

TeV emission from flat spectrum radio quasars: A systematic survey



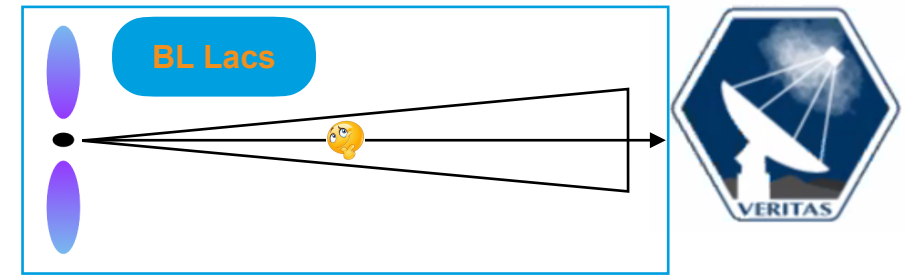
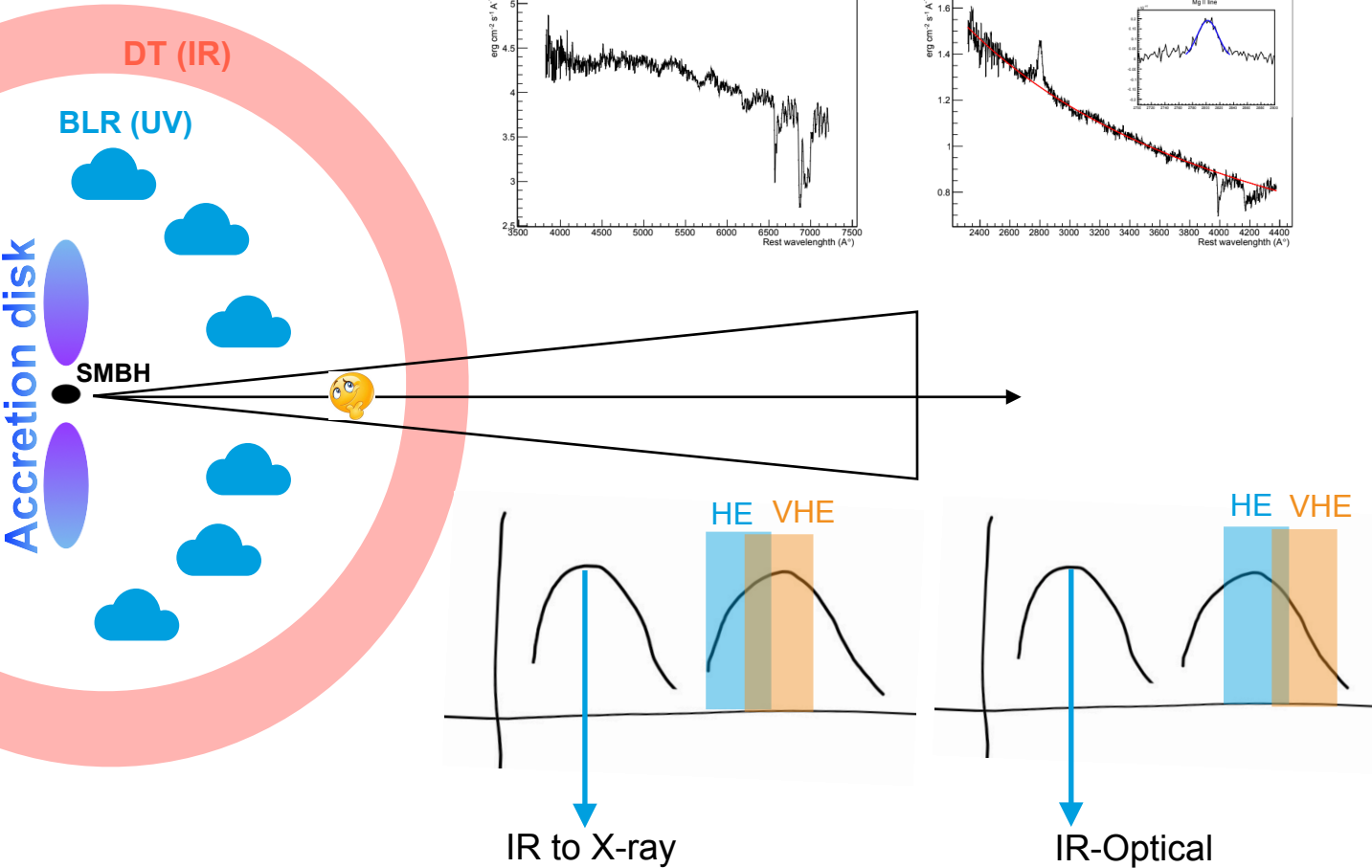
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DESY, Zeuthen
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Introduction

