

First G-APD Cherenkov Telescope (FACT)



Daniela Dorner for the FACT Collaboration

Outline

- * Reminder:
What is FACT?
- * What can we do
with FACT?
 - * Longterm Monitoring
 - * Quick Look Analysis
 - * Sensitivity of the
Instrument
- * What can FACT offer
for AMON?
 - * Observing strategy
 - * Real-time capabilities
 - * Sending alerts
 - * Receiving alerts
- * Status in AMON



First G-APD Cherenkov Telescope Major Goals

Proof of principle:

Silicon based photo
sensors (G-APDs*)
in Cherenkov
Telescopes



First successful use in
regular operation since 2011



Longterm monitoring
of bright TeV Blazars

- Variability studies
- Multi-wavelength + multi-messenger studies
- Flare alerts to other instruments

Facts about FACT

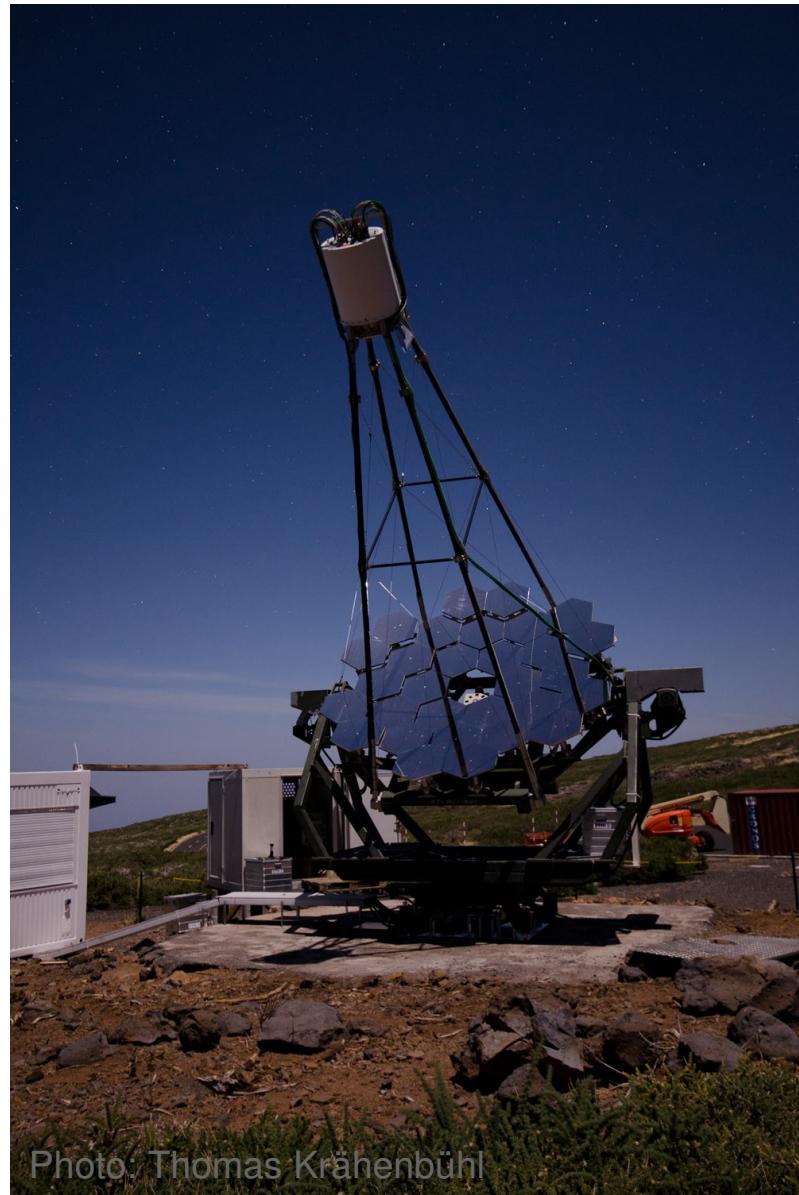


Photo: Thomas Krähenbühl

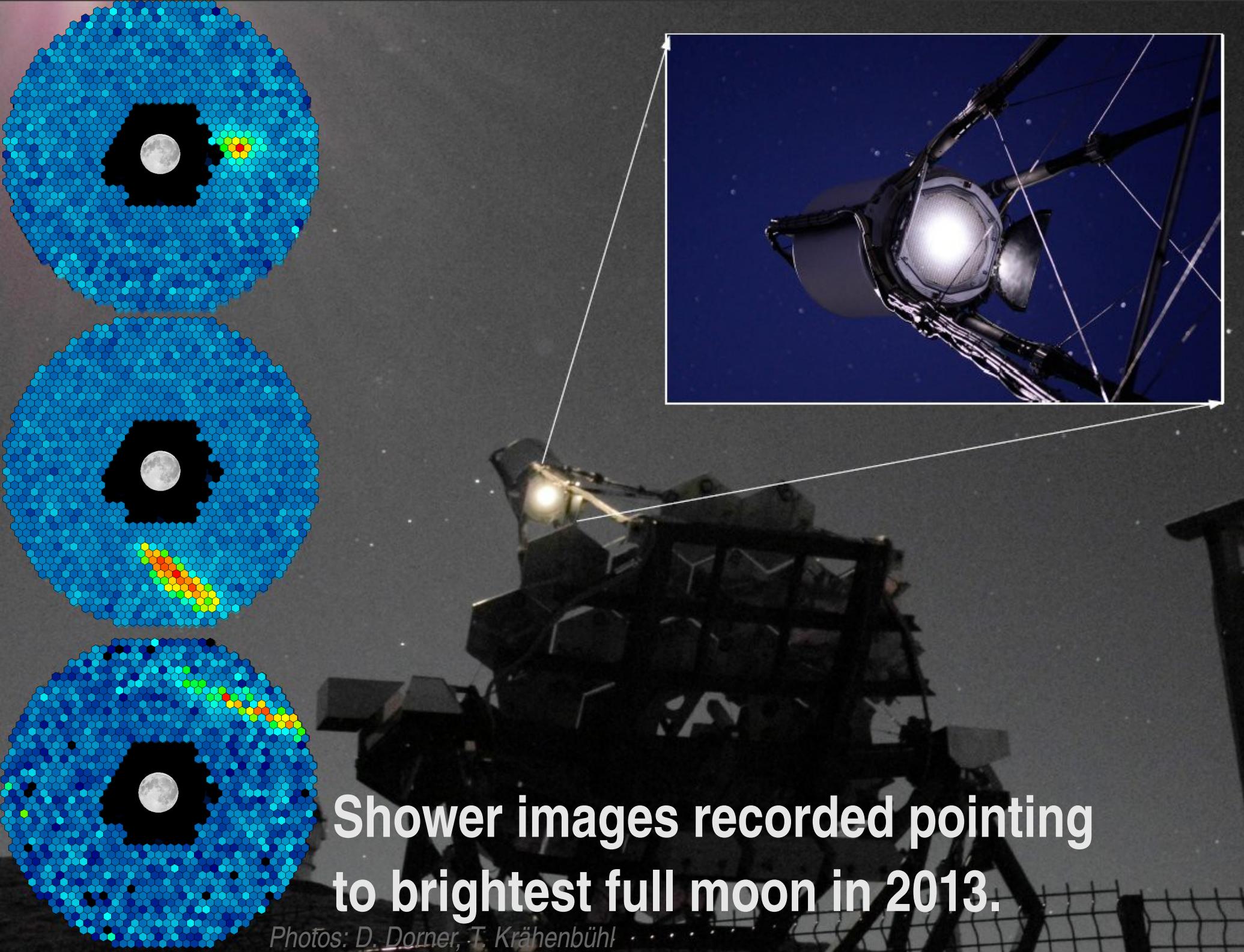
- 2200 m a.s.l.
Observatorio del Roque de los
Muchachos, La Palma
- Operational since Oct 2011
- 9.5 m² mirror area
- G-APD camera
 - Silicon based photosensors
 - 4.5° FoV, 1440 pixels à 0.11 °
 - Feedback system → stable gain
- More Details:
H Anderhub et al. 2013 JINST 8 P6008
A Biland et al. 2014 JINST 9 P0012

G-APDs – the Revolution in Cherenkov Astronomy



Photo: Daniela Dorner

- Robust and stable
 - Stable telescope performance
 - High data taking efficiency



