ASTRI-Horn correlation between the Sky Quality Meter and the Variance data

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ABSTRACT

We present the correlation between the Sky Quality Meter values of the sky brightness and the Variance using data from the ASTRI-Horn prototype. This correlation can be used to convert the Variance to sky absolute flux, helping to identify high level background periods and define the good time intervals in each observation. Moreover, the results obtained with ASTRI-Horn could be a good test-bench for the ASTRI Mini-Array telescopes.

ASTRI-Horn → ASTRI Mini-Array

The ASTRI Mini-Array [1] is an INAF project devoted to study gamma-ray sources emitting at very high-energy in the TeV spectral band. It consists of an array of nine innovative Imaging Atmospheric Cherenkov Telescopes, that are an evolution of the double-mirror ASTRI-Horn telescope [2] operating at the INAF "M.C. Fracastoro" observing station (Serra La Nave, Mount Etna, Italy). The ASTRI Mini-Array is under installation at the Teide Astronomical Observatory, Instituto de Astrofisica de Canarias, on Mount Teide in Tenerife (Canary Islands, Spain).

Fig. 1: ASTRI-1: the first ASTRI Mini-Array telescope under installation on Mount Teide in Tenerife (Canary Islands, Spain).

Fig. 2: ASTRI-Horn telescope installed on Mt.Etna (Italy) at the INAF ``M.G. Fracastoro" observing station.

Sky Quality Meter and Variance Data

ASTRI-Horn and the ASTRI Mini-Array are equipped with several auxiliary devices among which the Sky Quality Meter (SQM). This device provides, during observations, a quick evaluation of the sky quality in the optical band measuring the brightness of the night sky. It is coaxial with the telescope where it is mounted pointing in the same direction, and it returns integral information about the night sky brightness inside its fields of view (about 20º) in units of mag/arcsec.

Each telescope camera implements the Variance method [3] based on the statistical analysis of the signal detected by the front-end electronics whose variance is proportional to the flux impinging on the camera pixel. The Variance allows us to indirectly measure the sky flux and to monitor the presence of clouds and stars in the telescope field of view.

Data Analysis

The data used in this analysis are from observations performed with ASTRI-Horn on three clear nights during an observing campaign of the Crab Nebula in 2022/2023. They are listed in the table with their relative exposures.

Observation Date	Exposure (s)
2023-01-23	14944
2023-02-21	8632
2023-02-22	9363

For each nigh, the Variance and the SQM data were accumulated and correlated. The light curves for the 2023-01-23 night are shown in Fig. 3

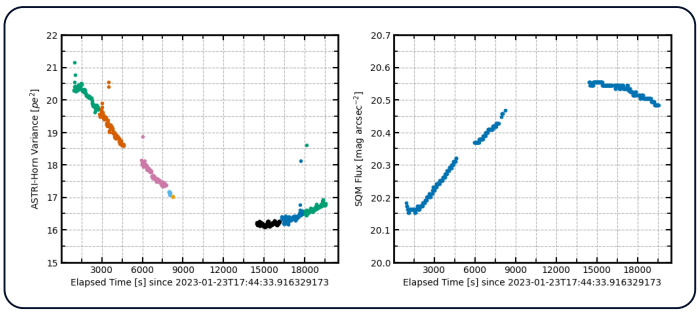

Fig. 3: Left panel: light curve of the Variance data for the observation performed on 2023-01-23. Colors identify the scientific observation runs of the night. Right panel: Flux measured by the SQM

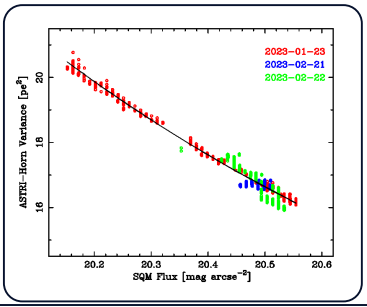

Fig. 4: Correlation between ASTRI-Horn Variance and SQM Flux. Colors identify the three nights. The black line is the fitting model.

Variance data and SQM flux are then correlated and fitted with the model:

$$Var = K \times 10^{-\frac{SQM\ Flux - 20}{2.5}} + Co$$

where K=16.14 ± 0.09 and Co=6.45 ± 0.06. These best fit values are valid for the Crab Nebula field of view. However, this method can be used in all pointings to convert the Variance to sky luminosity, helping to identify high level background periods and define the good time intervals. Moreover, these results obtained with ASTRI-Horn are a good test-bench for the ASTRI Mini-Array telescopes.

ACKNOWLEDGEMENTS

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References: .
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[2] Leto and et al, ICRC2023 PoS(ICRC2023)732