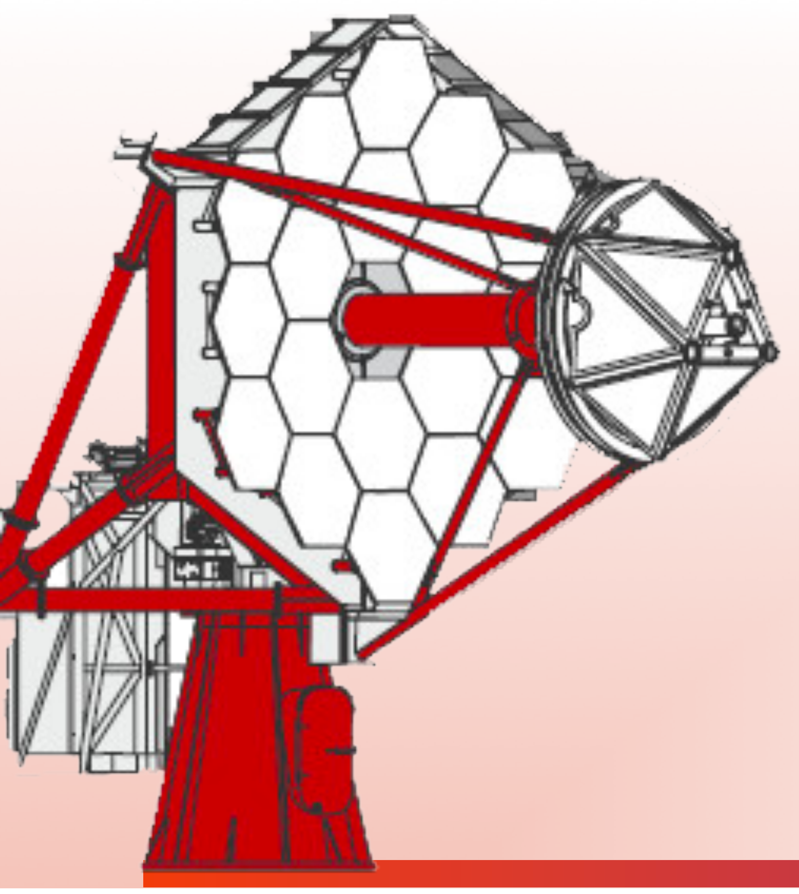

Performance of the ASTRI Mini-Array at the *Observatorio del Teide*

S. Lombardi *(INAF – Osservatorio Astronomico di Roma / ASI – Space Science Data Center),*
L. A. Antonelli, C. Bigongiari, M. Cardillo, S. Gallozzi, J. G. Green, F. Lucarelli, F. G. Saturni
for the ASTRI Project.

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saverio.lombardi@inaf.it

Overview

The ASTRI Mini-Array (ASTRI MA) is a next-generation ground-based gamma-ray observatory under construction at the *Observatorio del Teide* (Tenerife, Spain) [1]. It will be composed of nine small-sized (~4 m in diameter) Cherenkov telescopes operating in the energy range between 1 TeV and 100 TeV and beyond. Thanks to its differential sensitivity and angular/energy resolution over a wide field of view (~10 degrees), the system will allow unprecedented gamma-ray observations in the TeV and multi-TeV energy band [2], providing a fully functional complement to present- (VERITAS [3], MAGIC [4], HAWC [5]) and next-generation (LHAASO [6], CTAO Northern Array [7]) gamma-ray observatories in the Northern Hemisphere.

Monte Carlo simulations, data reduction, and analysis

In order to assess the performance of the ASTRI MA, detailed high-statistic Monte Carlo (MC) simulations were generated and subsequently reduced with `A-SciSoft` [8], the scientific software package of the ASTRI Project. The air shower (induced by primary gamma rays, protons, and electrons) simulations were generated with the `CORSIKA` package [9], while the array telescope response was produced with the `sim_telarray` package [10]. All MC simulations were generated assuming dark night conditions and a zenith angle of 20°. *Fig. 1* shows the layout of the ASTRI MA telescopes at the Teide Observatory site. The MC events were reduced applying standard methods implemented in the data reduction pipeline [8]. The final analysis cuts (in background rejection, arrival direction, and event multiplicity parameters) were optimized in differential sensitivity, considering different exposure times. The differential sensitivity was calculated for each considered exposure time by requiring a 5σ [11] detection in each given energy bin and off-axis bin, assuming a ratio of the off-source to on-source exposure equal to 5.

