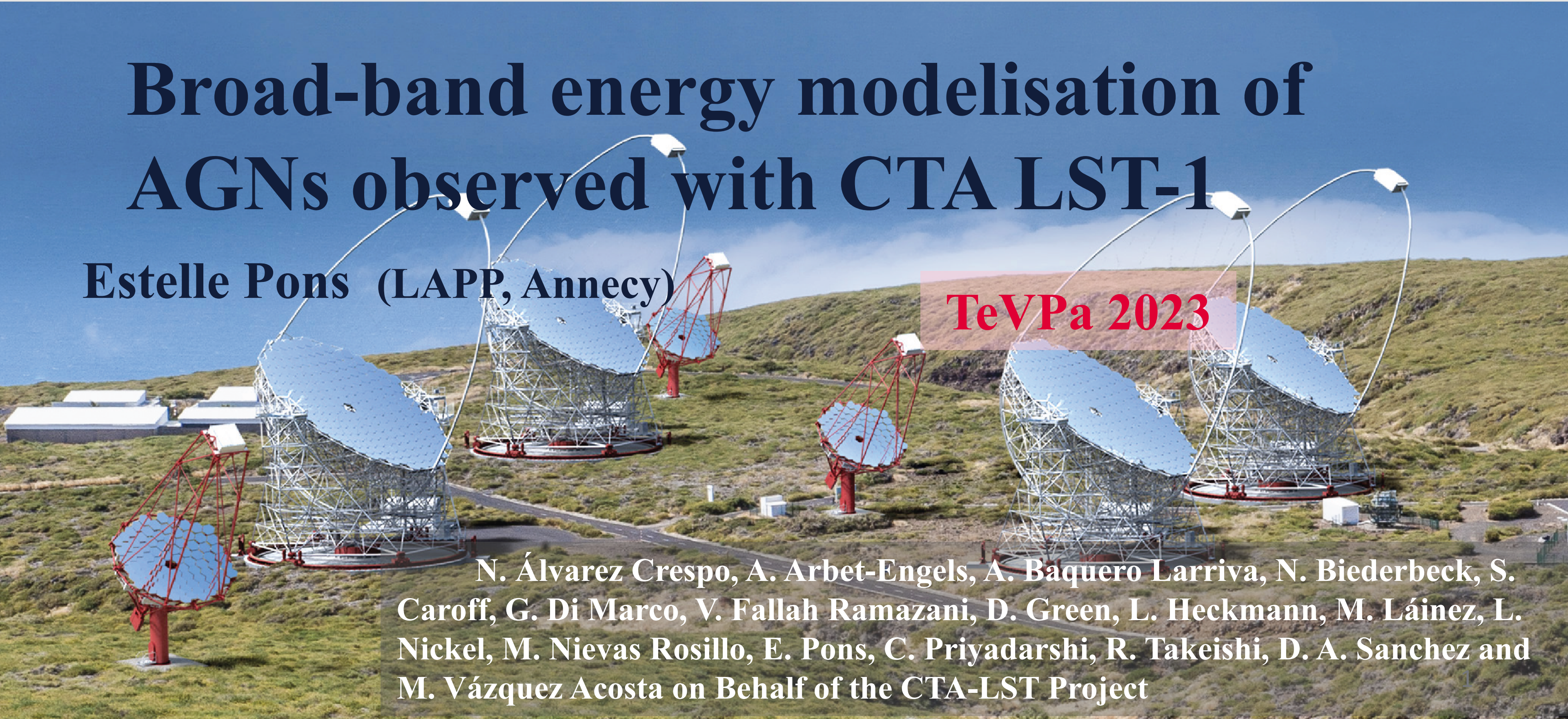


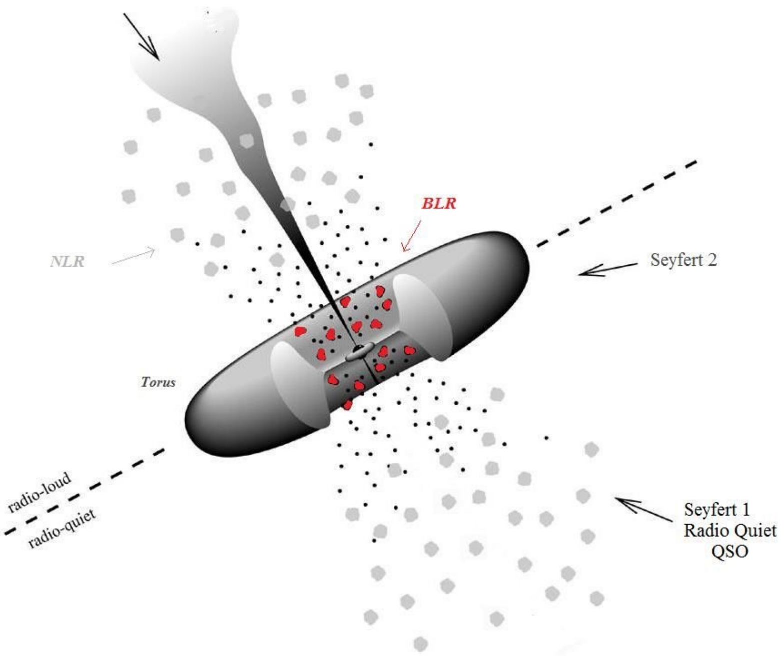
Broad-band energy modelisation of AGNs observed with CTA LST-1

