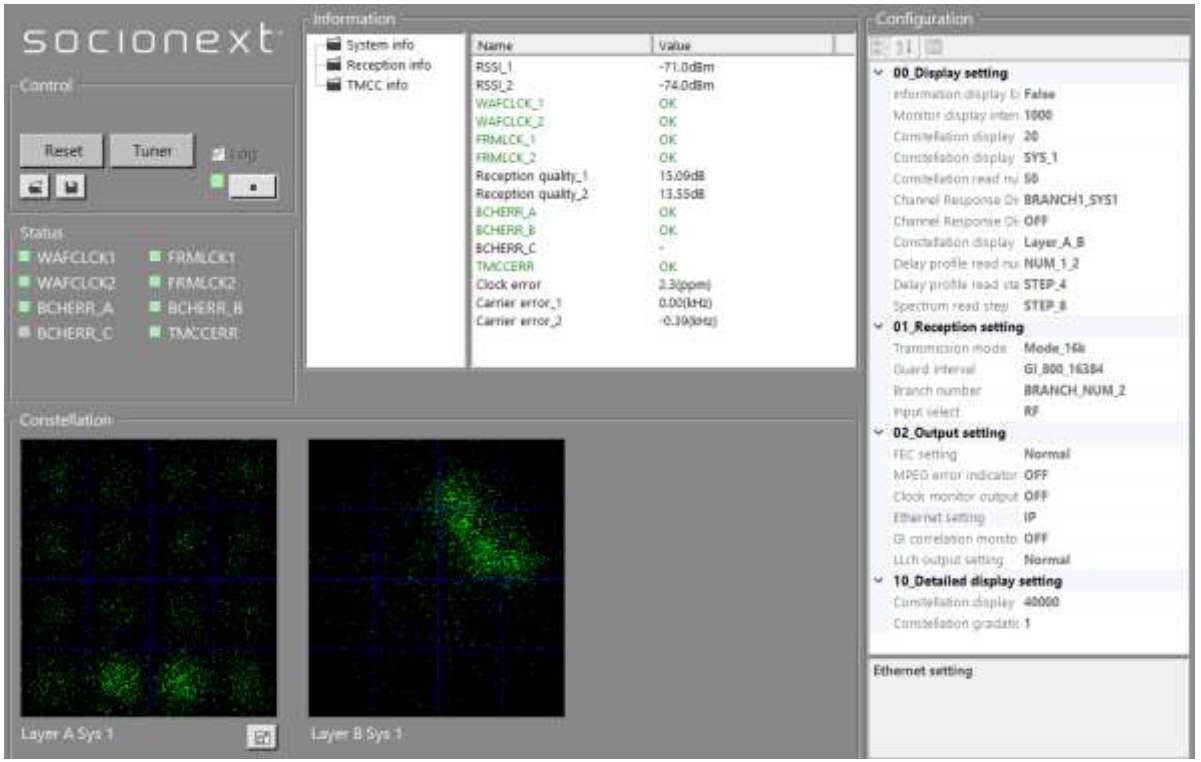


Figure 7.27 - Socionext Screen

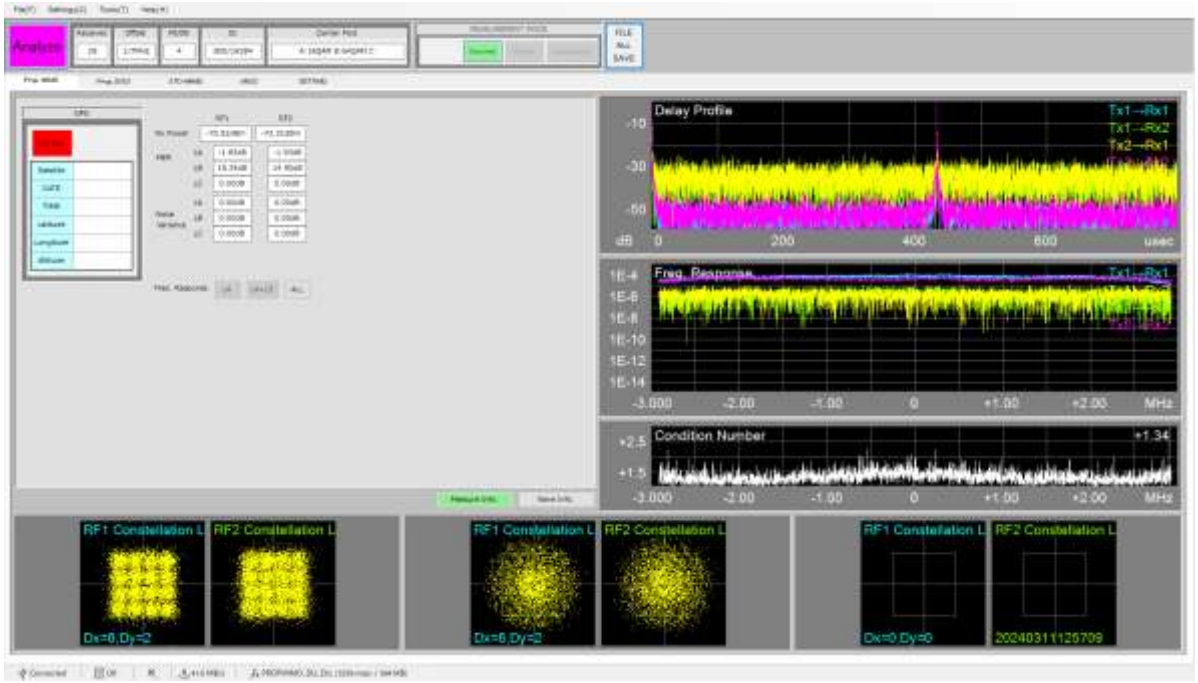


Figure 7.28 - Rintaro Screen

Chapter 8. Site 17

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

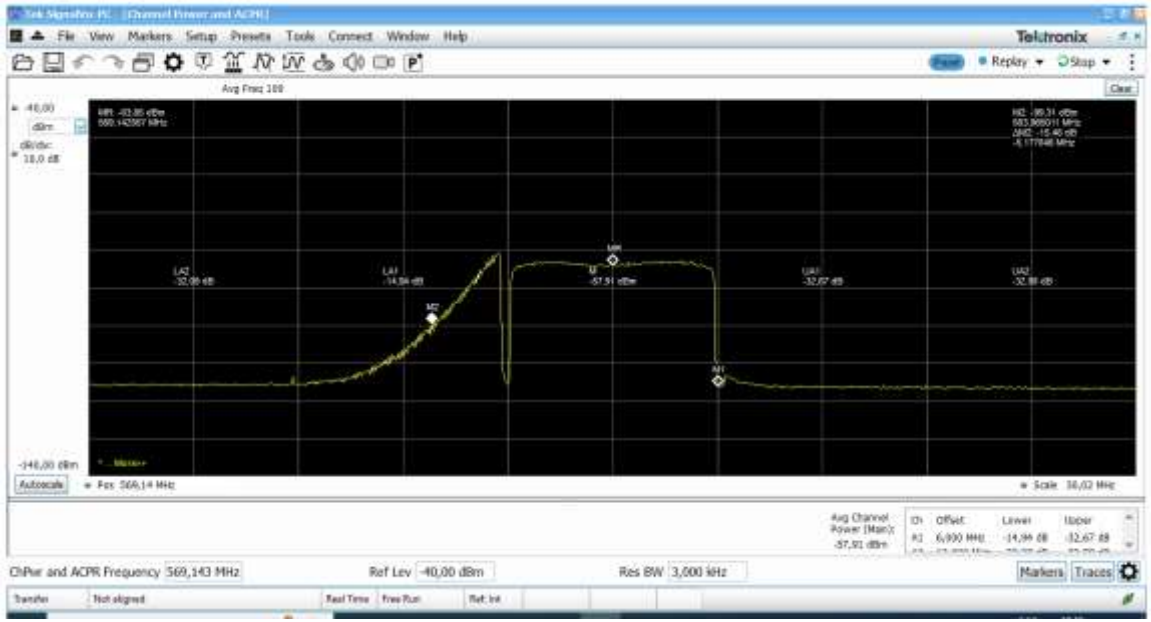


Figure 8.1 - Vertical

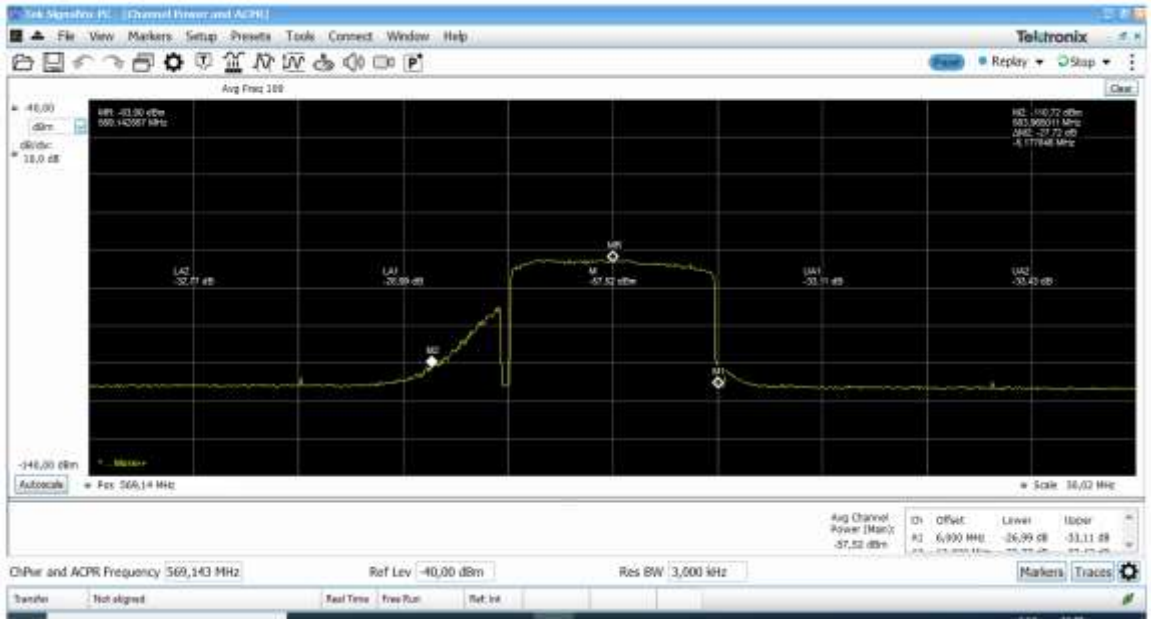


Figure 8.2 - Horizontal

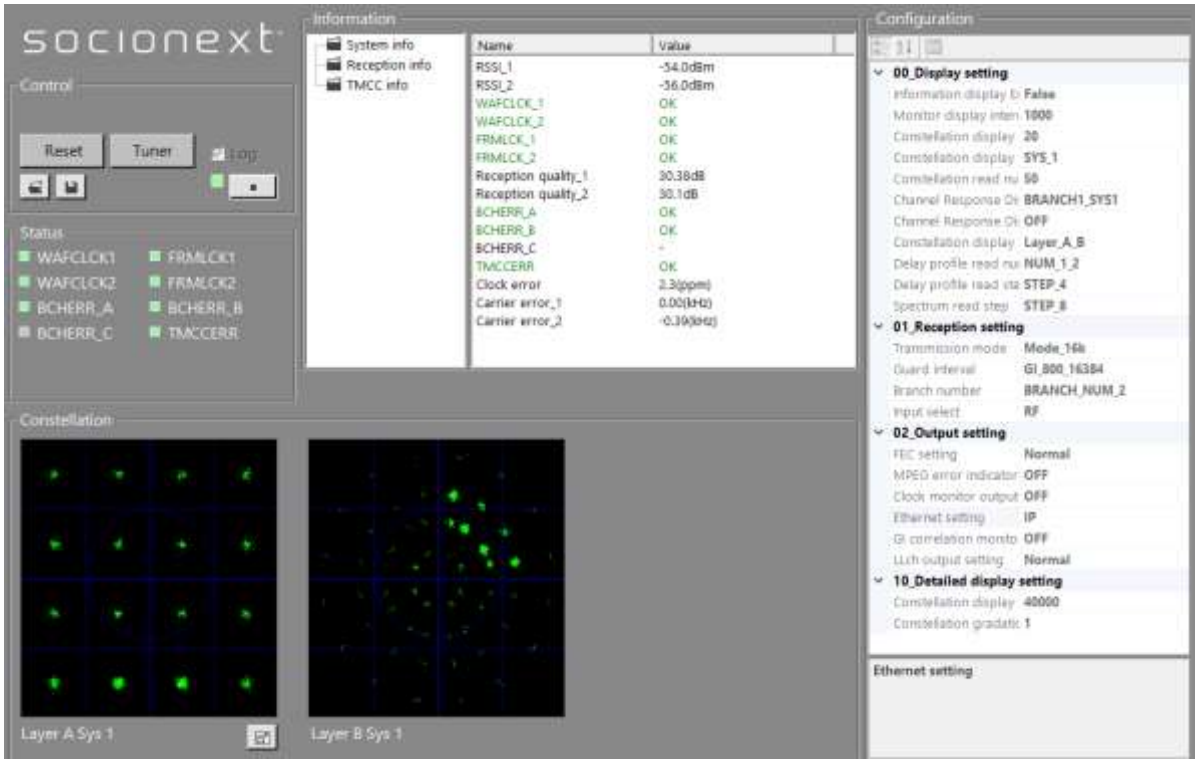


Figure 8.3 - Socionext Screen

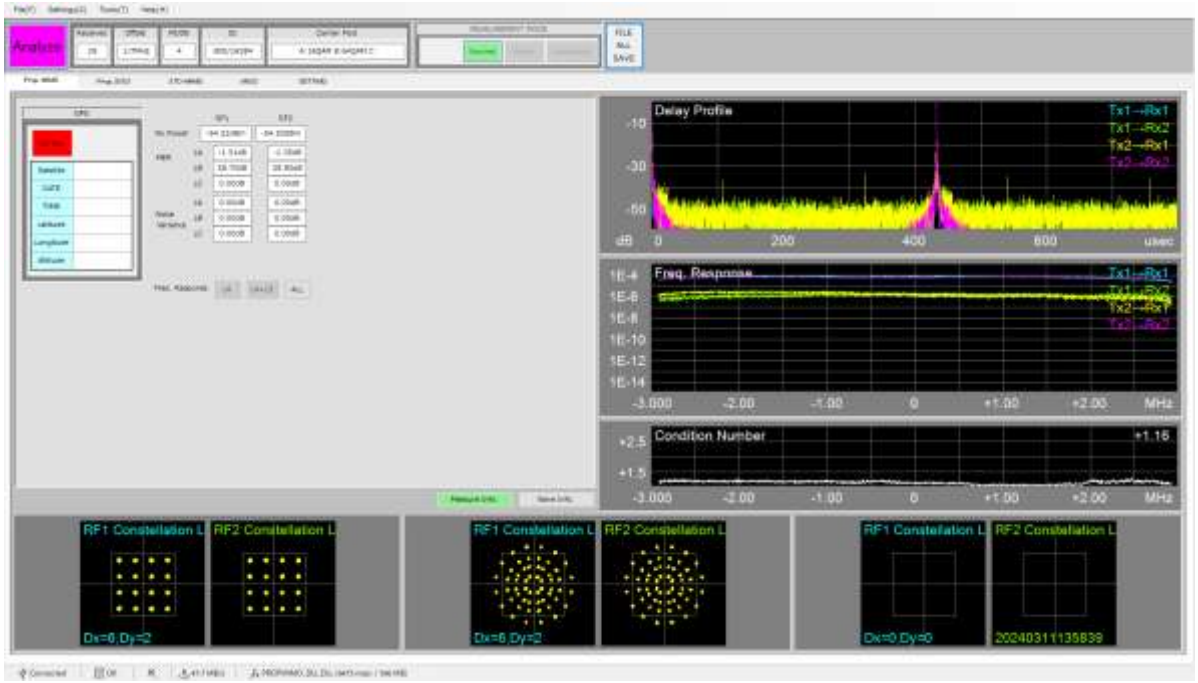


Figure 8.4 - Rintaro Screen

b) AWGN Power

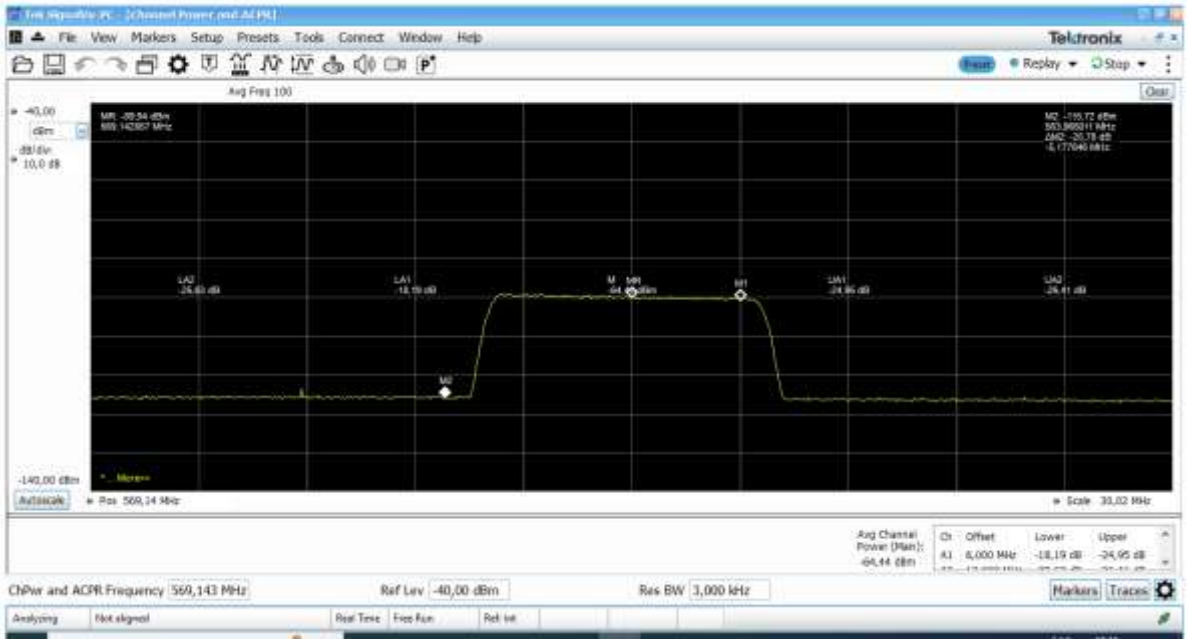


Figure 8.5 - Vertical

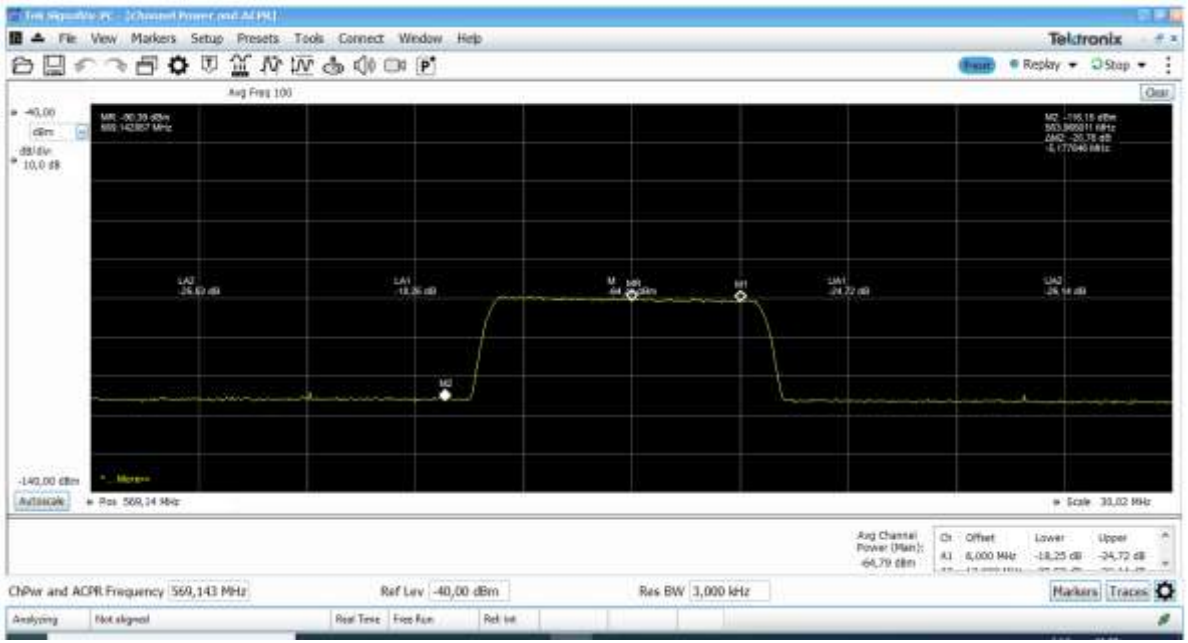


Figure 8.6 - Horizontal

c) C/N Threshold

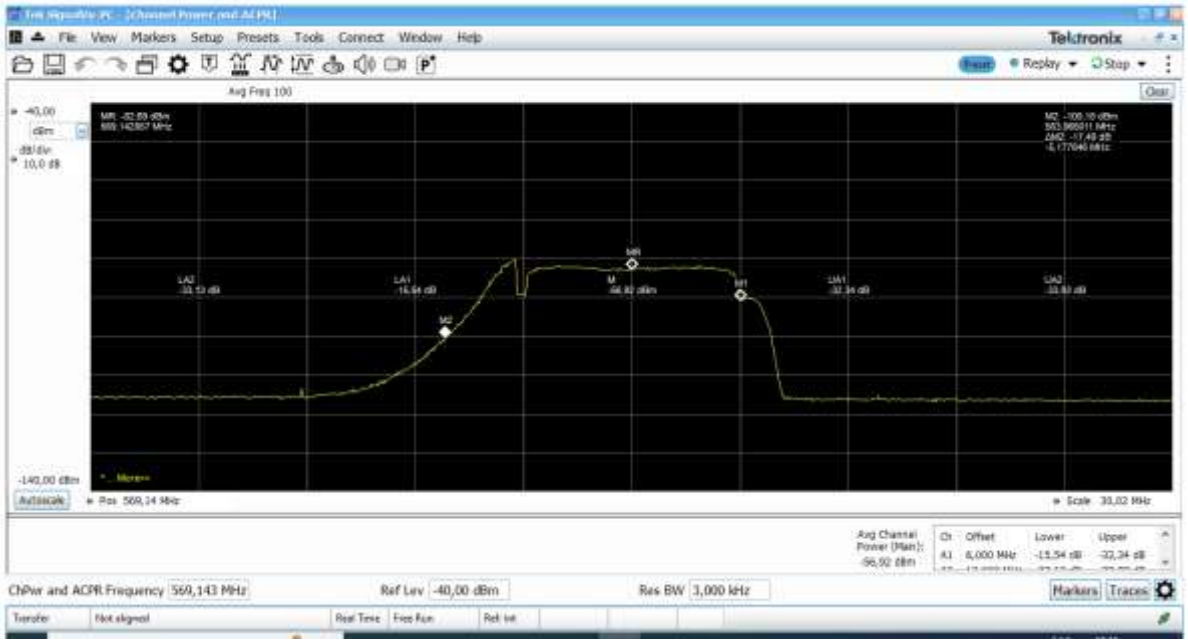


Figure 8.7 - Vertical

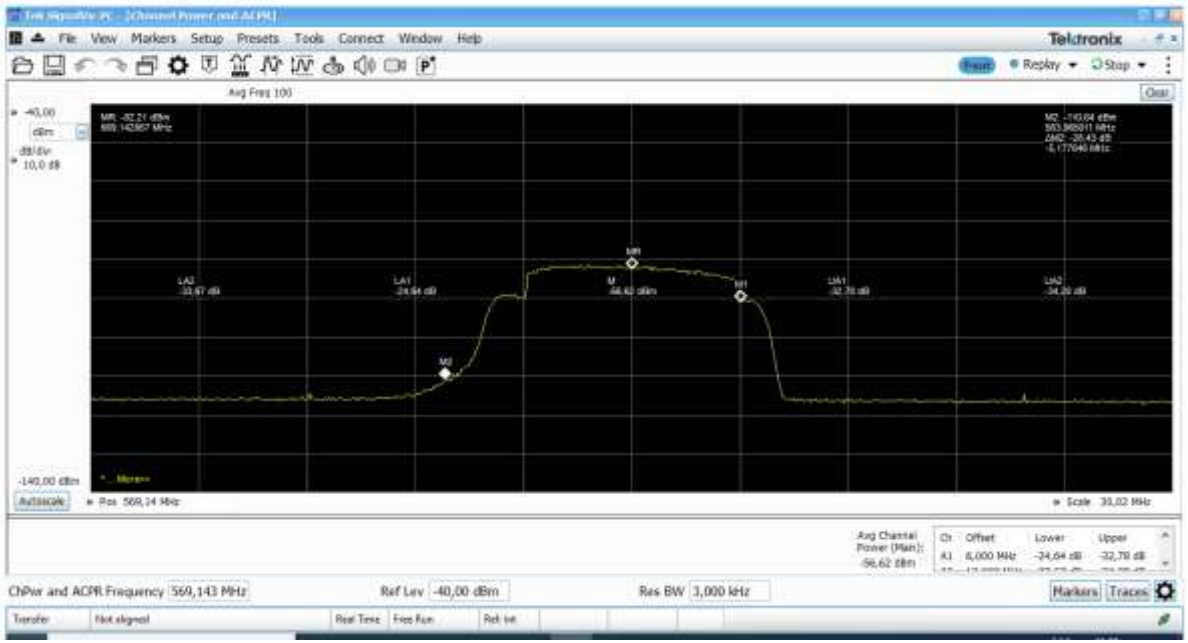


Figure 8.8 - Horizontal

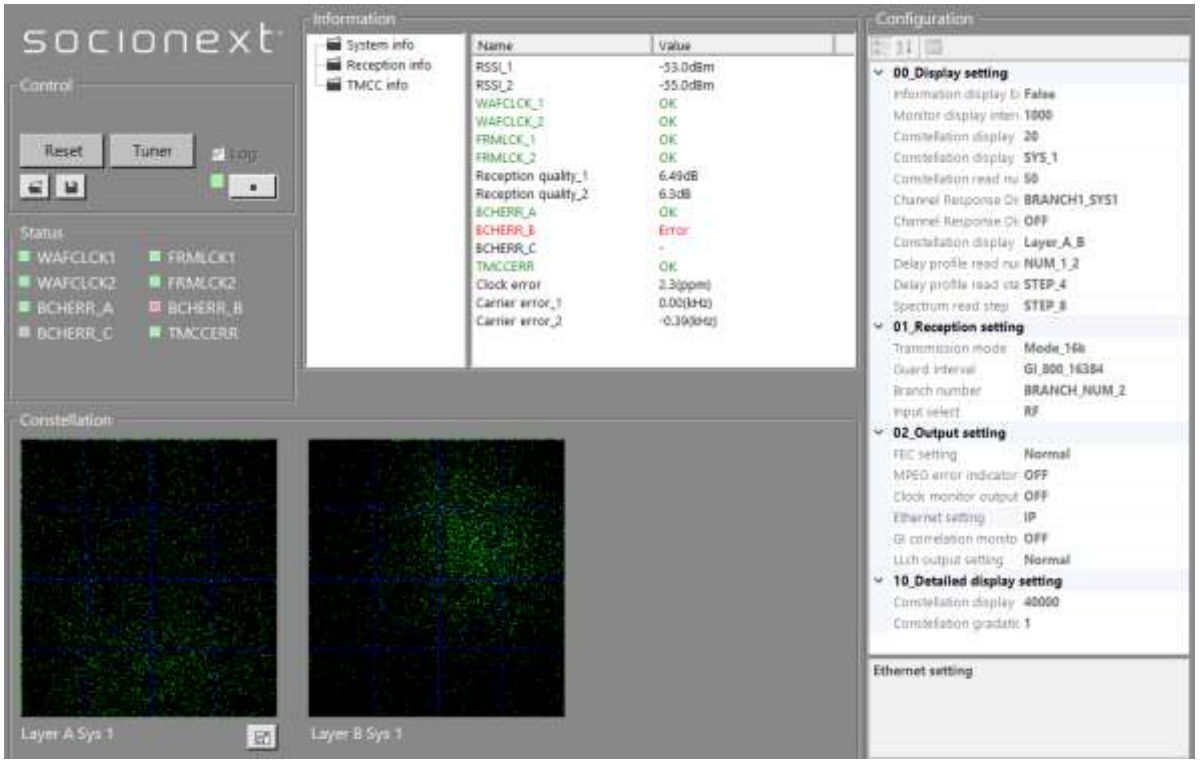


Figure 8.9 - Socionext Screen

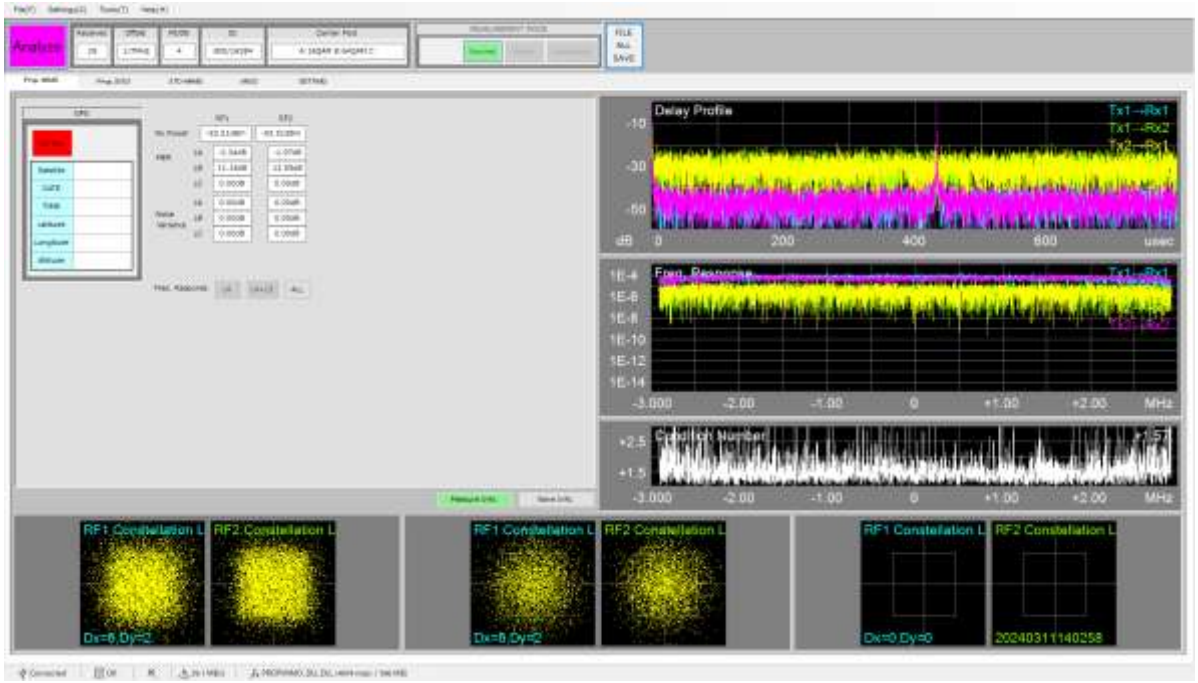


Figure 8.10 - Rintaro Screen

d) Reception Threshold

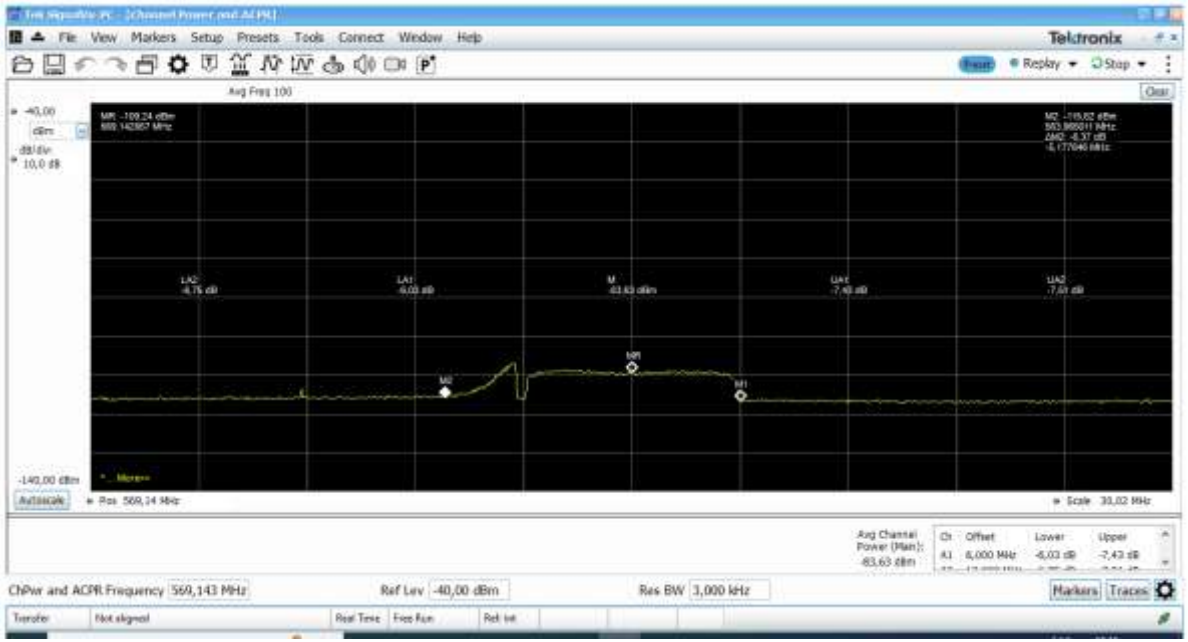


Figure 8.11 - Vertical

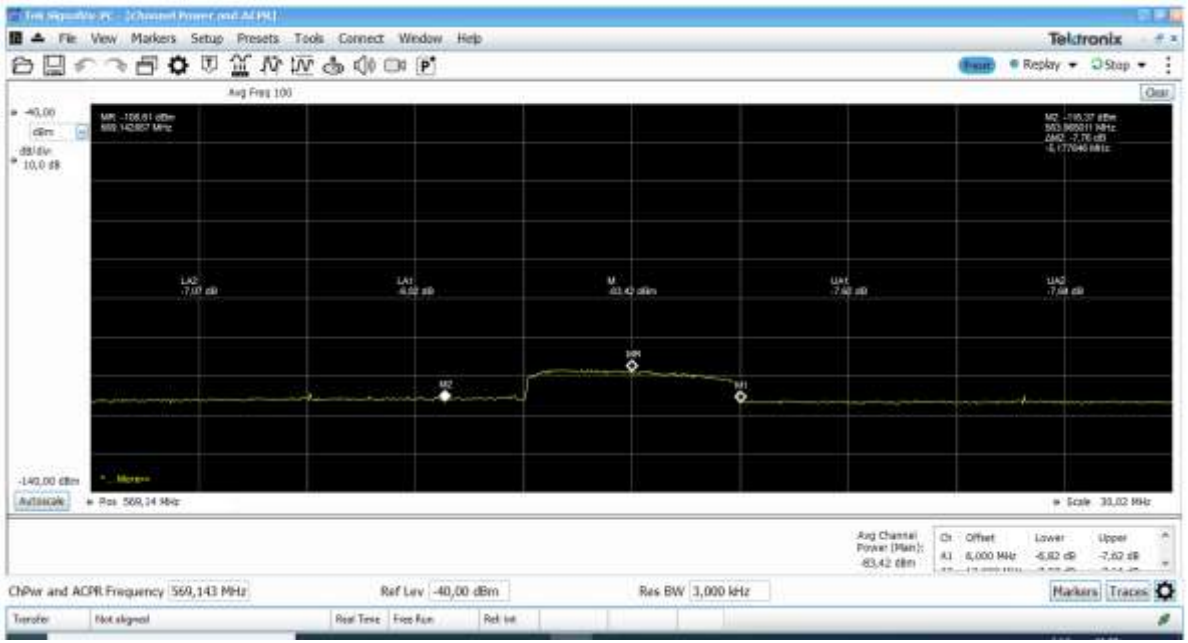


Figure 8.12 - Horizontal

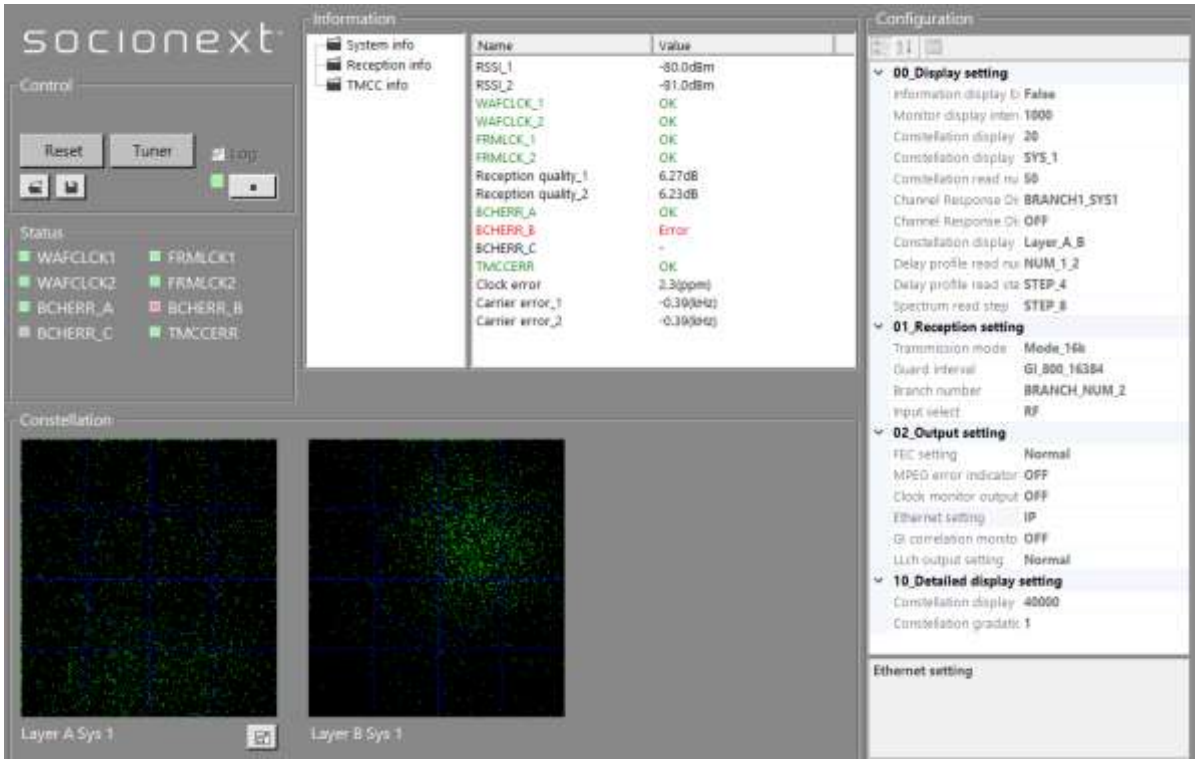


Figure 8.13 - Socionext Screen

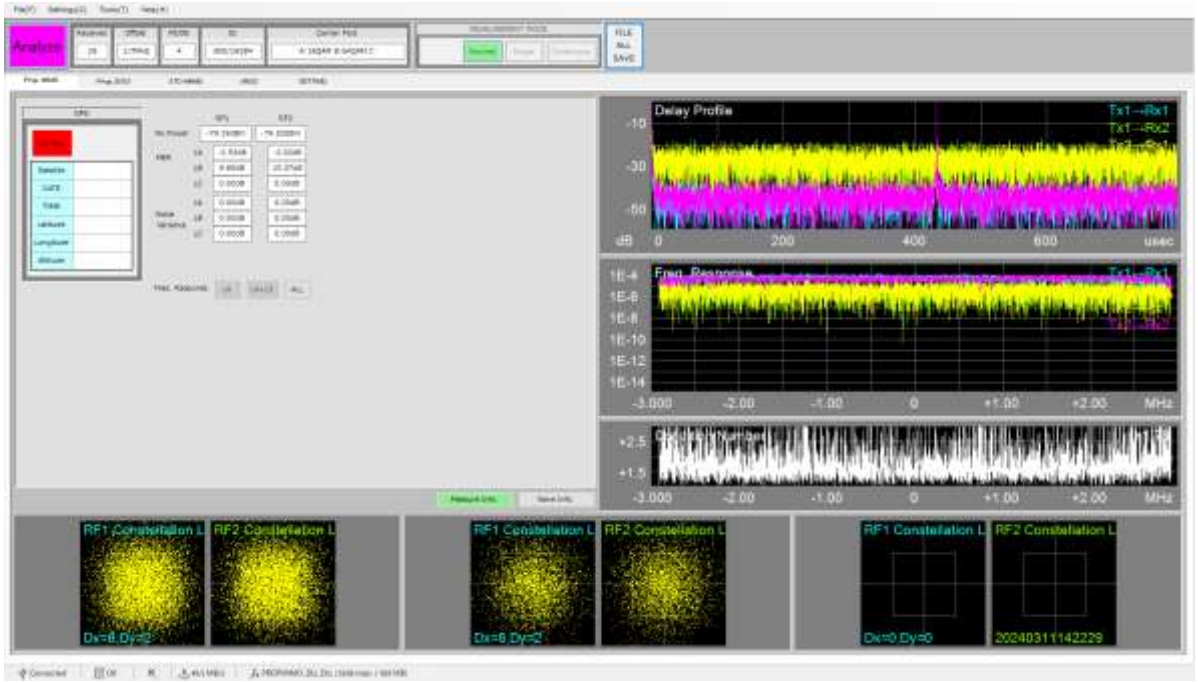


Figure 8.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

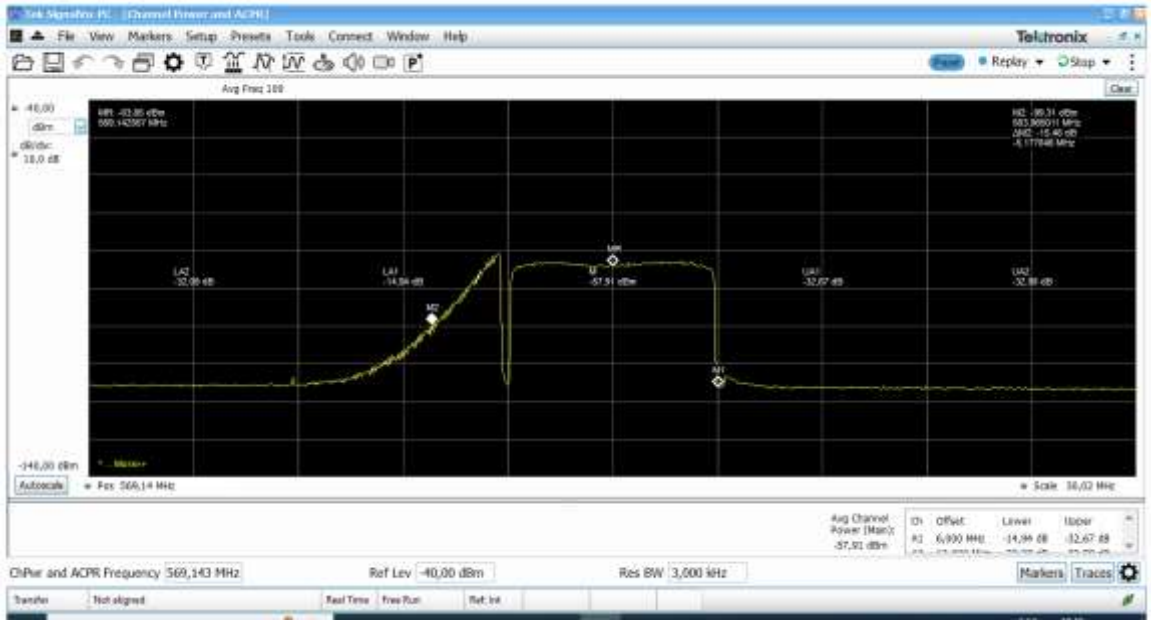


Figure 8.15 - Vertical

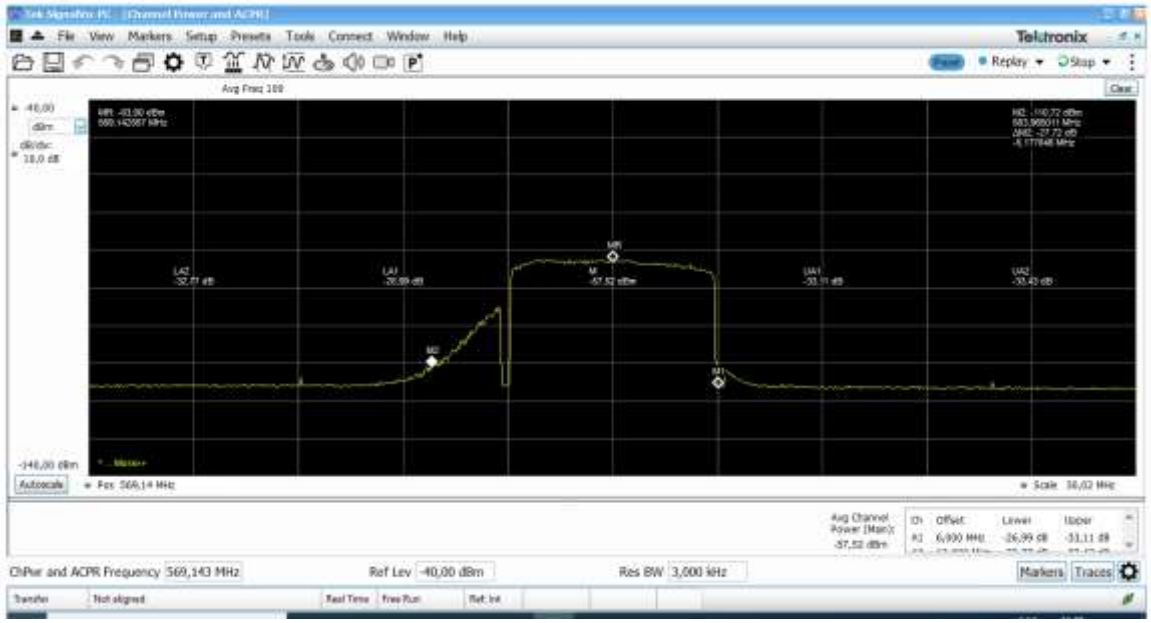


Figure 8.16 - Horizontal

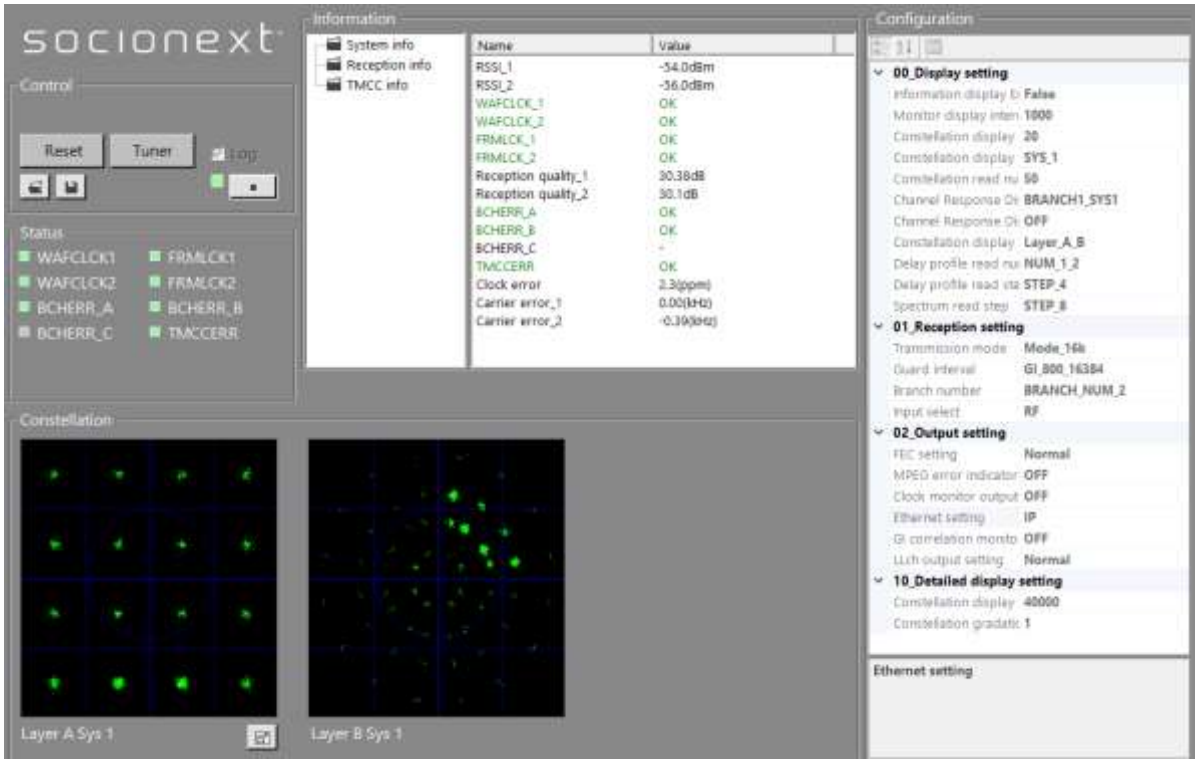


Figure 8.17 - Socionext Screen

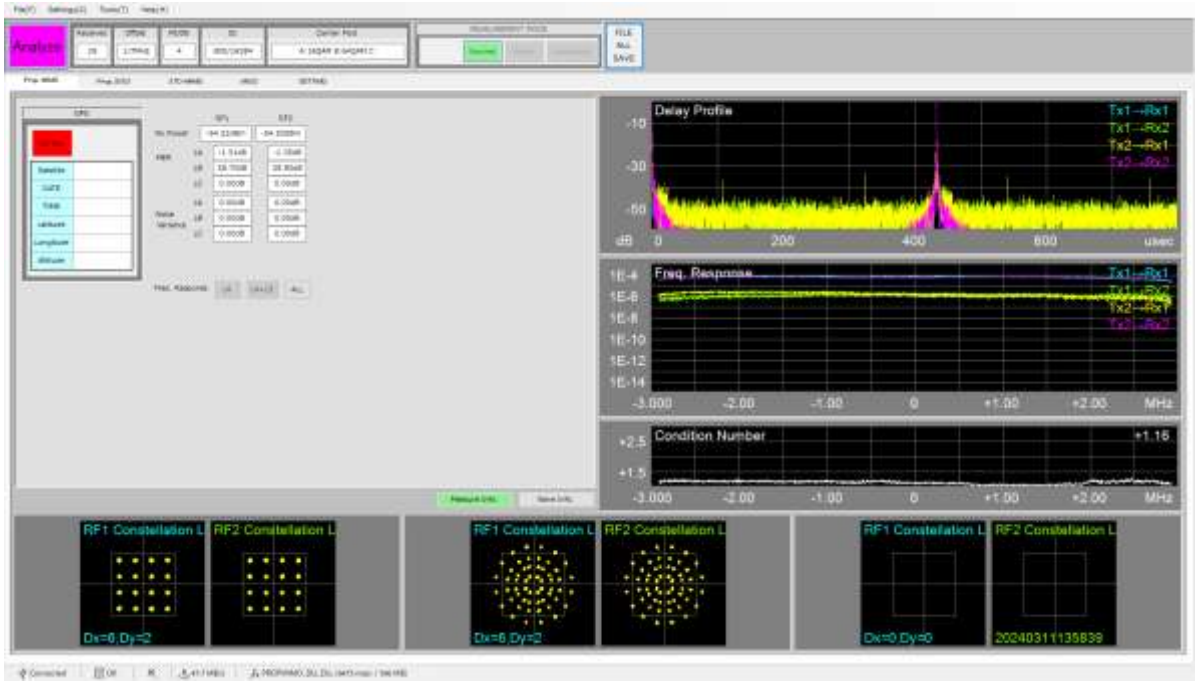


Figure 8.18 - Rintaro Screen

b) AWGN Power

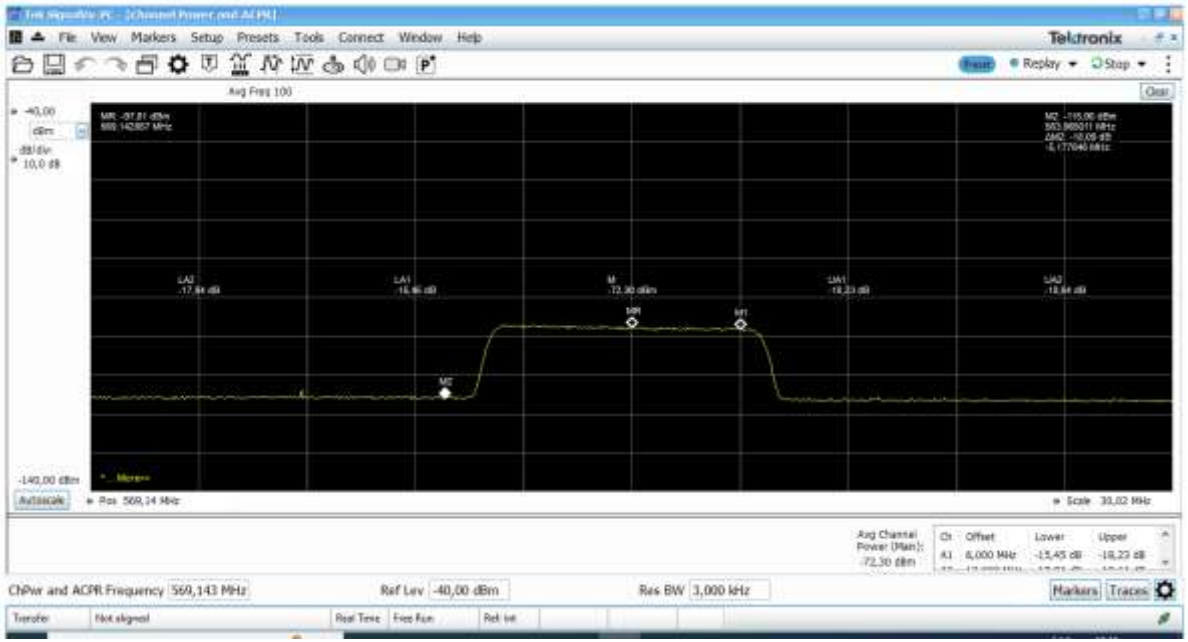


Figure 8.19 - Vertical

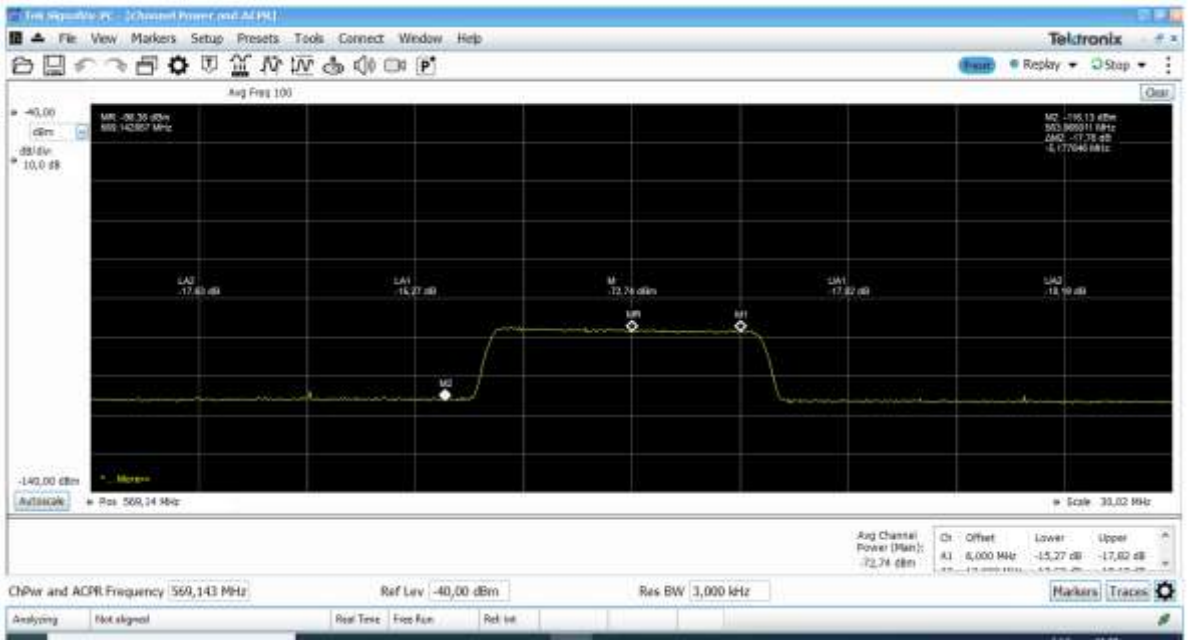


Figure 8.20 - Horizontal

c) C/N Threshold

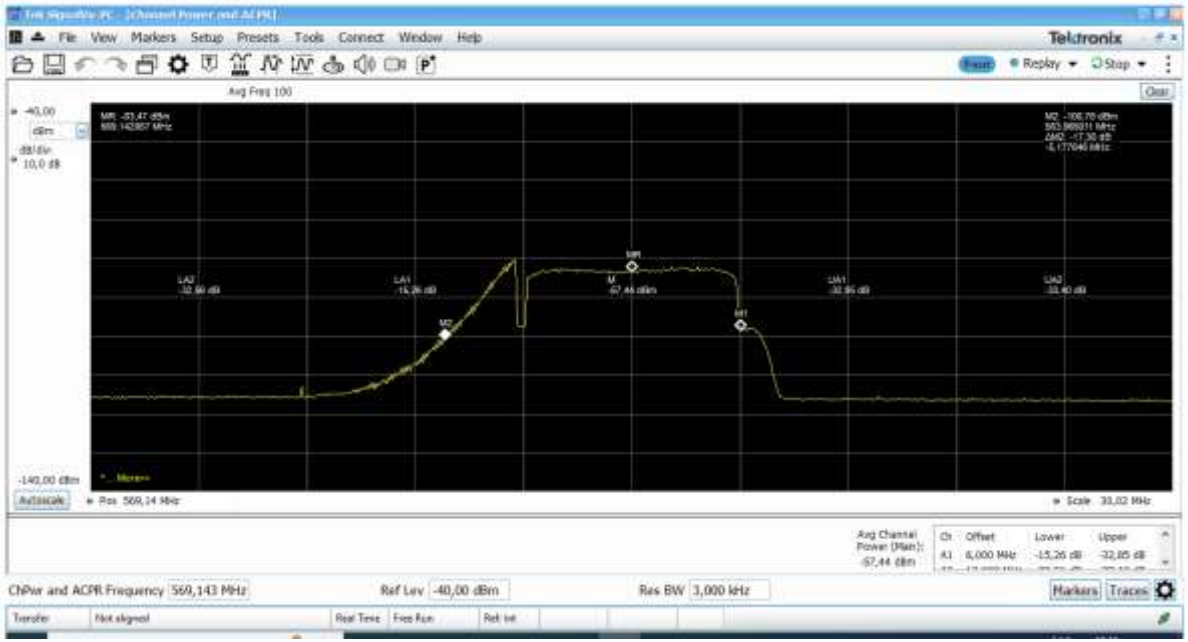


Figure 8.21 - Vertical

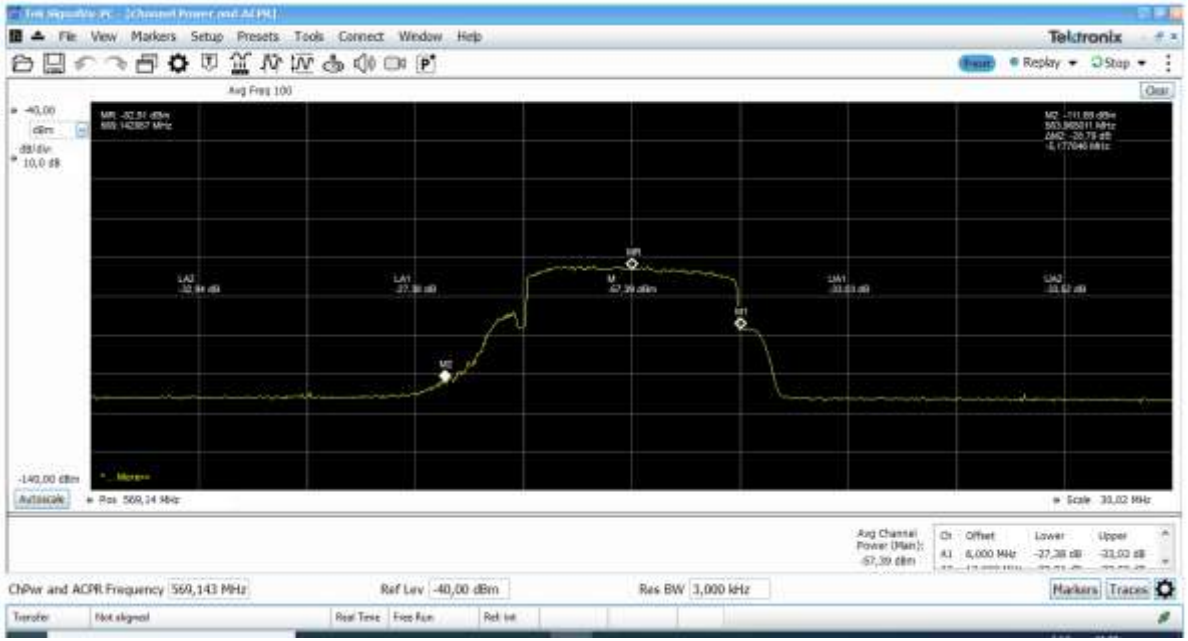


Figure 8.22 - Horizontal

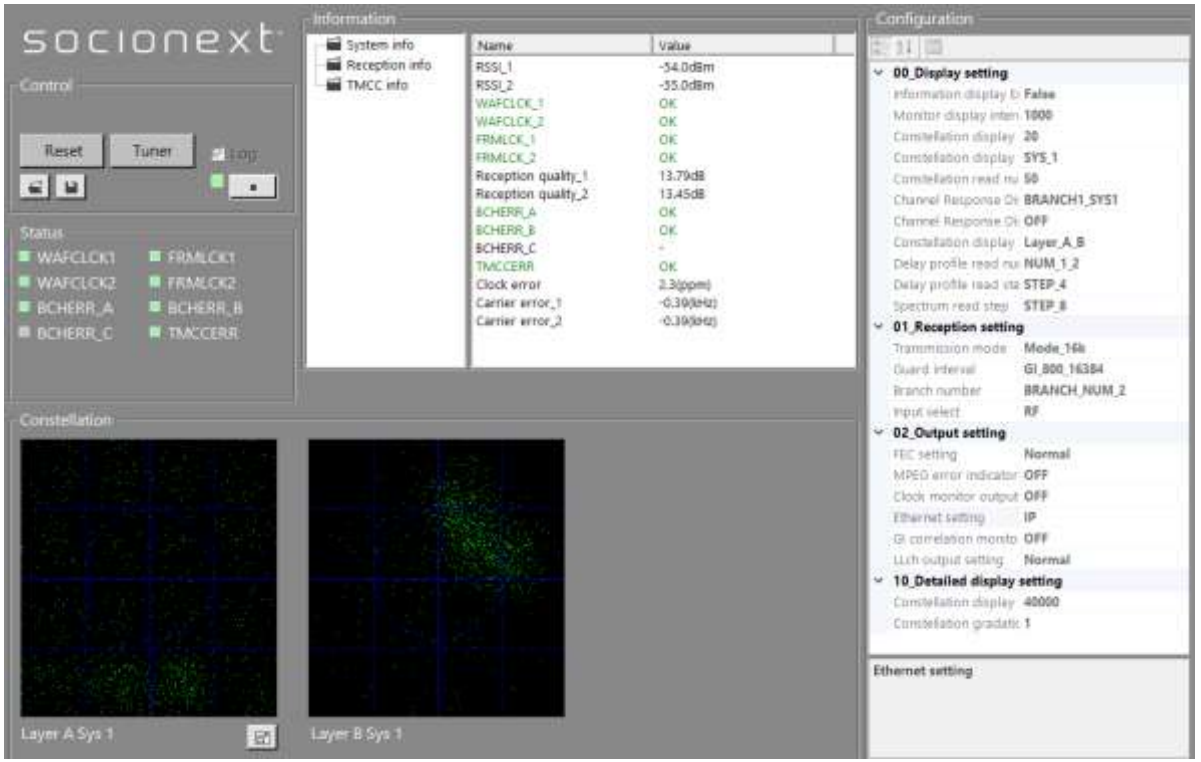


Figure 8.23 - Socionext Screen

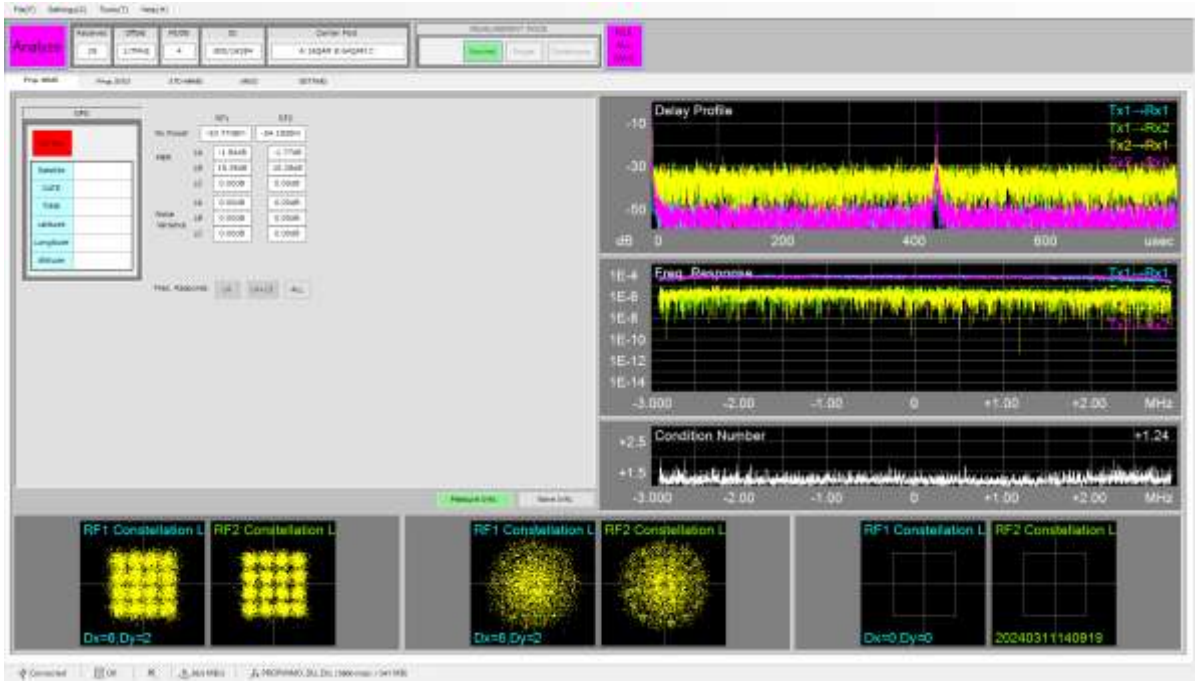


Figure 8.24 - Rintaro Screen

d) Reception Threshold

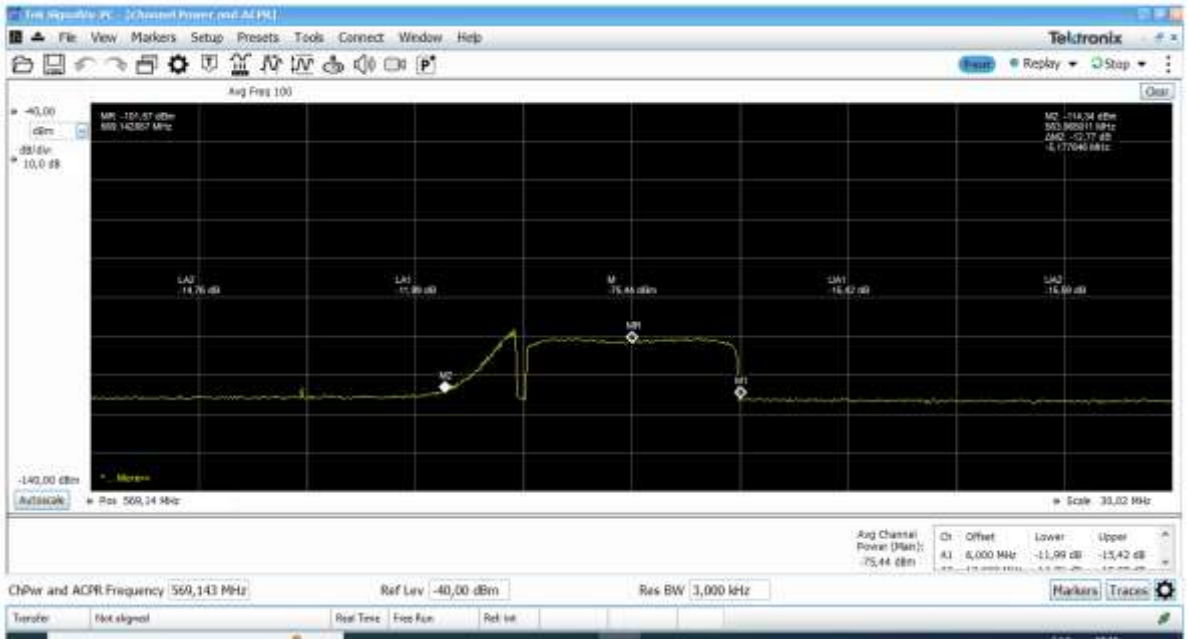


Figure 8.25 - Vertical

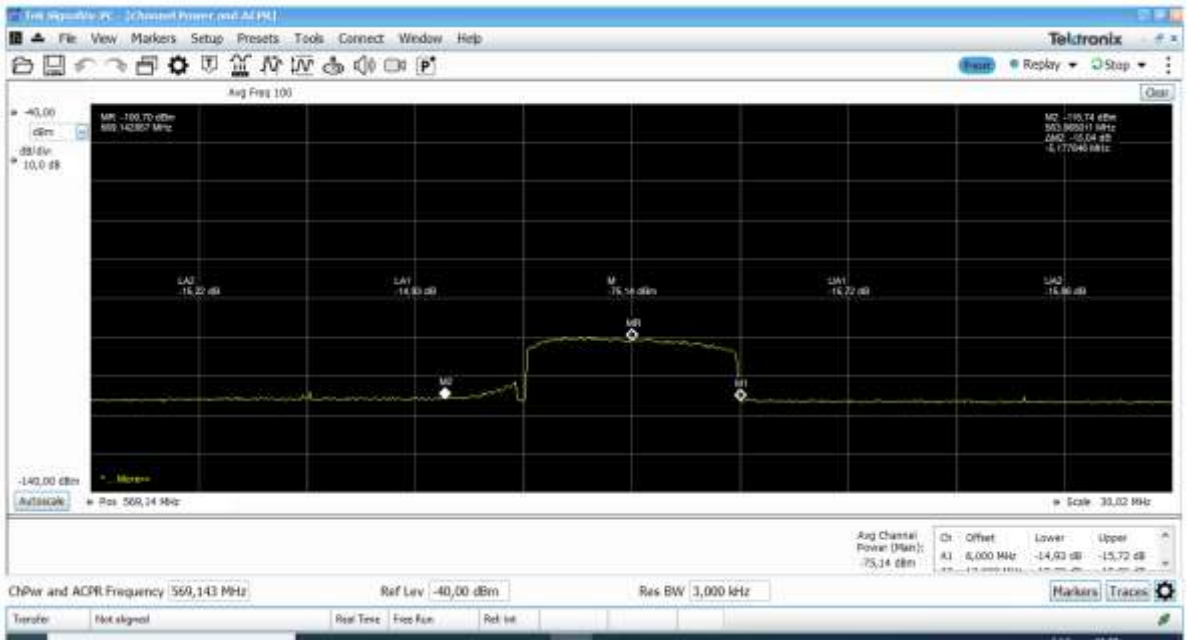


Figure 8.26 - Horizontal

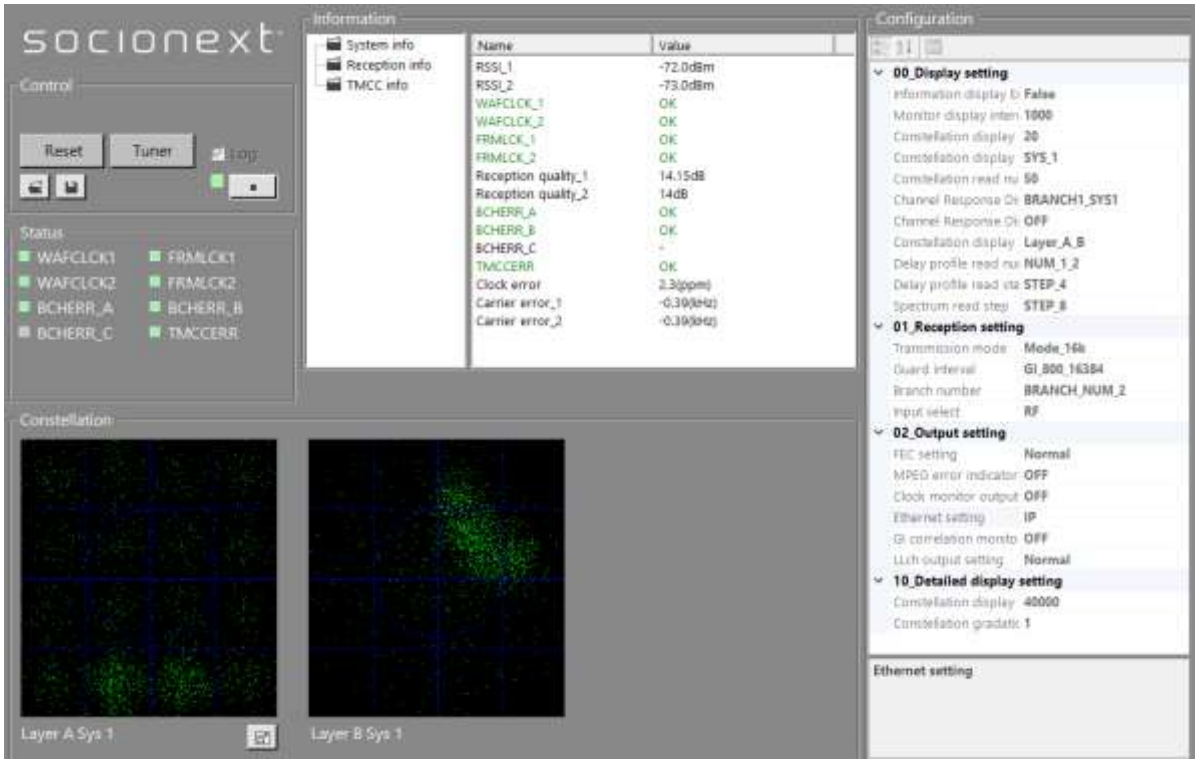


Figure 8.27 - Socionext Screen

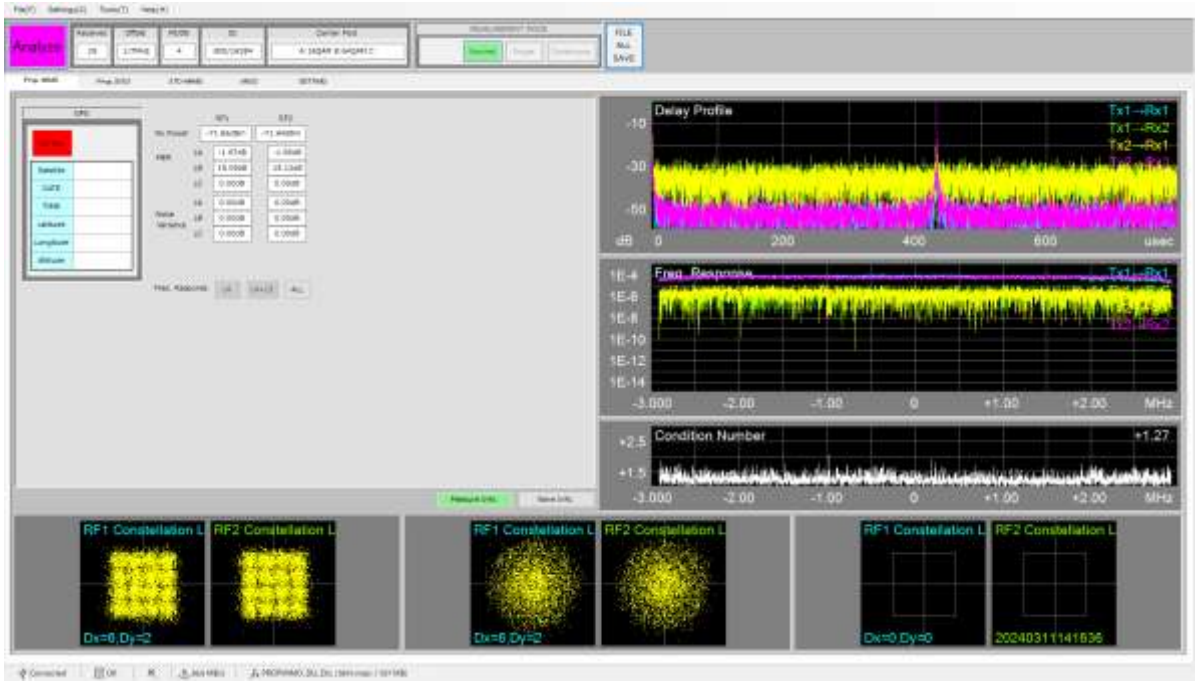


Figure 8.28 - Rintaro Screen

Chapter 9. Site 18

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

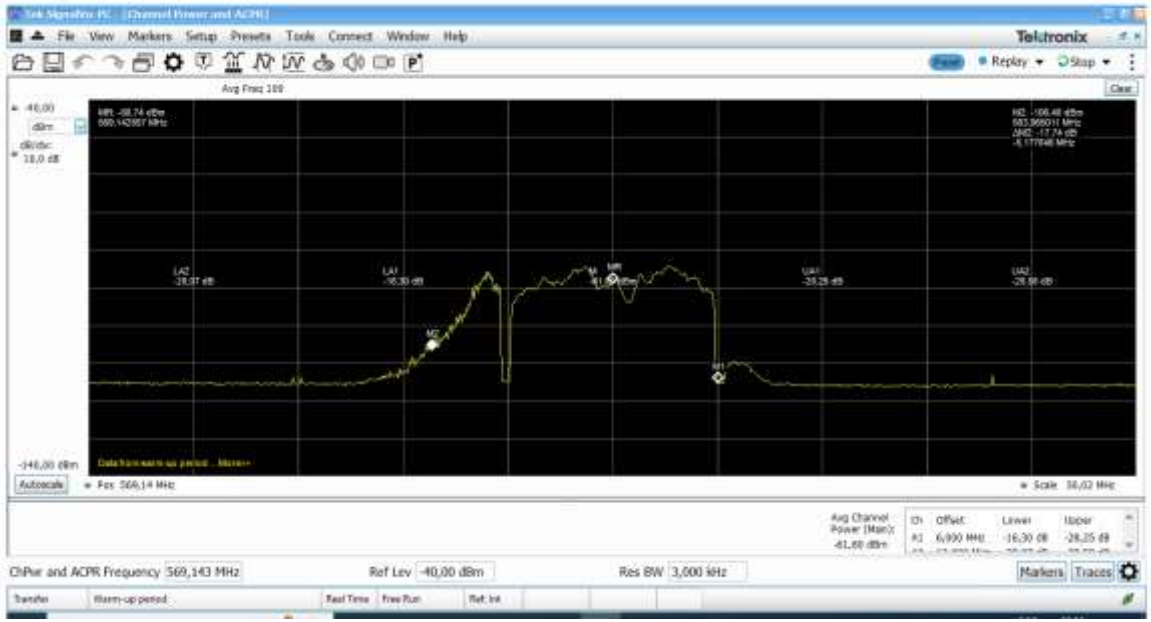


Figure 9.1 - Vertical

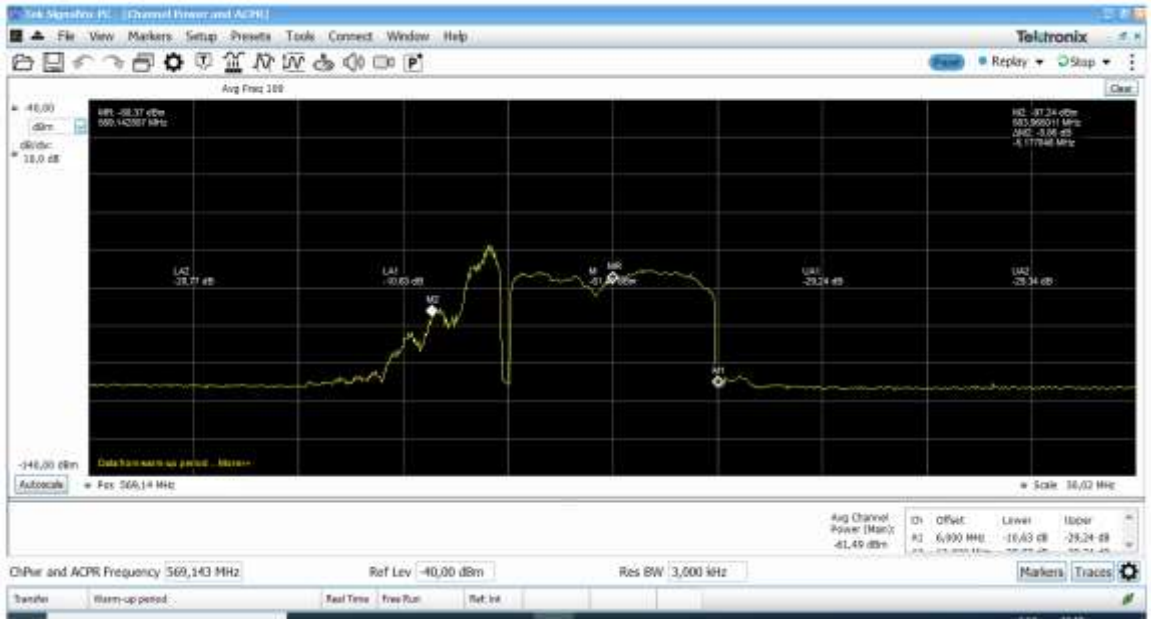


Figure 9.2 - Horizontal

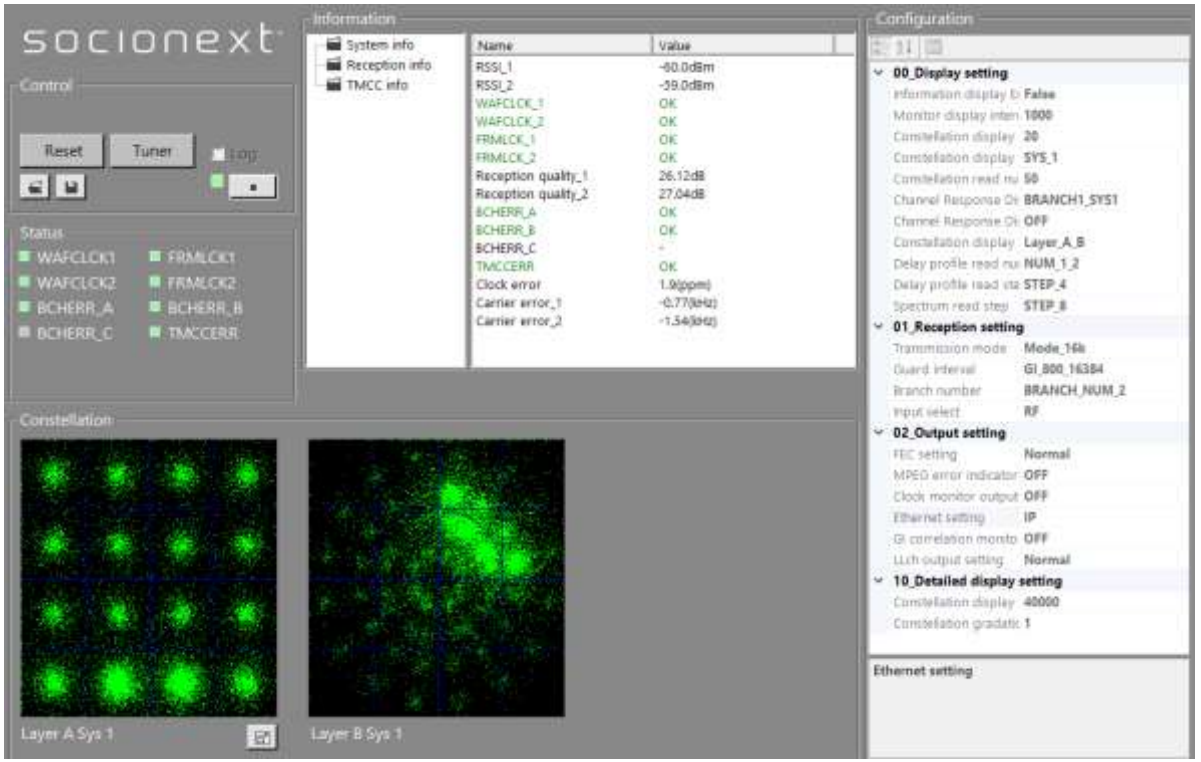


Figure 9.3 - Socionext Screen

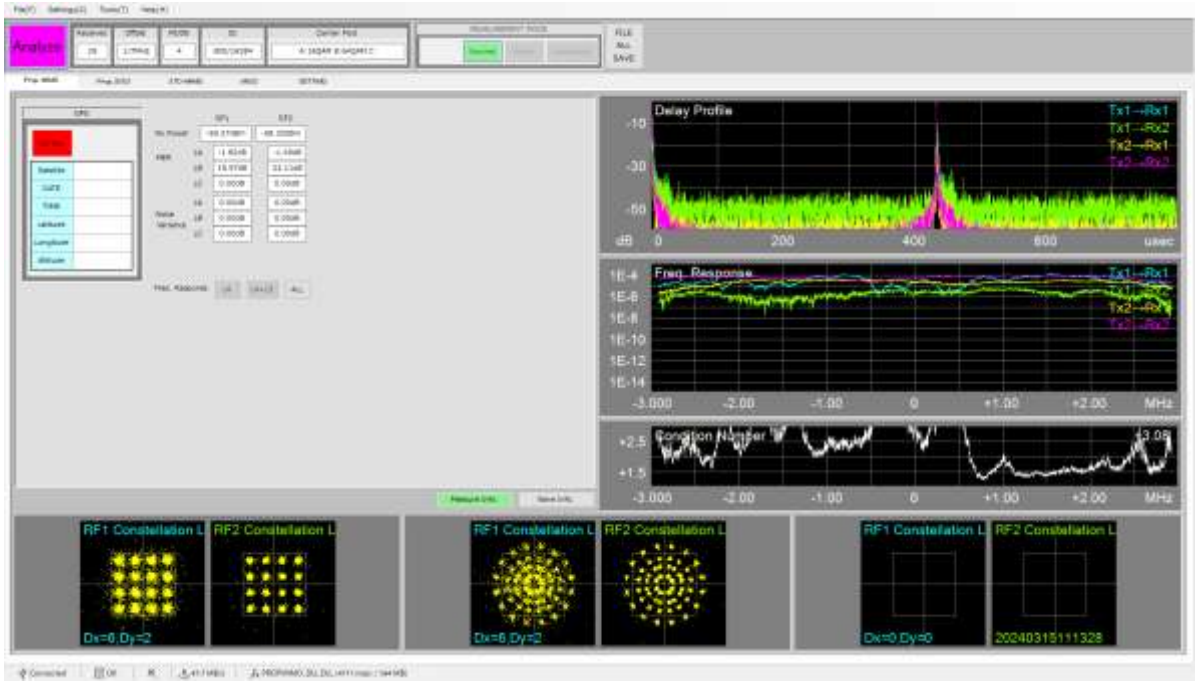


Figure 9.4 - Rintaro Screen

b) AWGN Power

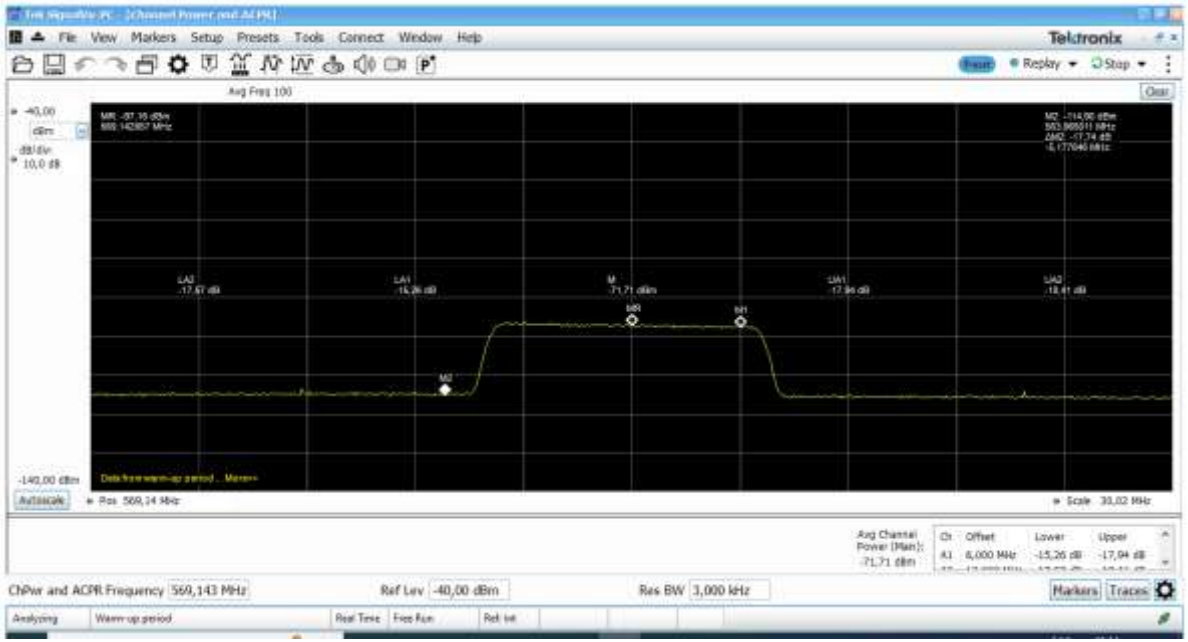


Figure 9.5 - Vertical

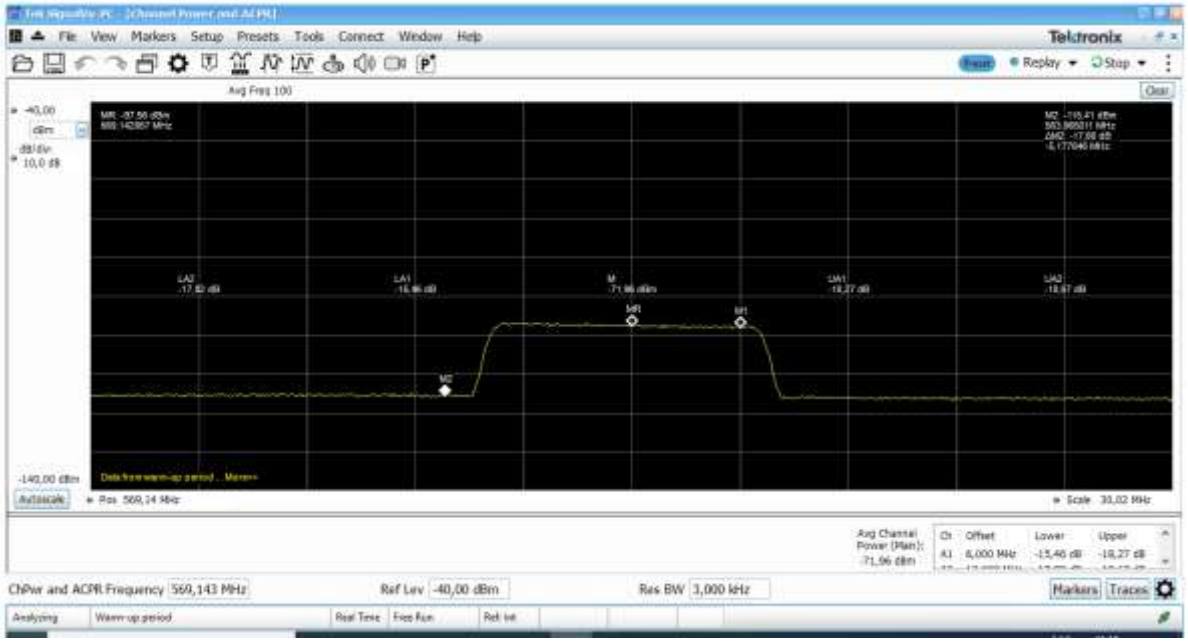


Figure 9.6 - Horizontal

c) C/N Threshold

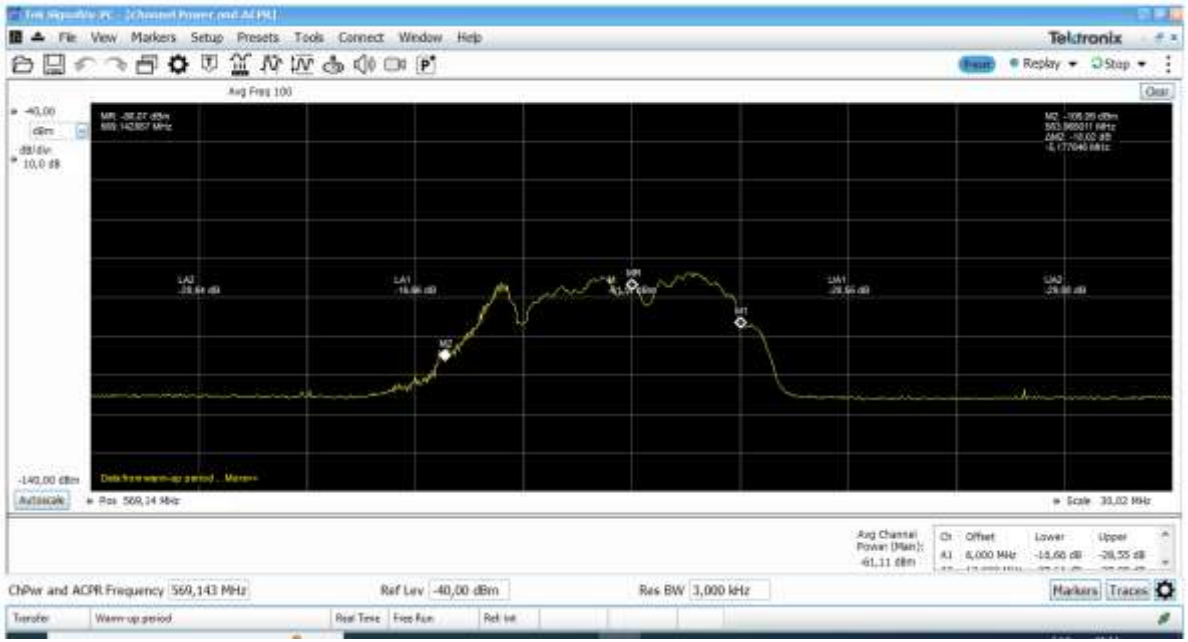


Figure 9.7 - Vertical

Figure 9.8 - Horizontal

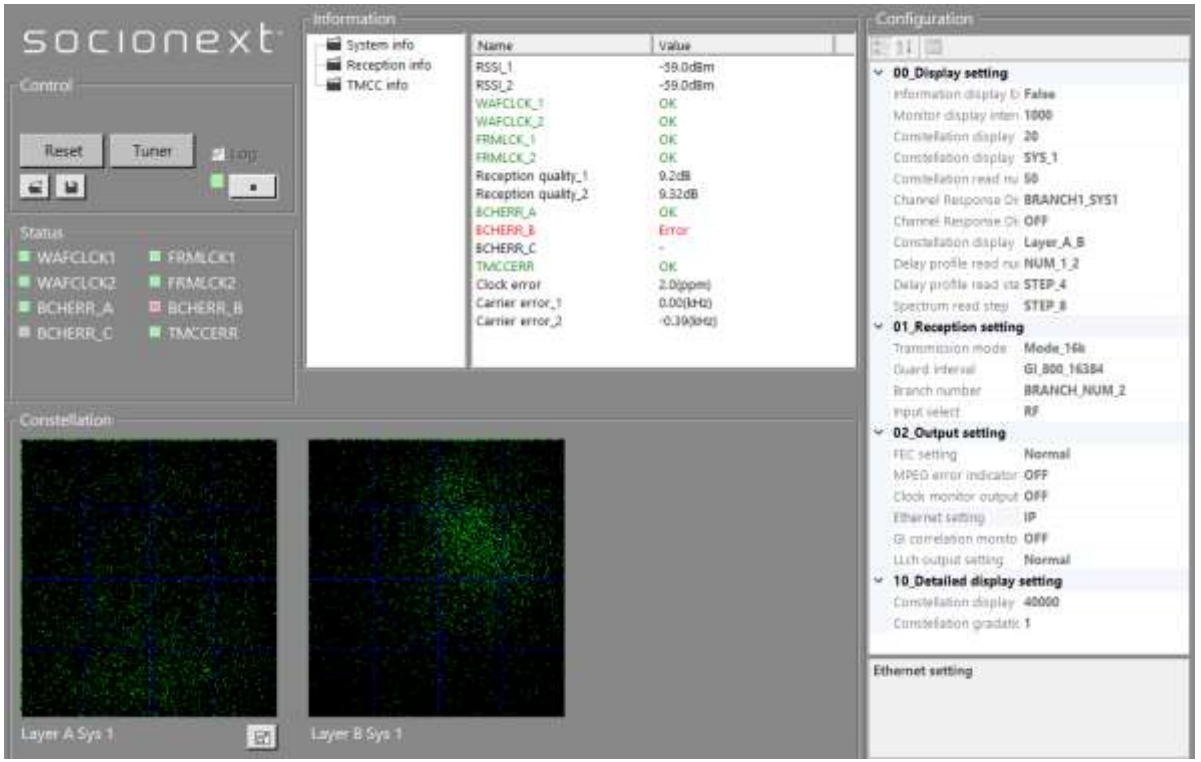


Figure 9.9 - Socionext Screen

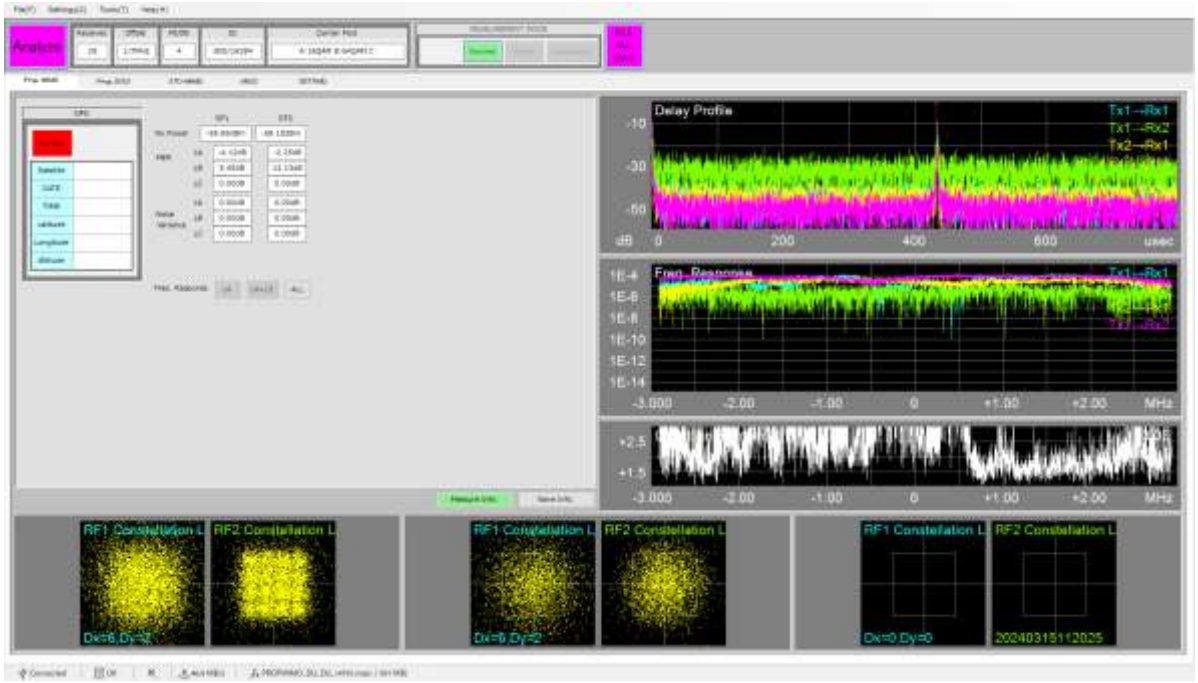


Figure 9.10 - Rintaro Screen

d) Reception Threshold

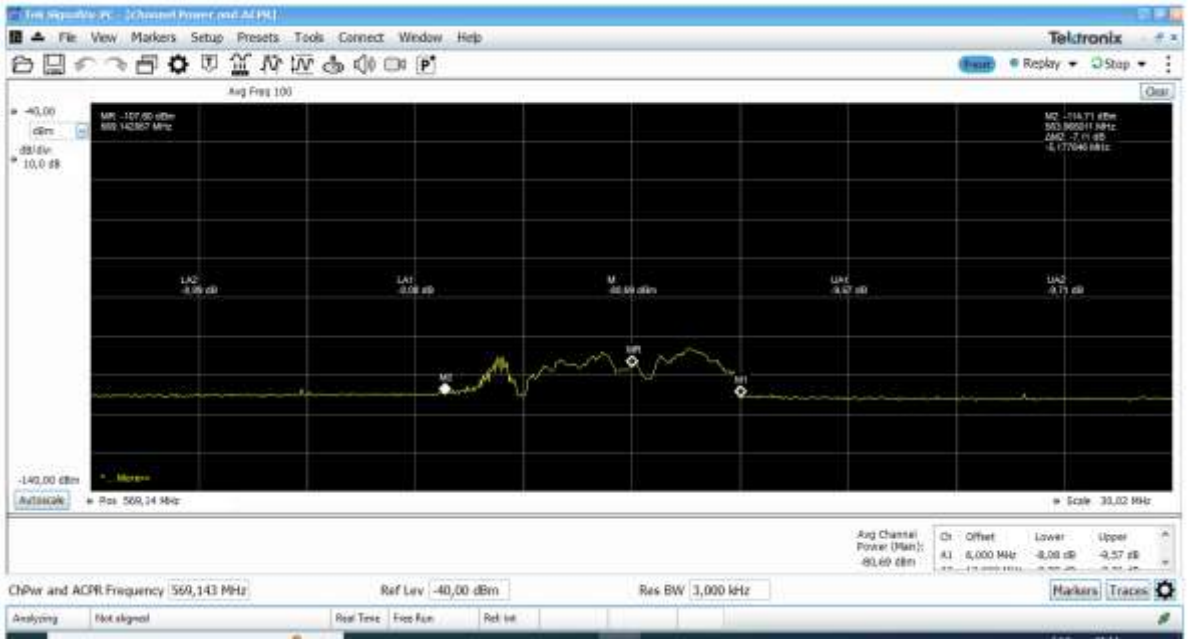


Figure 9.11 - Vertical

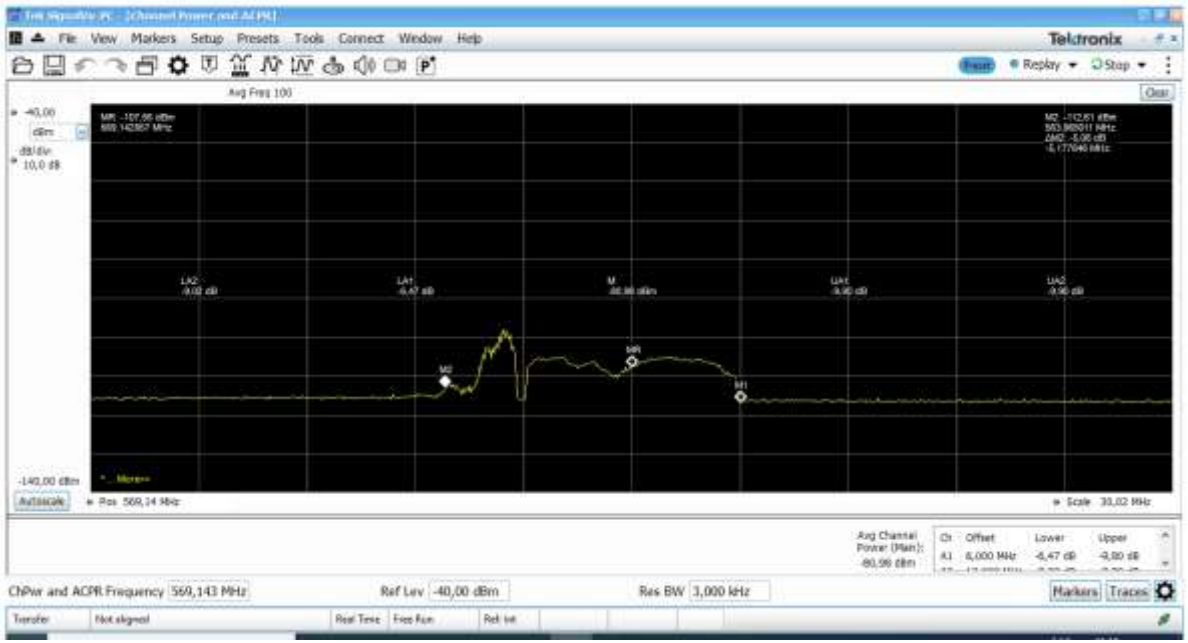


Figure 9.12 - Horizontal

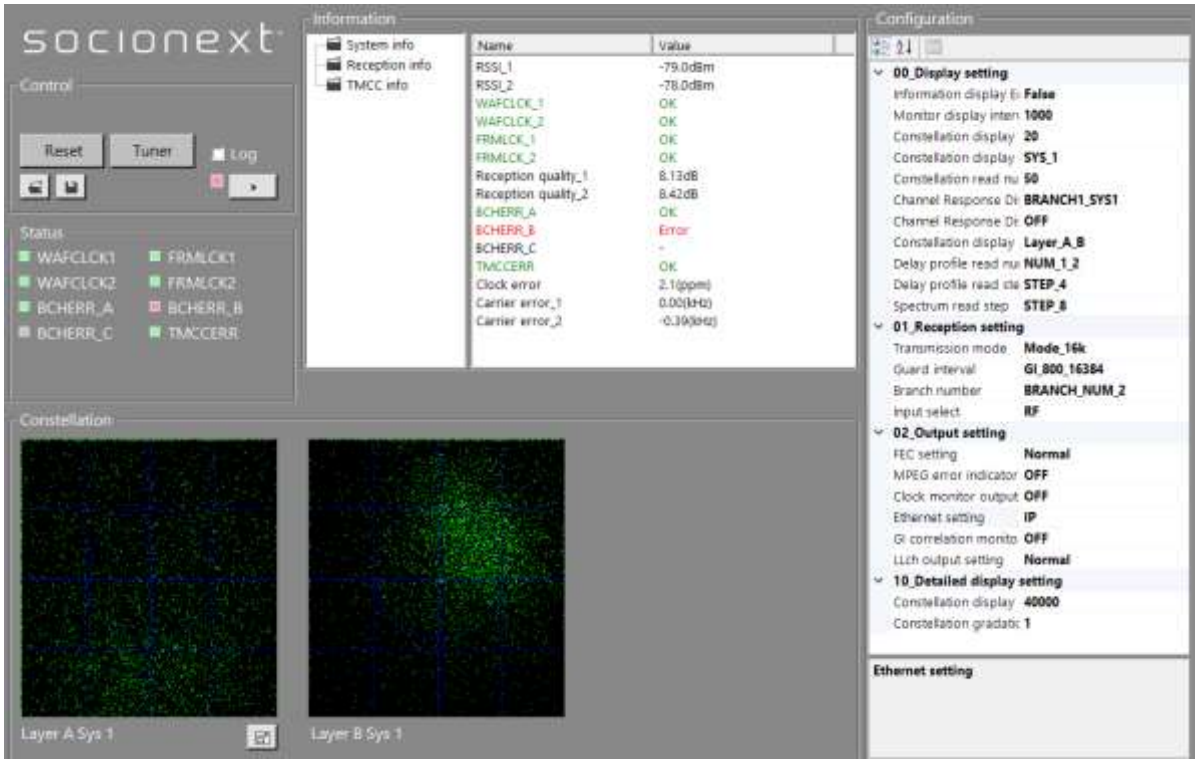


Figure 9.13 - Socionext Screen

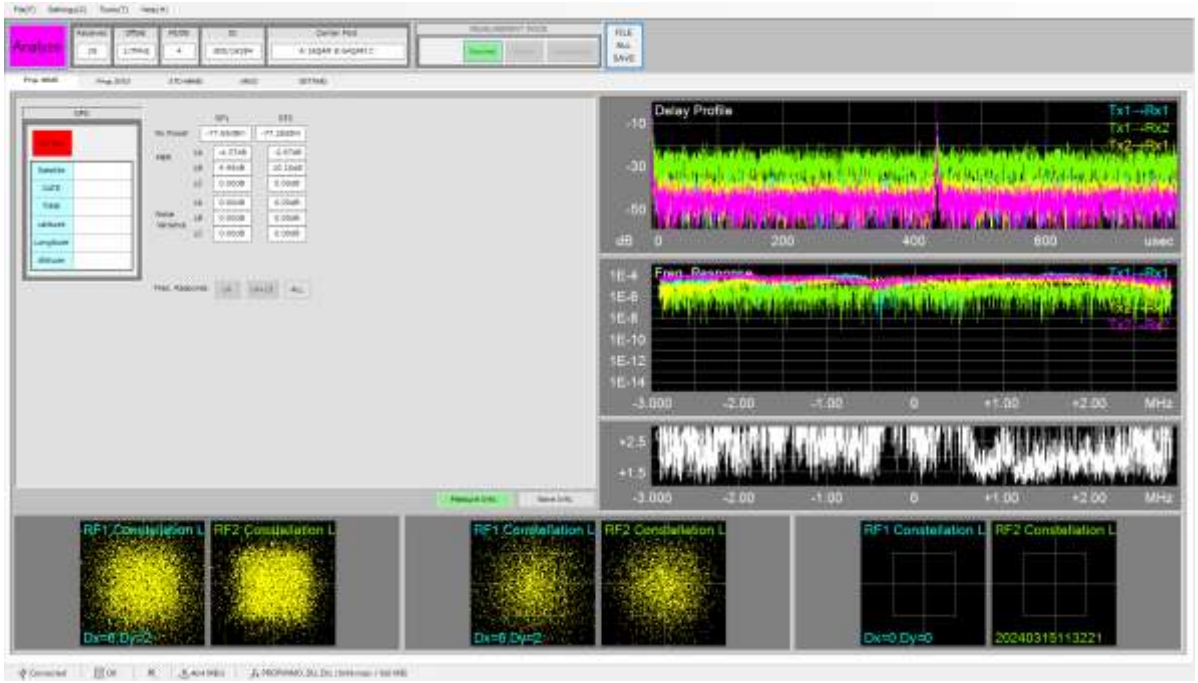


Figure 9.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

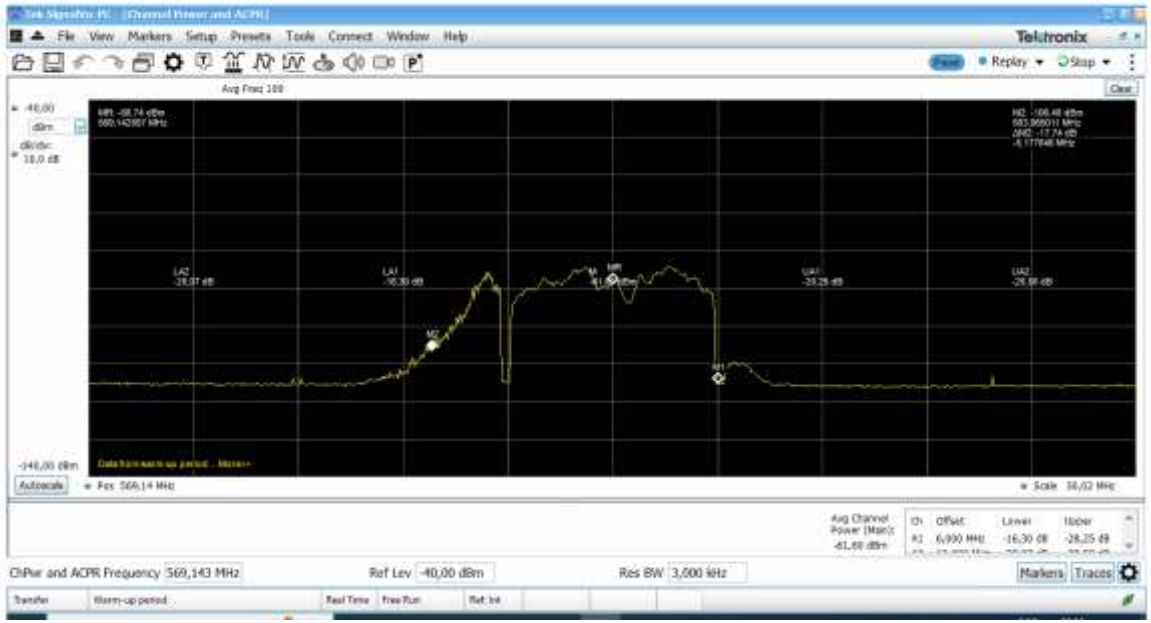


Figure 9.15 - Vertical

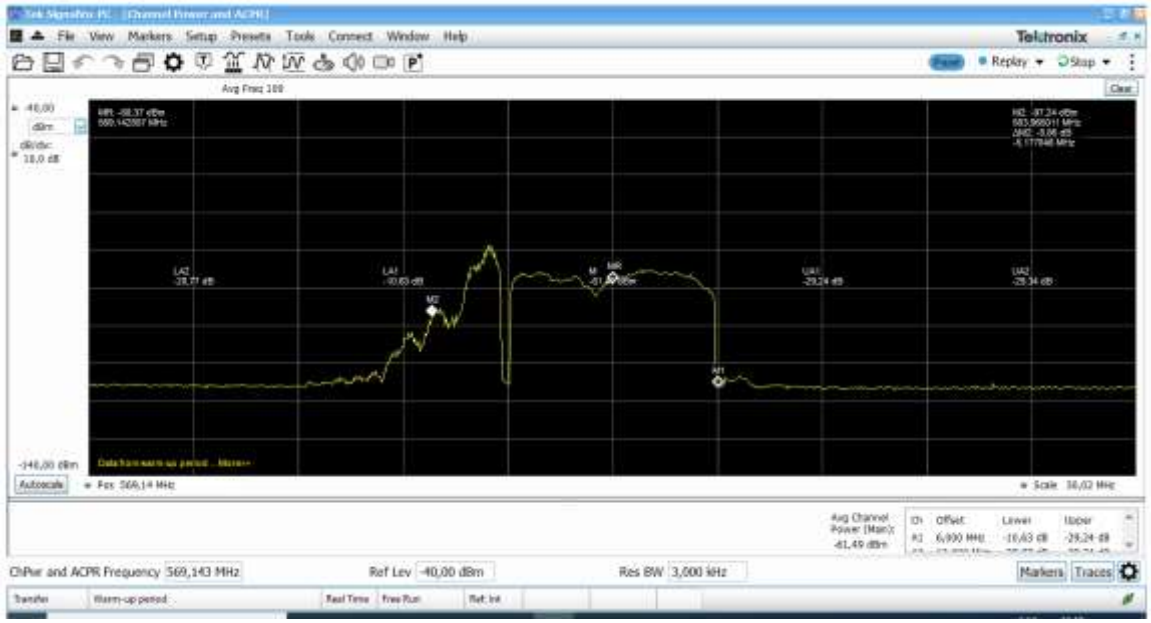


Figure 9.16 - Horizontal

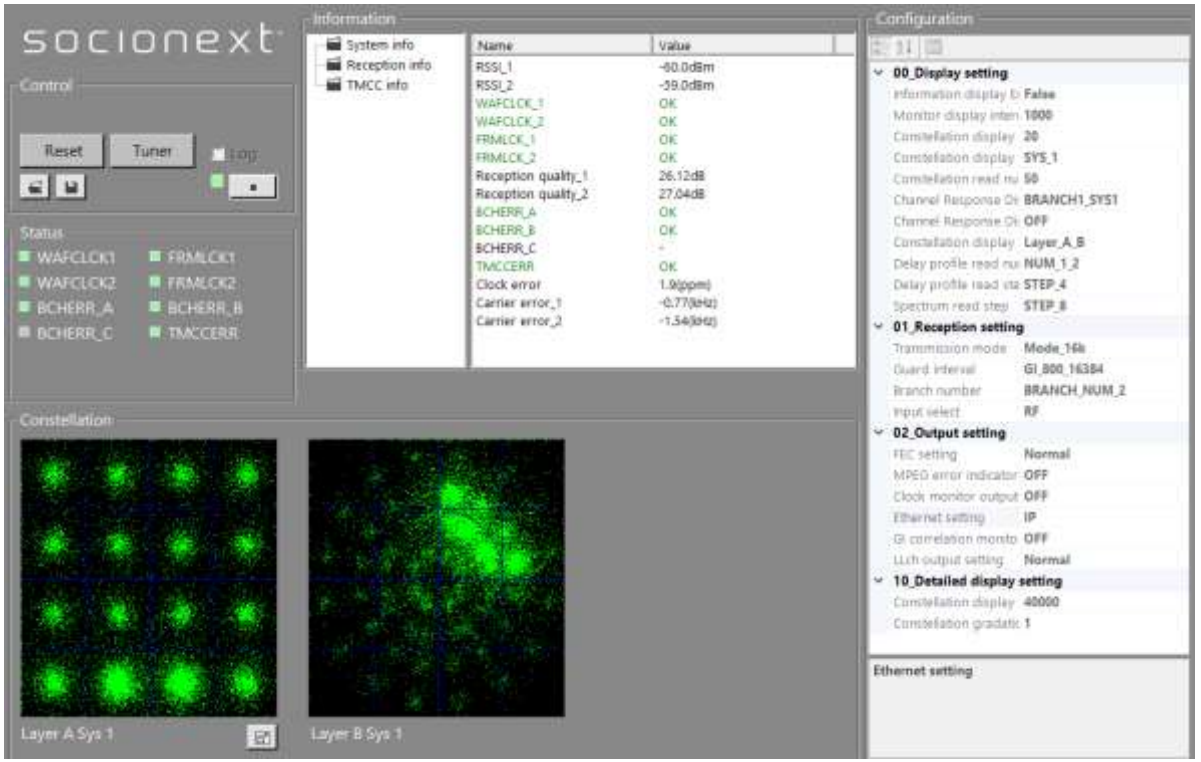


Figure 9.17 - Socionext Screen

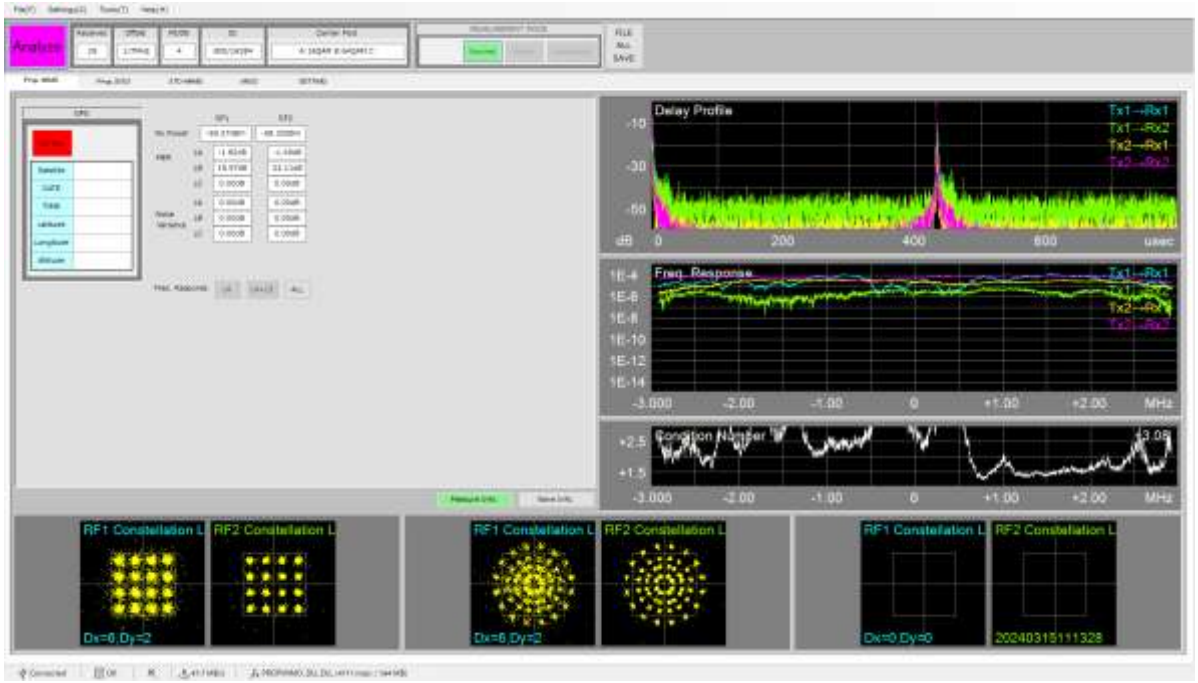


Figure 9.18 - Rintaro Screen

b) AWGN Power

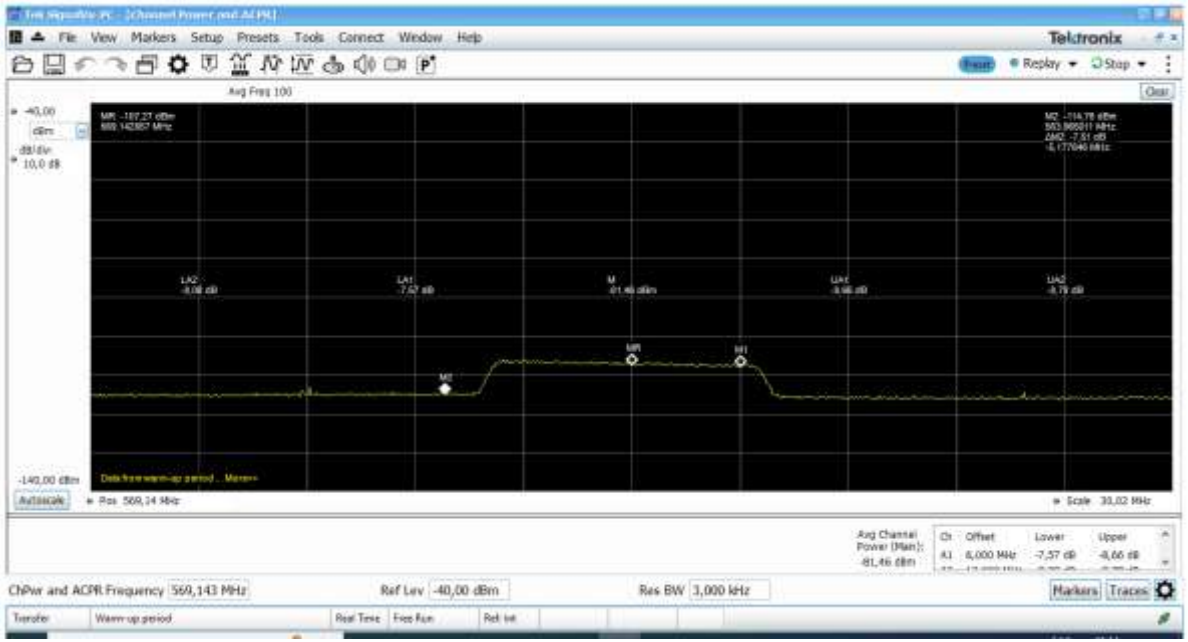


