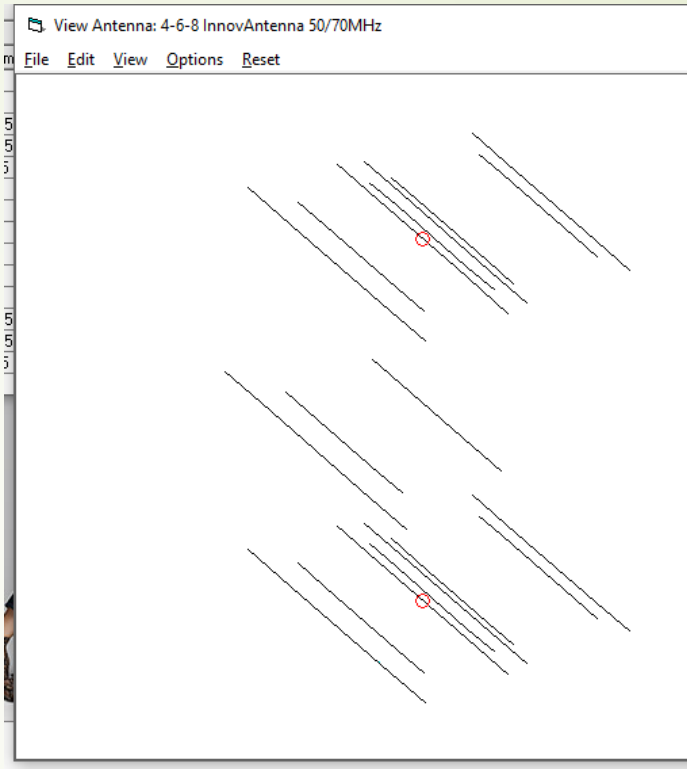


Enhancing performance of stacked Yagi arrays and BOLPA Development

Justin Johnson G0KSC

Agenda

- Who is G0KSC? G0KSC Designs
- ‘Optimum’ spacing for multiband Yagis; is there such a thing?
- A ‘Holy Grail’ solution?
- Usage of ‘open space’
- What’s the solution?
- Partial Yagi placement
- Application examples

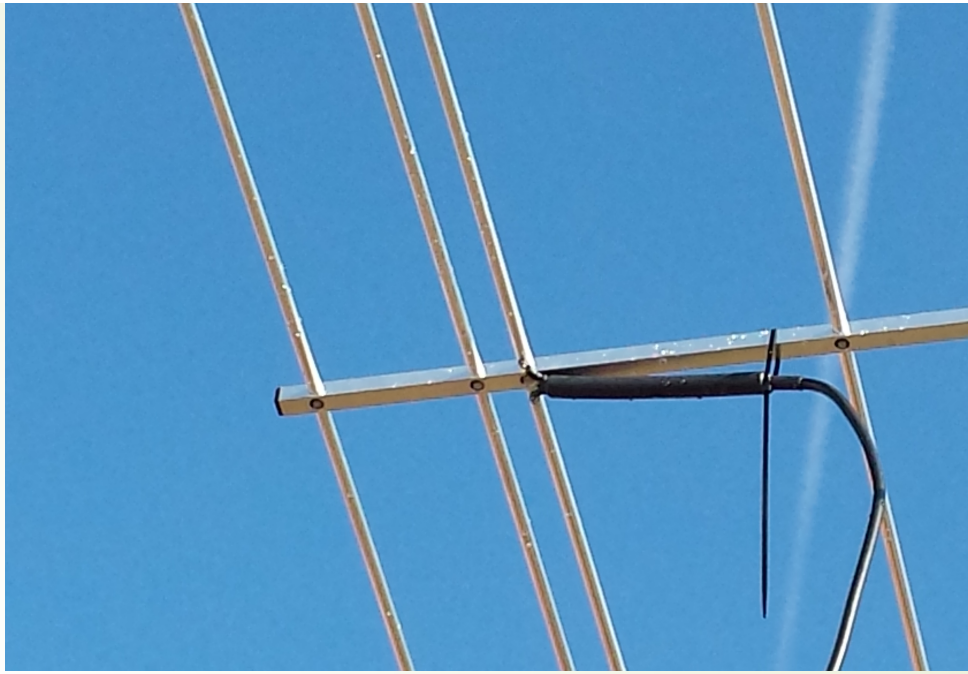
Who is G0KSC?

- Introduction of the Loop fed Array (LFA) Yagi in 2008
- Low Noise, Wide Band, Ultra-high efficiency
  - No Matching Loss
  - Direct 50Ohm feed
  - No need with modern methods
- OP-DES Yagi for HF
  - Opposing Phase Driven Element System
  - Very wideband
    - 2MHz coverage 28-30MHz
- OWL
  - Optimised wideband, Low impedance
    - 12.5Ω dipole = folded 50Ω
- G0KSC.co.uk self-build, why not?

OP-DES Yagi

- Opposing Phase Driven Element System
- Driven Element bent back towards Reflector
- Bent sections become impedance controller
  - Not D1 (OWA)
  - Not matching device
  - No associated losses; science tells us exist!
  - No power limitations associated with matching
- Very Wideband results
- Performance maintenance over wide range
- No ‘Ski Slope’ Gain or F/B results