Performance

The key performance features of the ASTRI MA shown in *Fig. 2*, *3*, and *4* can be summarized as follows:

- A differential sensitivity better than present-generation IACTs above a few TeV [3,4] and comparable to the CTAO Northern Array (in the construction phase configuration) above a few tens of TeV [7] (*Fig. 2*)
- An angular and energy resolution of a few arcmin and ~10% above a few TeV, respectively (*Fig. 3*)
- An excellent off-axis performance over a wide field of view of several squared degrees (*Fig. 4*)

These performance features will allow the simultaneous observation of multiple gamma-ray sources in crowded regions and large surveys of the sky [2]. In addition, unprecedented morphological and spectral studies of extended gamma-ray sources at the TeV and multi-TeV energy band – in particular those detected above tens of TeV by HAWC [5] and LHAASO [6] – will be feasible.

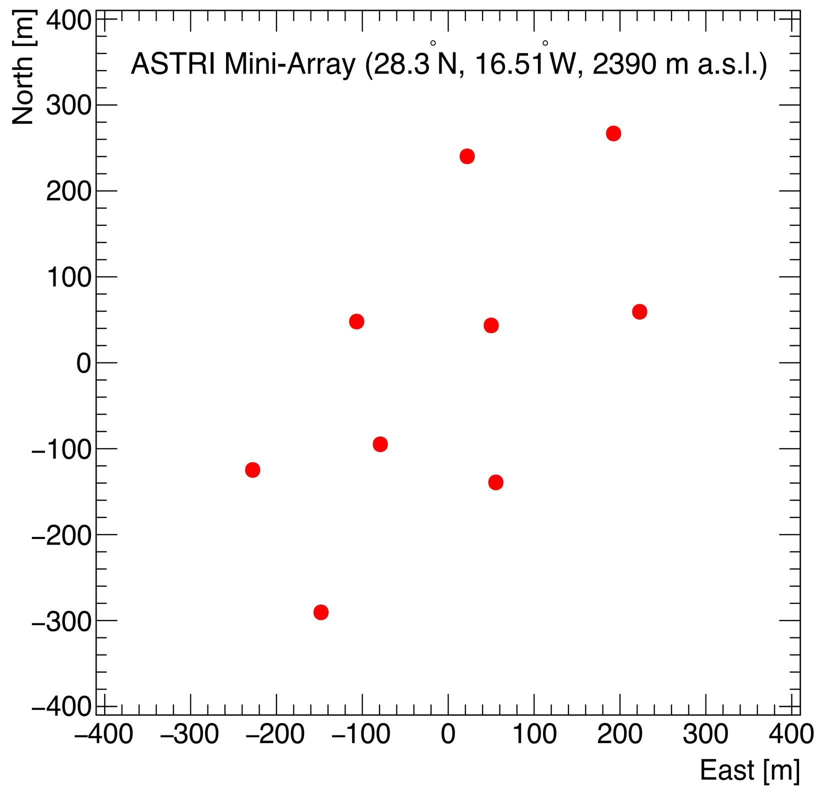

Figure 1: Layout of the ASTRI MA telescopes at the Teide Observatory site.

