North Texas NTMS Microwave Society

Working Small Stations on 10 and 24 GHz EME with the help of WSJT

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W5LUA

July 26, 2013
Central States VHF Society
Elk Grove Village, Illinois

The Microwave Bands

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Band	Frequency Range	Weak signal work in NA
33 cm	902 to 928 MHz	902 MHz (Region II only NA & SA)
23 cm	1240 to 1300 MHz	1296 MHz
13 cm	2300 to 2310 MHz	2304 MHz (2301 VK, 2320 some Europe and VE – cross band required
	2390 to 2450 MHz	2424 JA
9 cm	3300 to 3500 MHz	3456 MHz (3400 MHz used for EME)
6 cm	5650 to 5925 MHz	5760 MHz
3 cm	10000 to 10500 MHz	10368 MHz (10450 MHz used by JA)
1.25cm	24000 to 24250 MHz	24192 MHz (24048 MHz used for EME)
.6 cm	47000 to 47200 MHz	47088 MHz
.35 cm	77000 to 81000 MHz	78192 MHz (77184 MHz used by RW3BP, W5LUA, & VE4MA)

The problem…Not all countries have same allocation as us……..

How long have hams been doing EME on the upper bands?

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- First 902 MHz EME QSO on January 22, 1988 between K5JL and WA5ETV
- First 1296 MHz EME QSO in 1960 between W1BU and W6HB
- First 2304 MHz EME QSO in 1970 between W4HHK and W3GKP
- First 3456 MHz EME QSO on April 7, 1987 between W7CNK and KD5RO
- First 5760 MHz EME QSO on April 24, 1987 between W7CNK and WA5TNY
- First 10368 MHz EME QSO on August 27, 1988 between WA7CJO and WA5VJB
- First 24192 MHz EME QSO on August 18, 2000 between W5LUA and VE4MA
- First 47088 MHz EME QSO in January 2005 between RW3BP and AD6FP followed by W5LUA and RW3BP
- First 77184 MHz EME QSO TBD – RW3BP has heard echoes and was copied by W5LUA in June 2013, VE4MA also working towards EME.

JT-65 for EME

- Joe Taylor's (K1JT) WSJT digital modes have certainly revolutionized weak signal, meteor, and EME communications
- JT-65A used on 6M
- JT-65B used on 2M through 70 cm
- JT-65C used on 1296 MHz through 5760 MHz – Struggle at 5760 MHz due to excessive doppler shift during 1 minute transmission – Hand always on knob!
- Using JT-65C on 10 GHz and higher a struggle due to doppler shift being more than 200 Hz per minute!
- Additional challenge is that on 10 GHz and higher, the libration spreading can be as large as several hundred Hz which is much more than the 10.8 Hz tone spacing of JT65C – Signals sound aurora like

JT-4 Mode

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- The JT-4 mode uses 4 tones and offers a range of tone spacings up to 315 Hz.
- JT-4F was found to be optimum for 10 and 24 GHz based on normal spreading of the signal.
- Only disadvantage of JT-4F is that there is no sync pulse as power is divided equally among the 4 tones.

Bandwidth Comparison between JT4 Modes and JT-65C

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Mode	Expansion Factor N	Tone Spacing (Hz)	Bandwidth (Hz)
JT4A	1	4.375	17.5
JT4B	2	8.75	35
JT4C	4	17.5	70
JT4D	8	39.375	158
JT4E	18	78.75	315
JT4F	36	157.5	630
JT4G	72	315.0	1260
JT-65C		10.8 Hz	711 Hz

When libration spreading is low, contacts on 10 GHz are possible with JT-65C but our success rate went up with the JT-4 modes especially at 24 GHz where the spreading shows less peaking than seen at 10 GHz. Narrower antenna beamwidths also help to reduce the effective spreading of signals

Keeping on Frequency

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- The WSJT waterfall only has a several kHz wide passband.
- How do we keep our continuously doppler shifted signal within the pass band? Doppler can be as high as 25 kHz at moon rise on 10 GHz
- Answer…we must continuously correct our receive frequency to compensate for the mutual doppler between us and the station we are trying to work.
- Initially VK7MO was doing all the frequency correction at his end for both receive and transmit so all I had to do was set my Flex5000 to the sked frequency
- Recently K5GW wrote similar code for the Flex5000 to control both my receive and transmit frequencies so as to put my transmitted frequency precisely on the schedule frequency at any observer on earth by just knowing their 6 digit grid square.
- GPS frequency locking is a requirement for the microwave LO.

Picking the best times

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- Perigee (when the moon is closest to earth) is always best
- Need to pick times when spreading is lowest so that the tones can fall into the narrow spaced frequency bins required for both JT-65C and JT-4
- I use an EME tracking program by K5GW that predicts times of lowest libration spreading – other programs by VK3UM and F1EHN

5M and 2.4M Dishes at W5LUA

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Used on 432 MHz through 10 GHz

Used on 24, 47 and 77 GHz

VK7MO .7M Prime Focus Dish used on 10 GHz EME

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3dB Beamwidth =2.5 degrees

DB6NT Power amplifier 45 watts @ the feed

NF 1 dB

VK7MO uses rifle scope for tracking

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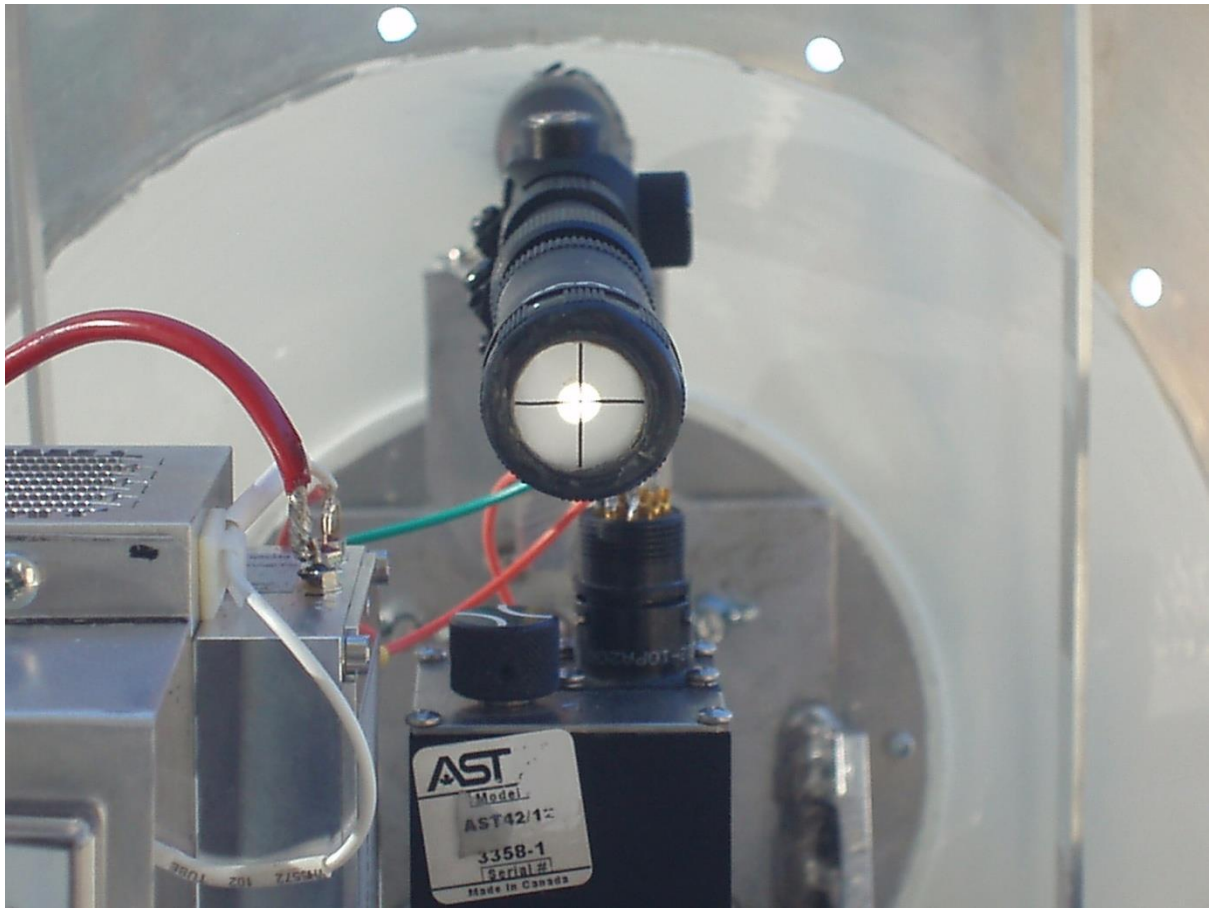