**Shower images recorded pointing
to brightest full moon in 2013.**

Photos: D. Dorner, T. Krähenbühl

G-APDs – the Revolution in Cherenkov Astronomy



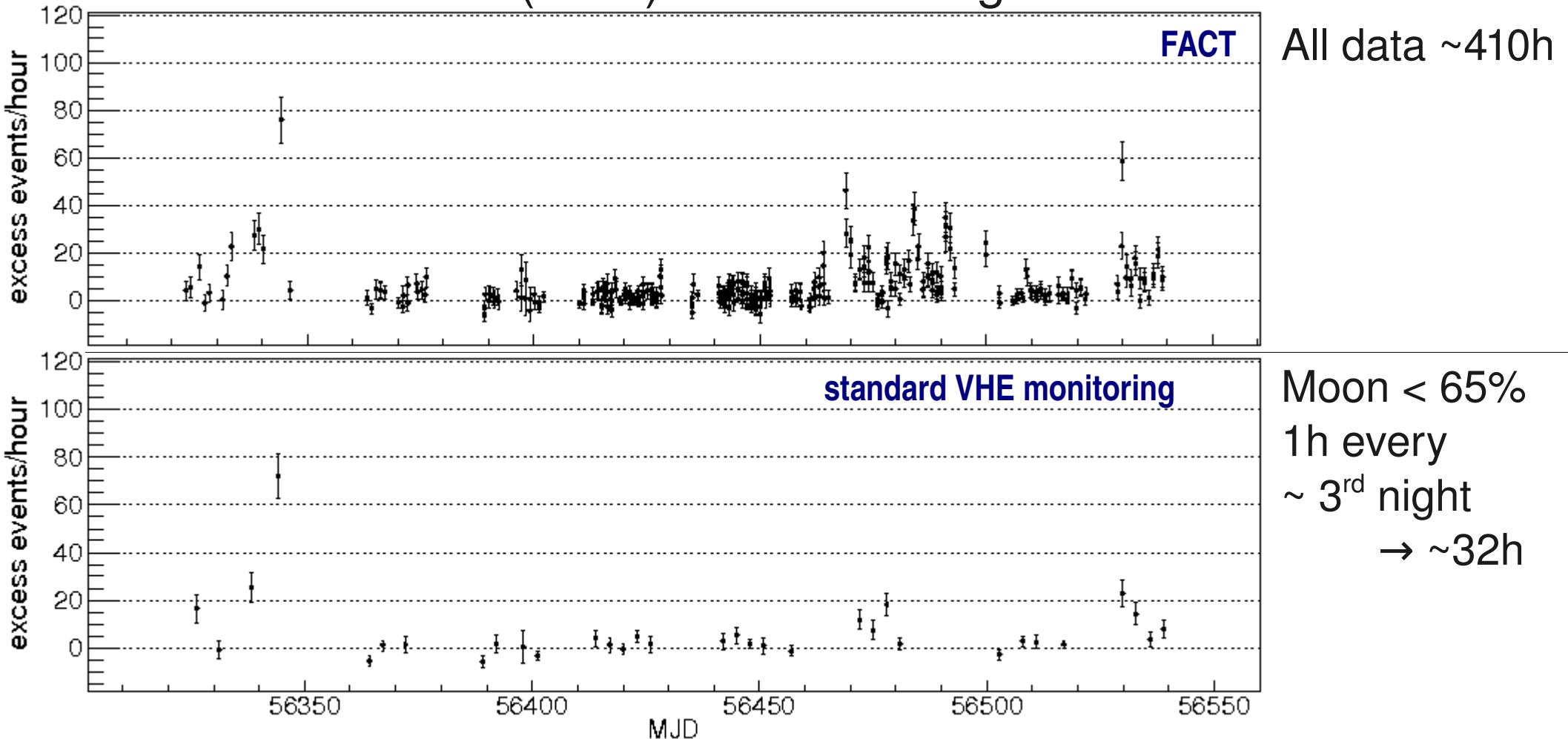
Photo: Daniela Dorner

- Robust and stable
 - Stable telescope performance
 - High data taking efficiency
- Observations during strong moon light
 - Larger duty cycle
 - More complete data sample

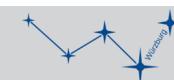
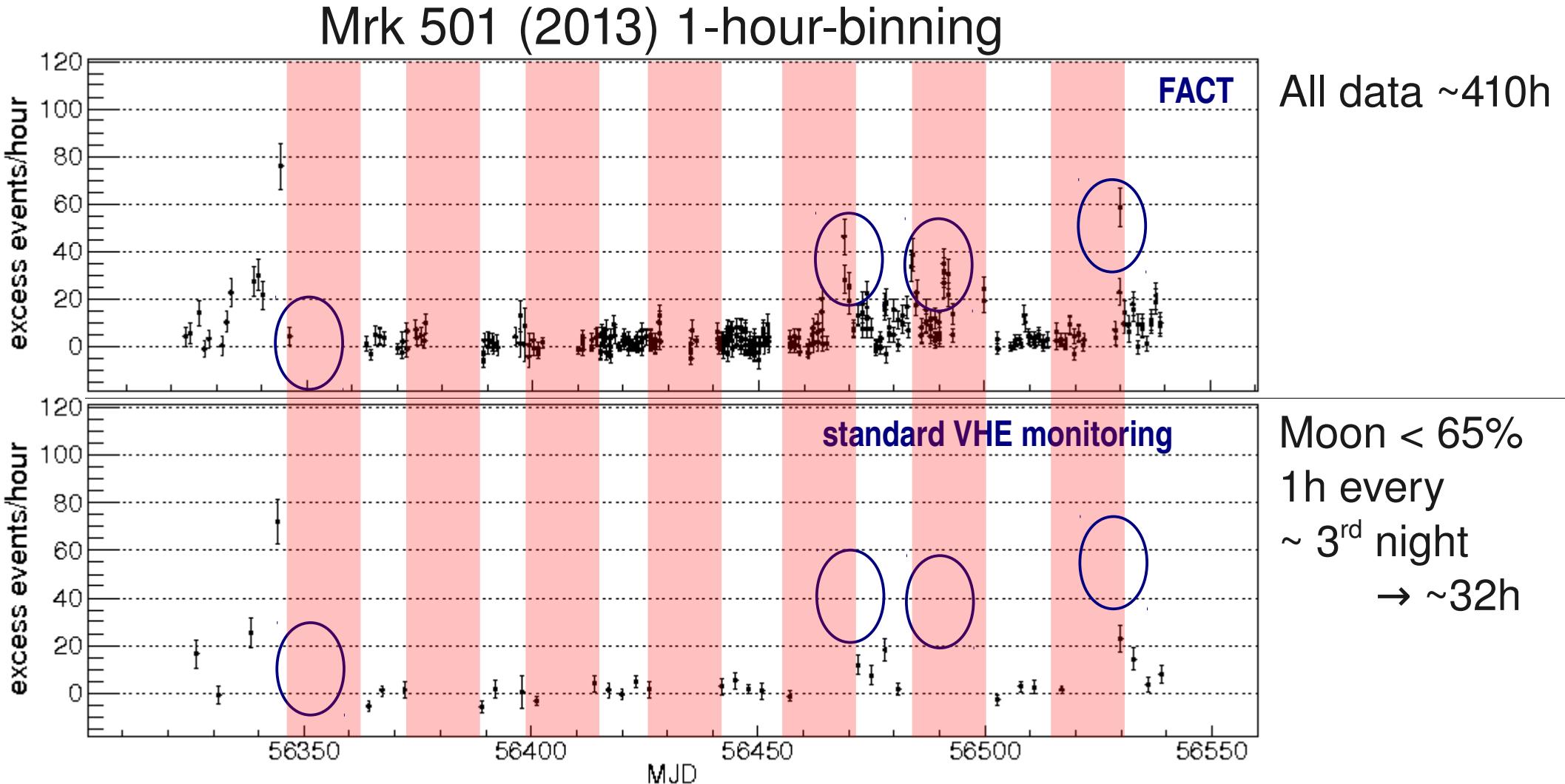
Ideal for Monitoring

Monitoring at TeV Energies

Mrk 501 (2013) 1-hour-binning



Monitoring at TeV Energies



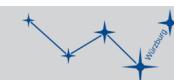
FACT: Observing Strategy

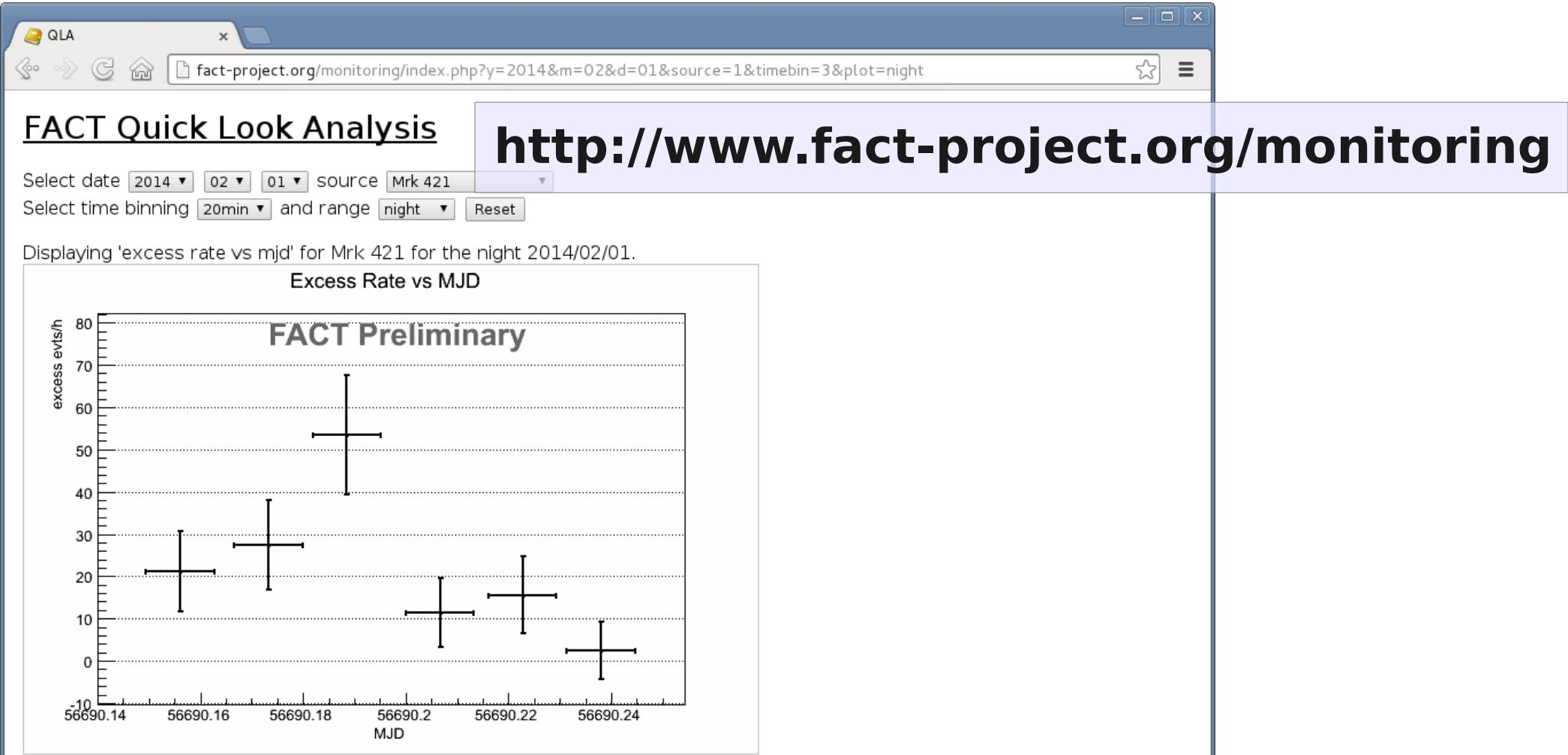
- Goal: Unbiased light curve of few selected sources
- Sample: Sources bright at TeV energies
 - Mrk 501, Mrk 421, 1ES 1959+650
- Monitoring preferably at small zenith distance (usually $< 45^\circ$)
- Multi-wavelength observations
 - Participate in campaigns
 - Follow-up of alerts
- Rest of time: flexible use for
 - performance studies (Crab Nebula)
 - monitor other sources, e.g. 1ES 2344+51.4, IC 310, 1ES 1218+304, ...
 - snapshots of larger sample of selected sources (coming soon)



