# $\gamma$-rays in flat-spectrum AGN: revisiting the fast jet hypothesis

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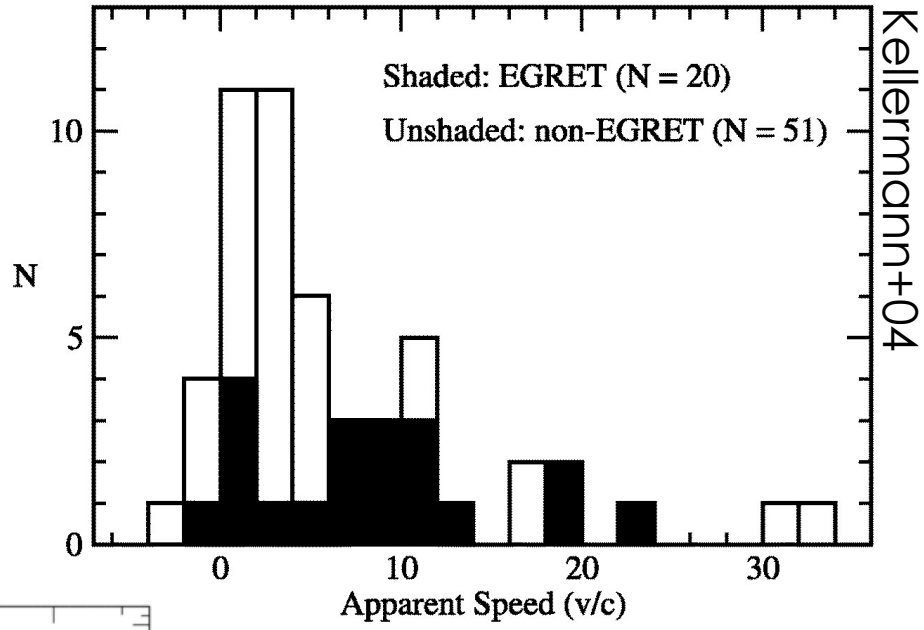
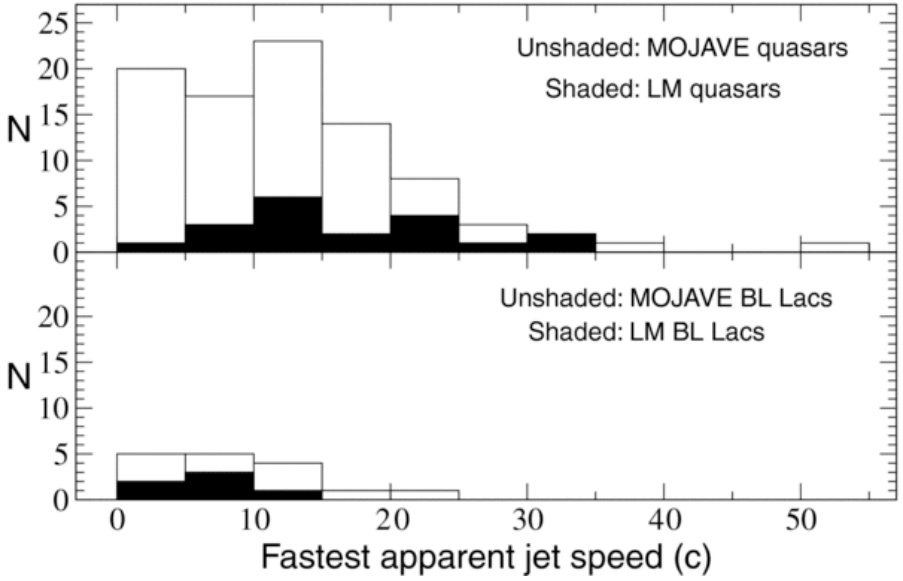
# Motivation

