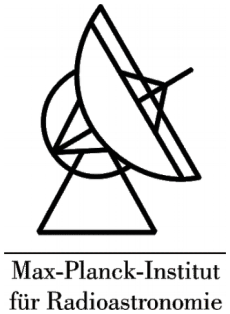
Exploring the magnetic field configuration close to the central engines using GMVA



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Why we need high-frequency polarization imaging

- ***Launching of jets***
  - **to probe regions where plasma is being injected and accelerated into the main jet stream.**

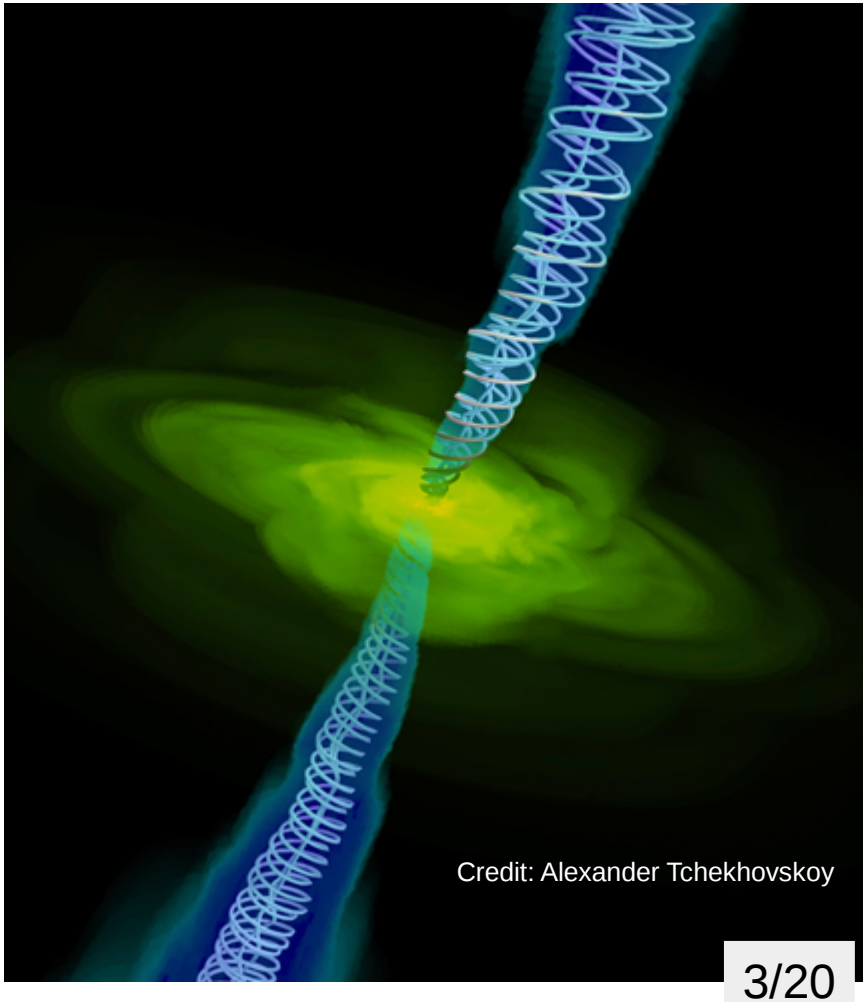
- ***Location and origin of high-energy emission***
  - **to determine jet's fine scale structures and provide clues regarding changes in physical conditions that cause gamma-ray flares.**

Jet launching

GMVA angular resolution: 50 micro-arcseconds

For a 10^9 $M_\odot$ BH, one could scale down up to ~1000 R_s at z=0.1

- We can probe the region where plasma is being injected and accelerated into the main jet stream.
- Provide better understanding of the role of magnetic field in AGN accretion and jet production



Location and origin of high-energy emission

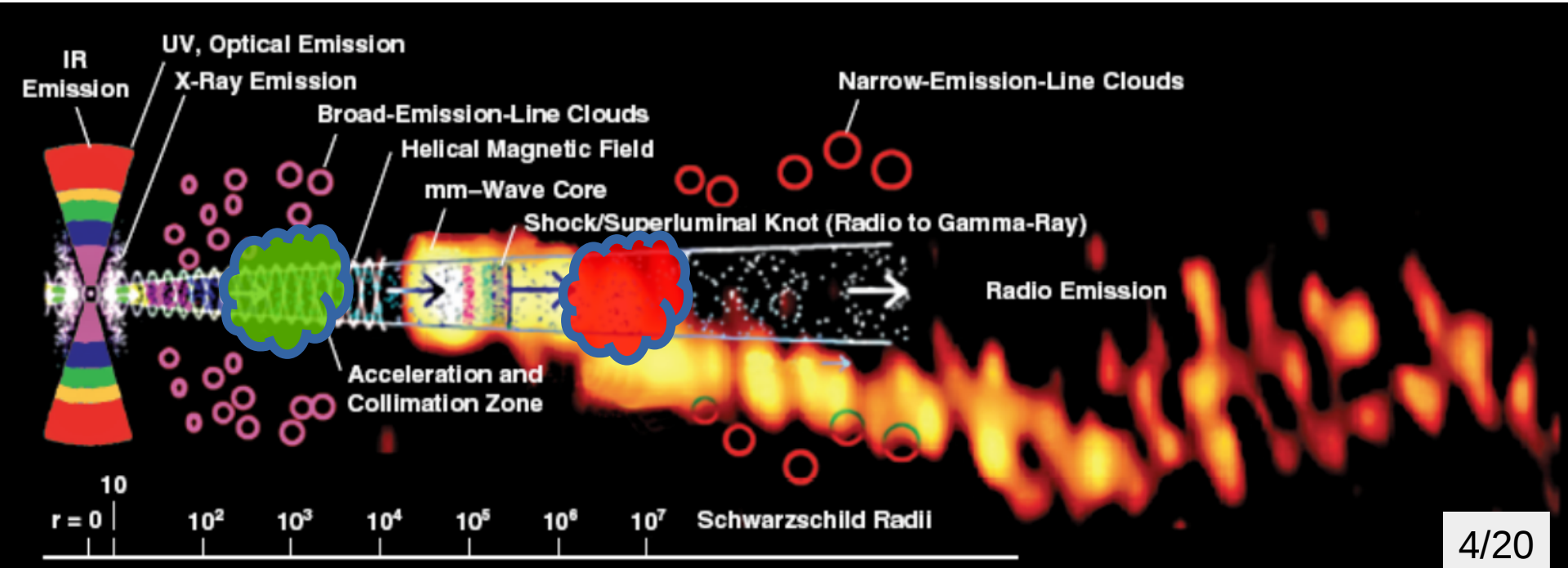
Particles acceleration:

High magnetization regions:

Magnetoluminescence and/or electromagnetic detonation (Blanford+15) and/or **Magnetic Reconnection** (Kang+15)

Low magnetization regions:

shocks etc. (Marsher & Gear 1985)



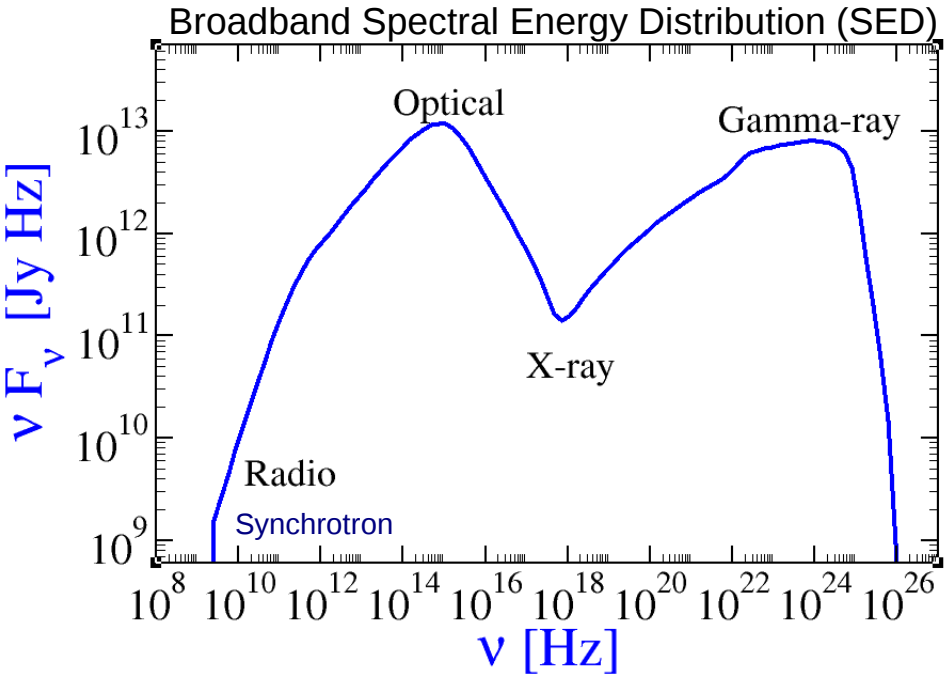
Location and origin of high-energy emission

Leptonic models :

Seed photons

Synchrotron : synchrotron photons
Self-Compton from the jet

External Compton : thermal photons from accretion disk, broad-line region, molecular torus



Hadronic models

Significant fraction of jet power converted into acceleration of protons in strongly magnetized (B ~ several tens of Gauss) environments reaching the threshold for pγ-pion production ($E_p \geq 10^{19}$ eV).

