# The Xray-TeV connection

## Open questions and new perspectives

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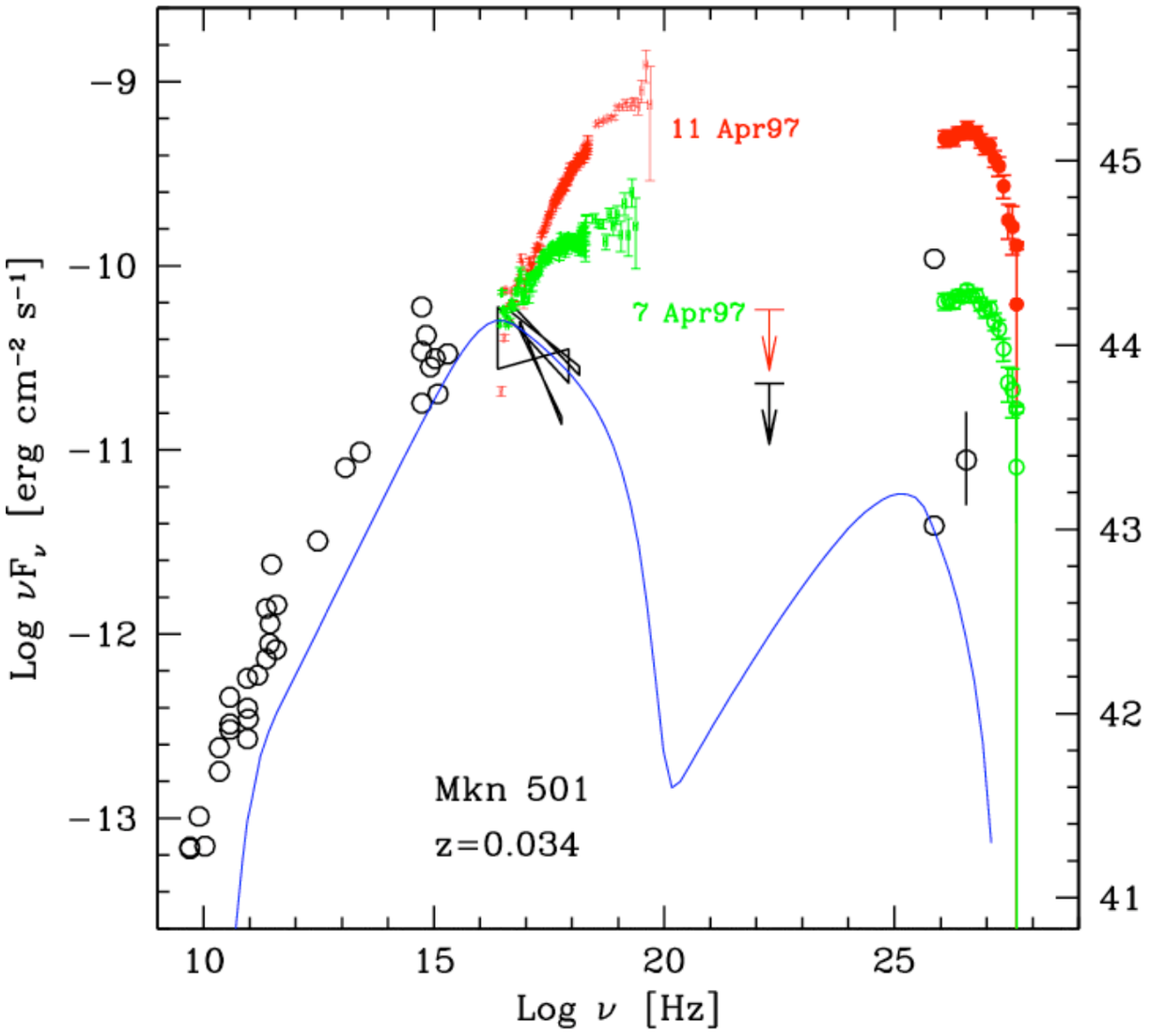
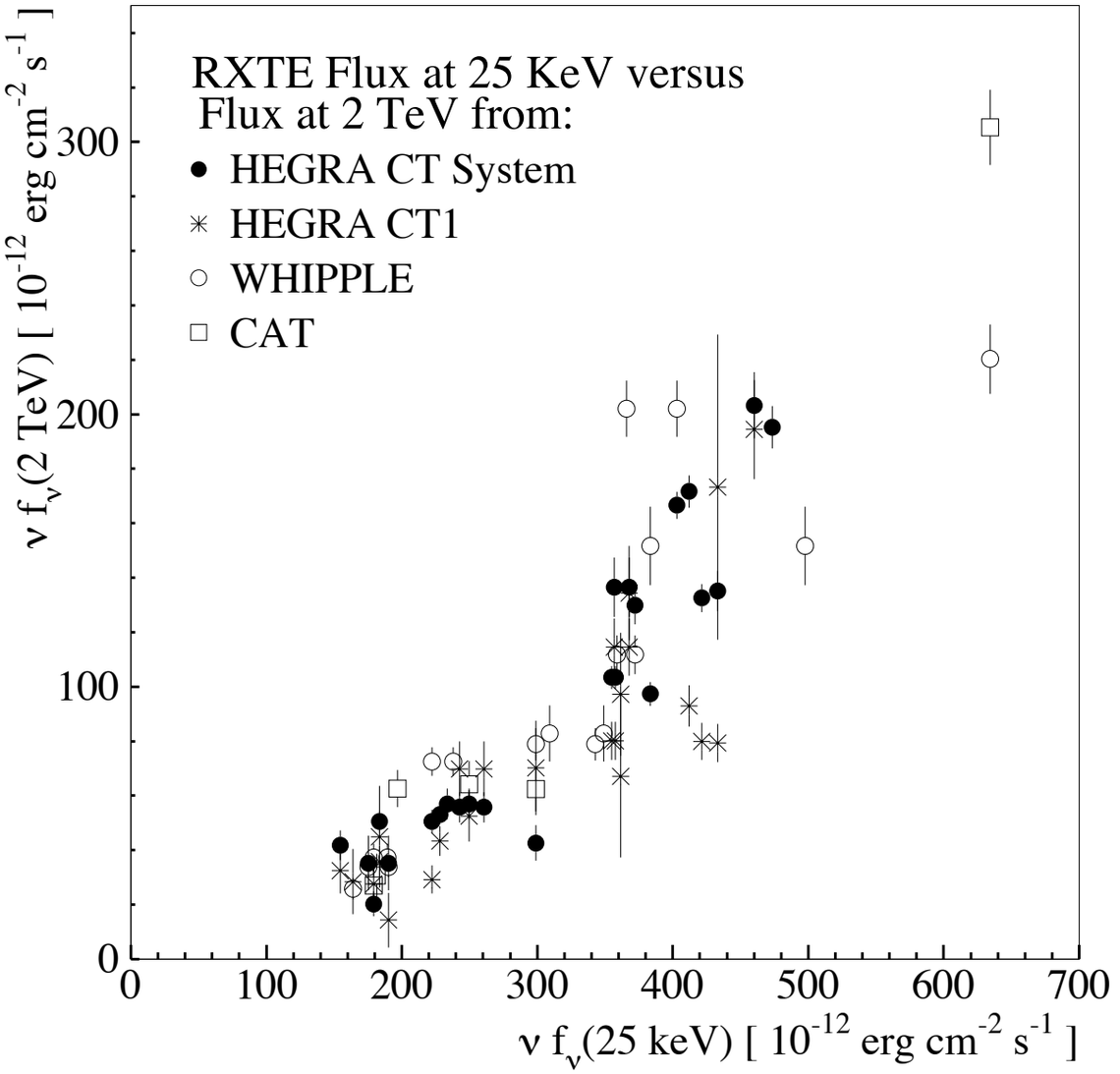
# RXTE importance for HBLs:

## it samples high energy electrons, freshly injected (short cooling timescales) which typically emit at VHE




Pian et al 1998, Krawczynski et al 2002

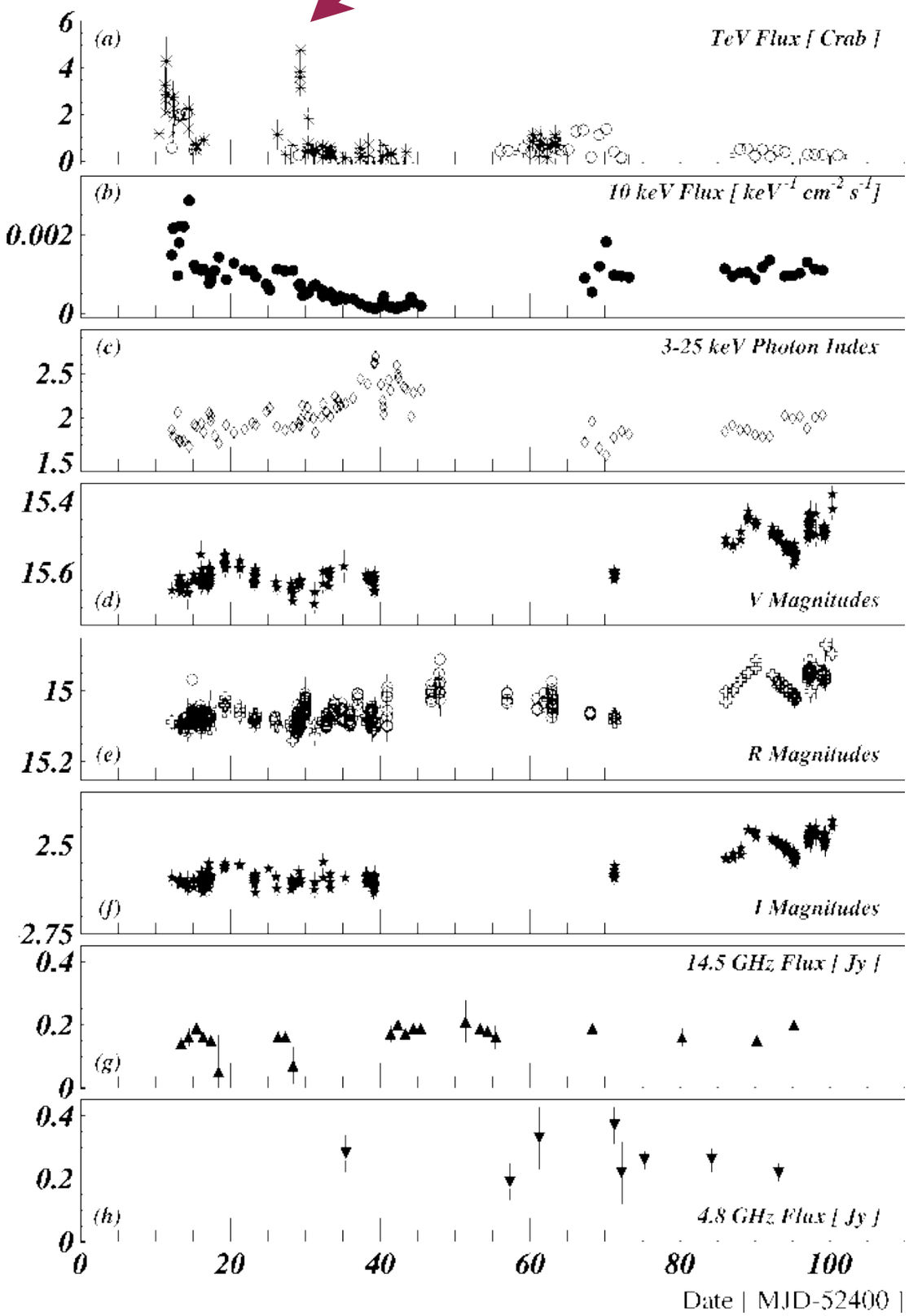
# RXTE importance for HBLs:

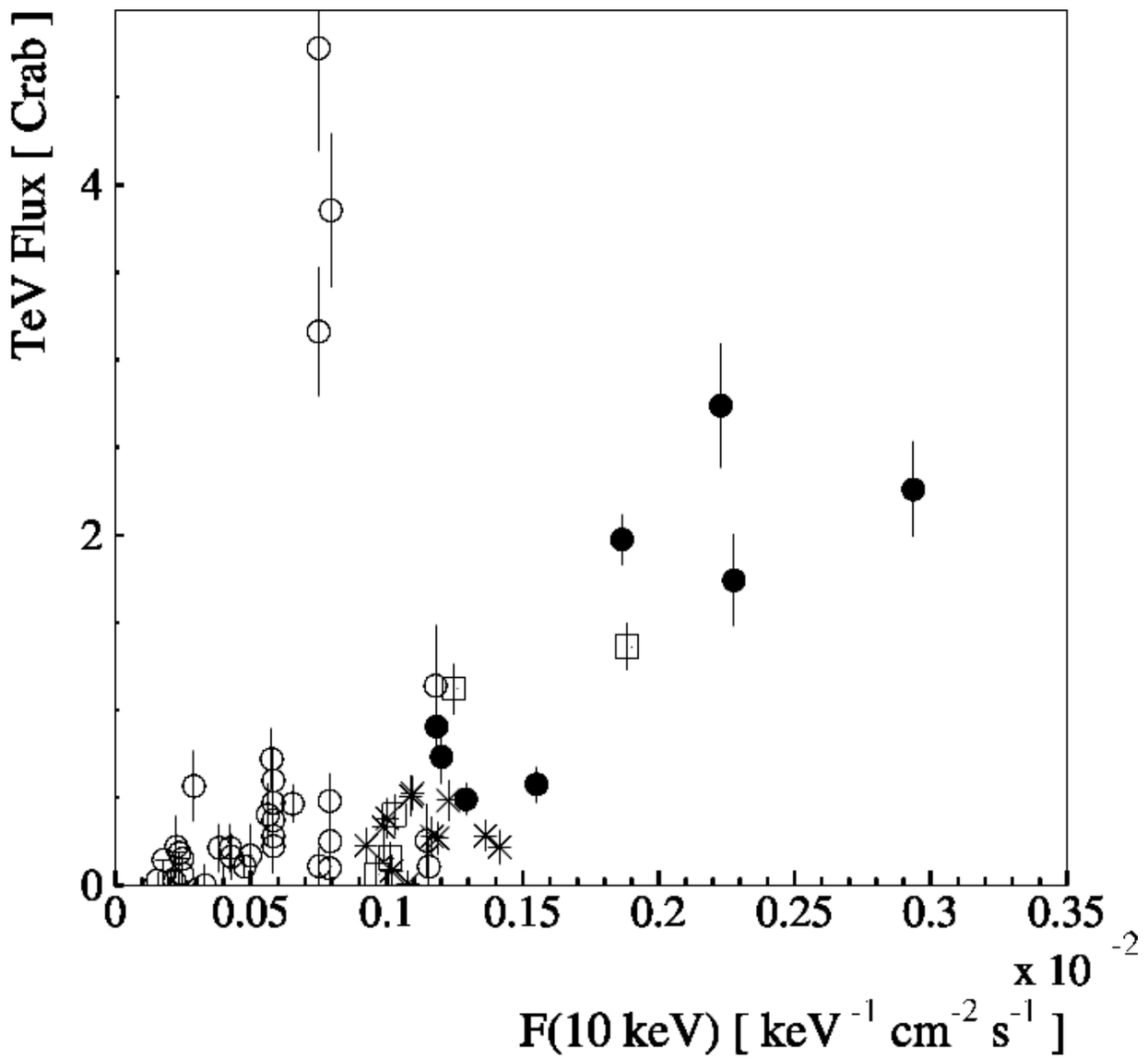
it samples high energy electrons, freshly injected
(short cooling timescales) which typically emit at VHE