Figure 9.19 - Vertical

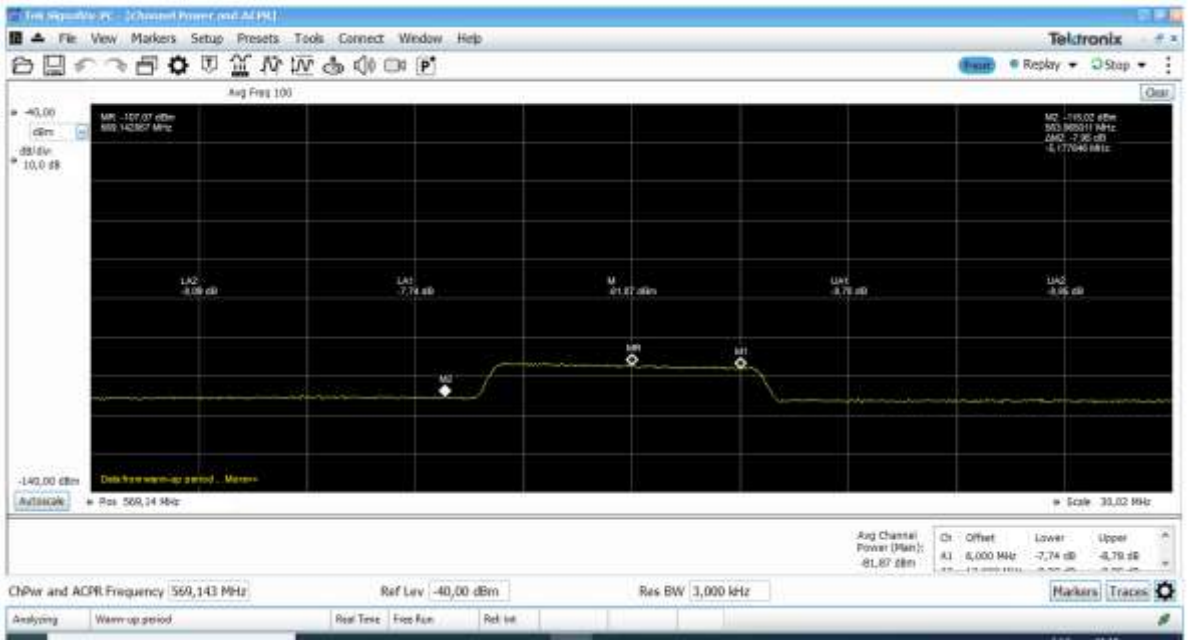


Figure 9.20 - Horizontal

c) C/N Threshold

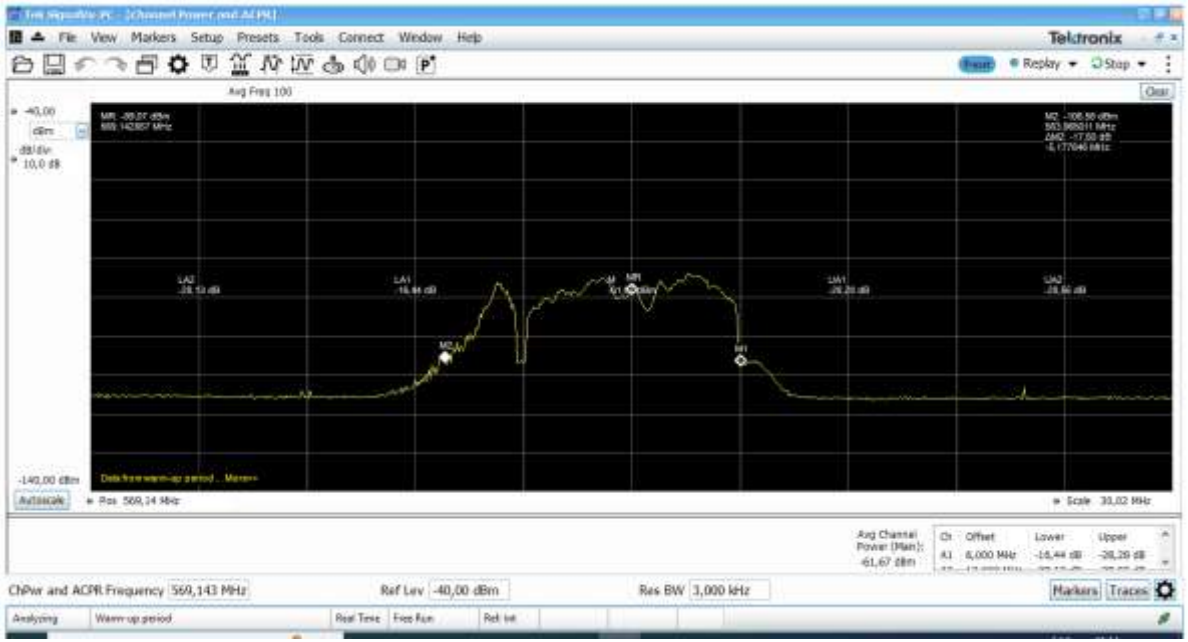


Figure 9.21 - Vertical

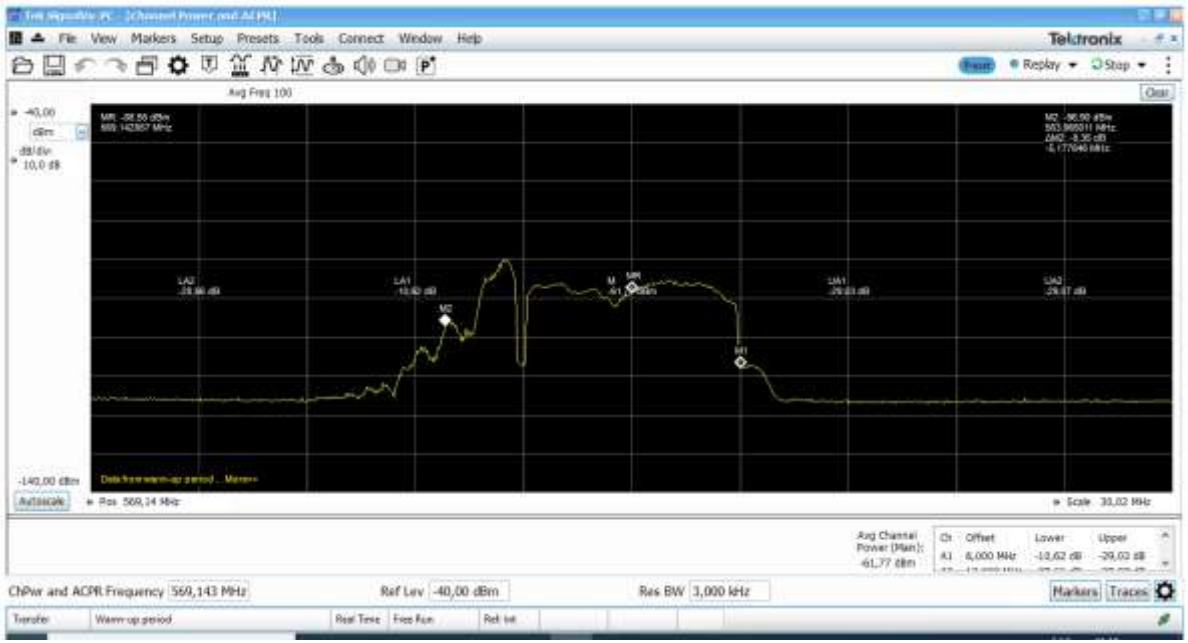


Figure 9.22 - Horizontal

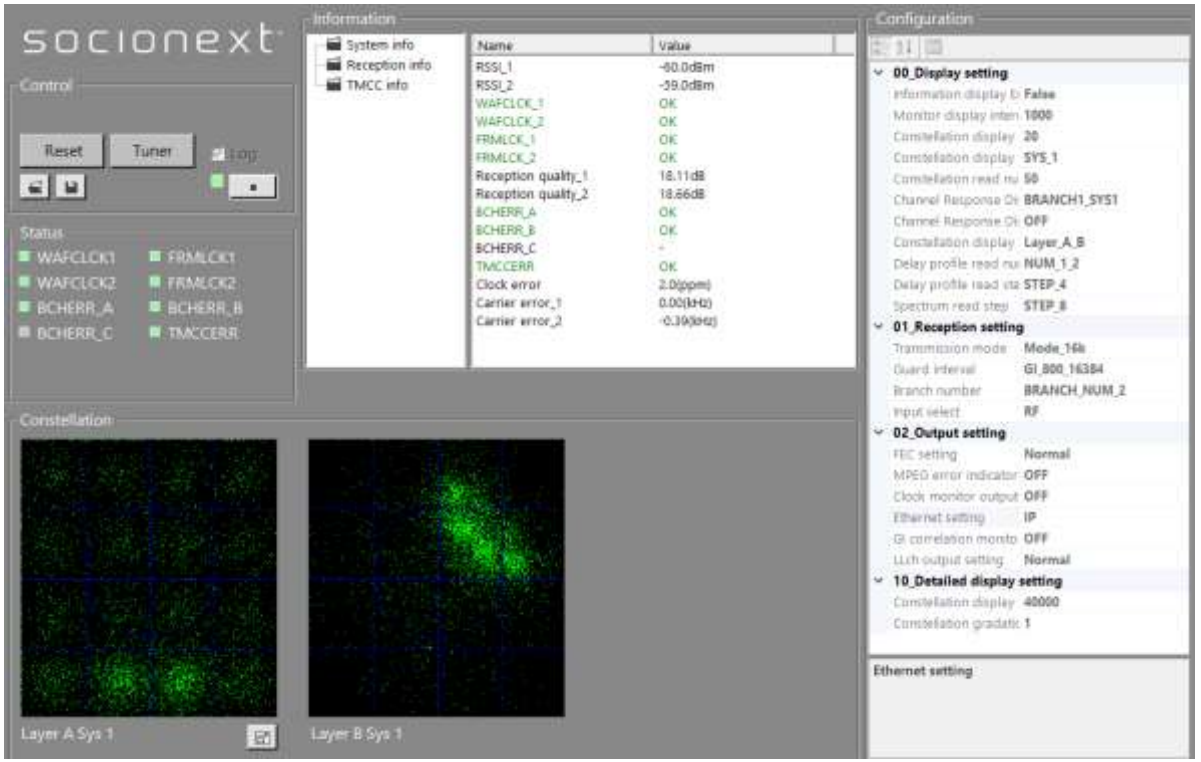


Figure 9.23 - Socionext Screen

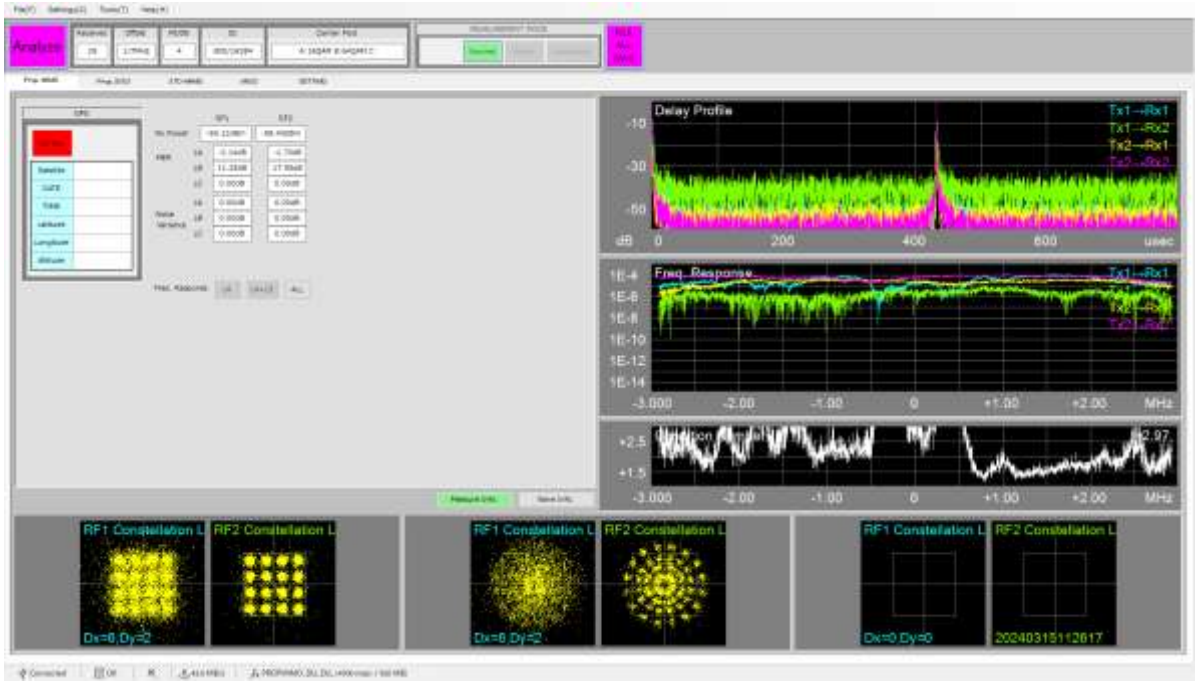


Figure 9.24 - Rintaro Screen

d) Reception Threshold

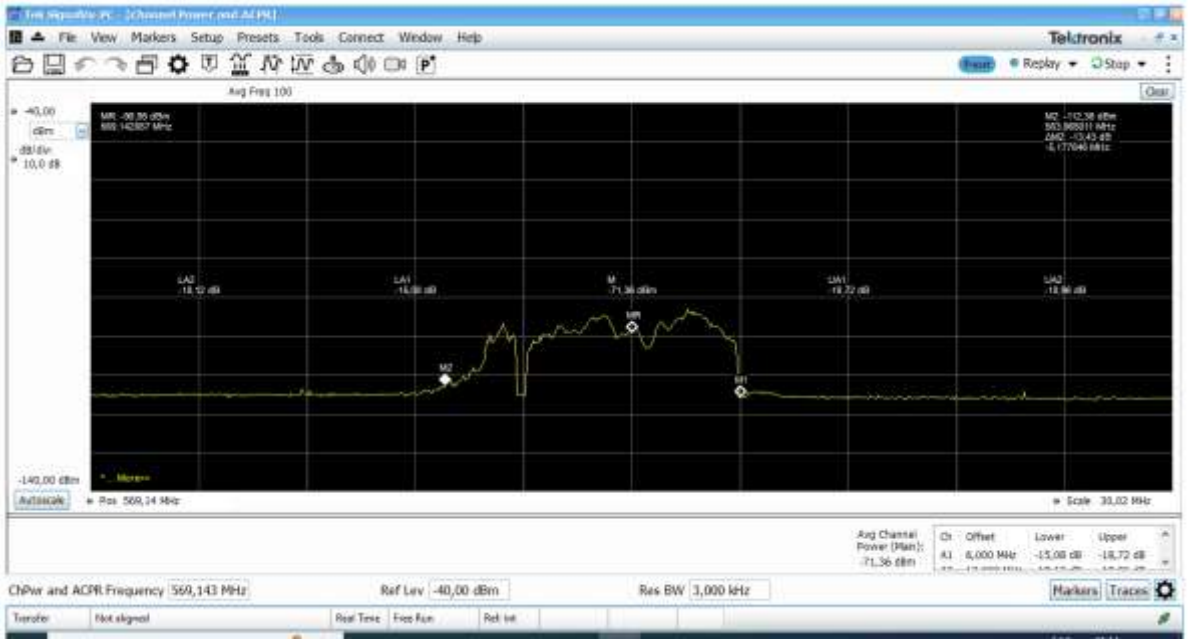


Figure 9.25 - Vertical

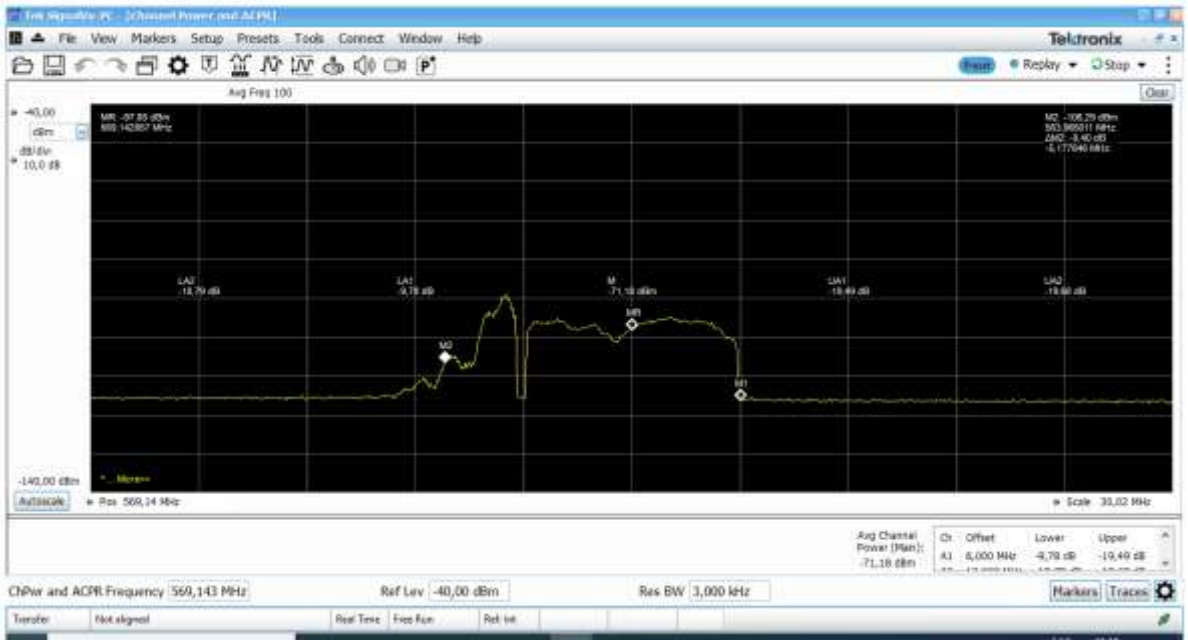


Figure 9.26 - Horizontal

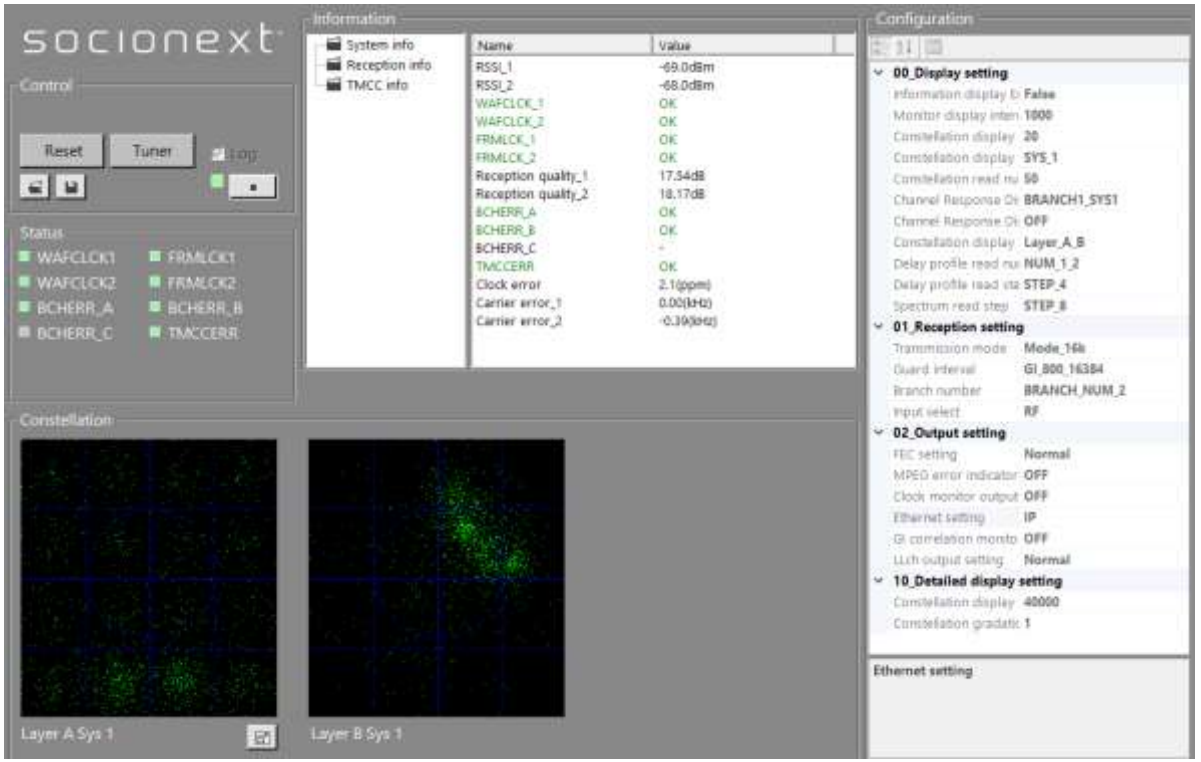


Figure 9.27 - Socionext Screen

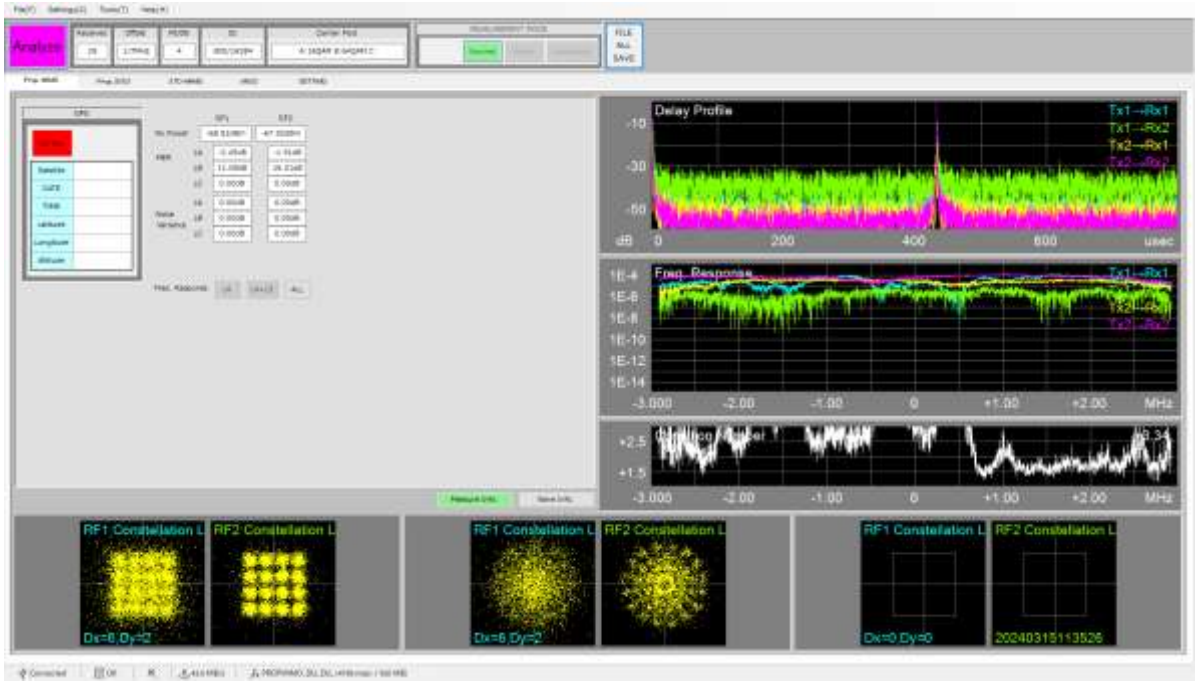


Figure 9.28 - Rintaro Screen

Chapter 10. Site 24

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

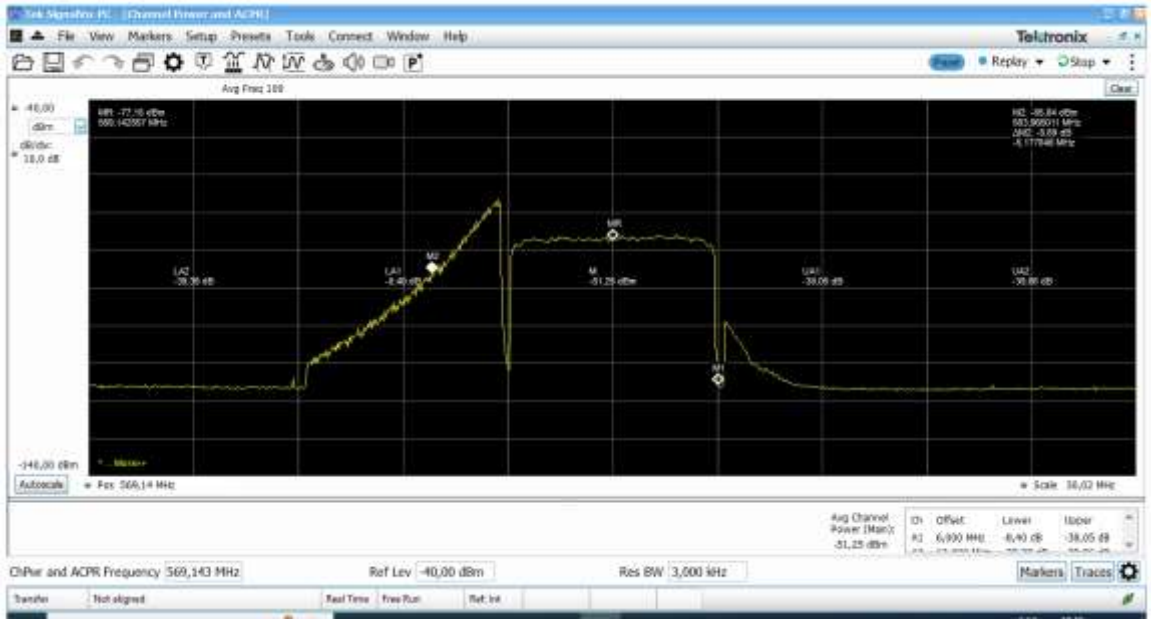


Figure 10.1 - Vertical

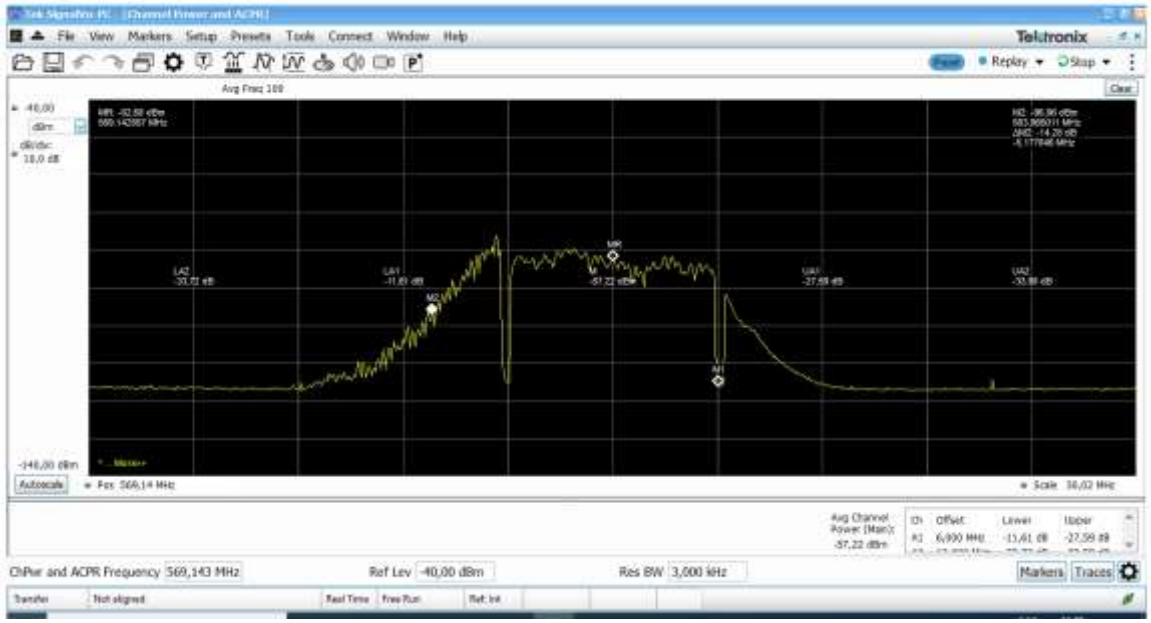


Figure 10.2 - Horizontal

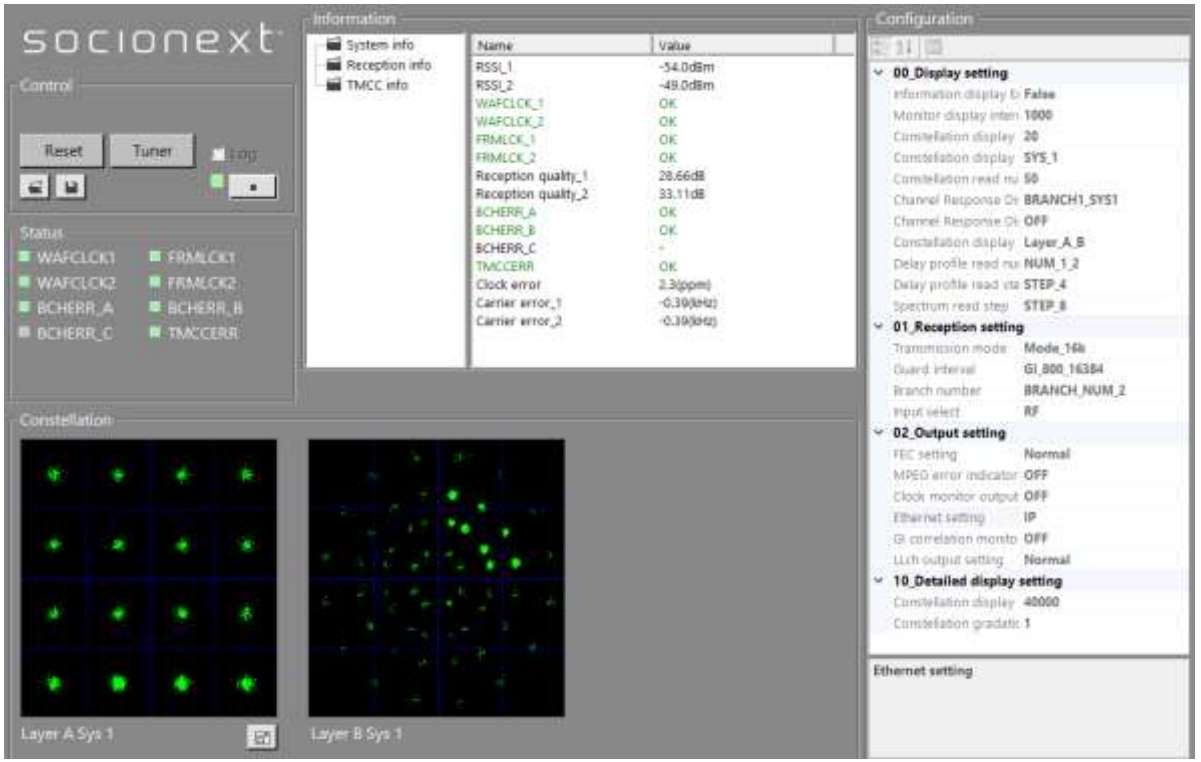


Figure 10.3 - Socionext Screen

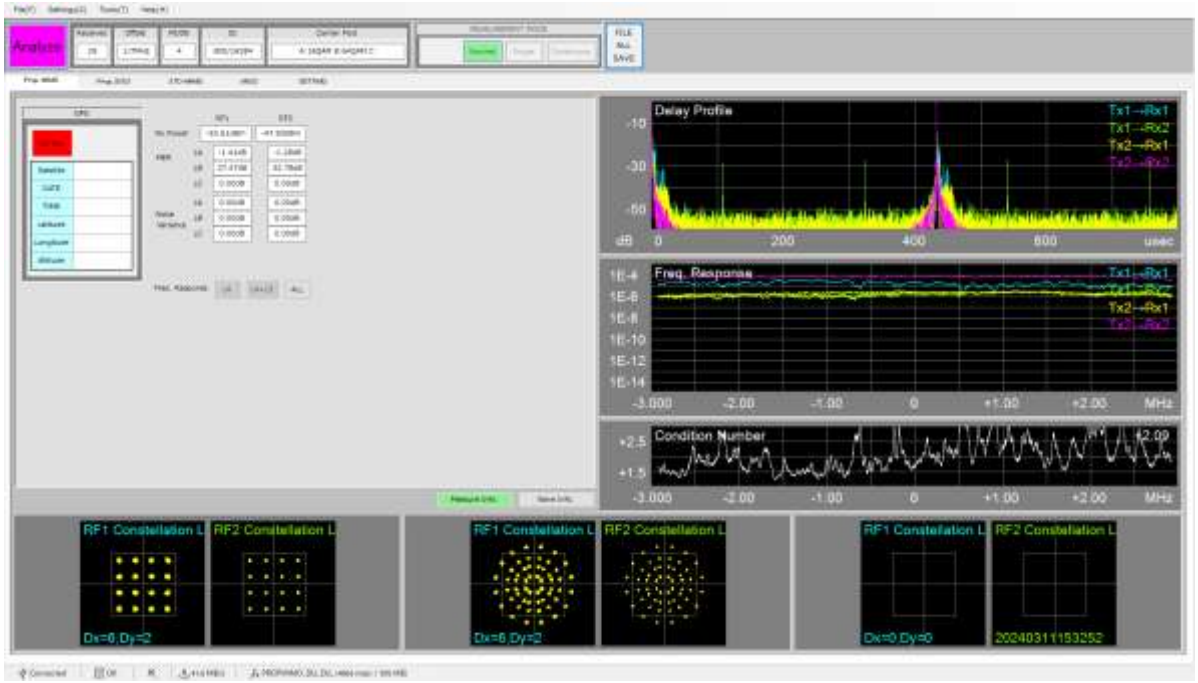


Figure 10.4 - Rintaro Screen

b) AWGN Power

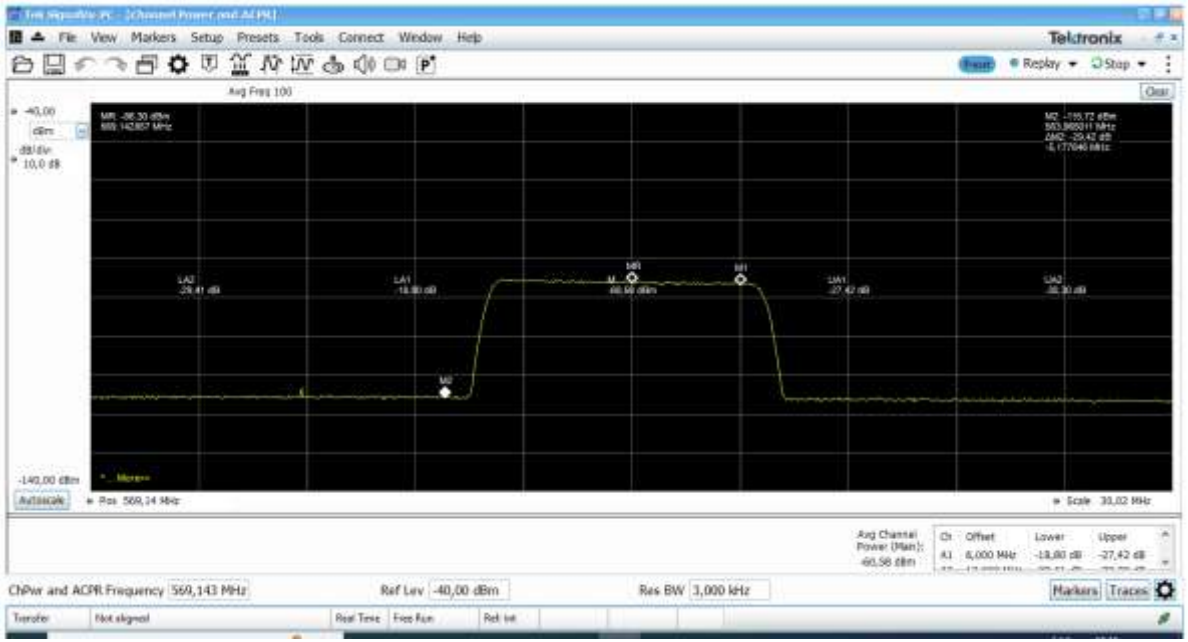


Figure 10.5 - Vertical

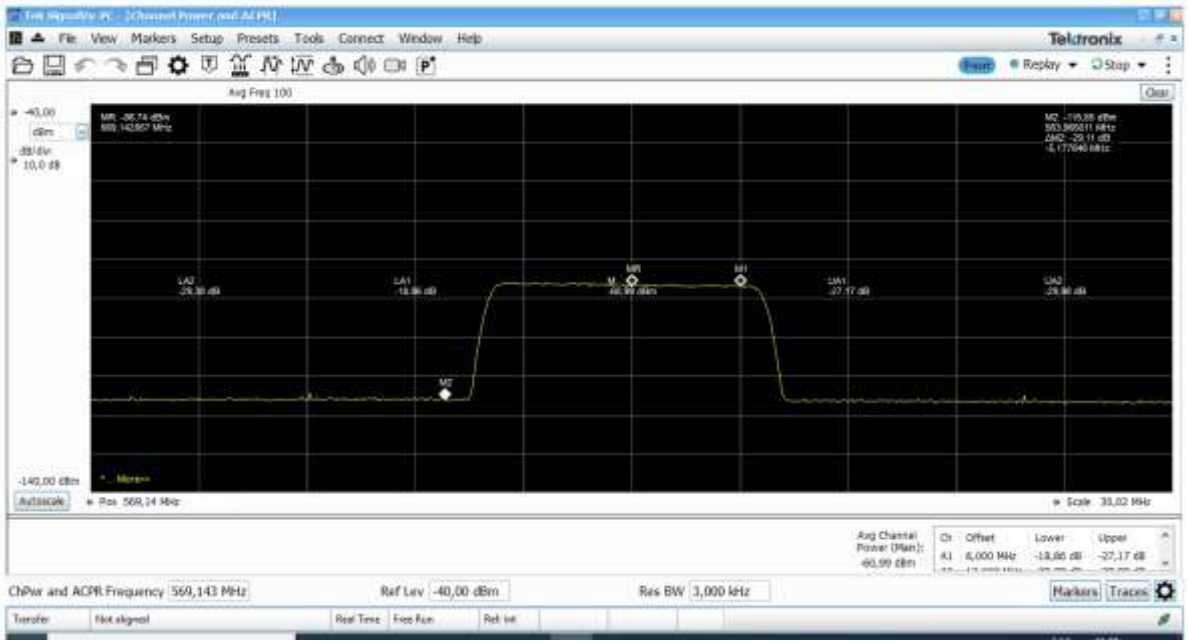


Figure 10.6 - Horizontal

c) C/N Threshold

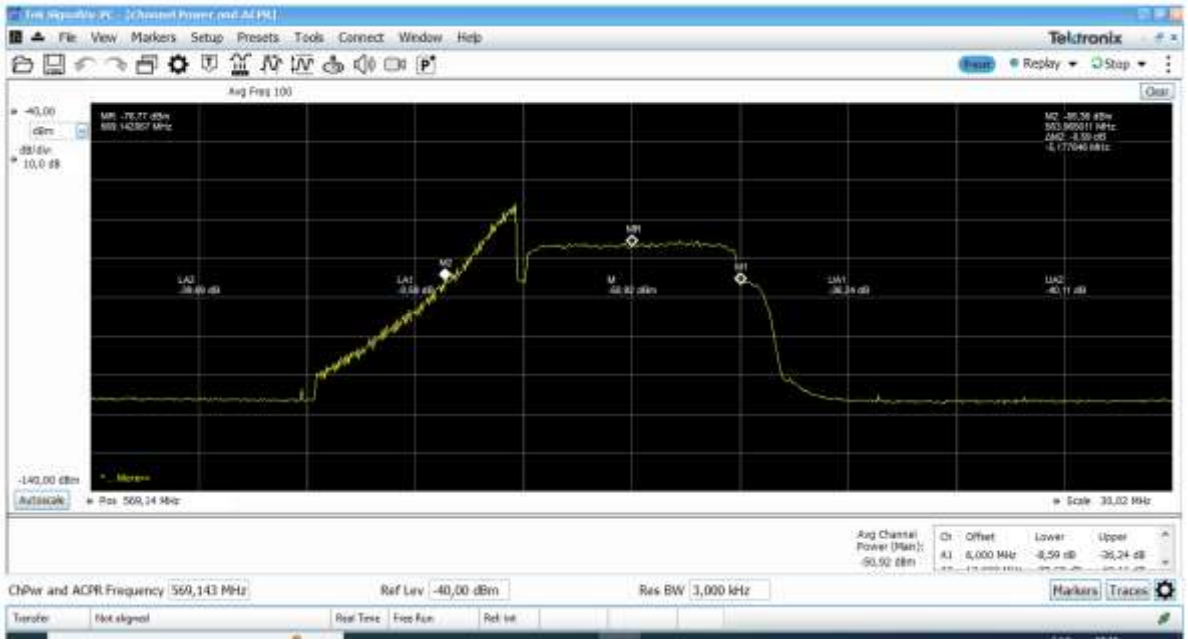


Figure 10.7 - Vertical

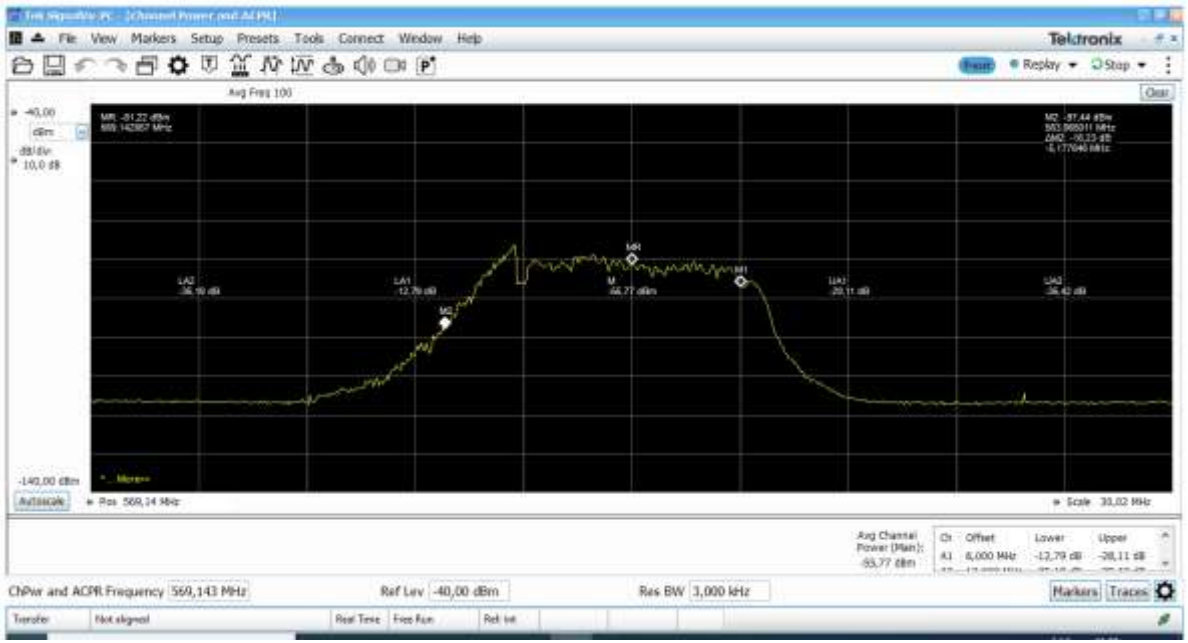


Figure 10.8 - Horizontal

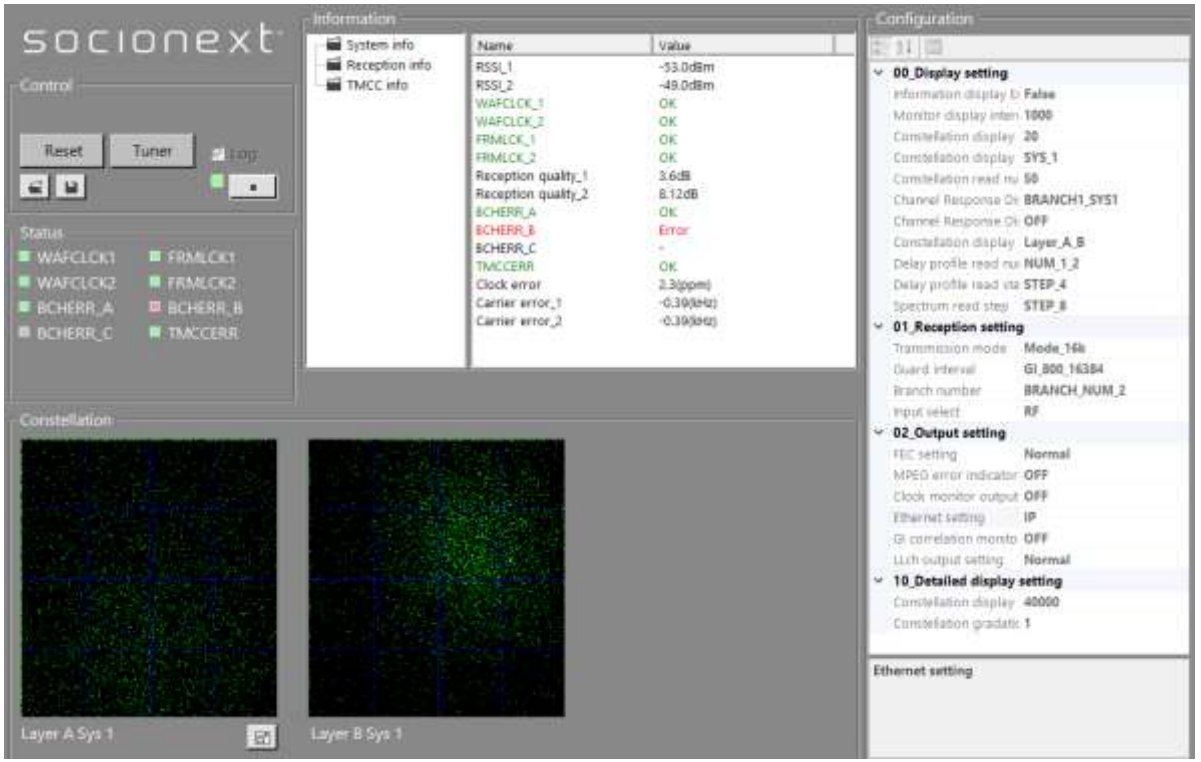


Figure 10.9 - Socionext Screen

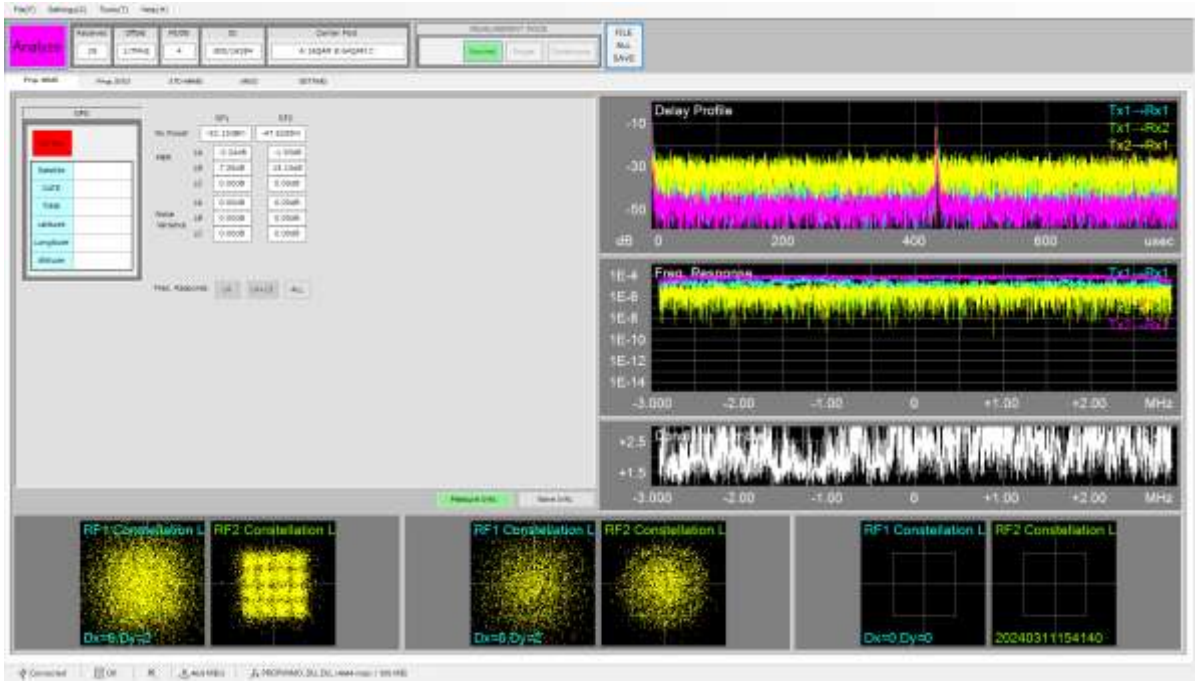


Figure 10.10 - Rintaro Screen

d) Reception Threshold

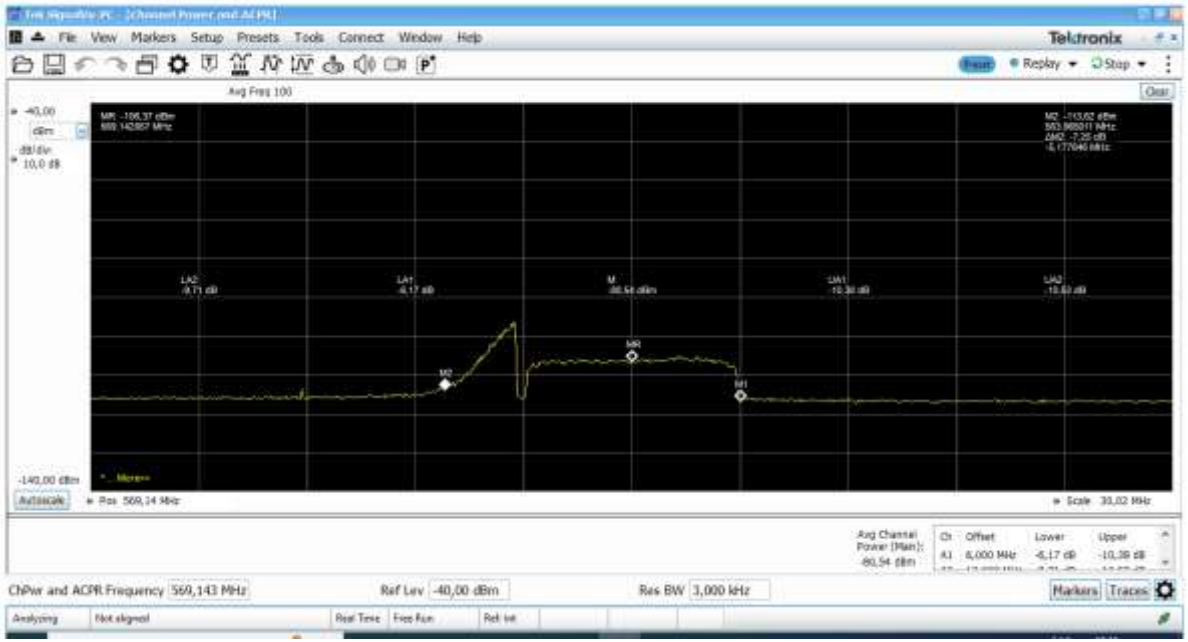


Figure 10.11 - Vertical

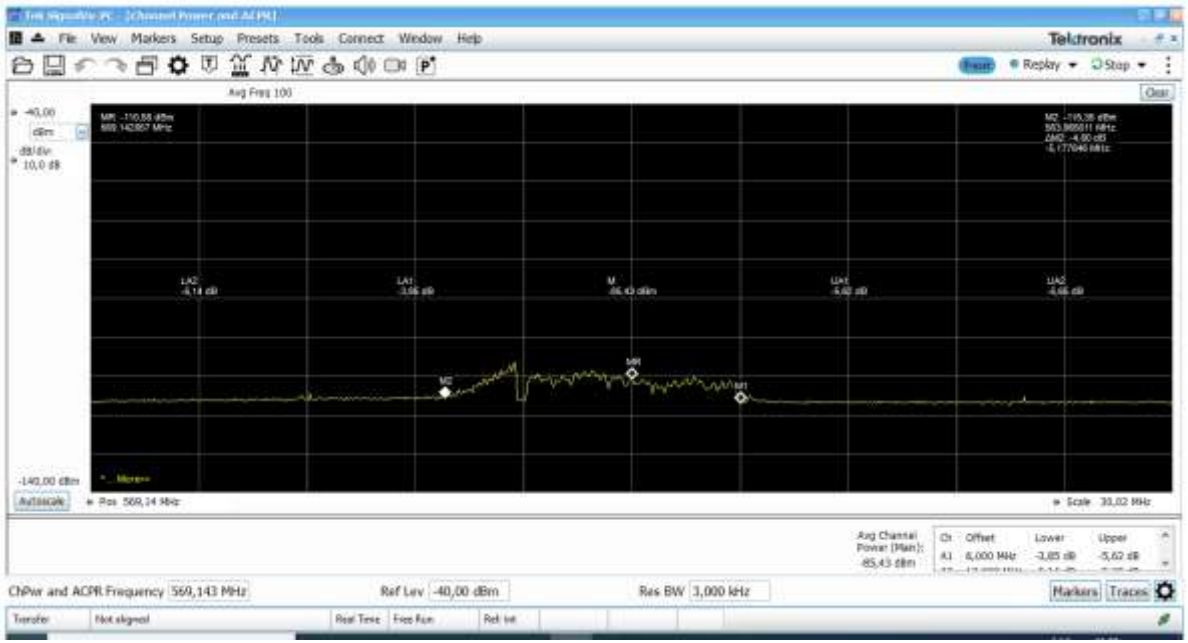


Figure 10.12 - Horizontal

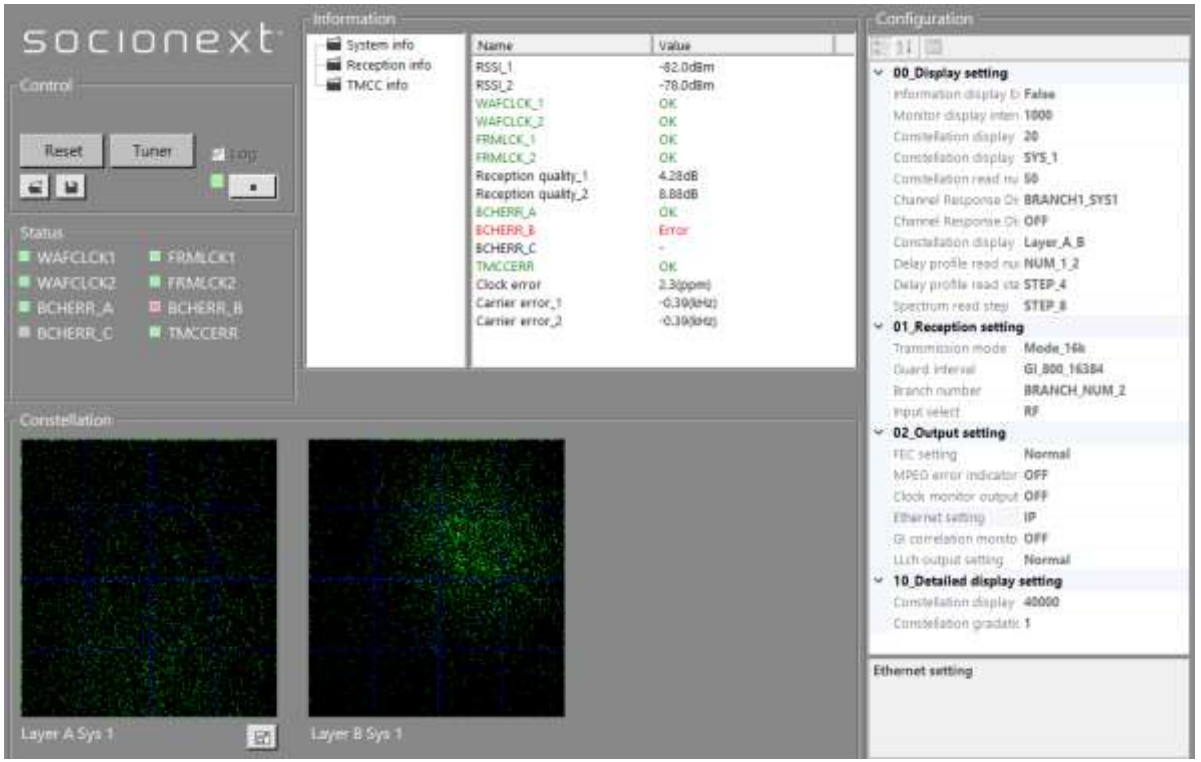


Figure 10.13 - Socionext Screen

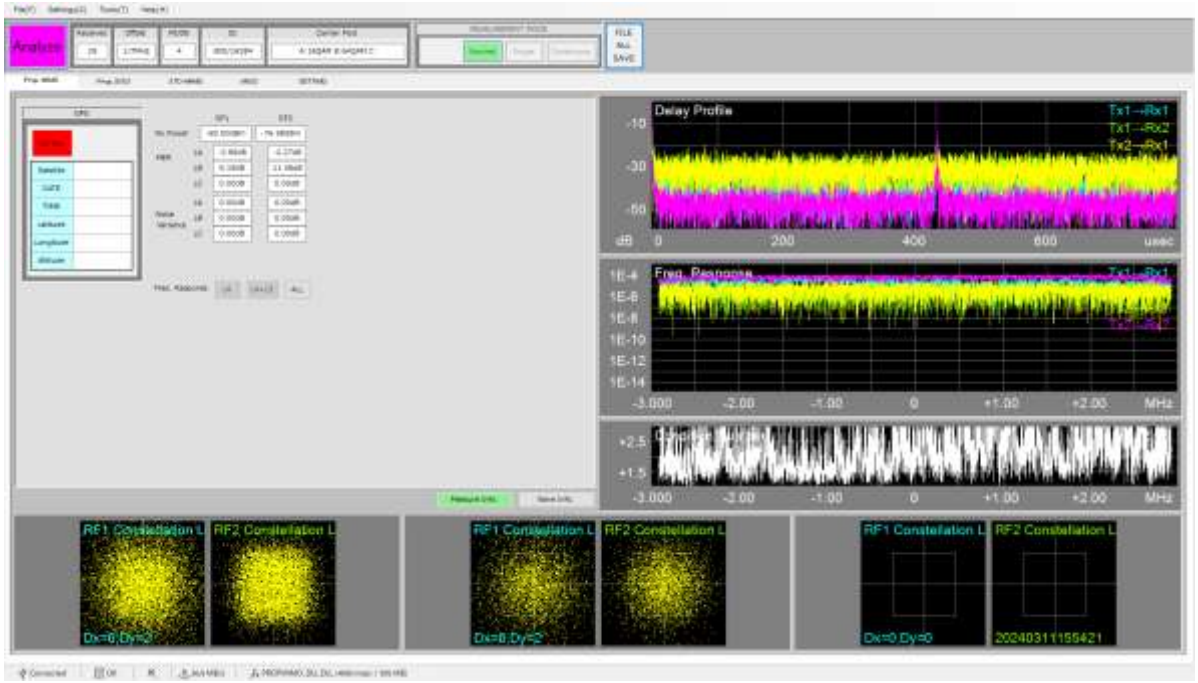


Figure 10.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

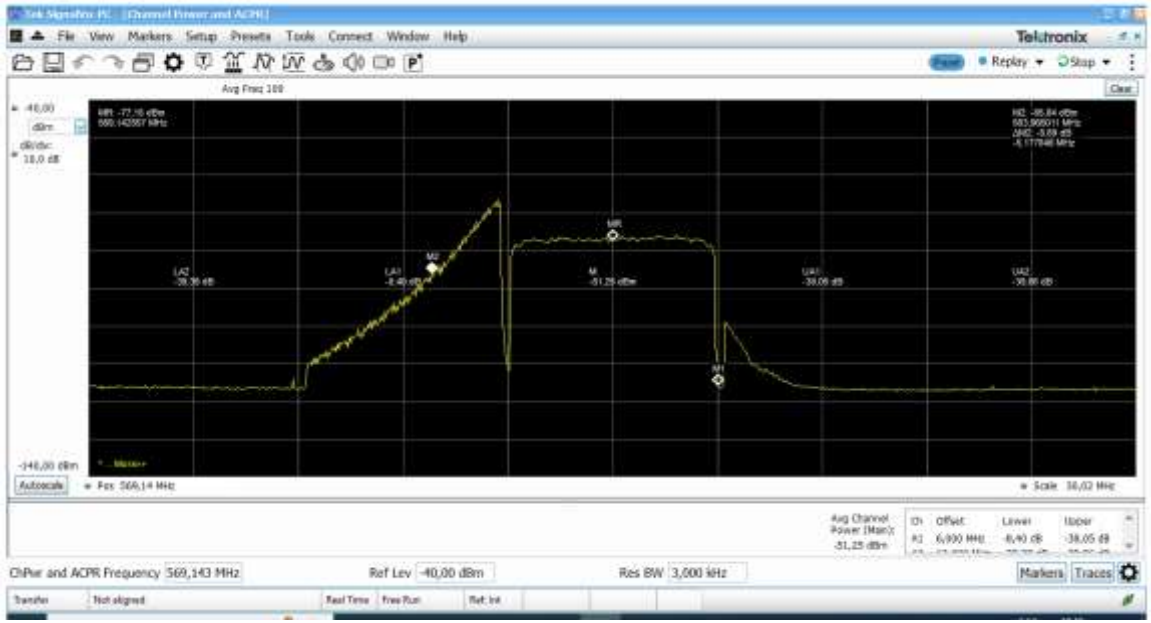


Figure 10.15 - Vertical

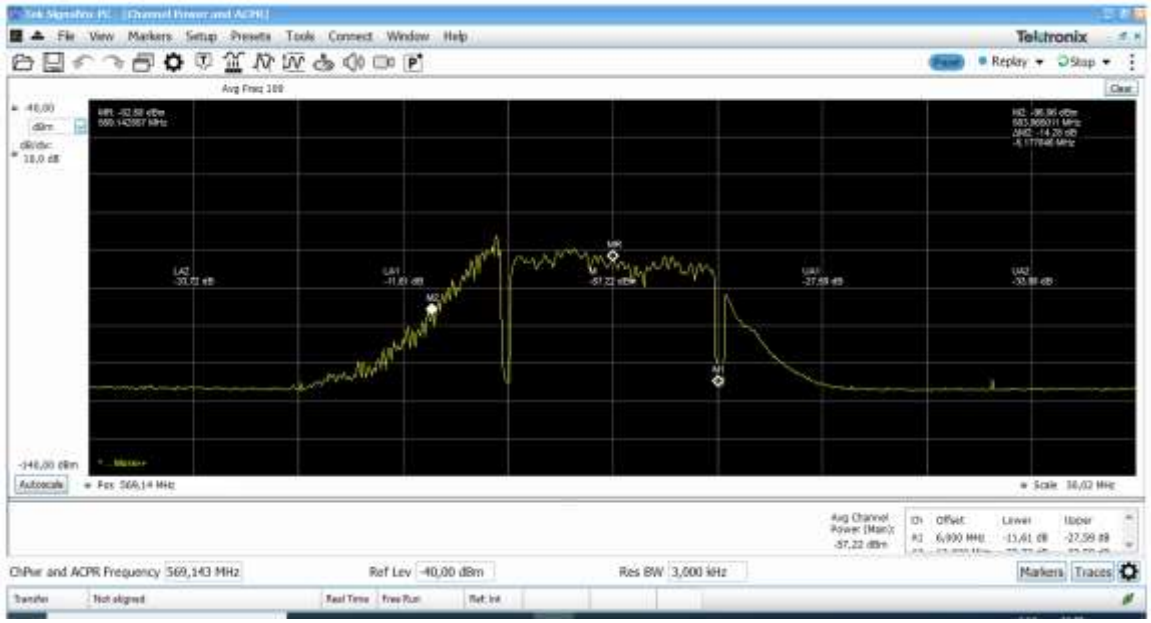


Figure 10.16 - Horizontal

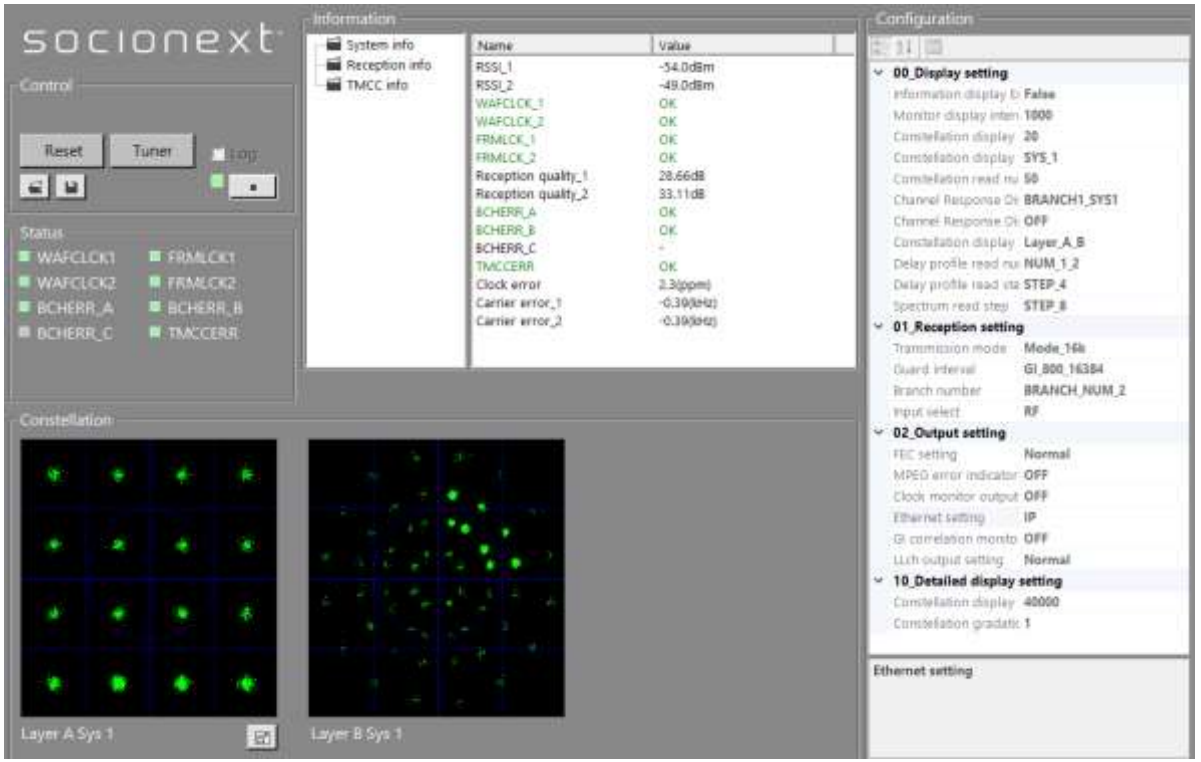


Figure 10.17 - Socionext Screen

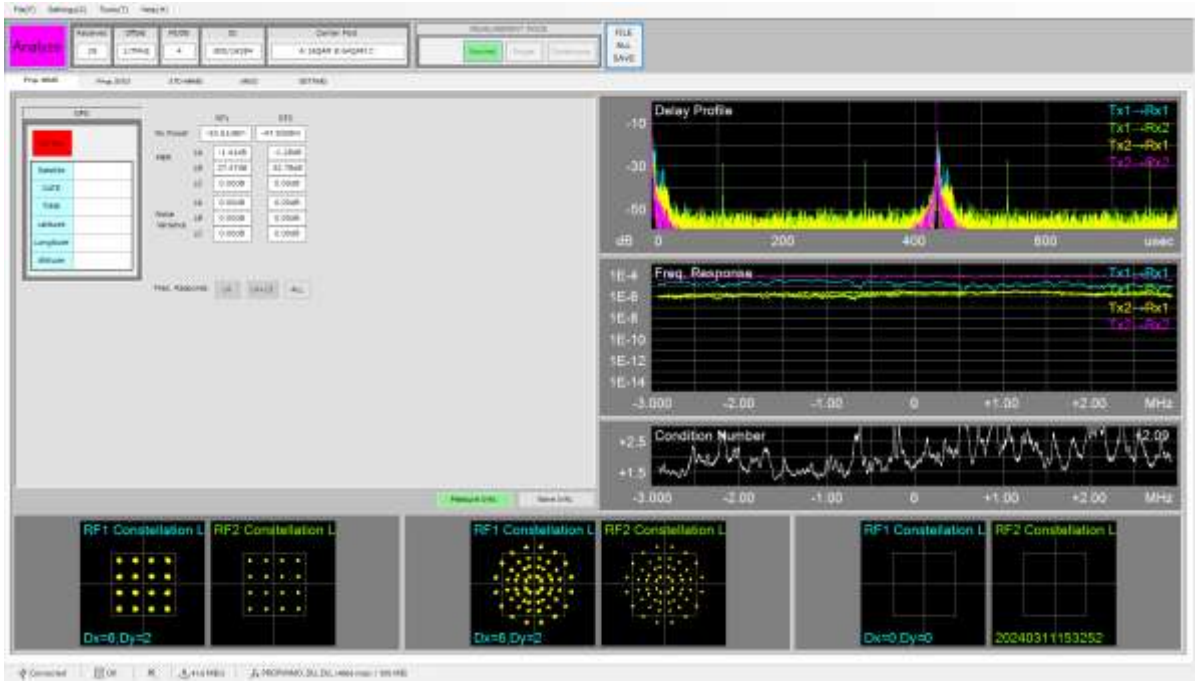


Figure 10.18 - Rintaro Screen

b) AWGN Power

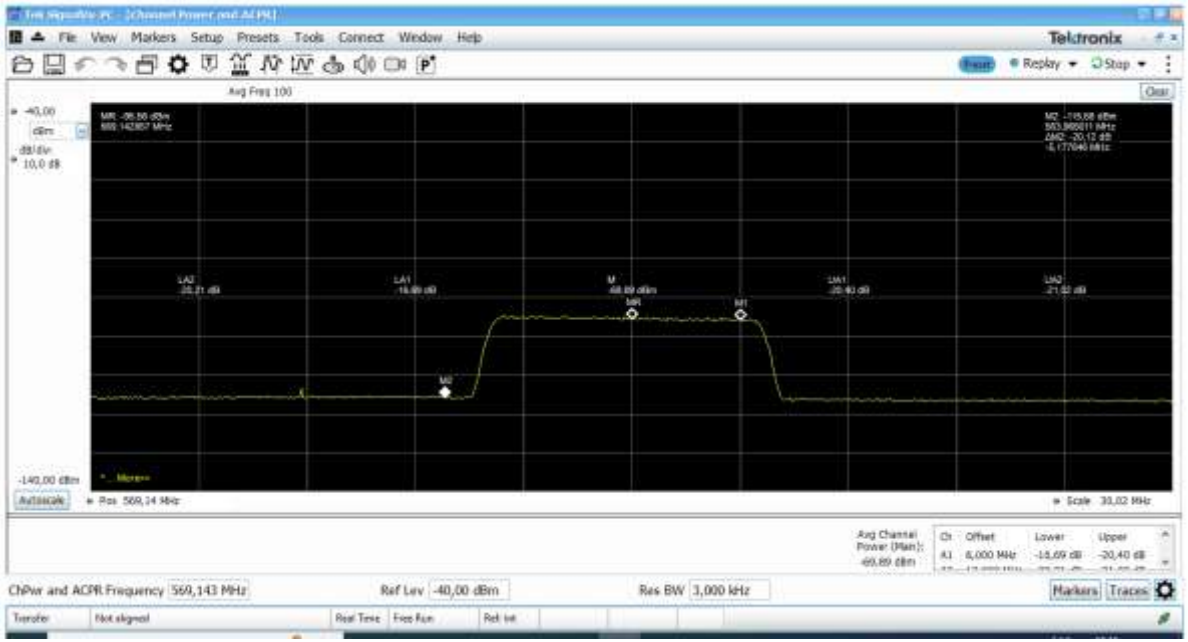


Figure 10.19 - Vertical

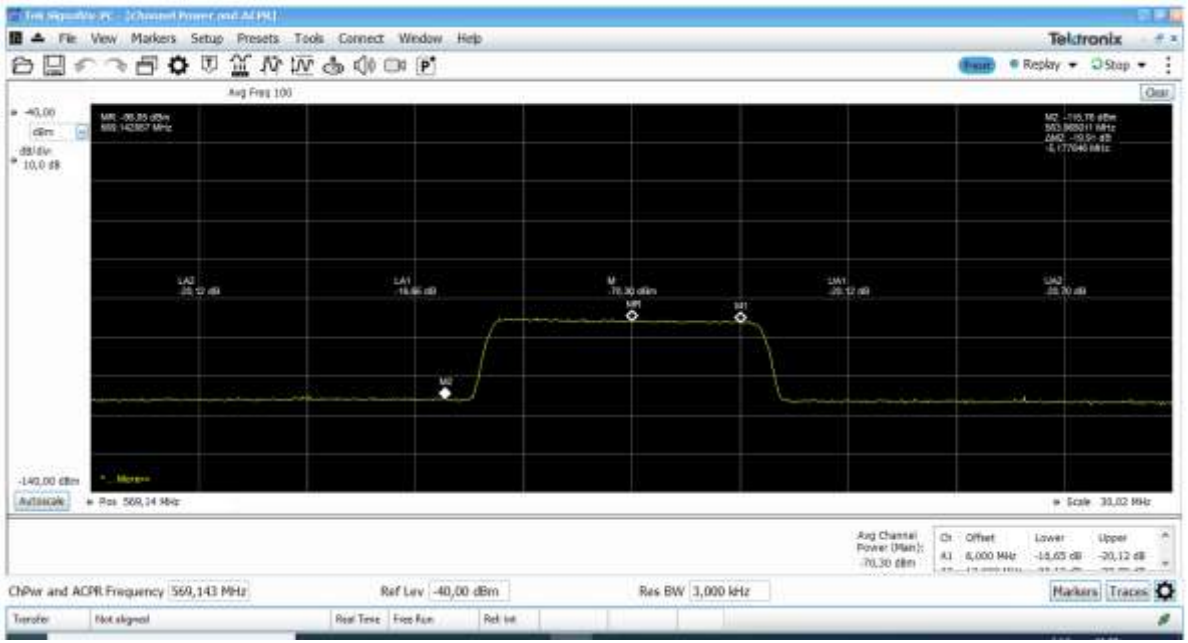


Figure 10.20 - Horizontal

c) C/N Threshold

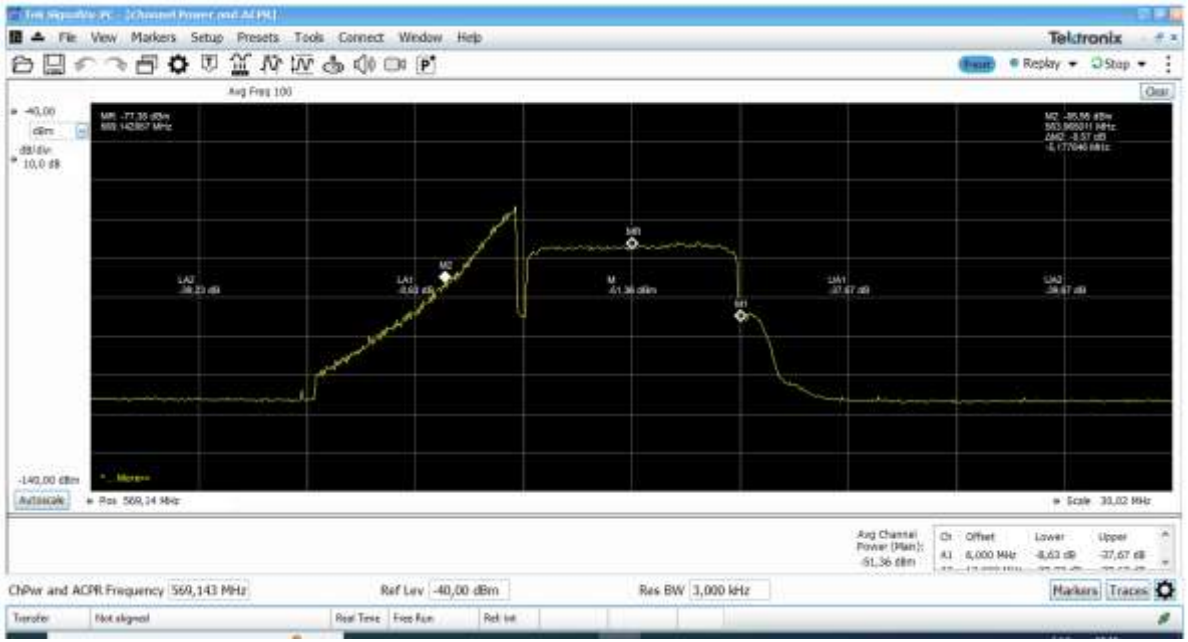


Figure 10.21 - Vertical

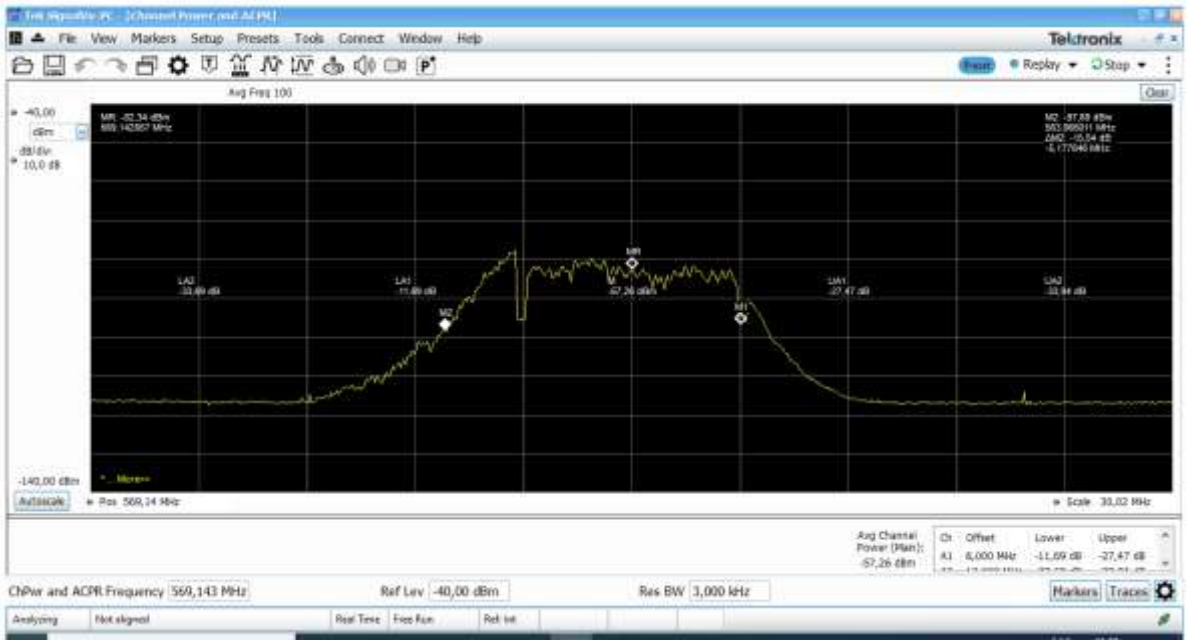


Figure 10.22 - Horizontal

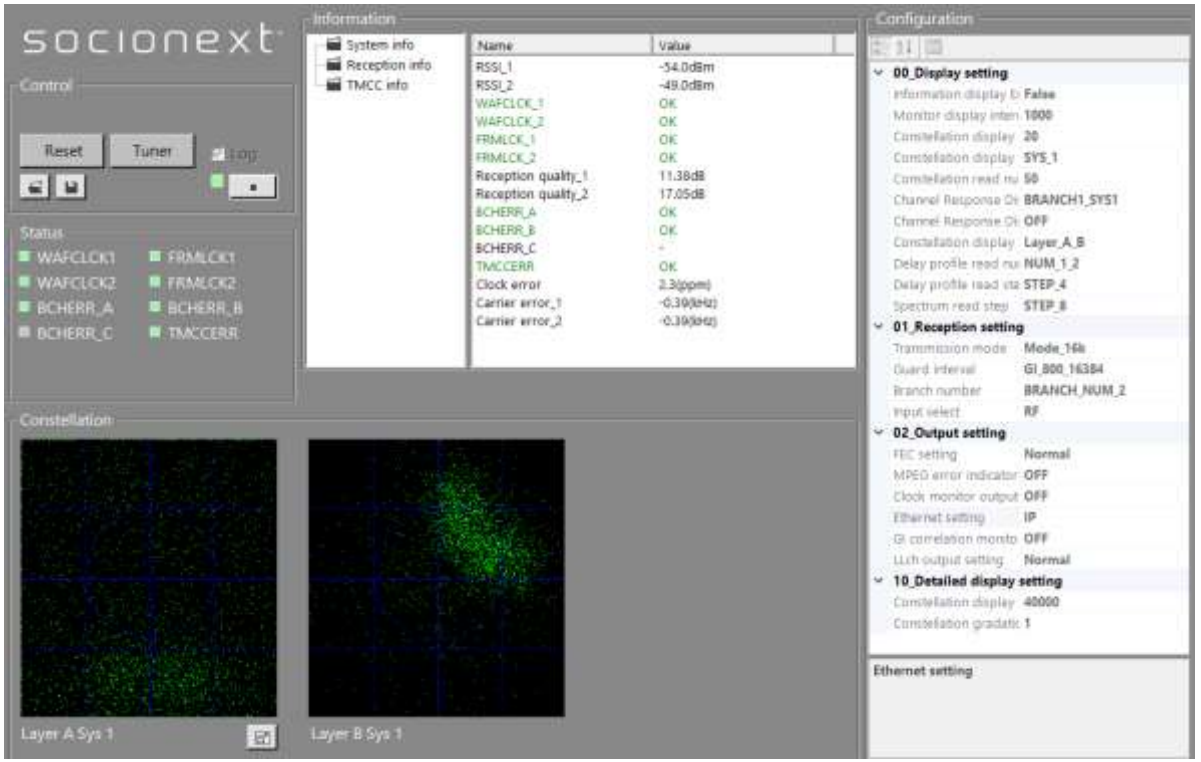


Figure 10.23 - Socionext Screen

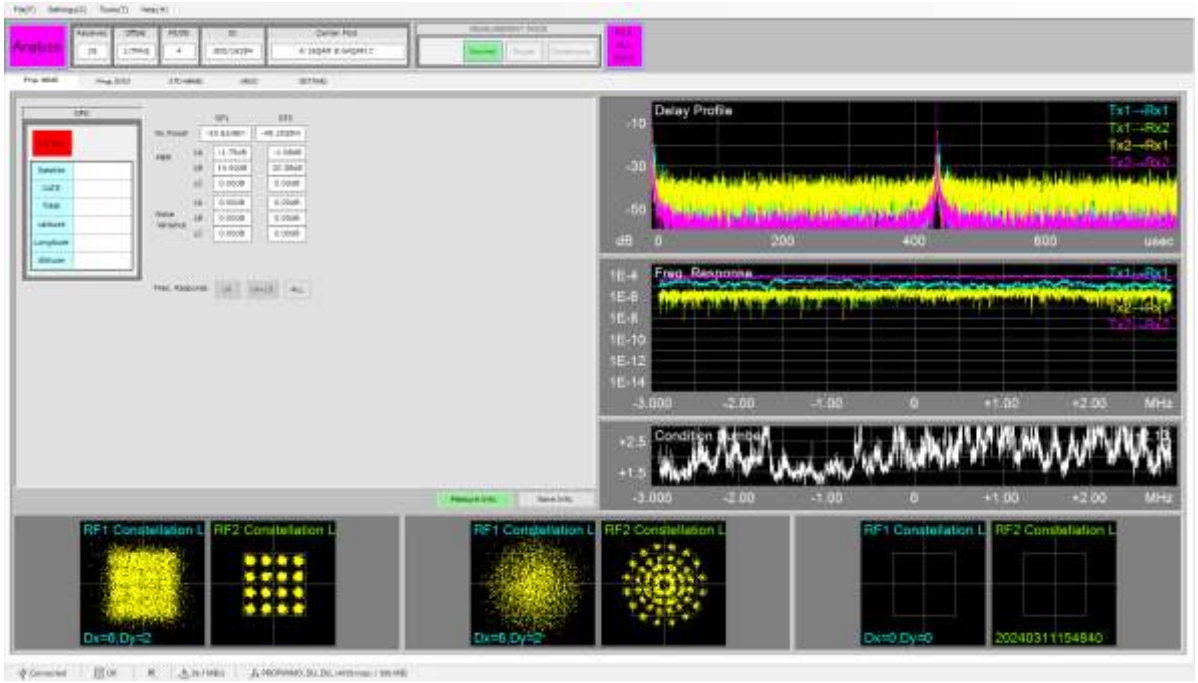


Figure 10.24 - Rintaro Screen

d) Reception Threshold

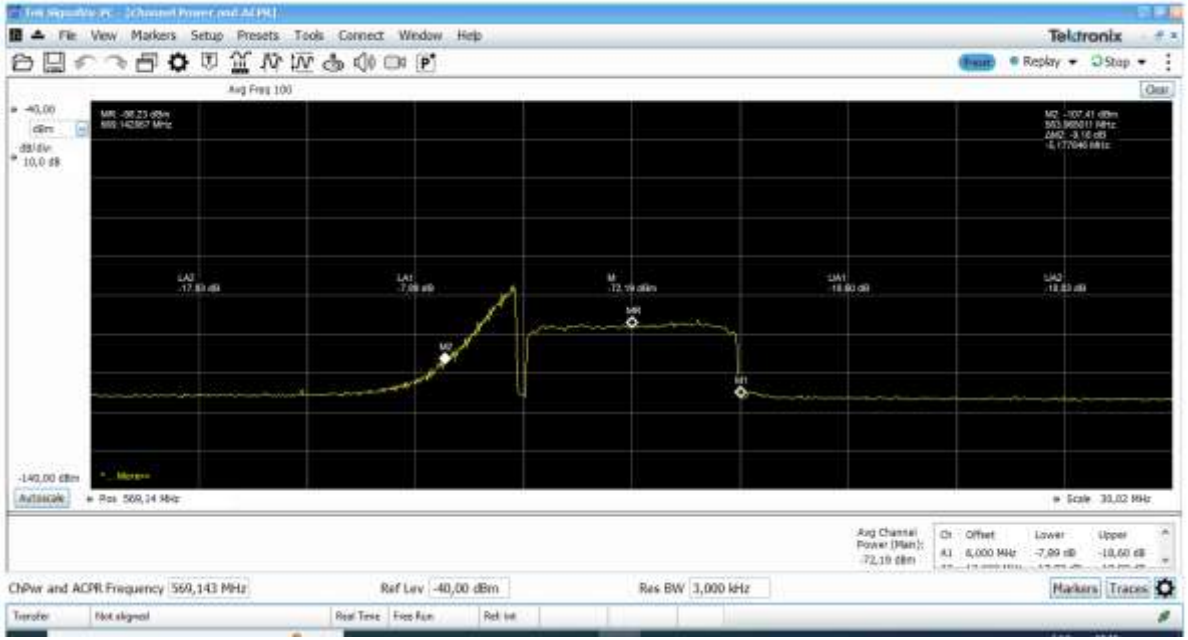


Figure 10.25 - Vertical

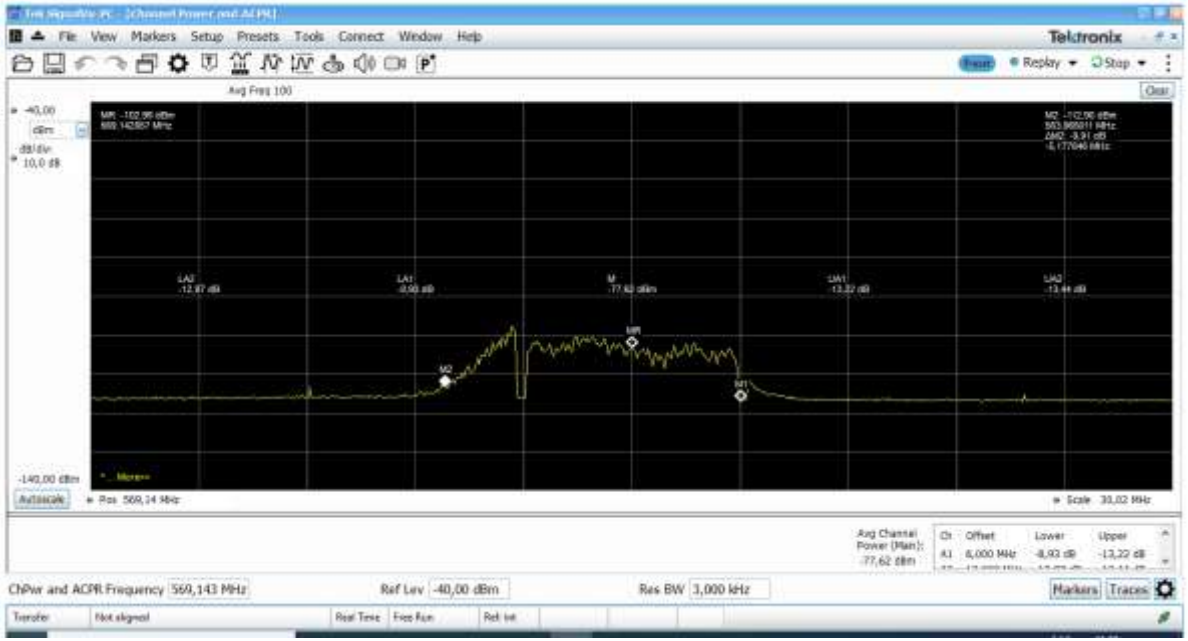


Figure 10.26 - Horizontal

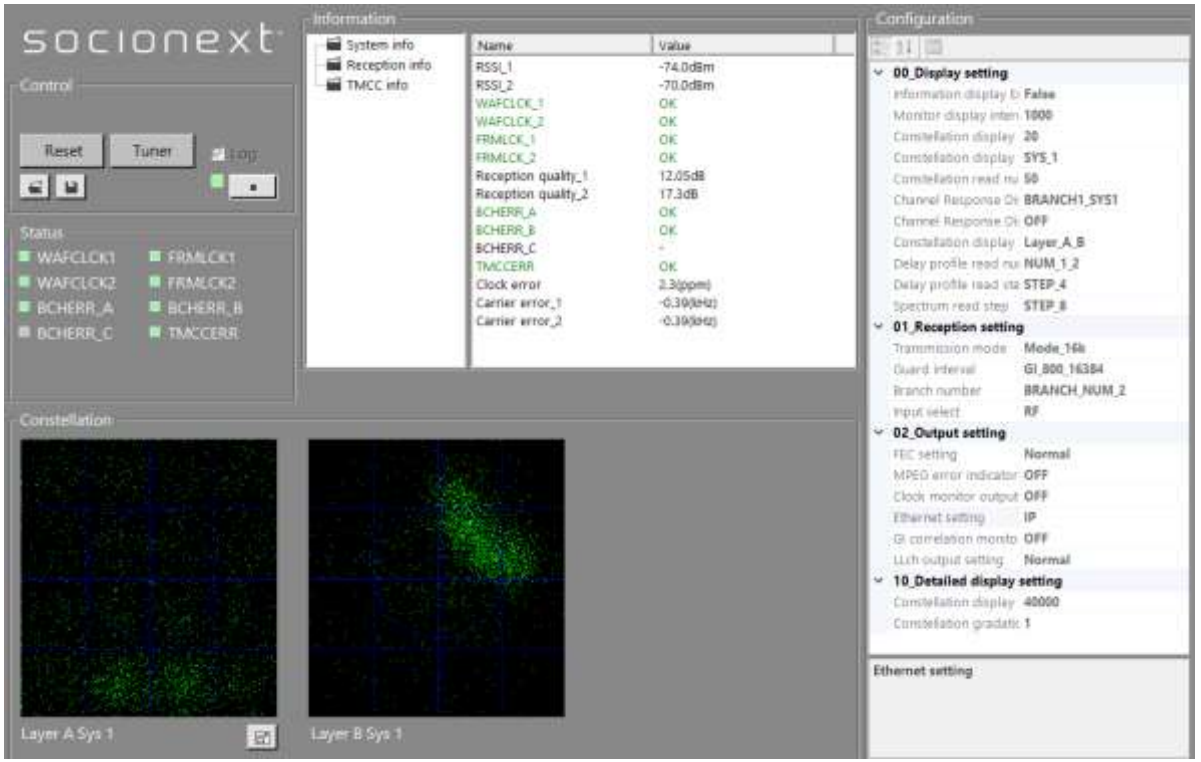


Figure 10.27 - Socionext Screen

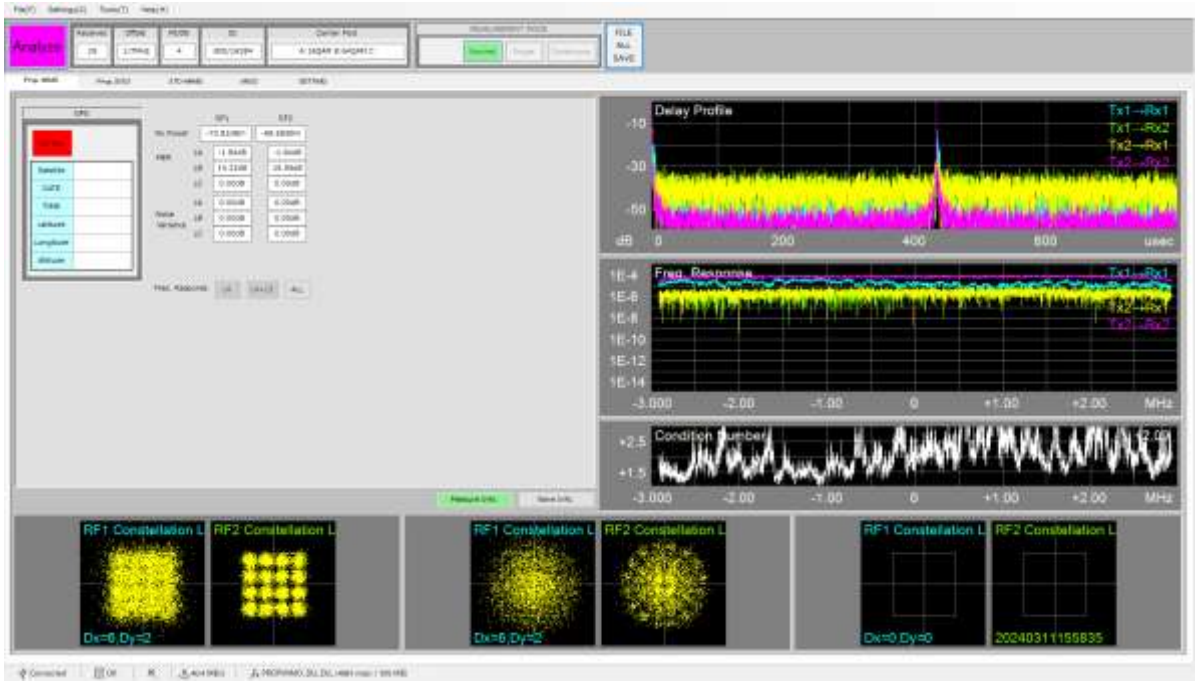


Figure 10.28 - Rintaro Screen

Chapter 11. Site 25

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

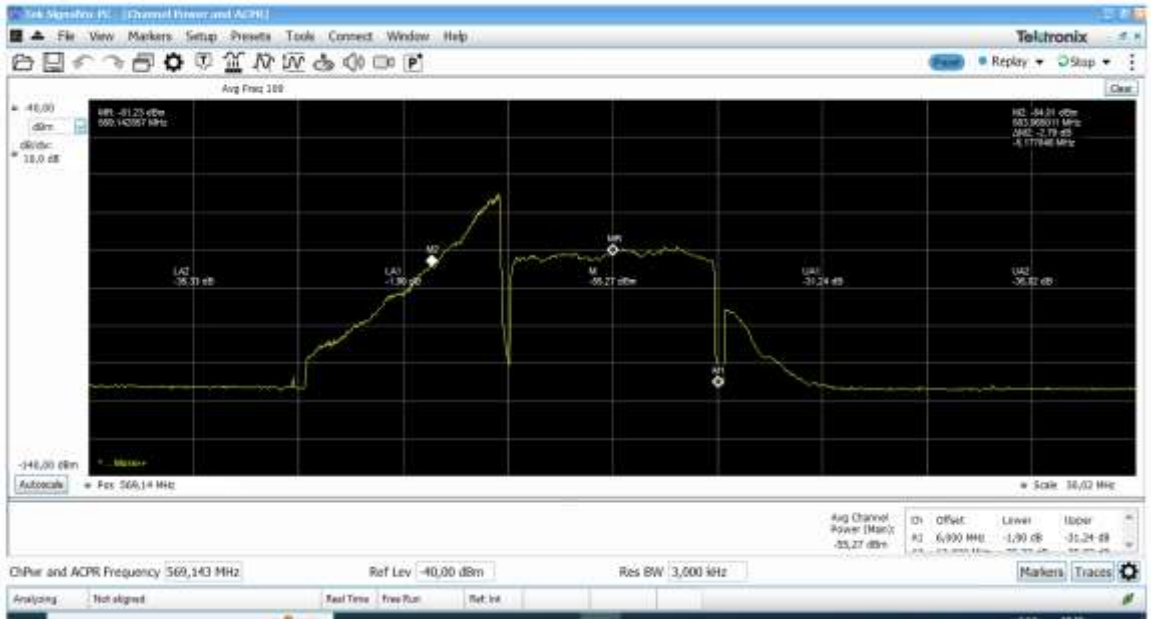


Figure 11.1 - Vertical

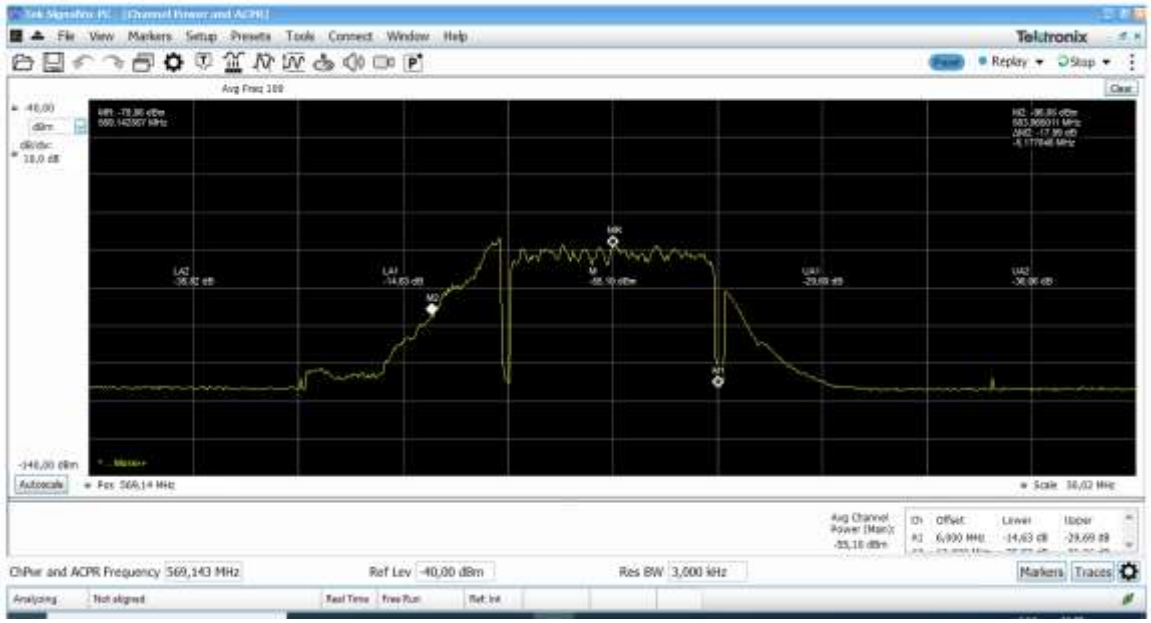


Figure 11.2 - Horizontal

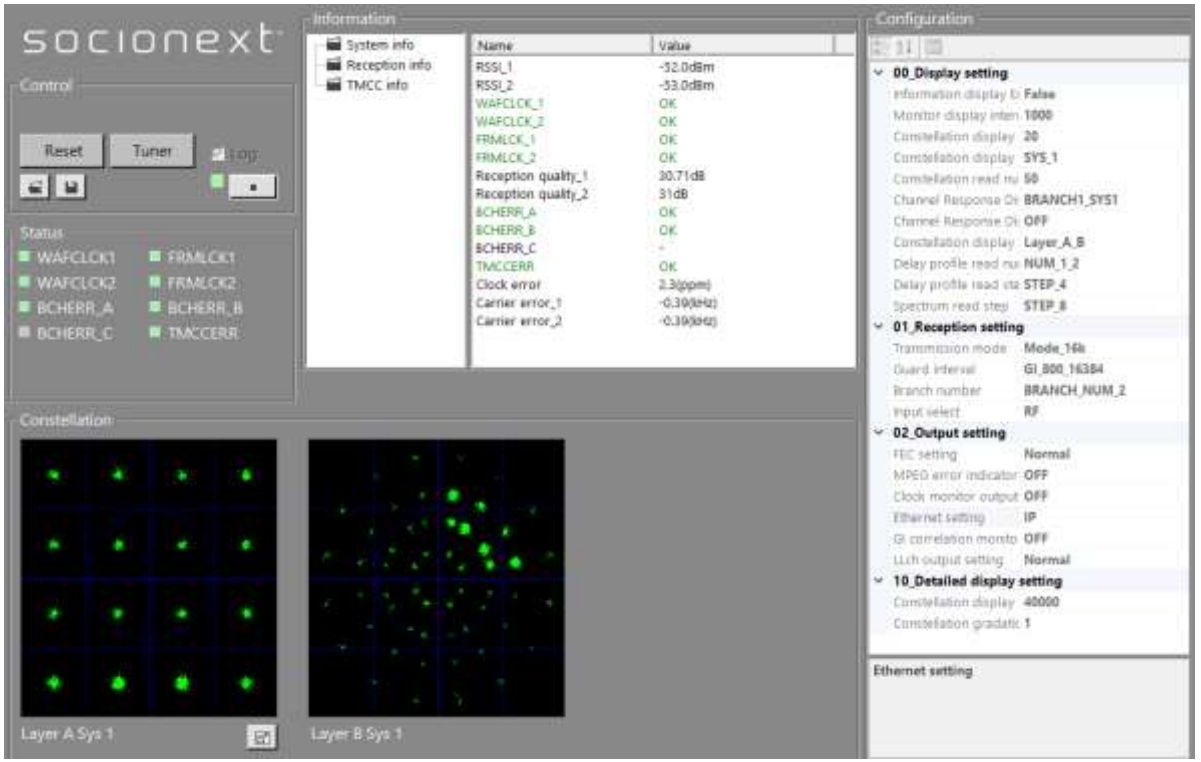


Figure 11.3 - Socionext Screen

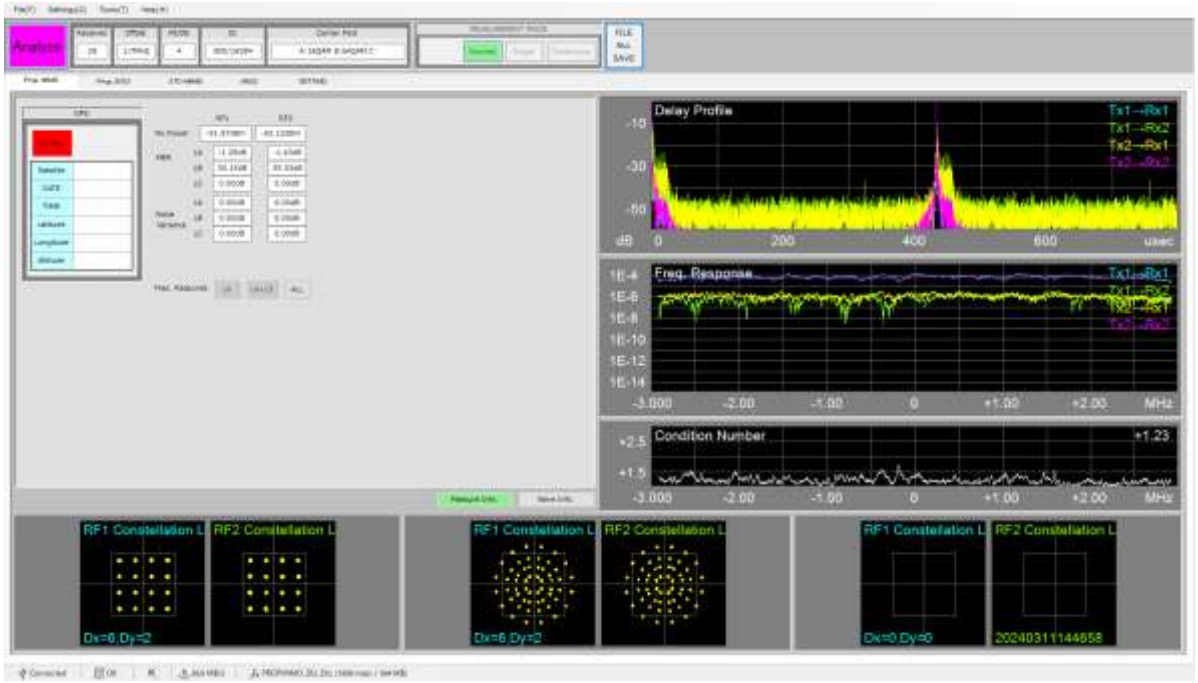


Figure 11.4 - Rintaro Screen

b) AWGN Power

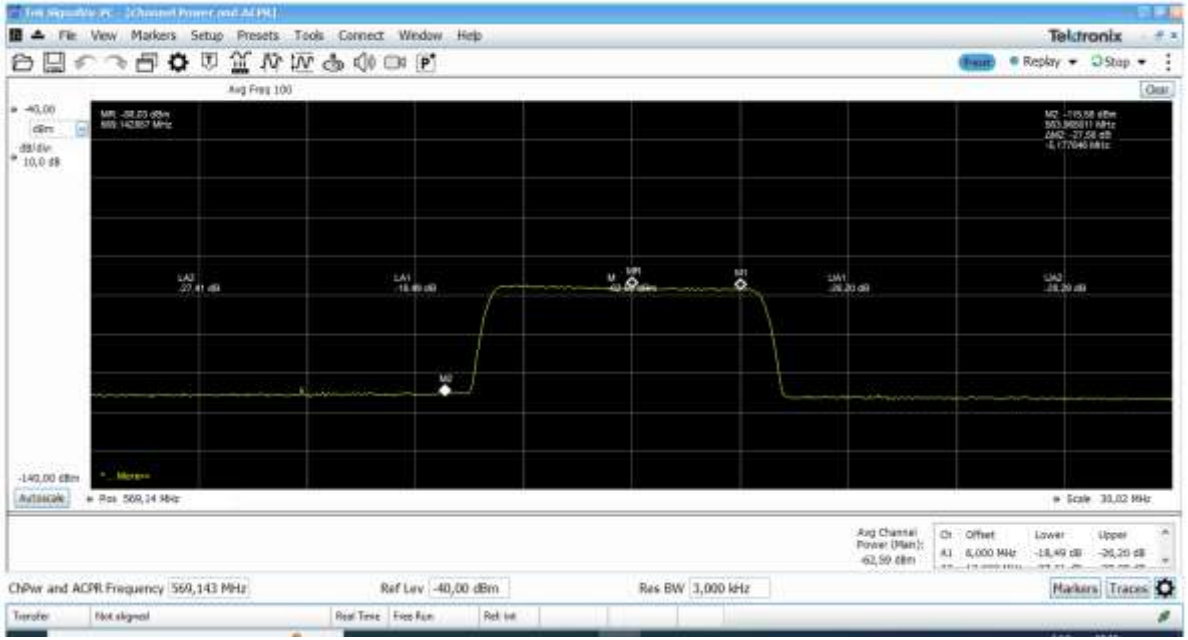


Figure 11.5 - Vertical

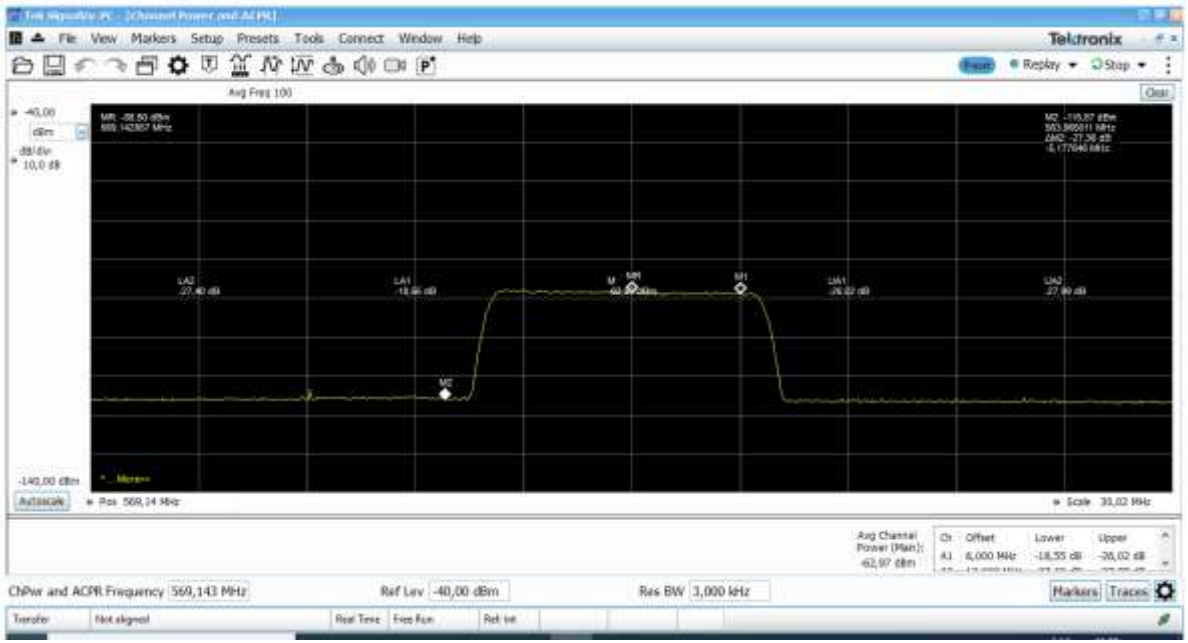


Figure 11.6 - Horizontal

c) C/N Threshold

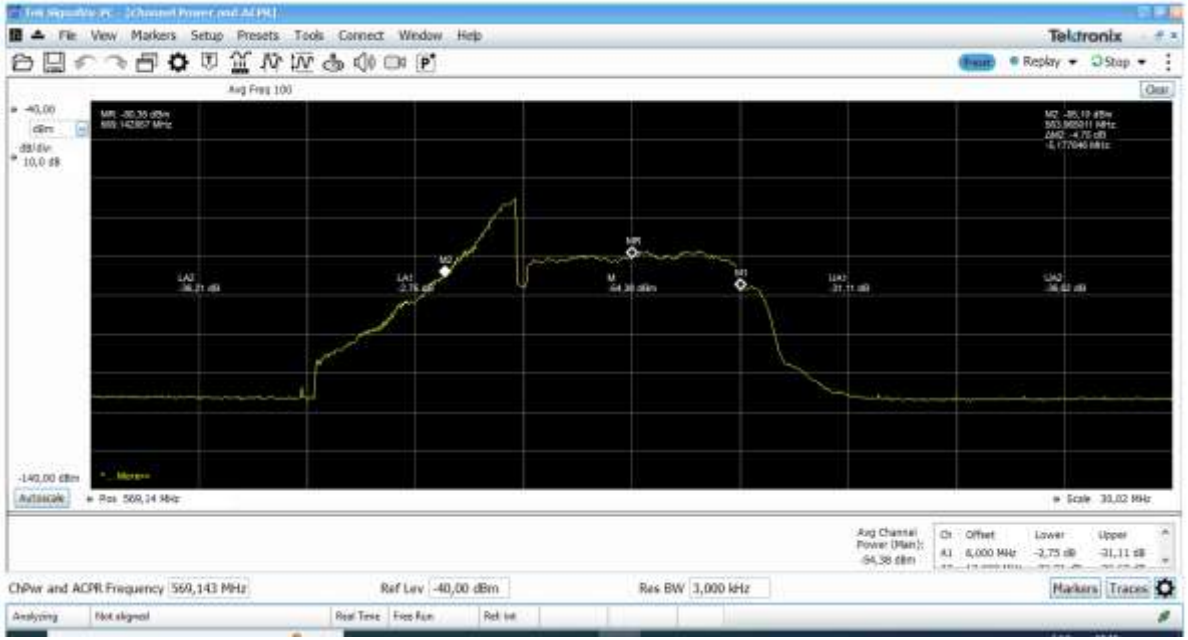


Figure 11.7 - Vertical

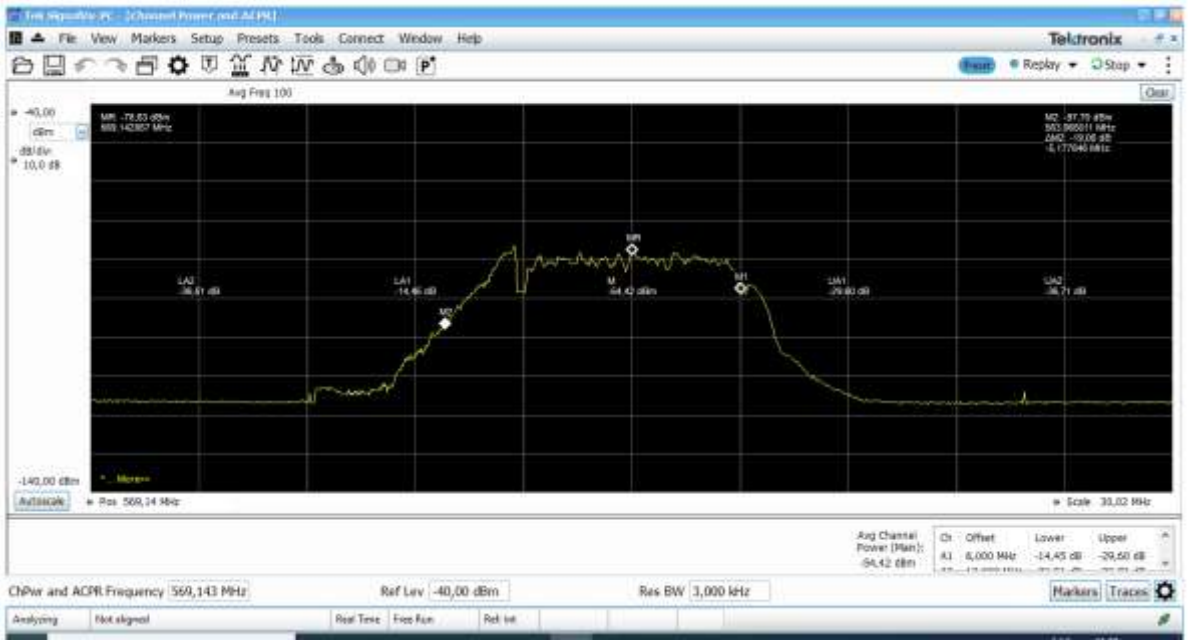


Figure 11.8 - Horizontal

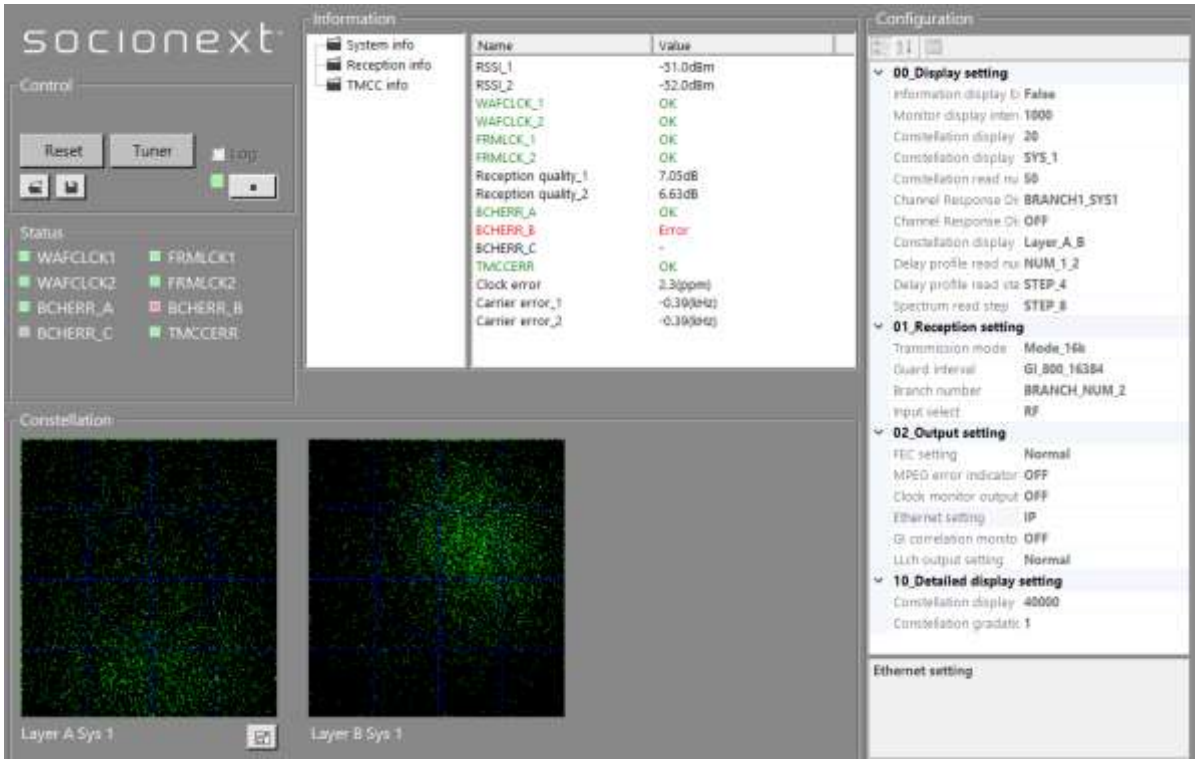


Figure 11.9 - Socionext Screen

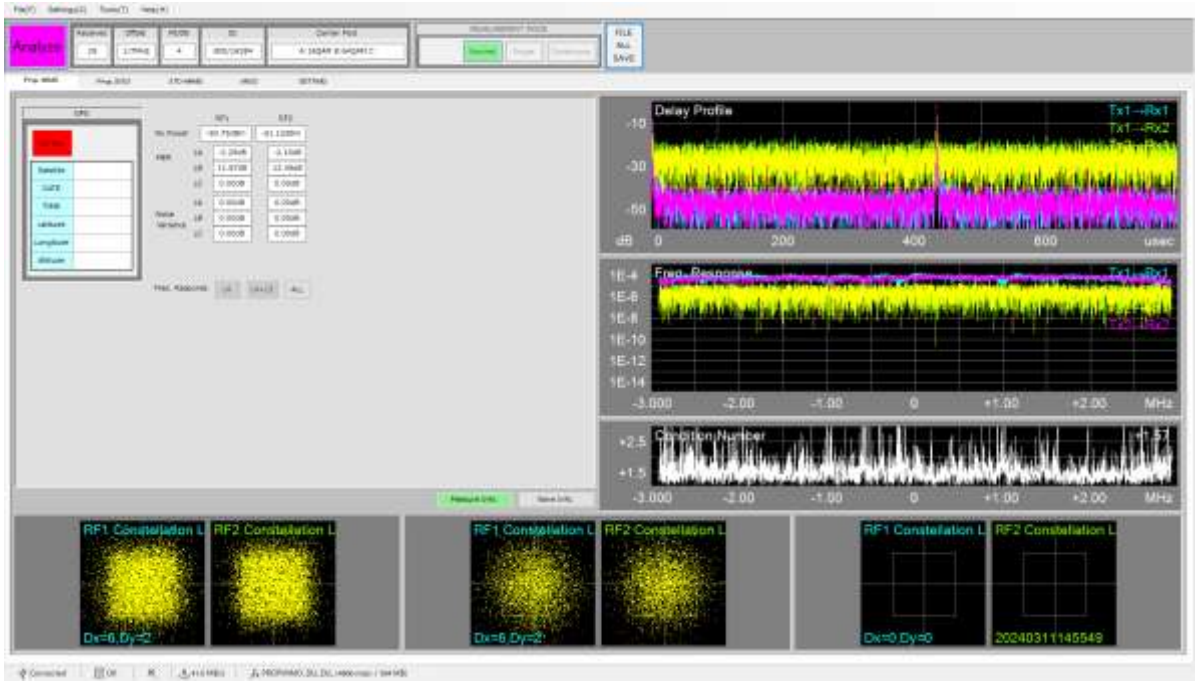


Figure 11.10 - Rintaro Screen

d) Reception Threshold

