DEPARTAMENTO DE INGENIERÍA ELÉCTRICA
UNIVERSIDAD DE CHILE

Cerro Calán
Observatorio Astronómico Nacional

UChile contributions for ALMA

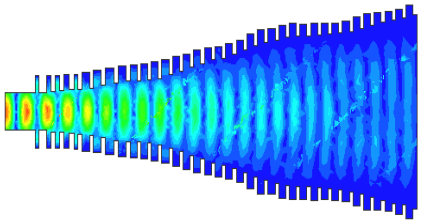
F. P. Mena
Millimeter & Submm Wave Laboratory
Depts. of Electrical Engineering & Astronomy
Universidad de Chile

Content

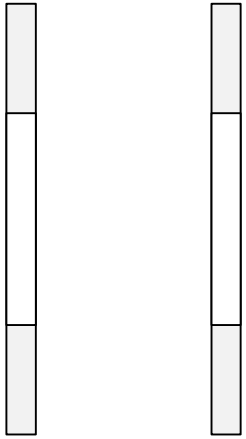
- Optics for Bands 1 and 2+3.
- OMT for Band 2+3
- Packaging of active components
- Other activities at UChile

Optics for Bands 1 and 2+3.

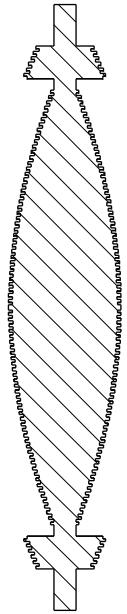
- General concept
  - Quasioptical analysis + simulation for optimization



Optimized profile
+
mechanical restrictions



15 K 110 K

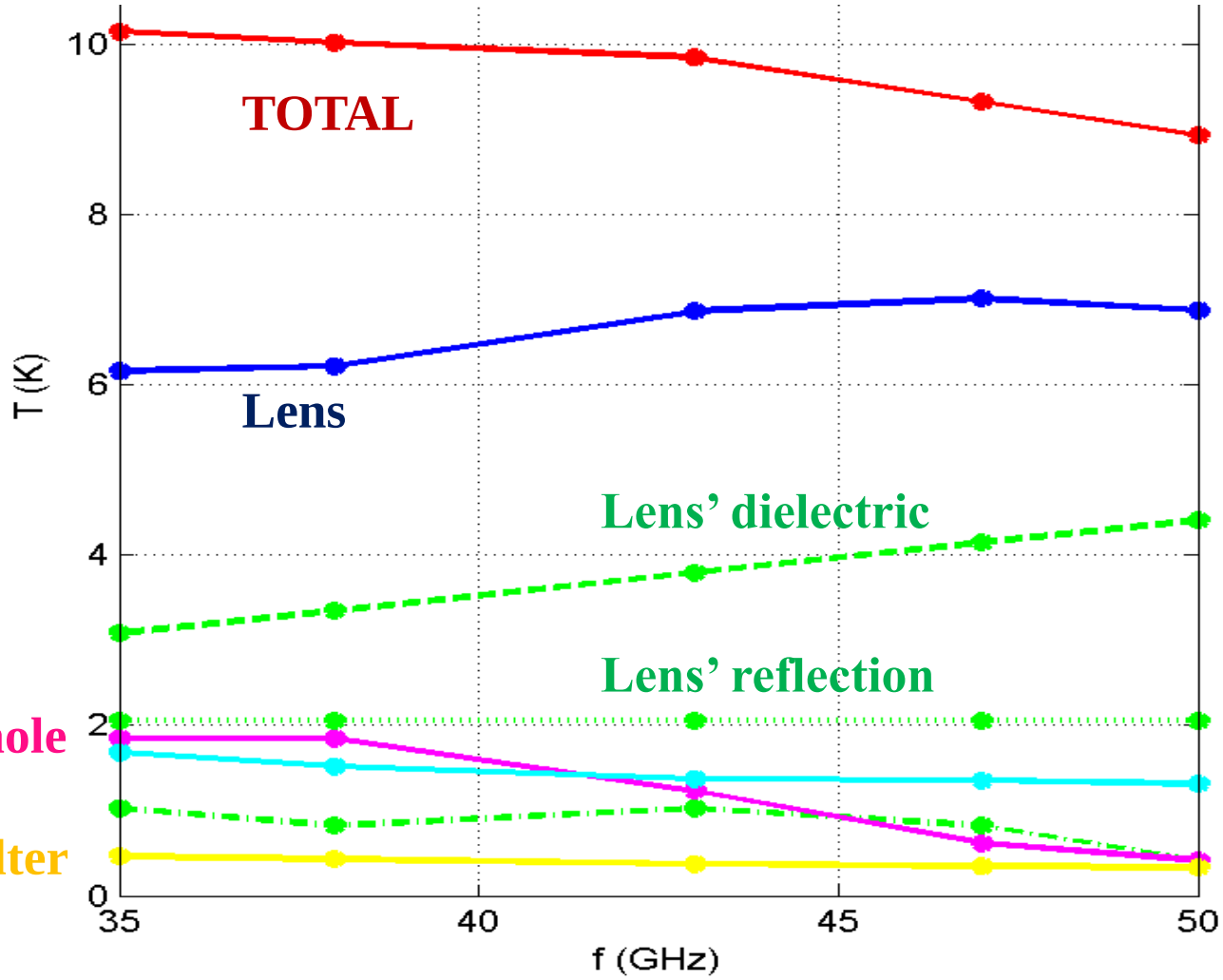


Fresnel bi-hyperbolic lens

Optics for Bands 1 and 2+3.

- General concept and design
  - Noise contribution of optics (HDPE lens)

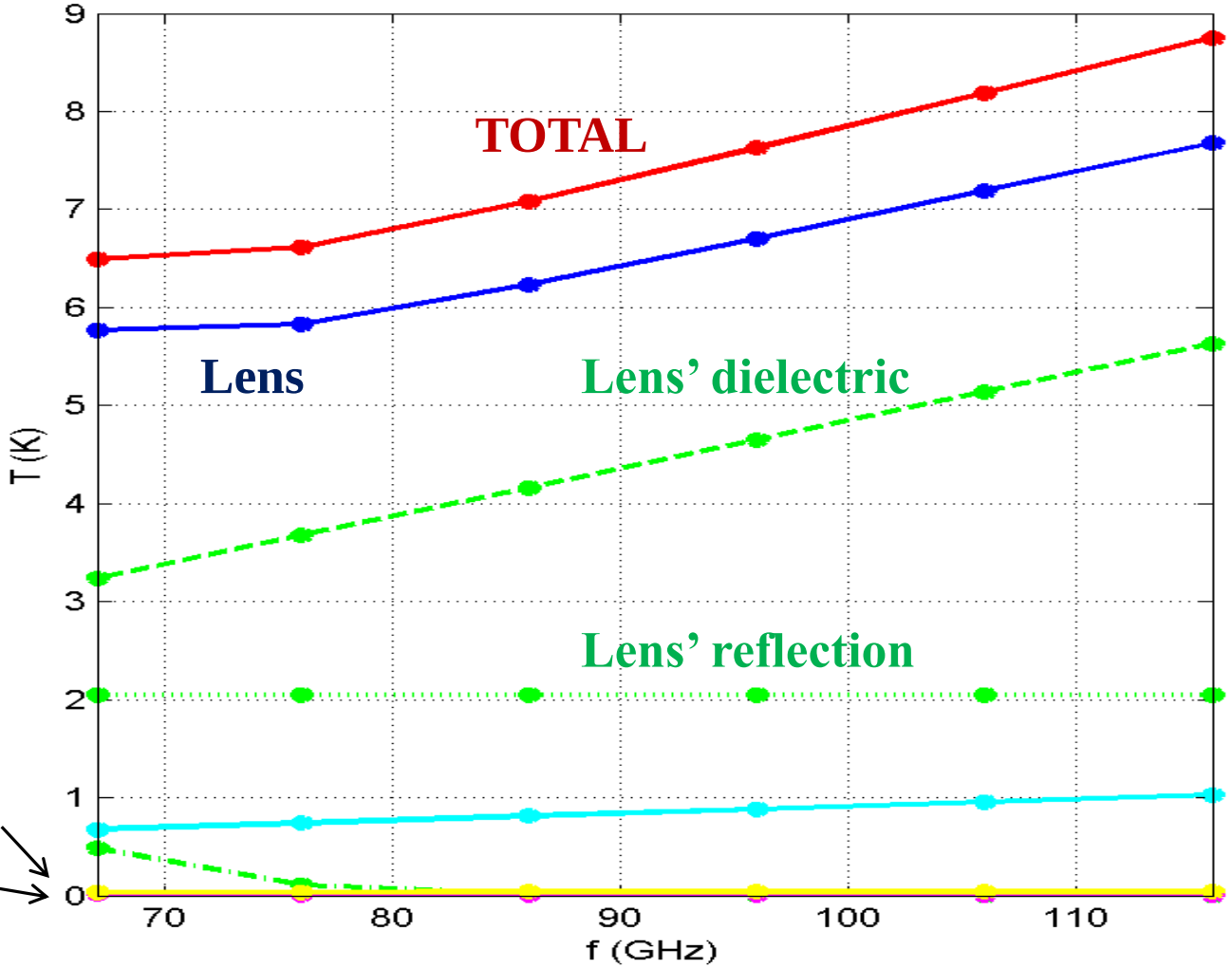
Band 1



Optics for Bands 1 and 2+3.

