

# 78 GHz Progress at VE4MA

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# 78 GHz Progress at VE4MA

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- EME Status?
- Terrestrial Work
- Technology Improvements
- Results to Date

# Working Towards 78 GHz EME

- **CPI Canada makes 80 W Tubes ~\$100K!**
- **4 - 5 dB NF Preamplifier Chips Available**
- **Dish Performance Questionable?**
- **78 GHz EME QSOs....Unlikely**

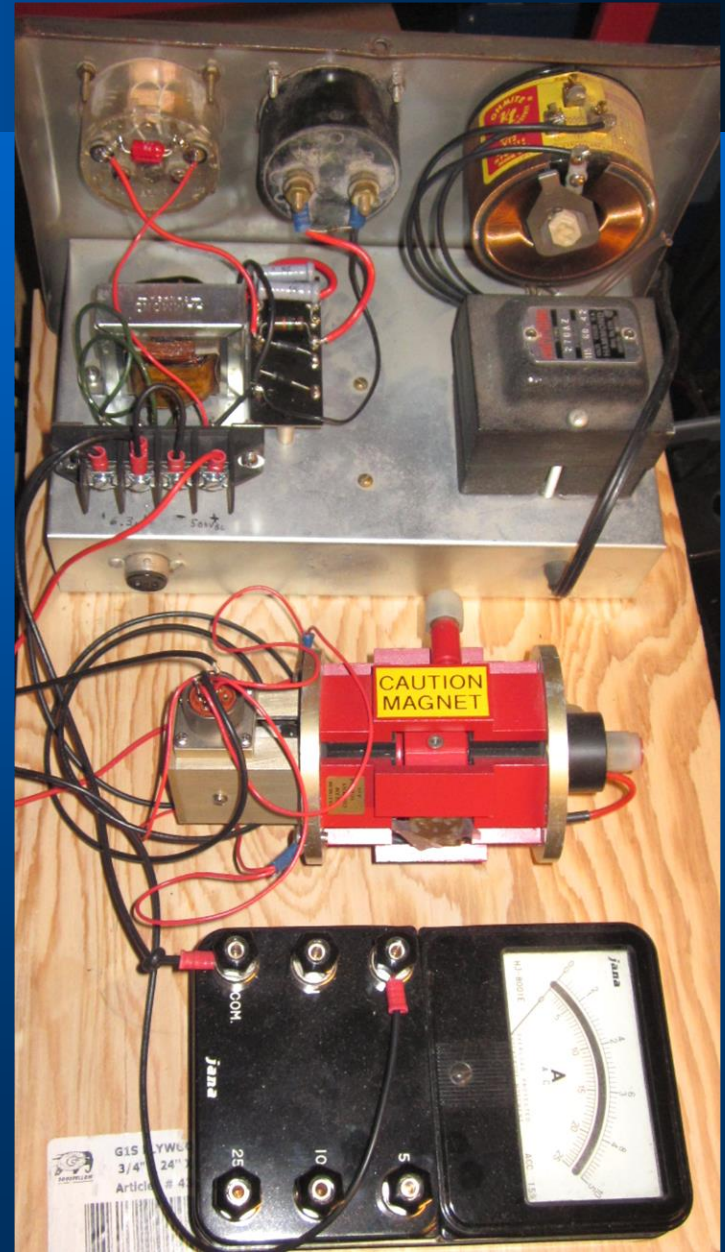
# 78 GHz Transmitter



- “I WON the LOTTERY !”
- 73 Watt Klystron Oscillator
- Factory Tested on  
78160 MHz +/- 82 MHz
- Needs 9 kV Power Supply  
and Really Good Water  
Cooling system
- Will need to be Phase  
Locked and FSK'd for  
Modulation

# 78 GHz Transmitter

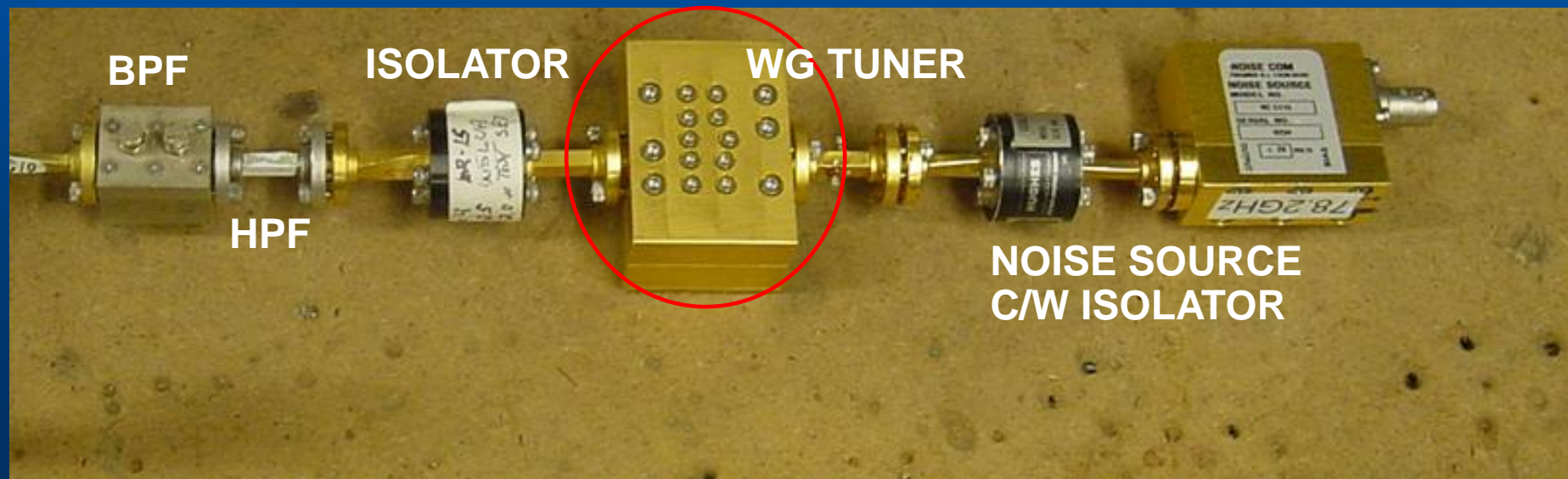
- This Tube is Dead !
- Gassy and Cathode Poisoned...Beyond Economic Repair
- Several More Tubes have shown up Surplus...
  - but HIGH COST > \$5K
  - NO GUARANTEE!
- Gassy Also?





