PAUL M1CNK

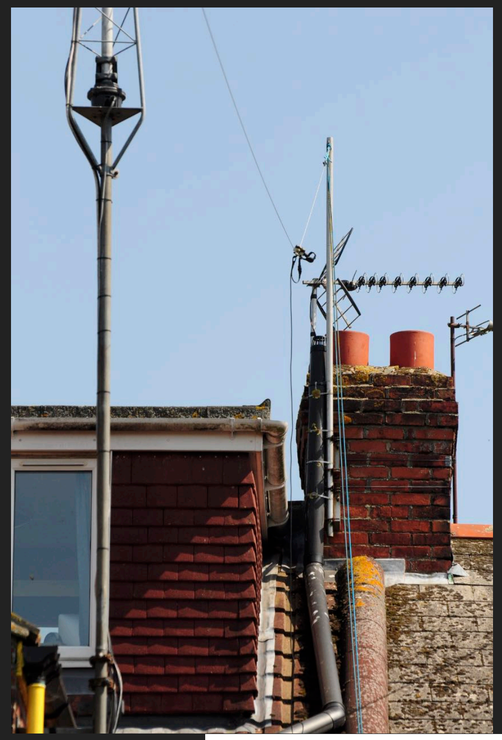
IMPROVING AN ANTENNA

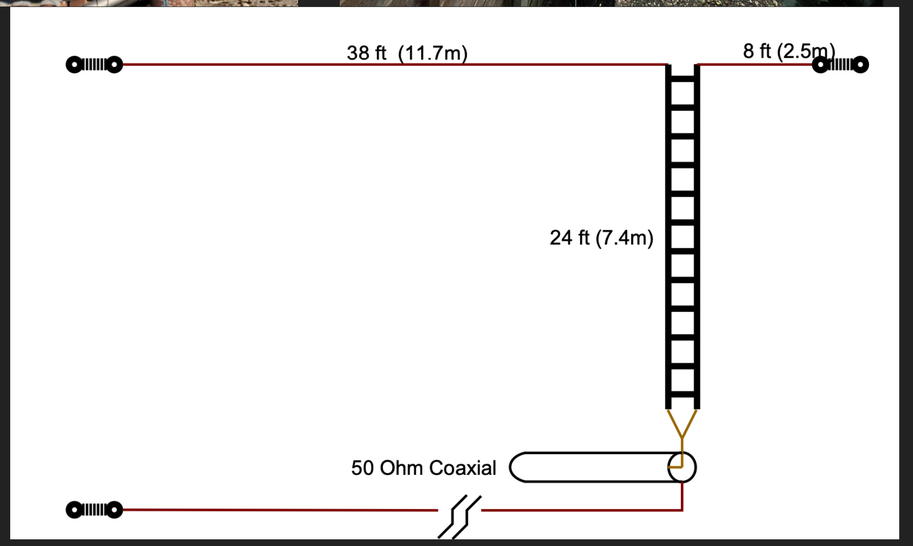
OUTLINE

- Introduction
- Comparing the TX Performance of Antennas
- Modelling
- Adding 160m
- Outcome

THE CHALLENGE

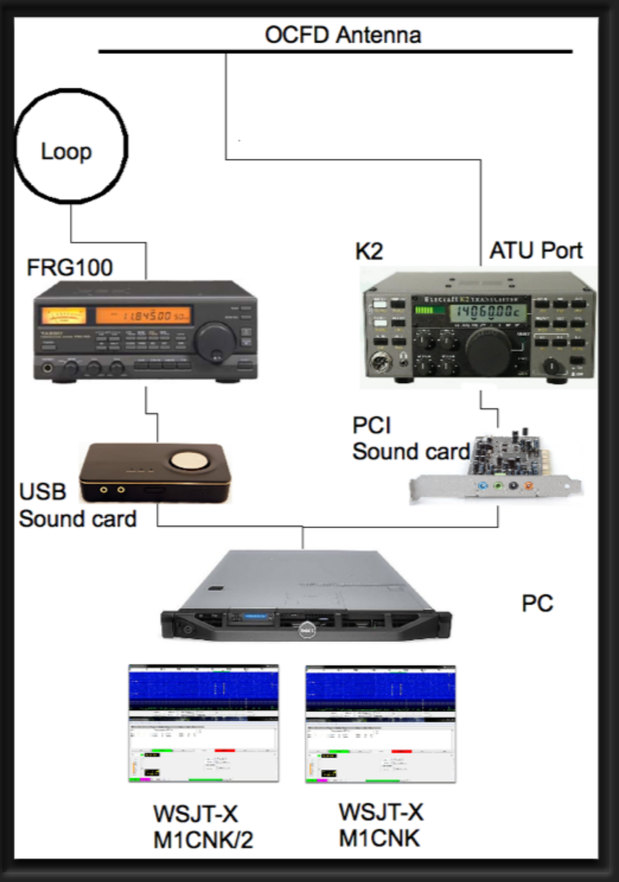
- Had OCFD antenna - lots of RFI issues back in the shack
- G7FEK antenna didn’t perform well on 20m - matched but a poor performer.
- Had a Comet CHA-250BX compromise multi-band vertical - how well did it work?
- No 160m capability

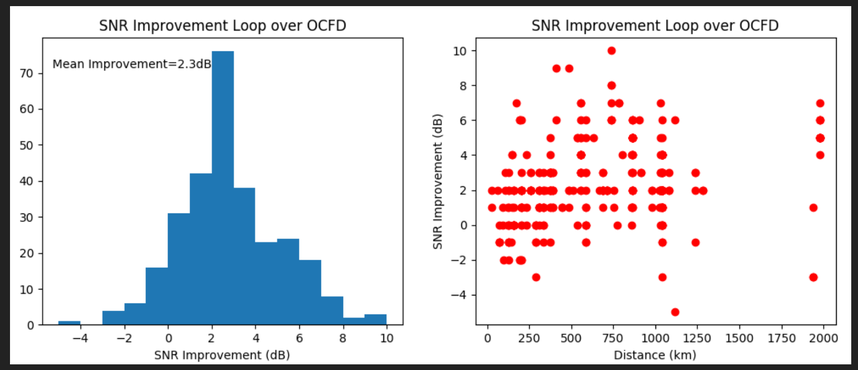




COMPARING ANTENNA PERFORMANCE

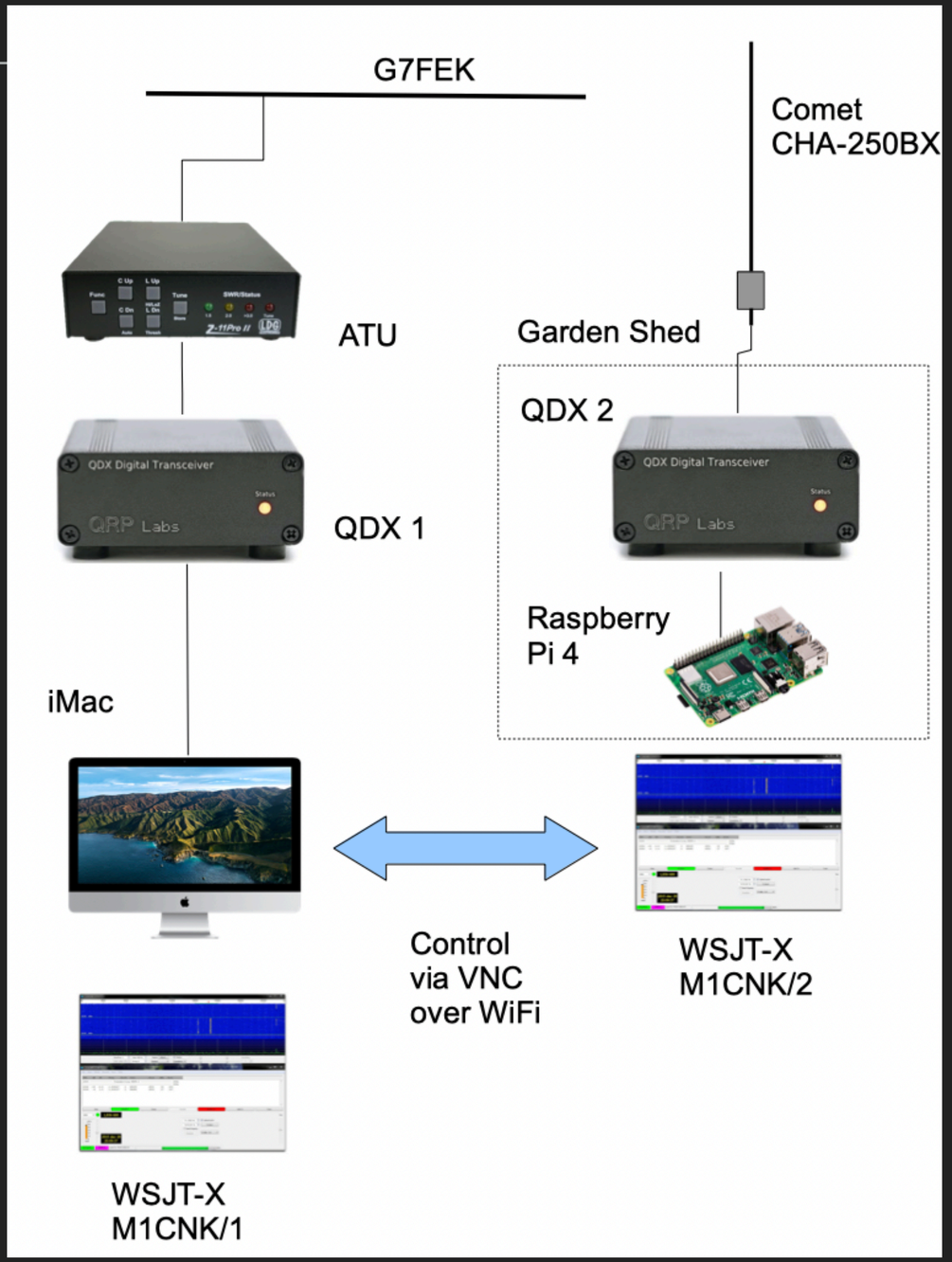
- Previously used WSPRnet to measure the RX performance of two antennas when comparing the club Loop antenna with my OCFD
- Relied upon receiving the same signal by two receivers/antennas and comparing the Signal to Noise Ratio (SNR) reported
- Proved very useful to show SNR improvements whilst removing propagation effects
- But how to extend it to TX performance measurement?





