The CTA Project – Upcoming Industrial Opportunities

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Industrial Opportunity Days 2022
Osservatorio Astronomico di Capodimonte (Napoli)

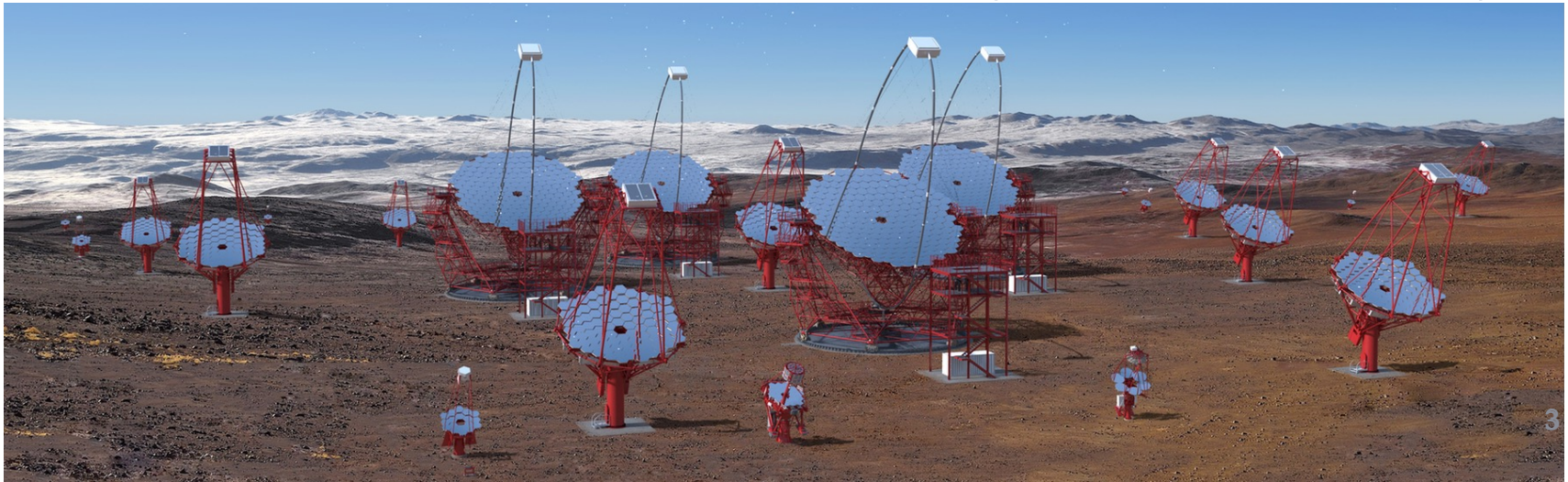
Most Advanced Gamma-Ray Observatory

- CTA, the Cherenkov Telescope Array, is the next generation ground-based observatory for gamma-ray astronomy at very high energies
- It will initially have 65 telescopes at two sites, in the North and South
  - Much larger and more sensitive than existing instruments
- It is designed and built in a large international collaboration
- It will be the first gamma-ray observatory run similarly to classical ones
  - Previous and existing instruments are run as experiments
- Cherenkov radiation is electromagnetic radiation emitted when a charged particle passes through a dielectric medium at a speed greater than the phase velocity of light in that medium
  - Discovered 1934 by Pavel Cherenkov (1904-1990) – Nobel price winner

What is CTA ?

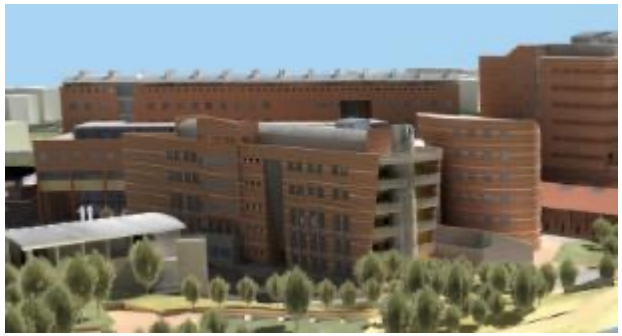
- North: 13 telescopes spread out over ~0.4km^2 (4 LSTs, 15 MSTs)

- South: 55 telescopes spread out over ~5km^2 (4 LSTs, 25 MSTs, 70 SSTs)



The CTA Observatory (CTAO)

