Gamma-Ray astrophysics with current and future detectors
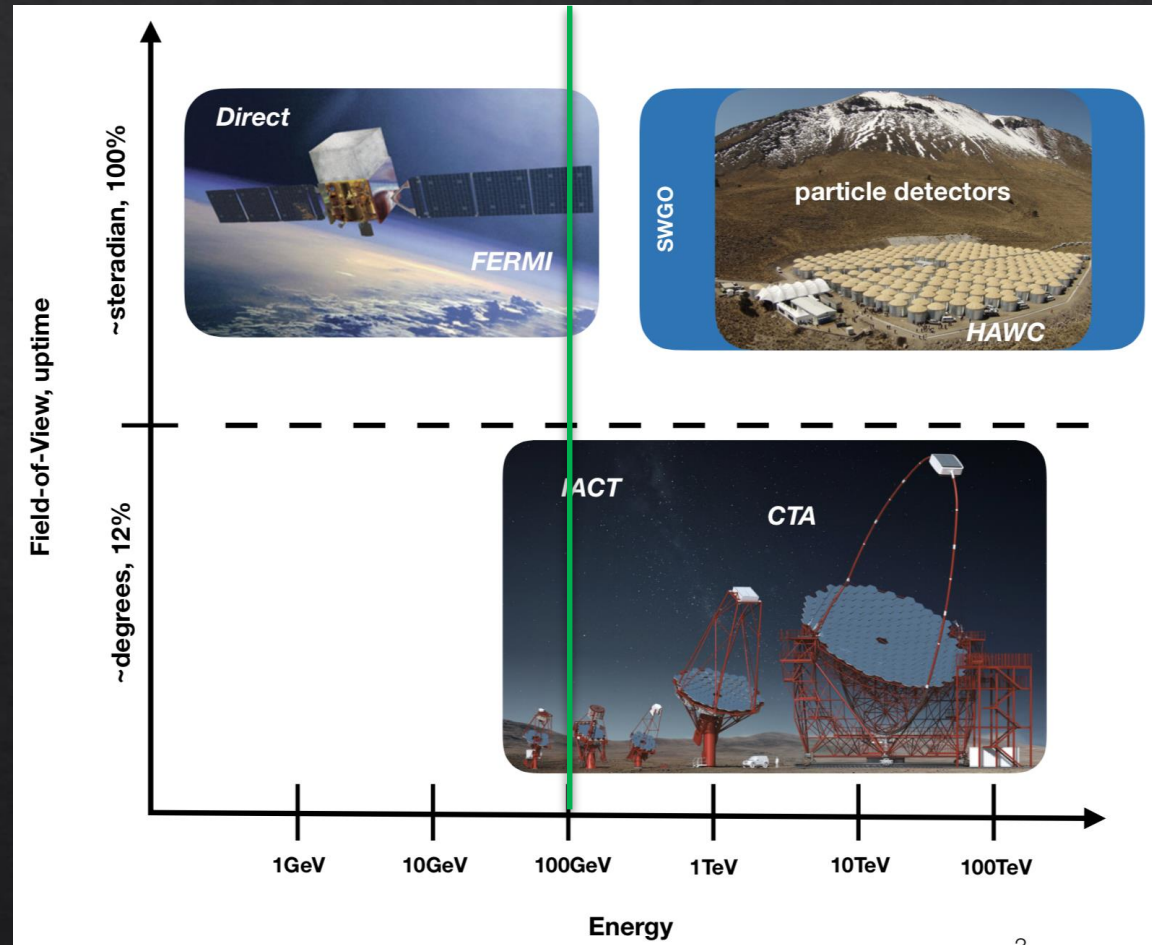
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Motivation

- **Southern Wide field-of-view Gamma-ray Observatory (SWGO)**
  - Planned to be built to monitor the Southern sky
  - Look for transient phenomena and extended sources
  - *What should be the energy range of the observatory?*

