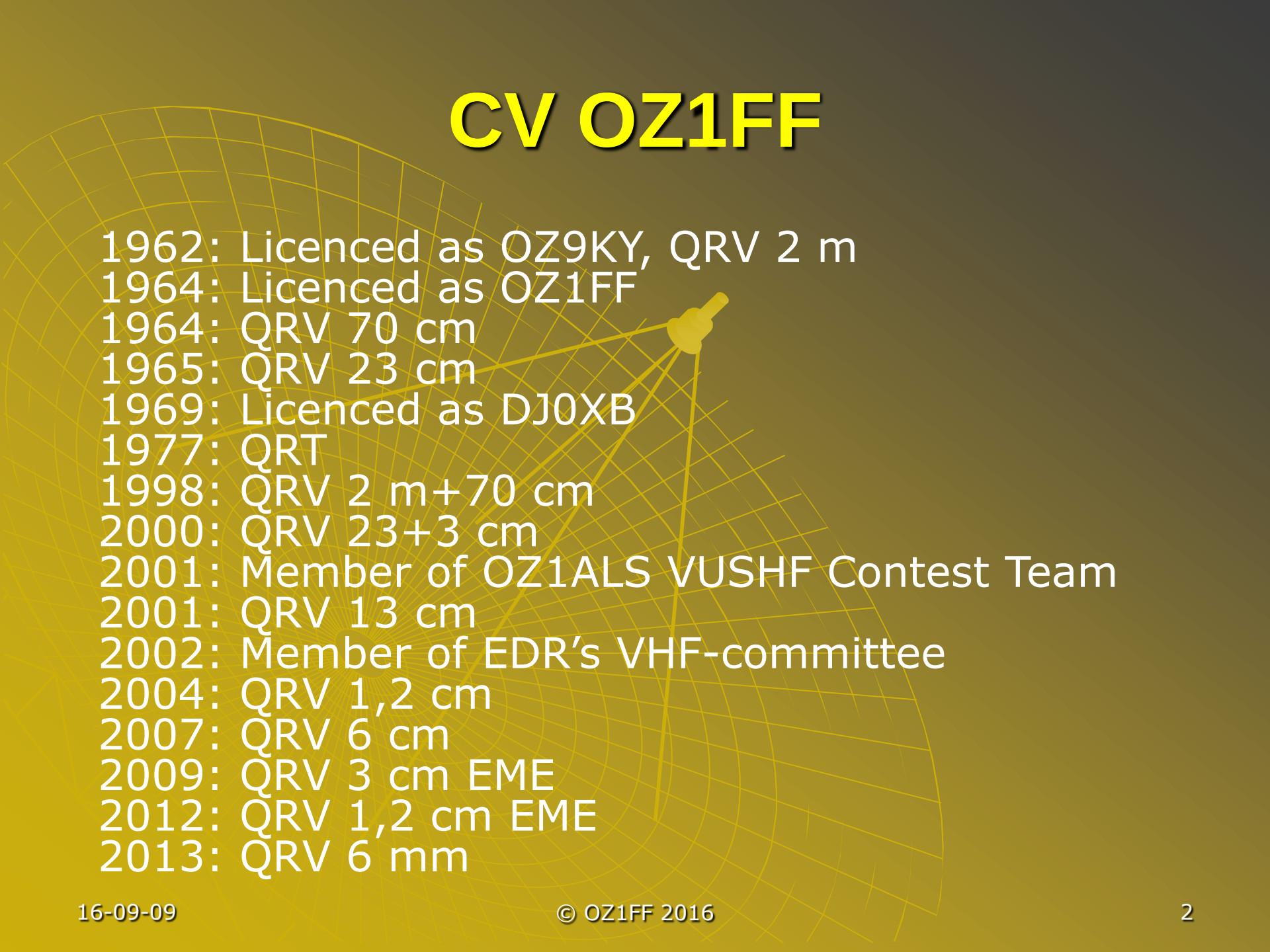


QRV on Microwave

How to build a modern Microwave Station

61. UKW Tagung Weinheim 2016

CV OZ1FF



1962: Licenced as OZ9KY, QRV 2 m
1964: Licenced as OZ1FF
1964: QRV 70 cm
1965: QRV 23 cm
1969: Licenced as DJ0XB
1977: QRT
1998: QRV 2 m+70 cm
2000: QRV 23+3 cm
2001: Member of OZ1ALS VUSHF Contest Team
2001: QRV 13 cm
2002: Member of EDR's VHF-committee
2004: QRV 1,2 cm
2007: QRV 6 cm
2009: QRV 3 cm EME
2012: QRV 1,2 cm EME
2013: QRV 6 mm

Microwave Bands

- ◆ Frequencies above 1.000 MHz = 1 GHz
- ◆ Possible bands/wavelengths
 - 1240 - 1300 MHz = 23 cm 1296 MHz
 - **2300 - 2450 MHz = 13 cm** **2320 MHz**
 - 3400 - 3410 MHz = 9 cm 3400 MHz
 - 5650 - 5850 MHz = 6 cm 5760 MHz
 - 10000 - 10500 MHz = 3 cm 10368 MHz
 - 24000 - 24250 MHz = 1,2 cm 24048 MHz
 - +47/76/122/134/241 GHz

Microwave Station

- ◆ Main components
 - Base band radio
 - Transverter
 - Low Noise Amplifier
 - Power Amplifier
 - Antenna Switch
 - Antenna
 - Computers/Internet

Past

- ◆ Early microwavers used to build their stations from component level
- ◆ They used plenty of time building
- ◆ Had to wait for fine weather to go portable for obtaining a few LOS contacts
- ◆ Some people still do it this way
- ◆ But today there is a easier solution:

Playing with Building Bricks

- ◆ Children and grandchildren do it
- ◆ Even Hams do it



- ◆ Thanks to DB6NT and many others for making building bricks for microwave

Present

- ◆ System design instead of radio design
- ◆ Microwave part is build up from transverter modules, oscillators, low noise preamplifiers, power amplifiers and antennas
- ◆ Base band radio is a commercial HF-transceiver
- ◆ Fixed operation rather than portable

Important Characteristics

- ◆ Microwave signals are mostly at the grass-root level
- ◆ High RX sensitivity = “long ears”



- ◆ High frequency accuracy and stability
- ◆ High dynamic range

Important Characteristics

- ◆ Transmitter
 - Tube amplifiers
 - TWT
 - High voltage
 - SSPA
 - Surplus
 - DB6NT, DG0VE, DL2AM
- ◆ QRO can be dangerous and is not always necessary

Important Characteristics

- ◆ TX power
 - 23 & 13 cm 50 W is fine for AR
 - 3 cm 200 mW OK for TR, 2 W and more is fine for RS
 - EME needs more power

High RX Sensitivity

- ◆ Use the best LNA direct at the antenna
- ◆ Fight losses in front of LNA
 - Low VSWR
 - Cables, connectors and relays/switches
- ◆ Select system gain for lowest NF and good dynamic properties

Cascading Noisy Amplifiers

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots + \frac{F_n - 1}{G_1 G_2 \dots G_{n-1}}$$

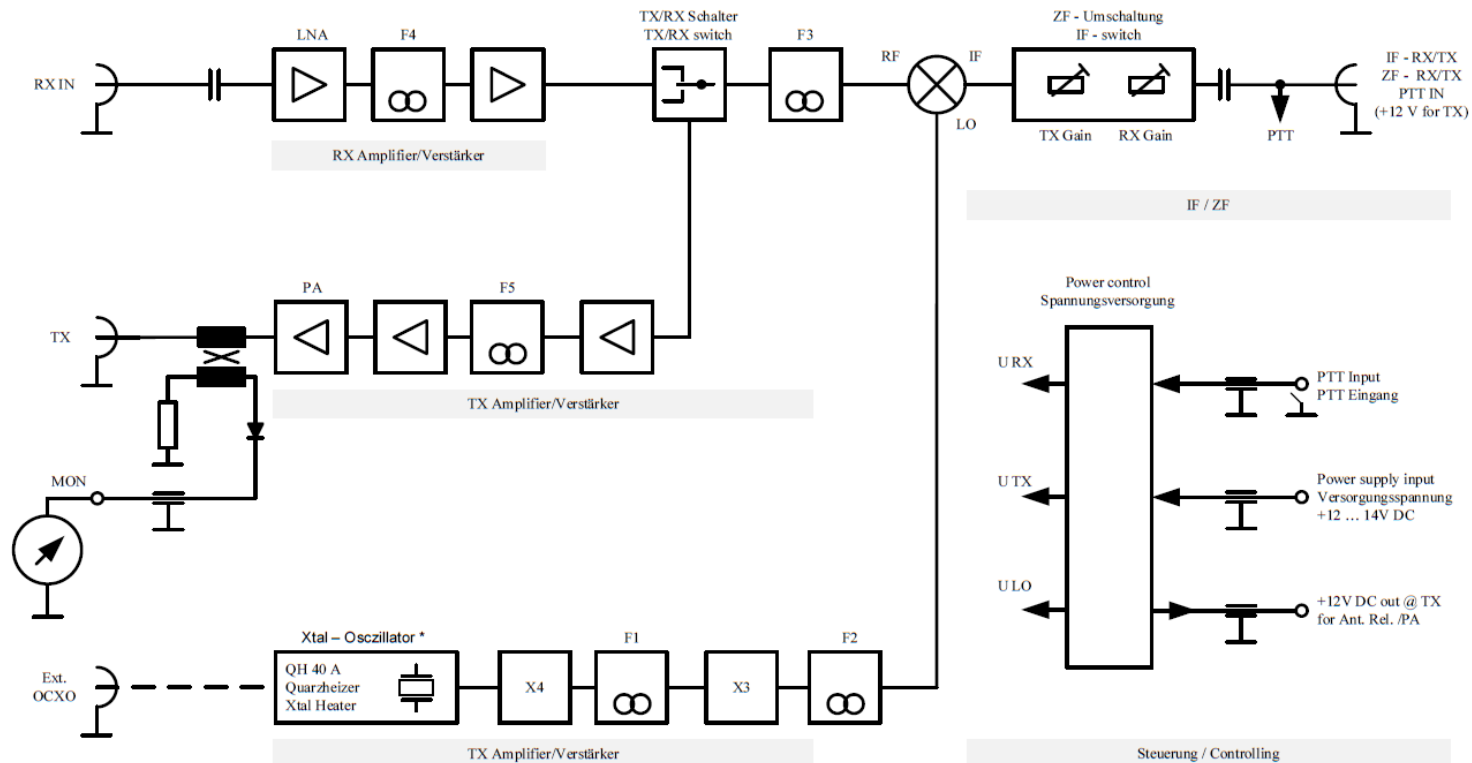
High gain minimizes system NF but can lead to overload of base band radio!

