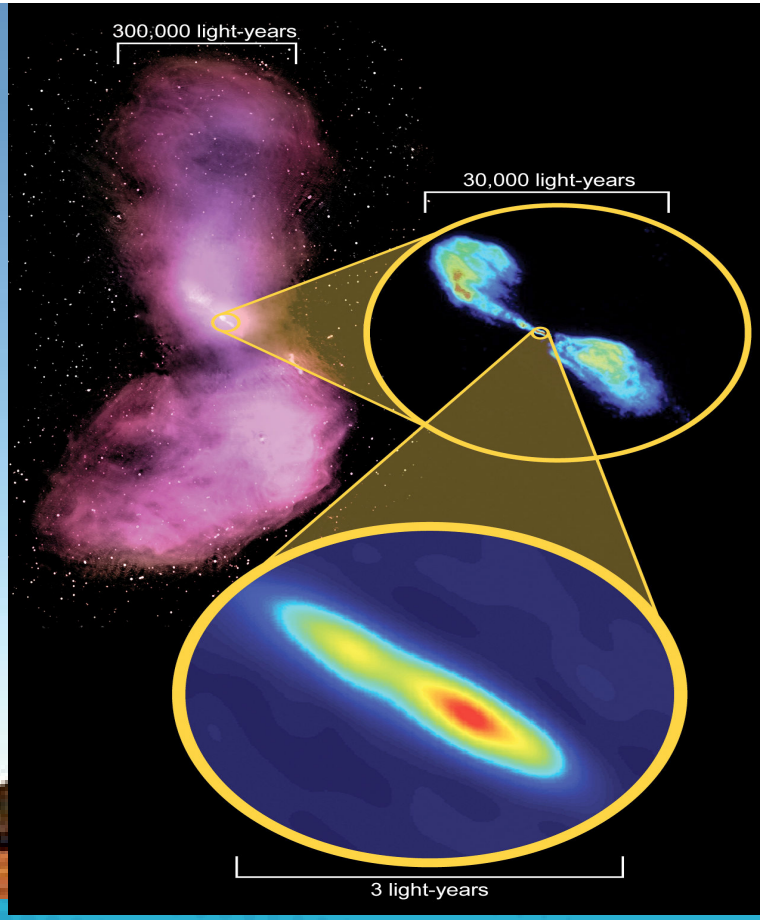

VLBI progress down under
- First VLBI with ASKAP and NZ

CSIRO Astronomy and Space Science
Tasso Tzioumis, September 2010

CSIRO

Radio Telescopes in Australia

Long Baseline Array (LBA)

- Telescopes in Australia /Asia-Pacific / Southern hemisphere
  - ATNF (ATCA, Mopra, Parkes); U.Tasmania (Hobart, Ceduna)
  - NASA (Tidbinbilla)
  - ASKAP ; + NZ ; AuScope; {New Norcia (ESA)}
  - + South Africa *(9000 km baselines)* – Hart (& KAT-7)
  - + Telescopes in Asia Pacific: Japan, China, Hawaii, VLBA,…
- Frequency range: 1-22 GHz
- Disks (XRAIDs) & eVLBI - up to 1Gbps (4 x 64 MHz)
  - All (almost) data transfers electronically – Petabyte store & ARCS
- Software correlator(s) - DiFX
  - Curtin University Supercomputer cluster - CUPPA
    - "Real time" correlation from disks & eVLBI
  - e-VLBI correlators at ATNF (Parkes; ATCA)
- **Open VLBI network -** proposals 15 June & December
  - ** Includes e-VLBI proposals **

