The ASTRI Mini-Array at the time of multi-messenger astronomy

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ABSTRACT

The ASTRI Mini-Array is currently being installed in Tenerife at the *Teide Observatory* to explore the gamma-ray sky in the 1–200 TeV energy range with unmatched angular resolution (a few arcminutes) across a wide field of view (10.5 degrees). The array consists of nine imaging atmospheric Cherenkov telescopes (IACTs), each equipped with a 4-meter diameter dual-mirror system featuring a Schwarzschild-Couder-like optical configuration, functioning as an aplanatic system, and an innovative compact camera which utilizes Silicon photomultipliers sensors. This contribution briefly overviews the ASTRI Mini-Array project layout, capabilities, and scientific objectives. The ASTRI Mini-Array can play an important role in multi-messenger astronomy to better understand Galactic and extragalactic astrophysical aspects, combining the information inferred by other observational facilities. In this respect, a parallel observation program with ASTRI Mini-Array and *Swift* already started.

ASTRI MINI-ARRAY STATUS

ASTRI-1 (see Fig. 1), the first telescope of the ASTRI Mini-Array [1,2], has been acquiring data at the Teide Observatory since October 2024. Four ASTRI telescopes will be operational by the end of 2025, while the full ASTRI Mini-Array will start scientific operations in 2026.

Fig. 1: ASTRI-1 telescope at the Teide Observatory. Credits: INAF/S. Bonuccelli

ASTRI-1 PRELIMINARY RESULTS

Fig. 2 shows the θ^2-distributions of the Crab Nebula (ON, black) and the background (OFF, grey) data (E ≳ 2 TeV) acquired with ASTRI-1 on 2024/12/4-5 (dark night, Zenith angle < 30°).

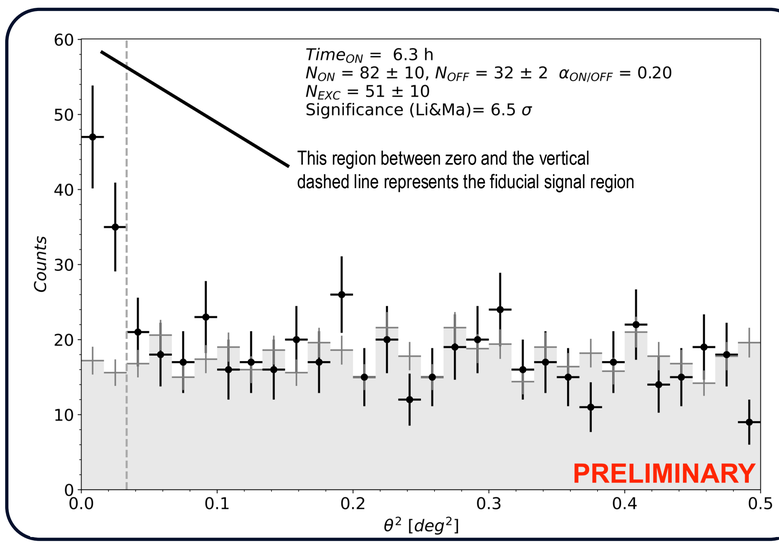

Fig. 2: Crab Nebula θ^2-distributions. Credits: Crestan & Lombardi, for the ASTRI Collaboration.

ACKNOWLEDGEMENTS
This work was conducted in the context of the ASTRI Project. Part of the research activities described in this paper were carried out with contribution of the Next Generation EU funds within the National Recovery and Resilience Plan (PNRR), Mission 4 - Education and Research, Component 2 - From Research to Business (M4C2), Investment Line 3.1 - Strengthening and creation of Research Infrastructures, Project IR0000012 – "CTA+ - Cherenkov Telescope Array Plus".

ASTRI MINI-ARRAY PERFORMANCE

Fig. 3 shows the ASTRI Mini-Array differential sensitivity both for 50h and 5σ compared with those of current IACTs and of the planned CTAO and for deeper exposures (200h/500h, 5σ) compared with current WCDs. The ASTRI Mini-Array will improve the current IACT sensitivity at energies greater than a few TeVs and will be complementary to current WCDs with its excellent angular resolution, which will allow us to investigate the nature of ultra high-energies sources.

