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

- **Red Atlantica de Estaciones Geodinámicas y Espaciales. Atlantic Network of Geodynamic and Spatial Stations**
- 4 VLBI2010 antennas

- Fulfils 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
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
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=8.25GHz
Tri-band Feed Simul.: Radiation Patterns of Feed
f=30.50GHz
13.2m RAEGE Antenna Simul.: Radiation Patterns $f=2.45\text{GHz}$
13.2m RAEGE Antenna Simul.: Radiation Patterns
f=8.25GHz
13.2m RAEGE Antenna Simul.: Radiation Patterns
f=30.50GHz
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.