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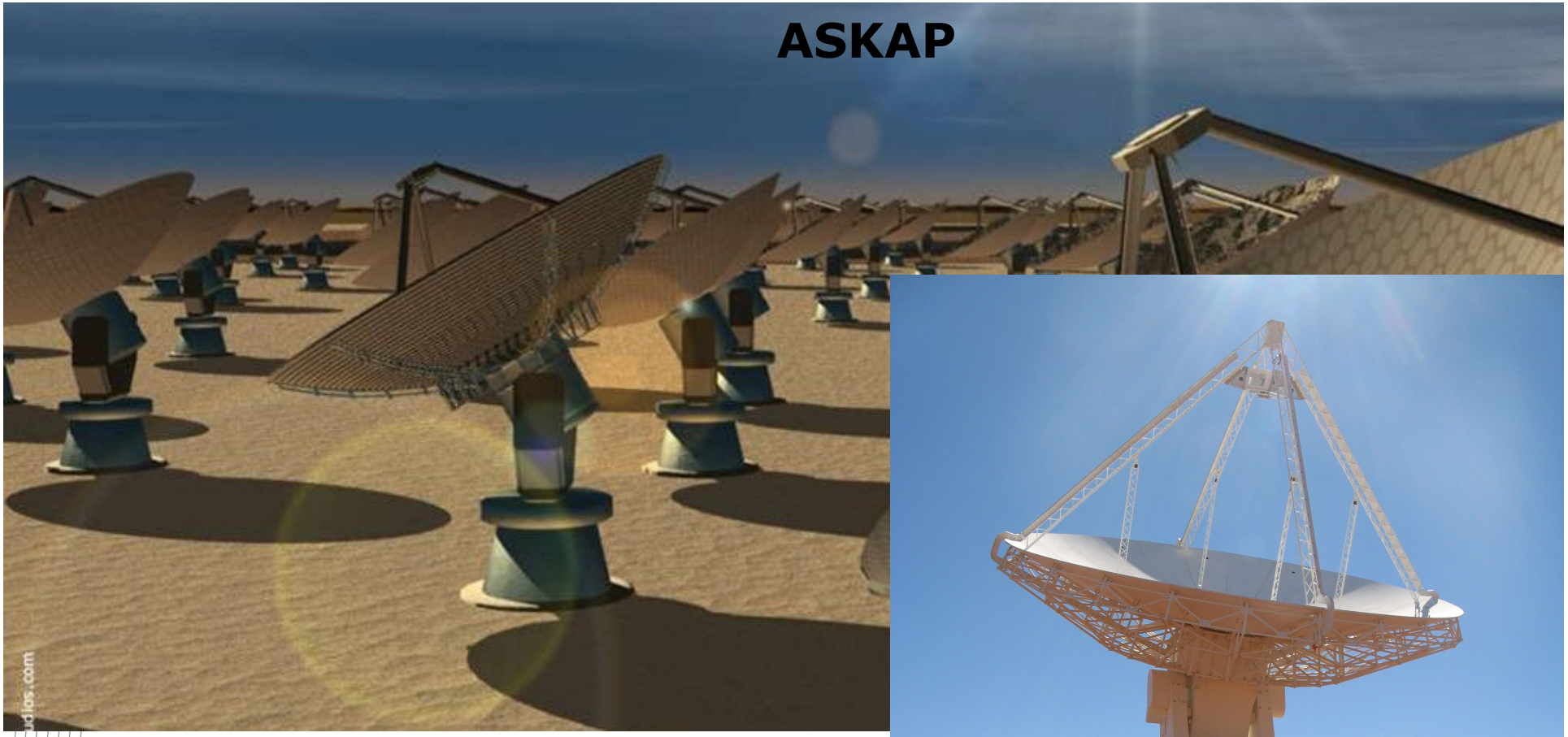
ASKAP



Number dishes	36
Dish diameter	12 m
Max baseline	6 km
Frequency	700 – 1800 MHz
FOV	30 deg^2
Bandwidth	300 MHz
Resolution	5 kHz
Channels	16k
PAF	2 x 96 elmts

NZ Warkworth radio telescope

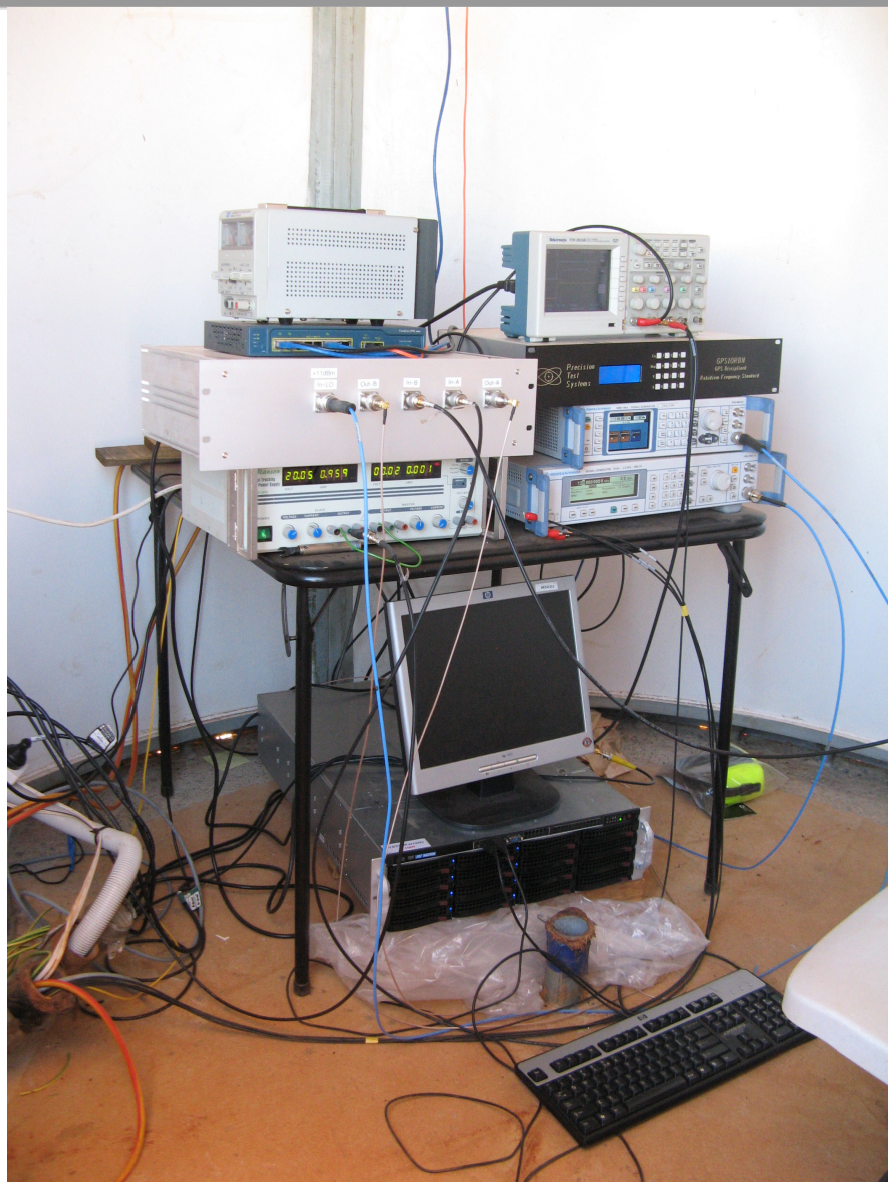
- 12m Patriot dish
- S/X feed
- Geodetic – IVS