Transverters

- ◆ DB6NT
 - Kits or ready build
- ◆ DEMI
- ◆ DG0VE
- ◆ I3OPW



Basic Transverter Principle

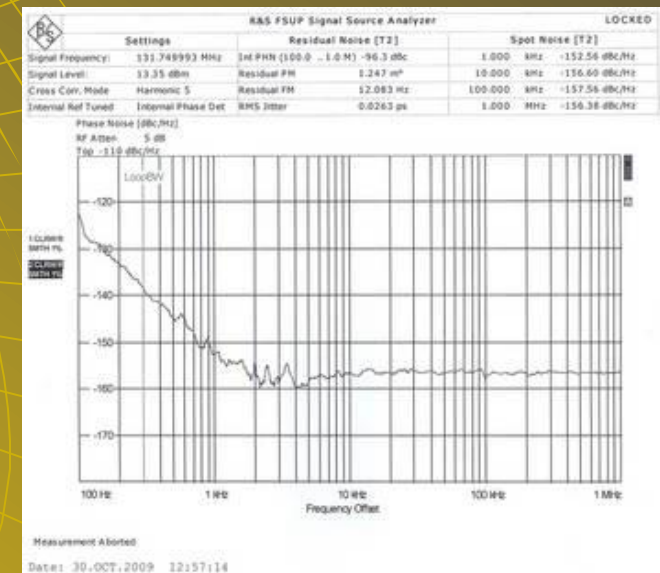


* Xtal @ 144 MHz IF = 96 MHz	Xtal @ 28 MHz IF 105,667 MHz
F1 = 384 MHz	F1 = 422 MHz
F2 = 1152 MHz	F2 = 1268 MHz
F3 = 1296 MHz	F3 = 1296 MHz
F4 = 1296 MHz	F4 = 1296 MHz
F5 = 1296 MHz	F5 = 1296 MHz

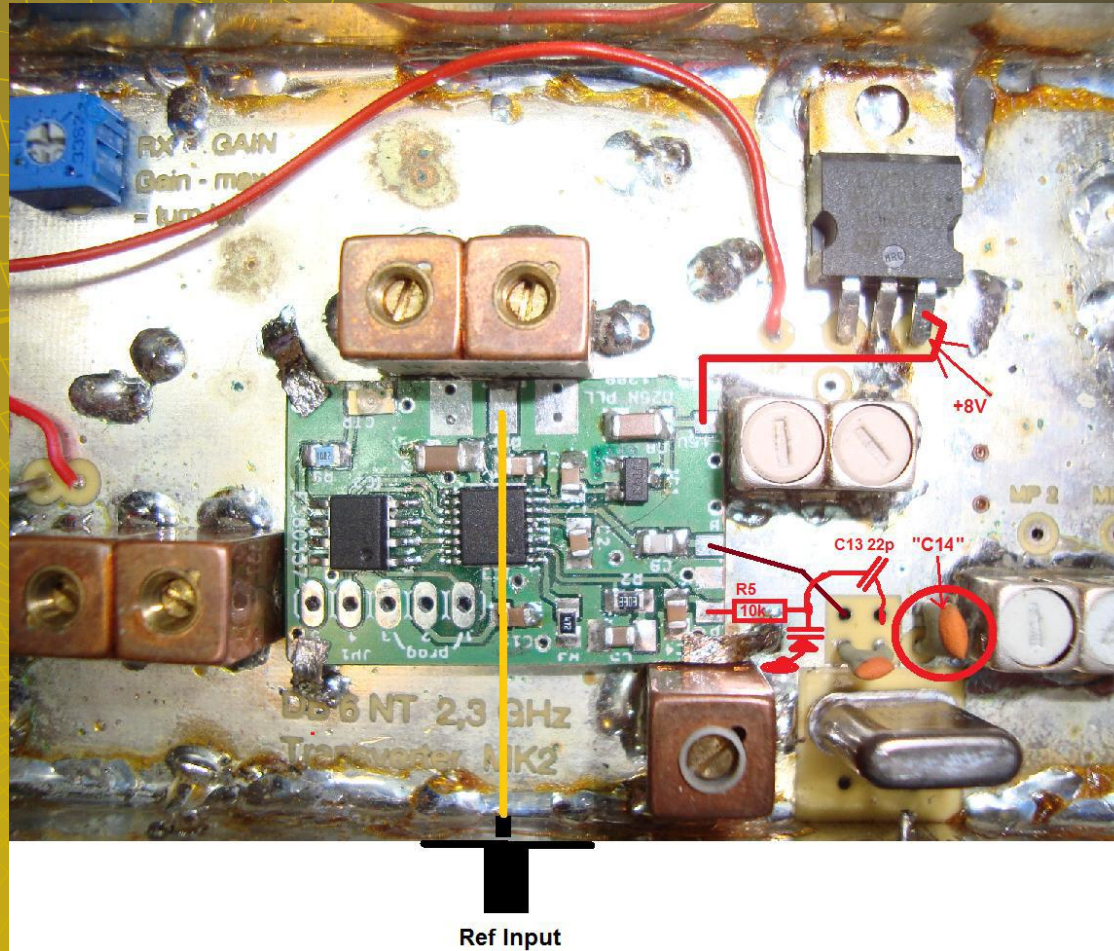
If 28 MHz IF additional TX filter is mandatory

Frequency accuracy and stability

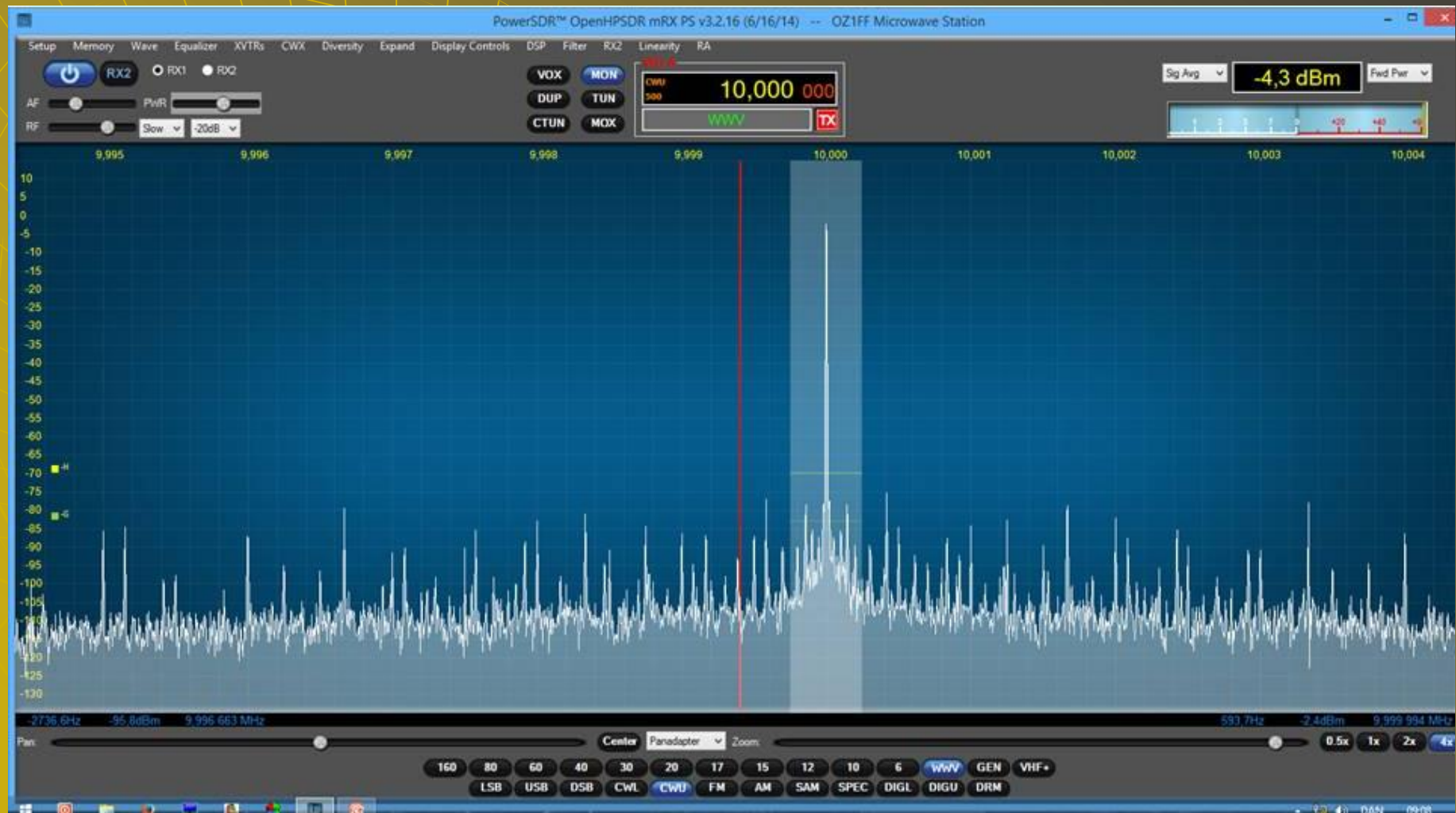
- ◆ Lock oscillators
 - Rb or GPSDO reference
- ◆ Oscillator phase noise



