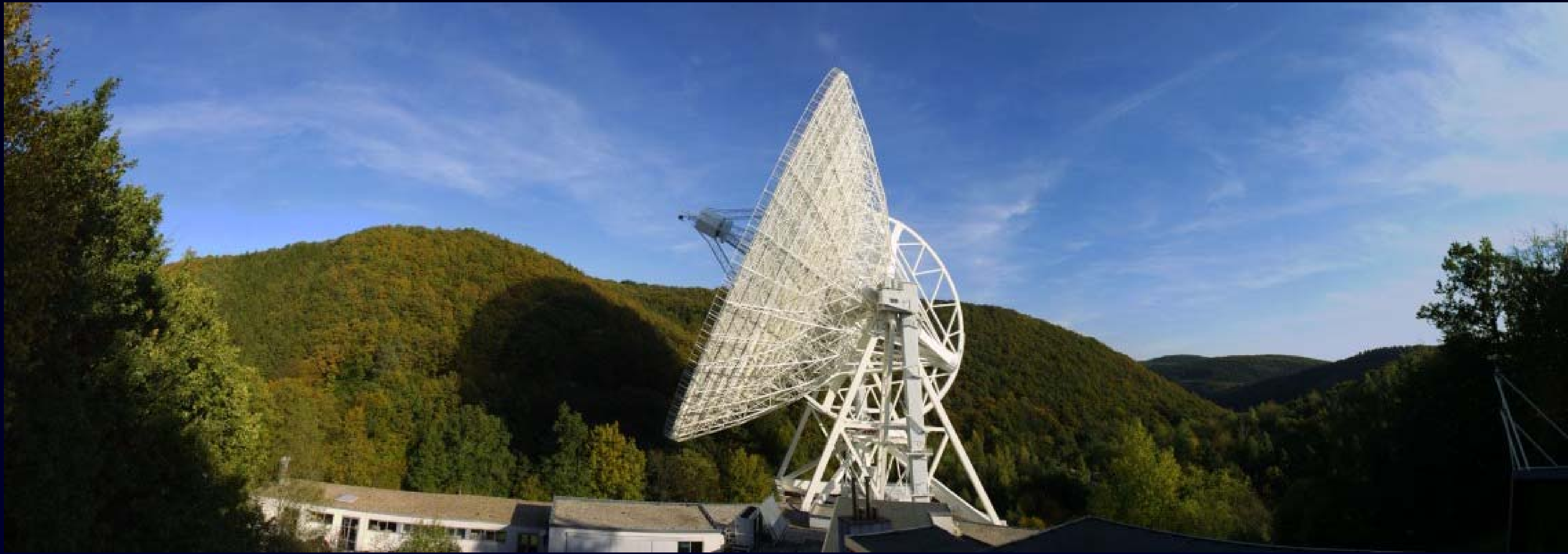

VLBI detections of a source weaker than 100 mJy at 86 GHz

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Jet Collimation

Jet collimation regions in AGN are 10...1000 R_s

	M_{BH} / 10^6 M_{sun}	0.1 mas Beam / R_s
Sgr A*	2.5	14
M 87	3400	24
Cen A	200	82
NGC 4261	490	286
M 81	63	309

But: 86 GHz VLBI limited to brightest ~150 sources

The Idea

Phase noise from wet troposphere proportional to frequency

Can use scaled-up phase corrections from reference frequency to calibrate target frequency phases

VLBA antennas can switch frequencies in < 10 s

Observe source while cycling between target and reference frequency in < 1/2 atmospheric coherence time

