Comprehensive study of a γ-ray to radio connection in 3C273

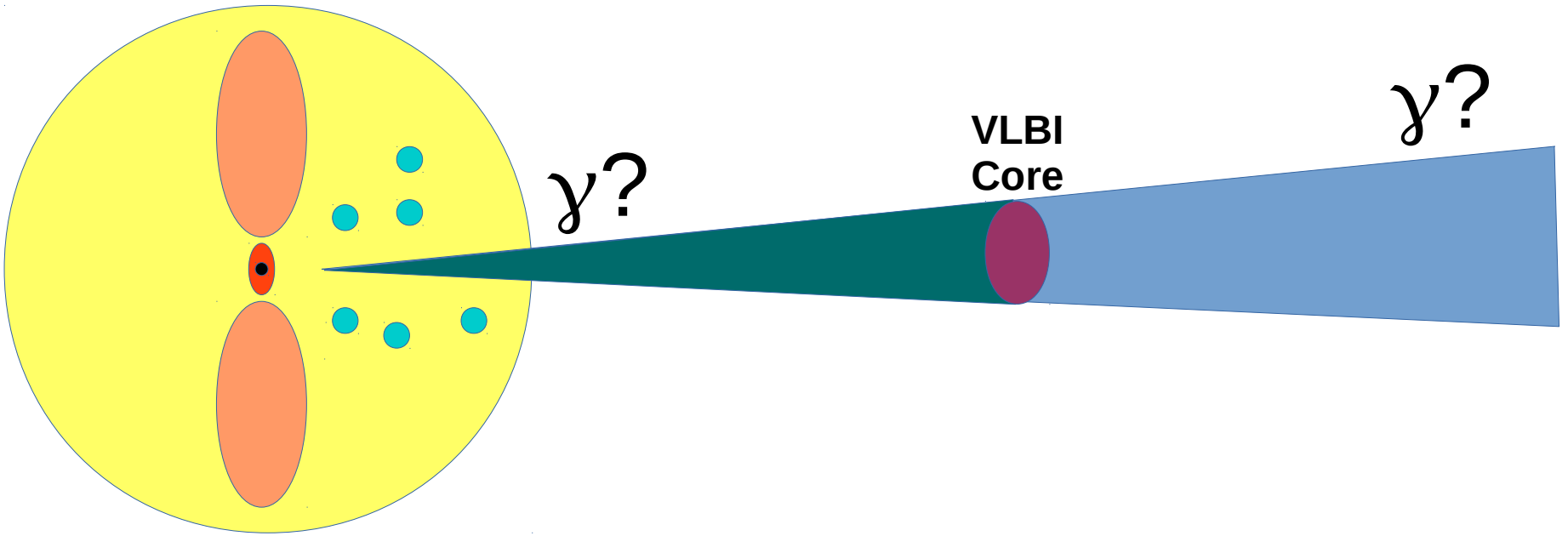
MIKHAIL LISAKOV
Astro Space Center

In collaboration with
Yuri Kovalev, Tuomas Savolainen, Talvikki Hovatta and Alexander Kutkin

EVNs, 23.09.2016, Saint Petersburg

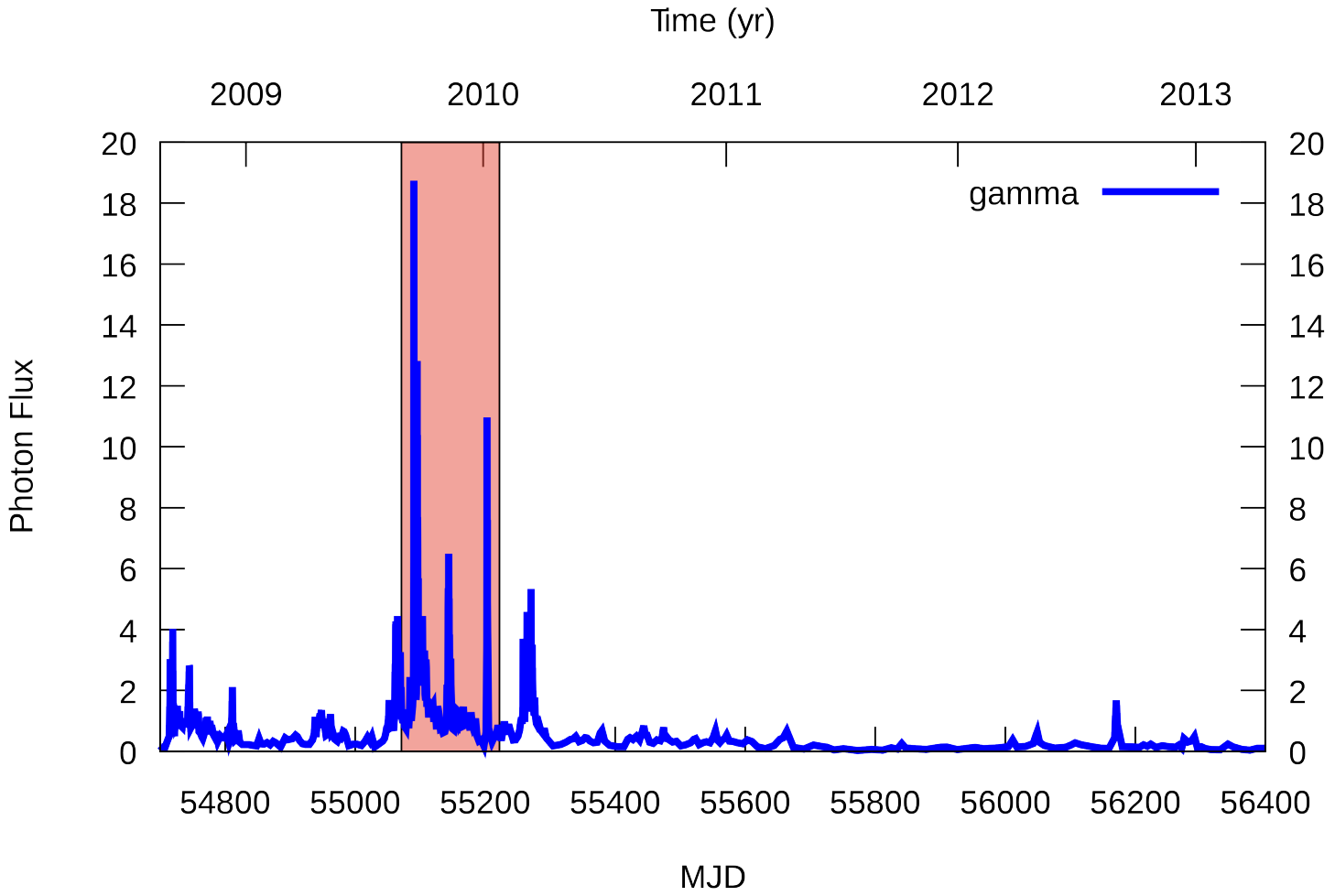
Motivation

Where does γ-ray emission originate?



