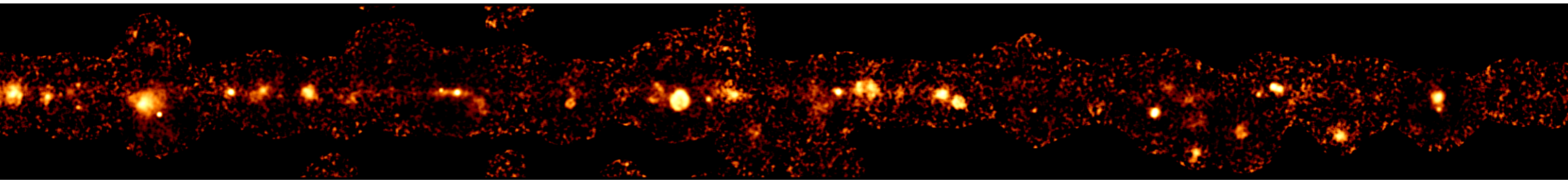




Gammapy overview

Fabio(s), Atreyee, for the Gammapy Team

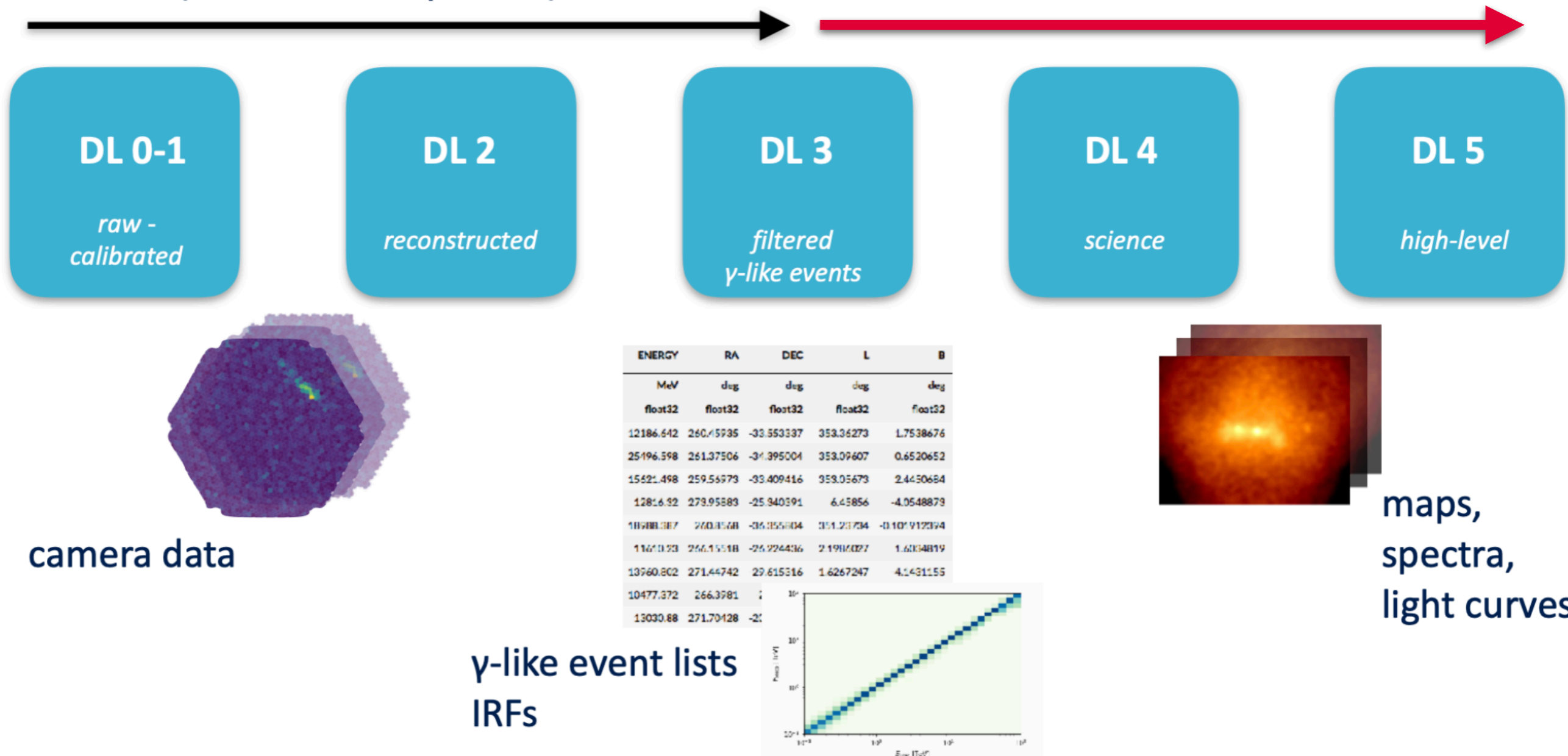
Based on presentations by **A. Donath, B. Khelifi, A. Sinha, R. Terrier et al.**



Separating instrument specific data treatment from common use cases and methods

Reconstruction pipeline
(instrument specific)

Science Tools (general users)





