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DI RIPRESA E RESILIENZA



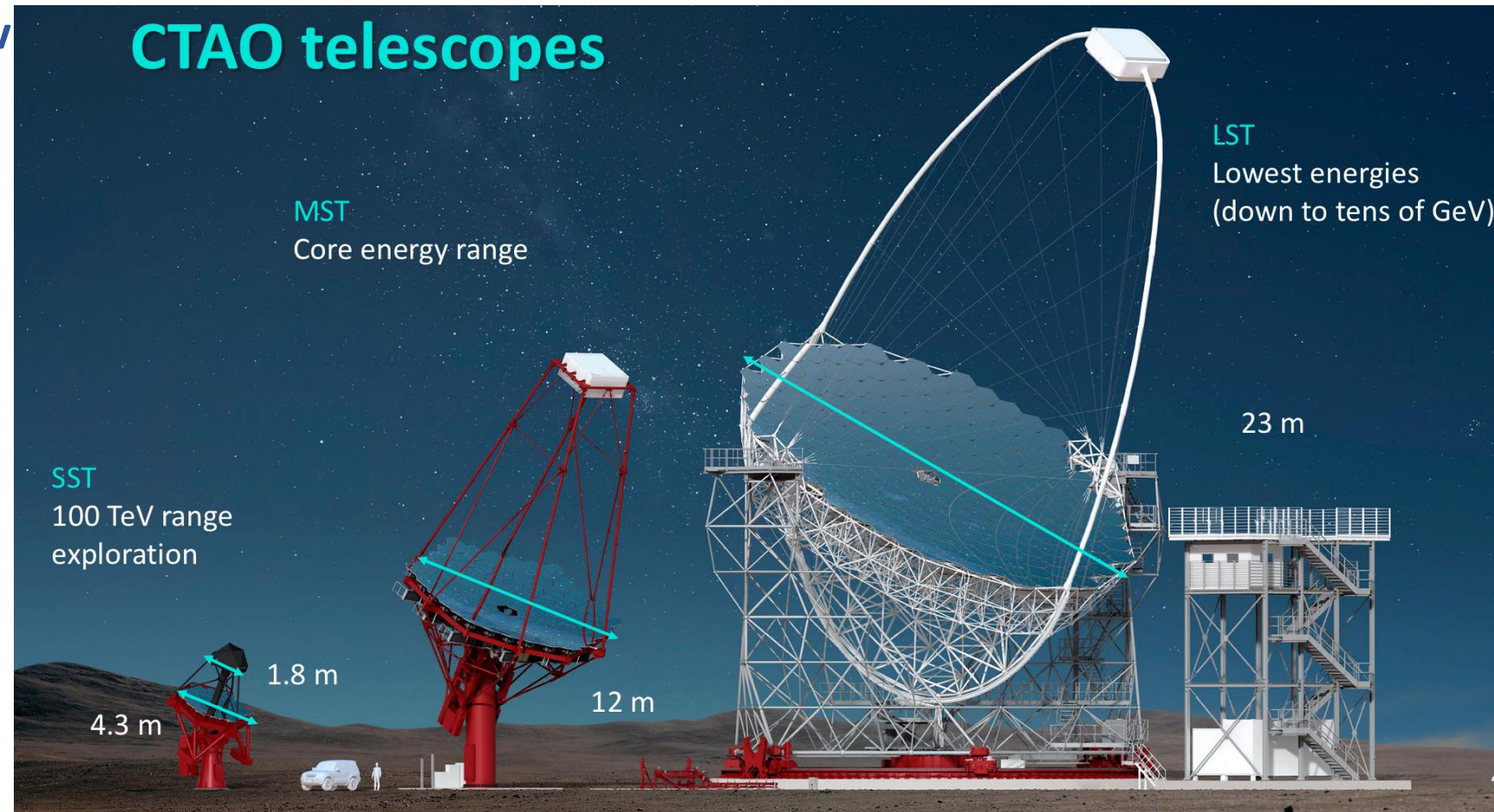
C. Aramo<sup>1</sup> for the CTA+  
Program, CTA-LST Project  
and CTA Consortium

<sup>1</sup> INFN – Sezione di Napoli  
email [aramo@na.infn.it](mailto:aramo@na.infn.it)

# The CTA+ Italian Program to complement the Cherenkov Telescope Array Observatory South Site

## CTAO: next-generation Cherenkov Telescope Array facility

- Originally envisioned:  $\sim 100$  telescopes of 3 different sizes
- Alpha configuration (defined 2022): 64 telescopes
- Expected to improve sensitivity by  $\sim$  factor 10 compared to existing facilities (H.E.S.S., MAGIC, VERITAS)
- Extend energy coverage:  
 $\sim 10$  GeV -  $>100$  TeV
- Alpha configuration expected to be fully operational  $\sim 2028-29$





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Large-Sized Telescopes (LSTs): 23 m  $\varnothing$ ;  
PMT camera; 1855 pixels; 4.3° FoV

Mid-Sized Telescopes (MSTs): 11.5 m  $\varnothing$   
PMT camera with 2 designs

- NectarCAM 1855 pixels
- FlashCam 1764 pixels; 8° FoV

Small-Sized Telescopes (SSTs): 4.3 m  $\varnothing$   
SiPM camera; 2048 pixels; 8.8° FoV



