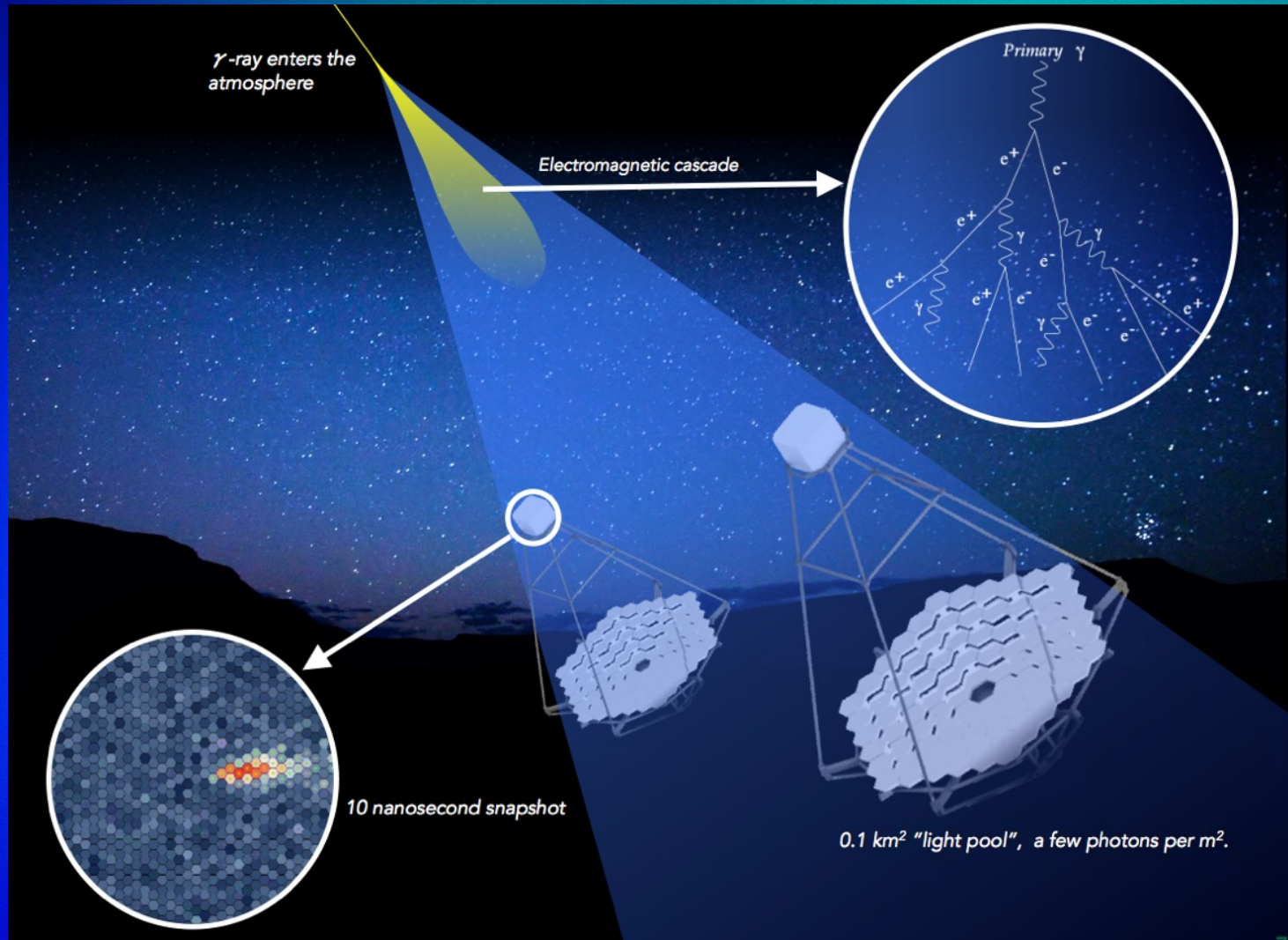


The Cherenkov Telescope Array Observatory: Construction Progress, and the Spanish Contribution

XVII CPAN Days, Valencia, November 2025

Igor Oya, CIEMAT.
CTAO Array Control and Data Acquisition Coordinator, Computing Deputy Coordinator.