Data

Fermi LAT



VLBA

6, 4, 2,

1.3 cm

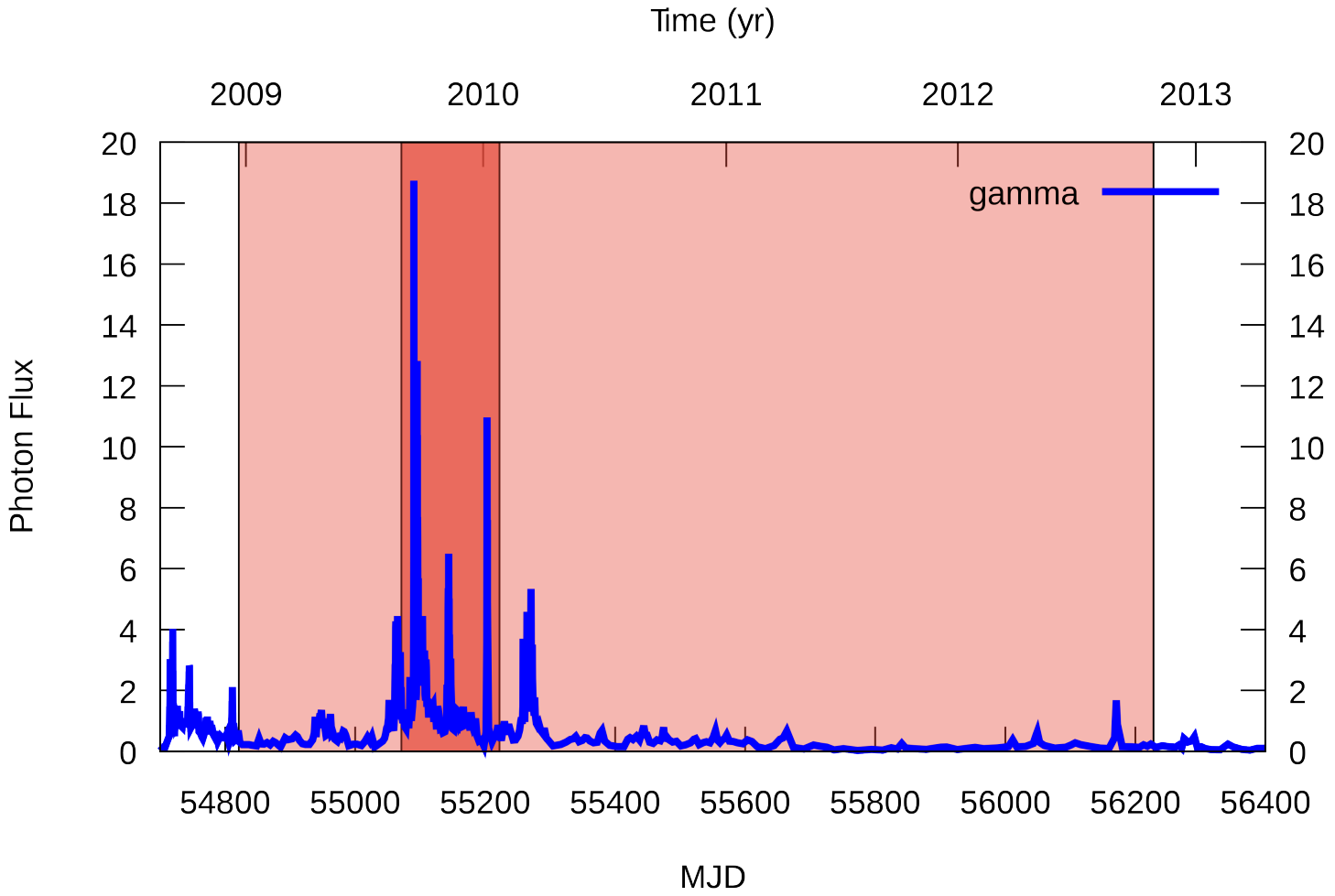
and 7 mm

4 epochs

2009-08-28
2009-10-25
2009-12-05
2010-01-26

Data

Fermi LAT



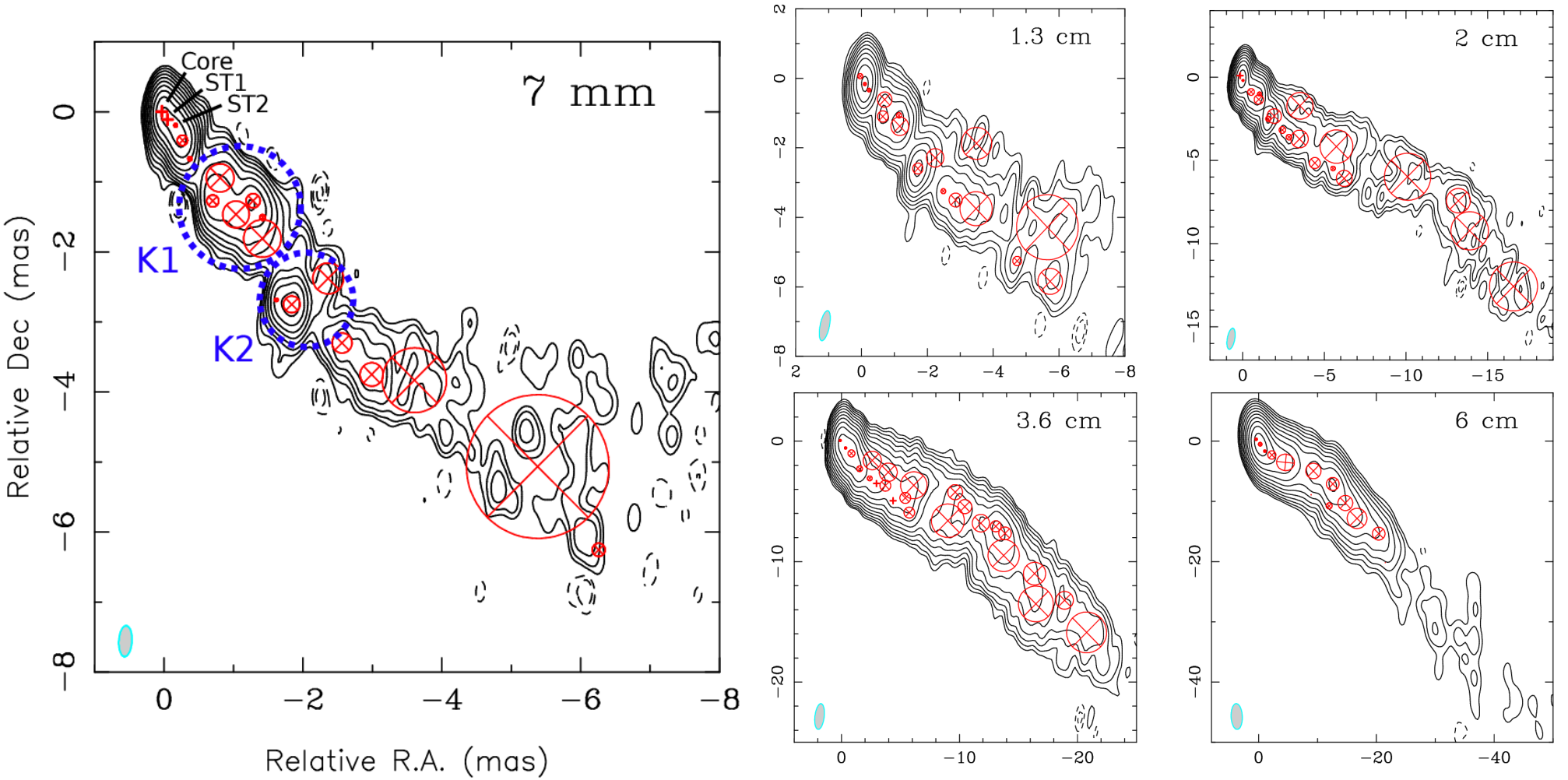
VLBA

7 mm

40 epochs

4 years

Fitting 3C273 structure with Gaussian components



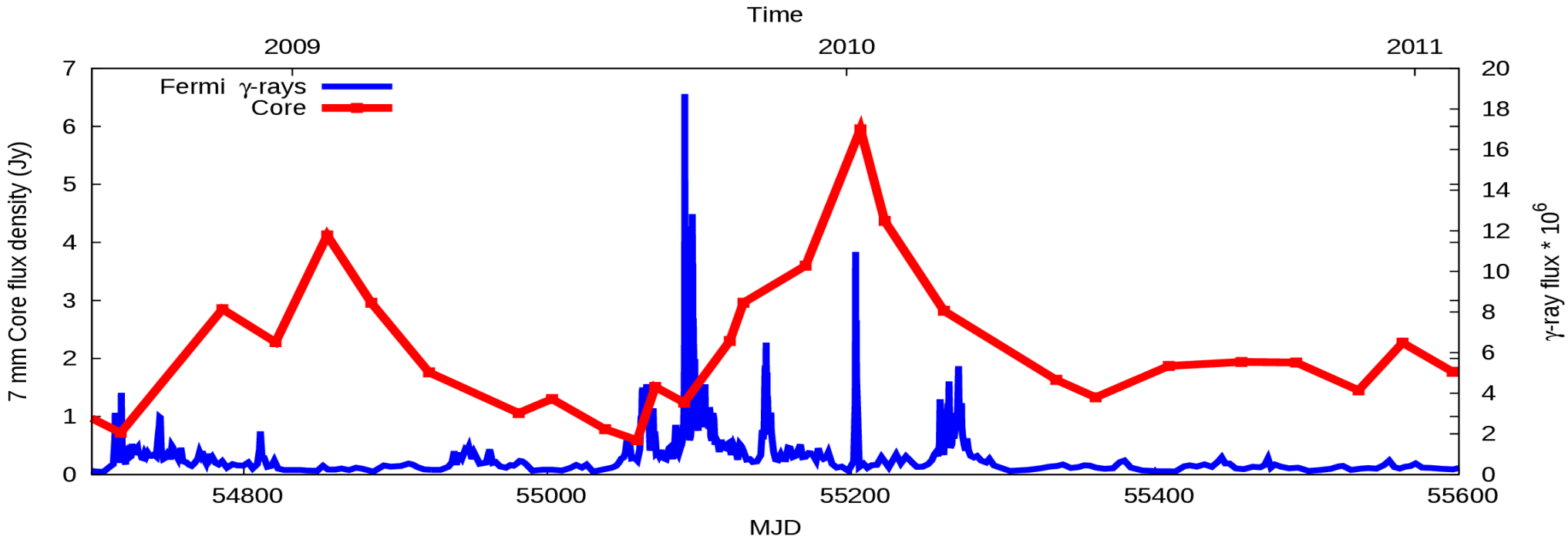
Light curves analysis

Light curves cross-correlation

γ