W5HN

VK7MO-W5LUA OCT 18 23:01Z

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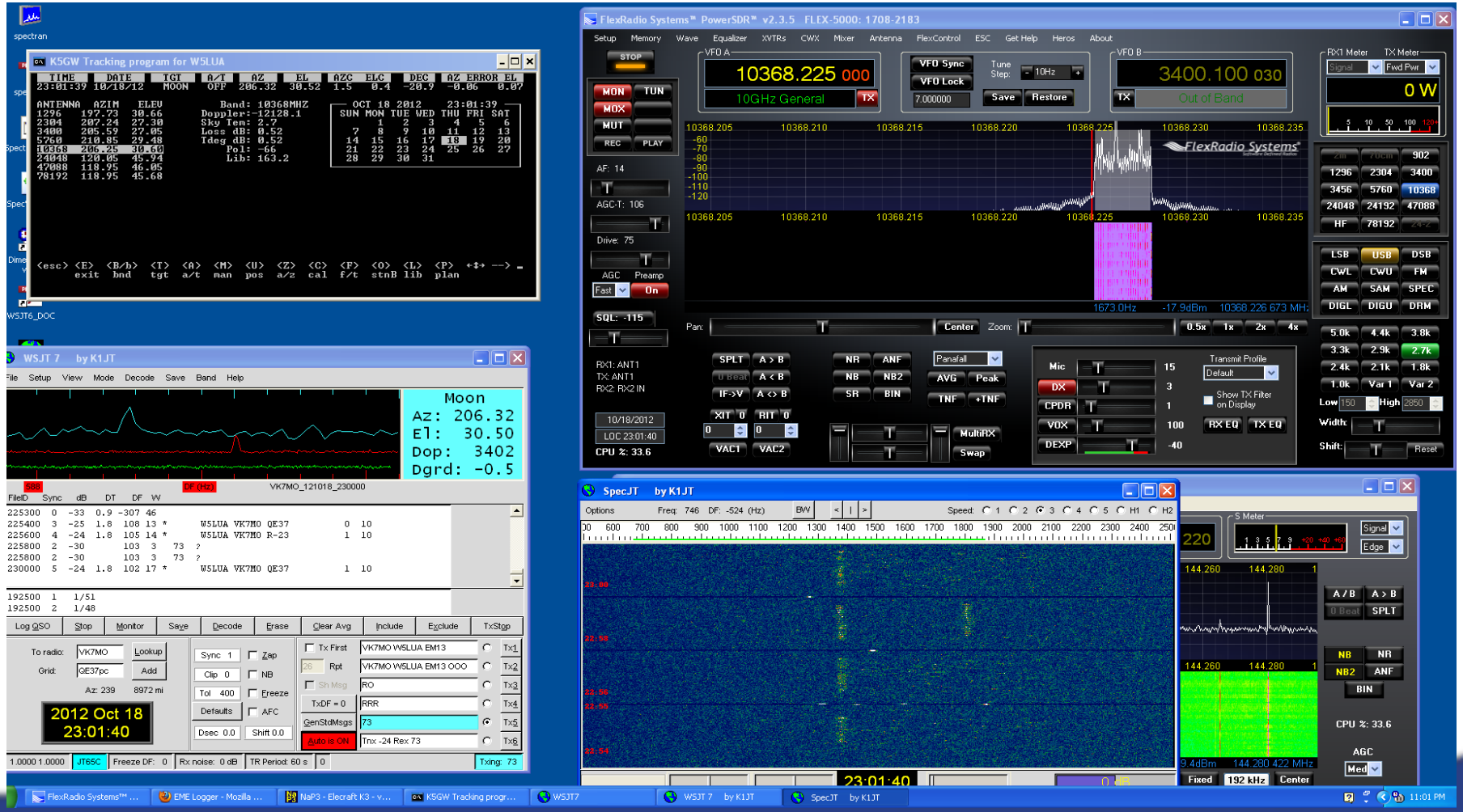

W5HN

VK7MO portable in OF89ai

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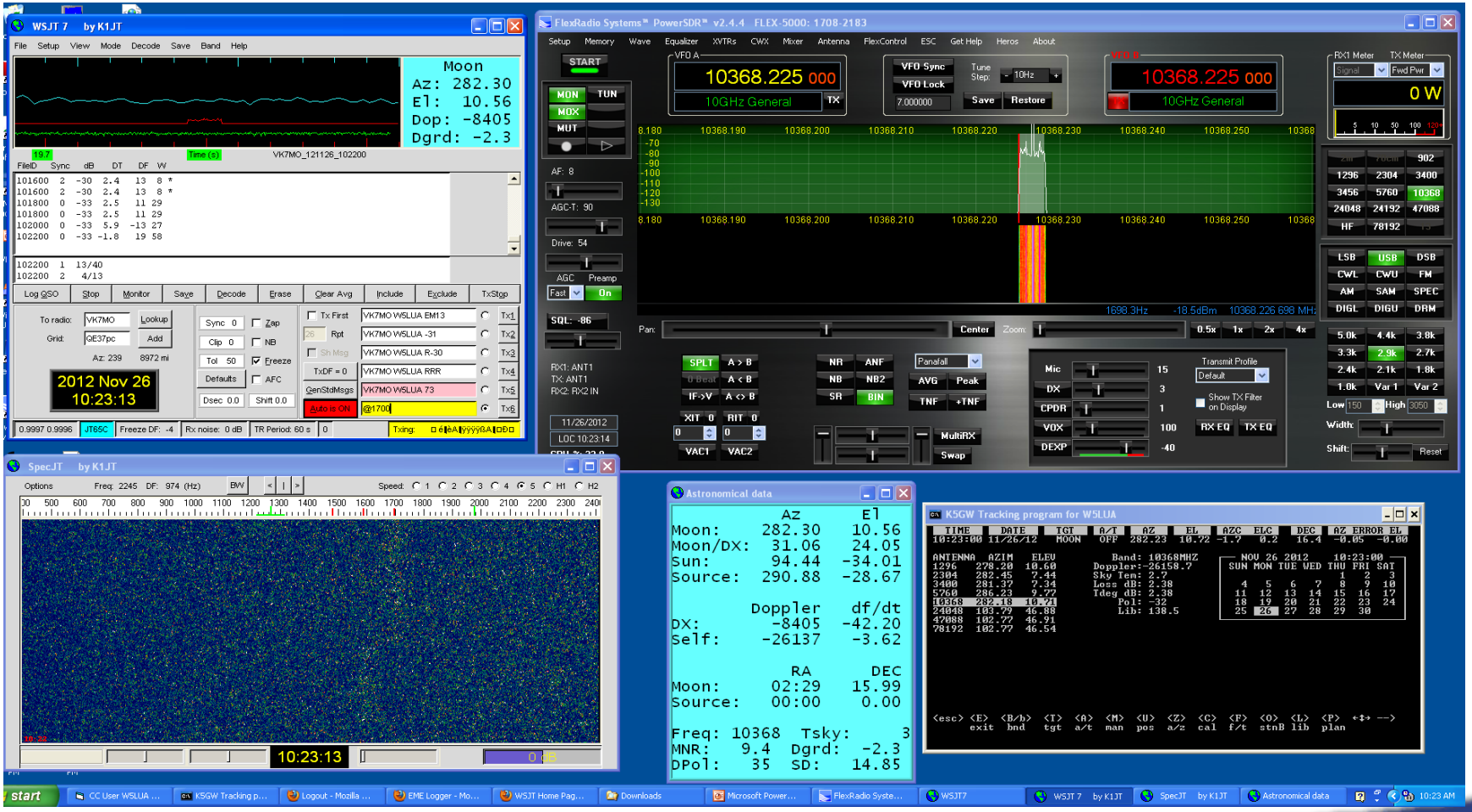

VK7MO Receiving W5LUA in Grid Square PF06 on 10 GHz

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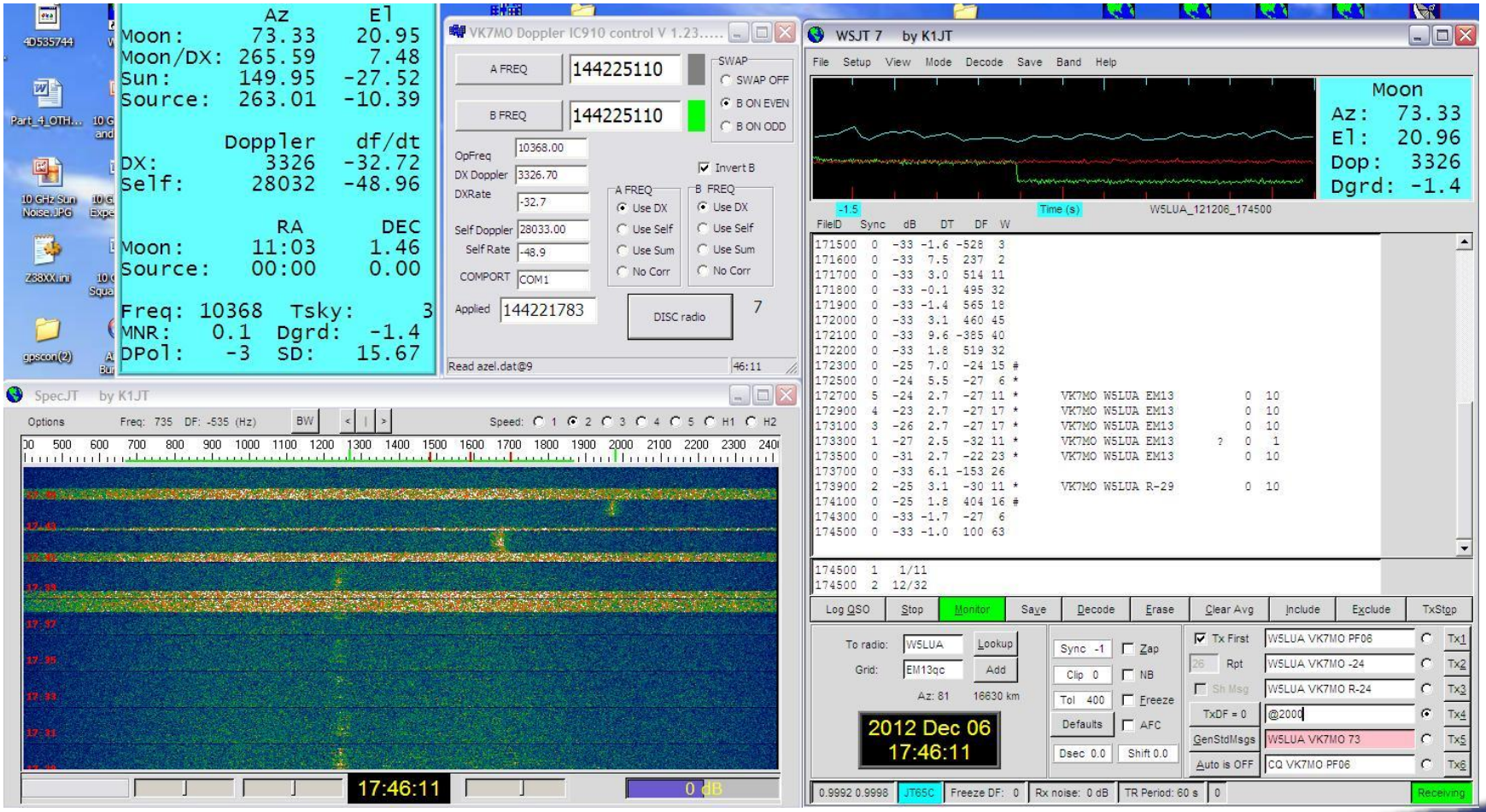

