“Multum in Parvo”

(Good things come in small packages)

5-band GHz EME from a European suburban garden

John Worsnop G4BAO

It’s actually quite small

Small dish EME

- “Backyard Moonbounce” has been “done to death” at Conferences.
- So what am I doing here?
- My backyard is not the size of Vermont.
- Microwave EME is a challenge
- Microwave EME with a 15λ dish is a bigger challenge
- I’m in this hobby to learn things
- I’ve learned SO much since 2010

My First attempt 2010

- 1.4m spun aluminium solid dish
- 2320MHz

My First attempt 2010

- 1.4m spun aluminium solid dish
  - Small enough to pick up and carry.
  - It cost me nothing!
  - 2320MHz
  - Polar mount TVRO positioner
  - Square Septum feed
  - Non – optimised “pie dish” choke ring

My First attempt 2010

- 1.4m spun aluminium solid dish
  - It worked but the dish is noisy on RX due to overspill
  - So, I'm an alligator

- But, I Worked

Call	mode	system
F2TU	CW	8m dish
OK1CA	CW	4.2m dish
G4CCH	CW	5.4m dish
ES5PC	JT65c	4.5m dish
G3LTF	CW	6m dish
OK1DFC	JT65c	10m dish
PY2BS	JT65c	2.7m dish
OK1KIR	CW	4.5m dish

More power to the Monster Igor!

- I Visited my local hardware store to ***make sure*** I could work LY/DL1YMK

- Chicken wire “screen”
  - To reduce dish overspill
  - It worked!
  - Worked Michael on JT65c!
- Very low XYL support coefficient ☺

“Back to the drawing board”

- I already have
  - A top-notch preamp
    - (G4DDK VLNA13 sub 0.4dBNF)
  - Plenty of power (200 Watts)
- Conclusion
- to (mis) quote Chief Brodie in “Jaws”
- “I think you’re gonna need a bigger dish”

System Issues and improvements planned

- I got better reports than I sent.
  - Bigger dish - RF Ham design 1.9m mesh was the biggest I could get away with in my garden
  - Quieter feed (less overspill) - Optimise the choke ring
- Finding and keeping on the moon
  - Tracking was by “button press”
    - Easy to over compensate/forget/lose track of time & GHA.
    - Need a better rotator
- Secondary 128MHz IF RX feed to listen on 2304MHz

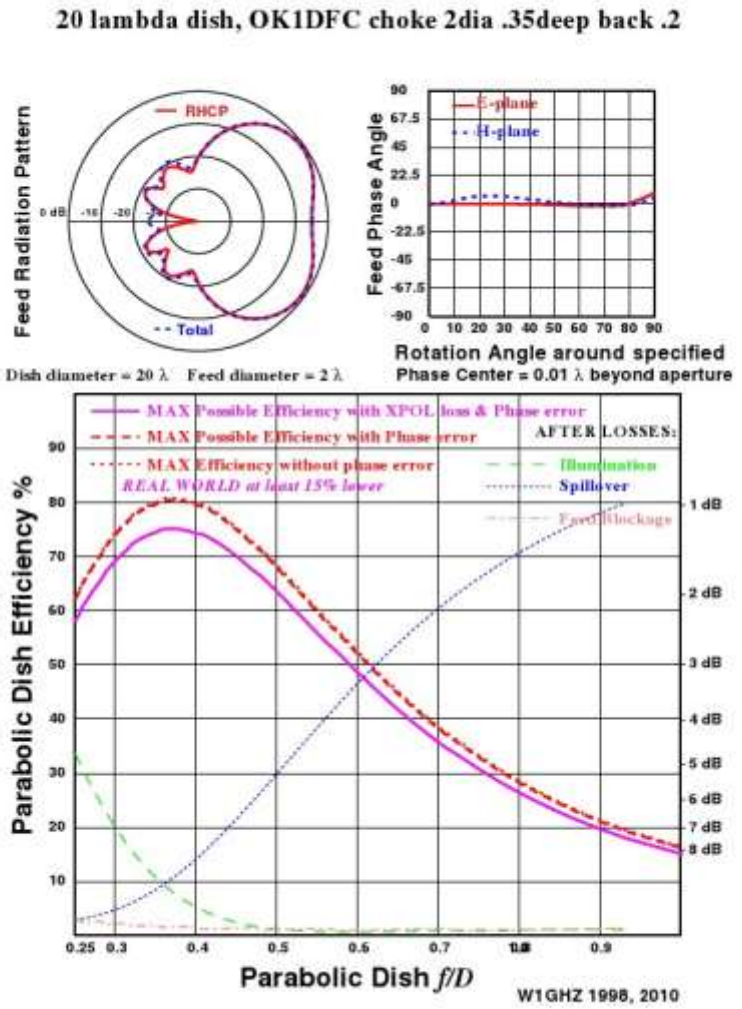
Setting up – lots of variables!