$$\Delta\tau = 112 \pm 9\, days$$

7 mm Core

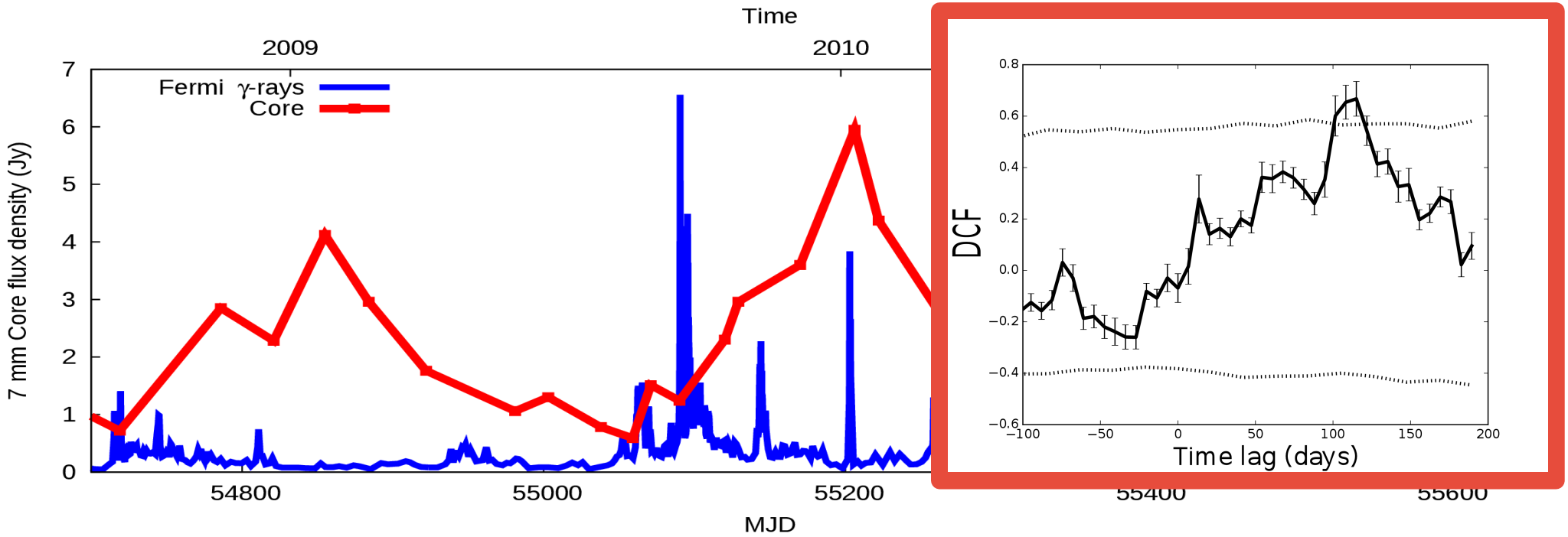


Light curves cross-correlation

γ

$$\Delta\tau = 112 \pm 9\, days$$

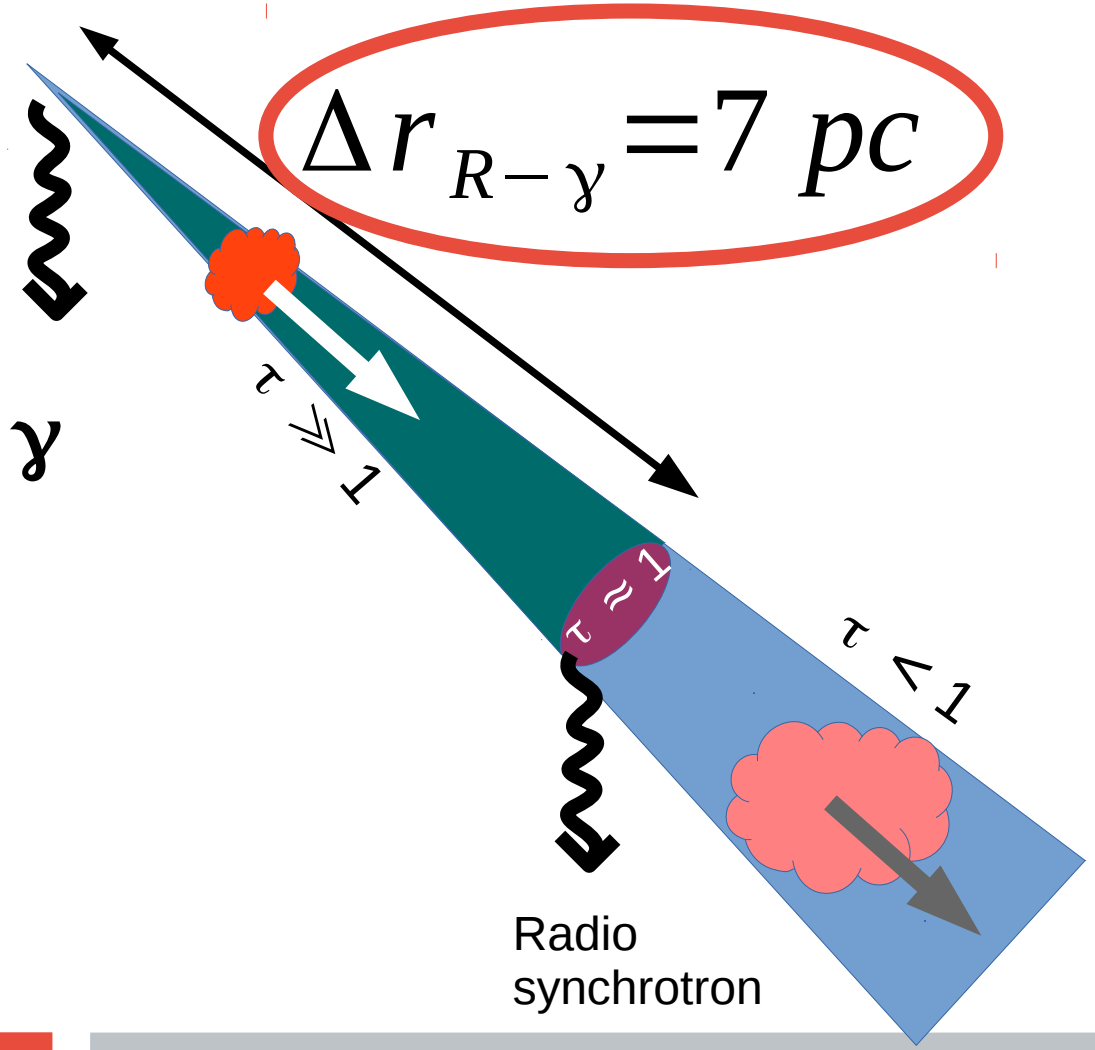
7 mm Core



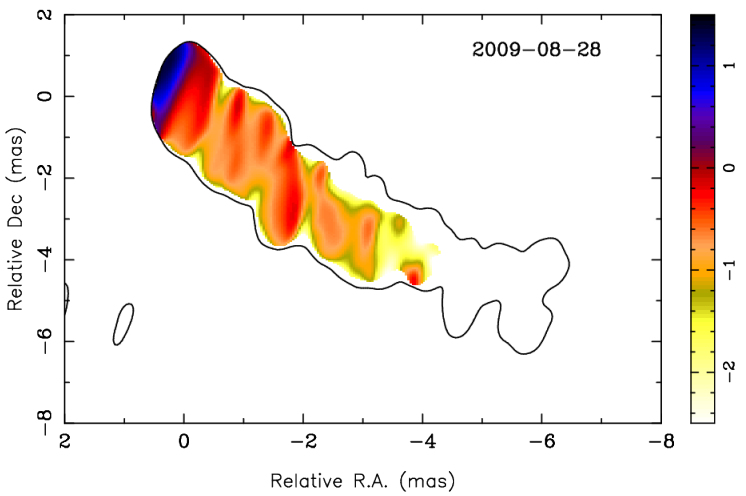
7 mm VLBI core to γ-rays distance

$$\Delta r_{R-\gamma} = 7\ pc$$

$$\Delta r_{R-\gamma} = \frac{\beta_{app}\, c\, \Delta t^{obs}_{R-\gamma}}{(1+z)\sin\theta}$$



