Long term variability of PKS 1510-089 in VHE γ-rays

Based on Master thesis work at University of Potsdam/DESY
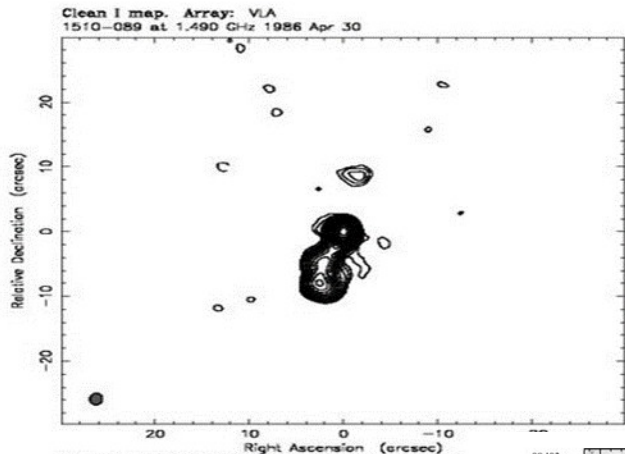
Sweta Menon

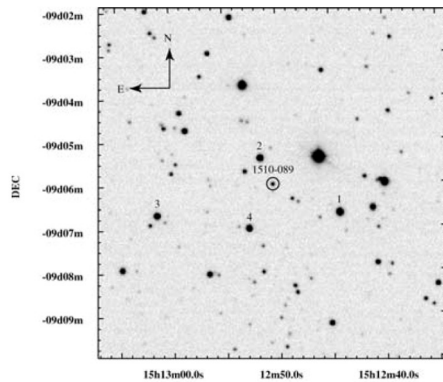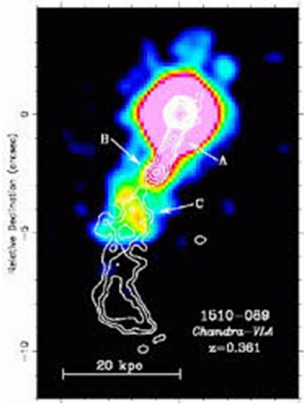PhD student at INAF- OAR/ University of Rome "Tor Vergata"

PKS 1510-089

- Redshift z = 0.36

- Optical Mag = ~16-17

- Flat Spectrum Radio Quasar

Lister et al., 2018, ApJS, 232, 12

Steep decline in VHE regime

synch   inverse Compton

BLR

EC-BLR
EC-dust
syn+SSC
total

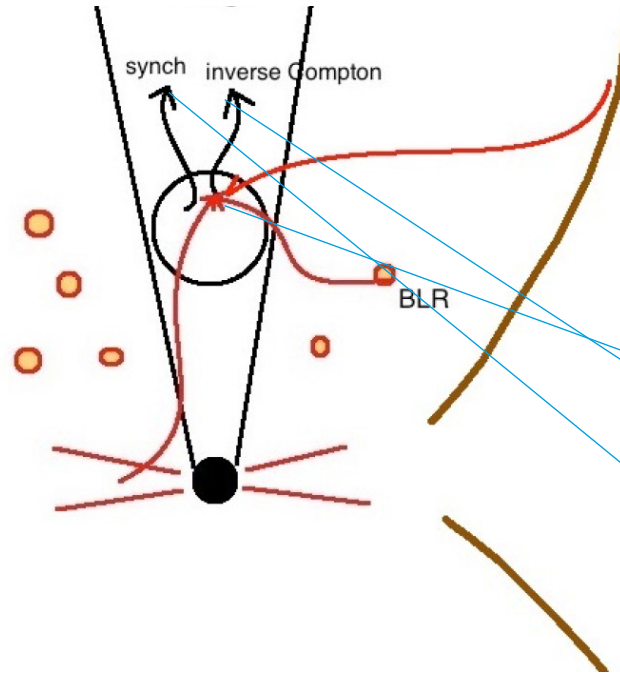νF_ν [erg cm^{-2} s^{-1}]

ν [Hz]

Clean I map. Array: VLA
1510-089 at 1.490 GHz 1986 Apr 30

Relative Declination (arcsec)

Right Ascension (arcsec)

