First VLBI observations with the LMT

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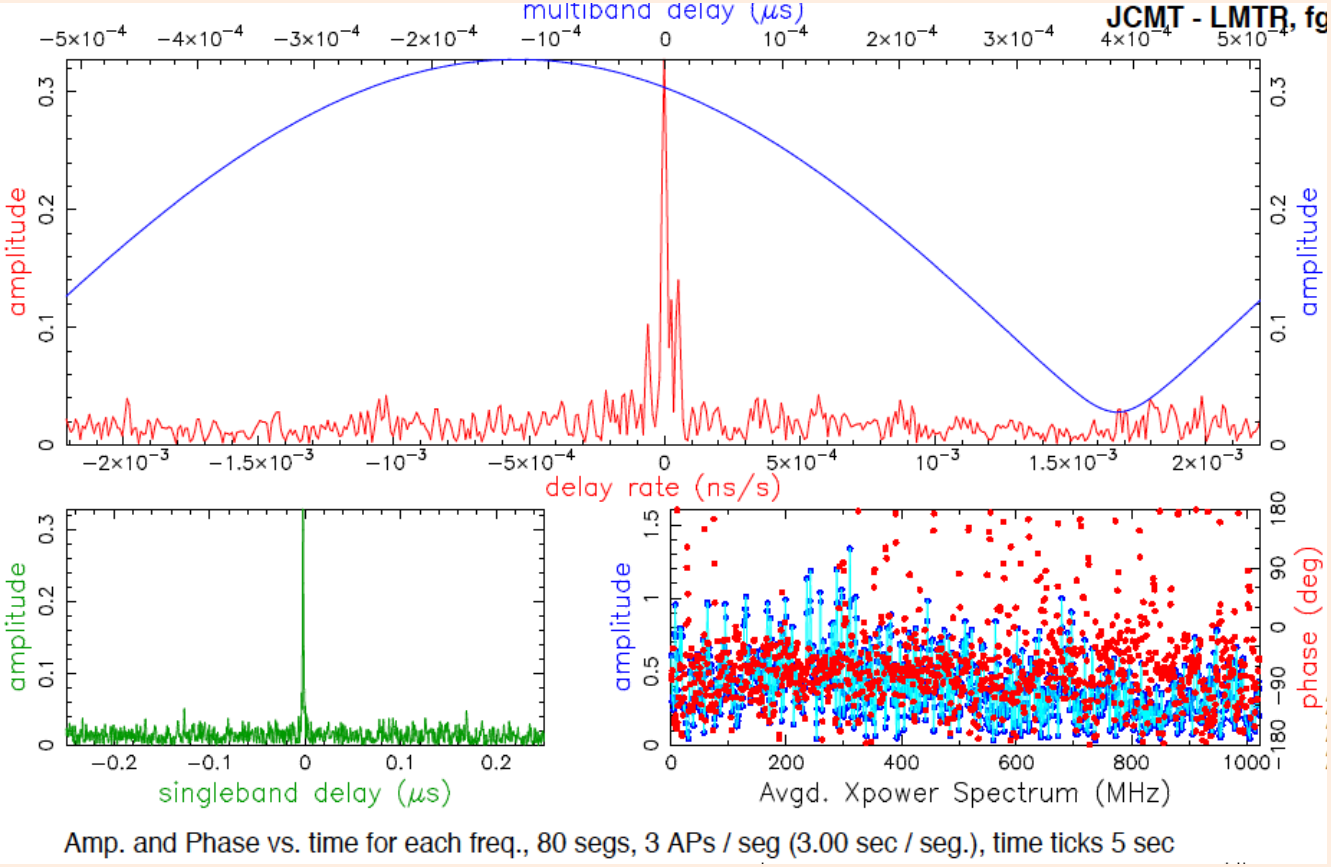
mm-VLBI data processing workshop, 8 June, Leiden

GTM/LMT INAOE HAYSTACK OBSERVATORY NRAO CfA CRyA Centro de Radioastronomía y Astrofísica

