

# 47 GHz EME – The Final Frontier?

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# The First 47 GHz EME QSOs

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- The Tests
- The Challenges
- The Technology
- Operating Results

# First 47 GHz EME Echoes

- RW3BP on July 24, 2004
- “Outstanding Accomplishment !”
- >100 Watts Output, 2.4 m Offset Dish,  
~ 50 MW ERP!
- ~4 dB NF “HB” Preamplifier,  
~10 dB Sun, 1 dB Moon Noise
- Copied By AD6FP, VE4MA, VE7CLD, W5LUA



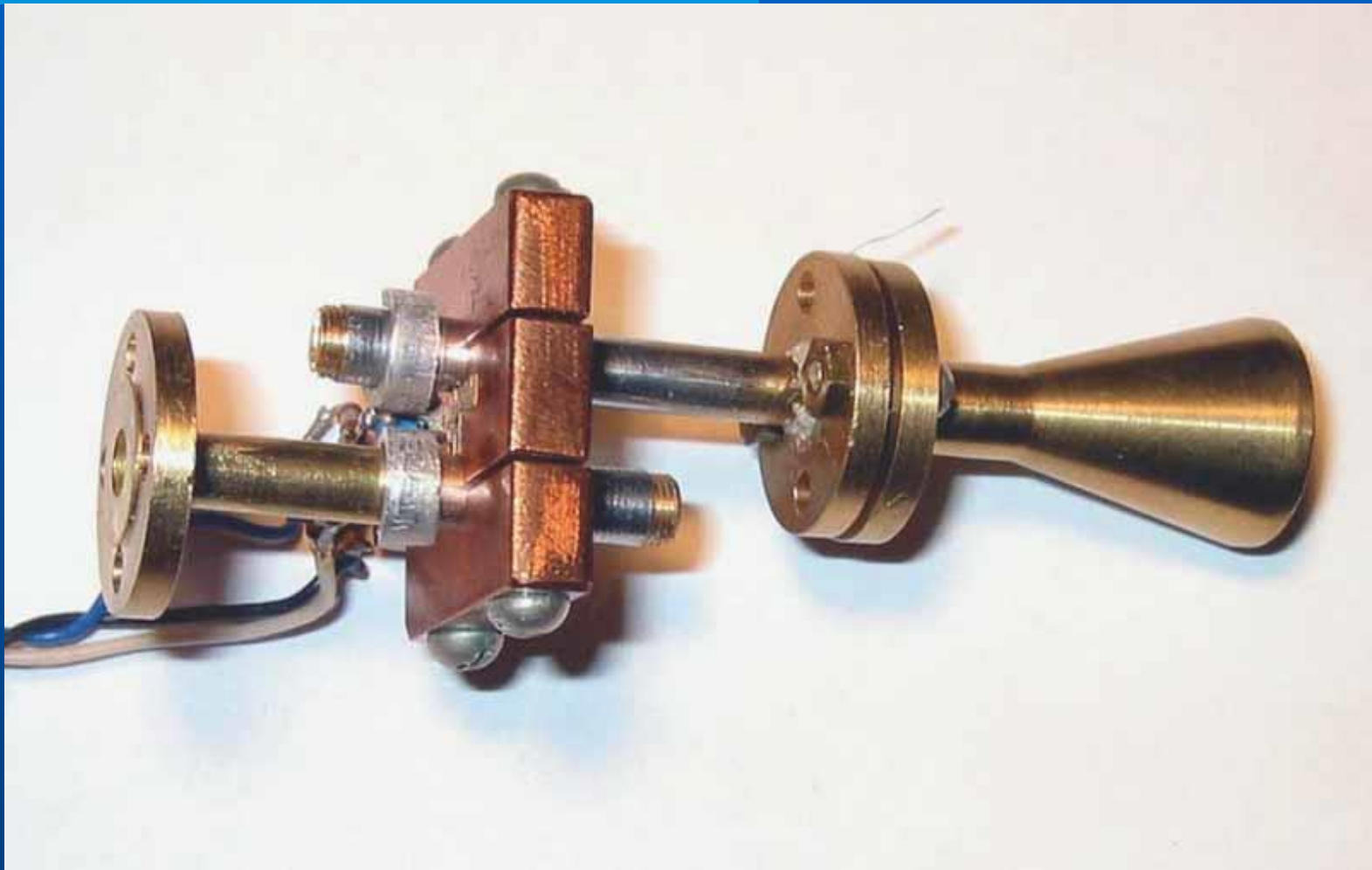
# 2.4 Meter Offset Fed Dish at RW3BP



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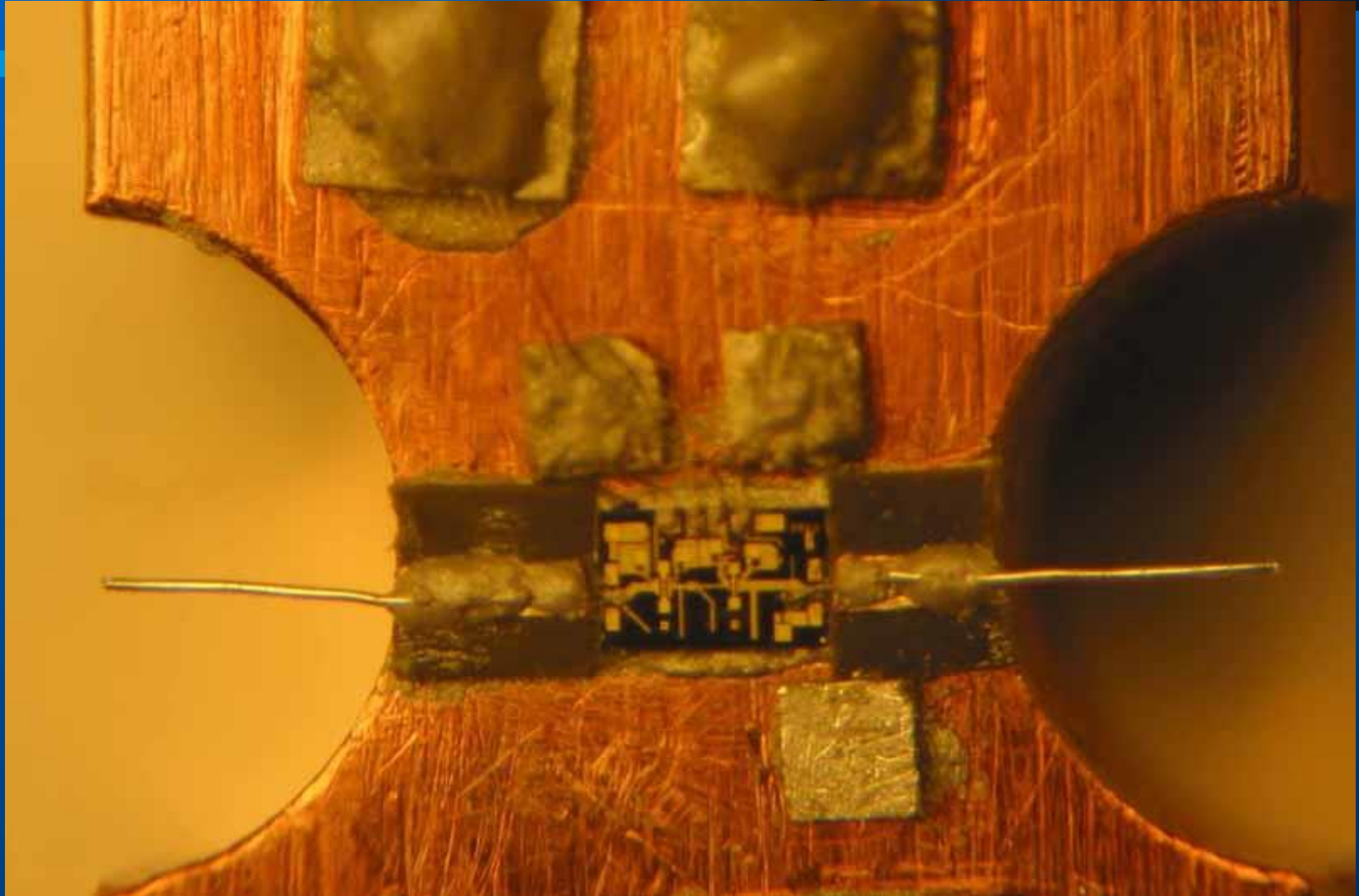


# RW3BP 47 GHz EME HB Preamplifier





# RW3BP 47 GHz EME HB Preamplifier



# The Moon at 47 GHz

- Rough surface of moon produces very rough sounding note – like aurora
- Spreading can be several hundred Hz making the use of very narrow bandwidth IF filters impossible
- Doppler shift upwards of +120 kHz on rising moon and –120kHz on setting moon
- Antenna beamwidths less than half the  $0.5^\circ$  subtended angle of the moon



# Atmospheric Effects at 47 GHz

- Unlike 24 GHz, 47 GHz is not significantly affected by Humidity
- Thick cloud cover has little effect
- Working through rain is certainly still a test of your equipment capabilities
- Best conditions occur ?????...at Lowest Moon noise?