- Special L-band feed and Rx by CSIRO (1.4 GHz)

Antennas used for the April-May 2010 VLBI observations

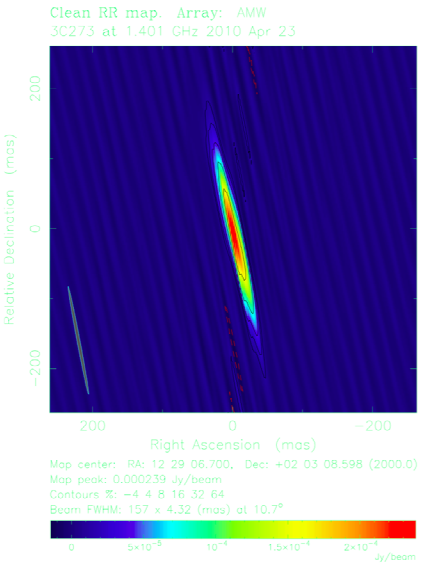
VLBI system for ASKAP and NZ

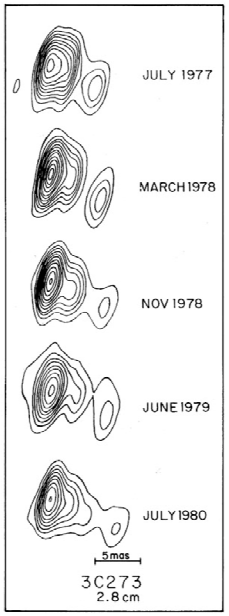
- ASKAP and Warkworth used custom-made feed and receiver system, dual circular polarization
  - ~6000 Jy systems
  - Signals downconverted to 256-320 MHz
- Custom-made digital system for recording (Curtin PhD student Bruce Stansby)
  - Uses commodity Signatec sampler/digitiser PCI-based card (Signatec PX14400) to sample at Nyquist rate, digitise with 14-bit precision
  - Recorded to disk (32TB), later converted to 2-bit precision for correlation

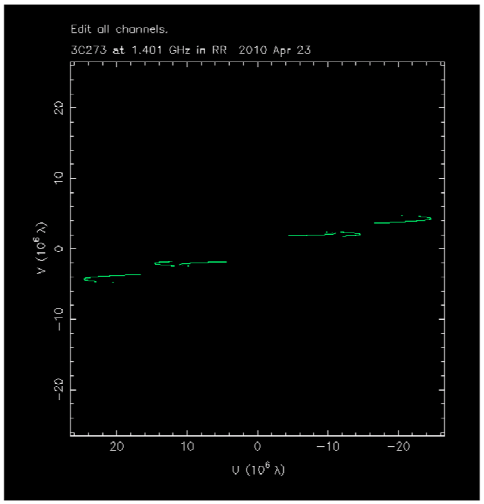


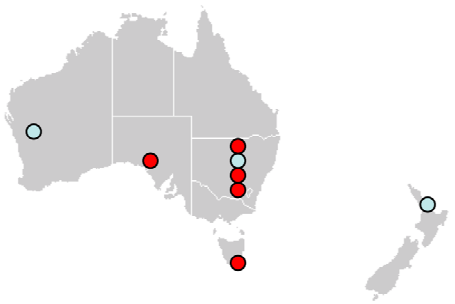
First science from ASKAP

Tingay, Stansby, Wayth, Reynolds, Hotan, Bignall (ICRAR)
Tzioumis, Phillips, Amy, Leach, Kesteven, Chung (CSIRO)
Gulyaev, Natusch (AUT)