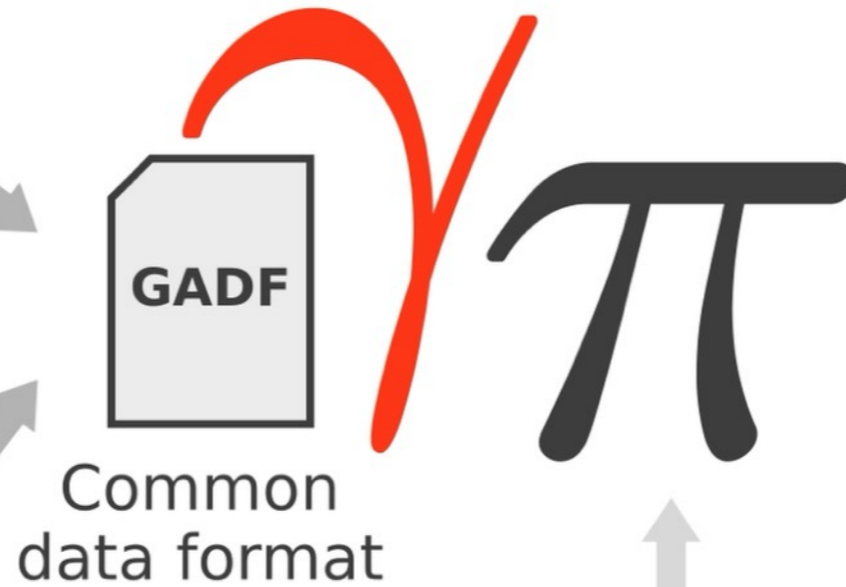
Main concept of Gammapy



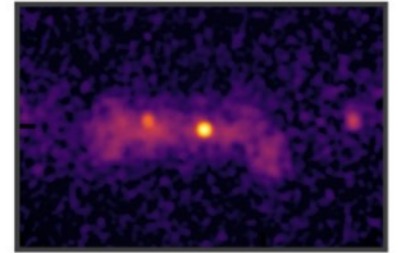
Pointing γ -ray Observatories



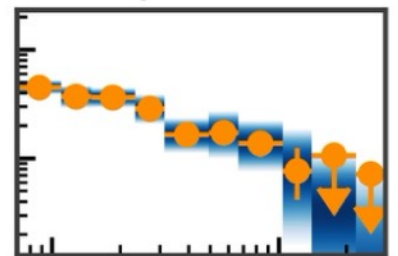
All-sky γ -ray Observatories



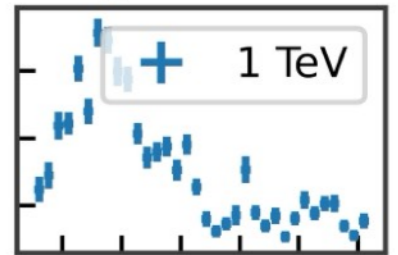
Sky maps



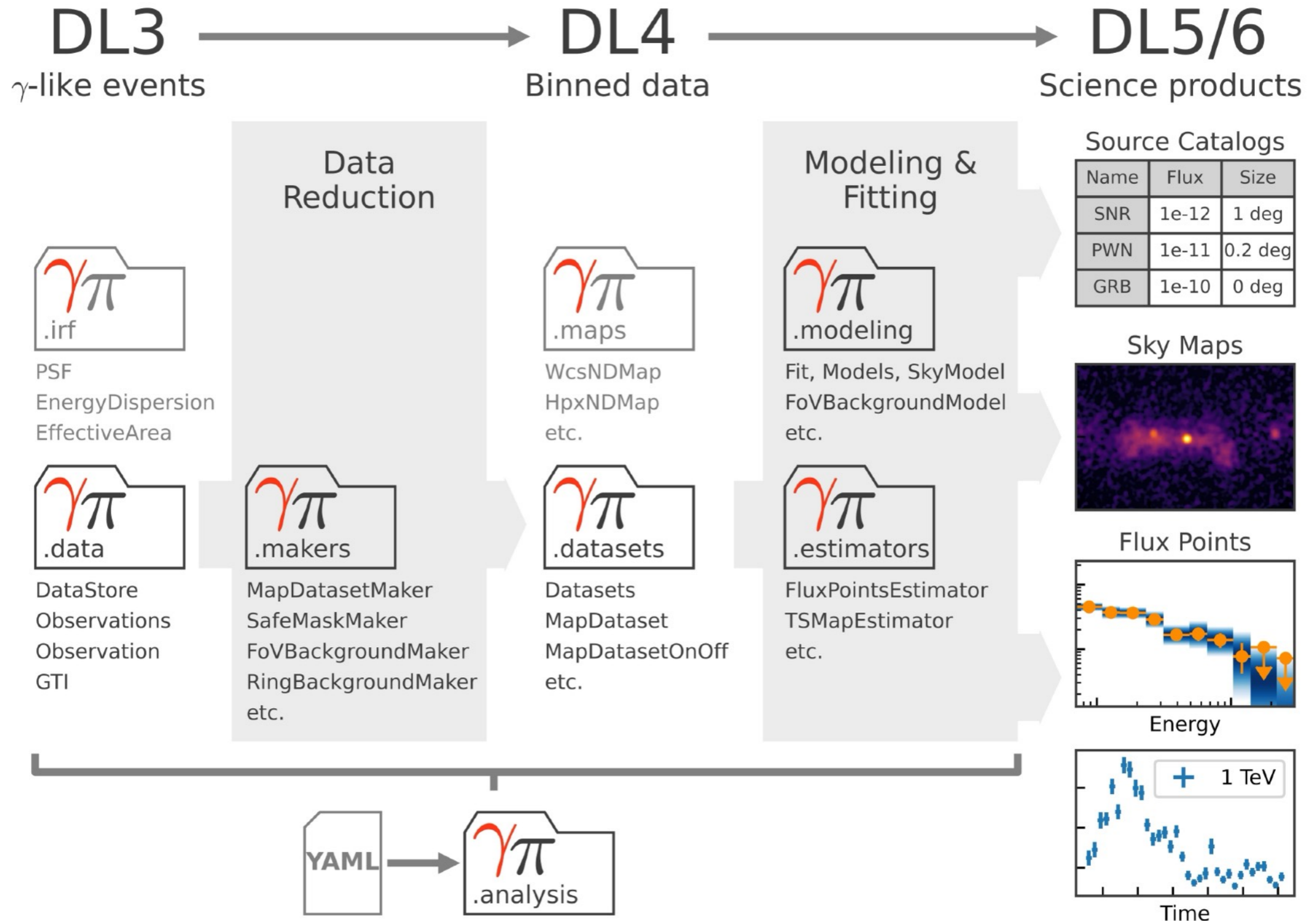
Spectra

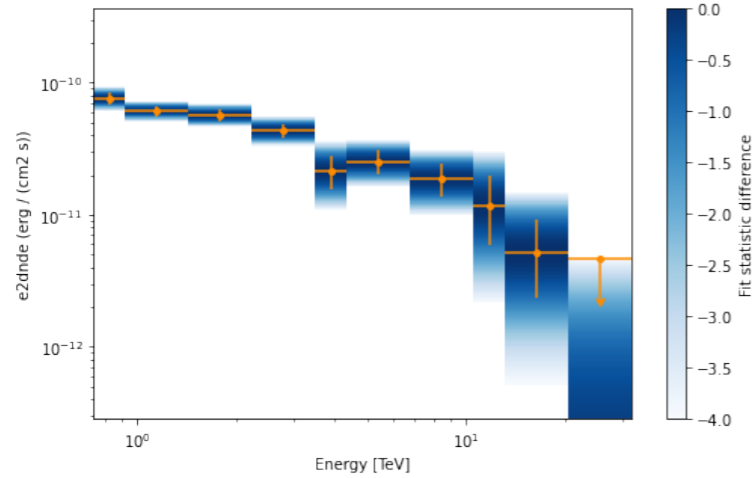


Lightcurves

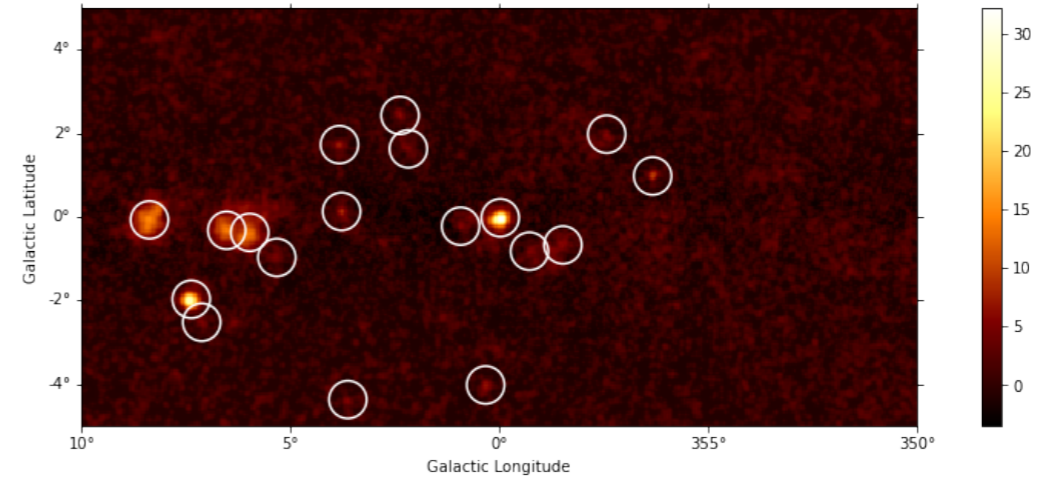


V1.2 released on Feb. 2024

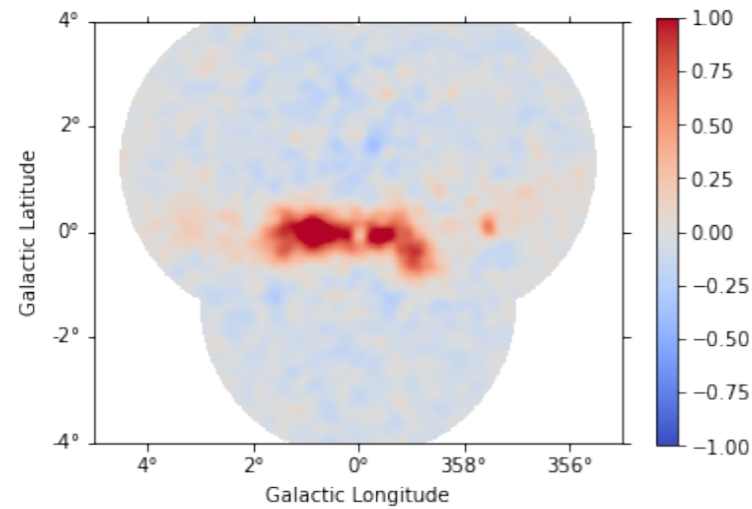




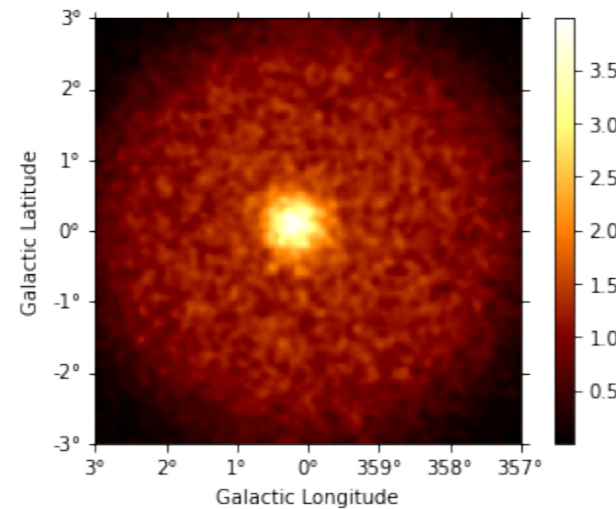
1D spectral analysis



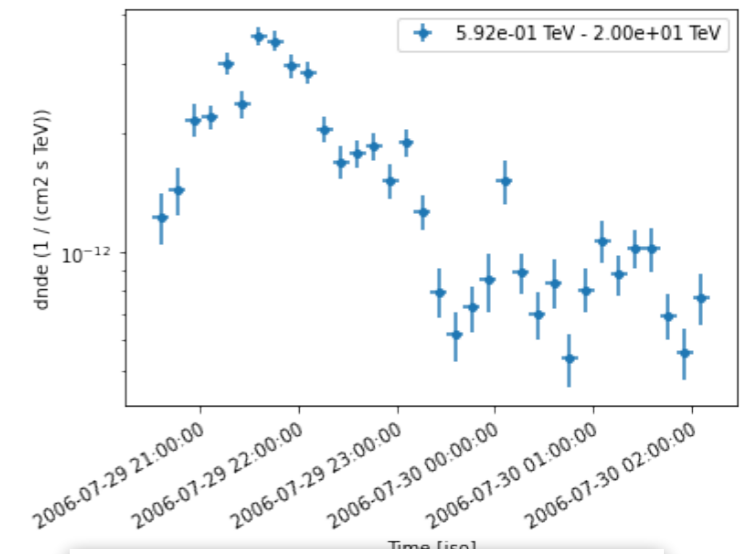
Source detection



3D analysis



Observation simulation



Light-curve extraction

All analysis types follow the same workflow and the same API



The basic analysis steps



DL3 to DL4

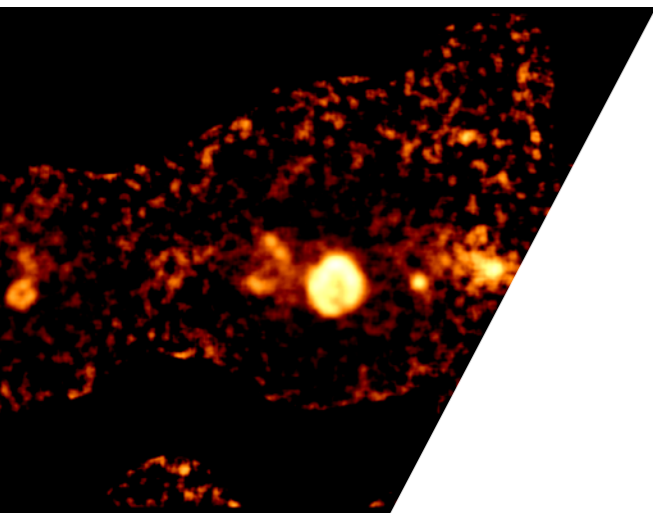
1. Select and retrieve observations
 - Datastore \rightarrow list of Observation
2. Define the reduced dataset geometry
 - Is the analysis 1D or 3D?
 - Define target binning and projection
3. Initialize the data reduction methods ([makers](#))
 - Data and IRF projection
 - Safe Mask determination
 - Background estimation
4. Loop over selected observations
 - Apply makers to produce [reduced datasets](#)
 - Combine them for [stacked](#) or [joint analysis](#)

DL3 to DL4

1. Select and retrieve observations
 - Datastore → list of Observation
2. Define the reduced dataset geometry
 - Is the analysis 1D or 3D?
 - Define target binning and projection
3. Initialize the data reduction methods ([makers](#))
 - Data and IRF projection
 - Safe Mask determination
 - Background estimation
4. Loop over selected observations
 - Apply makers to produce [reduced datasets](#)
 - Combine them for [stacked](#) or [joint analysis](#)

DL4 to DL5

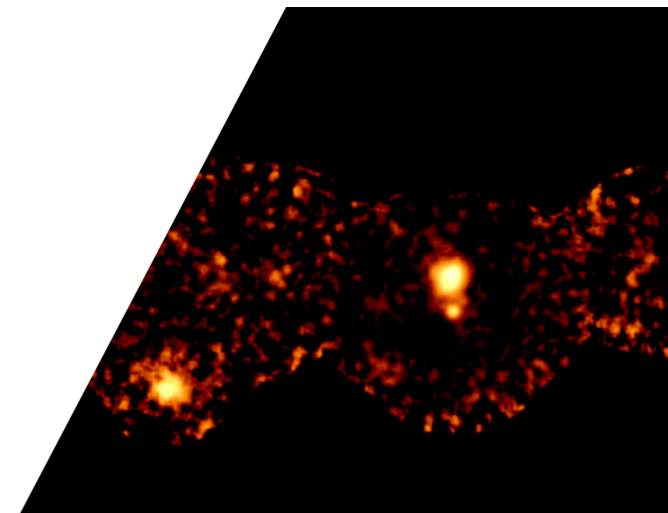
1. Modeling
 - Define your model(s)
 - Associate them/it to the correct datasets
2. Do the fit
 - Choose your minimization parameters
 - Make the control plots, compute significance
3. Run the DL5 estimators ([estimators](#))
 - Initialization of the geometry
 - Creation of the estimator(s)
 - Run it/them on dataset(s)