- Tune up the feed for best TX/RX VSWR and TX/RX isolation. ✓
- Optimise the preamp ✓
- Optimise the dish and feed
  - Measure ratio of sun to "cold sky" noise ✓
  - Find the position of the feed that gives best sun/cold sky ✓
  - Adjust choke ring position ✓
  - Adjust the choke ring dimensions

Optimising the choke ring

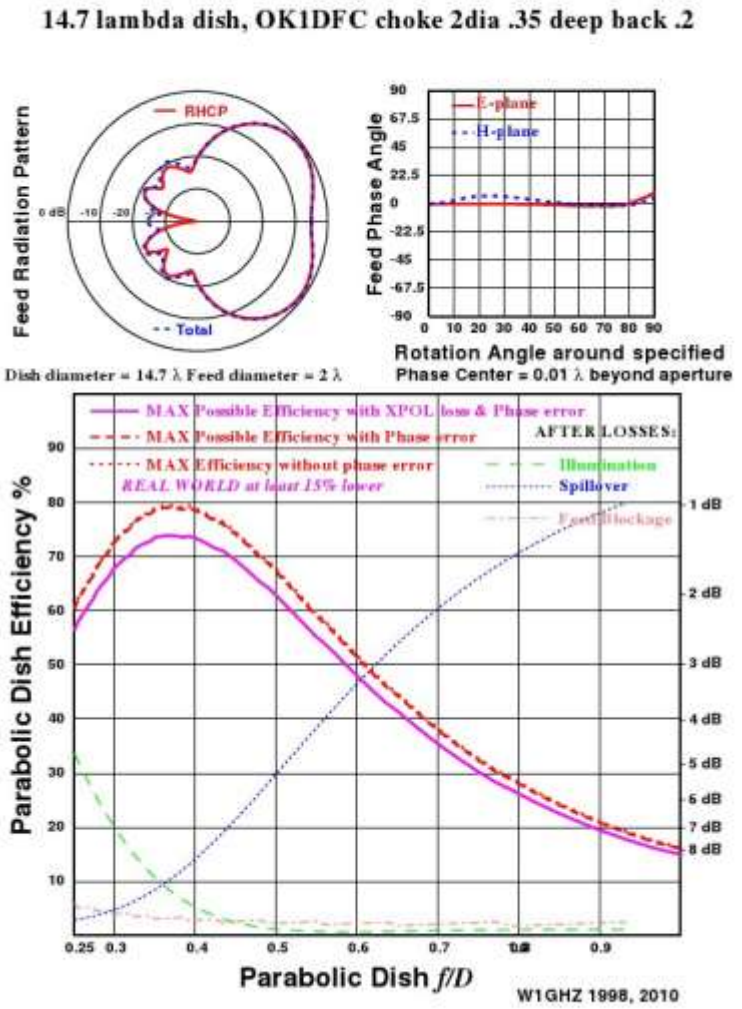
- Referred to Paul Wade, W1GHZ's excellent 2007 paper on Septum feeds
- "Enhancing the OK1DFC Square Septum Feed With a Choke Ring"
- http://www.w1ghz.org/antbook/conf/septum_feed_with_ring.pdf

- Ah…… but my dish is less than 20λ!
- Solution, - Email Paul



Optimising the choke ring

- Within 24hrs Paul had re- run the simulation and sent me this.
- A simulation for my exact dish size
- Don’t you just LOVE our hobby and it’s participants?
- Made up a 2 x 0.35λ choke ring, tried it, adjusted with Sun to cold sky
- I couldn’t find a better position that Paul’s theoretical prediction!
- Perfect!



