

The X-ray Universe 2017, Rome, Italy

Time-resolved SEDs of Blazar Flares

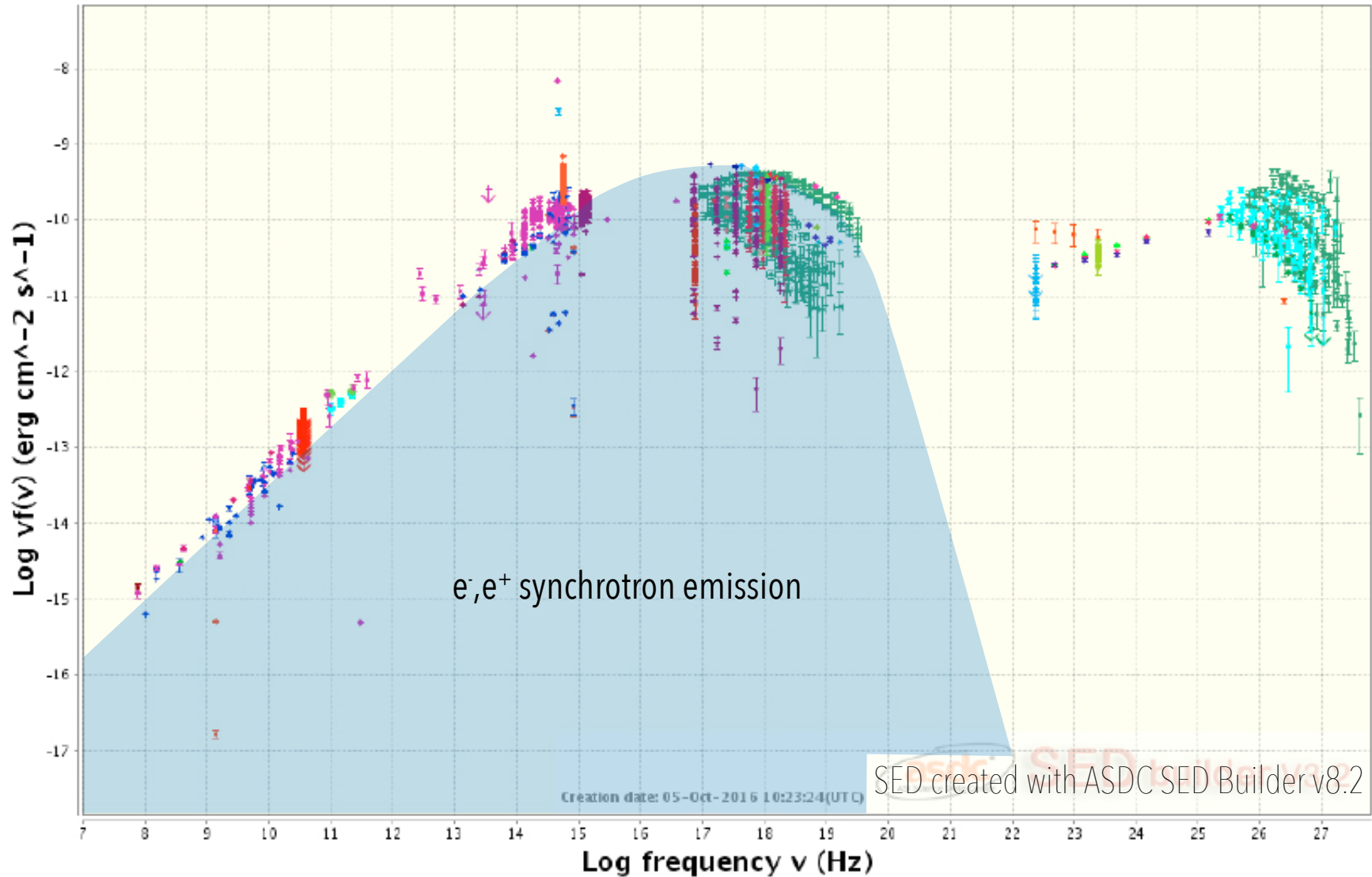
Annika Kreikenbohm, D. Dorner, M. Kadler, M. Kreter, T. Beuchert, N. Gehrels,
D. Glawion, I. Kreykenbohm, M. Langejahn, K. Leiter, K. Mannheim, C. Müller, S. Richter, J. Wilms,
and the FACT Collaboration

Leptonic or Lepto-Hadronic?



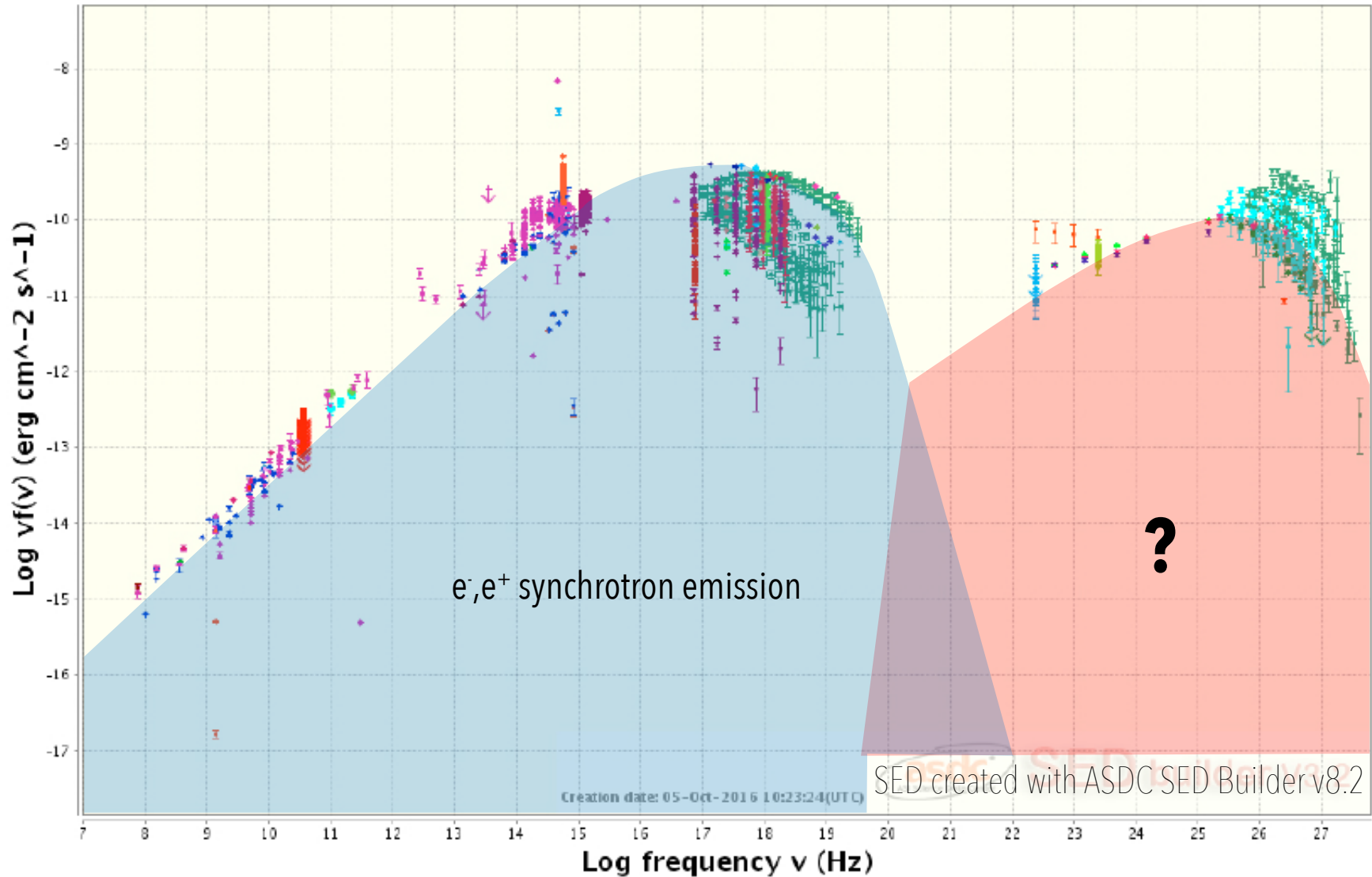
Non-Simultaneous SED of Mrk 421 (for recent extensive MWL studies, see e.g., Abdo+ 2011b, 2014; Ahnen+ 2016; Aleksic+ 2015; Balokovic+ 2016; Bartoli+ 2016; Cheng+ 2015; Furniss+ 2015; Fraija+ 2015; Hovatta+ 2015; Kakuwa+2015; Kataoka+ 2016; Lico+ 2014; Paliya+ 2015; Pian+2014; Sinha+ 2015, 2016; Zheng+ 2014; Zhu+ 2016; ...)