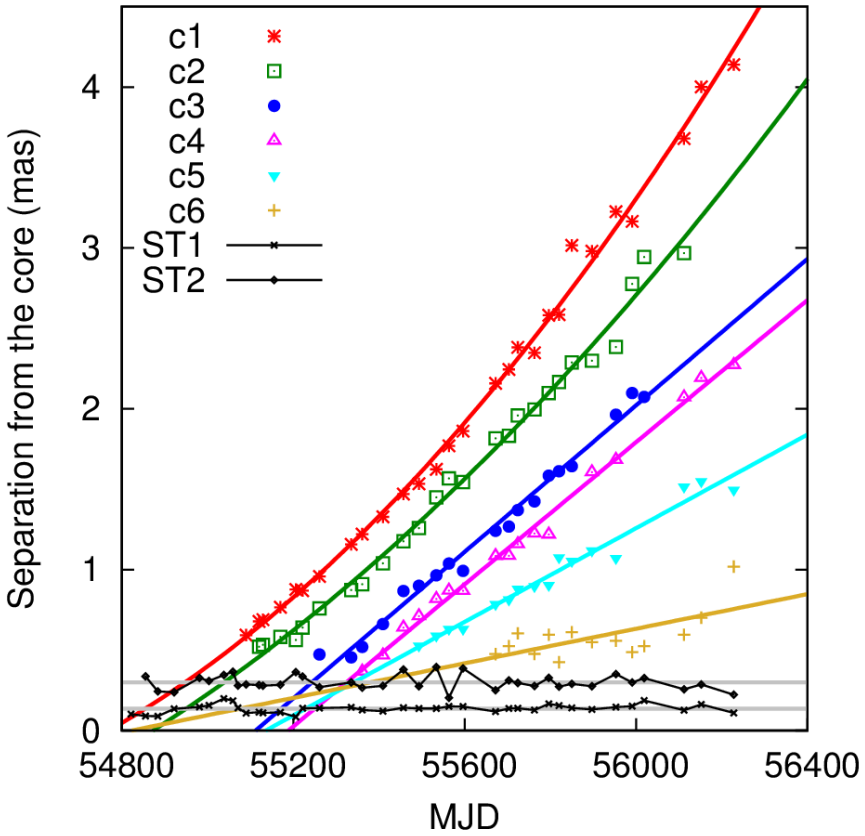
24 GHz – 43 GHz spectral index

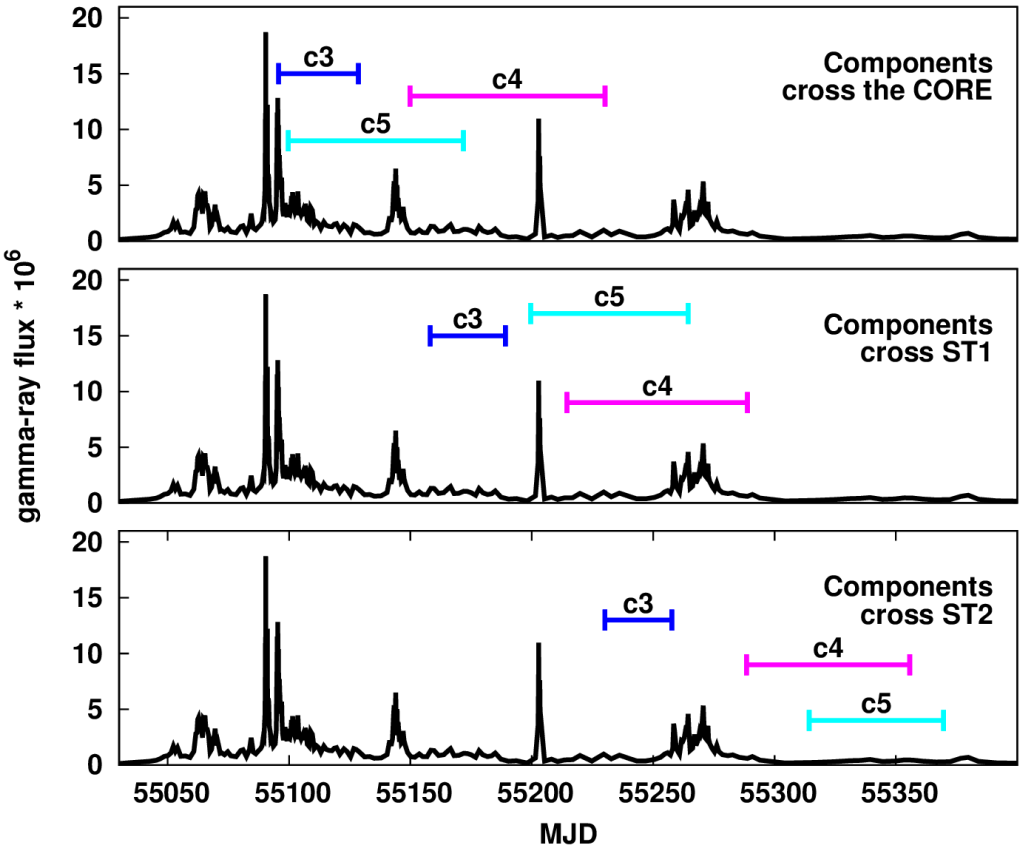


Component kinematics at 7 mm

Do γ-ray flares occur in the parsec scale jet of 3C273 ?

Moments of passing the core and stationary features do not coincide with the most powerful γ-ray flare.

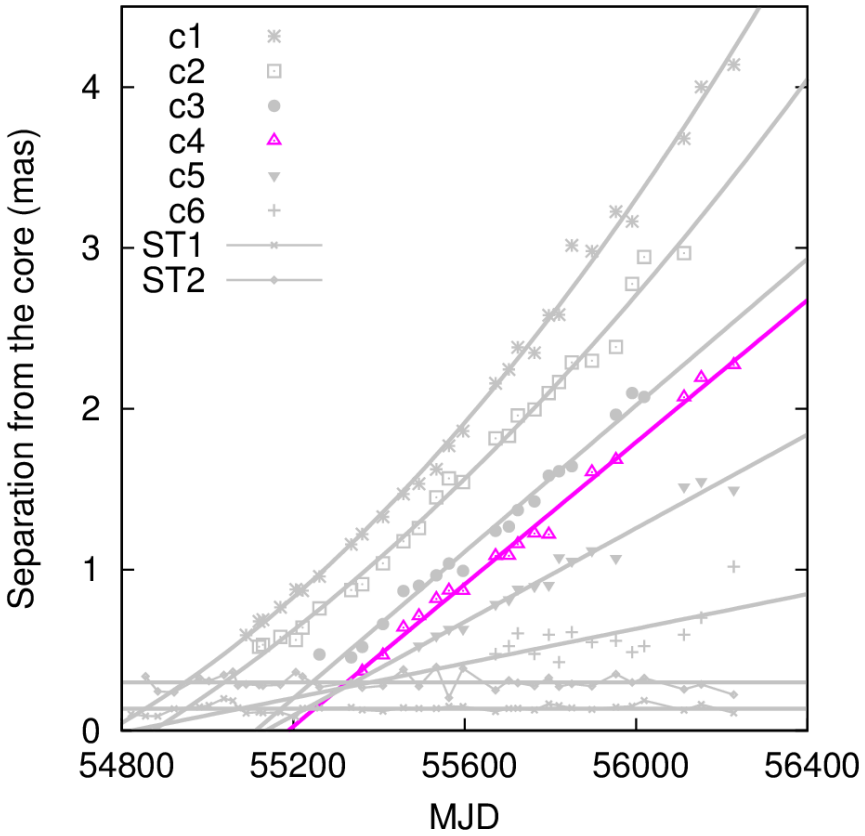




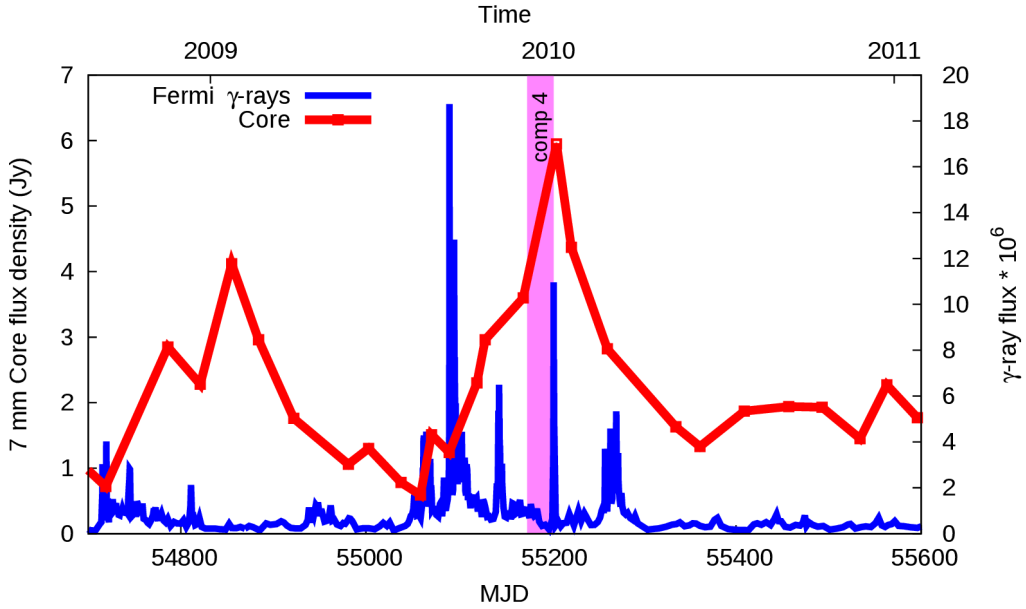
But can we at least associate any component with a γ-ray flare?

C4: μ=0.8 mas / yr

S_{max} = 6 Jy

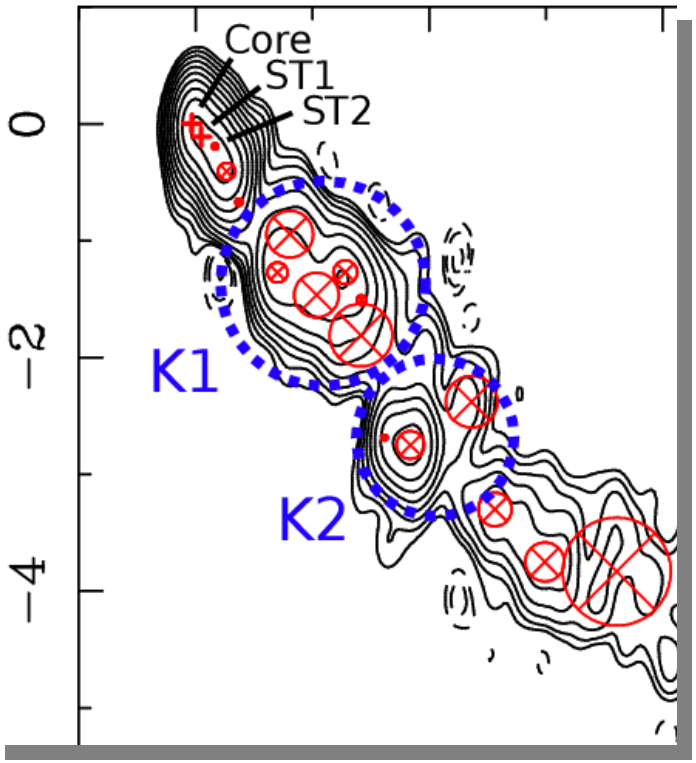


Component c4 was at the γ-ray emission site contemporaneously with the most powerful γ-ray flare