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# CTAO

## 2 Sites





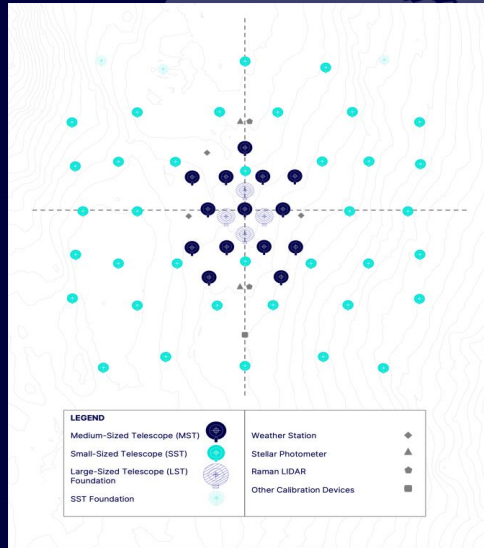
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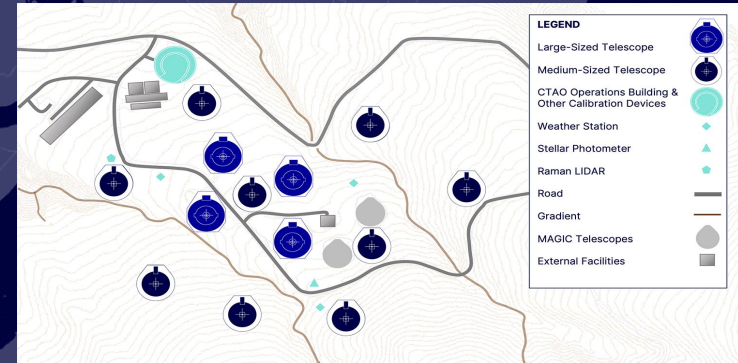


**CTAO South**  
Paranal, Chile

**Science Data Management Centre**  
Zeuthen, Germany

**Headquarters**  
Bologna, Italy

**CTAO North**  
La Palma, Spain





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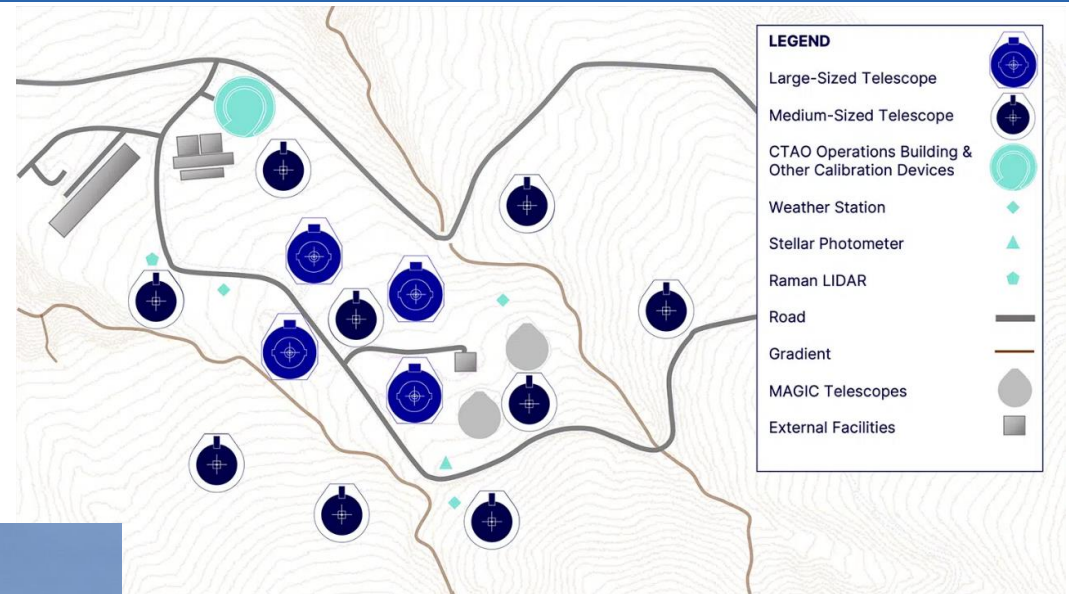


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# CTAO-North

## La Palma, Canary Islands, Spain



### Alpha Configuration:

- $\sim 0.5 \text{ km}^2$
- 4 LSTs
- 9 MSTs



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## CTAO- North

### La Palma, Canary Islands, Spain

- Prototype LST (LST-1) inaugurated in September 2018
- Telescope mounts for LST 2 – 4 mostly completed
- LST-4 dish structure lifted into mount in May 2024.





