

The ALMA Phasing Project Motivations and Status

Vincent L. Fish



ALMA

The world's most sensitive millimeter interferometer in one of the driest sites on the surface of the planet

Already producing headline-grabbing science as an interferometer

Collecting area equivalent to a single dish > 80 m in diameter

Sensitivity and location make it an ideal potential VLBI element

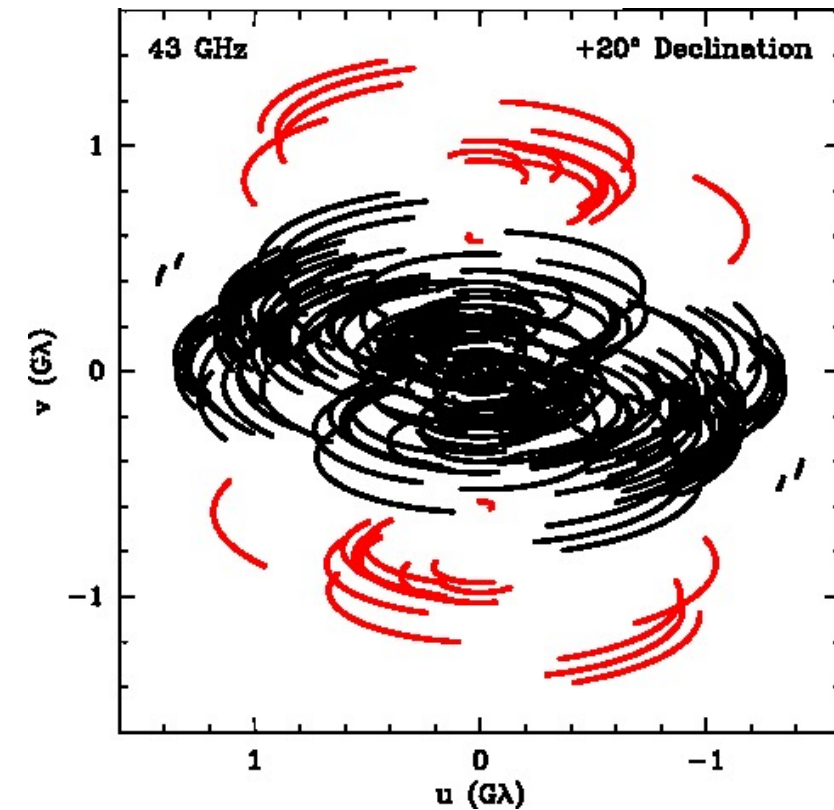
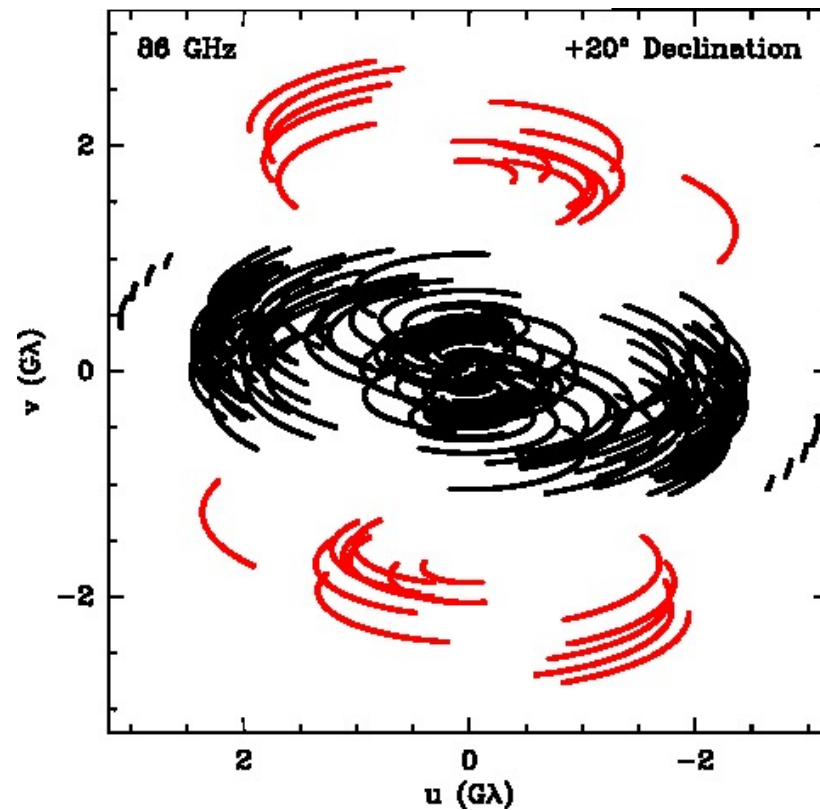
ALMA's VLBI Baseline Coverage

Significantly improved resolution/image fidelity (especially 3mm)

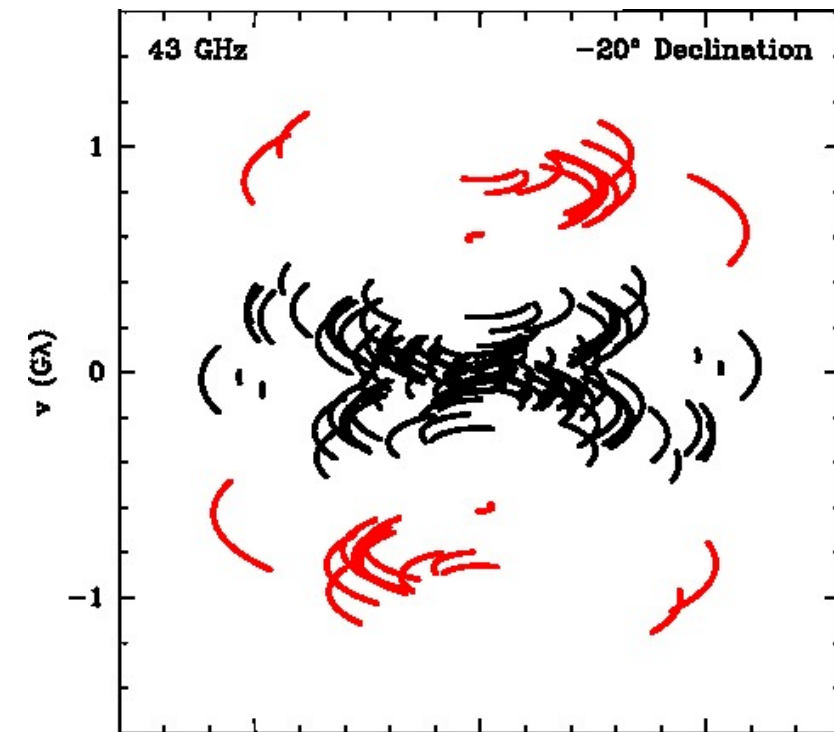
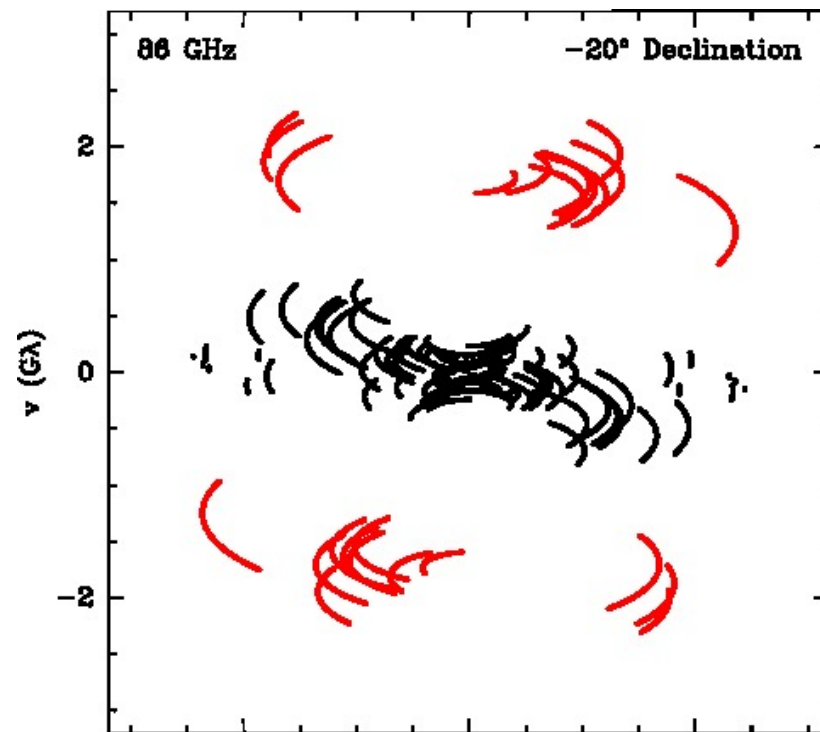
Band 3