1510-089
Chandra-VLA
z=0.361
20 kpc
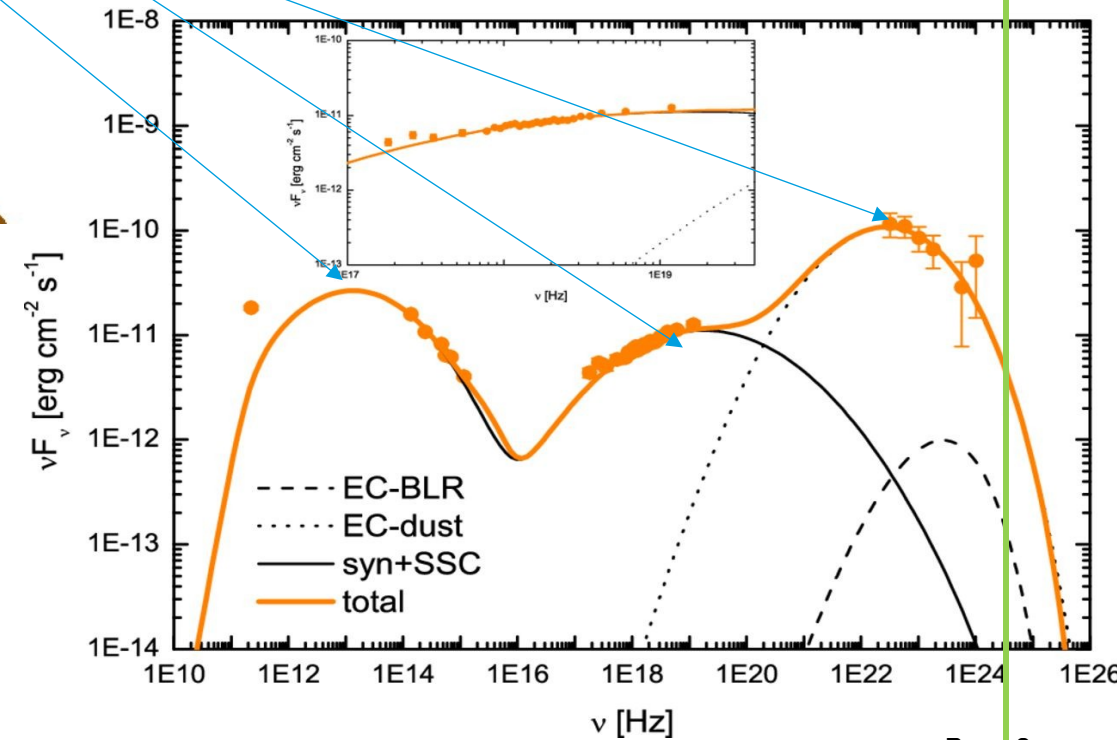
PKS 1510-089 in VHE gamma rays
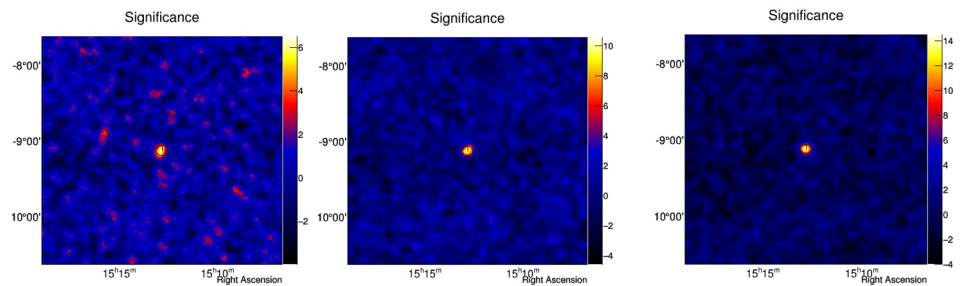
HESS-I   HESS-II   HESS-IU