Finding and keeping the Moon

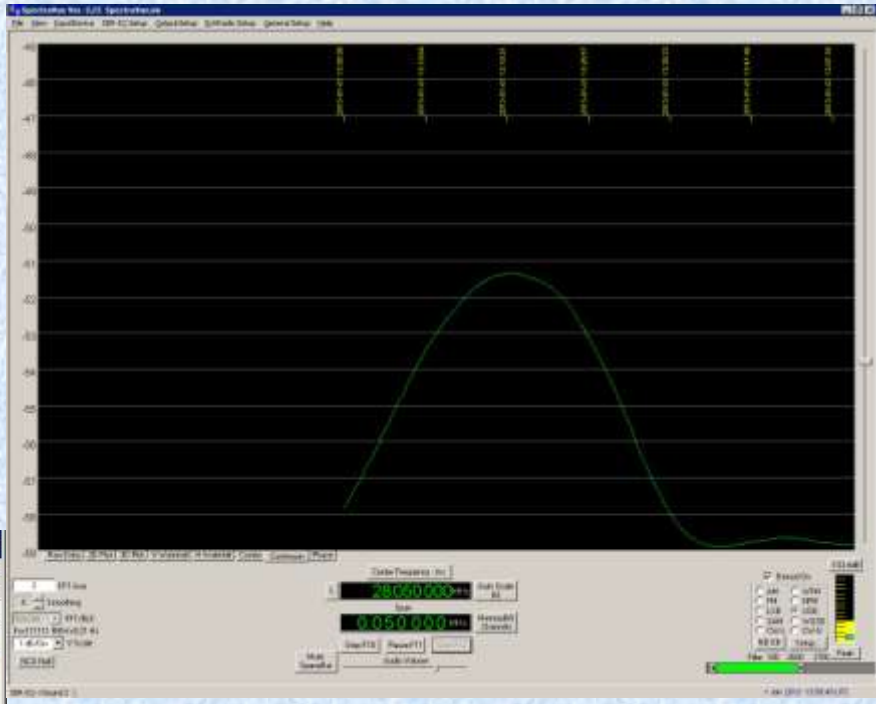
- Options
- "Clockwork" Polar mount running at constant rate
  - Daily fixed declination change
  - Cheap, simple…. BUT
- With a system not good enough to see moon noise
  - I have no easy starting place (absolute reference)