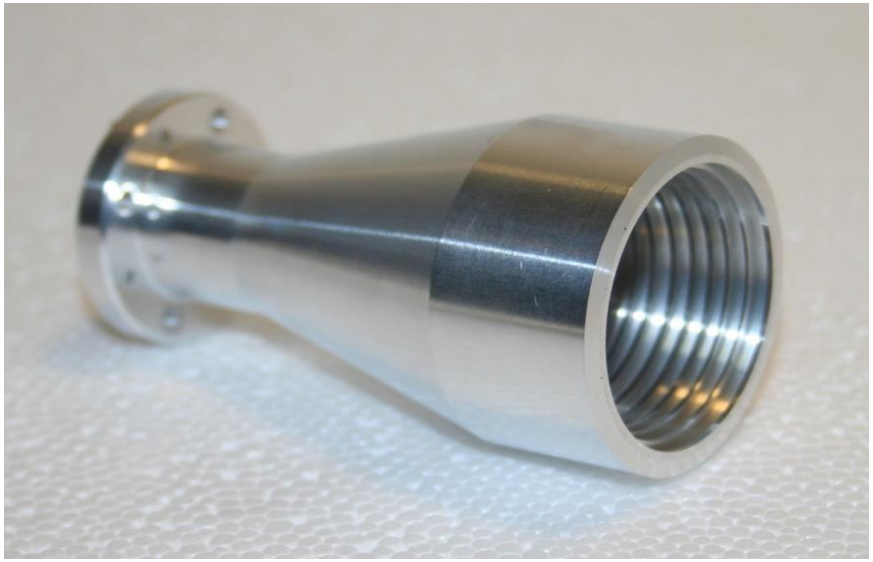
- General concept and design
  - Noise contribution of optics (HDPE lens)

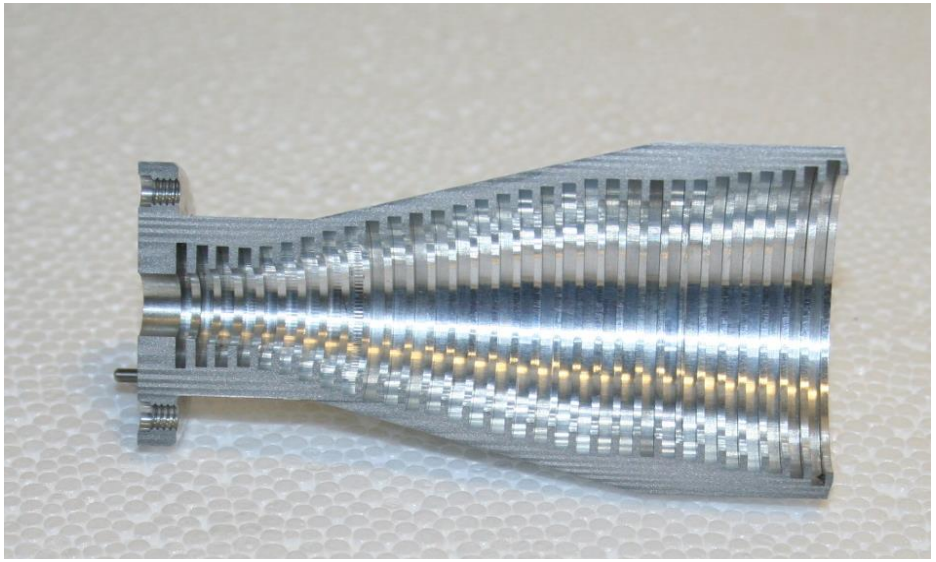
Band 2+3



Optics for Bands 1 and 2+3.

- Construction
  - Horn
    - Aluminum machined with a high-precision CNC lathe.
    - Errors within 5 μm.
    - **Band 1:** one single block.





Optics for Bands 1 and 2+3.

- Construction
  - Horn
    - **Band 2+3:** Two versions.
    - V1: split block.
    - Tested at ESO during phase A

Optics for Bands 1 and 2+3.

- Construction
  - Horn
    - **Band 2+3:** Two versions.
    - V2: one block + 8 rings.
    - To be tested at ESO next week

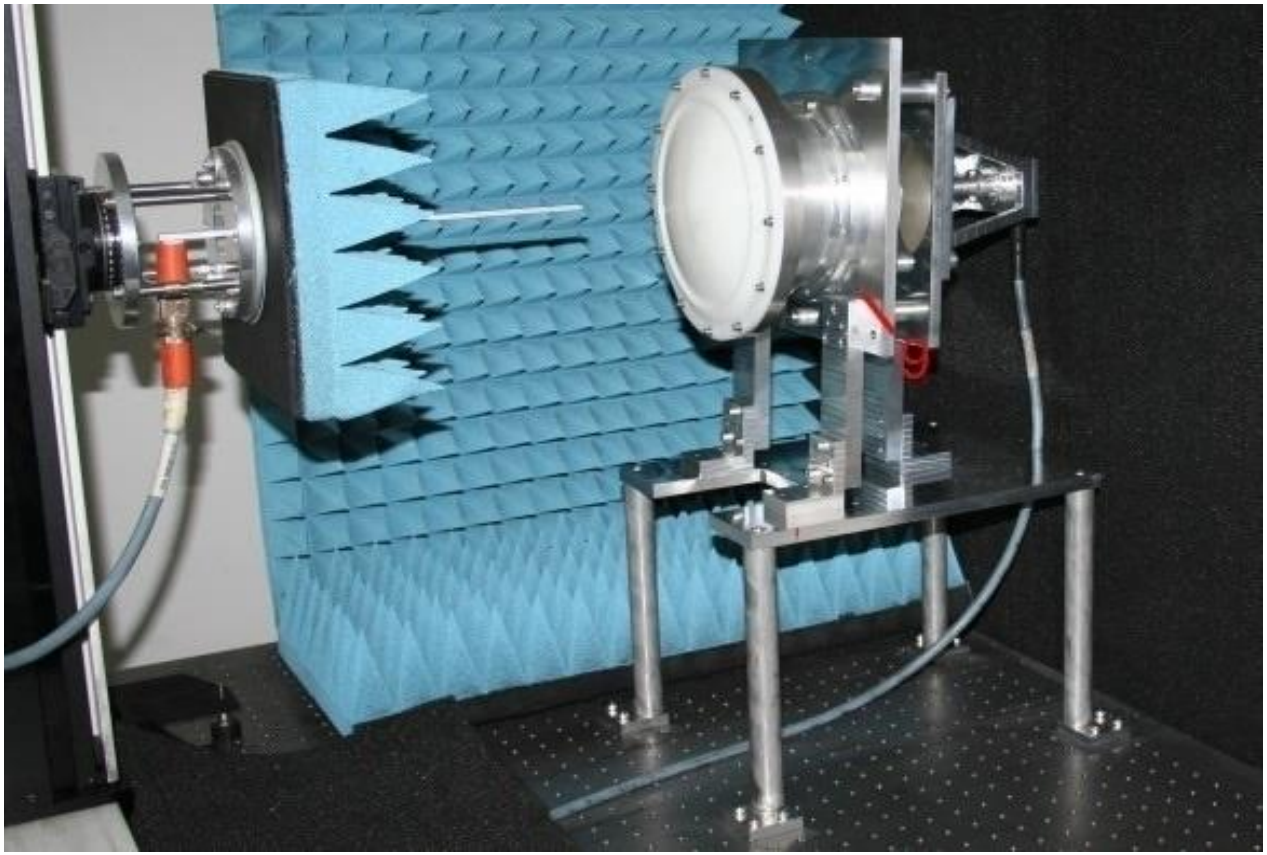
Optics for Bands 1 and 2+3.

- Construction
  - Lens
    - Machined from a well characterized HDPE block.

