Cherenkov Telescope Array Observatory: another future player in the Northern sky

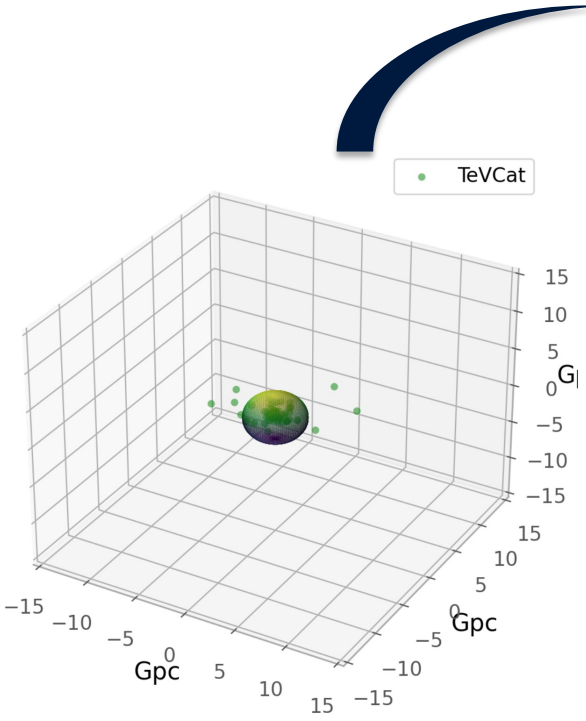
Roberta Zanin – CTAO Project Scientist
Roberta.Zanin@cta-observatory.org

Outline

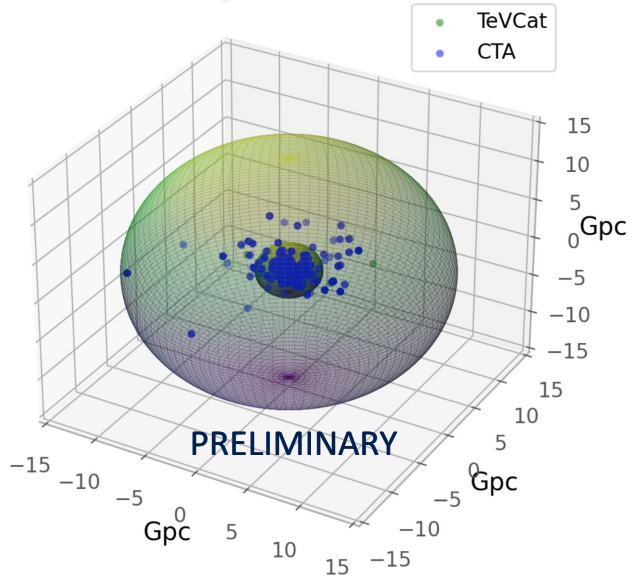
- Introduction to CTAO: why and how
- CTAO array performance
- Performance comparison: CTAO - ASTRI-MiniArray – LHAASO
- Conclusions

Design drivers for next generation IACT facility

- **SENSITIVITY x 10**
- **ARCMINUTE ANGULAR RESOLUTION**
- **10% ENERGY RESOLUTION**
- **WIDE ENERGY RANGE 20 GeV – 300 TeV**
- **FoV x 2**
- **FULL SKY COVERAGE**
- **30 s RESPONSE TO EXTERNAL ALERTS**