4 mas angular resolution at 1.4 GHz

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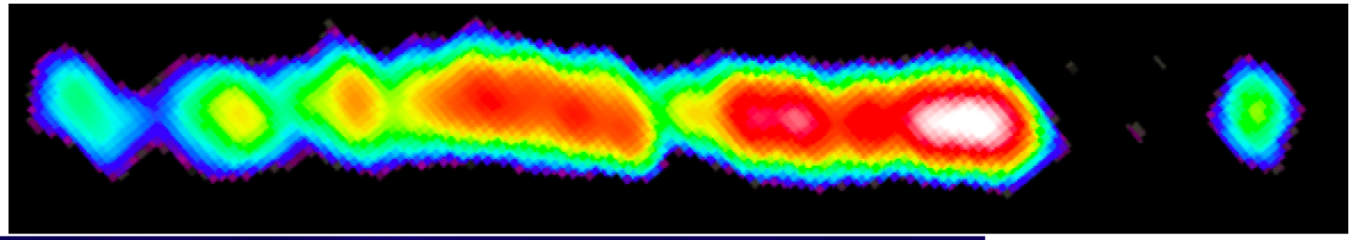
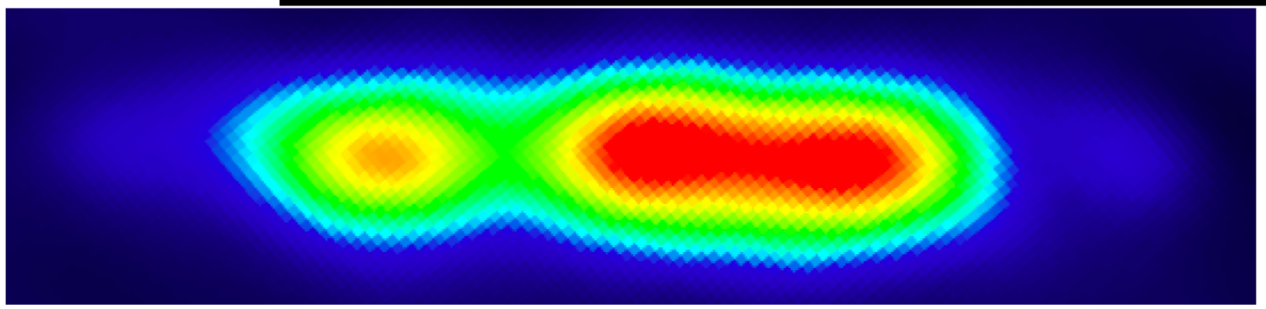
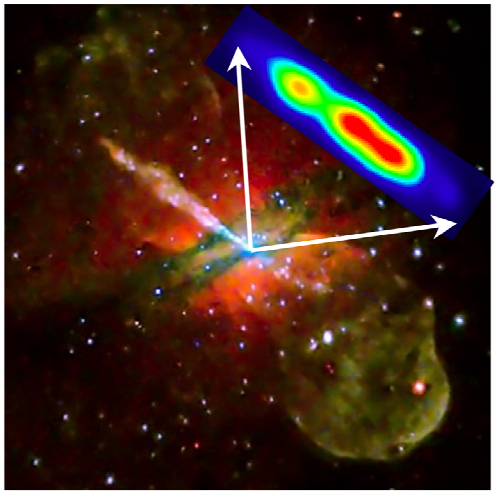
Centaurus A

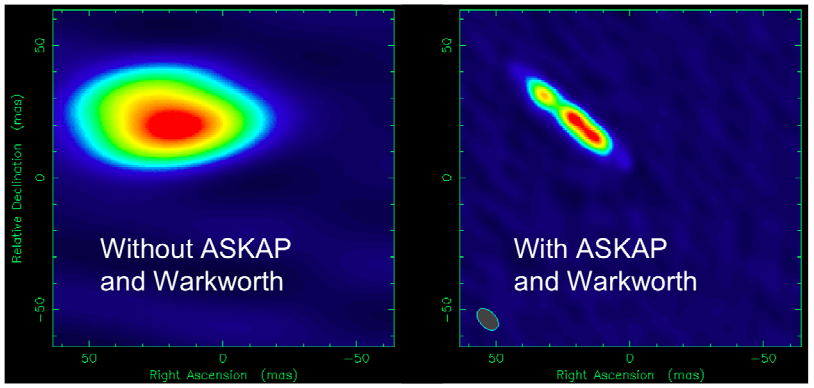
1 pc





Free-free absorbed structure





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Evolution of the pc-scale structure of PKS 1934-638 revisited: first science with the ASKAP and New Zealand telescopes

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Ellingsen, S., Dickey, J., Blanchard, J., Lovell, J.E.J.

