Flaring γ-ray emission from high-z blazars

M. Orienti
(INAF-IRA)

People involved: **F. D'Ammando**, M. Giroletti, J. Finke on behalf of the Fermi-LAT Collaboration, and D. Dallacasa

γ-rays from high-z blazars

Among the most luminous objects in the Universe

Under-represented in γ-ray catalogs:

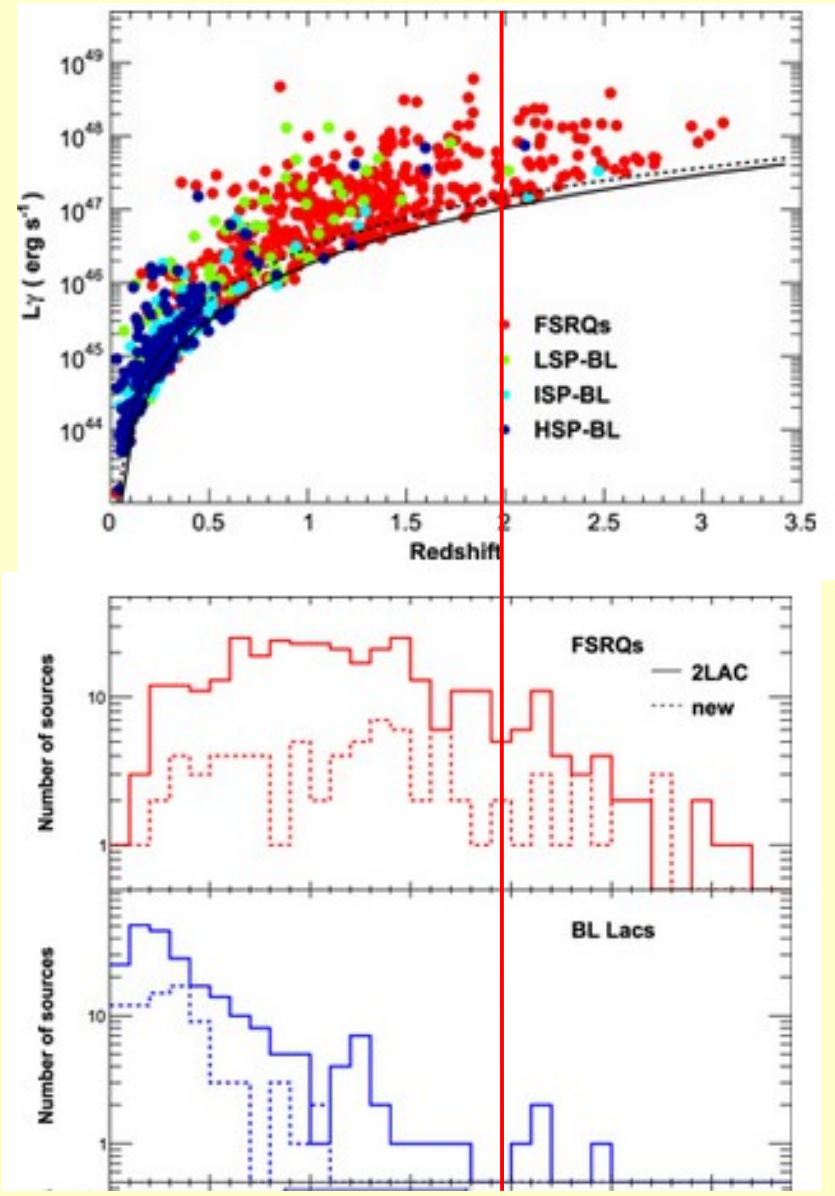
64 z>2 (2 with z>3) in the 3LAC

7 in 1FHL (E>10 GeV), 1 2FHL (E>50 GeV)

10 (z>3) observed in hard X-rays

Spectral bias towards hard X-rays (e.g. Ghisellini+11)

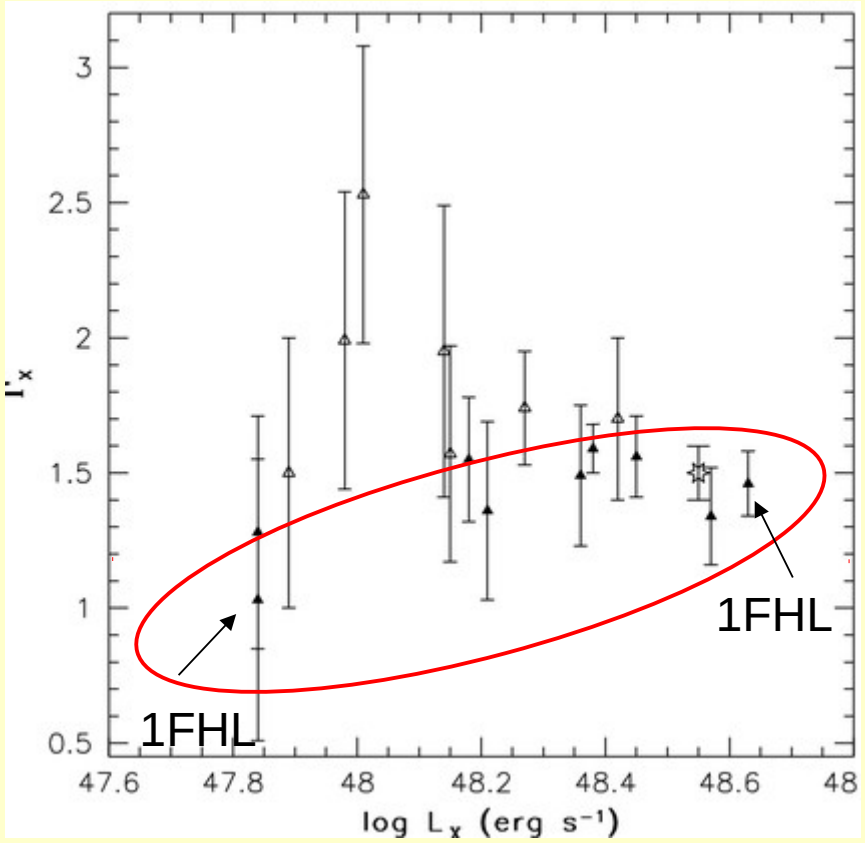
Ackermann+15



Spectral bias

The position of the IC peak highly influences the detectability of high-z blazars in hard X-ray and γ-ray bands.