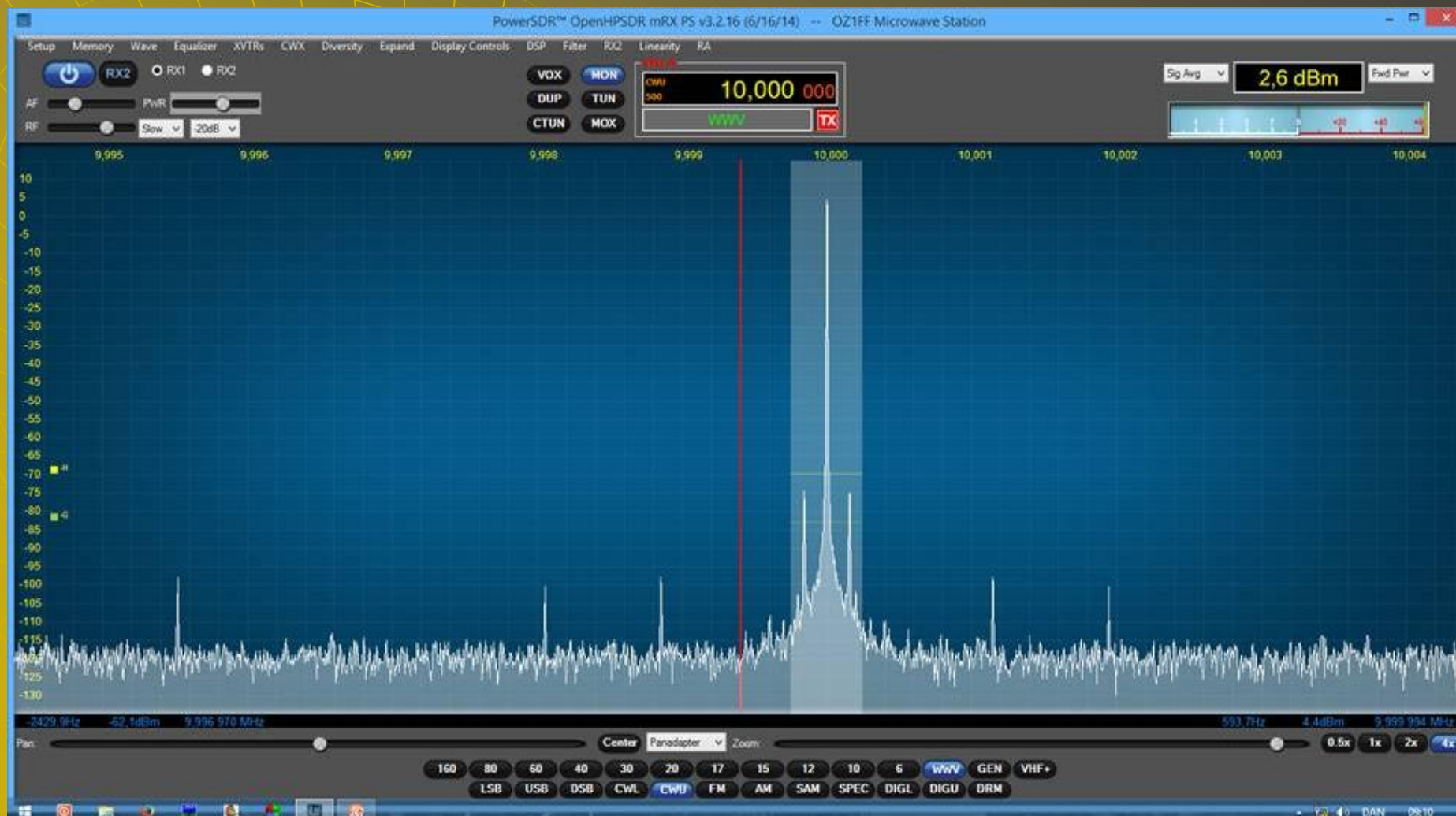
OZ5N One Size Fits All PLL



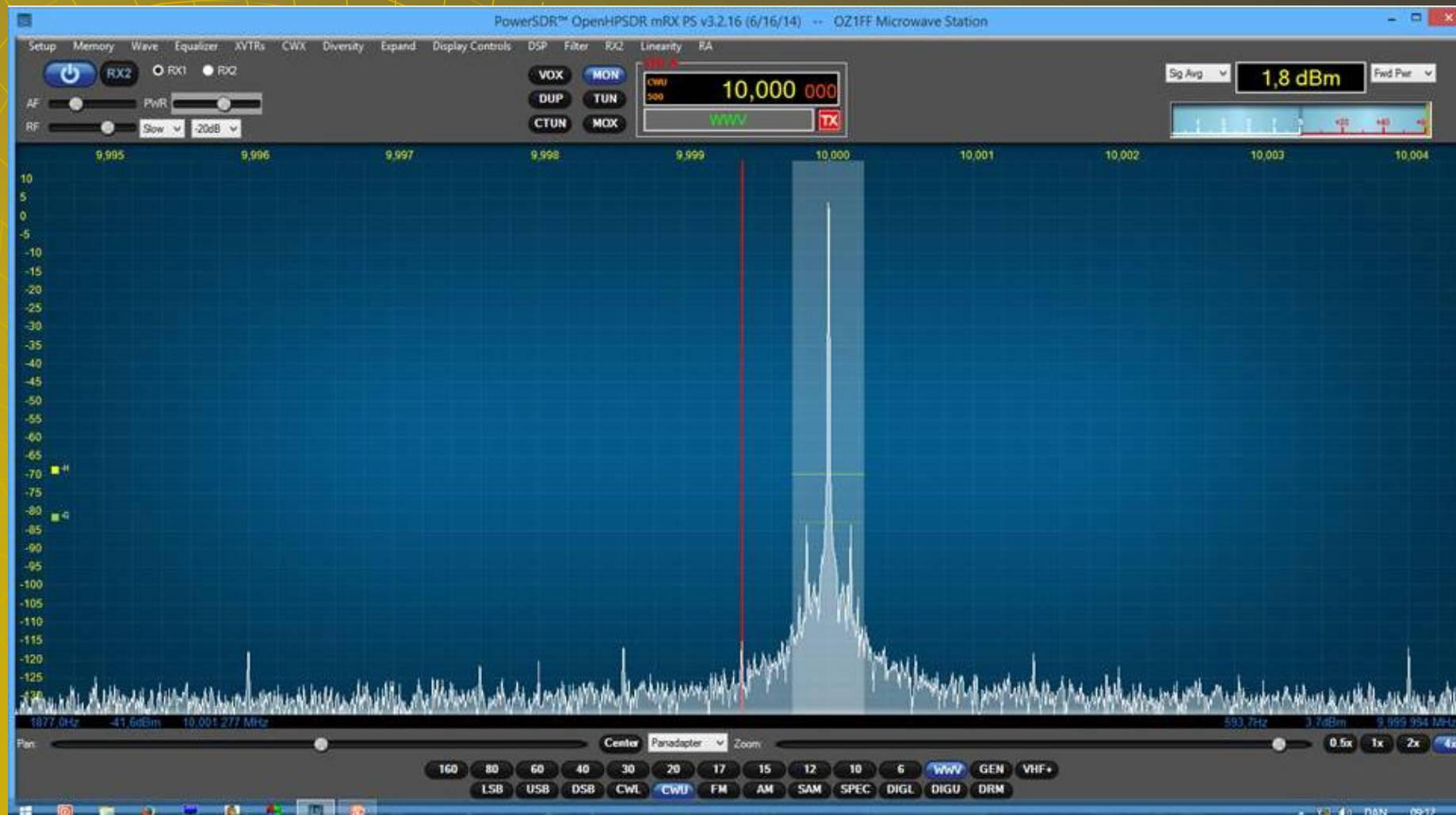
FE-5680A Rb Std.



Efratom LPRO-101 Rb Std.



G3RUH GPSDO



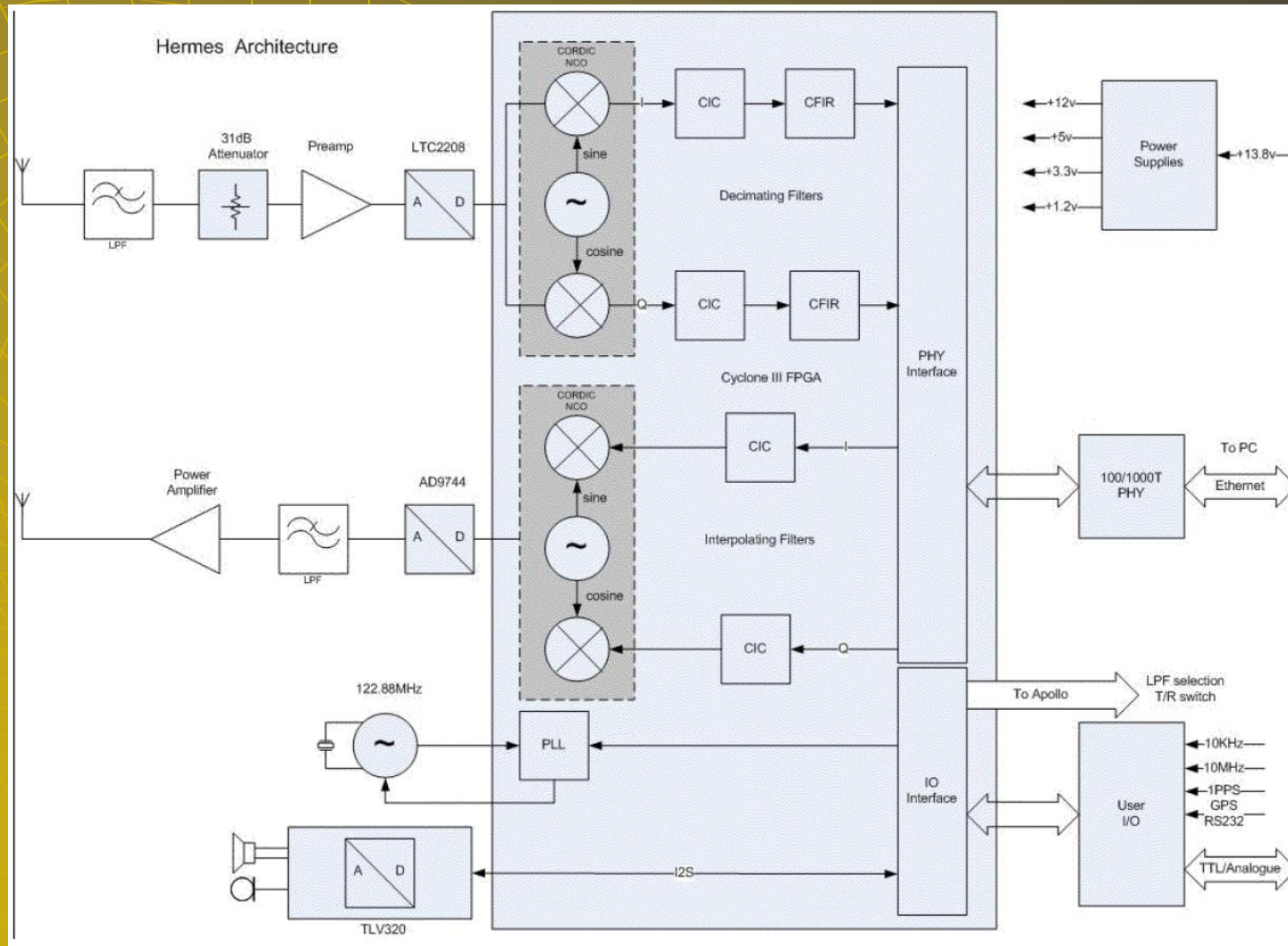
Base Band Radio

- ◆ HF-transceiver 28 – 30 MHz
- ◆ Frequency stability and accuracy
- ◆ Transverter 144/432 <> 28 MHz
- ◆ Interfacing
 - Transverter RF
 - Transverter switching
 - Supporting software – Spectran, WSJT etc.
- ◆ Best choice is >>>>>>>