| Dataset	Runs	date start dd/mm/yyyy	date stop dd/mm/yyyy	Livetime hr	N_{On}	N_{Off}	Alpha	Significance σ
HESS - I	81	22/03/2009	18/07/2012	34	370	12010	0.021	6.56
HESS - II	225	06/04/2013	27/06/2016	94.4	877	27358	0.021	11.11
HESS - IU	324	25/02/2017	30/07/2019	142.1	2875	99017	0.021	15.84
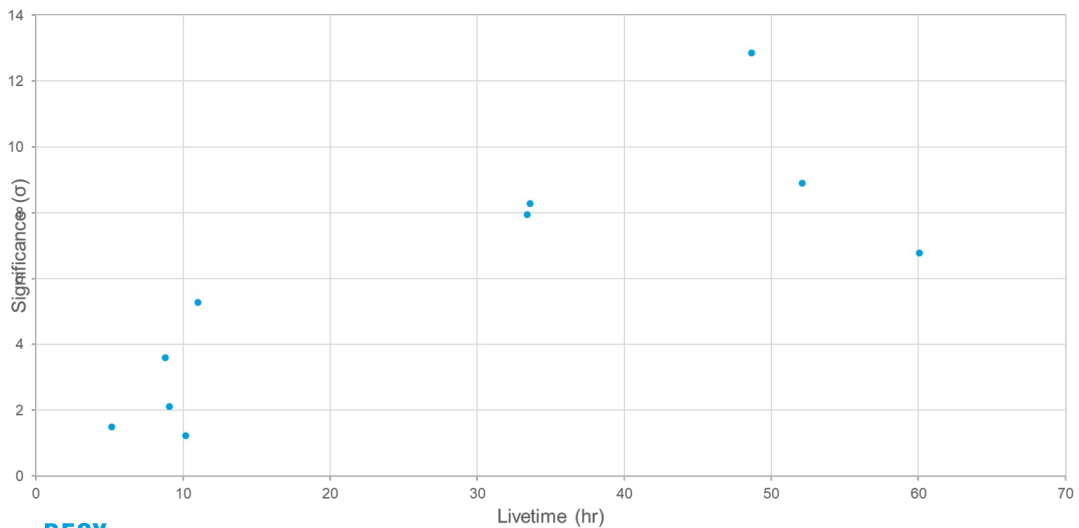
DESY.
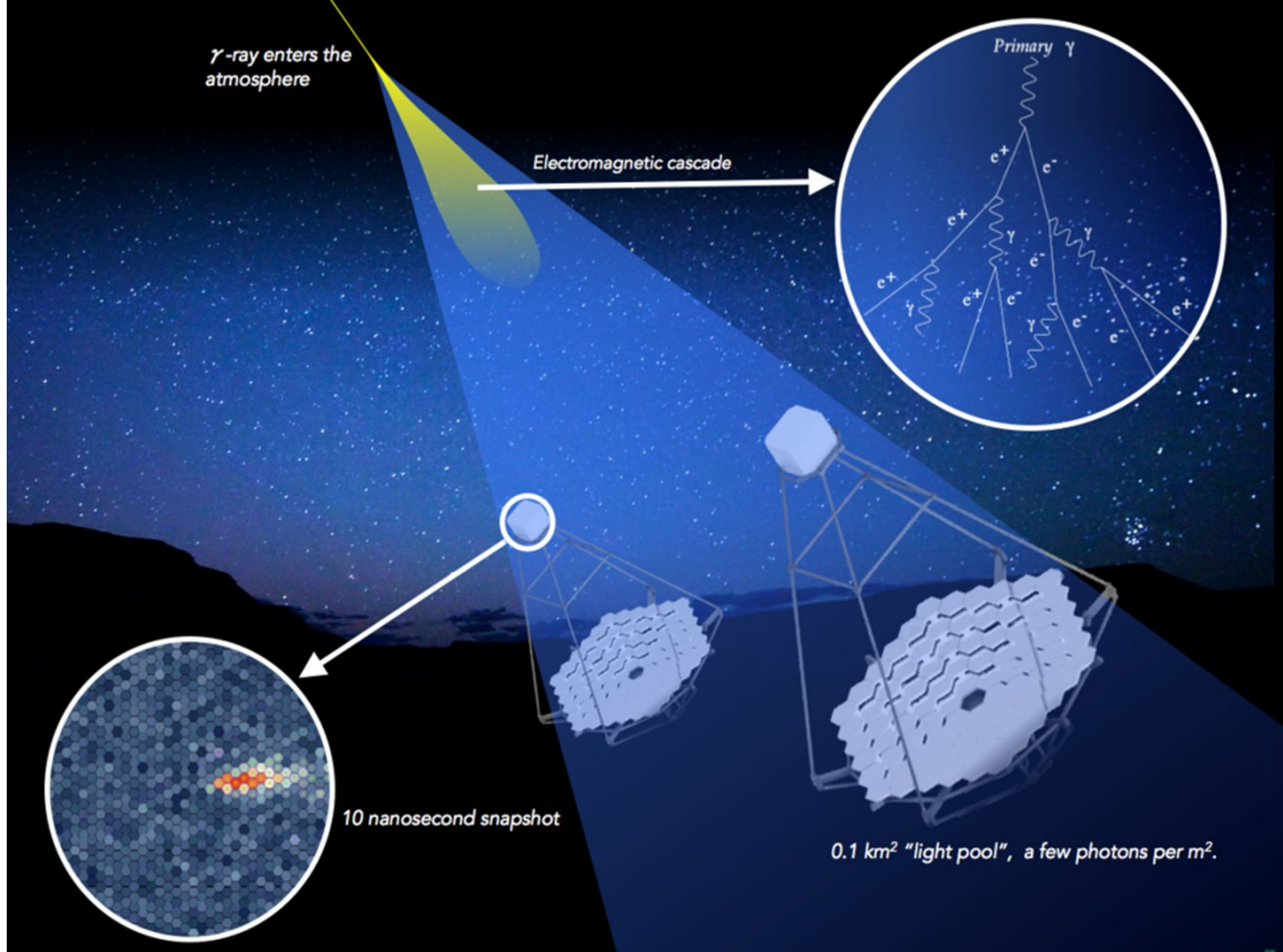
Light-curve