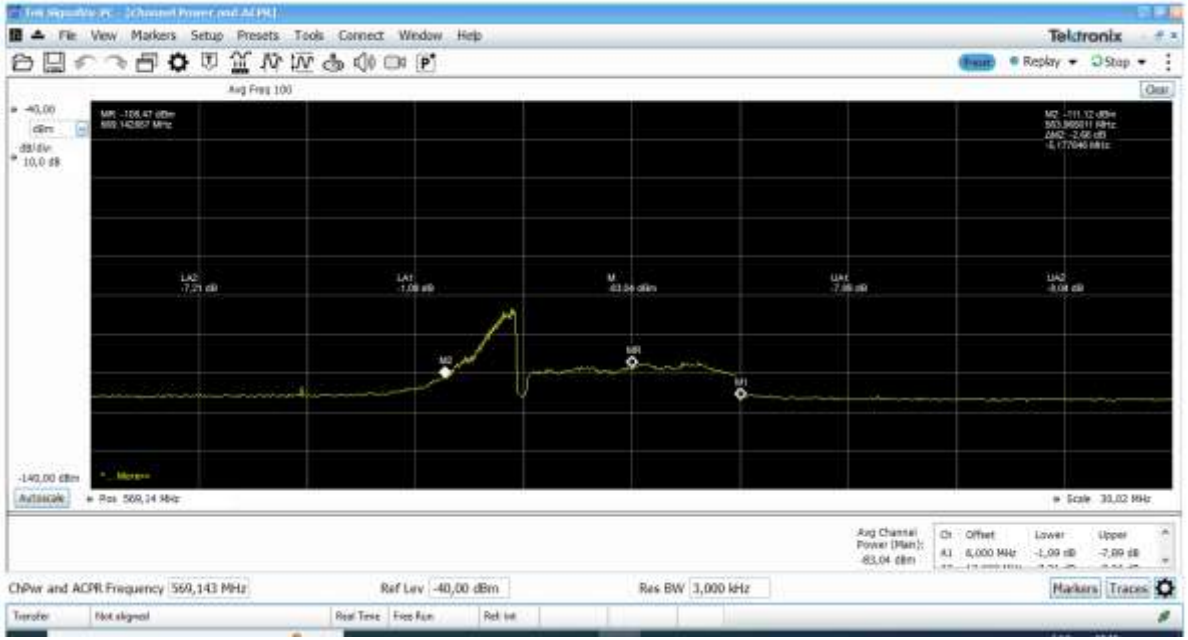


Figure 11.11 - Vertical

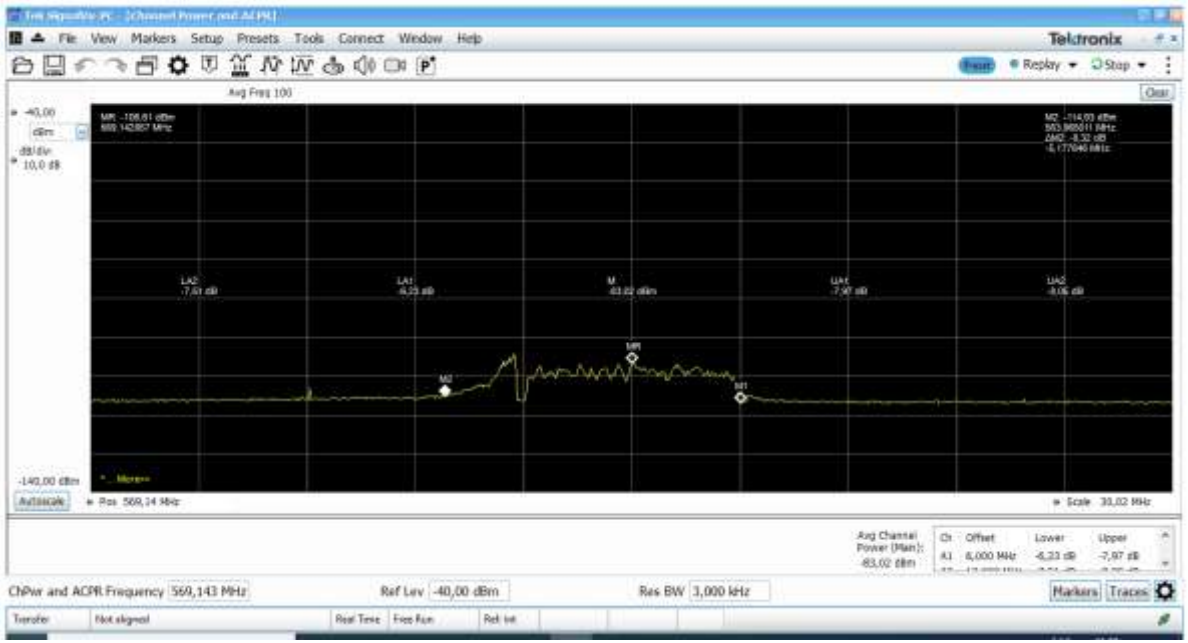


Figure 11.12 - Horizontal

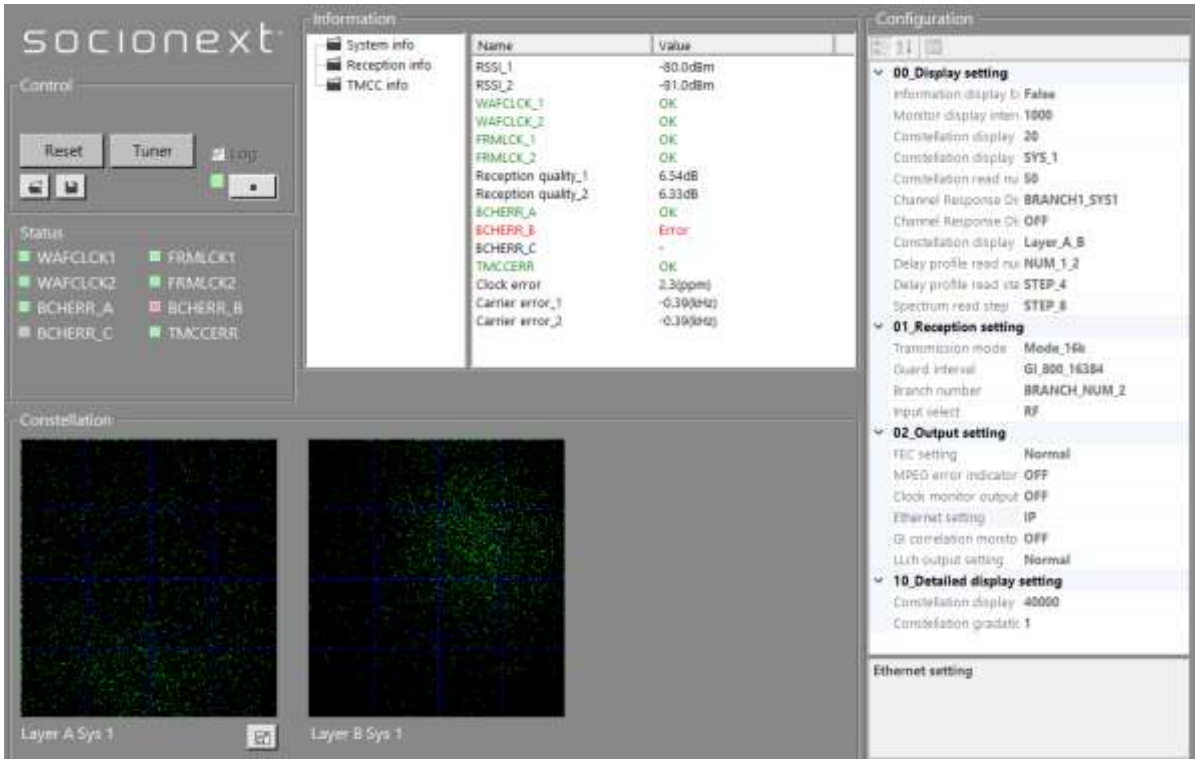


Figure 11.13 - Socionext Screen

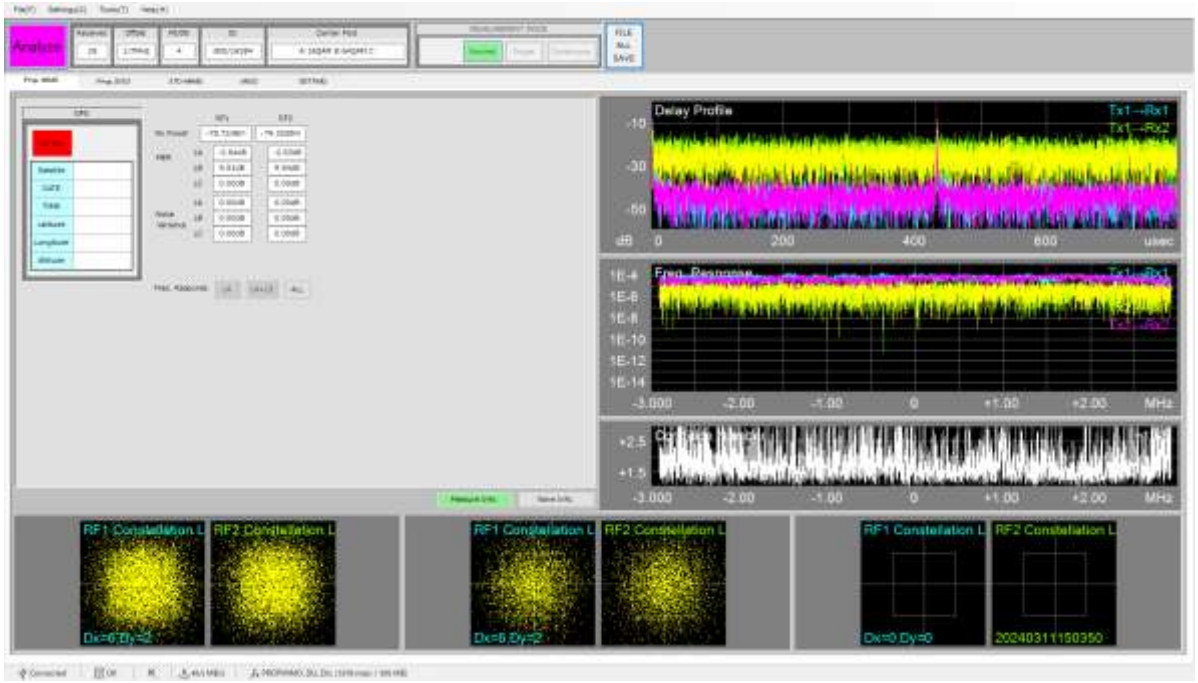


Figure 11.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

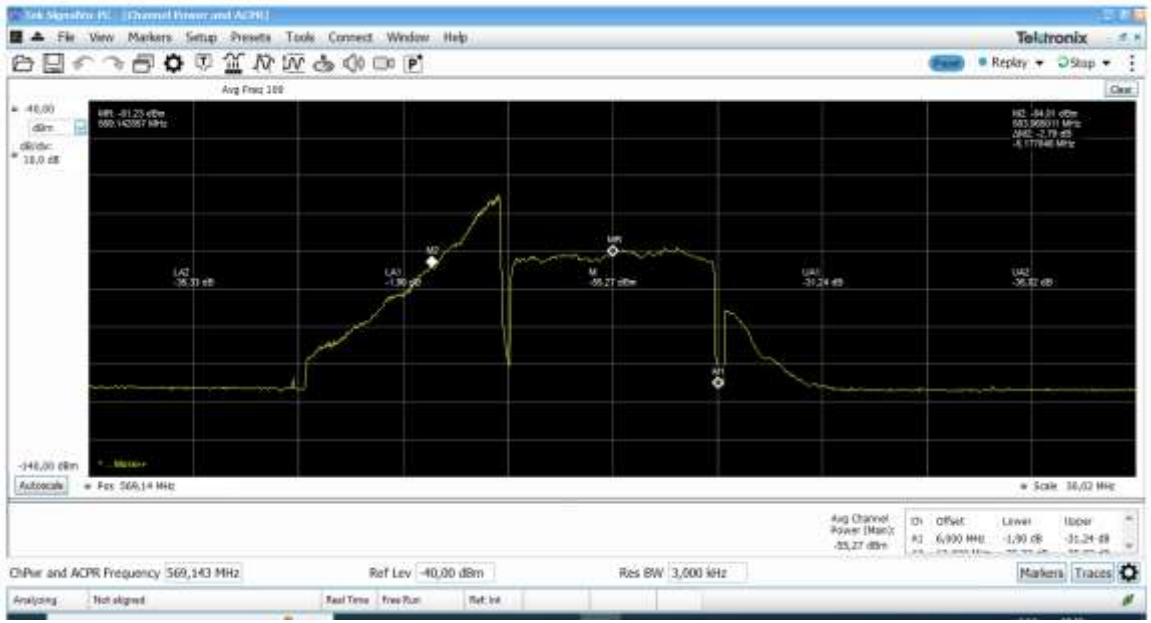


Figure 11.15 - Vertical

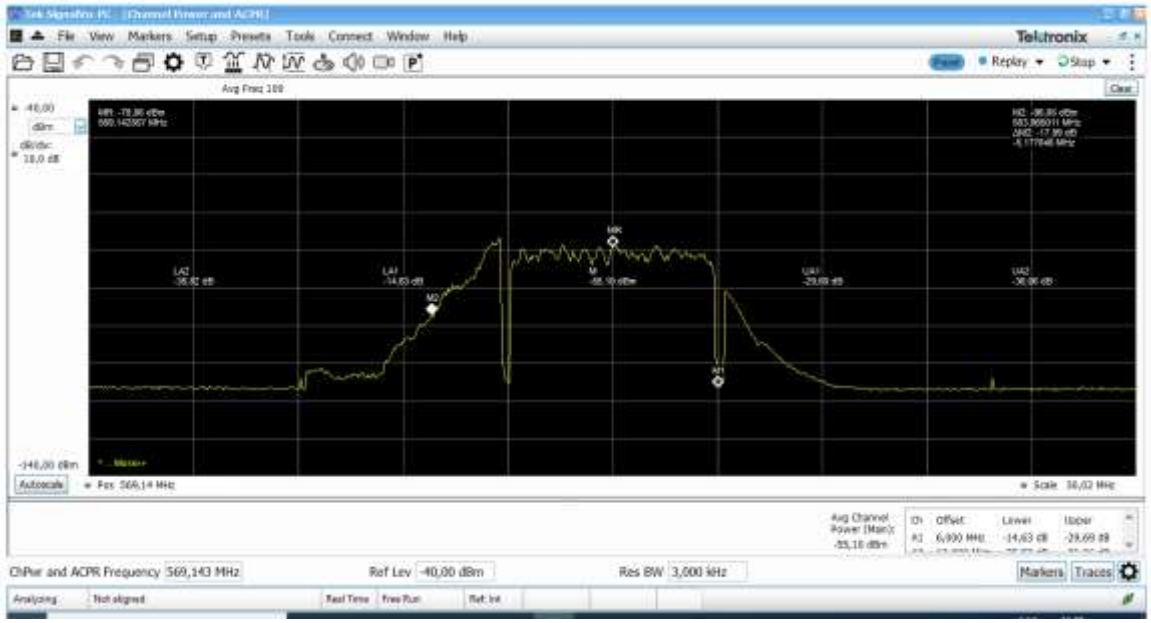


Figure 11.16 - Horizontal

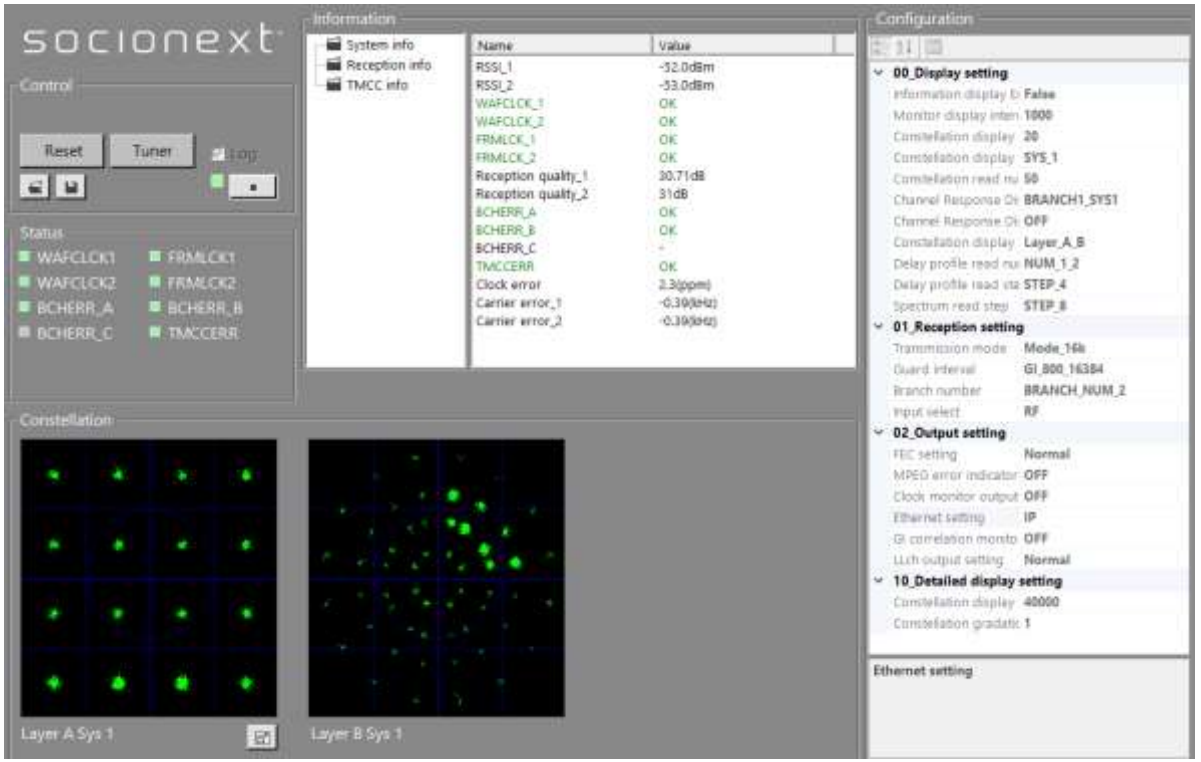


Figure 11.17 - Socionext Screen

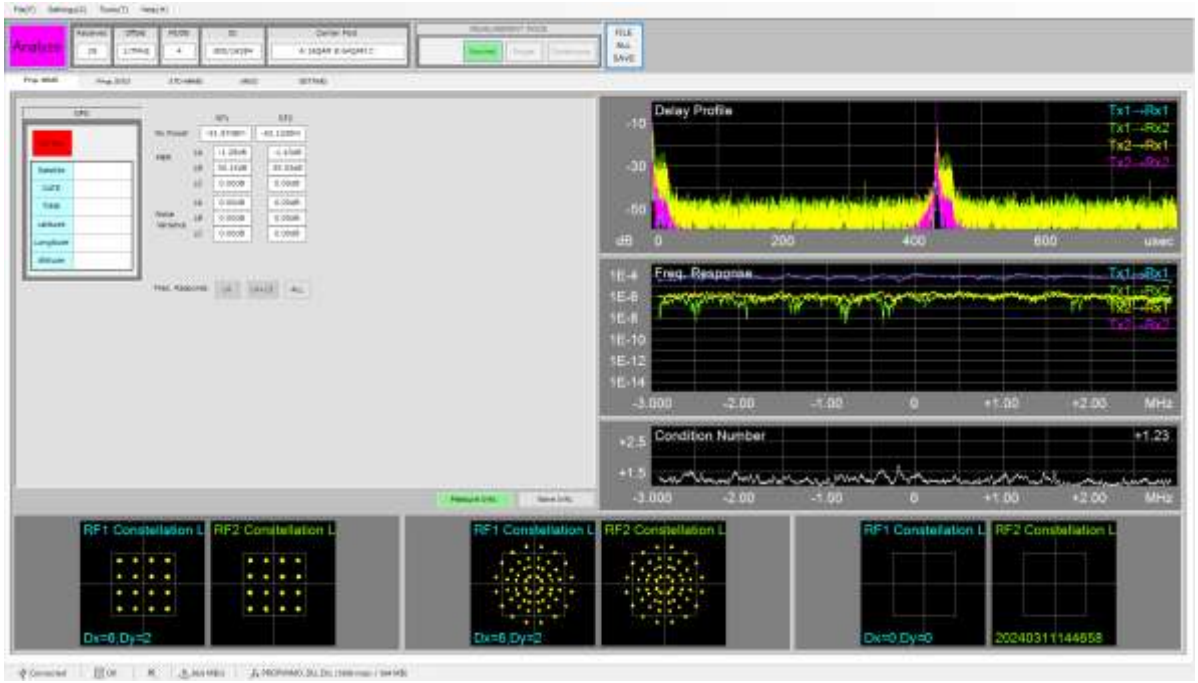


Figure 11.18 - Rintaro Screen

b) AWGN Power

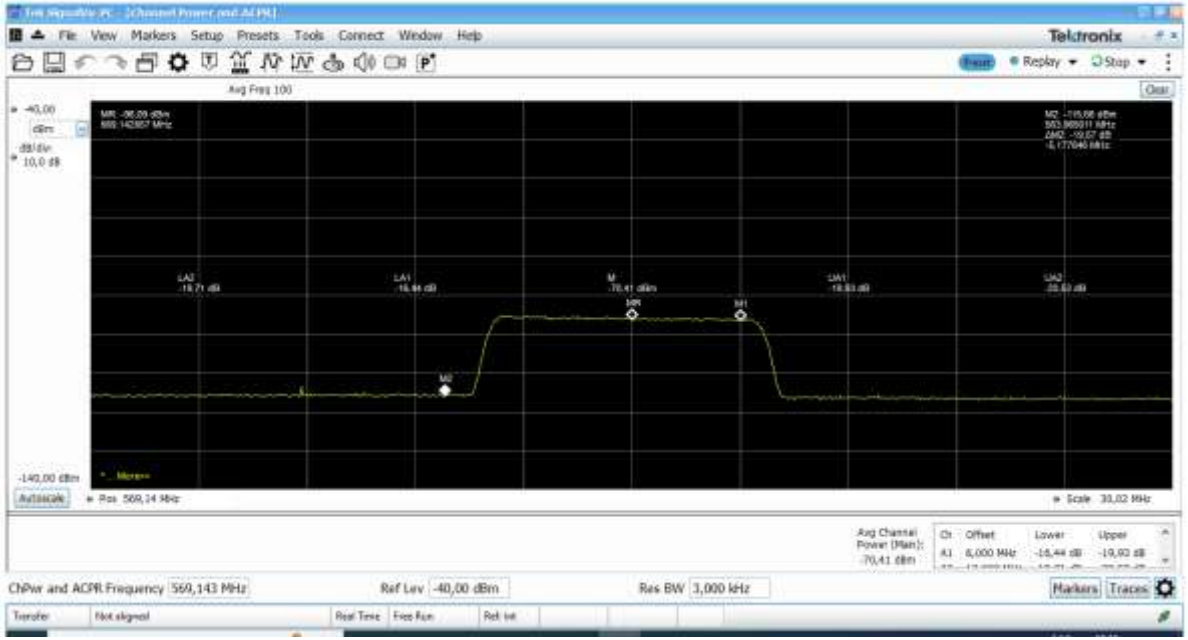


Figure 11.19 - Vertical

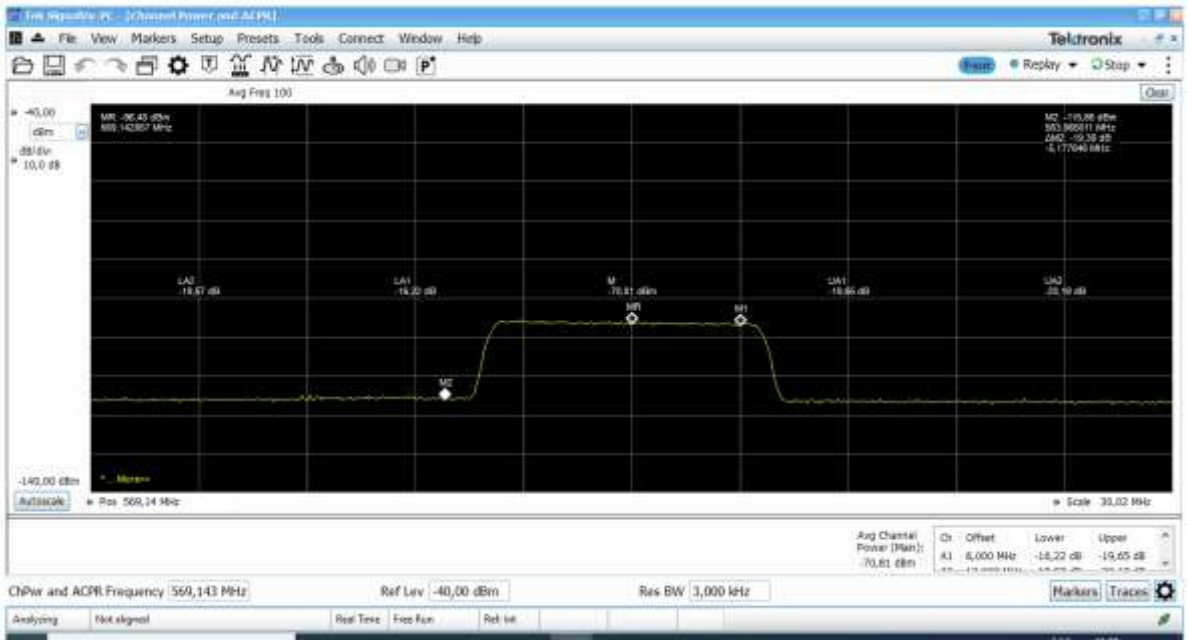


Figure 11.20 - Horizontal

c) C/N Threshold

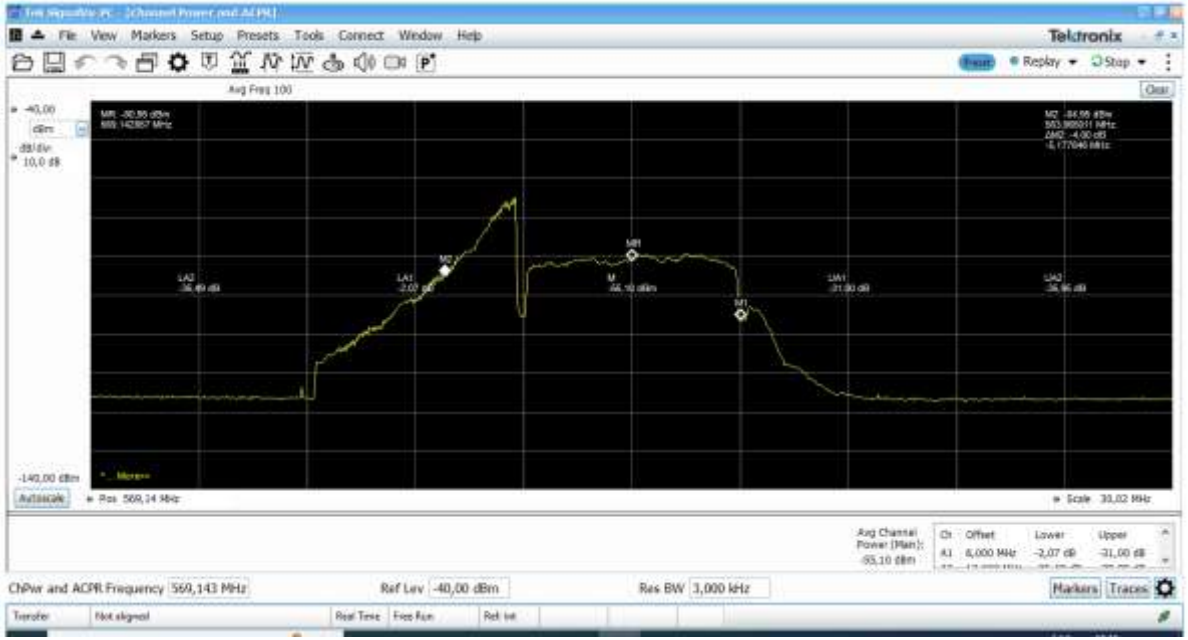


Figure 11.21 - Vertical

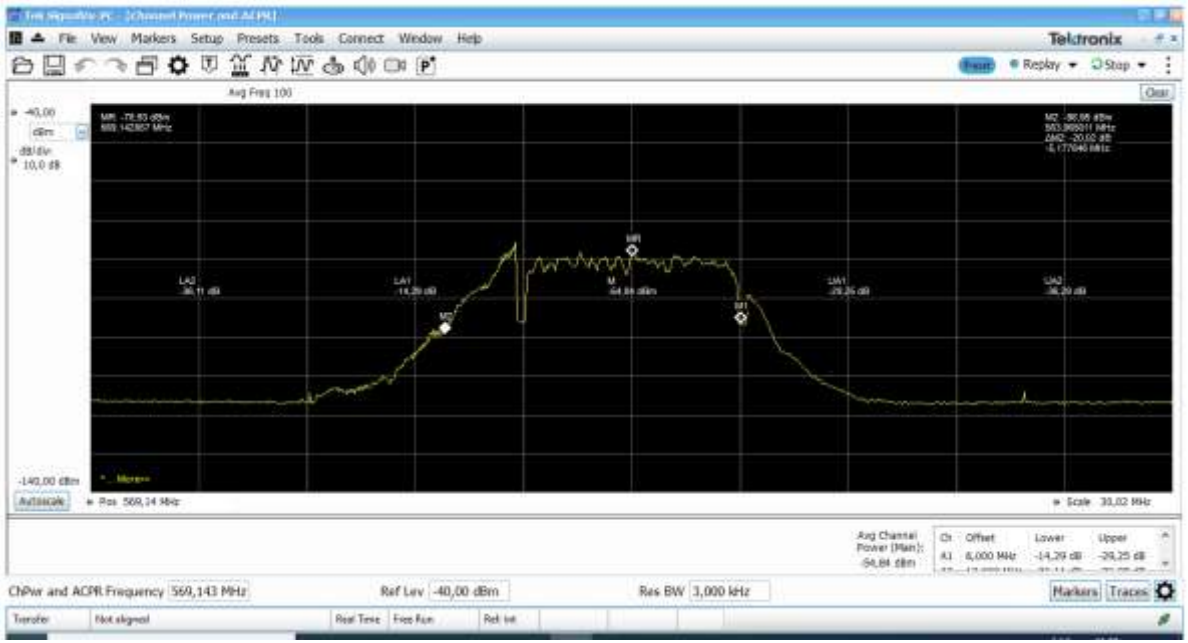


Figure 11.22 - Horizontal

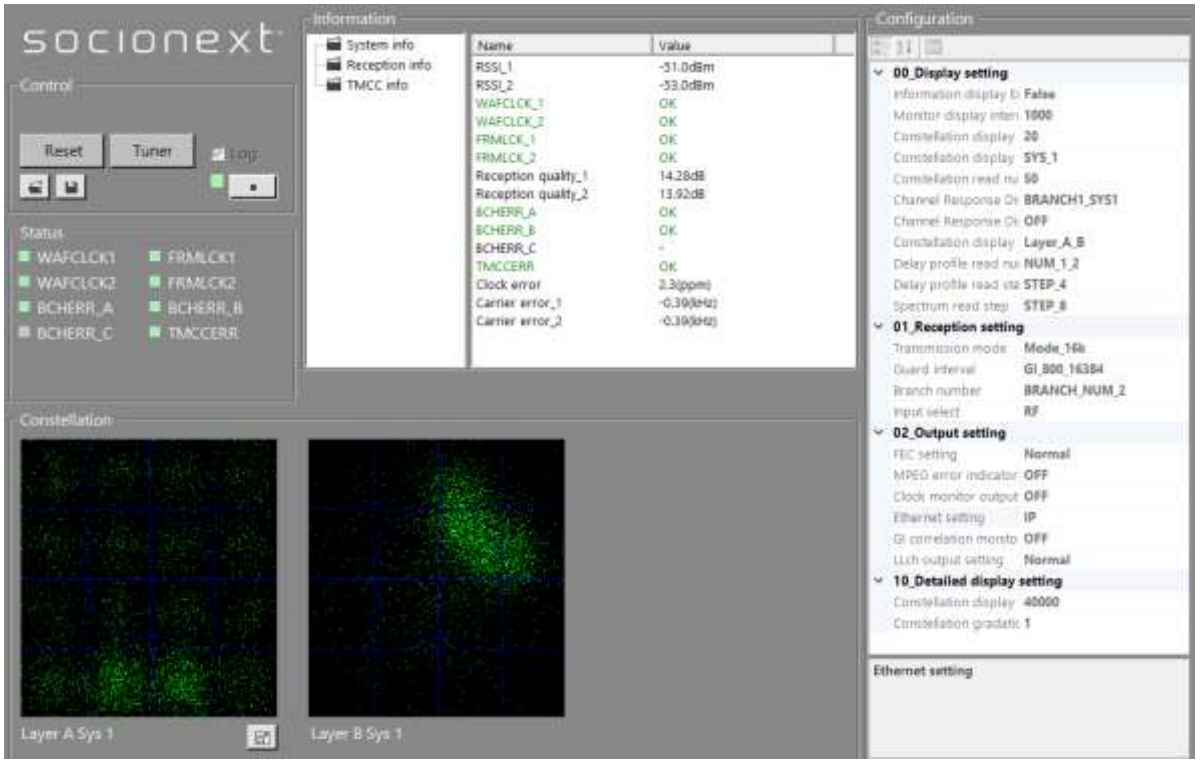


Figure 11.23 - Socionext Screen

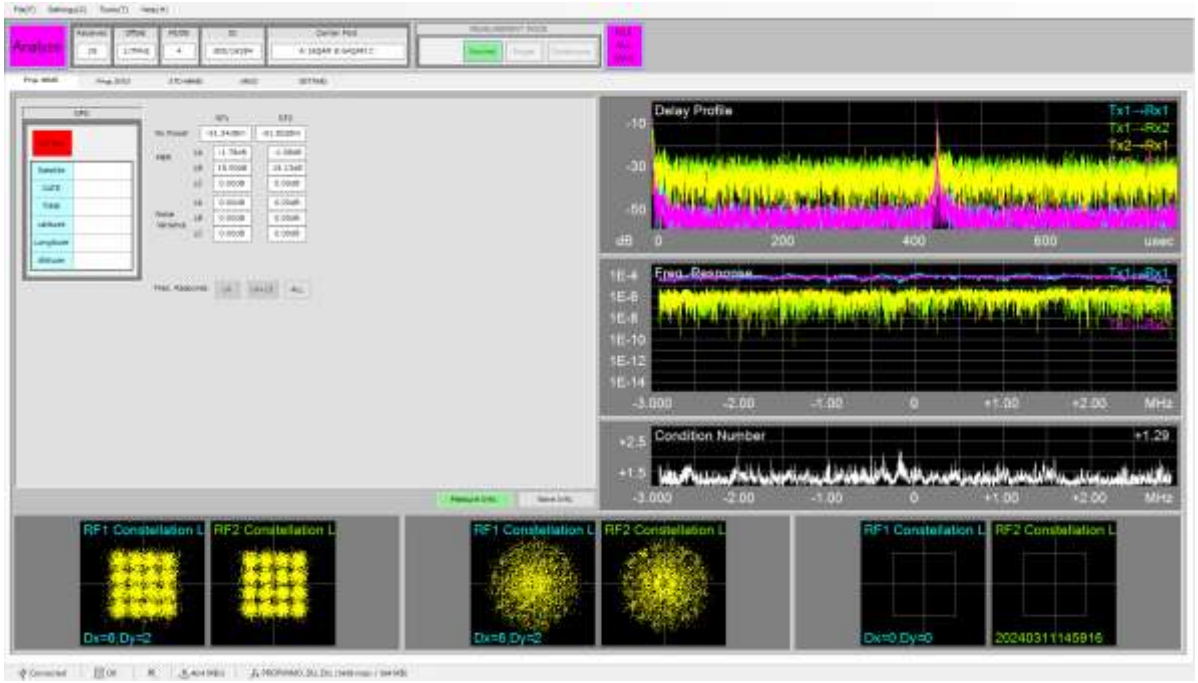


Figure 11.24 - Rintaro Screen

d) Reception Threshold

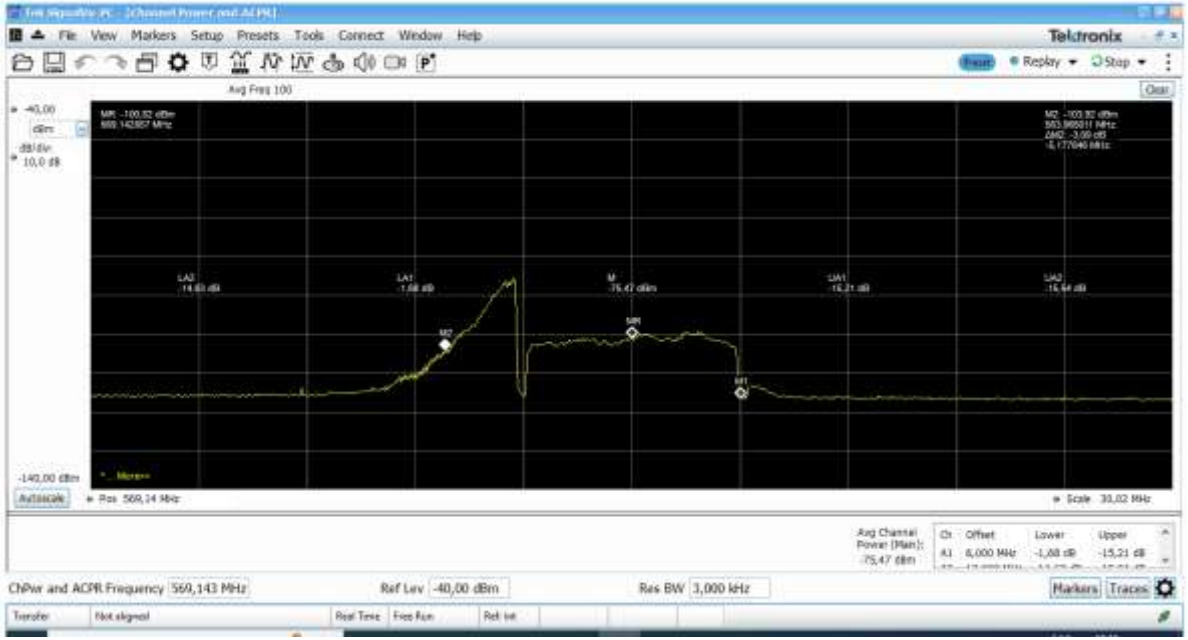


Figure 11.25 - Vertical

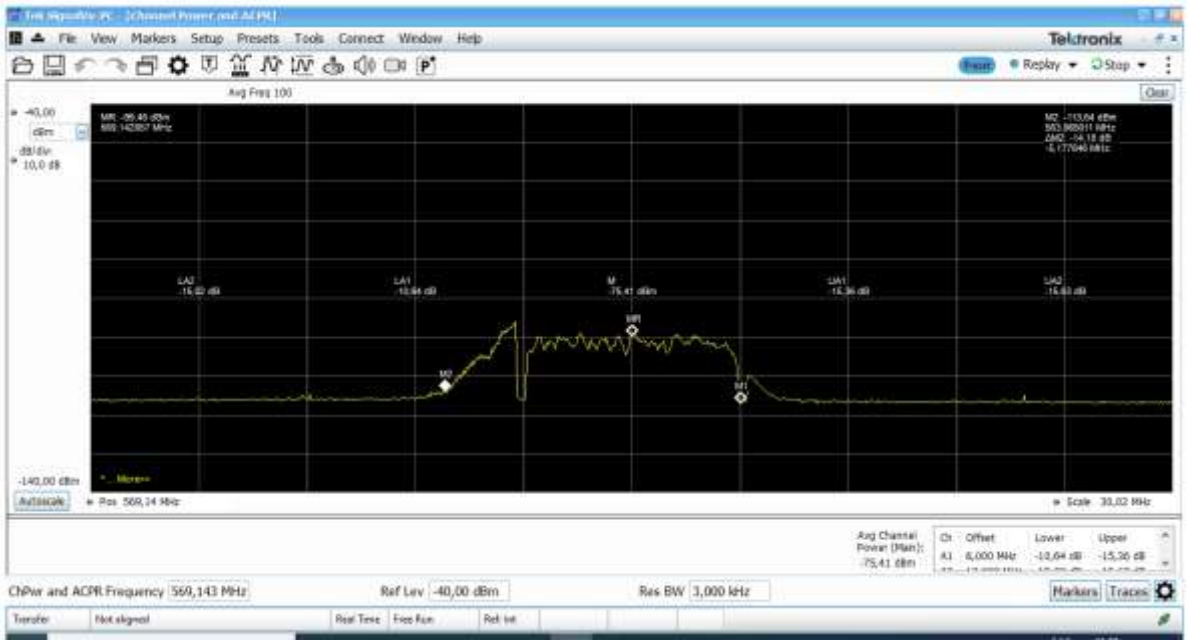


Figure 11.26 - Horizontal

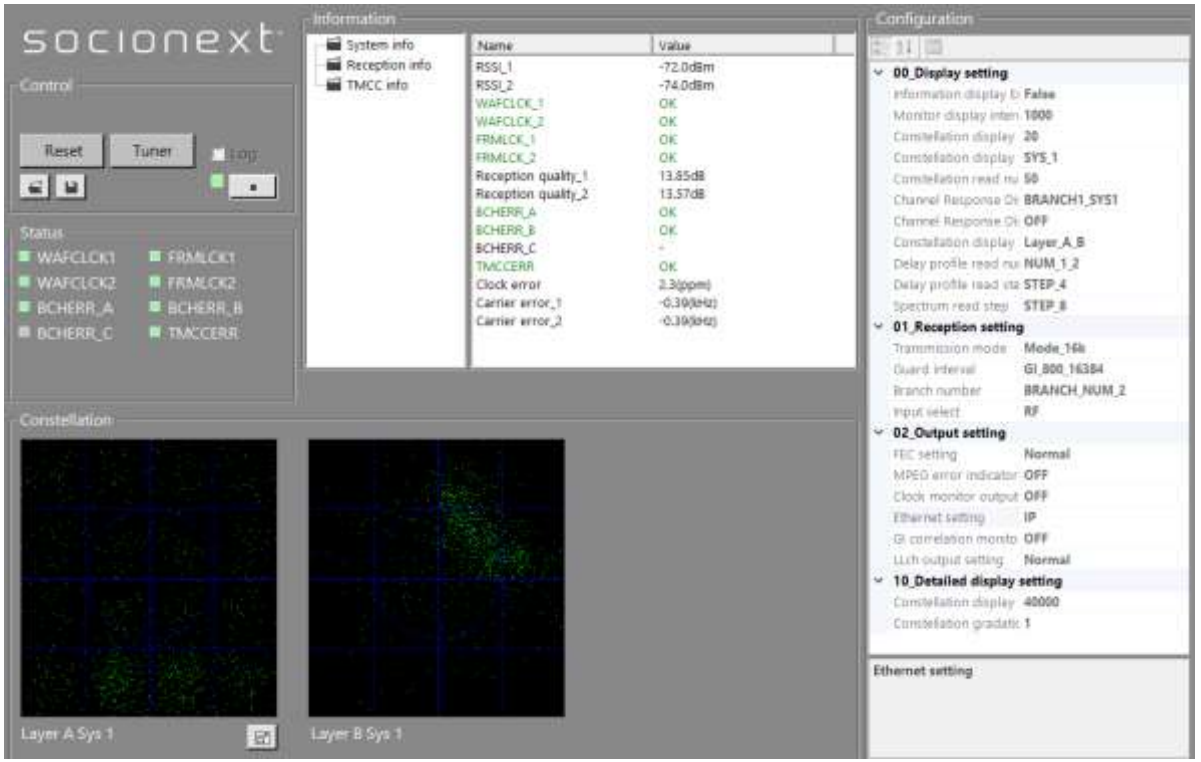


Figure 11.27 - Socionext Screen

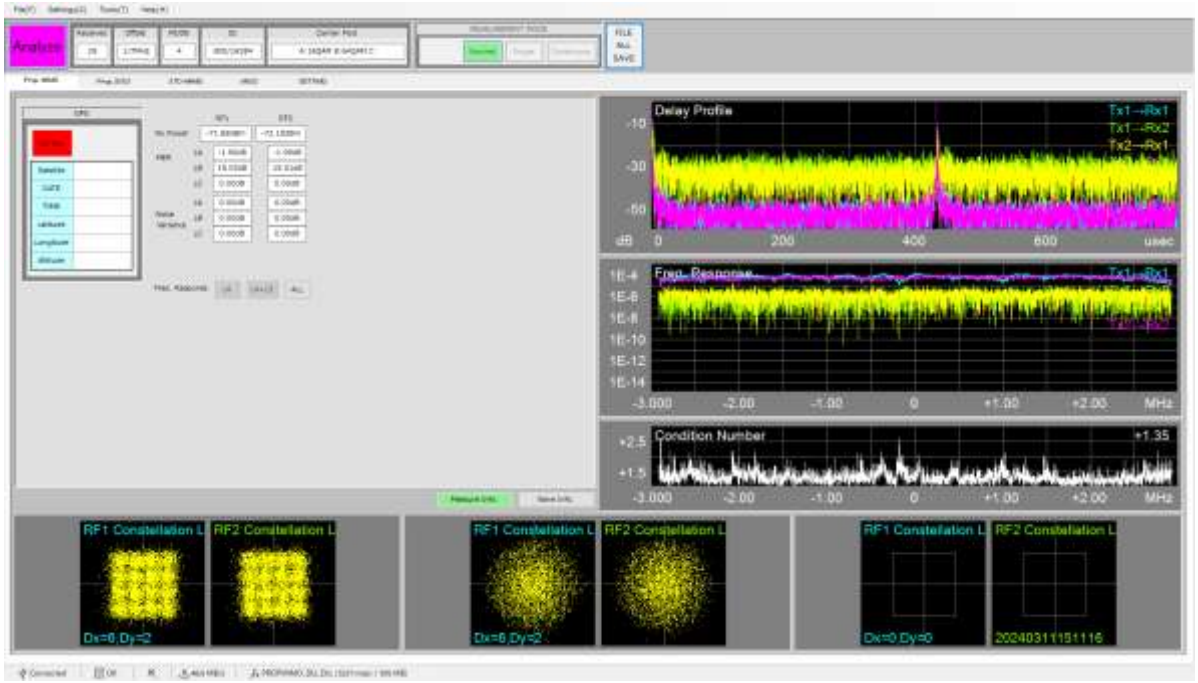


Figure 11.28 - Rintaro Screen

Chapter 12. Site 28

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

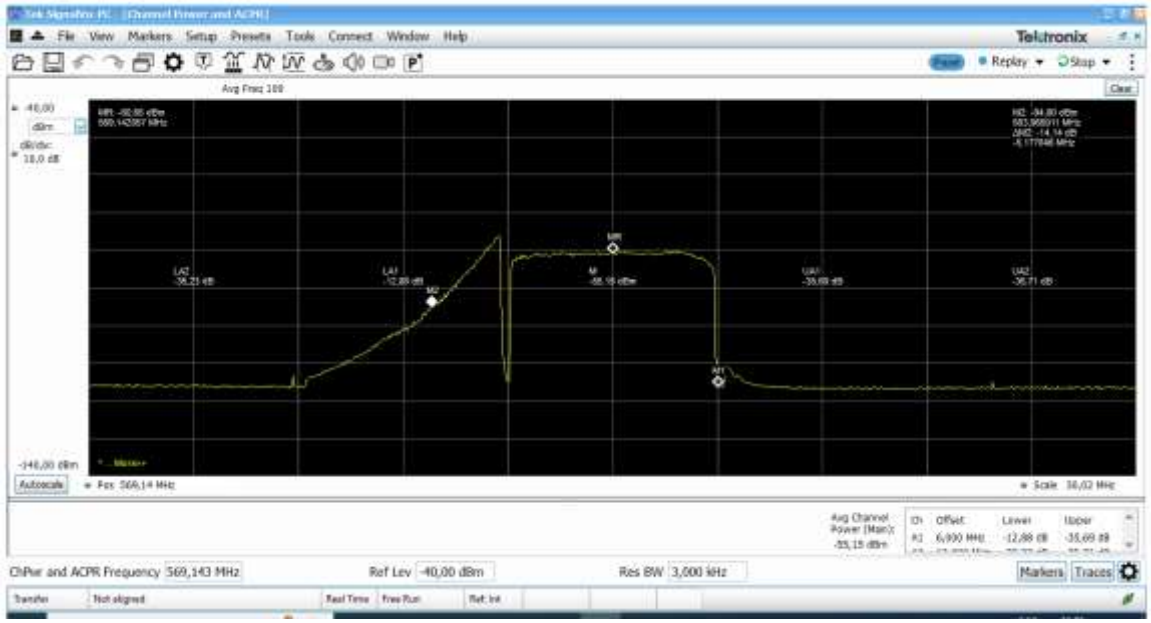


Figure 12.1 - Vertical

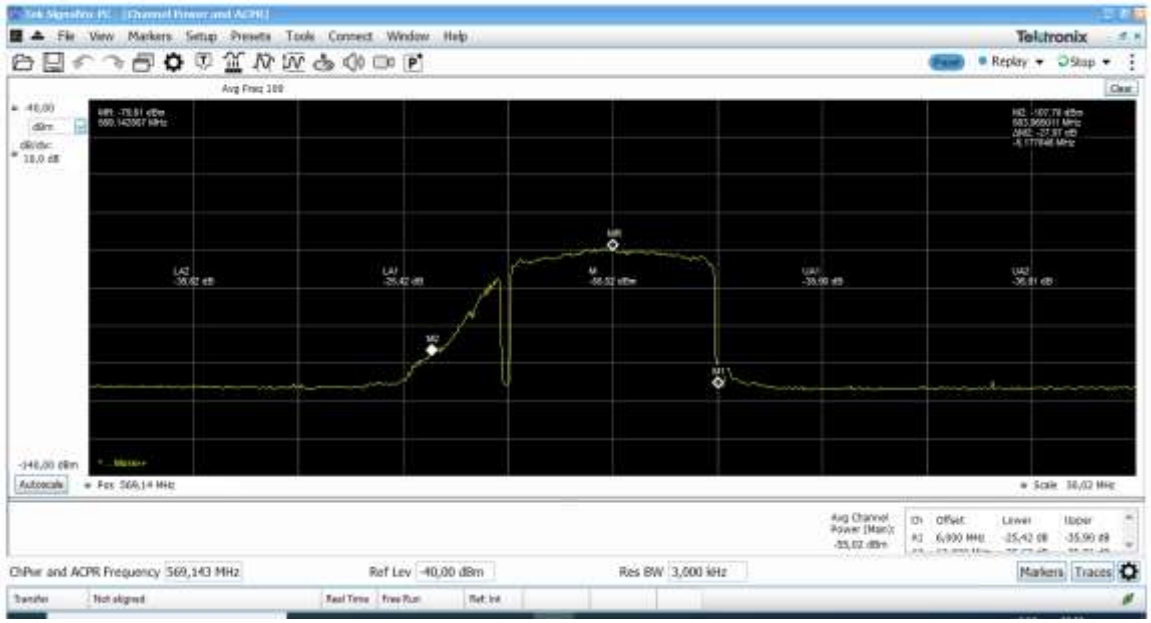


Figure 12.2 - Horizontal

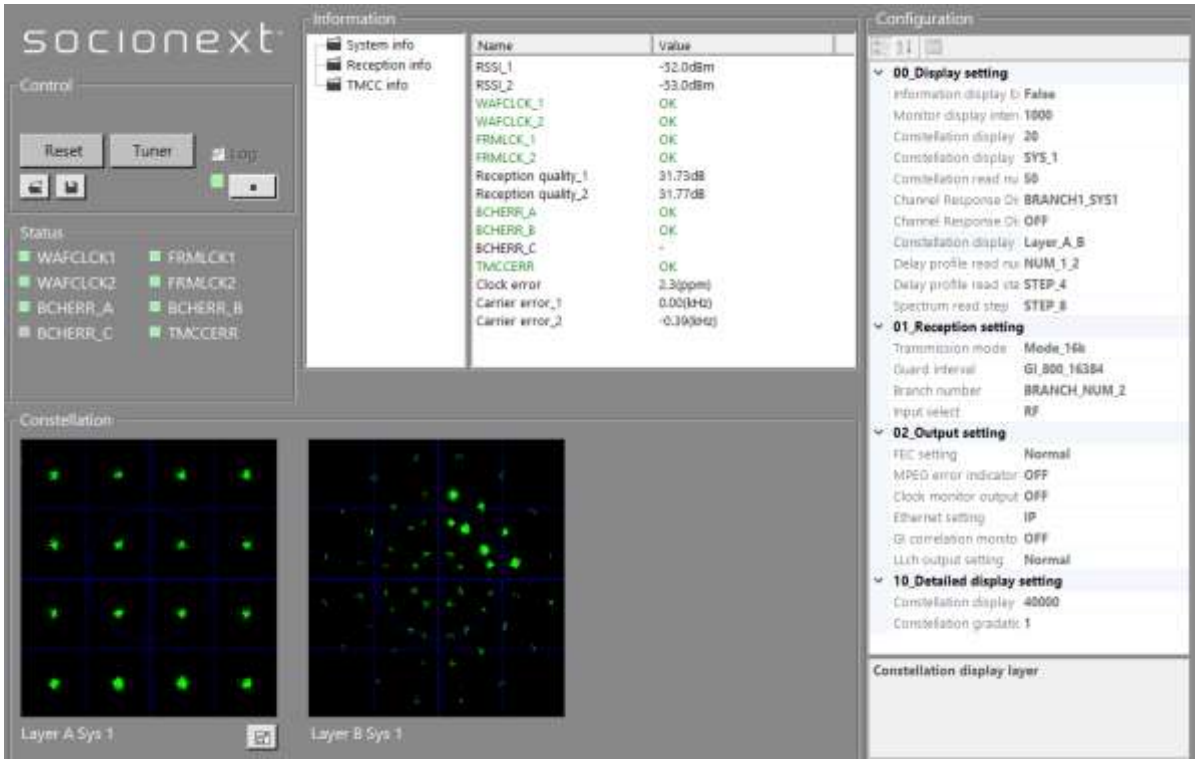


Figure 12.3 - Socionext Screen

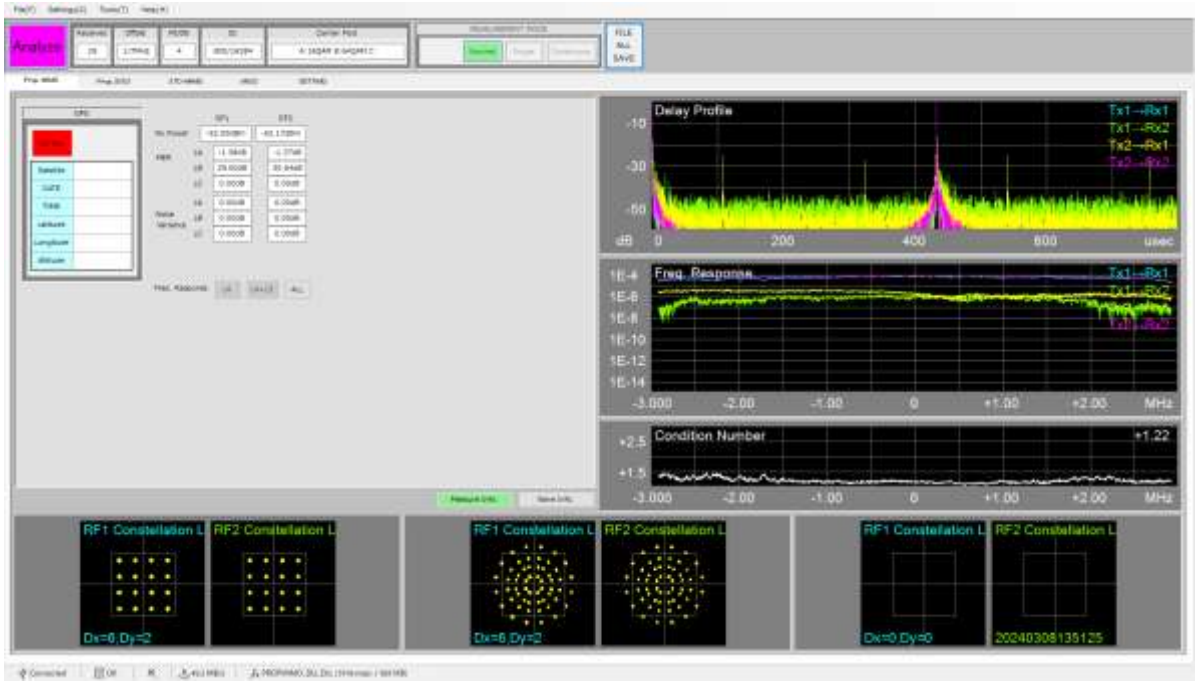


Figure 12.4 - Rintaro Screen

b) AWGN Power

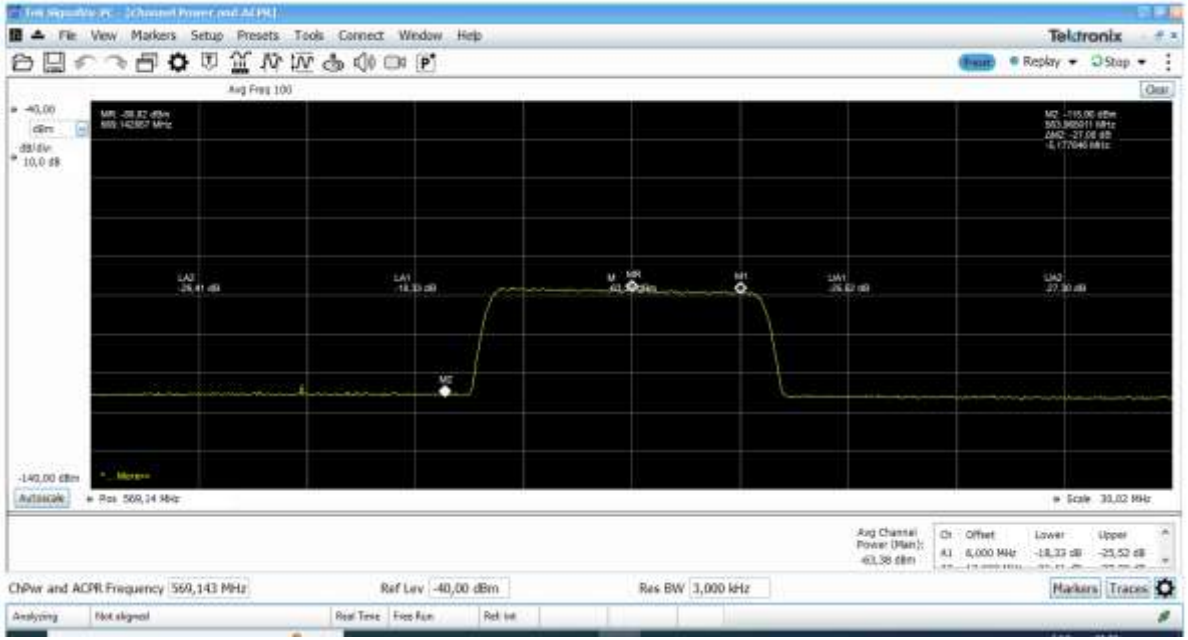


Figure 12.5 - Vertical

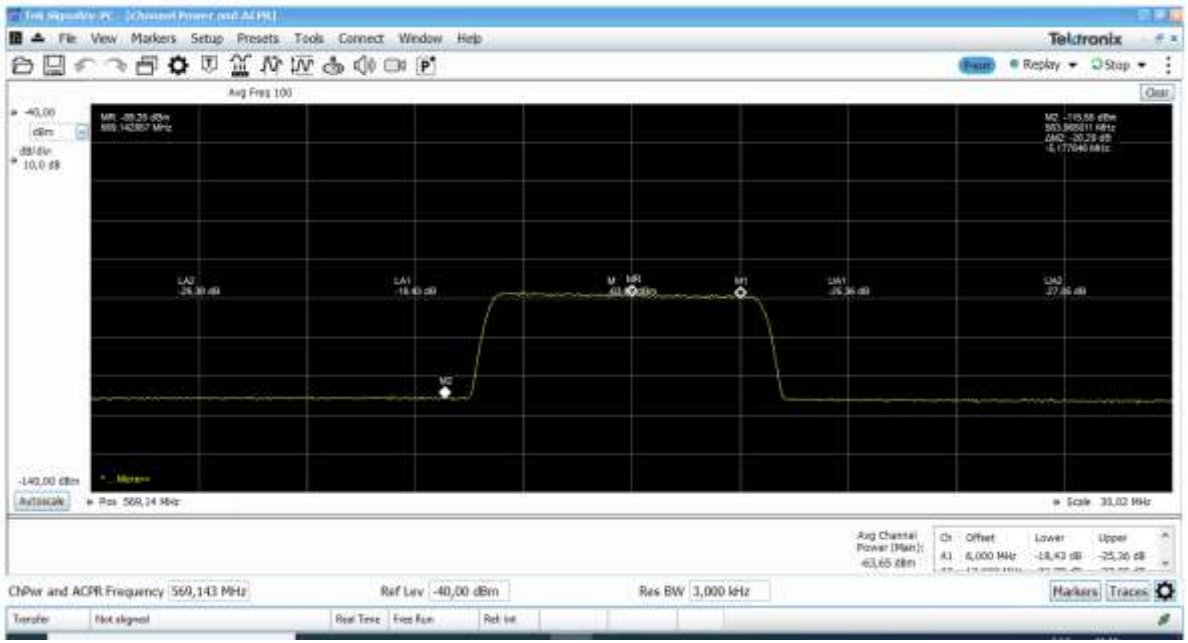


Figure 12.6 - Horizontal

c) C/N Threshold

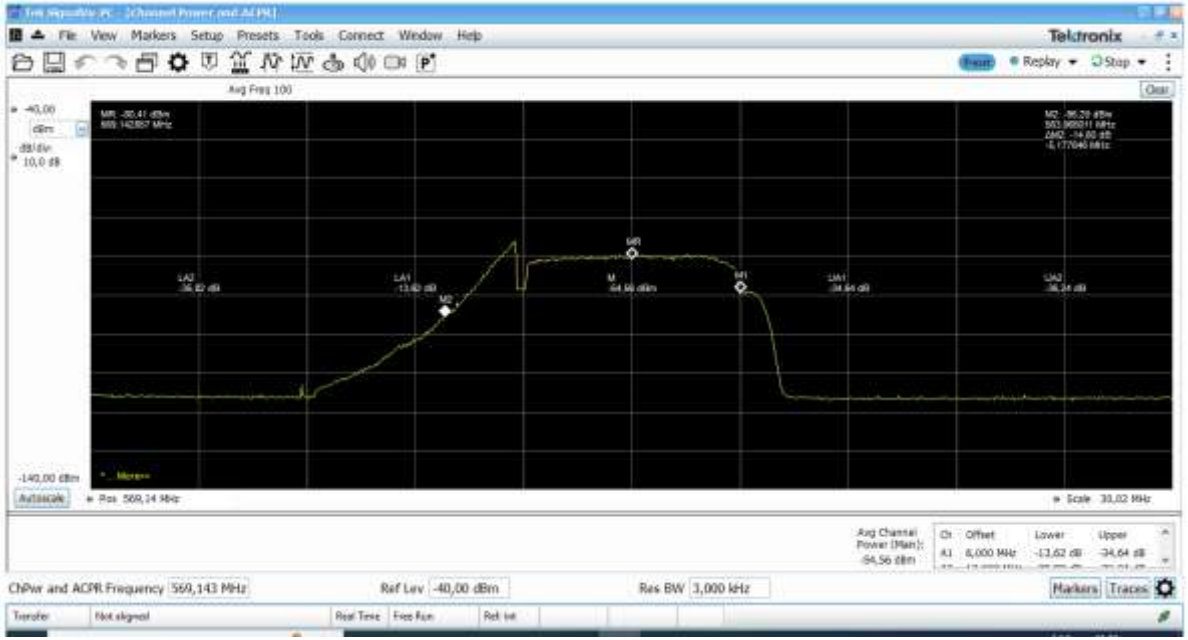


Figure 12.7 - Vertical

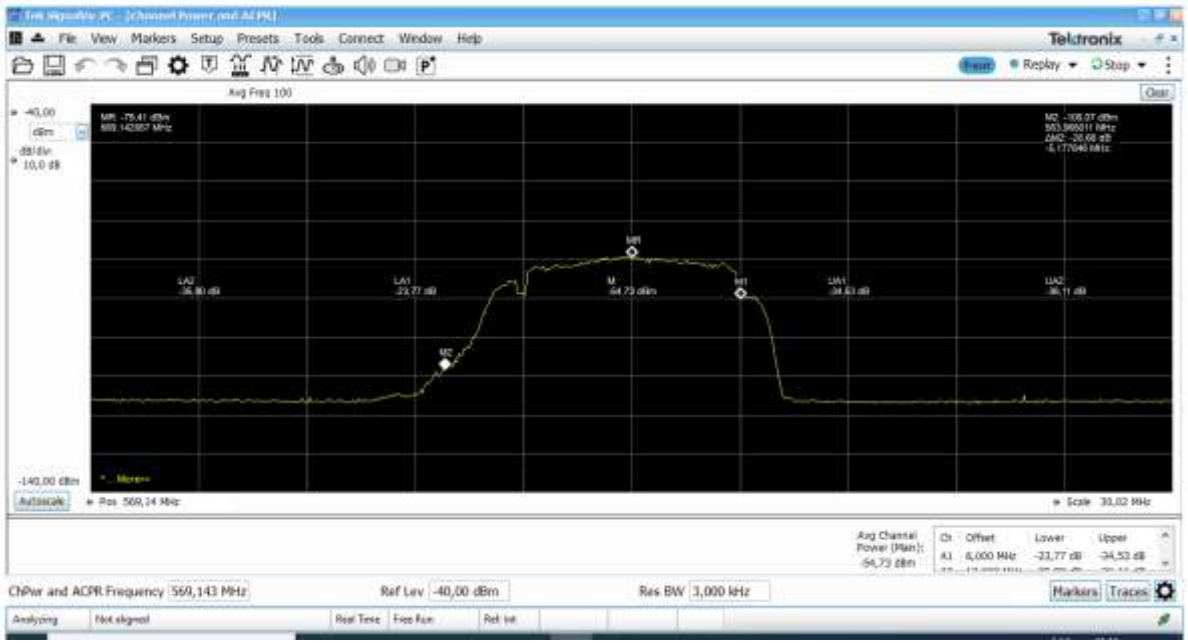


Figure 12.8 - Horizontal

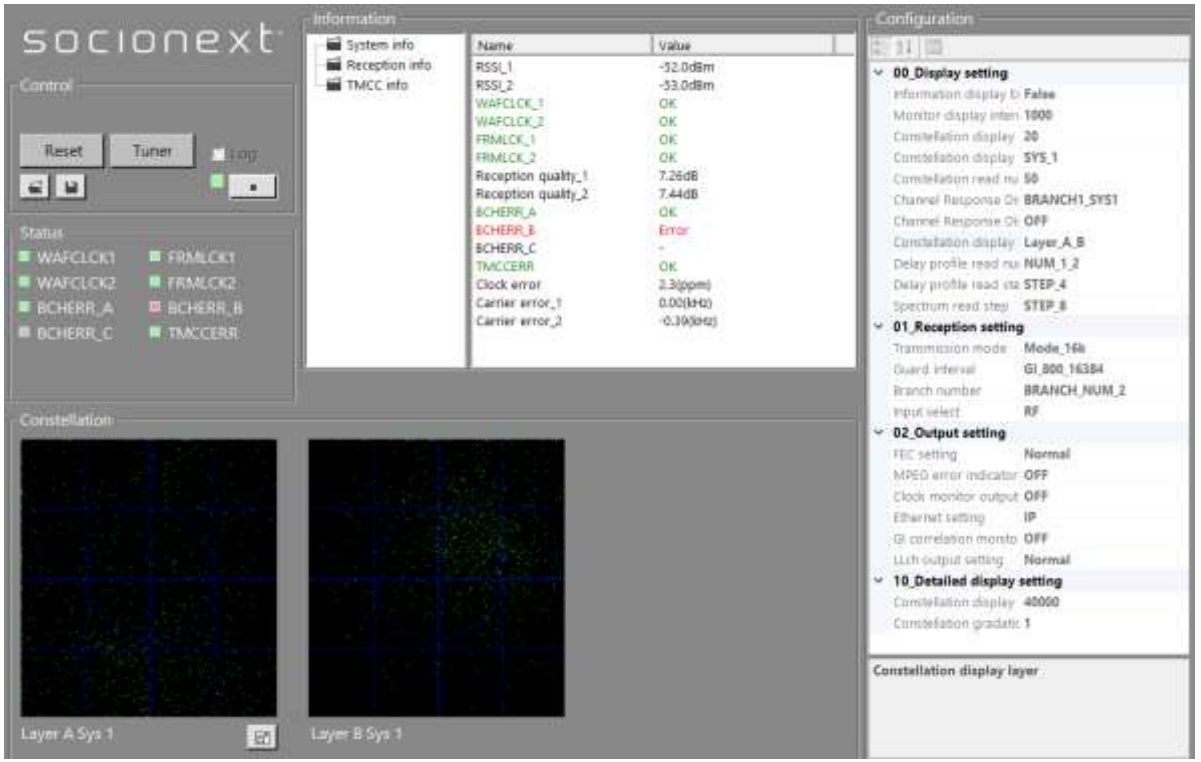


Figure 12.9 - Socionext Screen

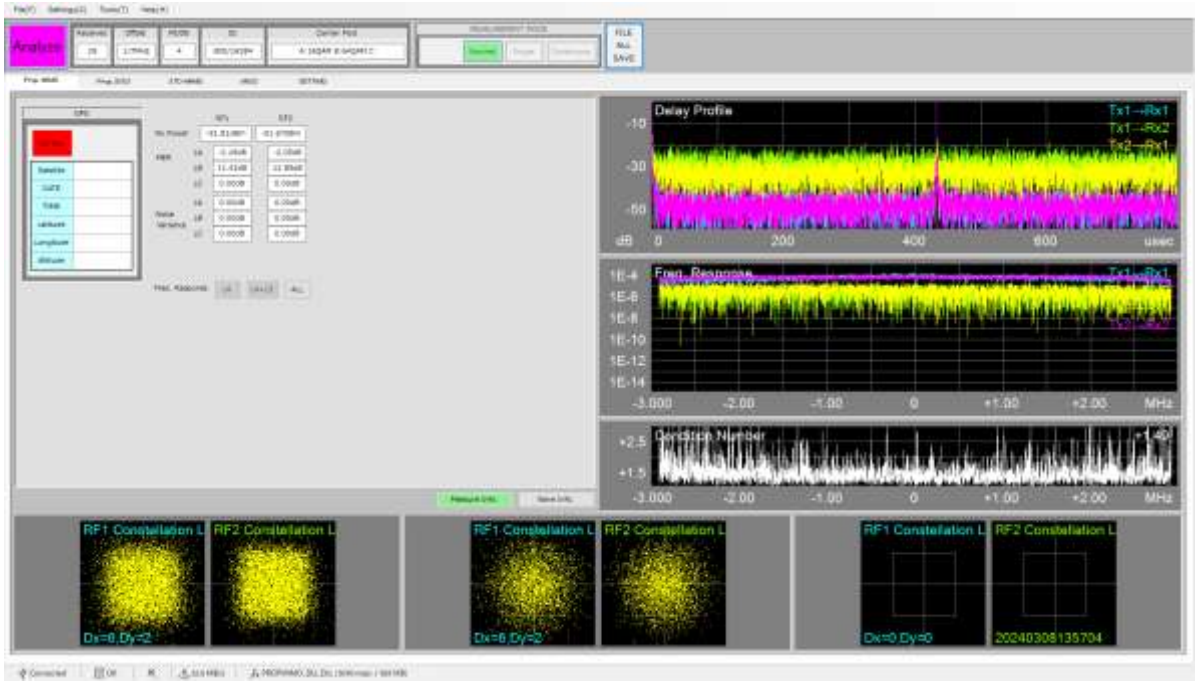


Figure 12.10 - Rintaro Screen

d) Reception Threshold

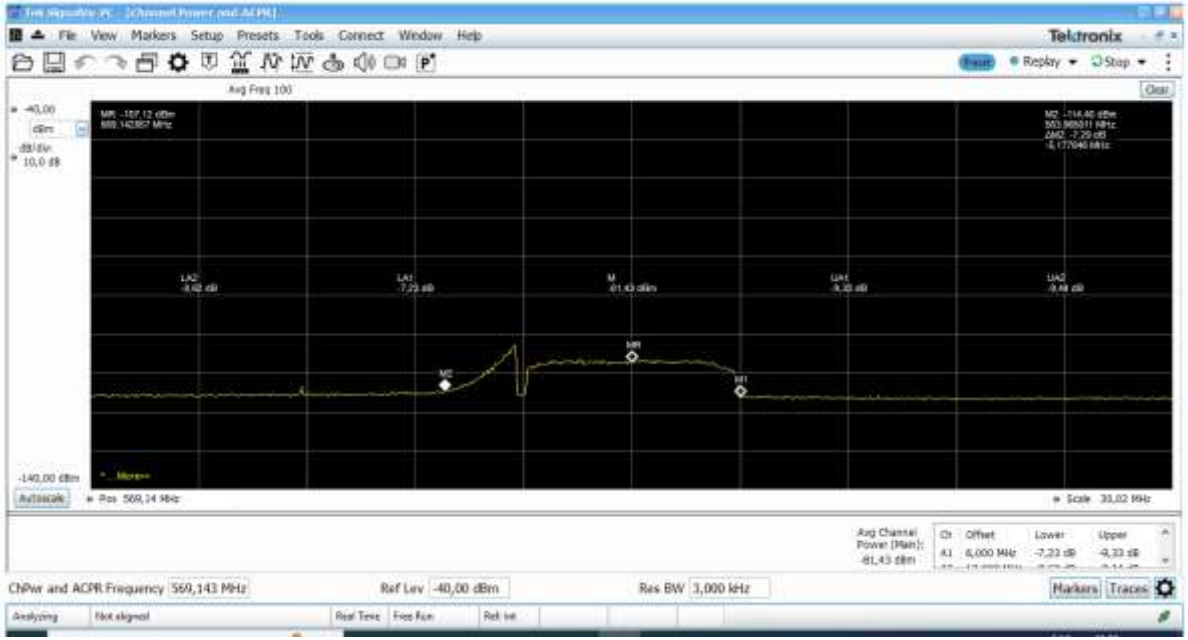


Figure 12.11 - Vertical

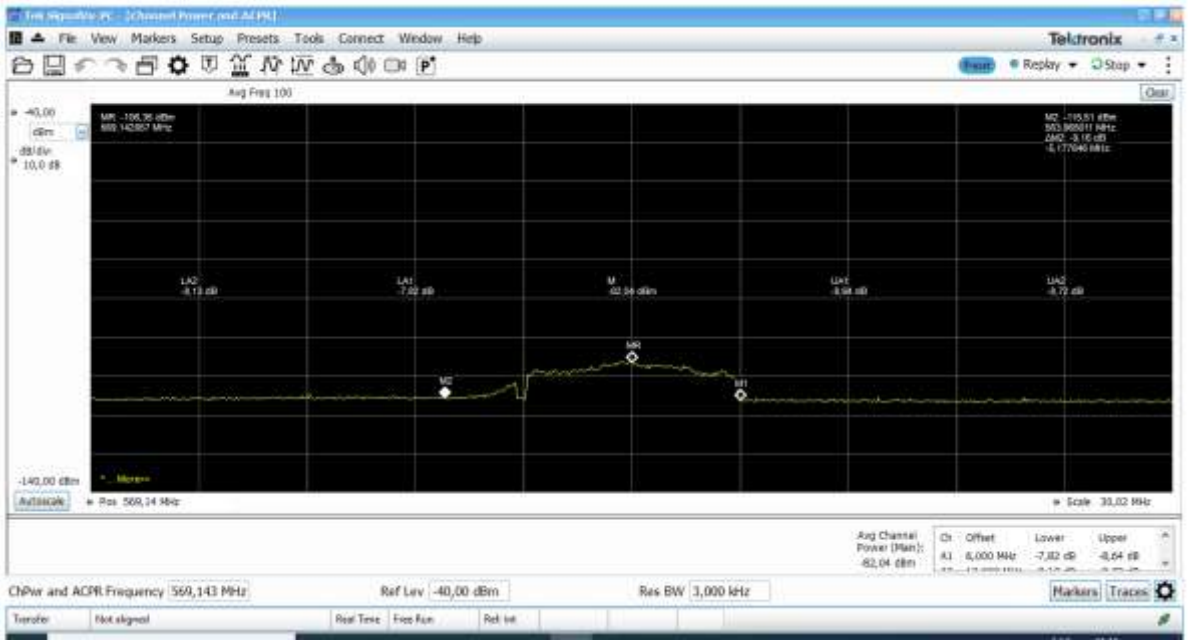


Figure 12.12 - Horizontal

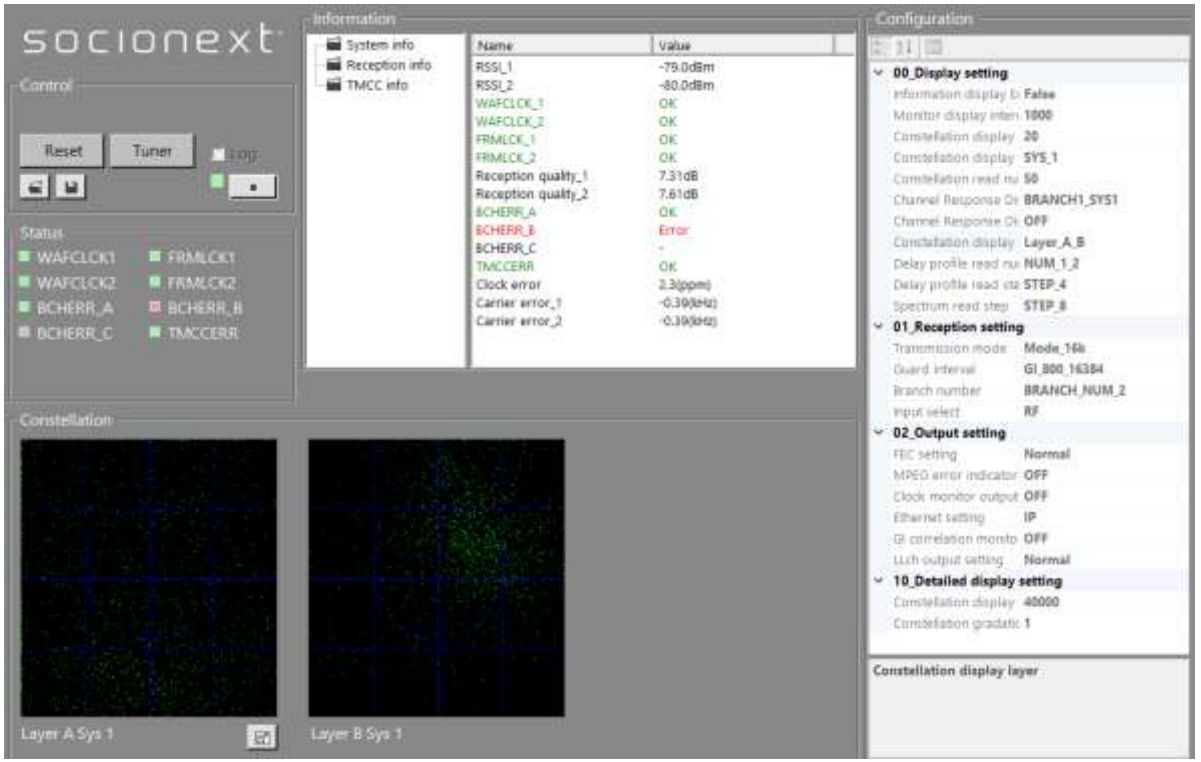


Figure 12.13 - Socionext Screen

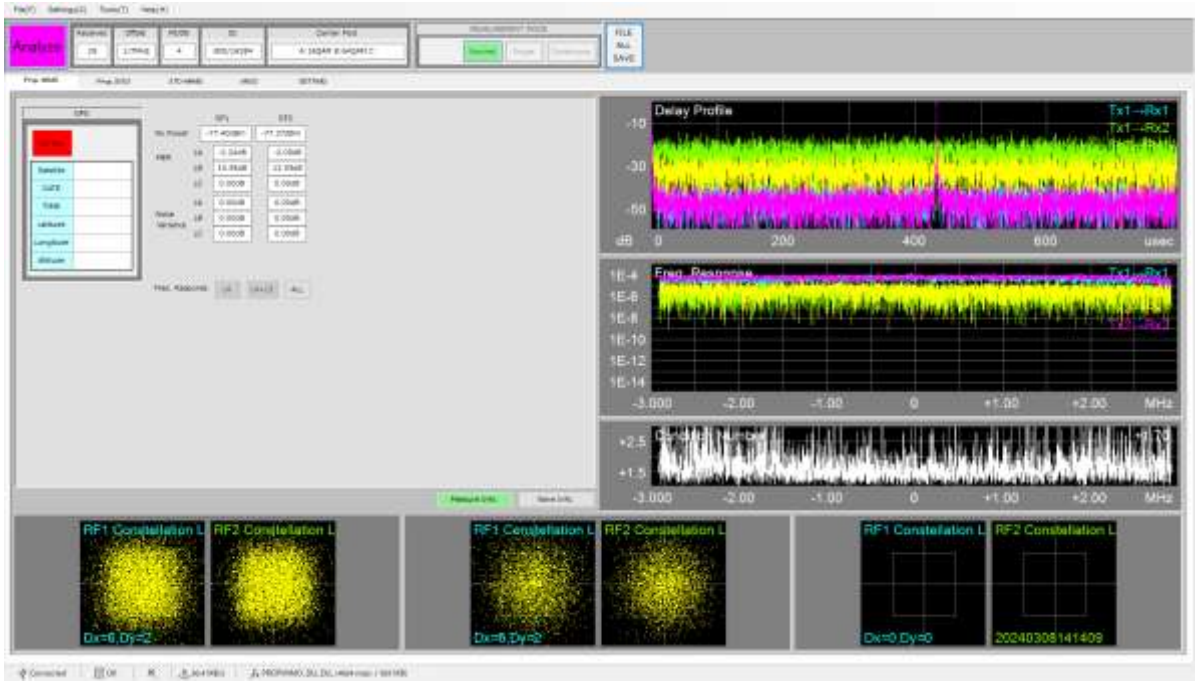


Figure 12.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

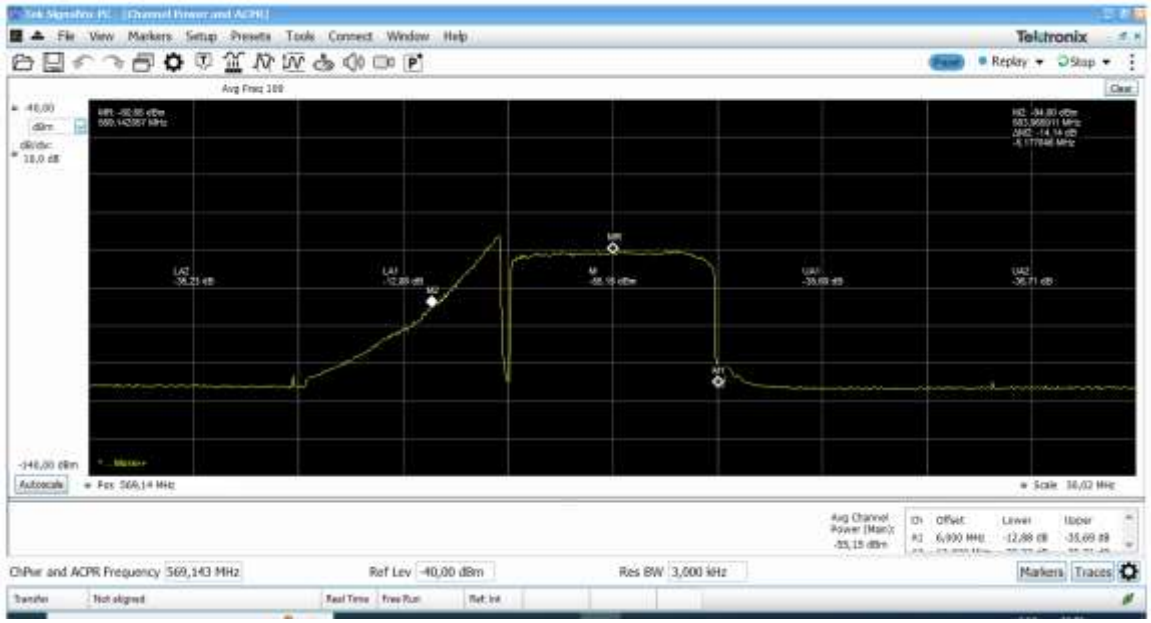


Figure 12.15 - Vertical

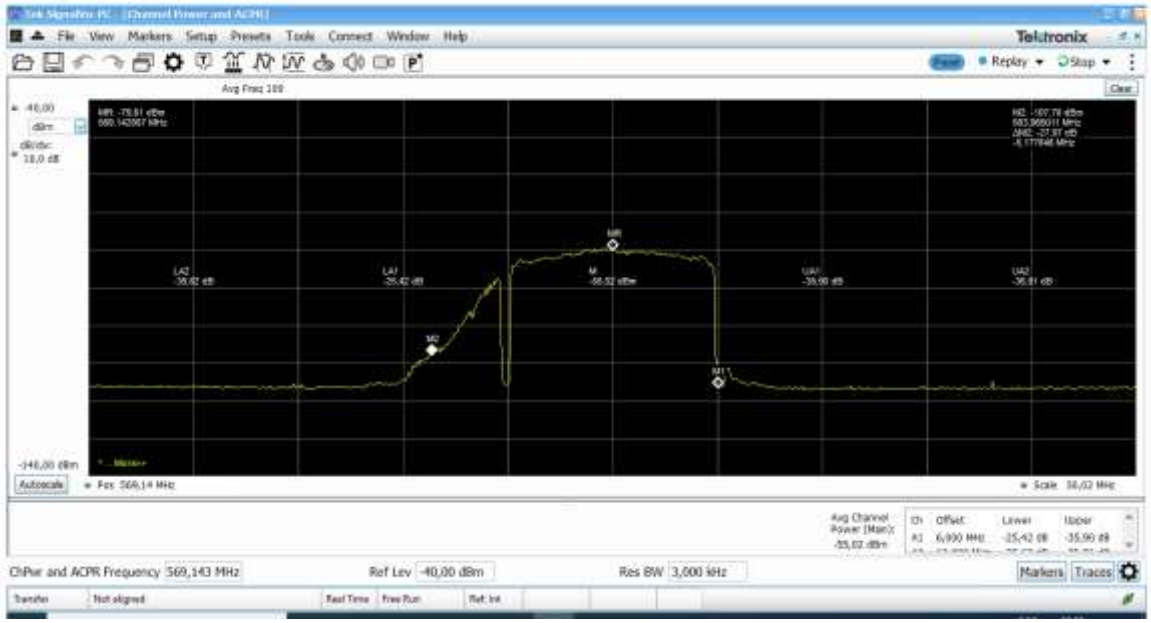


Figure 12.16 - Horizontal

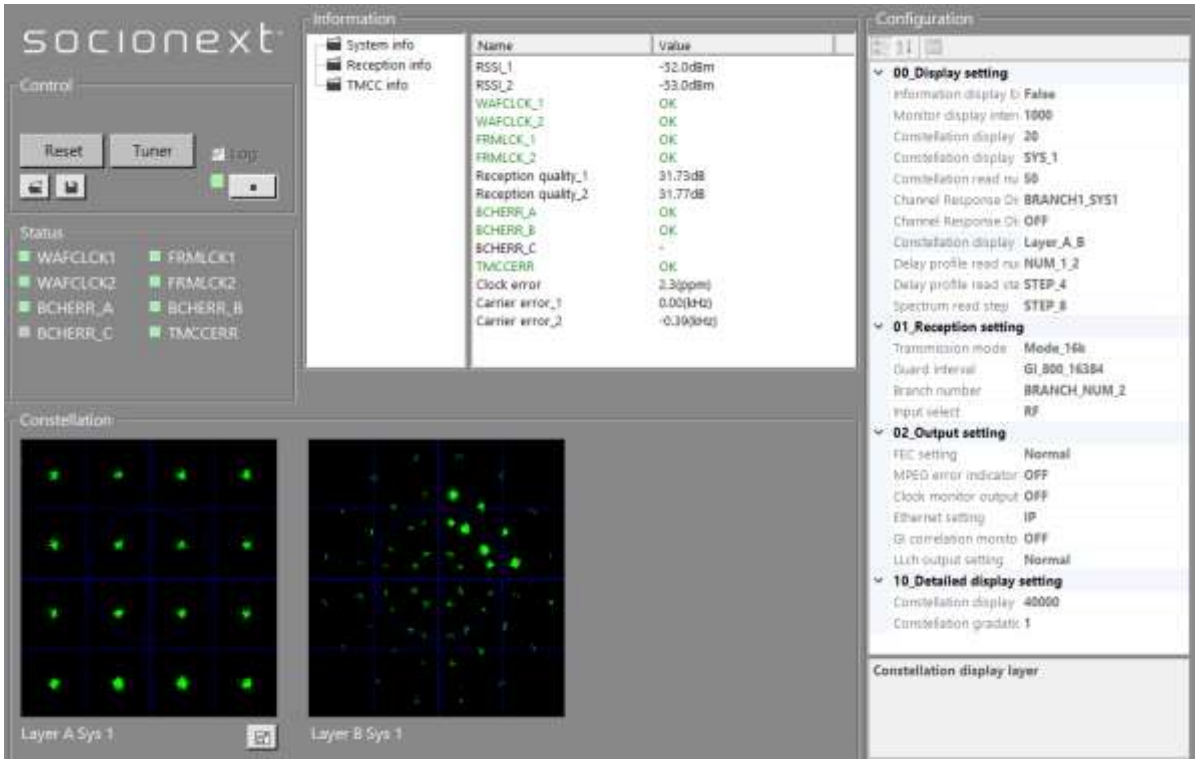


Figure 12.17 - Socionext Screen

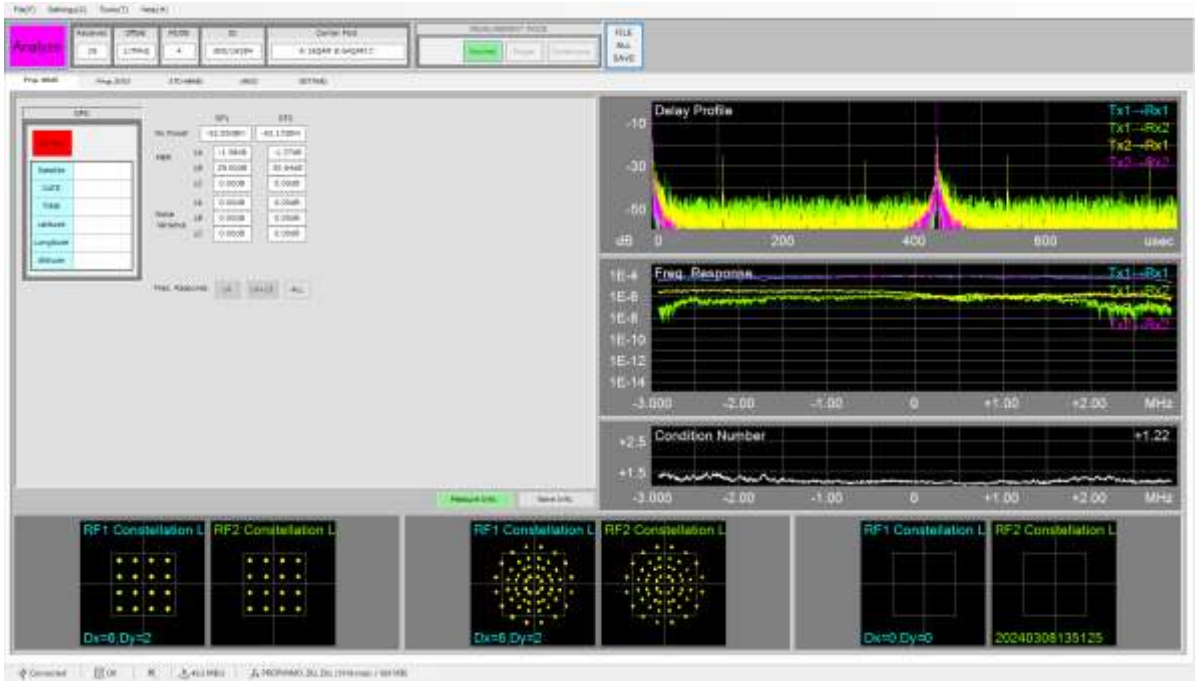


Figure 12.18 - Rintaro Screen

b) AWGN Power

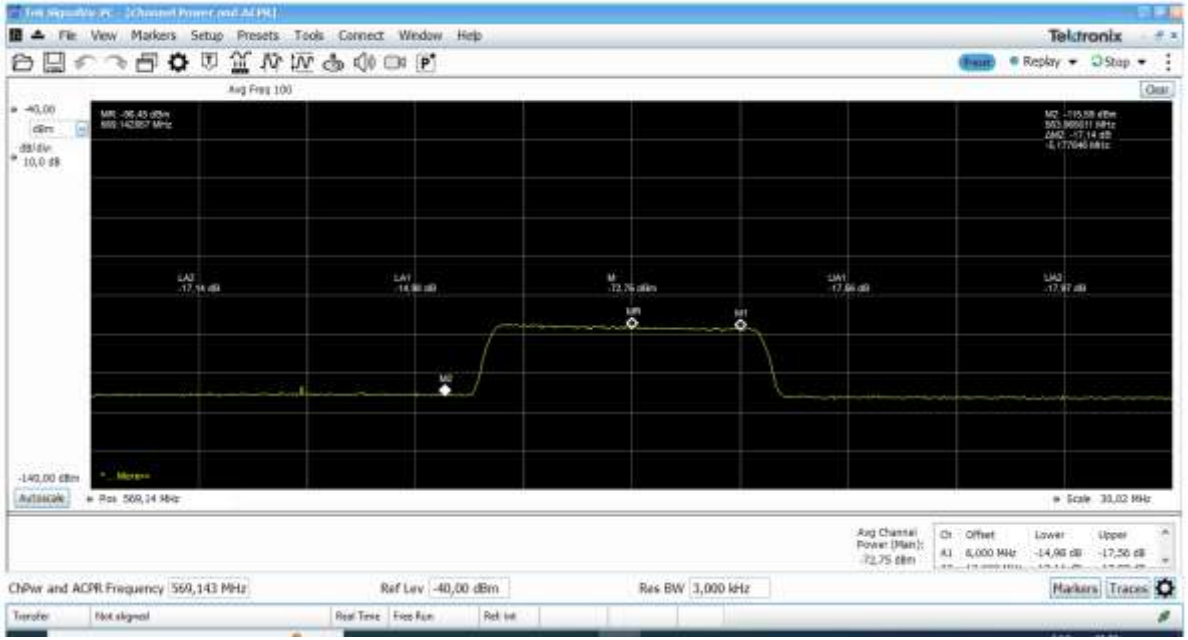


Figure 12.19 - Vertical

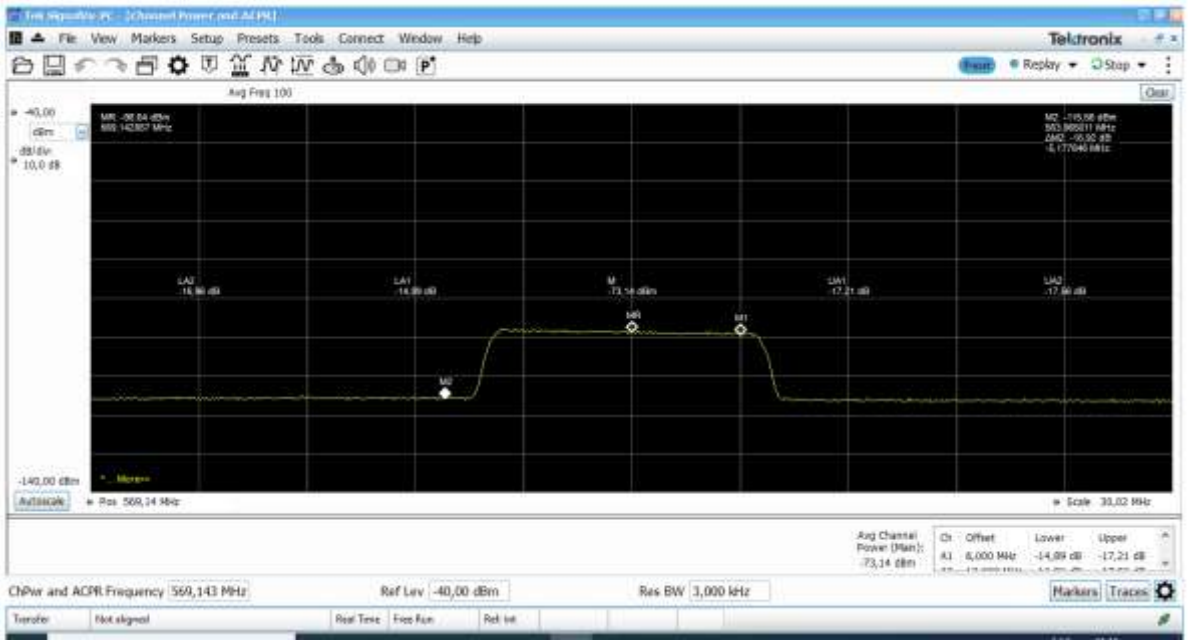


Figure 12.20 - Horizontal

c) C/N Threshold

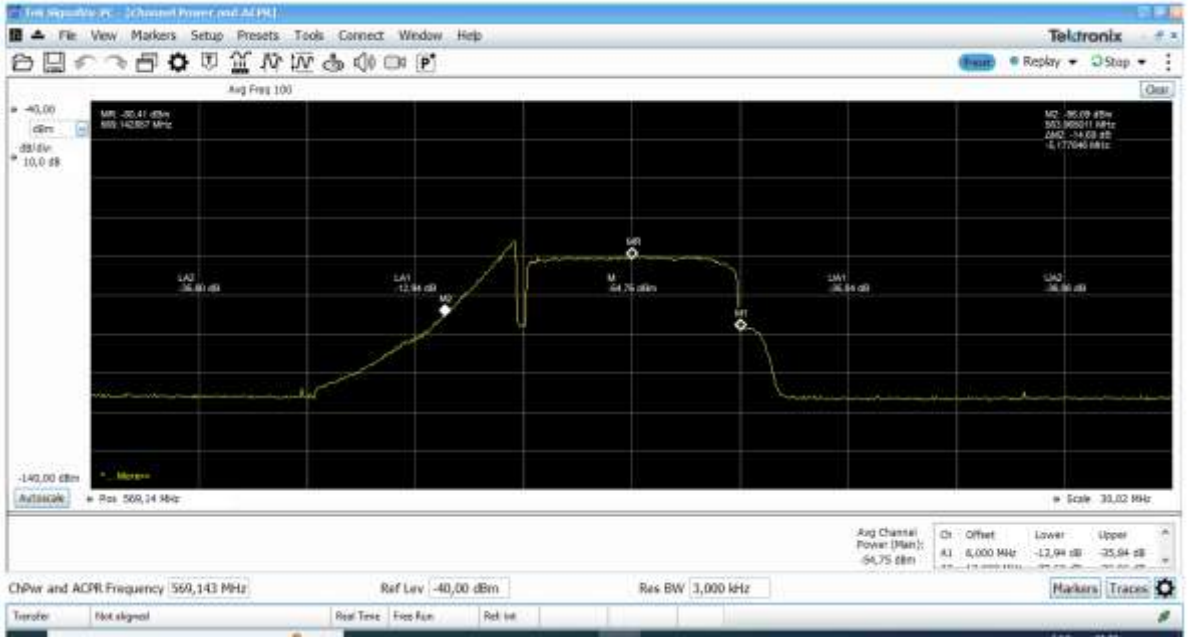


Figure 12.21 - Vertical

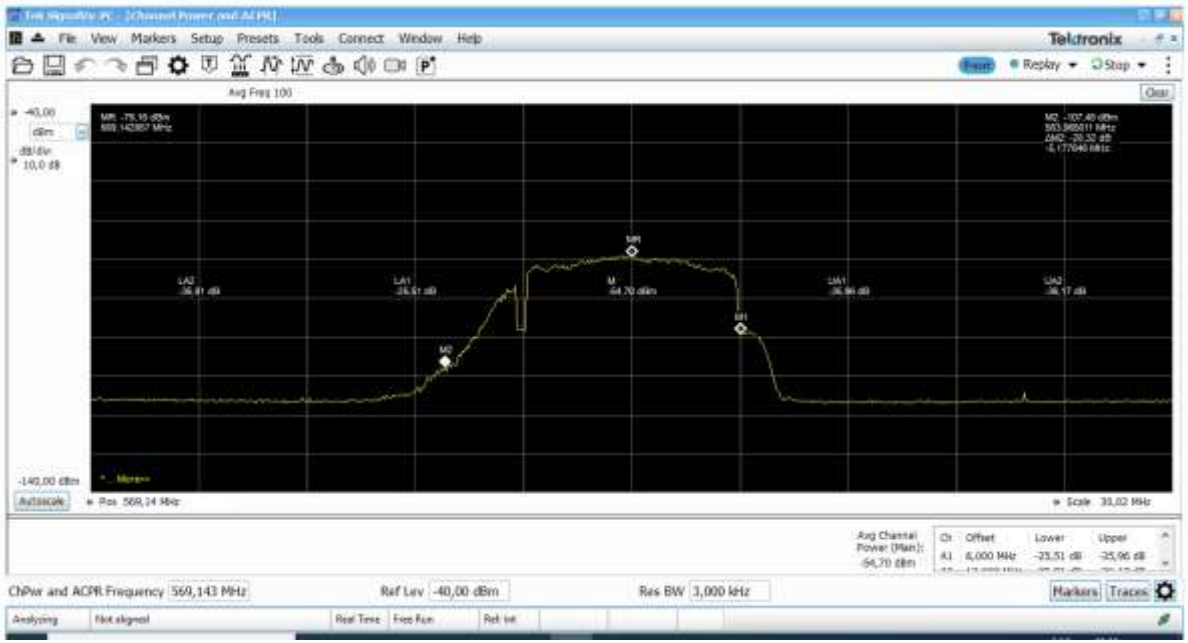


Figure 12.22 - Horizontal

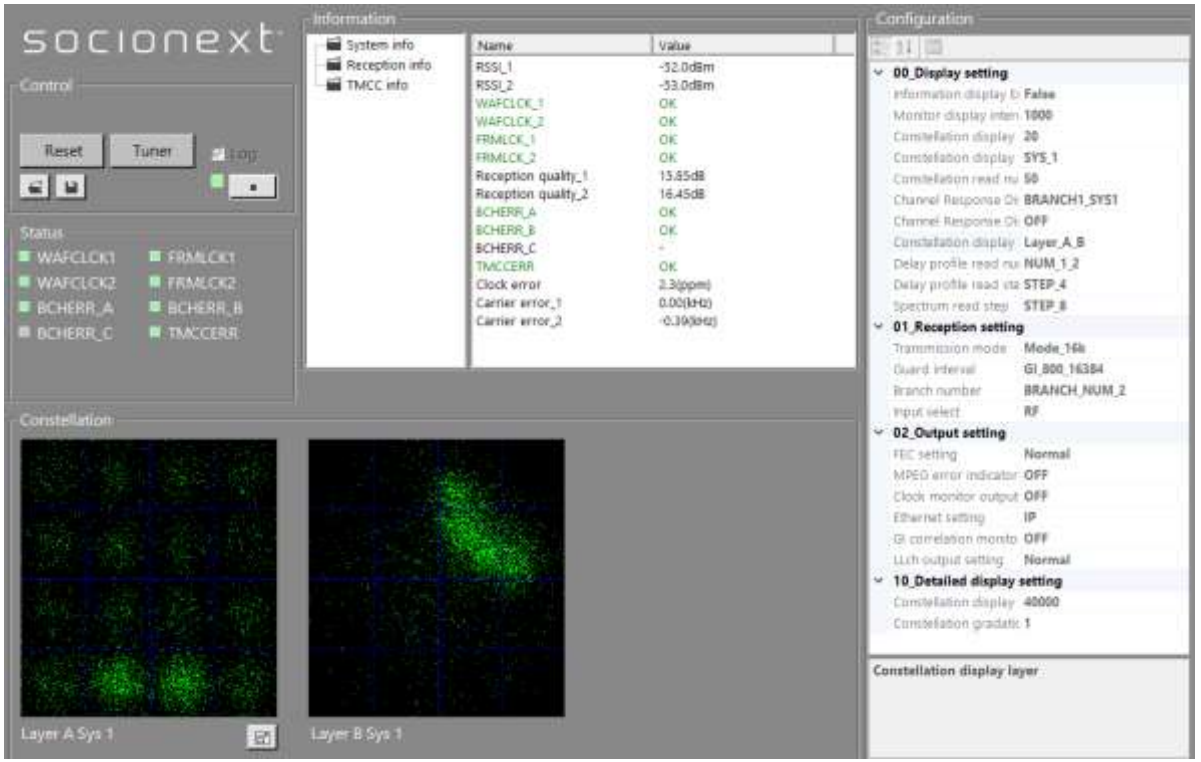


Figure 12.23 - Socionext Screen

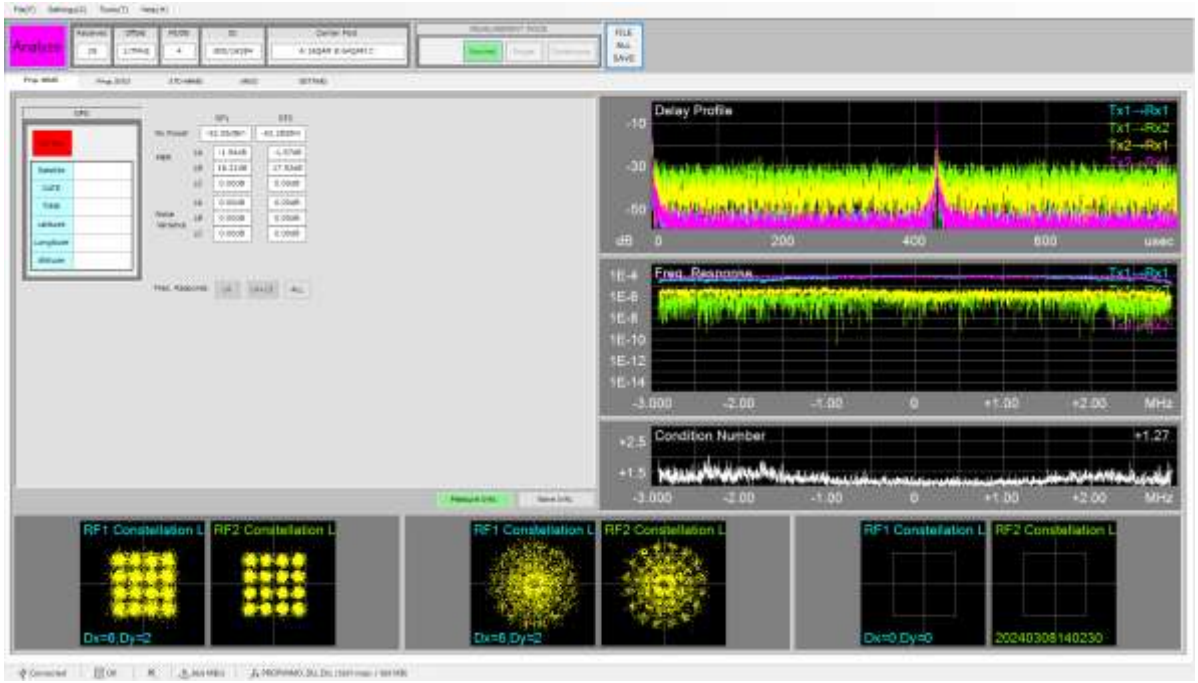


Figure 12.24 - Rintaro Screen

d) Reception Threshold

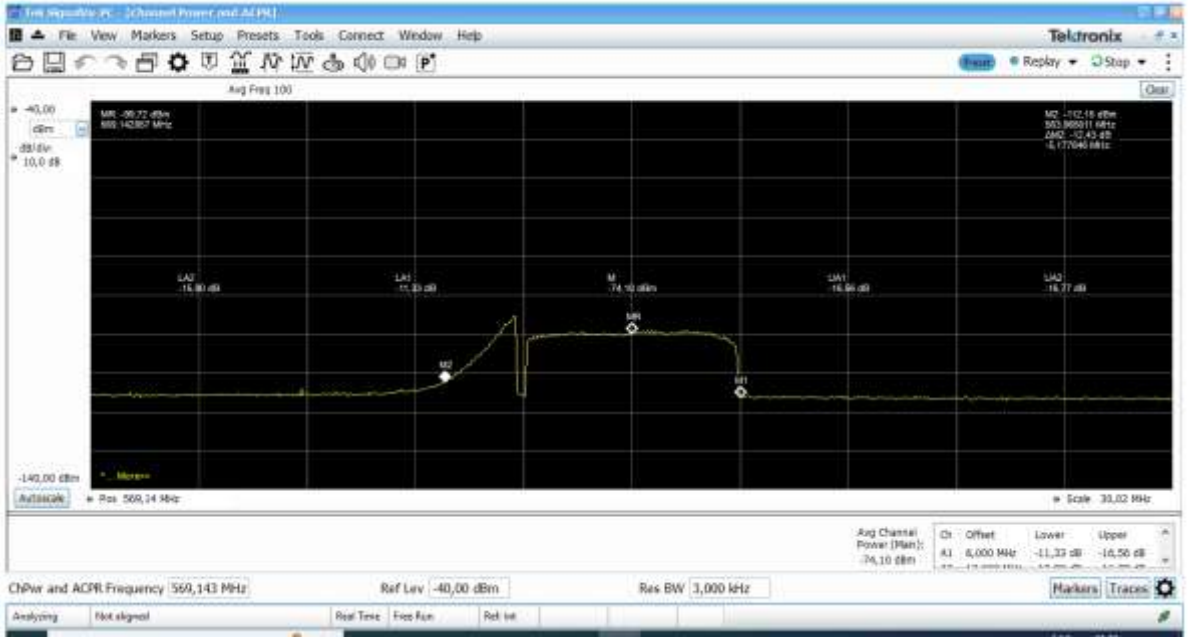


Figure 12.25 - Vertical

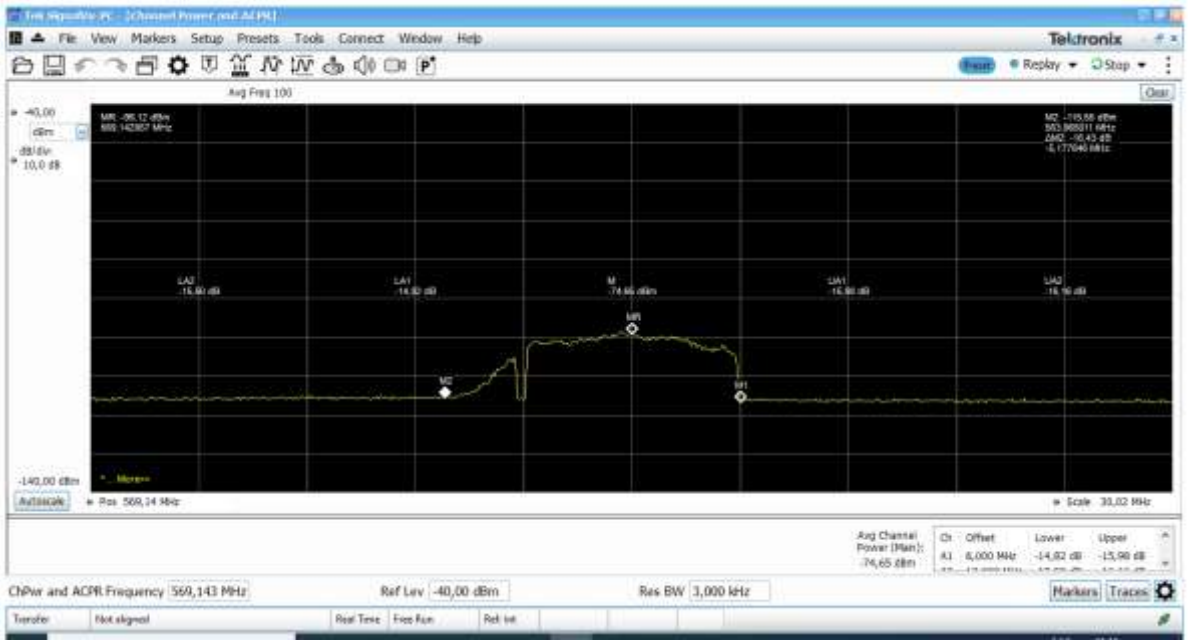


Figure 12.26 - Horizontal

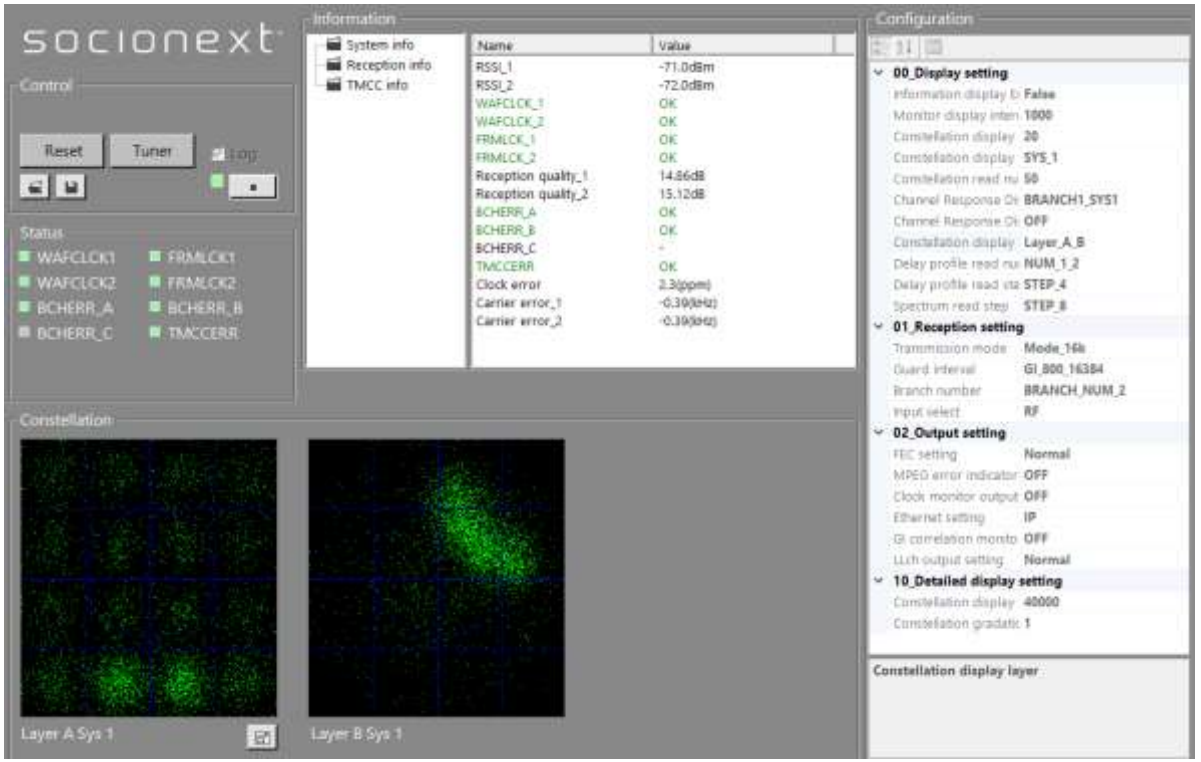


Figure 12.27 - Socionext Screen

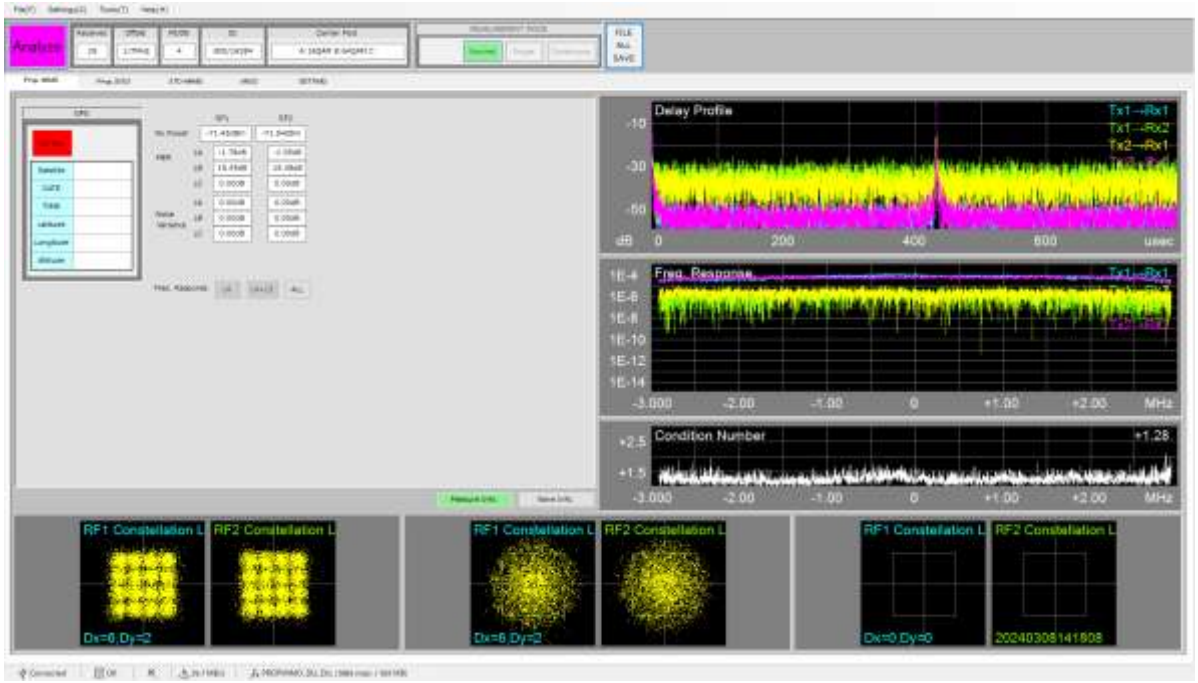


Figure 12.28 - Rintaro Screen

Appendix VI. Extra indoor measurements using Advanced ISDB-T - Configuration 3 - Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps; Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