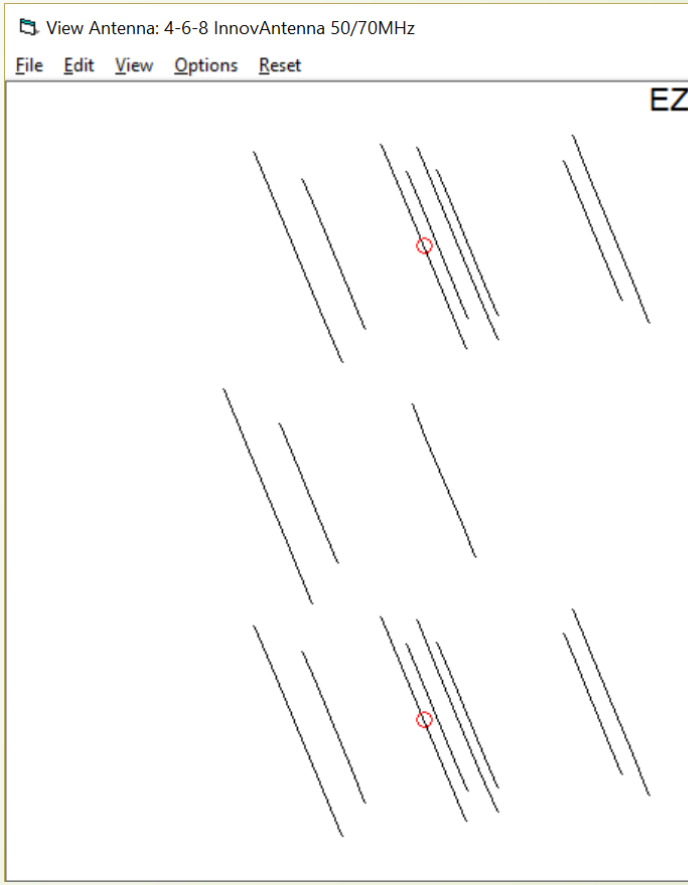
OWL Yagi



- Optimised Wideband Low Impedance
- Driven Element bent back towards Reflector
- Experiments show Low Impedance does not mean narrow band and unstable
- 'Driver Cell' much closer spaced
- Excellent results achieved
- Folded Dipole increases impedance from 12.5Ω back to 50Ω
- FD inline with all elements to avoid elevation pattern distortion
- Side of dipole not fed, 'grounded' to provide DC ground to the loop
- G/T results 'best in class' 9el 144MHz OWL G/T -3.08dB on VE7BQH list

Compromise Spacing of Multi-Band Yag

- Triband & multiband stacking a compromise?
- One band or other is optimised
  - Second band over or under-stacked
  - Compromise stack for all other bands
- Loss of F/B on more than one band
- Missed gain from under-stacking
- 15m compromise spacing?
  - 20/15/10 Triband example XR6 6 band Yagi

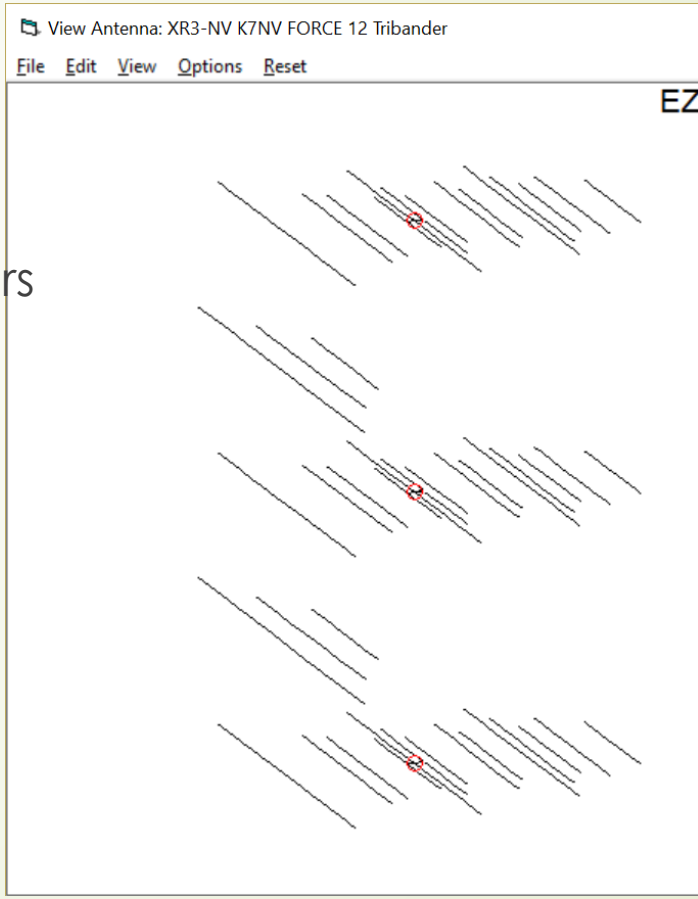


Multi-Band Yagi Stacking Compromise

- Stacked, multi-band Yagis in traditional form are a compromise
  - Dual-band close to mono-band performance so worth pursuing a solution?
- Stacking distances a compromise
  - What distance is best?
- G0KSC asked – What distance is best for XR3-NV?
- Experience of VHF/UHF mono-band stacking
  - There must be a way?
- Experiments begin!