Why TeV FSQRs?



Motivation:

- Only 8 FSRQs @TeV
- All of them detected during high flux state (except PKS 1510-089)
- Generally located at larger distance

$$J(E_\gamma) = J_0(E_\gamma) \times e^{-\tau(E_\gamma, z)}$$

- Spectral cutoff due to external radiation field (~ 20 GeV; [Stern & Poutanen 2014](#))
- Potential source of EeV-scale neutrino ([Righi et al. 2020](#))

Instruments

VERITAS and Fermi-LAT



Current Configuration



Energy range: 100 GeV to >30 TeV

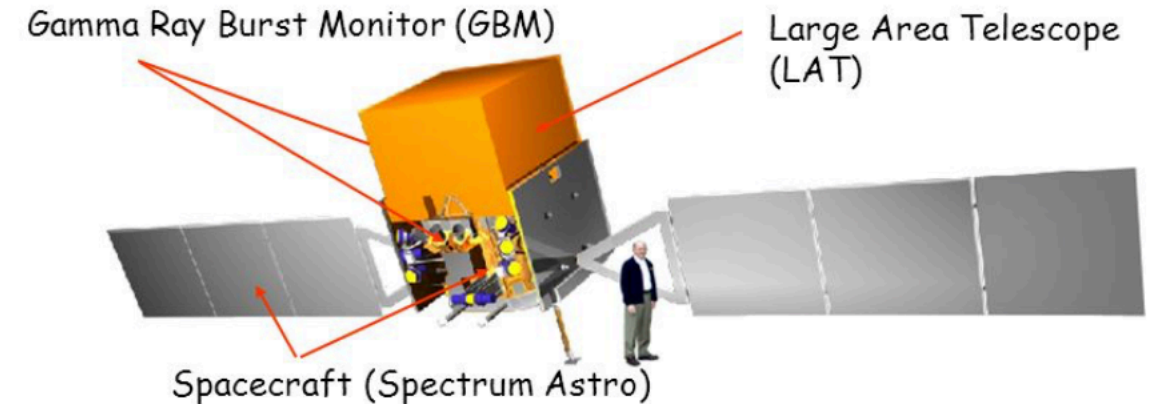
Energy resolution: 15-25%

Sensitivity: 1% Crab in ~25h

Angular resolution: $R_{68\%} < 0.1^\circ$ at 1 TeV

Pointing accuracy: Error < 50 arcsec

Each Telescope has 345 facets



Performance:

Energy range: 20 MeV - 300 GeV

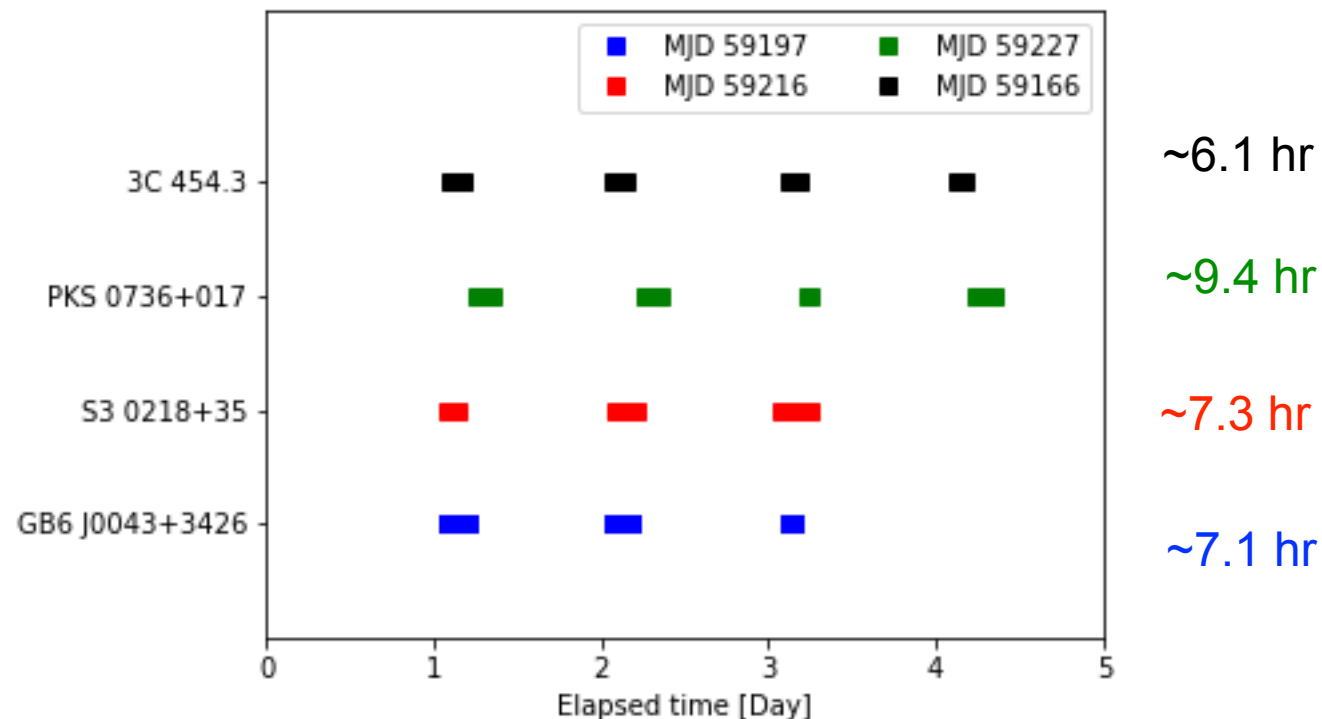
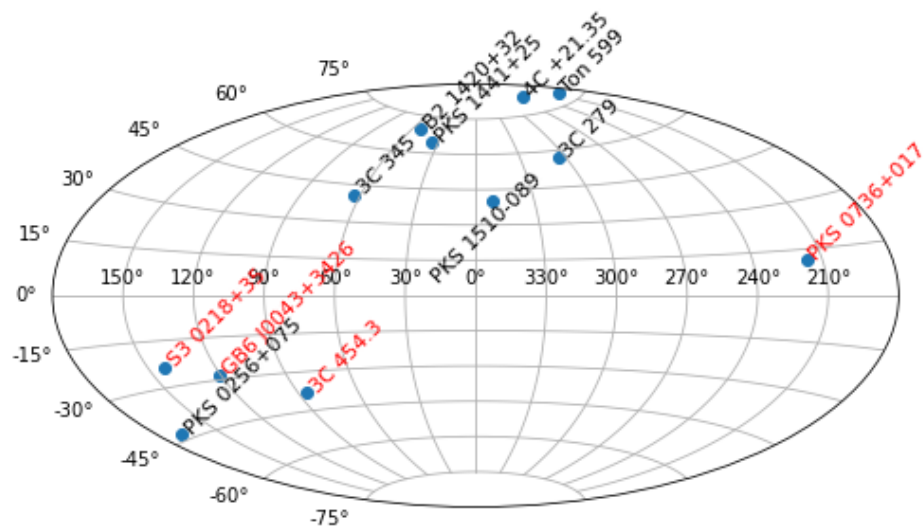
Energy resolution: <10 %

