The University of Manchester
Jodrell Bank
Observatory

MANCHESTER 1824

Radio Imaging of RS Oph

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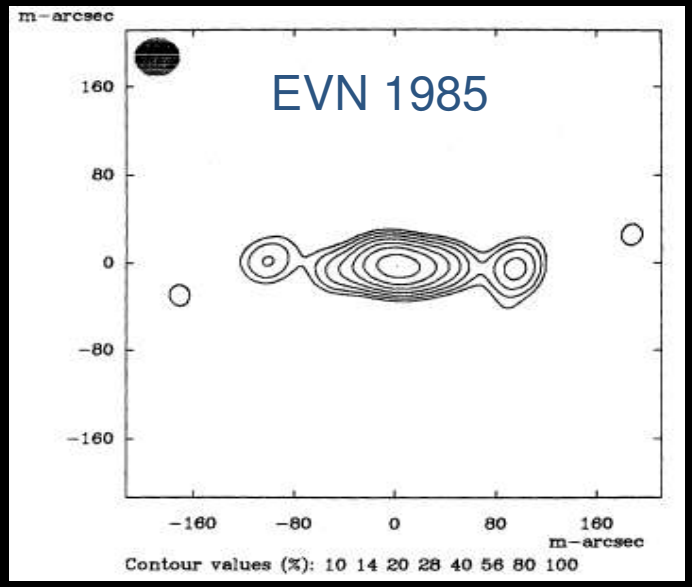
Bode (Liverpool), Porcas (MPIfR),
Muxlow, Beswick, Garrington, Vaytet, Davis (Manchester),
Eyres, Rushton (Central Lancs), Evans (Keele)

Radio observations in 1985

- Jodrell MkIa-MkII Interferometer from *t* = 18d, VLA, European VLBI Network
  Padin et al (1985), Hjellming et al (1986), Porcas et al (1987), Taylor et al (1989)

