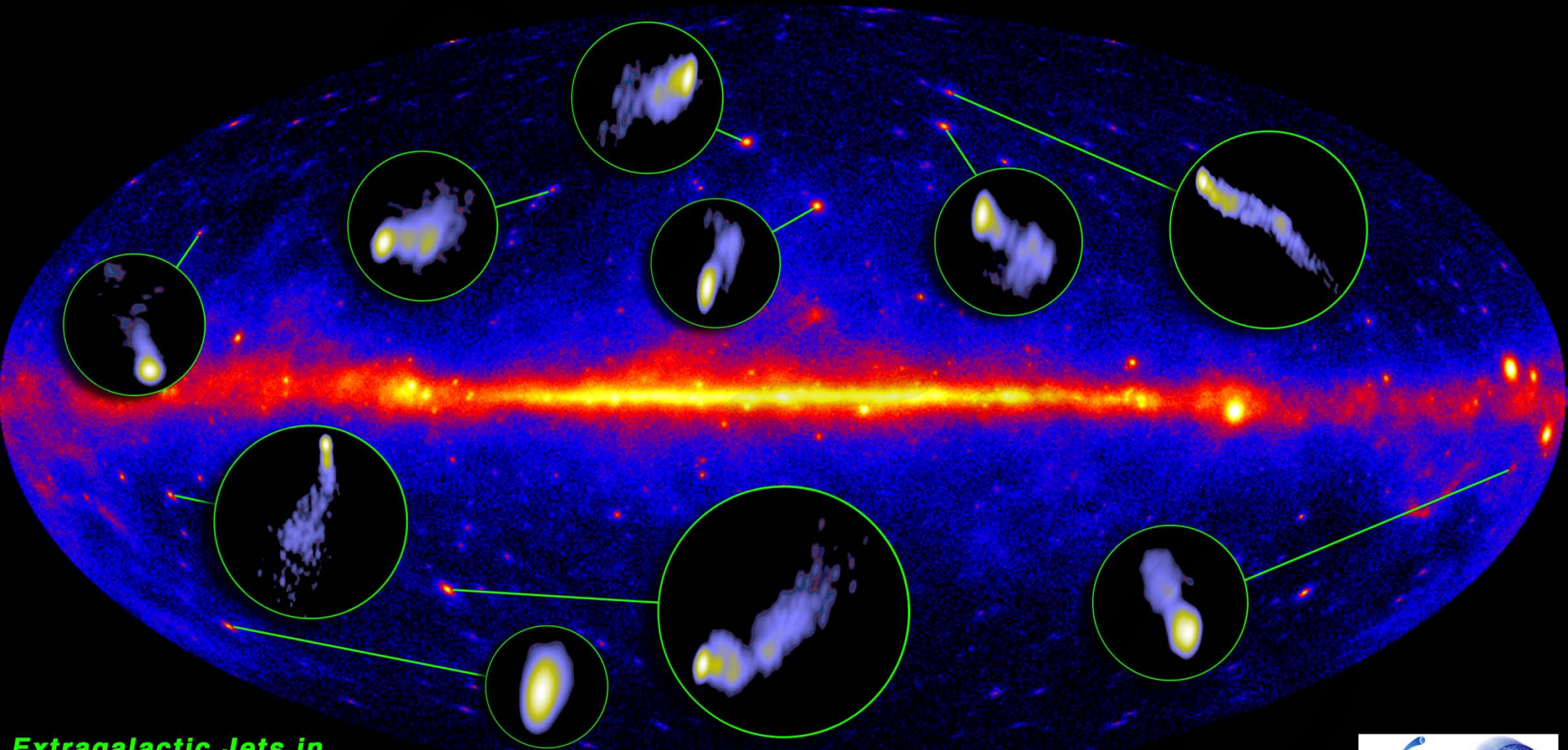


**MOJAVE-*Fermi* program:**  
**VLBI ejections in gamma-ray bright AGN jets**  
Y. Y. Kovalev  
*Astro Space Center of Lebedev Physical Institute, Moscow*



