Aaronia GHz Spurs

- 4GHz+-50MHz

18 October 2022

UCDAVIS
DEPARTMENT OF PHYSICS AND ASTRONOMY
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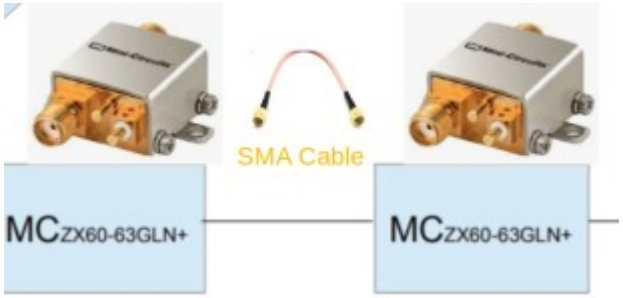
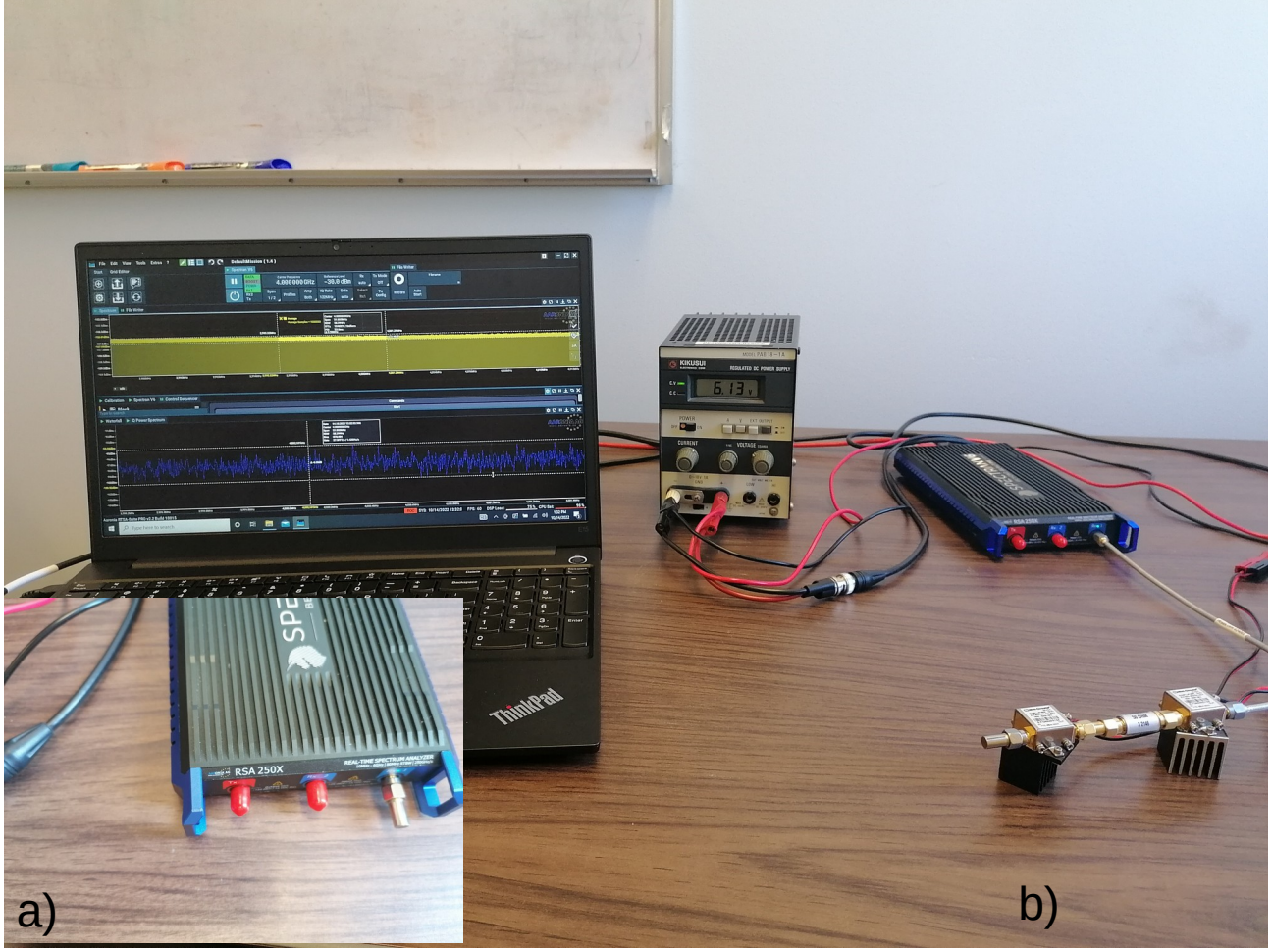
Aaronia Setup