# Additional 47 GHz Tests

- Gary AD6FP Operational
- ~30 W output Hughes 8901 TWT
- 1.8 m Offset Dish (~57 dB Gain)
- ~ 4 DB NF Preamps
- Tested for Possible QSO at “Low Power”
- **NO Signals Heard !**
- Predictions Said “More System Gain Needed”  
(NF, Ant Gain, or TX Power)

# AD6FP 47 GHz 1.8 Meter Dish

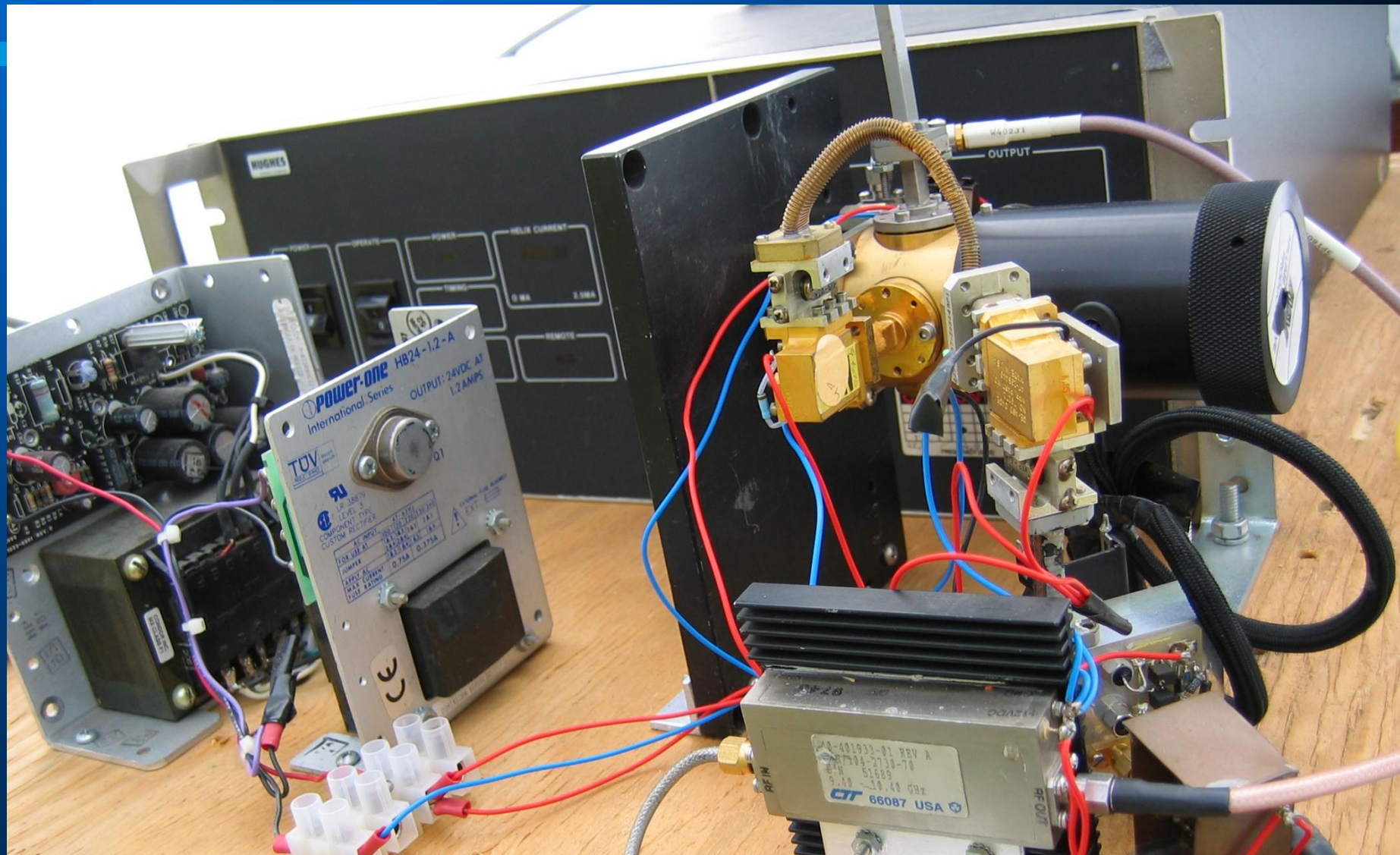


# AD6FP 47 GHz Station





# AD6FP 47 GHz Station





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# The First 47 GHz EME QSO?

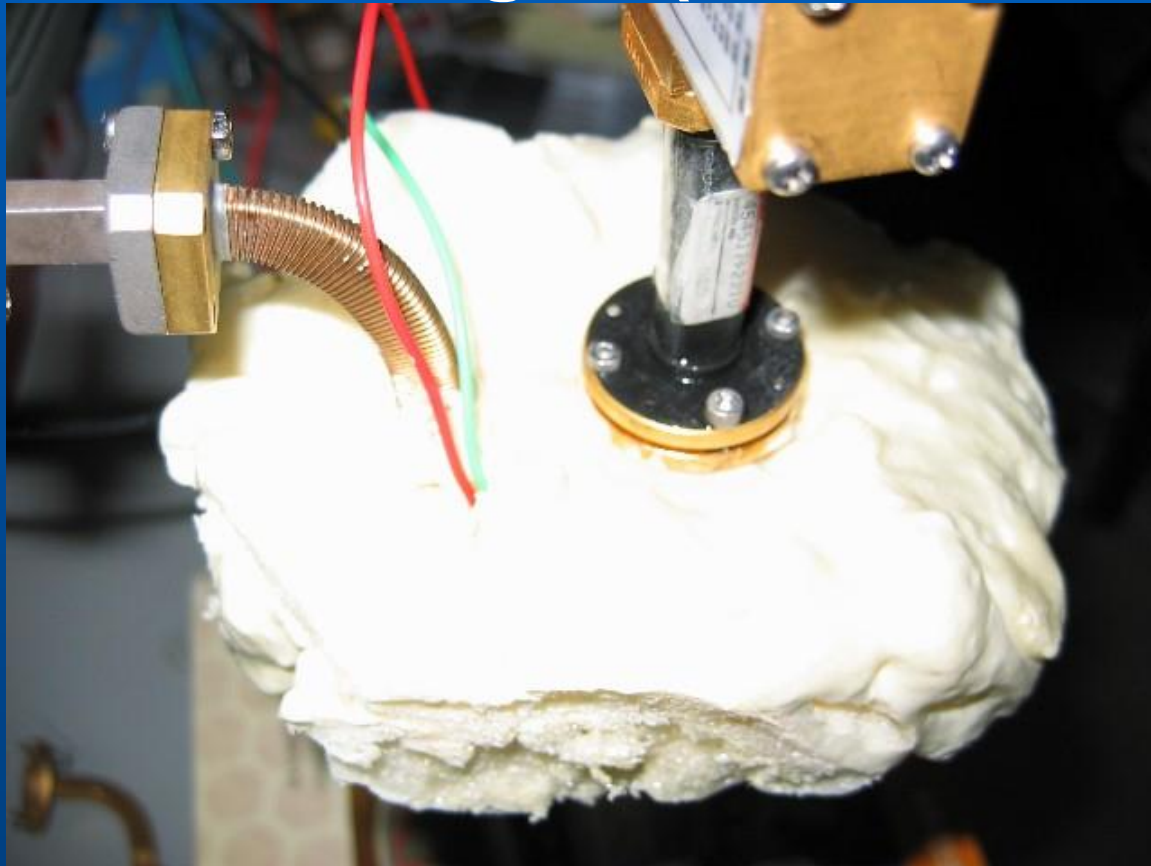
- More System Gain is Required
- More TX Power/ Ant Gain Not Practical
- Better NF Available Thru Cooling!
- Tests By Gary AD6FP with Liquid N2

# Better RX Performance With LN2?



# Better RX Performance With Liquid Nitrogen Cooling?

- 1.5 NF @ 77 deg K (4 dB @ 290 K)