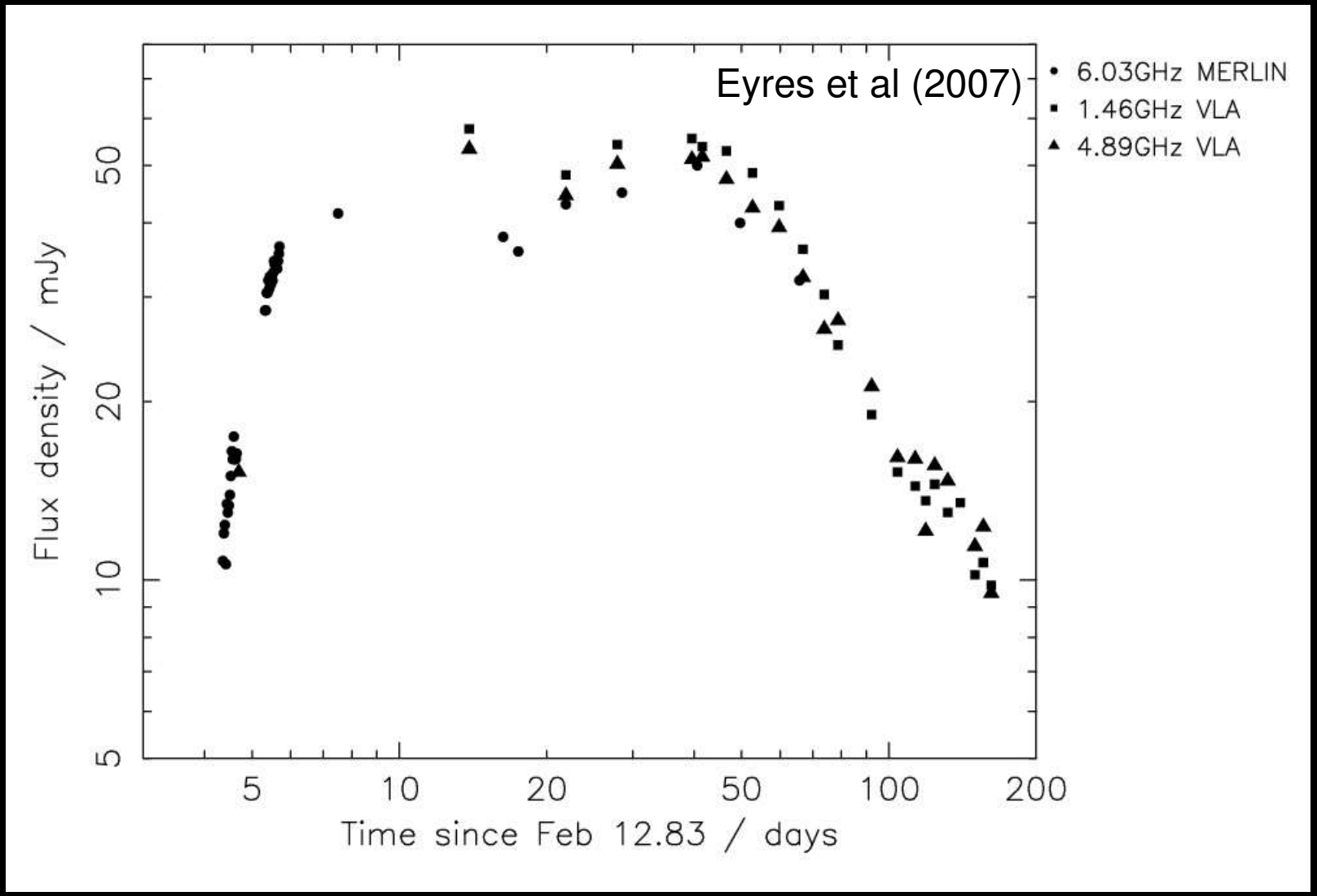


Effelsberg, Jodrell, Westerbork,
No fringes on JB-Wb

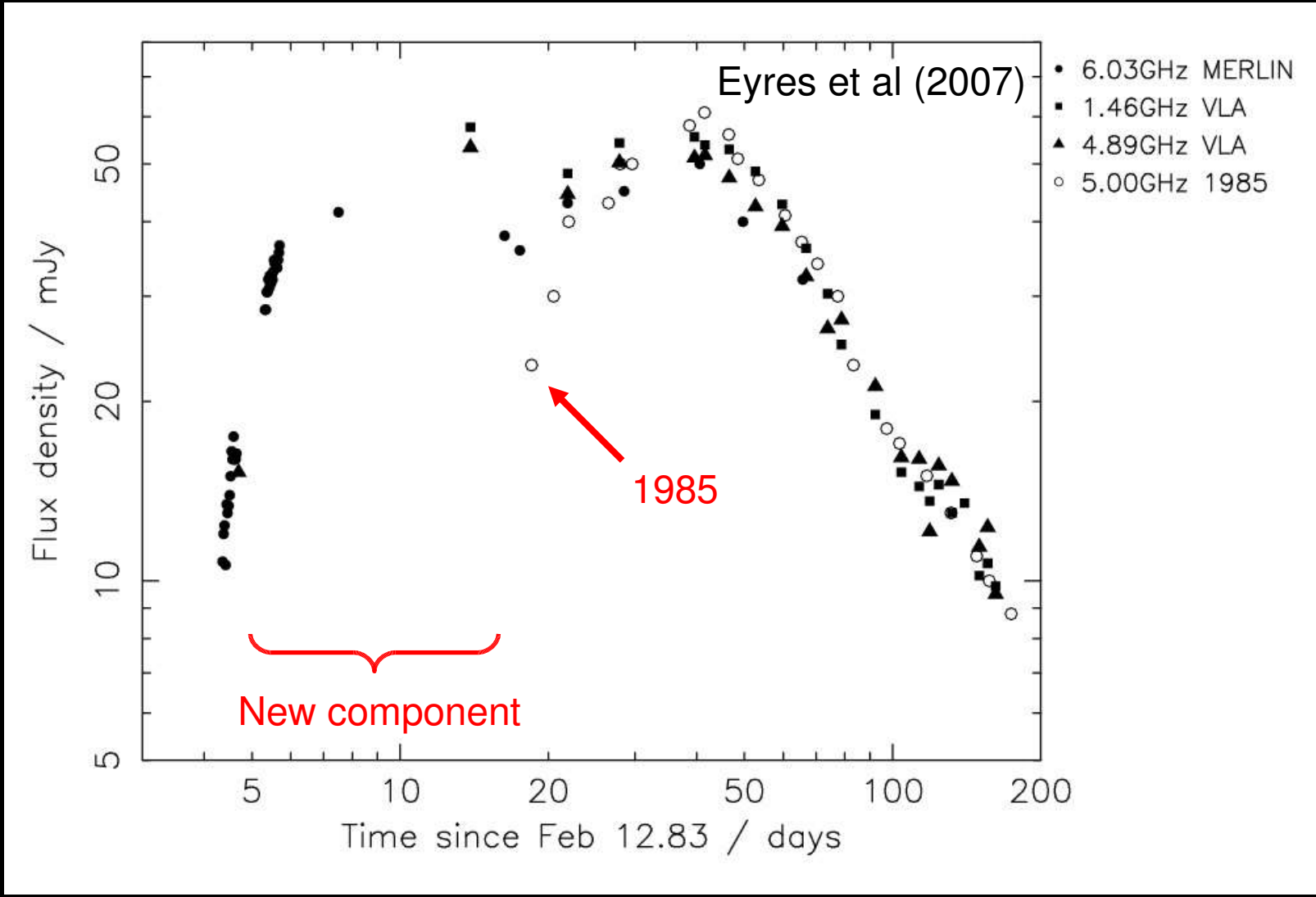
2006

- Monitoring from day 4.5 onwards with MERLIN, VLA, VLBA, and EVN (also GMRT & OCRA).