a) Terminated load, No Amplifier

b) Terminated load and Amplifiers



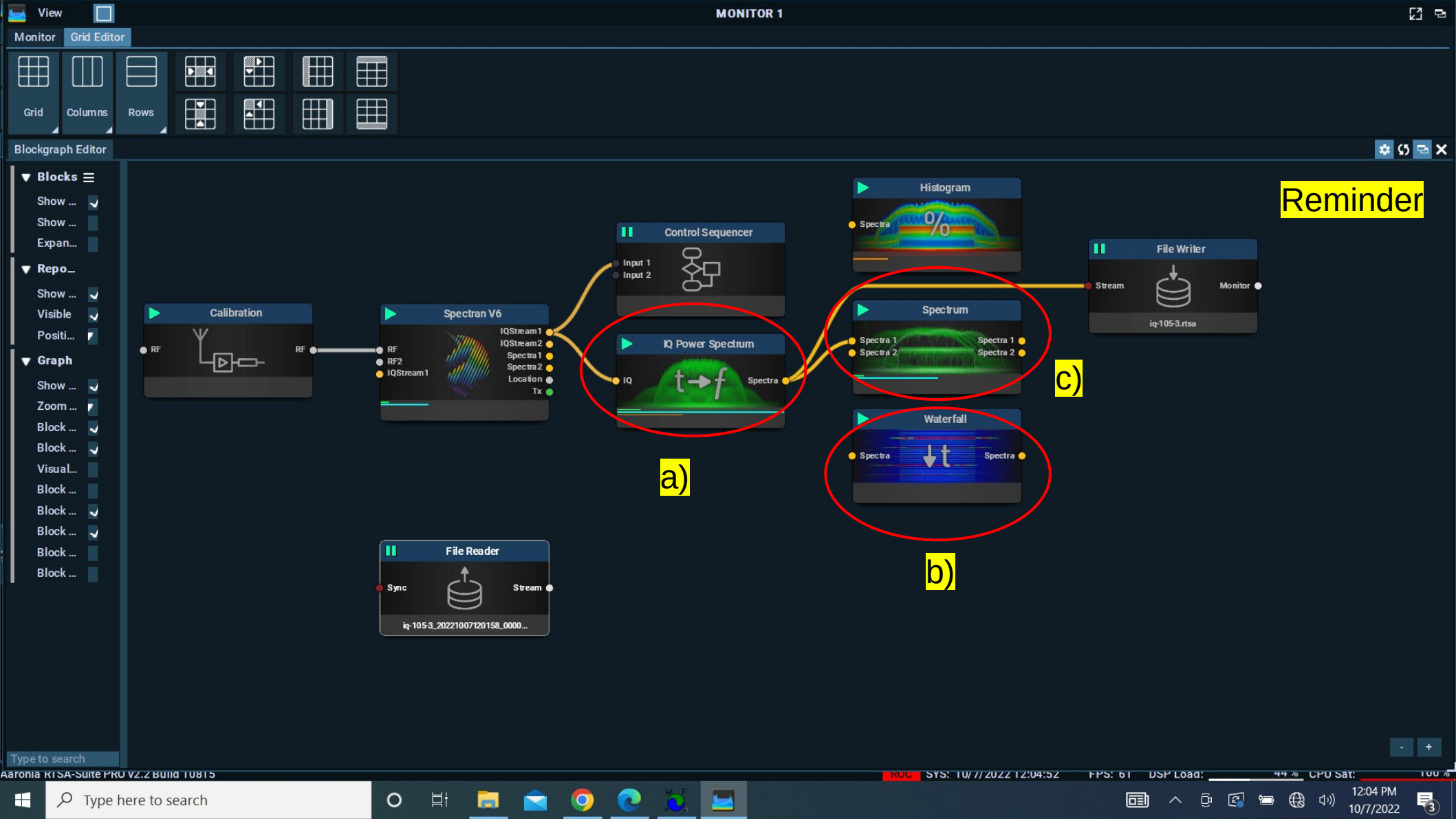


LNA ZX60_63GLN+@4GHz : 2 * 27.2dB N.F. 1, IP3 24.6 dBm

LNA Gain from Datasheet*:

3.6GHz	27.65dB
4 GHz	27.18dB
4.4GHz	26.87dB
..	
5GHz	26.27dB
6GHz	24.46dB

* https://www.minicircuits.com/pdfs/ZX60-63GLN+.pdf



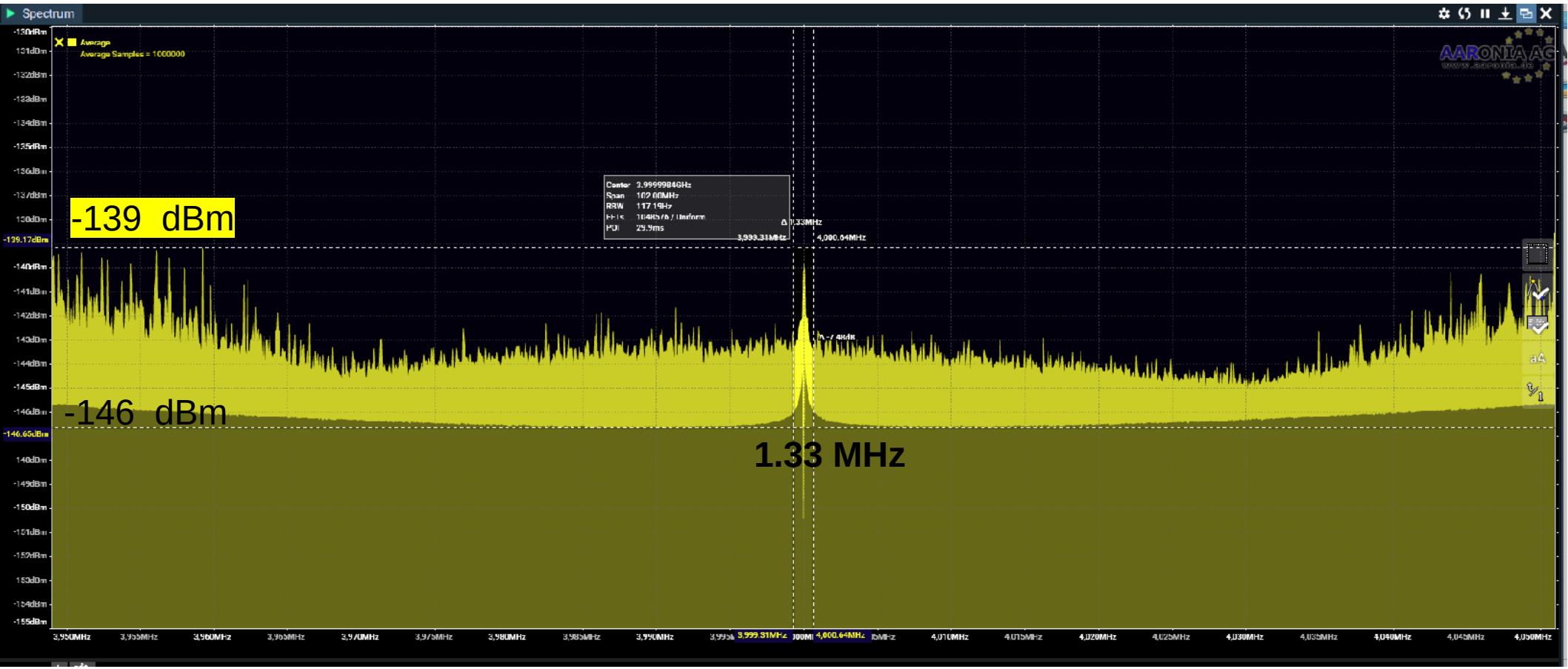
a) IQ Spectrum Instant. Data, No averaging

b) 2D plot, Data in Time and Frequency

c) Spectrum data with Averaging (average of 1-1e6 samples)

FFT 1M
Bin 870404
Span 102 MHz
RBW 117 Hz
Fc= 4 GHz

- Terminated Load, No Amplifier



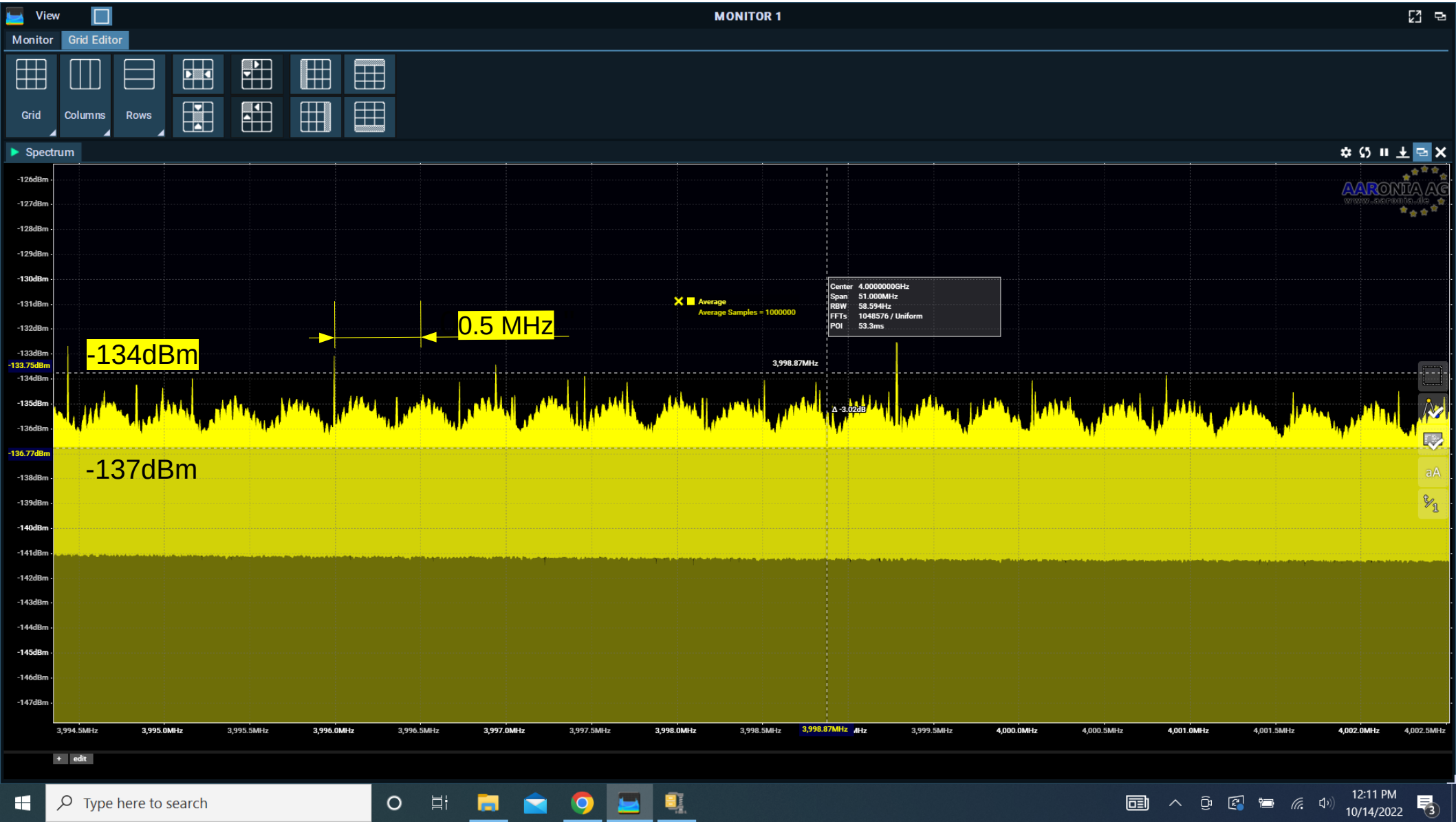
-139 dBm
-146 dBm

Spur at centre:

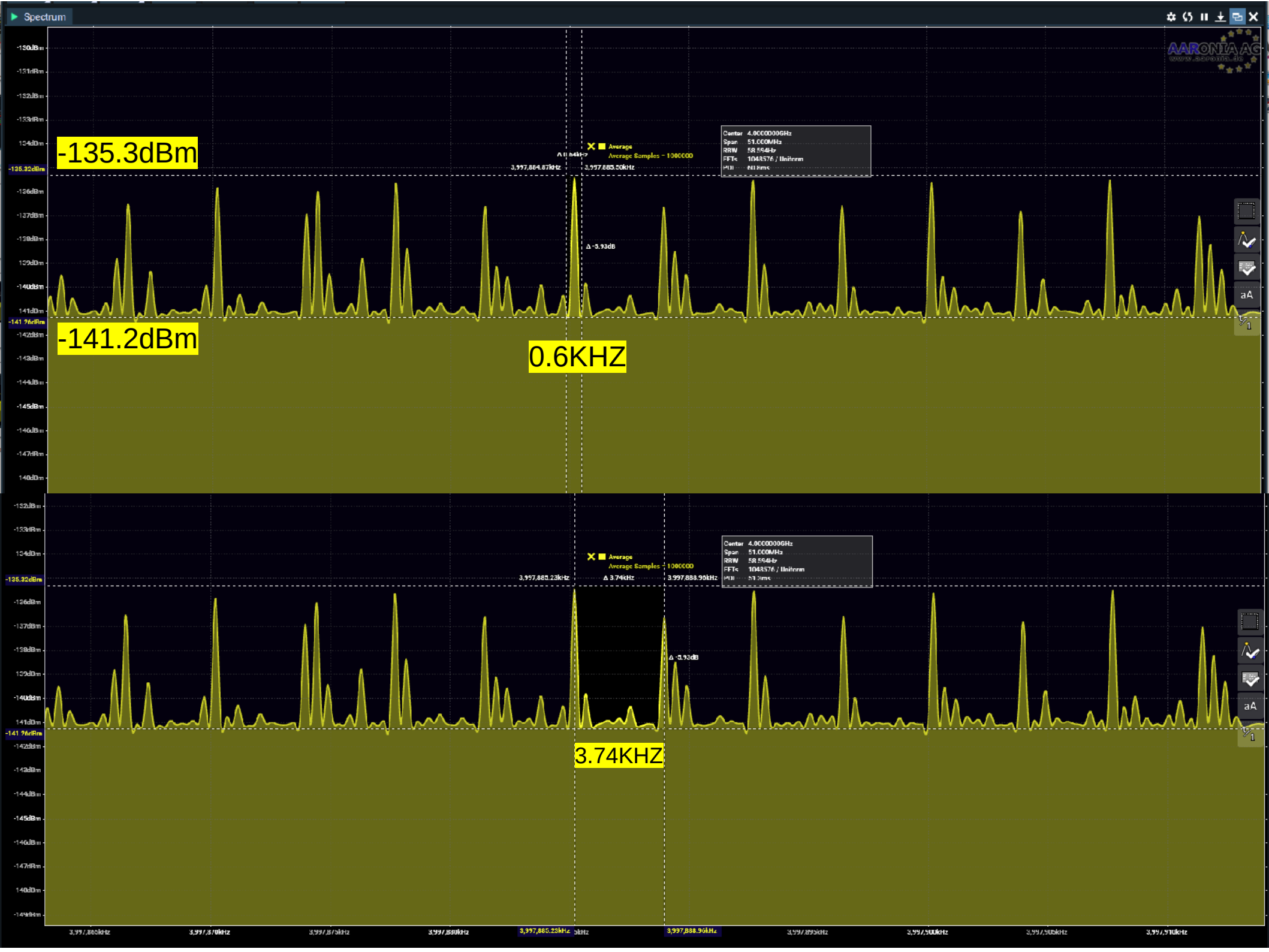
Fc@1.33 MHz BW

FFT 1M
Bin 870404
Span 102 MHz
RBW 117 Hz
