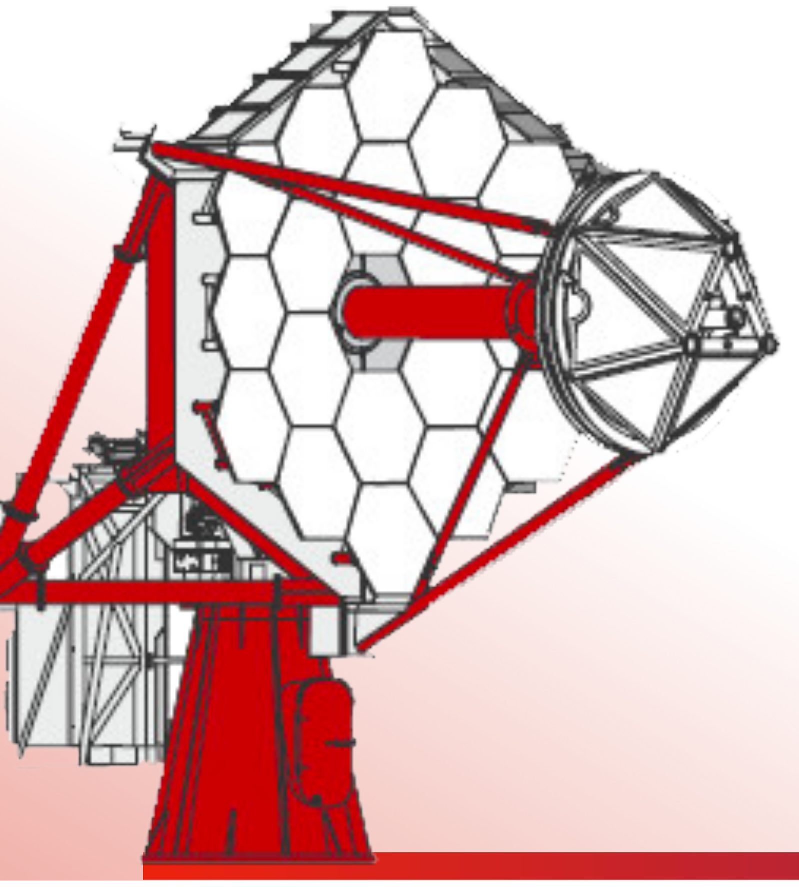

EXTRAGALACTIC OBSERVATORY SCIENCE WITH THE ASTRI MINI-ARRAY AT THE OBSERVATORIO DEL TEIDE

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ICRC 2021 - 37th International Cosmic Ray Conference
12 - 23 July 2021, Berlin.
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See also ICRC 2021 contributions dedicated to the ASTRI Project by Antonelli et al., Cardillo et al., Compagnino et al., Corpora et al., Costa et al., D'Aì et al., Iovenitti et al., Lombardi et al., Mineo et al., Parmiggiani et al., Stamerra et al. and Vercellone et al.

OVERVIEW

The ASTRI Mini-Array, a system of imaging atmospheric Cherenkov telescopes (IACTs) composed of nine dual-mirror ASTRI telescopes, is under construction at the *Observatorio del Teide* (Tenerife, Canary Islands) [1]. The telescopes (4-m diameter) are characterized by a large field of view (FoV) of up to ~10°, spatial resolution of few arcmin and energy resolution of ~10% at $E_\gamma > 1$ TeV [2].

After an experiment phase with a fixed list of core-science targets [3], an open observatory phase will follow. Here, the scientific prospects on extragalactic targets are evaluated using a suitable set of instrument response functions (IRFs), produced with the ASTRI pipeline *A-SciSoft* [4].

The main goals of extragalactic astronomy with the ASTRI Mini-Array are observations of AGN and indirect dark matter (DM) searches. The almost uniform ASTRI response across the FoV can be exploited to perform simultaneous observations of sources located within an angular distance of up to ~5° (Fig. 1).