**Extragalactic Jets in  
the *Fermi* Gamma-Ray Sky as  
Seen by the MOJAVE VLBA Program**



# The team

- M. and H. Aller (*Michigan University*)
- D. C. Homan (*Denison University*)
- M. Kadler (*Erlangen Uni, Bamberg Obs*)
- K. I. Kellermann (*NRAO*)
- Y. Y. Kovalev (*ASC Lebedev*)
- M. L. Lister, T. Hovatta (*Purdue University*)
- A. P. Lobanov, A. B. Pushkarev, T. Savolainen,  
J. A. Zensus (*MPIfR*)
- E. Ros (*U. Valencia*)

# Outline

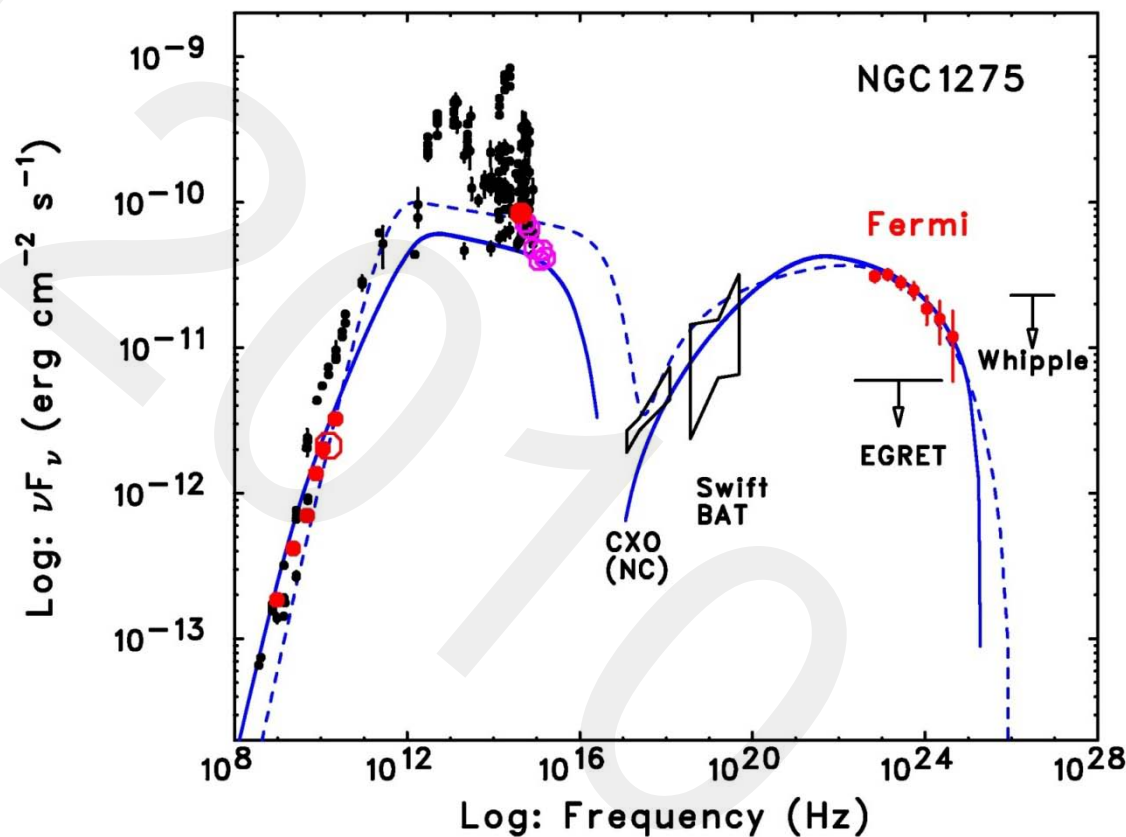
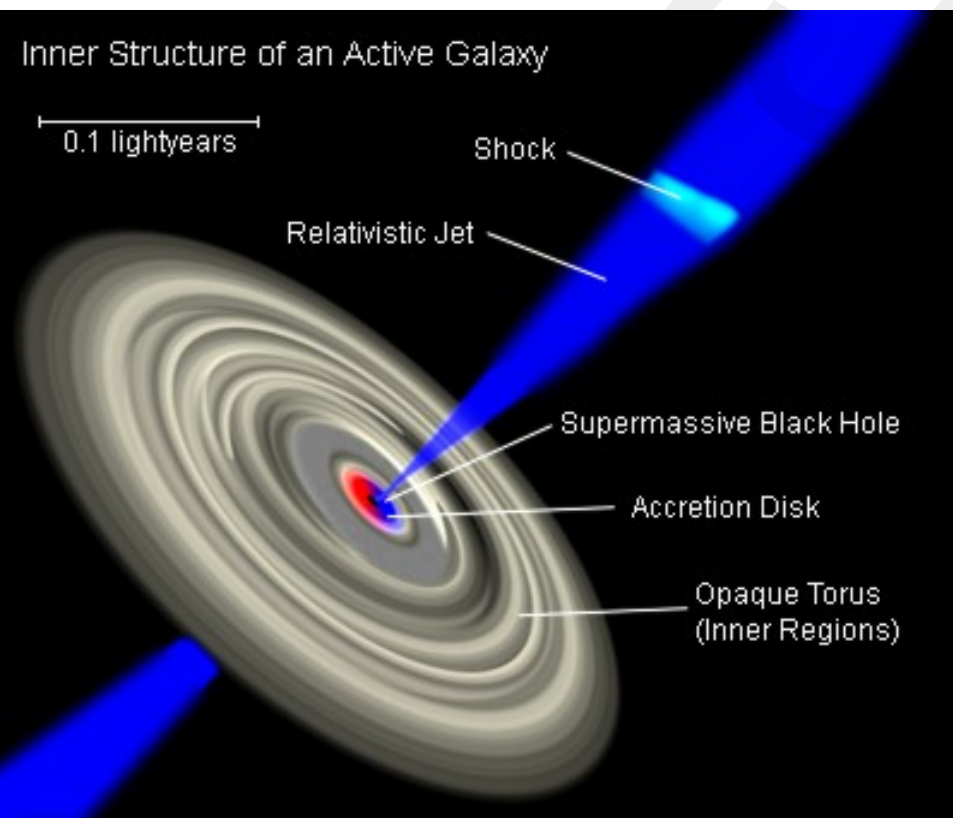
- Why do we care about moments of parsec-scale ejections in gamma-ray bright AGN?
- MOJAVE program and VLBI ejections during the *Fermi* era
- Expectations in a one year time

