JINST (2013) 8 P06008
JINST (2014) 9 P10012

FACT – Highlights from more than seven years of unbiased monitoring at TeV energies

Thomas Bretz

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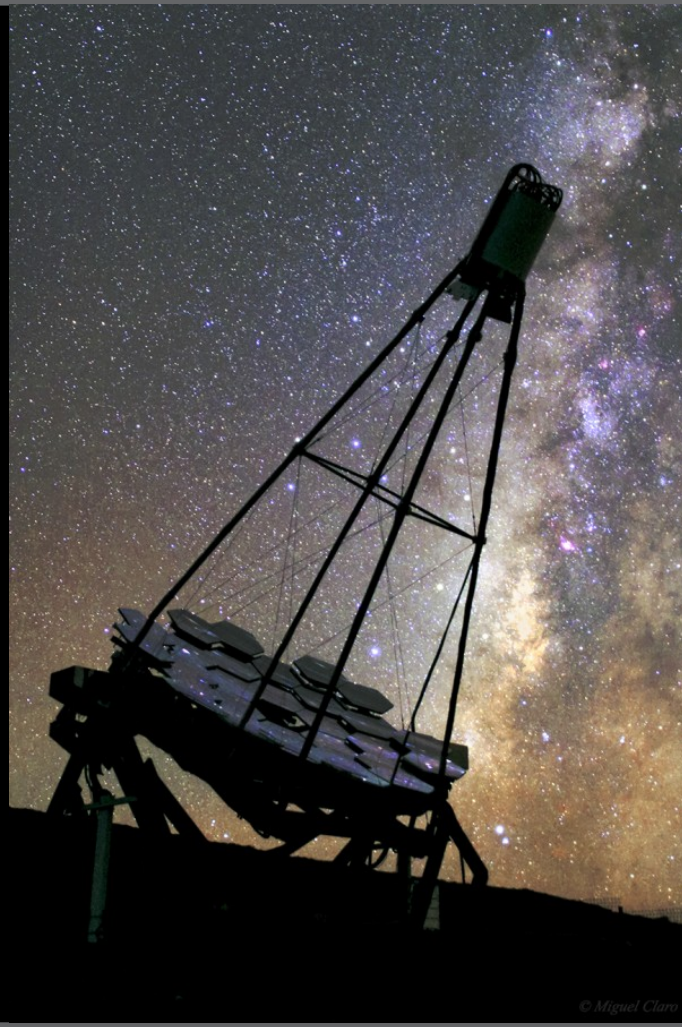
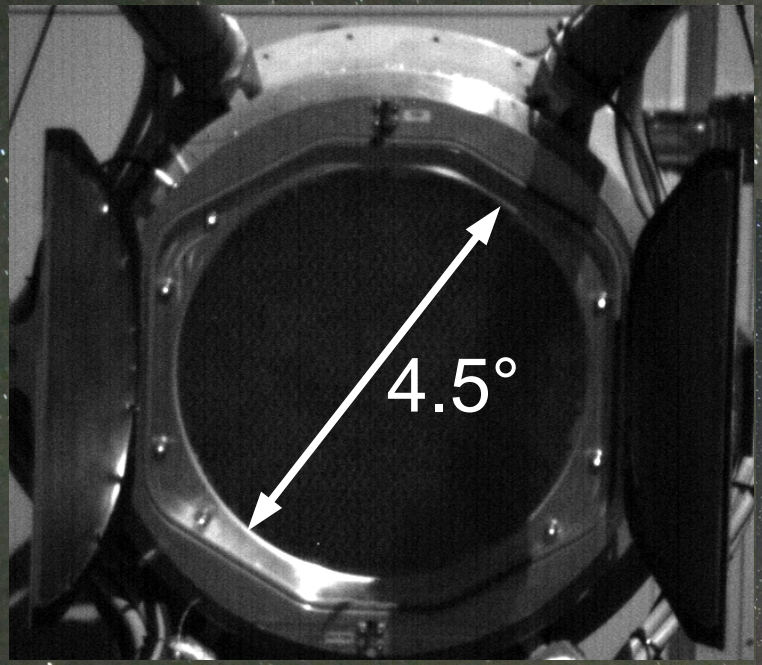
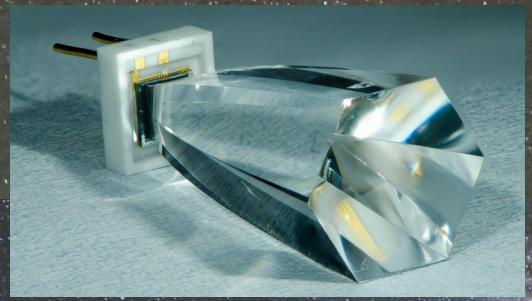
for the FACT Collaboration