Light-curve of 2009-2019; Spectral index = 4.2

- Binned per observation period ~ monthly

- Weighted flux mean = $(2.44 +/- 0.16) \times 10^{-12}$ cm^{-2} s^{-1} TeV^{-1}
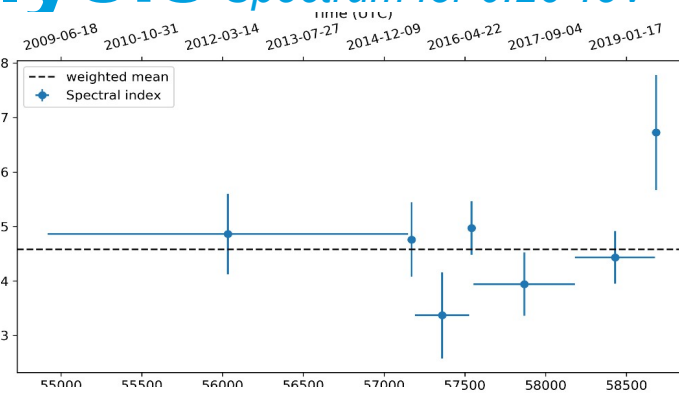
- $X^2/v = 2.3$, constant flux fit excluded by 4σ
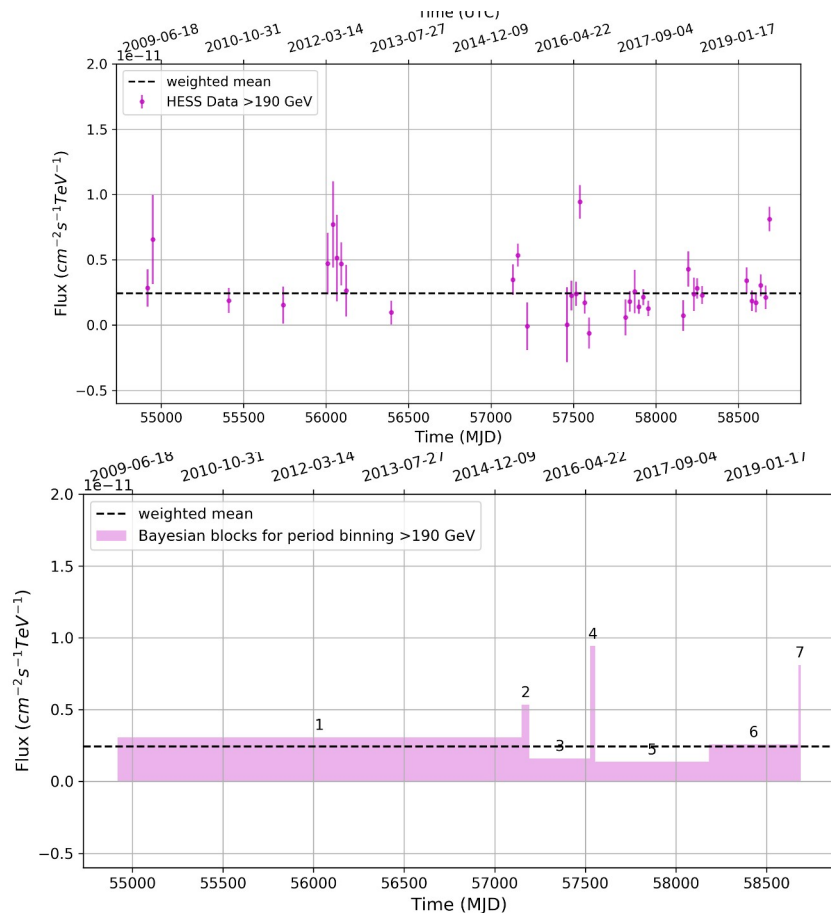
- Binned per night