# Object of our interest and motivation

## extragalactic jets emission across the electro-magnetic spectrum

Relativistic jet: synchrotron emission from radio up to X-rays.  
Some photons somewhere: Compton emission at high energies.

VLBI provides sub-parsec-scales resolution which help to locate the source of emission.



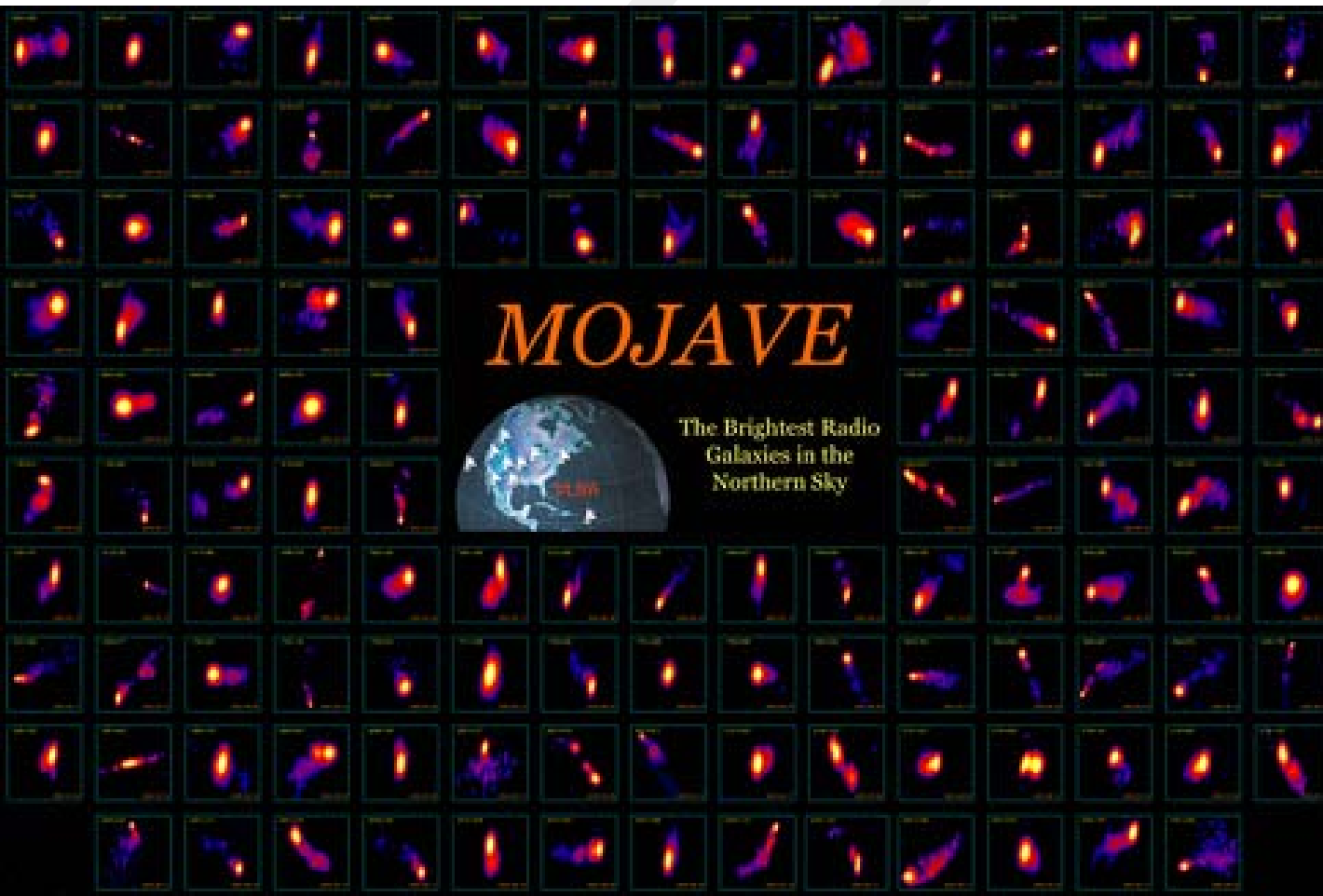
# The 2 cm VLBA Survey / MOJAVE

<http://www.physics.purdue.edu/astro/MOJAVE/>

Statistic studies of about 300 relativistic jets in AGN.