Band 1

+20 Dec



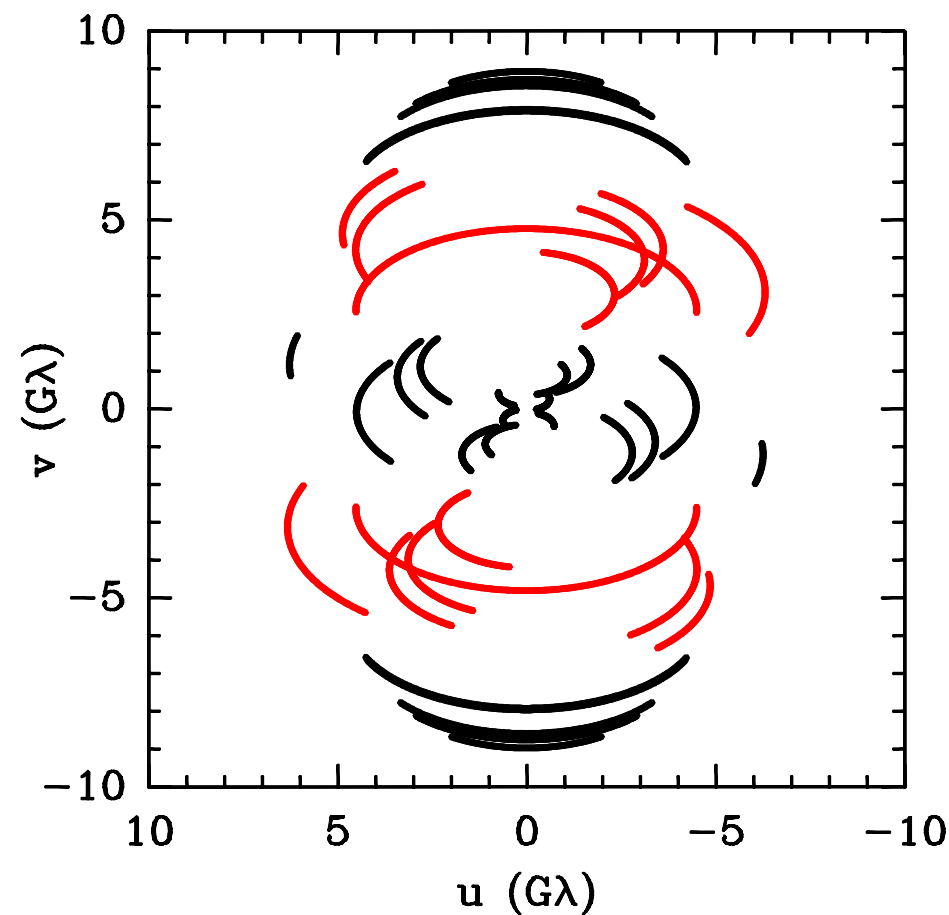
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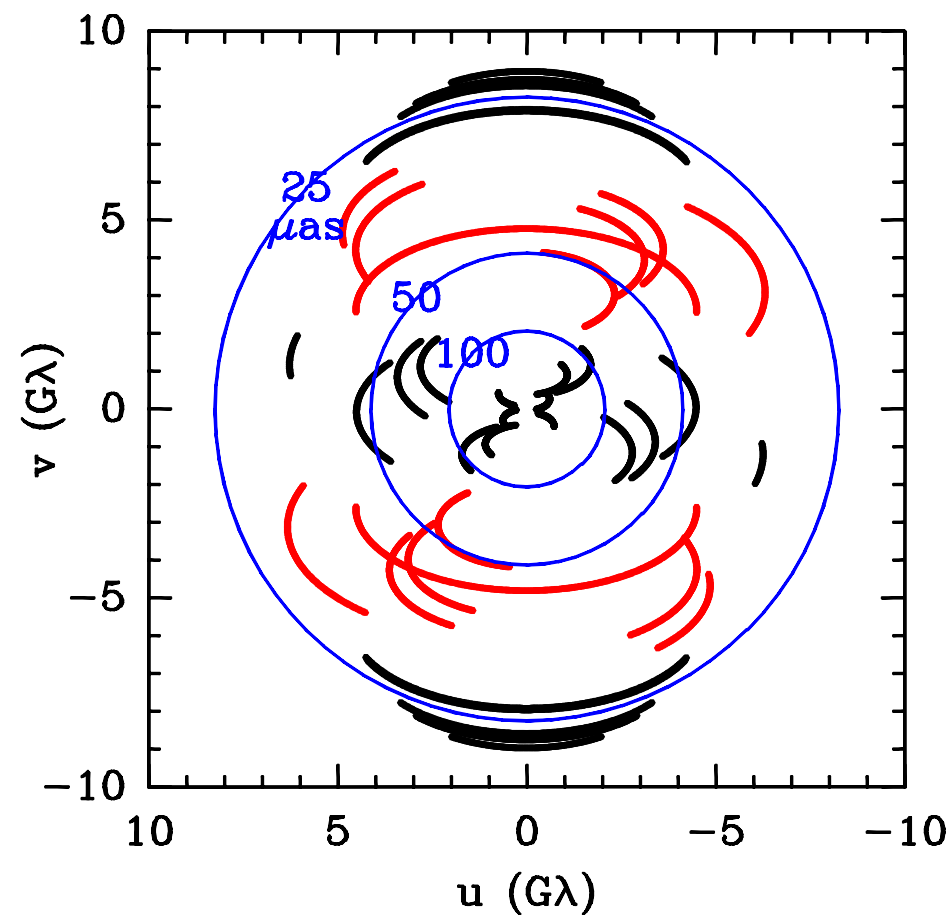
Resolution is critical for Sgr A* at 1.3 mm



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ALMA's VLBI Baseline Coverage

Significantly improved resolution/image fidelity (especially 3mm)

Resolution is critical for Sgr A* and M87 at 1.3 mm

ALMA more than doubles north-south resolution of global VLBI arrays

Sensitivity is key to maximizing the return on these long baselines (to compensate for lower correlated flux density)

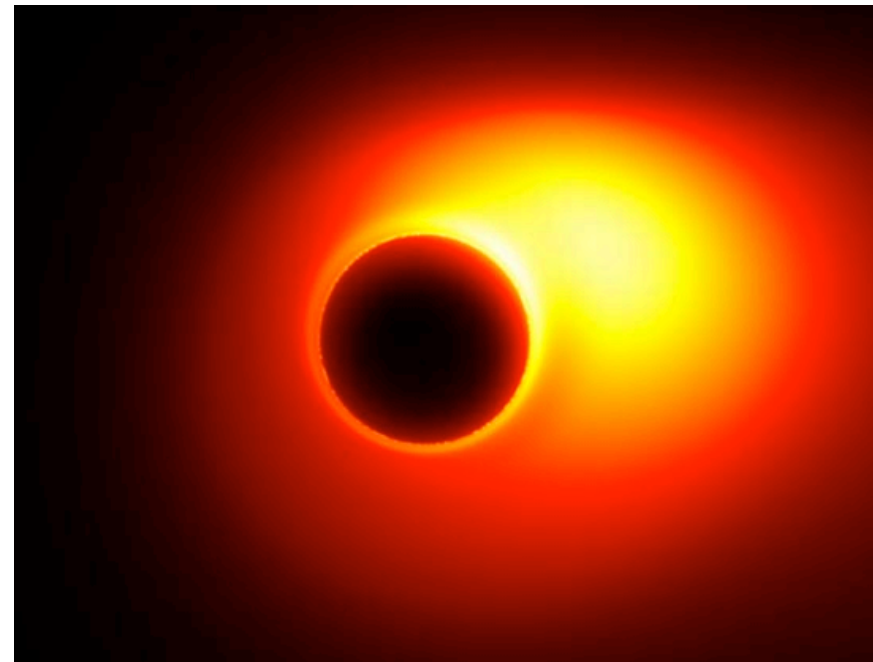
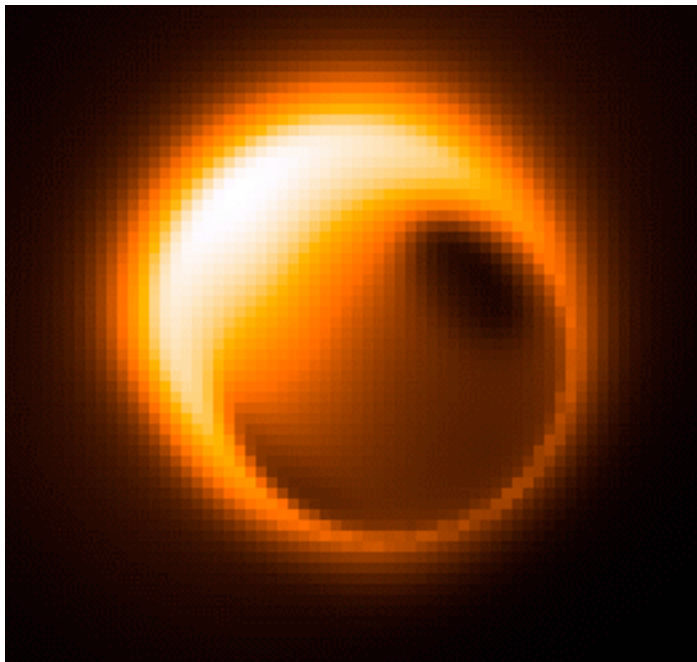
ALMA can serve as an anchor station for arrays, allowing for calibration of weak baselines

