

S/X/Ka Coaxial Feed for the Tri-band Receiver for RAEGE Antennas

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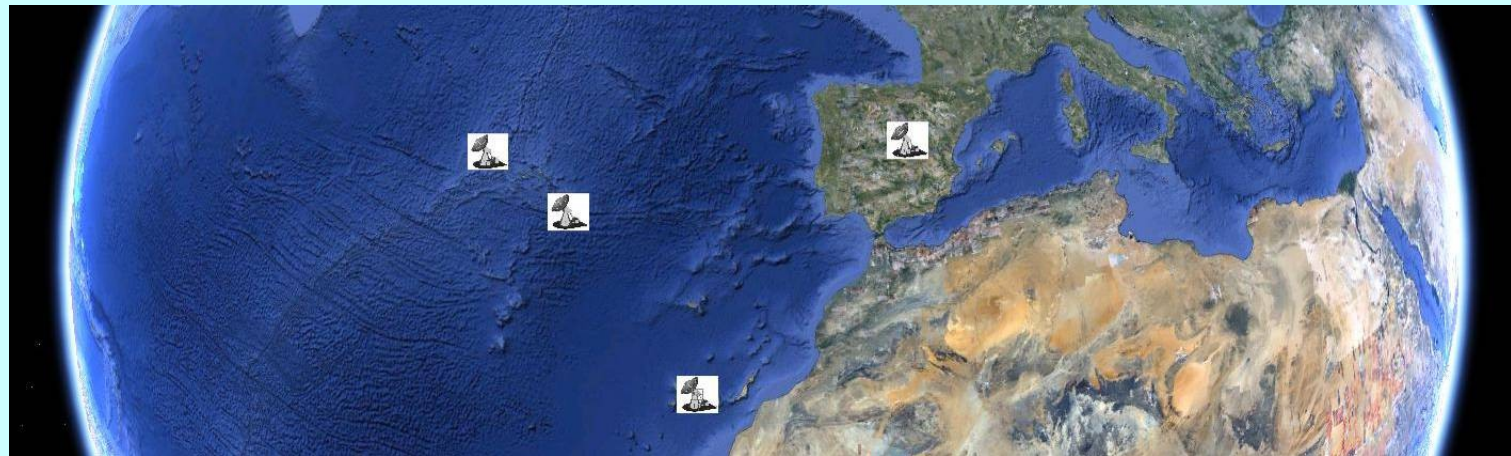
Outline

- RAEGE Antenna in the VLBI2010 Project
- 1st Light S/X/Ka Receiver
- Tri-band Feed Design
- Tri-band Feed Simulations
- 13.2m RAEGE Antenna Simulations
- Current Status
- Conclusions



RAEGE Antenna in the VLBI2010 Project

- **R**ed **A**tlantica de **E**staciones **G**eodinámicas y **E**spaciales. Atlantic Network of Geodynamic and Spatial Stations
- 4 VLBI2010 antennas

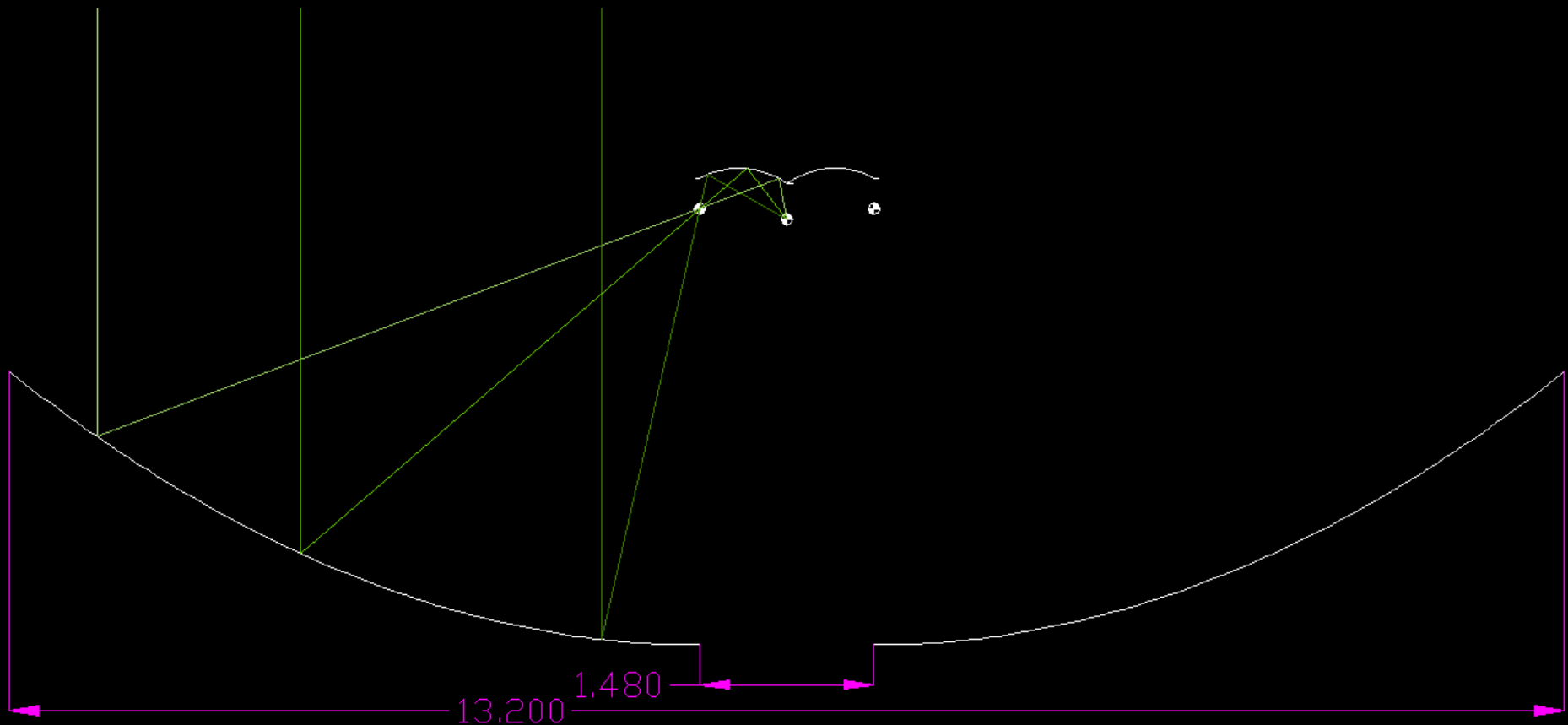


- Fulfills the IVS VLBI2010 specs.
 - 13.2 meter diameter
 - 12°/s Az slewing speed
 - 6°/s El slewing speed
 - Ring Focus Optics to accommodate wideband feeds
- Surface accuracy <200 mm RMS, operation up to 45GHz
- Pointing accuracy <20"