- Weighted mean = $(1.78 +/- 0.16) \times 10^{-12}$ cm^{-2} s^{-1} TeV^{-1}

- $X^2/v = 1.58$, constant flux fit excluded by 6σ

- Fractional variability = 1.8 +/- 0.1
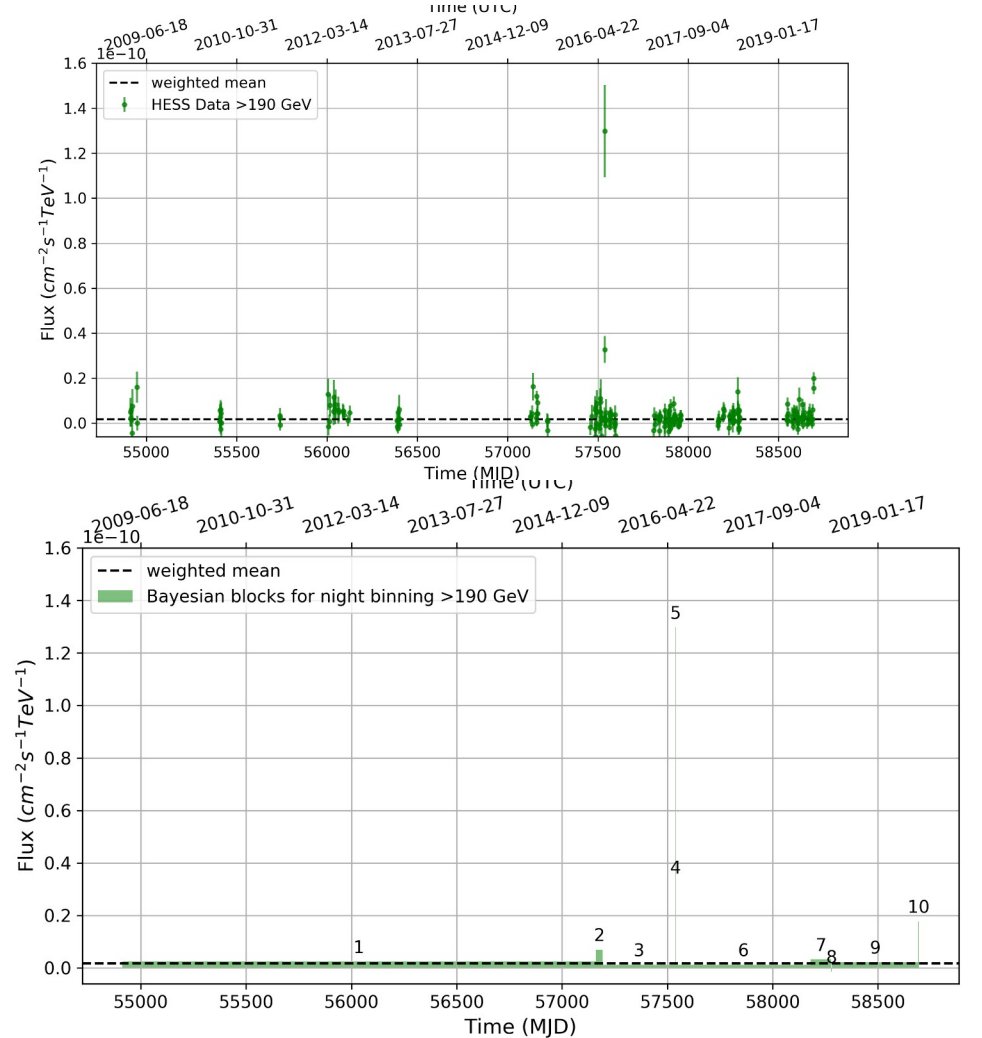