D'Ammando & Orienti 16



70-month BAT cat: 17 objects

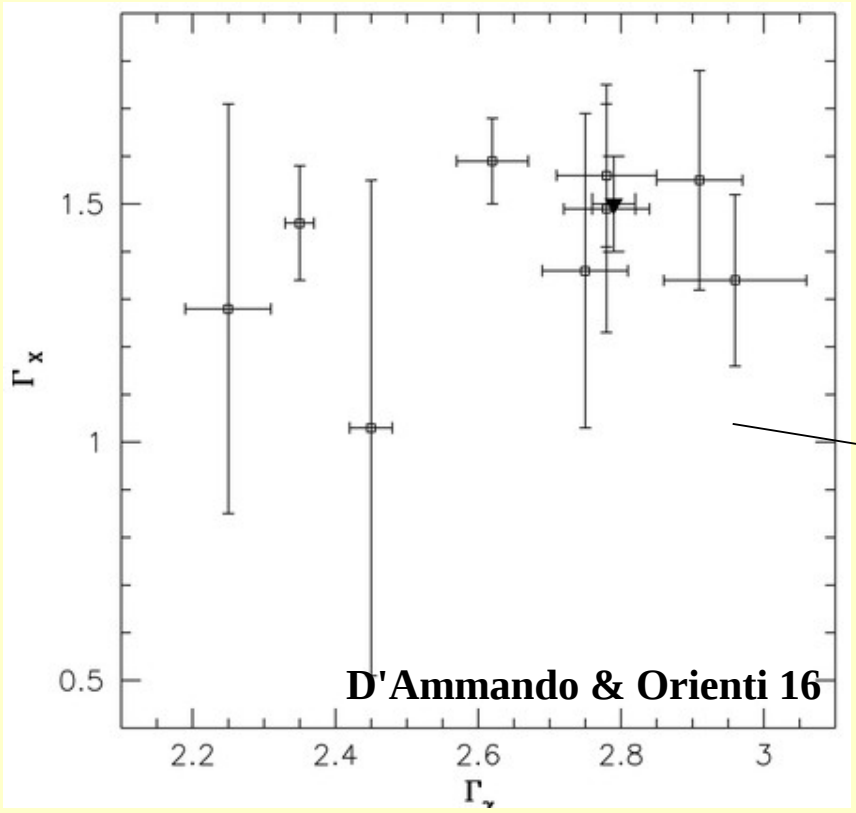
3LAC sample: 64 objects

In both samples: 10 objects

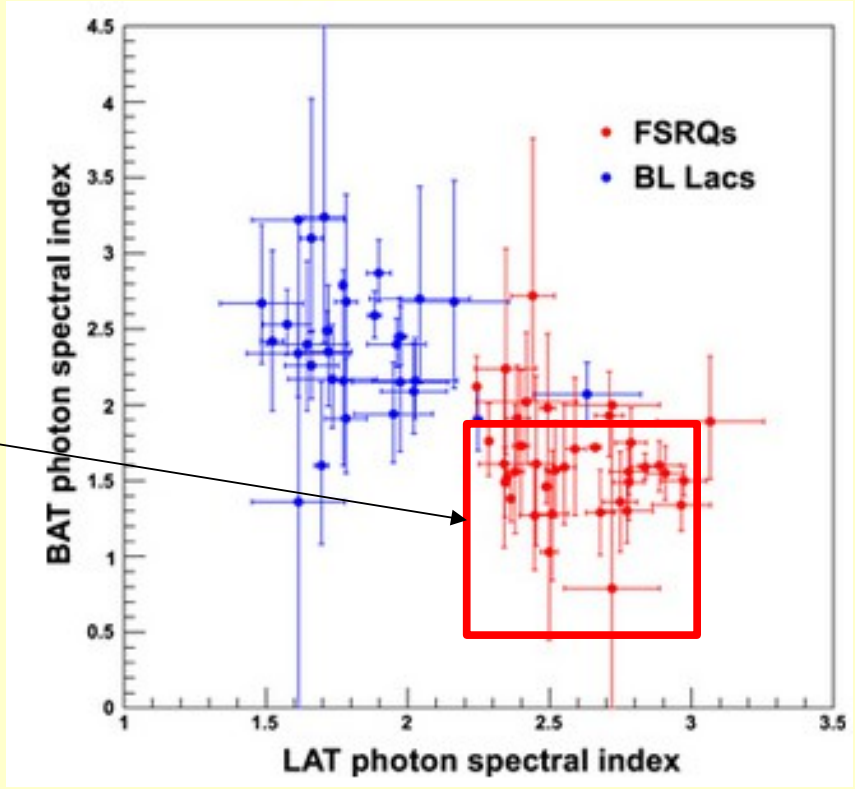
The γ-ray emitters have harder Γx and reach higher X-ray luminosity

γ-ray and hard X-ray connection

BL Lacs and FSRQ occupy two different regions, as expected.
High-z FSRQ have slightly harder X-ray spectra.



Ackermann+15

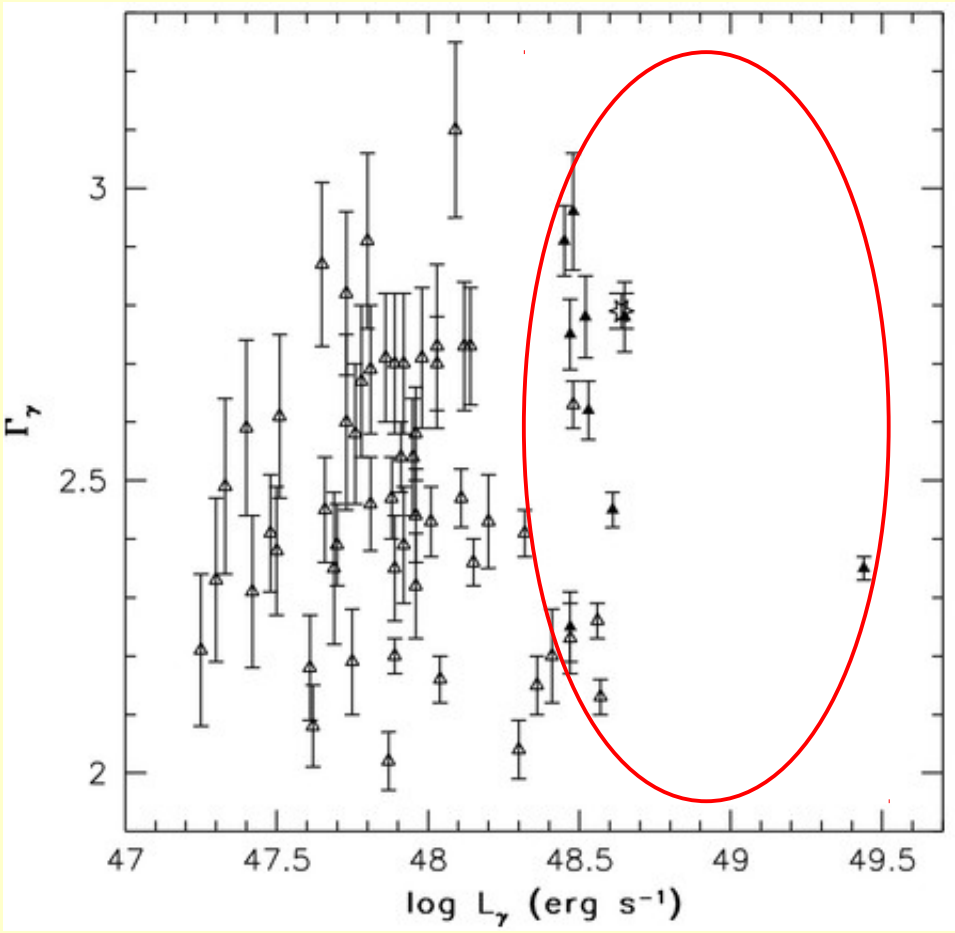


γ-ray luminosity

The X-ray emitters have higher gamma ray luminosity, but span the same Γx - Γγ range.