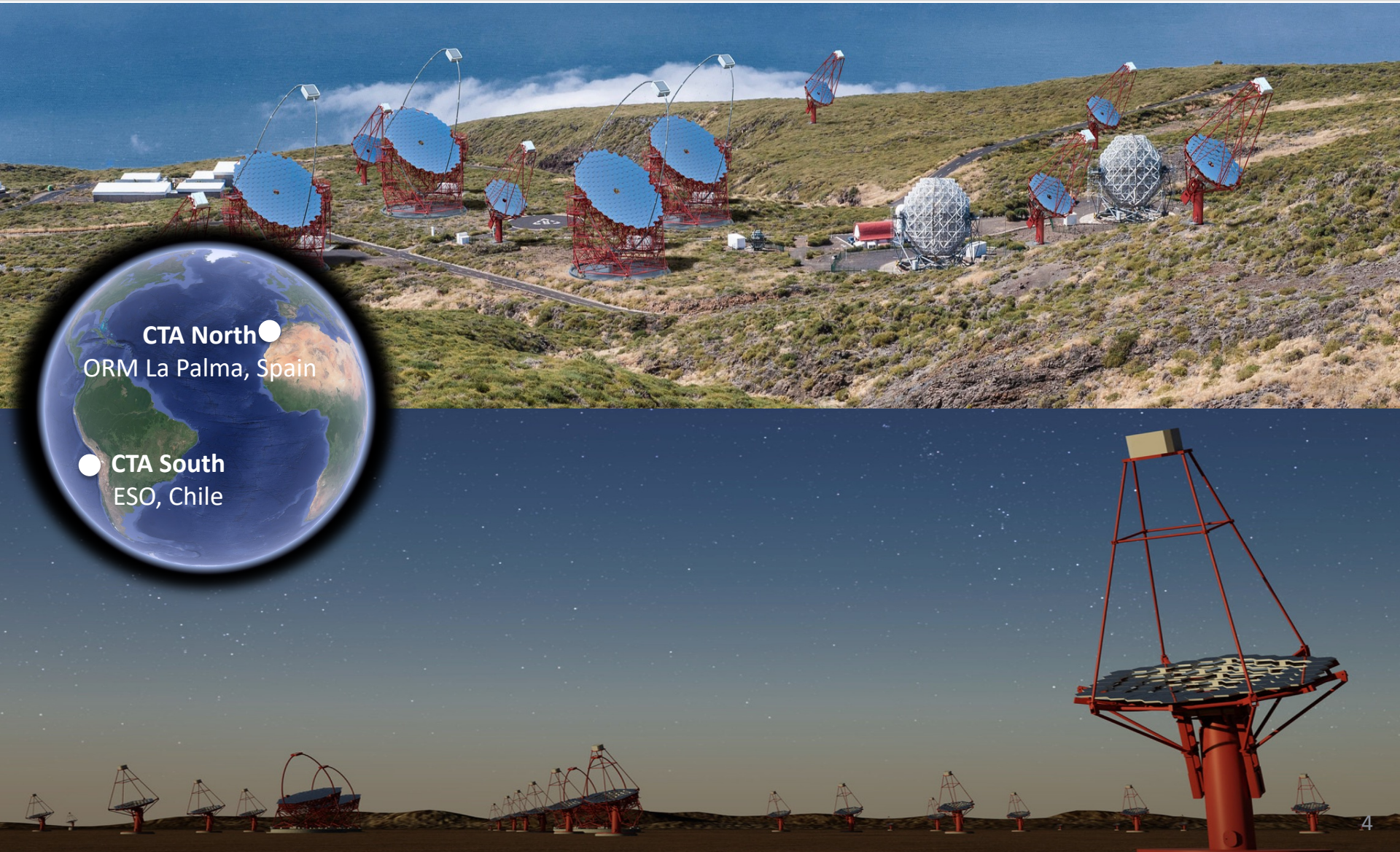
Energy Threshold ~ 80 GeV



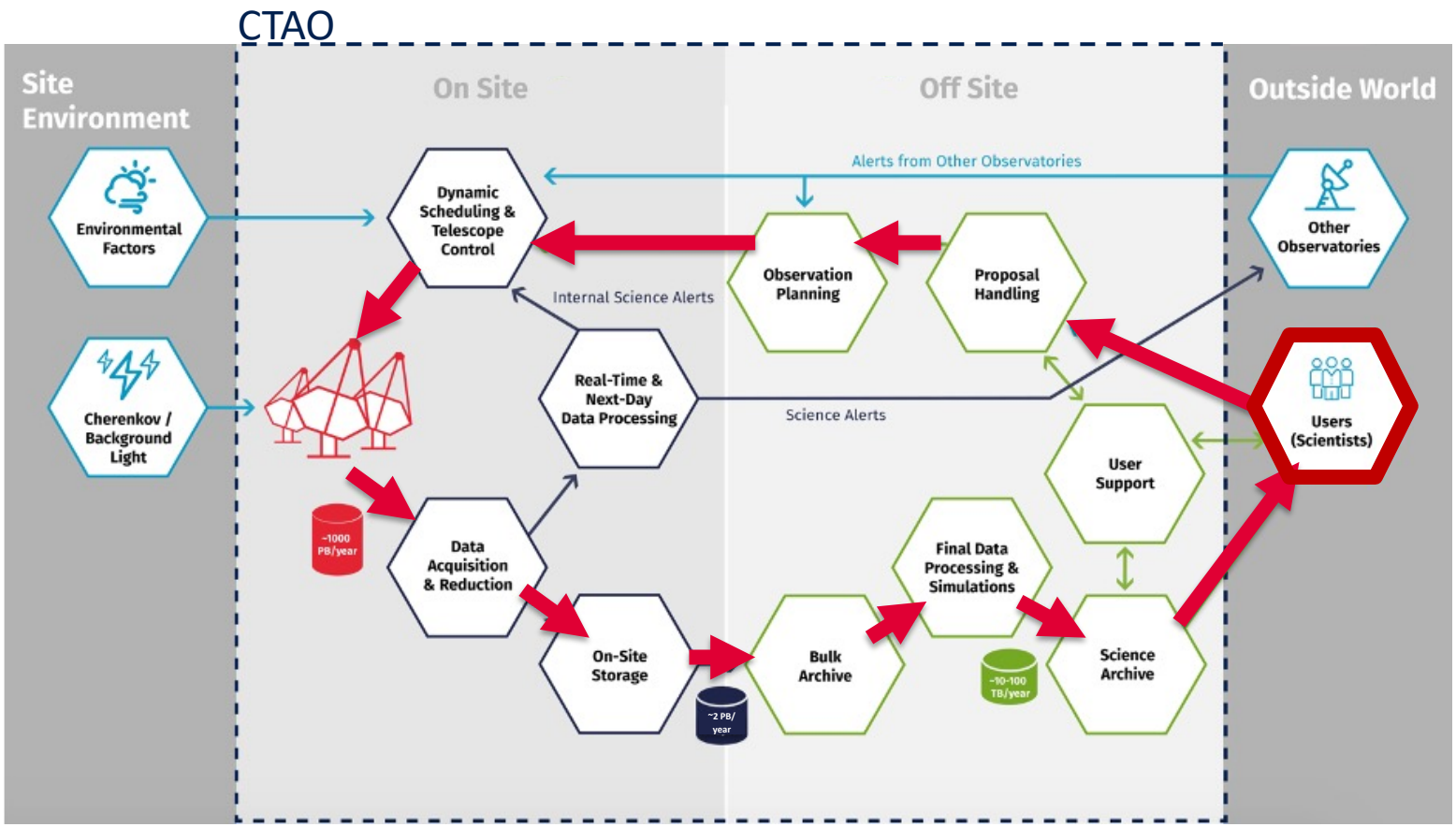
Energy Threshold ~ 20 GeV

Credits to J.P. Lenain

Full sky coverage

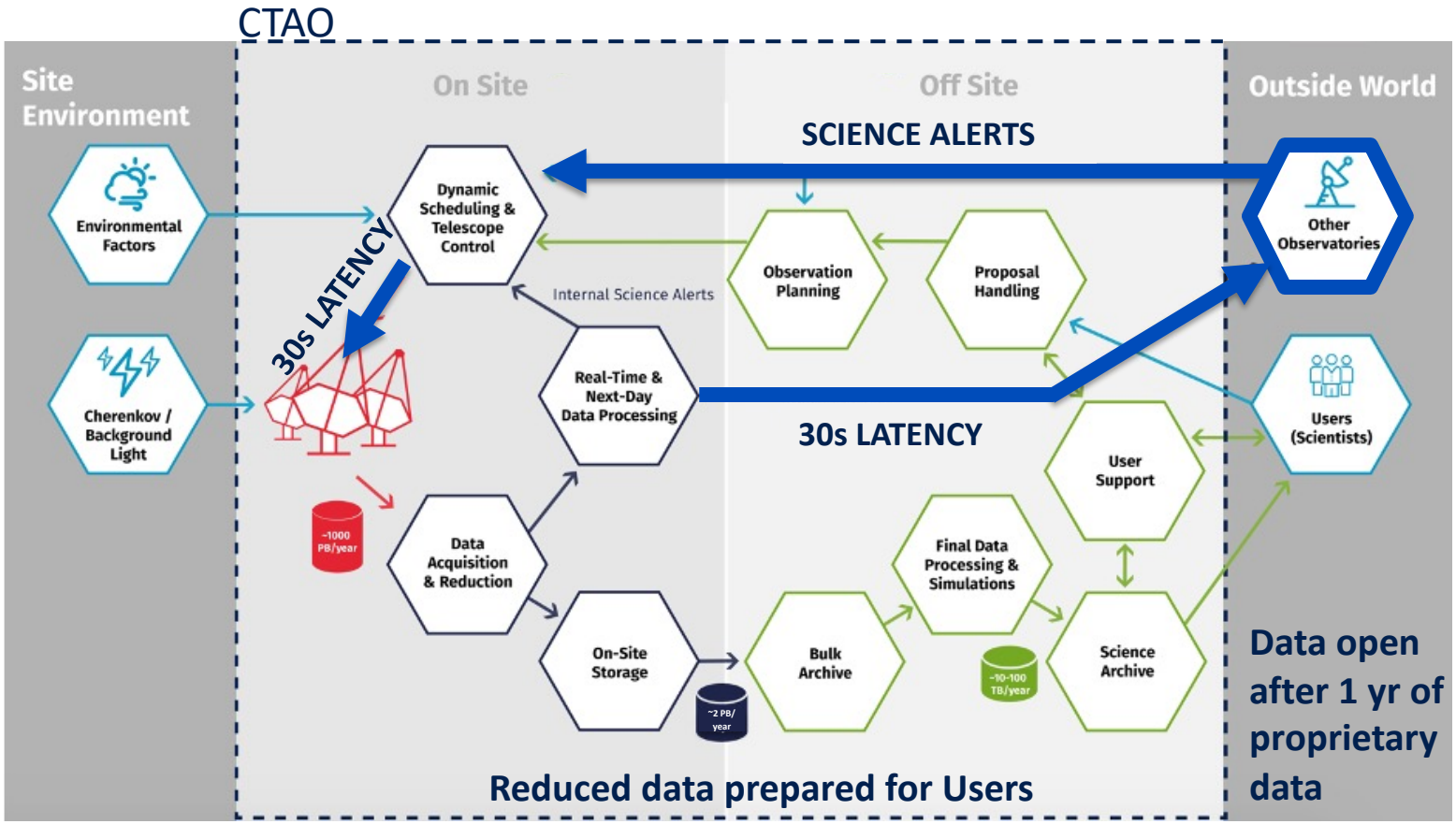


CTA Observatory



- **Proposal driven observatory**: standard proposals & Key Science Projects
- **Proposals evaluated on scientific merits** by a Time Allocation Committee

CTA Observatory



CTAO Construction phase is about to start

- **CTAO construction scope is agreed**
- The construction phase will start with the establishment of the final legal entity:

  CTAO European Research Infrastructure Consortium (ERIC)
  - by Summer / September 2023
  - last about 5 yr
- **Early science operations foreseen during the construction phase**