TX PERFORMANCE

- TX from two transmitters at the same time at either end of the WSPR 100Hz band - using callsigns M1CNK/1 and M1CNK/2 (important that both callsigns are the same length)
- Look for stations that received both spots
- Compare the SNR reported - local noise should be the same
- Used QDX since it was about 5W and has a good frequency stability with a TCXO



AN ASIDE ON SETTING FREQUENCY

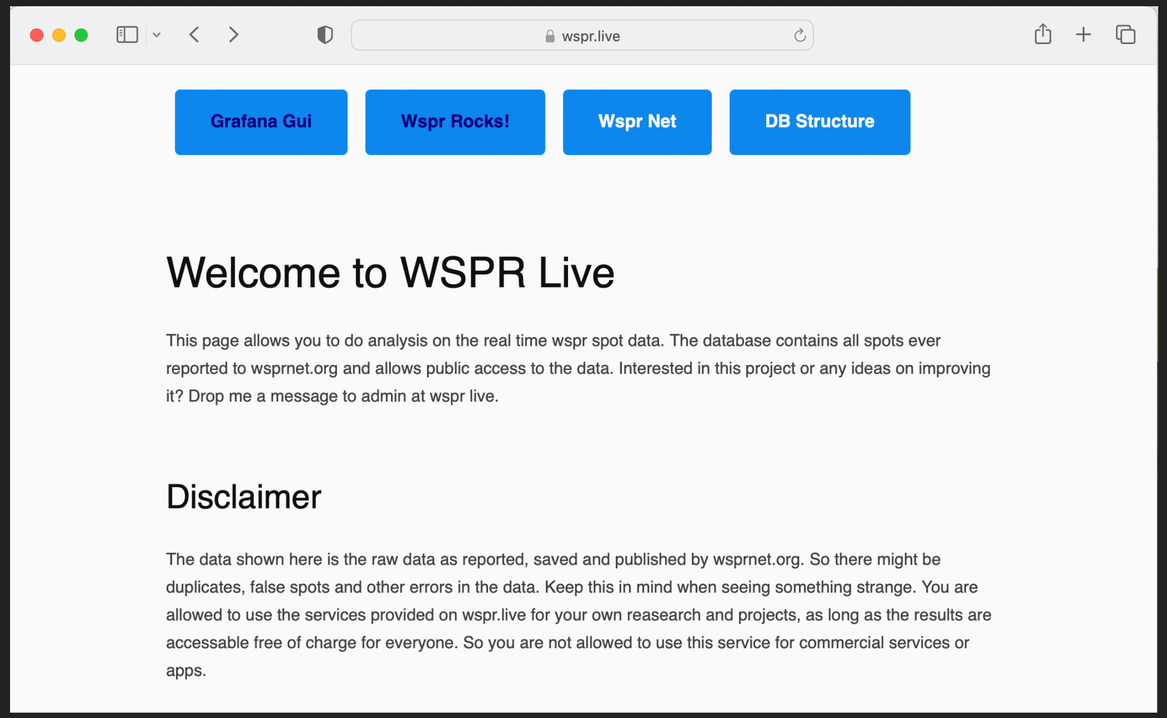
- The WSPR bands are only 100Hz wide so frequency accuracy is important
- QRP labs have set up a couple of webpages which will estimate your frequency accuracy by comparing to other stations on WSPR
- Either RX on 20m WSPR for a couple of cycles then go to https://qrp-labs.com/images/wsprnet/rxerror.html
- Or TX on 20m for a while then visit https://qrp-labs.com/images/wsprnet/txfreq.html