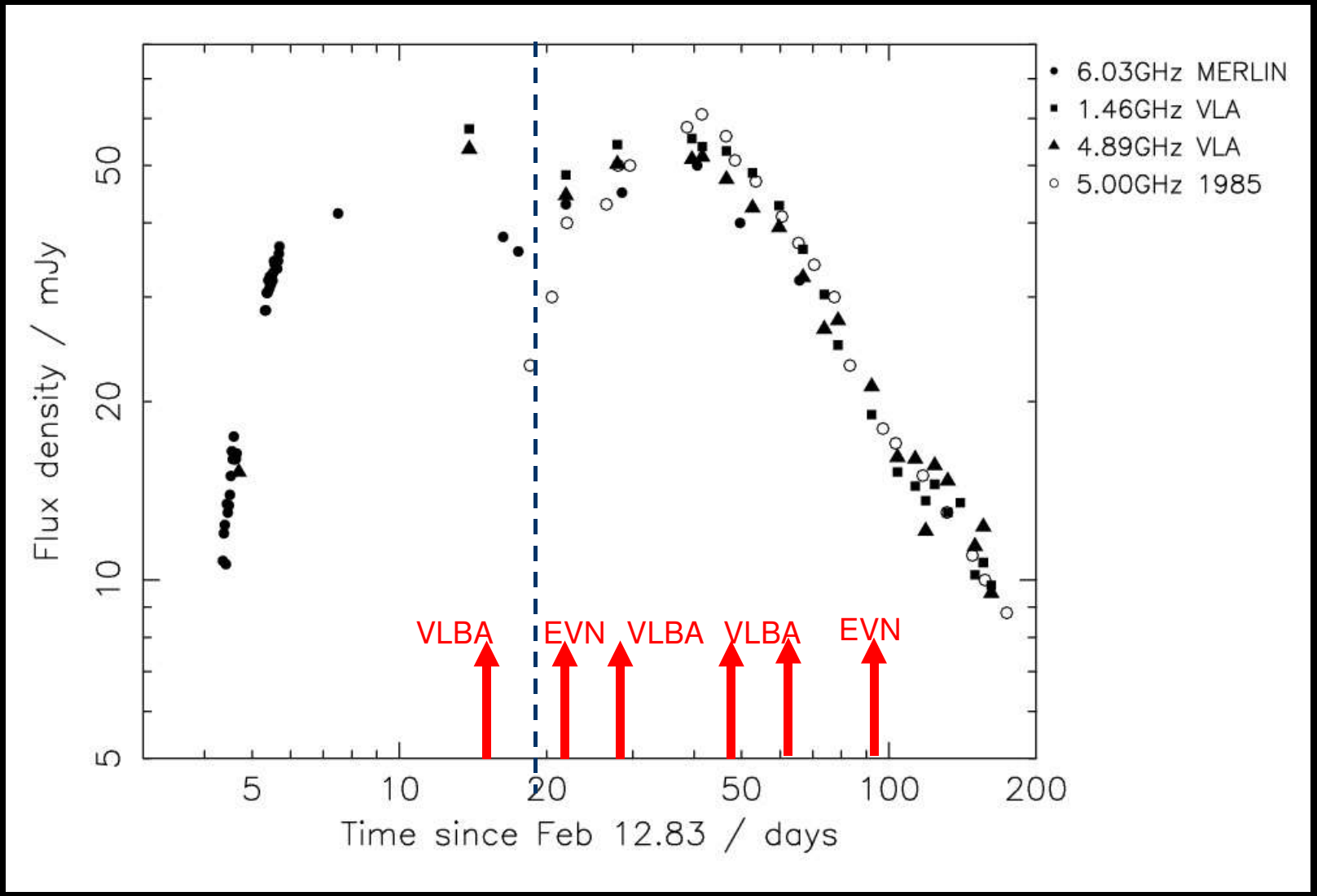
L/C-Band Lightcurve



L/C-Band Lightcurve



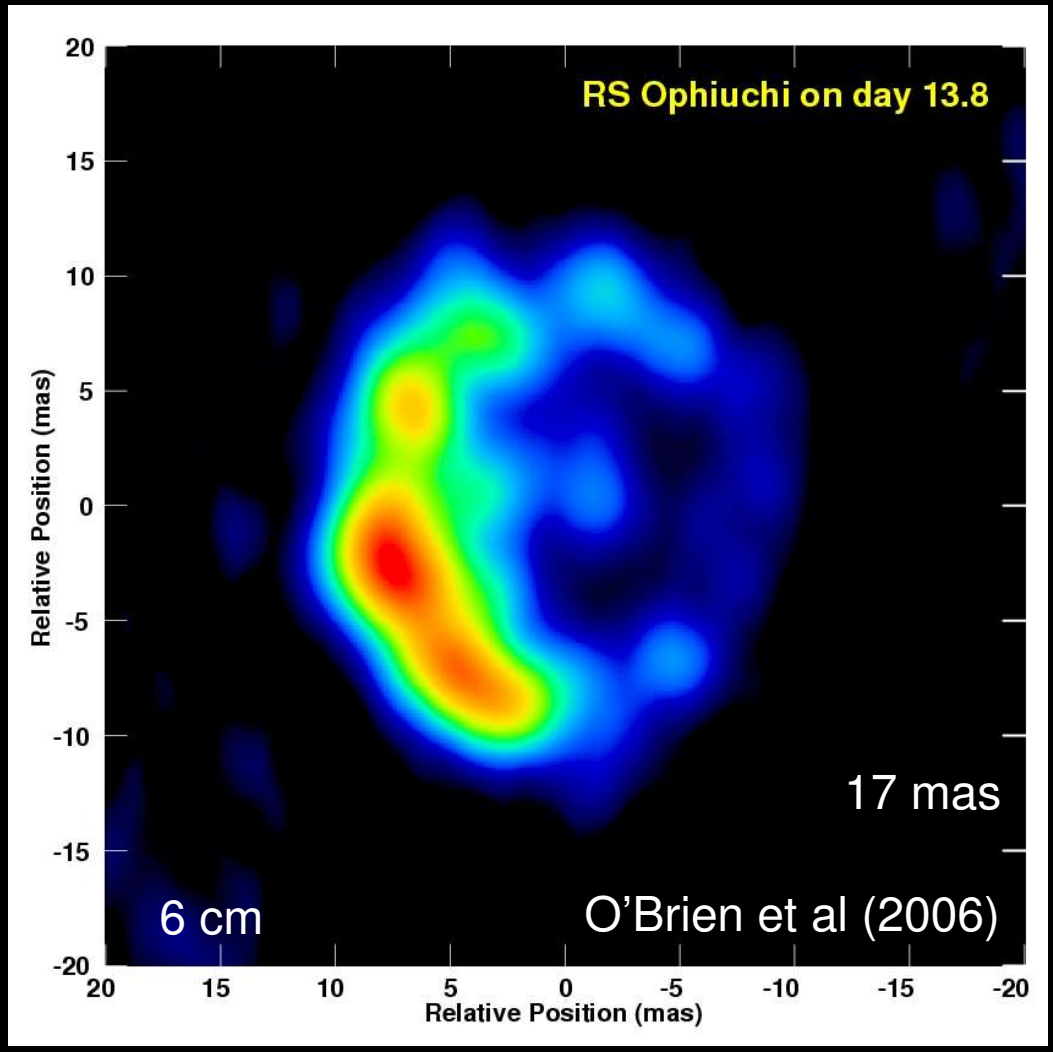
VLBI Imaging

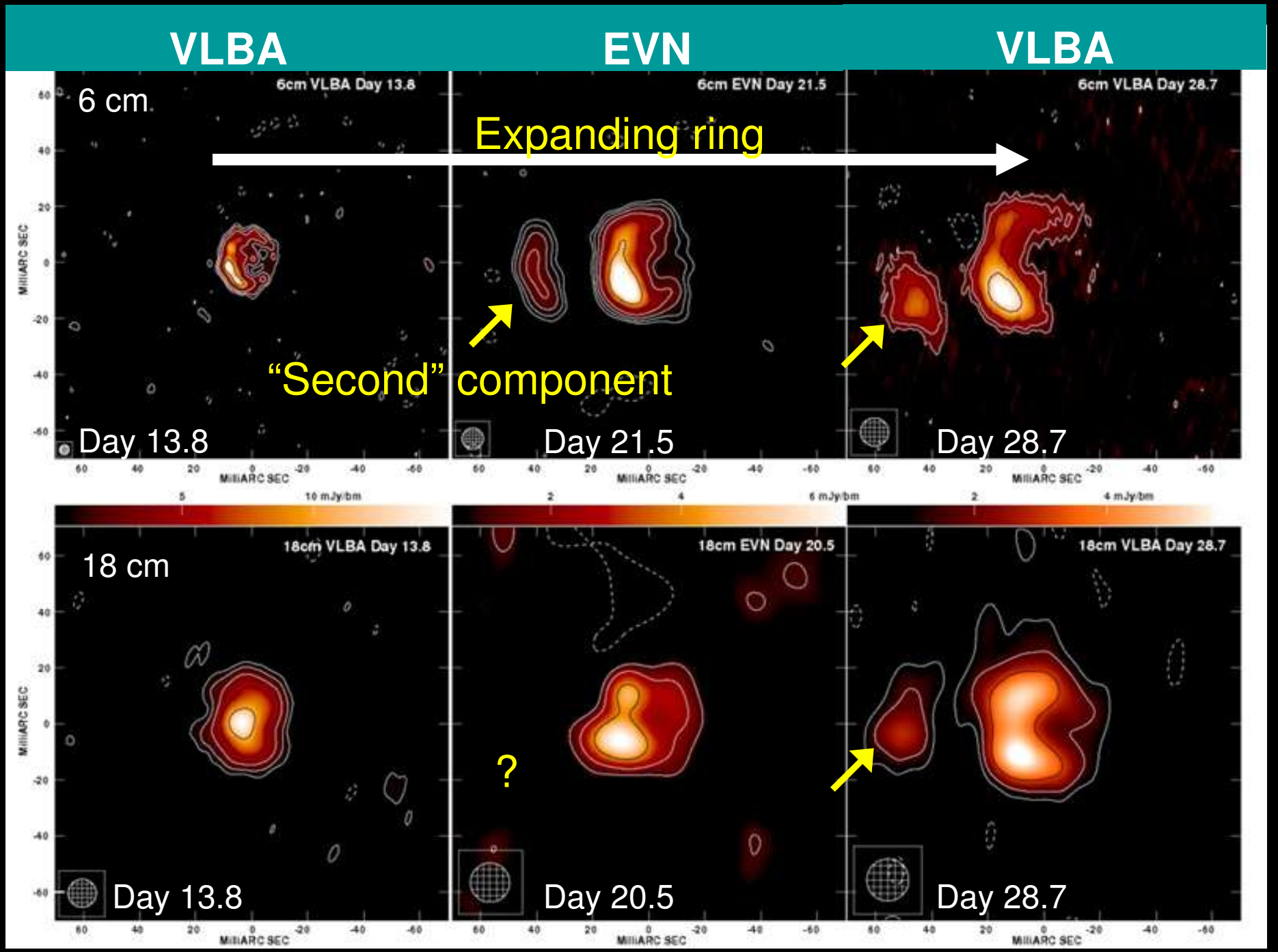


First VLBI image – Day 13.8

VLBA image reveals the shock wave in RS Oph for the first time. Earliest resolution of structure in any such explosion.

Res'n ~ 3 mas (5 AU)
Peak T_b ~ 4×10^7K
Non-thermal.