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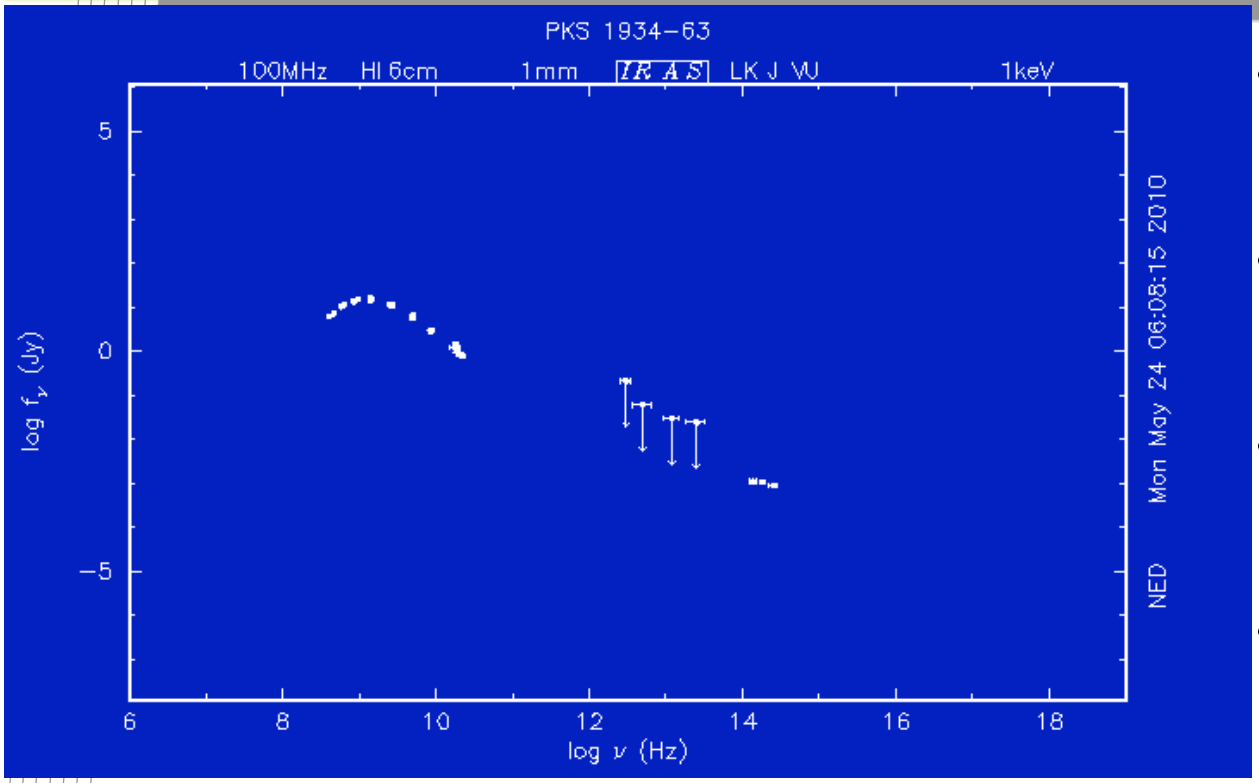
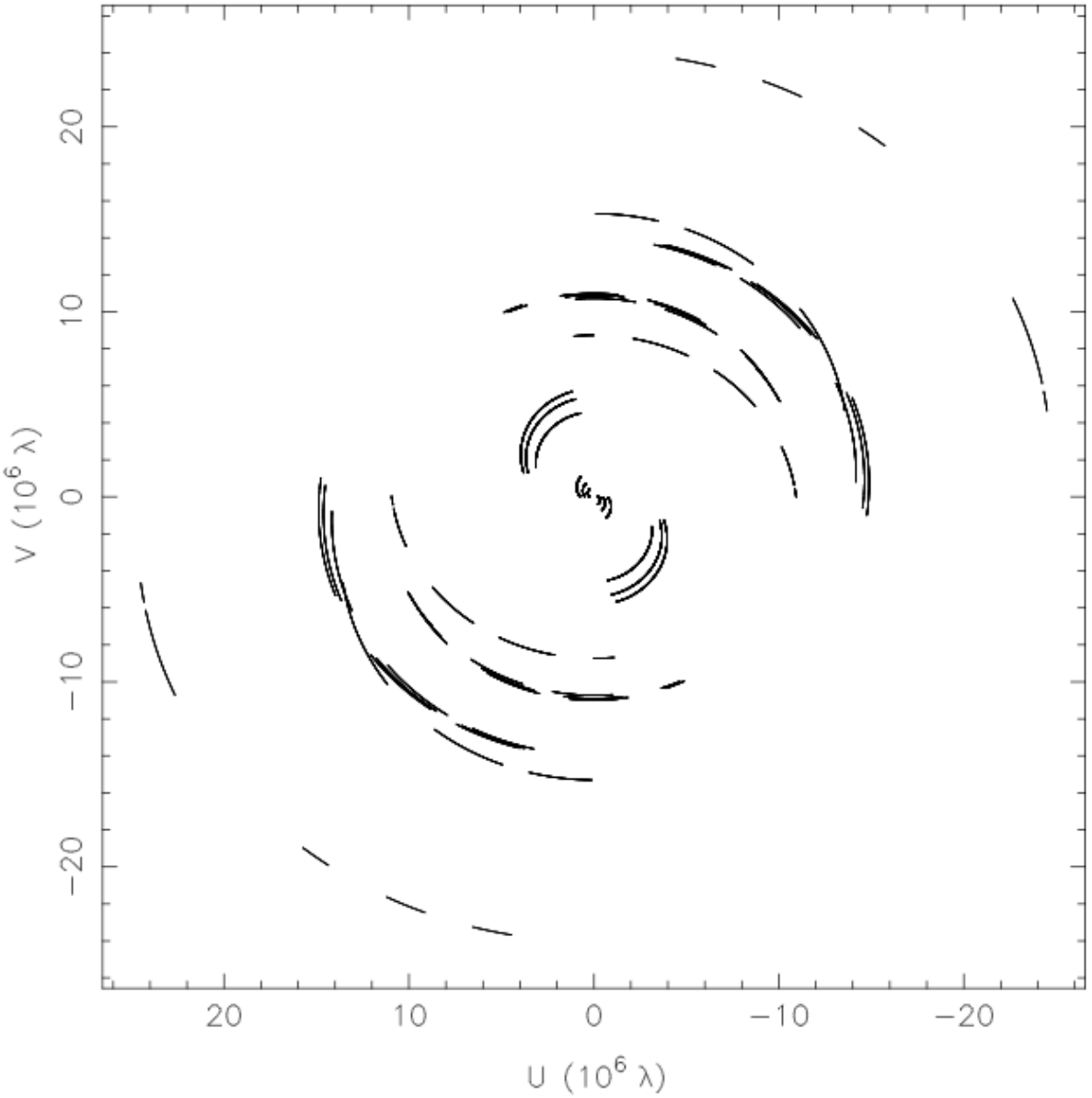
PKS 1934-638