Antenna Optics

- Ring Focus Antenna



Antenna Performance

- **Ring focus geometry**

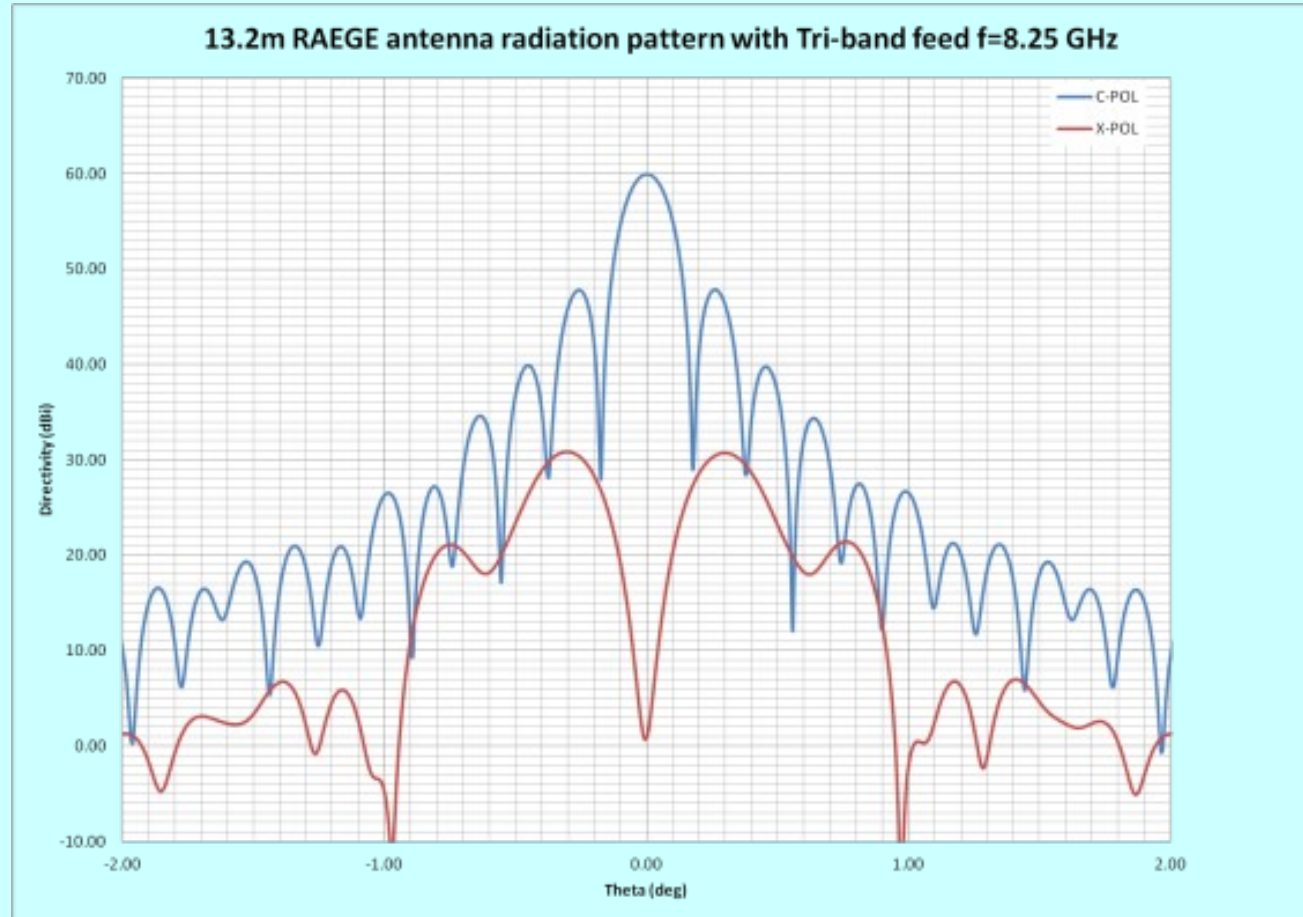
- Low noise optics
- Null blockage
- More uniform amplitude distribution improves aperture efficiency
- Level of first sidelobes

- **Low F/D**

- Wide-beam feed illumination (65° semi-angle). Required for wideband VLBI2010 feeds.
- High sensibility to errors due to feed and subreflector misalignment



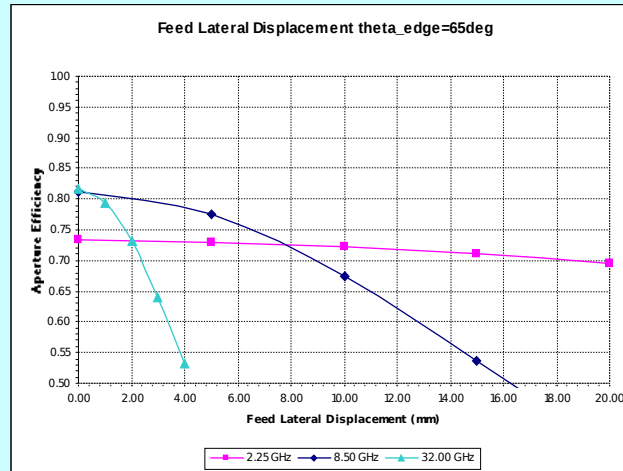
Antenna Performance



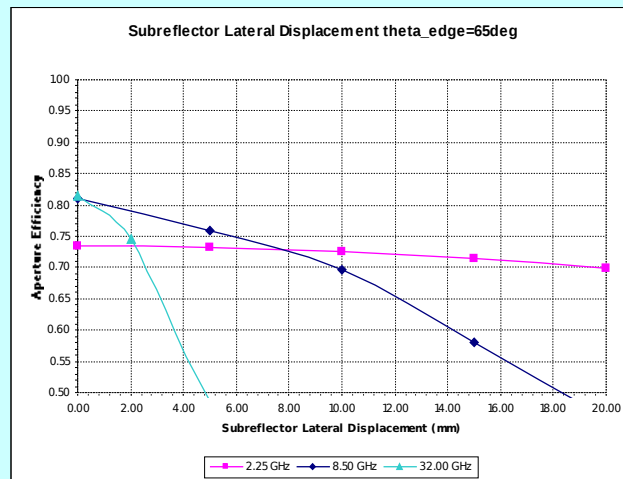
- -12-13 dB first sidelobes level due to the aperture illumination of the antenna



Antenna Performance



- Feed misalignments (axial and lateral) are critical in high frequency.