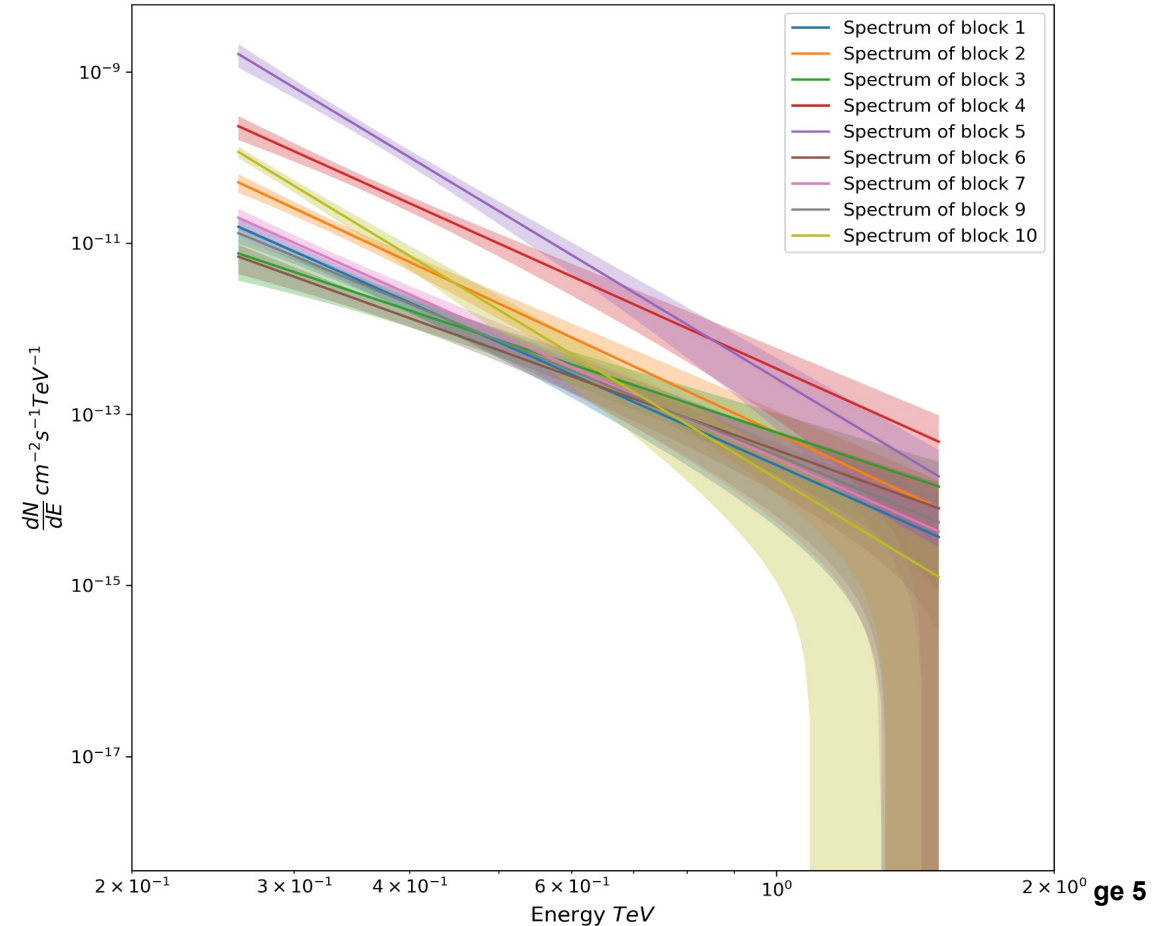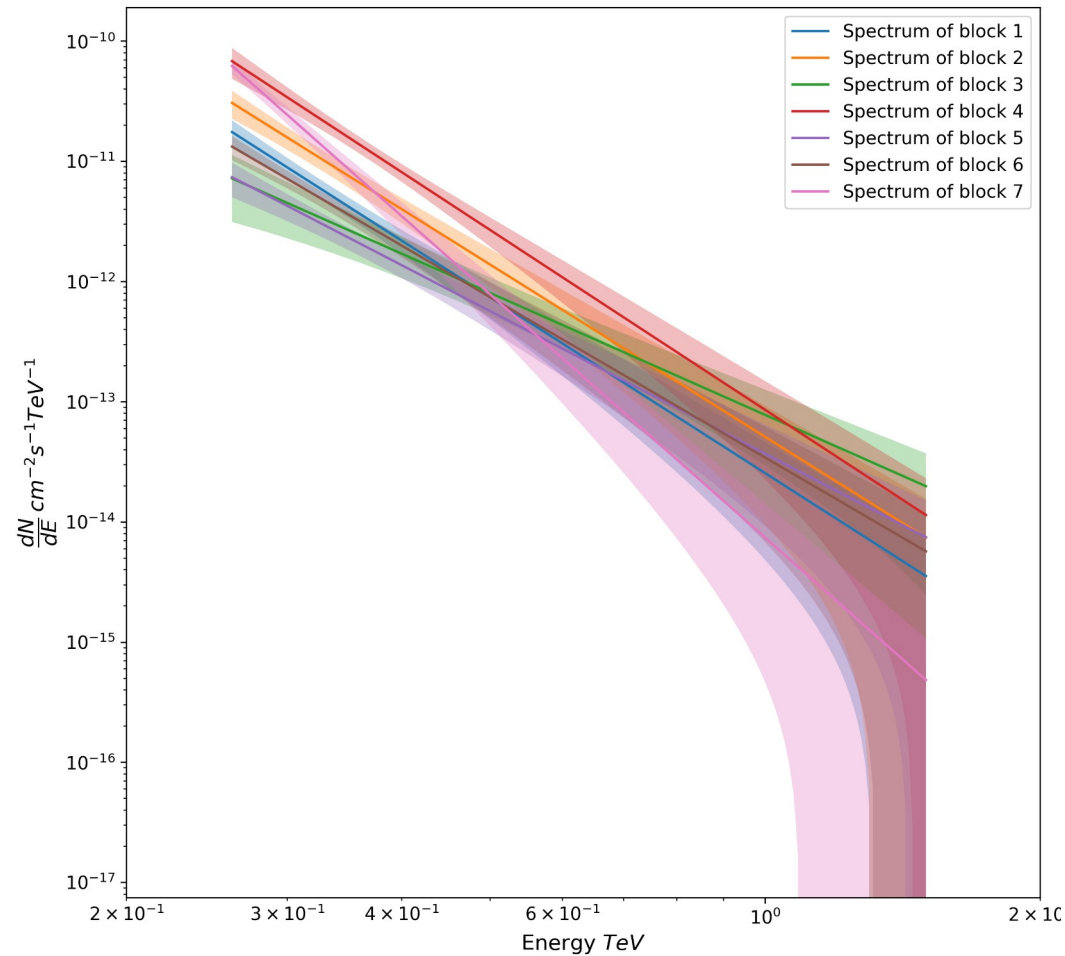
Spectral analysis *Spectrum for 0.26 TeV- 1.5 TeV*