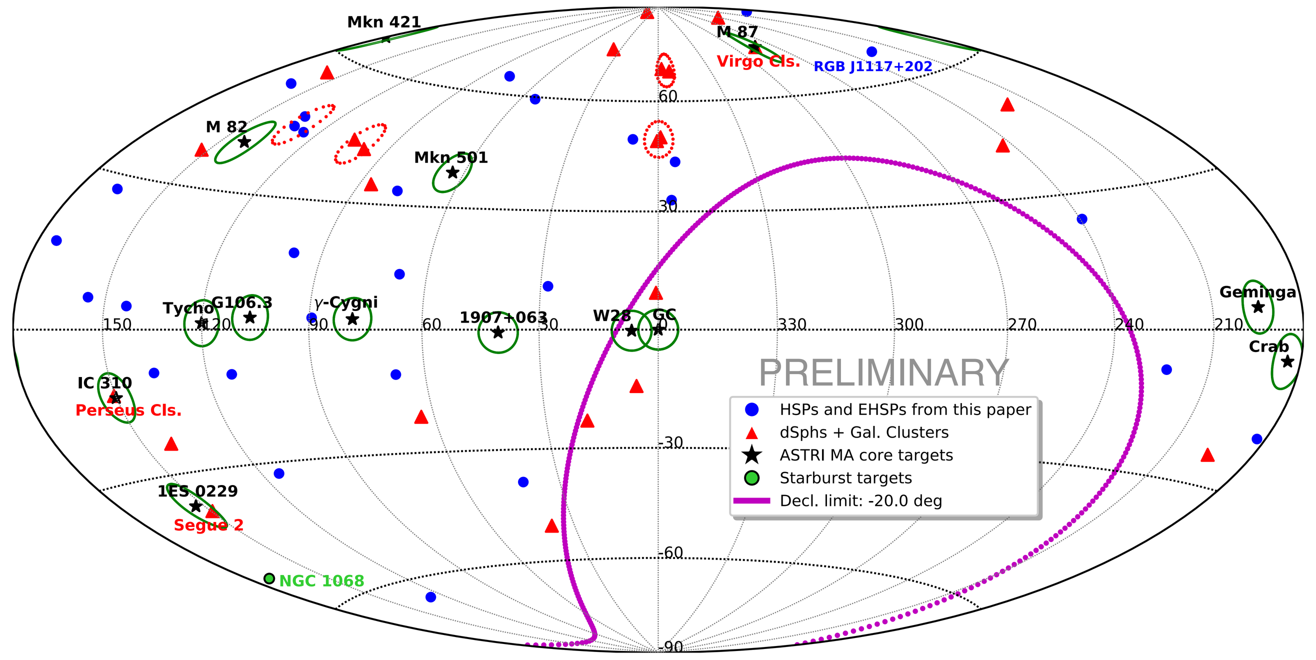

Fig. 1: Sky distribution of the ASTRI Mini-Array extragalactic targets (see legend). The position in Galactic coordinates of the ASTRI core-science targets (*black stars*) is also shown. A 5° radius circle is drawn around clustered extragalactic targets to be potentially observed in a single joint exposure (*red dotted circles*). Core-science targets (*green solid circles*) are also highlighted. The assumed limit on source declination for targets visible from the *Observatorio del Teide* (*purple line*) is indicated.

STUDY OF THE MULTI-TeV γ-RAY EMISSION FROM AGN

AGN represent the largest sample of extragalactic γ-ray emitters. Among them, blazars are dominated by non-thermal γ-ray emission from a plasma jet [5], which can reach energies >100 GeV in the so-called high-synchrotron peaked blazars (HSPs) [6] and in some cases >1 TeV ("extreme" HSPs, EHSPs) [7]. Seyfert galaxies are also found to emit γ-rays [8], but the precise origin of this emission is still unknown [9].