Estelle Pons (LAPP, Annecy)

TeVPa 2023

N. Álvarez Crespo, A. Arbet-Engels, A. Baquero Larriva, N. Biederbeck, S. Caroff, G. Di Marco, V. Fallah Ramazani, D. Green, L. Heckmann, M. Láinez, L. Nickel, M. Nievas Rosillo, E. Pons, C. Priyadarshi, R. Takeishi, D. A. Sanchez and M. Vázquez Acosta on Behalf of the CTA-LST Project

Active Galactic Nuclei model



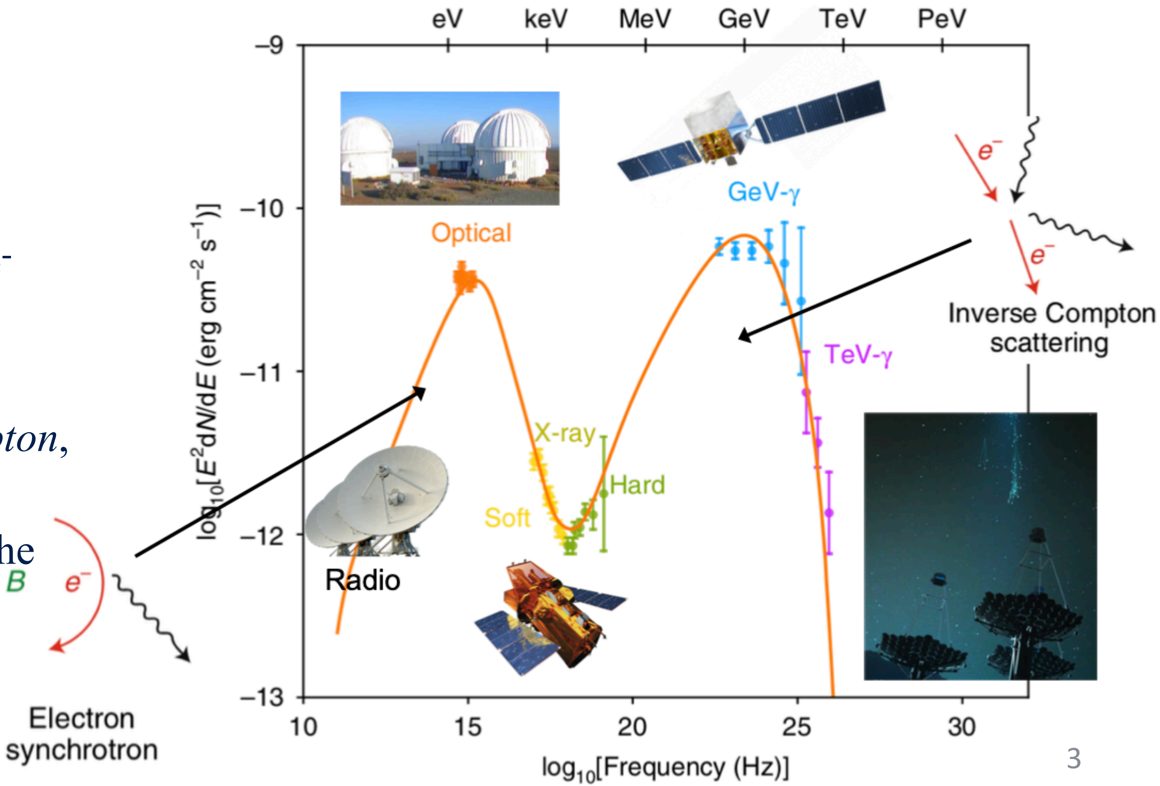
- AGN Unified Model
  - AGN classification depends on orientation only
  - 2 classes: Type 1 = Broad-line AGN

    Type 2 = Narrow-line AGN
  - Subclasses based on the presence of a jet
    - Jet towards the observer = **Blazars**
      - **BL Lac:** lack UV/opt emission-lines
      - **Flat Spectrum Radio Quasars (FSRQ)**

