North Texas NTMS Microwave Society

Flyswatter Experiments at 47 and 77 GHz

W5LUA

September 16, 2019

Periscope or Flyswatter Antenna

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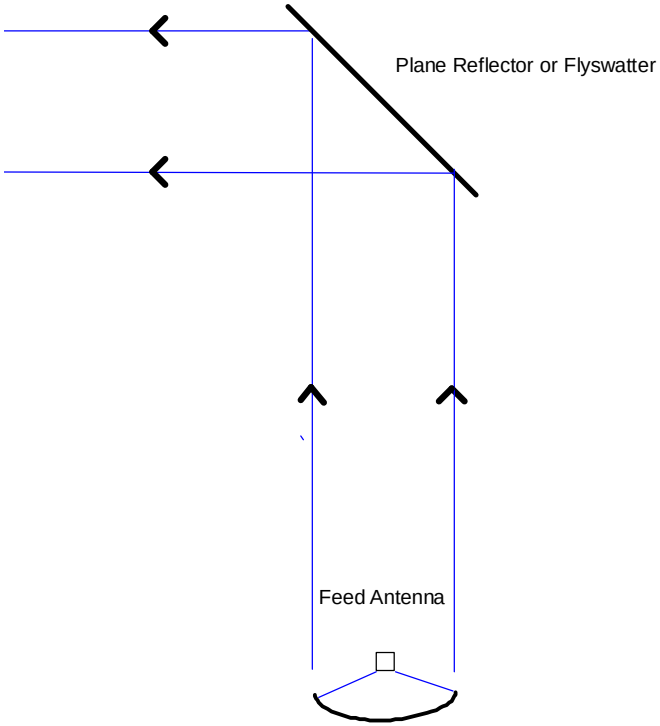

Lower Equipment Platform

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Two 6 ft Pieces 2 inch angle , ¼ inch thickness

Two guy wires and turnbuckles used for support and alignment

Platform with 77 & 47 GHz Xvtrs

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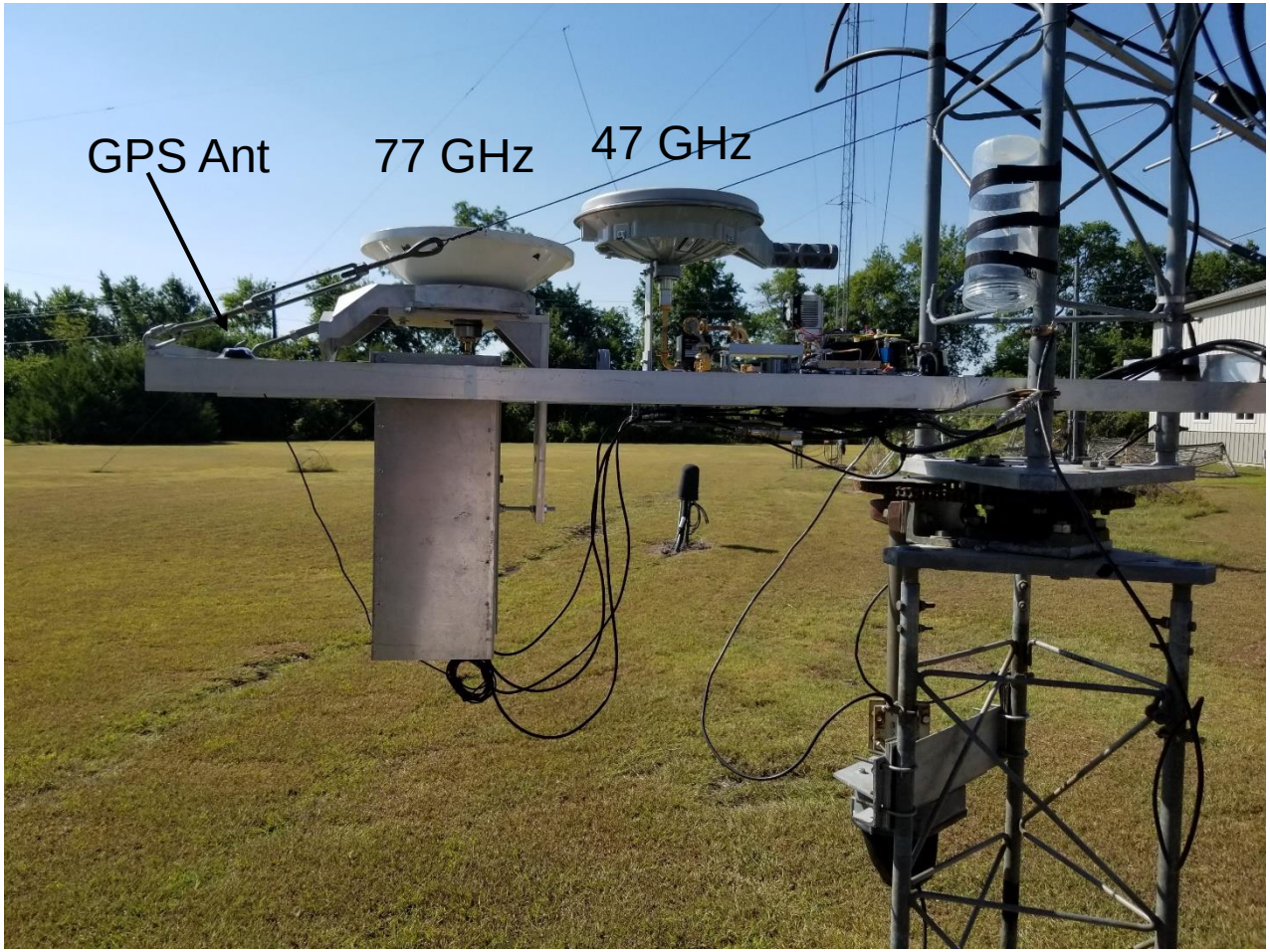

