EME: A beginners Journey



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Contents:

- Inspiration
- First approach: 23 cm
- The antenna; receiving (sun)noise
- RX results
- The first QSO's
- Second approach: 3 cm
- First receiving results
- TX power
- Actual station
- Future options, Conclusion

Inspiration

- Seventies: Jan PA0SSB, Marcel PA0MGA(†)
  - Huge antenna (6m dish)
  - A ring of 2C39 tubes
  - Space (a big garden....)
  - CW
  - Microwaves were a challenge (still is....)
- So I kept dreaming (…. and reading....)
- Building and designing radio equipment
  - from 80m up to 76 GHz.

Inspiration (2)

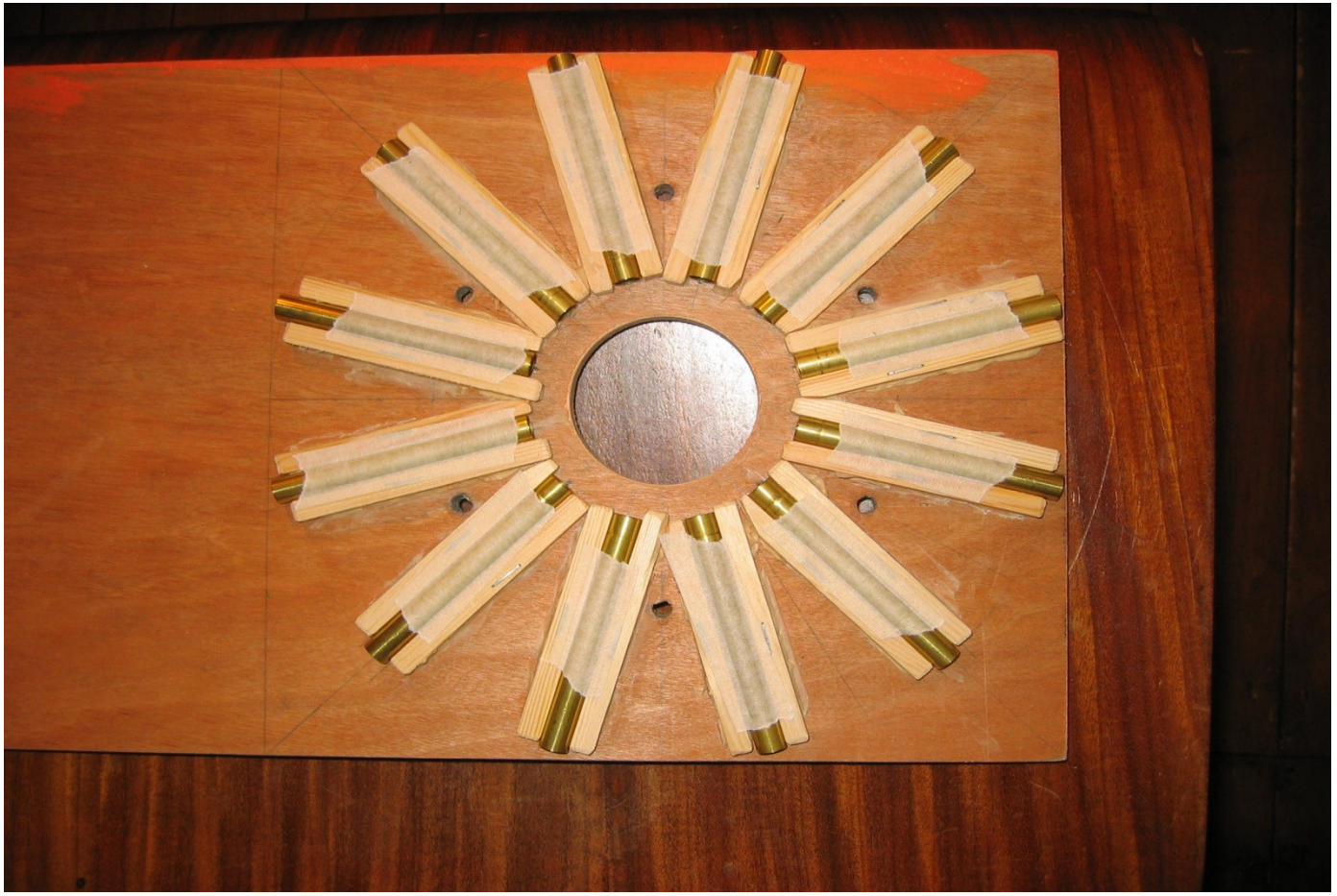
- Early this decade:
  - Stressed dish reflector (K2UYH)
  - High performance LNA's (G4DDK, WA2ODO)
  - Solid state RF Power Amplifiers
  - Software (WSJT)
  - Efficient feeds (W1GHZ, OK1DFC)
  - Big gun PI9CAM active
- Could I realise my dream?
  - VK3UM: I started thinking: YES!

