The connection between the radio jet evolution and the gamma-ray light curve in 3C 120

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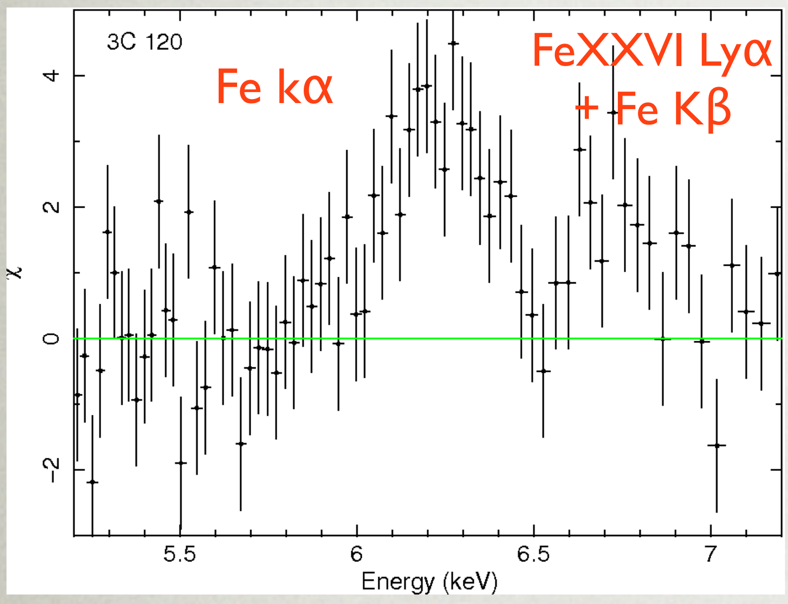
Casadio et al. in prep

The FRI RGs 3C 120

- relative nearby FRI radiogalaxy (z=0.033)
- blazar-like properties ⟶ superluminal motions
- X-ray properties similar to Seyfert galaxies



ppt - E.Torresi

X-ray emission from the disk

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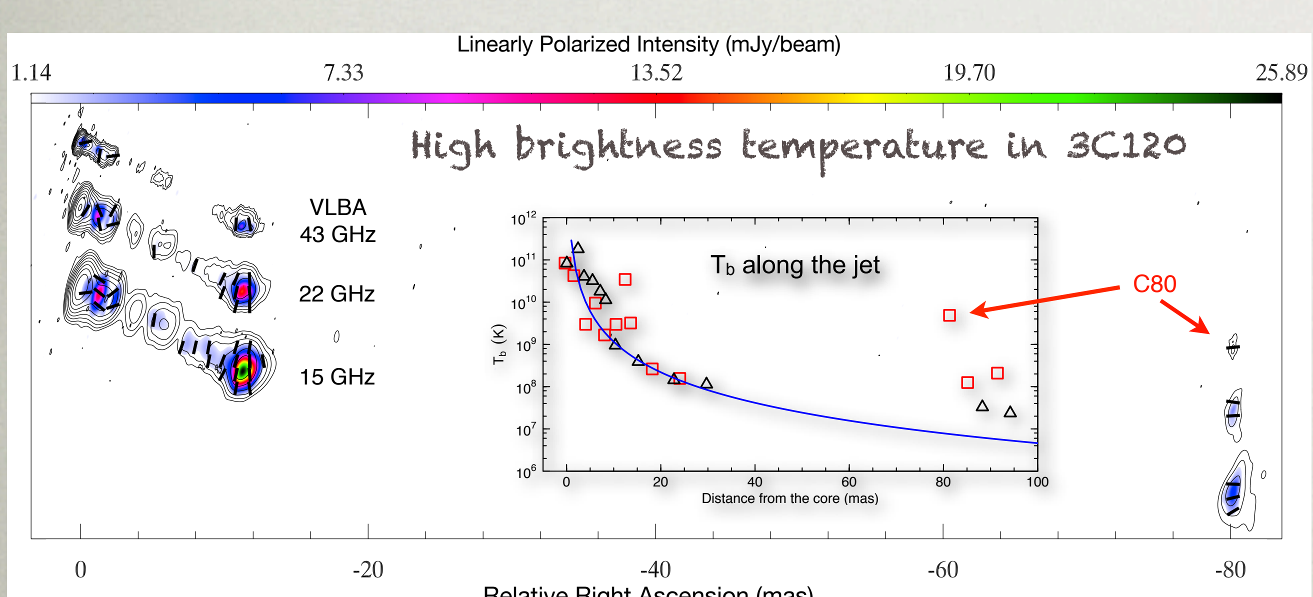
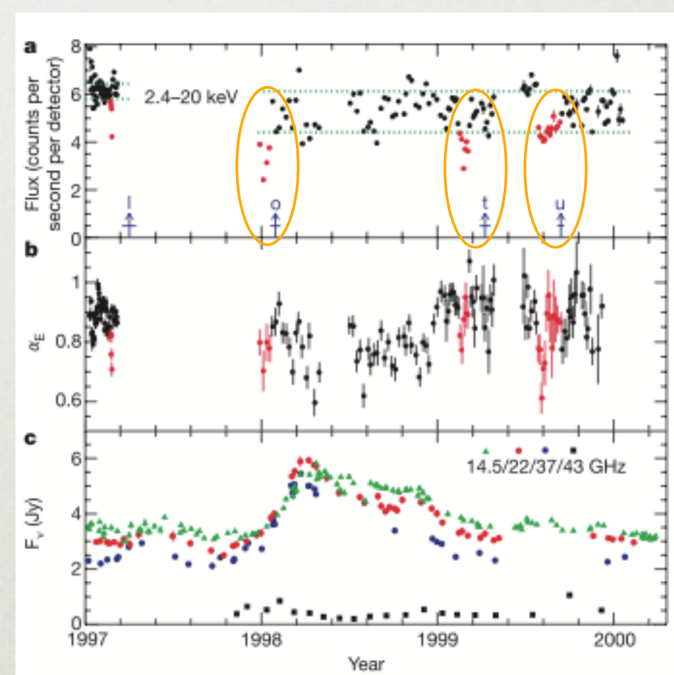
Strong connection between
disk and radio jet

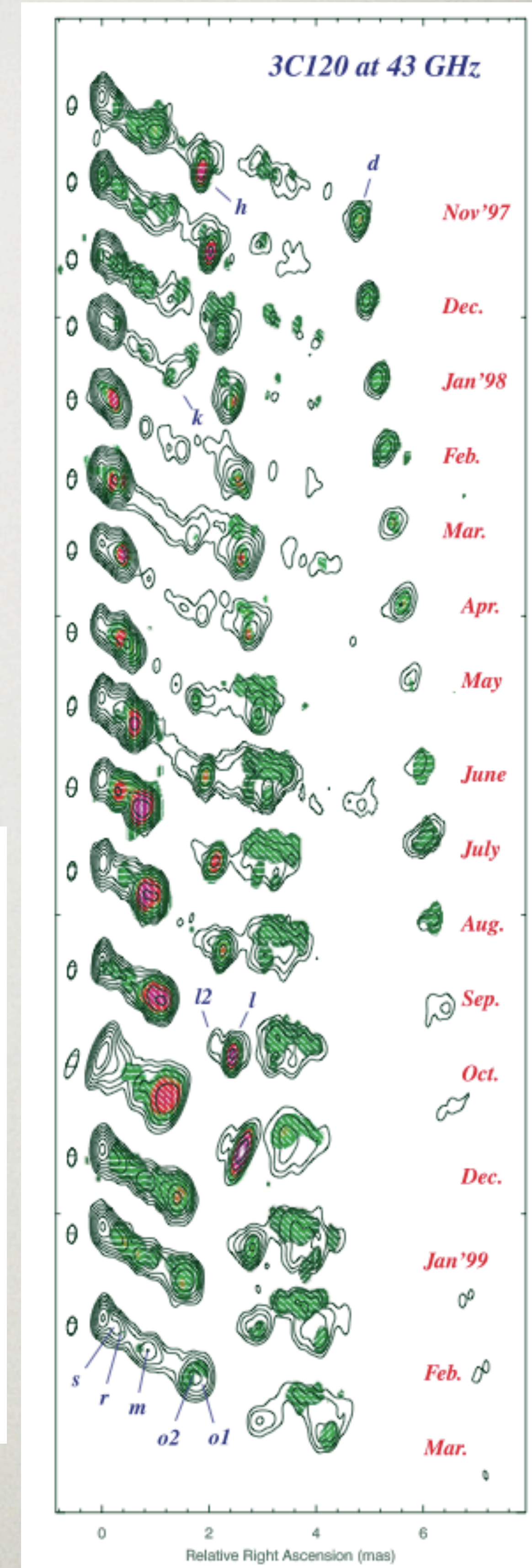
(Marsher et al.2002, Chatterjee et al. 2009)



Roca-Sogorb et al. 2010



Marsher et al.2002



Gomez et al. 2001

3C 120 (FR I) and 3C 111(FR II).. similar BLRGs

Fermi MAGNs sample: 3C 120 and 3C111 the two BLRGs detected in the GeV photon energy range

3C 120 and 3C 111.. properties in common:

- BLRGs (iron line at 6.4 KeV)
- disk + corona system (Haard & Maraschi 1991)
- disk - radio jet connection → X-ray dips between the ejection of a new radio component (Chatterjee et al. 2011)

Grandi et al. 2012 - Localize the gamma-ray emission region in 3C 111

↓

The GeV flare in late 2008 occurs during the ejection of a new bright know from the radio core