However: 3 recent fundamental campaigns
have changed our picture, uncovering new aspects

1ES 1959+650, Mkn 421, PKS 2155-304

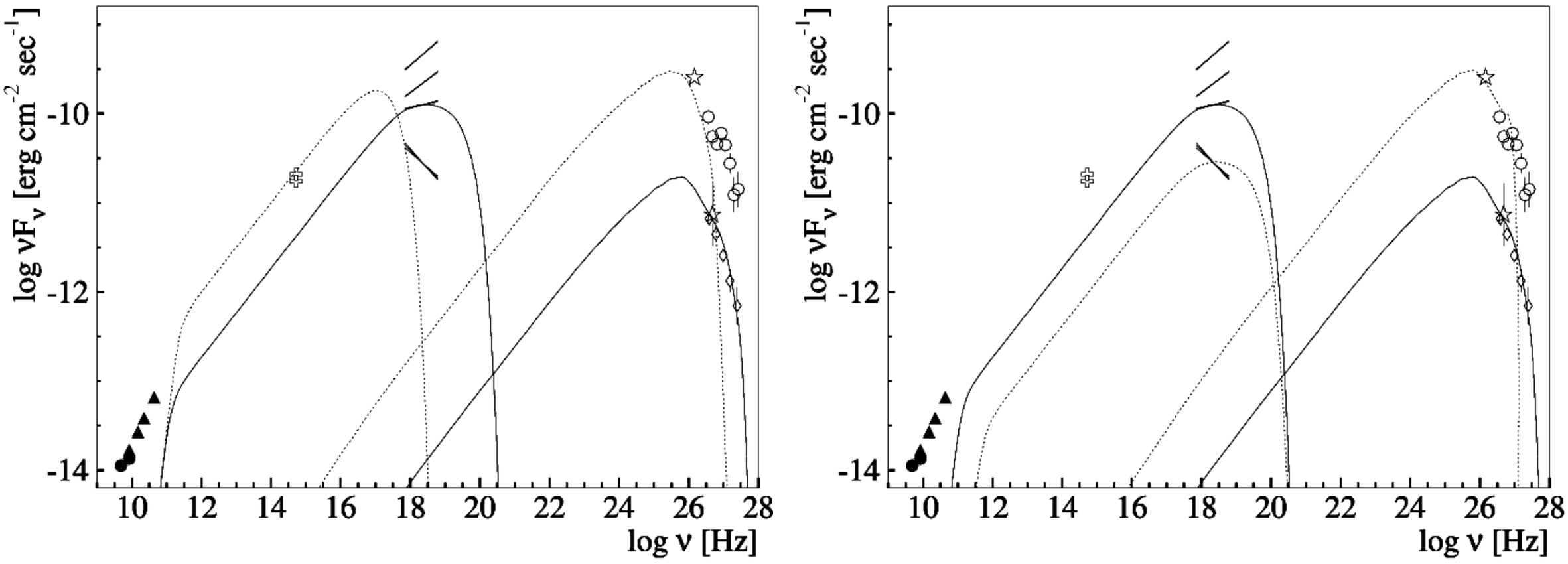
# 1ES 1959+650 in 2002: orphan flare



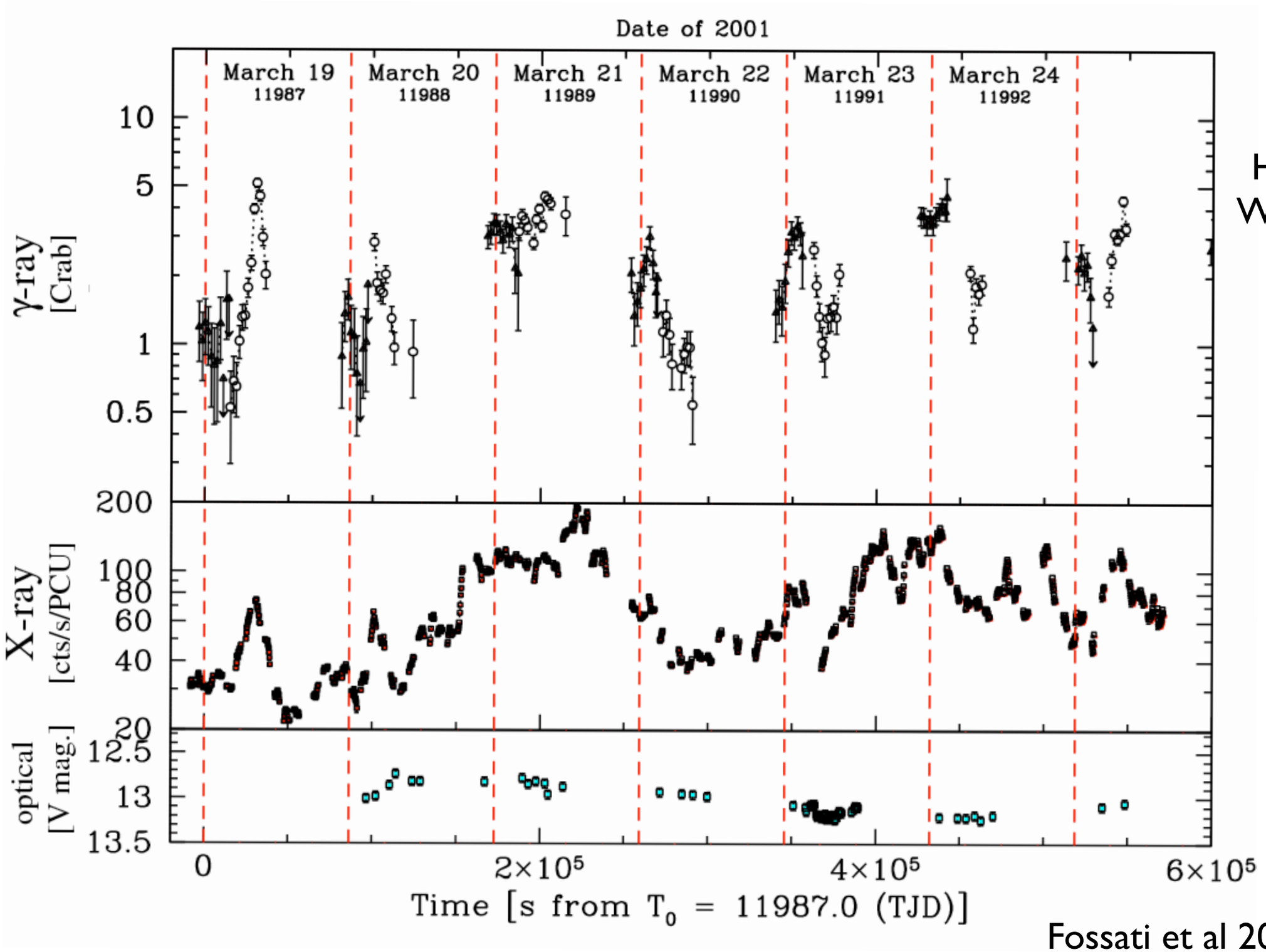

Krawczynski et al. 2004

# 1ES 1959+650 in 2002: orphan flare




Krawczynski et al. 2004

# Mkn 421 in 2001: quadratic decay

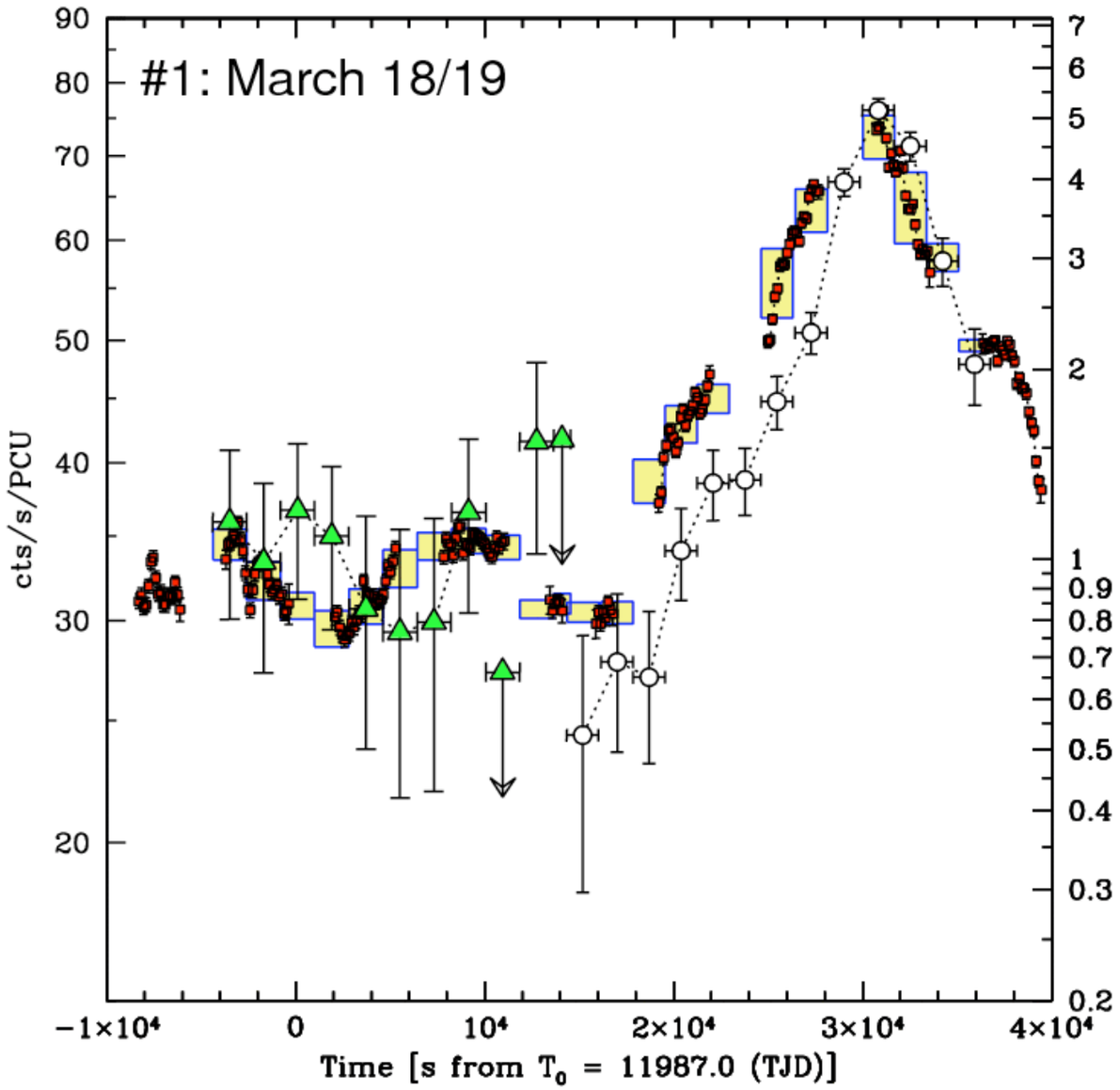