# The First 47 GHz EME QSO ?

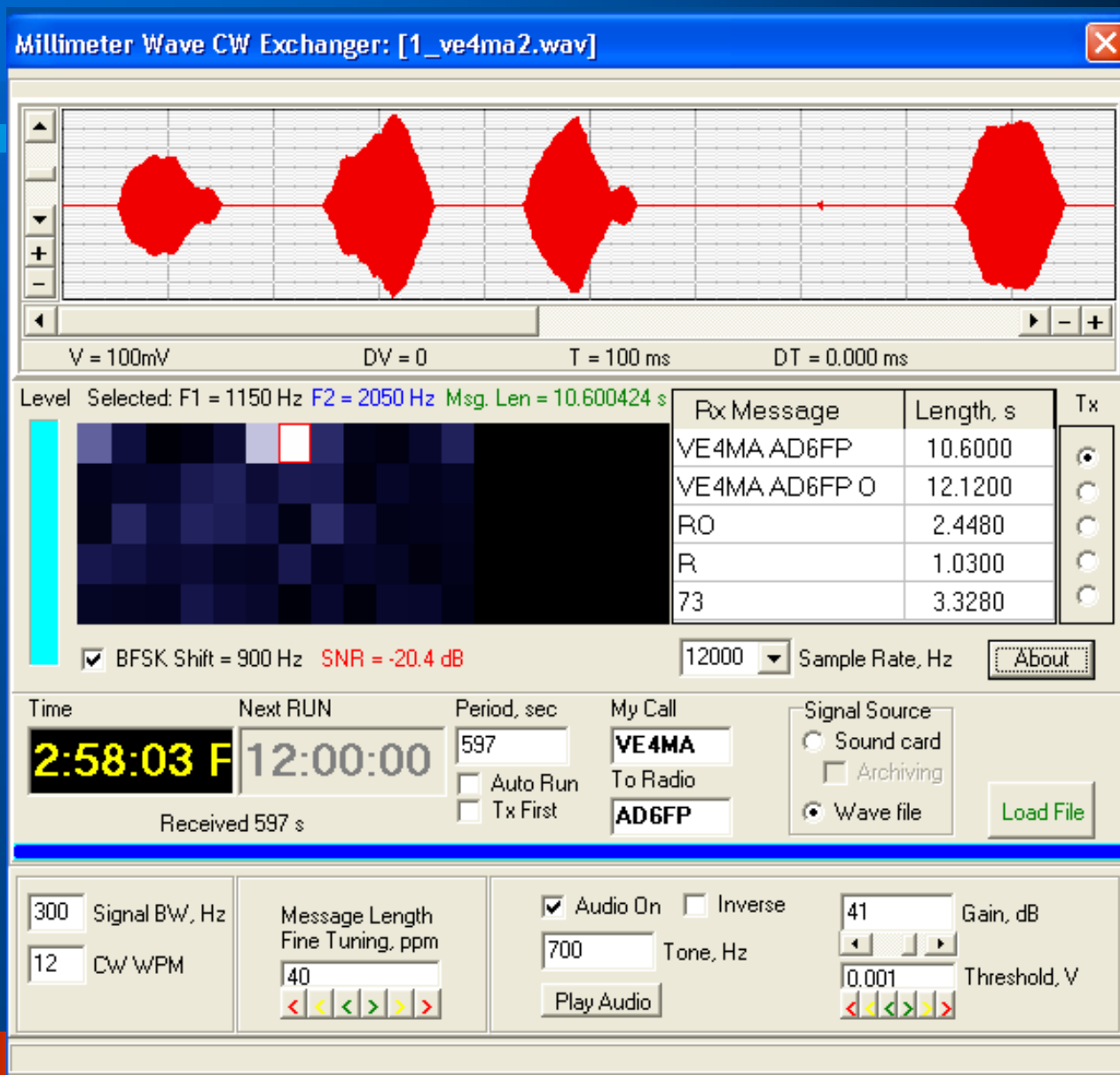
- Within a year ???
- 30 Watts is available...need more
- 4 dB noise figure is available....need better
- Good 2.4m Dish (Performance is a concern)
- Stations working toward 47 GHz EME QSOs  
AD6FP, RW3BP, VE4MA & W5LUA
- Lots of Work Still Required to Make it Happen!



# A Step Closer to 47 GHz EME QSO ?

- **RW3BP Produces Software to “Extend 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**
- **Several Versions of Software Tested**

# 47 GHz EME Software

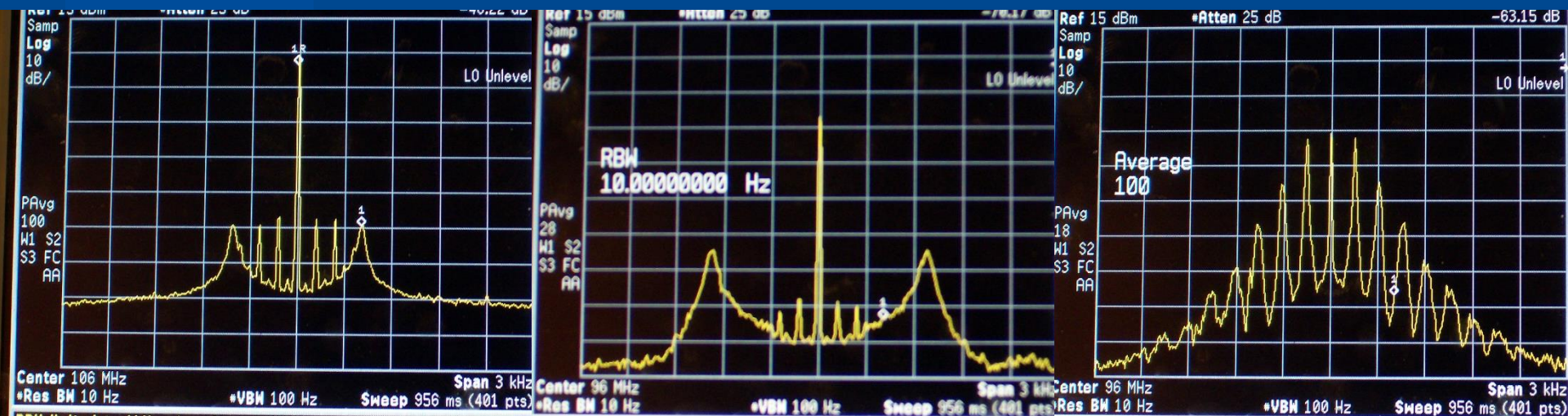


# Software Technical Requirements

- **Hold Frequency Within 100 Hz for 10 Min**
  - Need To GPS Lock 47 GHz LOs
  - Need to Correct for Doppler ....Exactly
- **Phase Locking Simple Now?**
- **Use Reflock...Simple Plug & Play**
- **Wrong !**

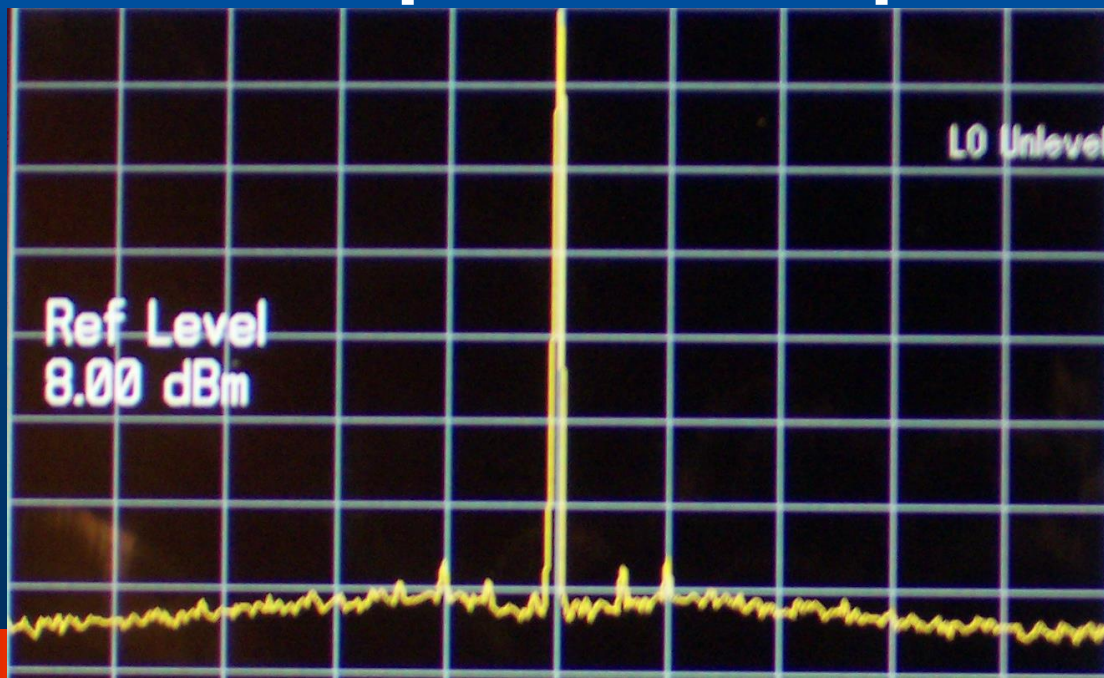
# Phase Locking with Reflock Board

- High Phase Noise (See Spurs Below)
- Small Lock-in Range
- Need to Optimize Loop Filter Components (Unique to Each XTAL)



# Phase Locking with Old VE1ALQ Board

- Low Phase Noise (See Below)
- Large Lock-in Range
- NO Need to Optimize Loop Filter