Img 1- Detectors comparison

Fermi Gamma-Ray Space Telescope

- It studies high-energy emitting bodies, mostly AGN.
- It is shortsighted for low-energy emissions.
- Has a far better resolution than ground-based Gamma telescopes.
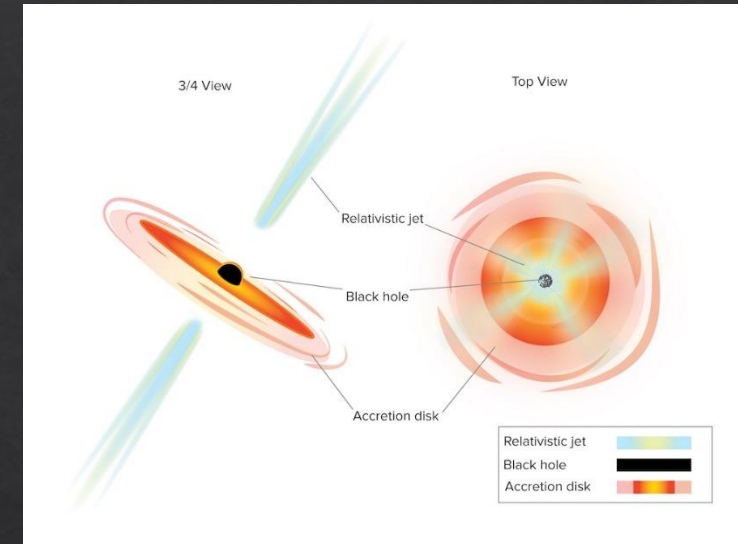- It was launched in 2008.
- It maps the entire sky every 3 hours.
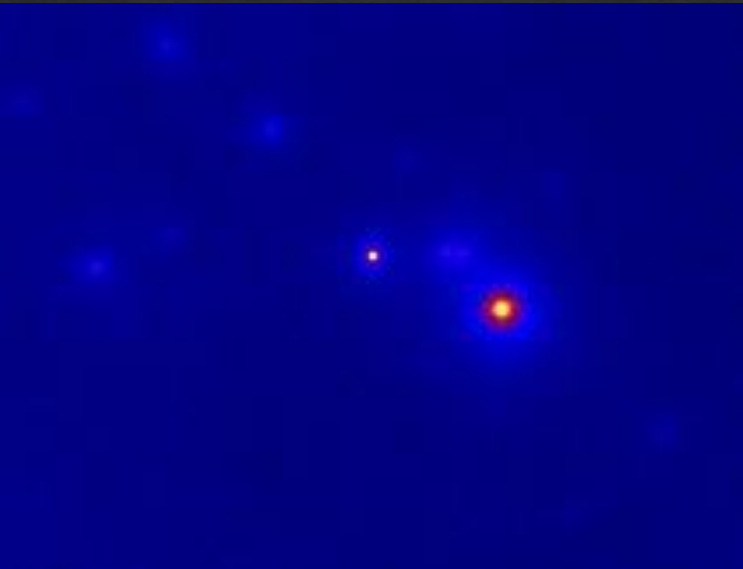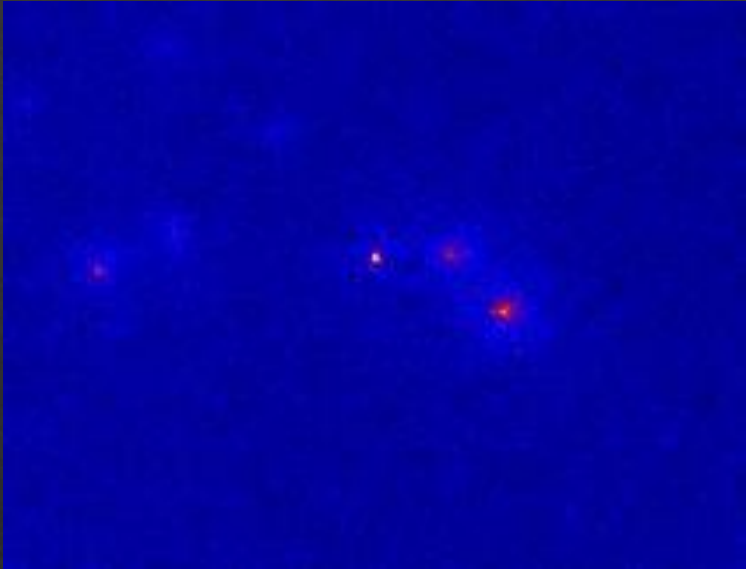