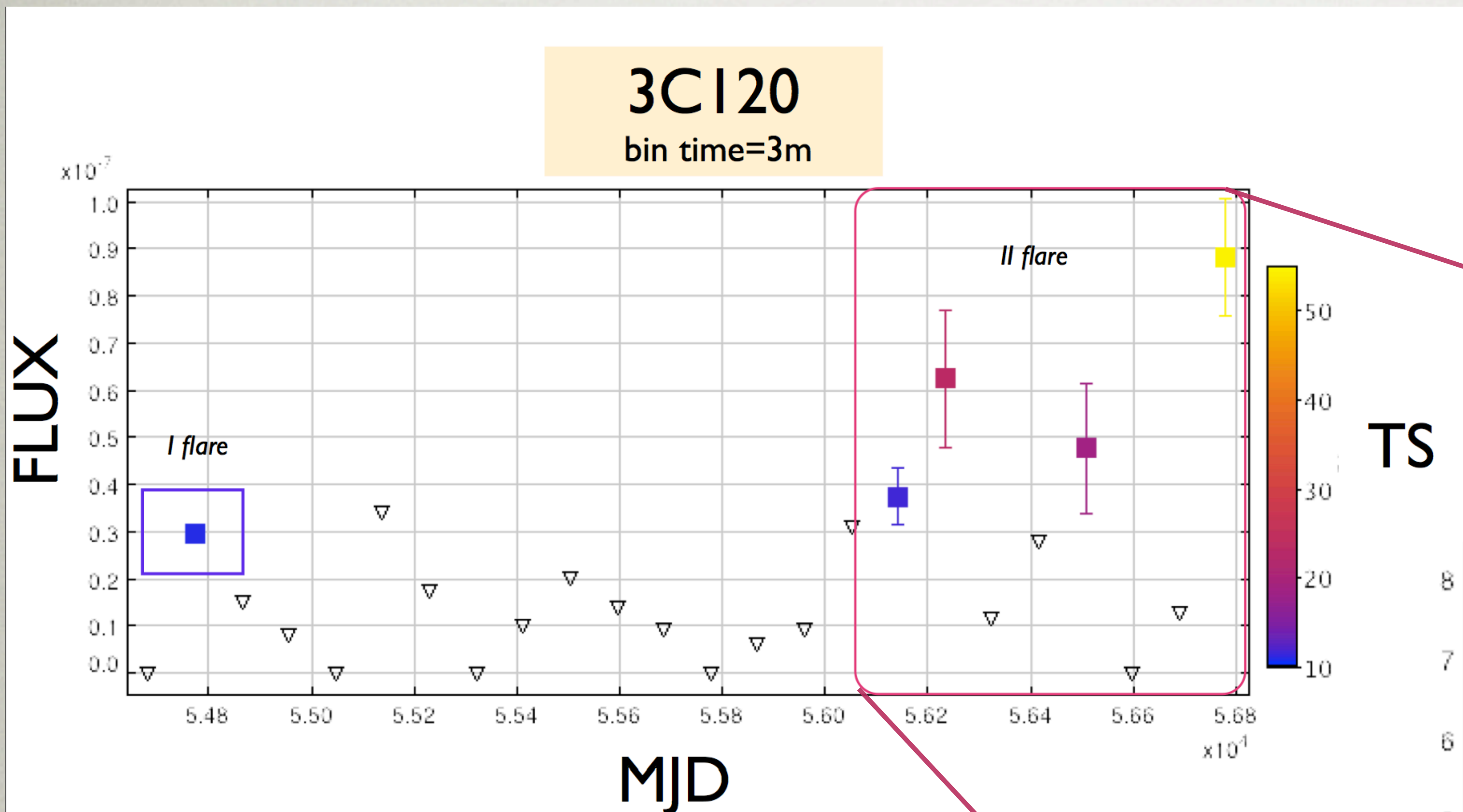
First time for a FR II RGs !

... is it the same for 3C 120?

Previous findings on FR I RGs:

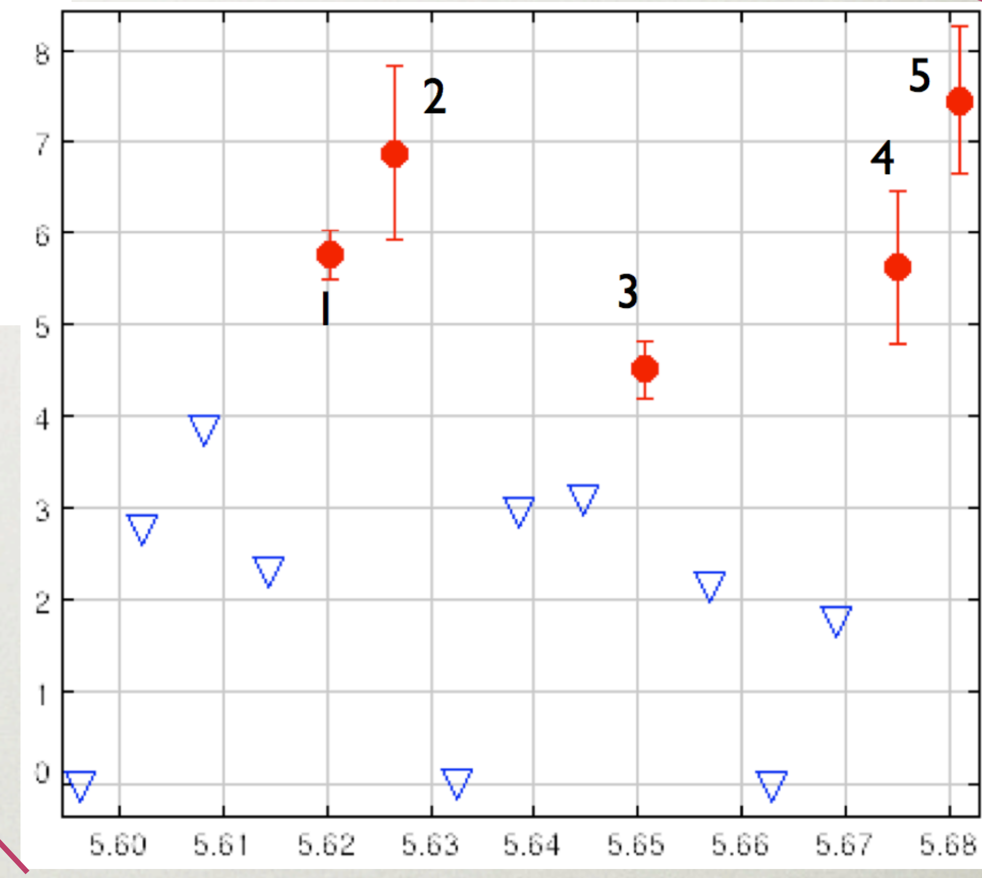
- NGC 1275 ɣ-ray variability on time scale of months + M87 TeV variability (Hada's talk) → ɣ-ray emission from compact regions
- ɣ-ray emission from the radio lobes of Centaurus A

3C 120 - *Fermi* Detections



thanks to P.Grandi & E.Torresi

bin time = 2 months



I - FLARE : 2008_11_03 --- 2009_02_03

II - FLARE : 1) 2012_10_03 --- 2012_12_03

2) 2012_12_03 --- 2013_02_02

3) 2013_08_03 --- 2013_10_03

4) 2014_04_03 --- 2014_06_03

5) 2014_06_03 --- 2014_08_03

+

24 September 2014, LAT detected a very bright ɣ-ray flare from 3C 120 (~ **1.0 x 10^-6 ph cm^-2 s^-1**) (ATel#6529)

3C 120 -The Radio Dataset (MOJAVE + VLBA-BU-BLAZAR)

MOJAVE data

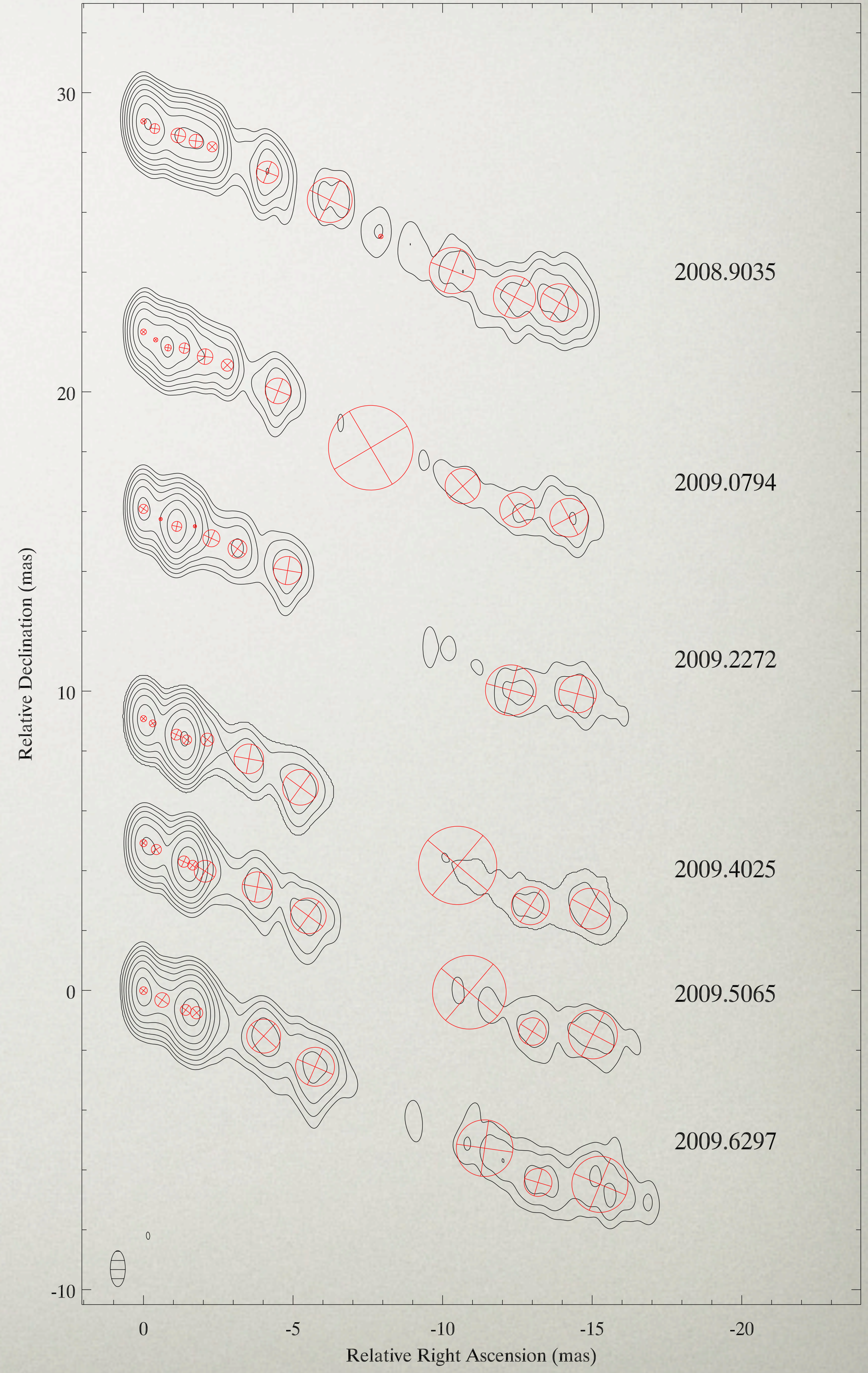
(VLBA at 15 GHz)

46 epochs covering the period of the first and second gamma-ray flare: **June 2008 - August 2013**

VLBA-BU-BLAZAR data

(VLBA at 43 GHz)

21 epochs covering the period of the second gamma-ray flare: **January 2012 - May 2014**



