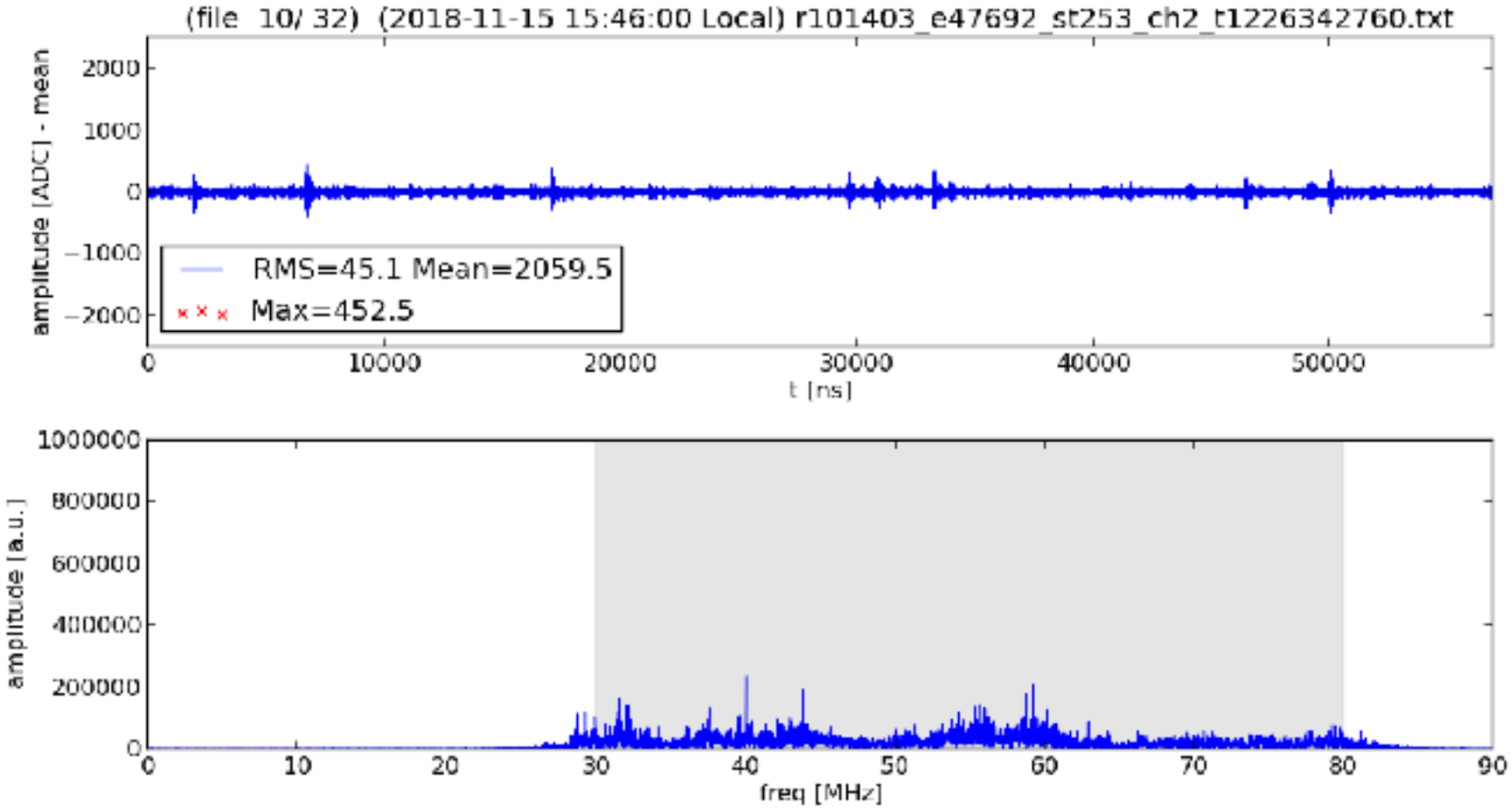
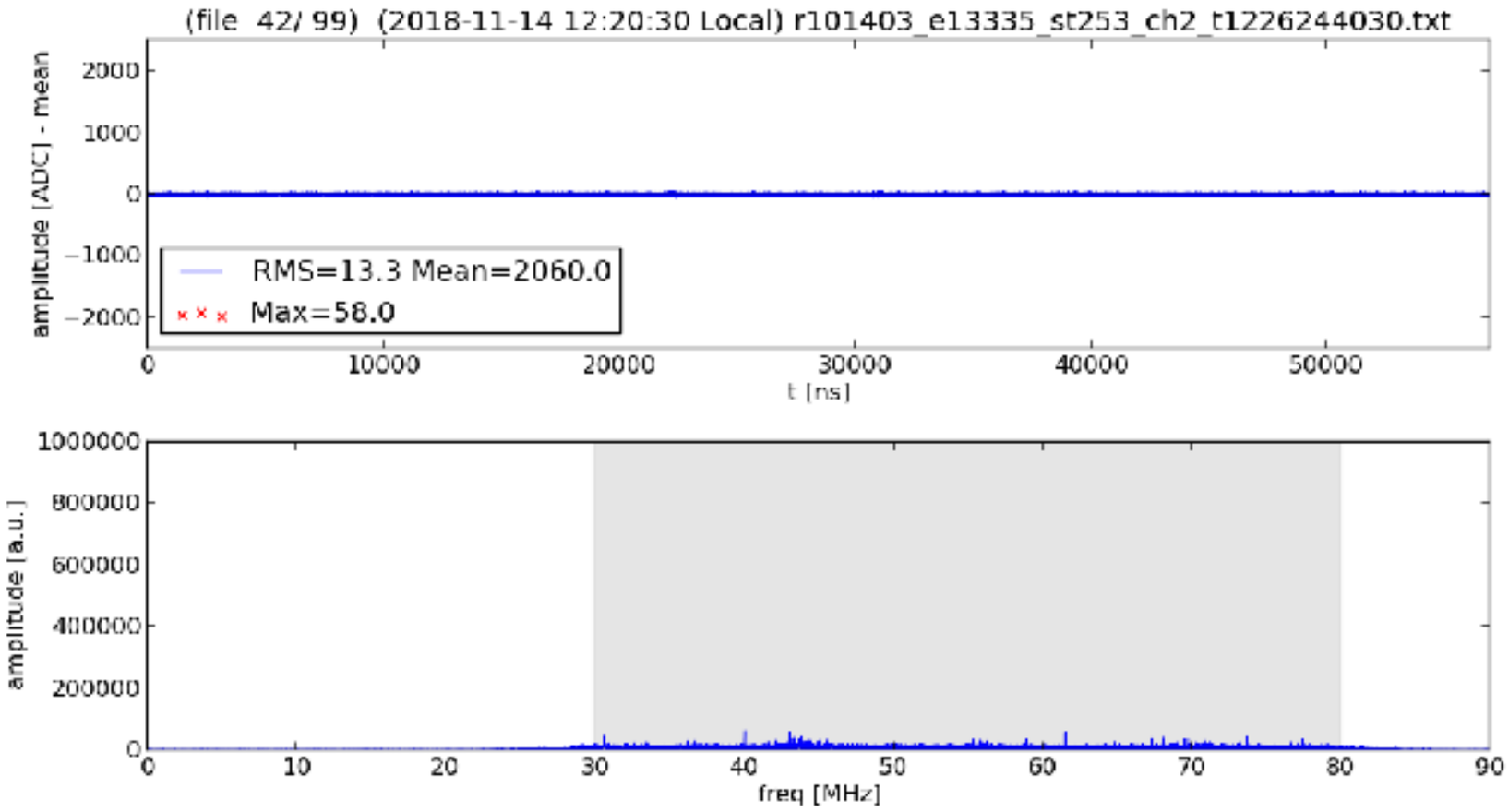
summary of field tests conducted on November 14th and 15th

AERA #153 at Clais

distance Clais electronics dome <—> AERA antenna ~5 m





summary

present status,
still emission from UUB

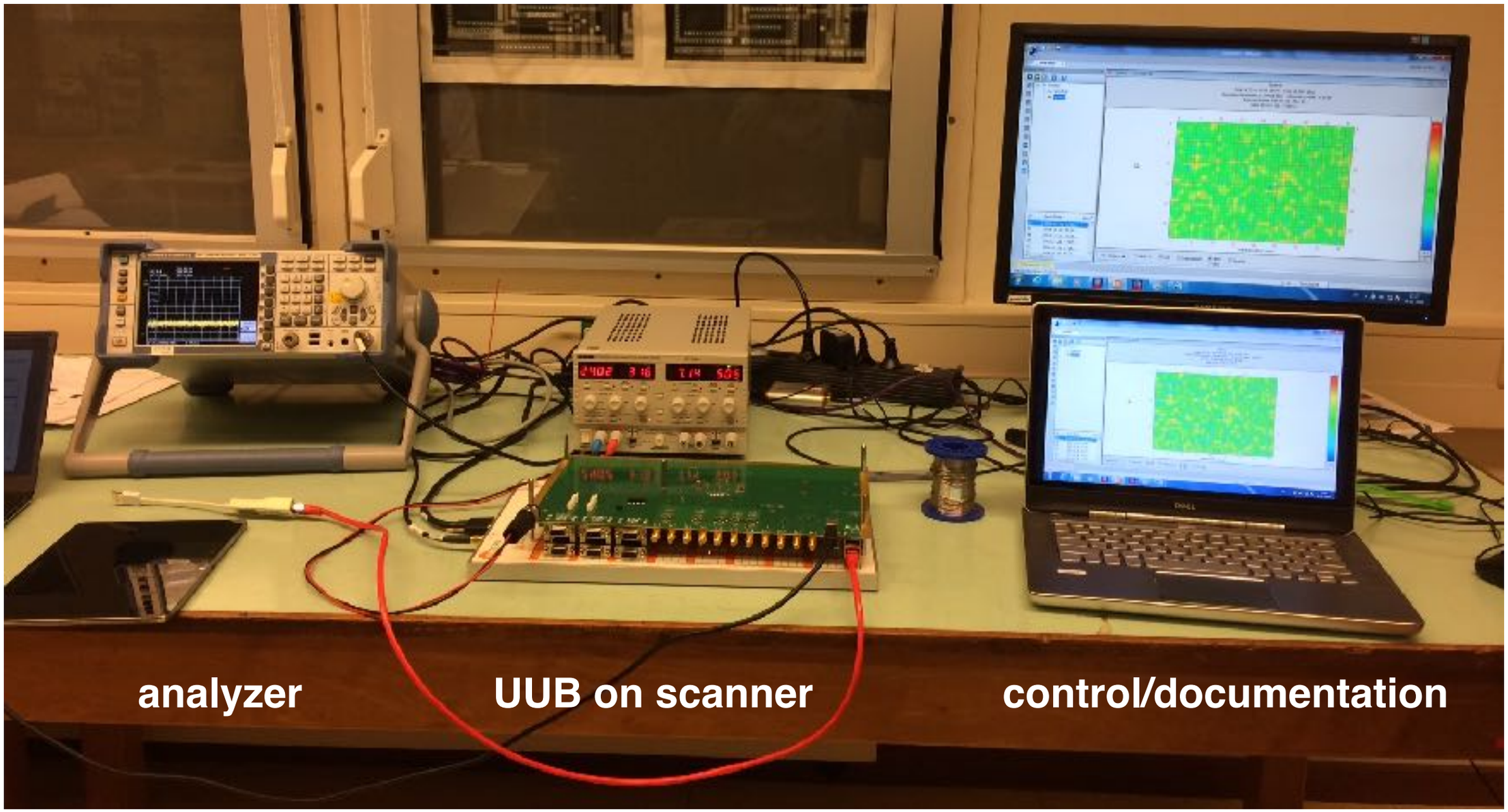
—> we need to identify the RFI source(s) on the UUB and try to put appropriate filters on the board