Can increase high-freq coherence time to hours

Can measure core-shift with frequency

Design of Pilot Project

Observations
NGC 4261 observed on May 5, 2003

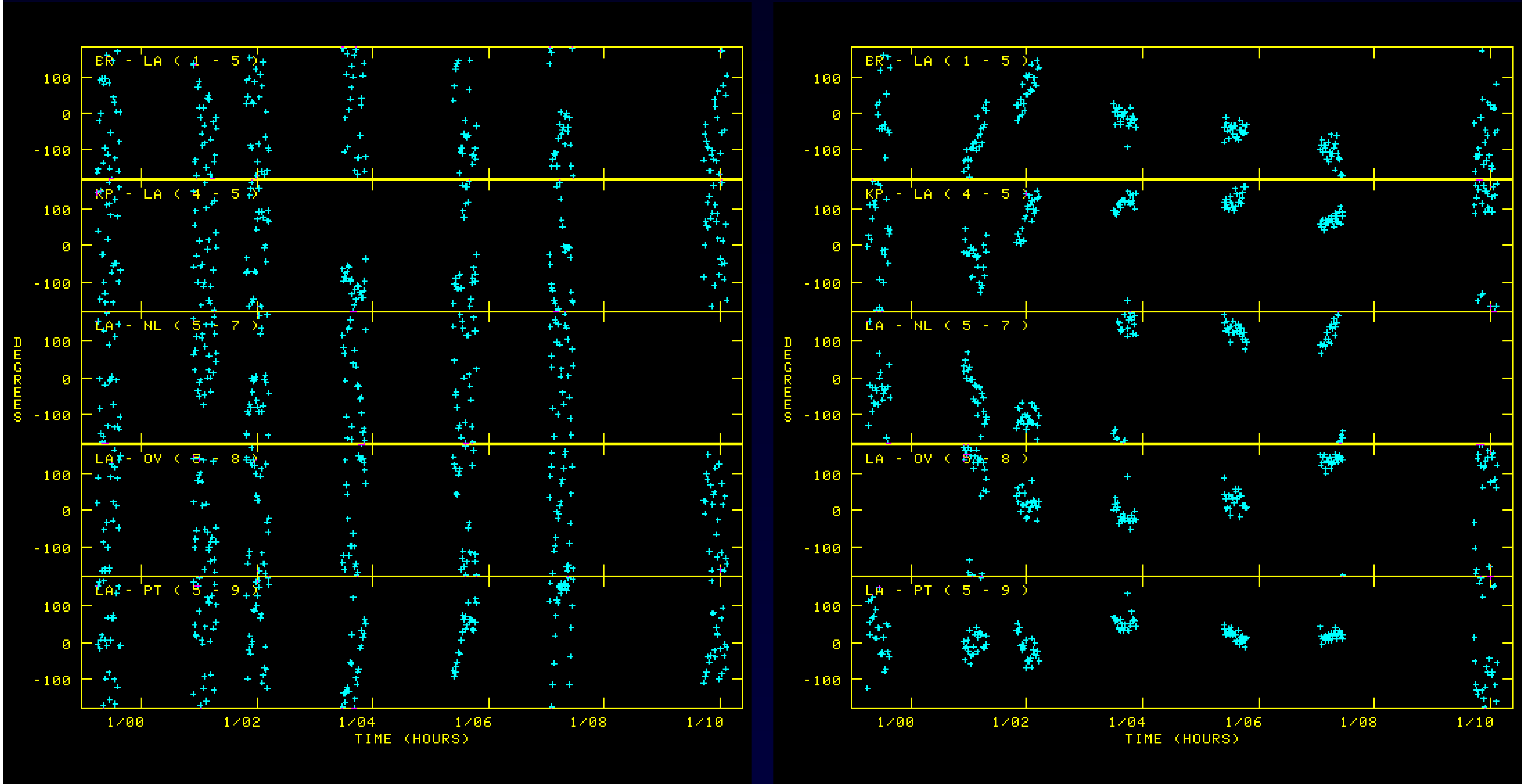
Frequencies
Integer ratios avoid unpredictable cycle slips
VLBA has 14.375 GHz
43.125 GHz ratio = 3.00
86.250 GHz ratio = 6.00

Switching cycles
in 50 s: 15 s at ν_r, 21 s at ν_t -> 42 % duty cycle

Non-standard steps outside AIPS
Scaling of self-cal phase corrections in Python program