Quick Look Analysis

- Fast processing on site
→ Excess rate curves
 - Results in almost real time
→ Publicly available on
<http://www.fact-project.org/monitoring>
→ Flare alerts to other telescopes
 - Not including:
 - Detailed data check
 - Correction for dependence of threshold on zenith distance and ambient light
- Since 12/2012
- Since 03/2014





REMARKS:

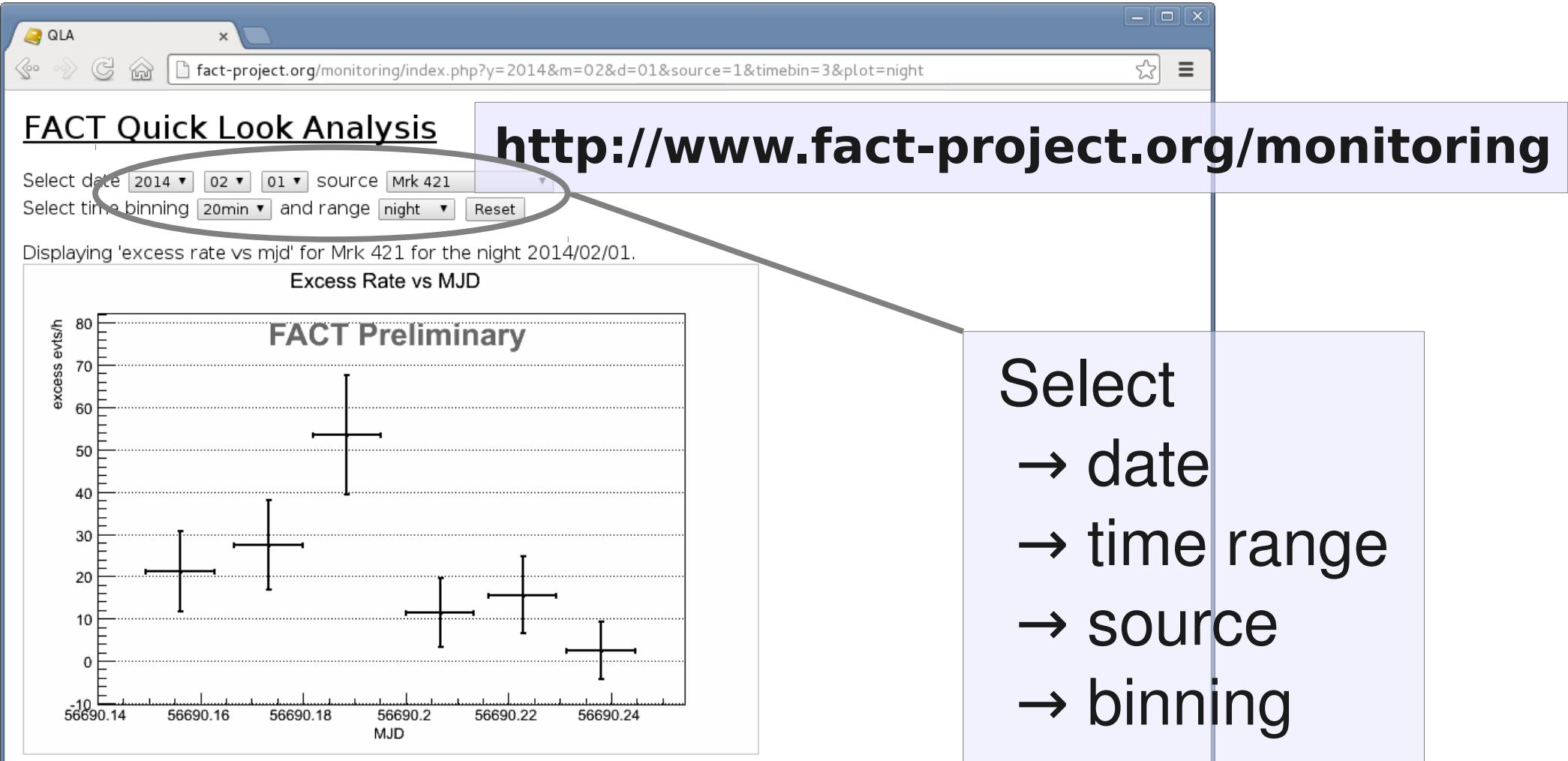
- These are the results of a **fast quick look analysis** on site, i.e. they are **preliminary**.
- The quick look analysis includes all data, i.e. no data selection done.
- The shown curves are not fluxes but **excess rates** (number of excess events per effective ontime), i.e. there is a dependence on trigger threshold and zenith distance of the observation (with the current analysis for zenith distance > 40 degree and trigger threshold > 500 DAC counts).
- The curves are provided with 20 min binning and nightly binning.
- In case, you need further details about the data or a different binning, please do not hesitate to contact us.
- Time range 'all' refers to all data since 12.12.2012. For older data, please contact us.

If you intend to use the data or information from this website, please let us know for reference.

Please cite this webpage and the [FACT design paper](#) when using information from this webpage or any FACT data.

Reference FACT Design Paper: H. Anderhub et al. JINST 8 P6008 [ADS open access](#)

Contact: Daniela Dorner <at>astro.uni-wuerzburg.de.



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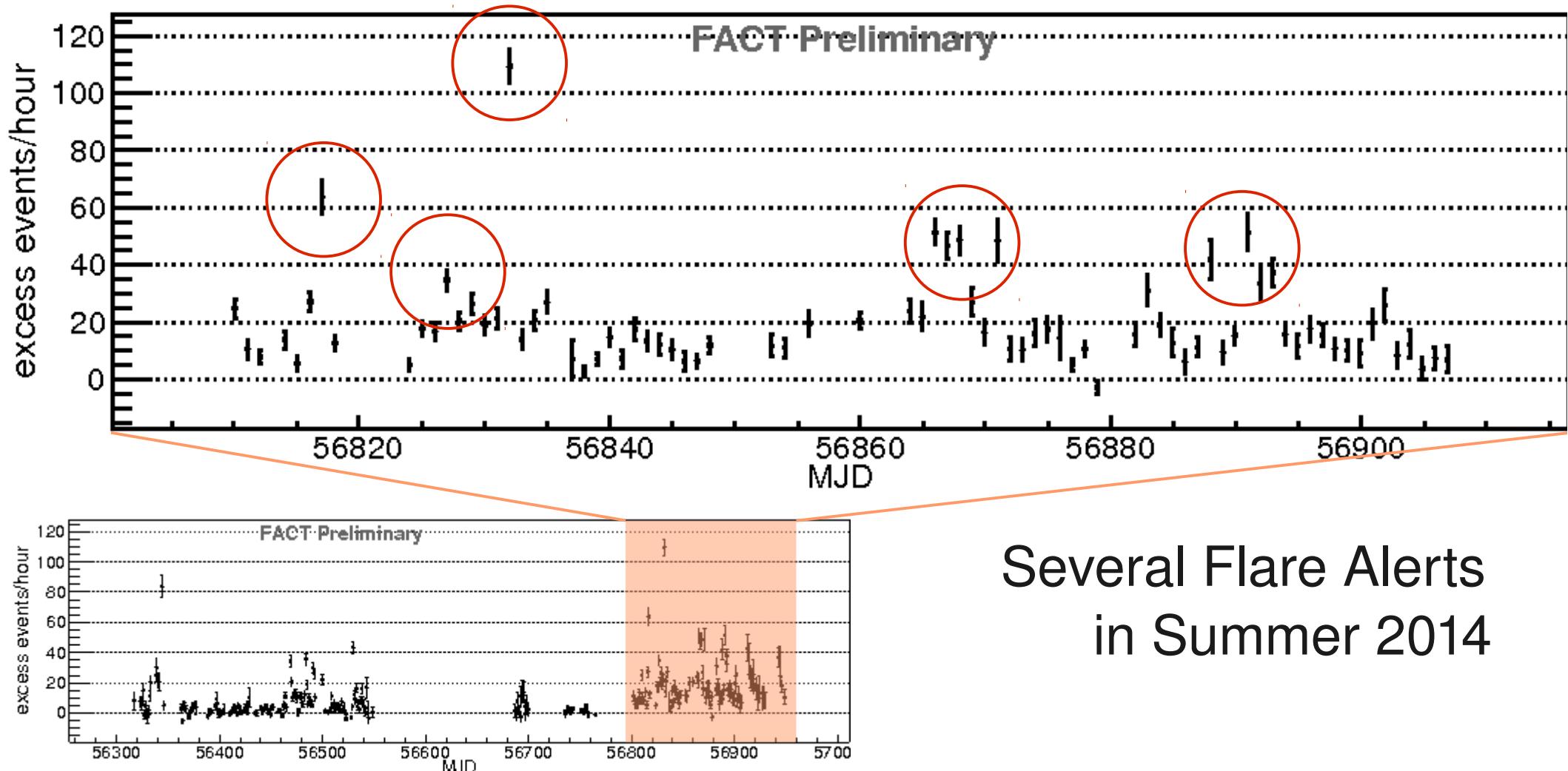
What can the QLA provide?