Field of view: < 2 sr

Angular resolution: 3.5° (100 MeV), $<0.15^\circ$ (>10 GeV)

Systematic search of TeV emission from FSRQs

Sample and VERITAS Observation



Sample selection:

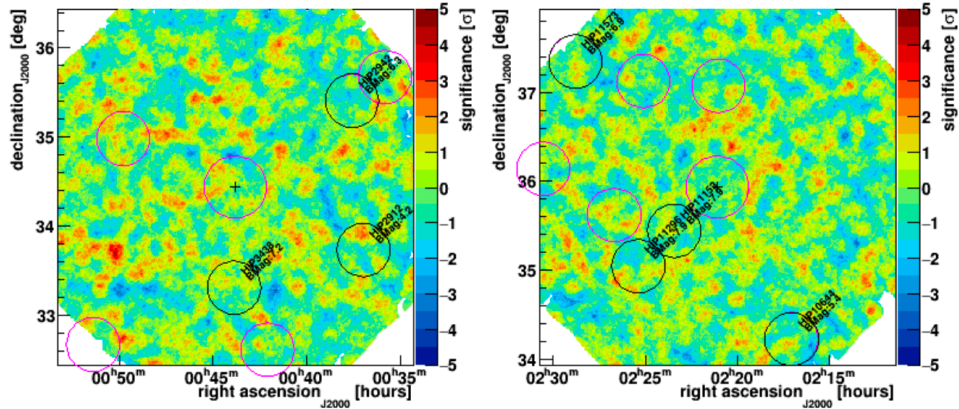
- 8 targets: Extrapolated 3FHL flux >1% Crab after EBL correction
- +4 TeV-detected targets:
 - Two having northern declinations but flux <1% Crab (PKS 0736+017, B2 1420+32)
 - Two most active TeV blazars (PKS 1510-089 and 3C 279)