$\gamma$-ray detected AGN show, on average, faster apparent jet speeds




Lister+09b



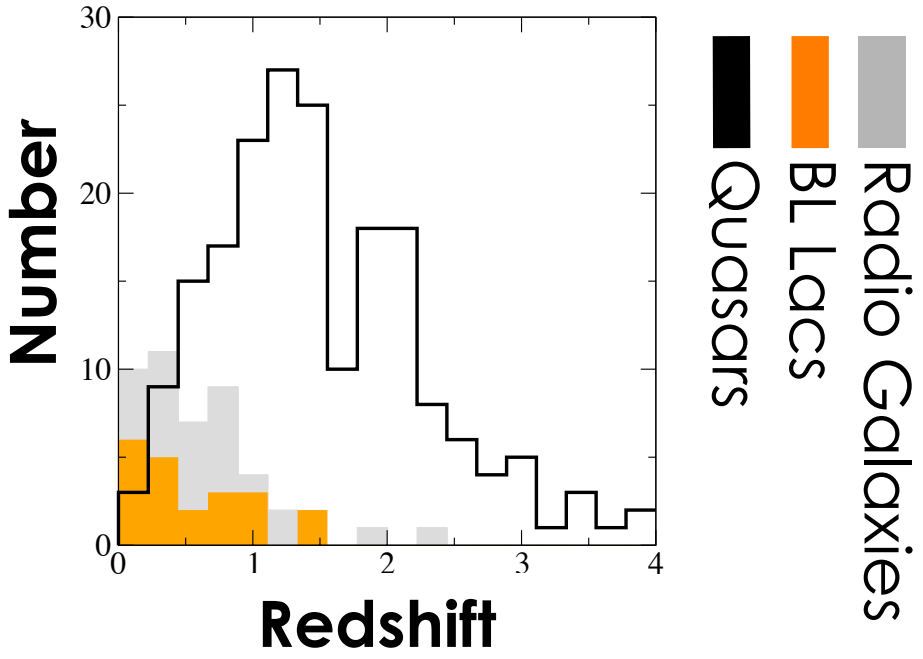

30 Fermi-LAT detected MOJAVE AGN

# Why the CJF?

**C**altech
**J**odrell Bank
**F**lat-spectrum

- 293 radio-loud active galaxies
→ 198 QSOs, 33 BL Lacs
- min. 3 epochs VLBI @5GHz/ source
- statistically complete in radio

| | |
|---|---|
| **Frequency** | **5GHz** |
| **Flux @5GHz** | **>350mJy** |
| **Spectral Index** | $\alpha \geq -0.5$ |
| **Declination** | $\delta \geq 35°$ |
| **Gal. Latitude** | $\lvert b \rvert \geq 10°$ |