Imaging Atmospheric Cherenkov Telescopes

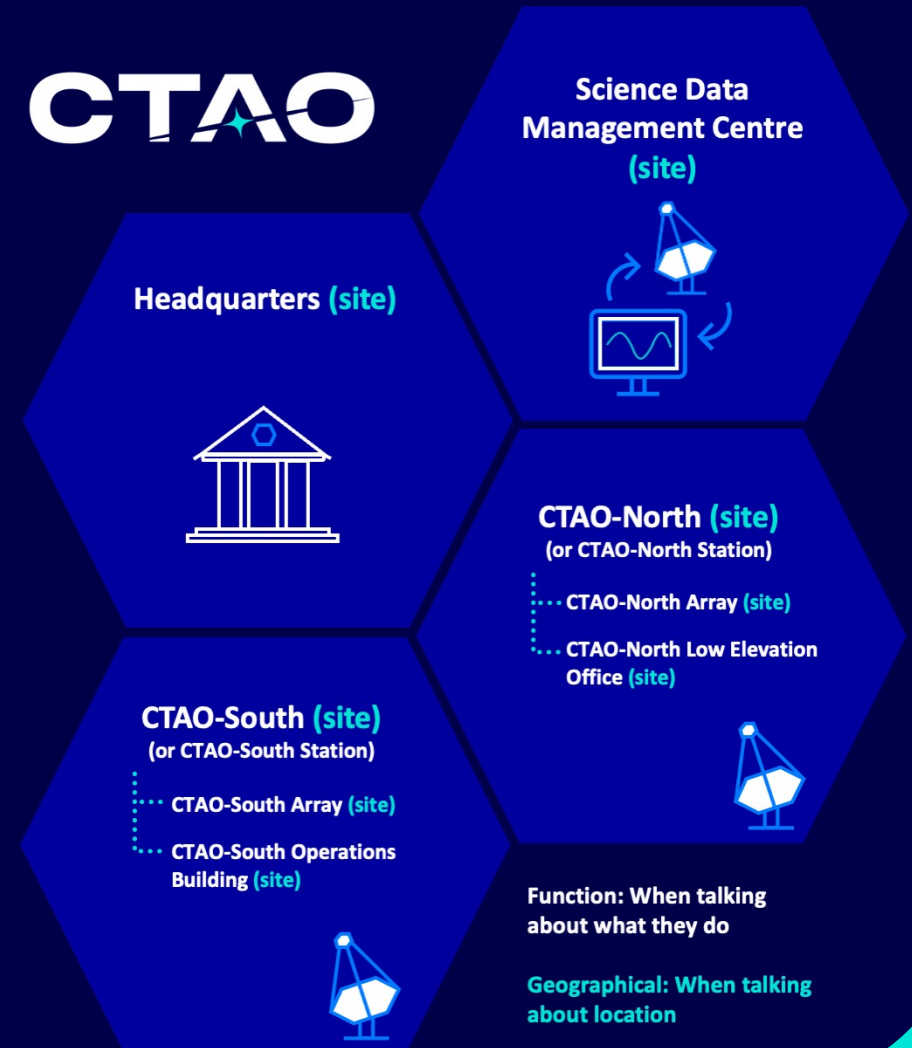
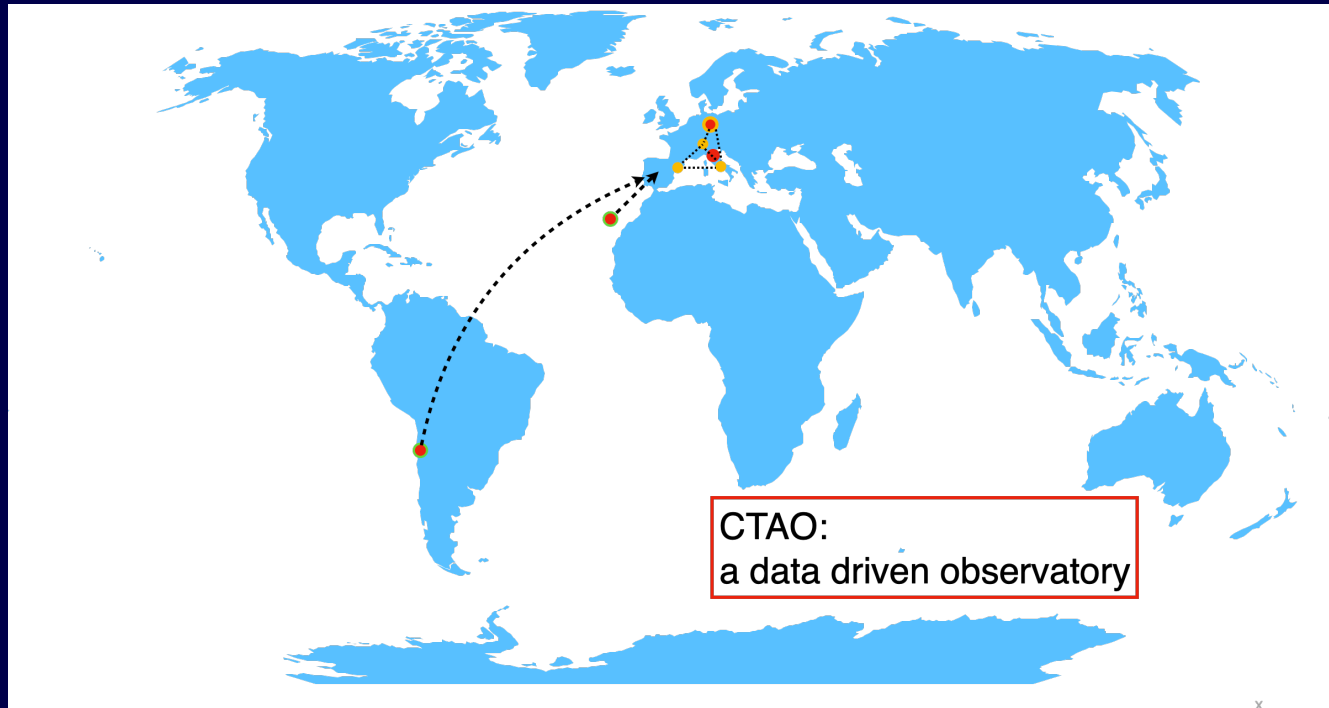


CTAO

CTAO figures:

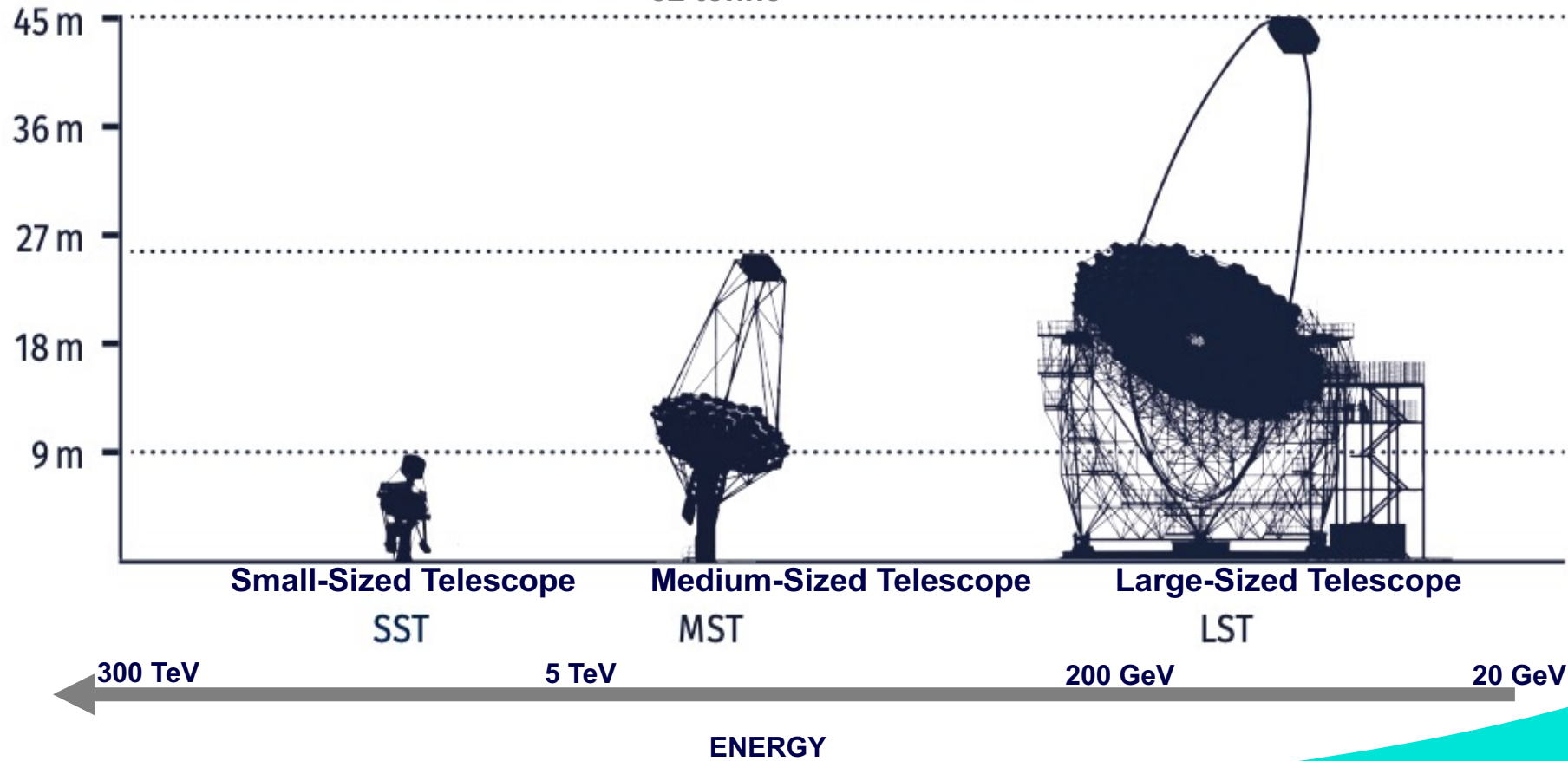
- Large collection areas ($10^5 - 10^6$ m²)
 - Excellent background rejection power
 - Wide energy range 20 GeV – 300 TeV
 - Good energy (15 to 7%) and angular resolution (0.15 – 0.02 deg)
 - Reaction to external science alerts and fast repositioning (30 s to point towards any direction in the sky)
 - Real-time analysis and internal science alerts
 - Big Data: 10s of PB/y of raw data
-
- The VHE sky is more populated than initially expected!