2 Transverters taking advantage of the larger than optimum reflector

I installed “Wings” on transverters so they can slide on the equipment platform

Sears Digital Torpedo Level and shims used to insure transverters are in good alignment with reflector

Stop Sign Flyswatter Reflector

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Built and originally used by KA5BOU

Small actuator used to optimize tilt from nominal 45 degree. Craig rotated the reflector since he used the reflector on a non-rotating tower. This also meant that he had to rotate the polarity of his source antenna to maintain horizontal polarity with respect to the horizon

Flyswatter Performance on 10, 24, 47 and 77 GHz

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					Actual system
Frequency	10.3 GHz	24 GHz	47 GHz	76 GHz	76 GHz
Optimum Dish Diameter	.85m (33.6")	.5m (19.7")	.23m (9")	.15m (6")	.34m (13.5")
Flyswatter Aperture	.76m (30")	.76m (30")	.76m (30")	.76m (30")	.76m (30")
Reflector Spacing	16.8m (55ft)	16.8m (55ft)	16.8m (55ft)	16.8m (55ft)	16.8m (55ft)
Suggested Flyswatter Aperture	1m (39.4")	0.6m (23.6")	0.5m (19.7")	0.4m (15.7")	0.4m (15.7")
Final Results					
Dish Gain	36.6 dBi	39.4 dBi	38.5 dBi	38.9 dBi	46.1 dBi
System Gain	34.7 dBi	39.8 dBi	34.7 dBi	34.3 dBi	34.2 dBi
Effective Gain of Periscope over Dish	-2.0 dB	.4 dB	-3.8 dB	-4.6 dB	-11.8 dB
Figure 1 Summary of data from Paul Wade's on-line antenna book					

Flyswatter Aperture and Reflector Spacing are fixed for my system

W5LUA Rig #1 Used by AA5AM

Rig set up at 77184 MHz. This rig used to copy Sergei RW3BP on EME.

Receive
Pair of WA1MBA LNAs and image reject filters made by WA5YWC. WR-15 waveguide mixer. SSB NF under 5 dB

LO is a Frequency Sources oscillator locked to an N5AC VHF ApolLO. Multipliers used to obtain 77.040 GHz LO. Reference oscillator is a Epson Toyocom TCO-6920N