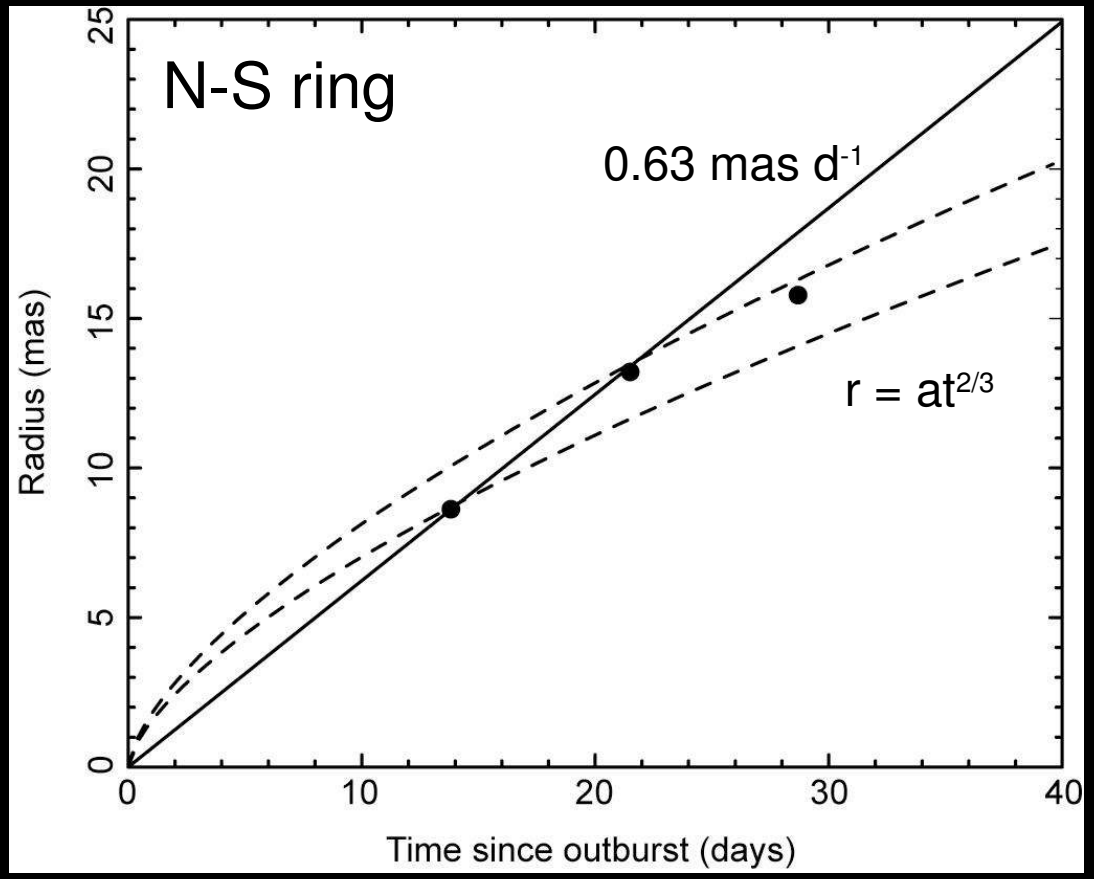

VLBA
EVN
VLBA
6 cm
6cm VLBA Day 13.8
6cm EVN Day 21.5
6cm VLBA Day 28.7
Expanding ring
"Second" component
Day 13.8
Day 21.5
Day 28.7
MilliARC SEC
10 mJy/bm
6 mJy/bm
4 mJy/bm
18 cm
18cm VLBA Day 13.8
18cm EVN Day 20.5
18cm VLBA Day 28.7
?
Day 13.8
Day 20.5
Day 28.7

Expansion velocity

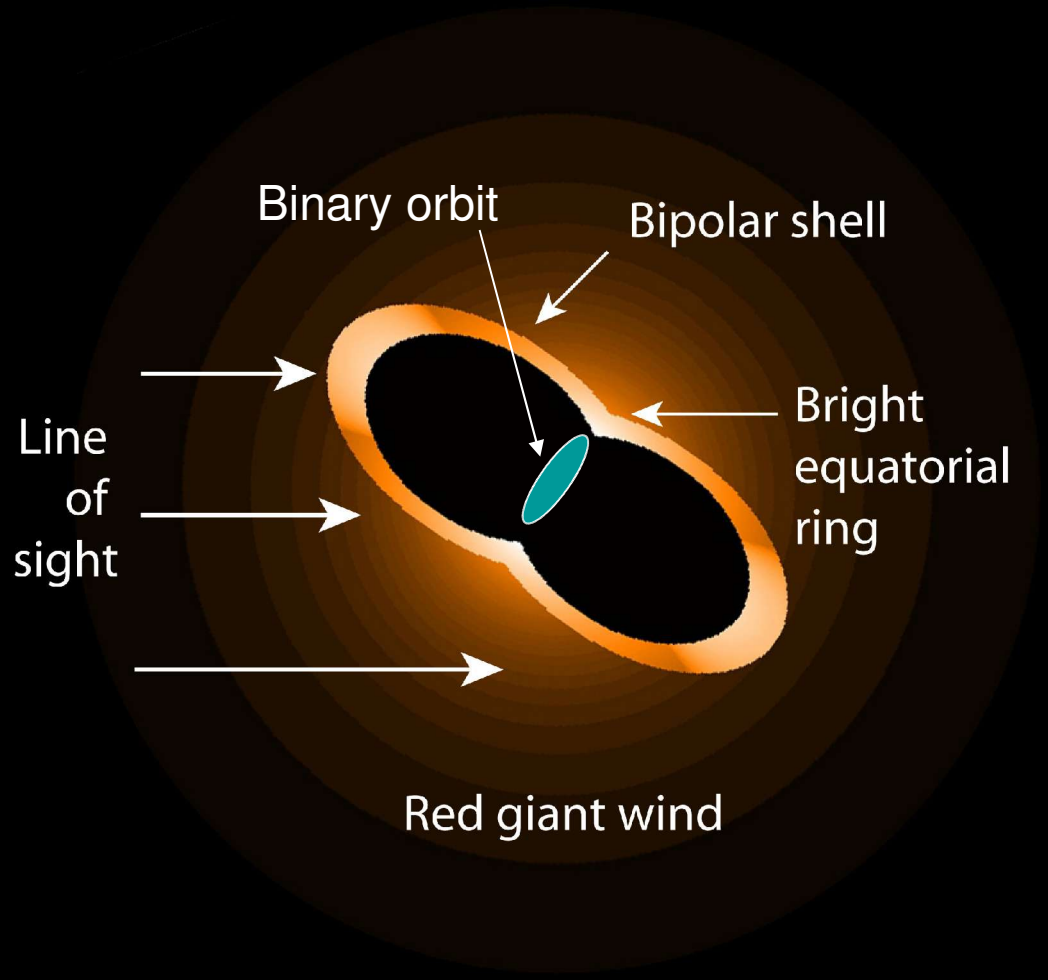
N-S ring = 0.63 mas/d =1750 km s^{-1} at 1600 pc

Consistent with X-ray temp's.