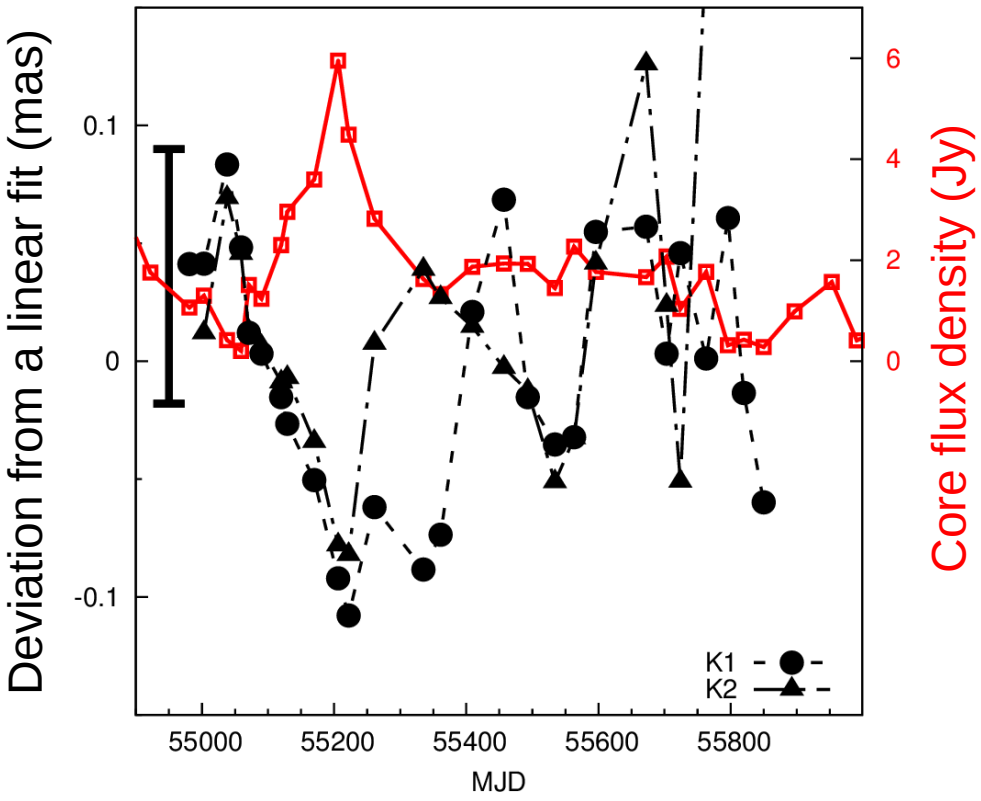


Cluster kinematics at 7 mm

Core shuttle

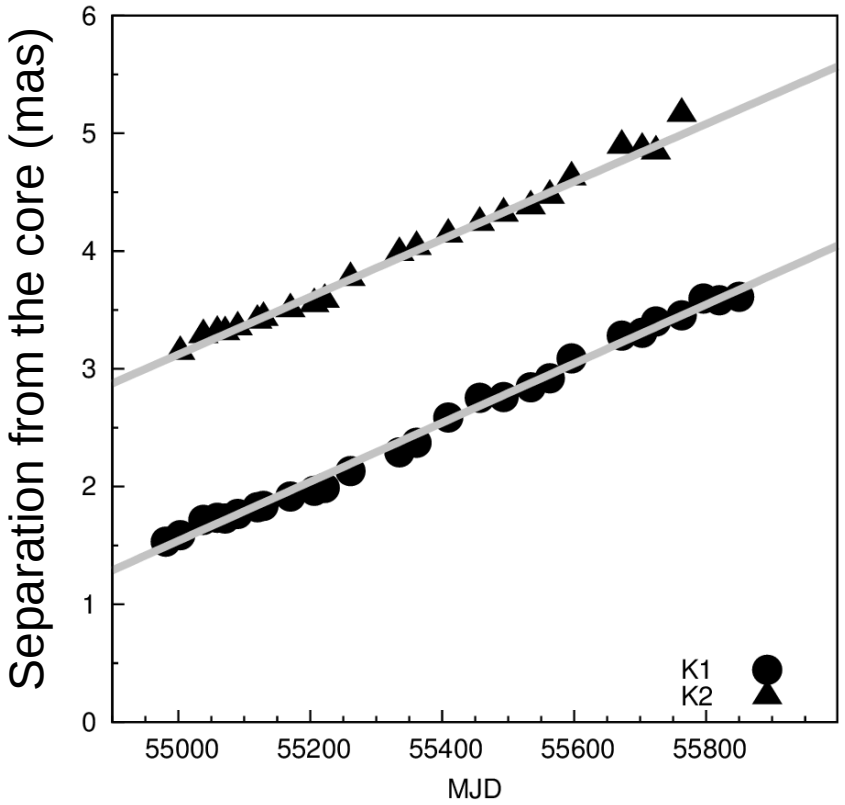


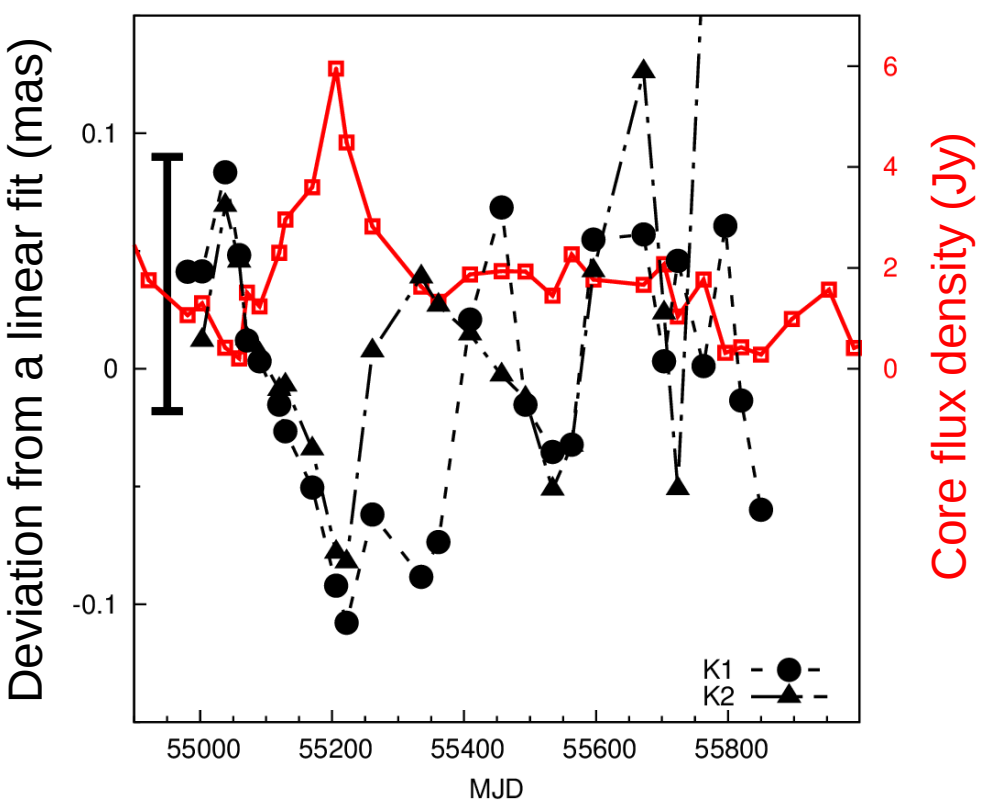
Chance probability ~ 0.001



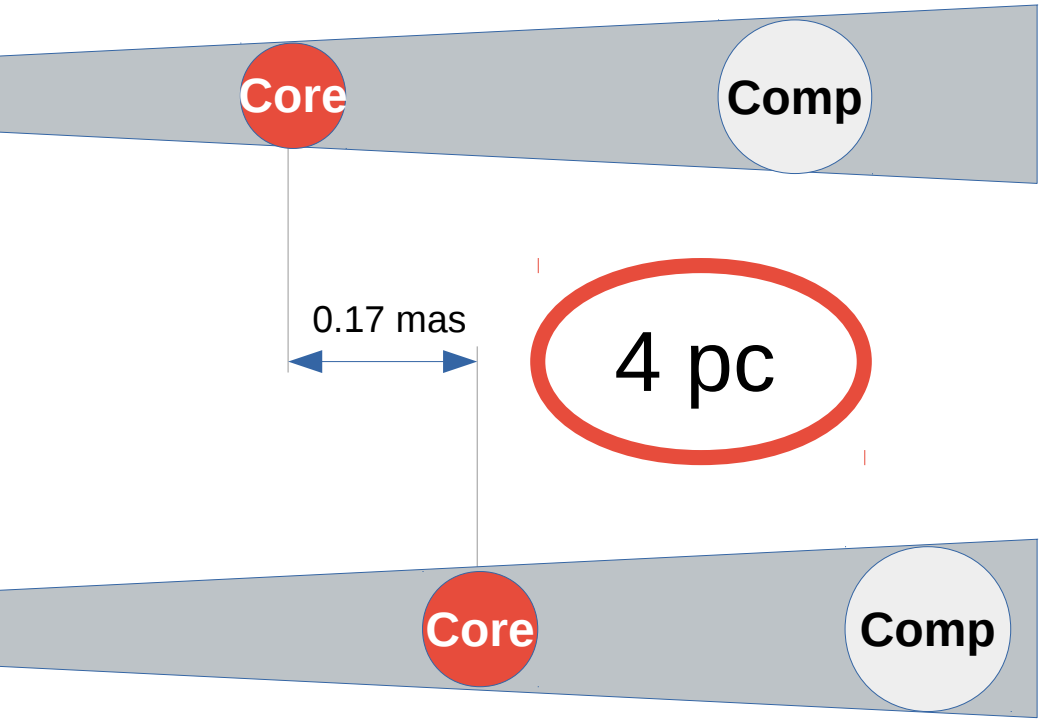
Core shuttle

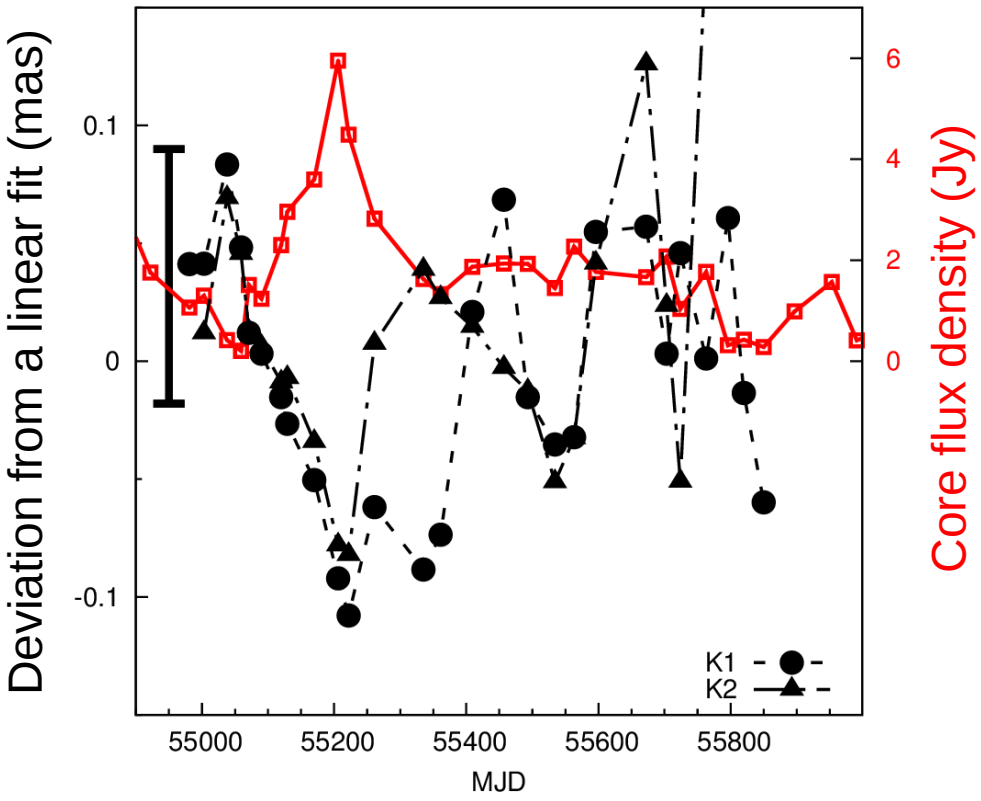
Chance probability ~ 0.001





Core shuttle

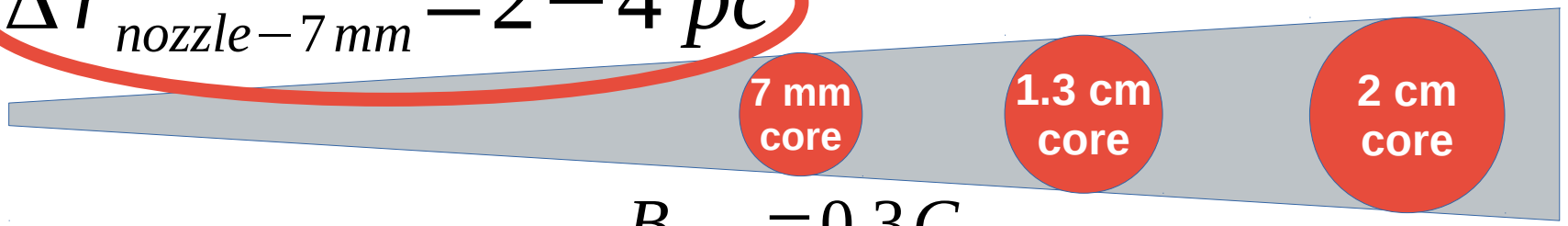




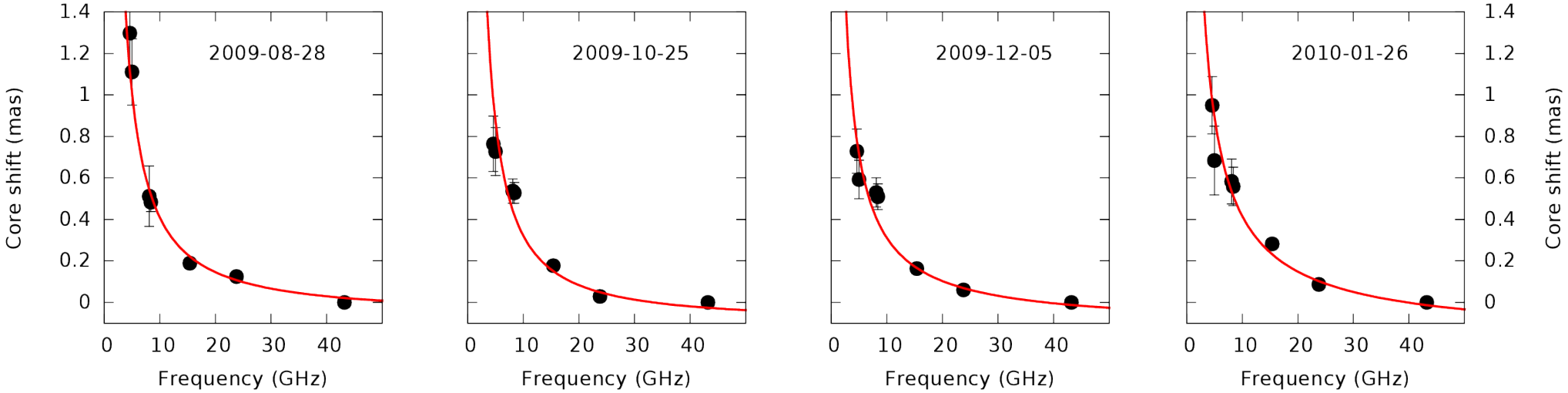
Core shift

Core-shift

$$\Delta r_{nozzle-7\,mm} = 2-4\ pc$$