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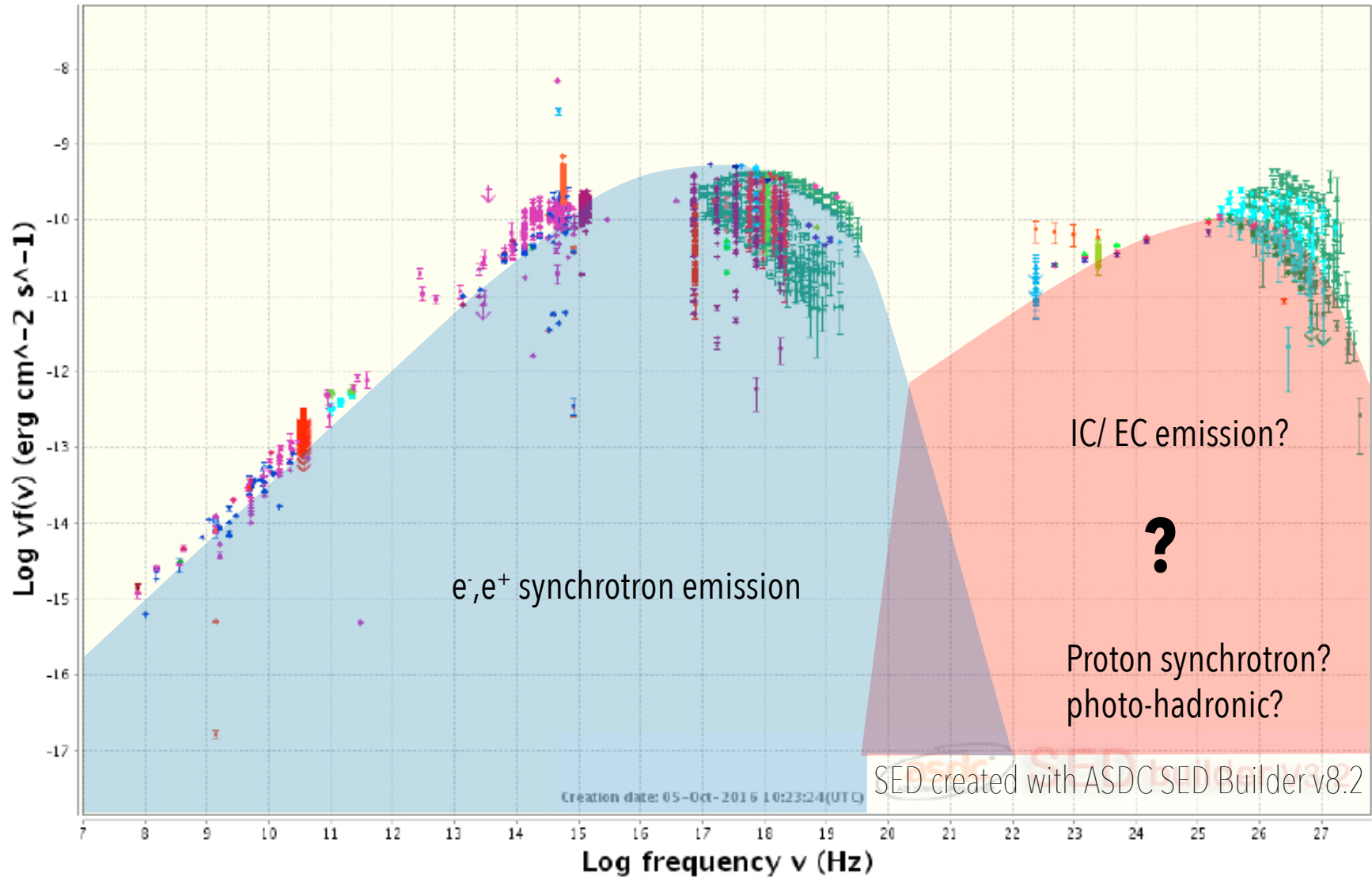
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Long-Term Monitoring

TeV band:

FACT (since 2012)

- daily VHE observations
- provides detailed variability information
- provides flare alerts

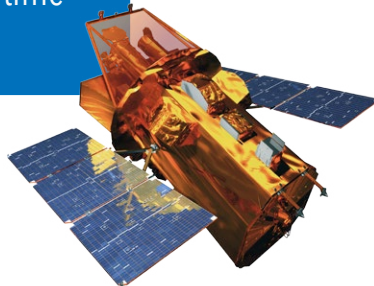
Trigger criterium:

VHE FACT rate > 70 evts/hour

X-ray / UV band:

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- weekly scheduled (~1ks)
- monitoring of the low-E emission
- test for orphan flares & time lags



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MWL ToO Program

ToO observations upon FACT trigger:

Soft X-ray / UV band:

Swift (~20ks total)

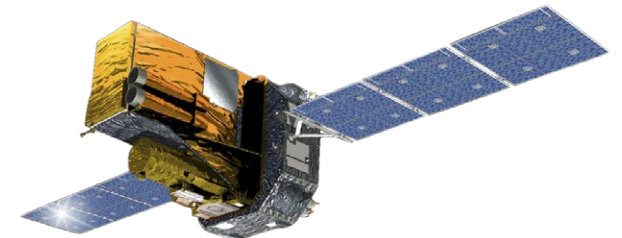
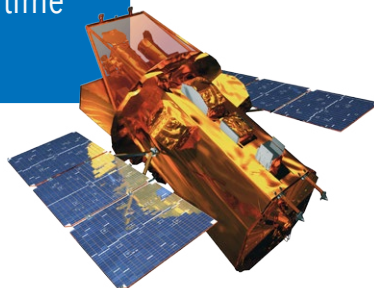
XMM-Newton (~100 ks total)

Hard X-ray/ γ -ray band:

INTEGRAL (~500 ks total)

Fermi/LAT (continuous)

FACT



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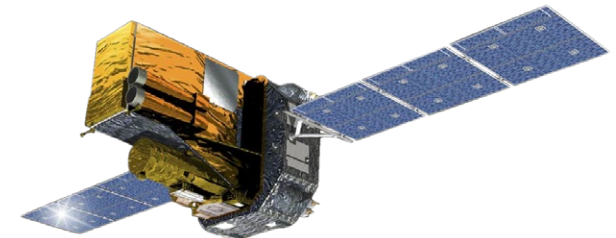
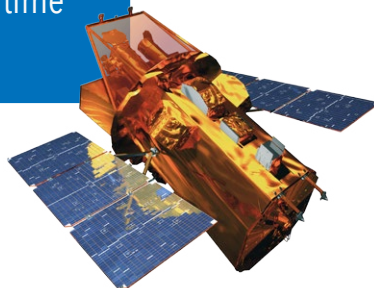
Fermi/LAT (continuous)

FACT

Time-Resolved SEDs

Apply time-resolved jet emission modes

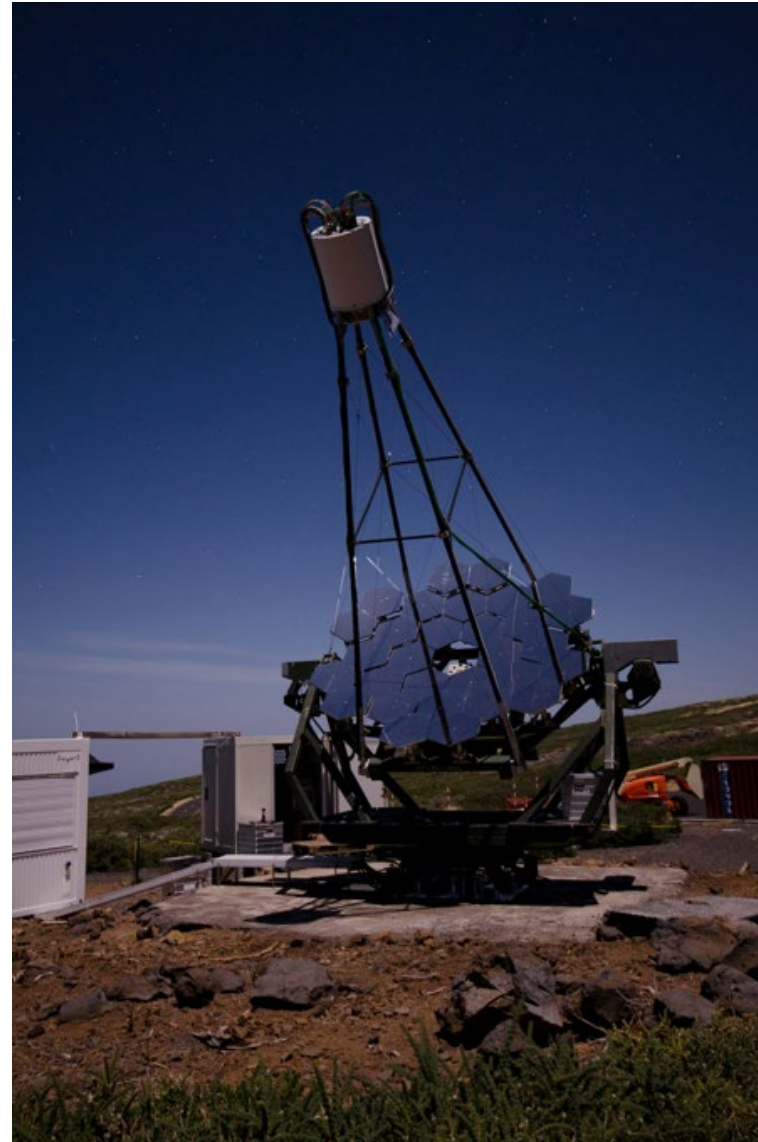
Provide constraints on jet emission models



FACT

First G-APD Cherenkov Telescope
(TU Dortmund, ISDC Geneva, Universität Würzburg, ETH Zürich)

- Operational since 2011
 - Imaging Cherenkov Telescope
 - Long-term monitoring of blazars at TeV energies
 - Silicon based photosensors:
 - _ Stable detector performance
 - _ Observations during moon light
- > Ideal for monitoring**
- FACT sources in the MWL Program:
Mrk 421, Mrk 501, 1ES 1959+650