Transmit
WR-15 mixer with no filtering and WA1MBA amplifier. Pout < 1mW

Antenna 1.1” X 1.4” Horn G~ 26 dBi, EIRP ~ 25 dBmi

77 GHz Reception at W5LUA of AA5AM with small horn

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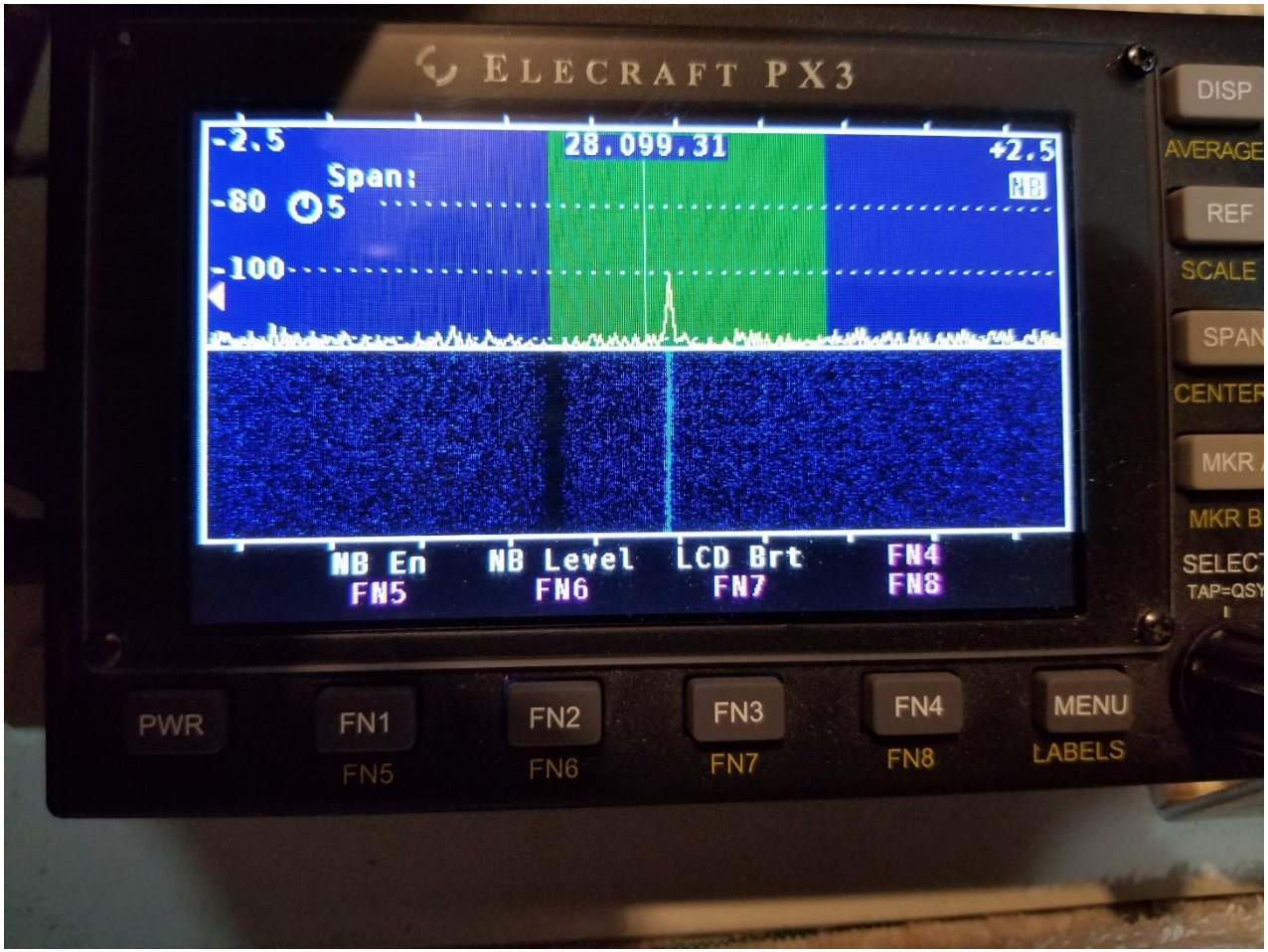

W5LUA Reception of AA5AM on 77 GHz

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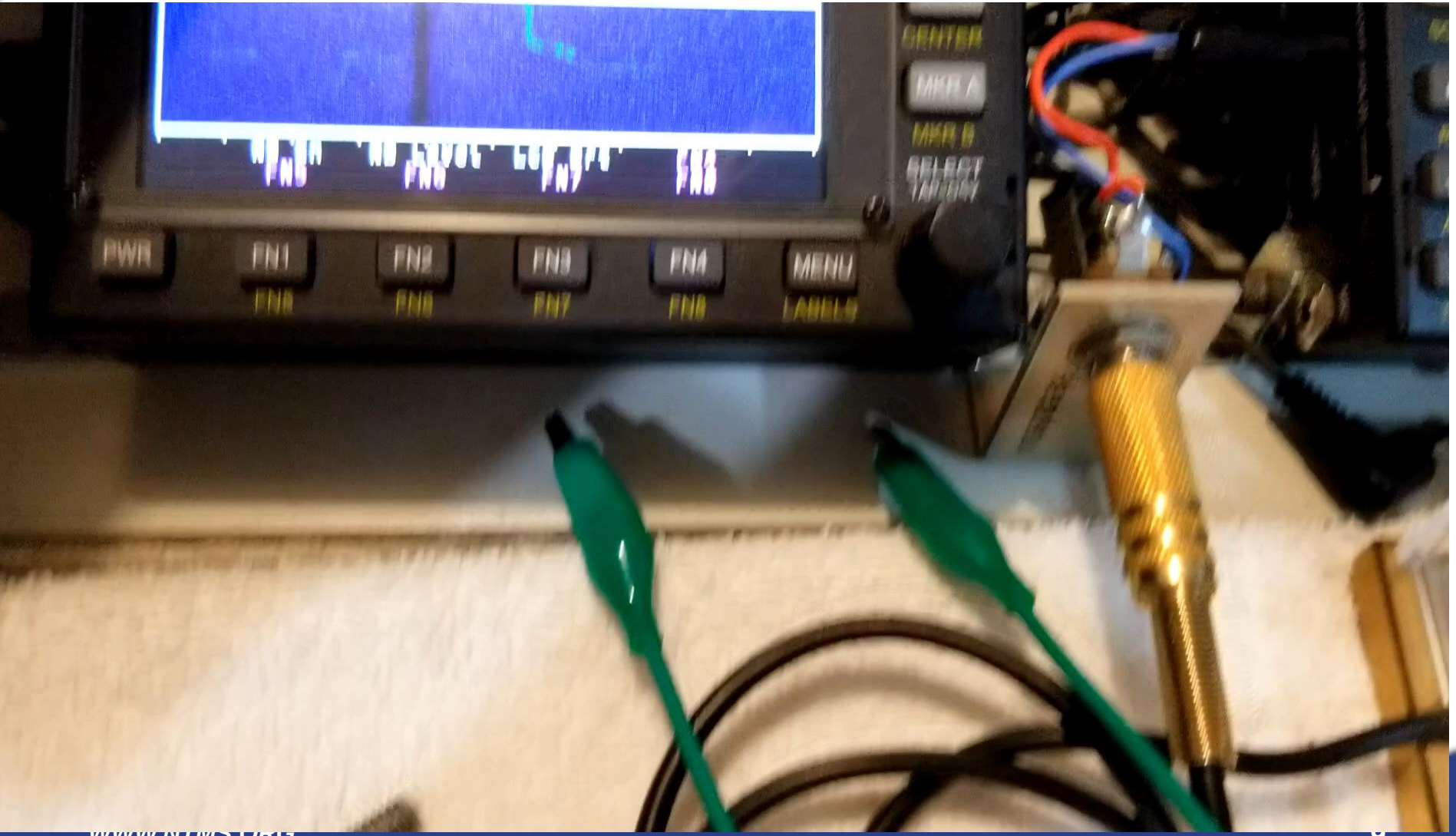

