GHz Bands EME from a “challenging” location

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RSGB 2022 Convention

EME for Bodgers - some observations

“Backyard Moonbounce” talks have been done to death at Microwave Round Tables, so why another one?

I got sick of going to “Backyard EME” talks where the first slide was:

- “First, find your obsolete 12ft TVRO dish and load it on to the back of your monster jeep and trailer.”
- or
- “Even a small 2x19 element 144MHz array can give you good results”

These people must have no neighbours and very compliant partners

EME for Bodgers - some observations

GHz Bands EME is satisfyingly “predictable”

It takes time to make something work

For me, 2 years from concept to first QSO.

There are no short cuts and you never stop “tweaking”

So, why is my QTH so “challenging?”

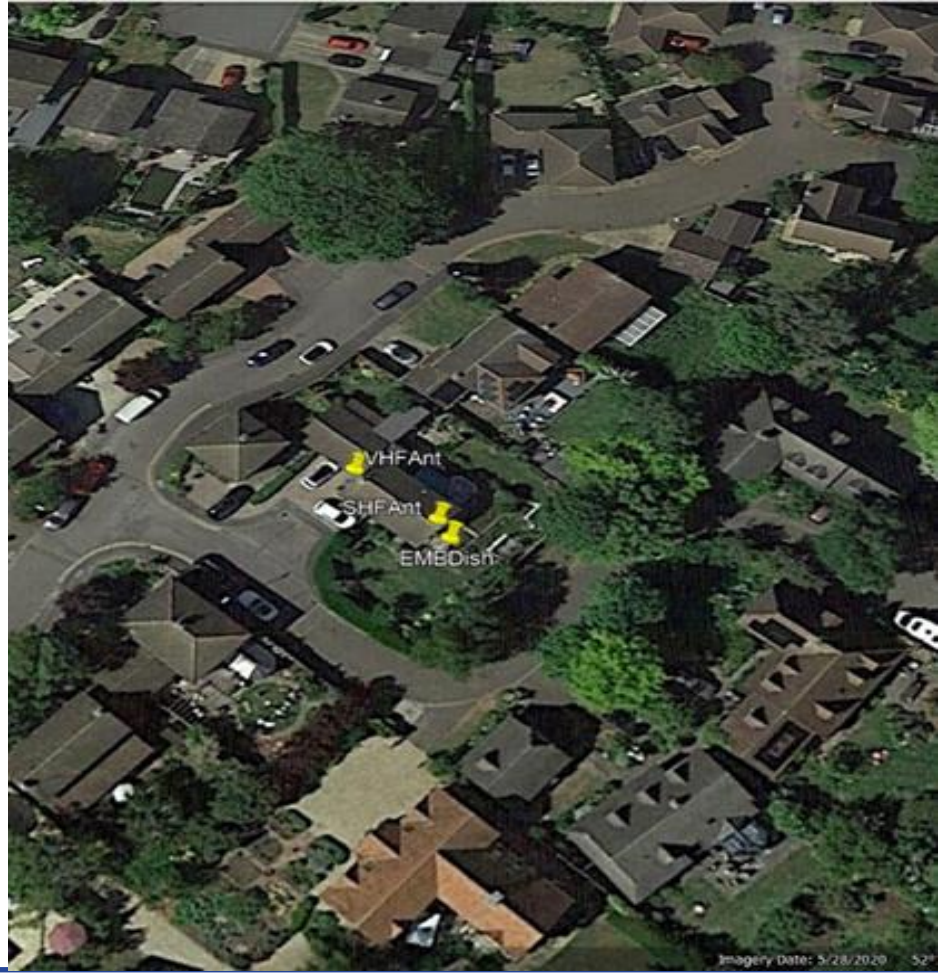
“Fen Edge flatland” and 4m ASL

Neighbours’ houses

No horizon view from ground level in any direction

Trees

Noise



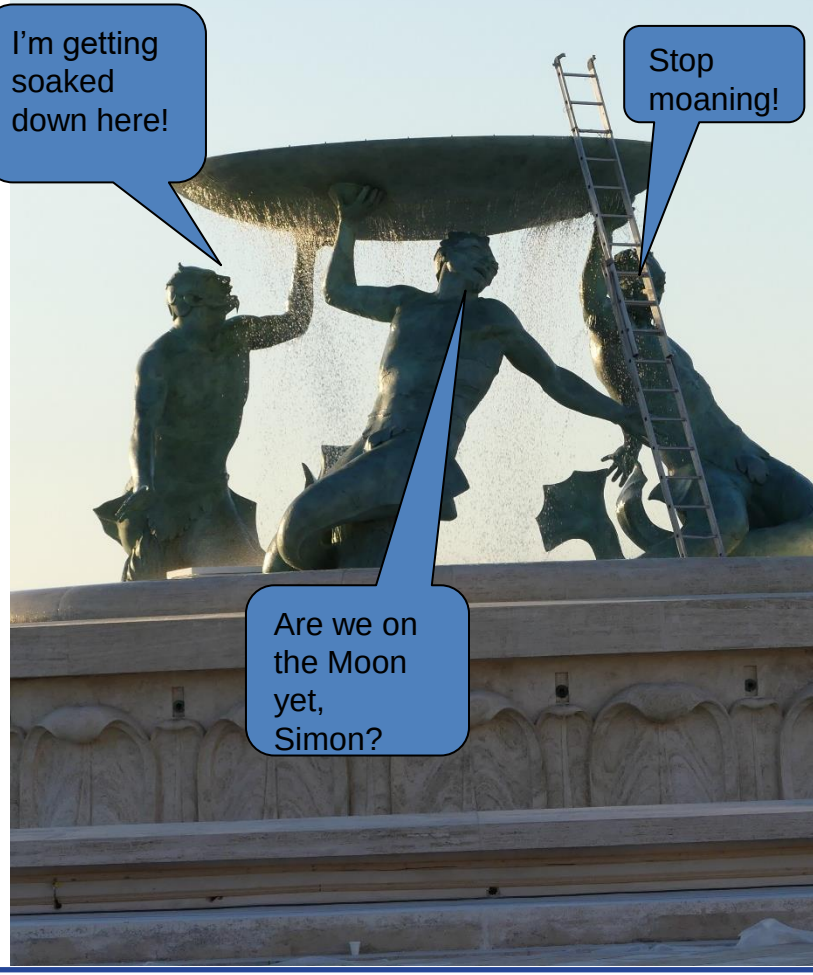
Assessing your “Moon Window”

Here I’m limited by (big) trees from Moonrise to Zenith at all but the highest declination.

I cannot operate below 20 degrees elevation due to houses and EMR limitations.

But you have to work around your QTH!

I still make QSOs



Beware small trees!

How it started (2012)

Beware small trees!