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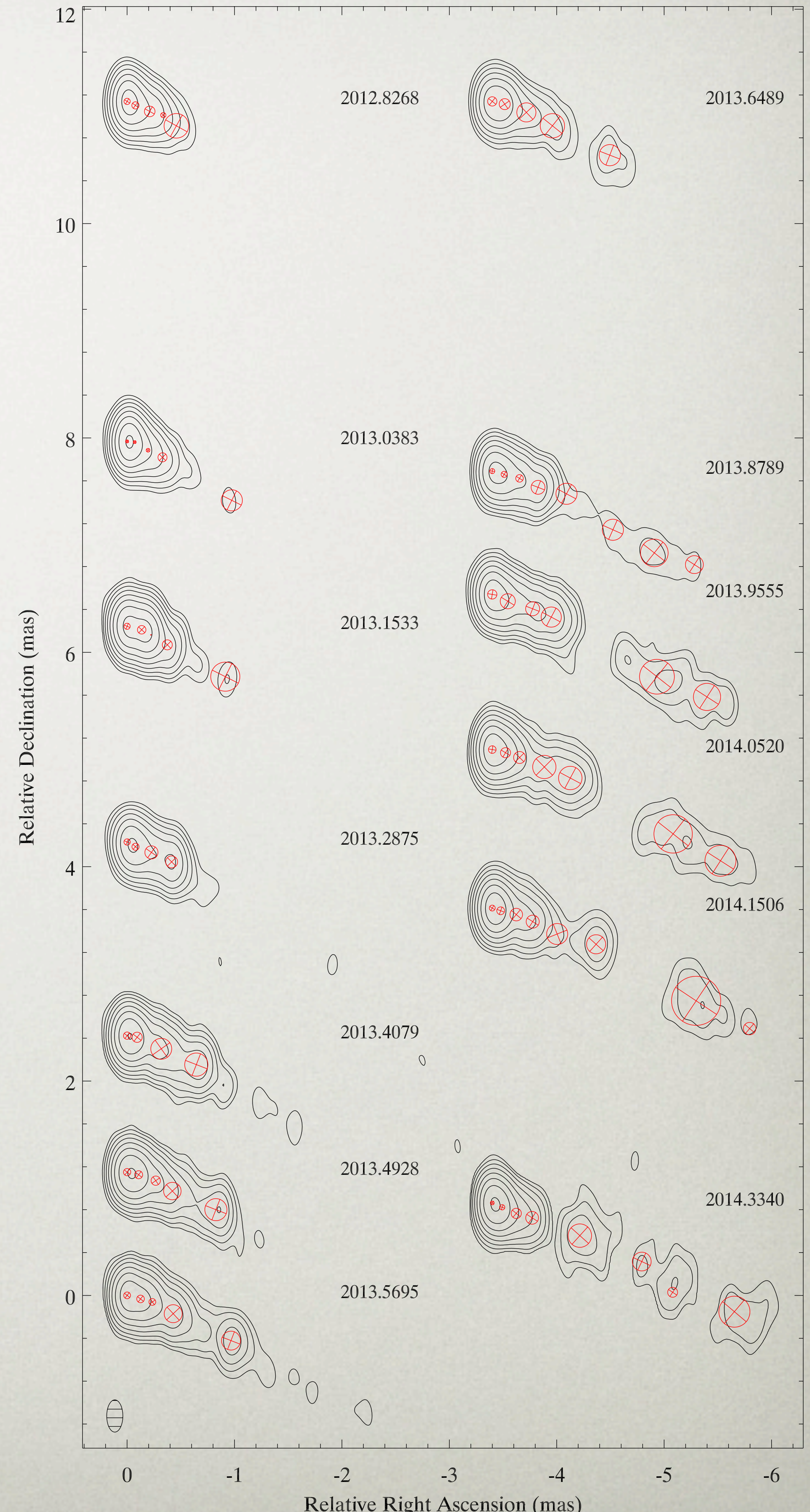

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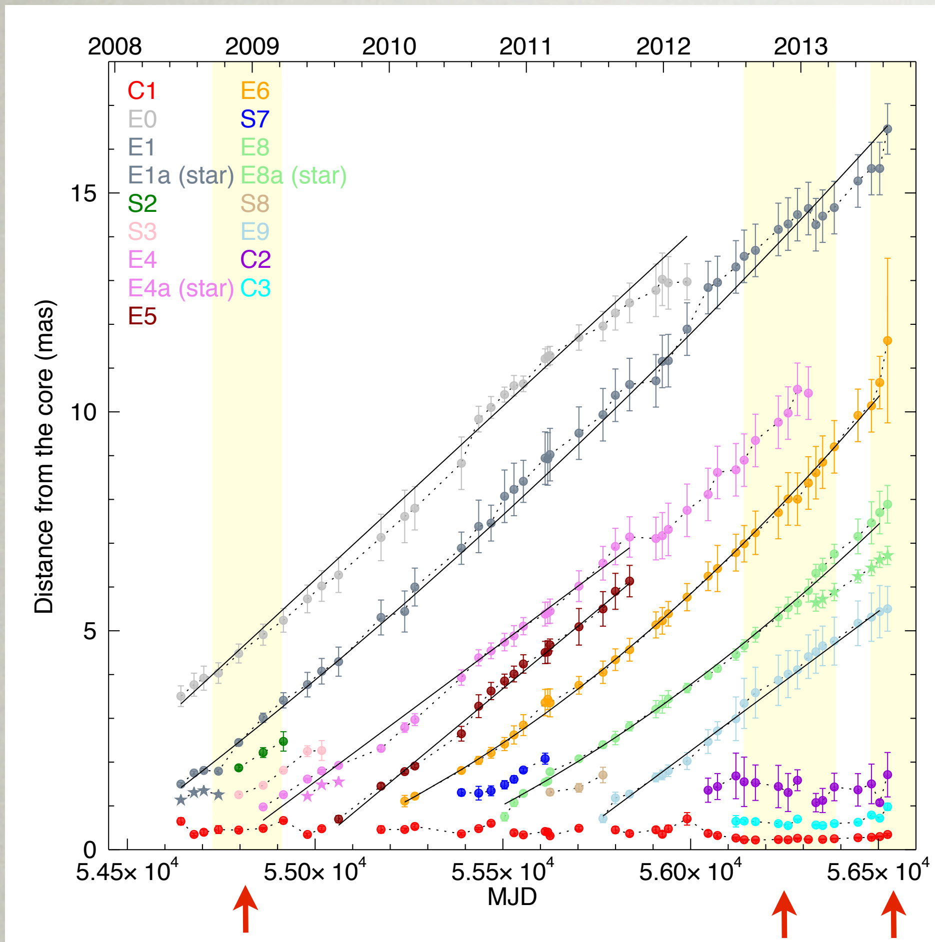
3C 120 - The Kinematics and Flux density variability at 15 GHz



I° ɣ-ray

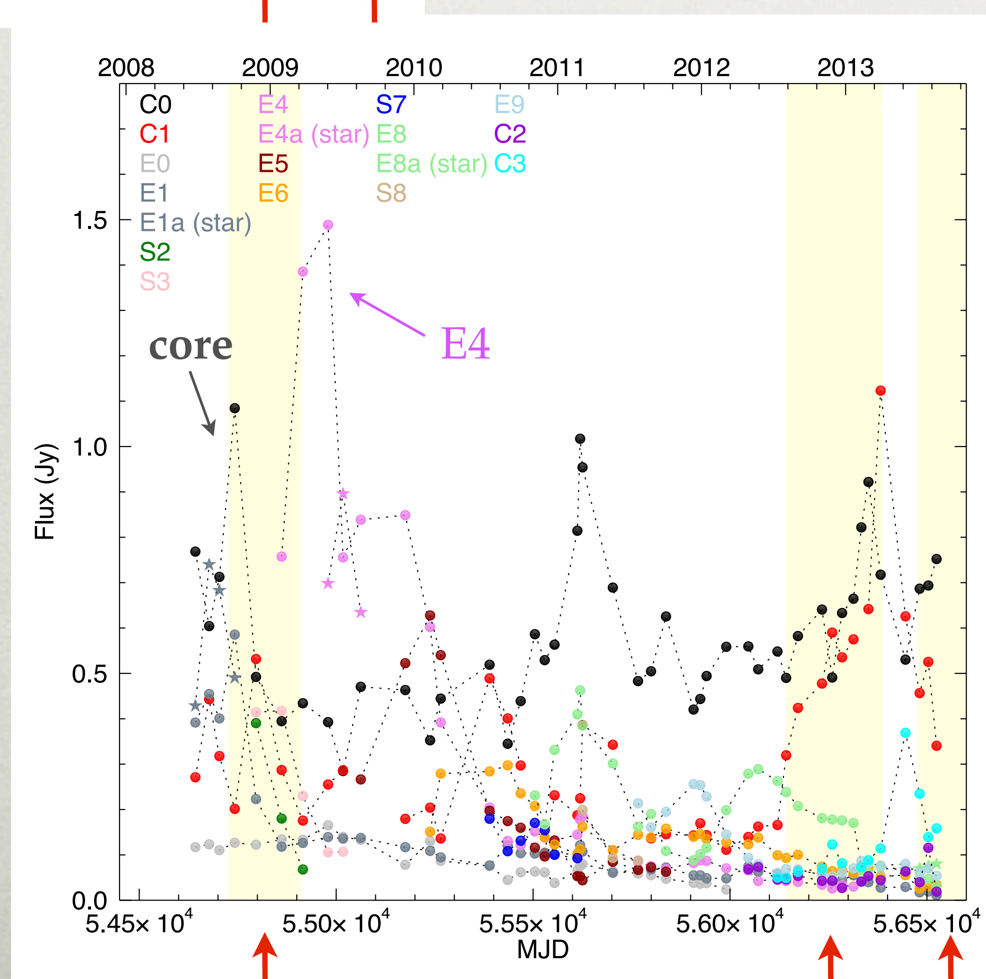
I ɣ-ray flare
(2008.8 - 2009.09)

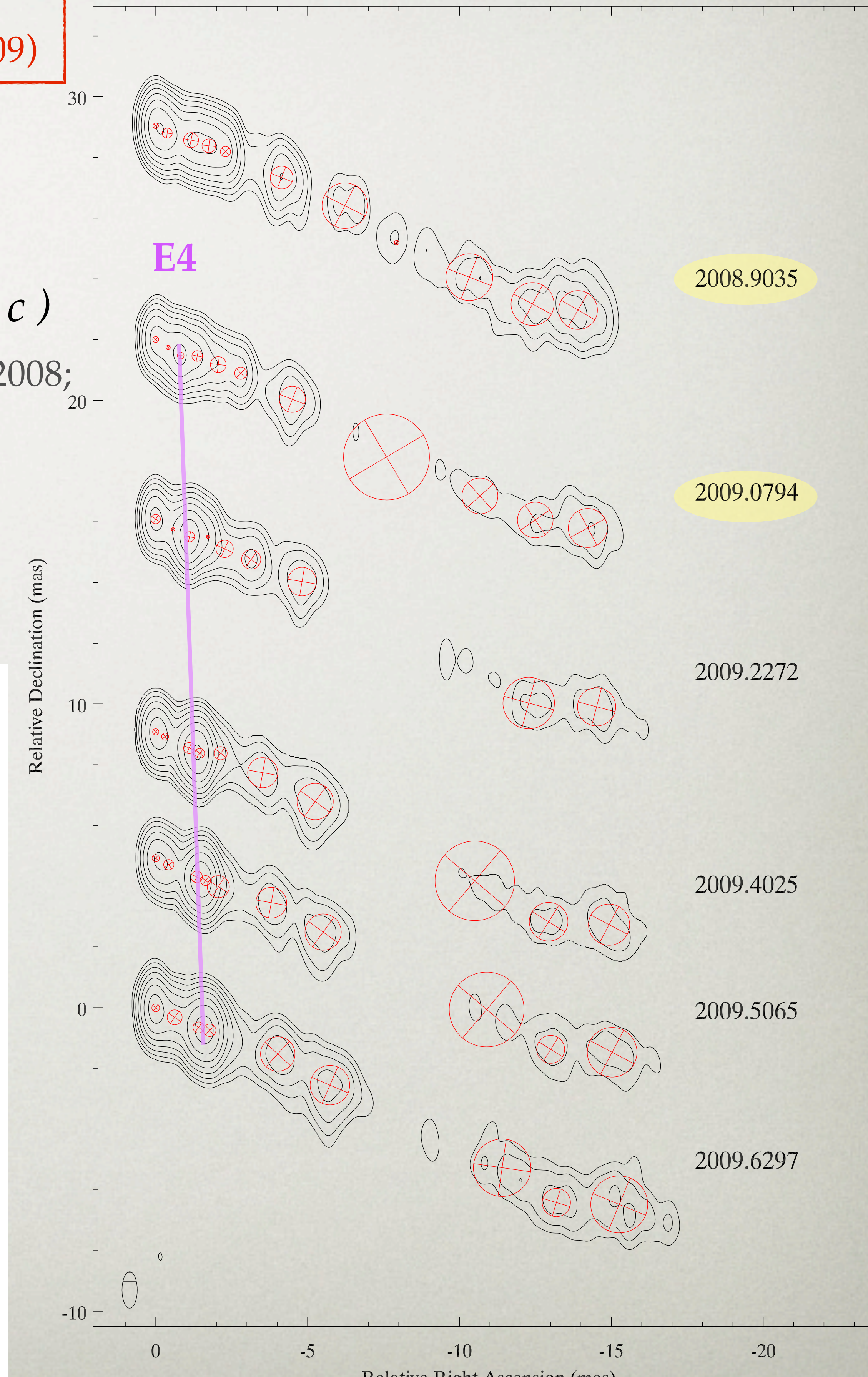
E4 Tej ~ **2008.79**

‹μ› ~ 2 mas/yr (~ 4.4 c)