desired situation to measure air showers

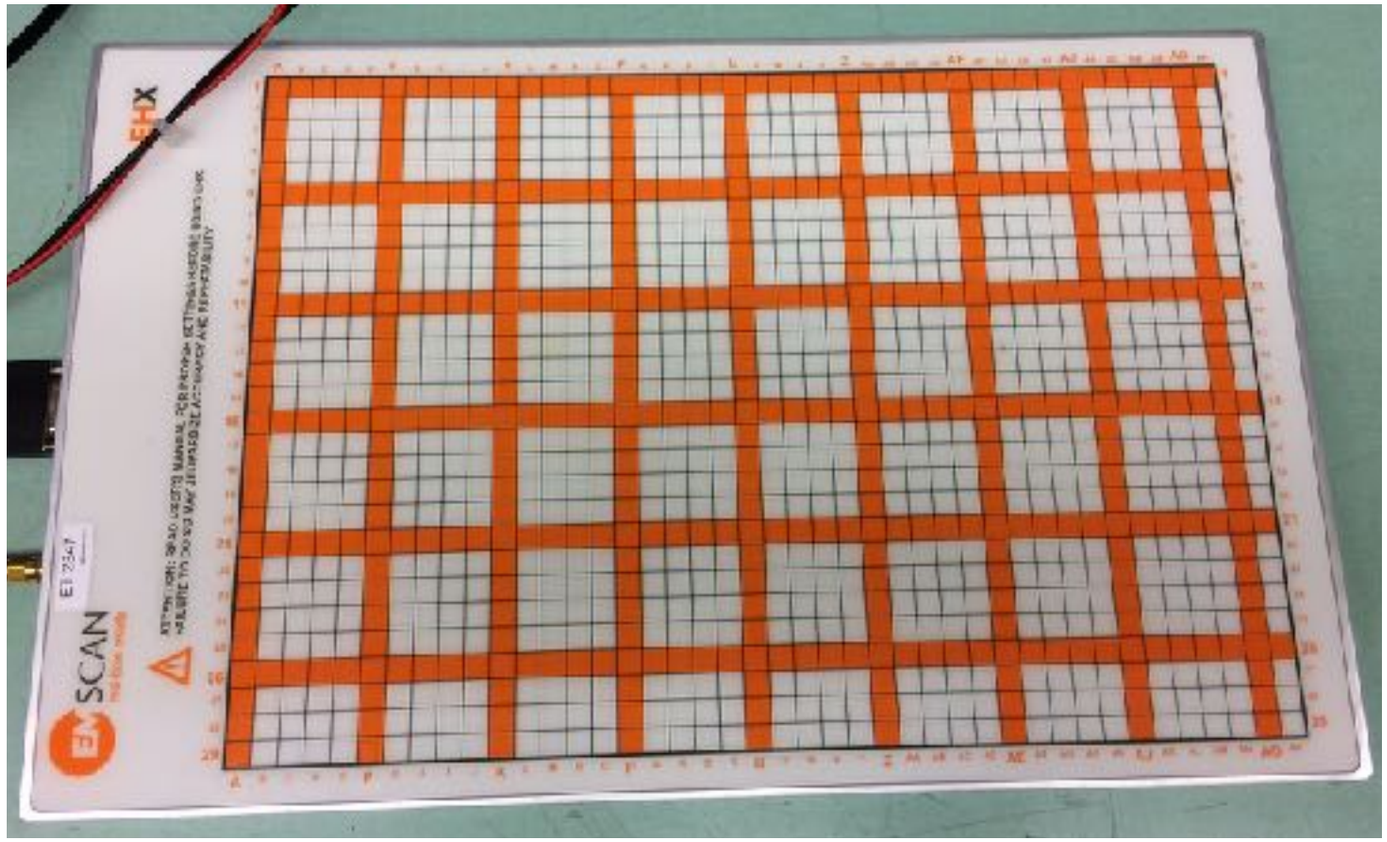
UUB RFI measurements

Nikhef 28 November 2018

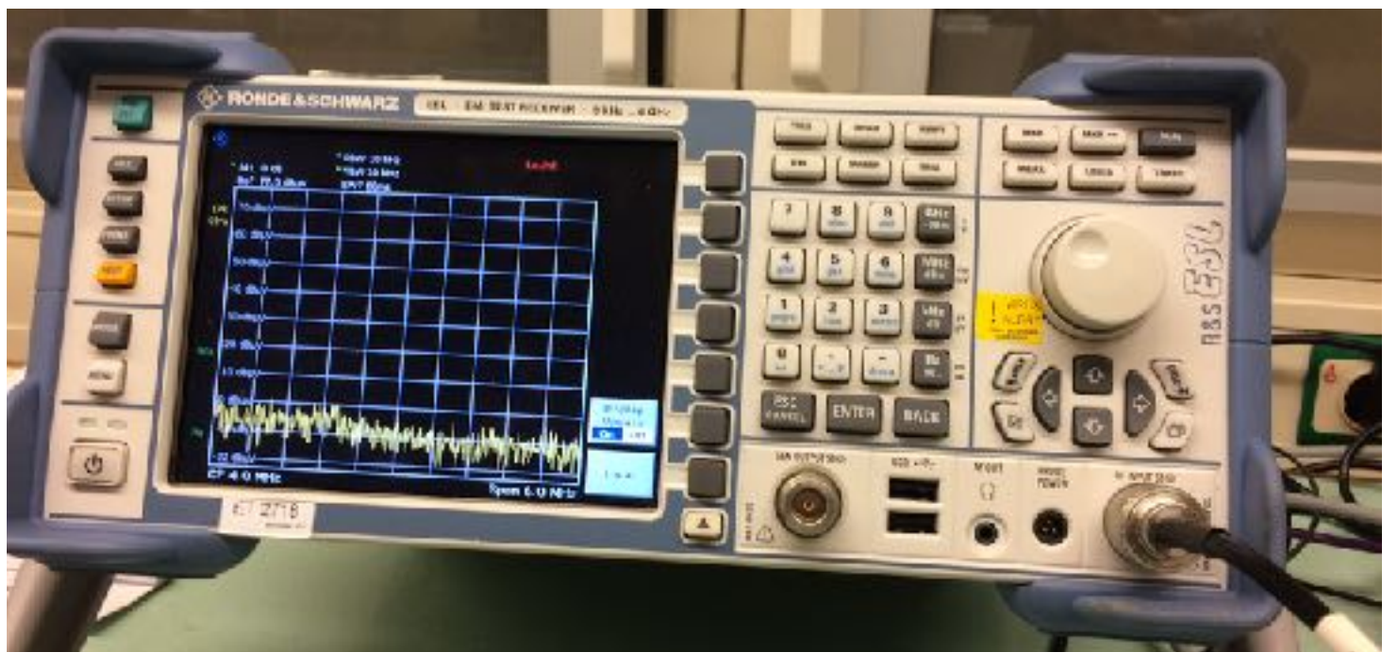
Hans Verkooijen
Julian Rautenberg
Jörg R. Hörandel



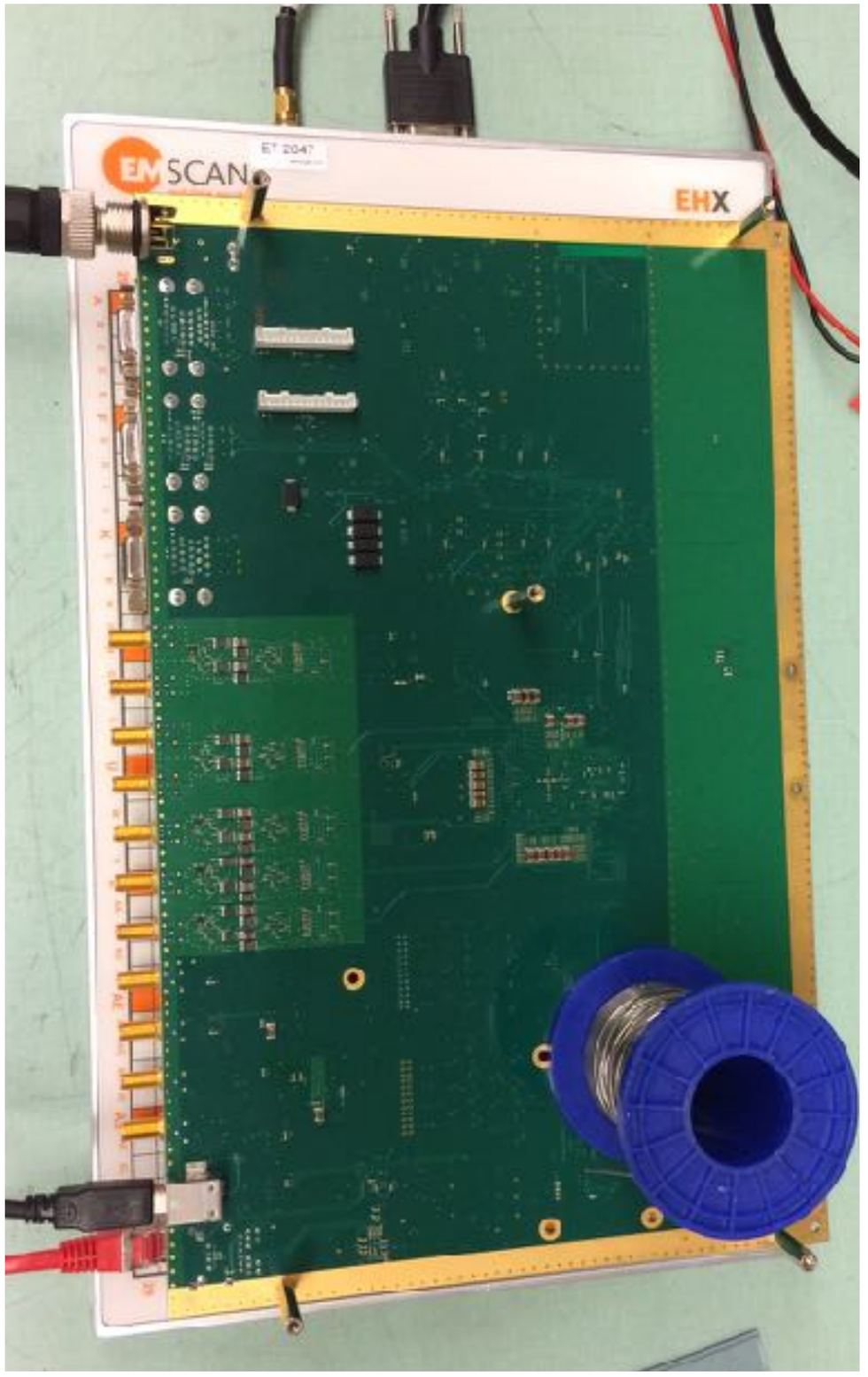
scanner

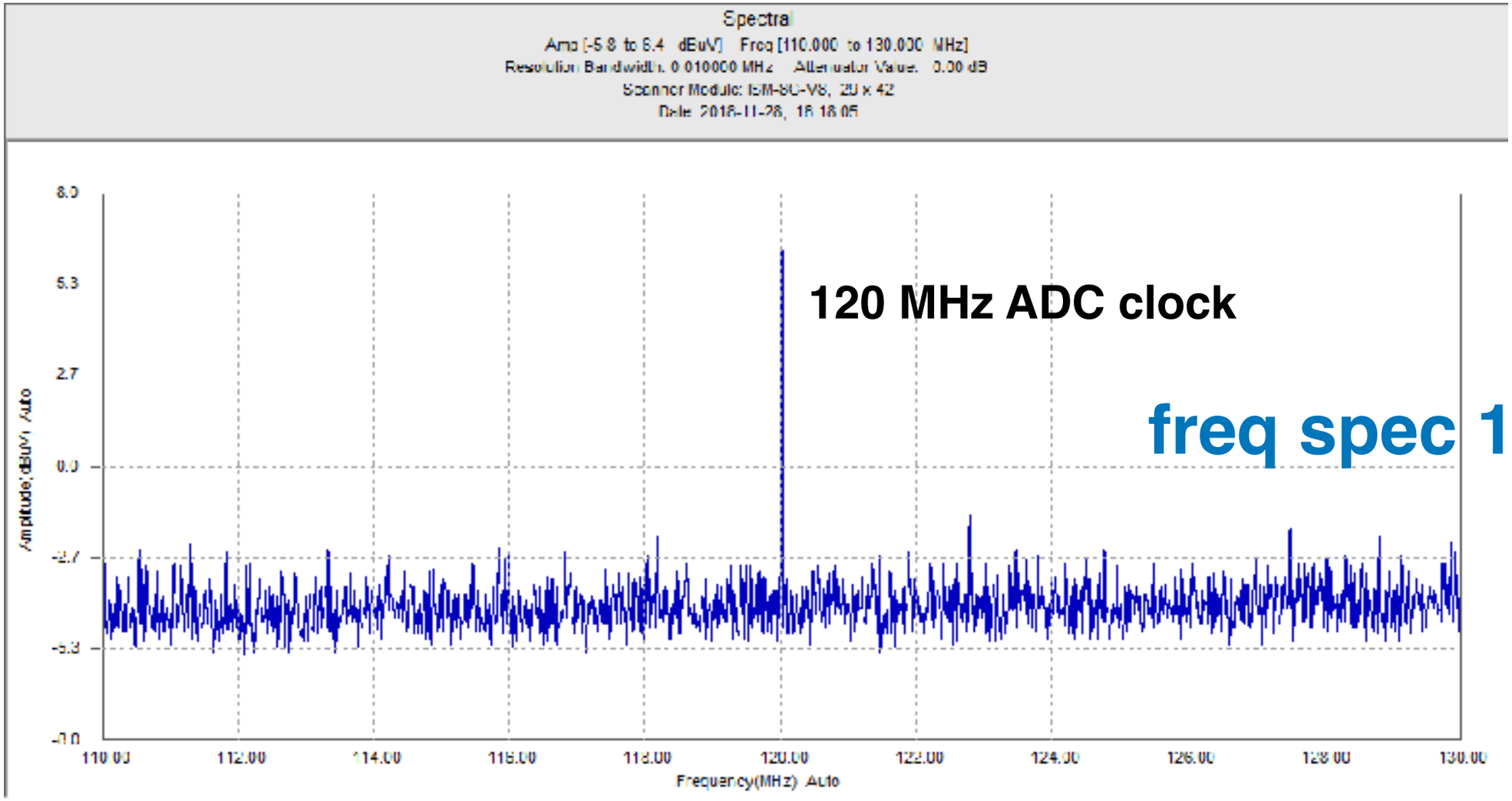


analyzer



UUB on scanner





freq spec 110 - 130 MHz

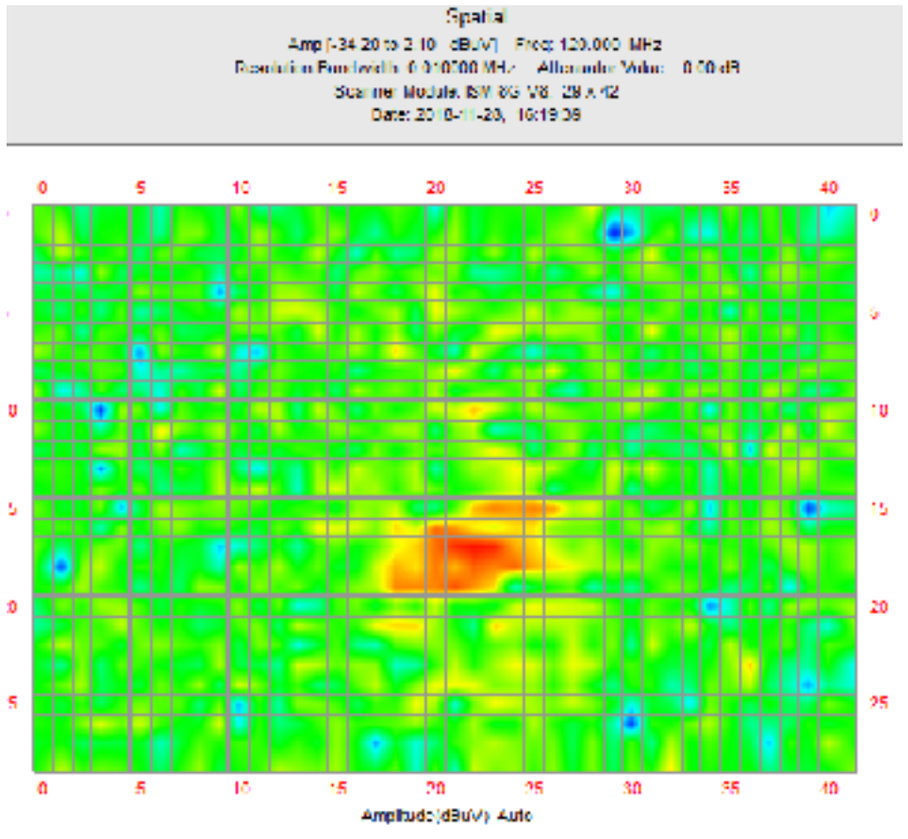


image of UUB at 120 MHz

120 MHz ADC clock
clock visible - not ADCs itself

freq spec 0.15 - 1 MHz (3 kHz resolution)