1.3 mm fringes

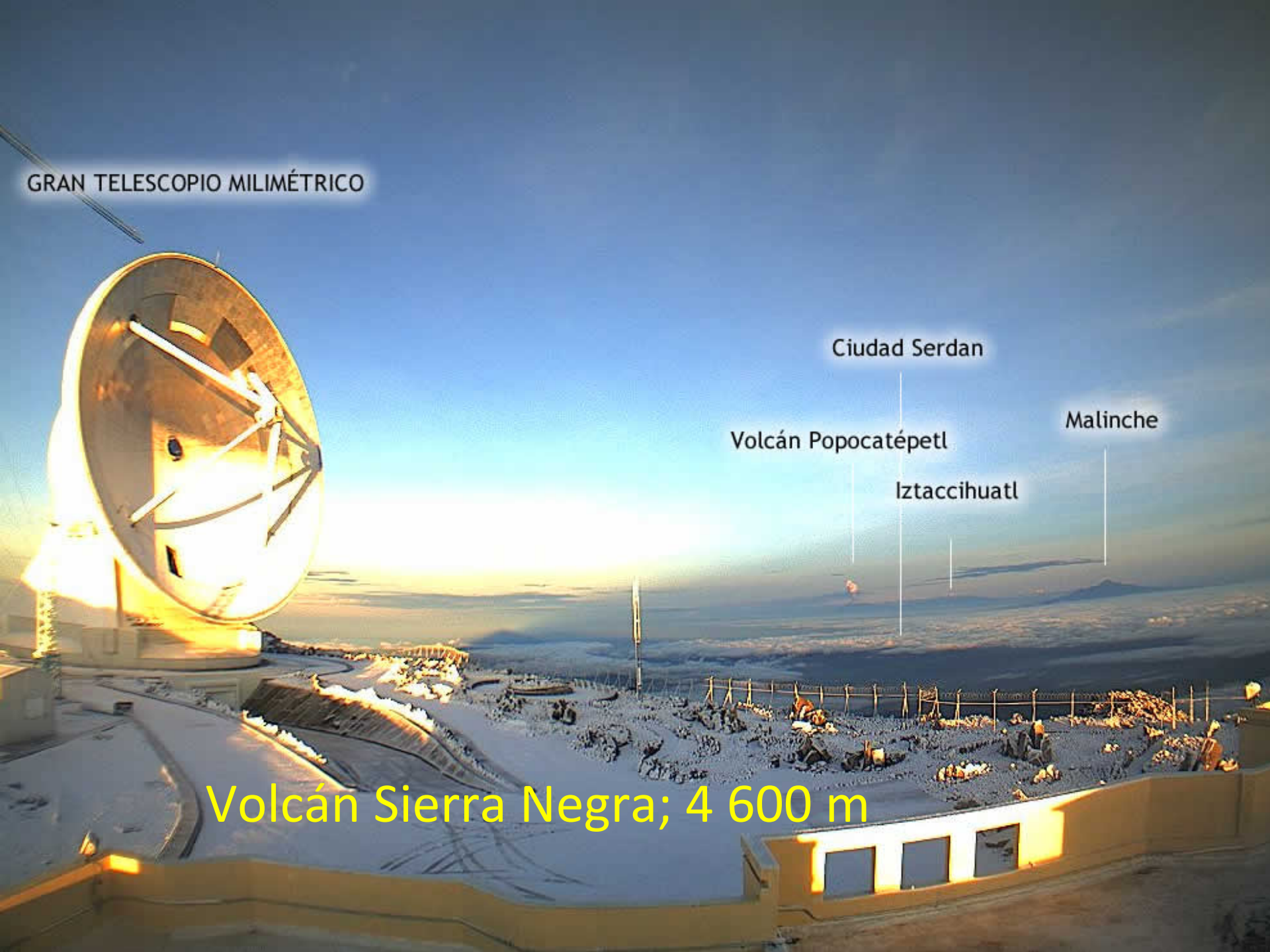
LMT-JCMT baseline

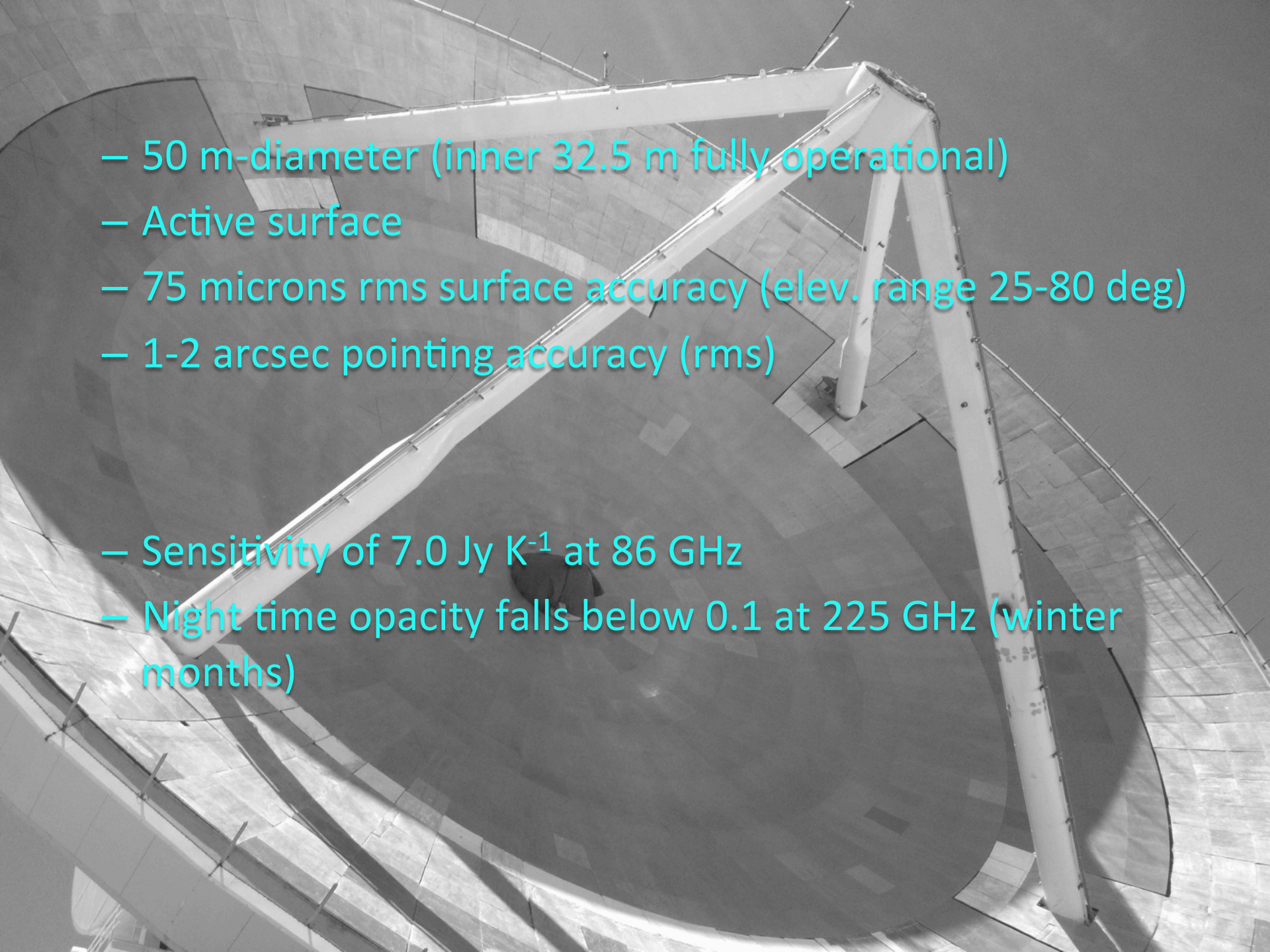


EHT run, 3C279, March 30, 2GHz BW

Outline

- Introduction to the LMT
- 3 mm VLBA+LMT observations
  - Commissioning
  - Data calibration
  - 3mm VLBA+LMT phase-referencing
- Observing considerations
- Summary


GRAN TELESCOPIO MILIMÉTRICO
Ciudad Serdan
Malinche
Volcán Popocatépetl
Iztaccihuatl
Volcán Sierra Negra; 4 600 m