77 GHz with 6 inch Lens Antenna

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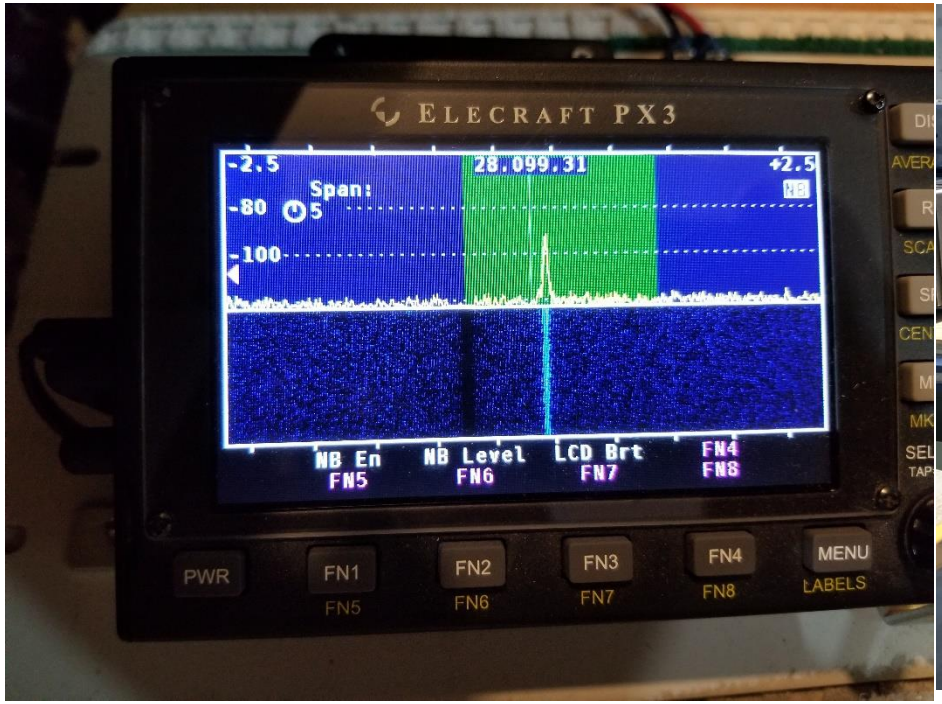