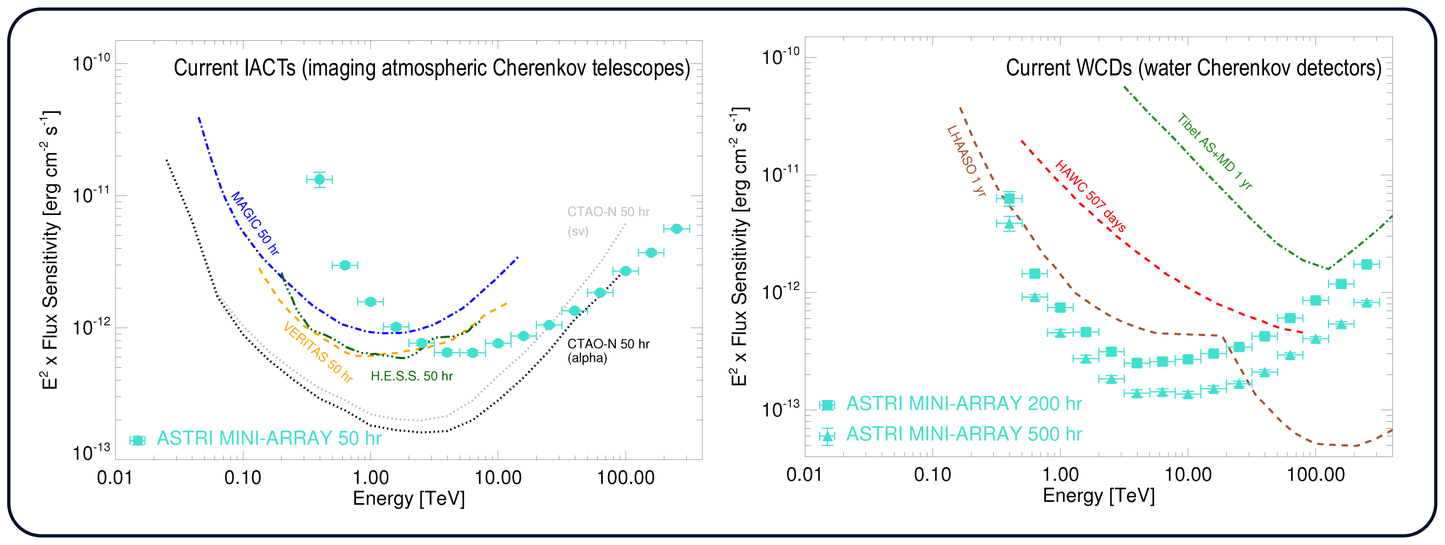

Fig. 3: ASTRI Mini-Array differential sensitivity for different integration times compared with both IACTs and WCDs ones. See [3,4]

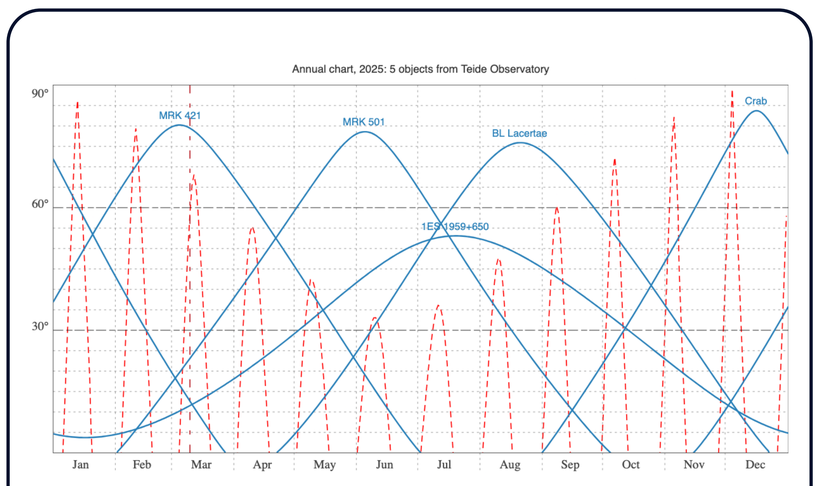

Fig. 4: 2025 visibility chart for MRK 421, MRK 501, BL Lac, 1ES 1959+650 and Crab

The ASTRI Mini-Array will be operated as an experiment for the the first four years. It will be devoted to the study of selected sky regions by means of deep pointings, in order to maximize the scientific return on a few open questions (see [5] for further details). Afterwards, it will gradually shift to an open observatory model of operation.

SYNERGIES

In November 2024 the ASTRI Collaboration was granted a proposal (PI: Vercellone) for monitoring observations of one blazar out of four simultaneously with *Swift*. The scientific goal is to investigate possible near simultaneous correlations in the synchrotron (optical–UV–X-ray) and inverse Compton (IC, GeV–TeV) energy bands, deriving an accurate description of the X-ray spectrum and its temporal evolution, which would allow us to extract the shape of the underlying electron population. Fig. 4 shows the 2025 annual visibility chart for MRK 421, MRK 501, BL Lac and 1ES 1959+650, reporting the altitude of each object at local midnight. These objects were chosen in order not to interfere with Crab Nebula calibration observations.

References: [1]: Scuderi S., et al., 2022, JHEAP, 35, 52; [2]: Scuderi S., 2024, Universe, 10, 146; [3]: Lombardi S., et al., 2022, ICRC2021, 884; [4]: Vercellone S., Universe, 2024, 10, 94; [5]: Vercellone S., et al., 2022, JHEAP, 35, 1