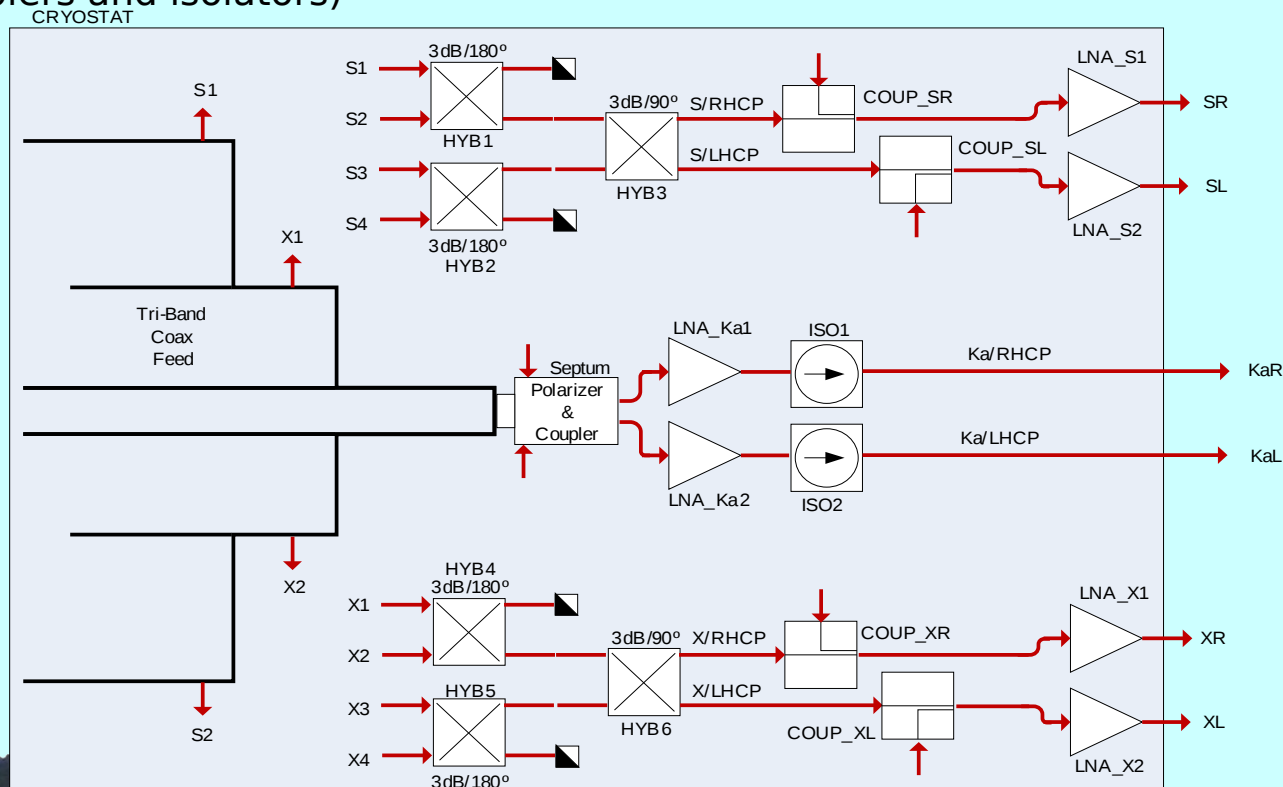
- Subreflector misalignment is as critical as feed misalignment.

- Subreflector servo system allows subreflector motion strategies to compensate misalignments due to the feed, the subreflector and the deformations in elevation



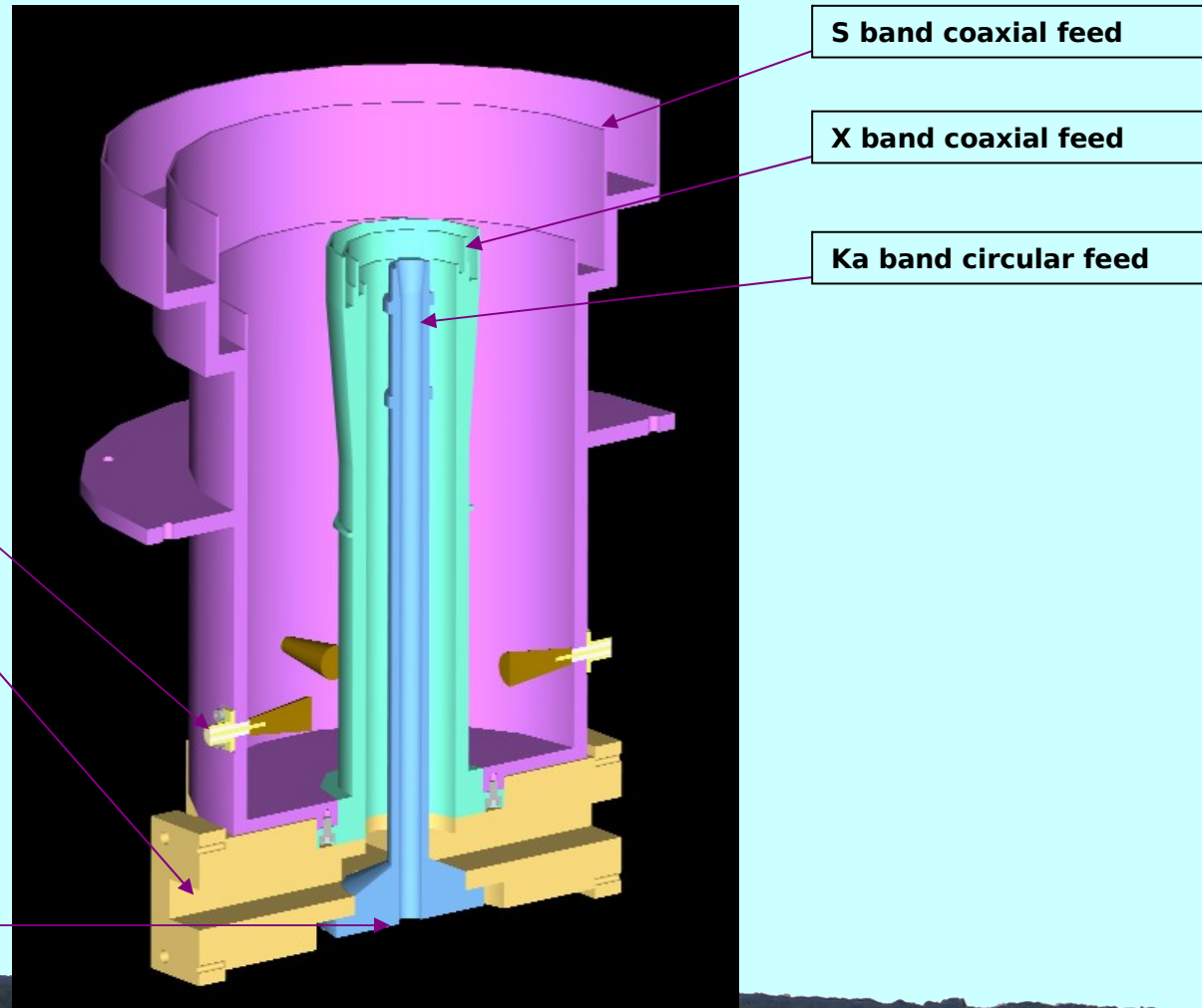
1st Light S/X/Ka Receiver

- Tri-band. S band 2.2-2.7 GHz, X band 7.0-9.0 GHz, Ka band 28.0-33.0 GHz
 - Backward compatibility with SX VLBI
 - Ka band for testing the antenna high freq. capabilities
 - X/Ka VLBI experiments
 - Dual Circular Polarisation
- Cooled front-end: feed, septum, hybrids, LNAs to keep a good sensibility
- Almost all RF cryostat inside components designed in Yebes Observatory (except 180° hybrids, couplers and isolators)