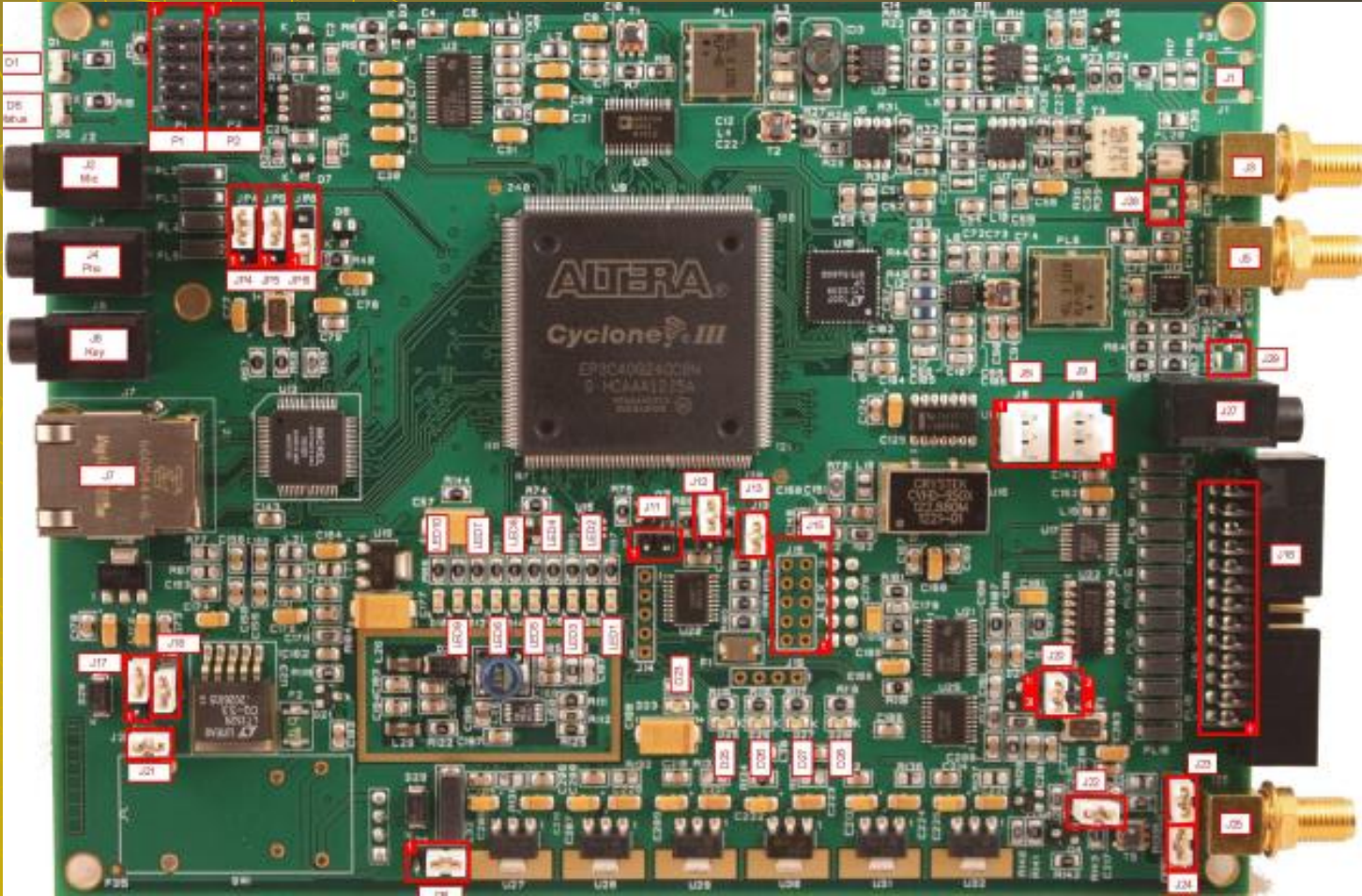
Software Defined Radio

- ◆ Spectrum and waterfall display
- ◆ Excellent filters
- ◆ High dynamic range
- ◆ Easy transverter control
- ◆ Cable free interfacing to supporting software using VAC and VSP
- ◆ Best solution today is Hermes/Anan or Flex-6XXX