➡ dominate the high-energy extragalactic sky

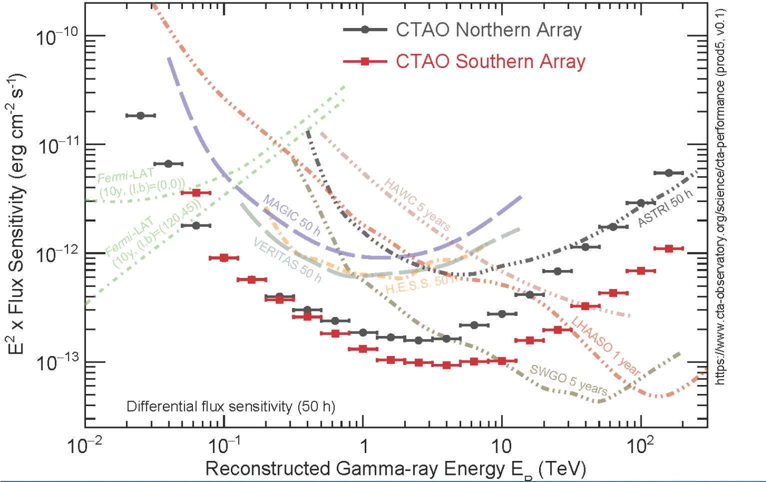
Blazars Broad Band Emission

- Typical 2-humps spectrum
  - 1^{st} peak: e^- synchrotron
  - 2^{nd} peak :
    - Leptonic model → Inverse Compton scattering of jet e^- interact with
      - synchrotron photons (*Synchrotron Self Compton*, SSC)
      - external photons from the local environment (*External Compton*)
    - Hadronic model



CTA - Large Sized Telescope (LST)

- CTA: next generation of atmospheric Cherenkov telescopes
  - 64 telescopes: distributed between the Northern and Southern hemispheres
  - 3 different sizes (SST, MST, LST) to cover the full range of energy (20 GeV up to 300 TeV)
  - 10x better sensitivity



- LST-1: 1st prototype of CTA telescope in La Palma since 2018
  - covered the low energy range (20 GeV - 3 TeV)

AGNs observed by LST-1

See next talk by J. Baxter

LST-1 AGN zoo paper

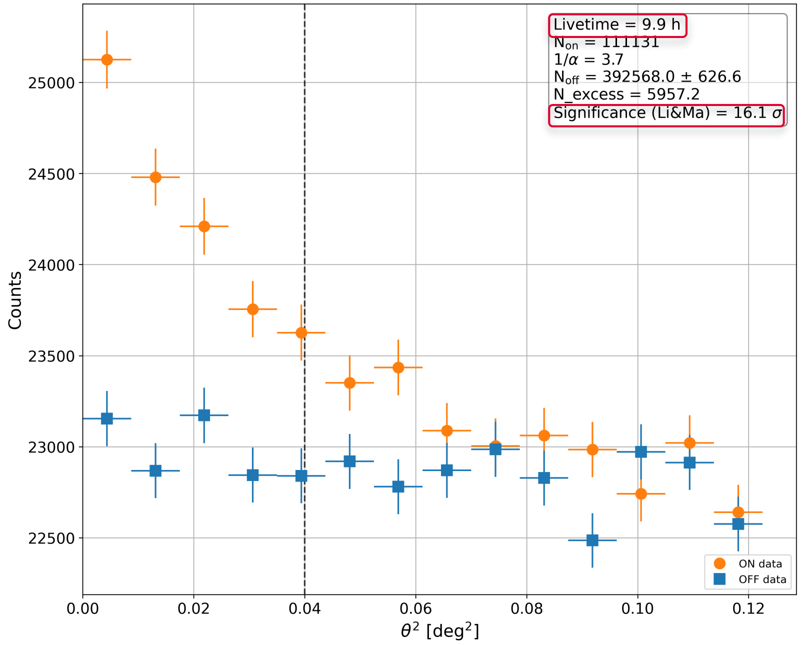
- Mrk 421 (z=0.03)
- Mrk 501 (z=0.03)
- 1ES 1959+650 (z=0.05)
- **1ES 0647+250 (z=0.45)**
- **PG 1553+113 (z=0.43)**
- M87 (z=0.004; not detected)

- PG 1553+113 and 1ES 0647+250
  - BL Lac class
  - The two most distant AGN observed by LST-1
  - Observations: 2020/12/16 - 2020/12/21 (1ES 0647+250)
    2021/04/08 - 2022/05/23 (PG 1553+113)
  - Global cuts (*gammaness* cut = 0.7, theta_cut = 0.2)
  - Spectral fitting: PL, LP, ECPL with EBL absorption

