

ALMA Band 9 technology for CCAT

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ALMA band 9 group



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Outline

- ALMA band 9 technology
- Results of >64 ALMA cartridges
- Use of ALMA mixers in FPA (CHAMP+)
- 2SB mixer technology

Main band 9 specification

- RF band 602-720 GHz
- DSB mixing scheme
- IF band 4-12 GHz (8 GHz bandwidth)
- 4 dB IF pass band ripple
- 10^{-8} relative total power stability @ 1s
- Sensitivity integrated over IF: 175 K (80% band)
240 K (20% band)
- Dual polarization
- -20 dB cross - polarization response
- Gain compression within 3% @ 400 K load
- Phase stability
- No moving parts
- Large amount of receivers

Band 9 cartridge layout

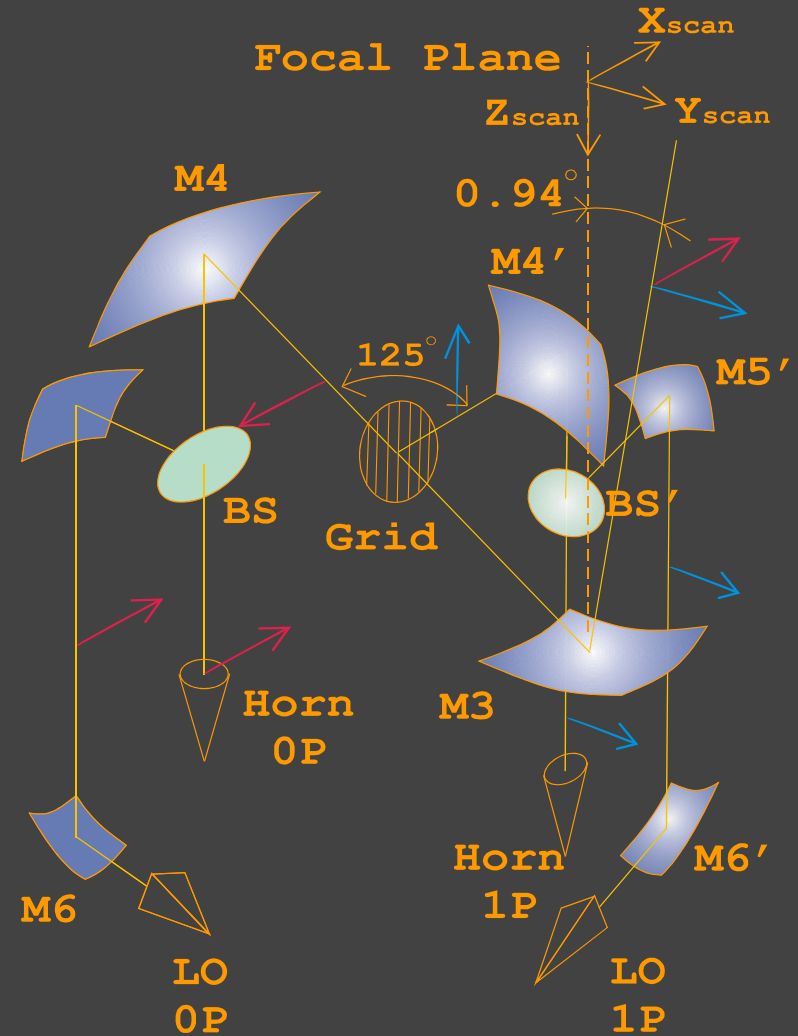
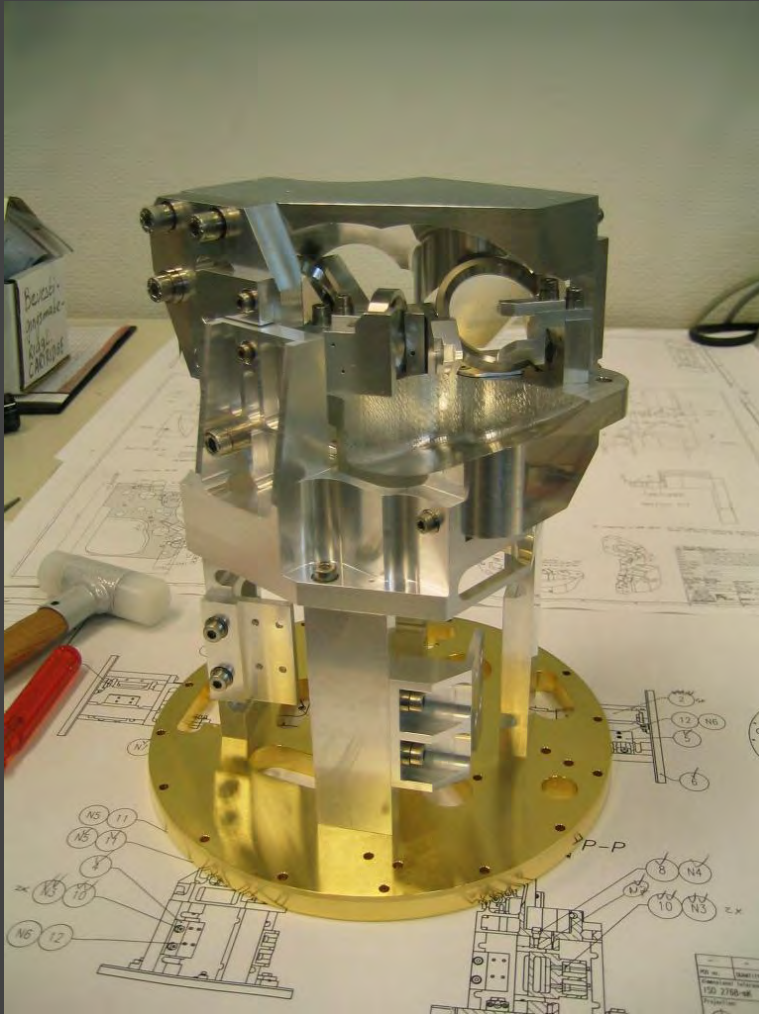


2004



2006

Cartridge Optics Layout



SIS mixer



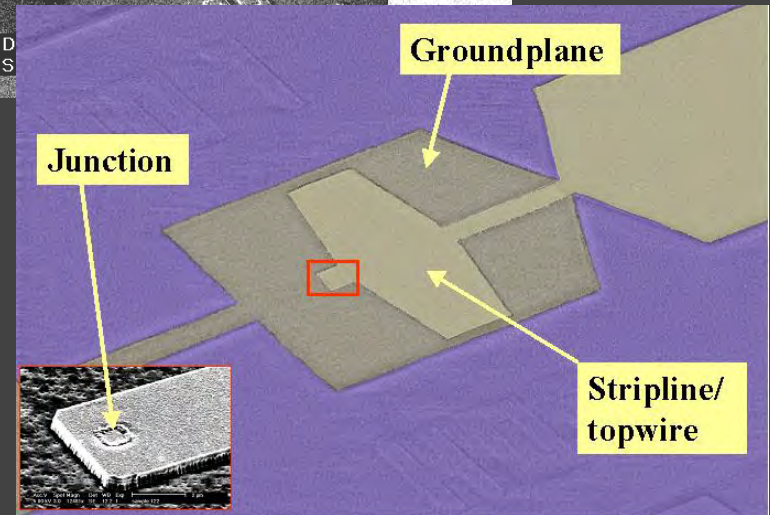
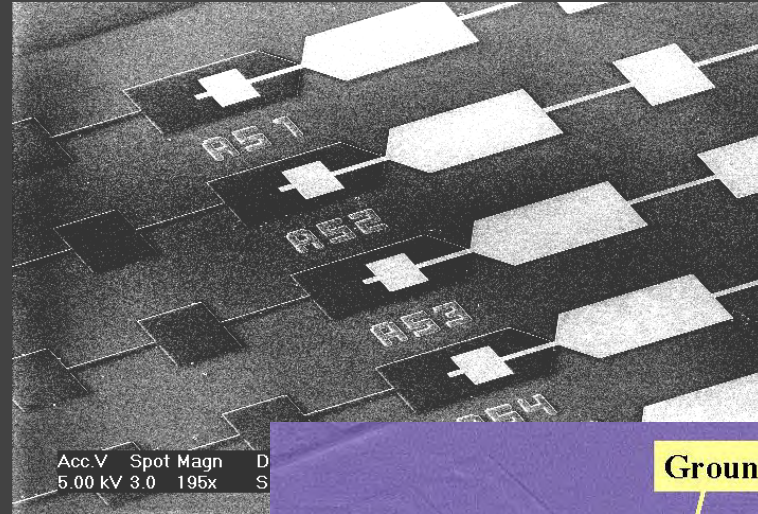
Simple construction
Easy to assemble