- The CTA Observatory is the legal entity for construction and operation of the Cherenkov Telescope Array
- An interim legal entity for preparation of CTA construction was set up in Heidelberg in 2014(Germany)
- The final legal entity for construction and operation, a ***European Research Infrastructure Consortium (ERIC)***, is being set up under European Union law, in Italy *https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures/eric_en*
- The *CTA Project Office* and future Headquarters are located in Bologna (Italy), hosted by INAF
- The *Science Data Management Centre (SDMC)* located in Berlin-Zeuthen (Germany), hosted by DESY in a new building



CTA Sites: Arrays, Headquarter, Data Center

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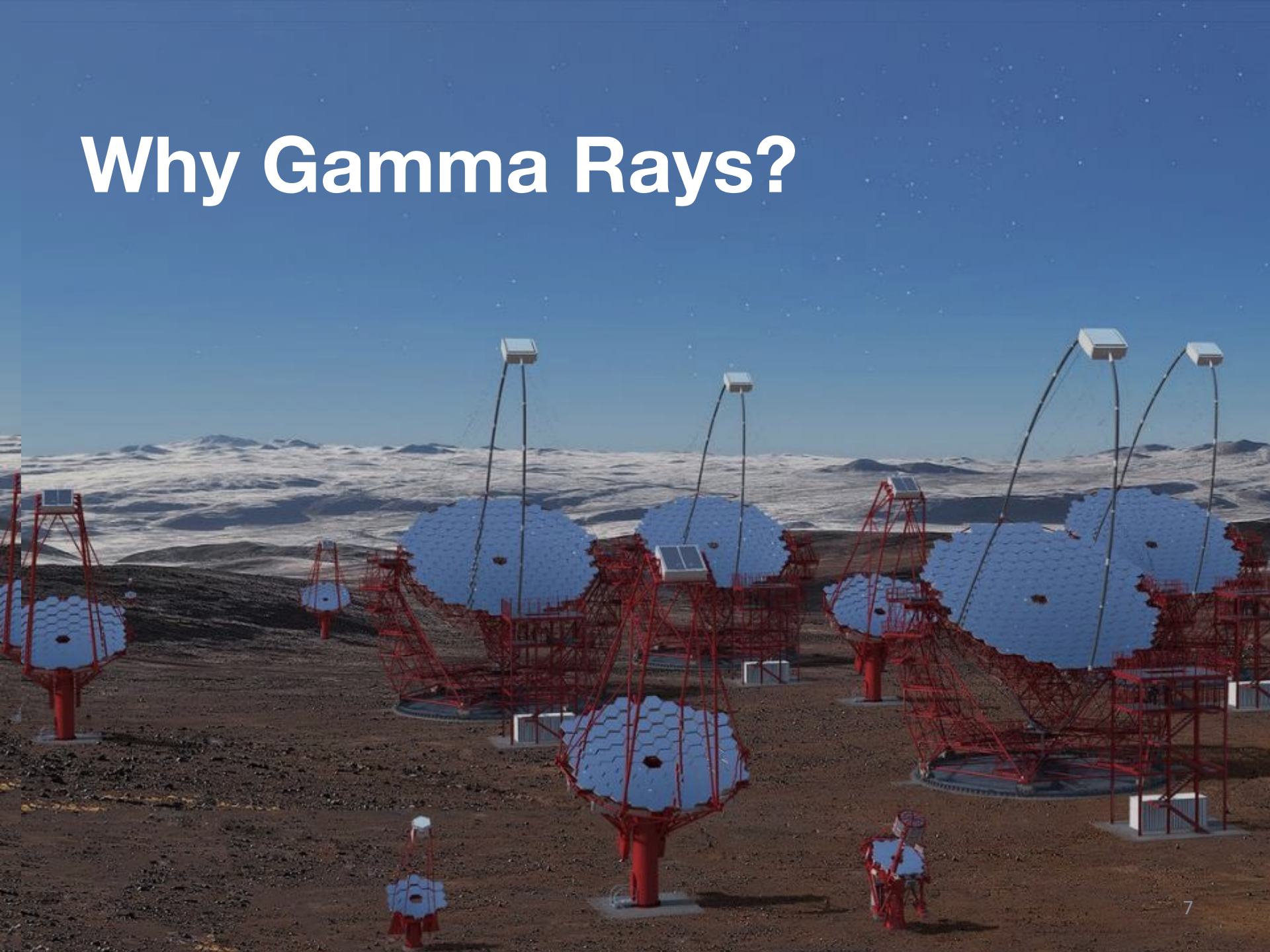
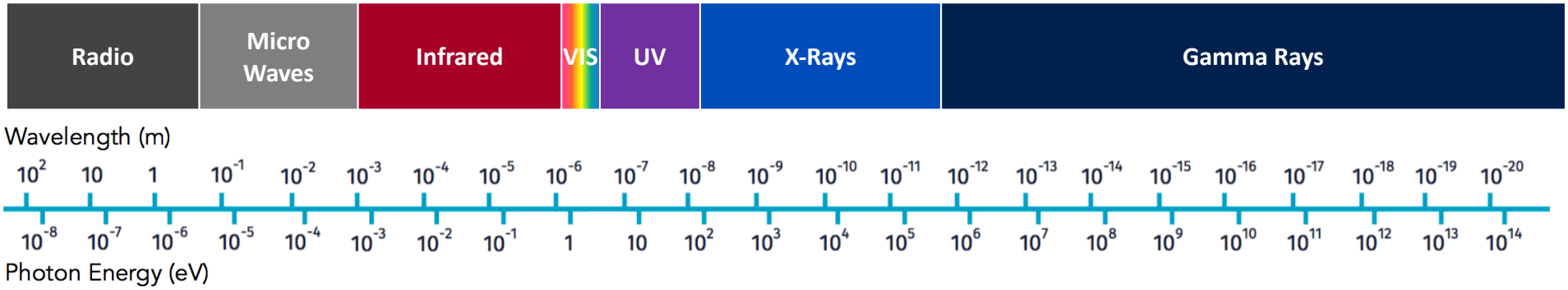
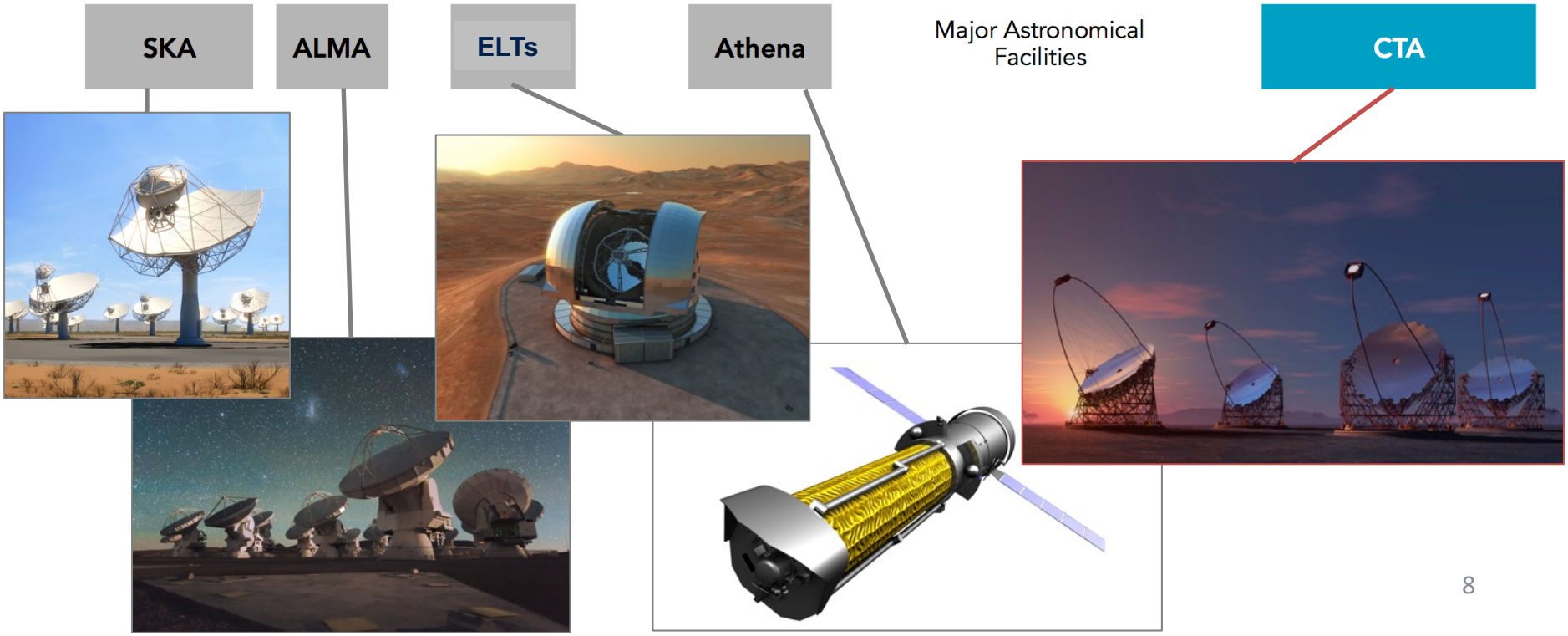
Why Gamma Rays?