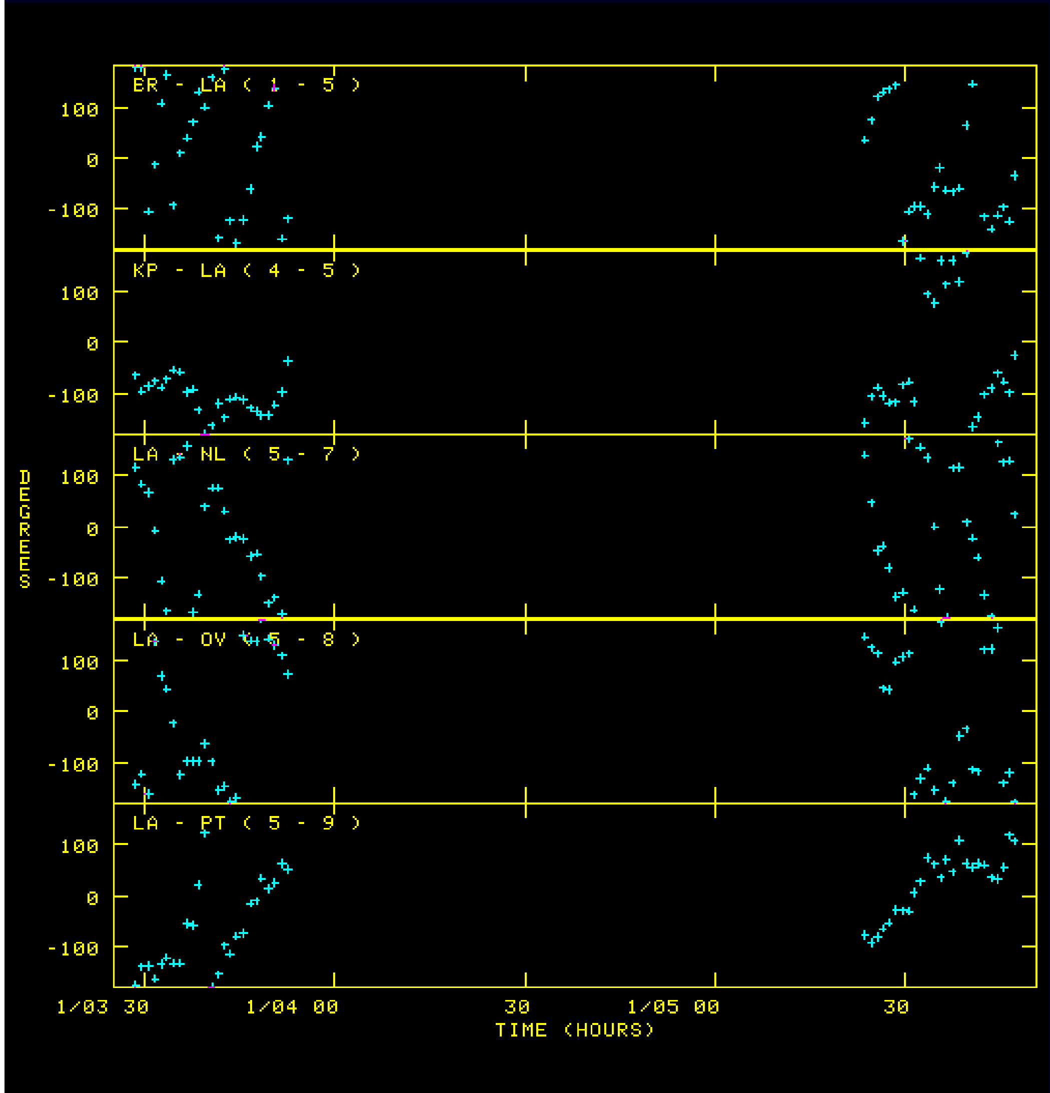
Results

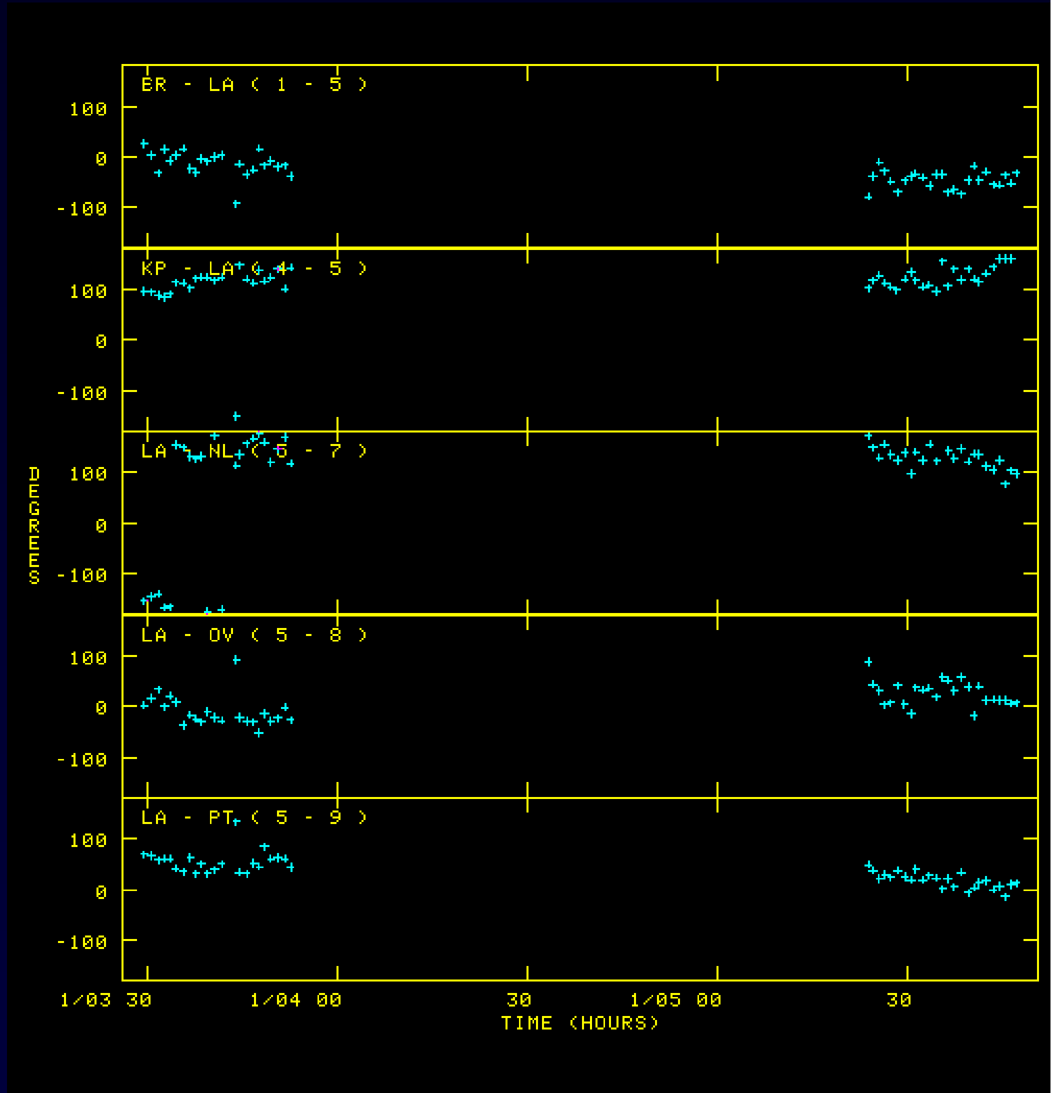
Solid detections of NGC 4261 at 43 GHz



