Standardized formats for γ-ray analysis applied to HAWC observatory data

Laura Olivera-Nieto[1], Vikas Joshi[2], Harm Schoorlemmer[1], Axel Donath[1] for the HAWC Collaboration

[1]Max Planck Institut für Kernphysik, [2]Erlangen Centre for Astroparticle Physics

Motivation

In recent years there has been an effort to make astronomy an open and accessible science. Within the γ-ray community this has translated to the creation of a common data format across different γ-ray observatories: the "gamma-astro-data-format" (GADF) [1]. This effort has been largely focused on IACT arrays, ignoring wide-field instruments.

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The HAWC observatory

HAWC is a γ-ray observatory that consists of 300 water Cherenkov detectors. Its wide field of view covers two-thirds of the sky uninterruptedly, allowing for constant monitoring and deep observations of the γ-ray sky. It has been in operation since November 2014.

Gammapy

A **Python** package for **gamma-ray** astronomy

Gammapy is a community developed Python package for γ-ray astronomy selected to be part of the CTA science tools. It has been successfully used and validated for the analysis of IACT data [2] and joint analysis with data from the Fermi-LAT observatory [3].

DOCUMENTATION

References

[1] Deil, C. et al. 2017, AIPC, 1792, 070006

[2] Mohrmann, L. et al. 2019, A&A, 632, A72

[3] Nigro, C. et al. 2014, A&A, 625, A10

[4] A.U. Abeysekara et al, 2019, ApJ, 881, 134

Validation on the Crab nebula

Using the same data range and background estimation method as in [4], and the instrument response functions described in this poster, we reproduce the Crab spectrum with *Gammapy*. We fit a 3-dimensional model: a point-source with a log-parabola spectral shape. We find excellent agreement using an analysis tool built with a different philosophy and structure to that used for the original result.