(as in Gomez et al. 2001, 2008; Jorstad et al. 2005)

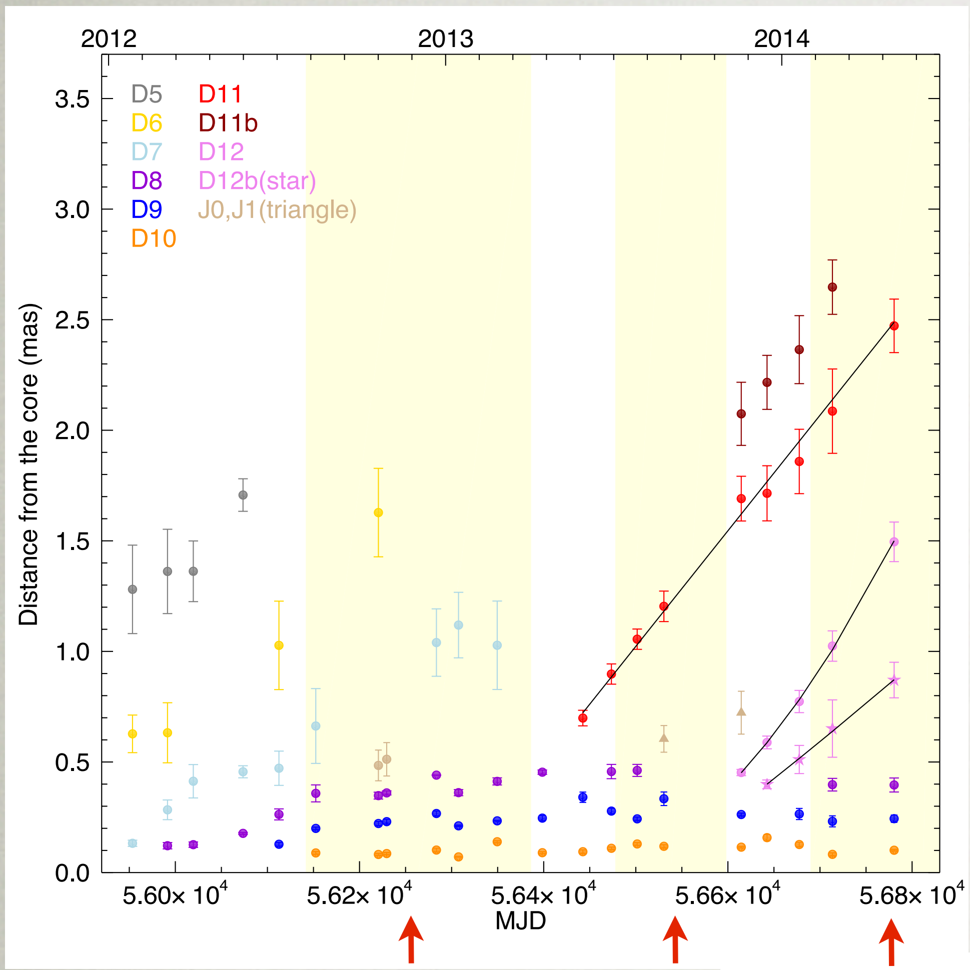
E4 peak flux
~ 1.5 Jy/beam





3C 120 - The Kinematics and Flux density variability at 43 GHz

II ɣ-ray flare
(20012.75 - 2014.58)