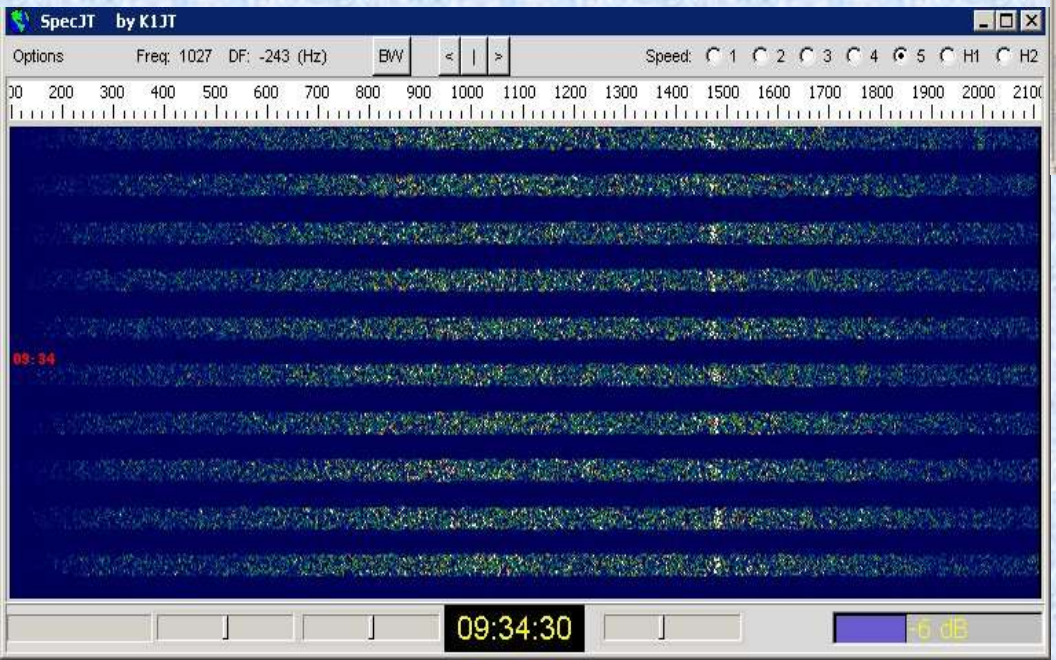
Finding and keeping the Moon

- Options
- Az-El mount
  - Absolute tracking on a small (5 degree beamwidth) dish
  - More expensive
  - Serious counterbalance needed
  - More computerised tracking support available
  - Tried “Standard” G500/G650 with Potentiometer feeback. They just won’t hack it (non-linearity and slop)
  - SpiD RAS - 1 degree per pulse encoder + “Moonsked” with 30 second update.
  - Finds the Moon and tracks it to within 0.5dB or so

Some results on 13cm

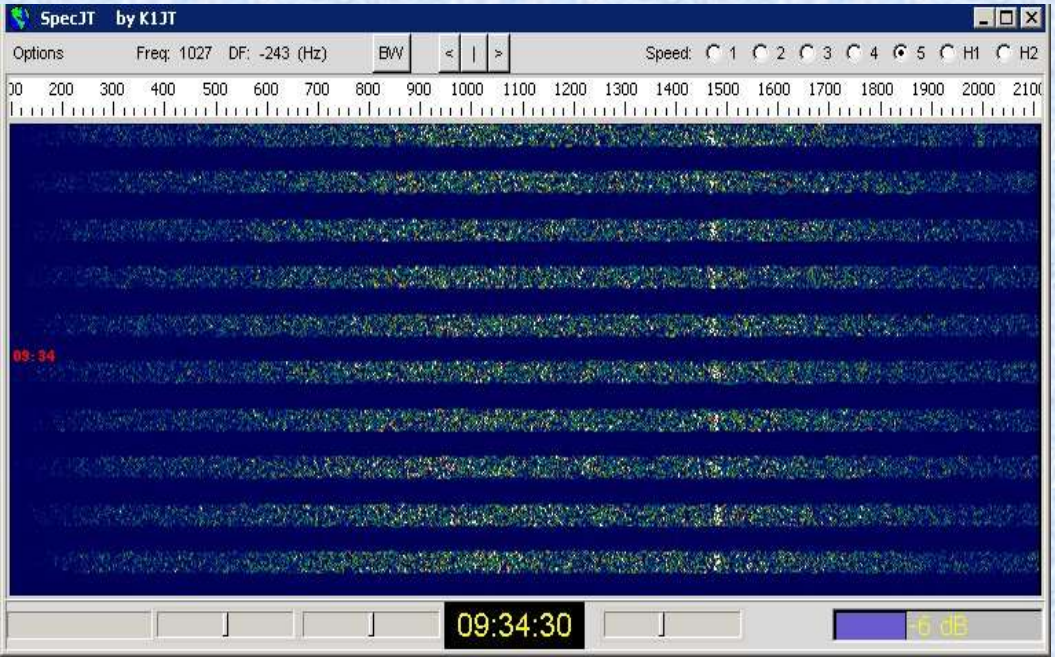
- Now typically 8dB sun to cold sky noise (SFI 110)
-
- -20 to -23 dB echoes in 2.5kHz (WSJT echo mode)