L > 10^{48} erg s^{-1}

D'Ammando & Orienti 16

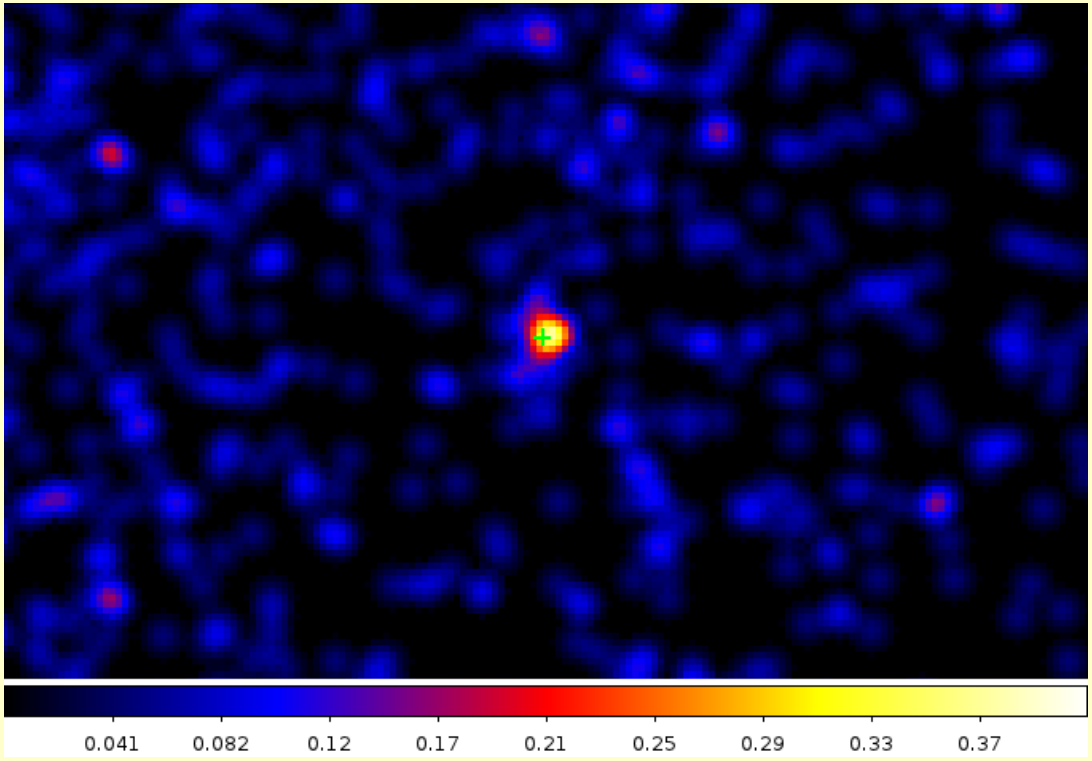


Flaring high-z sources

- Very hard to find. 13 high-z objects detected by Fermi-LAT during a flare
- The flaring threshold ($F > 10^{-6}$ ph $cm^{-2}s^{-1}$) implies that only extreme high activity at high-z can be detected
- The observed hardening of the spectrum helps a little the detection
- They can prove short variability time-scale
- Provide clues on EBL
- Interesting sources: PKS0536+145, PKS2149-306, and S5 0836+710

TXS 0536+145

- FSRQ at z=2.69
- γ-ray flare in 2012 March 22
- **The most distant γ-ray flaring blazar observed so far**
- Not in the 1LAC and 2LAC
- **Associated with 3FGL J0539.8+1434**

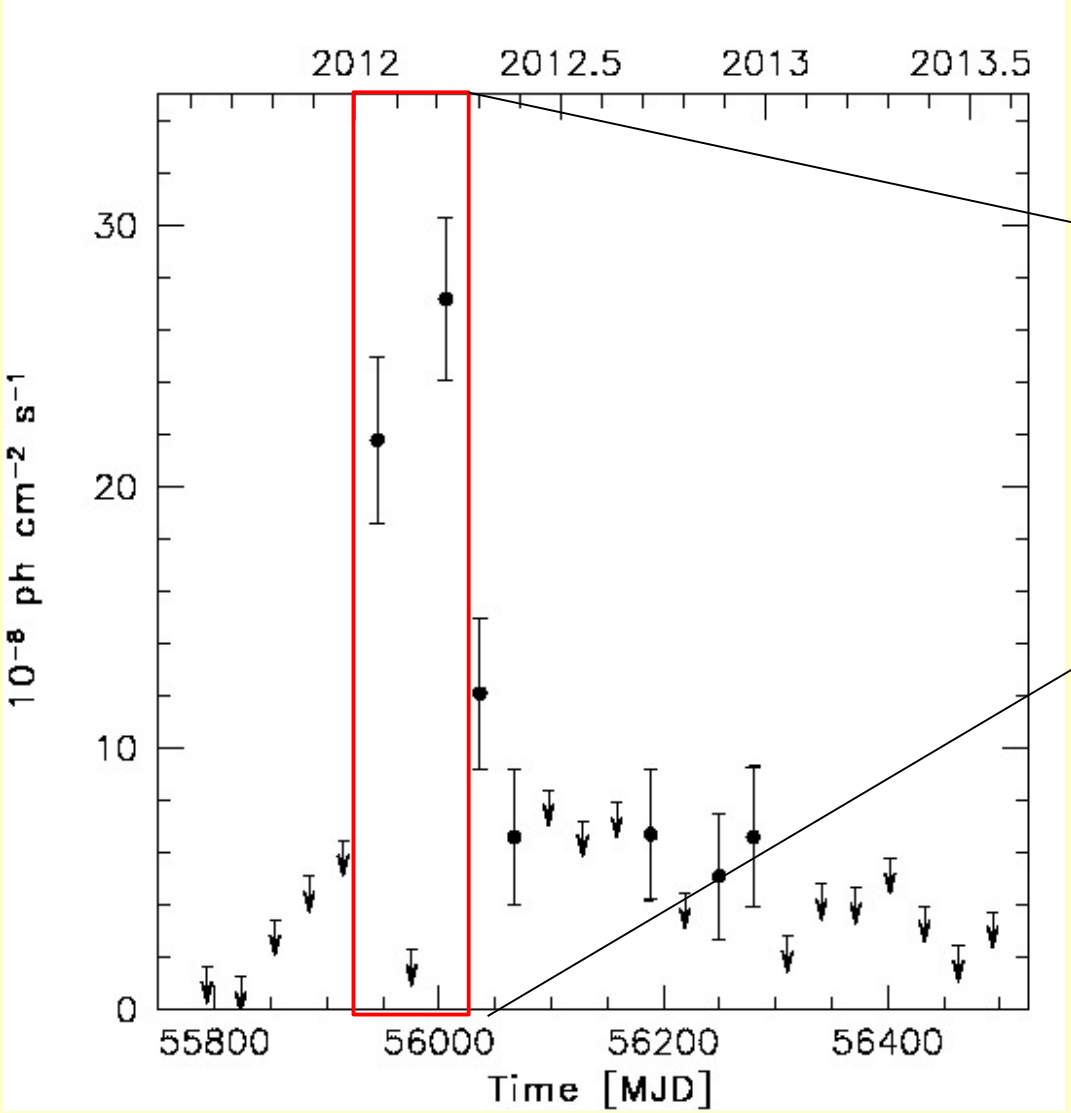


Energy range: 100 MeV – 100 GeV

The **correlated variability in X-rays** detected by triggered *Swift* observations **confirmed the identification** of the flaring -ray source with TXS 0536+145, never detected in gamma-rays before.