Band 1 **Band 2+3**

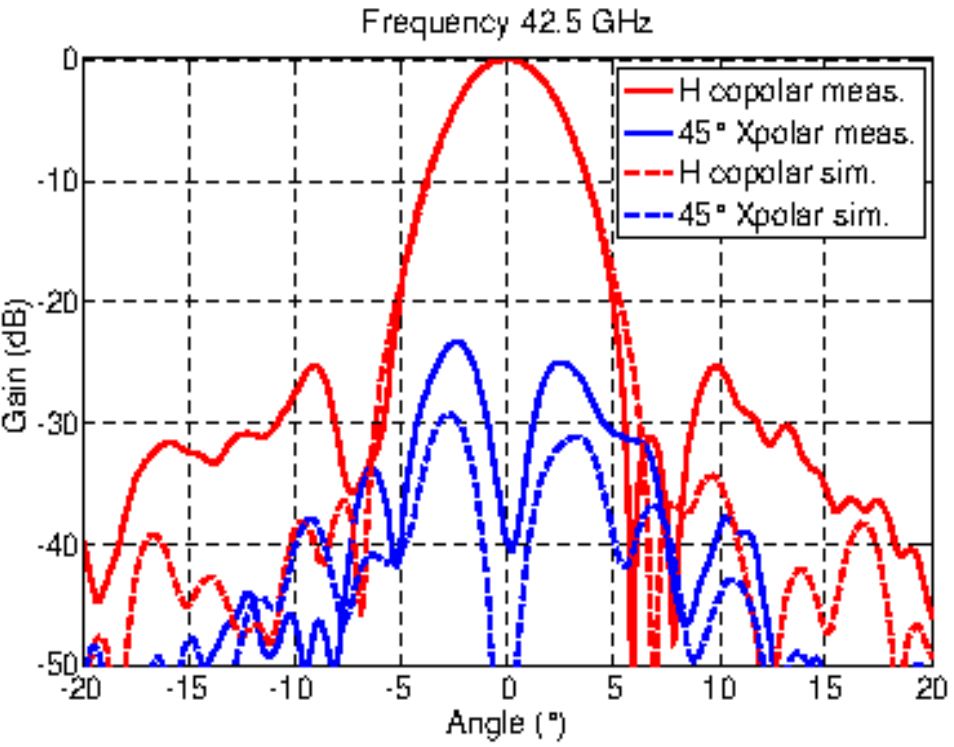
Optics for Band 1

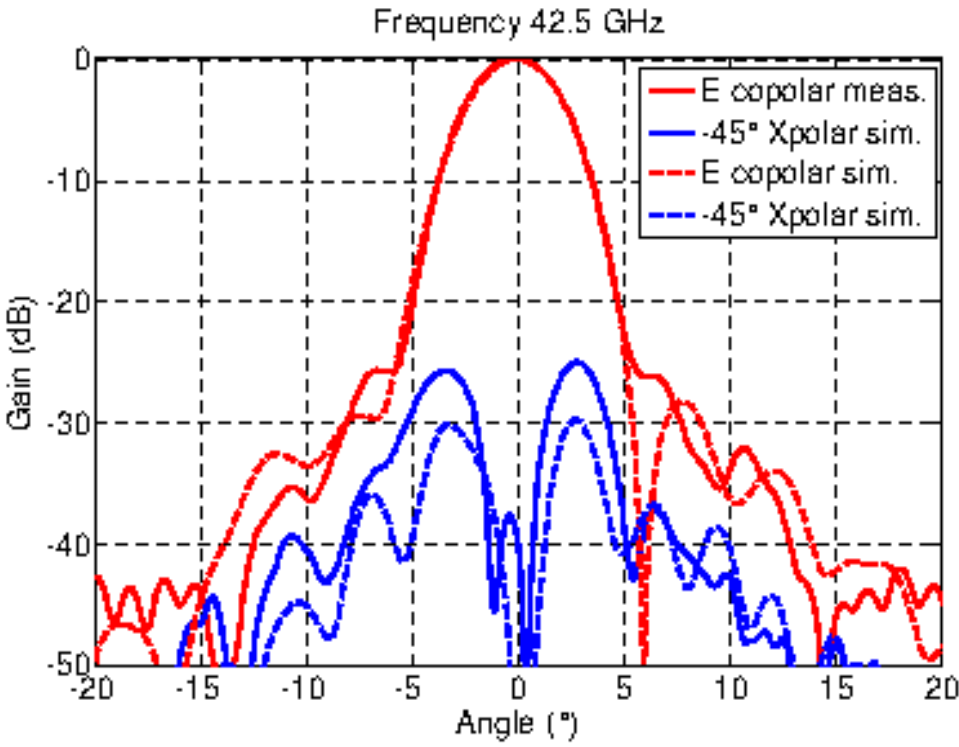
- Experiment
  - Anechoic chamber @ UChile



Optics for Band 1

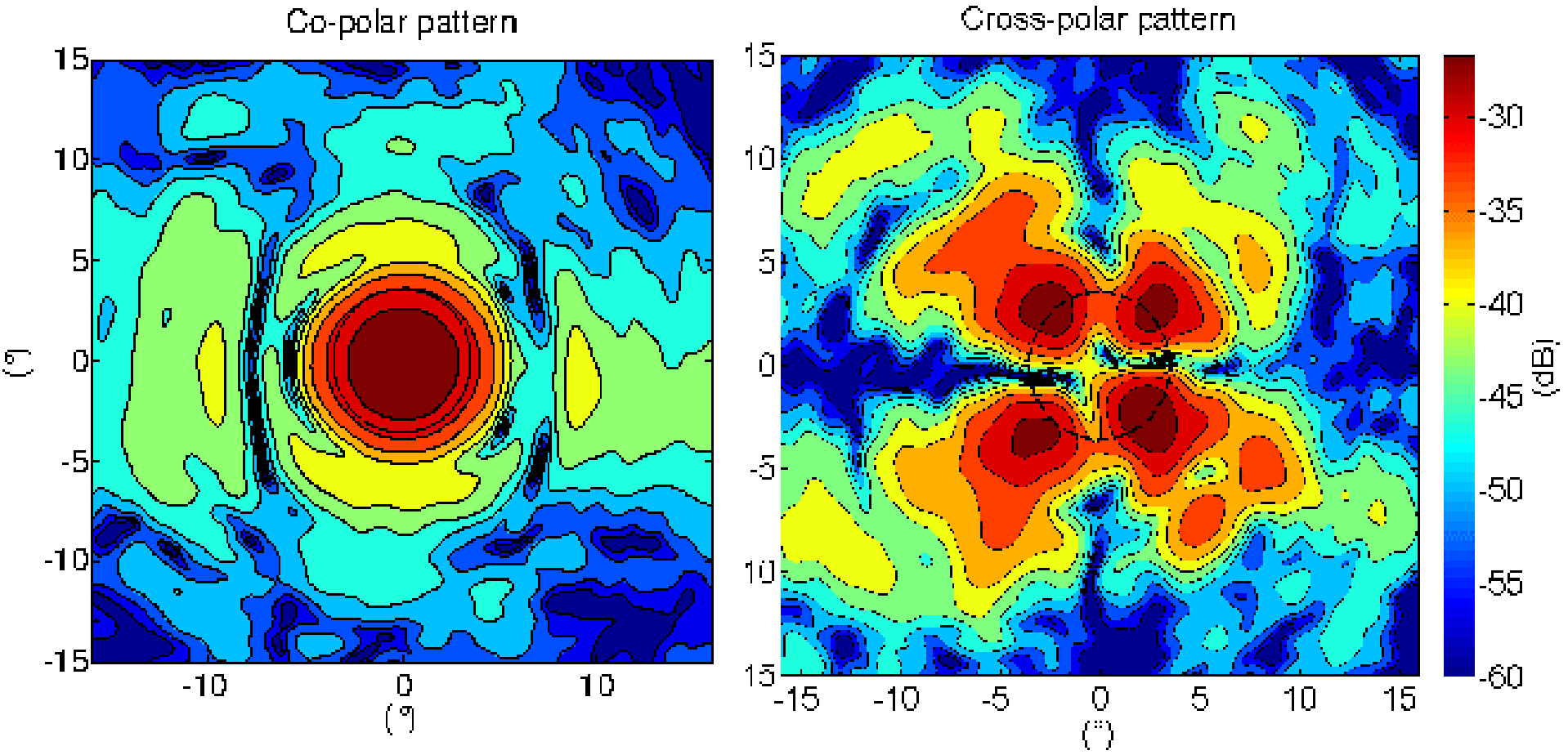
- Results
  - Beam pattern (measured & simulated)





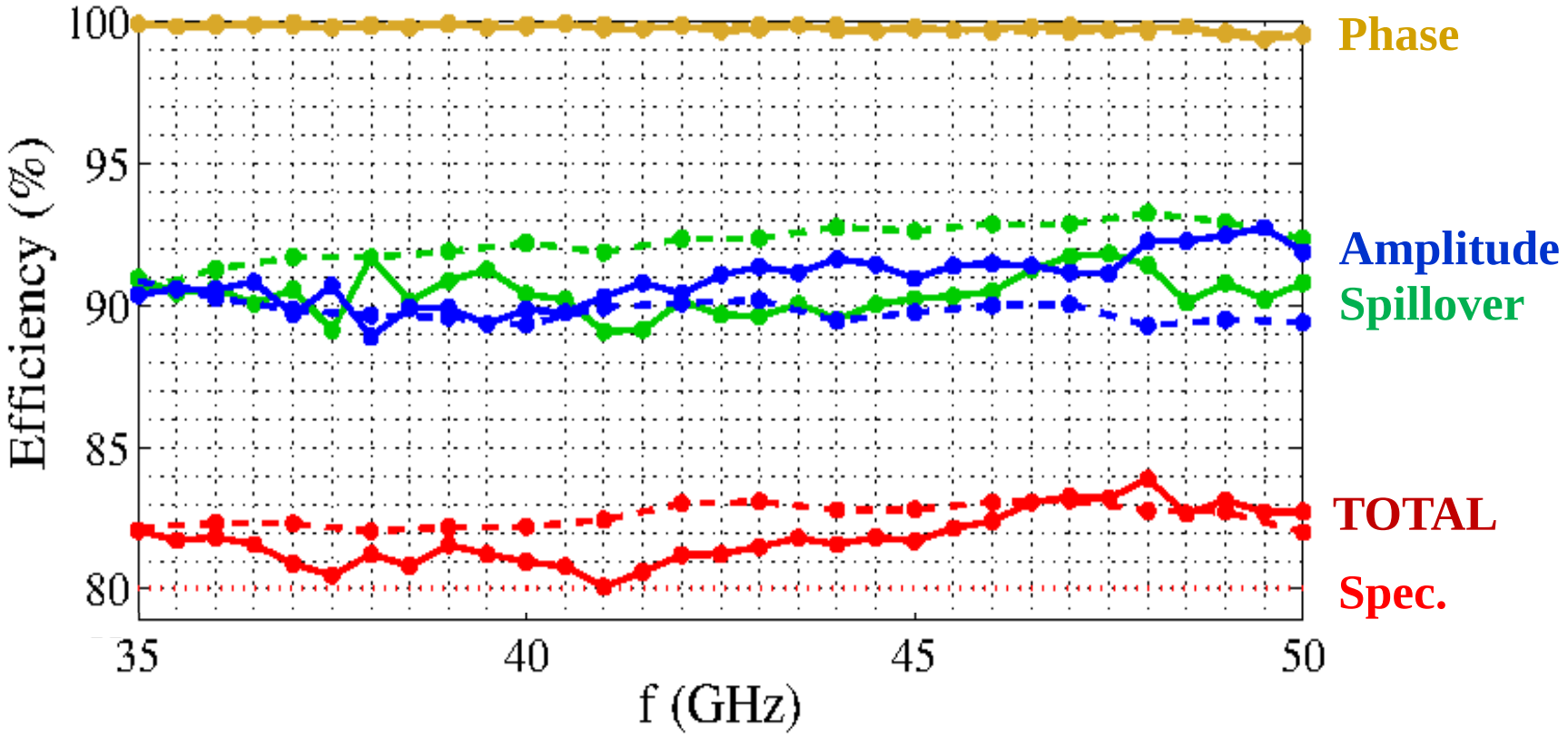
Optics for Band 1

- Results
  - Beam pattern (42.5 GHz)