Event Horizon Science

Sgr A* and M87 + other nearby sources

Imaging and time-domain science already covered by
S. Doeleman, C. Goddi

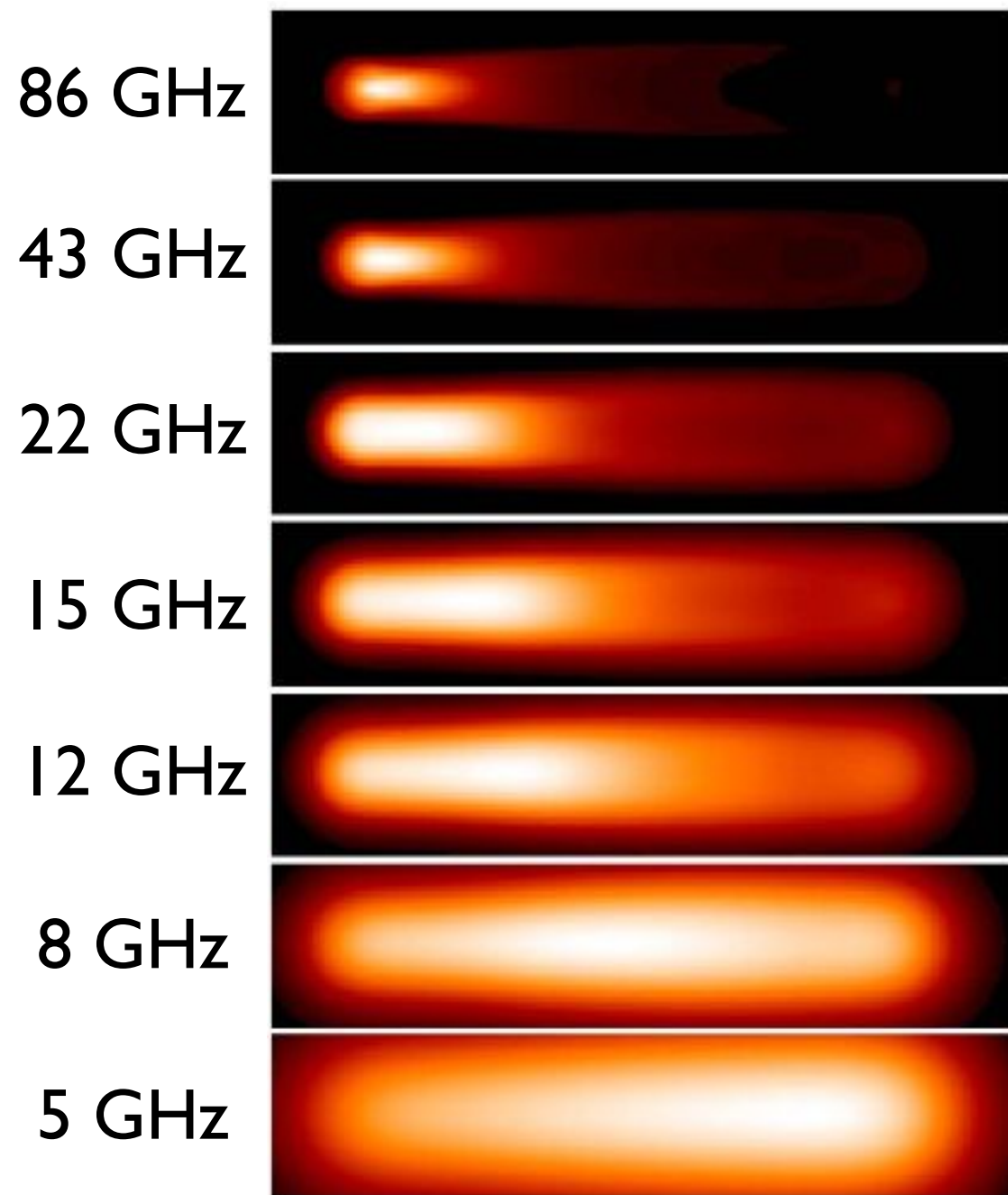
Ties to multiwavelength observing/monitoring campaigns:
infrared (e.g., GRAVITY), X-ray, longer-wavelength radio
(talks by A. Rushton & T. Jung)



