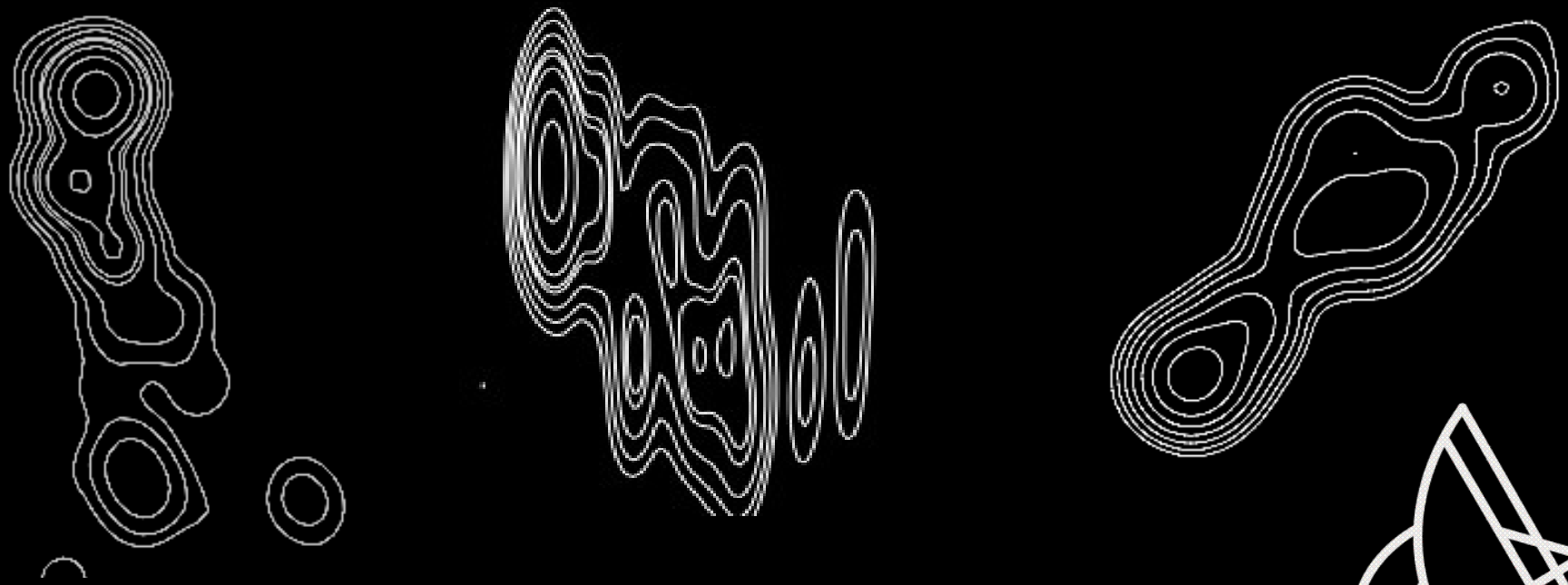
4 years of monitoring *Gamma-ray* blazars with the GMVA



Jeffrey A. Hodgson (MPIfR) – jhodgson@mpifr-bonn.mpg.de

T. P. Krichbaum (MPIfR), A.P. Marscher (BU), S. Jorstad (BU), B. Rani (MPIfR), J.L. Gomez (IAA), J.A. Zensus (MPIfR), I. Agudo (JIVE), M. Bremer (IRAM), A. P. Lobanov (MPIfR), L. Fuhrmann (MPIfR), V. Karamanavis (MPIfR)

Max-Planck-Institut für Radioastronomie

Outline

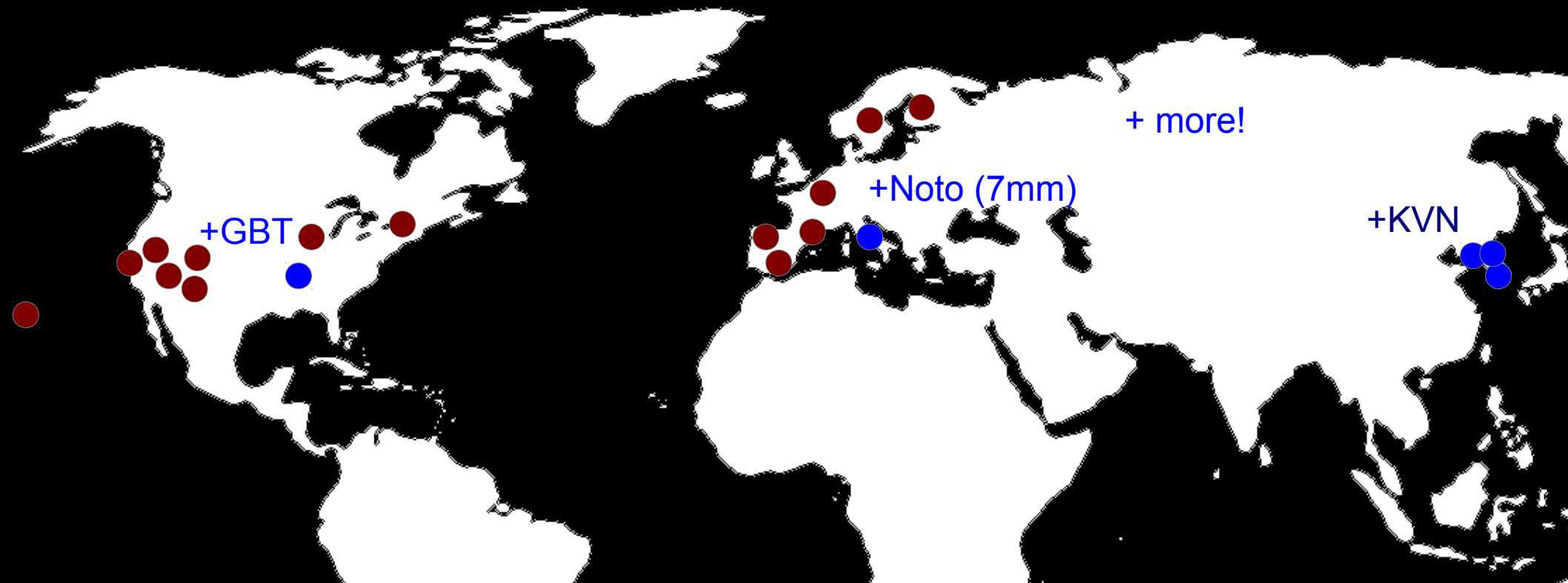
- Why the GMVA is unique for AGN science
- Gamma-rays/structural changes correlations
- Magnetic field strength estimates
- Use B-fields to determine the distance from the jet base to the VLBI “core”
- Estimate B-fields near BH