Optics for Band 1

- Results
  - Total efficiency: ~82%
  - Maximum achievable theoretical eff.: 84%

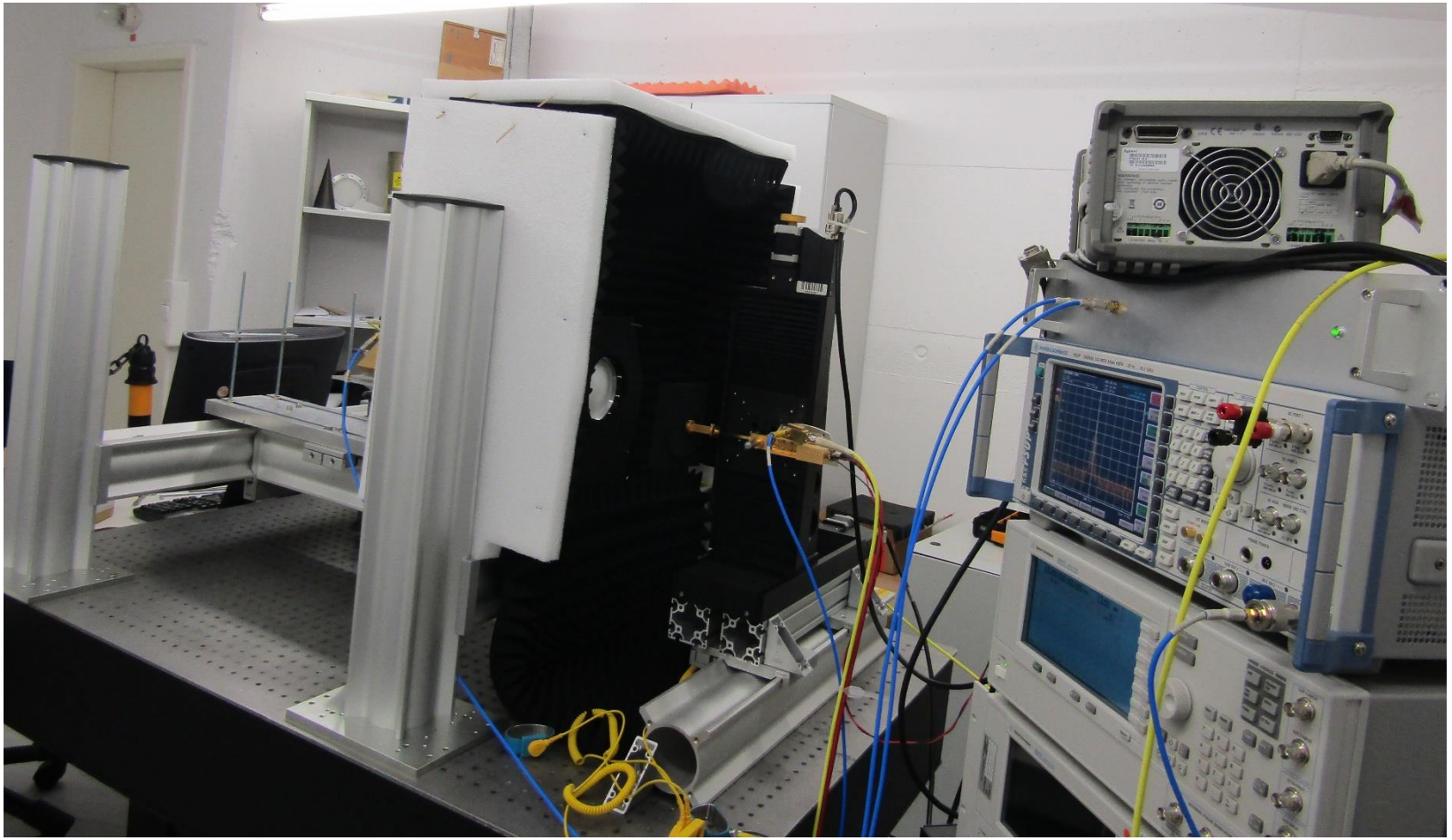


Optics for Band 1

- Ongoing/Future work
  - Entering to production phase
  - Fabrication of a B1 receiver for LLAMA