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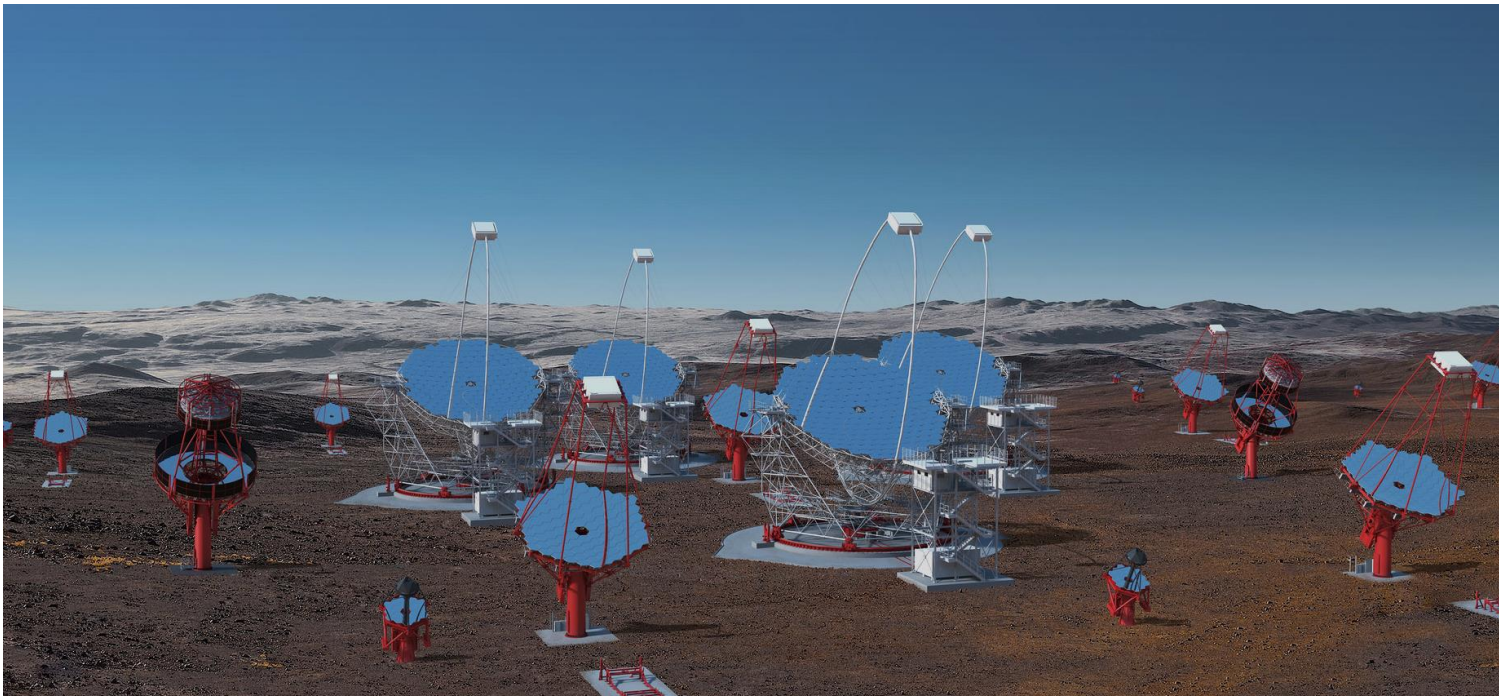
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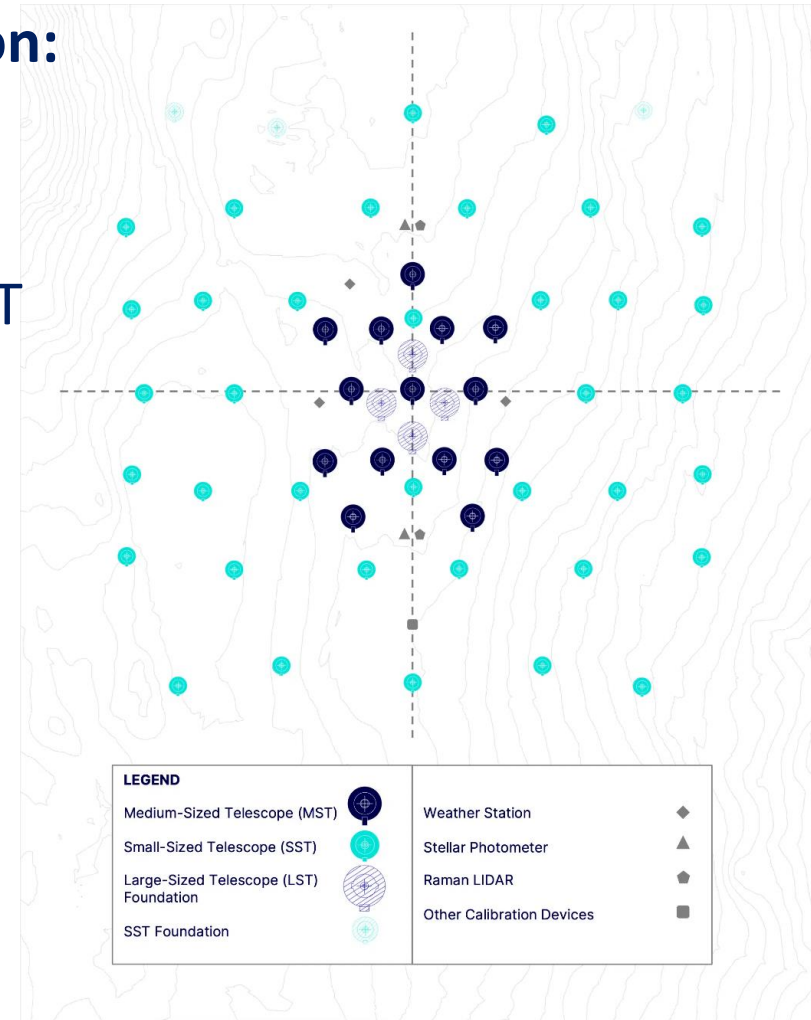


# CTAO-South ESO (Paranal), Chile



## Alpha Configuration:

- $\sim 3 \text{ km}^2$
- 14 MSTs
- 37 SSTs – NO LST







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# CTAO-South ESO (Paranal), Chile



**First infrastructure (access road, power infrastructure)  
construction started in March 2022.**

**Access road completed in 2024.**





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## CTA Headquarters



- At DESY Zeuthen (Berlin)
- Start of construction: March 2022
- Inauguration scheduled for October 2024