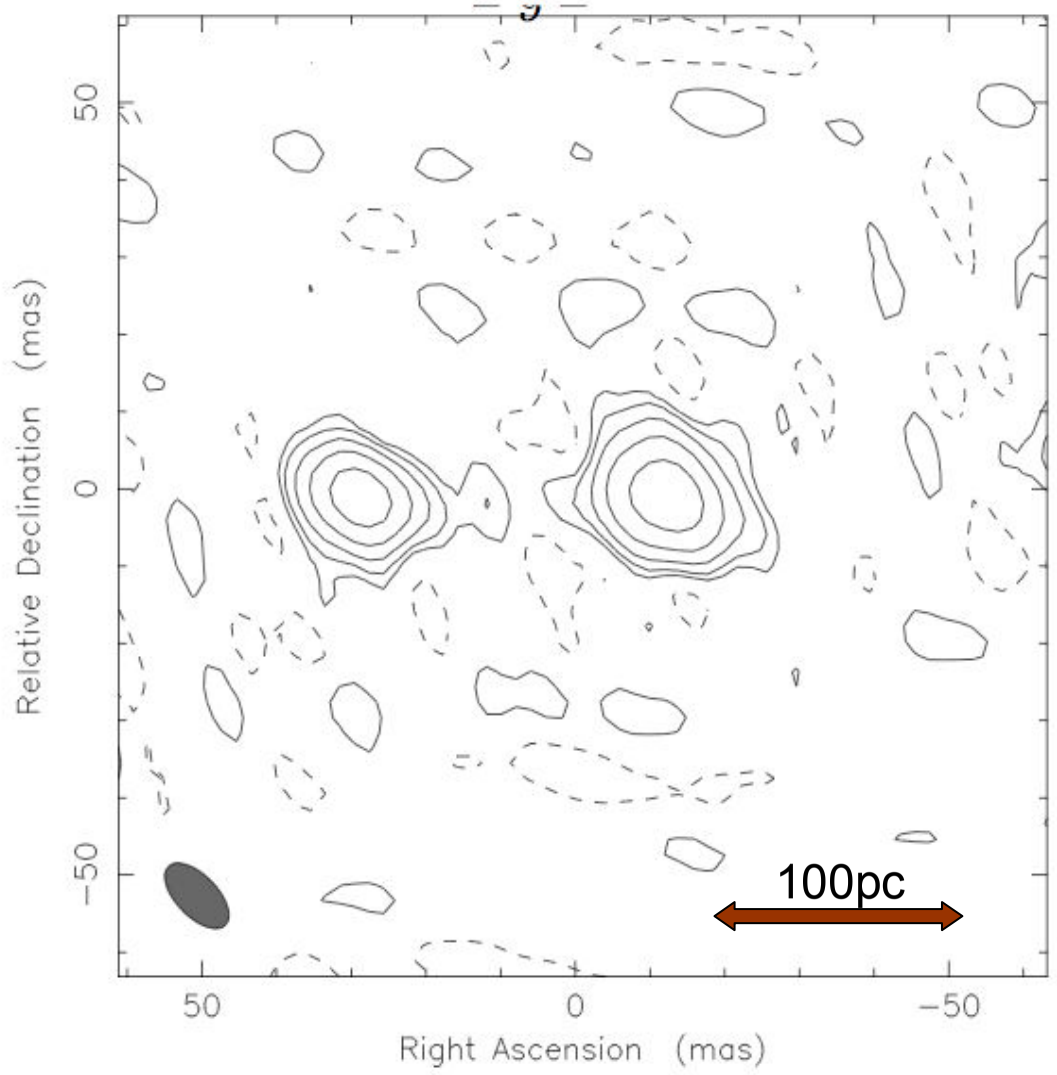
- Archetype Gigahertz Peaked Spectrum (GPS) radio source
- Very stable on long timescales - ATCA primary calibrator!
- Compact double structure (first by Gubbay et al. 1971) –
- ~40mas double