Results

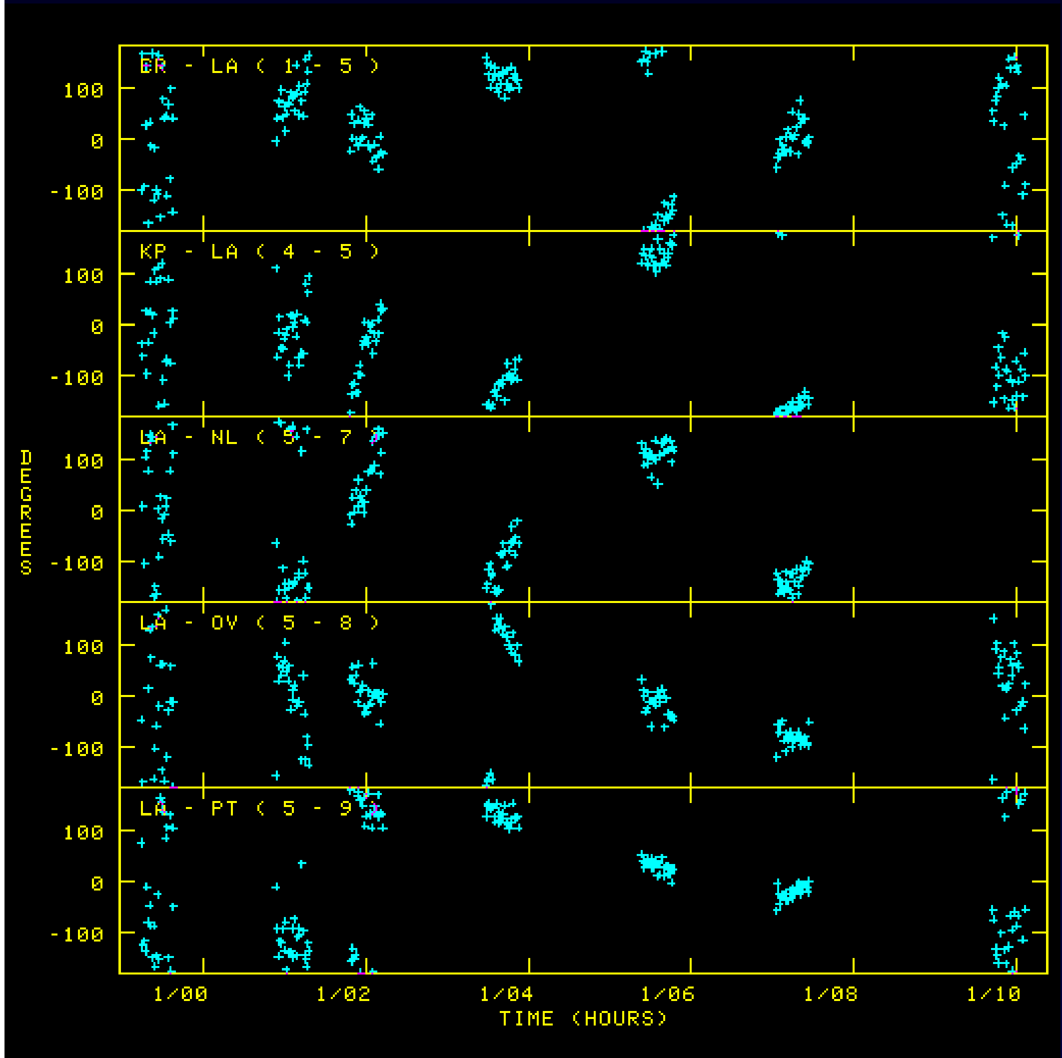
Solid detections of NGC 4261 at 43 GHz