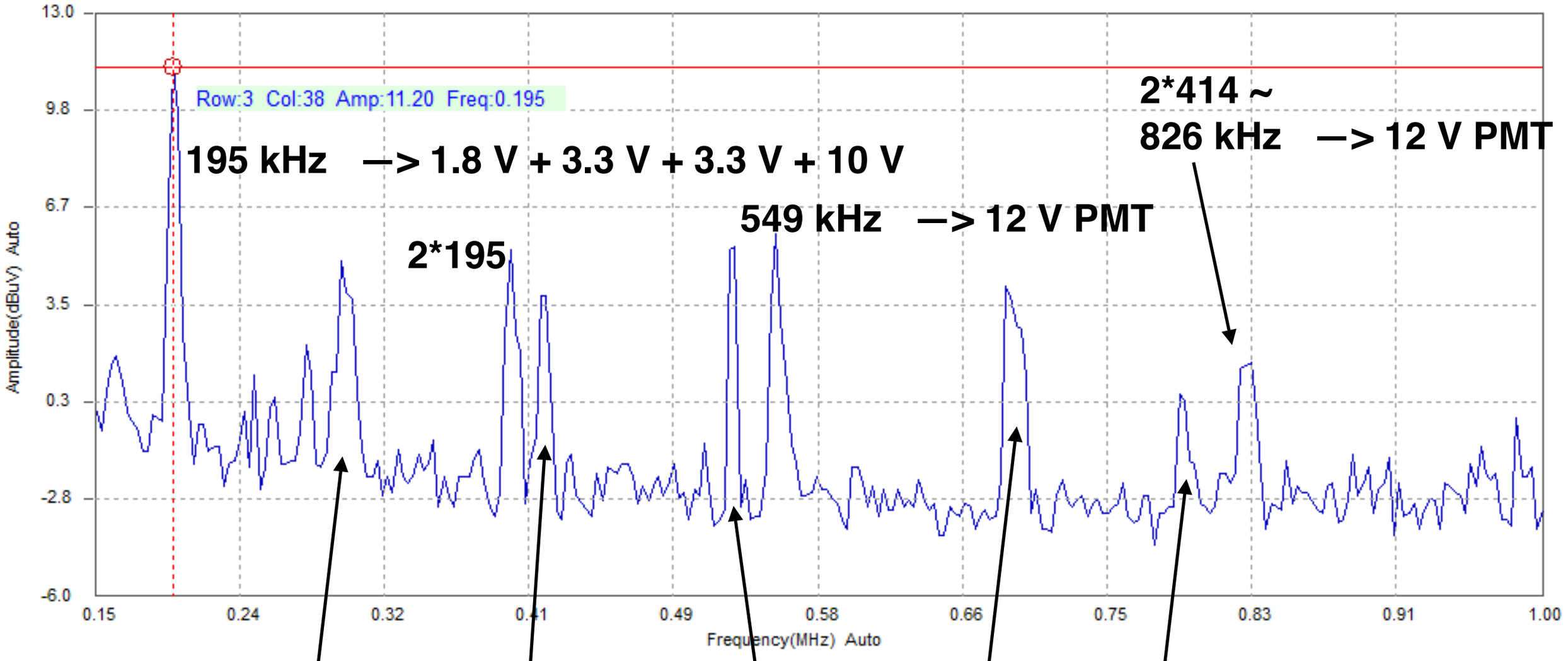
Spectral

Amp [-4.3 to 11.2 dBuV] Freq [0.150 to 1.000 MHz]

Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB

Scanner Module: ISM-8G-V8, 29 x 42

Date: 2018-11-28, 16:45:19



195 kHz —> 1.8 V + 3.3 V + 3.3 V + 10 V

2*195

549 kHz —> 12 V PMT

2*414 ~
826 kHz —> 12 V PMT

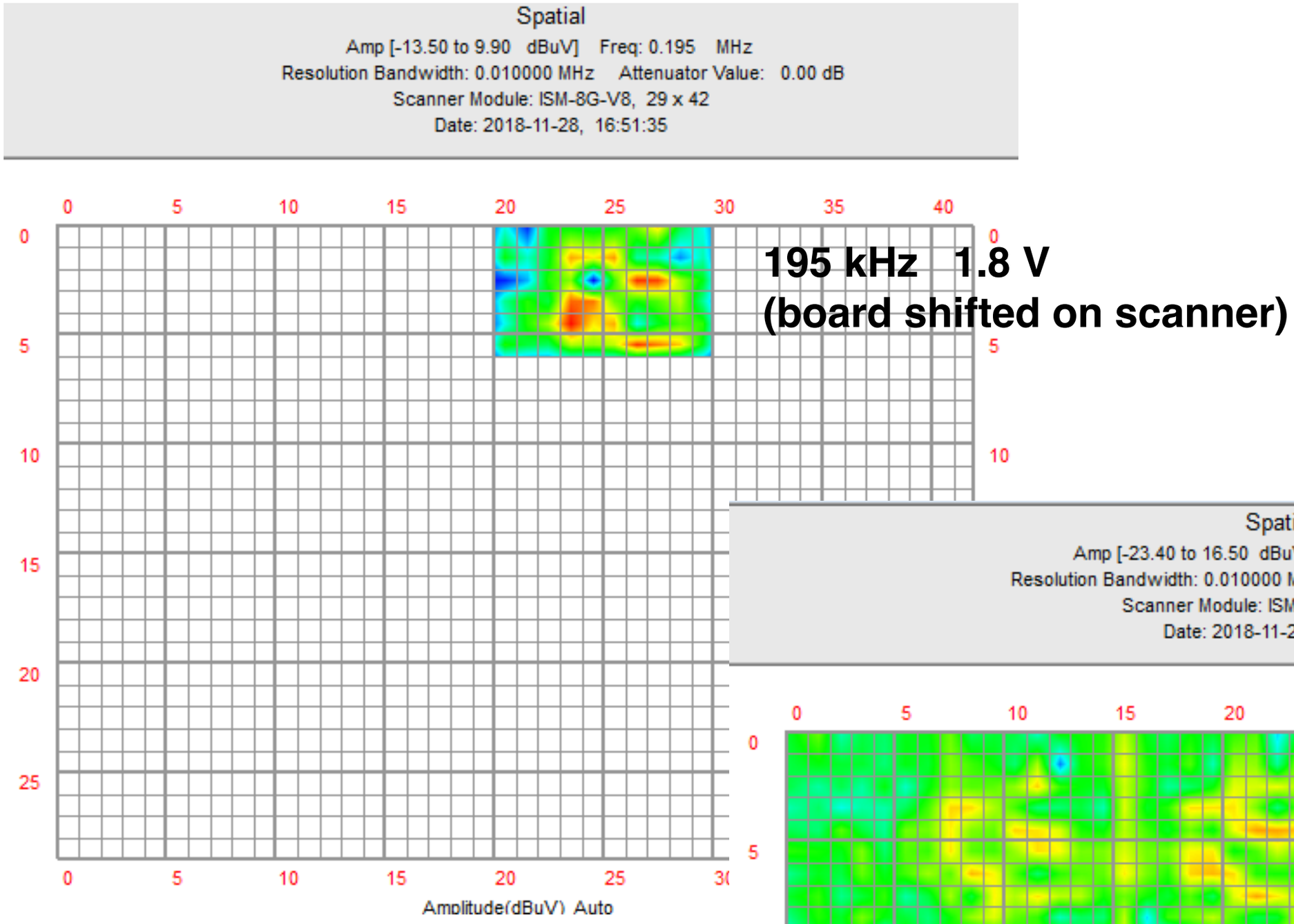
294 kHz —> 1.8 V + 3.3 V

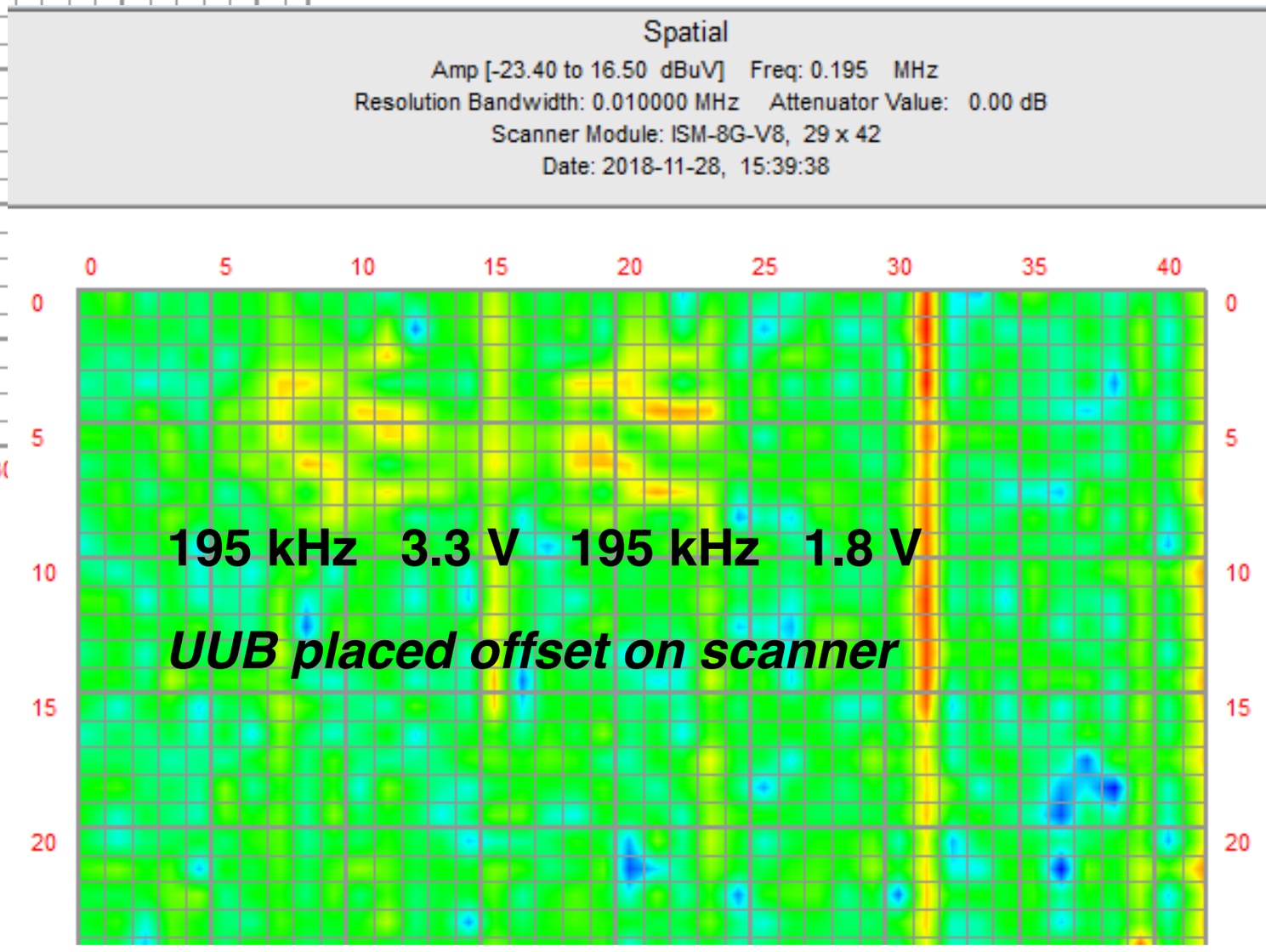
414 kHz 12 V PMT

523 kHz —> 3.3 V

688 kHz
12 V PMT

787 kHz —> 3.3 V


Spatial
Amp [-13.50 to 9.90 dBuV] Freq: 0.195 MHz
Resolution Bandwidth: 0.010000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 16:51:35
195 kHz 1.8 V
(board shifted on scanner)
Amplitude(dBuV) Auto


Spatial
Amp [-23.40 to 16.50 dBuV] Freq: 0.195 MHz
Resolution Bandwidth: 0.010000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 15:39:38
195 kHz 3.3 V 195 kHz 1.8 V
UUB placed offset on scanner