Chapter 1. Site 1

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

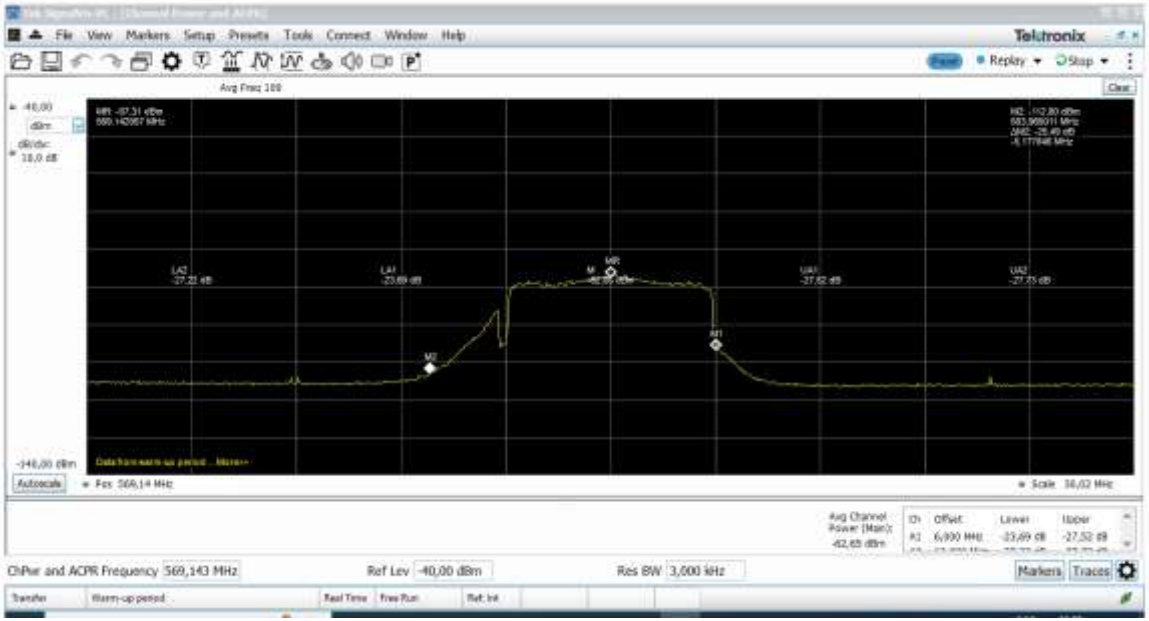


Figure 1.1 - Vertical

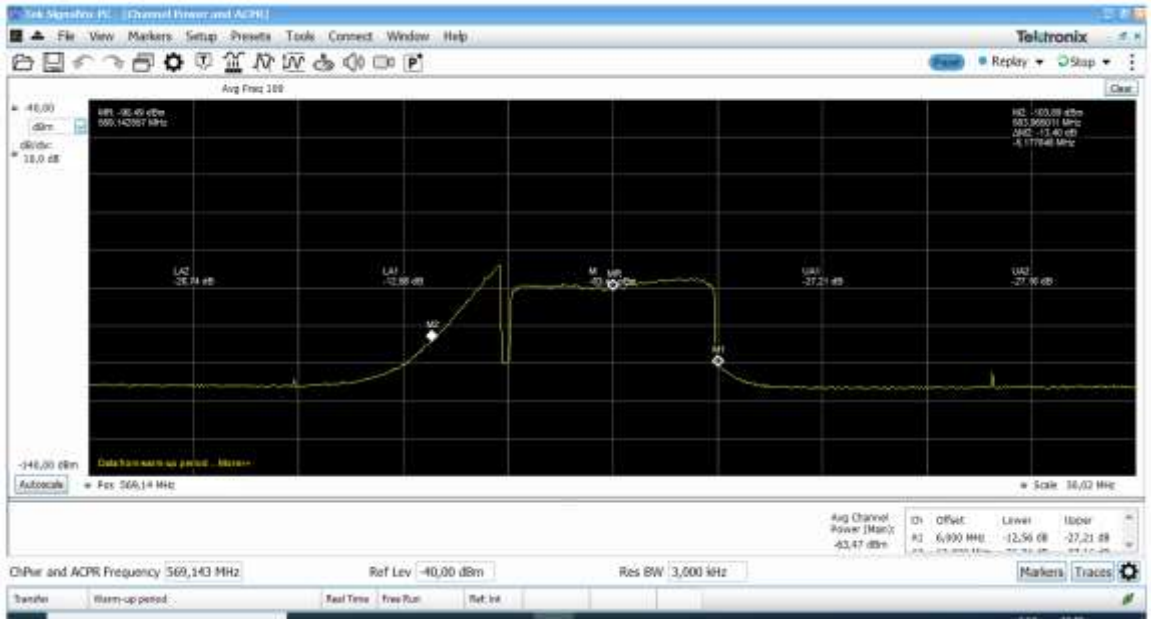


Figure 1.2 - Horizontal

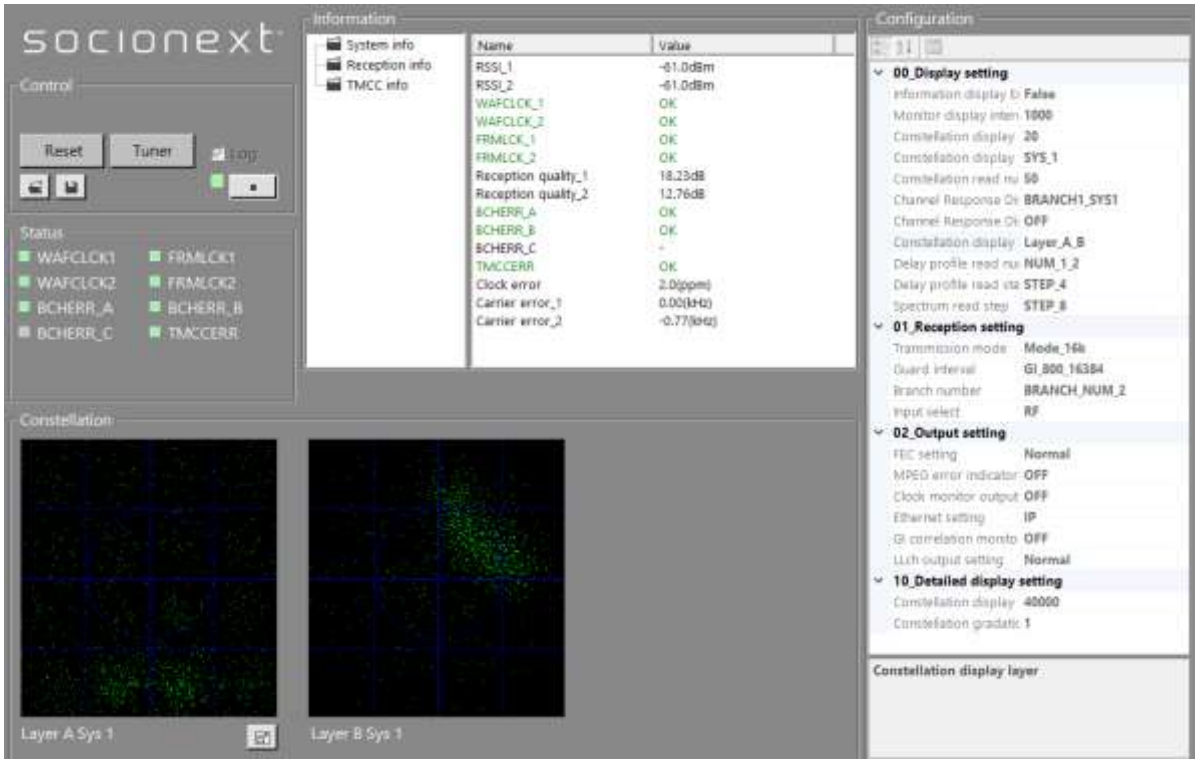


Figure 1.3 - Socionext Screen

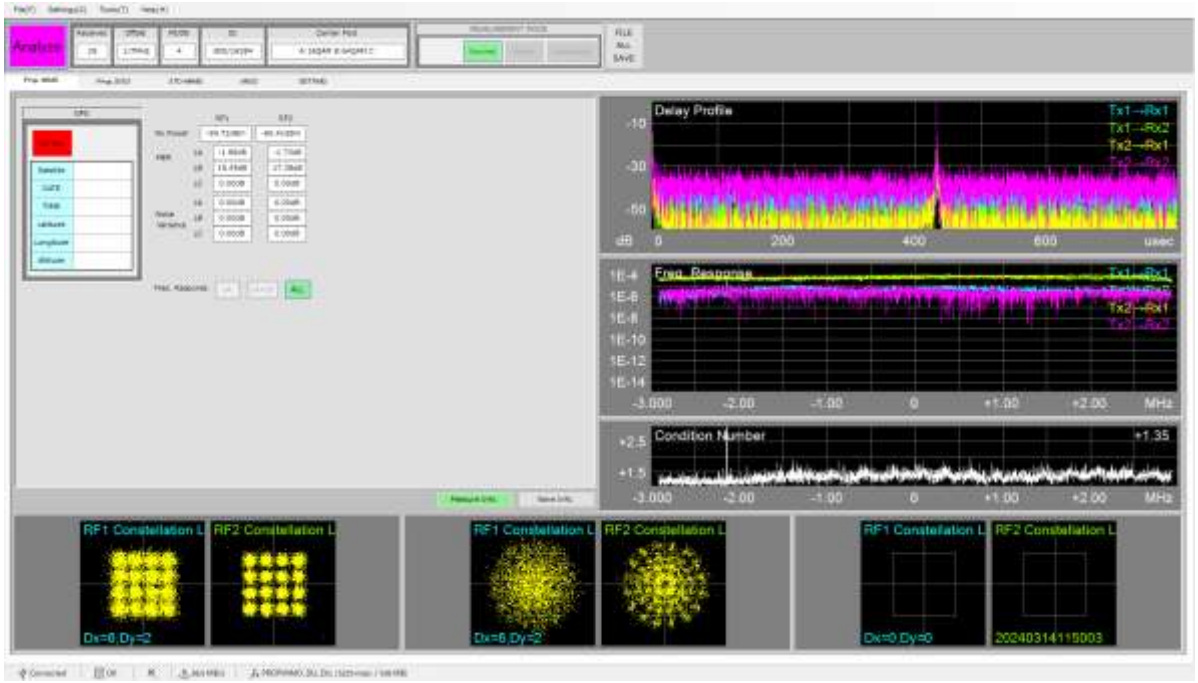


Figure 1.4 - Rintaro Screen

b) AWGN Power

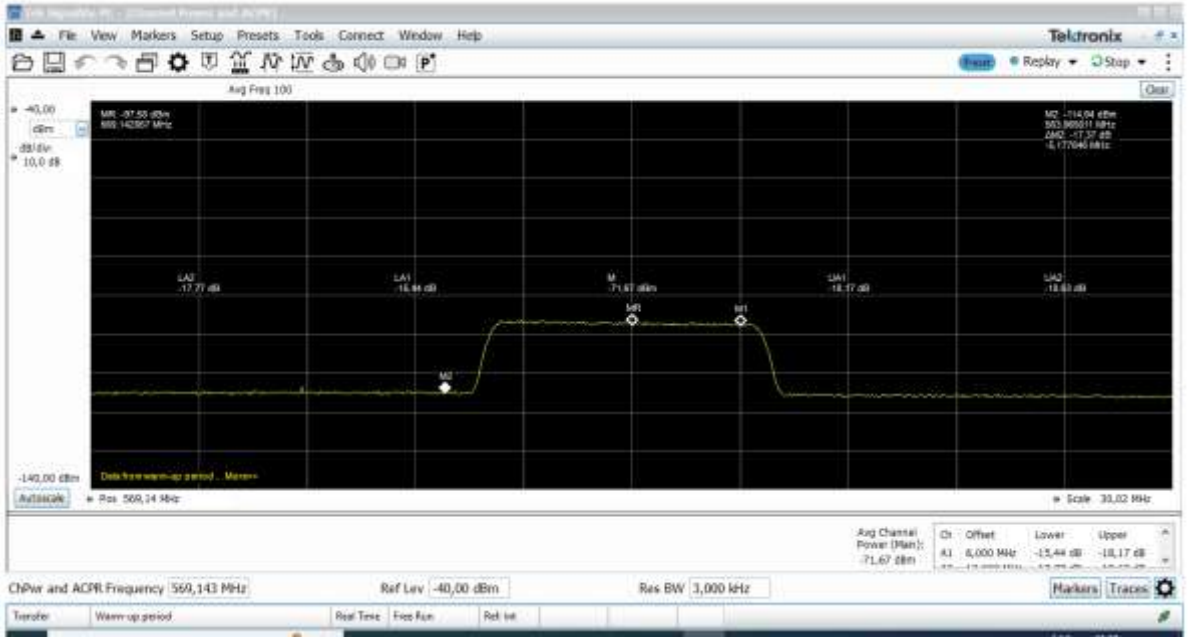


Figure 1.5 - Vertical

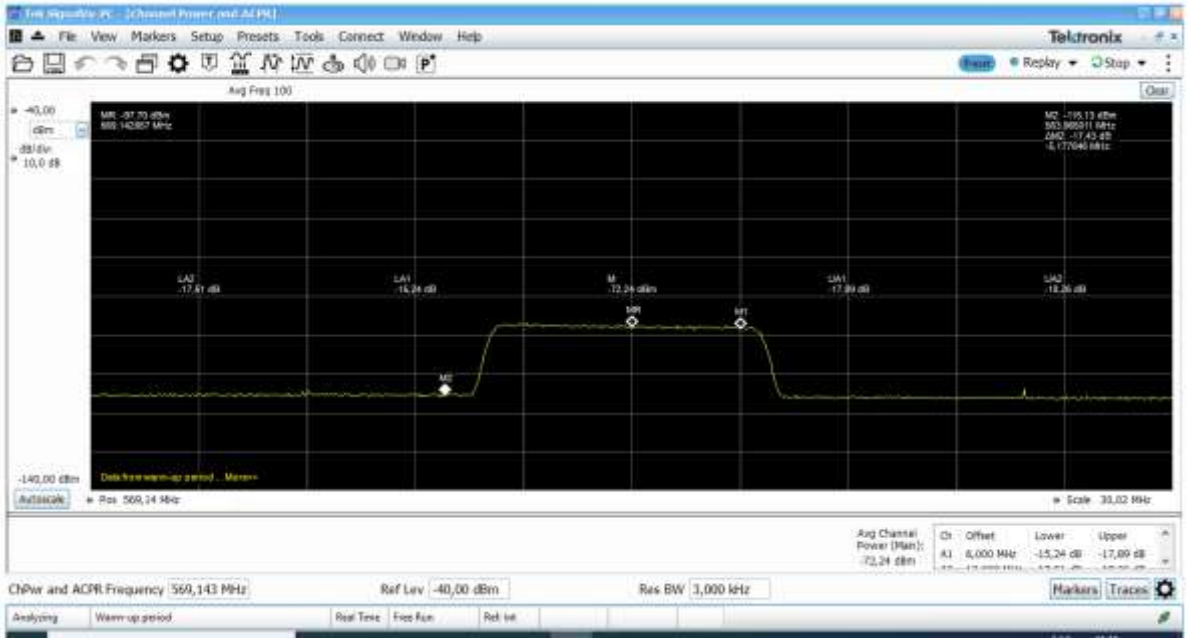


Figure 1.6 - Horizontal

c) C/N Threshold

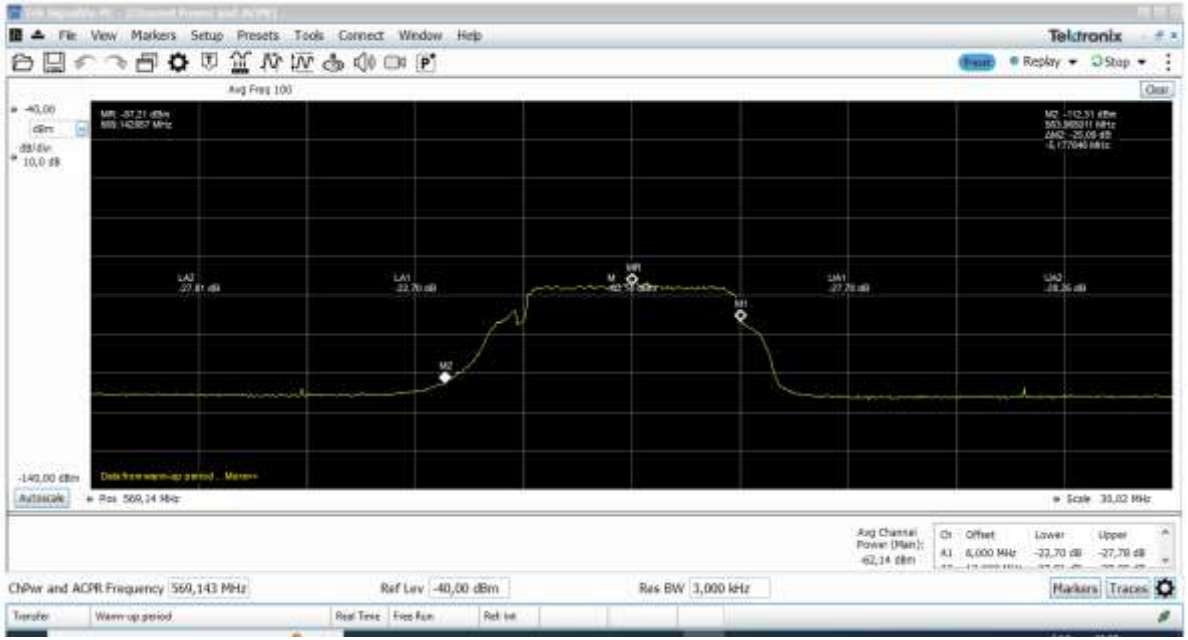


Figure 1.7 - Vertical

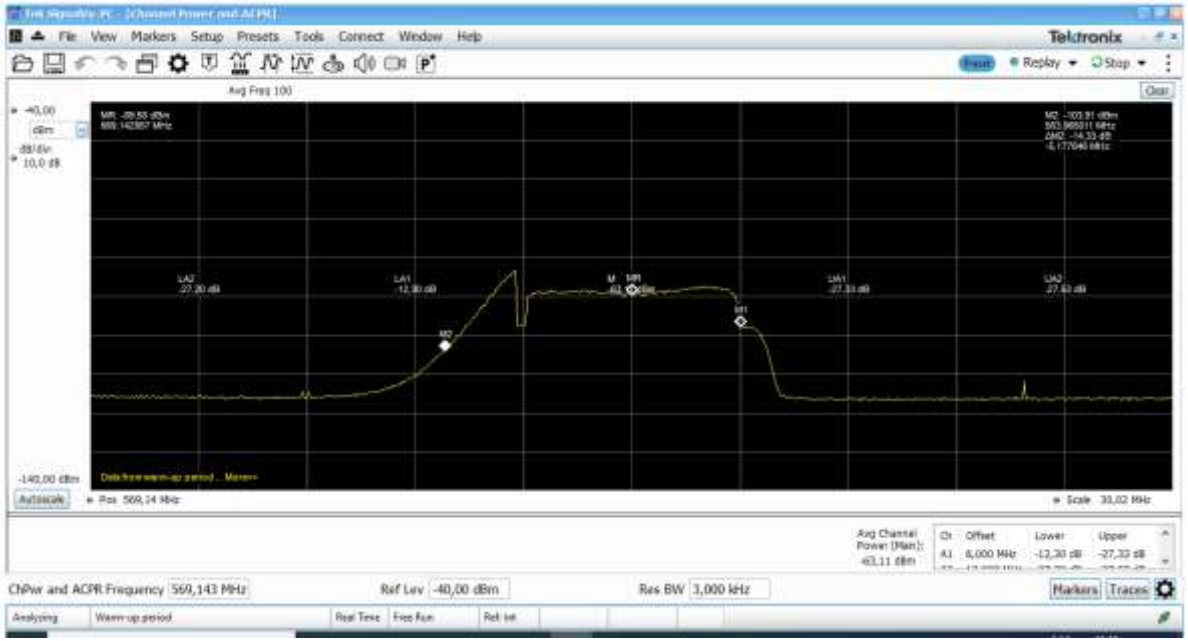


Figure 1.8 - Horizontal

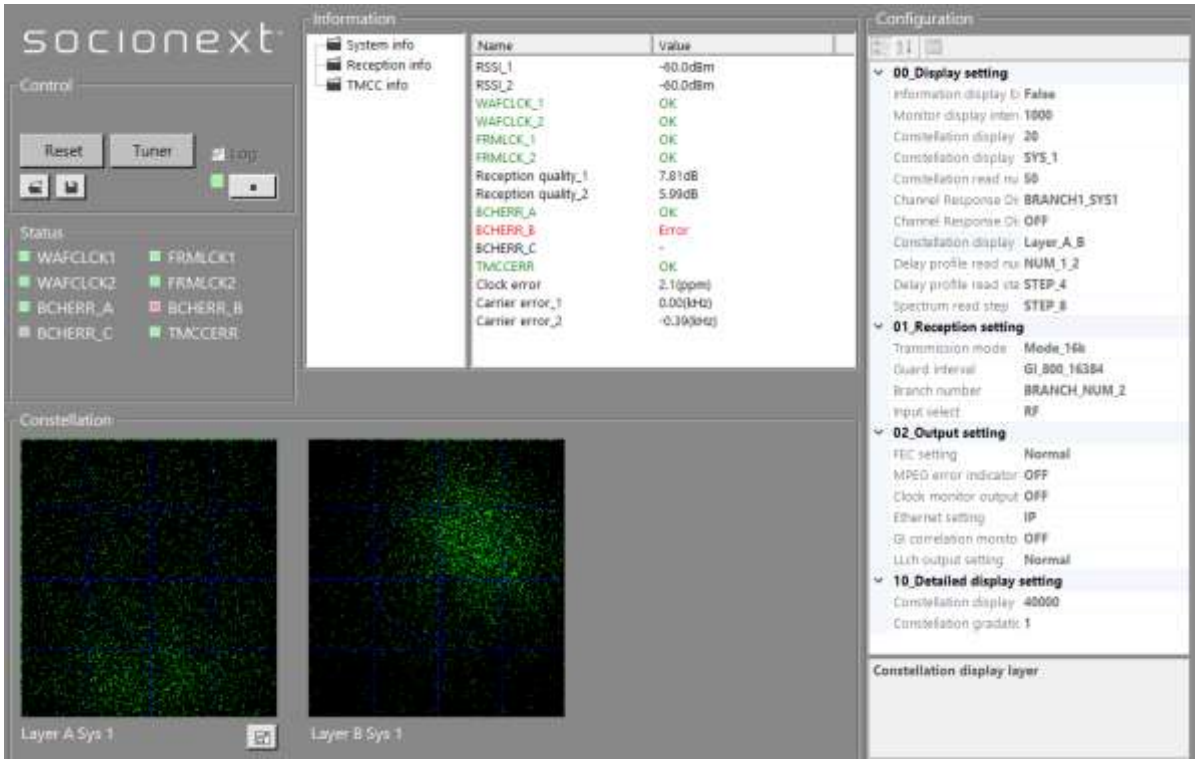


Figure 1.9 - Socionext Screen

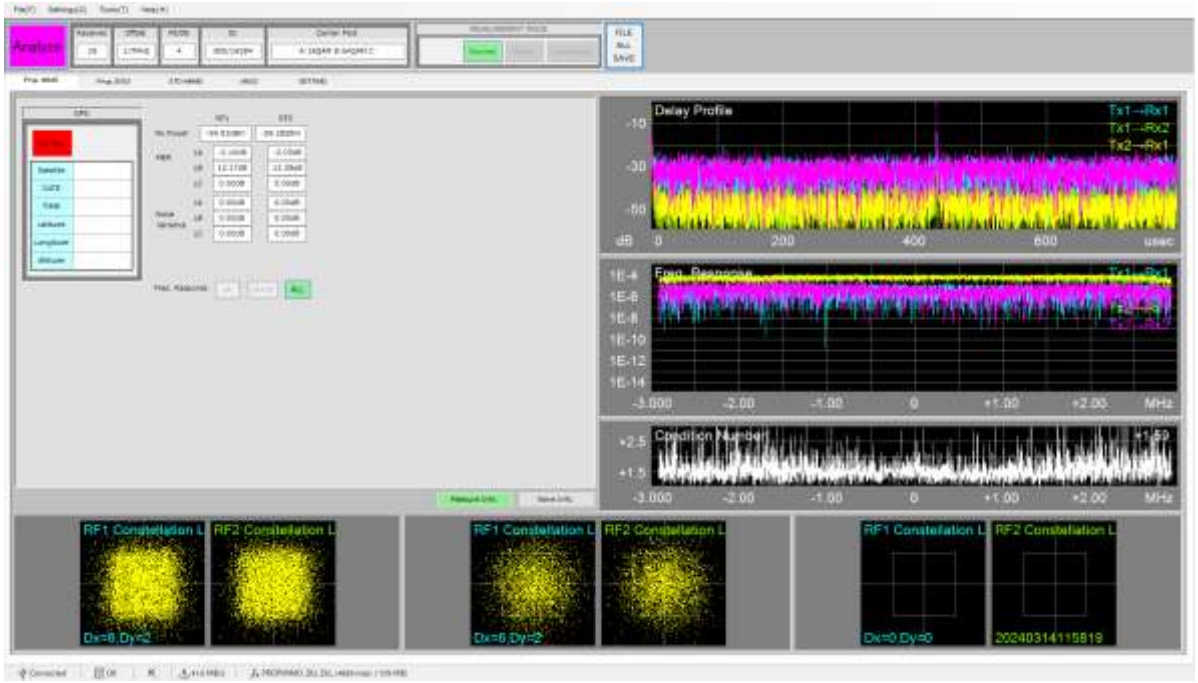


Figure 1.10 - Rintaro Screen

d) Reception Threshold

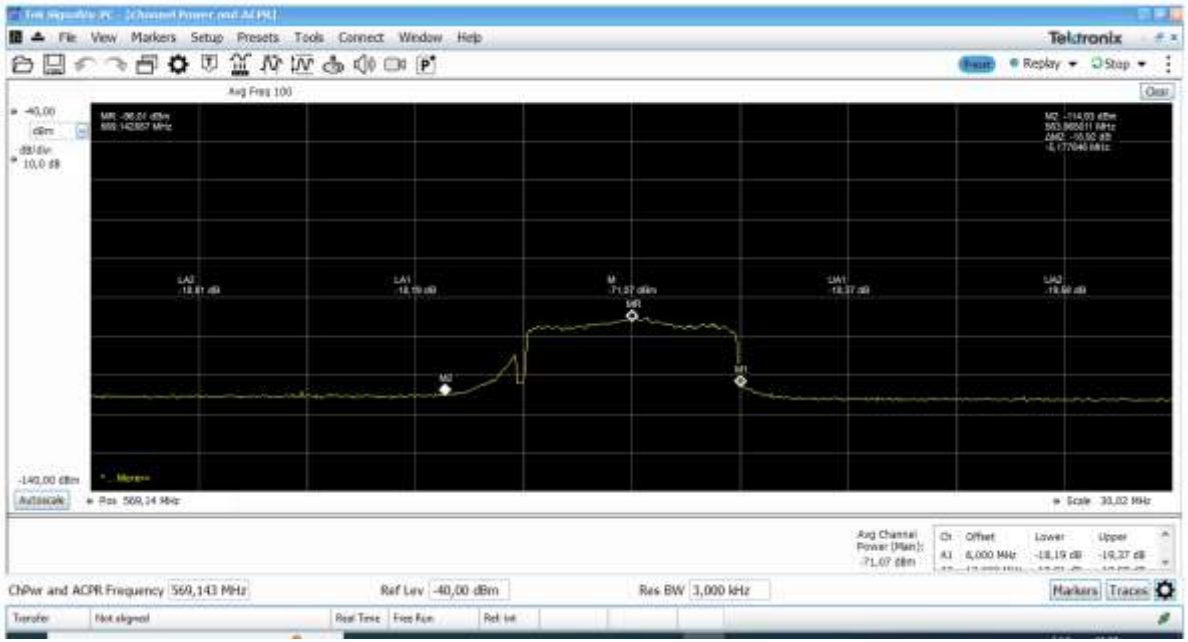


Figure 1.11 - Vertical

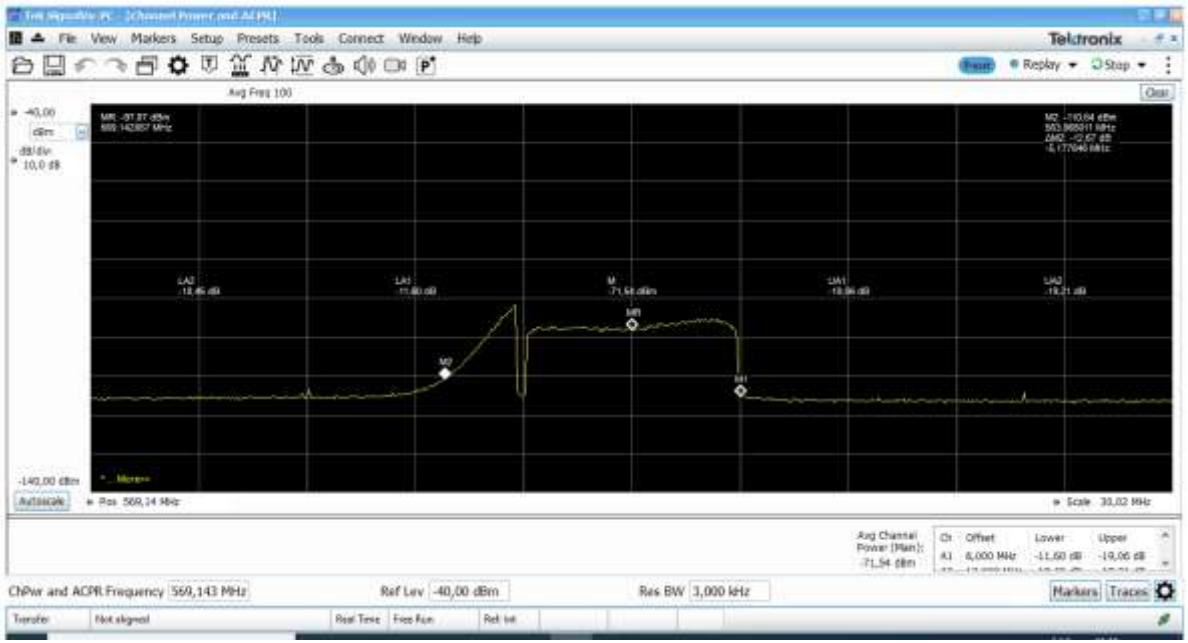


Figure 1.12 - Horizontal

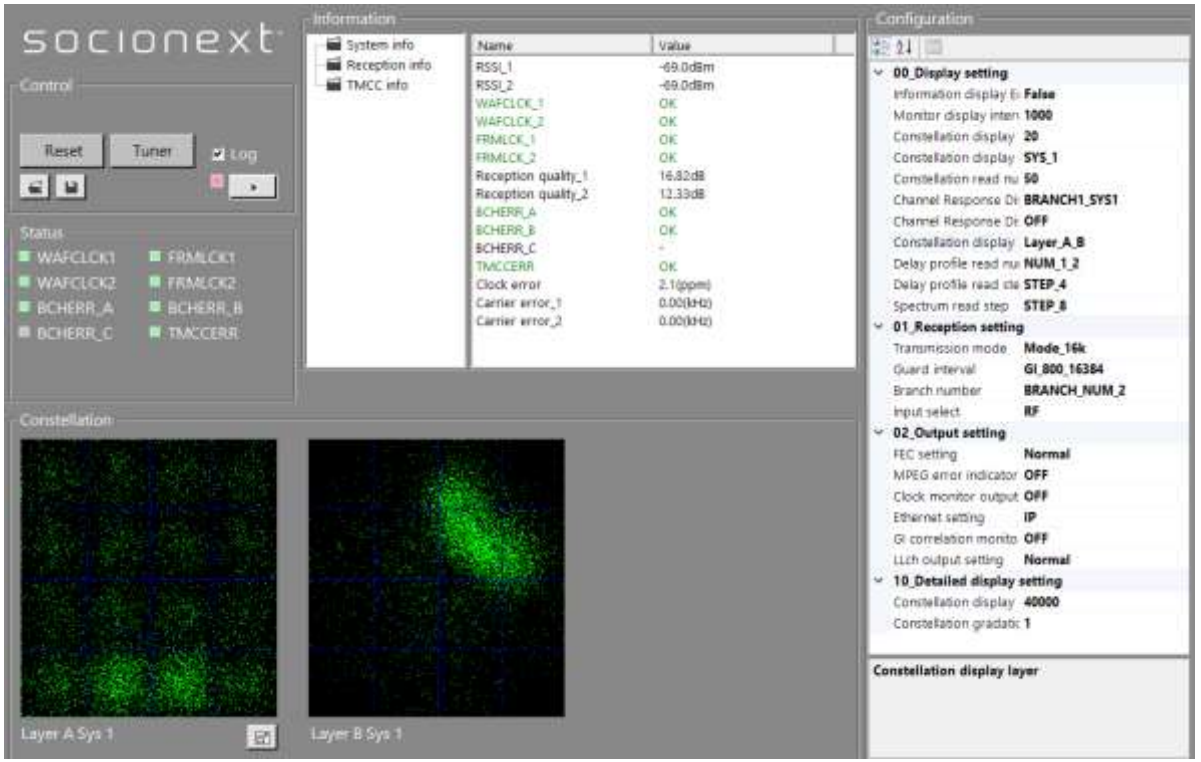


Figure 1.13 - Socionext Screen

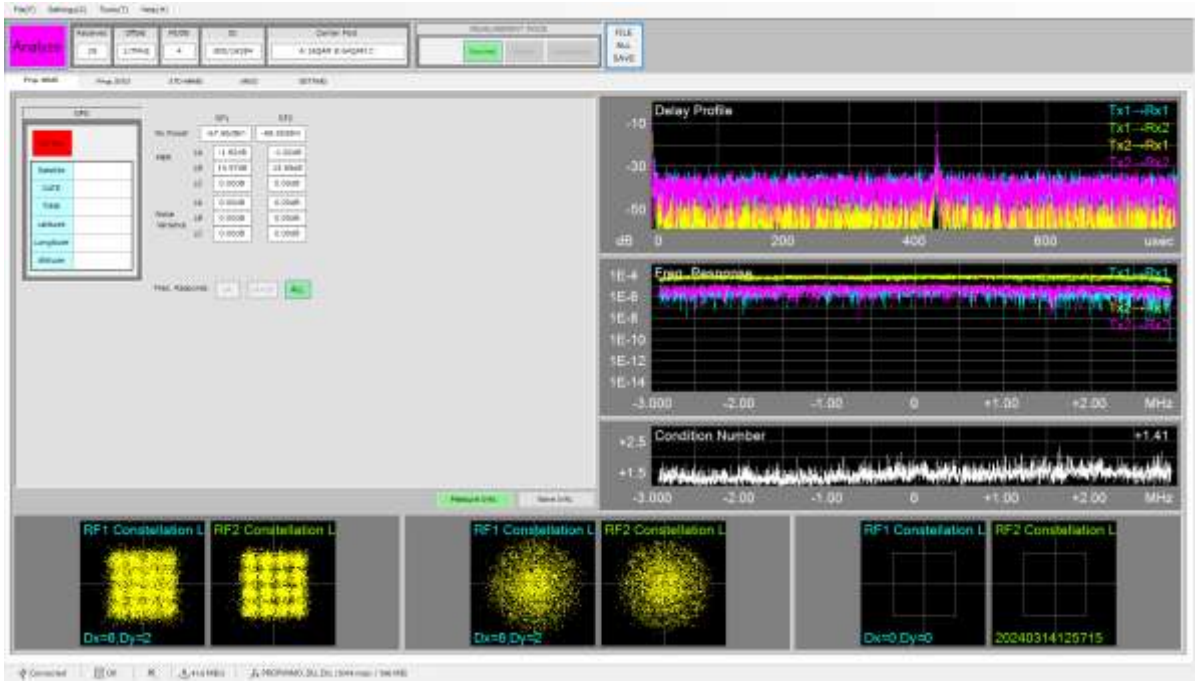


Figure 1.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

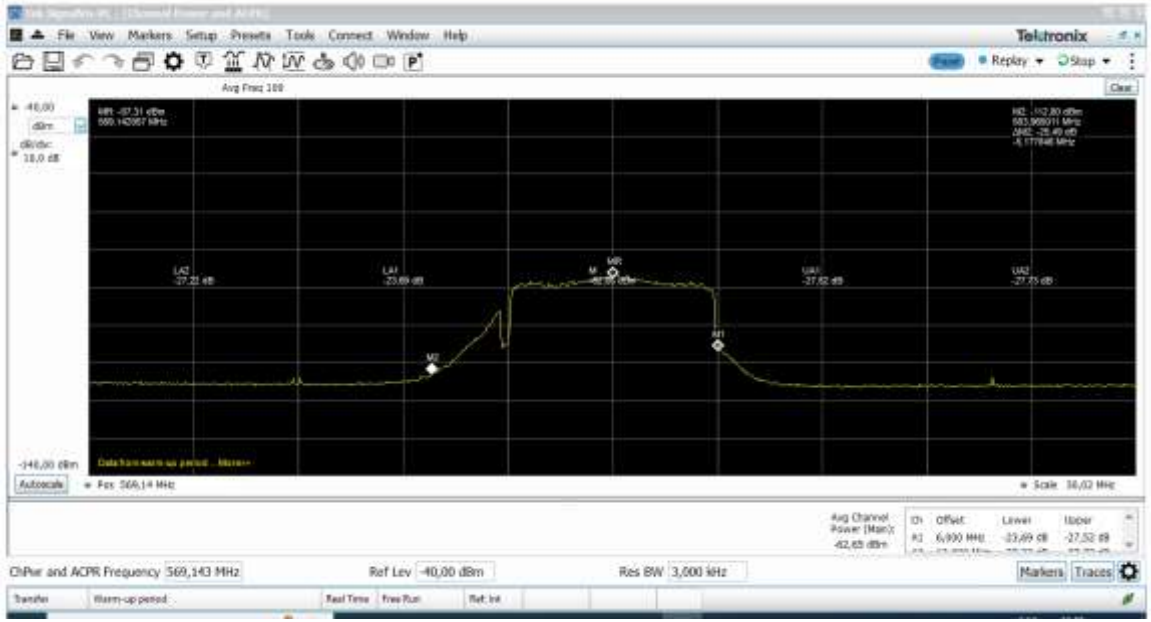


Figure 1.15 - Vertical

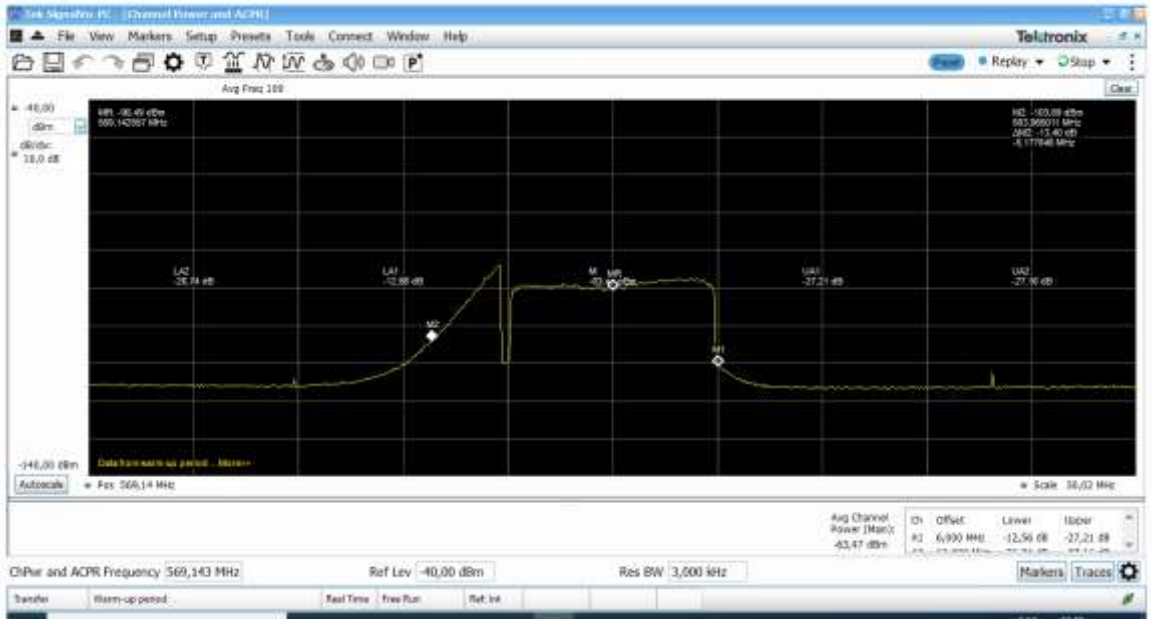


Figure 1.16 - Horizontal

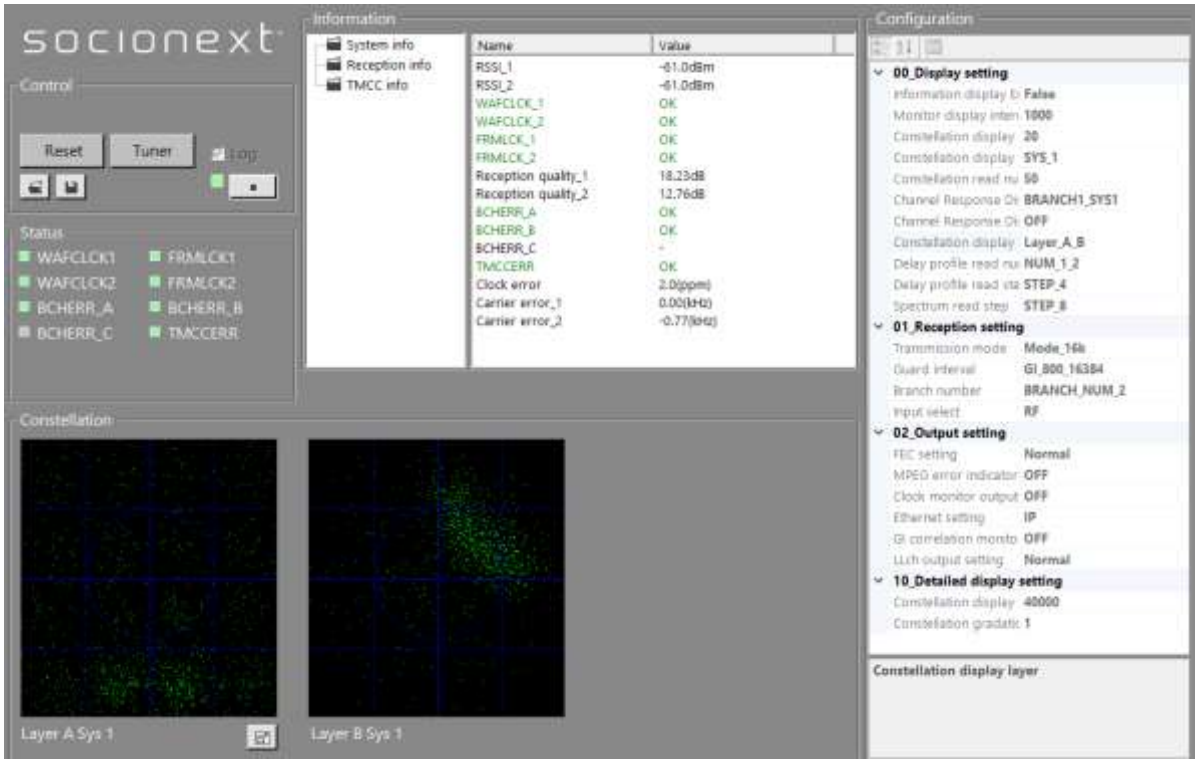


Figure 1.17 - Socionext Screen

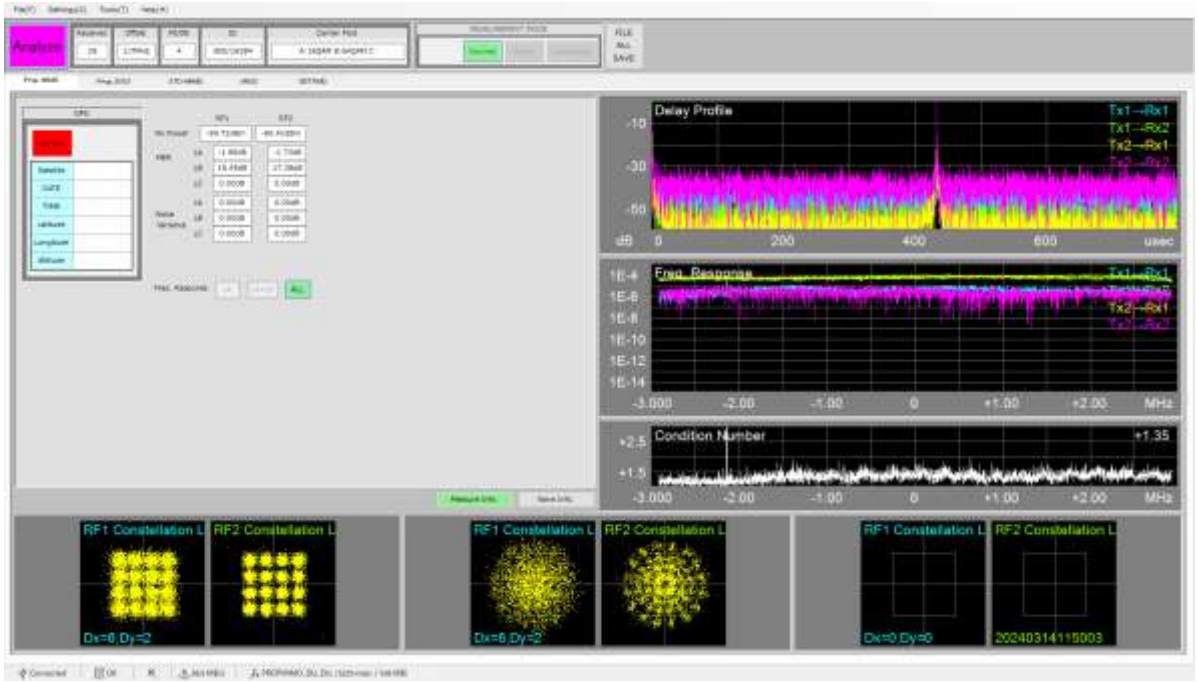


Figure 1.18 - Rintaro Screen

b) AWGN Power

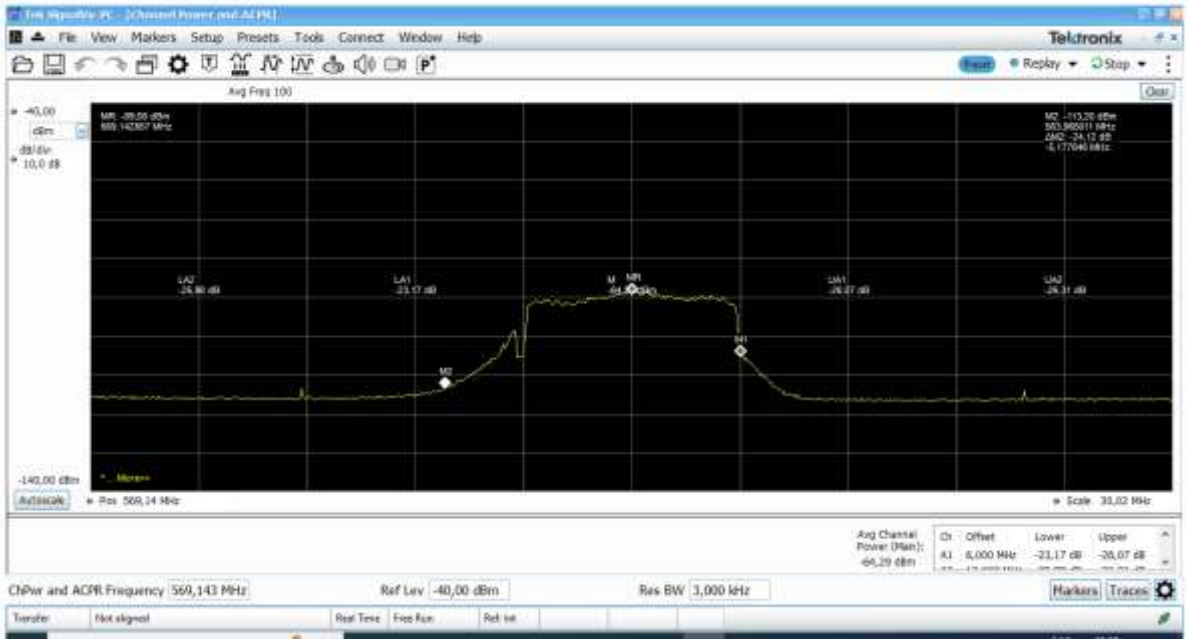


Figure 1.19 - Vertical

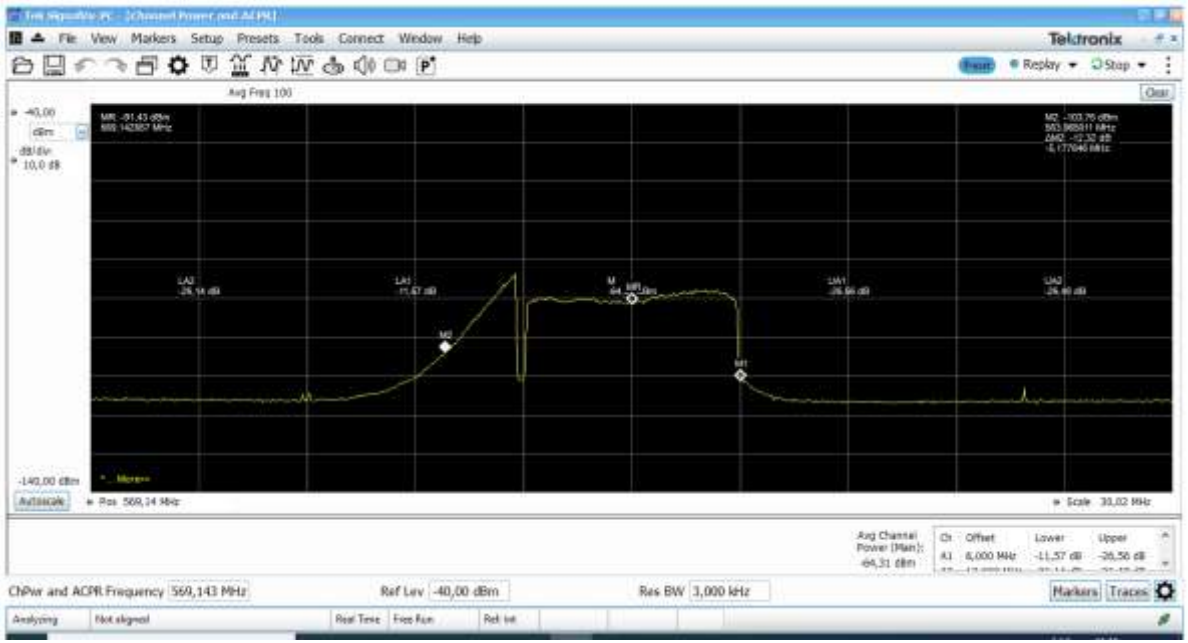


Figure 1.20 - Horizontal

c) C/N Threshold

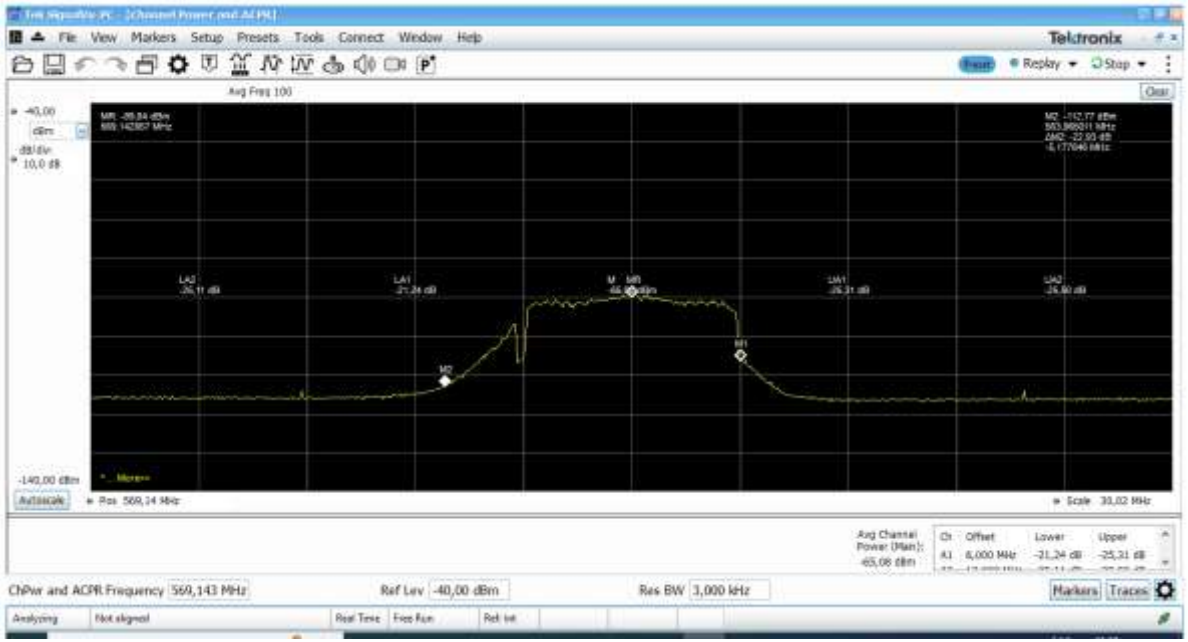


Figure 1.21 - Vertical

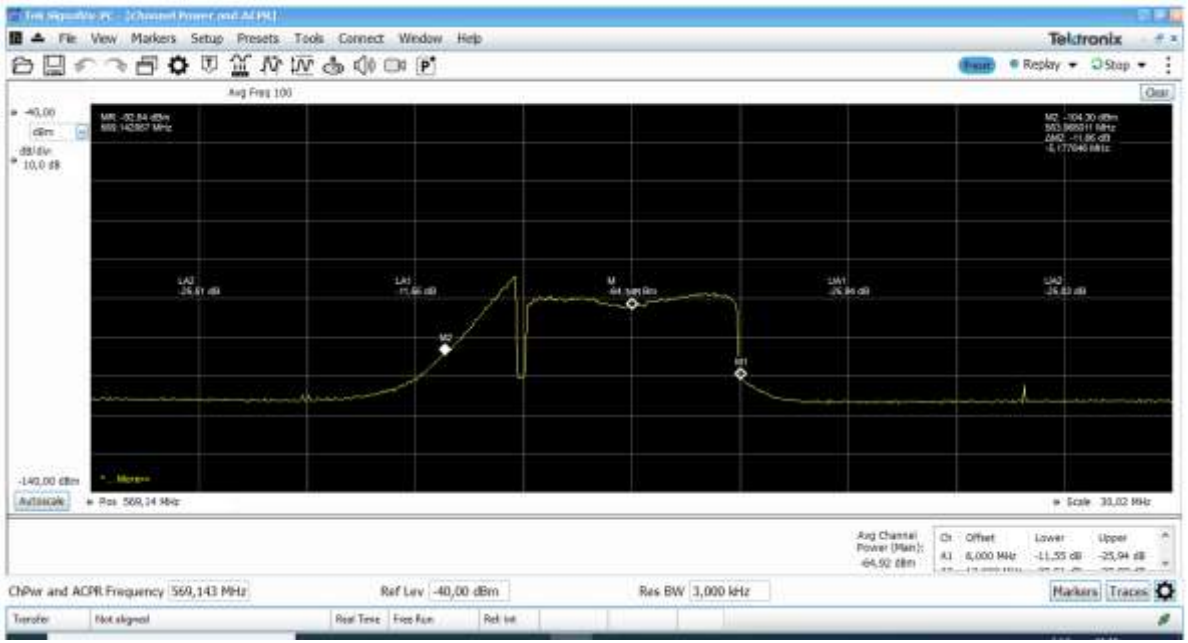


Figure 1.22 - Horizontal

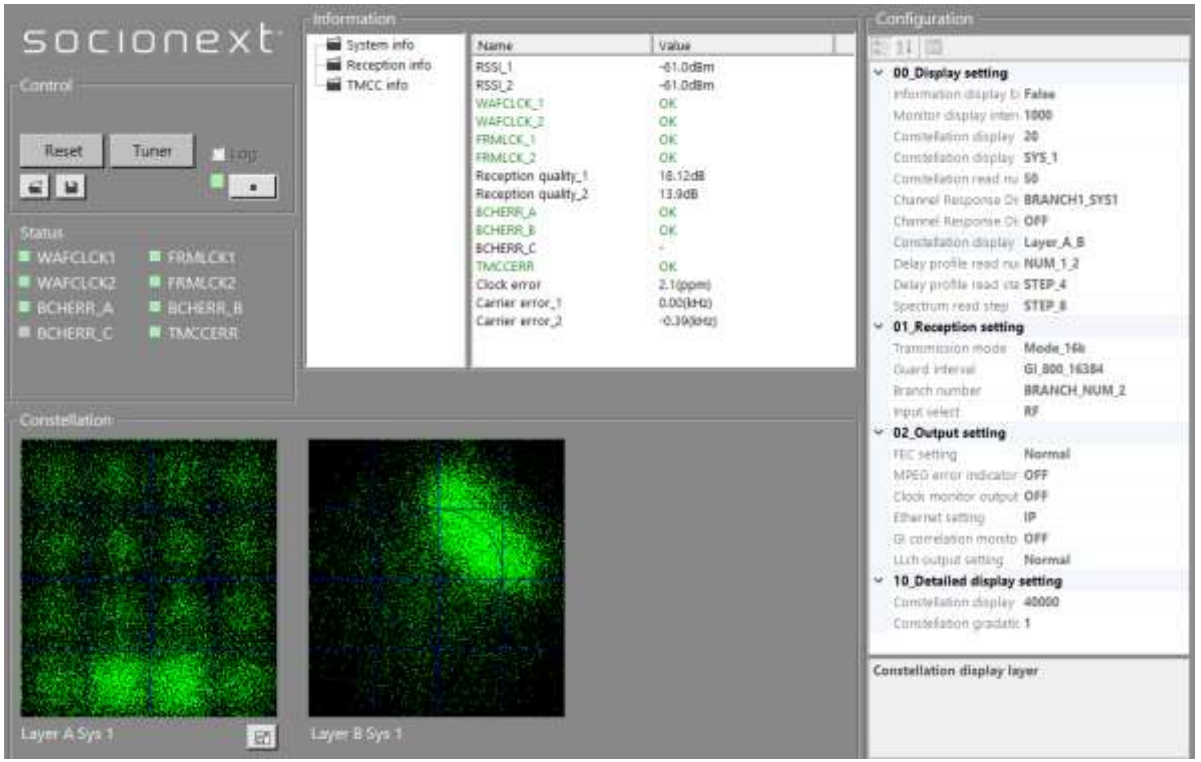


Figure 1.23 - Socionext Screen

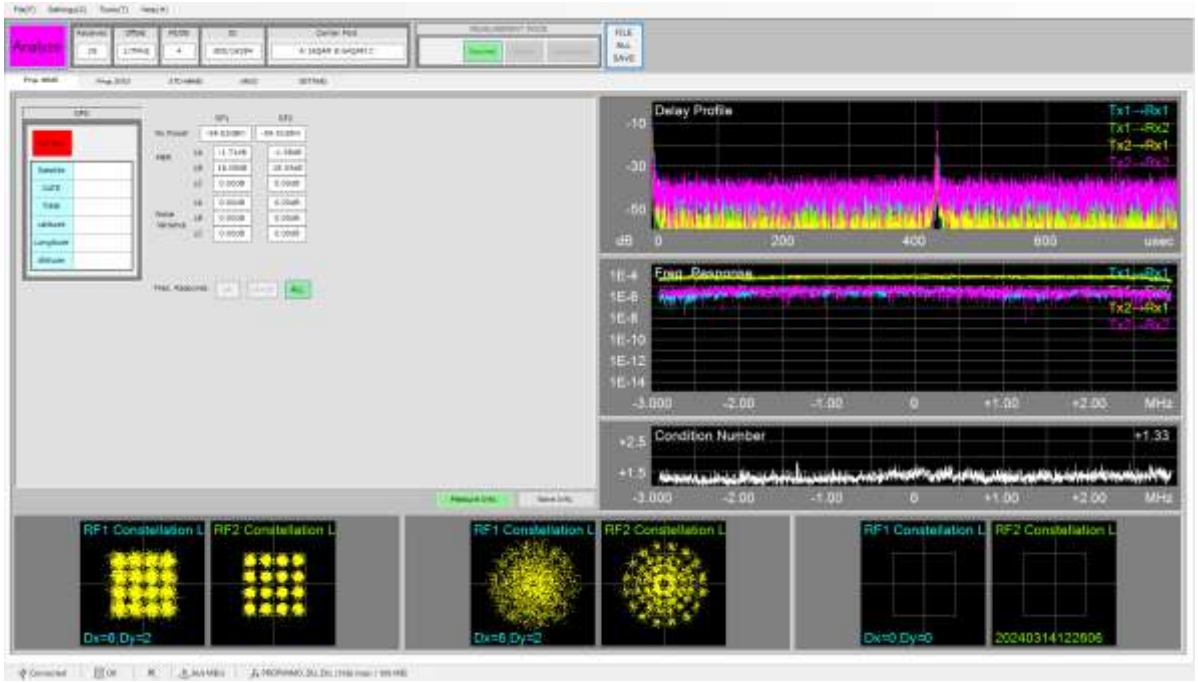


Figure 1.24 - Rintaro Screen

d) Reception Threshold

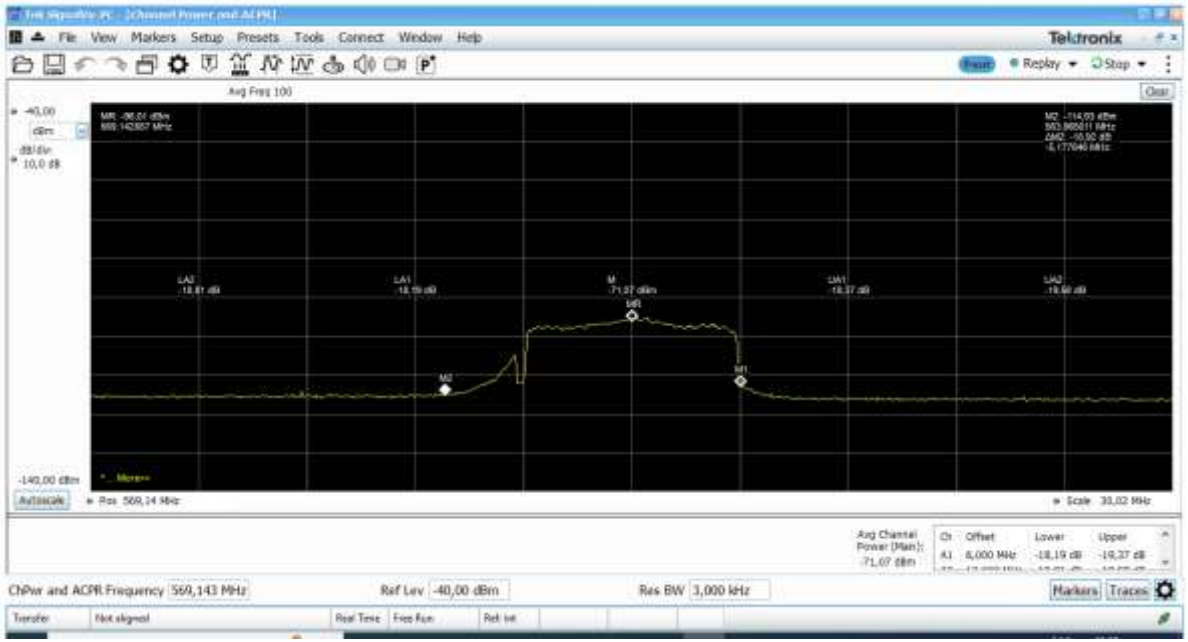


Figure 1.25 - Vertical

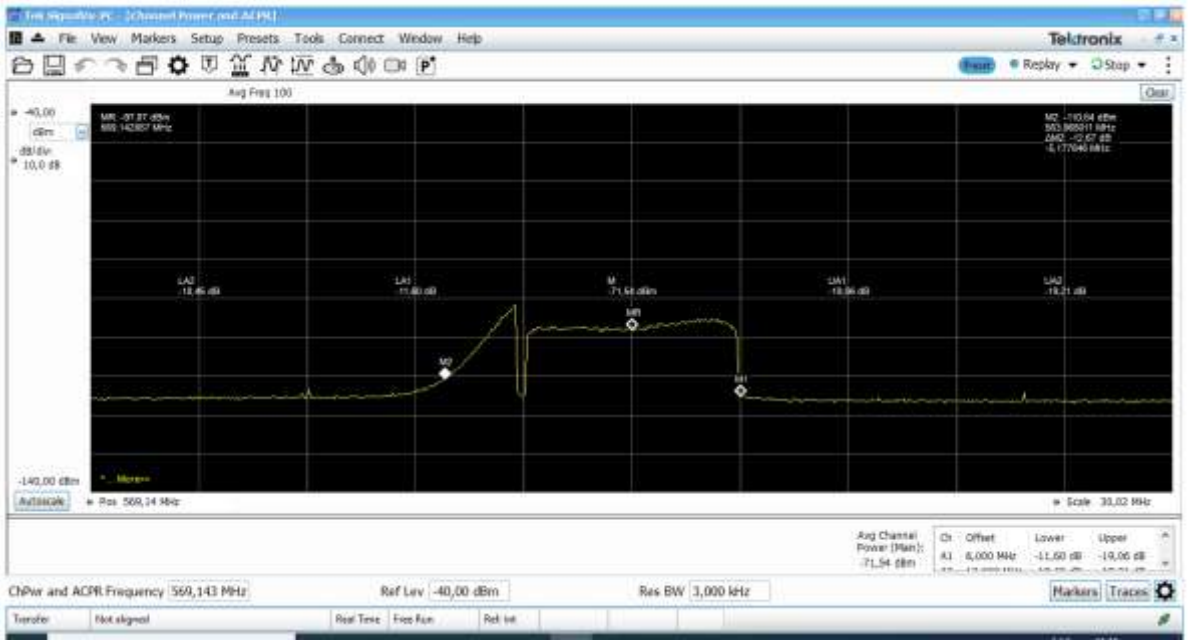


Figure 1.26 - Horizontal

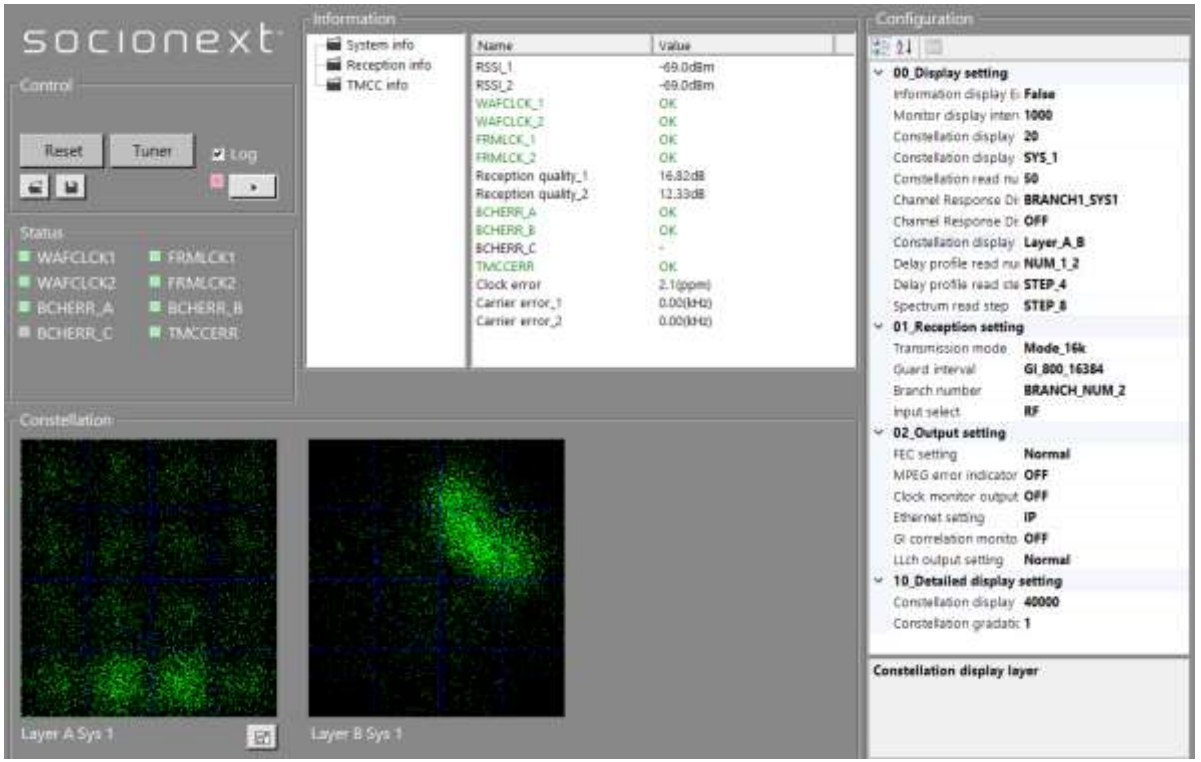


Figure 1.27 - Socionext Screen

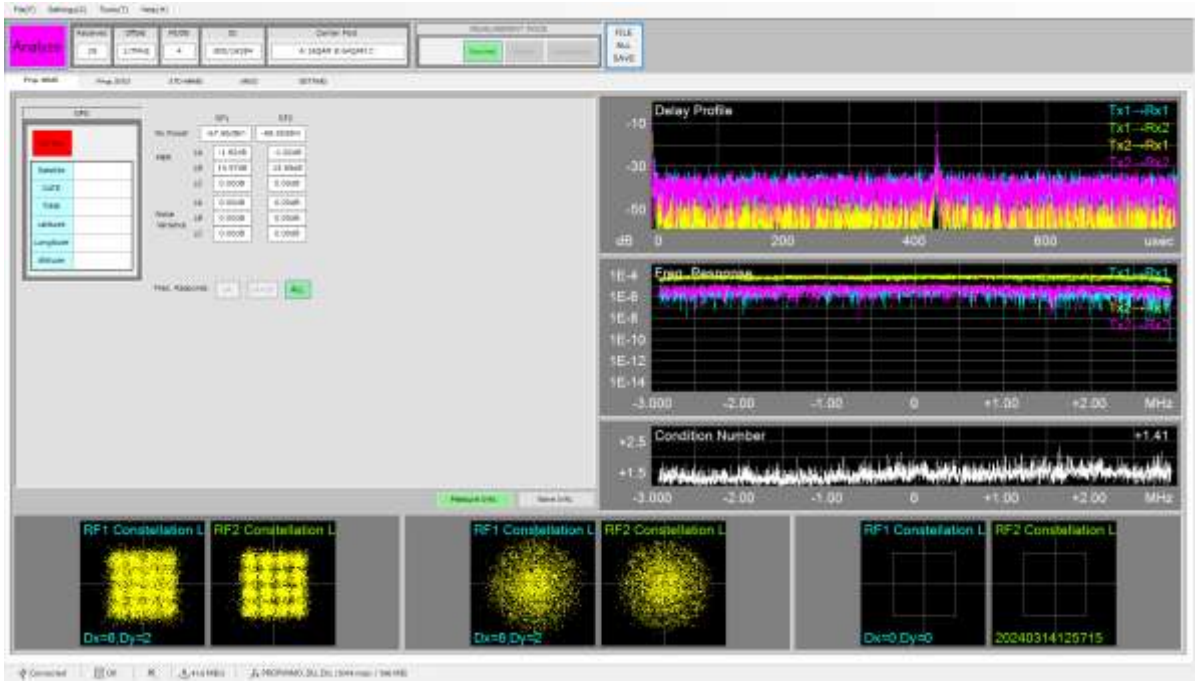


Figure 1.28 - Rintaro Screen

Chapter 2. Site 3

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

Figure 2.1 - Vertical

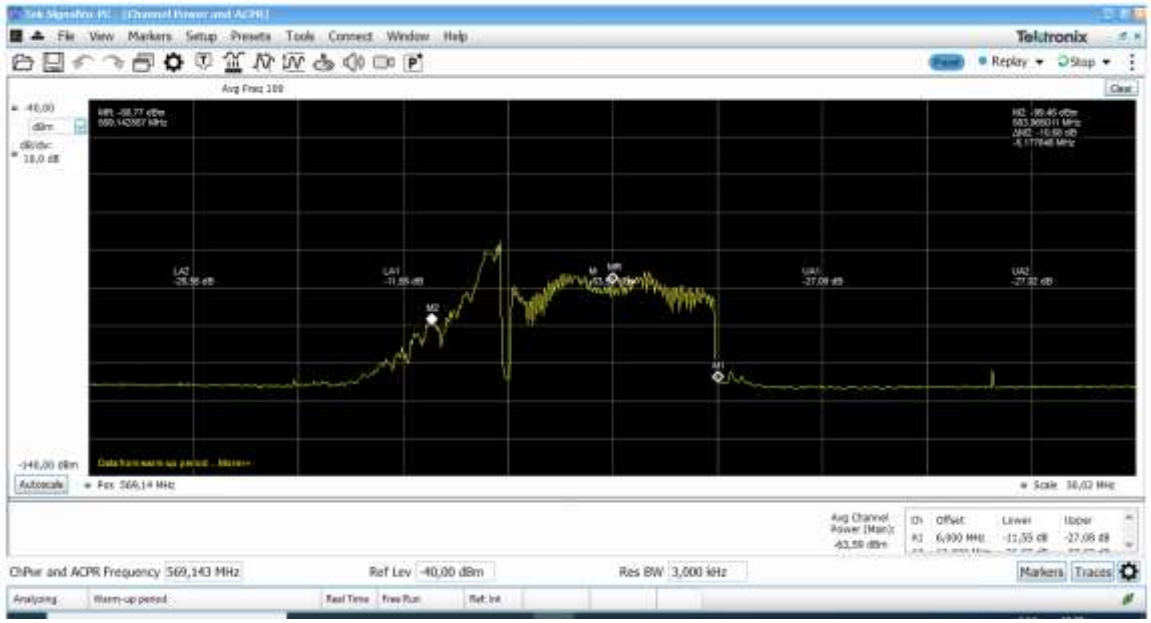


Figure 2.2 - Horizontal

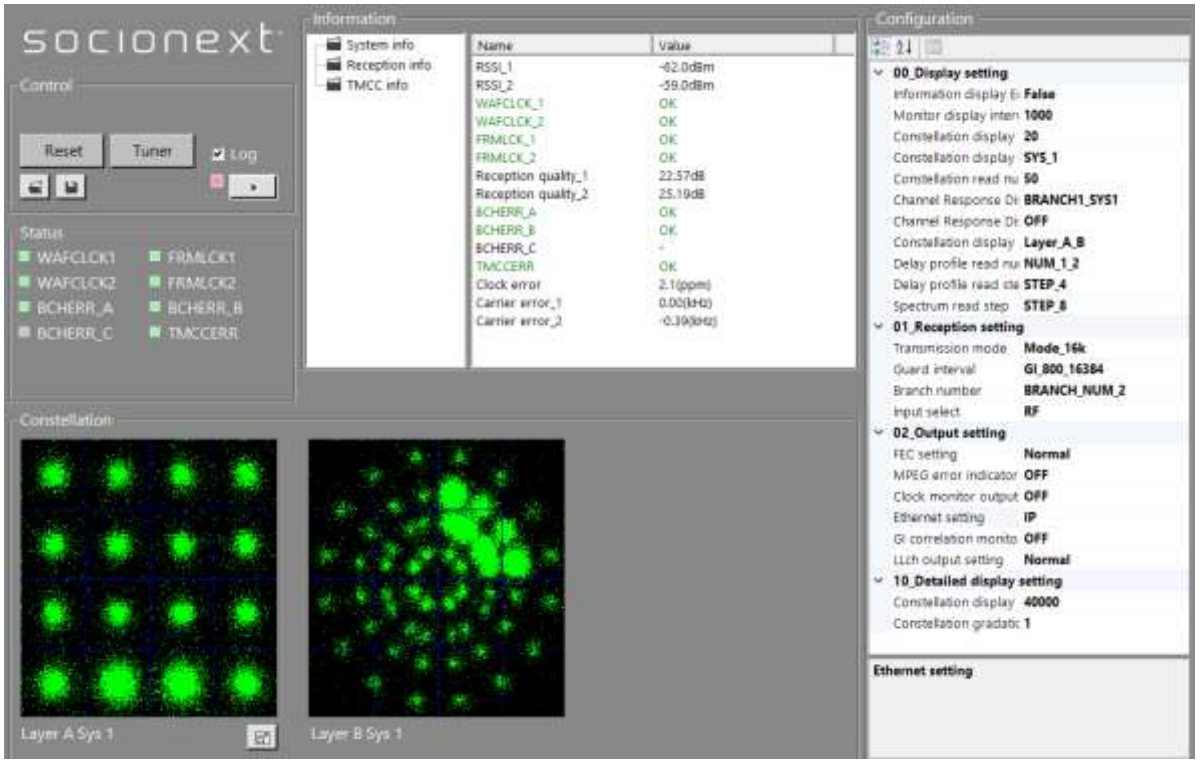


Figure 2.3 - Socionext Screen

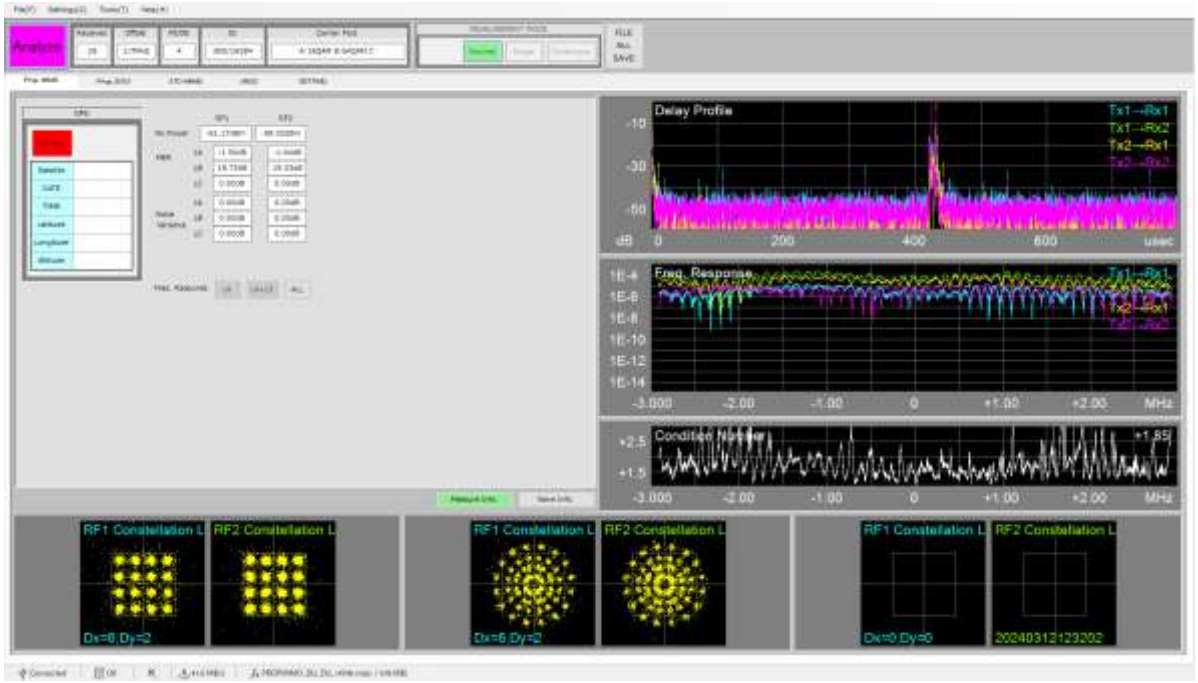


Figure 2.4 - Rintaro Screen

b) AWGN Power

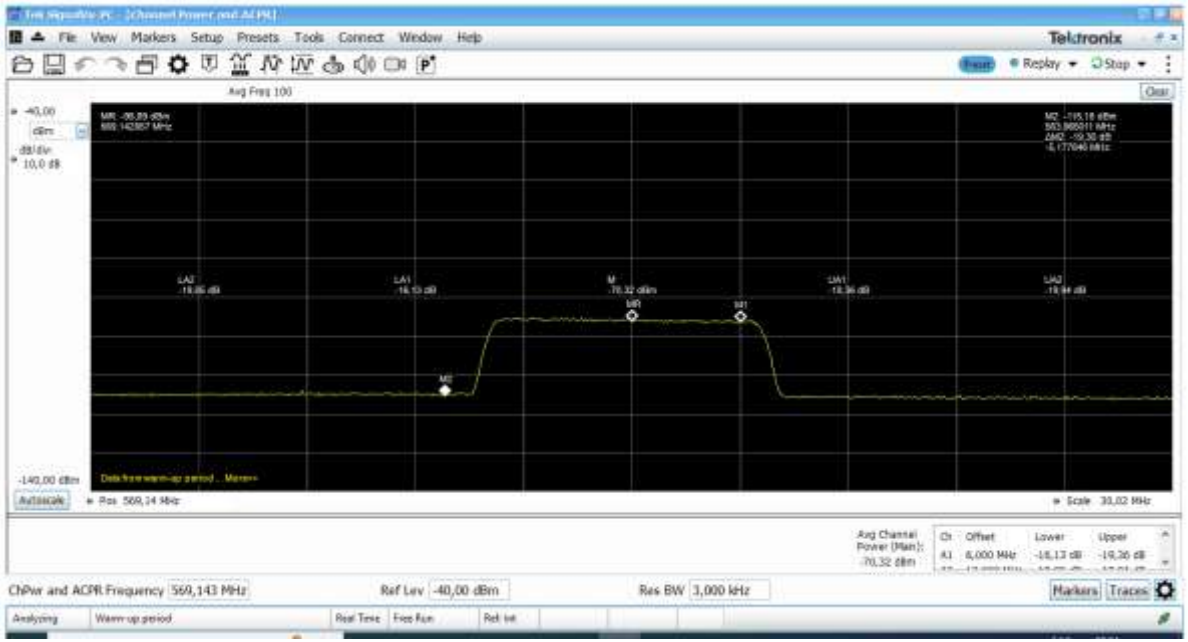


Figure 2.5 - Vertical

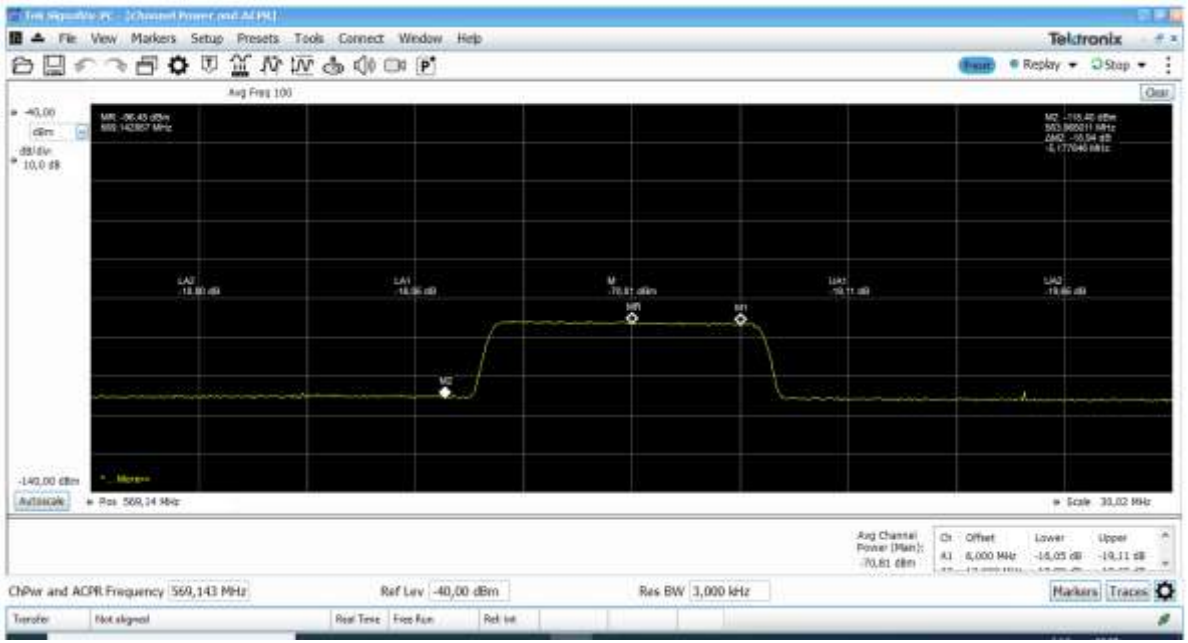


Figure 2.6 - Horizontal

c) C/N Threshold

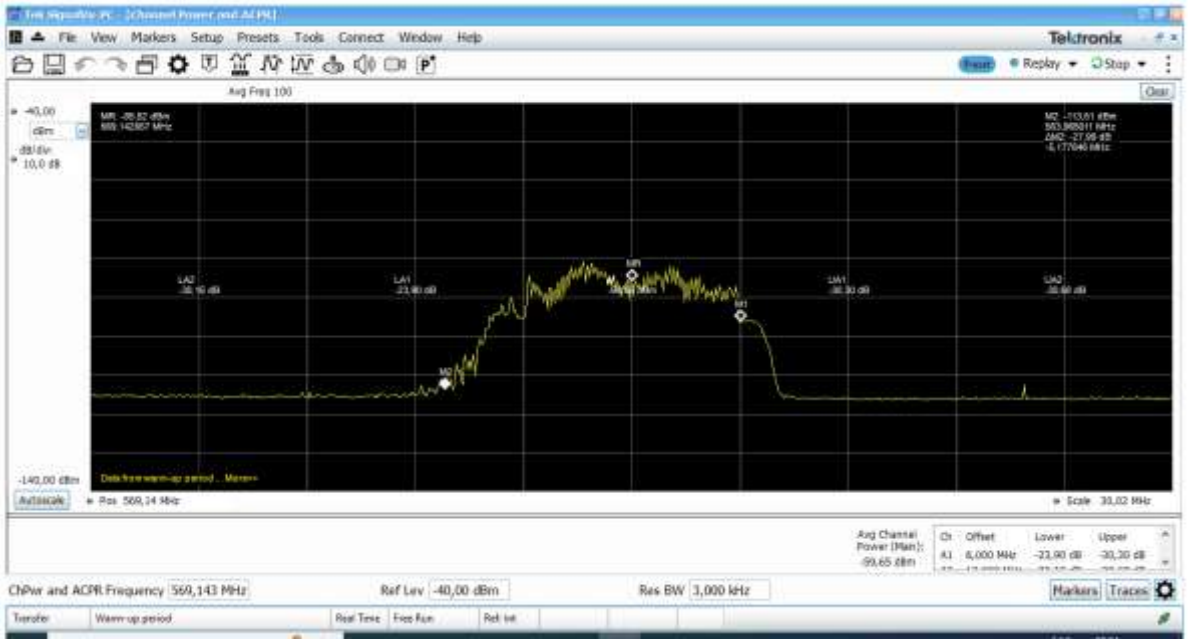


Figure 2.7 - Vertical

Figure 2.8 - Horizontal

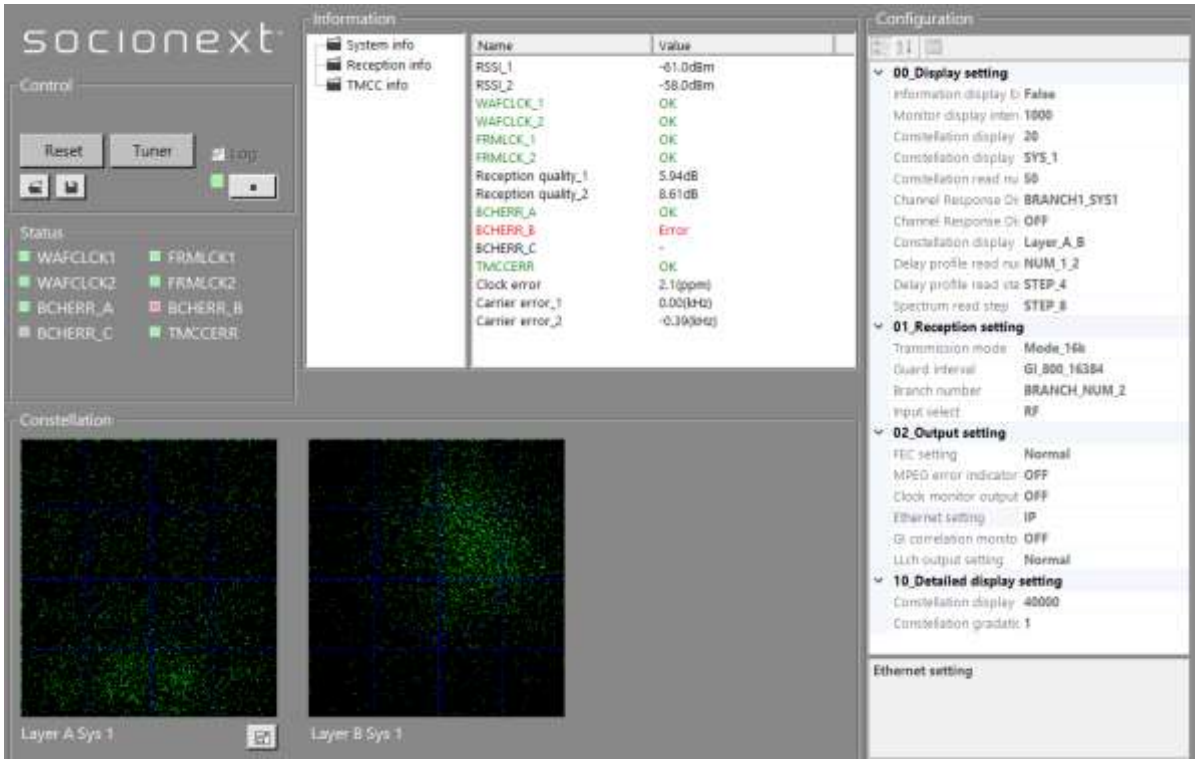


Figure 2.9 - Socionext Screen

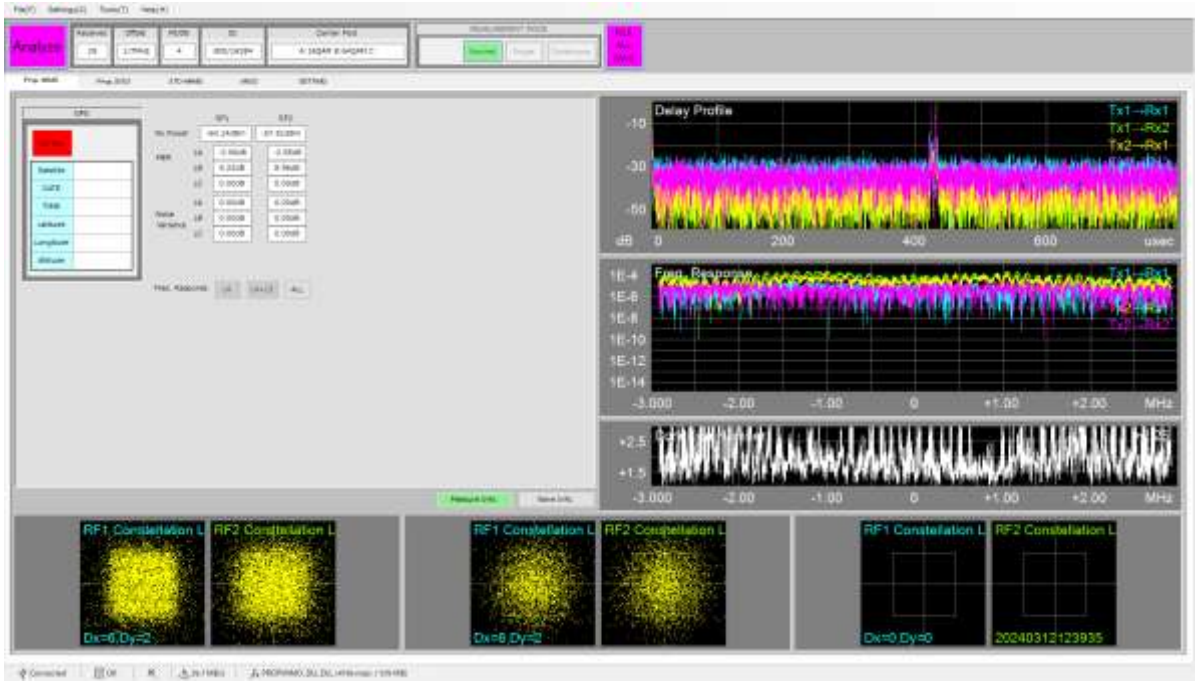


Figure 2.10 - Rintaro Screen

d) Reception Threshold

Figure 2.11 - Vertical

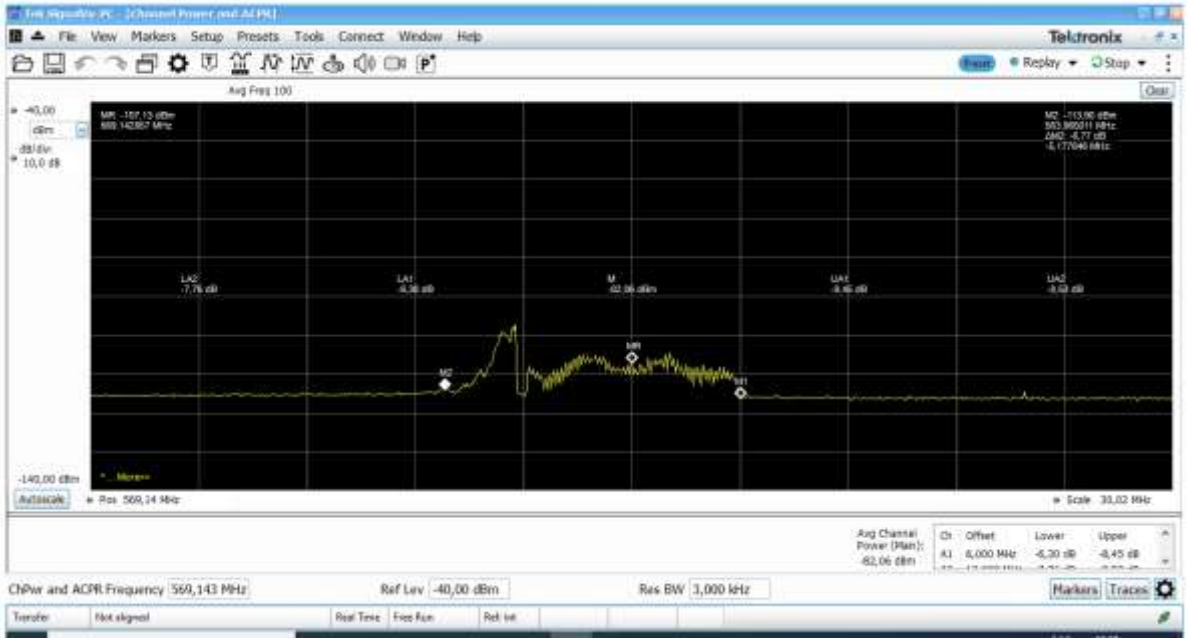


Figure 2.12 - Horizontal

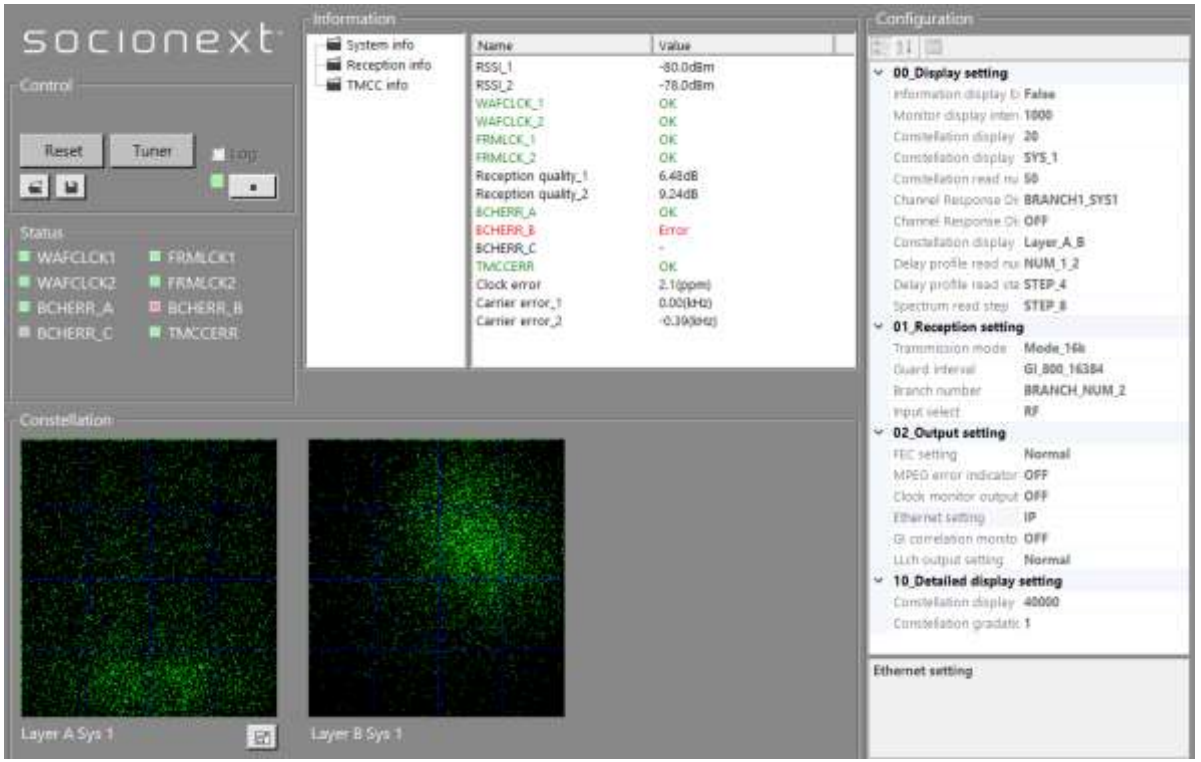


Figure 2.13 - Socionext Screen

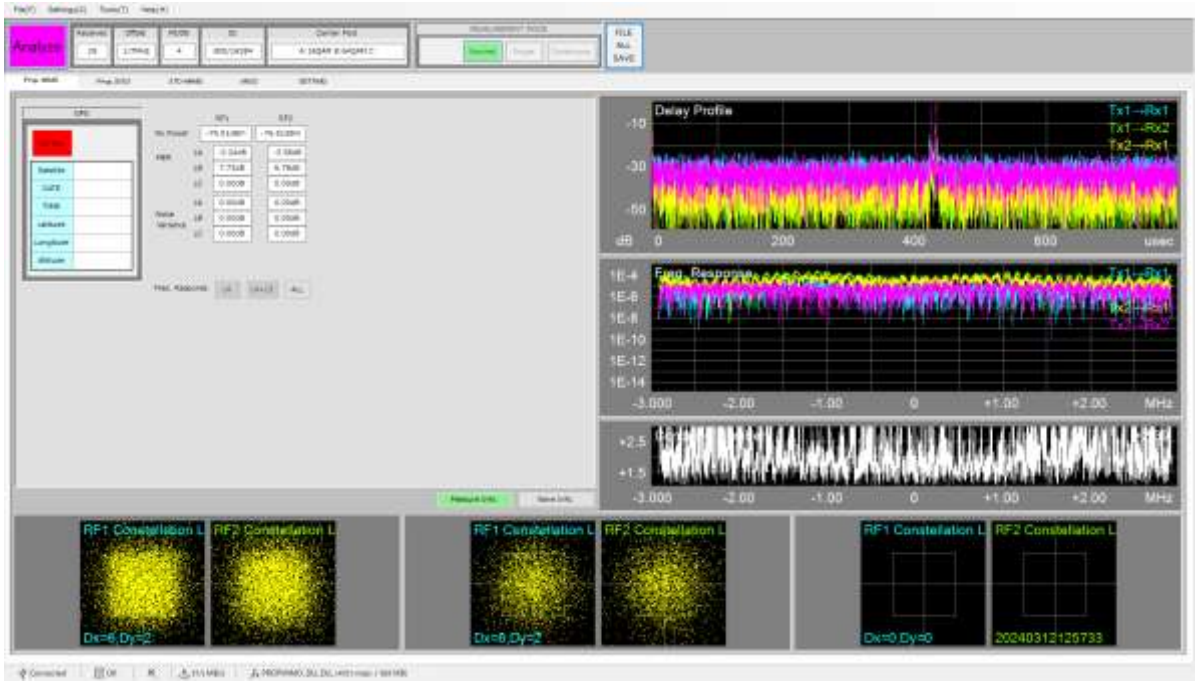


Figure 2.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

Figure 2.15 - Vertical

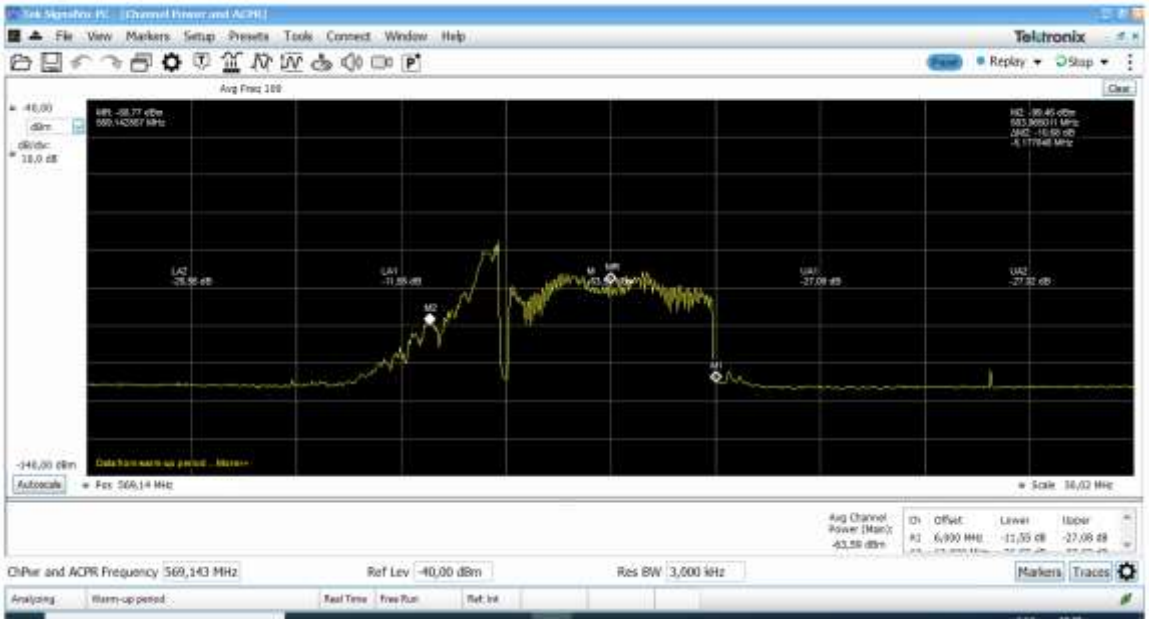


Figure 2.16 - Horizontal

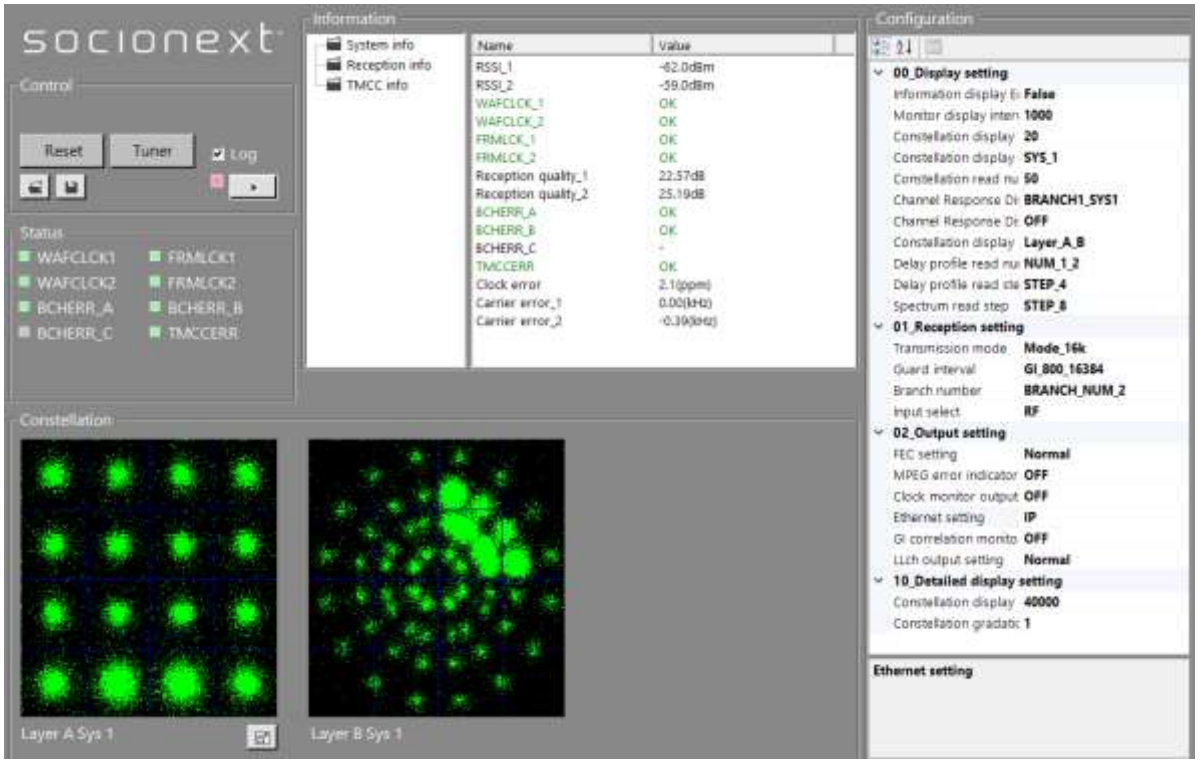


Figure 2.17 - Socionext Screen

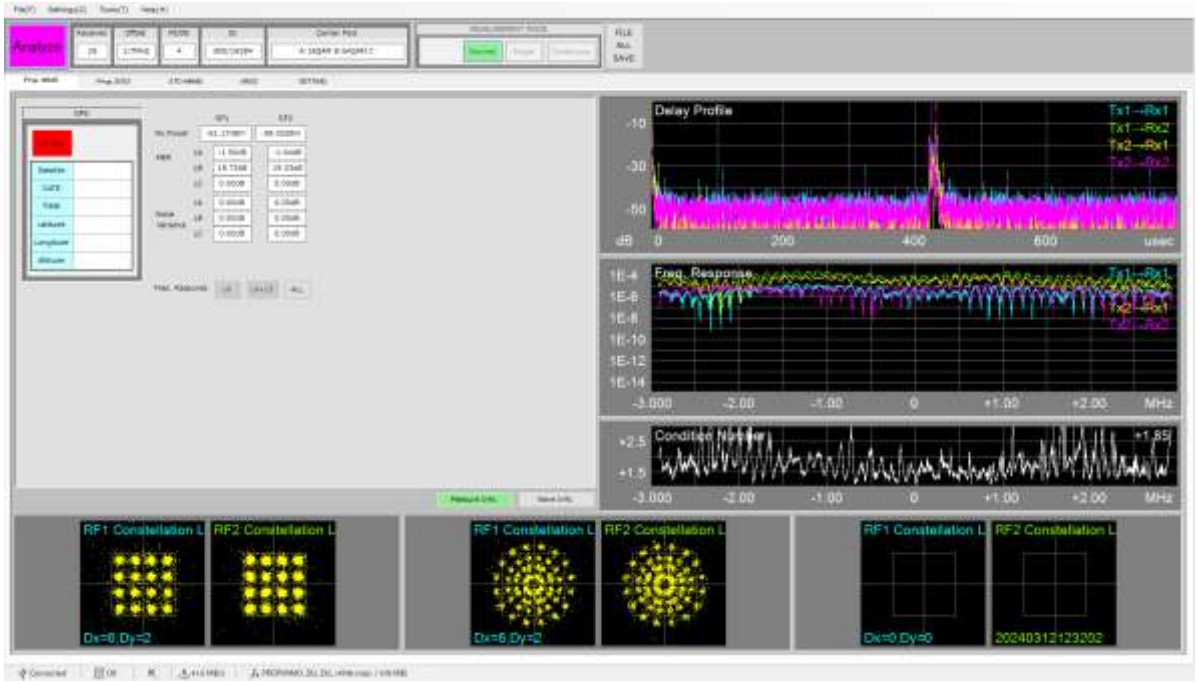


Figure 2.18 - Rintaro Screen

b) AWGN Power

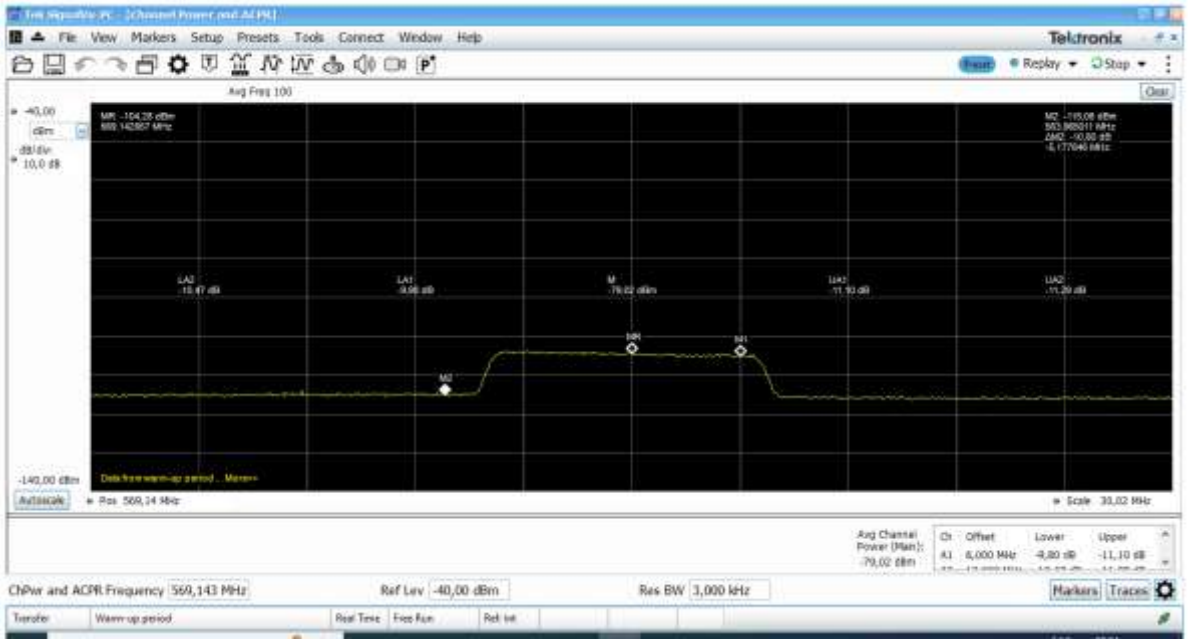


Figure 2.19 - Vertical

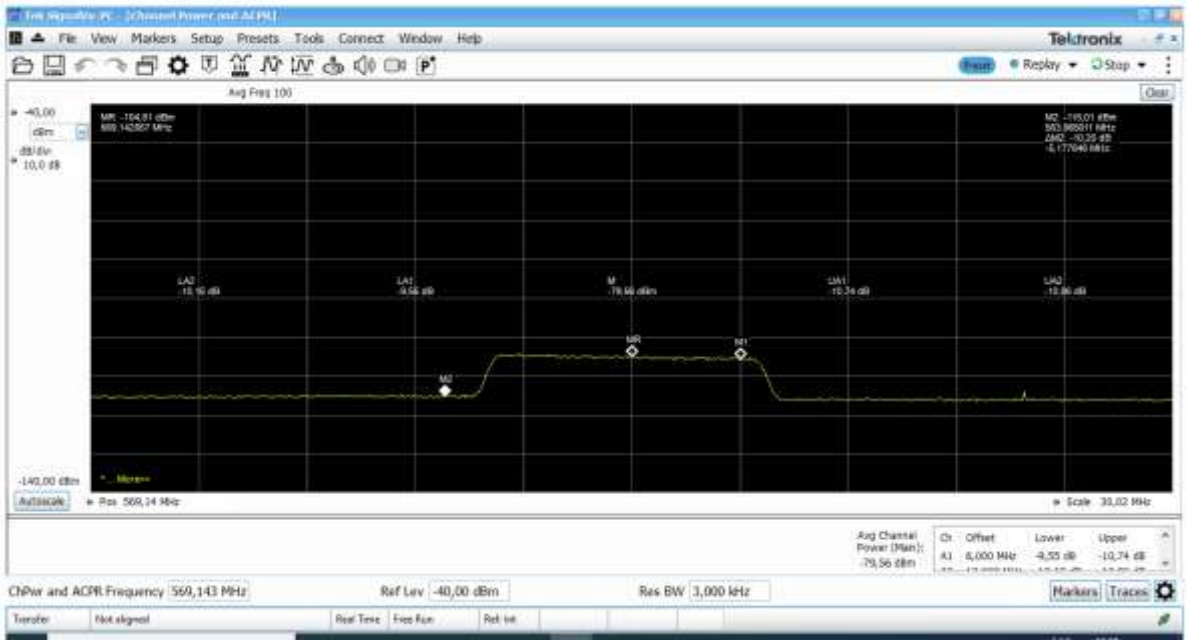


Figure 2.20 - Horizontal

c) C/N Threshold

Figure 2.21 - Vertical

Figure 2.22 - Horizontal

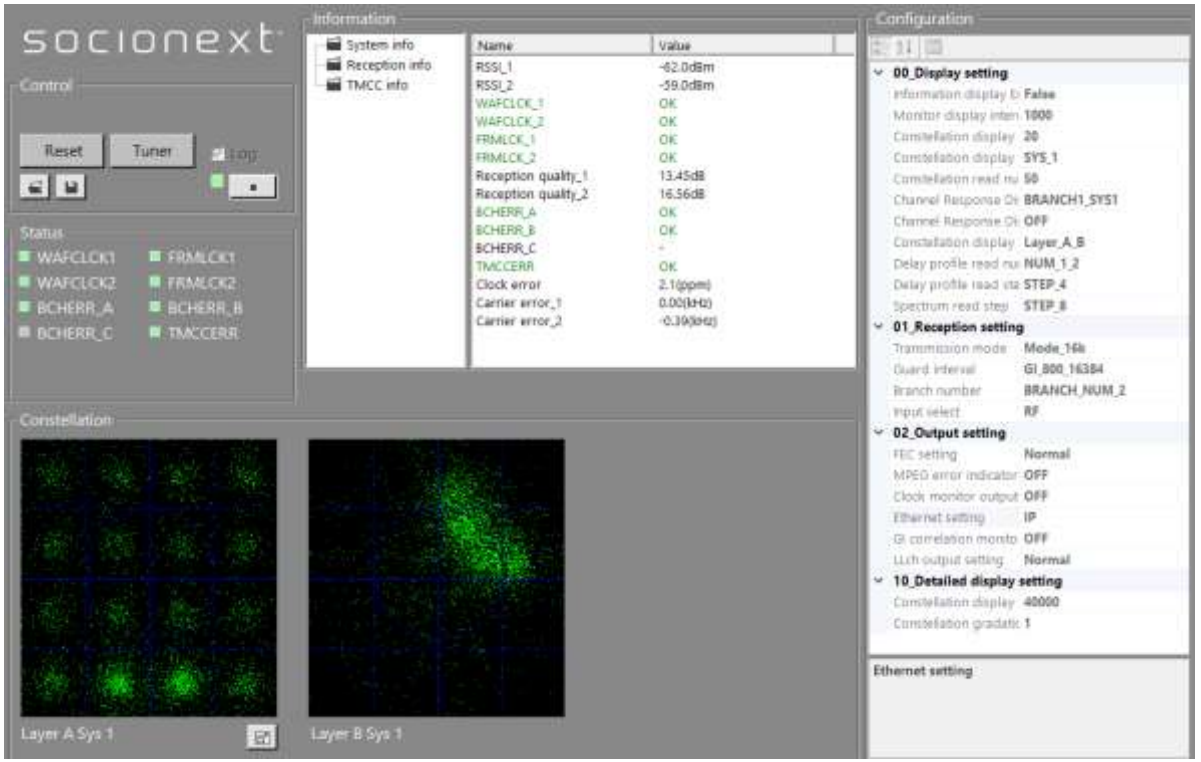


Figure 2.23 - Socionext Screen

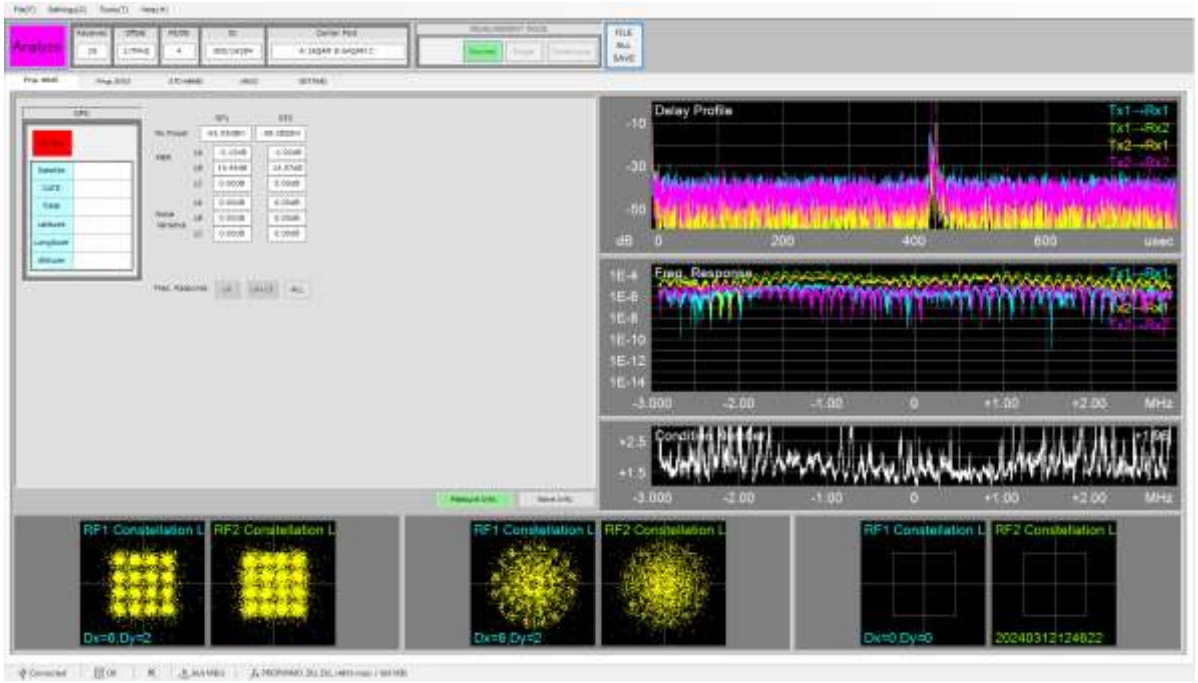


Figure 2.24 - Rintaro Screen

d) Reception Threshold

Figure 2.25 - Vertical

Figure 2.26 - Horizontal

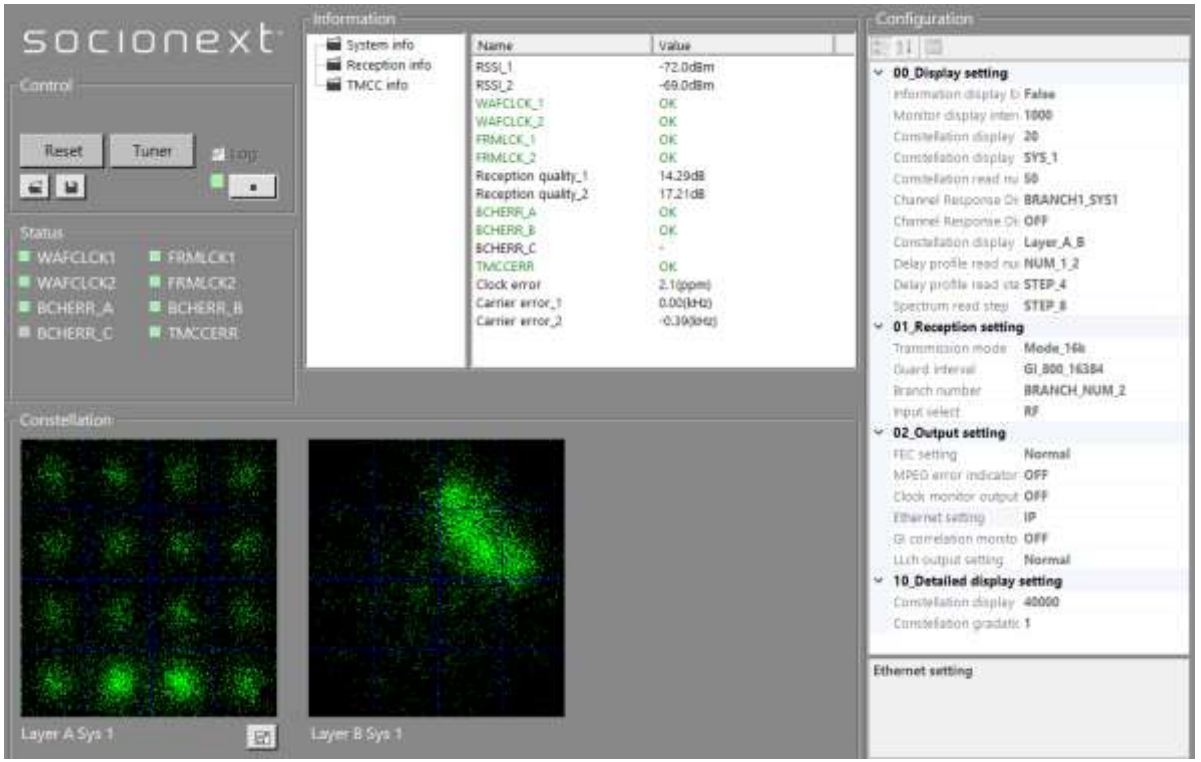


Figure 2.27 - Socionext Screen

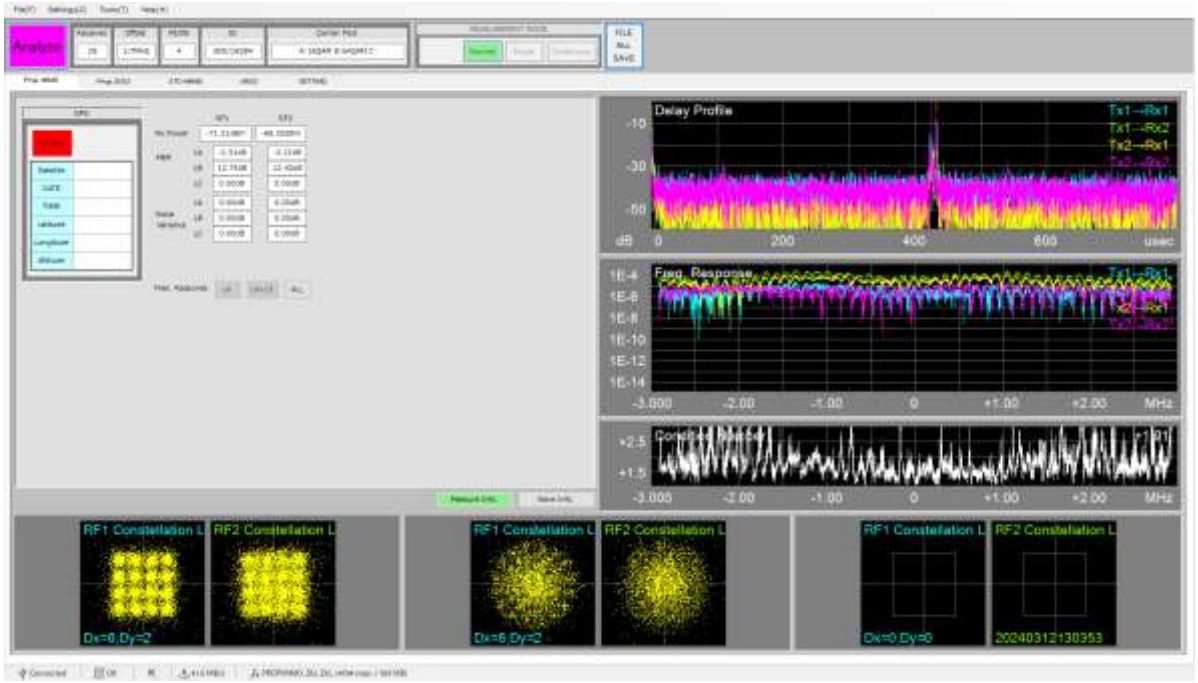


Figure 2.28 - Rintaro Screen

Chapter 3. Site 17

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

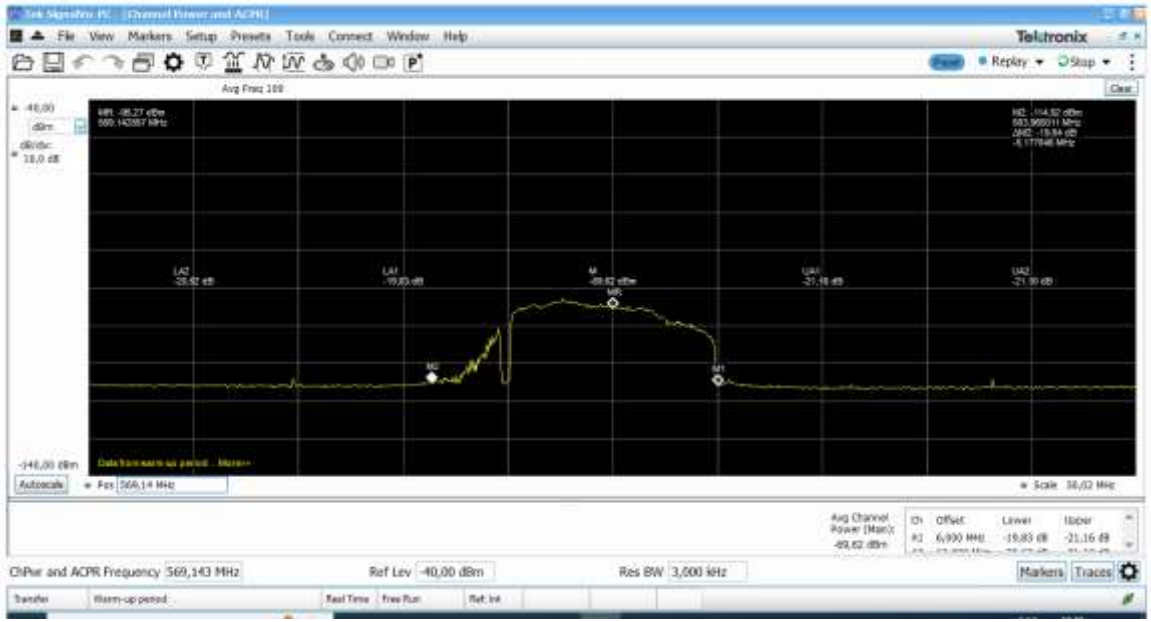


Figure 3.1 - Vertical

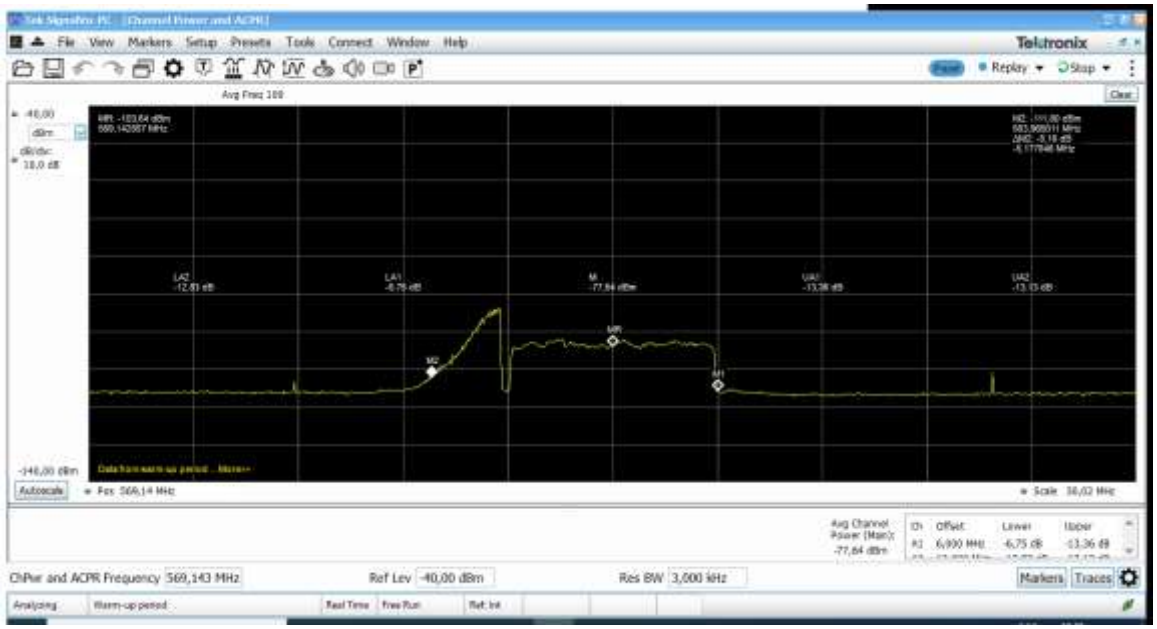


Figure 3.2 - Horizontal

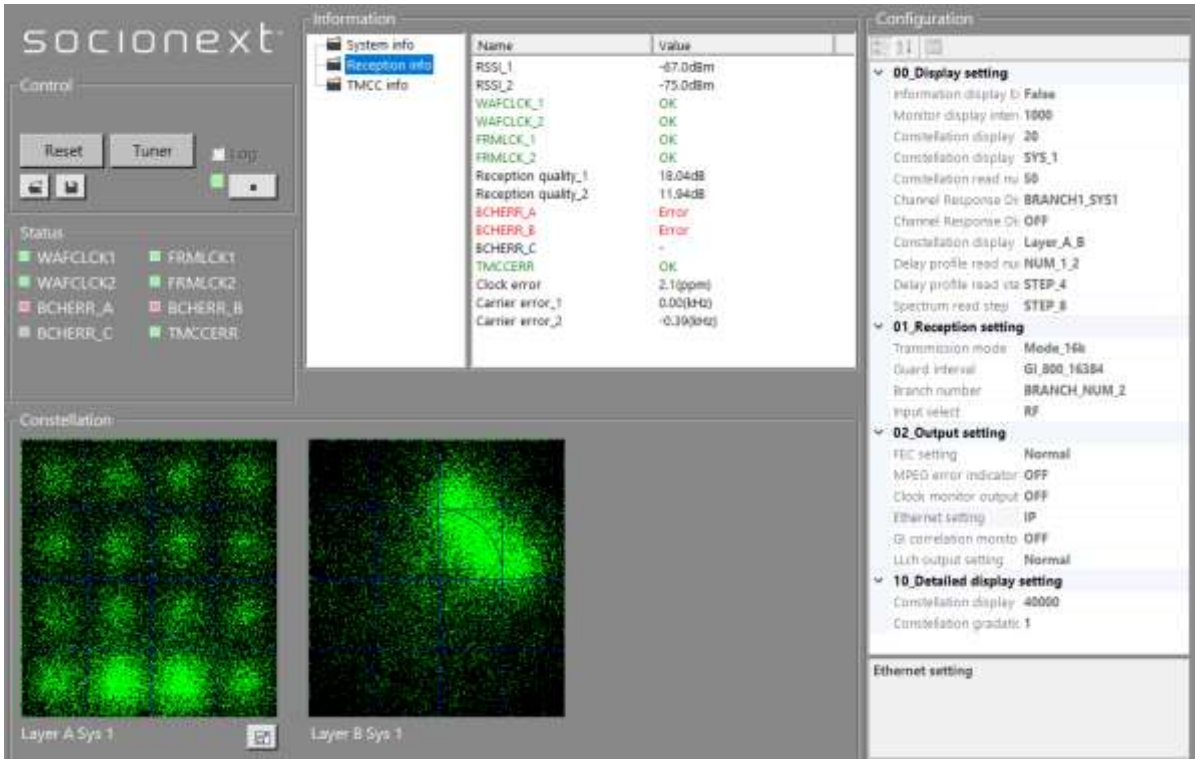


Figure 3.3 - Socionext Screen

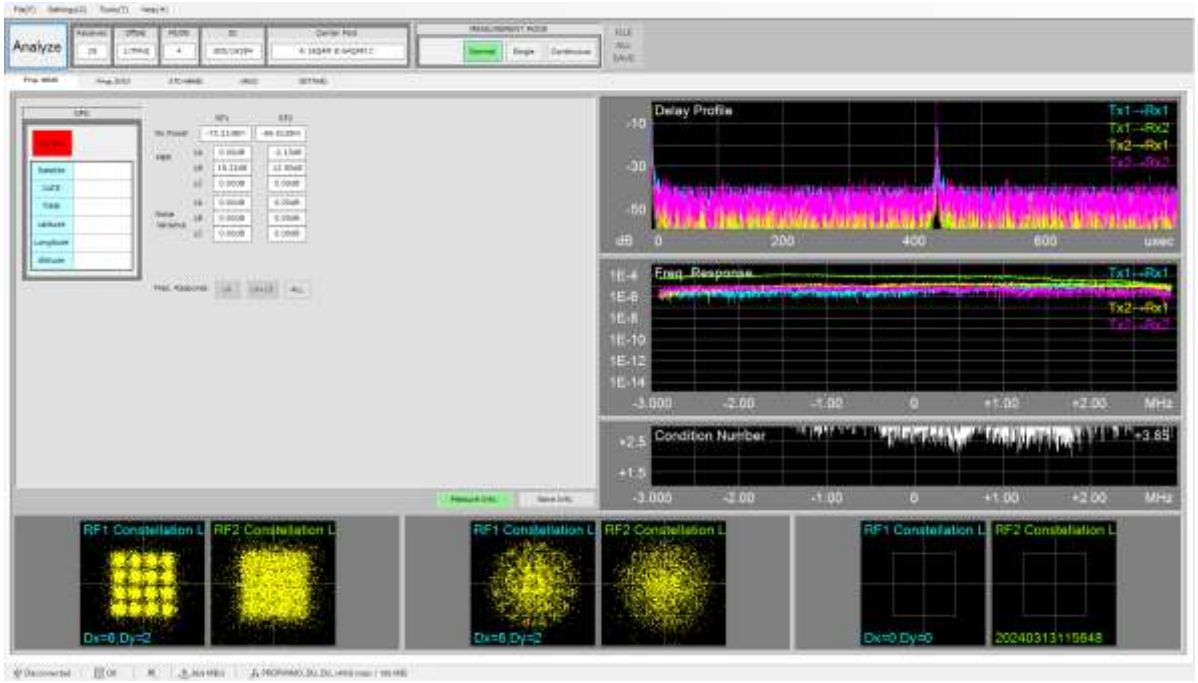


Figure 3.4 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

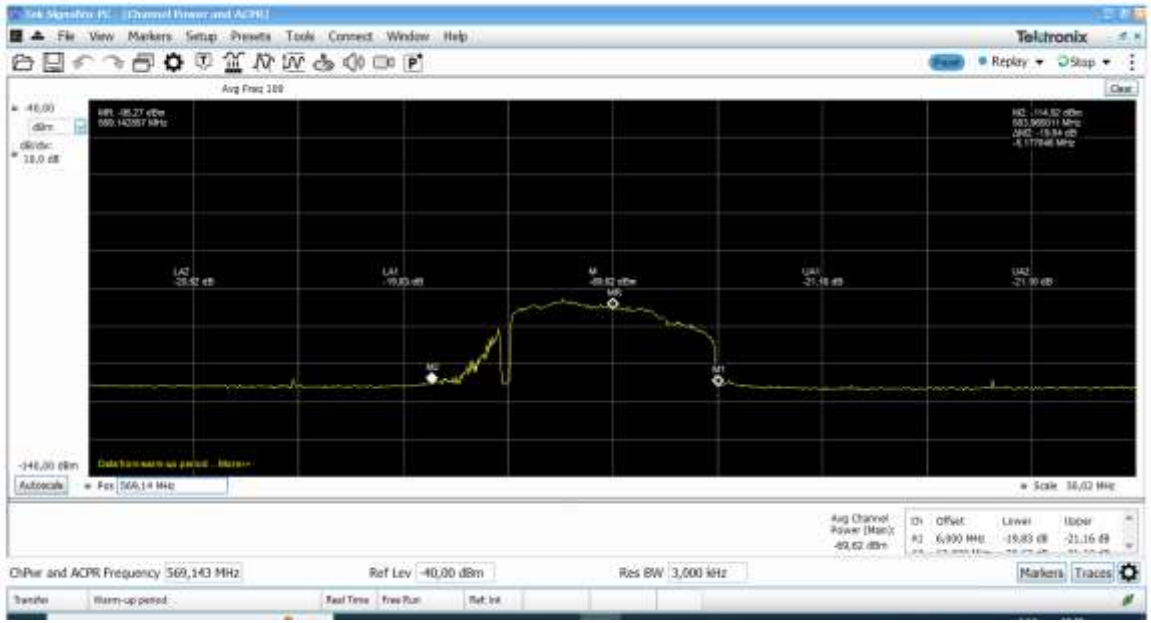


Figure 3.5 - Vertical

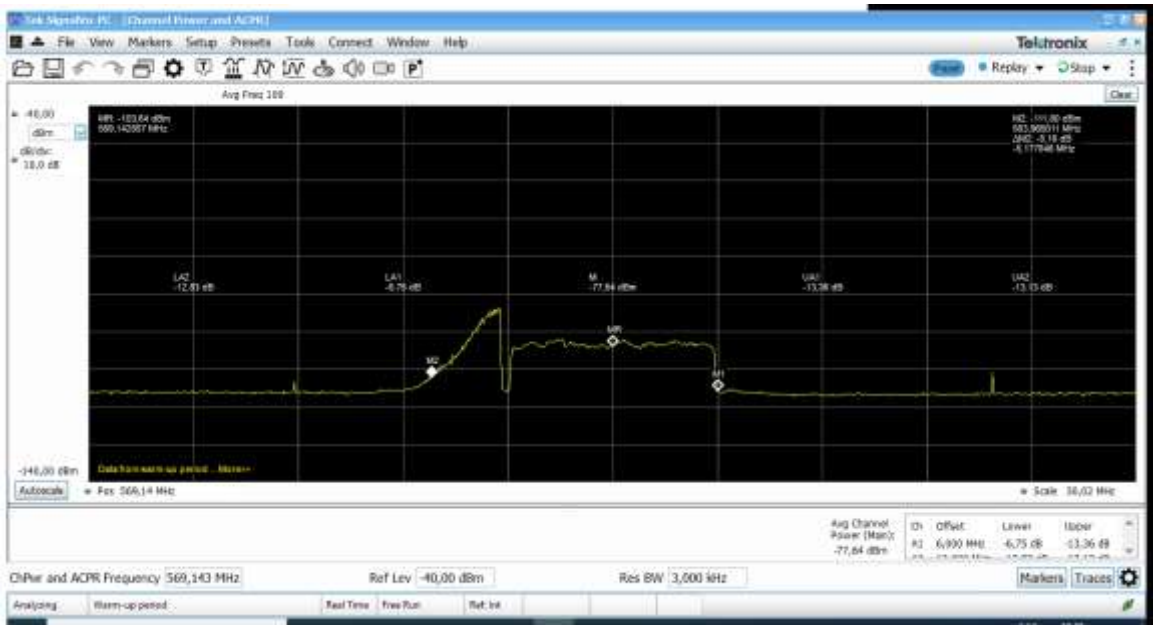


Figure 3.6 - Horizontal

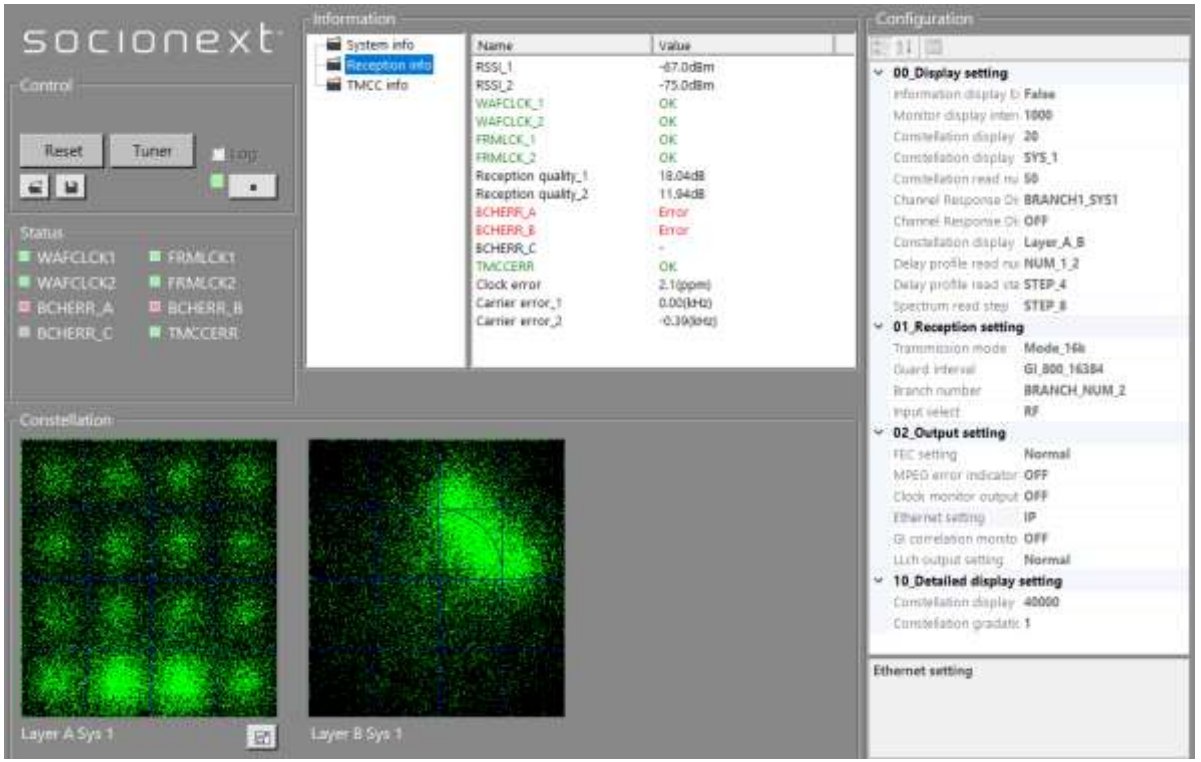


Figure 3.7 - Socionext Screen

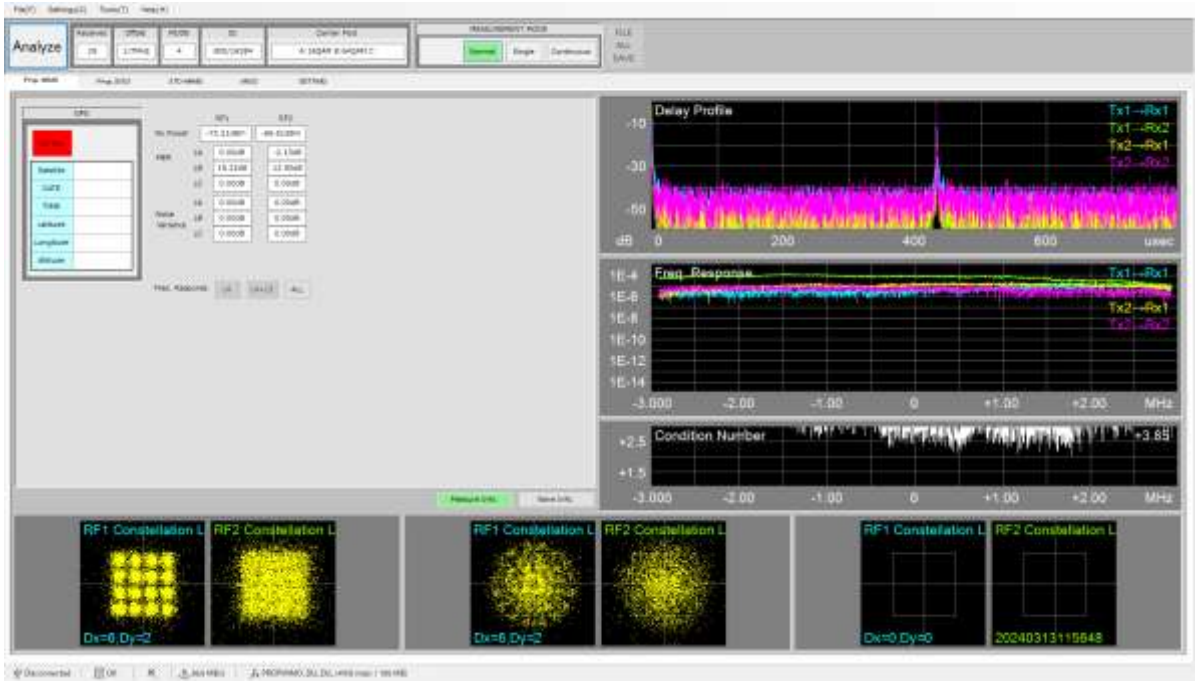


Figure 3.8 - Rintaro Screen

Chapter 4. Site 21

Layer A: 16-QAM UC, FEC 6/16, Bitrate 10.5 Mbps

a) Channel Power

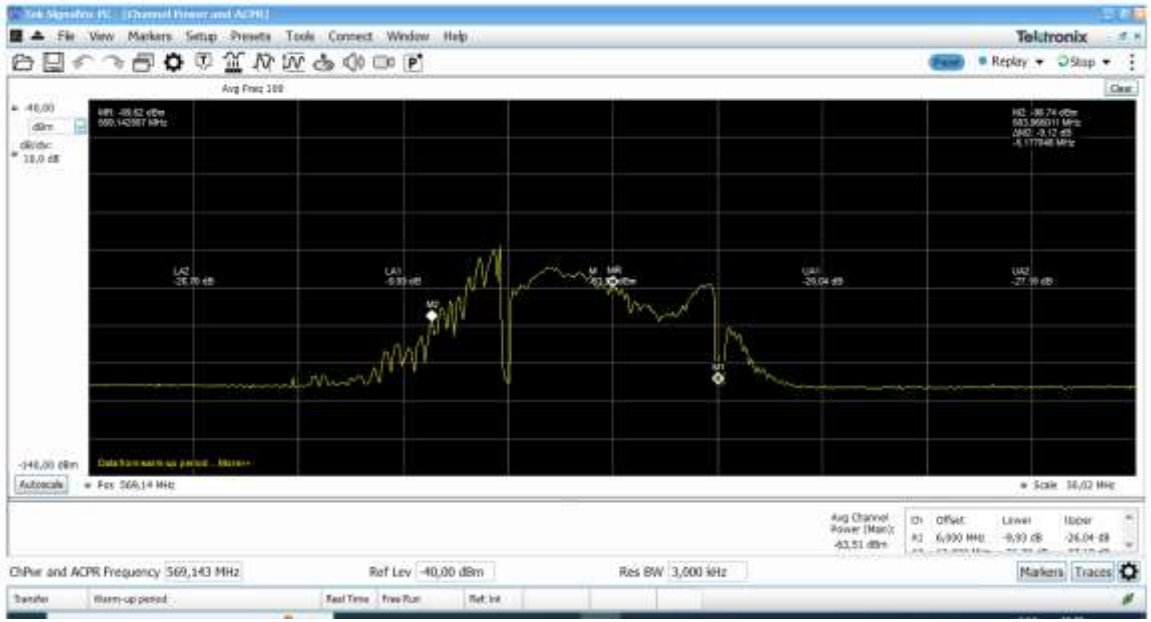


Figure 4.1 - Vertical

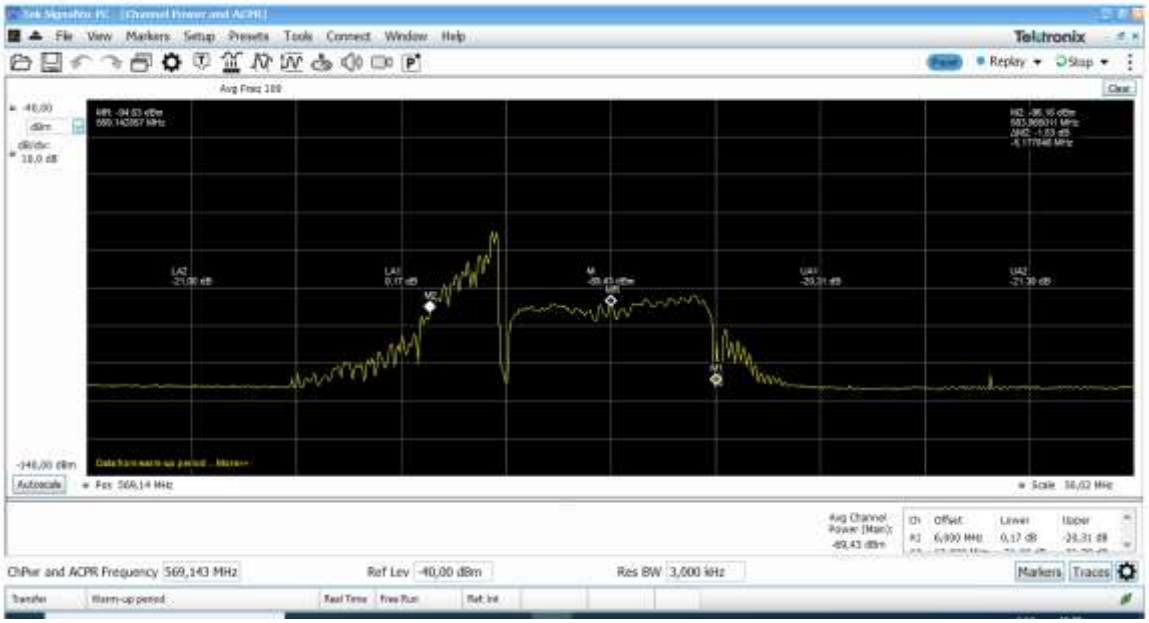


Figure 4.2 - Horizontal

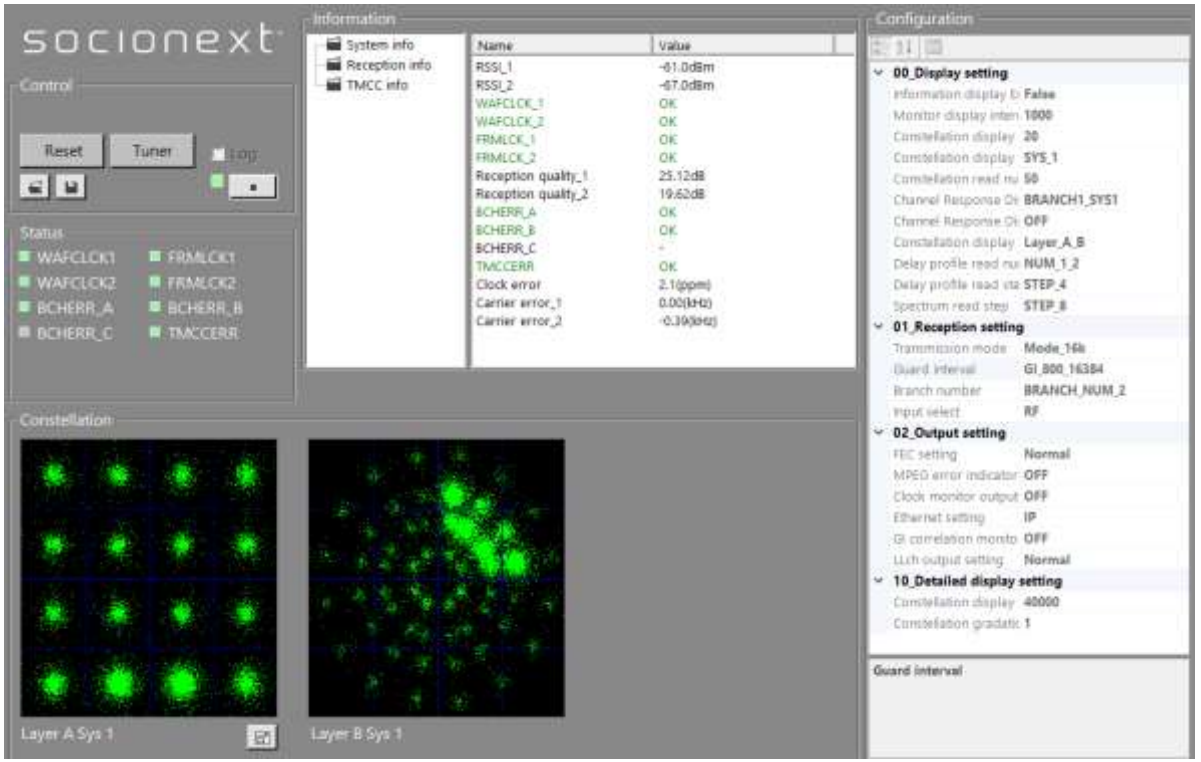


Figure 4.3 - Socionext Screen

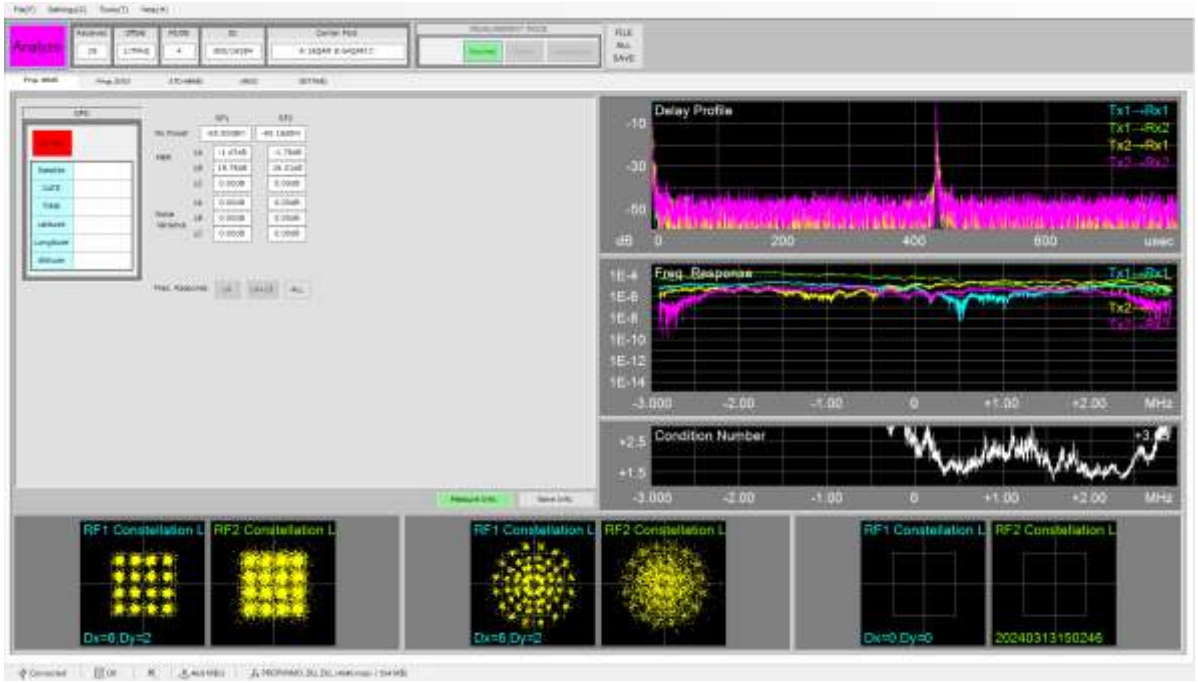


Figure 4.4 - Rintaro Screen

b) AWGN Power

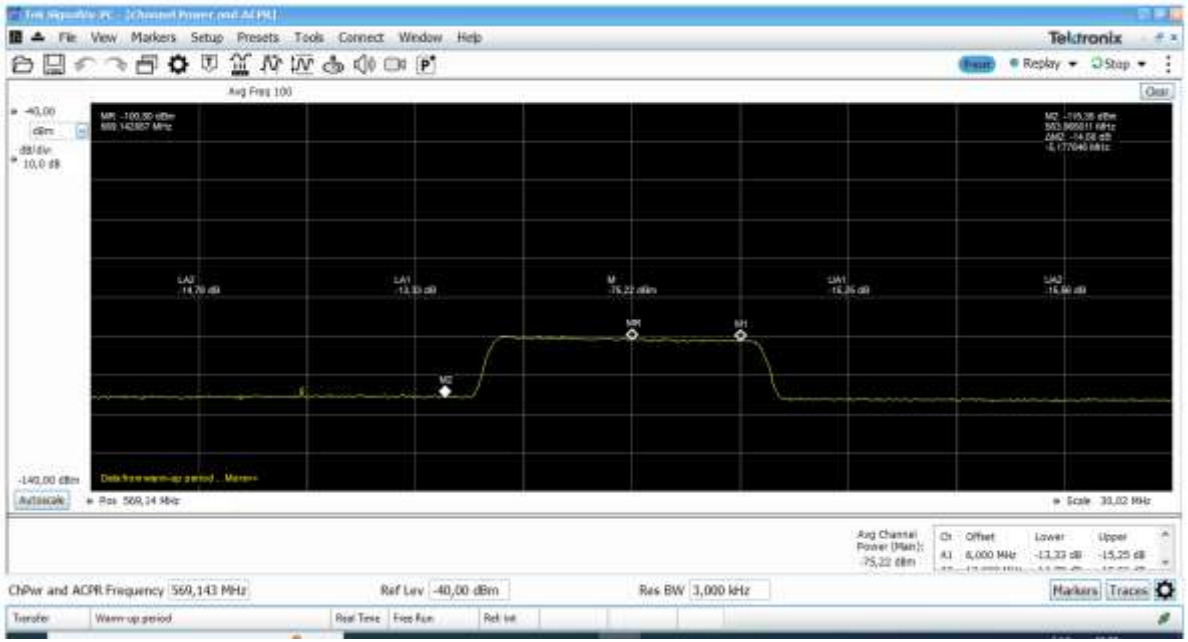


Figure 4.5 - Vertical

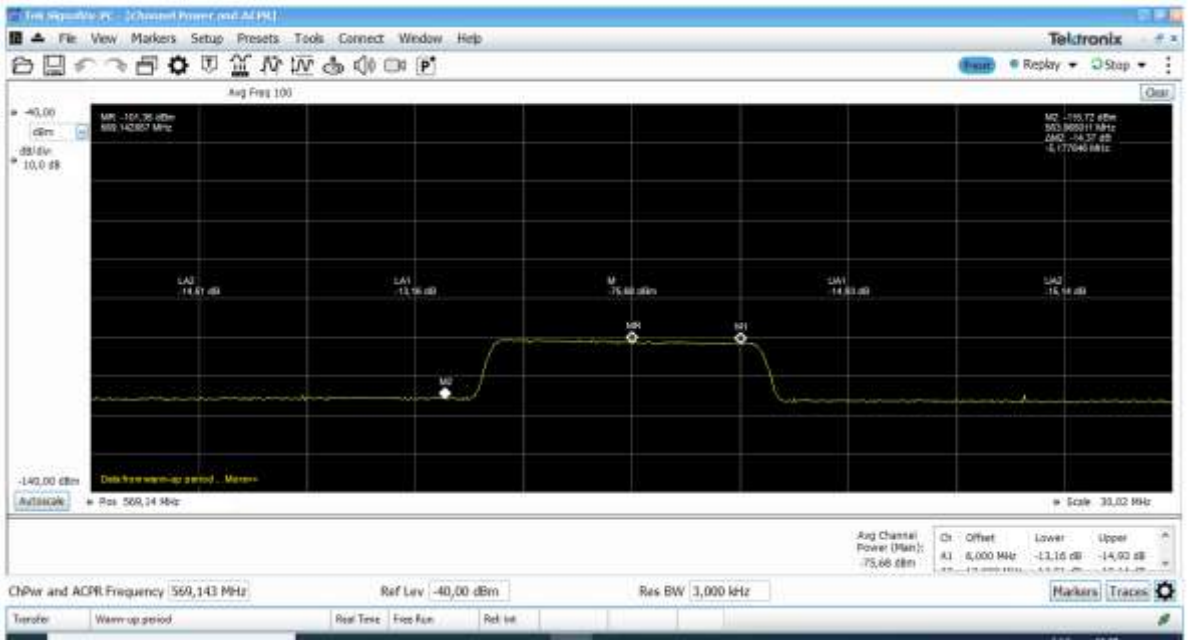


Figure 4.6 - Horizontal

c) C/N Threshold

Figure 4.7 - Vertical

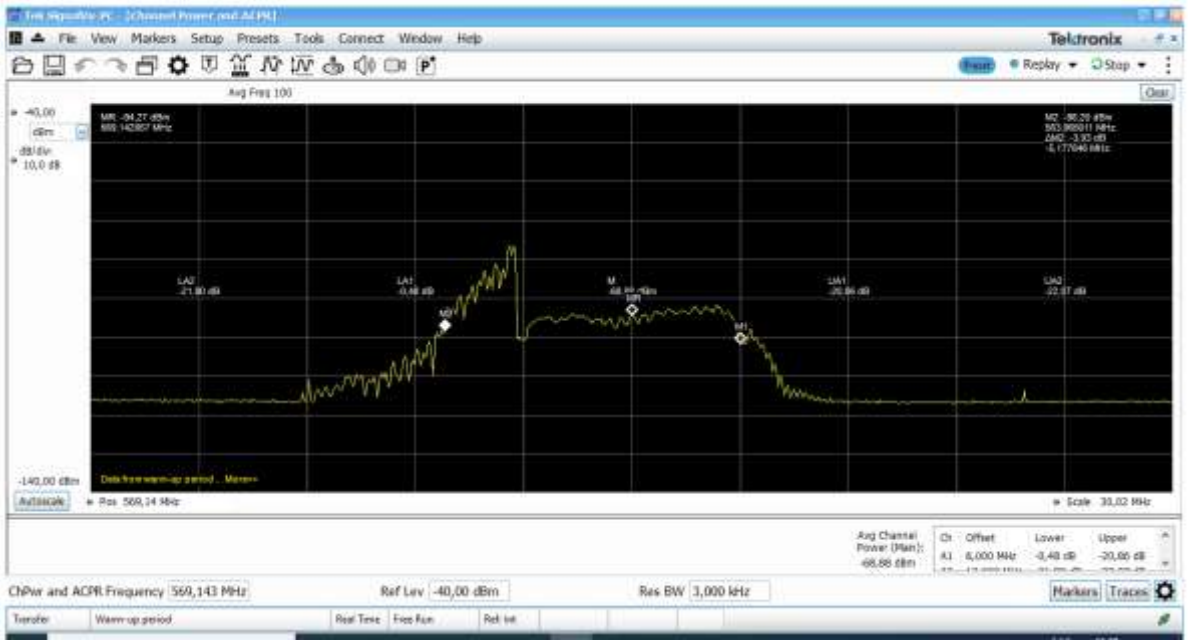


Figure 4.8 - Horizontal

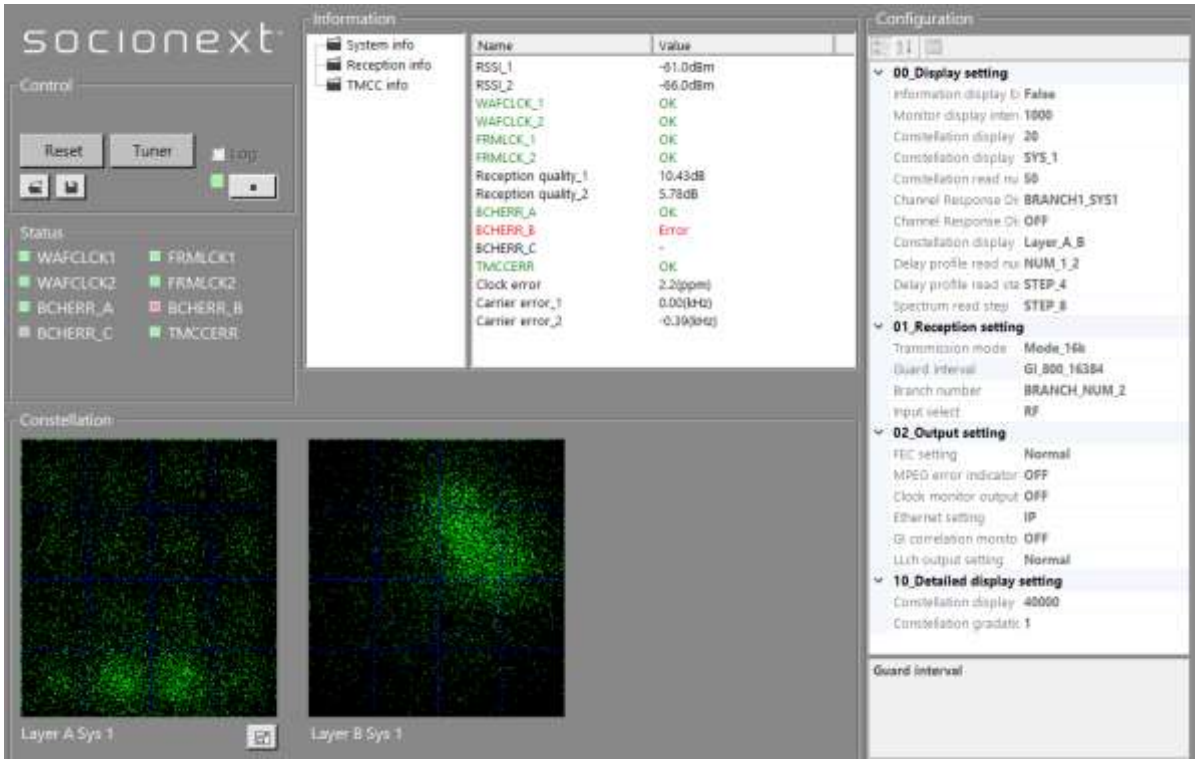


Figure 4.9 - Socionext Screen

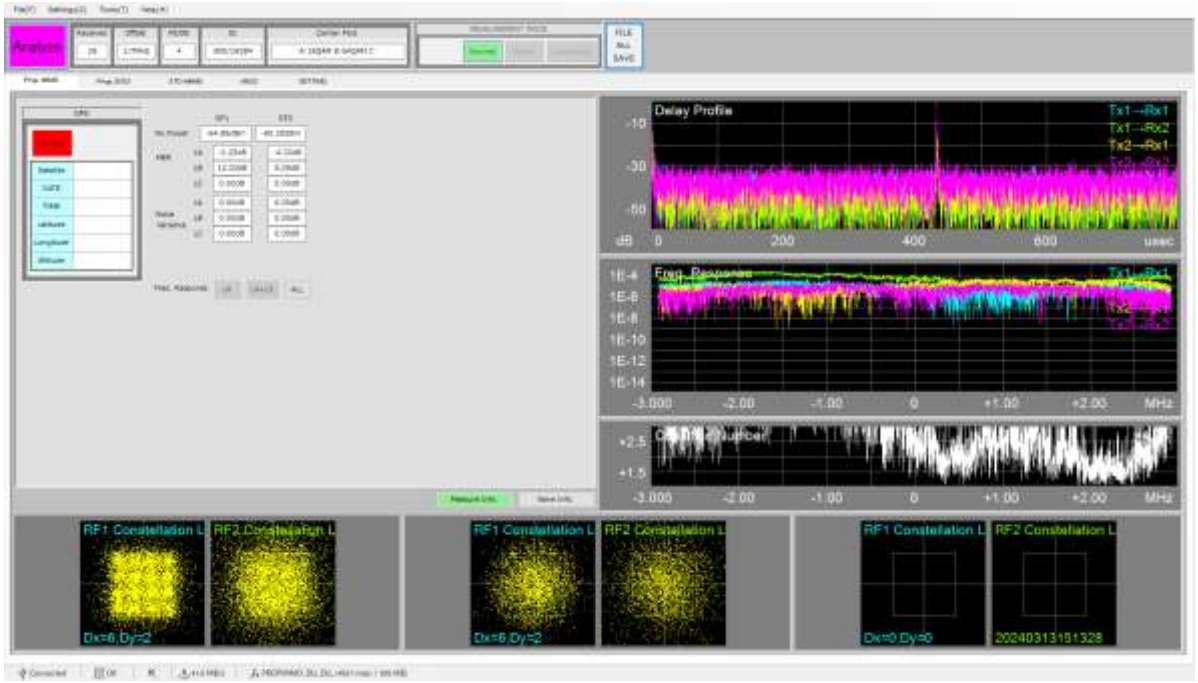


Figure 4.10 - Rintaro Screen

d) Reception Threshold

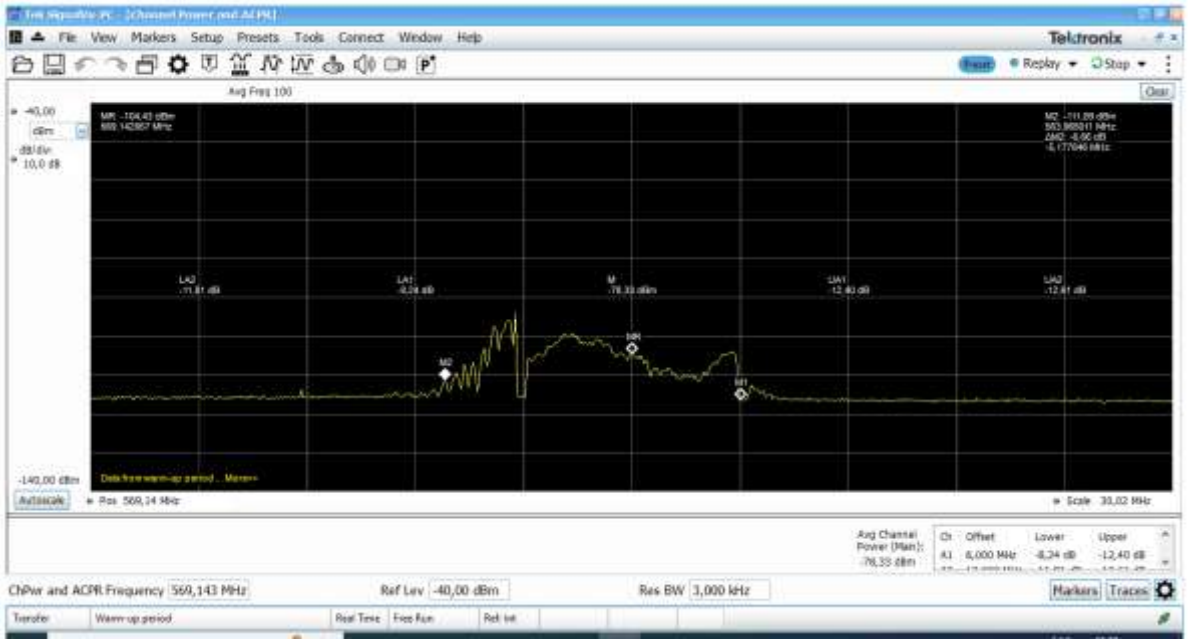


Figure 4.11 - Vertical

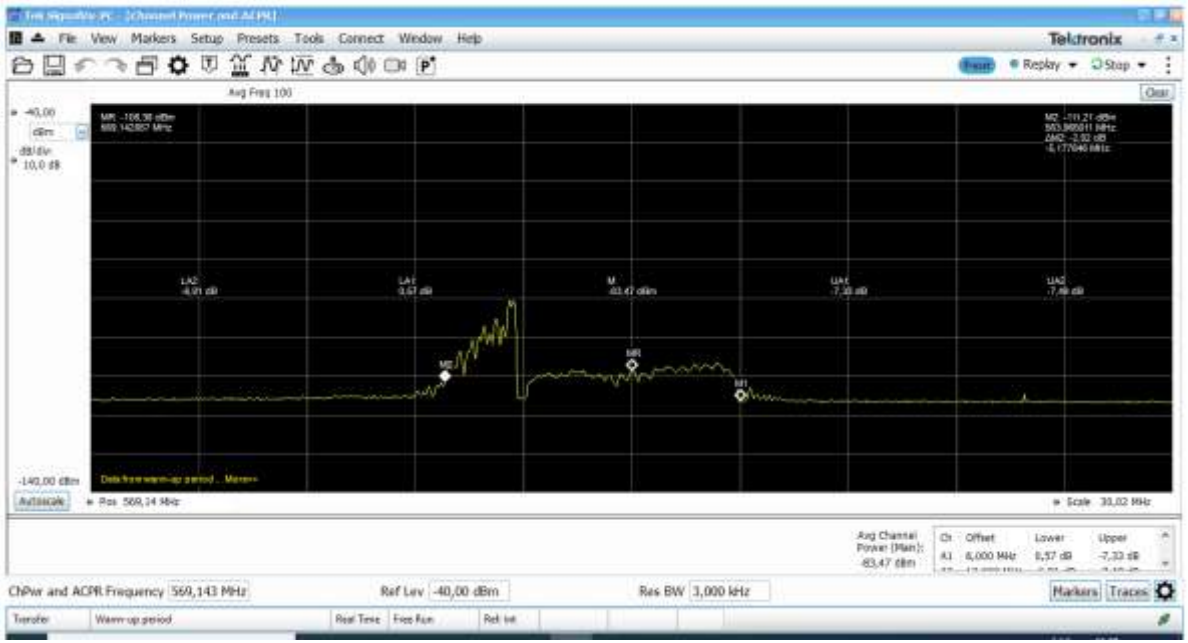


Figure 4.12 - Horizontal

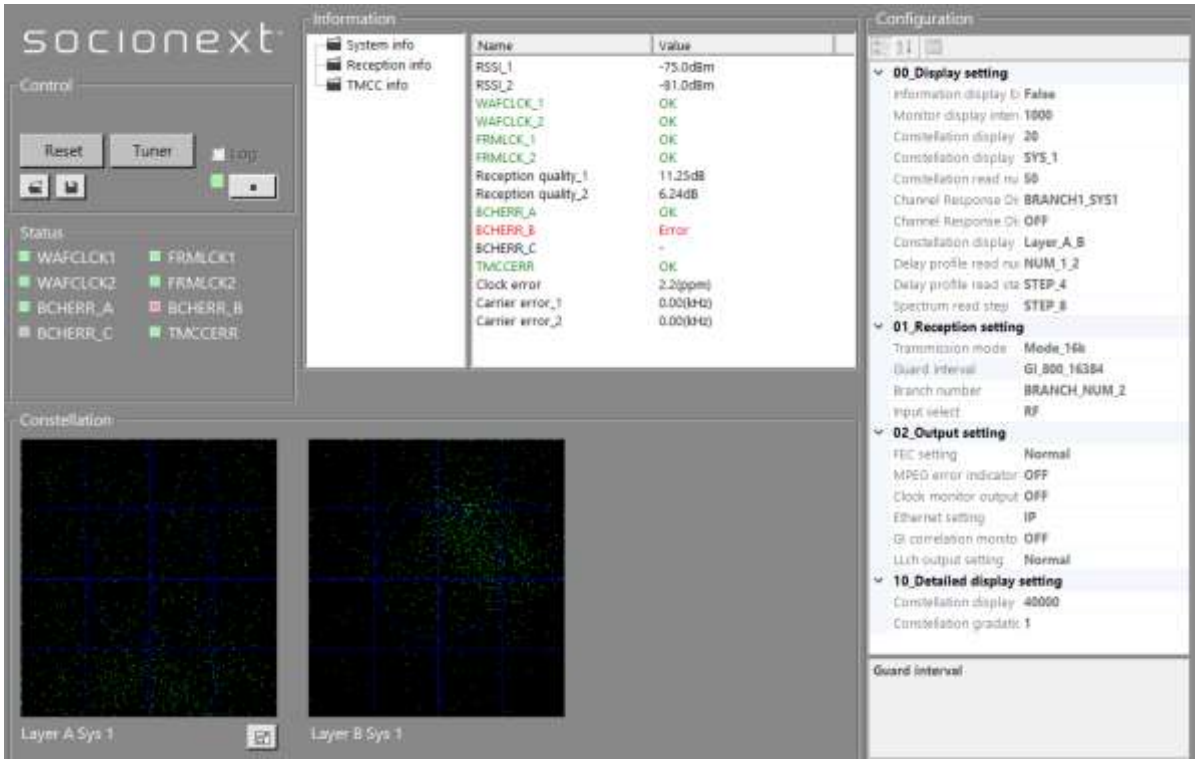


Figure 4.13 - Socionext Screen

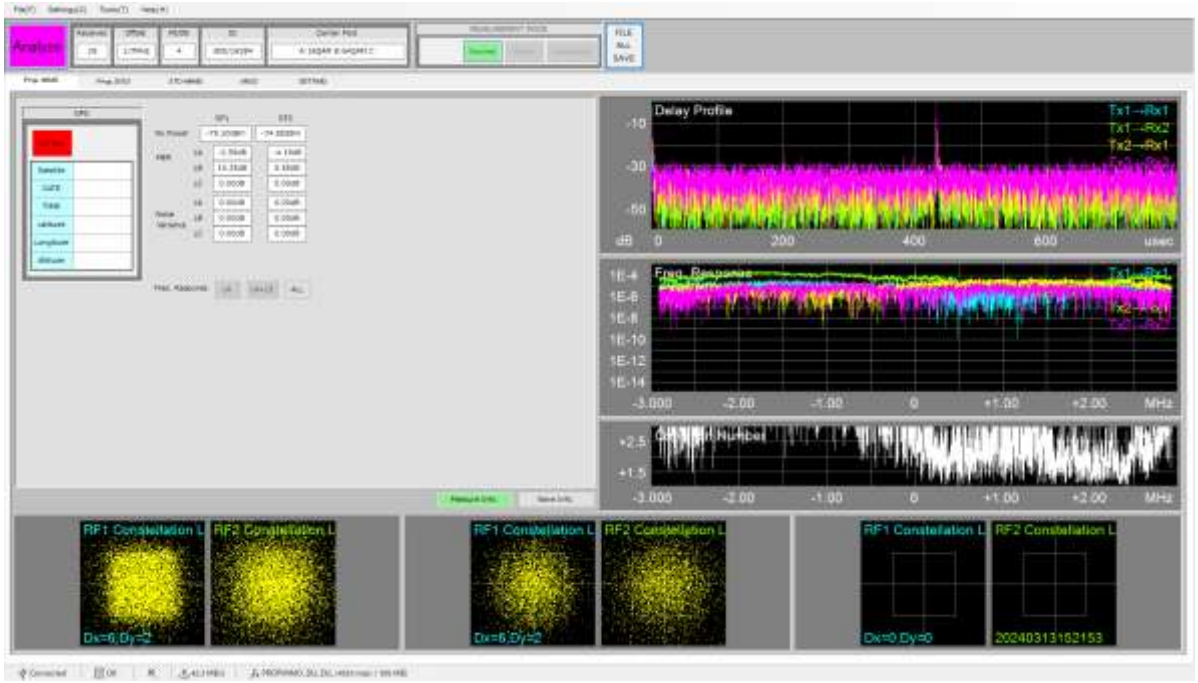


Figure 4.14 - Rintaro Screen

Layer B: 64-QAM NUC, FEC 10/16, Bitrate 10.5 Mbps

a) Channel Power

Figure 4.15 - Vertical

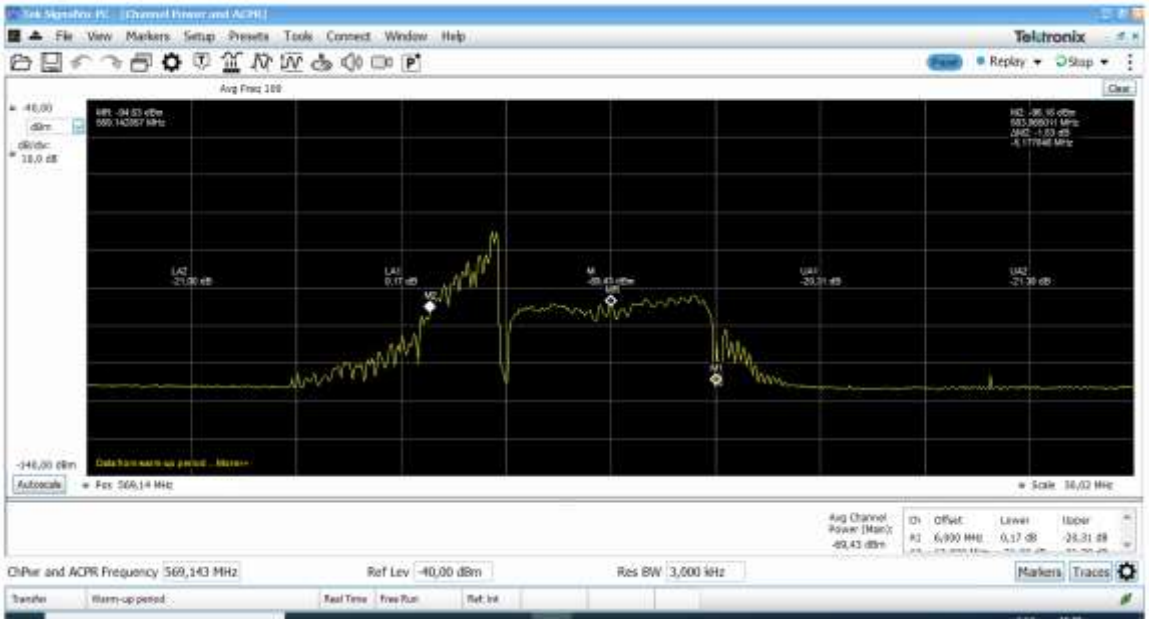


Figure 4.16 - Horizontal

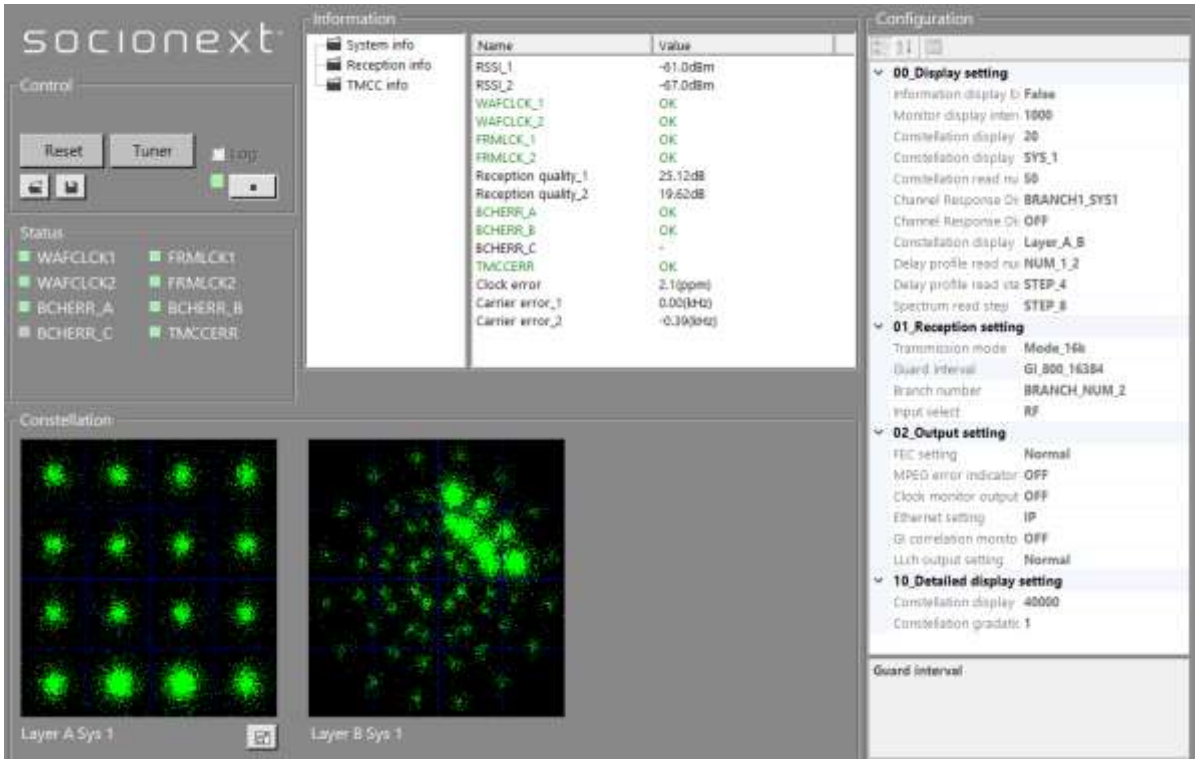


Figure 4.17 - Socionext Screen

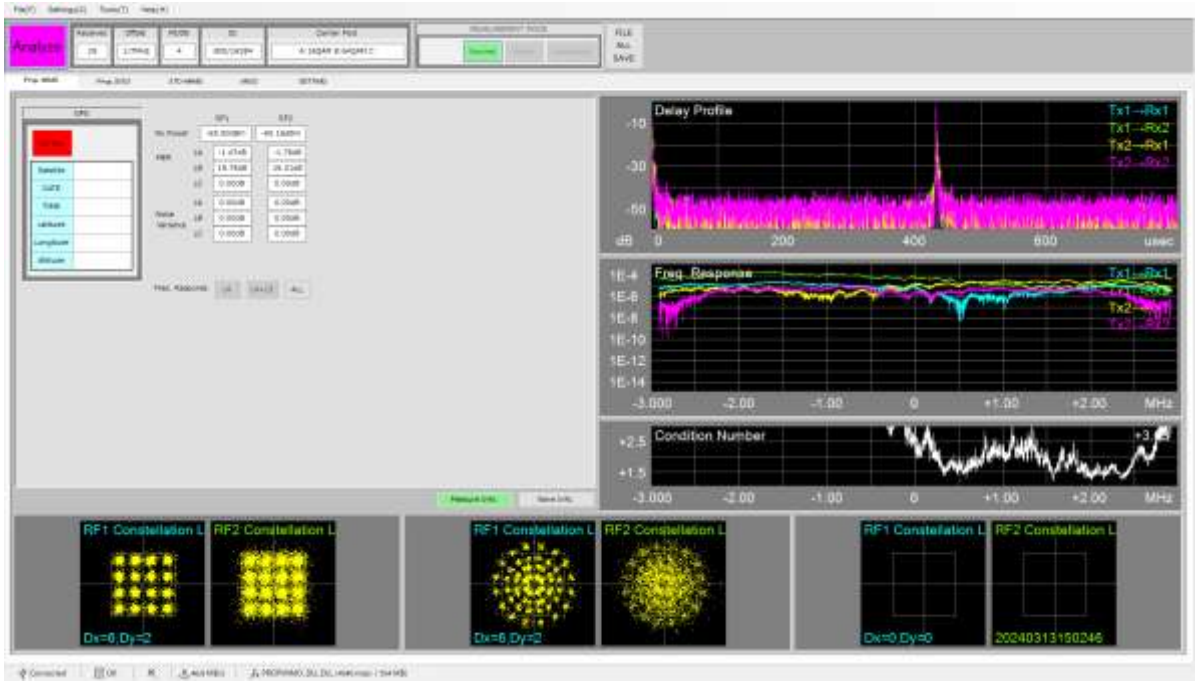


Figure 4.18 - Rintaro Screen

b) AWGN Power

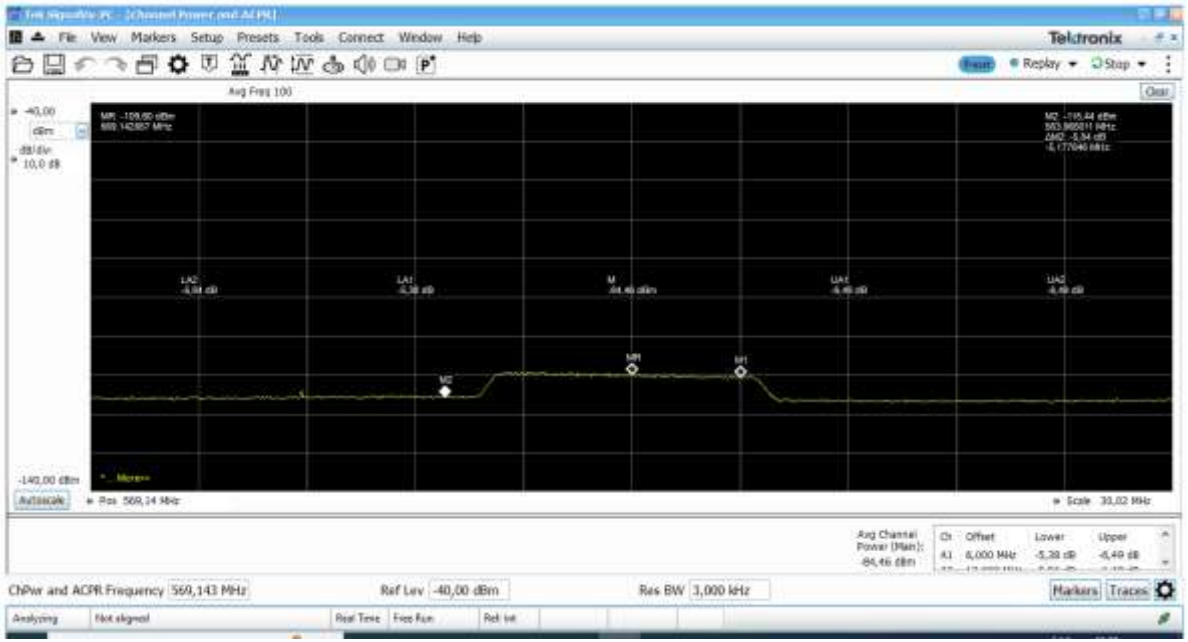


Figure 4.19 - Vertical

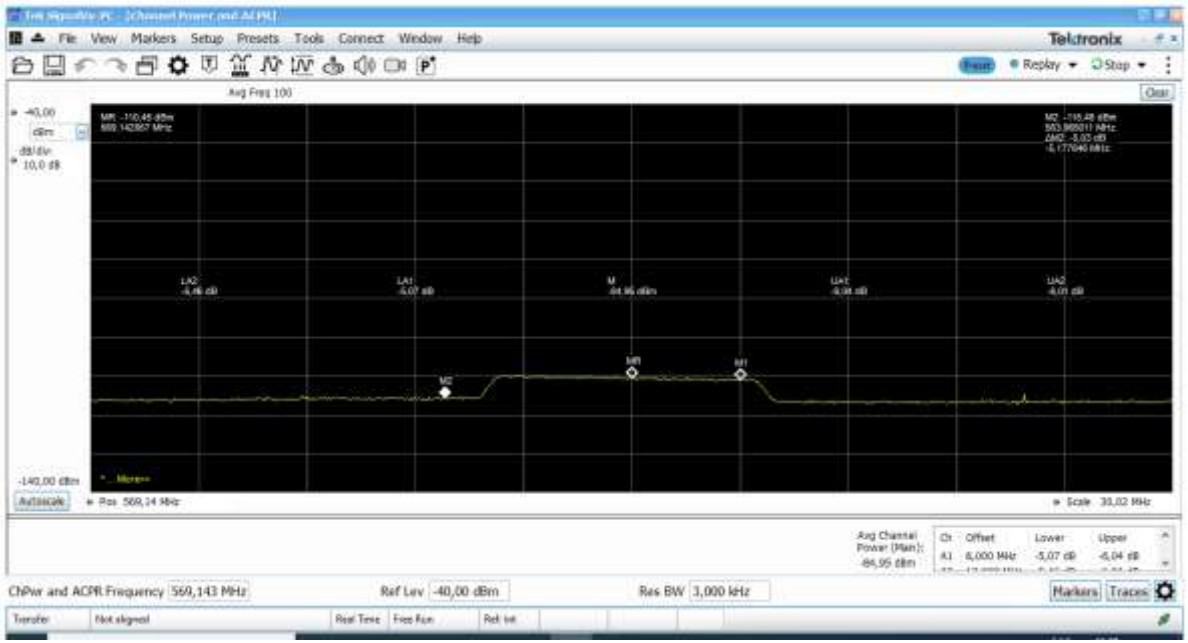


Figure 4.20 - Horizontal

c) C/N Threshold

Figure 4.21 - Vertical

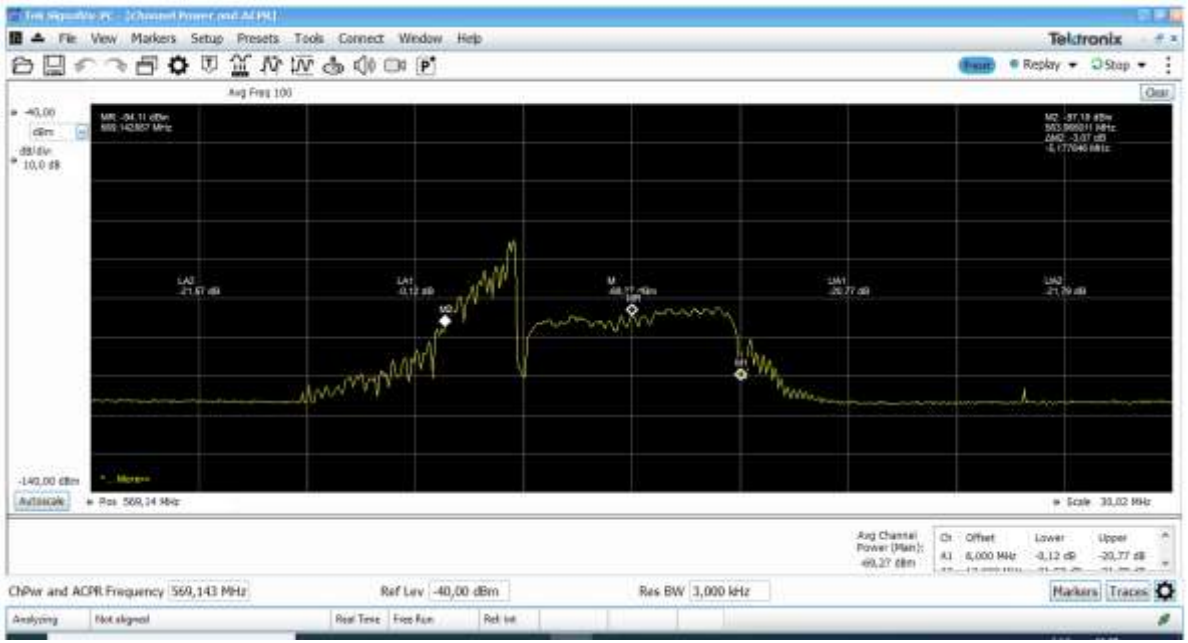


Figure 4.22 - Horizontal

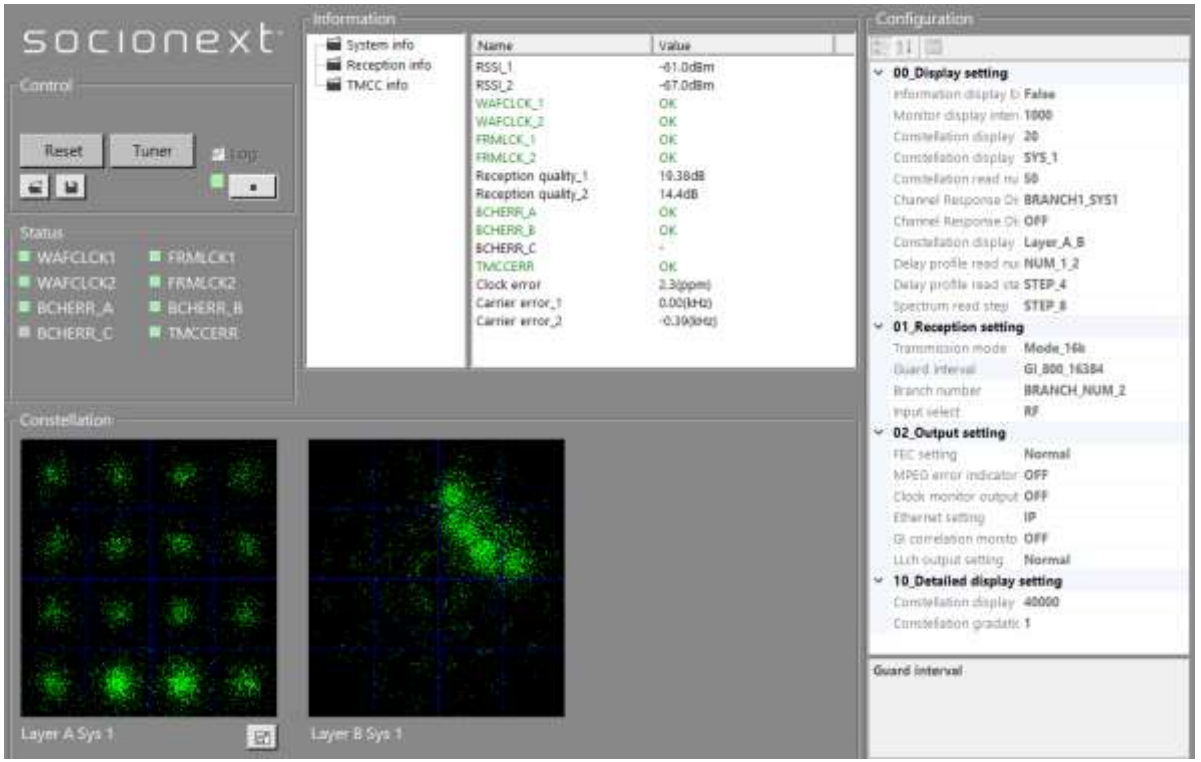


Figure 4.23 - Socionext Screen

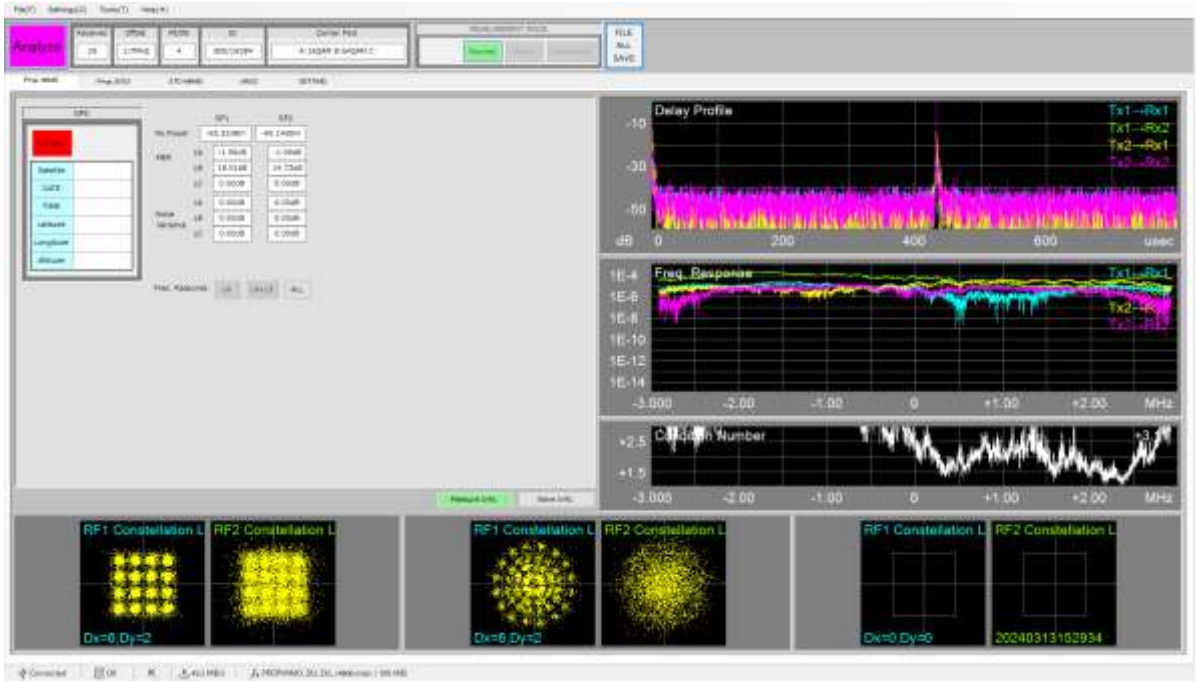


Figure 4.24 - Rintaro Screen

d) Reception Threshold

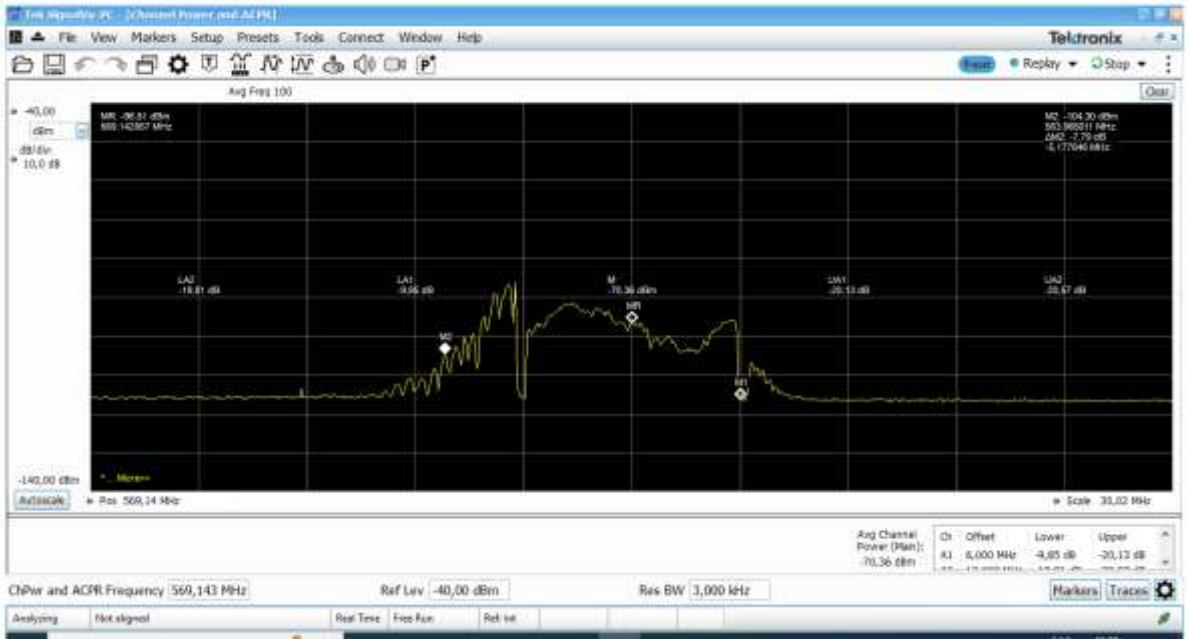


Figure 4.25 - Vertical

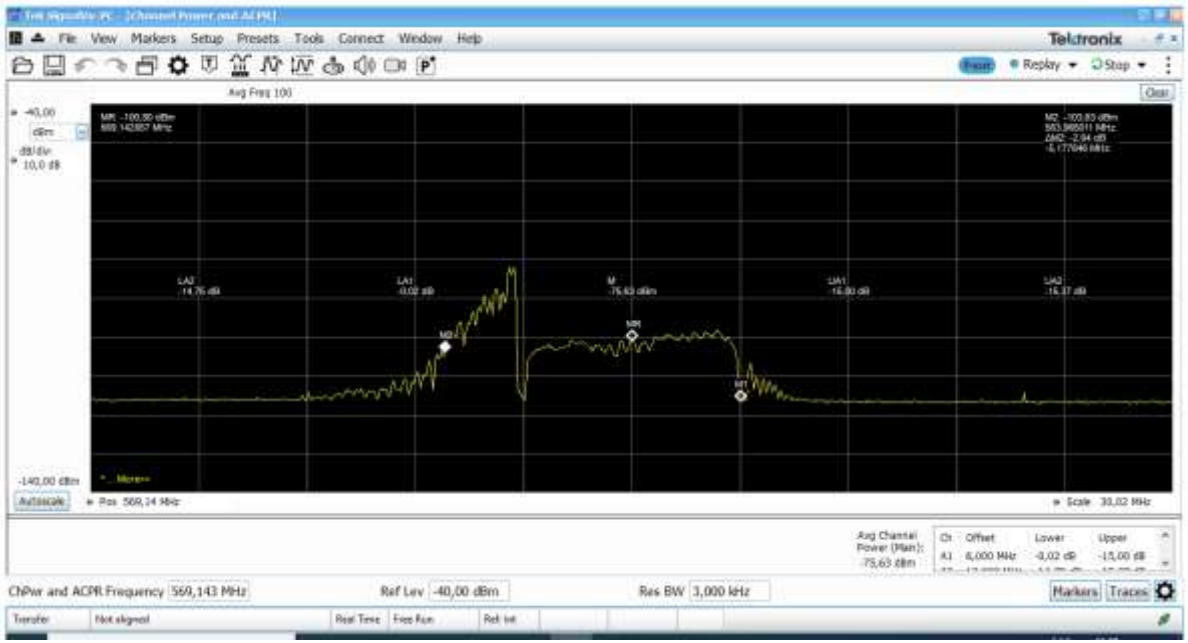


Figure 4.26 - Horizontal

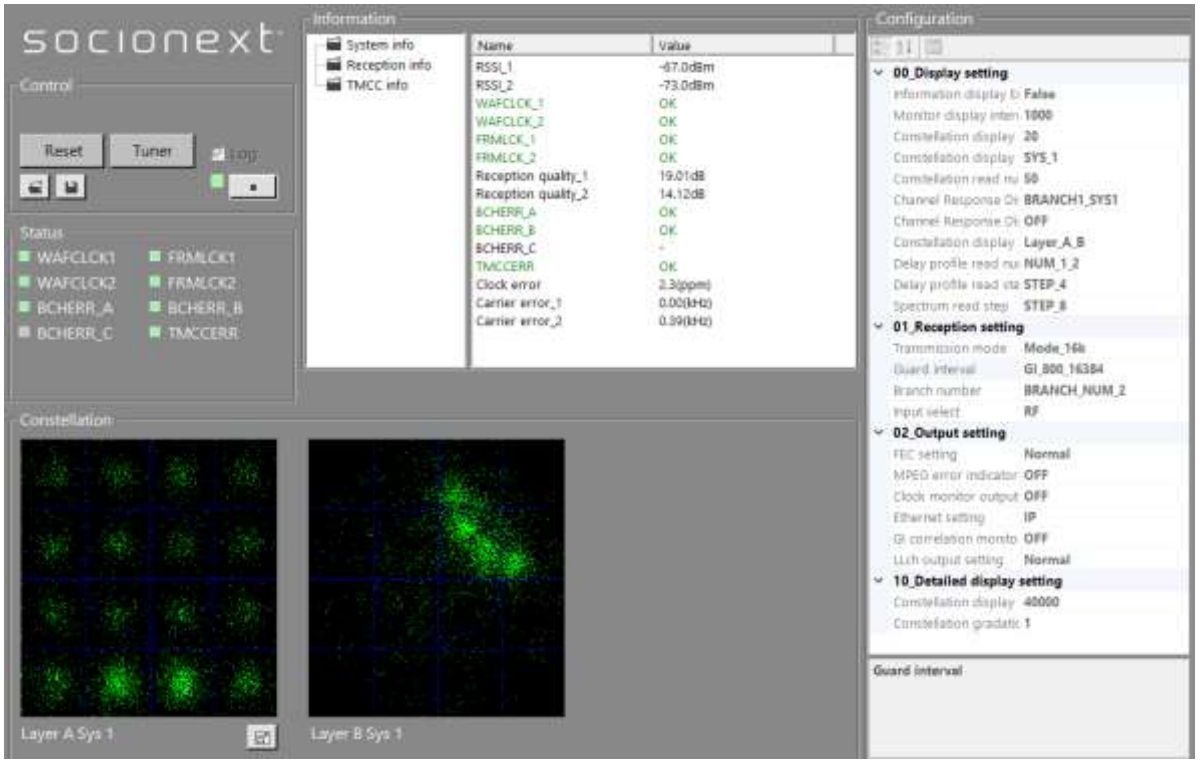


Figure 4.27 - Socionext Screen

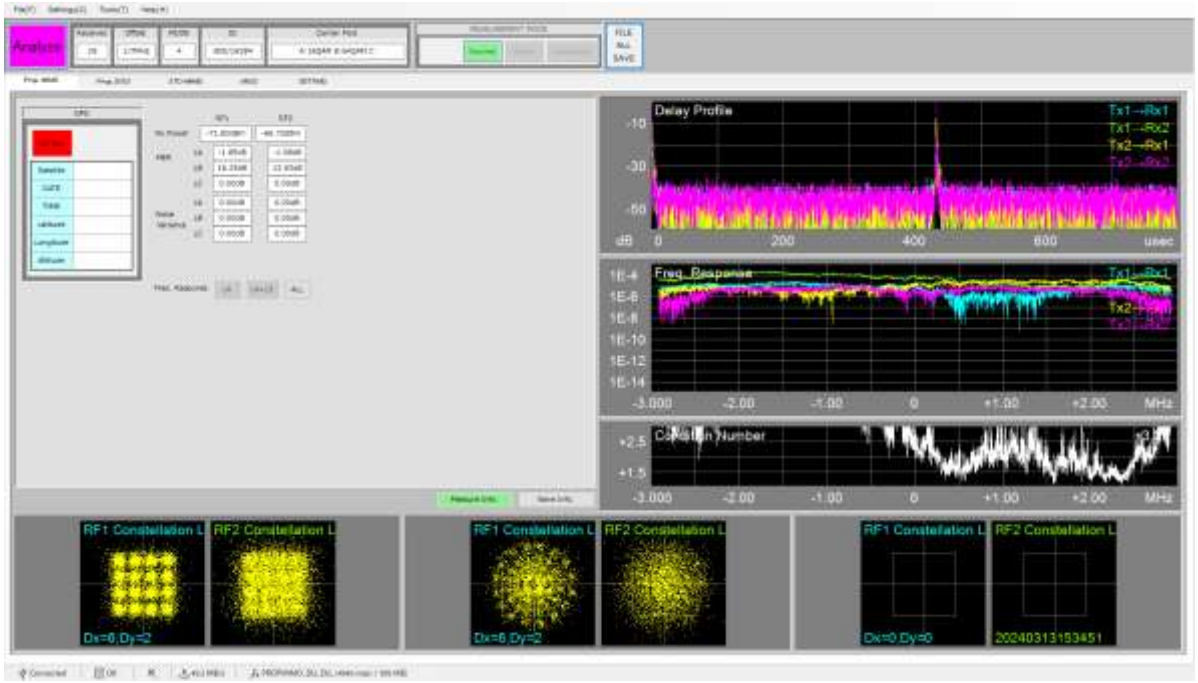


Figure 4.28 - Rintaro Screen

Appendix VII. Extra outdoor measurements using ATSC 3.0 - Configuration 3 - Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps; Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