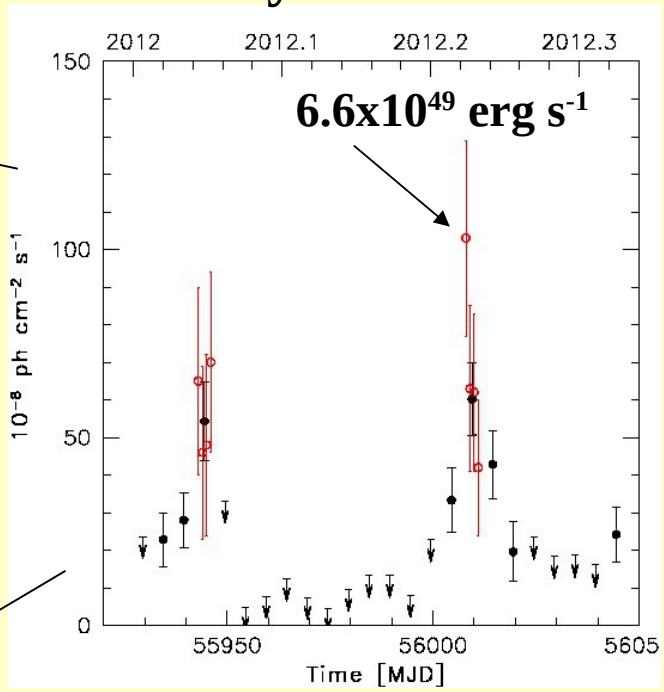
LAT light curve

2011 August 4 – 2013 August 4



1-month time bins

1/3-day time bins



Orienti+14

Peak flux

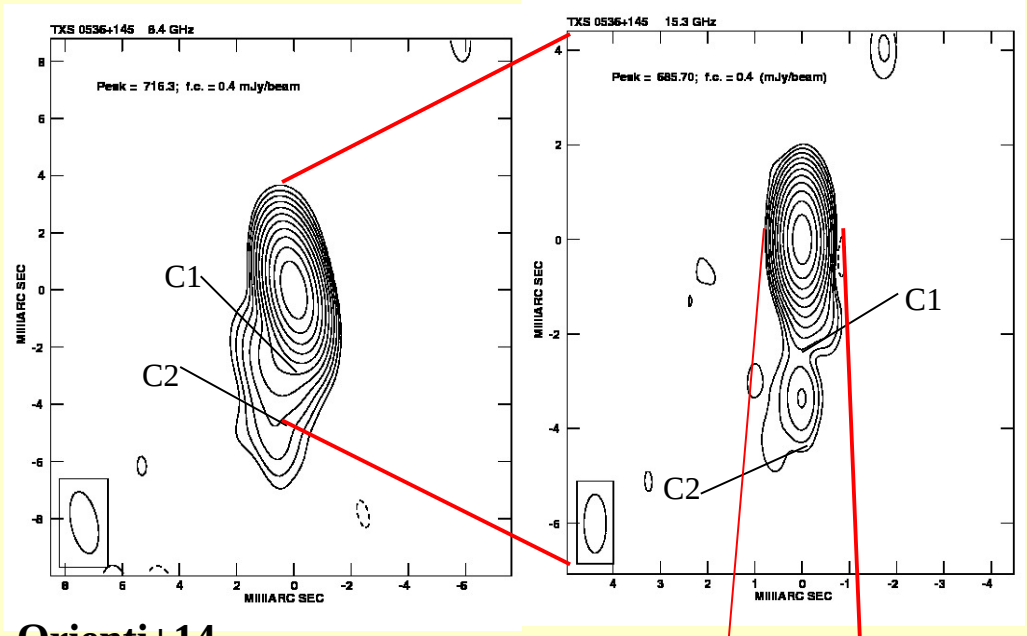
$(102 \pm 26) \times 10^{-8}$ ph cm^{-2} s^{-1}

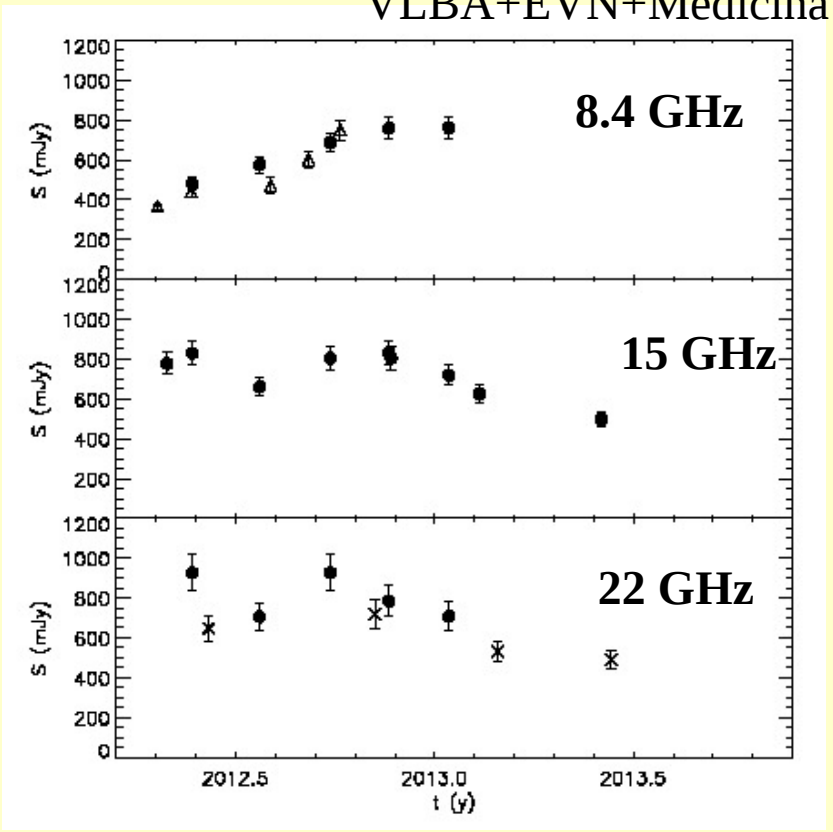
Average flux:

$(4.2 \pm 0.8) \times 10^{-8}$ ph cm^{-2} s^{-1}

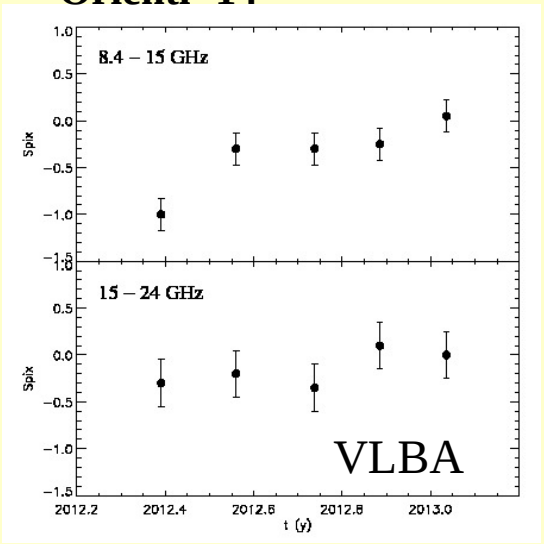
Radio observations

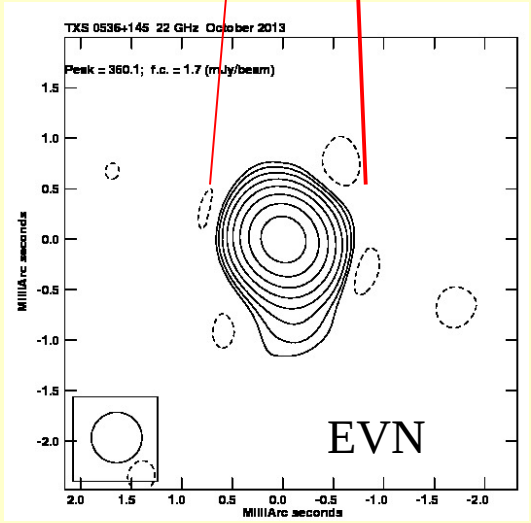
VLBA+EVN+Medicina





Orienti+14

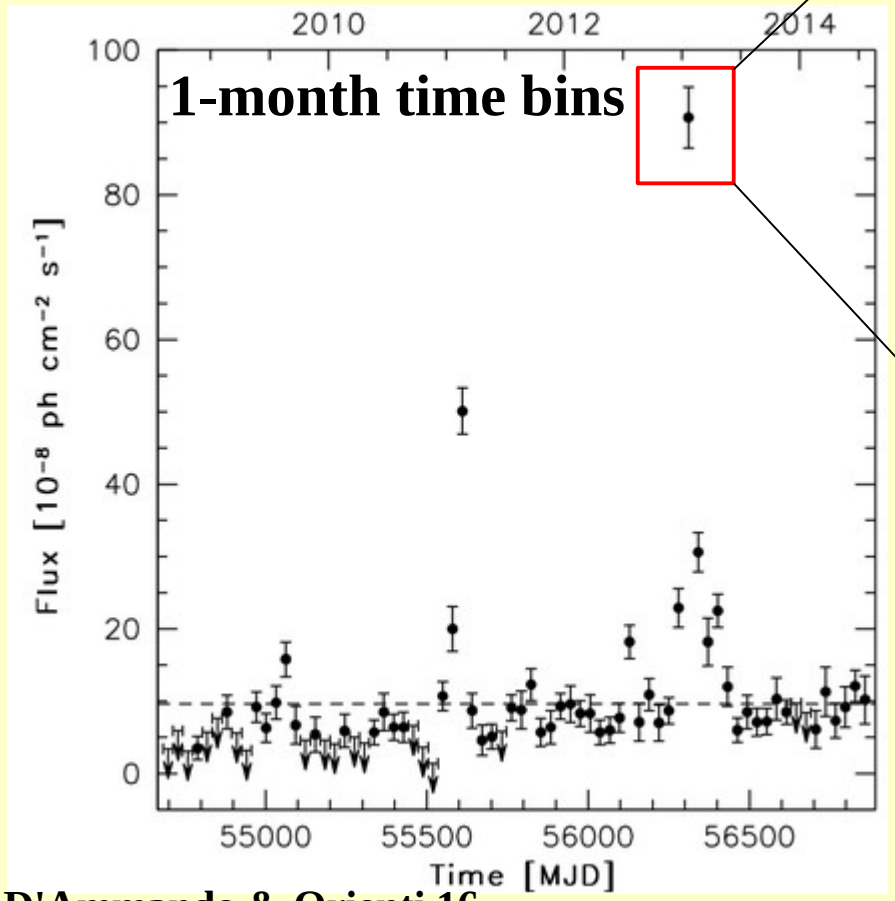




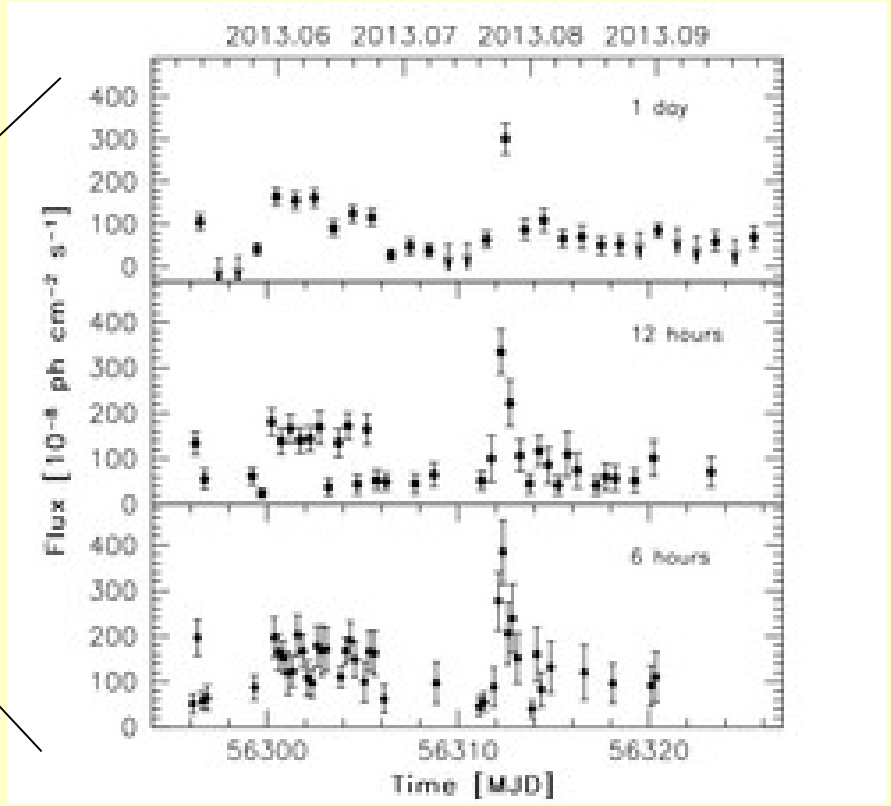
- Double hump in the radio light curve
- γ-ray/radio delay ~4-5 months
- Spectral index is inverted then flattens

PKS 2149-306

- FSRQ at z=2.345
- γ-ray flare in 2013 January 20



D'Ammando & Orienti 16



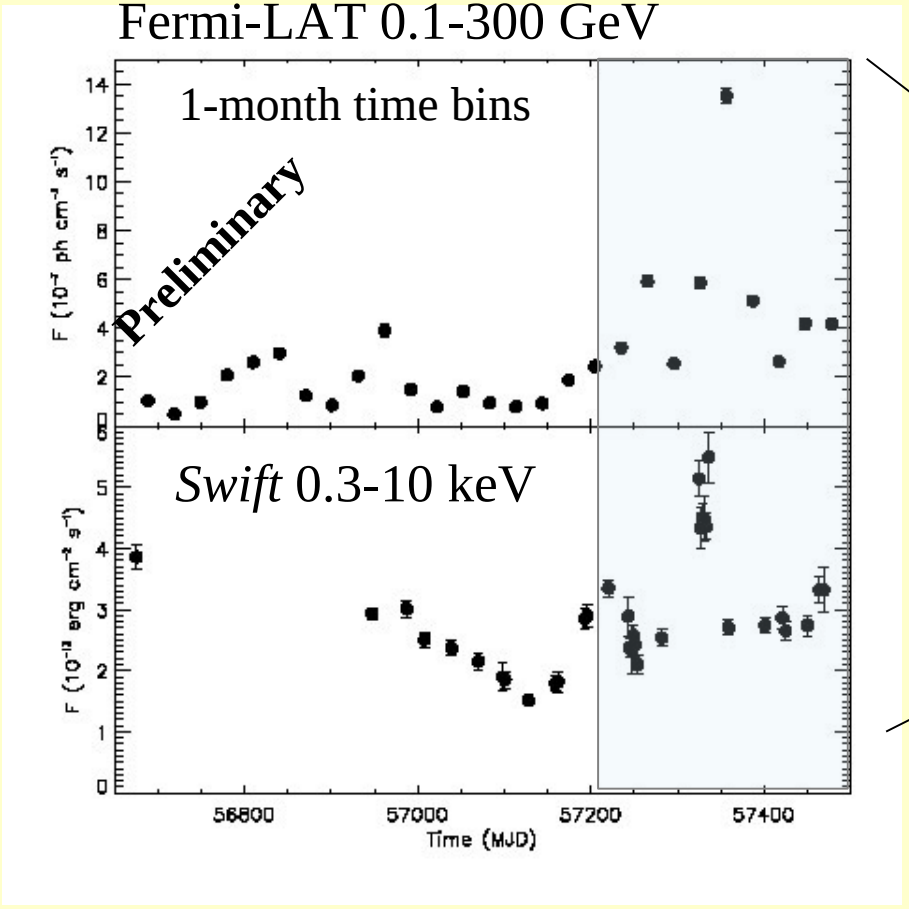
Peak flux (1.5 ±0.2) x 10^{50} erg s^{-1}