Results

Significance sky maps

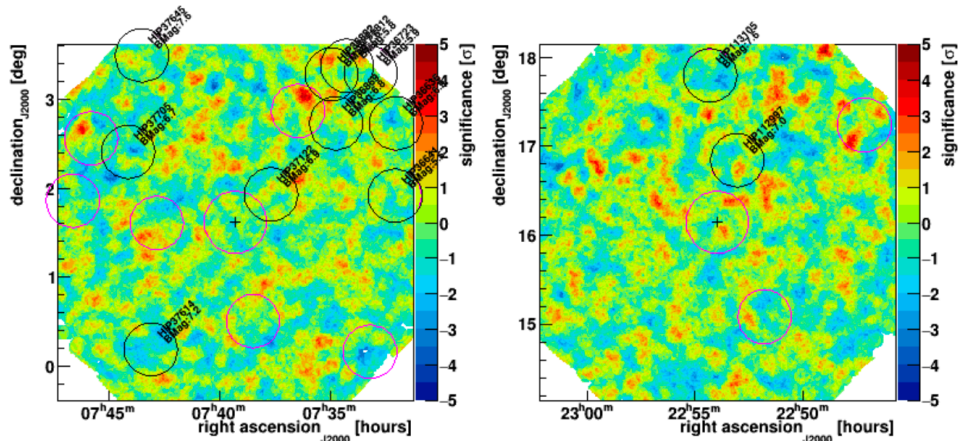


No Significant detection



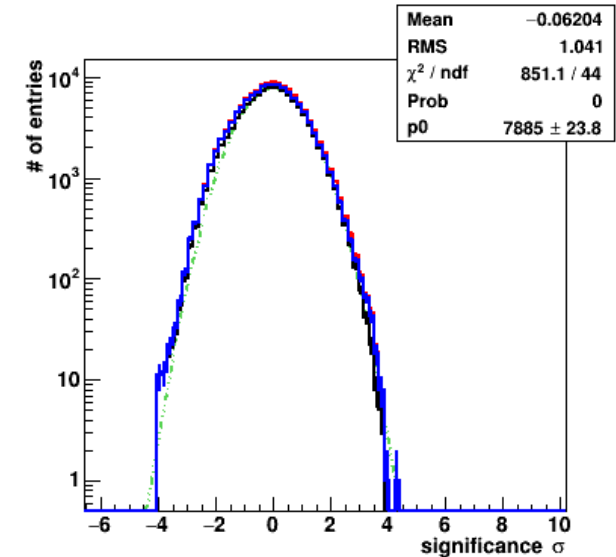
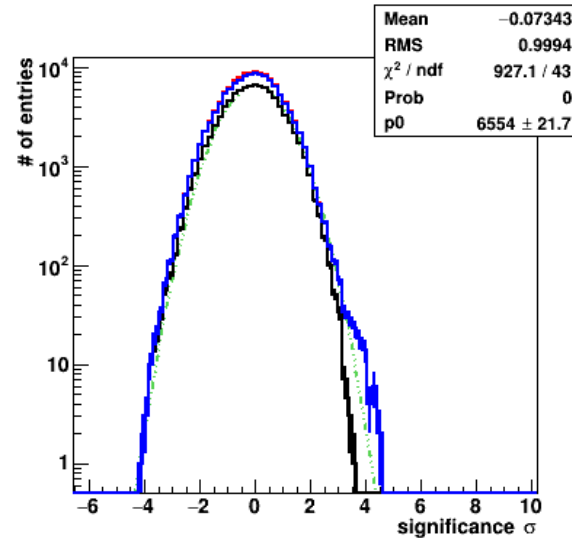
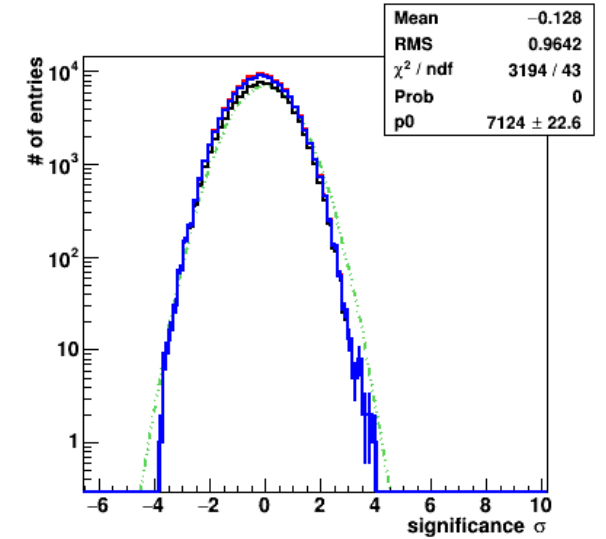
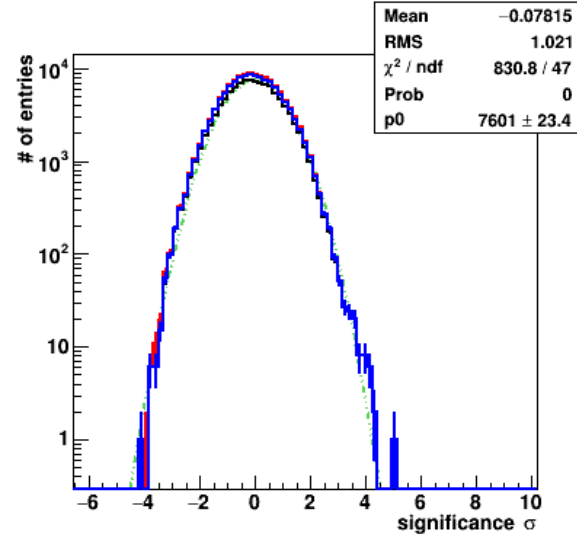
(a) GB6 J0043+3426