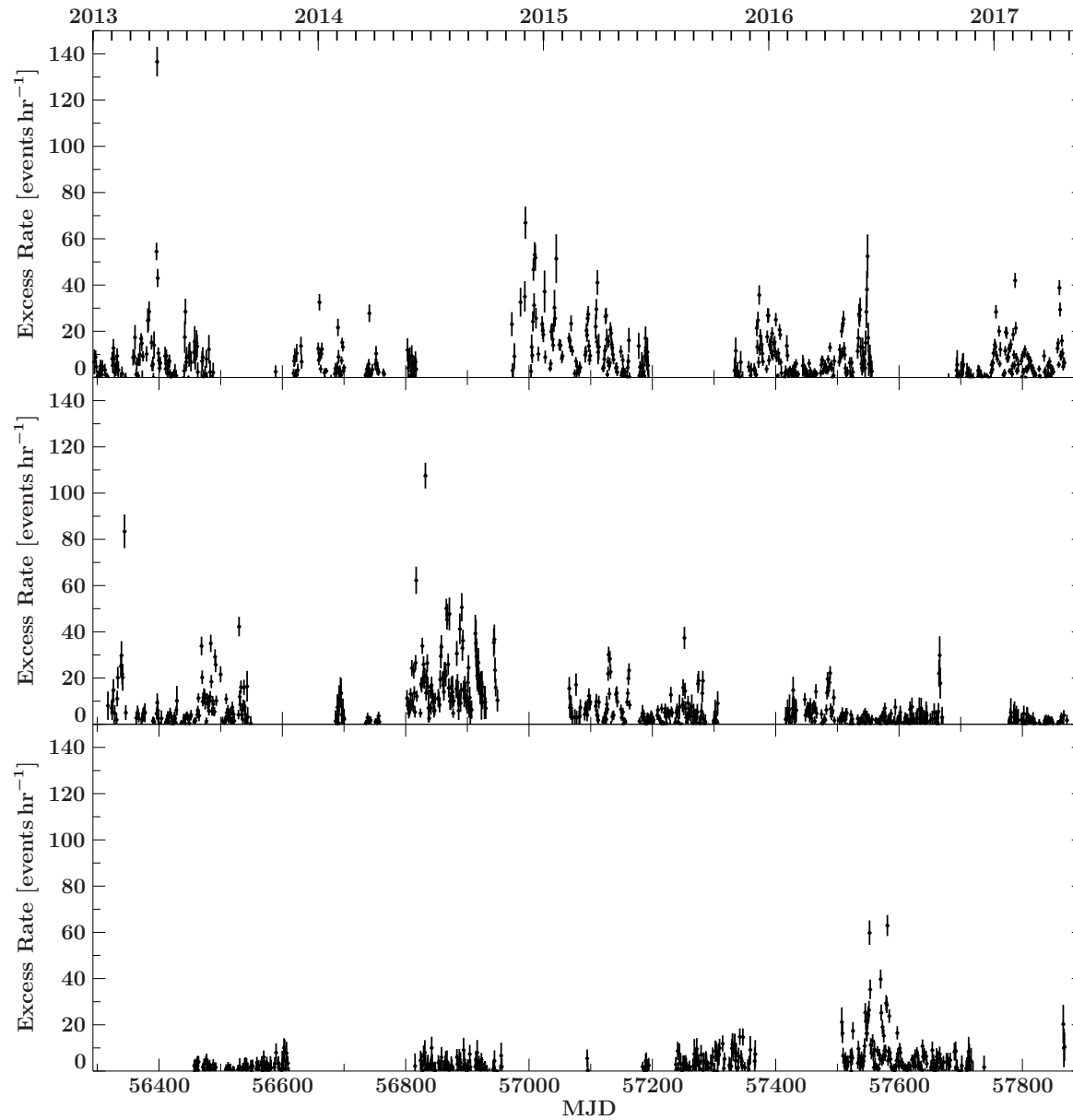


2200 m a.s.l., MAGIC site,
Observatorio del Roque de
los Muchachos, La Palma,
Canary Islands, Spain

Photo: Thomas Krähenbühl

Long-term VHE light curves (nightly binning)

FACT EXCESS RATE [evts/hr]



Mrk 421

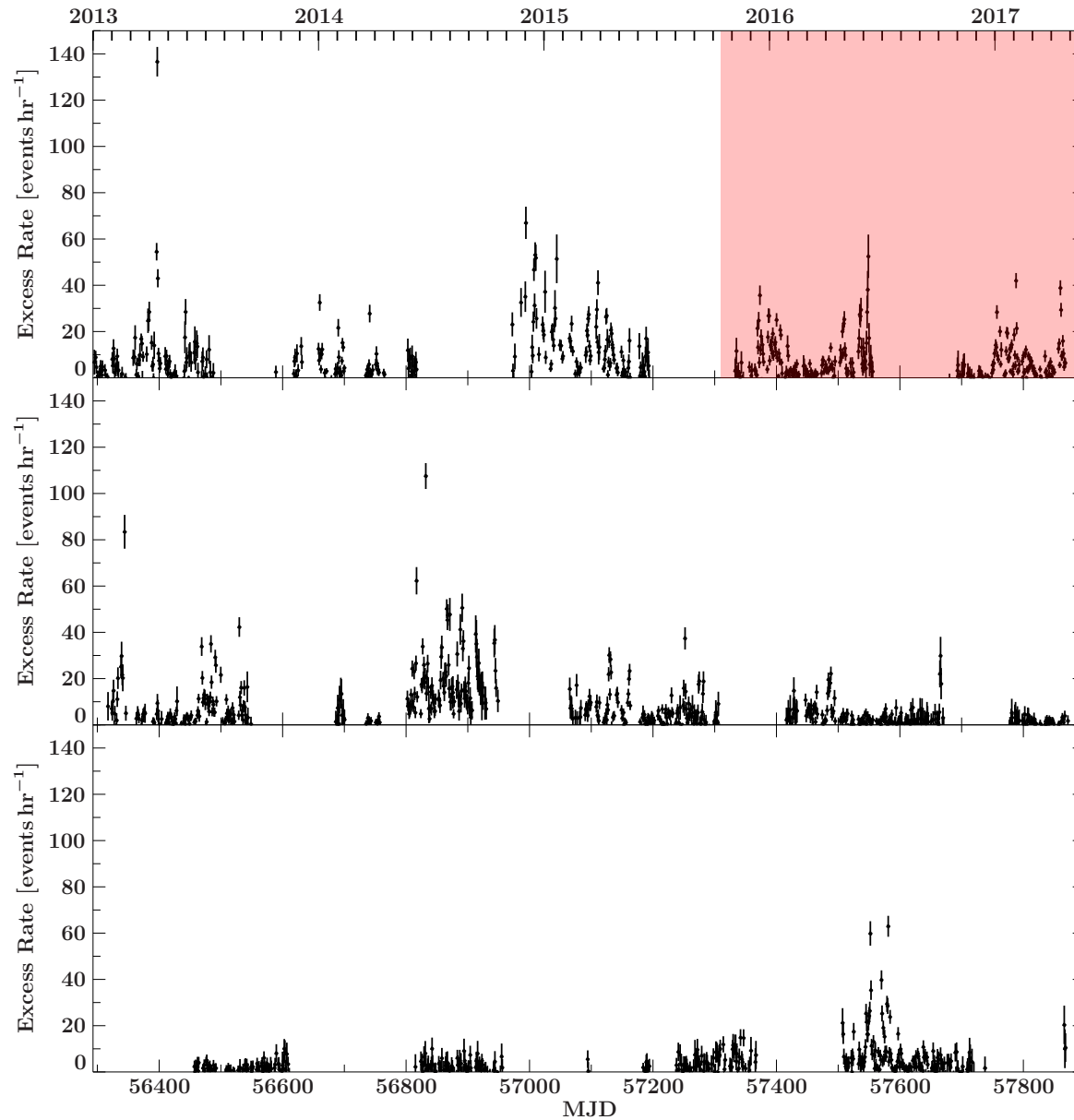
Mrk 501

1ES 1959+650

TIME [MJD]