Hermes SDR

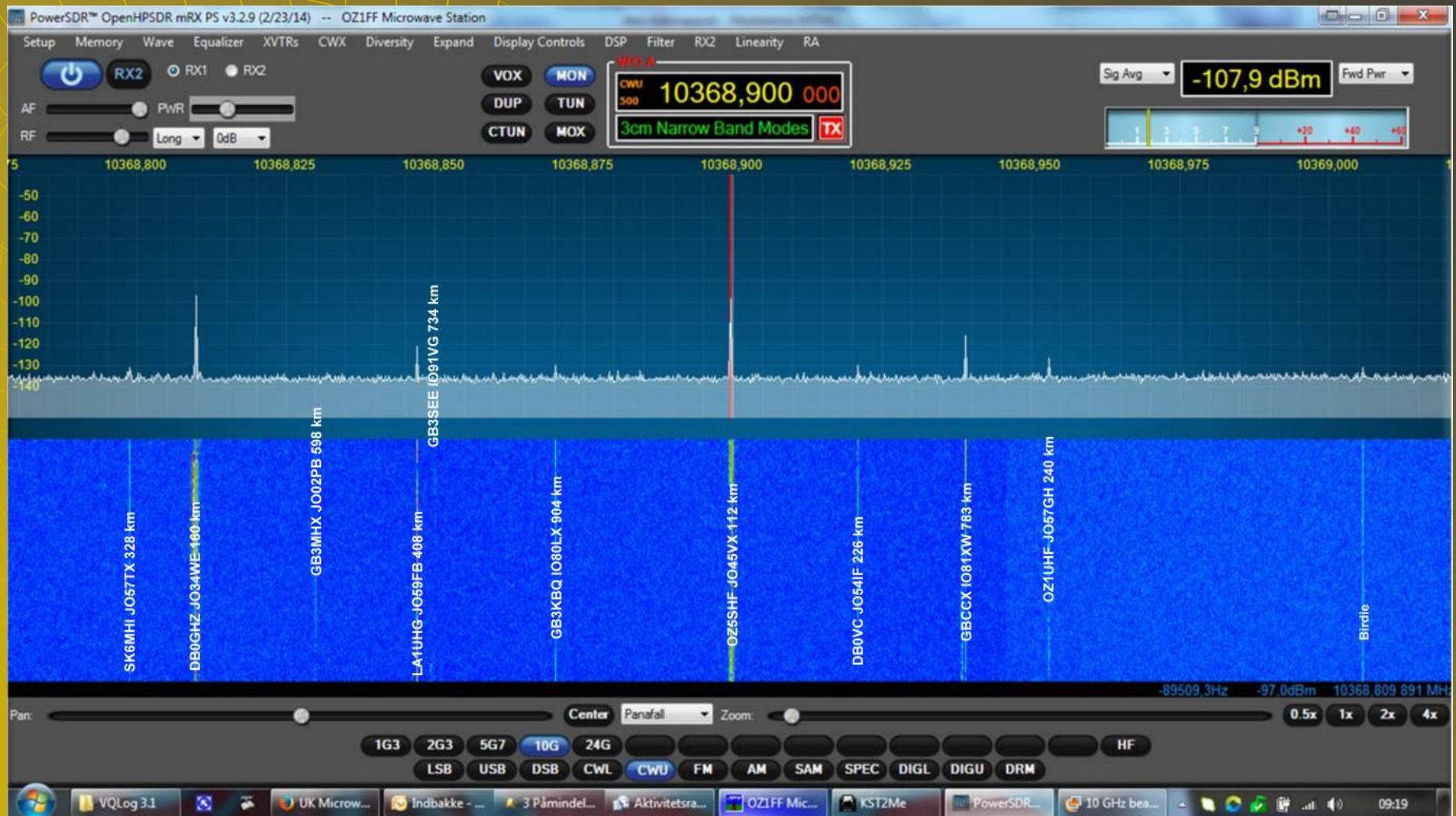


Hermes SDR

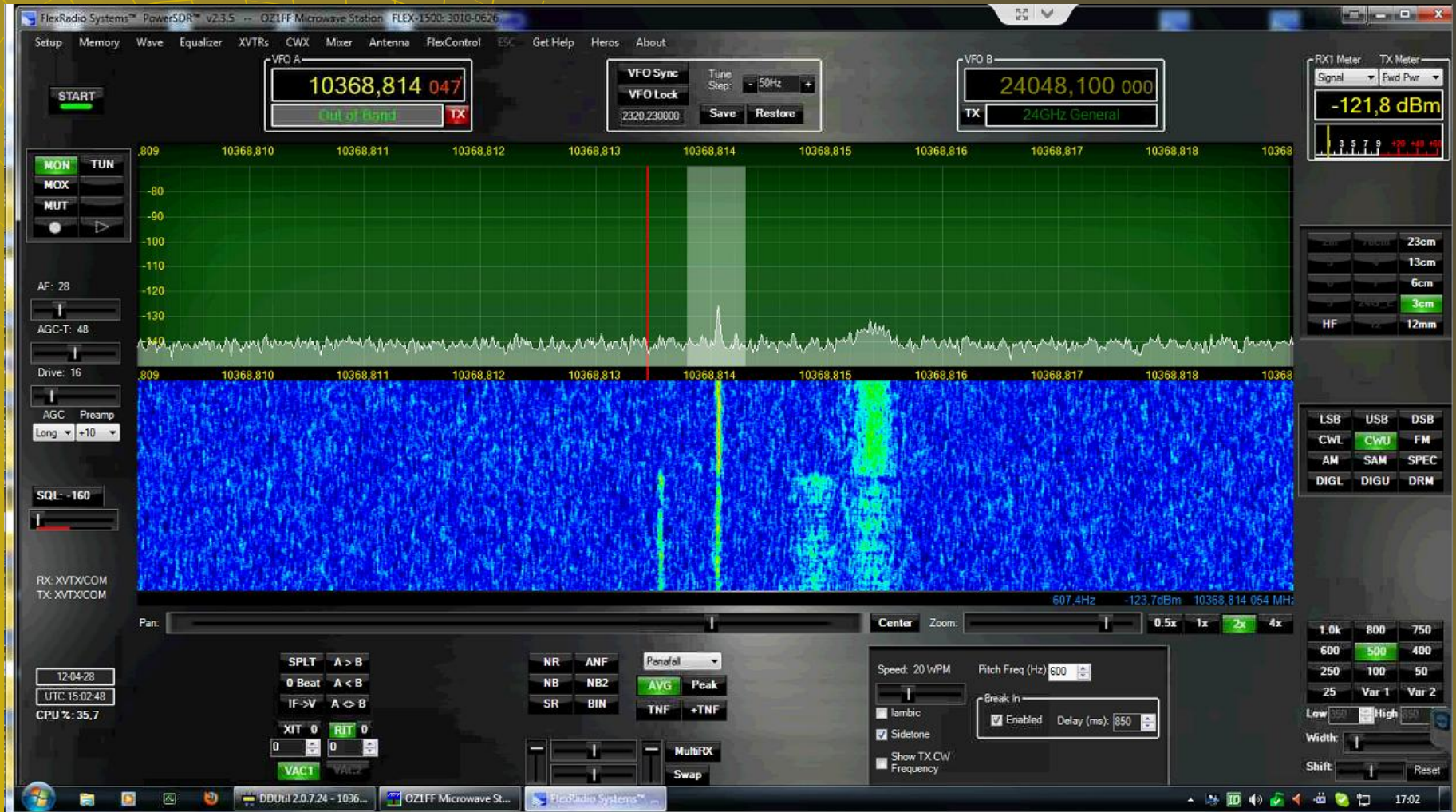


8 layer gold plated PCB 12 x 16 cm

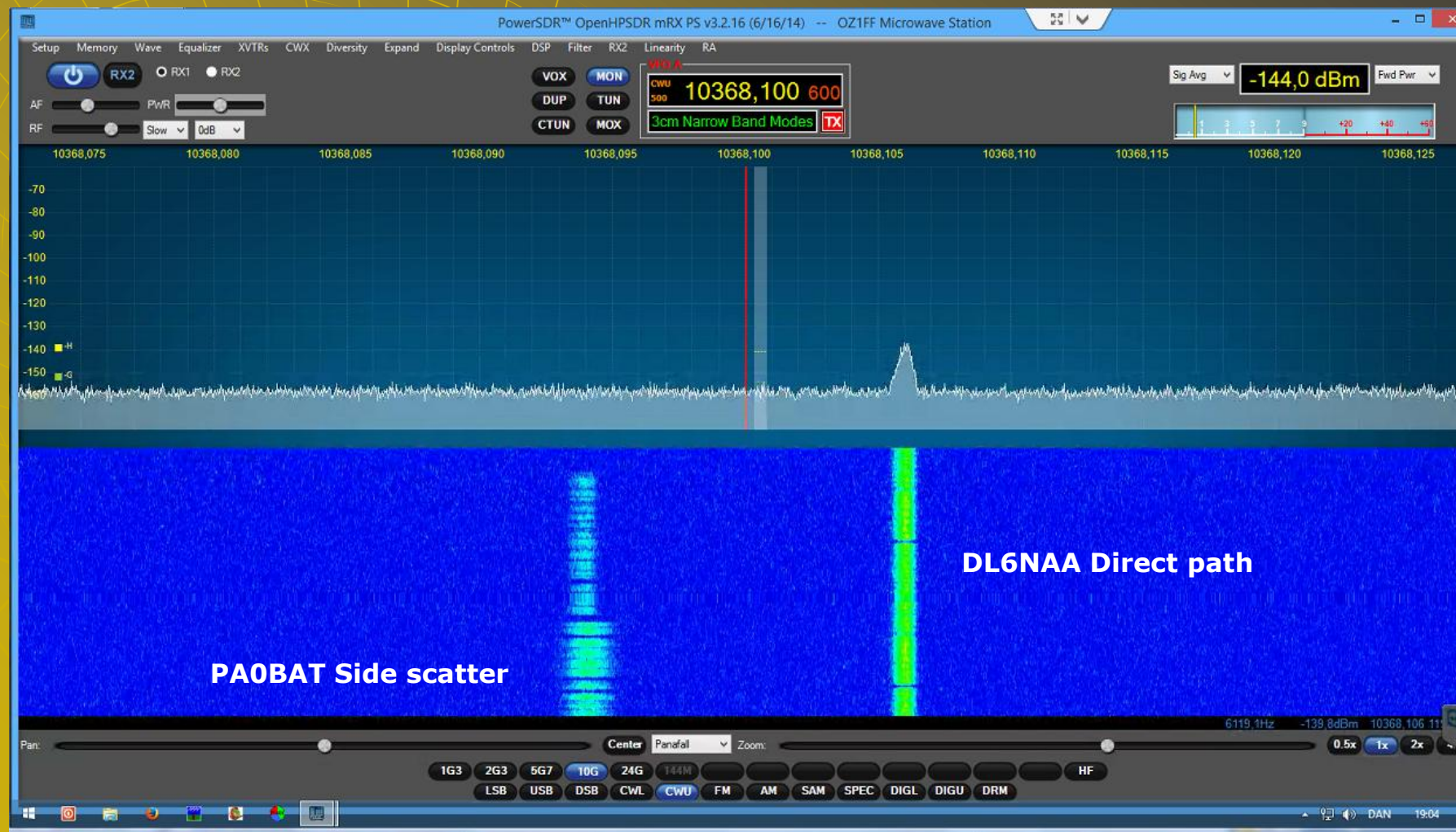
SDR Advantage



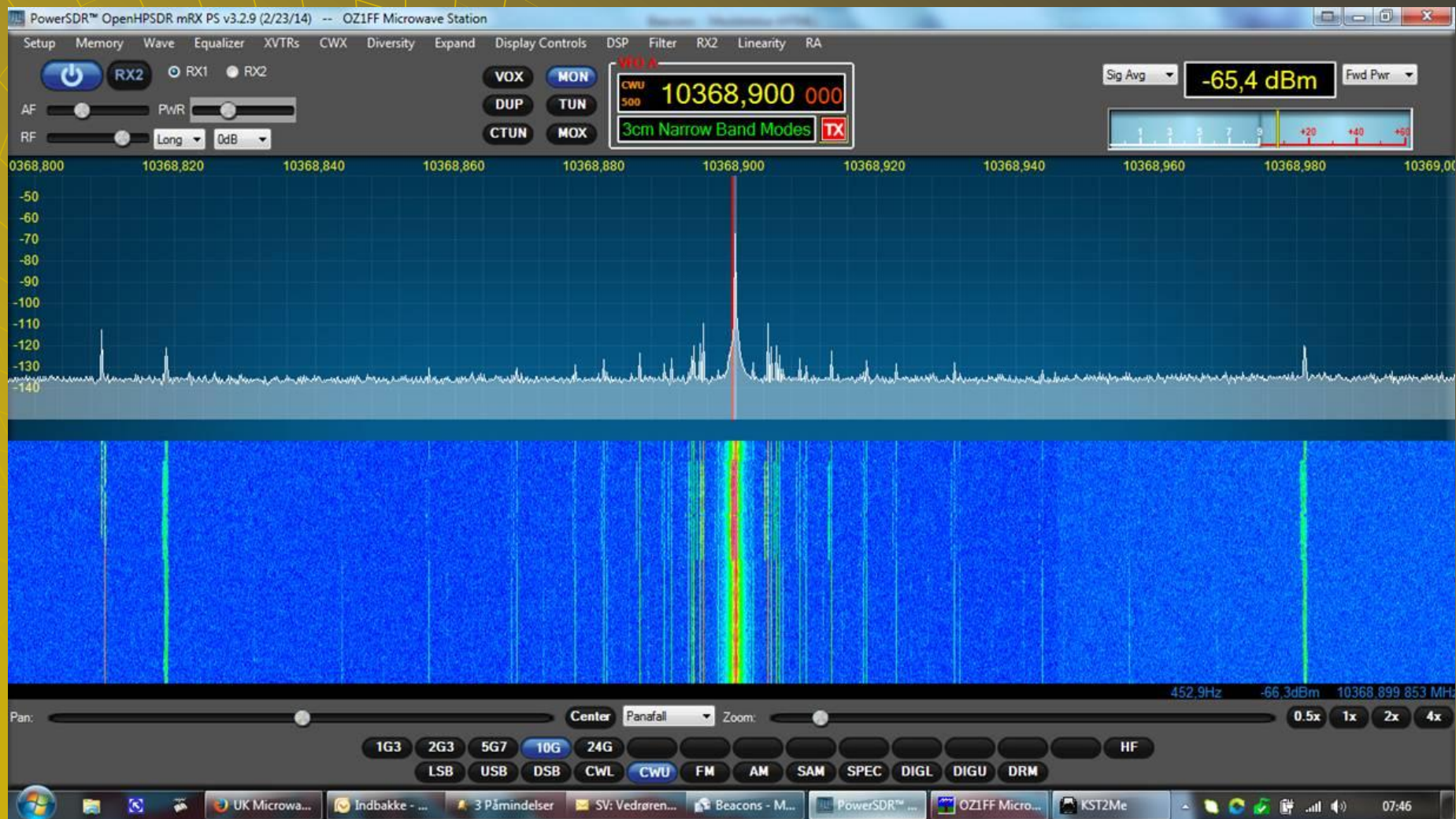
Rain Scatter



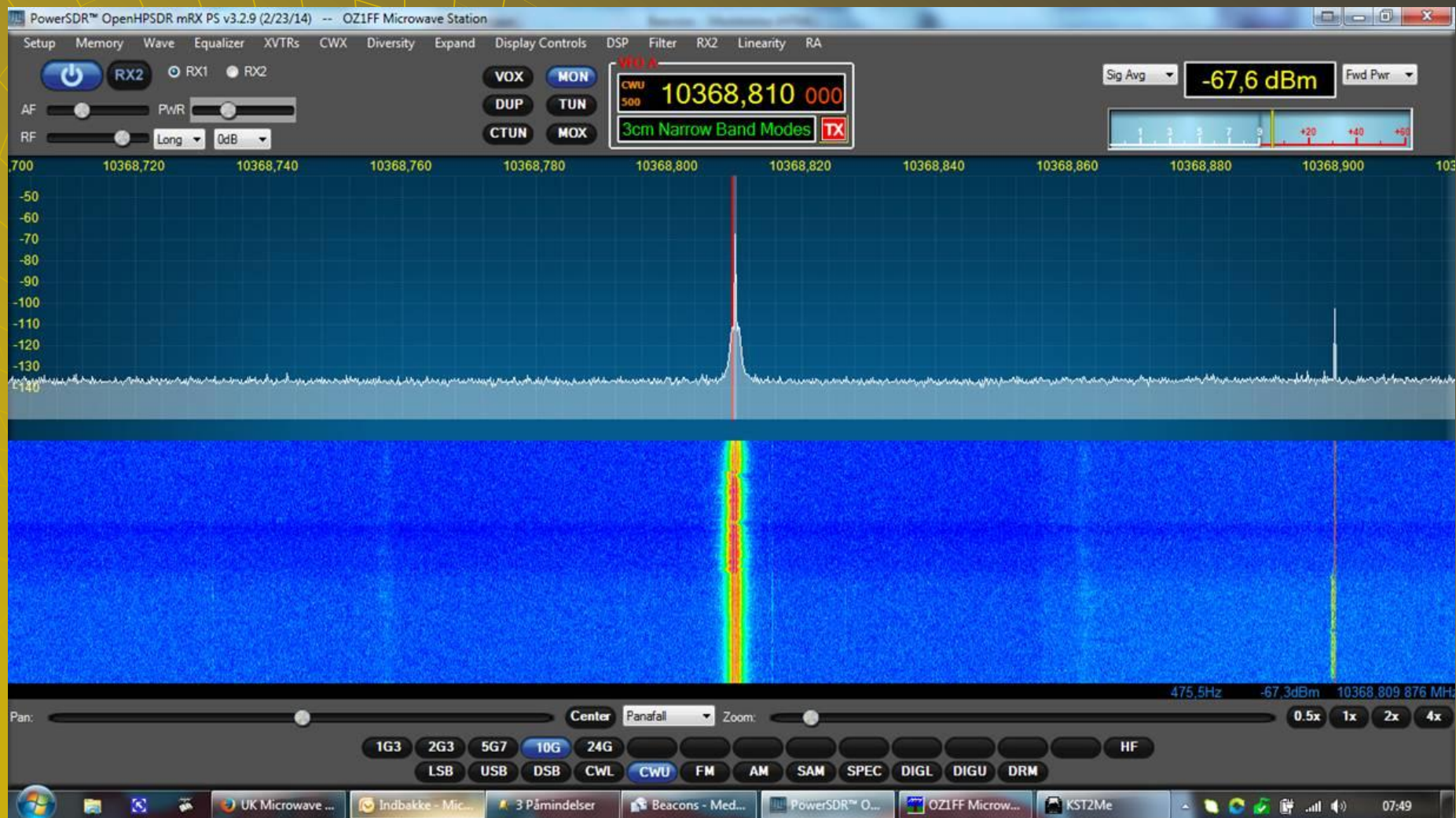
RS Activity



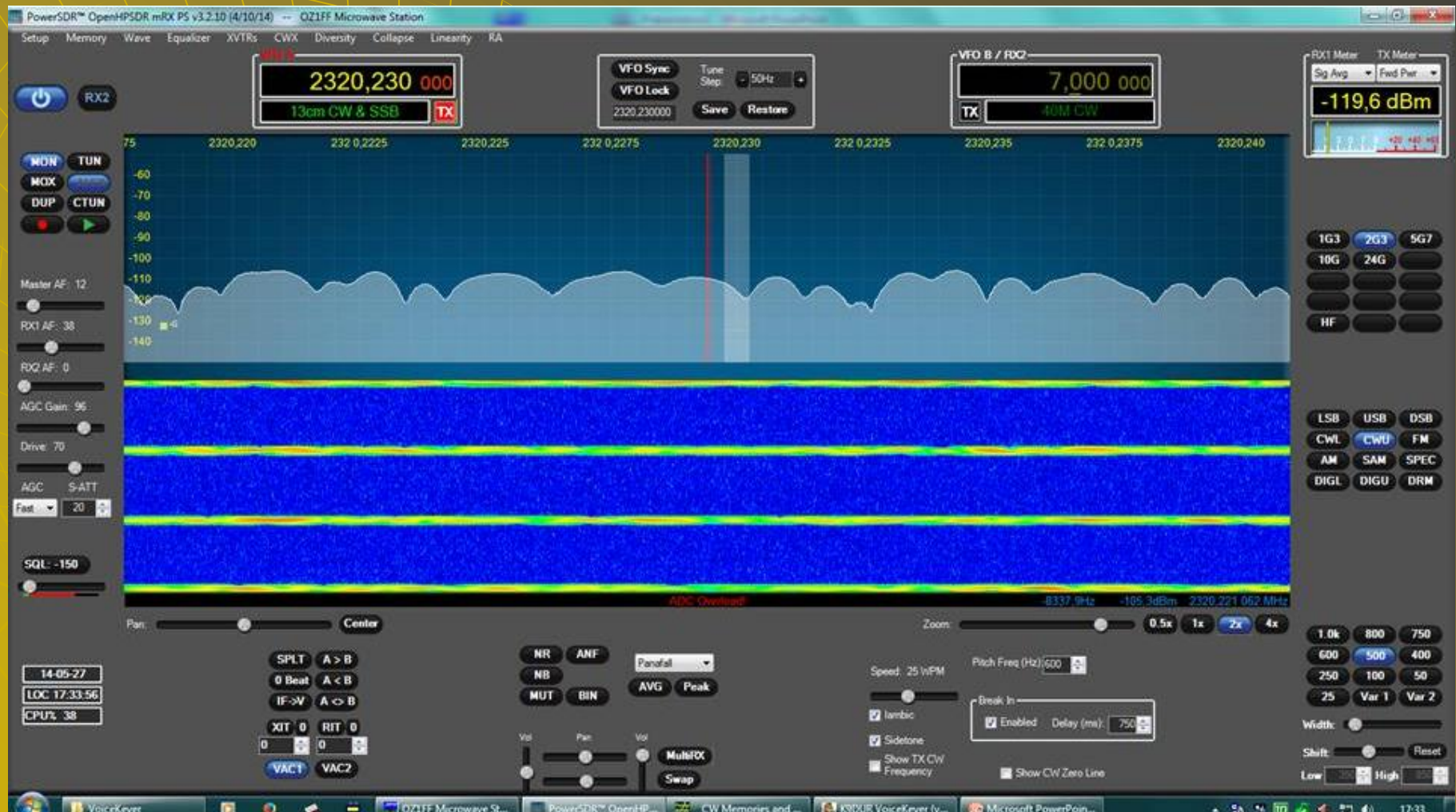
Noisy 10 GHz Beacon



"Clean" 10 GHz Beacon



Radar Noise



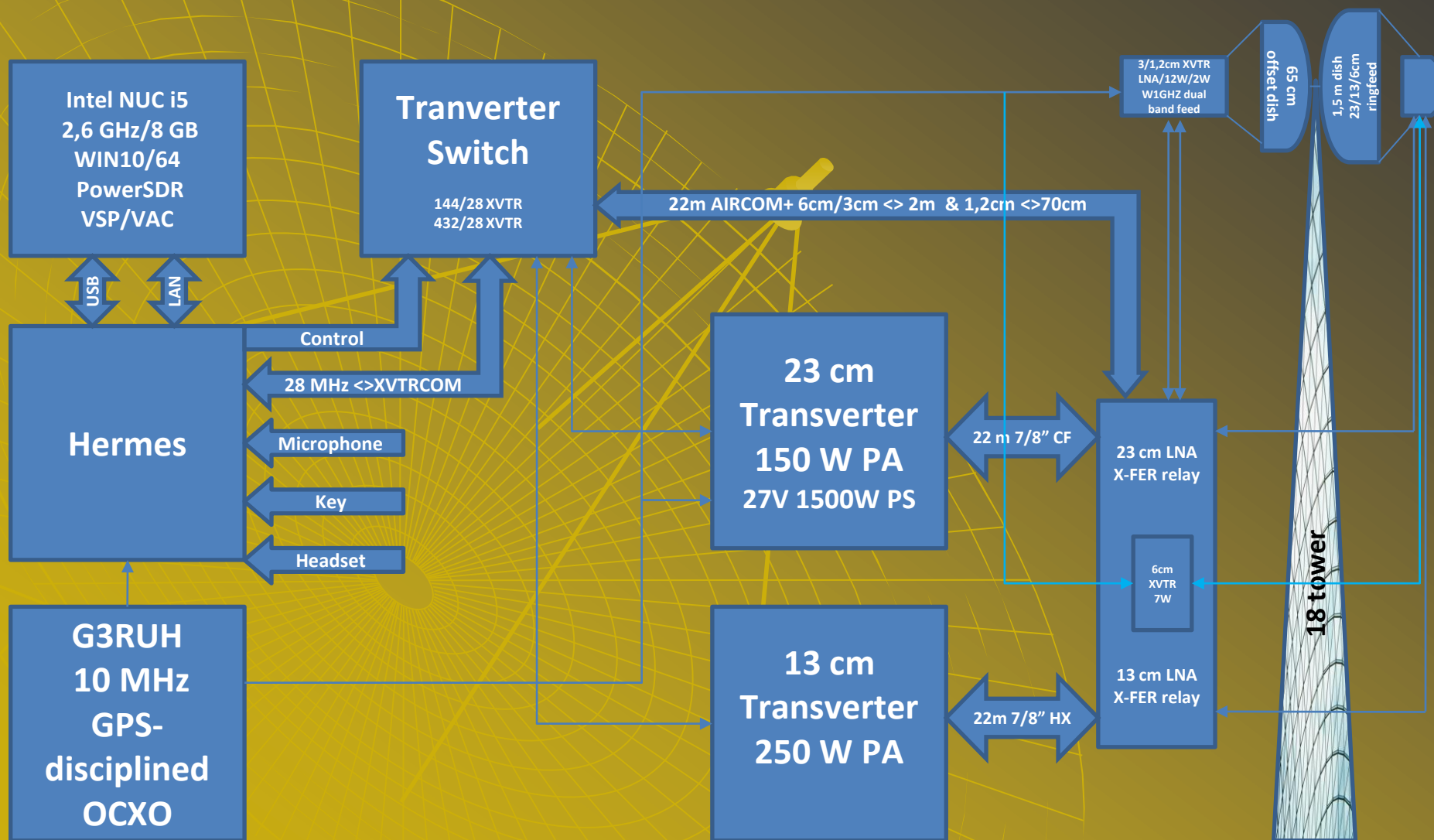
Station OZ1FF

Build and optimized since 1998

Band	XVTR	PreAmp	PA	Antenna