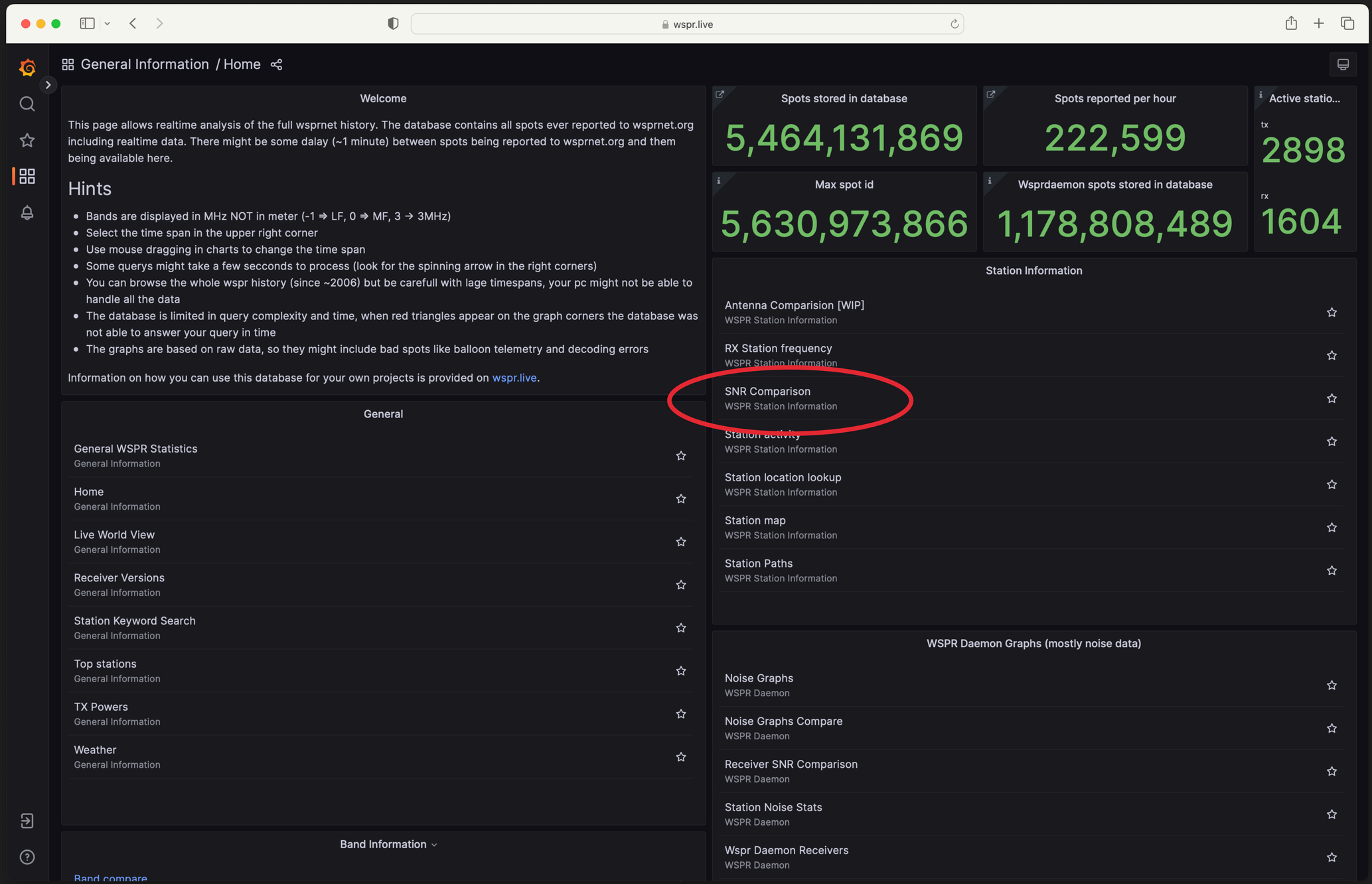
Last updated: 2023-04-08 20:14:00 UT

Call	Error (Hz)
22DX	52
2E0PYB	-40
30HS200	3
7L4IOU	-19
7L4IOU2	-19
9H1PI	10
9V1KG	1
AA0ZT	0
AA7NM	6
AB1YX	18
AC0G	4
AC1BC	-58
AC7IJ	10
AE6RQ	35
AF5GM	-65
AI6VN/KH6	0
AJ8S	-9
BA4XX	0
BD4OS	33
BM2KVV	0
BM4AIK/7	11
BM7GUP	-4
BV2YD	14

ANALYSING THE RESULT

- Previously I had used some home-brew Python scripts to the the analysis for RX
- However, there are now web-based schemes for doing this - go to wspr.live and select Grafana Gui




wspr.live
General Information / Home
Welcome
This page allows realtime analysis of the full wsprnet history. The database contains all spots ever reported to wsprnet.org including realtime data. There might be some dalay (~1 minute) between spots being reported to wsprnet.org and them being available here.
Hints
Bands are displayed in MHz NOT in meter (-1 ⇒ LF, 0 ⇒ MF, 3 → 3MHz)
Select the time span in the upper right corner
Use mouse dragging in charts to change the time span
Some querys might take a few secconds to process (look for the spinning arrow in the right corners)
You can browse the whole wspr history (since ~2006) but be carefull with lage timespans, your pc might not be able to handle all the data
The database is limited in query complexity and time, when red triangles appear on the graph corners the database was not able to answer your query in time
The graphs are based on raw data, so they might include bad spots like balloon telemetry and decoding errors
Information on how you can use this database for your own projects is provided on wspr.live.
General
General WSPR Statistics
General Information
Home
General Information
Live World View
General Information
Receiver Versions
General Information
Station Keyword Search
General Information
Top stations
General Information
TX Powers
General Information
Weather
General Information
Band Information
Band compare
Spots stored in database
5,464,131,869
Spots reported per hour
222,599
Active statio...
tx
2898
rx
1604
Max spot id
5,630,973,866
Wsprdaemon spots stored in database
1,178,808,489
Station Information
Antenna Comparision [WIP]
WSPR Station Information
RX Station frequency
WSPR Station Information
SNR Comparison
WSPR Station Information
WSPR Station Information
Station location lookup
WSPR Station Information
Station map
WSPR Station Information
Station Paths
WSPR Station Information
WSPR Daemon Graphs (mostly noise data)
Noise Graphs
WSPR Daemon
Noise Graphs Compare
WSPR Daemon
Receiver SNR Comparison
WSPR Daemon
Station Noise Stats
WSPR Daemon
Wspr Daemon Receivers
WSPR Daemon

wspr.live

WSPR Station Information / SNR Comparison

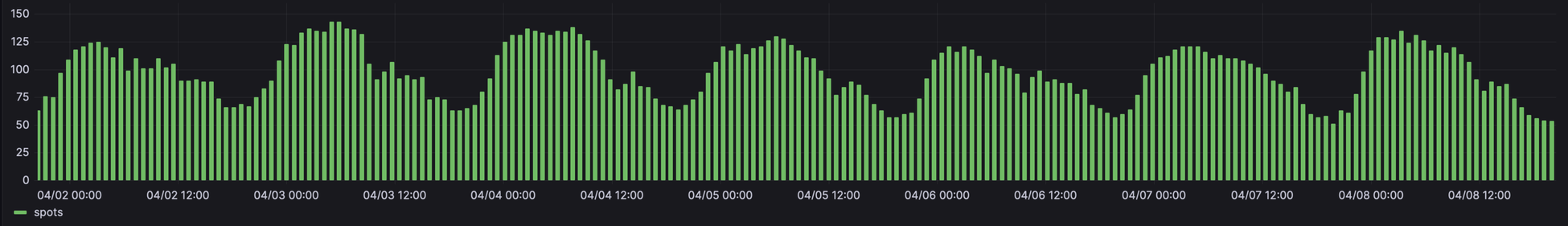
Last 7 days UTC

Test station: KFS | Reference station: KPH | doing: rx | Target station: % | Band: 10

Statistics

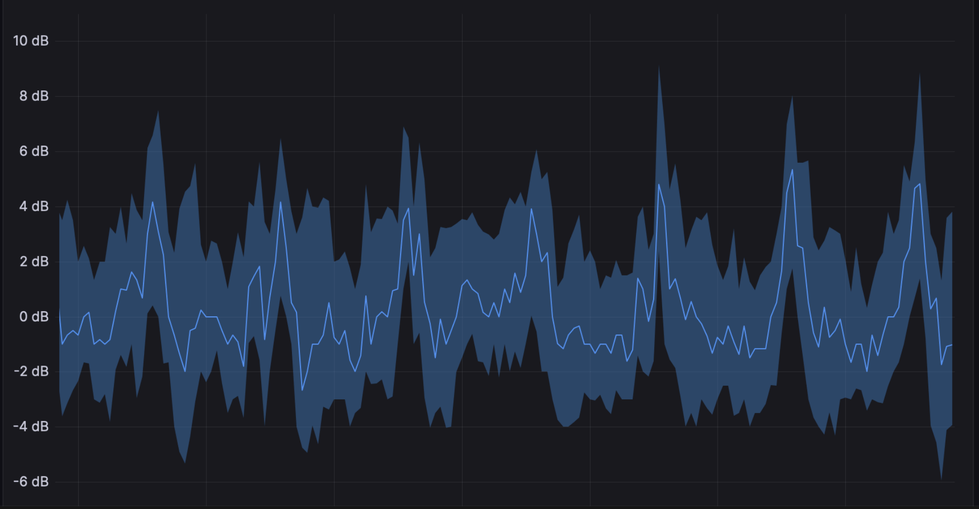
Test station spots in timeframe	Reference station spots in timeframe	Common spots	Aggregated SNR difference
56482	50460	45503	Average 0.82 Median 0.00