Long-term VHE light curves (nightly binning)

FACT EXCESS RATE [evts/hr]

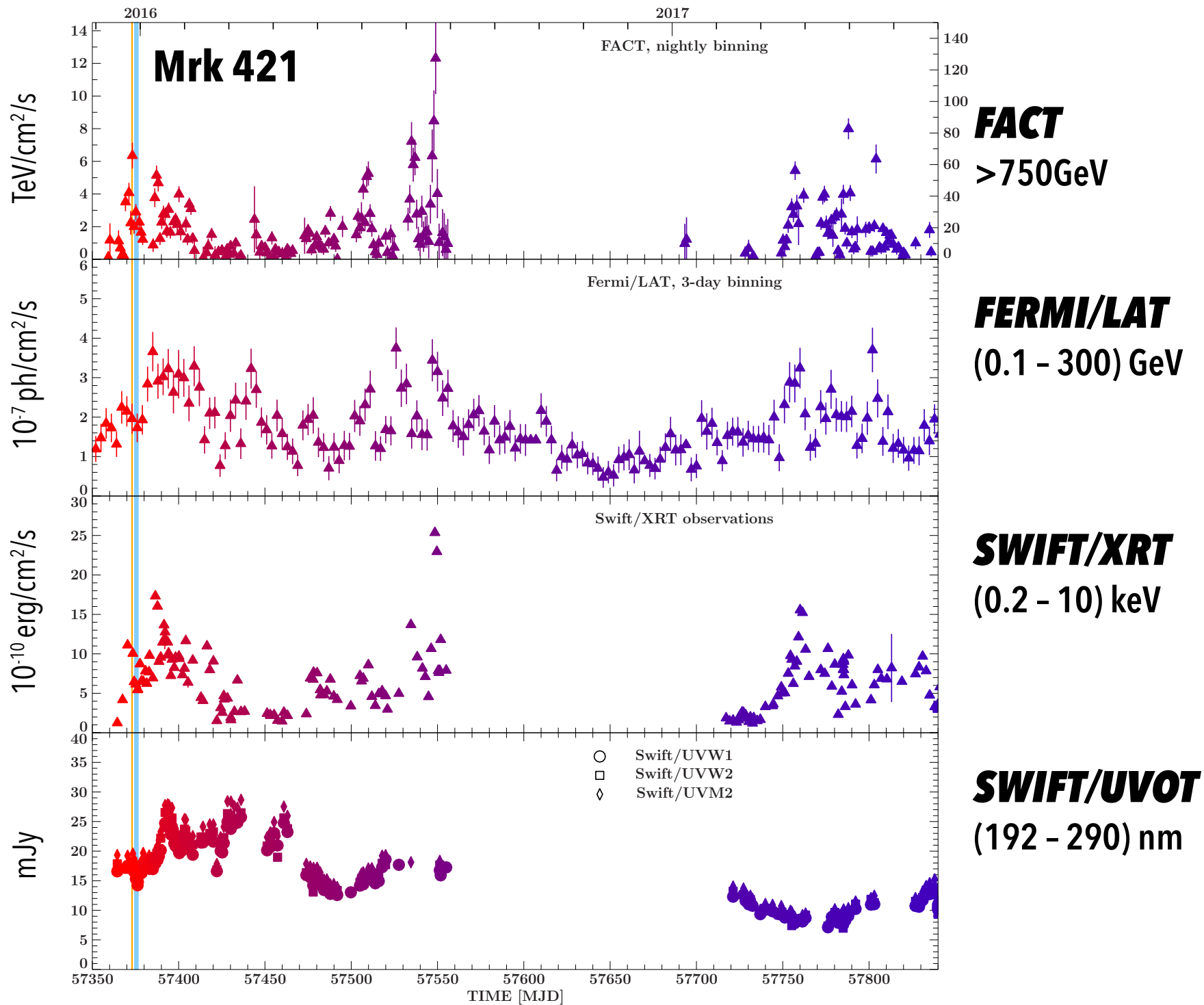


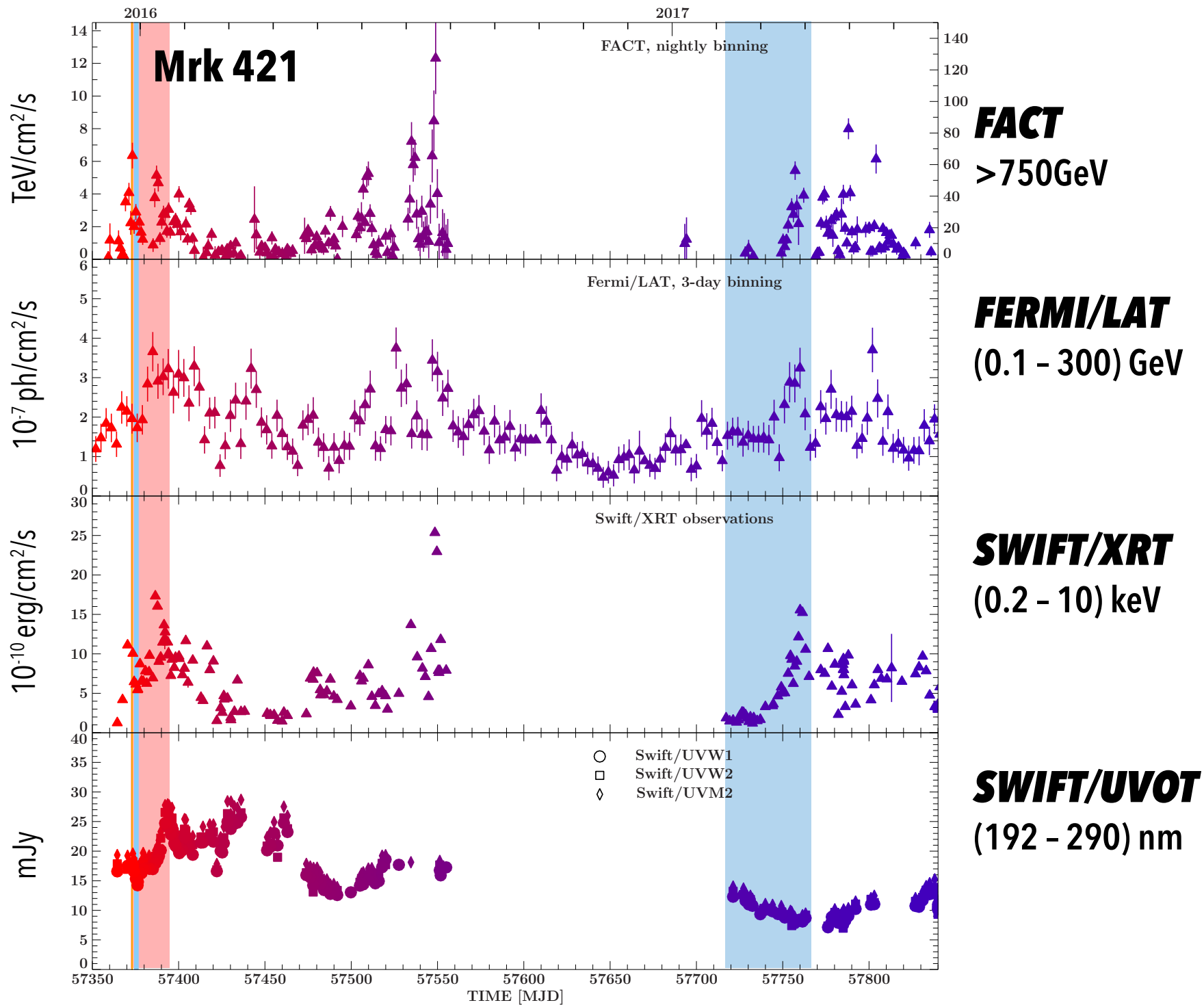