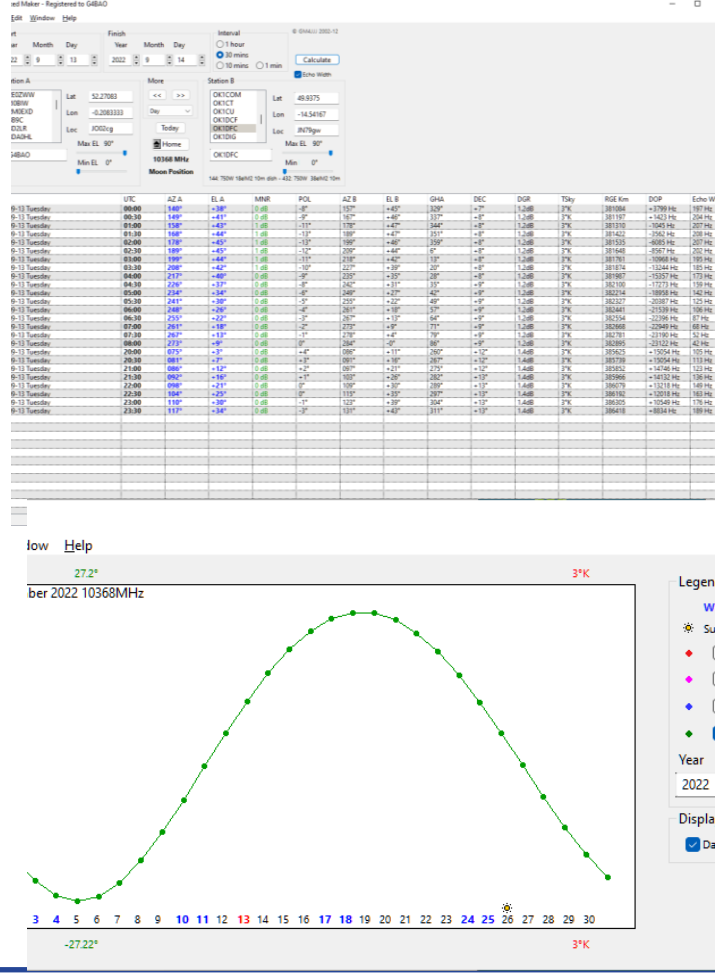
How it’s going (2022)

Assessing your “Moon Window”

Like the Sun, the Moon rises in the East and sets in the West

Unlike the Sun, the Moon’s DECLINATION and therefore it’s track across the sky “repeats” over a lunar month not over a year

GM4JJJ “Moonsked” lets you do minute by minute predictions or look ahead and back

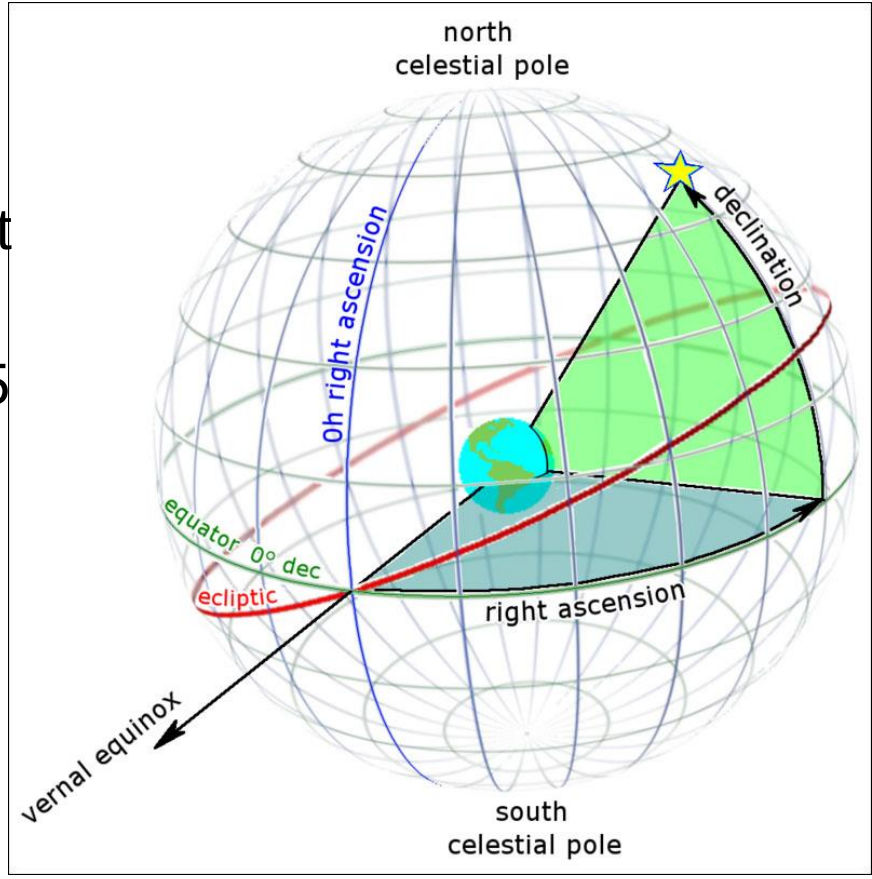


Declination

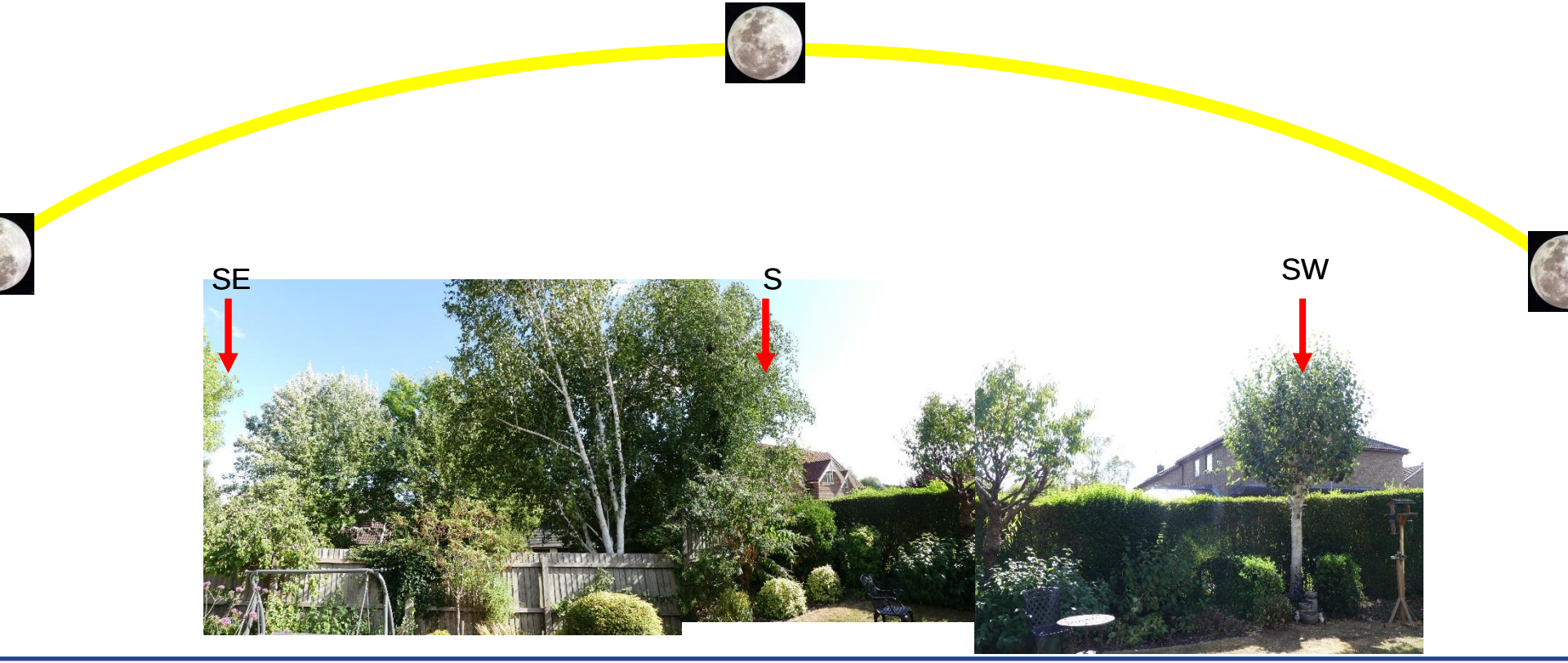
Moon declination varies between about +/-27 degrees over a lunar month.