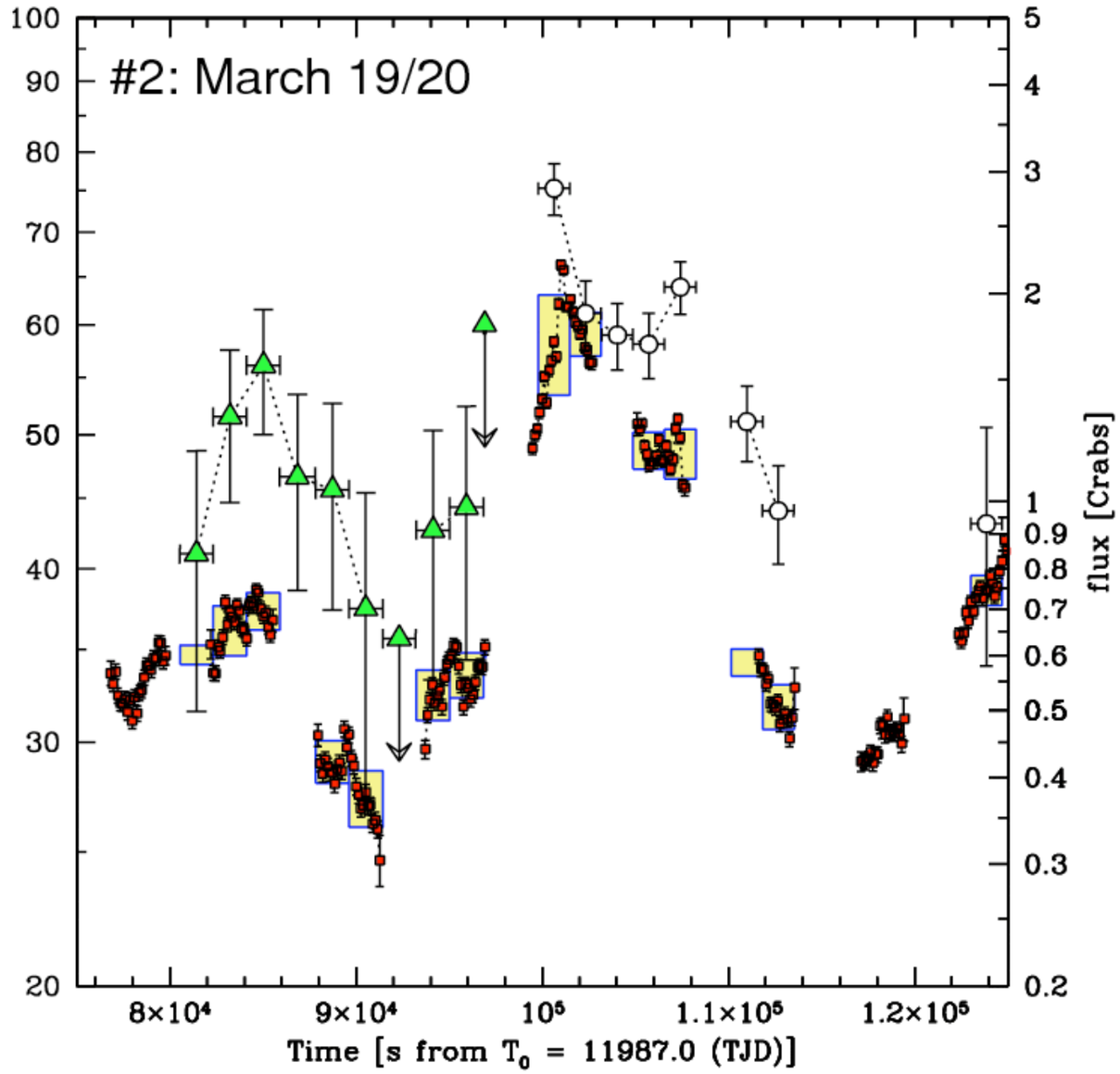

HEGRA

WHIPPLE

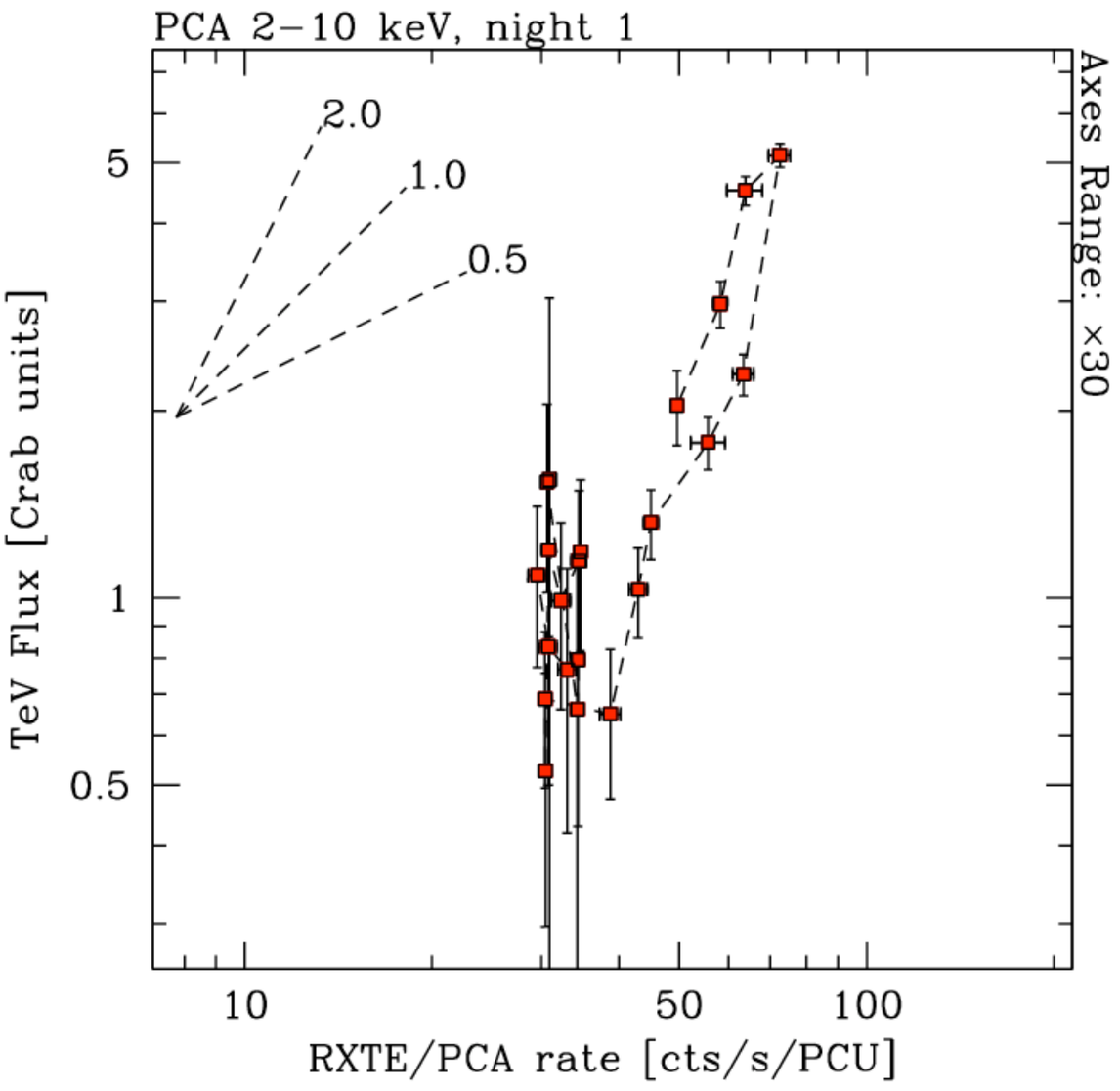
RXTE

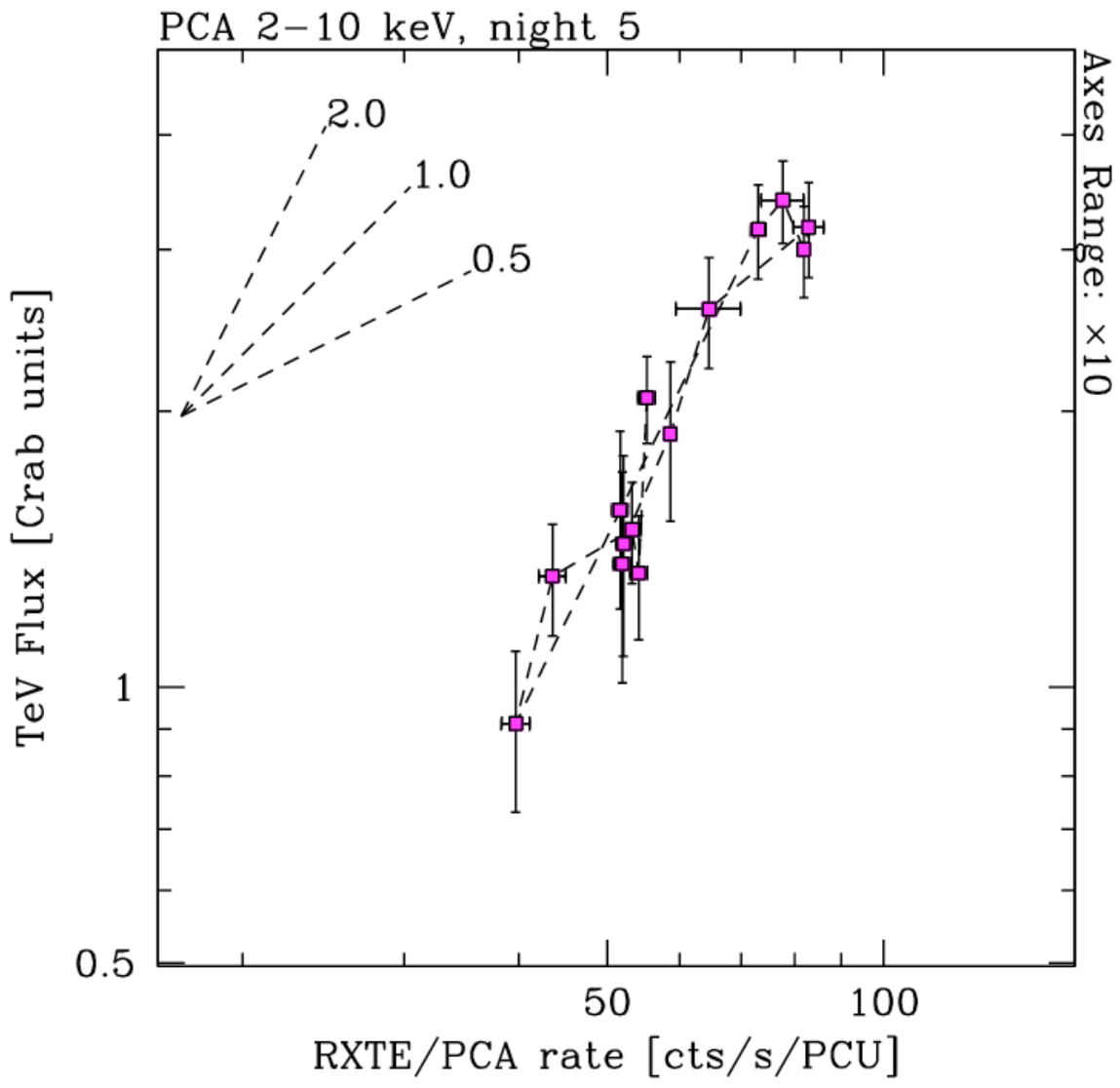
Fossati et al 2008


#1: March 18/19
cts/s/PCU
flux [Crabs]
Time [s from T0 = 11987.0 (TJD)]

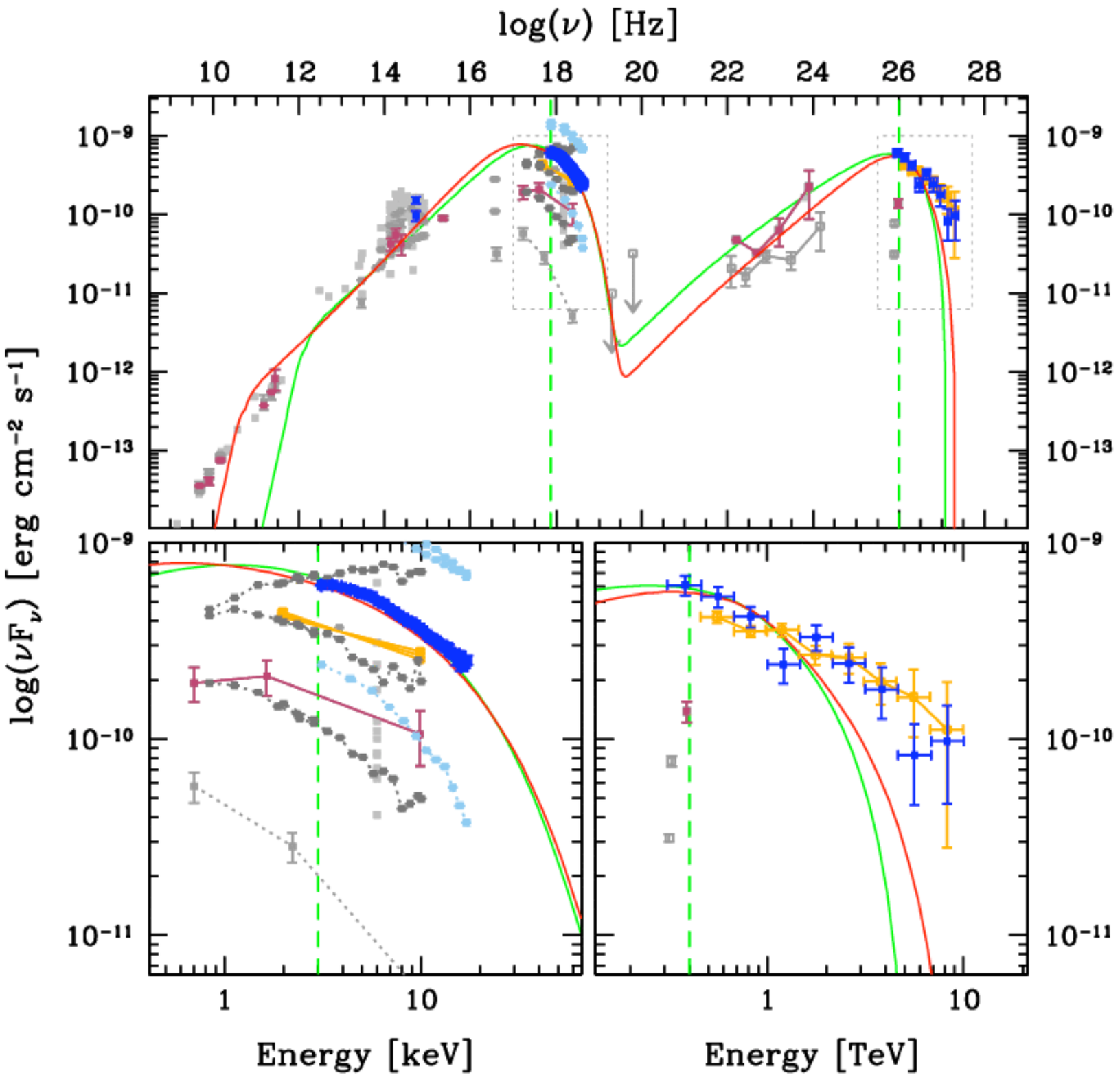

#2: March 19/20
cts/s/PCU
flux [Crabs]
Time [s from T0 = 11987.0 (TJD)]