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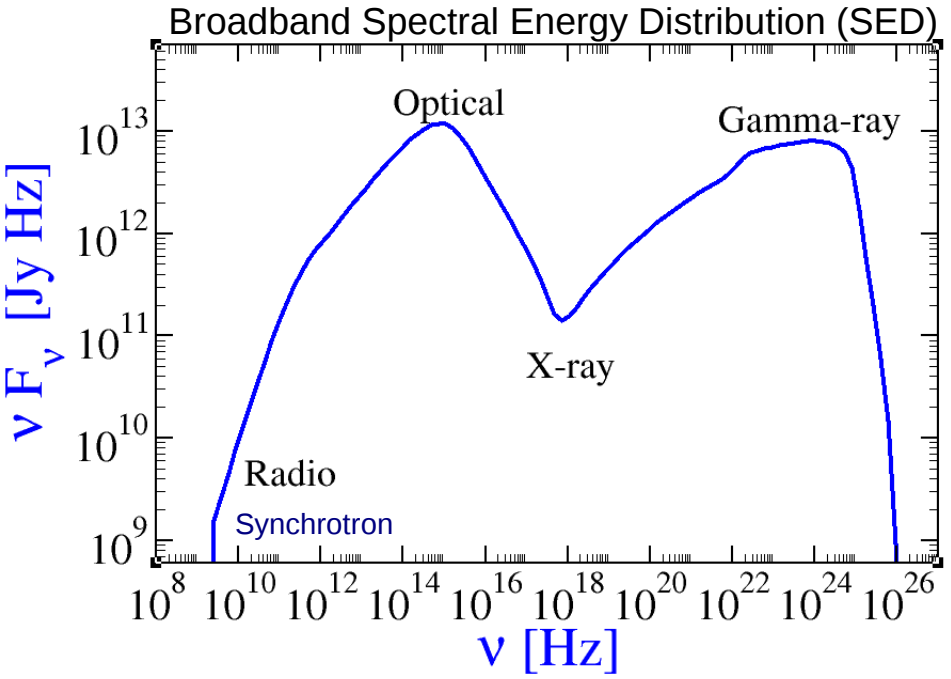

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Understanding B-field configuration is essential for probing the high-energy radiation processes.

BL Lac (B2200+420)

Red-shift: **0.069** (Vermeulen et al. 1995)

Distance: **300 Mpc**

Viewing angle: **6-10^{o}** (Jorstad et al. 2005)

Apparent velocity: **10** (Jorstad et al. 2005, Lister et al. 2013)

BH mass: **1.6×10^{8} $M_{\odot}$** (Woo&Urry 2002)

GMVA resolution:

0.05 mas = 4000 R_s

BL Lac is an excellent candidate to detect and resolve helical structures in jets at a very high spatial resolution, helping to answer key questions on jet launching and physical origin of helical jets.

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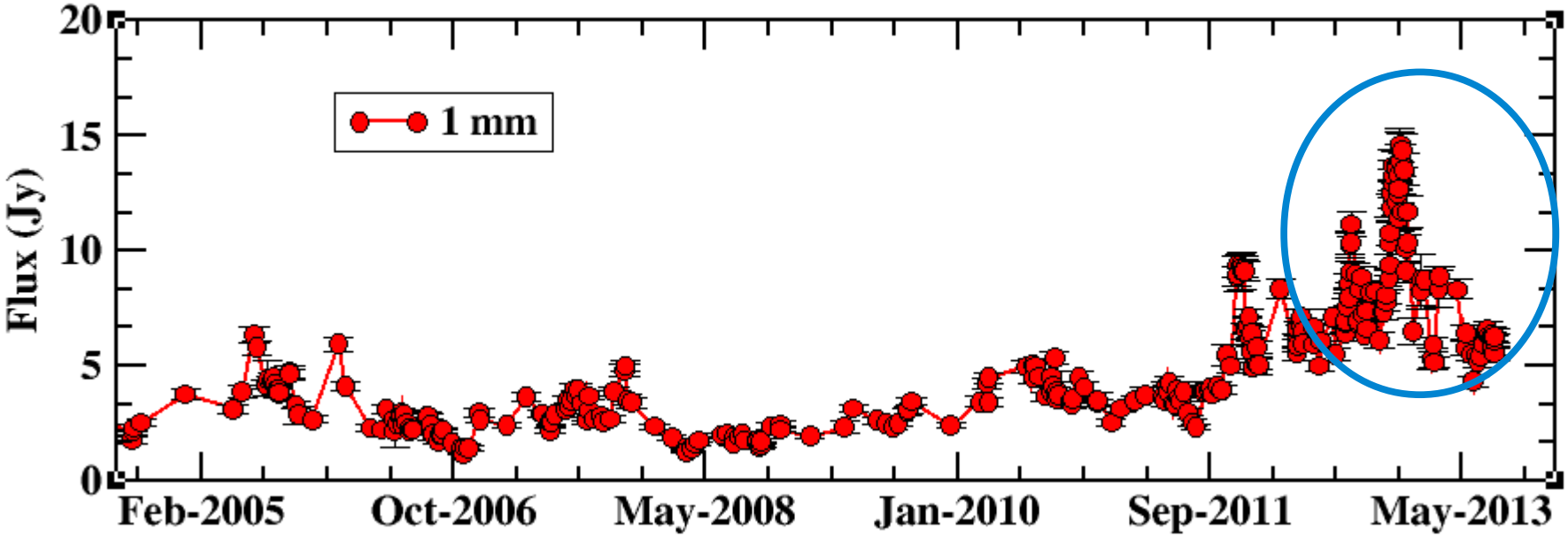
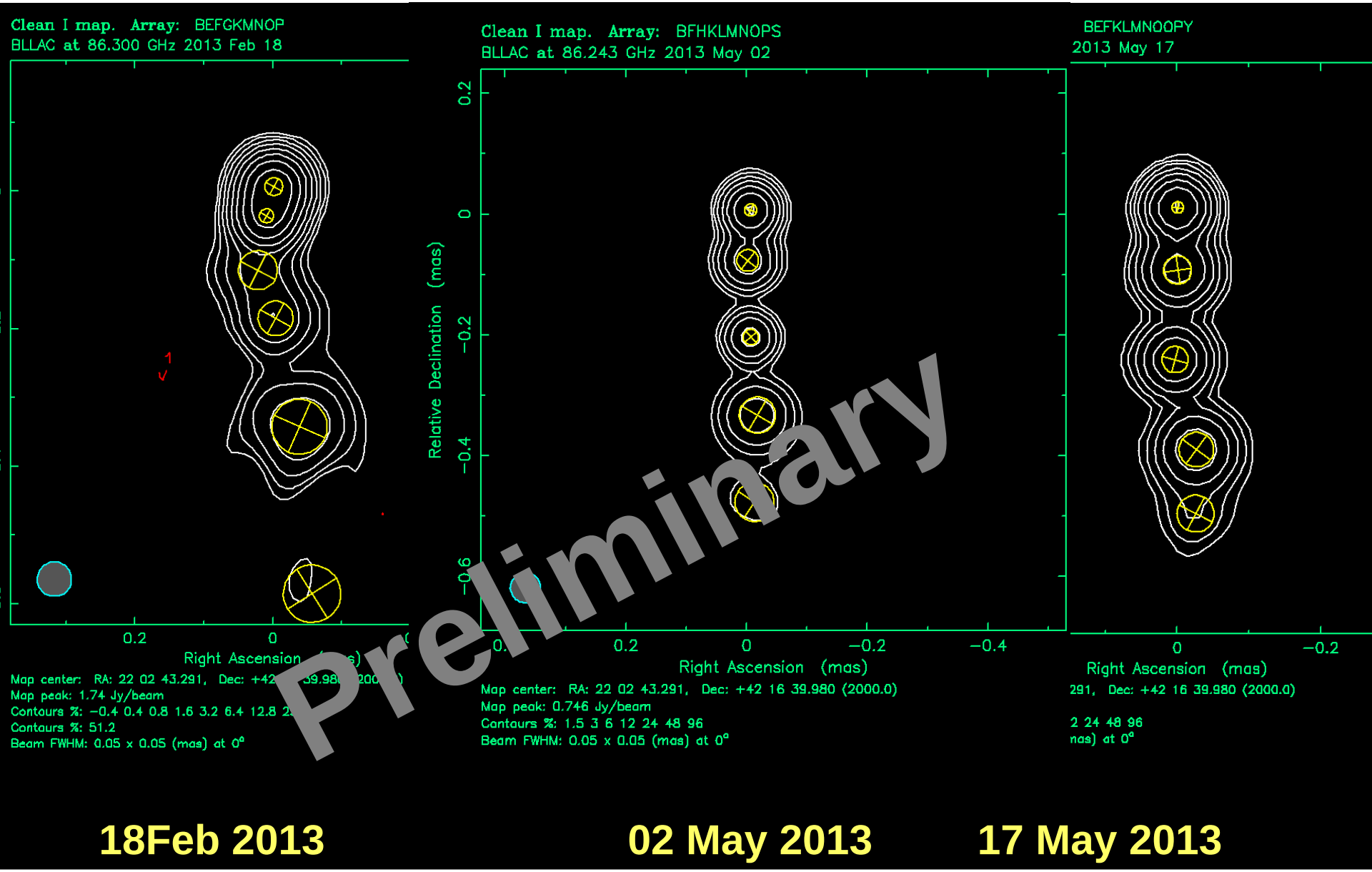