So, Moon Zenith varies from about +65 to just +9 degrees between max and min declination.

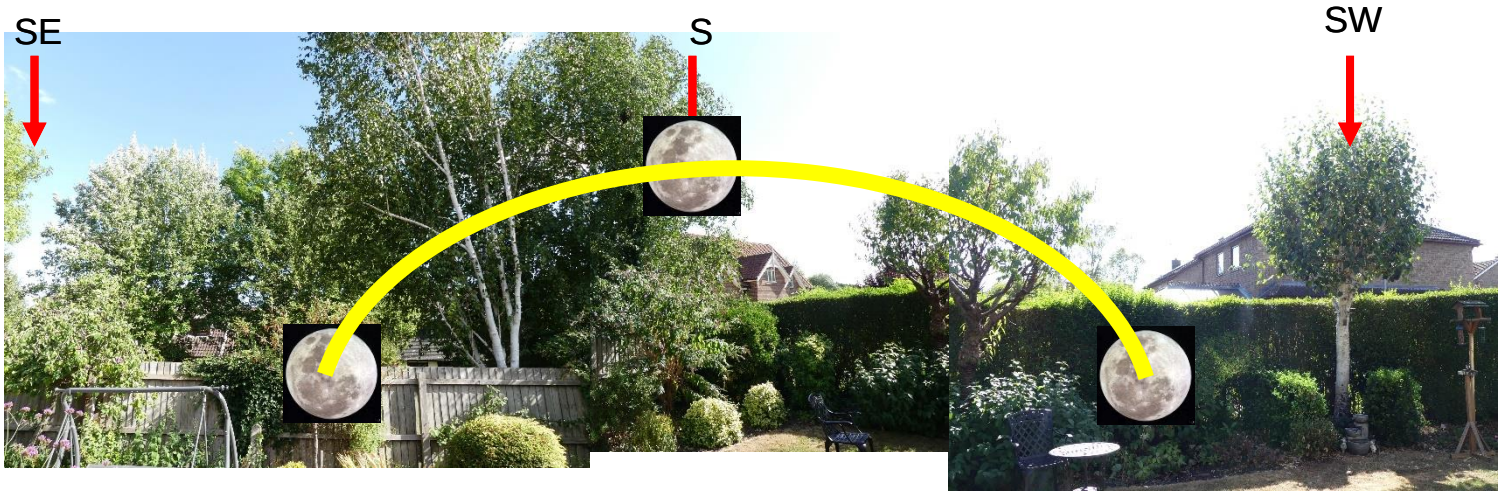
Meaning the Moon is above the horizon between 25 and 6½ hours.



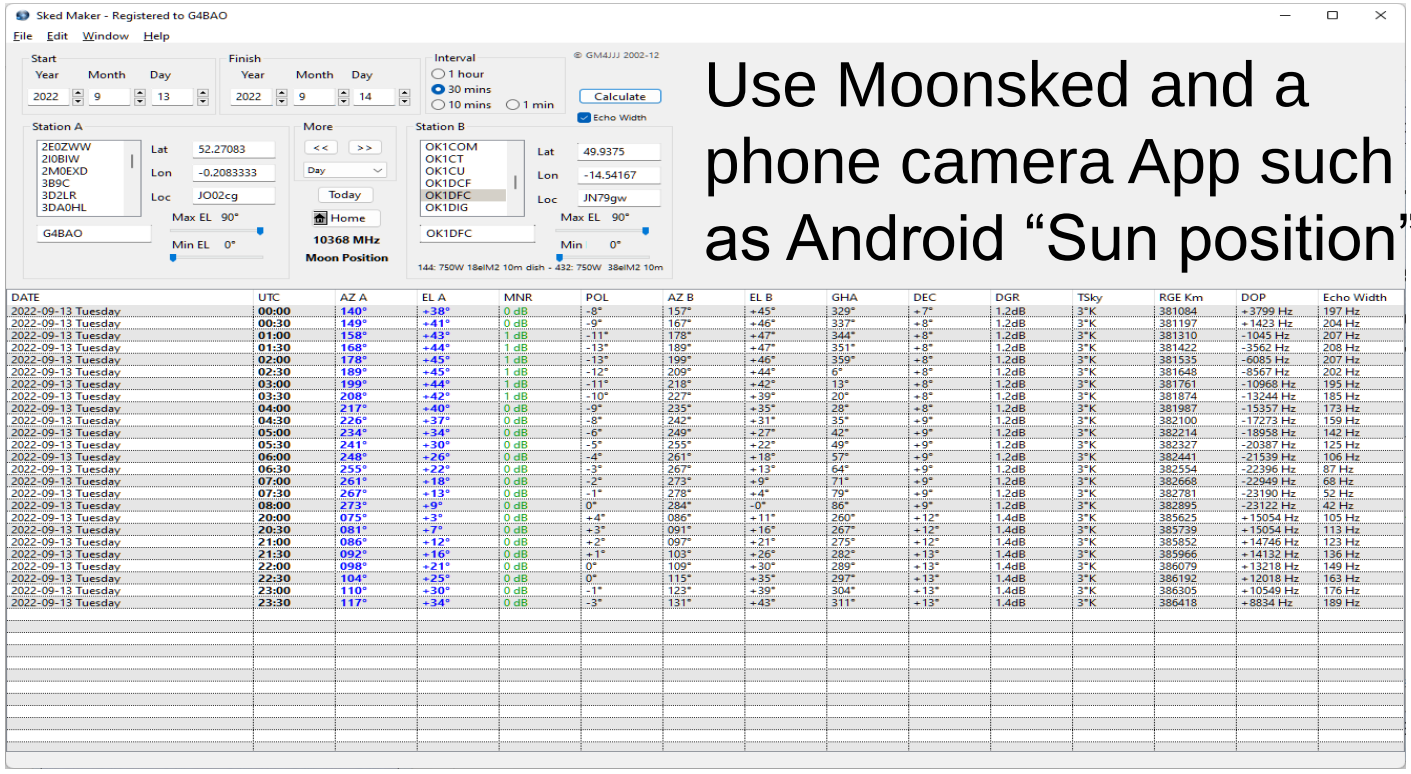
Max Declination



Min Declination



Assessing your Moon Window



Use Moonsked and a phone camera App such as Android “Sun position”