2º ɣ-ray

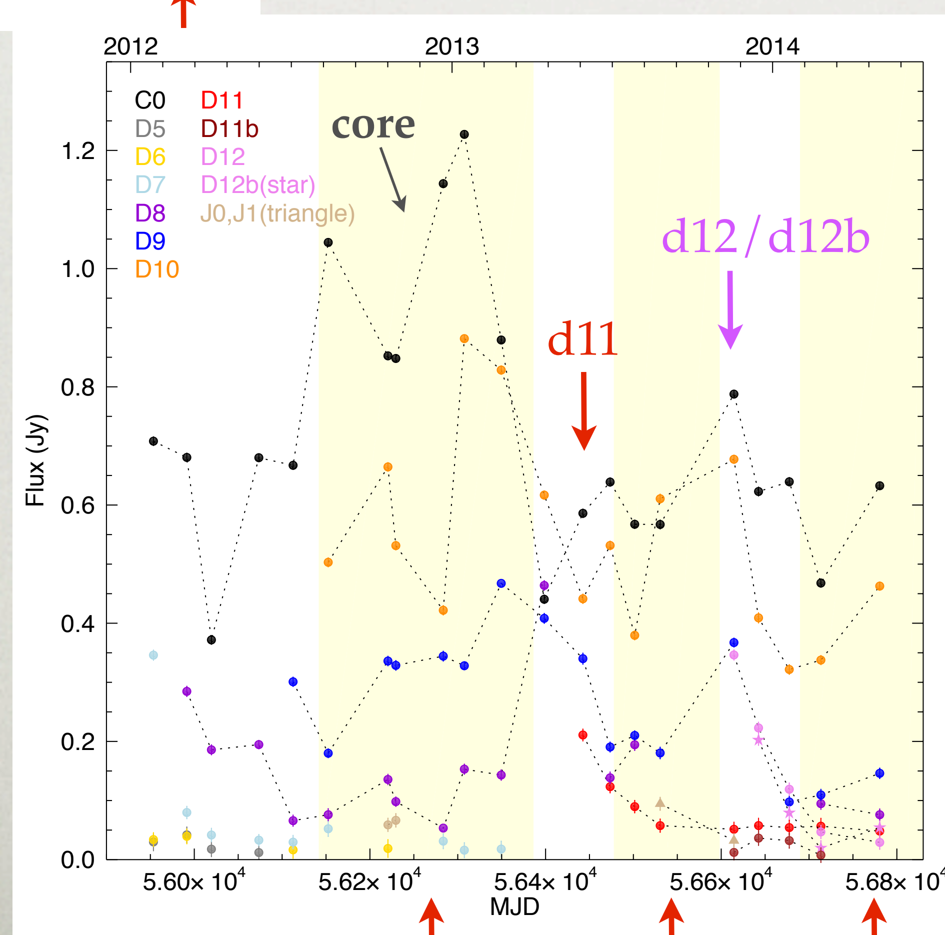
d11 Tej ~ **20013.03**

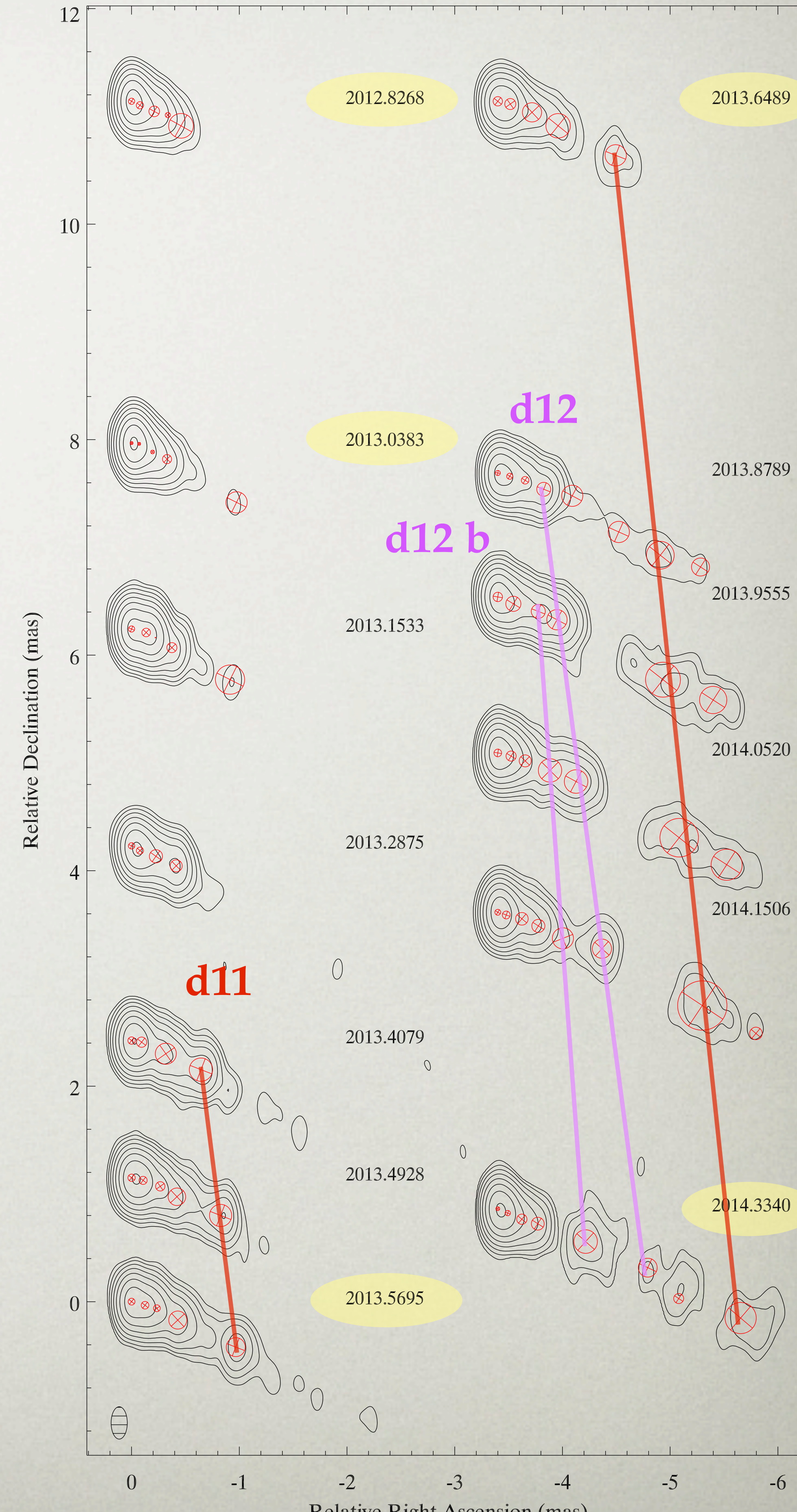
d12 Tej ~ **20013.61**

d12b Tej ~ **20013.62**

d12 accelerates

d12b decelerates





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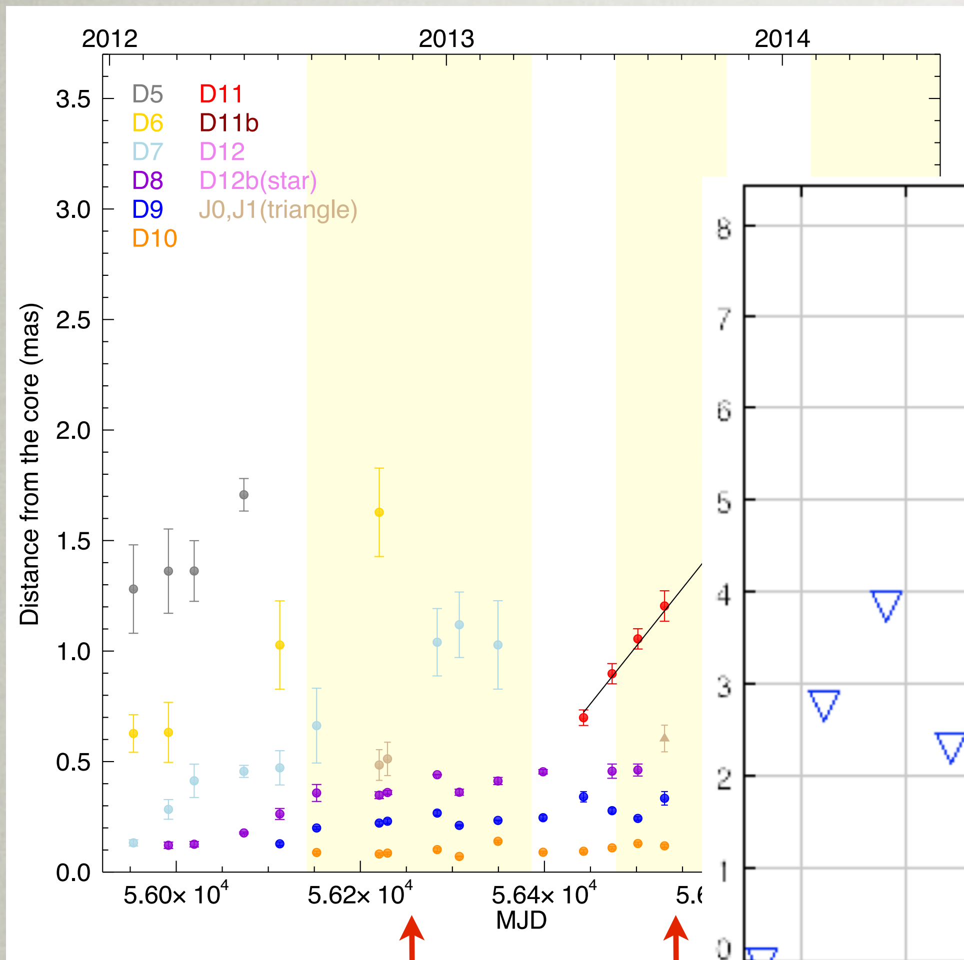

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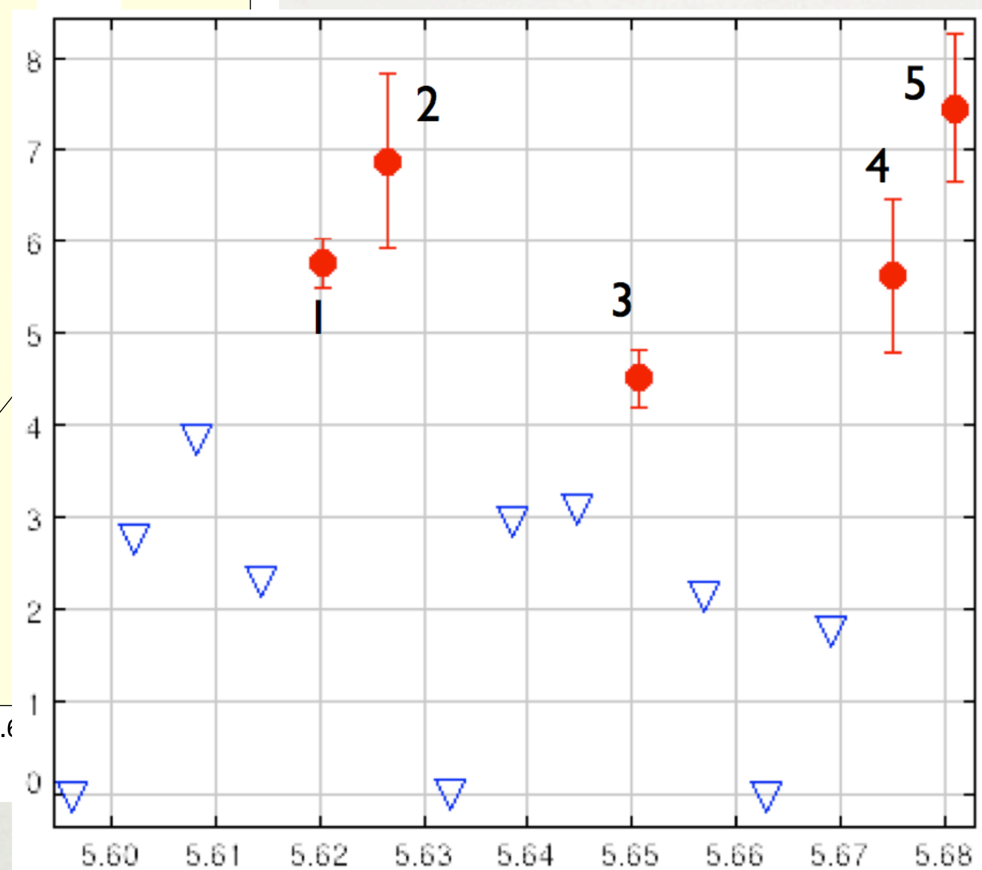
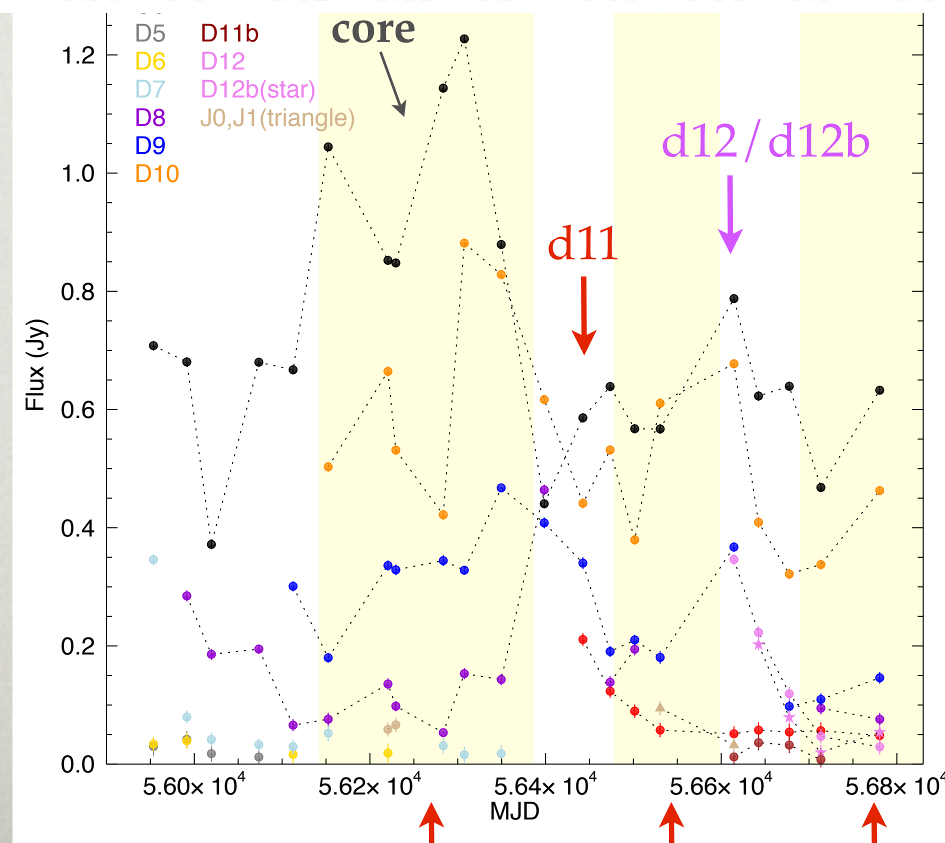
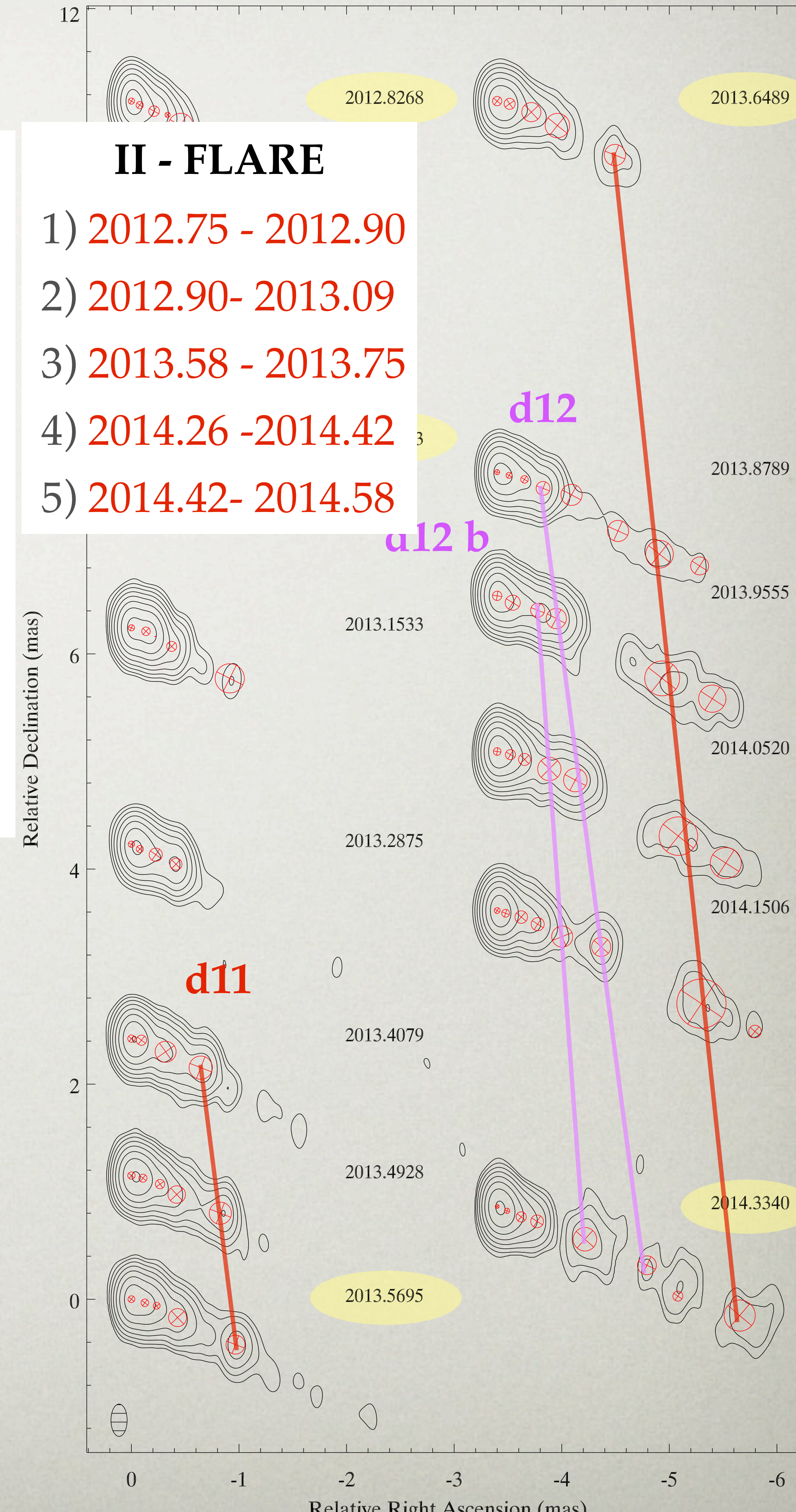