# 78 GHz System Hardware: Preamps

- Prototype WA1MBA Preamplifier
- ~ 3 dB Preamp NF... so System NF ~3.5 dB
- Production Preamps ~5 dB NF ~27 dB Gain



# 78 GHz Dish Tests at W5LUA



- **2.4 m & 1m Dishes**
- **Best Results from a 1m TV mini-dish**
- **7 dB Sun Noise, 0.75 dB Moon Noise**
- **Still Room to Optimize**

# 78 GHz Dish Tests at VE4MA



- **Best Results from a 1.2m Satellite dish**
- **4.8 dB Sun Noise (with 6.1 dB NF)**
- **Dish was old Hughes DirecWay “Ka” dish with aluminum foil added**

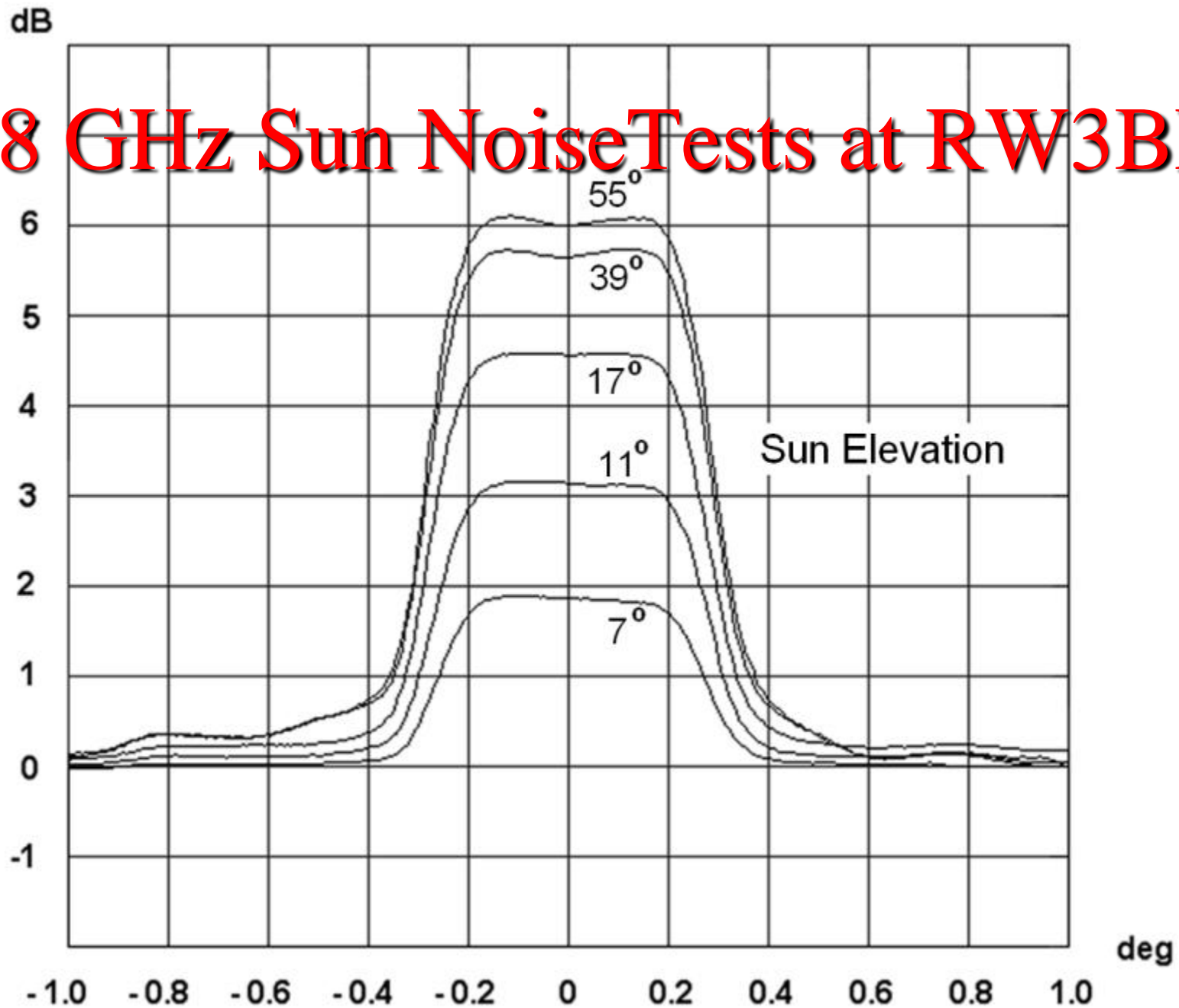


# 78 GHz Dish Tests at VE4MA

- Only 6.1 dB NF at time of Tests
- Better results from 2.4m TV dish than W5LUA,
- 3.5 dB Sun Noise on 2.4m
- Only 2.8 dB on 33 inch mini-dish mounted like W5LUA