Some Results on 13cm

- -21JT Echoes when moon close to perigee
- Easy to work 2.4m dish stations on JT65c
- 3.5m upwards to make CW QSOs
  - PA3DZL, OH2DG
- Probably a dB or so short of “easy” QSOs
  - (But if you want easy QSOs, go on 40 metres)



“Onwards and downwards”

(to 1296)

- With a 1.9m dish! –”You must be mad, John!”

- Discovered the SM6FHZ patch feed
- 160 then 250 Watts via standard 1-2GHz 100W N type hybrid
- 0.28dB G4DDK VLNA23

- To date, 105 all mode initials
- 30 CW initials
- WAC
-
- REALLY hard work, though `

“Onwards and upwards 2017”

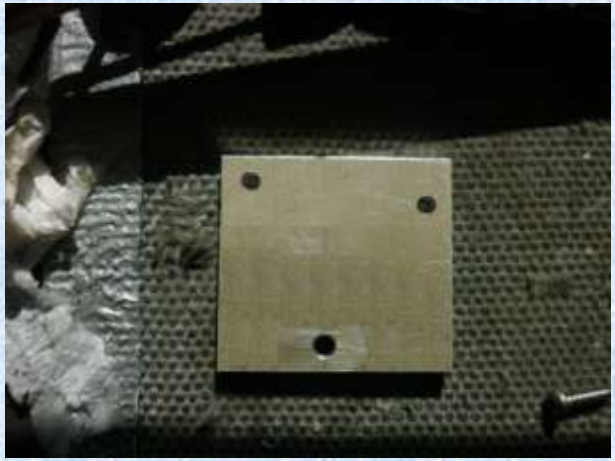
(5760MHz, Band #3)

- With a 6mm mesh dish! –”You must be mad, John!”
  - Correct - not very good
- Decided to re-mesh the dish with 2.4mm galvanised
- 25W to RA3EQ feed
- 0.9dB “Franco Board” LNA

- To date, 13 all mode initials
- 2 CW initials – G3LTF &DF3RU
- Not really performing as well as expected
  - Suspect the dish accuracy
  - Needs better pointing accuracy
- Upgraded the SPID in 2017 with 0.1 dB absolute sensors.