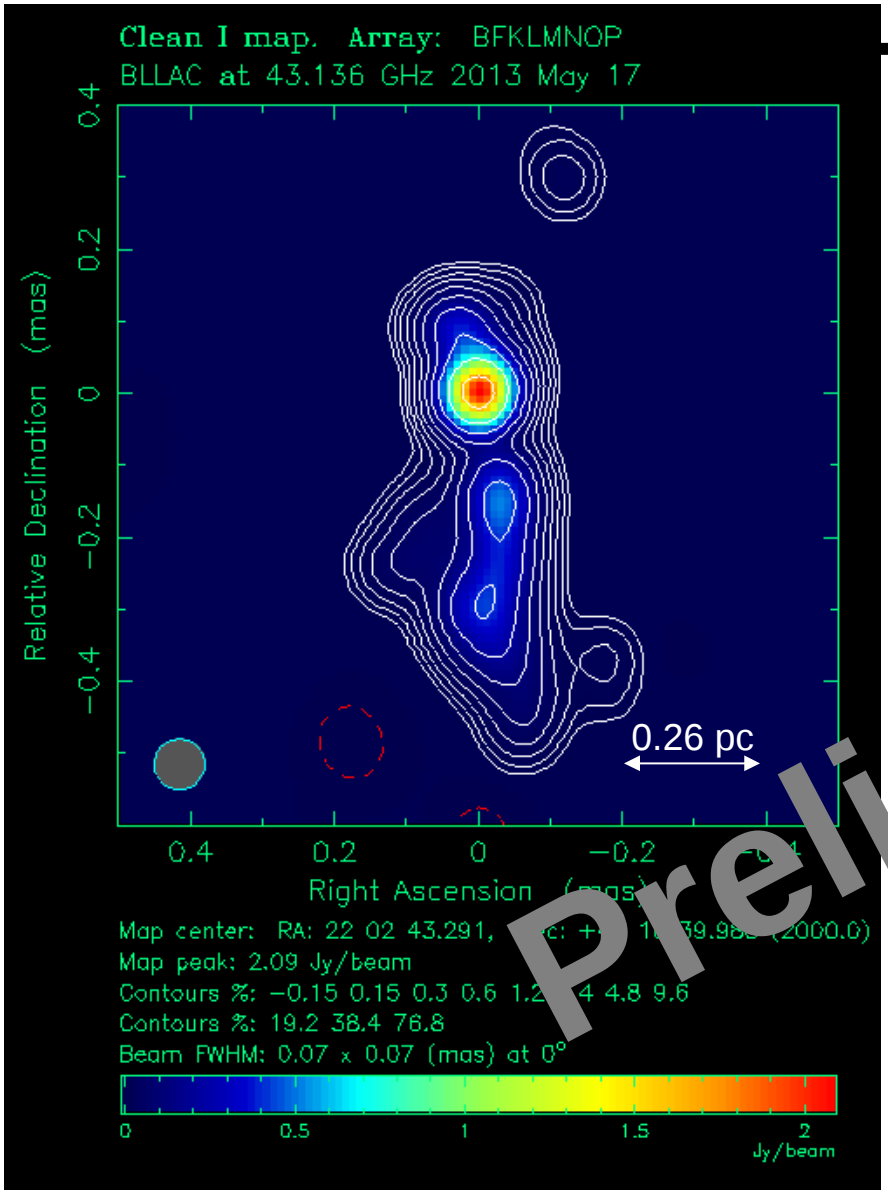
Jet morphology on sub-mas scales

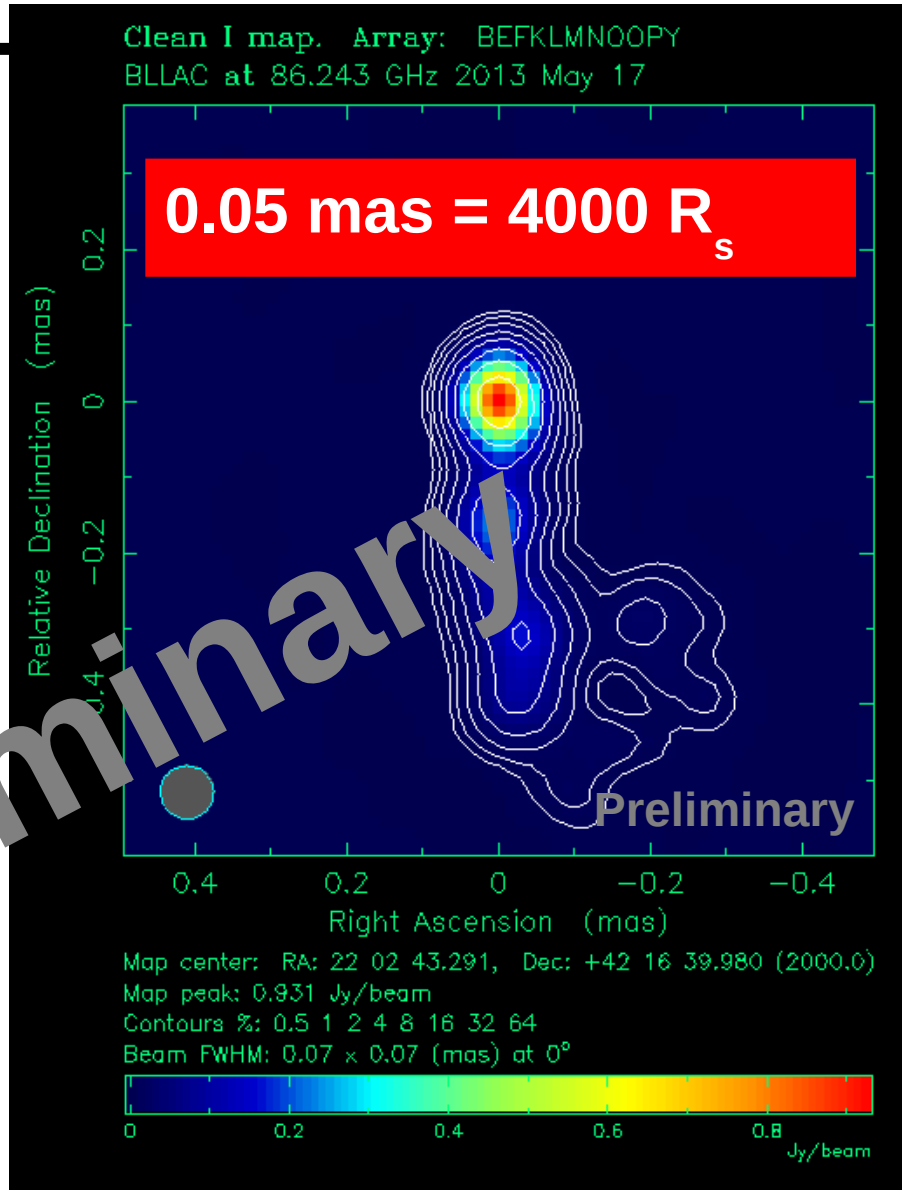


18Feb 2013 **02 May 2013** **17 May 2013**

Rani+16 (in preparation)