2010/10/16

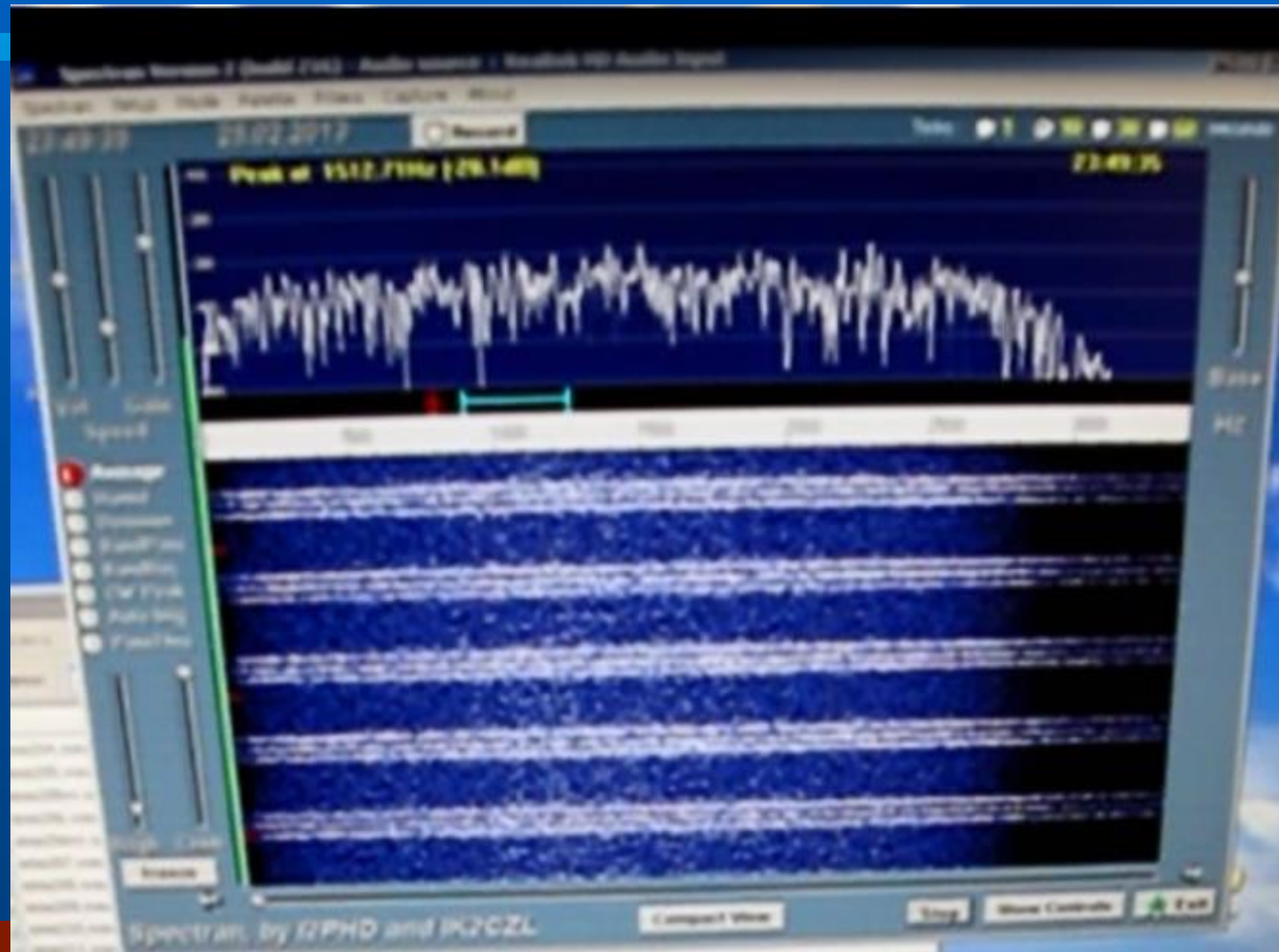
# 78 GHz Sun Noise Tests at RW3BP



# The First 78 GHz Moon Echoes

- **Sergei RW3BP on Feb 17, 2013 “Outstanding!”**
- **>60 Watts Output, 2.4 m Offset Dish 0.12 deg BW, ~ 107 MW ERP!**
- **~5 dB NF Preamplifier, ~7 dB Sun, 0.7 dB Moon**
- **Audible Echoes as well as Electronic Detection**
- **Frequency of 77.184 GHz ( 1.008 GHz away!)**

