The ASTRI Mini-Array: in search for hidden Pevatrons

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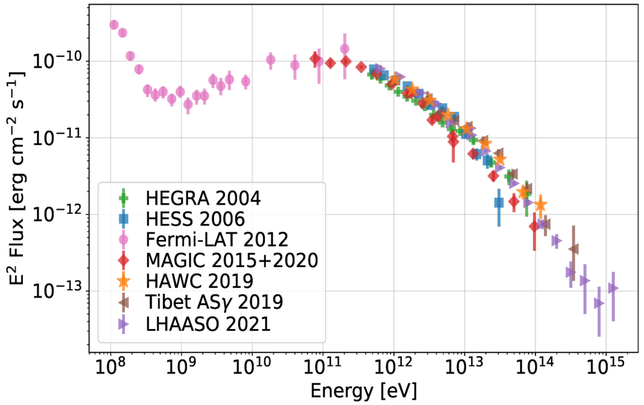
PeVatron context

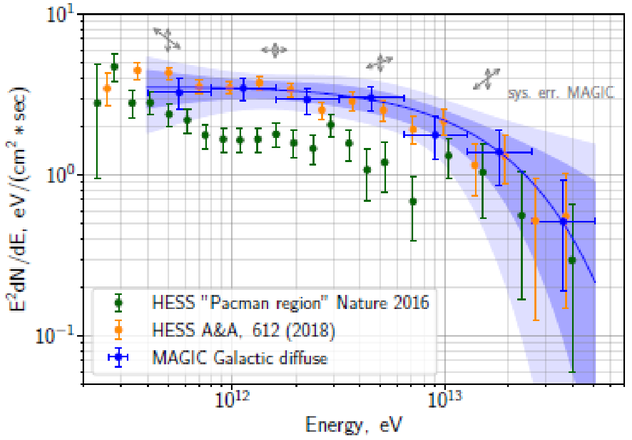
- In spite of the huge amount of collected data, Cosmic-Ray origin is still an open issue.
- Detection of hadronic PeVatrons (>100 TeV gamma-ray emission from protons with E>1 PeV) is the only direct proof of CR acceleration that we can have
- No Supernova Remnants (the main CR accelerator candidates) have been detected at these energies
- However, recent data show several different kinds of sources emitting at E ≥ 100 TeV

Crab and PWNe



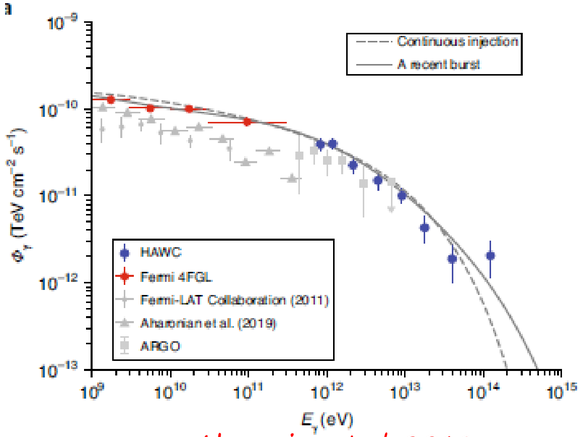
Tibet AS collaboration 2019, MAGIC collaboration 2020, LHAASO collaboration 2021, CAO et al. 2021, Amato&olmi 2022

Galactic Center

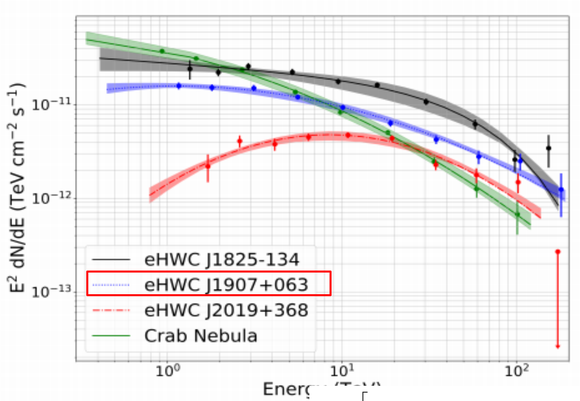


HESS collaboration 2016, 2018
MAGIC collaboration 2020

Massive Star clusters



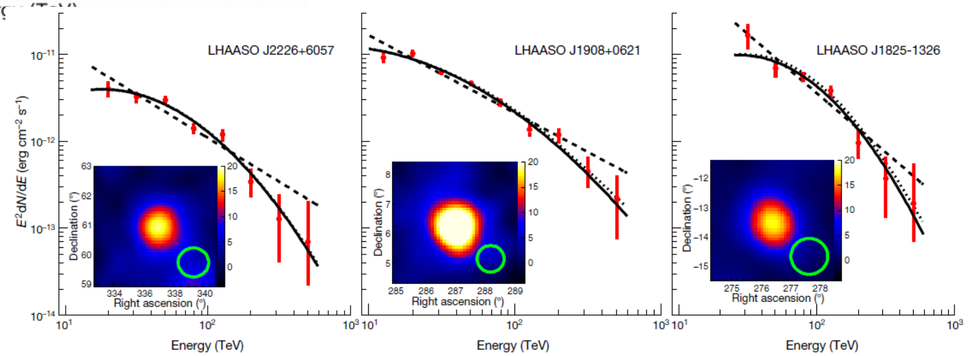
Aharonian et al. 2018
HAWC collaboration 2021