II - FLARE

1) 2012.75 - 2012.90
2) 2012.90- 2013.09
3) 2013.58 - 2013.75
4) 2014.26 -2014.42
5) 2014.42- 2014.58





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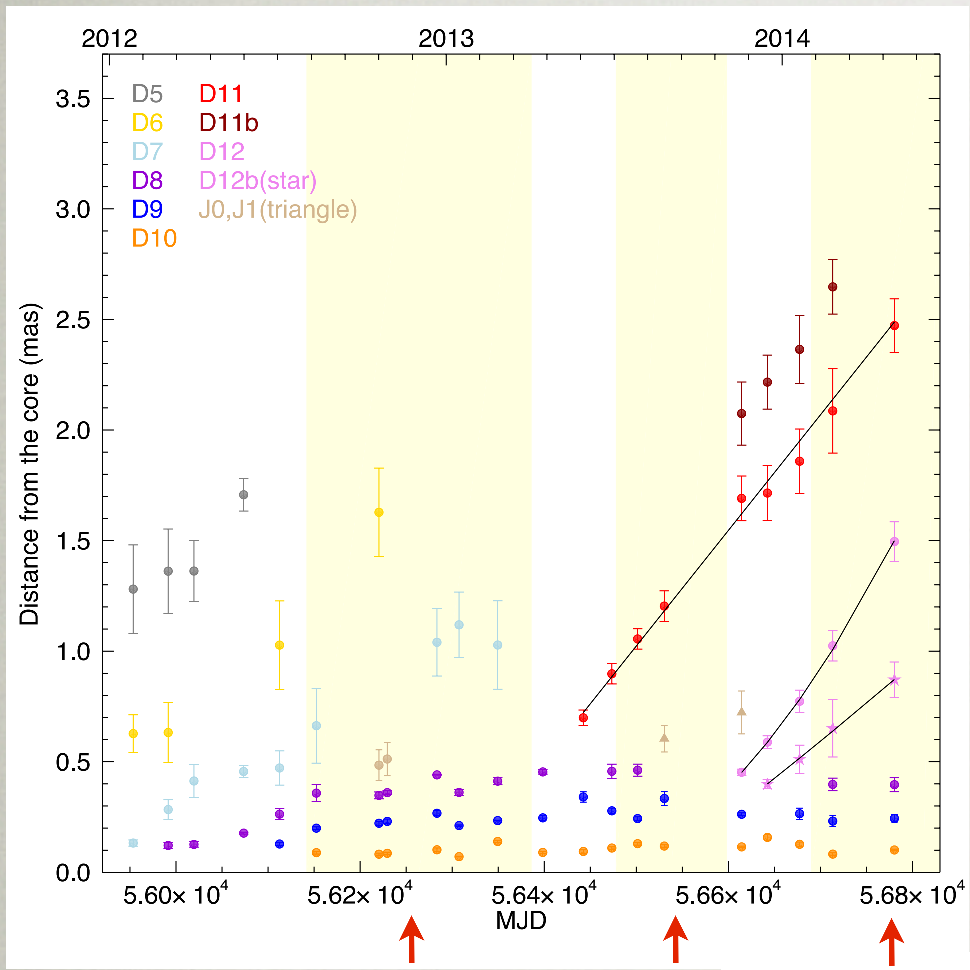

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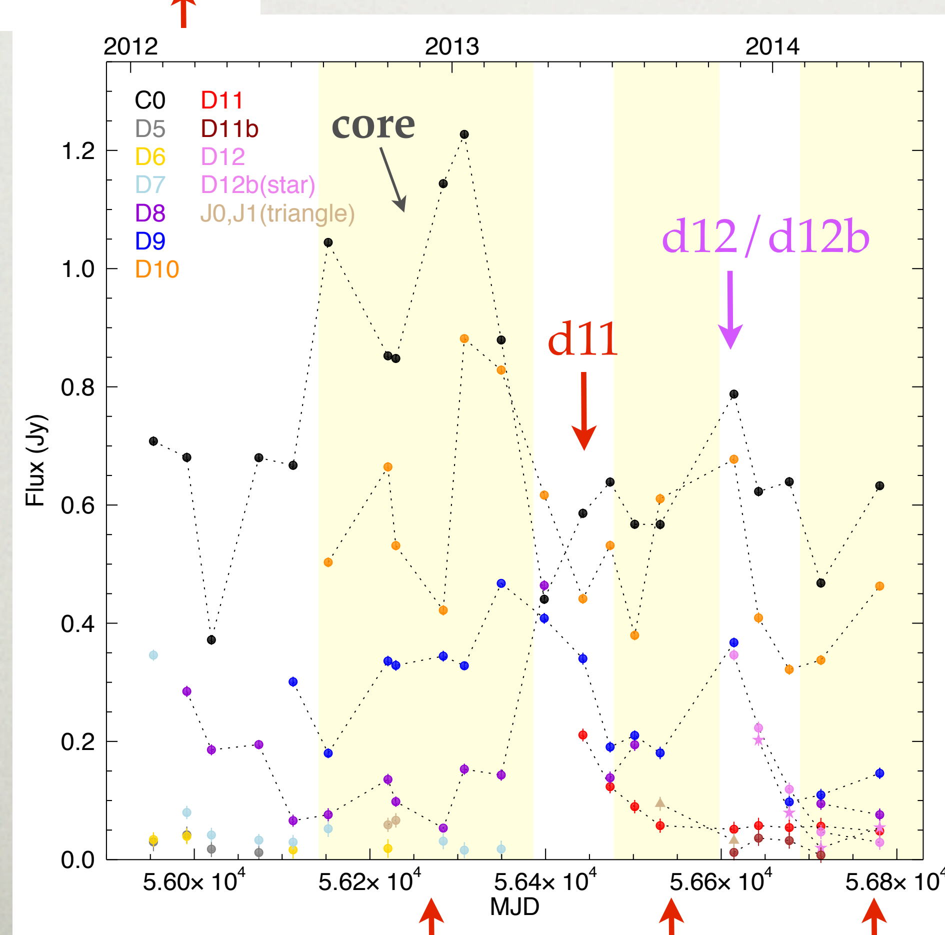
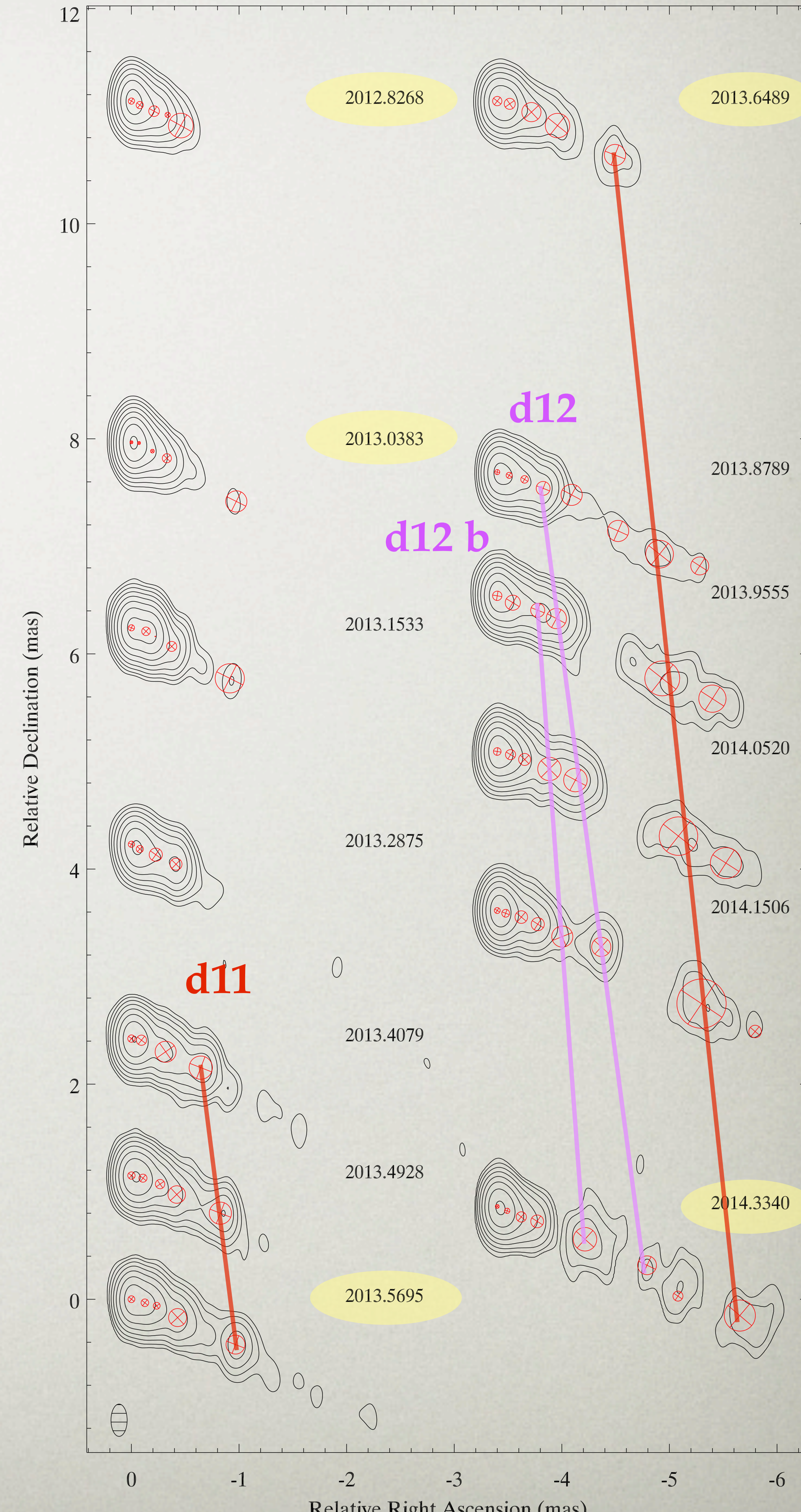
d12b decelerates