(b) S3 0218+35



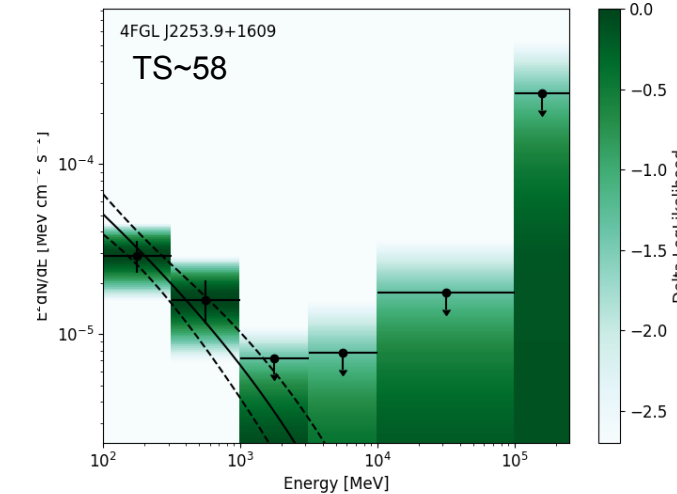
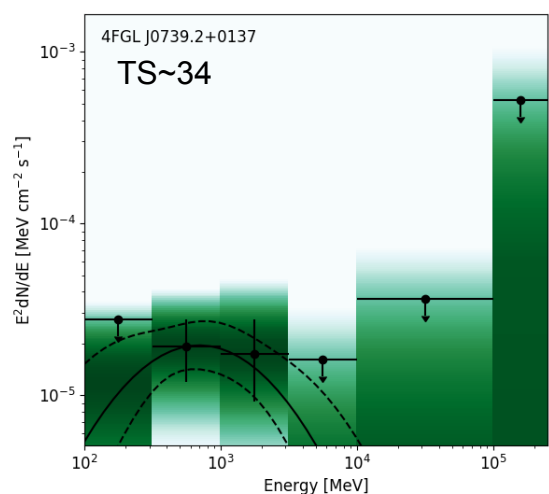