First Approach: 23 cm

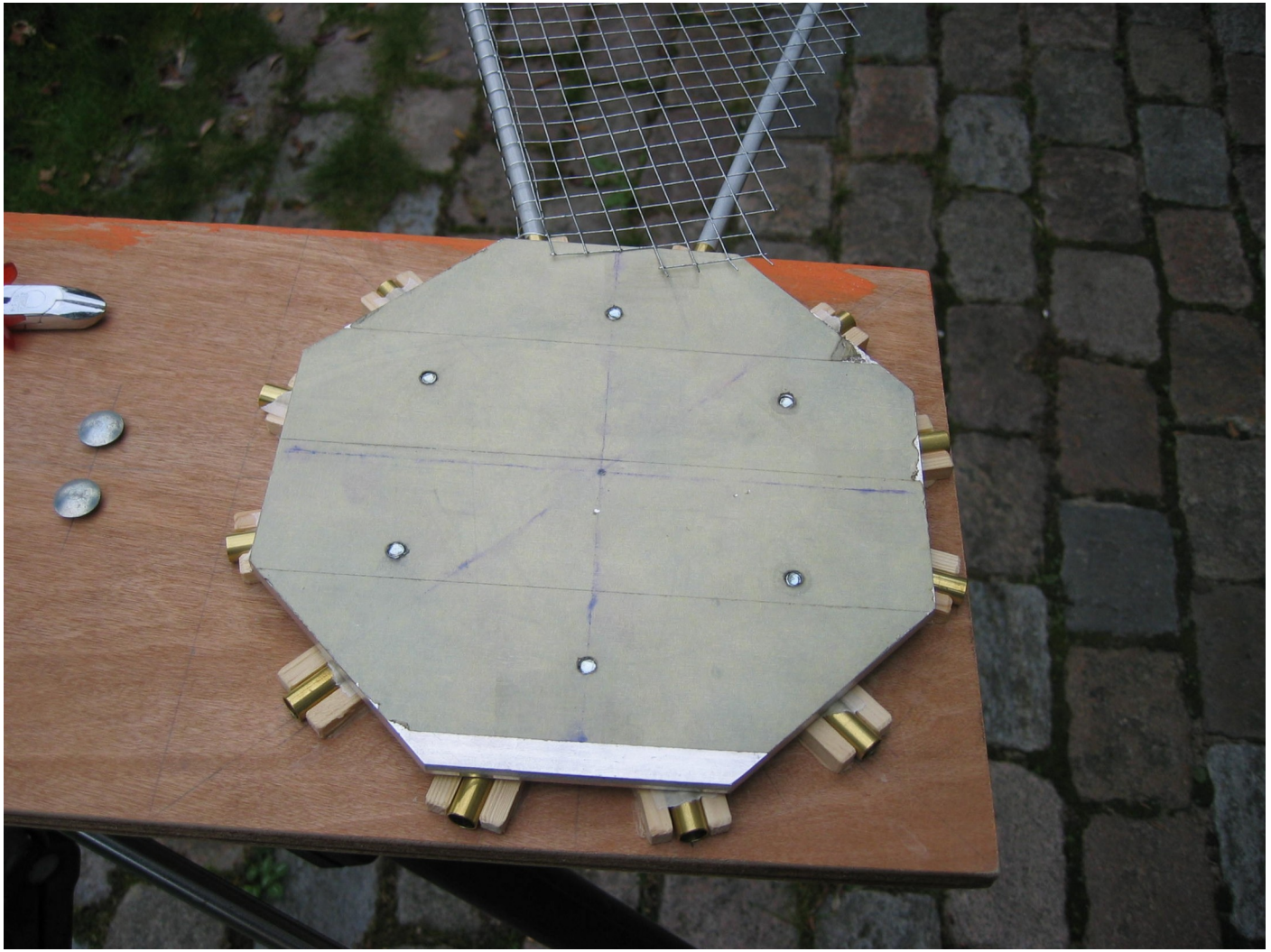
- Parabolic dish could be << 6 m diam.
  - Dish reflector preferred over Yagi's (circular pol)
- Self supporting stressed dish, centre fed
- Fibreglass rods: OD=8 mm, ID=6 mm
  - Standard length: 120 cm (kite industry)
  - Test stress one rod: accurate enough....
- 18 rods: 12 spokes, 6 for the rim, cut in half
- Rim is to force the parabolic shape
- Solid camera tripod