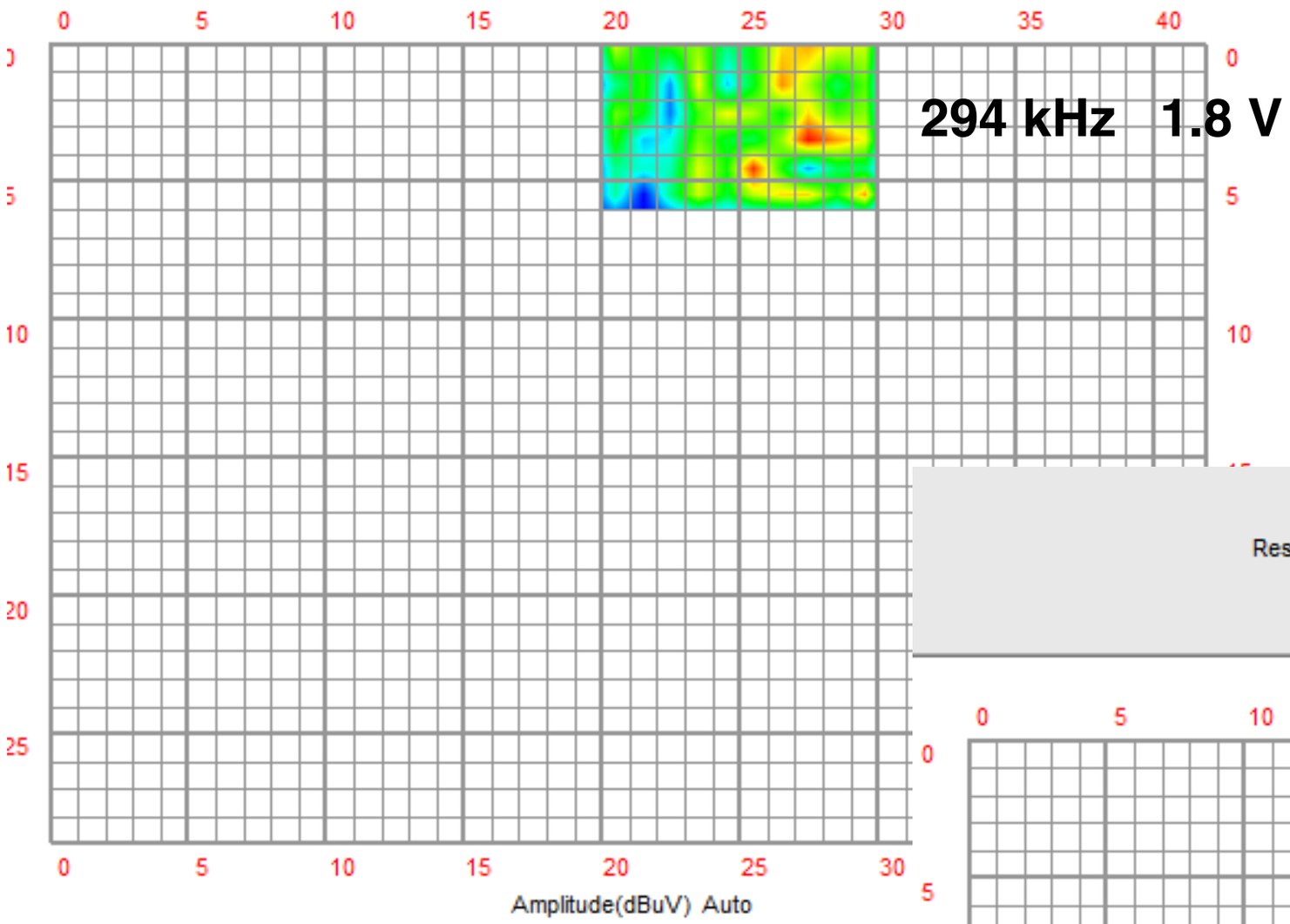
Spatial

Amp [-16.10 to 6.50 dBuV] Freq: 0.294 MHz

Resolution Bandwidth: 0.010000 MHz Attenuator Value: 0.00 dB

Scanner Module: ISM-8G-V8, 29 x 42

Date: 2018-11-28, 16:48:17



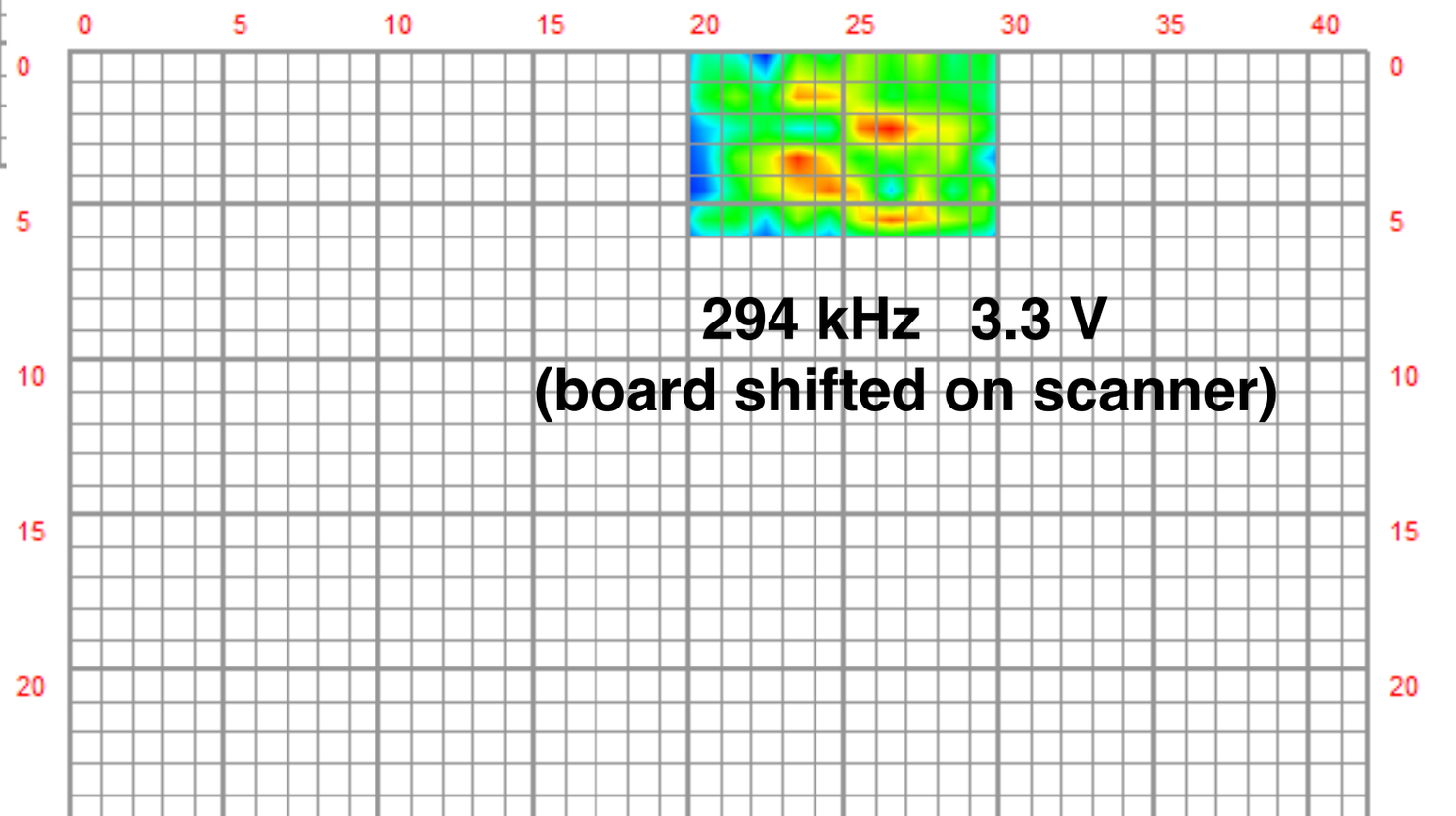
Spatial

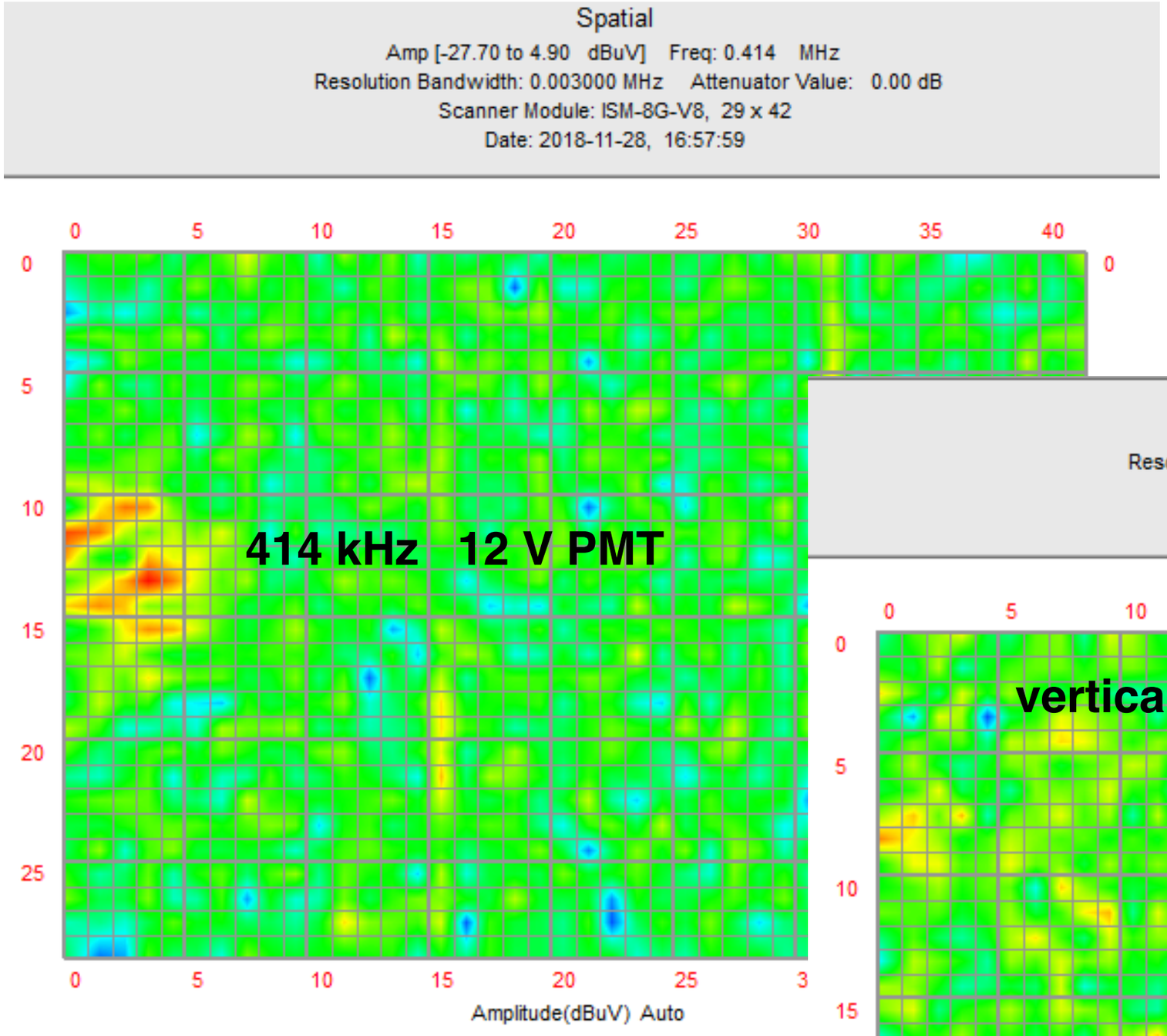
Amp [-12.30 to 11.80 dBuV] Freq: 0.195 MHz

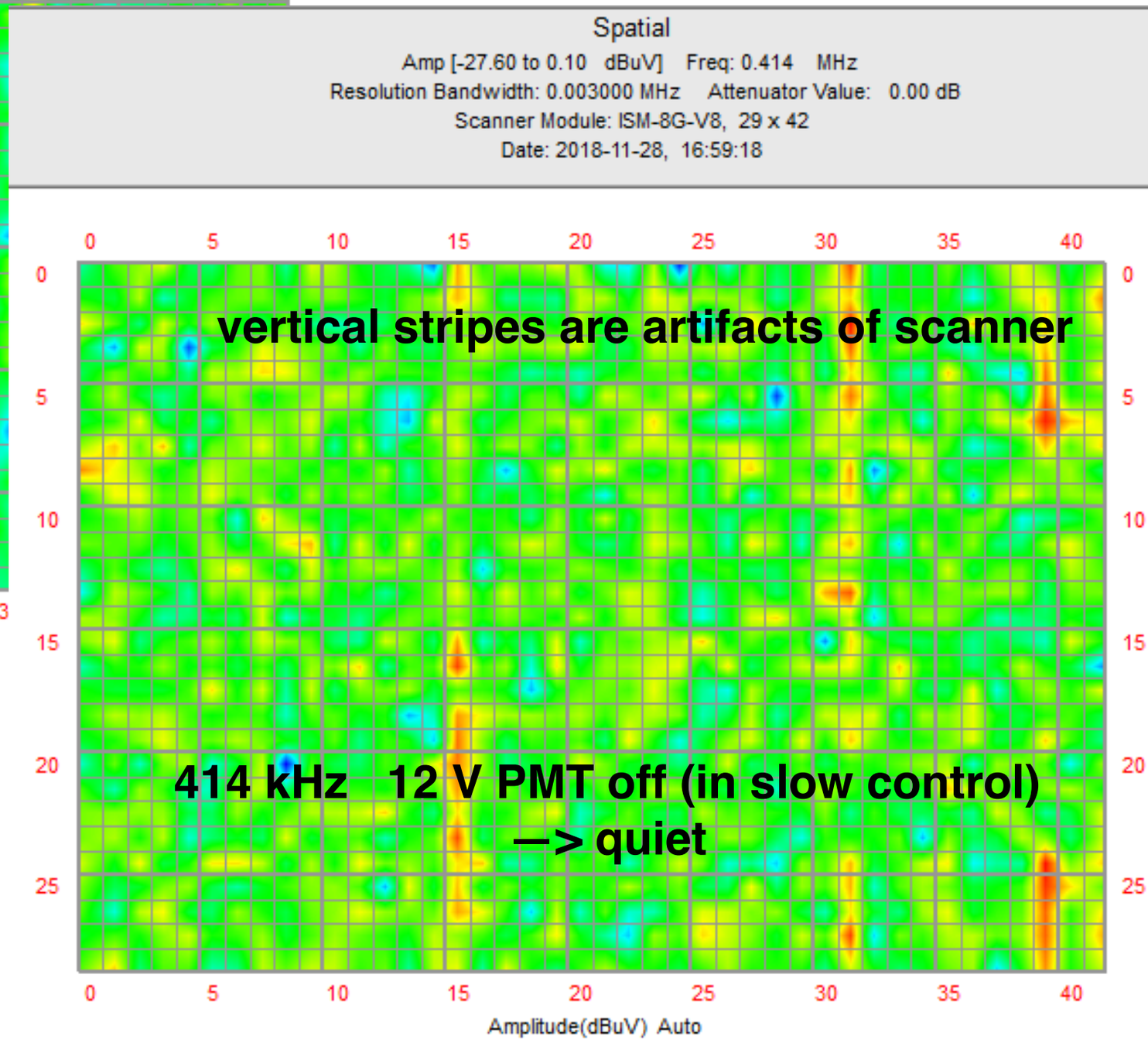
Resolution Bandwidth: 0.010000 MHz Attenuator Value: 0.00 dB