Mrk 421

Mrk 501

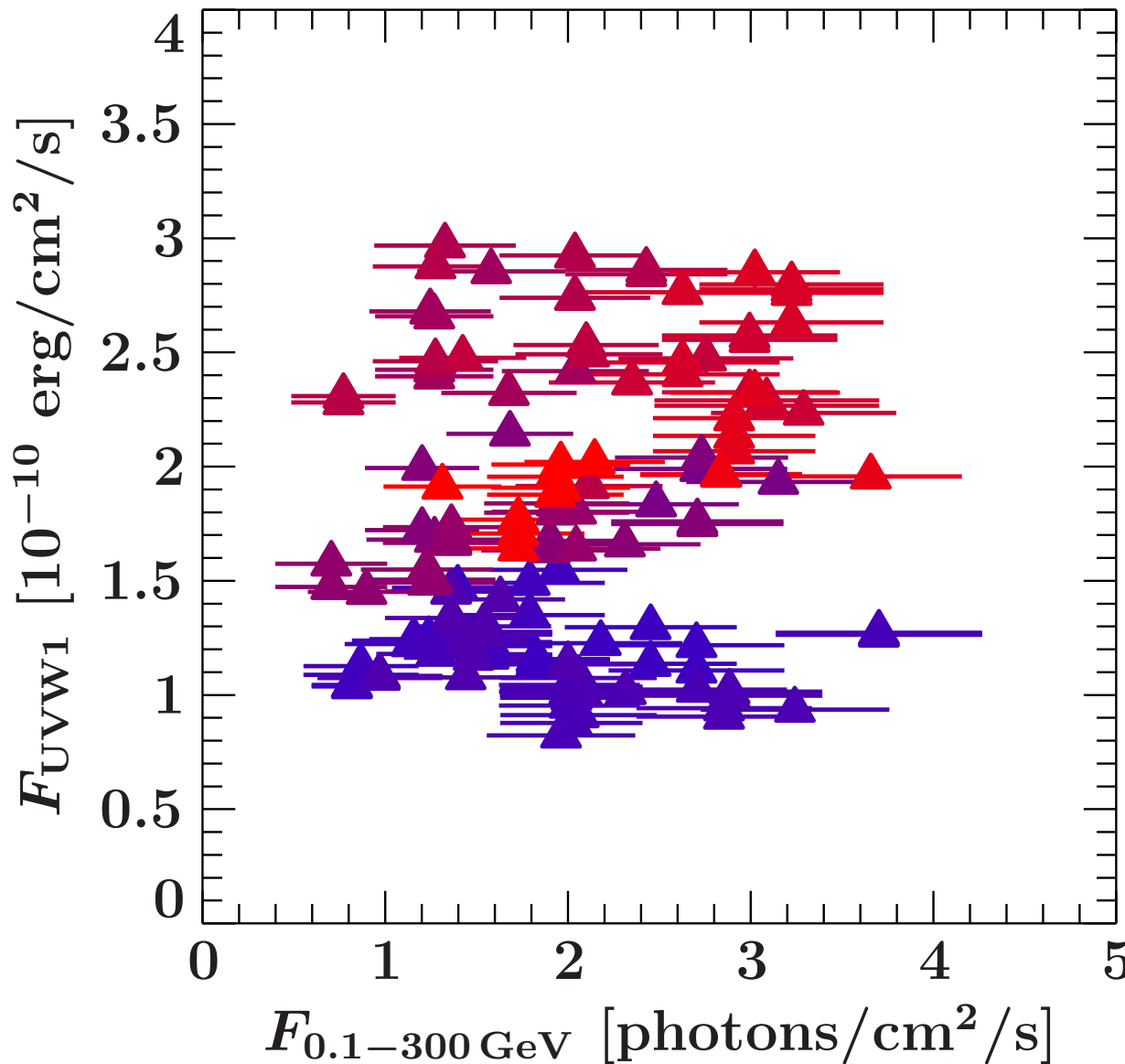
1ES 1959+650

TIME [MJD]





Flux variability 2015 - 2017



VHE/HE emission vs. X-ray flux:

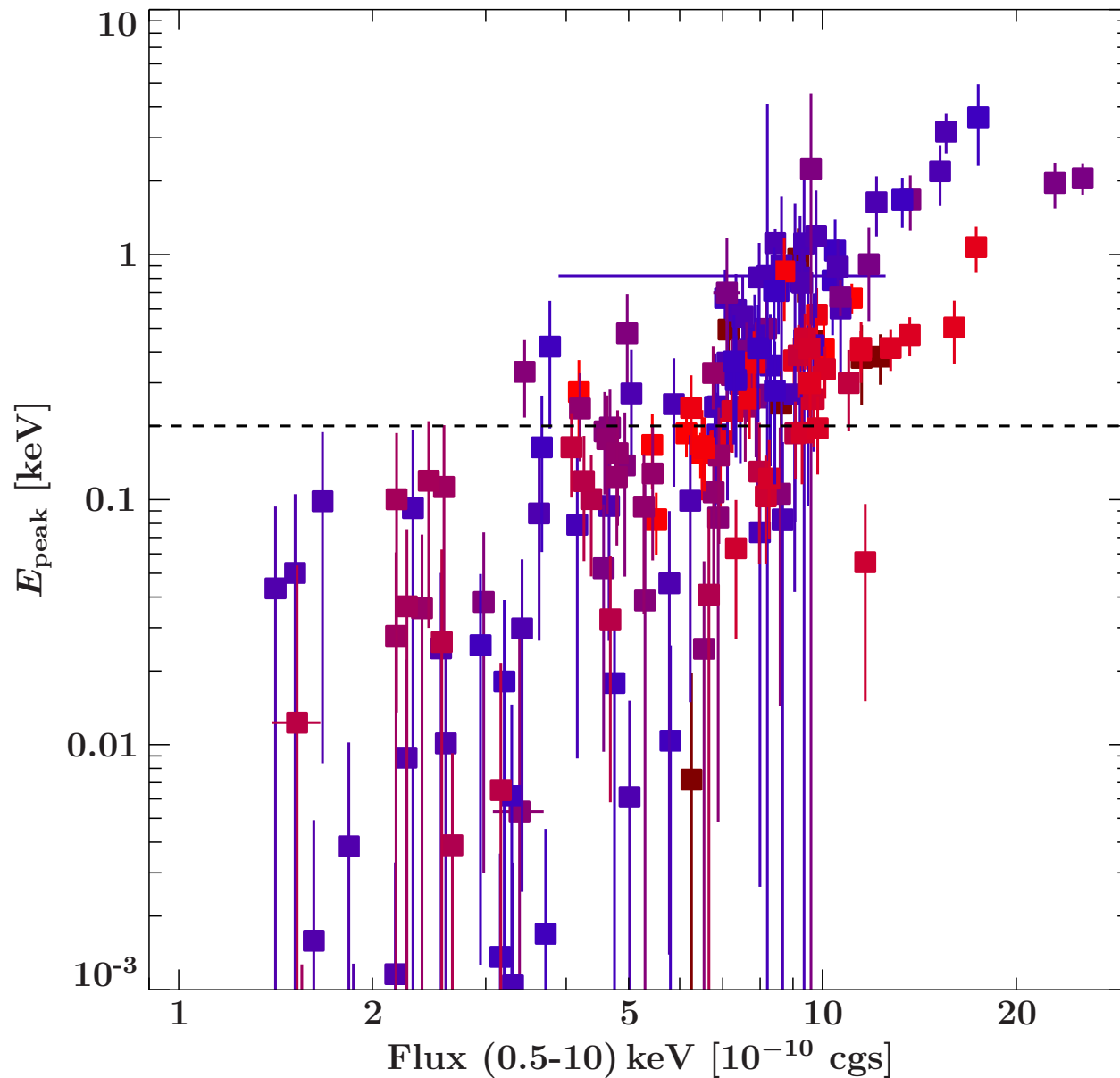
- tightly correlated flux variations
- no time lags!
- both outbursts in 2015 and 2017 follow the same correlation

Ultraviolet emission vs. X-ray flux:

- no correlation with high energy emission

Different variability trends in 2015 - 2017?

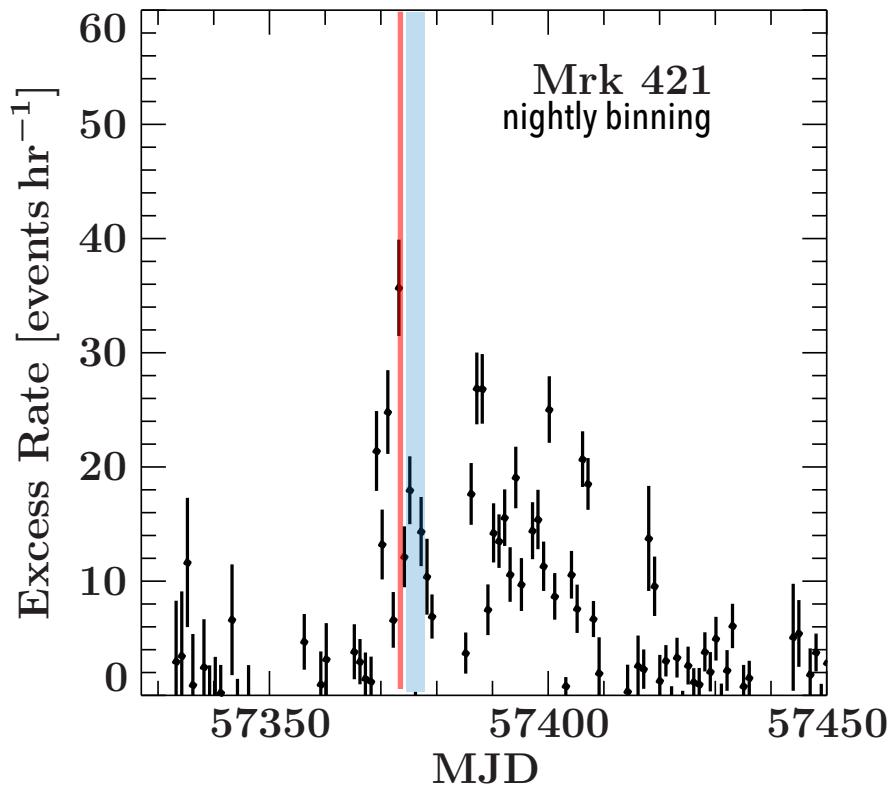
Synchrotron Peak Energy Evolution 2015 - 2017



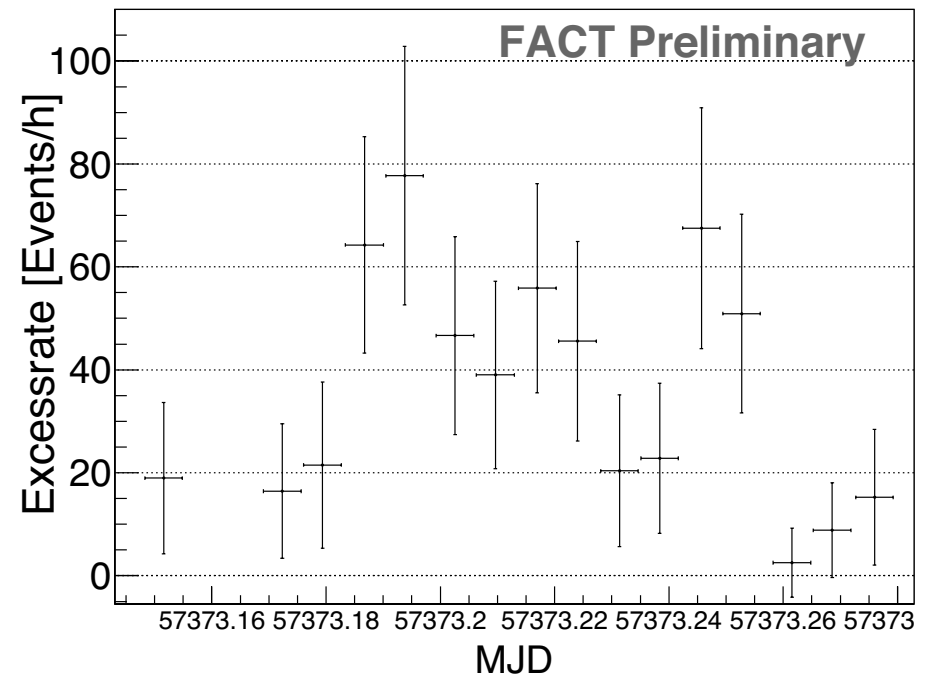
- correlation between X-ray flux and synchrotron peak energy E_{peak}