DATE	UTC	AZ A	EL A	MNR	POL	AZ B	EL B	GHA	DEC	DGR	TSky	RGE Km	DOP	Echo Width
2022-09-13 Tuesday	00:00	140°	+38°	0 dB	-8°	157°	+45°	329°	+7°	1.2dB	3°K	381084	+3799 Hz	197 Hz
2022-09-13 Tuesday	00:30	149°	+41°	0 dB	-9°	167°	+46°	337°	+8°	1.2dB	3°K	381197	+1423 Hz	204 Hz
2022-09-13 Tuesday	01:00	158°	+43°	1 dB	-11°	178°	+47°	344°	+8°	1.2dB	3°K	381310	-1045 Hz	207 Hz
2022-09-13 Tuesday	01:30	168°	+44°	1 dB	-13°	189°	+47°	351°	+8°	1.2dB	3°K	381422	-3562 Hz	208 Hz
2022-09-13 Tuesday	02:00	178°	+45°	1 dB	-13°	199°	+46°	359°	+8°	1.2dB	3°K	381535	-6085 Hz	207 Hz
2022-09-13 Tuesday	02:30	189°	+45°	1 dB	-12°	209°	+44°	6°	+8°	1.2dB	3°K	381648	-8567 Hz	202 Hz
2022-09-13 Tuesday	03:00	199°	+44°	1 dB	-11°	218°	+42°	13°	+8°	1.2dB	3°K	381761	-10968 Hz	195 Hz
2022-09-13 Tuesday	03:30	208°	+42°	1 dB	-10°	227°	+39°	20°	+8°	1.2dB	3°K	381874	-13244 Hz	185 Hz
2022-09-13 Tuesday	04:00	217°	+40°	0 dB	-9°	235°	+35°	28°	+8°	1.2dB	3°K	381987	-15357 Hz	173 Hz
2022-09-13 Tuesday	04:30	226°	+37°	0 dB	-8°	242°	+31°	35°	+9°	1.2dB	3°K	382100	-17273 Hz	159 Hz
2022-09-13 Tuesday	05:00	234°	+34°	0 dB	-6°	249°	+27°	42°	+9°	1.2dB	3°K	382214	-18958 Hz	142 Hz
2022-09-13 Tuesday	05:30	241°	+30°	0 dB	-5°	255°	+22°	49°	+9°	1.2dB	3°K	382327	-20387 Hz	125 Hz
2022-09-13 Tuesday	06:00	248°	+26°	0 dB	-4°	261°	+18°	57°	+9°	1.2dB	3°K	382441	-21539 Hz	106 Hz
2022-09-13 Tuesday	06:30	255°	+22°	0 dB	-3°	267°	+13°	64°	+9°	1.2dB	3°K	382554	-22396 Hz	87 Hz
2022-09-13 Tuesday	07:00	261°	+18°	0 dB	-2°	273°	+9°	71°	+9°	1.2dB	3°K	382668	-22949 Hz	68 Hz
2022-09-13 Tuesday	07:30	267°	+13°	0 dB	-1°	278°	+4°	79°	+9°	1.2dB	3°K	382781	-23190 Hz	52 Hz
2022-09-13 Tuesday	08:00	273°	+9°	0 dB	0°	284°	-0°	86°	+9°	1.2dB	3°K	382895	-23122 Hz	42 Hz
2022-09-13 Tuesday	20:00	075°	+3°	0 dB	+4°	086°	+11°	260°	+12°	1.4dB	3°K	385625	+15054 Hz	105 Hz
2022-09-13 Tuesday	20:30	081°	+7°	0 dB	+3°	091°	+16°	267°	+12°	1.4dB	3°K	385739	+15054 Hz	113 Hz
2022-09-13 Tuesday	21:00	086°	+12°	0 dB	+2°	097°	+21°	275°	+12°	1.4dB	3°K	385852	+14746 Hz	123 Hz
2022-09-13 Tuesday	21:30	092°	+16°	0 dB	+1°	103°	+26°	282°	+13°	1.4dB	3°K	385966	+14132 Hz	136 Hz
2022-09-13 Tuesday	22:00	098°	+21°	0 dB	0°	109°	+30°	289°	+13°	1.4dB	3°K	386079	+13218 Hz	149 Hz
2022-09-13 Tuesday	22:30	104°	+25°	0 dB	0°	115°	+35°	297°	+13°	1.4dB	3°K	386192	+12018 Hz	163 Hz
2022-09-13 Tuesday	23:00	110°	+30°	0 dB	-1°	123°	+39°	304°	+13°	1.4dB	3°K	386305	+10549 Hz	176 Hz
2022-09-13 Tuesday	23:30	117°	+34°	0 dB	-3°	131°	+43°	311°	+13°	1.4dB	3°K	386418	+8834 Hz	189 Hz

Which band? How I decided

What you can do on EME is determined by:

Budget (EME is not cheap)

Tolerance threshold of partner and neighbours, Patio size,

Moon Window

Dish size, equipment availability and cost

Which band? How I decided

My Starting point 2009

1.4m aluminium solid dish

It cost me nothing!

Anything much bigger looks “ugly” and attracts too much attention

Can be easily disguised as “garden furniture” when not in use.

Which band? How I decided

Requirements:

Must be good enough to work “big guns” on CW and for JT modes

Which band? How I decided

I chose 2.3GHz first because…

Surplus PAs and cheap LNAs (G4DDK) available

NF 0.35dB, TX power 200W with 1.4m dish

But….Low activity

Which band? The others

1.3GHz?

NF 0.3dB, TX power 200-400W, 1.9m dish minimum

Poor dish illumination so can be an alligator!!

Loads of digimode activity

Which band? The others

3.4GHz and 5.7GHz?

Do-able but PA could be expensive

Low activity

NF 0.4dB, TX power 50W

10GHz?

Expensive SSPA, or TWT needed

Loads of digimode activity

NF 0.7dB, TX power 45W 1.8m solid dish – or so “they” say?

My start on 2.3GHz “back in the day”

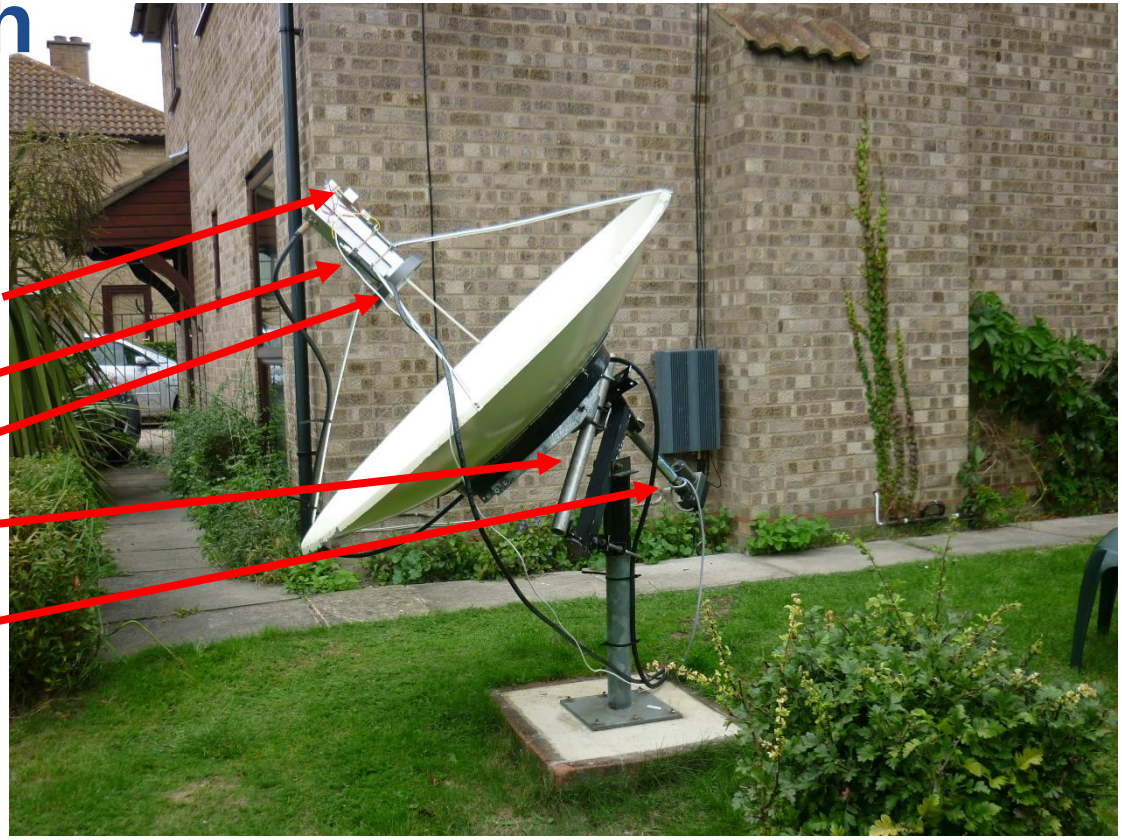
All homebrew transverter remote from shack