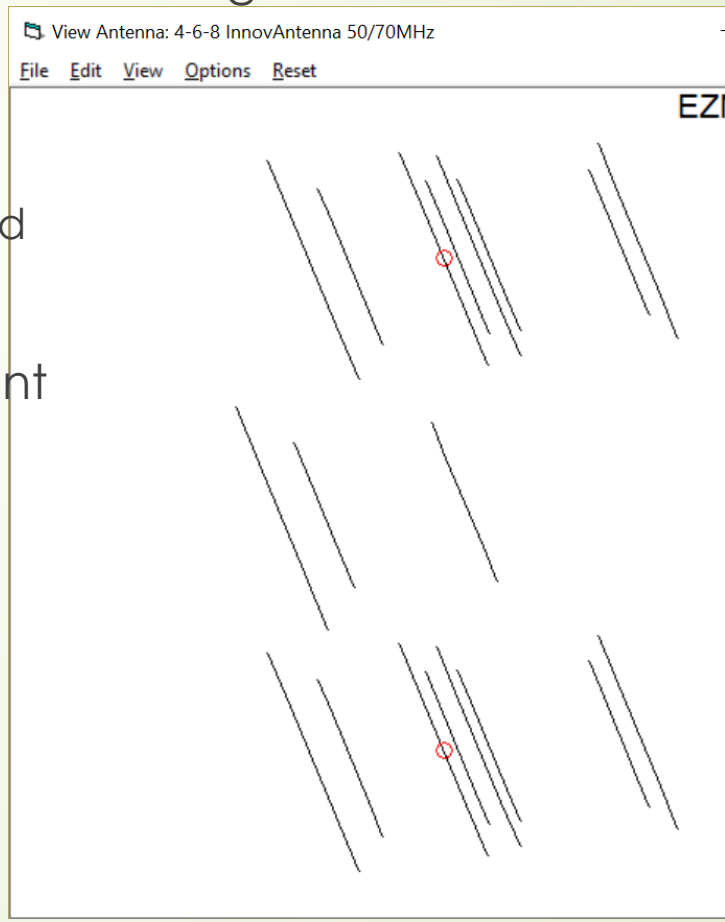
Use of ‘open space’ between Yagis

- Analysing the stacked array; Unused of space between Yagis?
- Space between the antennas not used; could it be?
- Complete, whole additional antennas too much, so how else?
- Free space element placement provides enhancement?
- Reflector and directors added between ‘full-sized’ Yagis
- Marked impact on performance?
- 3 x XR3-NV tri-band contest Yagis with additional Reflectors
- Optimisation of number of elements, position and length
  - Ensures best performance with ‘ideal’ spacing and…
  - Enables best results from compromised spacing
  - Ring and guy positions ‘optimised in’
- How much additional performance
  - Increased F/B
  - **3+dB extra gain**



‘Free Space’ Parasitic Enhanced Performa

- Additional elements between Yagis need ‘optimising’
- Element placement and length may change from those in ‘Yagi cell’
- Individual Yagi variants require different optimisation
  - Number of optimised ‘free space’ parasitics vary
  - Longer the boom, more often director mirroring required
  - Directors required in addition to reflector
- VHF Focus; 6m & 4m dual-bander focus for experiment
- 2 x InnovAntennas 8-6-4 dual-band Yagi example



Dual Band Optimisation - VHF

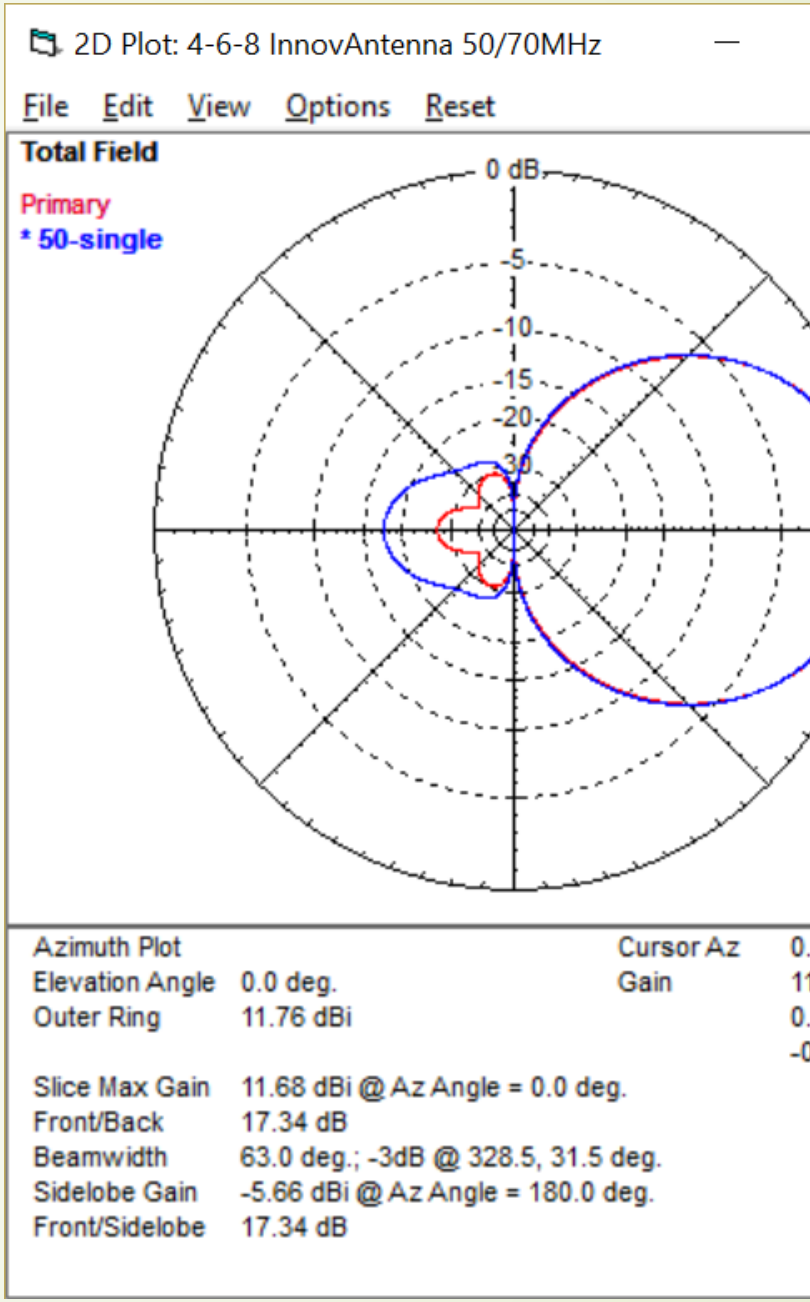
- Dual-Band Yagis *can* deliver near mono-band Yagi performance
  - Least element interaction
  - Assuming third harmonic variations are avoided, 2m/70cms, 6m/2m etc.
    - I get asked for them, but will not design them!
  - Development of multi-band, mono-performance arrays possible?
- Free space parasitic optimisation providing unparalleled performance
  - First and second band optimisation up to and beyond theoretical 3dB maximum
- Example 8 element (4el on 70MHz, 4el on 50MHz) on a 2.1m Boom
- Free space parasitic enhancement; 1 element on 50MHz, 2 on 70MHz
- 50/70 comparisons to follow!
- Example 'over-stacked' for both bands at 4.2m possible as a result of free space parasitic element additions

50MHz Yagi performance

- Performance:
  - 4.2m between antennas – 2.1m to free space parasitic elements
  - Single Yagi – 50MHz - **8.52dBi** & **20.91dB** F/B
  - Stacked Yagis – 50MHz – **11.68dBi** & **17.34dB** F/B
  - Stacked Yagis with parasitic enhancement – **11.76dBi** & **26.46dB** F/B
  - Net performance increase on 50MHz over standard stack
    - **0.08dB** gain, **14.7dB** F/B
  - **3.24dB** increase over single Yagi (1 additional free space element)