The Global mm-VLBI Array

- 13 stations (+ more coming), 7 and 3 mm , Spring and Autumn observations
- <50 μas resolution, above SSA turnover

The Global mm-VLBI Array

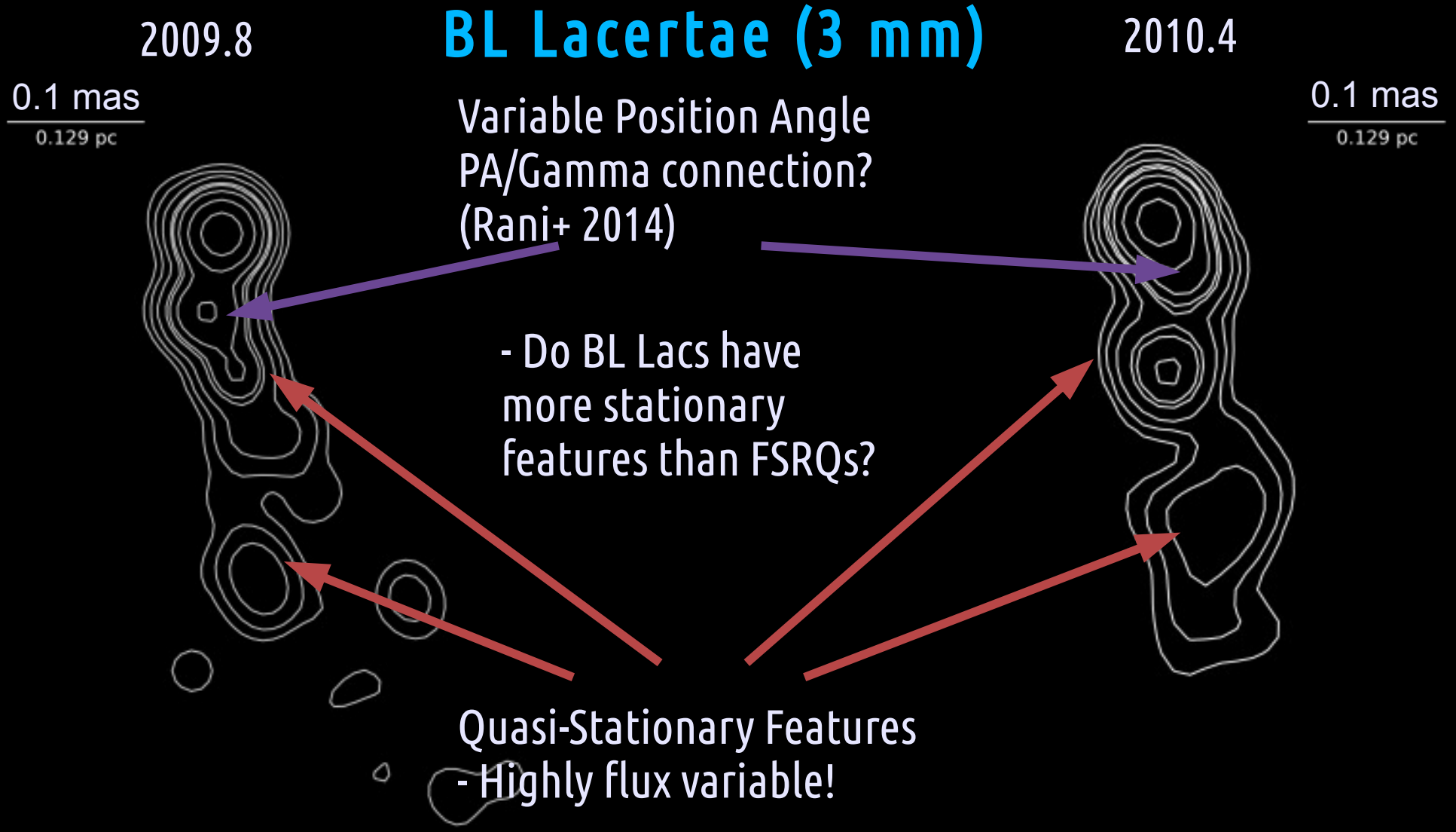
- 13 stations (+ more coming), 7 and 3 mm , Spring and Autumn observations
- <50 μas resolution, above SSA turnover