Count of common spots

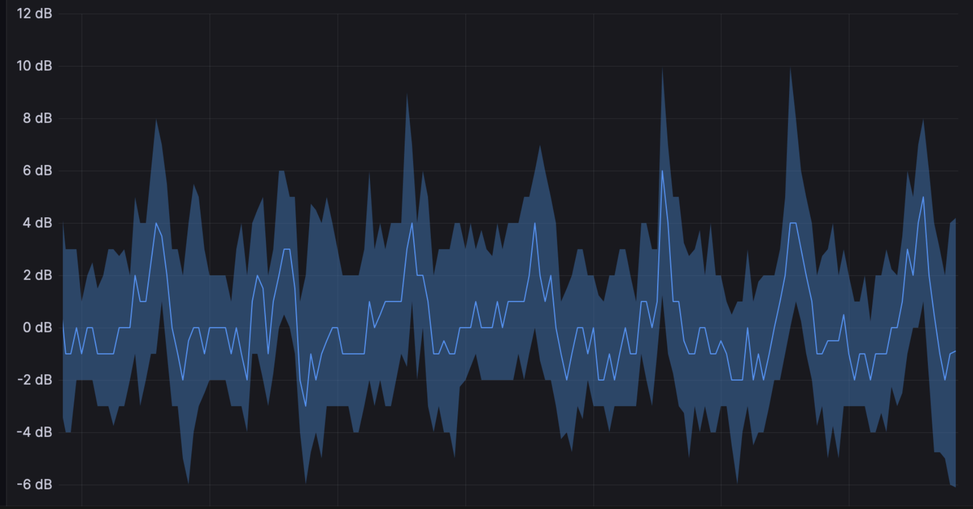


Difference vs Time

Mean receiver SNR differences



Best receiver SNR differences



wspr.live

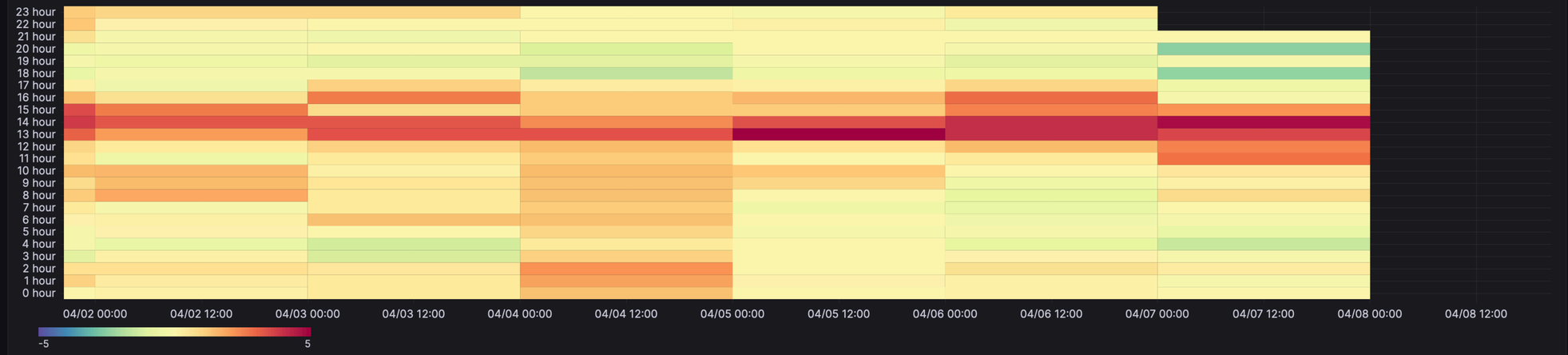
WSPR Station Information / SNR Comparison

Last 7 days UTC

Receiver SNR differences

Difference VS Time of Day

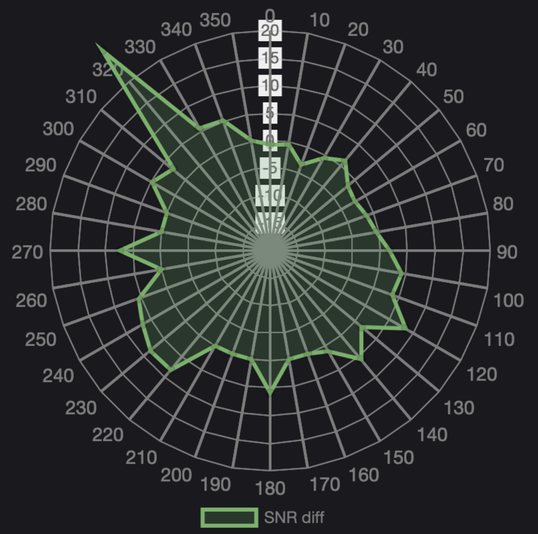
mean receiver SNR difference vs time of day