CTAO: A Distributed Facility



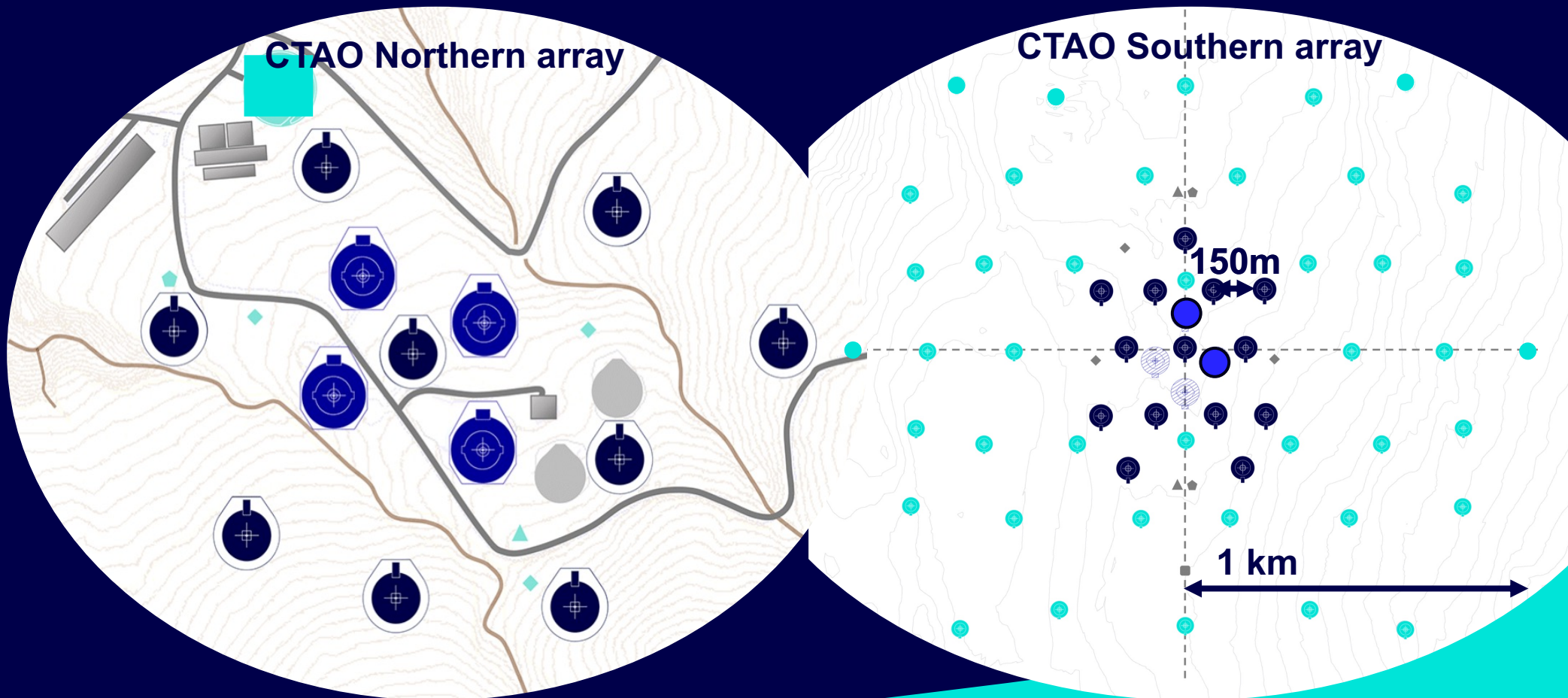
3 telescope designs

- 2-mirror Schwarzschild-Couder optical design
 - 4.3 m \varnothing primary reflective surface
 - SiPM camera: 2048 pixels (0.16°)
 - 8.8° FoV
 - 17.5 tonne
- Davies-Cotton optical design
 - 12 m \varnothing reflective surface
 - PMT camera – 2 designs:
 - NectarCAM: 1855 pixels
 - FlashCam: 1764 pixels
 - $\sim 7^\circ$ FoV
 - 82 tonne
- Parabolic optical design
 - 23 m \varnothing reflective surface
 - PMT camera: 1855 pixels (0.1°)
 - 4.3° FoV
 - 100 tonne



Two observation stations, one unique observatory

Improved Alpha configuration



CTAO – The ERIC Established

- CTAO European Research Infrastructure Consortium (ERIC) Established on January 7th, 2025
- The ERIC provides the CTAO with the legal stability and administrative advantages

Members of the CTAO ERIC

- Austria
 - Croatia
 - the Czech Republic
 - the European Southern Observatory (ESO)
 - France
 - Germany
 - Italy
 - Poland
 - Slovenia
 - Spain
 - Switzerland
- In addition, in process of joining the CTAO ERIC as Strategic Partners or Third Parties:
- Australia, Brazil, Japan, South Africa, and the United States
- Supported by the CTAO Consortium with ~1500 scientists around the world.
 - The CTAO science collaboration establishment is in progress.



From left to right: Francisco Colomer, Chair of the CTAO ERIC Council; Eva Ortega, Secretary General of Research at the Spanish Ministry of Science, Innovation and Universities; and Ana María Arias, Spanish Delegate at the CTAO ERIC Council. Credit: CTAO



Delegates from the CTAO ERIC Council in the inaugural meeting in Bologna, Italy. Credit: CTAO.

CTAO: Construction Status

- Rapid development at the CTAO-N
 - LST-1 prototype in operation and producing science, with three more LSTs expected online in 2026
 - A Joint Commissioning Team of LST, software, and central organization members has been established for the LST-1 in La Palma.
- CTAO-S construction ramping up
- CTAO products in advanced stage:
 - Most telescopes and software/computing systems passed or are passing the Critical Design Reviews (CDR)
- System-level verification planned to begin after the individual telescopes have been verified and accepted, to be followed with early science



On 2 July, a major contract, worth several million Euros, was signed between the CTAO's hosting partner, ESO (European Southern Observatory), and a consortium of Chilean companies for the construction of roads and telescope foundations for the CTAO's southern hemisphere array (CTAO-South)

CTAO-N as of today

LST-1 Operative

LST-2
Structure, mirrors installed

LST-4
Structure, mirrors and camera installed

LST-3
Structure, mirrors installed

All LSTs will be ready by 2026.
LSTs inauguration is being organised for mid October 2026 in La Palma

In addition:

- MST3 will be built soon
- Operation building: construction to start soon

CTAO-S as of today

- Large-scale CTAO-S infrastructure works have started



In addition:
First SST and MST
expected in 2026-
2027

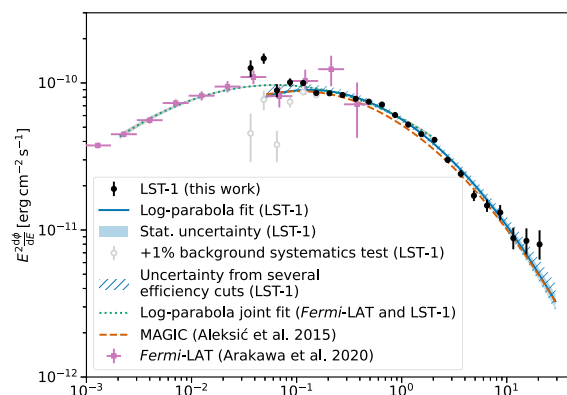
An intermediate data
centre and control
container to cover the
gap until the
operations building is
in place (late 2028)

LST1 – First Science Results

Credits to the CTAO LST collaboration

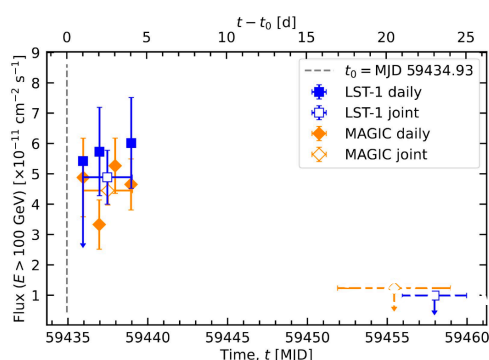
“LST-1 performance paper”