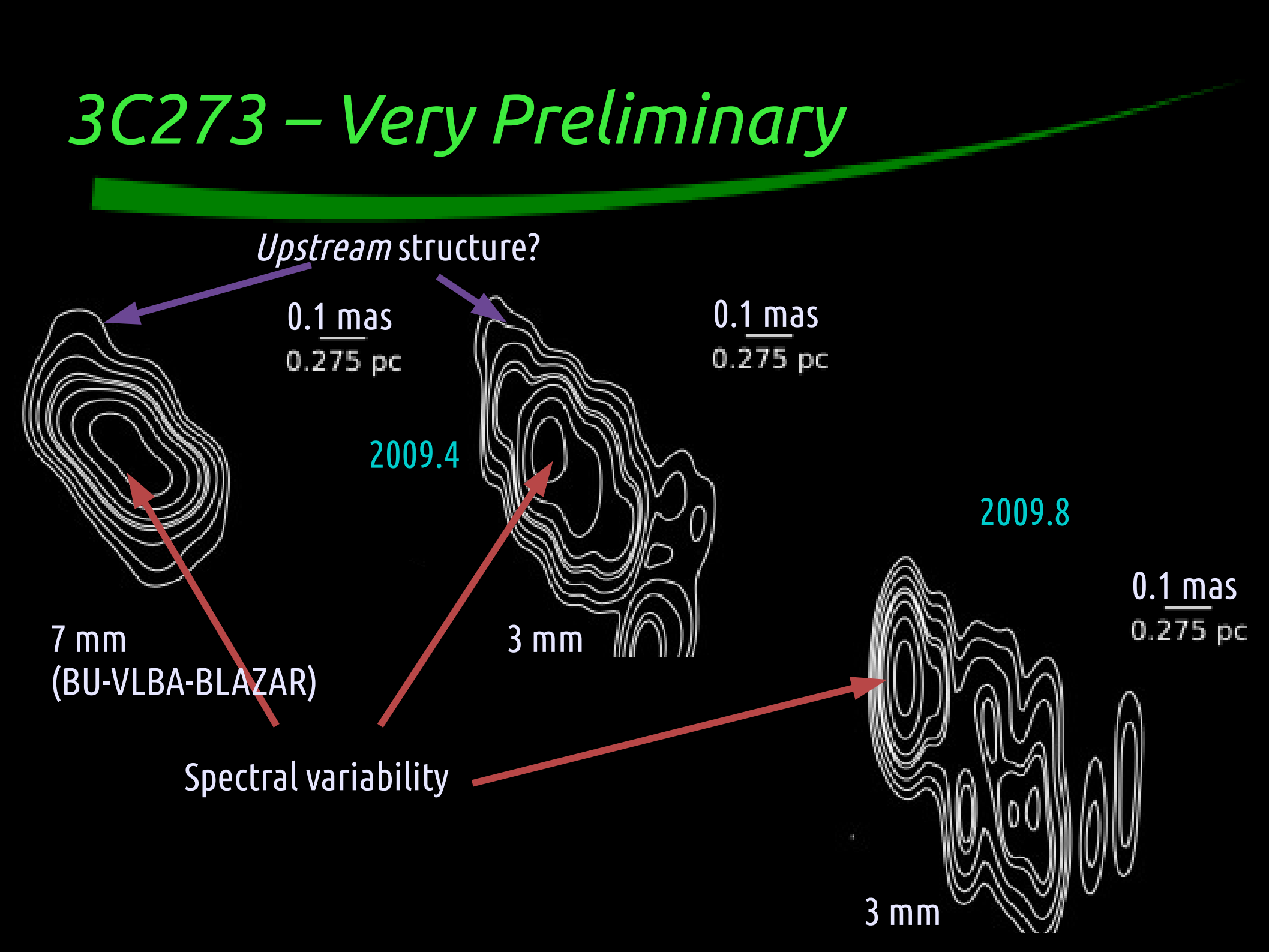
The sample

- 27 sources:
  - ~15 regularly observed
  - 19 FSRQs, 6 BL Lacs, 1 Radio Galaxy
- 10 epochs:
  - 2008.8 – 2014.8
  - Bi-monthly (almost)
- 1 (OJ 287) + full 7 mm kinematics, + quasi-simultaneous MOJAVE data
- Some highlights...