Event list

Binned data

From DL3 to DL4



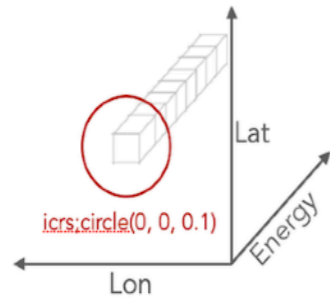
1D Counts

DL3
γ-like events

| EVENT_ID | TIME | RA | DEC | ENERGY |
|---------------|--------------------|----------|-----------|------------|
| | s | deg | deg | TeV |
| int64 | float64 | float32 | float32 | float32 |
| 5407363825684 | 123890826.66805482 | 84.97964 | 23.89347 | 10.352011 |
| 5407363825695 | 123890826.69749284 | 84.54751 | 21.004095 | 4.0246882 |
| 5407363825831 | 123890827.23673964 | 85.39696 | 19.41868 | 2.2048872 |
| 5407363825970 | 123890827.79615426 | 81.93147 | 20.79867 | 0.69548655 |
| 5407363826067 | 123890828.26131463 | 85.98302 | 21.053099 | 0.86911184 |
| 5407363826095 | 123890828.41393518 | 86.97305 | 21.837437 | 4.1240892 |
| 5407363826128 | 123890828.52555823 | 83.40073 | 19.771587 | 1.6680022 |
| 5407363826168 | 123890828.6629524 | 82.25036 | 19.22003 | 4.7649446 |
| 5407363826363 | 123890829.53362775 | 83.16322 | 22.008213 | 0.7920148 |
| ... | ... | ... | ... | ... |

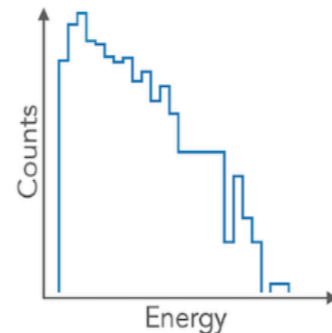
Observation and / or time selection

Data Reduction



Bin selection: Region & Energy

DL4
Binned data



Spectrum

SpectrumDatasetMaker

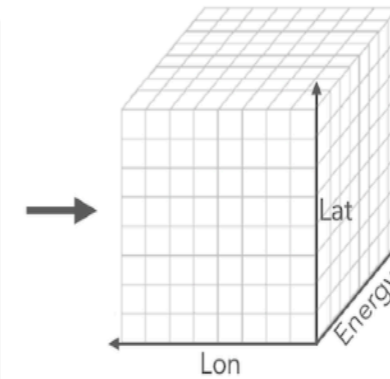
2D/3D Map

DL3
γ-like events

| EVENT_ID | TIME | RA | DEC | ENERGY |
|---------------|--------------------|----------|-----------|------------|
| | s | deg | deg | TeV |
| int64 | float64 | float32 | float32 | float32 |
| 5407363825684 | 123890826.66805482 | 84.97964 | 23.89347 | 10.352011 |
| 5407363825695 | 123890826.69749284 | 84.54751 | 21.004095 | 4.0246882 |
| 5407363825831 | 123890827.23673964 | 85.39696 | 19.41868 | 2.2048872 |
| 5407363825970 | 123890827.79615426 | 81.93147 | 20.79867 | 0.69548655 |
| 5407363826067 | 123890828.26131463 | 85.98302 | 21.053099 | 0.86911184 |
| 5407363826095 | 123890828.41393518 | 86.97305 | 21.837437 | 4.1240892 |
| 5407363826128 | 123890828.52555823 | 83.40073 | 19.771587 | 1.6680022 |
| 5407363826168 | 123890828.6629524 | 82.25036 | 19.22003 | 4.7649446 |
| 5407363826363 | 123890829.53362775 | 83.16322 | 22.008213 | 0.7920148 |
| ... | ... | ... | ... | ... |