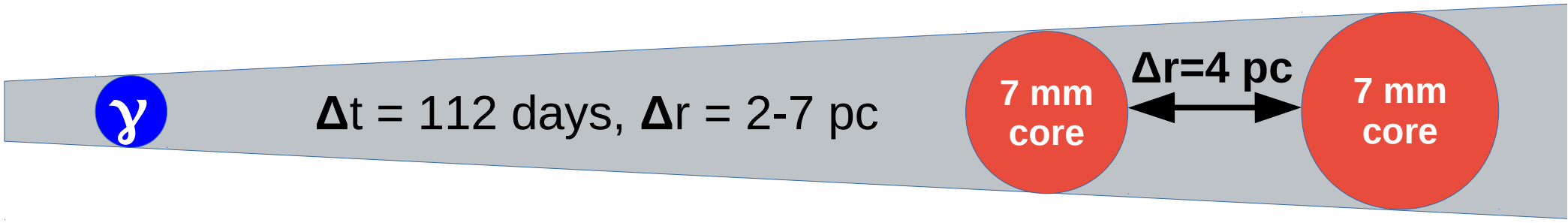


$$B_{7\,mm} = 0.3\,G$$



Conclusions

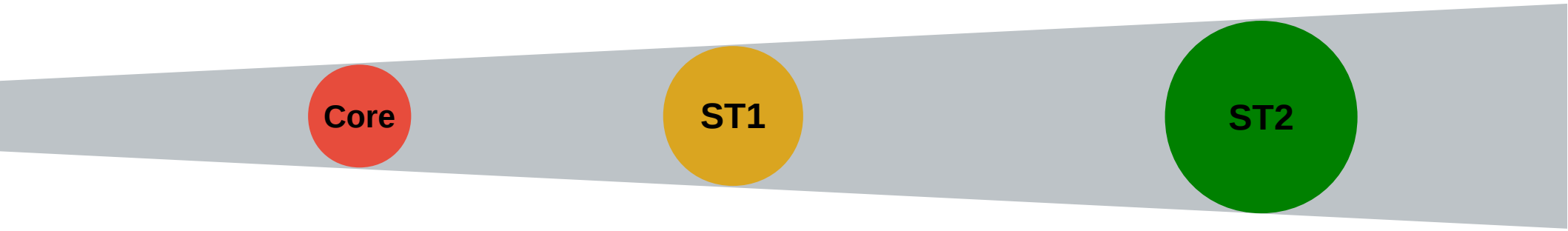
- We locate the γ-ray emission site 2-7 pc upstream from the 7 mm core, near to the apex of the jet

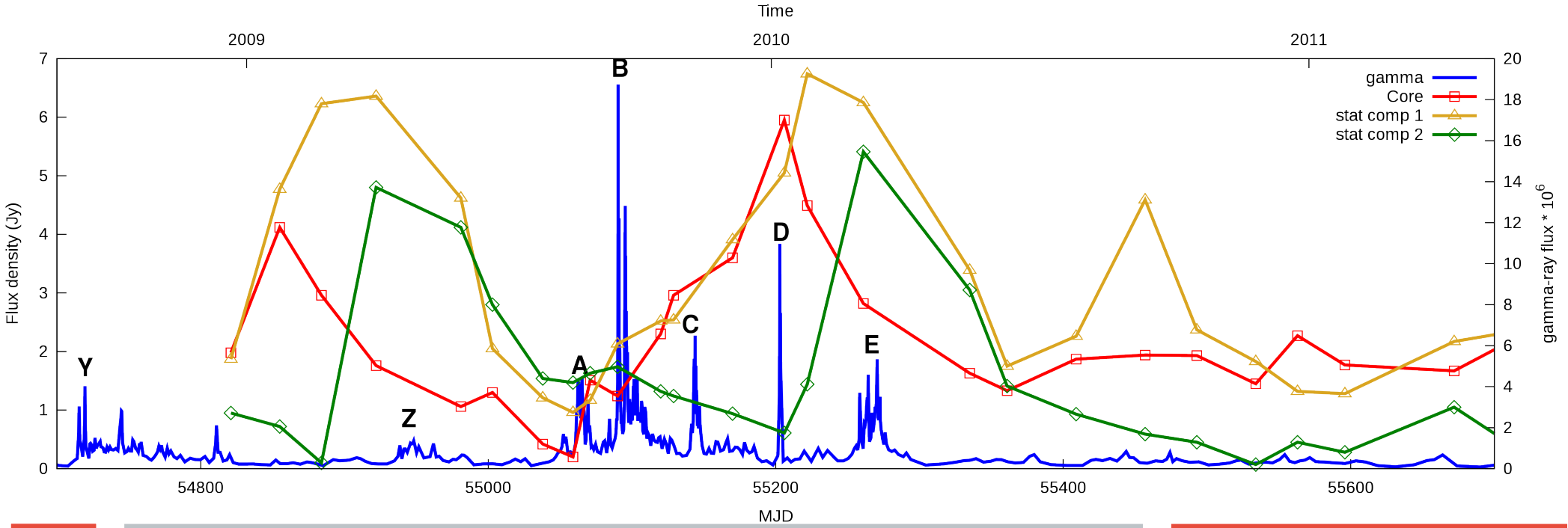


- Radio flare is mostly caused by the raise of N_e rather than B-field, which is almost constant at the position of 7 mm core: $B_{7\ mm} = 0.3$ G
- Component, assosiated with the major γ-ray flare has the highest Flux density