- Excess rates available after \sim 20 minutes
- Detection speed depending on flux
 - Detection in 5 minutes of data, e.g.
Mrk 501: 8.6.2012, 23.6.2014; Mrk 421: 14.4.2013
 - Crab in \sim 20 minutes (dark night, small zd)
- Flare alerts
 - Currently manual, in the future automatic
 - Trigger criteria
 - Mrk 501/421: 3 CU
 - Other blazars: 0.5 CU + $>$ 3 sigma



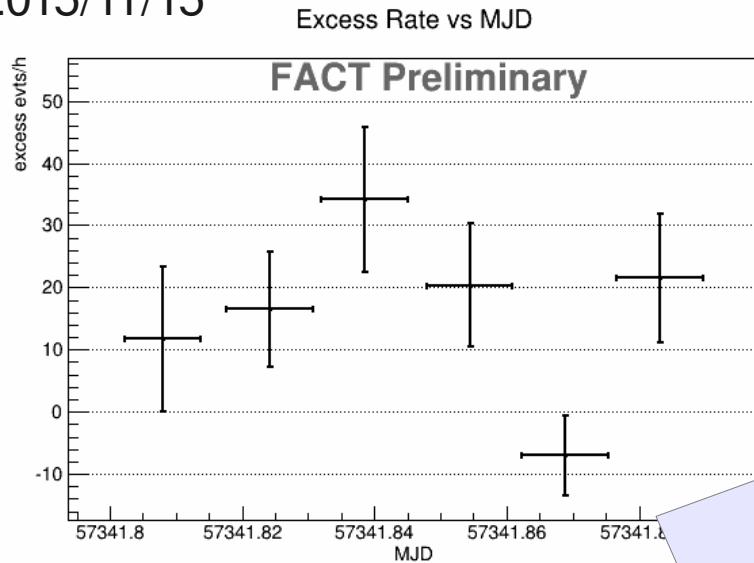
Successful Flare Alerts 2014

Excess rate curve of Mrk501 from QLA: 1.6.-10.8.2014

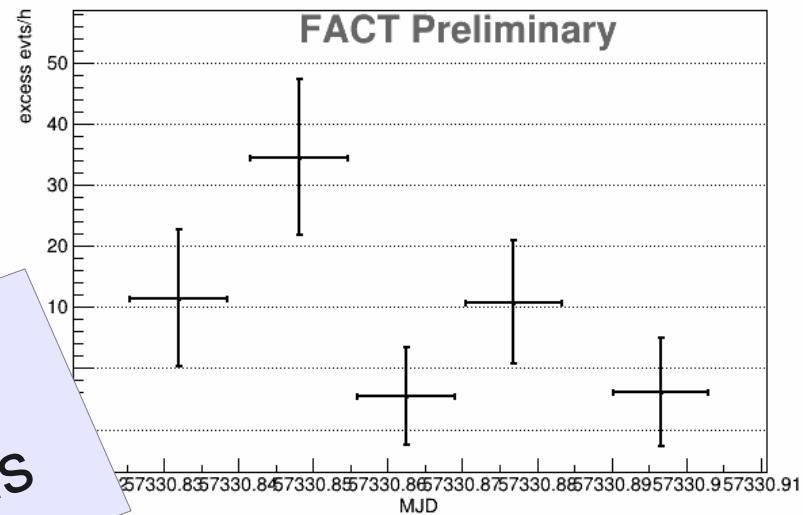


Recent Alerts on 1ES 1959+650

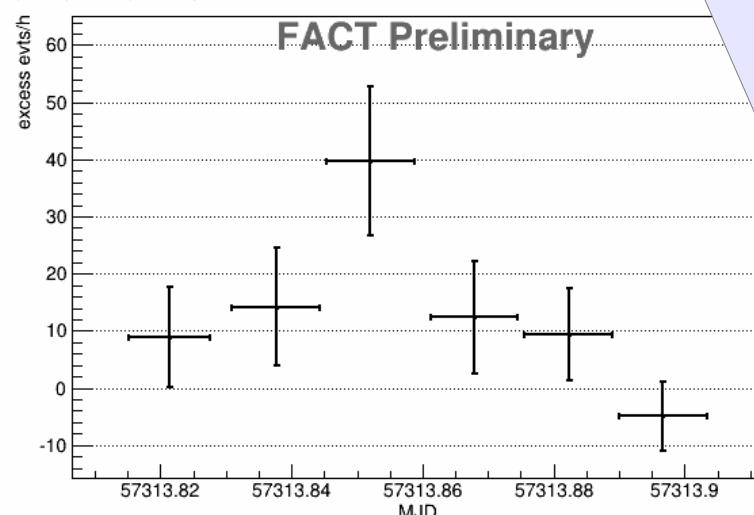
2015/11/15



2015/11/04

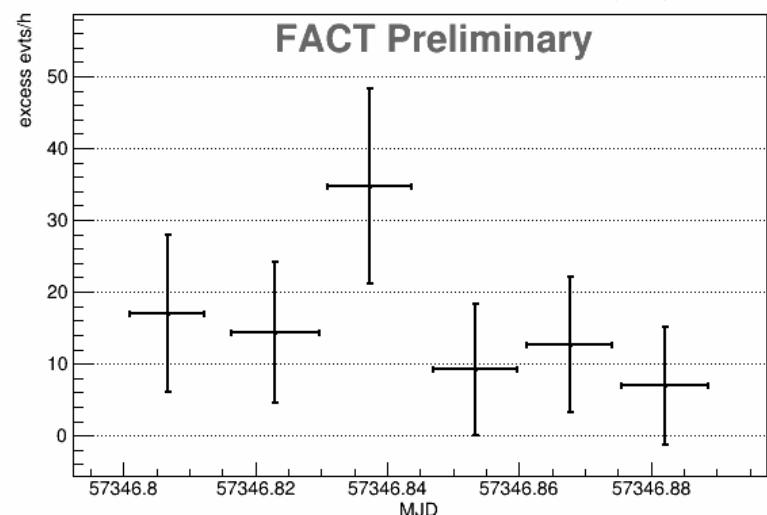


2015/10/18



From Quick
Look Analysis

2015/11/20



What can FACT offer?

- Sending alerts:
 - Anytime for our source sample
 - Trigger criteria need to be defined
 - e.g. for blazar ToO: 3 Crab Units
 - Significant detection within 20 minutes for flux > 1 Crab Unit (current analysis, small zenith distance, dark night)
- Receiving alerts:
 - Anytime
 - Observations carried out on best effort
 - FACT follow-up not needed, if other, more sensitive VHE instrument does follow-up