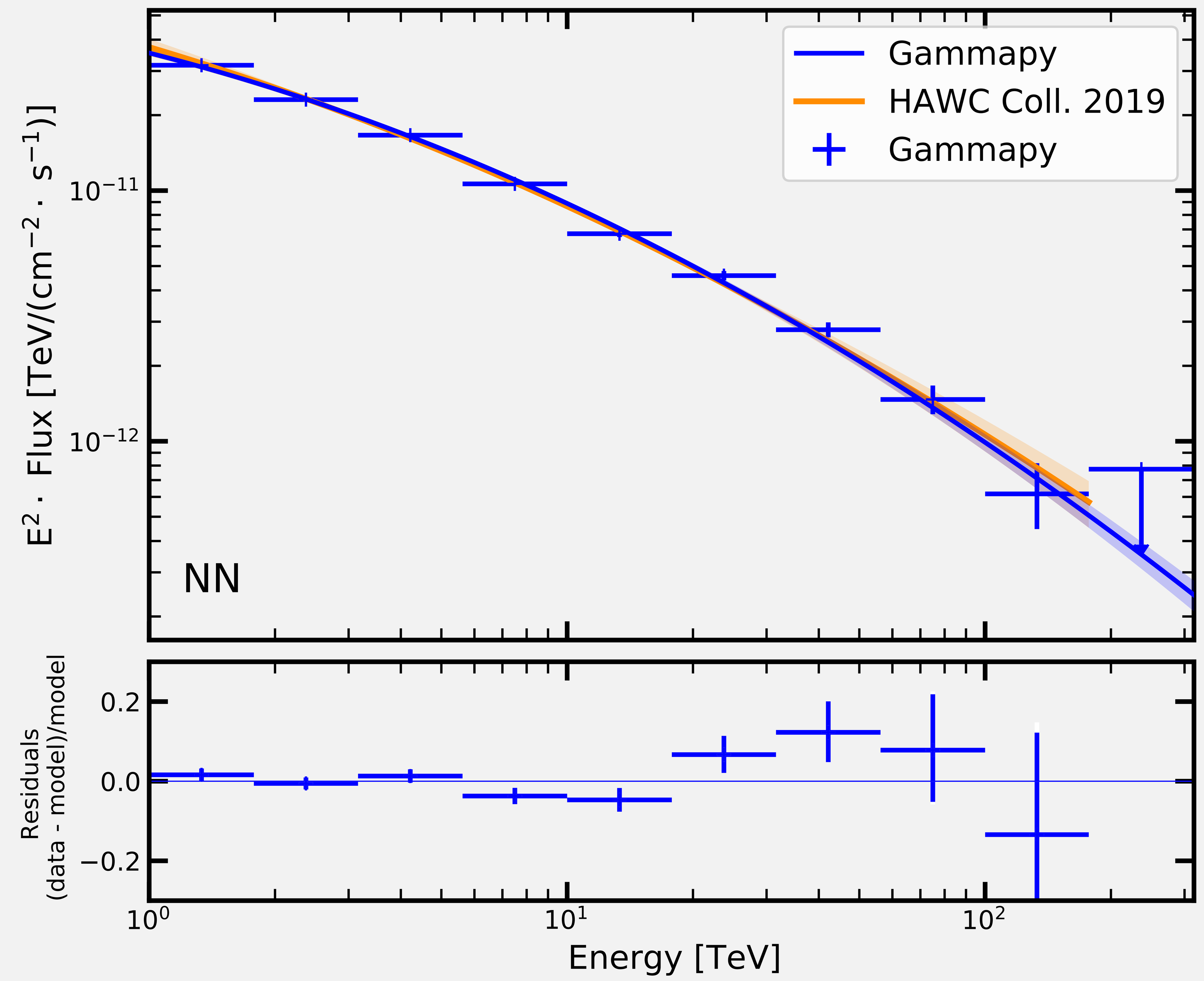

Figure 1: Best-fit Crab spectrum obtained with *Gammapy* compared with [4] for the case of the neural network energy estimator. The residuals show the comparison of the flux points with the model in [4].

Conclusion

Wide-field γ-ray observatory data can be made compatible with general community standards and thus analyzed with shared open-source tools like *Gammapy*.

Good time intervals and exposure

Good time intervals are the intervals during which the detector is taking data continuously. They are used to compute the exposure.

Effective area

The effective are is the combination of the detection efficiency with the observable area.

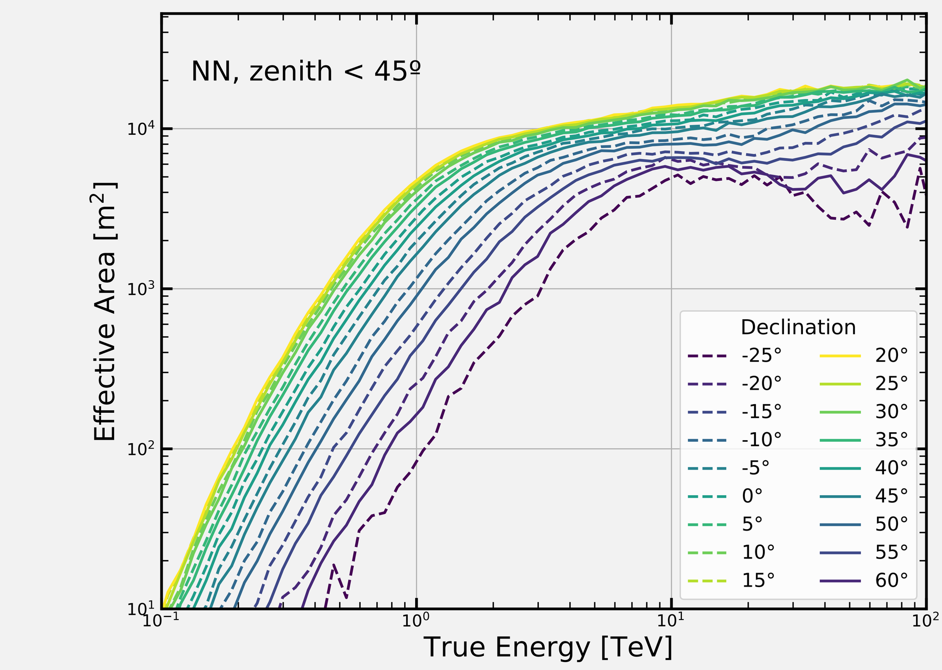

Figure 2: Effective area after background rejection.