Dish Construction

- Central “star”: sandwich of 8mm brass tubes, wood and aluminium disc



The central “Sandwich”



Step by step





Soldering of T-joints

- Silver soldered (8mm brass tubes and sheet)





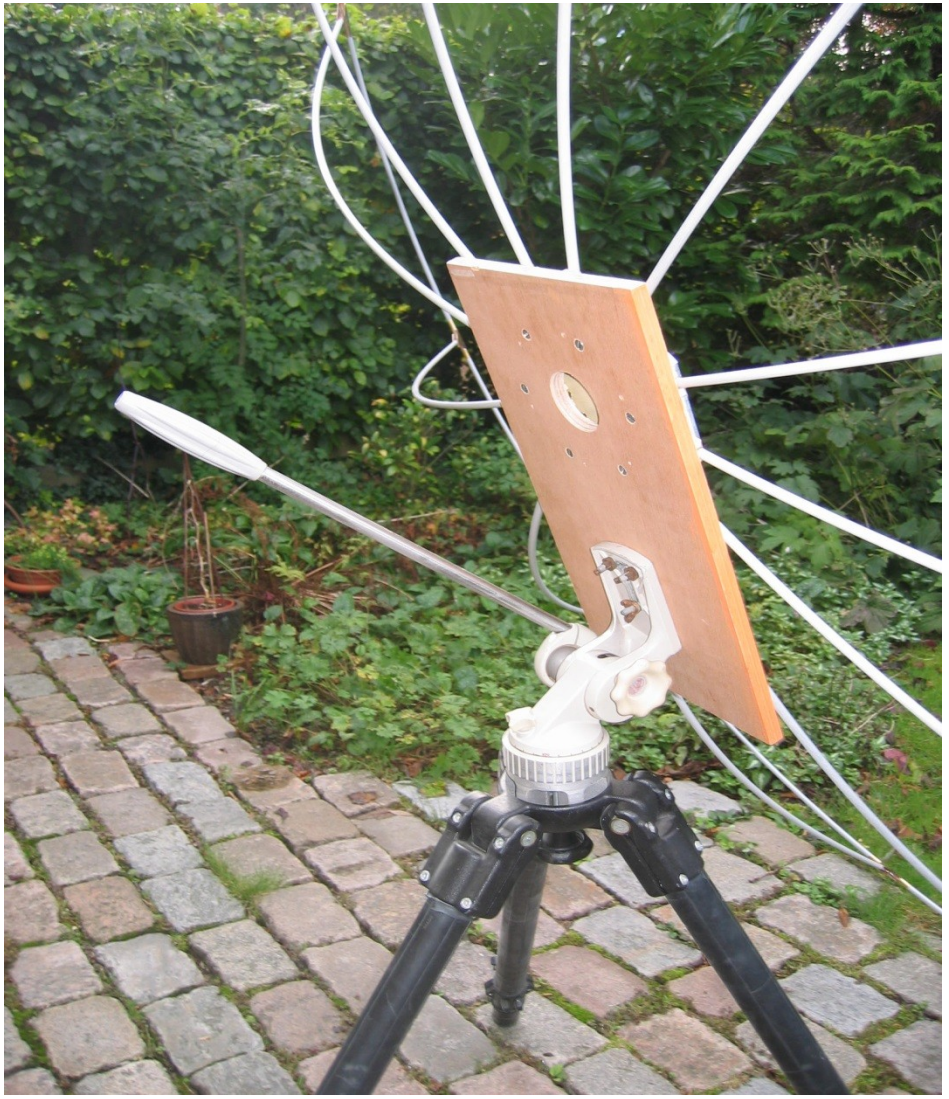
The Reflector is ready

- Add “chicken” mesh
  - 10 mm square holes
  - Folded around spokes
  - Tie wraps
- Feed support structure from centre of the dish
- Resulting dish: 2m40, F/D: +/- 0.42
- Septum Feed (OK1DFC), no choke yet...

