

Gammapy – A prototype for the CTA science tools

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Gammapy is a Python package for high-level gamma-ray data analysis, written in Python and built on Numpy, Scipy and Astropy. Starting with event lists and instrument response information, it is possible to analyse gamma-ray data and to create for example sky images, spectra and lightcurves, and to determine the position, morphology and spectra of gamma-ray sources.

So far Gammapy has mostly been used to analyse data from H.E.S.S. and Fermi-LAT, and now it is being used for the simulation and analysis of observations from the Cherenkov Telescope Array (CTA). We have proposed Gammapy as a prototype for the CTA science tools. This contribution will give an overview of the Gammapy package and show analysis application examples with simulated CTA data.

35th International Cosmic Ray Conference — ICRC2017

10–20 July, 2017

Bexco, Busan, Korea

*Speaker.

```

1  """Make a counts image with Gammapy."""
2  from gammapy.data import EventList
3  from gammapy.image import SkyImage
4  events = EventList.read('events.fits')
5  image = SkyImage.empty(
6      nxpix=400, nypix=400, binsz=0.02,
7      xref=83.6, yref=22.0,
8      coordsys='CEL', proj='TAN',
9  )
10 image.fill(events)
11 image.write('counts.fits')

```

Figure 1: An example script using Gammapy to make a counts image from an event list. This is used in Section 3 to explain how Gammapy works. TODO: probably should add a `def fill_events(events, image)` function and use that to illustrate how within Gammapy or in user scripts one can work efficiently with events and pixels from Python, using Numpy arrays and eventually calling into C extensions.

1. Introduction

TODO: write me!

Astropy [1], Sherpa [?], pyfact [2]

2. Gammapy

TODO: write me!

TODO: add figure with dependencies.

3. Code example

An example script using Gammapy is shown in Figure 1.

Message: Gammapy is high-level Python, data in Numpy arrays, others have written C and Python wrappers already (WCSLib, CFITSIO, SOFA/ERFA).

4. Application example

TODO: add a CTA analysis example (probably only an image, no spectrum or lightcurve yet).

See https://nbviewer.jupyter.org/github/gammapy/gammapy-extra/blob/master/notebooks/cta_data_analysis.ipynb or if CTA-DC becomes available, a TS image from the Galactic plane survey would be nice.

5. Conclusions

TODO: write me!

Briefly discuss Gammapy approach pro / con here or above?

References

- [1] Astropy Collaboration, T. P. Robitaille, E. J. Tollerud, and P. Greenfield et al., *Astropy: A community Python package for astronomy*, *AAP* **558** (Oct., 2013) A33.
- [2] M. Raue and C. Deil, *PyFACT: Python and FITS analysis for Cherenkov telescopes*, in *American Institute of Physics Conference Series* (F. A. Aharonian, W. Hofmann, and F. M. Rieger, eds.), vol. 1505 of *American Institute of Physics Conference Series*, pp. 789–792, Dec., 2012.