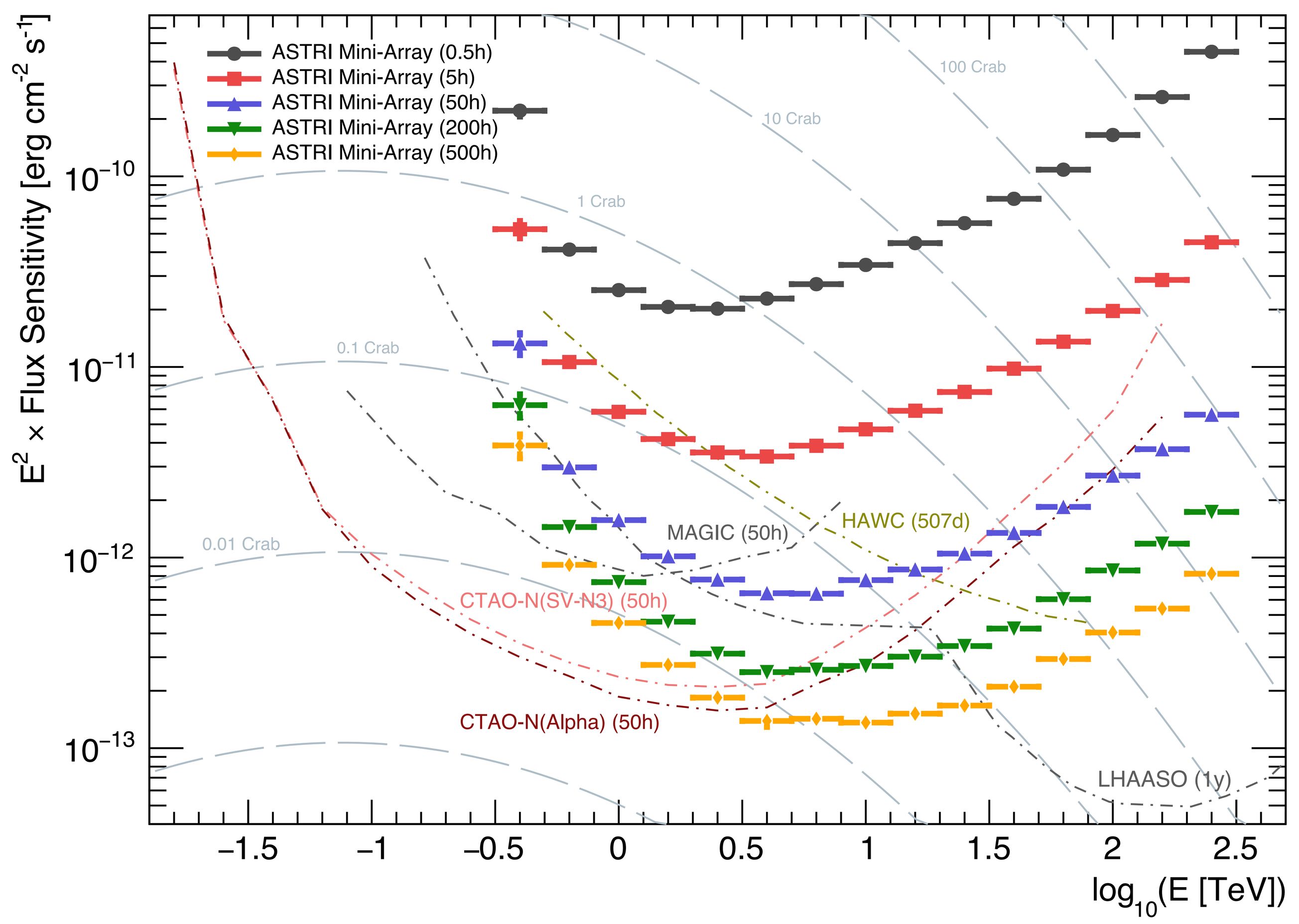

Figure 2: On-axis point-like source differential sensitivity of the ASTRI MA (at a zenith angle of 20°) for five exposure times: 0.5 (dark gray), 5 (red), 50 (blue), 200 (green), and 500 (orange) hours. The differential sensitivities of other instruments – MAGIC (50h), HAWC (507d), LHAASO (1y), and CTAO Northern Array (50h, for two configurations) – are shown for comparison.