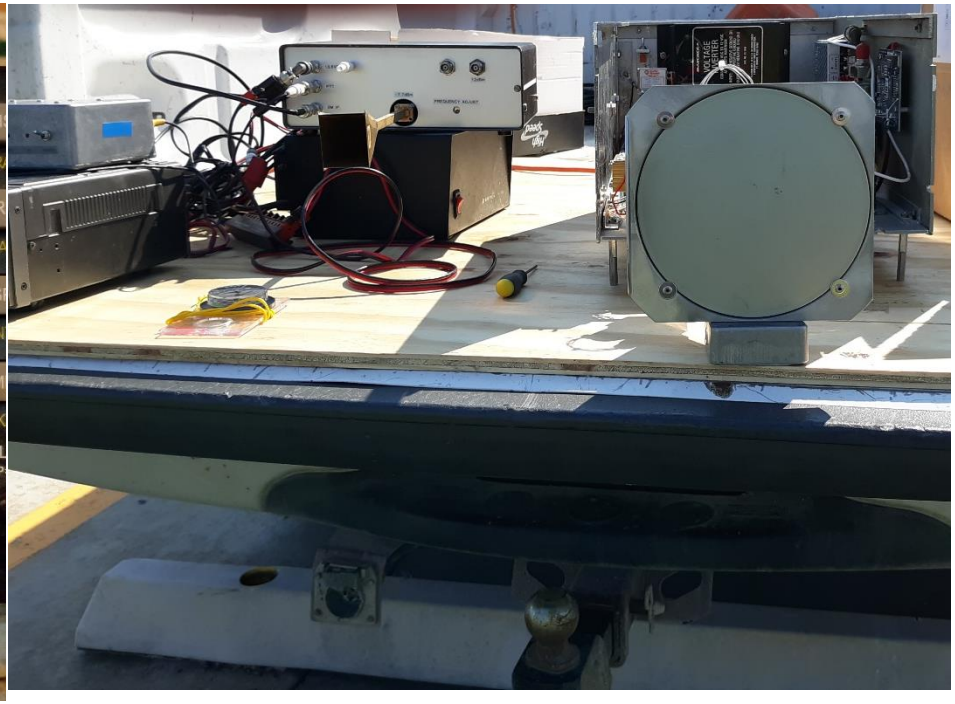

6” WR-15 Lens Horn Antenna manufactured by Flann Microwave Model 2585EICF with published gain of 37.5 dBi at ? Frequency. On loan from WA5VJB. The 47 GHz rig with horn sits to the left of the 77 GHz rig

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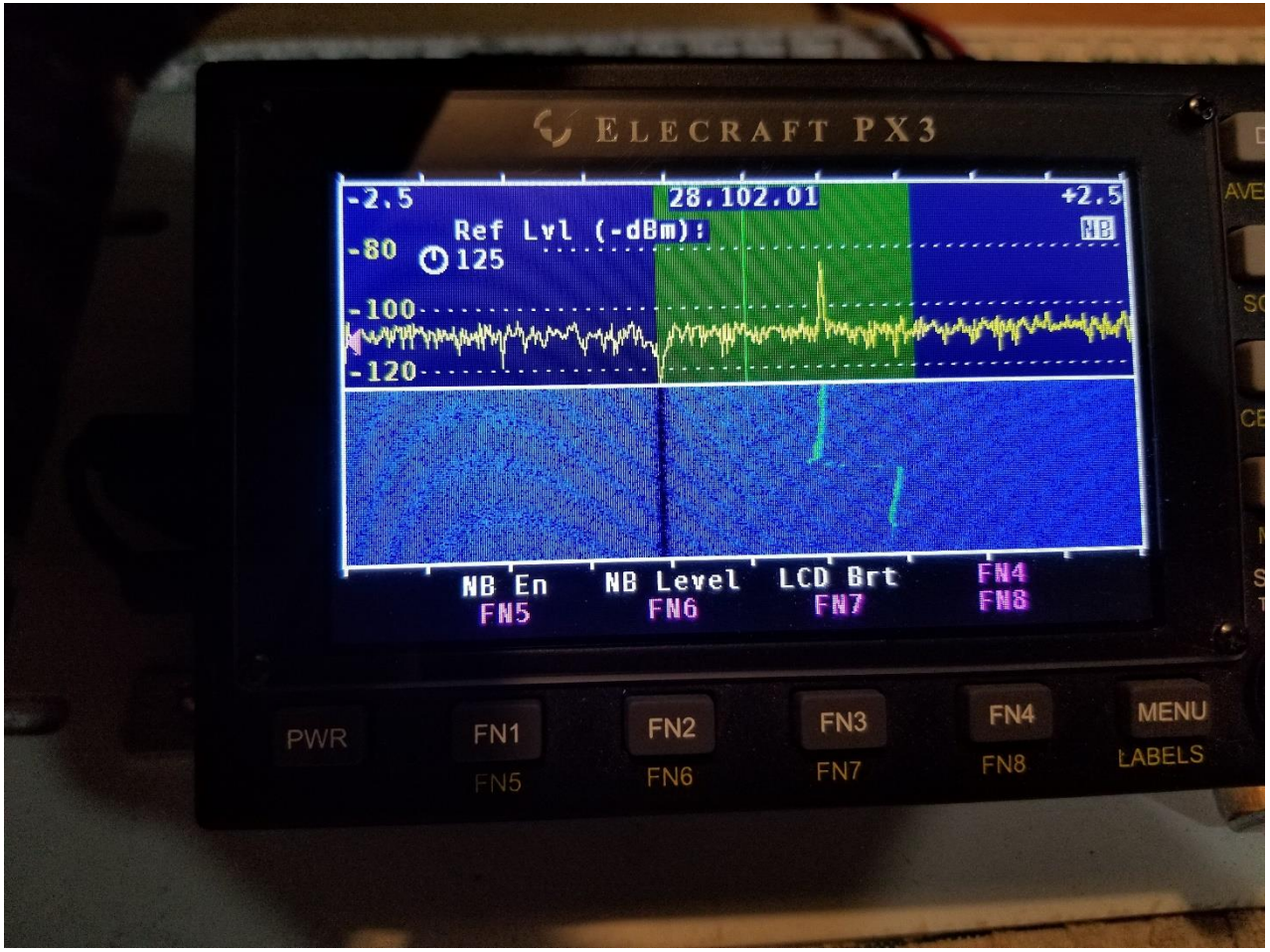
AA5AM 47 GHz Signal