Some common features



3C273 – Very Preliminary



3C273 – Very Preliminary

7 mm

0.1 mas
0.275 pc

2009.4

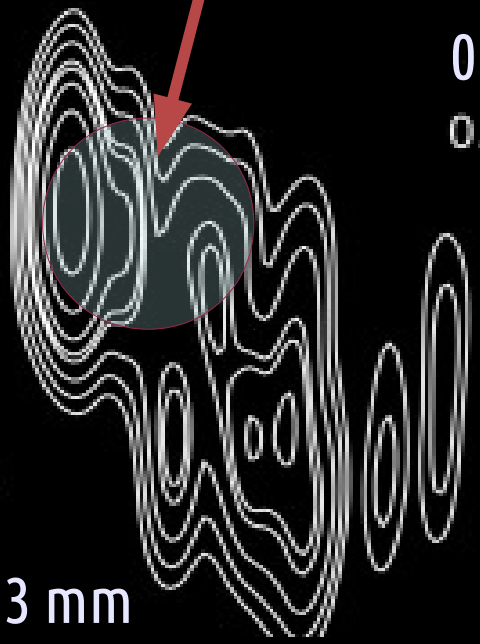
3 mm

0.1 mas
0.275 pc

Large Gamma-ray Flare between observations

2009.8

0.1 mas
0.275 pc

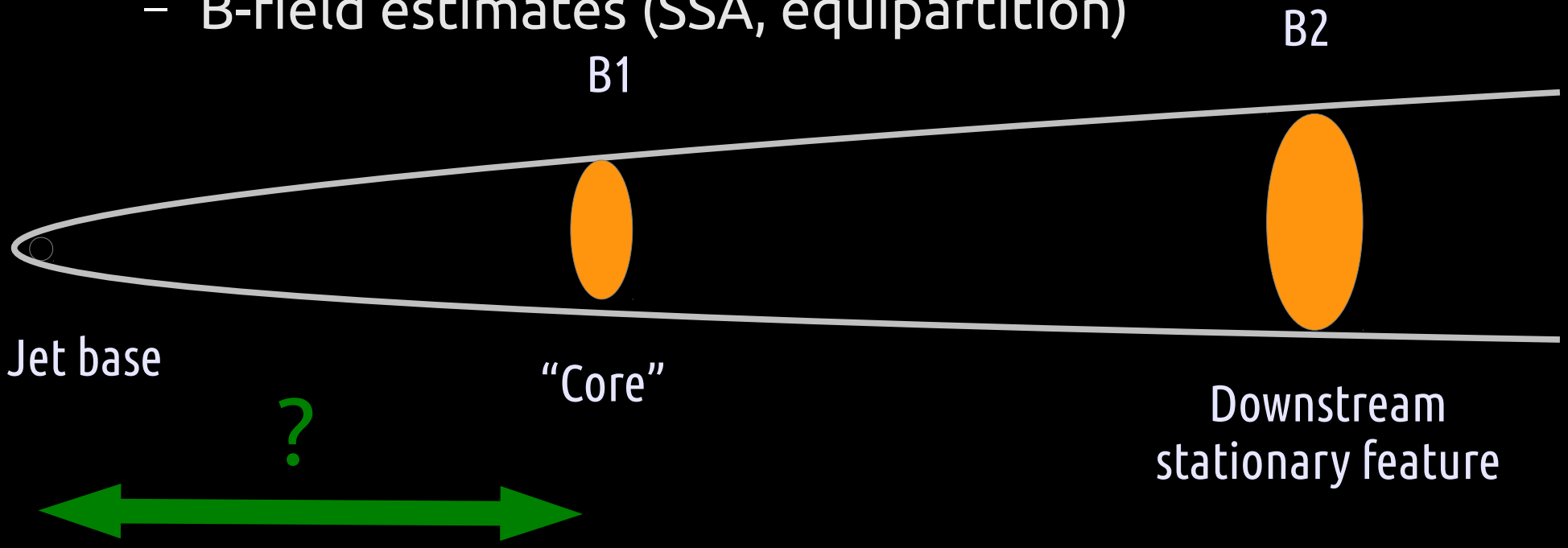


3 mm

See also: Poster by V. Karamanavis

Where is the VLBI "Core"?

- Assume $B \propto r^n$; 0 > n > 2
- Assume toroidal (n=1) B-field configuration (Reichstein+ 2011, Broderick & McKinney+ 2010, this conference...)
- (20 – 7 – 3) mm Spectral decomposition
  - B-field estimates (SSA, equipartition)