# The First 78 GHz Moon Echoes





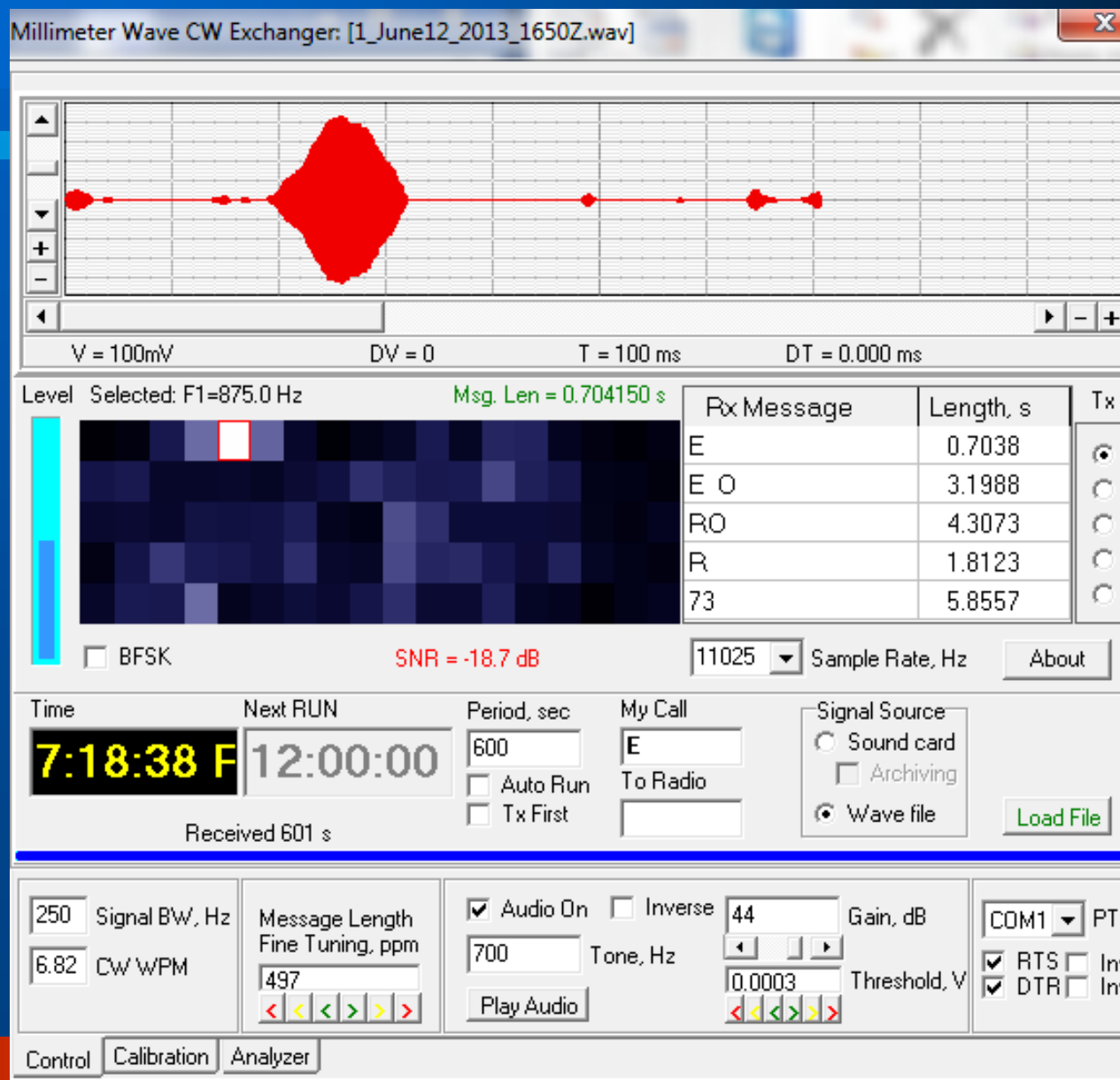
# 2.4 m Offset Fed Dish at RW3BP



# 78 GHz EME RX Improvement?

- **RW3BP Software “Extends The Receive Threshold”**
  - Signal Spread from 300 to 450 Hz Wide
  - Long Transmission Periods
  - CW Transmission
  - BFSK & “Special” CW Modulation
- **Time Averaging Techniques to Extend Minimum RX Threshold**
- **CW Playback of Averaged Signal**
- **Newer Software JT4G ???**

# Decoded 78 GHz Signal from RW3BP



# EME Challenges at 78 GHz

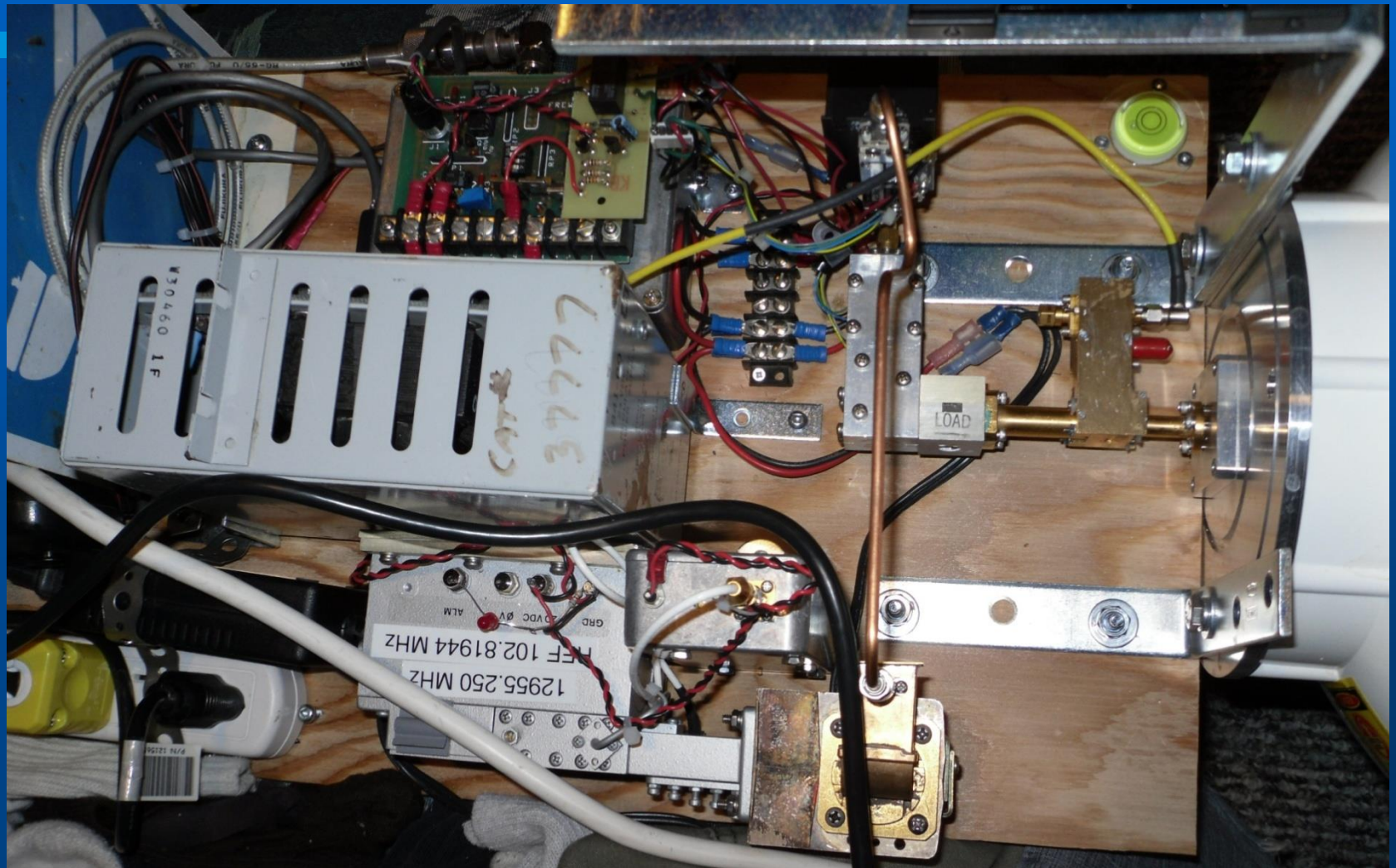
- Rough surface of moon produces very rough sounding note several hundred Hz wide
  - Like aurora
- Doppler shift upwards of +200 kHz on rising moon and –200kHz on setting moon
  - Continuous Doppler Correction Required
- Beamwidth of  $0.12^\circ$  means Antenna pointing correction every 15 seconds!