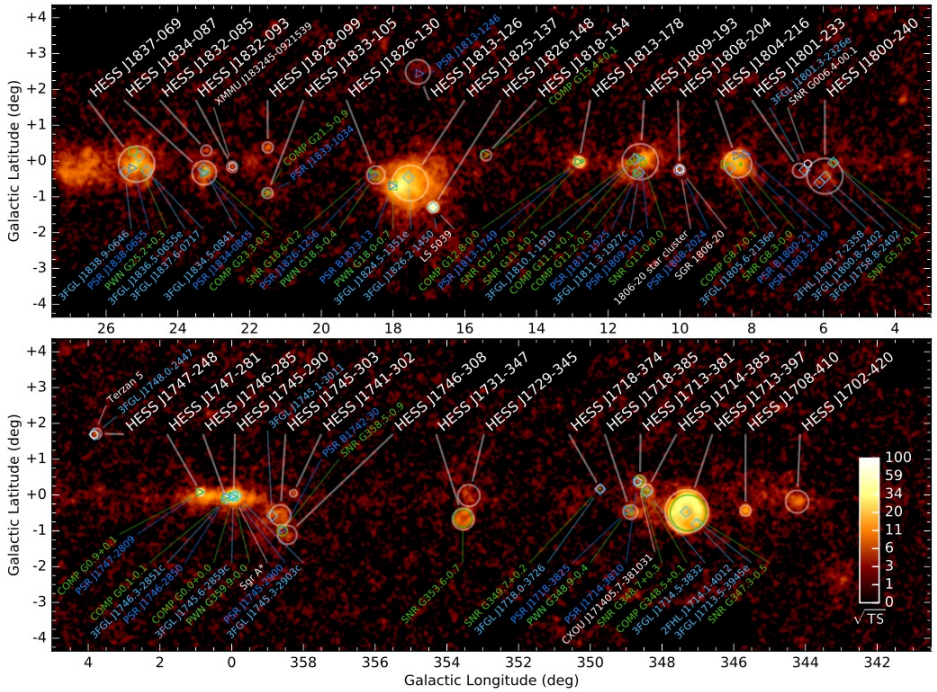
Waveband Coverage: a New Window





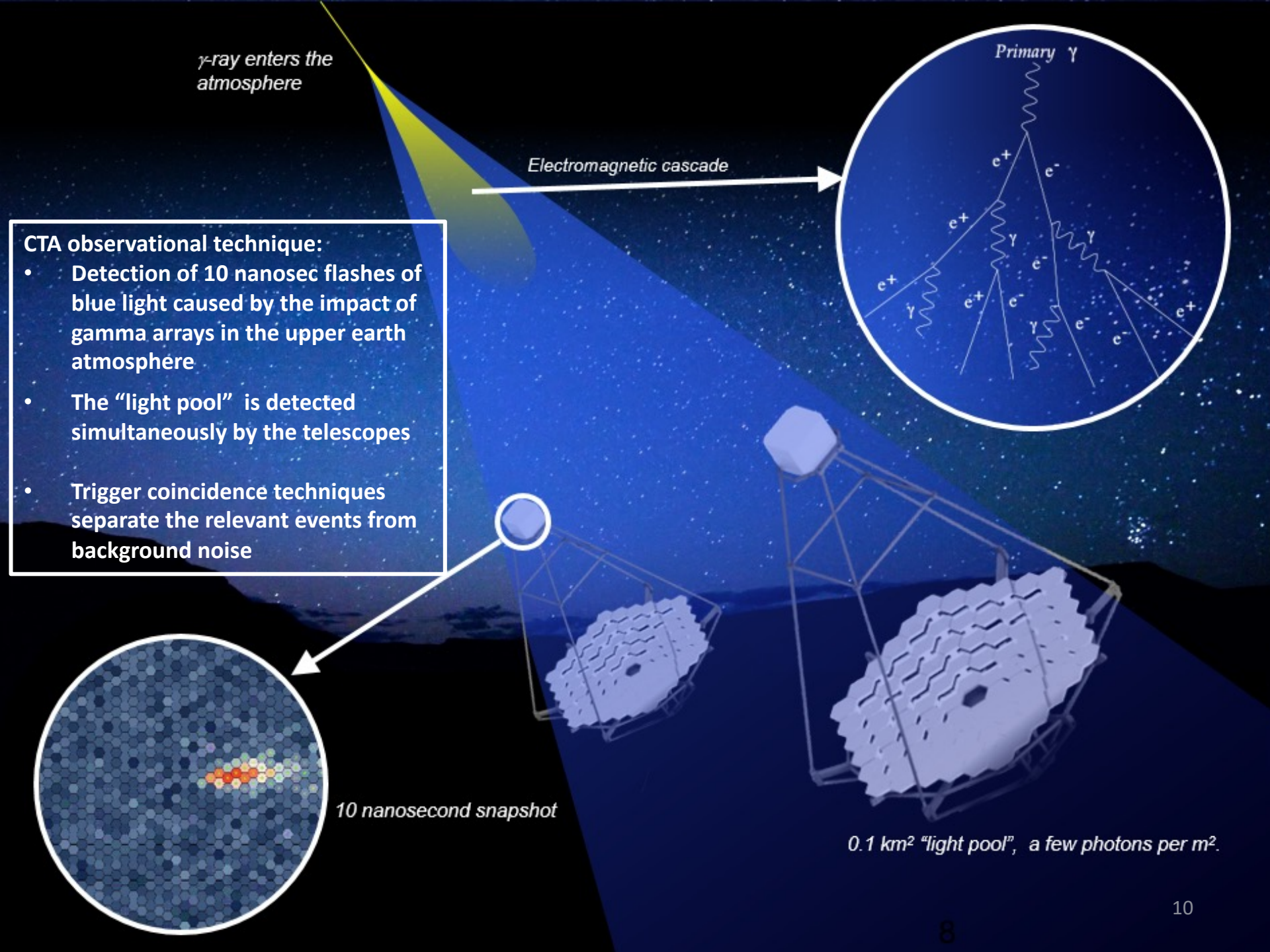
Why gamma rays: A different sky

- Observation of gamma rays give access to the most energetic phenomena in the Universe
- Gamma ray astronomy is a young field with tremendous discovery potential
  - First astronomical gamma array detection in 1967 by a satellite
  - First ground-based gamma ray observations in early 1970s



H.E.S.S. Coll.
A&A. Vol 612 (2018)

Shown here:
central 40° of Galaxy



CTA observational technique:

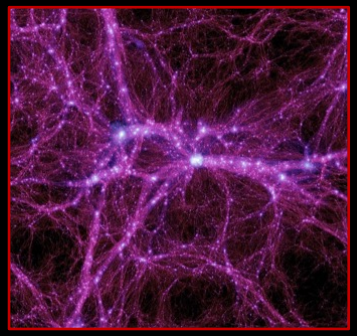
- **Detection of 10 nanosec flashes of blue light caused by the impact of gamma arrays in the upper earth atmosphere**
- **The "light pool" is detected simultaneously by the telescopes**
- **Trigger coincidence techniques separate the relevant events from background noise**

CTA cience themes

Theme 1: Cosmic Particle Acceleration
- How and where are particles accelerated?
- How do they propagate?
- What is their impact on the environment?

Theme 2: Extreme Environments
- Close to neutron stars and black holes
- Relativistic jets, winds and explosions
- Cosmic voids

Theme 3: Physics Frontiers
- What is the nature of Dark Matter?
- Is the speed of light constant?
- Do axion-like particles exists?



Sep 2017, 213 page volume, available at

https://arxiv.org/abs/1709.07997

and the CTA web site

CTA Technology – One Page Summary

Imaging of very faint nano-second long blue light (Cherenkov) flashes requires:

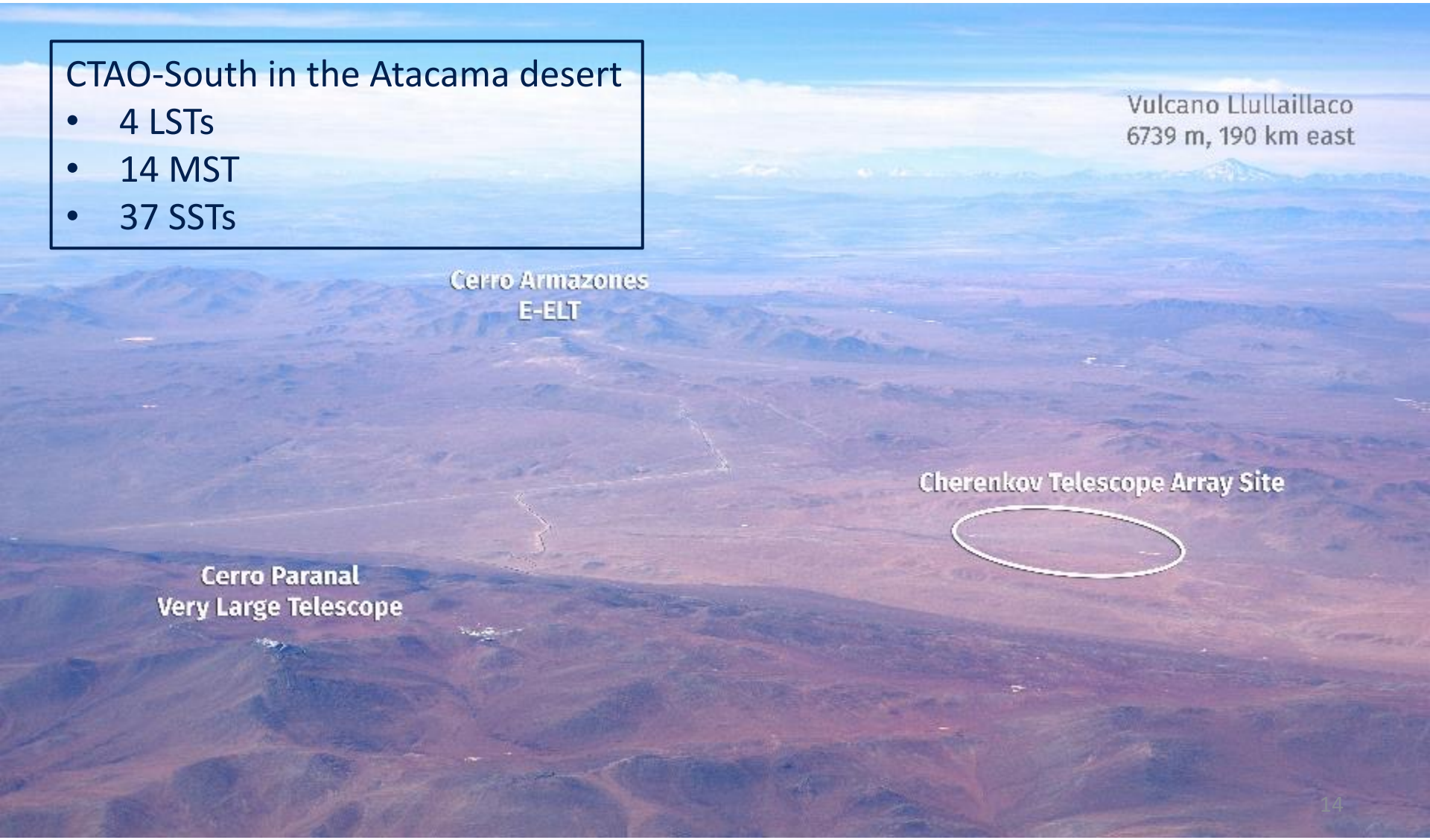
- Three types of telescopes to cover the CTA energy range from 20 GeV to 300 TeV
  - Large-Sized (23m, *LST*), Medium-Sized (12m, *MST*) and Small-Sized (4m, *SST*) Telescopes
- Very sensitive cameras with many pixels (~10^3), using photomultiplier tubes (PMTs) or silicon photomultipliers (SiPMs)
- Accurate (nano-second) timing & clock over the whole array
- Challenging calibration techniques and algorithms
  - Earth atmosphere is part of the detector !
- Substantial software development, “Big Data”
  - Expect 3.7 PB (reduced) raw data volume and ~4 PB of data products per year

CTAO & In-Kind Contributions

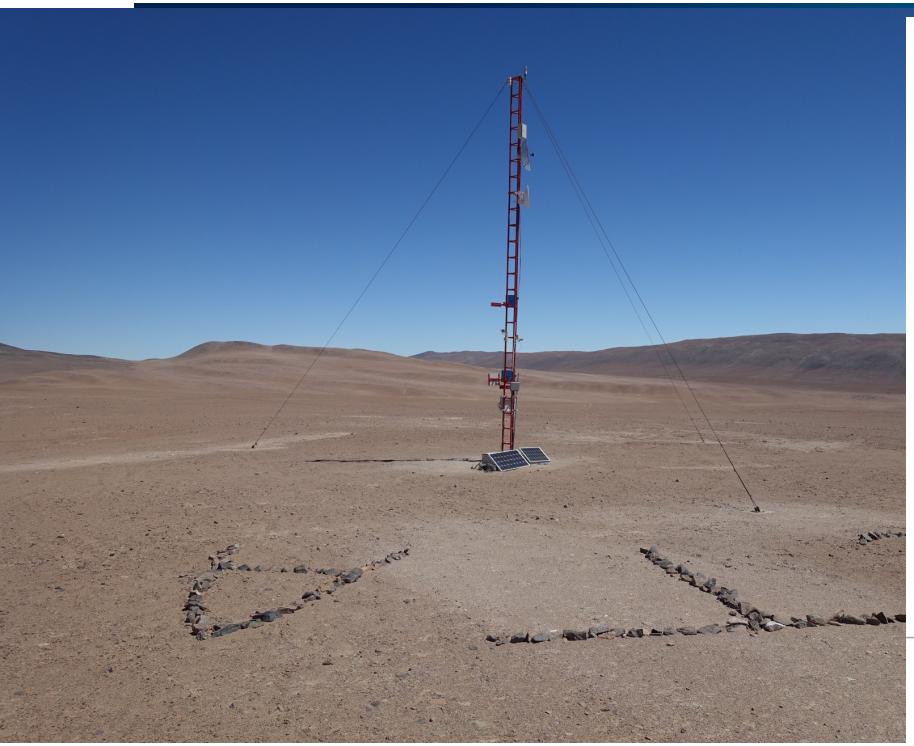
- Most of the CTA Observatory will be built with ***In-Kind Contributions*** (IKC) from participating scientific institutions in 10+ countries
  - Most of the industrial procurement done by these institutions
  - Various prototypes of telescopes and cameras have been built by IKCs
  - Project moving now to (serial) production and construction