Chapter 1. Site 1

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

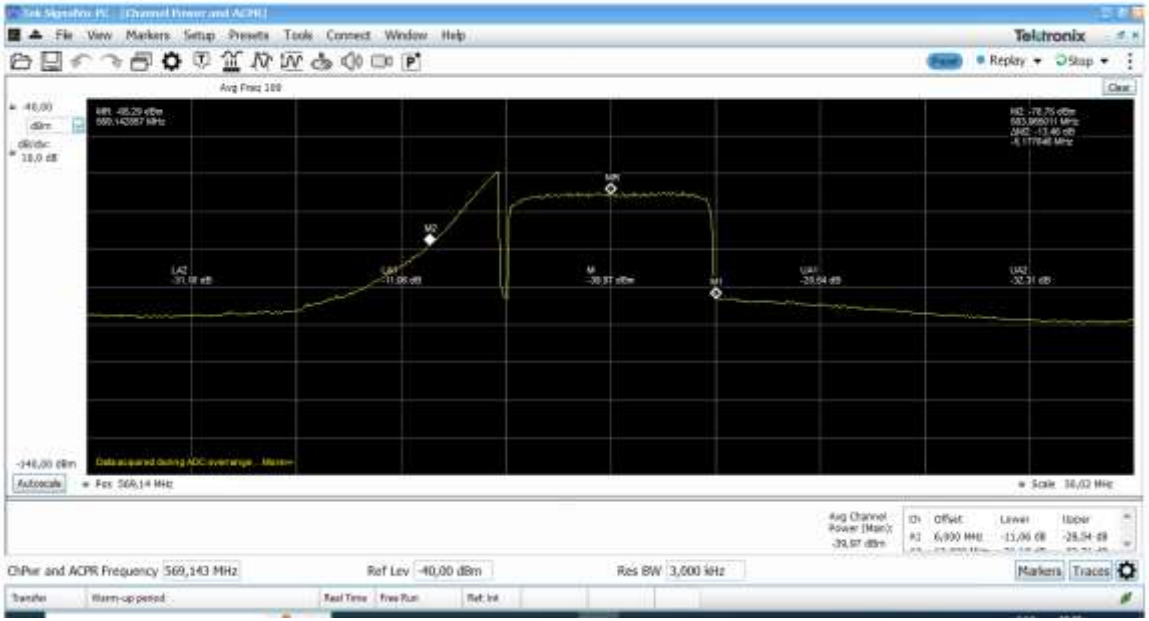


Figure 1.1 - Vertical

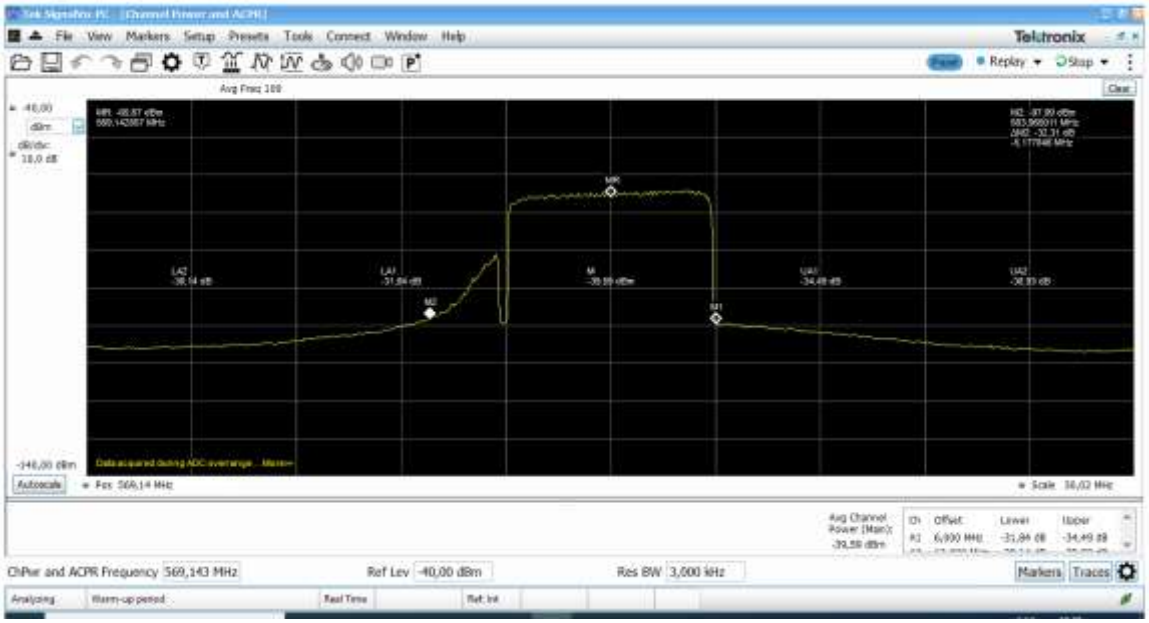


Figure 1.2 - Horizontal

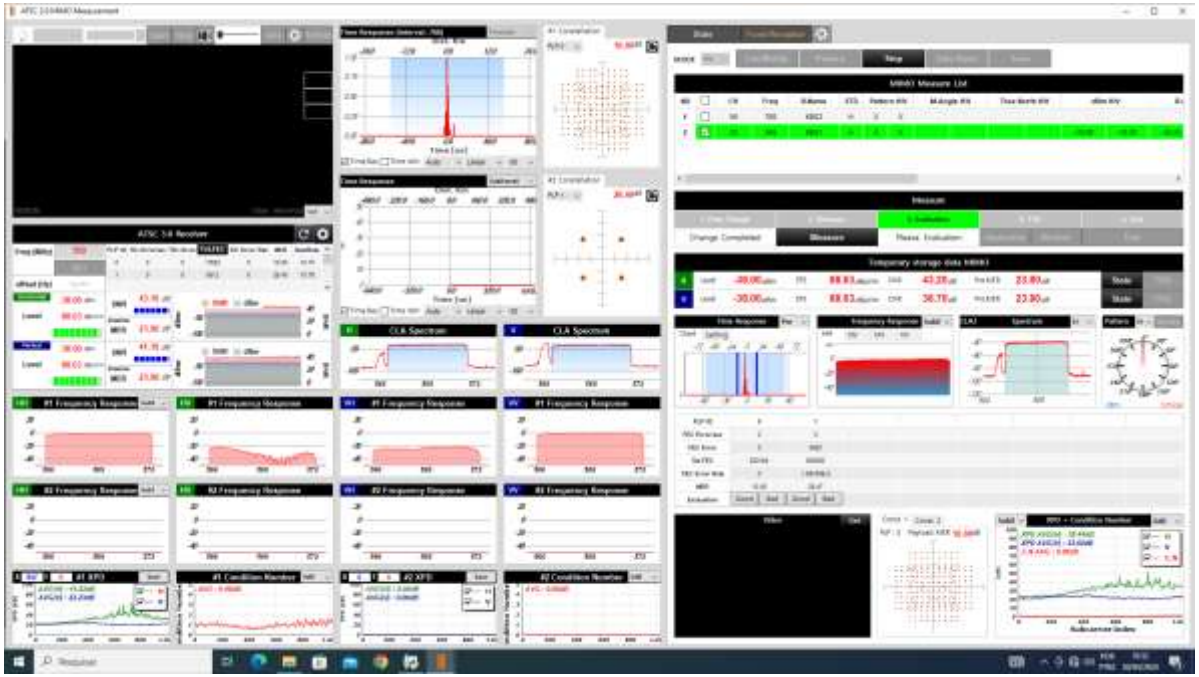


Figure 1.3 - IMAS Screen

b) AWGN Power

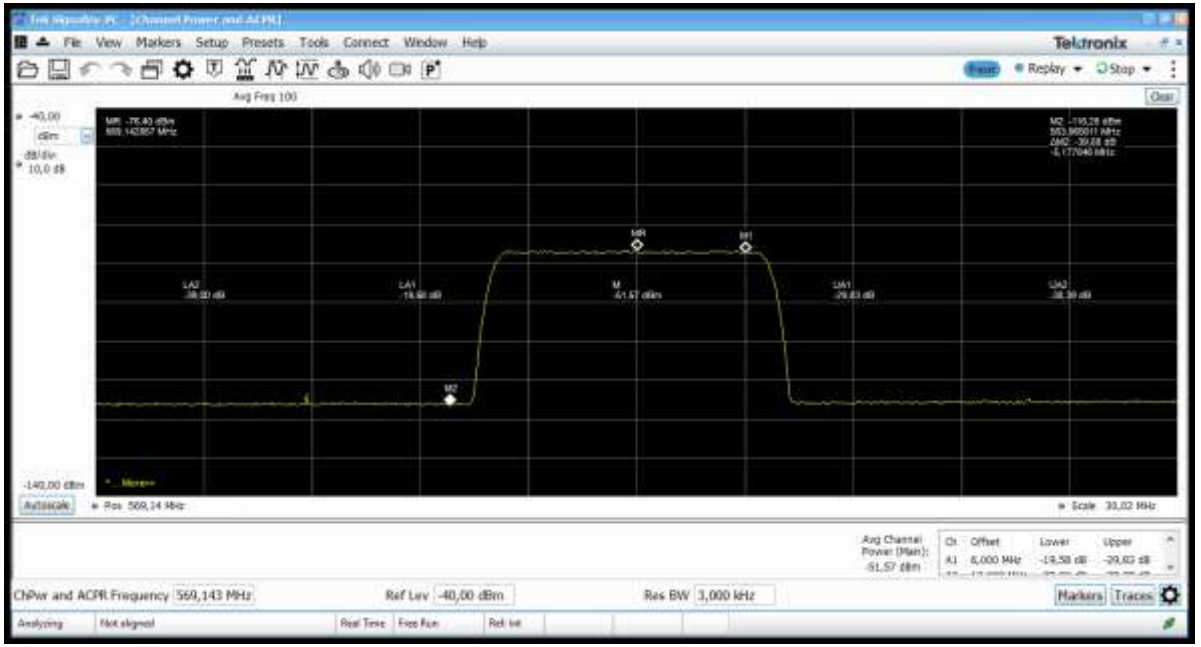


Figure 1.4 - Vertical

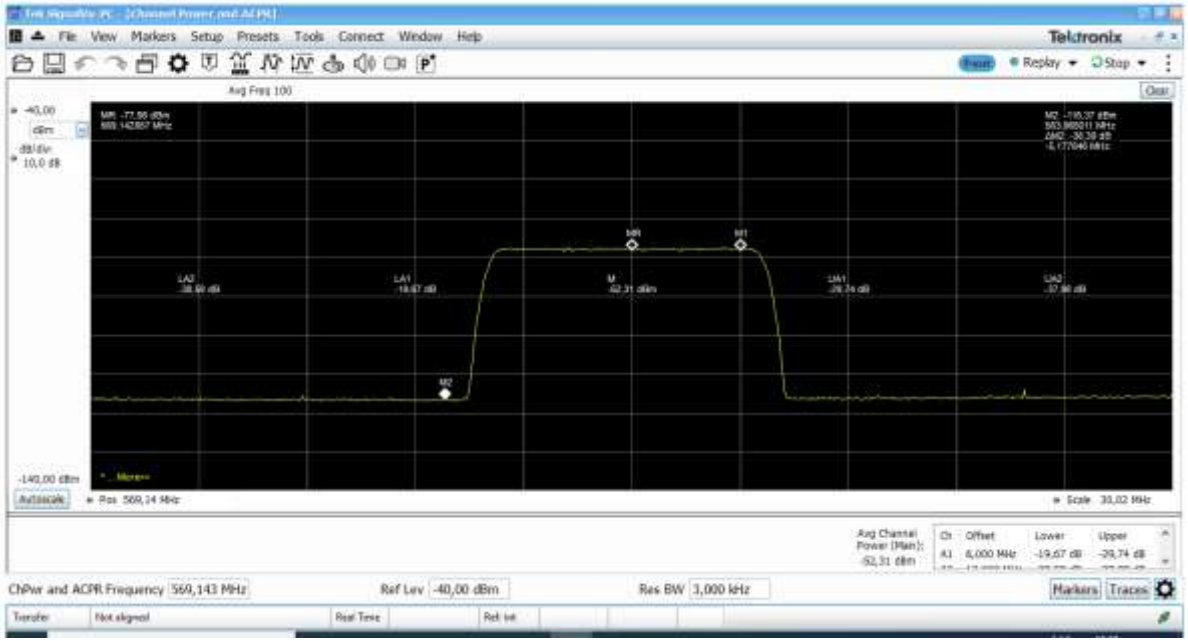


Figure 1.5 - Horizontal

c) C/N Threshold

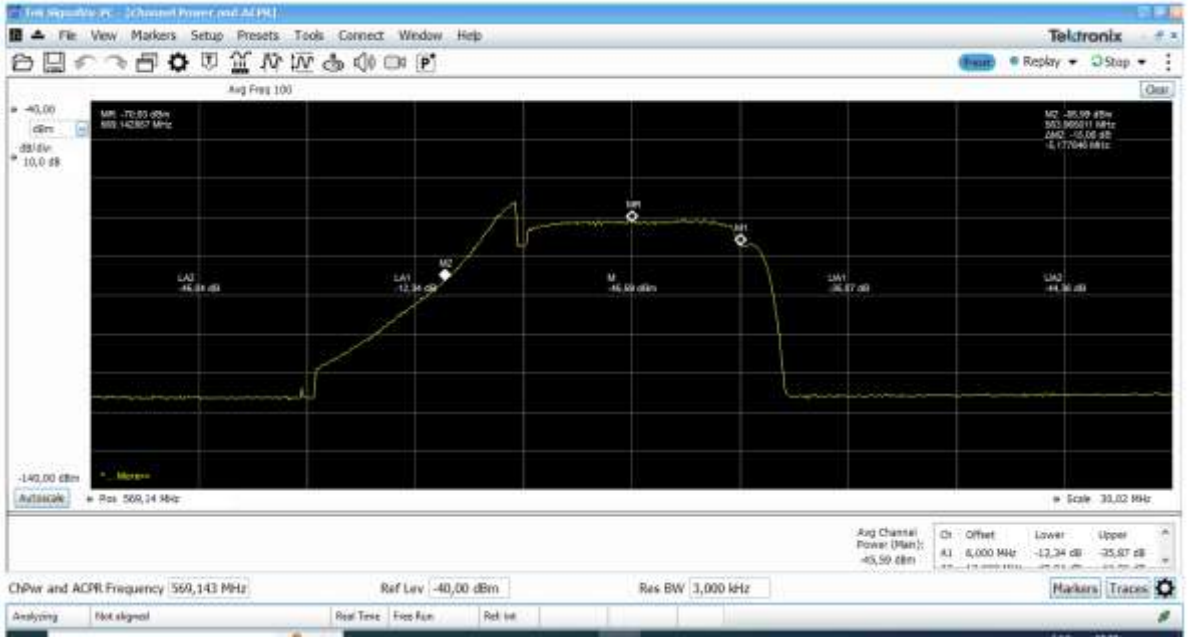


Figure 1.6 - Vertical

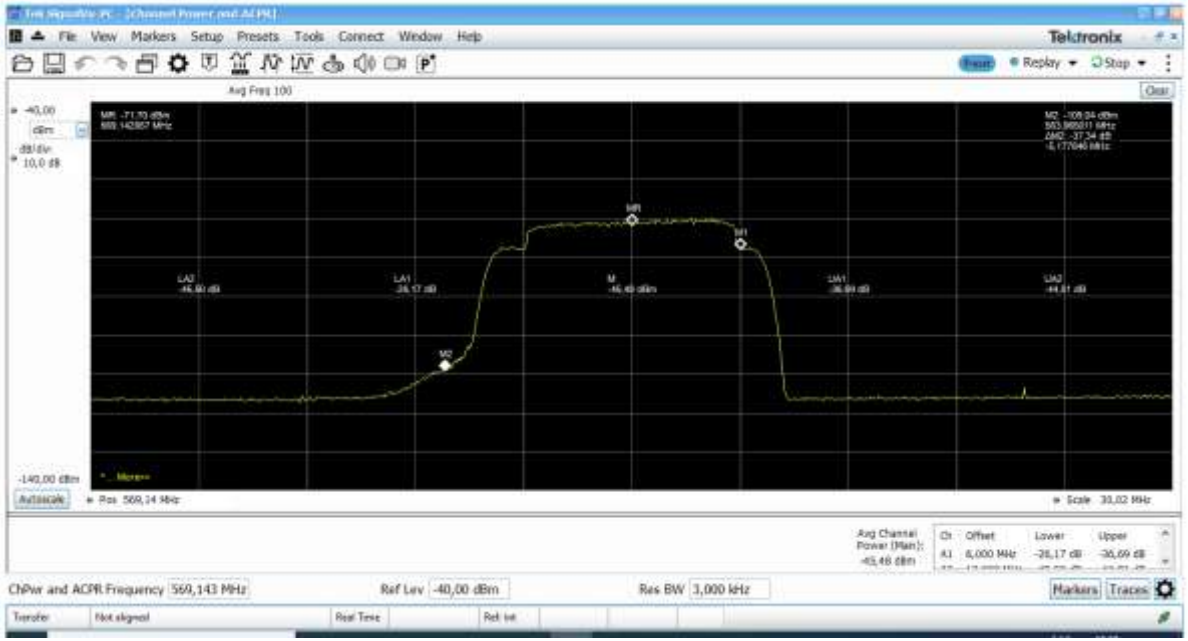


Figure 1.7 - Horizontal

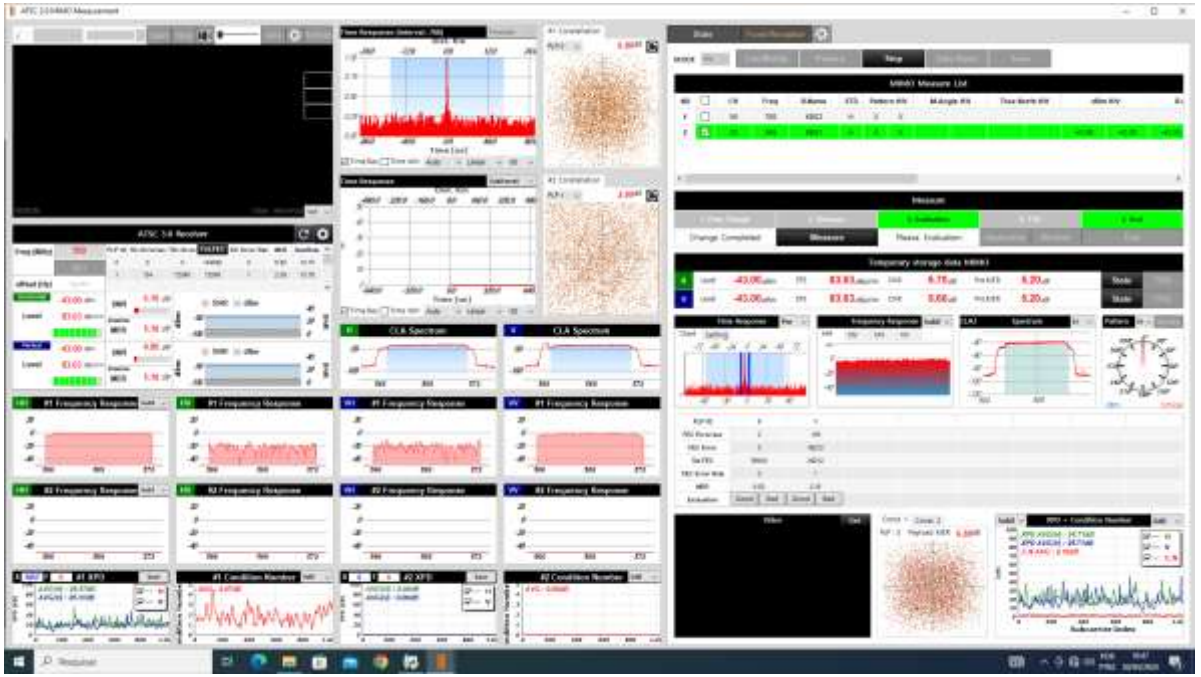


Figure 1.8 - IMAS Screen

d) Reception Threshold

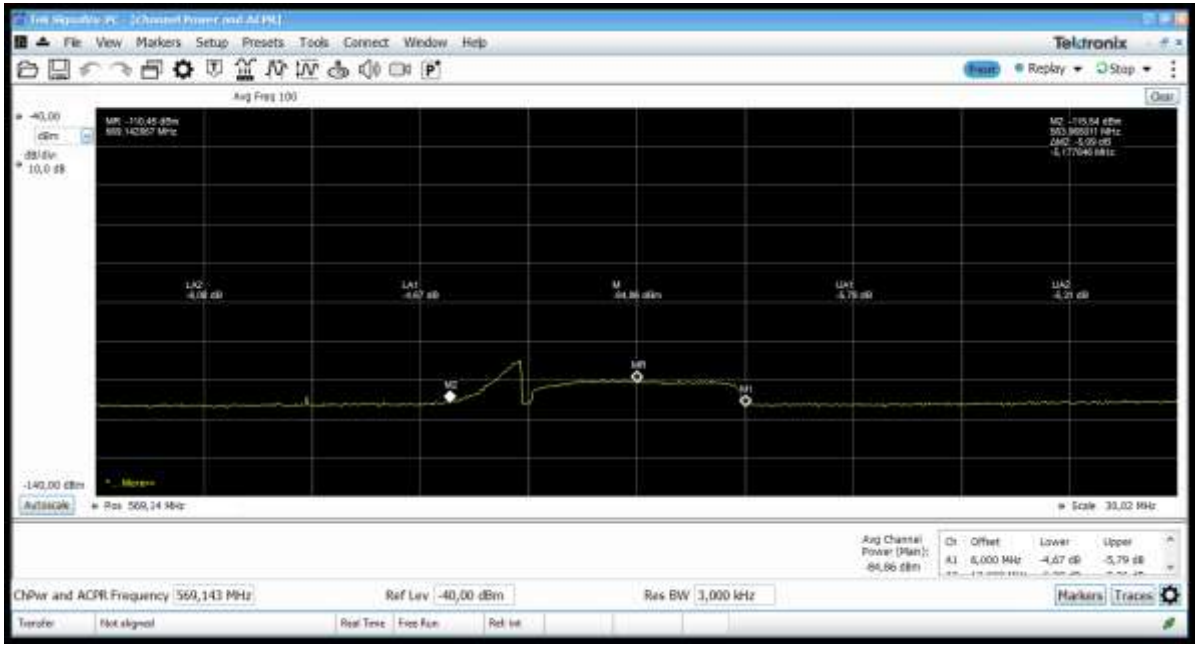


Figure 1.9 - Vertical

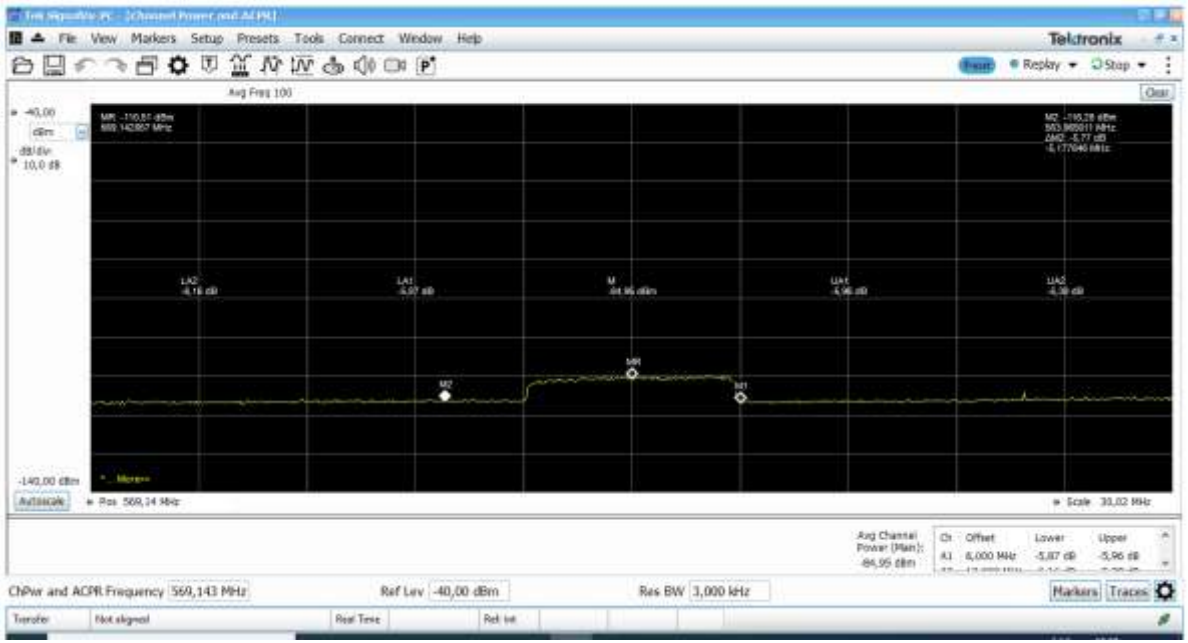


Figure 1.10 - Horizontal

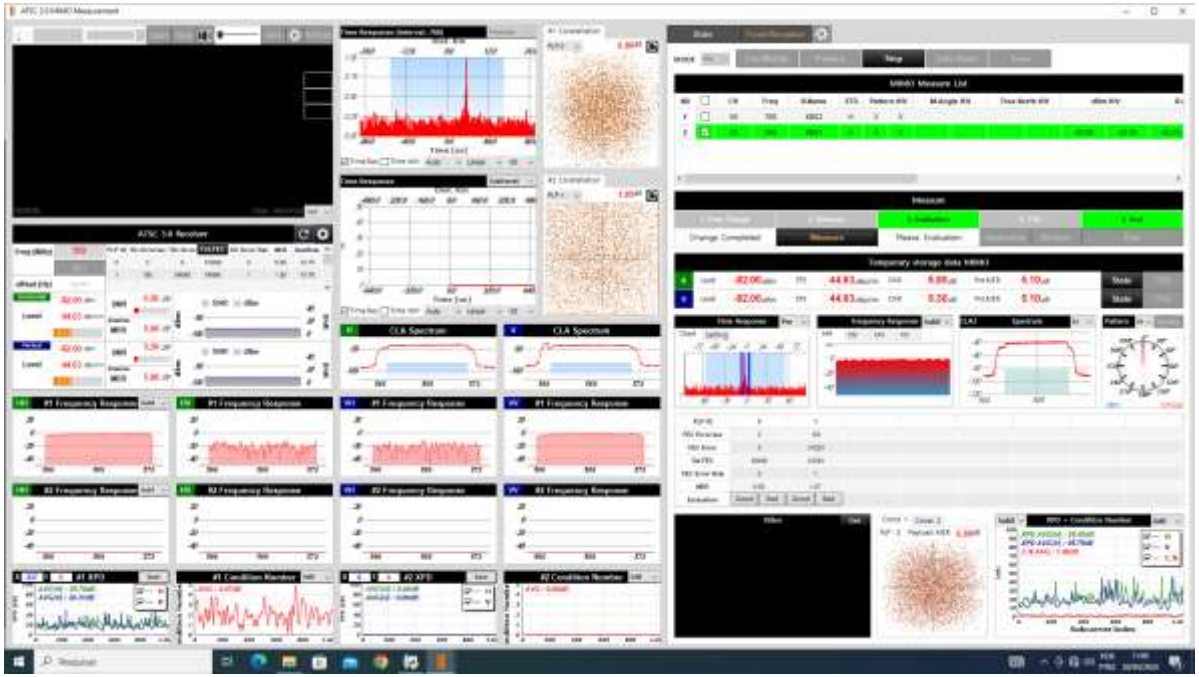


Figure 1.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

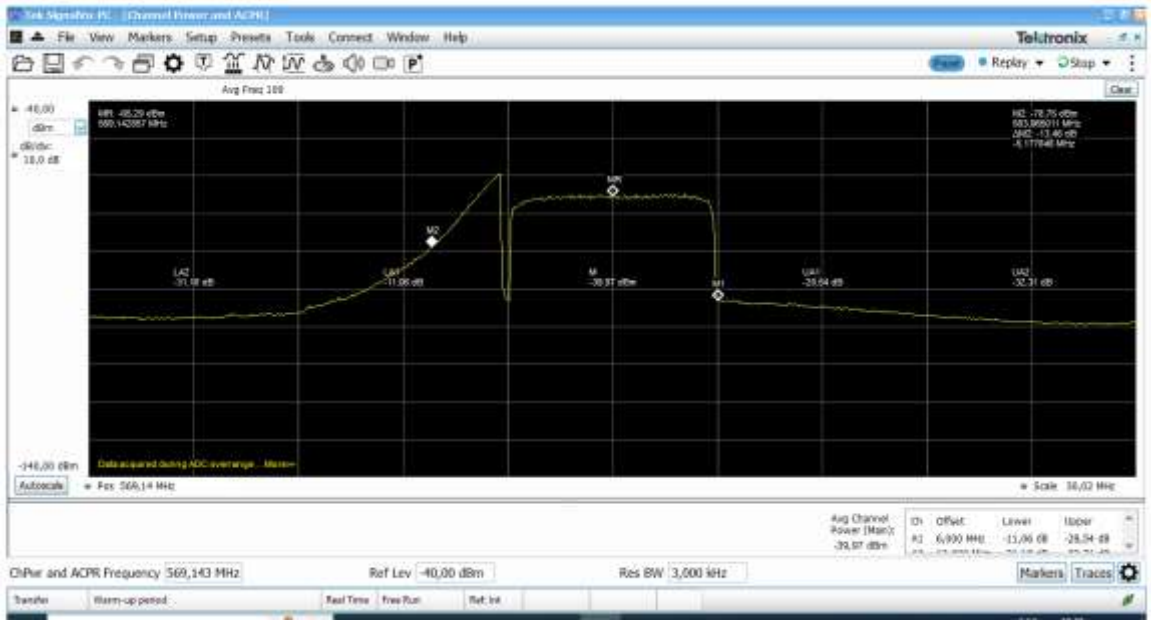


Figure 1.12 - Vertical

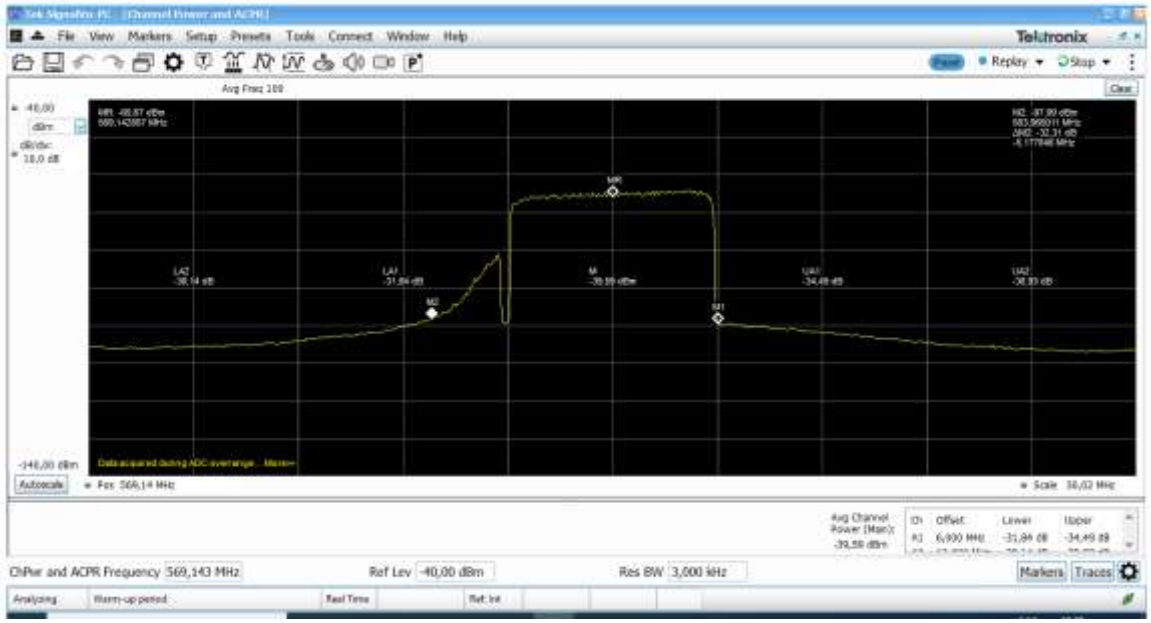


Figure 1.13 - Horizontal

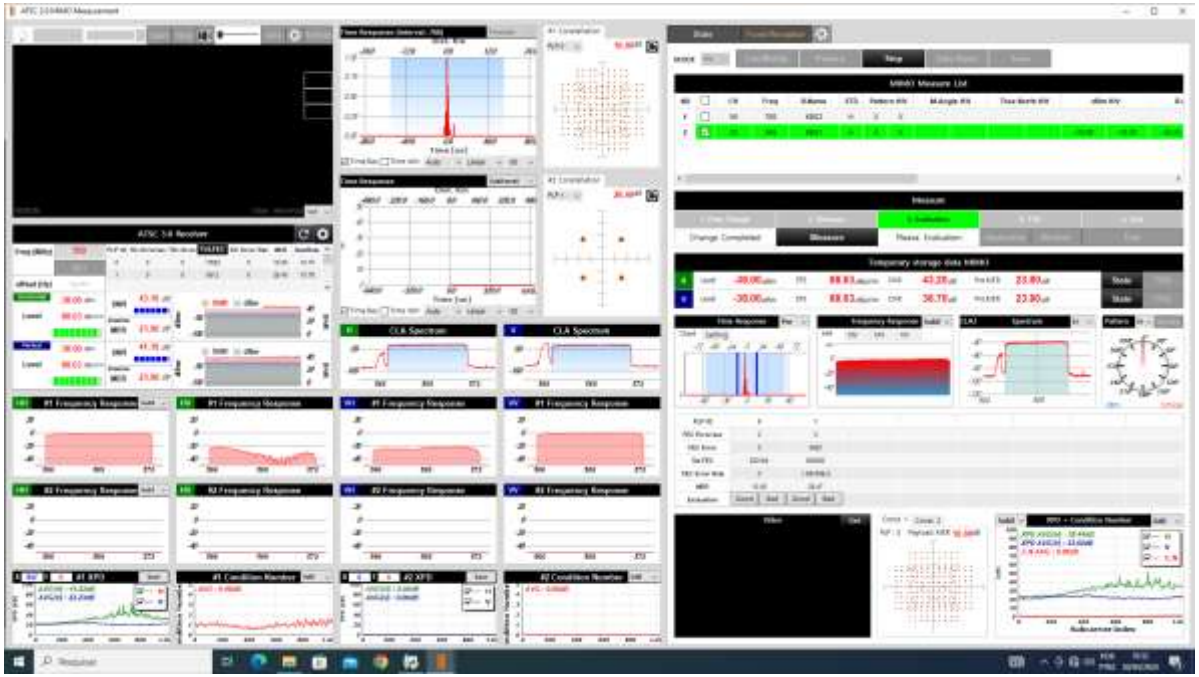


Figure 1.14 - IMAS Screen

b) AWGN Power

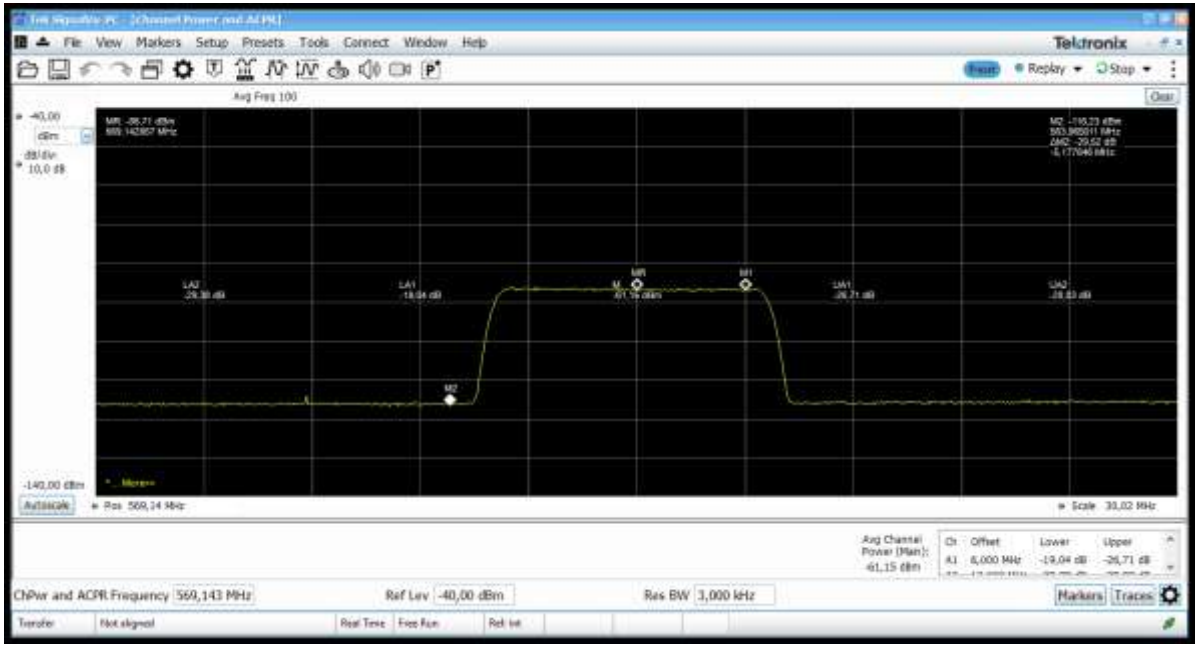


Figure 1.15 - Vertical

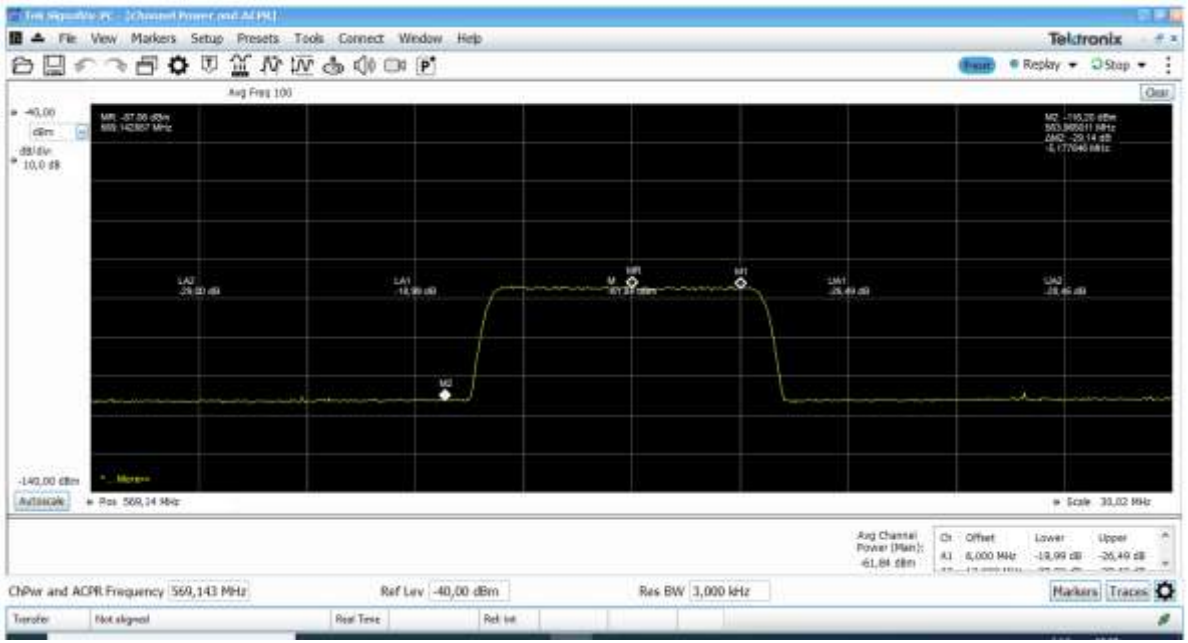


Figure 1.16 - Horizontal

c) C/N Threshold

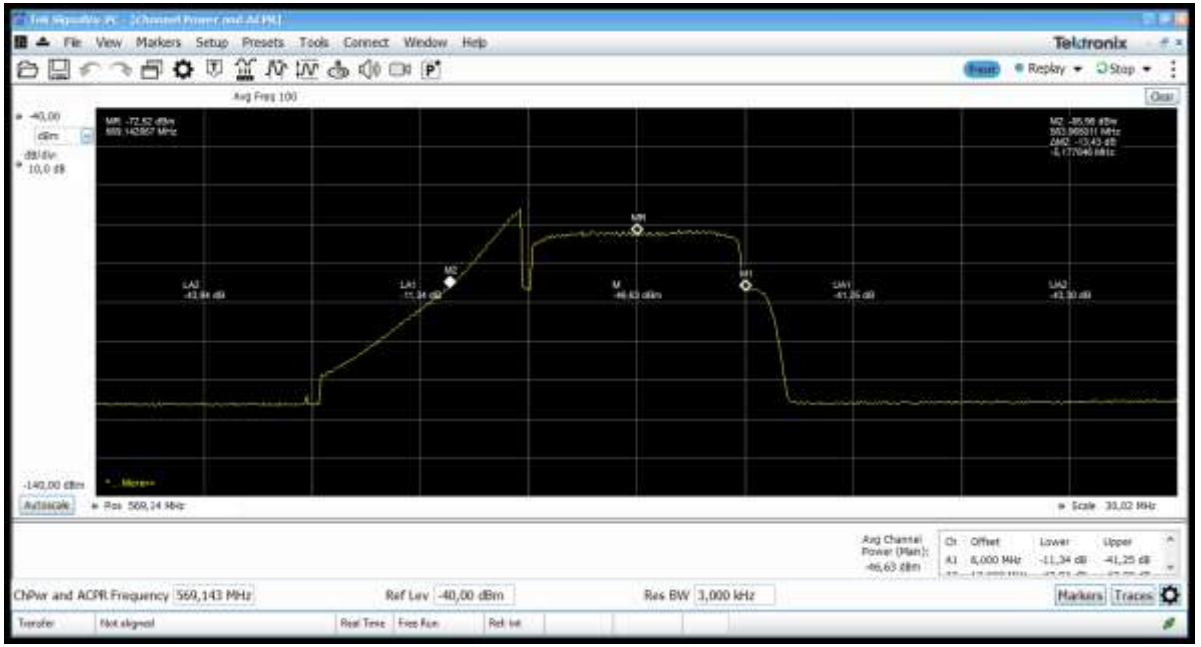


Figure 1.17 - Vertical

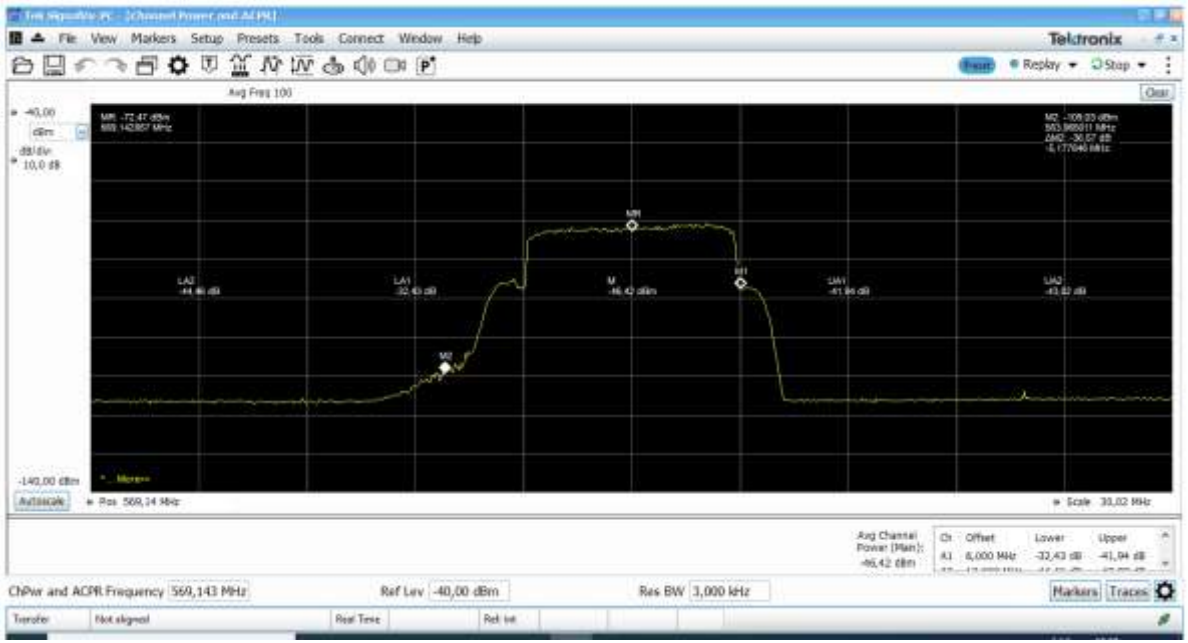


Figure 1.18 - Horizontal

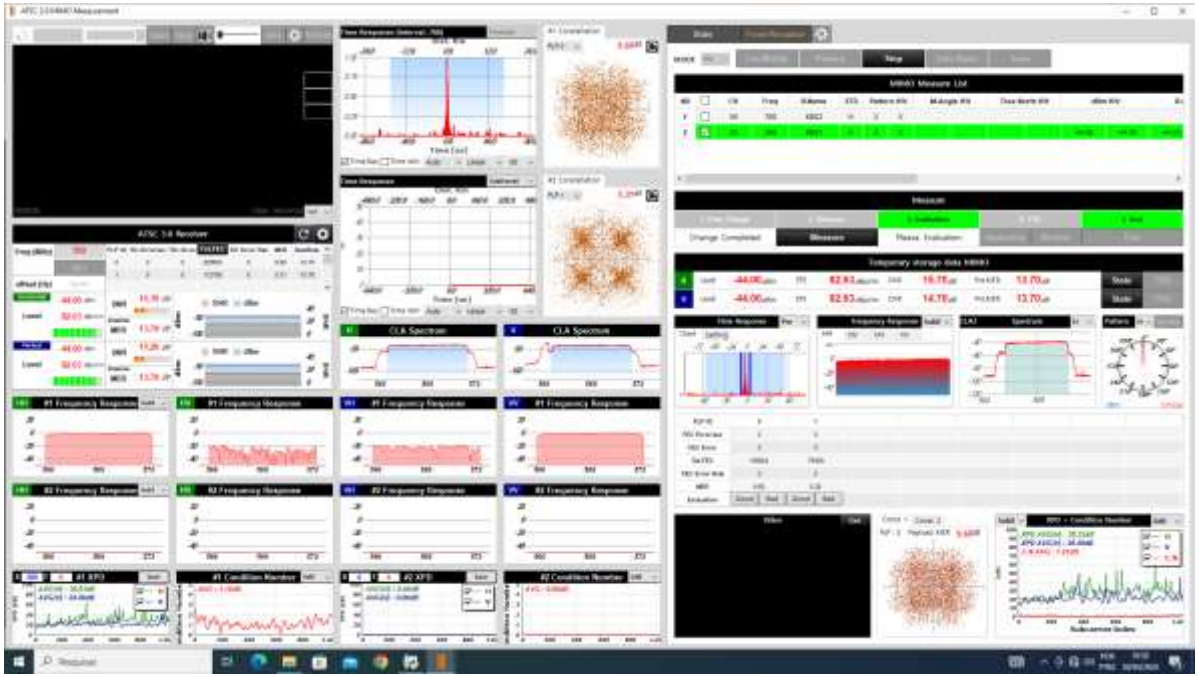


Figure 1.19 - IMAS Screen

d) Reception Threshold

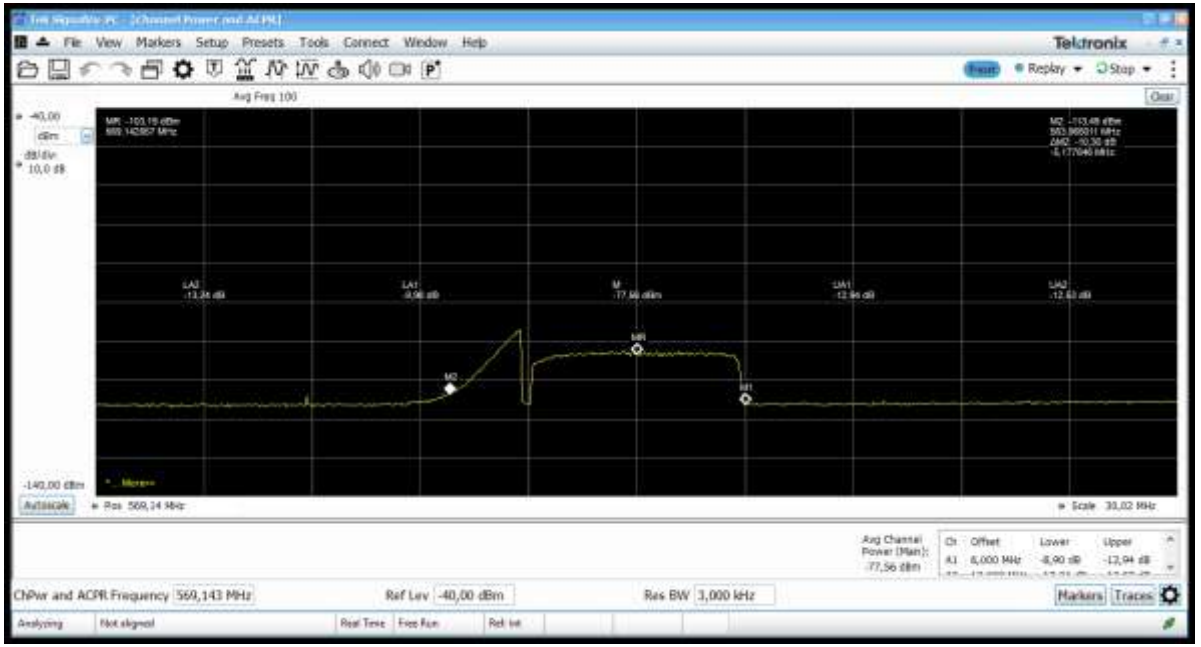


Figure 1.20 - Vertical

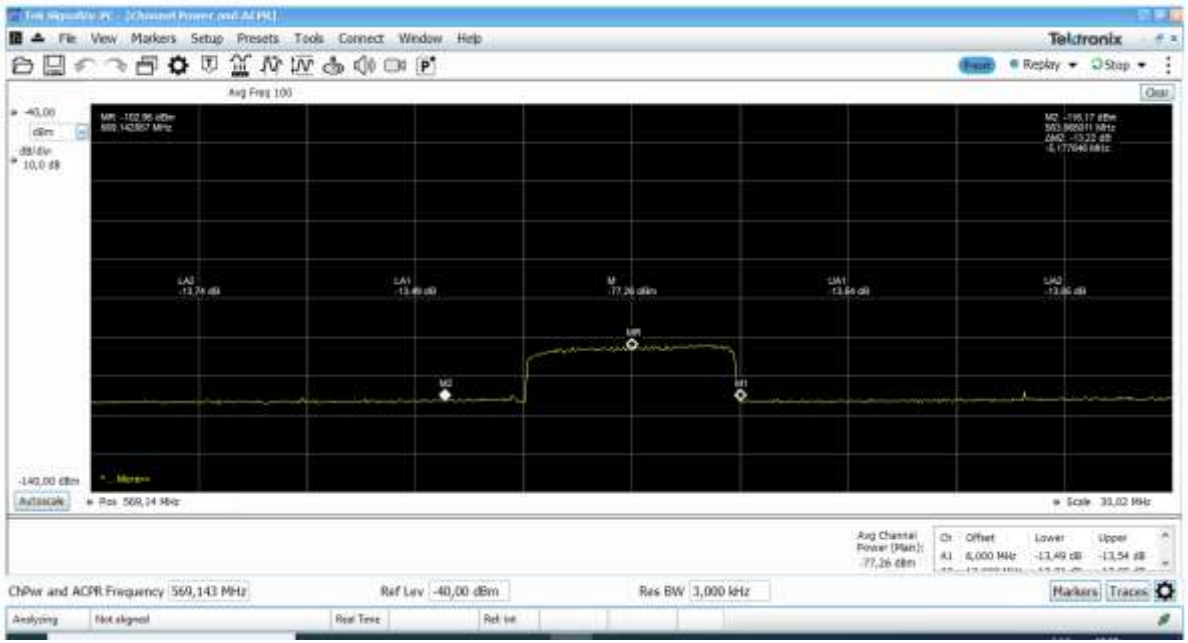


Figure 1.21 - Horizontal

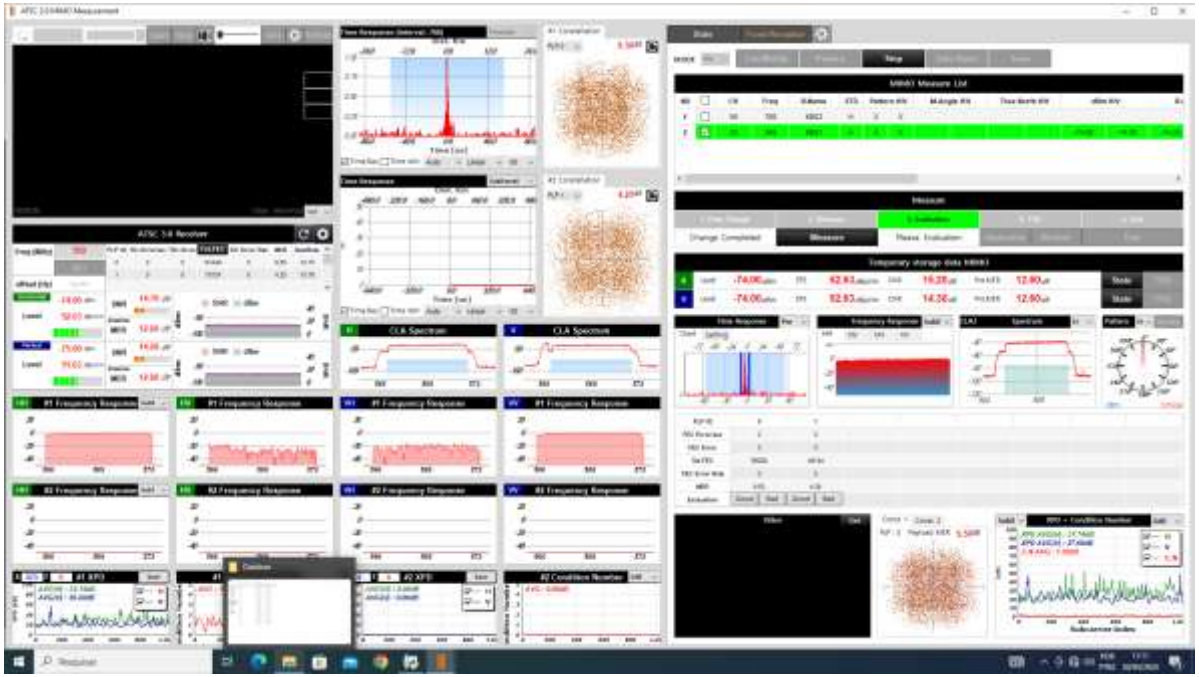


Figure 1.22 - IMAS Screen

Chapter 2. Site 4

Core Layer: 16-QAM NUC – FEC 4/15 – Bitrate 10.7 Mbps

a) Channel Power

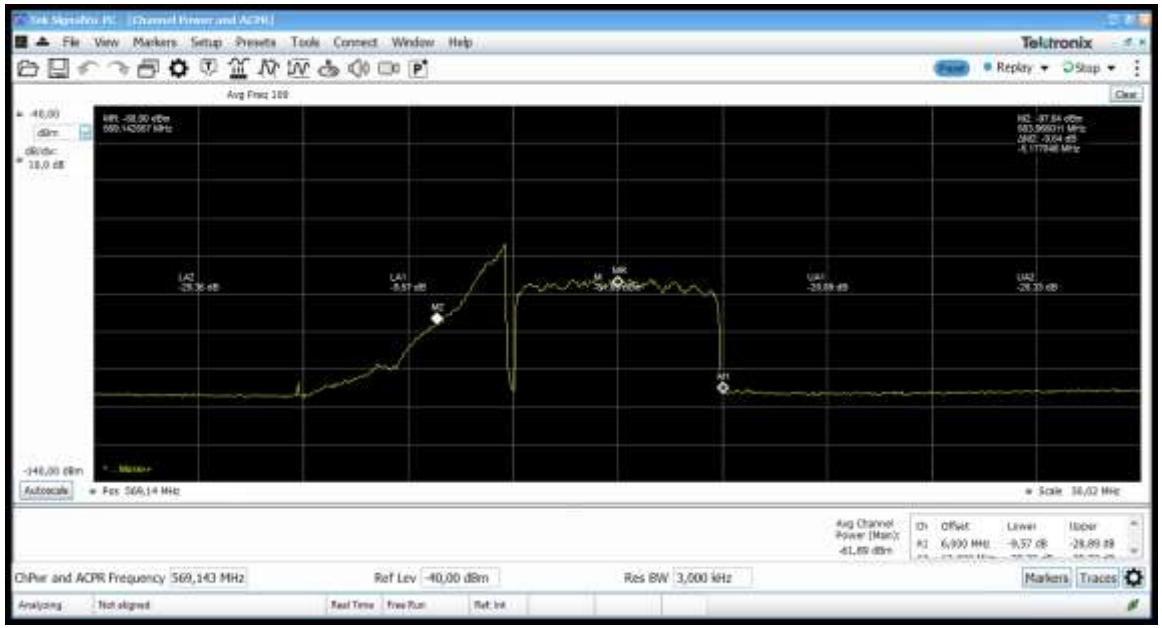


Figure 2.1 - Vertical

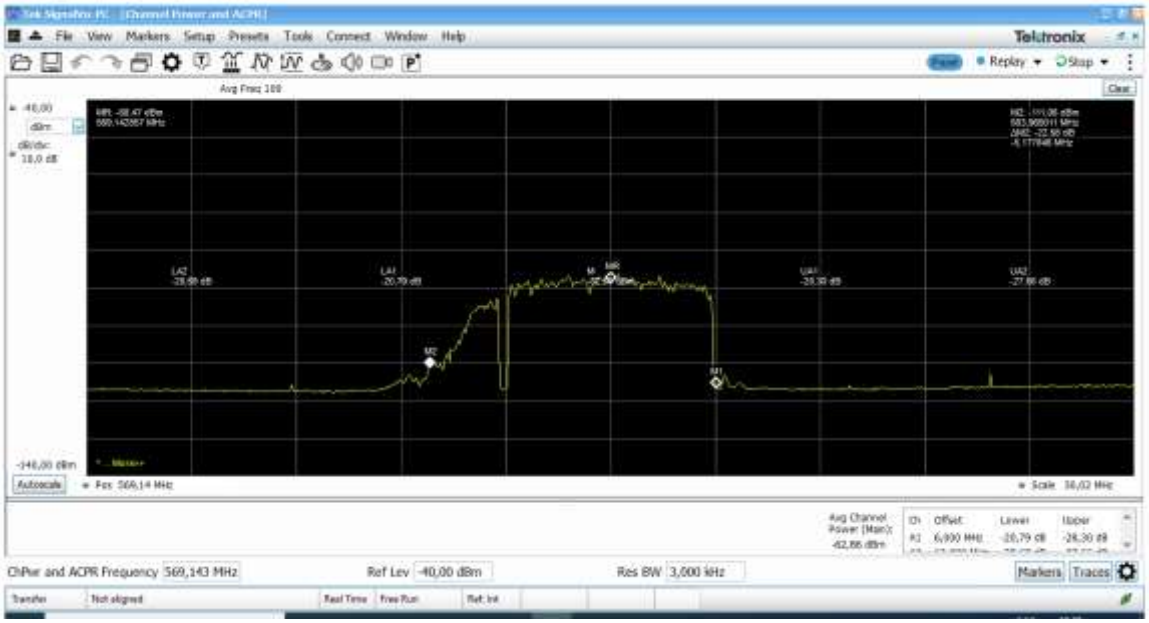


Figure 2.2 - Horizontal

Figure 2.3 - IMAS Screen

b) AWGN Power

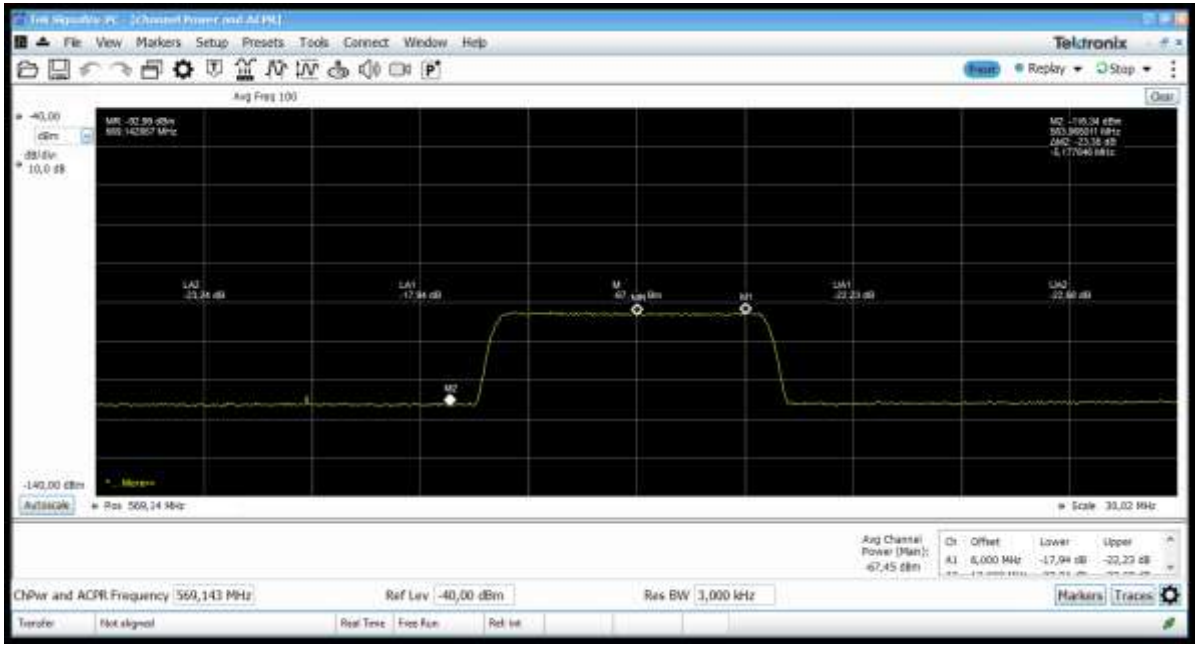


Figure 2.4 - Vertical

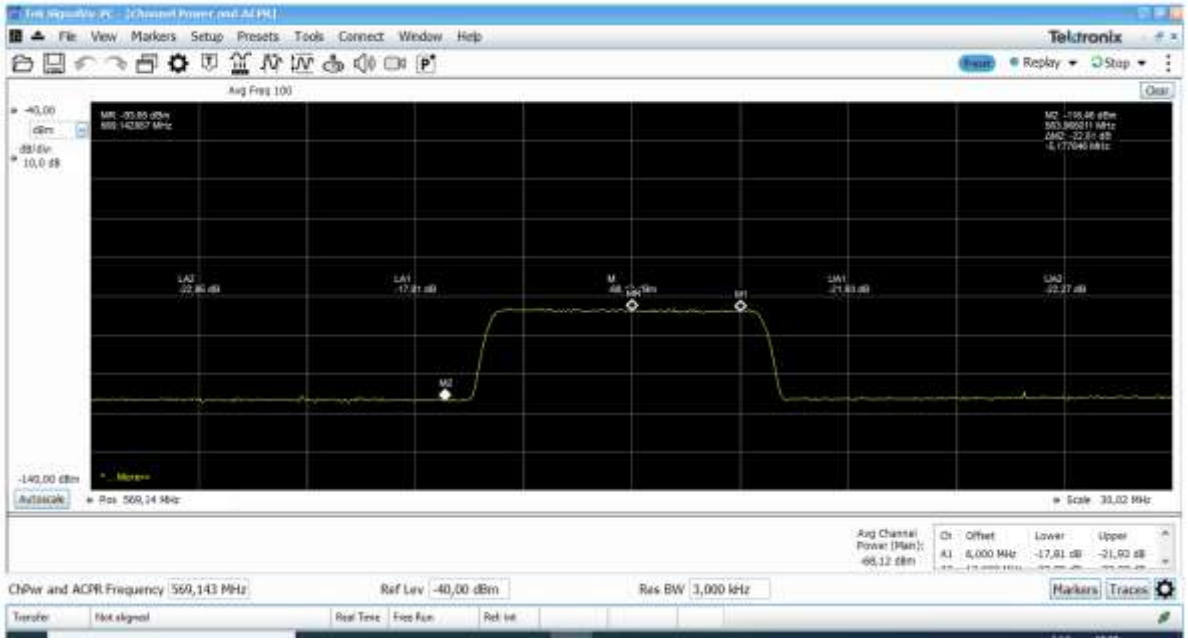


Figure 2.5 - Horizontal

c) C/N Threshold

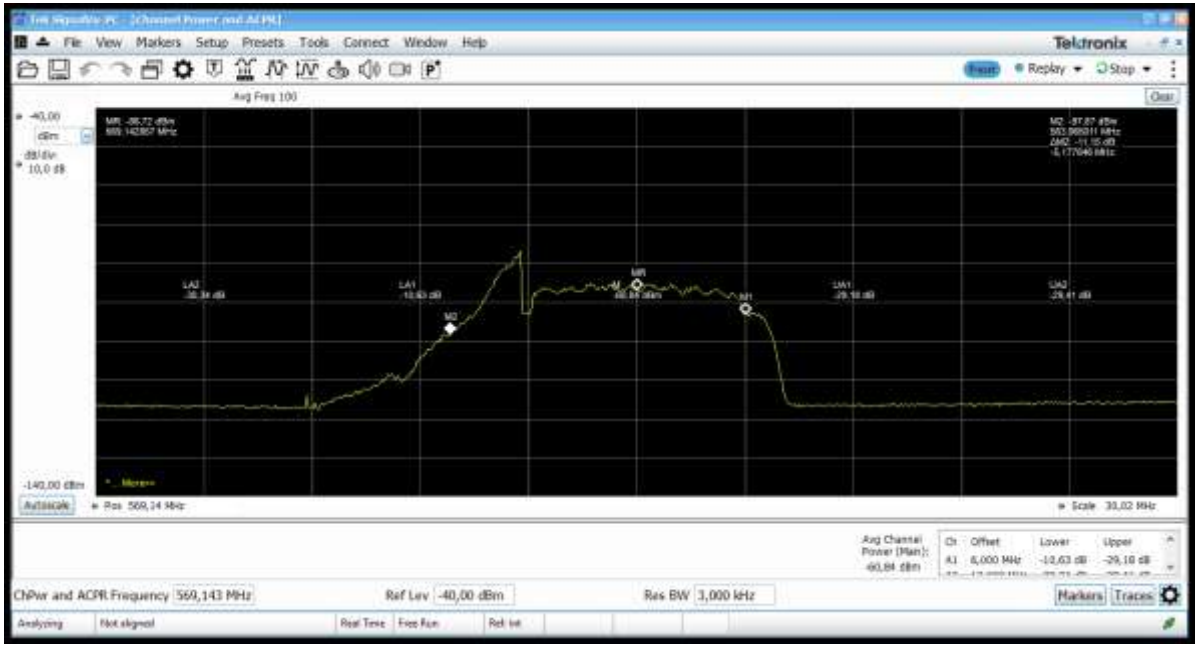


Figure 2.6 - Vertical

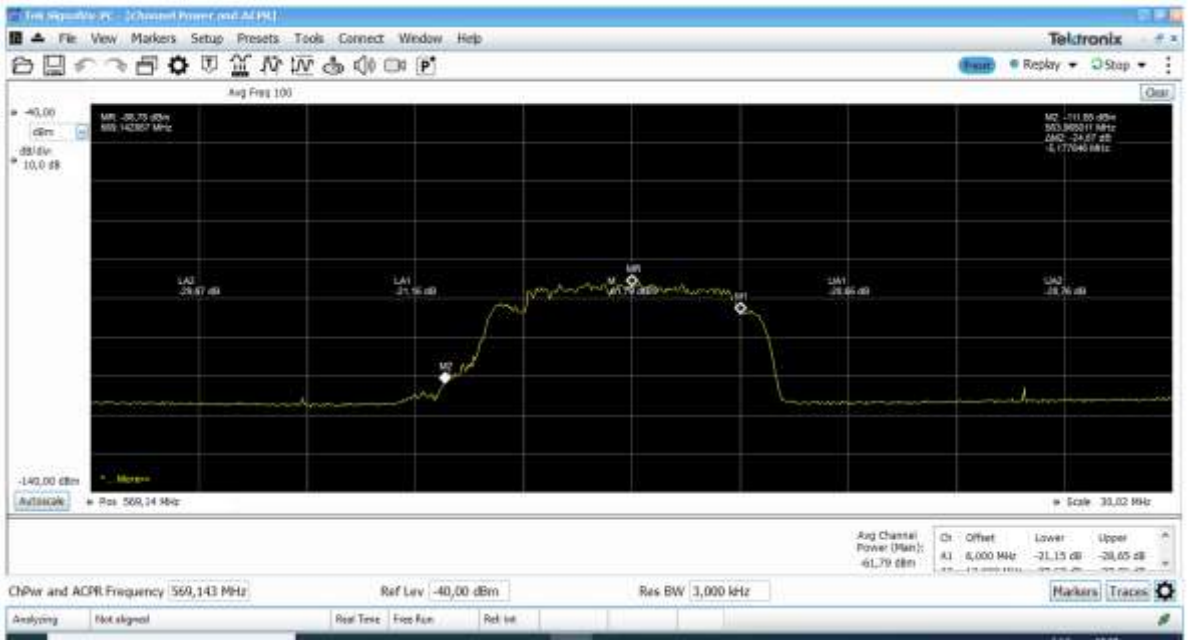


Figure 2.7 - Horizontal

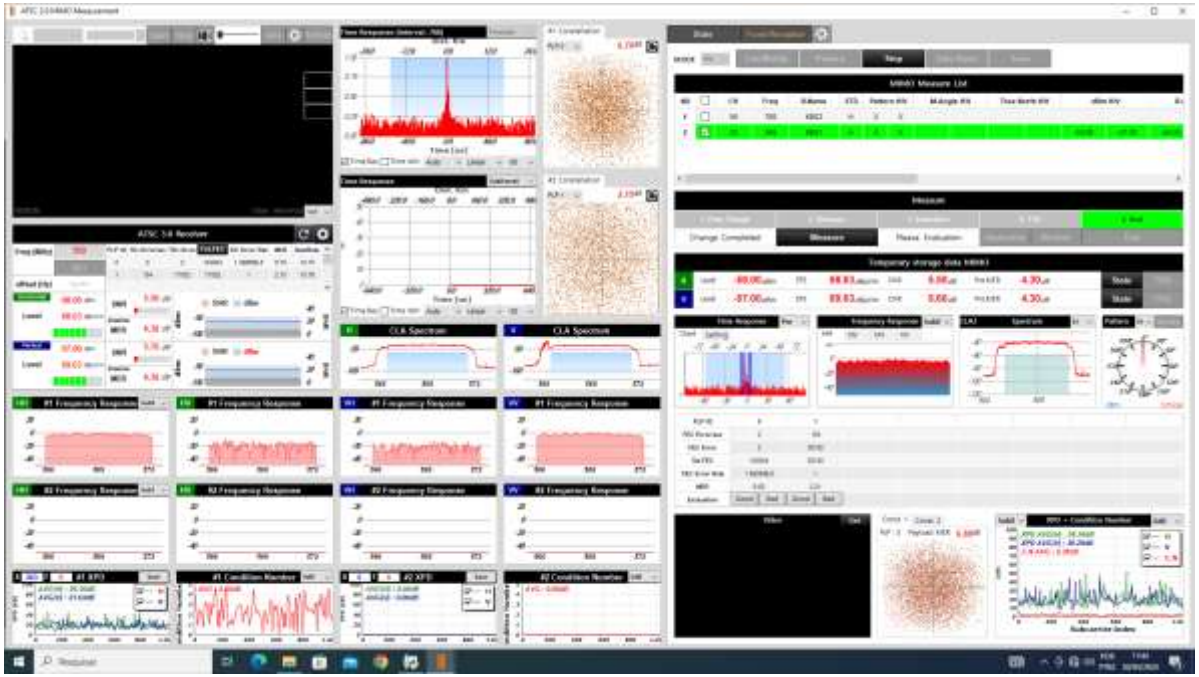


Figure 2.8 - IMAS Screen

d) Reception Threshold

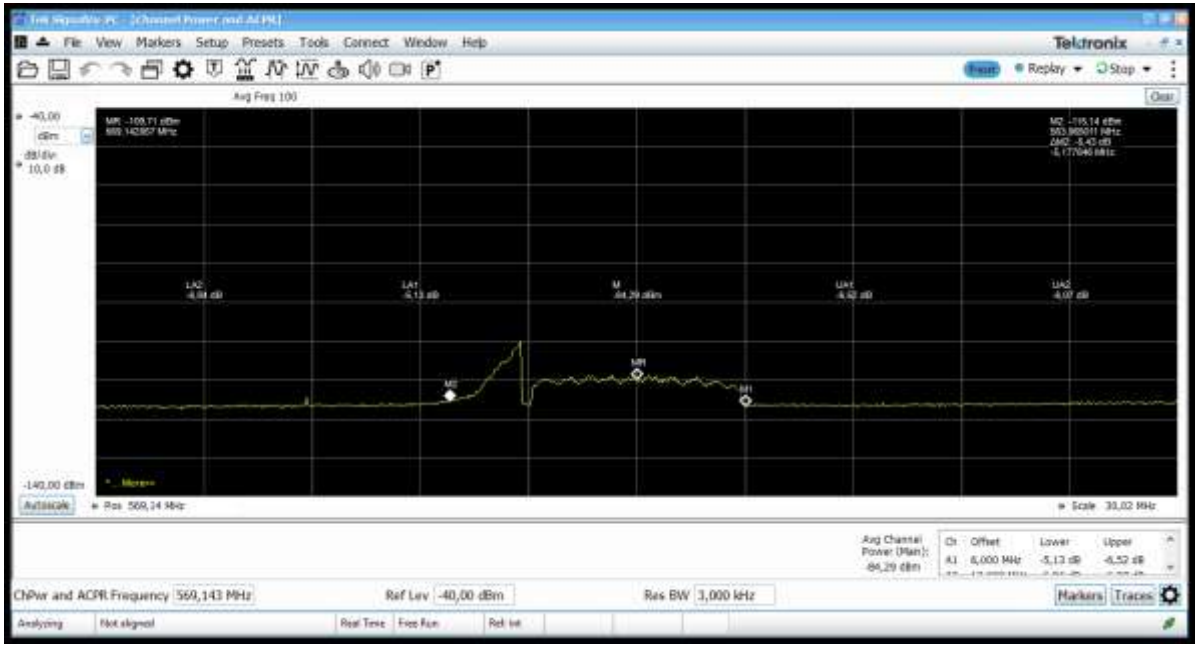


Figure 2.9 - Vertical

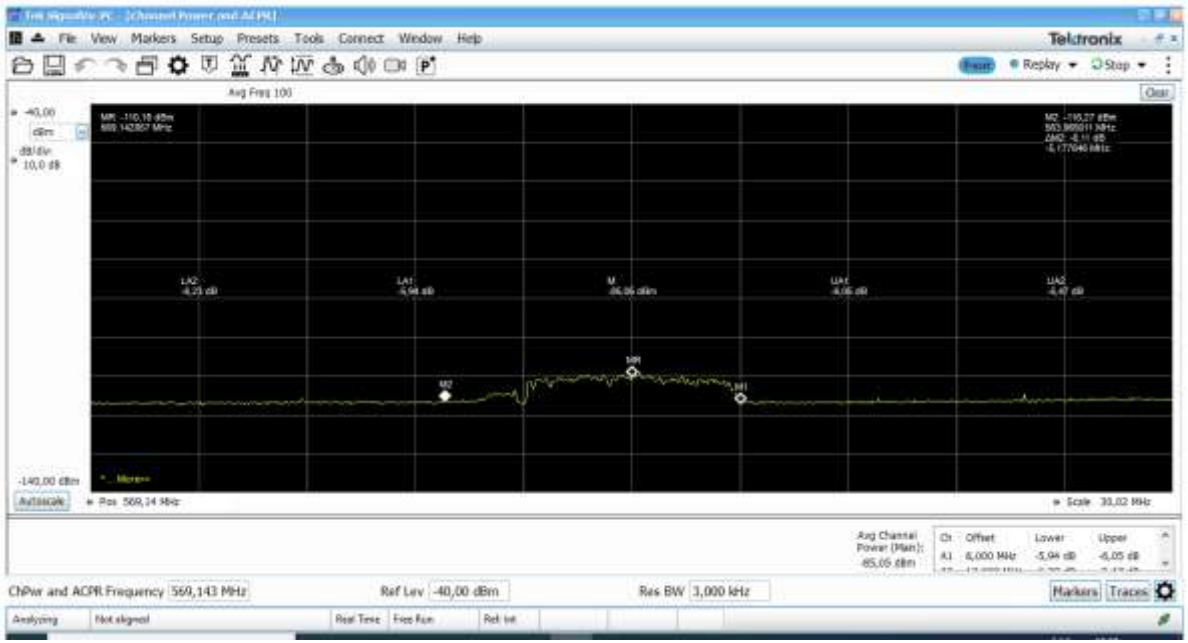


Figure 2.10 - Horizontal

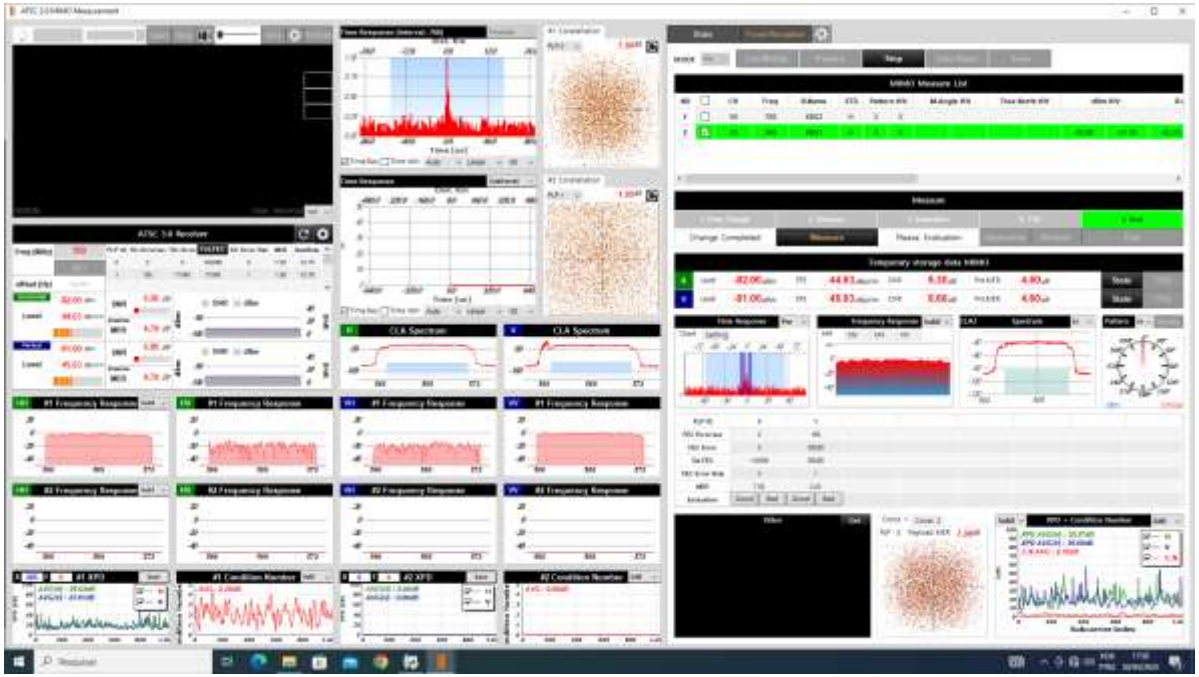


Figure 2.11 - IMAS Screen

Enhanced Layer: QPSK UC – FEC 8/15 – Bitrate 10.7 Mbps

a) Channel Power

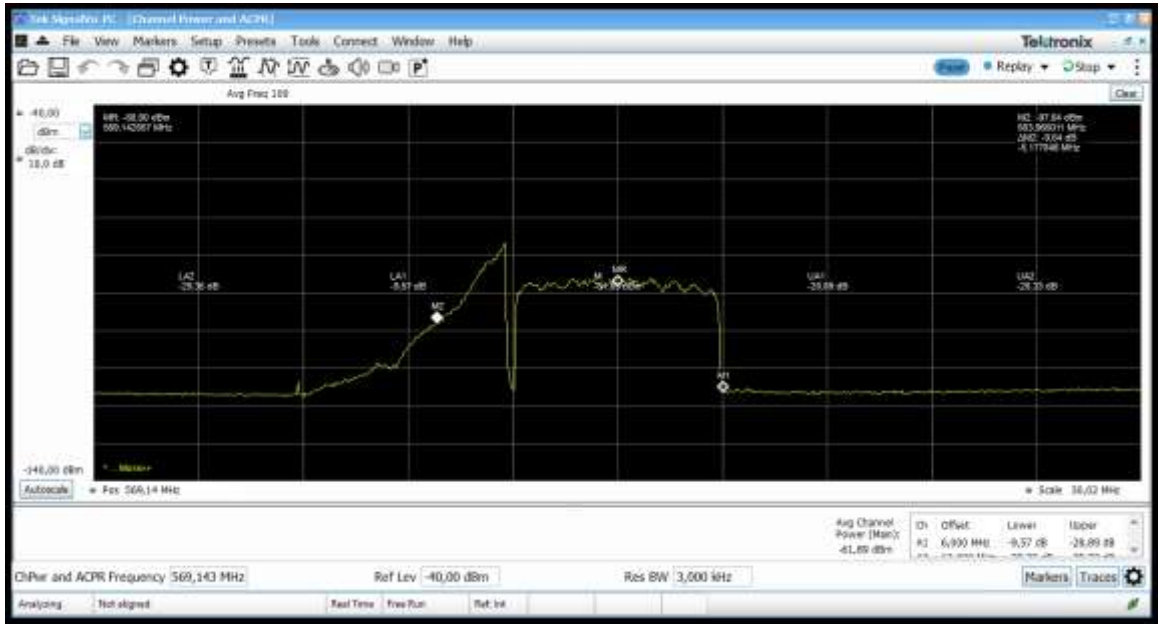


Figure 2.12 - Vertical

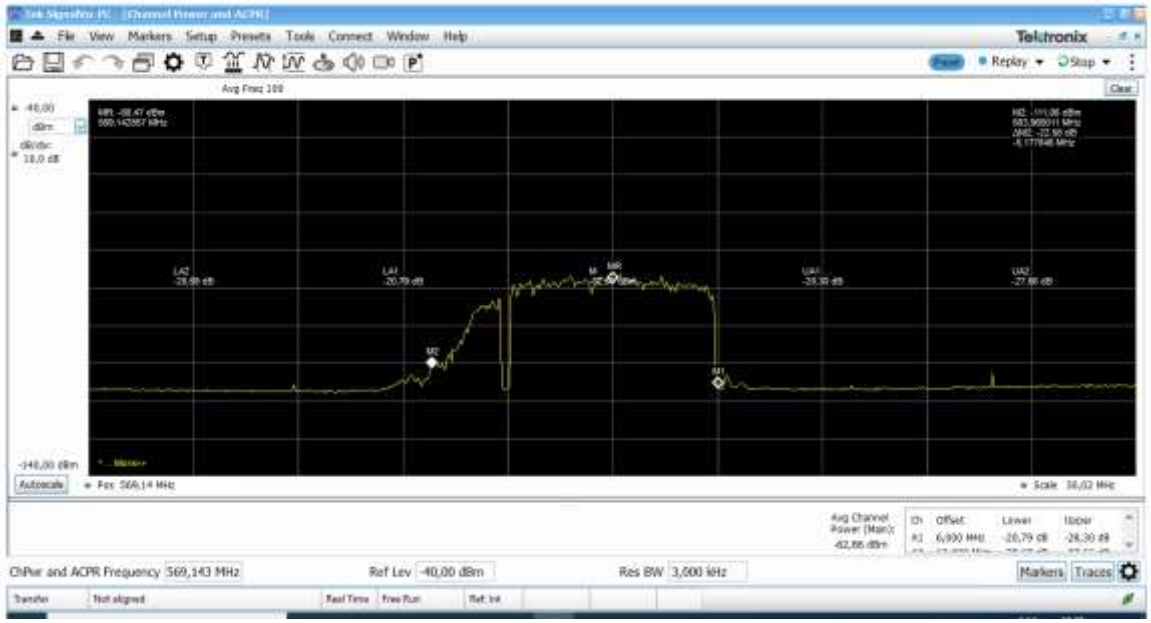


Figure 2.13 - Horizontal

Figure 2.14 - IMAS Screen

b) AWGN Power

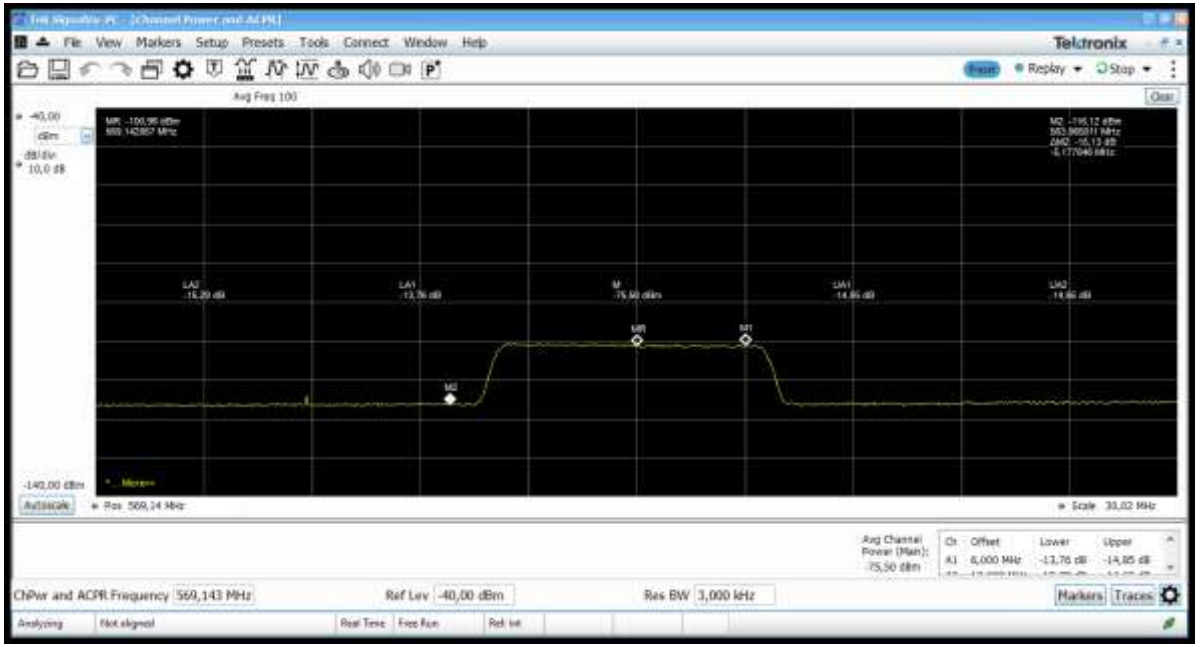


Figure 2.15 - Vertical

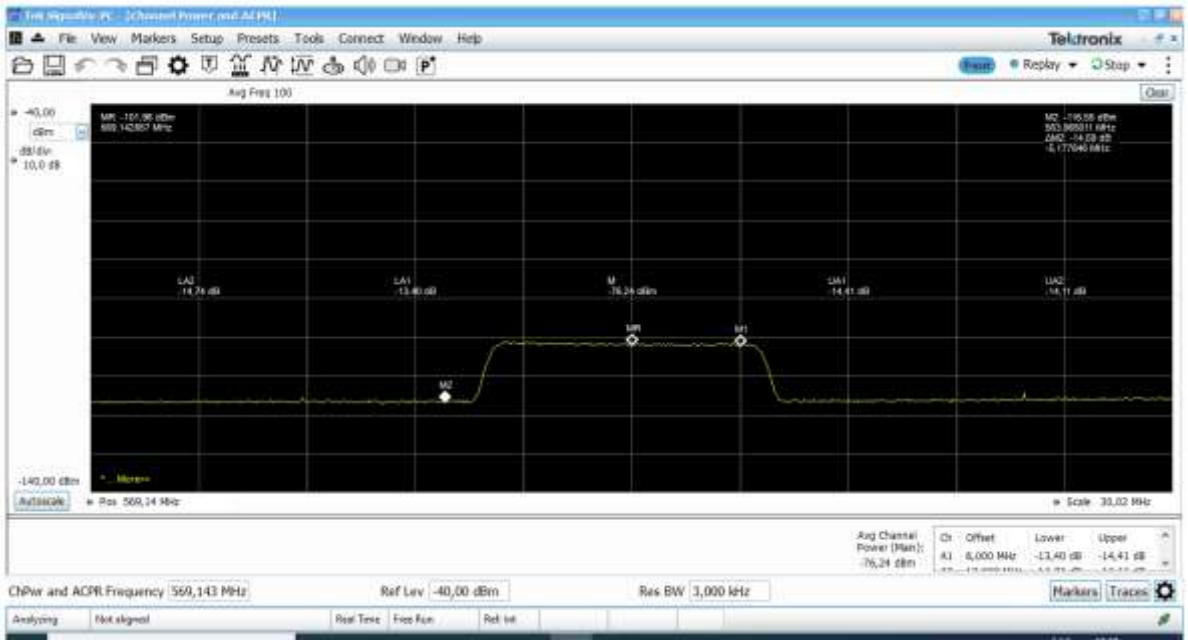


Figure 2.16 - Horizontal

c) C/N Threshold

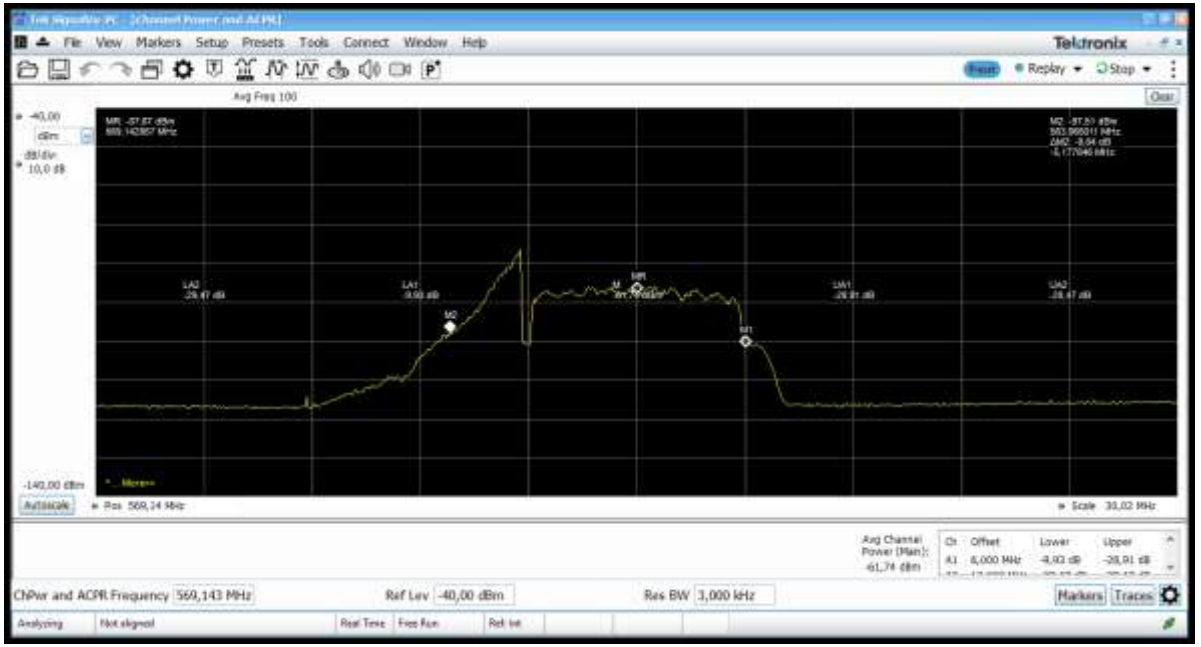


Figure 2.17 - Vertical

Figure 2.18 - Horizontal

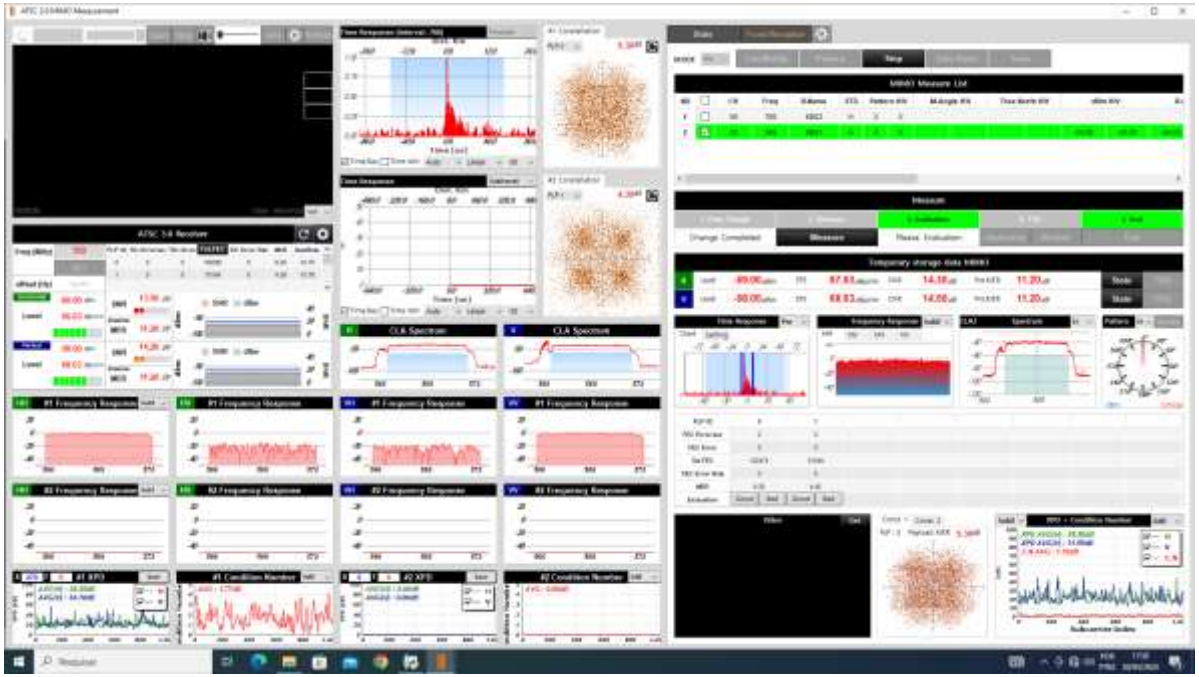


Figure 2.19 - IMAS Screen

d) Reception Threshold

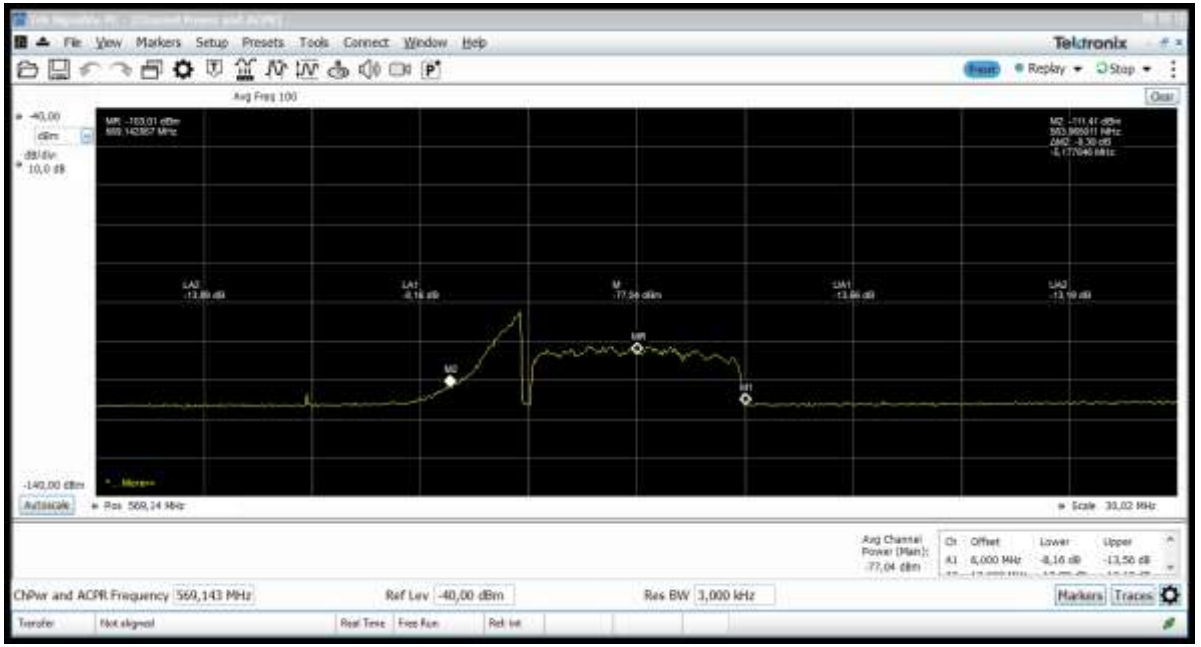


Figure 2.20 - Vertical

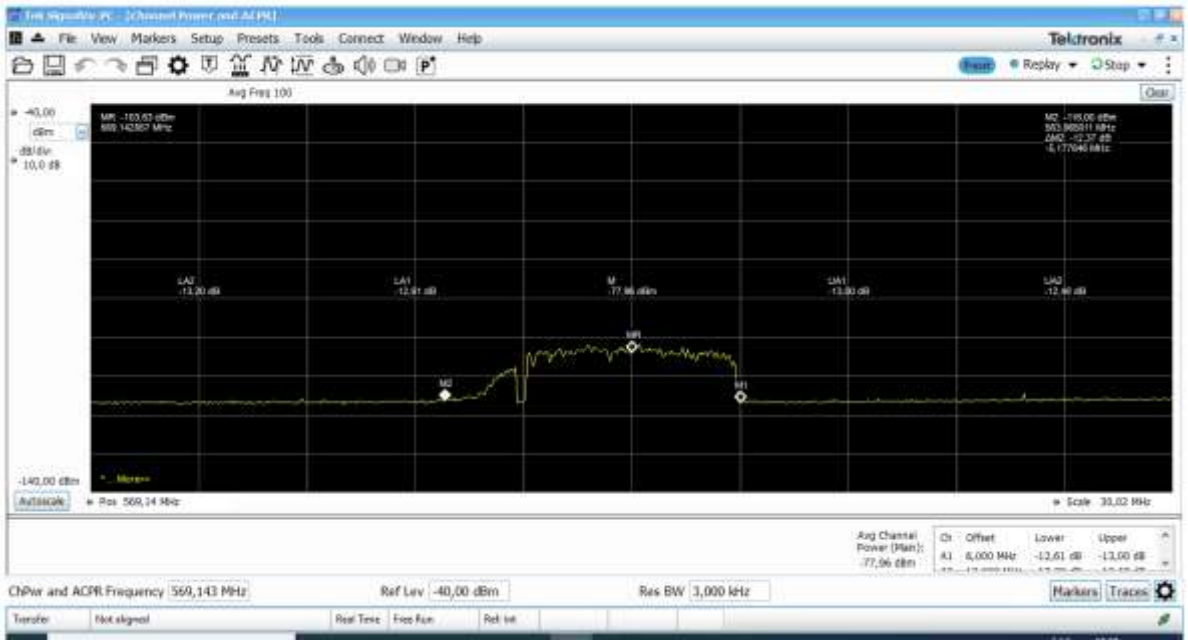


Figure 2.21 - Horizontal

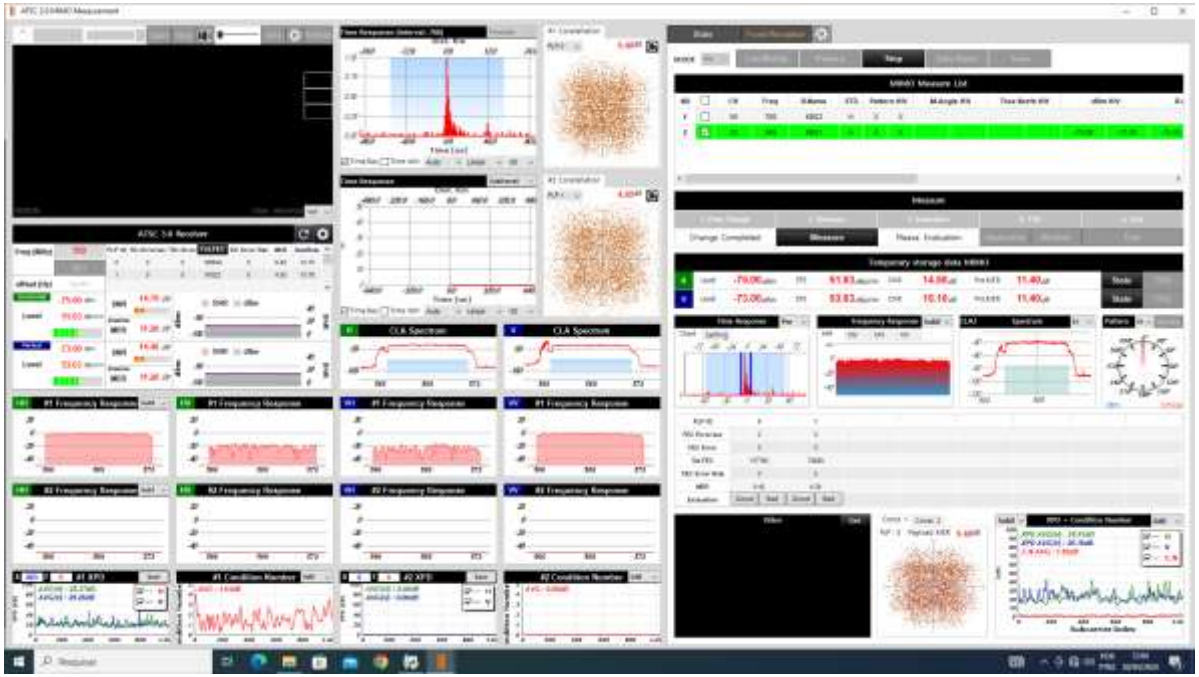


Figure 2.22 - IMAS Screen

Chapter 3. Site 6

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

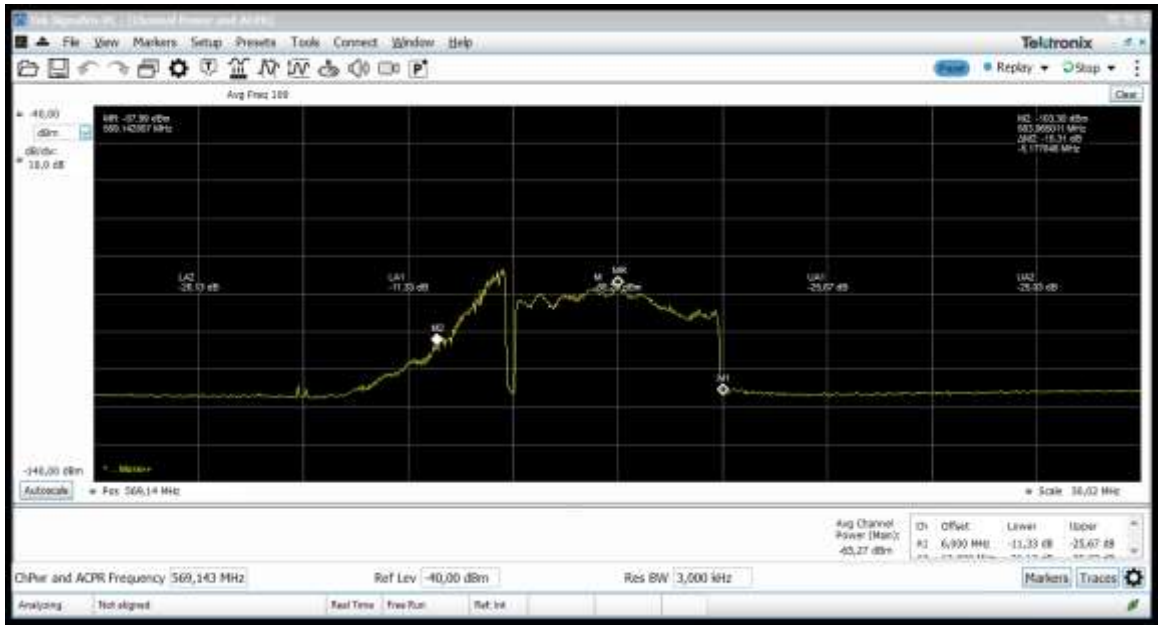


Figure 3.1 - Vertical

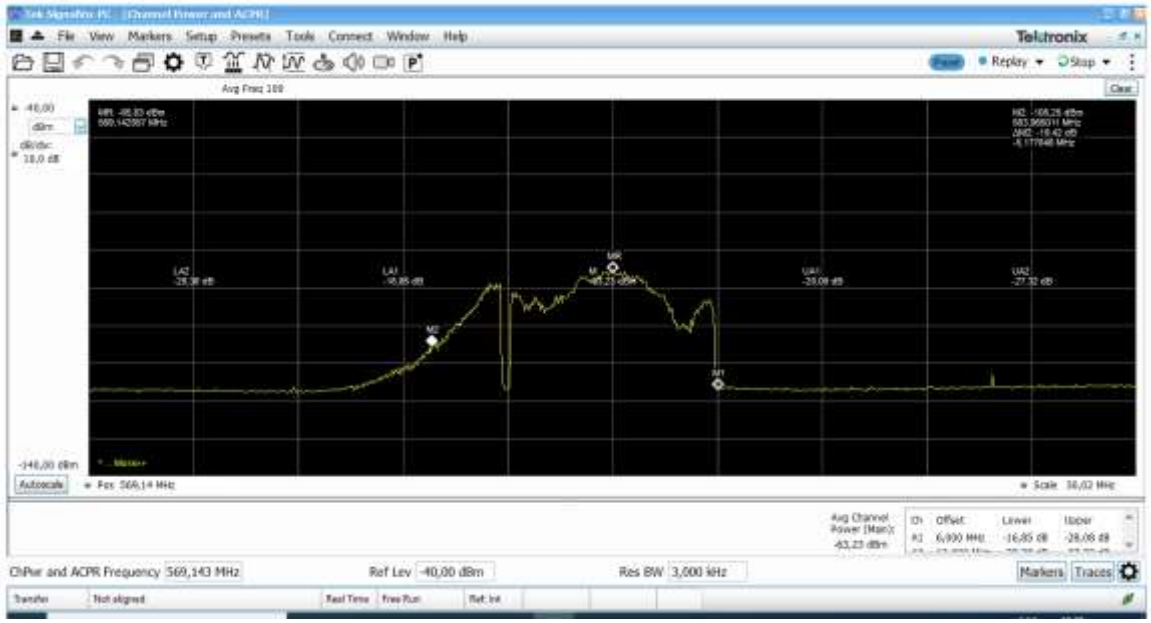


Figure 3.2 - Horizontal

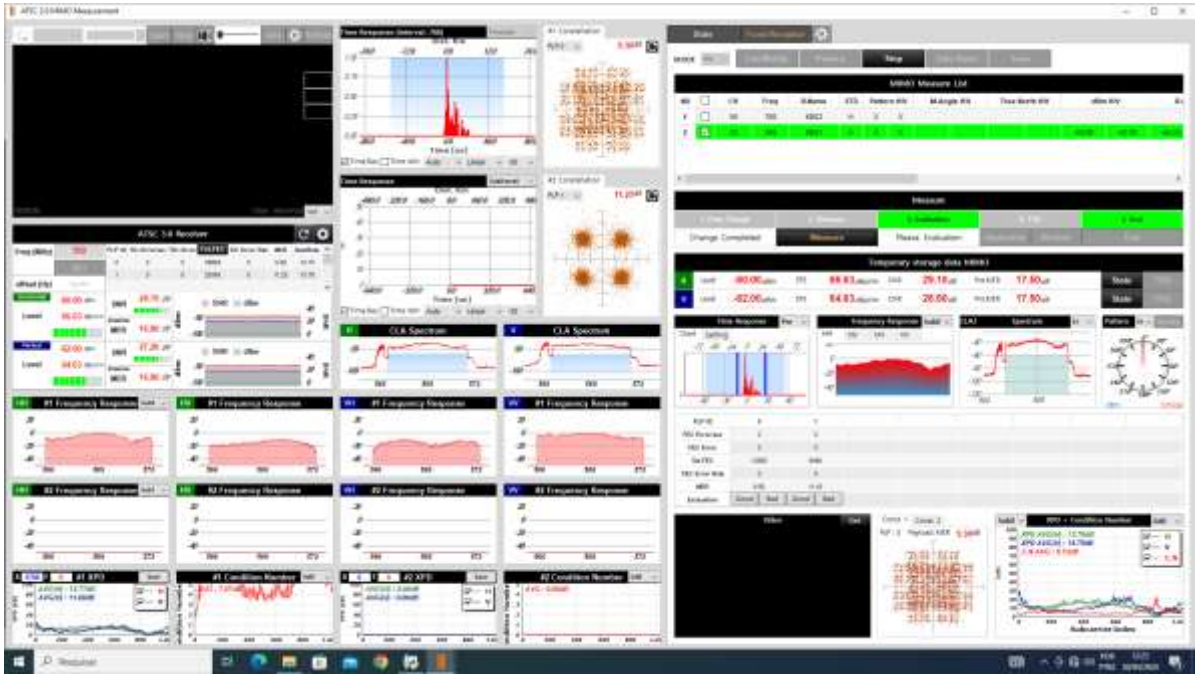


Figure 3.3 - IMAS Screen

b) AWGN Power

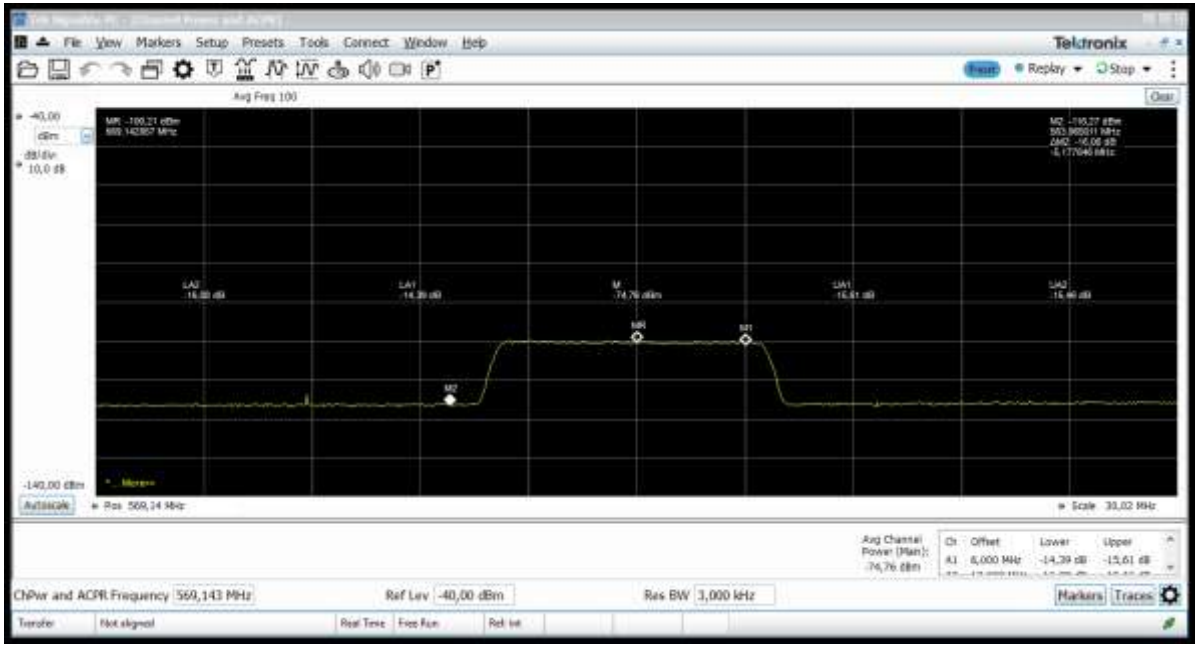


Figure 3.4 - Vertical

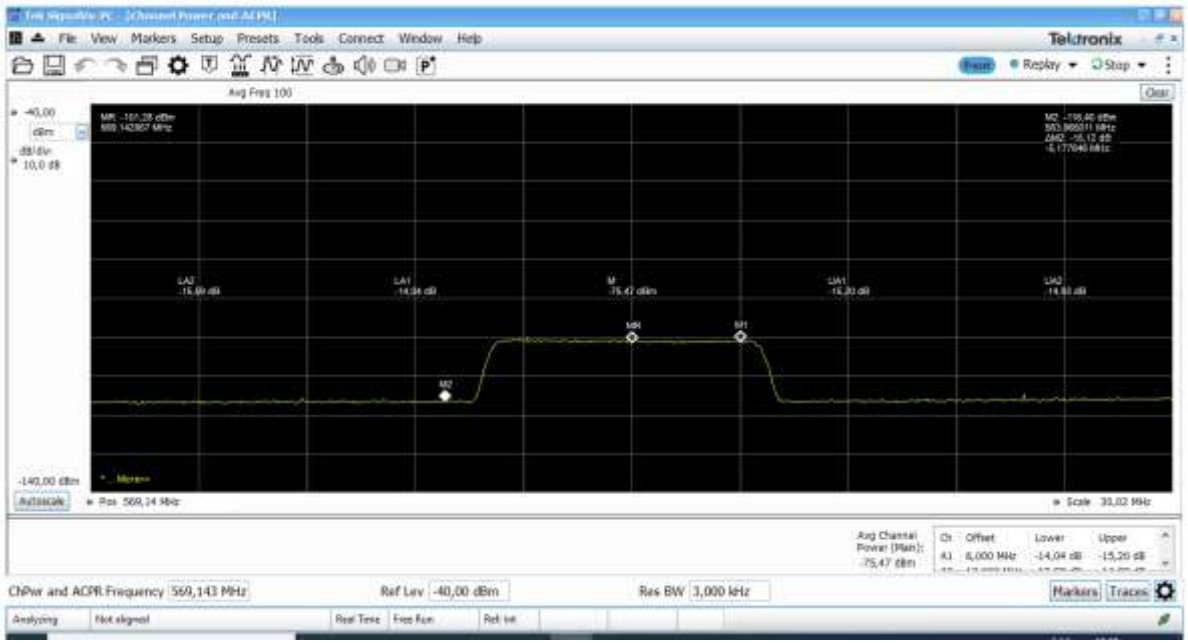


Figure 3.5 - Horizontal

c) C/N Threshold

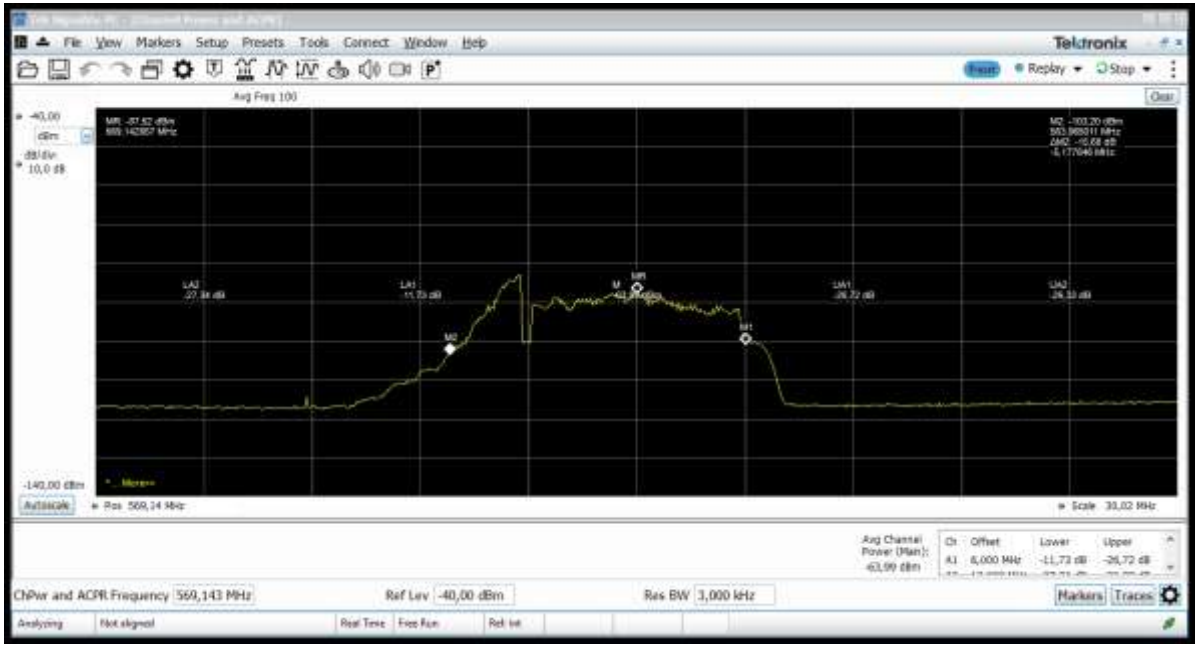


Figure 3.6 - Vertical

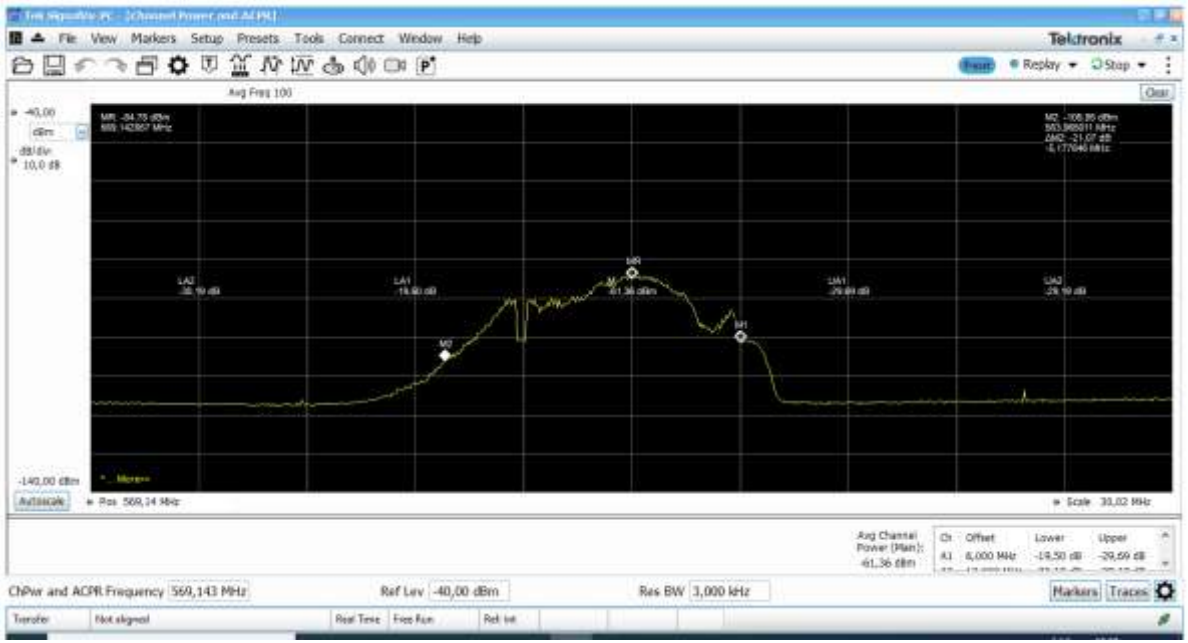


Figure 3.7 - Horizontal

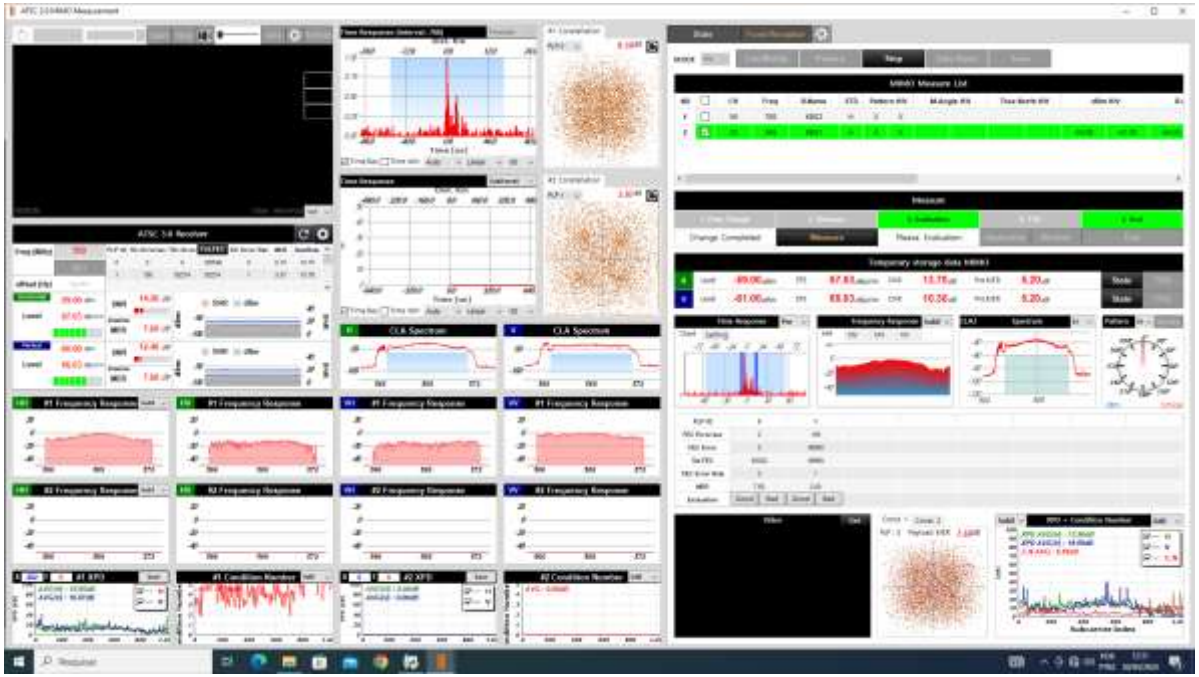


Figure 3.8 - IMAS Screen

d) Reception Threshold

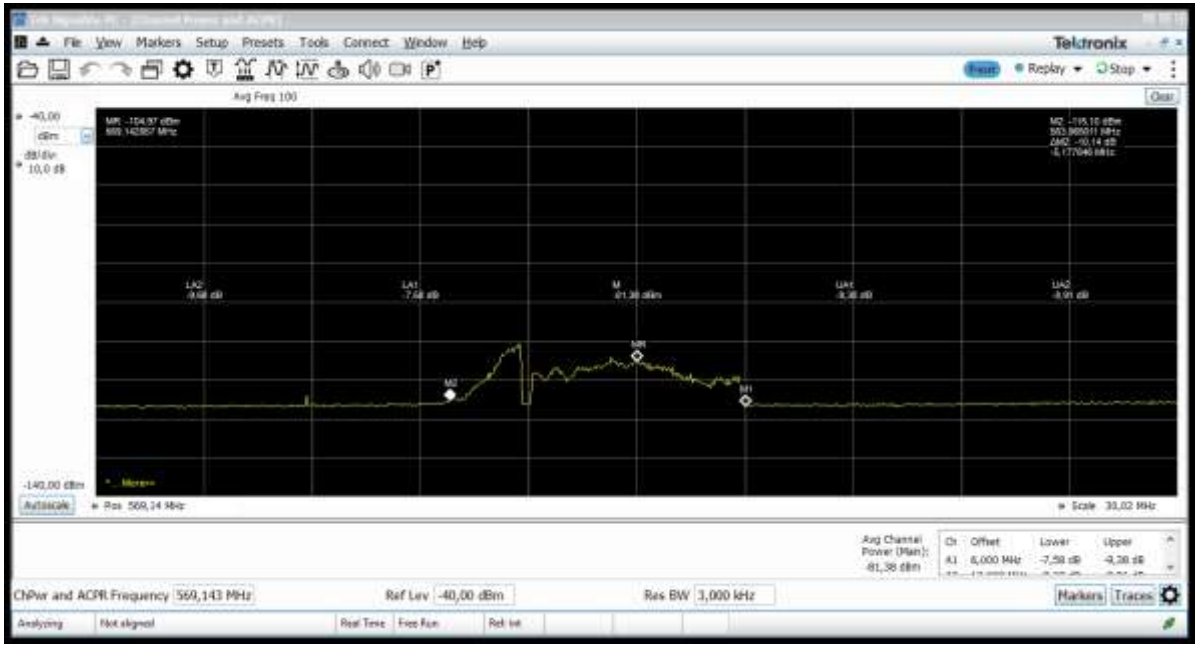


Figure 3.9 - Vertical

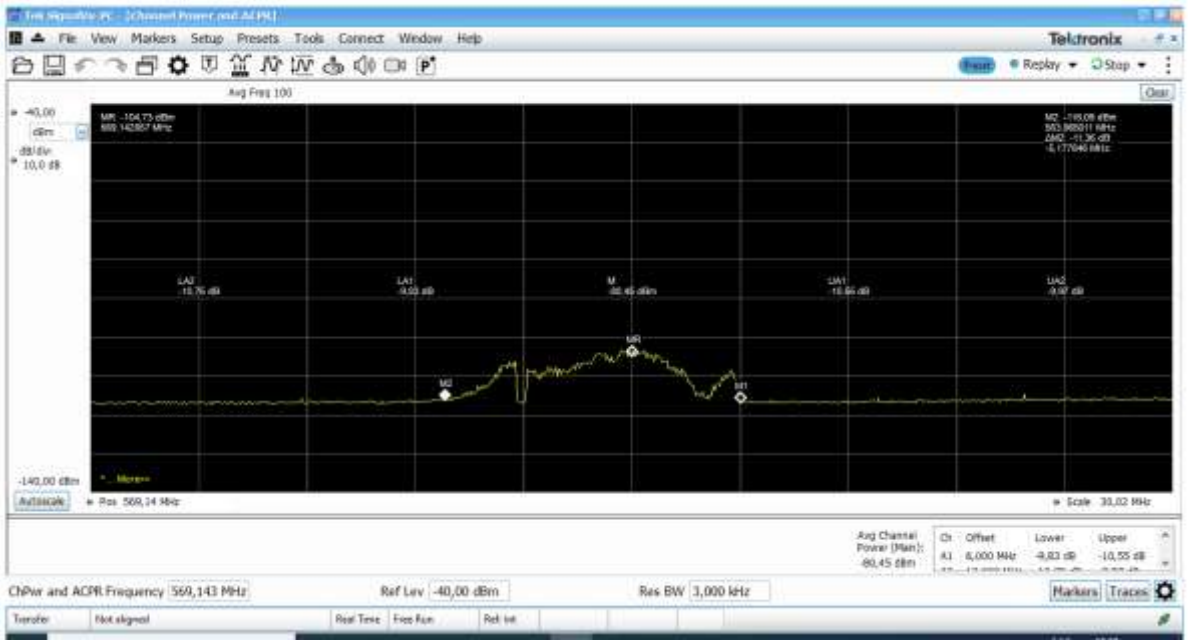


Figure 3.10 - Horizontal

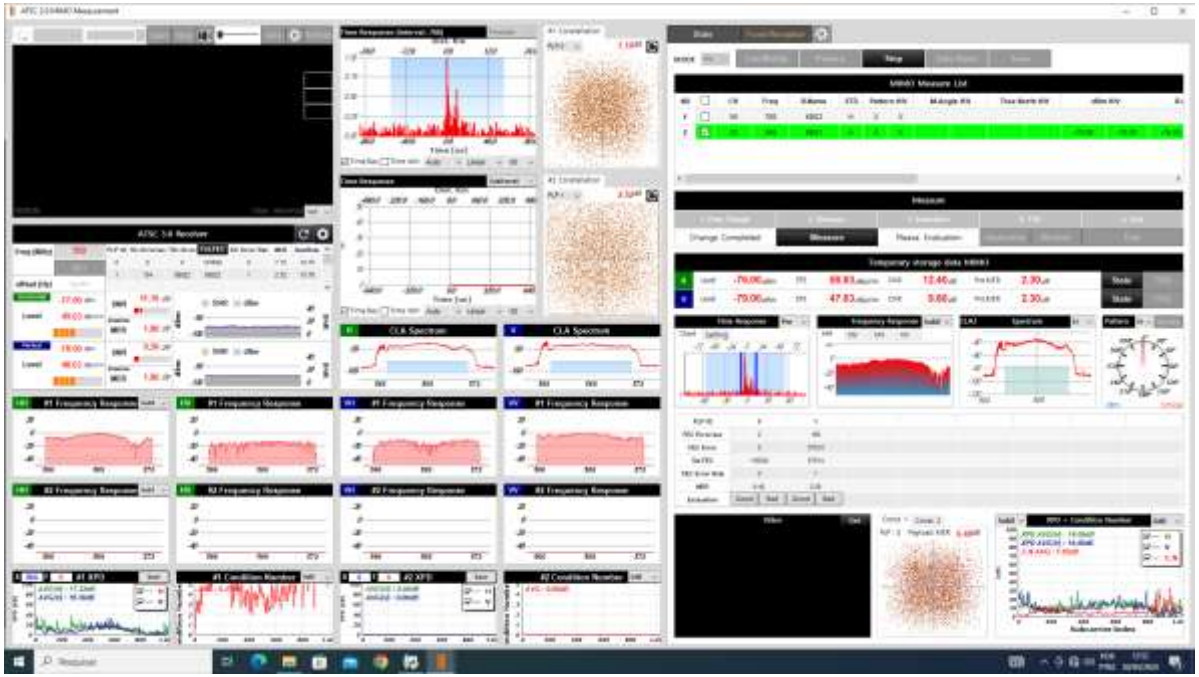


Figure 3.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

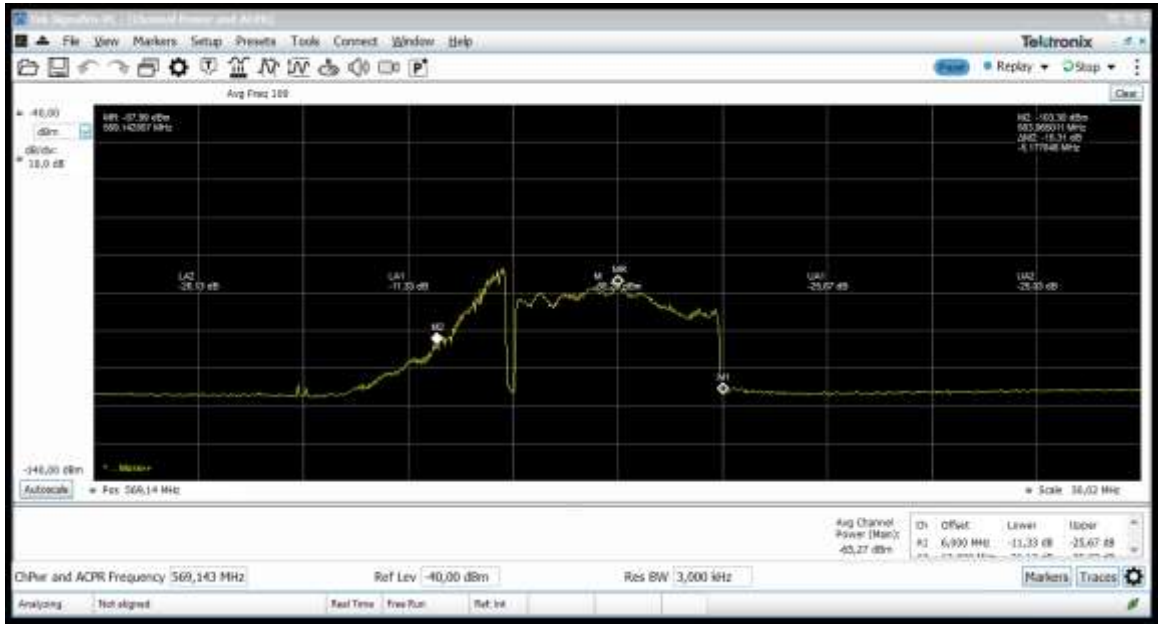


Figure 3.12 - Vertical

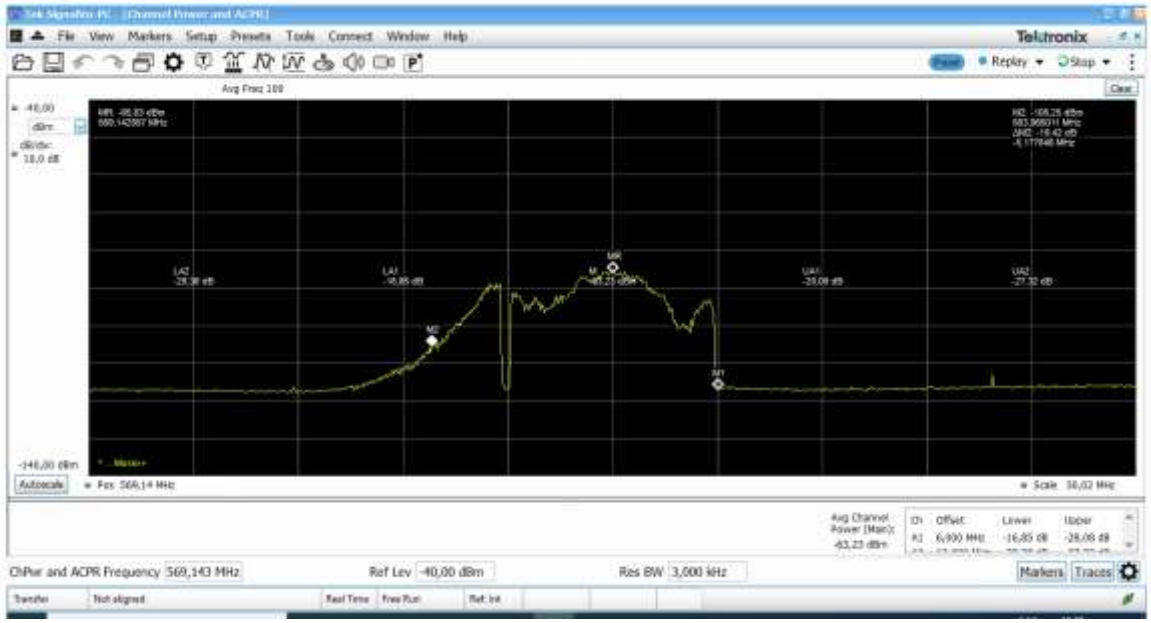


Figure 3.13 - Horizontal

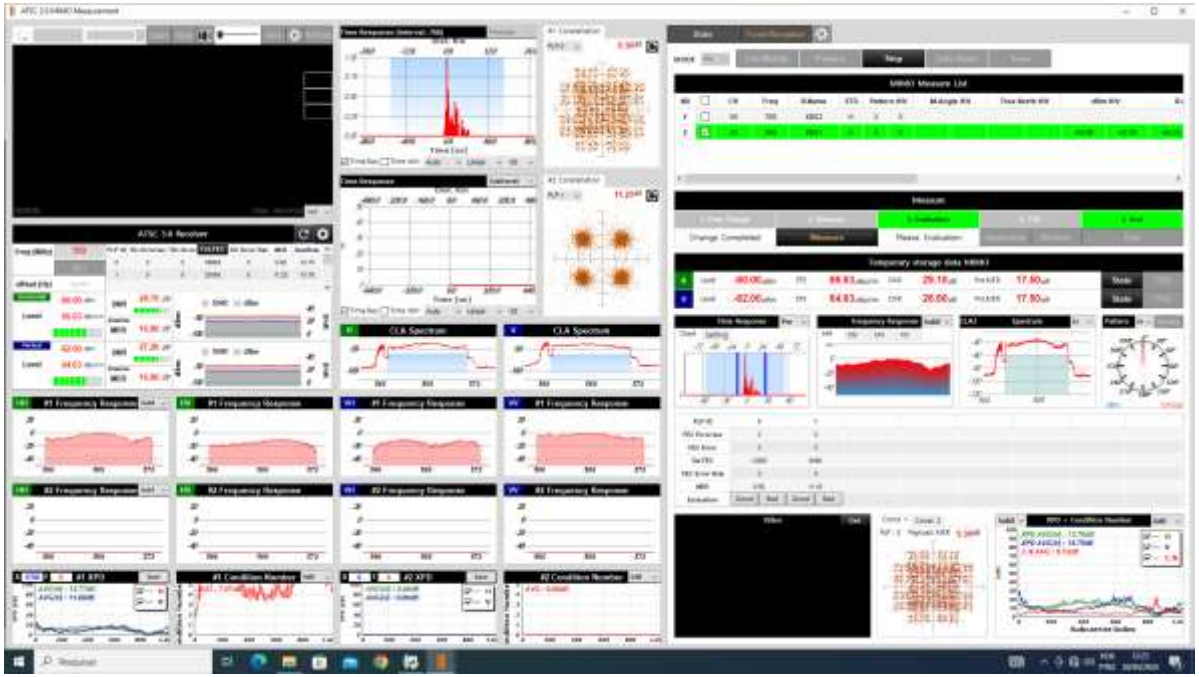