- change in the SED between 2015 and 2017 variations

Outburst 2015 Dec 17



FACT alert on 2015-Dec-17 (MJD 57373)
rate >70evt/h in 10 min binning

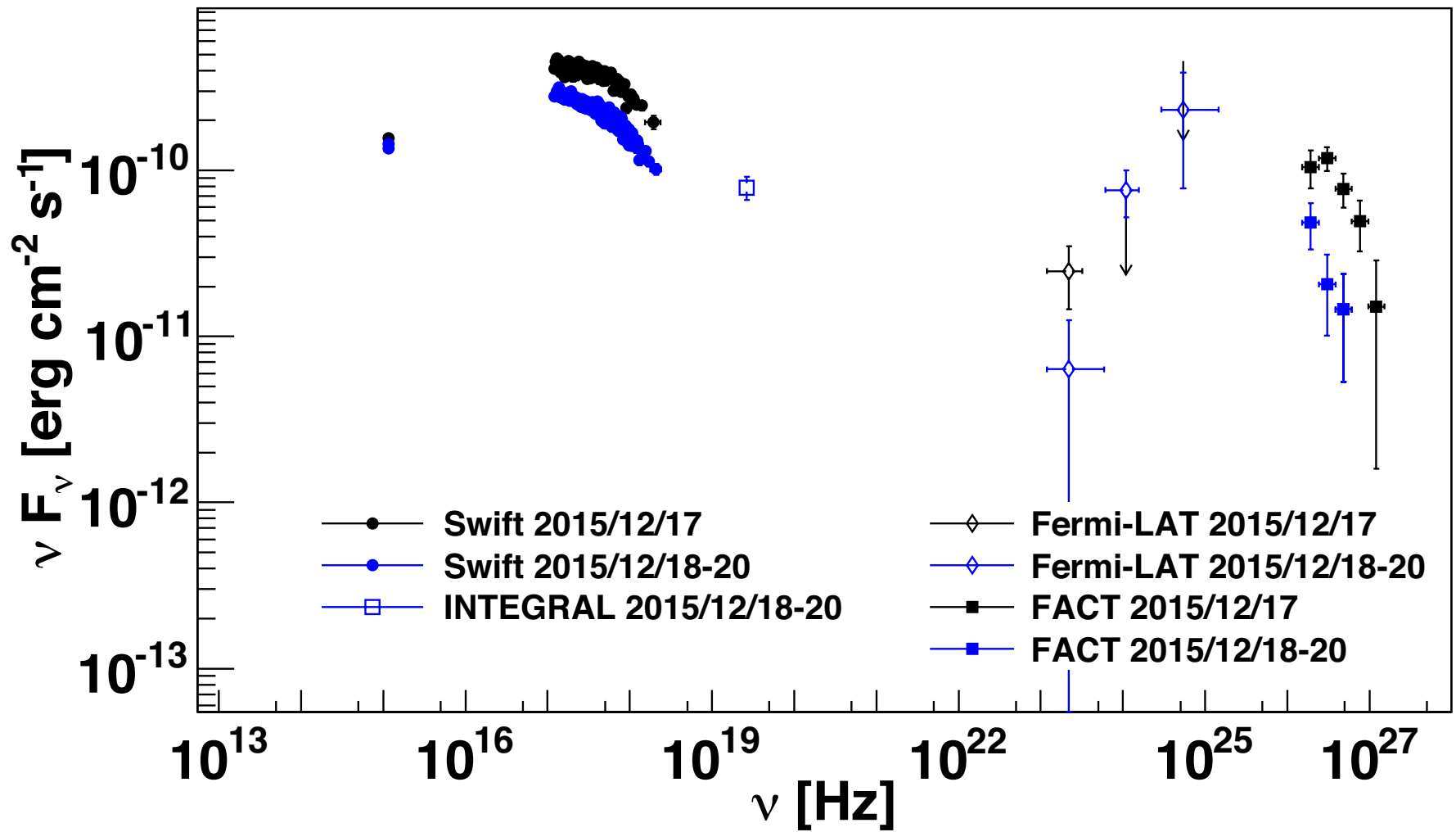


Triggered observations

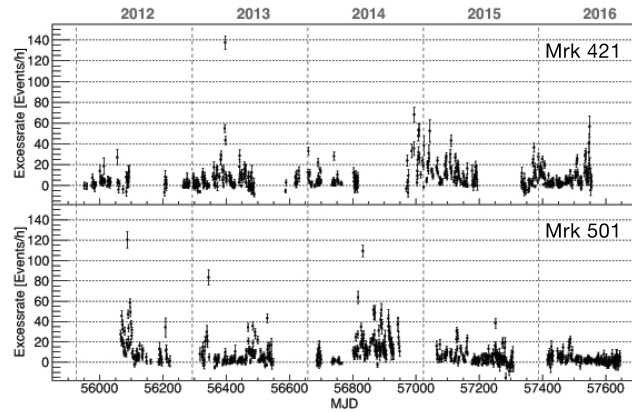
Swift MJD 57374 - 57378, ~2 ks daily

INTEGRAL MJD 57375 ~165 ks

Outburst 2015 Dec 17



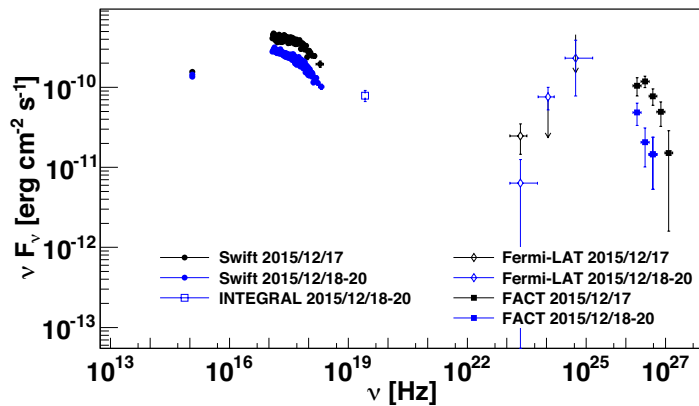
Summary



FACT VHE monitoring provides fast triggers for MWL campaigns (**within 30 min!**)
Complementary information by monitoring by *Swift* & *Fermi*.



Comprehensive MWL ToO program during outbursts.



Time-resolved broad band SEDs of Blazars in VHE outburst!

MWL Campaign is ongoing.

Kreikenbohm et al. in prep.