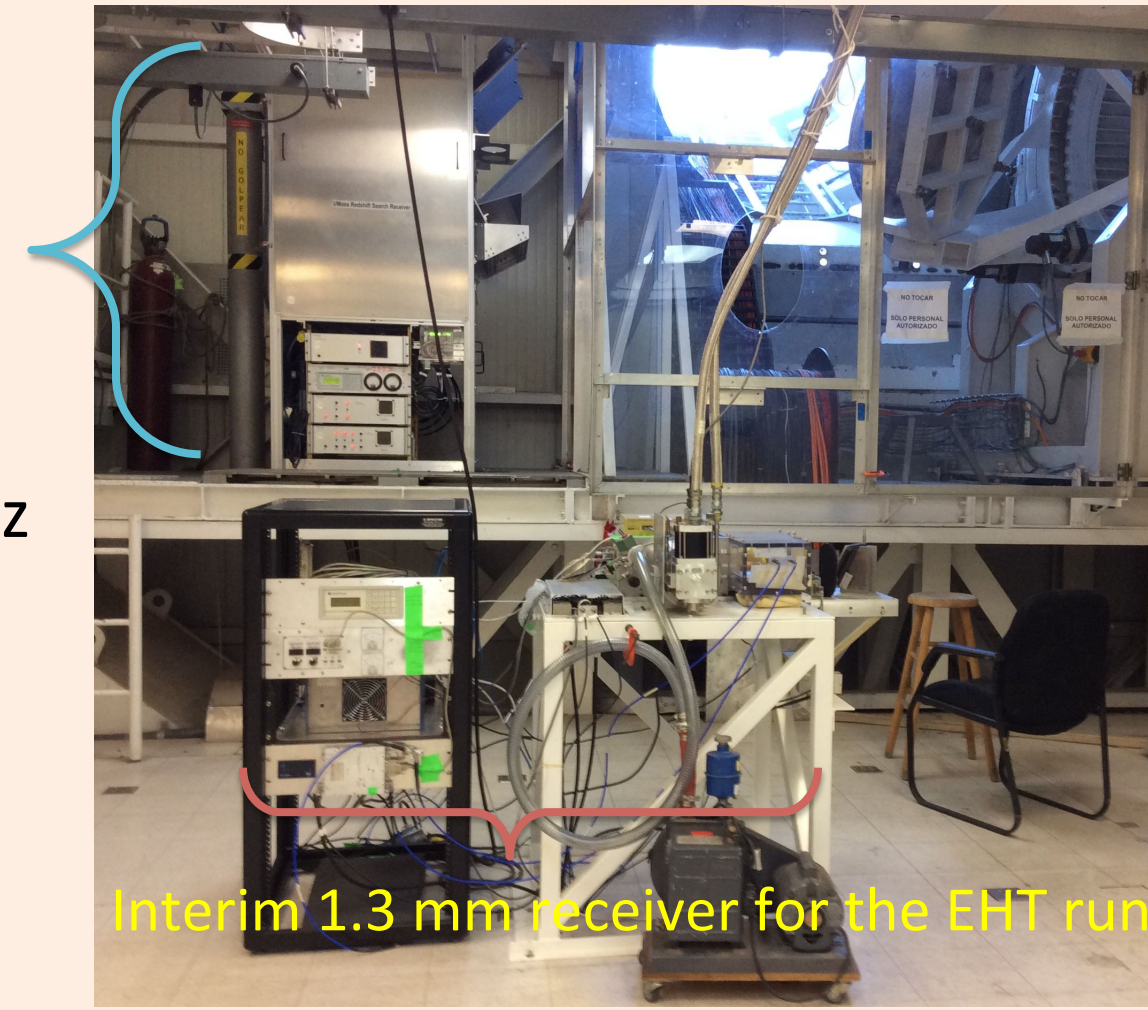


- 50 m-diameter (inner 32.5 m fully operational)
- Active surface
- 75 microns rms surface accuracy (elev. range 25-80 deg)
- 1-2 arcsec pointing accuracy (rms)

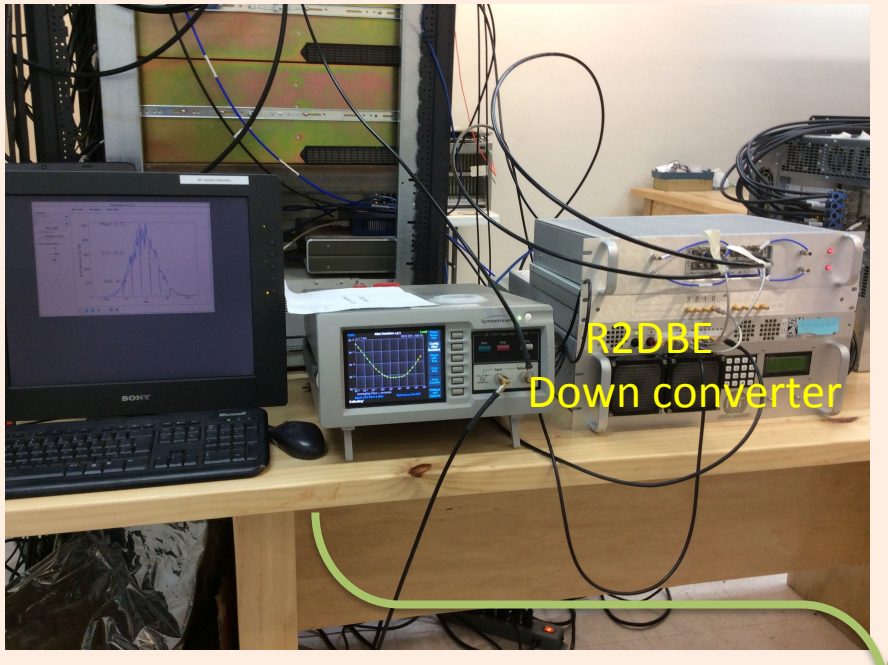
- Sensitivity of 7.0 Jy K^{-1} at 86 GHz
- Night time opacity falls below 0.1 at 225 GHz (winter months)

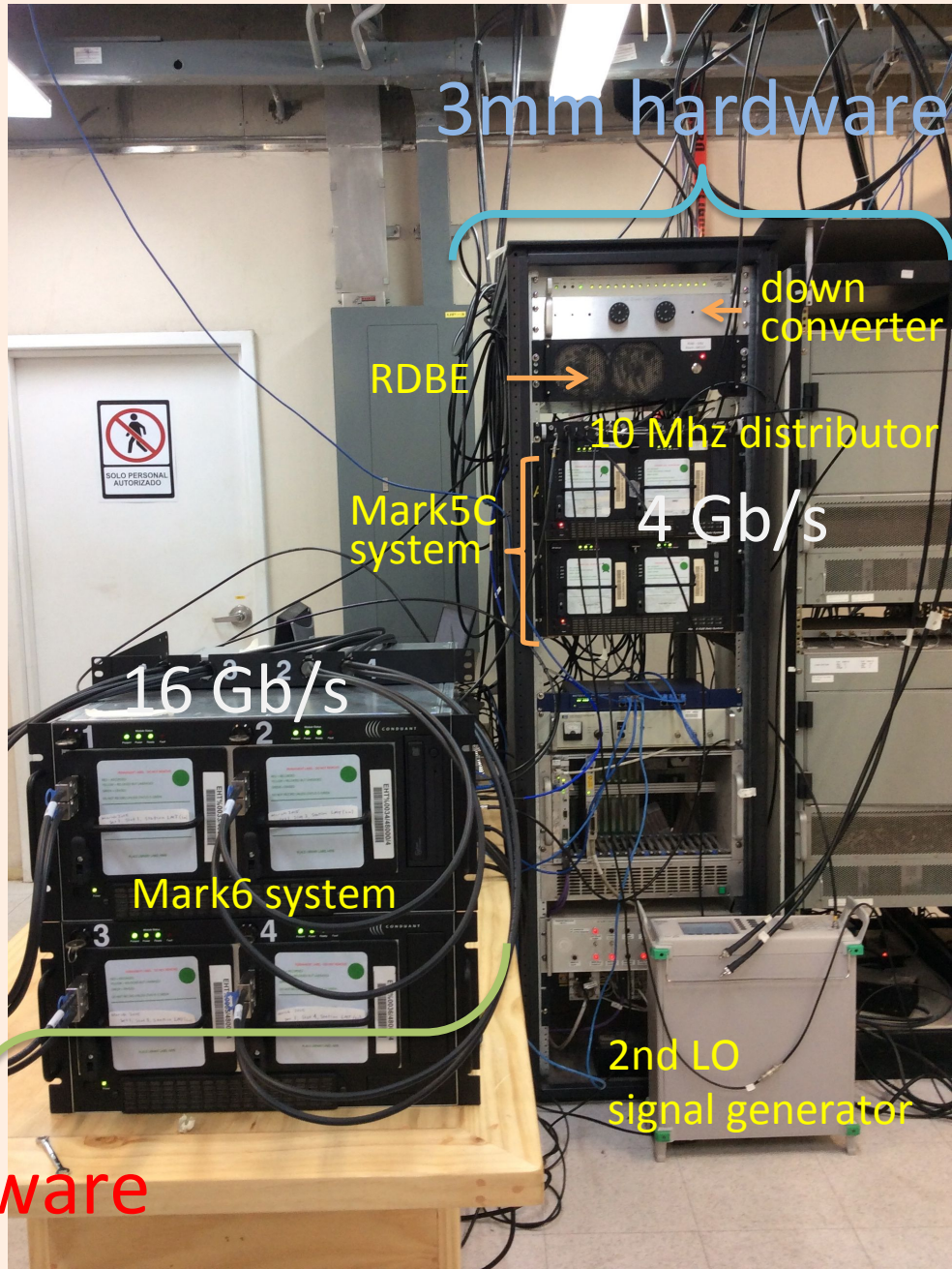
Instruments

- Redshift Search Receiver
  - Four receivers covering 73-111 GHz
  - Dual beam, dual polarization