- The CTAO is the central entity for construction & operation
  - Develops the system concept and subsystem requirements
  - Receives sub-systems & CTAO-North infrastructure as in-kind contributions
  - Procure / builds the CTAO-South infrastructure
  - Integrates sub-systems into the overall observatory system
  - Manages the software development
  - Will operate the observatory

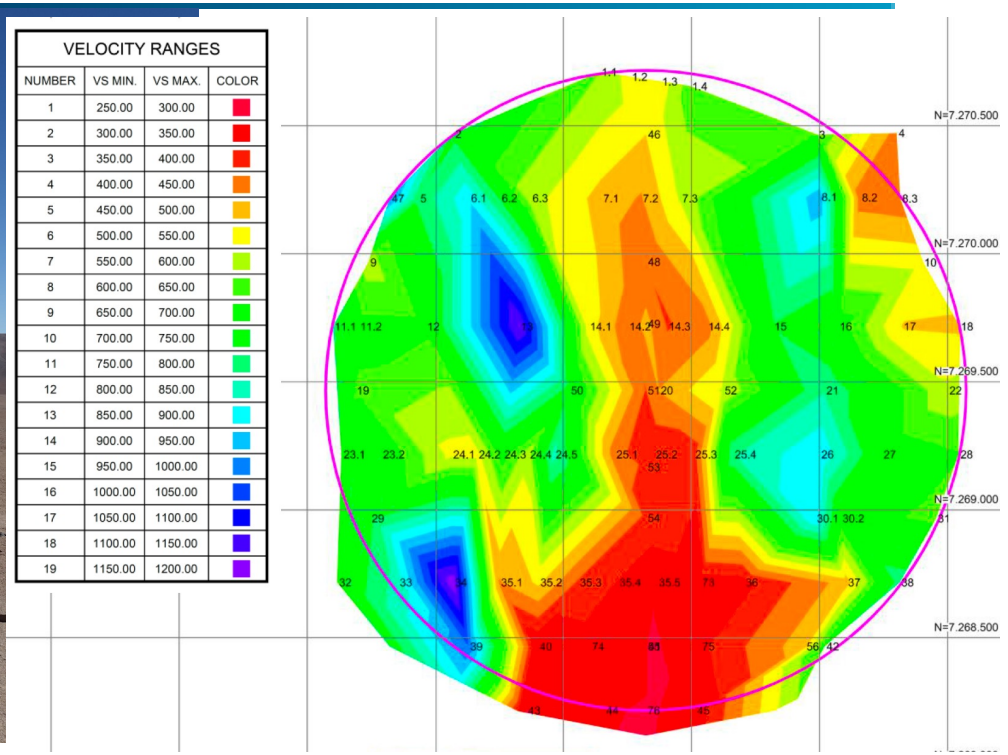
CTAO-South Site, ESO (Chile)



Atmospheric Testing & Geotechnical studies



VELOCITY RANGES			
NUMBER	VS MIN.	VS MAX.	COLOR
1	250.00	300.00	
2	300.00	350.00	
3	350.00	400.00	
4	400.00	450.00	
5	450.00	500.00	
6	500.00	550.00	
7	550.00	600.00	
8	600.00	650.00	
9	650.00	700.00	
10	700.00	750.00	
11	750.00	800.00	
12	800.00	850.00	
13	850.00	900.00	
14	900.00	950.00	
15	950.00	1000.00	
16	1000.00	1050.00	
17	1050.00	1100.00	
18	1100.00	1150.00	
19	1150.00	1200.00	