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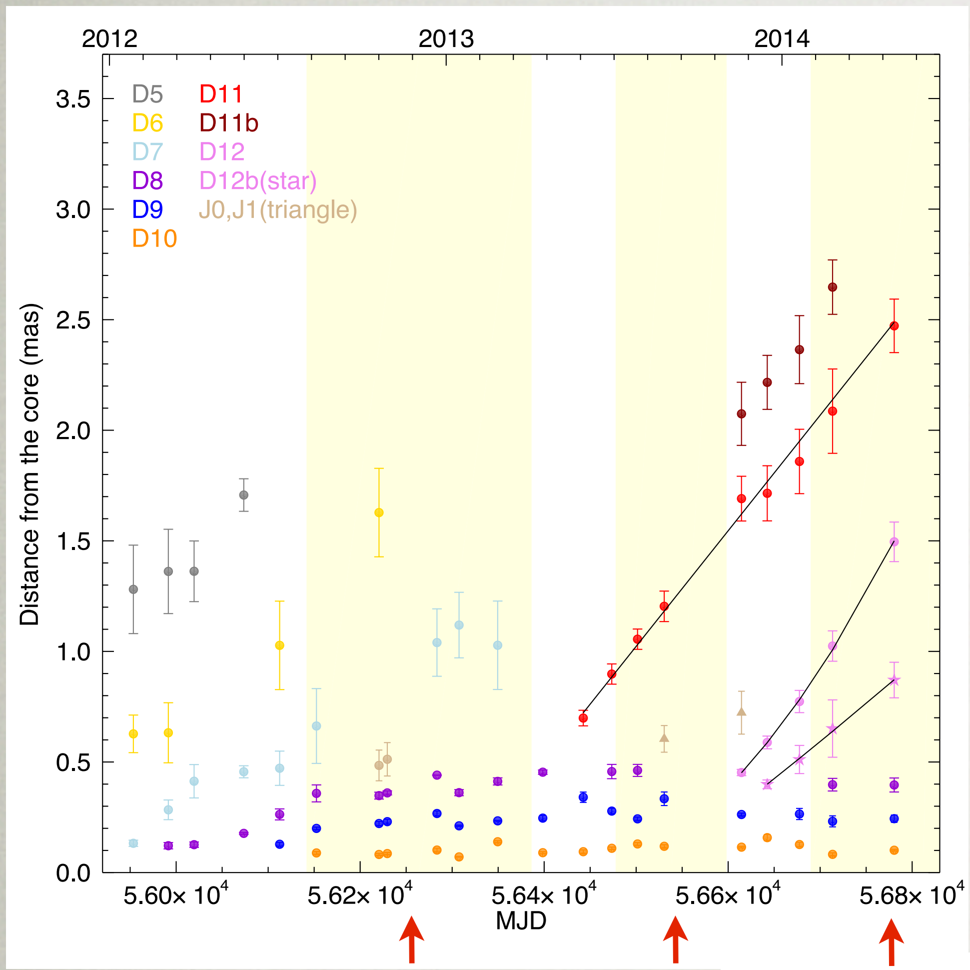

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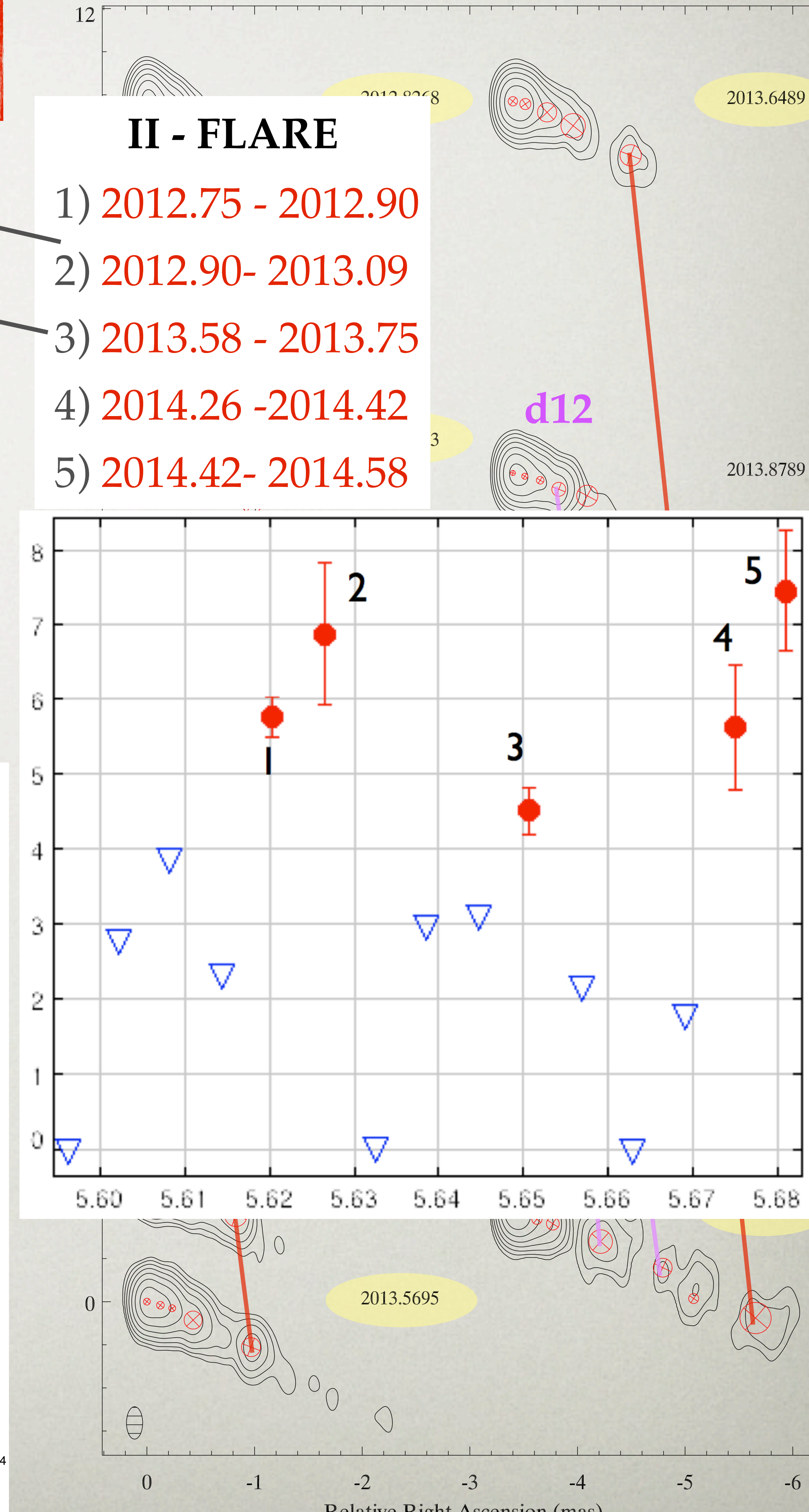