Img 2- Artist rendition of Fermi

MRK-501

- RA: 16h 53m 52.21s
- De: 39º 45' 47.6''
- It is situated in the northern hemisphere.
- It is an elliptical galaxy.
- The AGN is a blazar, responsible for the high energy emissions.

Img 4- Optical image of MRK-501

4

Img 5- One year of data.

Data treatment

o Download 10 years of data
o Fit all the years together to improve the useful data.
o Build a model based on such data.
o Compare the model and the actual data to see its precision and accuracy.
o Extract a light curve and study the interesting parts of it.

Img 6- Ten years of data.
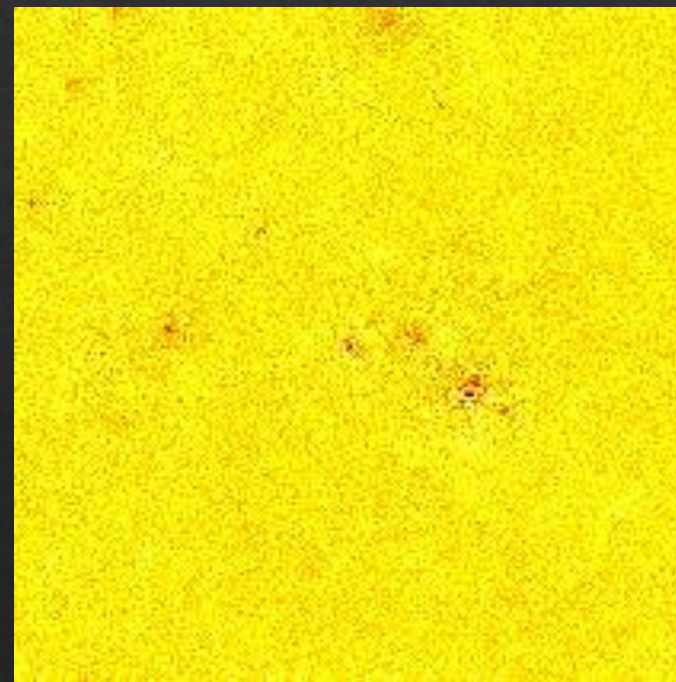
Model and Data comparison

- The model is created differently than normal methods.

- It is a likelihood model, compared with the data.