Abeysekara et al. 2020
Albert et al. 2020

HAWC and LHAASO sources

Cao et al. 2021



The Role of the ASTRI Mini-Array

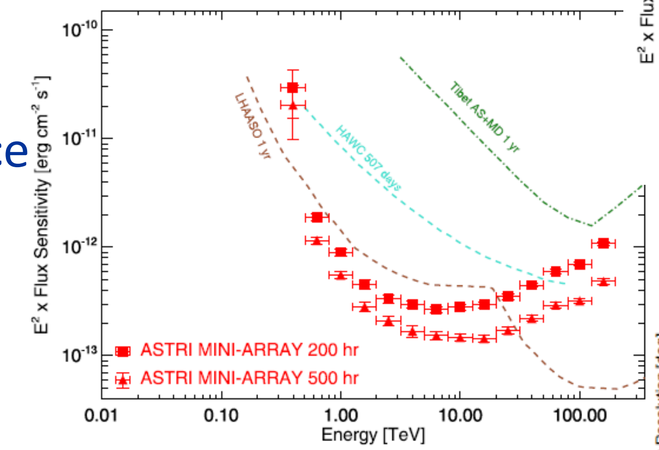
See Giuliani and Vercellone Talks

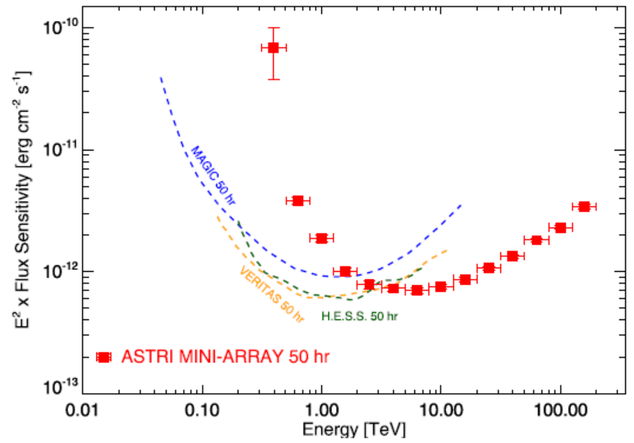
- Despite these new detections at E>=100 TeV, we still have no clear evidence of pure hadronic emission (and consequently CR acceleration proof) at energies above several tens of TeV
- The ASTRI Mini-Array, under construction at the Teide Observatory site (Tenerife, Spain), may shed light on this open issue

The ASTRI Mini-Array

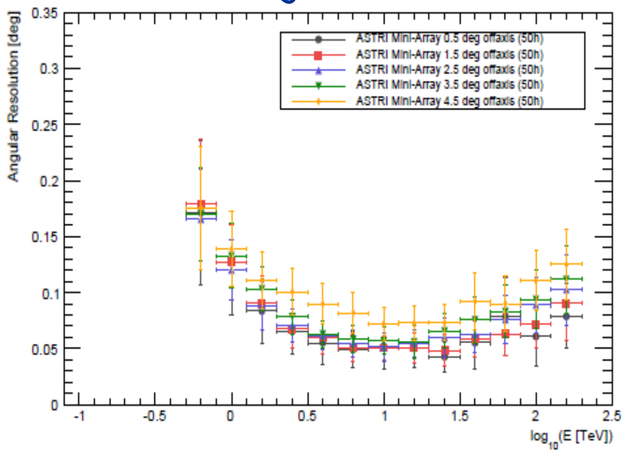
- Wide FoV with almost homogeneous off-axis acceptance
  - ✓ Multi-target fields, surveys, and extended sources
  - ✓ Enhanced chance for serendipitous discoveries
- Sensitivity: better than current IACTs (E > a few TeV):
  - ✓ Extended spectra and contsraints on cut-offs
- Energy/Angular resolution: ~10% / ~ 0.05° (E ~ 10 TeV)
  - ✓ Characterize extended sources morphology