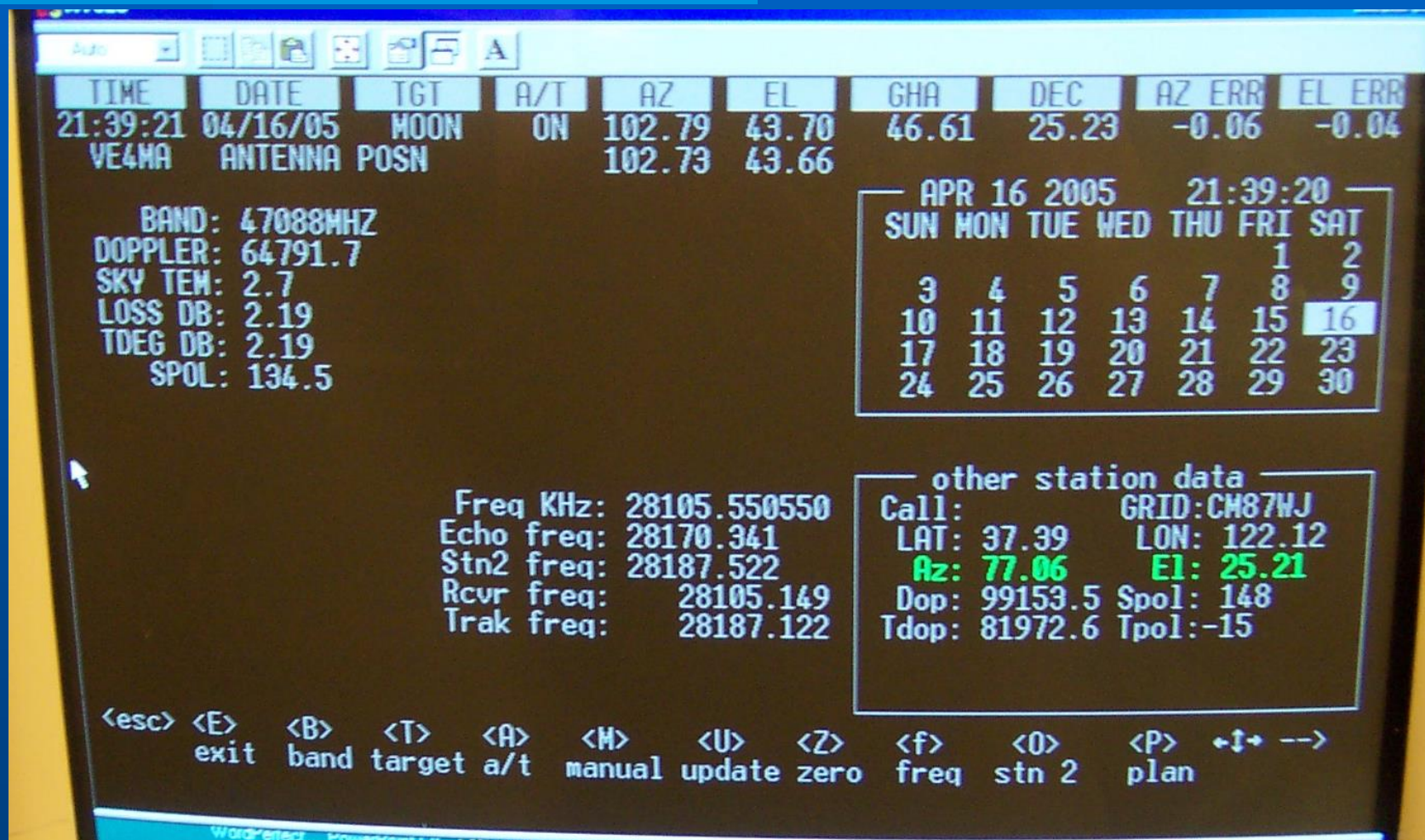
# Phase Locking with VE1ALQ Board

- **New Board Created With CLPD Chip**
- **Low Phase Noise & Large Lock-in Range**
- **NO Need to Optimize Loop Filter**
- **Boards to be Made Available from DEMI**
- **Compatible With DEMI LOs !**

# Doppler Calculation & RX Tuning

- **AD6FP and RW3BP use F1EHN's software for autotracking and Doppler correction**
- **VE4MA and W5LUA use K5GW's software for auto-tracking, Doppler correction and automated receiver tuning.**