2nd component = 4000 km/s in plane of sky



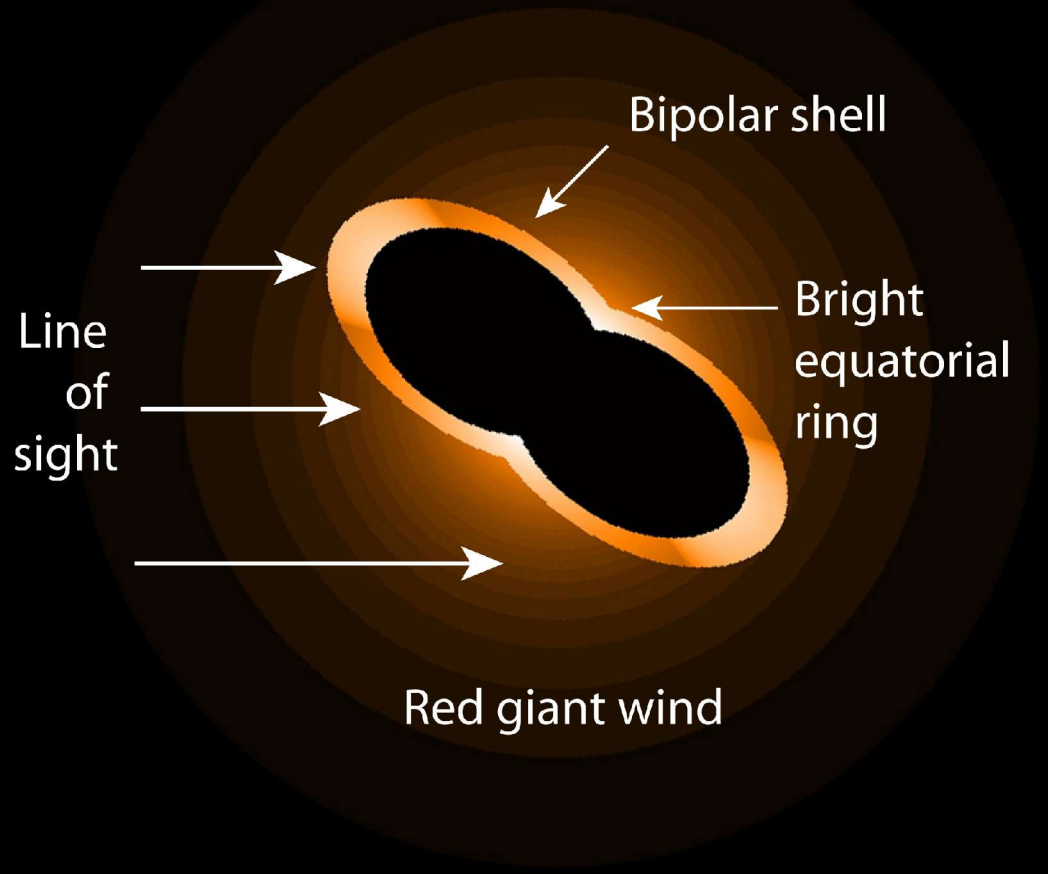
A simple model



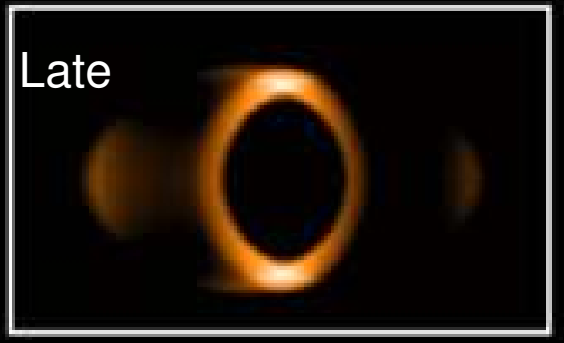
Bipolar shell viewed at the (known) inclination of the binary orbit and partially obscured by the overlying red giant wind.

A simple model

As the source expands the overlying free-free absorption is reduced and it becomes symmetrical.



Synthetic images



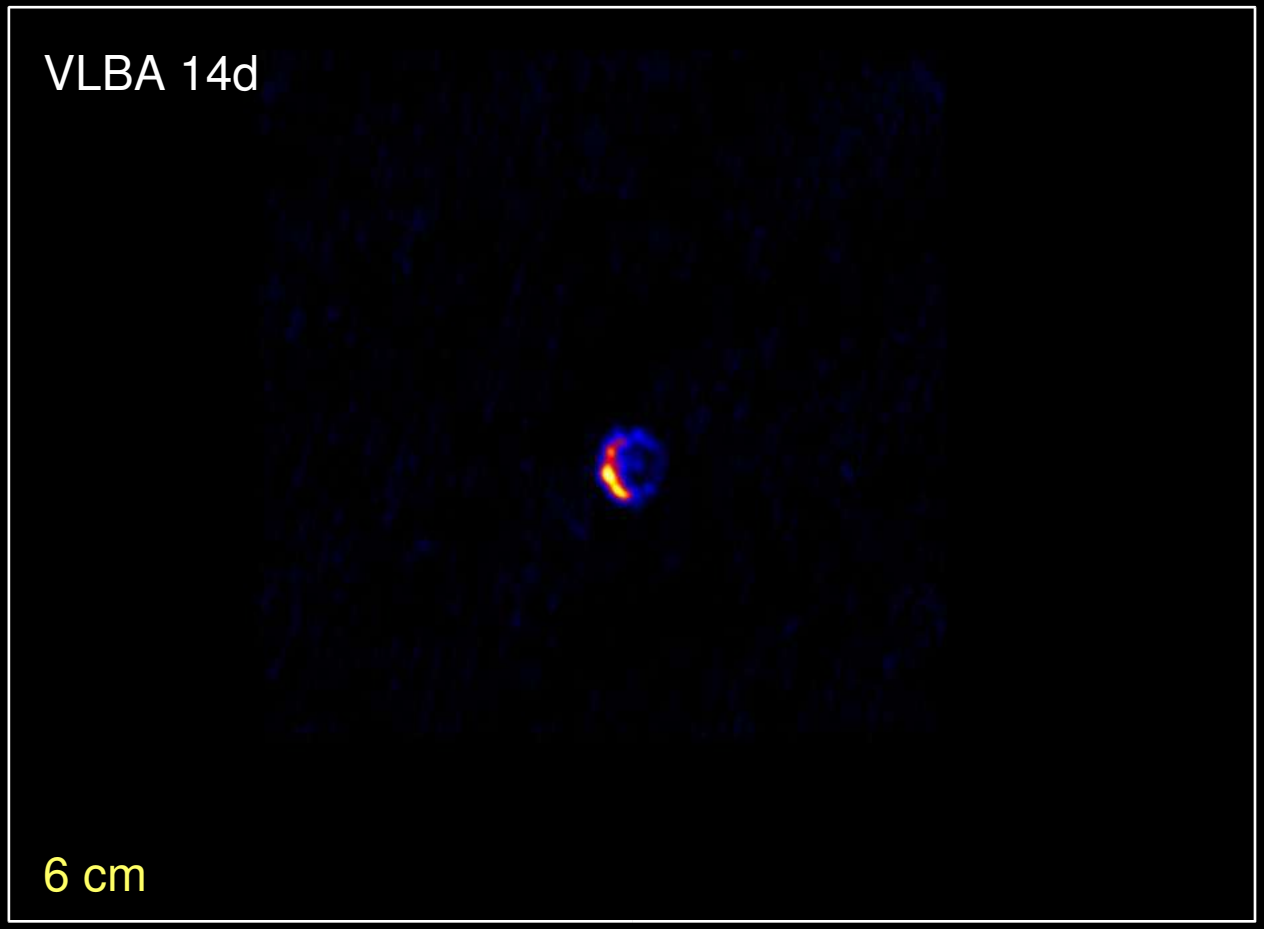
MERLIN imaging

- Second component to east clearly visible from day 21 onwards.
- Third component to west visible around day 50.
- Source evolves into E-W structure.