Fc= 4 GHz

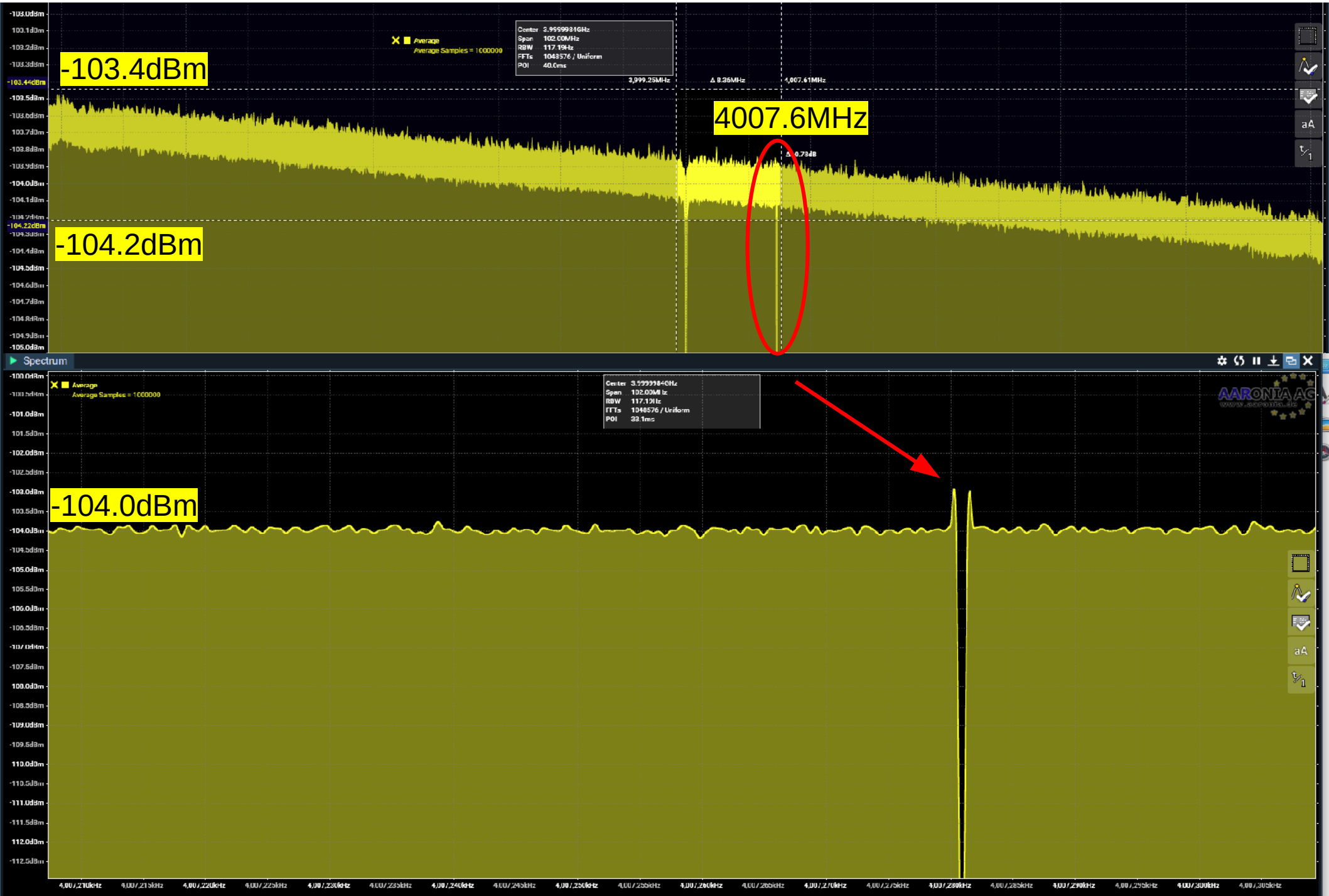
- Terminated Load, No Amplifier, Half span