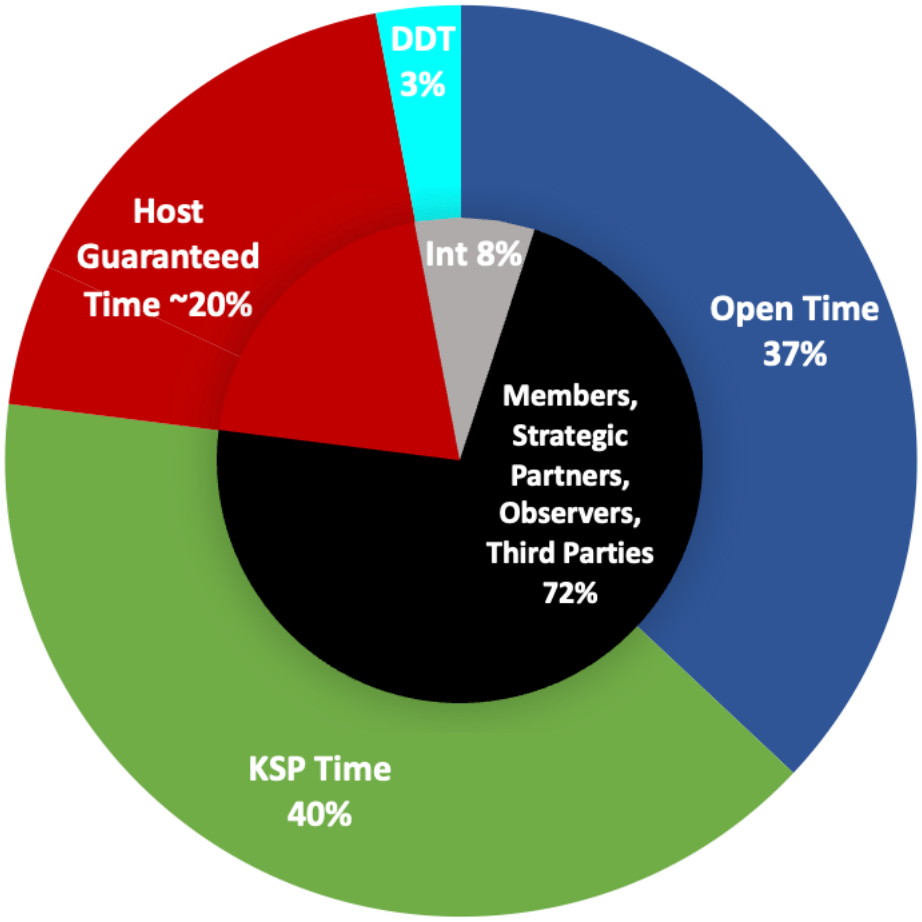
CTAO: 4 places of operations

geographically distributed:

- **headquarters in Bologna (Italy)**
- **science data management center in Zeuthen (Germany)**
- **two observation stations**

CTA Observatory

Access to observing time mainly allocated to CTAO ERIC members

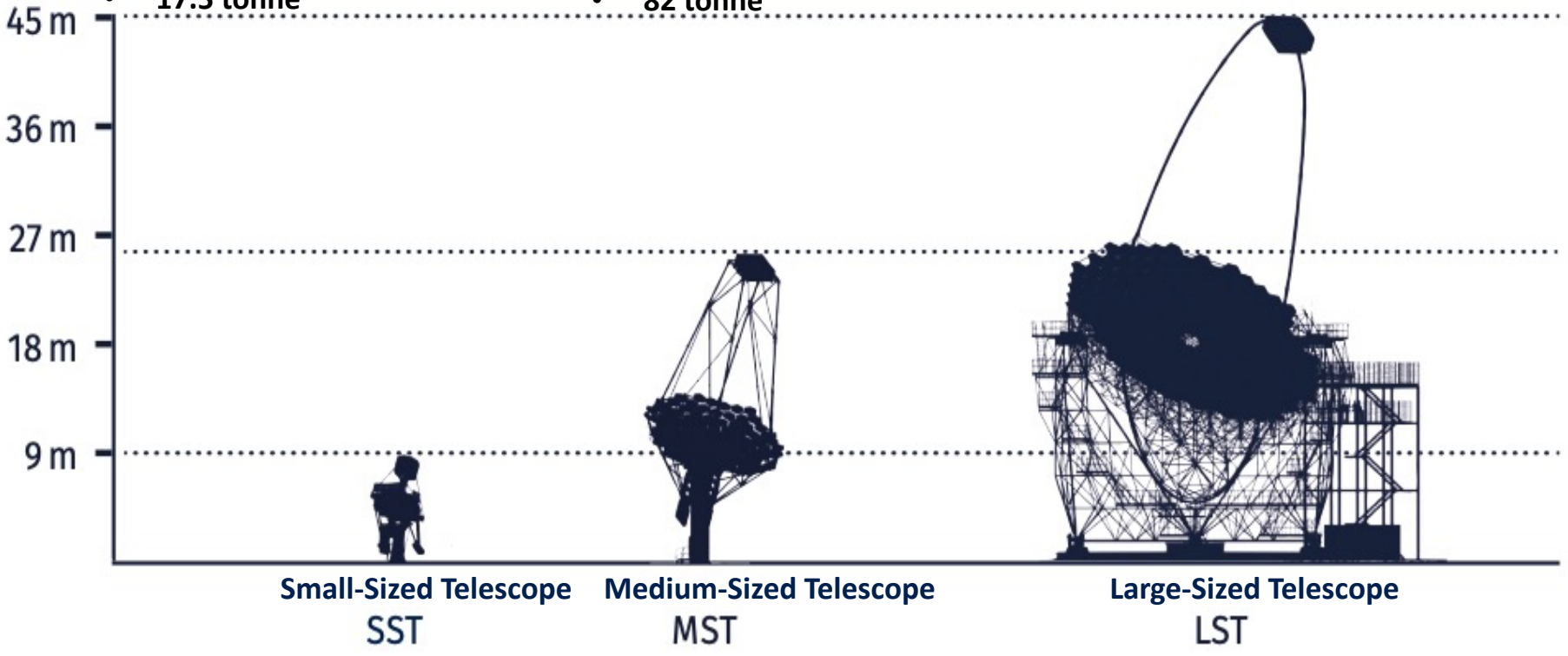


3 telescope designs

- 2-mirror Schwarzschild-Couder optical design
- 4.3 m ⌀ primary reflective surface
- SiPM camera: 2048 pixels (0.16°)
- 8.8° FoV
- 17.5 tonne

- Davies-Cotton optical design
- 12 m ⌀ reflective surface
- PMT camera – 2 designs:
  - NectarCam: 1855 pixels
  - FlashCam: 1764 pixels
- ~7° FoV
- 82 tonne

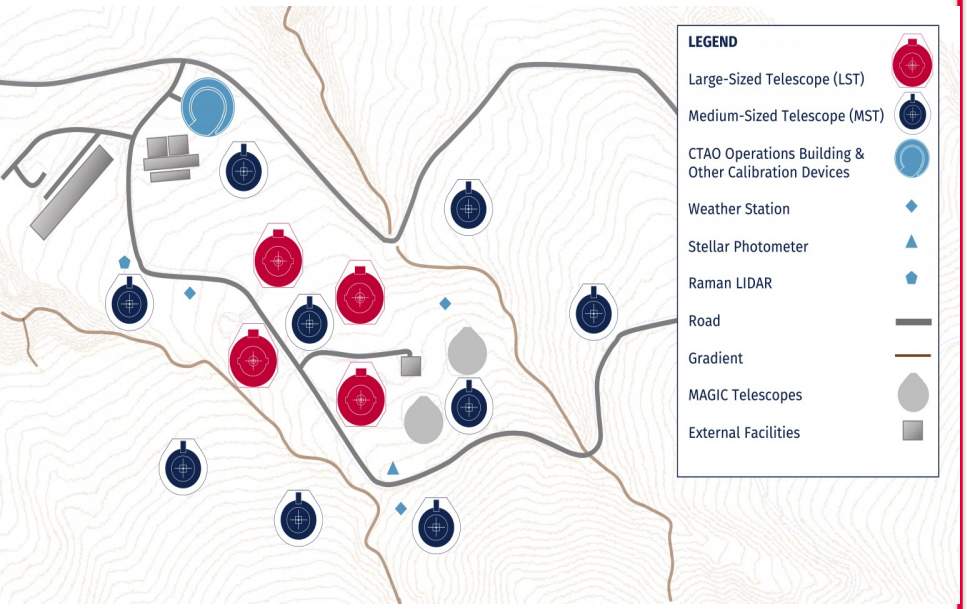
- Parabolic optical design
- 23 m ⌀ reflective surface
- PMT camera: 1855 pixels (0.1°)
- 4.3° FoV
- 100 tonne



