VLBI observations of 96 sources in the ATLAS/CDFS field

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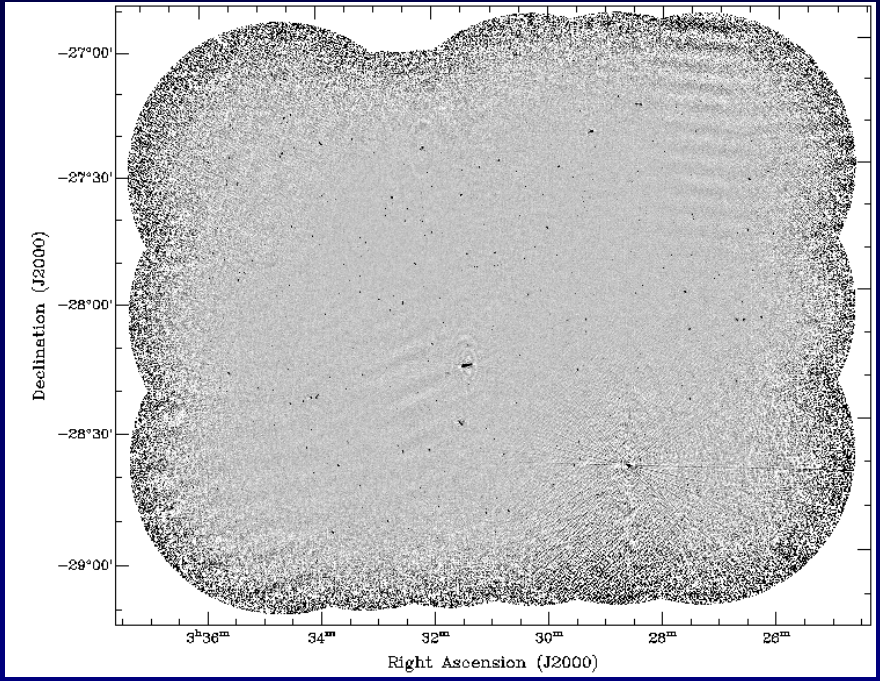
ATLAS – Summary

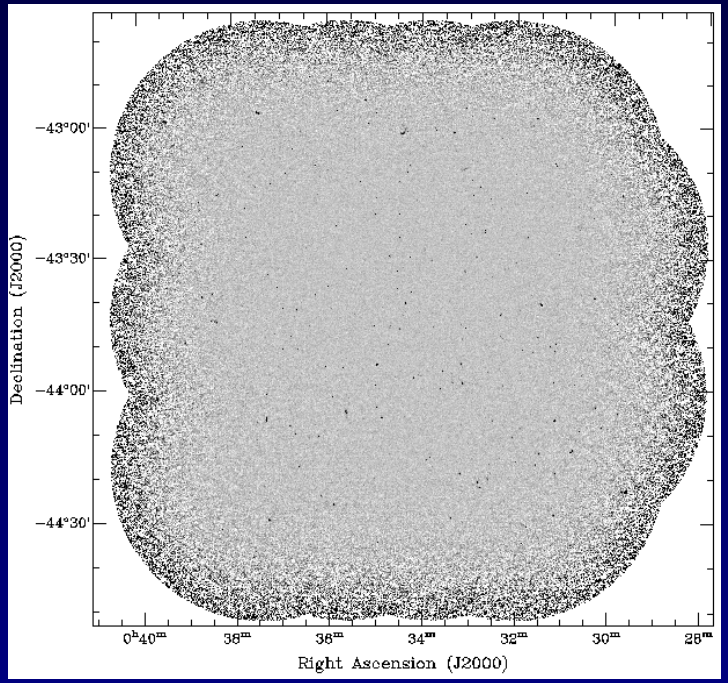
ATLAS
Australia Telescope Large Area Survey

Australia Telescope Large Area Survey:
A study of the evolution of galaxies since z~3

- contributions of AGN and starbursts
- high-z AGN
- radio-FIR relation: function of z / galaxy properties?
- origin of cosmic magnetism
- large-scale cosmic structure
- rare sources
- imaging & techniques