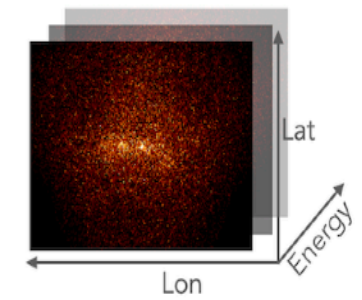
Observation and / or time selection

Data Reduction



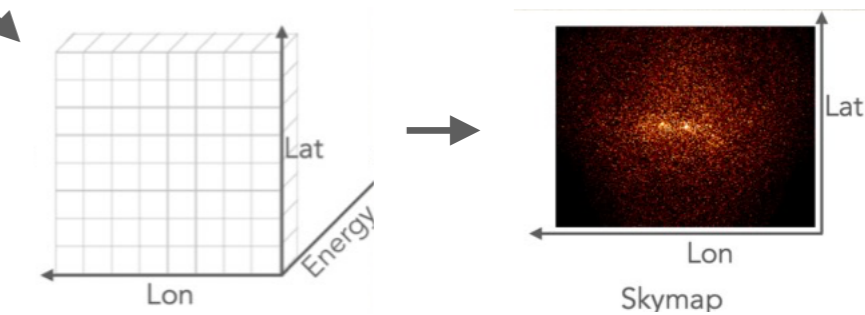
Bin selection: WCS & Energy

DL4
Binned data

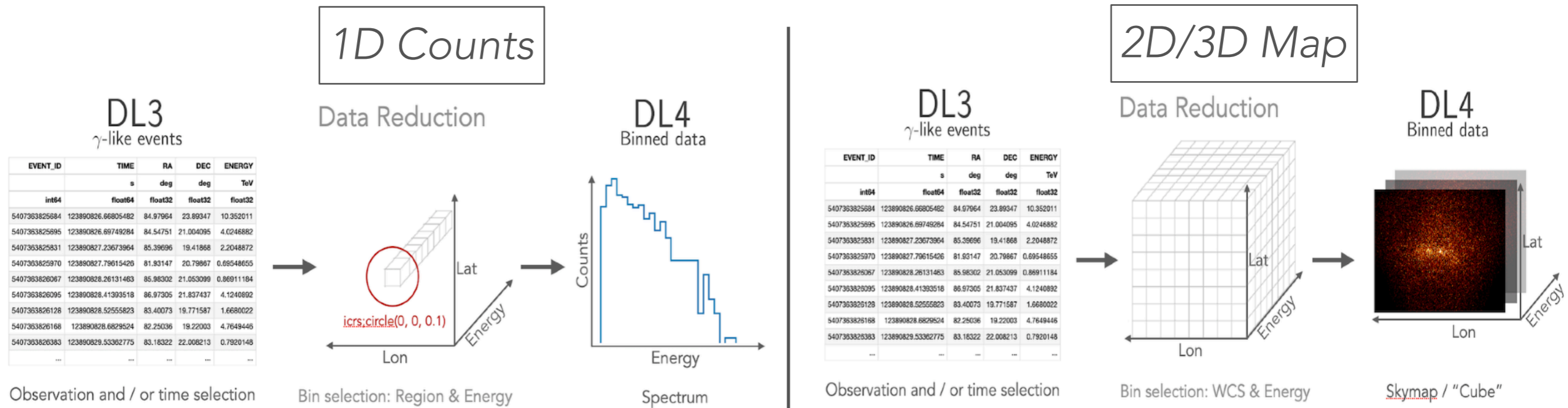


Skymap / "Cube"

MapDatasetMaker



3D with one bin



SpectrumDatasetMaker

MapDatasetMaker

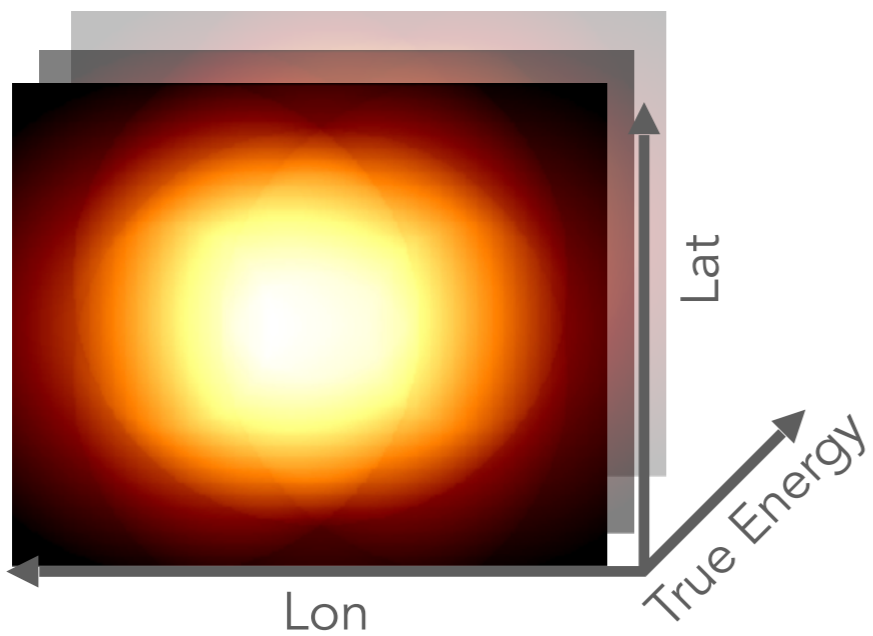
```

empty = MapDataset.create(
    geom,
    energy_axis_true=energy_true,
    name="my-dataset")
maker = MapDatasetMaker(selection=["exposure", "background", "psf", "edisp"])
dataset = maker.run(empty, observation)
    
```

3D with one bin

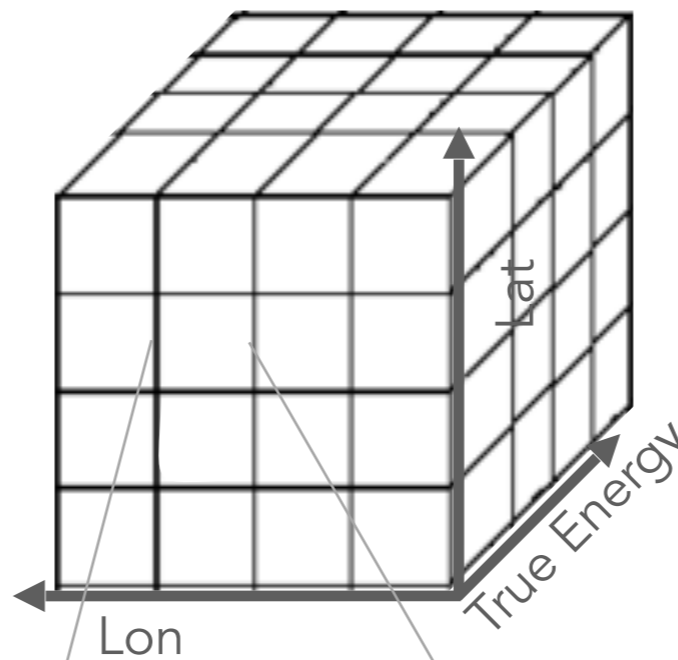
- DL3 IRFs are reprojected by the DatasetMaker on the target geometry

Exposure

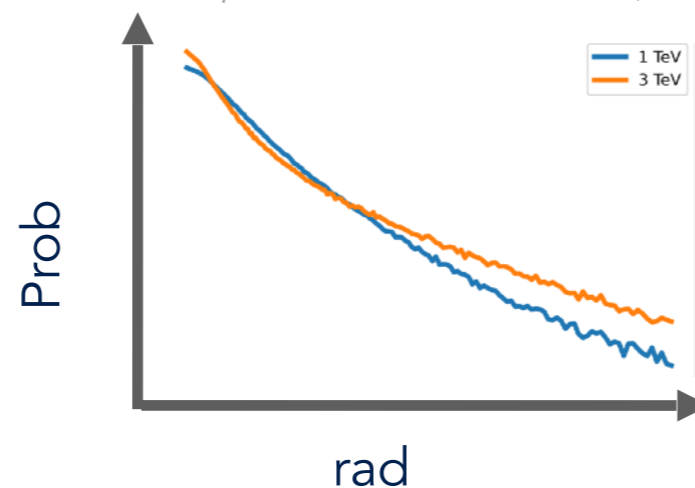


PSF

4th Dimension: rad

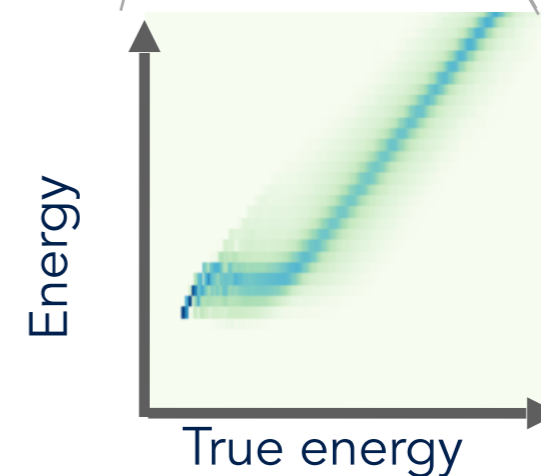
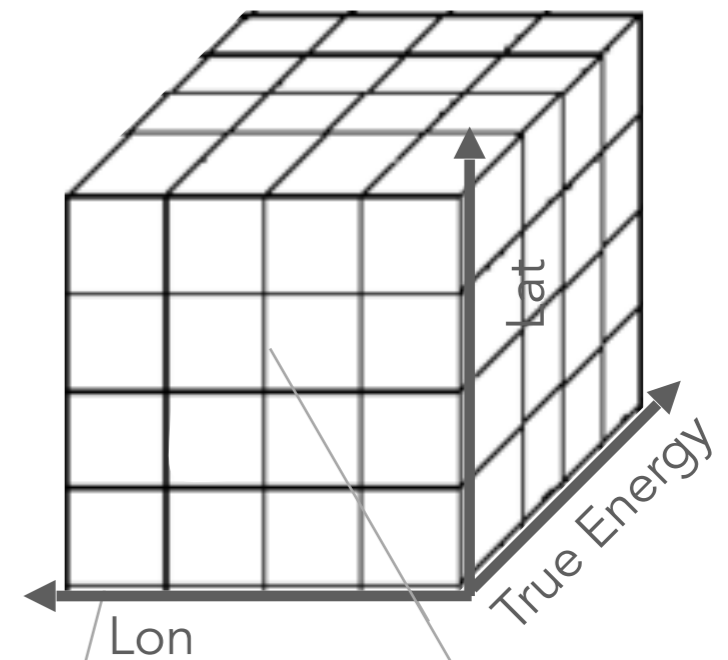