[Abe et al. 2023](#)



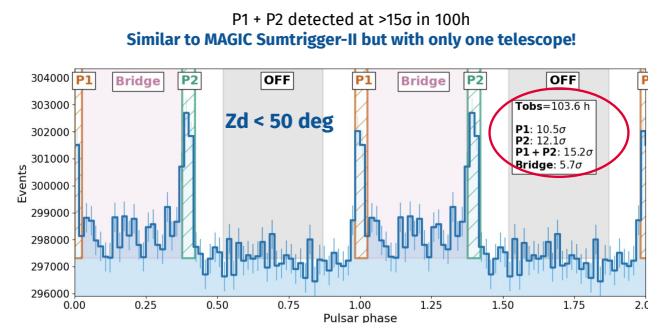
Nova RS Ophiuchi: First nova ever detected at VHE gamma rays

[Abe et al. 2025b](#)



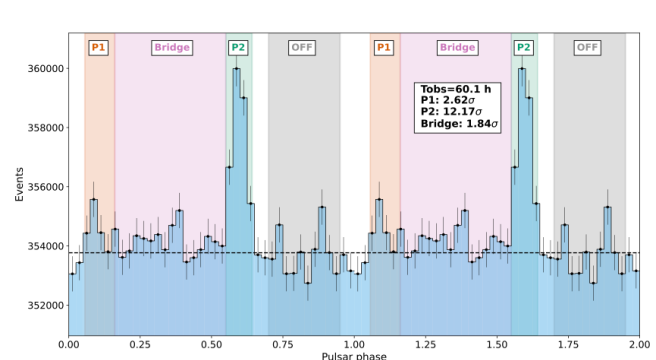
LST-1 observations of the Crab PSR

[Abe et al. 2024](#)



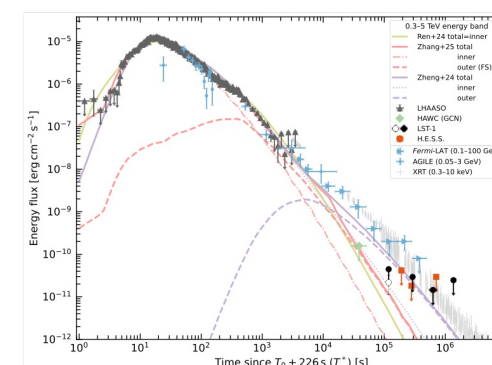
LST-1 observations of the Geminga PSR

[Abe et al. 2025a, accepted](#)



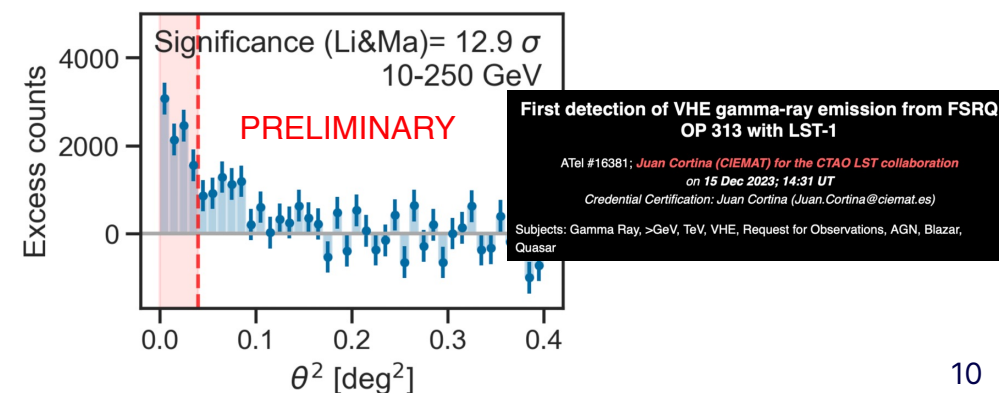
GRB221009A: The brightest of all time (“The BOAT”) GRB, 1 event every $\sim 10^3$ yrs

[Abe et al. 2025c \(accepted\)](#)