- VLBI backend

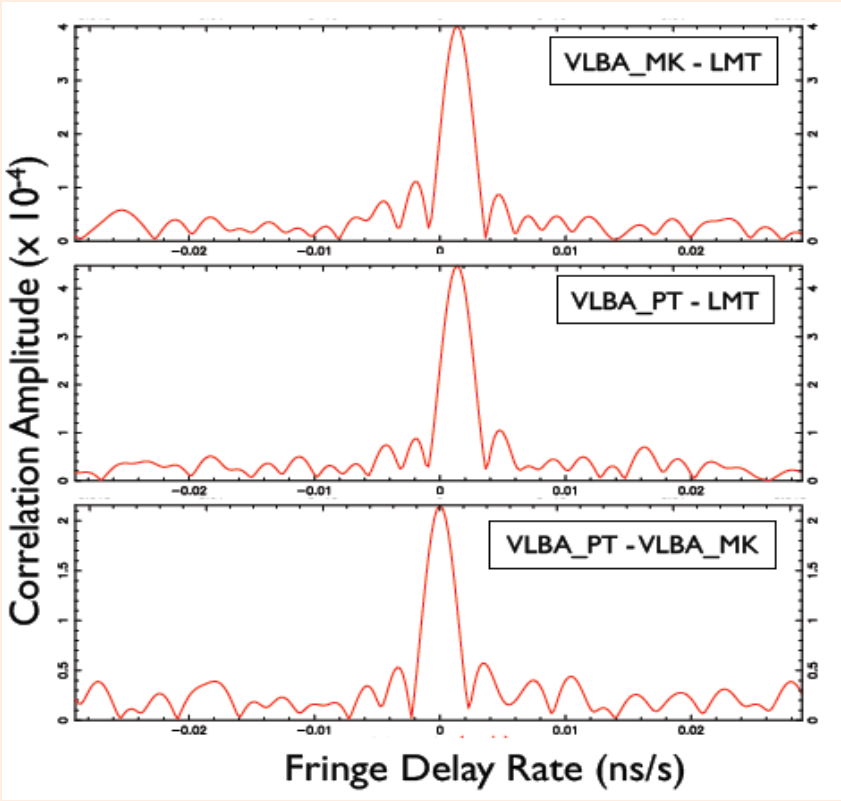




EHT hardware

3 mm VLBA+LMT observations

- 3 successful seasons completed
  - June 2013
  - Fringes on SiO masers



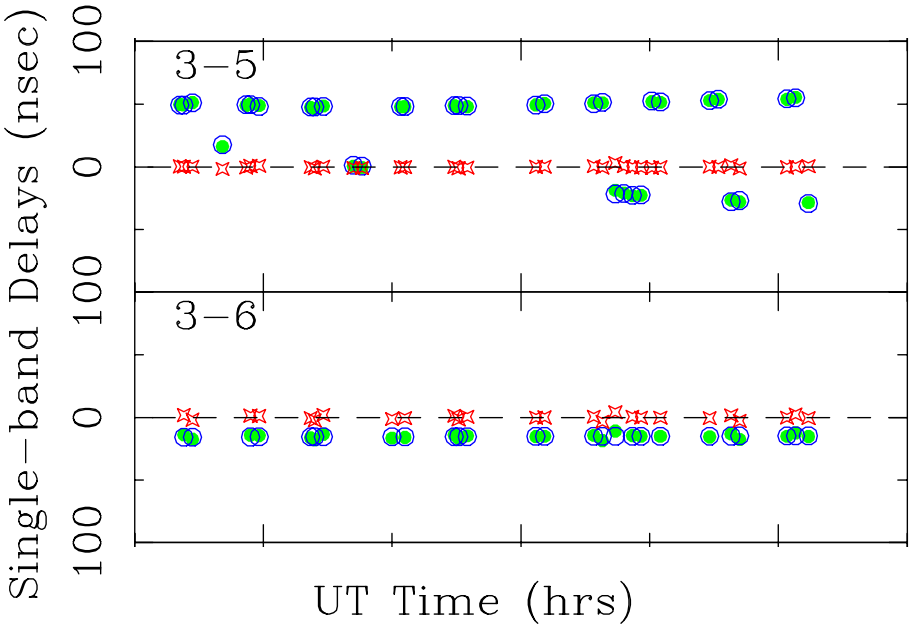
– 2014:

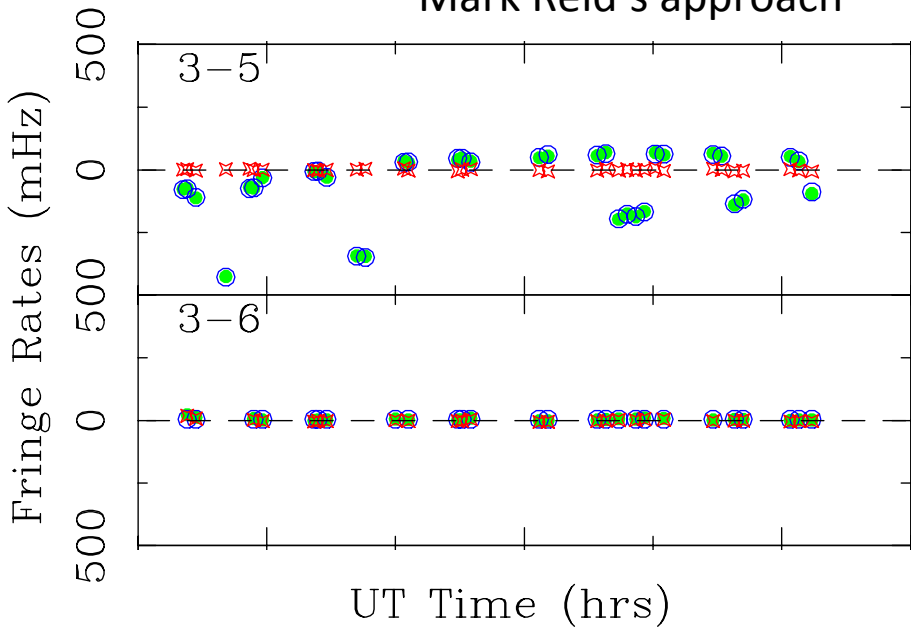
- maser installation
- 4 observing nights for science commissioning, focusing on Sgr A*
- Single polarization mode, 480 MHz bandwidth
- 7 VLBA antennas participating

- Data calibration and analysis
  - Antenna position errors derived from modeling geometric delays.