- GPS radio galaxies are proposed to be the young progenitors of FR-I and FR-II radio galaxies
  - Measurement of “hot spot” separation velocity in principle provides estimate of source age

(u,v) coverage of the VLBI observation of PKS 1934-638



Stokes I image of PKS 1934-638 at 1.4 GHz



Peak: 2.4 Jy/beam

Contour levels: -4, 4, 8, 16, 32, 64%

Beam 10.8 x 5.4 mas at 45.7◦.

Fitted component separation: 41 ± 0.6 mas

Separation robust – deep amp-phase beats

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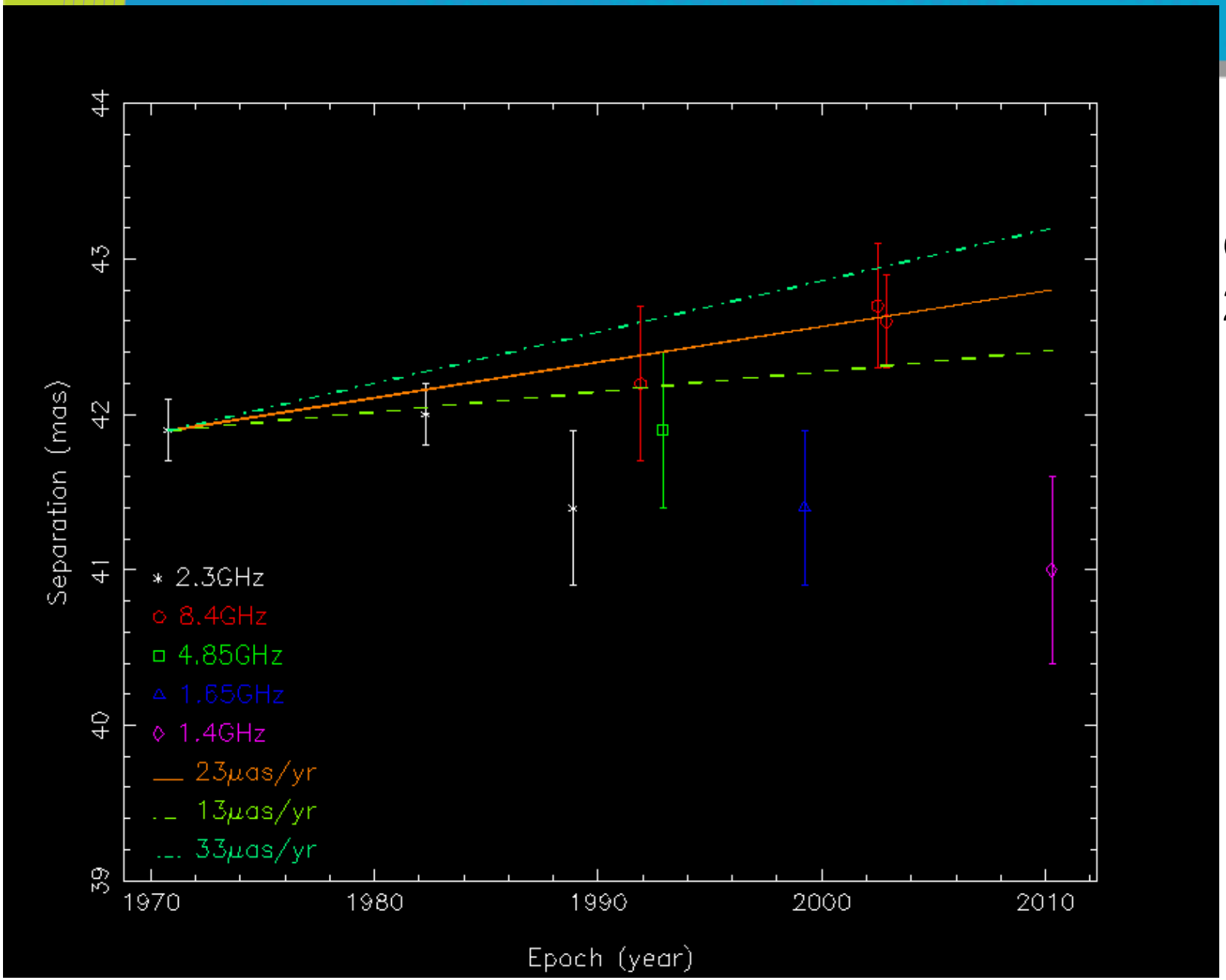
Comparison with historical data