Watertight “Storno” base station cabinet close to dish to minimise feeder losses

Locked to 10MHz reference in shack

Low voltage 28V DC (27Amps!) fed out from house via “Sky feeder” hole

2.3GHz 1.4m dish system.
It worked (just)



2.3GHz 1.4m dish system results

Call	Locator	mode
F2TU	JN38LG	CW
OK1CA	JO7ØGM	CW
G4CCH	IO93QL	CW
ES5PC	KO38HJ	CW
G3LTF	IO91GG	CW
OK1DFC	JN79GW	JT65c
PY2BS	GG76	JT65c
OK1KIR	JO6ØPM	JT65c
LY/DL1YMK	KO06mb	JT65c

Updated 1.9m system (better)

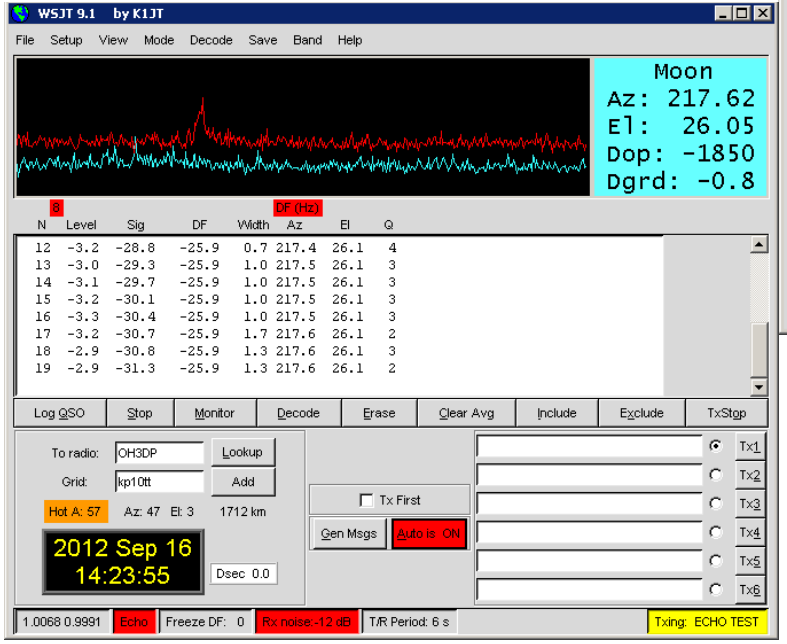
Spid RAS rotator

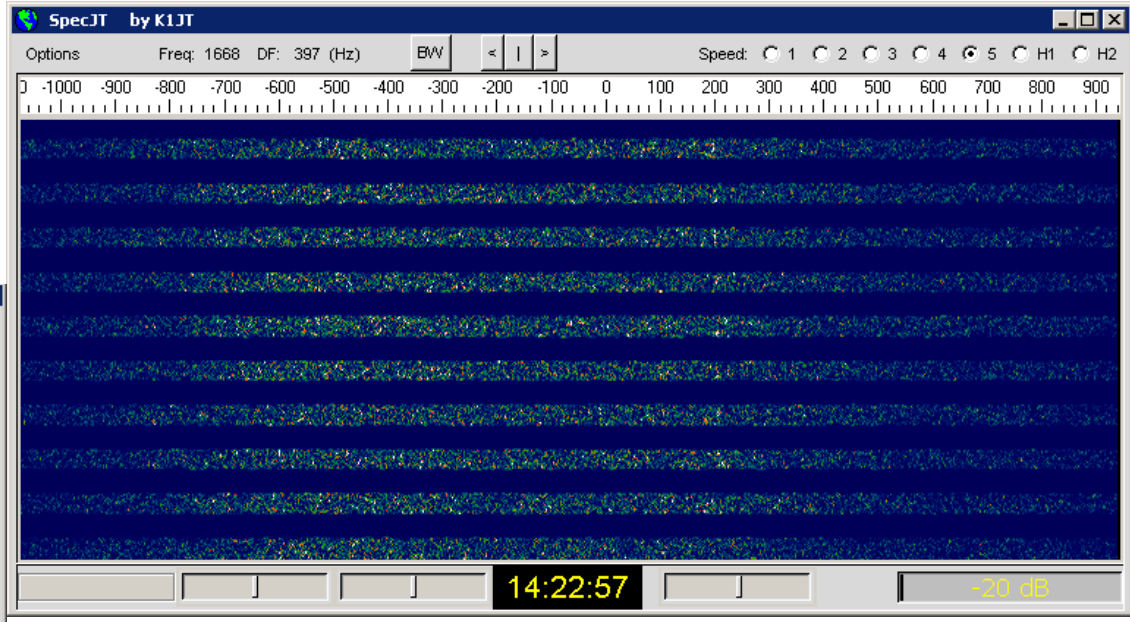
Counterbalance

Optimised choke ring

Transverter+PSU moved closer to dish

Updated 1.9m system (better)



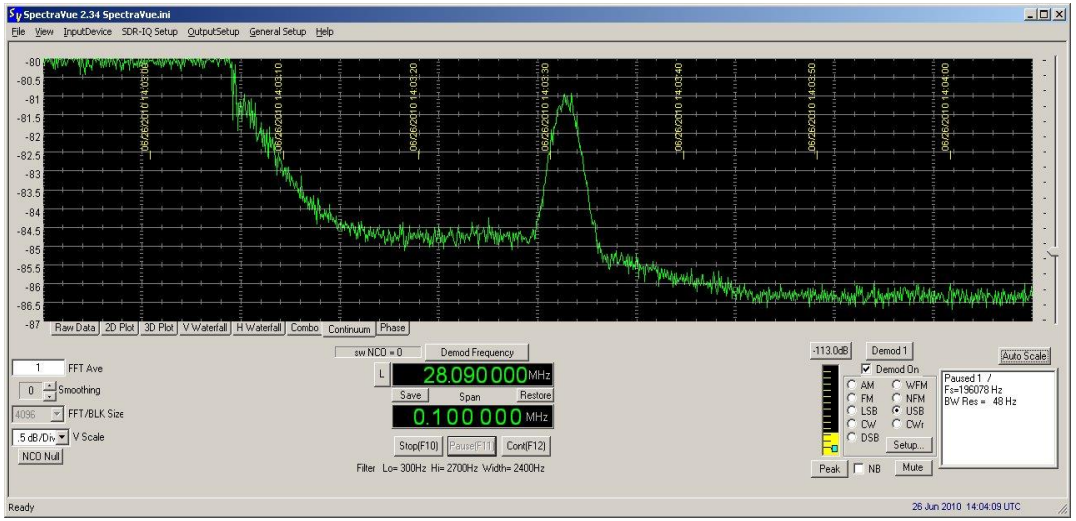


I could “see” my 2.3GHz echoes on WSJT Echo mode…… Woo - Hoo!!!!!

It’s all about the setting up

First tune up the feed for best TX/RX VSWR and TX/RX isolation.