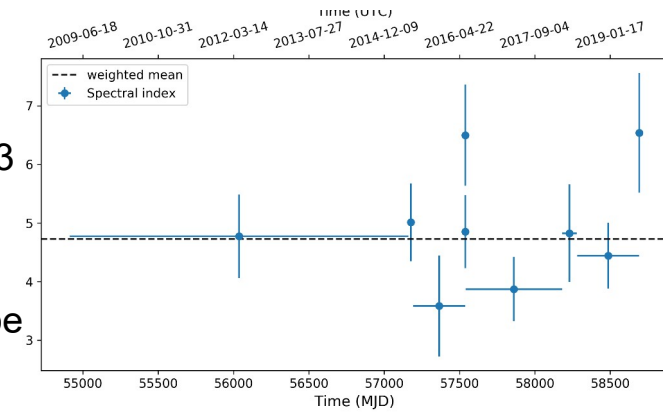Events binned monthly

- Spectral index = 4.58±0.24

- X^2/v = 0.75

- Spectral variability can not be established

Events binned daily

- Spectral index = 4.73+/- 0.23

- X^2/v = 1.12

- Spectral variability can not be established

ge 5

Summary and Outlook

- Analysed H.E.S.S. data from 2009-2019

- Light-curve analysis with several statistical tests

- Seven flux states having source significance >3 σ identified for flux binned per period. Ten flux states identified flux binned per night with source significance >3σ for nine of them

- Low flux state ~ $(1.70\pm0.23)\times10^{-12}\,cm^{-2}\,s^{-1}$

- No spectral variability found within the time blocks associated with the nightly or period-wise binned data

- Contemporaneous multiwavelength data studies will help shed more light on the emission regions and Compton processes in the jet of PKS 1510-089

- Observational prospects with LST-1 : the source is about 0.03 crab. May be observable in relatively low flux states too!
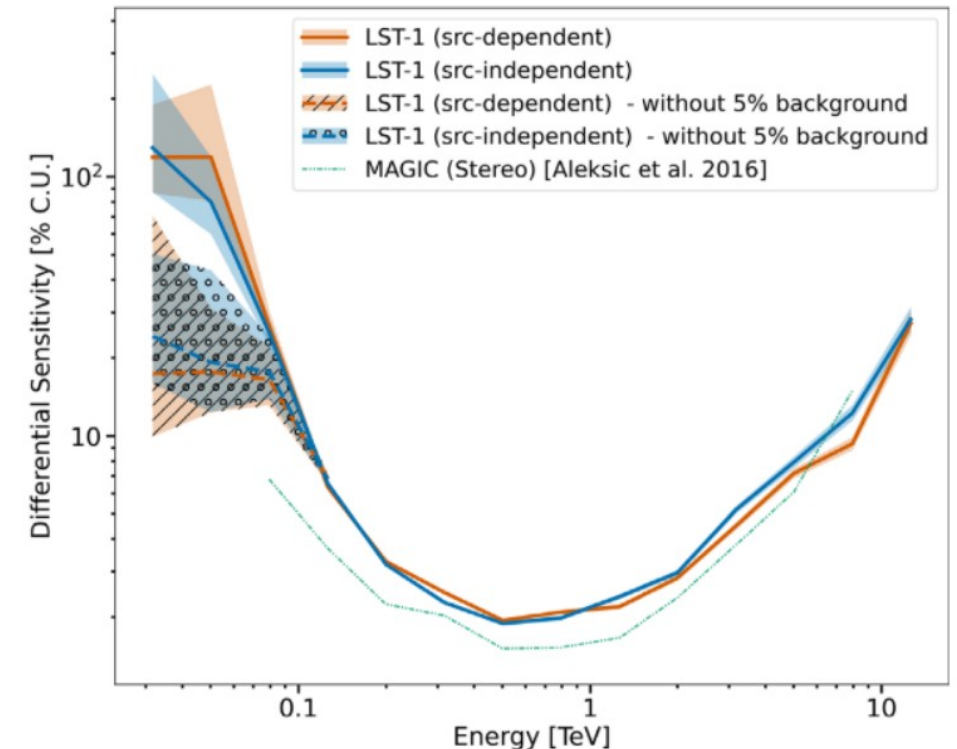

Figure 15. Differential sensitivity for source-dependent and source-independent analyses, vs. reconstructed energy, with and without including the condition that the signal-to-background ratio has to be at least 5%. The MAGIC reference is taken from Aleksić et al. (2016).