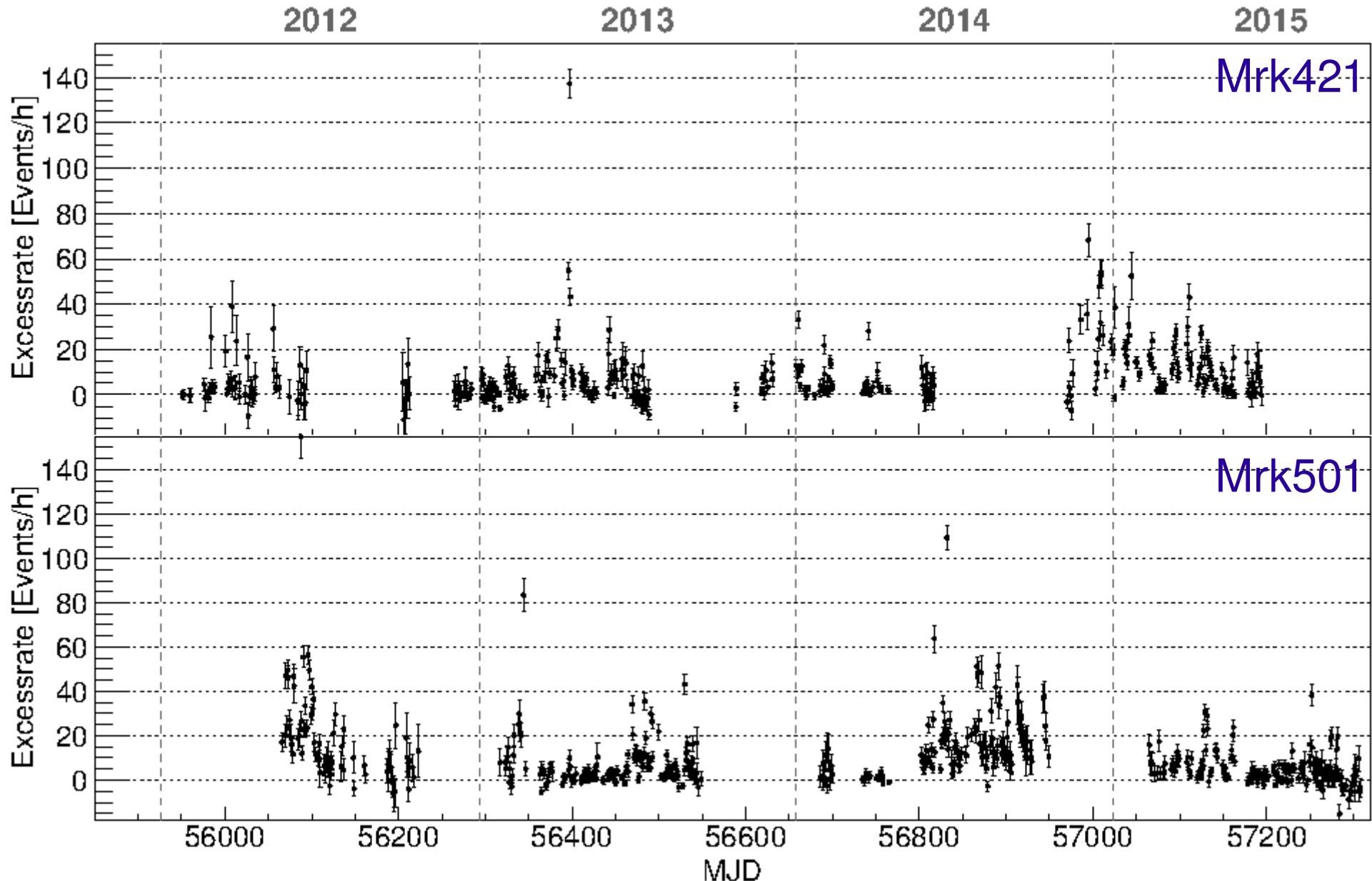


Status in AMON

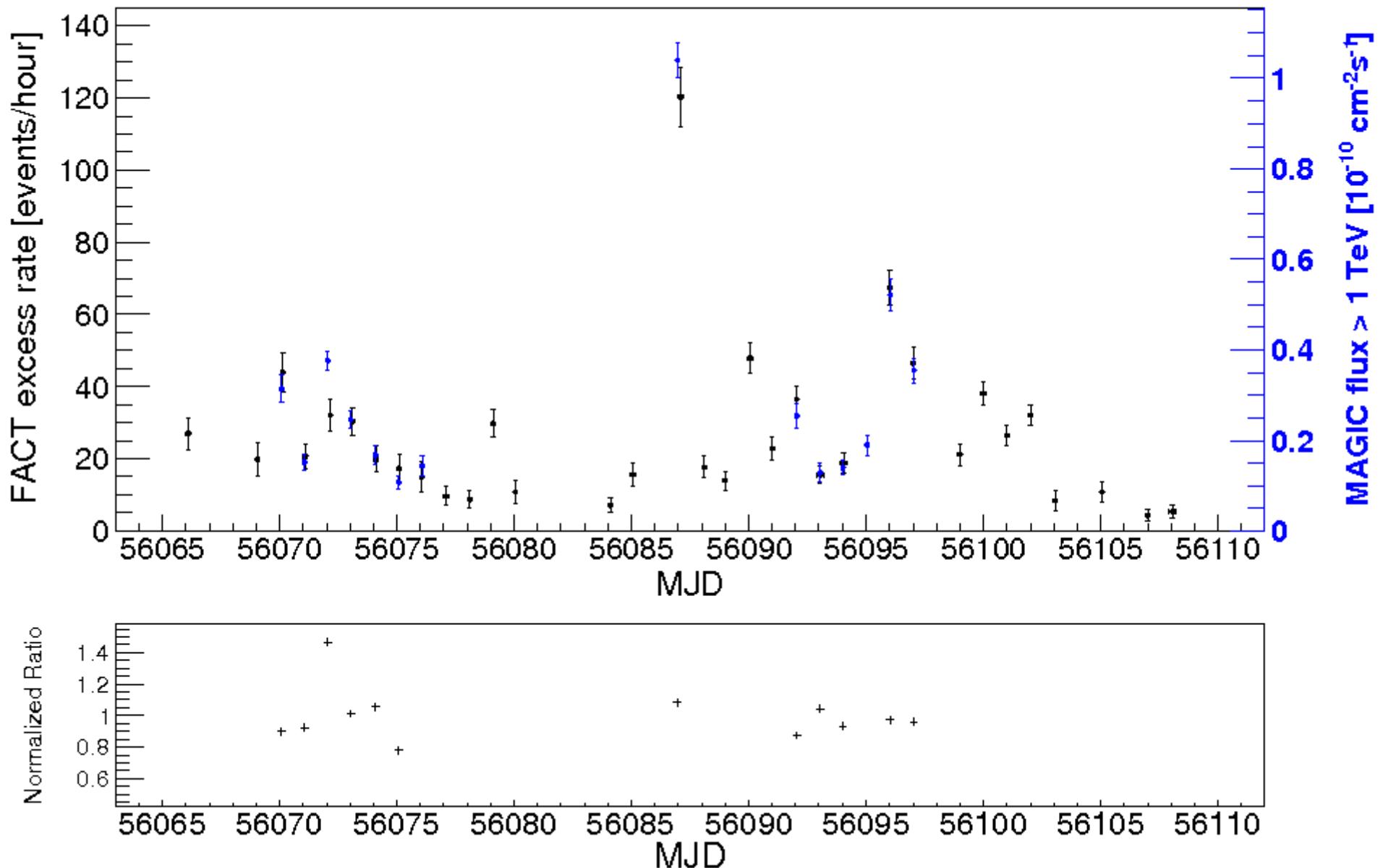
- MoU signed
- Quick Look Analysis ready to send alerts
- Next steps
 - Define flare event
 - Fill archival data to data base
 - Try software
 - Test sending alerts
 - Implement full procedure