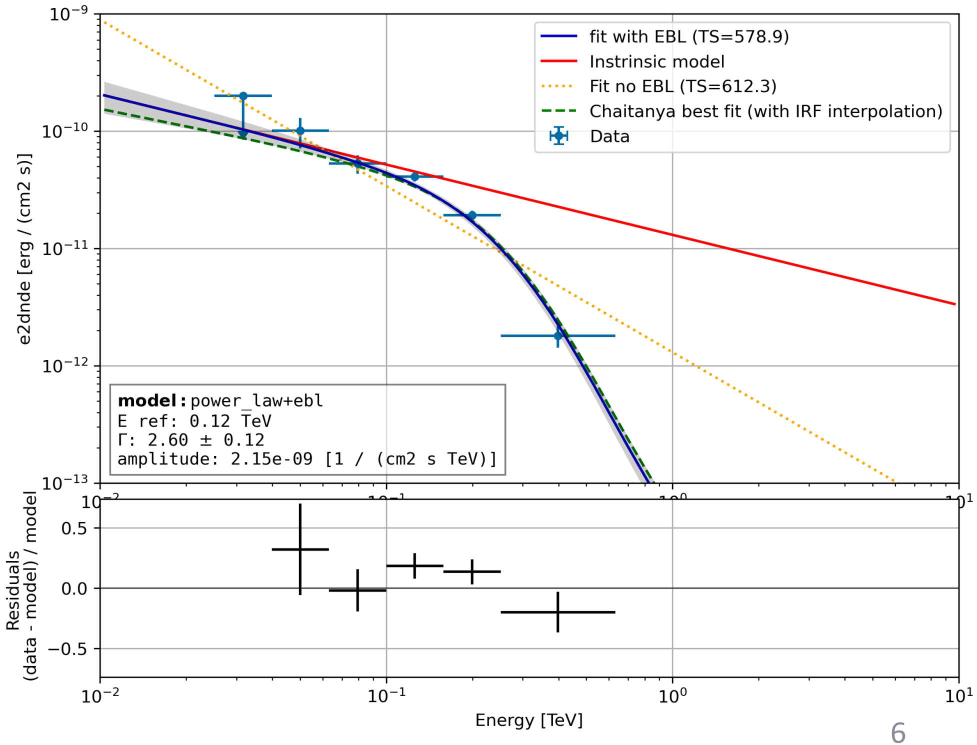
LST-1: PG 1553+113

Preliminary results

θ^2 plot



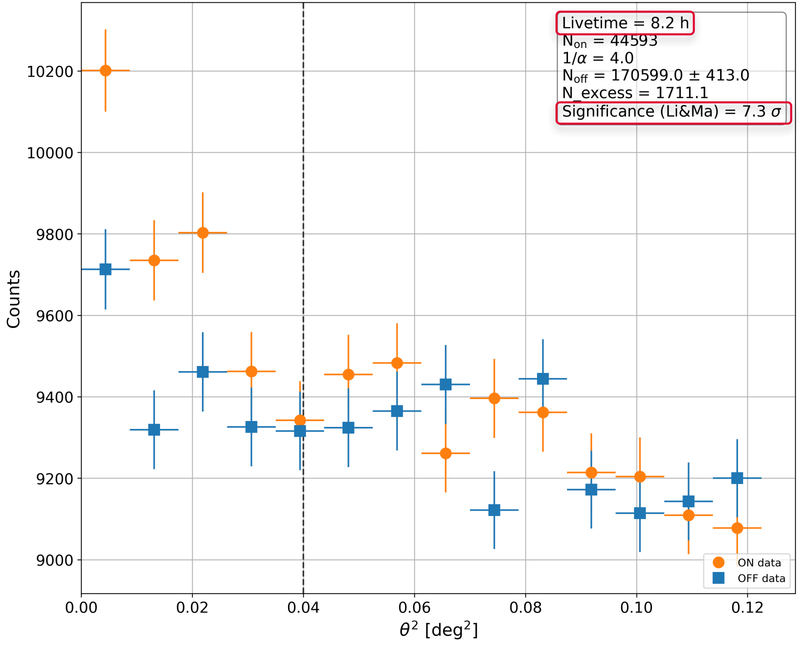
SED: Best Fit: PL + EBL



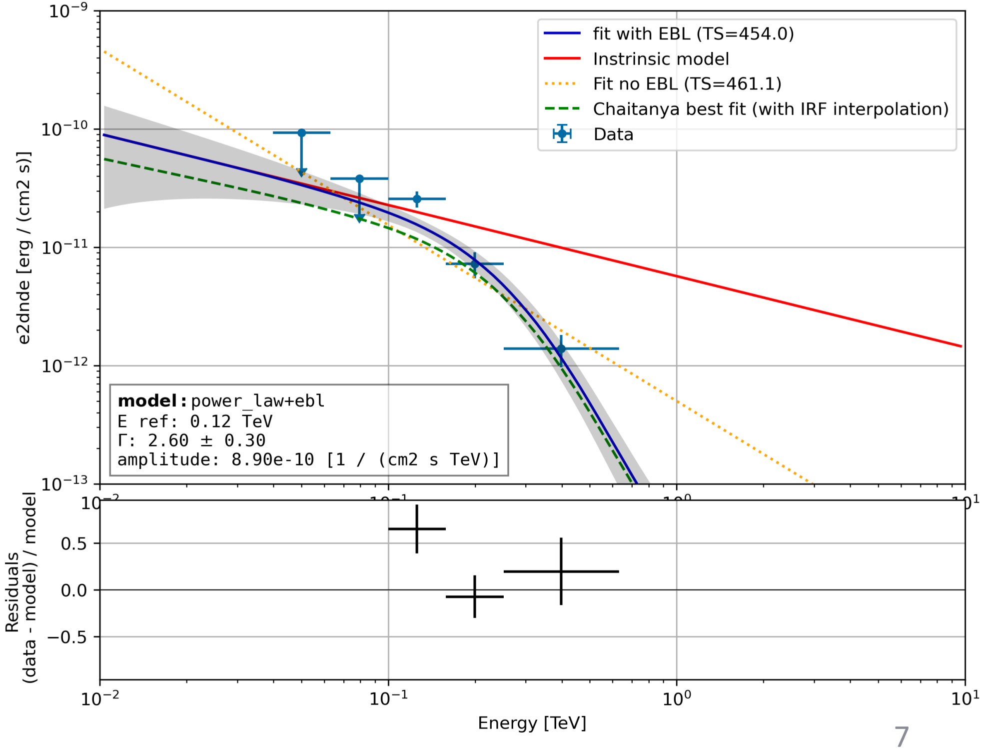
LST-1: 1ES 0647+250

Preliminary results

θ^2 plot



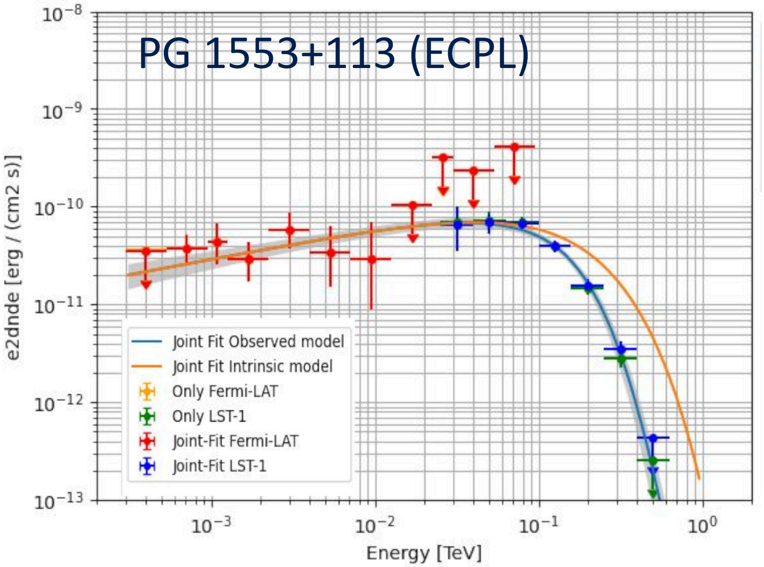
SED: Best Fit: PL + EBL