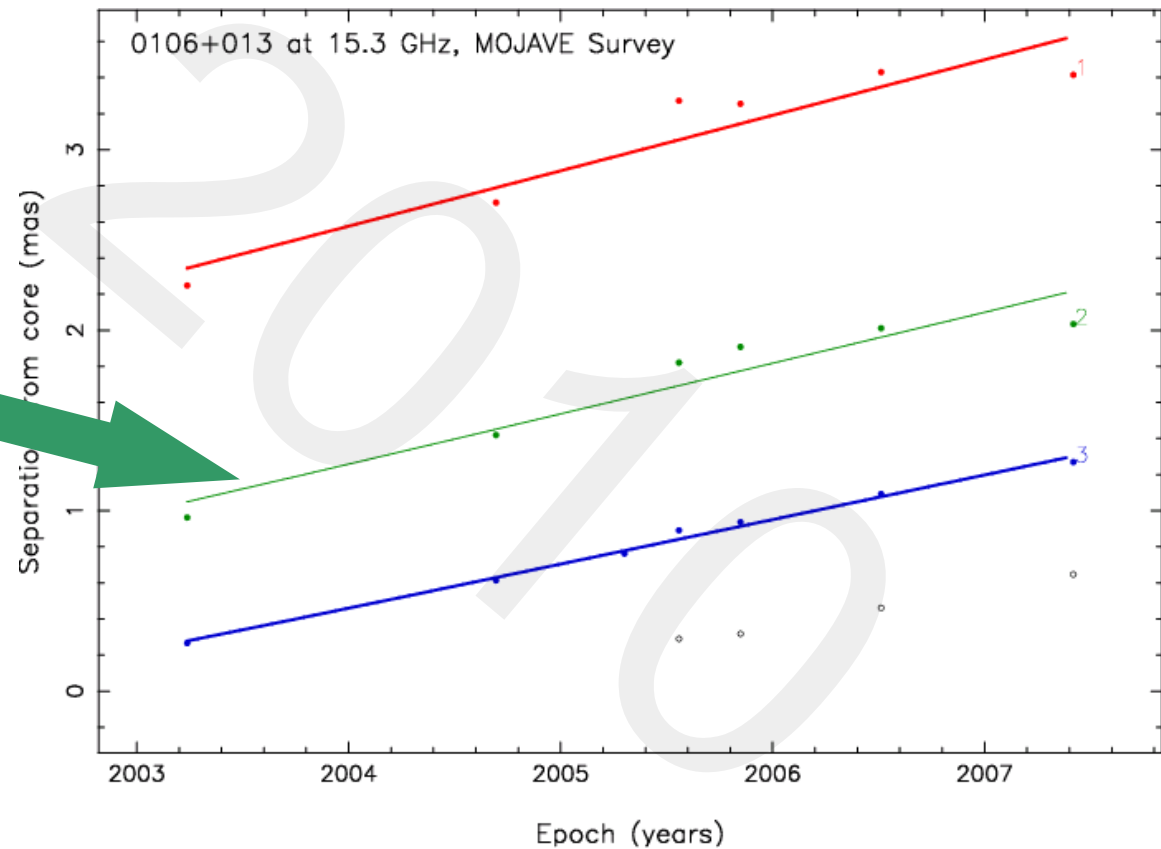
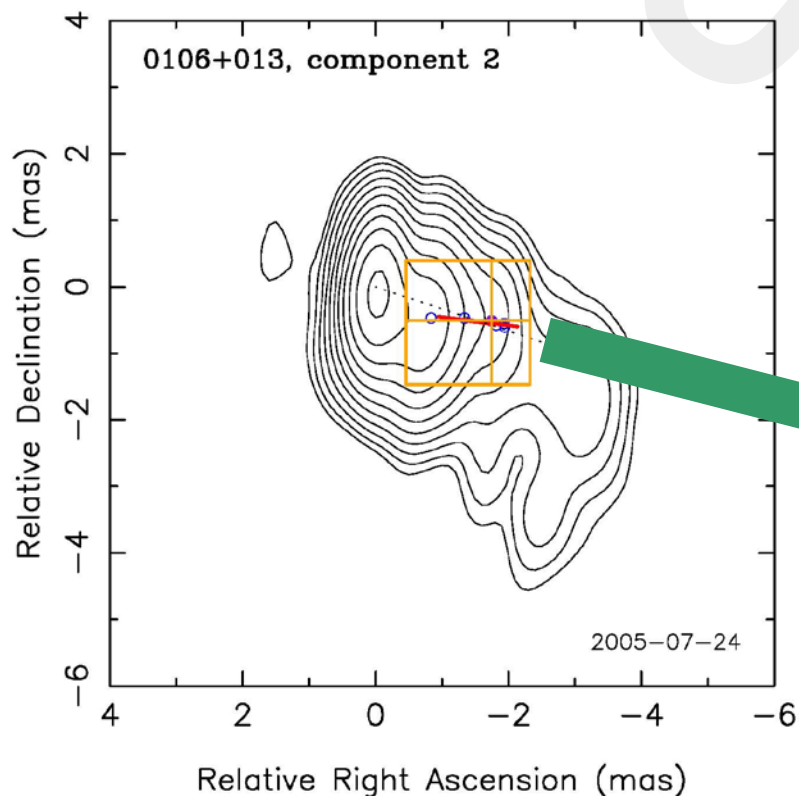
Statistically complete sample of 135 AGN jets since 2002; 82 objects are in 1FGL.

Support of *Fermi* since 2008 – adding *Fermi* detected AGNs. Currently, the monitoring includes about 180 1FGL objects down to 200 mJy.



# Recent pre-*Fermi* 2 cm MOJAVE monitoring results

- ✓ 135 sources in the sample
- ✓ About 500 robust components measured
- ✓ Ejection epochs are estimated for about 250 of them
- ✓ About 20 ejection epochs per (recent) year
- ✓ Typical accuracy: one/two/several months
- ✓ We need to wait some time (months/years) until VLBI ejection becomes resolved from the core and is observed for a high enough number of epochs (4-5 and more) to allow robust estimate of ejection epoch.