ATCA 20cm image of CDFS





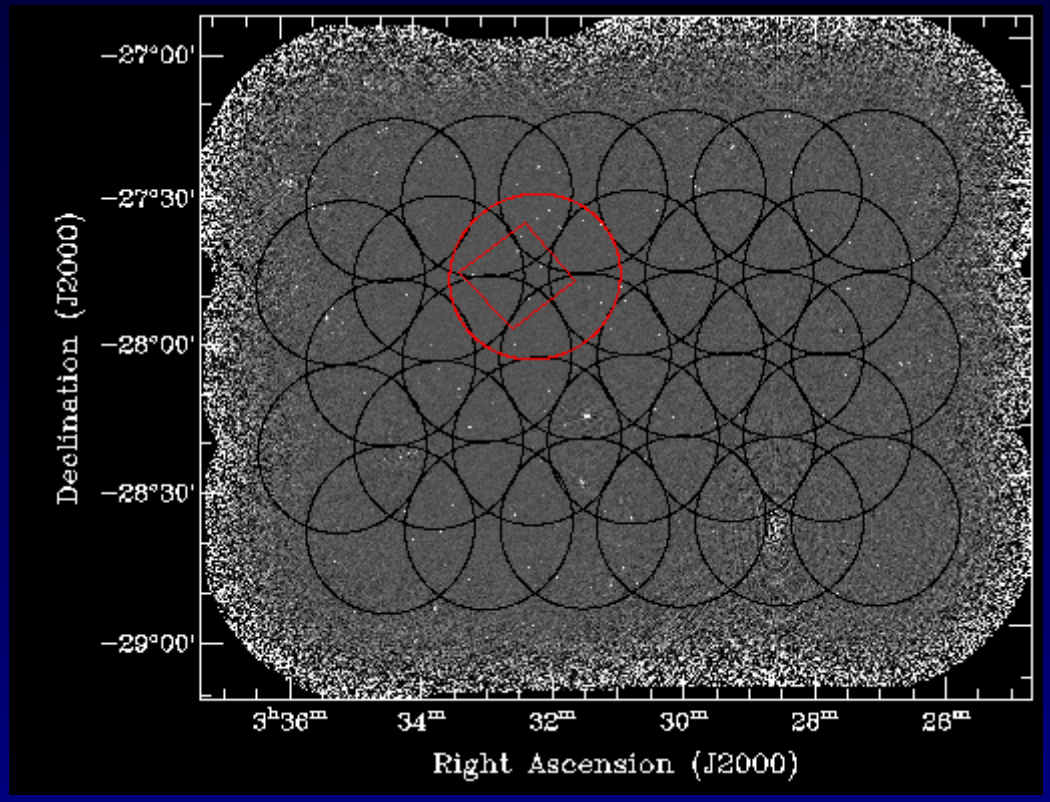
ATCA 20cm image of ELAIS

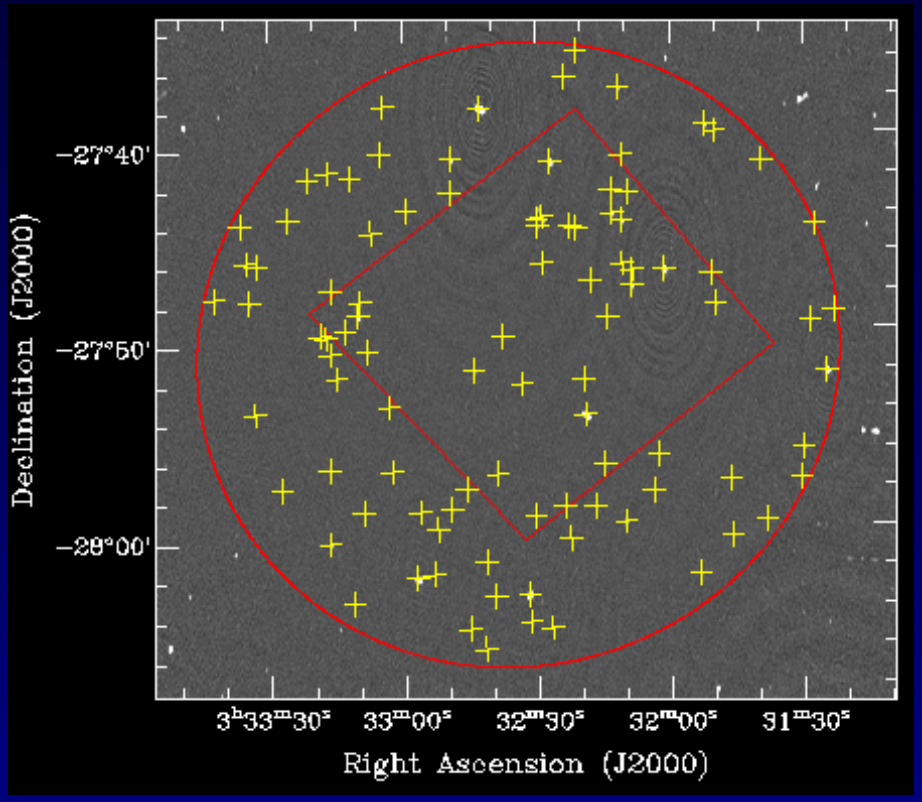
Motivation for a VLBI survey

- source classification
  - where are AGN?
  - do AGN and starbursts frequently occur in the same galaxy?
- pc-scale morphology as a function of z in unbiased sample
  - more or less terra incognita
- technical aspects
  - can we do it?