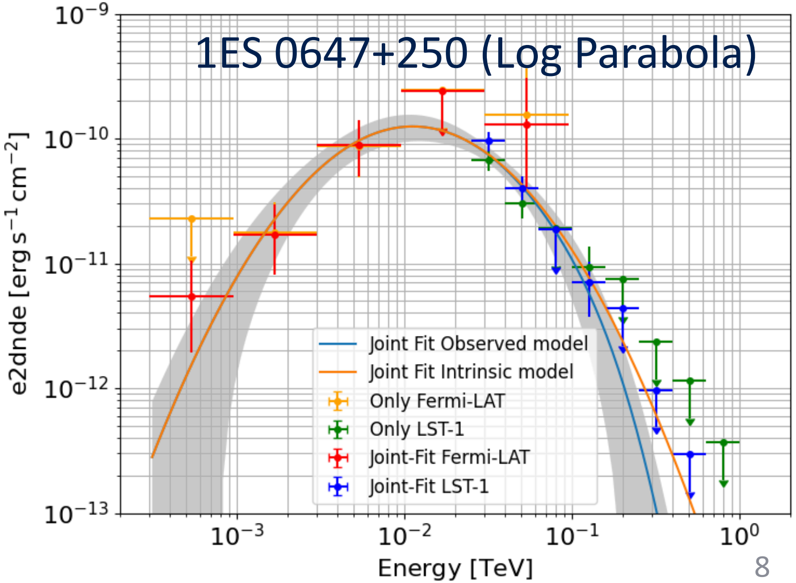


Joint-Fit Fermi + LST-1

Preliminary results

- Test LST-1 low energy performance → Fermi+LST: `asgardpy`[1]
  - best-fit spectral model for the HE-VHE range is not a simple Power Law
  - better and more physical understanding of the SED → multi-wavelength modelling



