

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.

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Figure 1: The Gammapy stack. Required dependencies NumPy and Astropy are illustrated with solid arrows, optional dependencies (the rest) with dashed arrows.

1. Introduction

TODO: write me!

Numpy [1] Scipy [2] Matplotlib [3]

Astropy [4] Sherpa [5, 6, 7] pyfact [8] naima [9] 3ML [10] Astronomy software survey [11]

Gammapy is starting to be used for scientific studies for existing ground-based gamma-ray telescopes [12, 13] as well as the Fermi-LAT space telescope [14], as well as for CTA [15, 16, 17].

ctapipe: <https://github.com/cta-observatory/ctapipe> conda, pip

Open data for gamma-ray astronomy [18].

2. Gammapy

TODO: write me!

Gammapy dependency stack is shown in Figure 1

3. Code example

An example script using Gammapy is shown in Figure 2.

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

```

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 2: 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.

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.

For further application examples see e.g. [15, 16, 17], as well as <http://docs.gammapy.org>.

5. Conclusions

TODO: write me!

Briefly discuss Gammapy approach pro / con here or above?

6. Acknowledgements

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We thank the GitHub (<http://www.github.com>) team for providing us with an excellent free development platform, ReadTheDocs (<https://readthedocs.org>) for free documentation hosting, Travis (<https://www.travis-ci.org>) and Appveyor (<https://appveyor.com>) for free continuous integration testing, and Slack (<https://slack.com/>) for a free team communication channel.

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