# Doppler Calculation & RX Tuning



# 2.4 Meter Dish at W5LUA



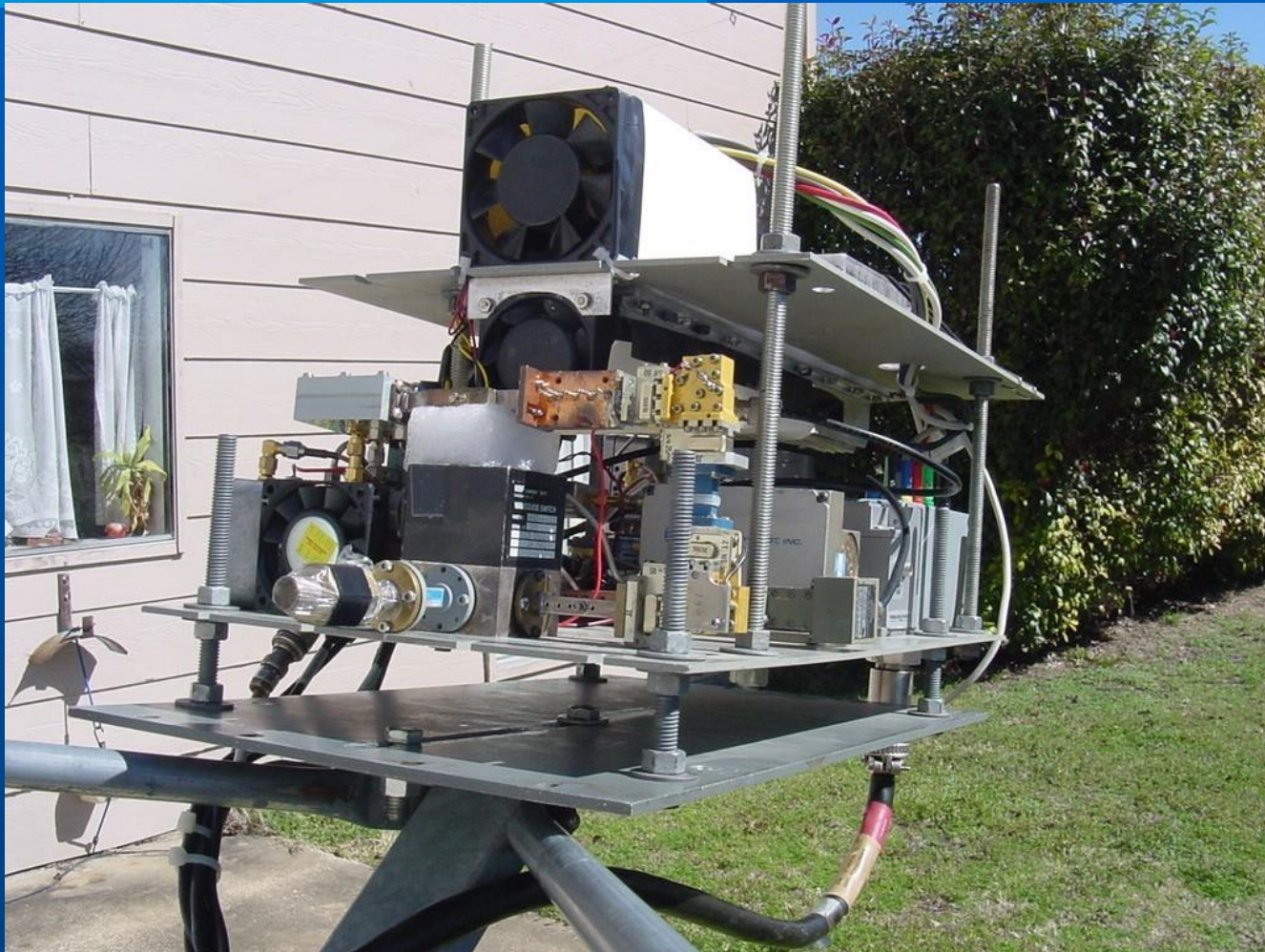


# W5LUA 32 Watt TWT for 45 GHz

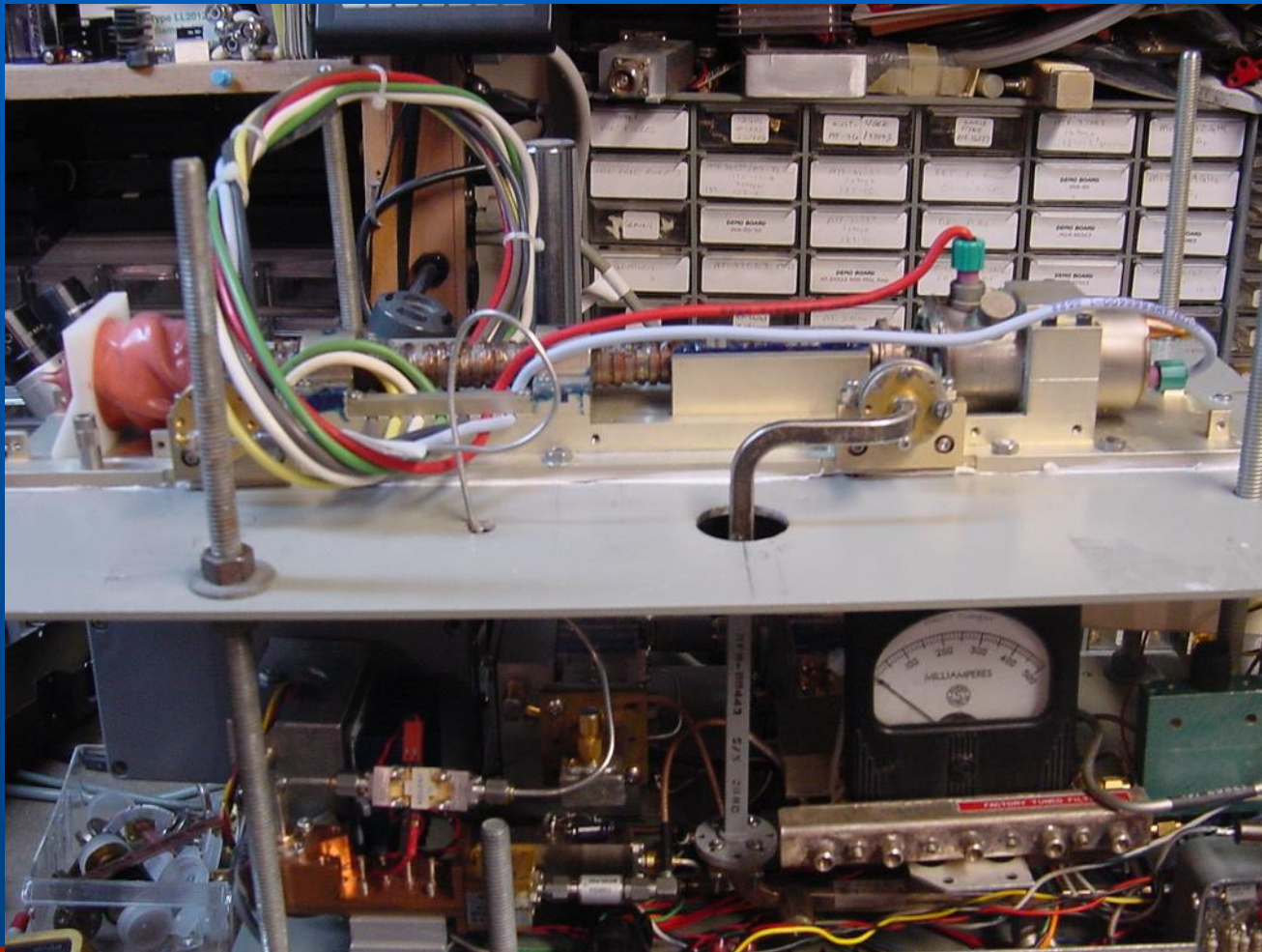




# 47 GHz Transverter at W5LUA



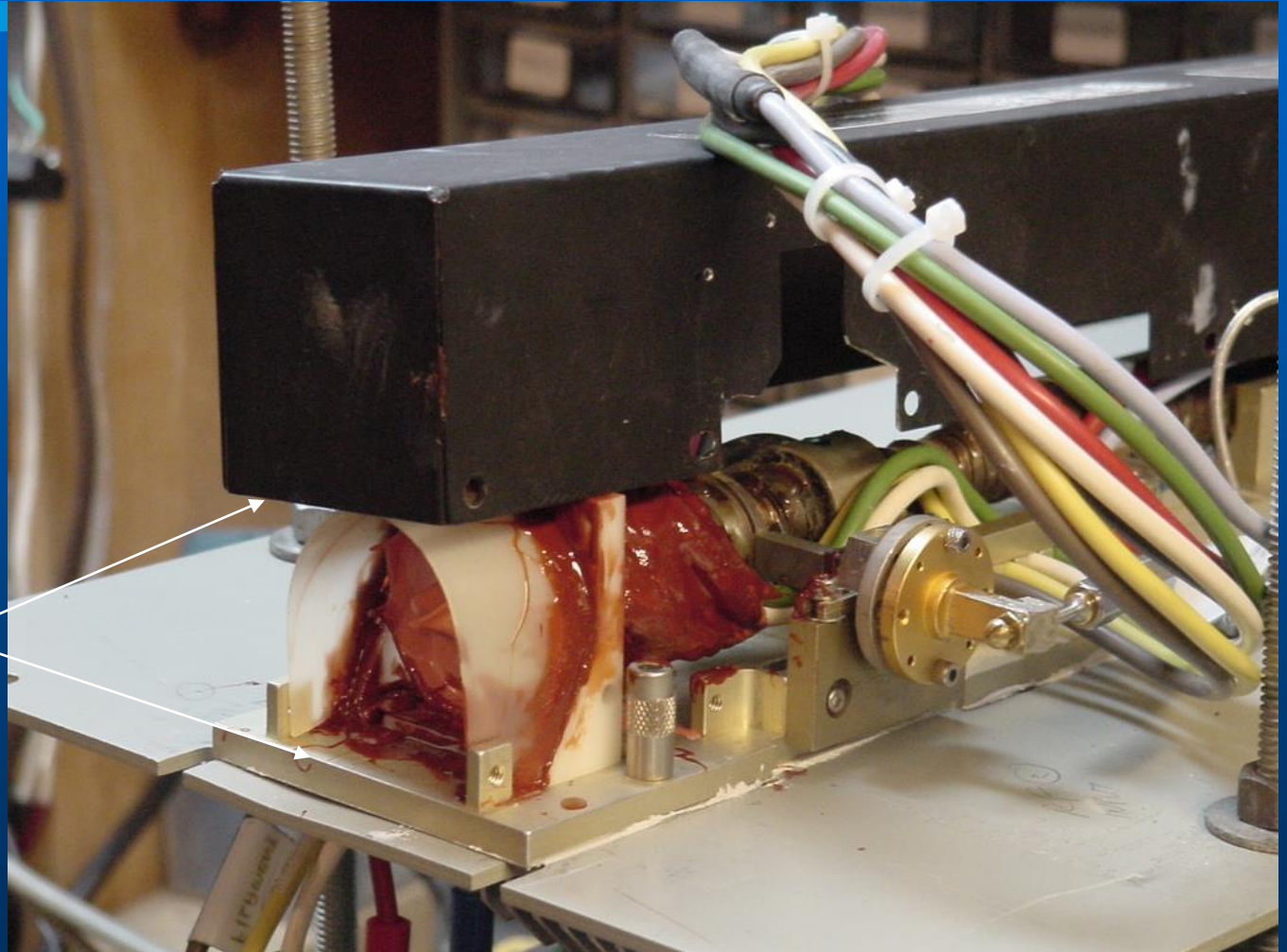