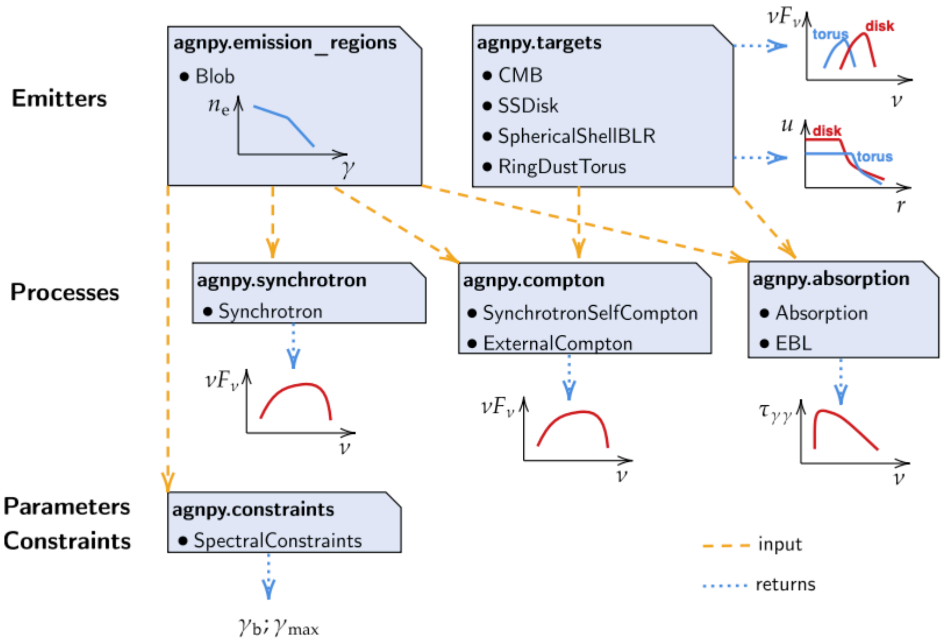


[1] https://asgardpy.readthedocs.io/en/latest/

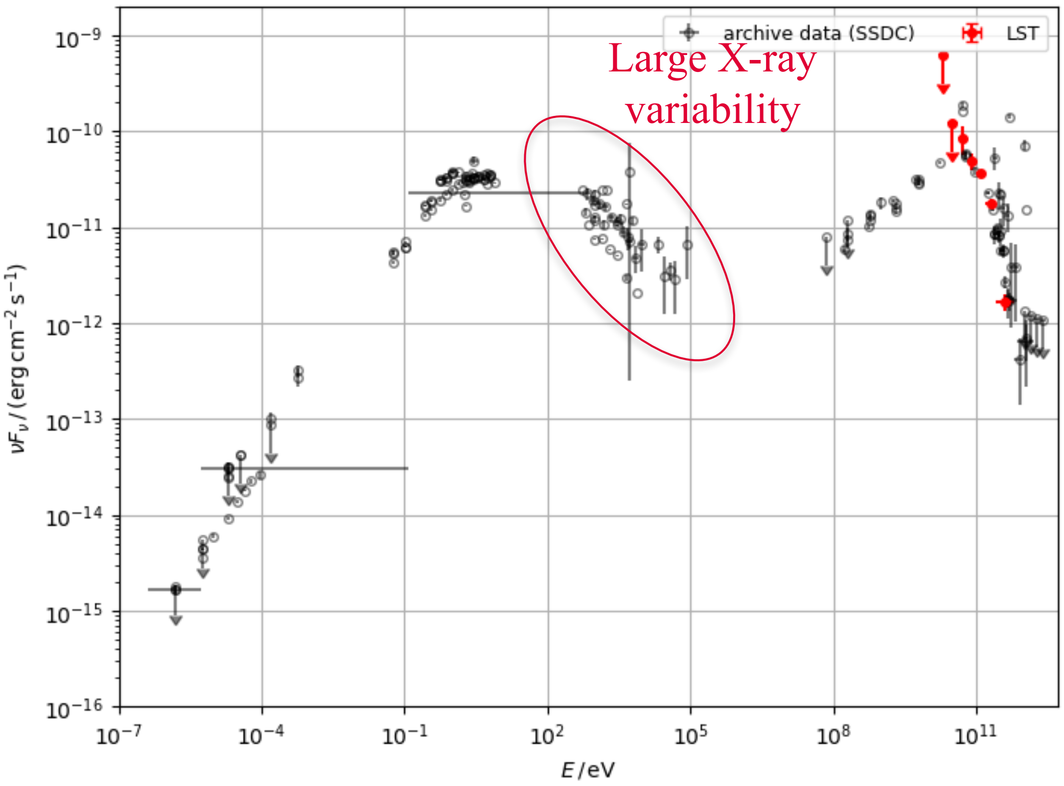
agnpy: modelling the radiative process of jetted AGN

https://agnpy.readthedocs.io/en/latest/index.html

- open-source python package (Nigro+2022)
- SED from radio to γ-rays
- Leptonic model
  - Emission: e$^-$ distribution (`blob`) & thermal emission (FSRQ)
  - Radiative process (synchrotron + Compton)
  - Absorption