The two initial CTAO arrays: the Alpha Configuration

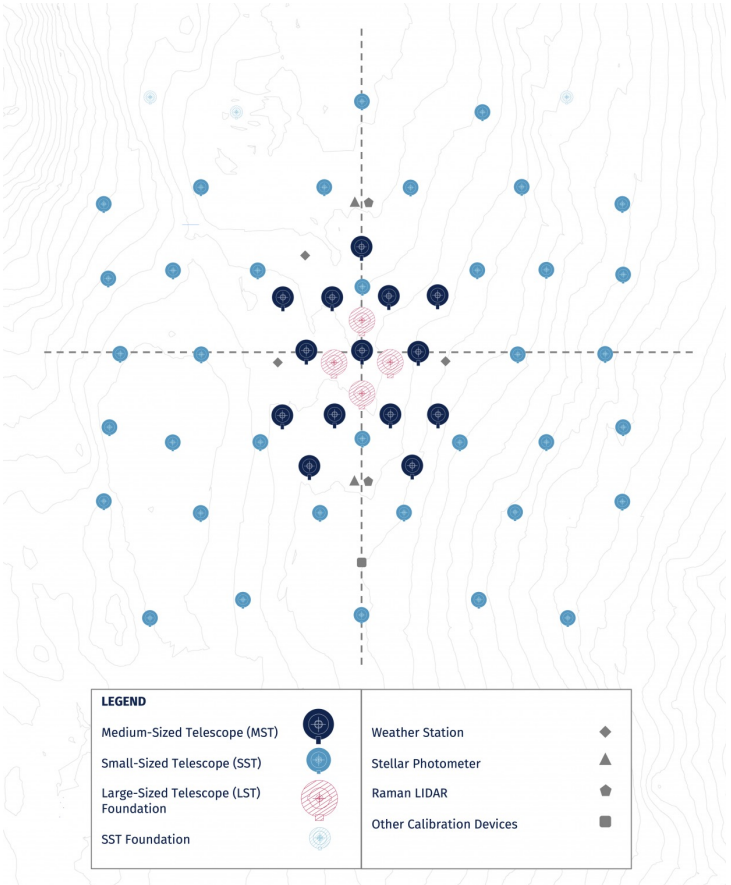
CTAO Northern Array

- **4 LSTs + 9 MSTs**
- 0,025 km^2 footprint
- focus on extra-Galactic science

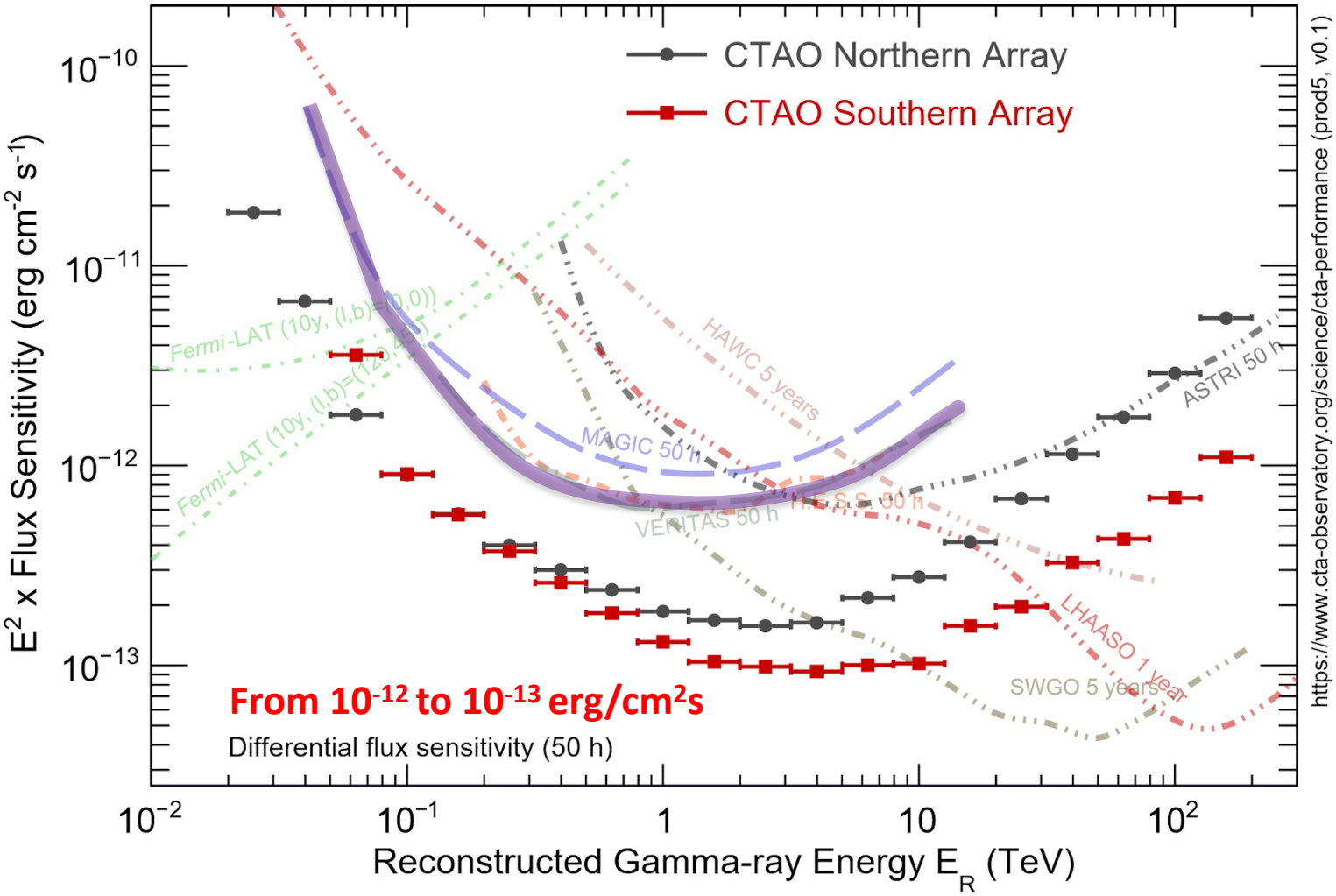


CTAO Southern Array

- **14 MSTs + 37 SSTs**
- 3 km^2 footprint
- focus on Galactic science

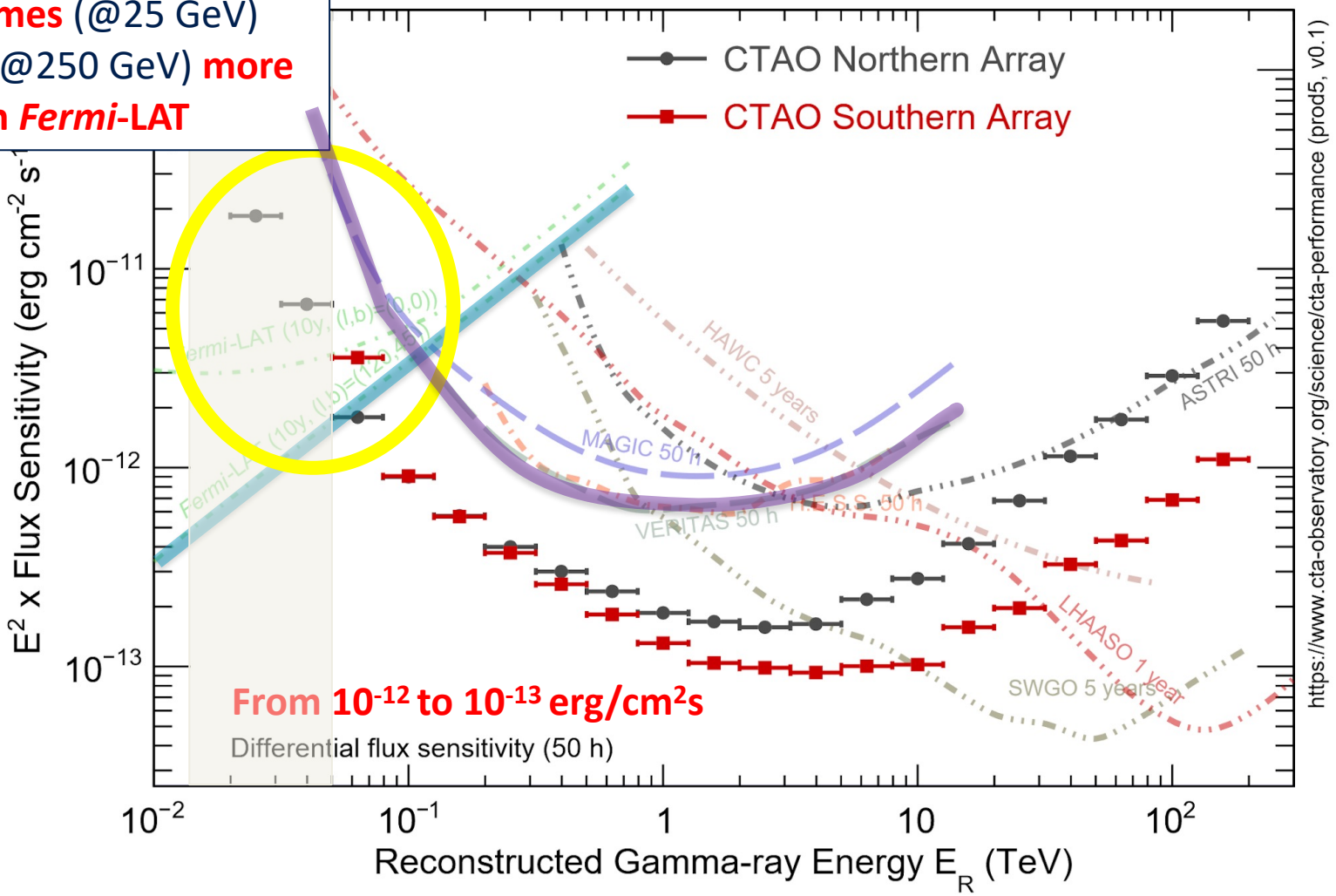