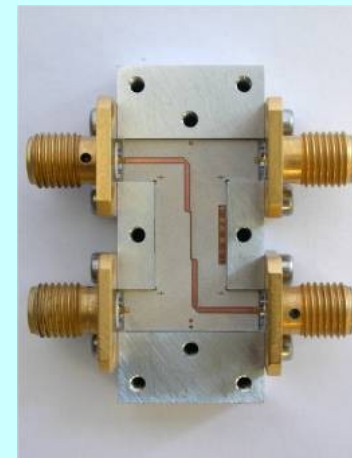
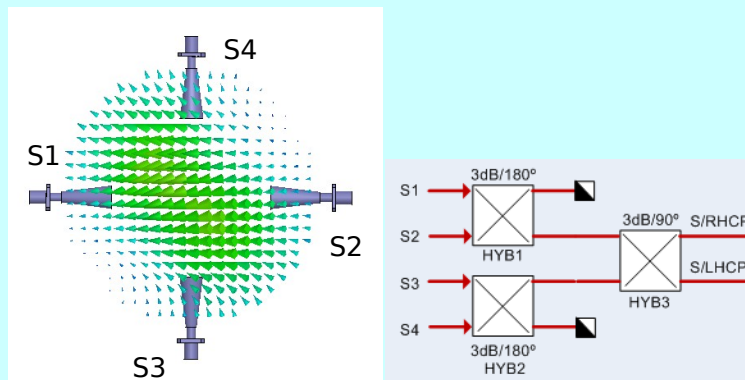
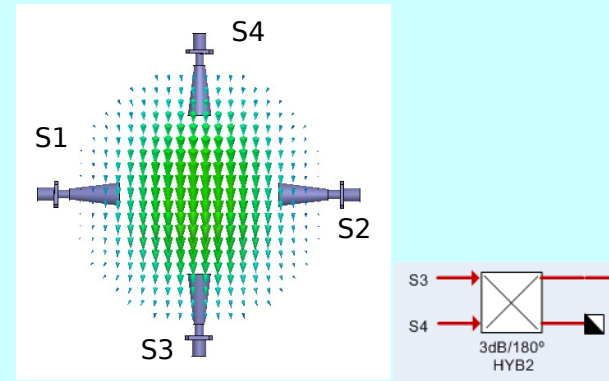
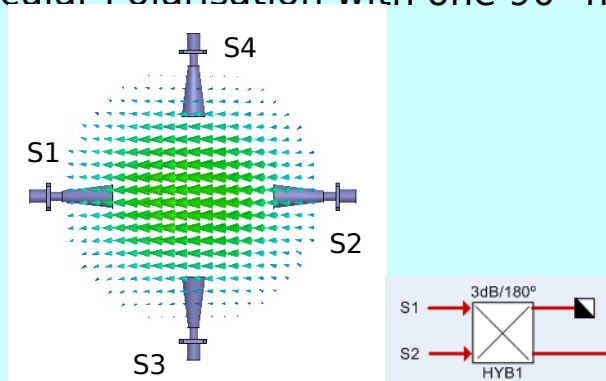
Tri-band Feed Design

- Coaxial feeds for S/X.
- Smooth circular feed for Ka.
- 25cm x 20cm. 3Kg



Tri-band Feed Polarisation S/X

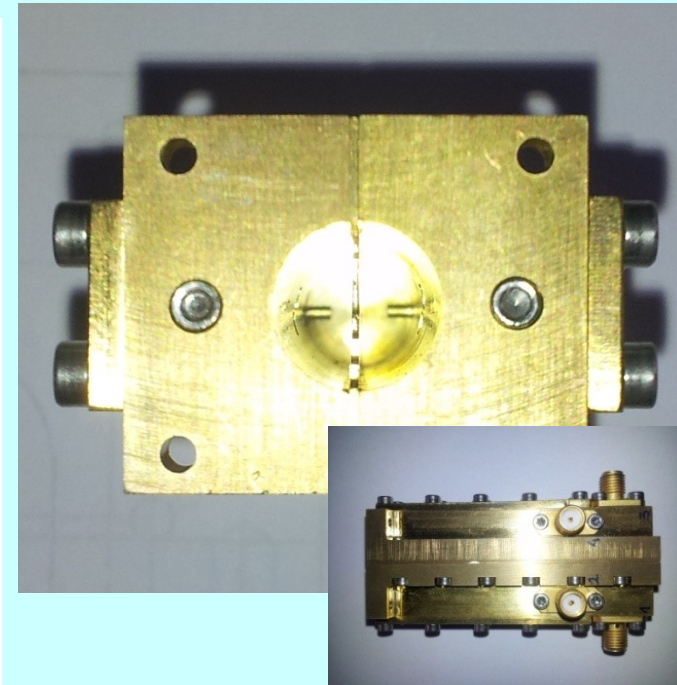
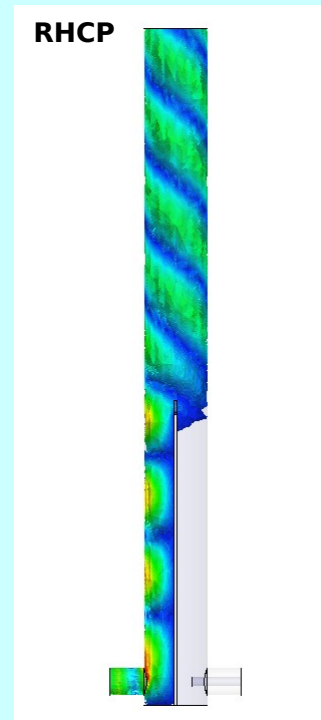
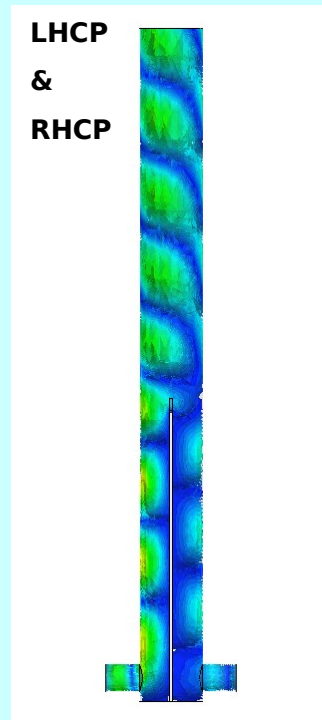
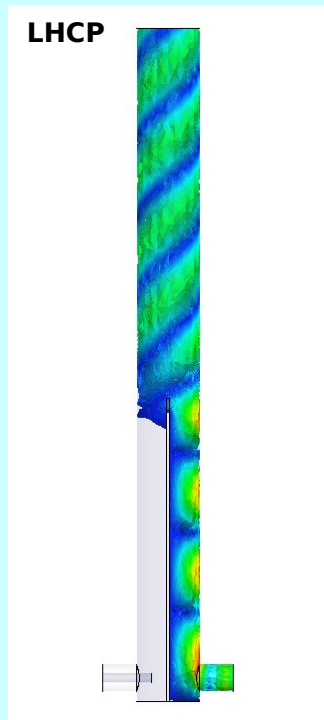
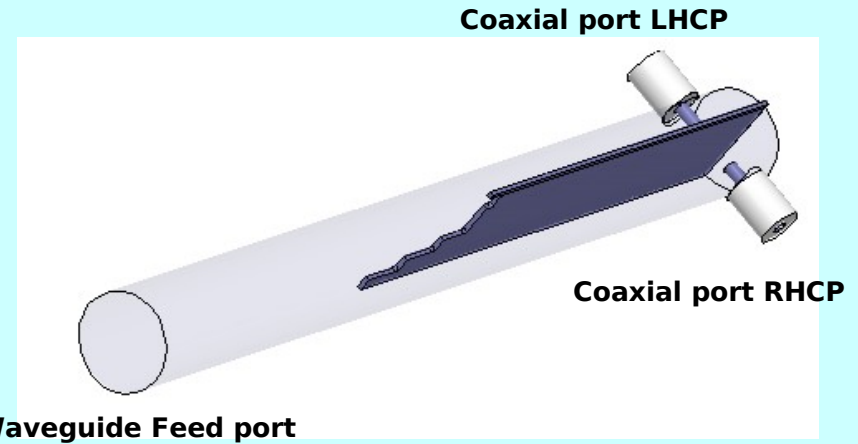
- Four unbalanced ports for S/X must be properly combined to radiate with circular polarization
- Linear Polarisation with 180° hybrid exciting opposite ports
- Circular Polarisation with one 90° hybrid