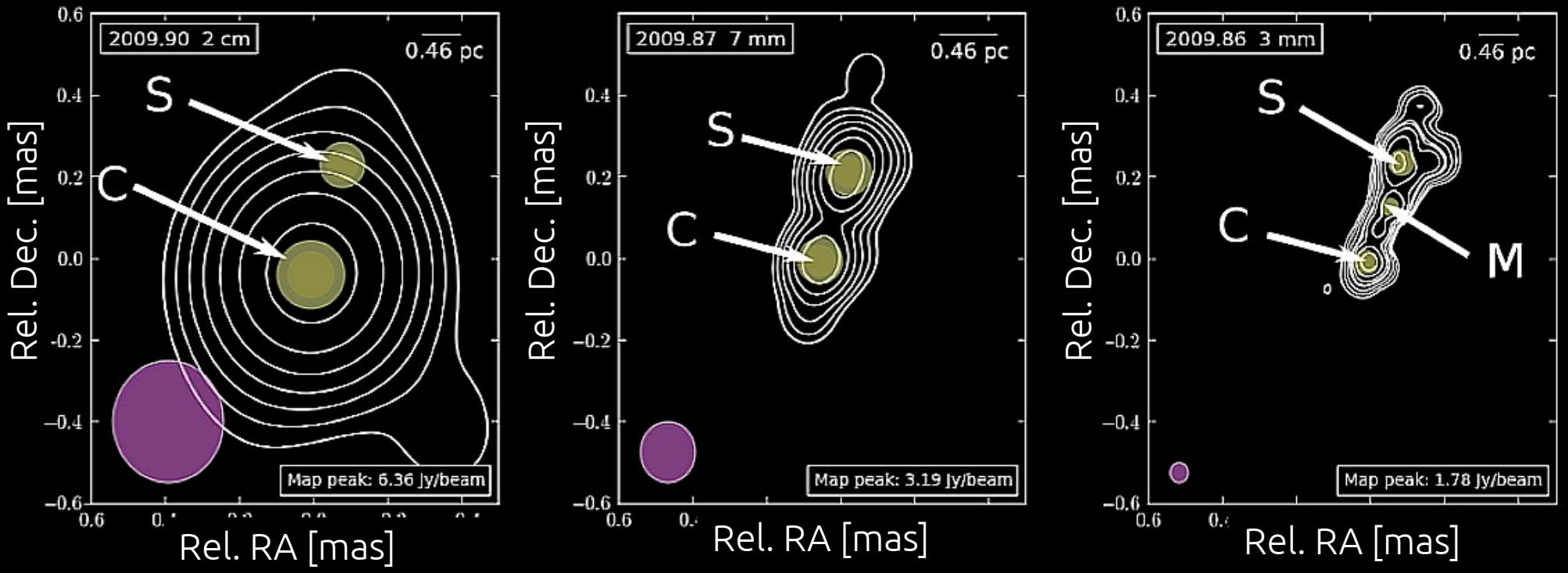


Limitations

- Large powers! SSA: $B \propto \nu_m^5 \theta_m^4$
- When using lower frequencies, lack resolution
- “Core”/Stationary features can be dominated by flaring activity
  - Causes stronger magnetic fields than “normal”
- Assume constant Doppler factor
- Despite this, useful limits can be determined