CTAO performance (Alpha Configuration)



CTAO performance (Alpha Configuration)

On time scales <1 h
CTAO is **10^3 times** (@25 GeV)
to **10^6 times** (@250 GeV) **more sensitive than *Fermi*-LAT**



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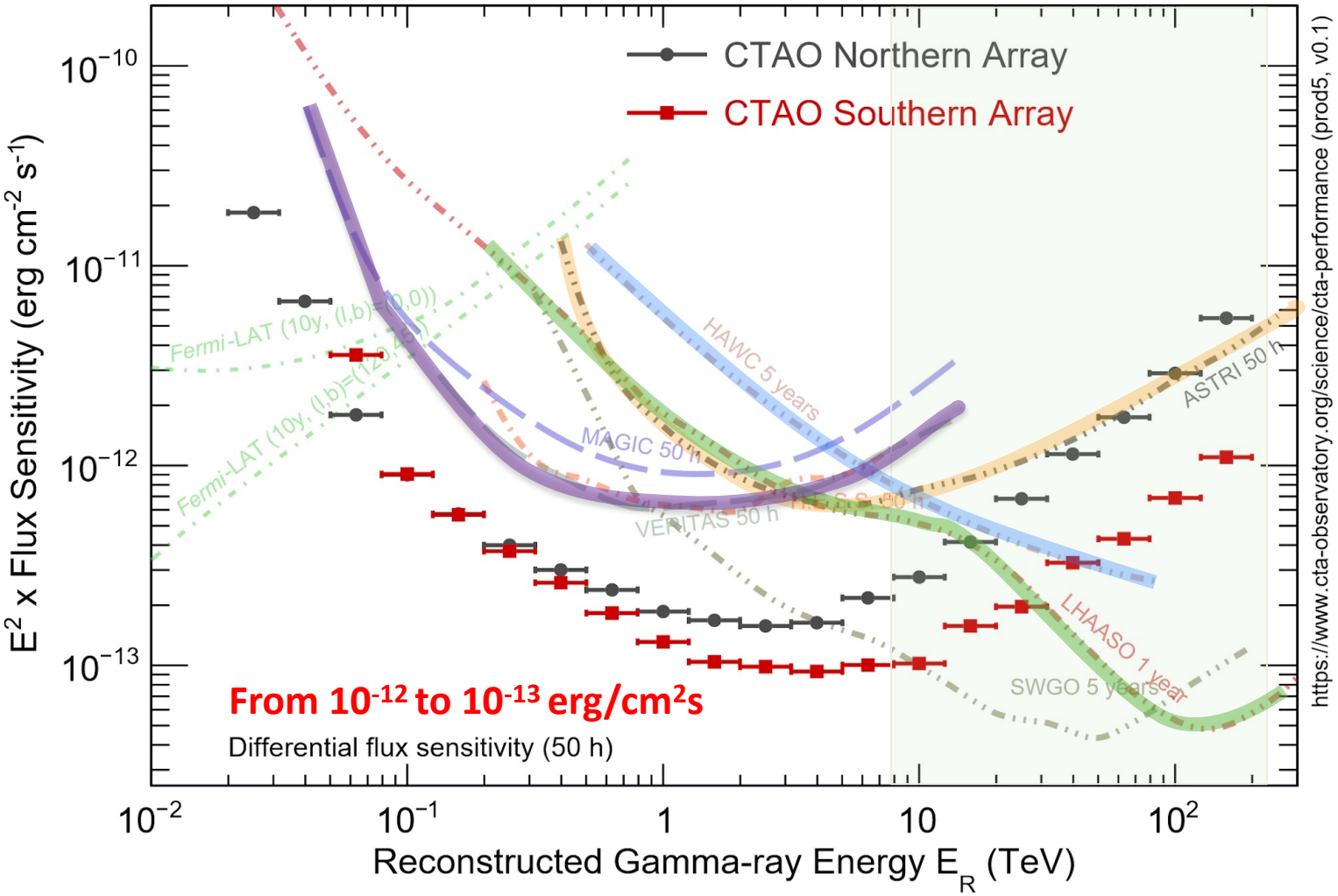

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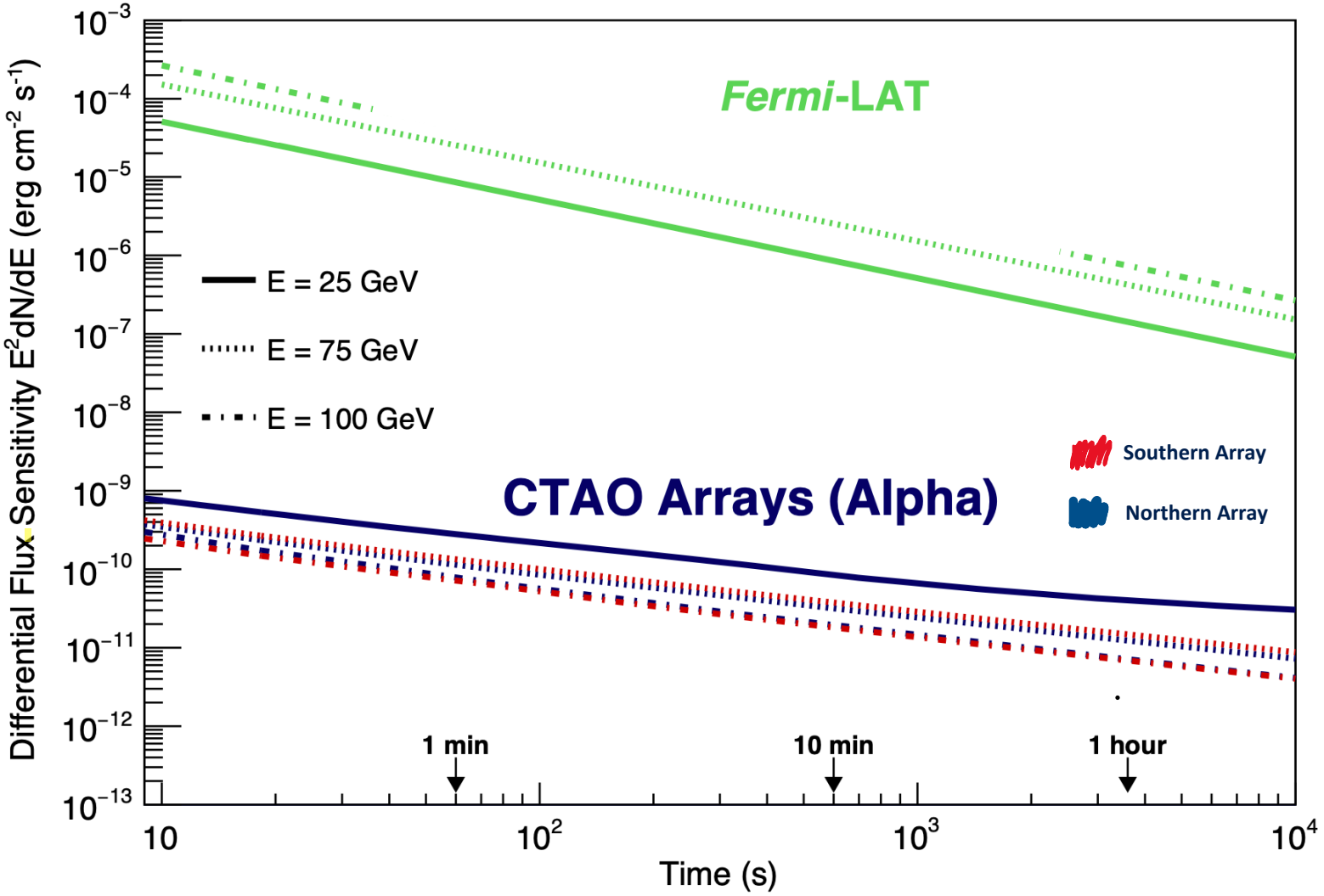