VK7MO working W5LUA from motel room on 10 GHz EME from Grid Square PF58kn

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Using JT-4G on 10 GHz

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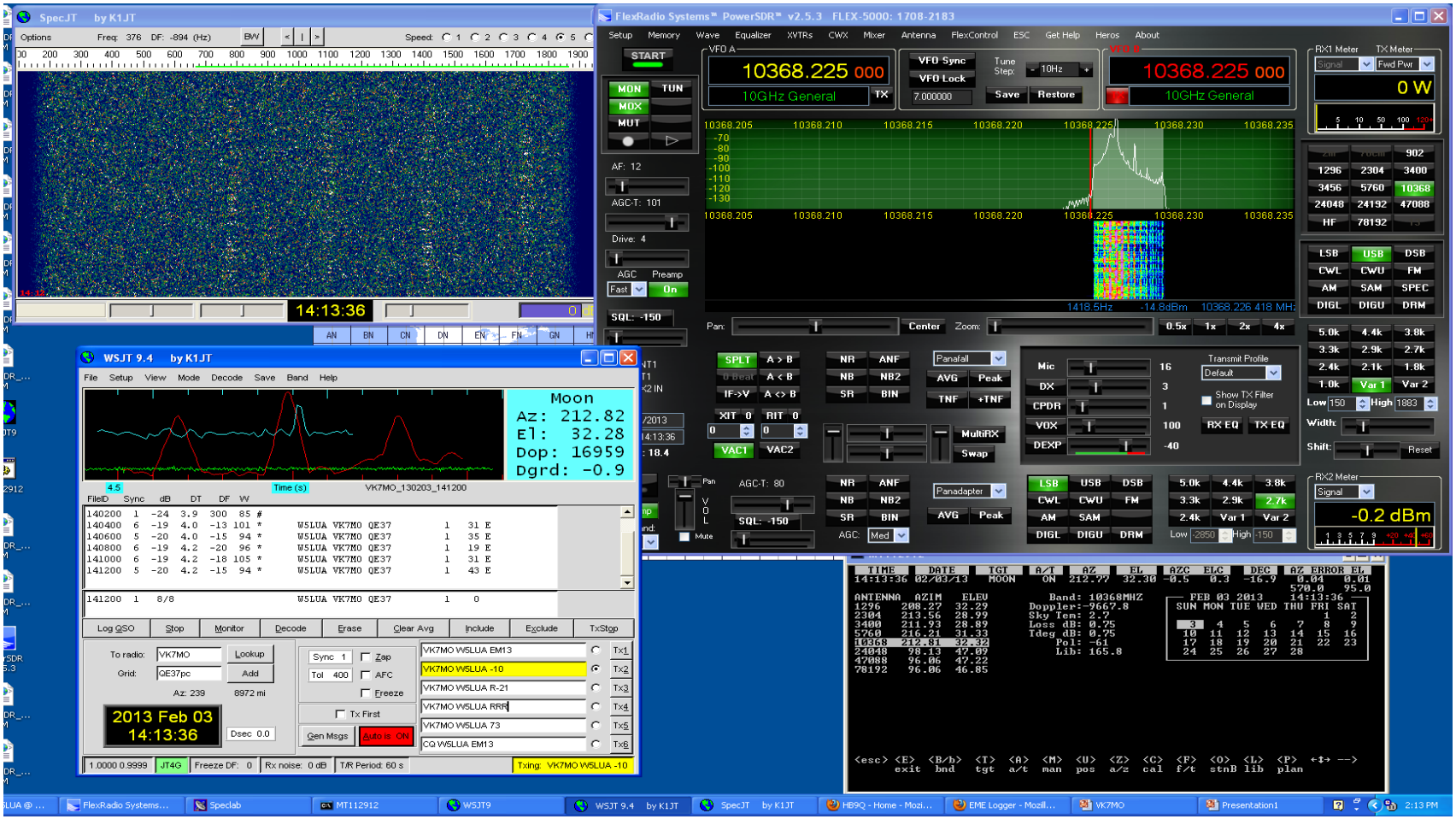

Working some issues with DT numbers that appear to be 1 to 2 seconds high compared to actual path delay prediction

QSO Procedure using JT-4F/G

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- Both stations send 1270 Hz to help with alignment – usually for about 5 minutes
- Both calls are sent
- When both calls are received then send both calls and dB signal report as calculated by WSJT
- When both calls and report are received then send single tone @1500 Hz which designates R
- When R is received , then send single tone @1700 Hz which designates 73
- When signals are strong then text can be substituted for single tones

1.14M Prime Focus Dish used by VK7MO on 24 GHz EME

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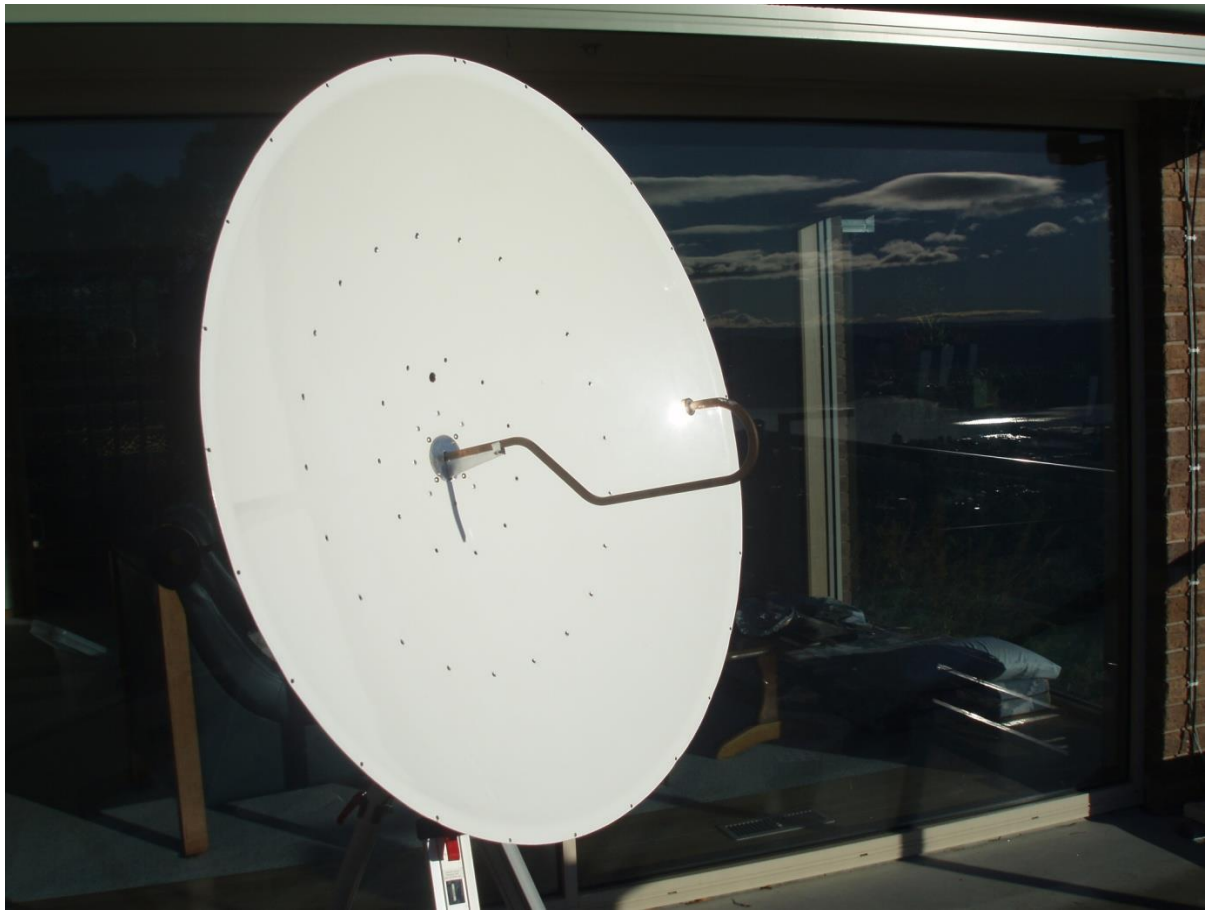
AZ-EL Mount Details