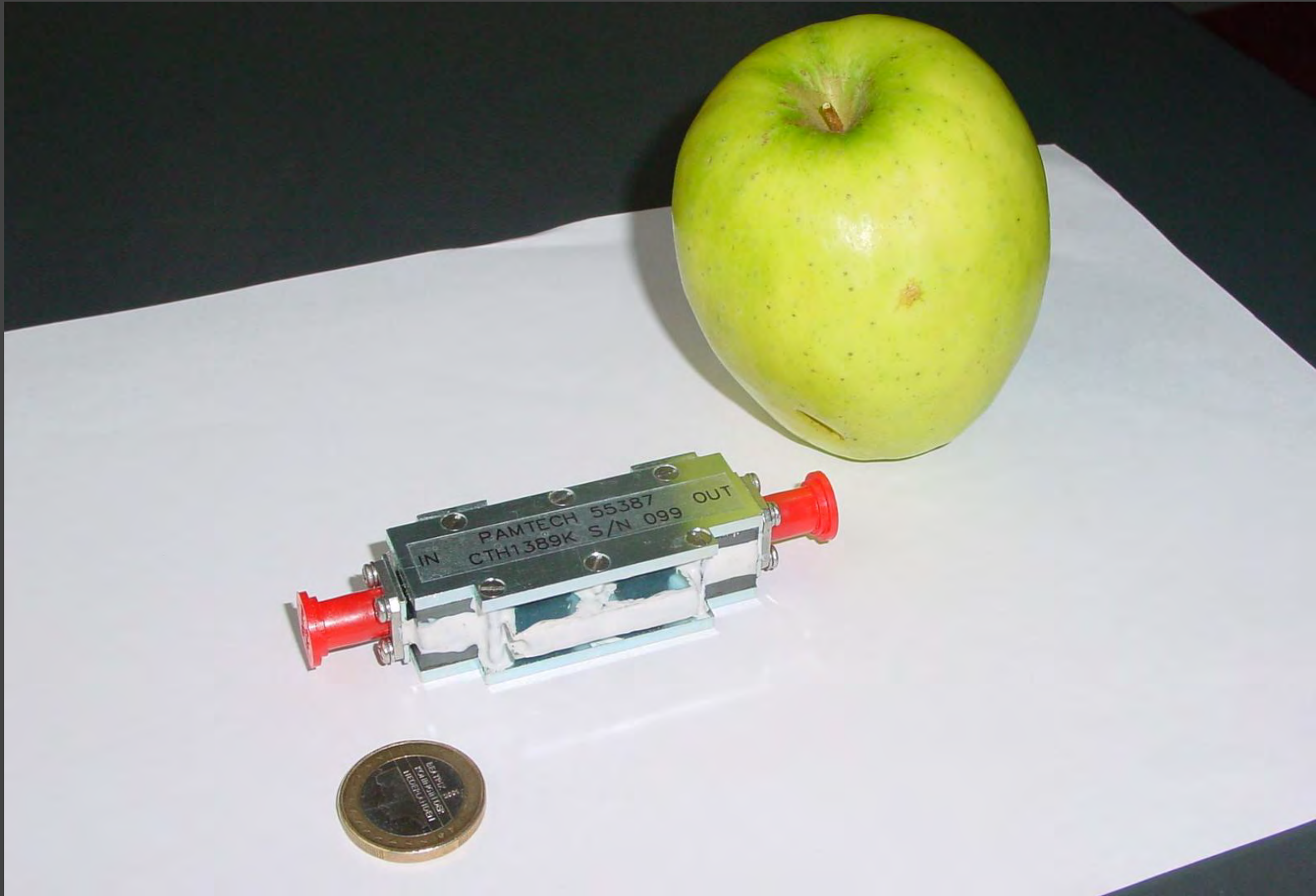
SIS Technology

- THz SIS mixers
 - quantum-limited sensitivities
 - 600-720 GHz bandwidth
 - LO tuning range
 - 4-12 GHz IF bandwidth
 - 4-8 GHz in HIFI
- SIS junctions (TU Delft)
 - Nb SIS technology
 - optimized fabrication
 - larger quantities
 - improved pattern accuracy
 - 1 μm structures are 1 μm
- waveguide device mounts
 - optimized for series production
- corrugated horn antennas (RPG)
 - commercial product
 - 100 μm structures +/- 5 μm

SIS Junctions (TU Delft)



4-12 Cryogenic isolator



8 cartridges



ALMA 2012



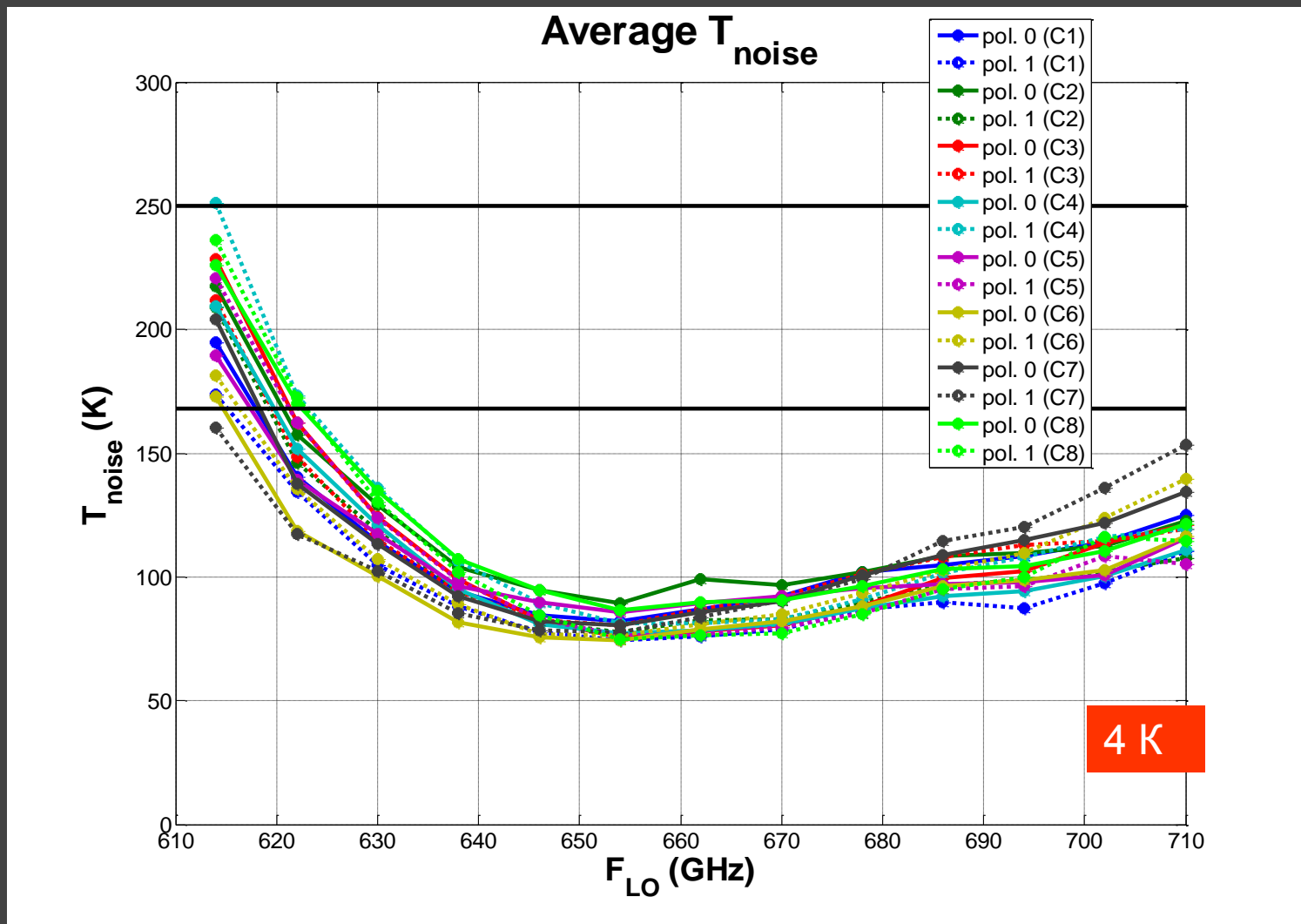
2012!!