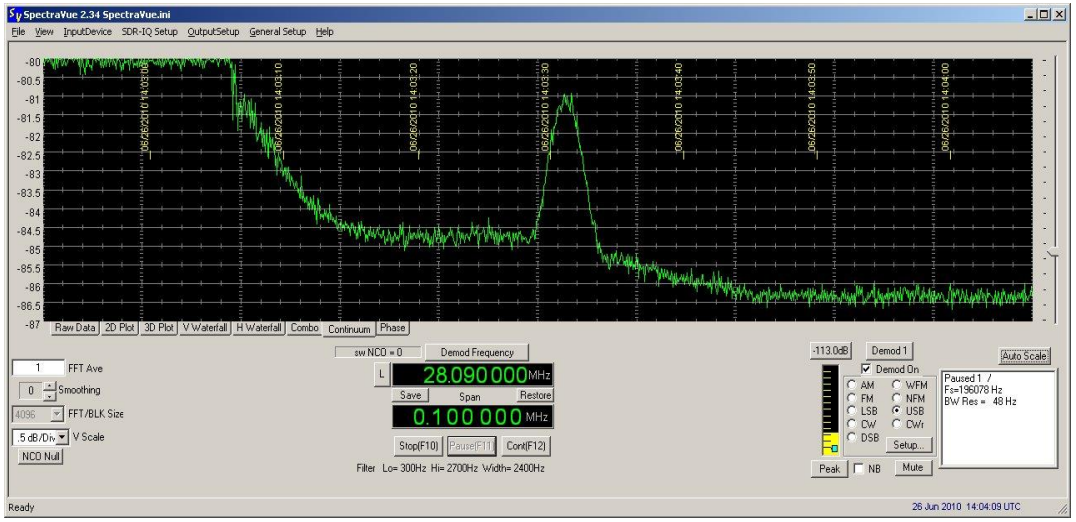
Optimise the dish and feed by measuring ratio of sun to “cold sky” noise



Find the position of the feed that gives best sun/cold sky and adjusting the choke ring for same

It’s all about the setting up

Note that this is not the same as highest sun noise!
Adjust LNA (in situ) for best sun/cold sky



Check for correct dish illumination on TX (overspill)
Recheck sun/cold sky ratio

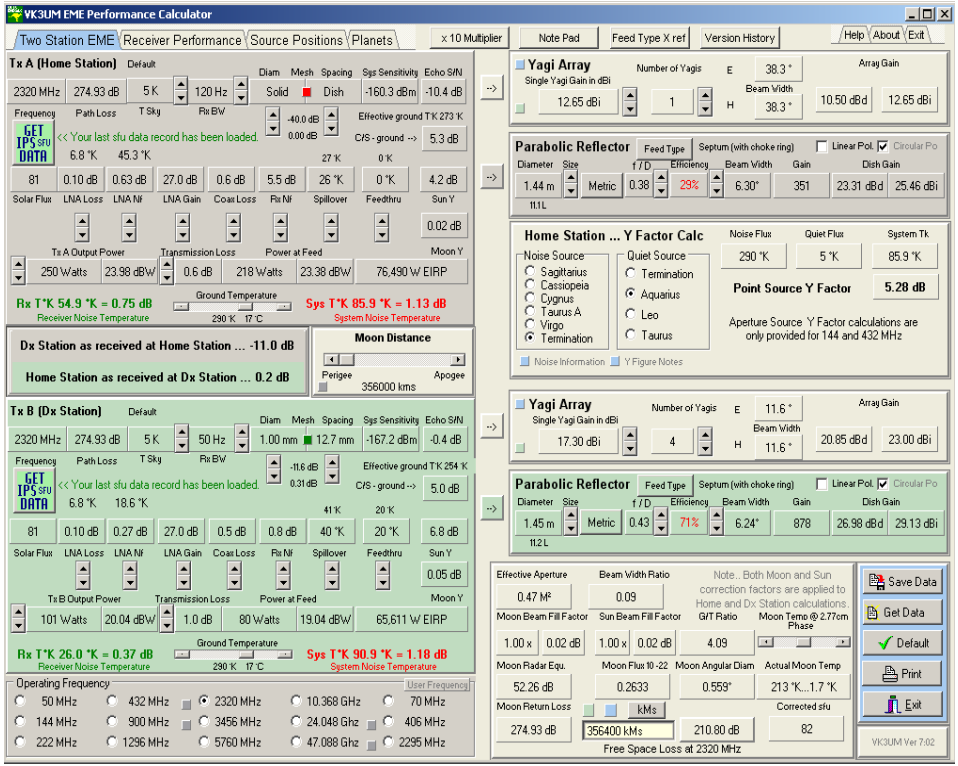
This is an “iterative” process

VK3UM EMECalc

Automates system calculations.

“What if” analysis of

- Band
- Dish size and shape
- Feed Type
- Power and RX performance
- Moon distance
- Sun noise



What next?

By end of 2015 I had 26 initials on 13, but frustrated by low activity

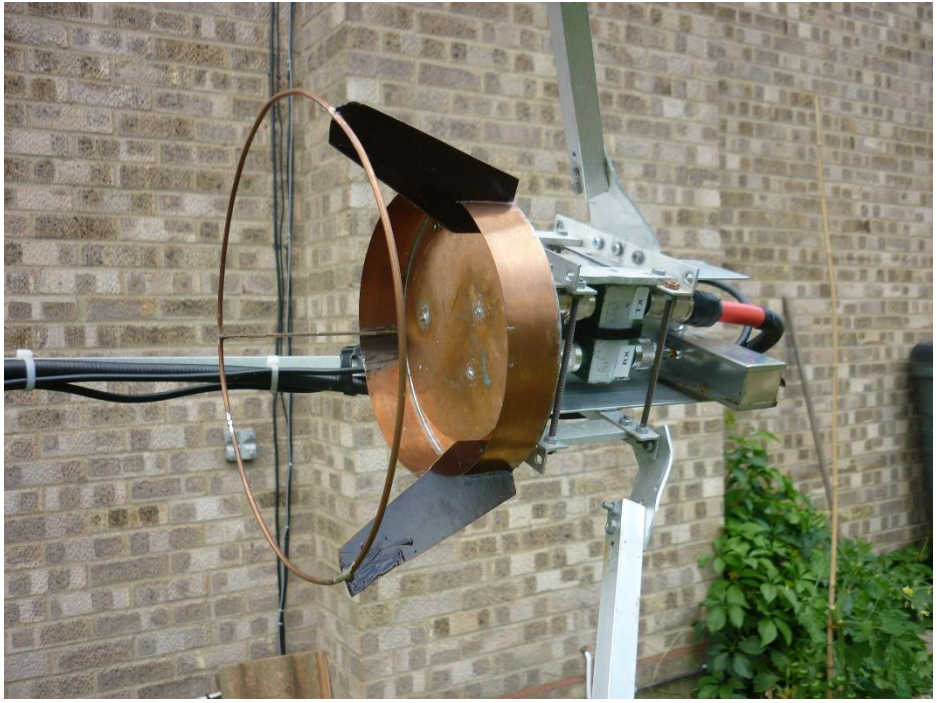
1.3GHz is where the activity is, but my dish is getting “really small” at only 8λ