BL Lac: Comparison of simultaneous 43 / 86 GHz maps

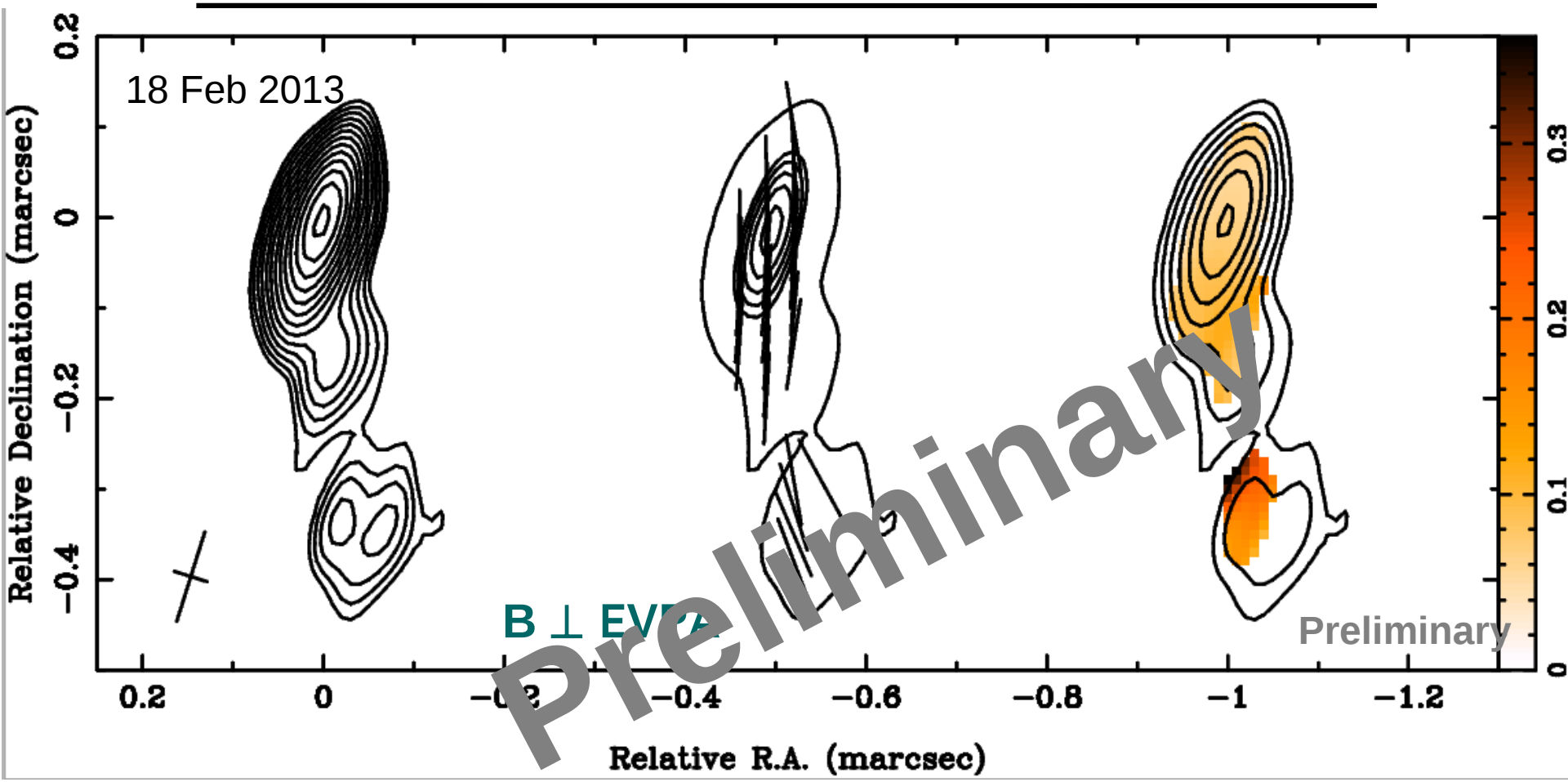




Rani+16 (in preparation)

convolved with circular 0.07 mas beam

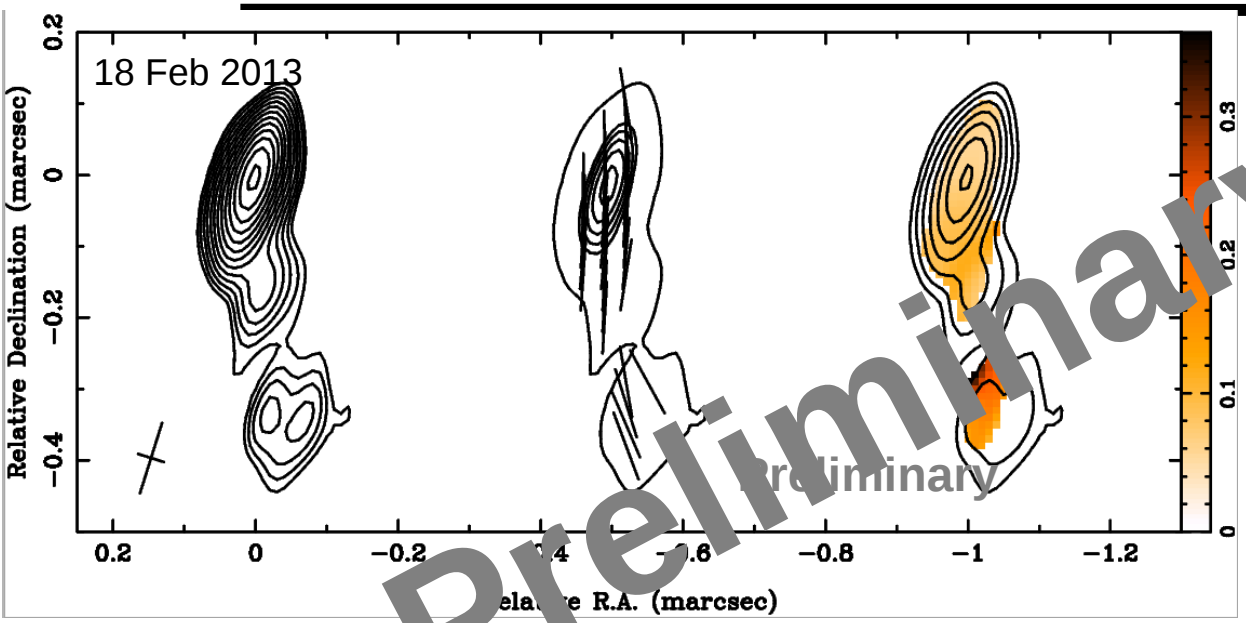
Polarimetry at 86 GHz: BLLac



B ⊥ Jet axis

Rani+16 (in preparation)

