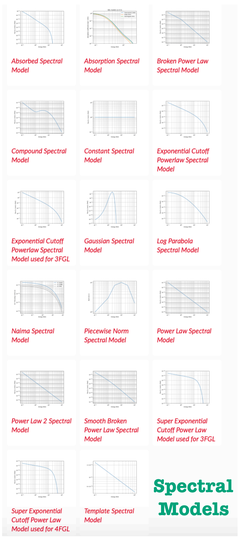
Gammapy - An open source python package for gamma ray astronomy

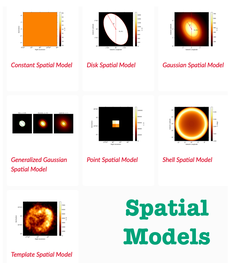
A. Sinha[1], A. Donath[2], R. Terrier[3], B. Khelifi[3], L. Giunti[3], Q. Remy[2], J. E. Ruiz[4] for the Gammapy team.

[1] LUPM, Université de Montpellier, CNRS, [2]Max-Planck-Institut für Kernphysik, Heidelberg, [3]APC, Université Paris Diderot, CNRS, [4]Instituto de Astrofísica de Andalucía - CSIC

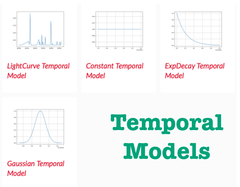
gammapy.modeling

- SkyModels provide support for simultaneous modelling of **temporal, spatial** and **spectral** profiles
- Standard models provided within gammapy
- Easy to implement custom models
- Allows energy dependent morphological models
- Allows fitting of temporal models
- Allows different fitting backends like **iminuit, sherpa, scipy**
- Simultaneous fitting of multiple models
- Convenient i/o file covariance handling
- Compute and plot likelihood profiles and contours



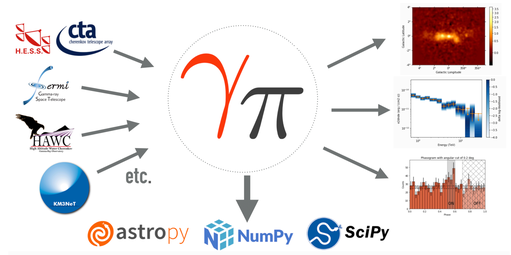


Models shipped with gammapy



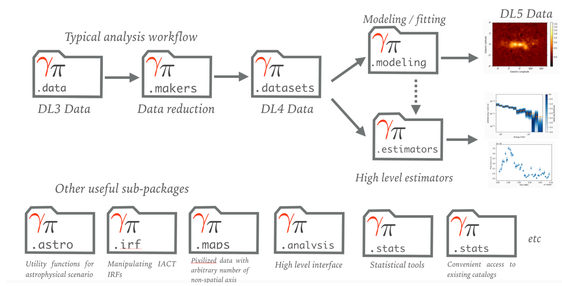
Salient features

- Python package based on numpy, scipy and astropy, with other optional dependencies
- Framework for gamma ray data reduction starting from DL3 FITS data
- Supports a variety of background estimation techniques
  - Traditional methods: **ring and reflected regions**
  - Field of view 3D (spatial & energy) background models
- Produces high level products - flux maps, light curves, etc
- Proposed science tools for the CTA
  - Used in the first CTA Data Challenge
- Used within HESS for high level analysis
  - Reproduced known results on the first HESS Data release



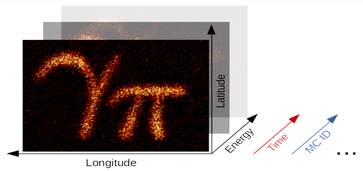
API and Package structure

- Sub-package structure based on API and data level
- Dedicated sub-packages for specialised tasks
- High level API for most common use cases
  - Automatize processes using YAML configuration file
- Mid-level API for detailed analysis
- Allows Event Sampling to simulate a list of events
- Currently supports binned analysis



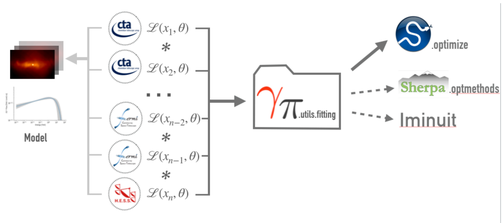
gammapy.maps

- WCS and HEALPix image based data structures
- Arbitrary number of non spatial axes (eg: energy, time, etc)
- Uniform API for WCS and HEALPix based maps
- Containers for sky maps, energy dependent IRFs, etc
- N-dim interpolation, re-projection, smoothing, convolution, FITS i/o, interactive plotting

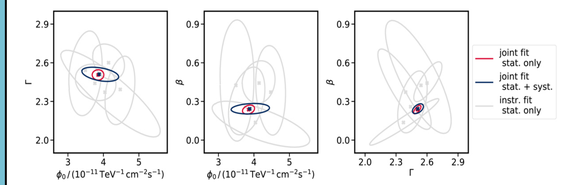


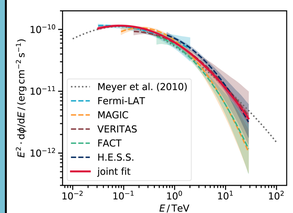
Multi-instrument fitting

- Joint likelihood fitting across datasets
  - Simple platform for combined multi-instrument analysis
  - Incorporate systematic errors into the likelihood
  - Better constrains on parameters ranges
  - Across different energy and time bins



- Simultaneous fitting of Crab spectrum using VERITAS, MAGIC, H.E.S.S., FACT and Fermi-LAT data





Crab nebula SED for individual instrument fits and from the joint fit (left) and Likelihood contours corresponding to 68% probability content for the fitted spectral parameters (top)
(from Nigro et al, A&A, 625 (2019) A10)

Validation and benchmarking

Validation of standard science results and performance benchmarks are executed nightly using Github actions: https://github.com/gammapy/gammapy-benchmarks

For further information, please see: https://docs.gammapy.org/ . Join us at gammapy.slack.com or follow the development at https://github.com/gammapy/gammapy

Installation and setup

1. $ curl -O https://gammapy.org/download/install/gammapy-0.18-environment.yml
2. $ conda env create -f gammapy-0.18-environment.yml
3. $ conda activate gammapy-0.18