# Quadratic relation also in decaying phase



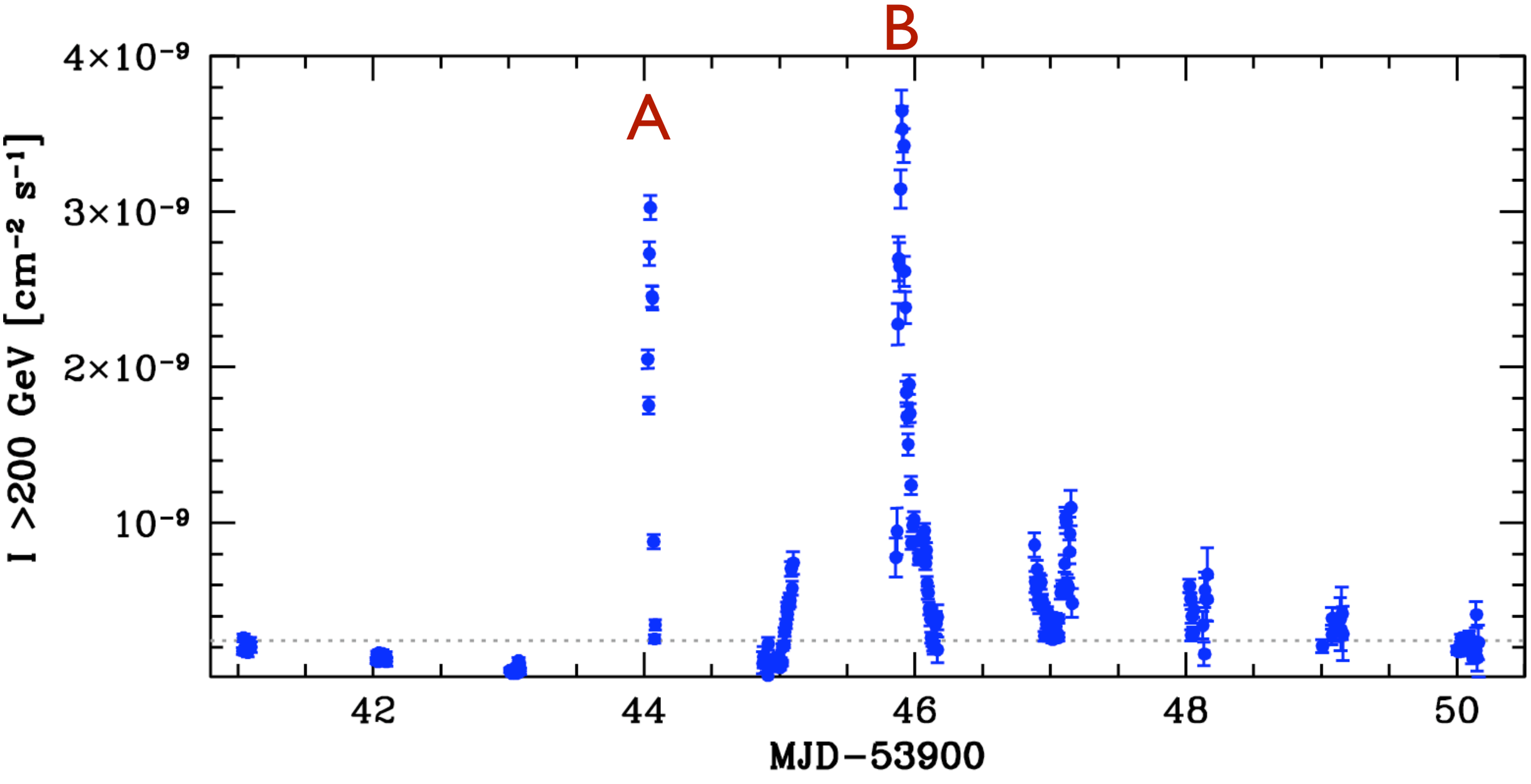




Fossati et al 2008

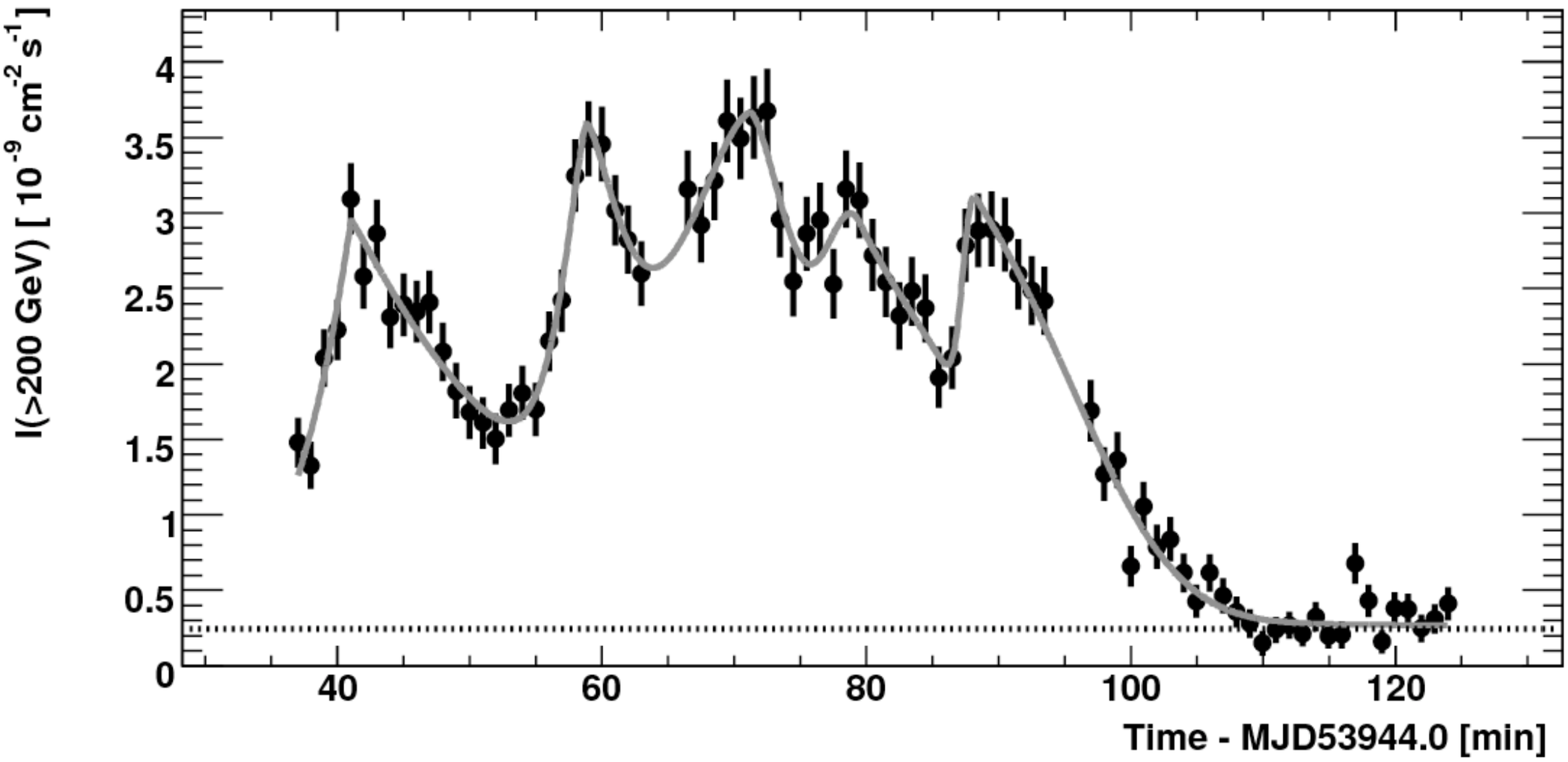



Fossati et al 2008

# Most surprising: PKS 2155-304 in 2006



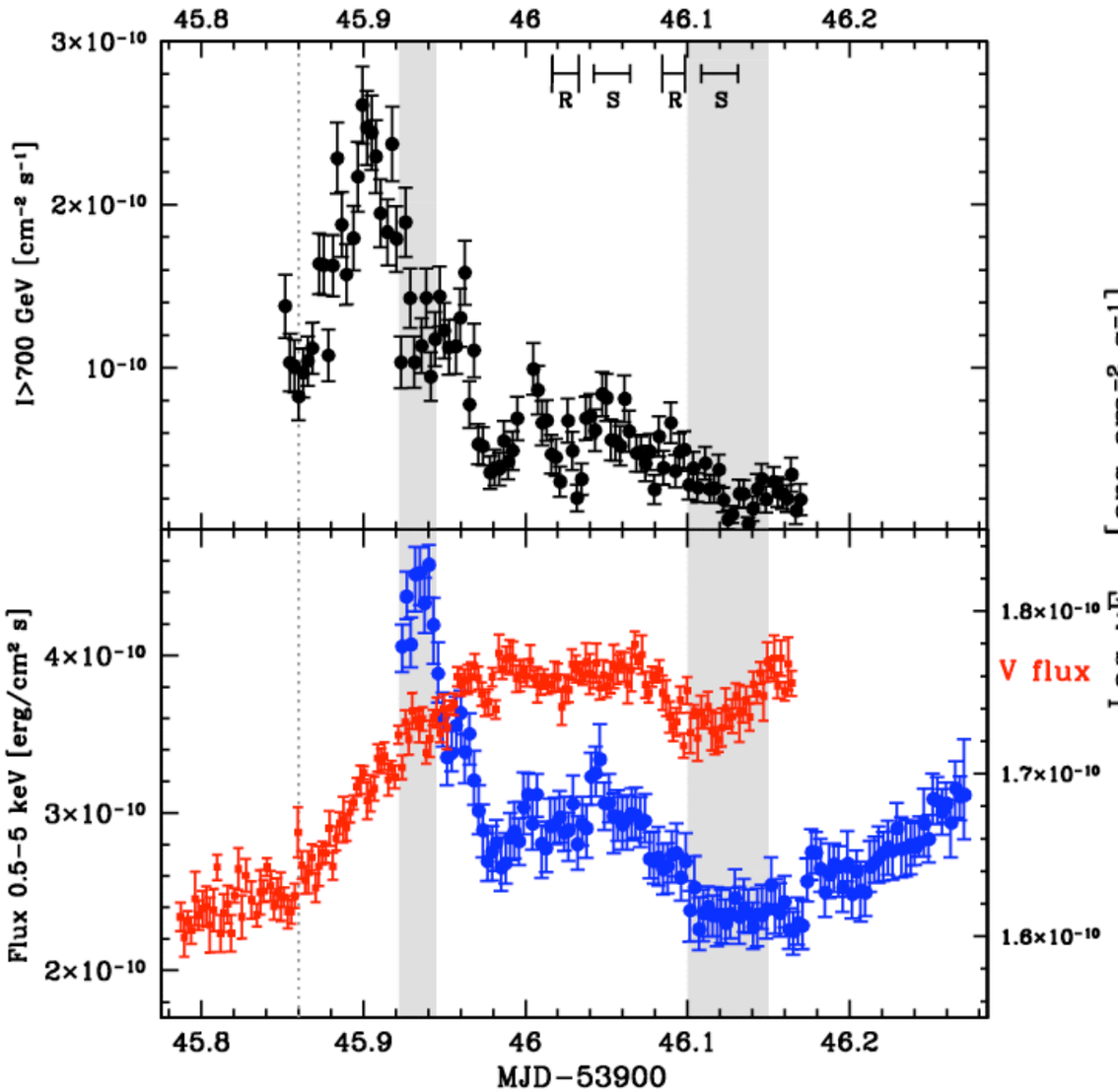
A

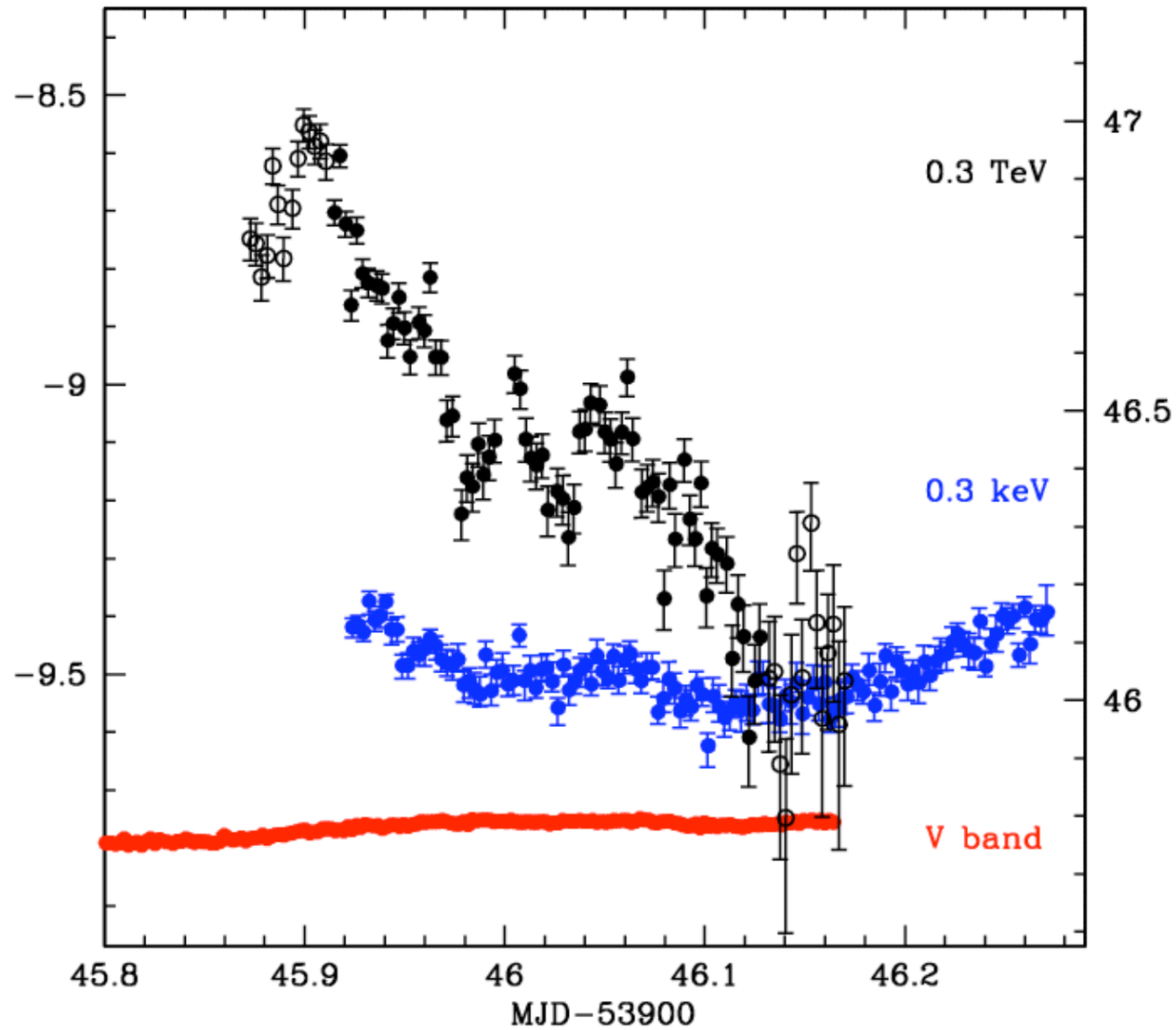



Aharonian et al 2007

# Full night simultaneous HESS-Chandra-Optical observations

B



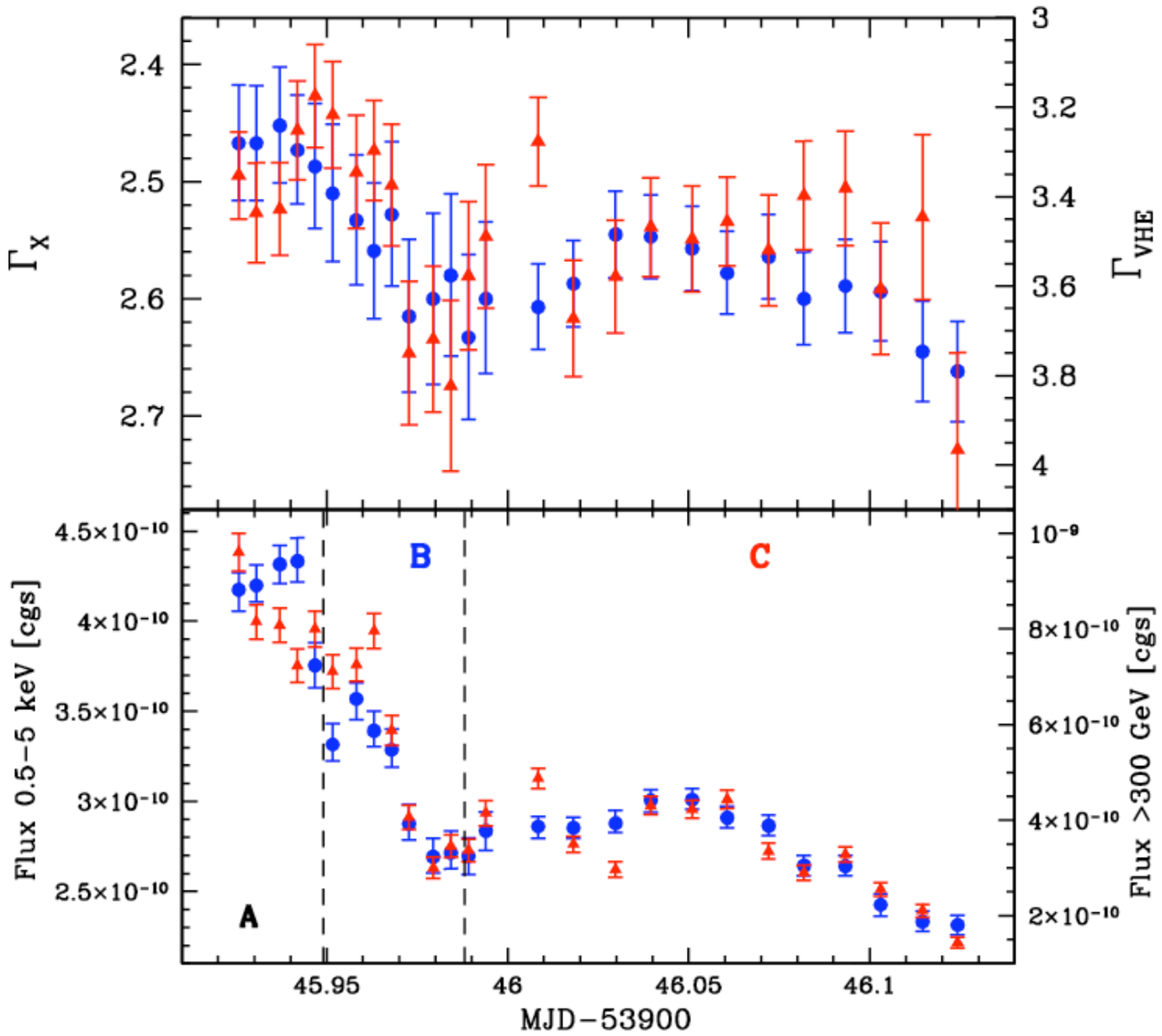



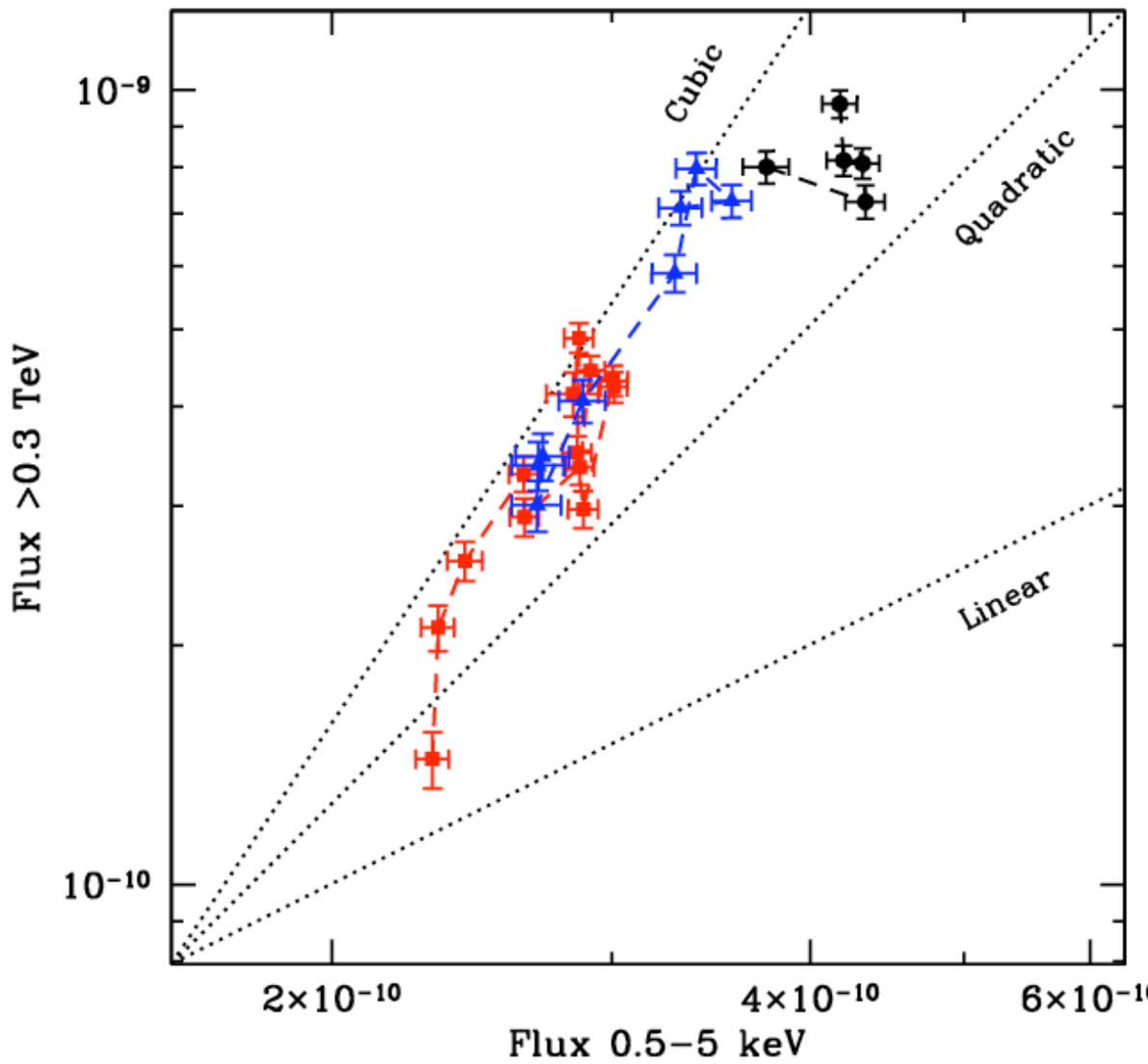

First time in HBL: high Compton Dominance !

LC et al. 2007, 2008
Aharonian et al. 2009

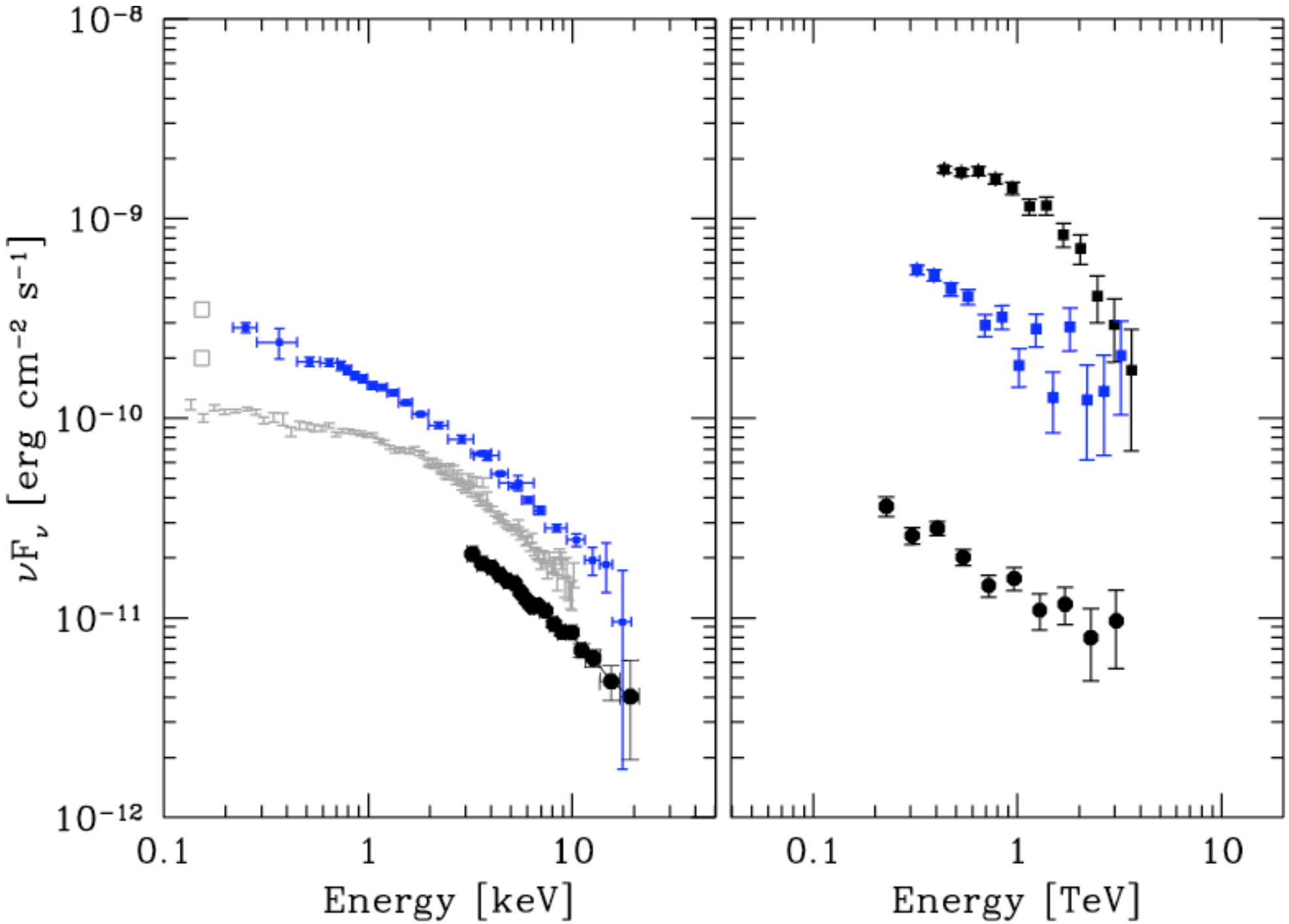