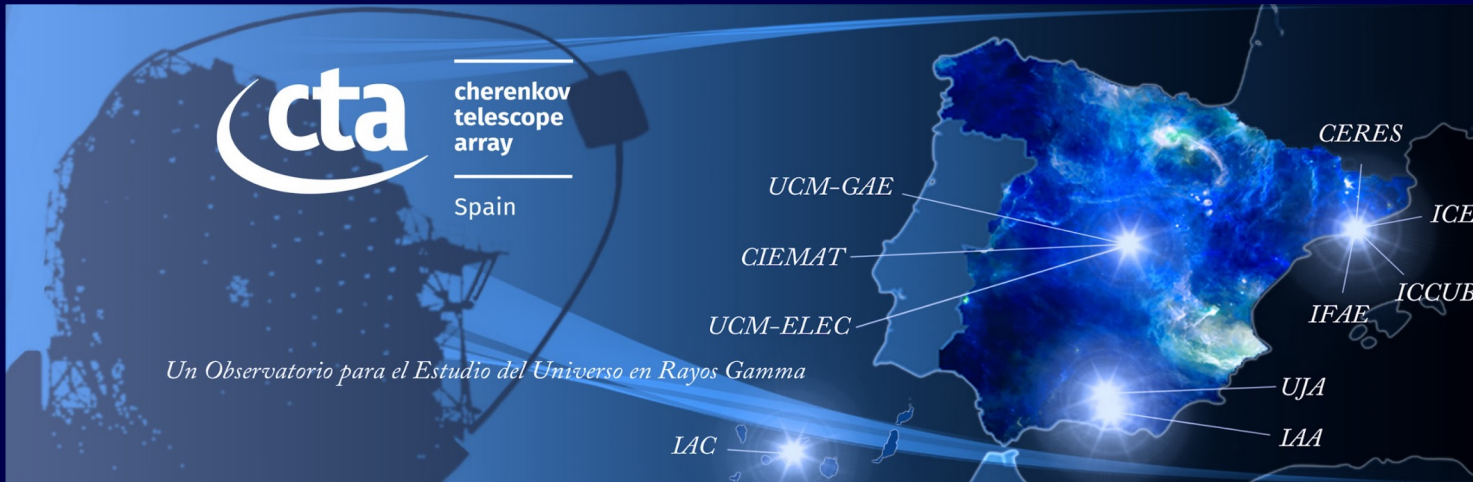


Hint of detection with LST-1 on Oct. 10 (T0 + 1.33 d): 4.1σ

OP 313: the farthest AGN @ VHEs $z=0.9973$



Spanish contribution



- About 140 scientists and engineers in 10 institutions
- Organized under a MoU with a coordinator
- Funding from AEI as coordinated projects, and from FEDER for the construction of CTAO-N

- Infrastructure of CTAO-North
- Design and funding of LST and MST structures and mechanics
- Data center of CTAO at PIC (1 out of 4 distributed data centers)
- Contribution to software systems: Array control system, scheduler, data reduction and analysis software
- Array Common Elements (ACE), Coordination, LIDAR, weather stations, etc.

Cameras of LSTs and NectarCAM MSTs, including:

- Structure and mechanics
- Cooling
- Power supplies and power distribution
- Analog amplifiers
- Trigger and Timing distribution system
- Cabling
- Camera Control
- Assembly, Integration & Verification
- R&D for Advanced LST SiPM-CAM

An Astronomical Observatory

An open, proposal-driven observatory

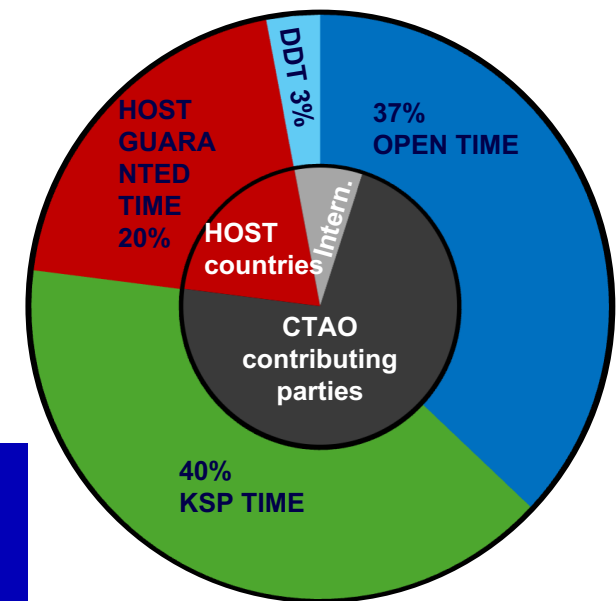
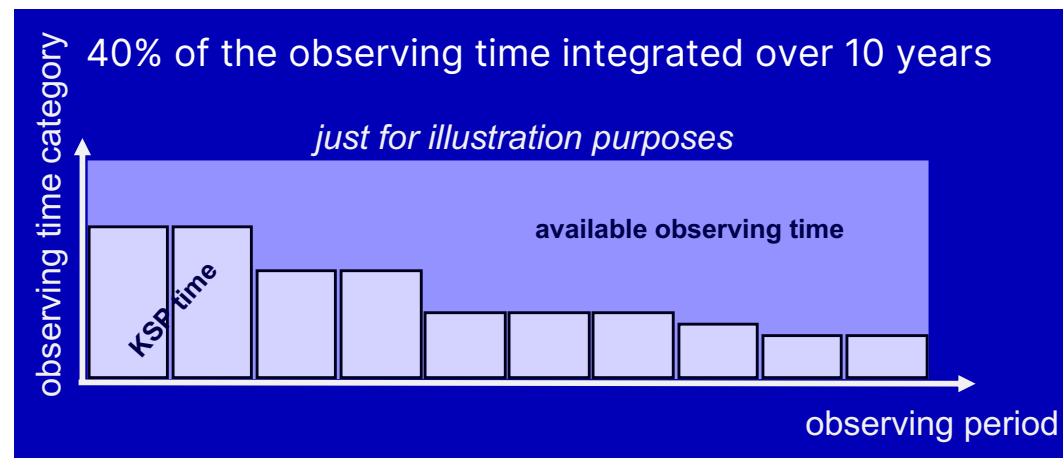
- Data with a proprietary period of 1 yr after that fully open
- KSPs are granted to contributors of the CTAO Construction Project, contingent upon the formation of the CTAO scientific collaboration.
- Key Science Projects (KSPs): observational projects requiring more than 300 hr, over more than one observing period with the aim of delivering legacy data sets and gamma-ray catalogues, on key science cases promising major breakthroughs.