SiPM with solid cone

First G-APD Cherenkov Telescope

La Palma, Spain

since Oct. 2011

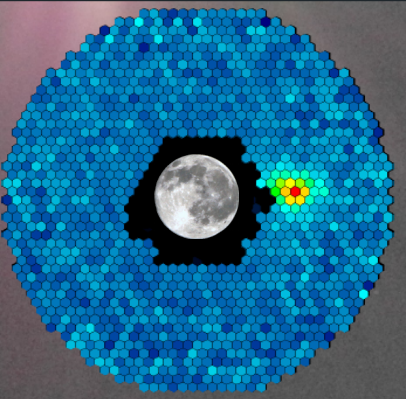
technische universität dortmund

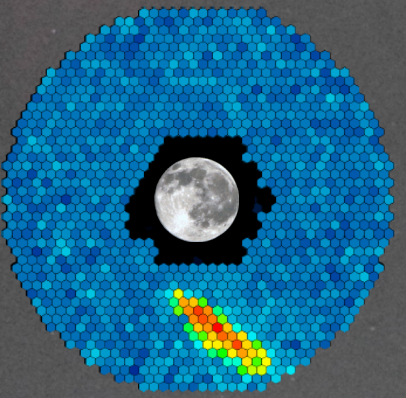
Julius-Maximilians-UNIVERSITÄT WÜRZBURG

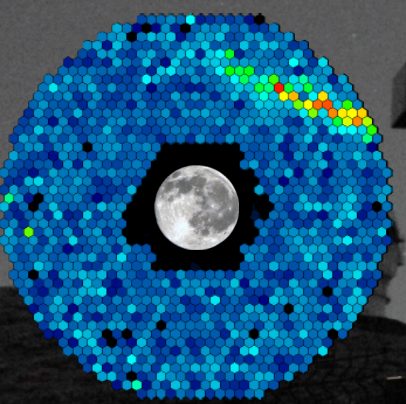
UNIVERSITÉ DE GENÈVE

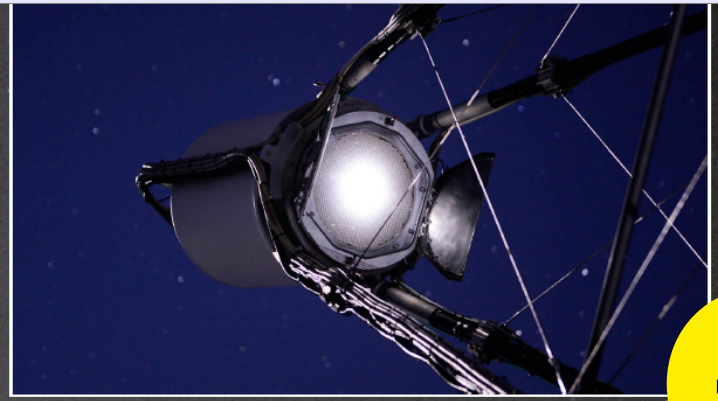
ETH zürich

Operation during moon light



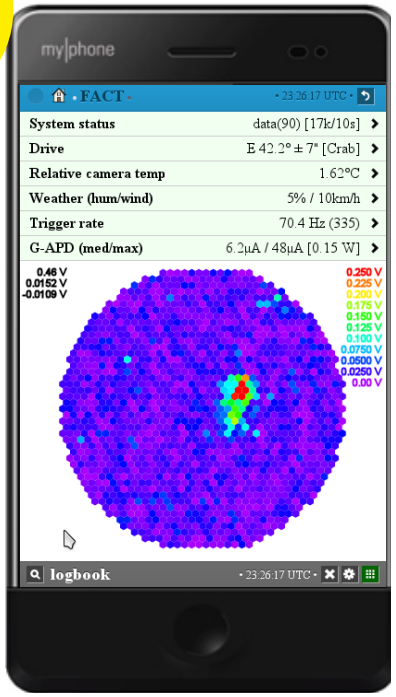