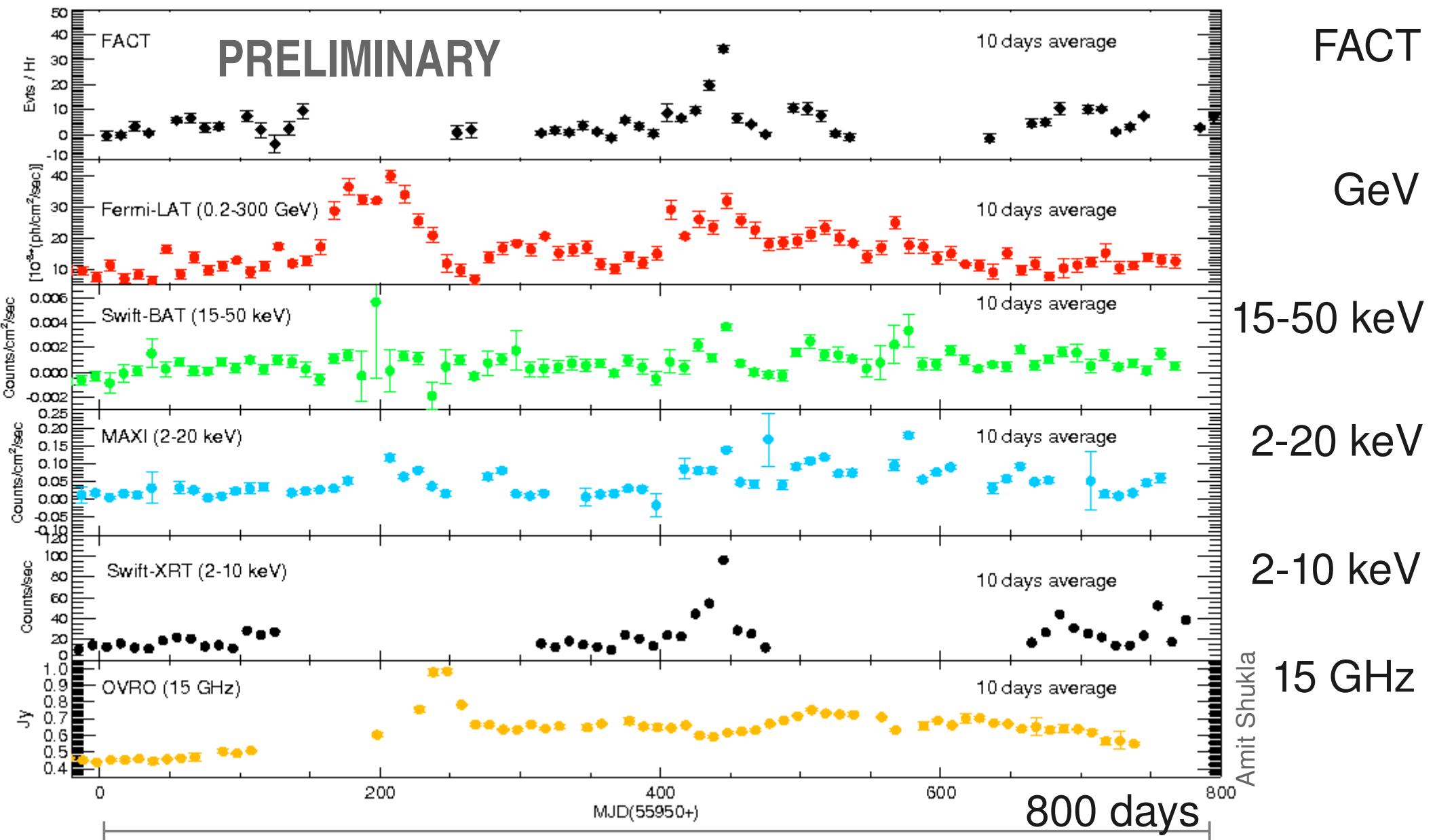
3.5 Years of Monitoring



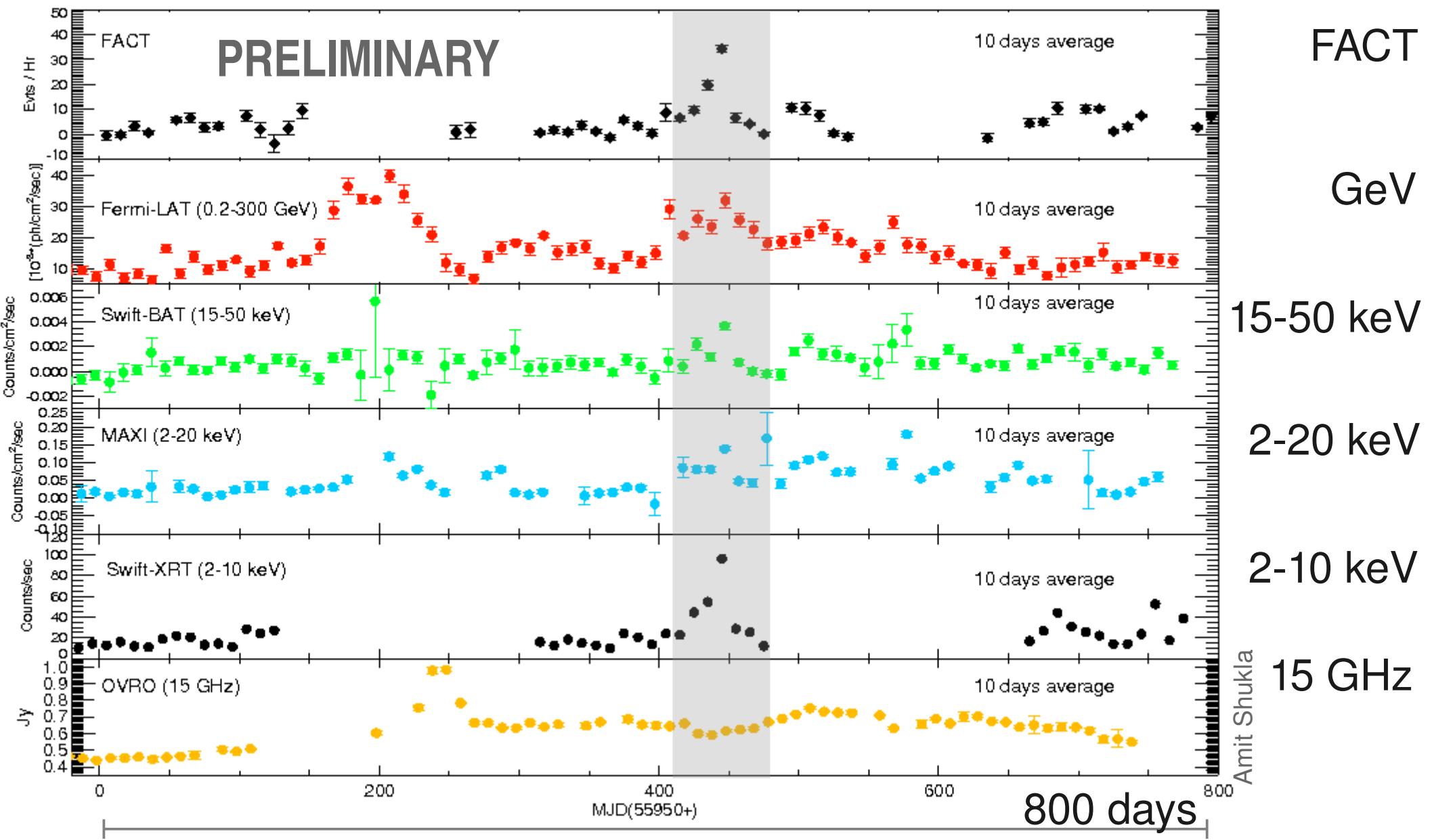
Mrk 501 – Flares May/June 2012



Multi-Wavelength Campaign Mrk 421

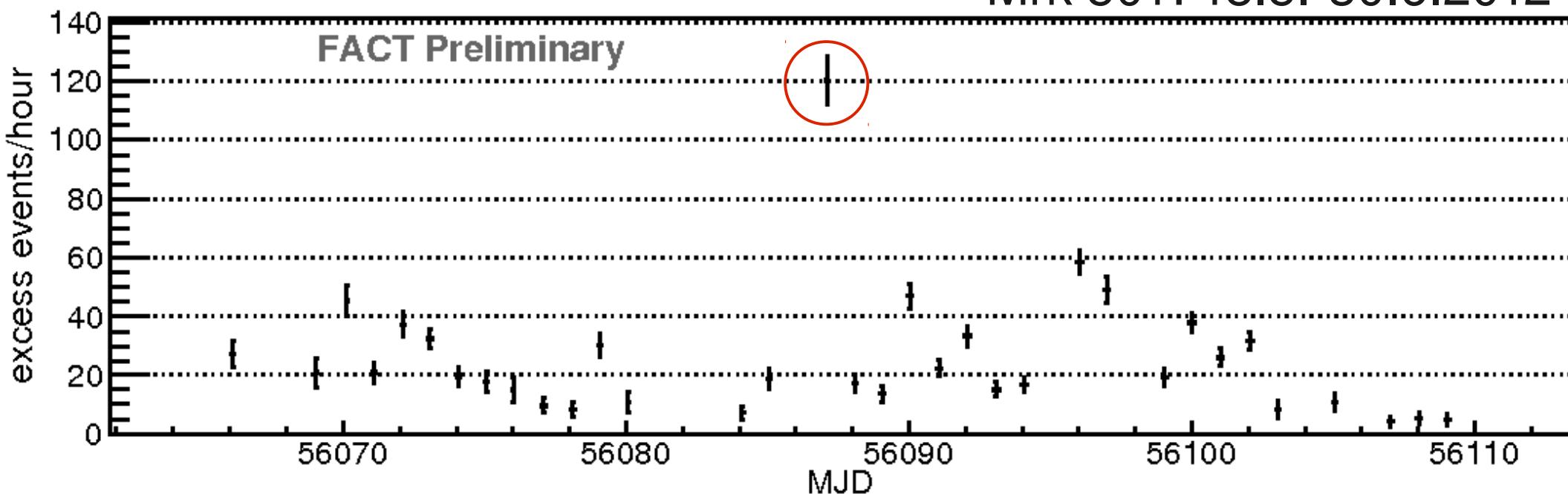


Multi-Wavelength Campaign Mrk 421



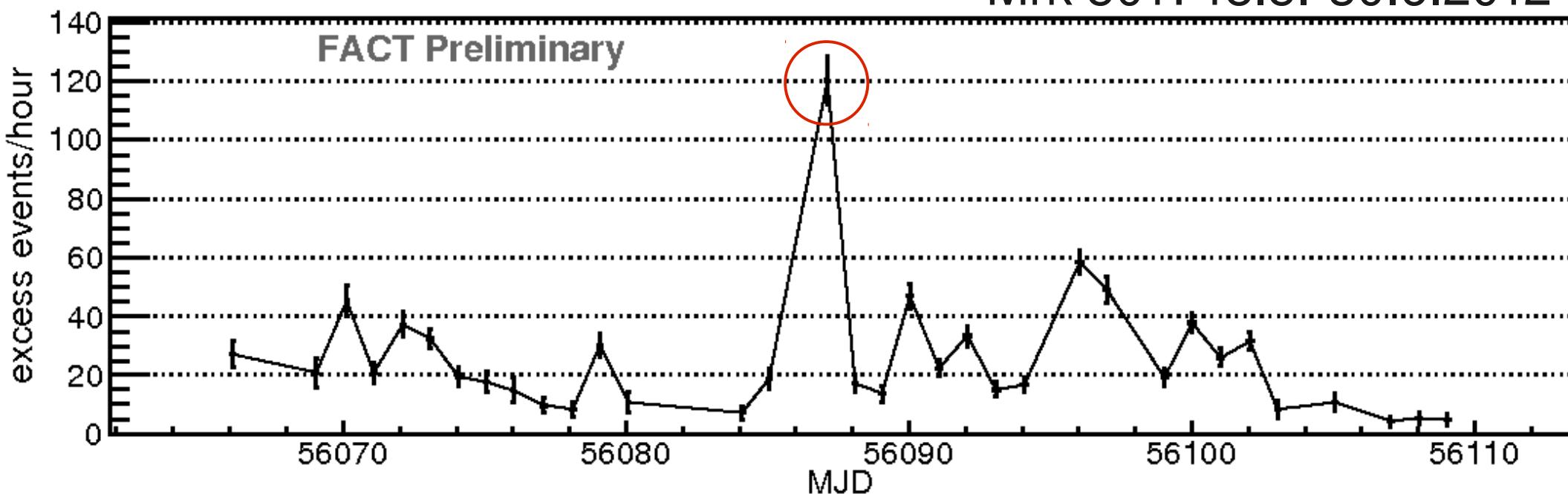
Outlook

Mrk 501: 18.5.-30.6.2012

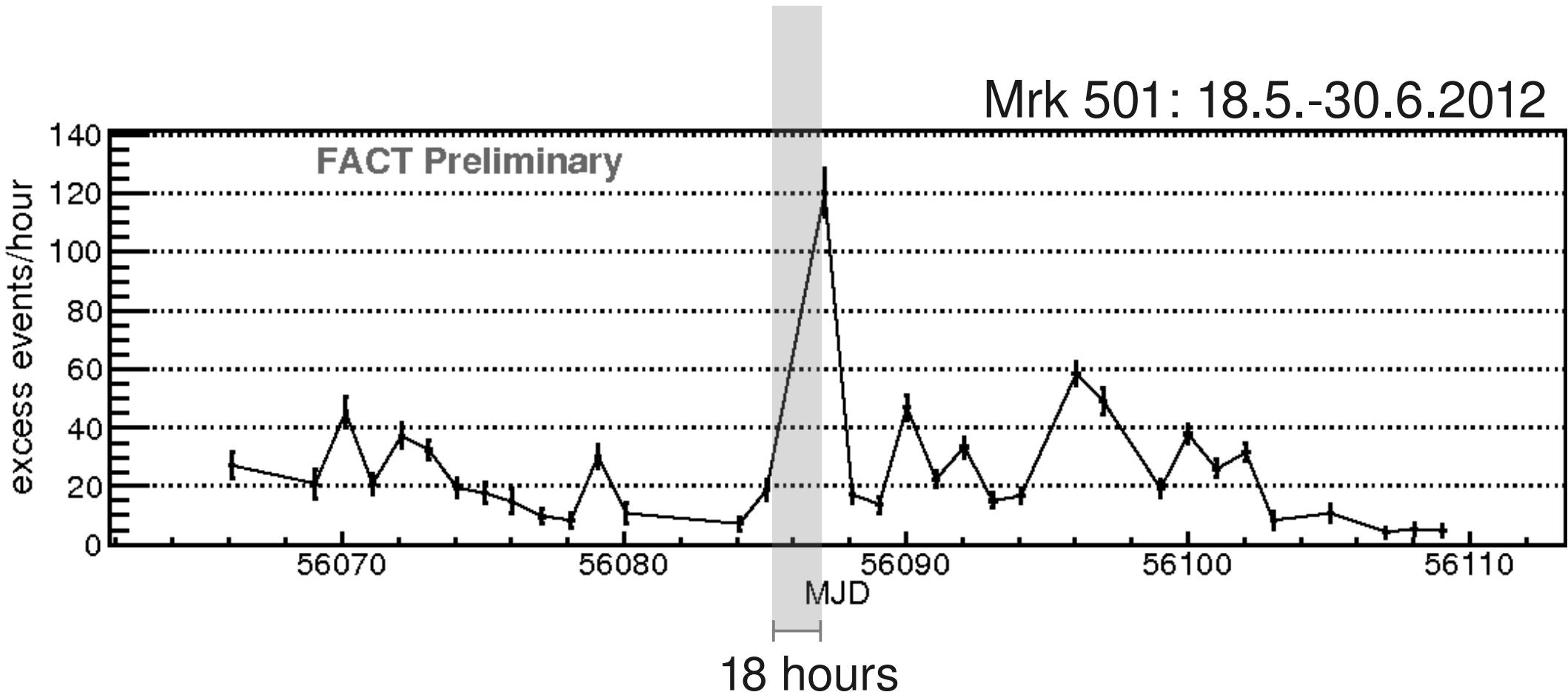