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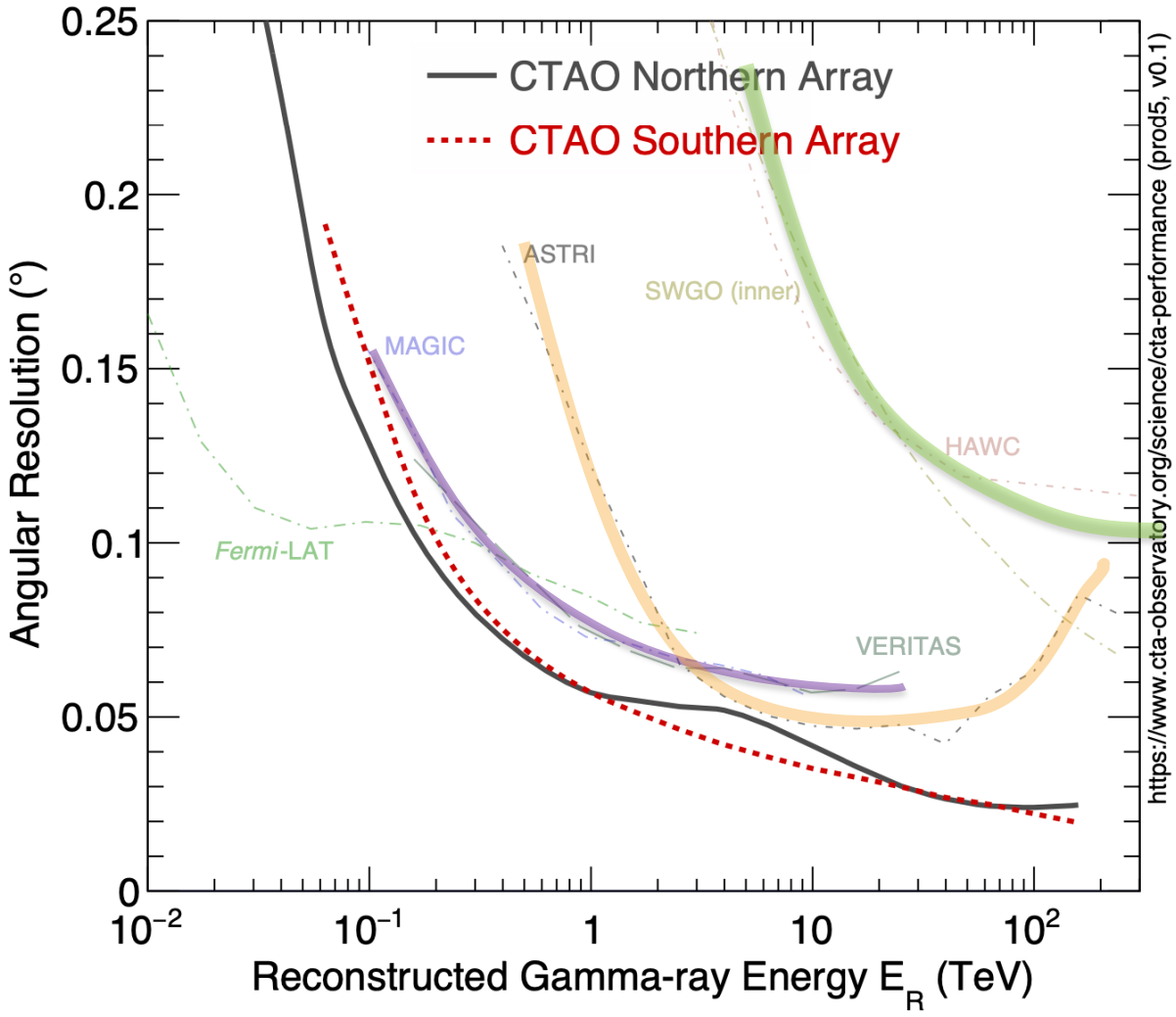