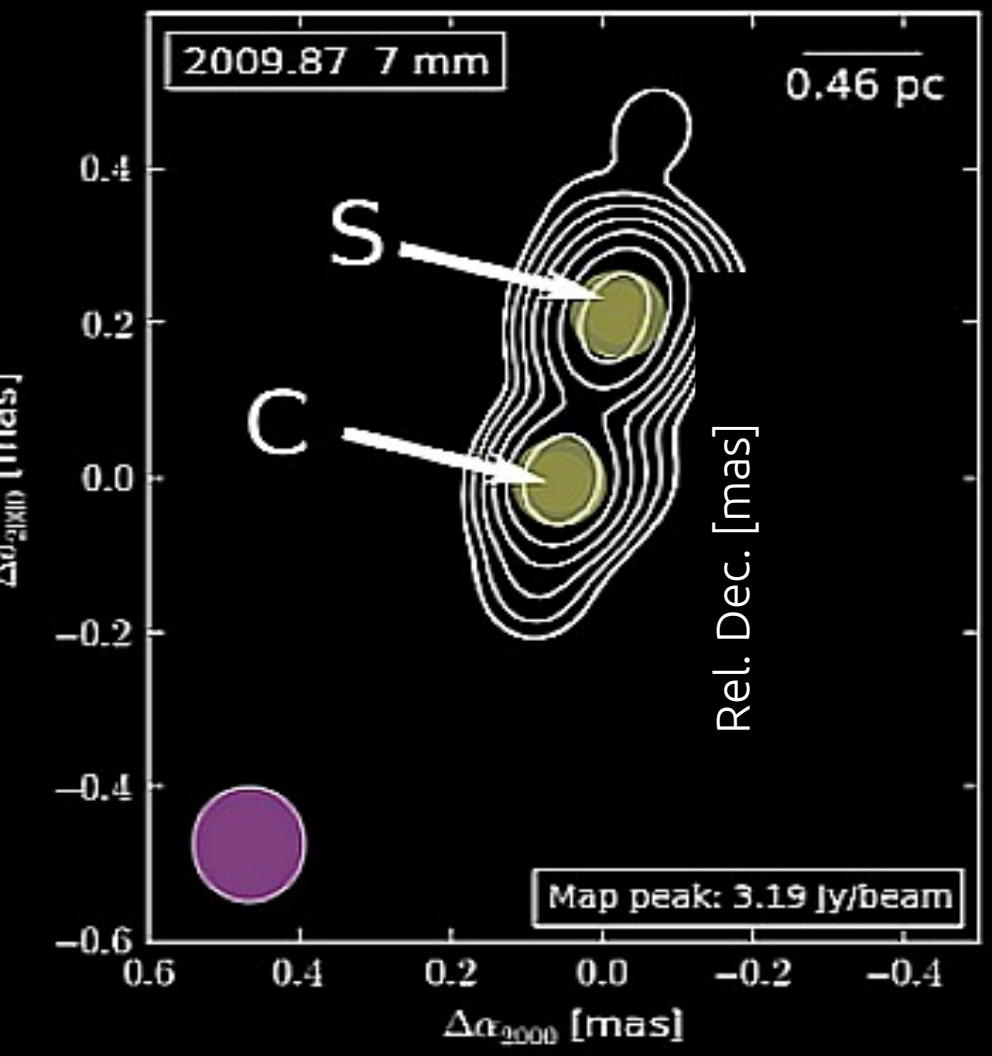
OJ 287

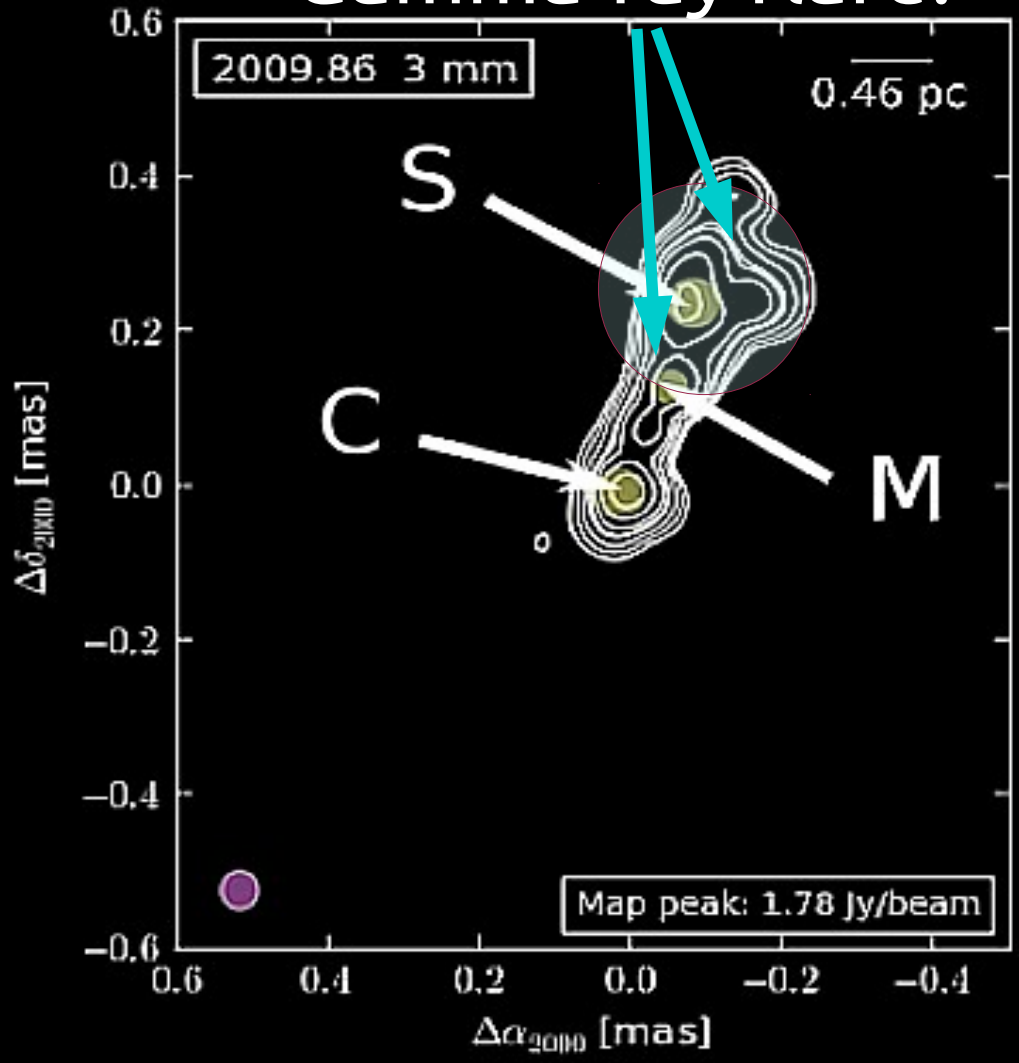
- (2cm – 7mm – 3mm) Spectral decomposition
- Gamma-rays in “core” (C), in downstream stationary feature (S) or both (Agudo+ 2011, Hodgson+ in prep)?