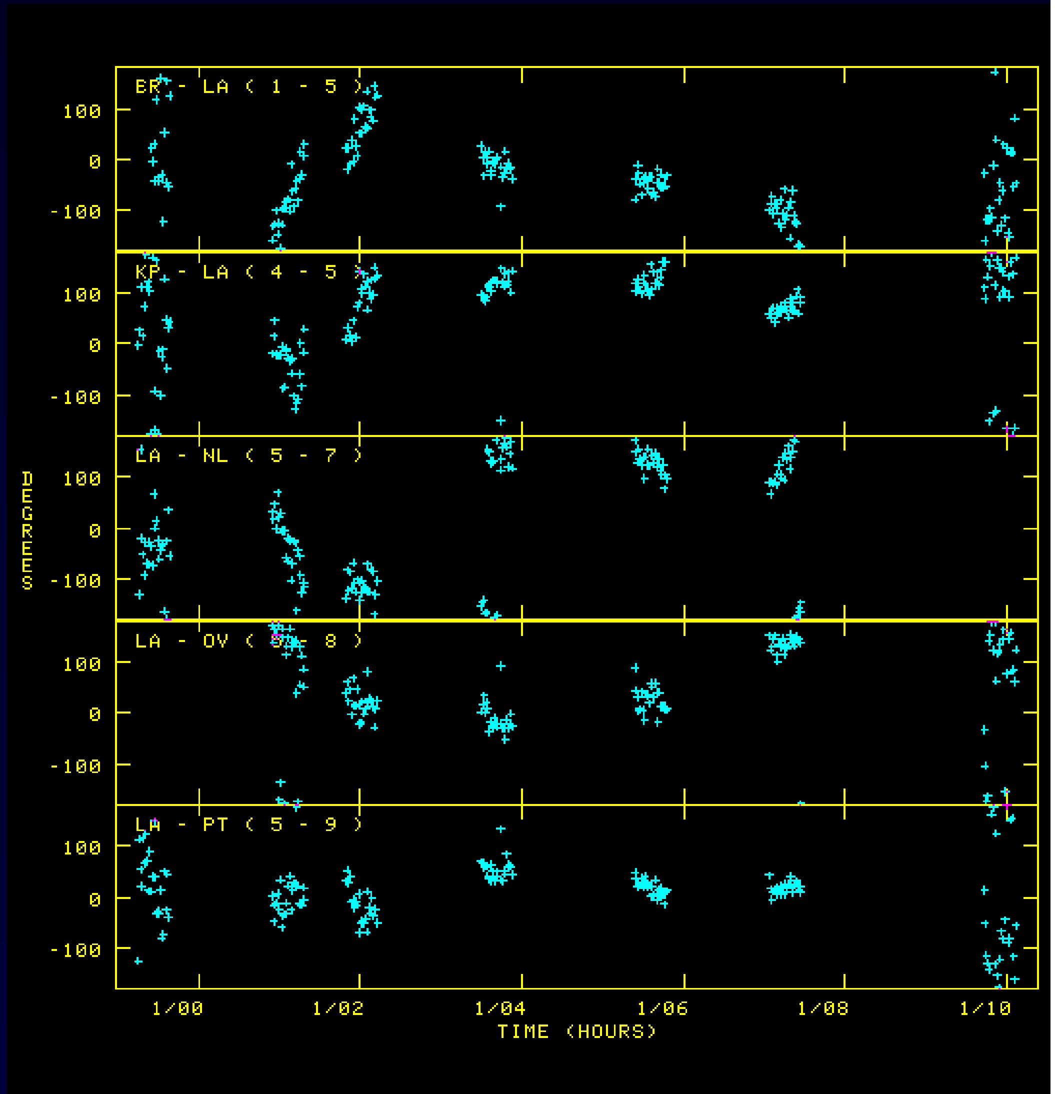




Results

Calibration of ionospheric phase noise
43 GHz data

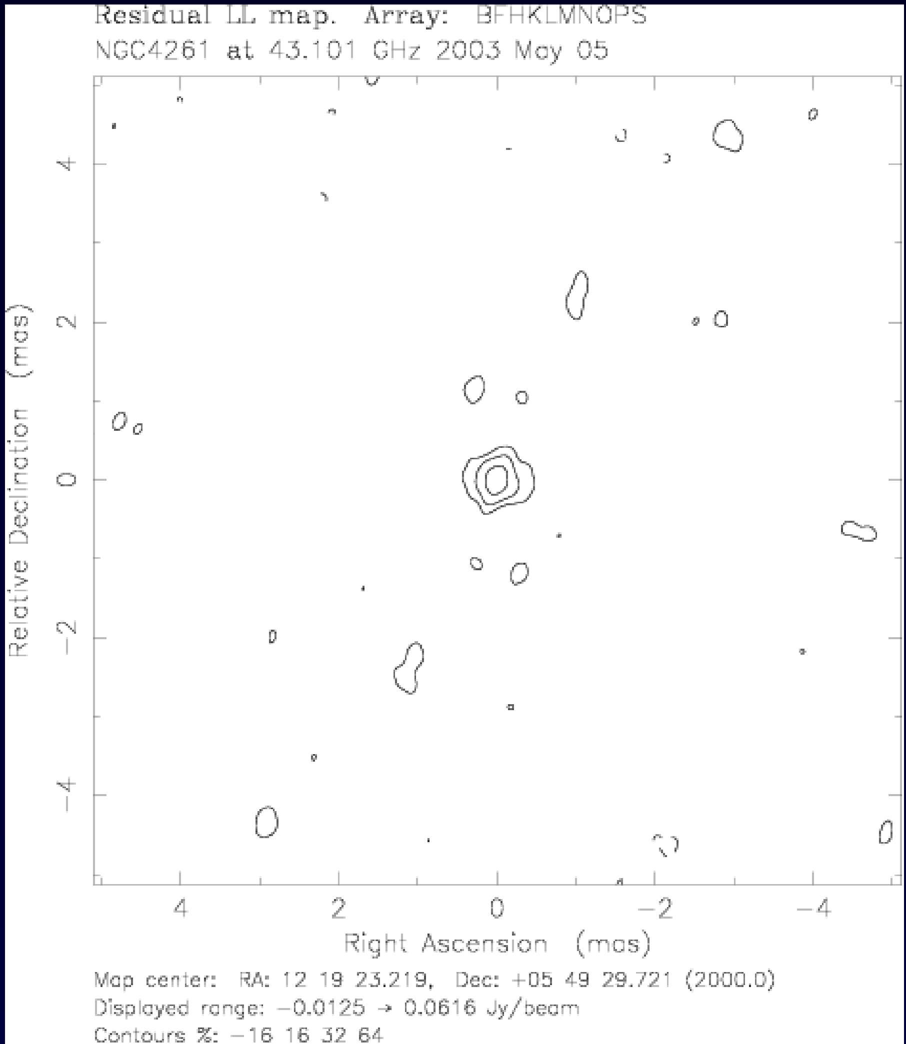