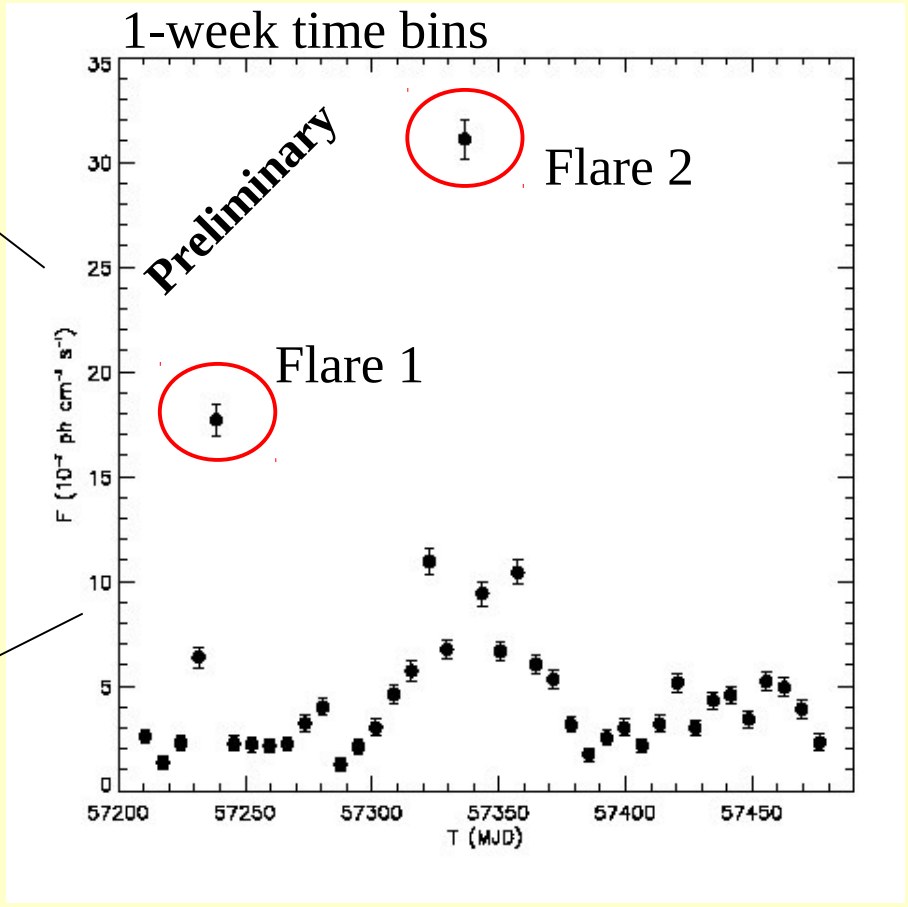
Variability over 6-h time scale

Comparable to the light crossing time of the BH event horizon

S5 0836+710

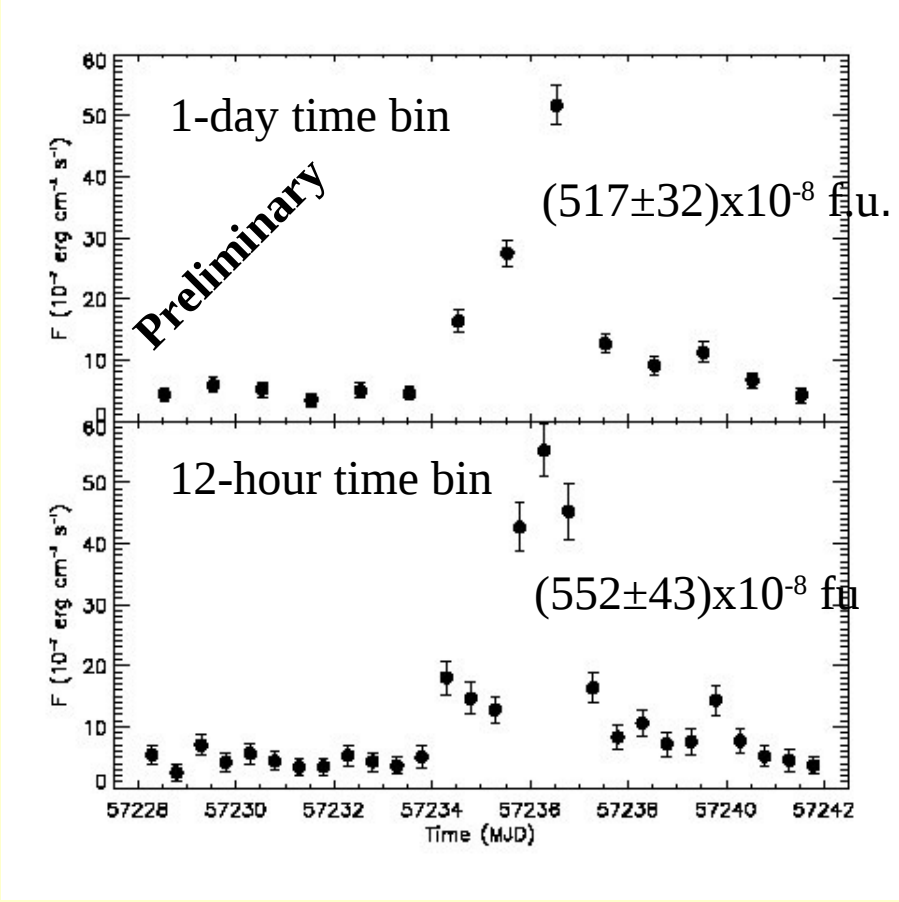
- High activity states starting in 2015 August