# Inside View of TWT



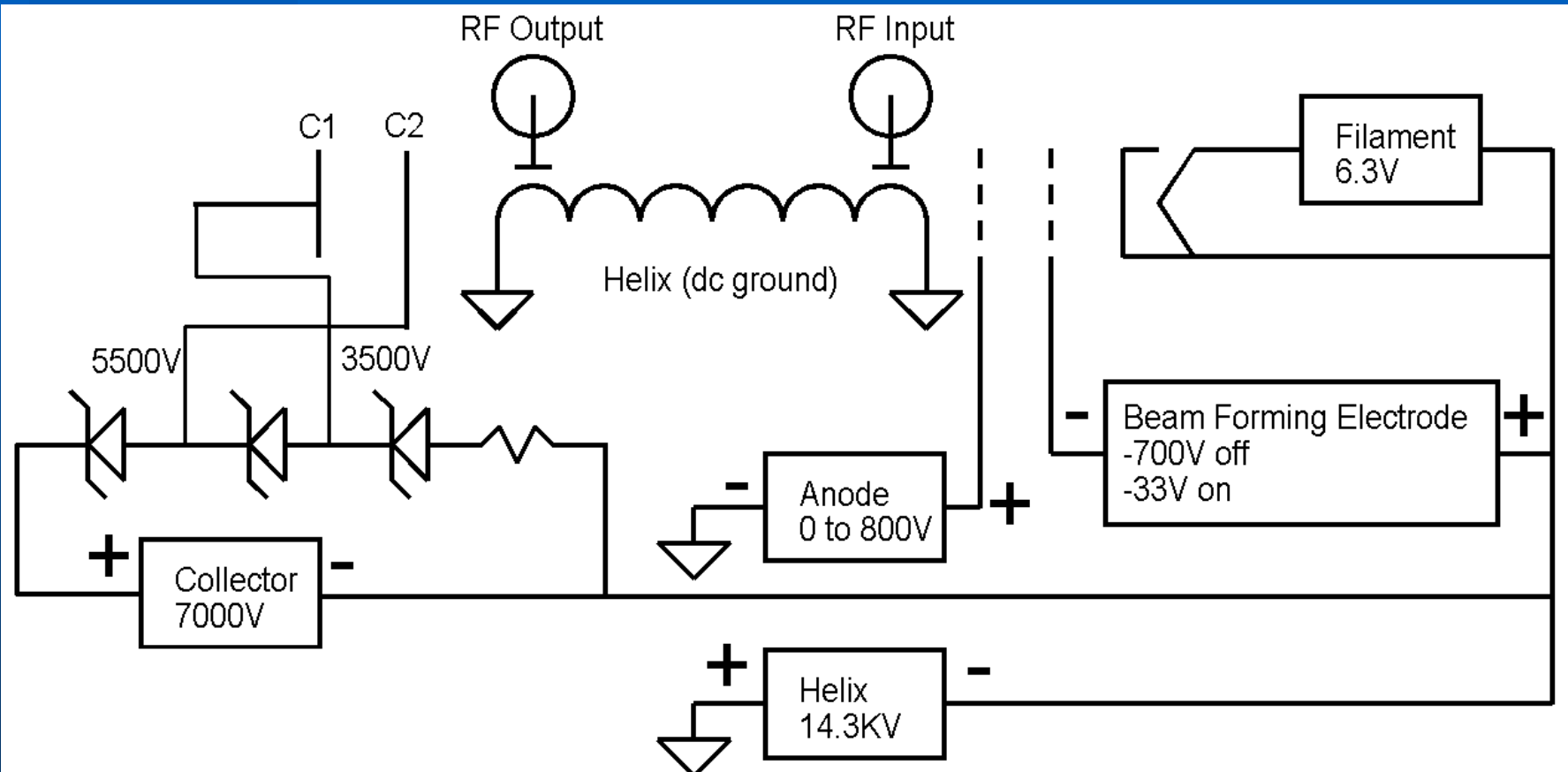


# Arcing Problems with TWT

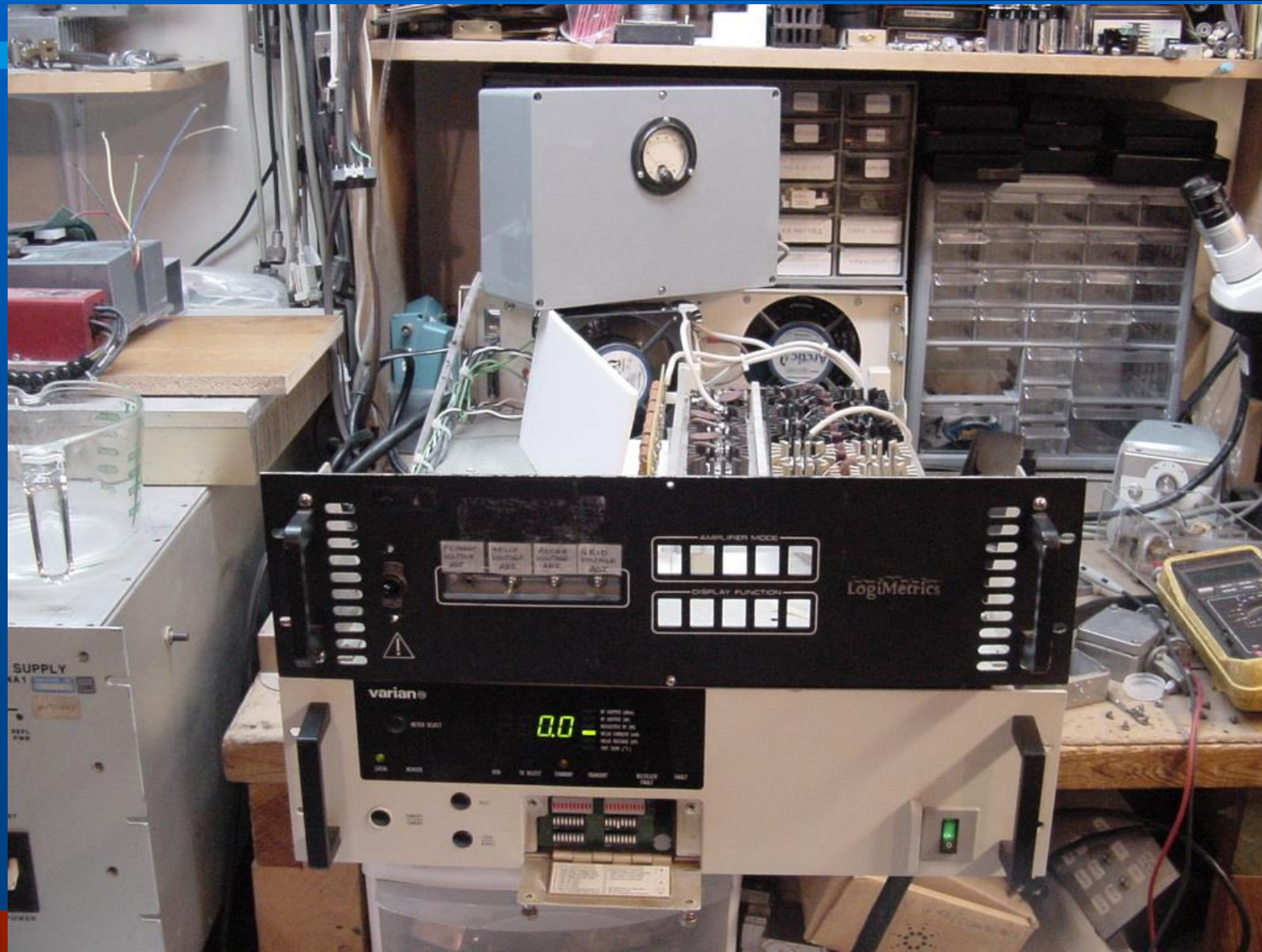
Arc's here  
when lid  
is down



# TWT Power Supply

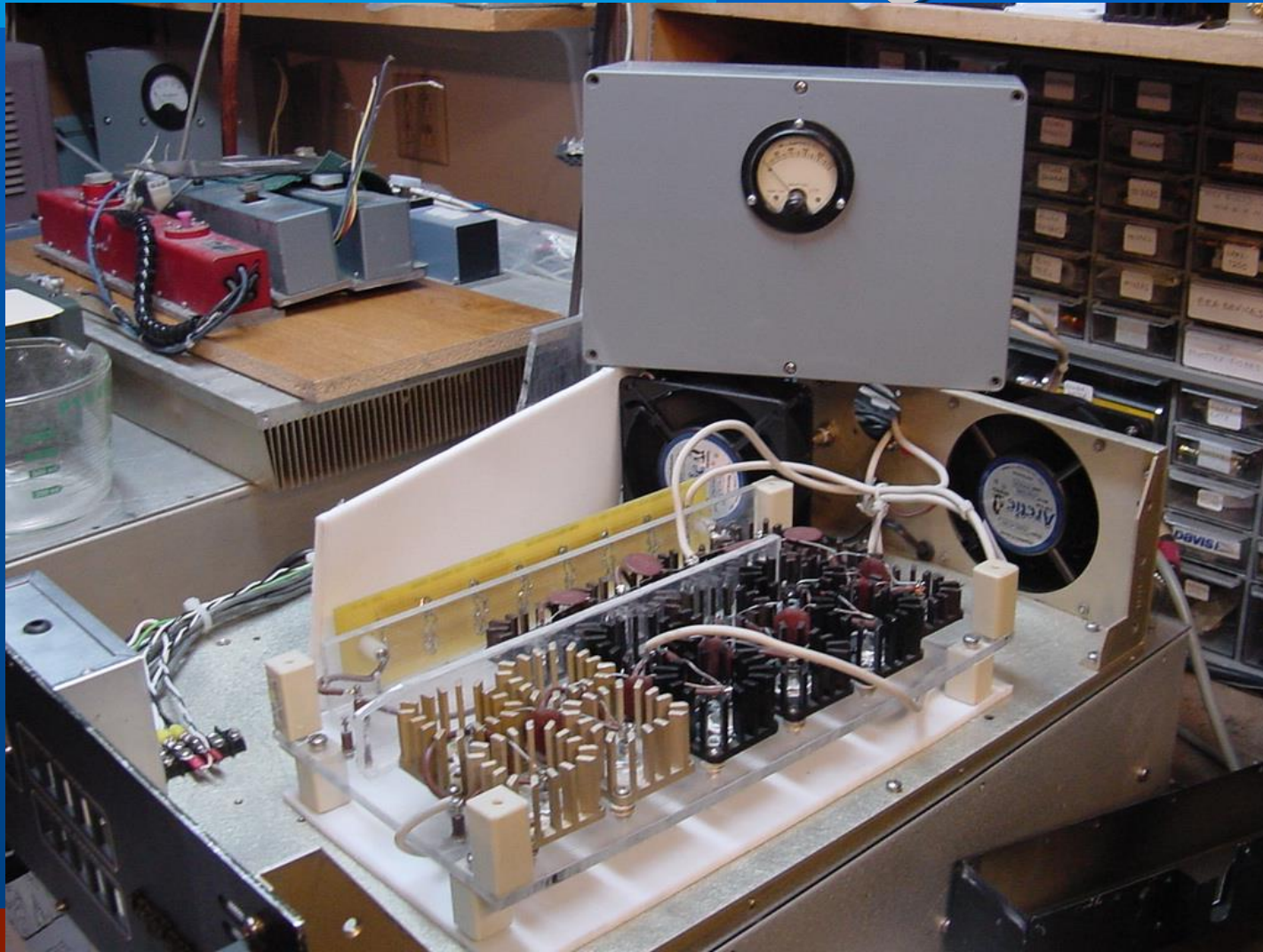