Outlook

Mrk 501: 18.5.-30.6.2012



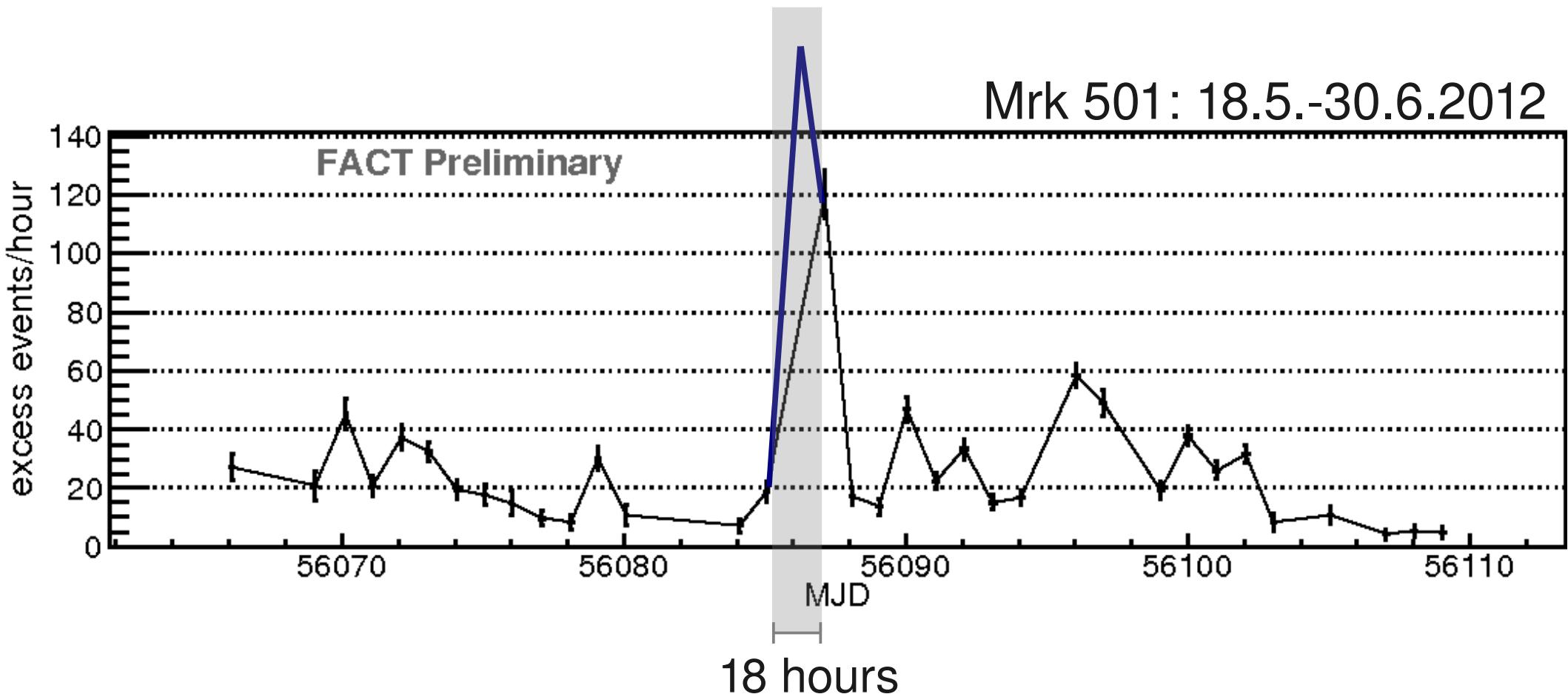
Outlook



Gaps due to daytime



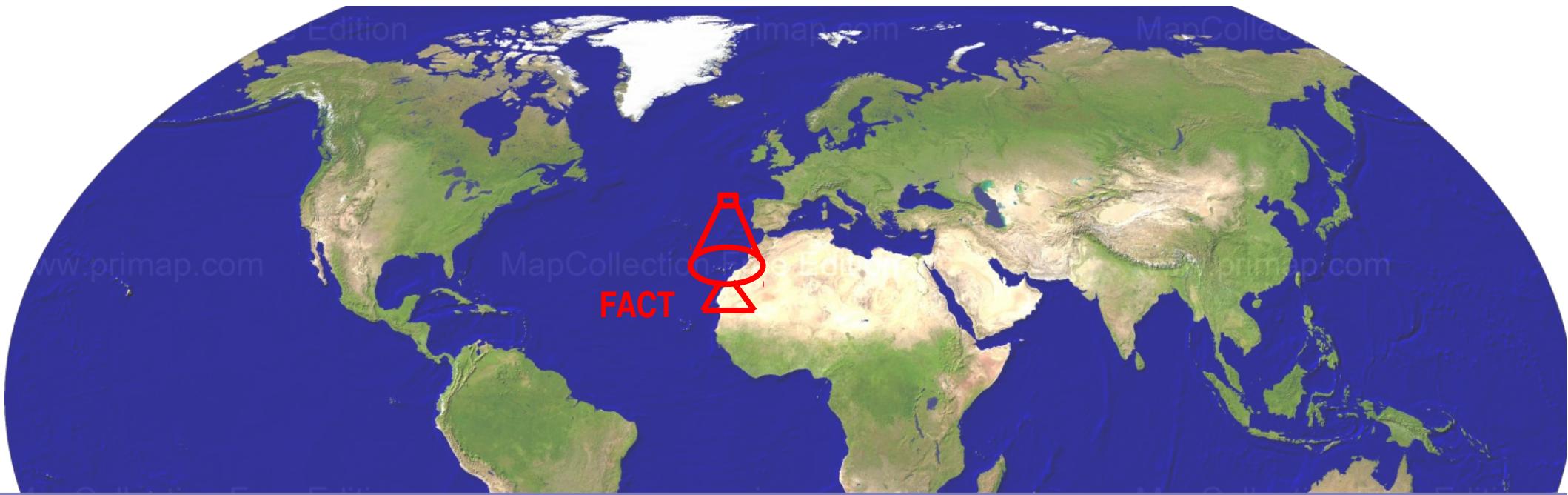
Outlook



Gaps due to daytime
→ continuous monitoring around the globe needed



Continuous Monitoring

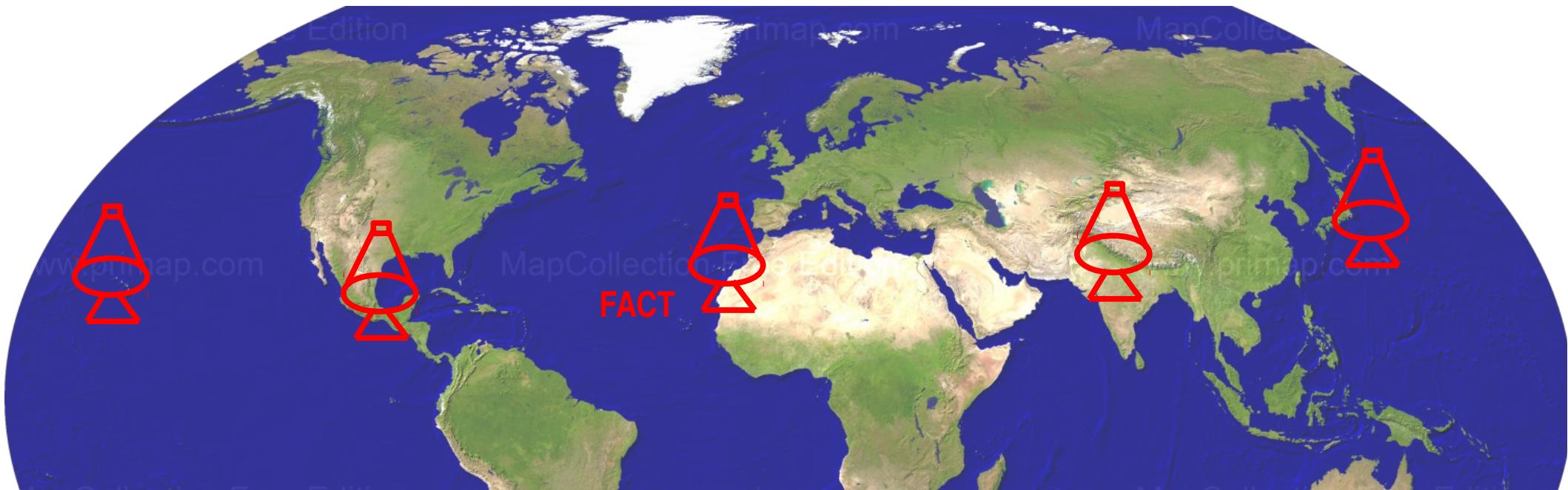


Gaps due to daytime

DWARF Network (M. Backes et. al ICRC 2009)