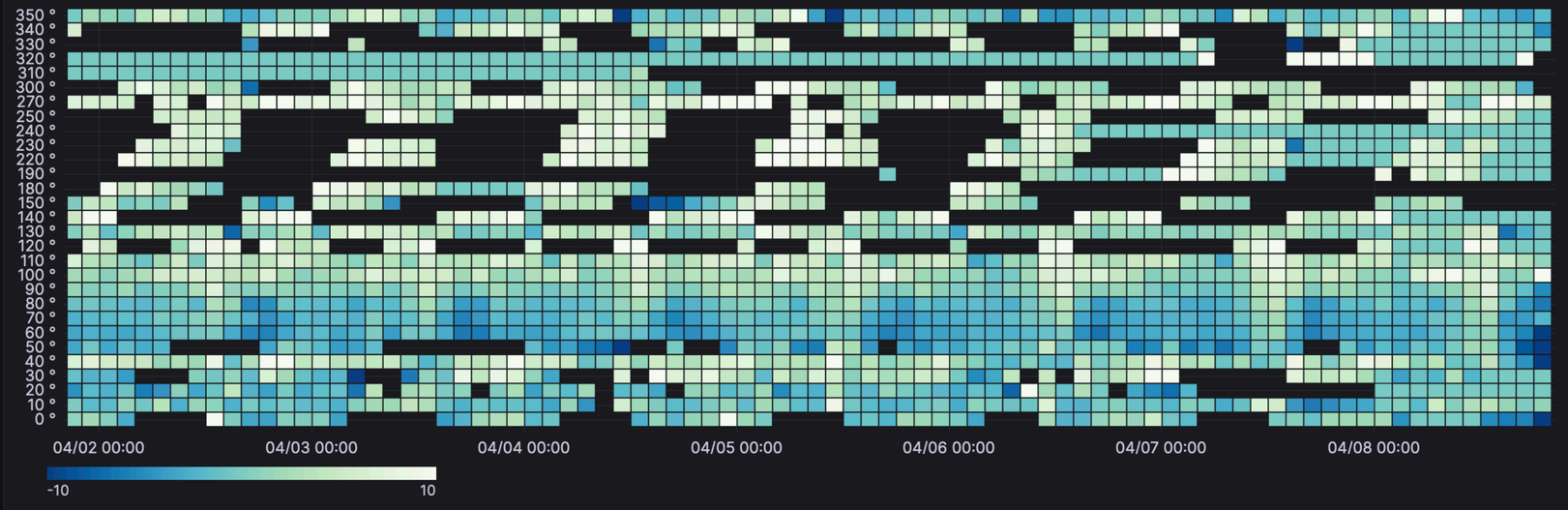
Difference VS direction

Difference VS direction

SNR difference vs direction

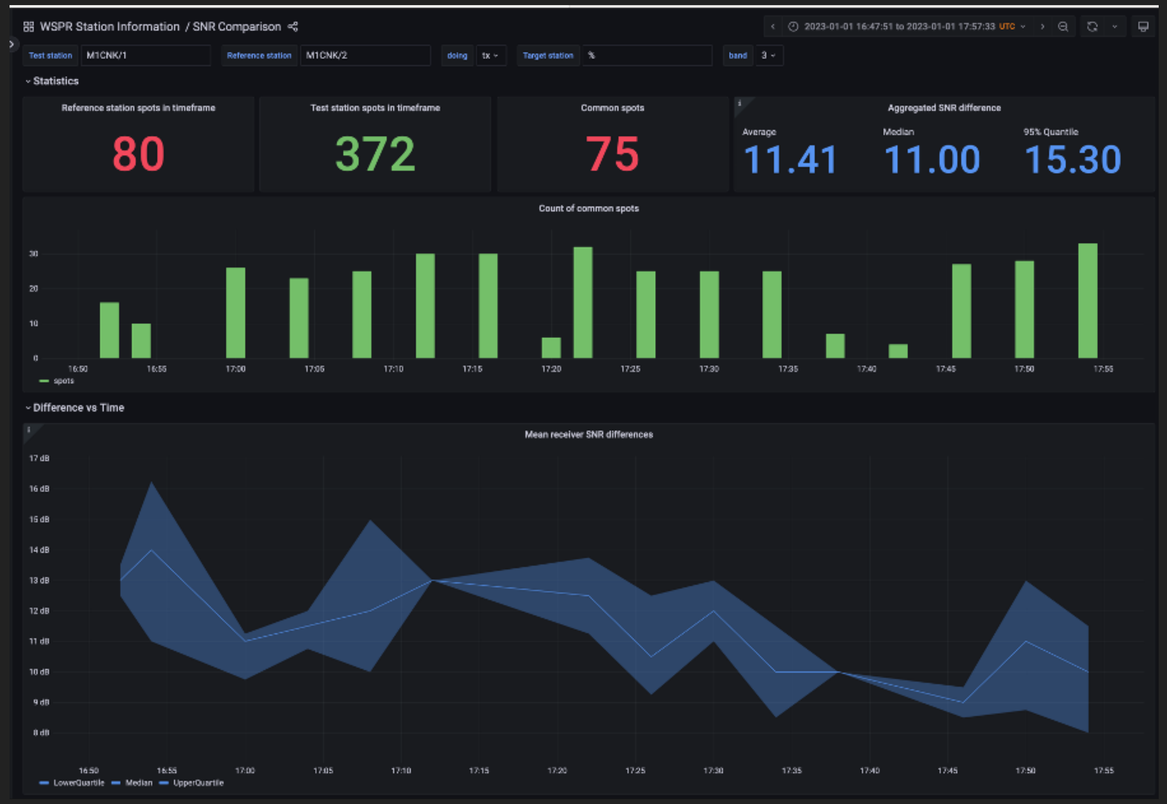


mean receiver SNR difference vs time and azimuth



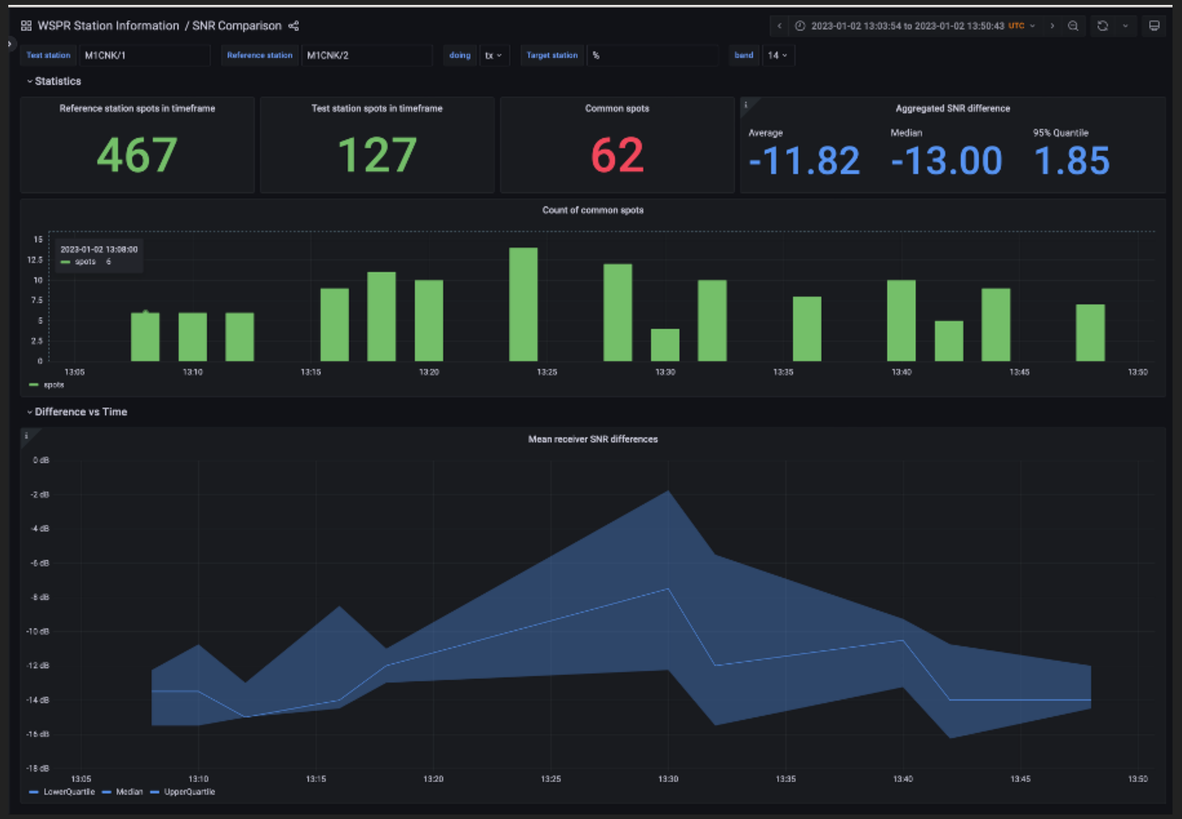
80M EXAMPLE

- Found that adding a couple of radials to the Comet improved it’s performance
- However, it’s still 11.4dB down on average to the G7FEK



20M EXAMPLE

- However, on 20m, it’s reversed the Comet was 11.8dB better than the G7FEK

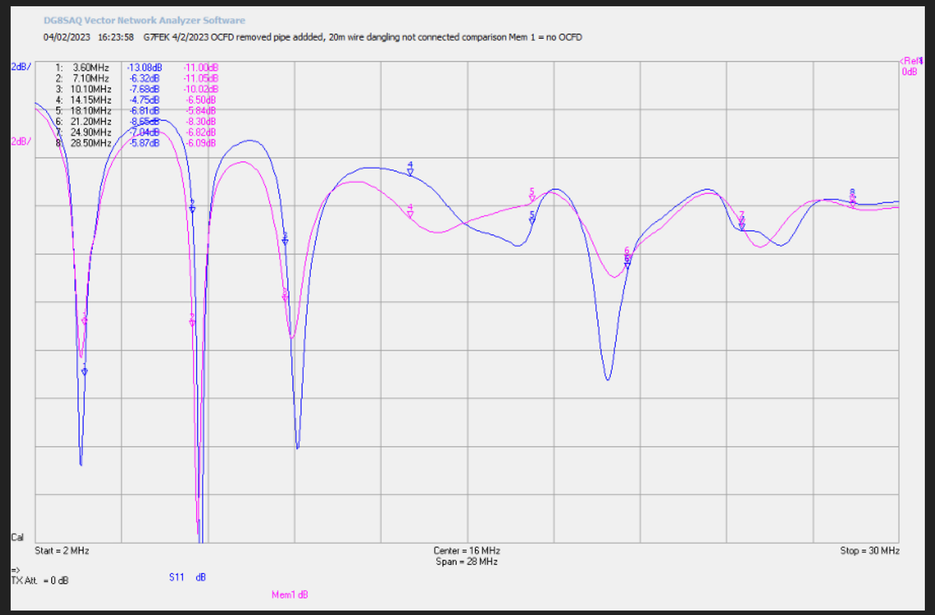


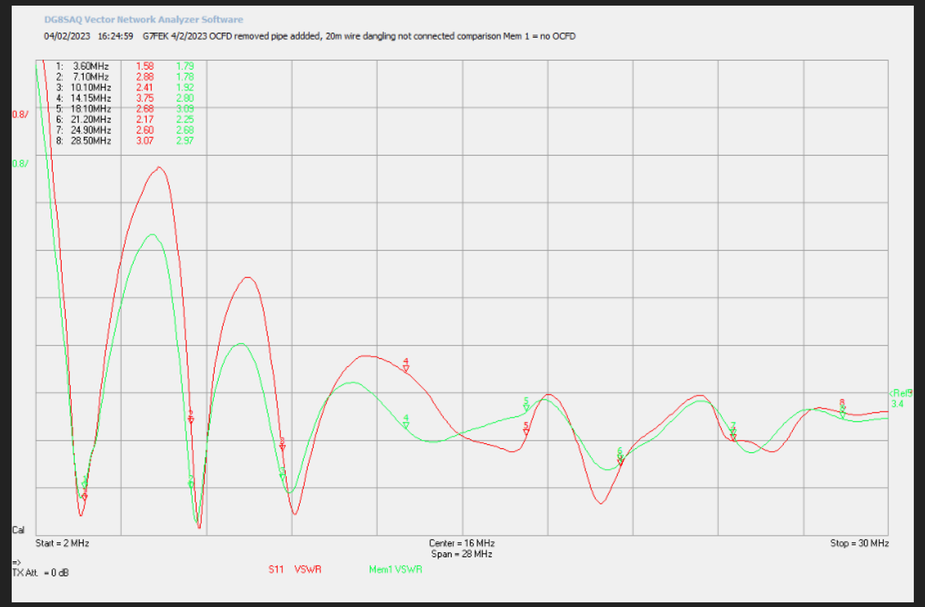
THE DRAIN PIPE

- The bush around the ladder line of the G7FEK had grown around it and was very close
- Decided to put in into a drain pipe where it was held central with some 3d printed spacers