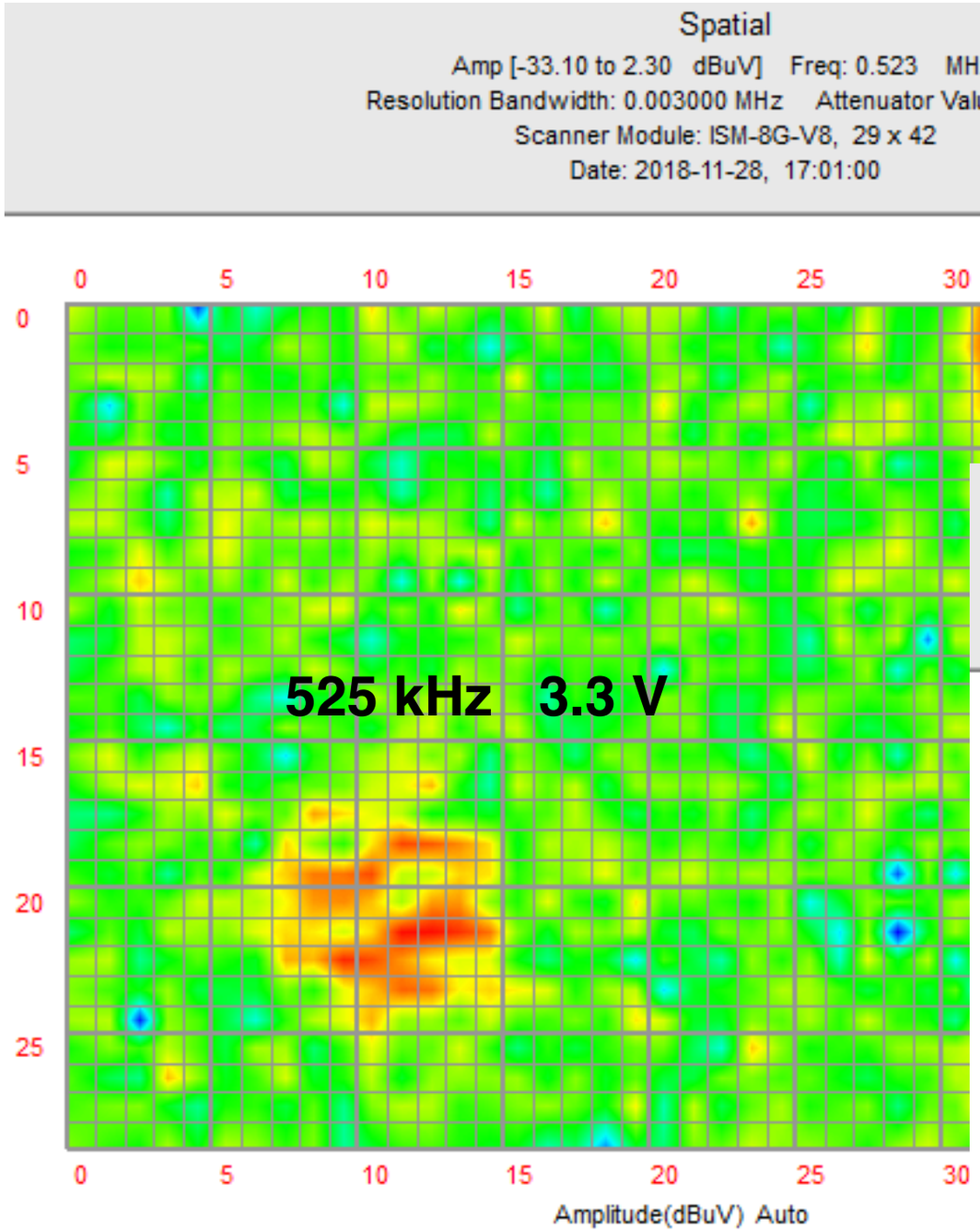
Scanner Module: ISM-8G-V8, 29 x 42

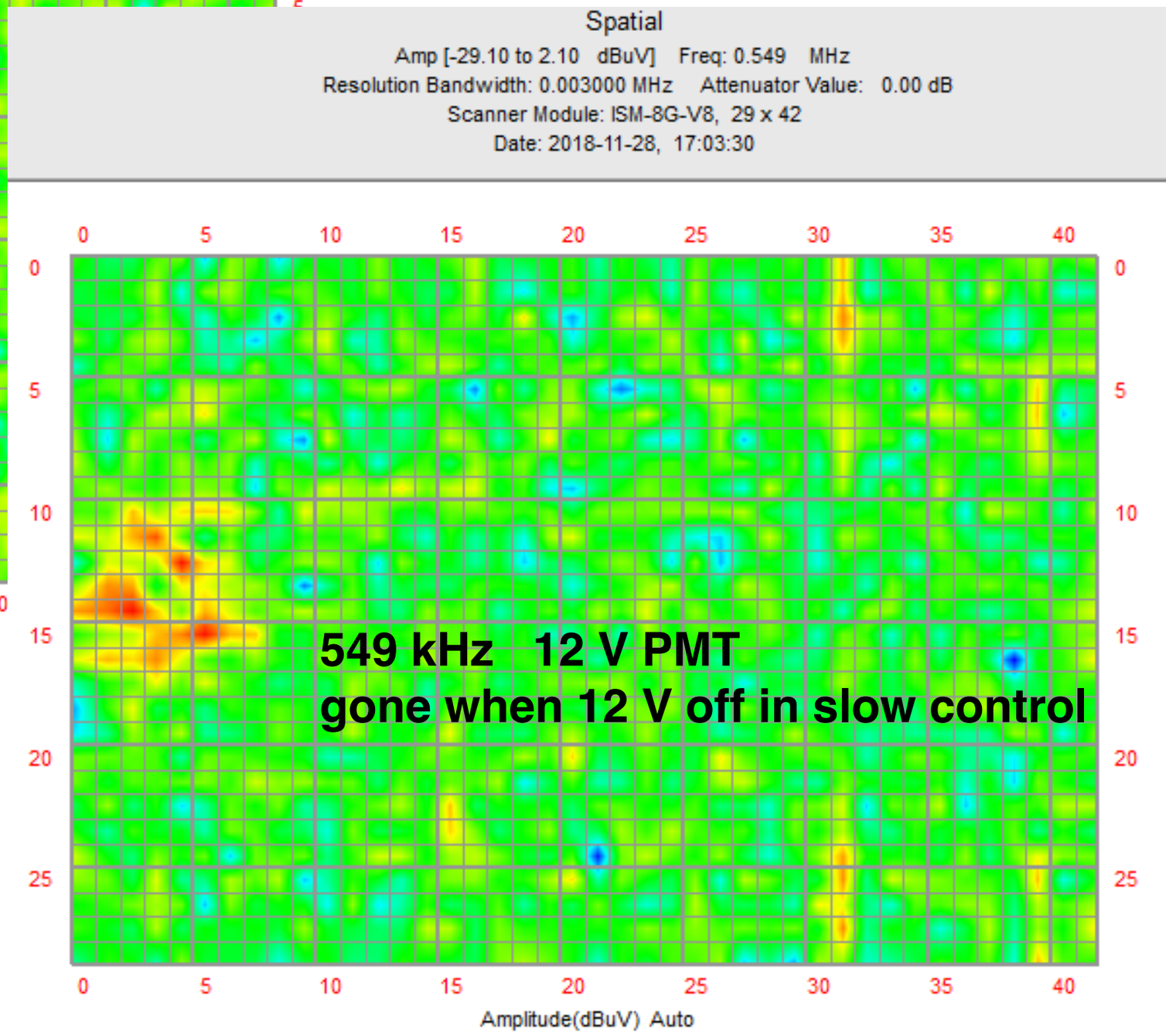
Date: 2018-11-28, 16:53:07

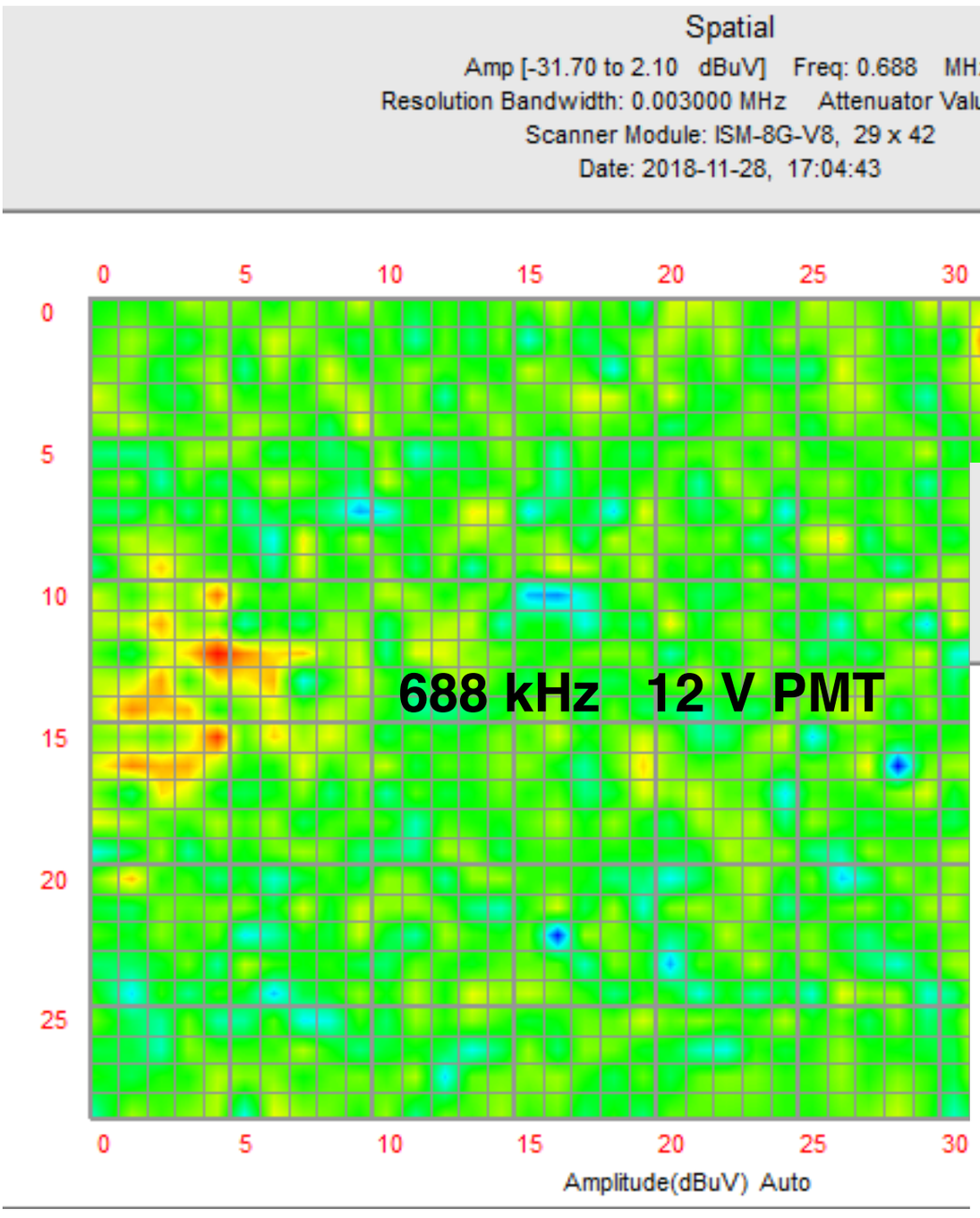


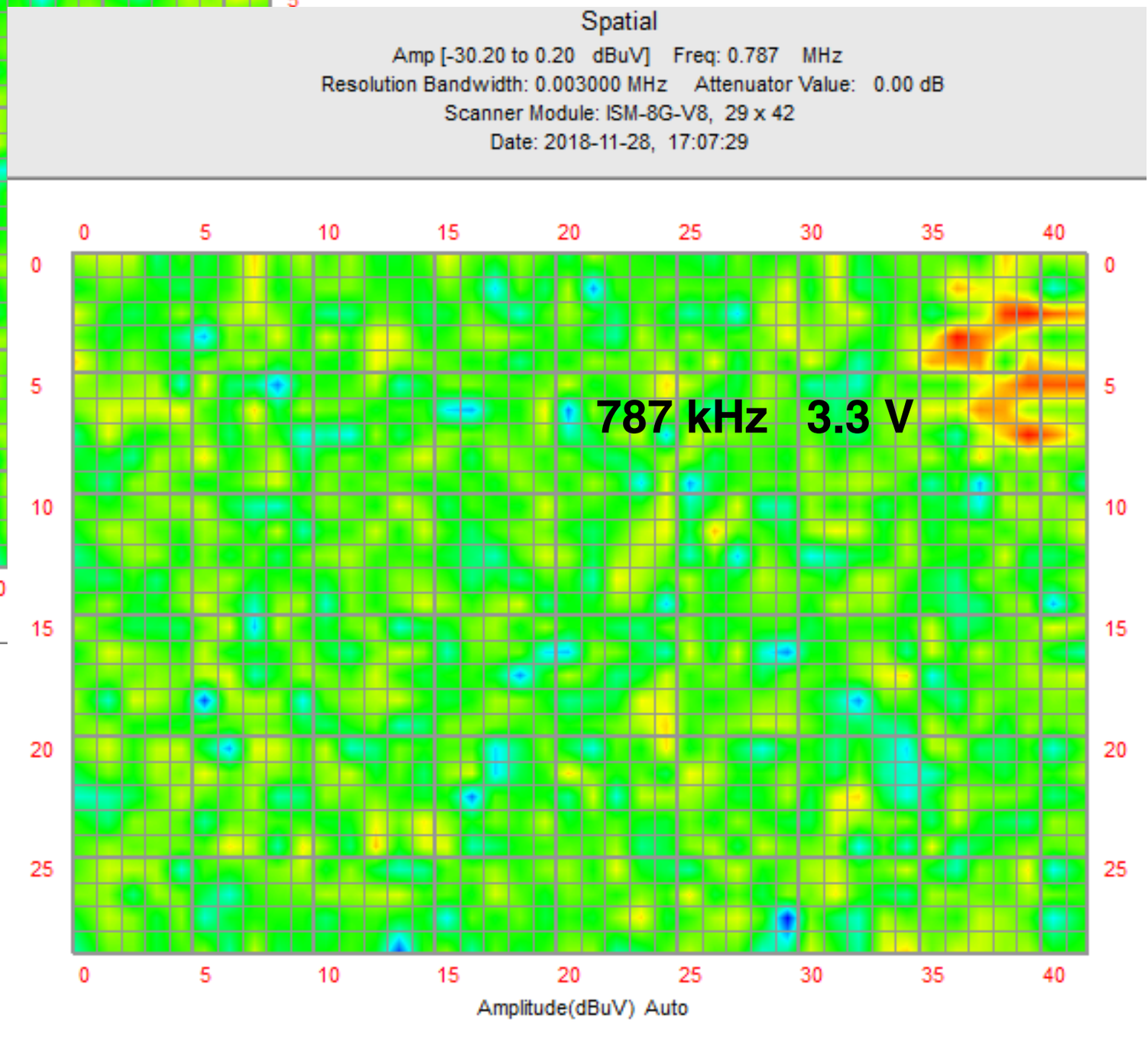

Spatial
Amp [-27.70 to 4.90 dBuV] Freq: 0.414 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 16:57:59
0 5 10 15 20 25 30 35 40
0 5 10 15 20 25
414 kHz 12 V PMT
0 5 10 15 20 25 3
Amplitude(dBuV) Auto


Spatial
Amp [-27.60 to 0.10 dBuV] Freq: 0.414 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 16:59:18
0 5 10 15 20 25 30 35 40
0 5 10 15 20 25
vertical stripes are artifacts of scanner
414 kHz 12 V PMT off (in slow control)
—> quiet
0 5 10 15 20 25 30 35 40
Amplitude(dBuV) Auto


Spatial
Amp [-33.10 to 2.30 dBuV] Freq: 0.523 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 17:01:00
525 kHz 3.3 V
Amplitude(dBuV) Auto


Spatial
Amp [-29.10 to 2.10 dBuV] Freq: 0.549 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 17:03:30
549 kHz 12 V PMT
gone when 12 V off in slow control
Amplitude(dBuV) Auto


Spatial
Amp [-31.70 to 2.10 dBuV] Freq: 0.688 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 17:04:43
688 kHz 12 V PMT
Amplitude(dBuV) Auto


Spatial
Amp [-30.20 to 0.20 dBuV] Freq: 0.787 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 17:07:29
787 kHz 3.3 V
Amplitude(dBuV) Auto