Adding rotary sensors to the SPID RAS

Azimuth Ideas based on work by DJ5AR and others



Plate

Shaft & plate in position

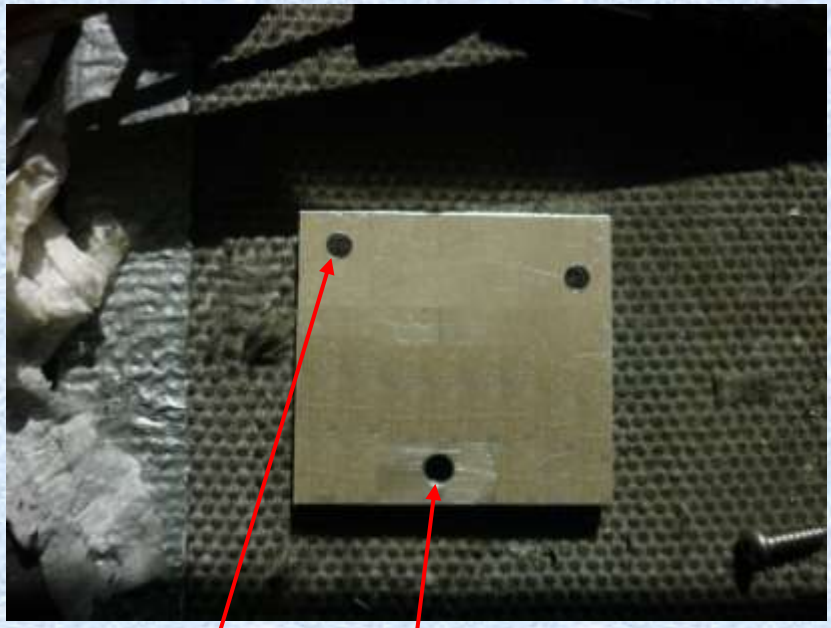
Centre shaft

Tube and sensor mount

Adding rotary sensors to the SPID RAS

Azimuth - Ideas based on work by DJ5AR and others

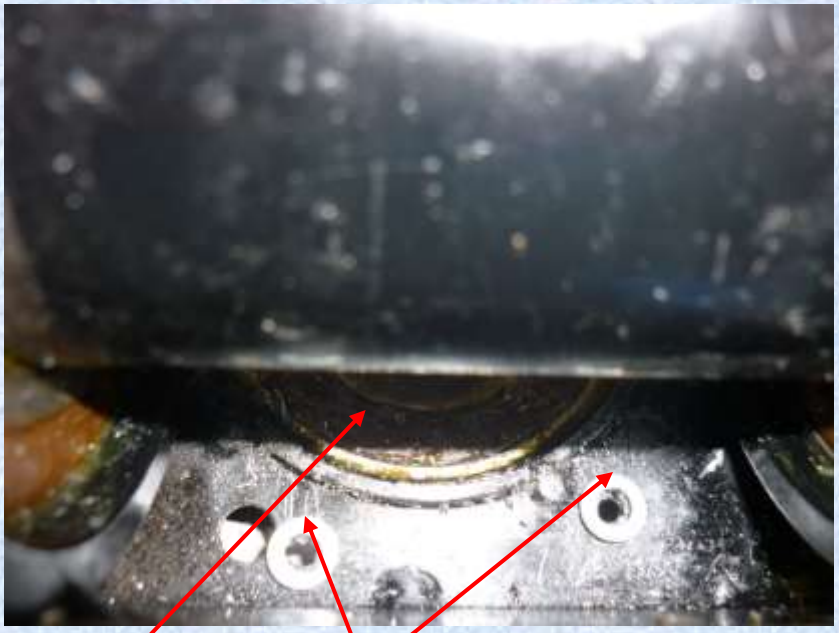
The “L bar” shaft mount



Plate

Mounting holes

Threaded Shaft hole

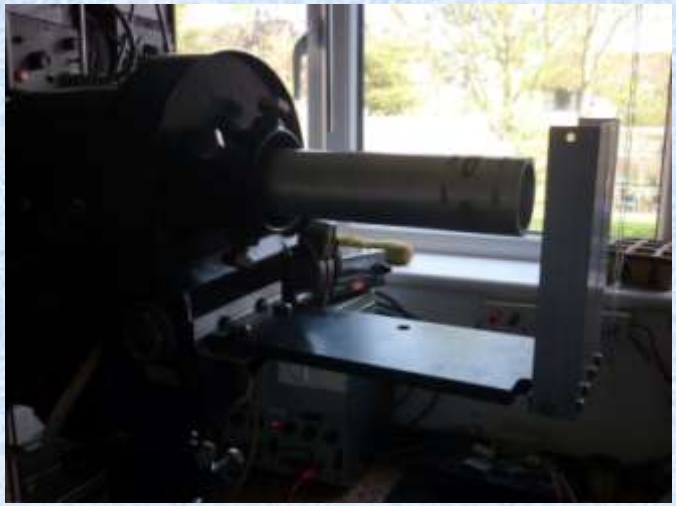


Holes inside SPID for self- tap plate mounting

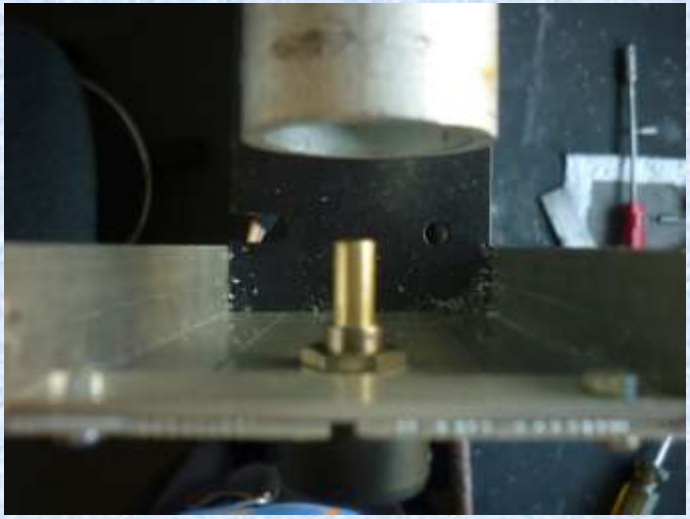
Plate slides under the elevation shaft above the bearing

Adding rotary sensors to the SPID RAS

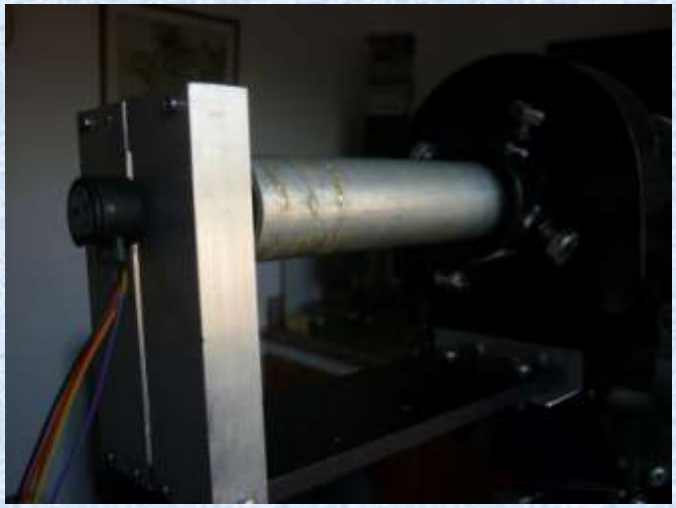
Elevation



Sensor in position



Outrigger



Overall view

“Onwards and upwards 2017”

(10368MHz, Band #4)

- With a mesh dish! –”You must be mad, John!”
  - Correct again - not very too good
- 12 Watts to Linear SM6FHZ Kumar horn feed
- 0.6dB F1OPA LNA

- To date, 2 all mode initials – HB9Q, OZ1LPR
- It’s a start!
- Not really performing as well as expected
  - Suspect the dish accuracy

“Back down again 2018”