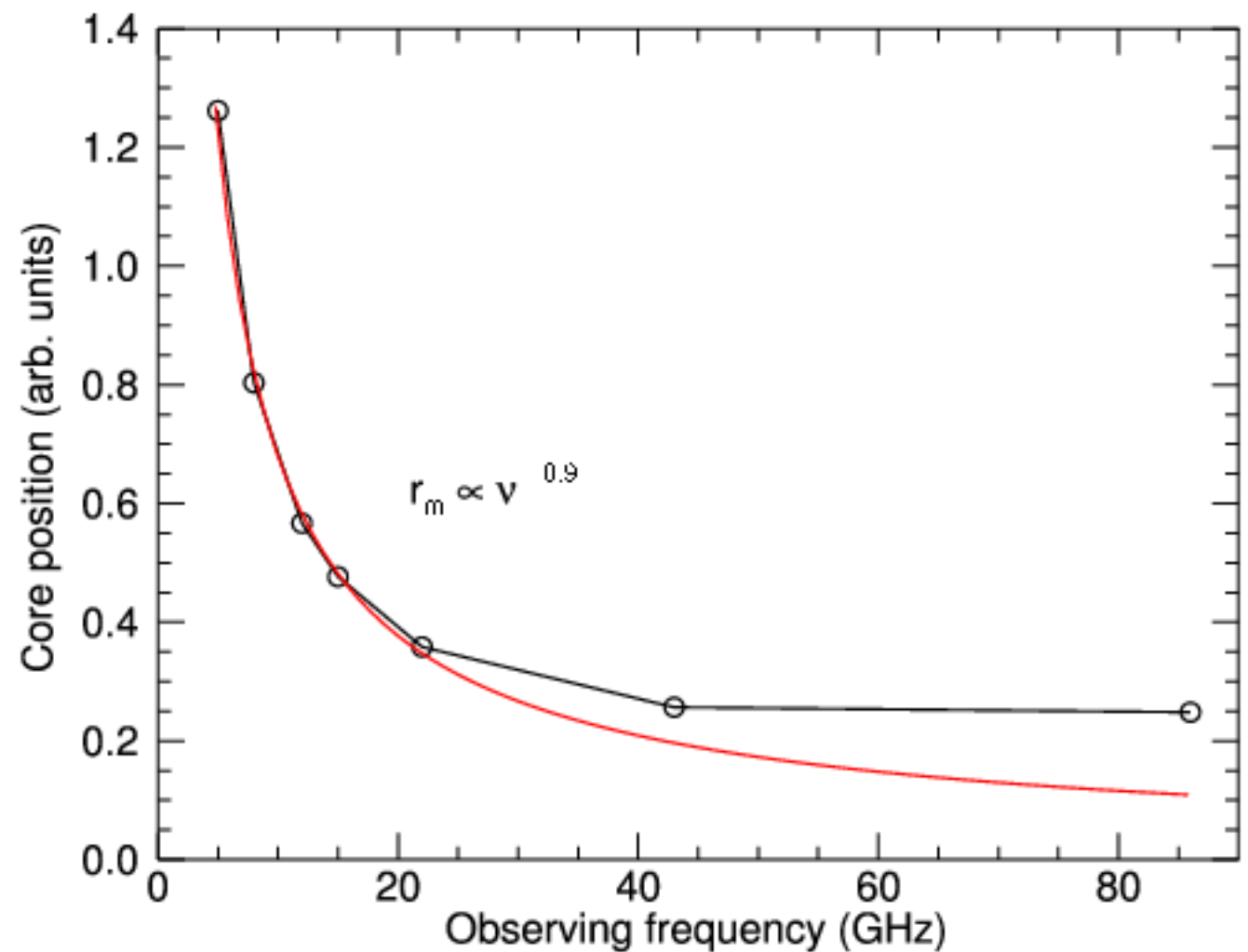
courtesy A. Broderick

Jet Physics

Opacity obscures recollimation shock at typical VLBI frequencies



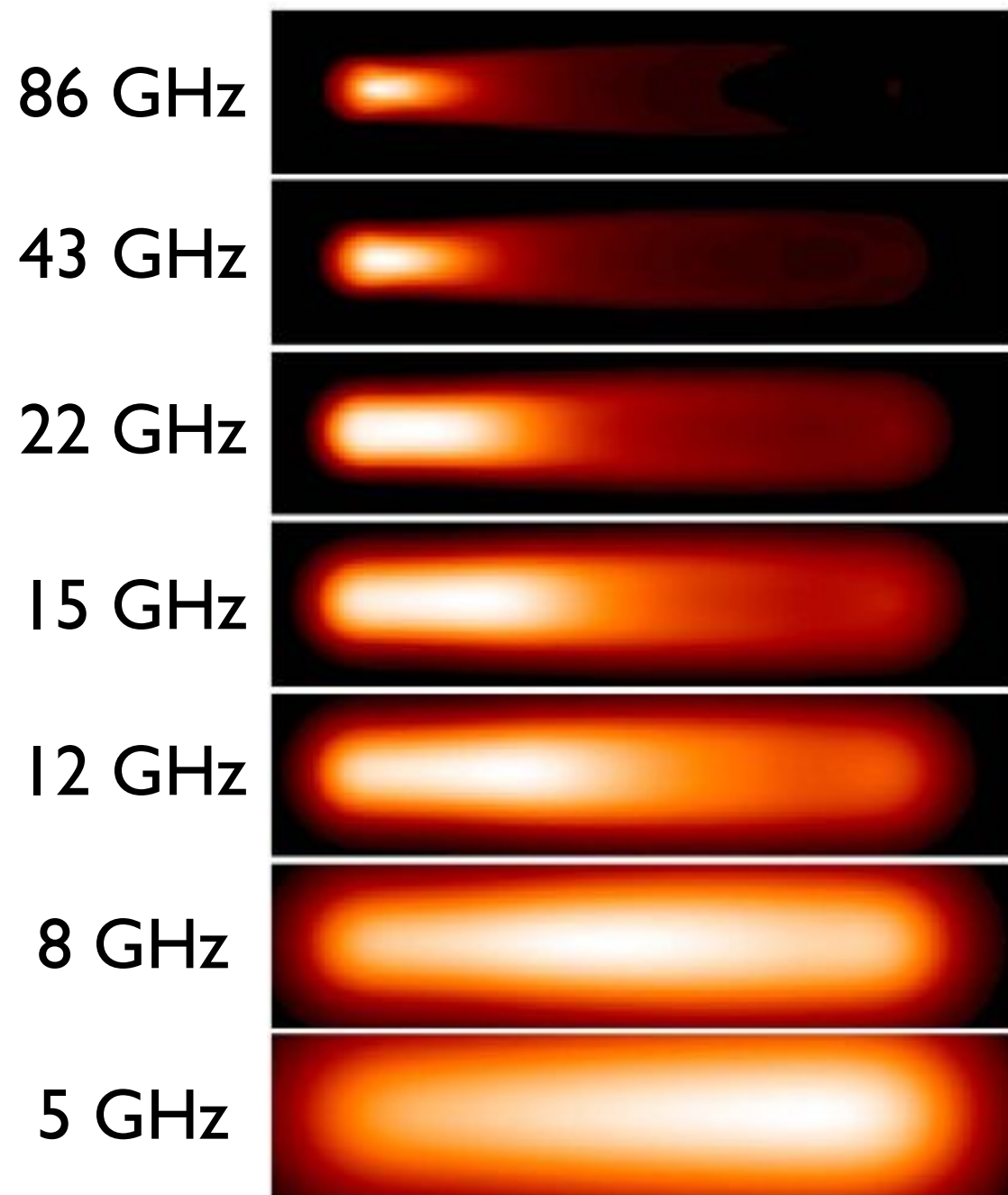
Jet models (Gomez et al.)



The observed core location (black) deviates from a Blandford & Konigl model (red) at high frequencies, indicative of the location of a recollimation shock

Jet Physics

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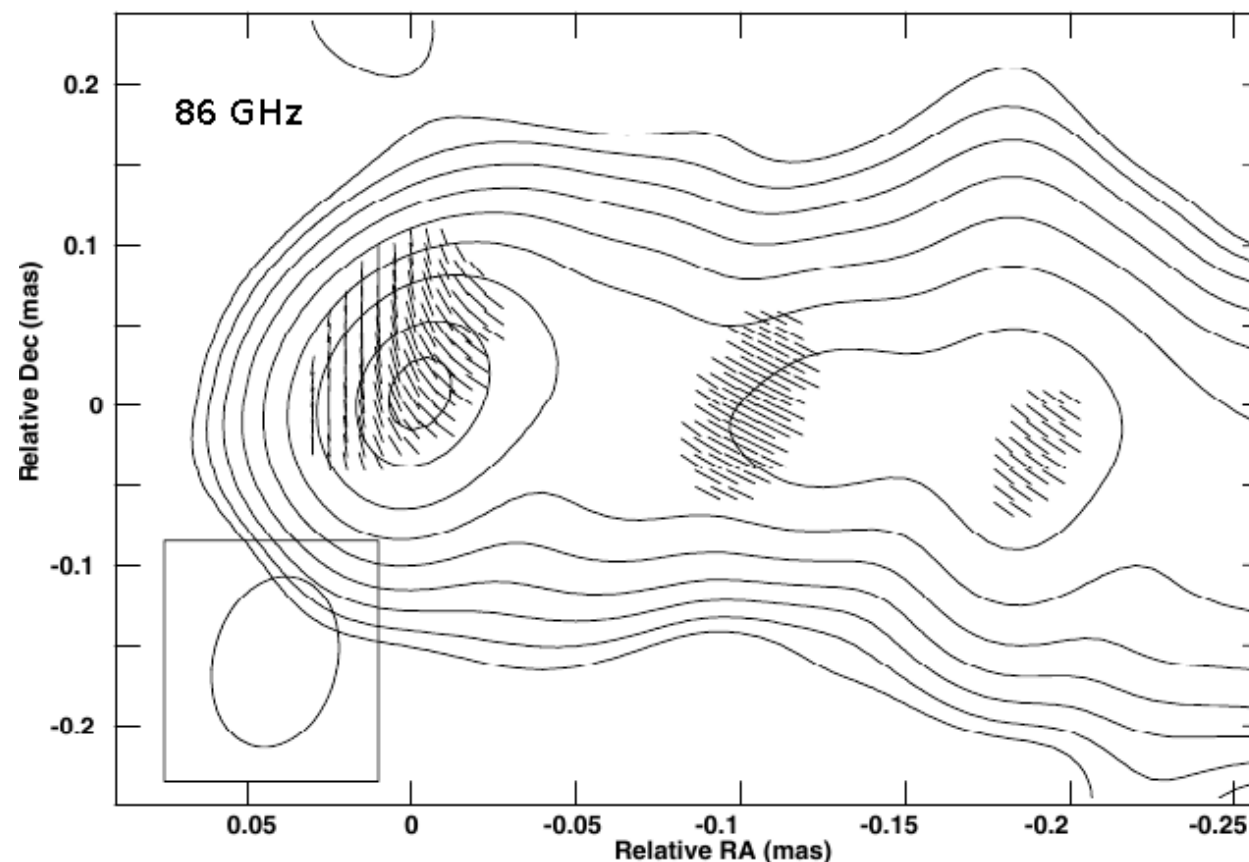
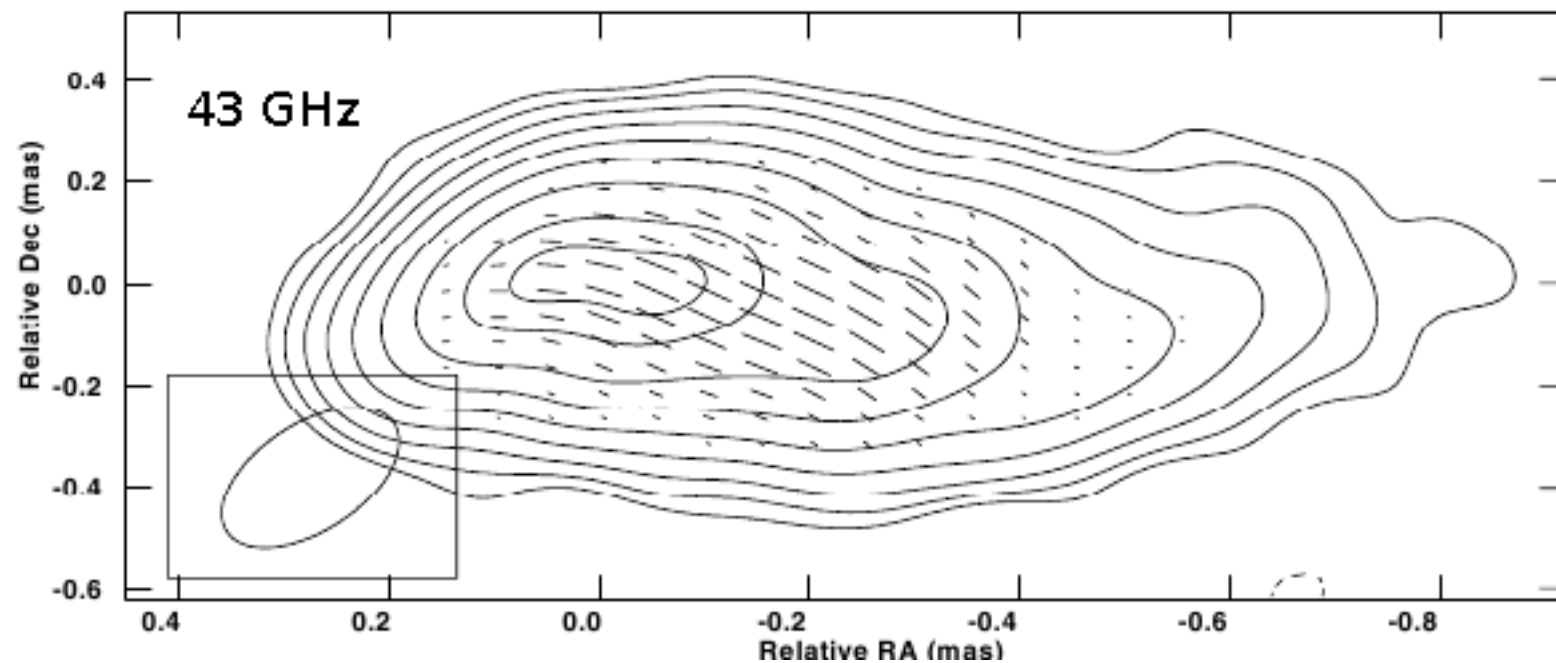