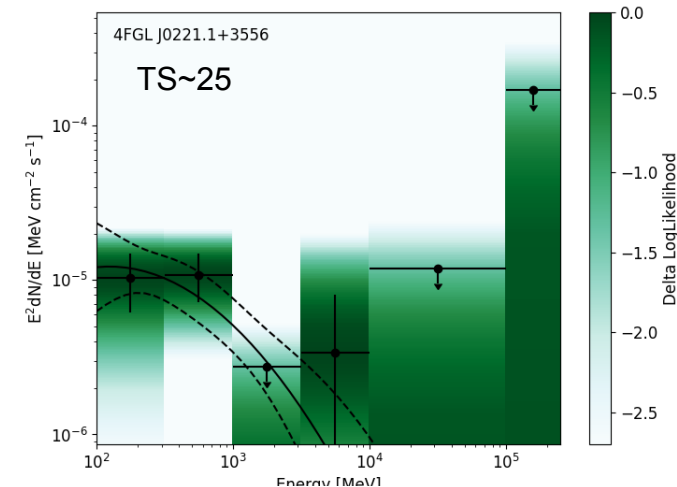
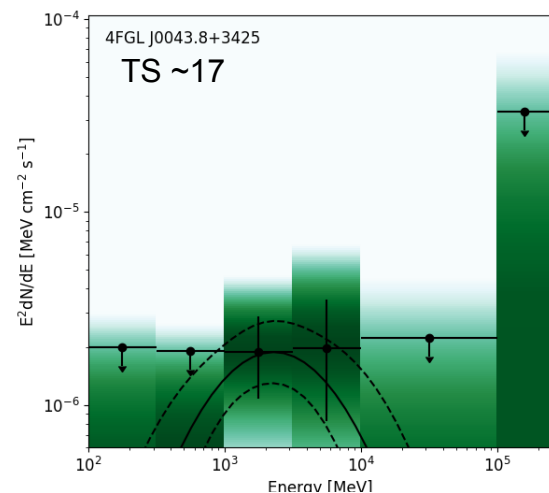
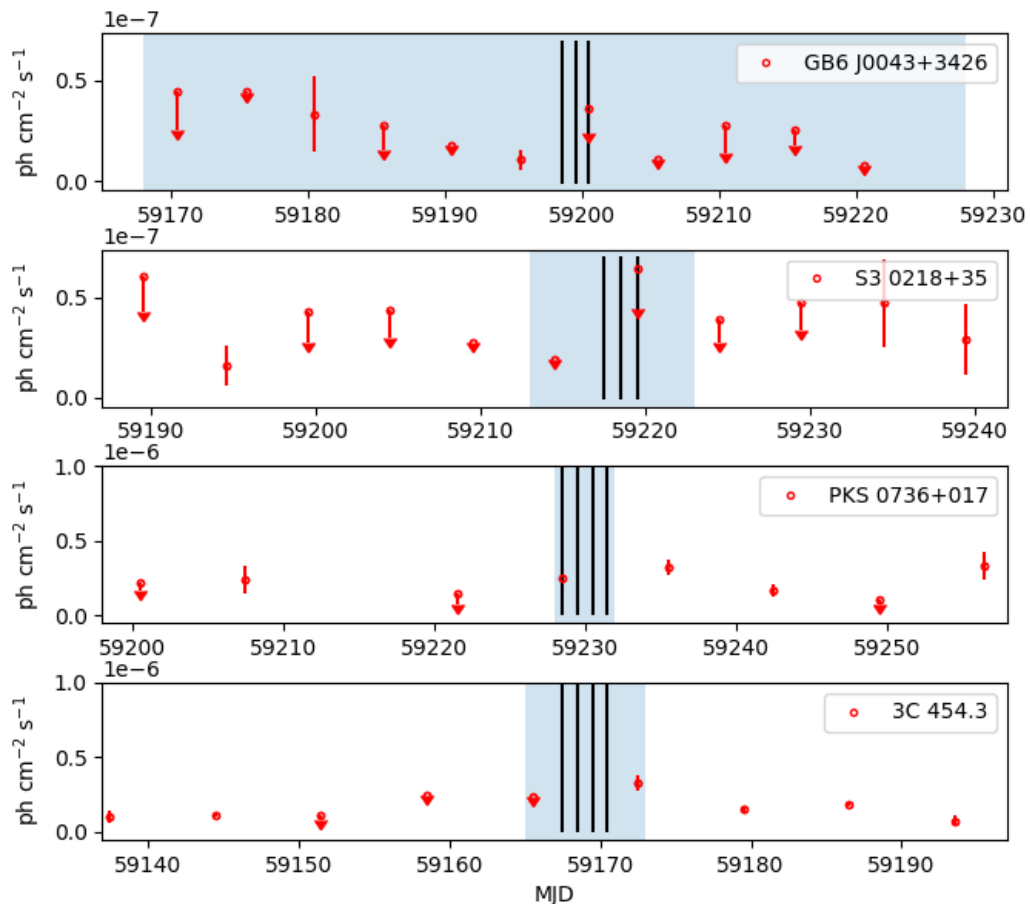
(c) PKS 0736+17