- If new sources appear in the comparison, the model needs to be redone.
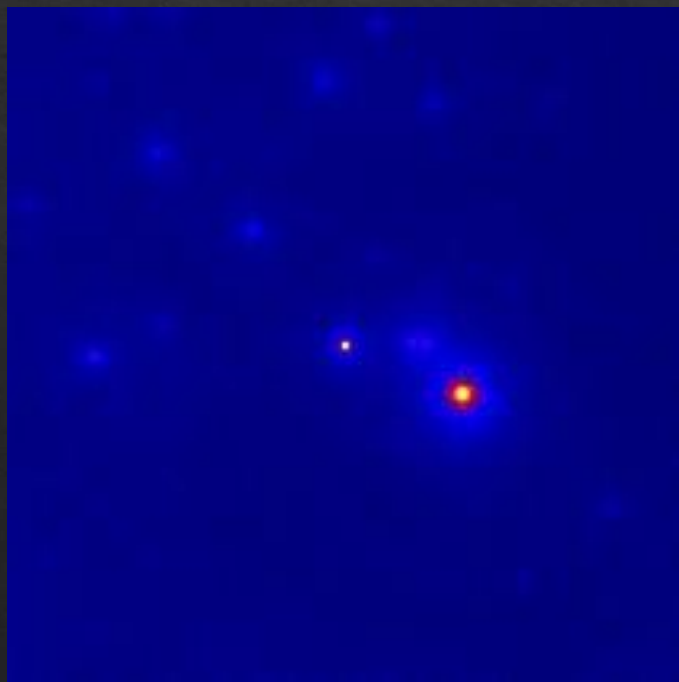
Img 7- 10 years of data.
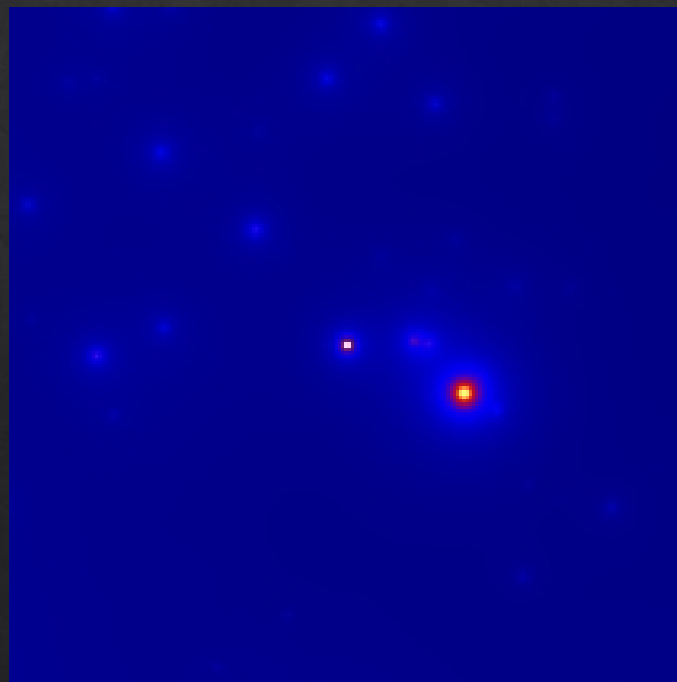
Img 8- Model of MRK-501 (Gamma region)

Img 9- Comparison between the model and the actual data.

Critical Error

- Scripts used were created in a Linux based operations system, the Fedora.

- Issues arose because the bash interpreter has a slightly different behavior for specific Linux distributions.

Example:

WRONG LINE: requiredDiffrsp=`python
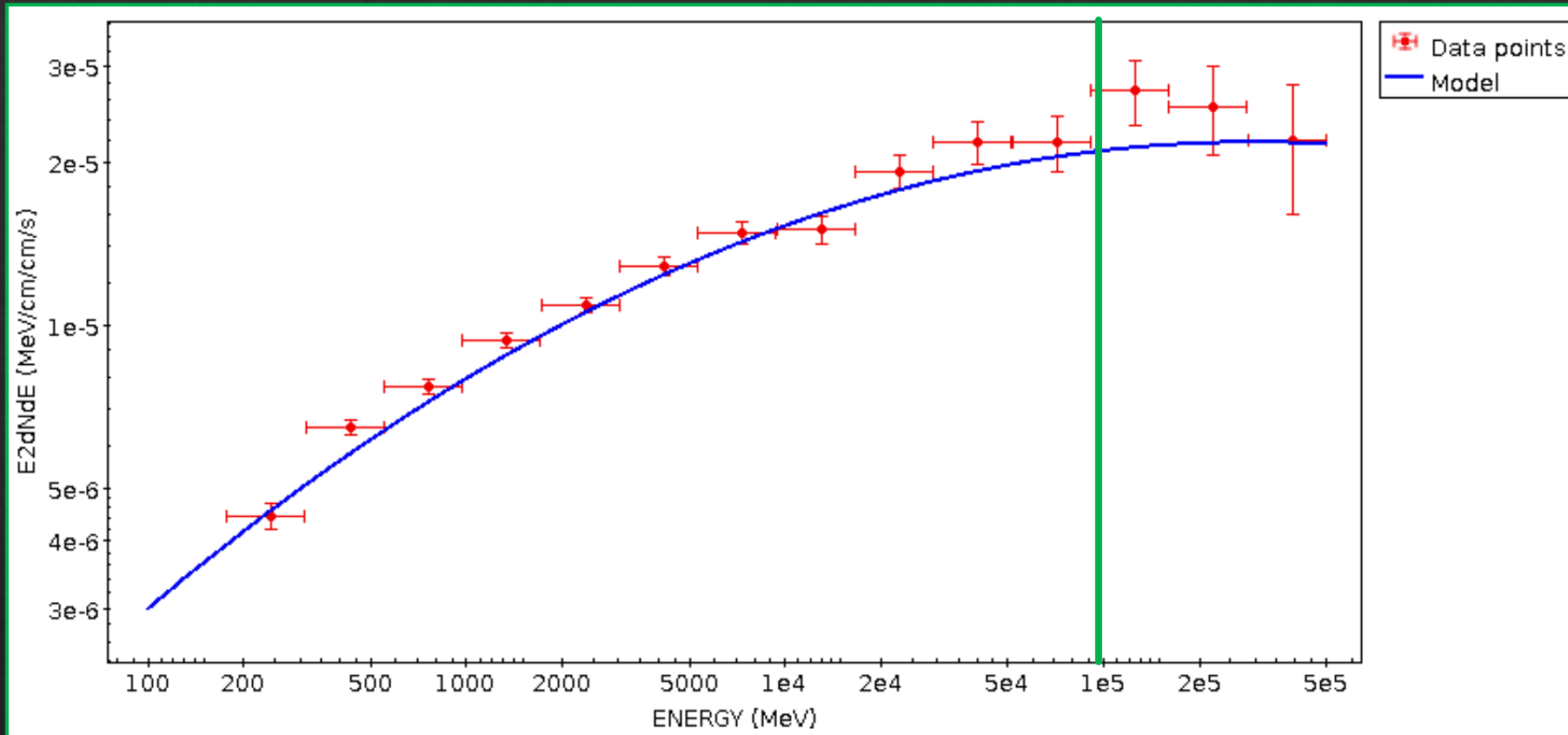 $LAT_SCRIPT_DIR/check_diffrsp.py

    $filteredName

CORRECT LINE: requiredDiffrsp=$(python
           $LAT_SCRIPT_DIR/check_diffrsp.py

    $filteredName)

Img 10- Incorrect subtraction of the model.