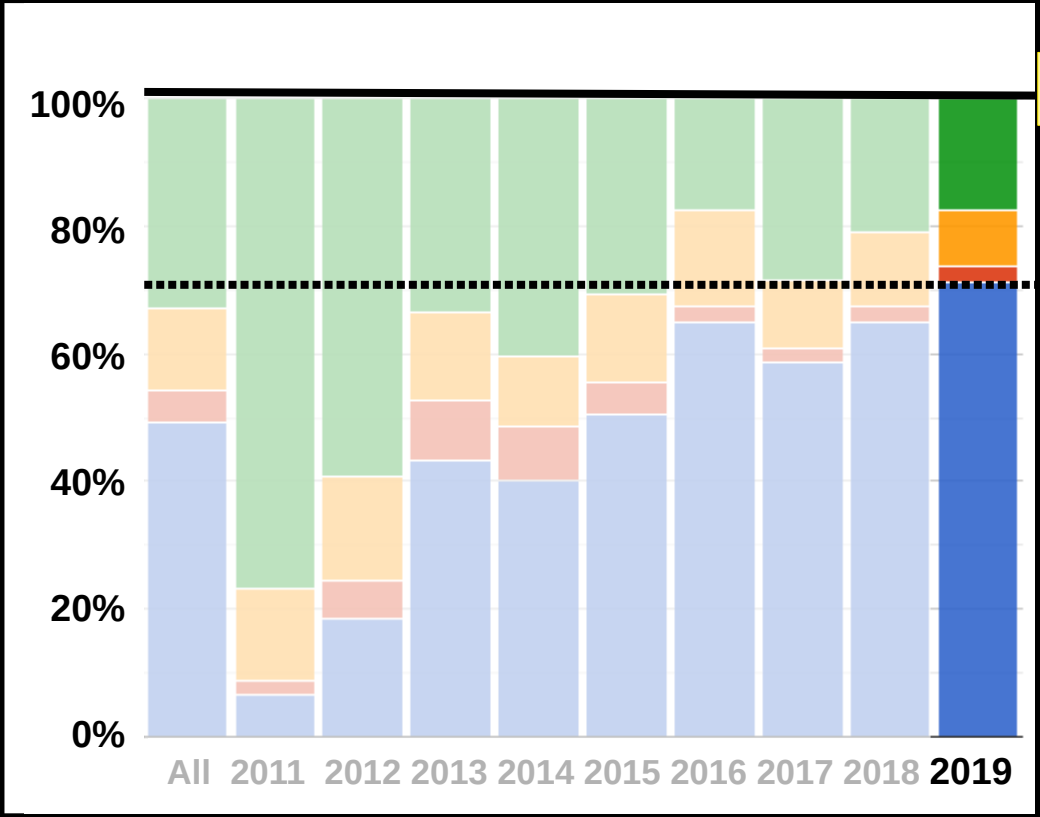
no calibration required

unattended and automatic data taking



www.fact-project.org/smartfact

→ High Duty Cycle



42% Night time per year

~71% Physics data per year

→ 0.42 · 0.71 = 30%

2600 h

exclude ~52 days shutdown due to safety restrictions

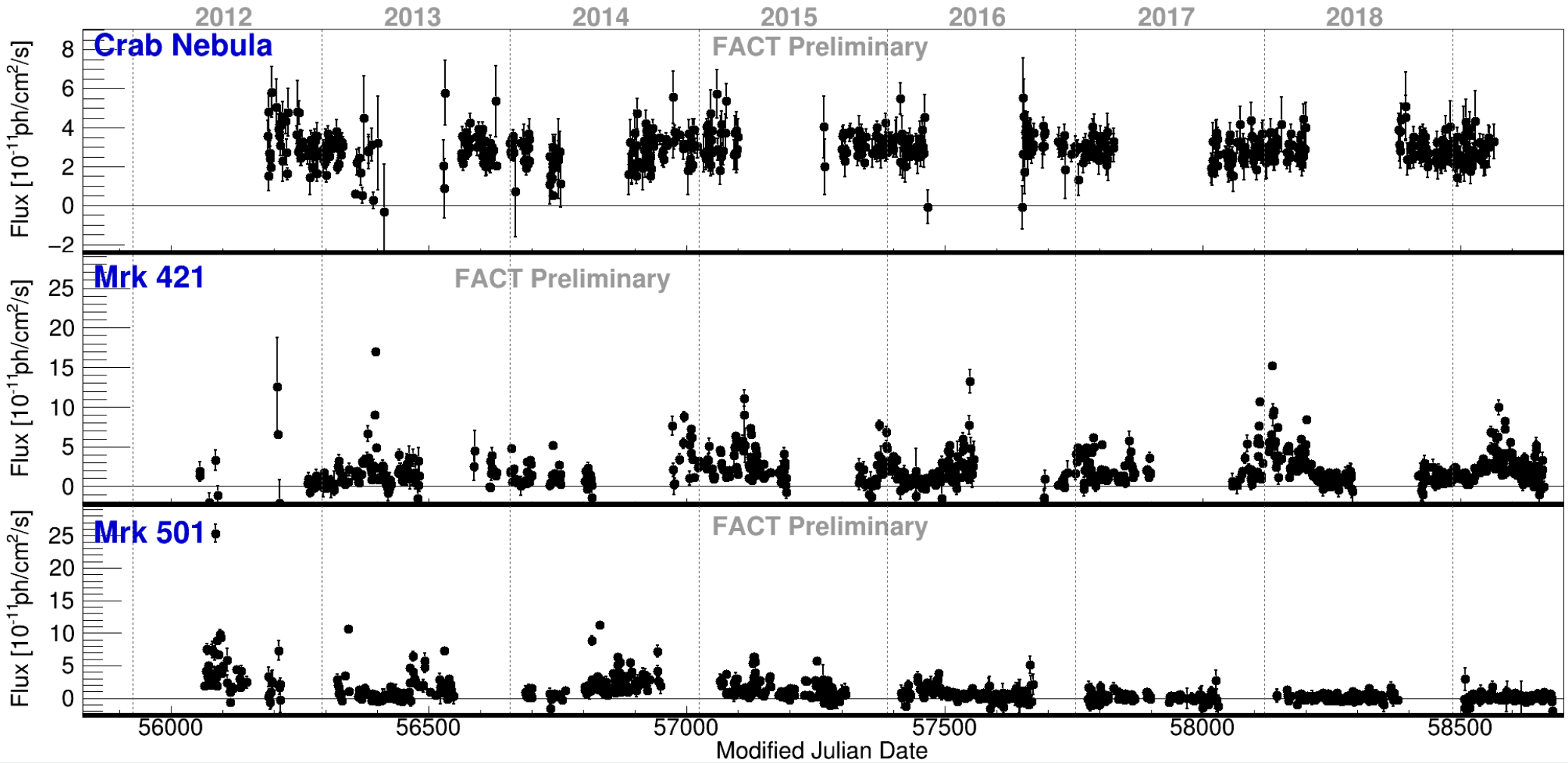
→ x 1.16 = 35%

3000 h

→ ideally suited for monitoring

7y Continuous Unbiased Monitoring

also 1ES 1959 & 1ES 2344 (not shown)