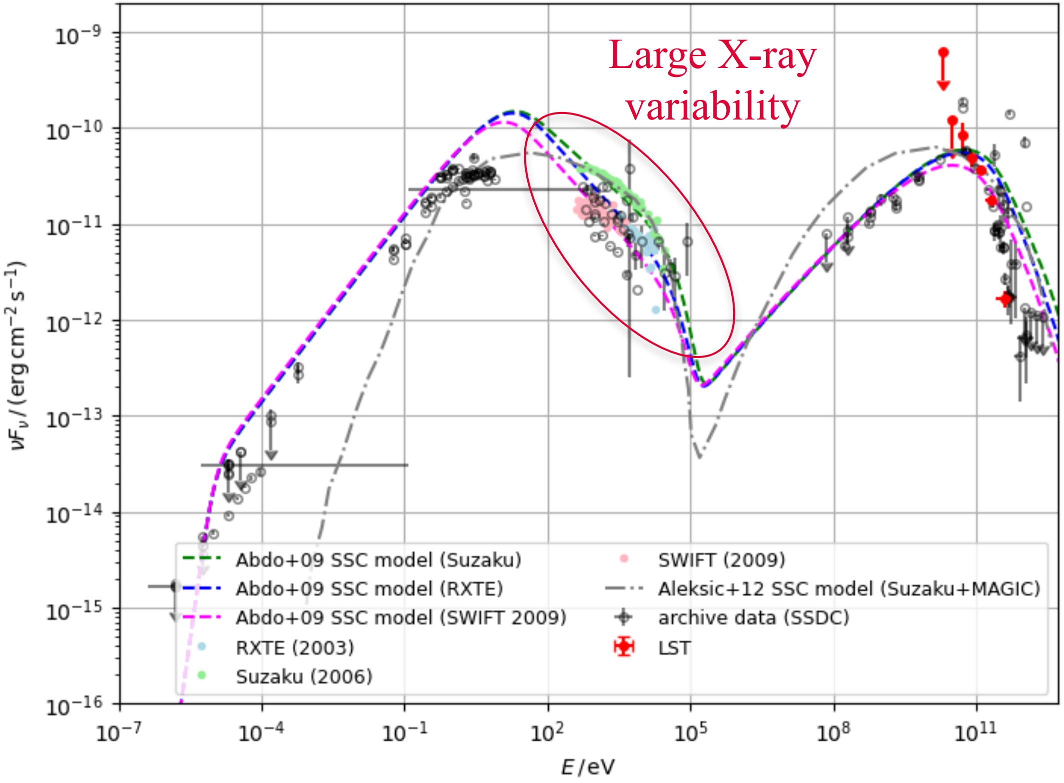


PG 1553+113: MWL SED



- LST consistent with previous VHE observations
- Archive data
  - Large scatter in X-rays catalogue data