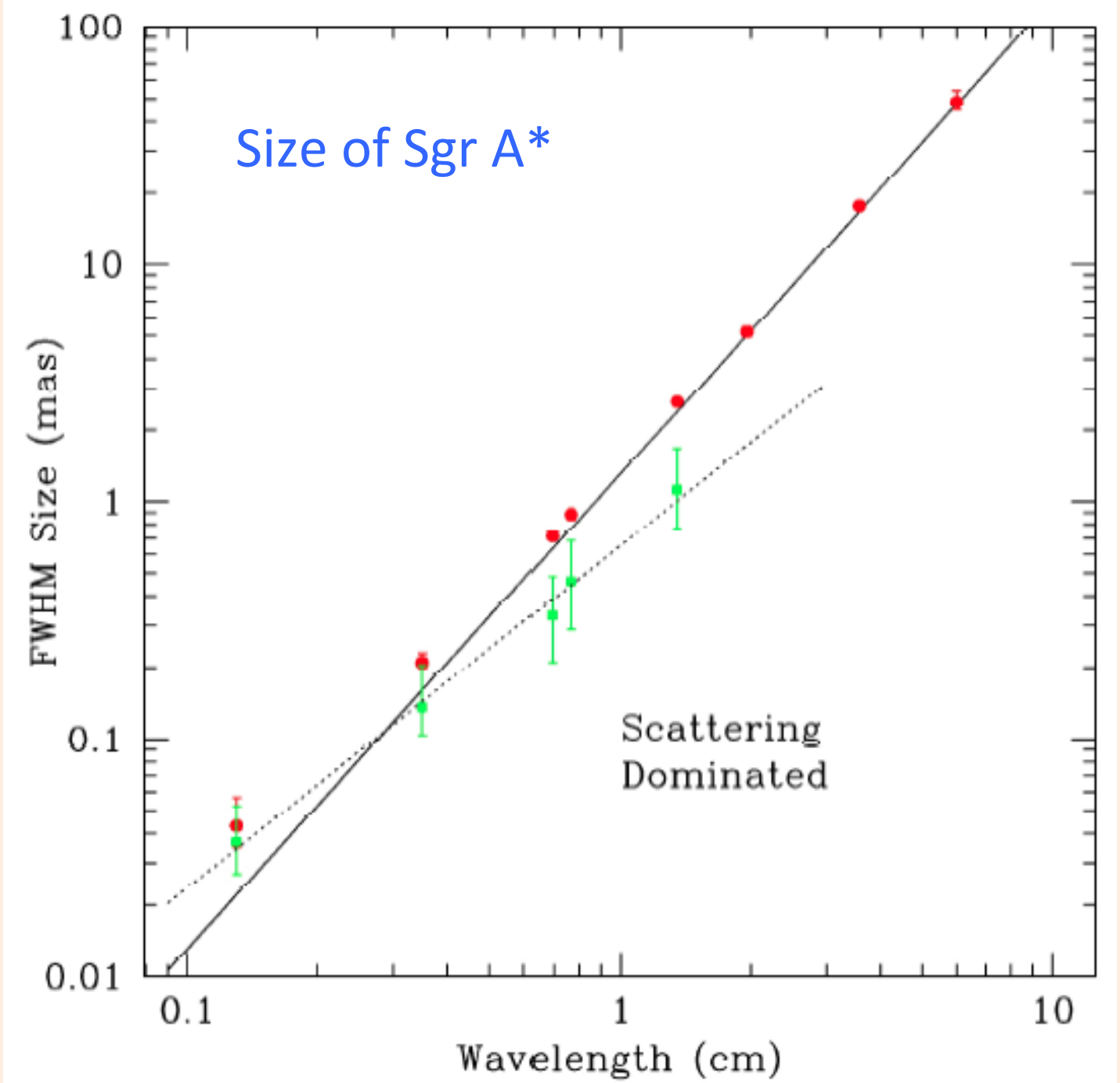
$$\tau_g = \frac{\vec{b} \cdot \vec{k}}{c}$$