50MHz overlay

- Stack & Enhanced stack overlay

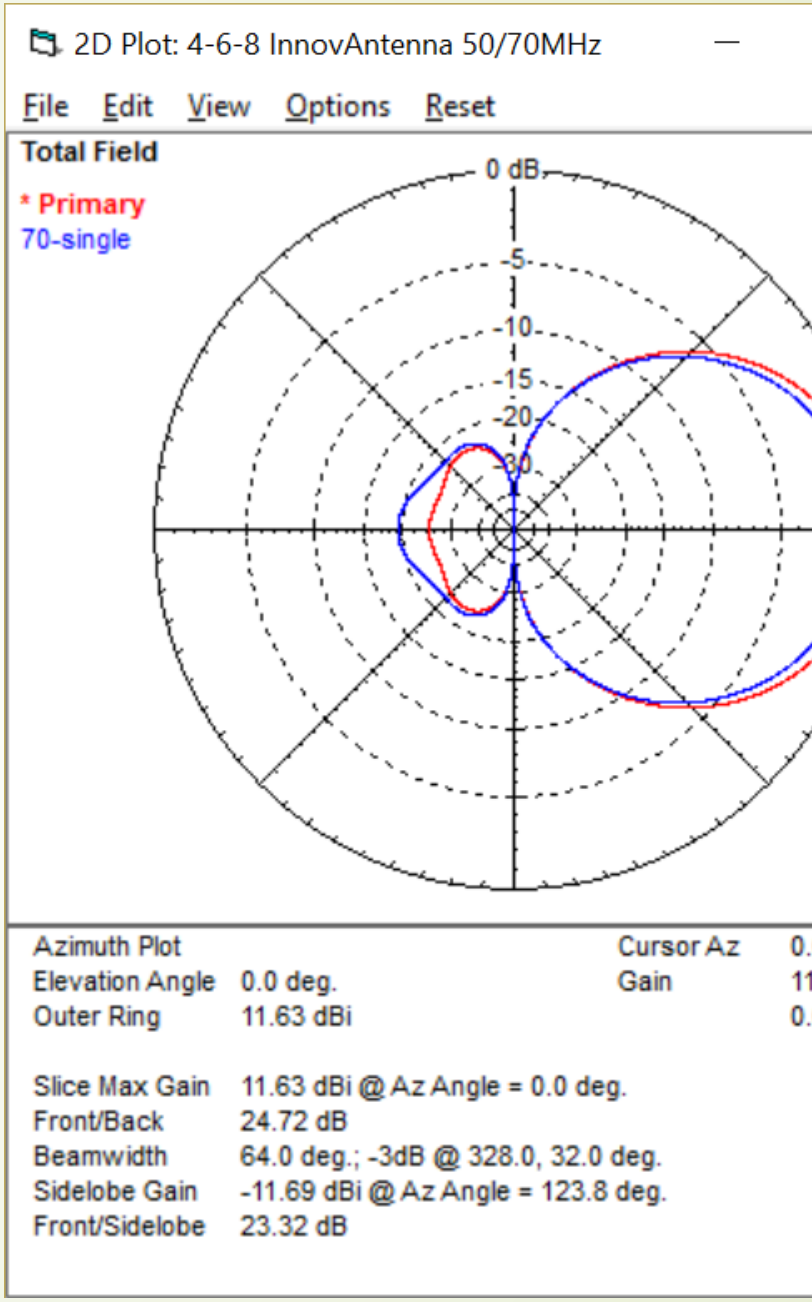


70MHz Yagi performance

- Performance:
  - 4.2m between antennas – 2.1m to free space parasitic elements
  - Single Yagi – 70MHz – **7.83dBi** & **21.32dB** F/B
  - Stacked Yagis – 70MHz – **10.92dBi** & **18.67dB** F/B
  - Stacked Yagis with parasitic enhancement – **11.63dBi** & **24.72dB** F/B
  - Net performance increase on 50MHz over standard stack
    - **0.71dB** gain, **6.05dB** F/B
  - 3.8dB increase over single Yagi (2 additional free-space elements)