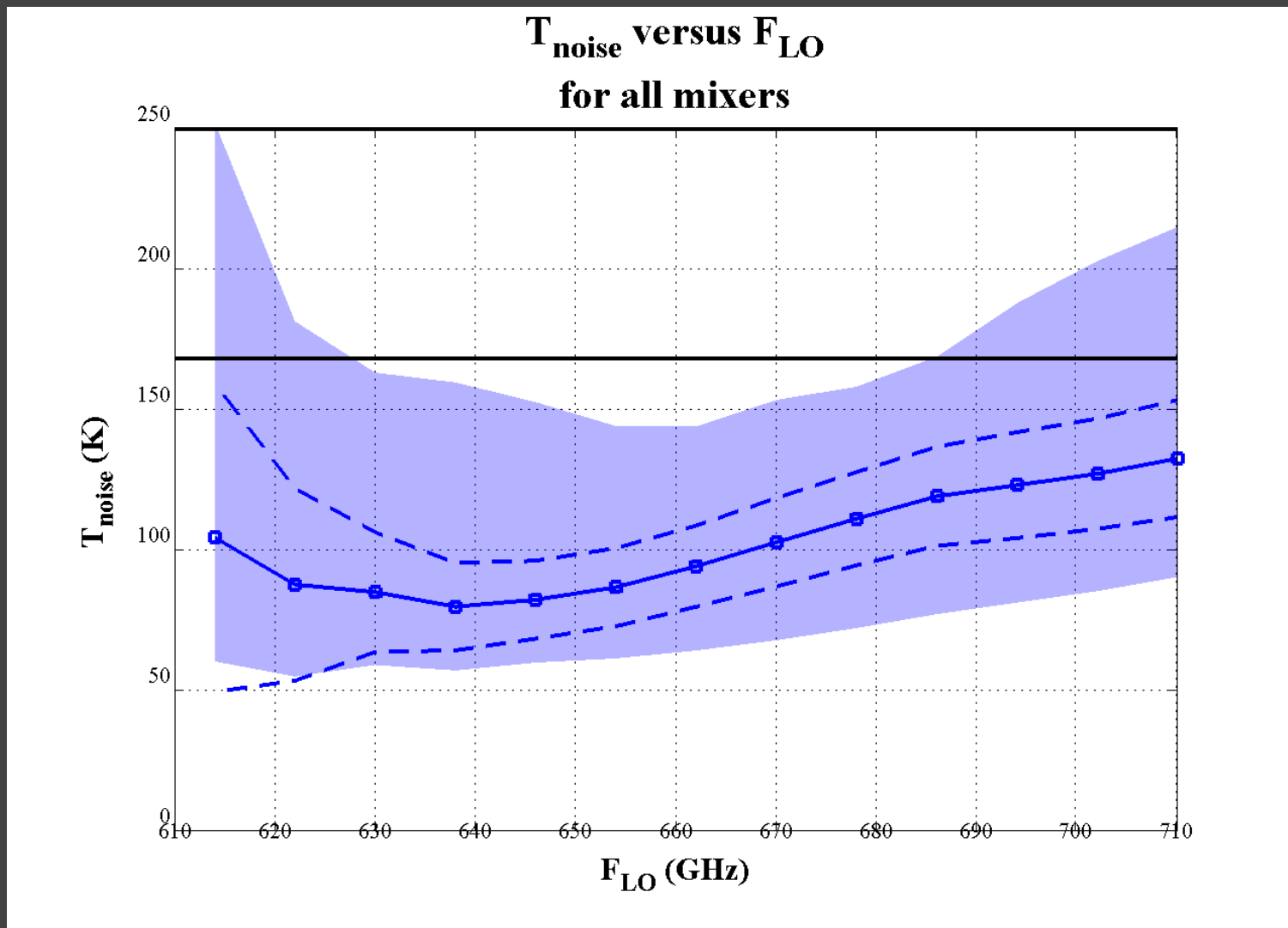
university of
 groningen



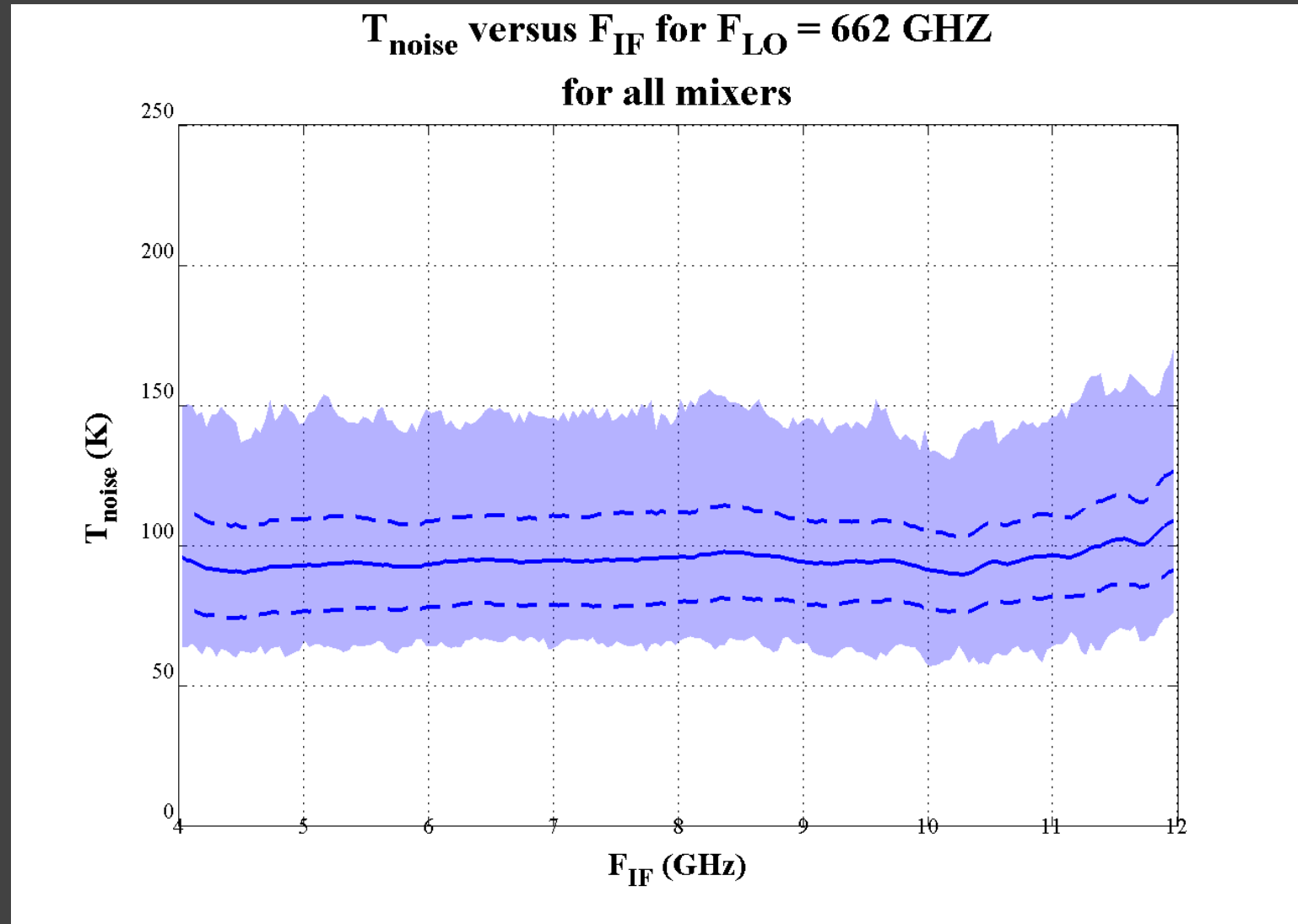
Noise temperature #1..#8



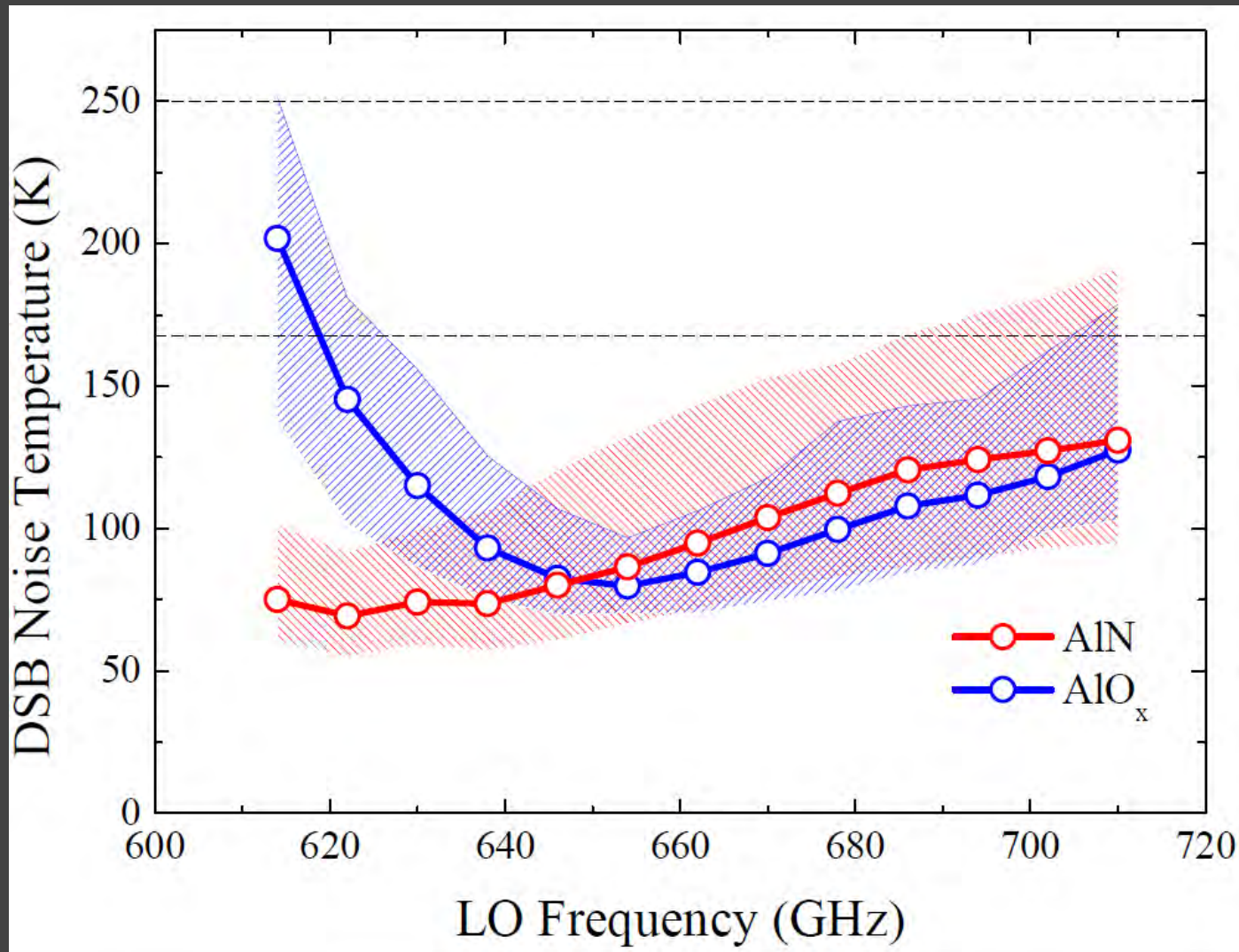
Noise temperature for 64+ cartridges



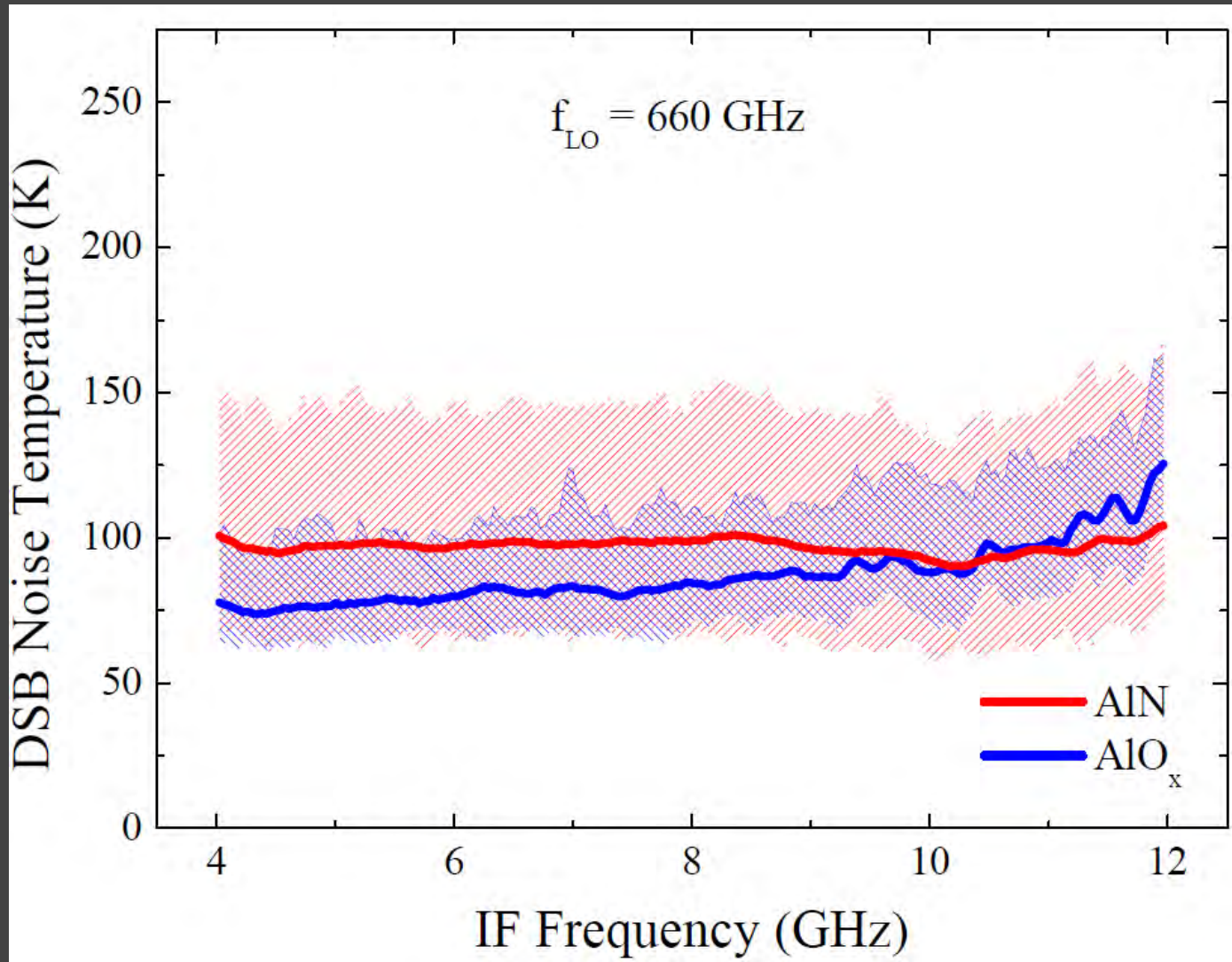
Noise temperature for 64+ cartridges



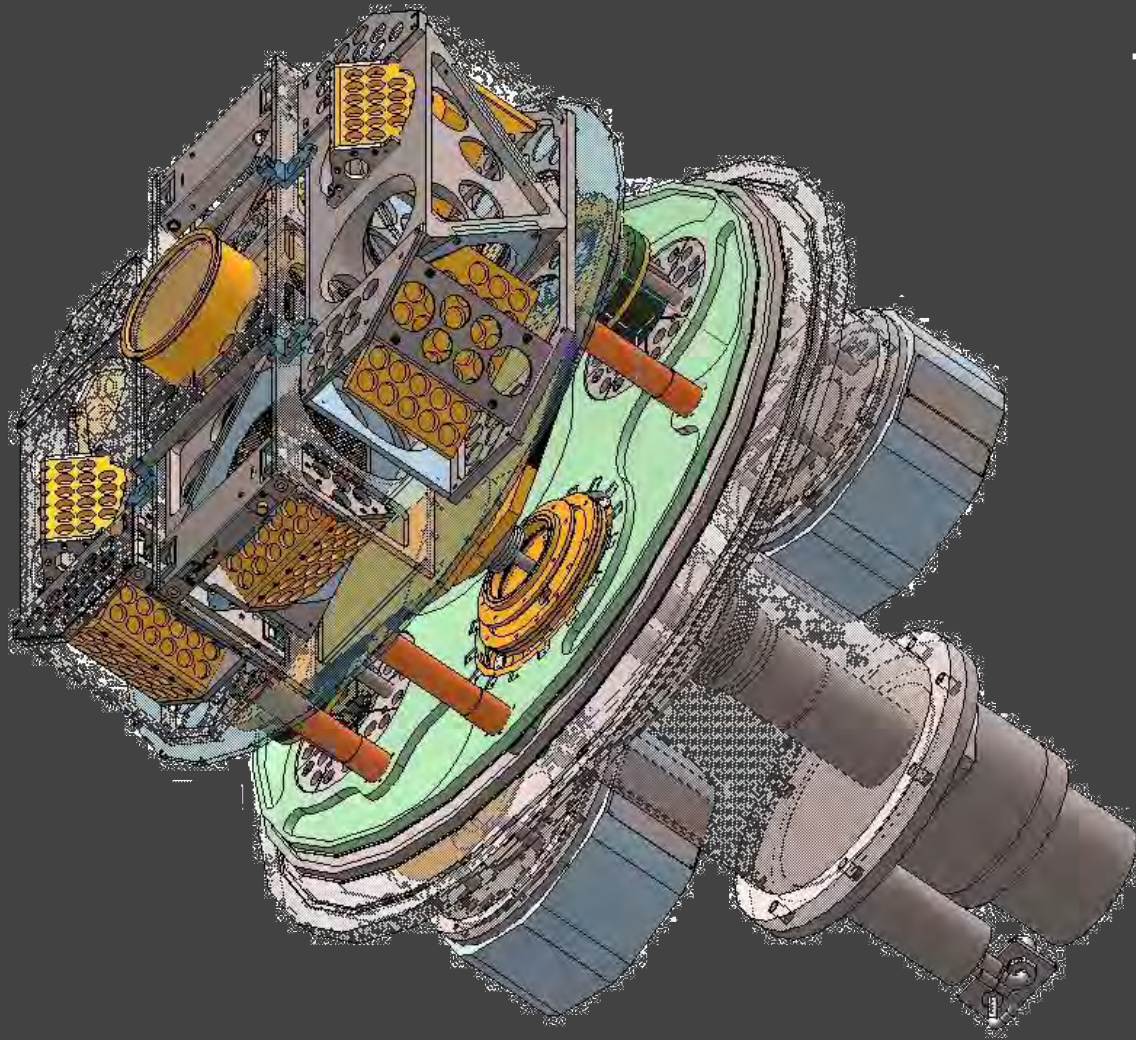
Tnoise vs LO per junction technology



Tnoise vs IF



CHAMP+: A powerfull sub-millimeter heterodyne array



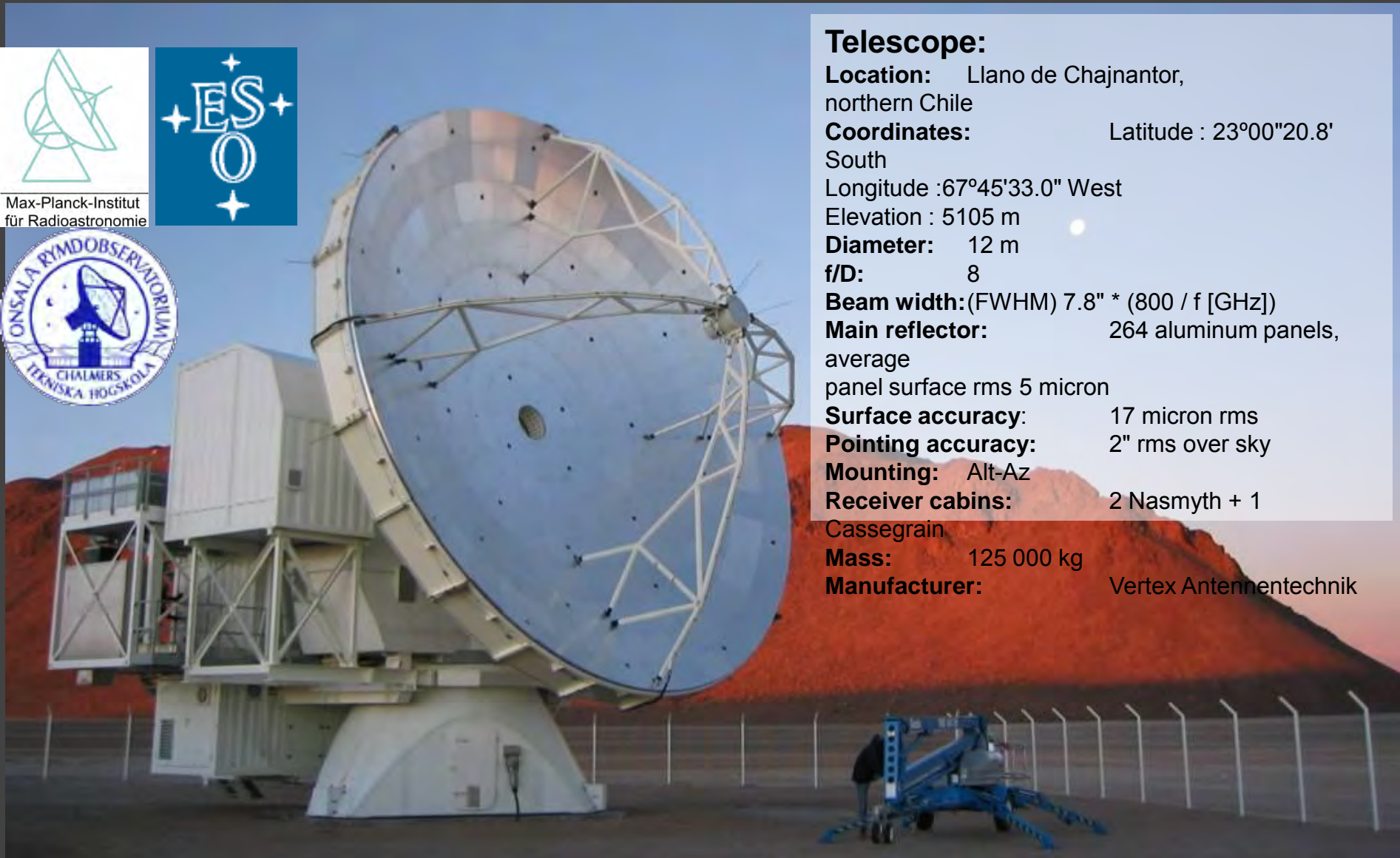