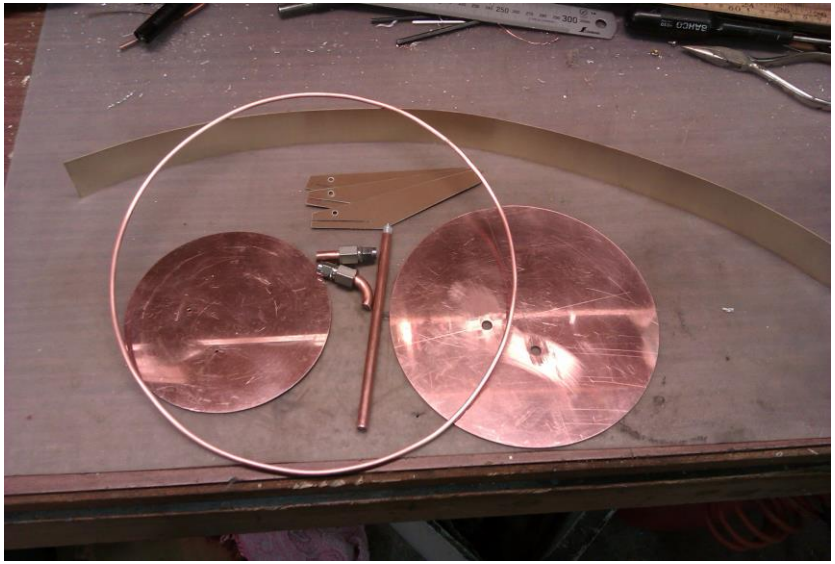
Dish blockage can be an issue with big waveguide feeds

Answer? - SM6FHZ Patch feed

- Custom designed for 1.8m prime focus dish

SM6FHZ patch feed





Photos G4BAO & SM6PGP

1.3GHz results 2015-2020

121 “initials” including 33 on CW

Worked all continents completed on 1.3GHz in 2017

Faraday the shack cat

What next?

I had an old 10GHz transverter.

From G4HUP's estate, I bought a 12W 10GHz PA, plus a 3.4GHz transverter.

I'd earlier bought a 5.7GHz transverter from G4BAH's estate.

Already had some Ferranti 18W 7GHz PAs

Real microwave EME!

Going higher - System Issues

Dish mesh was 6mm so pushing it at 5.7GHz (0.1 λ criterion)

3 dB beamwidth at 2.3GHz = 5 degrees
At 5.7GHz = 2 degrees
At 10GHz = 1 degree

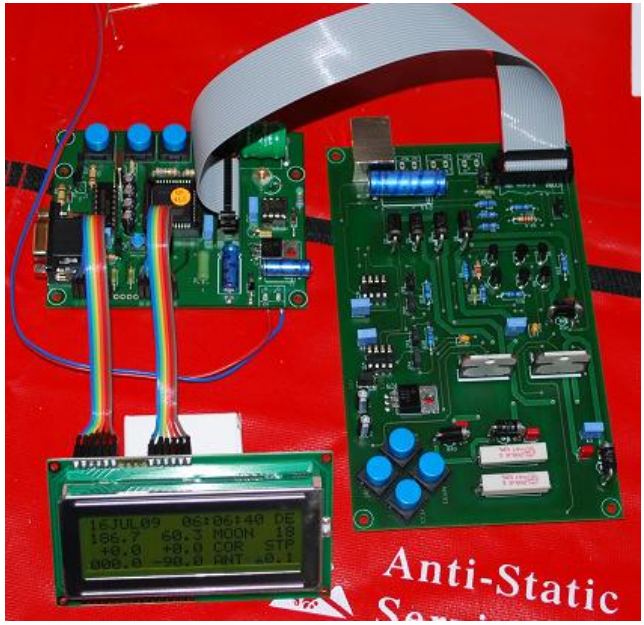
Spid's basic tracking readout to 1 degree just not good enough to find and keep the moon above 2.3GHz

Need to upgrade mesh and tracking

Going higher - System Issues

Dish mesh was upgraded to 2.7mm
In theory, good to 10GHz?

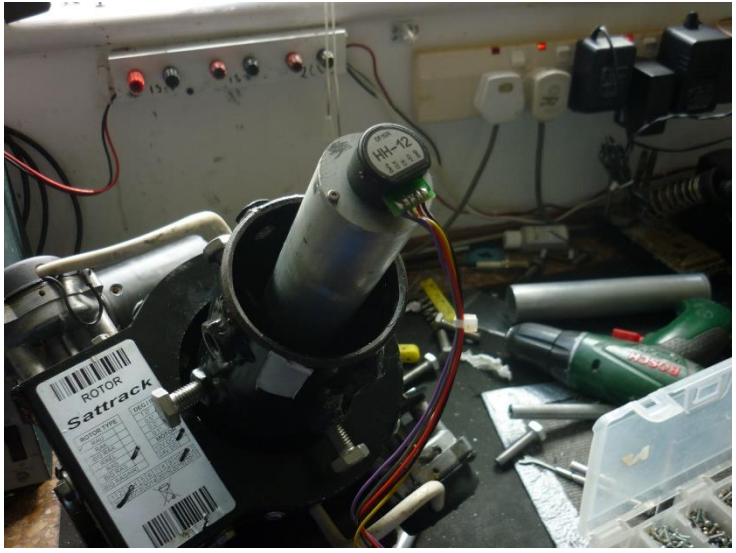
OE9JFL/DRIACS controller
Uses absolute 12 bit 0.1-degree az/el position sensors, not pots or pulse counters
Standalone PWM speed controller
No PC needed to track
Need to fit new sensors to the Spid



Design by Hannes - OE5JFL, implementation by Alex - HB9DRI

Fitting absolute sensors to a SPID/RAS

Based on Work initially done by Andreas DJ5AR et al

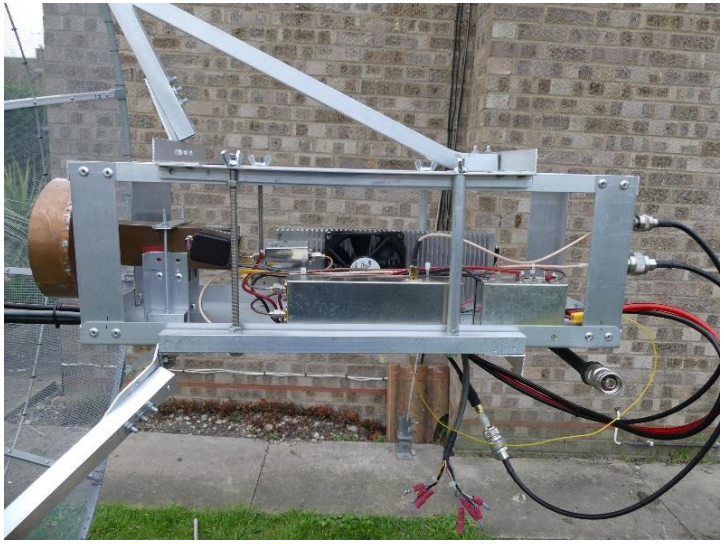


Elevation relatively easy- fit the sensor on an “outrigger”.

See my article in Dubus vol 49 2/2020 for details

Going multiband – Electronics

Common mechanical and electrical interface



Quick Change – 4 wing nuts
5 band swappable Transverter and PAs in feed cage 1.3 – 10GHz

Results on 1.9m Mesh dish to 2017

16 initials on 3.4GHz – 8 on CW
18 initials on 5.7GHz – 5 on CW

On 10GHz
QSOs with “big guns” HB9Q and OZ1LPR JT4F Running just 12 Watts

Poor QSO results and Moon noise on 10GHz.

Beginning to look as if neither the tracking nor the mesh dish was “up to the job” on 10GHz

Downsizing!

Decided to concentrate on 10GHz and try a 1.1m solid offset dish (Because I had one!)

Whoah! – outperformed the old 1.9m prime focus on Sun and Moon noise!