70MHz overlay

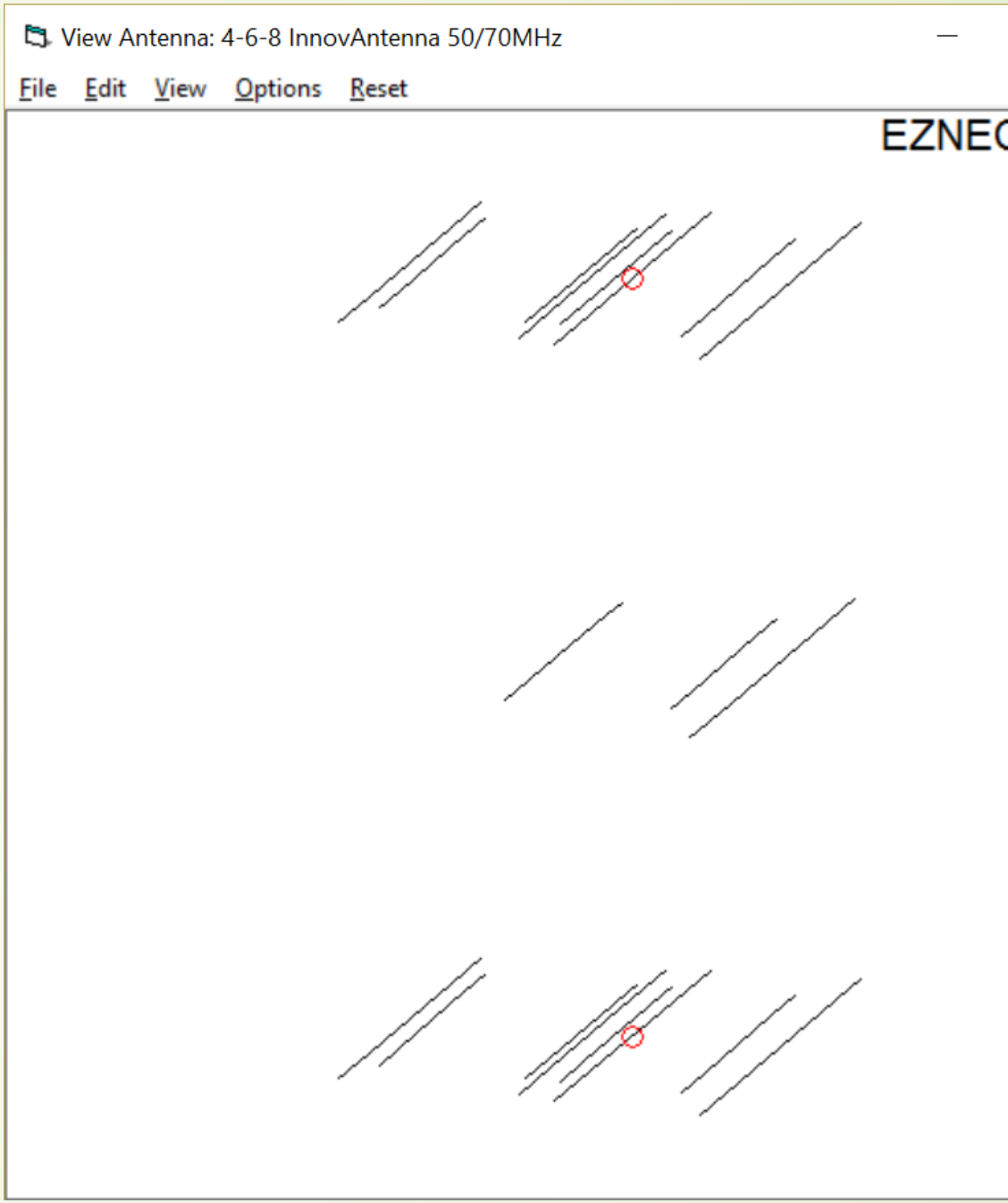
- Stack & Enhanced stack overlay



Summary of achievements

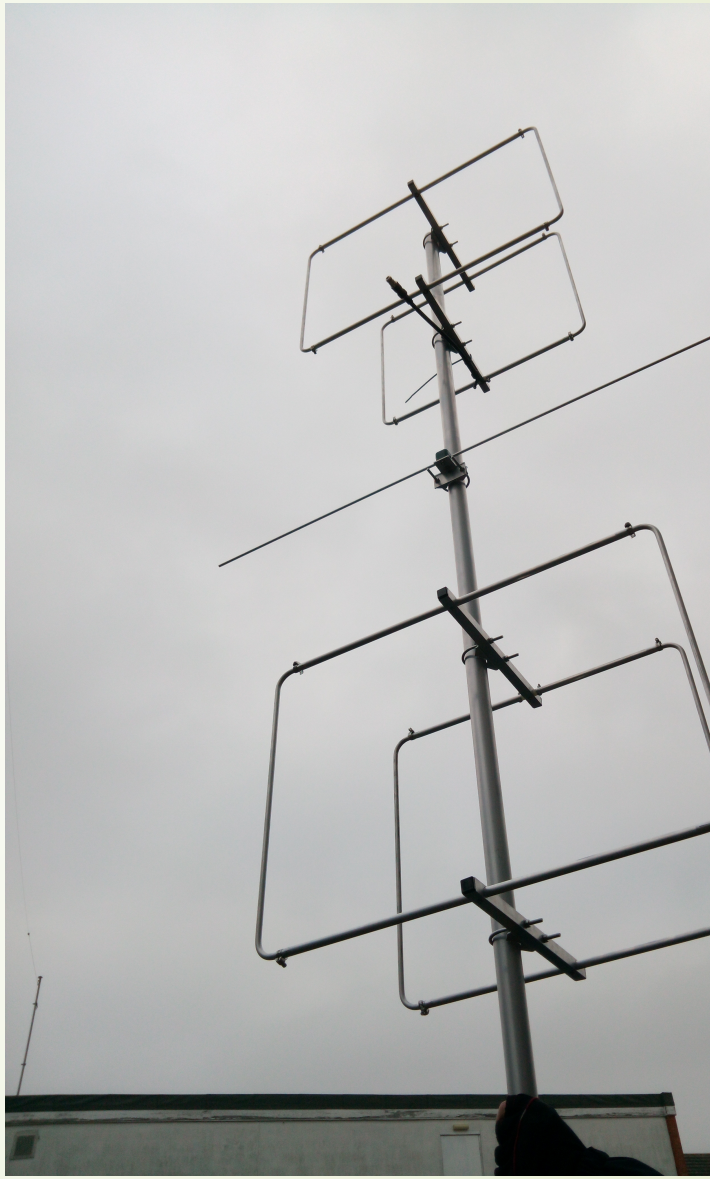
- Additional gain on both bands
- Similar achievements on 3 or more band stacks (more towards HF)
- Huge increase in F/B
- Increase of the 'ideal' stacking distance per antenna
- Removal of compromise spacing
- 3dB theoretical increase maximum no longer applies
- Higher performance per foot of boom; ideal for small station installations
- Utilisation of unused space

A Closer Look



Further developments?

- Monoband stacks, including Quads
- Single reflector enhancement
- Increasing stacking distance
- Maintaining azimuth bandwidth
- Producing more gain
- Higher F/B
- Over 11dB gain, 22dB F/B
  - Single Large ‘Reflector’
  - Mid-way between elements/Yagis

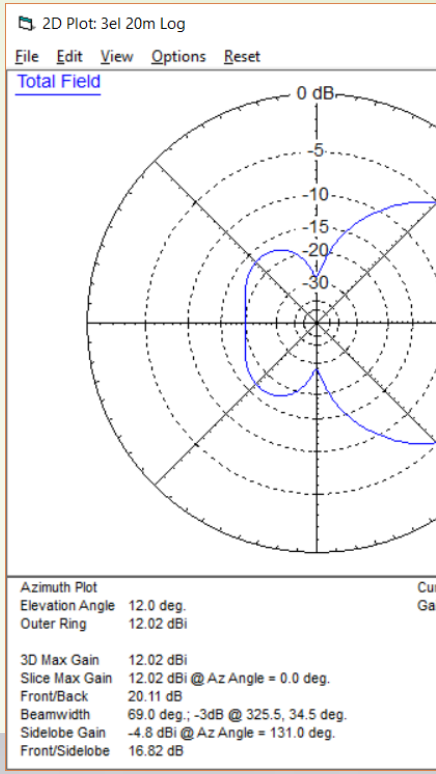


Developing the BOLPA

- BOLPA – Band Optimised Log Periodic Array
- A ‘What if?’ experiment – monoband Log Periodic Array
- 3 element monobander
  - Optimised with 50Ohm feed
  - Excellent F/B
  - 20dB ++ F/B
  - 20m example 6’ long
- Multiband development
  - How?