OJ 287

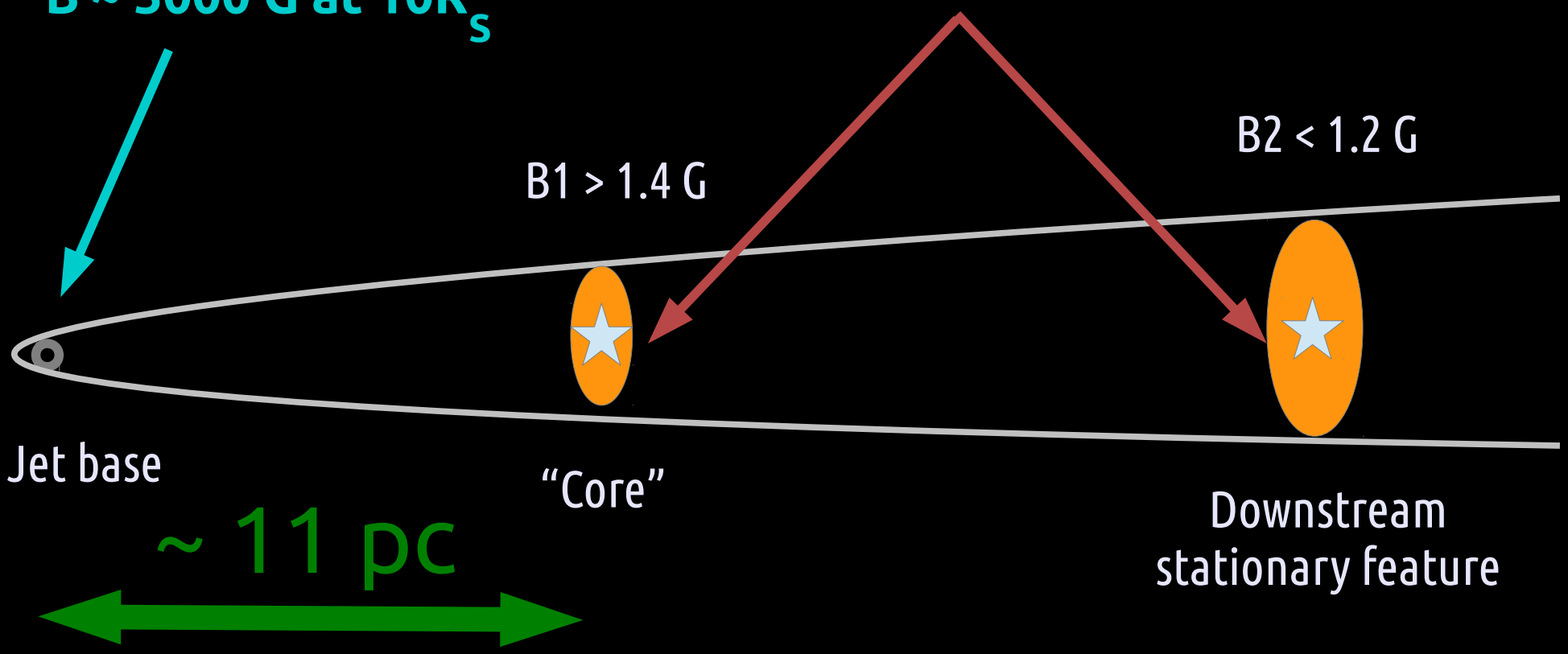
At peak of
Gamma-ray flare!



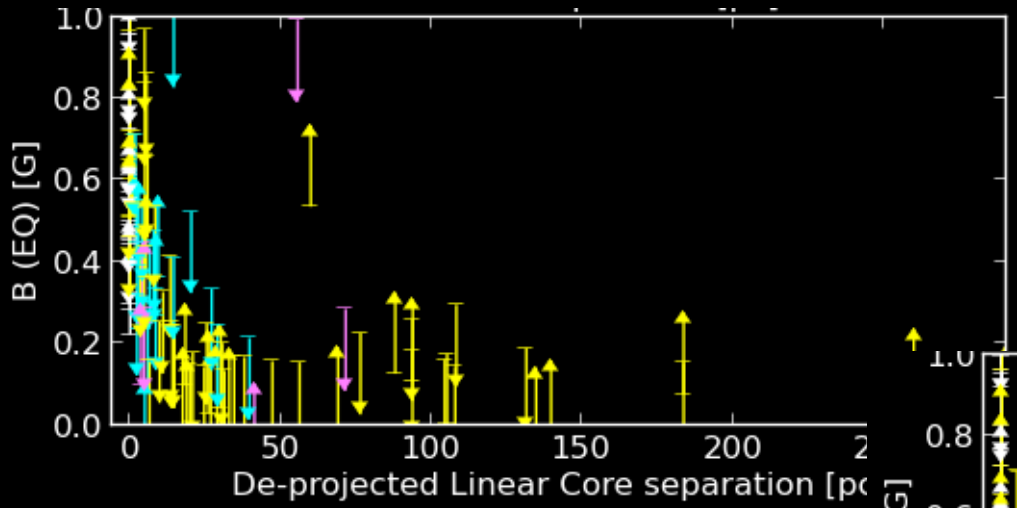


B-fields in OJ287

B1/B2 (SSA) > 20%
Gamma-rays ~ 11 pc (~$10^5 R_s$)



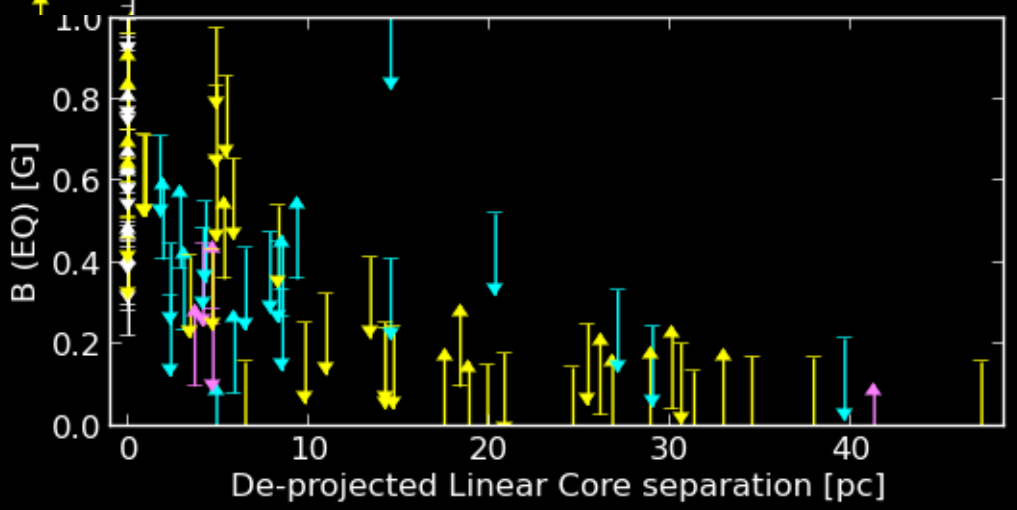
Equipartition B-fields



"Cores"