# 78 GHz Terrestrial Work 2011

- 78 GHz RF Hardware Difficult to Find and Make work
- Antennas are 12 inch Prime Focus Commercial 45 dB gain for 75-90 GHz “Internet” band ( 0.9 deg BW)
- 78 GHz Frontends are commercial Hughes harmonic mixer units modified for Sub harmonic LO (~13 dB NF)
- 39 GHz LO chain is 13 GHz X 3
  - Approx 10 mW for Best RX NF/ 80 mW for Best TX
  - Raw TX output ~ -20 dBm ?

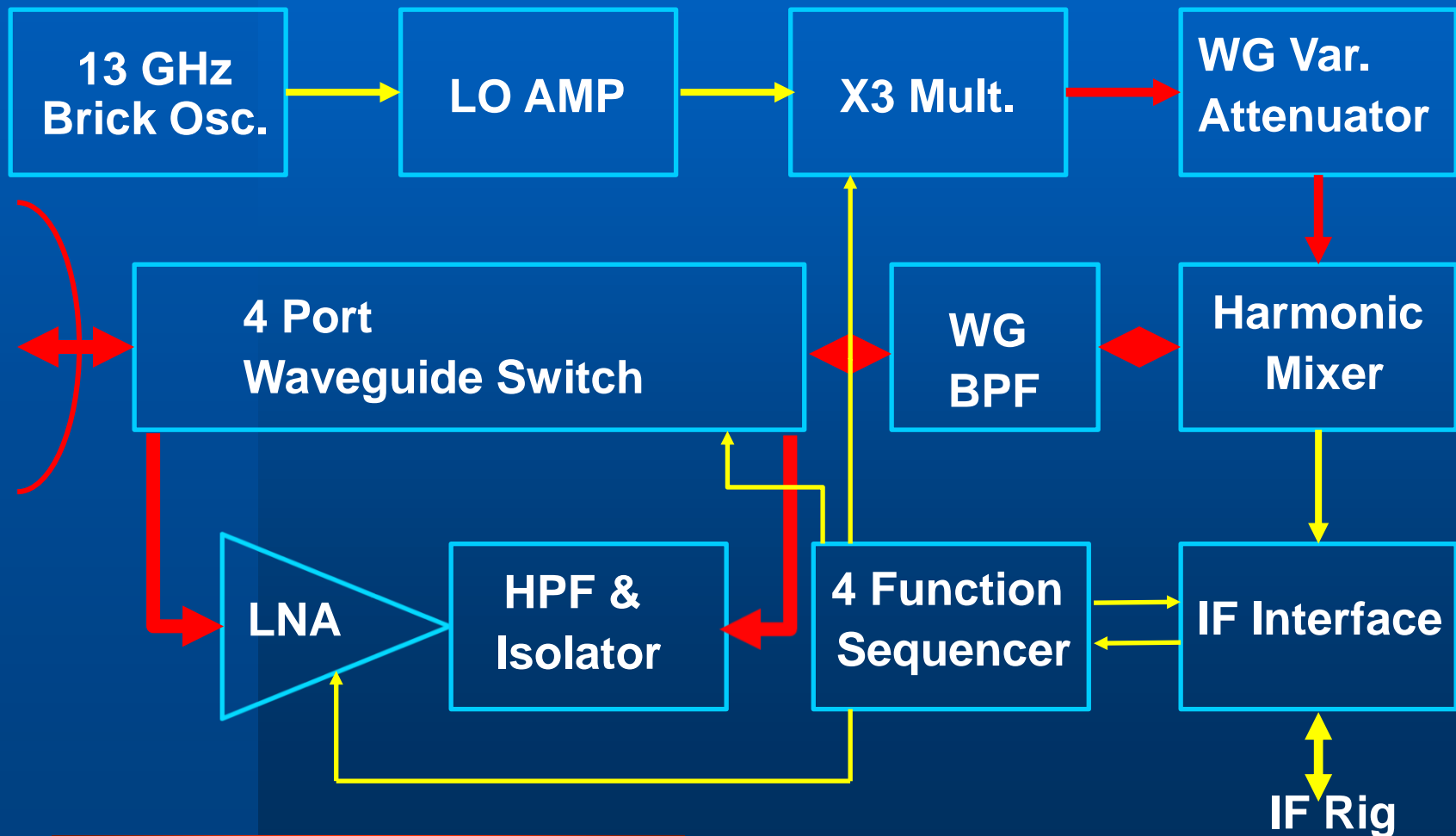
# The Terrestrial 78 GHz Rigs in 2011



# The Terrestrial 78 GHz Rigs in 2011

- Fortunate to have “Borrowed” a Prototype 78 GHz LNA
- ~ 3.25 dB NF , 27 dB of gain & 10 mW output !!!!!
- So Second Rig had much Extra Performance
- Amplifier was Wrapped Around a 4 Port WG Switch to make it Bidirectional
- Sequencing Essential to Avoid Having a Power Oscillator
  - Used Sequencer for Both Rigs as it controls LO power Level