No dish blockage
Better dish illumination

Latest 10GHz system

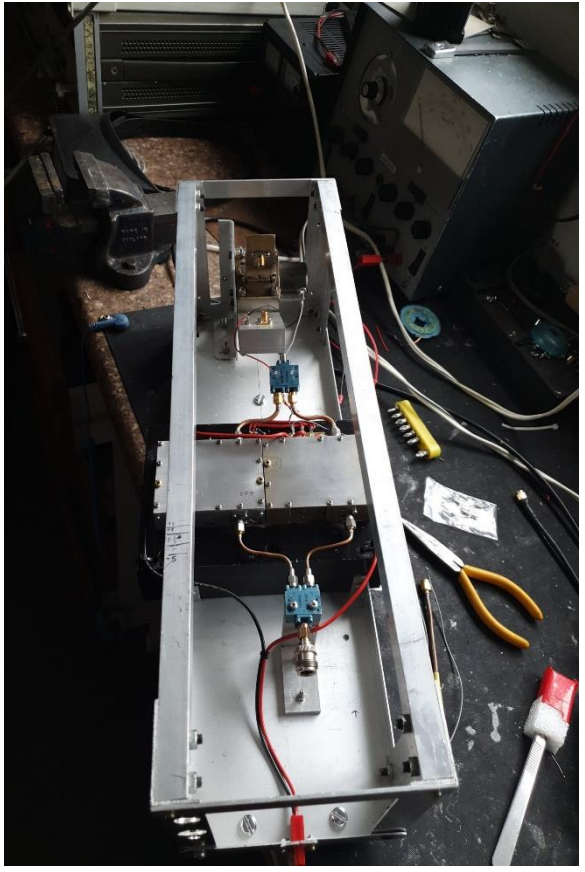
Built myself a 2x GAsFET 25W PA using cloned DB6NT boards

Upgraded to a 1.2m offset dish.

Slightly better!

Now 33 JT initials

No CW QSO yet!

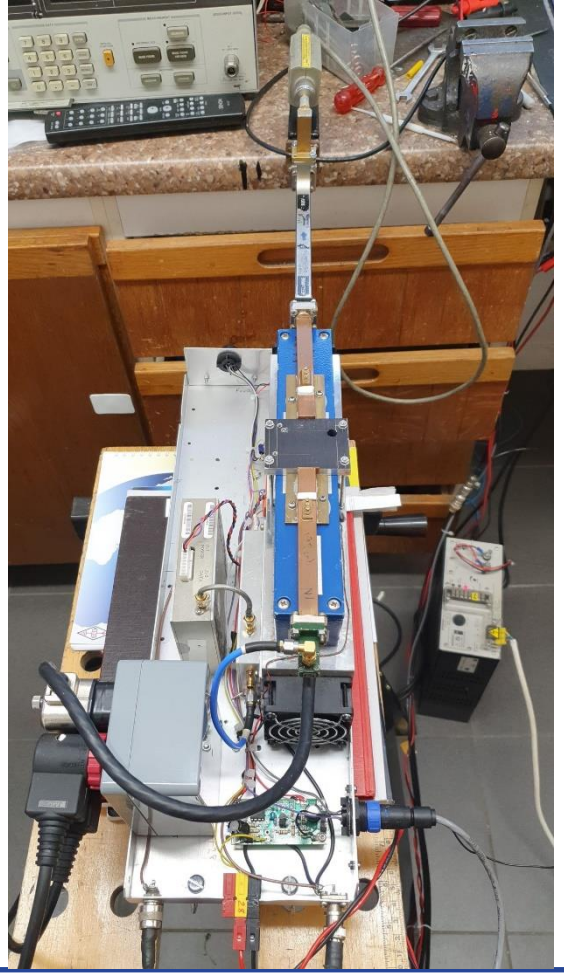


Bucket List anyone?
24GHz EME

Working on a 24GHz system.

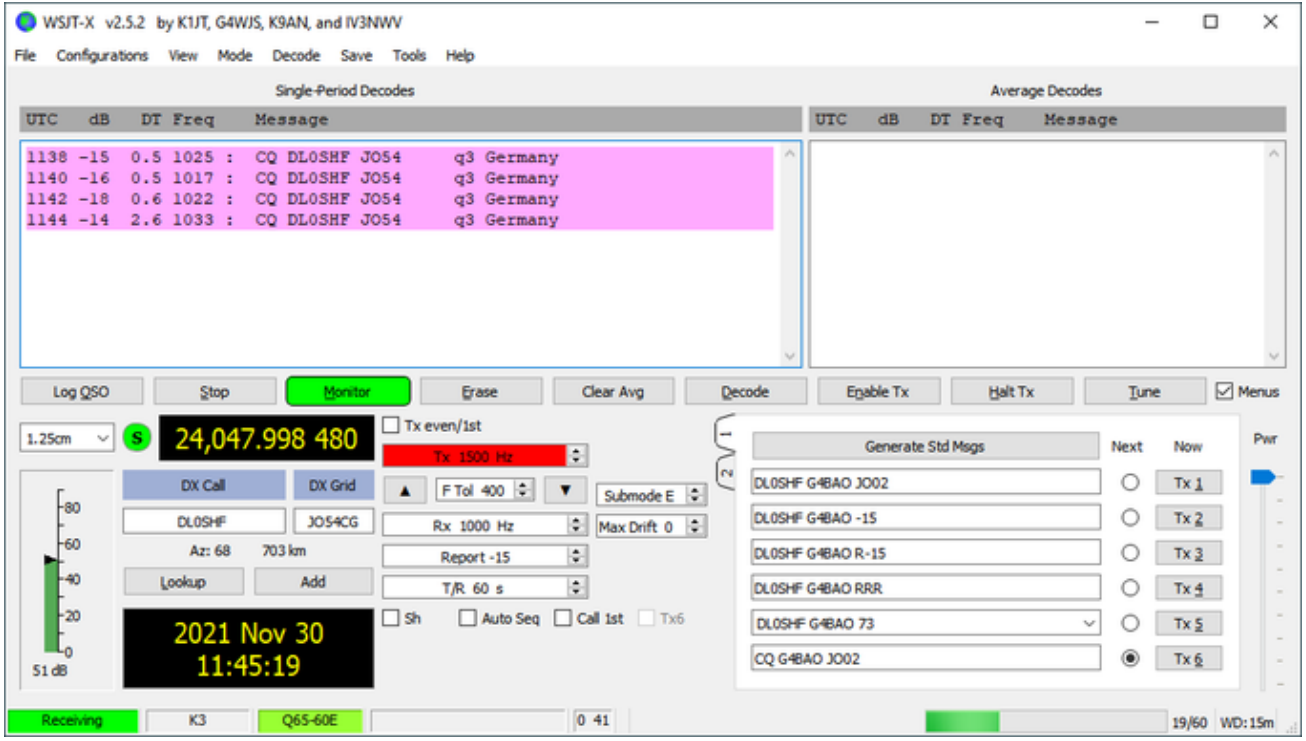
With a travelling wave tube to do around 25 Watts output

Scary high voltages involved



Bucket List anyone?
24GHz EME

Have received the DL0SHF 24GHz Moon beacon in QRO mode



Acknowledgements

Thanks to:

Bernie G4HJW for giving me the 1.4m dish in the first place

All those EME “experts” who said “Nah, you can’t do EME with a 1.2m dish” and still sneer at “doodle modes”

But especially to those who said “Give it a go,” particularly

G3LTF, G4DDK, the HB9Q team

Find out more…

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