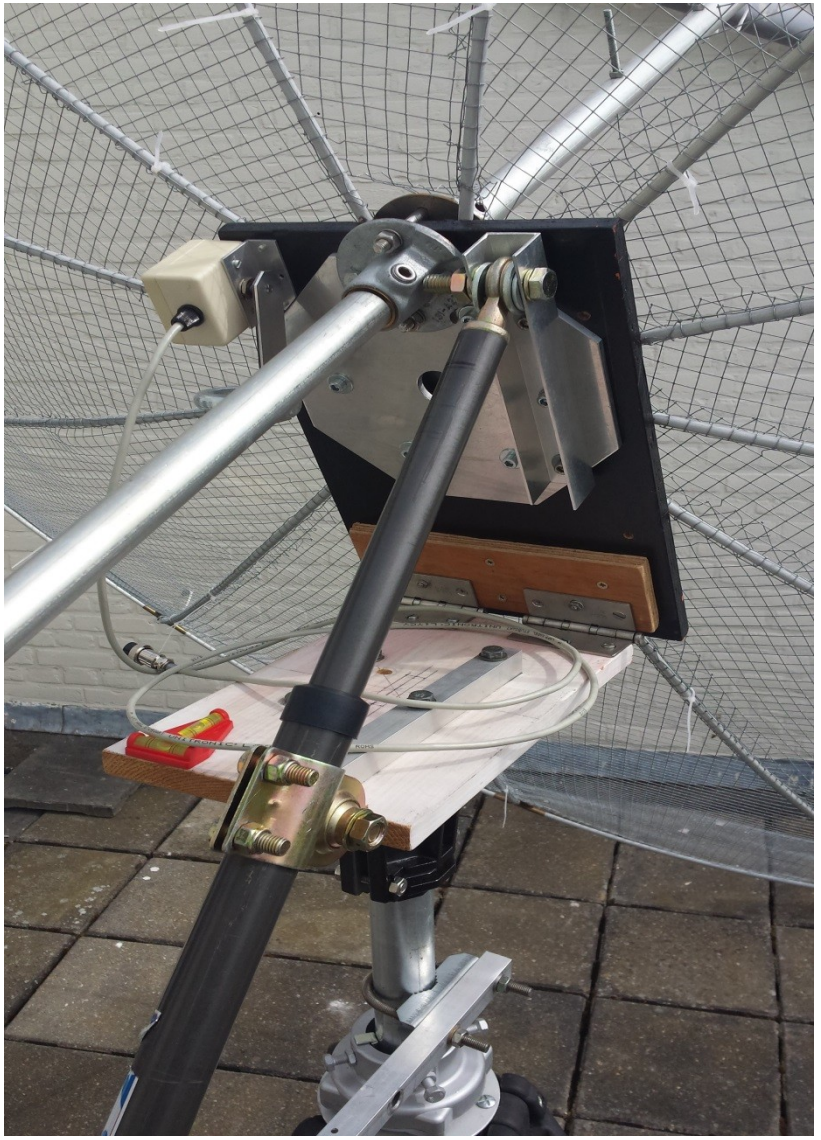
Reflector framework



First (weak) mount construction



Actual centre disk construction



Sun Moon tracking

- Azimuth: KR 1000 rotator
- Elevation: satellite actuator
- Controller: OE5JFL, replaced by PA0HRK
- Old HB IF transceiver (2m)
  - (abt 30 years old, no RIT no CAT; audio I/O and VOX added)
- DB6NT 23 cm transverter (KVG OCXO added)
- WA2ODO LNA (Nf = 0.25 dB)
- Funcube Pro+, Spectravue (continuum mode!)