The GREAT team:

- MPIfR (PI-Institute)
 - C. Kasemann
 - R. Güsten
 - S. Heyminck
 - B. Klein
 - T. Klein
 - G. Wieching
 - H. Hafok
 - A. Korn
 - G. Schneider
 - A. Hänssler
 - C. Castenholz
 - H-J Wunsch
 - F. Schäfer
 - F. Pacek
- Mixer development (SRON)
 - A. Baryshev (SRON)
 - T.M. Klapwijk (TU Delft)

APEX



Max-Planck-Institut
für Radioastronomie



Telescope:

Location: Llano de Chajnantor,
northern Chile

Coordinates: Latitude : 23°00'20.8'
South

Longitude : 67°45'33.0" West

Elevation : 5105 m

Diameter: 12 m

f/D: 8

Beam width: (FWHM) 7.8" * (800 / f [GHz])

Main reflector: 264 aluminum panels,
average

panel surface rms 5 micron

Surface accuracy: 17 micron rms

Pointing accuracy: 2" rms over sky

Mounting: Alt-Az

Receiver cabins: 2 Nasmyth + 1

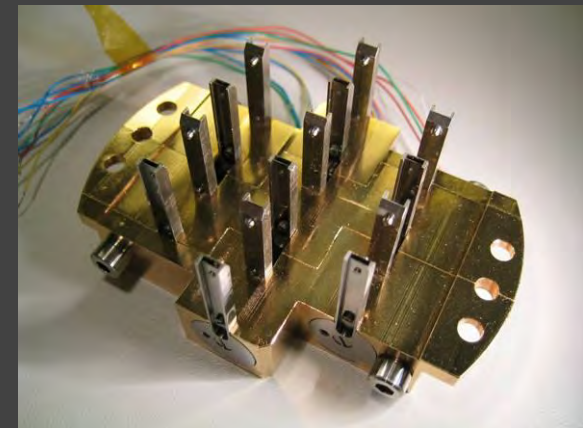
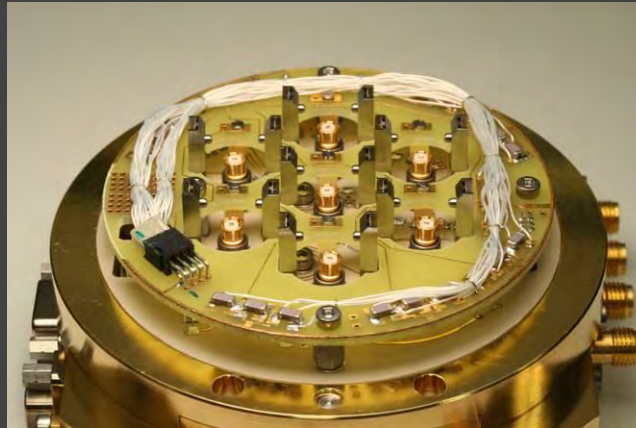
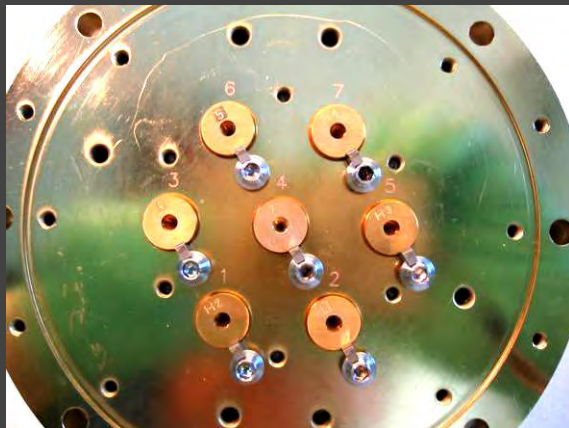
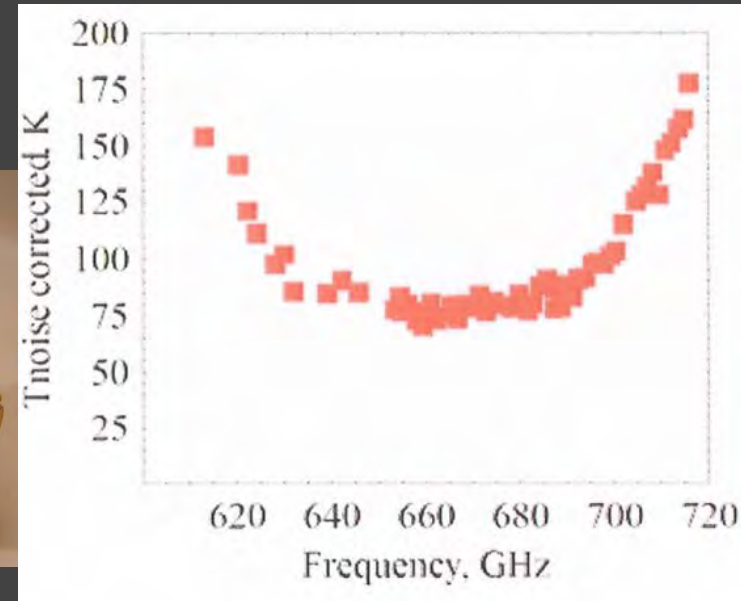
Cassegrain