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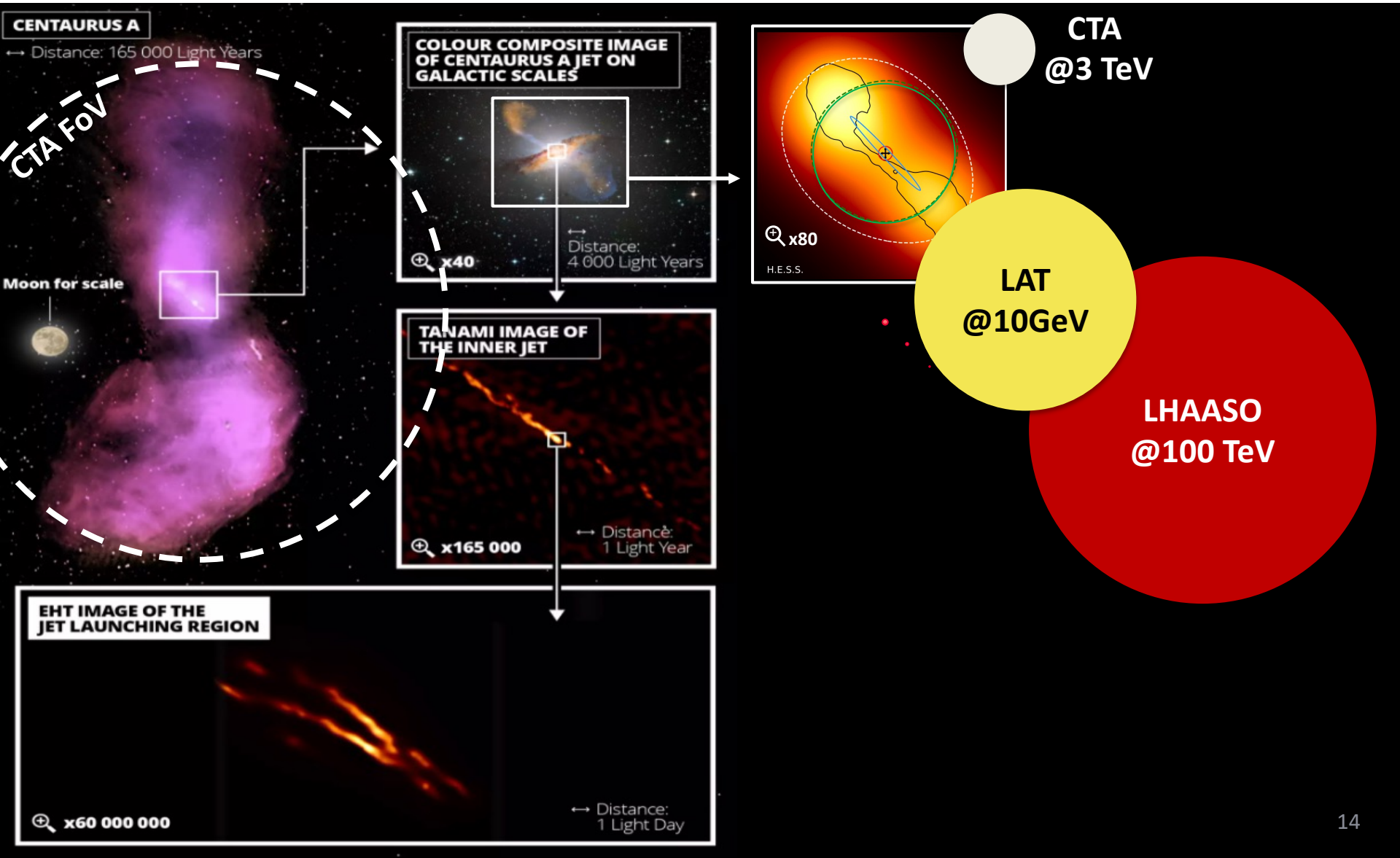
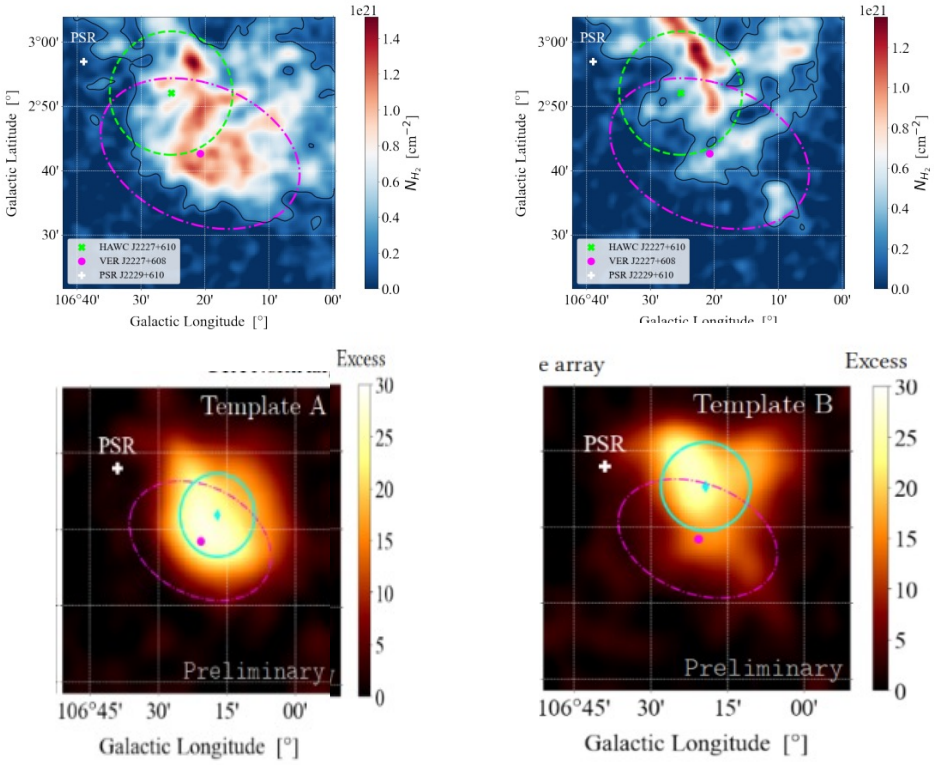


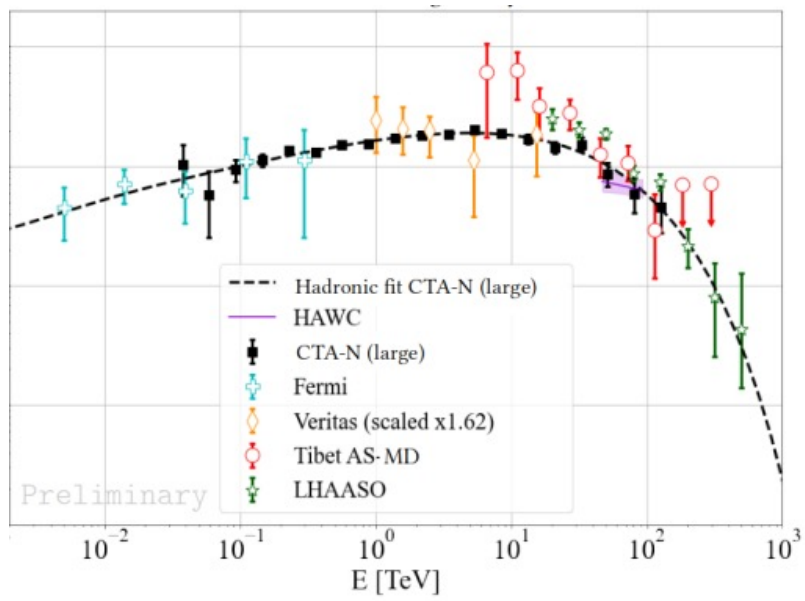
IACT arrays & particle shower detector: complementary techniques

- Each of these detection techniques has its own strenght: angular resolution versus sensitivity (both energy dependent) & also different duty cycles

- Just their complementarity can help addressing the still open questions:
  - source discoveries vs detailed physical studies
  - different performances in distinct energy bands

IACT arrays & particle shower detector: complementary techniques





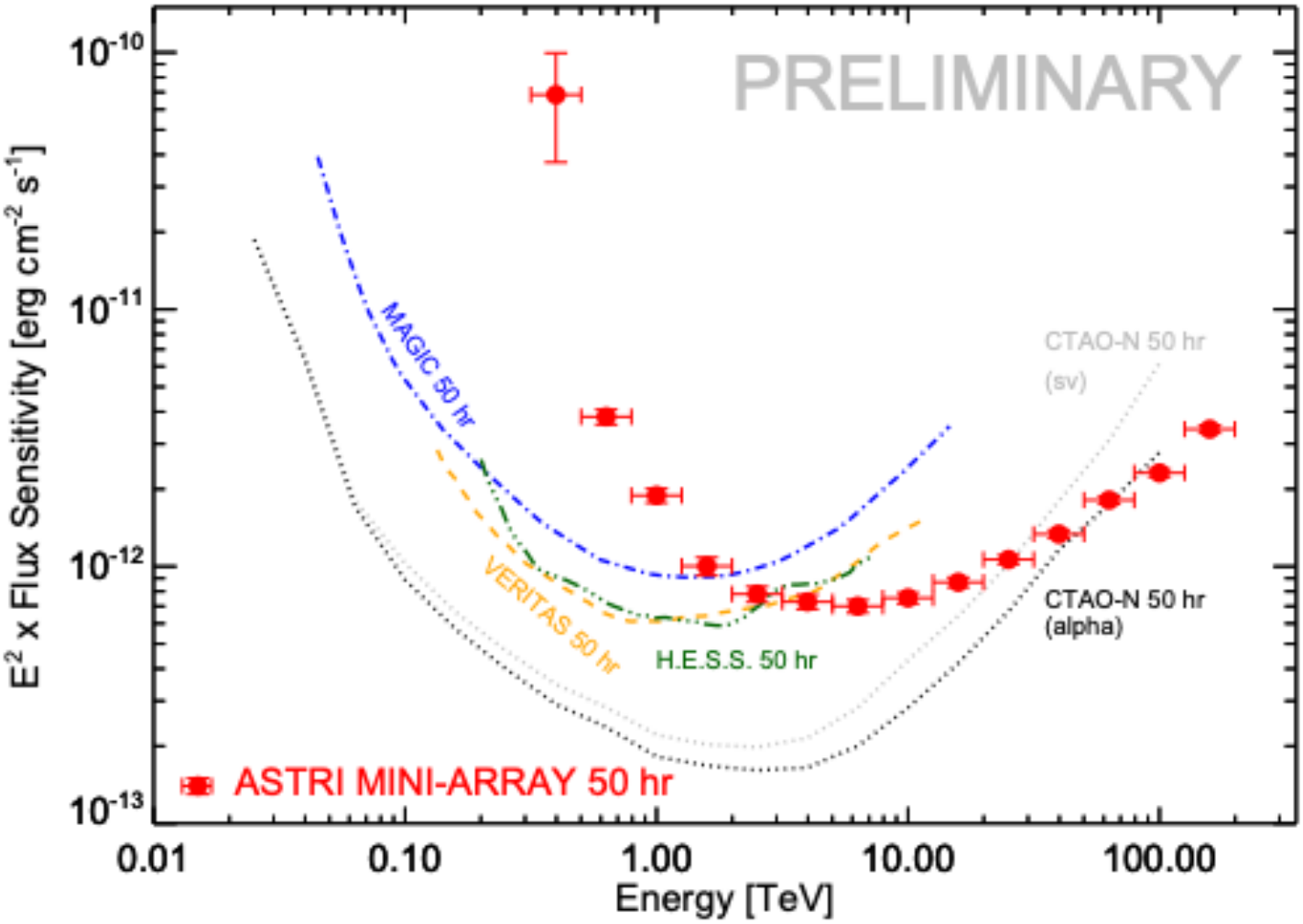
morphological studies will do the game thanks to the excellent angular resolution