Polarimetry at 86 GHz: BLLac

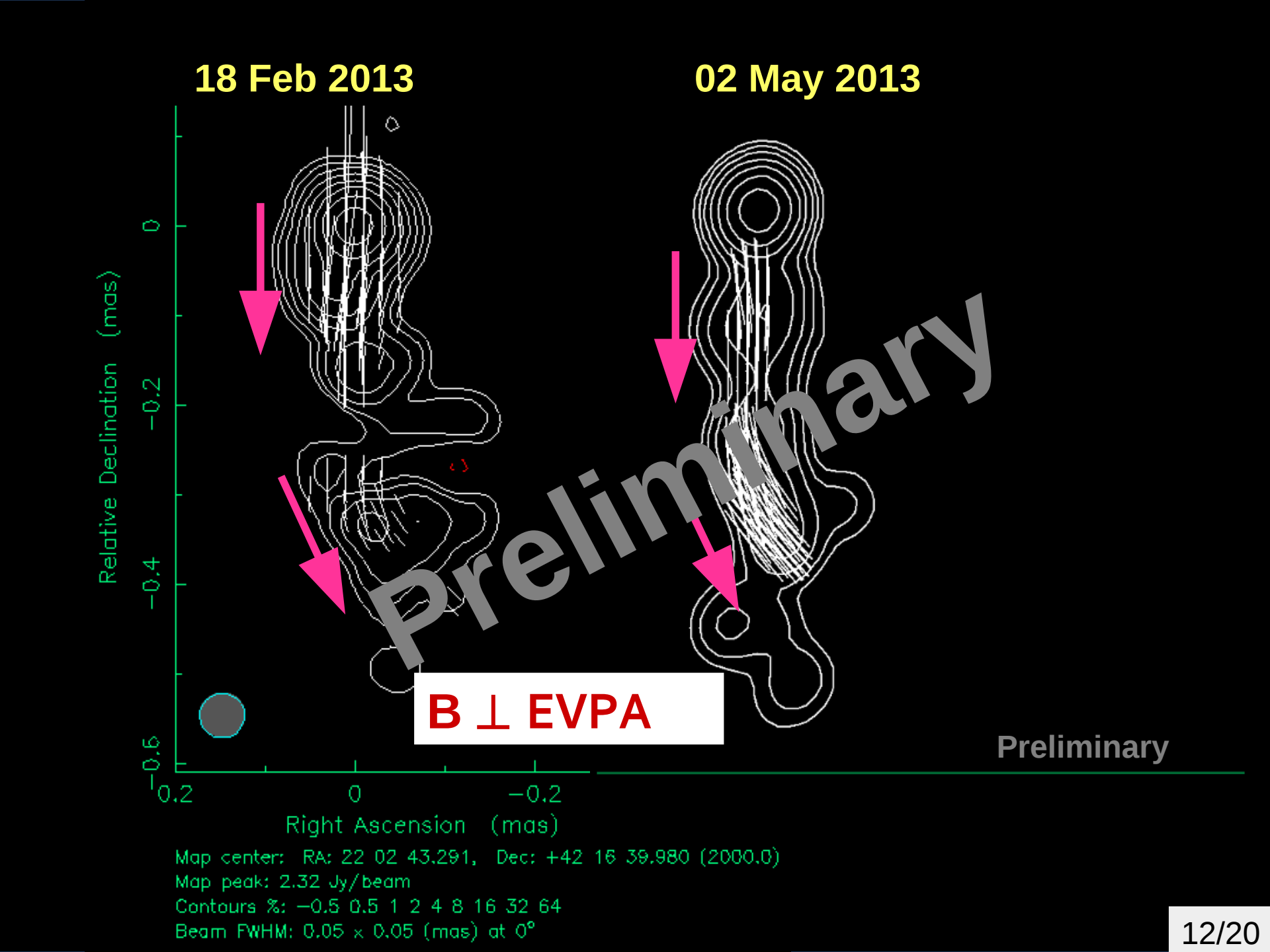


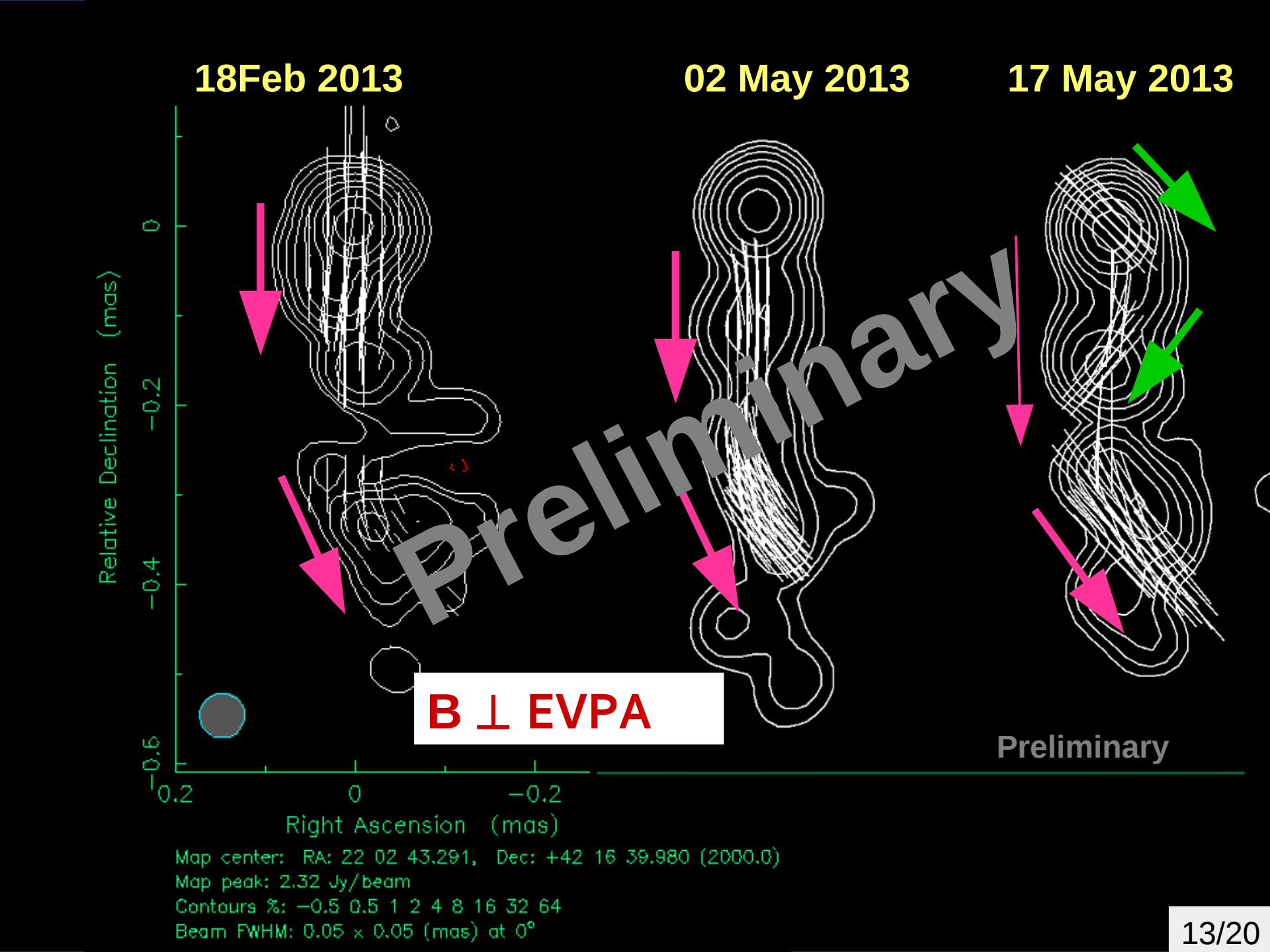
B ⊥ Jet axis

B ⊥ Jet axis: toroidal magnetic field

Helical B fields – rotation of central accretion disk + outflow

Transverse shocks – B-field becomes ordered in plane of compression


18 Feb 2013
02 May 2013
Preliminary
B ⊥ EVPA
Preliminary
Relative Declination (mas)
0
−0.2
−0.4
−0.6
0.2
0
−0.2
Right Ascension (mas)
Map center: RA: 22 02 43.291, Dec: +42 16 39.980 (2000.0)
Map peak: 2.32 Jy/beam
Contours %: −0.5 0.5 1 2 4 8 16 32 64
Beam FWHM: 0.05 x 0.05 (mas) at 0°