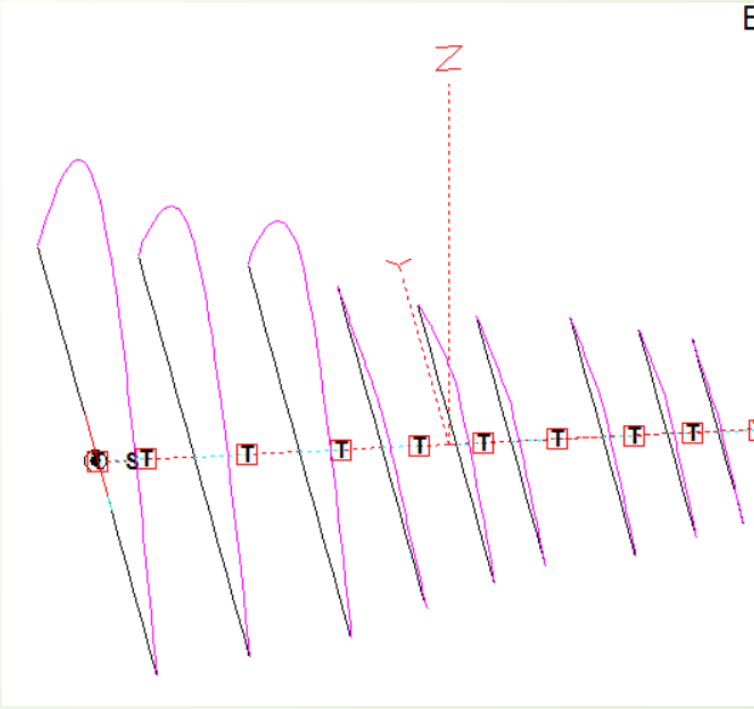
Developing the BOLPA

- 3el Monoband 50Ohm Log Periodic for 20m band
- Just 6’ long
- ‘Unlimited’ power handling – no 4:1 balun
- Proven twin square boom design doubling as feedline



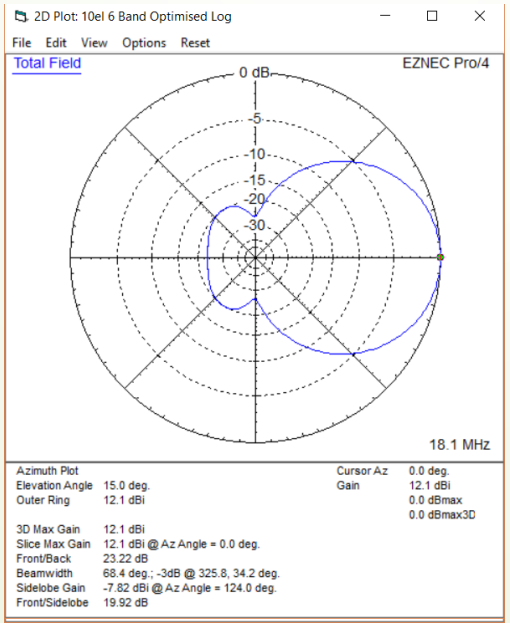
Developing the BOLPA – How does it work

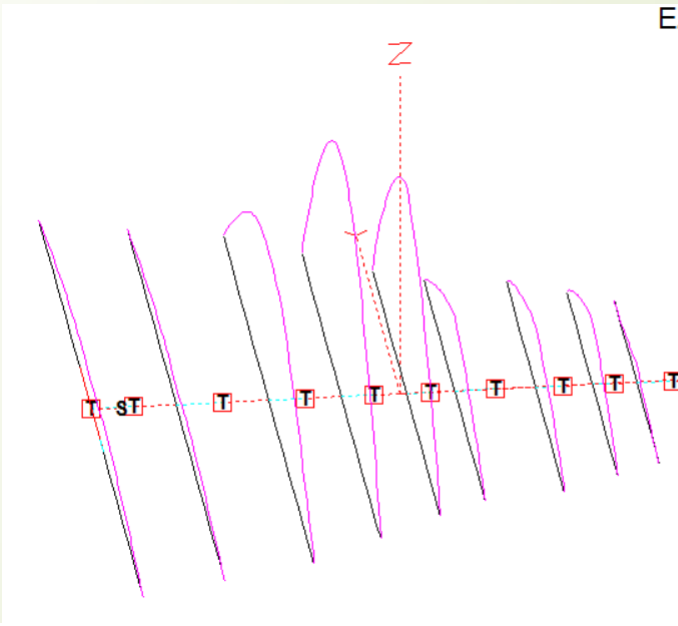
- First 3el 20m Monoband log optimised
- Scaled and optimised for 15m then 10m
- All 3 x 3el monoband logs placed on same boom/feedline
- Spacing between each 3el combination optimised for best performance
- Result is excellent on all 3 bands plus of bonus band, 12m included free!
- How about 17m?