Figure 3.14 - IMAS Screen

b) AWGN Power

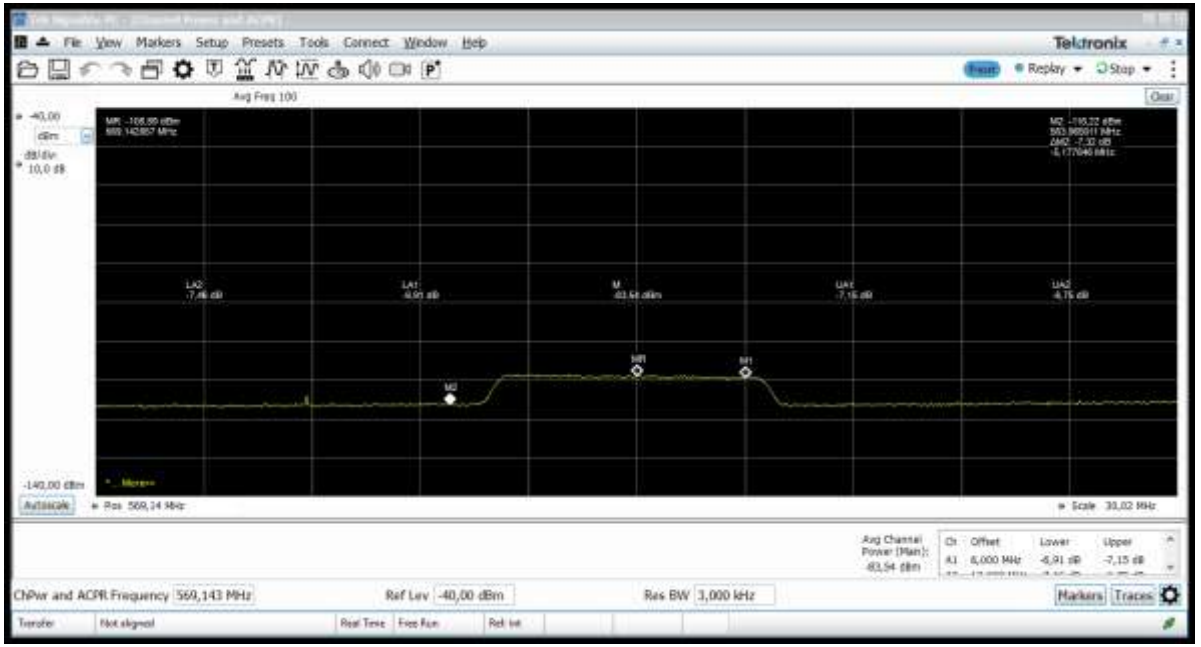


Figure 3.15 - Vertical

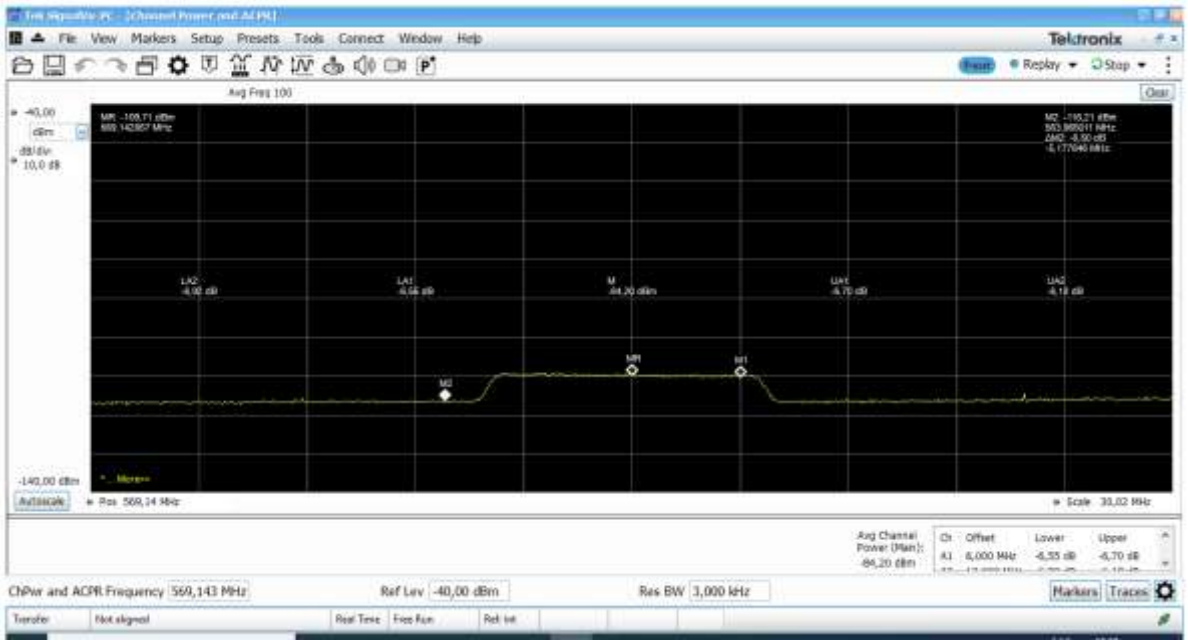


Figure 3.16 - Horizontal

c) C/N Threshold

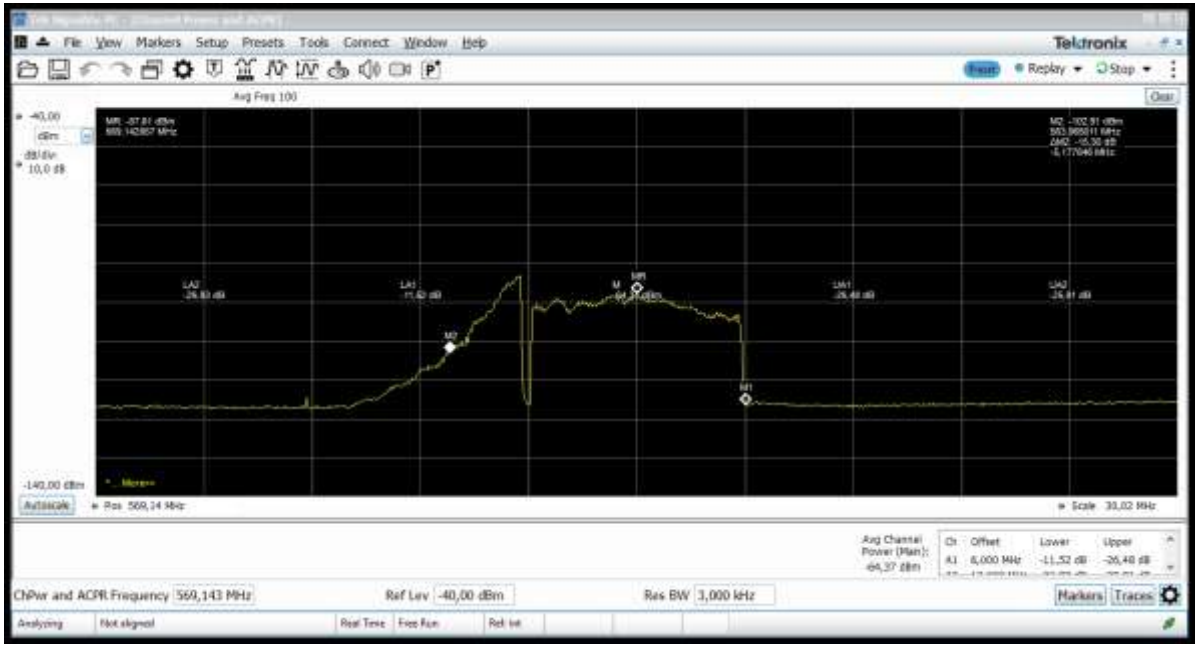


Figure 3.17 - Vertical

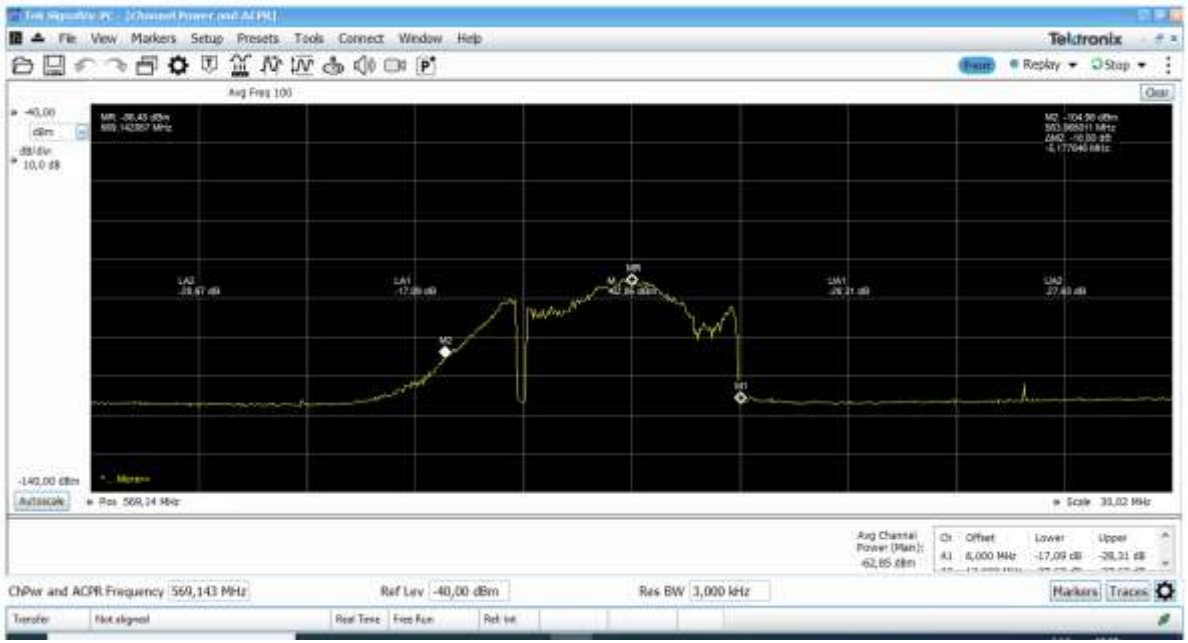


Figure 3.18 - Horizontal

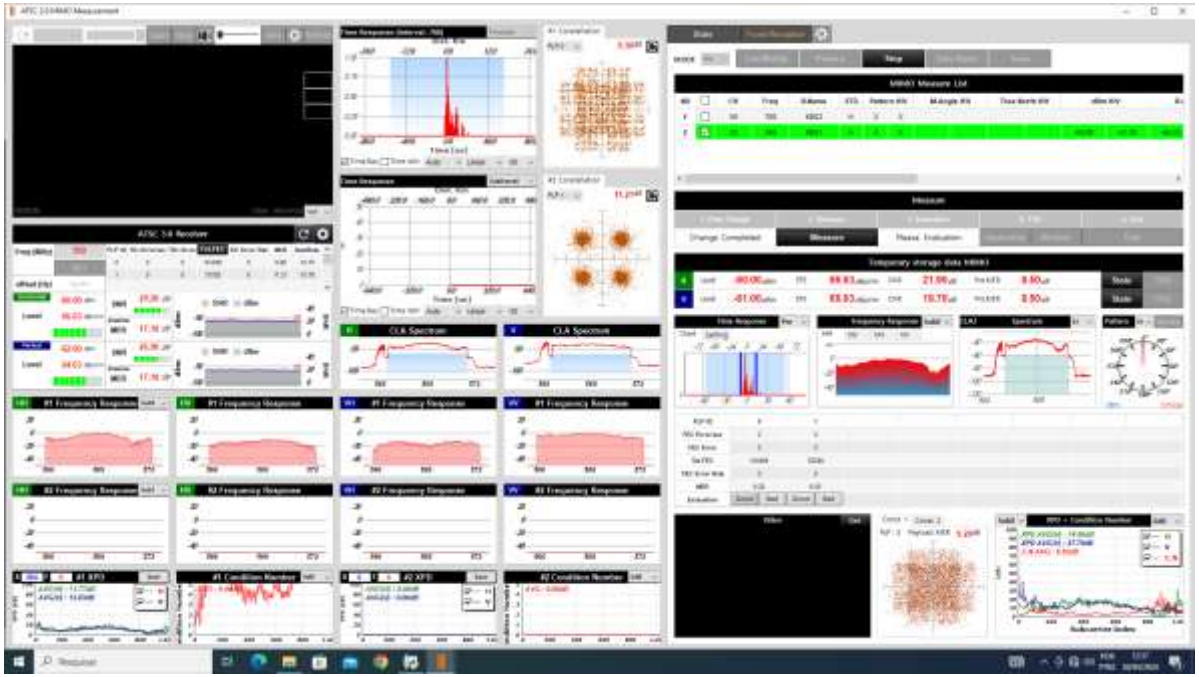


Figure 3.19 - IMAS Screen

d) Reception Threshold

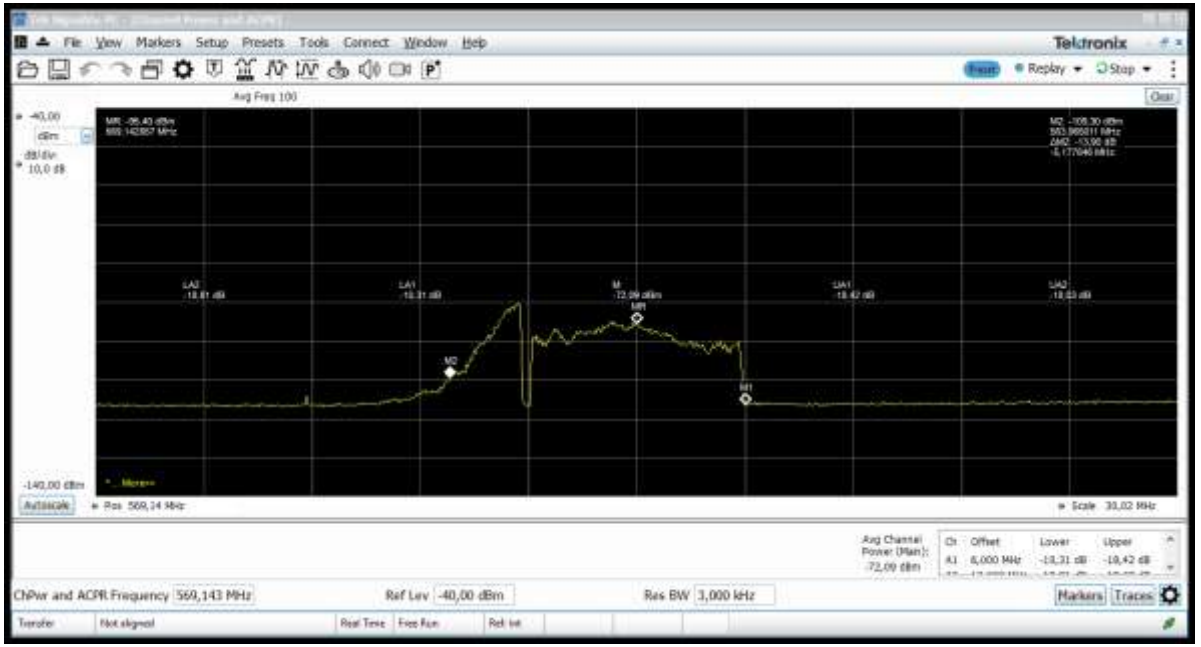


Figure 3.20 - Vertical

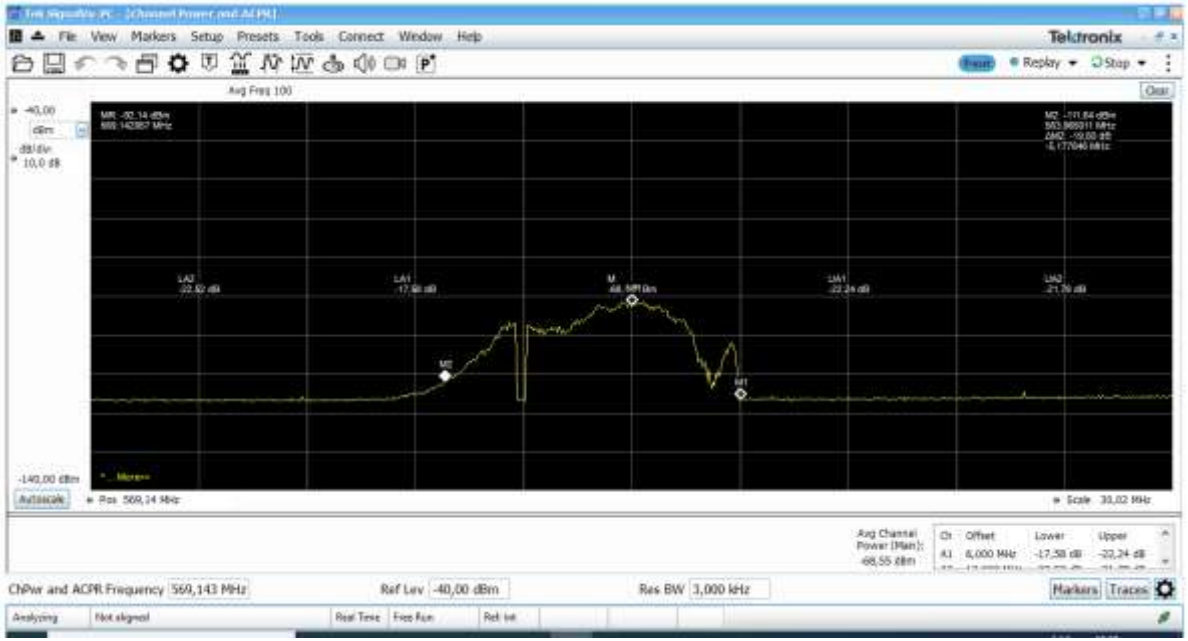


Figure 3.21 - Horizontal

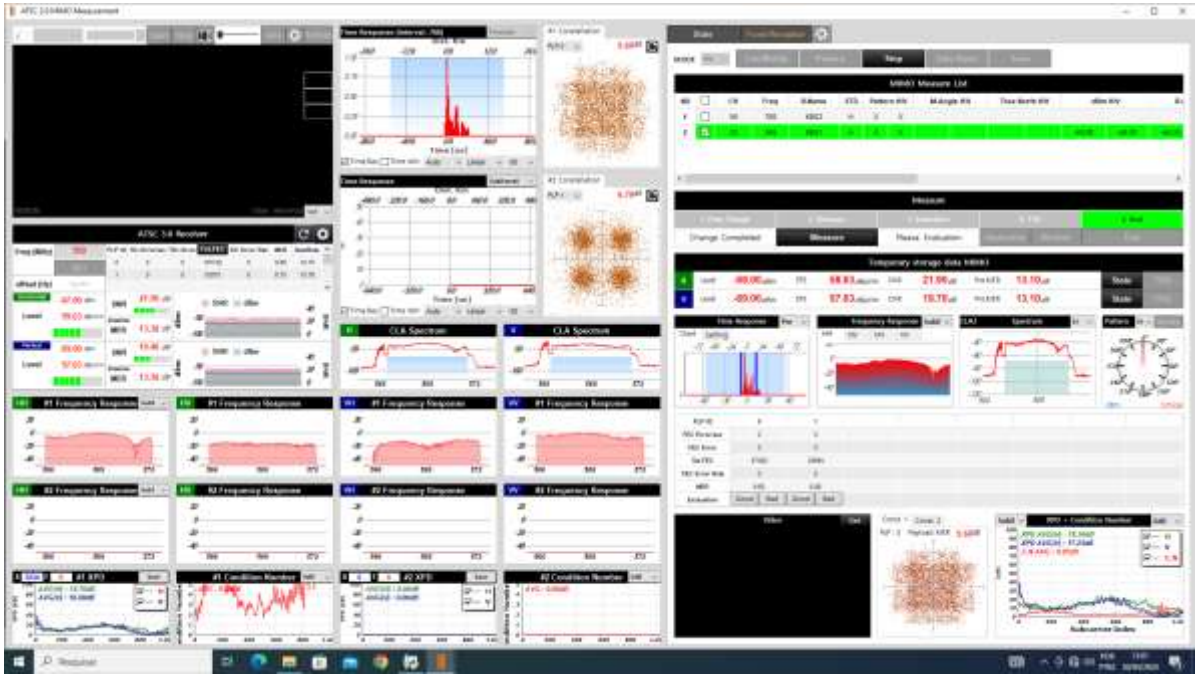


Figure 3.22 - IMAS Screen

Chapter 4. Site 7

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

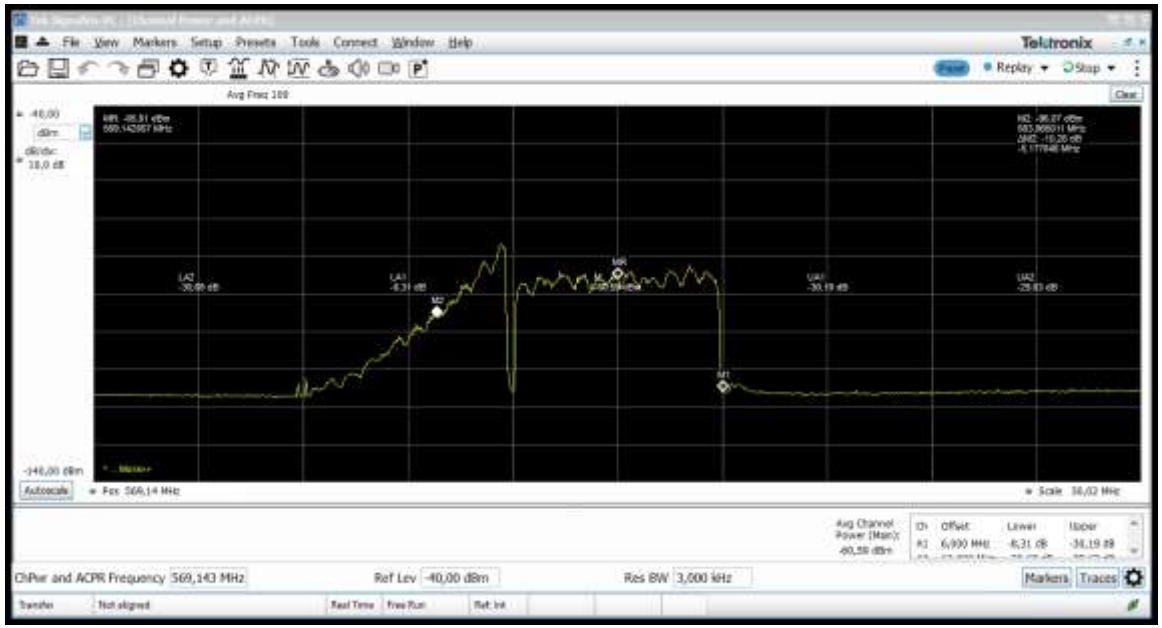


Figure 4.1 - Vertical

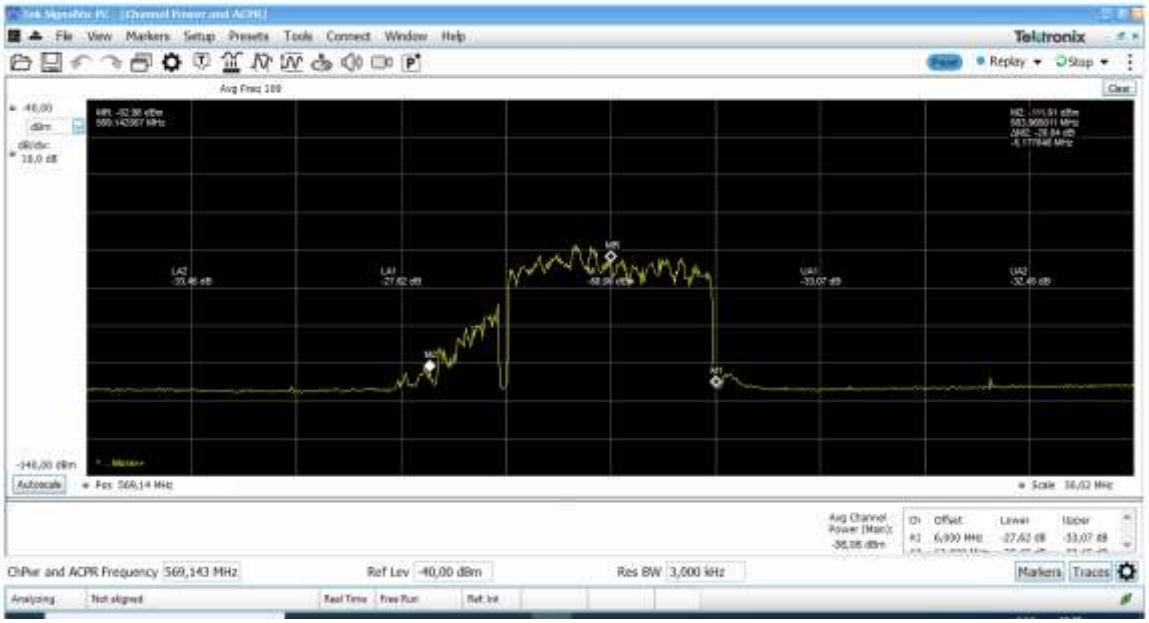


Figure 4.2 - Horizontal

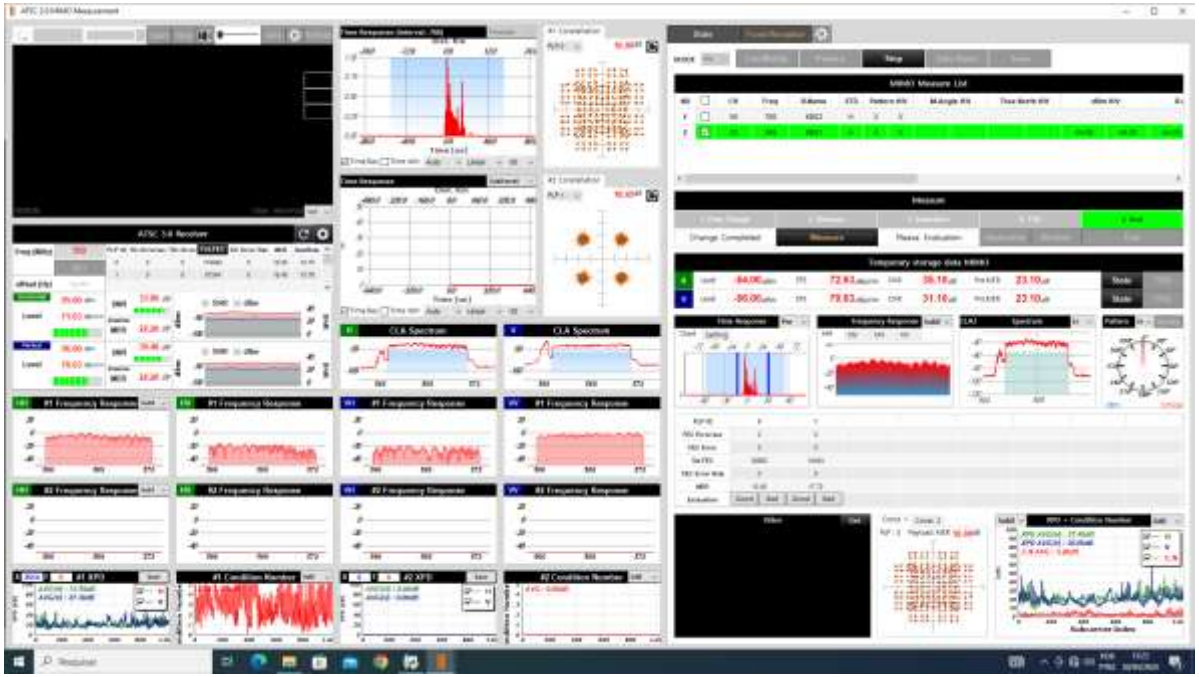


Figure 4.3 - IMAS Screen

b) AWGN Power

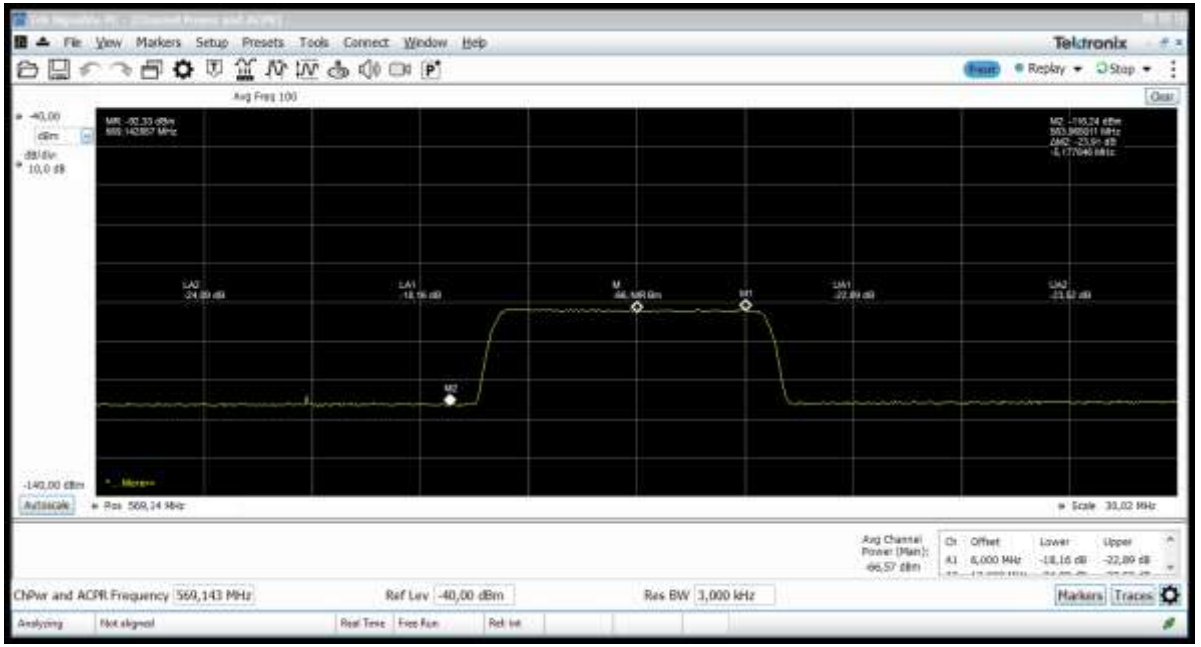


Figure 4.4 - Vertical

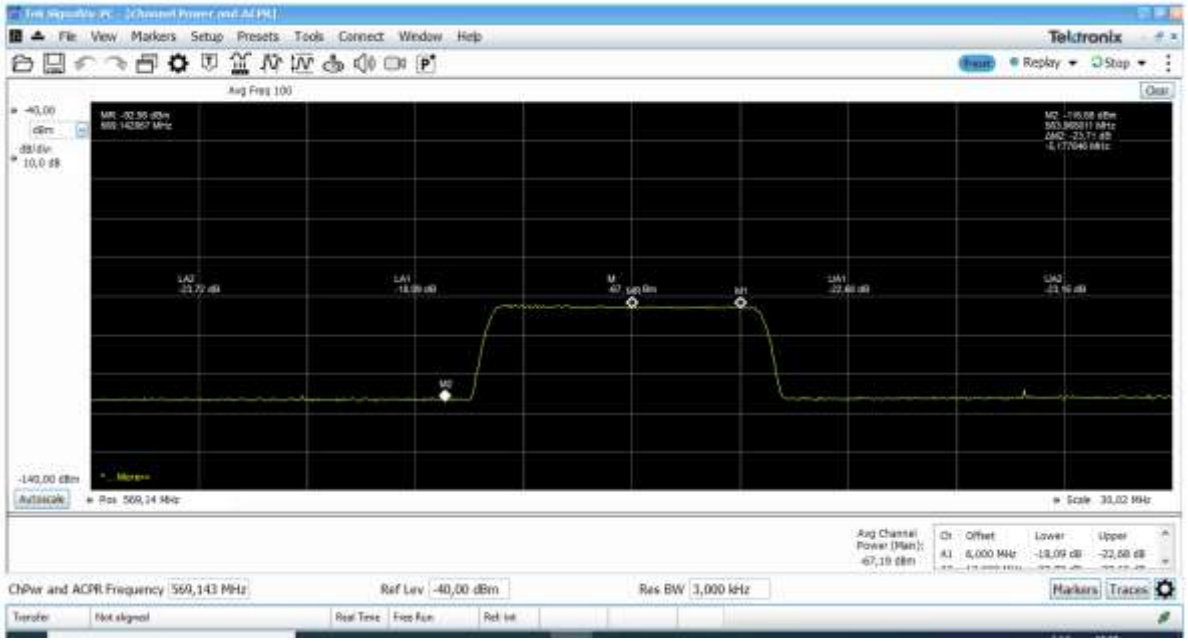


Figure 4.5 - Horizontal

c) C/N Threshold

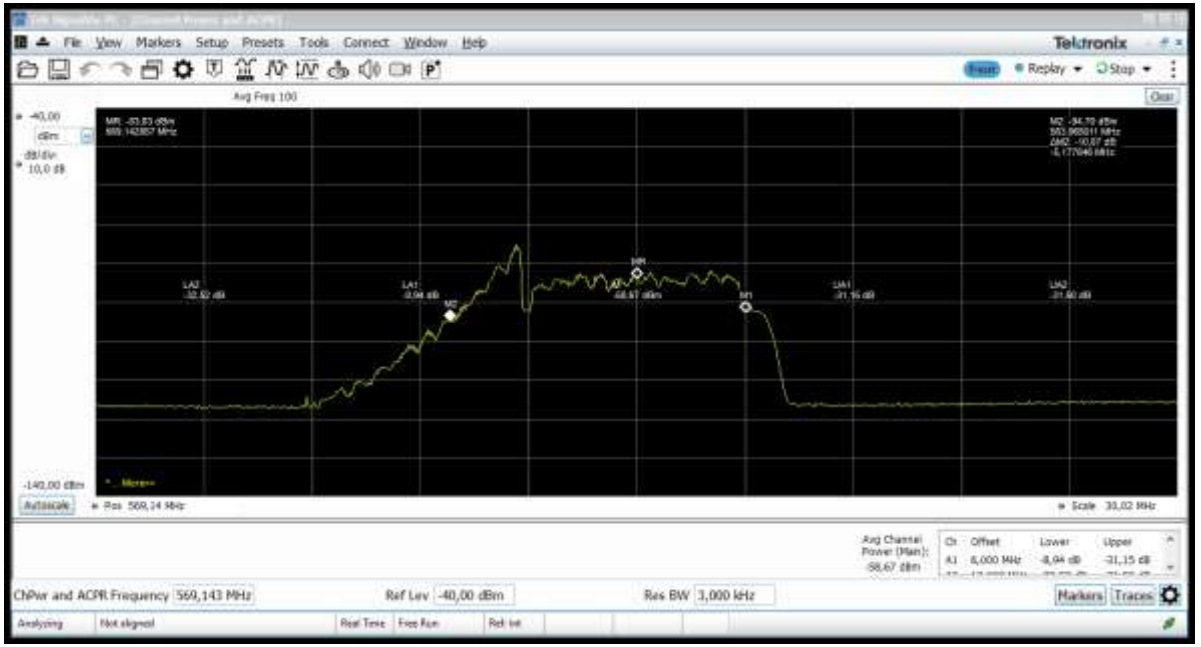


Figure 4.6 - Vertical

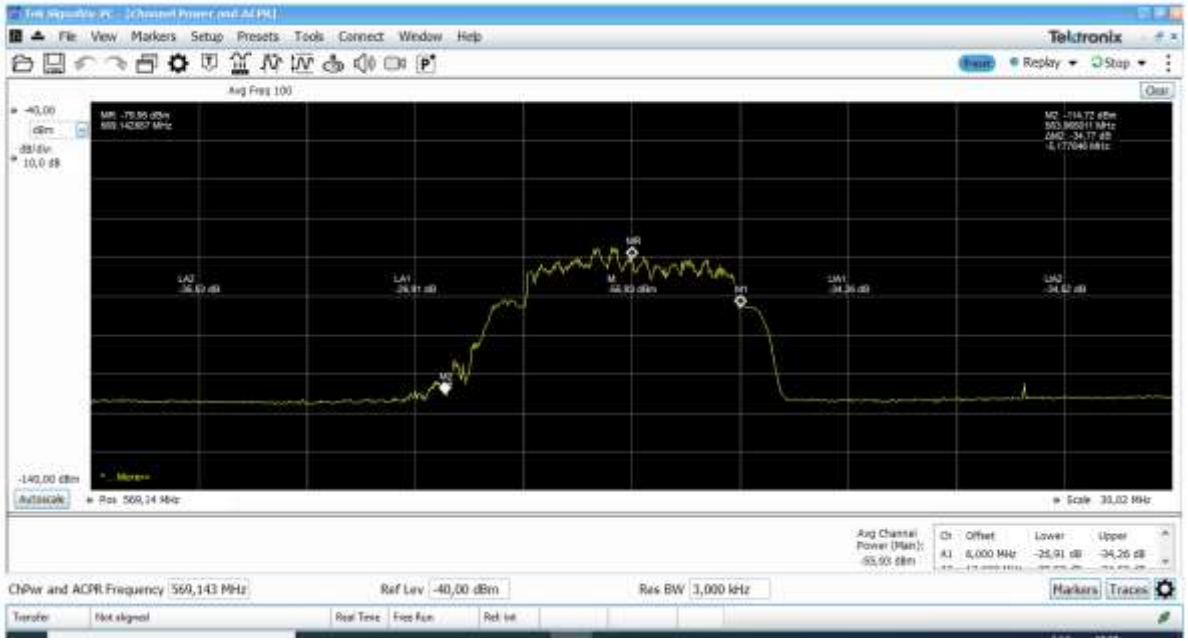


Figure 4.7 - Horizontal

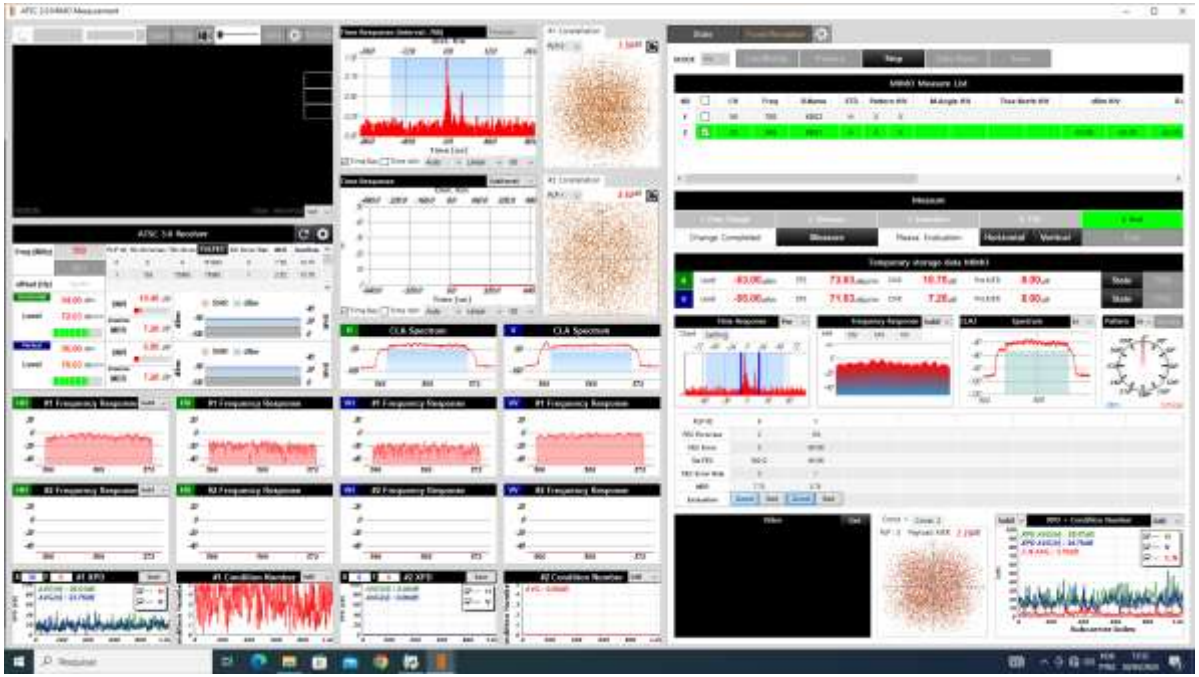


Figure 4.8 - IMAS Screen

d) Reception Threshold

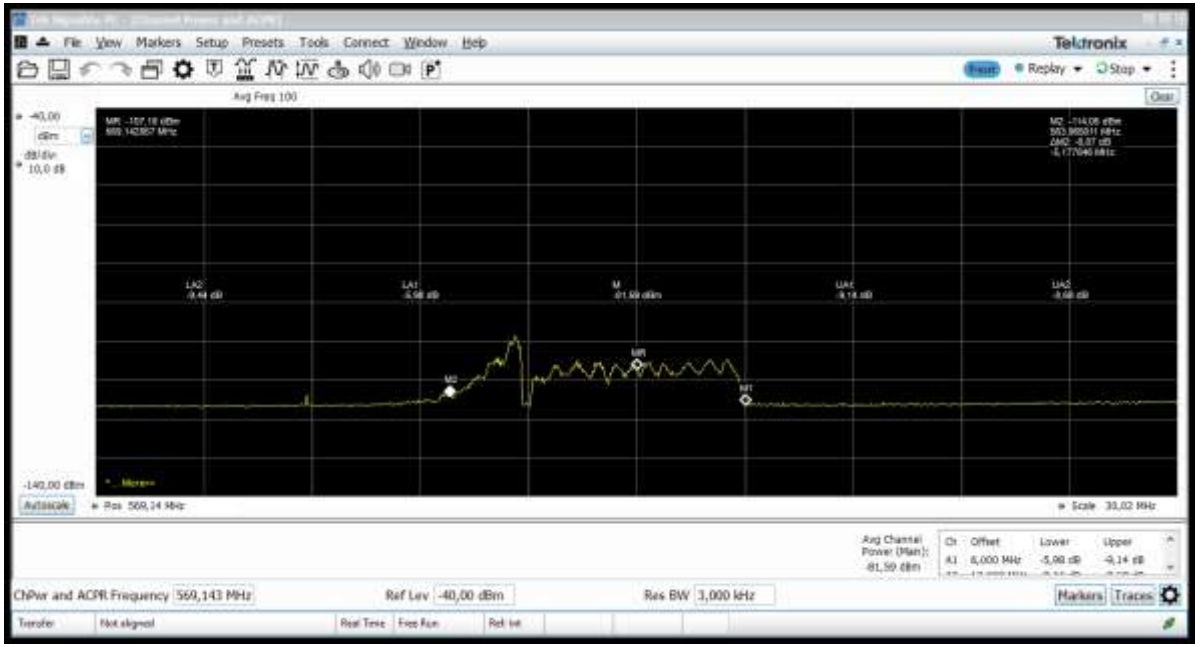


Figure 4.9 - Vertical

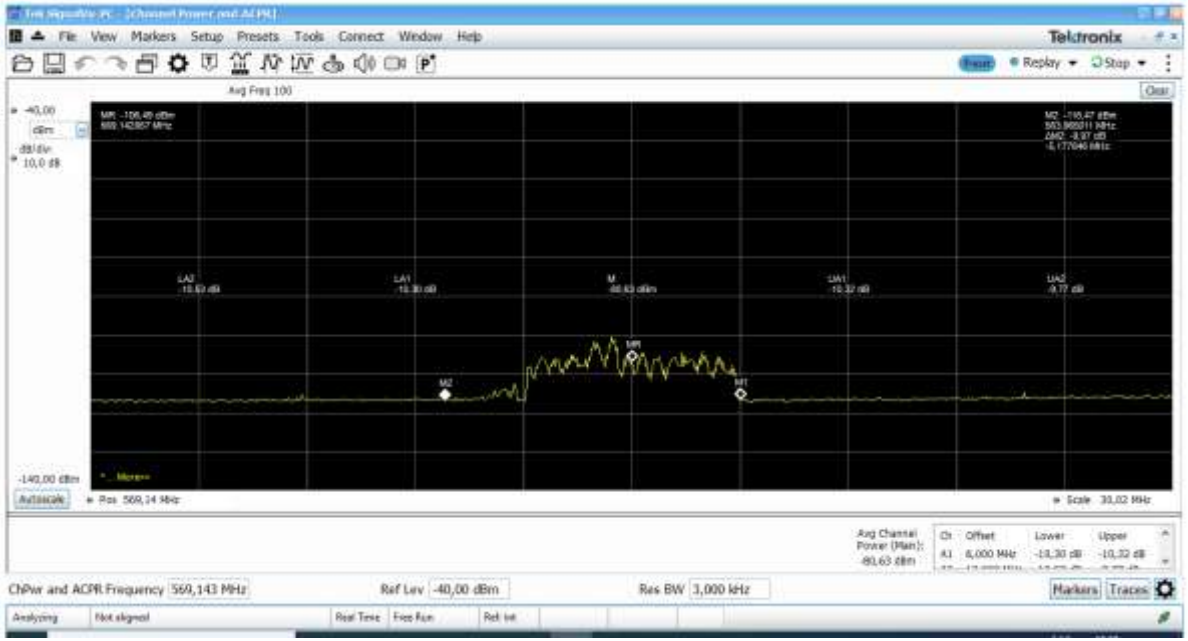


Figure 4.10 - Horizontal

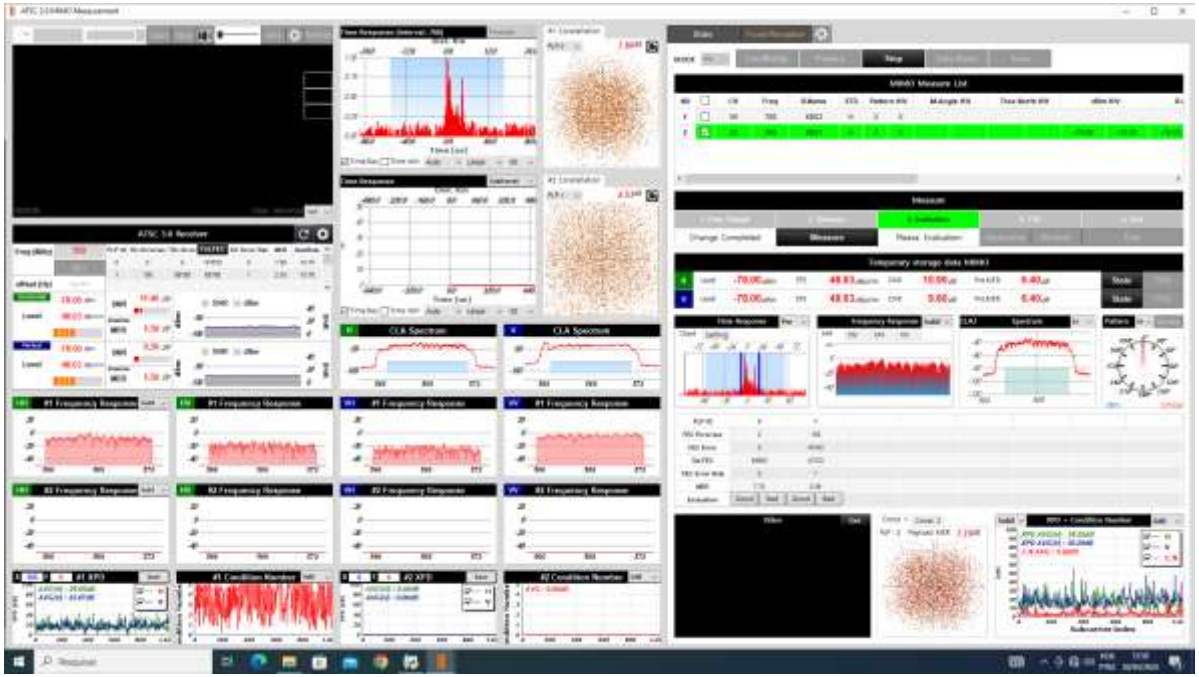


Figure 4.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

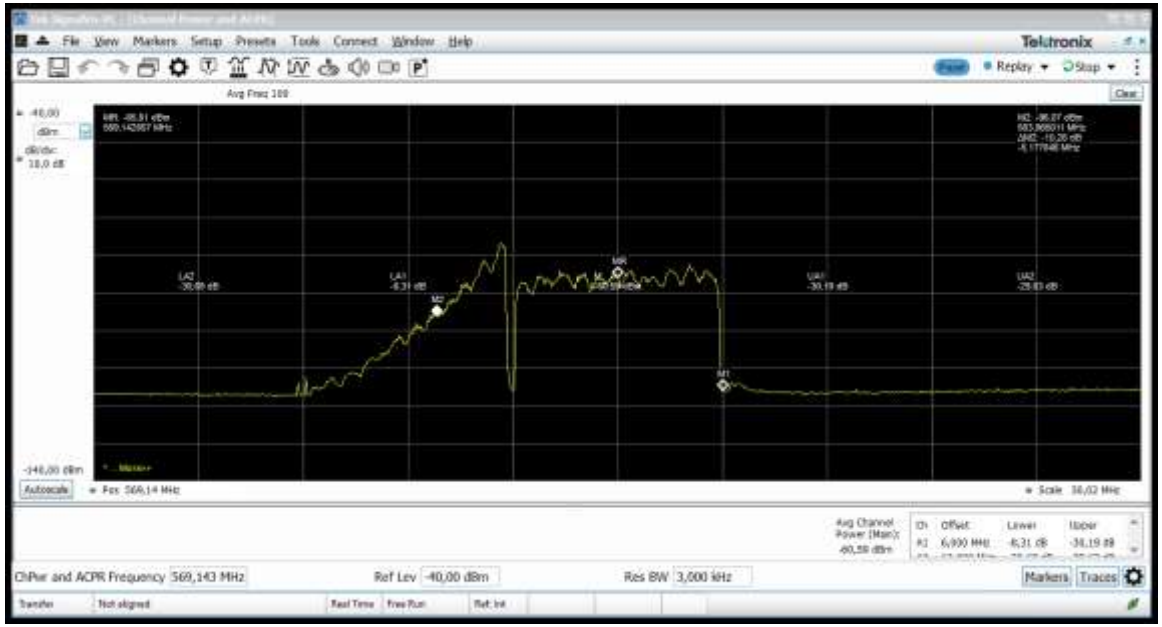


Figure 4.12 - Vertical

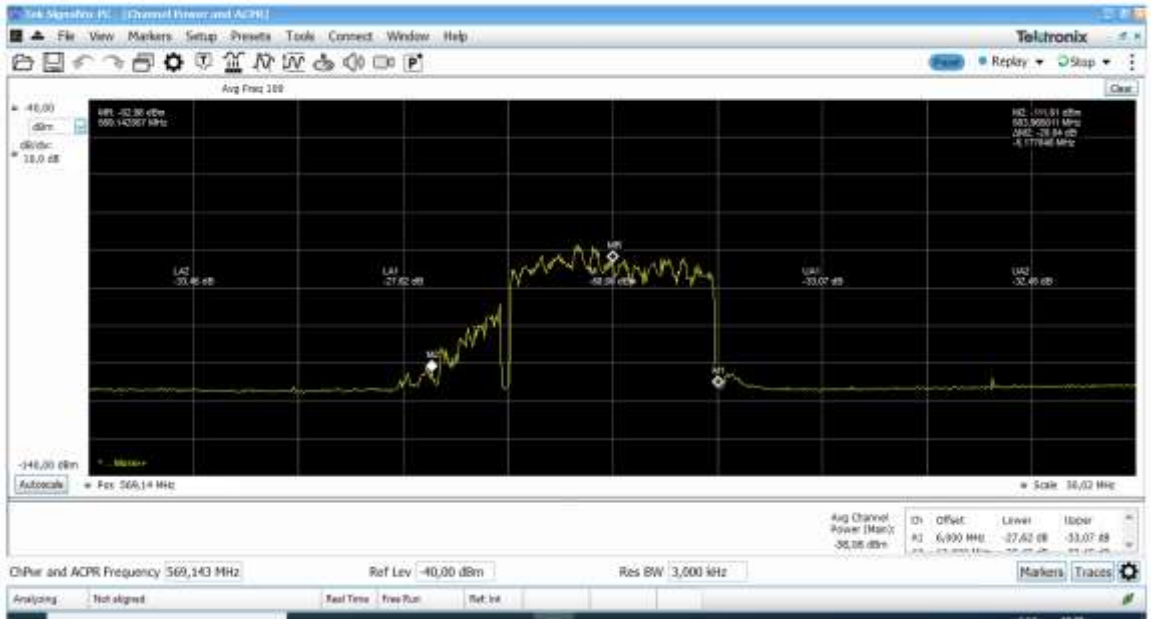


Figure 4.13 - Horizontal

Figure 4.14 - IMAS Screen

b) AWGN Power

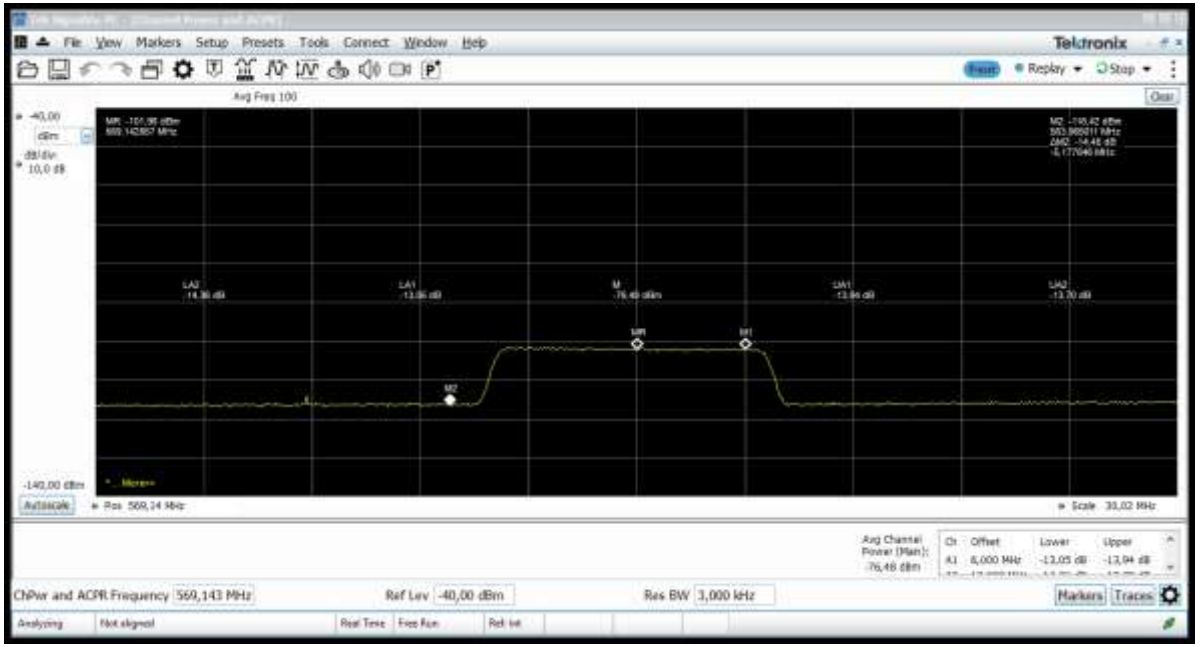


Figure 4.15 - Vertical

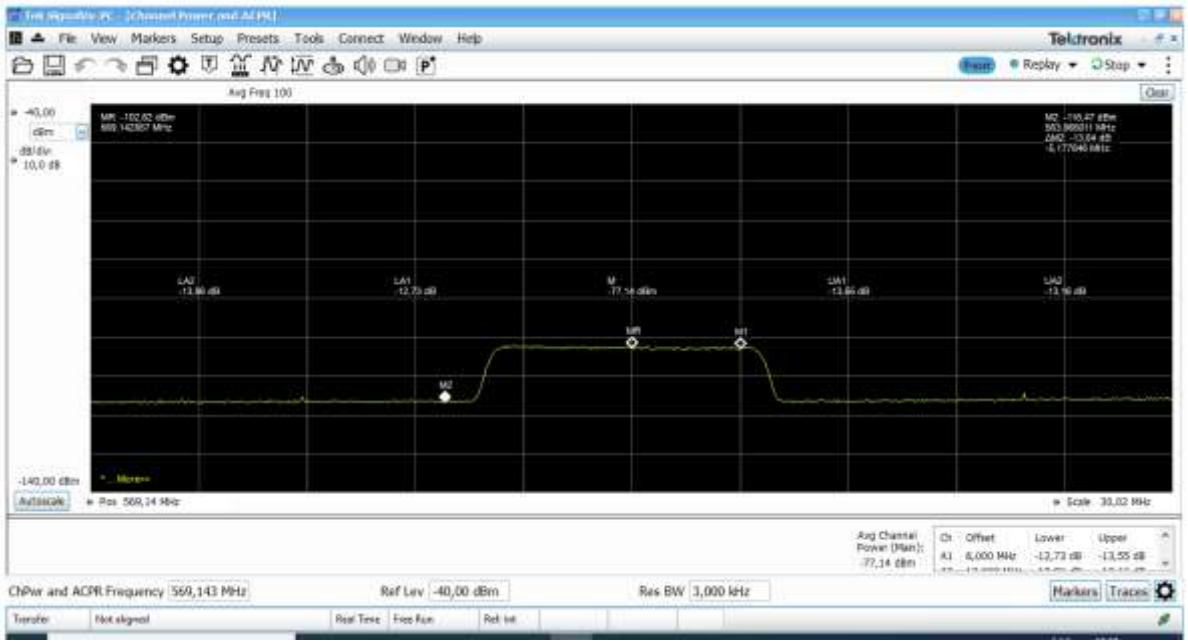


Figure 4.16 - Horizontal

c) C/N Threshold

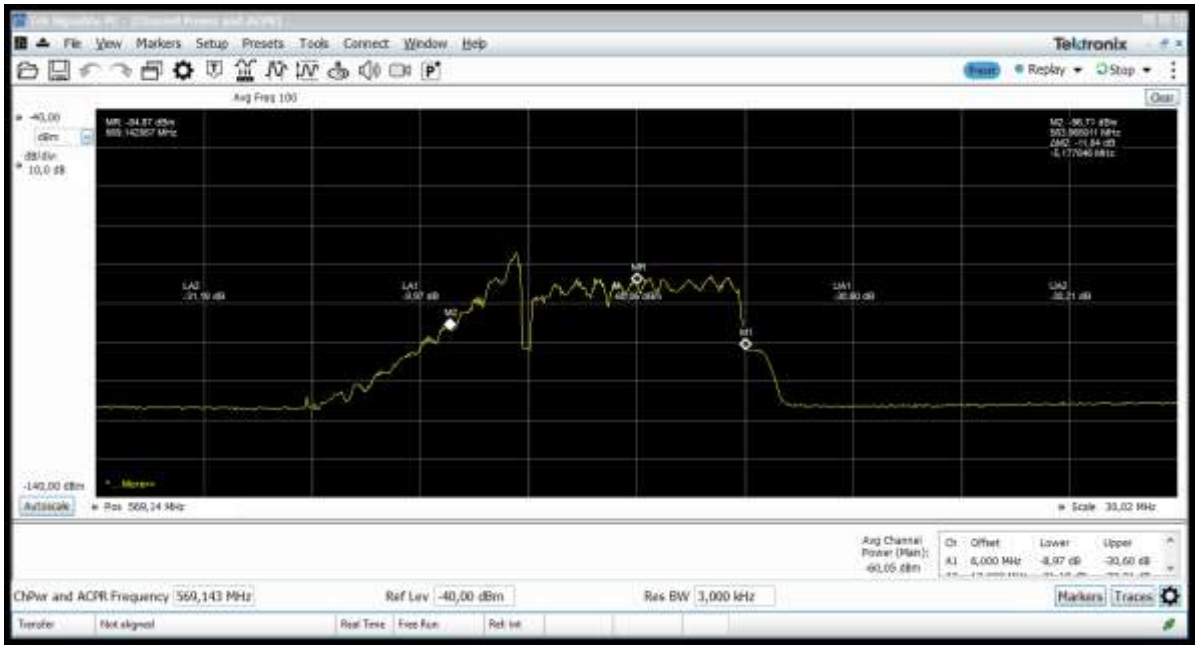


Figure 4.17 - Vertical

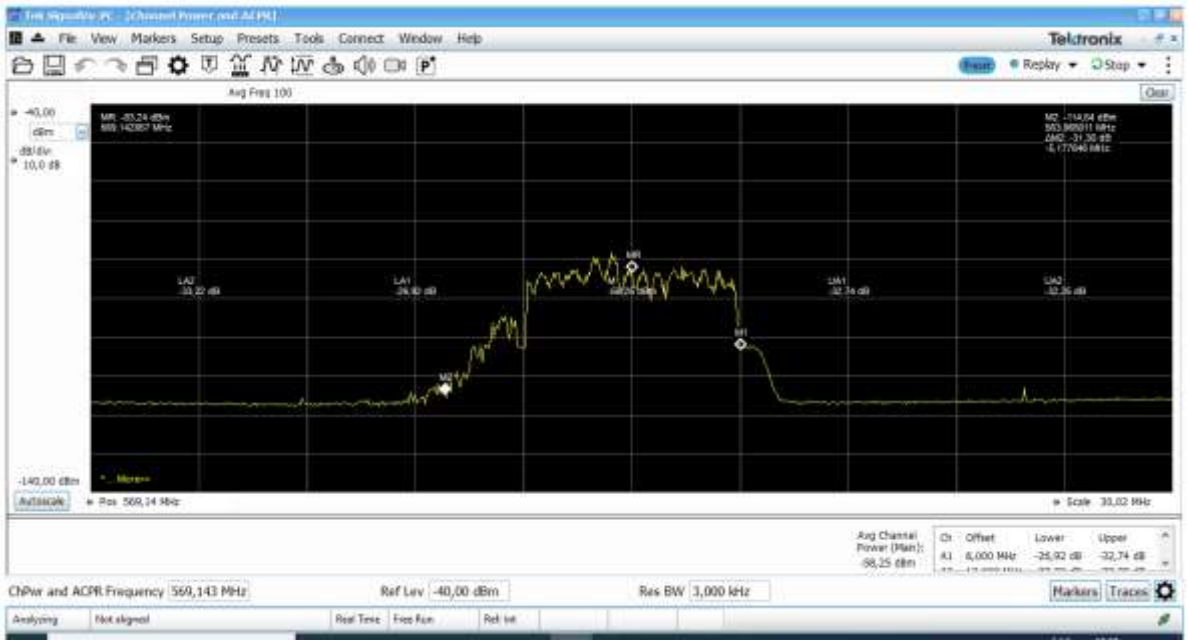


Figure 4.18 - Horizontal

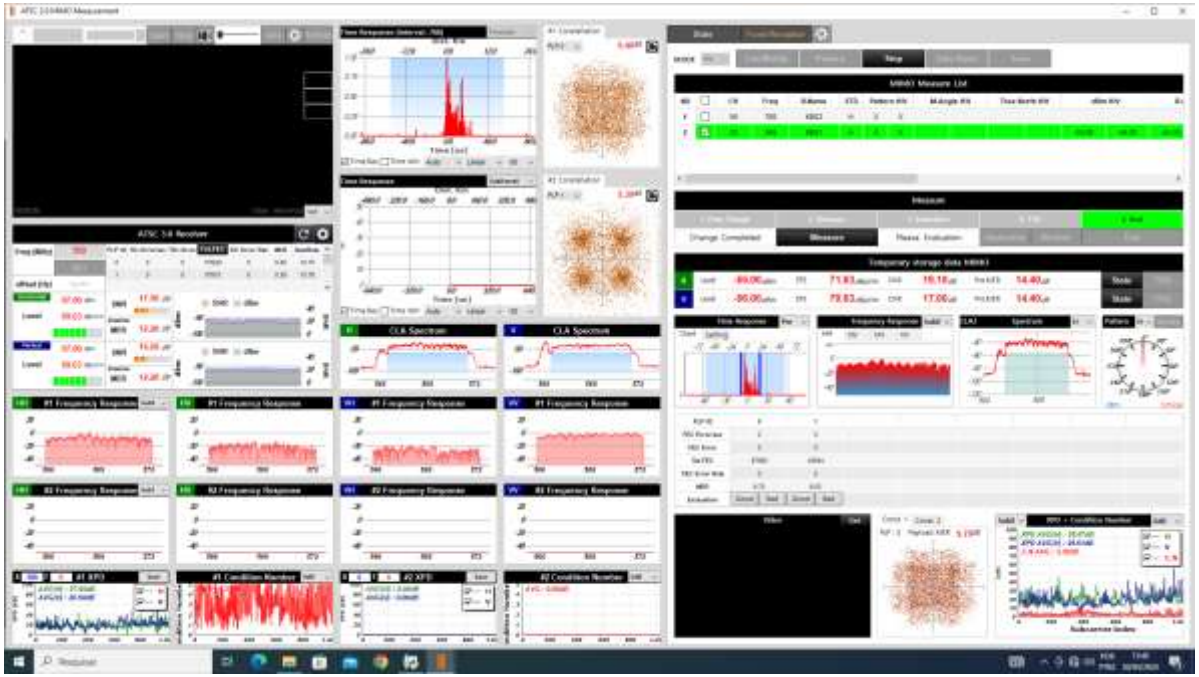


Figure 4.19 - IMAS Screen

d) Reception Threshold

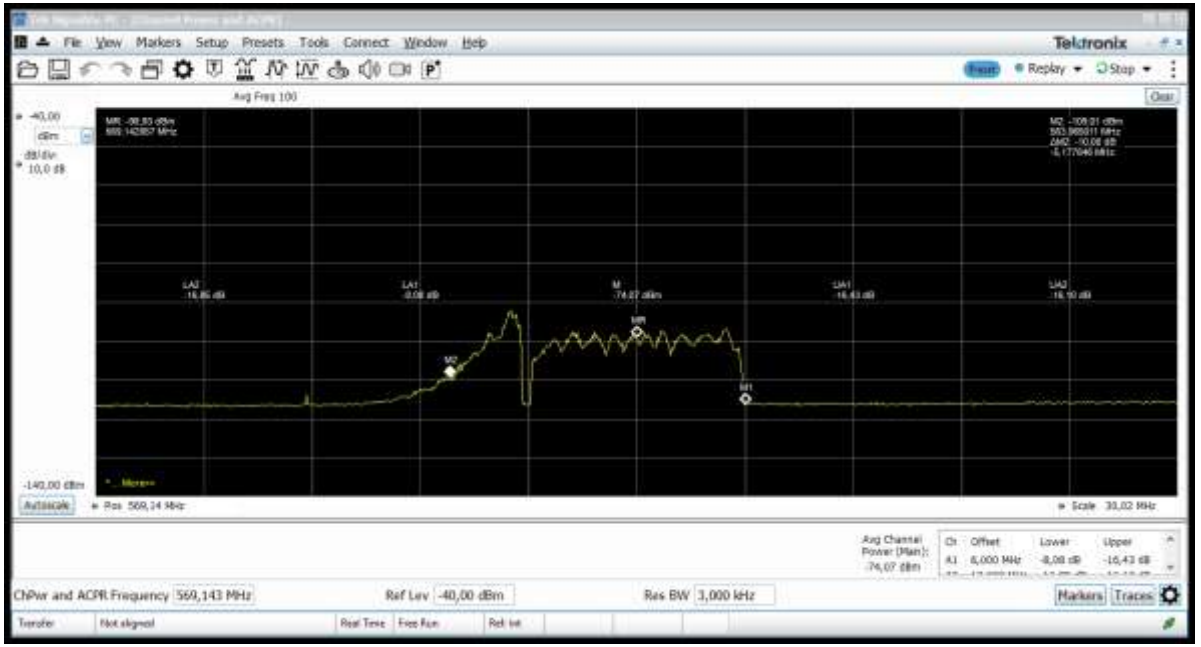


Figure 4.20 - Vertical

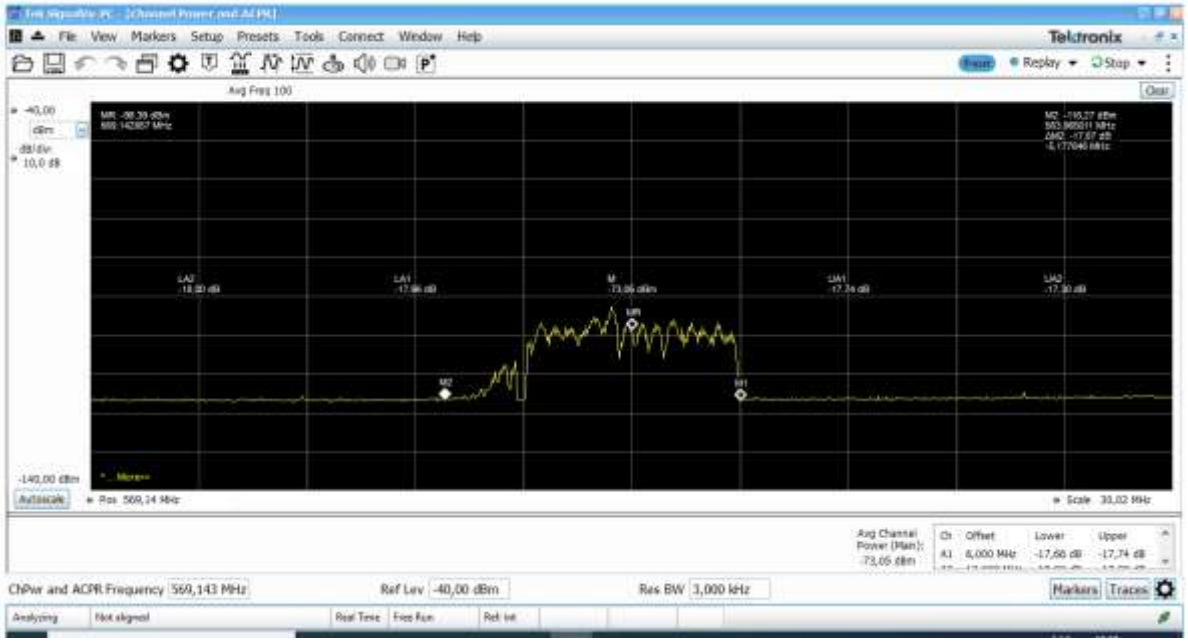


Figure 4.21 - Horizontal

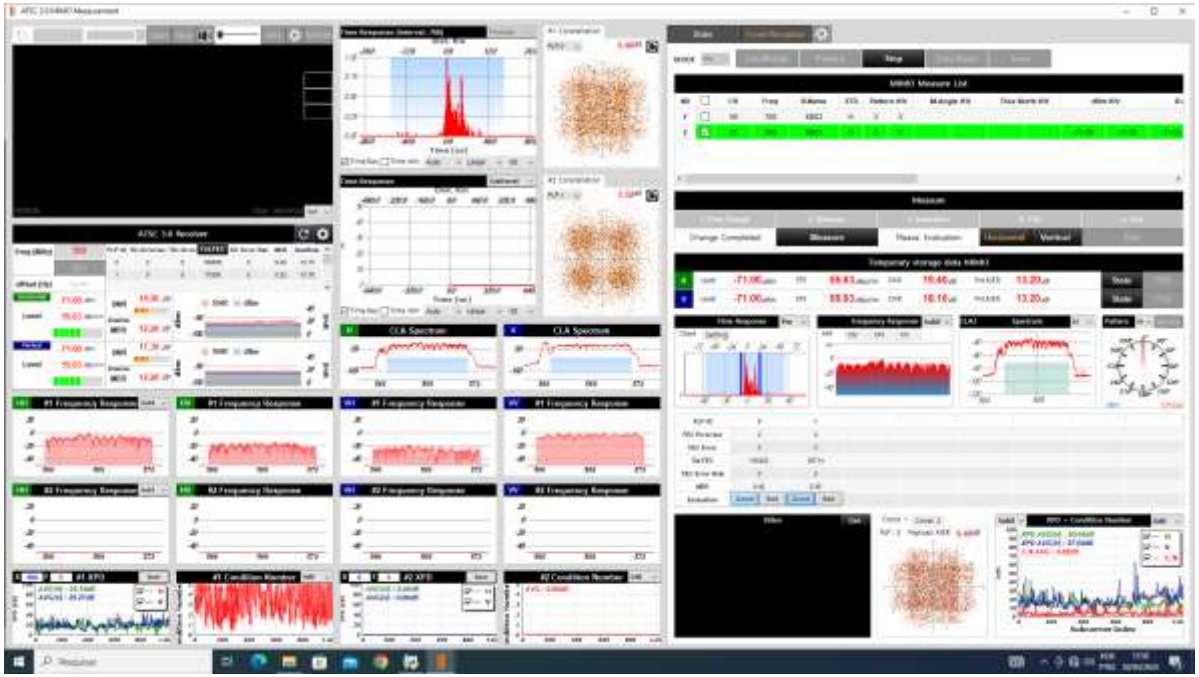


Figure 4.22 - IMAS Screen

Chapter 5. Site 8

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

Figure 5.1 - Vertical

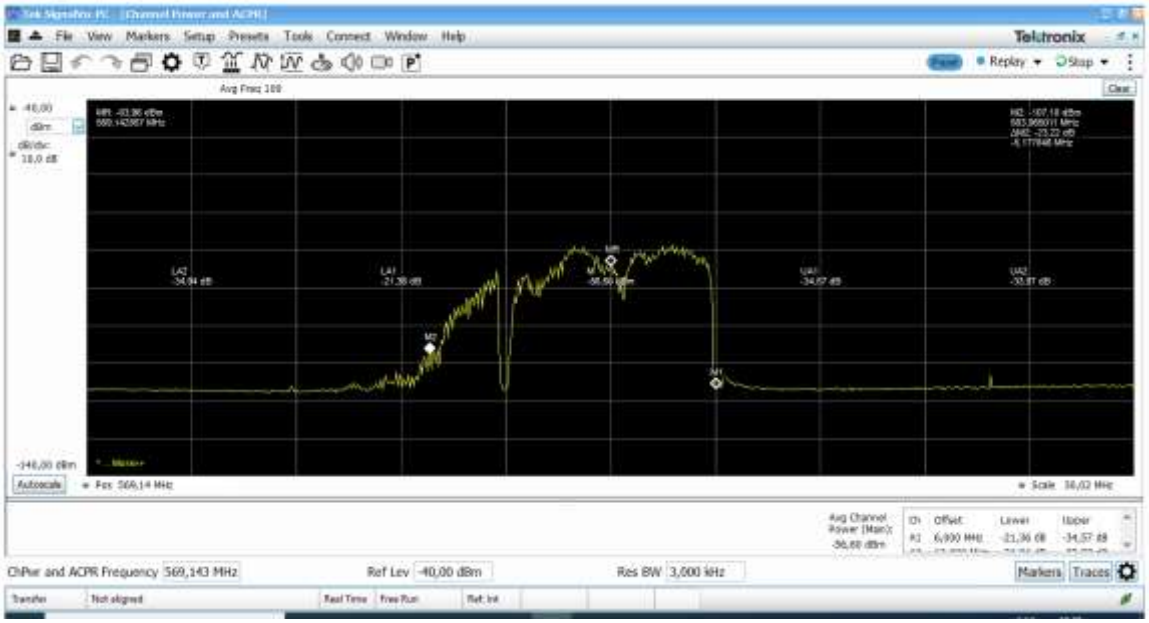


Figure 5.2 - Horizontal

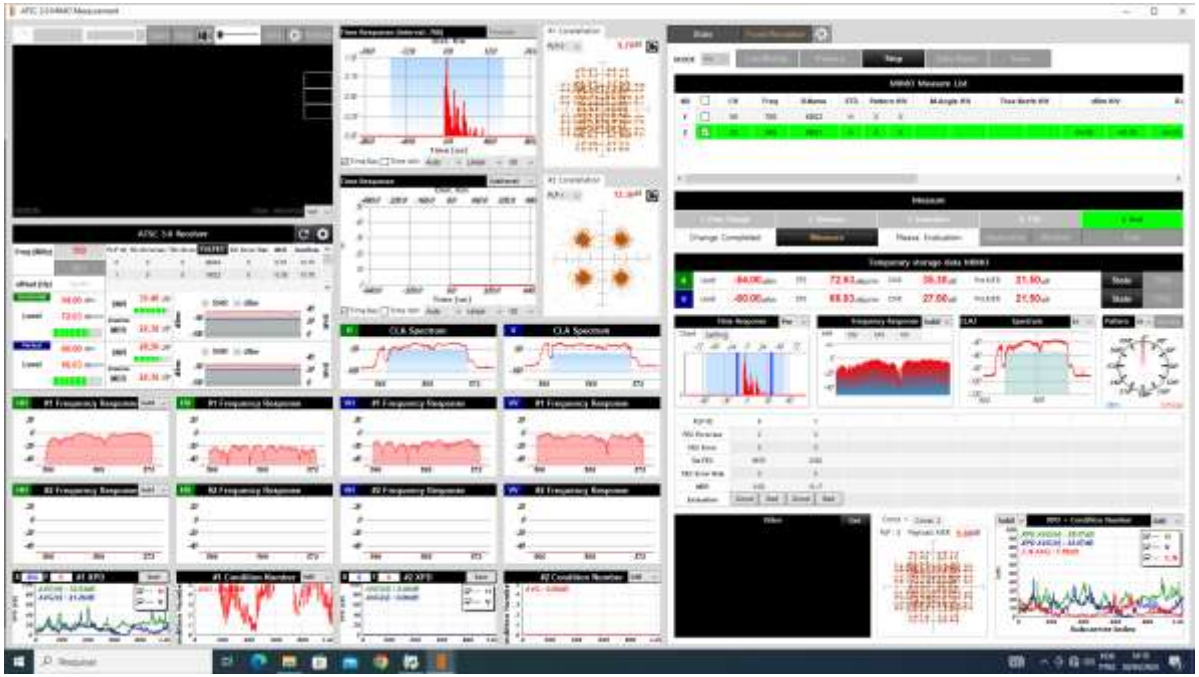


Figure 5.3 - IMAS Screen

b) AWGN Power

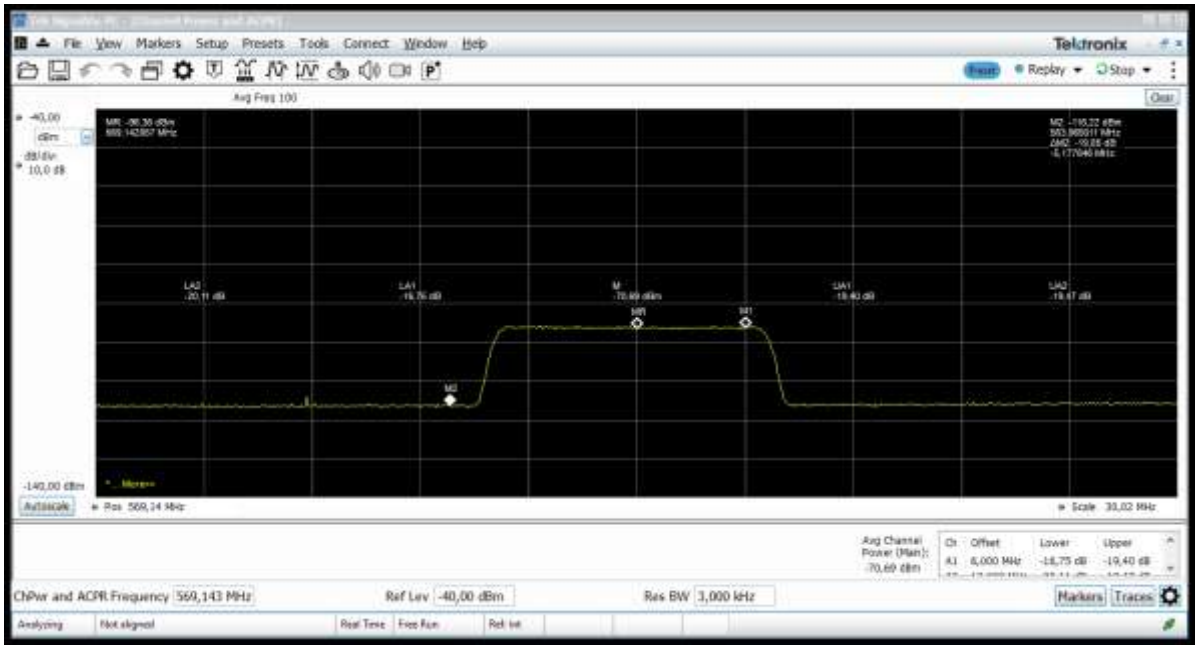


Figure 5.4 - Vertical

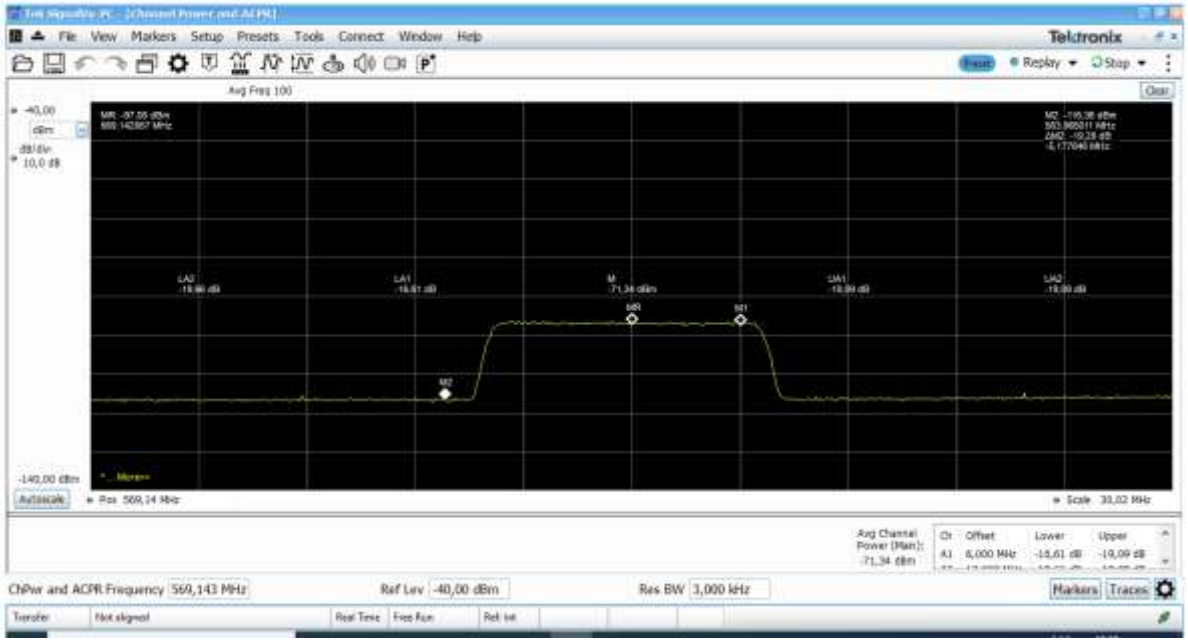


Figure 5.5 - Horizontal

c) C/N Threshold

Figure 5.6 - Vertical

Figure 5.7 - Horizontal

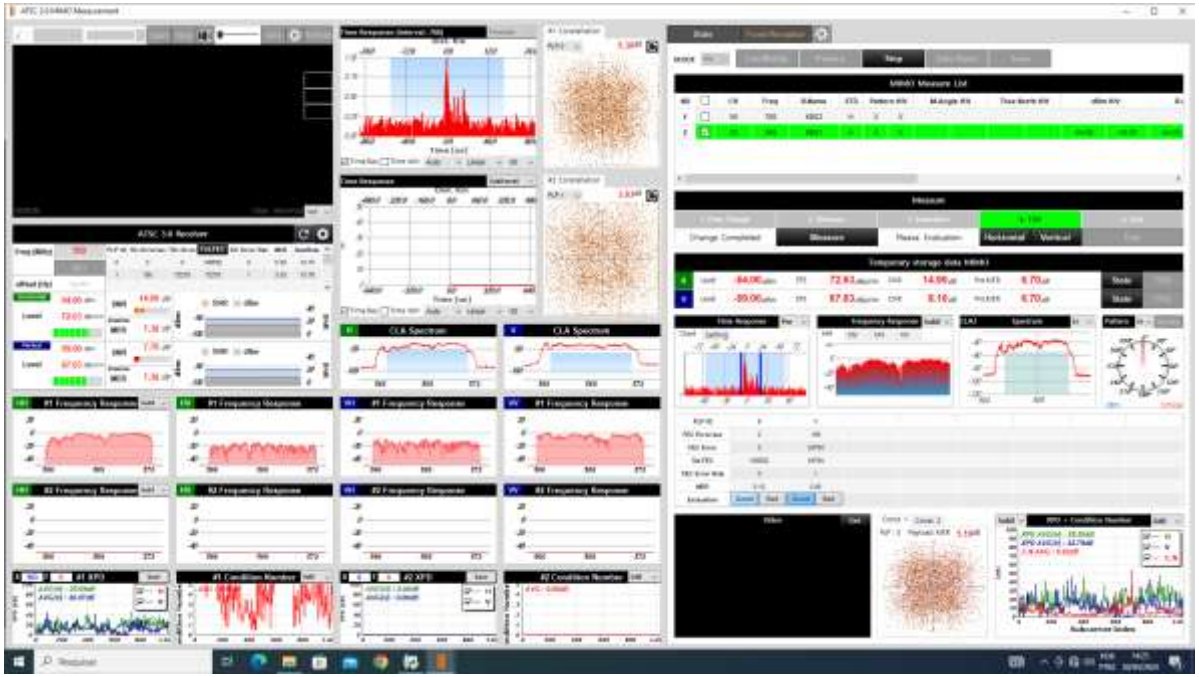


Figure 5.8 - IMAS Screen

d) Reception Threshold

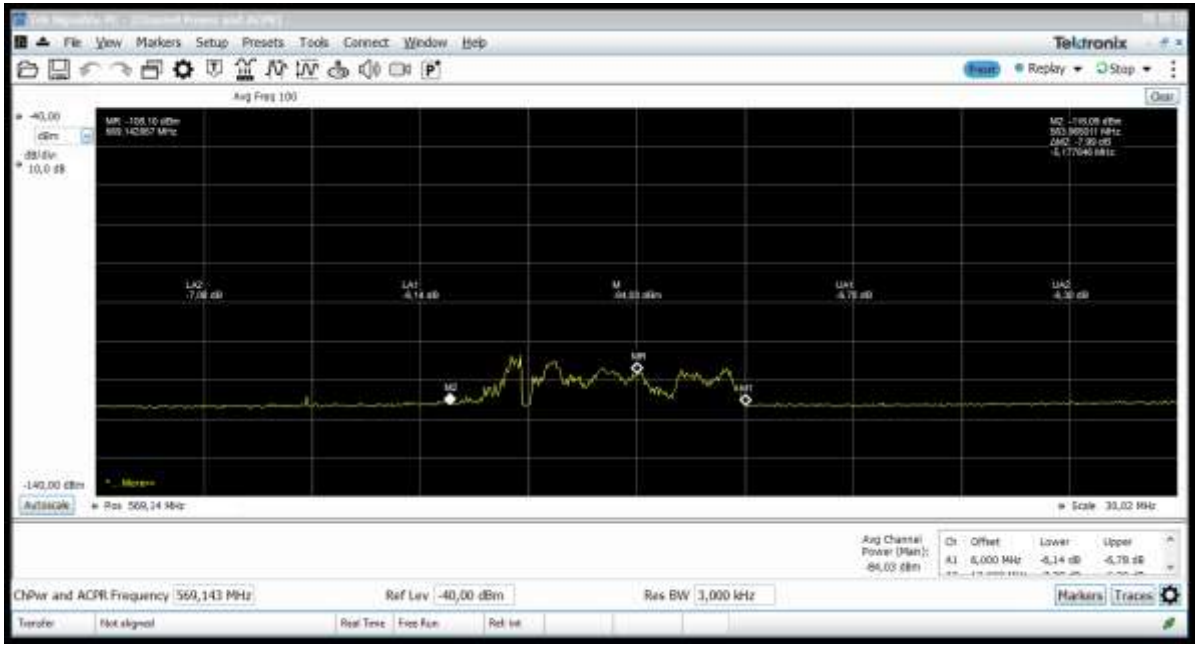


Figure 5.9 - Vertical

Figure 5.10 - Horizontal

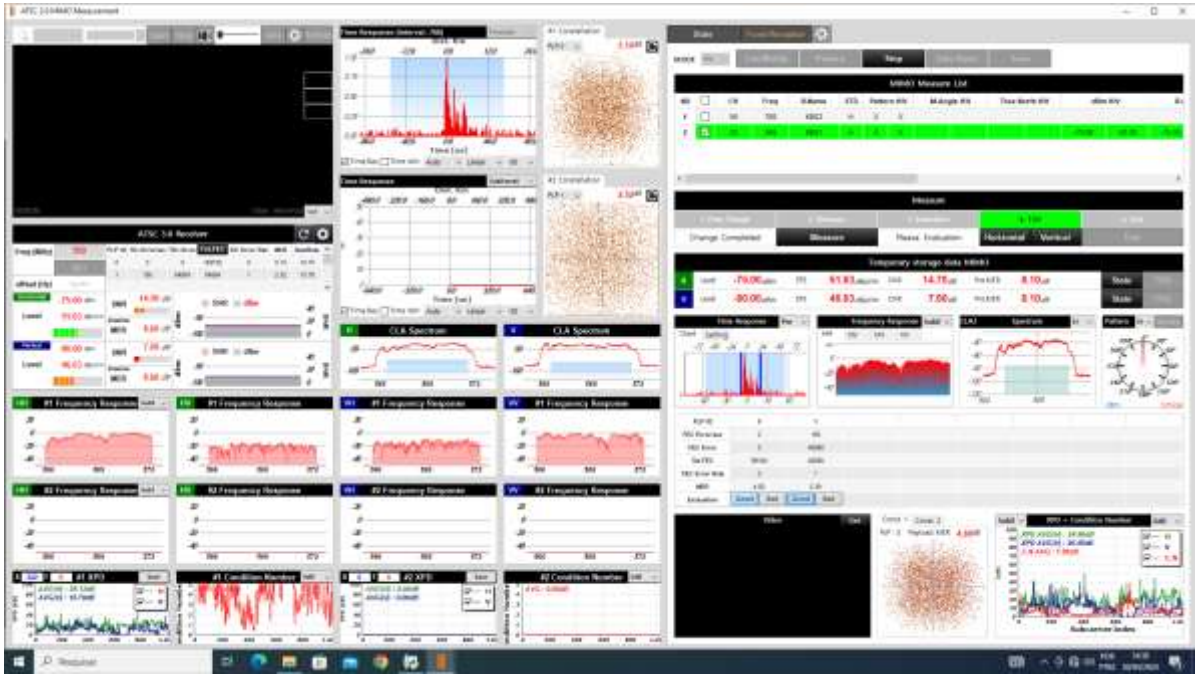


Figure 5.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

Figure 5.12 - Vertical

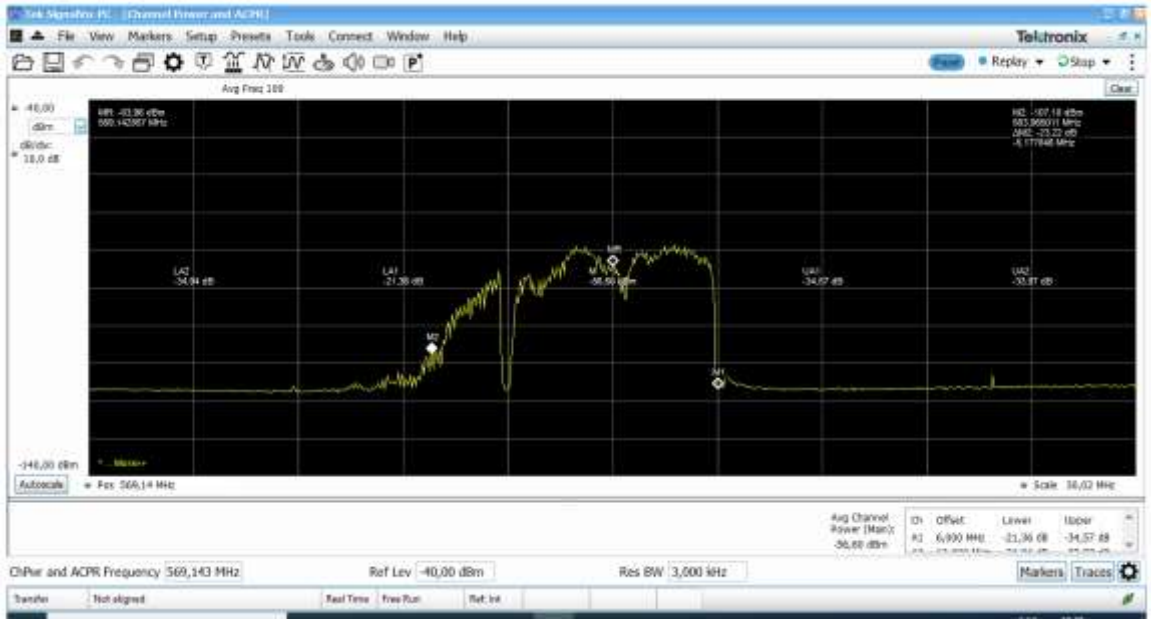


Figure 5.13 - Horizontal

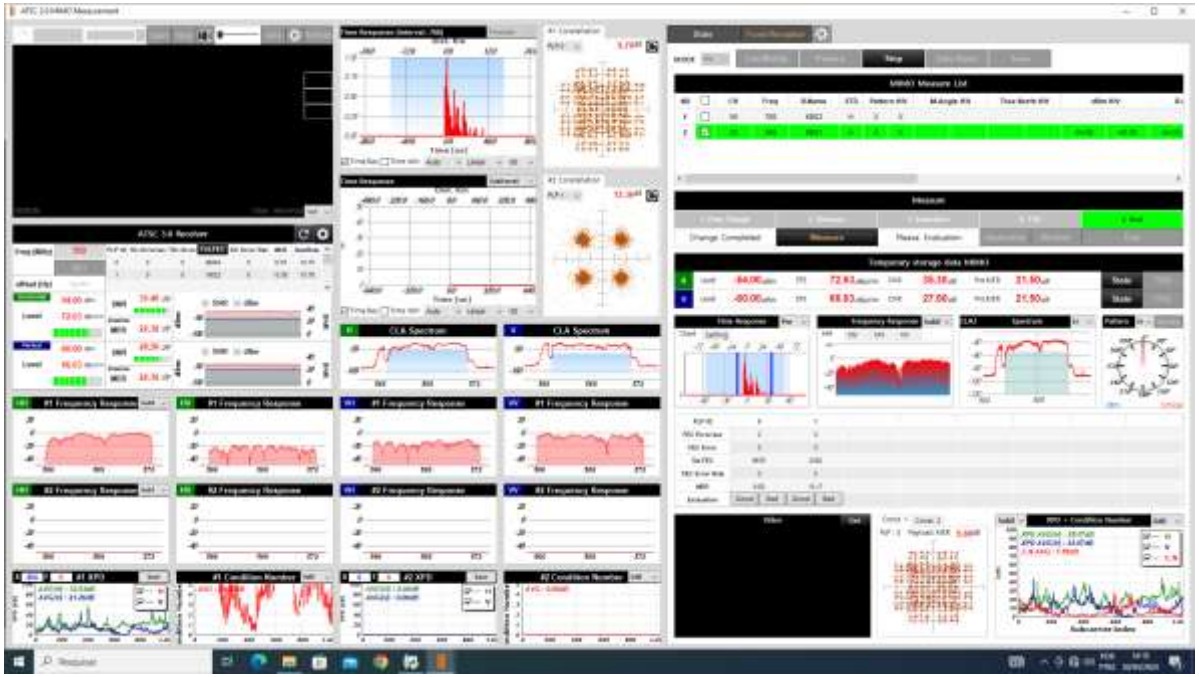


Figure 5.14 - IMAS Screen

b) AWGN Power

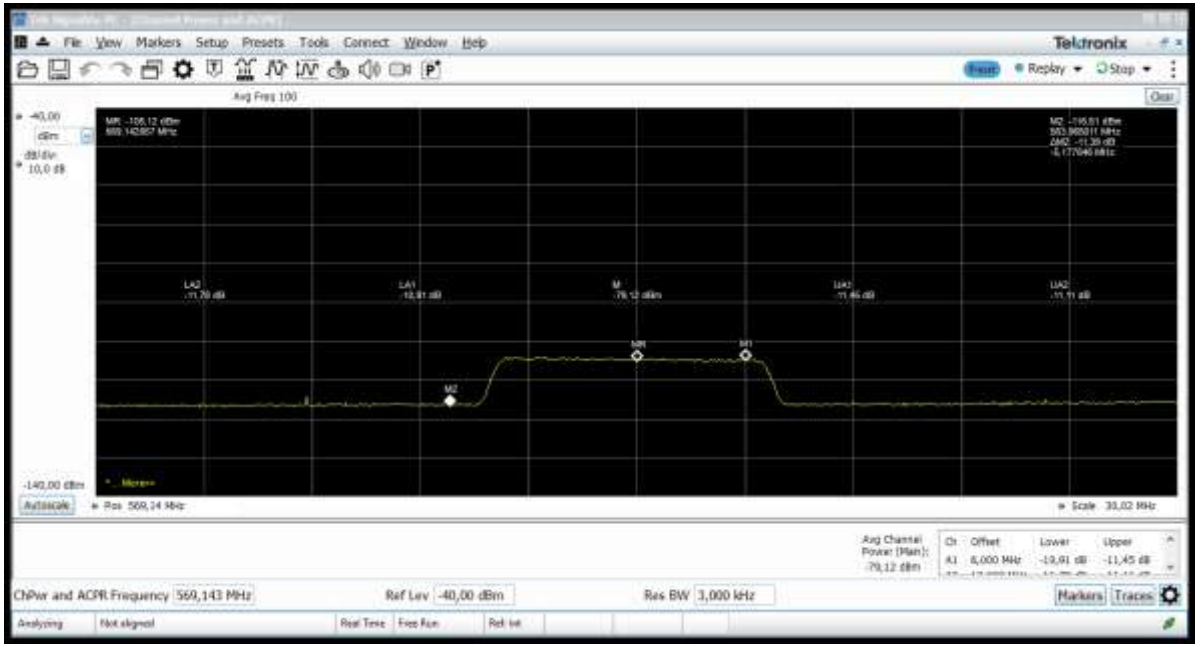


Figure 5.15 - Vertical

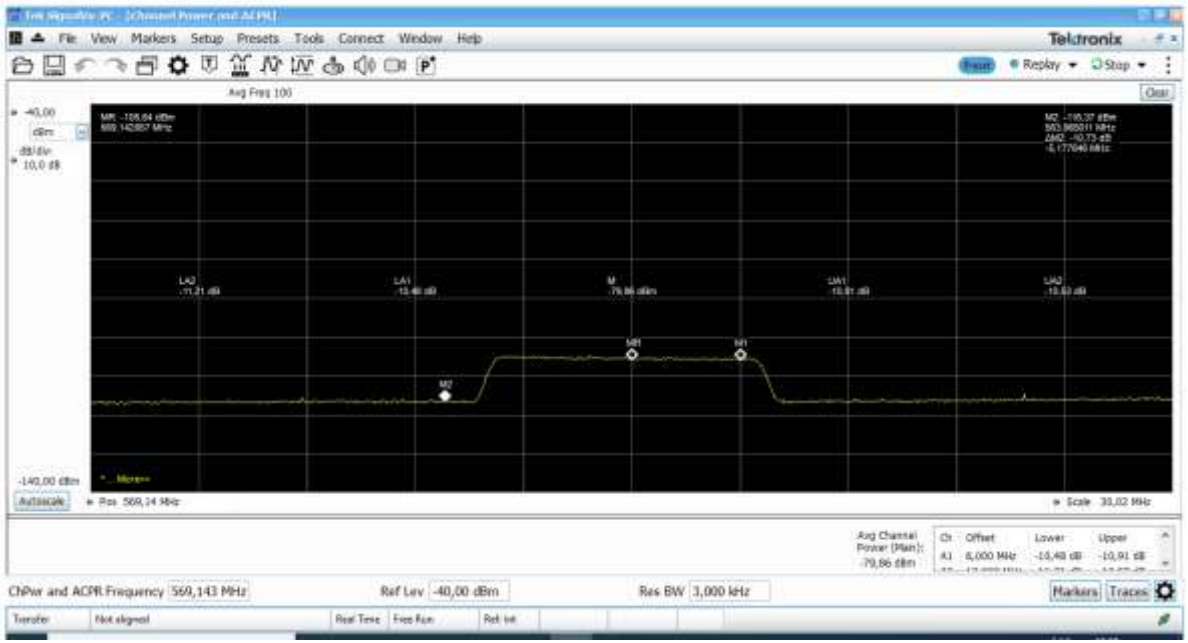


Figure 5.16 - Horizontal

c) C/N Threshold

Figure 5.17 - Vertical

Figure 5.18 - Horizontal

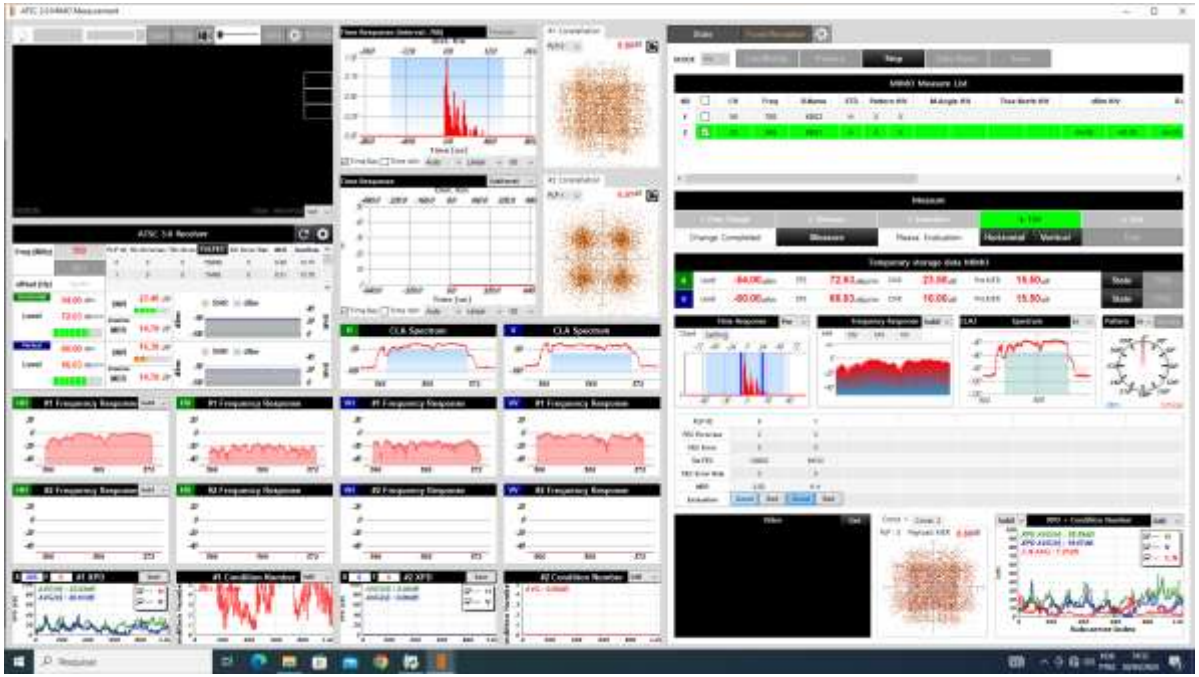


Figure 5.19 - IMAS Screen

d) Reception Threshold

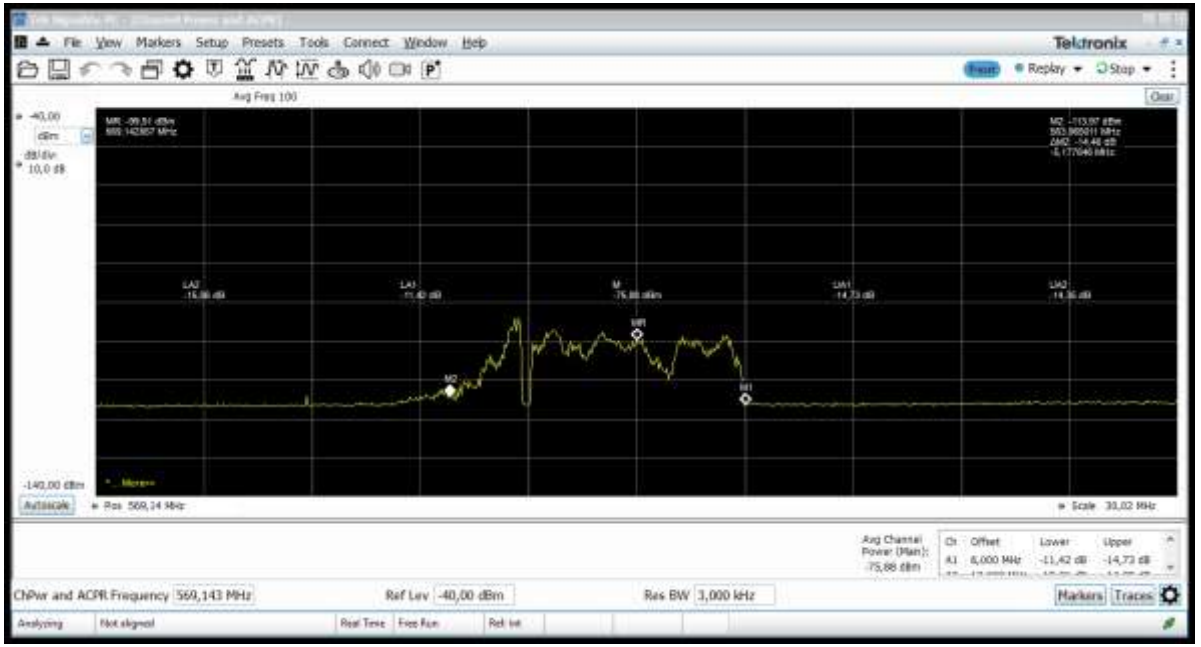


Figure 5.20 - Vertical

Figure 5.21 - Horizontal

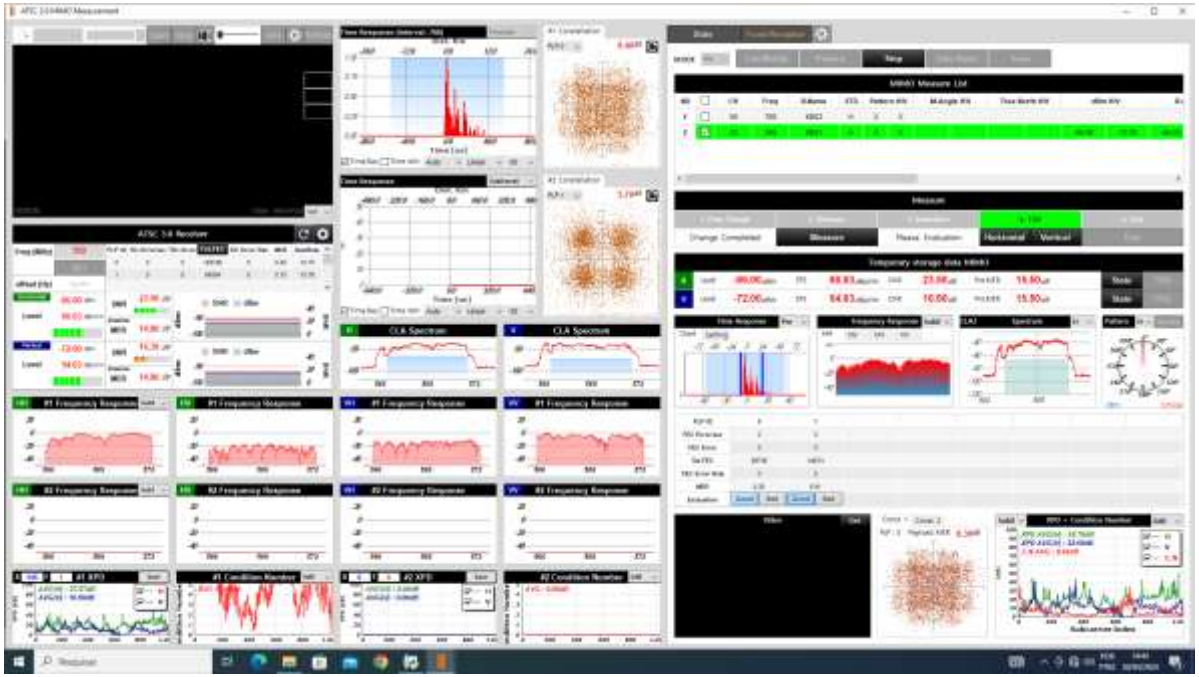


Figure 5.22 - IMAS Screen

Chapter 6. Site 12

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

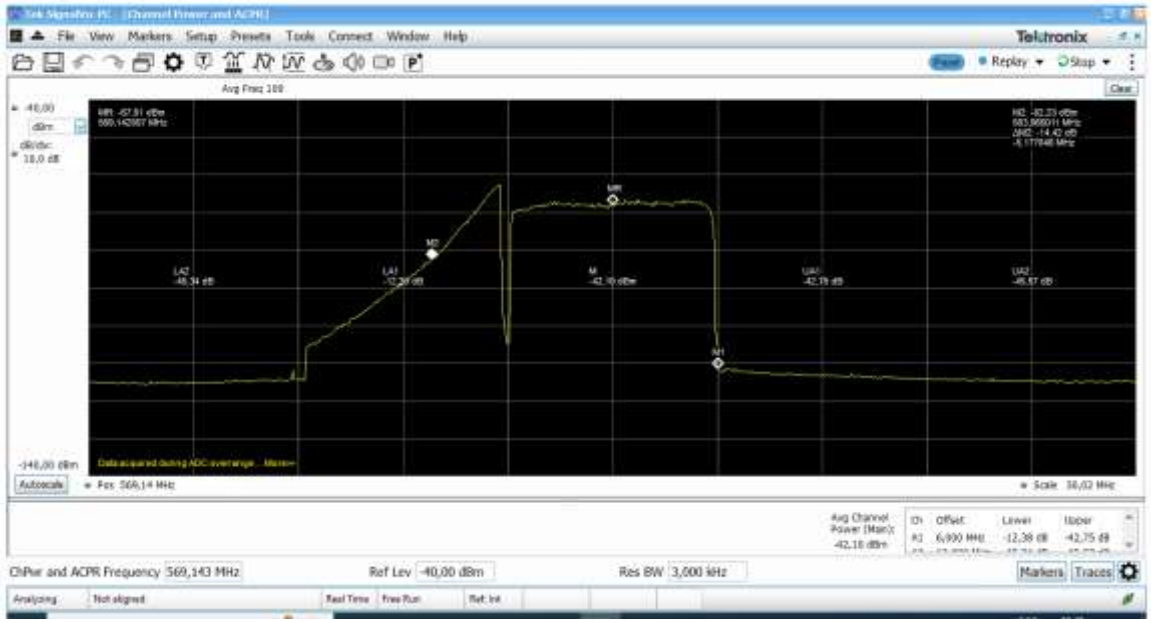


Figure 6.1 - Vertical

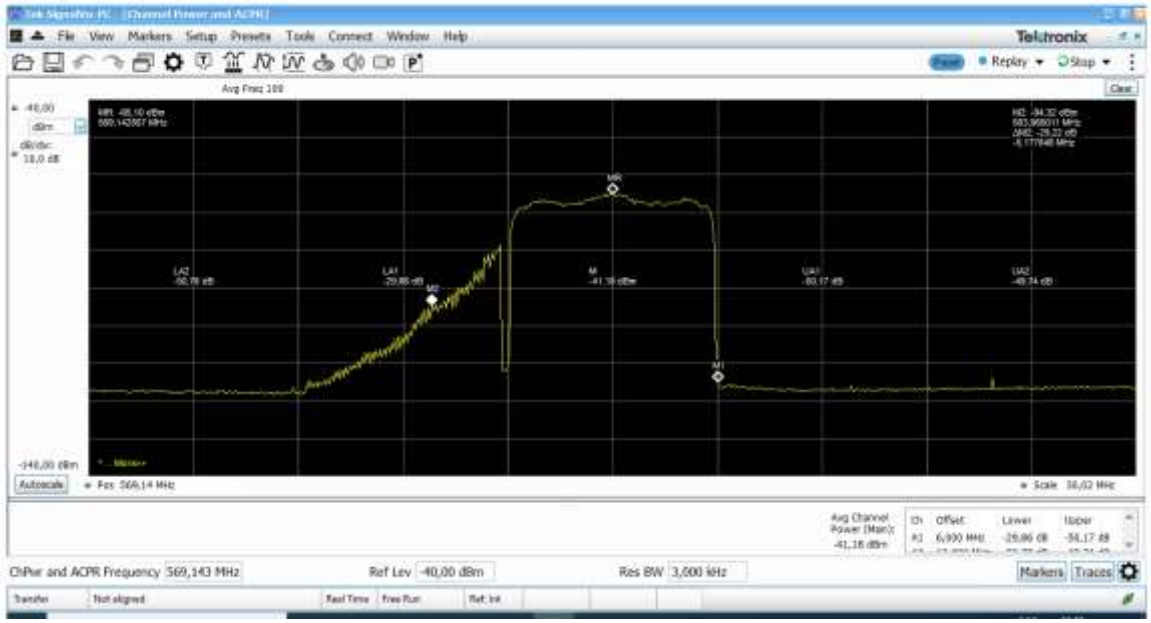


Figure 6.2 - Horizontal

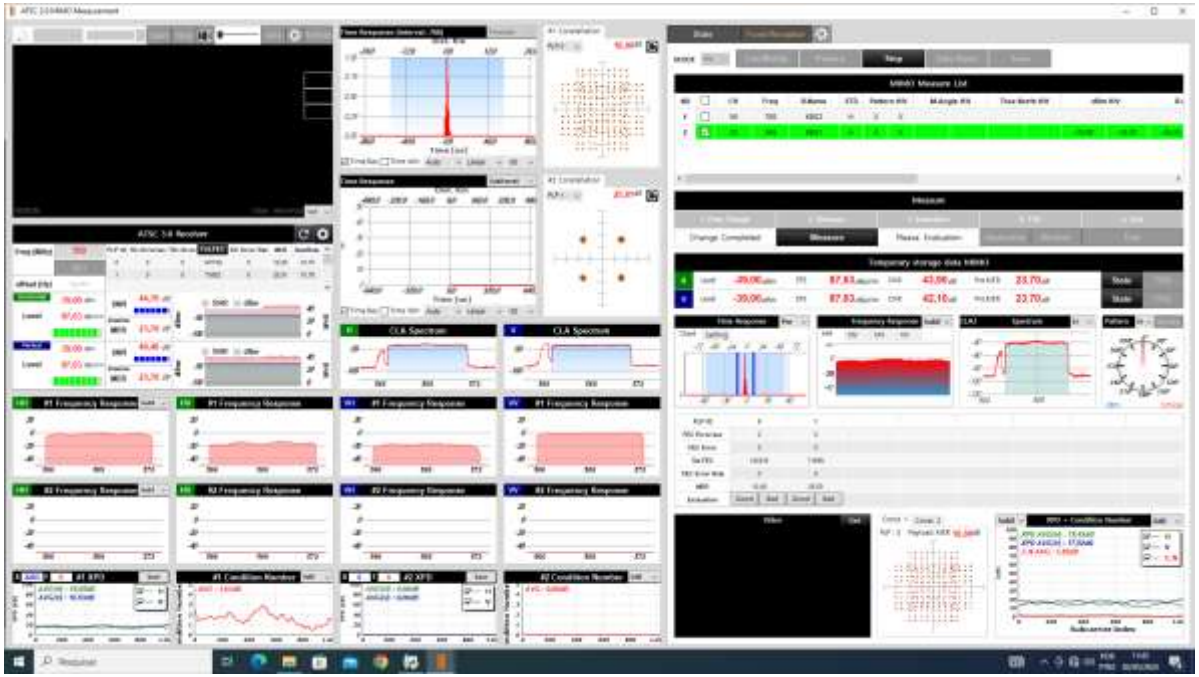


Figure 6.3 - IMAS Screen

b) AWGN Power

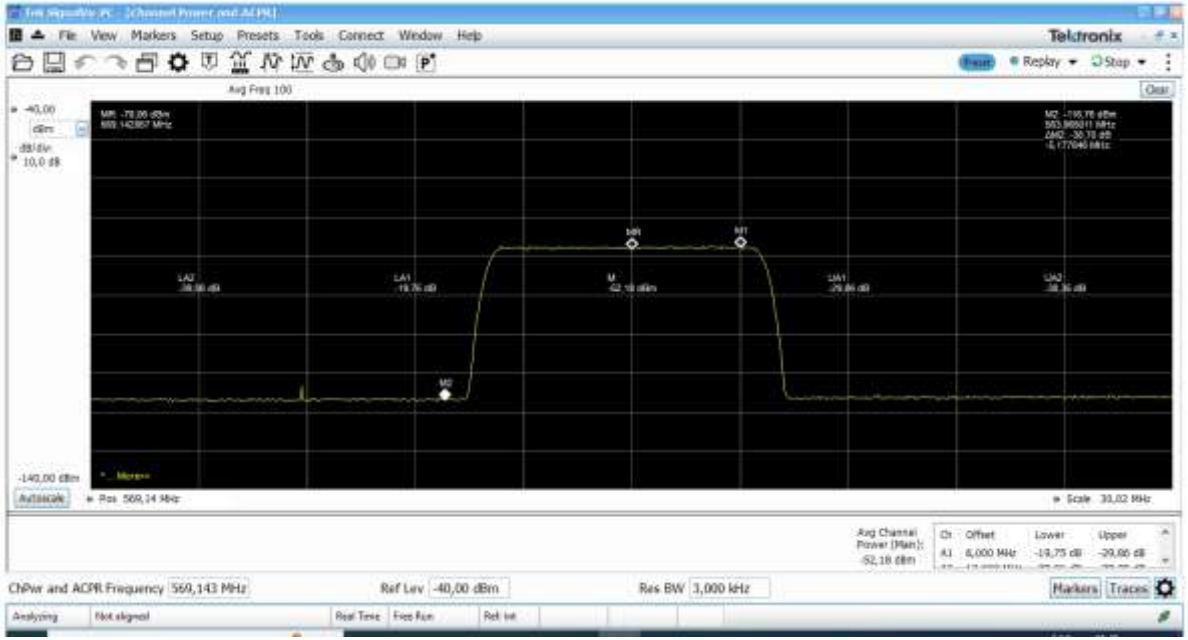


Figure 6.4 - Vertical

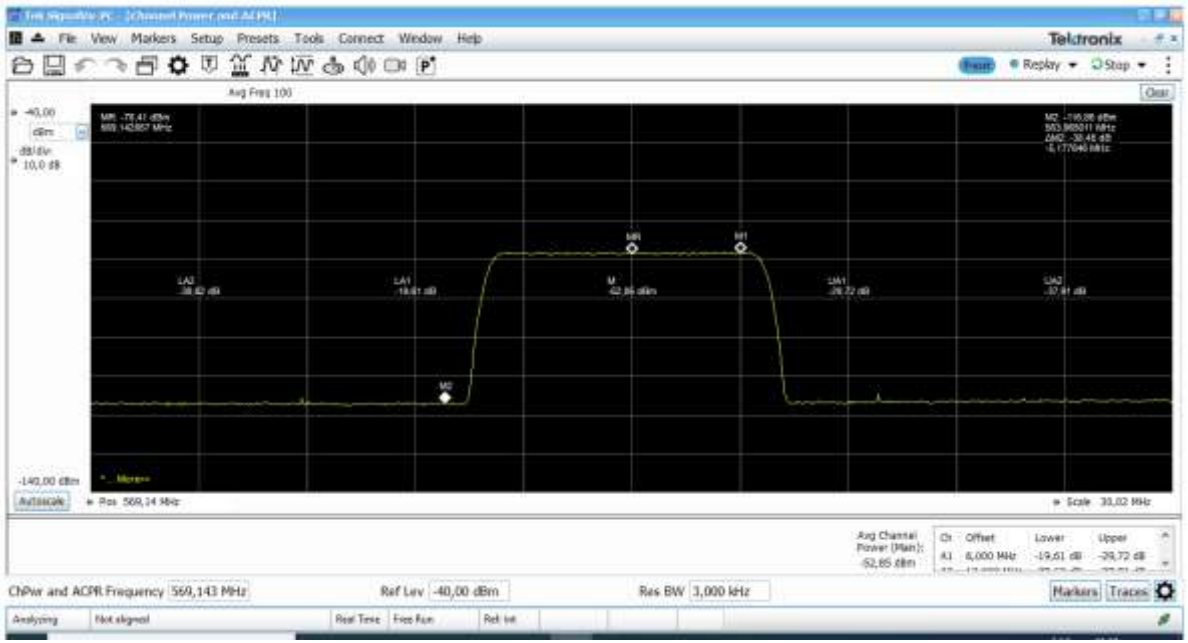


Figure 6.5 - Horizontal

c) C/N Threshold

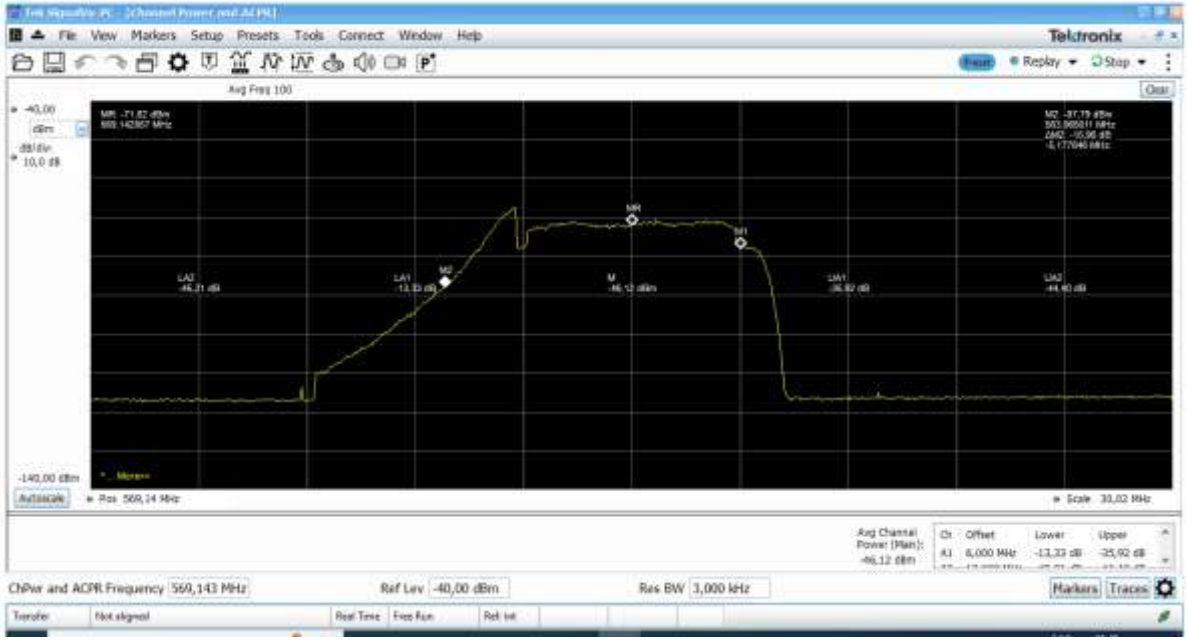


Figure 6.6 - Vertical

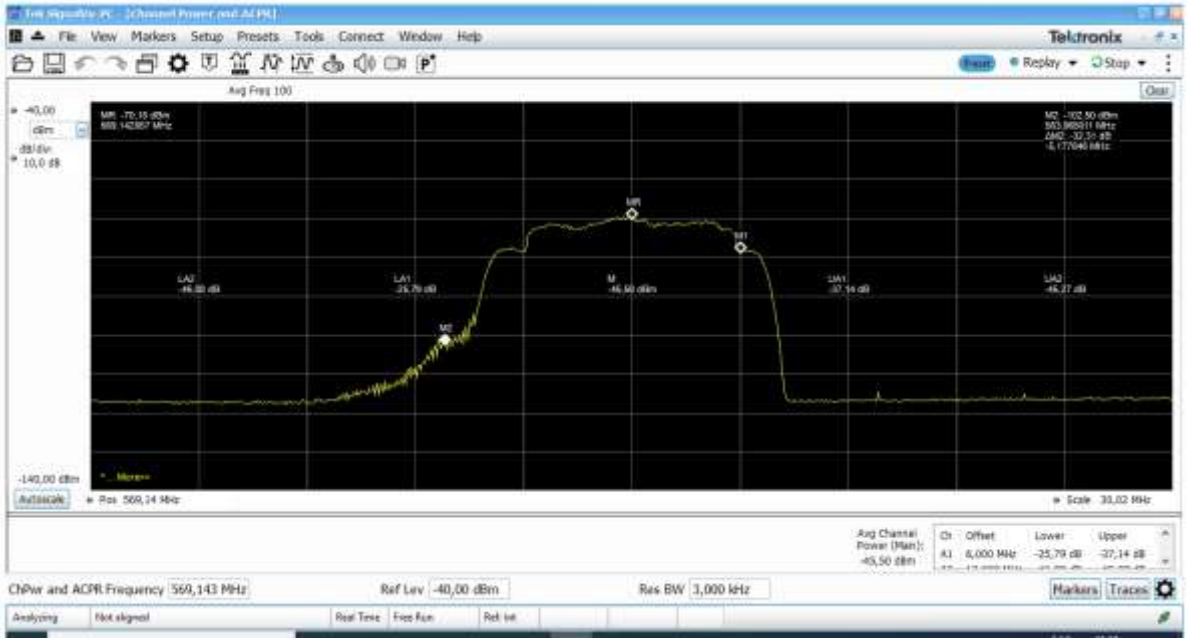


Figure 6.7 - Horizontal

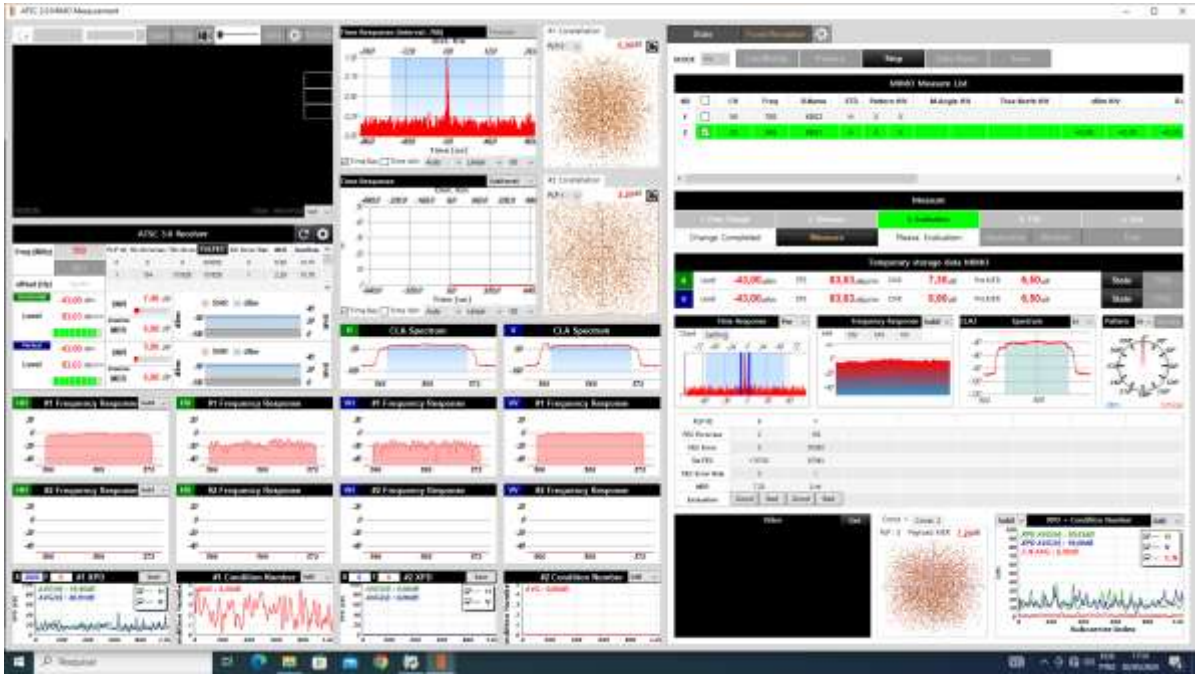


Figure 6.8 - IMAS Screen

d) Reception Threshold

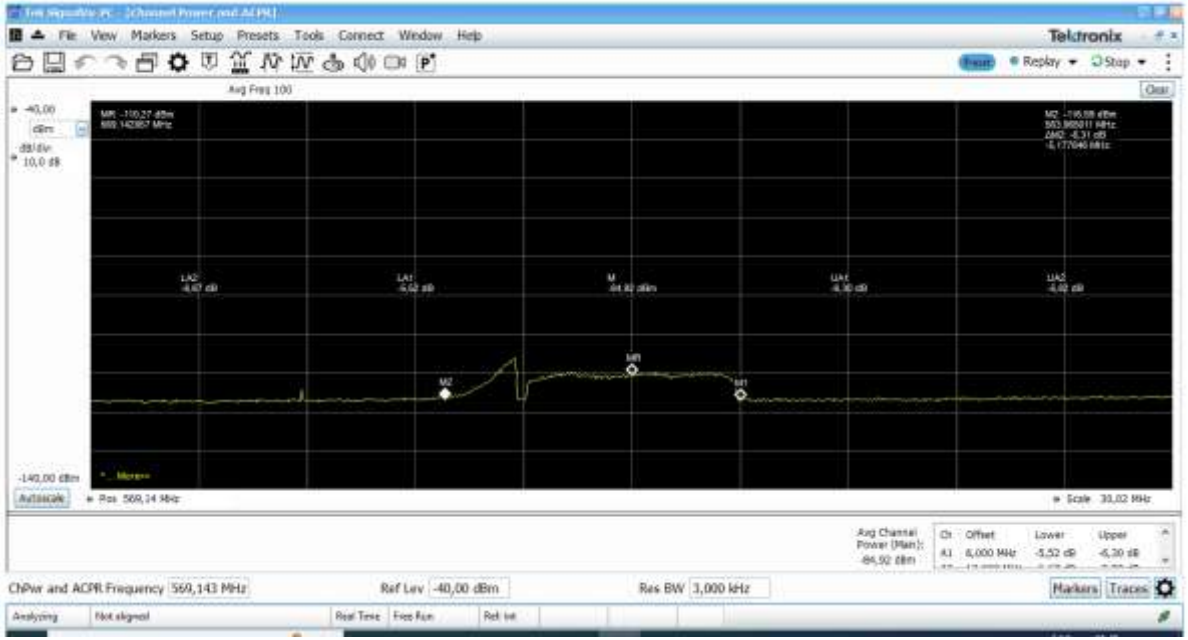


Figure 6.9 - Vertical

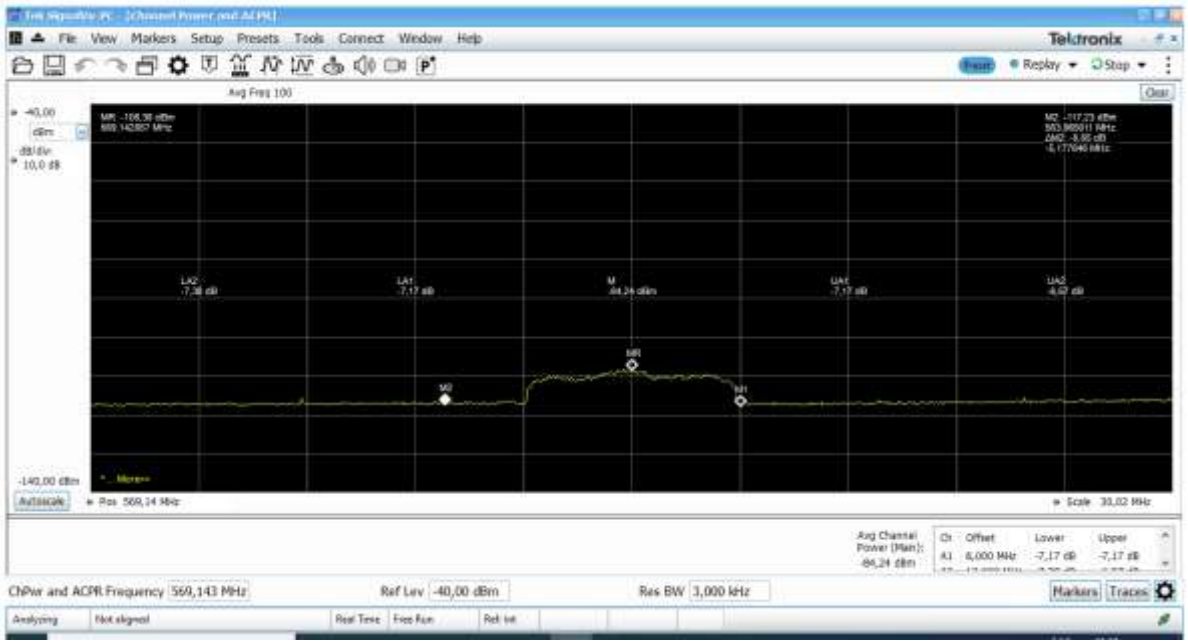


Figure 6.10 - Horizontal