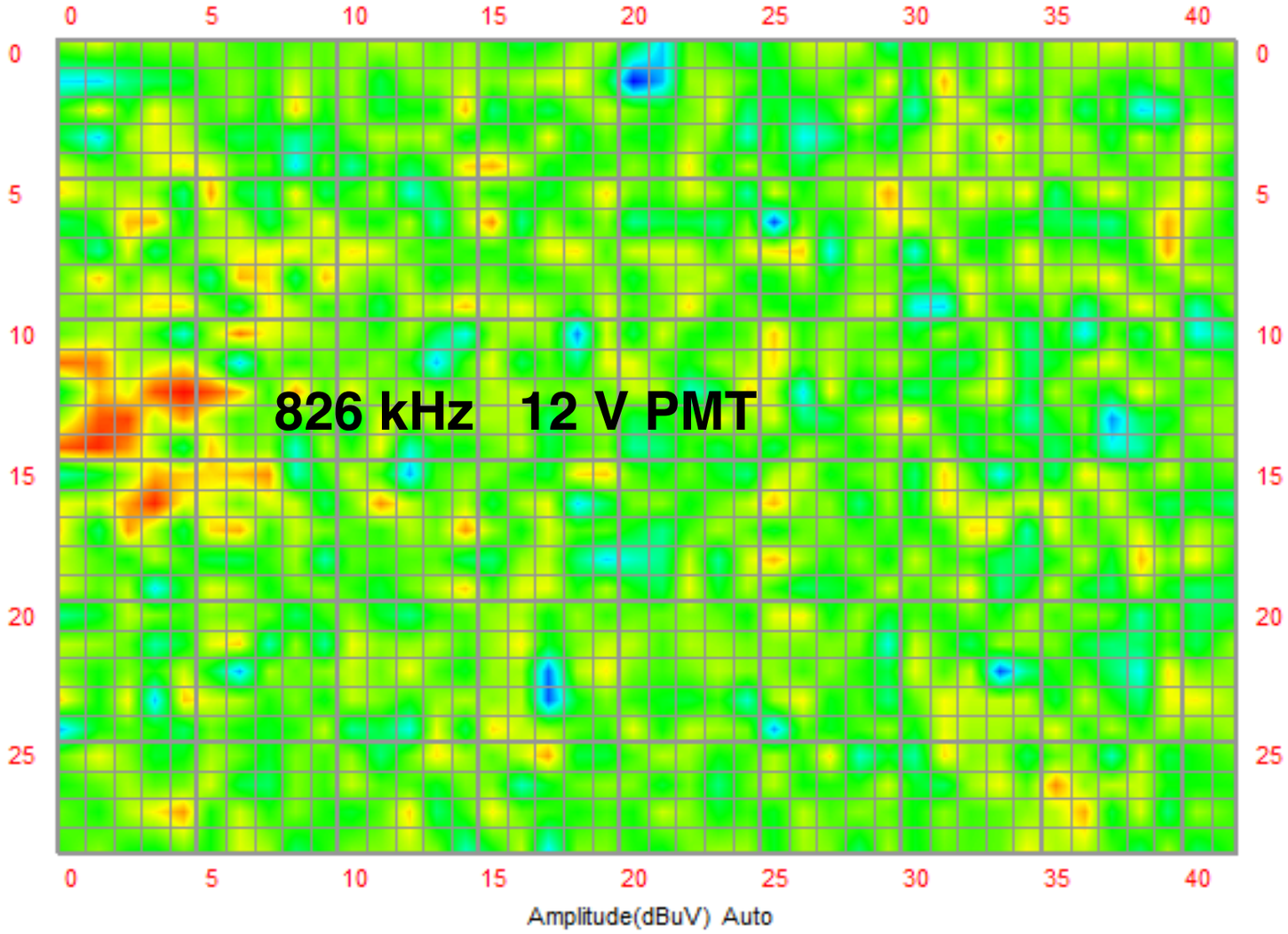
Spatial

Amp [-30.50 to -1.30 dBuV] Freq: 0.826 MHz

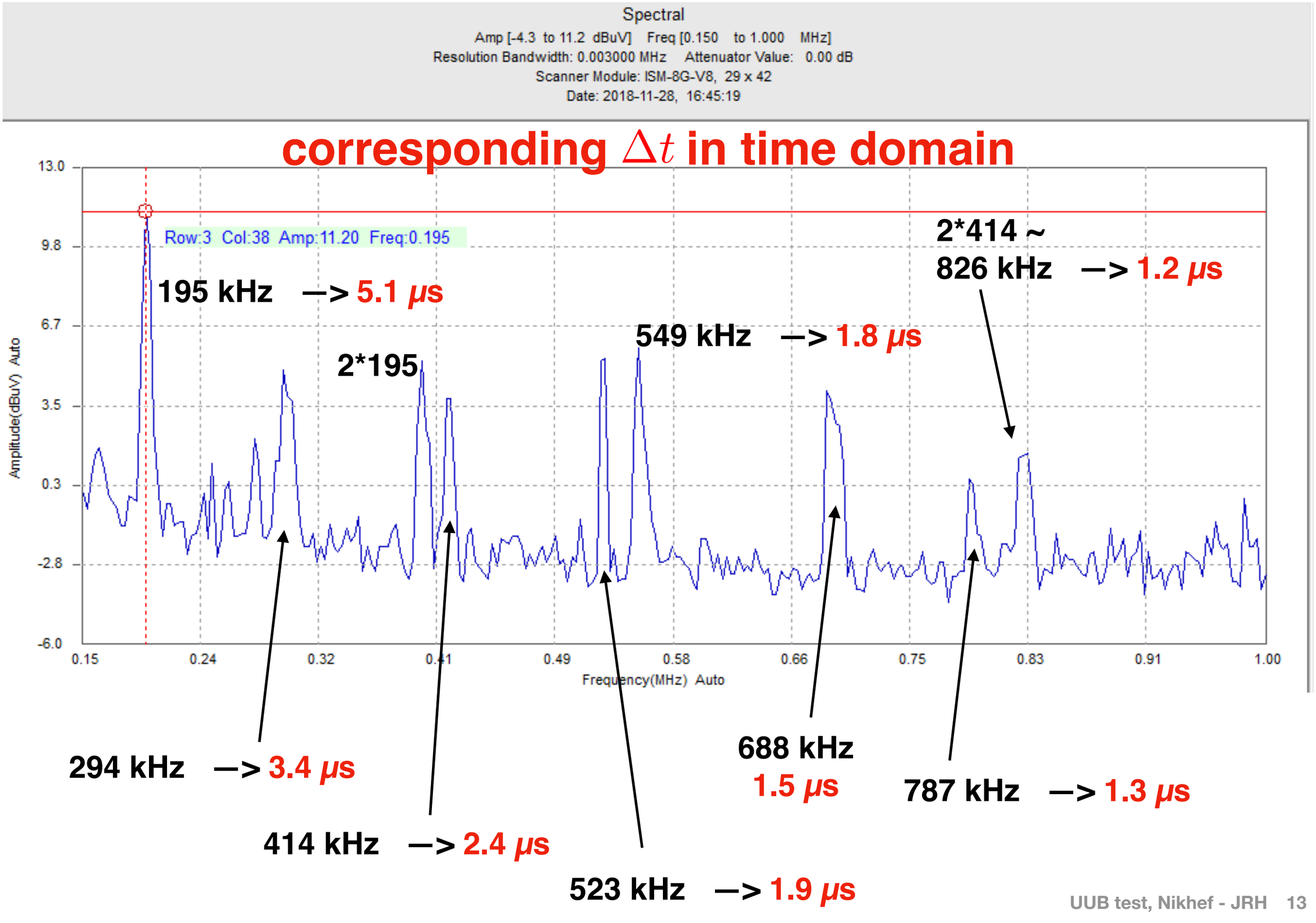
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB

Scanner Module: ISM-8G-V8, 29 x 42

Date: 2018-11-28, 17:08:52

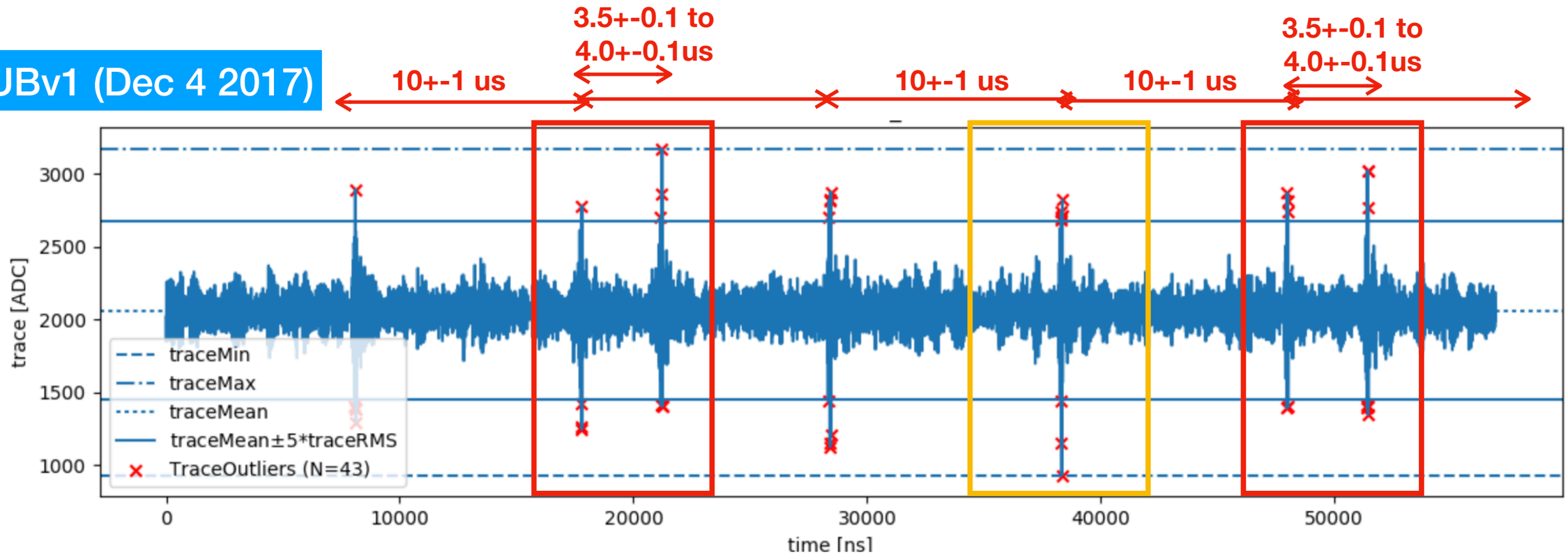


freq spec 0.15 - 1 MHz (3 kHz resolution)

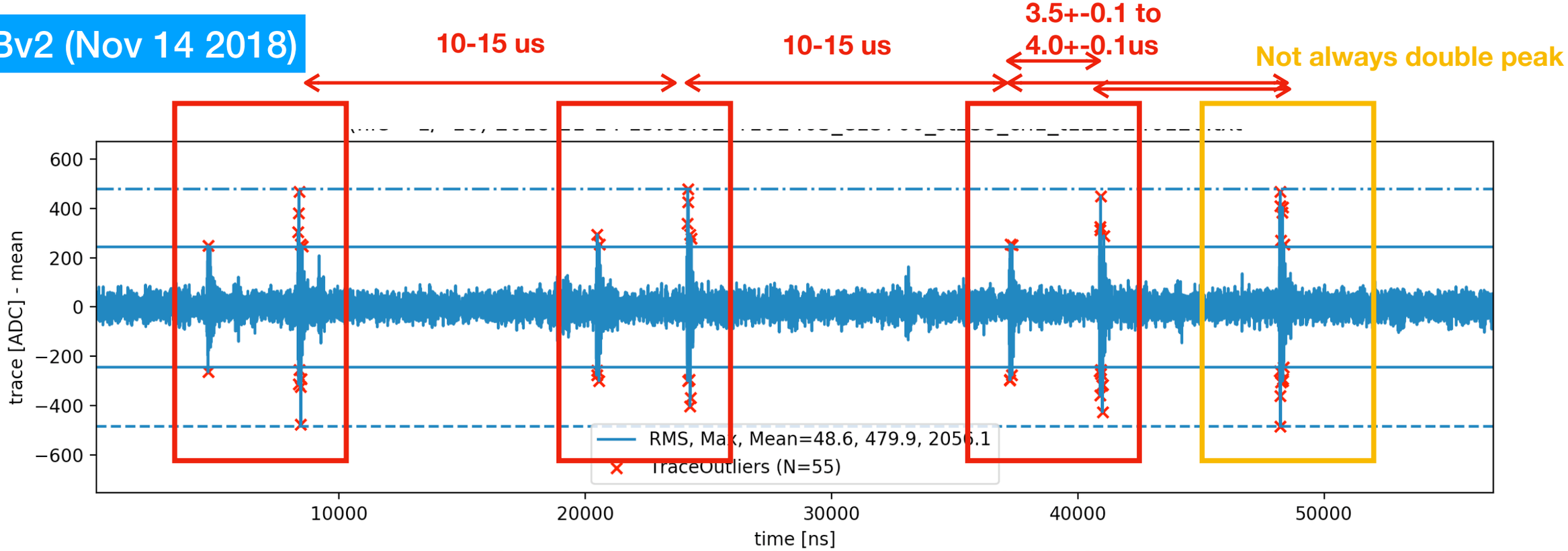


pulses sometimes come in pairs at regular intervals

UUBv1 (Dec 4 2017)



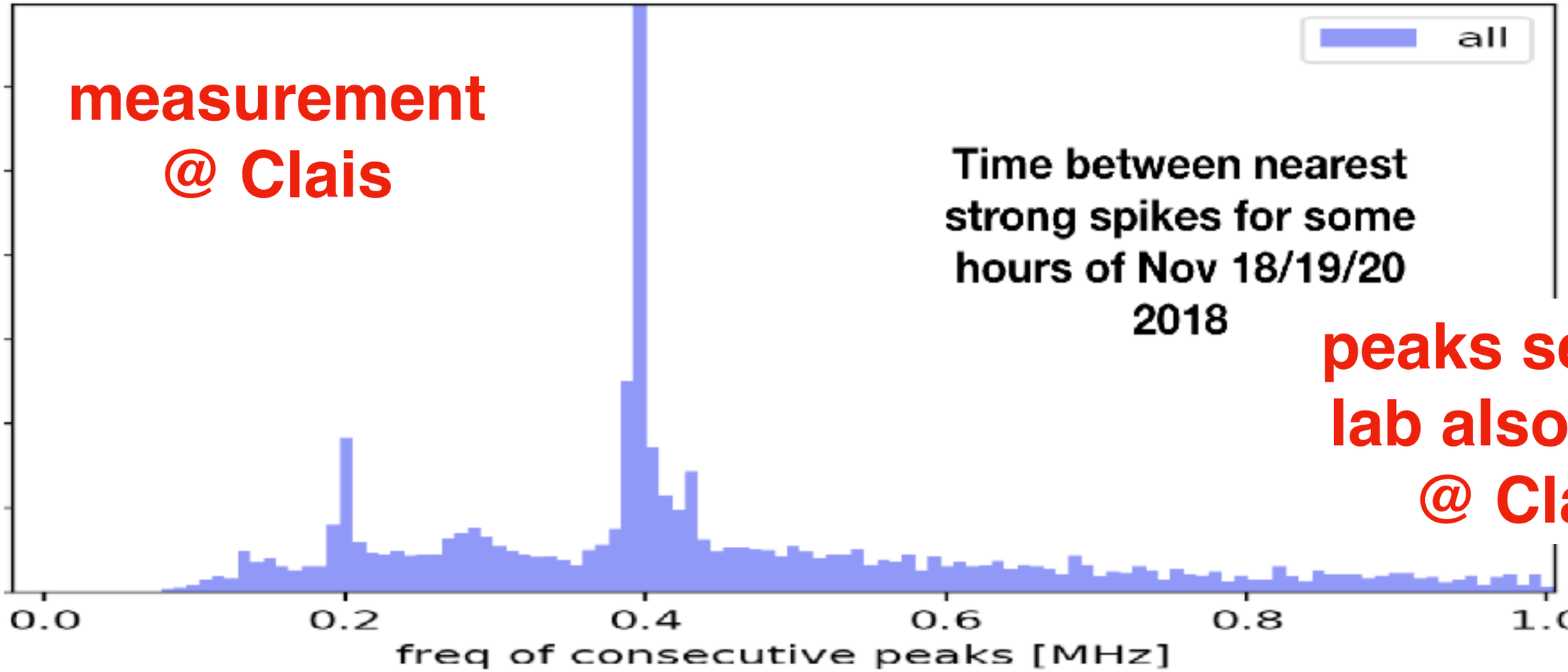
UUBv2 (Nov 14 2018)