(3400MHz, Band #5)

- SM6FHZ Septum feed built by PA7JB
- 40Watt Toshiba Amp
- 0.4dB “G4DDK VLNA9

- To date, looking good after 1 weekend.
- 4 all mode initials – DF3RU, OK1KIR, PA0BAT, PA3DZL
- Need more power, second Toshiba amp planned

Band changing and dish feeds

- 23, 13 and 9cm
  - Just preamp and feed at dish focus
- 6 and 3cm
  - Transverters and PAs also at focus

Band changing and dish feeds

- Common feed cage
- Feed slides in and out

So there you have it. 5 band EME

- I’m not going to win contests
- I’m not going to work all the DXpeditions
- I’m only going to do SSB with big guns!
  - Worked F2TU, G3LTF, OK1KIR, on 13cm, PI9CAM on 23cm and HB9Q on 13cm AND 23cm!
- But boy, I’m learning AND having fun!

Photo by Michael Nunes on Unsplash

Acknowledgements

- My XYL Vicki for tolerating a radio nerd for so long.
- Sam Jewell, G4DDK for getting me interested in small dish EME.
- Peter Blair, G3LTF for endless advice, parts and inspiration.
- John Lambo PA7JB for his peerless Mechanical Engineering skills.
- VK3UM, HB9Q, K1JT, SM6FHZ and others, too numerous to mention.