# Cubic relation Xray-TeV flux !

Time-resolved spectroscopy
7-14 min bins



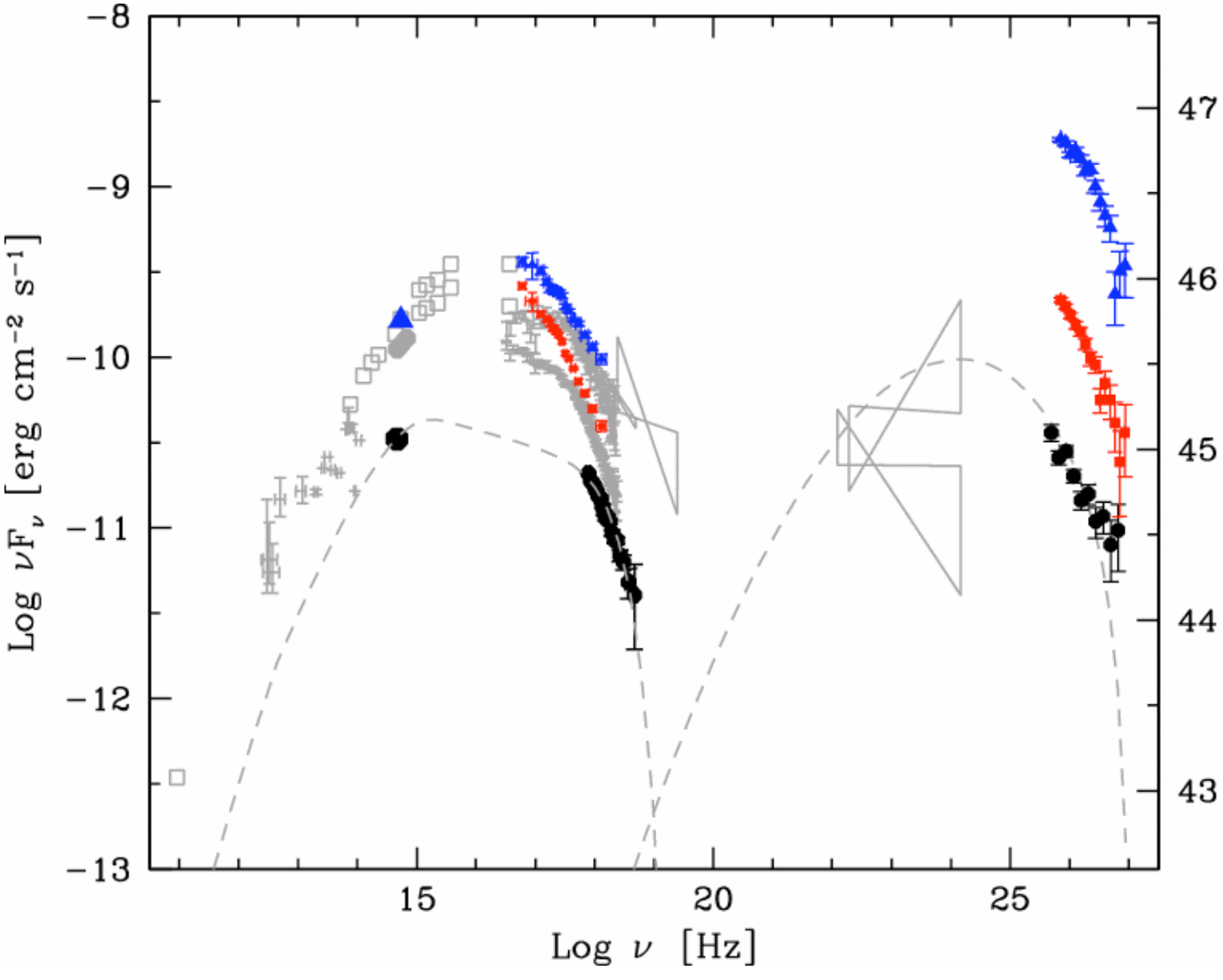



# Chandra+RXTE



# Difficult to explain with one-zone model.

## Thomson alone ( $\delta$ >100 ) not enough to explain cubic decay

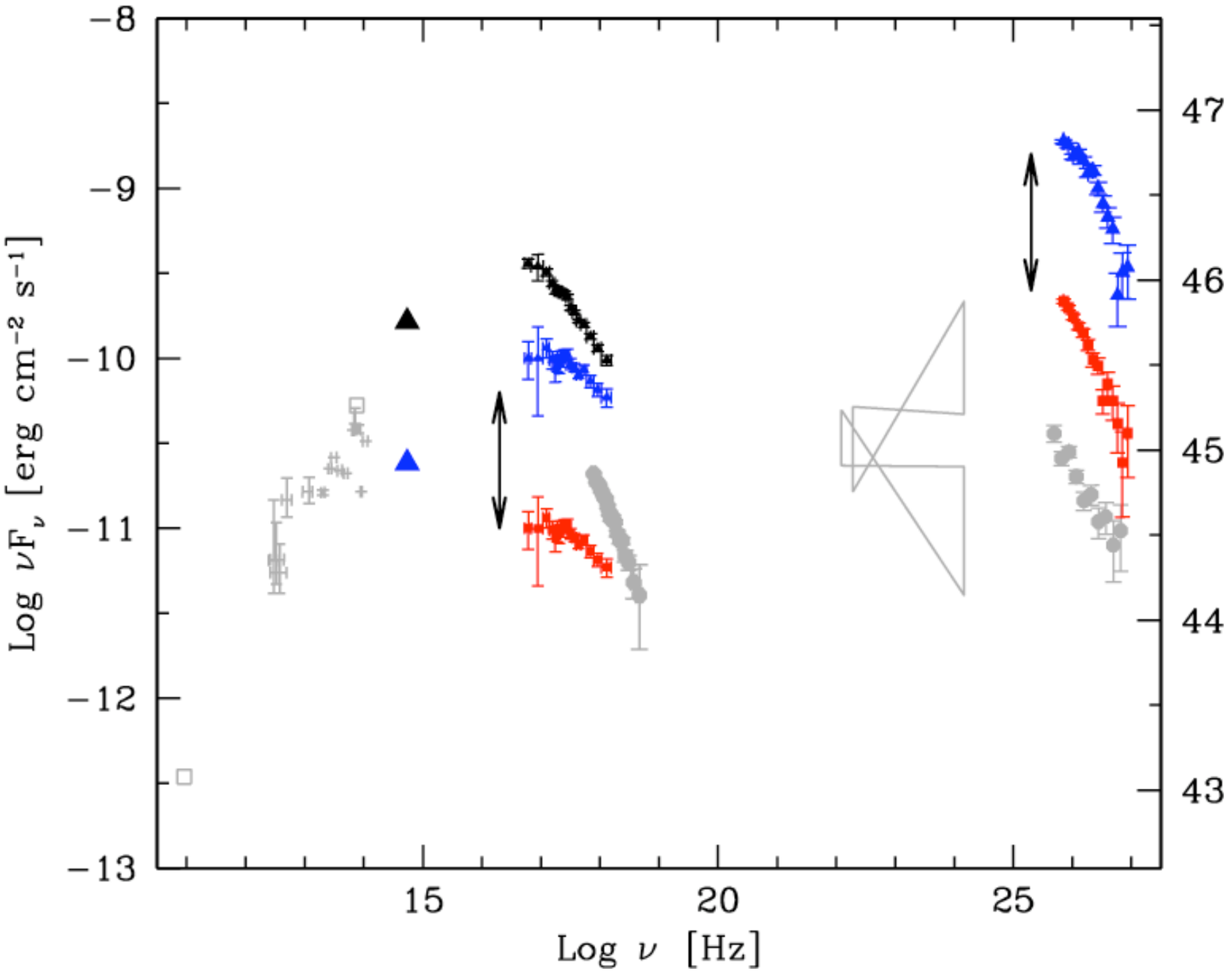



One zone => high energy electrons have not cooled

Adiabatic expansion:
could work, but would imply B to increase as $B \propto R^{+0.4}$ (i.e. $W_B \sim R^{3.8}$) on same timescales of X-ray/TeV variations.

This would imply a 15% decrease in Optical synchrotron, not observed.