Thank you

Light curves cross-correlation





Comparison with other methods

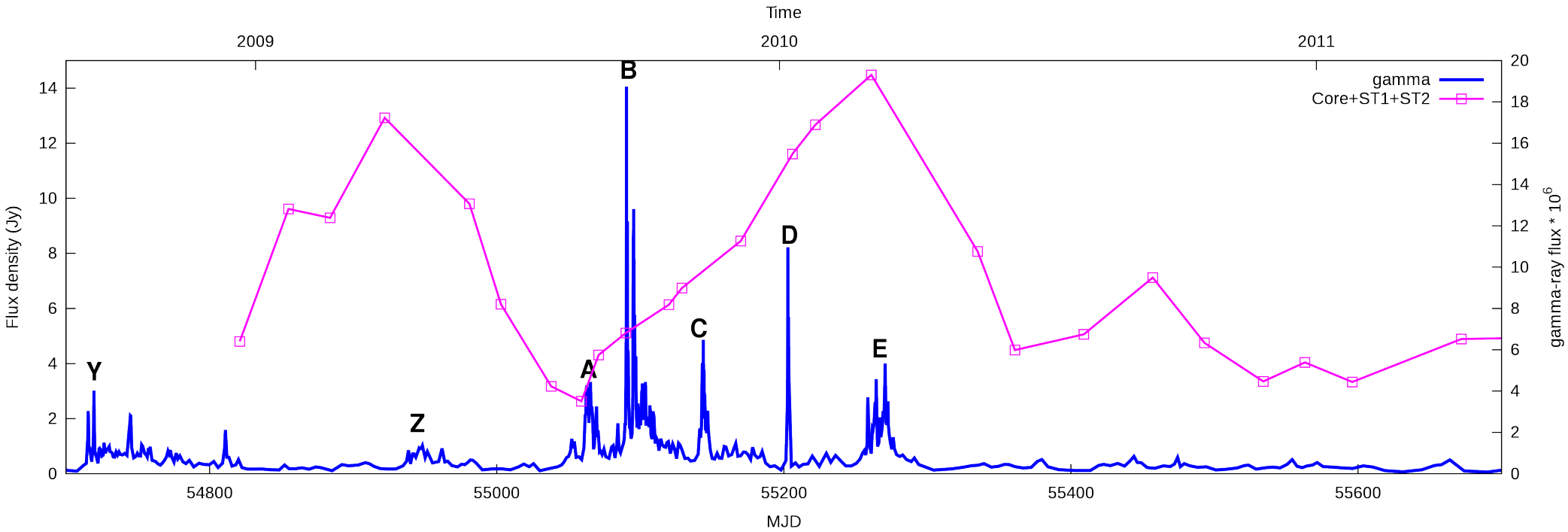
$r_\gamma < 1.6\,pc$
Rani et. al. 2013

γ

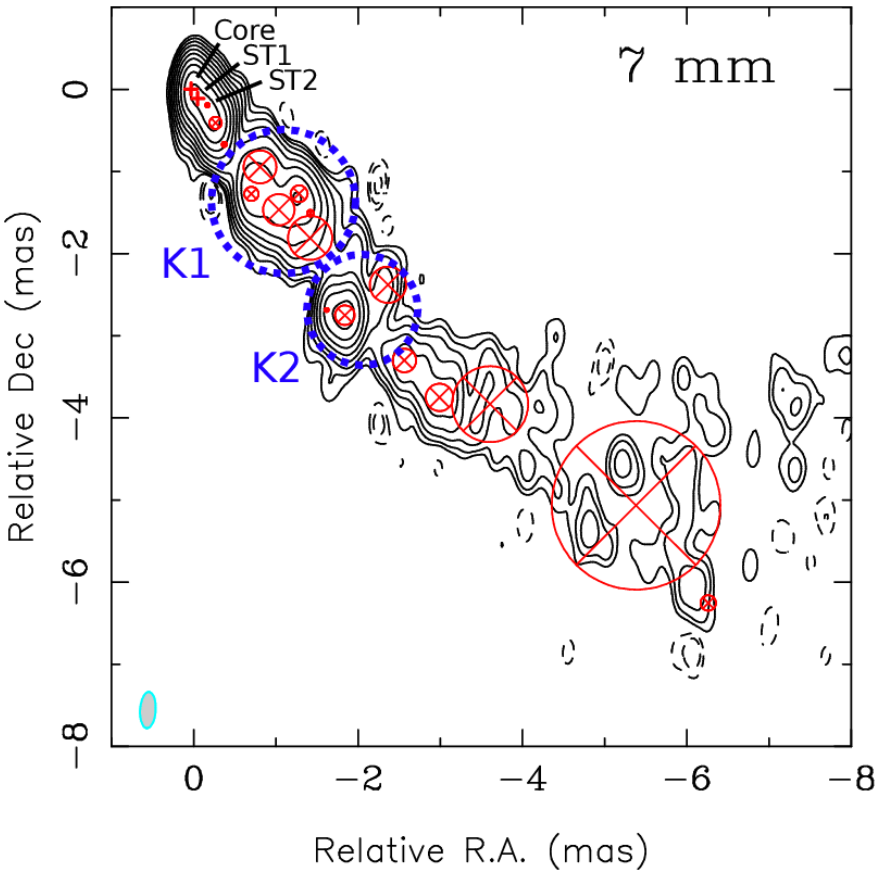
$\Delta\tau = 170\,days$
$\Delta\tau = 160\,days$