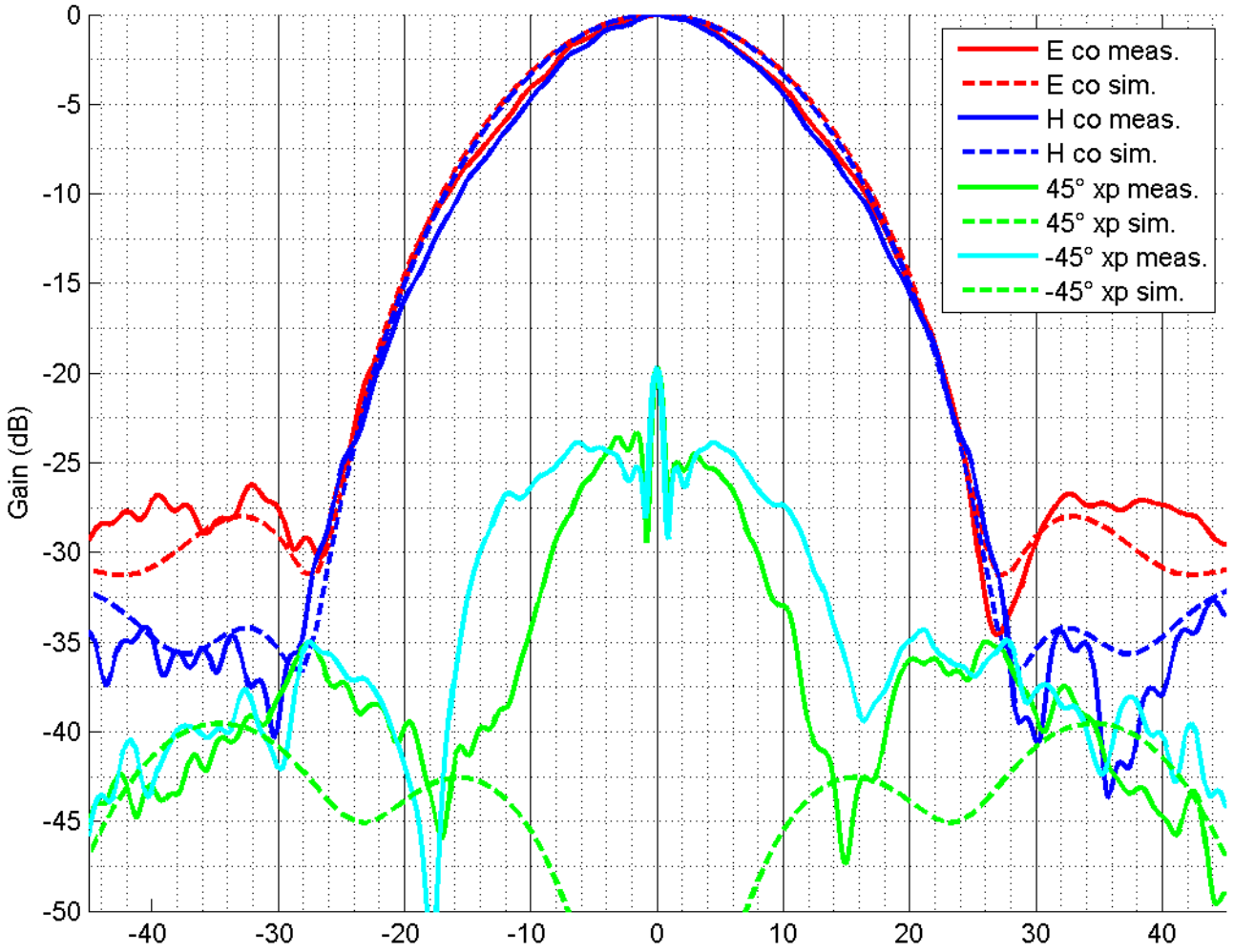
Optics for Band 2+3

- Experiment
  - Setup @ ESO



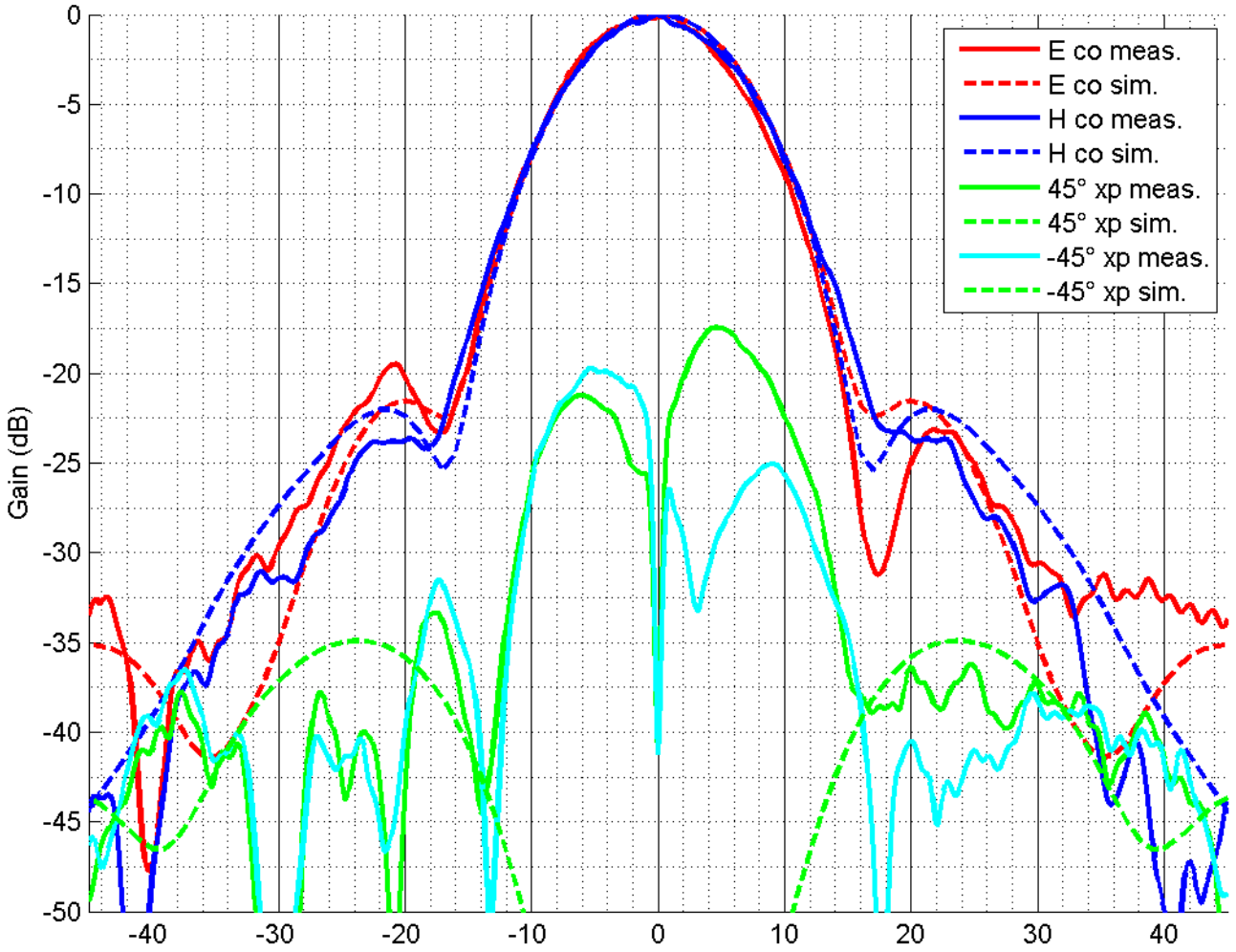
Optics for Band 2+3

- Results
  - Beam pattern split-block horn: 73 GHz



Optics for Band 2+3

- Results
  - Beam pattern split-block horn: 111 GHz

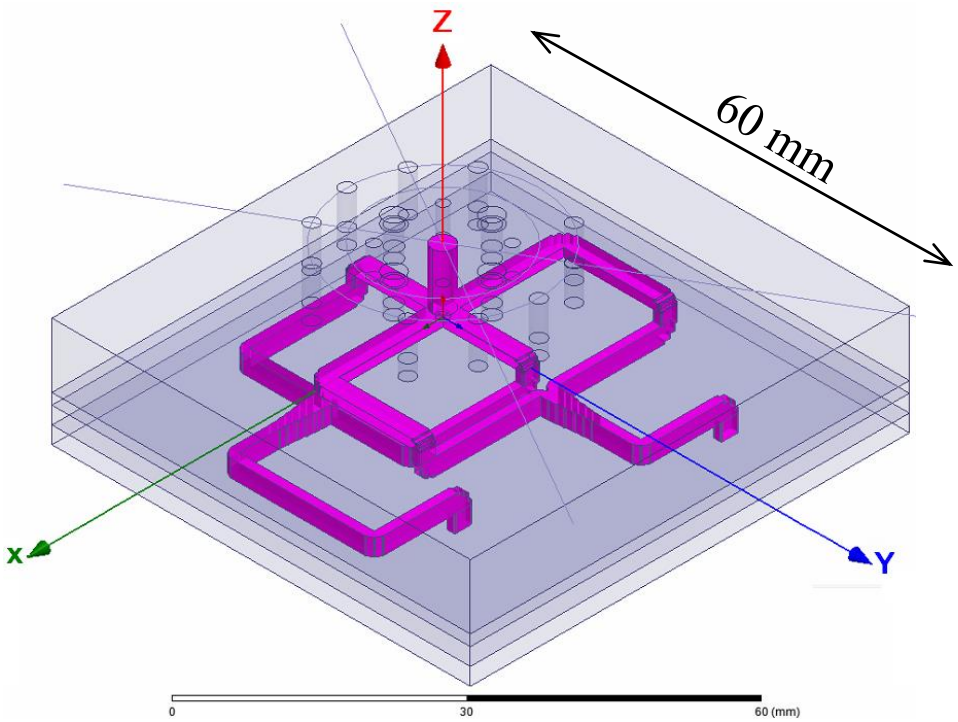


Optics for Band 2+3

- Ongoing/Future work
  - Optimization of components
  - Extension of anechoic chamber @ UChile
  - Study of other materials for lens: High-purity silicon

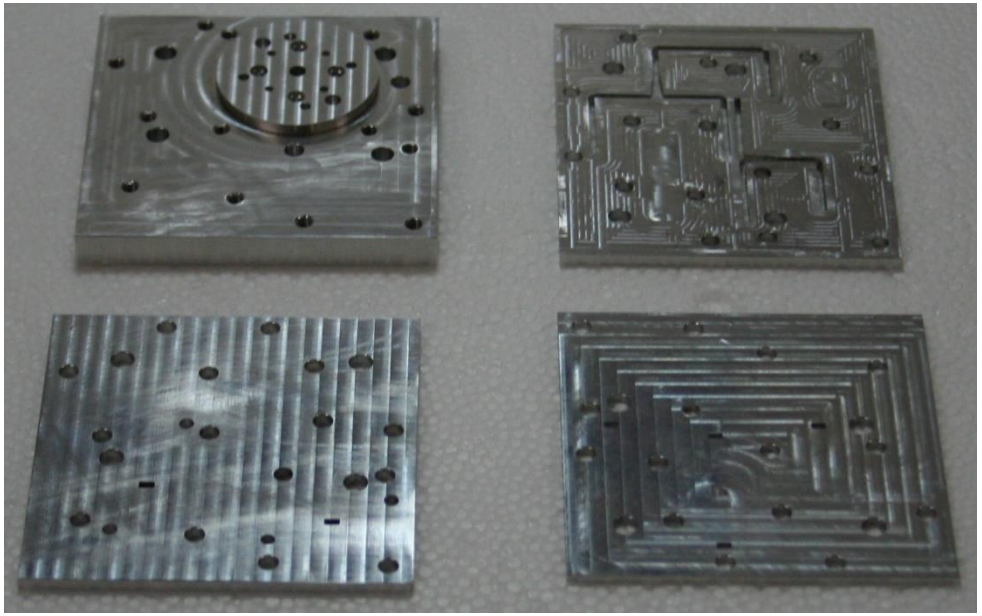
OMT for Band 2+3

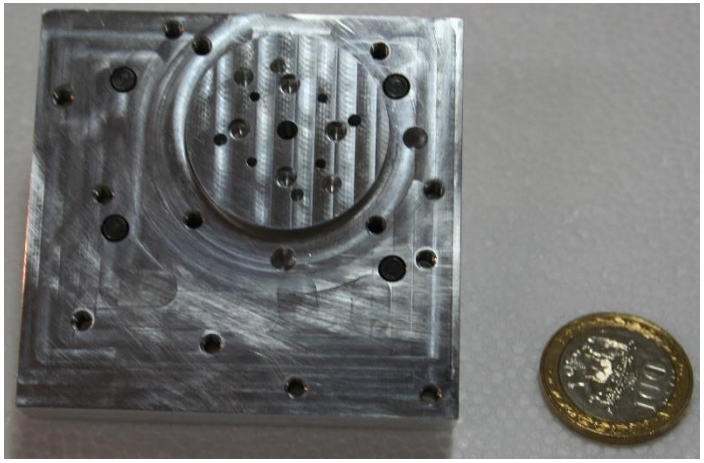
- Design
  - Turnstile junction allows to cover entire bandwidth.
  - Length maximized to avoid trapped modes.