# TWT Power Supplies





# Using Zener Diodes to Set Correct Collector Voltages



# AZ-EL for W5LUA 2.4 Meter Dish

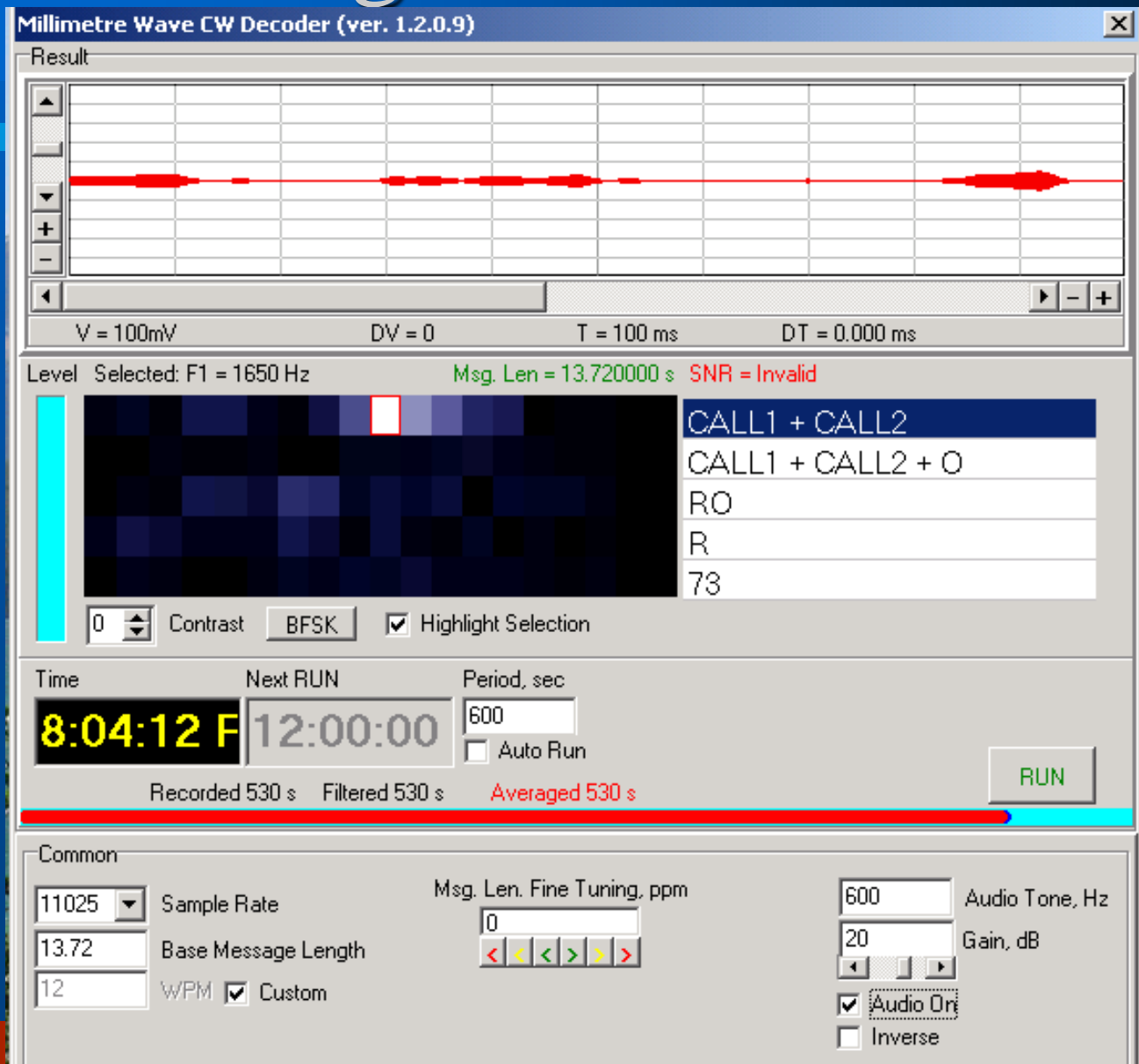




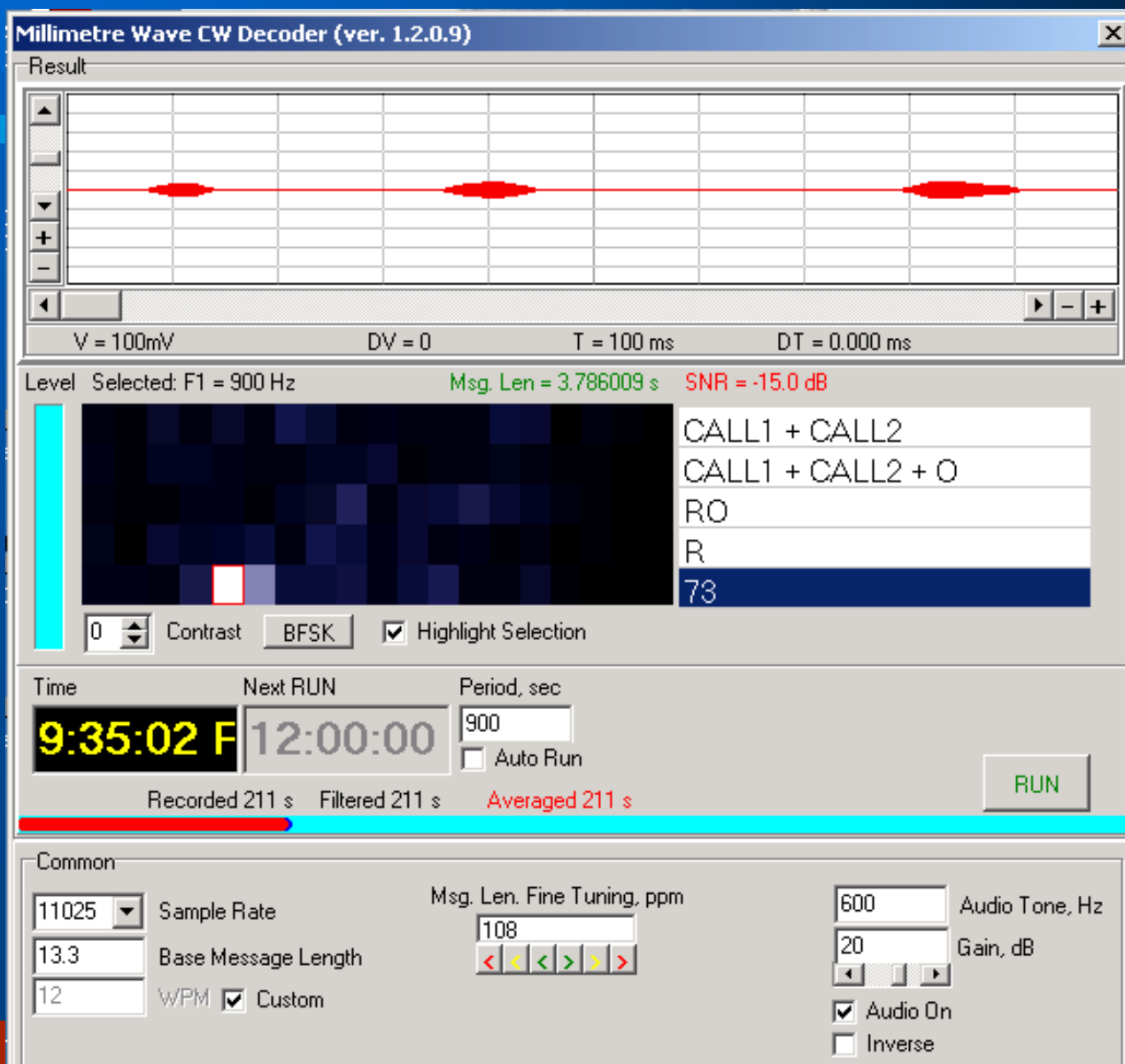
# 3 Computers to make 1 QSO !