Mark Reid's approach



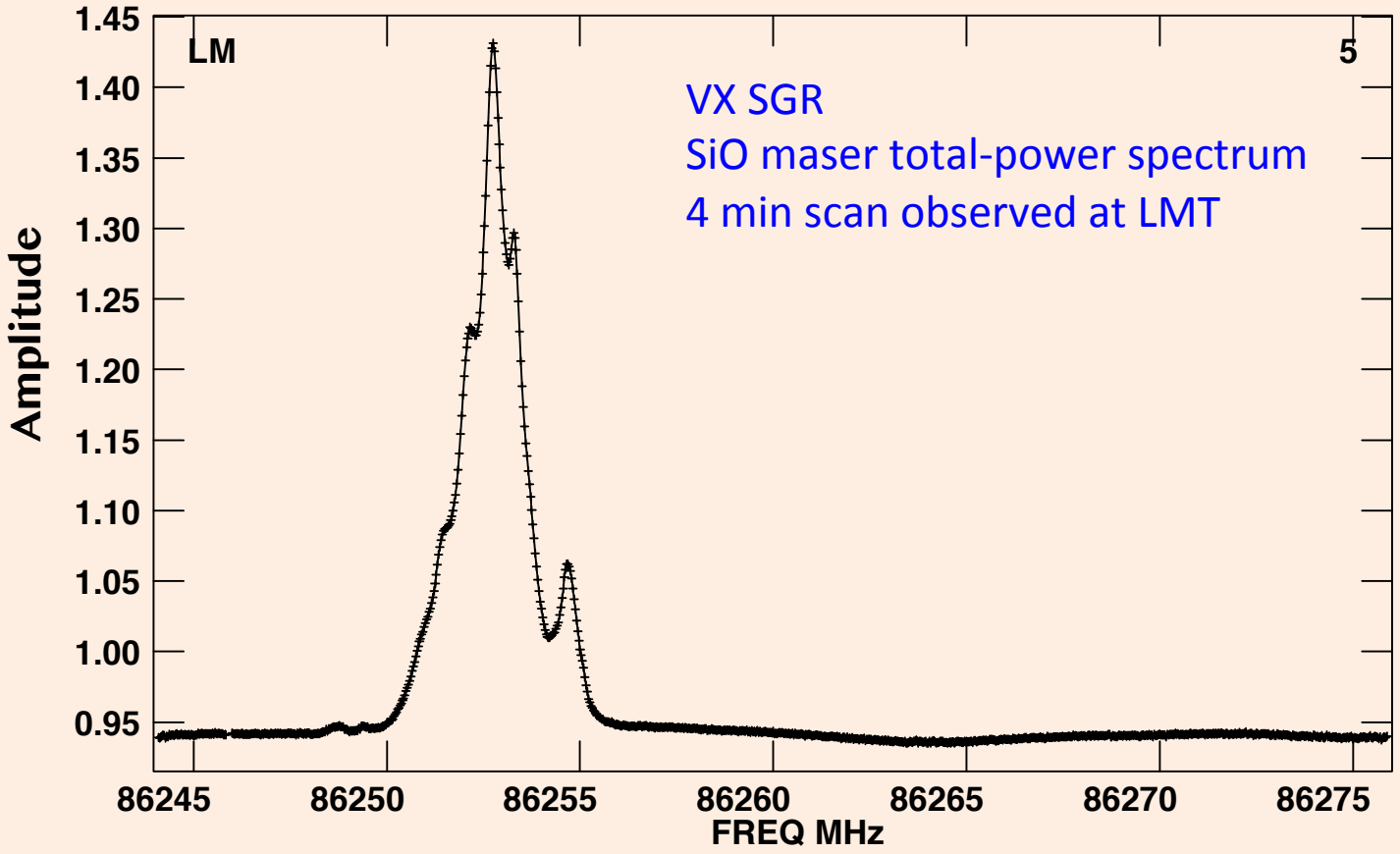


  - Position is now known to better than 7 mas



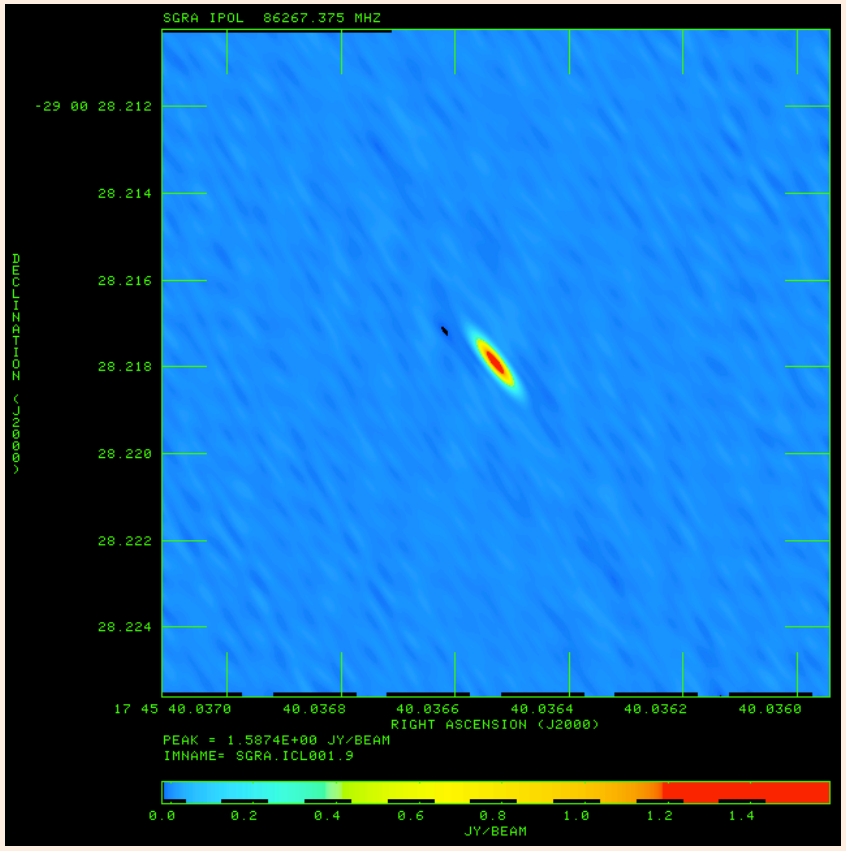
Doeleman et al. 2008

- Amplitude calibration: three different approaches
  - *Tsys* method is not the best for the LMT
  - Template spectrum method (ACFIT task in AIPS)

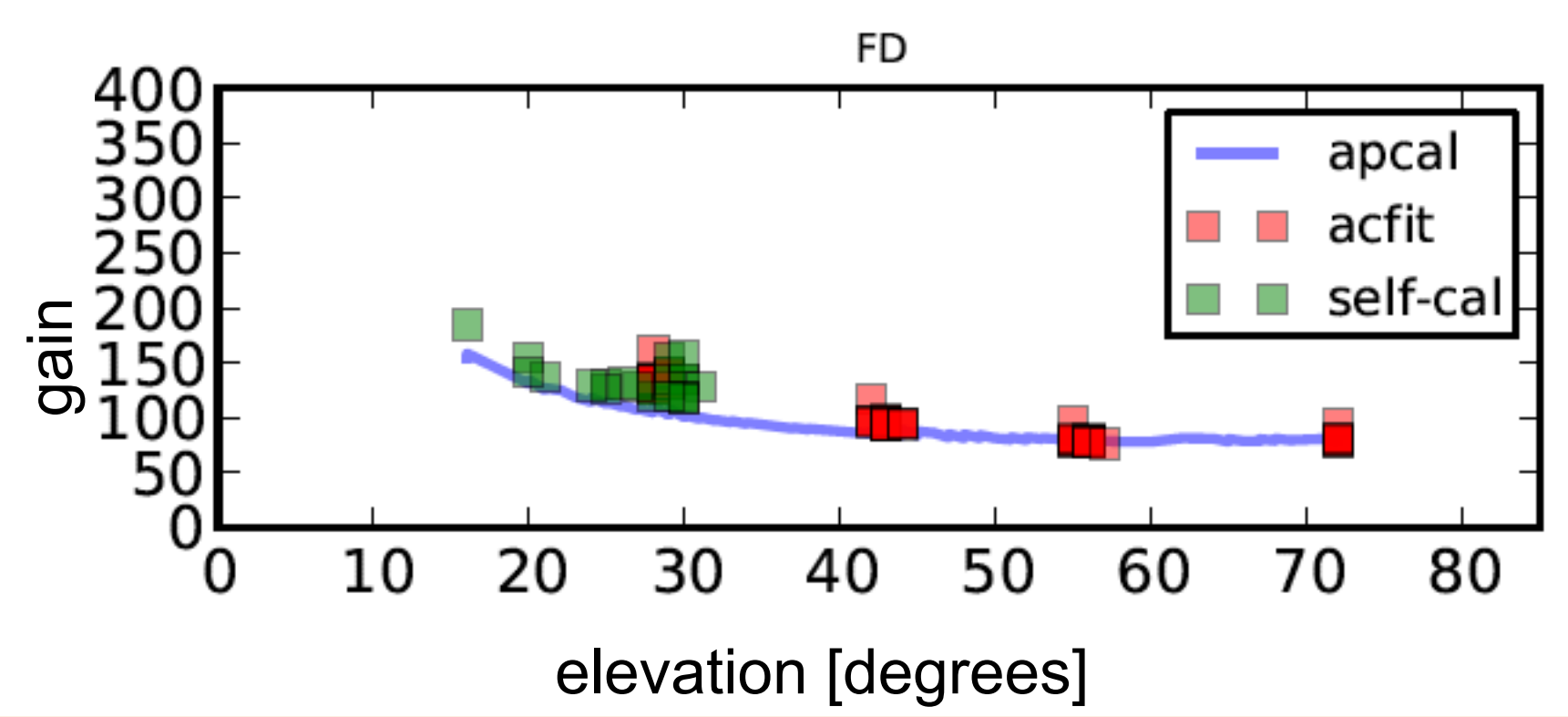


– Self-calibration (CALIB task in AIPS)