18Feb 2013
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Preliminary
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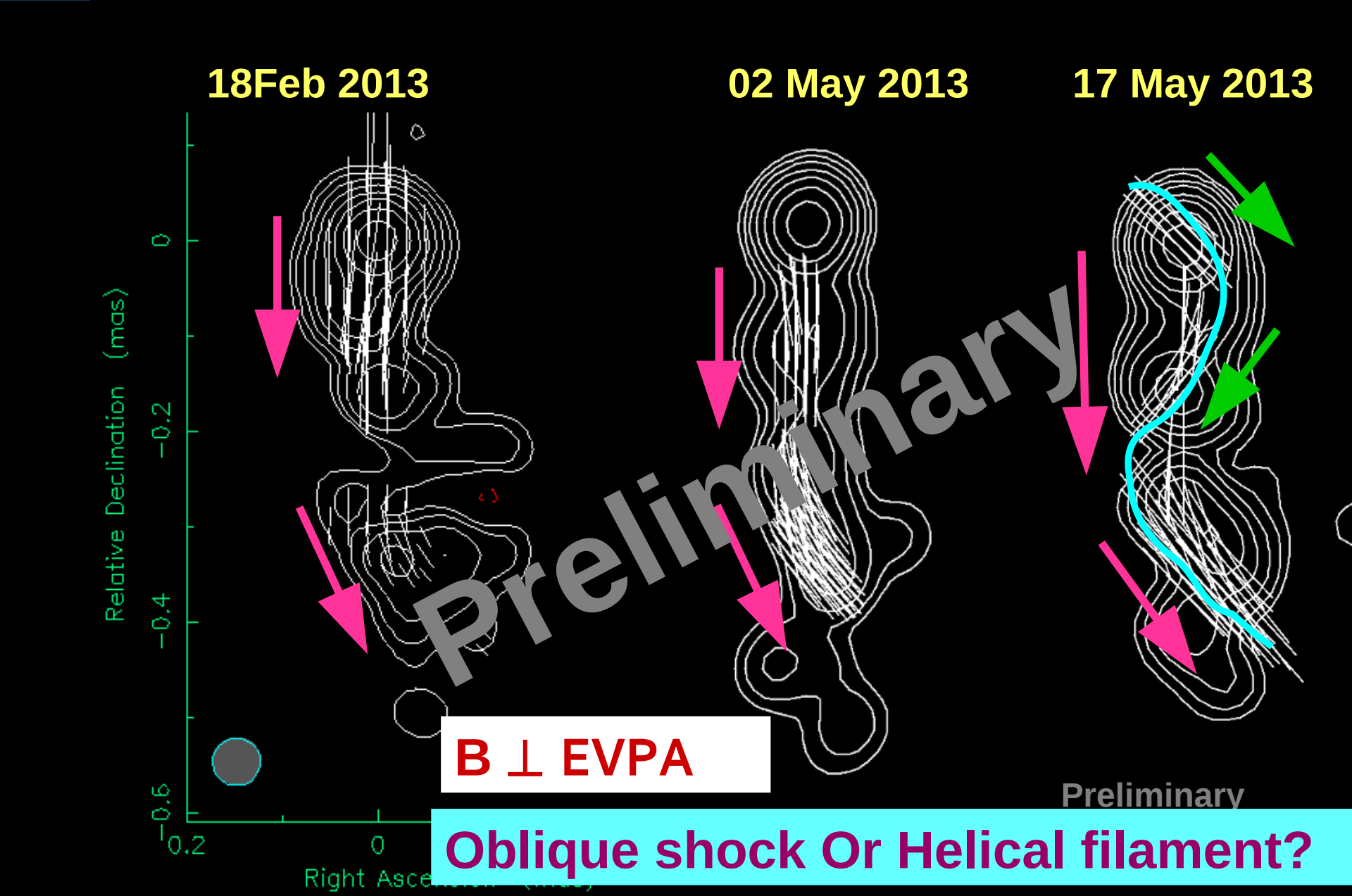
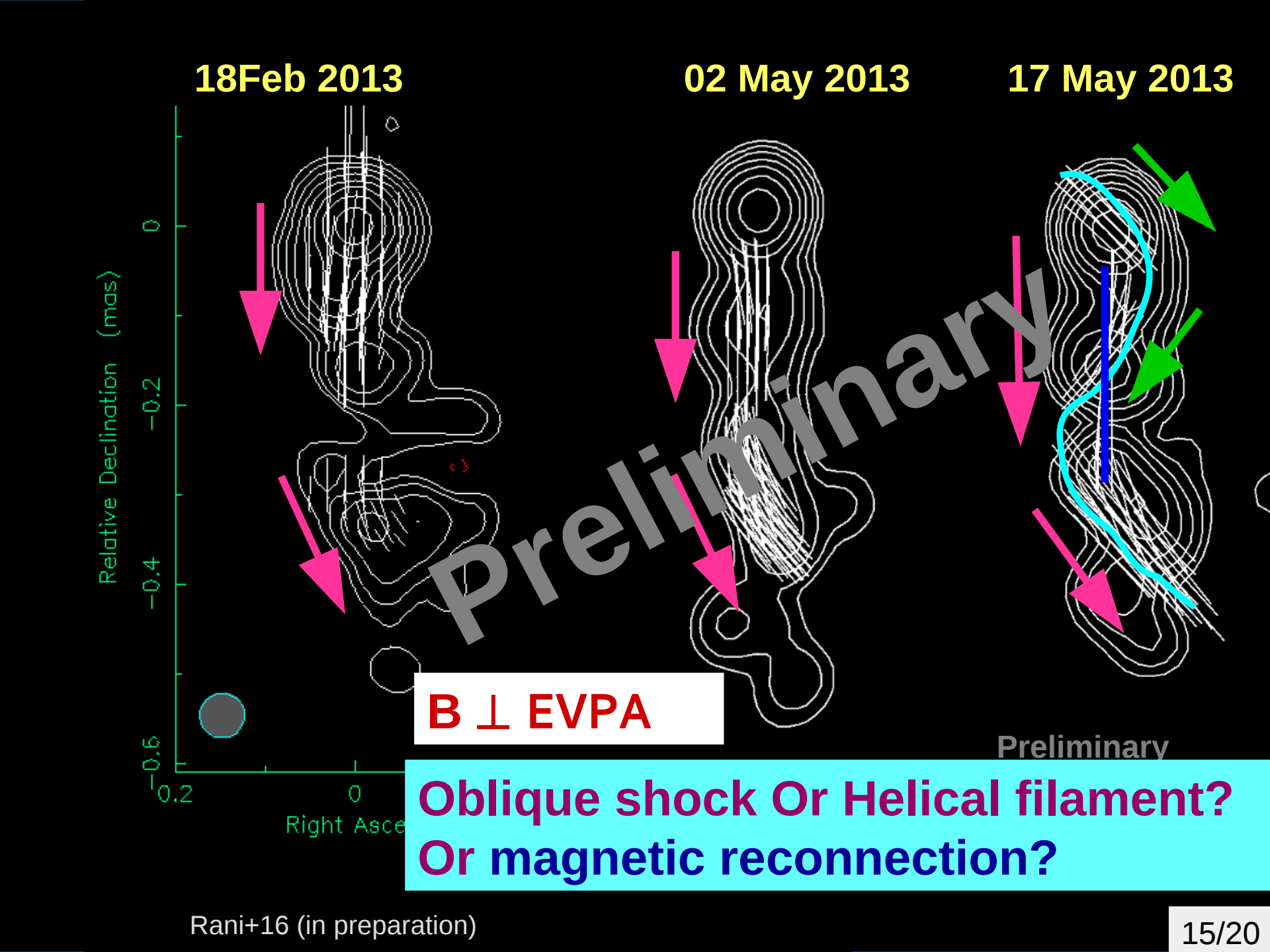
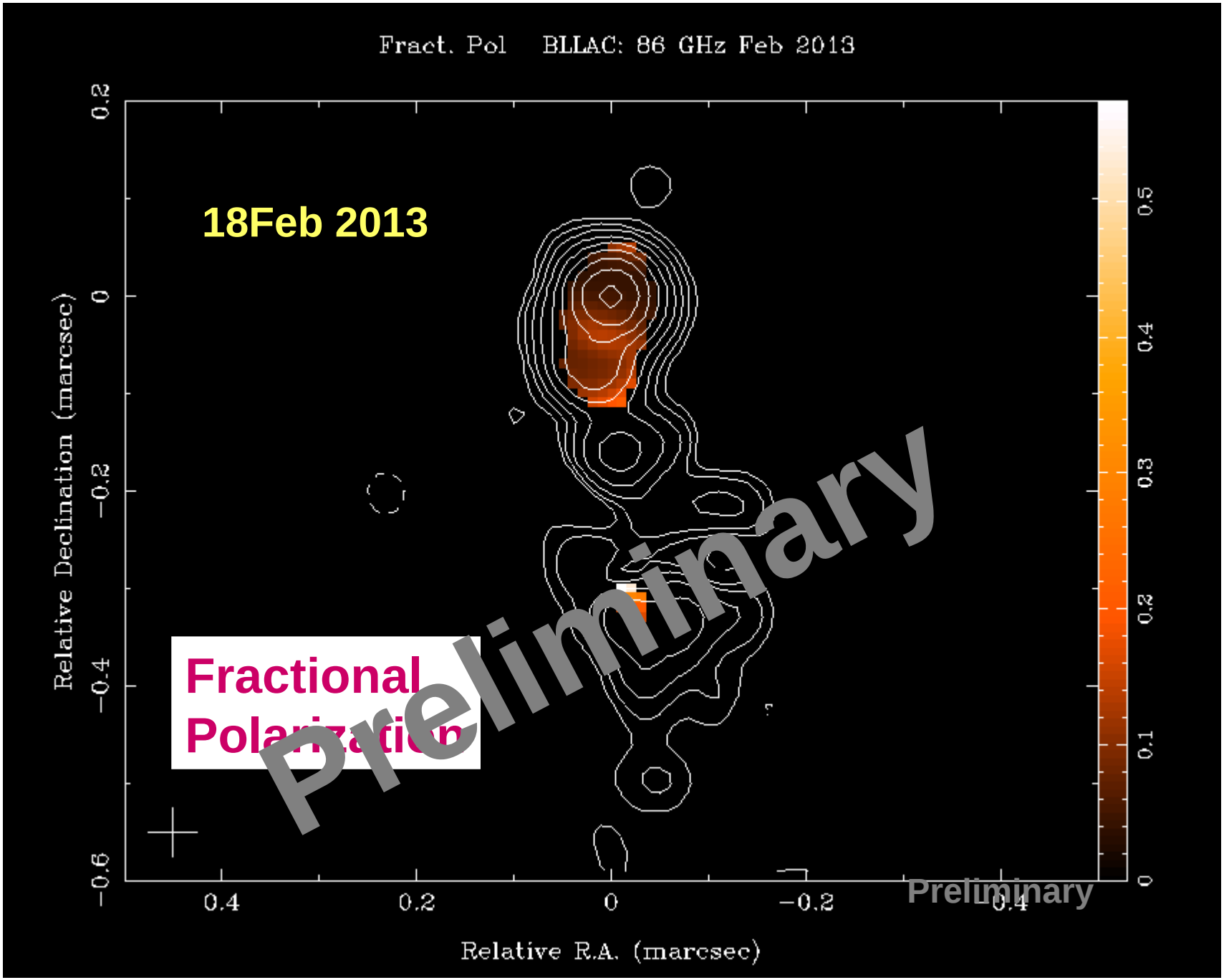
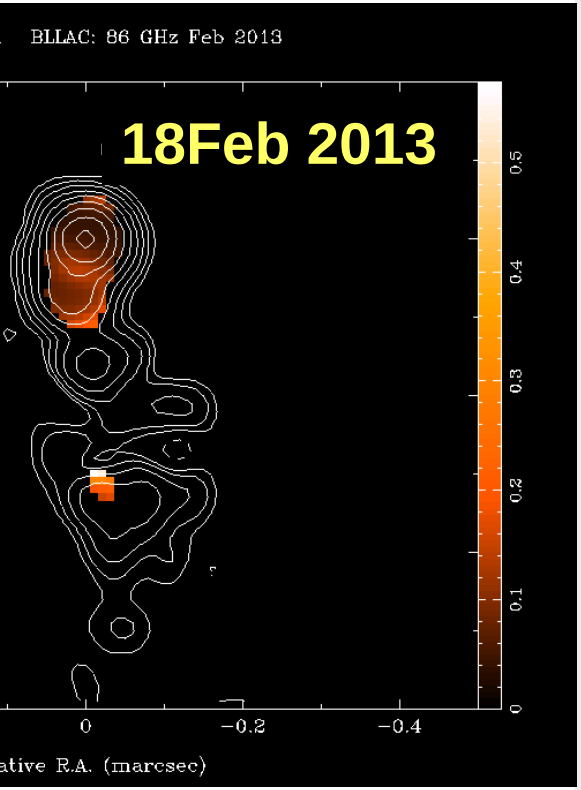
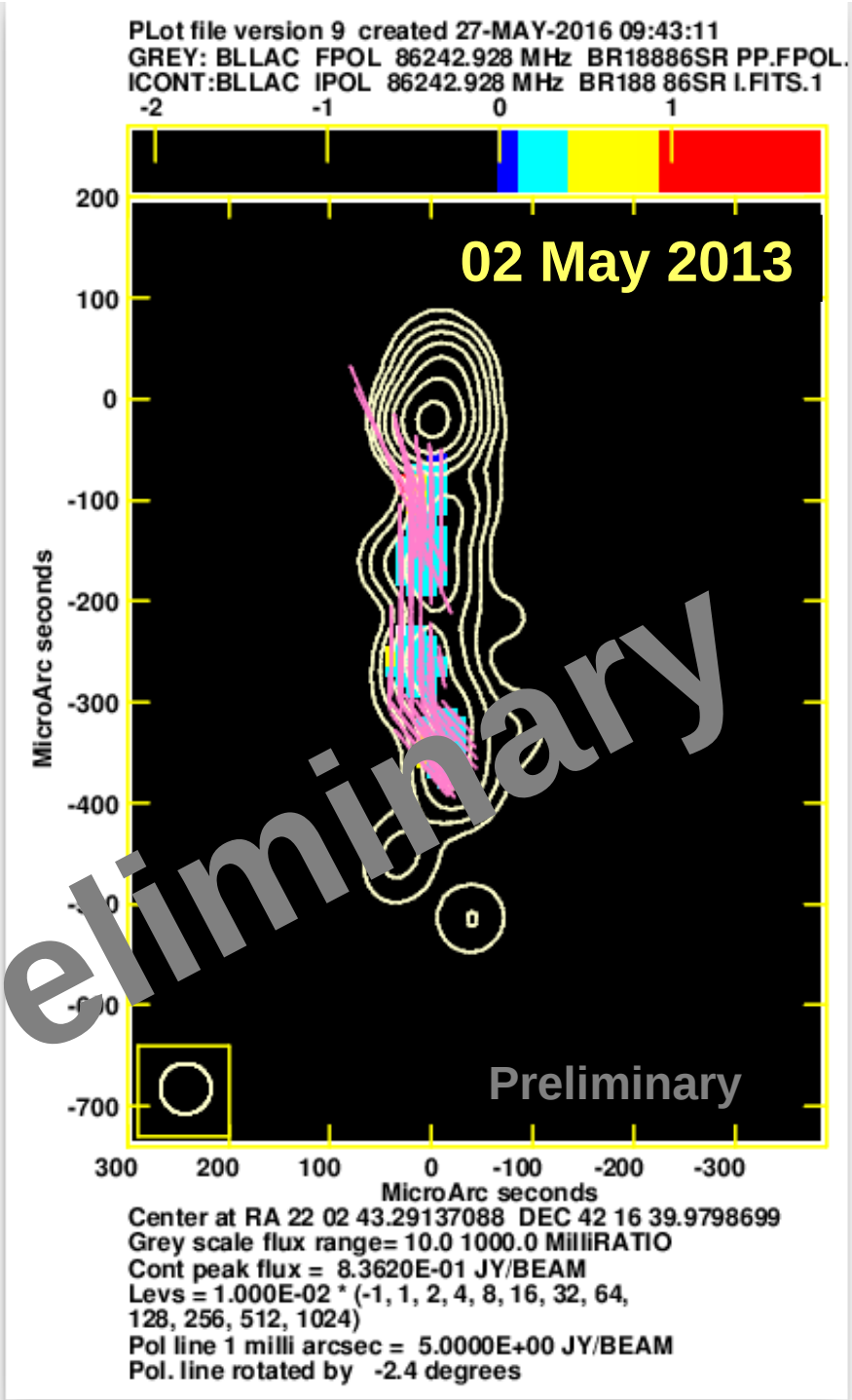