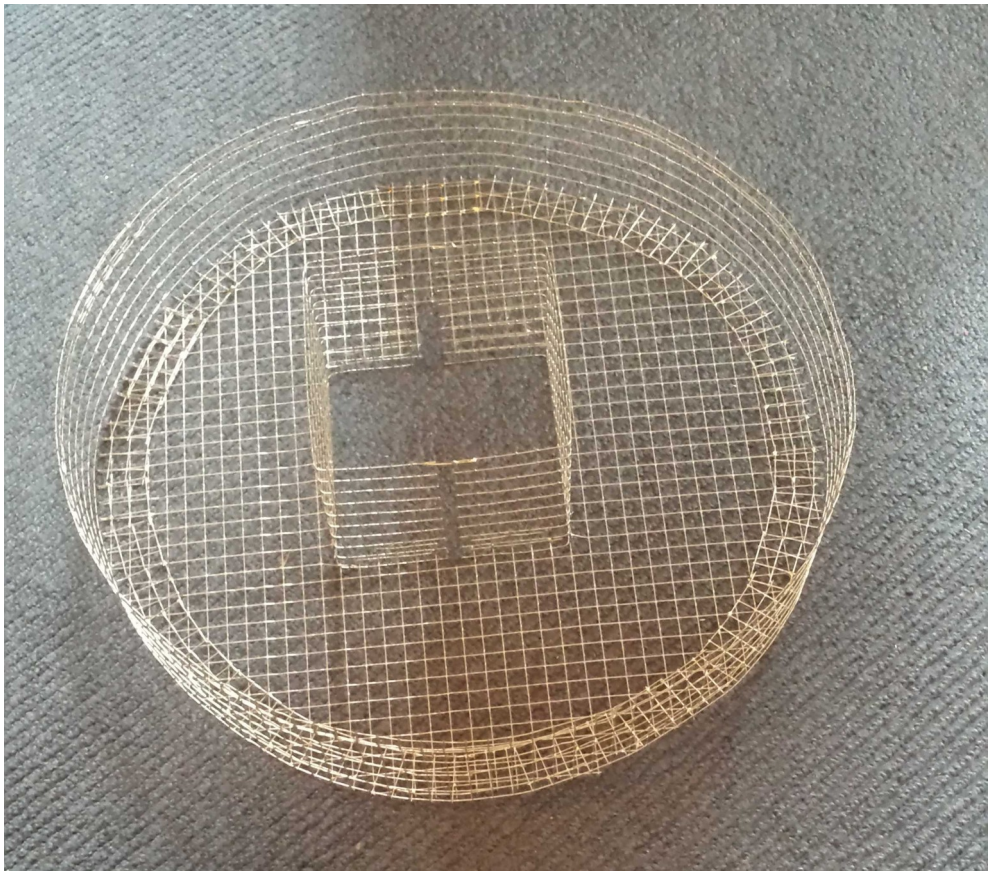
First RX results

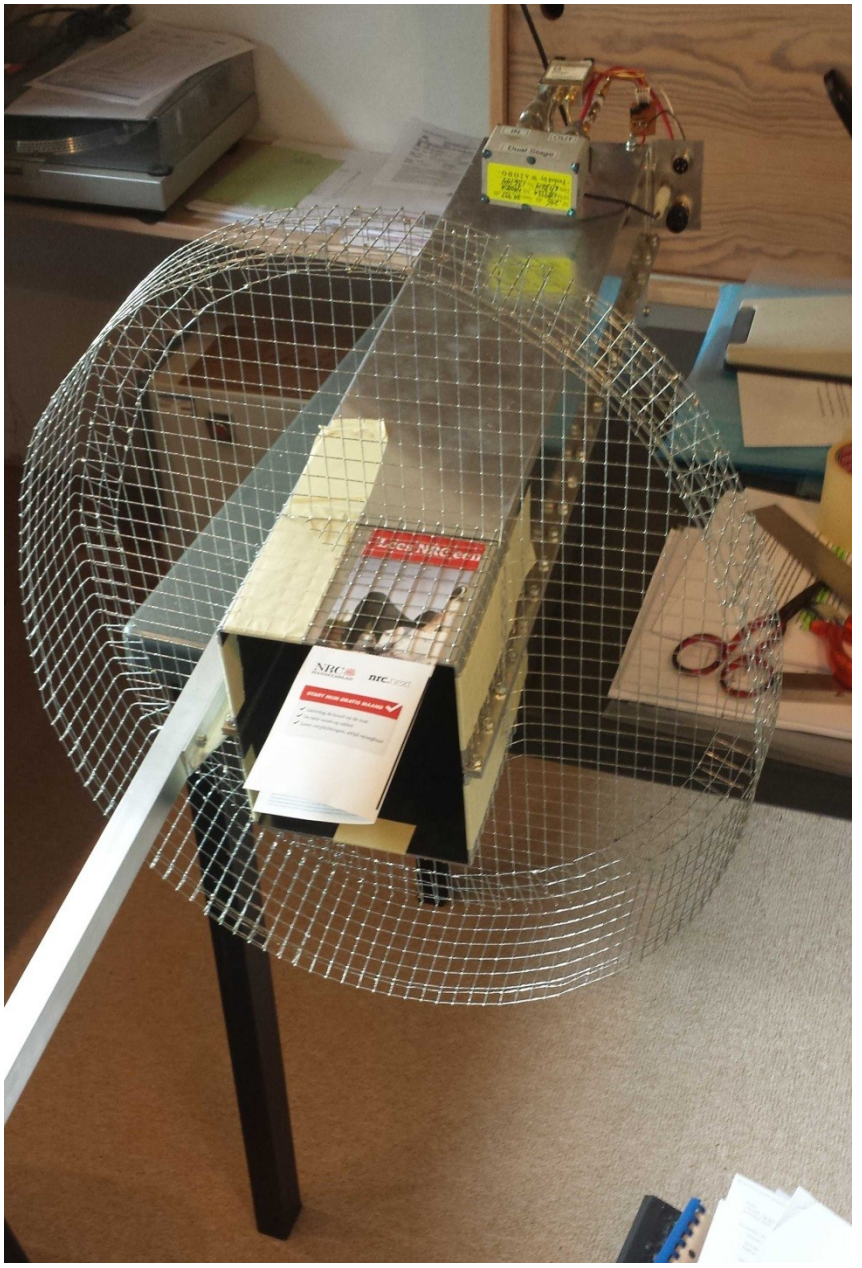
- Some 6-7 dB of sun noise
- July 2014: first stations heard in cw: SM4IVE, I1NDP
- Dish not rigid enough:
  - add 4 ropes to feed support structure
- Add choke (advice K2UYH @ EME 2016)
  - 1 dB increase in sun noise (7.6 dB)
- Optimise feed-reflector distance (2cm steps)
- QTH change (antenna on balcony: 2 open sides)