☐ 0 Photons/pixel/sec

☐ 5-10 Photons/pixel/sec

☐ 10-20 Photons/pixel/sec
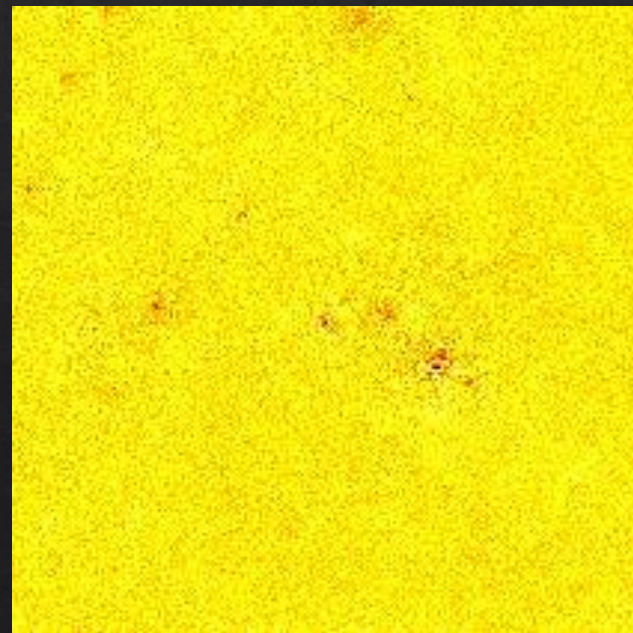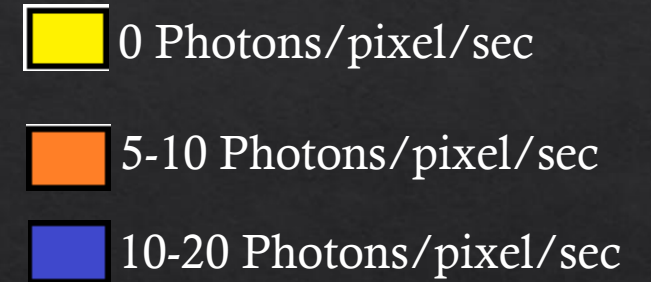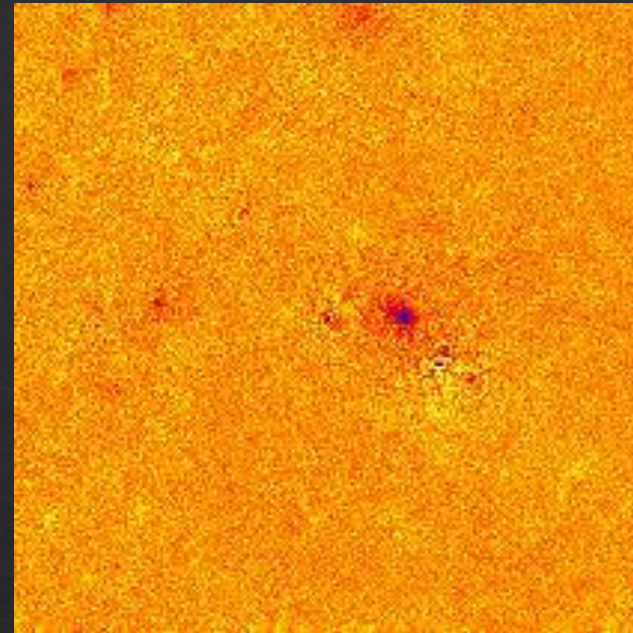
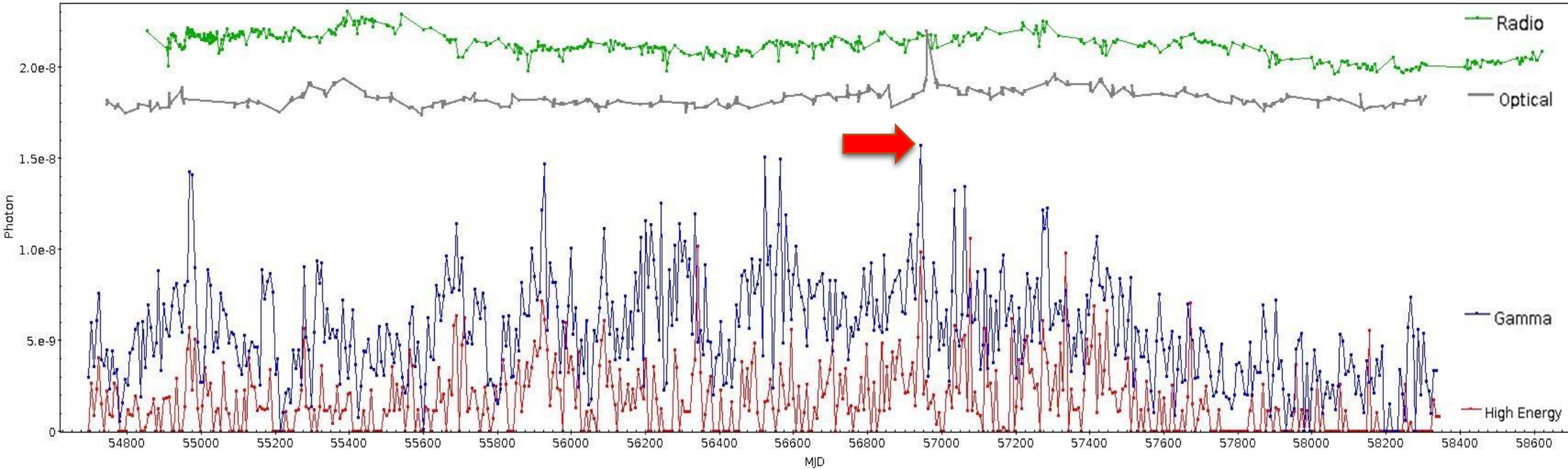Img 11- Correct subtraction of the model.