23cm	MKU13G2	LNA131AH-HEMT	145 W	1,5m dish
13cm	MKU144G2/MKU23G2	LNA231AH-HEMT	250 W	1,5m dish
6cm	MKU144G2/MKU57G2	N/A	7 W	1,5m dish
3cm	MKU144G2/MKU10G3	LNA101AS-HEMT	12/50 W	65/240 cm dish
1,2cm	MKU432G2/MKU24GA	MKU243RX2	2/10 W	65/240 cm dish

28 – 30 MHz Base Band Radio: Hermes

OZ1FF Microwave Station



Antennas

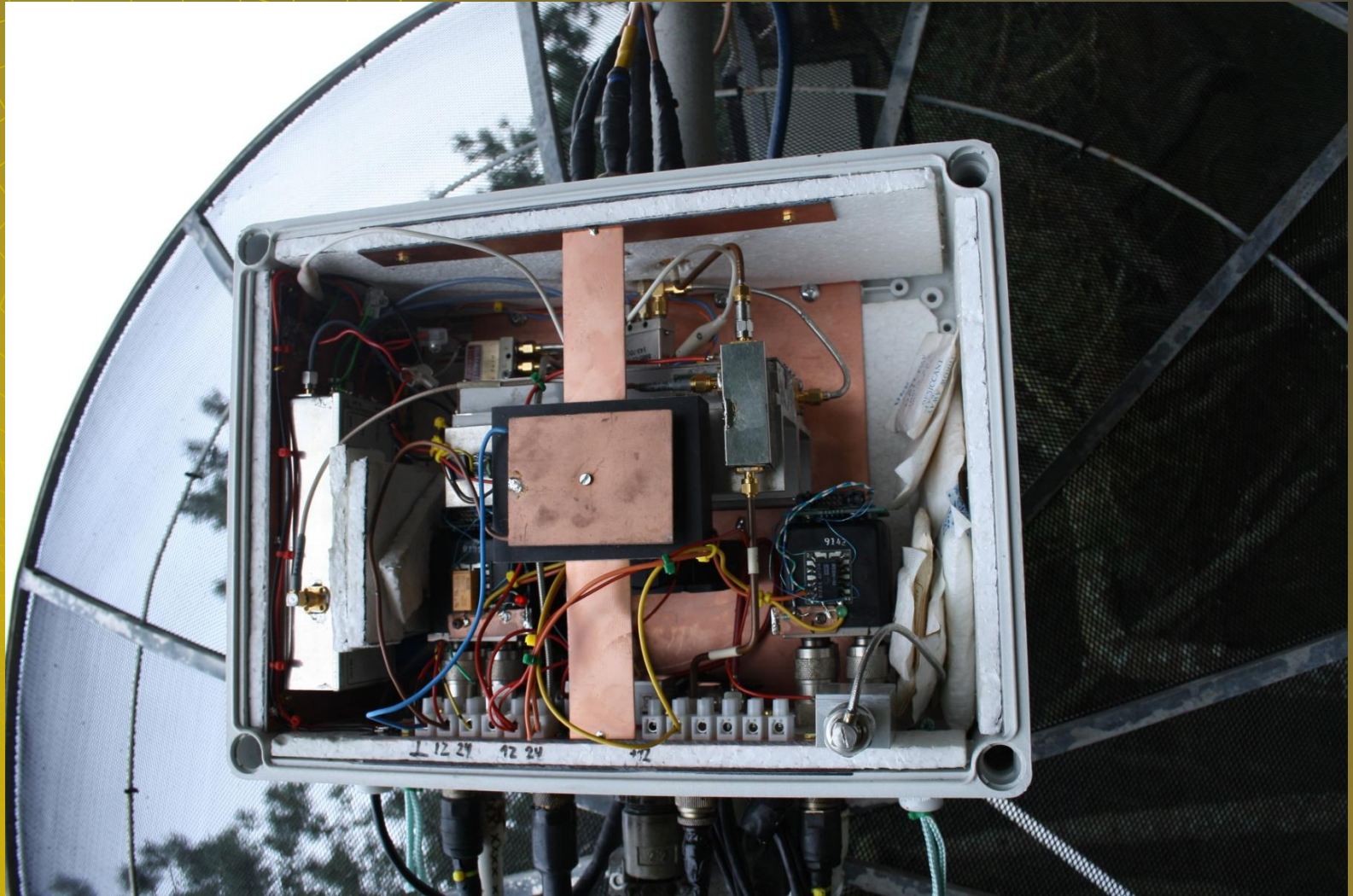
- ◆ QTH JO45BO58 5 mASL
- ◆ 18 m tower
- ◆ 1,5 m dish
 - RF HamDesign kit
 - Ringfeed 23/13/6 cm
- ◆ 65 cm dish
 - Modified TV-SAT dish
 - Chapparel feed 3/1,2 cm