Jet models (Gomez et al.)

Multiple talks in next session:
M. Giroletti, J. Gomez,
M. Kadler, T. Krichbaum

The Role of Magnetic Fields in Jets

Synchrotron depth and beam depolarization contribute to different apparent polarimetry at different frequencies



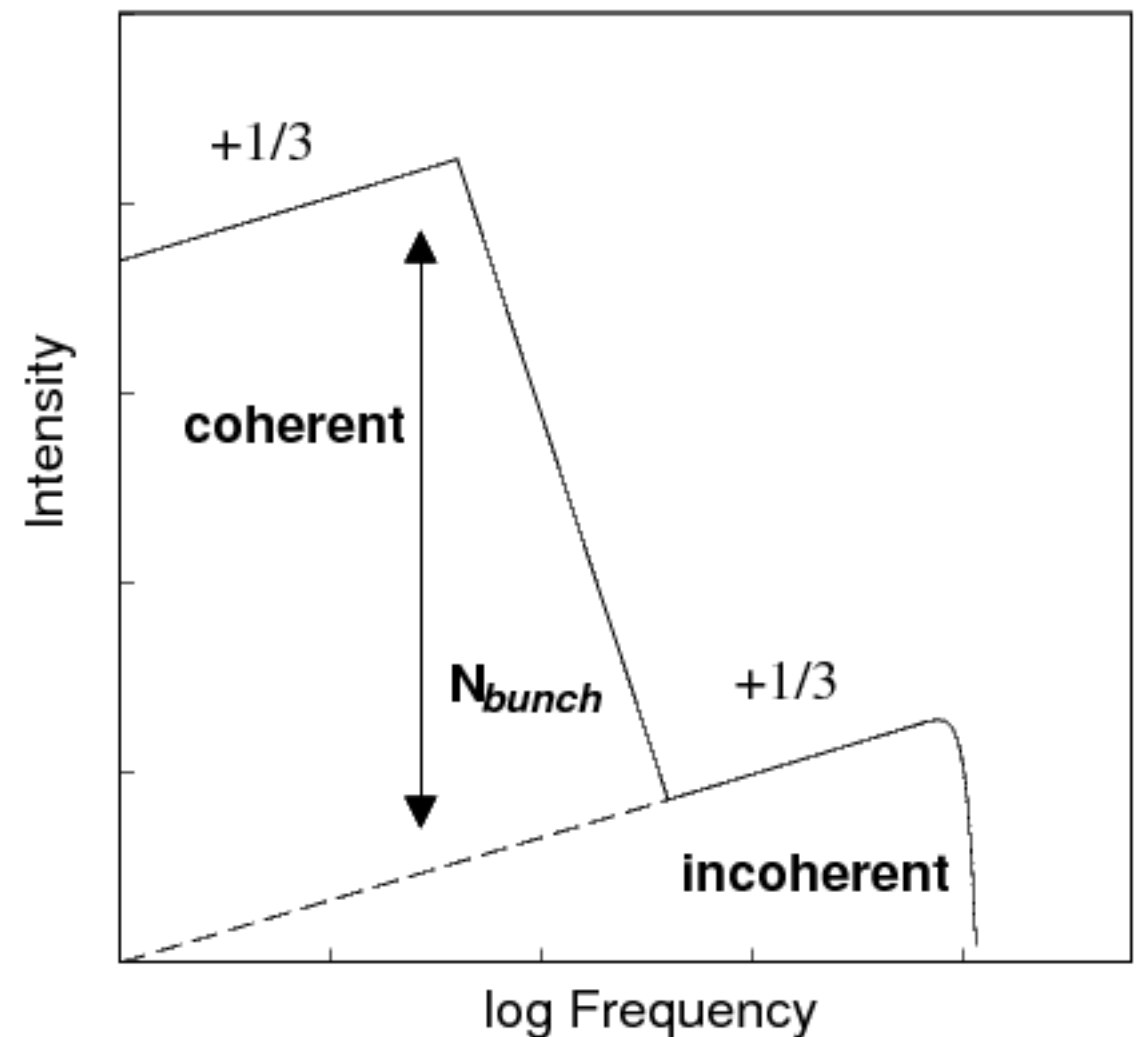
Note: Different scale

Images courtesy I. Marti-Vidal
and S. Jorstad

Pulsars

Pulsars and magnetars have been detected at mm wavelengths

Evidence for turnover at high frequency---different emission mechanism?