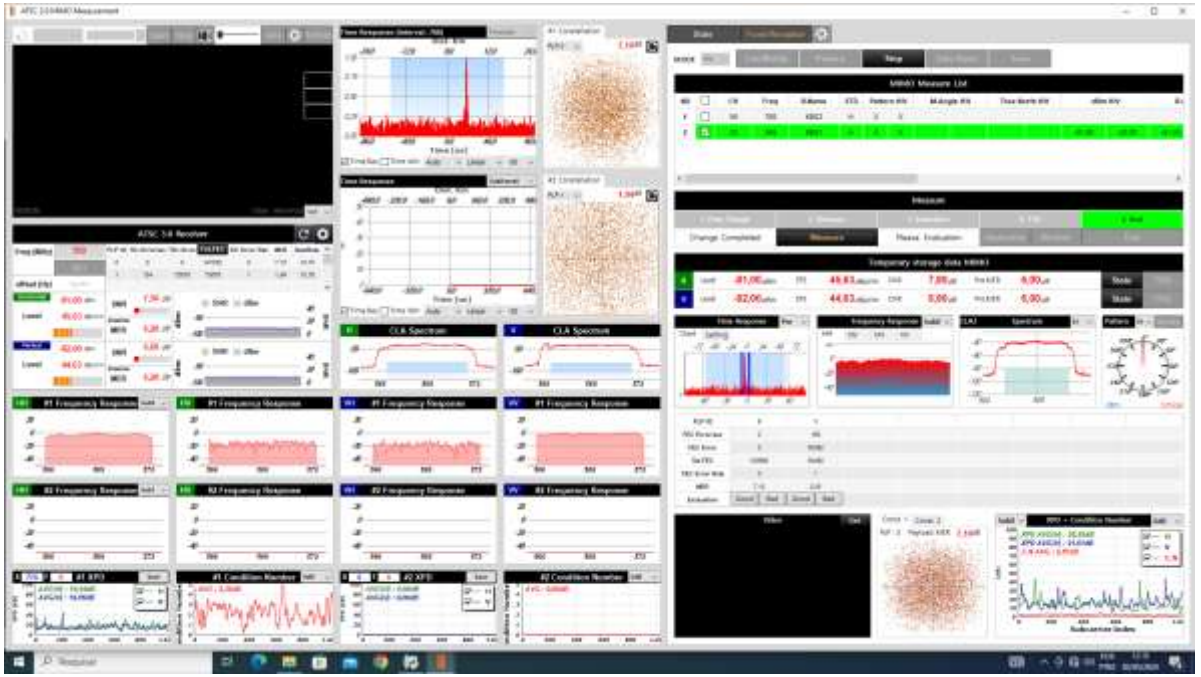


Figure 6.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

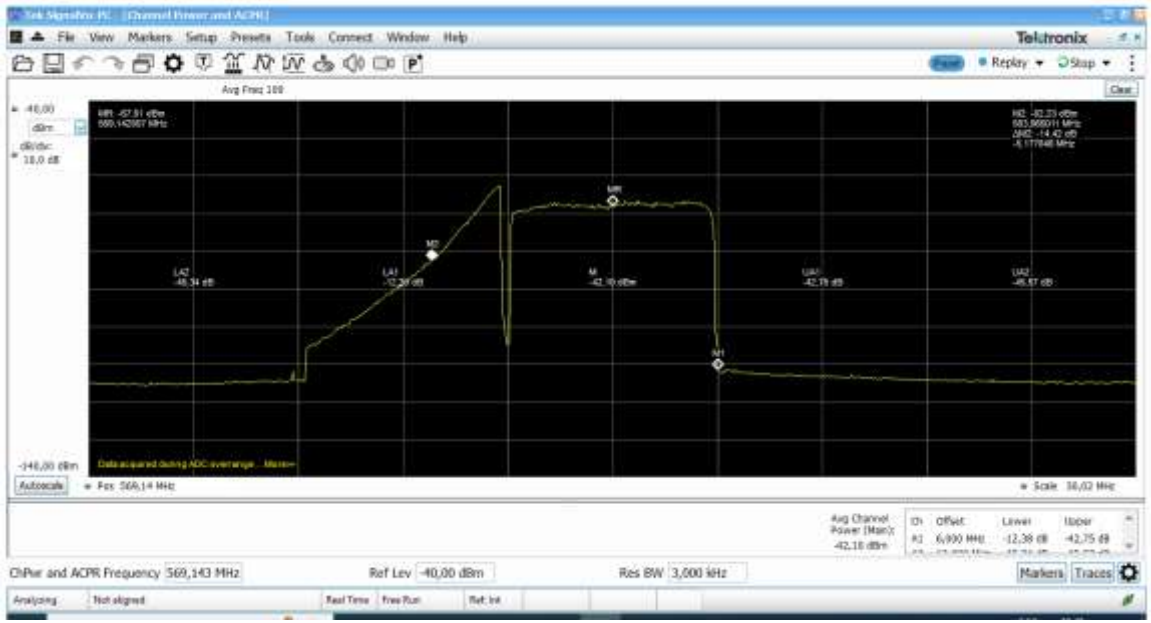


Figure 6.12 - Vertical

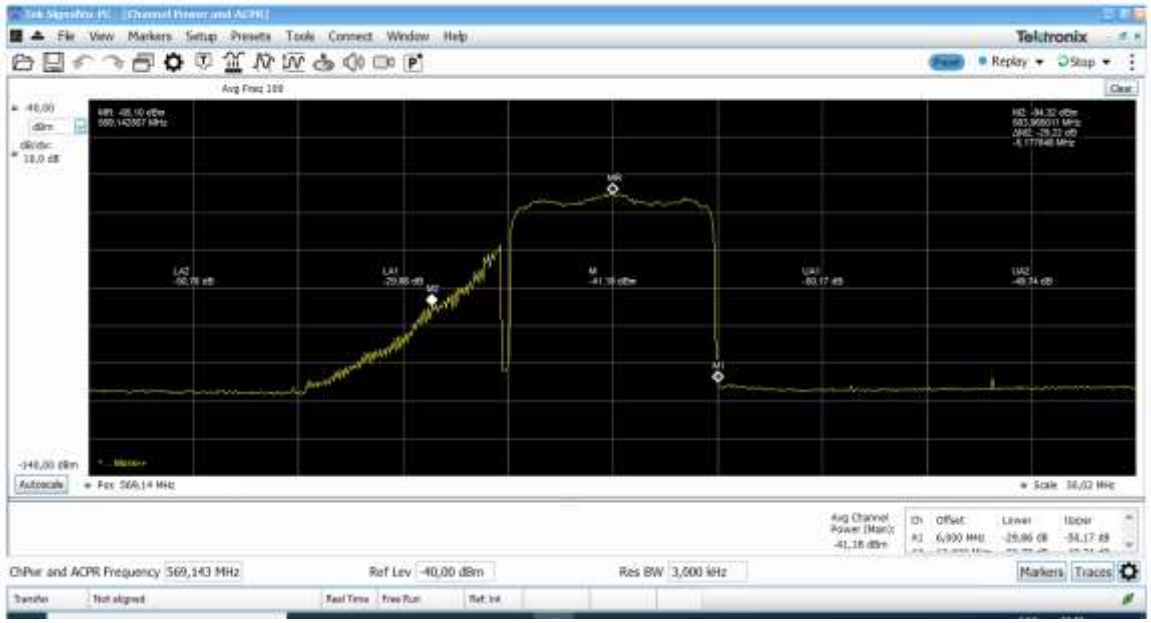


Figure 6.13 - Horizontal

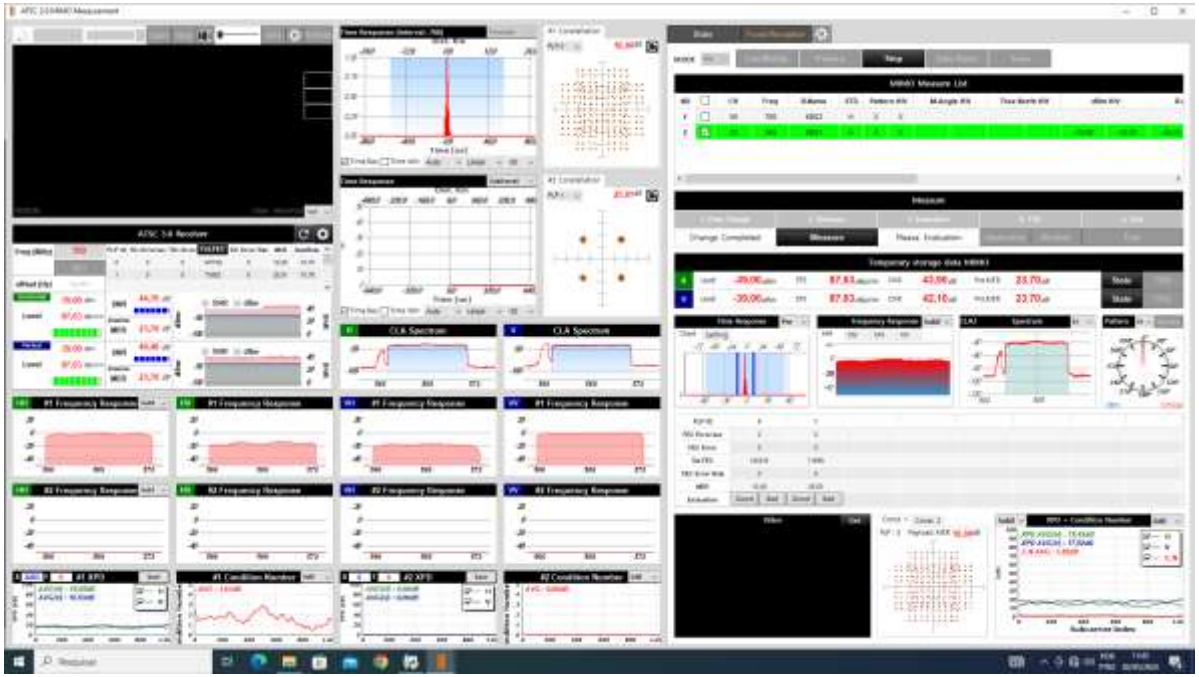


Figure 6.14 - IMAS Screen

b) AWGN Power

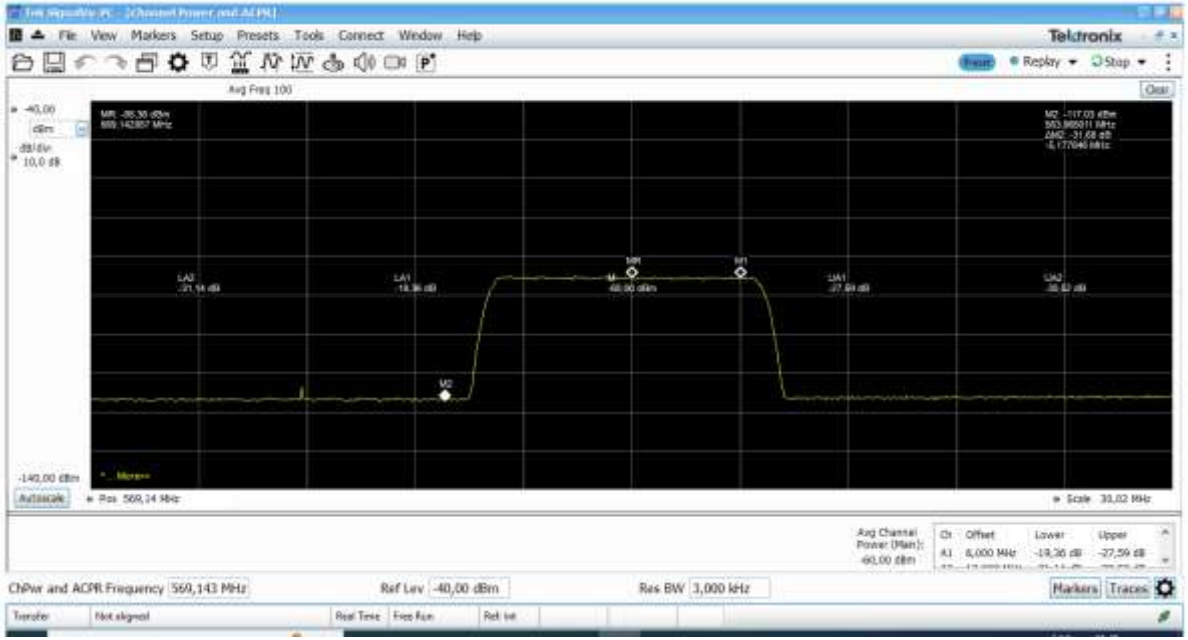


Figure 6.15 - Vertical

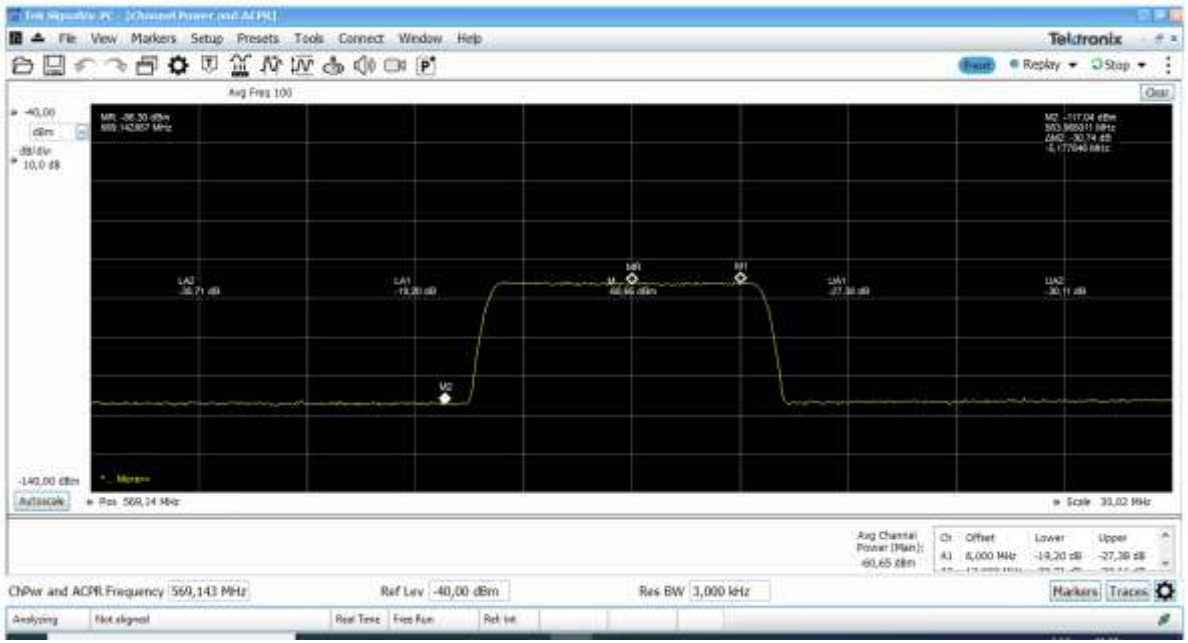


Figure 6.16 - Horizontal

c) C/N Threshold

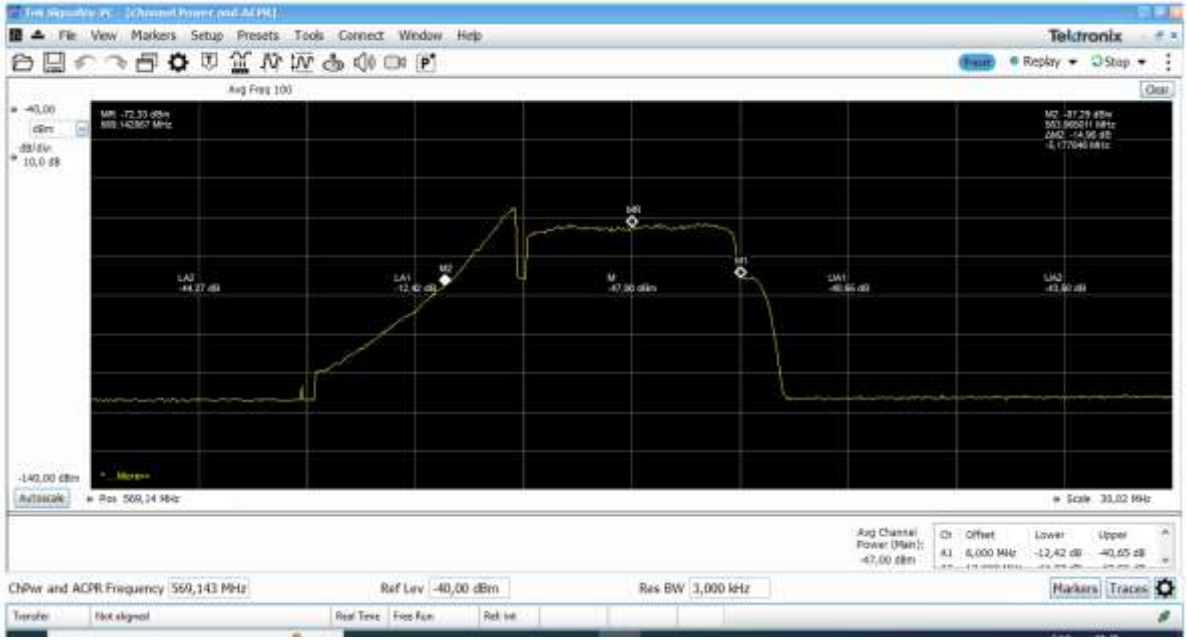


Figure 6.17 - Vertical

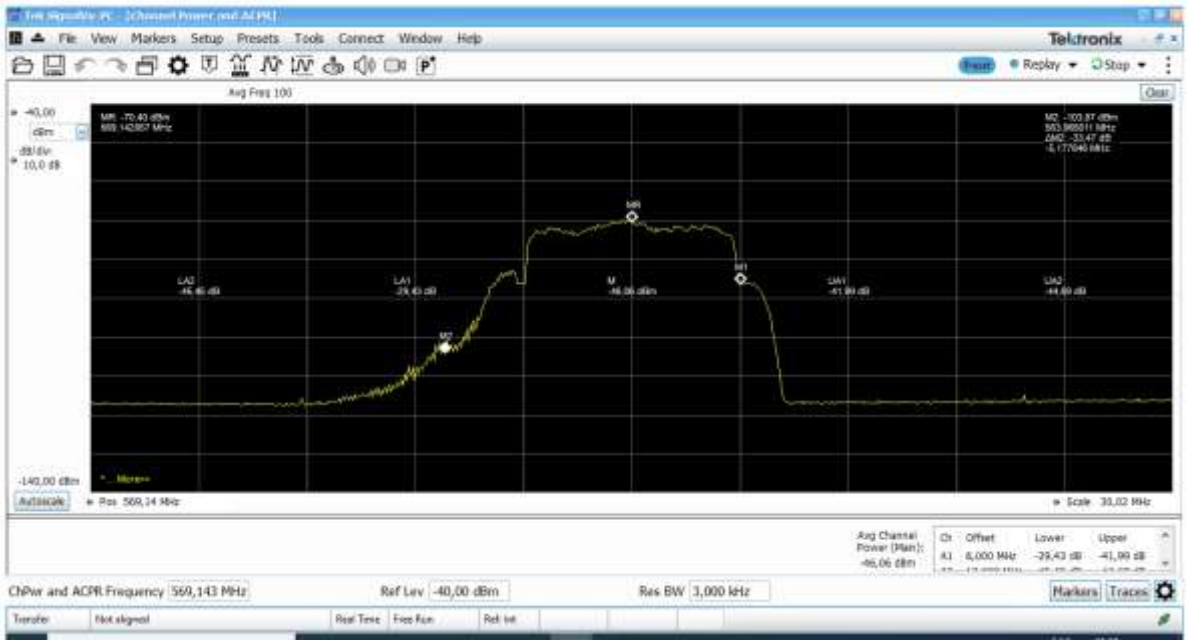


Figure 6.18 - Horizontal

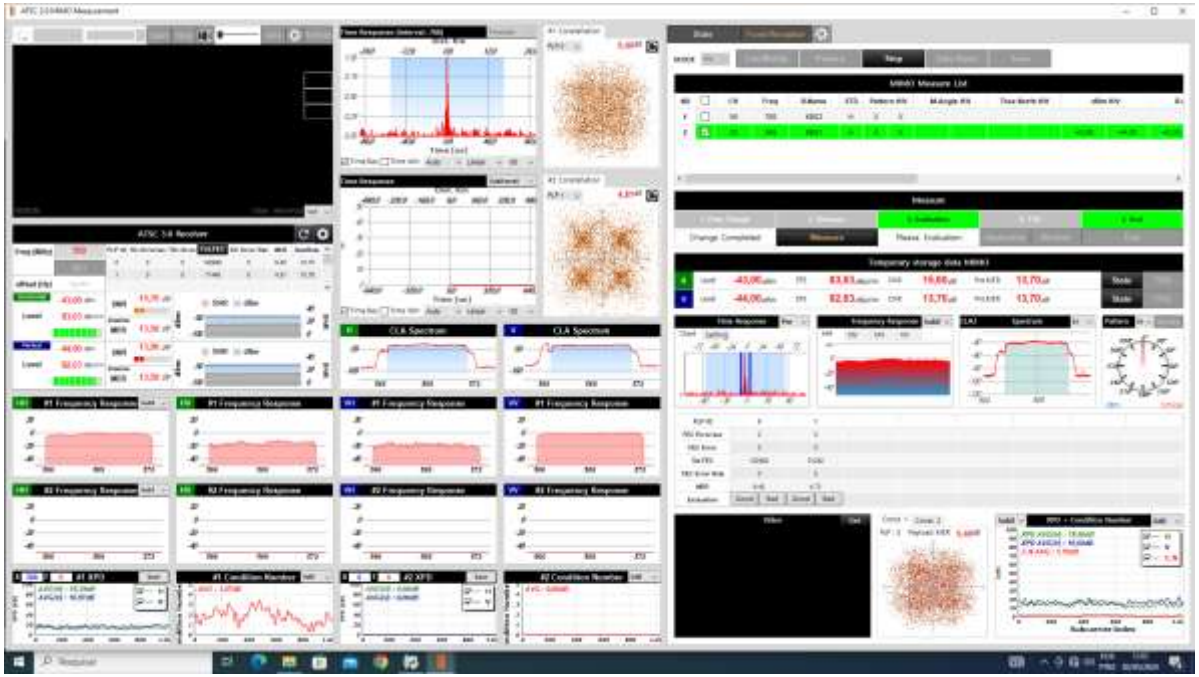


Figure 6.19 - IMAS Screen

d) Reception Threshold

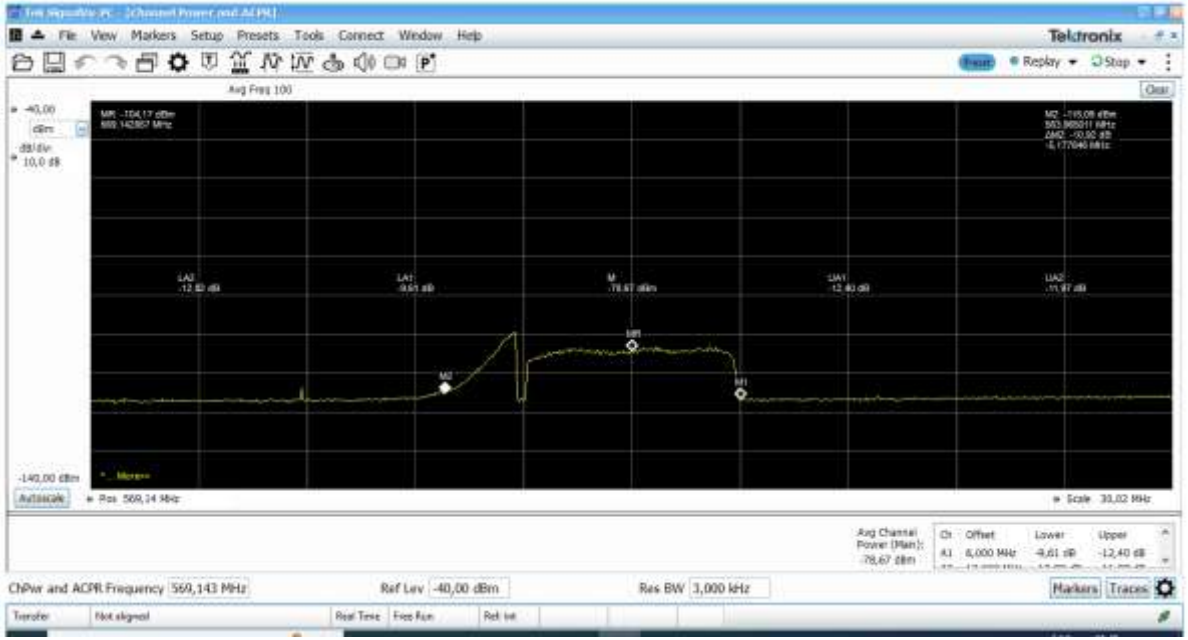


Figure 6.20 - Vertical

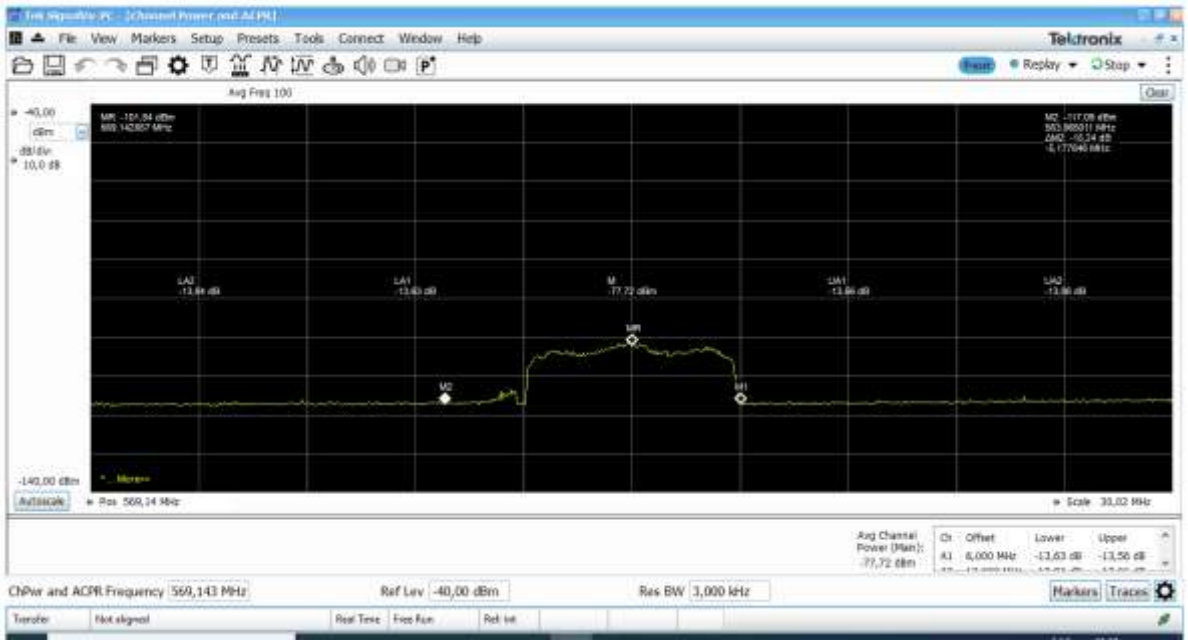


Figure 6.21 - Horizontal

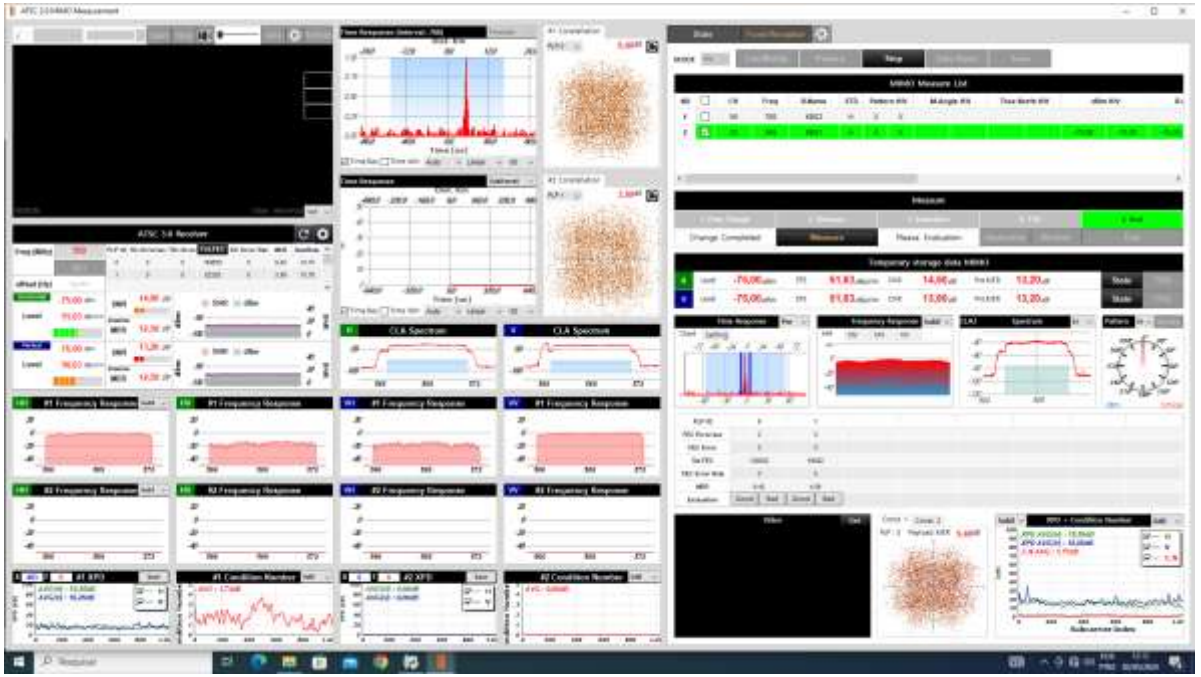


Figure 6.22 - IMAS Screen

Chapter 7. Site 17

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

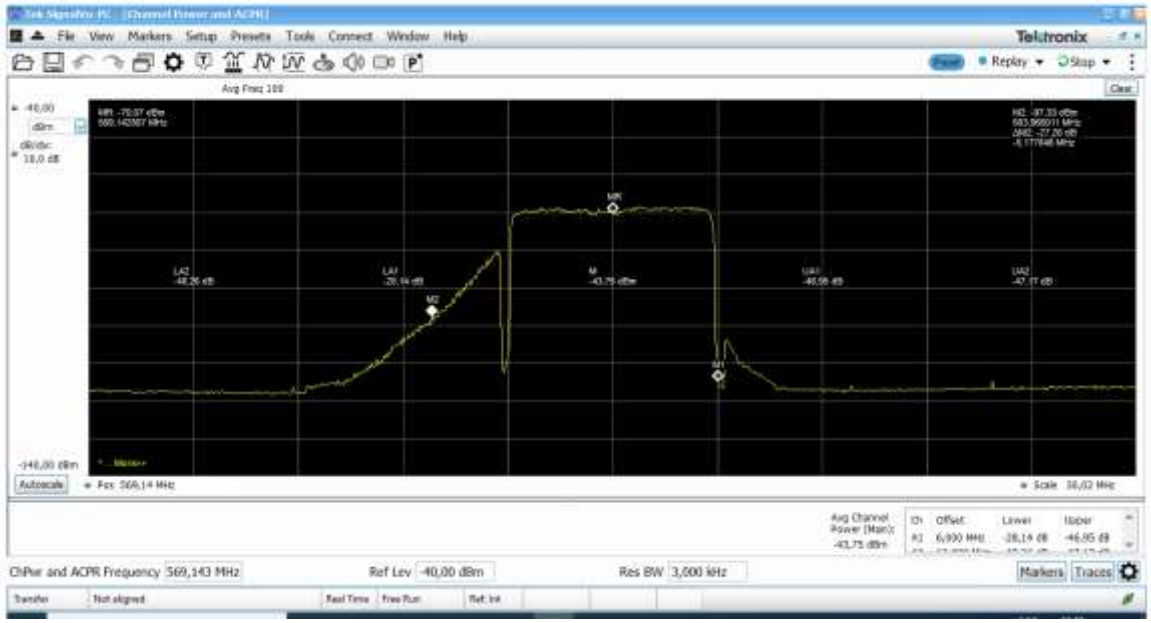


Figure 7.1 - Vertical

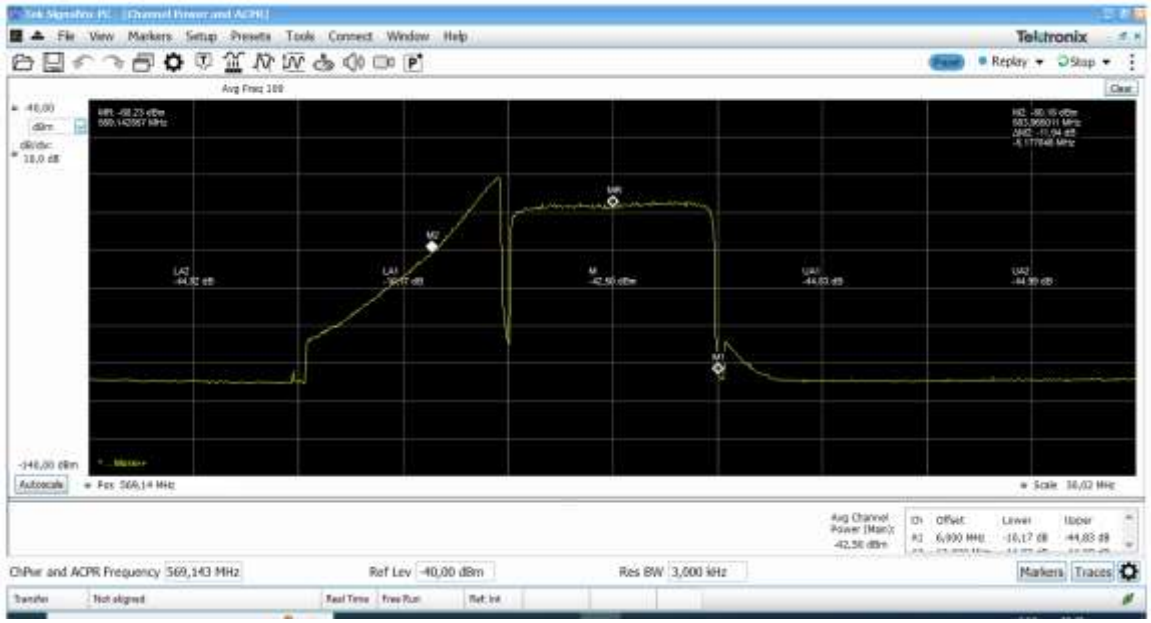


Figure 7.2 - Horizontal

Figure 7.3 - IMAS Screen

b) AWGN Power

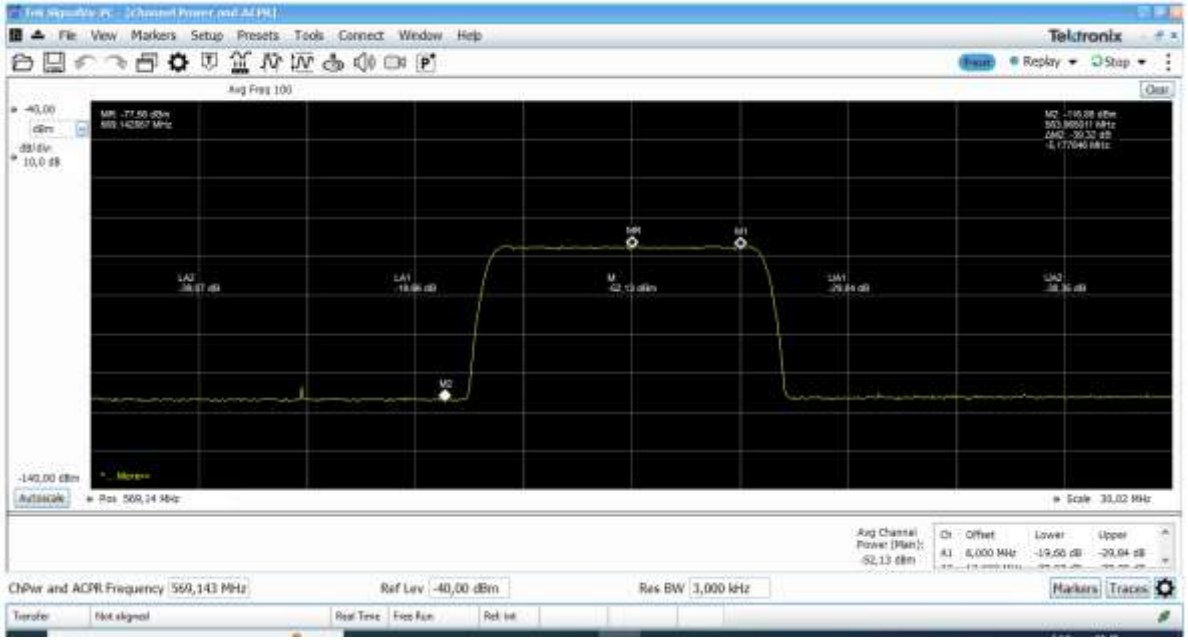


Figure 7.4 - Vertical

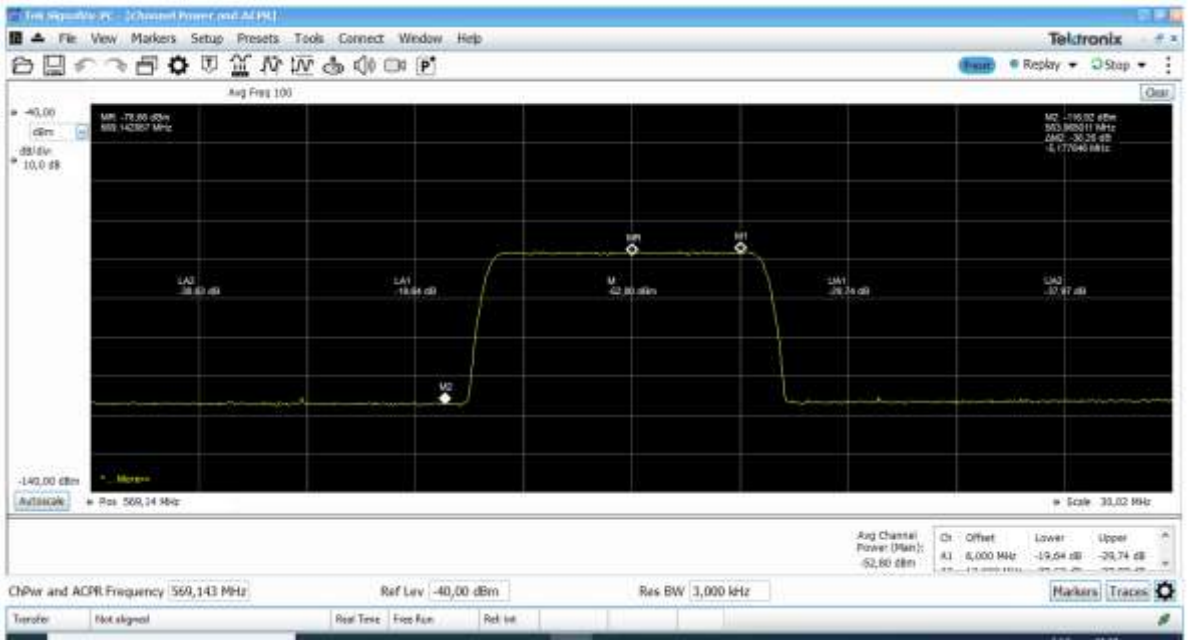


Figure 7.5 - Horizontal

c) C/N Threshold

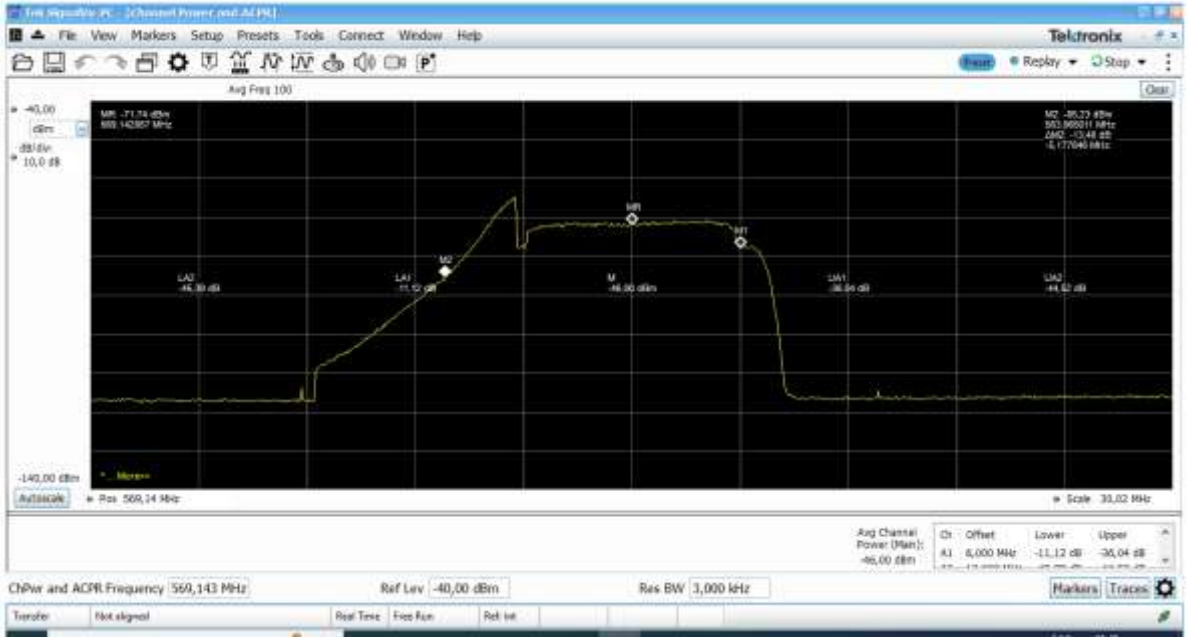


Figure 7.6 - Vertical

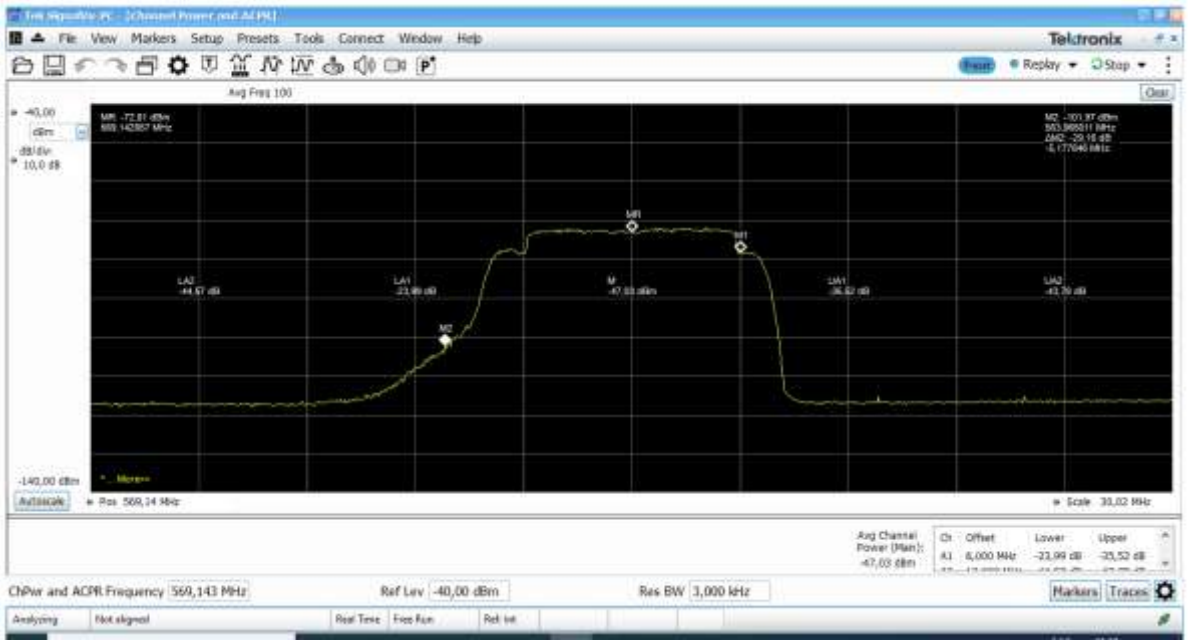


Figure 7.7 - Horizontal

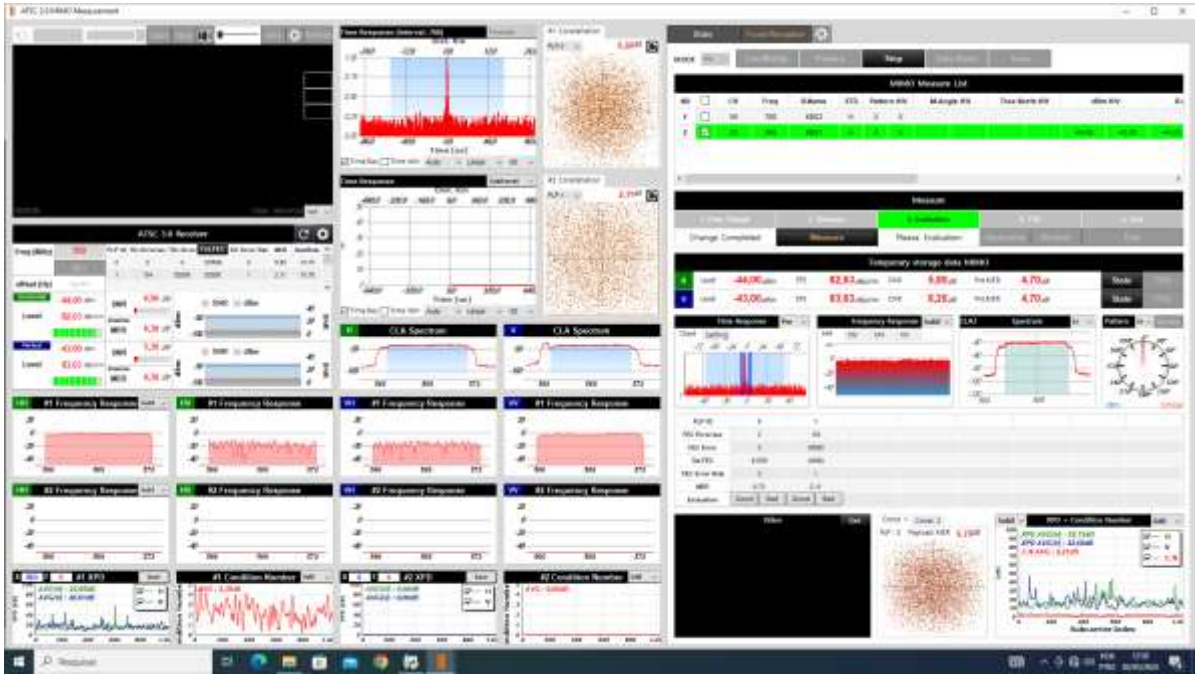


Figure 7.8 - IMAS Screen

d) Reception Threshold

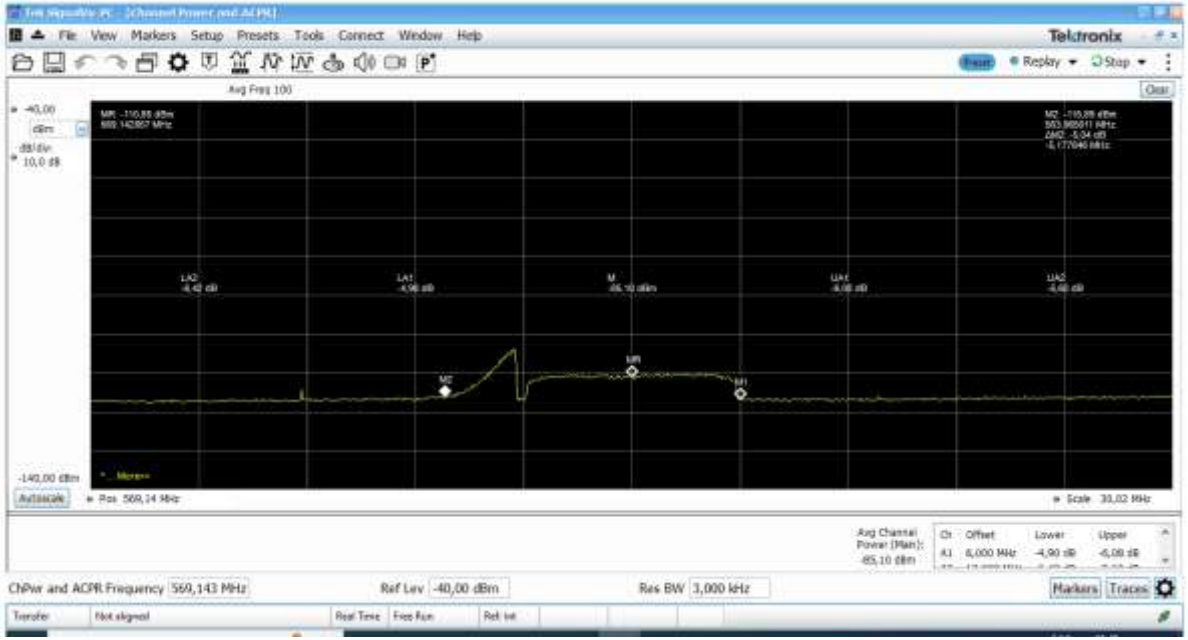


Figure 7.9 - Vertical

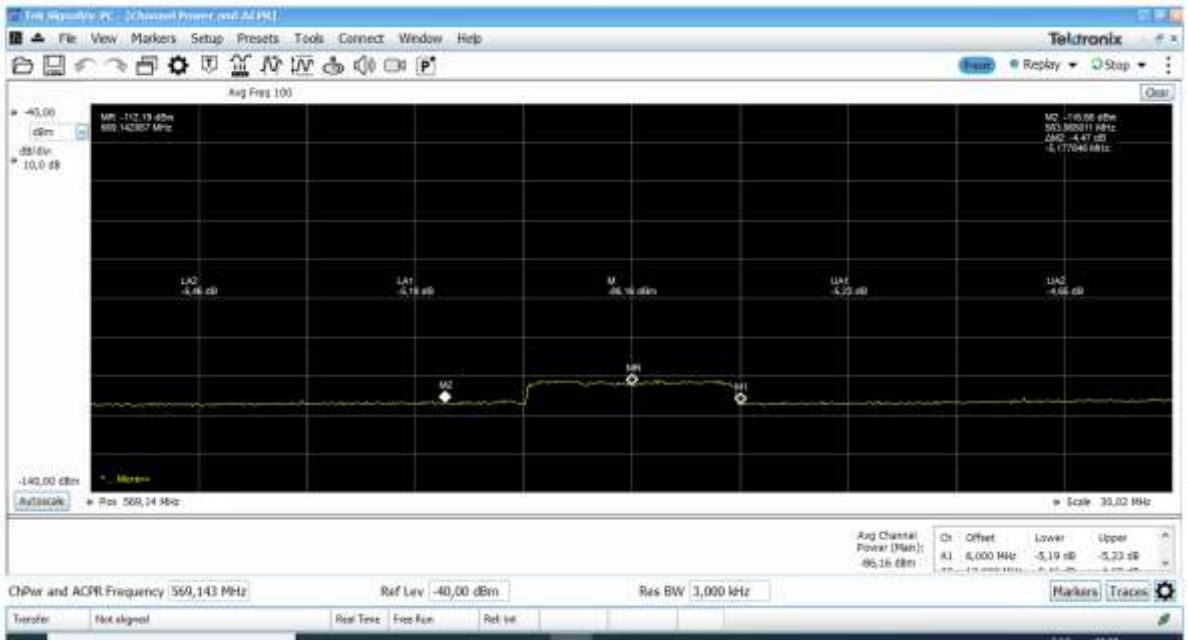


Figure 7.10 - Horizontal

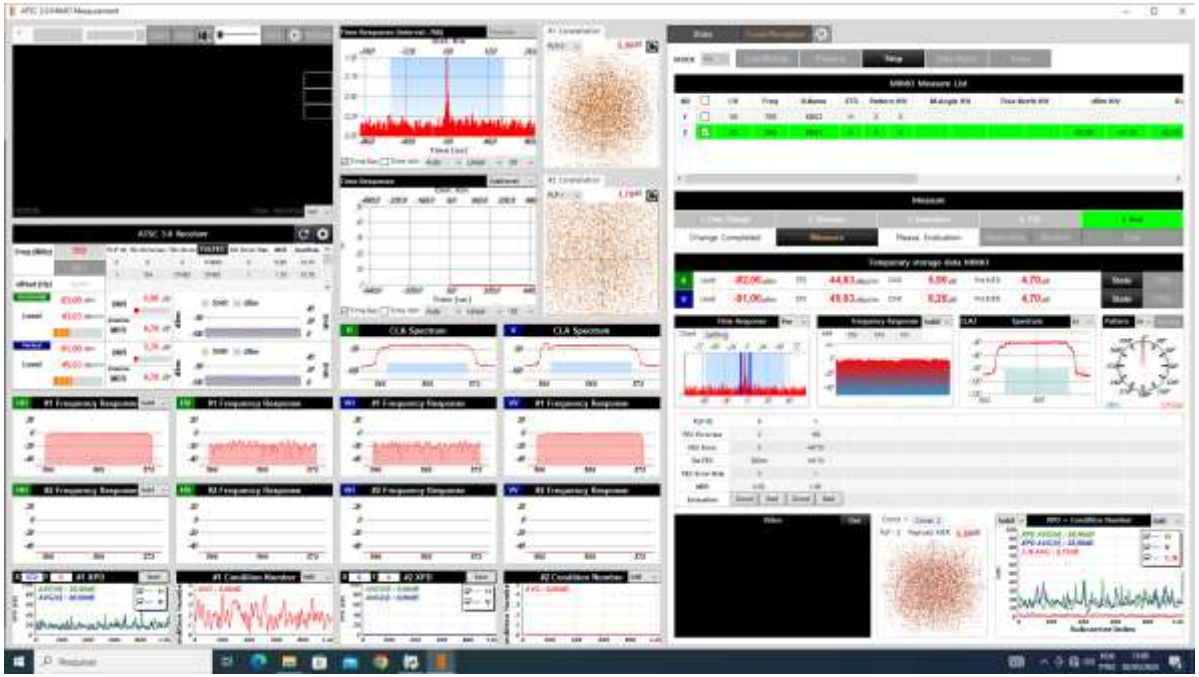


Figure 7.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

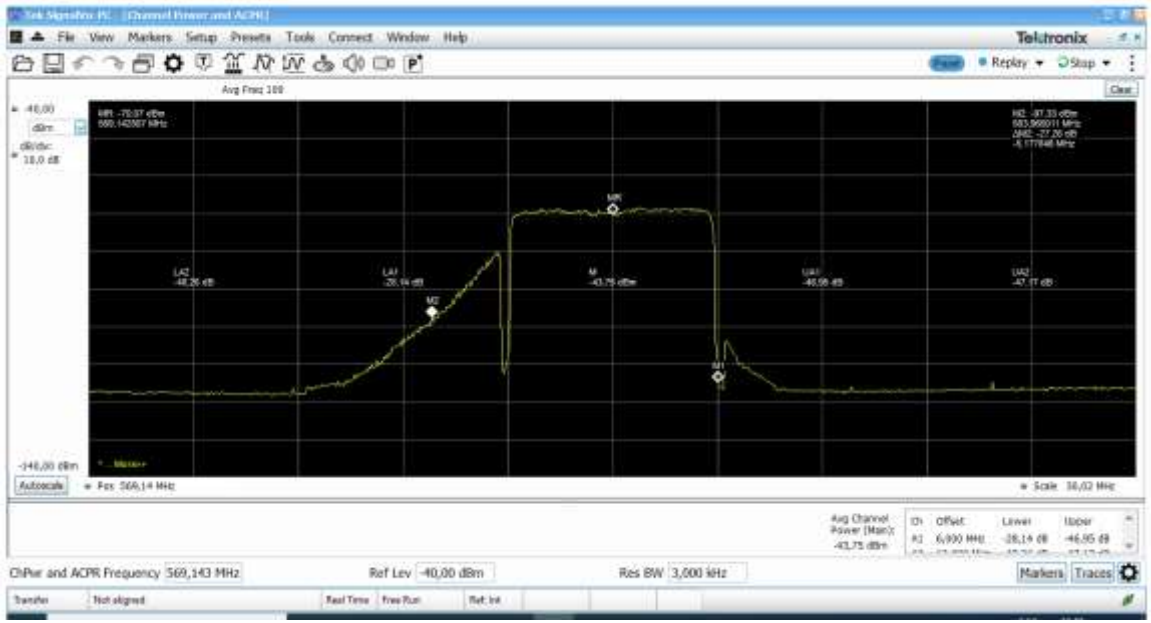


Figure 7.12 - Vertical

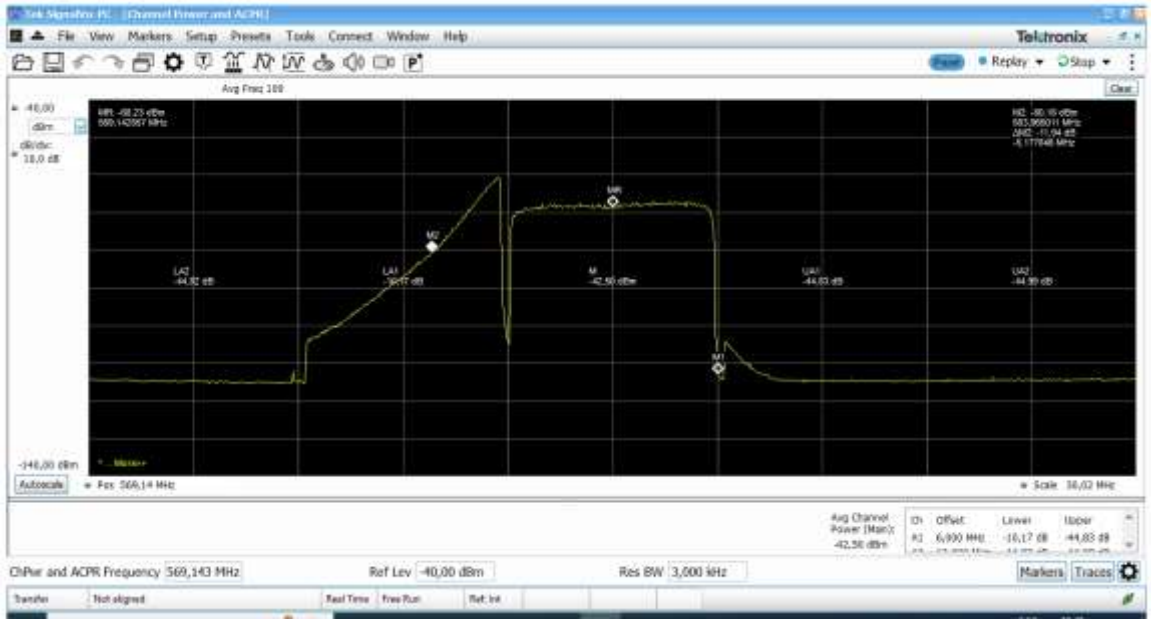


Figure 7.13 - Horizontal

Figure 7.14 - IMAS Screen

b) AWGN Power

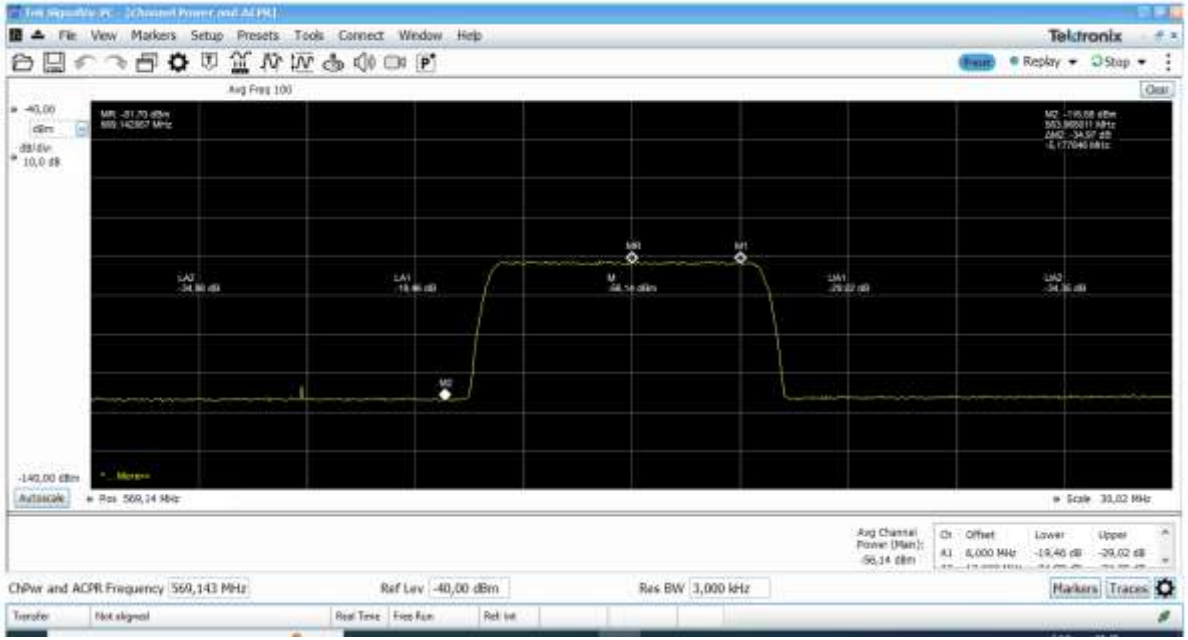


Figure 7.15 - Vertical

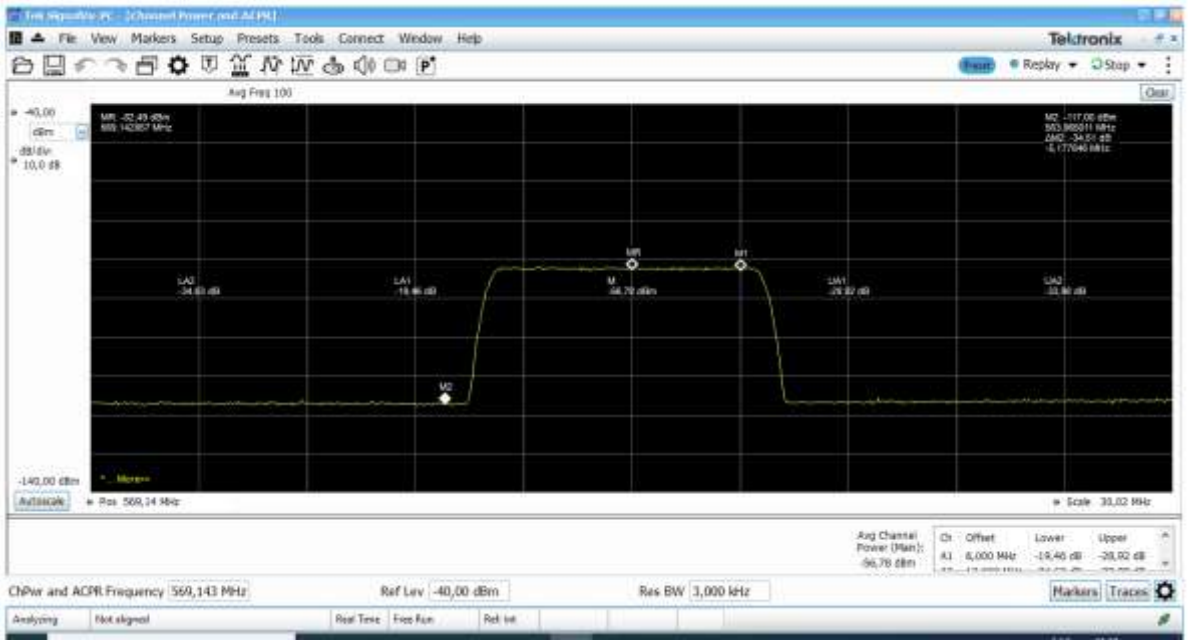


Figure 7.16 - Horizontal

c) C/N Threshold

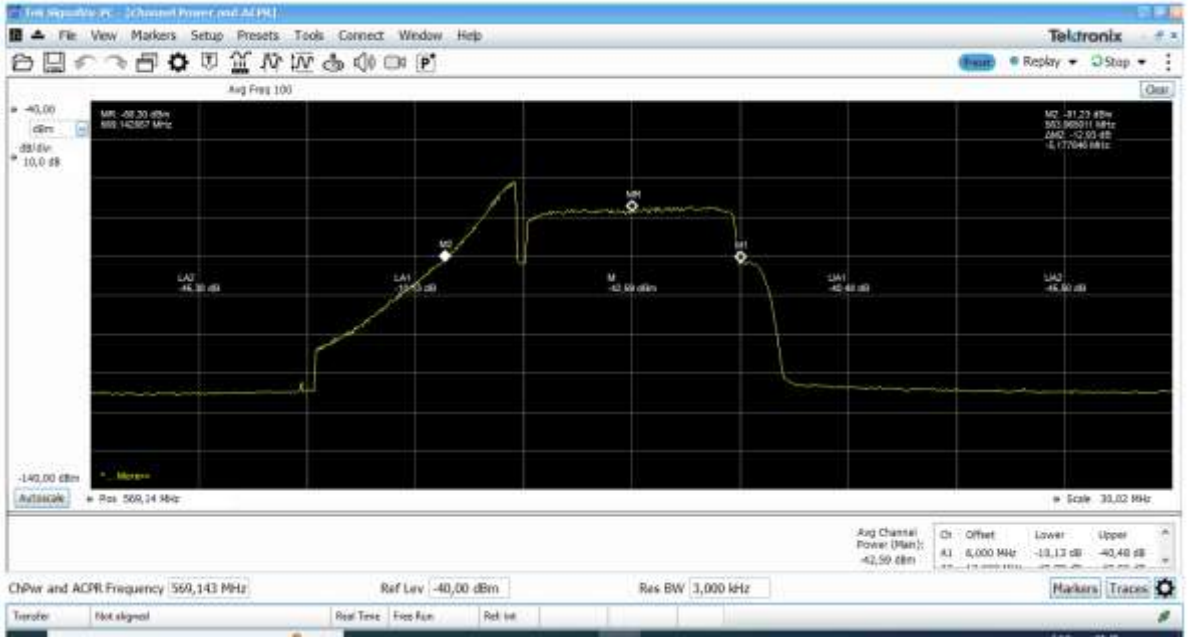


Figure 7.17 - Vertical

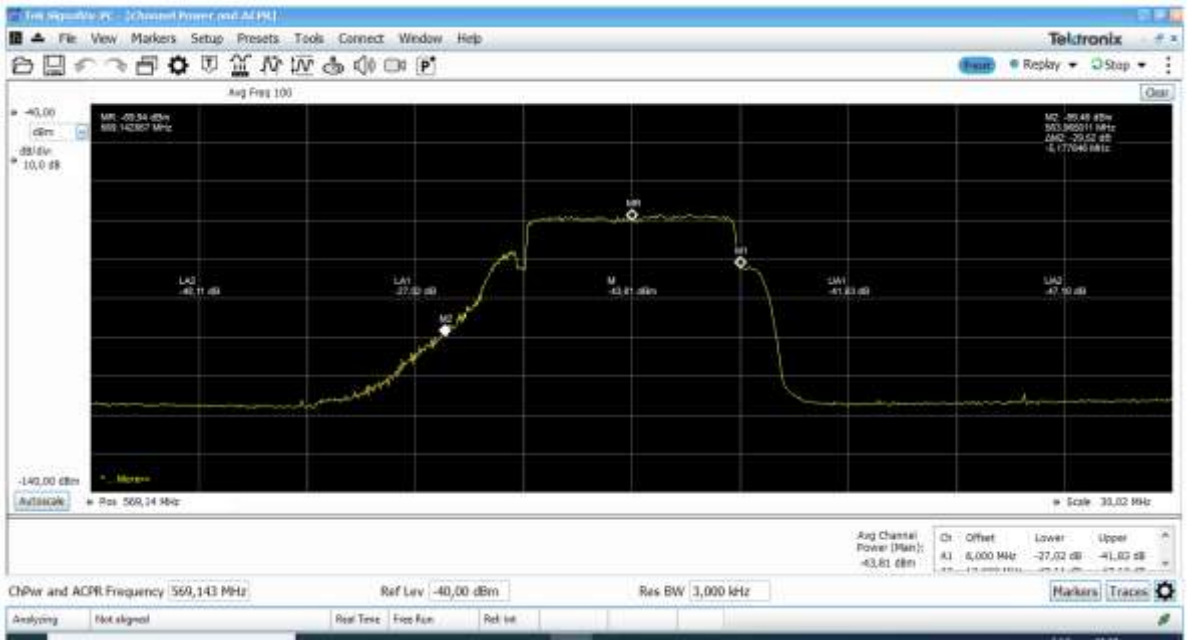


Figure 7.18 - Horizontal

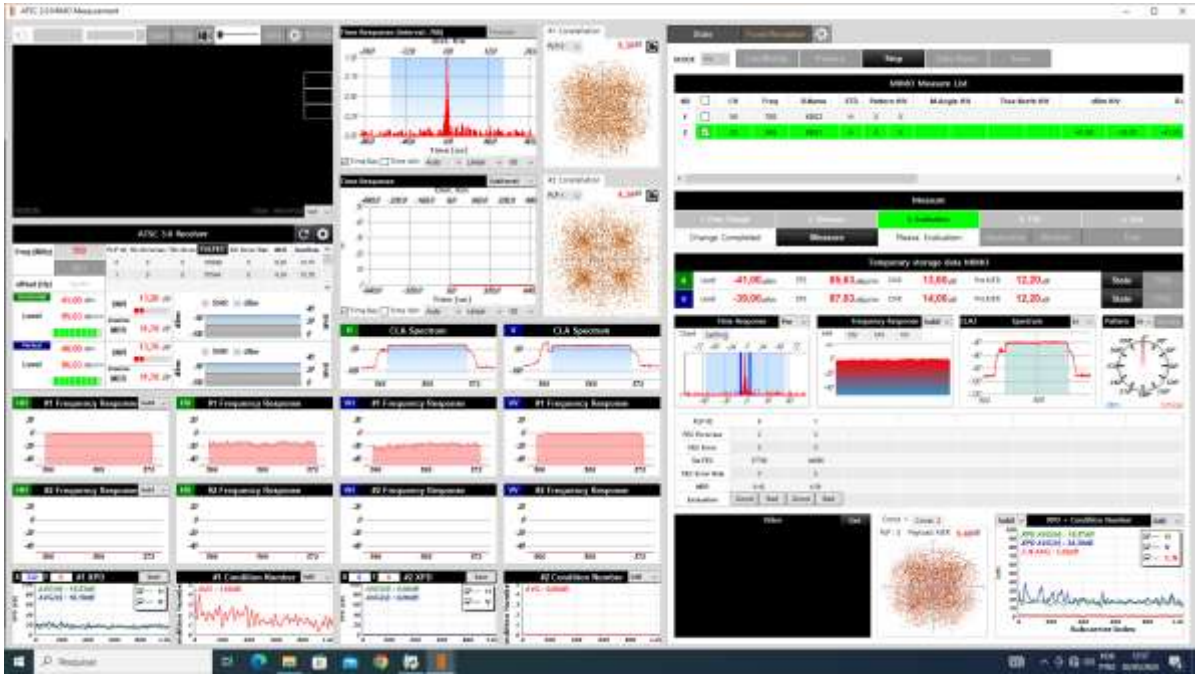


Figure 7.19 - IMAS Screen

d) Reception Threshold

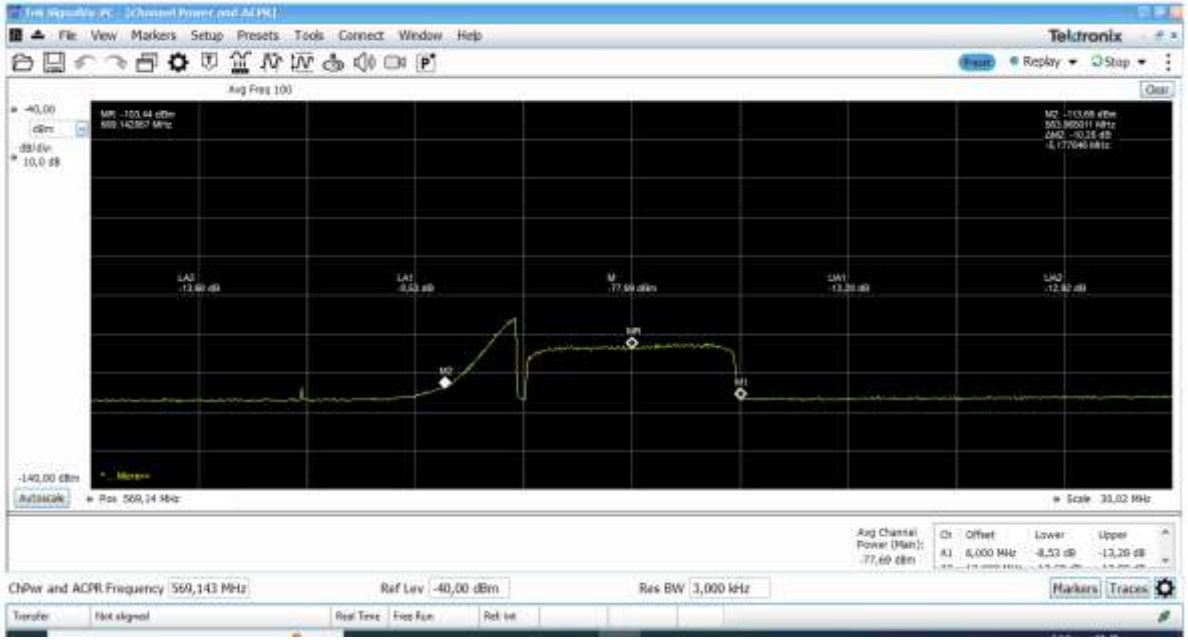


Figure 7.20 - Vertical

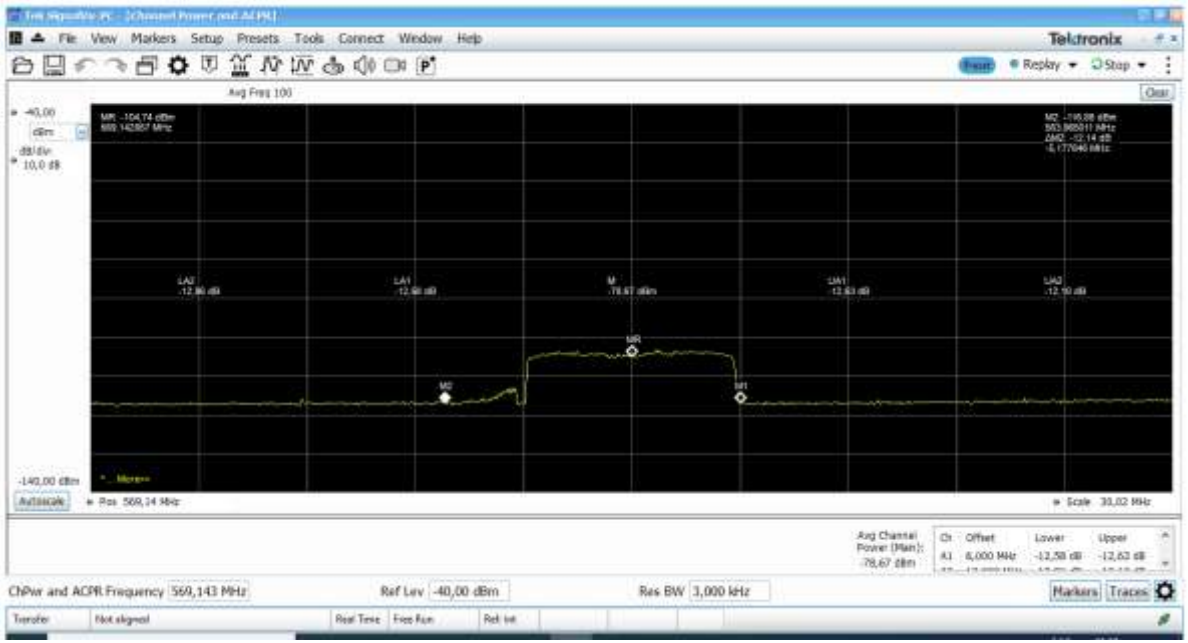


Figure 7.21 - Horizontal

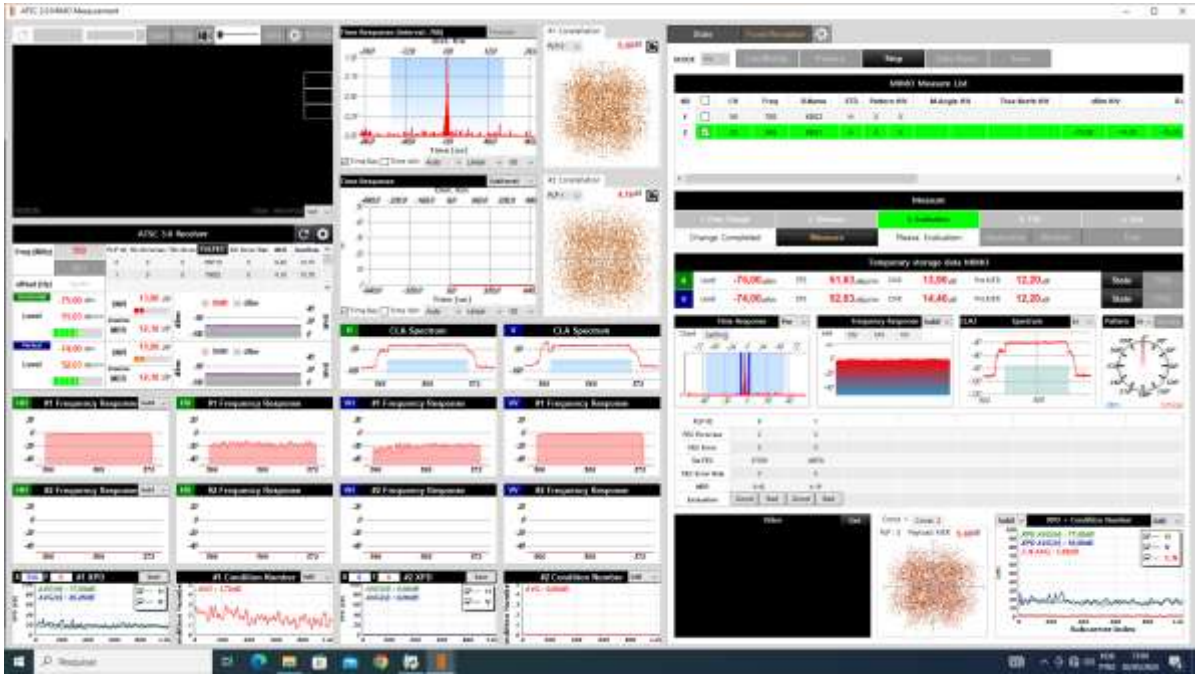


Figure 7.22 - IMAS Screen

Chapter 8. Site 28

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

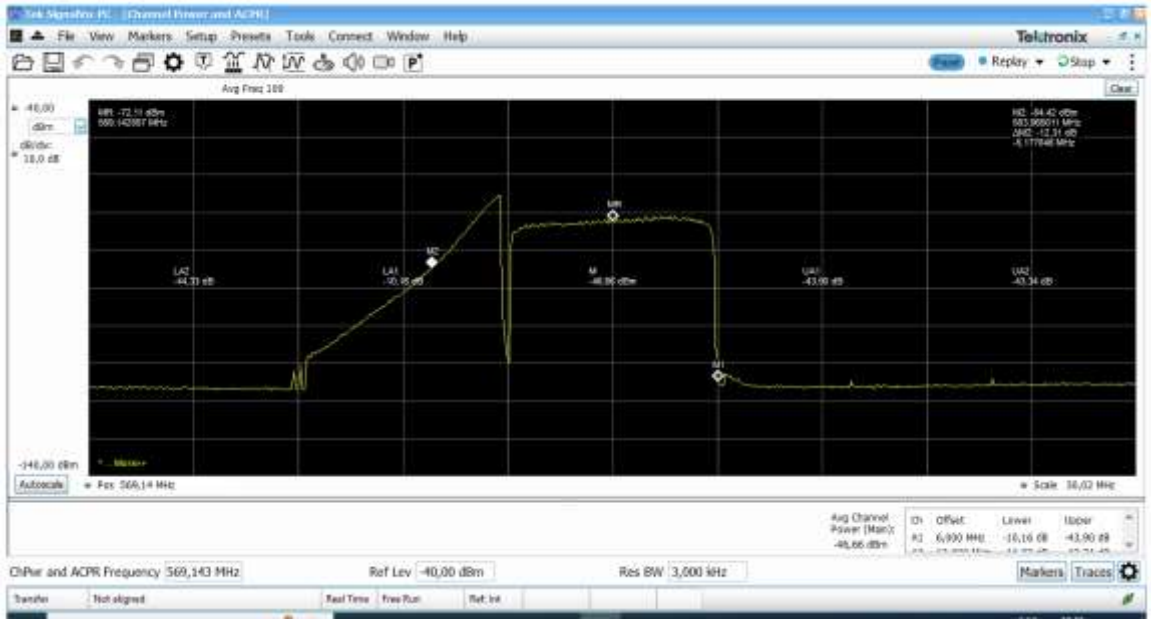


Figure 8.1 - Vertical

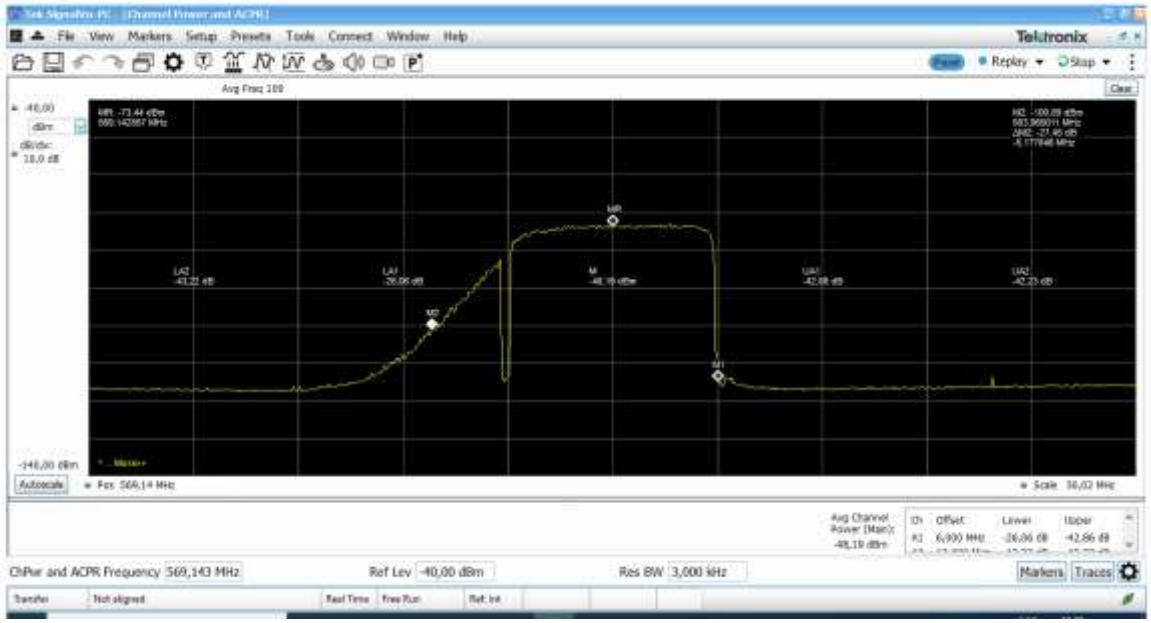


Figure 8.2 - Horizontal

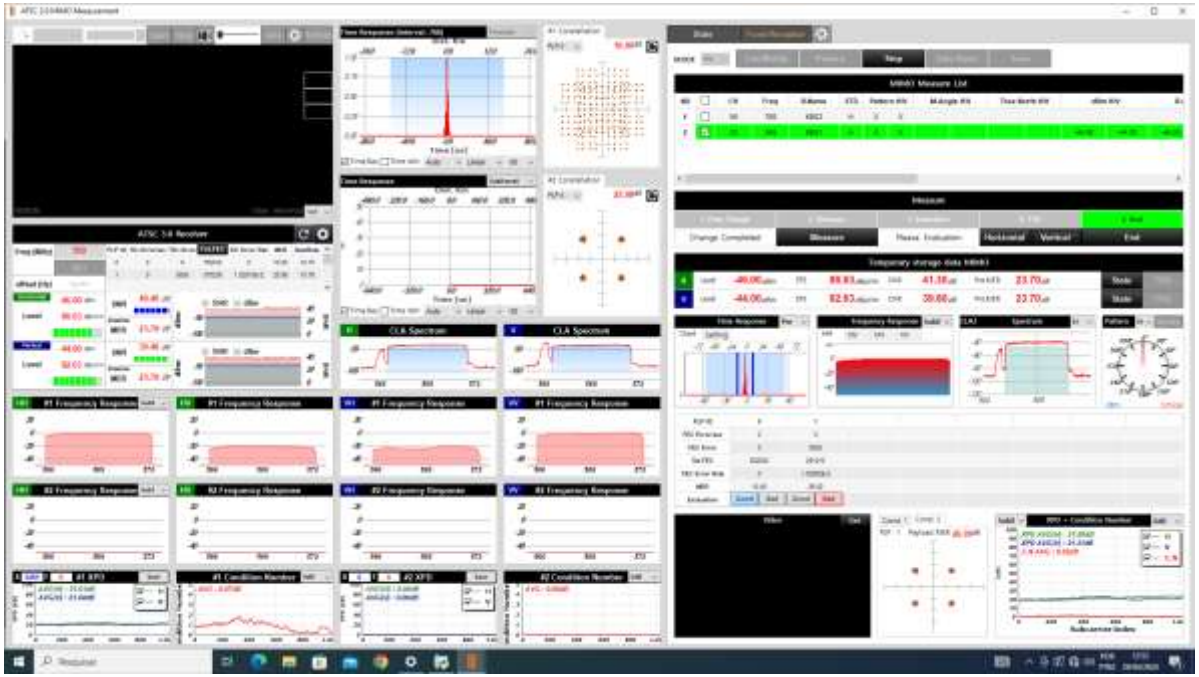


Figure 8.3 - IMAS Screen

b) AWGN Power

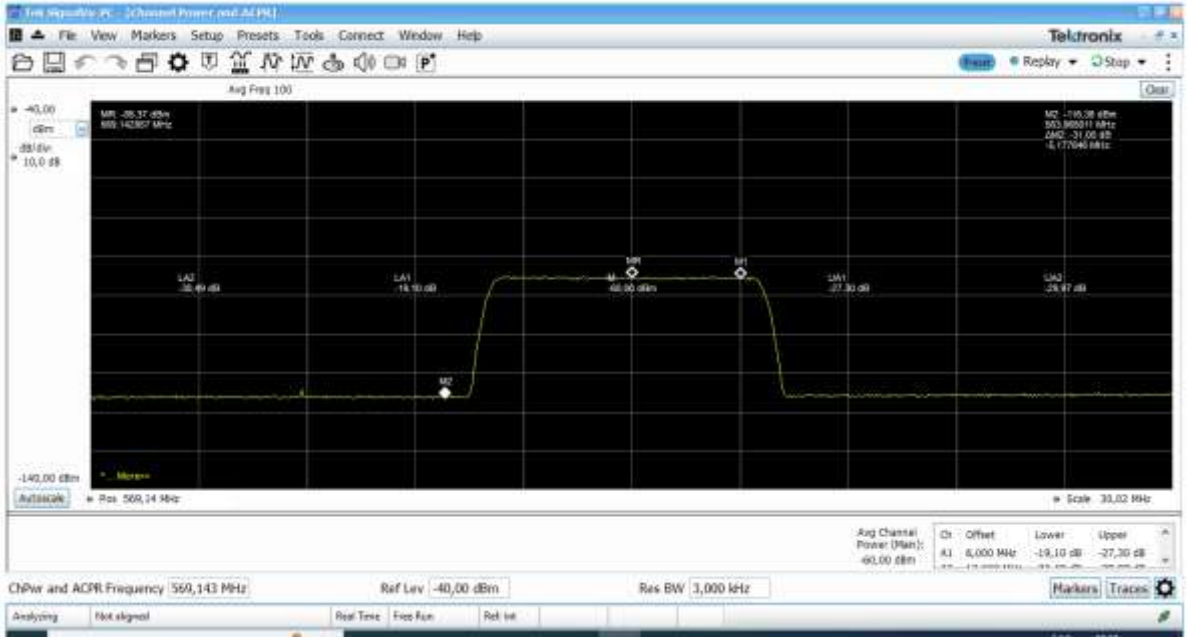


Figure 8.4 - Vertical

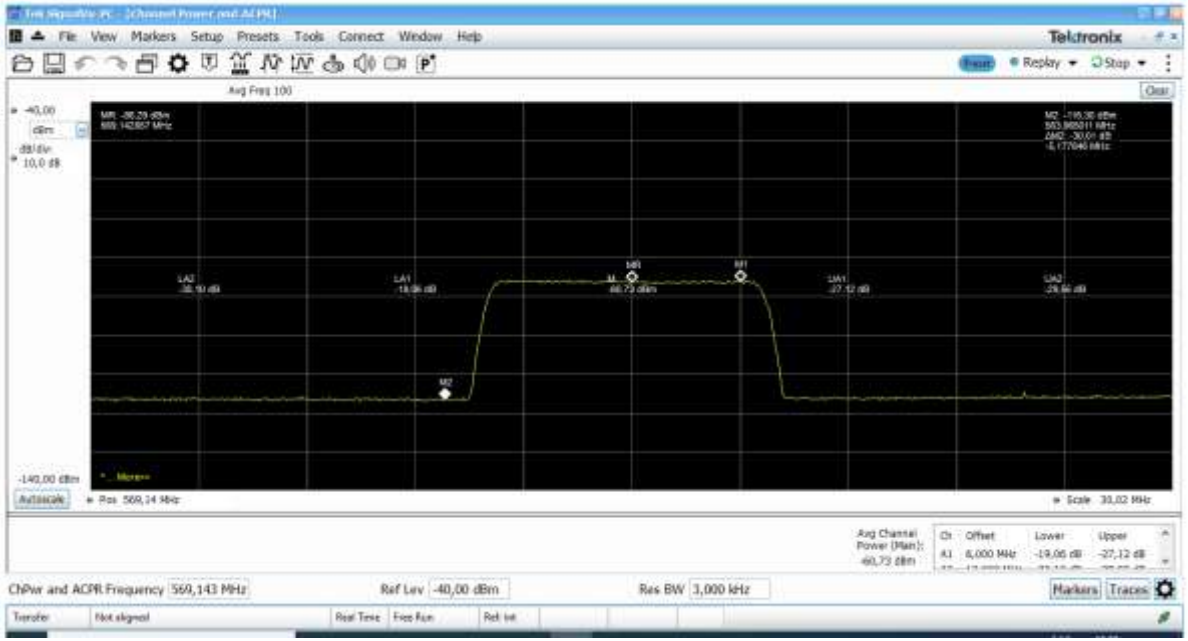


Figure 8.5 - Horizontal

c) C/N Threshold

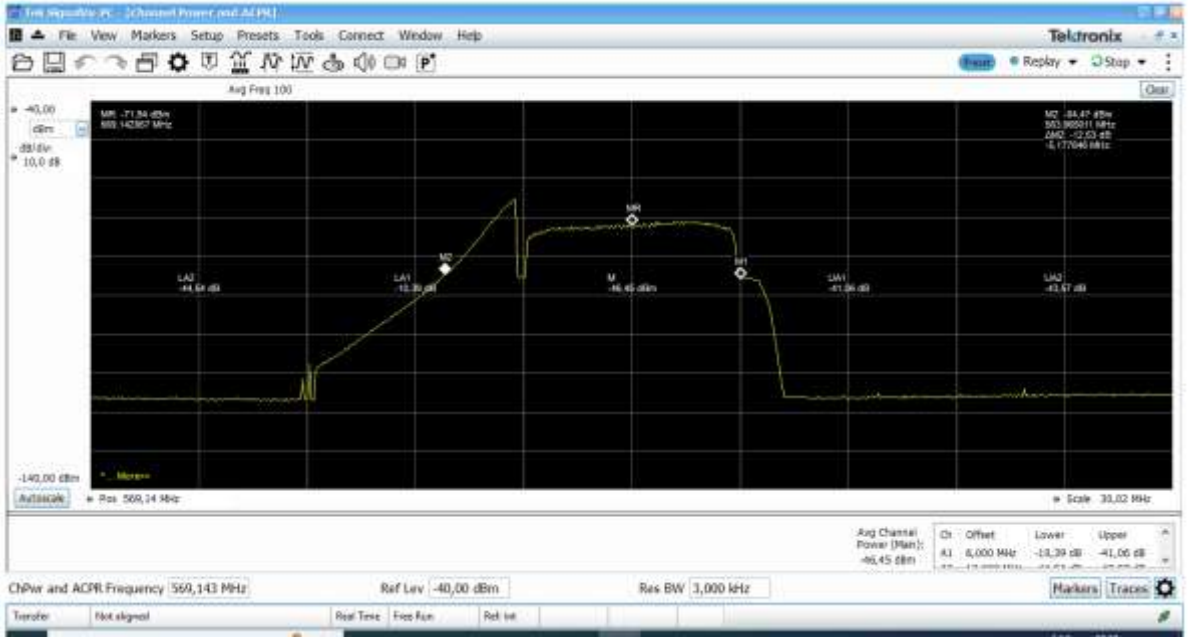


Figure 8.6 - Vertical

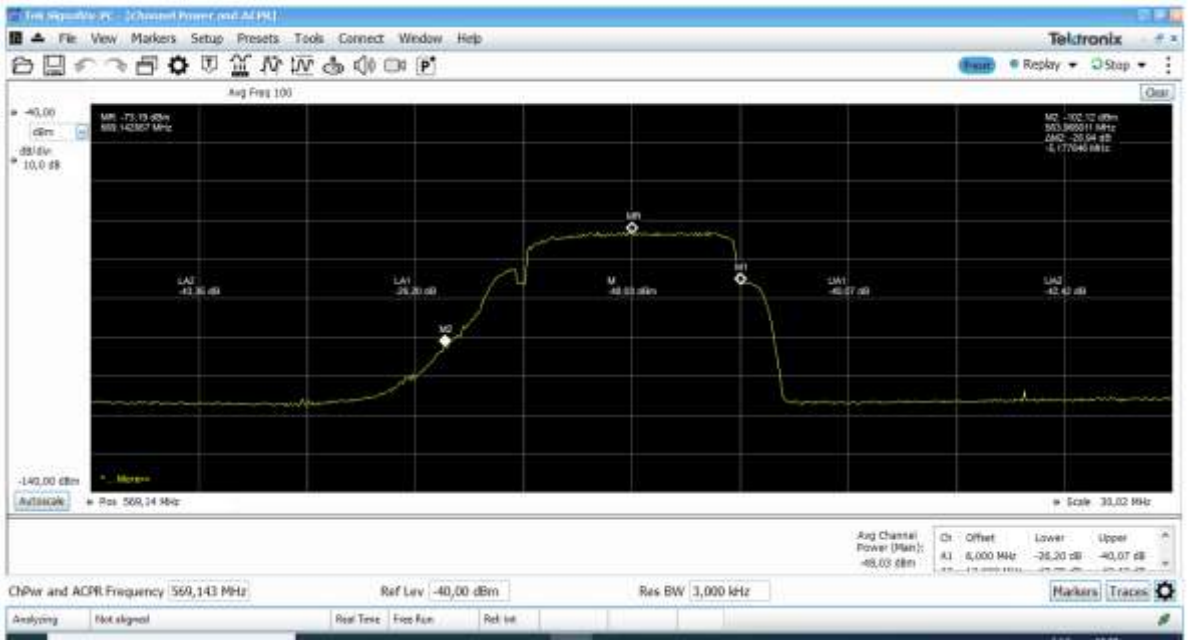


Figure 8.7 - Horizontal

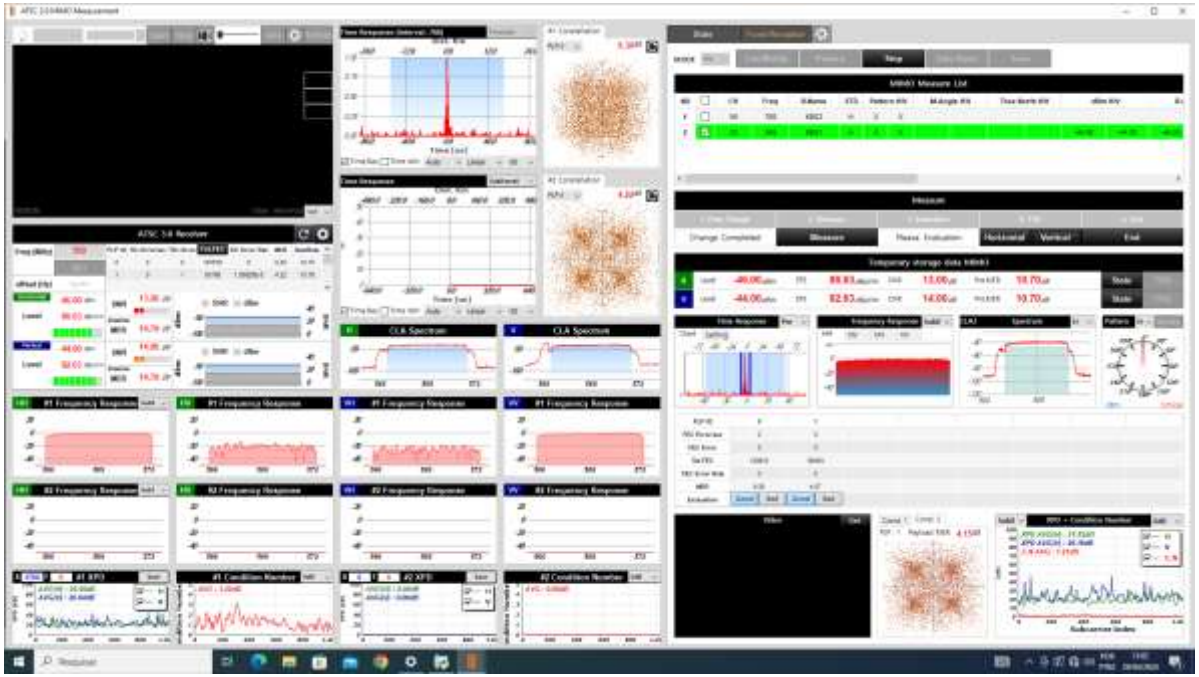


Figure 8.8 - IMAS Screen

d) Reception Threshold

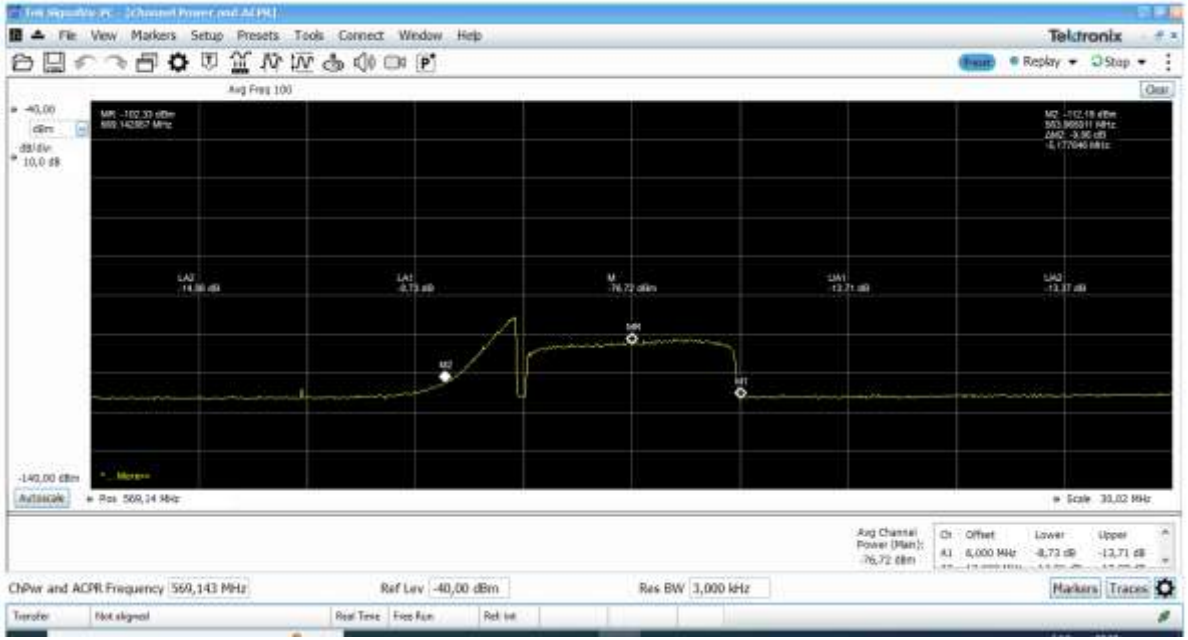


Figure 8.9 - Vertical

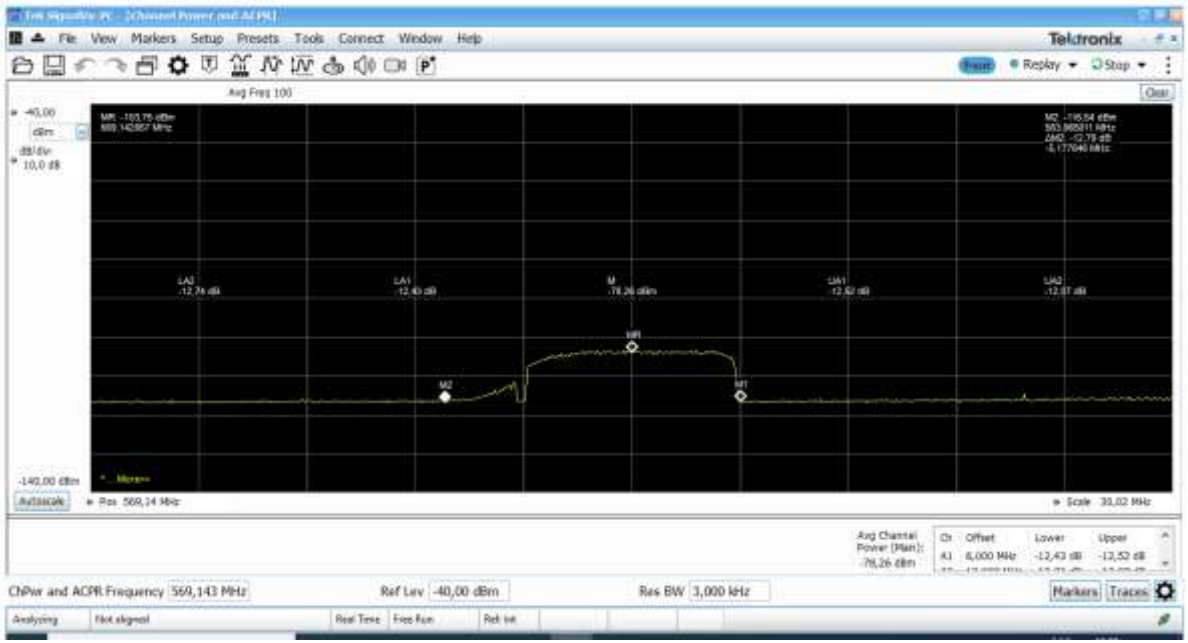


Figure 8.10 - Horizontal

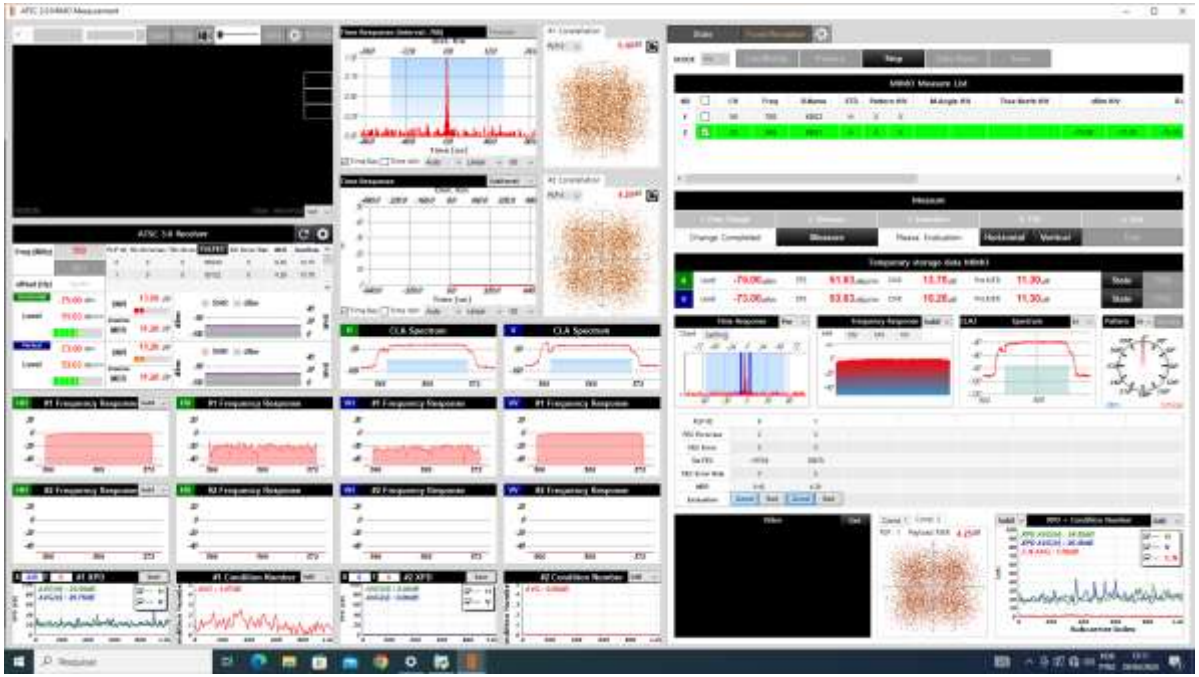


Figure 8.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

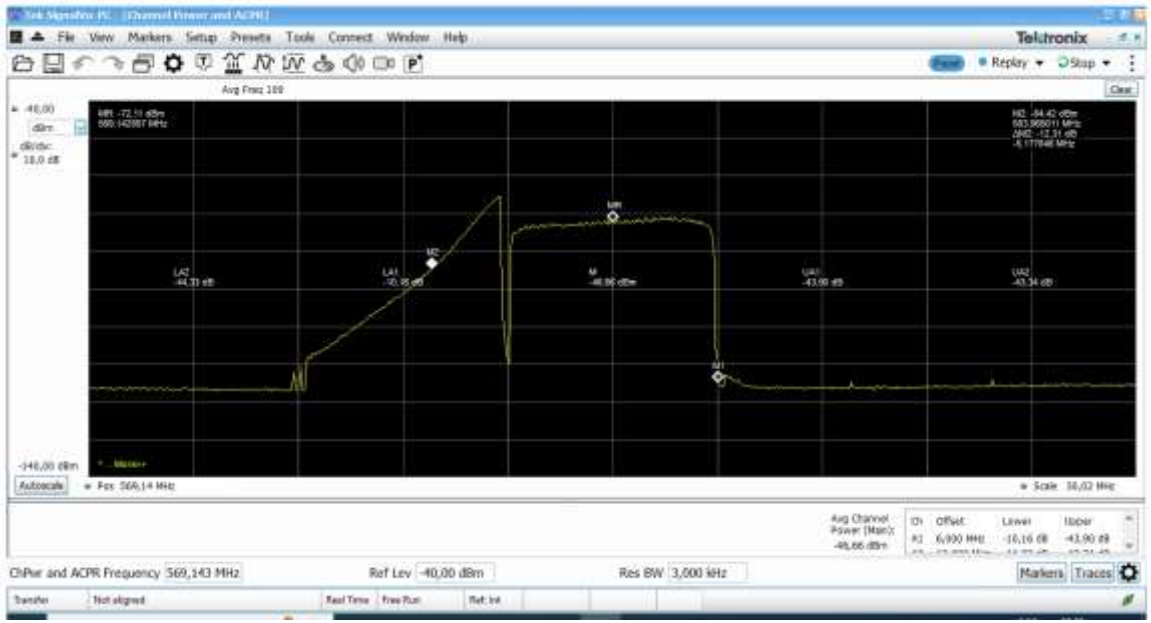


Figure 8.12 - Vertical

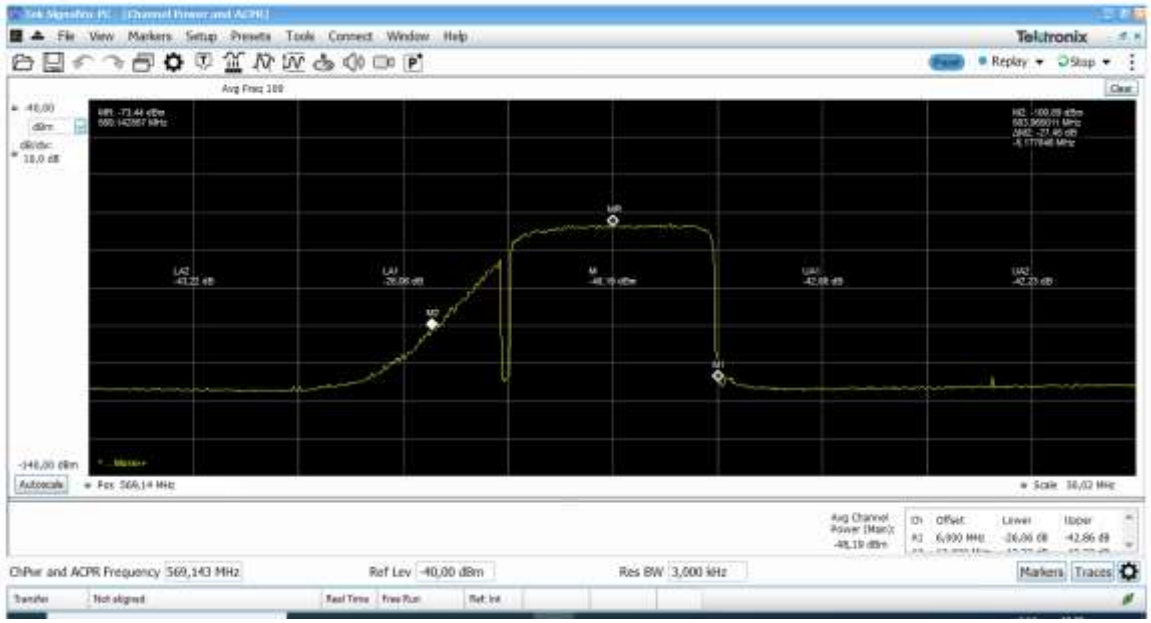


Figure 8.13 - Horizontal

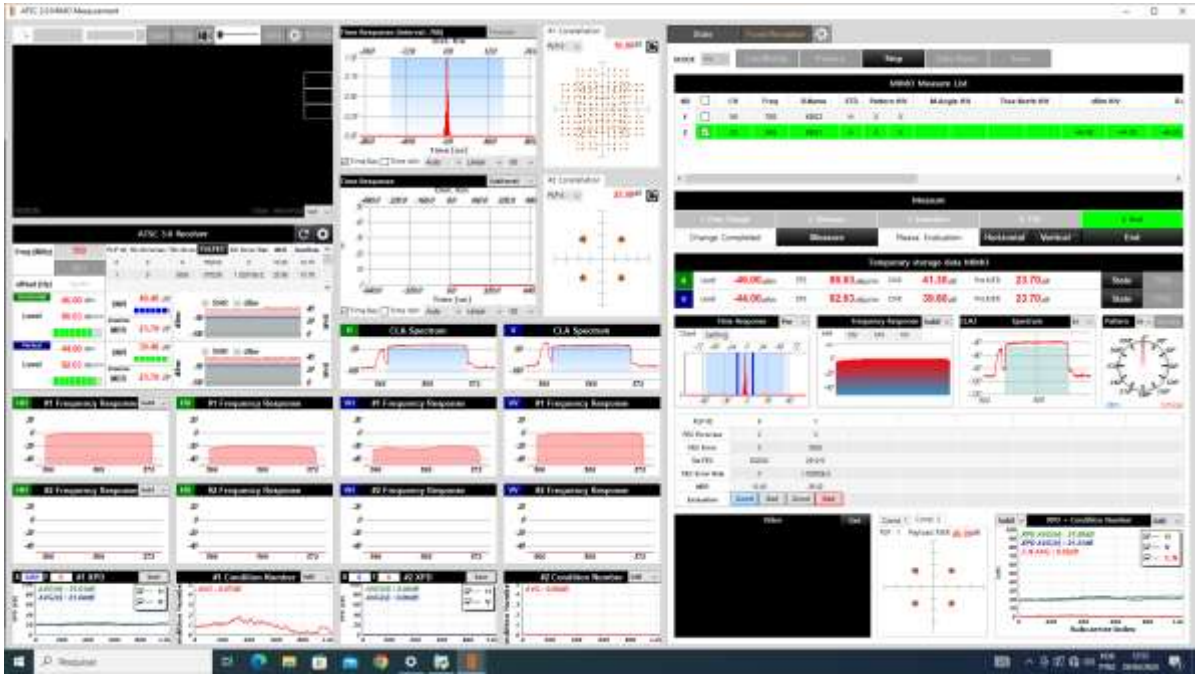


Figure 8.14 - IMAS Screen

b) AWGN Power

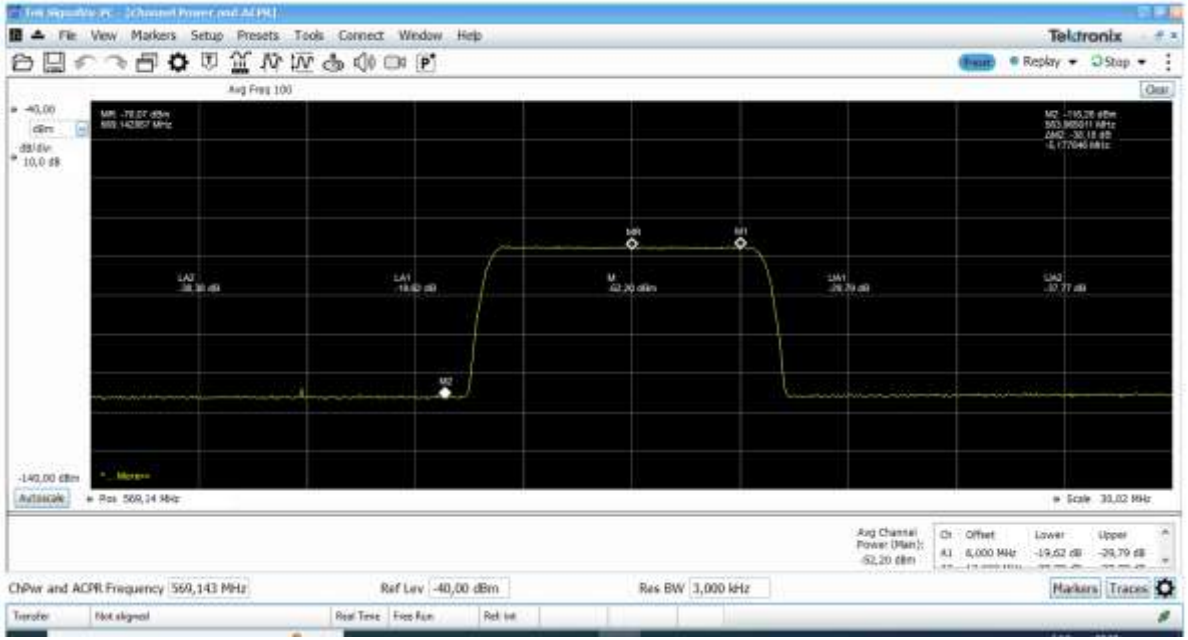


Figure 8.15 - Vertical

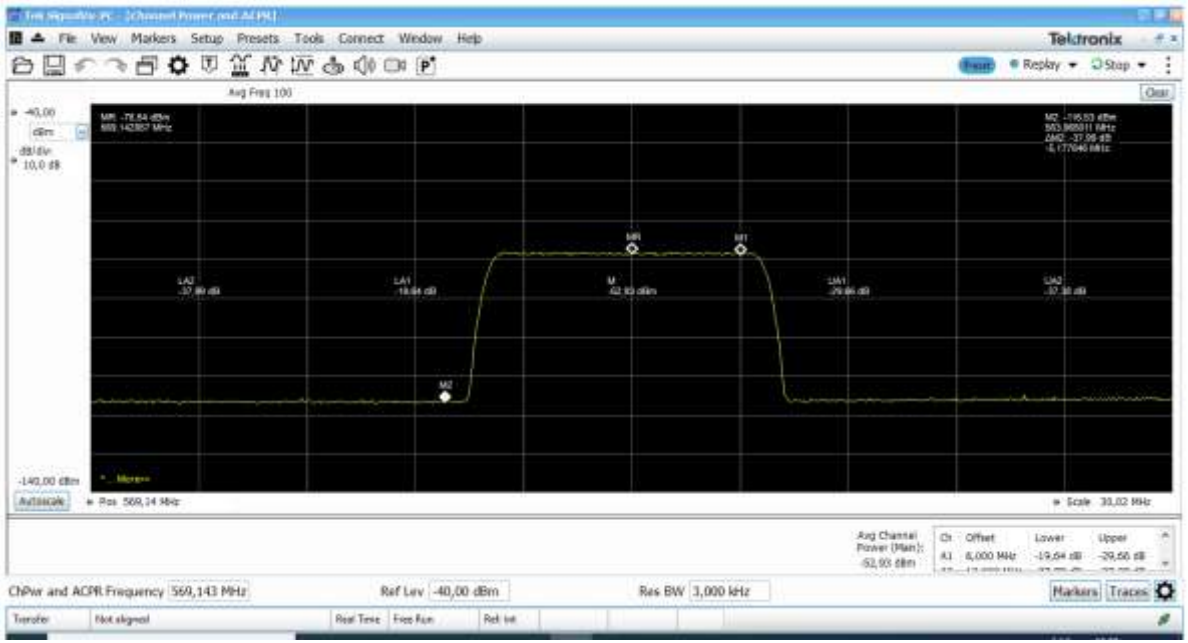


Figure 8.16 - Horizontal

c) C/N Threshold

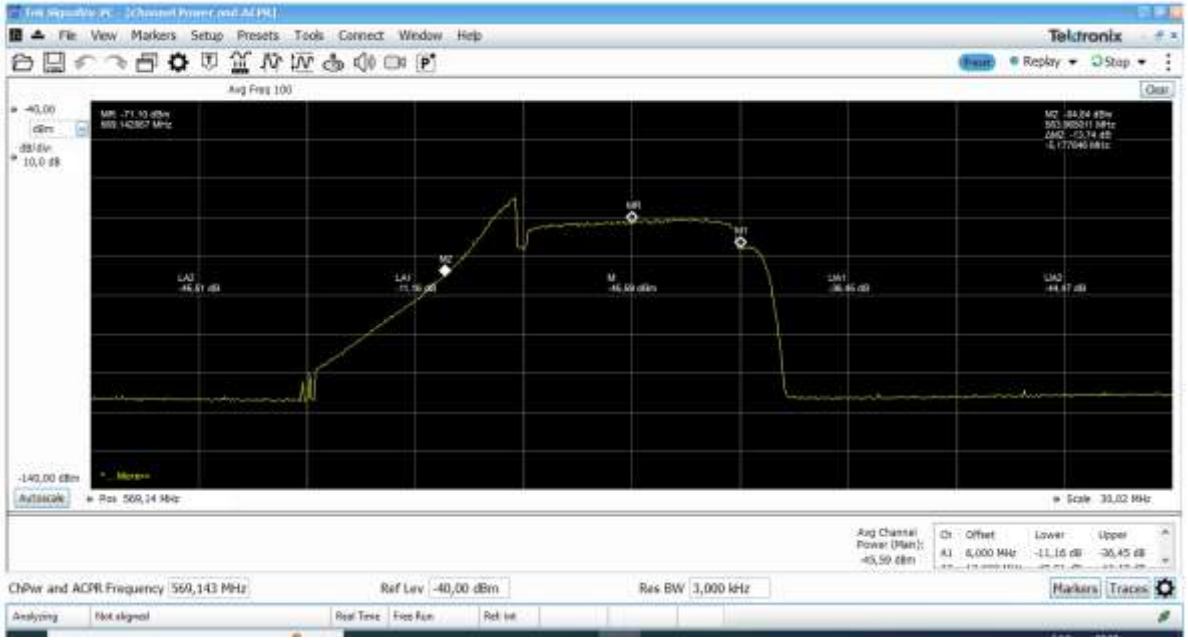


Figure 8.17 - Vertical

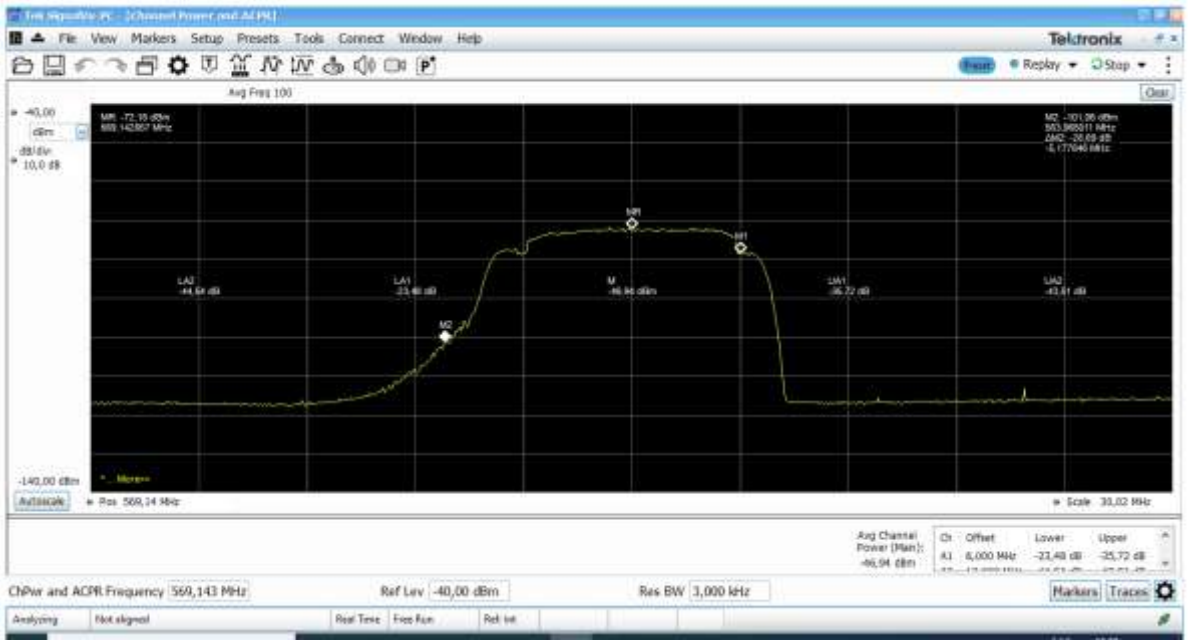


Figure 8.18 - Horizontal

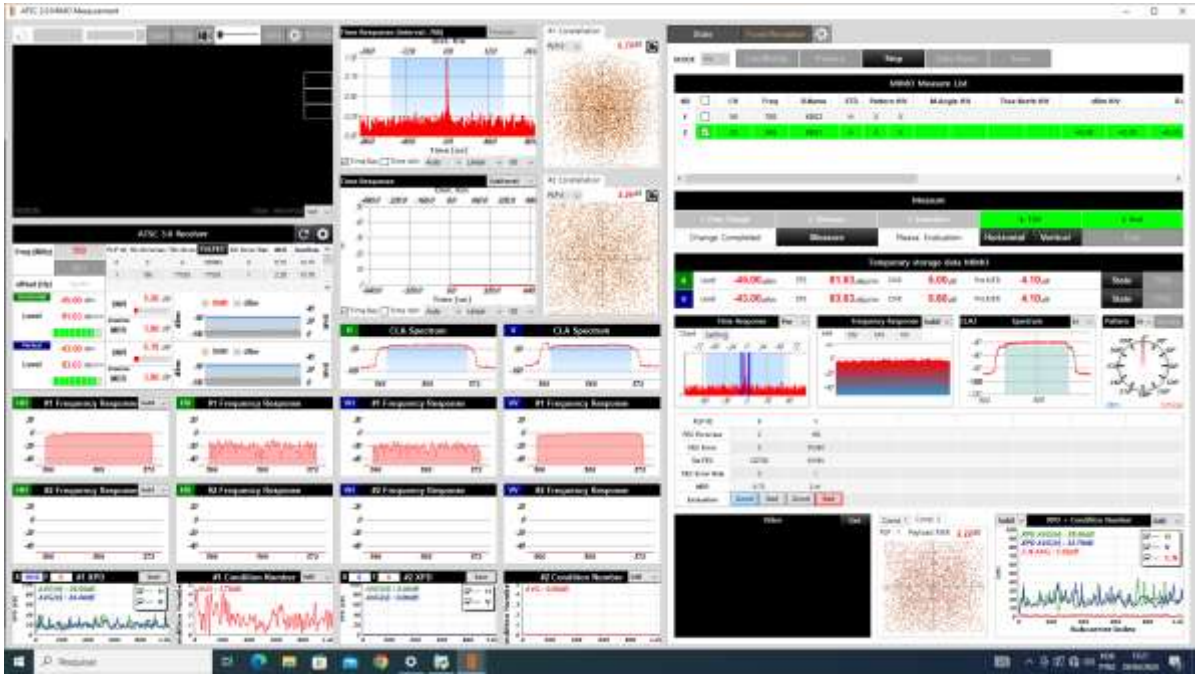


Figure 8.19 - IMAS Screen

d) Reception Threshold

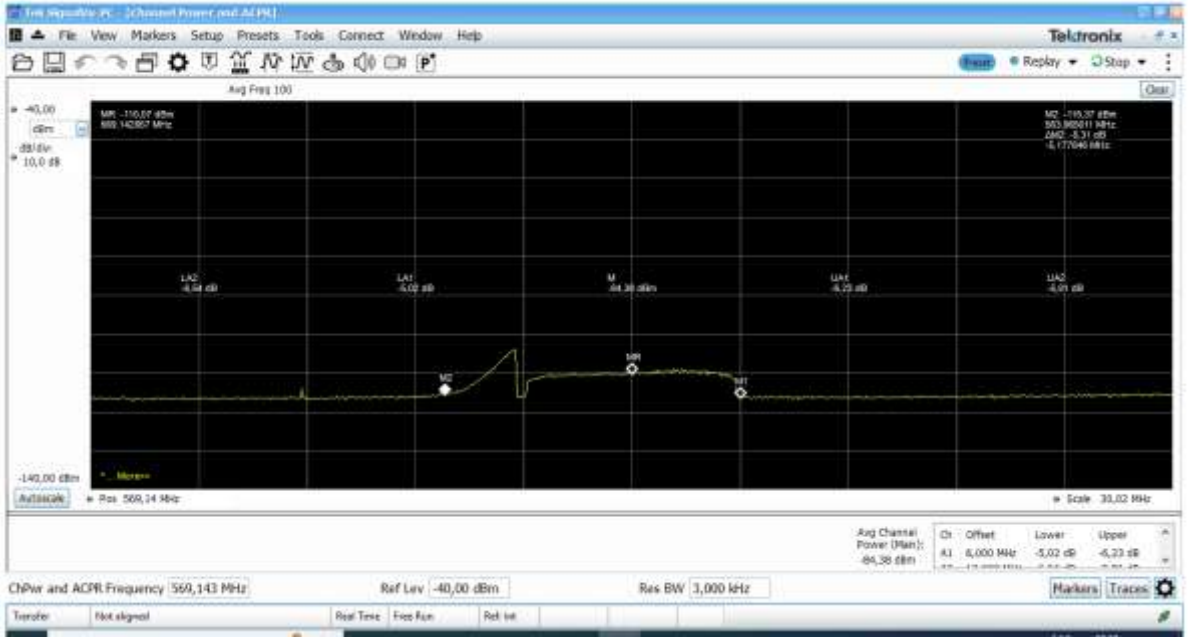


Figure 8.20 - Vertical

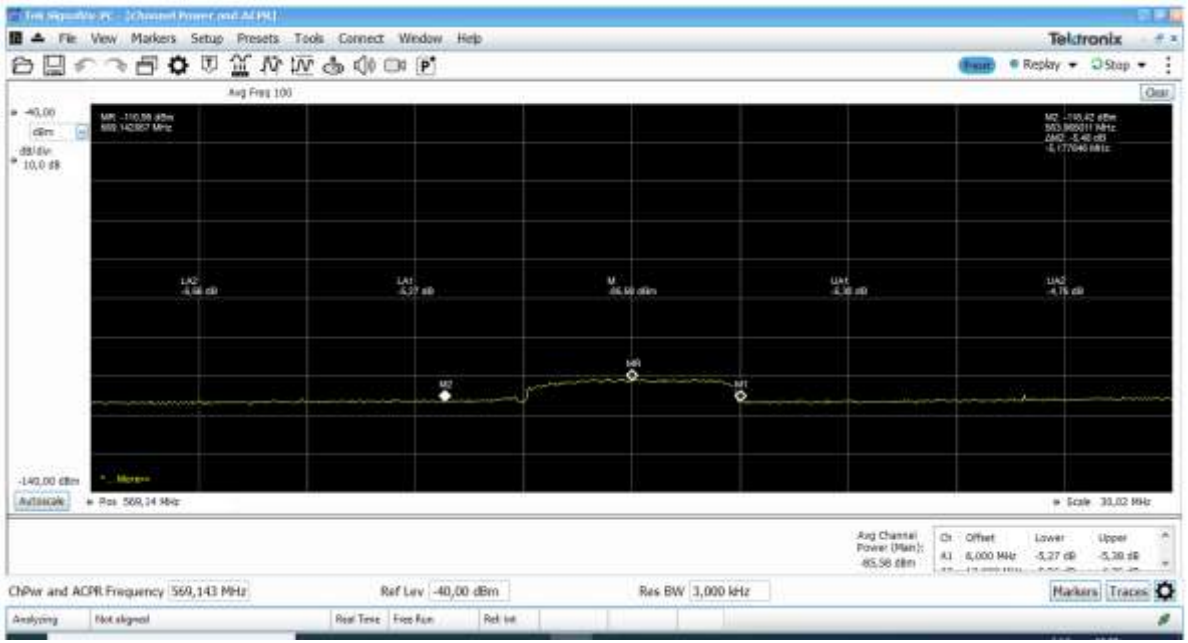


Figure 8.21 - Horizontal

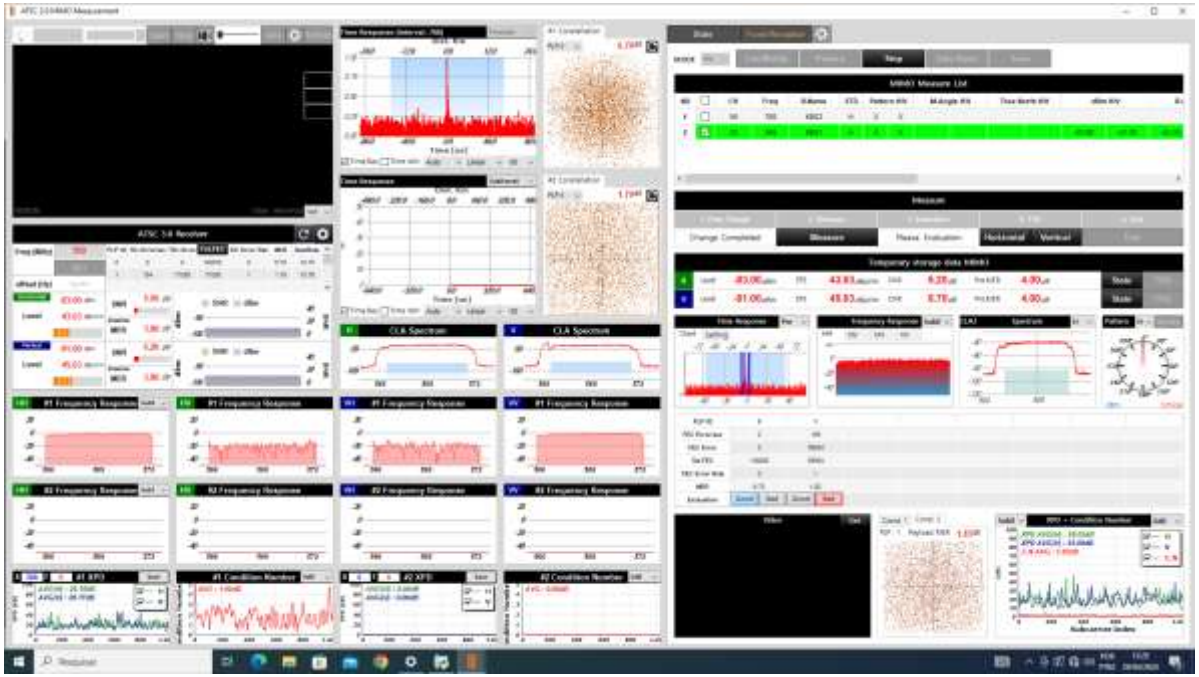


Figure 8.22 - IMAS Screen

Appendix VIII. Extra indoor measurements using ATSC 3.0 - Configuration 3 - Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps; Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