CTAO will be able to detect the spectral cutoff at ~50 TeV in 50 hr at more than 5σ

not enough to disentangle between hadronic or leptonic origin

Credits to G. Verna

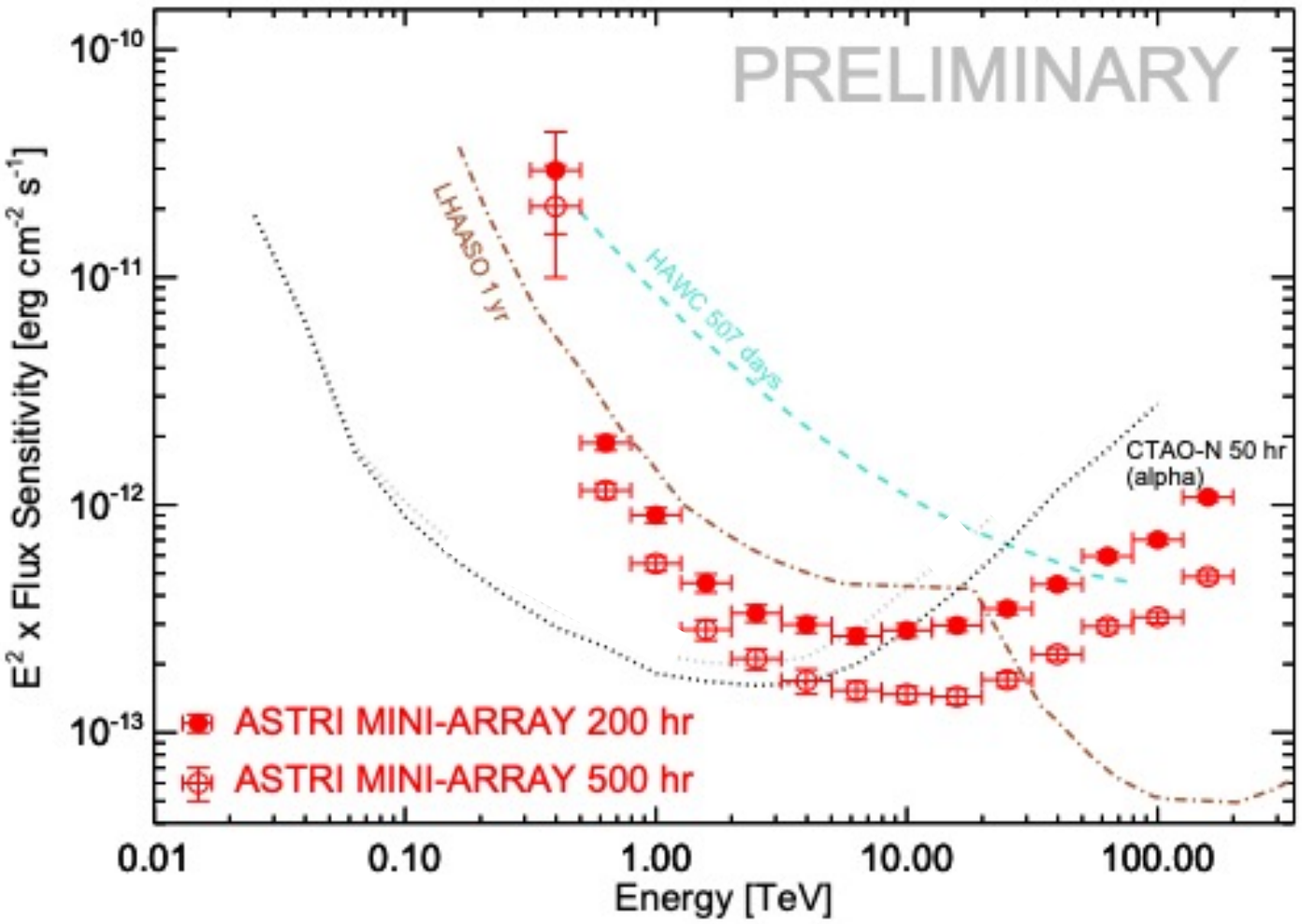
Comparison between similar techniques



Credits to S. Vercellone

- Key point: these instruments have different schedules

Comparison between future facilities



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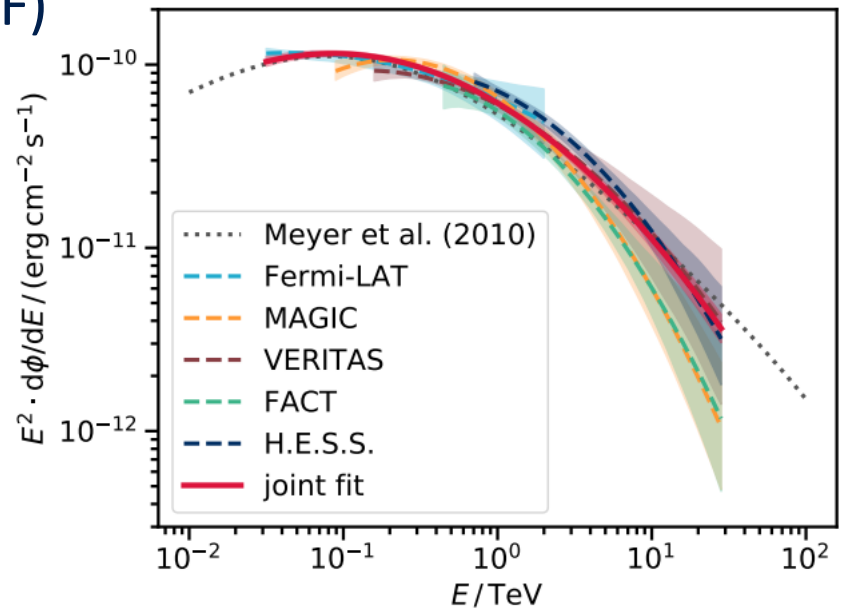
Take-away message

- Particle shower detectors and IACT arrays have both been proven successful
- Larger scientific exploitation can be obtained by fostering synergies between the future facilities of both kinds keeping in mind the access policies and their construction schedules
- IACT arrays are coming in with excellent angular and energy resolution, whereas LHAASO and potentially SWGO (can) provide an unprecendented sensitivity at >>50 TeV

Preparing our future…

- We should certainly explore synergies CTAO Northern array and ASTRI both during early science and later one
  - without discussing the access policies of the two facilities, we should aim to guarantee same data model/format to be able to combine the data (well on track thanks to VODF)

- Same argument applies to LHAASO as well but there more effort is needed



cherenkov telescope array

Thank you