AI in teaching mode.....



VE4MA choke





First TX results

- RF Power 150 W (PE1RKI)
- PA directly to feed, mounted behind dish
- Power measuring via RX port of septum feed
  - Need protection relay anyway

2016-09-24

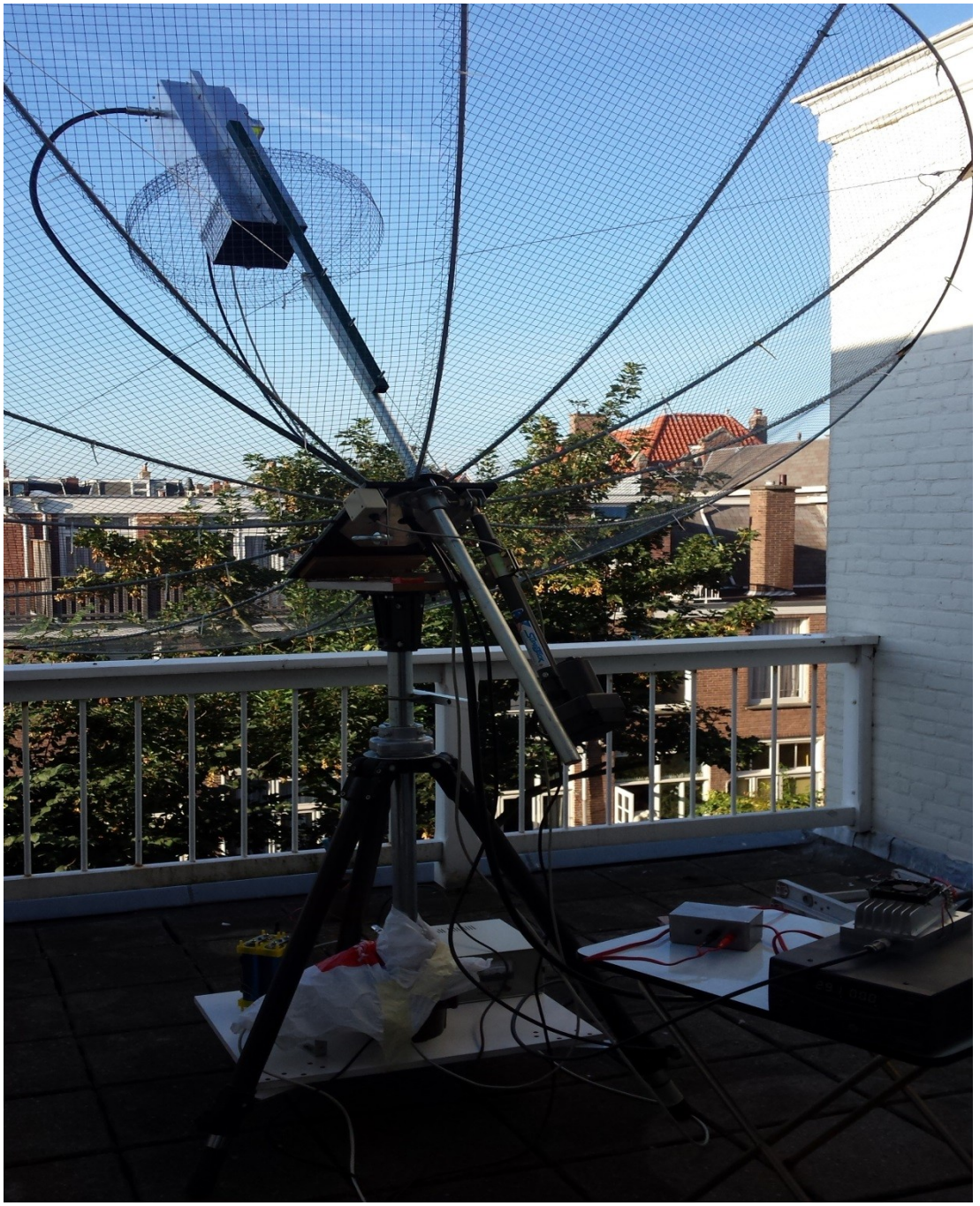
- I1NDP and G4CCH worked in cw!
  - With nice signals!