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24 GHz QSO with VK7MO using JT-4F

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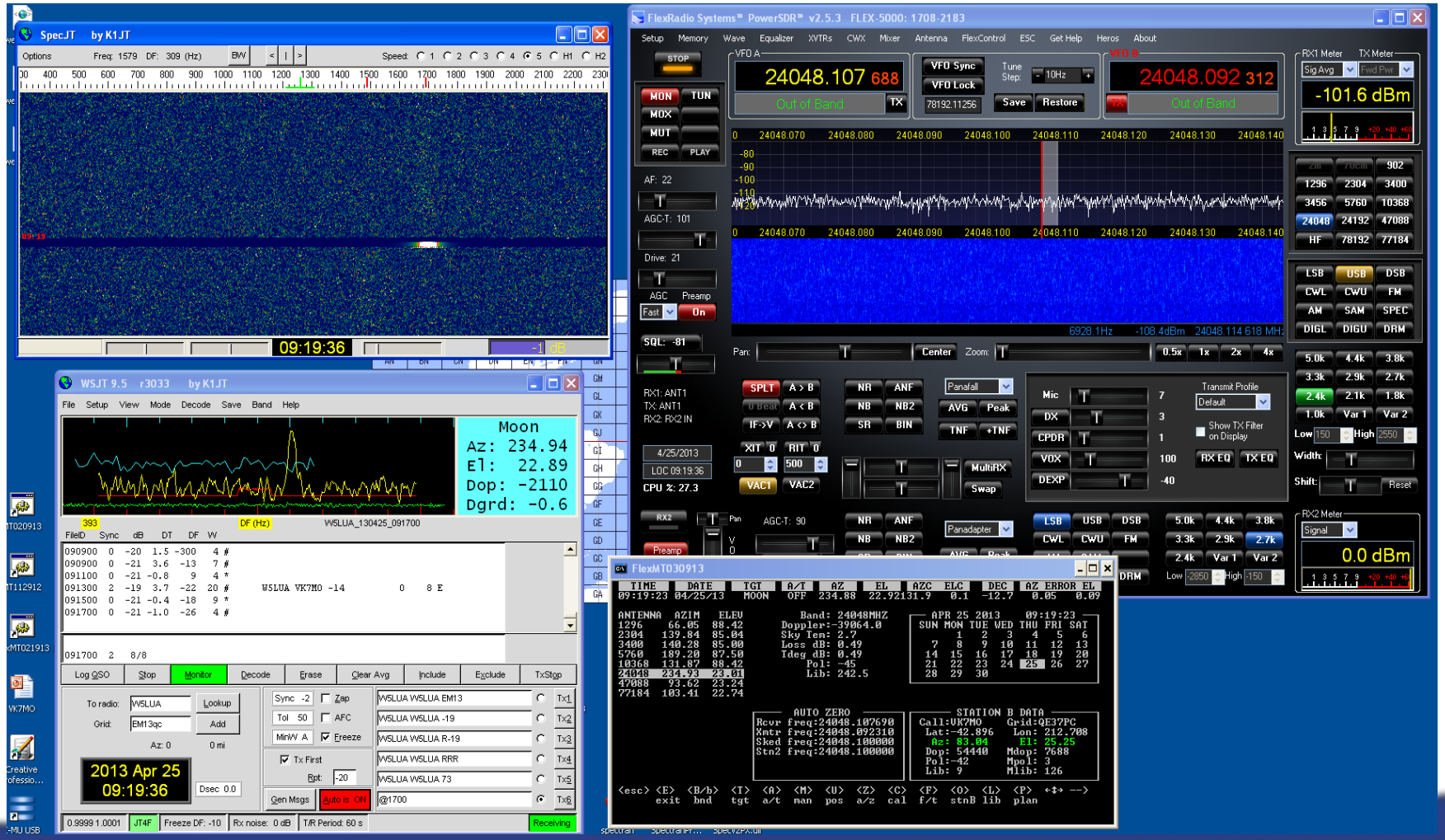

VK7MO Seeing his Echoes on 24 GHz

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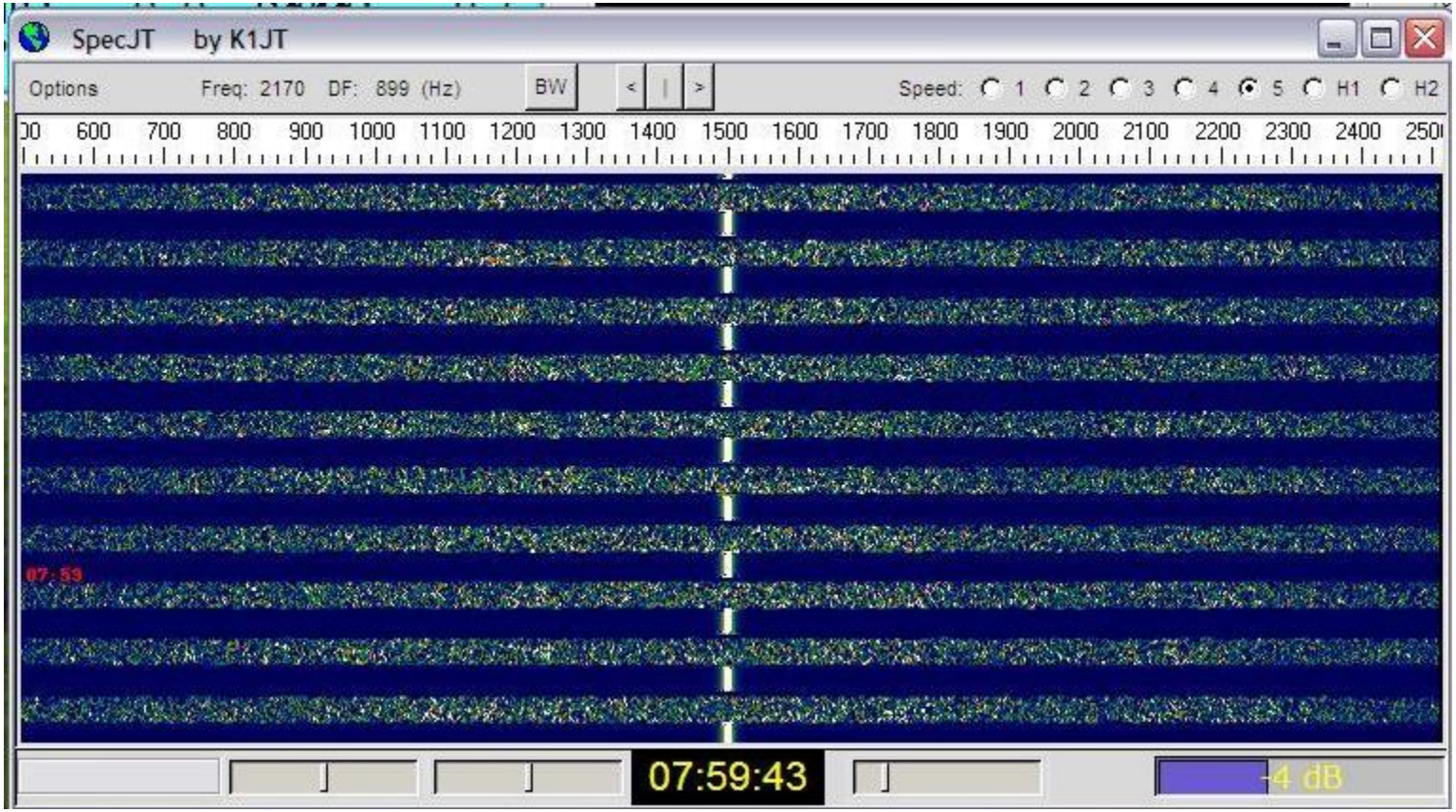

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24 GHz EME QSO Between W5LUA and OZ1FF March 2013