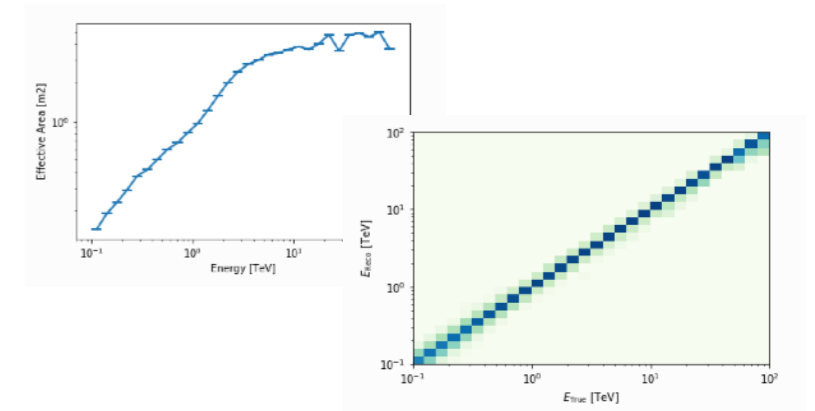
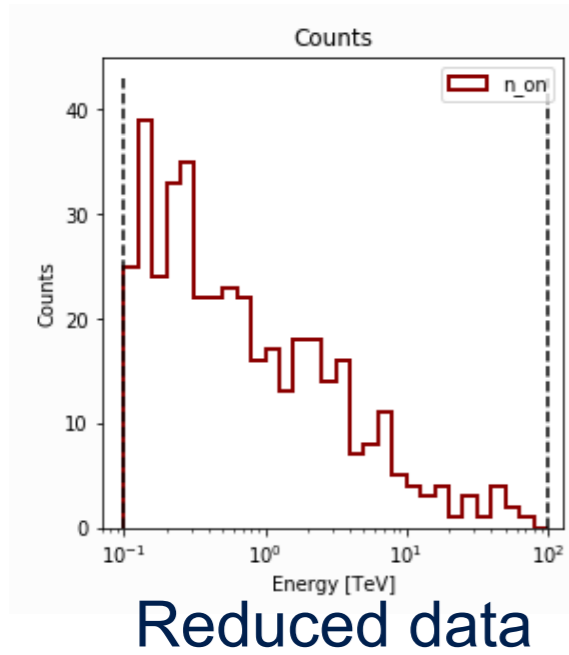
PSFMap /
EDispKernelMap