Actual situation 23 cm

- Modified PST2051 rotator
  - Much better accuracy (0.2 degree) and stability
  - Potmeter replaced by MAB 25 absolute encoder
- DF9IC Power amplifier (300 W output)
- Cellflex TX cable
- Many more stations worked in JT65C
- Heard HB9Q in SSB (alas no PI9CAM yet)
- Station gets mature in some way....

Actual 23 cm



Second approach: 3 cm

- Inspired by:
  - HB9AFO (using PLL-LNB for 3cm reception)
  - PA0EHG (EME 2014 conference)
- 1m1 Sat dish on existing 23 cm stand
  - Started with Avenger PLL-LNB
  - Not stable enough
- Modified DB6NT MKU10G2 transverter:
  - Locked at 10 MHz (Morion MV89 OCXO)
- LNA: DB6NT, DU3T, F1OPA available
  - Surplus TV-sat feed (WG 17 with transistion to WG 16)

PLL-LNB test



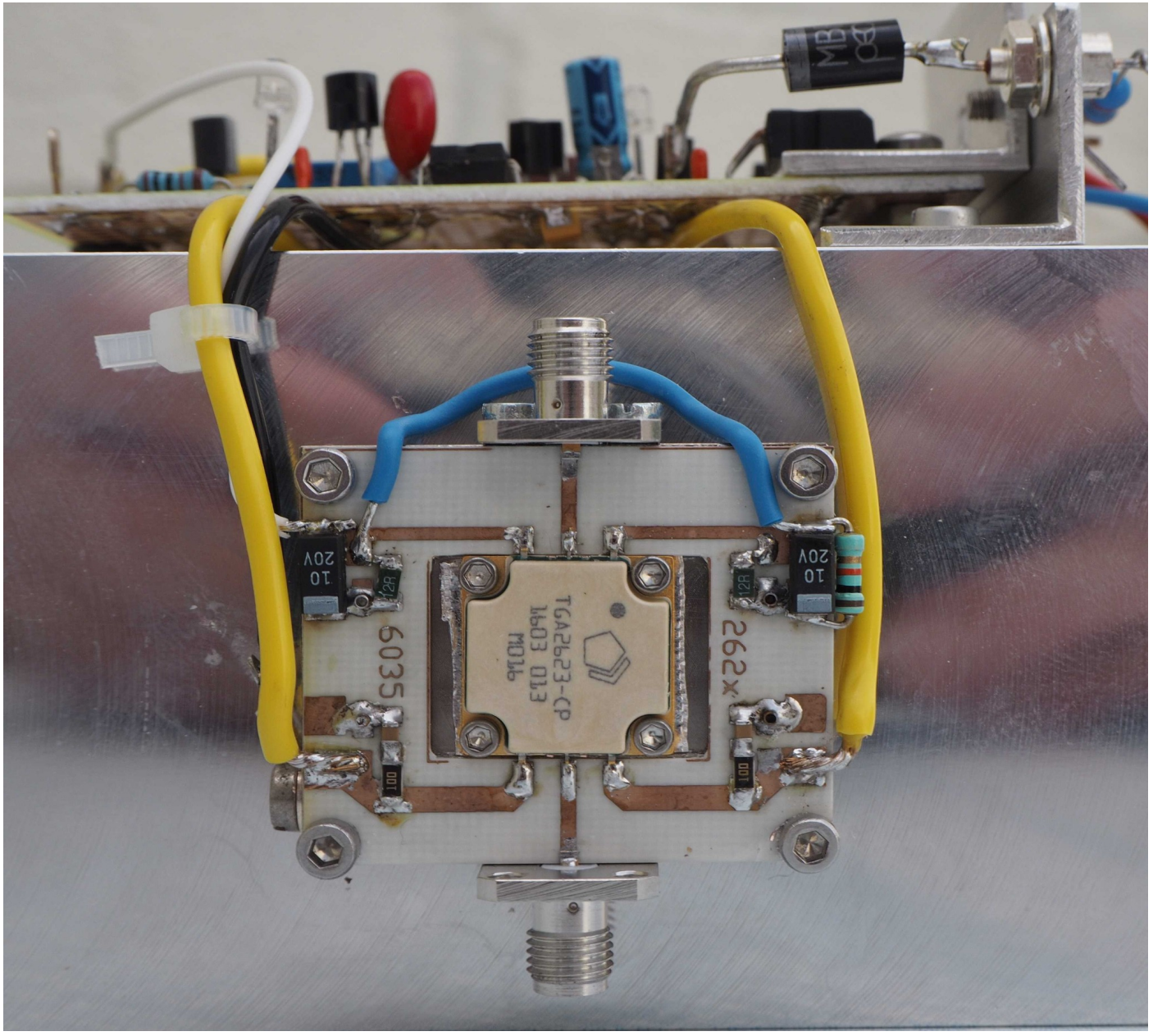
First RX results

- May 2017:
  - Sun-noise: 7.7-8.6 dB (LNA dependent)
  - Heard: OZ1LPR (loud!) and G3WDG in cw
  - Moon-noise: 0.3-0.4 dB
  - DL0SHF heard on speaker level
  - Doppler can be 1 Hz/sec.
- Need to calibrate elevation depending the weight of the LNA. WG relais is also rather bulky
- Now on to the next step....

The transmitter

- A GaN FET Power Amplifier was built
  - with the help of Charlie (G3WDG)
- Characteristics (TGA 2623):
  - Output power: 22 W RF (+43.5 dBm)
  - Vd = 28 V, Id = 2.2 A
  - Gain: 30 dB
  - Fet legally imported by myself
- Directly driven from DB6NT transverter

3cm GaN power Amplifier



First 3cm TX results

- A blown LNA