OZ1FF on 24 GHz – 1270 Hz

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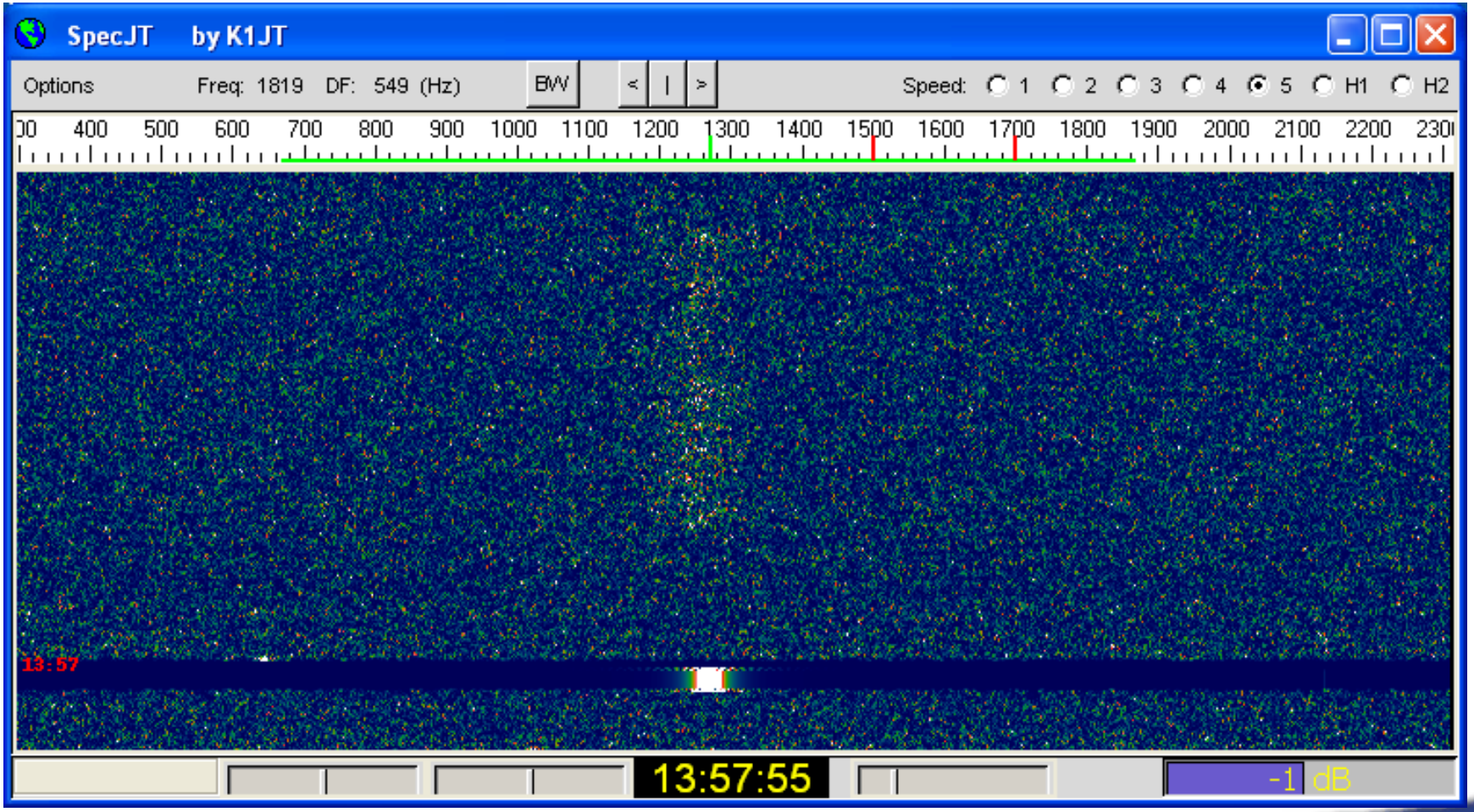

OZ1FF on 24 GHz – 1270 Hz

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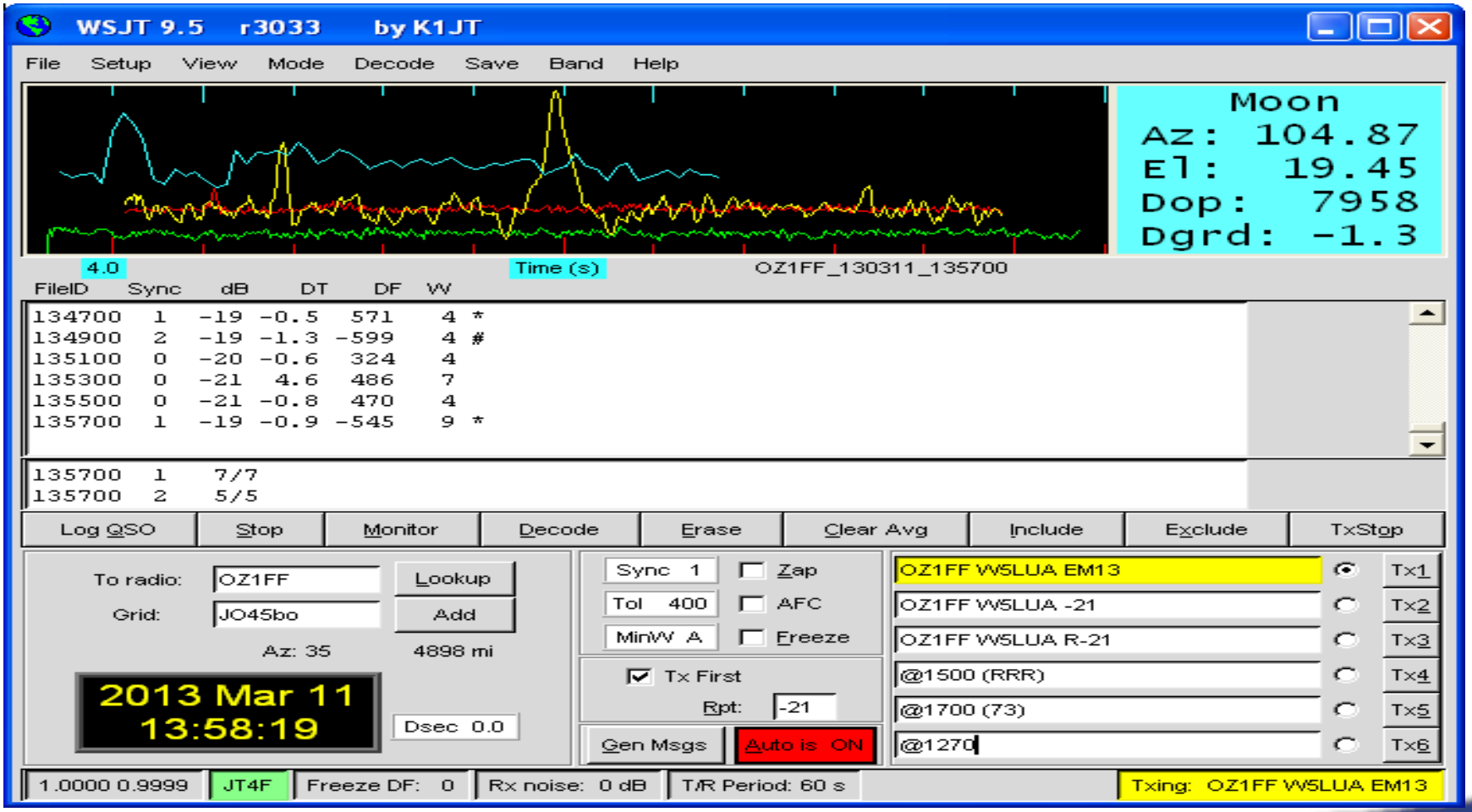

OZ1FF on 24 GHz sending messages

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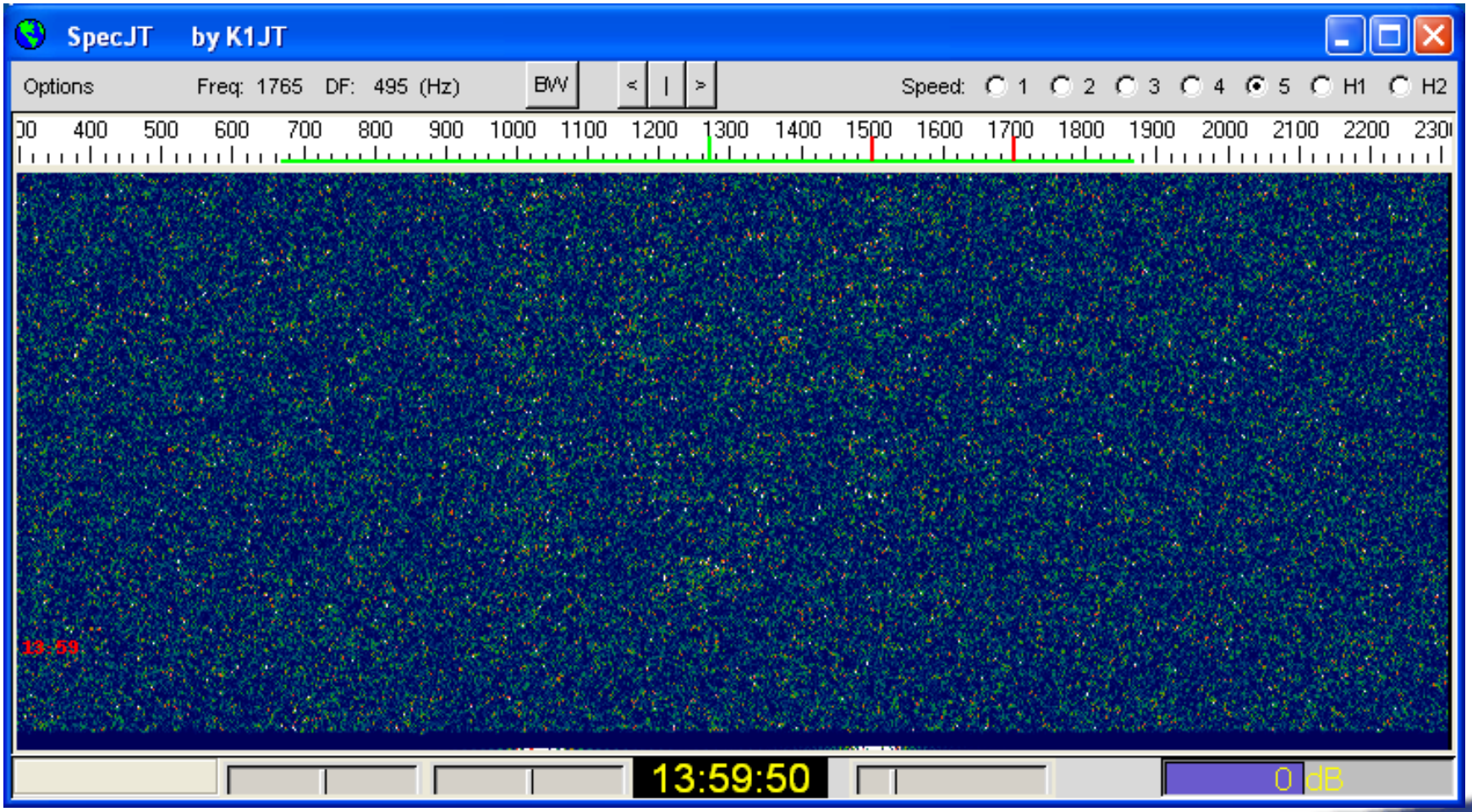