**Some references:**
*Taylor et al. (1996)*
*Britzen et al. ('99,'07,'08)*
*Karouzos et al. ('10,'11,'12a,b)*

# Why the CJF?

**C**altech
**J**odrell Bank
**F**lat-spectrum

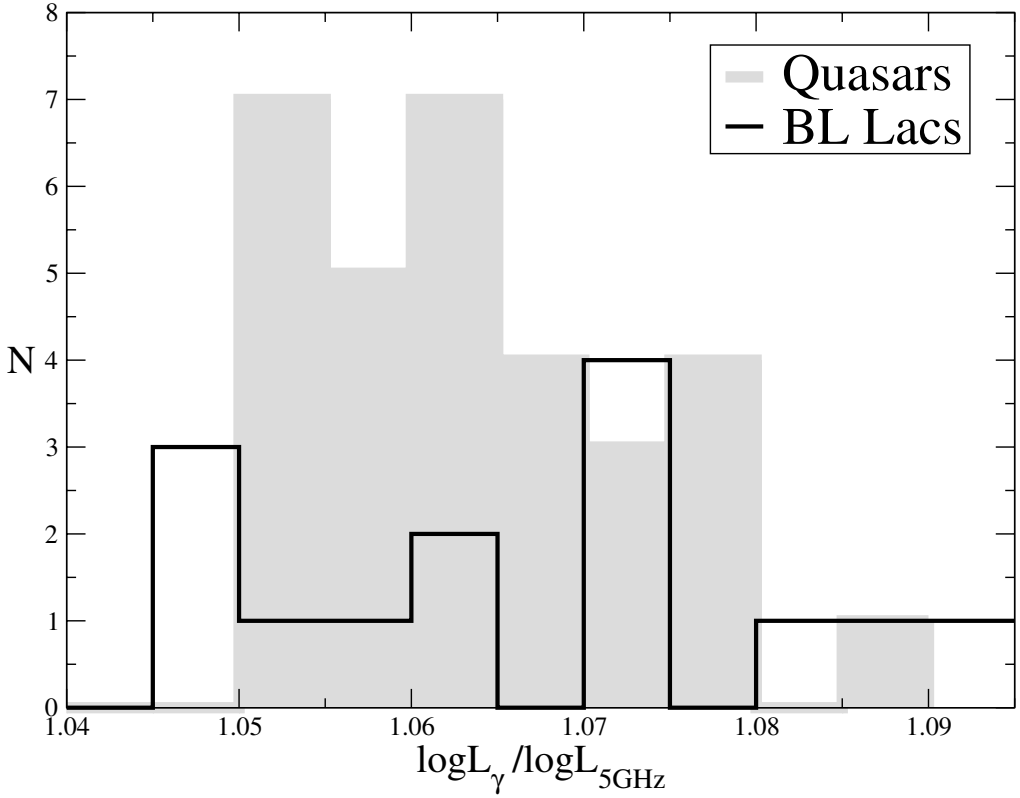
61 CJF sources detected by Fermi-LAT

- 24 BL Lacs
- 32 FSRQs
- 5 RGs

1. The number of Fermi-LAT detected flat-spectrum AGN is doubled
2. Different frequency of observations (5GHz)
   - ✧ different distance to the VLBI core
   - ✧ different depth of the jet