Energy dispersion matrix

The energy dispersion describes the probability of an event with a given simulated energy (E_{True}) to be reconstructed with a different energy (E_{Reco}).

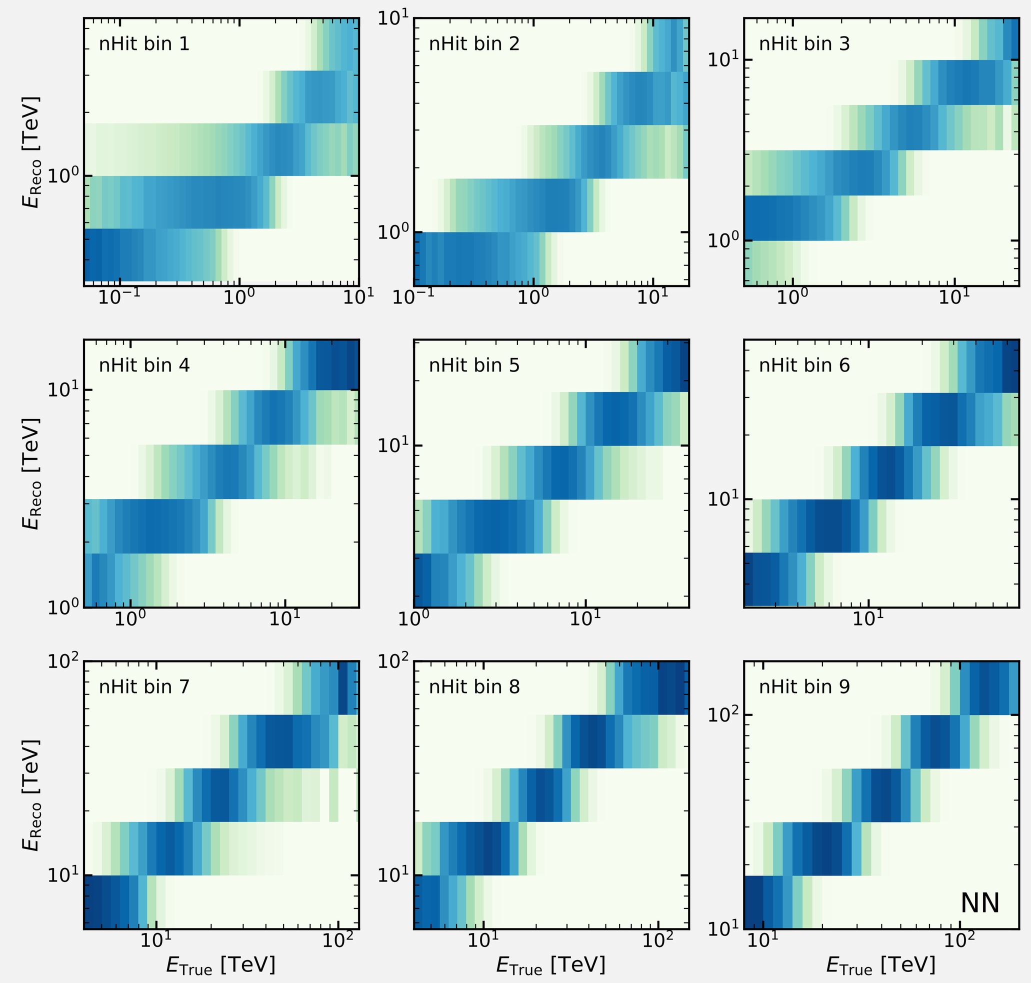

Figure 3: Energy dispersion matrix at the Crab location.