Mass: 125 000 kg

Manufacturer: Vertex Antennentechnik

SIS-Mixers

- THz SIS mixers
 - quantum-limited sensitivities
 - 600-720 & 780-950 GHz RF-bandwidth
 - 4-8 GHz IF bandwidth
- SIS junctions (TU Delft)
 - Nb SIS technology (660GHz)
 - Nb-NbTiN SIS technology (850GHz)
 - optimized fabrication
 - larger quantities
 - improved pattern accuracy
 - high reproducibility
- waveguide device mounts
 - optimized for series production
- corrugated horn antennas (RPG)

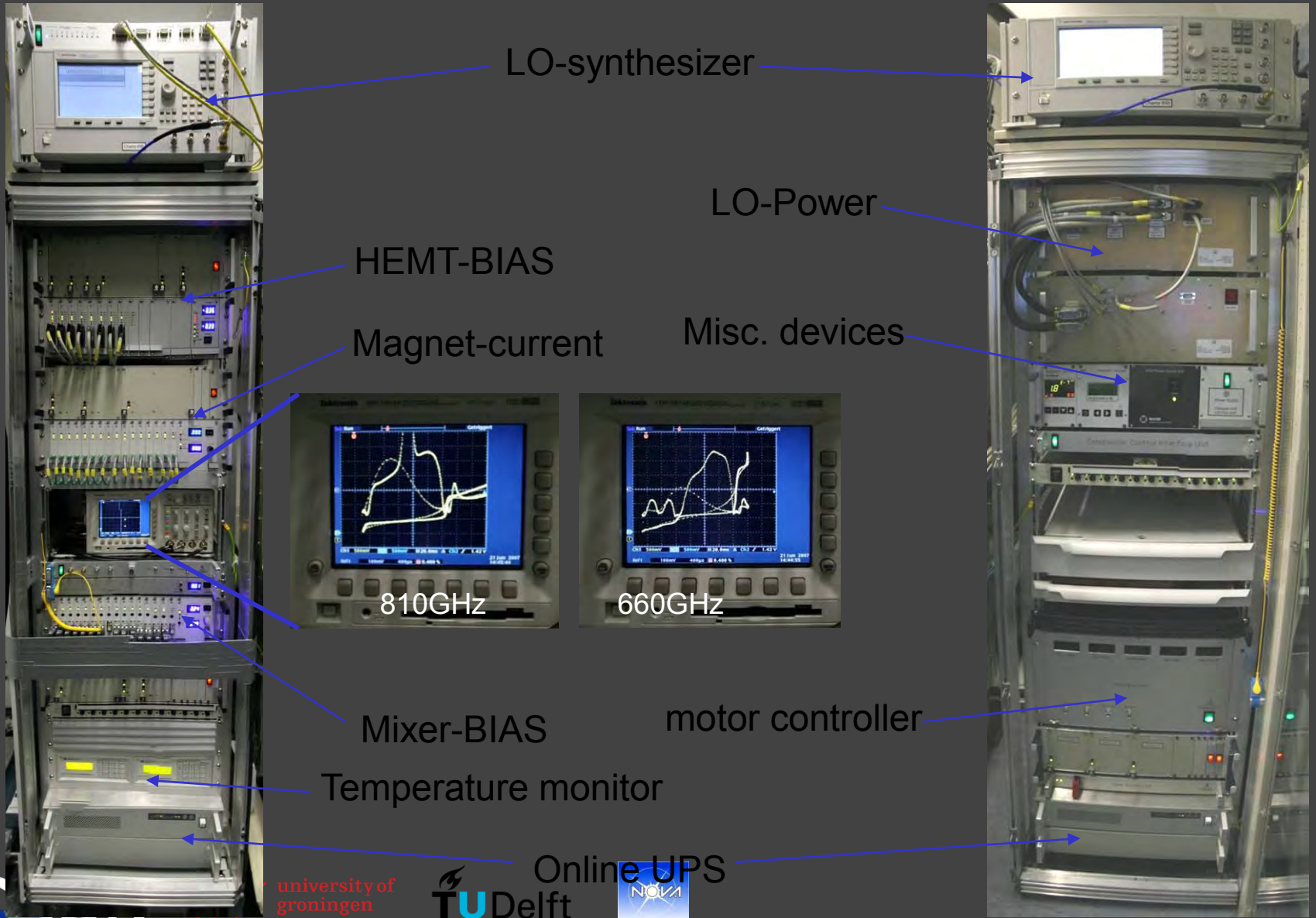


Mixers assembled to the mixer-mount  

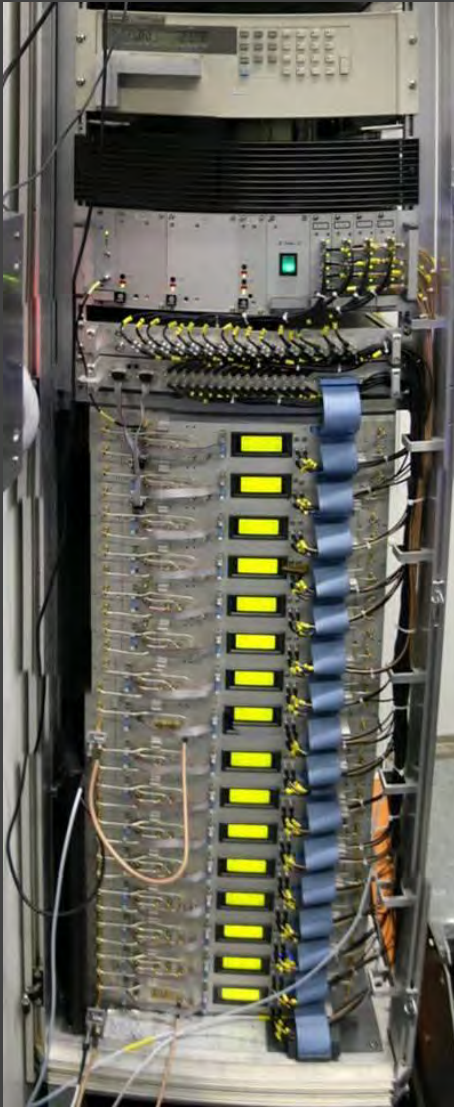
Mixer electronics with connector-block  

Magnet block

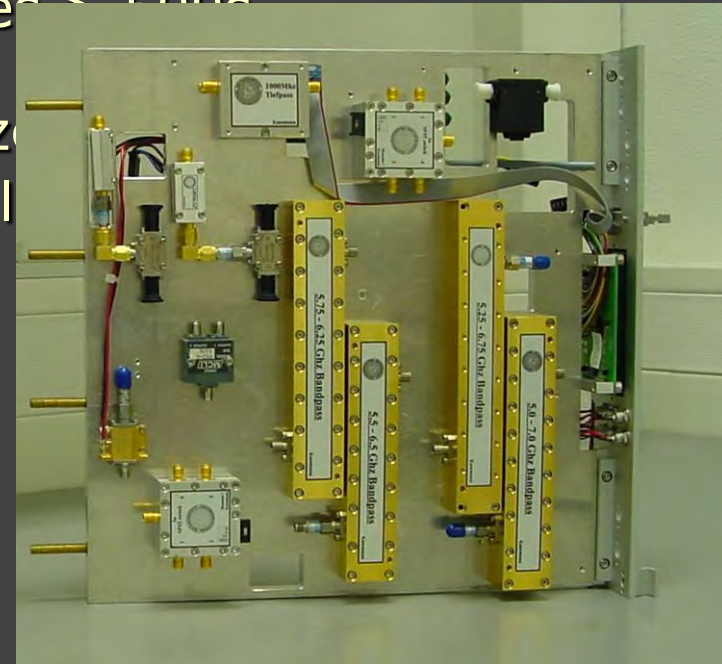
Control electronics



IF-Processor



- 14 input channels
 - IF bandwidth 4.625 – 7.475 GHz
- 28 output channels
 - output 0.05 – 1.55 GHz
 - individual output attenuator
 - total power detector
- Allan minimum time > 500 s (@ 1MHz resolution)
- temperature stabilization
- fully remote control



"New" backend: FFTS



Array FFTS (Fast Fourier Transform Spectrometer)

32 backend-channels, each providing

- 1.5GHz instantaneous bandwidth
- 8192 spectral channels
- to be installed at APEX in the next two weeks

more details: talk 6-7 of B. Klein:

"The Next Generation of Fast Fourier Transform Spectrometer"