**Bologna, Italy, completed 2019**

## Science Data Management Centre





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# The CTAO Consortium

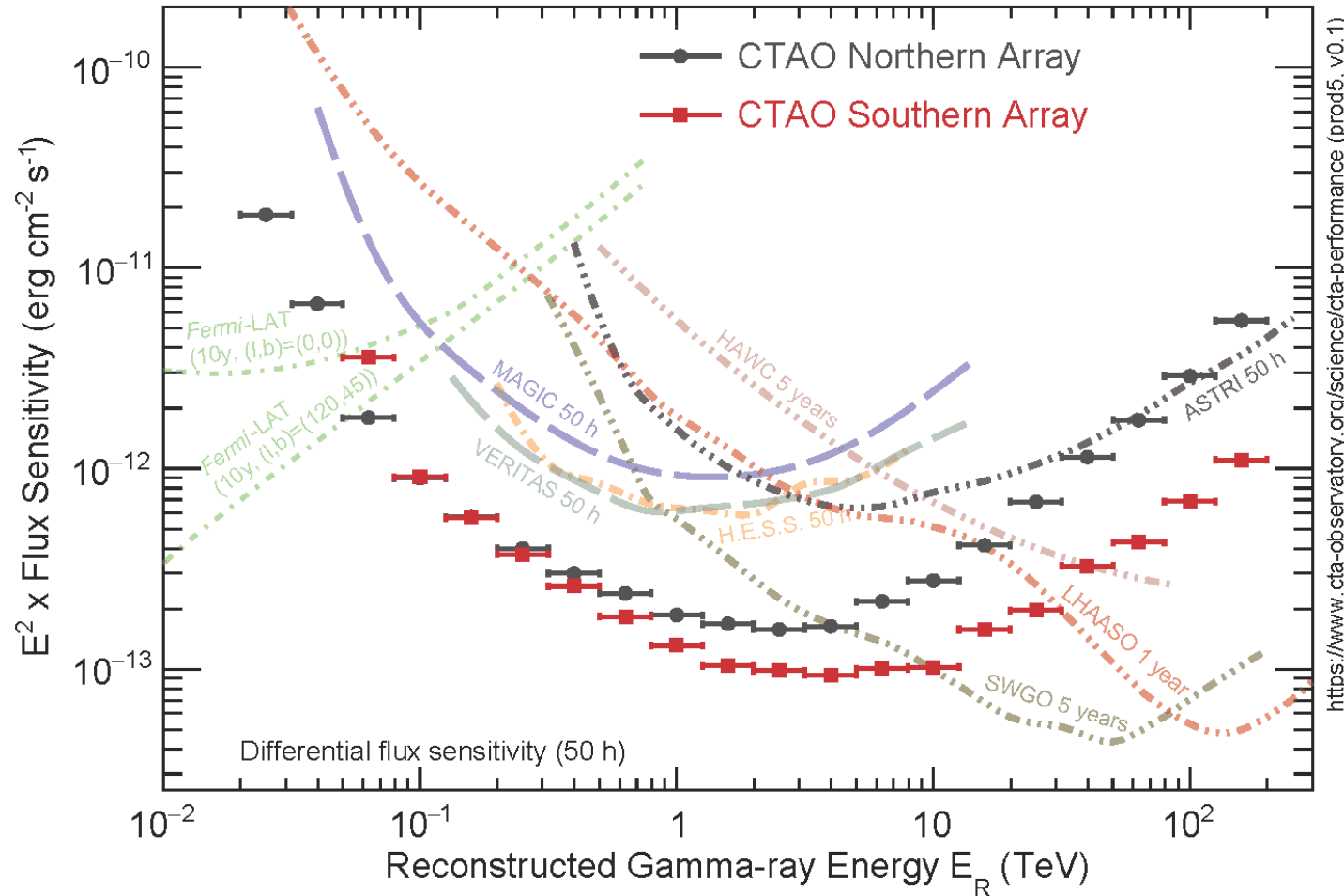


- More than 1400 scientists
- ~ 200 institutes
- 25 countries on 6 continents



Masahiro Teshima  
(Tokyo) recently  
elected new  
spokesperson





<https://www.cta-observatory.org/science/cta-performance> (prod5, v0.1)



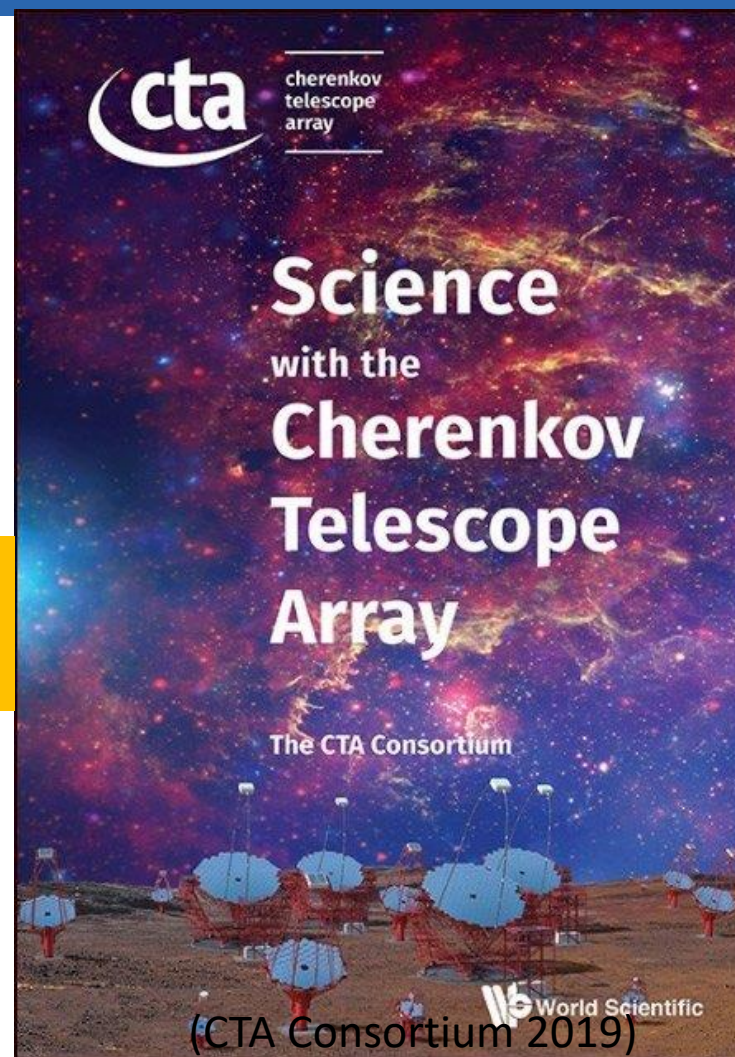
# Expected Sensitivity

The first (open) Observatory in the TeV energy range

# Key Science Projects

- Indirect Dark Matter Searches
- Deep observations of the Galactic Centre
- Galactic Plane Survey
- Large Magellanic Cloud Survey
- Extragalactic Survey
- Transients
- Cosmic-Ray PeVatrons
- Star Forming Systems
- Active Galactic Nuclei
- Clusters of Galaxies