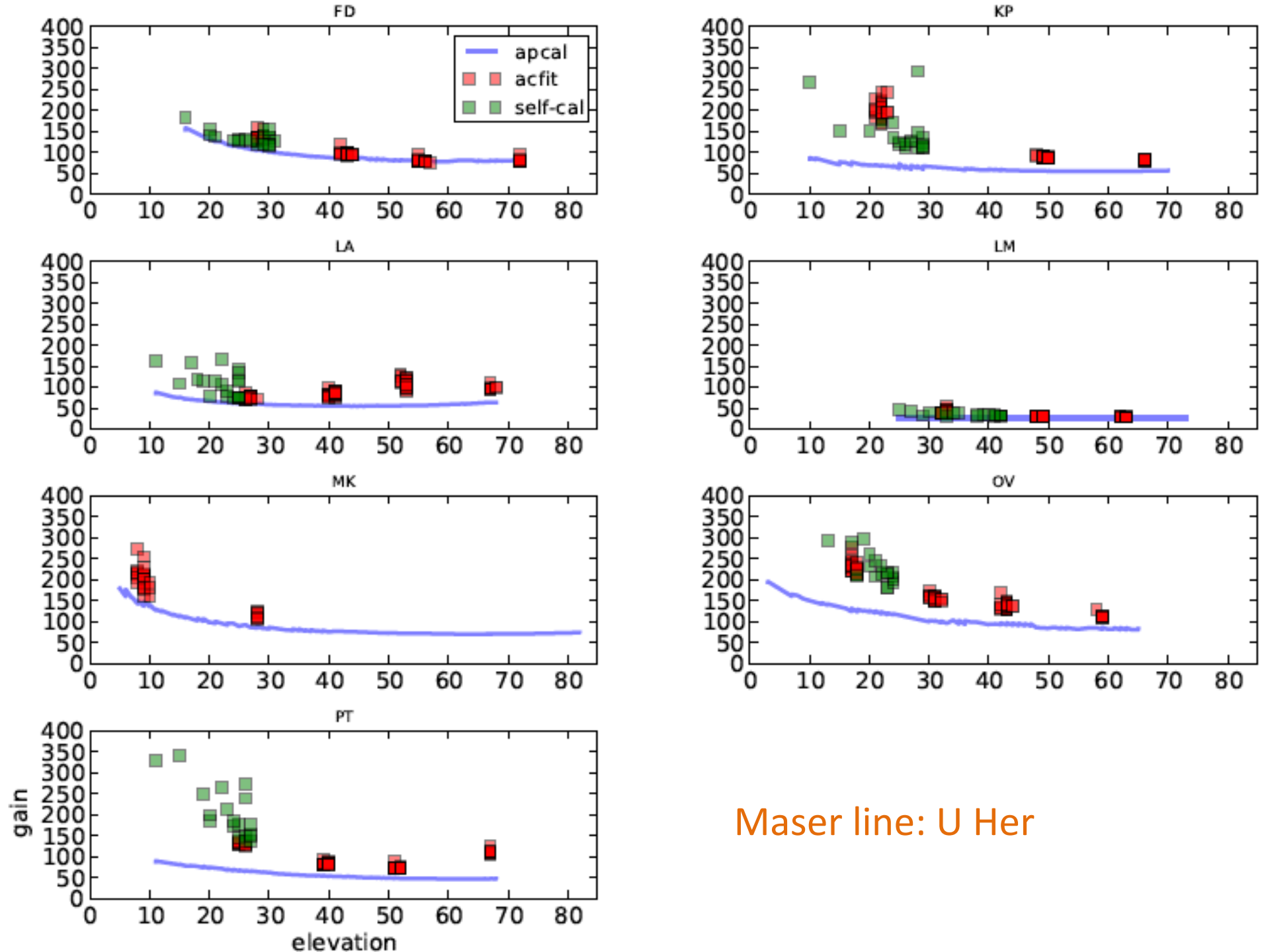
- Major axis size scales as λ^2
- Source model at 3 mm: 0.175 mas x 0.088 mas,
  P.A.= 80 deg., flux density=2 Jy



– Amplitude gain curves comparison for Fort Davis
– 2014 data, 9 hours observing run



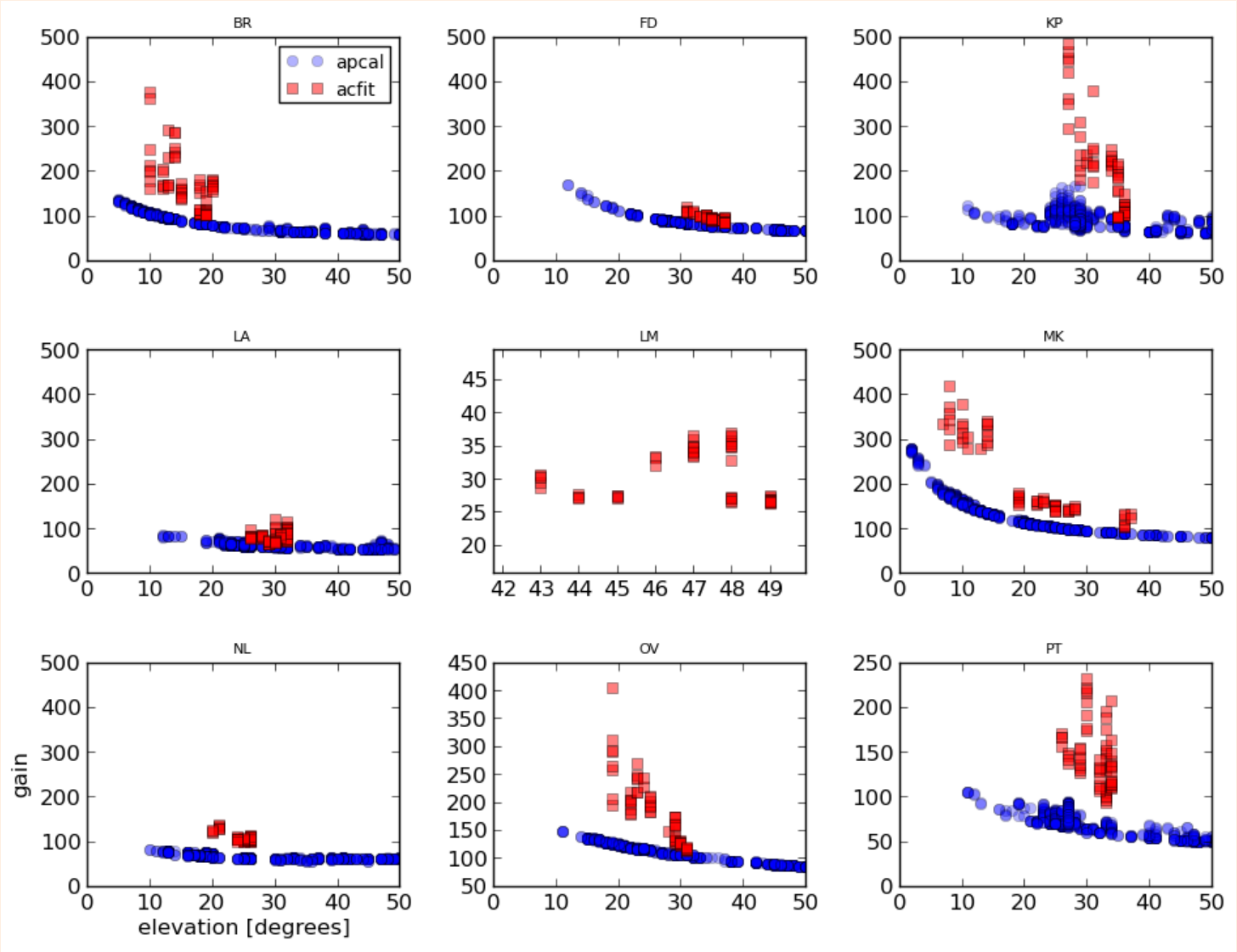
Maser line: U Her, 16h25m47.4717, 18d53’32.856”