We investigate simulations of the two closest blazars Mkn 421 and Mkn 501, of the HSP RGB J1117+202 [10] and of the Seyfert 2 NGC 1068 to quantify the capabilities of the ASTRI Mini-Array to detect and study AGN spectral features. We find that, depending on the source state, observing times from ~1 h to ~200 h may allow for the characterizaton of γ-ray spectral features of blazars (e.g., emission lines [11]), unveiling the signal of sources still undetected with current IACTs, and potentially testing different emission models in Seyferts galaxies (Fig. 2).

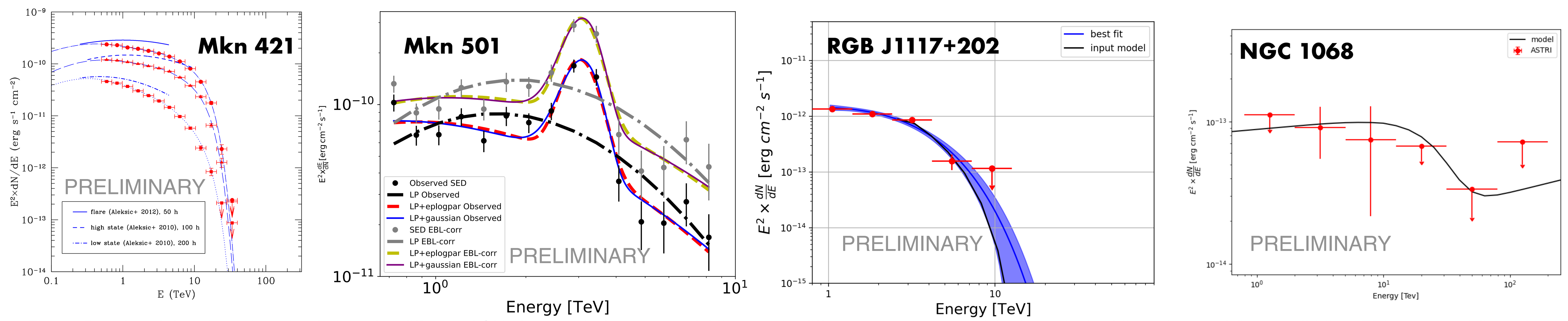

Fig. 2: Results of the observing simulations for different AGN classes. *Leftmost panel*: Mkn 421 in different source states (*dot-long-dashed line*: observed flare, *solid line*: EBL-corrected flare, *long-dashed line*: observed high state, *short-dashed line*: EBL-corrected high state, *dotted line*: observed low state, *short-dot-dashed line*: EBL-corrected low state) for different exposure times (50 h, 100 h, 200 h respectively). *Left middle panel*: short-duration (1-h exposure) simulation of the Mkn 501 γ-ray narrow emission feature in the high state (both observed and EBL-corrected). *Right middle panel*: spectrum of RGB J1117+202 observed in 200 h. *Rightmost panel*: simulated γ-ray spectrum of NGC 1068 for 200-h observations.

INDIRECT DARK MATTER SEARCHES IN DWARF SPHEROIDAL GALAXIES

A frontier of indirect DM searches is represented by the identification of weakly interacting massive particles (WIMPs) that could annihilate or decay into γ-ray photons [12]. The most promising DM-dominated extragalactic sources are the dwarf spheroidal galaxies (dSphs) [13], due to their proximity ($d_\odot < 250$ kpc) and lack of background.

We consider the three best-choice dSphs Ursa Minor (UMi), Coma Berenices (CBe) and Ursa Major II (UMaII) [14], observed for 100 h each. For UMaII, we also perform 300-h observing simulations. We then derive constraints on the DM annihilation cross section and decay lifetime through a full-likelihood analysis chain [15].

The final 300-h sensitivity curves for single-target (UMaII) and stacked observations (UMi, CBe and UMaII) show that the ASTRI Mini-Array may provide constraints on the properties of DM particles comparable or better than those currently available, especially at multi-TeV masses (Fig. 3).