See F. Longo Talk  
This conference

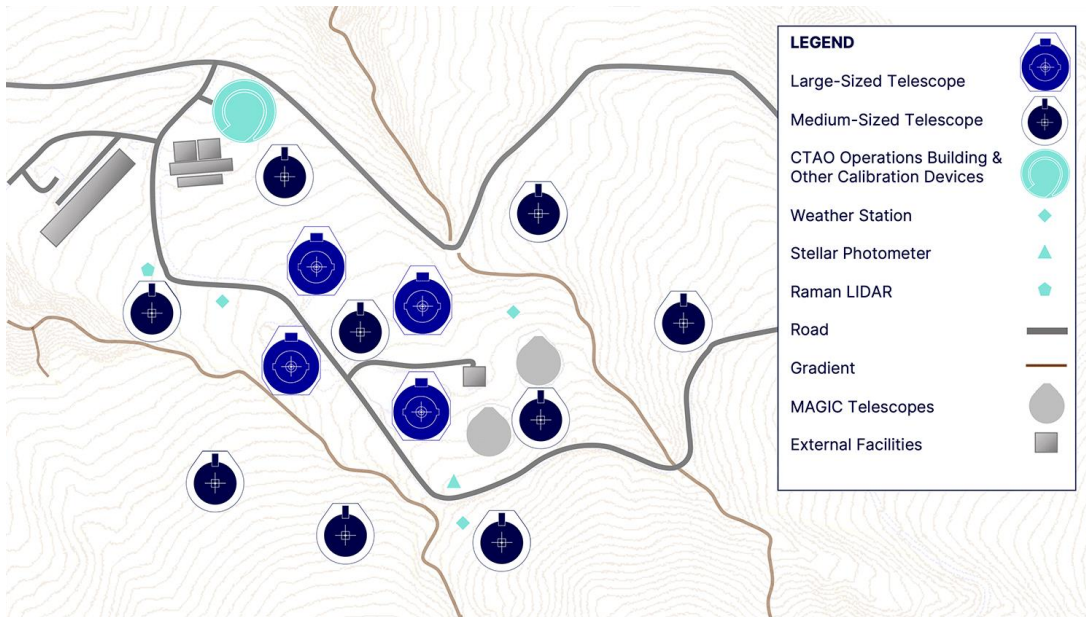


# CTAO Alpha Configuration + CTA+

## CTAO North

4 LSTs

9 MSTs



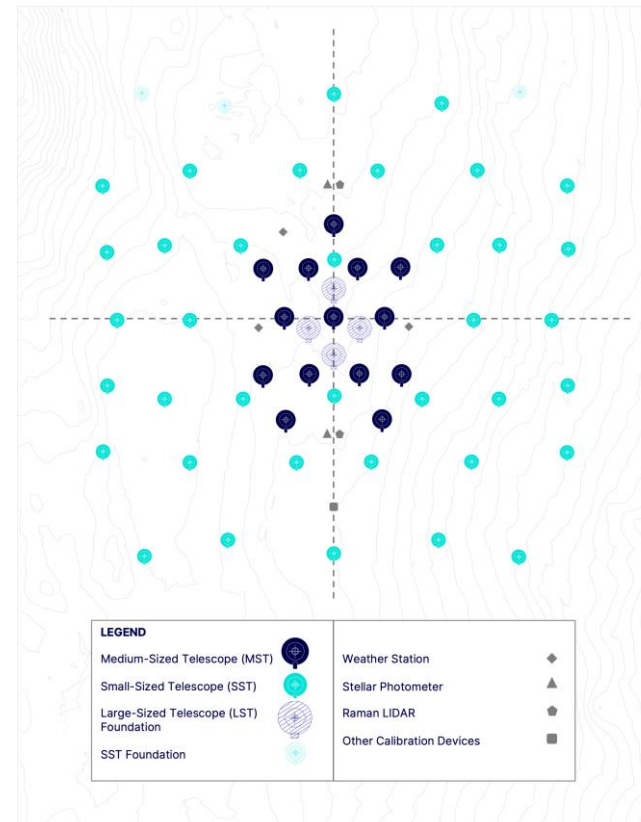
# CTAO

## CTAO South

14 MSTs

37 SSTs

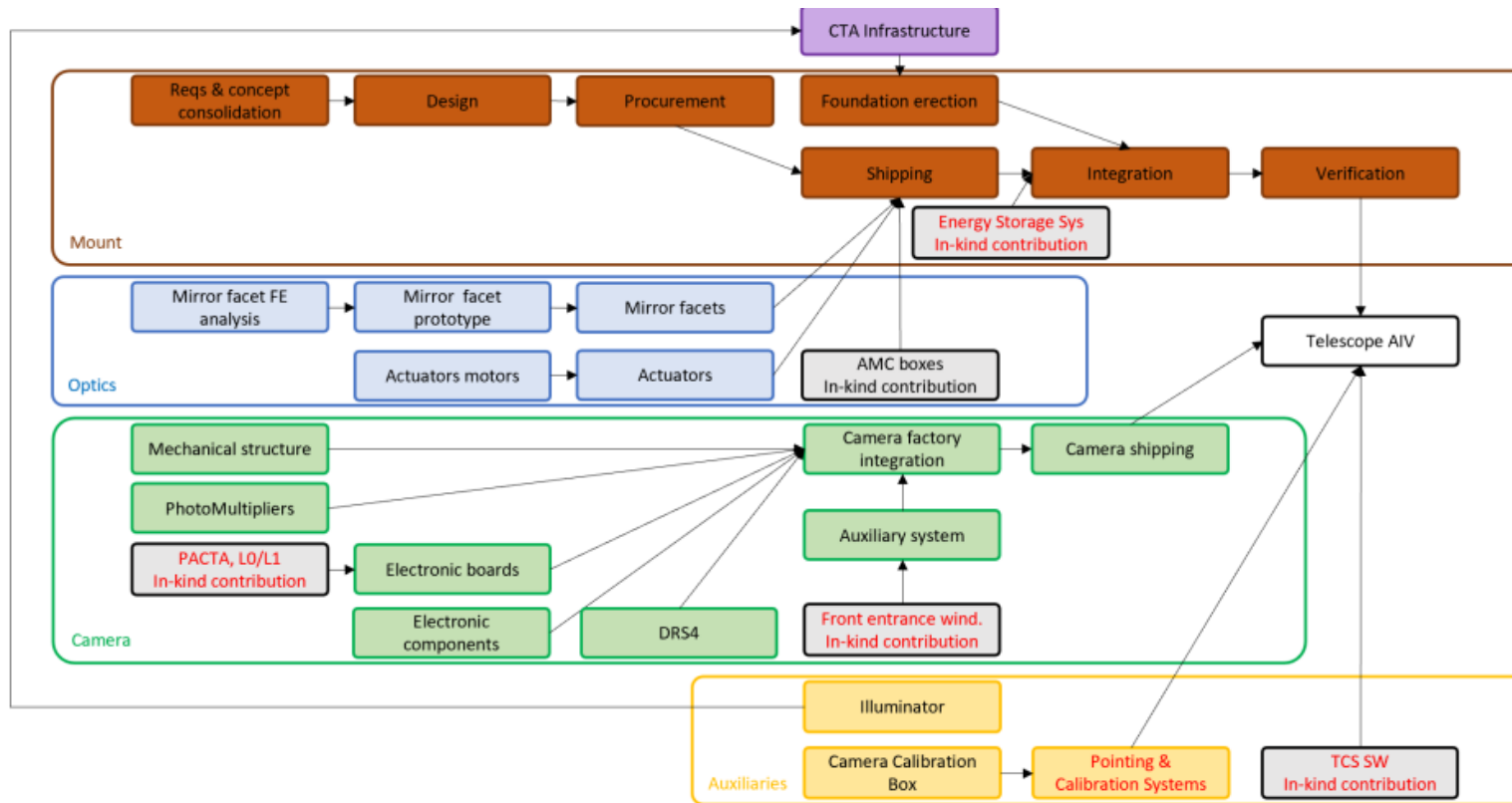
2 LSTs +  
5 SSTs



## The CTA+ program

- CTA+ is an Italian program funded by National Program for Resilience and Resistance (PNRR in Italian), funded by the European Union – NextGenerationEU to enhance the CTAO infrastructure of the CTAO southern array
- Total funding ~ 70 M€