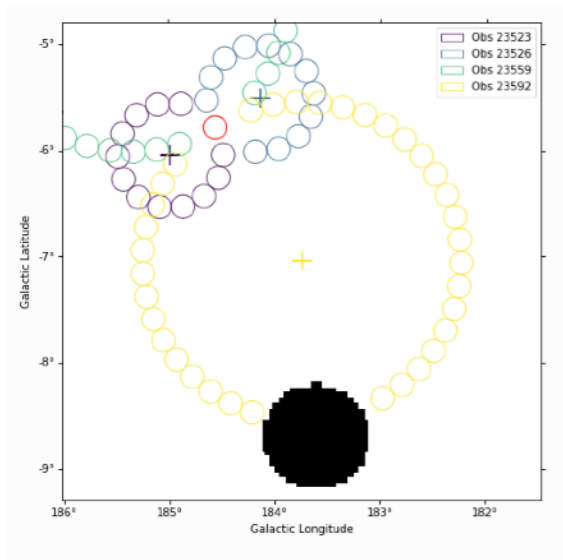
EDisp

4th Dimension: Energy

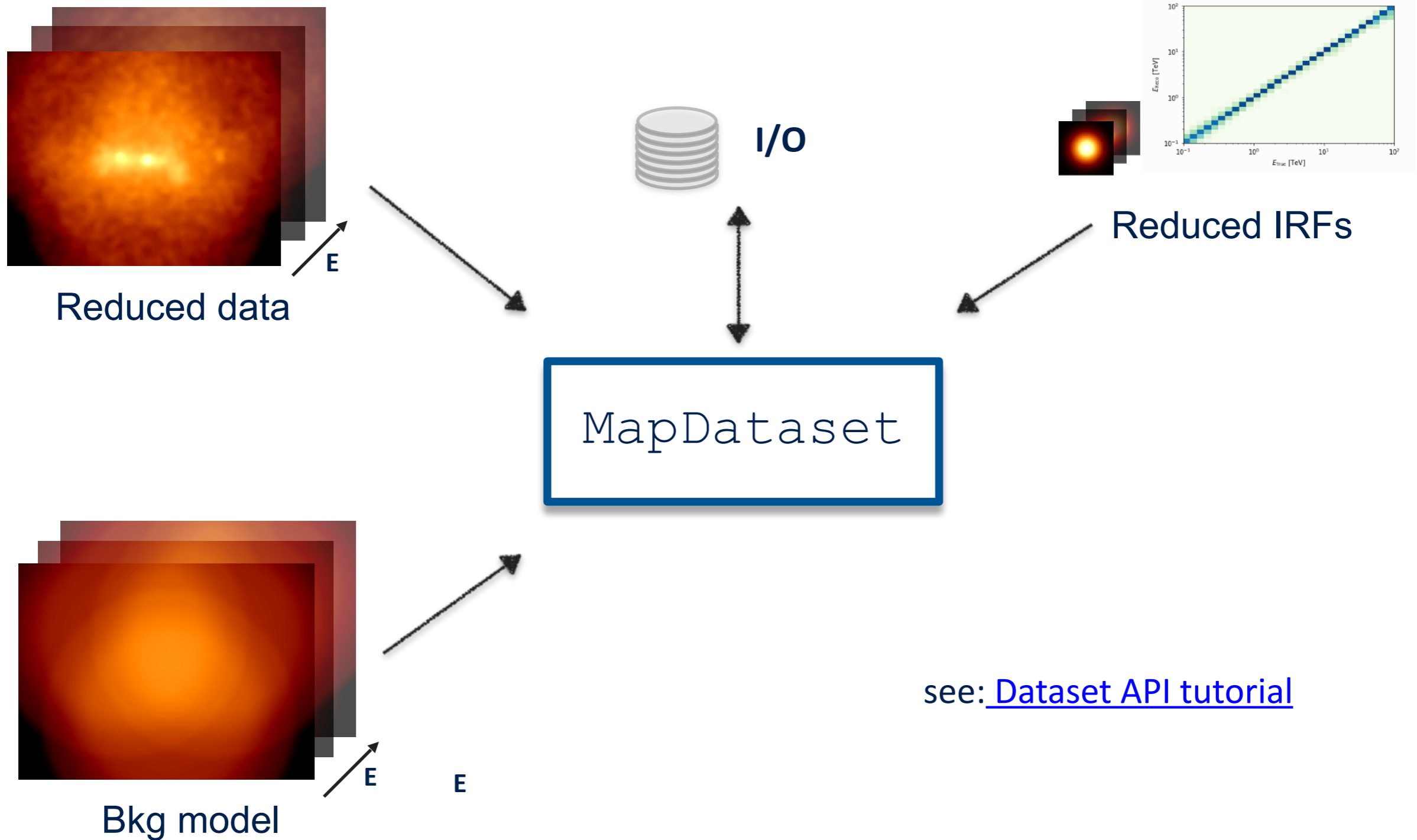




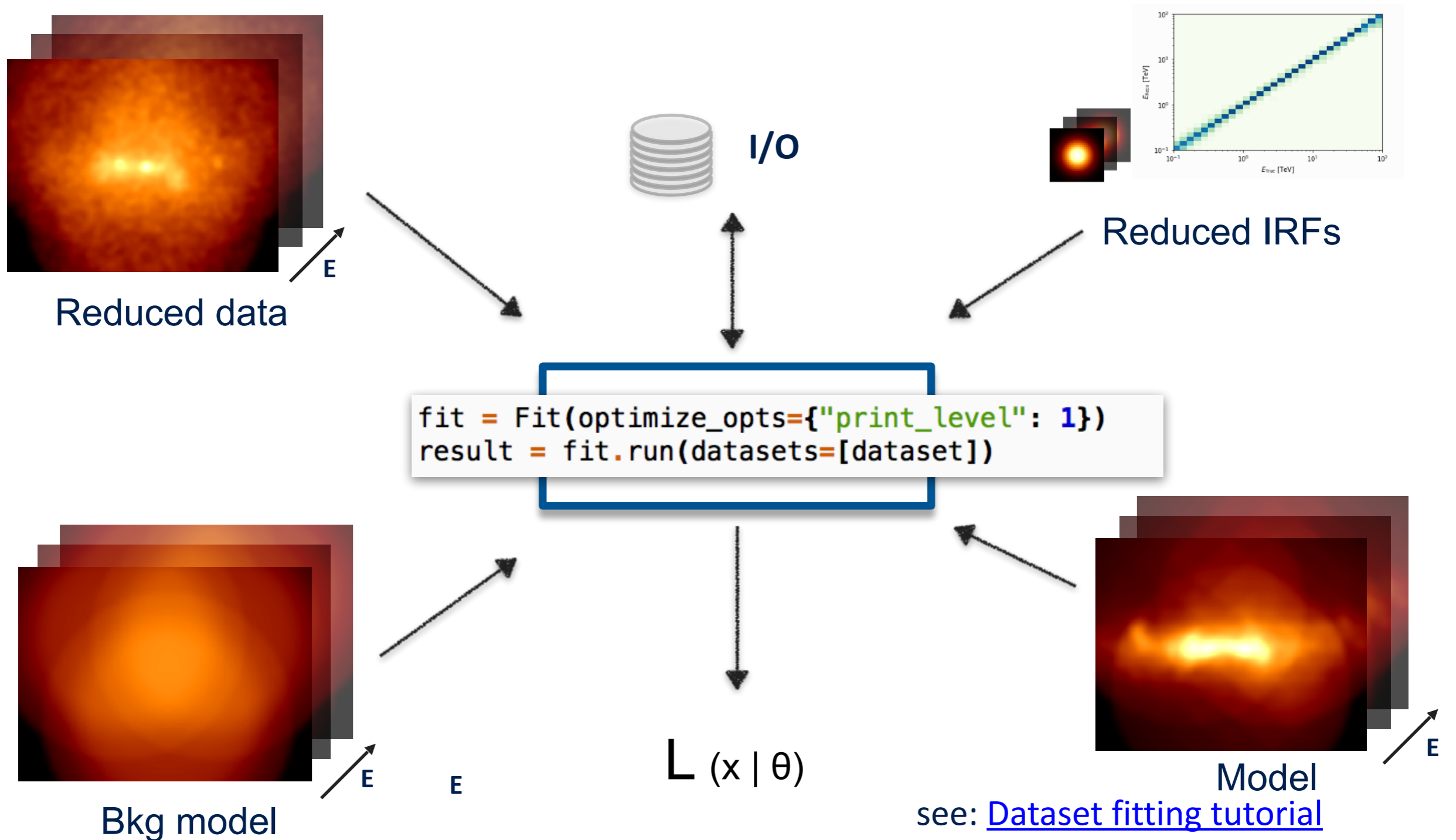
SpectrumDataset



see: [Dataset API tutorial](#)

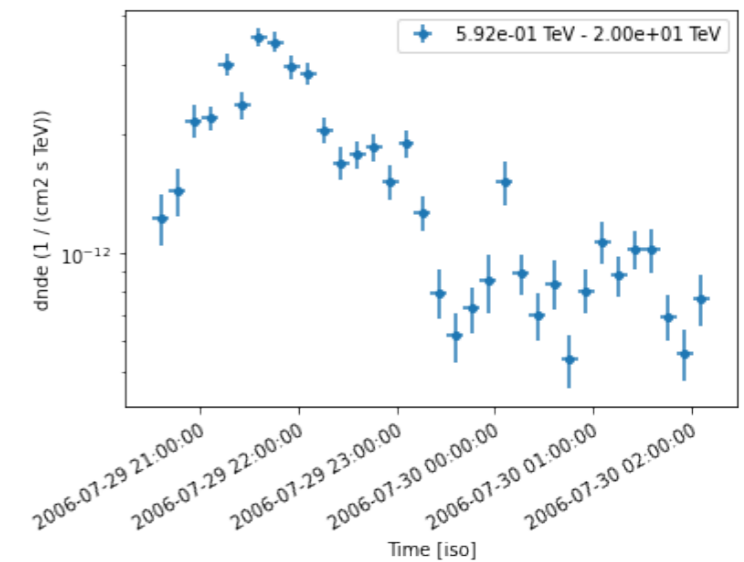
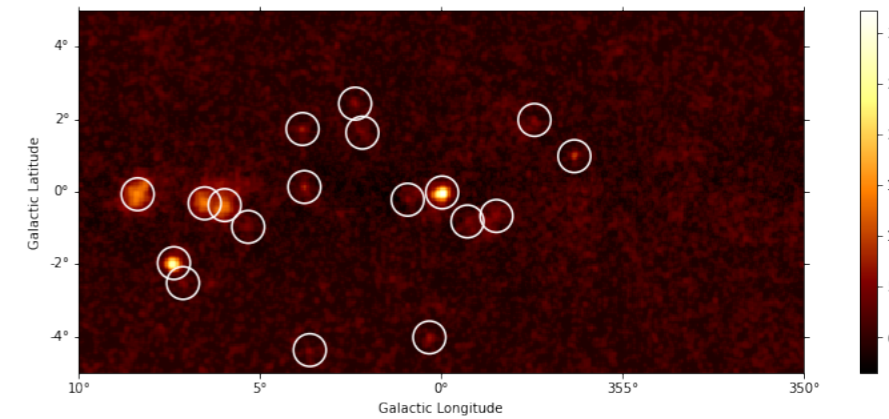
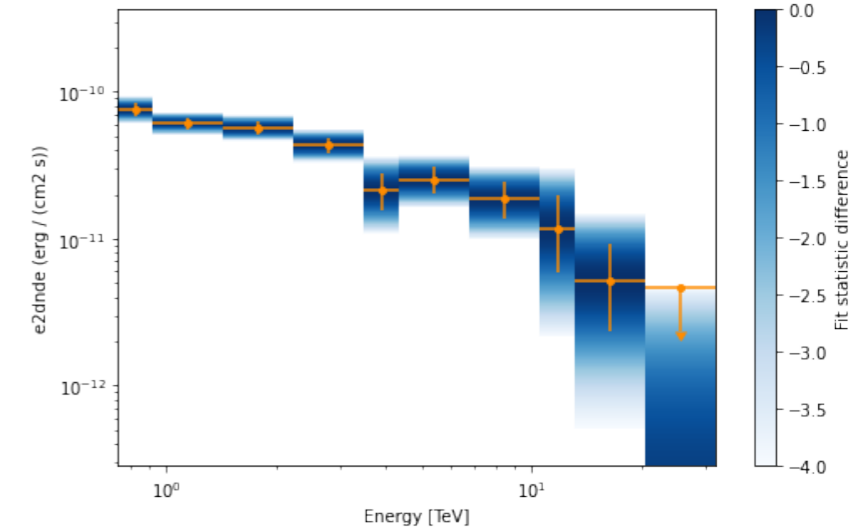
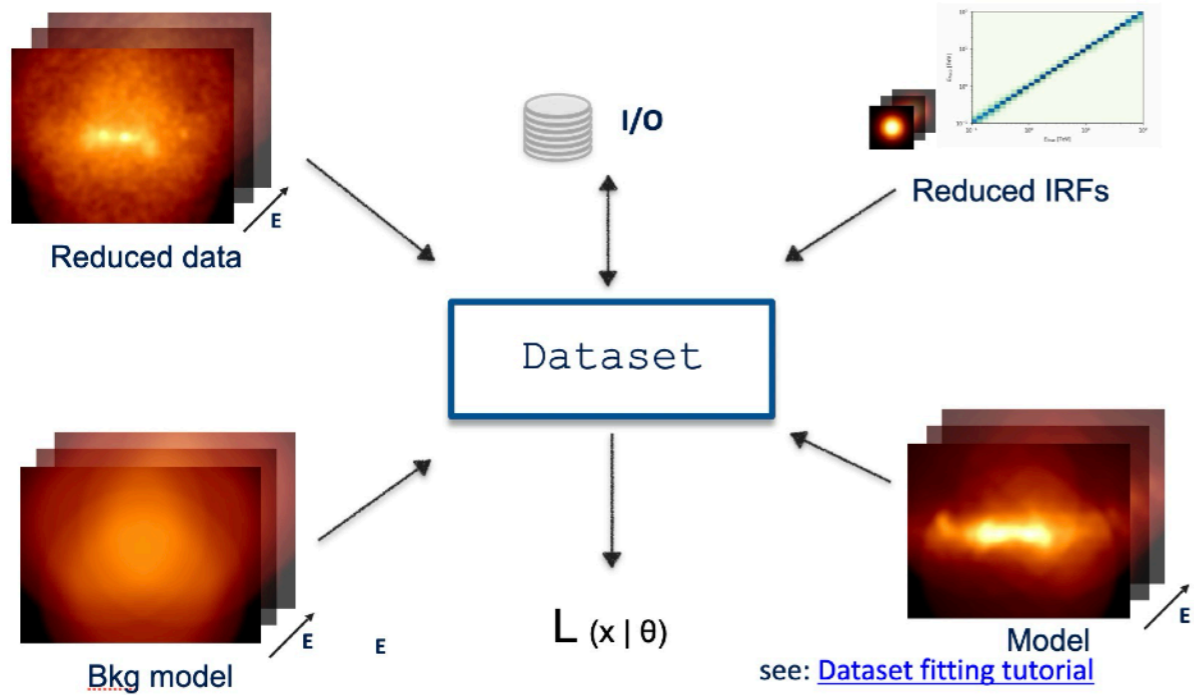


see: [Dataset API tutorial](#)