# Two components: persistent + flaring




a) If $F_\gamma \propto F_x^2$

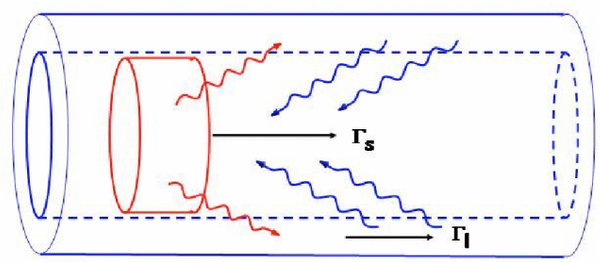
SSC ok with B ~1G

R ~3-5 $10^{14}$ cm

b) If $F_\gamma \propto F_x$

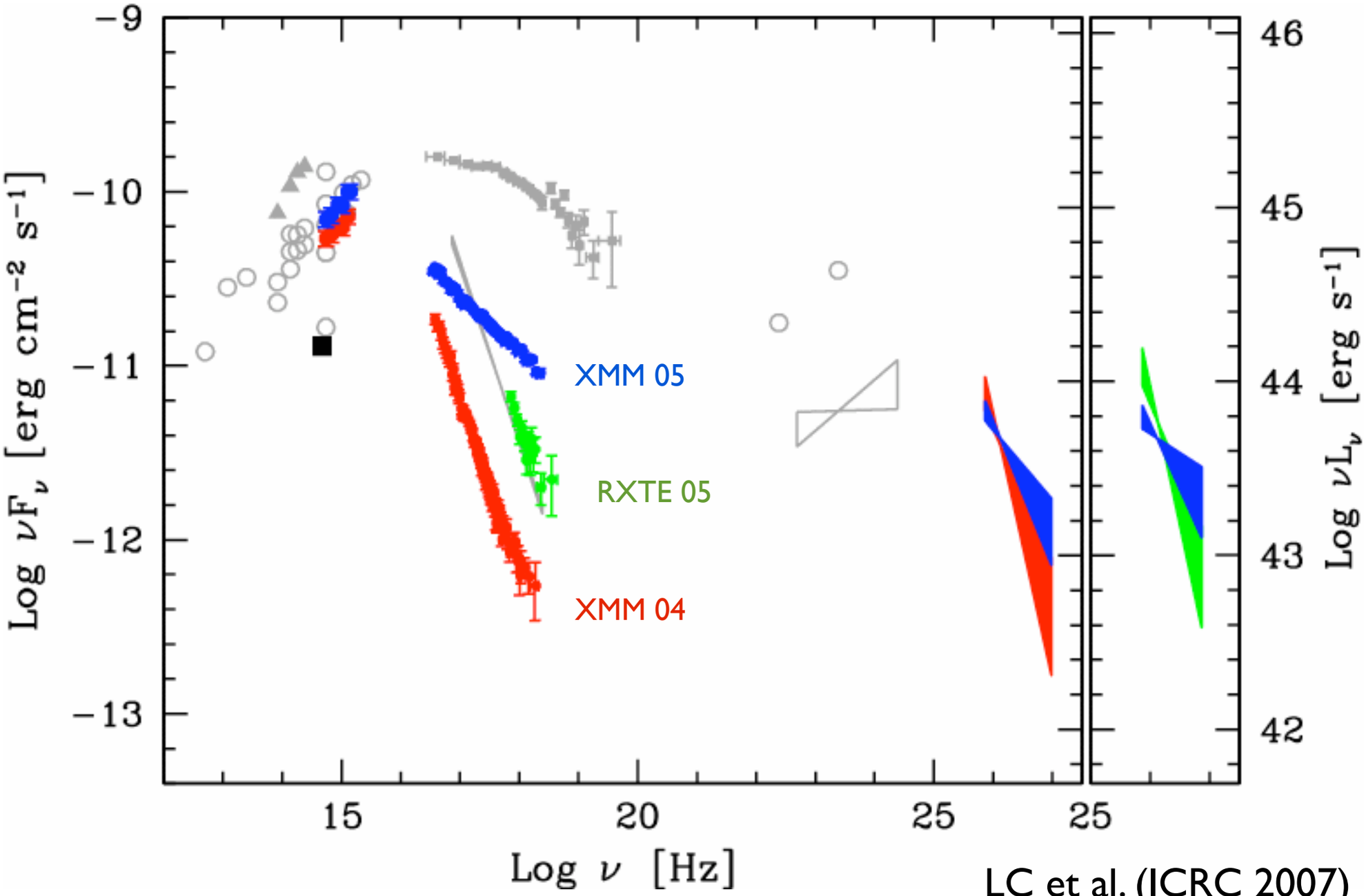
Constantly high Compton Dominance !

External Compton on structured jet ?



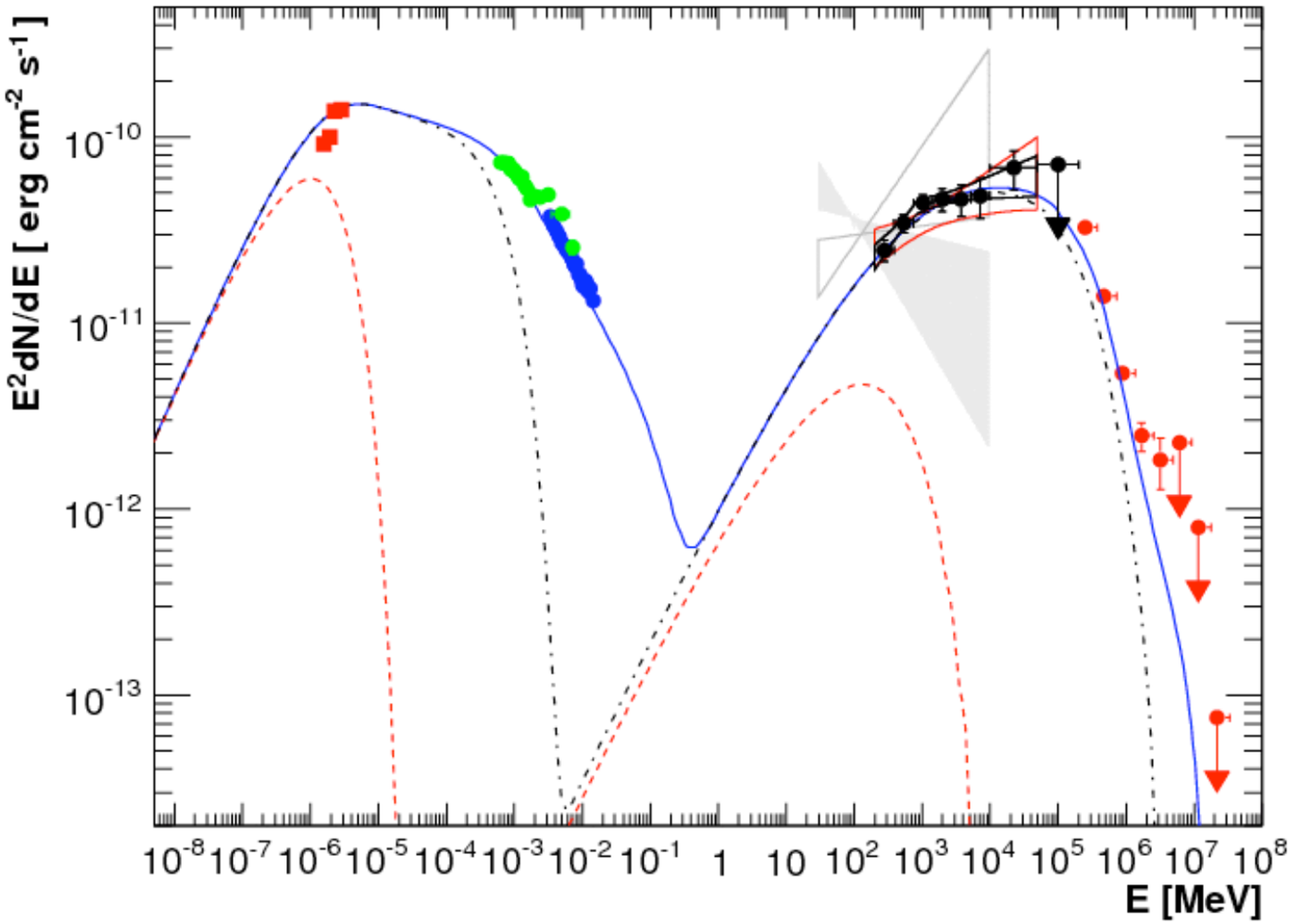
# Emerging of new components: PKS 2005-489

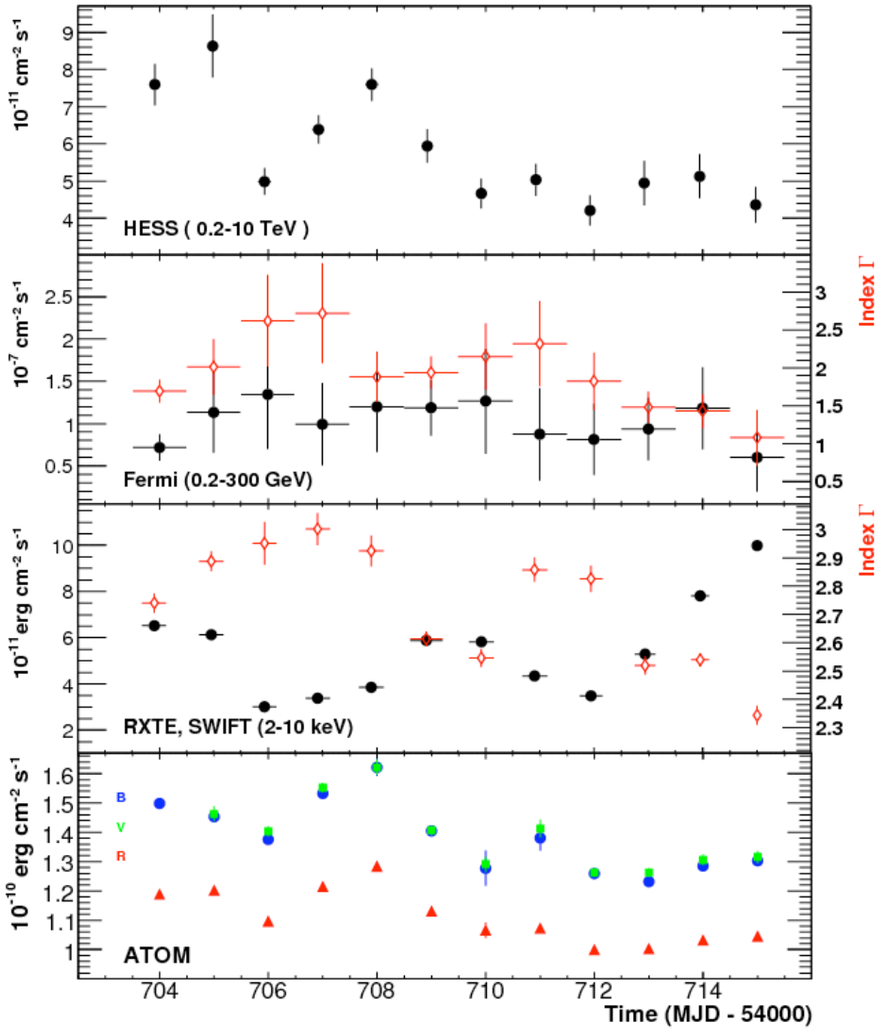
Mwl campaigns XMM-RXTE-HESS in 2004-2005




LC et al. (ICRC 2007)
Aharonian et al. 2009 (submitted)

# Xray-TeV emission might also correspond to different branches of single electron population




LAT+ HESS collab. (Aharonian et al 2009)