- INAF leadership with co-participation of INFN and several Universities
- Main goals:
  - Enhance CTAO southern array at the lowest ( $< 100$  GeV) and highest ( $>$  tens TeV) energies
  - Improve multi-messenger facilities for a better synergy with CTAO
  - Science and outreach program with CTAO
  - R&D activities: new detectors for Cherenkov telescopes or complementary

# LST-South workflow

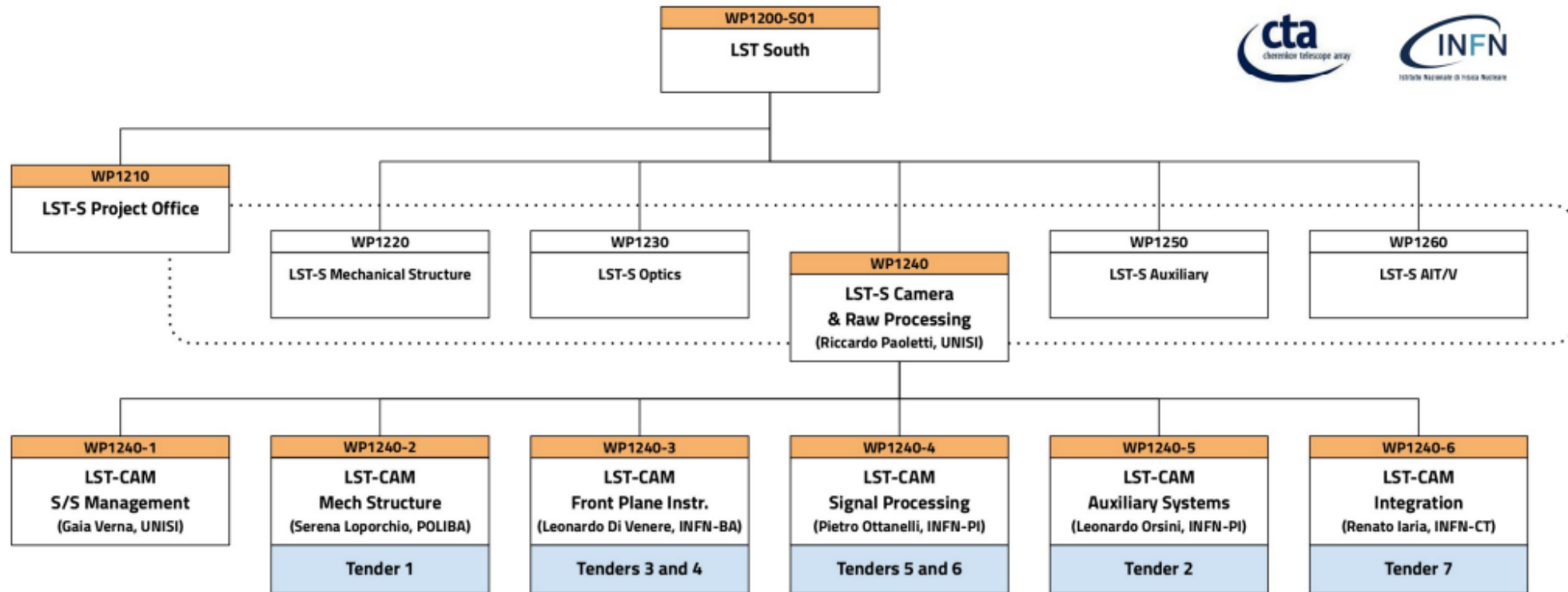


- Mount to be adapted to cope with CTAO-S site conditions
- Camera, optics and auxiliaries will be as in LST-North