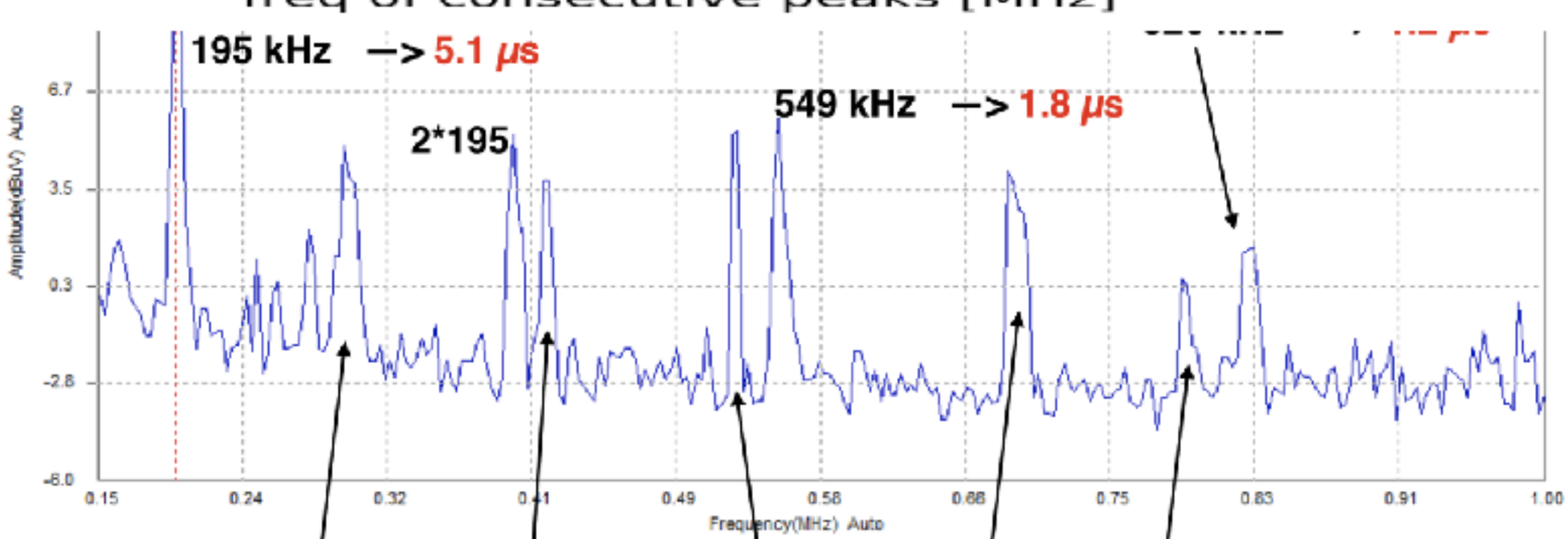
There is also some variation between individual traces regarding amount of double peaks

time-domain analysis Clais (B Pont)

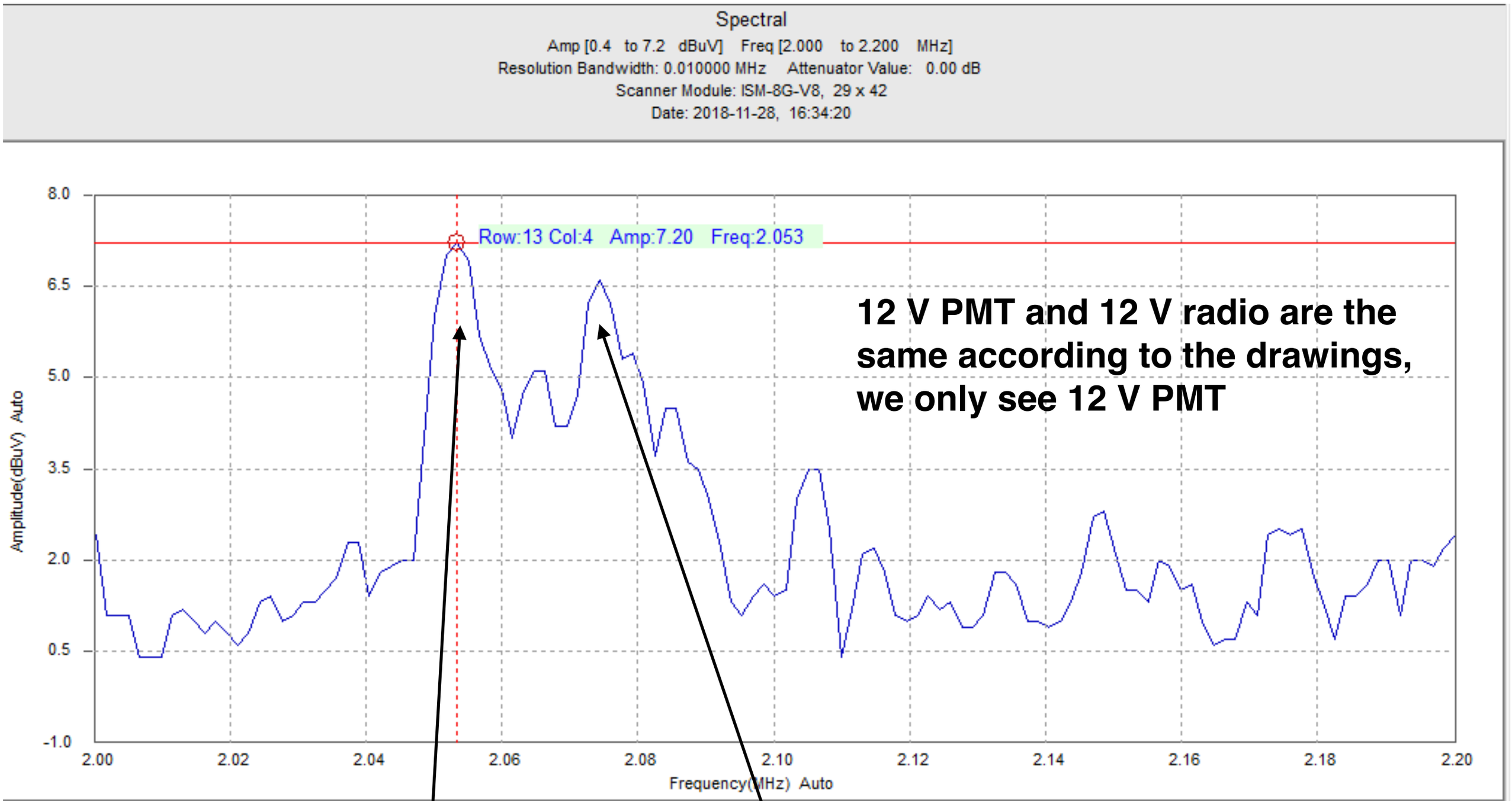
measurement @ Clais



peaks seen in lab also seen @ Clais



freq spec 2.0 - 2.2 MHz (10 kHz resolution)