Estimators

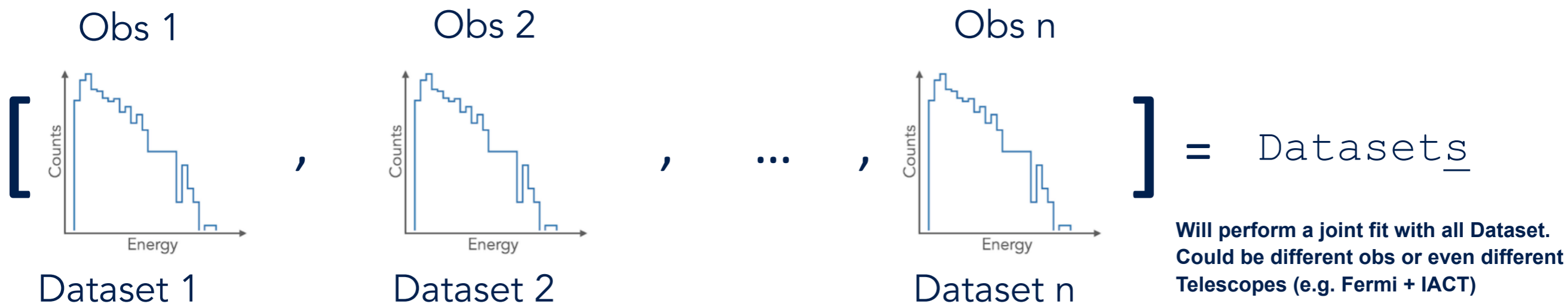
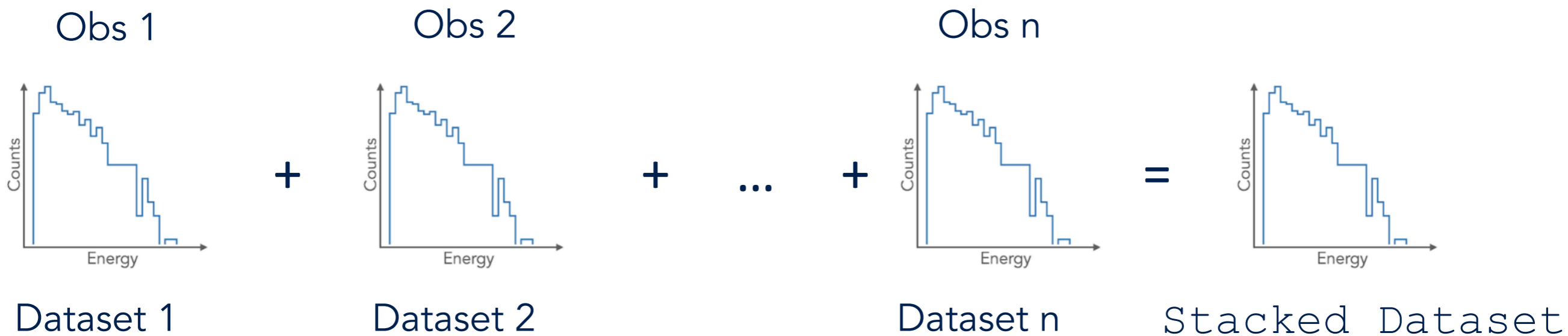
- FluxPointEstimator
- TSMAPEstimator
- Etc





Dataset & Datasets

- Apply makers to produce [reduced datasets](#)
- Combine them for [stacked](#) or [joint](#) analysis





**Where to start &
get help ?**



See docs.gammapy.org

- Where/How to interact with dev team and experienced users, provide feedback, get help:

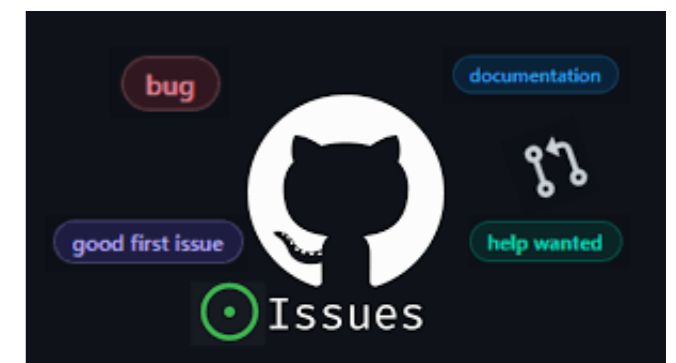
- [gammapy.slack](https://gammapy.slack.com)

- In particular: #help channel

- [GitHub discussions](#)

- help category

- [GitHub issues](#) to report bugs or feature requests





Getting started: documentation **CTAO**

Q Search the docs ...



Gammapy

Date: Feb 09, 2024 Version: 1.3.dev0

Useful links: [Web page](#) | [Recipes](#) | [Discussions](#) | [Acknowledging](#) | [Contact](#)

Gammapy is a community-developed, open-source Python package for gamma-ray astronomy built on Numpy, Scipy and Astropy. It is the core library for the CTA Science Tools but can also be used to analyse data from existing imaging atmospheric Cherenkov telescopes (IACTs), such as H.E.S.S., MAGIC and VERITAS. It also provides some support for Fermi-LAT and HAWC data analysis.



Getting started

New to Gammapy? Check out the getting started documents. They contain information on how to install and start using Gammapy on your local desktop computer.

To the quickstart docs



User guide

The user guide provide in-depth information on the key concepts of Gammapy with useful background information and explanation, as well as tutorials in the form of Jupyter notebooks.

To the user guide

slide between versions

Q Search the docs ...

Gammapy analysis workflow and package structure

How To

Model gallery

Gammapy recipes [↗](#)

Glossary and references

User guide



Analysis workflow and package structure

An overview of the main concepts in Gammapy package.

[To the package overview](#)



How To

A short "frequently asked question" entries for Gammapy.

[To the How To](#)



Model gallery

Gammapy provides a large choice of spatial, spectral and temporal models.

[To the model gallery](#)

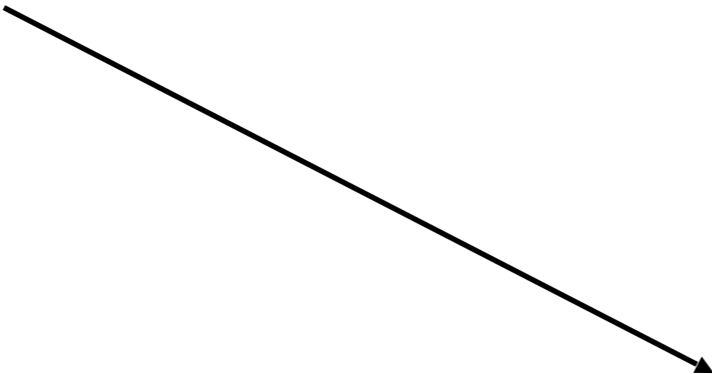
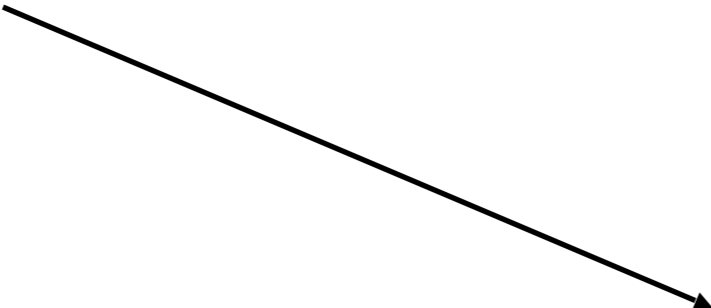


Gammapy recipes

A collection of **user contributed** notebooks covering aspects not present in the official tutorials.

[To the recipes](#)

- Learning with examples: the [Tutorials](#)
- More in depth: the [API description](#)



Introduction

The following three tutorials show different ways of how to use Gammapy to perform a complete data analysis, from data selection to data reduction and finally modeling and fitting.

The first tutorial is an overview on how to perform a standard analysis workflow using the high level interface in a configuration-driven approach, whilst the second deals with the same use-case using the low level API and showing what is happening *under-the-hood*. The third tutorial shows a glimpse of how to handle different basic data structures like event lists, source catalogs, sky maps, spectral models and flux points tables.

High level interface *Low level API* *Data structures*

Data exploration

Package / API

The following tutorials demonstrate different dimensions of the Gammapy API or expose how to perform more specific use cases.

Makers - Data reduction *Source catalogs* *Models*

Modelling *Fitting* *Maps*

PIG 24 - Authorship policy

- Authors: Bruno Khélifi, Thomas Vuillaume
- Created: May 25th, 2022
- Accepted: Oct. 20th, 2022
- Status: accepted
- Discussion: [GH 3970](#)

Abstract

Given that the Gammapy library is more widely used by the community, a proper citation of the project including a policy about the authorship is necessary. This PIG addresses this issue by setting an authorship policy for the Gammapy project for each type of products (releases, papers and conferences).