# 78 GHz Transverter Block Diagram





# The Amplified 78 GHz Rig in 2011





# First Canadian 78 GHz QSOs

## October 11, 2010 VE4MA QTH

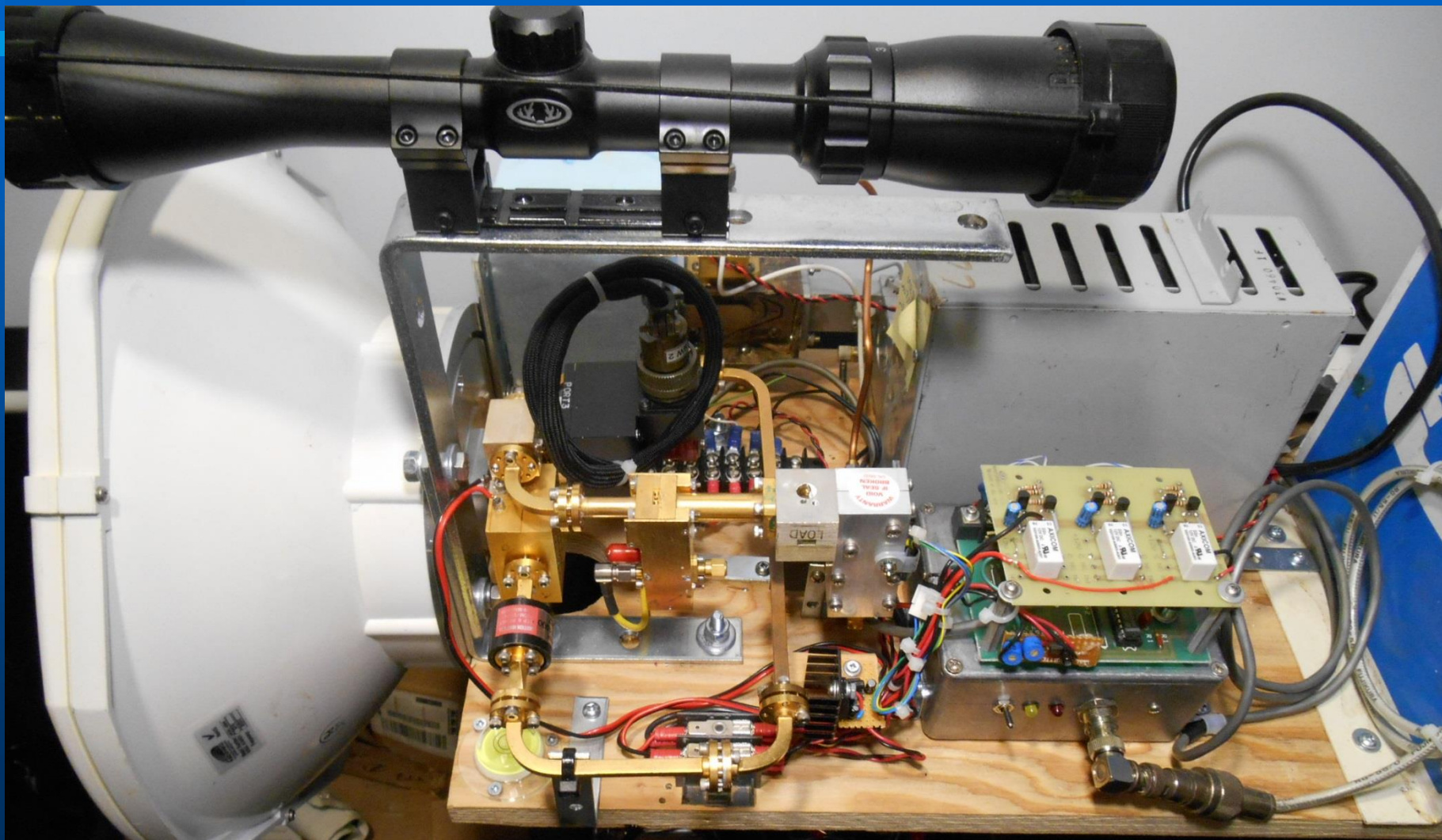


# 78 GHz Terrestrial Work 2015

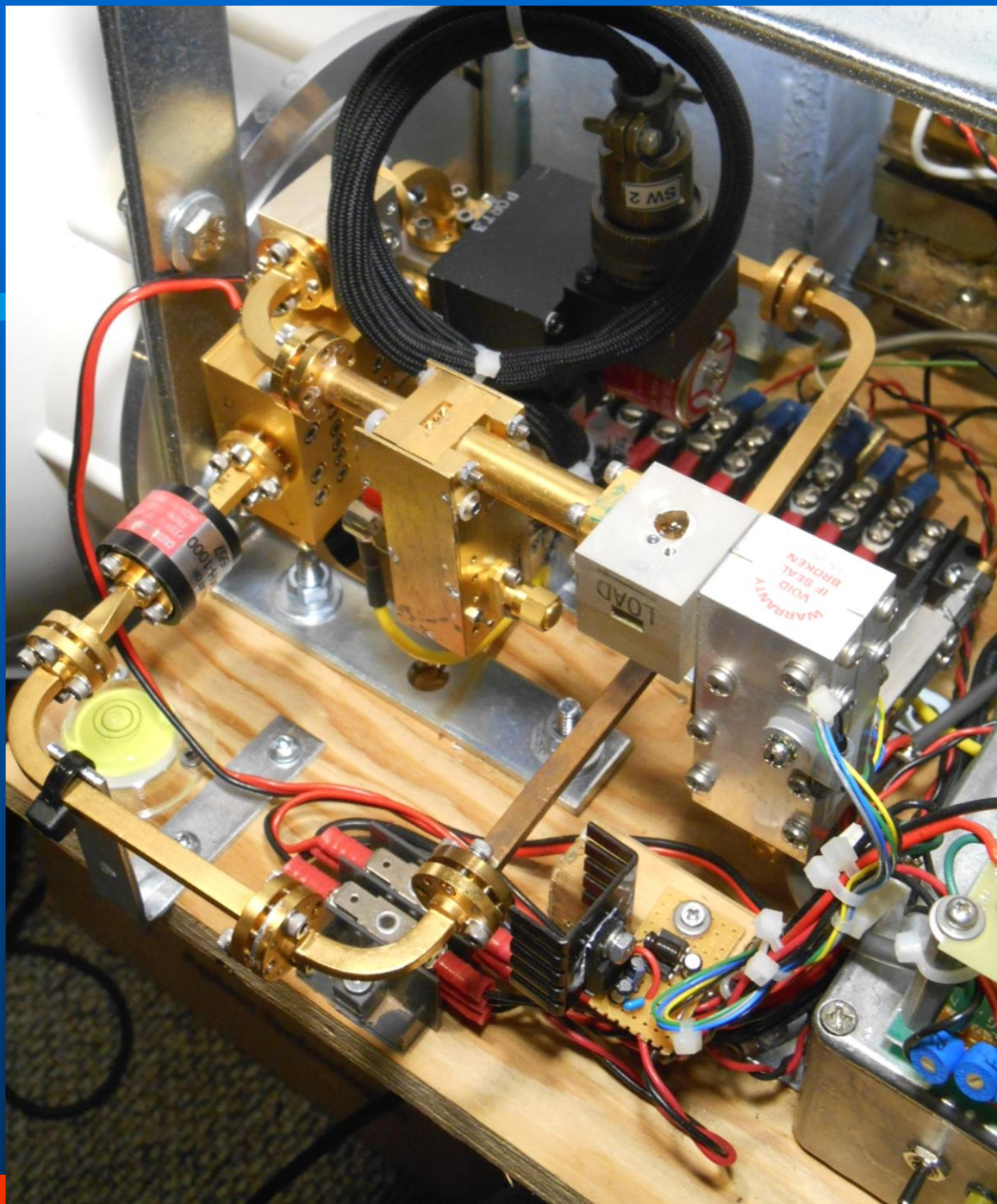
- Both Rigs have 78 GHz Bi-directional LNAs
- ~ 5 dB NF , 27 dB of gain & 5 mW output !!!!!
- Amplifiers Wrapped Around 4 Port WG Switches to make them Bi-directional
- Sequencing Essential to Avoid Having 78 GHz Power Oscillators and possible damage
  - Also Used Sequencer for Both Rigs to control LO power Level
- Extra Hardware used: 78 GHz BPF, Isolator, 75 GHz HPF