Similar signal levels at 47 & 77 GHz

Path Loss in the 4mm Band

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- Free Space Path Loss is defined as
  20 log (4πd/λ)
- 23km Path at 4mm = 157 dB loss
- Additional loss due to moisture per graph by WA1ZMS = 18 dB for a dew point of 68F for total loss of 175 dB
- Pout = -1 dBm into 26 dBi horn =+25 dBmi (30 dB under the legal limit !)
- Power received at W5LUA antenna = +25 - 175 dB path loss = -150 dBm
- Adding in periscope system antenna gain of 34 dBi should result in a received signal level of -150 + 34dBi = -116 dBm at receiver port
- My receiver noise floor = -174 dBm + 5dB NF + 10 log (11Hz BW) = -158 dBm
- My expected received signal level from Scott as measured on my PX-3 panadapter should be -116 - - 158dBm = 42 dB S/N.
- I measured a maximum of about 22 dB S/N so I still have some work to do but the system does work!
- I do question the equivalent bandwidth of the PX-3 panadapter

Attenuation due to Moisture

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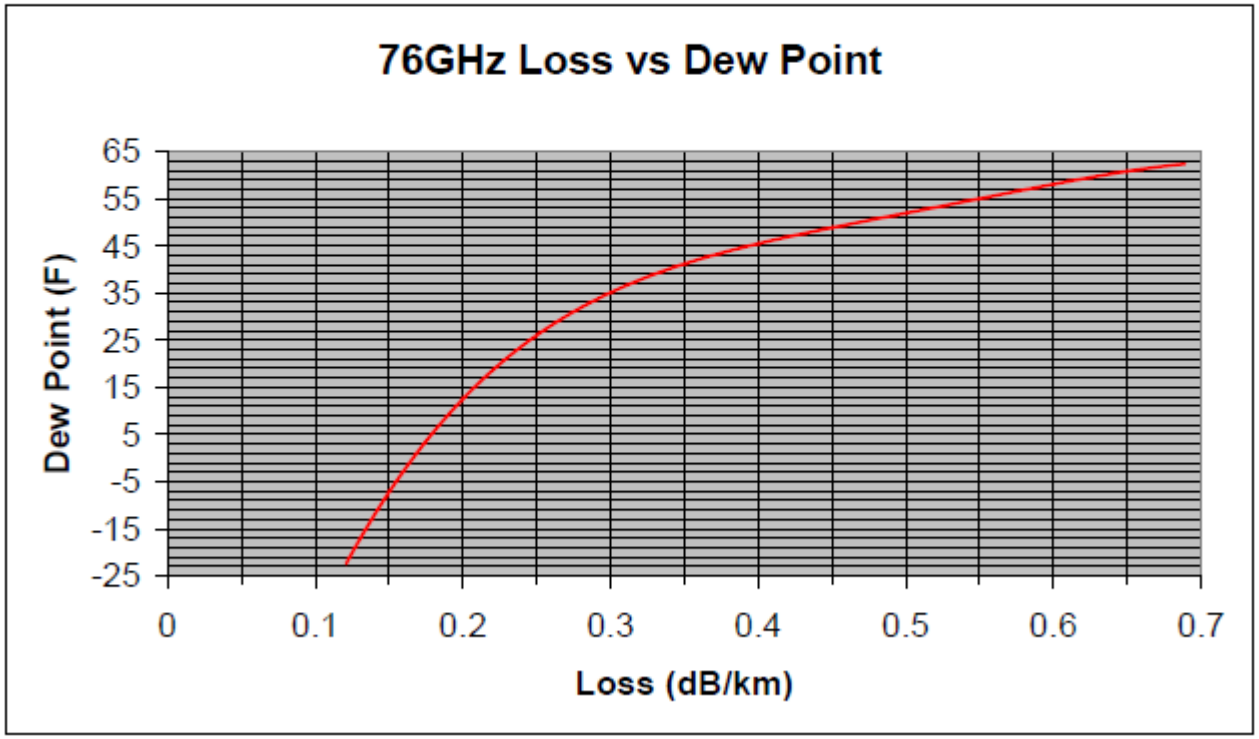
Path Loss Charts. This path loss is ONLY the part due to atmospheric attenuation/absorption. Based on Lieb formulations
Prepared by Brian Justin WA1ZMS. Calculated for Sea Level (standard pressure).