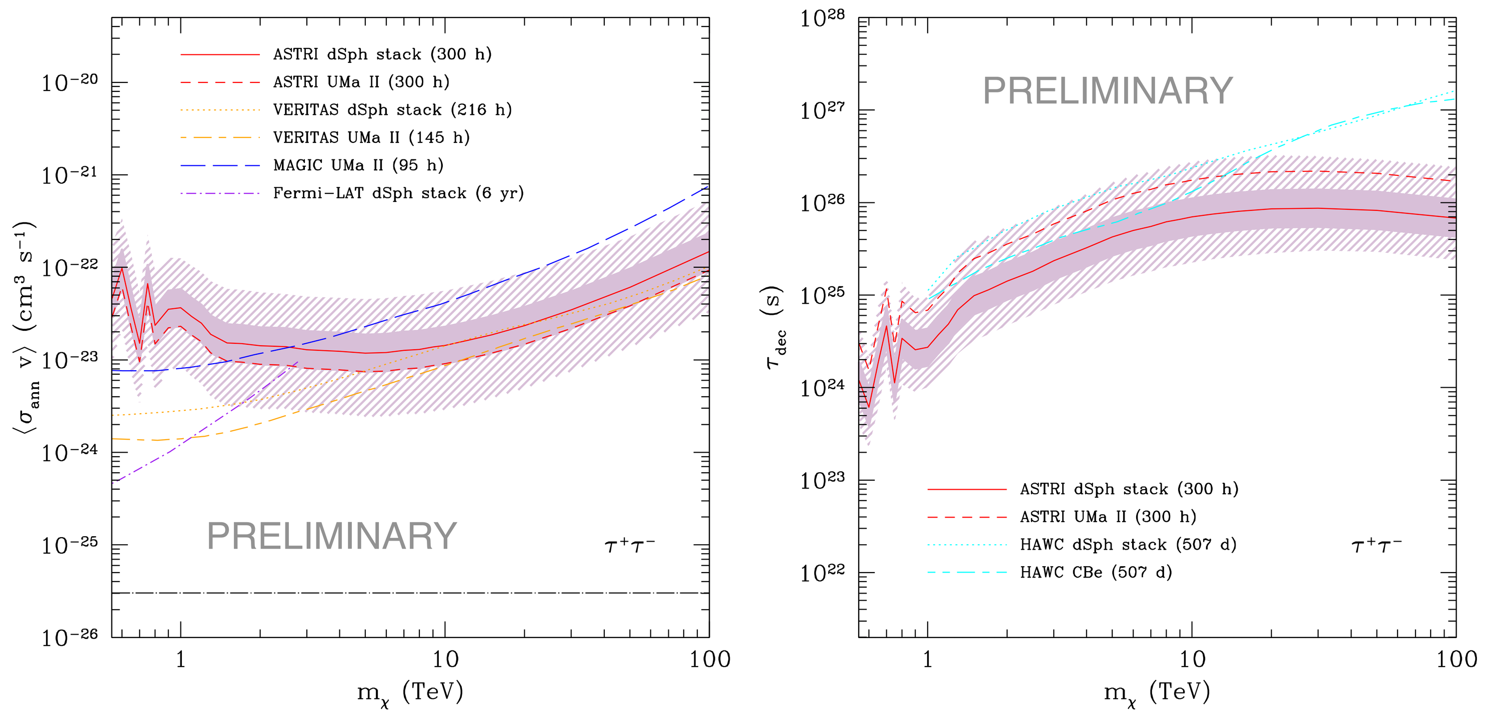

Fig. 3: Comparison between 300-h sensitivity limits to DM particle cross section (*left panel*) and lifetime (*right panel*) in the τ-τ channel for the three optimal dSphs stacked together and for UMaII alone — with 68% confidence error bands due to photon statistics (*pink shaded areas*) and uncertainties on the DM amount (*pink hatched areas*) — and the similar limits obtained by current space- and ground-based facilities for γ-ray observations (see legends for colors and line-styles).

ACKNOWLEDGEMENTS
We gratefully acknowledge support from the Italian Ministry of Education, University, and Research (MIUR) and the Italian Ministry of Economic Development (MISE).

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