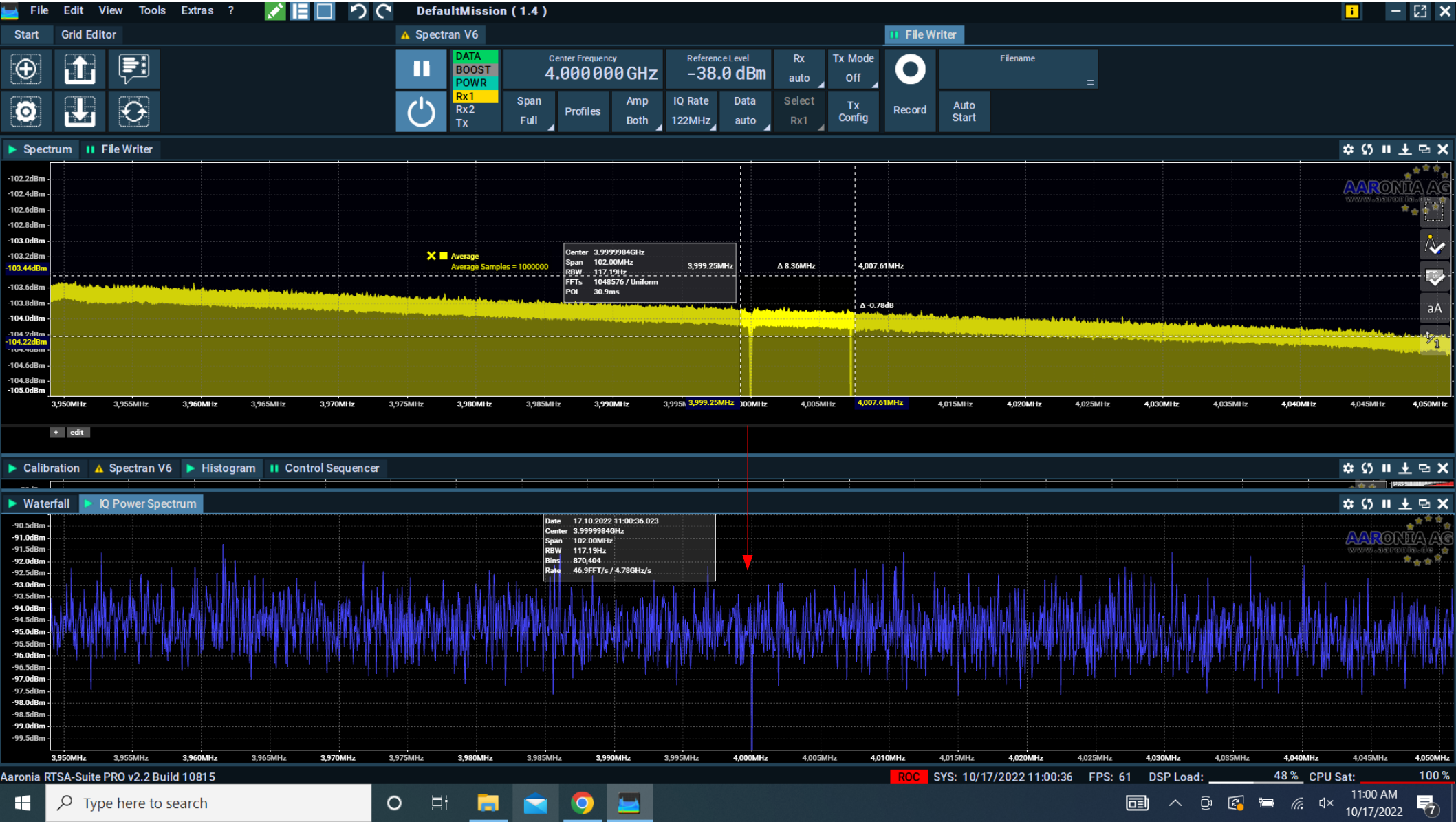


~ -134dBm
-137dBm


Spectrum
-135.3dBm
-141.2dBm
0.6KHZ
3.74KHZ

Terminated Load, ~ 54 dB Amplifier, NF 1dB

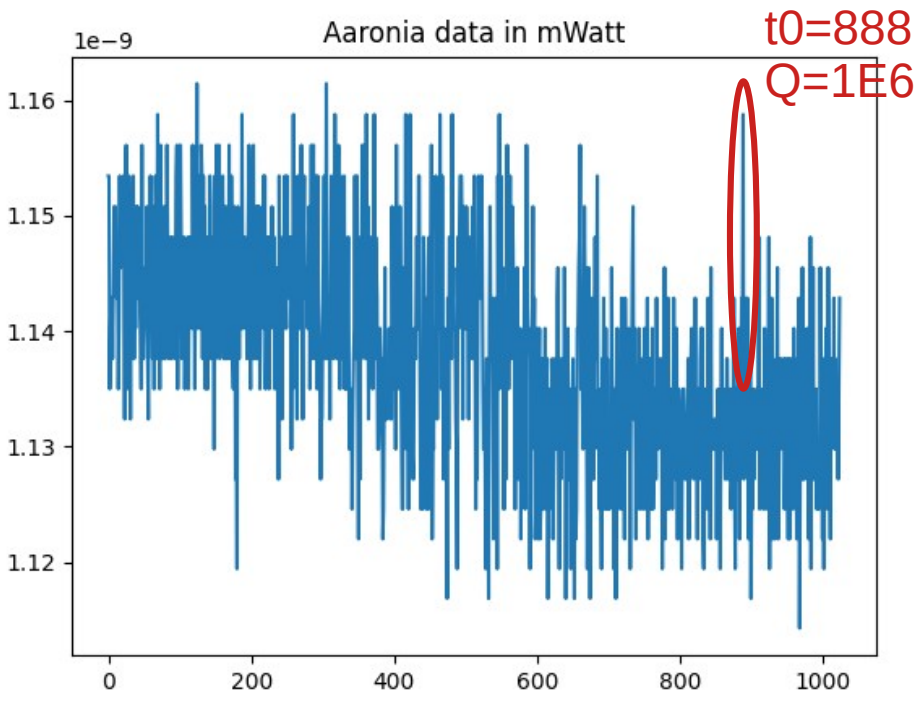


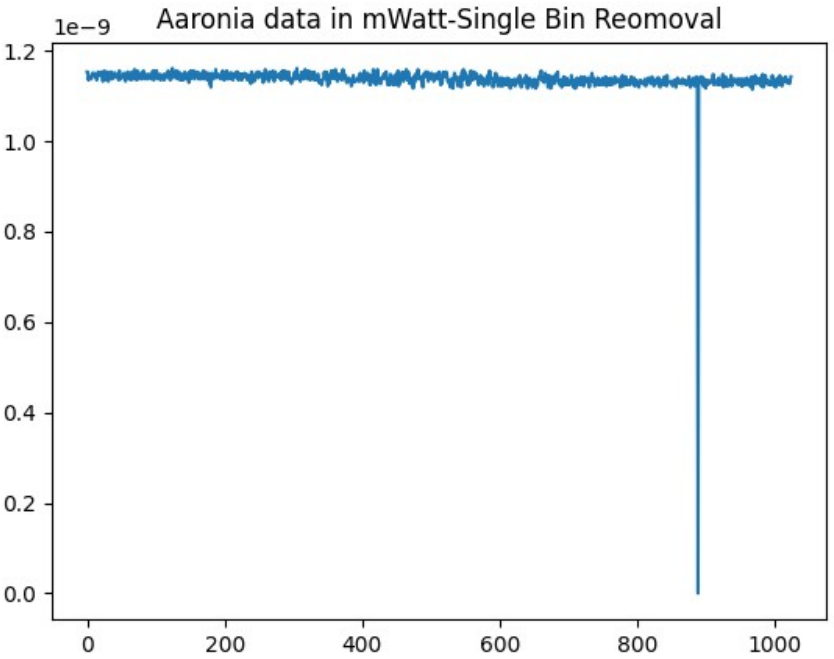

File Edit View Tools Extras ?
DefaultMission (1.4)
Start
Grid Editor
Spectran V6
File Writer
DATA
BOOST
POWR
Rx1
Rx2
Tx
Center Frequency
4.000000 GHz
Reference Level
-38.0 dBm
Rx
auto
Tx Mode
Off
Span
Full
Profiles
Amp
Both
IQ Rate
122MHz
Data
auto
Select
Rx1
Tx Config
Record
Filename
Auto Start
Spectrum
File Writer
Average
Average Samples = 1000000
Center 3.9999984GHz
Span 102.00MHz
RBW 117.19Hz
FFTs 1048576 / Uniform
POI 30.9ms
3,999.25MHz
Δ 8.36MHz
4,007.61MHz
Δ -0.78dB
-102.2dBm
-102.4dBm
-102.6dBm
-102.8dBm
-103.0dBm
-103.2dBm
-103.44dBm
-103.6dBm
-103.8dBm
-104.0dBm
-104.22dBm
-104.6dBm
-104.8dBm
-105.0dBm
3,950MHz
3,955MHz
3,960MHz
3,965MHz