18Feb 2013
02 May 2013
17 May 2013
Relative Declination (mas)
0
−0.2
−0.4
−0.6
0.2
0
Right Ascension (mas)
Preliminary
B ⊥ EVPA
Preliminary
Oblique shock Or Helical filament?



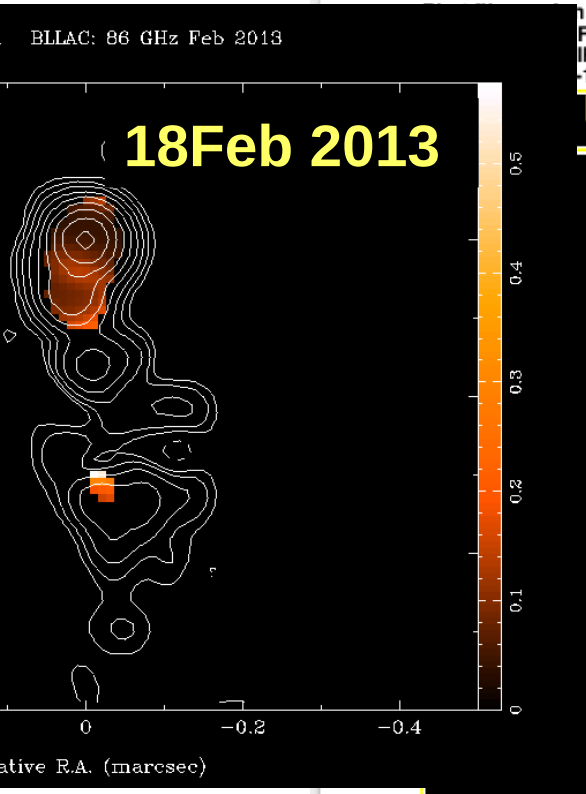
Rani+16 (in preparation)

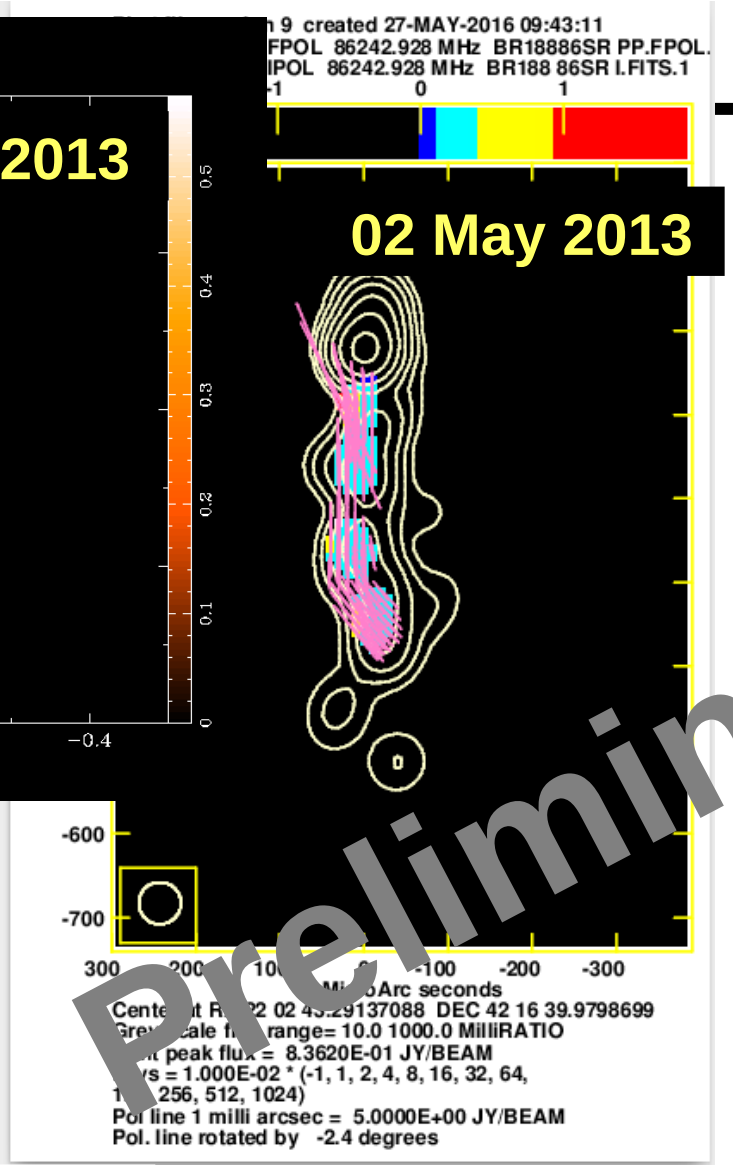

Fract. Pol BLLAC: 86 GHz Feb 2013
18Feb 2013
Fractional Polarization
Preliminary
Preliminary
Relative Declination (marcsec)
Relative R.A. (marcsec)
0.2
0
−0.2
−0.4
−0.6
0.4
0.2
0
−0.2
0.4
0.5
0.4
0.3
0.2
0.1
0