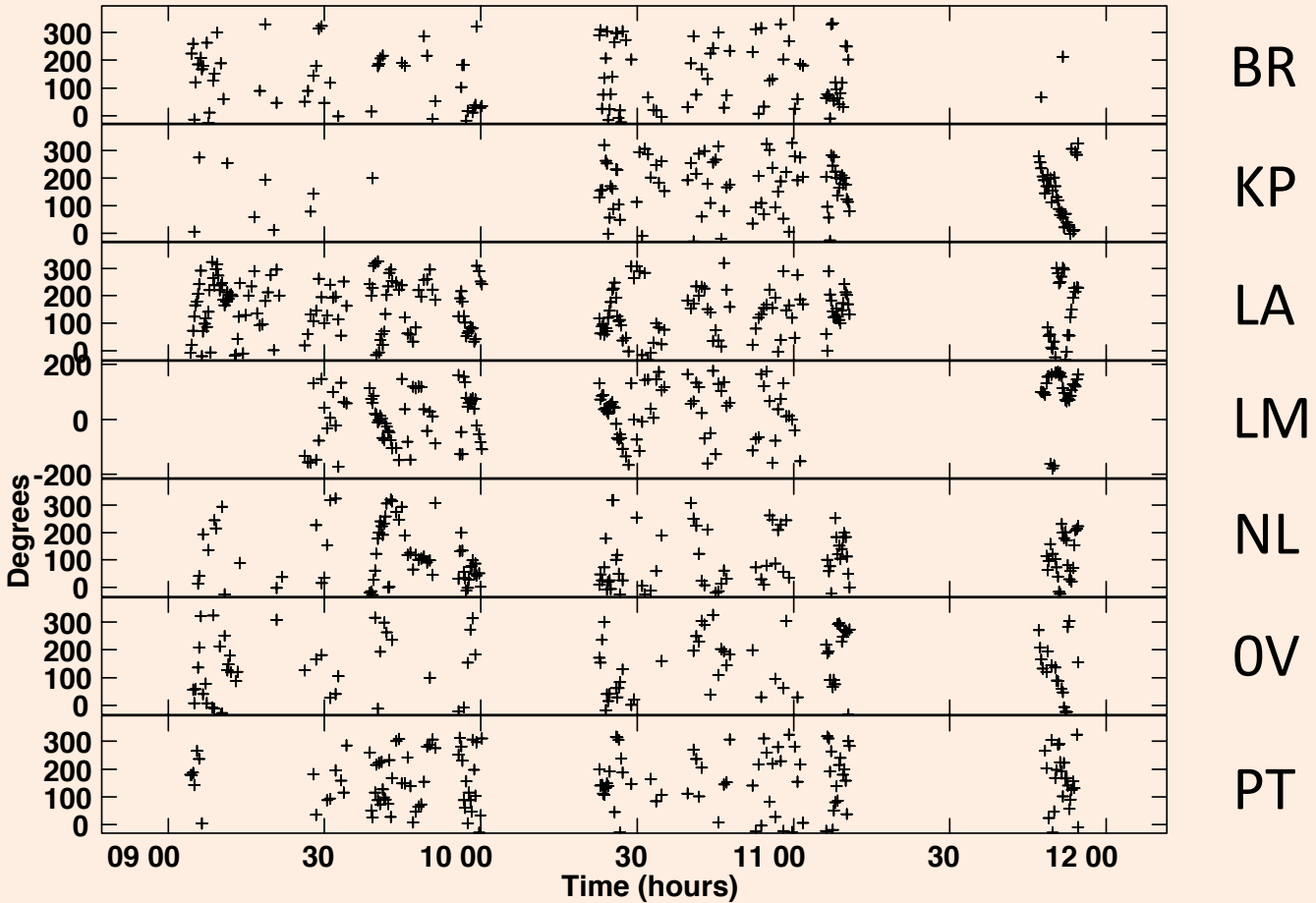
Maser line: U Her

– 2015 data: comparison of *T*sys and template spectrum gain curves

Maser line: VX SGR



- Phase-referencing observations (2015):
  - Fast switching between Sgr A* and the quasars 1745-283 and 1748-291
  - Antenna switching cycle of 16 seconds



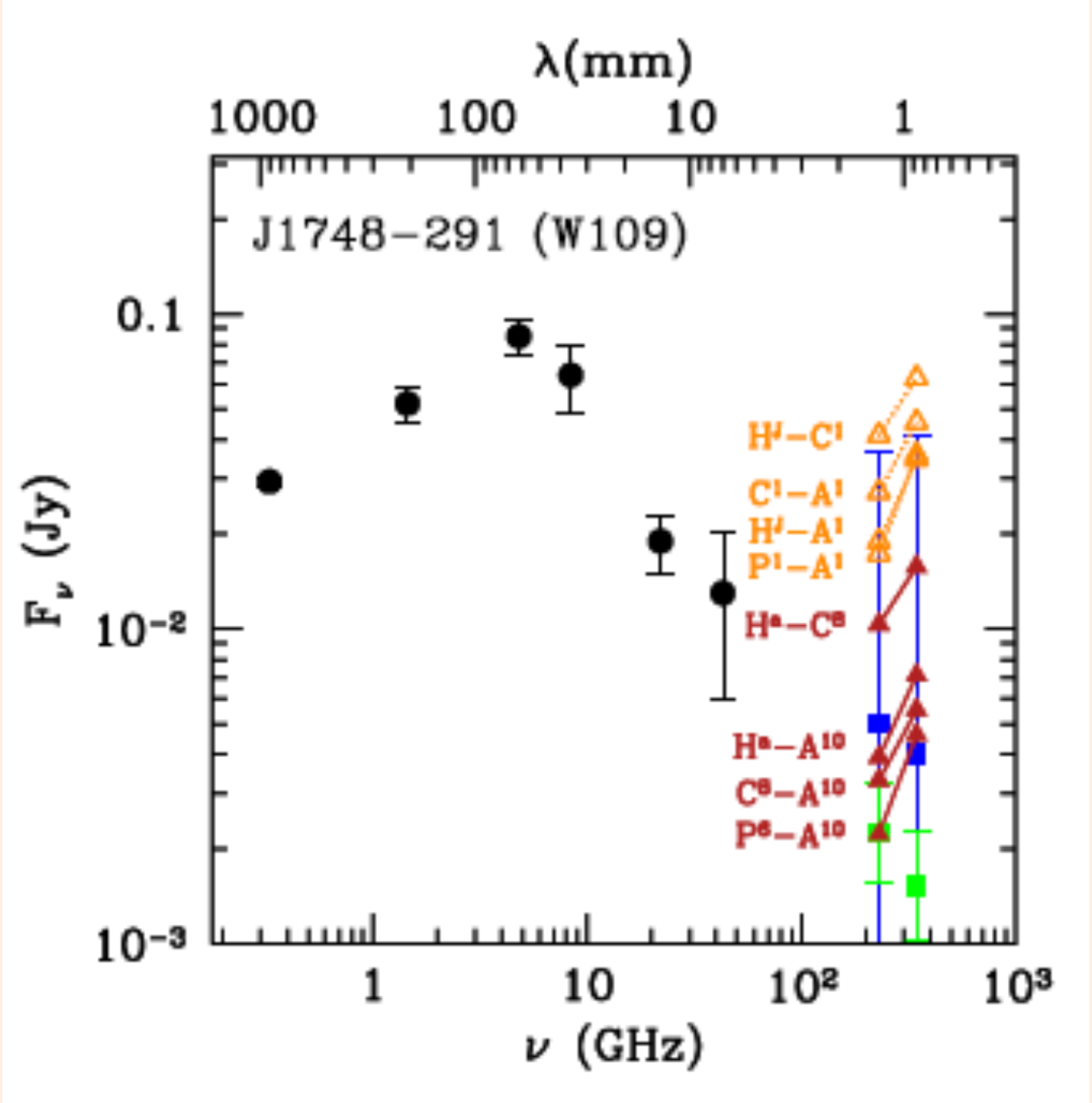
- 1745-283 and 1748-291 have not yet been detected.
- Scenarios to explain this:
  - Poor SgrA* phase coherence
  - Amplitude calibration errors

– It could be hard to success in a phase-referencing observation at this wavelength even including the LMT.

- Some observing considerations for VLBI
  - Hysteresis effect in elevation.
    - Up to 2.5 min to go from SgrA* to J1730-130 at lower elevations.
  - Calibration for pointing takes about 5 min
  - Calibration for *Tsys* takes about 1 min

Summary

- The VLBI facility at the LMT is now operational.
- We have completed 3 seasons of observations at 3 mm with the LMT+VLBA, and we are working on the analysis of the data product.
- 1.3 mm observations with the EHT succeed and fringes on baselines including the LMT have been found.



Broderick et al. 2011