THE DRAIN PIPE

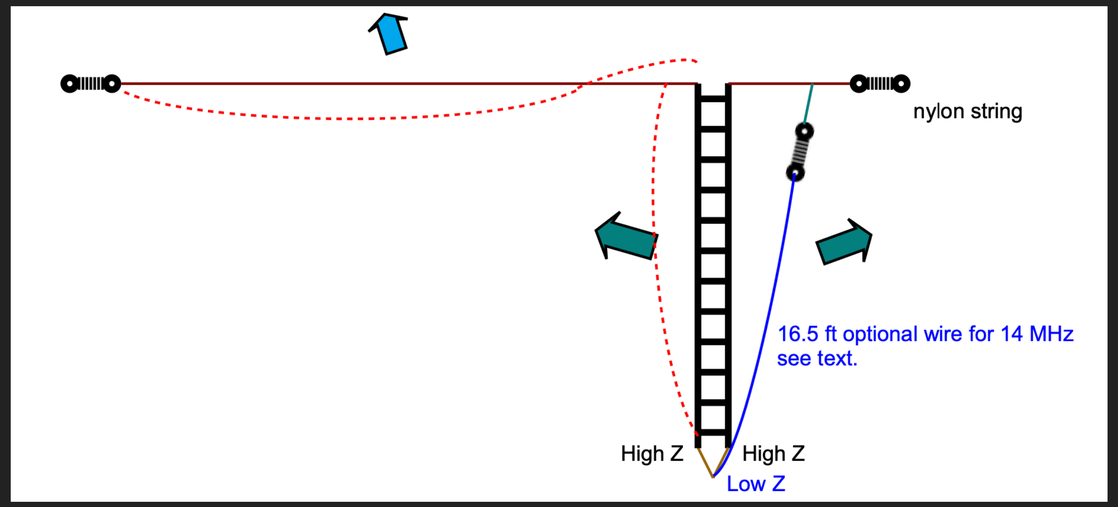
- The Return Loss was measured at the shack end before (purple) and after (blue).
- The deeper resonant dips indicate lower loss
- VSWR plot (before = green, after = red) shows that the match at 20m is poor - even after at 35m of RG58





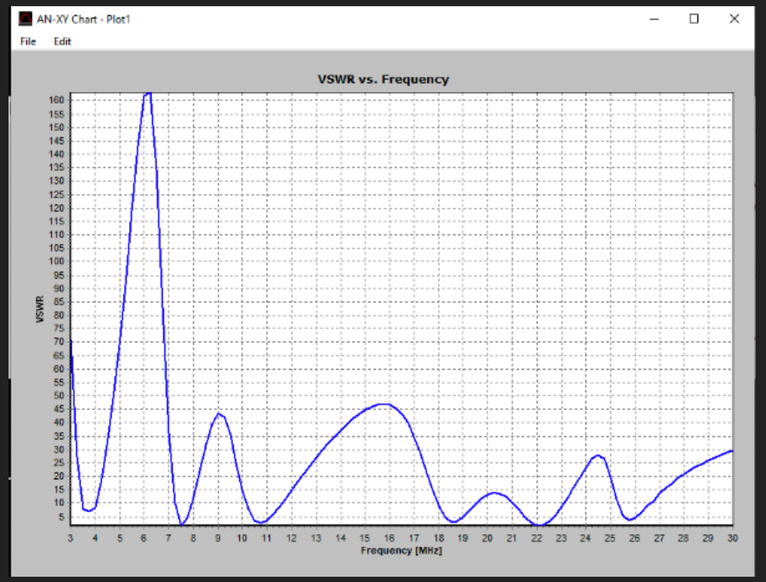
20M WIRE

- The original paper for the G7FEK showed an optional wire to improve 20m performance
- Given Comet CFA was nearly 12dB better, adding this wire could be useful
- However, could it be modelled? NEC2 or MMANA-GAL can’t do it due to the close spacing of the ladder line
- NEC4 or NEC5 would be better but also have limitations plus cost lots

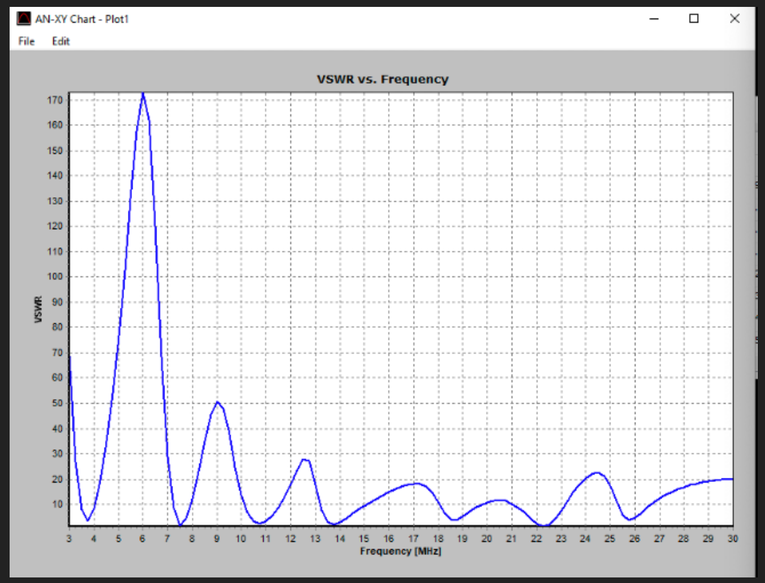


MODELLING THE 20M WIRE

- However, there is a newer affordable software package on the market - AN-SOF by Golden Engineering (not be confused with Ansys!)
- Works in the same way as NEC but doesn't make the same approximations so can model close wires (and also circular loops)
- Modelled before and after the 20m wire was added