Calls Received

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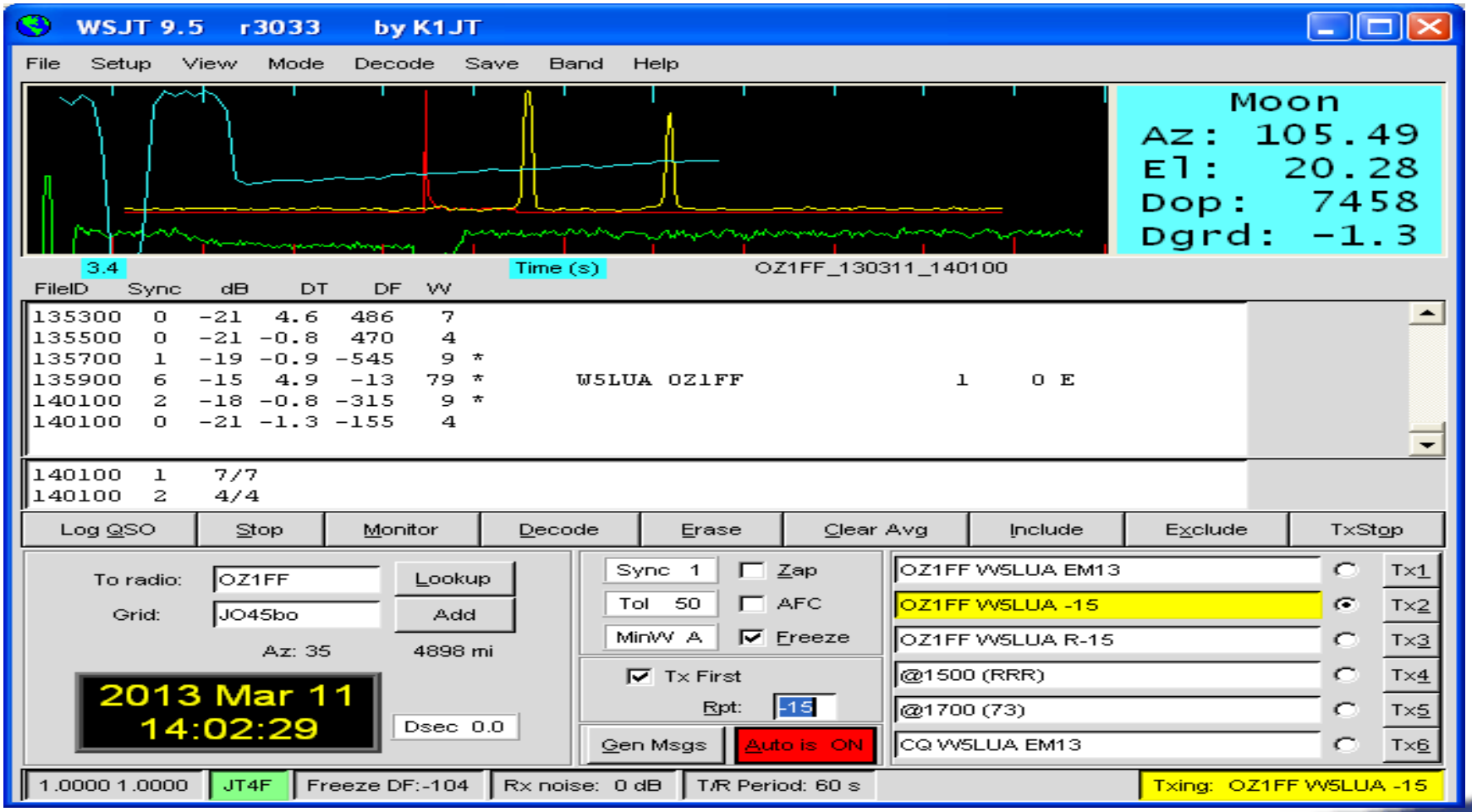

Receiving single tone R from OZ1FF

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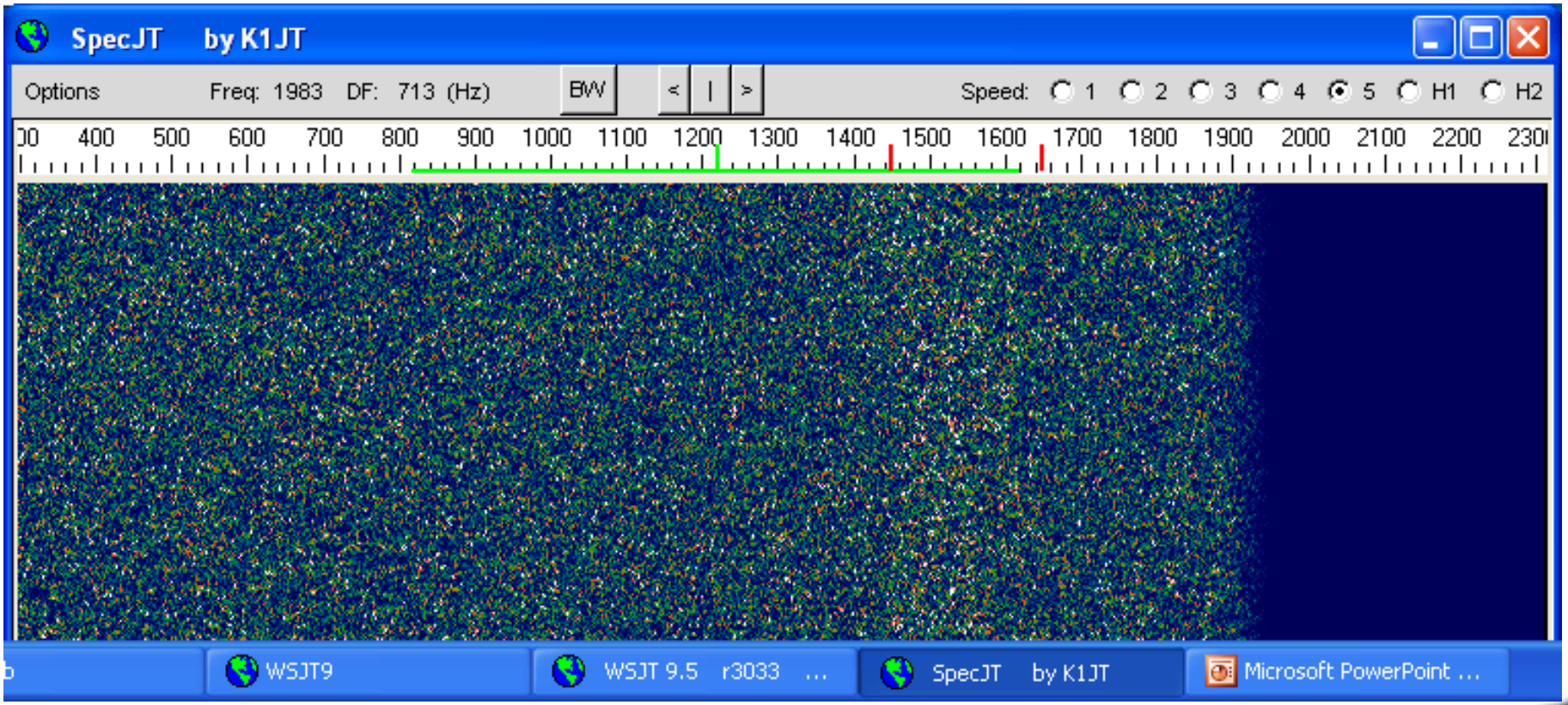