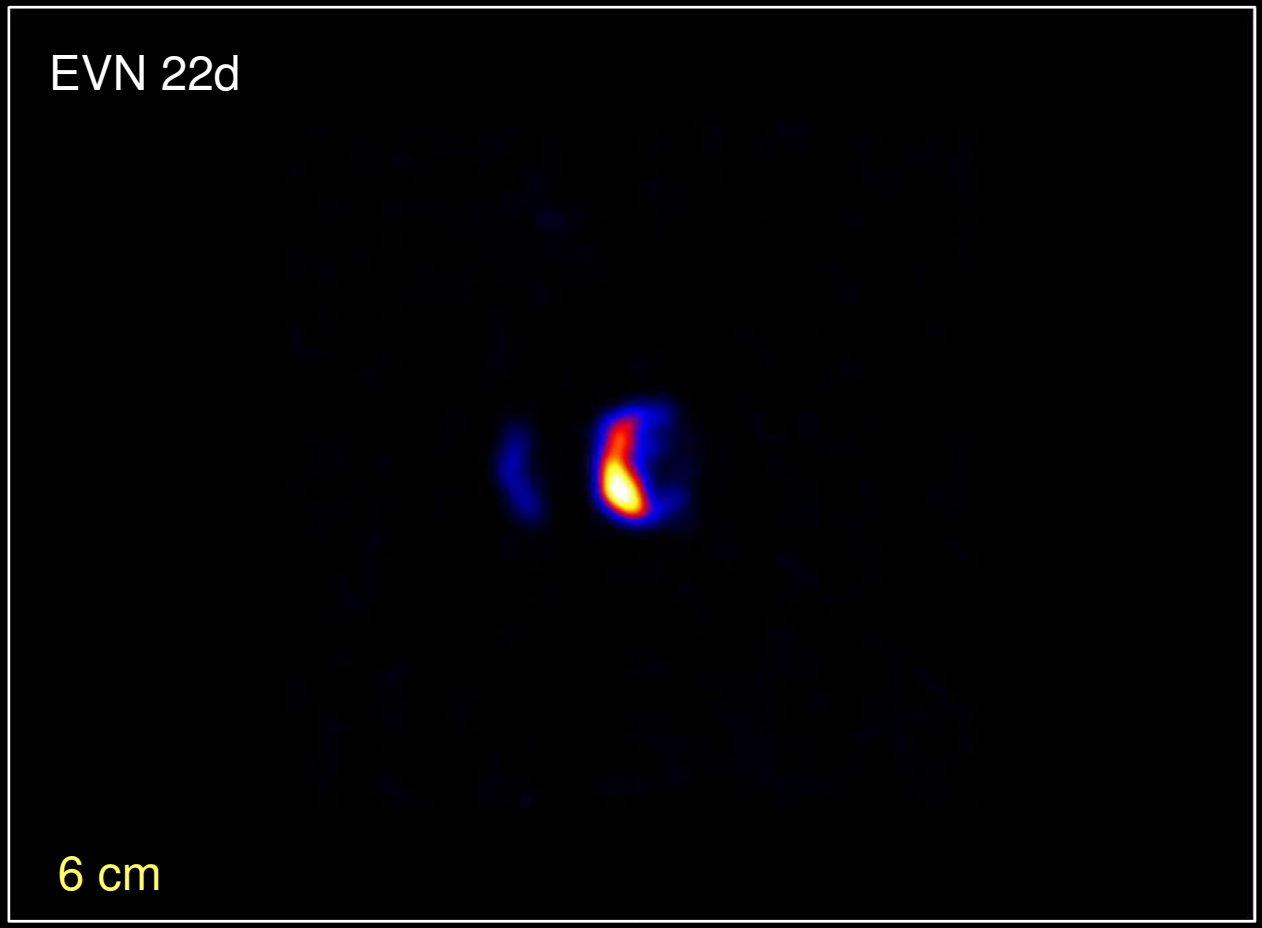
MERLIN Radio observations of the 2006 outburst of RS Ophiuchi

(O'Brien, Muxlow, Beswick et al)