Developing the BOLPA – How does it work

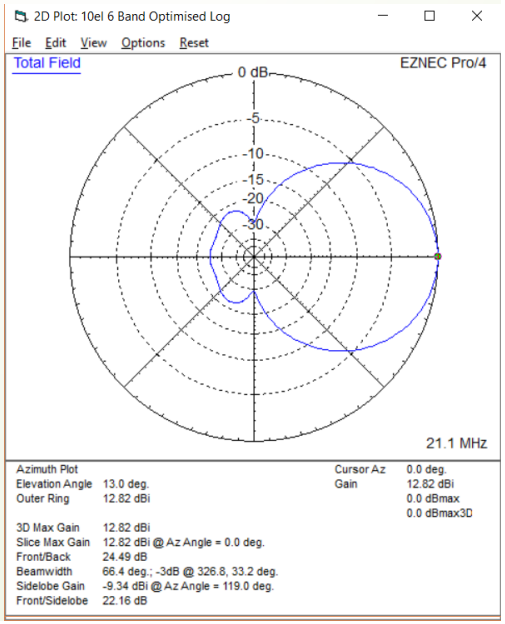
- 17m no elements?
- Shifted 20m ‘cell’ back on the boom
- Insert 1element between 20m cell and15m cell
- Optimise that element length
- Shift forward and reward cells to optimise SWR and performance for 17m
- Without adjust any element length other than the single 17m element

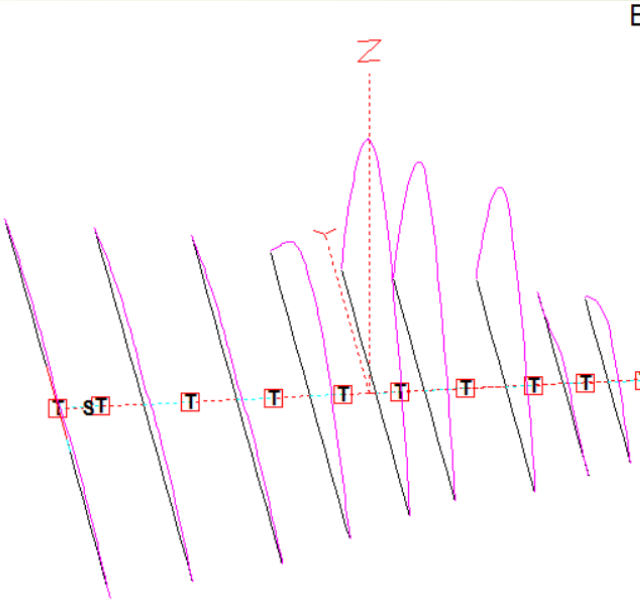




Developing the BOLPA – How does it work

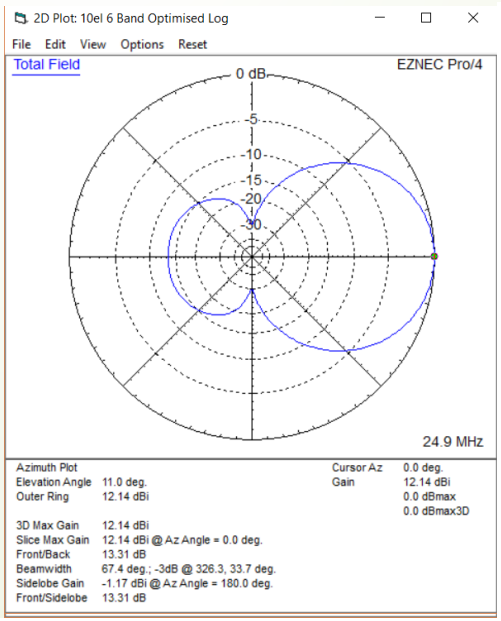
- 15m bonus provided from 17m element?
- Current within 17m element means 4el + on 15m
- 12.8dBi @ 50' up on this band
- Almost 25dB F/B

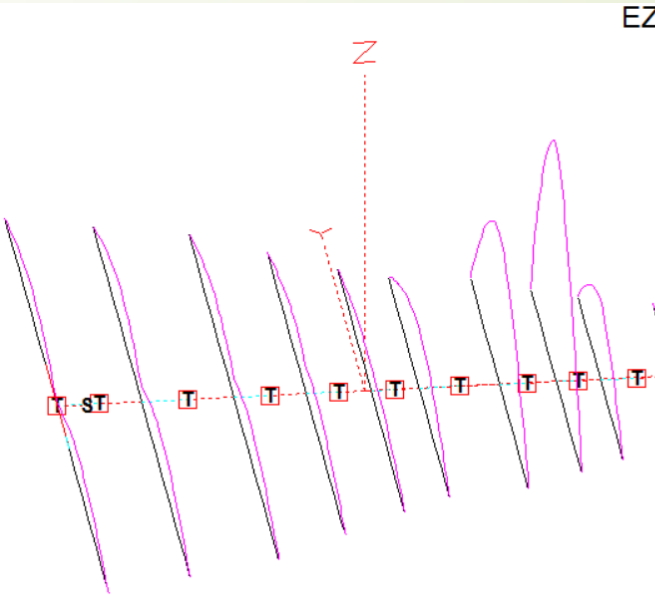




Developing the BOLPA – How does it work

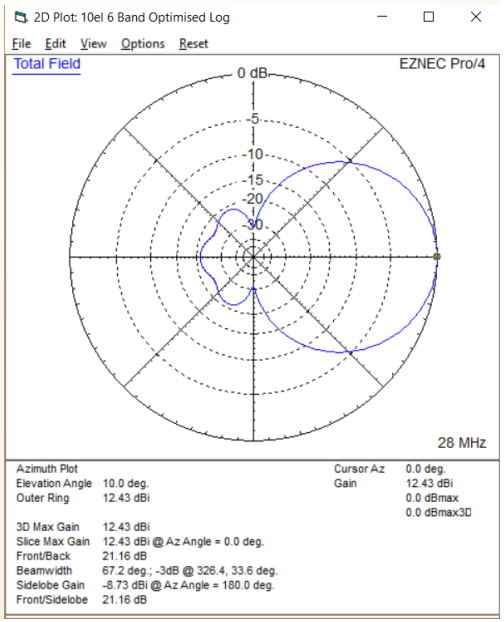
- 12m bonus provided from 17m element?
- Current profile shows 1+ element on this band
- Acceptable gain (similar to 14MHz)
- Loss of F/B
- Flat SWR across the band – bonus!