First

Guaranteed
Early Science

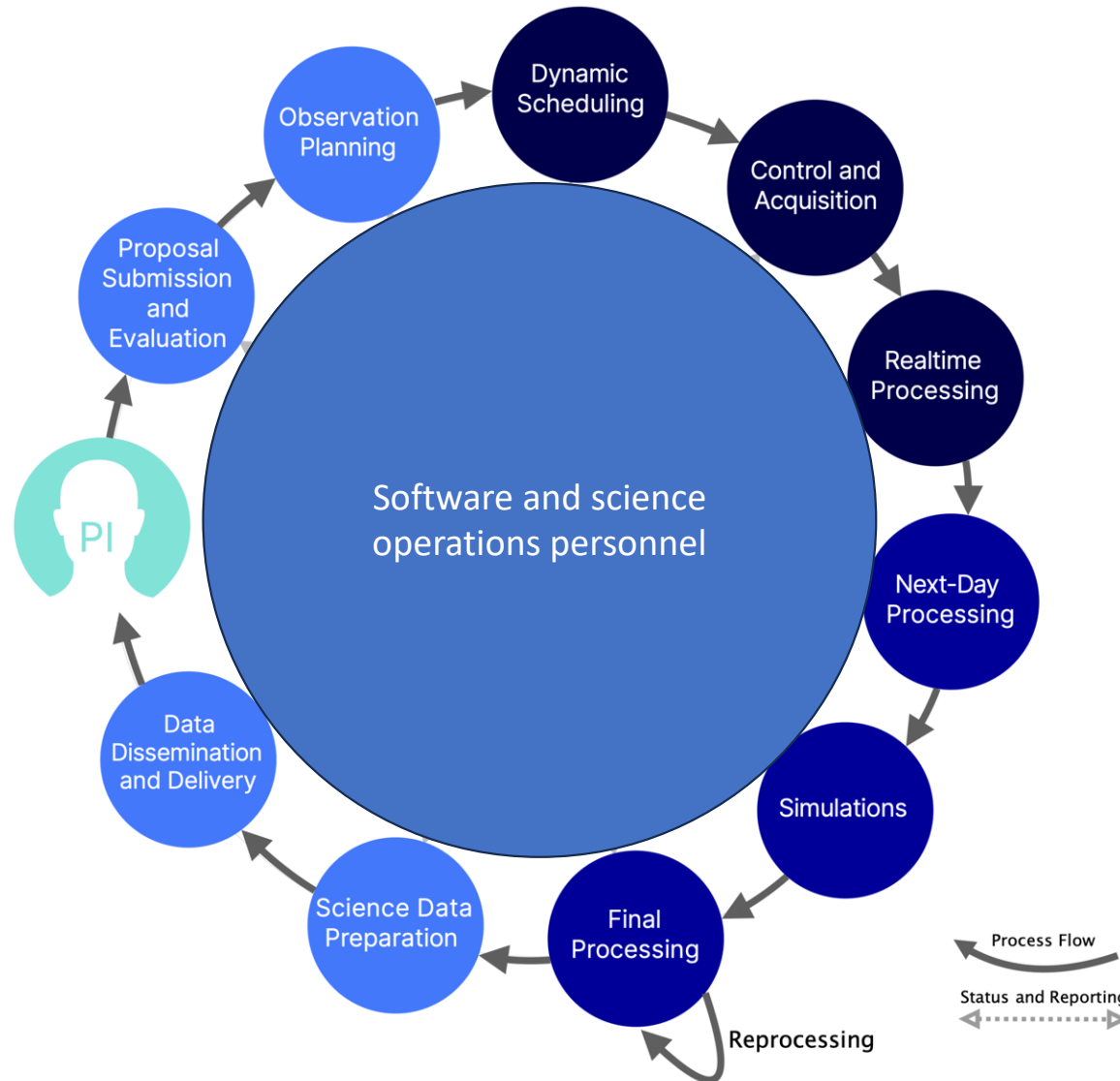


Later



Integrated over 10 yr

Science Operations



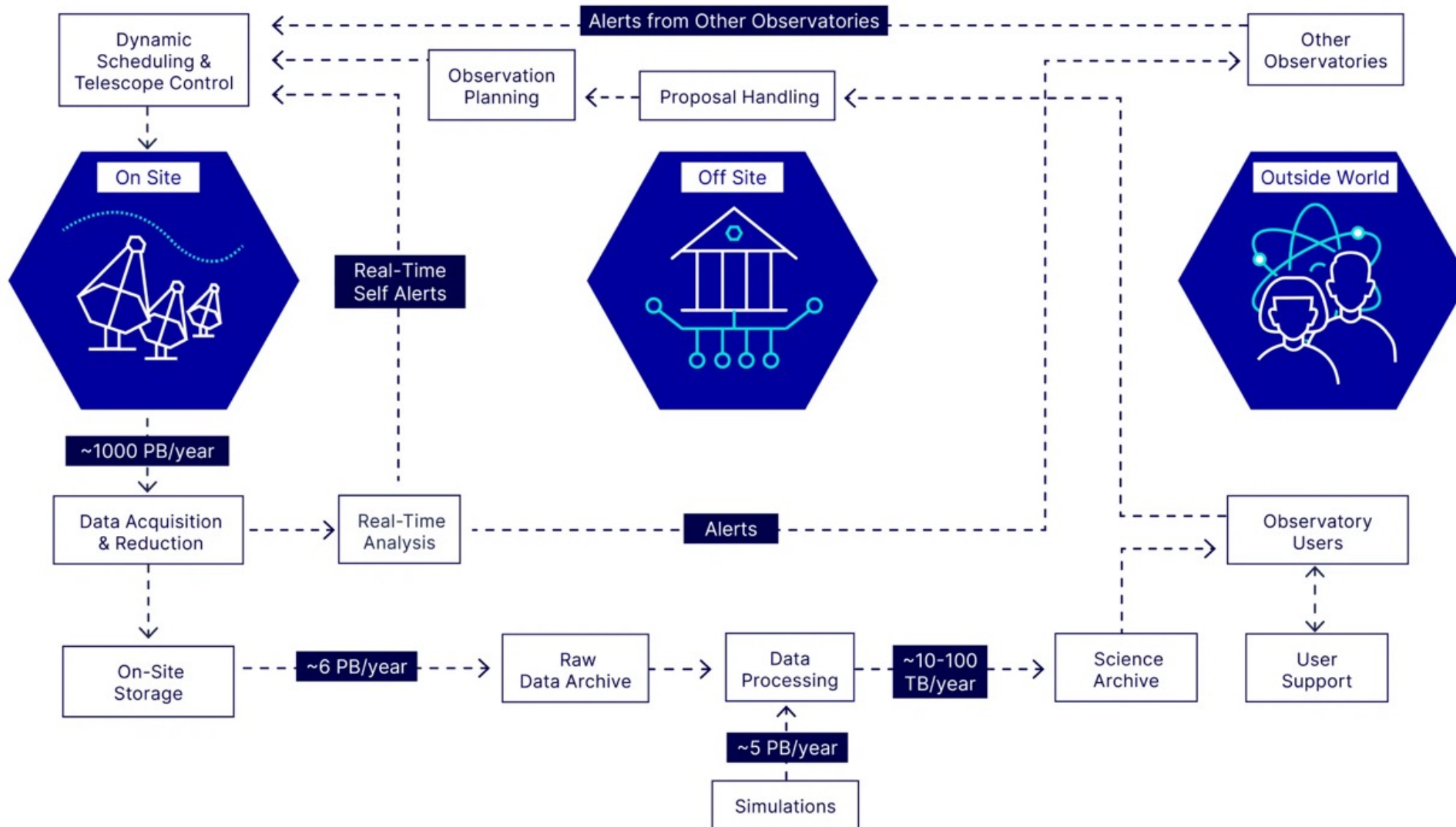
Operate as proposal-driven observatory

Conclusions and Outlook

- CTAO-N in development in La Palma
 - One LST operative, and another three LSTs being commissioned in CTAO-N
 - Technical building and 1st MST construction to start soon
- CTAO-S
 - Large tenders for site infrastructure awarded → construction has started
 - First MSTs and SSTs expected to go online in 2026
 - Setting up an intermediate data centre and control container
- Software to support array operations, analysis and calibration progressing steadily, with the first official versions already released and tested
- Early science exploitation phase will arrive within the next few years after the first groups of telescopes have been commissioned and integrated into the arrays