  - set up computer cluster, software correlator, investigate strategies
  - learn how to deal with huge data volumes

VLBA observations – the pilot project

- in July 2007, observed the GOODS/CDFS with the VLBA at 1.4GHz, using 512Mbps recording in 8 dual-pol IFs
- processing on 128-node cluster at MPIfR in Bonn, using the DiFX software correlator (Deller et al. 2007)



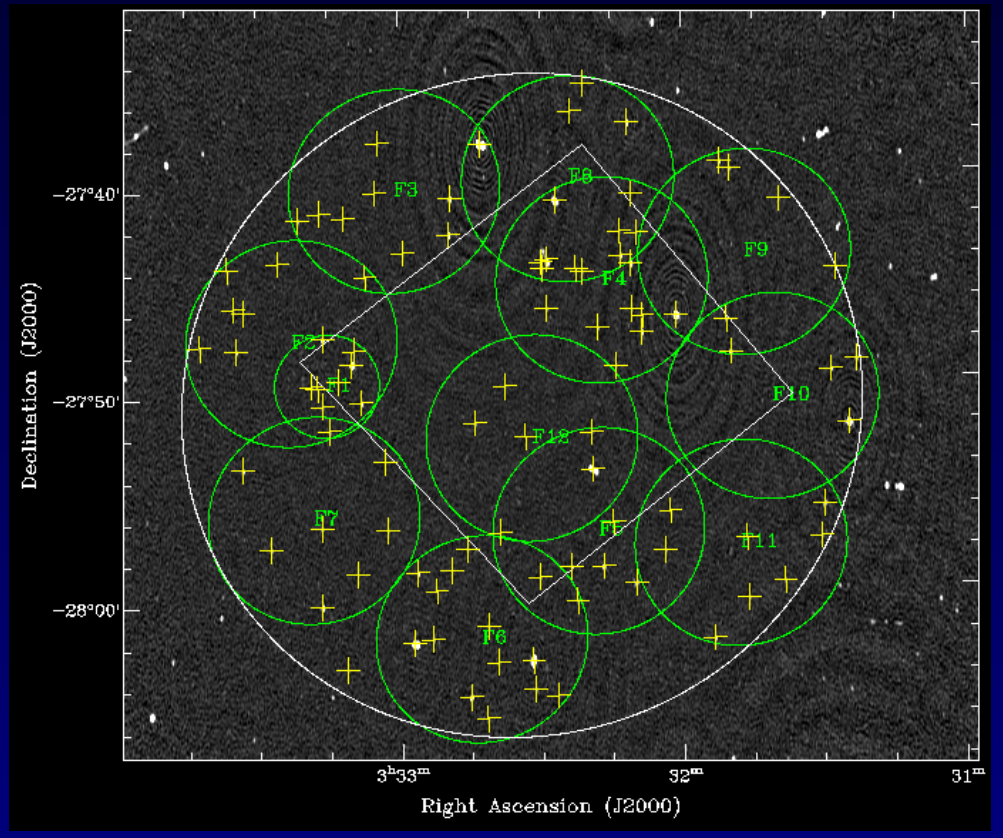


Wide-field effects (Bridle & Schwab, ASPC, 180, 371)