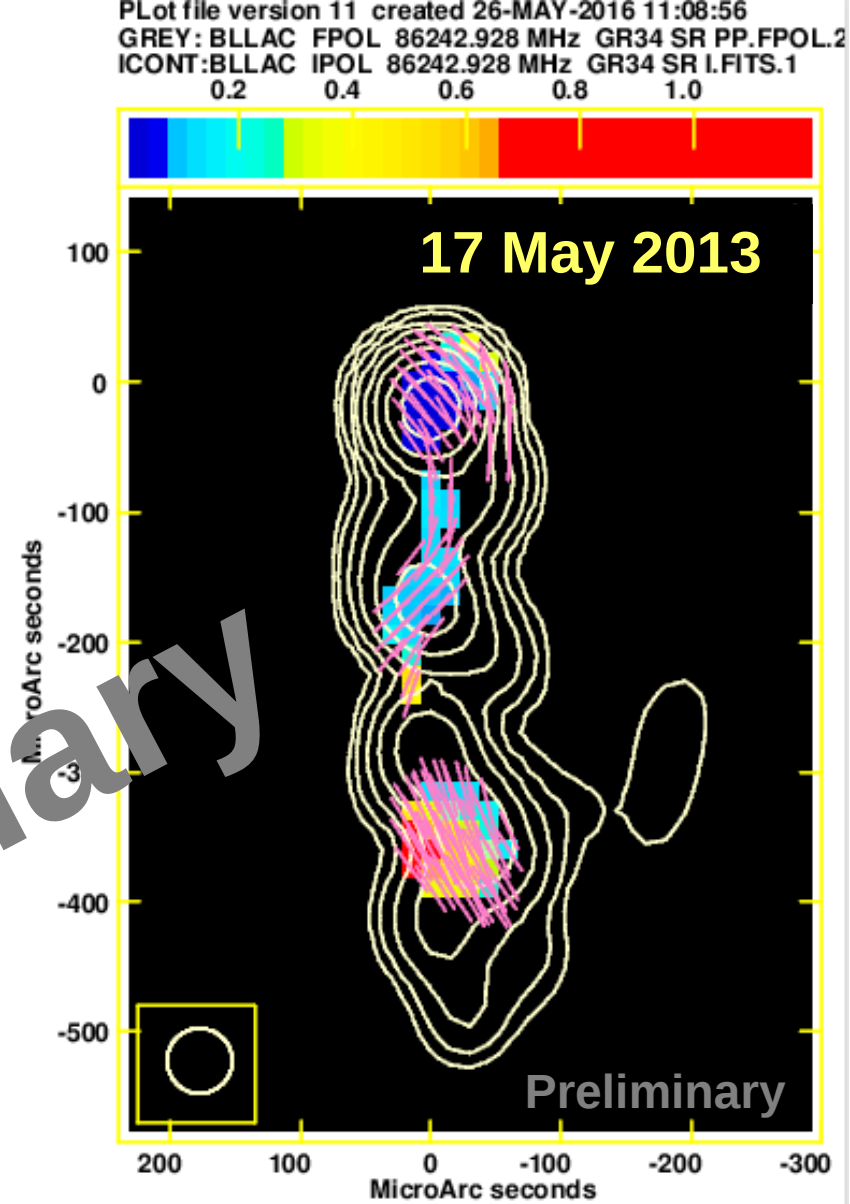




Fractional Polarization







Fractional Polarization

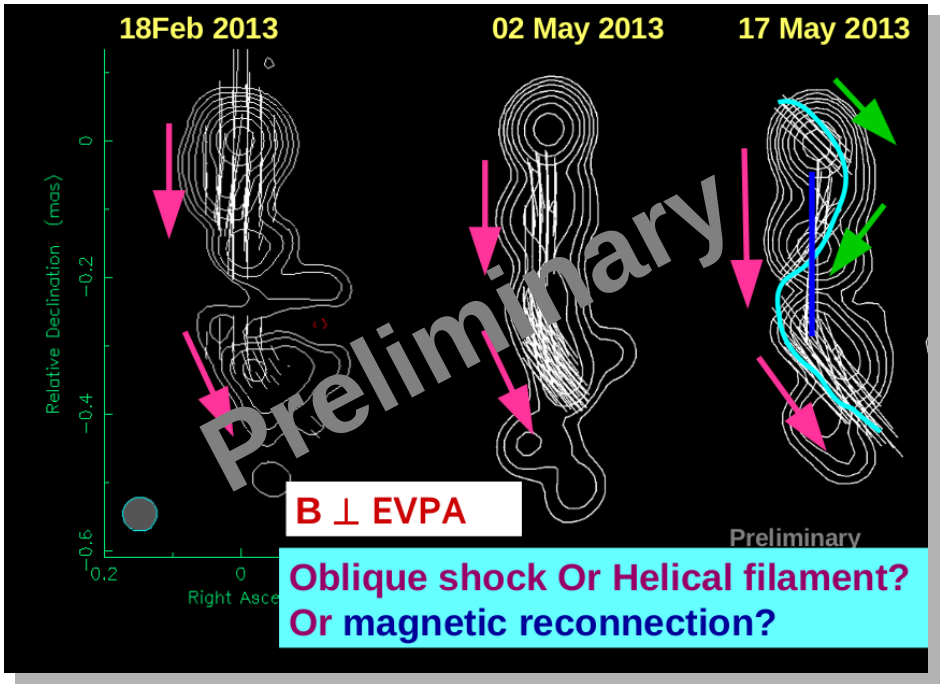
Rani+16 (in preparation)

Summary

- High-frequency polarization imagining is technically quite challenging.

- It is however crucial to probe the magnetic field configuration close to central engines and also important to understand the high-energy emission processes in blazars.

Using GMVA, we start to probe the B-field configuration in the vicinity of the launching region



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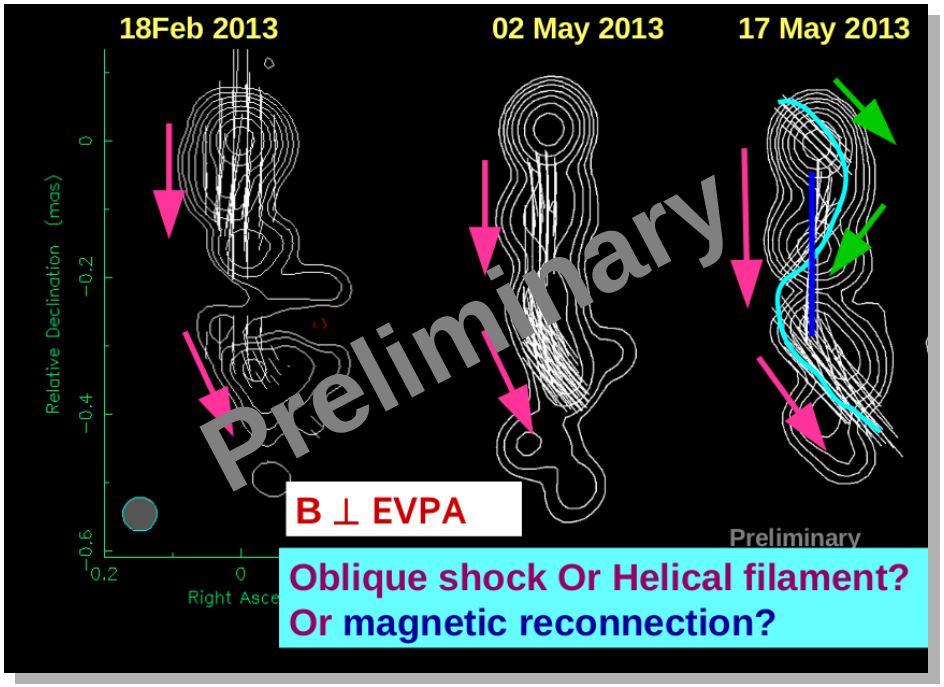
Stay tuned for more updates



Thanks for your attention