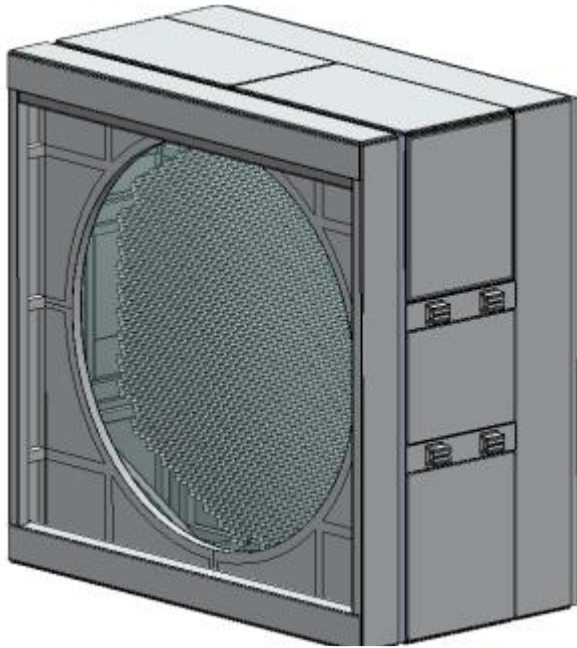




# LST-South camera



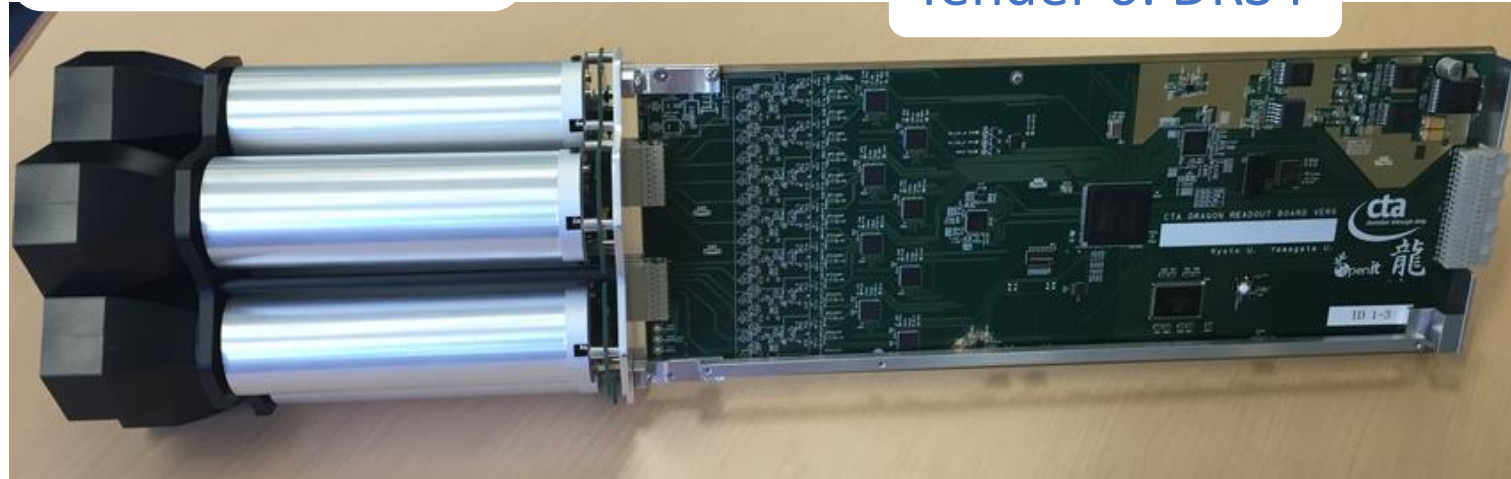
Tender 1: camera mechanics



Tender 3: PMTs procurement

Tender 5: Active components

Tender 6: DRS4



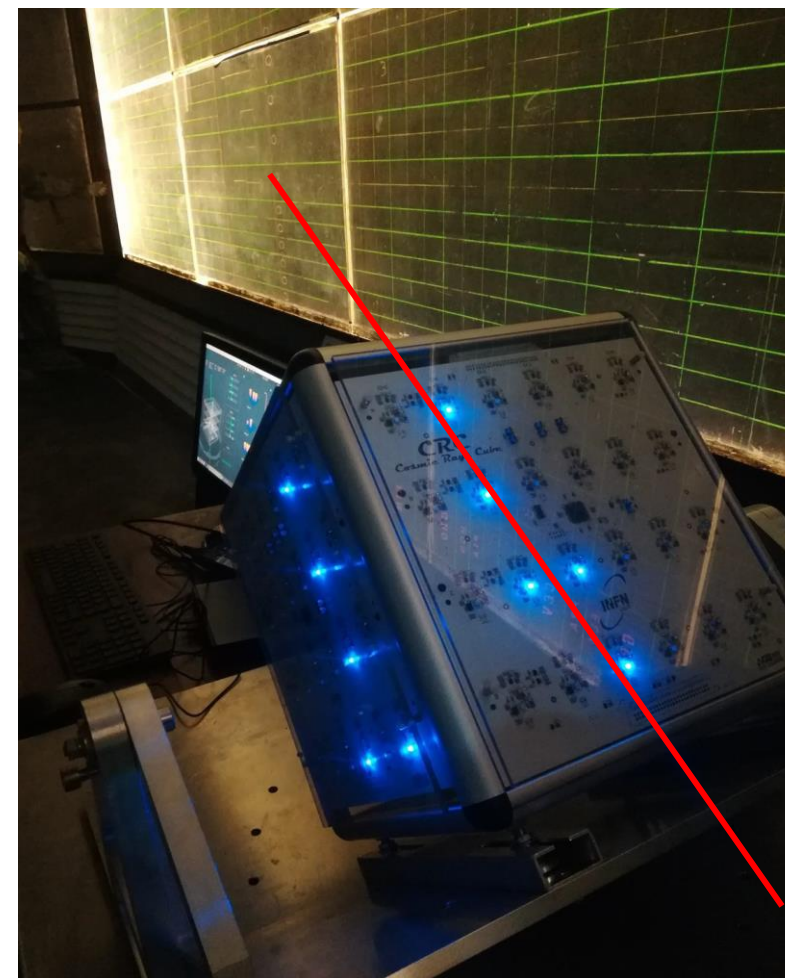
Tender 4: Cluster electronics production & assembly