Stationary features

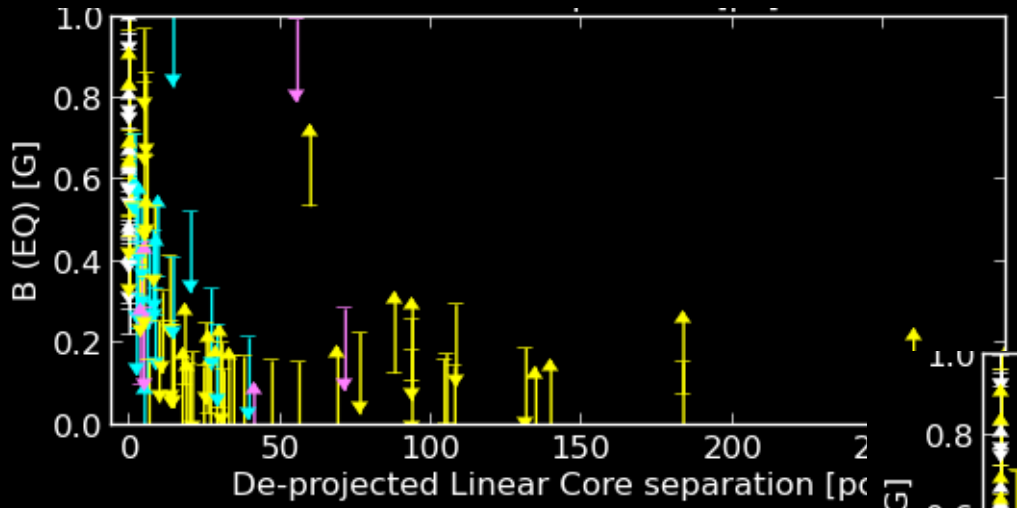
Travelling comps.



~30 pc cut-off?

Very preliminary!

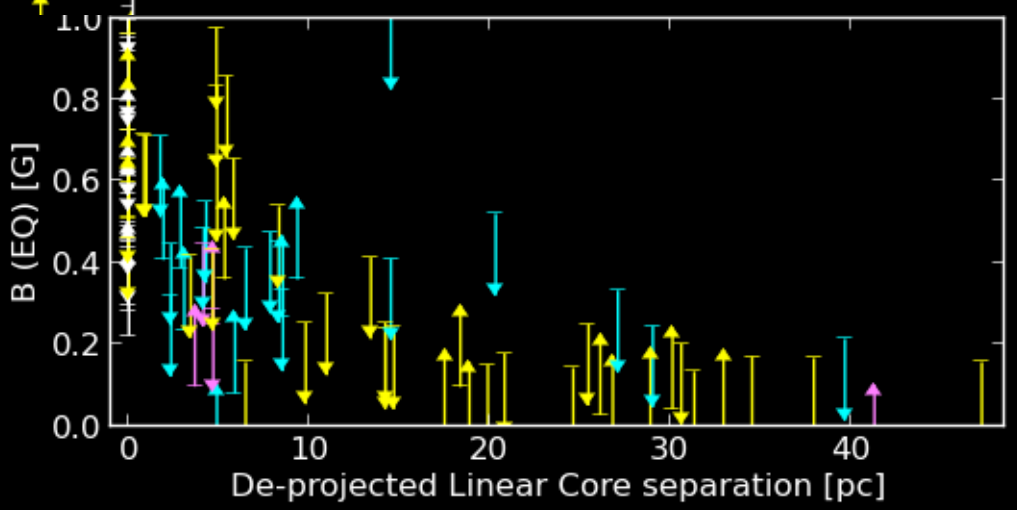
Equipartition B-fields



"Cores"

Stationary features

Travelling comps.



Assume 5×10^8 M_{sol}

~ 12 pc to jet base

~ 3000 G at 10 R_s

Very preliminary!

Summary

- Structural changes appear to correlate with Gamma-ray flares
- Independent method for determining Gamma-ray site: Gamma-rays are ~ 10 pc (~10^5 R_s) from jet base
- B-field strength at jet base ~ thousands G
  - Recent work by Kino+ (2014); M87 B ~ 15 G at $10R_s$
  - Silant'ev+ (2013) ; B ~3000 G in Mrk6 (Seyfert 2)

Outlook

- Higher cadence > better measures of size, flux, trace structural changes with greater accuracy
- Polarisation
- Synergies with RadioAstron, EHT
  - (2cm-7mm-3mm-1mm) decomposition, 3C84, BL Lac?
- B-field/BH mass connection?
- Slower, less active sources better for B-field analysis

Thank you!