(d) 3C 454.3





As simultaneous as possible LAT spectra



Results

VERITAS, 3FHL and 4FGL together!



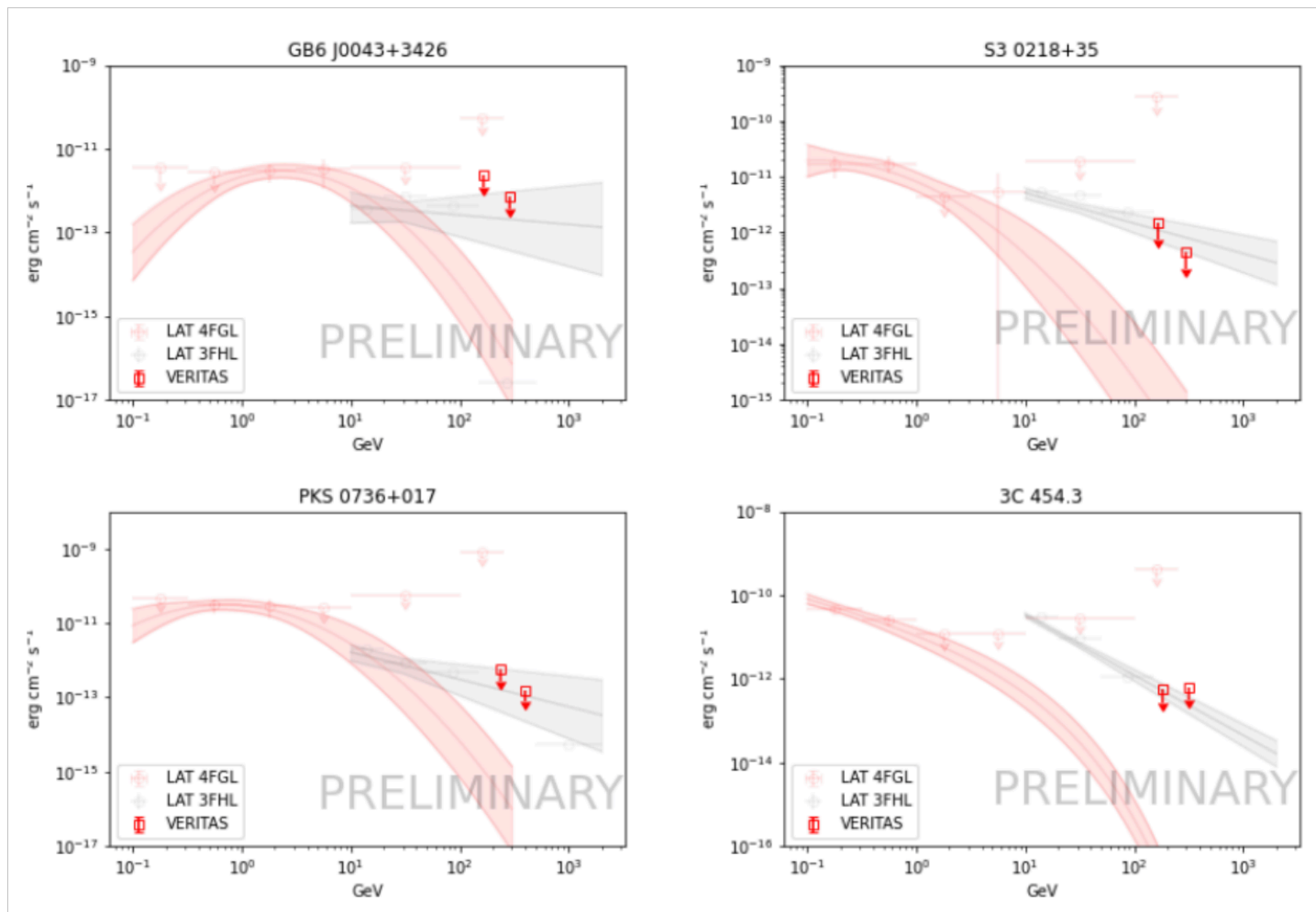
4FGL: 0.1 - 300 GeV

3FHL: 10 GeV - 2 TeV (catalog)

VERITAS: $>(\sim 170-240)$ GeV

- 95% UL: Power law index -3.5

Source	Significance	Flux ($10^{-12} \text{ cm}^{-2} \text{ s}^{-1}$)
GB6 J0043+3426	0.53	< 5.74
S3 0218+35	-0.09	< 3.66
PKS 0736+017	-0.92	< 0.97
3C 454.3	-1.28	< 1.26



Summary and Outlook



- VHE signal is absence from four sources during 2020-21 observations
- Remaining sources: Observation in next season
- Complementary dataset to characterise extra-galactic TeV sky
- The quantitative statement on **limited duty cycle of TeV emission from FSRQs**
- Quantification of **spectral breaks between GeV and TeV**: Dominant cooling mechanism of highest energy electrons



Thanks:

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LAT analysis - Sonal, Victoria Han

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Observation - All Observers, SAO/Project office, TAC