# Results

- Synchrotron vs. Inverse Compton



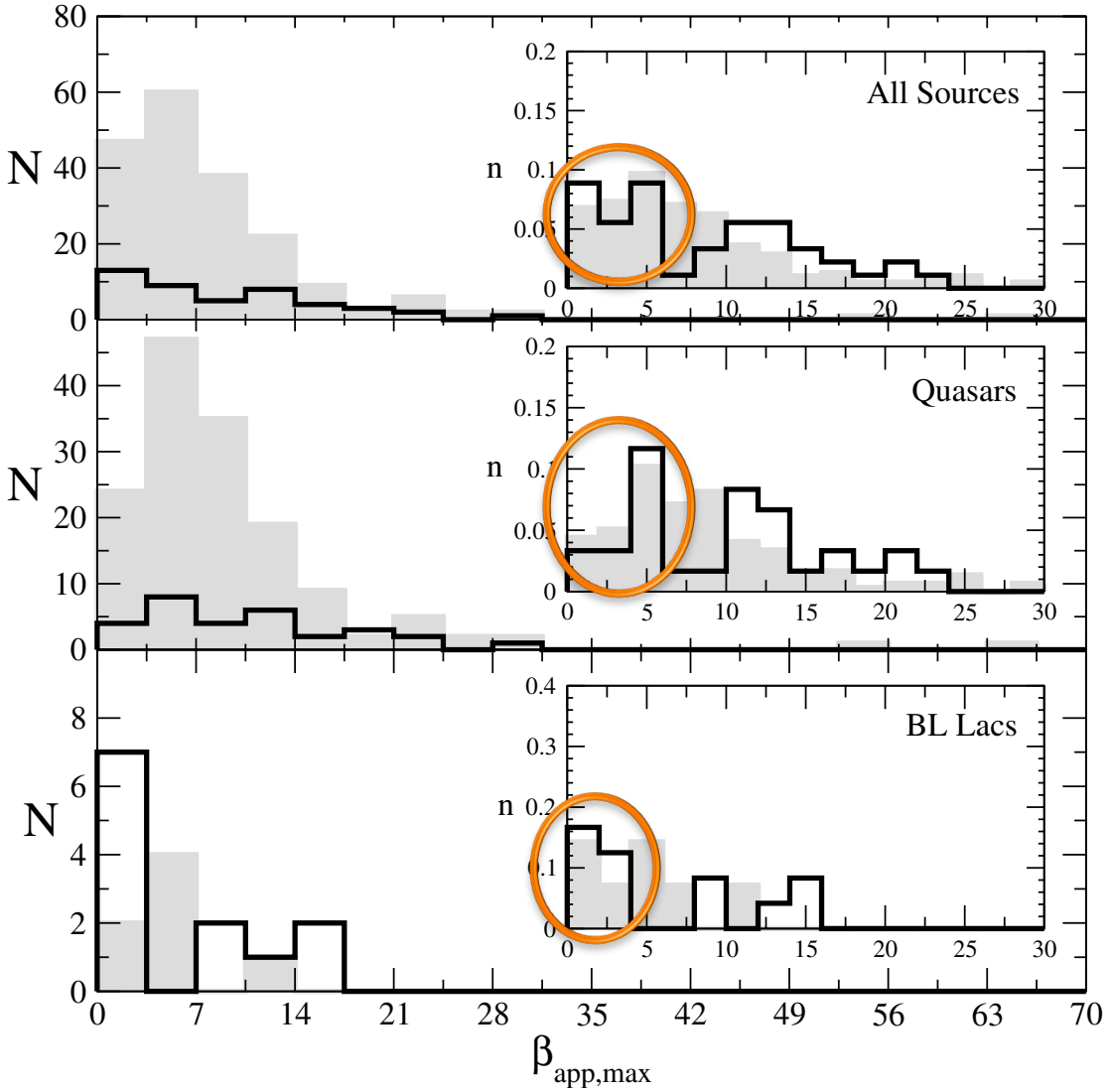

$\gamma$-CJF sources more luminous in optical/ radio

+

fainter in soft X-rays (ROSAT)

# Results

- $\gamma$-CJF sources & apparent jet speeds

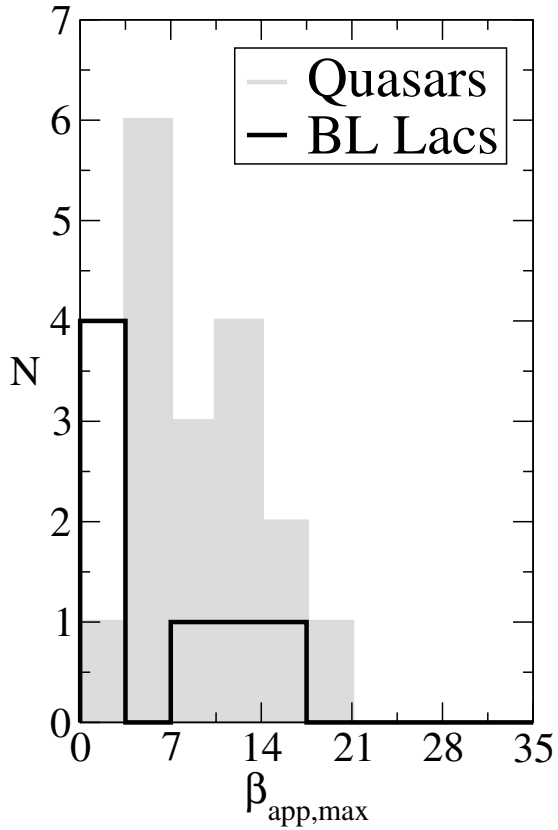



$\gamma$-detected FSRQs & BL Lacs show low velocity populations

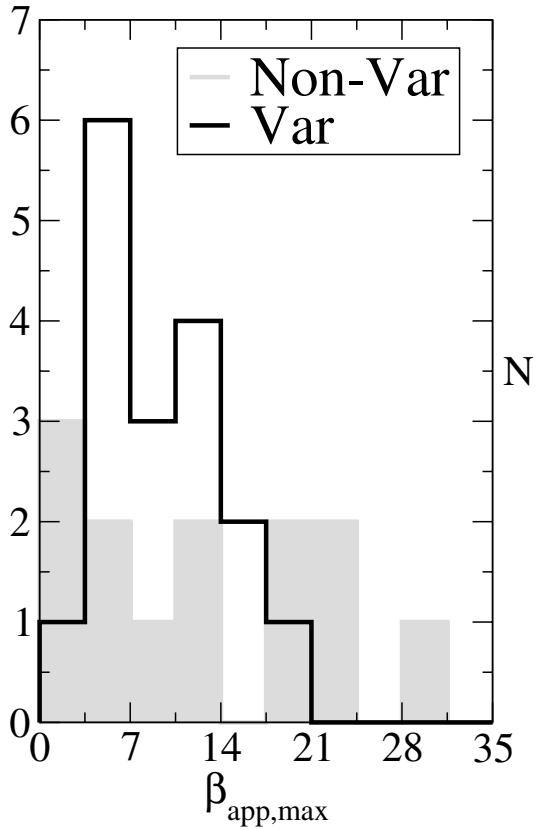
K-S test: 93.7% (all), 95.4% (FSRQs), 97.7% (BL Lacs) samples are different

