3D joint-likelihood analysis using Fermi-LAT and HESS
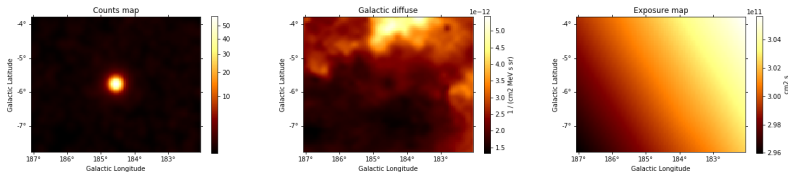
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July 15, 2019
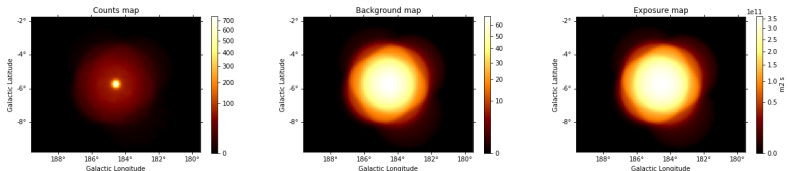
The case of the Crab nebula

The data

Fermi-LAT: joint-crab paper dataset, ▸ Fermi-LAT data with Gammapy

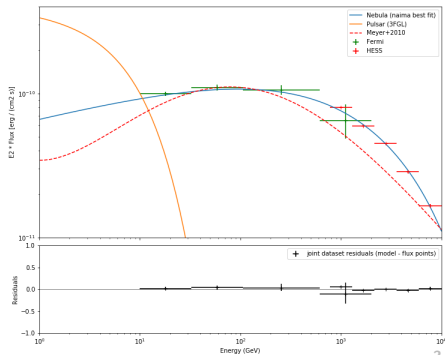**HESS:** 166 runs (stacked), ▸ 3D analysis

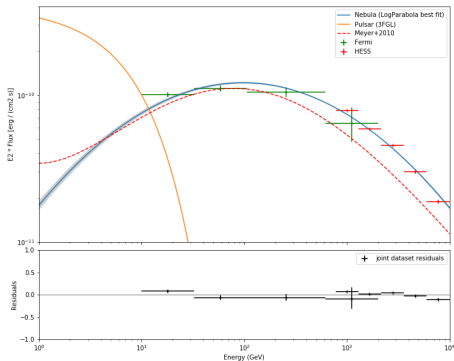**Source model:**

  i Pulsar (*freezed*)
  - ▸ Spatial model: SkyPointSource
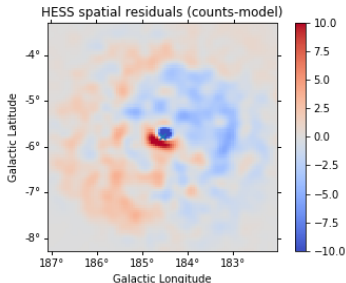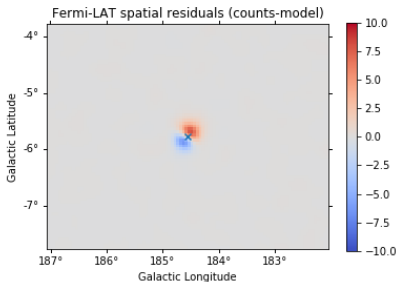 - ▸ Spectral model: from 3FGL

  ii Nebula (*fitted*)
  - ▸ Spatial model: SkyPointSource
  - ▸ Spectral model: LogParabola, or NaimaModel (IC on CMB+FIR)

Fit results: spectral residuals 👍

**Fit results:** Spatial residuals (for the NaimaModel case) 👎

This clearly needs to be improved! (Fitting the nebula position and/or describing it with a small SkyGaussian does not improve the result)

But, things are missing for sure in the HESS data reduction:

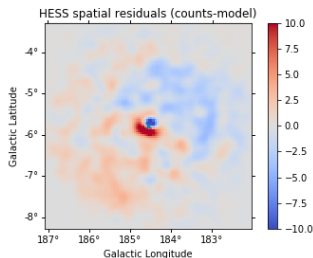- Safe energy threshold (for each run)
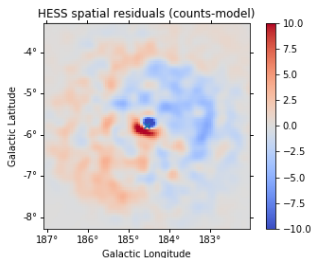- FOV background normalization

- Safe energy thresholds: 10% A_{eff} at Crab position
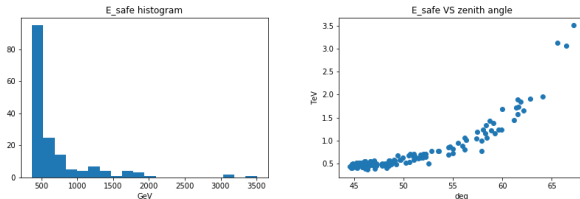
- For each run:
  - **i** Run MapMakerObs
  - **ii** Apply safe energy threshold (multiply the maps by an energy mask)
  - **iii** Normalize the IRF background (mask known γ-ray sources and rescale the background to the observed off counts)
  - **iv** Fill the stacked maps
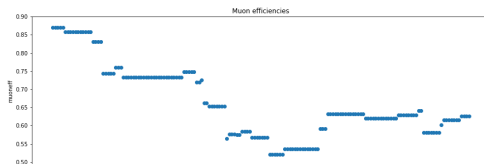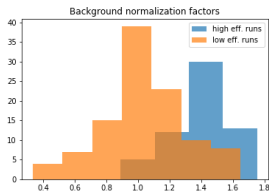
Comparison: Spatial residuals, without (left) or with (right) safe energy thresholds and FOV backround normalization:

Not a striking improvement :(

Issues / missing features ⚠

- Runwise background normalization
- Safe energy threshold handling
- Proper IRF stacking (as opposed to averaging at the source's position)
- Uncertainty estimation in the case of the Naima models
- Parameter linking to models
- Residuals plot methods (both spatial and spectral)