Fitting the data

Img 12- Plot of energy flux vs Energy.
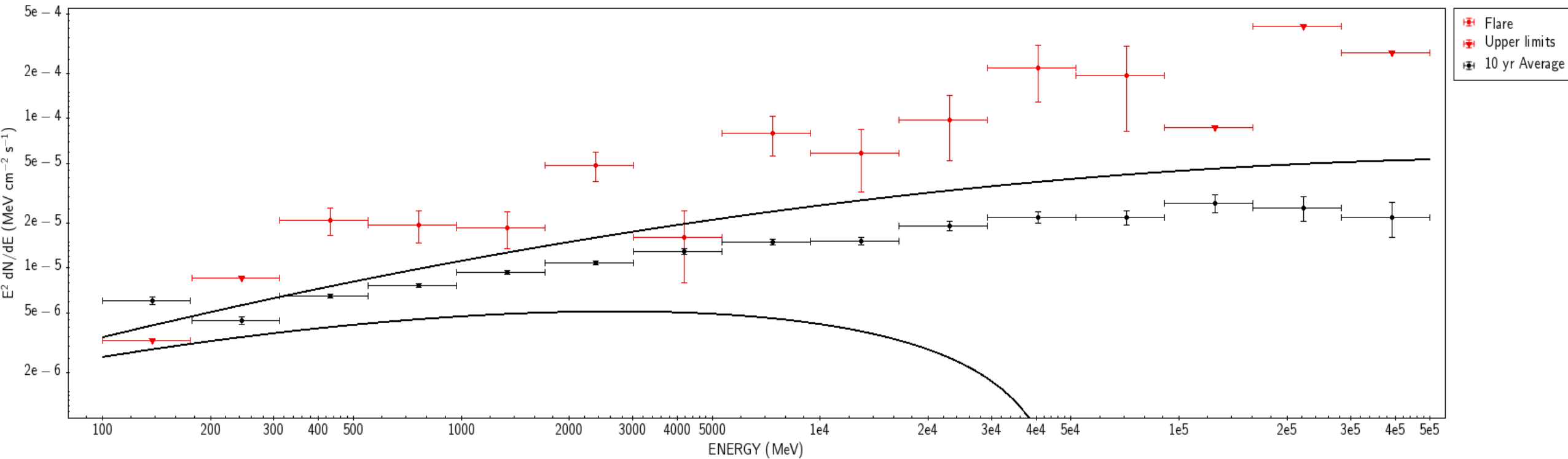
Light Curve

Img 13- Light Curve Summary.

o Works with **every week for ten years**.
o High energy particles and Gamma emission are close, as expected.
o Marked week has interesting data.

Flare

Fermi

HAWC

SWGO

Img 14- Plot of the flare with the 10 years average.

☐ Brightest flare of this source confirms that we expect an excess of high energy photons.

☐ Unfortunately, FERMI is not sensitive enough to constrain this process on short time-scales.