Ringfeeds 1,3 – 10 GHz



Tower Box



10/24 GHz XVTR Box



EME 10 GHz

2,4 m offset dish

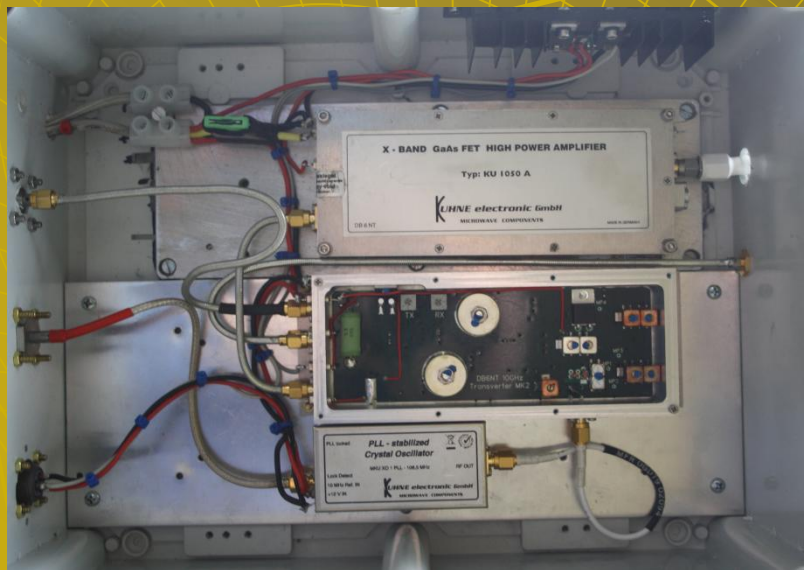
Feed horn/WGS/preamp



EME 10 GHz

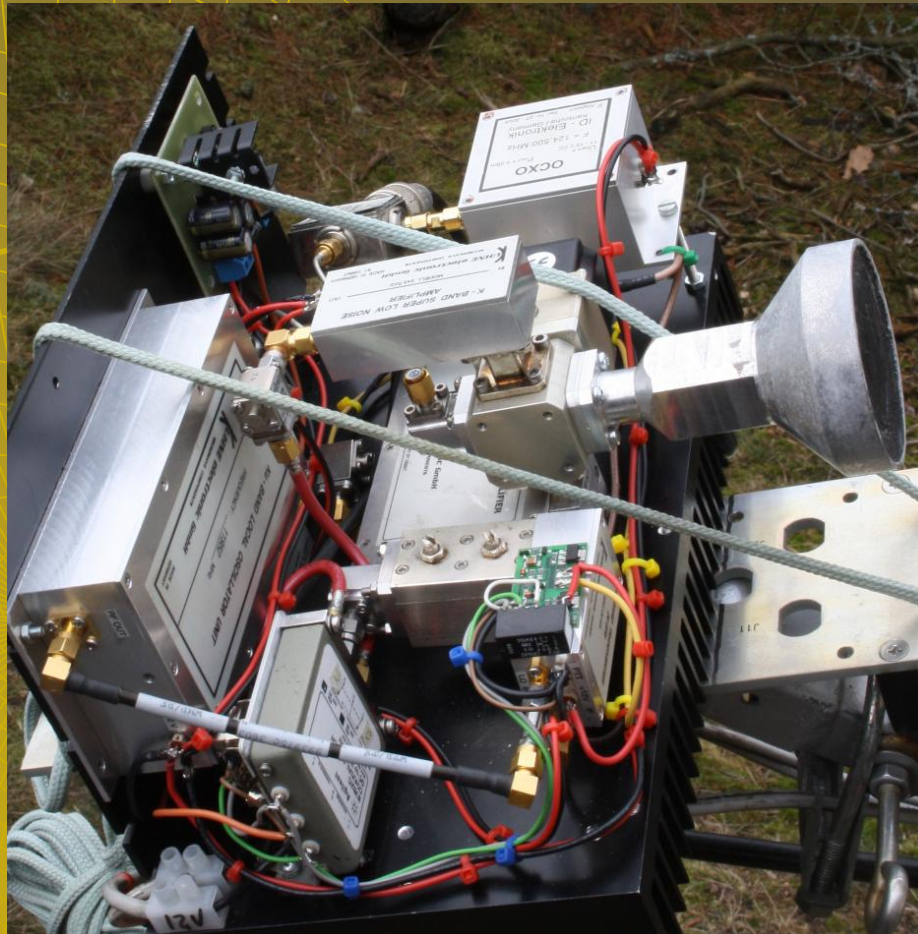
Transverter

Echo



EME 24 GHz

Transverter



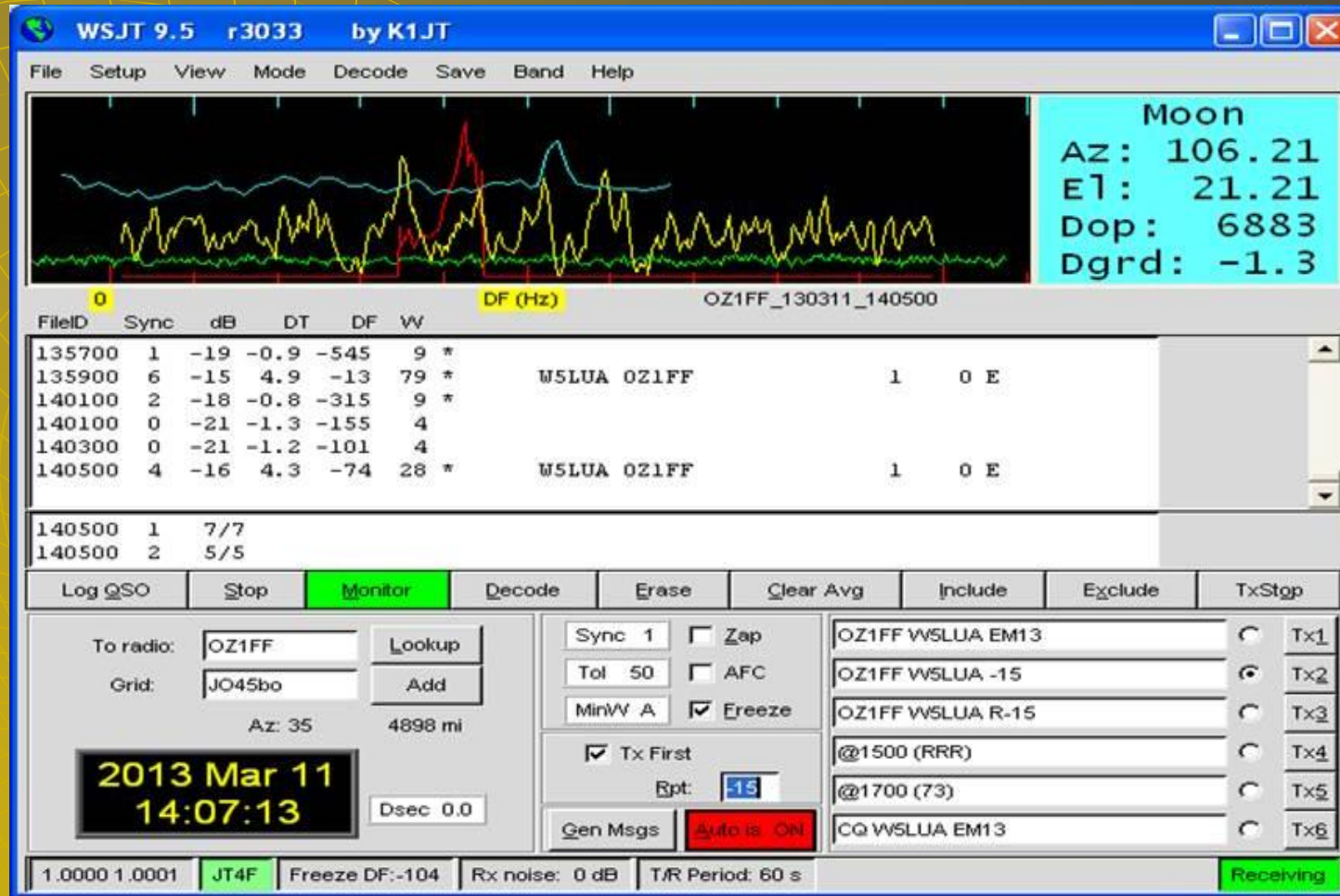
W5LUA Echo Test



OZ1FF Echo Test