On this page

- Abstract
- Introduction
- Citation scheme
- Authorship policy
- Metadata files
- Possible implementations
- Suggestions
- Decision

Gammapy Presentations

A collection of Gammapy presentations given at conferences, including posters and slides for talks.

| Conference | Topics and Material | Contributors |
|------------|---|-------------------|
| Scipy 2023 | Gammapy - slides , talk | A. Donath et al. |
| ICRC 2023 | Gammapy - poster | B. Khélifi et al. |
| Gamma2022 | Gammapy - talk | A. Sinha et al. |
| ICRC 2021 | Gammapy - poster | A. Donath et al. |

Gammapy hands-on sessions and schools

Disclaimer: list under construction! Please, do not hesitate to make a pull request in order to add your contribution..

| Name | Material and links | Contributors |
|-----------------------------------|------------------------------------|---------------------------------|
| CTA Hands-on (Granada, 2023) | Hands-on | B. Khélifi, R. Terrier |
| ASTRI Hands-on (Palermo, 2022) | Hands-on | F. Pintore |
| ISAPP School (Orsay, 2022) | Hands-on | R. Terrier, F. Acero |
| CTA Hands-on (Bologna, 2022) | Hands-on | A. Sinha, L. Guinti |
| Hands-on (KU, 2022) | Hands-on | A. Sinha, R. Terrier |
| Thai-CTA workshop (Bangkok, 2021) | Hands-on | A. Sinha, B. Khélifi |
| Hands-on (Vaxjo, 2020) | Hands-on | B. Khélifi |
| CTA Hands-on (Lugano, 2019) | Hands-on (private) | A. Donath |
| CTA Hands-on (Berlin, 2018) | Hands-on (private) | A. Donath |
| CTA Hands-on (Orsay, 2018) | Hands-on (private) | C. Deil, R. Terrier, B. Khélifi |
| Hands-on (Meudon, 2017) | Hands-on | F. Acero, B. Khélifi |
| PyGamma15 | Hands-on | C. Deil, A. Donath et al. |

- Gammapy is a community effort
- Each Gammapy release is an official publication
 - The SWH/ZenodoDOI has an author list.
 - Any contributions makes you an author of the next release.
- Each presentation, hands-on session, school is promoted

Don't hesitate to join the Dev team ([#dev](#) in Slack)

Acknowledging or Citing gammapy

[In publications](#) | [In presentations](#) | [In projects](#)

Cite: 1)the paper & 2) the version

In publications

If you use Gammapy for work or research presented in a publication (whether directly, or as a dependency to another package), we ask you to add two citations to Gammapy:

- [Gammapy paper in A&A](#) (as a general citation)
- [Gammapy on Zenodo](#) (with the specific version used) - e.g. for the v1.2:

Copy BibTeX to clipboard

Copy BibTeX to clipboard



Published February 29, 2024 | Version v1.2

Software Open

Gammapy: Python toolbox for gamma-ray astronomy

Acero, Fabio¹; Bernete, Juan²; Biederbeck, Noah³; Djuvsland, Julia⁴; Donath, Axel⁵; Feijen, Kirsty⁶; Fröse, Stefan³; Galilli, Claudio⁷; Khélifi, Bruno⁸; Konrad, Jana³; Kornecki, Paula⁷; Linhoff, Maximilian³; McKee, Kurt⁹; Mender, Simone³; Morcuende, Daniel⁹; Olivera-Nieto, Laura¹⁰; Pintore, Fabio¹¹; Punch, Michael⁶; Regeard, Maxime⁶; Remy, Quentin¹⁰; Sinha, Atreyee¹²; Stapel, Hanna⁶; Strell, Katrin¹³; Terrier, Régis⁶; Unbehaun, Tim¹³

Show affiliations

Gammapy analyzes gamma-ray data and creates sky images, spectra and lightcurves, from event lists and instrument response information; it can also determine the position, morphology and spectra of gamma-ray sources. It is used to analyze data from H.E.S.S., Fermi-LAT, HAWC, and the Cherenkov Telescope Array (CTA).

Notes

If you use this software, please cite it using the metadata from this file.

Files

- gammapy/gammapy-v1.2.zip
- gammapy/gammapy-v1.2.zip

Export

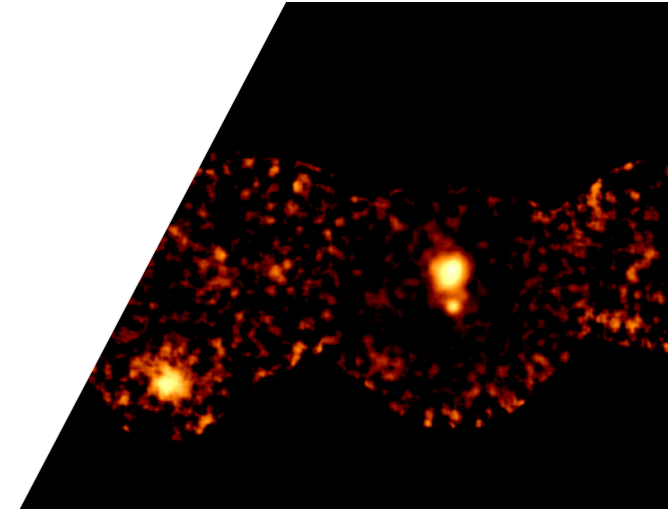
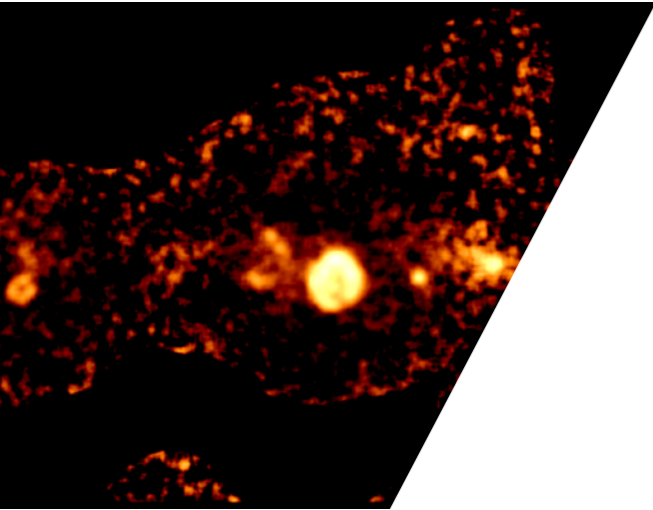
BibTeX Export

Gammapy: A Python package for gamma-ray astronomy

Axel Donath¹, Régis Terrier², Quentin Remy³, Atreyee Sinha⁴, Cosimo M
 Bruno Khélifi², Laura Olivera-Nieto³, Jose Enrique Ruiz⁷, Kai Brügge^{8,9}, Maximilian Lin
Fabio Acero¹⁰, Arnau Agasca-Cabot^{11,12,13,14}, David Berge^{15,16}, Pooja Bhattacharjee¹
 Catherine Boisson¹⁹, David Carreto Fidalgo²⁰, Andrew Chen²¹, Mathieu de Bony de Lavergne
Cardoso²², Christoph Deil³, Matthias Fülling²³, Stefan Funk²⁴, Luca Giunti², Jim Hinton³, Léa
Julien Lefaucheur^{27,2}, Marianne Lemoine-Goumard²⁸, Jean-Philippe Lenain²⁹, Rubén López
³, Daniel Morcuende⁴, Sebastian Panny³², Maxime Regeard², Lab Saha⁴, Hubert Siejkowski
 Brigitta M. Sipőcz³¹, Tim Unbehaun²⁴, Christopher van Eldik²⁴, Thomas Vuillaume¹⁷ and R

Received: 23 March 2023 | Accepted: 7 July 2023

Next sessions...



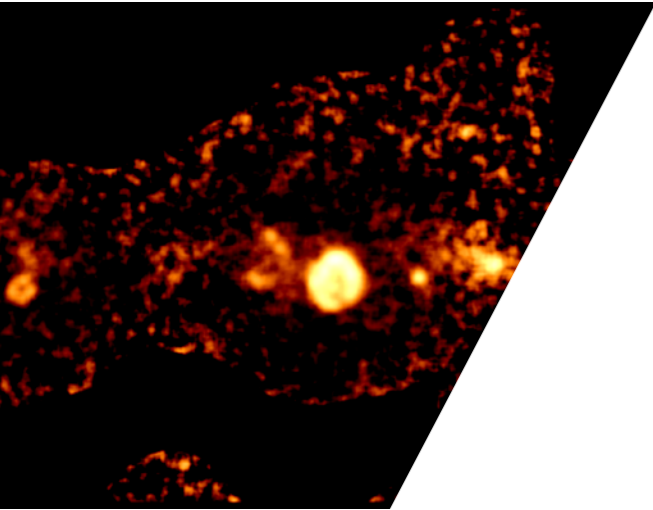


Today's agenda



Mix of **presentation**, **analysis hands on**, **open problems**:

- I. **Introduction to gammapy and concepts**
- II. **Data handling & IRFs and 1D analysis**
- III. **3D analysis concepts & Minimization pitfalls**
- IV. **3D analysis**
- V. **--- LUNCH ---**
- VI. **Source simulation**
- VII. **Open problems : Simulations, light curves, source catalog**
- VIII. **Multi-instrument joint fit**



Backup slides