# Results

- Apparent speeds, $\gamma$-variability, AGN class




Variable FSRQs
vs.
Variable BL Lacs



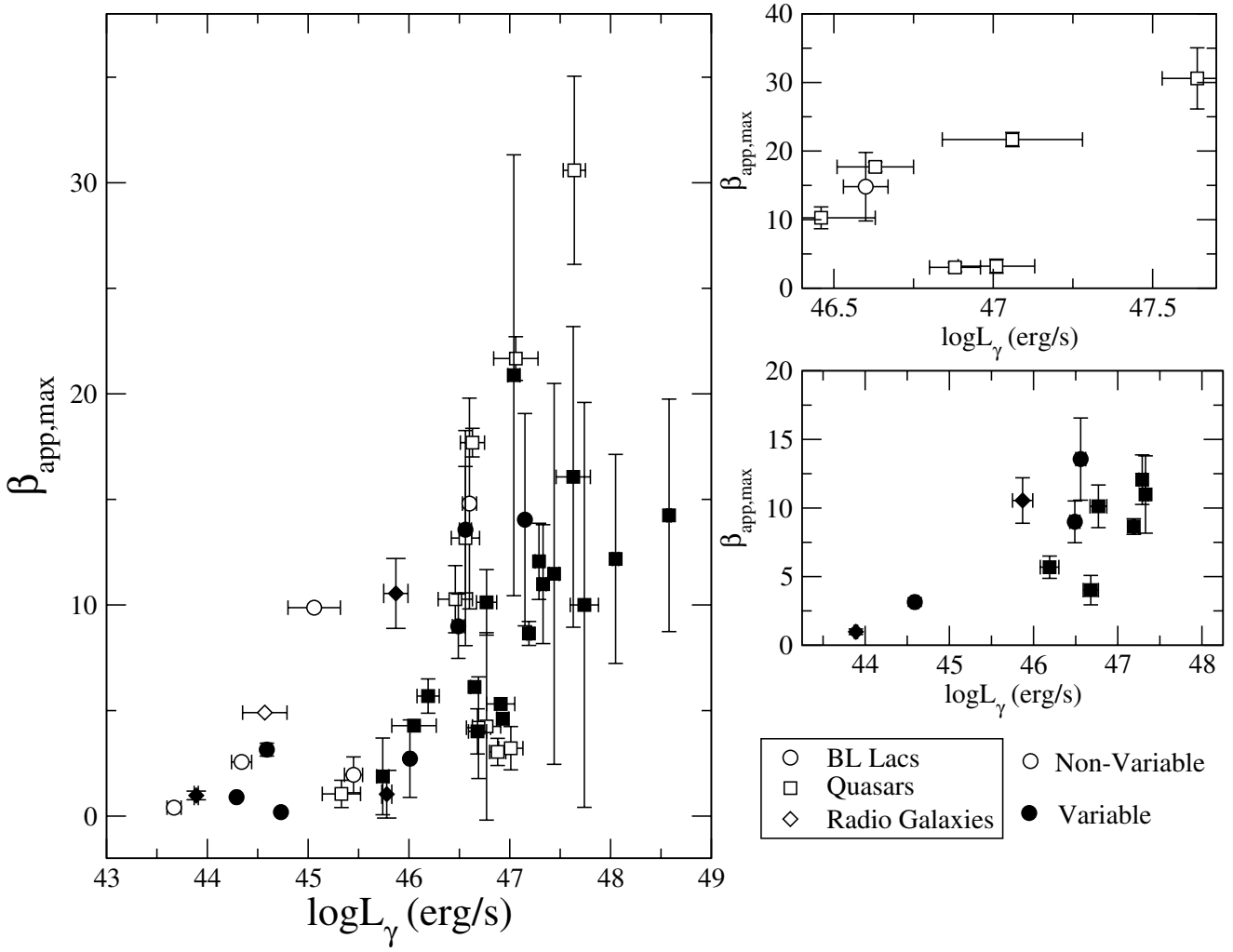

Variable FSRQs
vs.
Non-variable FSRQs

FSRQs faster jets than BL Lacs

Variable FSRQs faster jets than non-variable ones

# Results

- Apparent speeds & $\gamma$-luminosity

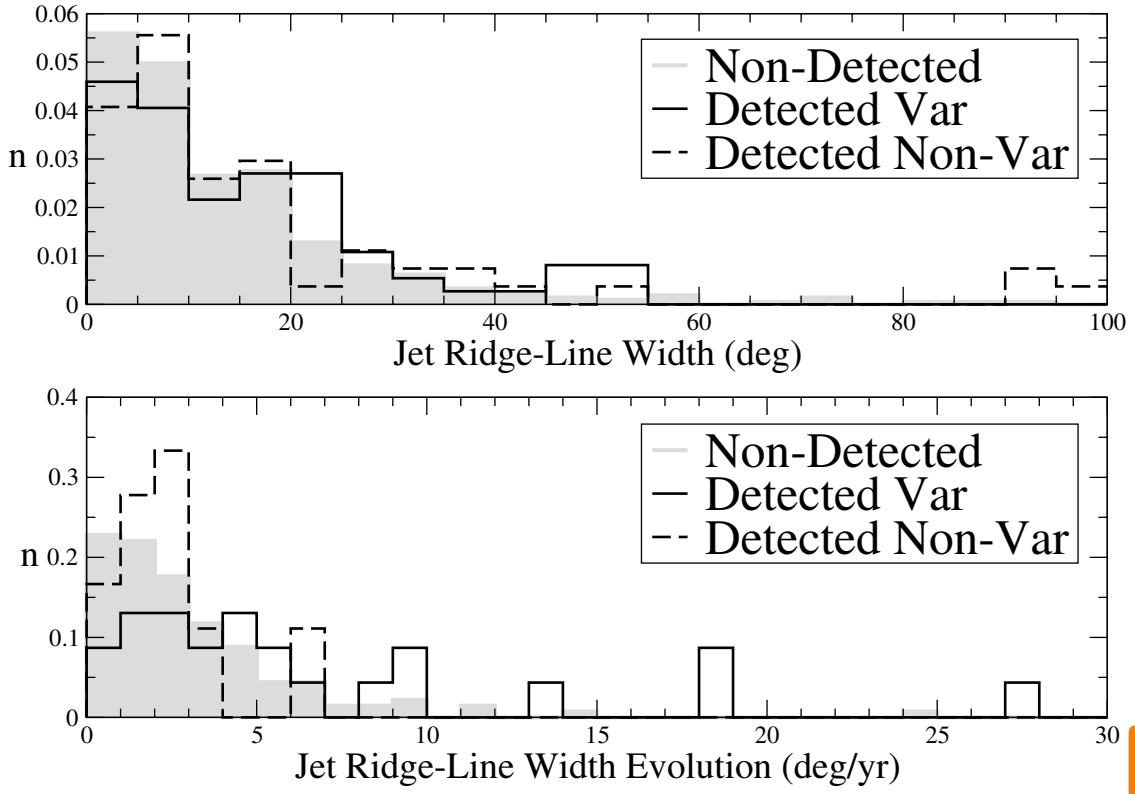



Spearman correlation coefficient 0.77 (>99.999% significance)

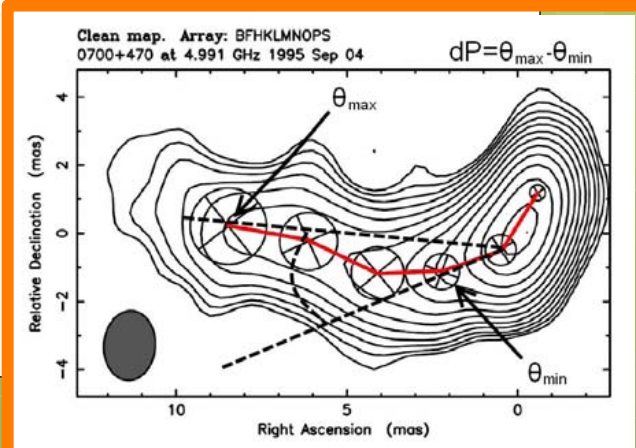
Variable sources follow the trend best, non-variable ones show large scatter

# Results

- $\gamma$-detection & jet-ridge lines




$\gamma$-CJF sources:
larger apparent widths
+
stronger changes in their apparent widths



# Conclusions

- We find no strong link between fast jets and $\gamma$-detection
- AGN class and $\gamma$-variability are connected to jet speeds
- A correlation between $\gamma$-luminosity and $\beta_{\mathrm{app,max}}$ is found (stronger for $\gamma$-variable sources)
- $\gamma$-detected sources show apparently wider and more strongly changing jet-ridge lines

# Implications

Why the difference with previous studies?

- Different observing frequency (5GHz vs. 15GHz)
  - → implies different emission properties @ different scales
  - → spine/sheath models
- Different (coarser) sampling of kinematics
  - → fastest components missed
  - → (but) parent sample kinematics not so different

Side note:
BL Lacs preferentially detected **BUT** show intrinsically different kinematics (see Karouzos+12a,b)

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