Line of Sight for W5LUA at 55ft

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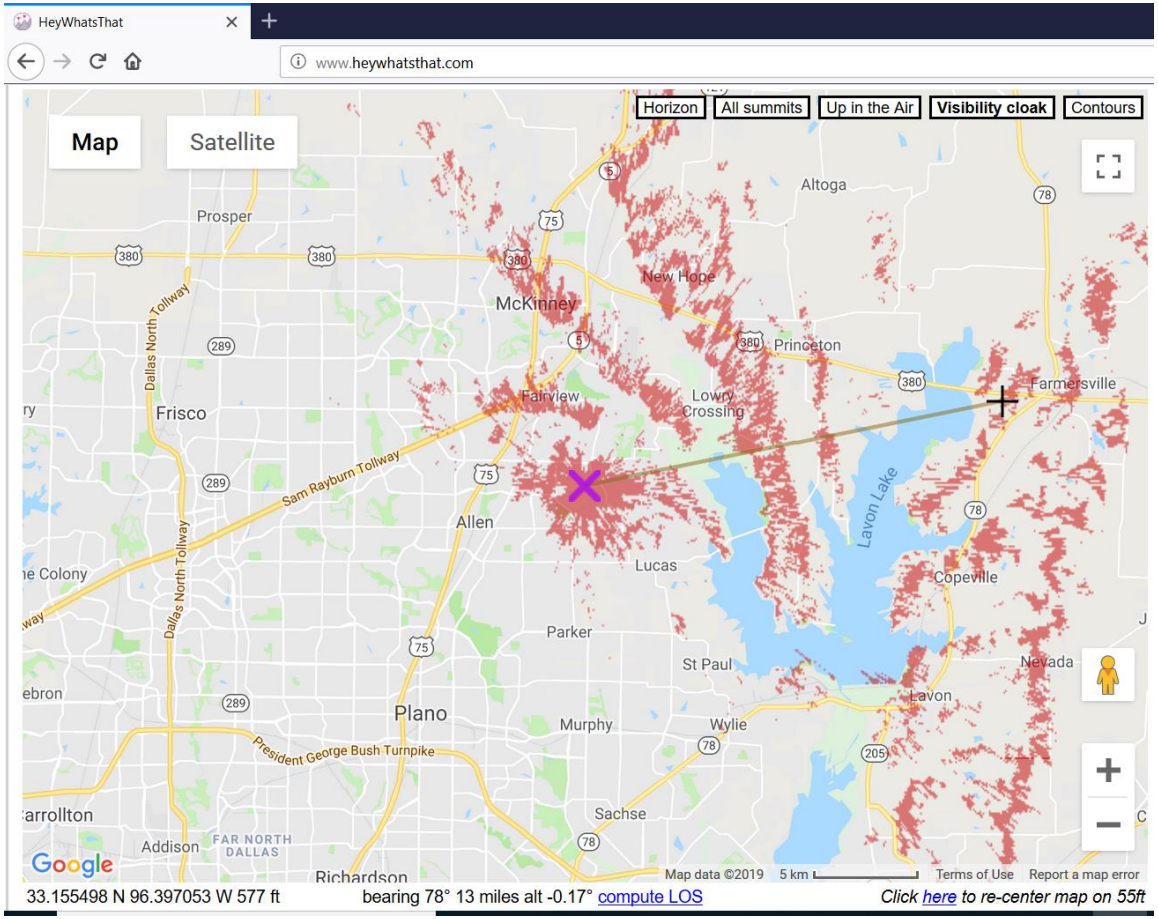

Flyswatter antenna at 55 ft

Areas in red indicate line-of-sight at 55 ft.

Max line-of-sight around 30 km

Path shown is W5LUA to EM13td at 23 km

EM13qc68il to EM13td37gw

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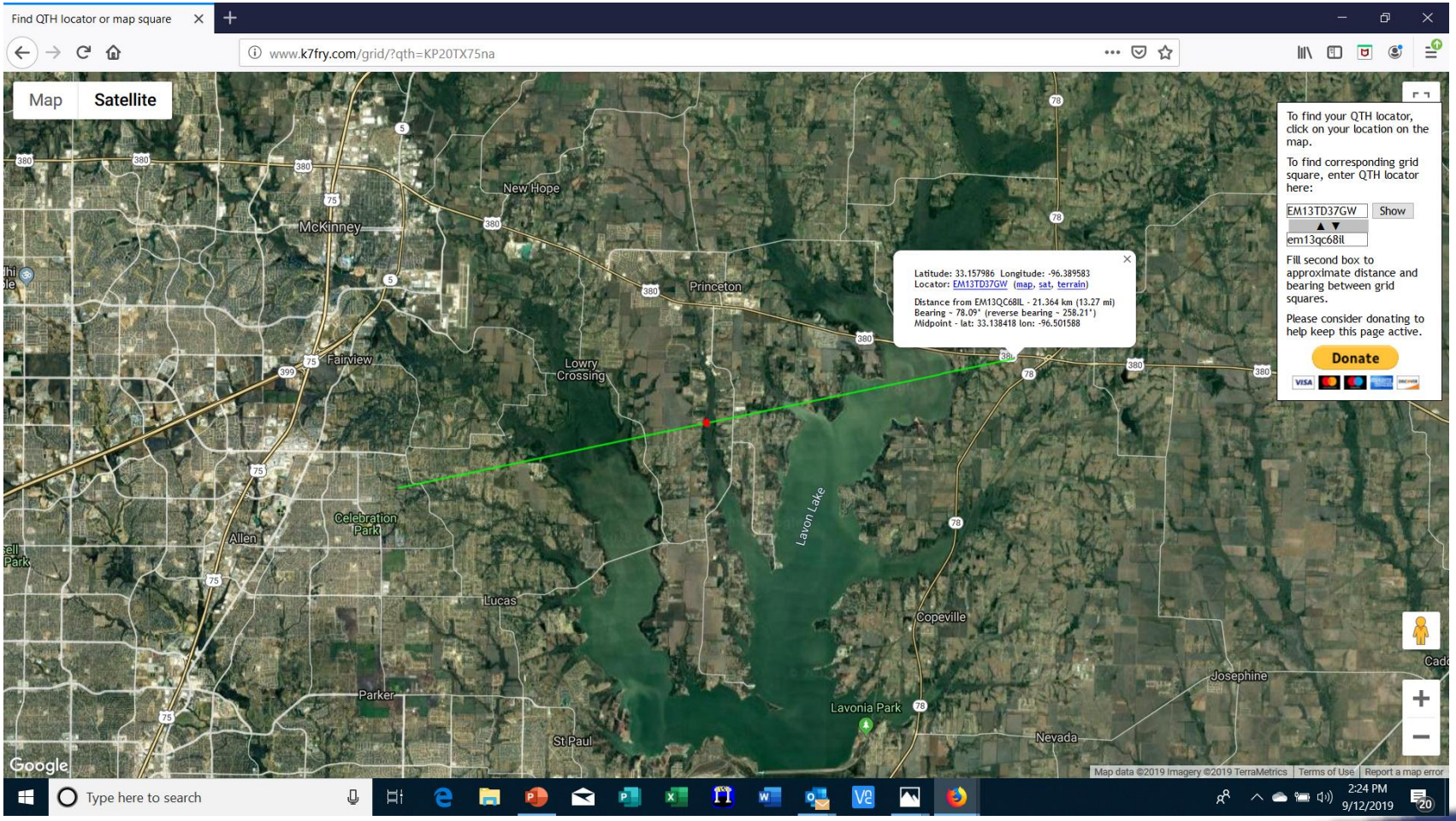