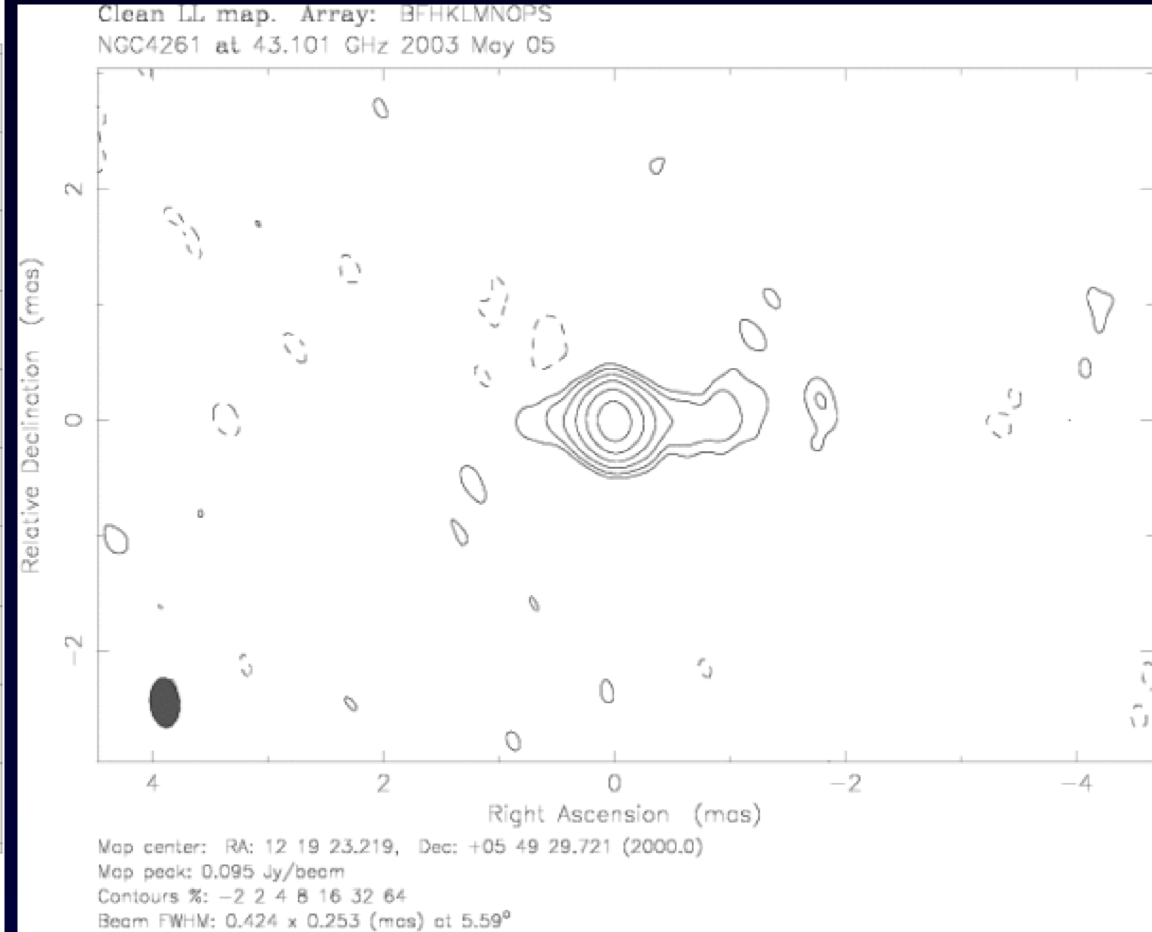
Residual phase rates require self-cal -> no “pure” phase-referencing