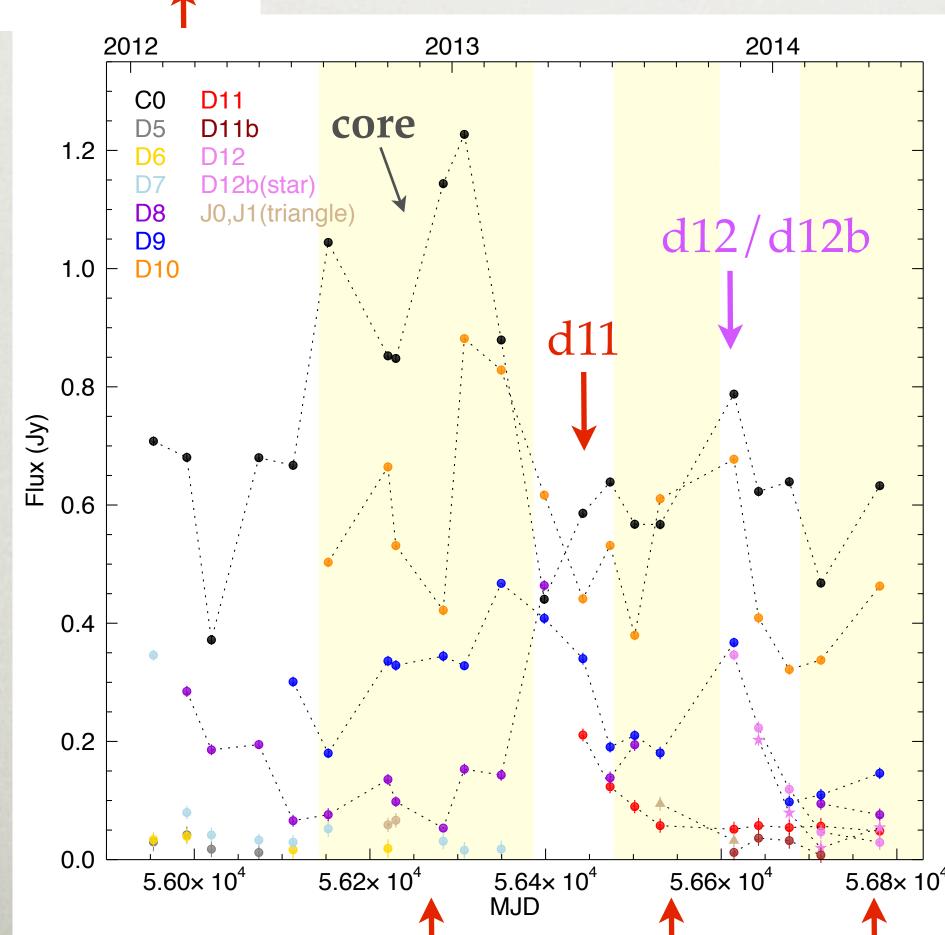

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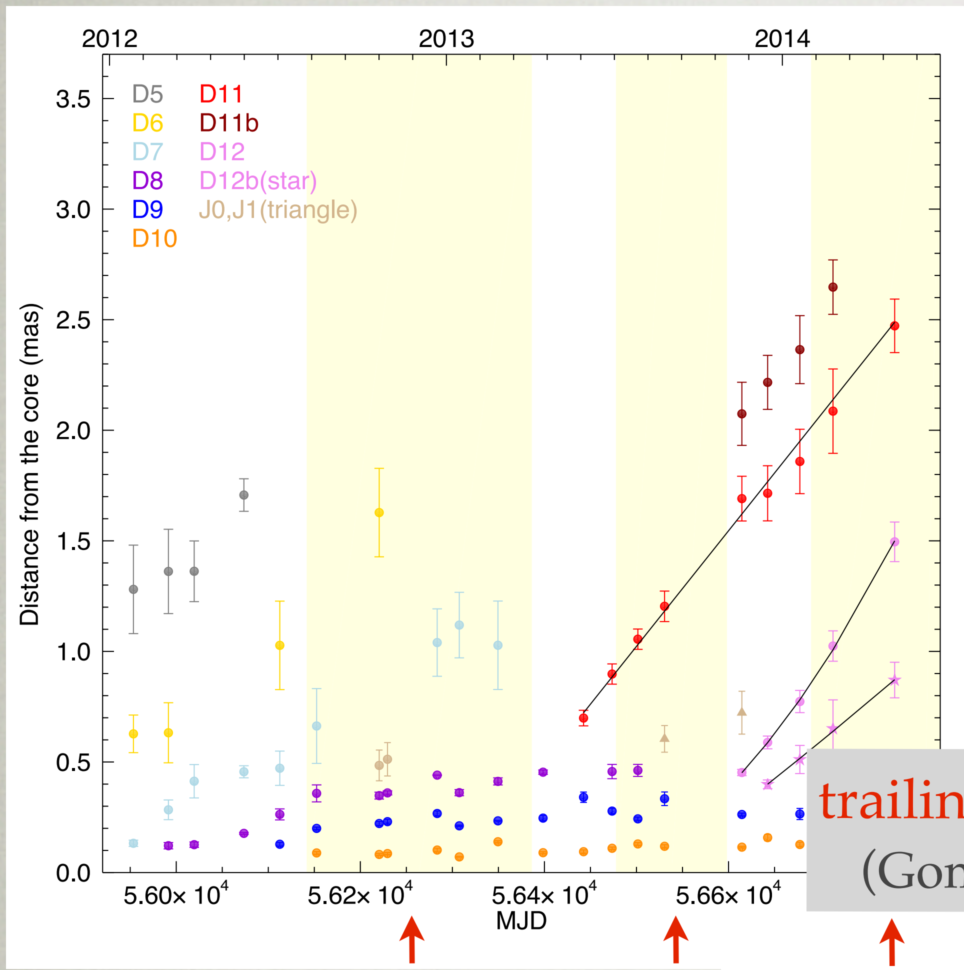

2º ɣ-ray

II ɣ-ray flare
(20012.75 - 2014.58)

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d12 accelerates

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trailing component or reverse shock ?

(Gomez et al. 2001, Jorstad et al. 2005)

II - FLARE

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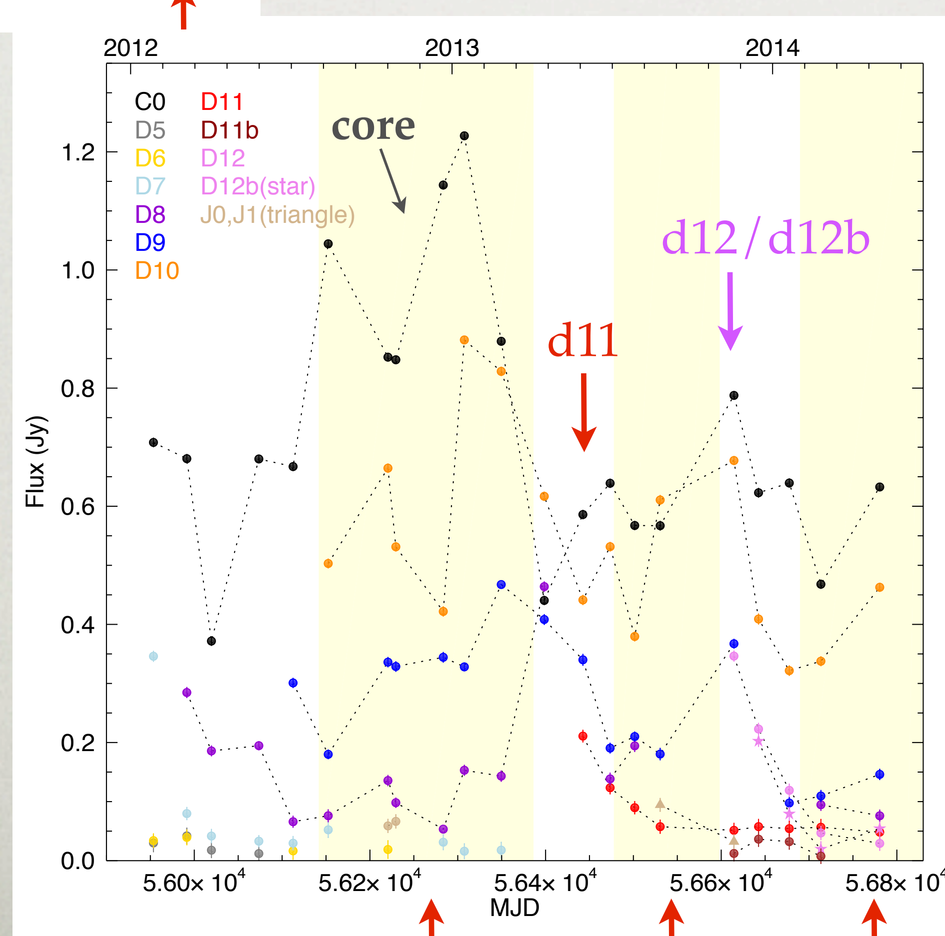

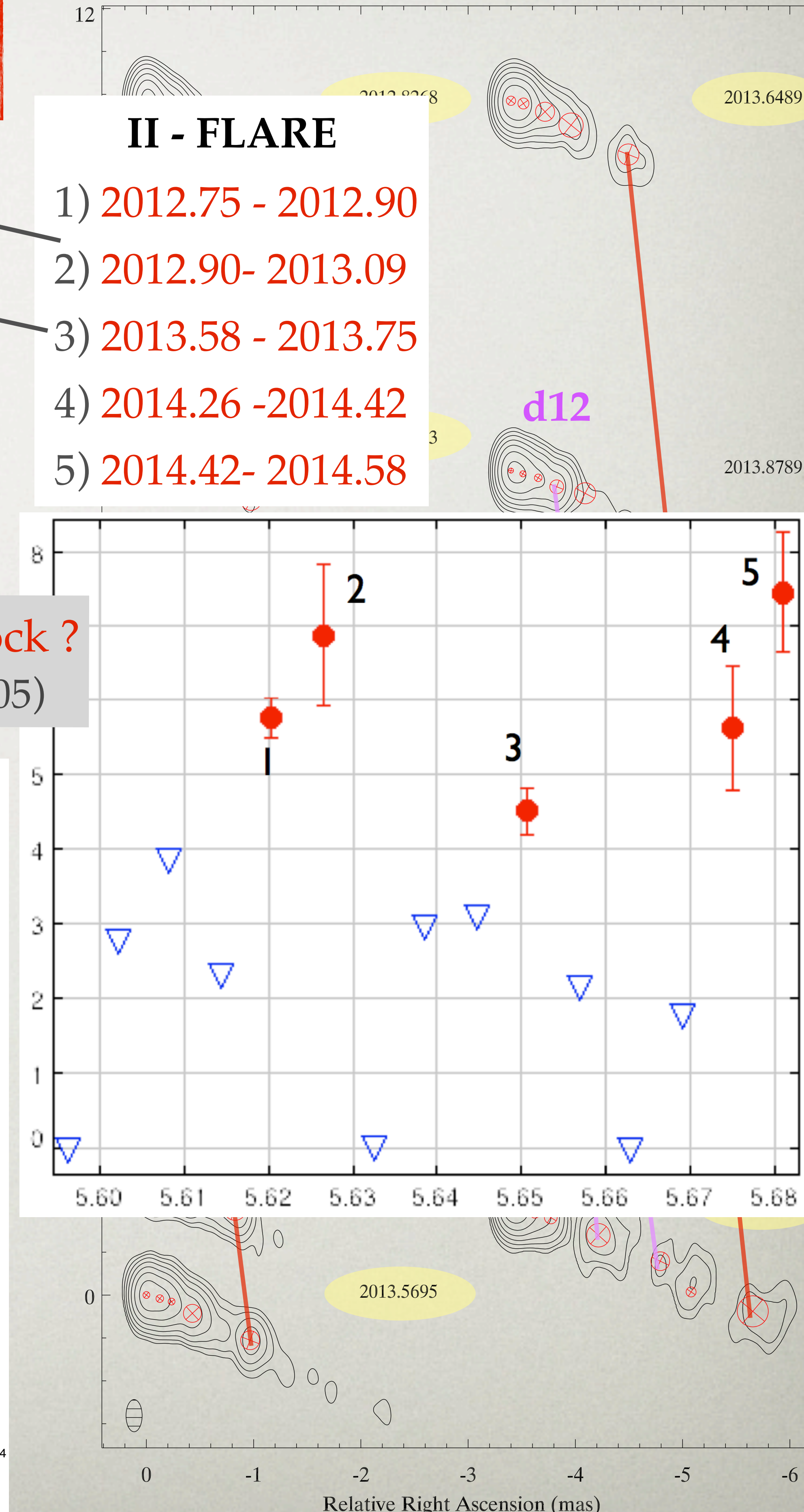

Conclusions

We found a clear connection between gamma-rays detections and high state of flux density of the radio core at 15 and 43 GHz and we associated the 1º and 2º gamma-flares with the ejection of new superluminal components from the radio core.

at 15 GHz

The radio core and stationaries components close to it display three peaks of flux:

1º- the first peak occurs during the first gamma-ray flare (end of 2008) and a new superluminal very bright component (E4) has been ejected from the core;

2º- the second peak (beginning 2011) is not associated with gamma-ray activity and not even with the ejection of a new component;

3º- the third peak occurs during the second gamma-ray flare (beginning 2013) but until August 2013 (the last epoch in 15 GHz data) we do not observe the expulsion of a new component.

at 43 GHz

The radio core and progressively the stationaries components close to it display two peaks of flux:

1º- the first peak occurs during the first two gamma-ray detections of the second gamma-ray flare (beginning 2013). The peak moves from the core along the jet, crossing the stationaries features close to the core (up to ~0.5 mas) , and then a new superluminal component (d11) appears at ~ 0.5 mas;

2º- the second peak occurs during the third gamma-ray detection of the second gamma-ray flare (~ 2013.6) and after the peak moves along the jet as during first peak two new components appeared (d12 and d12b).

Possible explanation of the radio flares and the gamma-ray activity

The stationaries components observed at 43 and 15 GHz should be **recollimation shocks**

↓

the interaction between a new superluminal component ejected from the core and these recollimation shocks could provoke the gamma-ray activity

The radio flare occurred at 15 GHz at the beginning of 2011 (no gamma-ray activity and no component associated) can be due to a **change in the jet orientation**

↓

The change in the jet orientation causes the appearance of the three stationary features (or recollimation shocks) observed at 15 and 43 GHz since middle 2012

↓

The very big and long second gamma-flare can be due to the passage of a new knot ejected from the core throught these three recollimation shocks

+

the different orientation of the jet could explain an higher Doppler factor in this second big flare (ATel#6529)

Thanks!