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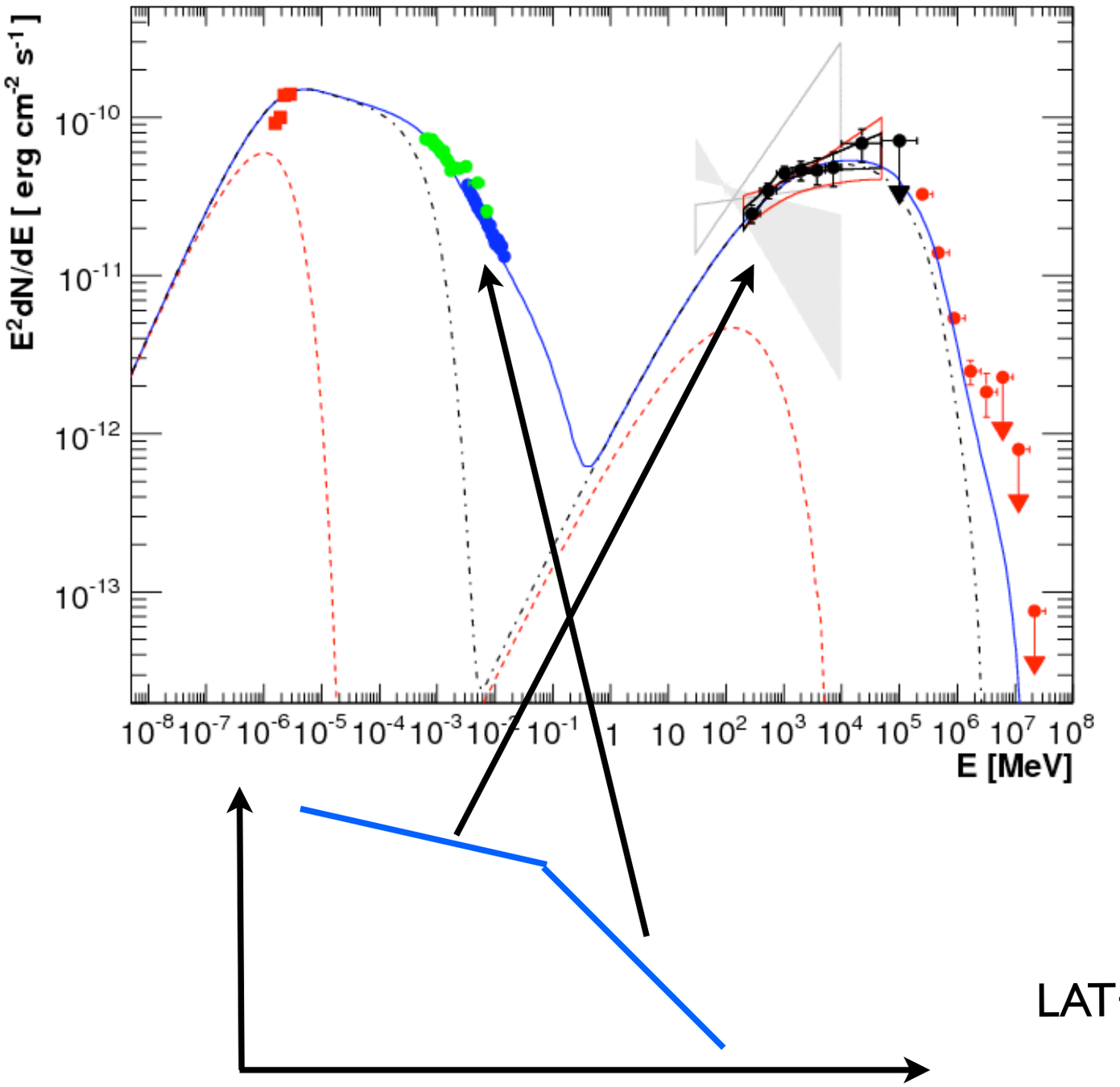
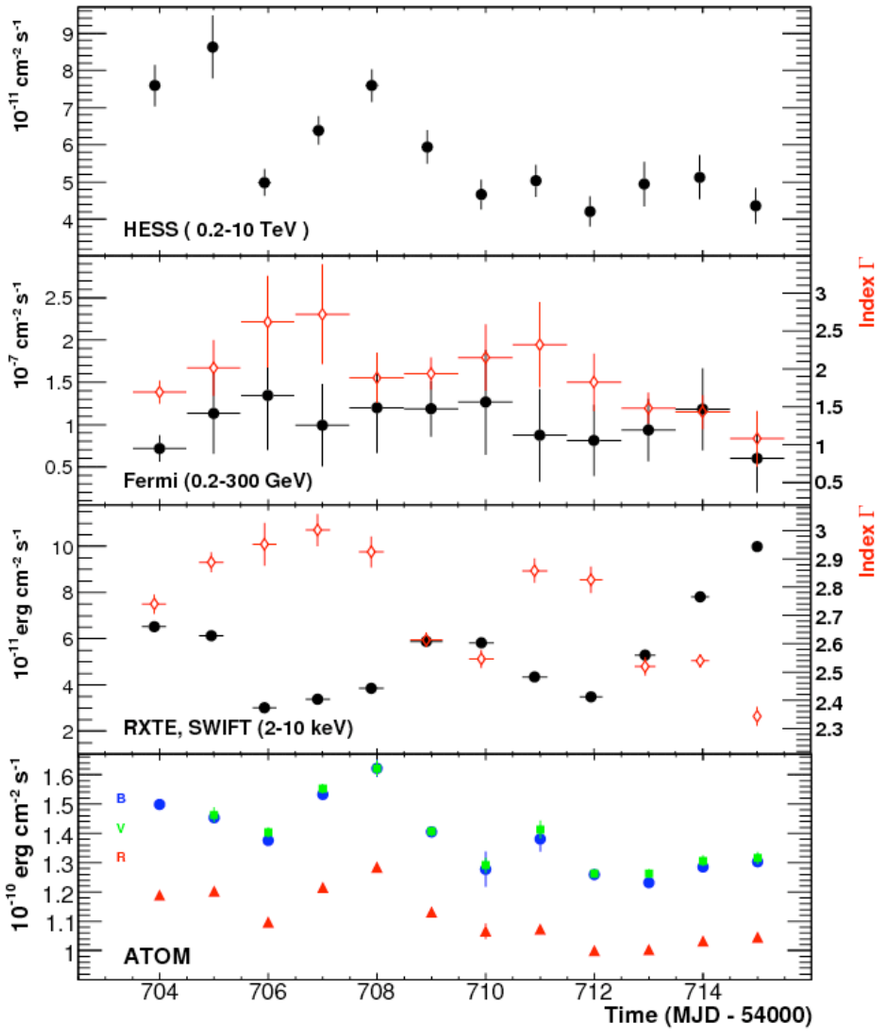
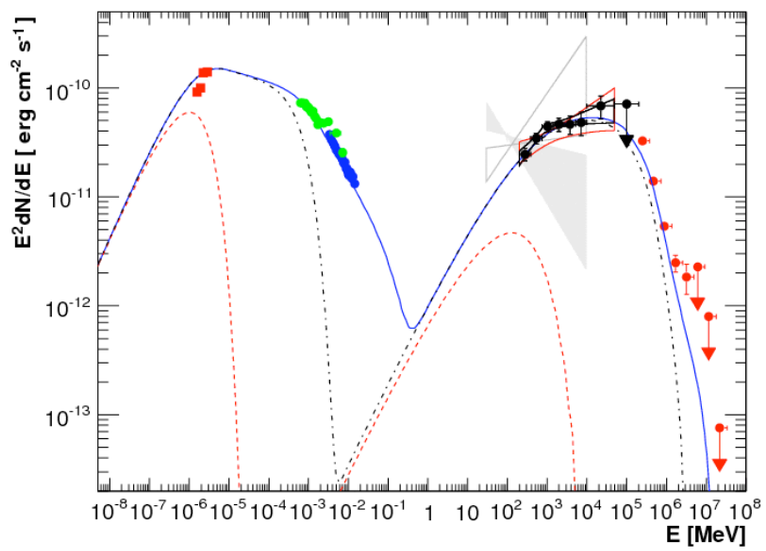



LAT+ HESS collab. (Aharonian et al 2009)

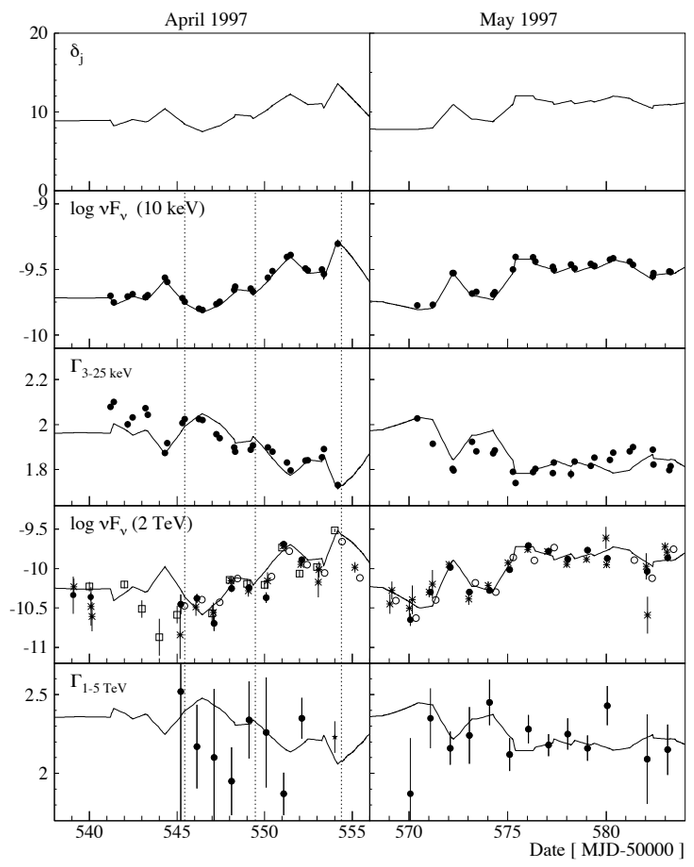
# RXTE synergies
## with LAT & Cherenkov Telescopes

LAT: study the evolution of the *entire* particle population, below and above the peak




CT: details of the acceleration/ cooling processes (time dependent modelling)

e.g. Coppi & Aharonian 1999
Krawczynski et al. 2001




delta

Flux

X spec

TeV flux

TeV spec

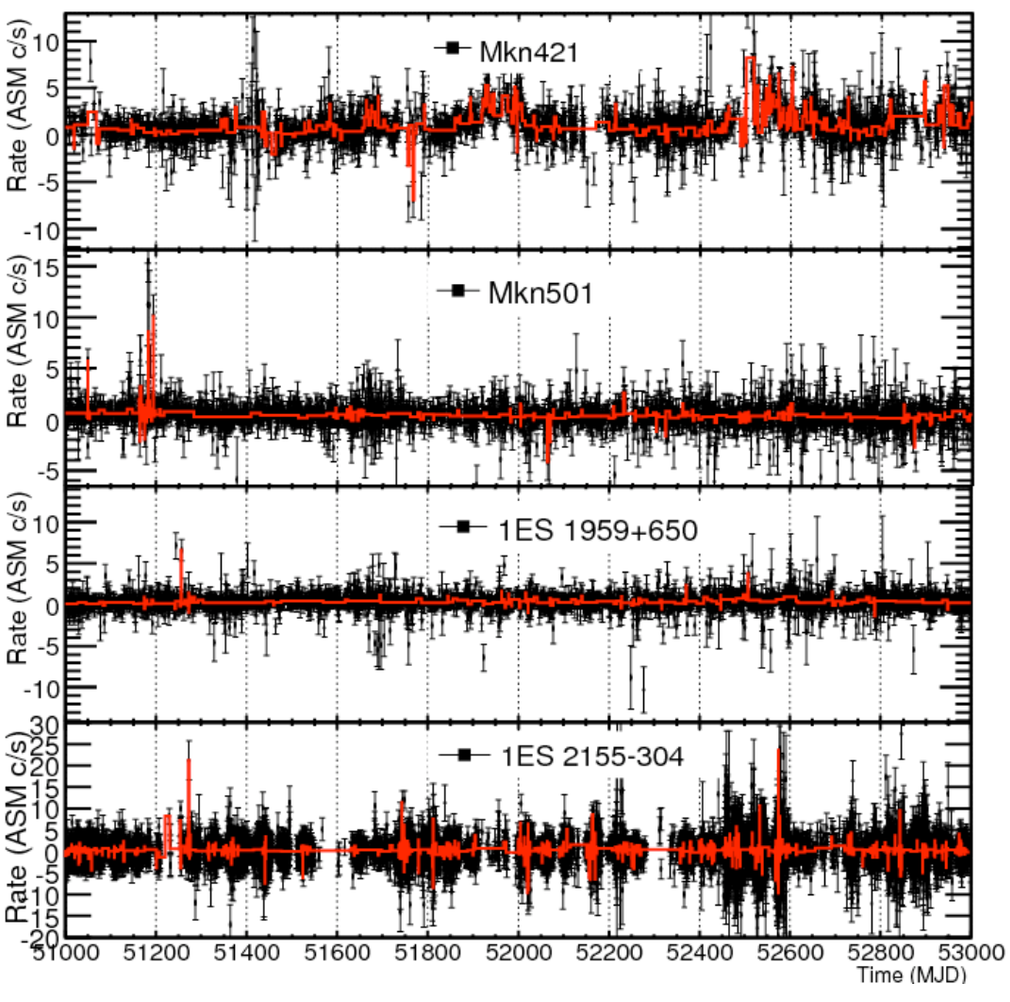
# Variability: 2 different aspects !

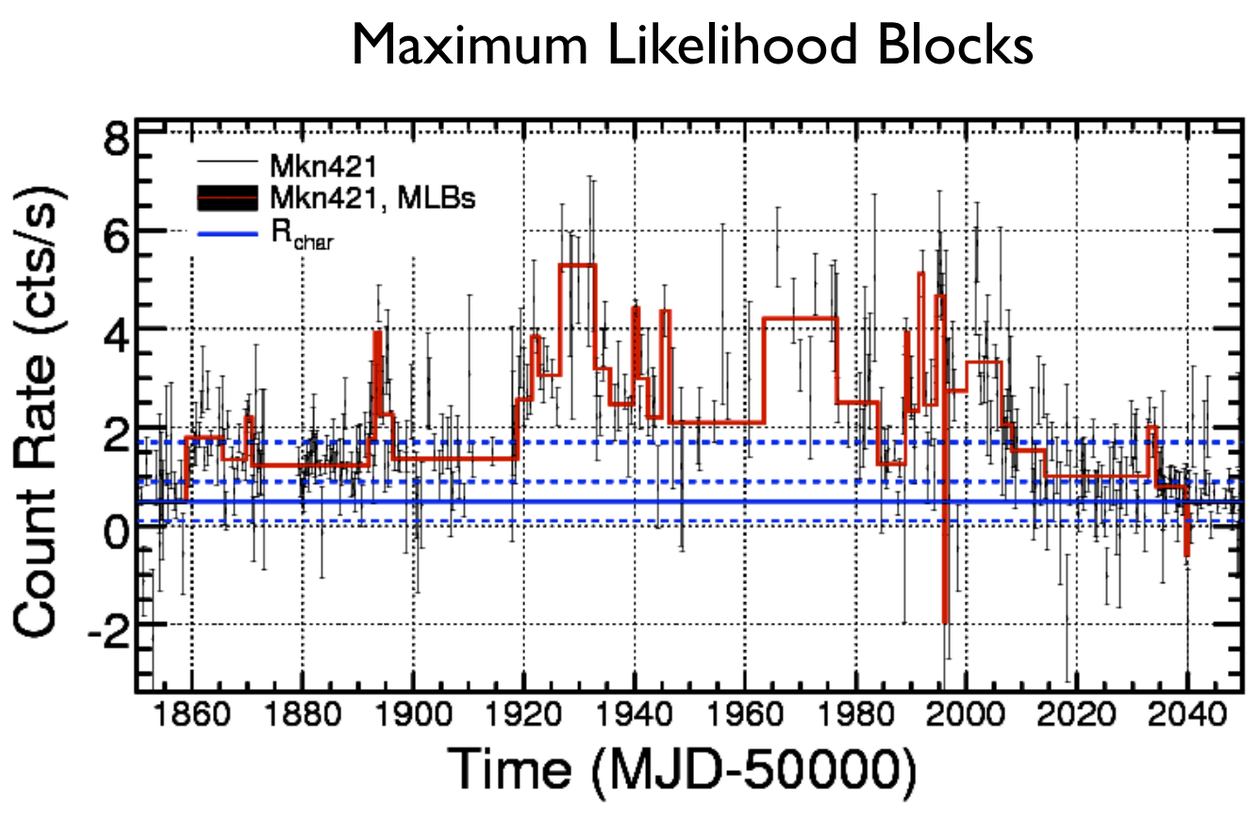
1) short term (single flares): jet structure, details of acceleration/cooling mechanisms

2) long term (months): properties of the central engine !
   -Modulation of the disturbances along the jet;
   -Duty cycle and power