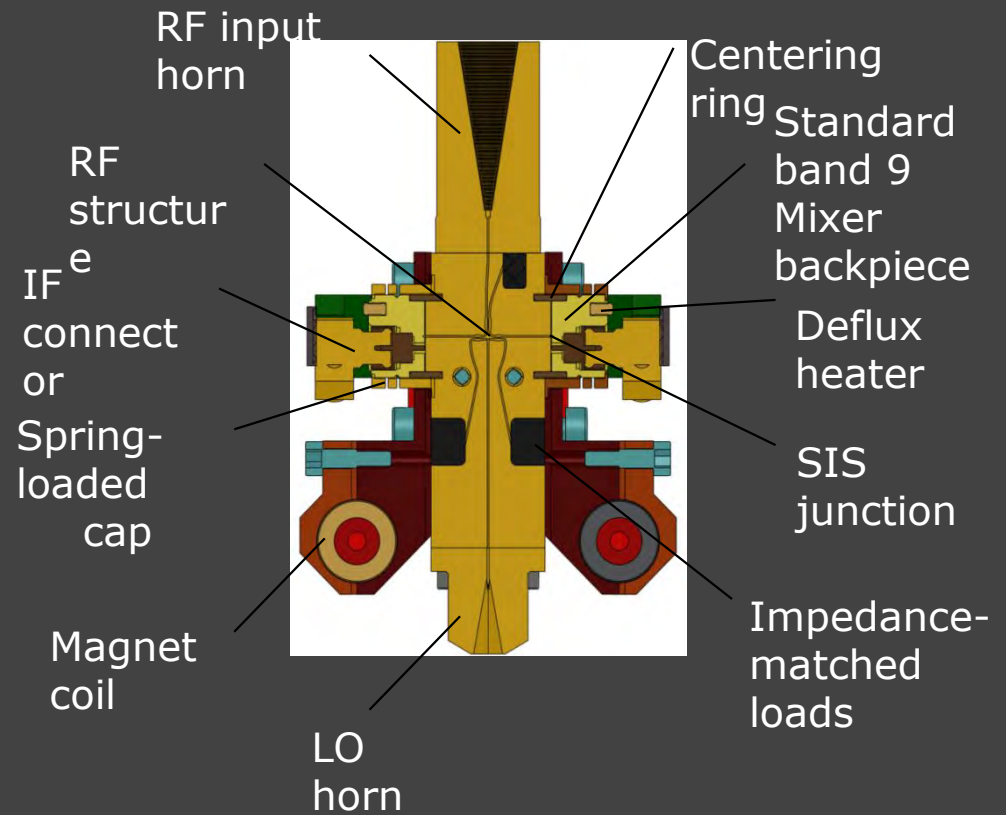
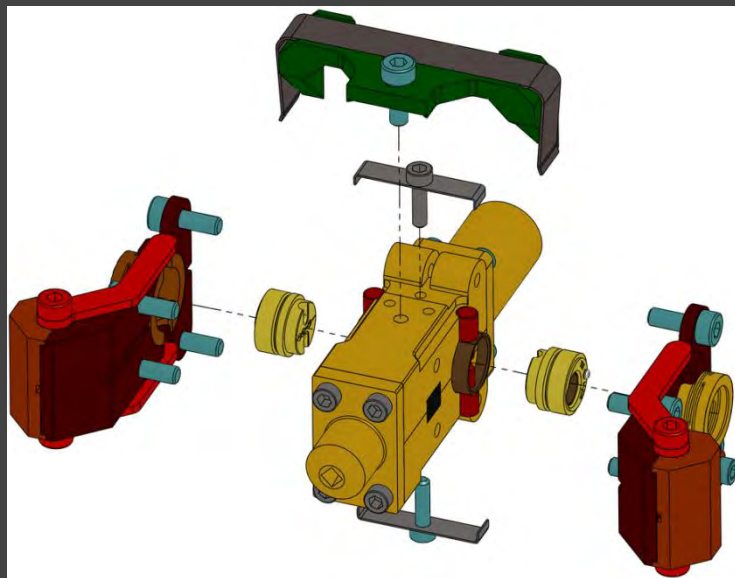
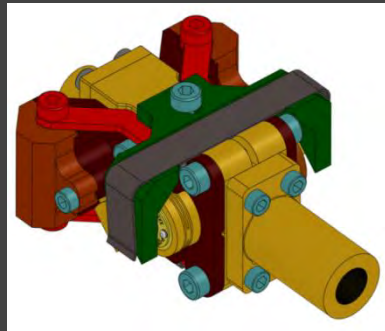
"Old" backend:

MACS auto-correlator system

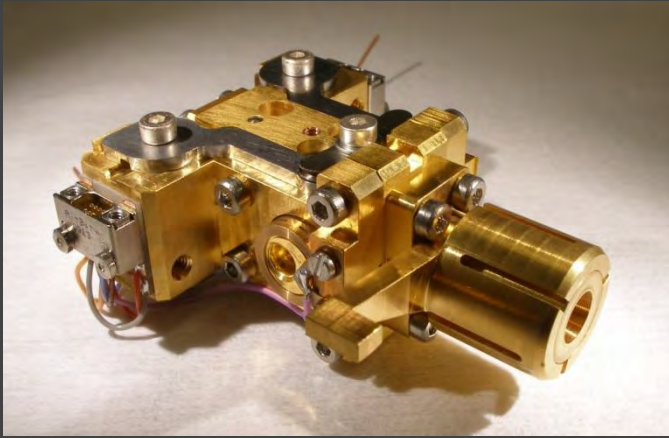
32 backend channels, each providing

- 1GHz instantaneous bandwidth
- 1024 spectral channel
- operational at APEX since January 2007