- Bandwidth smearing (eq. 18-29):
  $I/I_{0,BW} = (1+\beta^2)^{-1}$, with $\beta=\nu_0/\nu * \theta_0/\theta_{FWHM}$
- Time smearing (eq. 18-43):
  $I/I_{0,t} = 1-1.22\cdot10^{-9} * (\theta_0/\theta_{FWHM})^2 * \tau^2$
- Example:
  Standard VLBA observation, 1' phase centre offset:
  $I/I_{0,BW} = 0.43$, $I/I_{0,t} = 0.22$

Technical challenges / Strategy (1)

- wide field requires high resolution
  - amplitude losses <5% on 5000km baseline: τ=50ms, $\Delta\nu$=4kHz (typical: 2s, 500kHz), requires software correlator
- required resolution yields ~~60~~ 3TB per 9h of observing
  - need to find other solution
- break correlation down into smaller pieces
  - 250GB/data set, 3TB total
- correlate a field, recompute uvw/phase/delay for each source, average, make an image



Status of the project

- all 12 sub-fields correlated, ~~6~~ 3 processed
- 44 sources imaged, 8 detected (18%)
- Most sources are point-like, only few have substructure
- some trouble with phase calibration across primary beam

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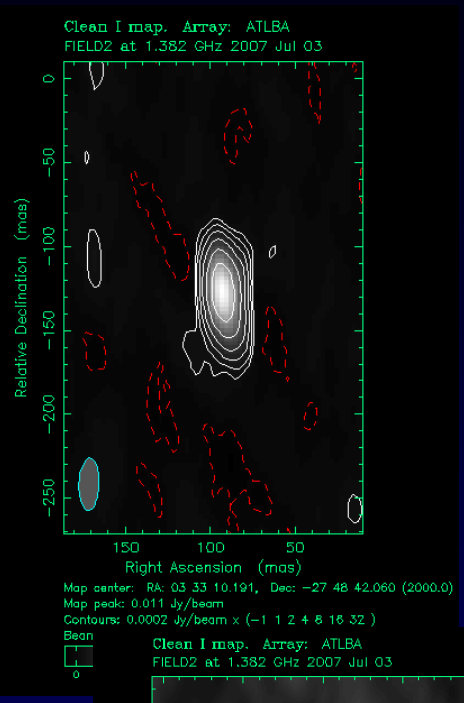
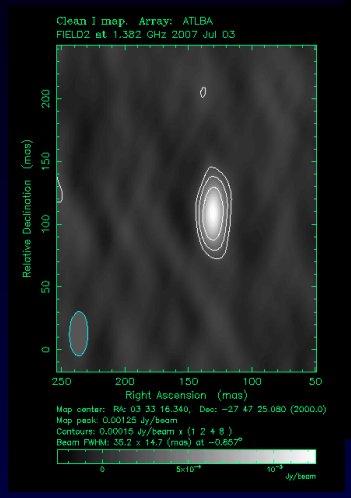
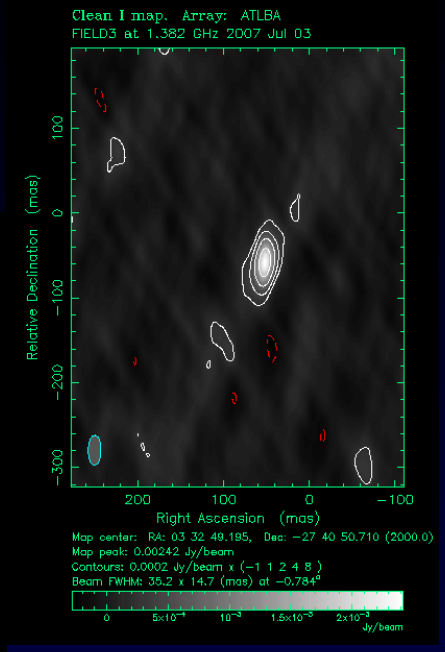
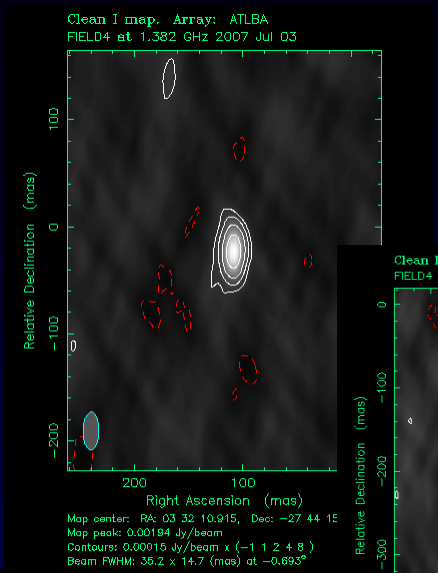
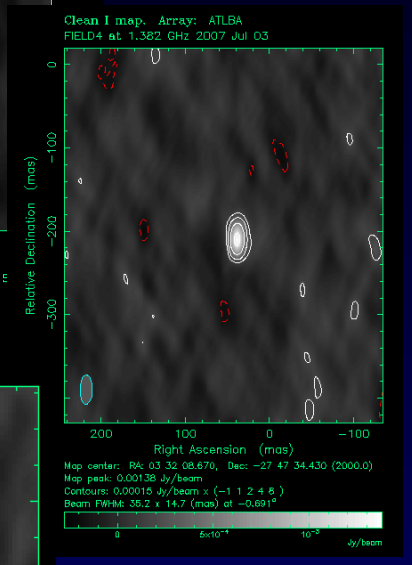
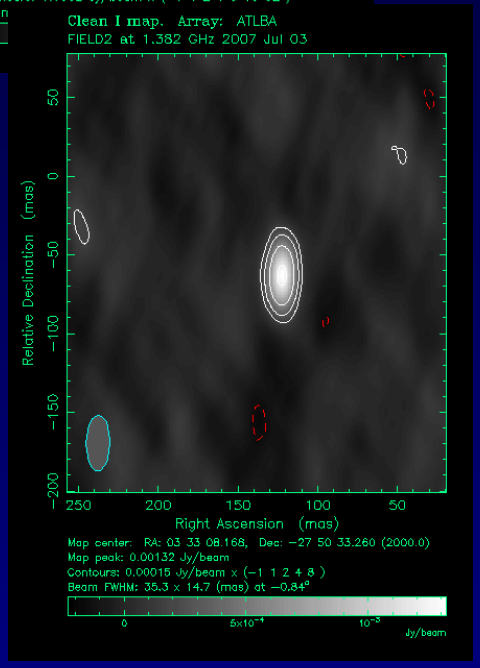