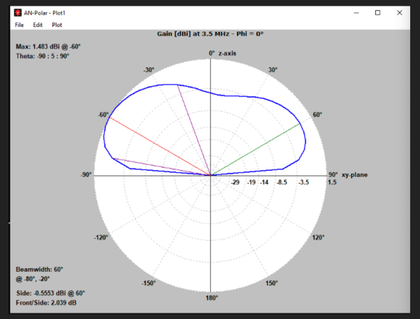
Before 20m wire



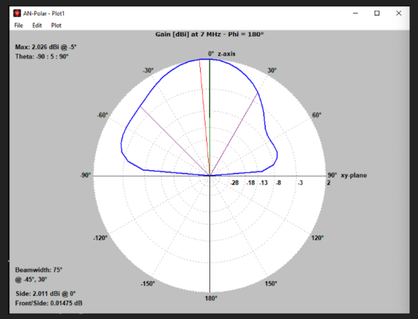
After 20m wire

MODELLING THE 20M WIRE

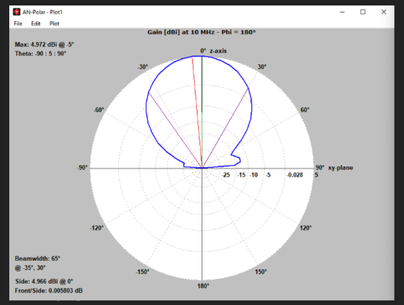
80m



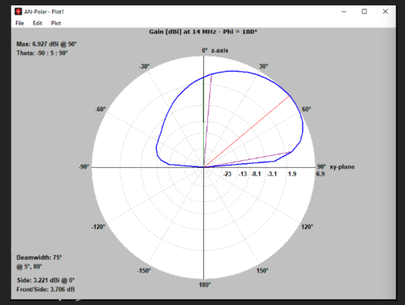
40m



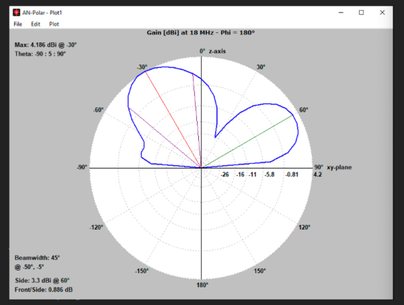
30m

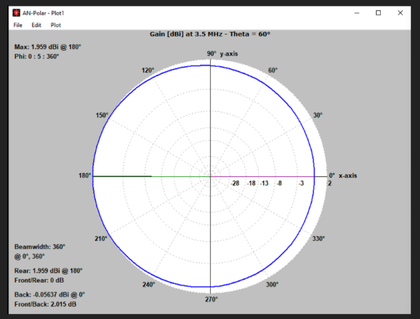


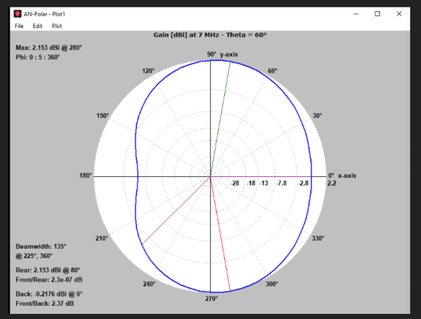
20m

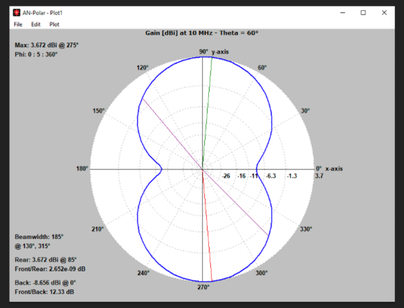


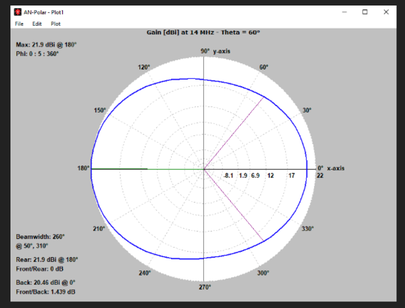
17m

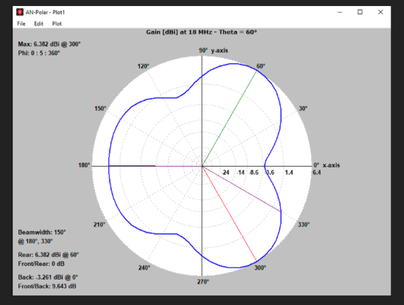






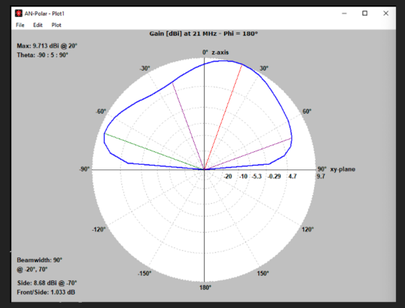


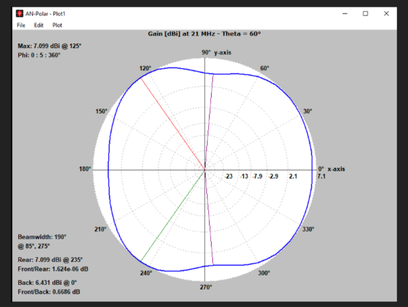




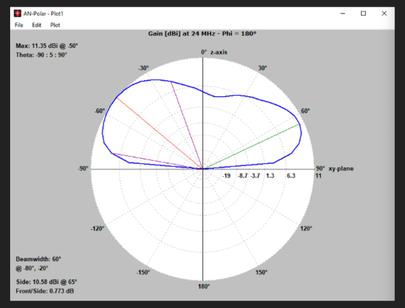
MODELLING THE 20M WIRE

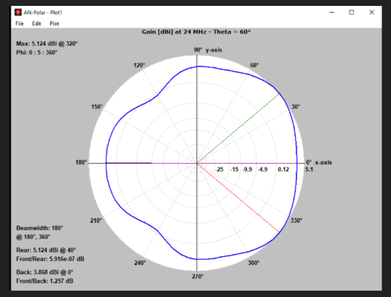
15m



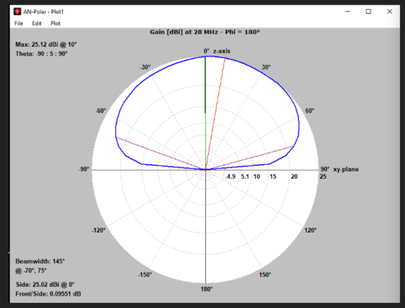


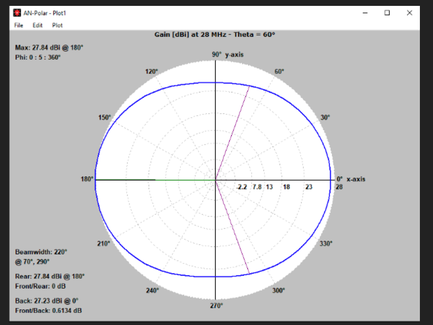
12m





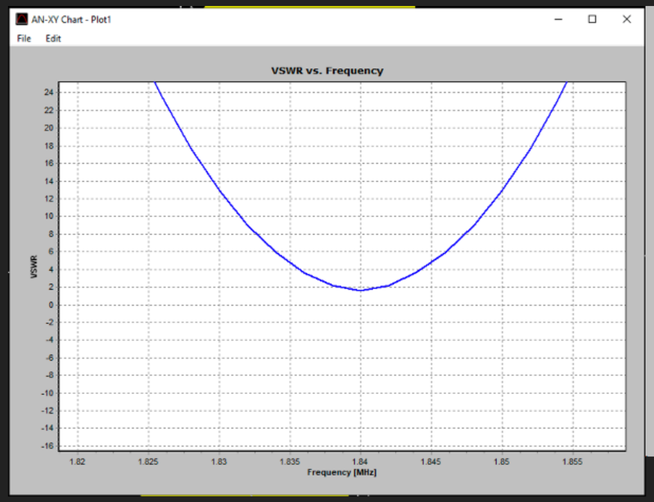
10m

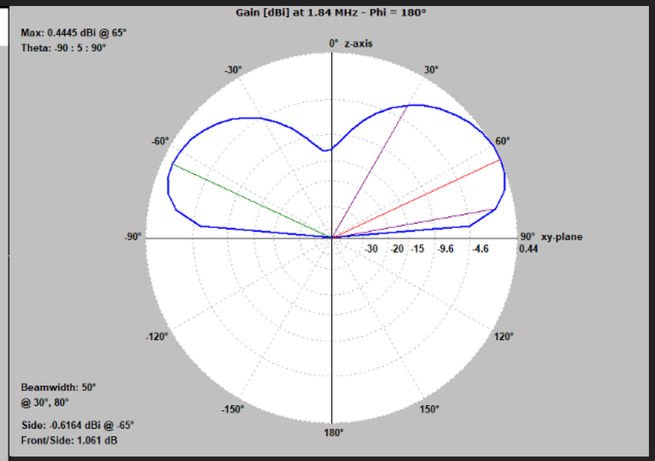


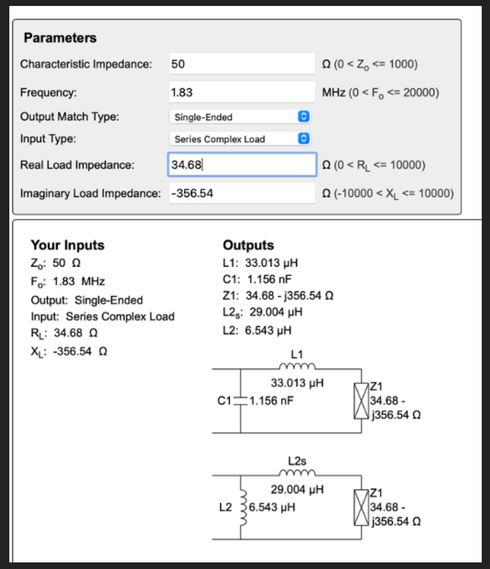


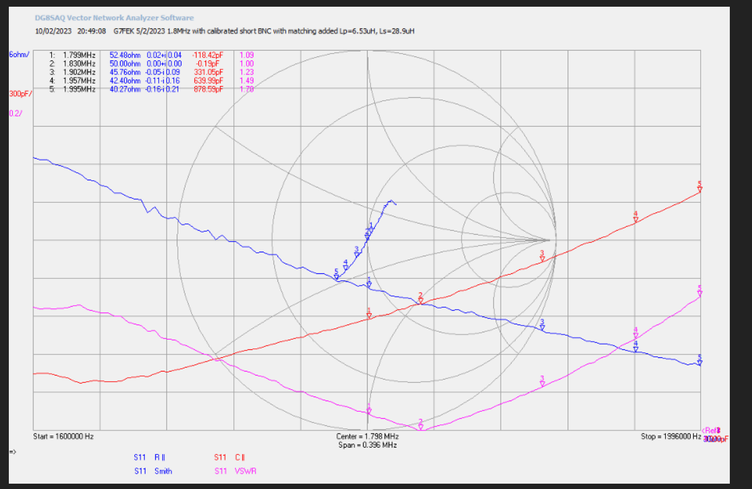
ADDING 160M CAPABILITY

- Modelling indicated that an L-match would provide a useful 160m capability, at least for FT8
- So added the 20m wire and then measured the impedance at the antenna feed point using a VNA calibrated at that feed point.
- Used the measurement into an online L match design tool (Analog Devices)
- Went with the two coil match