# Main opportunity: long term campaigns on HBL

## Example from ASM: duty cycle and characteristic levels

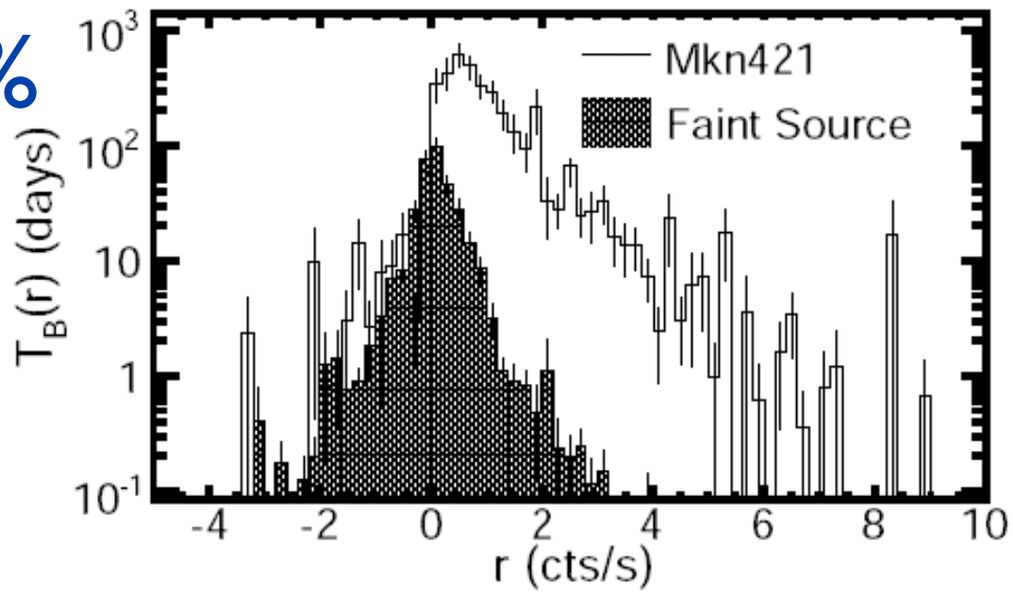


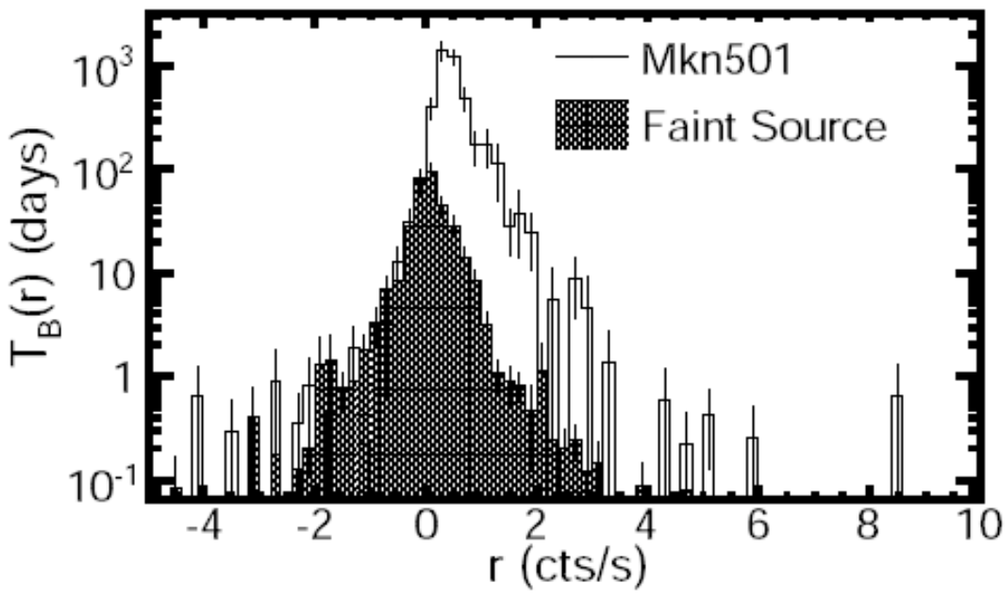




Resconi, LC et al. 2009

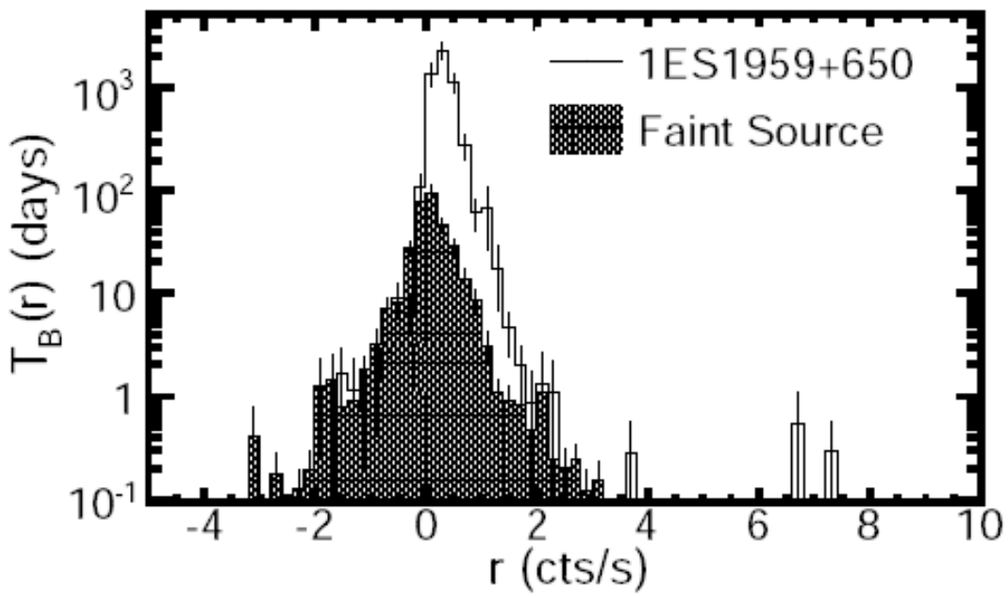
# Duty cycle

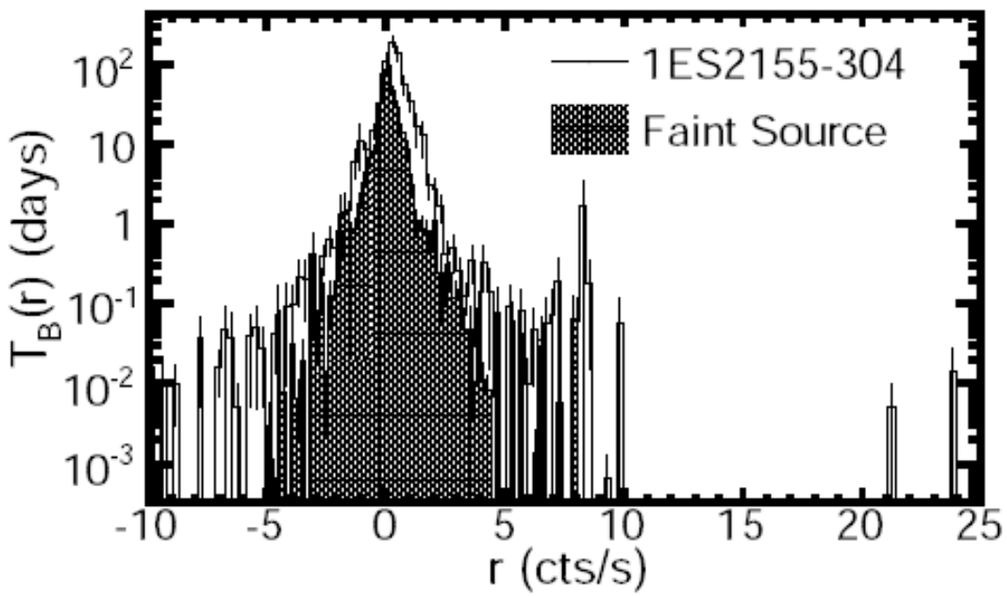
18%




10%




e.g.: time passed at flux 3 sigma above characteristic level

Resconi, LC et al. 2009

# Modulation of the jet

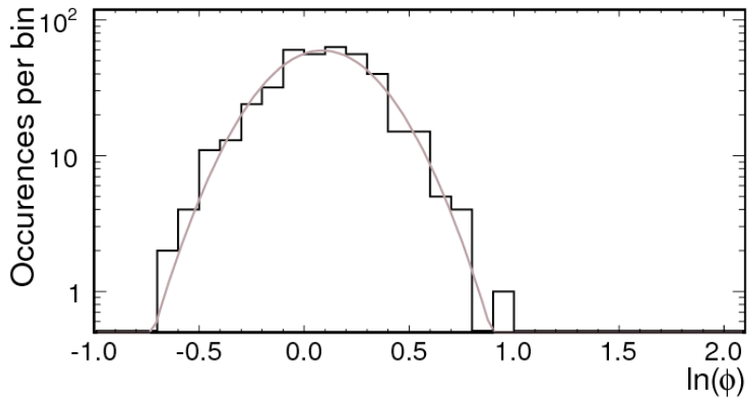
## structure function, power density spectrum

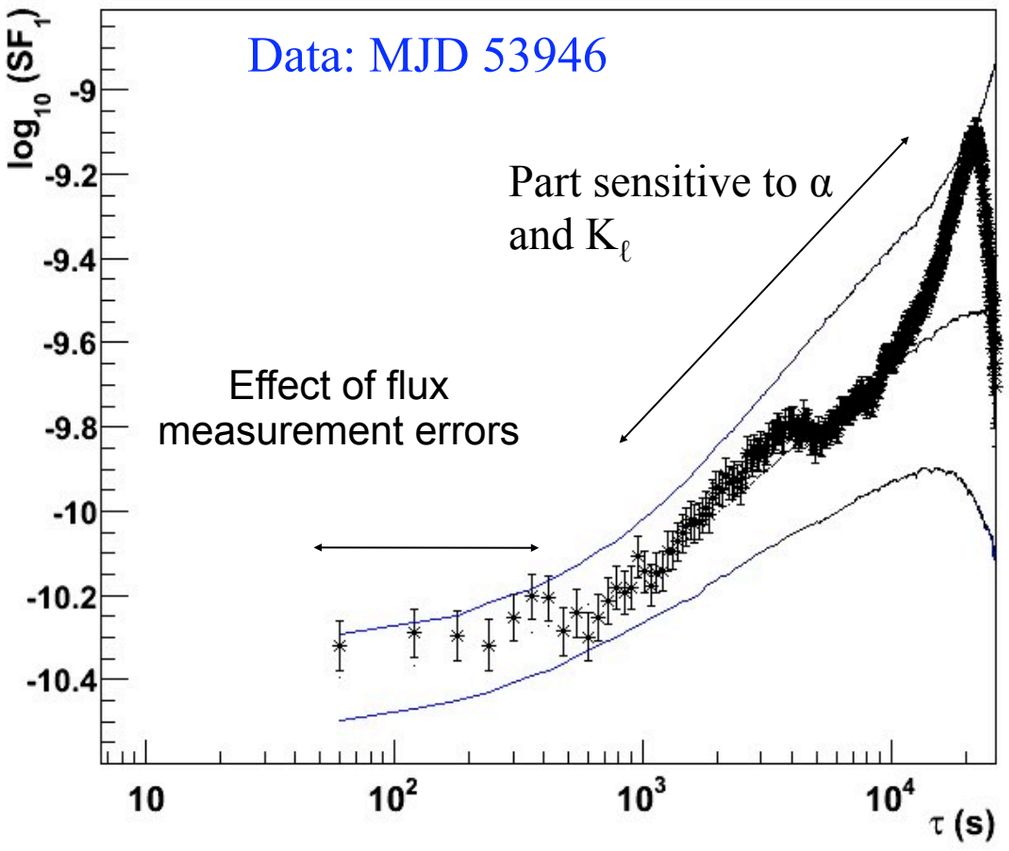
Engine activity seems due to a log-normal stationary process

Gaussian variable is ln(Flux), not Flux

e.g. PKS 2155-304 at VHE

Degrange et al. 2008


e.g. BL Lac in X-rays

Giebels & Degrange 2009

# NOTE: 2 types of HBL !

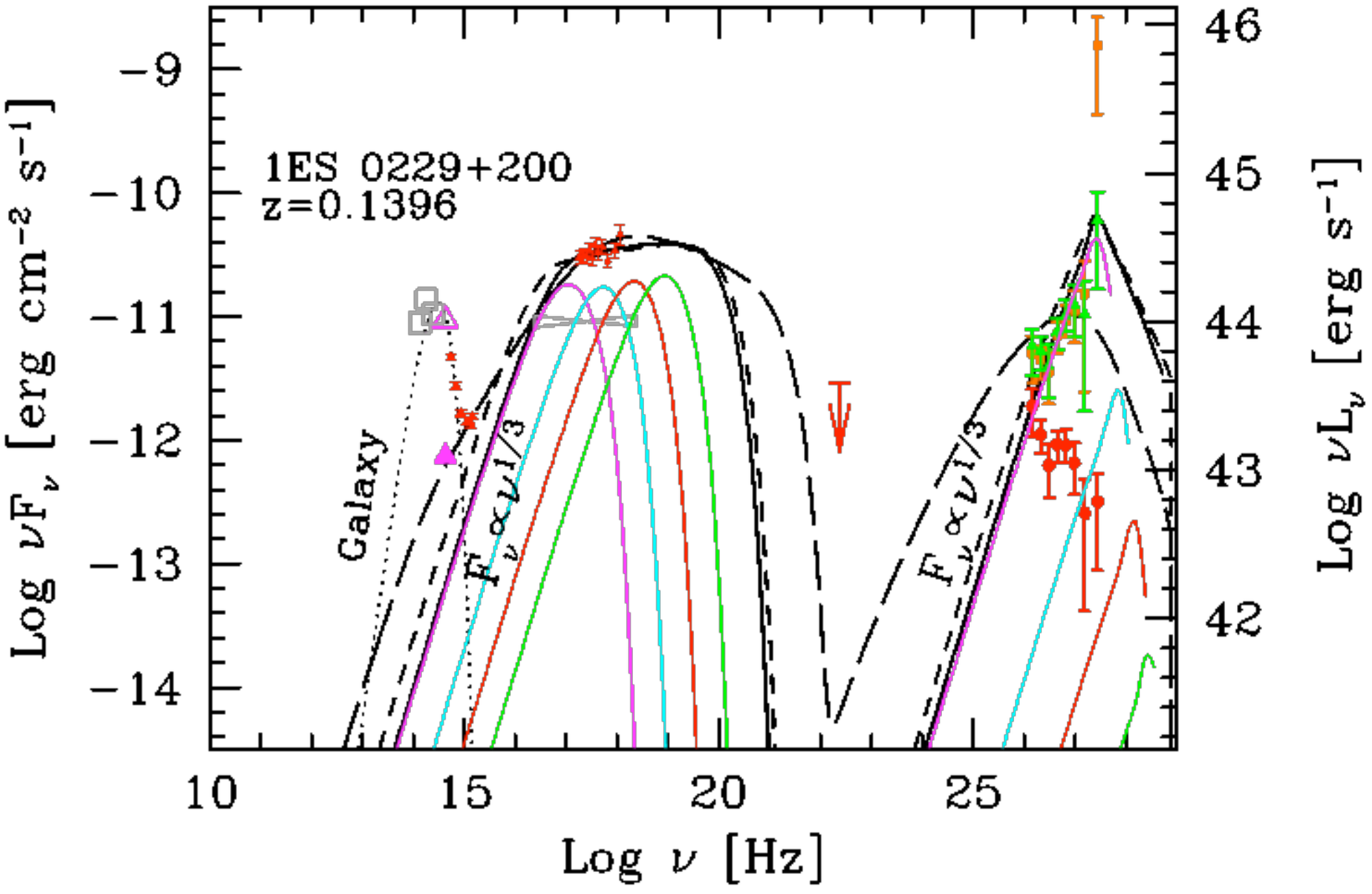
1) Classical HBL, IC-peak @100-300 GeV

2) Extreme HBL, hard TeV spectrum,
IC-peak >3-10 TeV !

(best cases: 1ES 0229+200, 1ES 1101-232, 1ES 0347-121)

These are the most puzzling for SSC modelling,
NOT GeV bright (not detected by LAT),
with different variability properties ?!

# I ES 0229+200




Aharonian et al. 2008
Tavecchio, LC et al. 2009

# Summary 1: open questions

- We don't understand yet the Xray-TeV connection
  - complex relation (orphan flares, super-quadratic slope)
  - though SSC works well overall (time-dep models to be used)

- Poorly studied: central engine variability properties
  - (duty cycle, structure functions, low-frequency break)

- Hard TeV sources: real puzzle for SSC,
  acceleration process in new conditions

# Summary 2: RXTE strenghts

- Multiple zones/components emerge at highest energies,
  RXTE-PCA monitoring can unveil them at best

- Extreme HBL: peak ≥ 1 keV ,
  RXTE best suited to unveil peak changes

- Snapshot-SED, source identifications: best Swift
  RXTE: long term, systematic observations,
  interlaced with Swift =>coverage during fast flares

# Summary 3: RXTE strategy

## Capitalize RXTE-PCA strenghts

1) Time for LONG CAMPAIGNs (1-2 years) on few selected HBLs: duty cycle, central engine, evolution multiple components

2) LAT synergy: unique chance! long term evolution of the particle population across the peak (never done before)

3) CT synergy: 3 next gen CTs on-line !
ToO + shorter but more dense sampling.
- details acceleration/emission mechanisms
- complex X-ray/TeV connection
=> time dependent modelling of the emitting regions