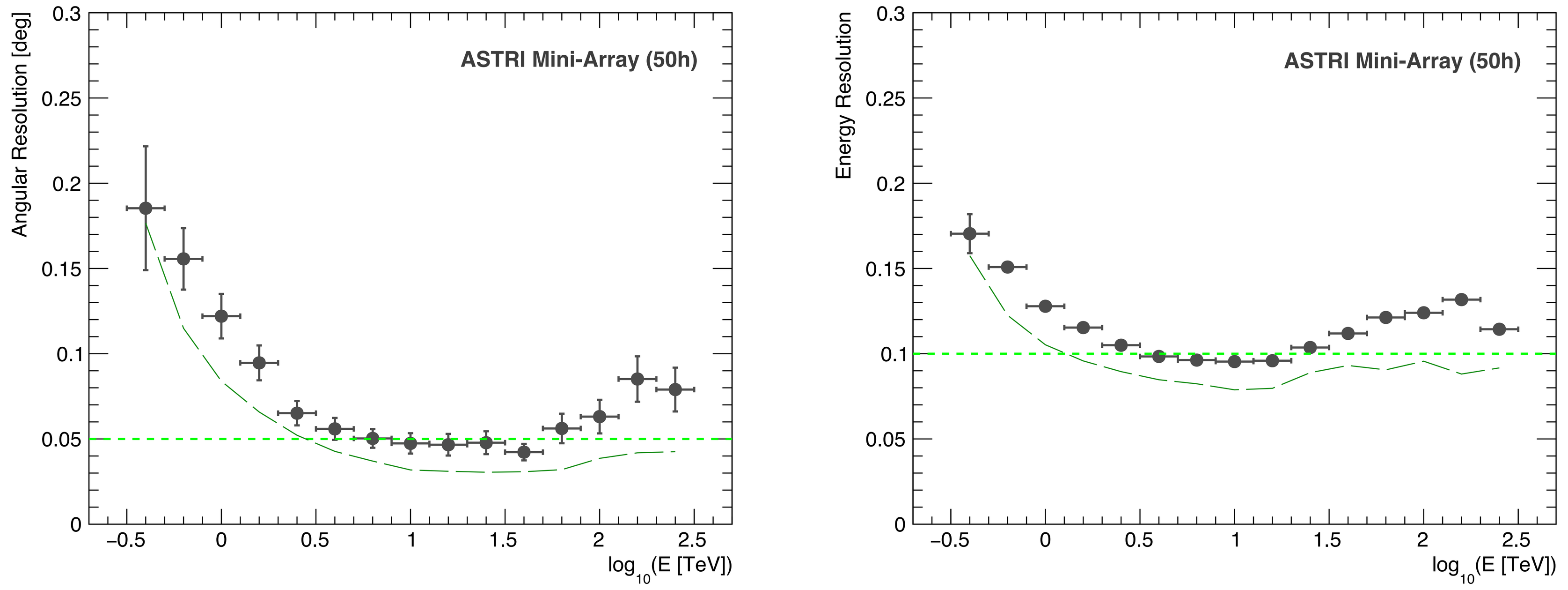

Figure 3: On-axis angular resolution (*left*) and energy resolution (*right*) of the ASTRI MA (at a zenith angle of 20°). The dark gray curves were achieved with analysis cuts optimized for differential sensitivity in 50 hours. The dashed dark green line in the left(right) panel shows the angular(energy) resolution achieved with cuts that take into account both differential sensitivity and angular(energy) resolution in the cut optimization process, while the dashed green horizontal line represents an angular(energy) resolution of 3 arcmin(10%).

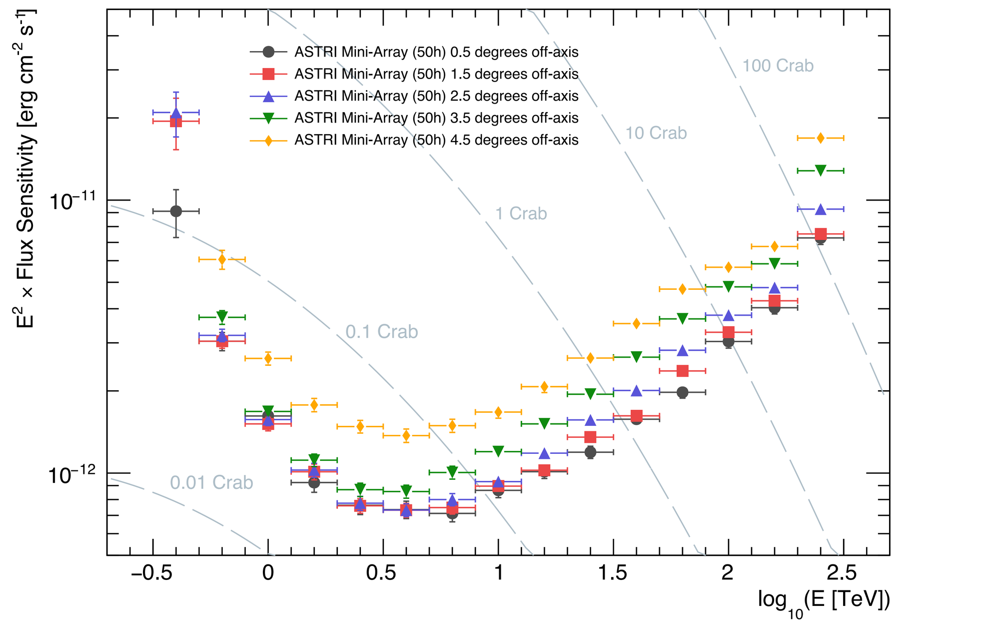

Figure 4: Off-axis point-like source differential sensitivity of the ASTRI MA (at a zenith angle of 20°) in 50 hours for five off-axis bins between 0° and 5°. The performance up to 3°(5°) from the center of the field of view will be within a factor of ~1.5(~2) equal to the nominal on-axis performance.

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References: **[1]** Antonelli, L. A., *The ASTRI mini-array at Teide Observatory*, Proc. 37th ICRC, Berlin, ID0832 (2021). **[2]** Vercellone, S., et al., *The ASTRI Mini-Array Core Science Program*, Proc. 37th ICRC, Berlin, ID0574 (2021). **[3]** Park, N., et al., Proc. 34th ICRC, The Hague, 34, 769 (2015). **[4]** Aleksić, J., et al., Astropart. Phys., 72, 76 (2016). **[5]** Albert, A., et al., ApJ, 905, 76 (2020). **[6]** Cao, Z., et al., Nature 594, 33–36 (2021). **[7]** Gueta, O., *The Cherenkov Telescope Array: layout, design and performance*, Proc. 37th ICRC, Berlin, ID0088 (2021). **[8]** Lombardi, S., et al., Proc. SPIE, 10707, 107070R (2018). **[9]** Heck, D., et al., Report FZKA, 6019, Forschungszentrum Karlsruhe (1998). **[10]** Bernlöhr, K., Astropart. Phys., 30, 149 (2008). **[11]** Li, T.-P. and Ma, Y.-Q., ApJ, 272, 317 (1983).