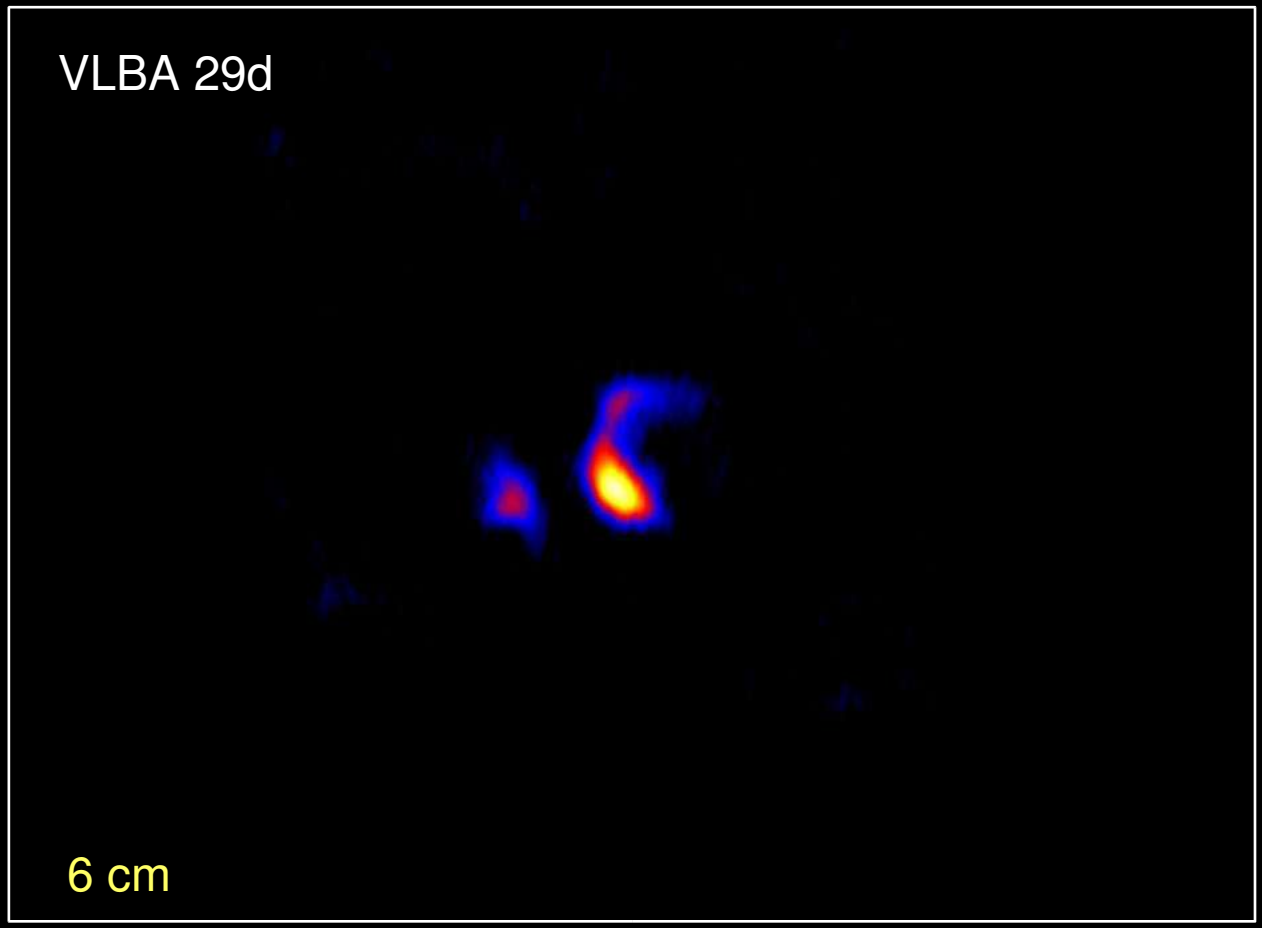
VLBI Sequence



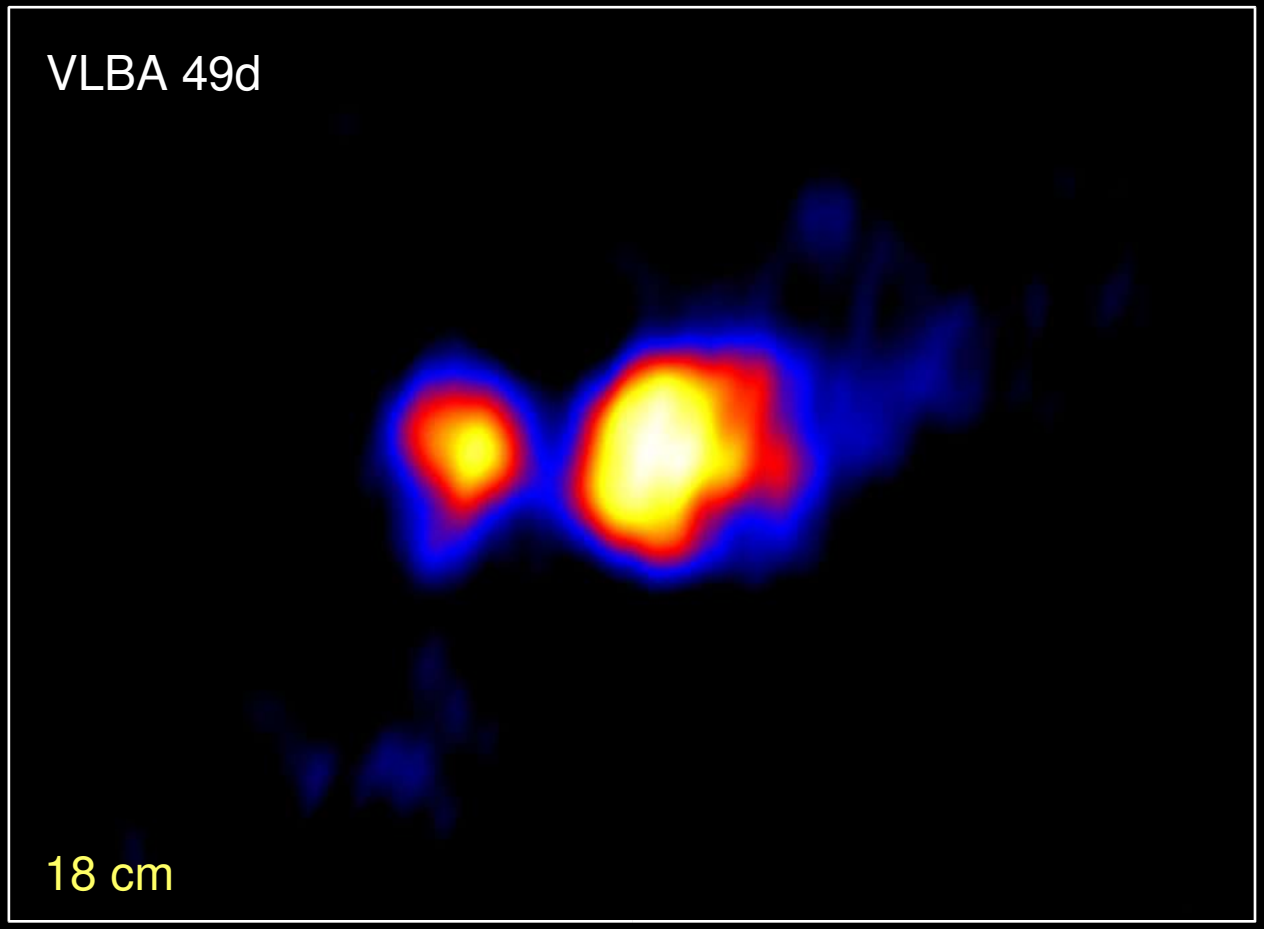
VLBI Sequence



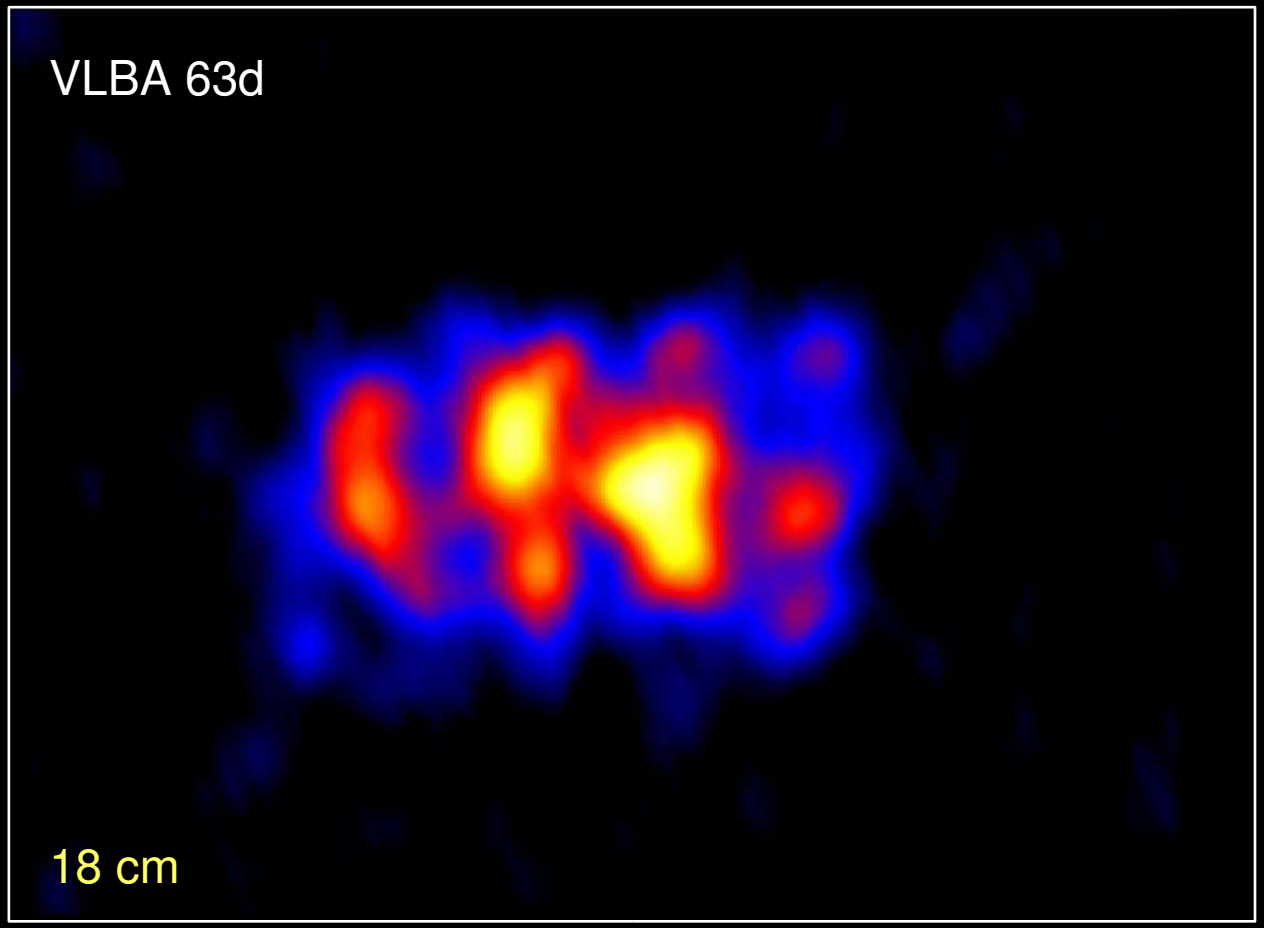
VLBI Sequence



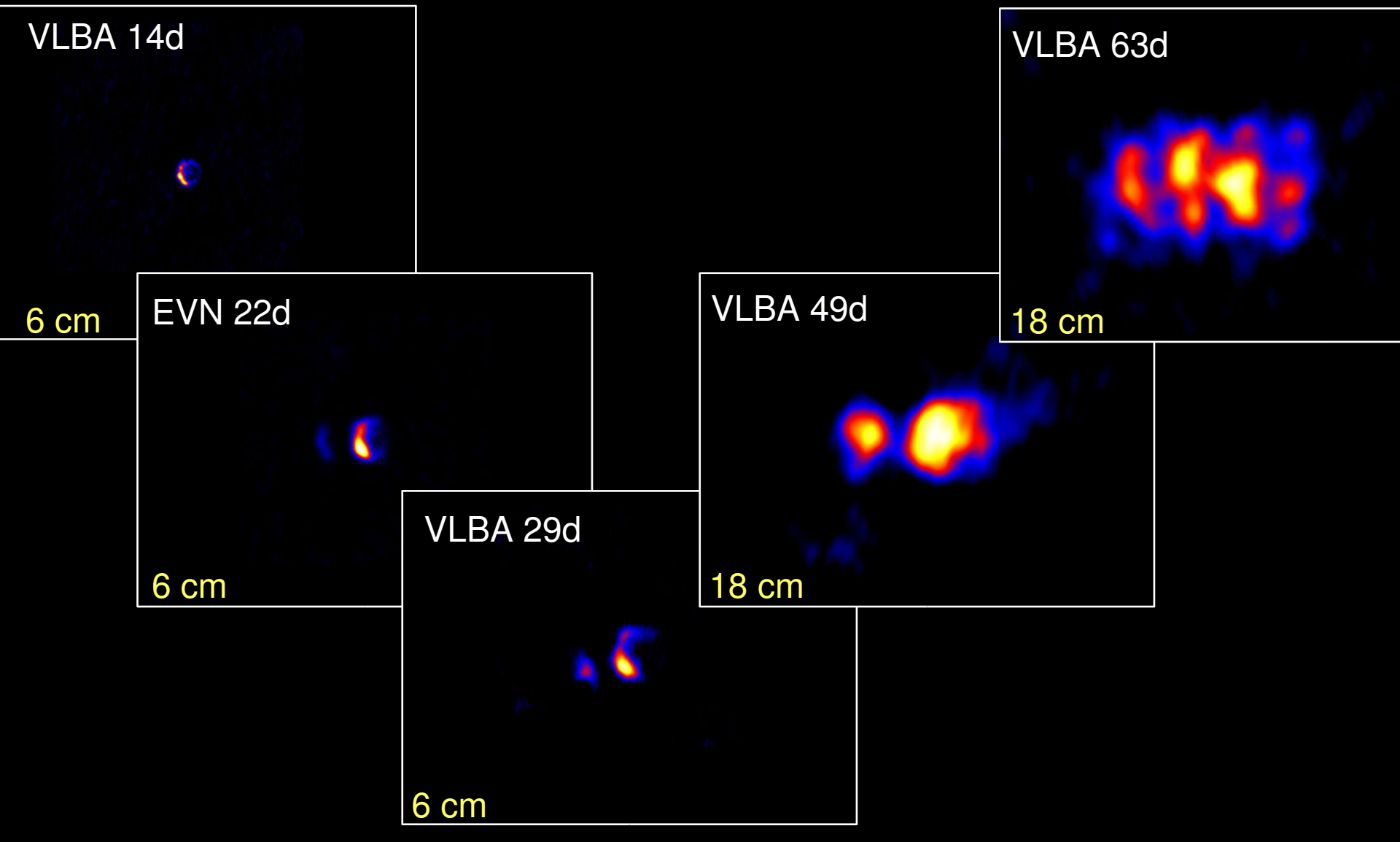
VLBI Sequence



VLBI Sequence

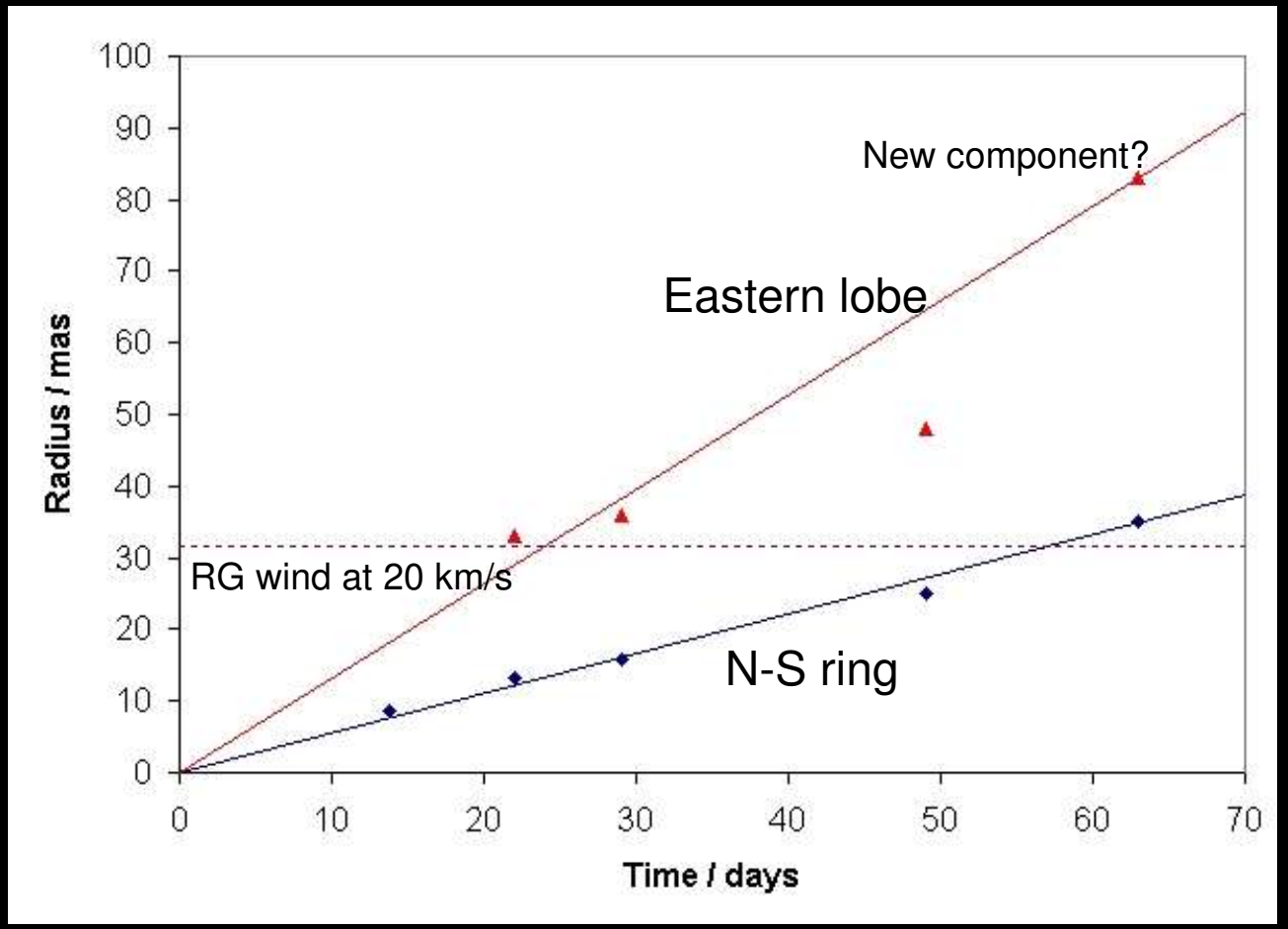


VLBI Sequence



Expansion revisited

E lobe:
v ~ 1.3 mas/d
= 3700 km/s
= 6400 km/s
(corrected for inclination)



Summary

- First direct imaging of synchrotron-emitting shock wave.
- Size consistent with X-ray temperature.
- Very asymmetric.
- Develops into E-W structure (cf 1985).
- Is this evidence for collimated ejecta (jets) or confinement by equatorial RG wind?
- Simple bipolar model obscured by RG wind or something more complex?