Receiving 73 from OZ1FF

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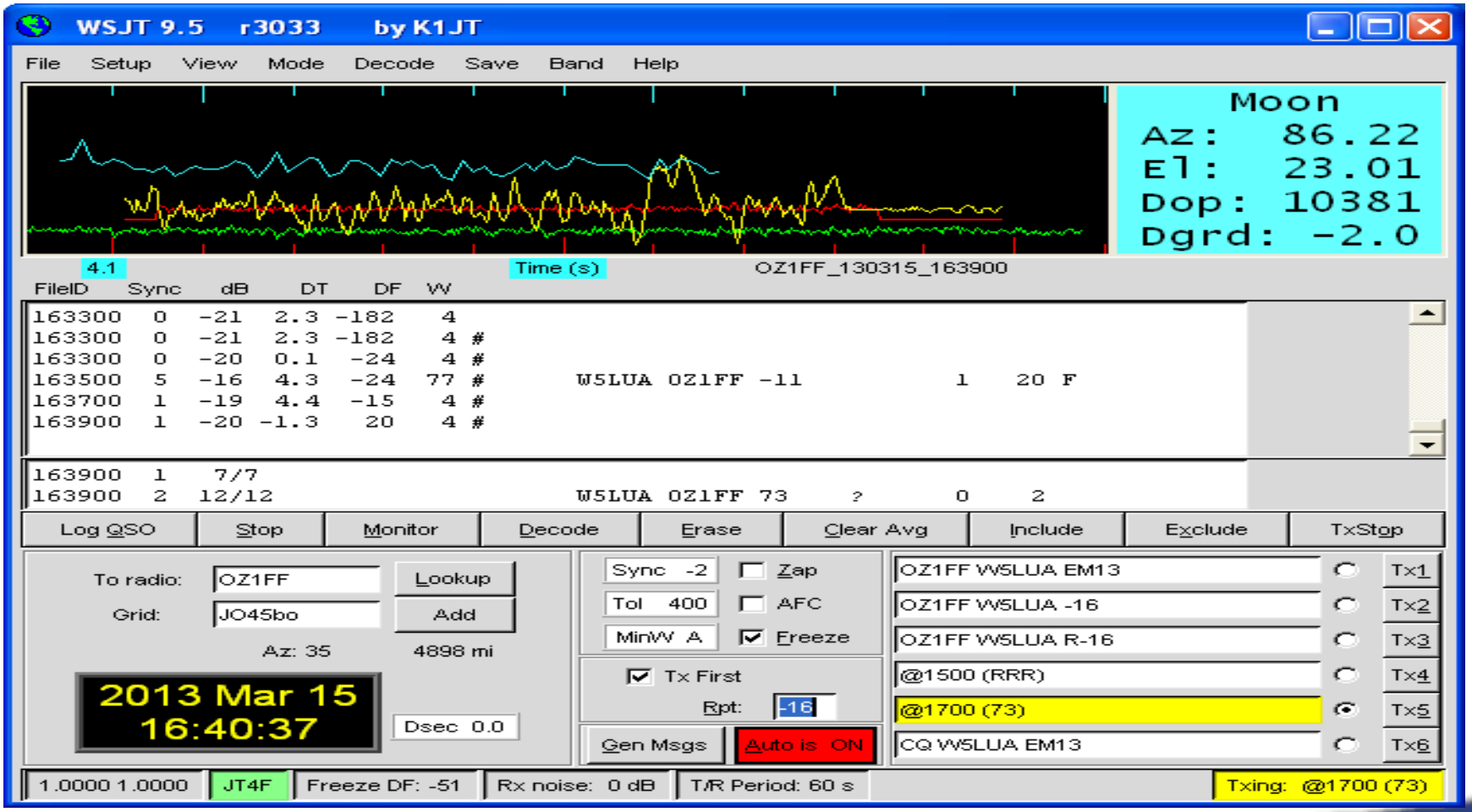

24 GHz Stations using JT-4

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- VK7MO .7 M Prime focus dish and 9 watts
- W5LUA 2.4M Offset fed dish and 100 watts
- OK1KIR 4.5M Prime focus dish and 20 watts
- VK3XPD 3M Prime focus dish and 15 watts
- OZ1FF 1.8M Offset fed dish and 10 watts

Other stations QRV on 24 GHz EME via CW include VE4MA, RW3BP, OK1UWA, LX1DB, G4NNS, DK7LJ, DF1OI, PA0EHG, DL7YC, IK2RTI, JA6CZD, F2CT, RK3WWF

Coordination

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- HB9Q Logger for schedule coordination and chat on 432 MHz and higher http://hb9q.ch/version2/index.php
- 432 MHz and Above newsletter published every month for over 30 years http://www.nitehawk.com/rasmit/em70cm.html
- Moon-Net Reflector http://www.nlsa.com/nets/moon-net-help.html
- Moon Reflector http://lists.moonbounce.info/cgi-bin/mailman/listinfo/moon
- Microwave Reflector http://lists.valinet.com/cgi-bin/mailman/listinfo/microwave

You might very well be close with your tropo setup but..

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- Are you GPS locked?
- Do you have the proper software for predicting the moon location?
- Can you track the moon? Remember a 36 inch dish has a 3dB beam width of 2.3 degrees and a 1 dB beam width of 1.3 degrees at 10 GHz
- Elevation is easy – Remote a Sears inclinometer as written up by WA8RJF
- Azimuth – Use either a US Digital absolute encoder or an incremental encoder and a W2DRZ system or an HB9DRI system for both az and el. Other option for US Digital absolute encoders is the use of a Weeder RS-232 controlled relay control board and K5GW software
- Calibration – use the sun
- Let's run!

Thanks to K1JT & VK7MO

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- Thanks to Joe Taylor K1JT for taking inputs and comments from VK7MO to help optimize the JT-4 modes for 10 and 24 GHz EME
- Check out Dubus 2/2013 for the article “Small Station EME at 10 & 24 GHz by Rex Moncur, VK7MO, and Joe Taylor, K1JT

EME has been conquered through 47 GHz
Next Challenge – 77GHz EME

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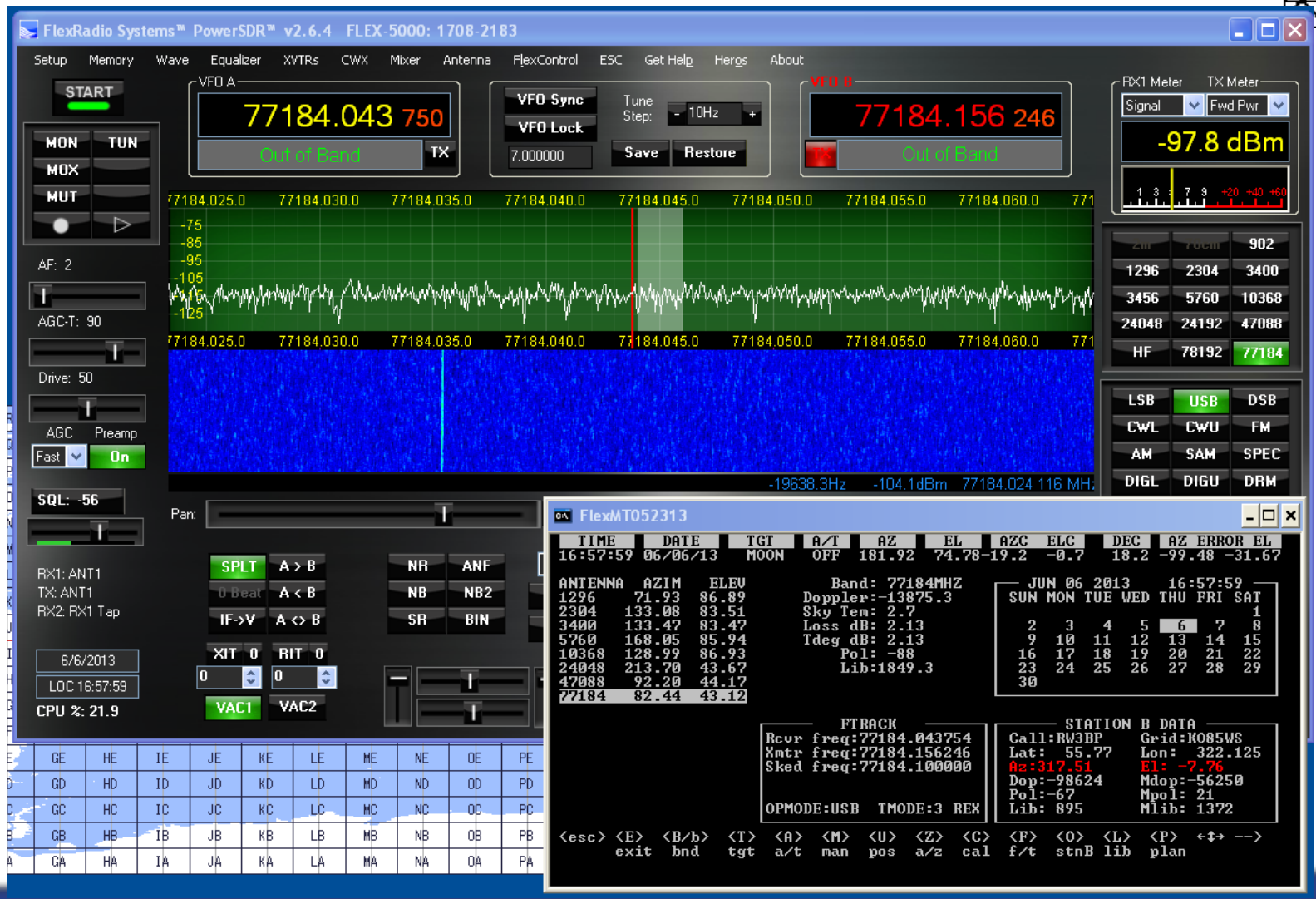

Reception of RW3BP by W5LUA on 77184 MHz on June 12, 2013 using RW3BP's MMCW Program