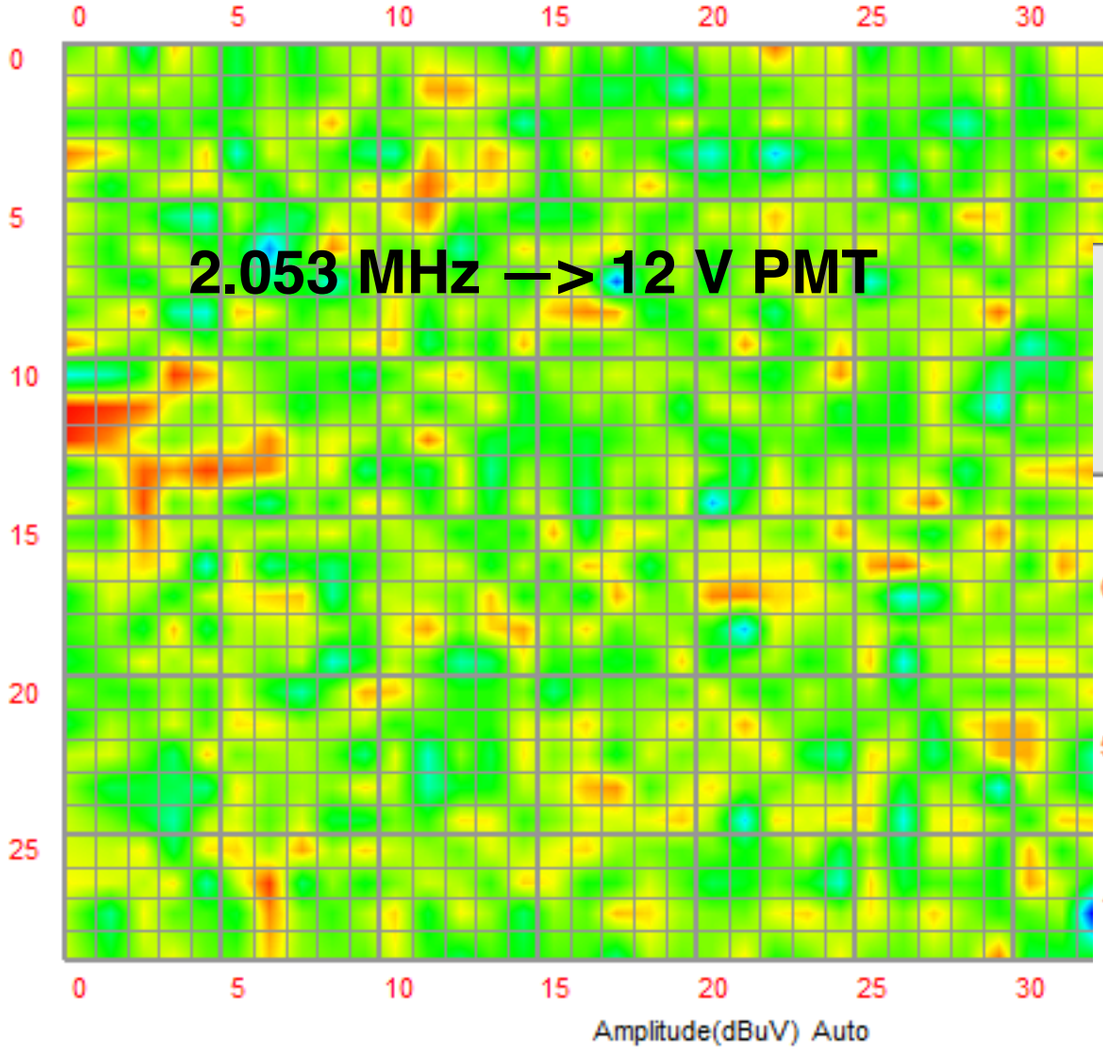
Spatial

Amp [-31.40 to -2.50 dBuV] Freq: 2.053 MHz

Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB

Scanner Module: ISM-8G-V8, 29 x 42

Date: 2018-11-28, 16:36:27



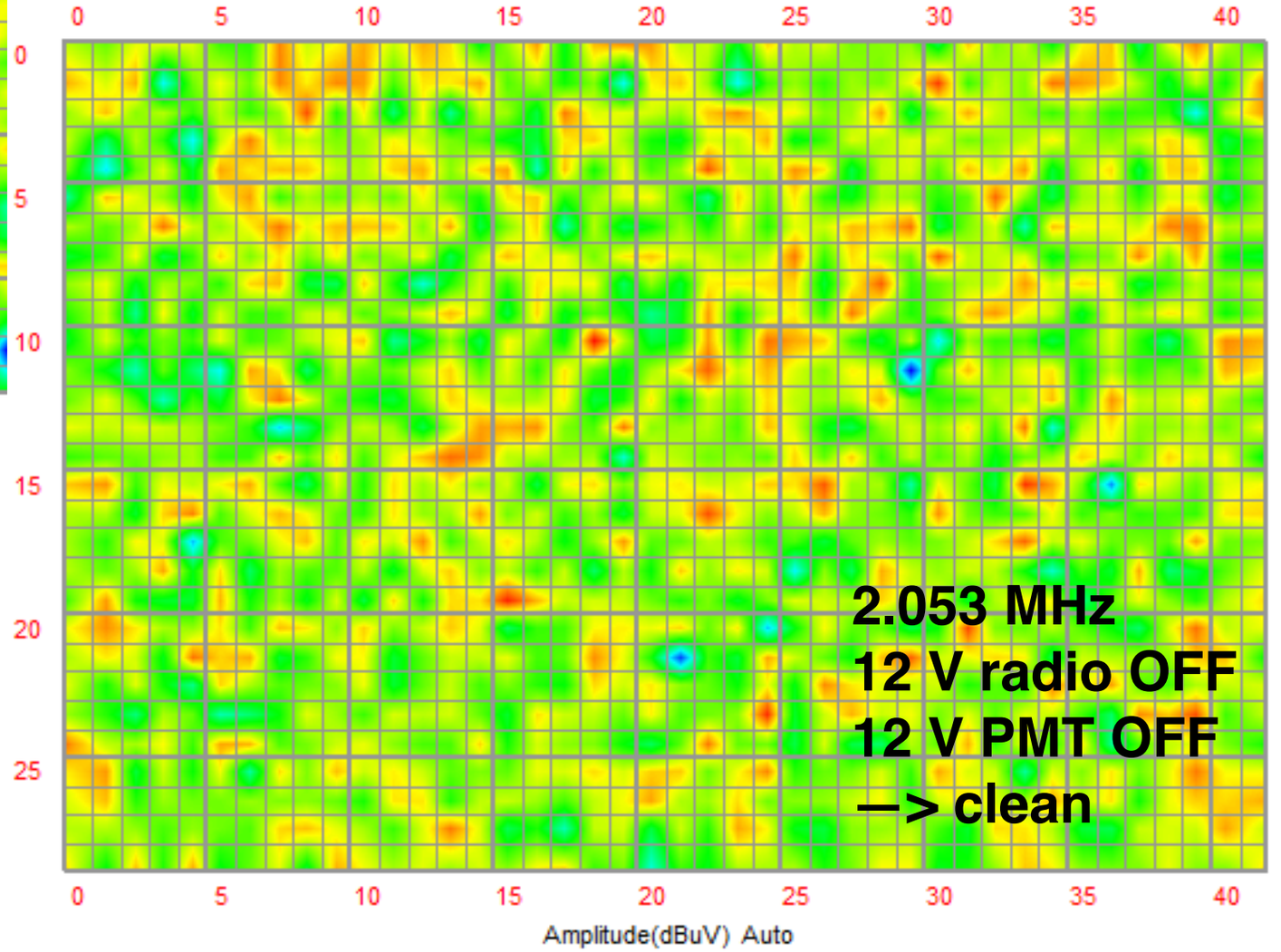
Spatial

Amp [-32.50 to -3.80 dBuV] Freq: 2.053 MHz

Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB

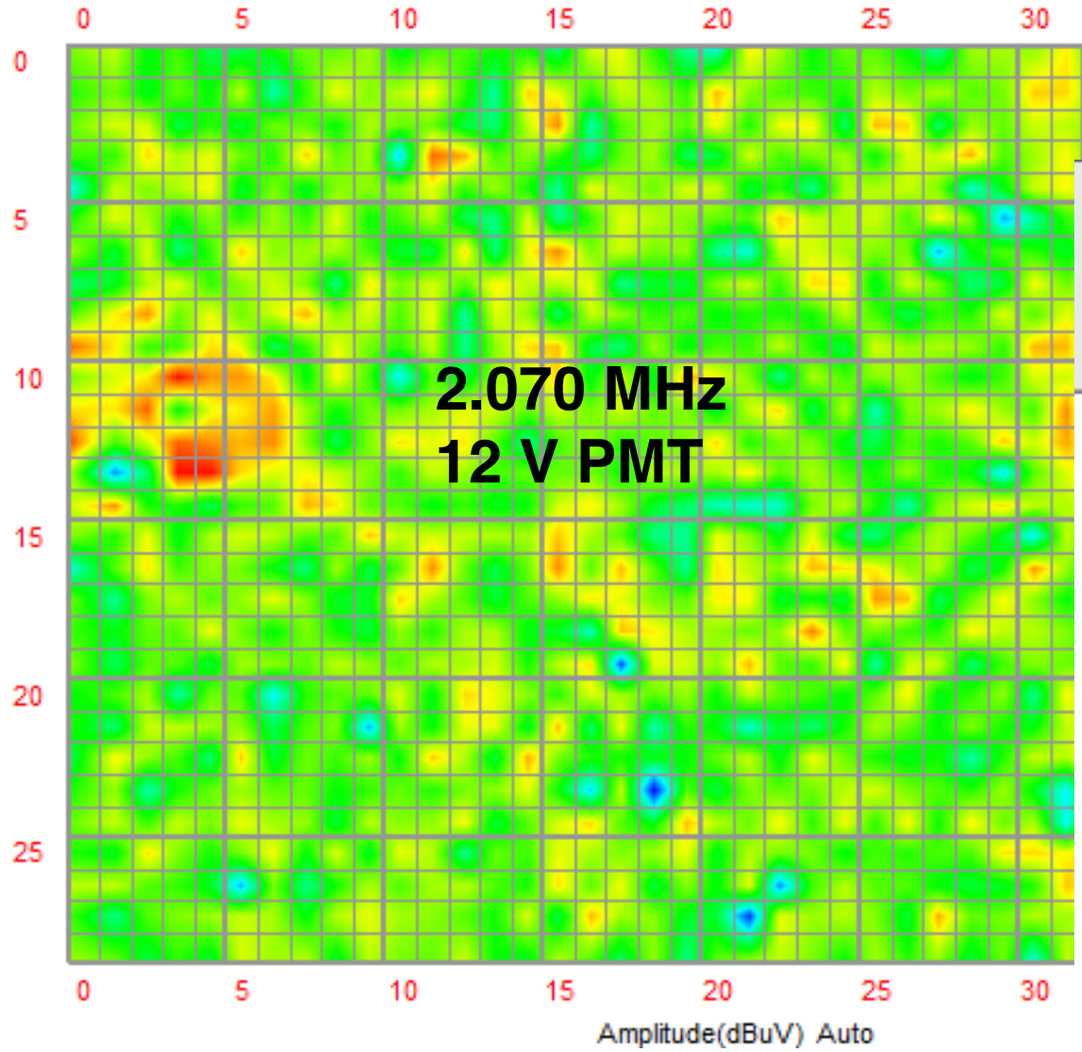
Scanner Module: ISM-8G-V8, 29 x 42

Date: 2018-11-28, 16:39:23



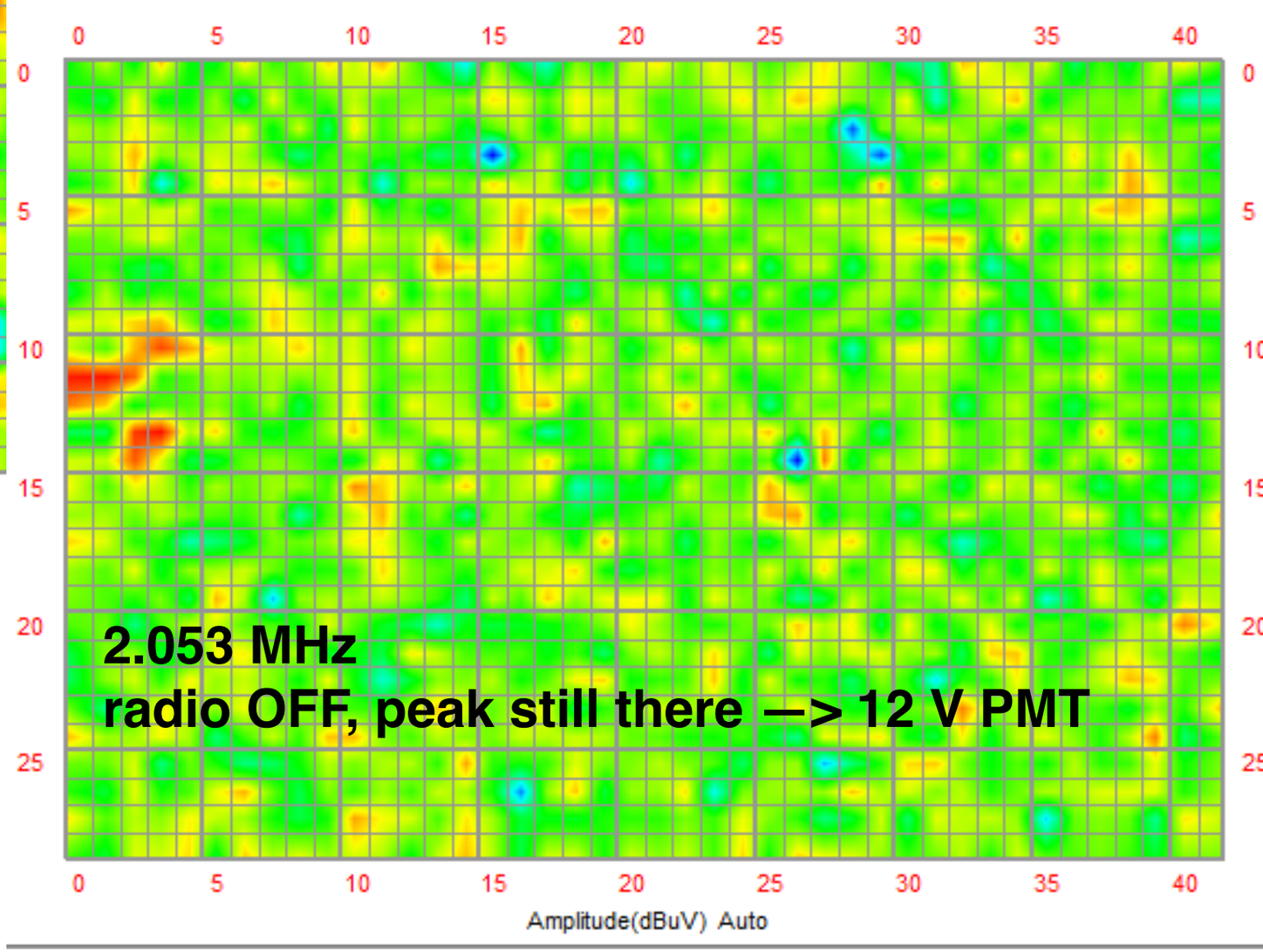
Spatial

Amp [-29.50 to 4.30 dBuV] Freq: 2.070 MHz
Resolution Bandwidth: 0.010000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 16:27:44



Spatial

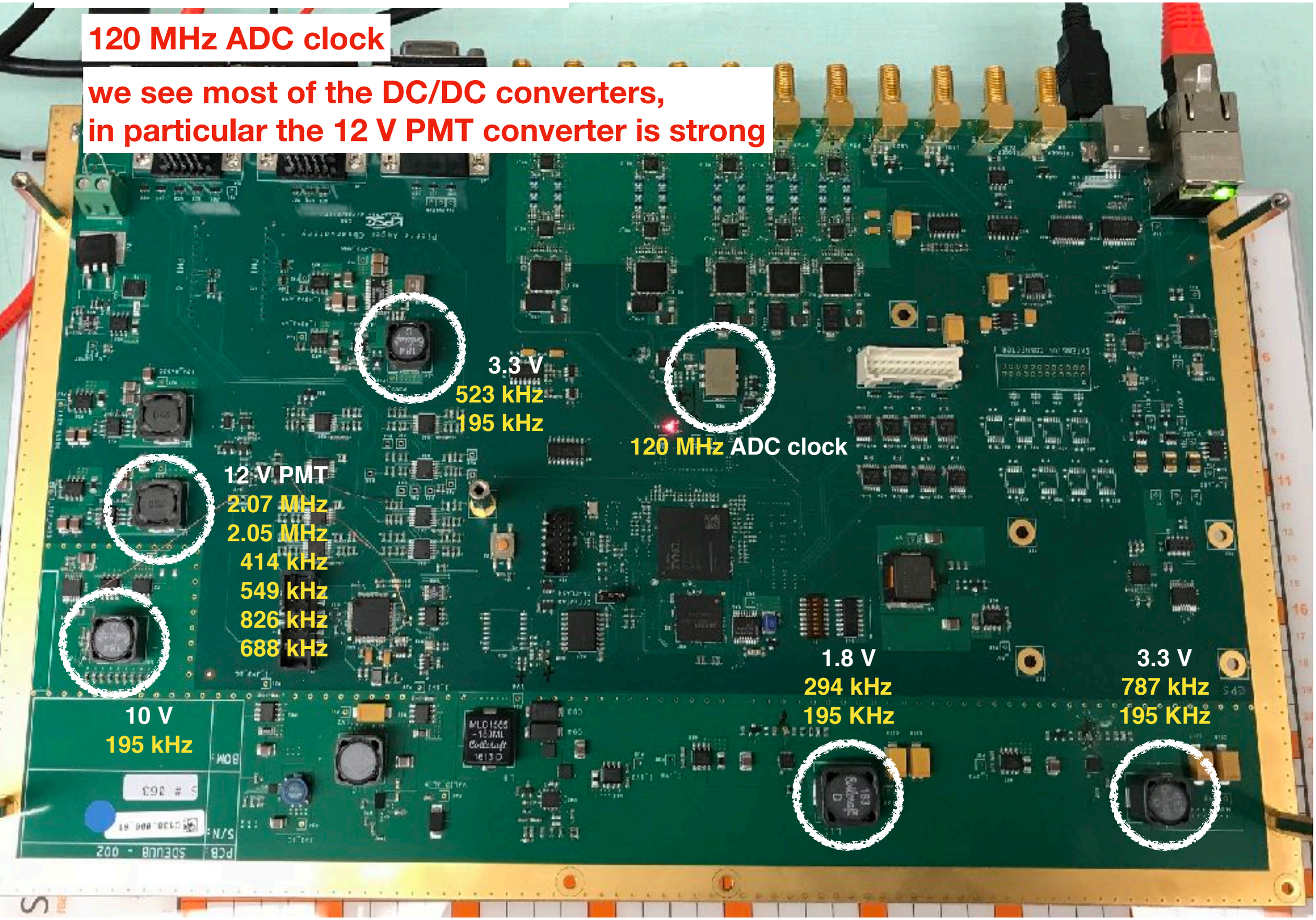
Amp [-32.40 to -1.40 dBuV] Freq: 2.053 MHz
Resolution Bandwidth: 0.003000 MHz Attenuator Value: 0.00 dB
Scanner Module: ISM-8G-V8, 29 x 42
Date: 2018-11-28, 16:37:21



we see noise sources on the board

120 MHz ADC clock

we see most of the DC/DC converters,
in particular the 12 V PMT converter is strong

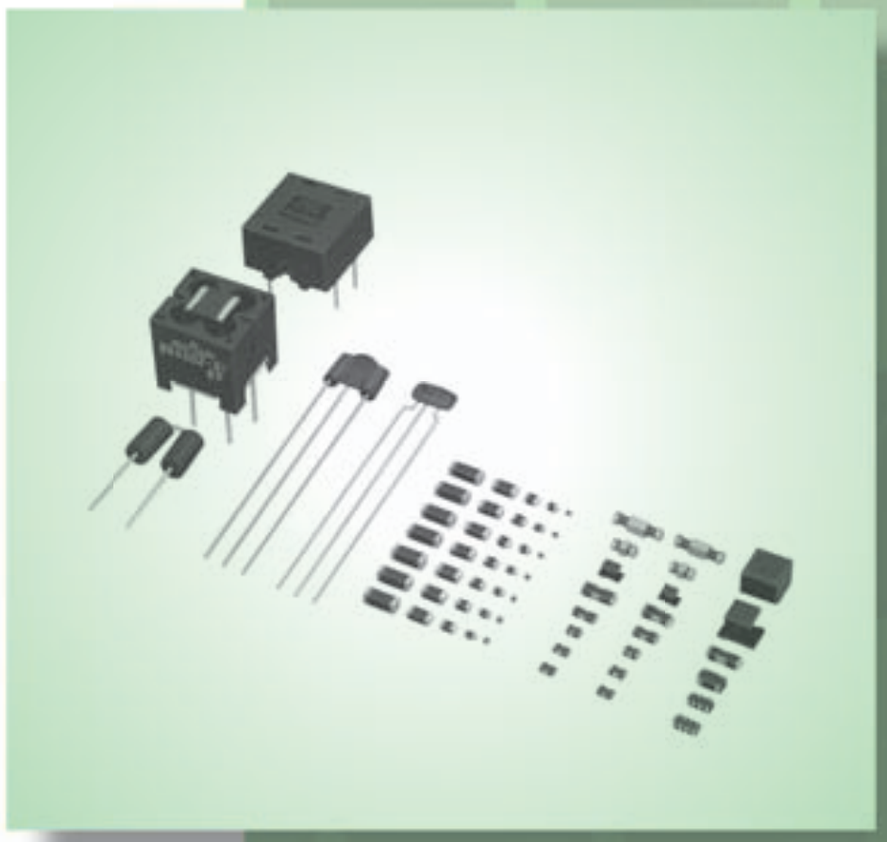


comments on UUB from radio group:

1. Improve the noise performance of the DC/DC converters.
   Issue: All DC/DC converters on the board have an external coil. The coil is big and emits electromagnetic radiation.
   The EM radiation of converters with an internal coil is beneath a certain level according to a standard. We suggest (almost) all converters can be replaced with converters with an internal coil.

2. Reduce the emitted noise from the DC/DC converters.
   Issue: A DC/DC converter produces switching noise on the in- and output. This has to be filtered. Otherwise the spiky supply voltages are on the power planes of the board and radiate noise.
   We suggest to place a common mode filter between the power inlet and the first converter. Place ferrite beads between the in- and output of every converter.

Noise Suppression by EMIFIL®
Application Guide



Application Manual

muRata *Innovator in Electronics*

Murata
Manufacturing Co., Ltd.

Cat.No.C35E-2

Installing EMI Filters on the DC Power Supply Input

Since noise is radiated from the DC power supply cable of the AC adapter, some noise suppression is necessary at input to DC power supply of personal computer. The DC power supply line contains both differential mode noise and common mode noise. Both mode noises need to be suppressed.

The GND and metal plate are first connected together. The NFM31K series (Chip EMIFIL®) and the BLM □□ P series (Chip Ferrite Bead) are used for differential mode noise suppression. The DLW5BS/AH series (Chip Common Mode Choke Coil) is used for common mode noise suppression.