courtesy M. Kramer

Pulsars

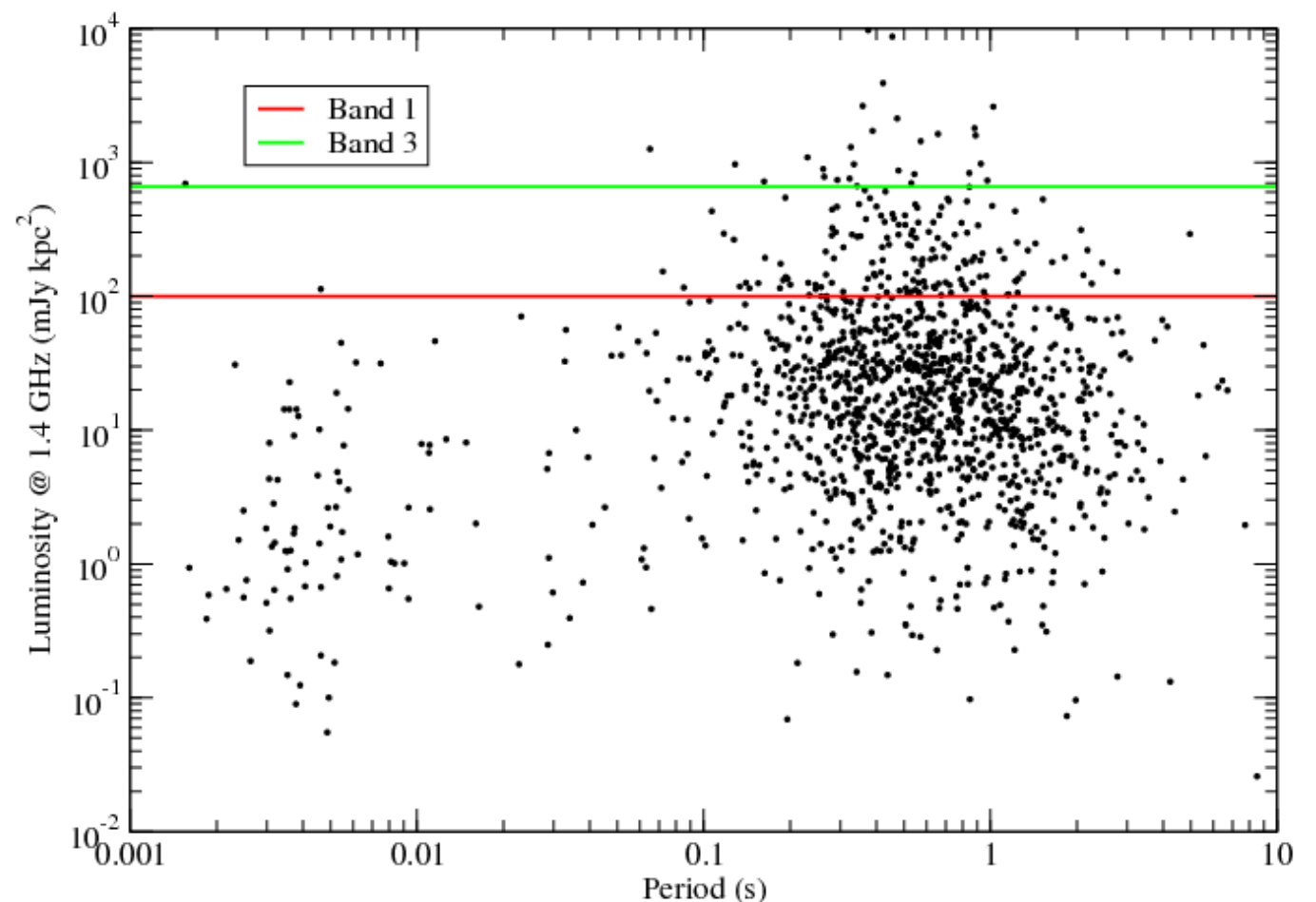
Pulsars and magnetars have been detected at mm wavelengths

Evidence for turnover at high frequency---different emission mechanism?

Galactic Center pulsar searches aim to find pulsar near Sgr A* for precise tests of general relativity

A substantial population of pulsars is predicted in Galactic Center, detectable with phased ALMA

Searches can be commensal with other observations



Pulsars

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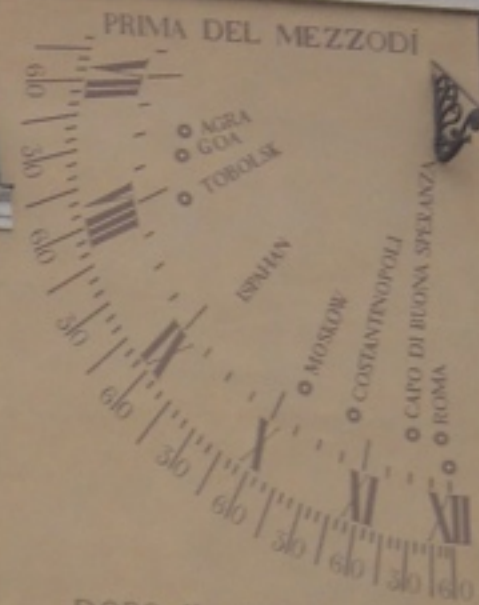
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Talk by M. Kramer

Searches can be commensal with other observations

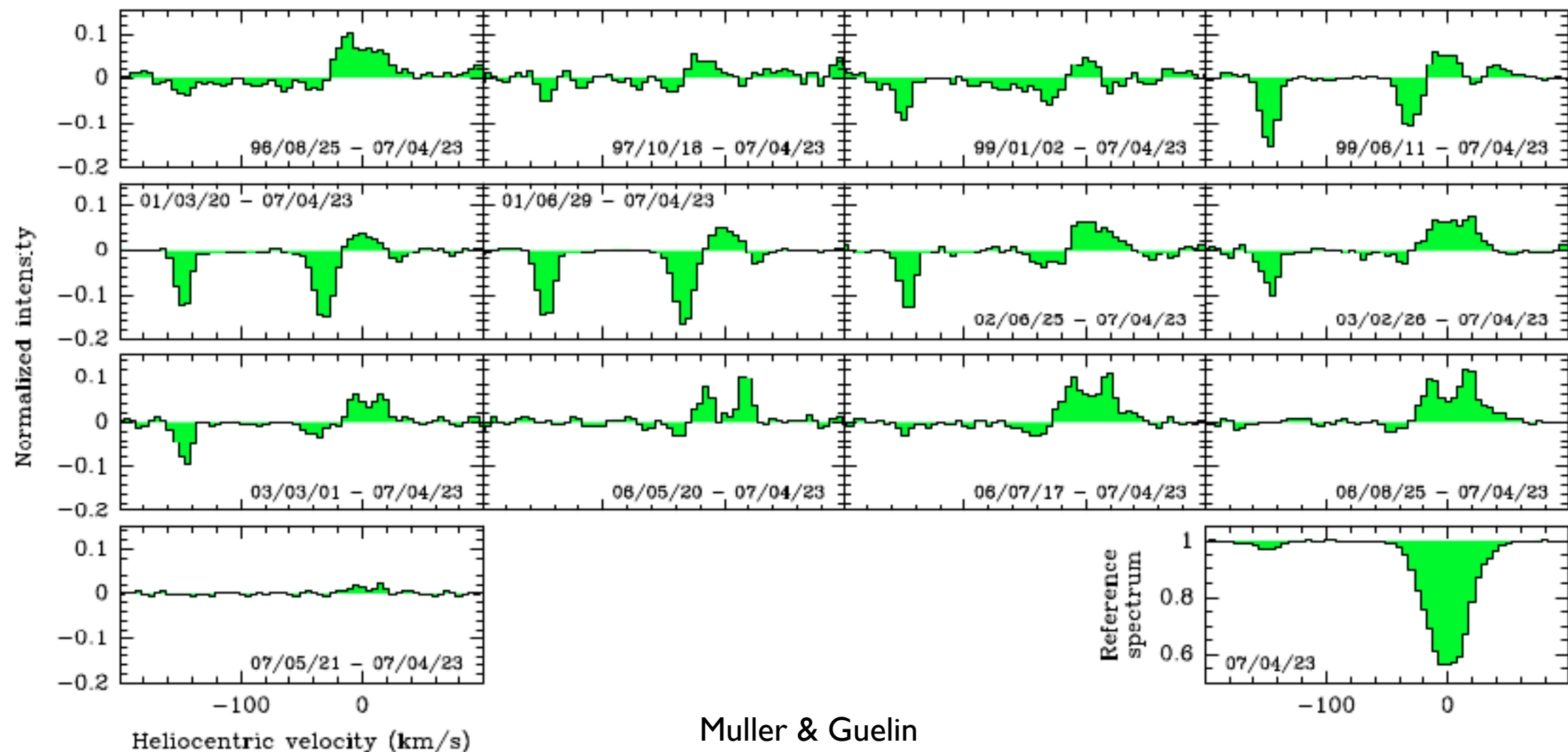


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Absorbers

PKS 1830-211 absorbing system offers opportunity to measure isotopic abundance ratios, CMB temperature, fundamental constant variation at cosmological distances