Lomb-Scargle Periodogram for Crab

after efficiency correction

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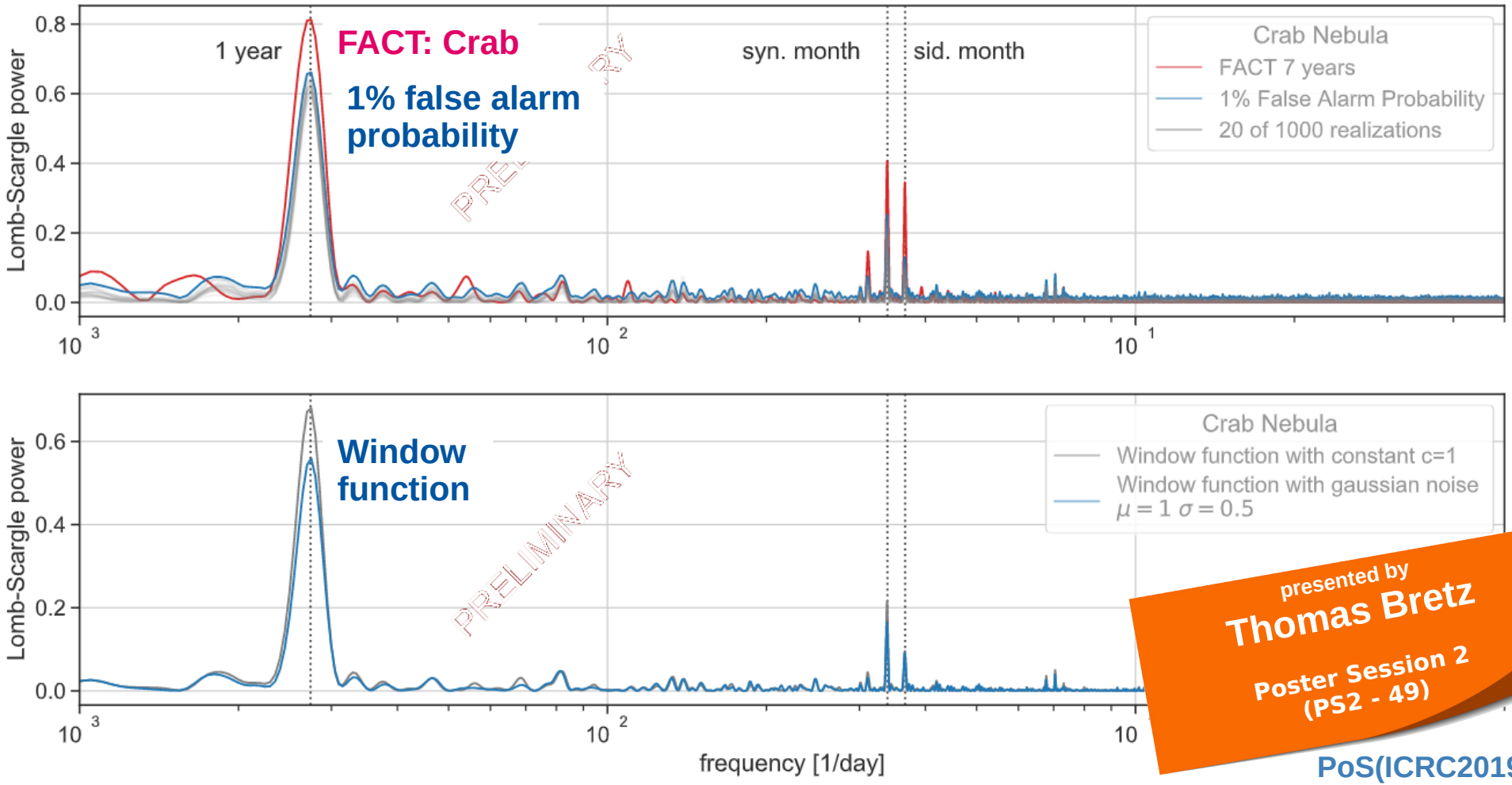
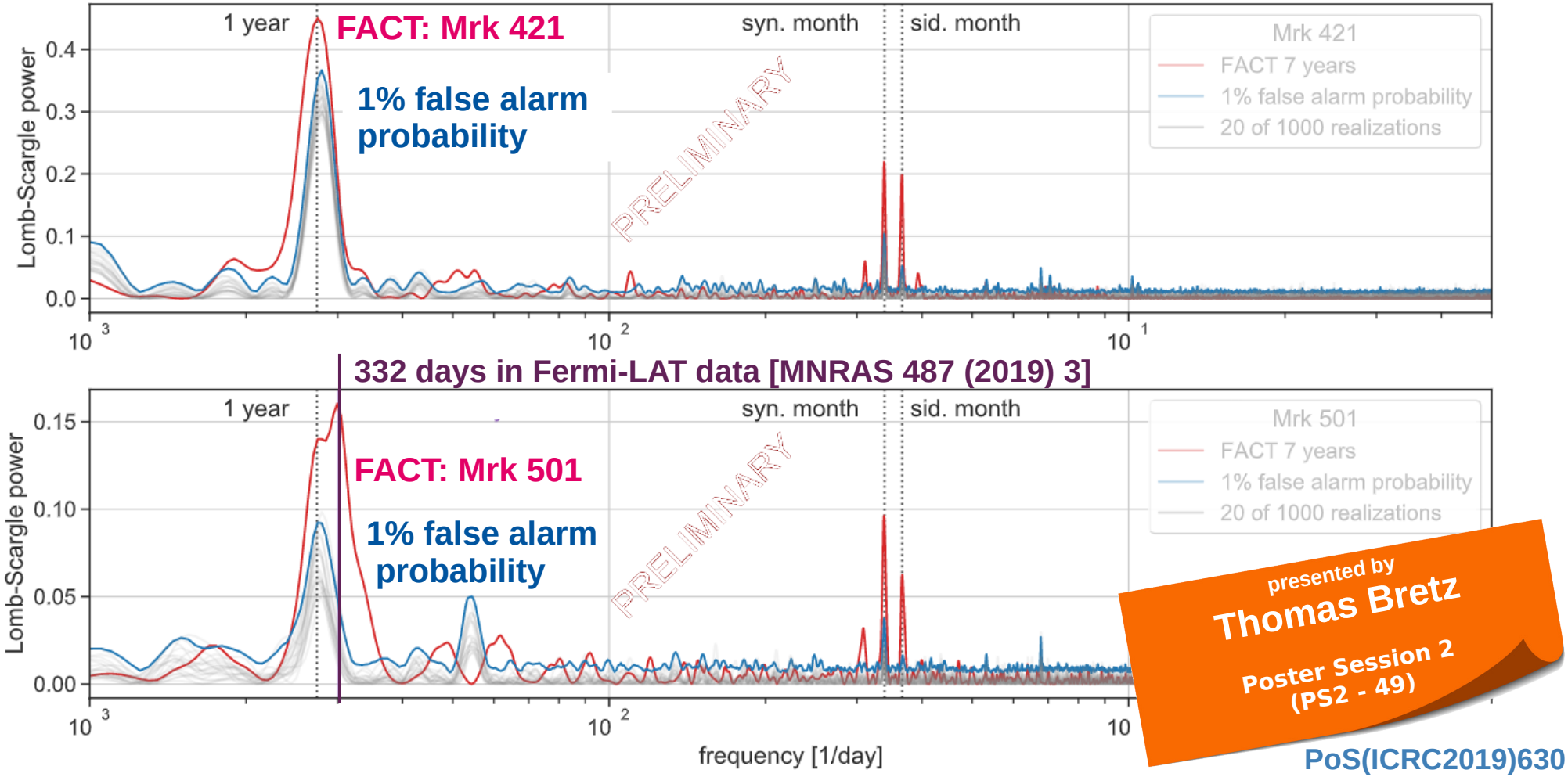


presented by
Thomas Bretz
Poster Session 2
(PS2 - 49)

PoS(ICRC2019)630

Lomb-Scargle Periodogram for Mrk 421 and Mrk 501



presented by
Thomas Bretz
Poster Session 2
(PS2 - 49)

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Unbiased monitoring required

Markarian 421
Fermi-LAT, MAGIC et al.