3,970MHz
3,975MHz
3,980MHz
3,985MHz
3,990MHz
3,995MHz
4,000MHz
4,005MHz
4,010MHz
4,015MHz
4,020MHz
4,025MHz
4,030MHz
4,035MHz
4,040MHz
4,045MHz
4,050MHz
Calibration
Spectran V6
Histogram
Control Sequencer
Waterfall
IQ Power Spectrum
Date 17.10.2022 11:00:36.023
Center 3.9999984GHz
Span 102.00MHz
RBW 117.19Hz
Bins 870,404
Rate 46.9FFT/s / 4.78GHz/s
-90.5dBm
-91.0dBm
-91.5dBm
-92.0dBm
-92.5dBm
-93.0dBm
-93.5dBm
-94.0dBm
-94.5dBm
-95.0dBm
-95.5dBm
-96.0dBm
-96.5dBm
-97.0dBm
-97.5dBm
-98.0dBm
-98.5dBm
-99.0dBm
-99.5dBm
Aaronia RTSA-Suite PRO v2.2 Build 10815
ROC
SYS: 10/17/2022 11:00:36
FPS: 61
DSP Load:
48 %
CPU Sat:
100 %
Type here to search
11:00 AM
10/17/2022

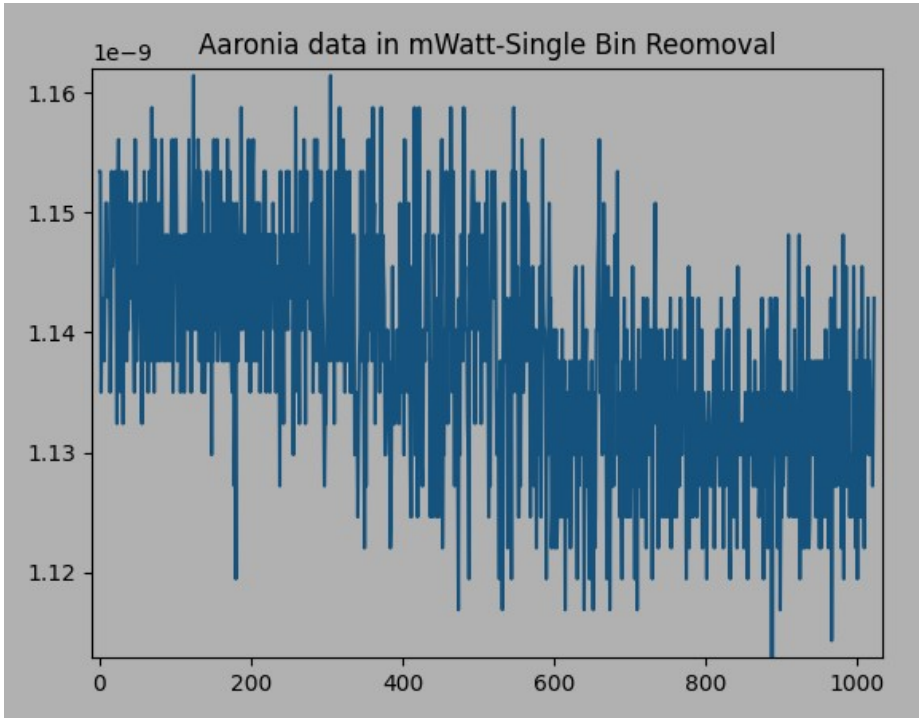
Sensitivity

Sensitivity at 4 GHz with 1e6 averaging :
-153 dBm – 10*log10(117) = -173dBm/Hz

Notch Filter for Spurs Removal







Data after single-bin removal

Notch0.py

- NEXT:

  1- **Spurs between 50MHz-350MHz (vs. ROACH)**

  3- Long-run data - Averaging

  4-DP Constraints @ 4.1 GHz
  (~HEPCAT REDO)
  Gain and AF

  ==========

  Spurs around 4GHz (Detection and Removal)

Aaronia - Further development

1GHz RTBW, with server x

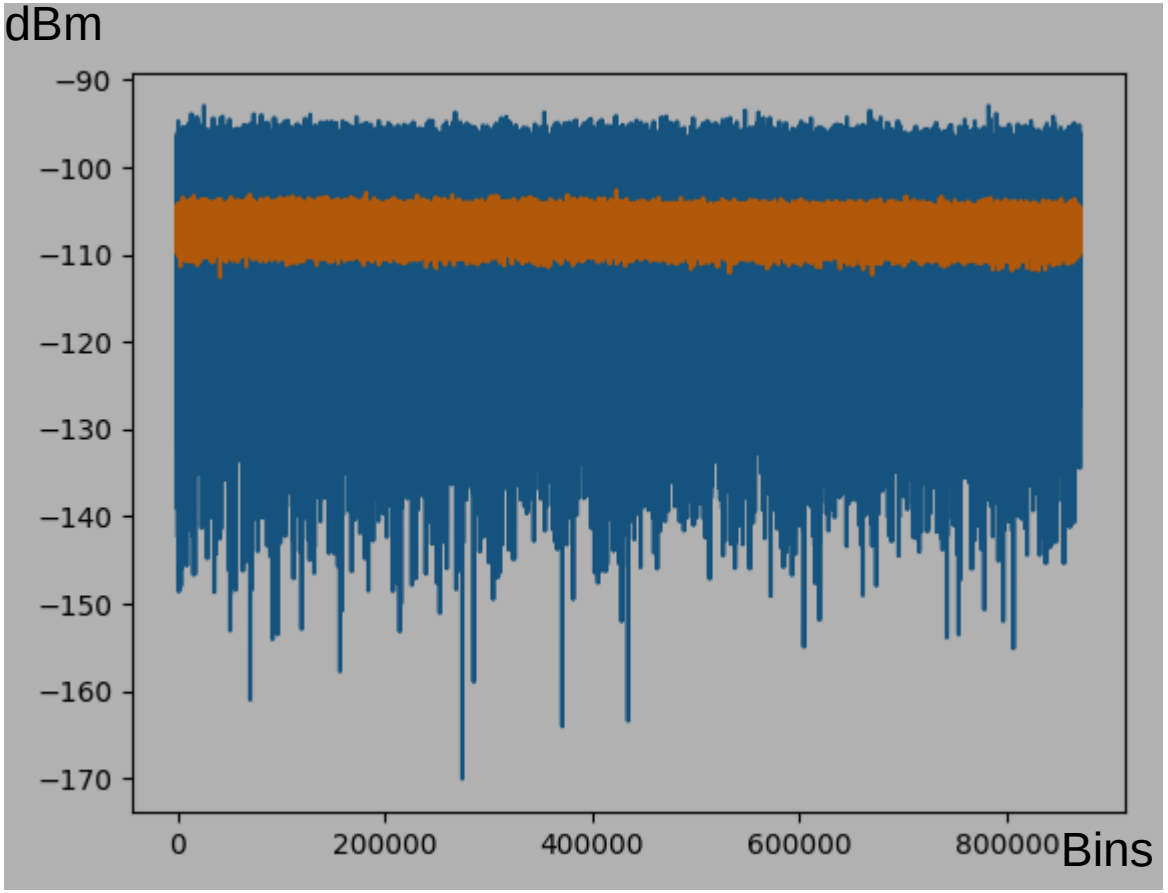
pos	qty		article number	description	unit price EUR	total price EUR
1	1	Stk	102/025	SPECTRAN® V6 Enterprise-6 Real-time Spectrum Analyzer (10MHz - 6GHz) according to industry standard 19" 2U Server Blade with eight Rx inputs, RTBW 960MHz, 4380GHz/s sweep speed incl. redundant PSU, pre-configured OS and 'RTSA-Suite PRO' Software	249.980,00	249.980,00

!?

RSA2000X + Preamp + extension to 8GHz + > extension to 245MHz RTBW + 1M FFT ~ 22K EUR

pos	qty		article number	description	unit price EUR	total price EUR
1	1	Stk	102/003 	SPECTRAN® V6 RSA2000X USB Real-time Spectrum Analyzer (10MHz -6GHz), 2 Rx inputs and 1 Tx output, RTBW 160MHz incl. PC software "RTSA-Suite PRO" on USB stick, power supply and USB cables	9.998,00	9.998,00

Noise Averaging, with two amplifiers and terminated load



On Preamp and Amp - Aaronia

- https://v6-forum.aaronia.de/forum/topic/amplifier-selection/#postid-1544

- “SPECTRAN V6 offers a superb NF of 4 dB
- The internal amplifier offers around 17 dB, the optional pre-amplifier around 20 dB of gain but as mentioned you can not go below the physical limit of -170dBm/Hz DANL with 4dB system NF so a regular external amplifier can´t improve those specs.
-
- The only way to get higher sensitivity would be to use an external super low noise amplifier with a NF below 0,5dB. In this case you might be able to optimise the performance by another 1-1,5dB to reach around -171,5dBm/Hz DANL.”
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- *Negative frequencies Maths.*