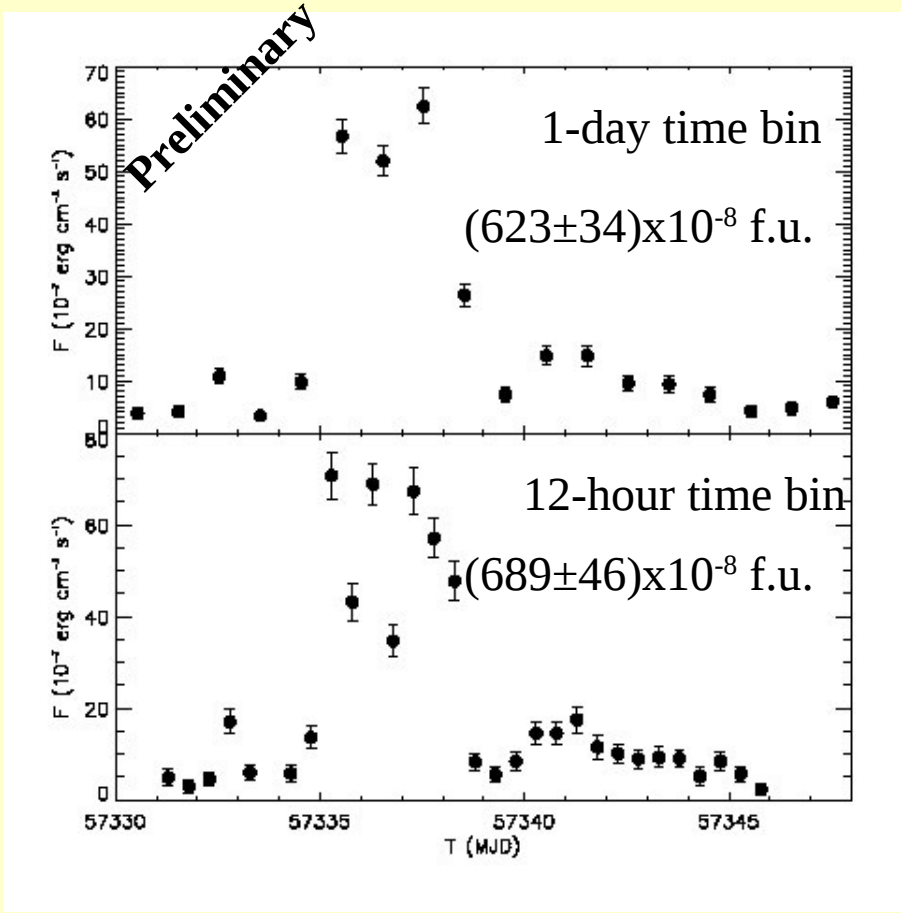


S5 0836+710

- Brighter than 3C 454.3 in flare, short-time variability



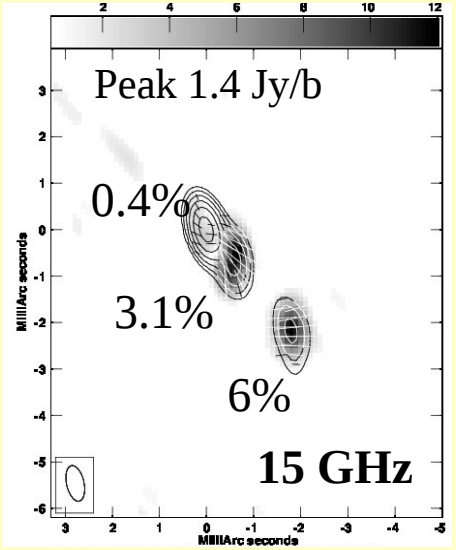
Well-defined shape

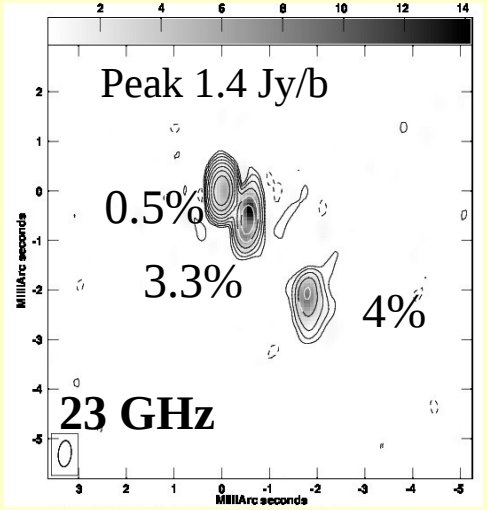


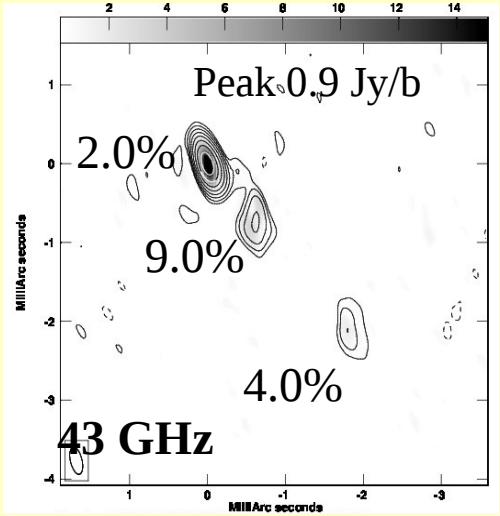
L = (2.9±0.3)x10^{50} erg s^{-1}

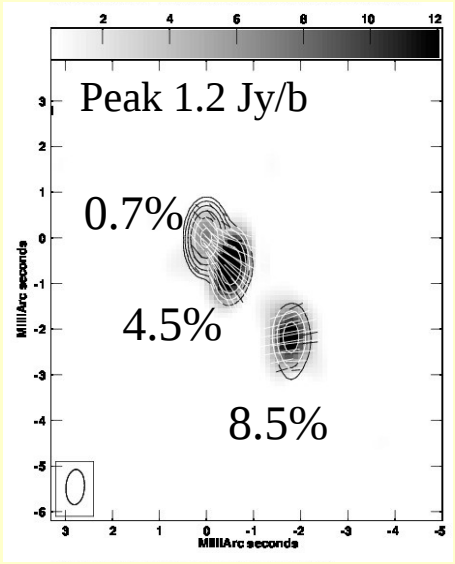
S5 0836+710

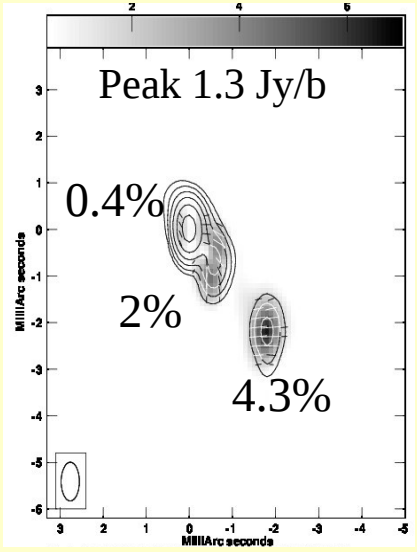
6 epoch full polarization VLBA observations at 15, 23, and 43 GHz