OMT for Band 2+3

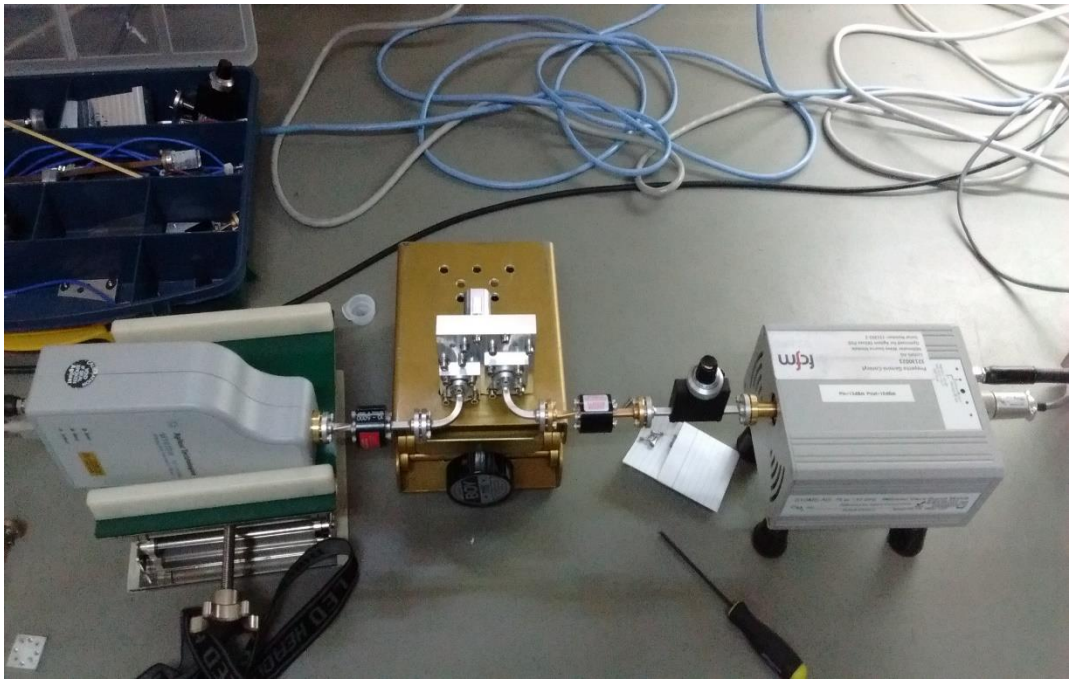
- OMT – construction
  - Four slabs (one of them machined on both sides).
  - Other designs with only three slabs





OMT for Band 2+3

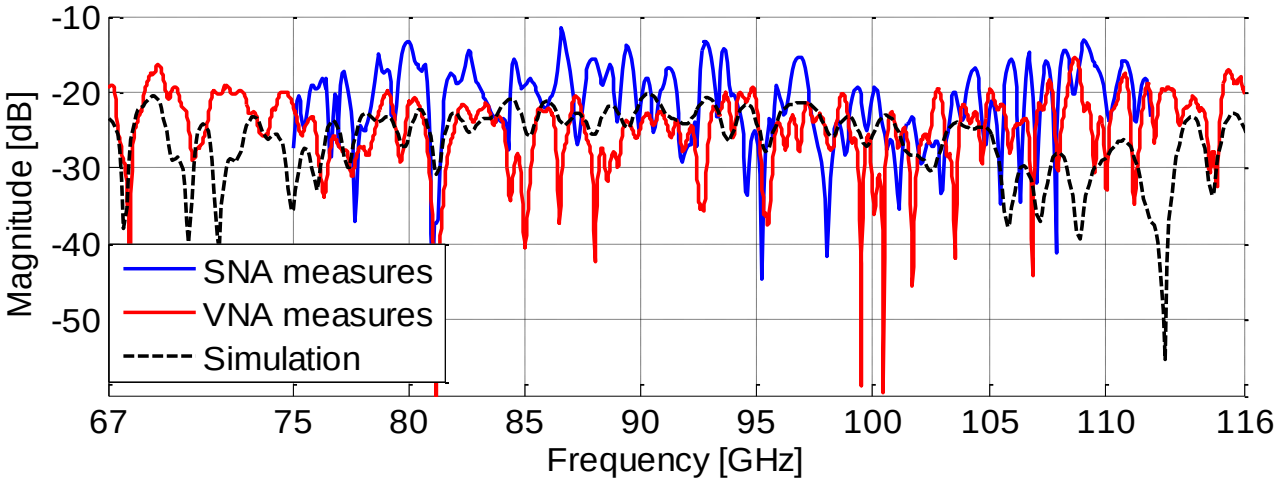
- Experiment
  - Home-made scalar analyzer (bands V & W)
  - Good performance
  - Reflection limited by load to −30 dB



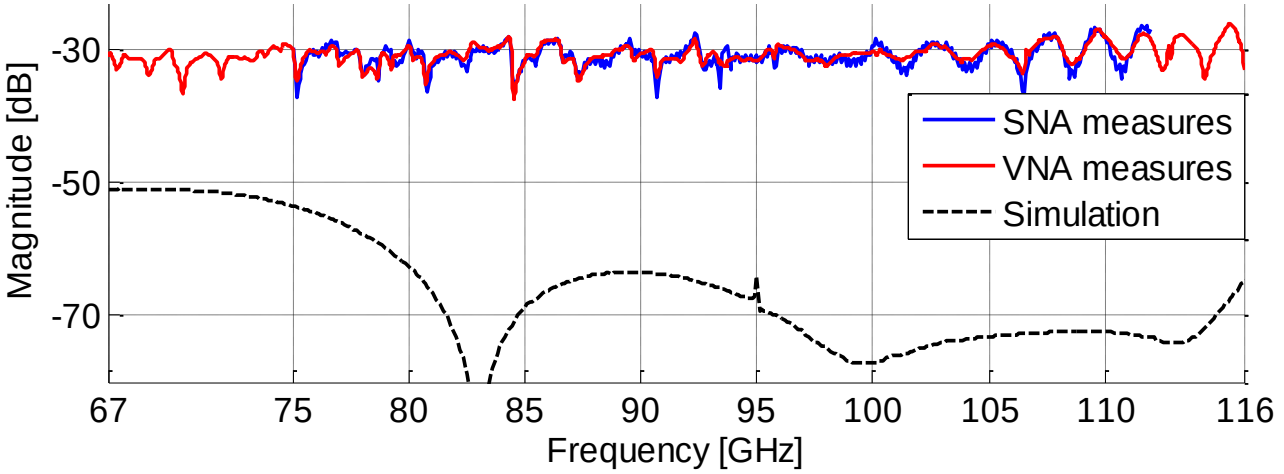
OMT for Band 2+3

- Results
  - Good reflection & isolation

Reflection at output port

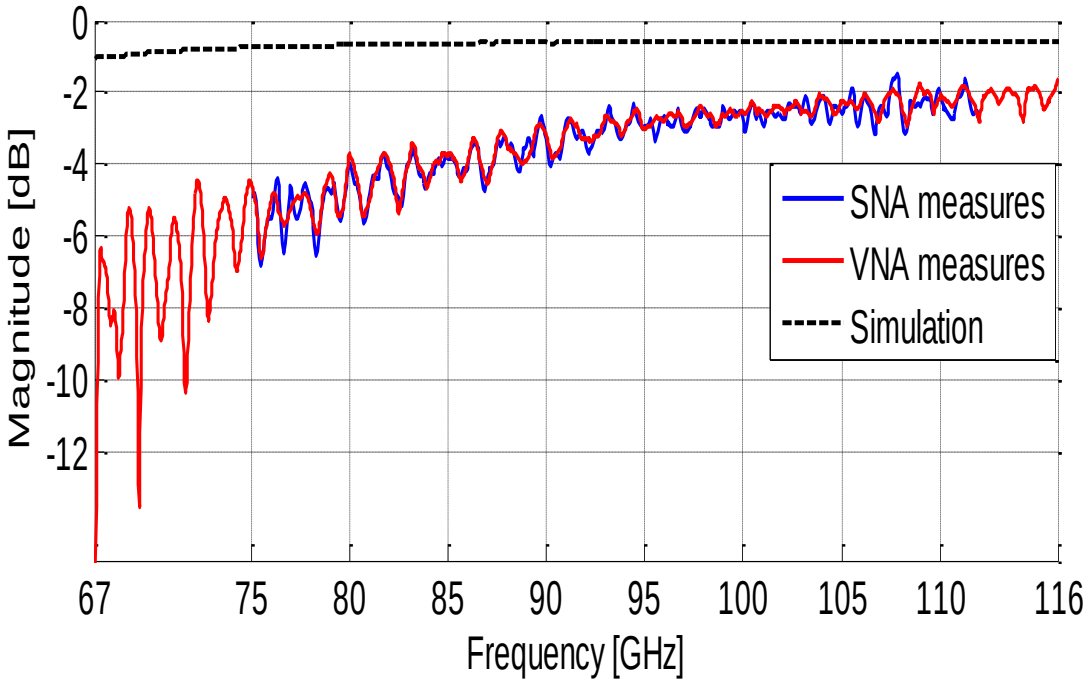


Isolation



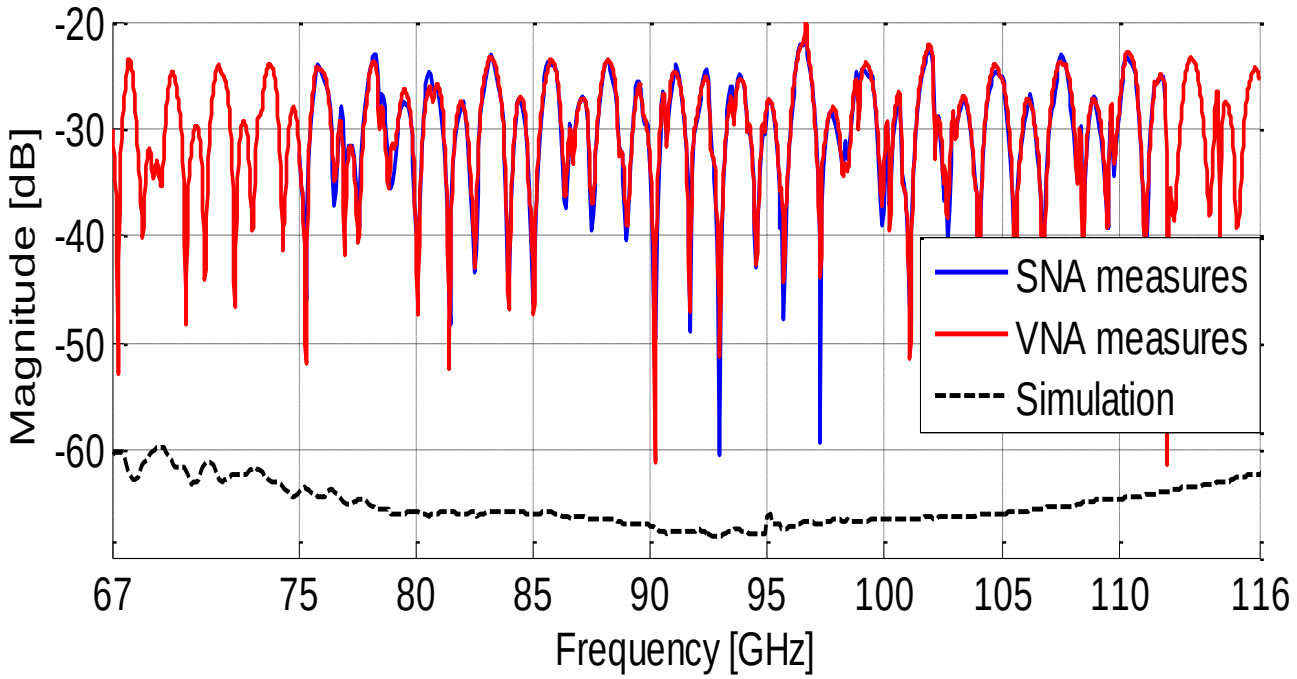
OMT for Band 2+3

- Results
  - Copolar transmission
    - Measured on reflection (transition to be constructed)
    - We believe it relates to slab machined on both sides
    - Other materials to be studied