ASTRI Mini-Array Sensitivity





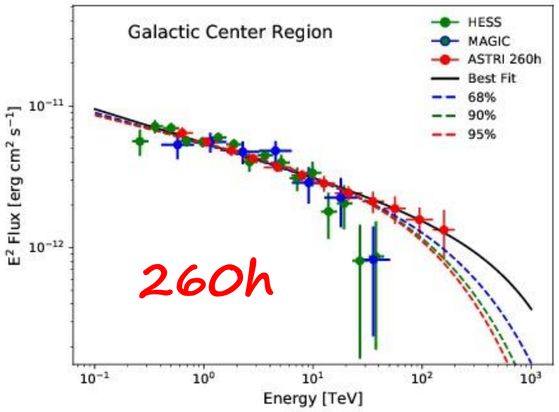
ASTRI Mini-Array Angular Resolution

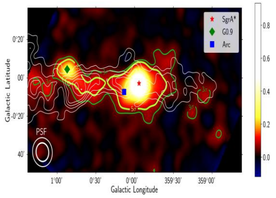


Vercellone et al., 2022, JHEAP, 35,1
Scuderi et al. 2022, JHEAP, 35, 52

Candidates Galactic Pevatrons with the ASTRI Mini-Array

Vercellone et al., 2022, JHEAP, 35,1



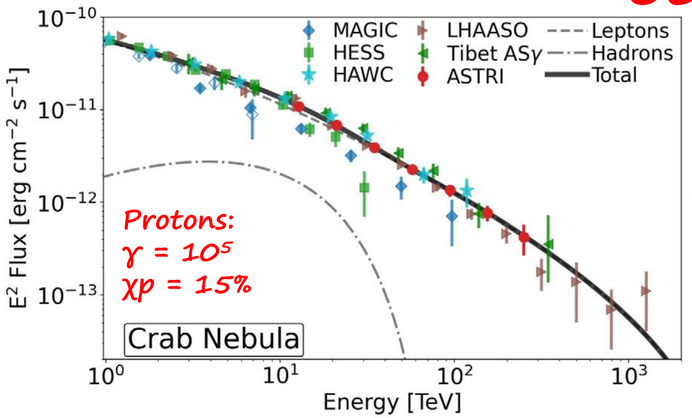


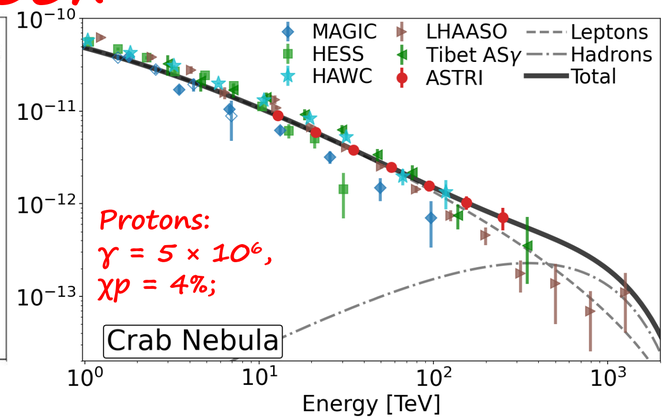
Acciari et al. 2020

Galactic Center (and superbubbles)

- With the same HESS exposure time, ASTRI Mini-Array will establish the likely PeVatron nature of the GC region
- Mapping of the whole GC region with a single observation (dimension 1,5°×0,2°)
- Resolving different sources in the region

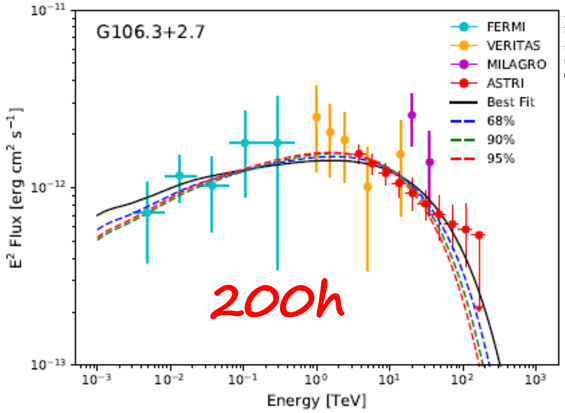
500h

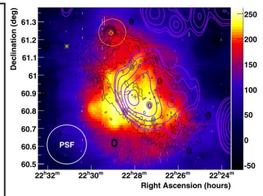




Crab Nebula (and PWNe)

- The ASTRI Mini-Array sensitivity will allow us to constrain the hadronic contribution in the Crab Nebula (and similar sources) → different fraction and energies of hadrons implies different behavior at the highest energies





SNRs (and other VHE detected sources)

- A detection with the ASTRI Mini-Array in 200 hr at E~100TeV will constrain the proton maximum energy up to energies ~500 TeV
- The ASTRI Mini-Array angular resolution will allow us to disentangle different components of the G106.3+2.7 region at different energies

Conclusions

What are the sources of Galactic Cosmic-Rays?

ASTRI Mini-Array has the needed potential to answer this question

- Improved sensitivity w.r.t. current IACTs at energies above a few TeV → detection of sources above 100 TeV and constraints on physical parameters (e.g. diffusion coefficient)
- Excellent angular resolution at very high-energies → morphology characterization and strong constraints to gamma-ray emission/Molecular Cloud association
- Larger FoV → large field (e.g. Galactic Center region) and extended sources (e.g. TeV halo) in-depth analysis

1 telescope operative → early 2023 (already on-site!!)

3 telescopes operative → by 2023

Complete Array→ by 2024