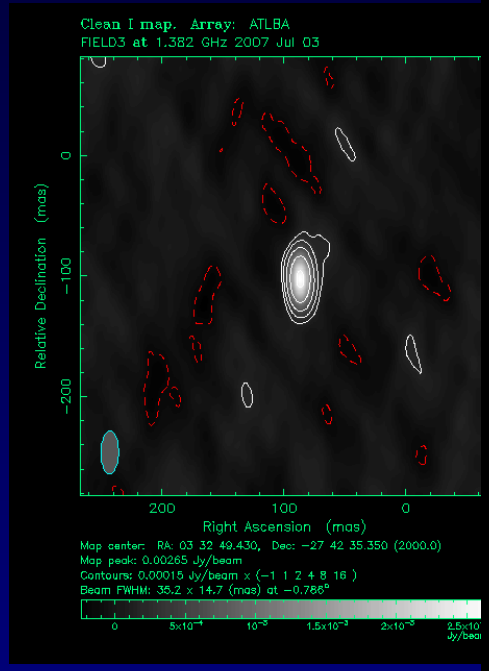


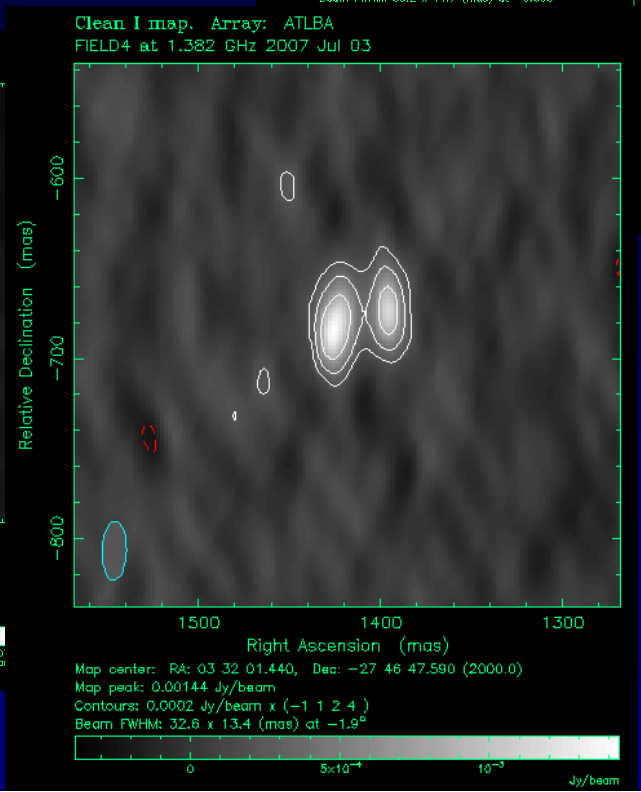






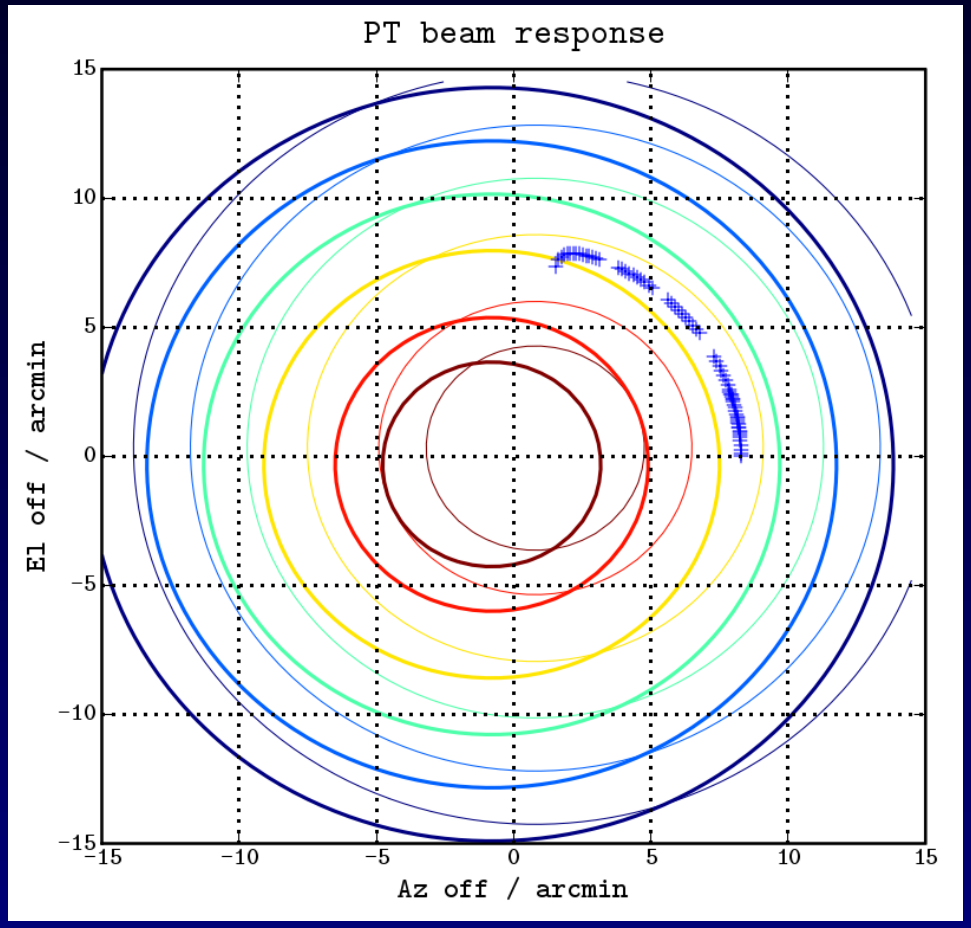


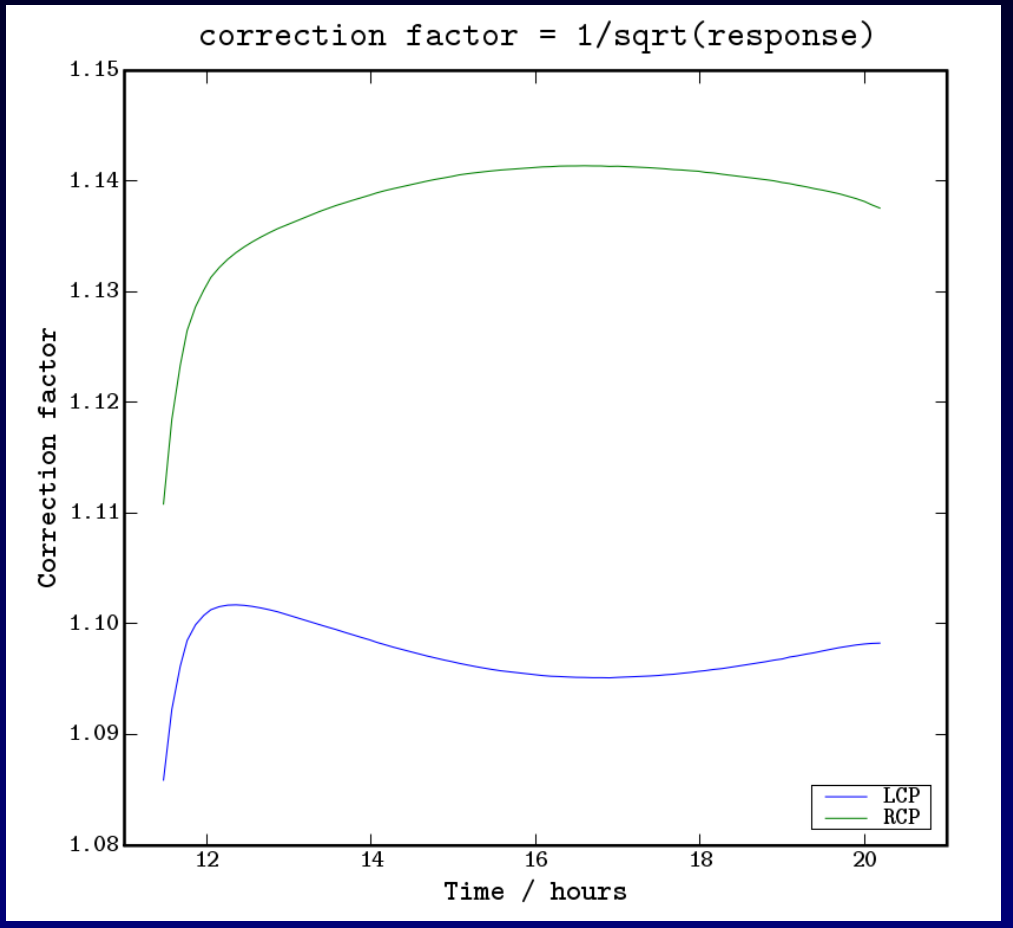




Technical challenges / Strategy (2)

- VLBA antennas have beam squint, so primary beam attenuation is different for LCP and RCP





In the near future

- Refine correlation/calibration procedures
- Image remaining 52 objects
- Survey entire ATLAS/CDFS (requires 30 runs, or 240h), and image all 726 radio sources with mas-scale resolution

Summary

- Wide-field VLBI is about to become manageable
- requires some effort
- requires big disks