Cryogenic 90° hybrid developed in Yebes

Tri-band Feed Polarisation Ka

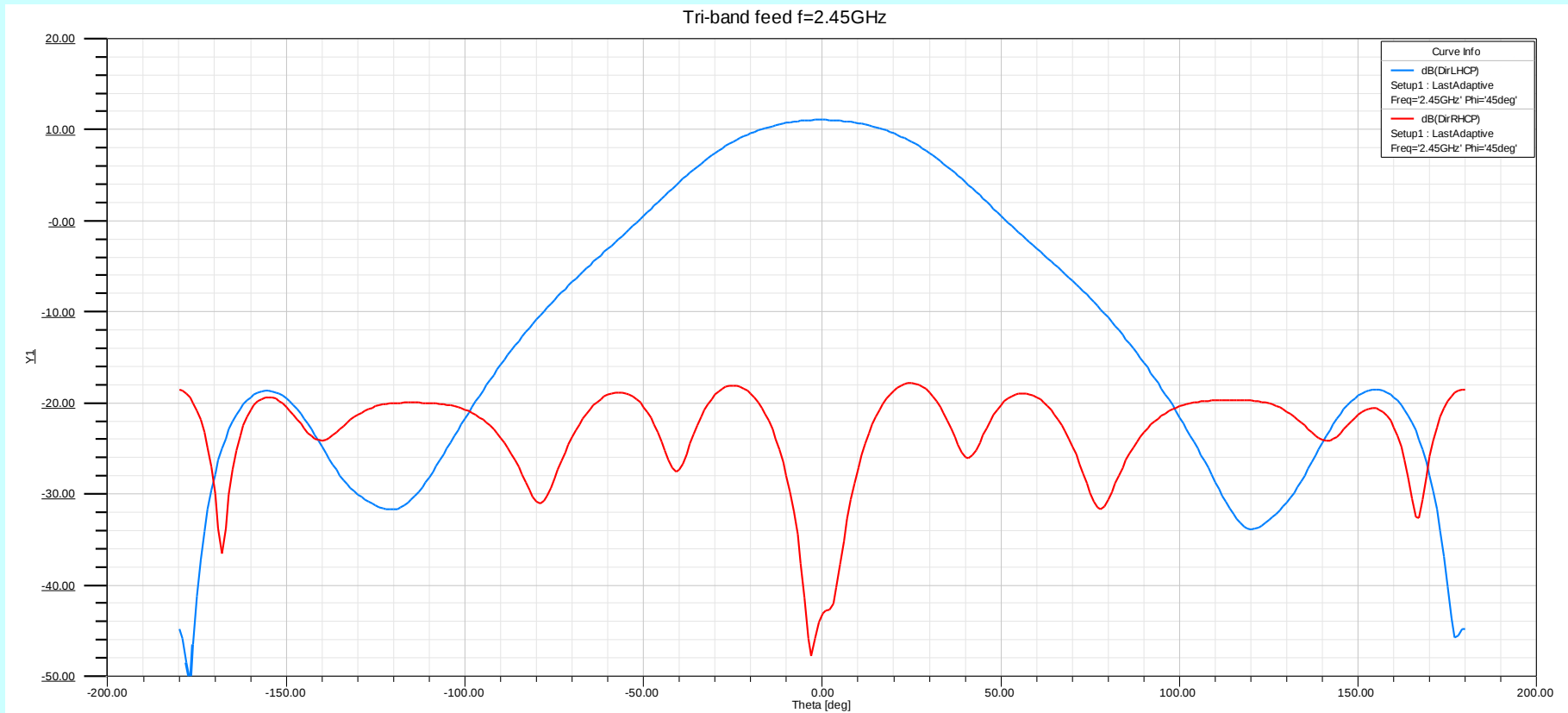
- Circular waveguide supports dual polarisation
- Septum polarizer obtains directly both circular polarisations with a slim stepped metal sheet in the waveguide