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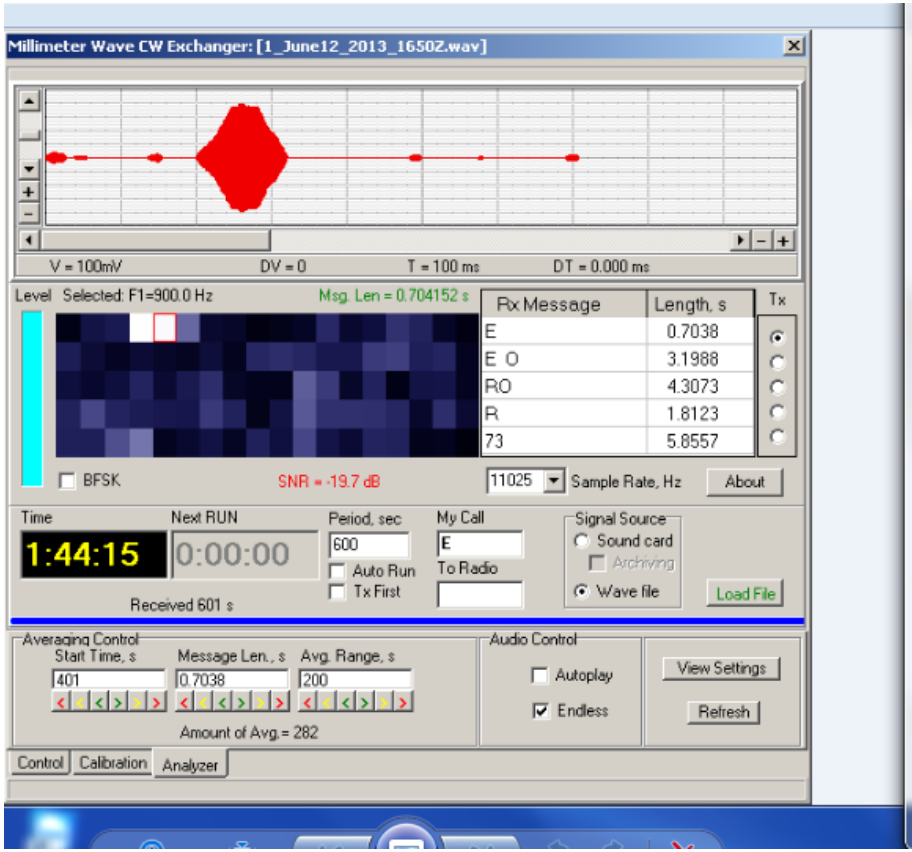

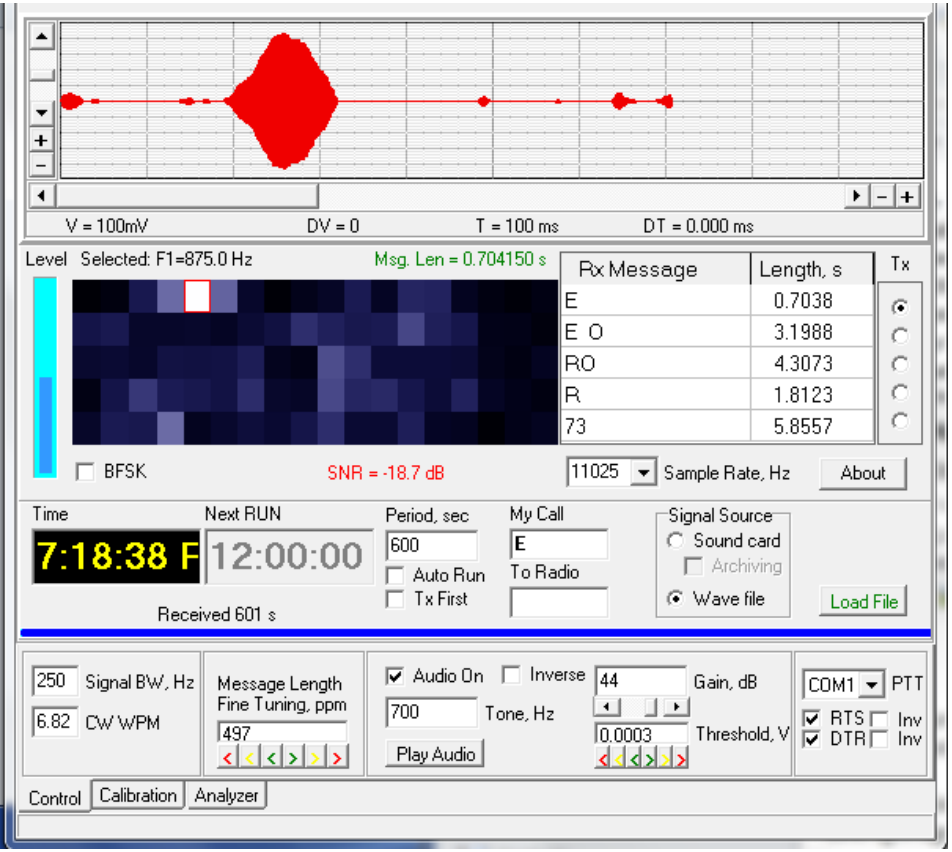

.wav file as replayed by RW3BP

Same .wav file as replayed by W5LUA with 497 ppm correction to message length

W5LUA 77 GHz Assembly at Feed of 2.4 M Dish

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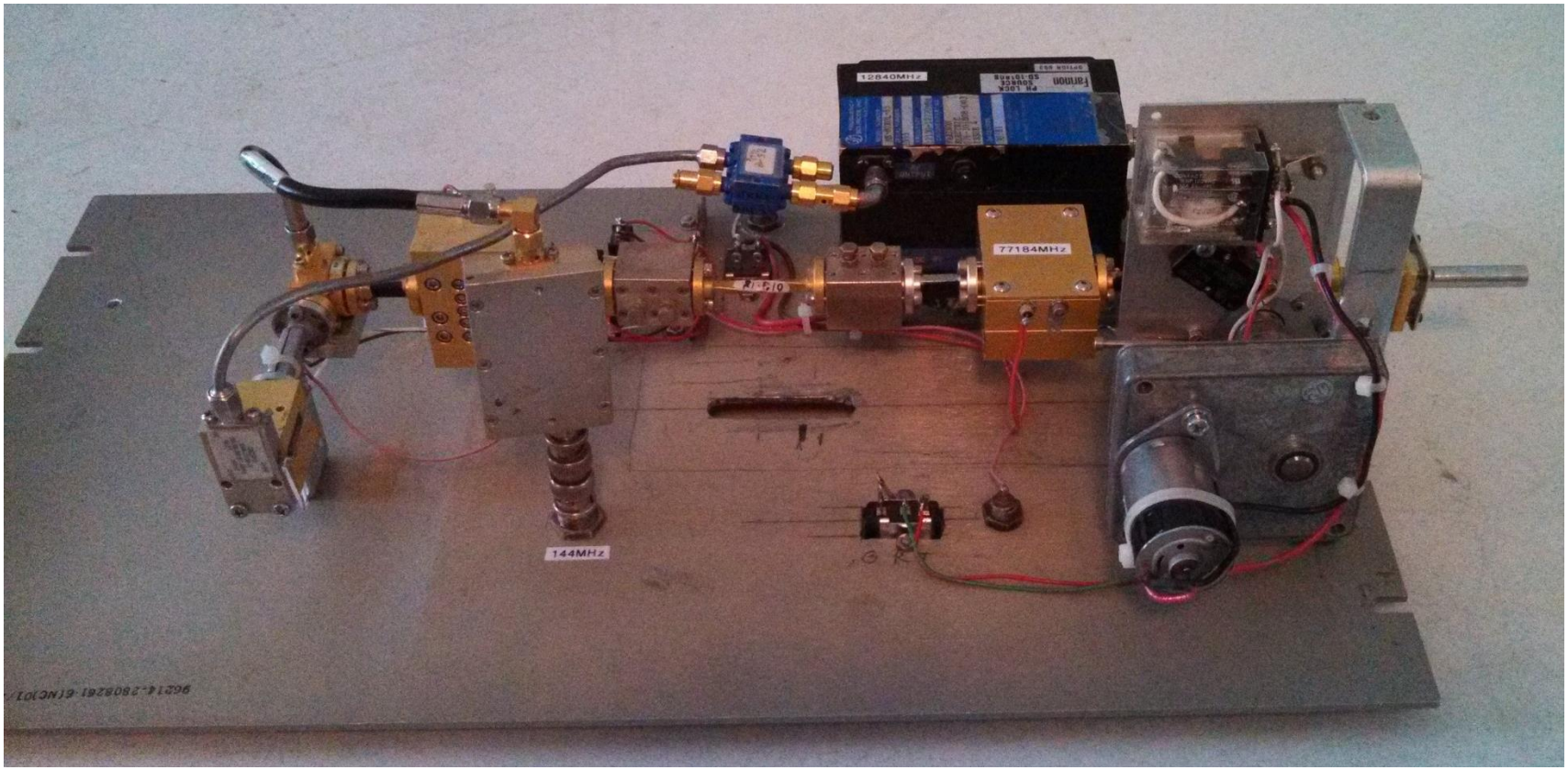

77 GHz Power Needed!

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- Power needed – any leads on available power in the 77 to 81 GHz frequency range appreciated! My 47 GHz TWT is providing about 13 dB gain at 77 GHz but not sure of the power capability, also tuning is very touchy!

Thanks for Listening!

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- Any Questions?
- My presentation will be posted to www.ntms.org after the conference