Variability in emission profiles indicates very compact absorption

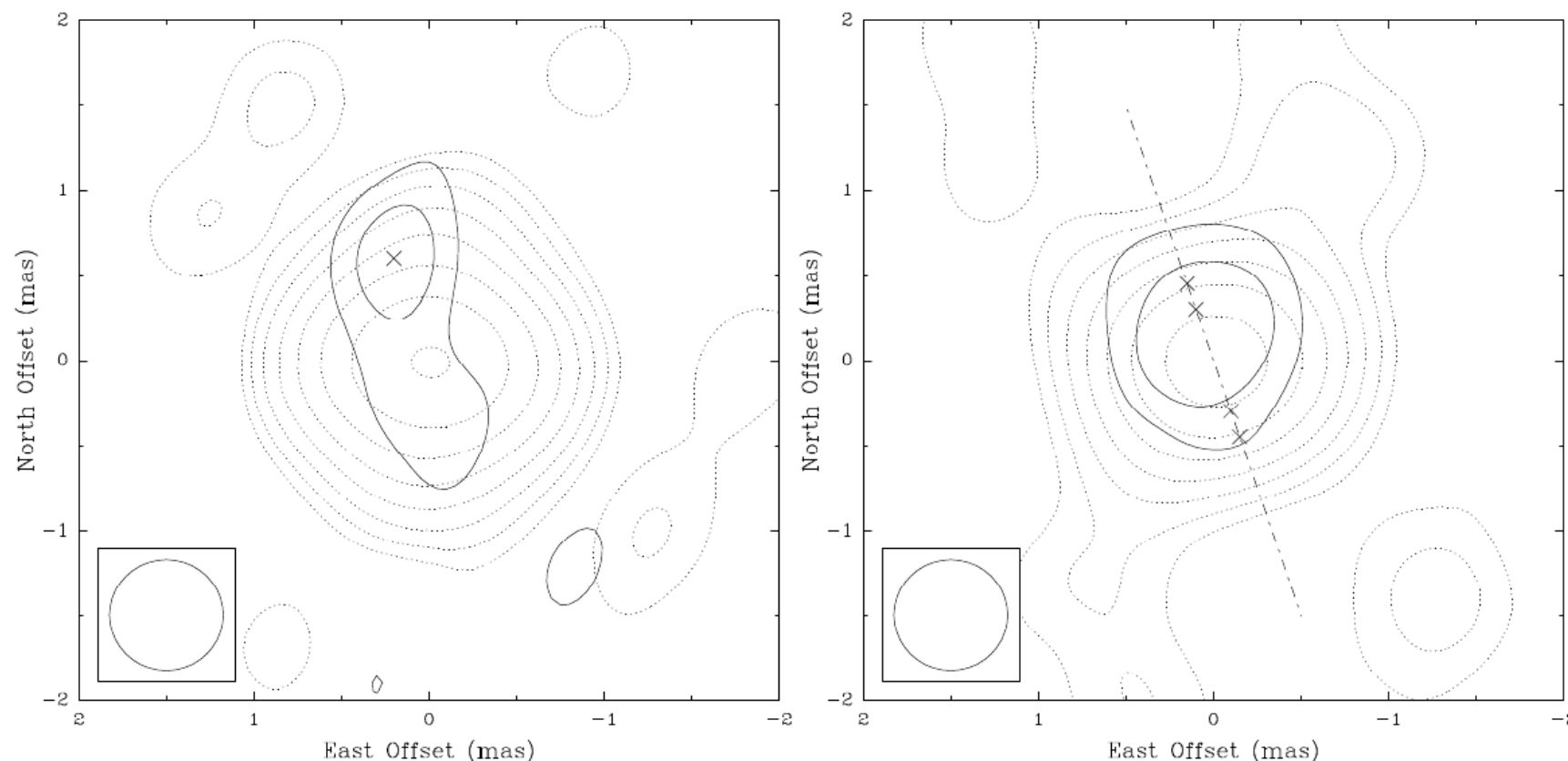


Absorbers

PKS 1830-211 and other absorbing systems offer opportunities to measure isotopic abundance ratios, CMB temperature, fundamental constant variation at cosmological distances

Variability in emission profiles indicates very compact absorption

This structure is still unresolved; better sensitivity and resolution will provide stronger limits on fundamental constant variation



Two transitions of HC_3N absorption (solid) against continuum (dotted contours) (Sato et al.)

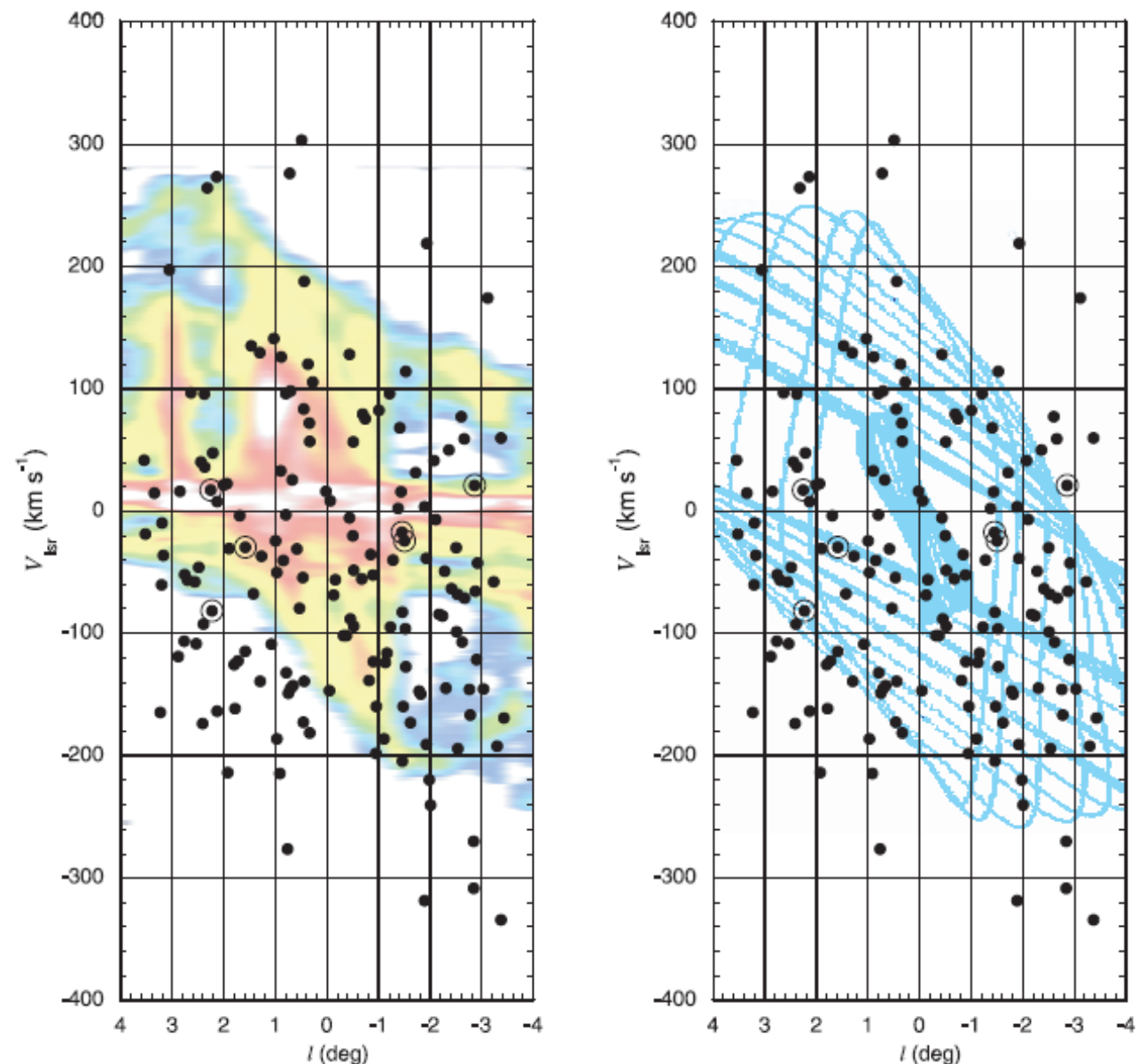
Masers

Numerous species/transitions of masers in ALMA bands

SiO and H₂O masers are very compact (others too?)

Masers can be studied for their own sake (e.g., understanding details of excitation mechanisms) or as precise astrometric tracers for measurements of distance, proper motion, and structure

Rich Southern-hemisphere targets (especially Galactic bulge and LMC)



Longitude-velocity of SiO masers in the Galactic bulge atop CO emission (Fujii et al.)