Septum polarizer developed in Yebes

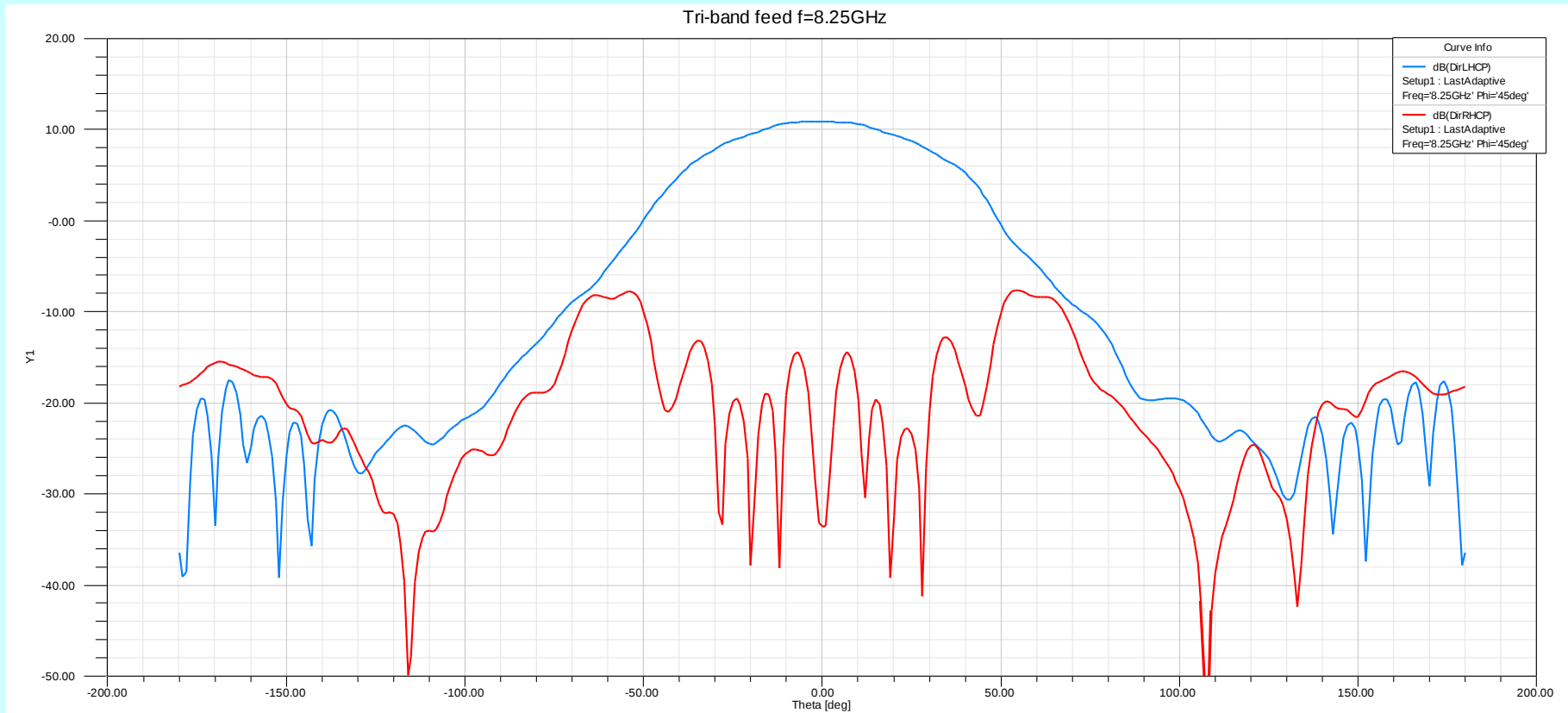


Tri-band Feed Simul.: Radiation Patterns of Feed $f=2.45\text{GHz}$



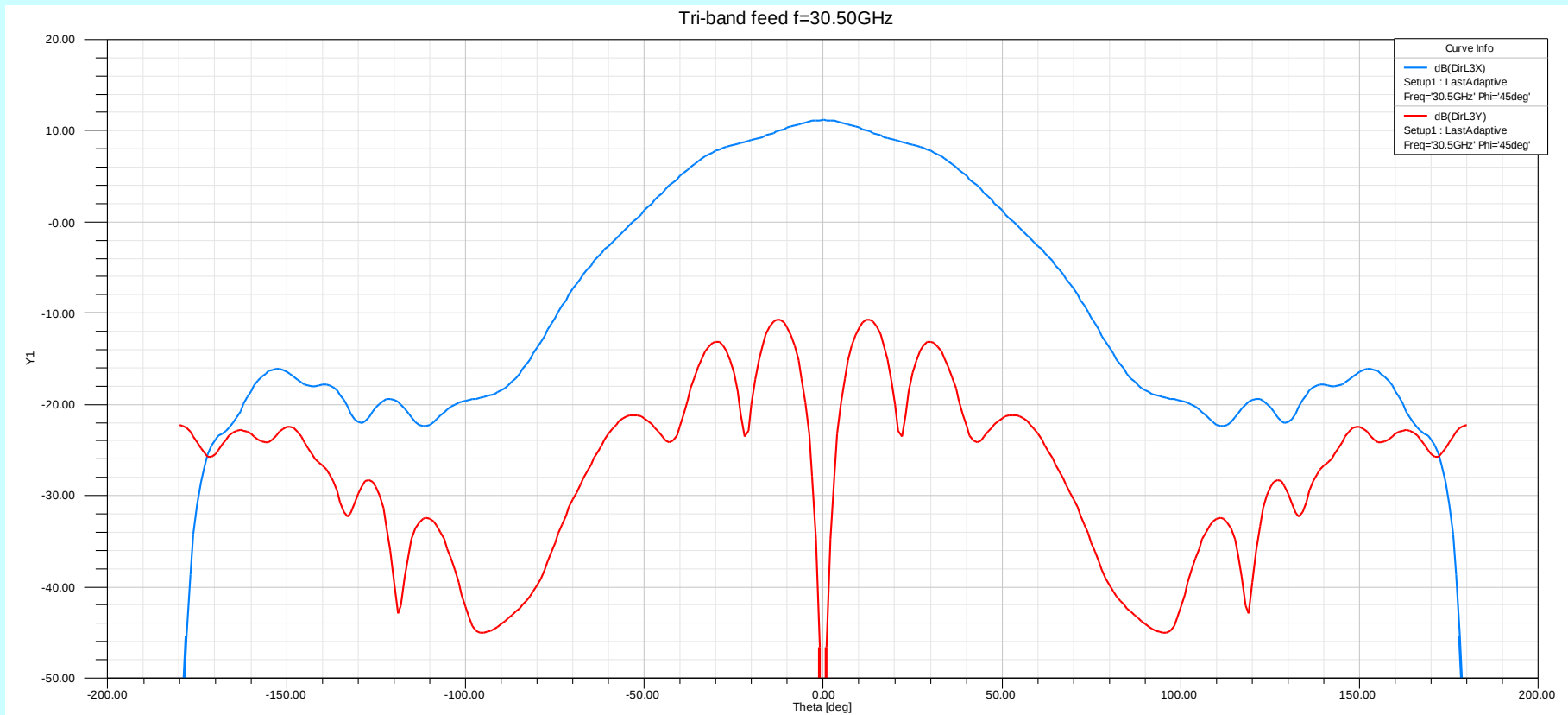


Tri-band Feed Simul.: Radiation Patterns of Feed $f=8.25\text{GHz}$