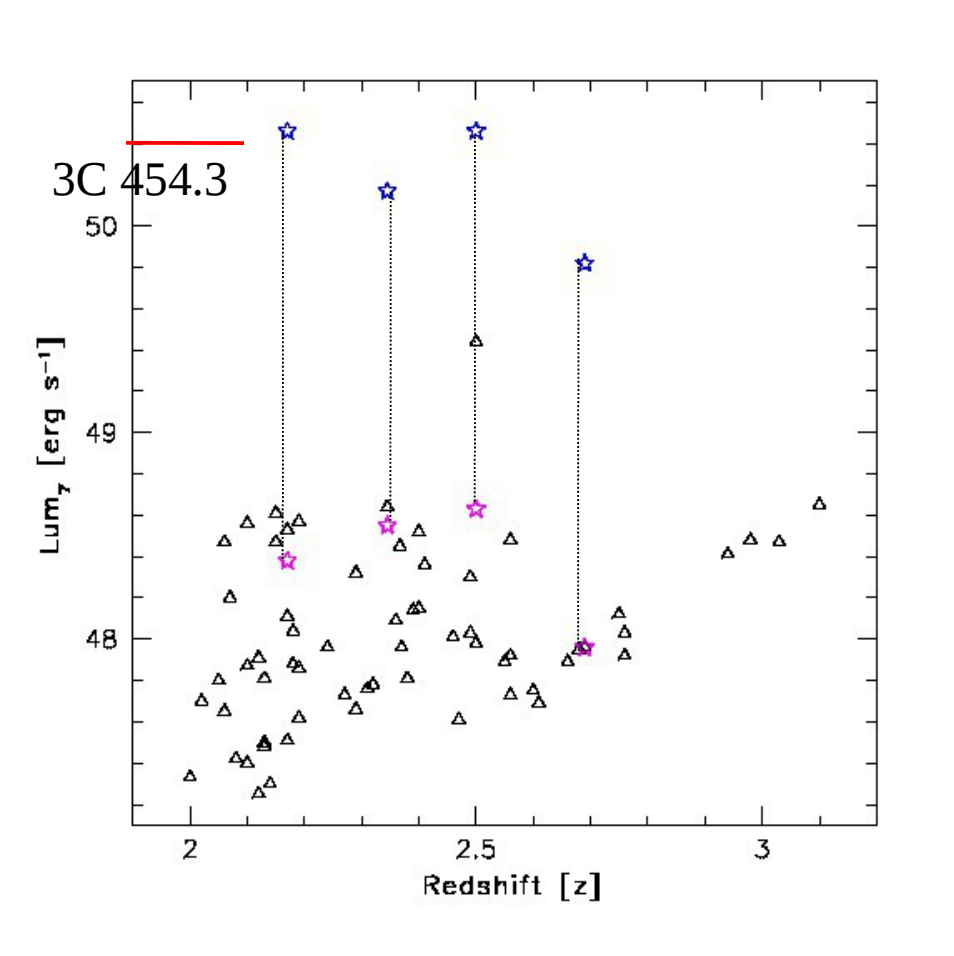


In the core the fractional polarization increases with frequency

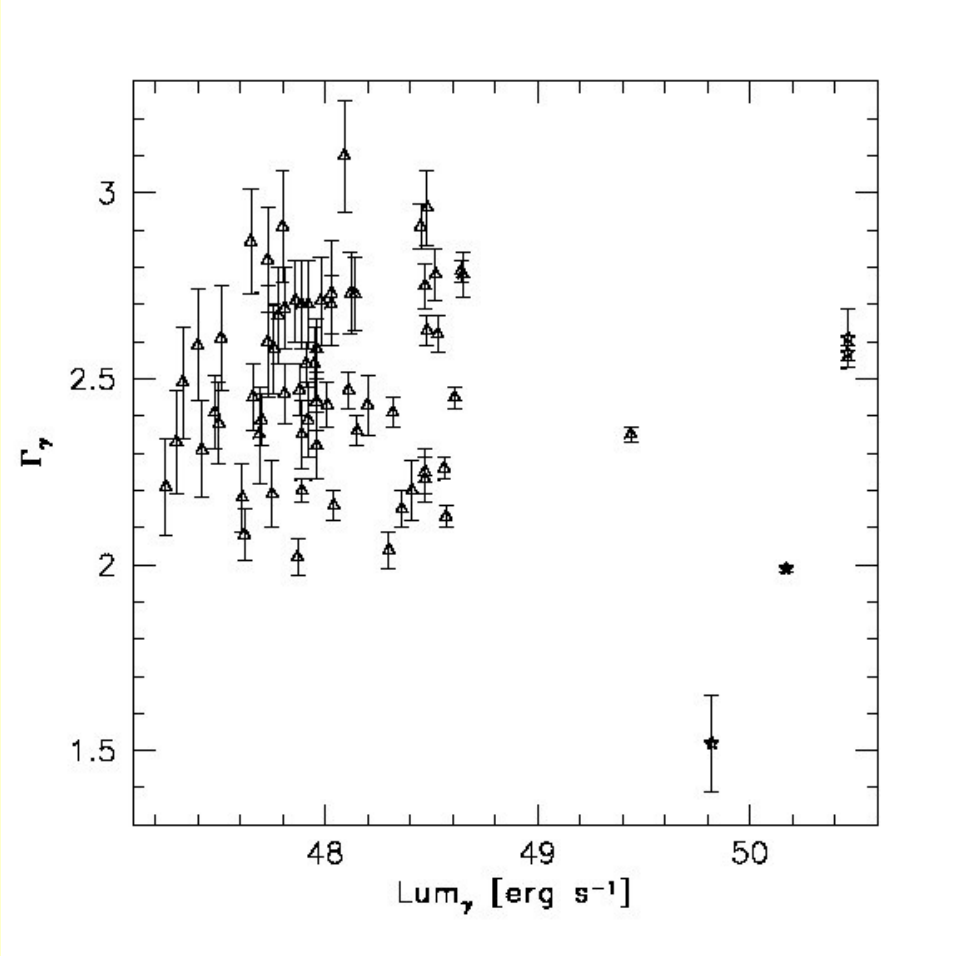
EVPA ~ stable in the knot

EVPA changes in the core

High-z γ-ray flaring blazars



Jump of 2 orders of magnitude



Different spectral behaviour: Changes in the curvature, harder-when-brighter, nothing....

Summary

- **High-z blazars are under-represented at γ-rays**

- **Flaring γ-rays are rare gems, difficult to be picked up by current facilities. Dedicated short-variability may increase the detection fraction**

- **Studies of their short-term variability as well as spectral curvature may provide information of the particle acceleration, high-energy production region**

- **Future facilities, like CTA, may improve our chance to detect some flaring high-z objects at VHE and put tight constraints on EBL models and origin on seed photons**

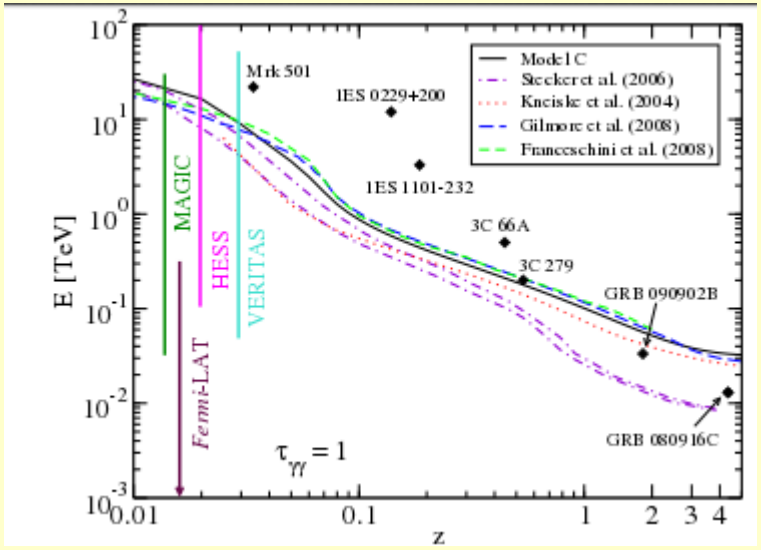
Summary

- **High-z blazars are under-represented at γ-rays**

- **Flaring γ-rays are rare gems, difficult to be picked up by current facilities. Dedicated short-variability may increase the detection fraction**

- **Studies of their short-time variability as well as spectral curvature may provide information fn the particle acceleration, high-energy production region**

Finke+10



- **Future facilities, like CTA, may improve our chance to detect some flaring high-z objects at VHE and put tight constraints on EBL models and origin on seed photons**