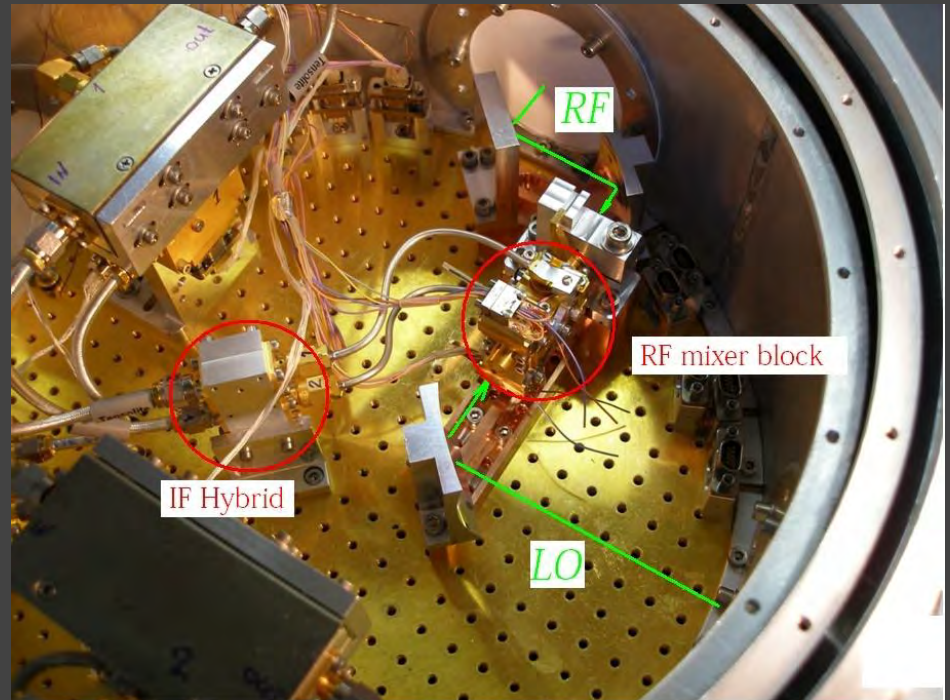
The mixer block - assembly



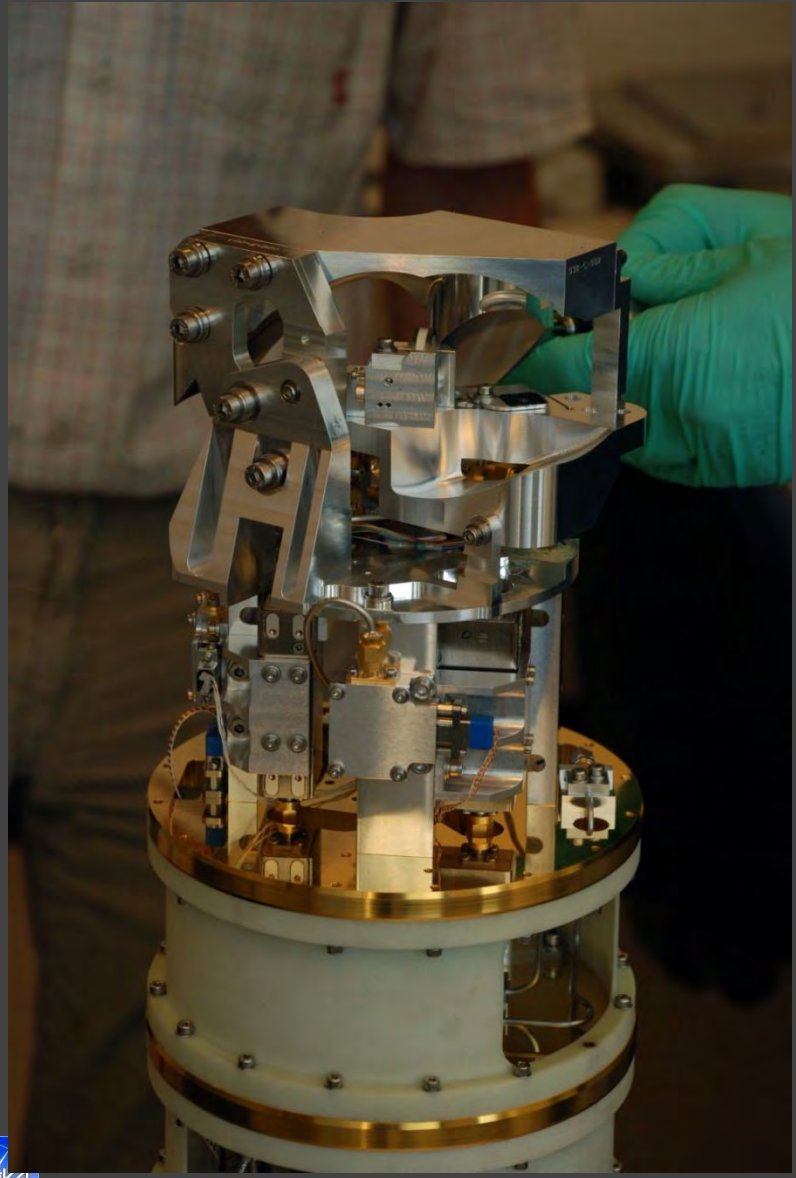
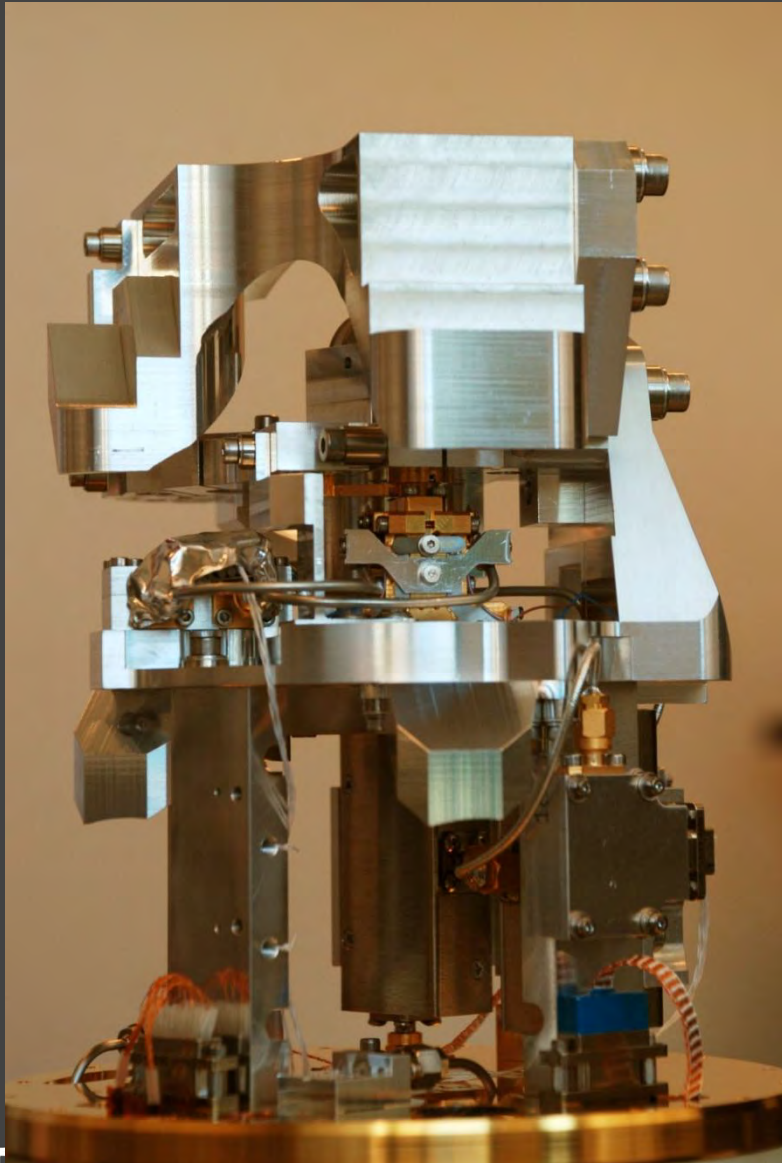
RF mixer Block



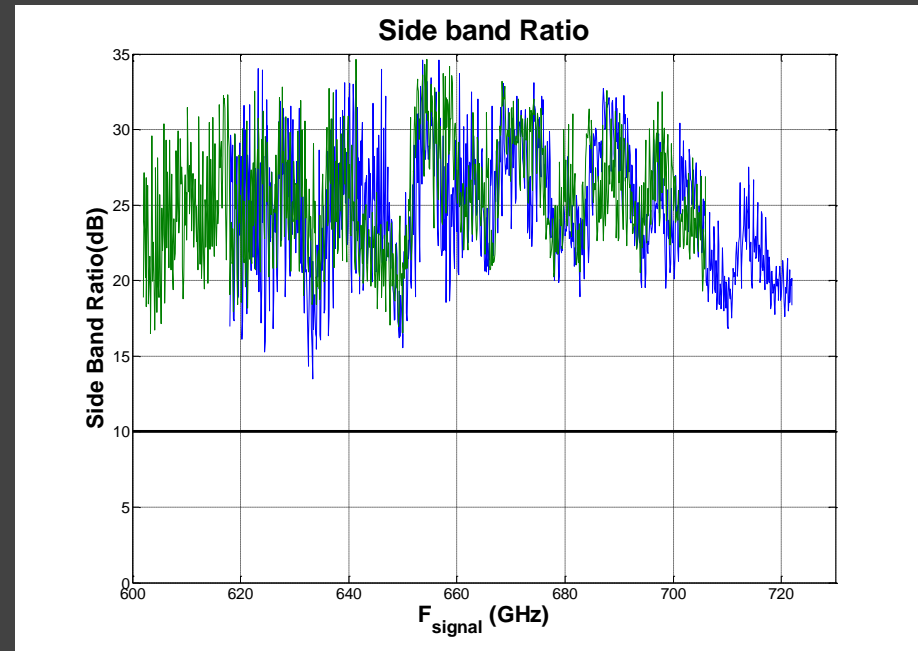
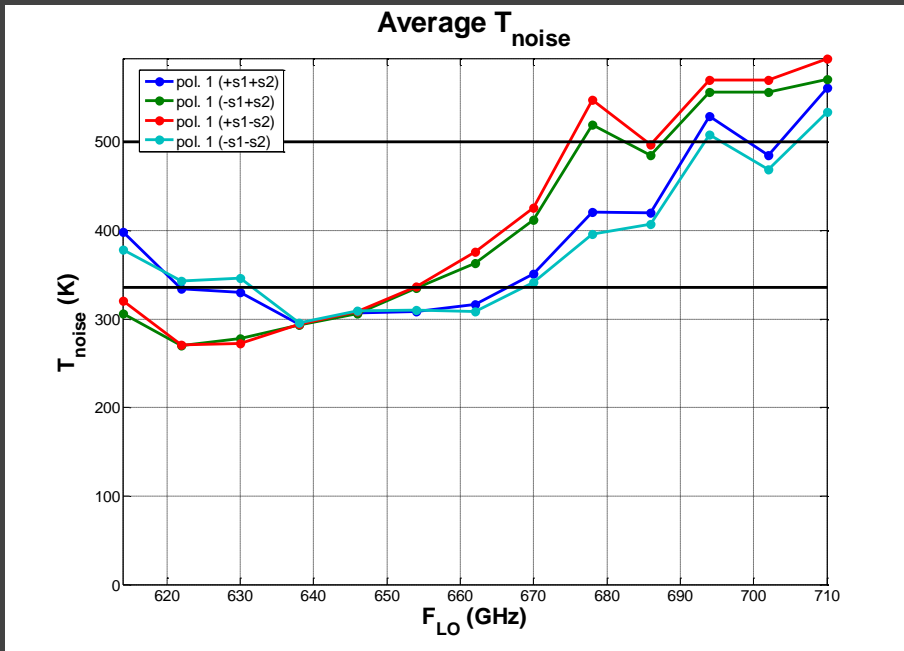
Block size:
45 x 21 x 53 mm³



2SB ALMA Cartridge!!!



2SB Cartridge. First tests.



- 1) Cartridge prototype – fabricated, works!
- 2) LO optics designed and approved
- 3) New 4-12 GHz Hybrid successfully tested

Conclusions

- Good performance large series DSB mixers have been demonstrated, base line for CCAT
- These can be used in large focal plane arrays
- 2SB mixer for ALMA band 9 has been demonstrated
- Ready for CCAT FPA (classical technology)
- Many challenges for real CCAT FPA >64 pixels