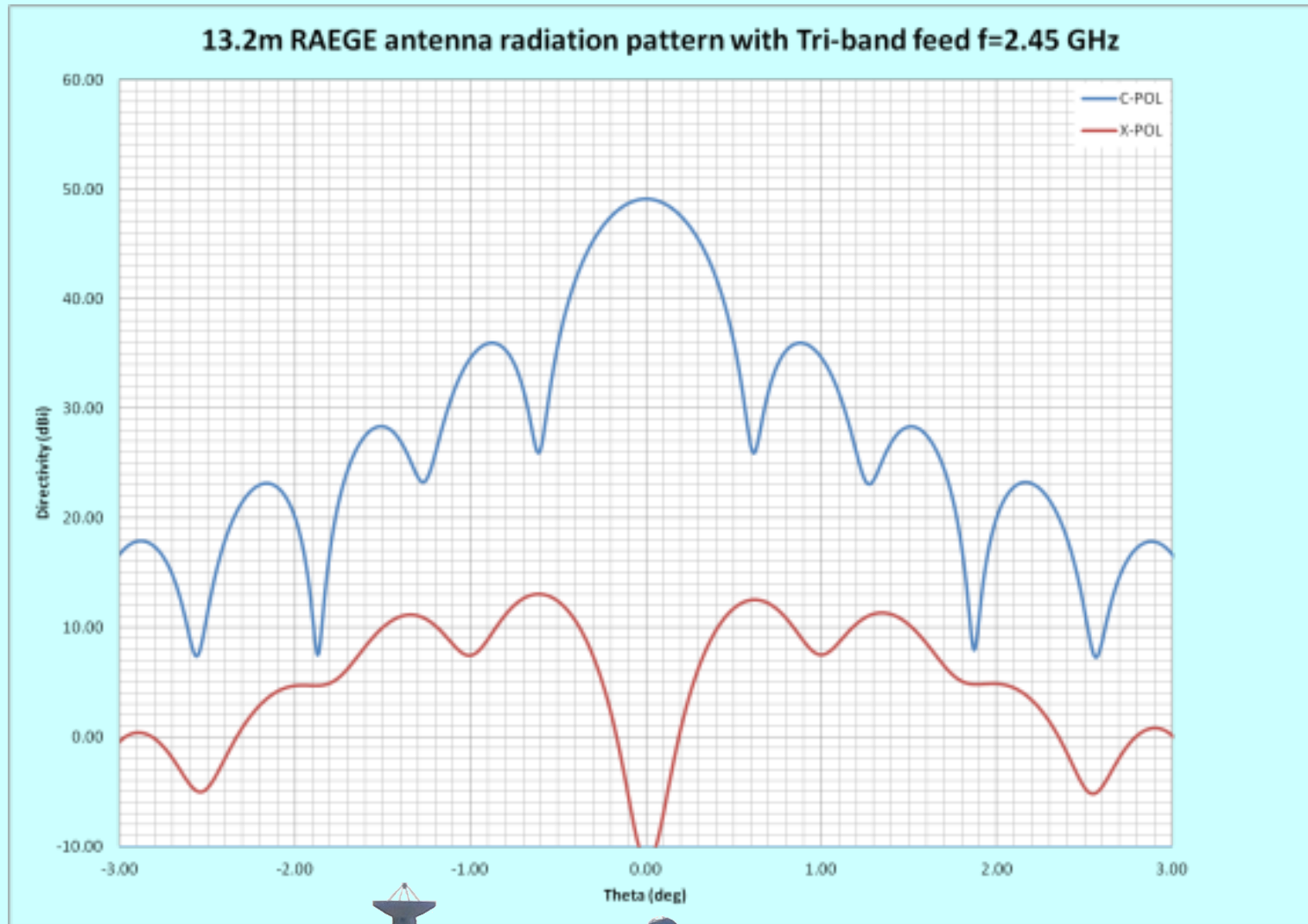




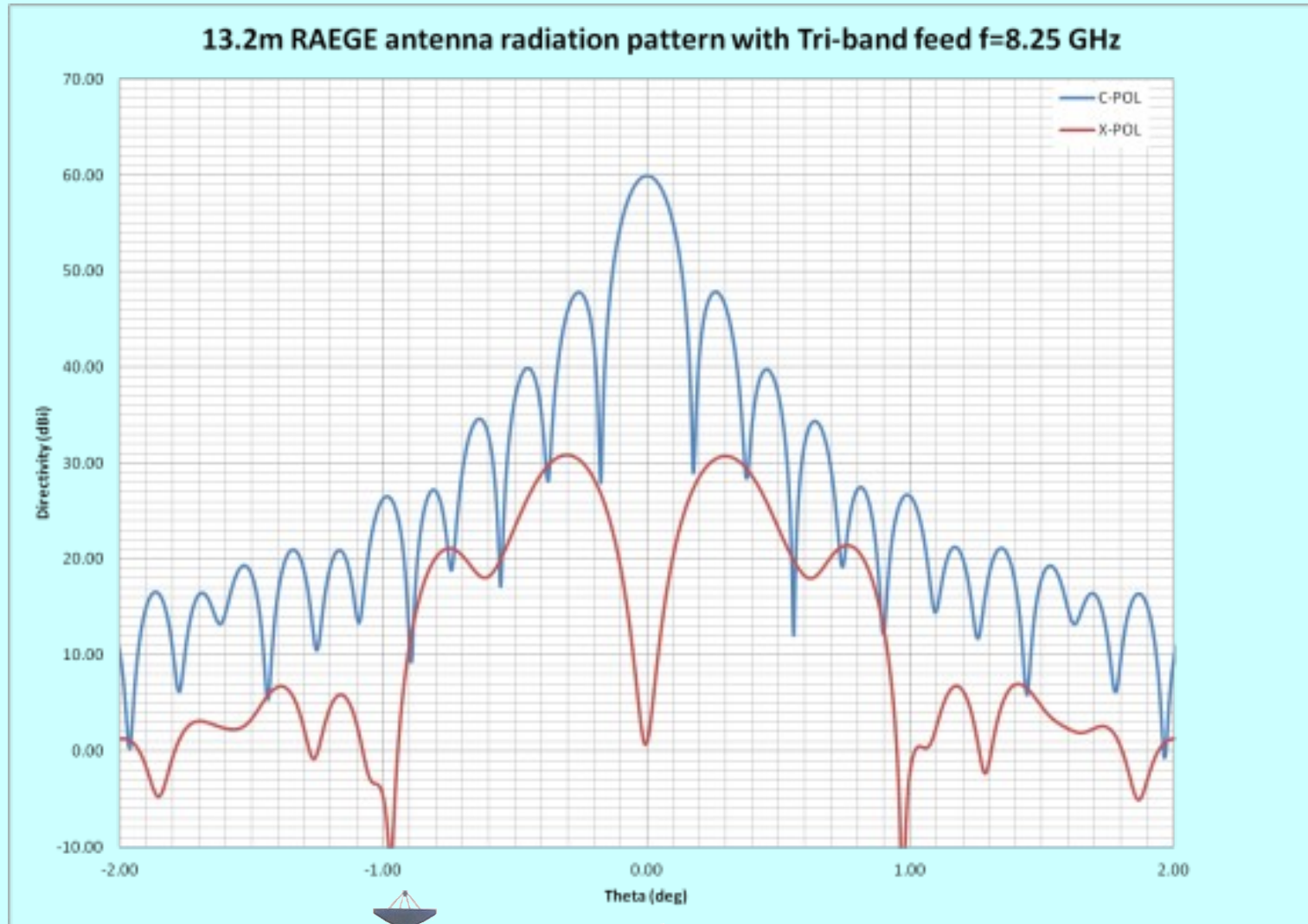
Tri-band Feed Simul.: Radiation Patterns of Feed $f=30.50\text{GHz}$



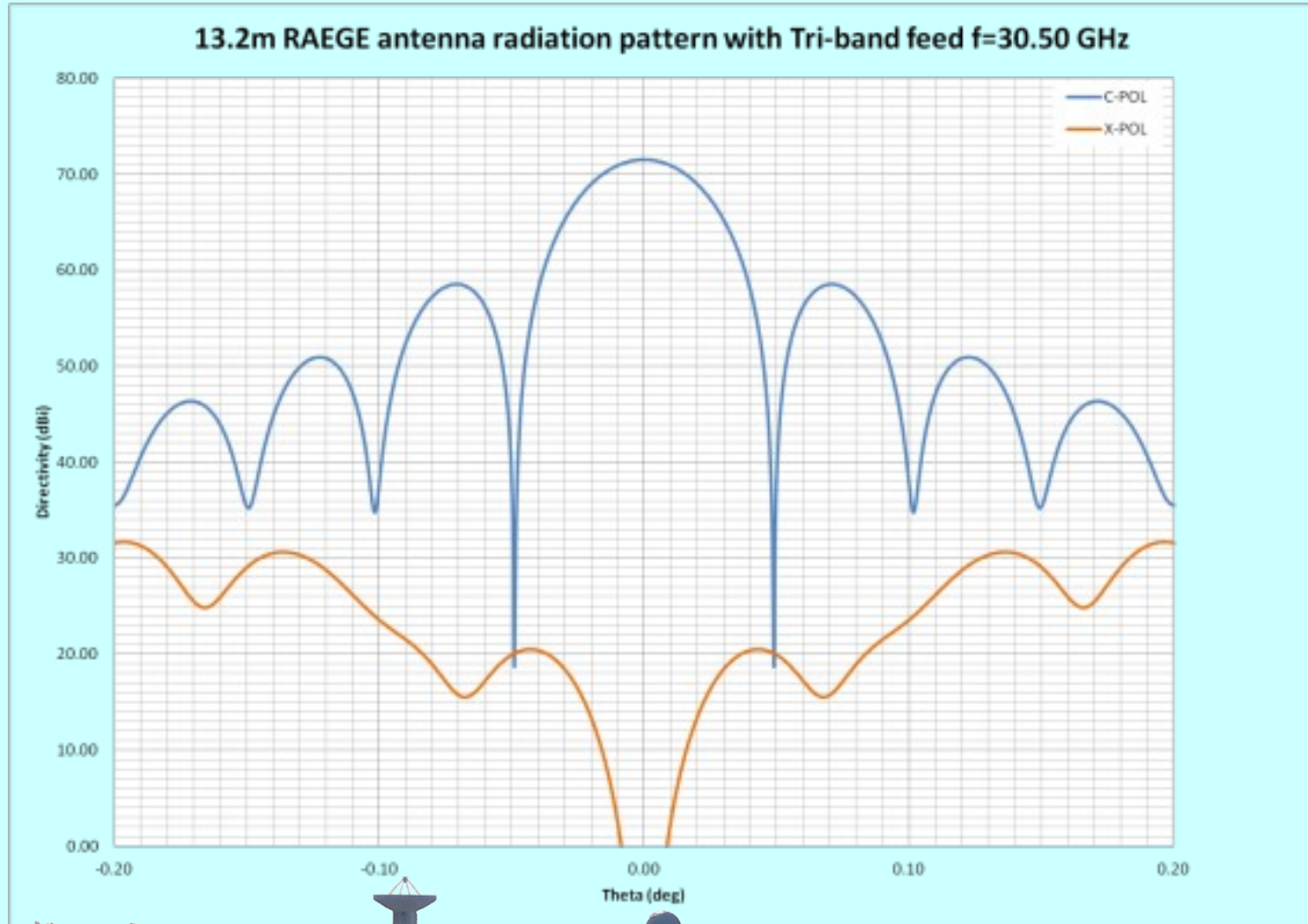
13.2m RAEGE Antenna Simul.: Radiation Patterns $f=2.45\text{GHz}$