Core+ST1+ST2
Ramakrishnan et.al. 2015
Chidiac et al. 2016

Core+ST1+ST2



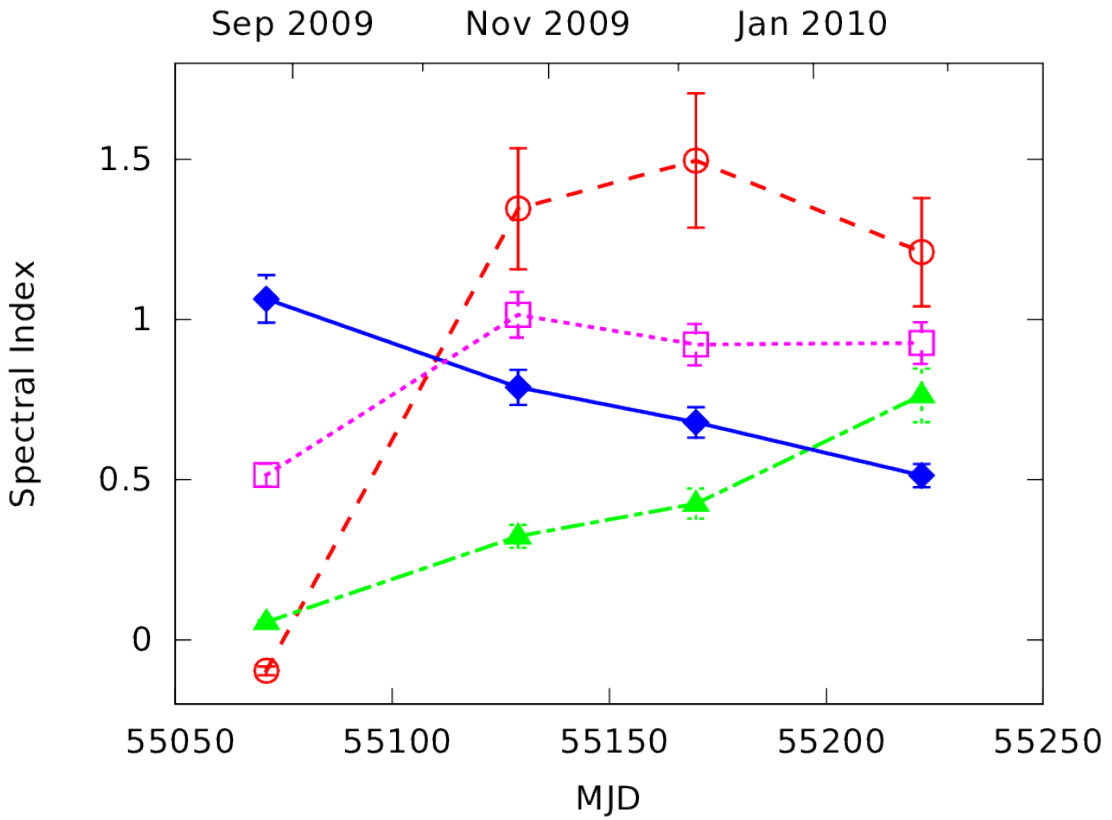
Cluster kinematics at 7 mm



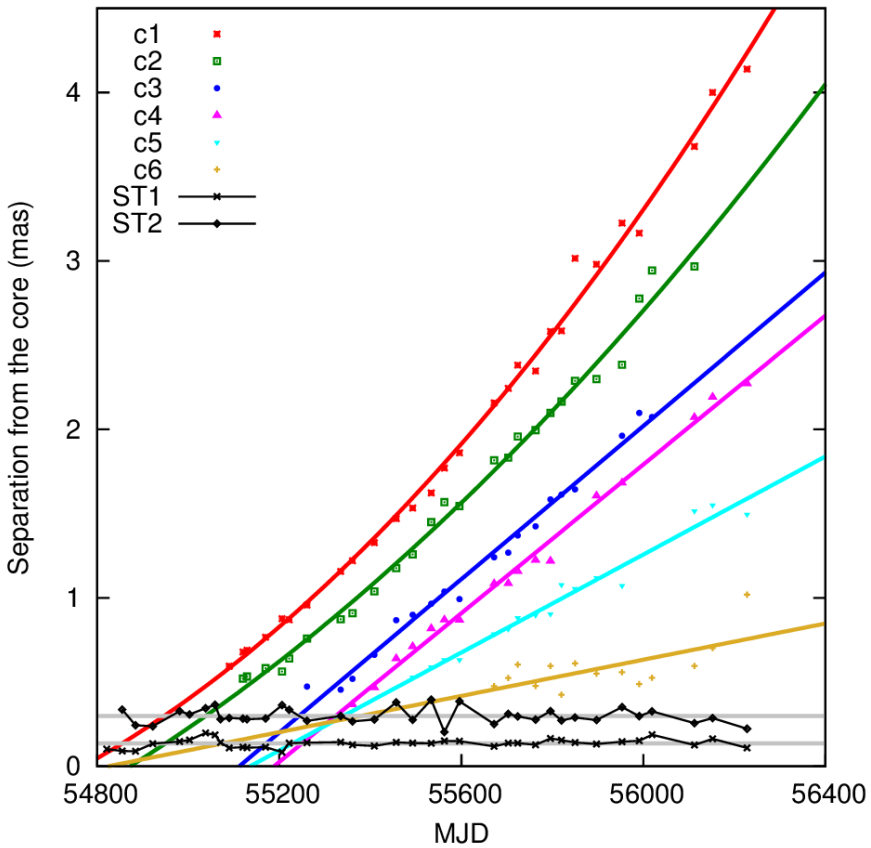
$$r_{cluster} = \frac{\sum_i F_i r_i}{\sum_i F_i}$$

Spectral index

Core spectral index



7 mm kinematics

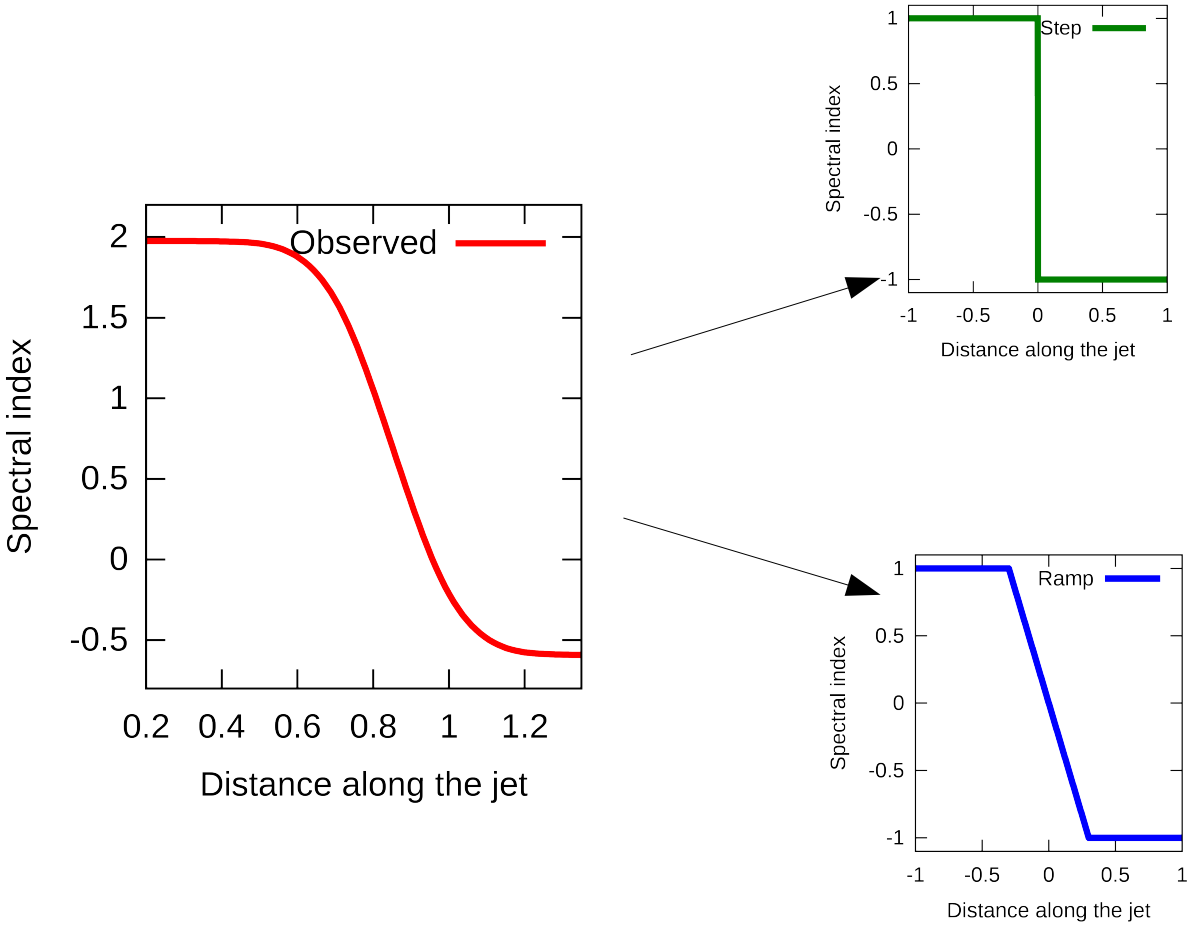
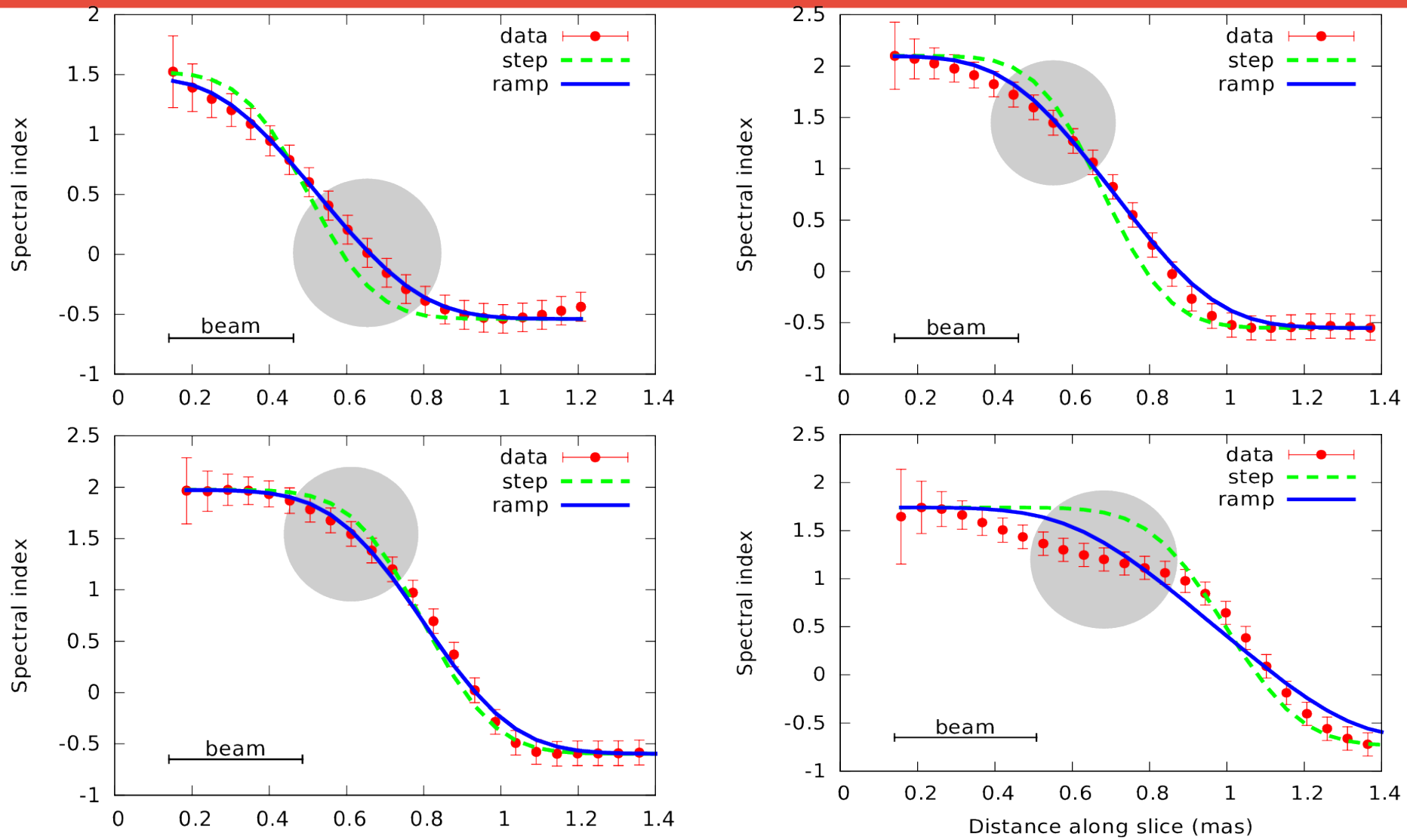


Comp	Ejected (MJD)	Speed (mas/yr)	Accel (mas/yr /yr)
1	54837	1.17 (0.85)	0.26
2	54885	0.96 (0.87)	0.17
3	55112	0.83	-
4	55188	0.81	-
5	55135	0.53	-

$T_b \sim 10^{12}$ K

S ~ 6 Jy

Transition through τ=1



Transition through τ=1