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Rich Southern-hemisphere targets (especially Galactic bulge and LMC)

Talks by F. Colomer &
A. Richards

APP Status

APP is past major gating reviews

- PDR
- CDR
- System Integration & Test Review
- Master Acceptance
- Hardware Acceptance

Remaining tasks

- Some software (most of the critical software is done; remaining software tasks primarily relate to usability)
- Debugging/Testing
- Commissioning

Note:ALMA polarization is dual linear (talk by I. Marti-Vidal)

January APP Activities

Test observations last week

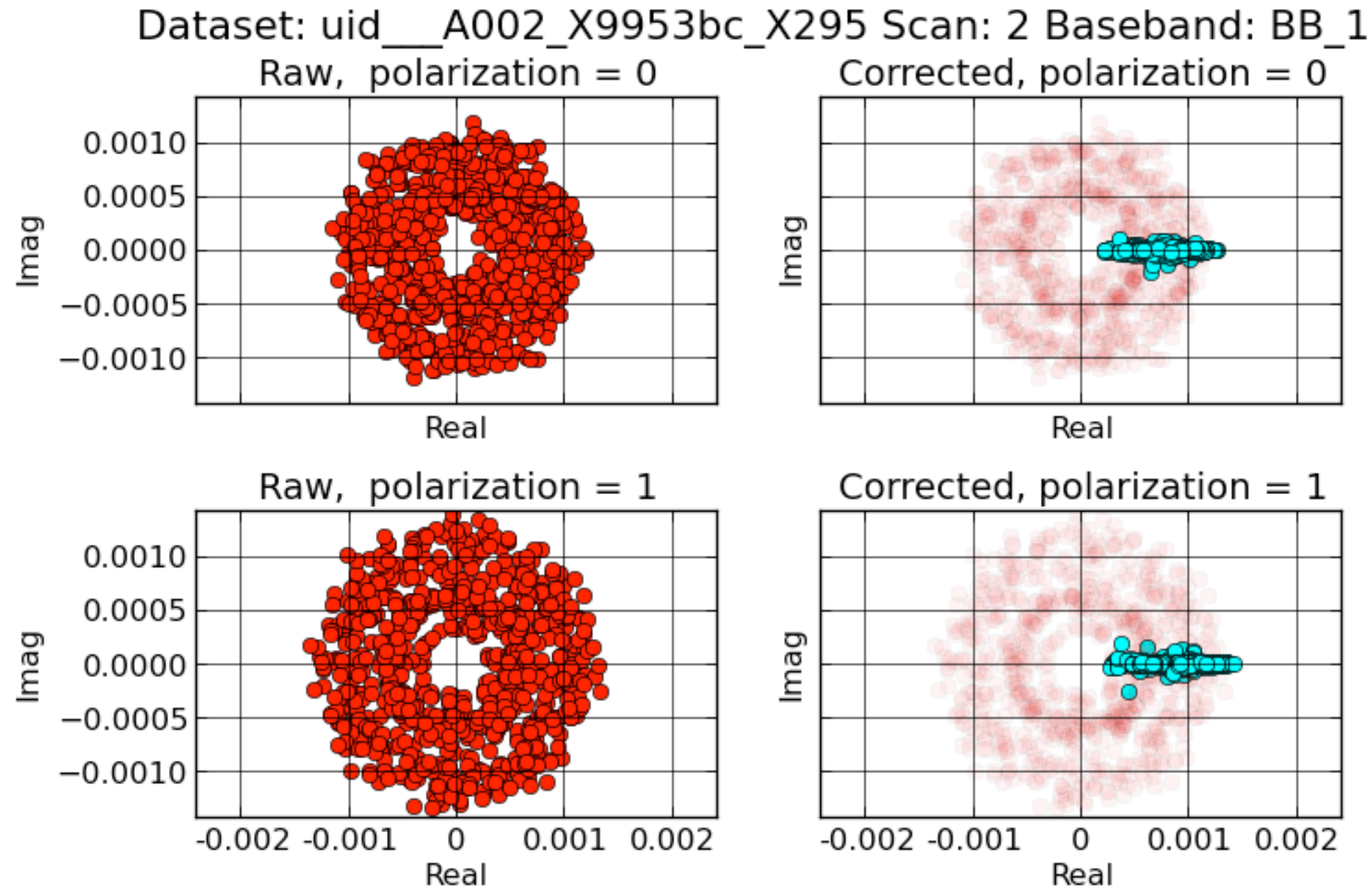
ALMA-APP + ALMA-OSF + APEX

Quick look at data on site to verify phasing loop

Full correlation to verify VLBI results will occur at Haystack

Phasing Loop

Results from January test



Band 3
~40 antennas
15 s scans
300 m baselines
PWV 4-5 mm
No WVR

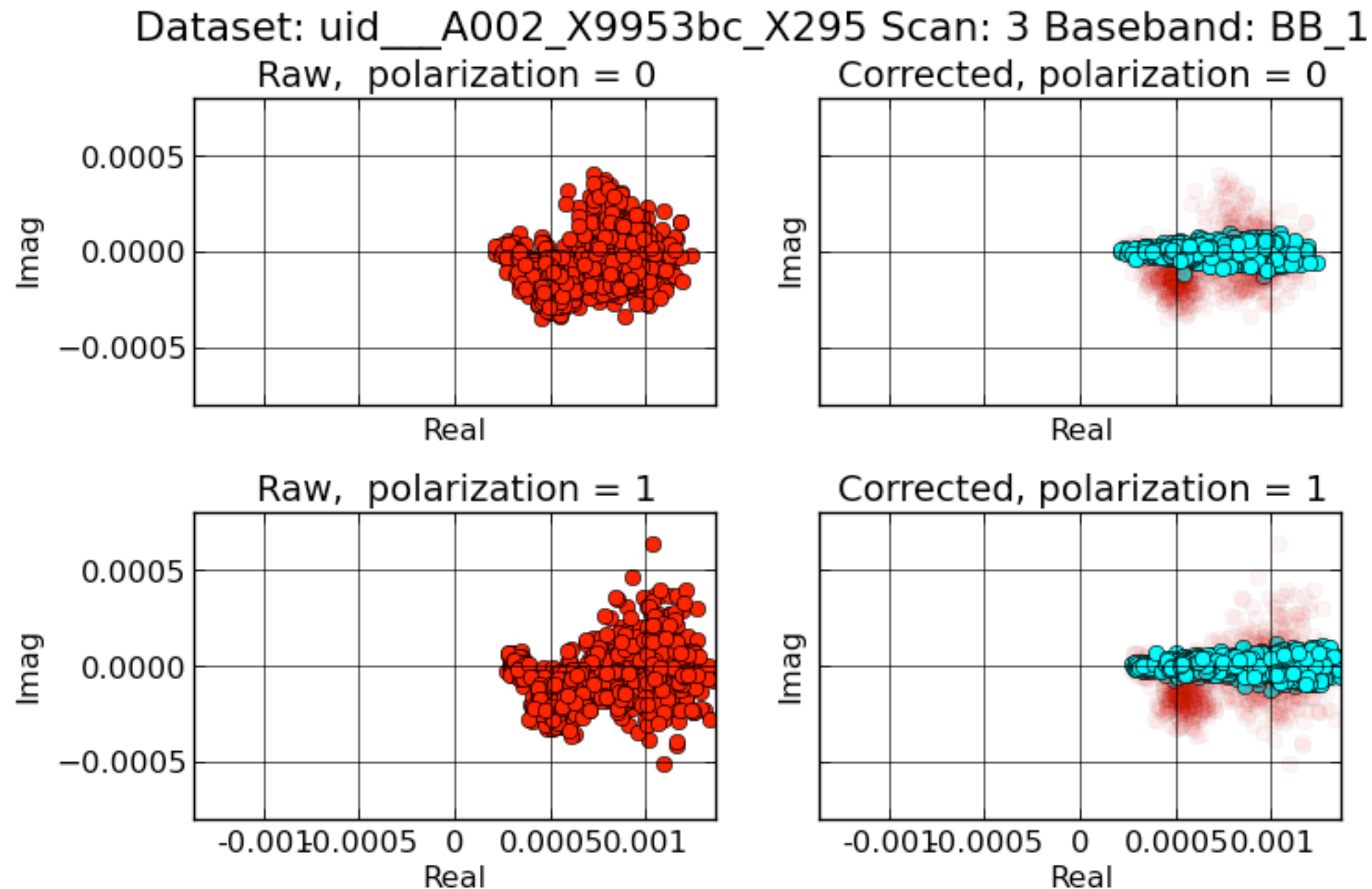
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Scan: 2
Baseband: BB_1
DataUID: uid://A002/X9953bc/X299
Excluded: [15, 39, 44, 21]

Efficiencies

unphased (pol 0/1): 6.82% / 2.56%
phased (pol 0/1): 99.96% / 99.96%

Phasing Loop

Results from January test



Band 3
~40 antennas
15 s scans
300 m baselines
PWV 4-5 mm
No WVR

ExecBlockUID: uid__A002_X9953bc_X295
Scan: 3
Baseband: BB_1
DataUID: uid://A002/X9953bc/X29c
Excluded: [15, 39, 44, 21]

Efficiencies

unphased (pol 0/1): 98.16% / 98.21%
phased (pol 0/1): 99.90% / 99.89%

The APP in 2015

We have just begun commissioning

Plans are to complete commissioning later this year

Scientific use of the APP must await completion of commissioning

Goal is to provide ALMA with phased-array capabilities for most common VLBI observing modes

Hardware upgrades to partner 1.3 mm VLBI sites are underway to match ALMA capabilities (talk by R.Tilanus)