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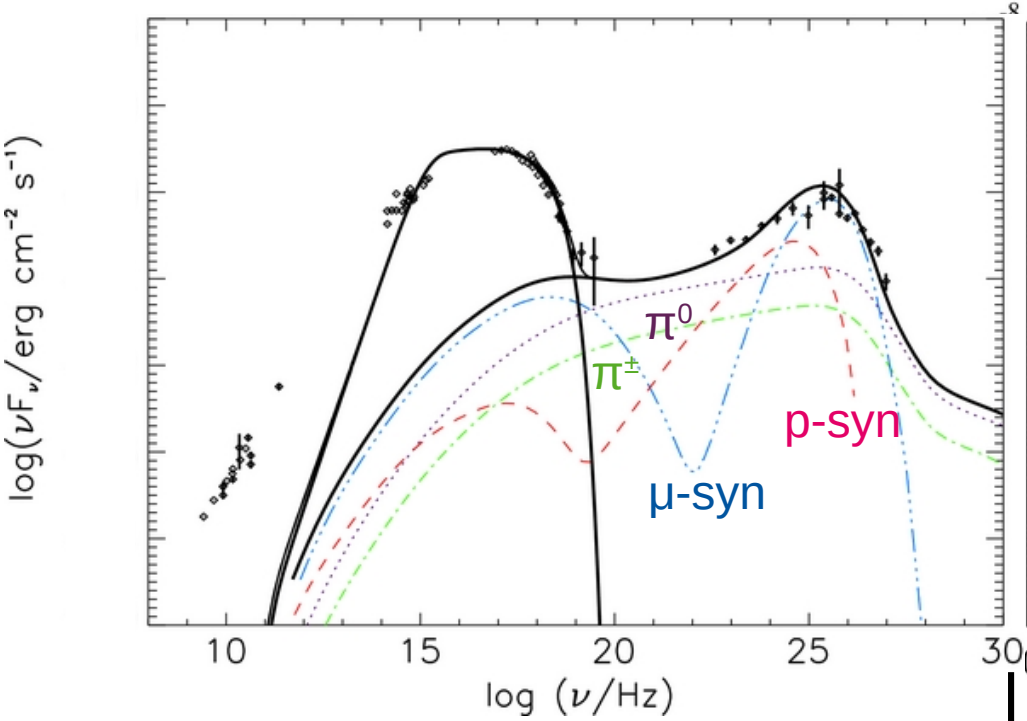
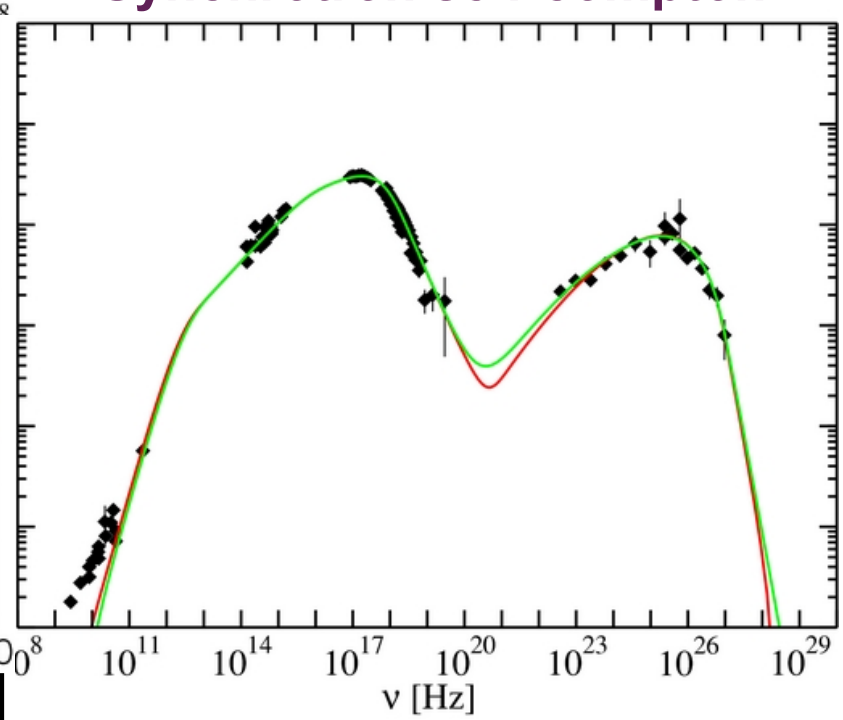
Abdo et al. ApJ (2011) 736

Hadronic model



Synchrotron self-compton

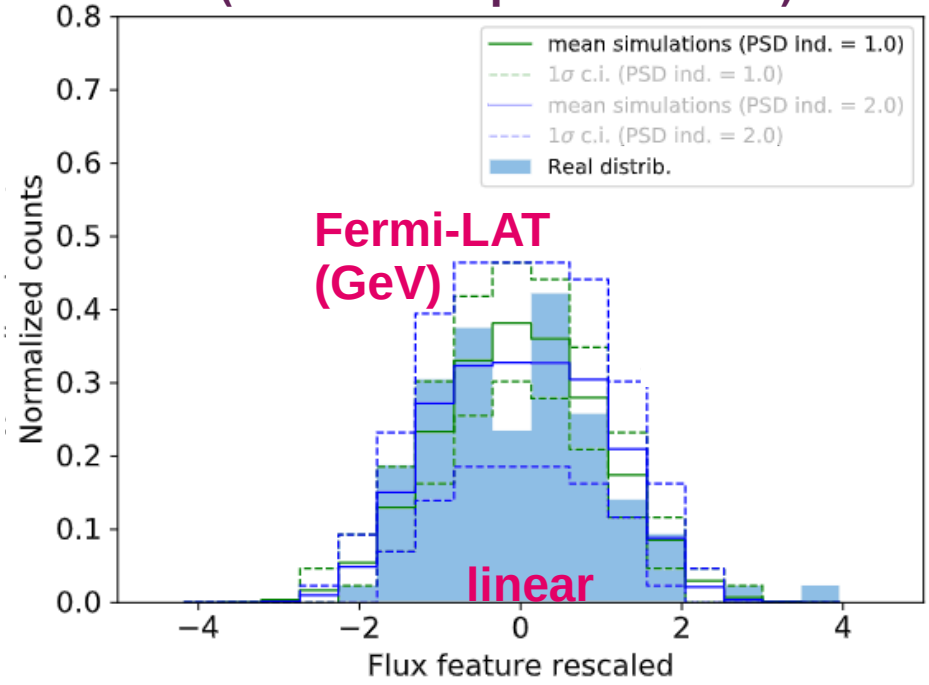


Magnetic field:	50 G	~50 mG	typ. >10 free parameters
Co-moving emission region:	30 AU	300 AU	