Chapter 1. Site 1

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

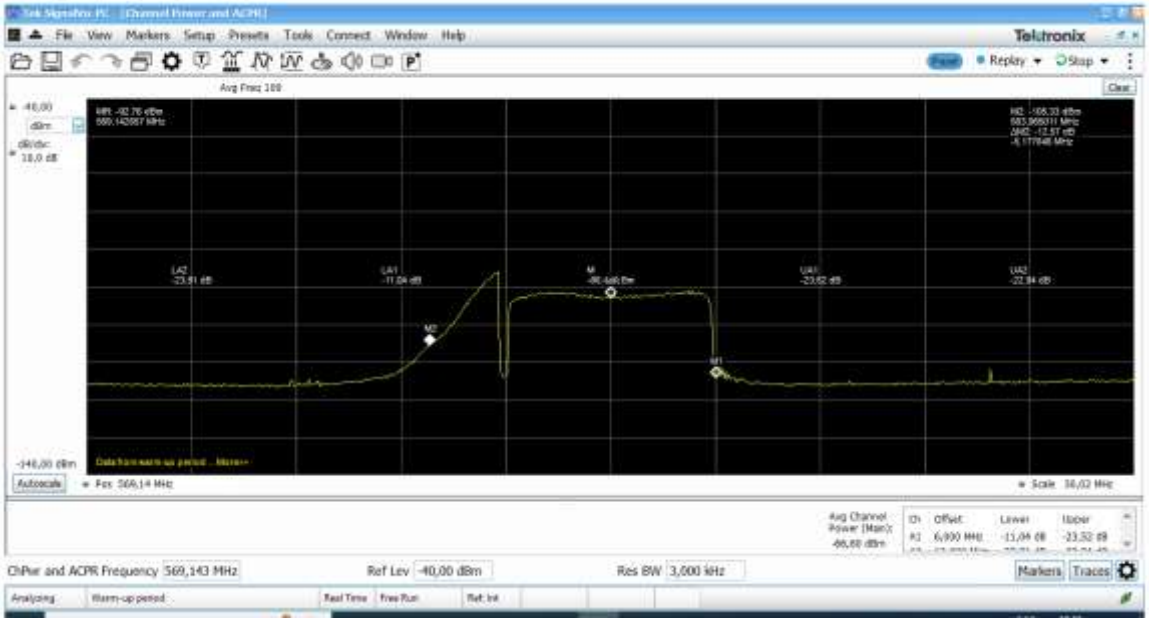


Figure 1.1 - Vertical

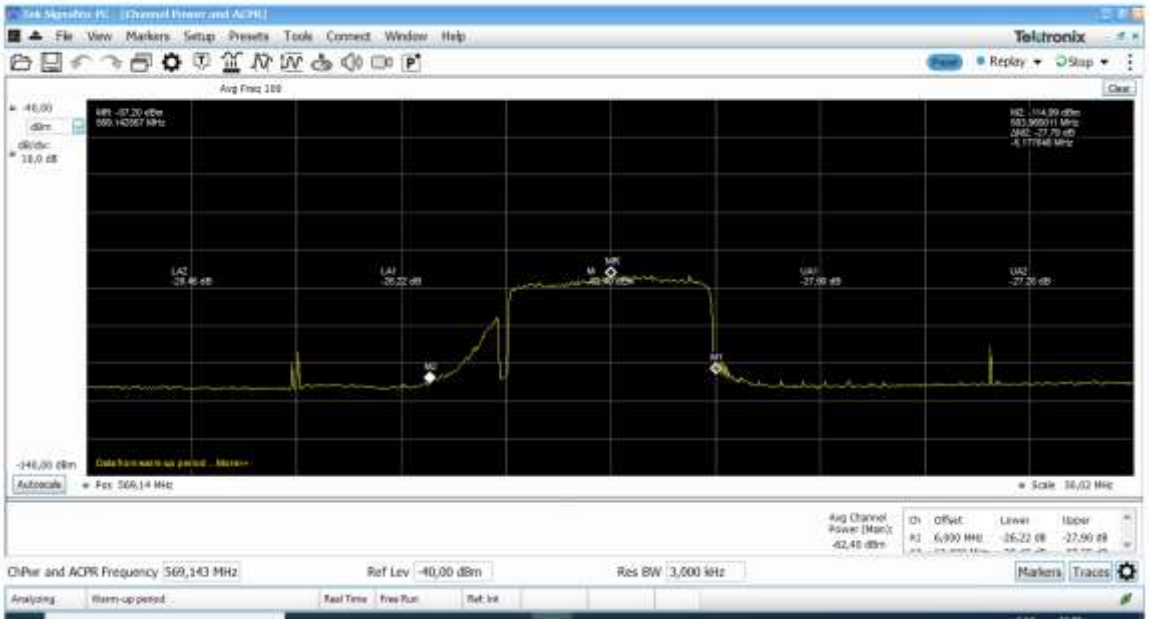


Figure 1.2 - Horizontal

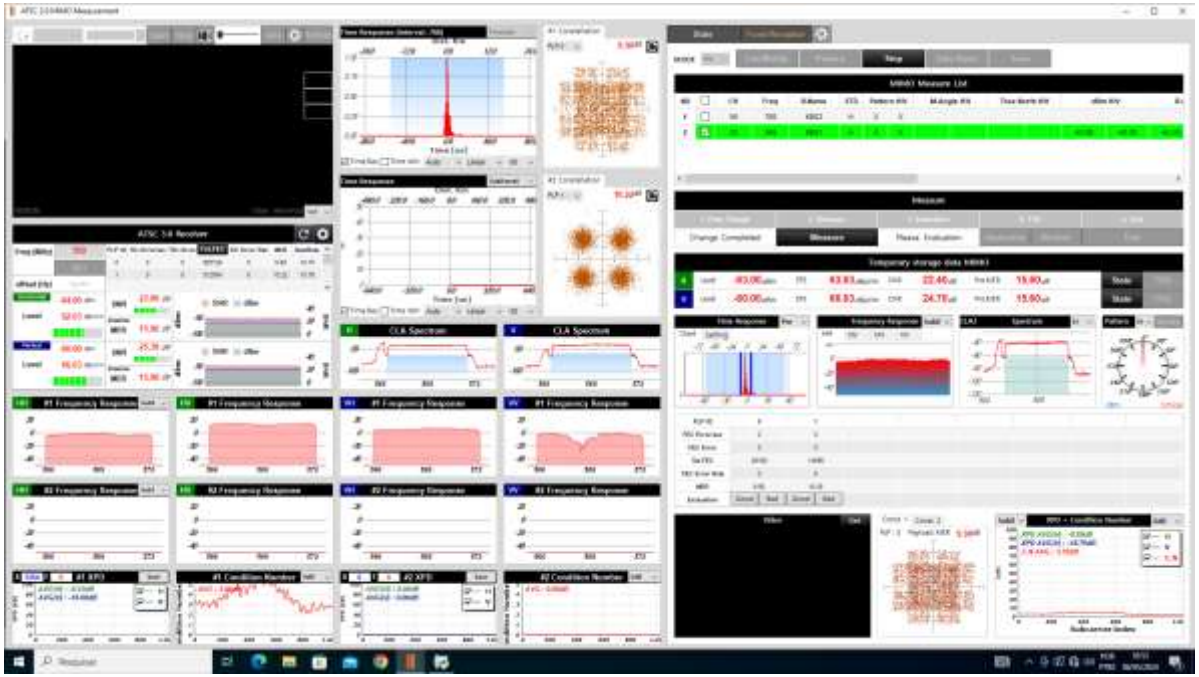


Figure 1.3 - IMAS Screen

b) AWGN Power

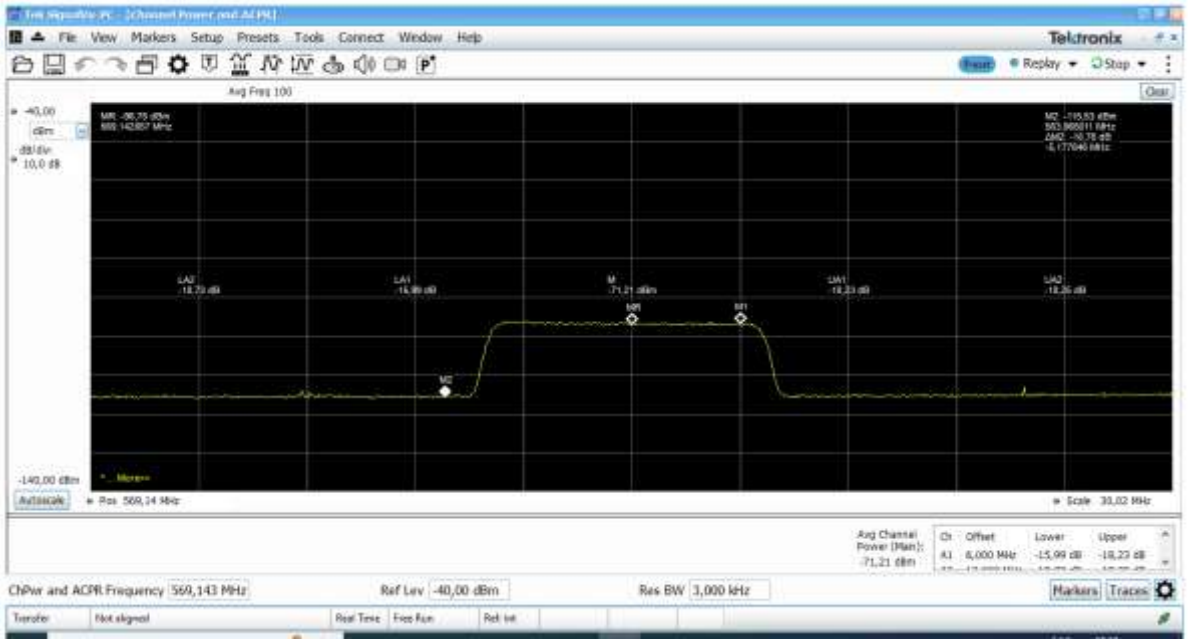


Figure 1.4 - Vertical

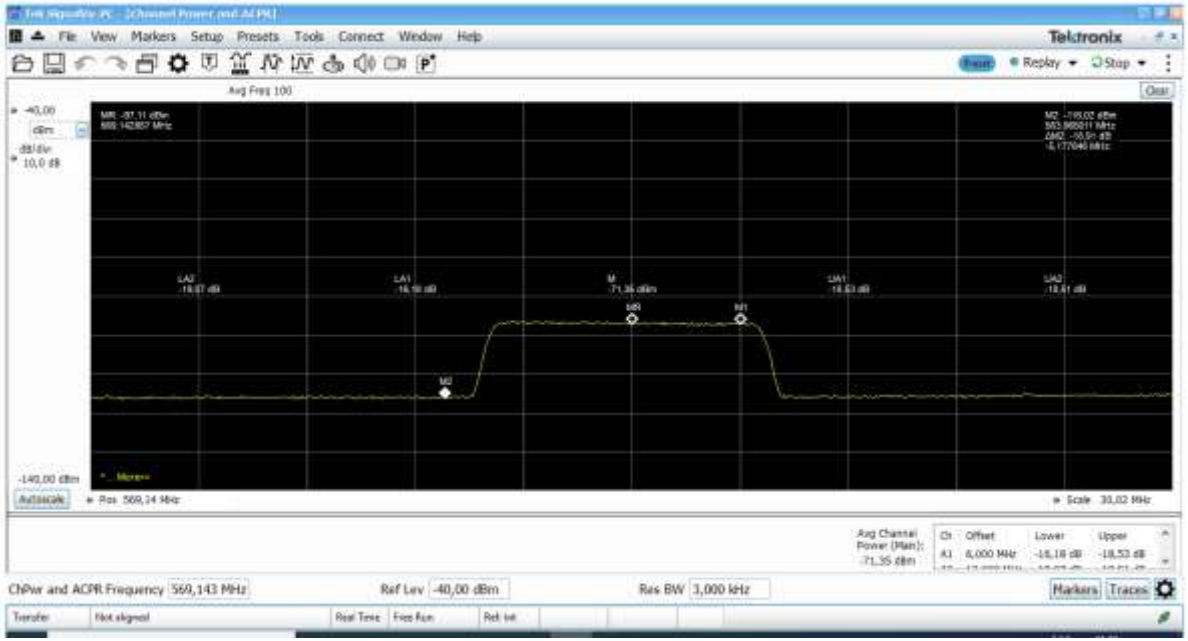


Figure 1.5 - Horizontal

c) C/N Threshold

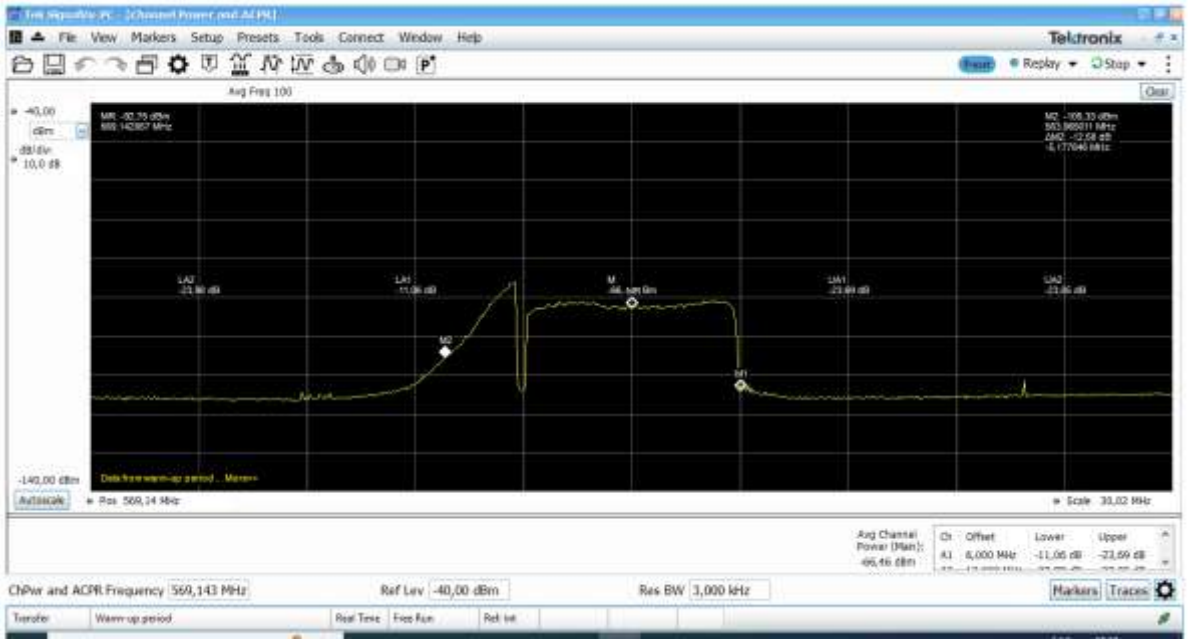


Figure 1.6 - Vertical

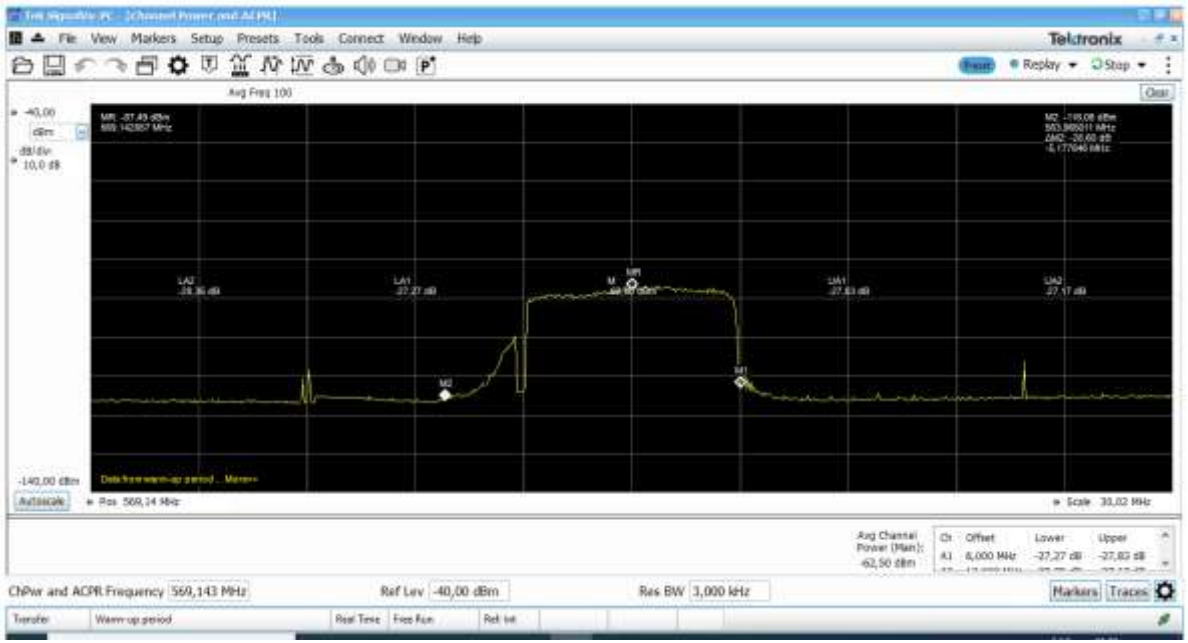


Figure 1.7 - Horizontal

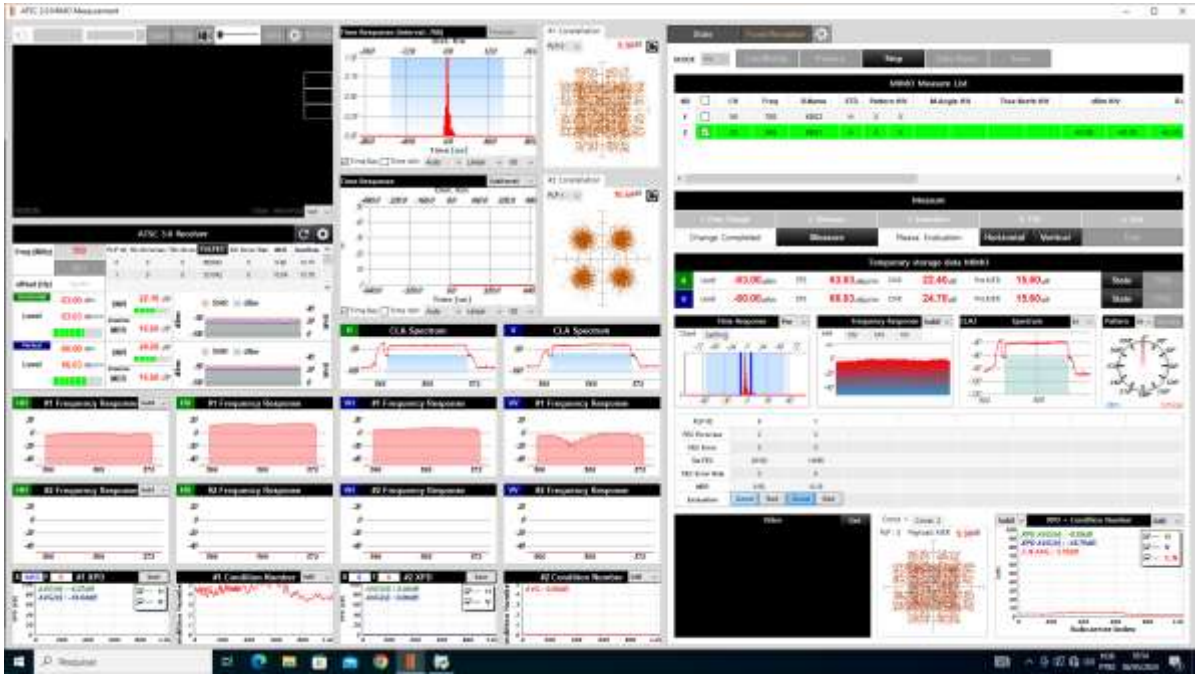


Figure 1.8 - IMAS Screen

d) Reception Threshold

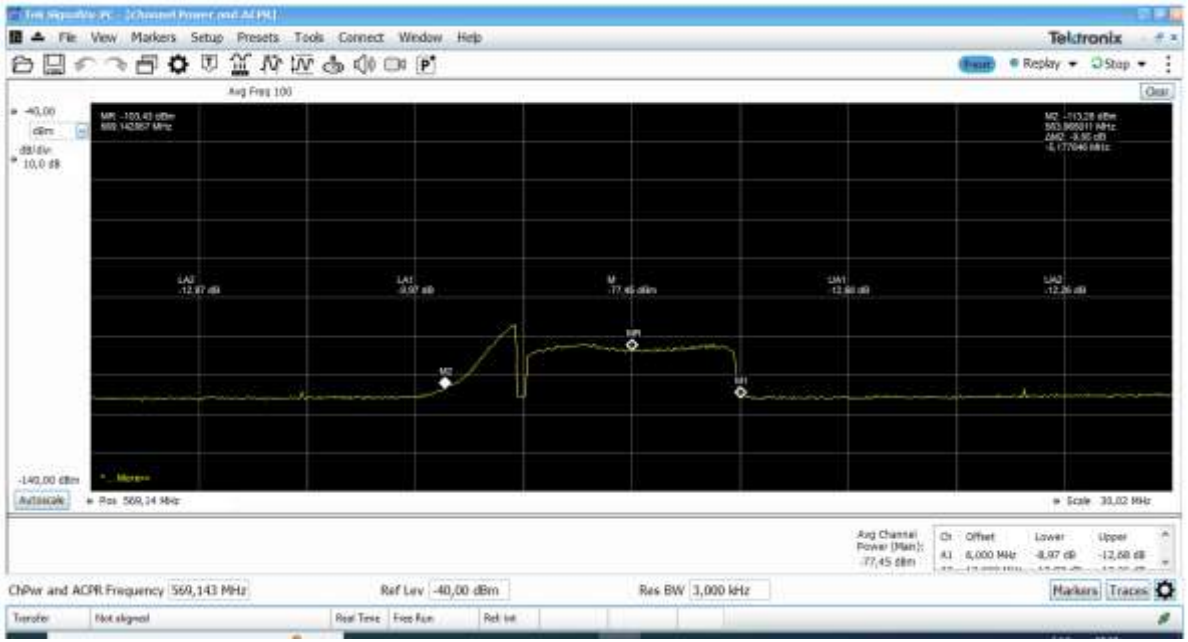


Figure 1.9 - Vertical

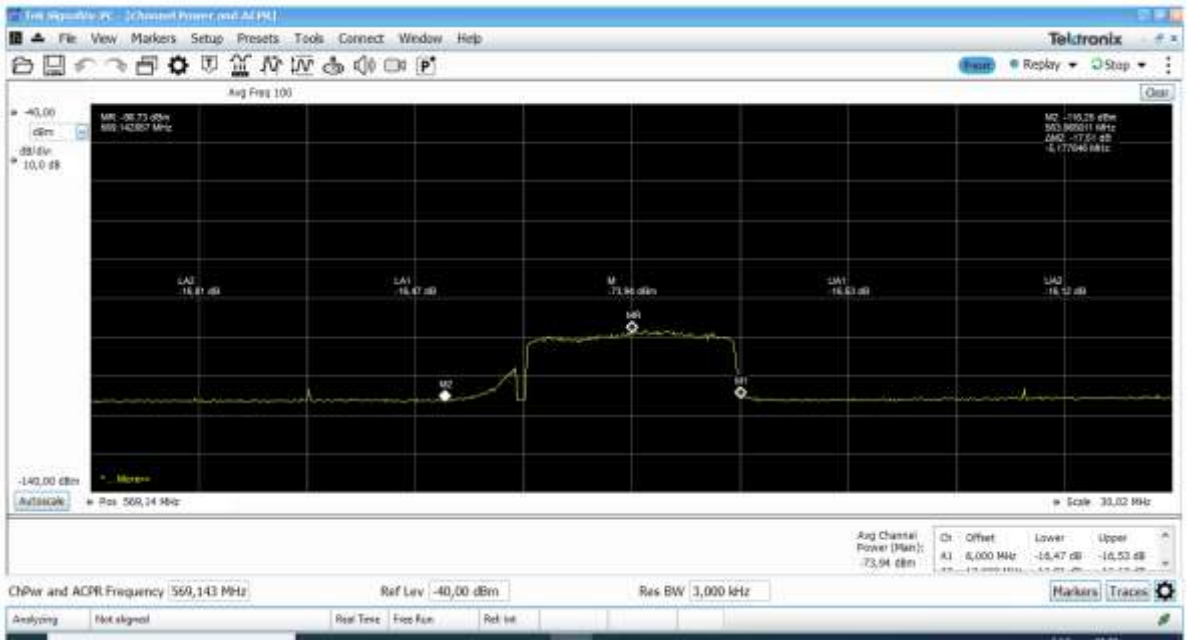


Figure 1.10 - Horizontal

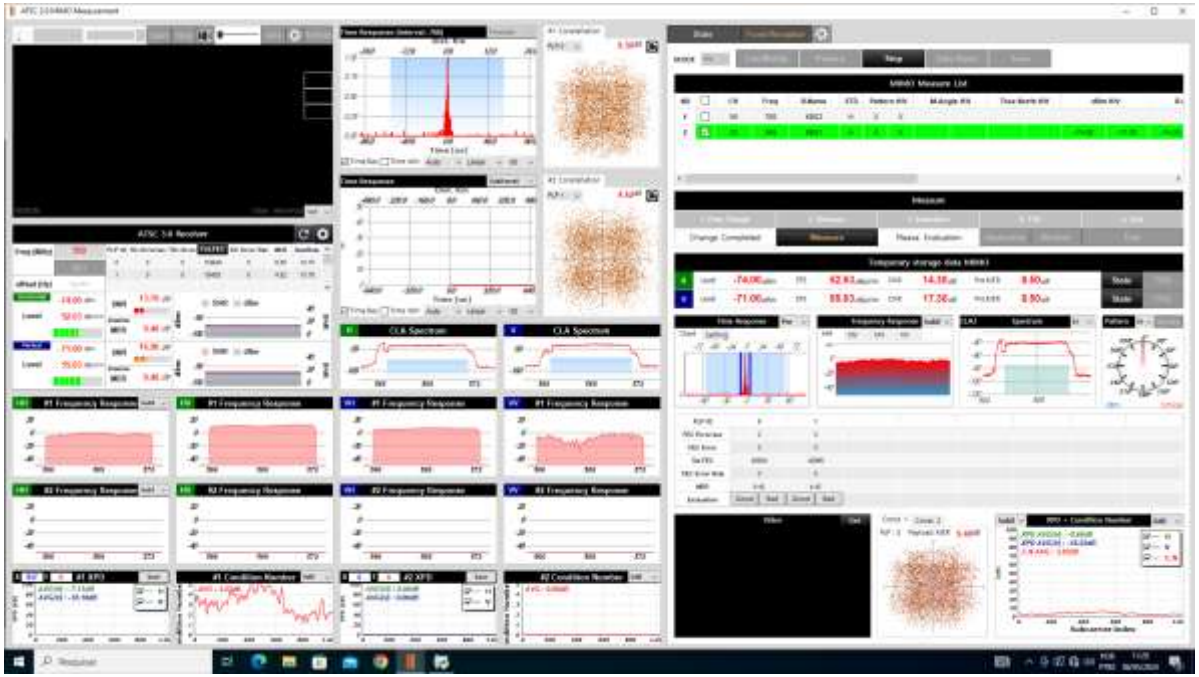


Figure 1.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

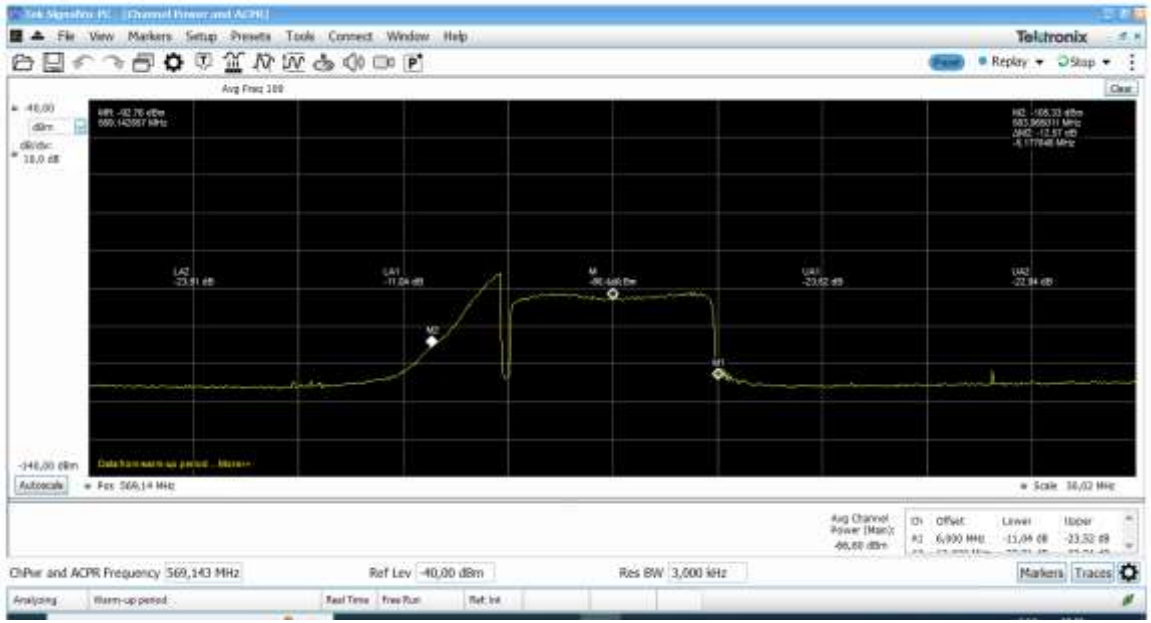


Figure 1.12 - Vertical

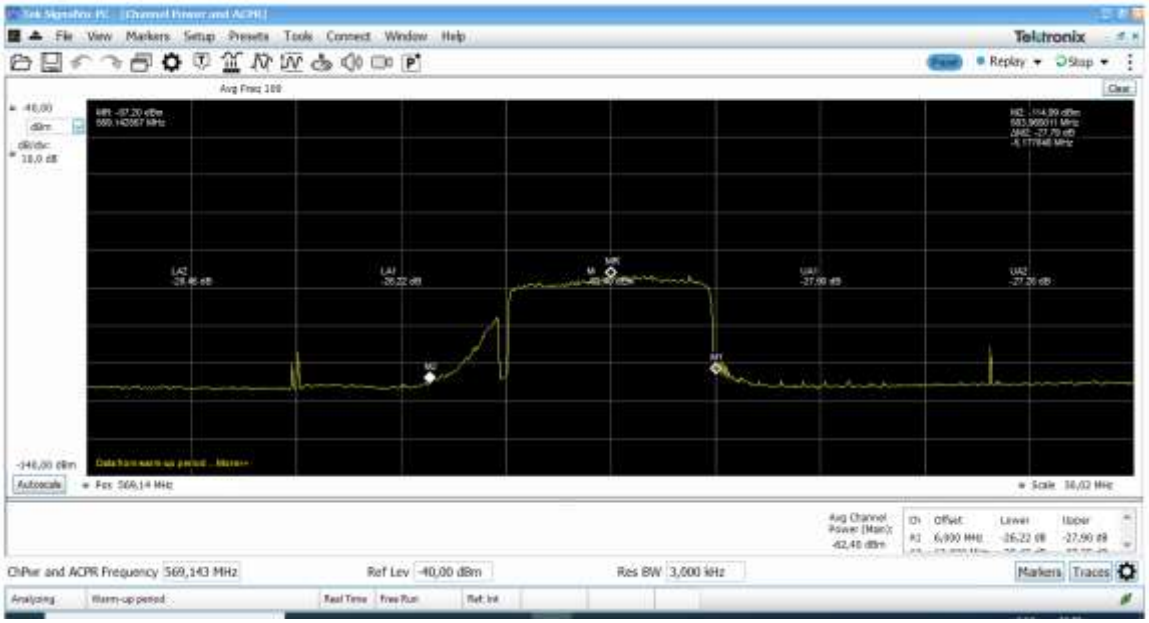


Figure 1.13 - Horizontal

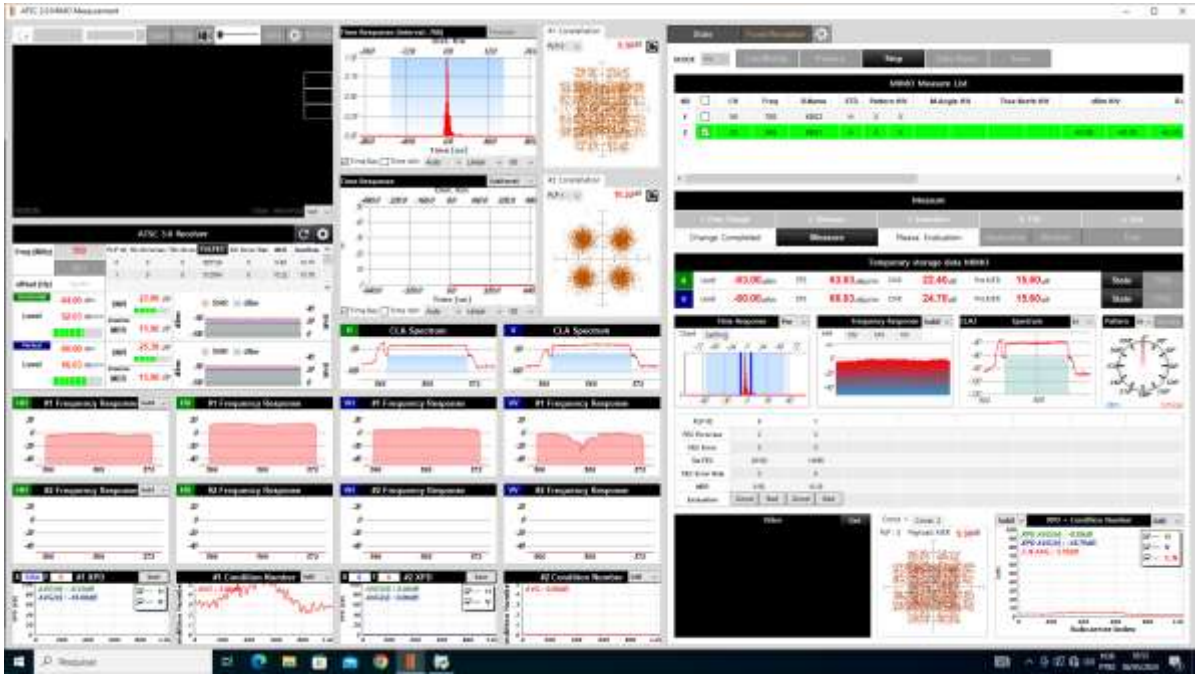


Figure 1.14 - IMAS Screen

b) AWGN Power

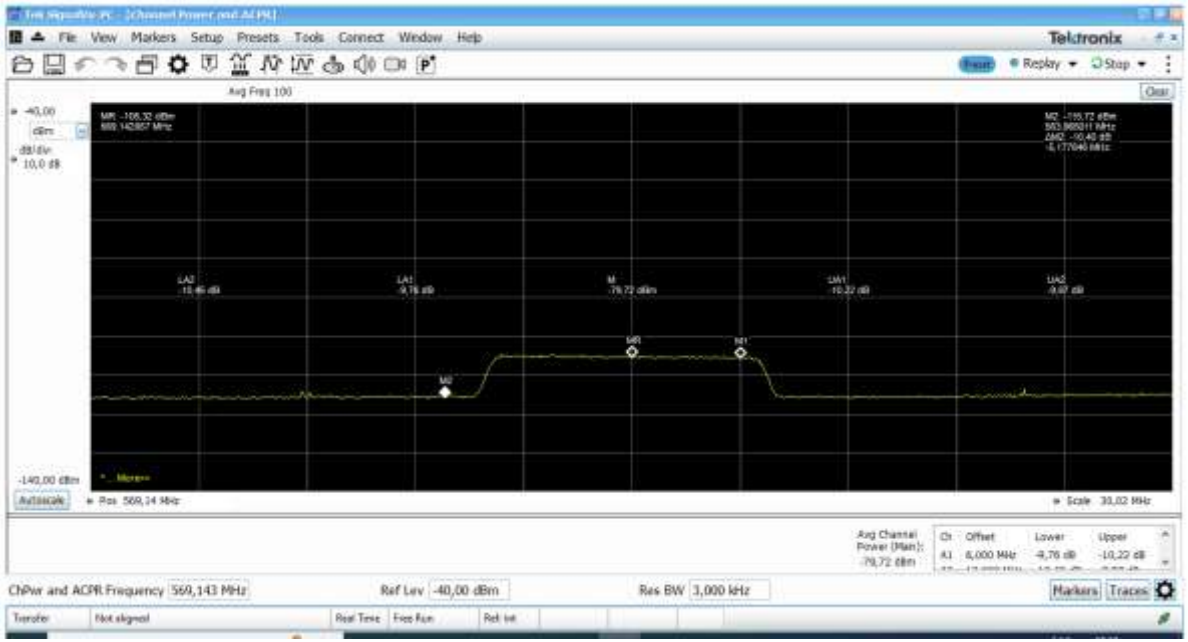


Figure 1.15 - Vertical

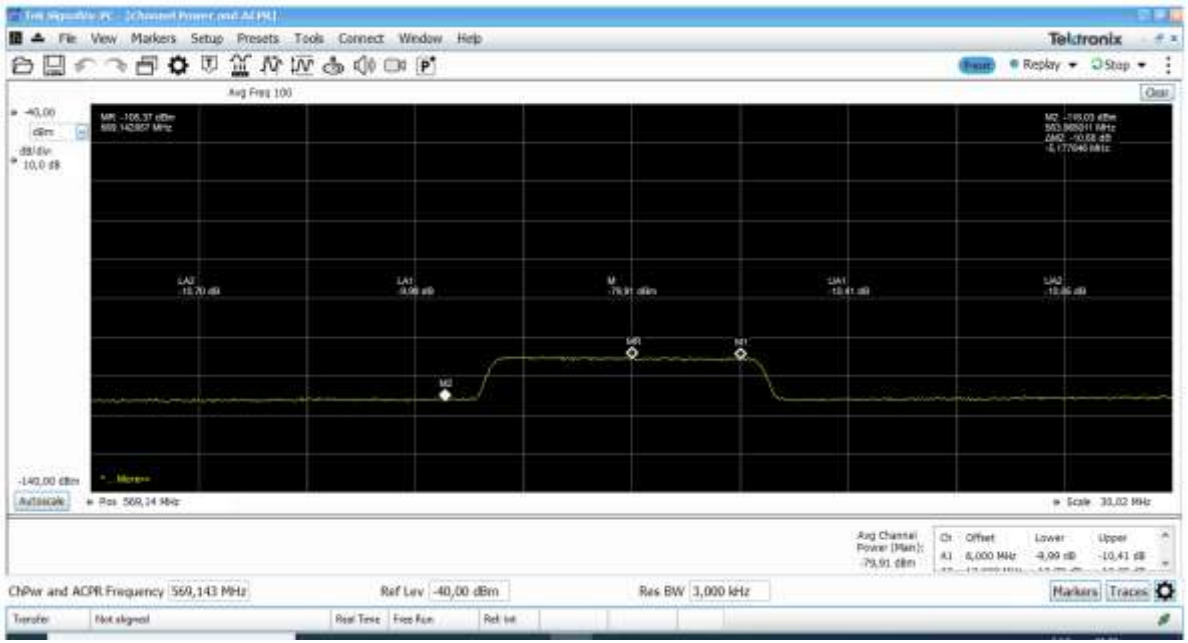


Figure 1.16 - Horizontal

c) C/N Threshold

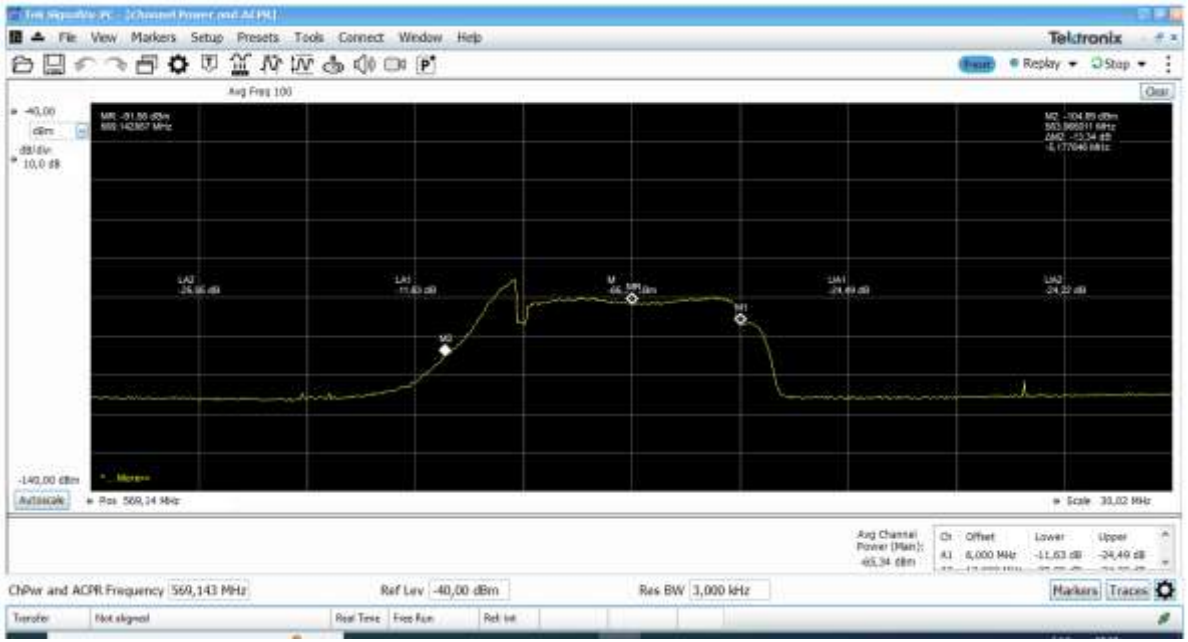


Figure 1.17 - Vertical

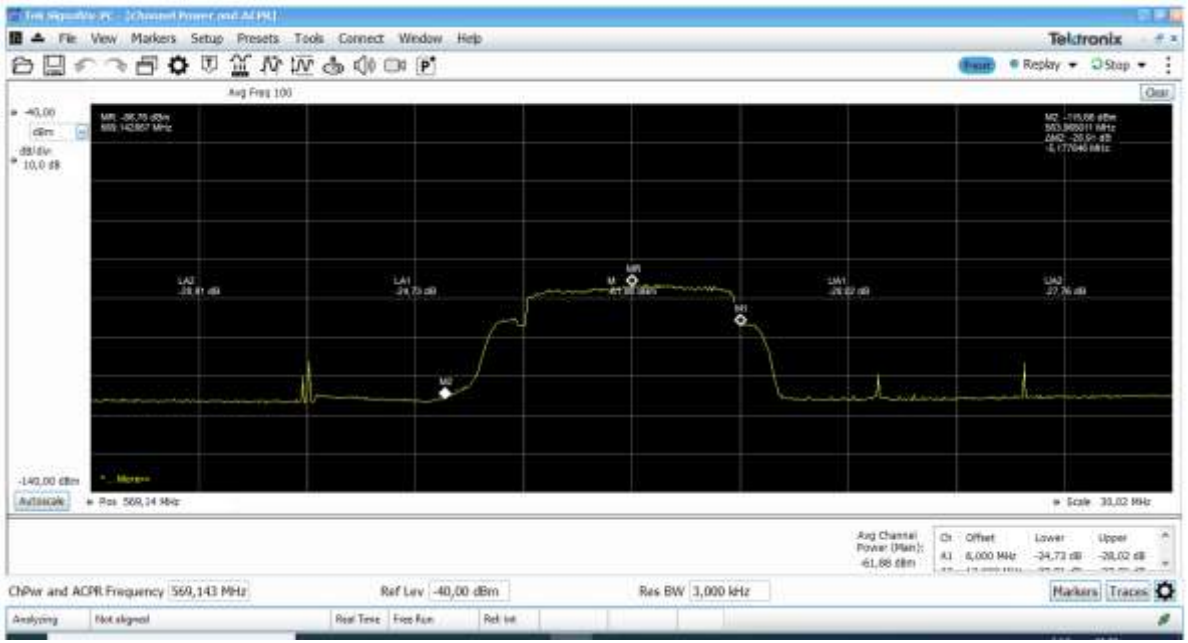


Figure 1.18 - Horizontal

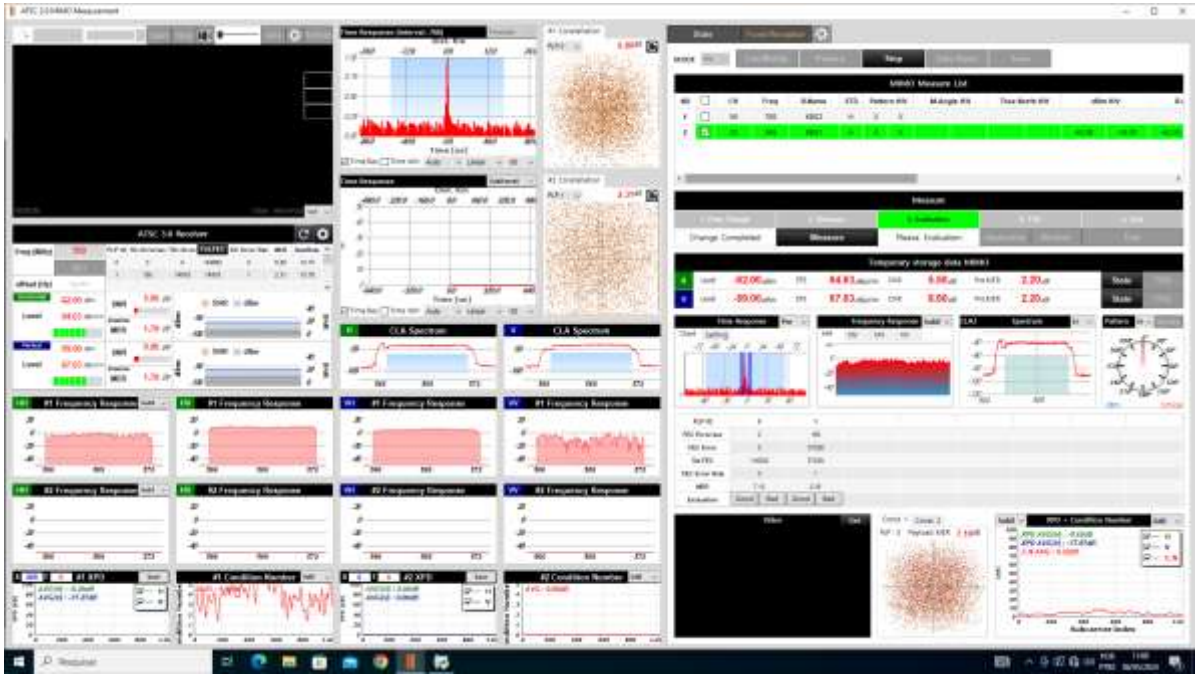


Figure 1.19 - IMAS Screen

d) Reception Threshold

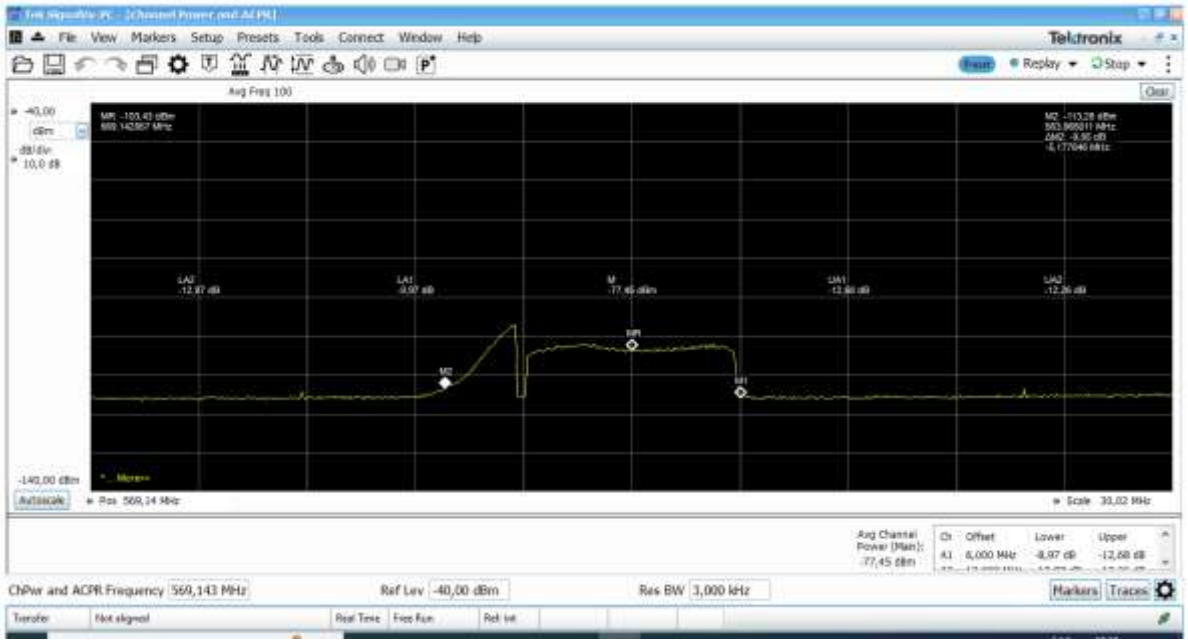


Figure 1.20 - Vertical

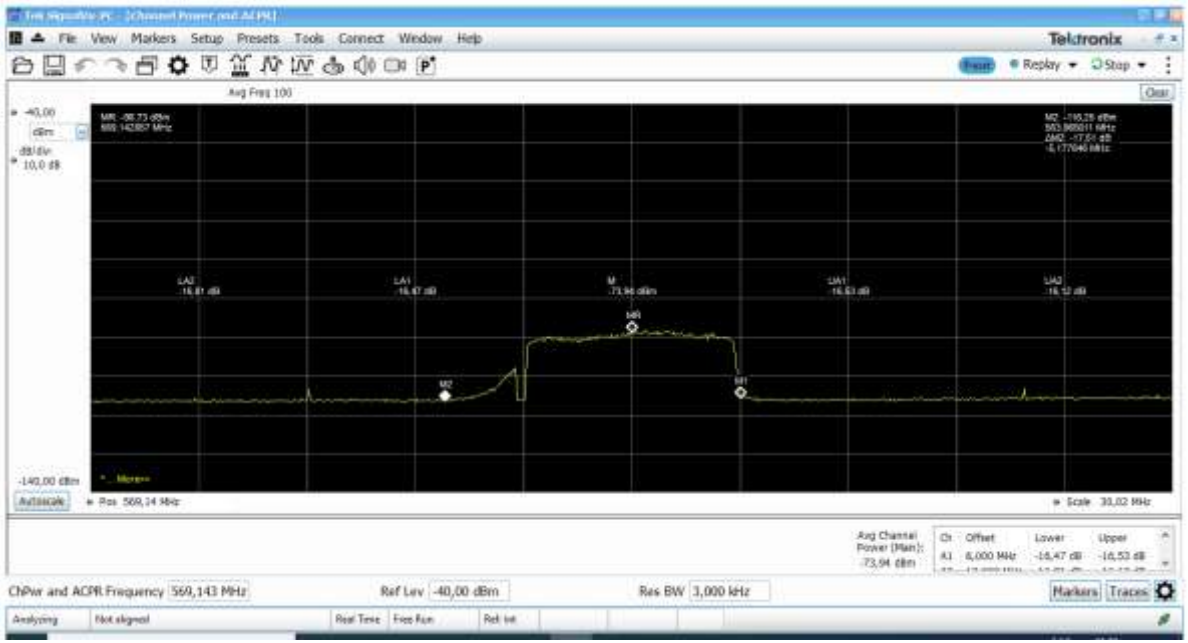


Figure 1.21 - Horizontal

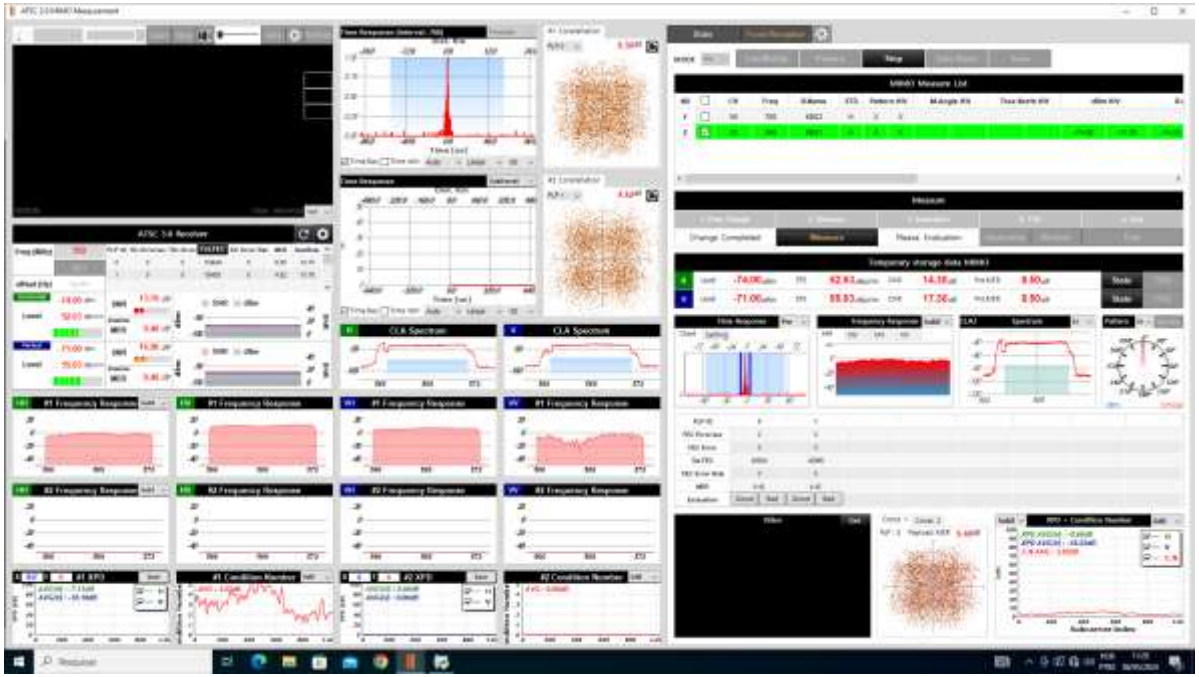


Figure 1.22 - IMAS Screen

Chapter 2. Site 17

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

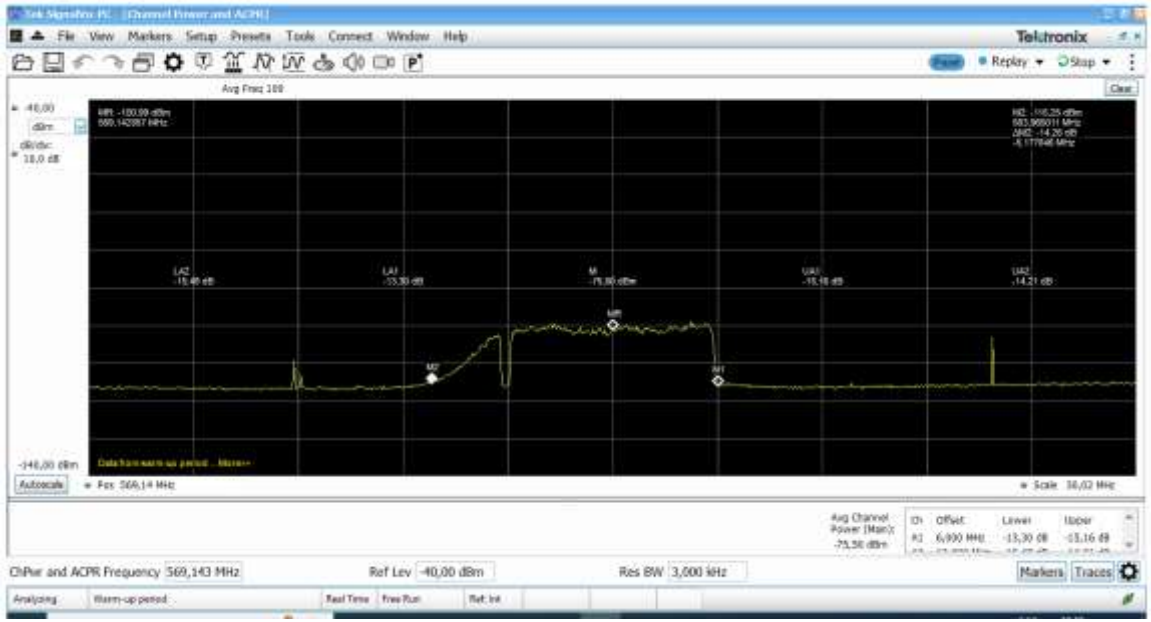


Figure 2.1 - Vertical

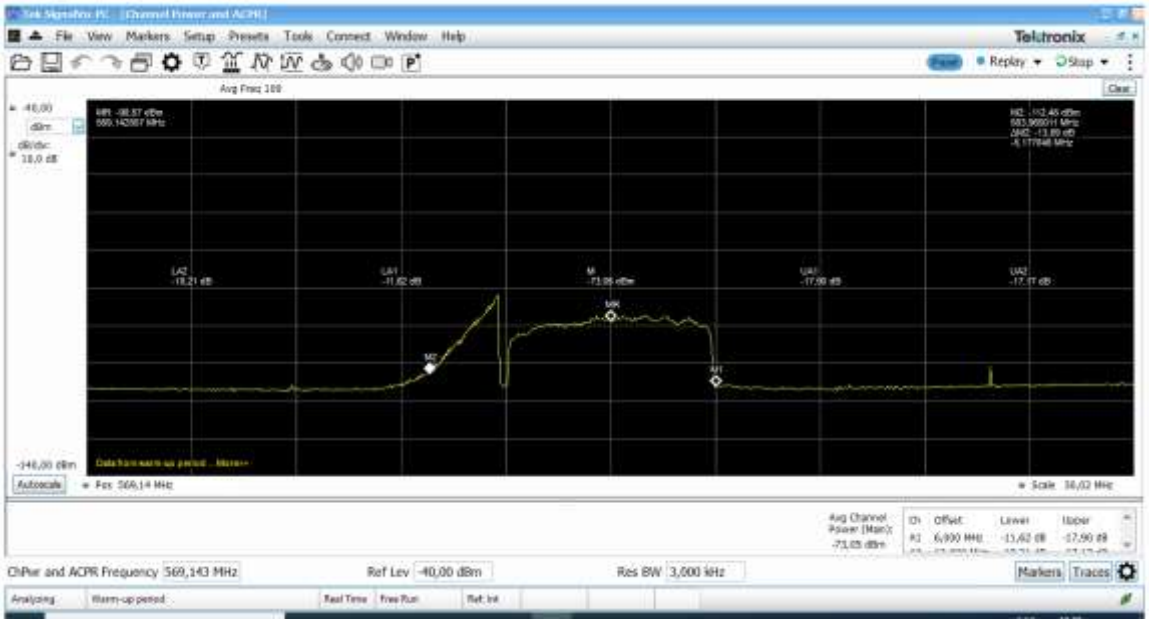


Figure 2.2 - Horizontal

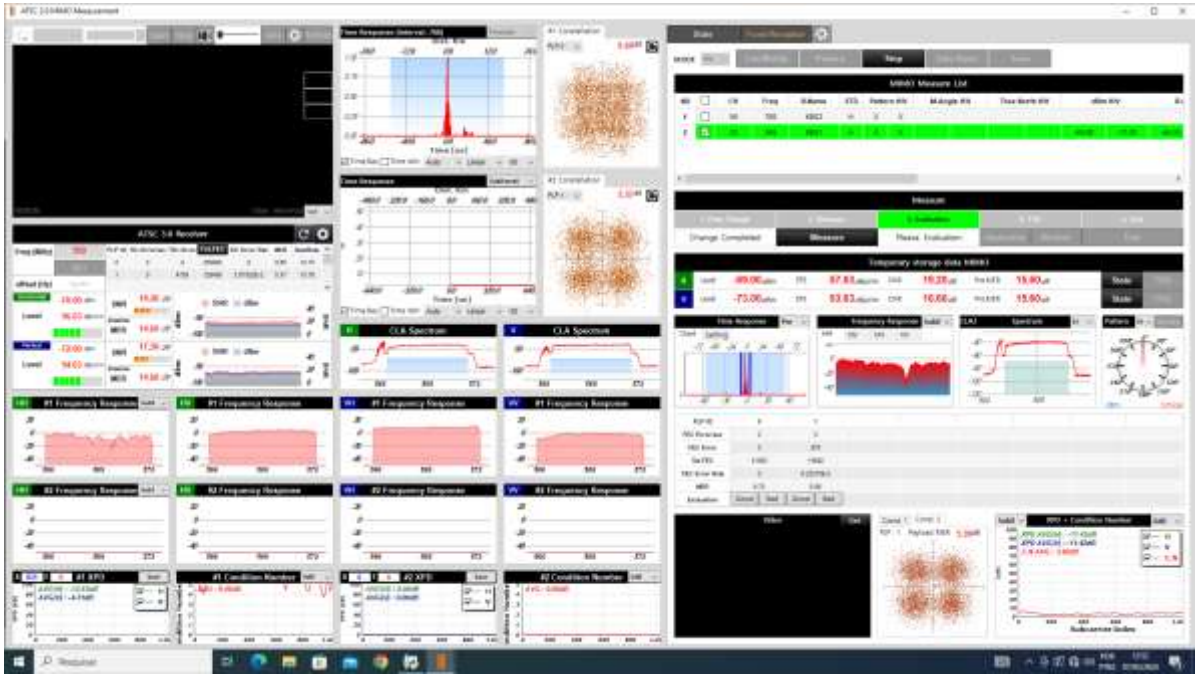


Figure 2.3 - IMAS Screen

b) AWGN Power

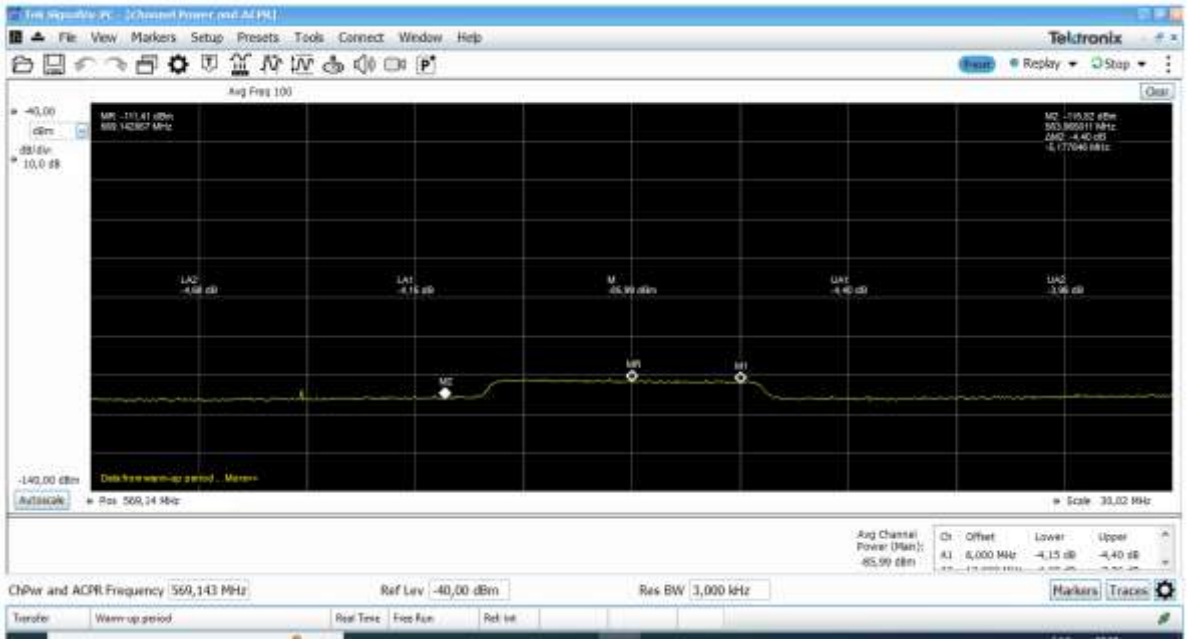


Figure 2.4 - Vertical

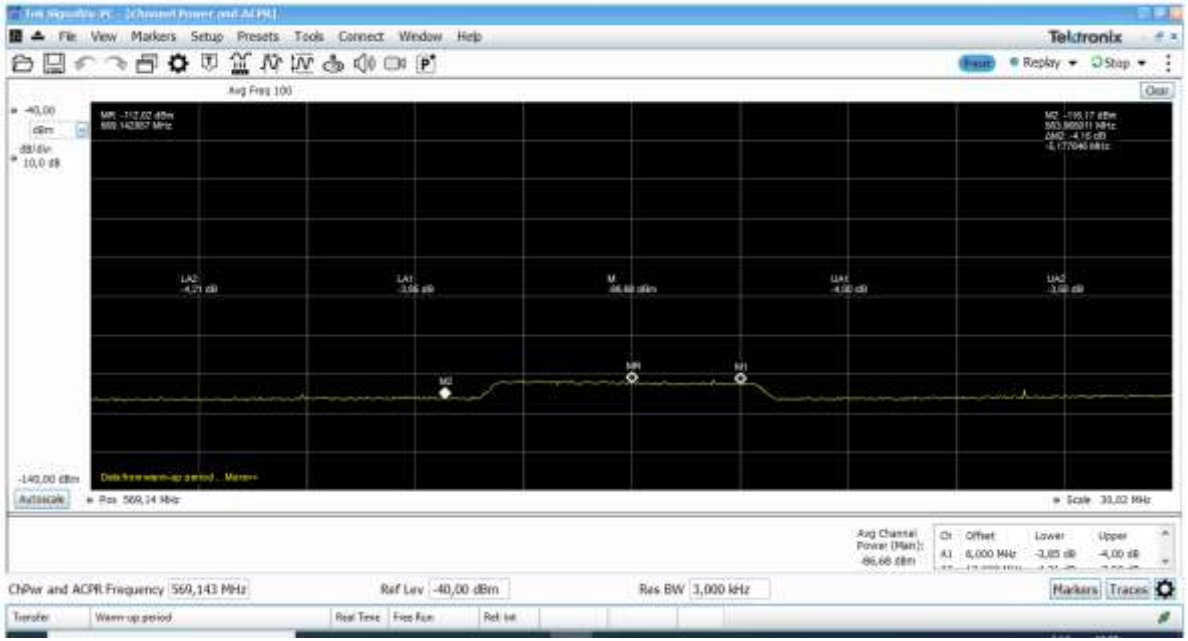


Figure 2.5 - Horizontal

c) C/N Threshold

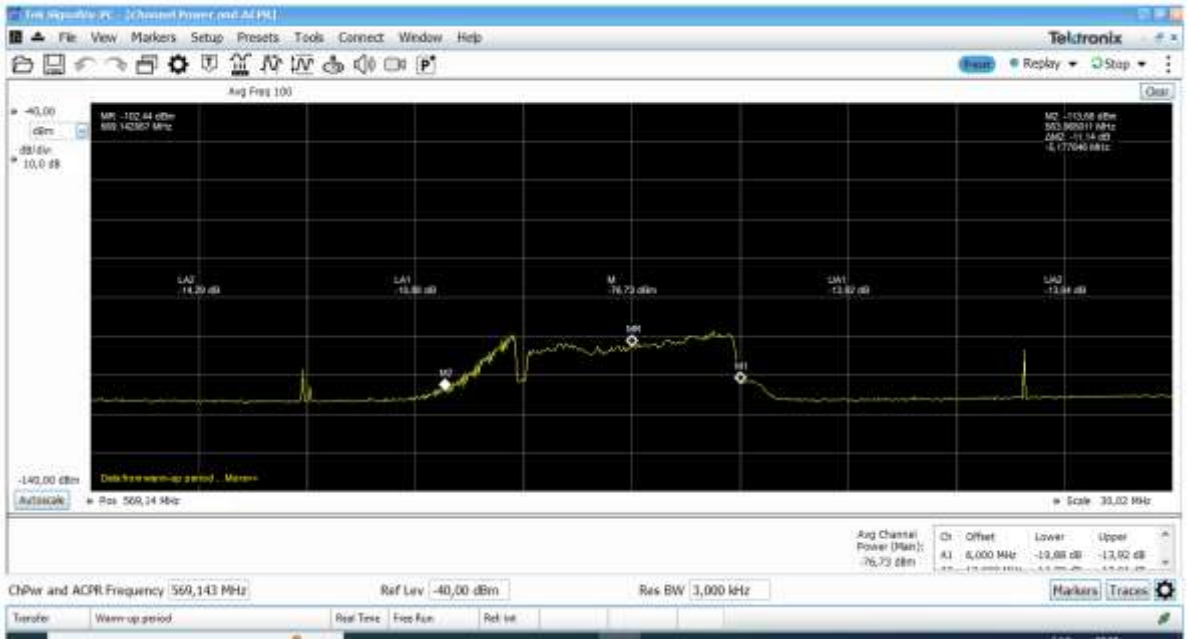


Figure 2.6 - Vertical

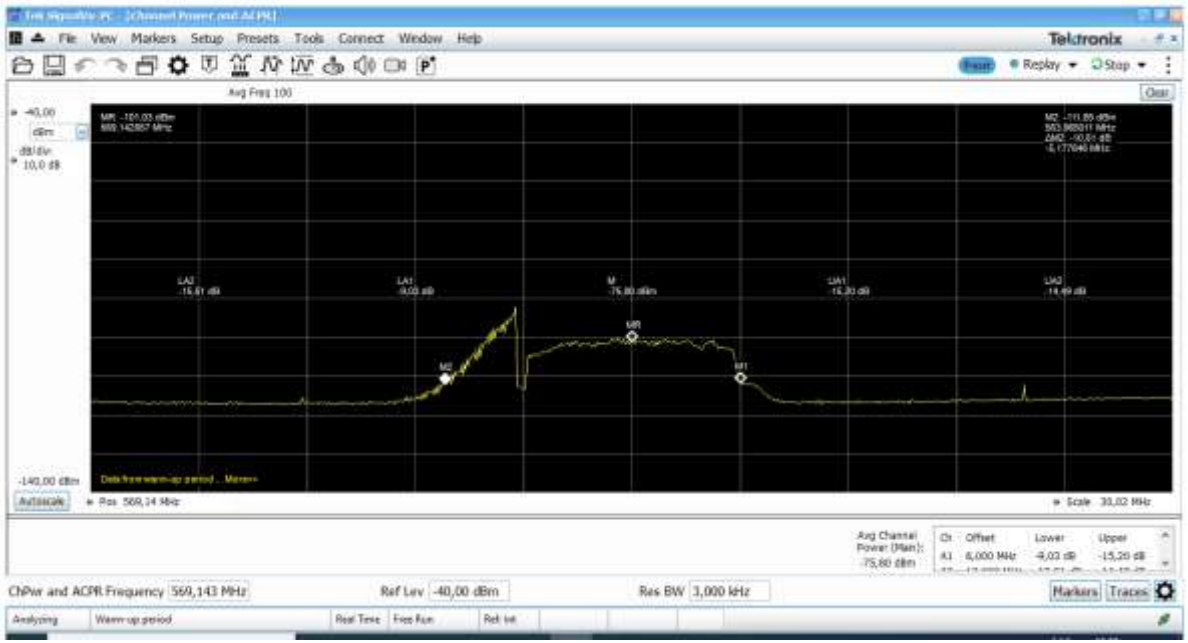


Figure 2.7 - Horizontal

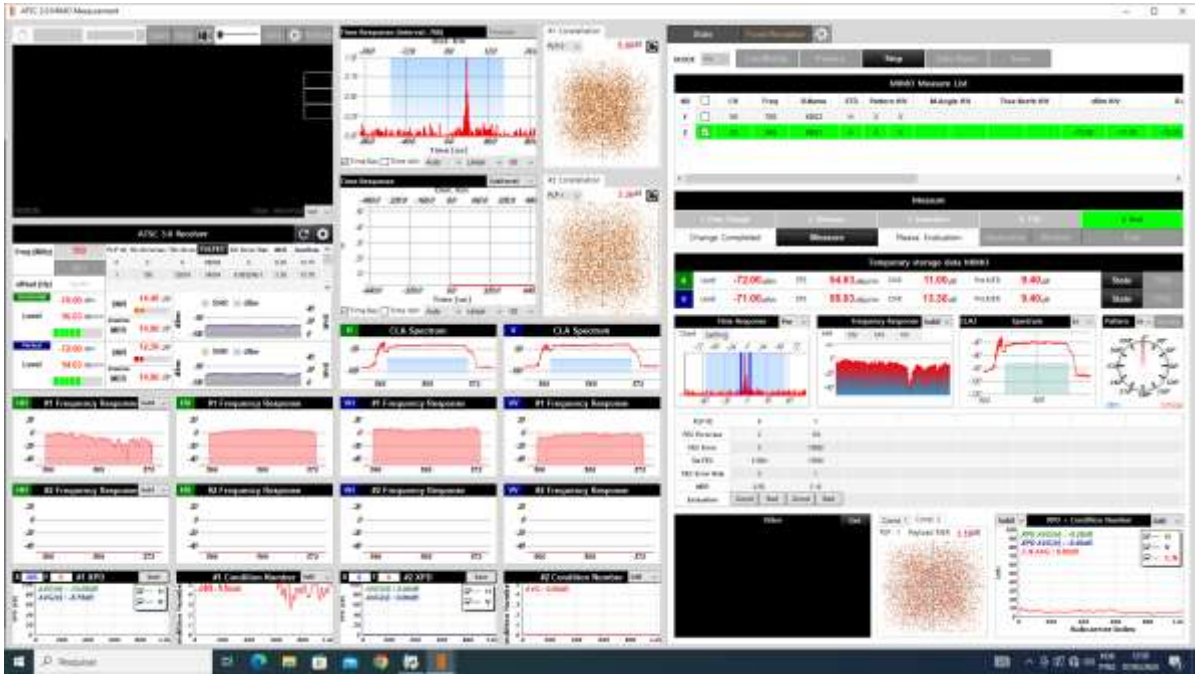


Figure 2.8 - IMAS Screen

d) Reception Threshold

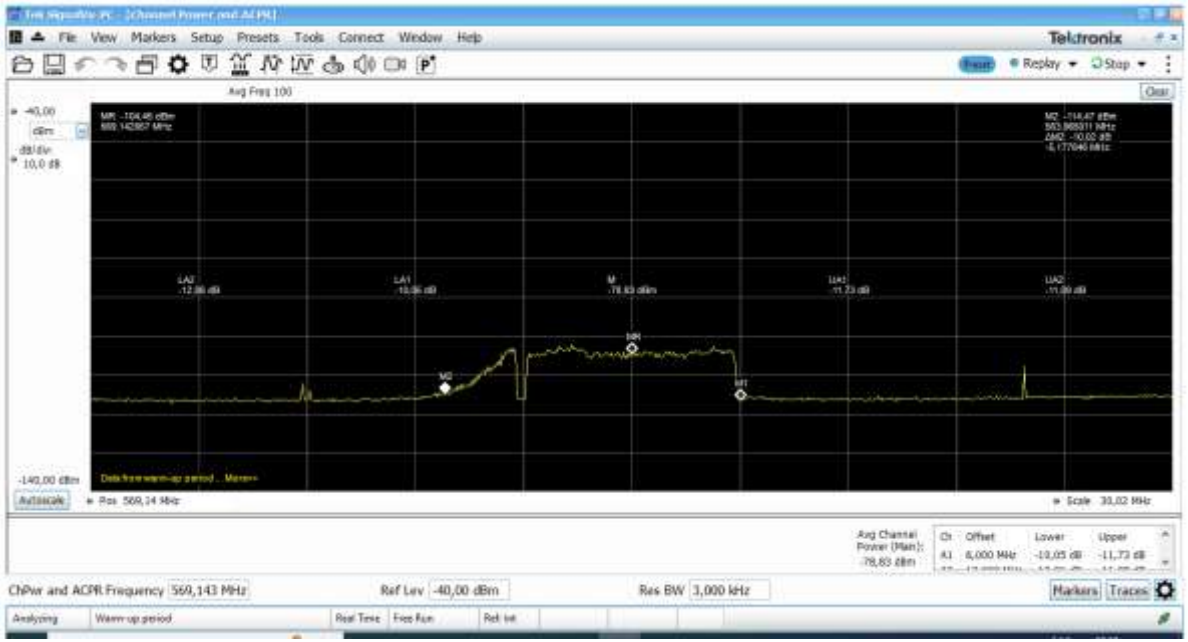


Figure 2.9 - Vertical

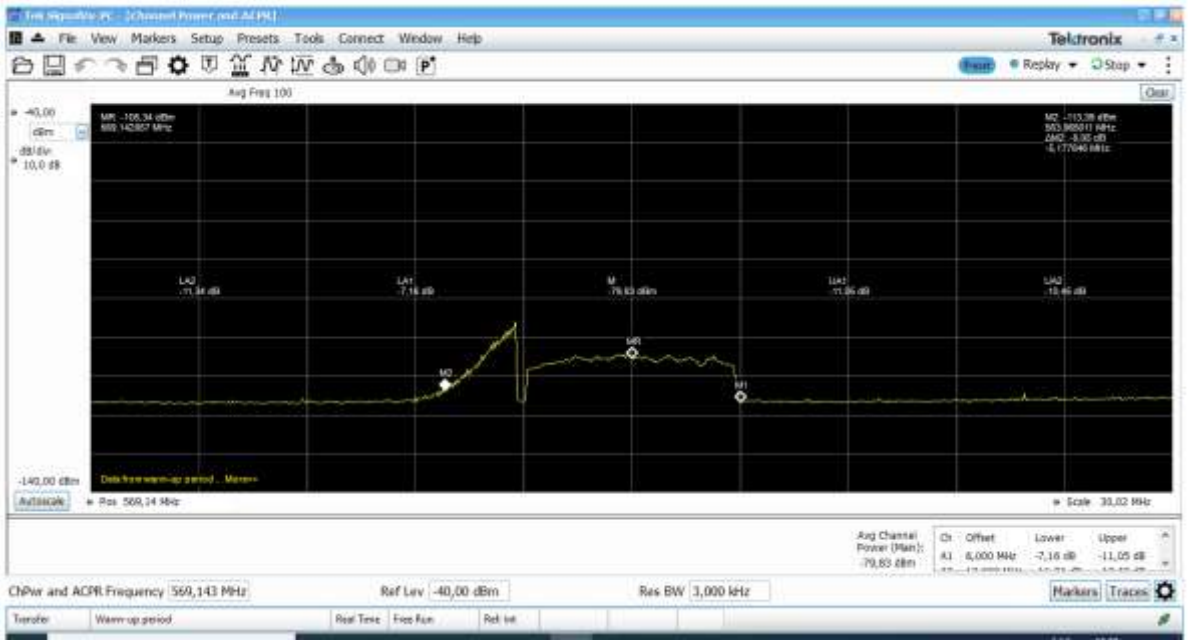


Figure 2.10 - Horizontal

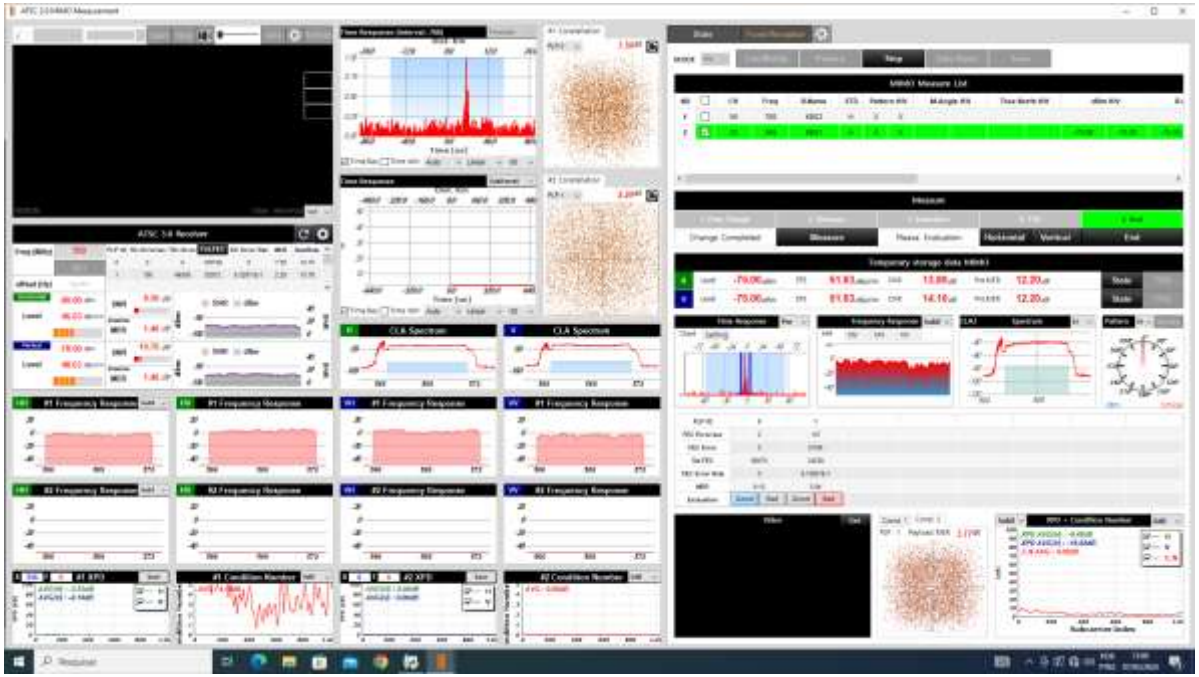


Figure 2.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

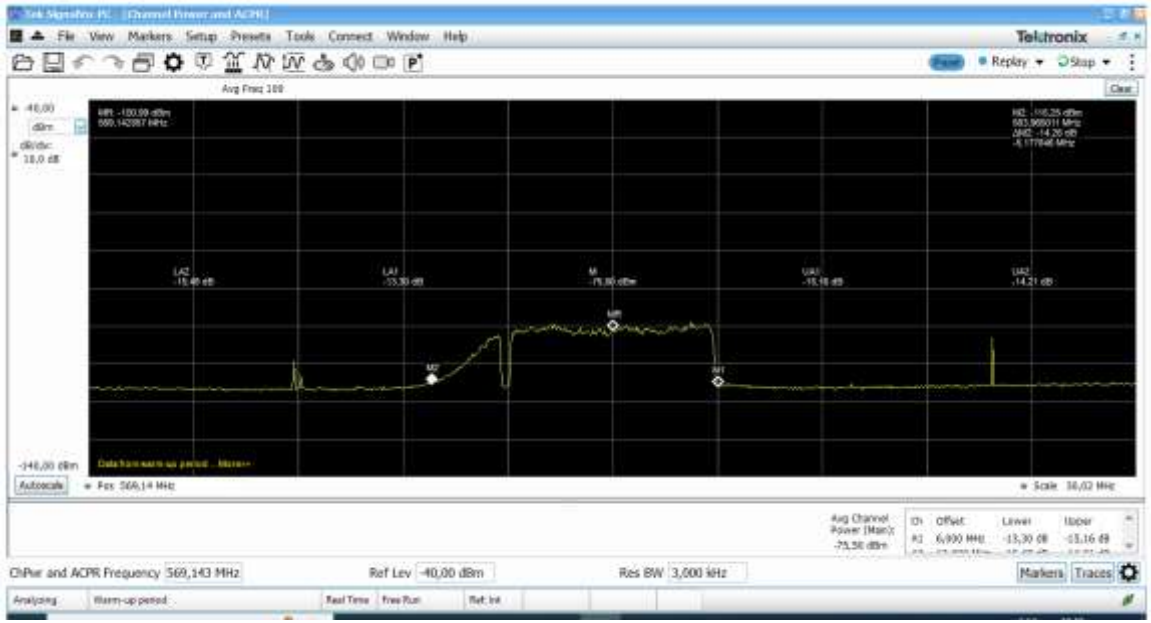


Figure 2.12 - Vertical

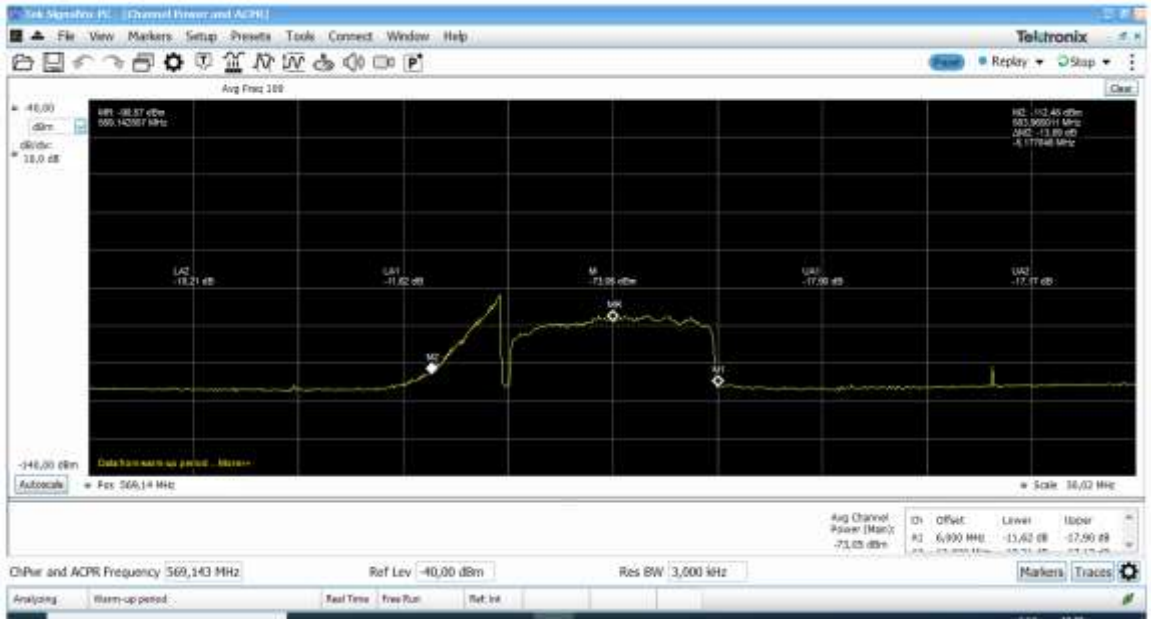


Figure 2.13 - Horizontal

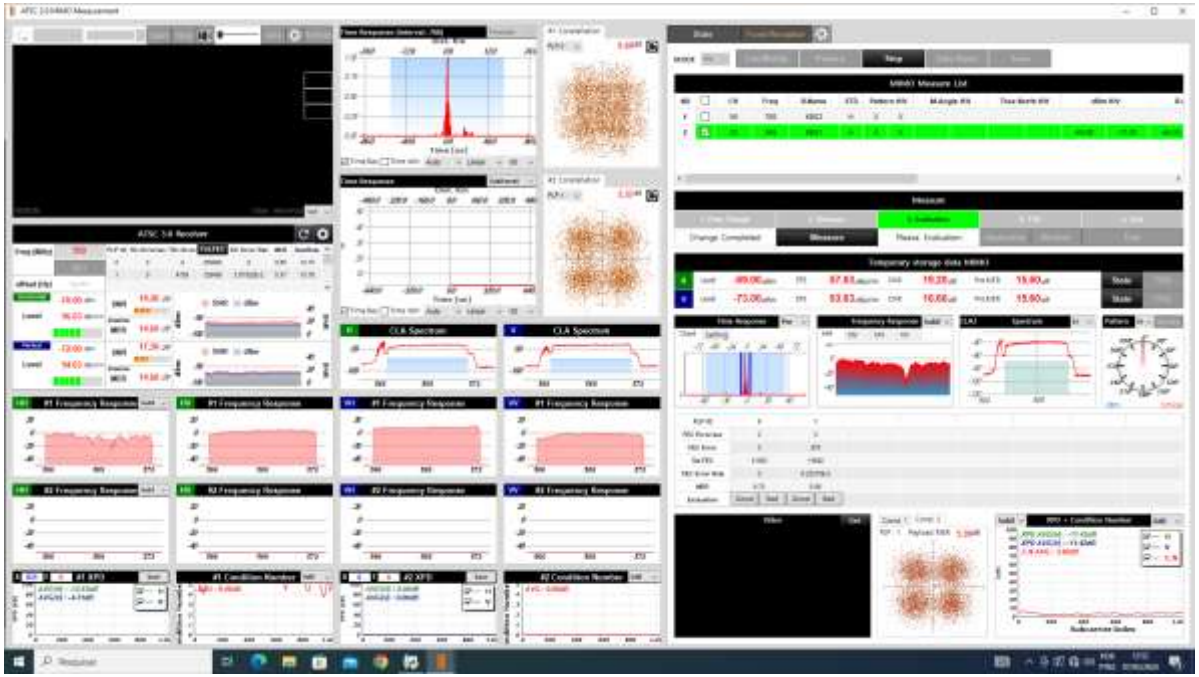


Figure 2.14 - IMAS Screen

Chapter 3. Site 18

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

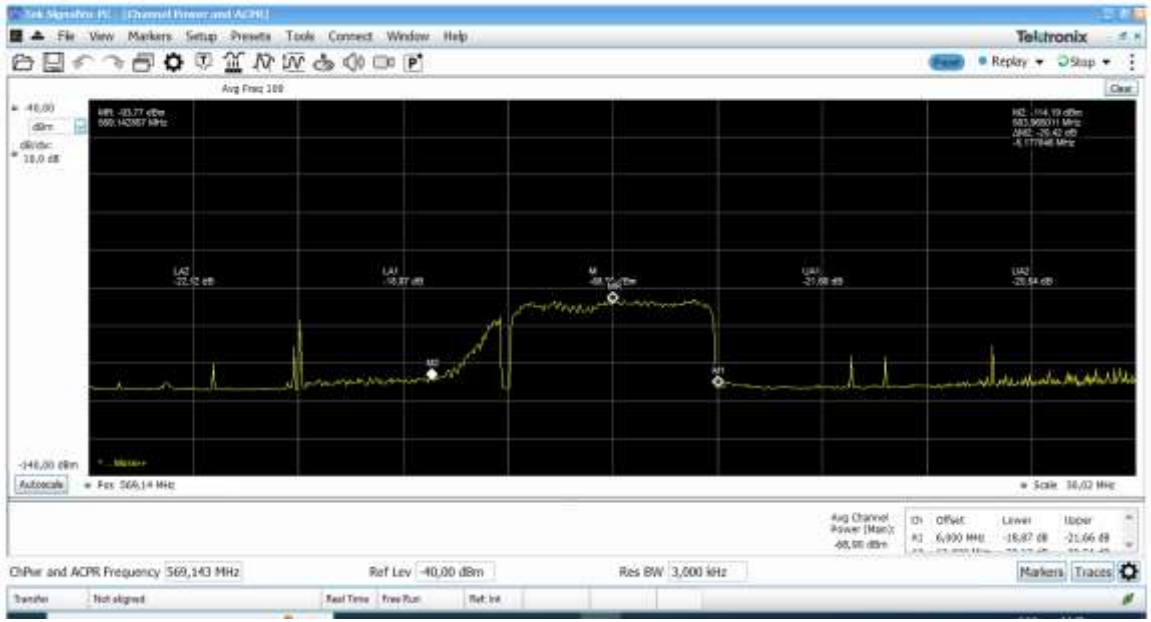


Figure 3.1 - Vertical

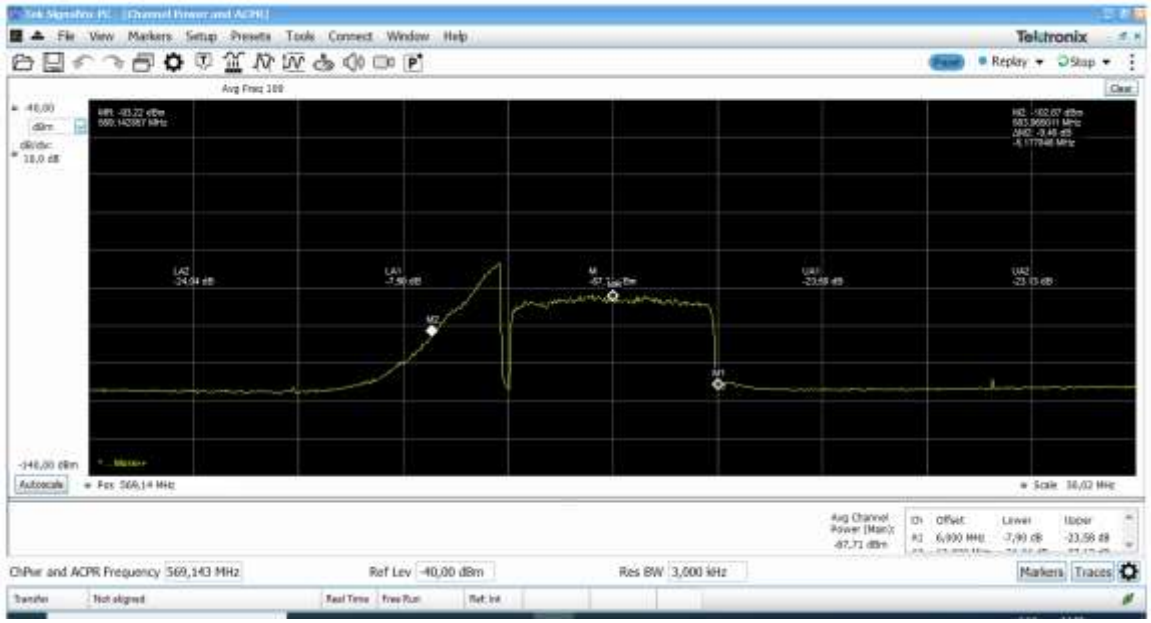


Figure 3.2 - Horizontal

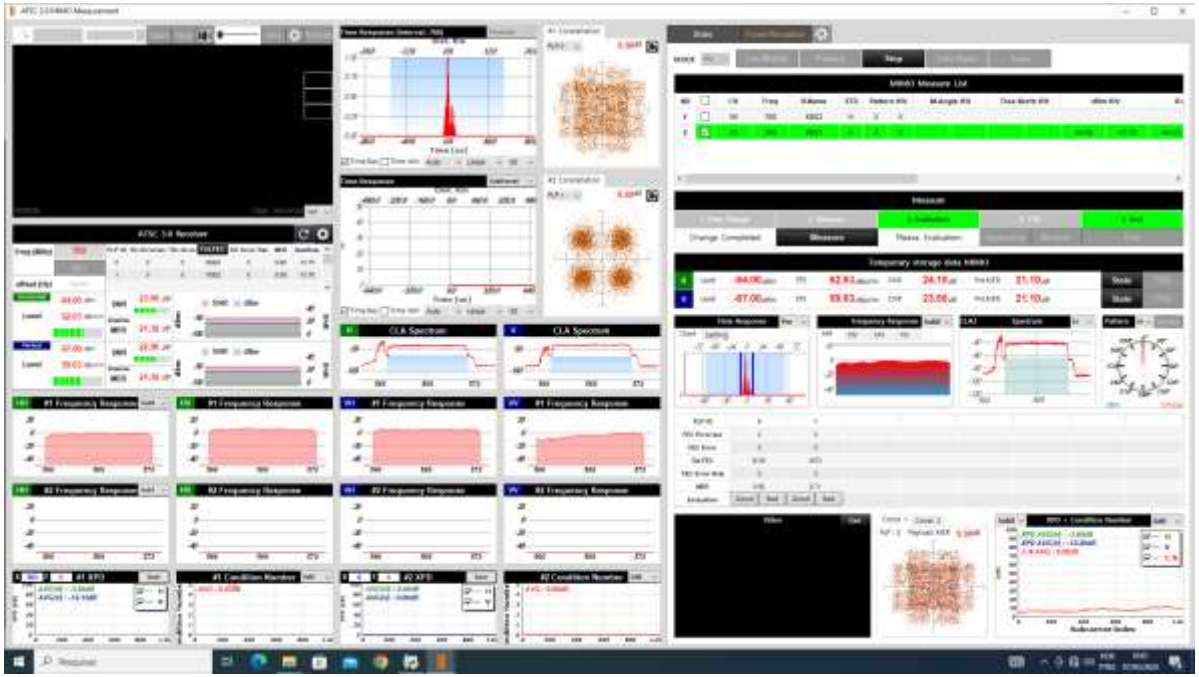


Figure 3.3 - IMAS Screen

b) AWGN Power

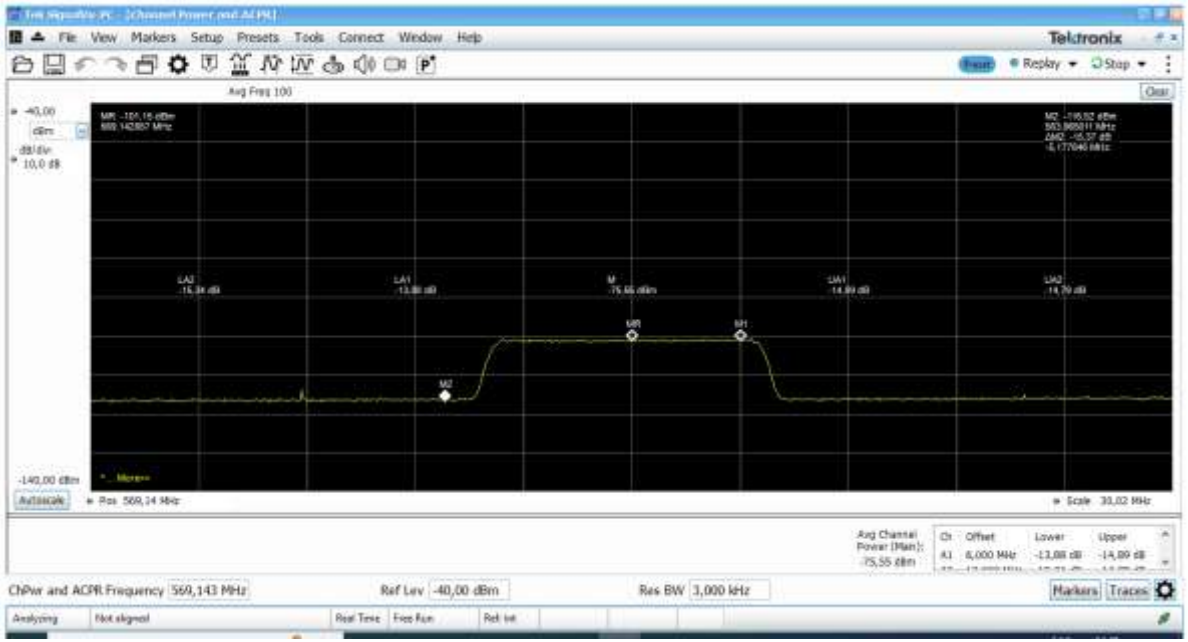


Figure 3.4 - Vertical

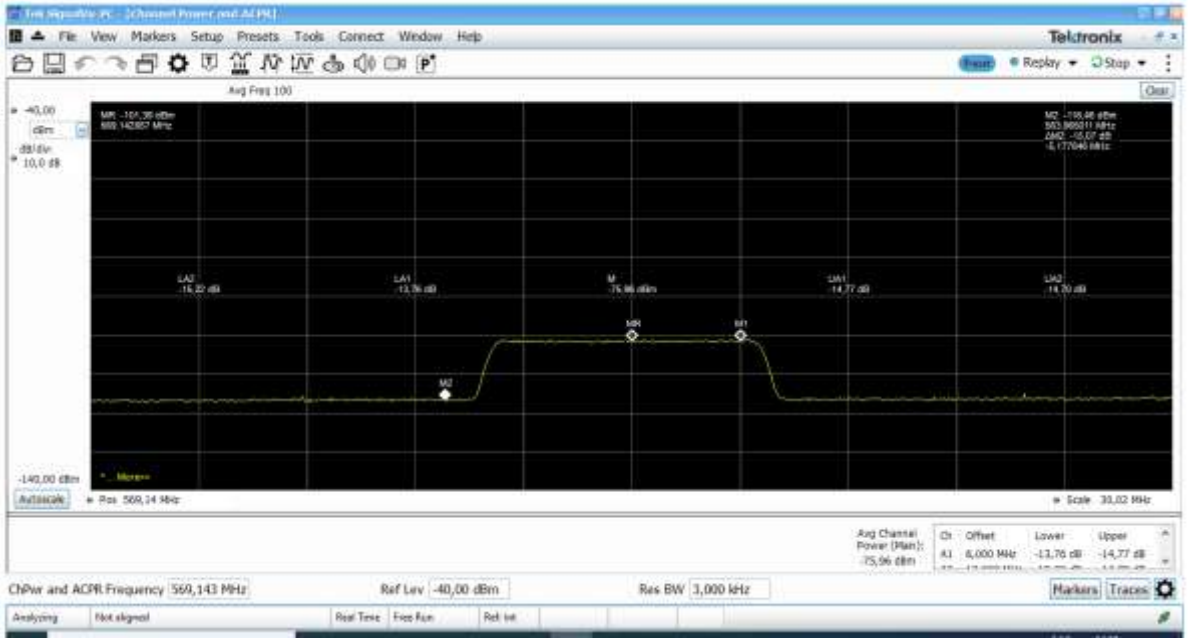


Figure 3.5 - Horizontal

c) C/N Threshold

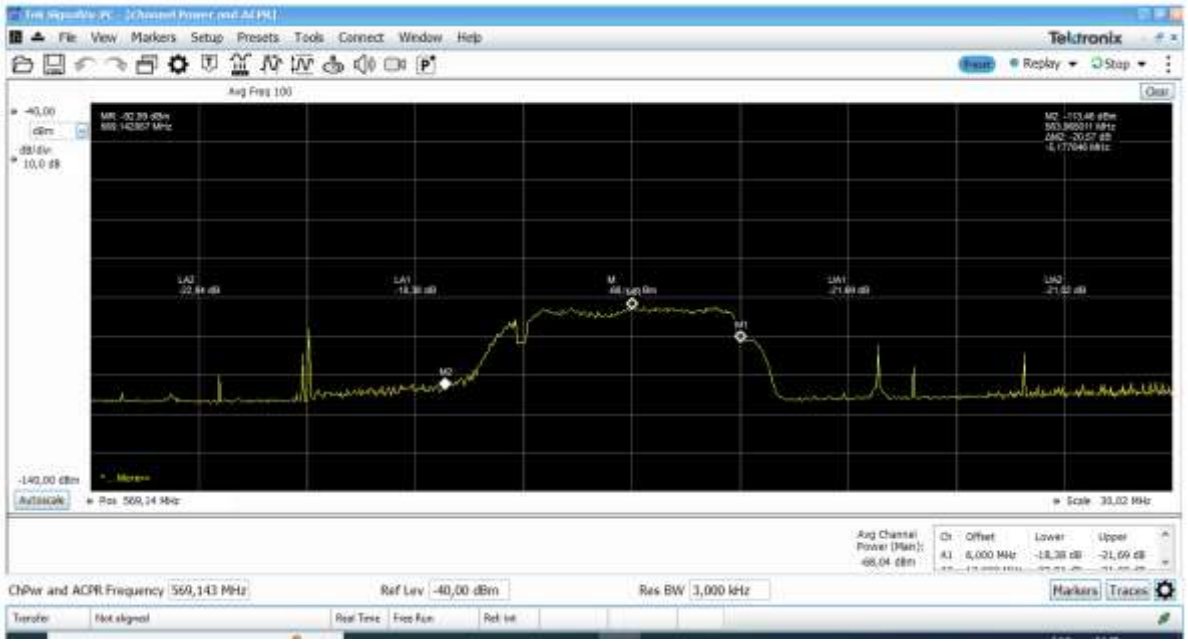


Figure 3.6 - Vertical

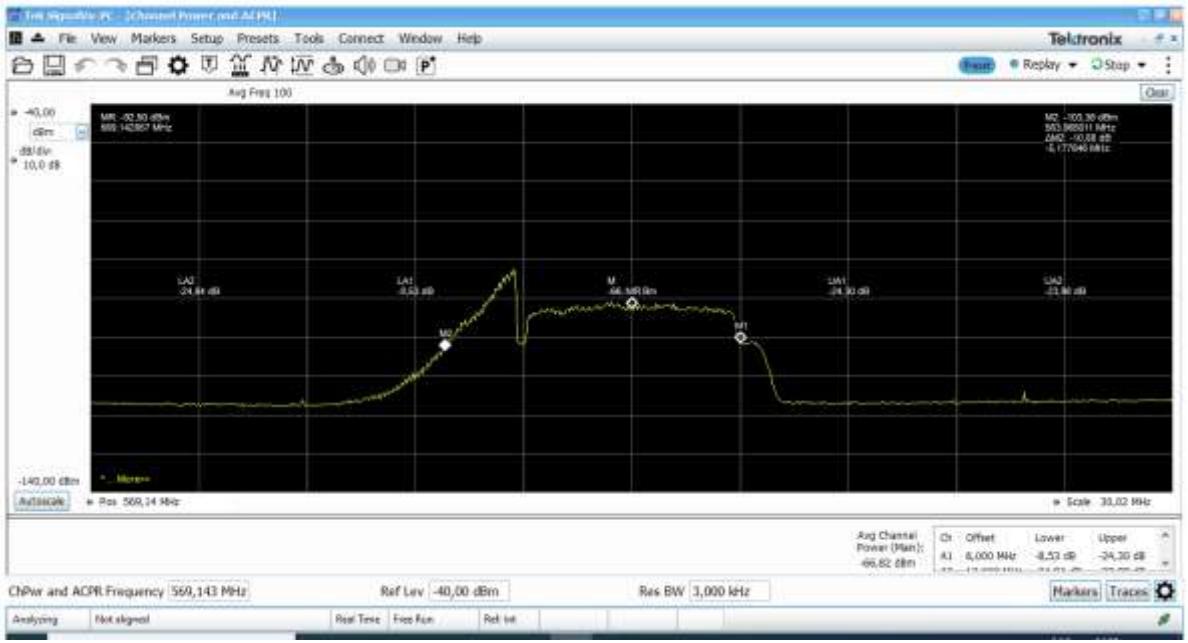


Figure 3.7 - Horizontal

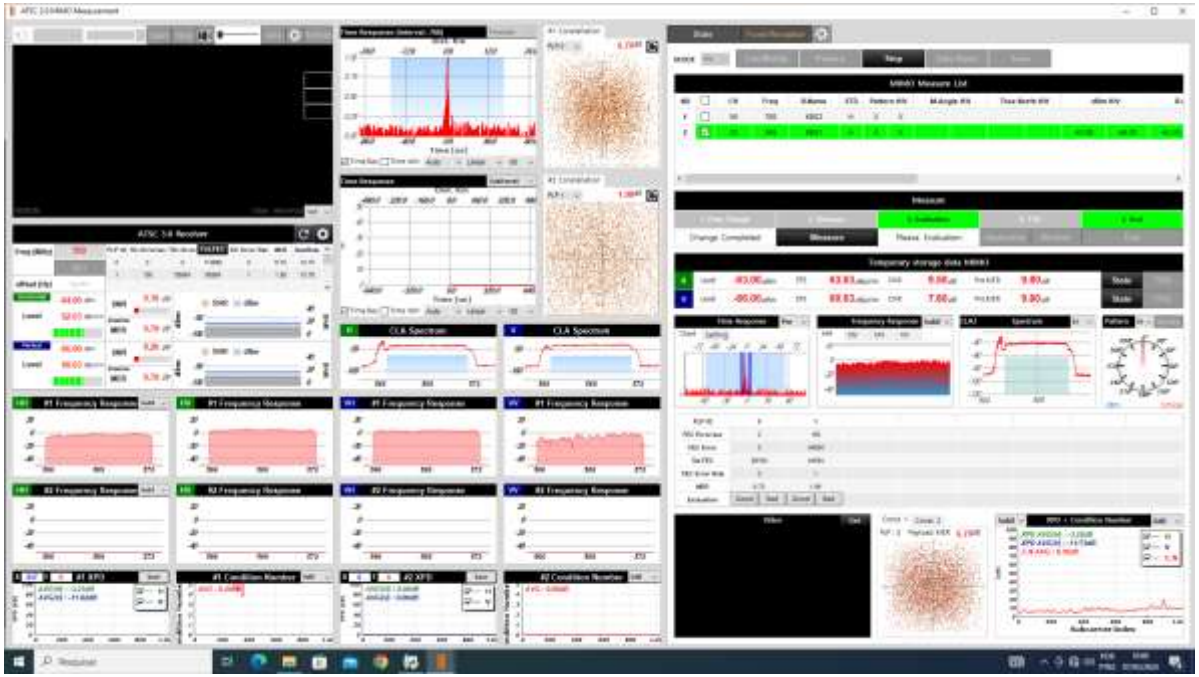


Figure 3.8 - IMAS Screen

d) Reception Threshold

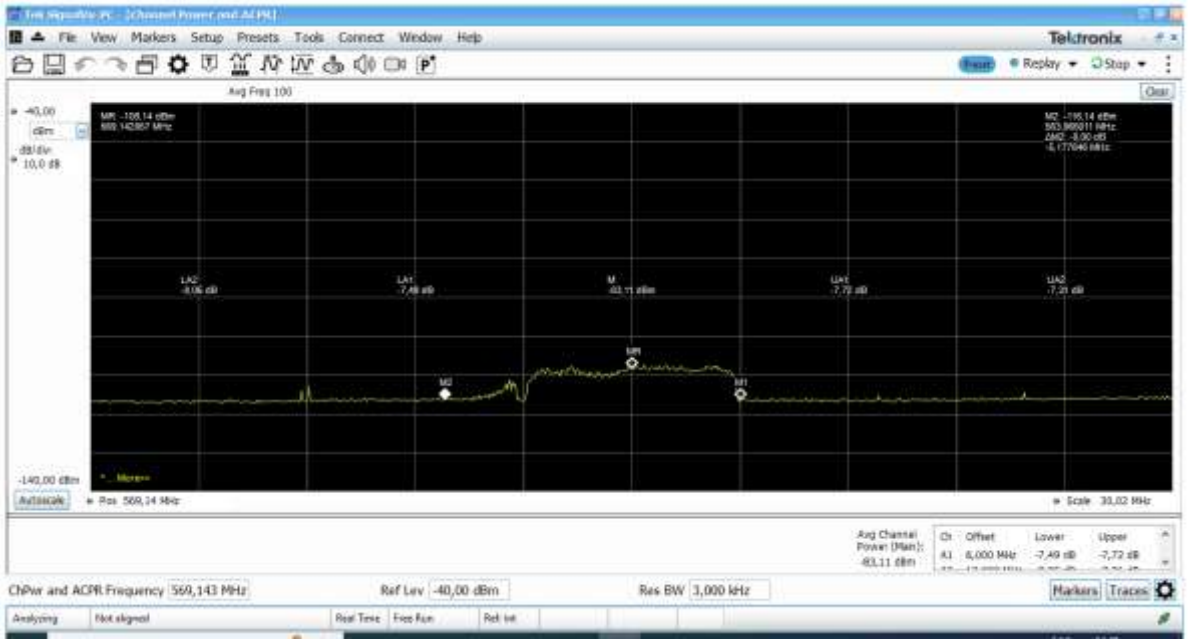


Figure 3.9 - Vertical

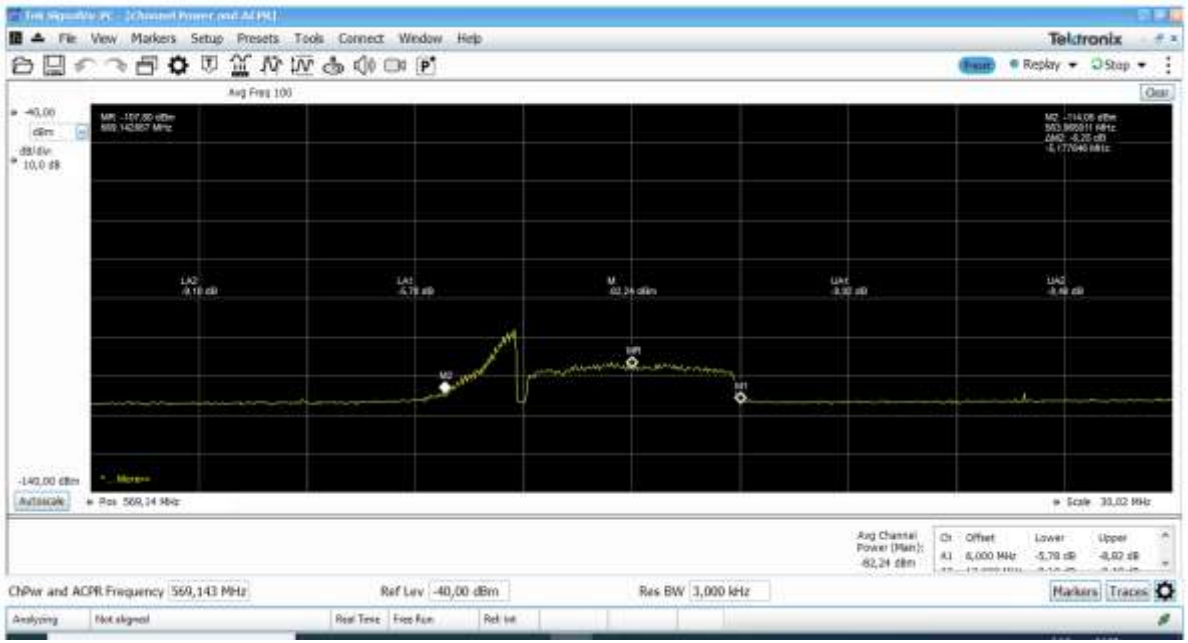


Figure 3.10 - Horizontal

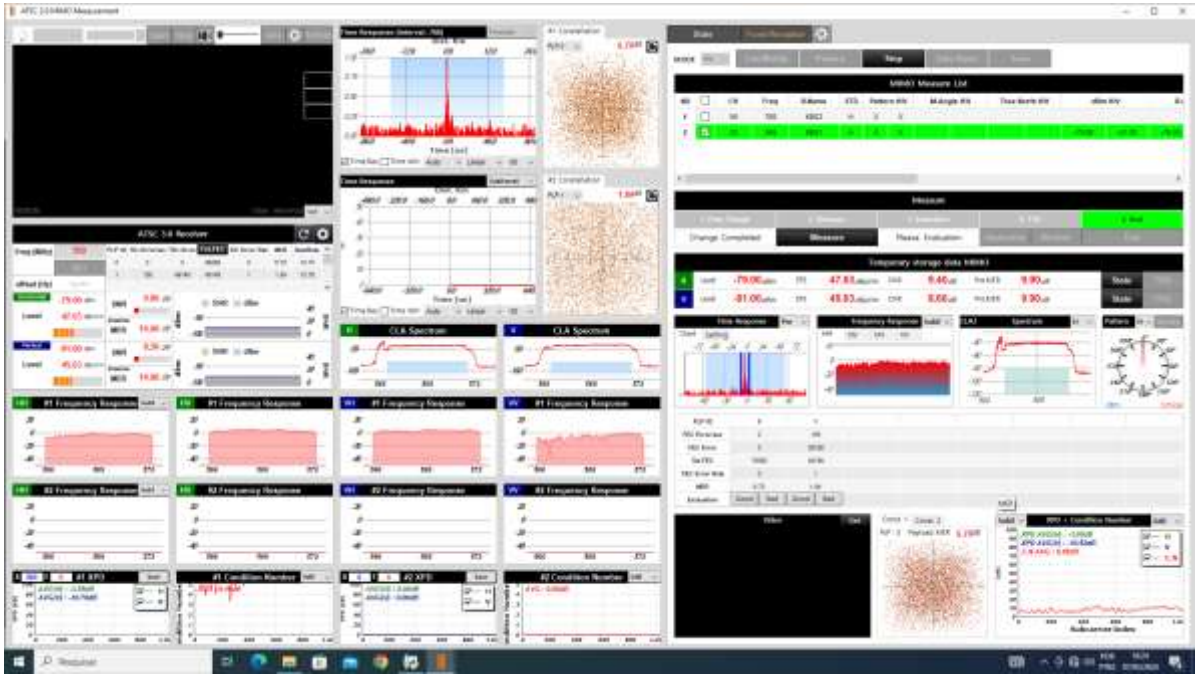


Figure 3.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

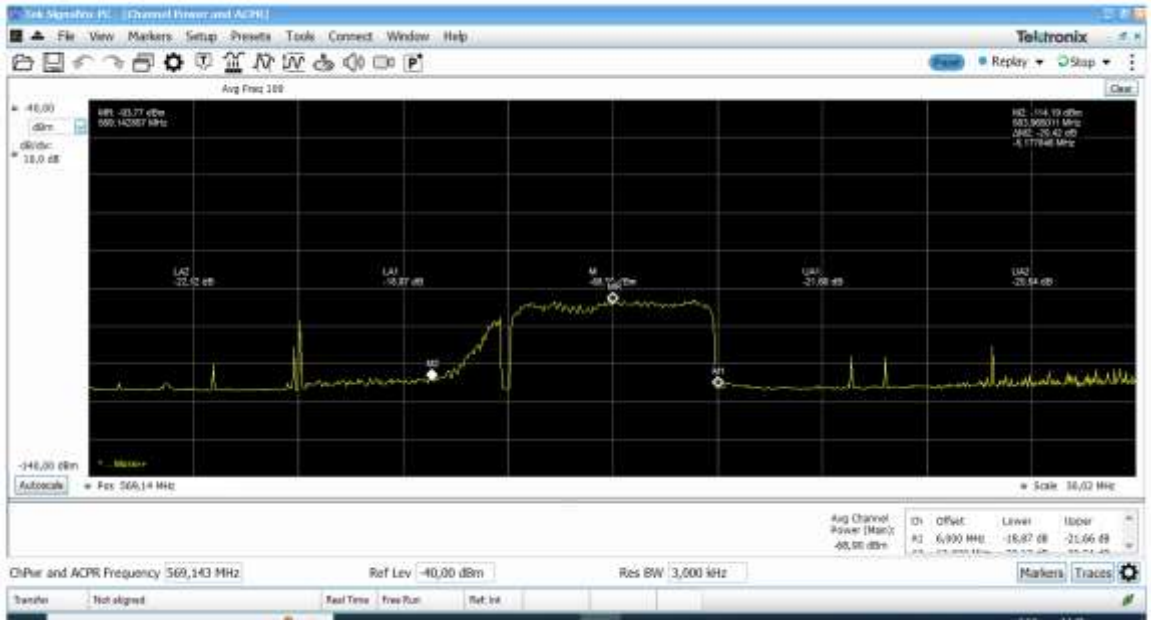


Figure 3.12 - Vertical

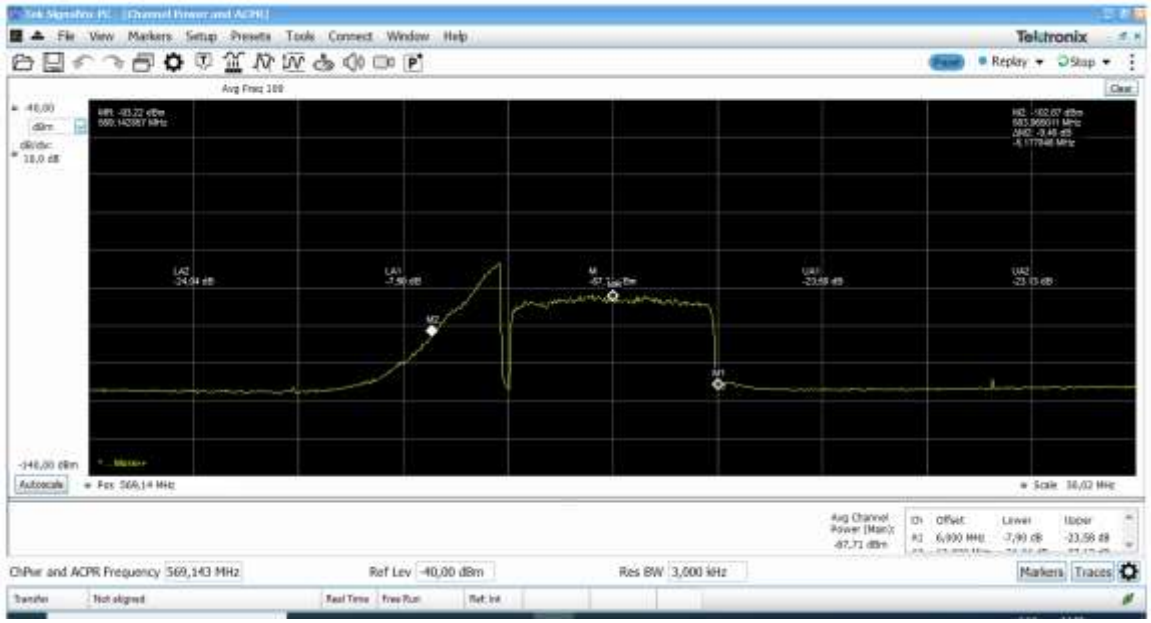


Figure 3.13 - Horizontal

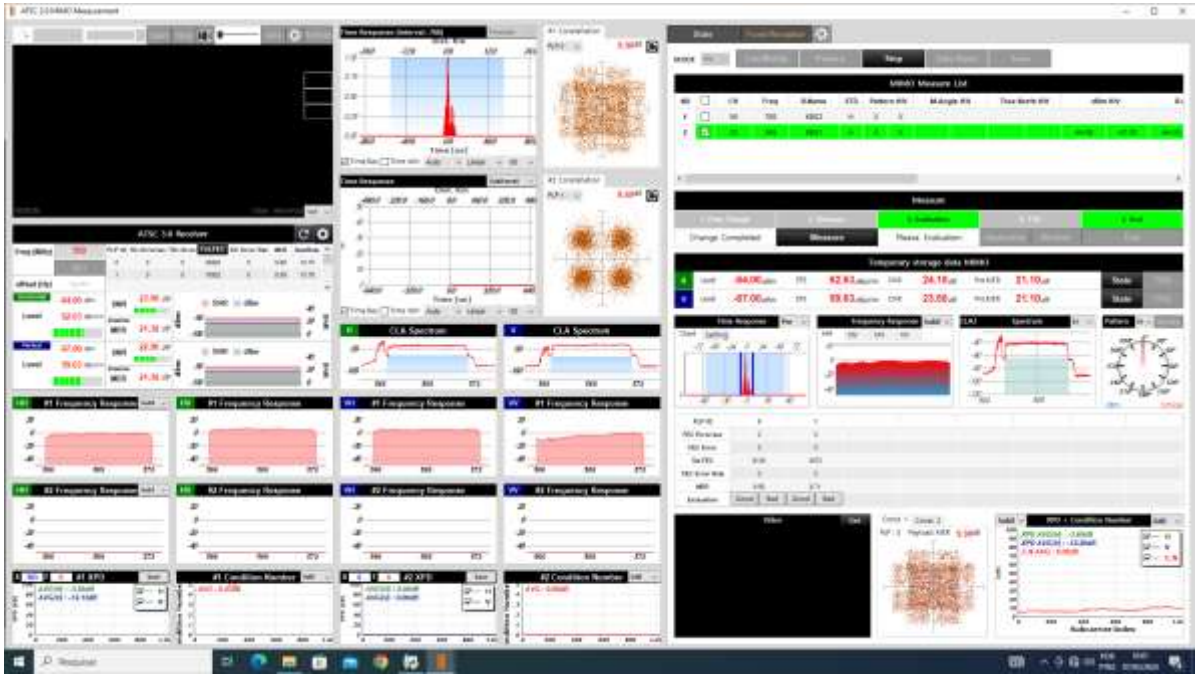


Figure 3.14 - IMAS Screen

b) AWGN Power

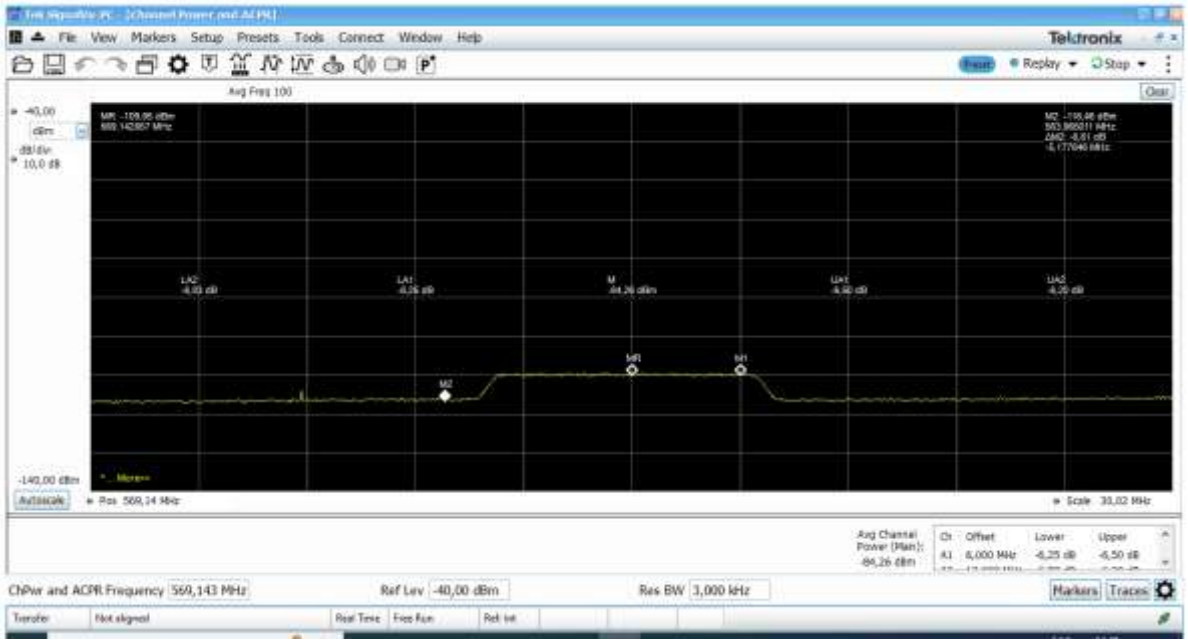


Figure 3.15 - Vertical

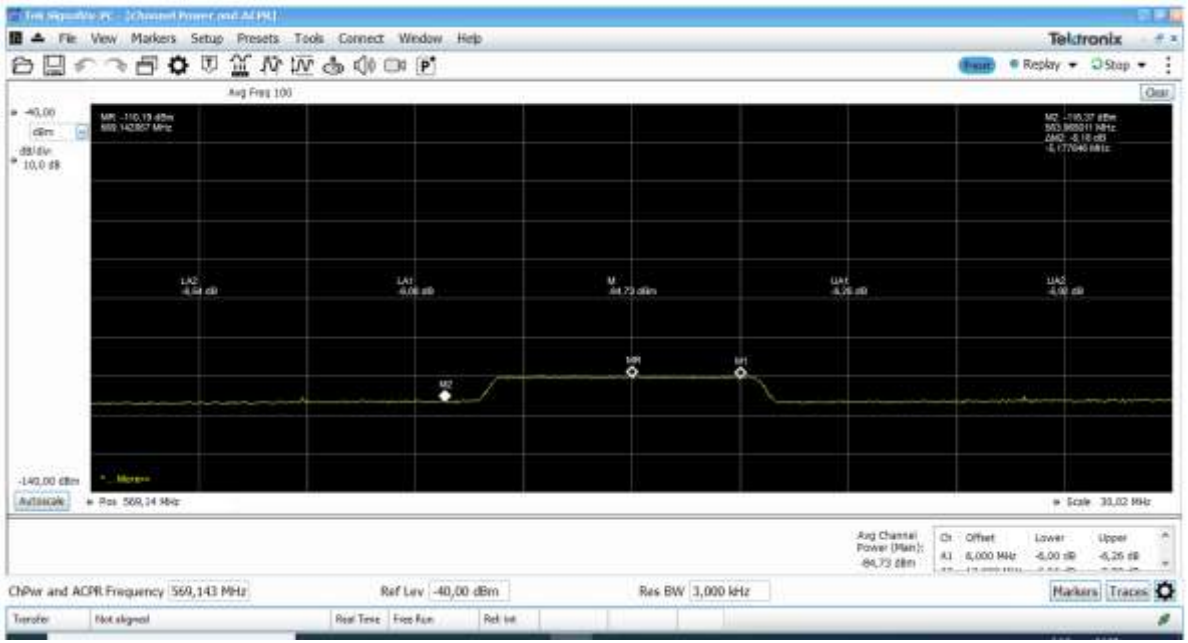


Figure 3.16 - Horizontal

c) C/N Threshold

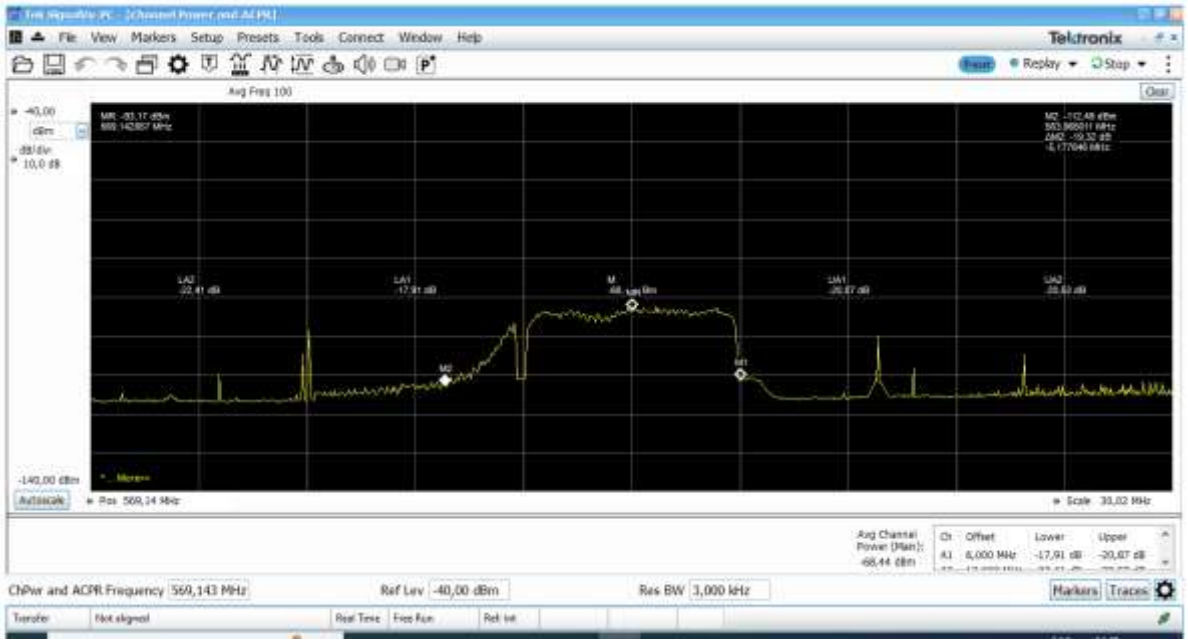


Figure 3.17 - Vertical

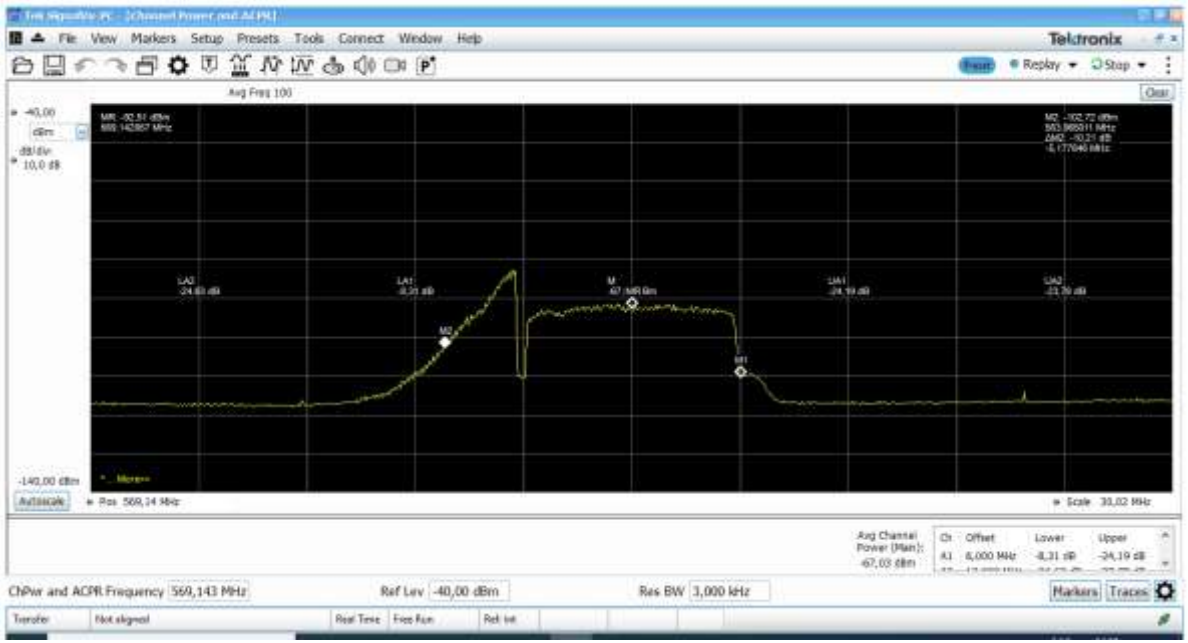


Figure 3.18 - Horizontal

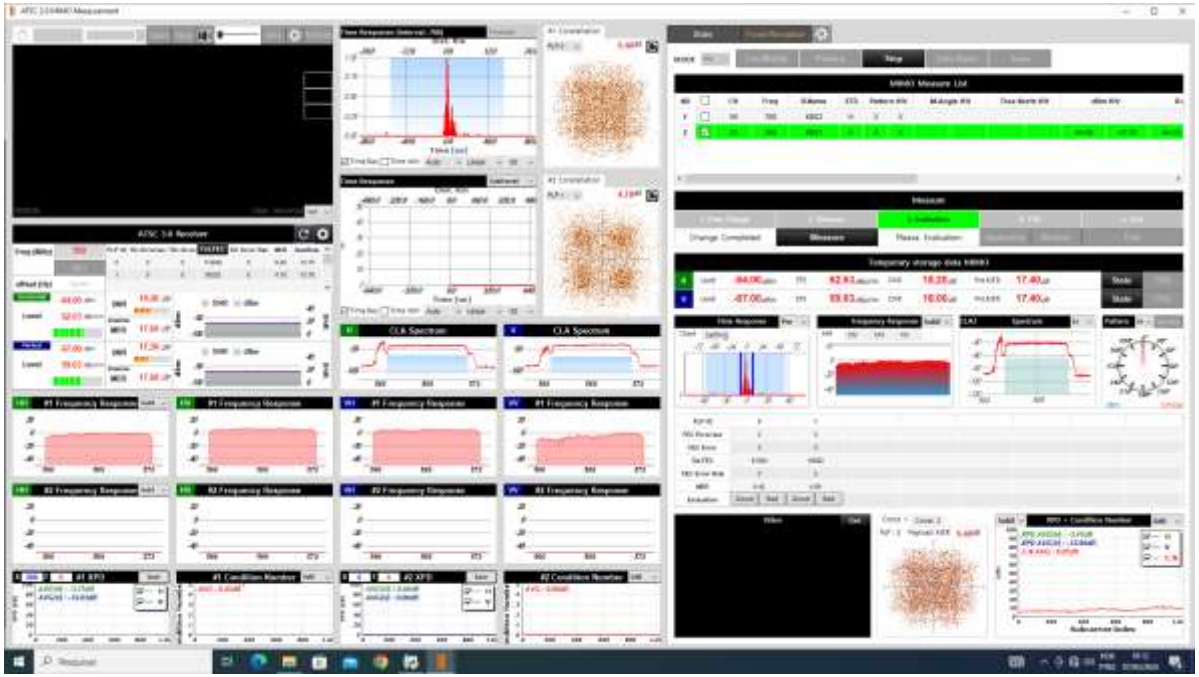


Figure 3.19 - IMAS Screen

d) Reception Threshold

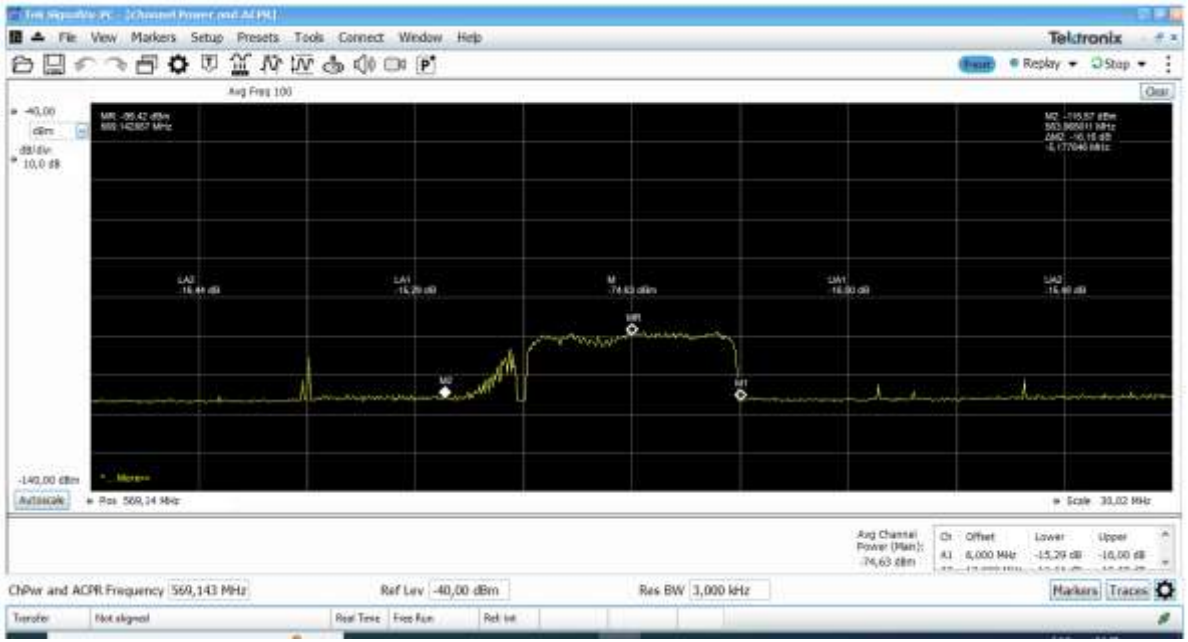


Figure 3.20 - Vertical

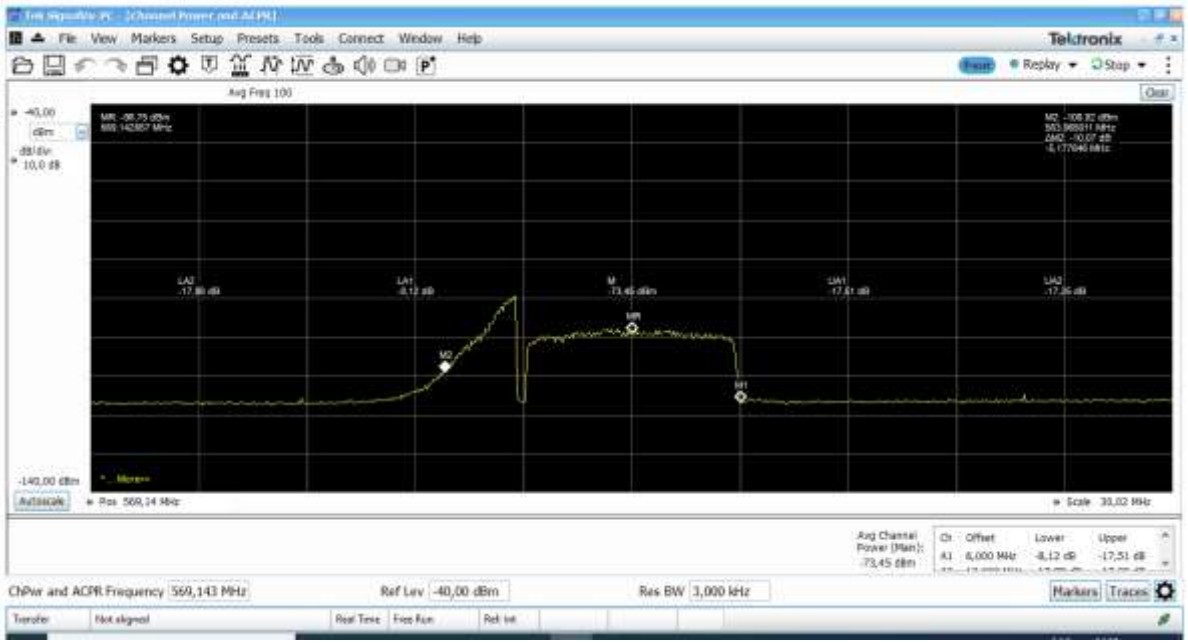


Figure 3.21 - Horizontal

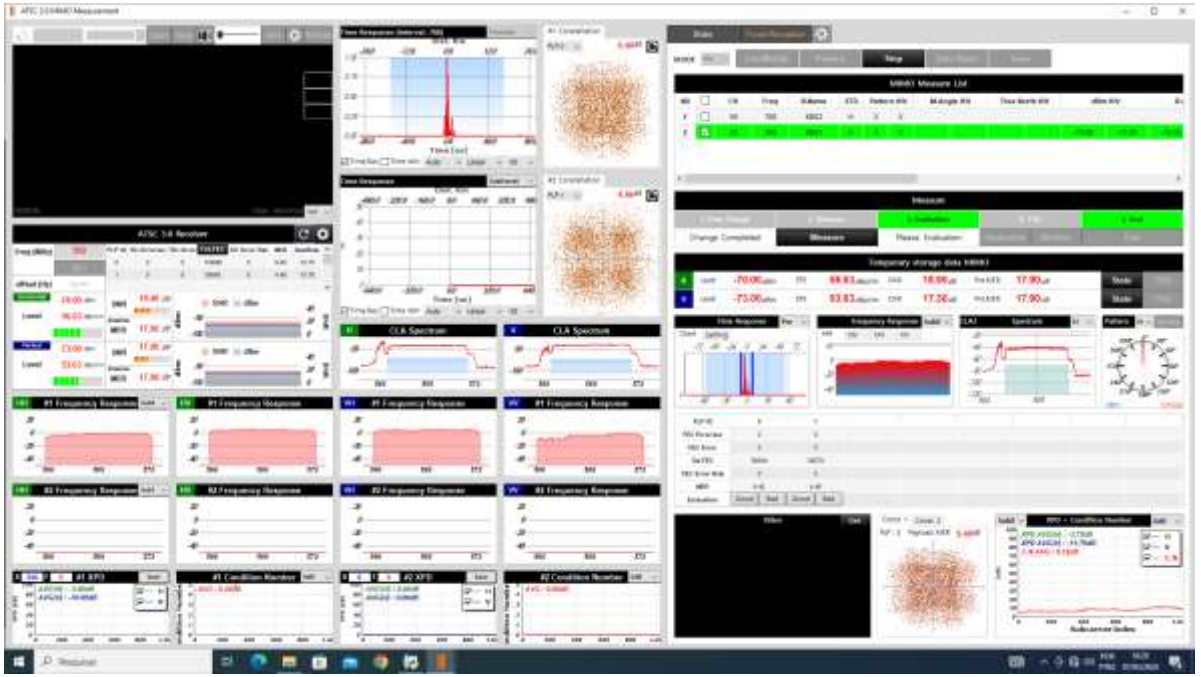


Figure 3.22 - IMAS Screen

Chapter 4. Site 21

Core Layer: 16-QAM NUC, FEC 4/15, Bitrate 10.7 Mbps

a) Channel Power

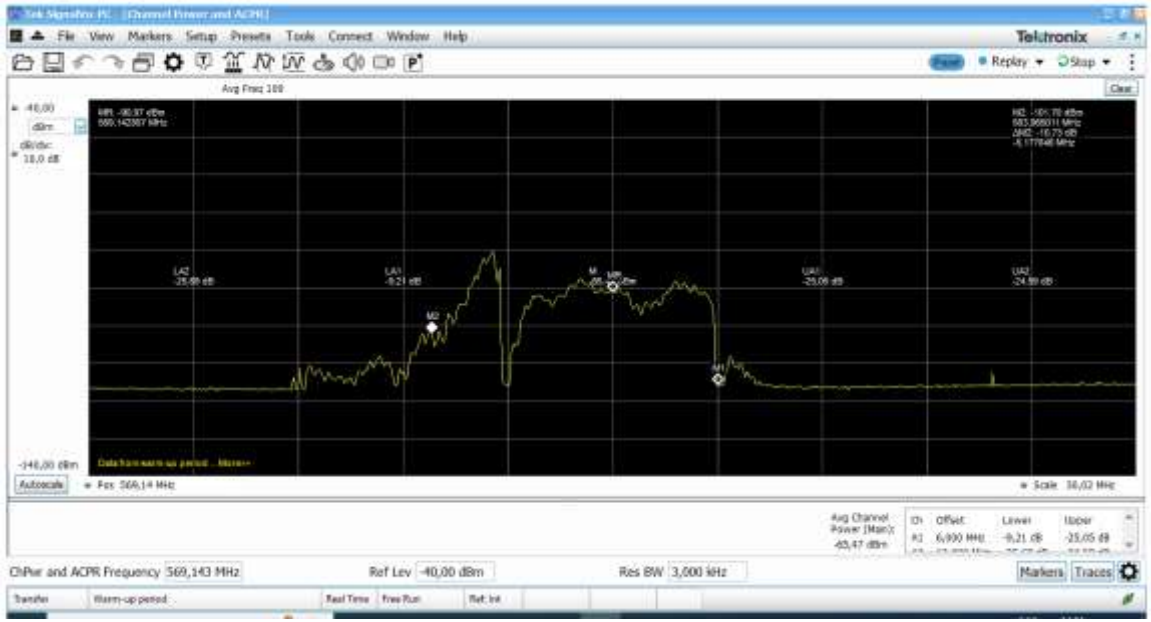


Figure 4.1 - Vertical

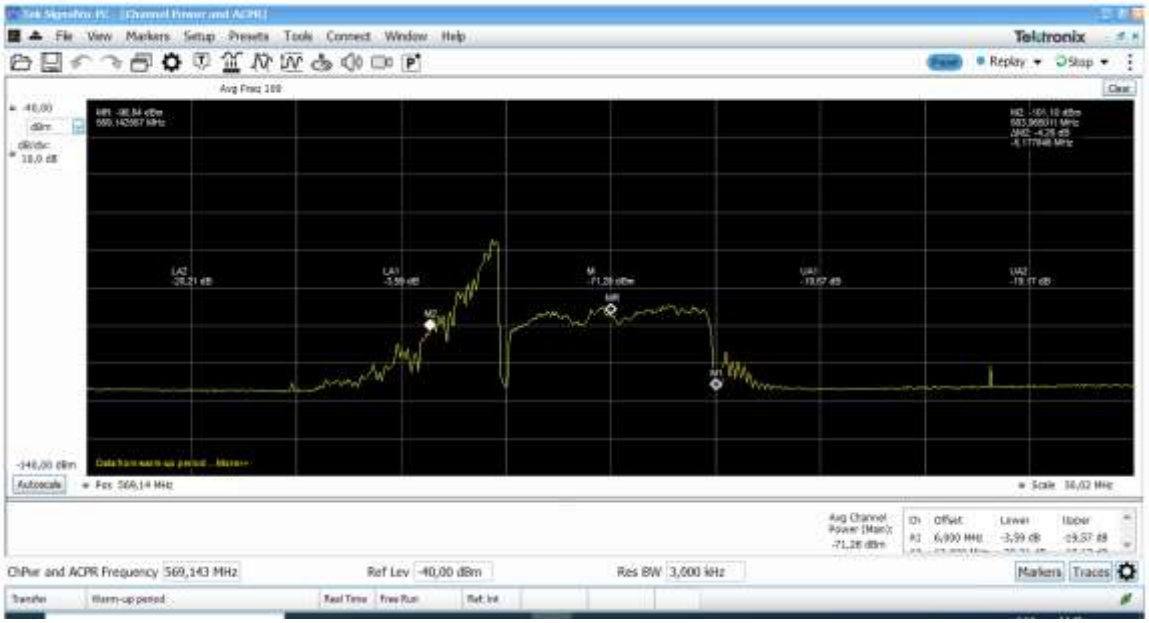


Figure 4.2 - Horizontal

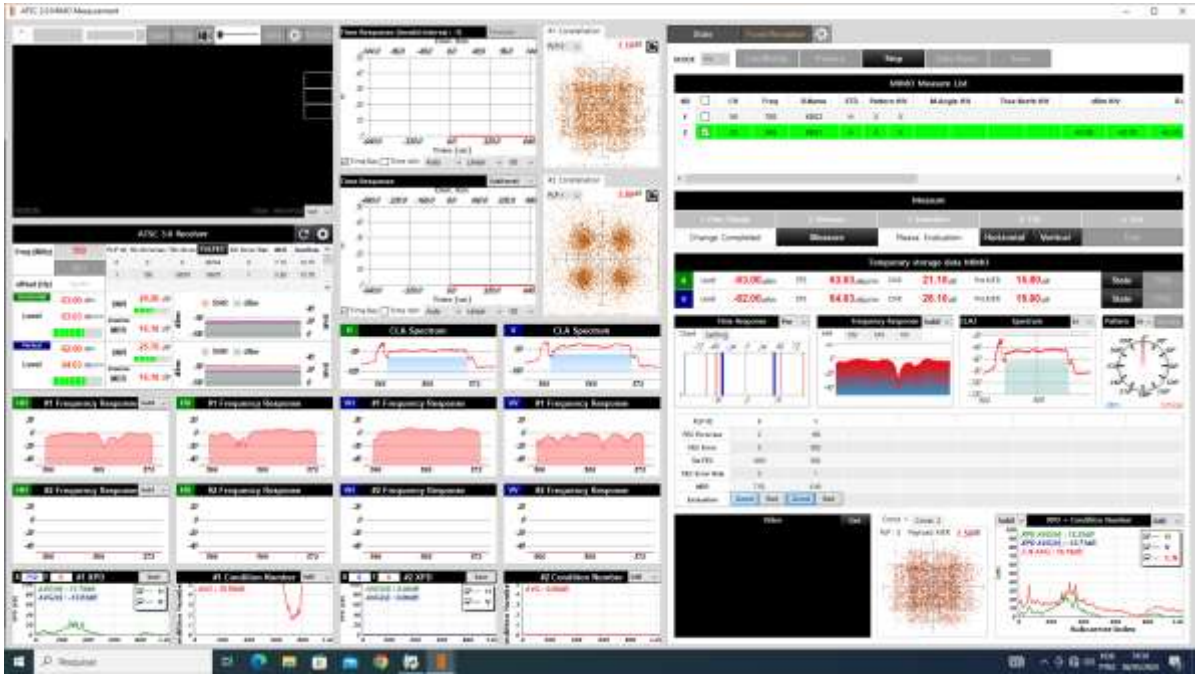


Figure 4.3 - IMAS Screen

b) AWGN Power

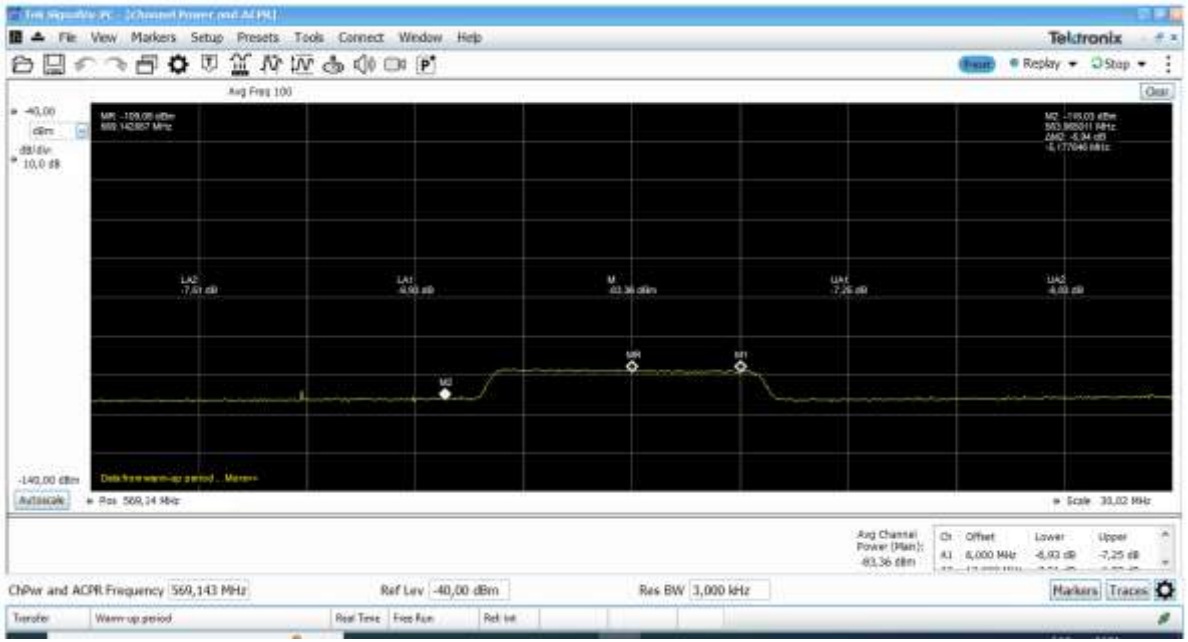


Figure 4.4 - Vertical

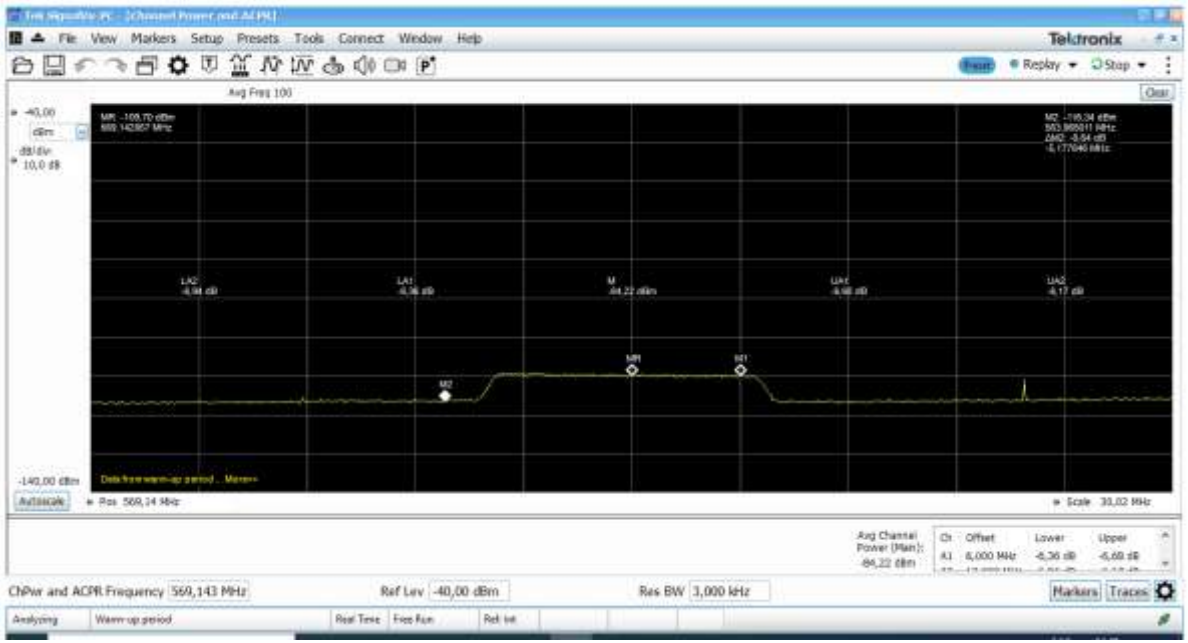


Figure 4.5 - Horizontal

c) C/N Threshold

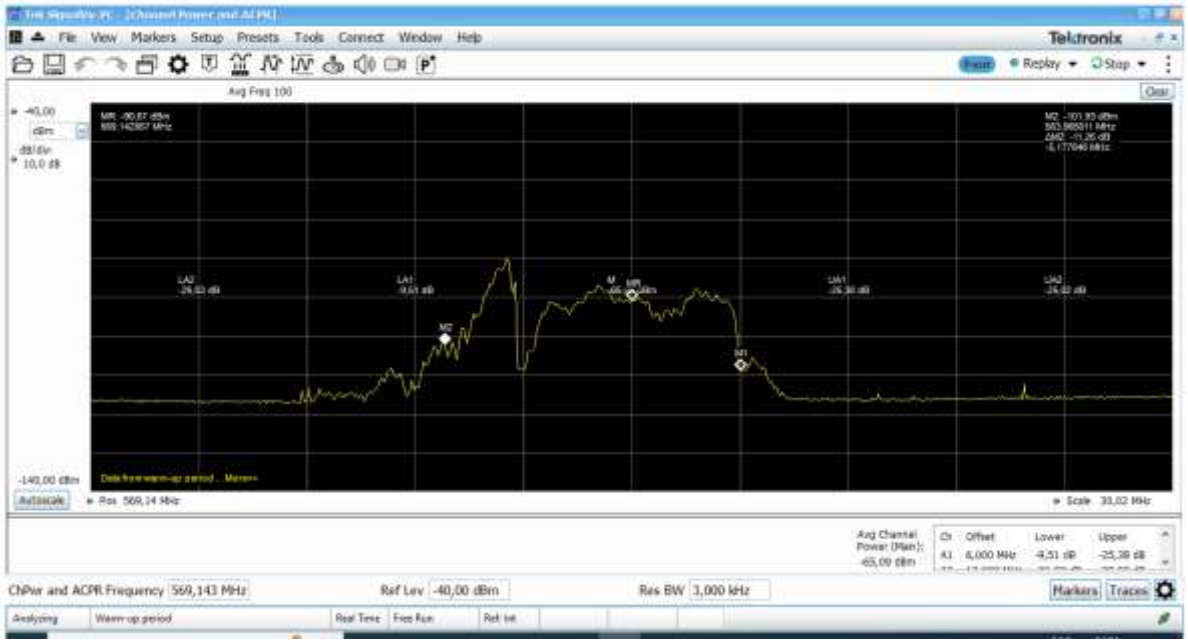


Figure 4.6 - Vertical

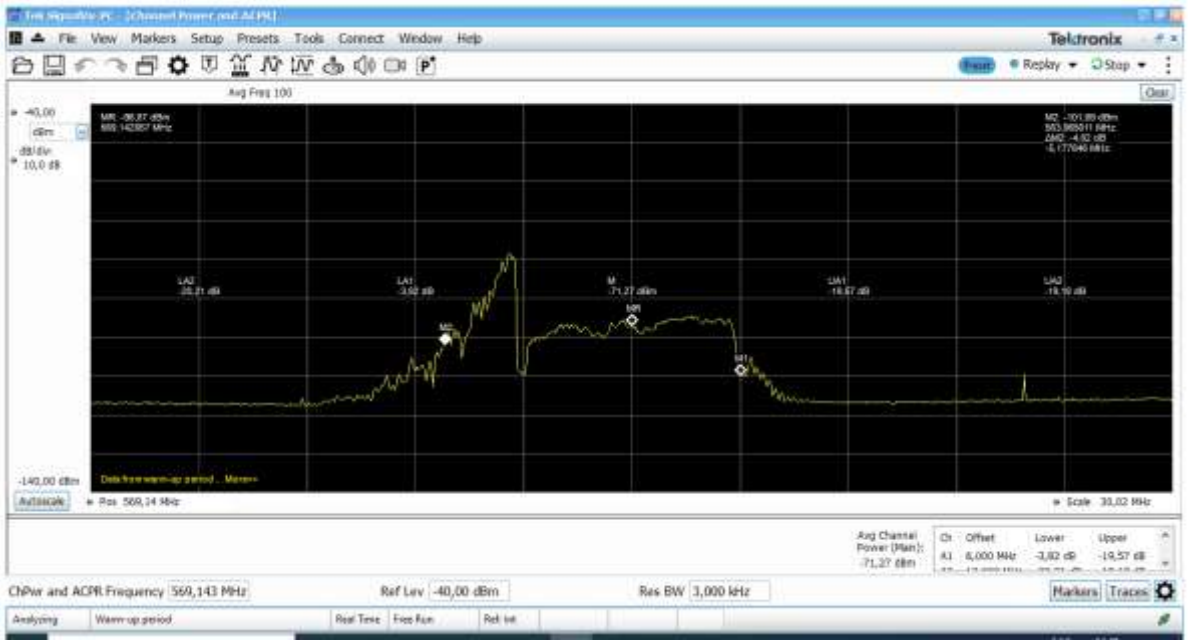


Figure 4.7 - Horizontal

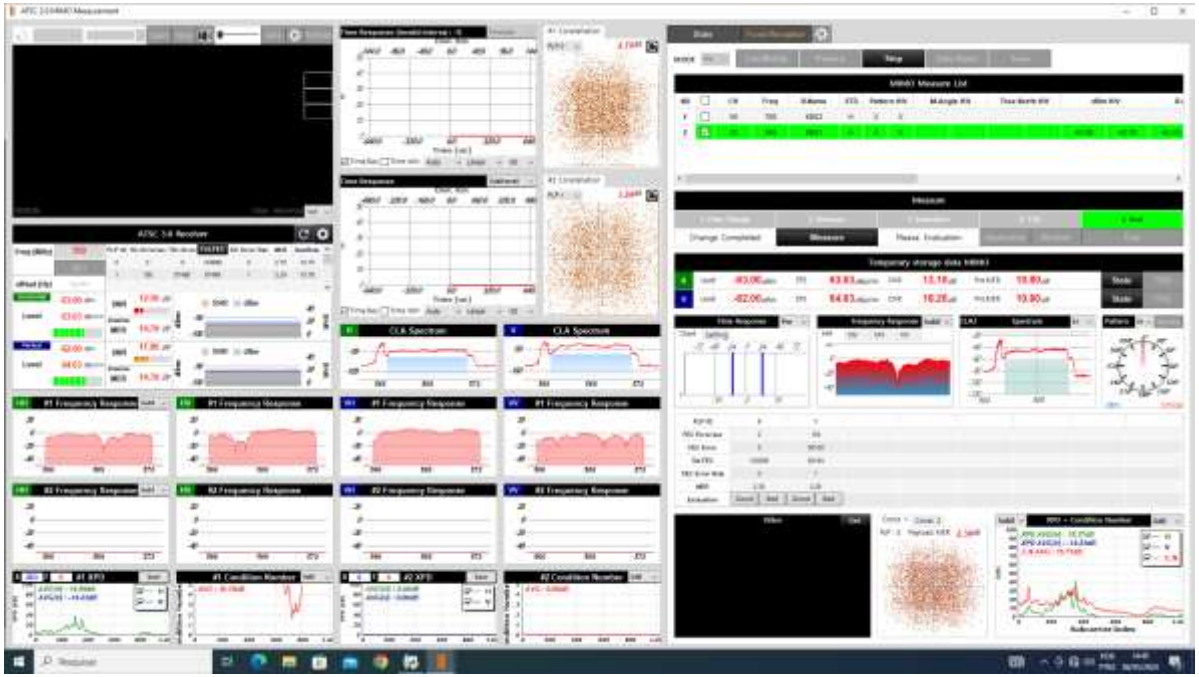


Figure 4.8 - IMAS Screen

d) Reception Threshold

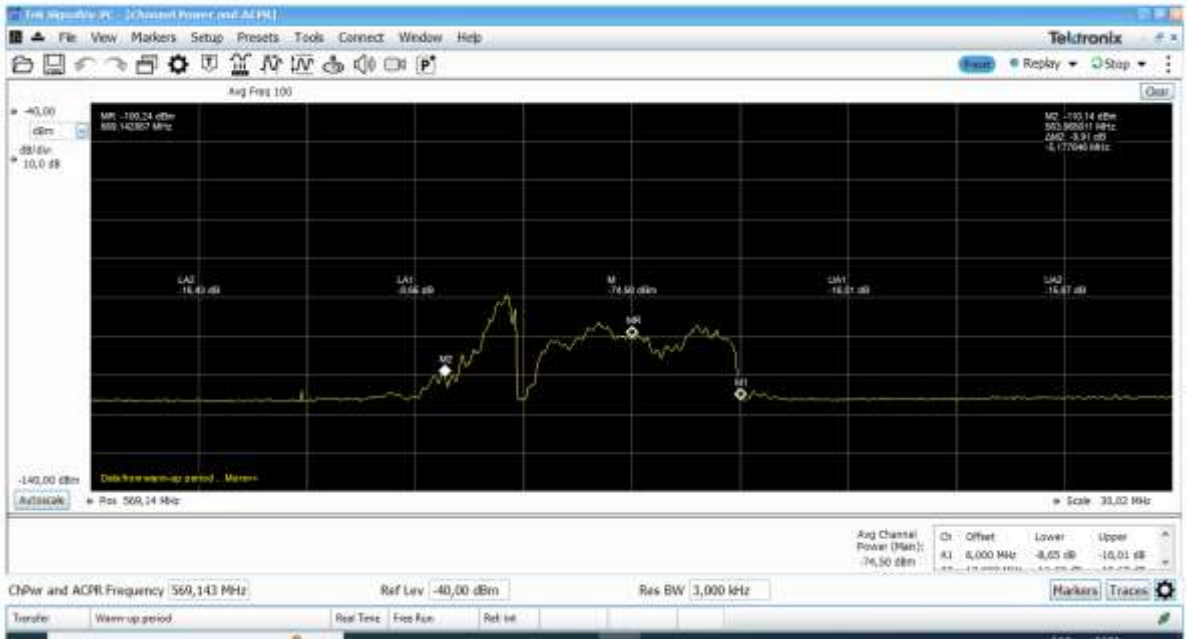


Figure 4.9 - Vertical

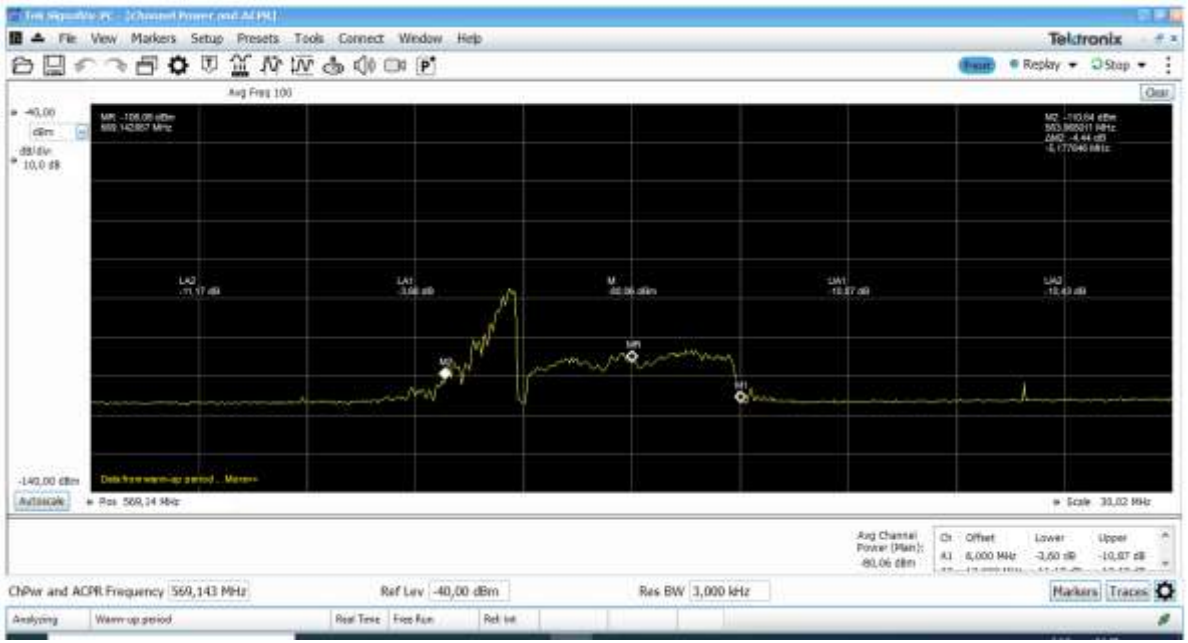


Figure 4.10 - Horizontal

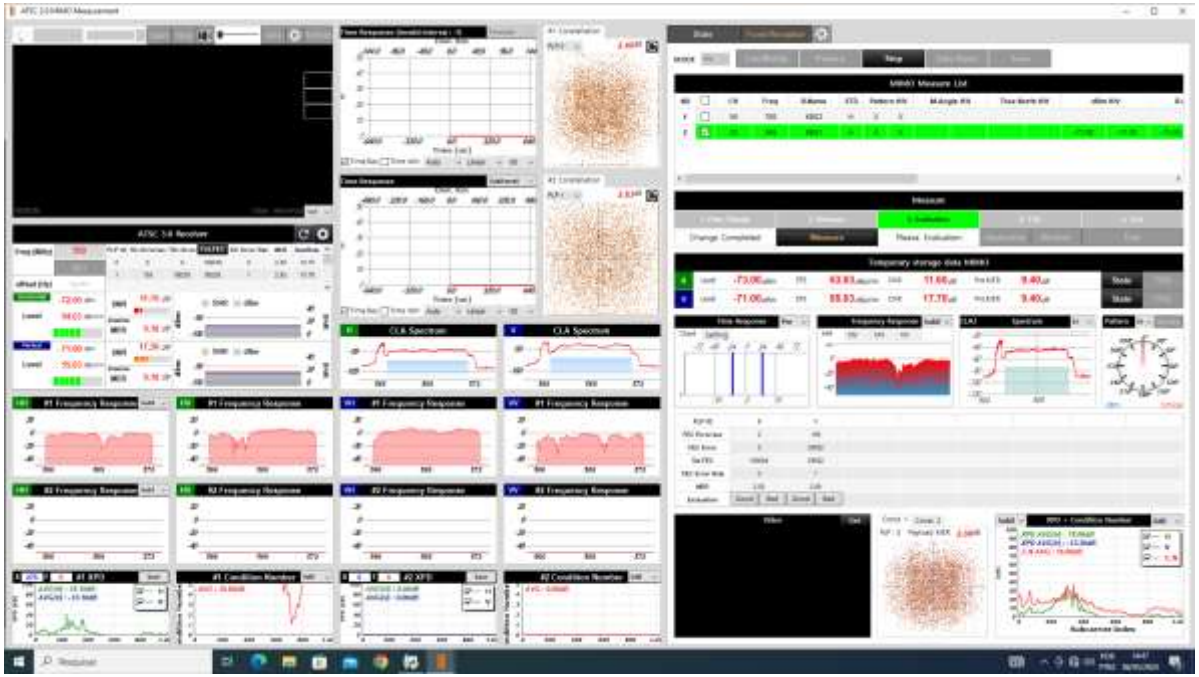


Figure 4.11 - IMAS Screen

Enhanced Layer: QPSK UC, FEC 8/15, Bitrate 10.7 Mbps

a) Channel Power

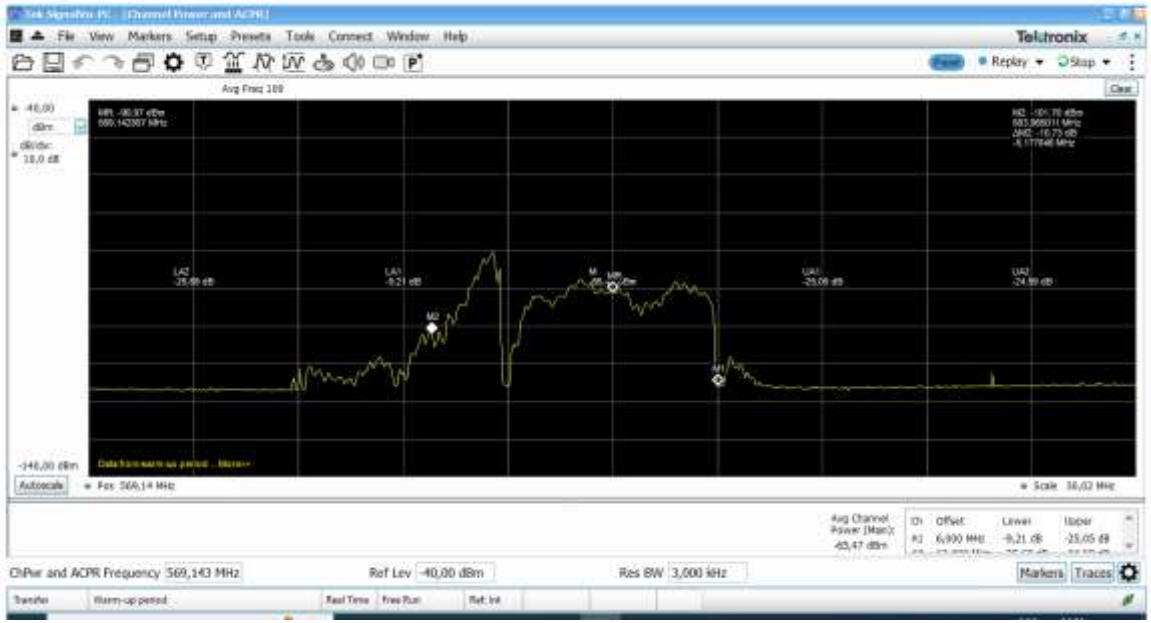


Figure 4.12 - Vertical

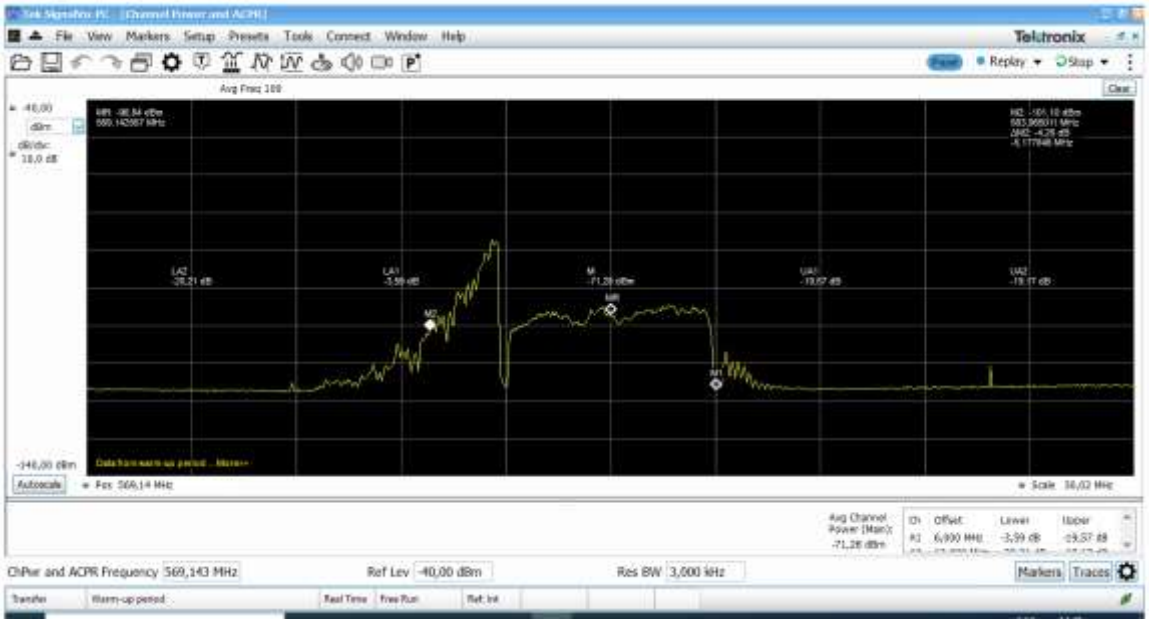


Figure 4.13 - Horizontal

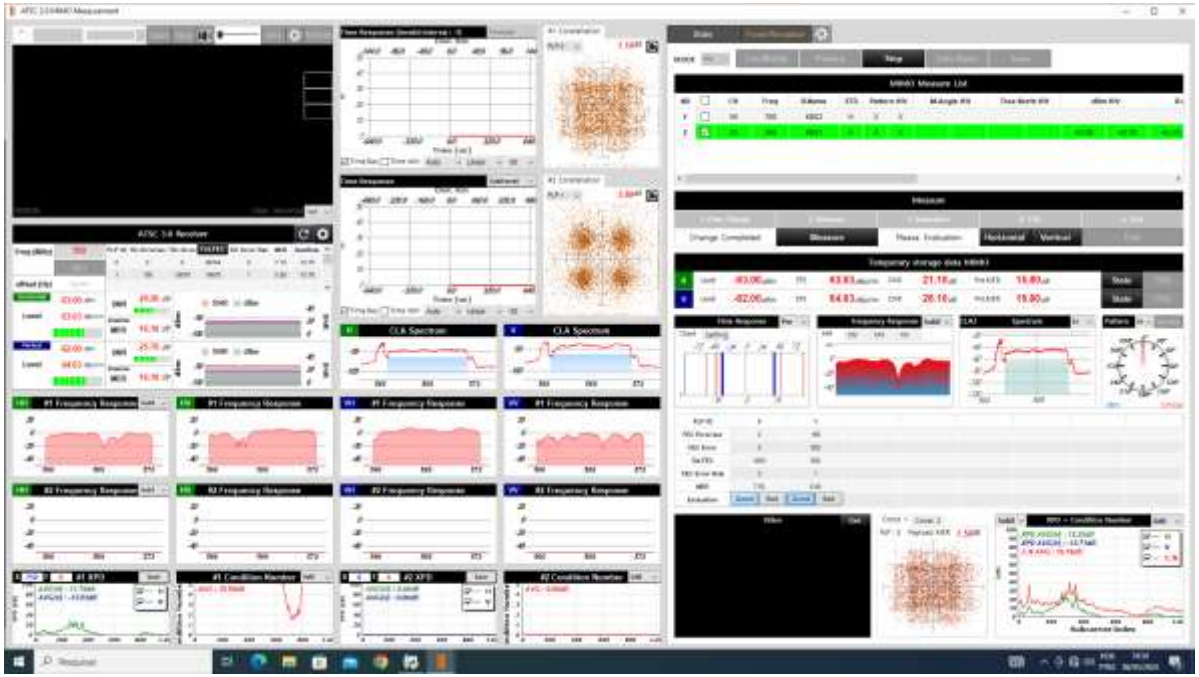


Figure 4.14 - IMAS Screen