OMT for Band 2+3

- Results
  - Crosspolar transmission
    - Measured on reflection (transition to be constructed)
    - We believe it relates to slab machined on both sides
    - Other materials to be studied

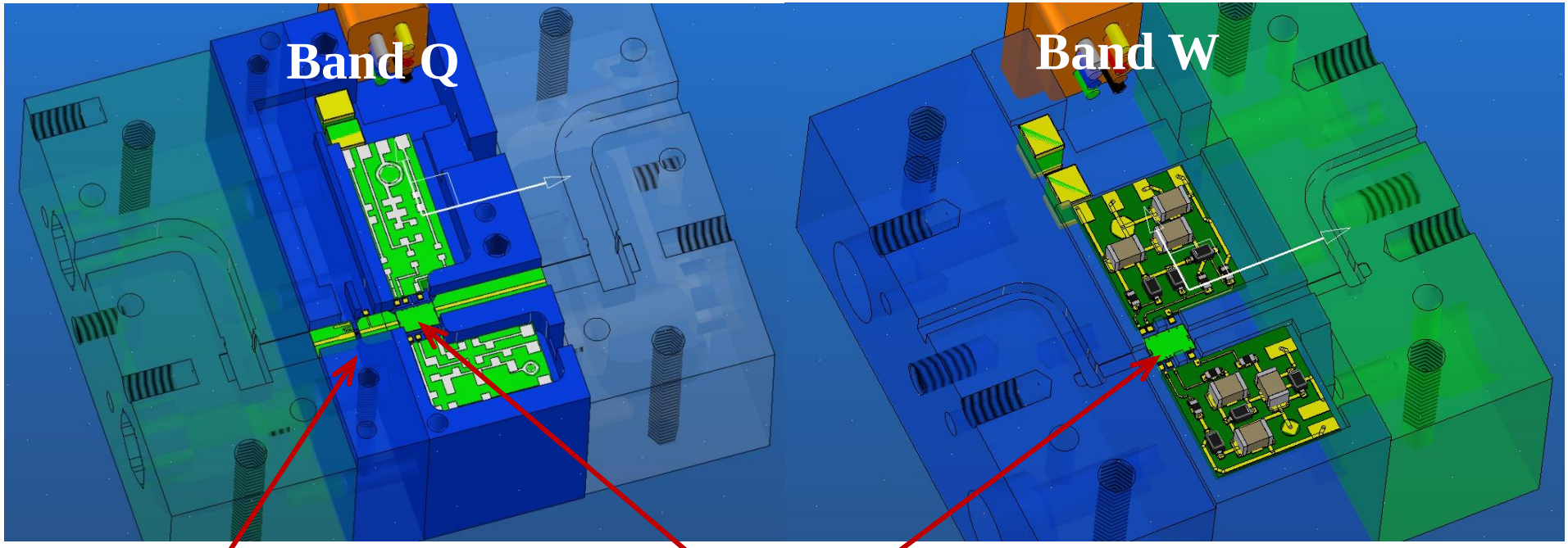


OMT for Band 2+3

- Future work
  - Further optimization
  - Version with only 3 slabs
    - Machined on only one side
  - Study of other materials (copper, bronze)

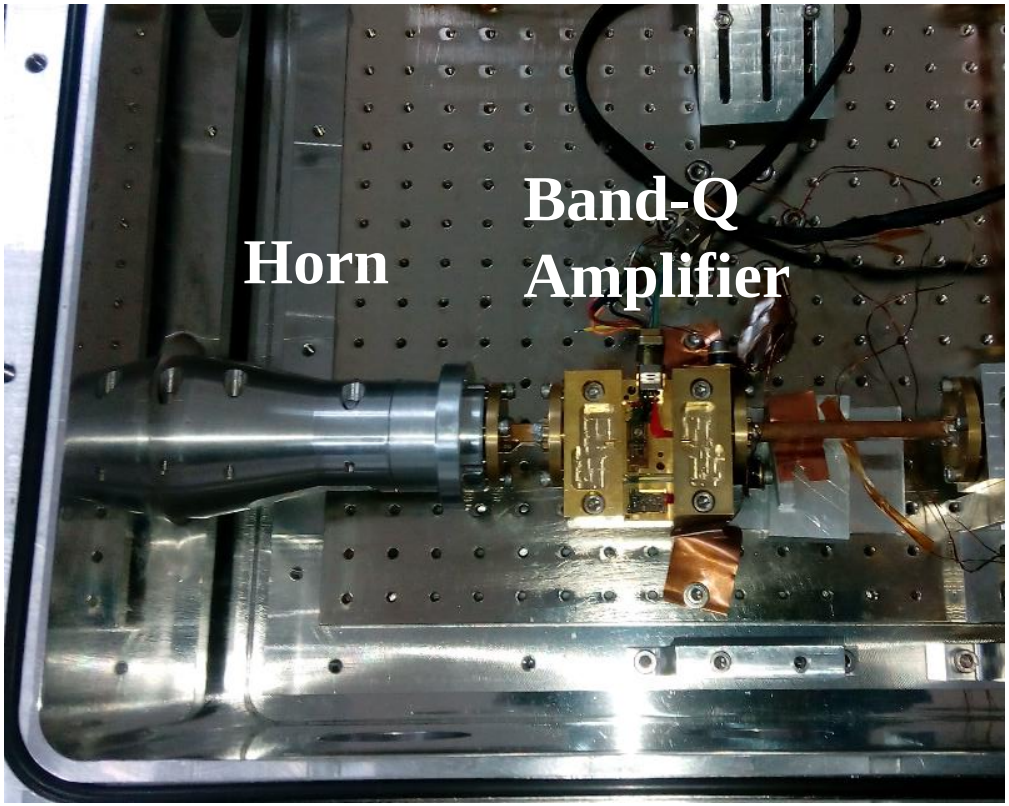
Packaging of active components

- Amplifiers for Bands Q & W
  - Modular design to facilitate optimization
  - Commercial + custom components



Packaging of active components

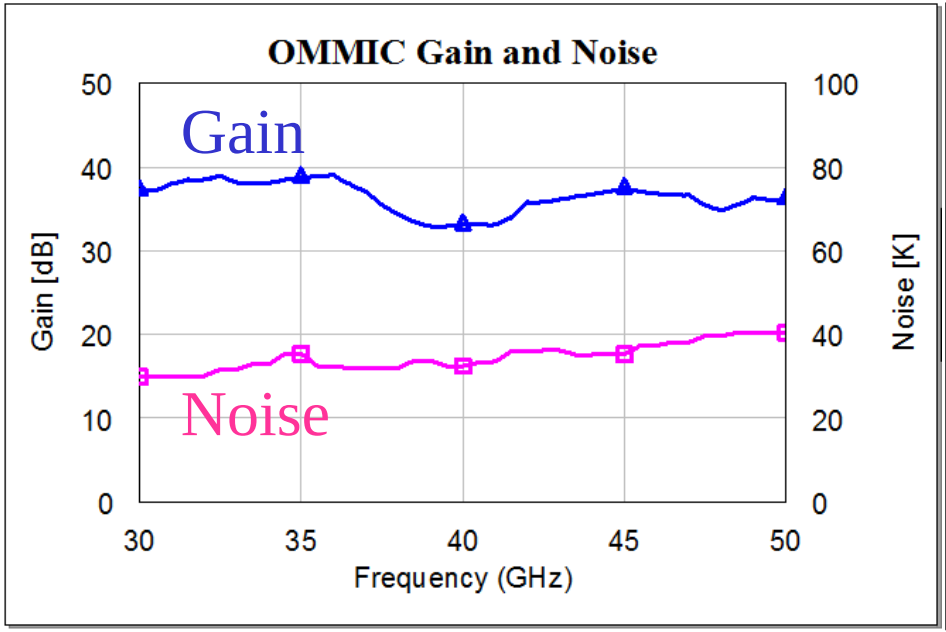
- Amplifiers for Bands Q & W
  - Cryogenic characterization
  - External hot/cold