- Significant Spanish contribution in CTAO Telescopes, Array Common elements, infrastructure, software and computing infrastructure
- Exciting times ahead: CTAO early science is around the corner

Backup

CTAO – Data Flow

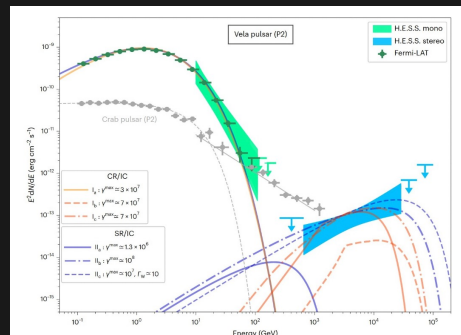


- Control 60+ telescopes
- BIG DATA project, generate hundreds of petabytes (PB) of data in a year (at least 6 PB after compression)
- Two sites and four off-site data centres

Science cases of the VHE astronomy

- The VHE sky is more populated than initially expected!!!

H.E.S.S. coll. Nature 2023



sub-TeV

- Transients
- Cosmological sources
- Pulsars

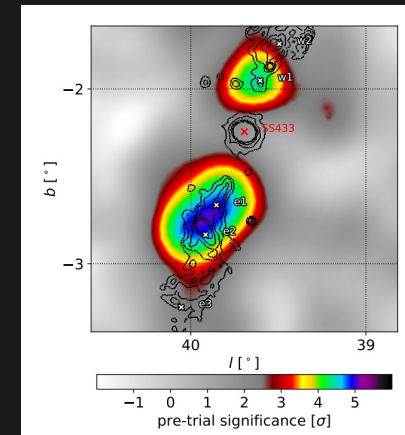
TeV

- EBL
- Dark Matter
- diffuse emission
- morphological studies
- surveys

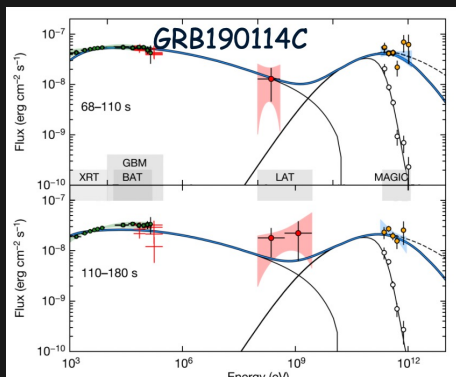
multi-TeV

- PeVatrons
- SFRs

HAWC coll. Nature 2018



MAGIC coll. Nature 2020



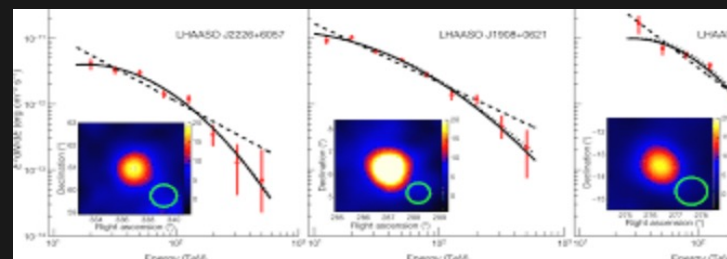
20 GeV

500 GeV 1 TeV

10 TeV

300 TeV

LHAASO coll. Nature 2021



GPS VERITAS + H.E.S.S.