+ Tender 7: Integration facility in Catania

**Outcome: 2 fully equipped LSTs + 470 spare modules (PMT + readout + backplane) + 1 spare cooling unit**

## CTA+ outreach program

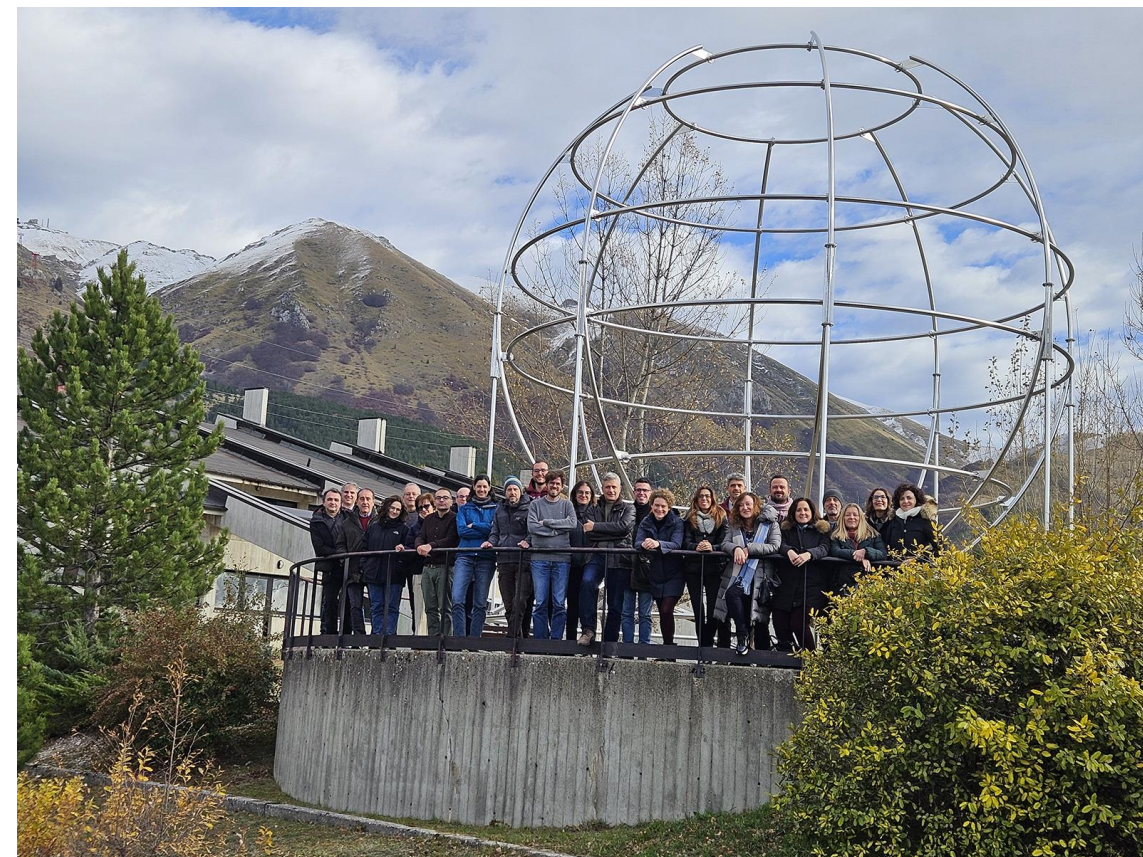
- The CTA+ program also includes many outreach and science communication activities, with events for the general public, but above all with activities for students and training for teachers to bring them closer to the fascinating world of gamma rays and astroparticle physics.
- Among all these activities, I will briefly describe two courses dedicated to Italian high school teachers, also using the Cosmic Ray Cube telescopes, founded by CTA+ program



## Discovering cosmic rays for in-service high school physics teachers

**From 10 to 13 December 2023**, 17 secondary school teachers from all over Italy attended the "Discovering Cosmic Rays" a course at the Gran Sasso National Laboratories.

The 2.5-days residential course was an opportunity to learn more about the fascinating topic of cosmic rays and gamma rays, the experiments that observe them and the messages they can bring us from space.



During the practical sessions, **participants were actively involved in building a muon telescope**, performing a muon flux measurement and analysing the data.



The aim of the course was to provide an overview of the subject matter, enabling participants to familiarise themselves with the activities, experience them first hand and build on their prior knowledge and skills, **thus facilitating immediate implementation of the activities in the classroom.**

## Second Teachers' Course: 8-11 September 2024 - Department of Physics and Astronomy, University of Padua.

The 2.5-days residential course will give the 30 participants the opportunity to approach the fascinating topic of gamma rays, among the protagonists in the study of the high-energy universe, and **to learn about the experiments that observe them** and the astronomical sources that produce them, in particular active galactic nuclei.

During the practical sessions, **participants will use astronomical portals available online to obtain data from the latest astronomical observatories** (<https://firmamento.hosting.nyu.edu/home>).



## Conclusions

- CTA+ will improve the performance and scientific output of the CTA South Array
- The larger and most ambitious goal of the CTA+ programme is to implement two LSTs and five SSTs at the CTA South site in about three years, using an end-to-end approach.
- The two telescopes will be realised using the same basic design as the northern LSTs, with the exception of the modifications required to meet the environmental requirements of the southern site and to further reduce construction risks and costs.
- The production of the auxiliary instruments, cameras, mirrors and mechanical structures will be realised through large industrial contracts overseen by the CTA+ management with the support of the LST Collaboration and the CTAO.
- Some international partner countries of the LST Collaboration also provide in-kind contributions to the realisation of part of the telescopes.
- CTA+ is carrying out an R&D programme for future CTAO detectors and ancillary instruments.
- The science and outreach programme is well integrated and developed.

## Acknowledgement

This work has been realized with the EU funding program "Next Generation EU" in the context of the PNRR-IR "CTA+". The acknowledgements for CTA Consortium are listed here: [https://www.cta-observatory.org/consortium\\_acknowledgments/](https://www.cta-observatory.org/consortium_acknowledgments/) . We gratefully acknowledge financial support from the following agencies and organisations listed here: <https://www.lst1.iac.es/acknowledgements>.

## Questions?