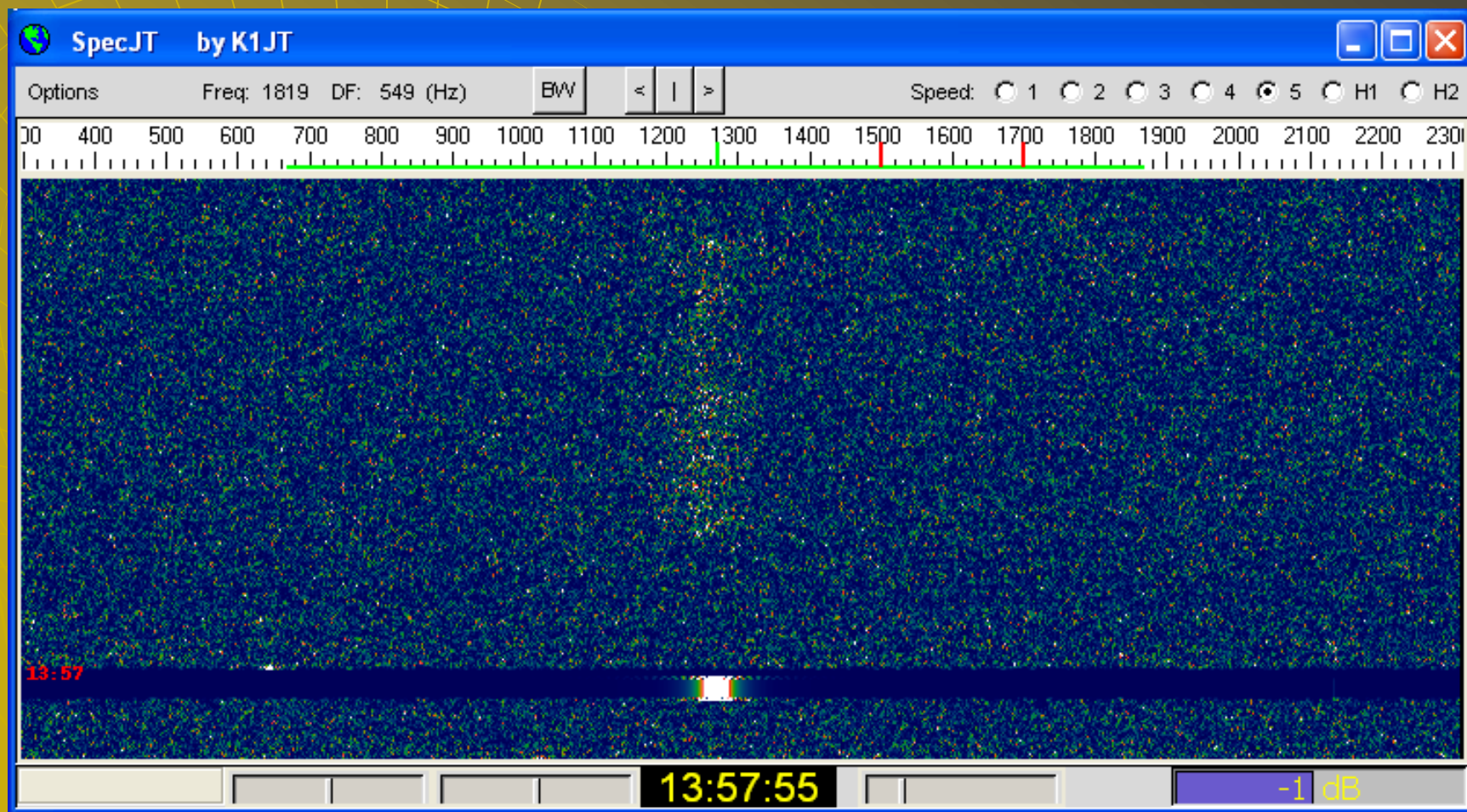


OZ1FF @ W5LUA

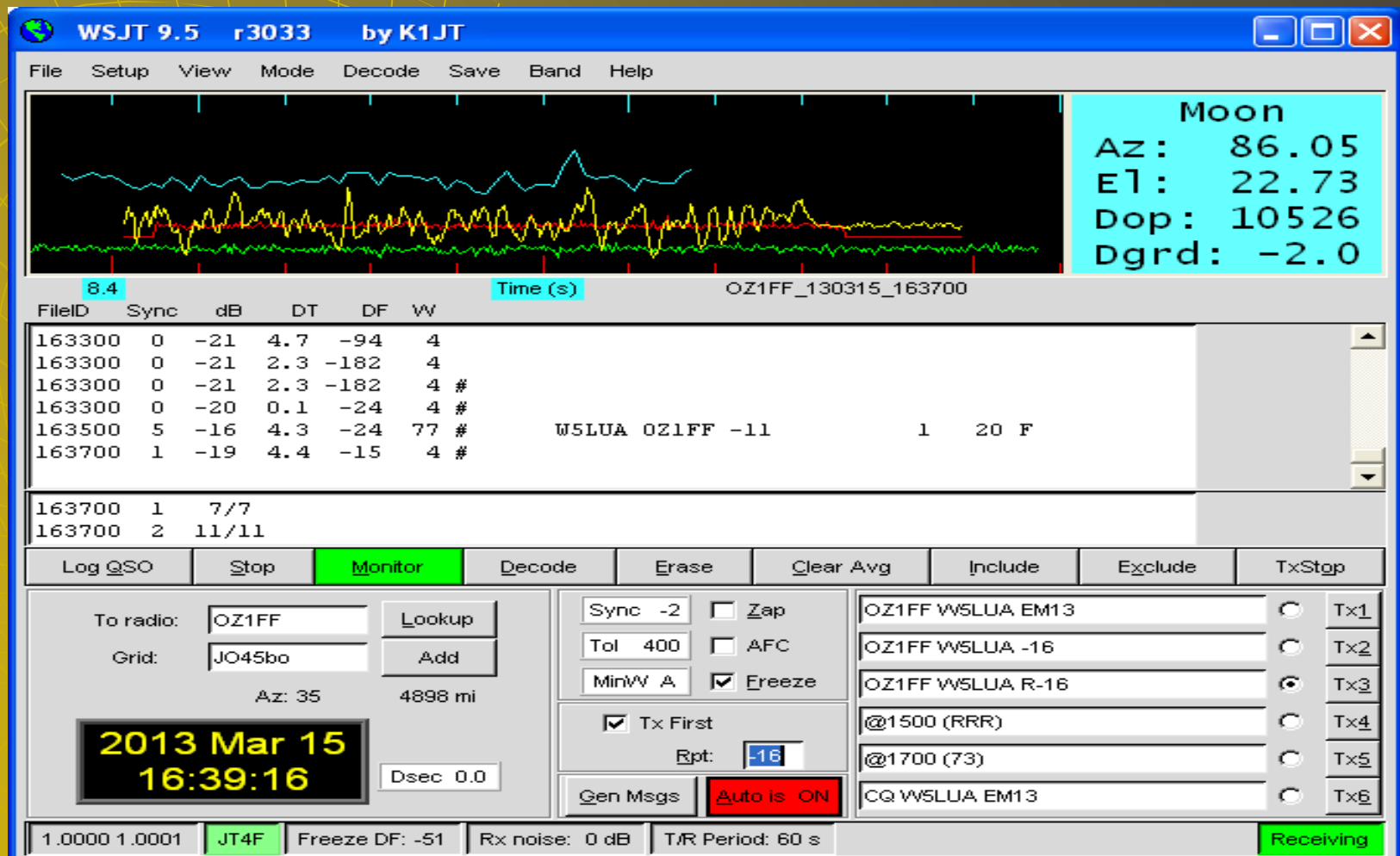


W5LUA using automatic Doppler correction

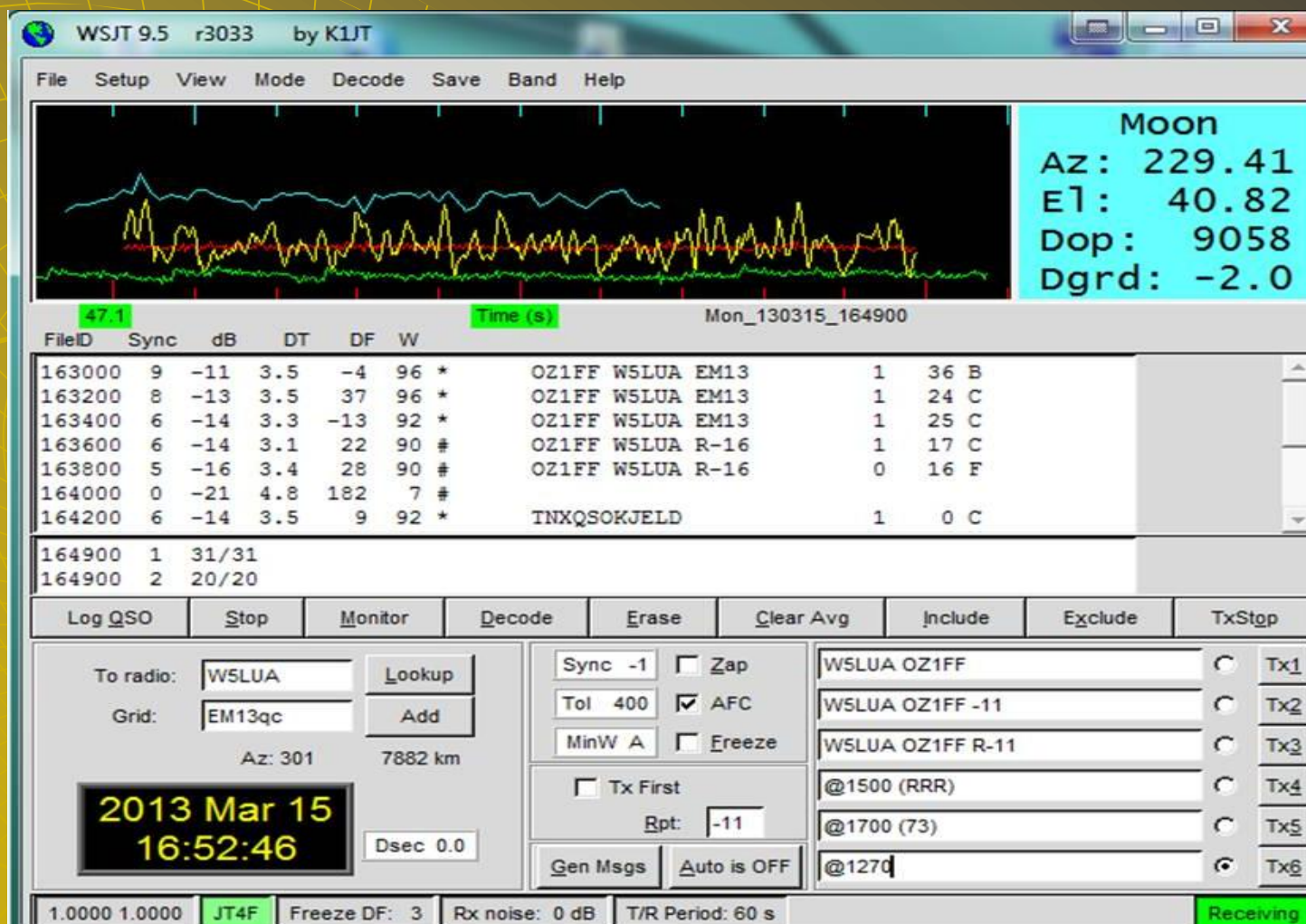
OZ1FF 1270 Hz Sync. tone



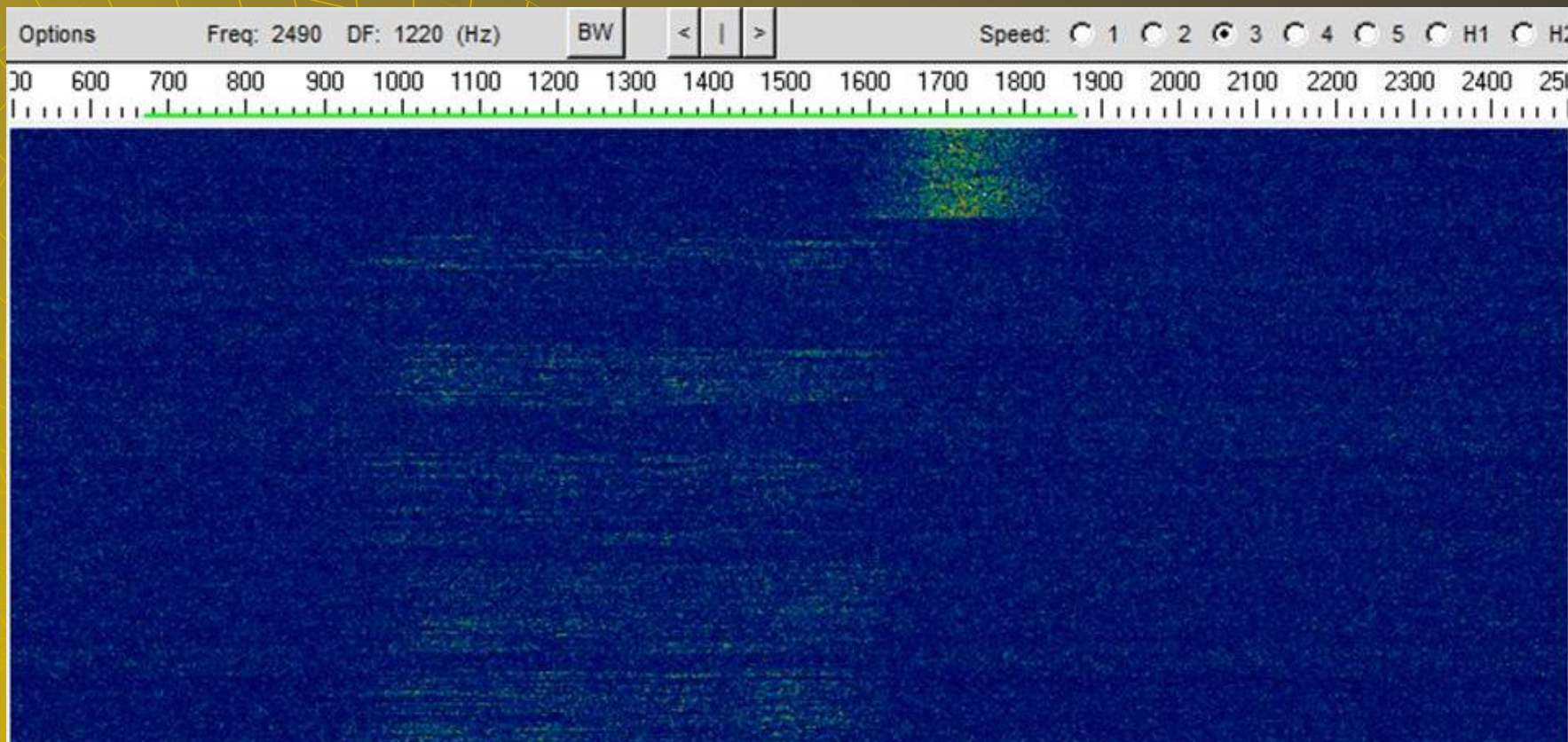
OZ1FF @ W5LUA



W5LUA @ OZ1FF



W5LUA 73



Any Questions?

How About This?