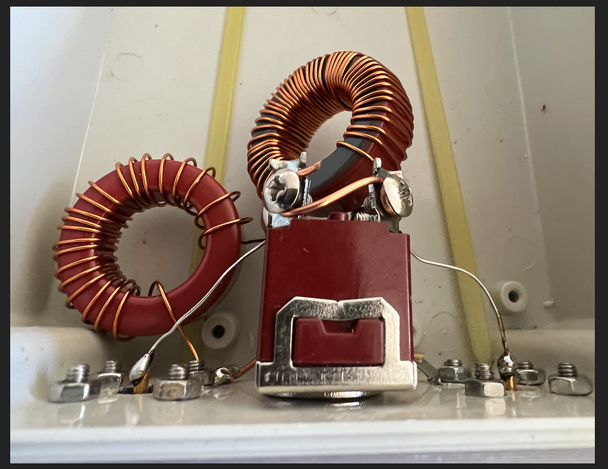


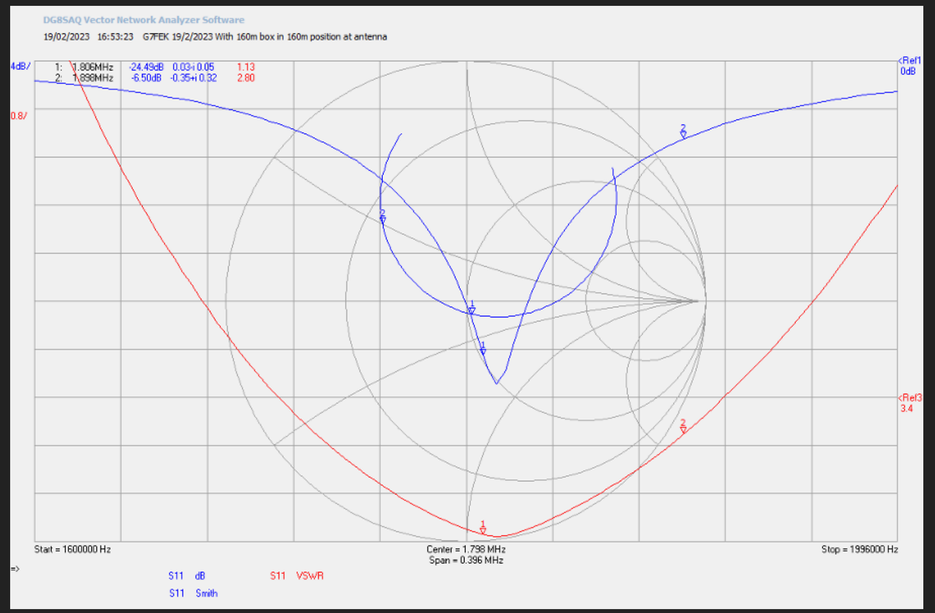




ADDING 160M CAPABILITY

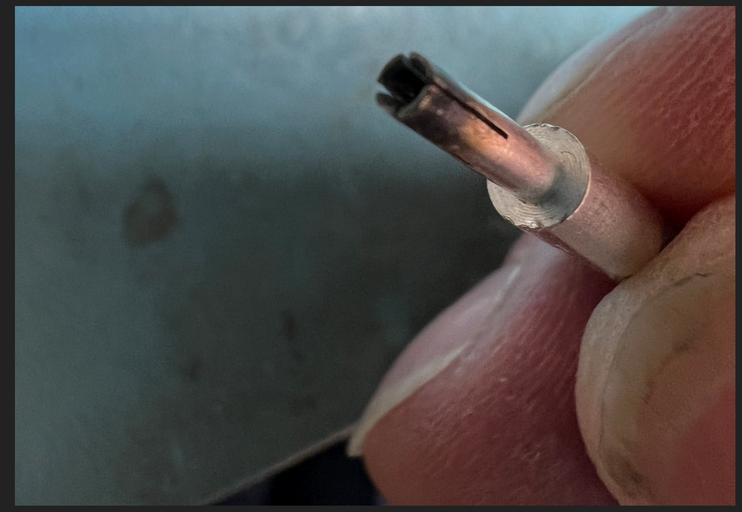
- Wound the coils using T130-2 toroids
- Added a switch to have either 160m or HF selectable
- Mounted in a waterproof box at the base of the antenna
- Good match until I applied 100w.....





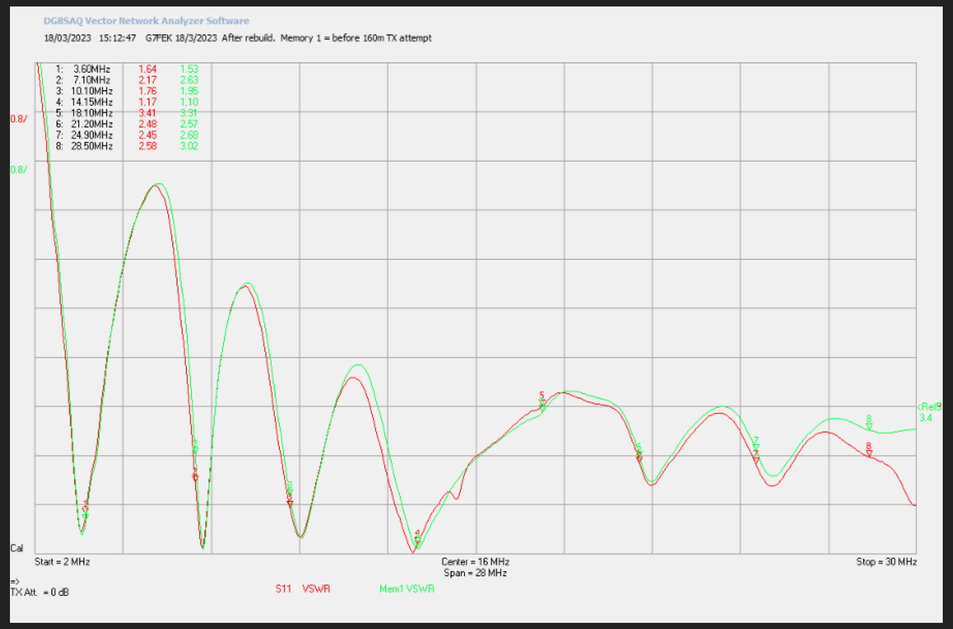
PROBLEM WITH 160M

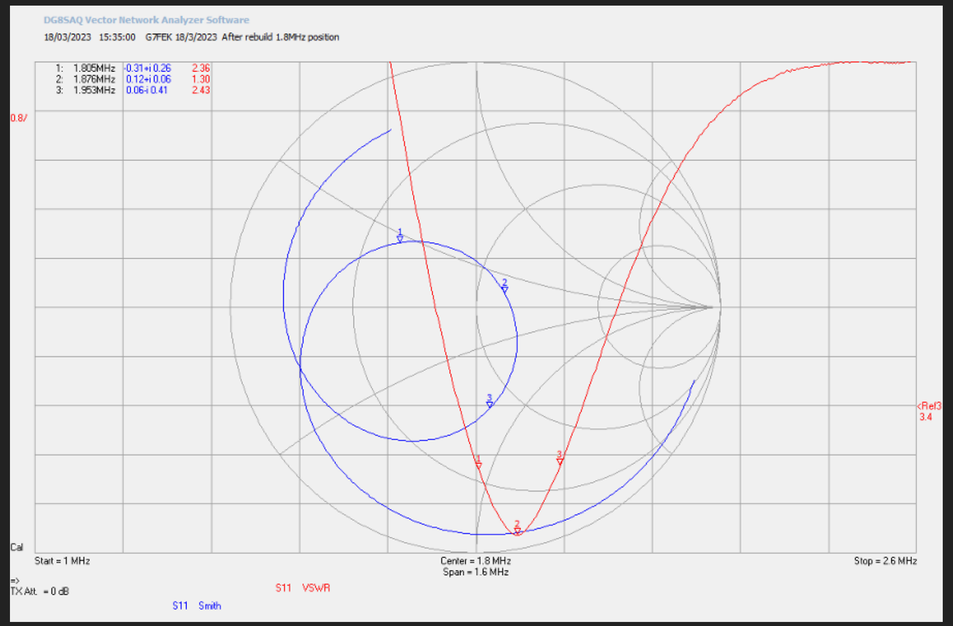
- Water in the dipole piece at the bottom of the antenna had caused corrosion in PL250 to BNC adaptor plus a conductive path between the two connections which would flash over…..
- Replaced it with 3D printed plate plus a coax pig-tail all sealed with plastic rubber solution



END RESULTS – MATCHING

- Got good matching on most bands - measured at the shack
- 160m around the FT8 frequency certainly usable





END RESULTS – WSPR COMPARISON

- Repeated the WSPR test - got the following improvements

Band	Improvement	Gain over Comet
80m	12.3dB	23.7dB
40m	13.8dB (or 2dB)	11.0dB
20m	15.8dB	4.0dB

END RESULTS – DX

- Worked two DXpeditions - Sable Island and Rwanda after a few calls on FT8
- Worked South Africa, Japan, Indonesia and Korea - all new DXCC for me
- Total DXCC worked is now 102, confirmed 85 LOTW
- 11 DXCC on 160m work, 7 confirmed