Ojha et al 2004

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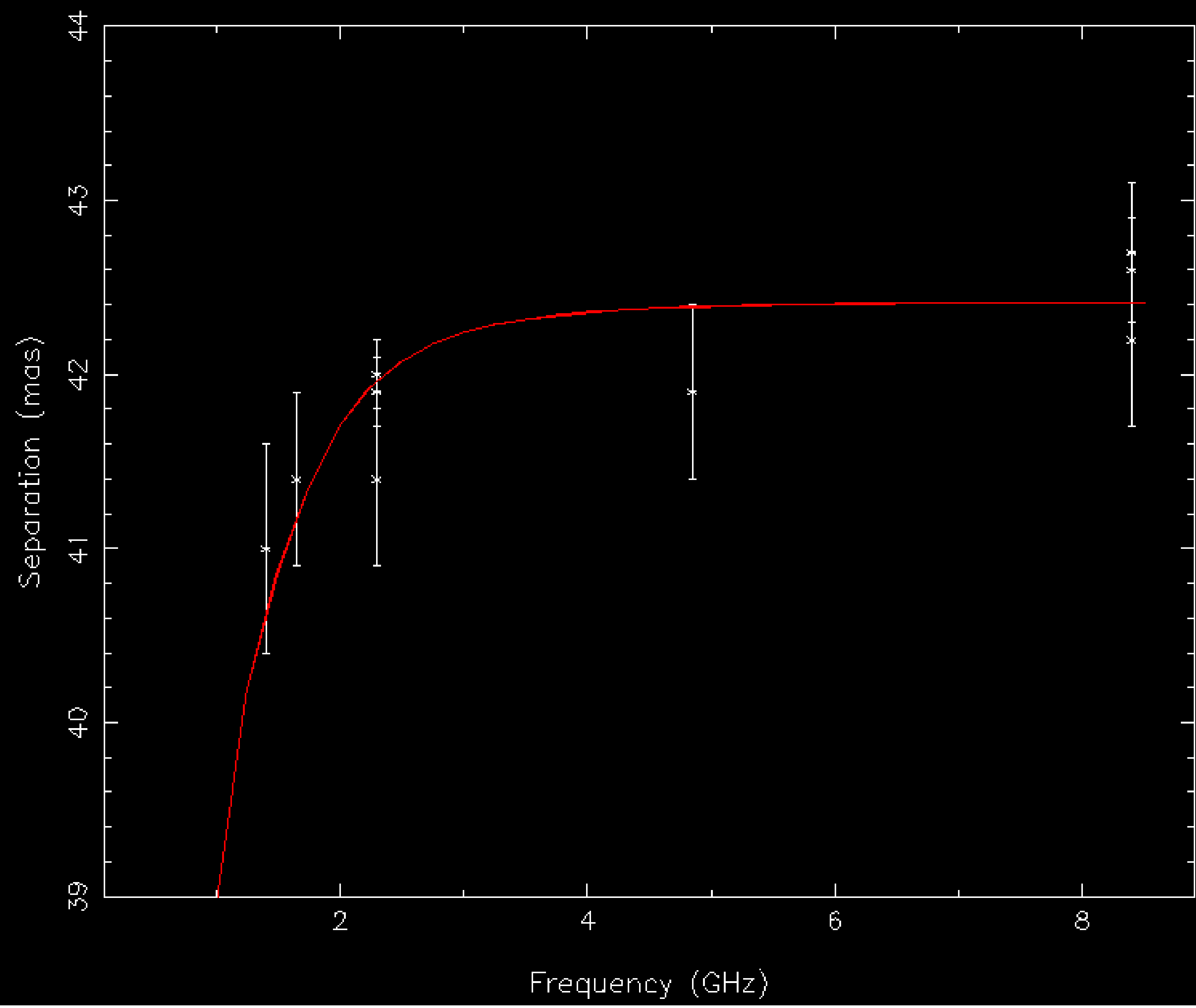
Separation (mas)
44
43
42
41
40
39
2
4
6
8
Frequency (GHz)

Summary of PKS1934-638 results

- Evidence for frequency dependent structure
  - Optical depth effects due to synchrotron self-absorption, if the two components are terminal shocks associated with jets impinging on a dense medium
  - Backflow will be optically thin, causing component centroids to have smaller separation at lower frequencies
  - Fitted well with simple synchrotron self-absorption model
- Weakens evidence for expansion of the source with time (marginal detection reported by Ojha et al. 2004)
- Care must be taken when comparing data at different frequencies
- Note: Similar dependence seen for CTD 93 (Shaffer, Kellermann & Cornwell 1999; Nagai et al. 2006).

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Conclusions & Future

- LBA resolution greatly enhanced by addition of ASKAP and NZ (Warkworth) antennas.
- First scientific results achieved and published.
- Systems are available on request via the regular LBA proposal process
- Future:
  - NZ systems available at S/X bands
  - AuScope antennas also at S/X
  - ASKAP tied-array beams
  - VLBI with KAT-7 and Hart
  - VLBI with GMRT

  → e-VLBI with new telescopes ***

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Astronomy and Space Science

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