PG 1553+113: MWL SED

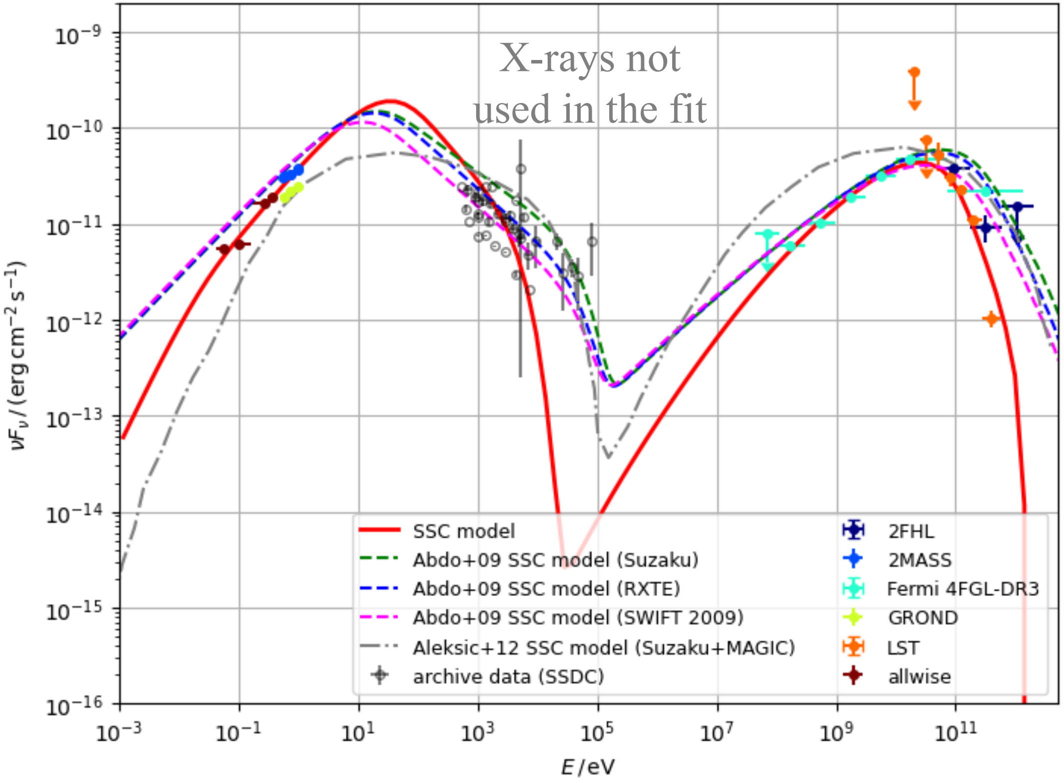


- Abdo+2010 Fermi paper
  - SSC models for different epochs of X-ray data
- Aleksic+2012
  - SSC model (Suzaku + MAGIC data)

⚠️ need careful selection of data and simultaneous opt. /UV / X-rays observations

PG 1553+113: `agnpy fit`

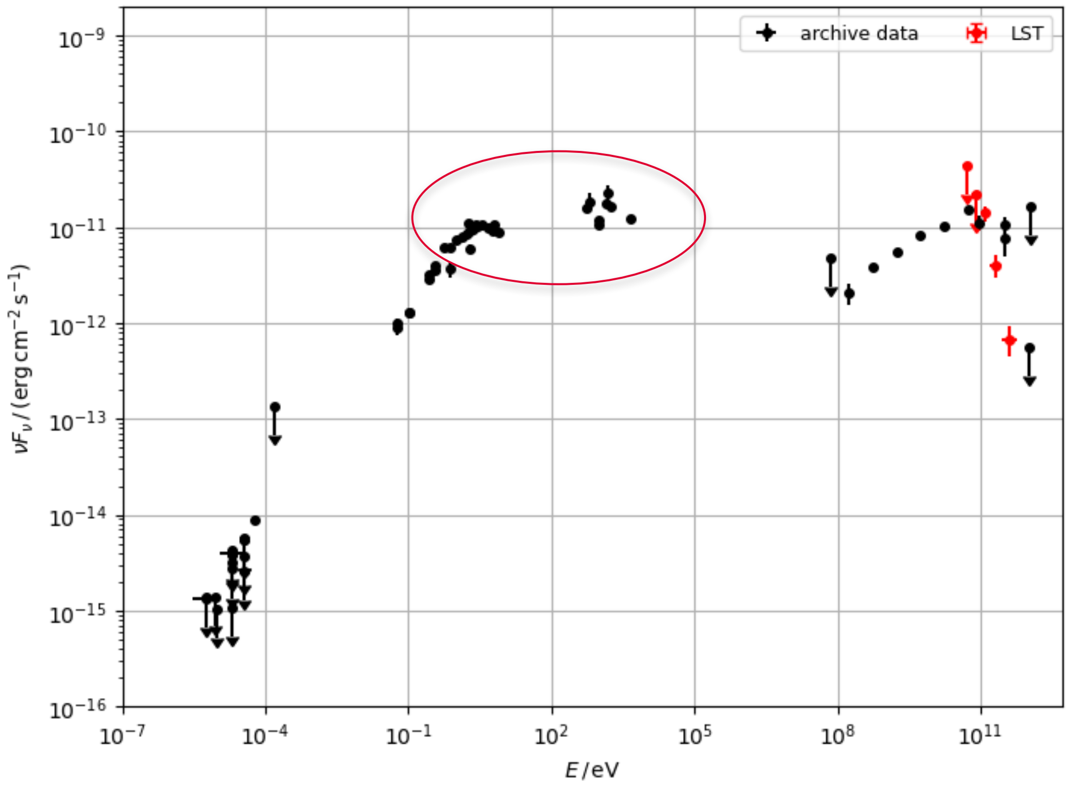
Preliminary results



- `agnpy` 1st fit
  - Catalogue data: IR + Fermi & LST
  - Compatible with X-rays catalogue data

Next: look for UV/X-rays (Swift) and Fermi simultaneous observation

1ES 0647+250: MWL SED



- MWL Catalogue data (SSDC) + LST
- Challenging fit for archive data with single zone SSC
  - ”flat” synchrotron peak compared to Compton peak
- Acciari+2023
  - Also variable in X-rays/γ-rays

need also UV/X-rays (Swift) and Fermi simultaneous observation

Conclusion

- LST SED consistent with Fermi
  - but combined fit parameters do not constrain emission model
- MWL SED fitting: `agnpy`
  - From fit → physical parameters of the emission
  - Fit vary depending on which data are included → challenging fit
- AGN variability:
  - SED can vary a lot (especially in the X-rays)
  - Next step: look for UV/X-rays (Swift) and gamma-rays (Fermi) data simultaneous with LST observations

Back Up

agnpy
parameters