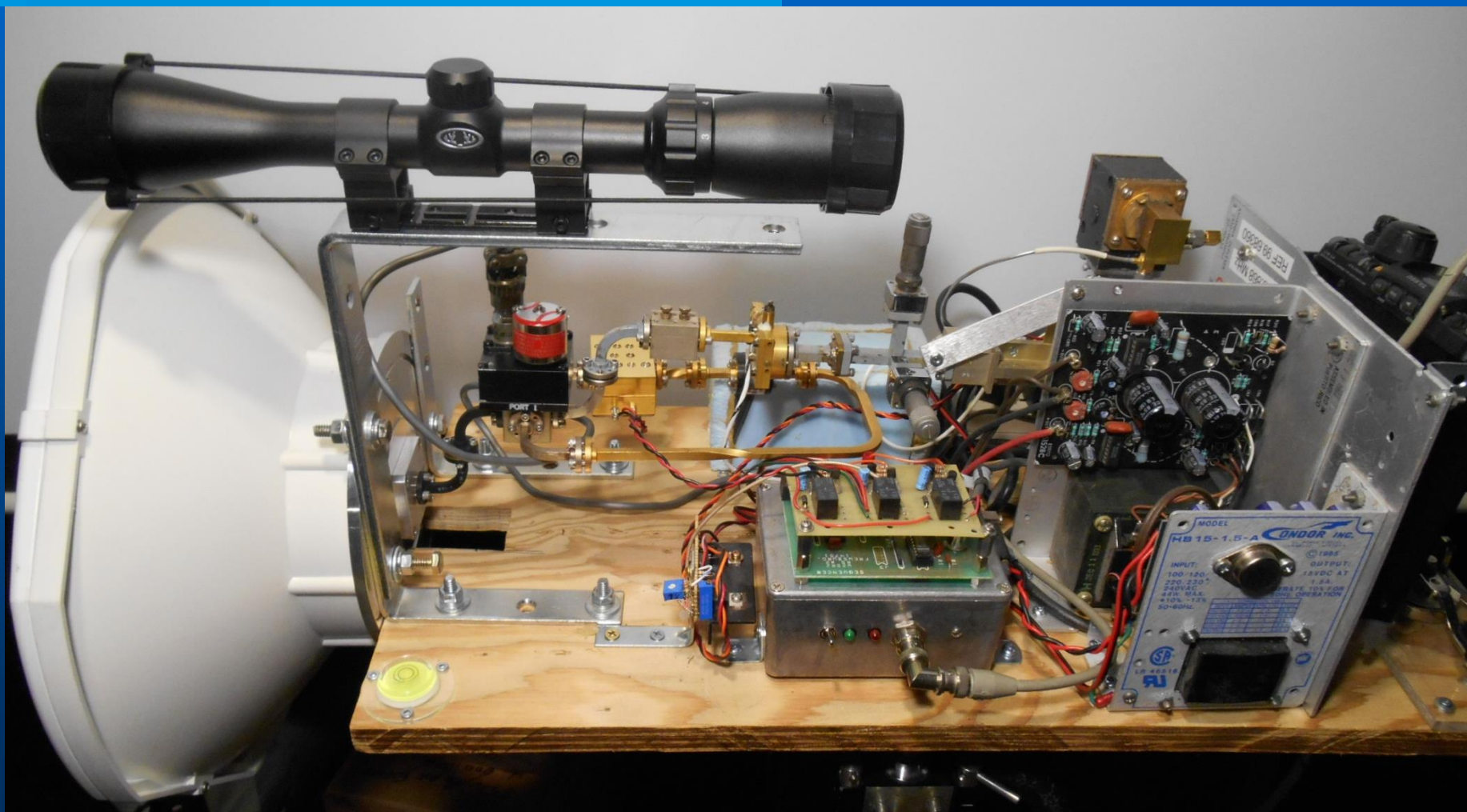
# The Terrestrial 78 GHz Rigs in 2015





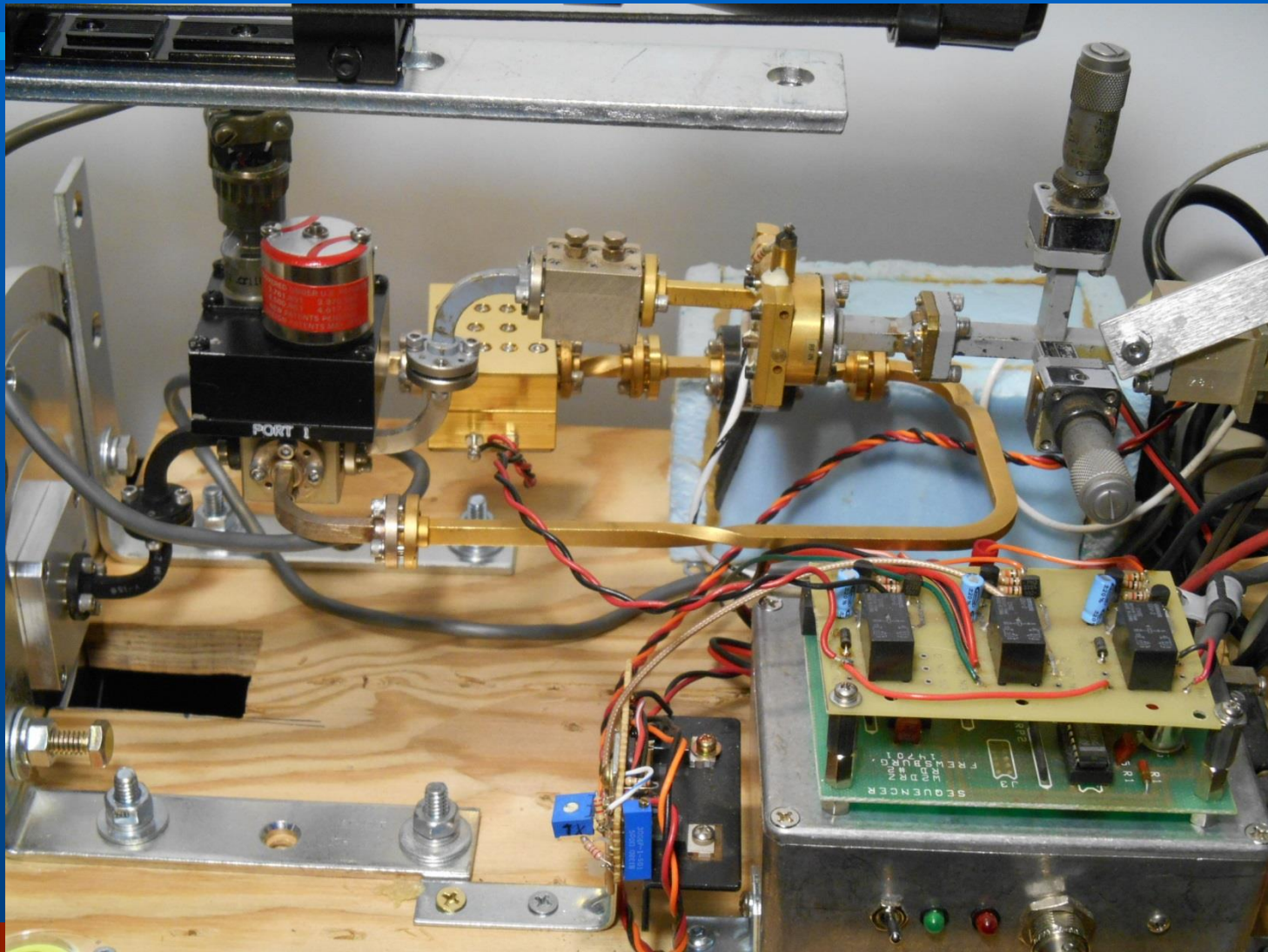


# The Terrestrial 78 GHz Rigs in 2015





# The Terrestrial 78 GHz Rigs in 2015



# Further 78 GHz Terrestrial Work 2015

- **Better BPFs (Lower Insertion Loss) available now**
  - Existing units actually for 47 GHz
- **LO and IF drives need to be Optimized for best Output Powers ( Hard to measure mW powers with stability).**
- **Power Amplifiers becoming available at “reasonable cost” with +18 dBm out and 17 dB gain**
- **+23 dBm ....even up to several Watts possible now !**
- **Need to explore use of Surplus Image Reject mixers**
  - Need +13 dBm LO power at 77 GHz



# 78 GHz Terrestrial Work 2015

- **Need to Explore Long Haul Paths**
  - Really ...in the Plains?
  - Will do the Best we can.....Buck Hill..other?
  - Use the Best Technology possible and Try it !
- **Possibly Establish Beacon to Look for Tropo on 78 GHz**
  - When does Radio start behaving like Light?
  - Tropo seen on 24 GHz in the Red River Valley
  - Higher power and good RX will make it possible
  - Frequency Stability and Antenna Pointing Challenges !

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