# Ejection epoch analysis: main goals

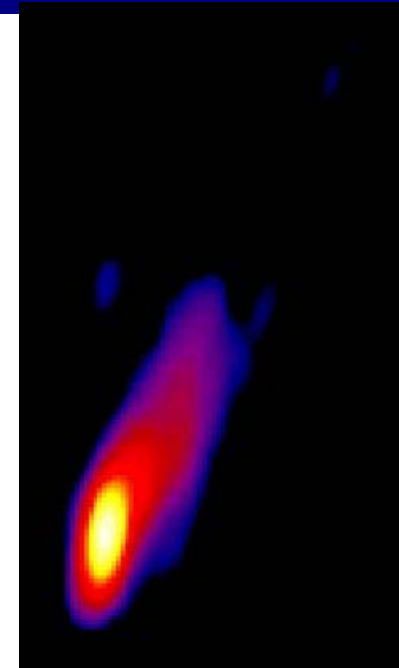
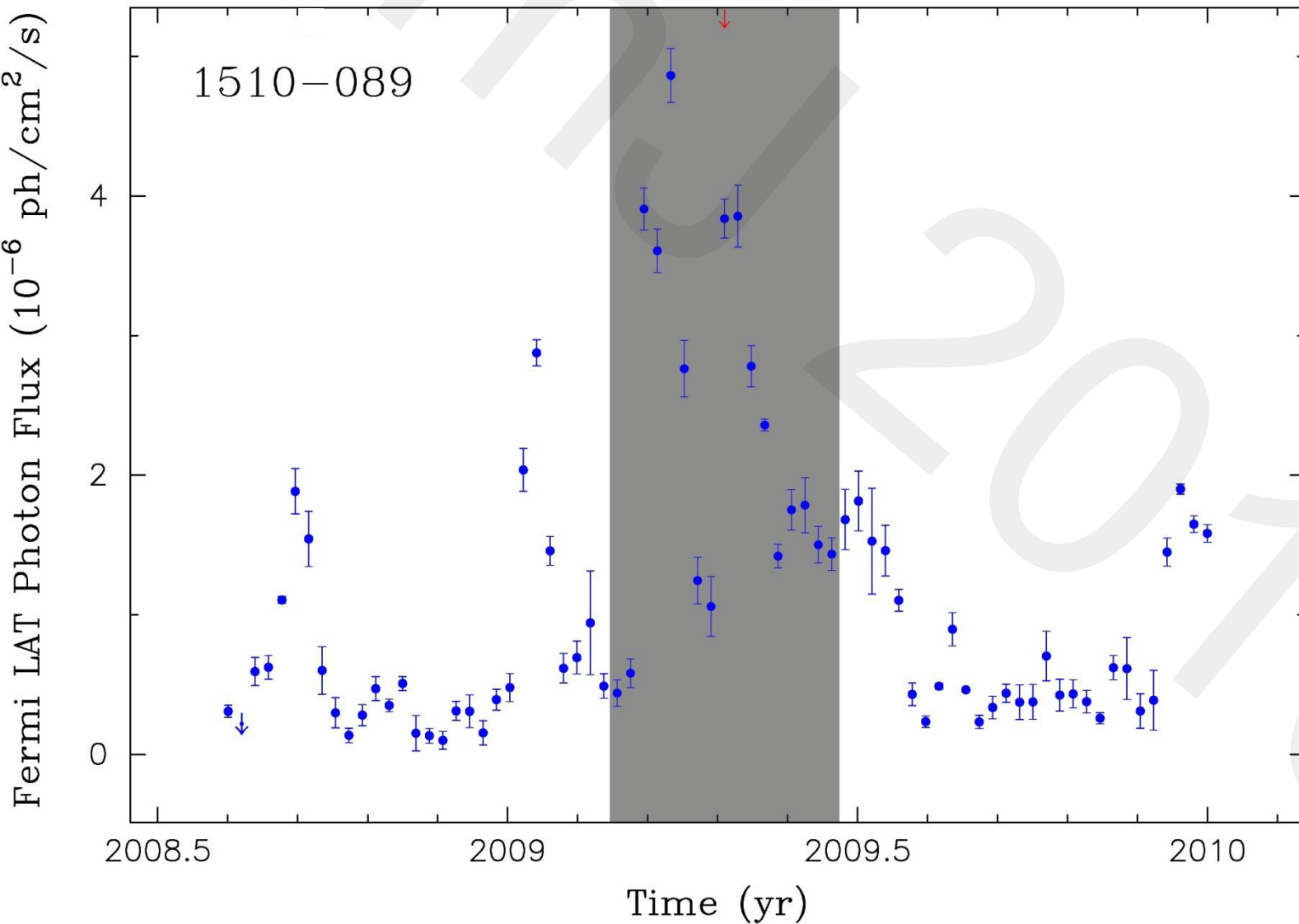
To address the following questions with high statistical significance:

1. Are VLBI ejections associated with gamma-ray flares in gamma-ray bright AGN jets? All of them?
2. What are the delays between the gamma-ray flares and the moment of ejection? This will allow better localization of the gamma-ray emitting region.

In addition:

Follow up on individual well identified gamma-ray flares / VLBI components.

# “Robust” moment of ejection during the *Fermi* era: 1510-089

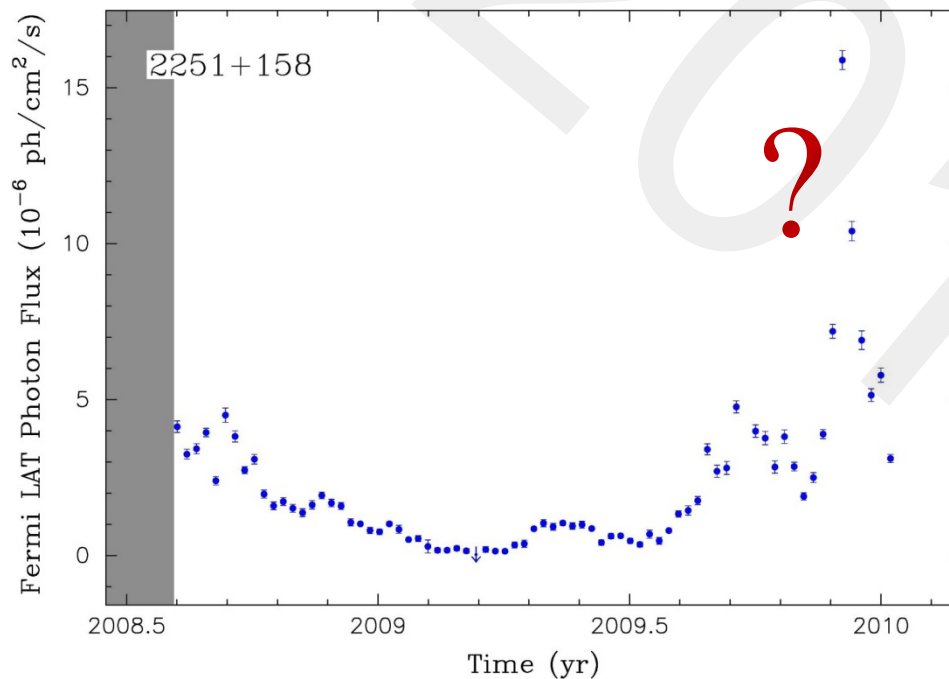


See also  
Marscher et al. (2010)



# Expected results

On the basis of our previous experience (Lister et al. 2009) as well as increased number of 1FGL sources monitored in MOJAVE and a relatively high observing cadence for the newly added gamma-ray bright jets, we expect to measure moments of ejections happening during the *Fermi* era for about 30 features in the monitored sample by 2011. This will allow us to perform statistical analysis over a high number of ejections versus three years long *Fermi* light curves.



# Summary

- ✓ Moments of ejection of parsec-scale features in AGN jets are unique time stamps for associating VLBI and gamma-ray events as well as for locating the region of gamma-ray production.
- ✓ So far: one robust ejection epoch during *Fermi* era. Coincides with a huge gamma-ray flare.
- ✓ MOJAVE program will deliver a useful data set of ejection epochs for many gamma-ray bright AGN jets. Be patient. We monitor many 1FGL objects, but we need some time to get robust estimates of the moments of ejections.