# Receiving RW3BP at W5LUA



# RW3BP Sending 73's to W5LUA

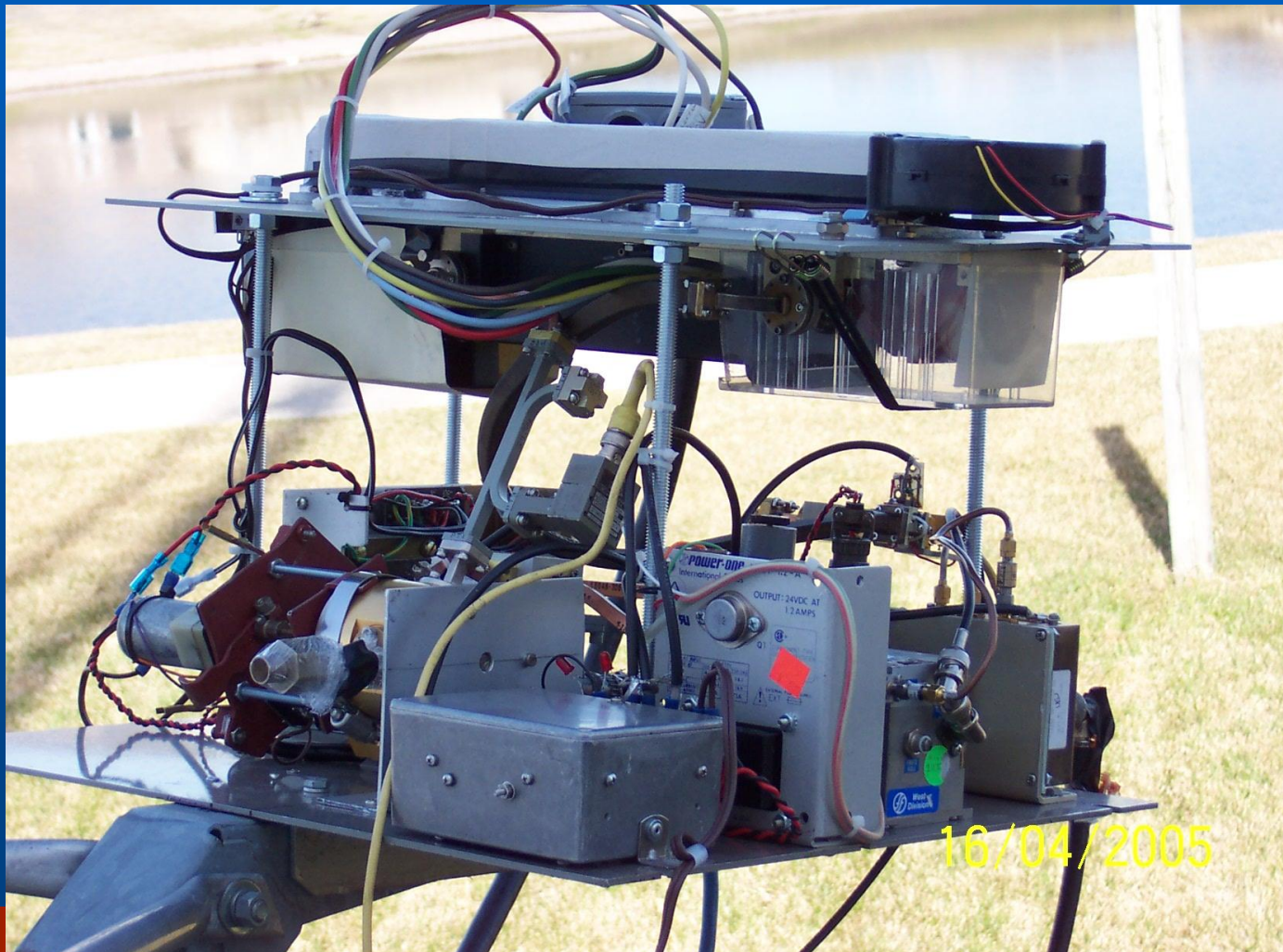




# 2.4m Dish at VE4MA



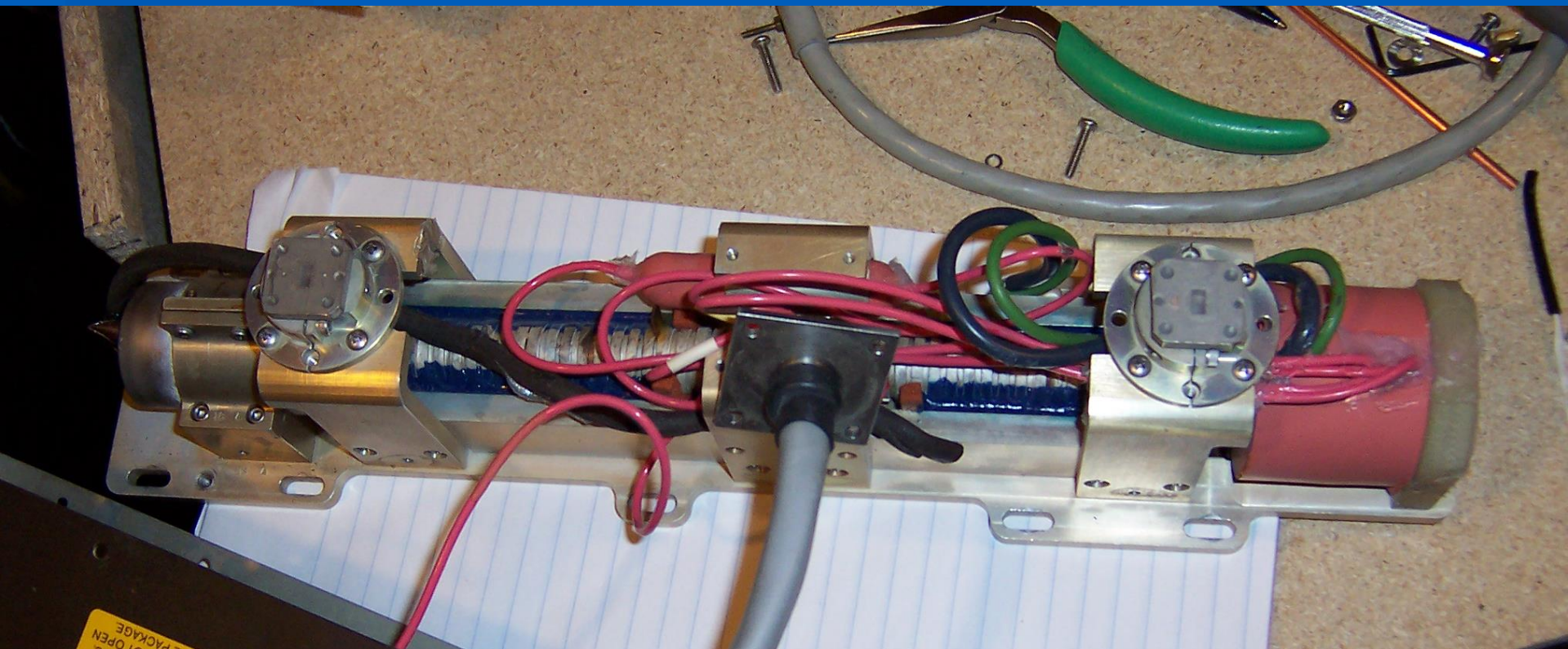
# 2.4m Dish at VE4MA



16/04/2005

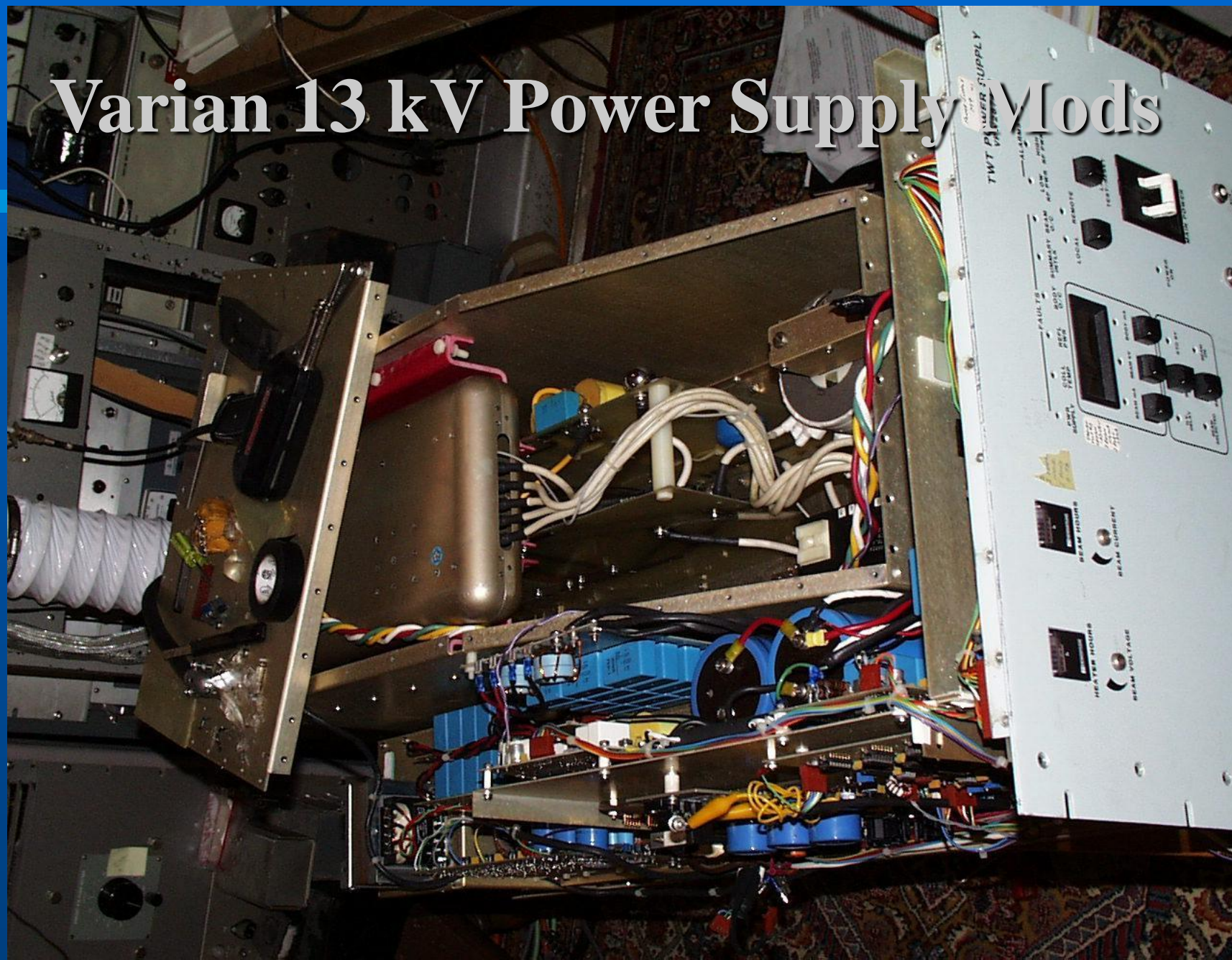


# “Dead” 30 Watt TWT for 45 GHz





# Varian 13 kV Power Supply Mods





# The First 47 GHz EME QSO !

- We have the Technology!
- Stations making 47 GHz EME QSOs with RW3BP: AD6FP, W5LUA & VE4MA
- Additional QSOs achieved between VE4MA and AD6FP & W6YX
- Tests to be conducted between AD6FP and W5LUA in October

# The First 80 GHz EME QSO ?

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

# The First 47 GHz EME QSOs

- The Tests
- The Challenges
- The Technology
- Operating Results
- Questions ?