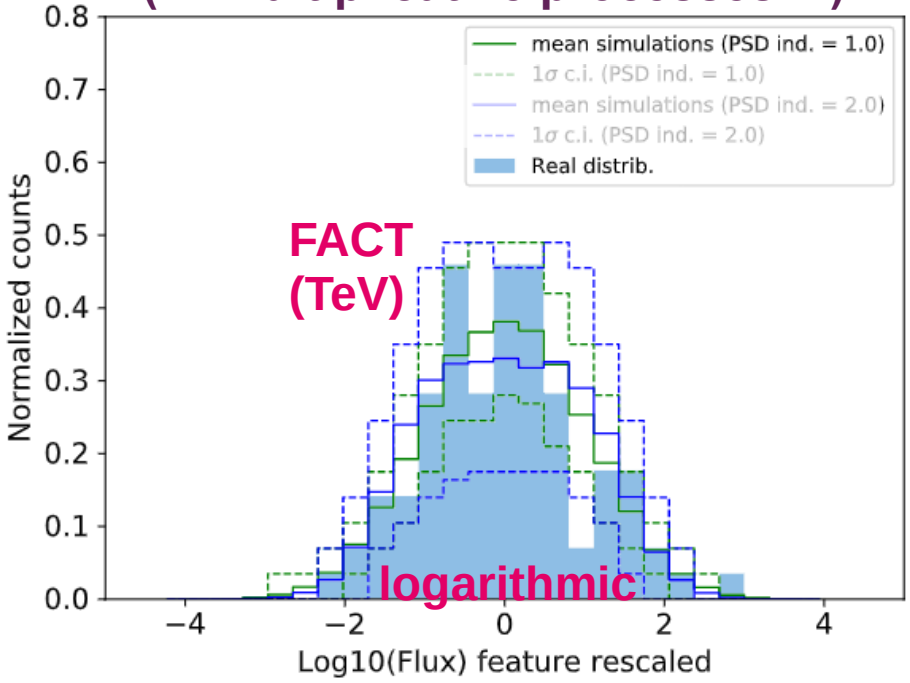
Flux Distribution Mrk 501

Galaxies 6 (2018) 4

More Gaussian
(… additive processes ...)



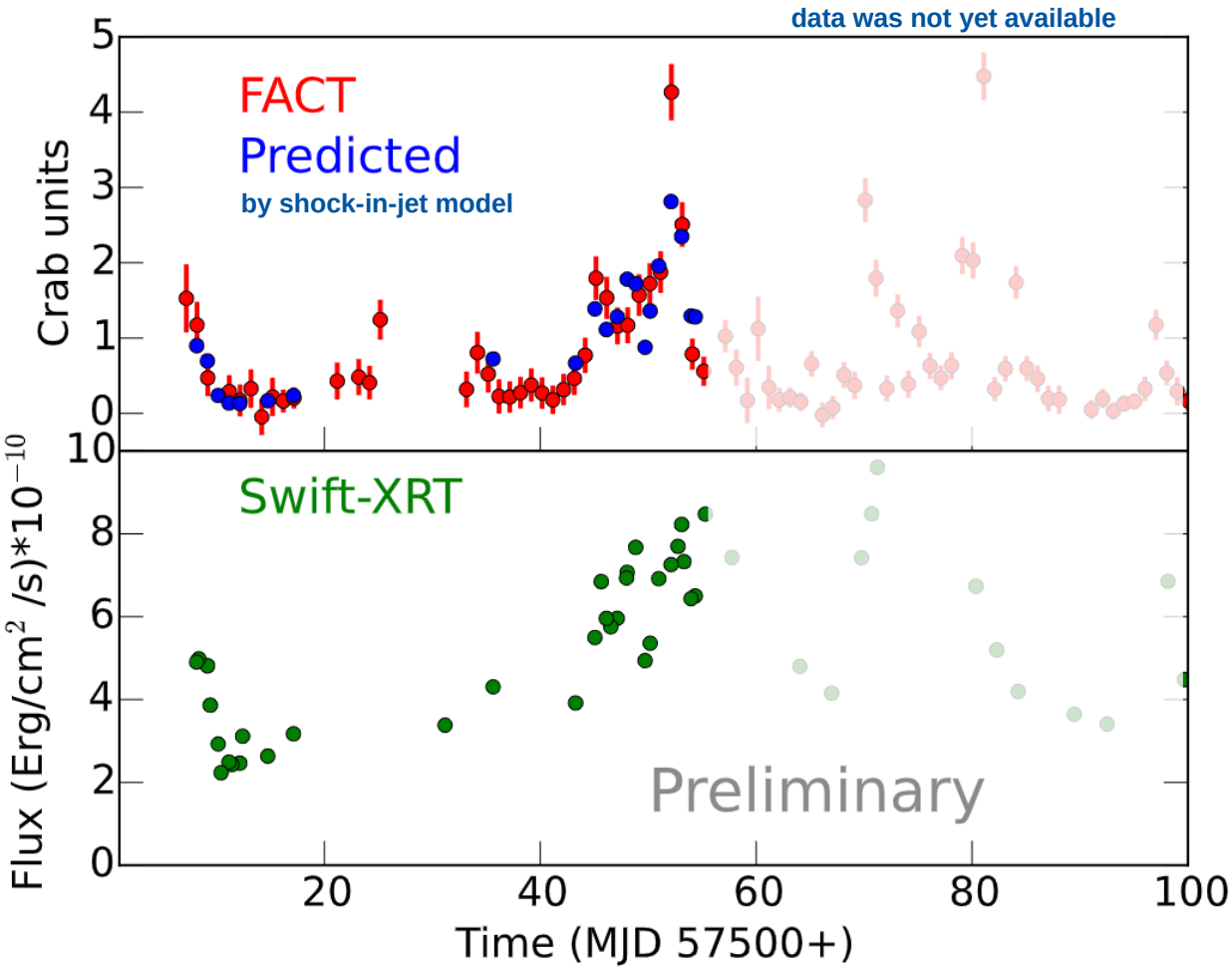
More Log-normal
(… multiplicative processes ...)



→ **multi-zone models disfavored for TeV emission**
→ **no or weak correlation between GeV / TeV**

1ES 1959+650 – X-ray (keV) / TeV Correlation

PoS (ICRC2017) 608



One-zone SSC fit
XRT (keV) → FACT (TeV)

Good description,
but fails to describe
short bright flares

5.5 years Mrk 421 (MWL)

TeV (FACT), Fermi-LAT (GeV), MAXI/ Swift (X-ray), UVOT (UV), OVRO (radio)