EM13qc68il to EM13td37gw

www.heywhatsthat.com

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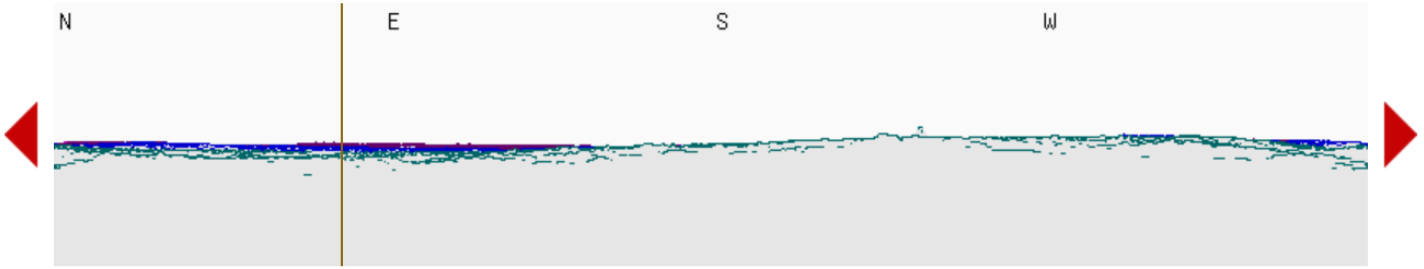
55ft

atitude 33.1187 N longitude 96.61369 W

elevation 678 ft above sea level (55 ft above ground)

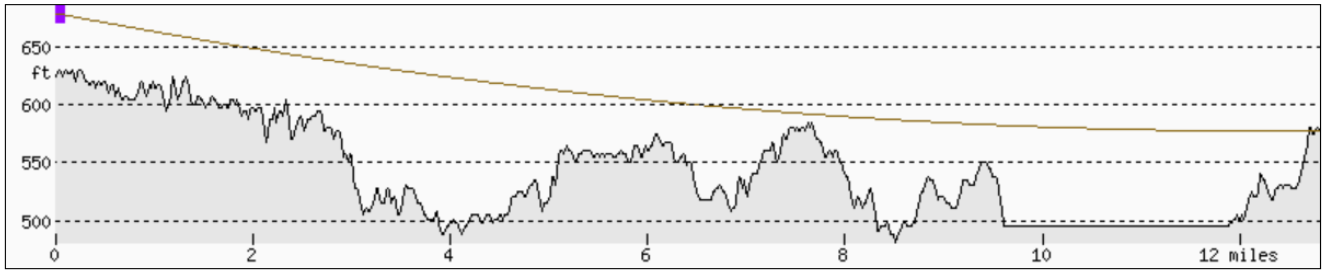
https://www.heywhatsthat.com/?view=MWIT2A6N

View



(vertical scale exaggerated 10x)

☐ show 0° and 1° alt



Parameters

EM13td to EM13qc

Summary

- I am extremely pleased that my periscope system works on 77 GHz
- I have many things to do to improve system
  Need accurate tilt indicator
  Need to work on alignment to reflector
  Use LASER to help with alignment
  Theoretically I could improve my system gain with a smaller reflector aperture
- Now to see how it works on 122 GHz!
- Questions?