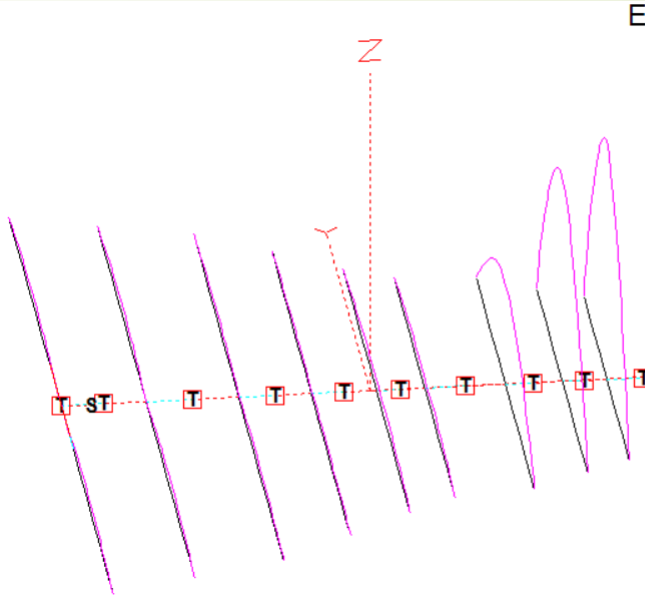




Developing the BOLPA – How does it work

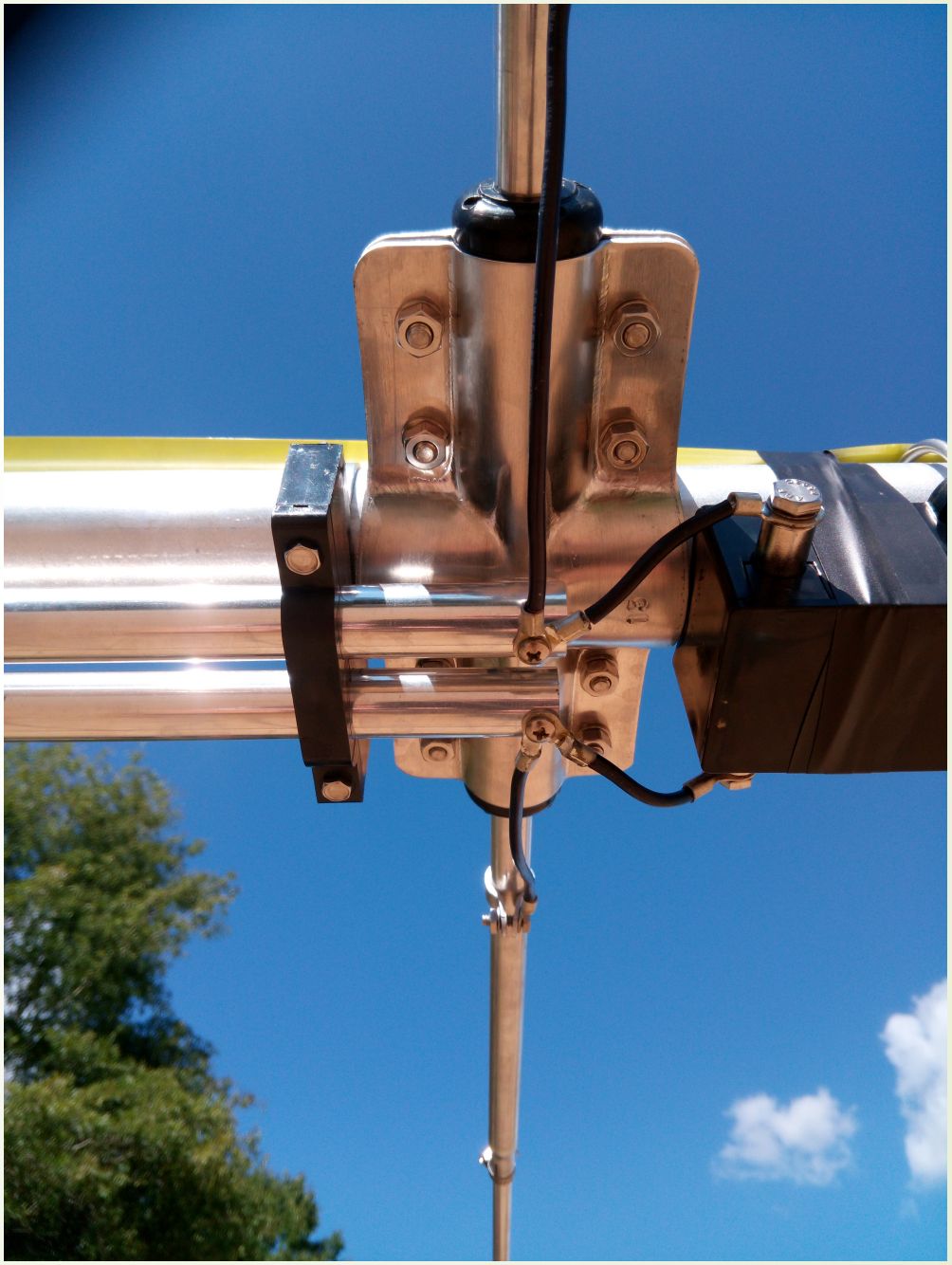
- 10m band current profile confirms 4 active elements
- Gain at 12.43dBi at 50'above average ground
- SWR below 1.5:1 from 24MHz to 30MHz
- F/B above 20dB in 10m band
- Additional elements (parasitic) can be added to enhance 12m/10m performan





Developing the BOLPA – Summary

- Individual ‘band cell’ optimised Log Periodic Arrays on one boom/feedline
- Band cell positon placement optimised to increase performance
- Individual cells re-optimised once placed in their respective positions
- hy-gain BOLPA is ‘next-gen’ with parasitic enhancements for 10m/12m
- hy-gain BOLPA supplied with option of enhanced 10m/12m AND 6m band cell
- Extremely stable design with ‘above average’ log cell performance
- Ideal SDR multi-slice partner antenna for single SCU/ADC operation
- No ATU needed on any band so ideal SO2R partner with full legal power




CAUTION
PRECAUCIÓN

User Comment on BOLPA

Customer Comment from SJR Service, our dealer in Sweden:

'My customer with the BOLPA has sent me this info:
SWR:
20m 1:1
17m 1:1
15m 1:1
12m 1:3
10m 1:1
He says he should have bough this antenna years ago!'

Questions?

- Thank you for your time!