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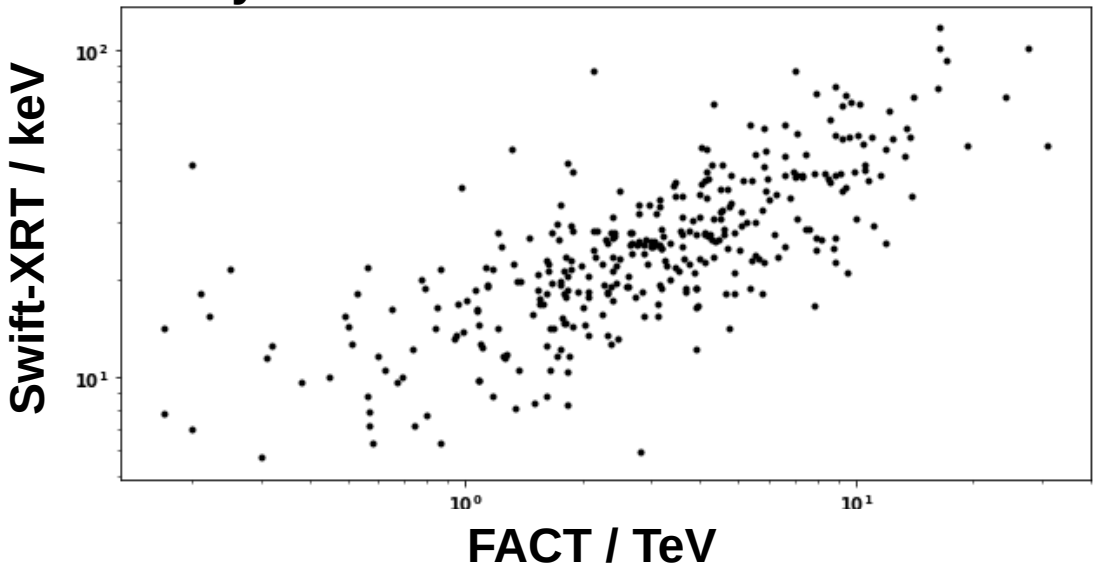
presented by
Roland Walter
Poster Session 2
(PS2 - 84)

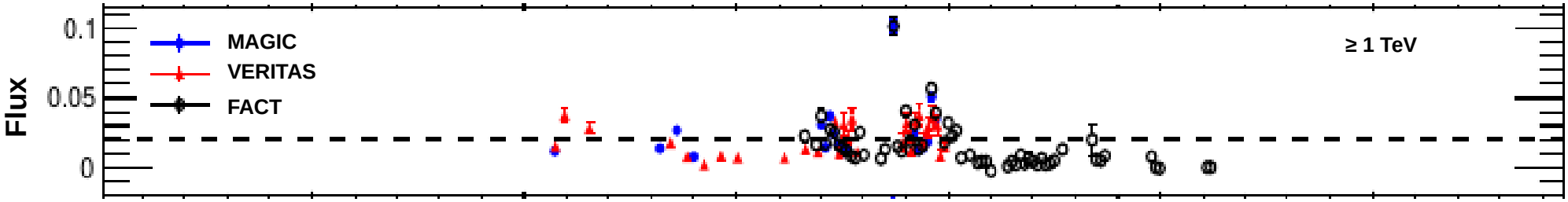
PoS(ICRC2019)796

- GeV/TeV uncorrelated
- Highest fractional variability in X-ray/TeV and **X-ray/TeV correlation**
  → synchronous change of cut-off energy
- No lag X-ray/TeV
  → same component?
- ~43 days delay in radio response
  → emission region moving outwards
- In general: Hadronic / lepto-hadronic models fail to explain:
  - short variability in X-rays
  - missing X-ray / TeV lag

X-ray/TeV correlation



Extreme HBL Behavior of Markarian 501 in 2012



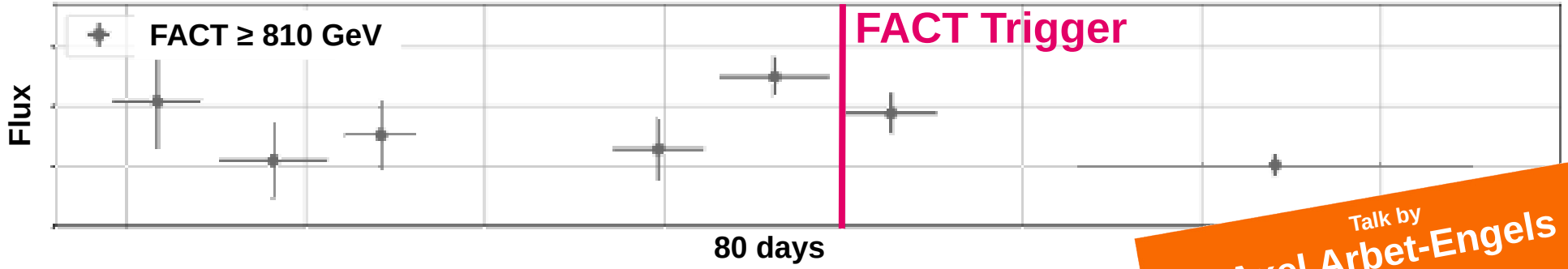
good correlation between MAGIC &FACT

- During Multi-wavelength campaign (radio to TeV)
- In Summer 2012:
  - Synchrotron peak above 0.5 keV
  - inverse-Compton peak above 0.5 TeV