Results

43 GHz images



30-min self-calibration

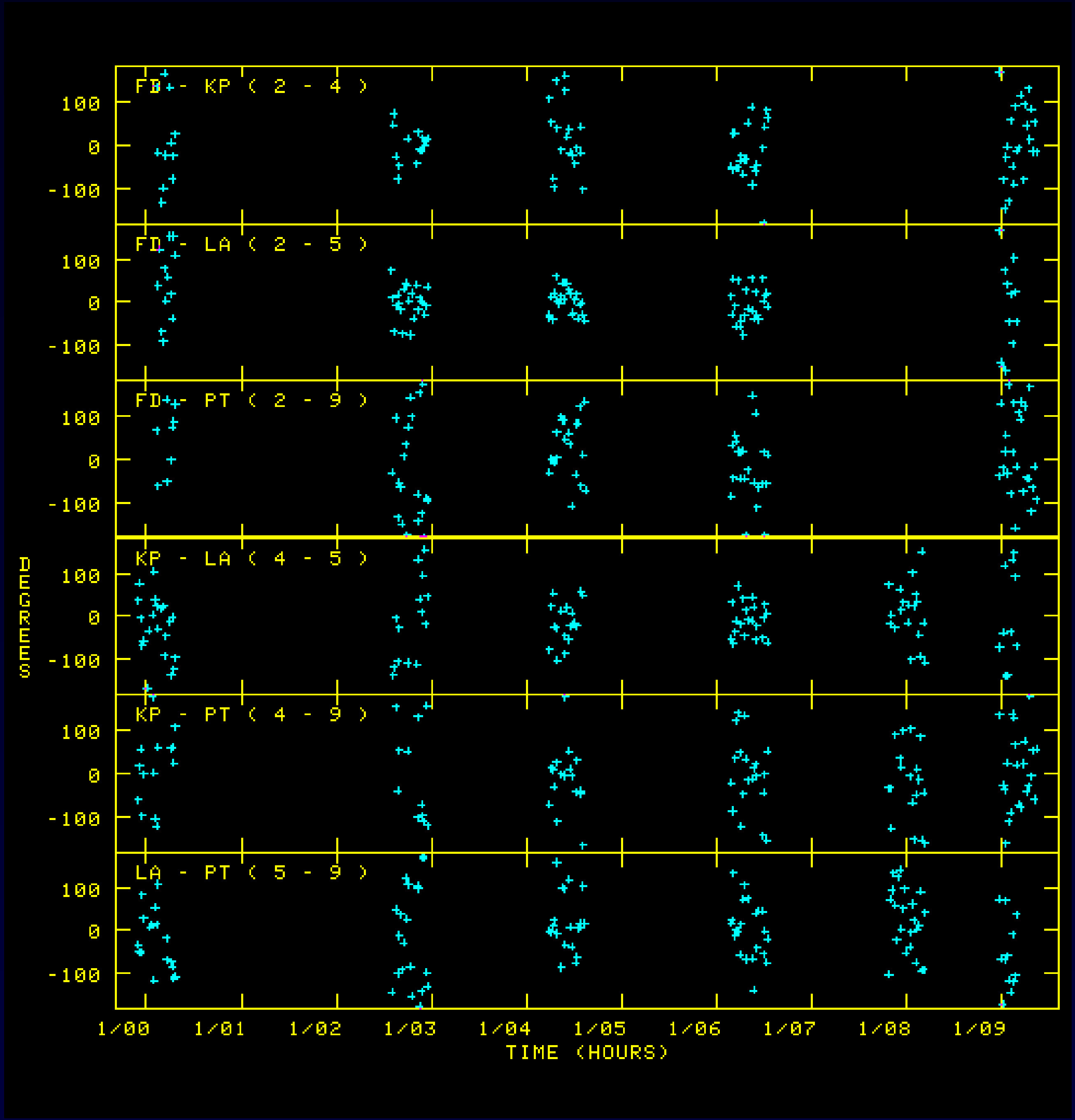


Final map after hybrid mapping

Results

First detection of NGC 4261 at 86 GHz

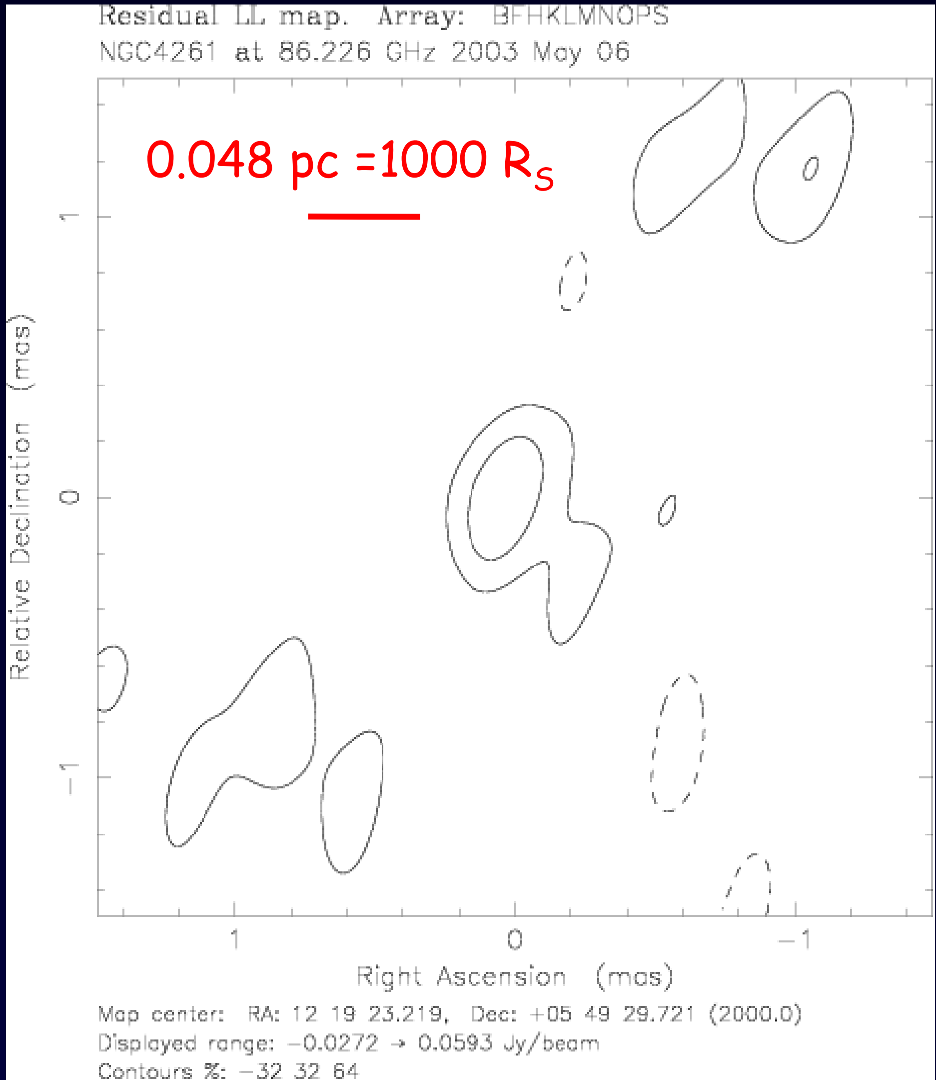
Weakest source detected so far with 86 GHz VLBI



30-min self-calibration

Results

86 GHz image



30-min self-calibration

59.3 mJy beam^{-1} peak flux density

angular resolution: 0.35x0.54 mas = 1000 R_s

Can be improved with low-frequency scans

Only 2 other objects observed with higher linear resolution

Summary

-Successful developed & tested new
phase-referencing technique

-Ionospheric correction is crucial
GPS-based correction not good enough
→ Observe source at L-band with wide band

-Requires minimal extra effort

-Can observe any source at 86 GHz that has
~100 mJy compact flux density at 15 GHz

-High-frequency window opened for weak sources

-Jet collimation regions may no longer be out of reach

of 86 GHz sources ~ 1000