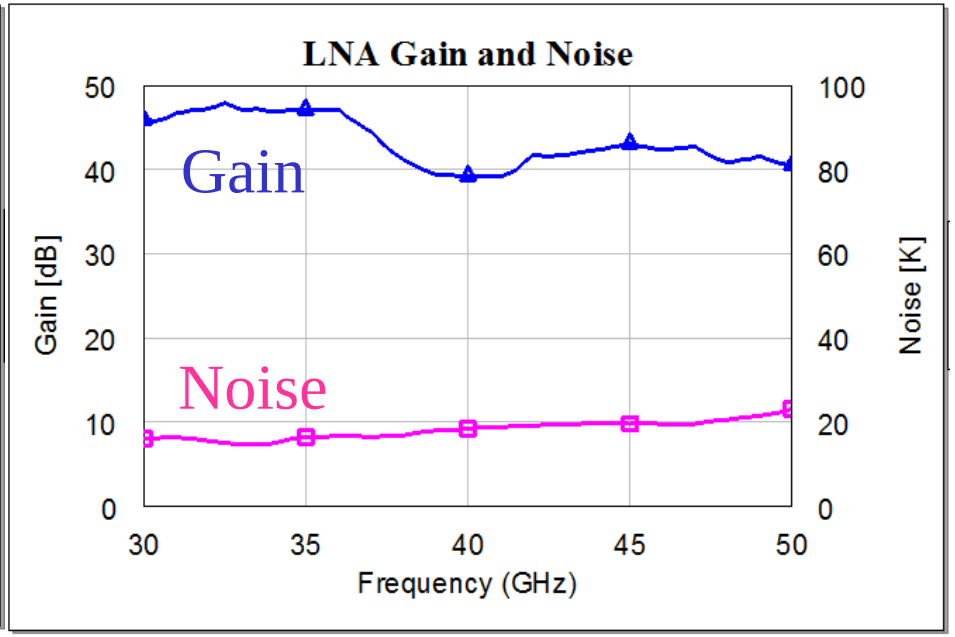
Packaging of active components

- Amplifiers for Band Q
  - Results with MMIC from OMMIC

Measured: only MMIC @ 20 K



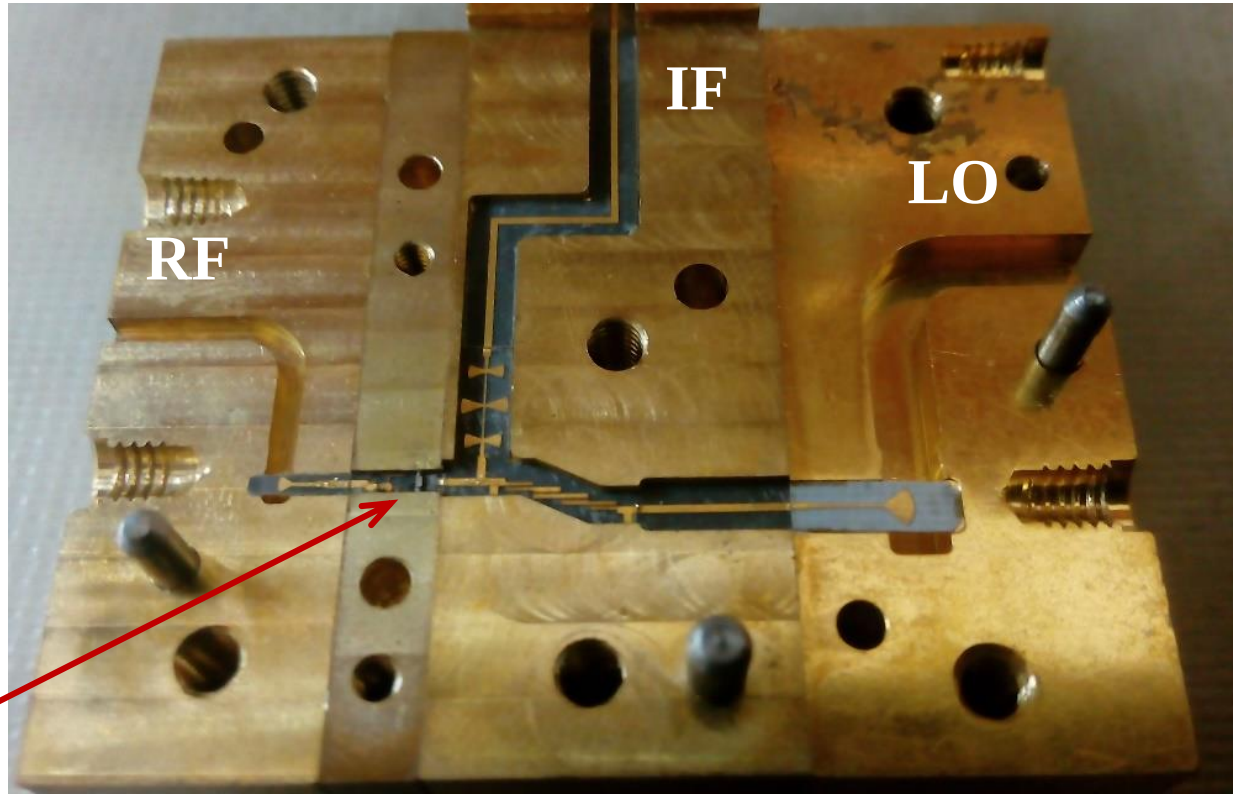
Simulated: MMIC + Cryo 3



Packaging of active components

- Sub-harmonic mixer for Band W
  - Modular design to facilitate optimization
  - Commercial + custom components

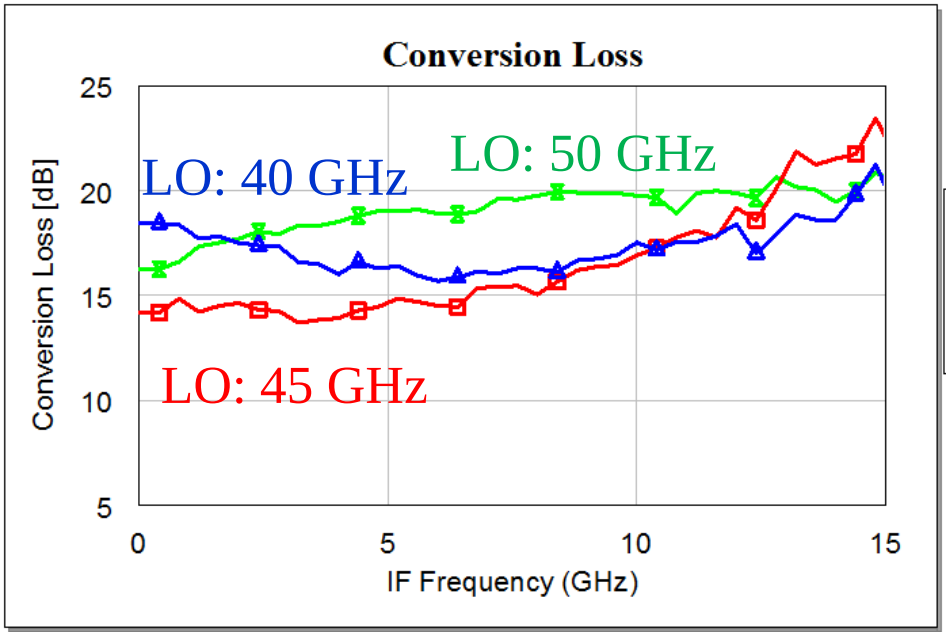
Commercial diode from UMS



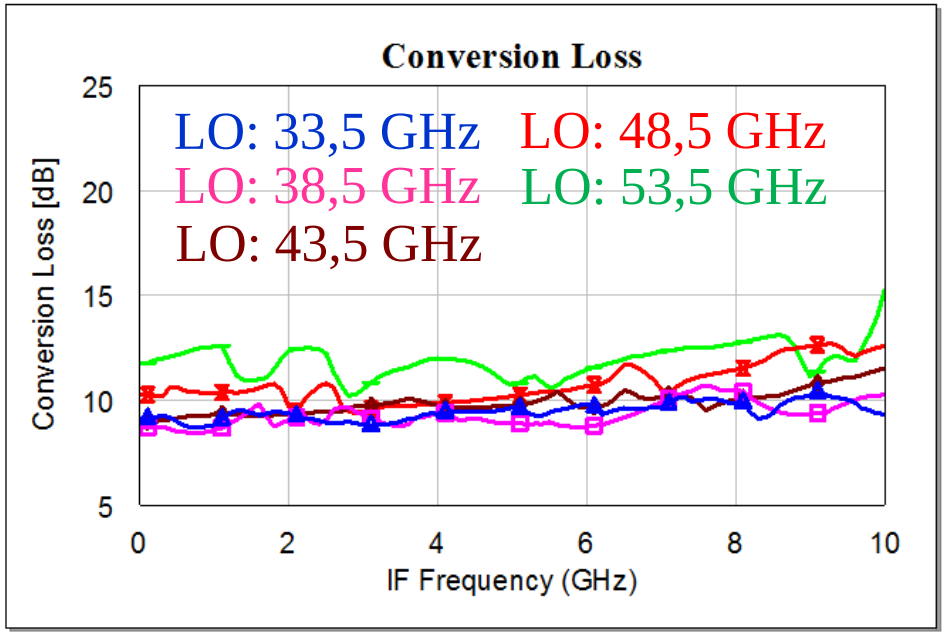
Packaging of active components

- Sub-harmonic (× 2) mixer for Band W
  - Results

Measured at band W



Simulated at band V+W



Other Activities at UChile

- High precision machining
- Testing of ALMA receivers
- Digital back ends
- Upgrading own 1.2-m survey telescope
- Photonics
- Cubesats

Conclusions

- Optics Bands 1 and 2+3
  - Same design and strategy.
  - Compact optimized horn. Easy fabrication.
  - Excellent performance.
  - Efficiency limited by existing cryostat
- OMT for Band 2+3
  - Promising design. More optimization needed.
- Packaging of active components
  - Modular design
  - It permits to identify correct components