Continuous Monitoring



Gaps due to daytime
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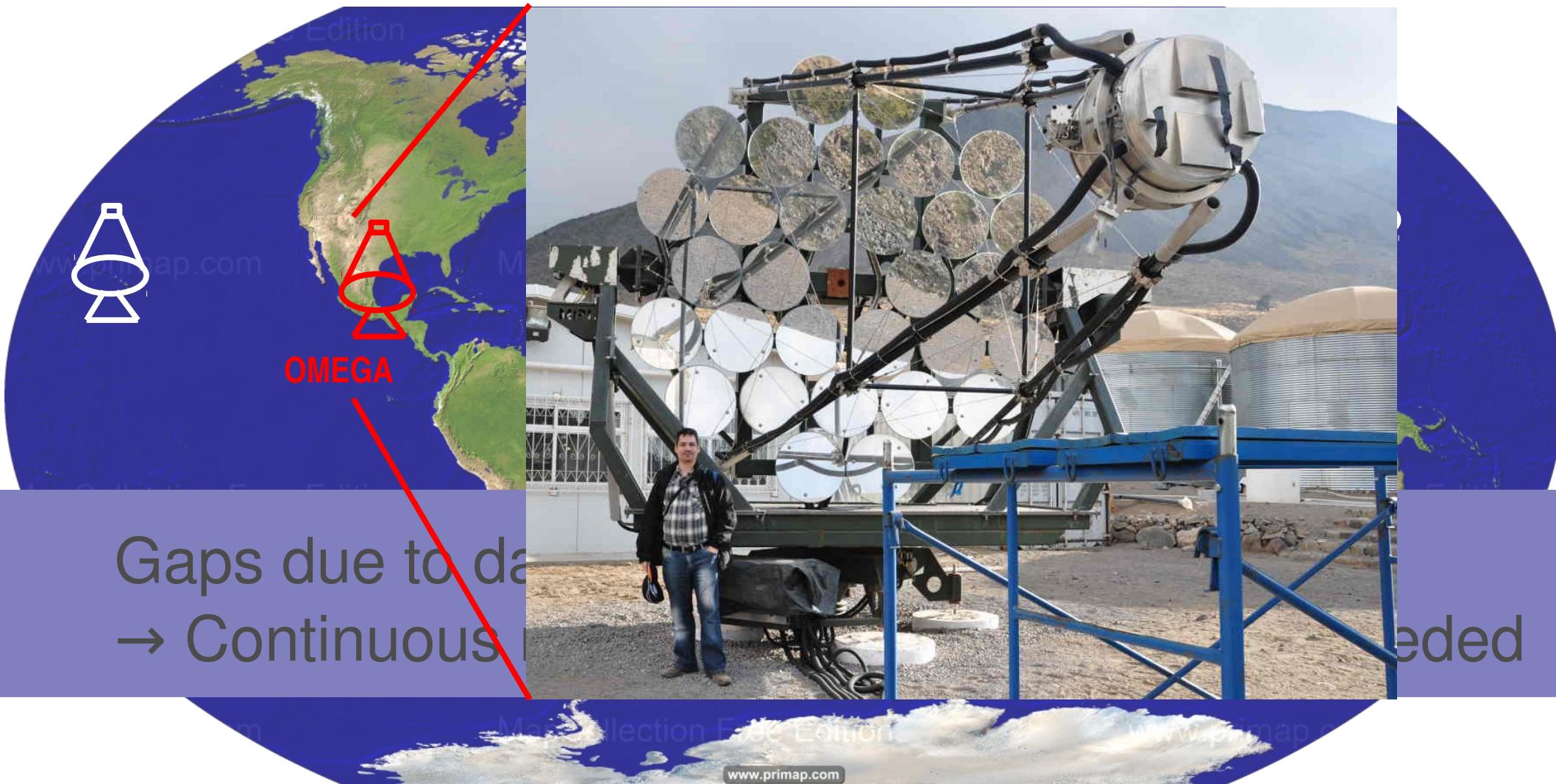
Continuous Monitoring



Gaps due to daytime
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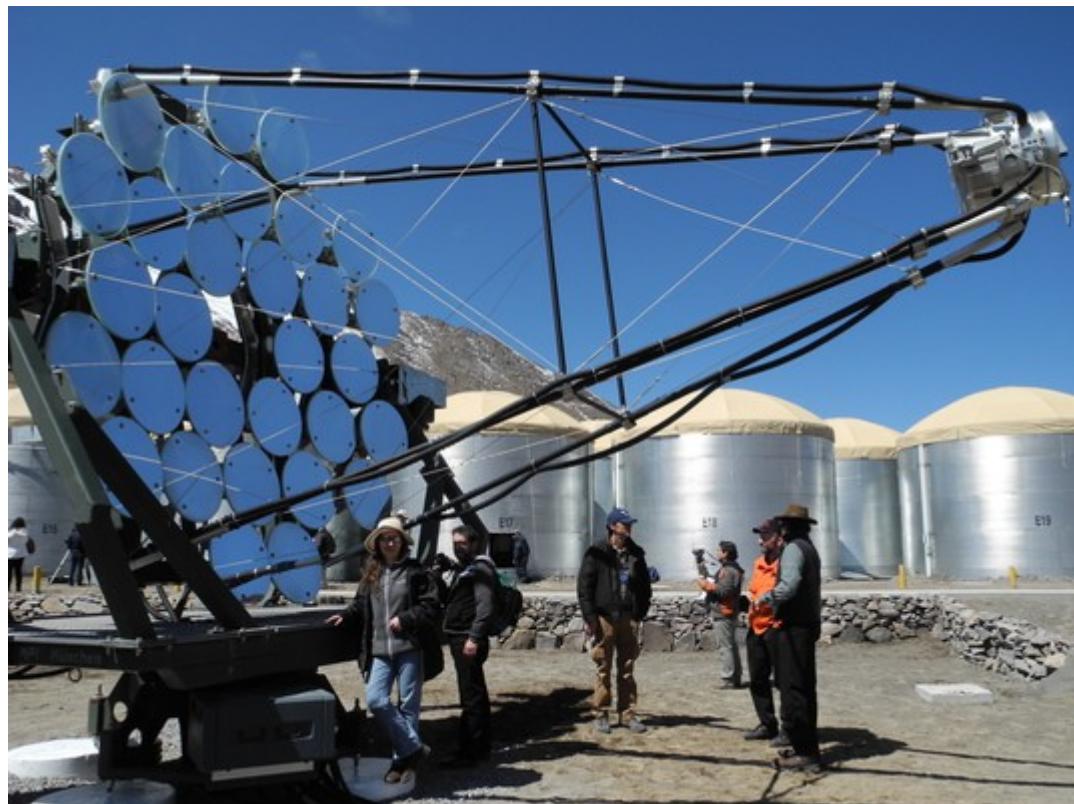


Continuous Monitoring



Second Telescope: M@TE

- M@TE:
Monitoring at TeV Energies
- 2 mounts from OMEGA
project available
- Mexico:
two possible sites:
5 or 7 hours from La Palma
- Goal: Equip mount with
improved SiPM camera
→ close more gaps in
TeV monitoring

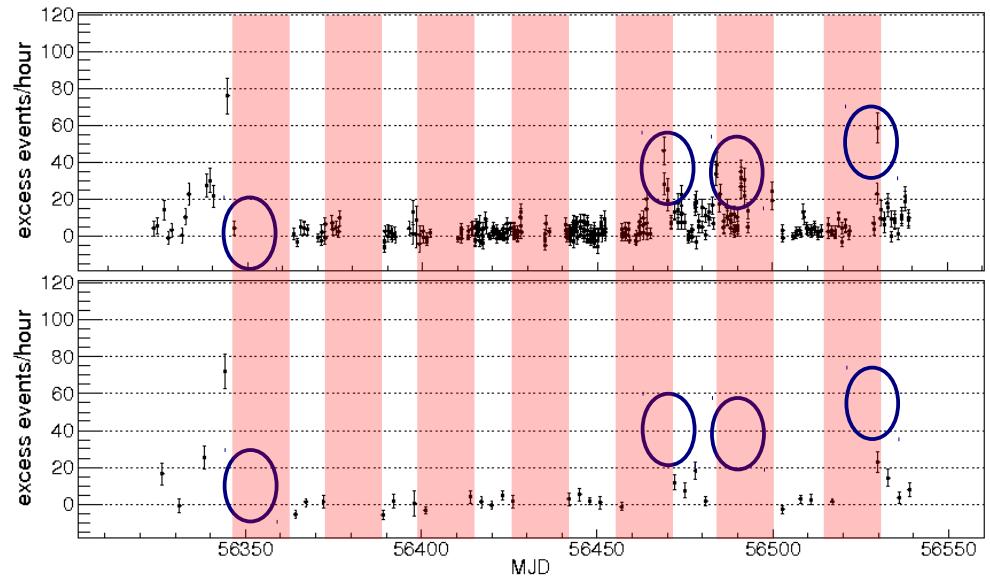
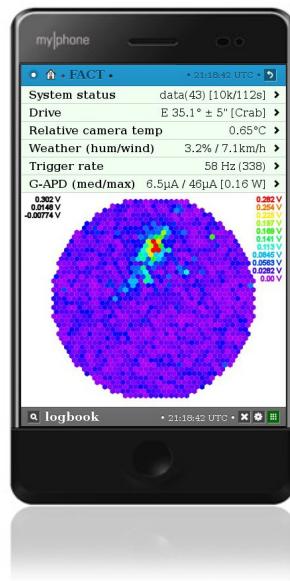


Summary

- Ideal Monitoring Telescope
FACT
 - Longterm monitoring of bright TeV blazars
→ Variability studies
 - Several flaring activities
→ Multi-wavelength studies
 - Large unbiased data sample:
 - Total observation time
~ 5500 hours
 - e.g. > 1300 hours for Mrk501
- Automatic Quick Look Analysis
 - Results publicly available
 - Alerts within same night
 - 10 flare alerts sent
- Status in AMON
 - MoU signed
 - Next steps:
 - Prepare data set for archival analysis
 - Send flare alerts to AMON



Summary



<http://www.fact-project.org/monitoring>