  - Sequencer was designed for sma relais, not for WG relais!
- Sequencer was modified the same day....
- August 2017: first TX tests
  - OZ1LPR and G3WDG worked in QRA64D!
  - LSB (reversal of sideband necessary!)
- Two days later: OK1KIR (my rpt - 20)
- Thanks to their patience:
  - Remember: no RIT and no CAT!

Actual 3cm front end



The Future?

- A much better IF transceiver!
- Hear my own echo in cw on 23 cm
- Power on 3cm:
  - 60W: to combine two HB GaN PA's with HB9BBD couplers
- Following transverters are available:
  - 13 cm: 2.4m dish, feed, LNA are ready
  - 5760 MHz: 1m1 dish, LNA is ordered
  - 24.192 MHz: 1m1 dish, LNA ordered

Conclusion

- Think about it! Go for it! It's so much FUN!
- Make it rigid (not heavy, semi portable)
- Improve continuously, keep a log,
  - record everything, also what you want to improve
- Be sure that FCD works in linear area.
- Finding “cold” spot is difficult (balcony)
- Improve operating practice
- Big thanks to Simon (PA0S)
  - for his critical remarks and mechanical support

Some References

- http://www.nitehawk.com/432_MHz_EME/stress_dish.pdf
- http://www.hb9afo.ch/articles/pll-lnb/10ghz_pll-lnb.htm
- Dubus 1/2015; 50W GaN PA for 10 GHz, by G3WDG
- PST mod: http://pa0ply.nl/articles/Replace%20sensor%20in%20PST%20Rotator%20by%20PA0HRK.pdf
- 3cm GaN Power Amplifiers by PA0HRK (note to be published)
- Antenna controller by PA0HRK: http://parac.eu/projectpaohrk-1.htm
- Contact: pa0hrk@gmail.com