“Multum in Parvo.... part II”

Optimising a REALLY small microwave EME system

John Worsnop G4BAO

It’s actually quite small

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“Backyard Moonbounce” has been “done to death” at Microwave Round Tables.

So what am I doing here (again)?

Microwave EME is a challenge

Microwave EME with a $15\lambda$ dish is a bigger challenge

I’m in this hobby to learn things

I’ve learned SO much since 2010
My First attempt

- 1.4m spun aluminium solid dish
My First attempt

- 1.4m spun aluminium solid dish
  - Small enough to pick up and carry.
  - It cost me nothing!
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
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My First attempt

• 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

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<th>Call</th>
<th>mode</th>
<th>system</th>
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<tbody>
<tr>
<td>F2TU</td>
<td>CW</td>
<td>8m dish</td>
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<tr>
<td>OK1CA</td>
<td>CW</td>
<td>4.2m dish</td>
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<tr>
<td>G4CCH</td>
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<tr>
<td>ES5PC</td>
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<td>OK1KIR</td>
<td>CW</td>
<td>4.5m dish</td>
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</table>
More power to the Monster Igor!

- I Visited B&Q 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
- “Must Have”
  - Automates system calculations.
  - Used for “What if” analysis of
  - Band
  - Dish size and shape
  - Feed Type
  - Power
  - Receiver performance
  - Moon distance
  - Sun noise

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VK3UM EME Calc

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“Back to the drawing board”

• I already have
  – A top-notch preamp
    • (G4DDK VLNA2 sub 0.4dB NF)
  – More power than most
    • (250 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 noise
  - Adjust choke ring position
  - Adjust the choke ring dimensions

Spectravue “Continuum mode”

5-6dB sun/ cold sky noise
- 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
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 20\(\lambda\)!
- 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!

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Optimising Illumination (direct method)

- I’ve focussed on RX improvement using sun/cold sky
- It’s possible to measure illumination directly
- Feed low power to TX port and use a probe antenna to measure illumination.
  - For lowest noise aim for illumination of -14dB
  - For maximum gain aim for illumination of -10dB
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 feedback. 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

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

- Easy to work 3m dish stations on JT65c
  - PA3FXB
- 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)