A new multibeam receiver for KOSMA with scalable fully reflective focal plane array optics

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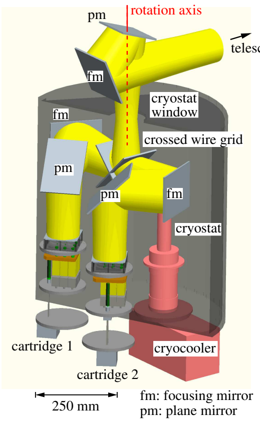
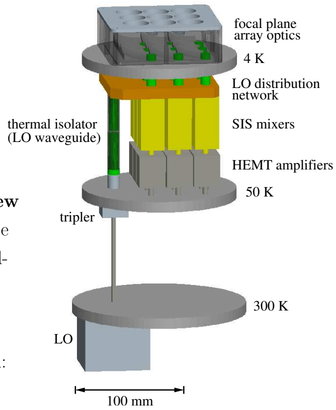
Overview

- **Heterodyne multibeam receivers boost the mapping performance of mm/submm telescopes**
- **Development of an 18 beam array receiver for KOSMA**
- **3×3 beam cartridge-type receiver modules**
- **Scalable fully reflective focal plane array optics**
- **345 GHz focal plane optics prototype has been built and its near field patterns have been measured**



Receiver overview

- Gaussian telescope
- Two receiver modules
- Beam separation: crossed wire grid
- Image de-rotation: rotating cryostat

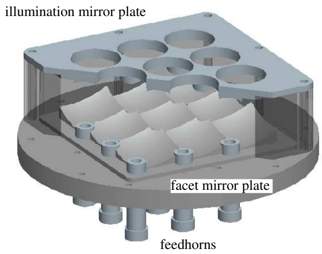


Receiver module

- Focal plane array optics
- Sideband-separating SIS-mixers
- LO: Synthesizer/ multiplier chain
- LO distribution network in waveguide technology → compact optical design.

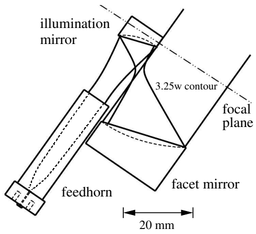
Focal plane array optics

- **Fully reflective → avoids absorbtion and reflection losses of dielectric lenses**
- **Scalable in frequency and number of beams**
- **Large optical subassemblies machined monolithically → no need for optical alignment**
- **Feedhorns optimized for near field operation**



3x3 beam focal plane unit

345 GHz prototype



Optics unit–cell

Array optics

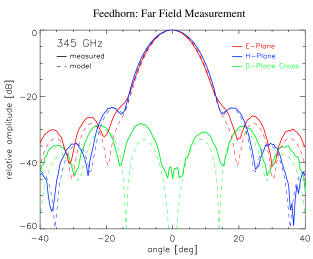
- Beams are arranged on a rectangular grid
- Feedhorns and small illumination mirrors located in the gaps between the beams
- First fully reflective array scalable to an arbitrary number of beams

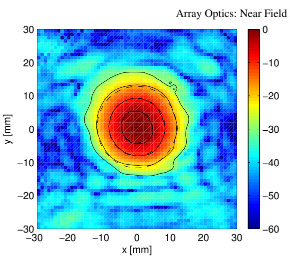
Optics unit-cell

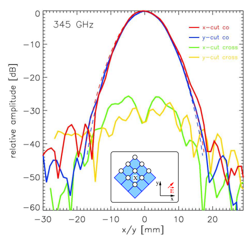
- Smooth-walled spline-profile feedhorn, optimized for a Gaussian beam 22 mm in front of the aperture, w_0=1.8 mm
- Illumination mirror: f=7.4 mm
- Facet mirror: f=21.2 mm

Measurements

- **Feedhorn and focal plane array patterns**
- **Measurements in amplitude and phase with a scanning vector network analyzer**
- **Planar scans at 345 GHz, cuts at 330, 345 and 360 GHz**







Feedhorn

- Near and far field measurements (planar scan 22 mm in front of the feedhorn aperture, angular far field cuts)
- w_0=1.8 mm at 345 GHz
- Waist located 2.8 mm outside the aperture plane

Focal plane array optics

- Near field measurements (planar scan 100 mm in front of the array focal plane)
- w_0=7 mm at 345 GHz
- Beam separation ∼3.6 w_0 (∼2.3 HPBW on the sky)
- Gaussicity >98%

Conclusions

We are developing a new submillimeter heterodyne array receiver for the KOSMA telescope. It employs cartridge-type receiver modules with a new fully reflective and scalable focal plane array optics. A 345 GHz 3×3 beam optics prototype was built and successfully tested.

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