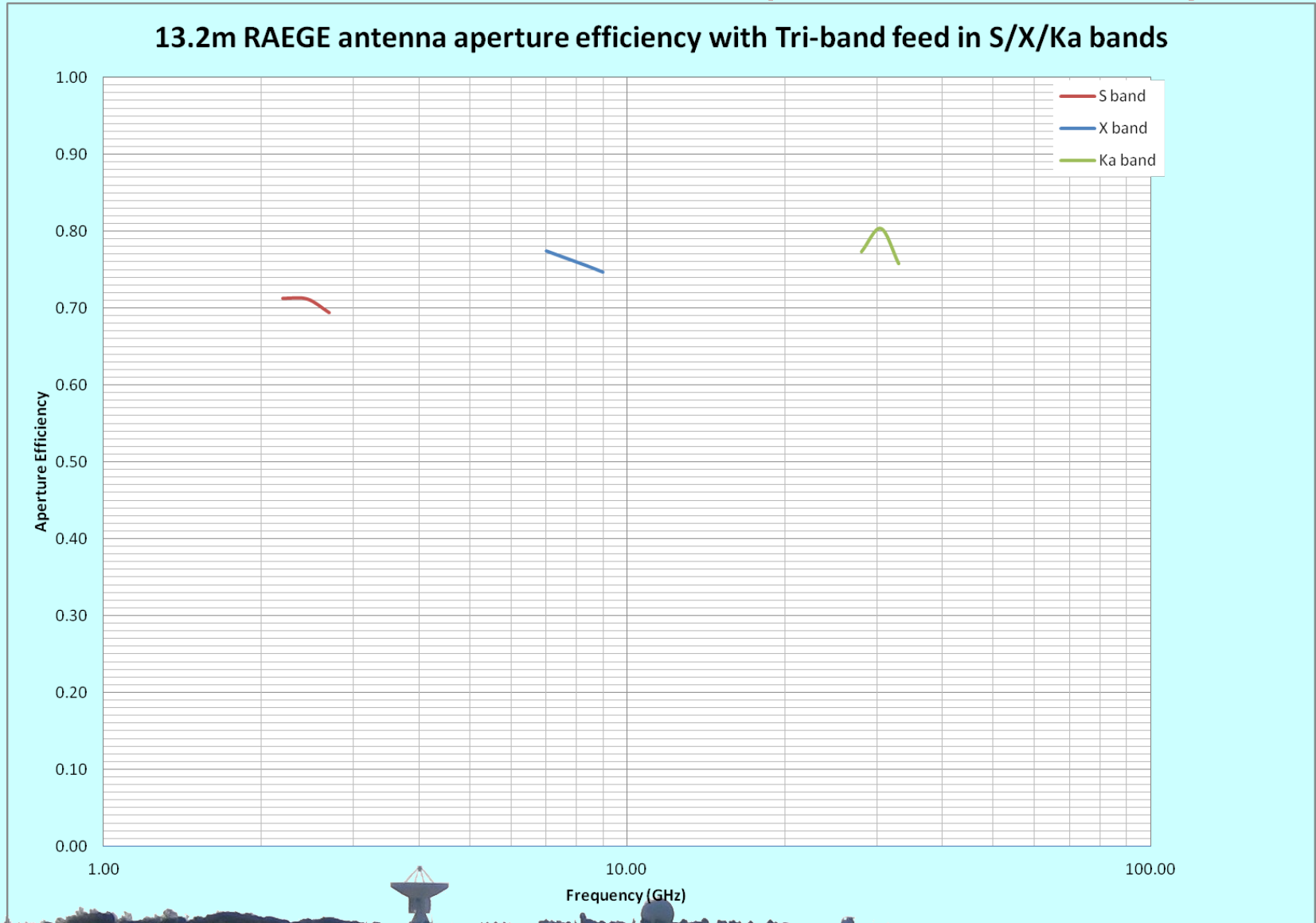
13.2m RAEGE Antenna Simul.: Radiation Patterns $f=8.25\text{GHz}$



13.2m RAEGE Antenna Simul.: Radiation Patterns $f=30.50\text{GHz}$

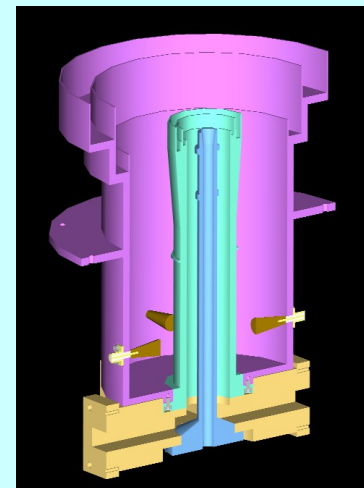
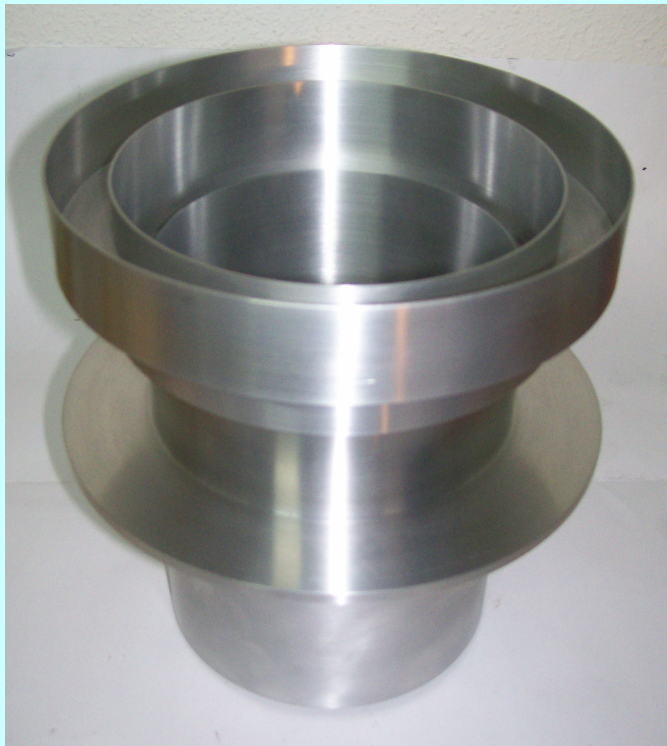


13.2m RAEGE Antenna Simul.: Aperture Efficiency



Current Status

- Feed is being manufactured



Conclusions

- The Yebes Observatory is developing a 1st light receiver for the RAEGE antennas commission in S/X/Ka bands
- All the front-end components (feed included) are inside of the cryostat to improve sensibility
- The feed is a tri-band coaxial type in S/X bands and smooth circular in Ka band.
- It is dual circular polarised with hybrids in S/X bands and with a septum polarizer in Ka band
- Simulations of the CAD model in the RAEGE antenna optics show a 0.71, 0.76 and 0.80 aperture efficiency for S/X/Ka respectively
- Currently the feed is being manufactured in the workshop and we expect to test it soon