  } Extreme HBL (EHBL)
- Source behaves temporarily like an EHBL

Ahnen et al. A&A 620 (2018) A181

Extreme HBL Behavior of 1ES 2344+51.4 in 2016



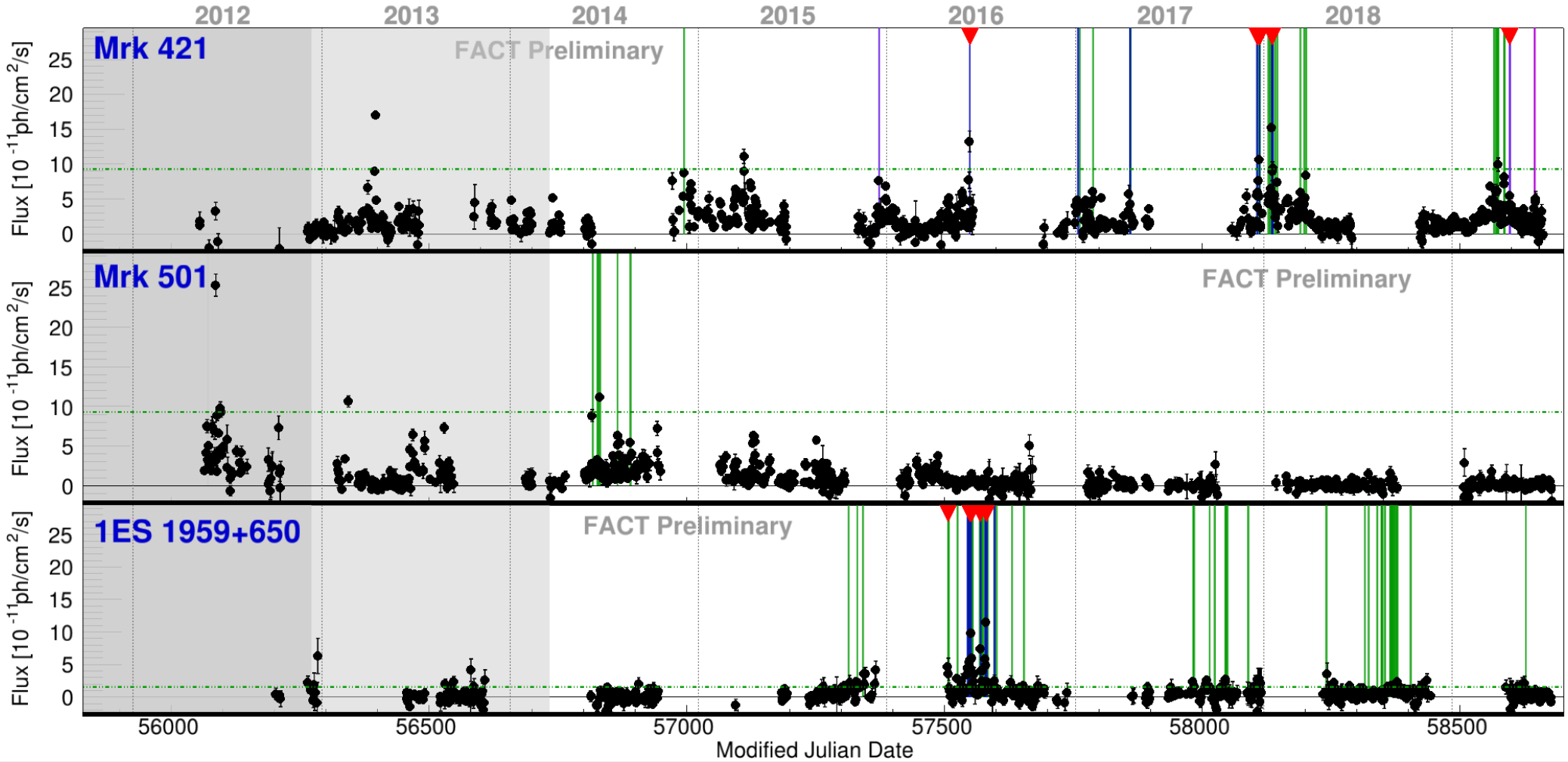
Talk by
Axel Arbet-Engels
Studying the Extreme Behaviour of 1ES 2344+51.4

- Source previously classified as EHBL
  Giommi et al. MNRAS 317 (2000) 743
  … but not found to be extreme again in low-state
  Aleksic et al. A&A 556 (2013) 28
- In 2016, MWL Campaign **triggered** by FACT during outburst
- First time simultaneous GeV/TeV data during flare
  → unprecedented measurement of HE peak
  → Source found again in extreme state
  → EHBL-state only temporary feature

PoS(ICRC2019)620

~100 Flare Triggers

ATEL
XMM-Newton
INTEGRAL
SWIFT-XRT
MWL Partners
manual



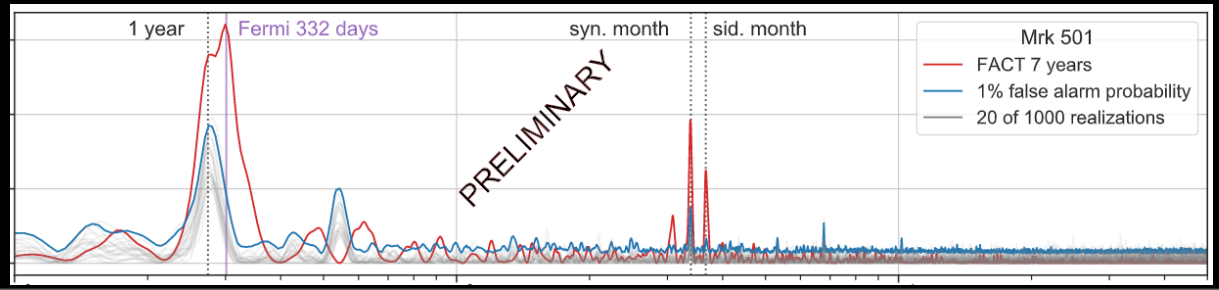
Summary

Unbiased Monitoring:
> 7 years / 13,600 h
2600 h during past 12 months

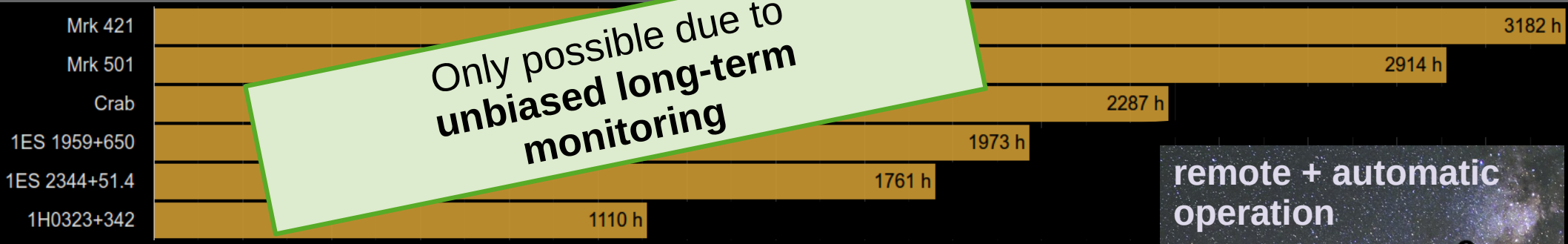
- very stable, O(100) triggers

- EHBL temporary feature rather than blazar type (501, 2344)
- no significant correlation GeV/TeV, but...
  - radio/GeV, X-ray/TeV correlations (except bright flares)

- Mrk 501 periodicity?



Summary



Only possible due to **unbiased long-term monitoring**

- very stable, O(100) triggers

- EHBL temporary feature rather than blazar type (501, 2344)
- no significant correlation GeV/TeV, but...
  - radio/GeV, X-ray/TeV correlations (except bright flares)

- Mrk 501 periodicity?