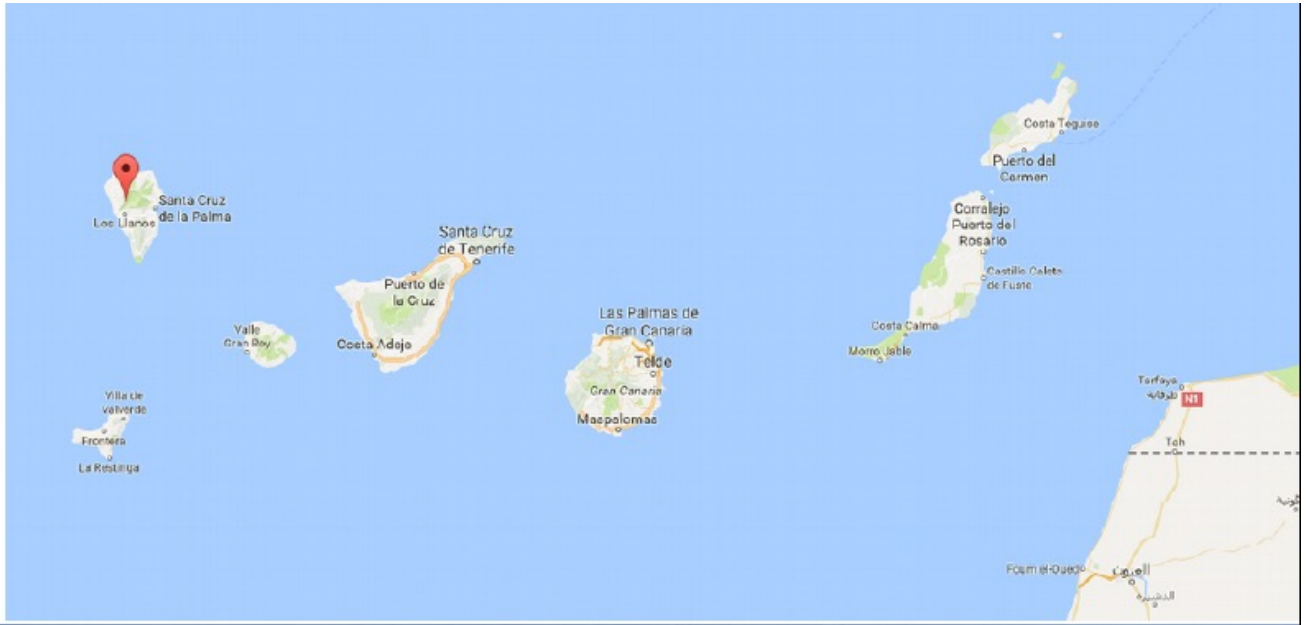


CTAO-South Access Road Construction

CTAO-North Site (La Palma, Spain)

Observatorio Roque de los Muchachos, IAC, La Palma, Canary Islands (Spain):

- 4 LSTs
- 9 MSTs

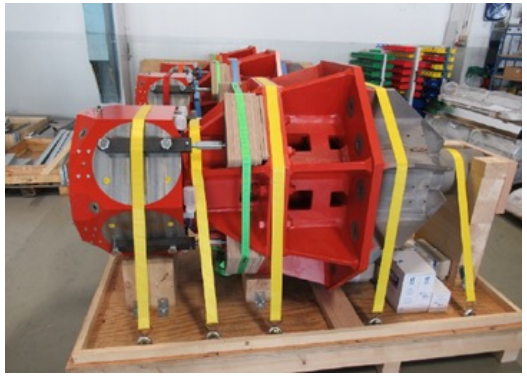


Prototype Large-Sized Telescope (LST-1)

- 23m LST prototype built and being commissioned on La Palma (Spain)
- By a collaboration of 30+ institutes in 11 countries
- Recent clean-up of ashes after78-day volcano outbreak on La Palma

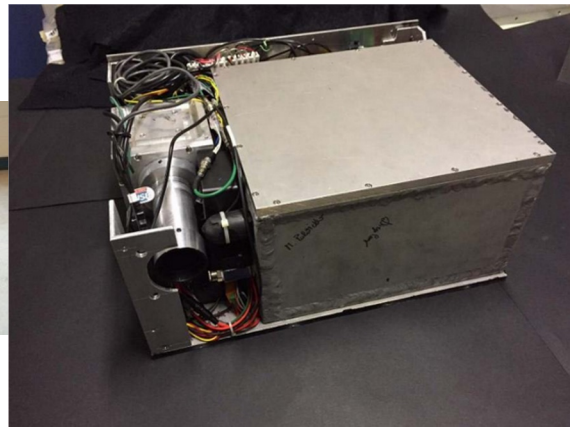
LST-2 to 4 Production (I)

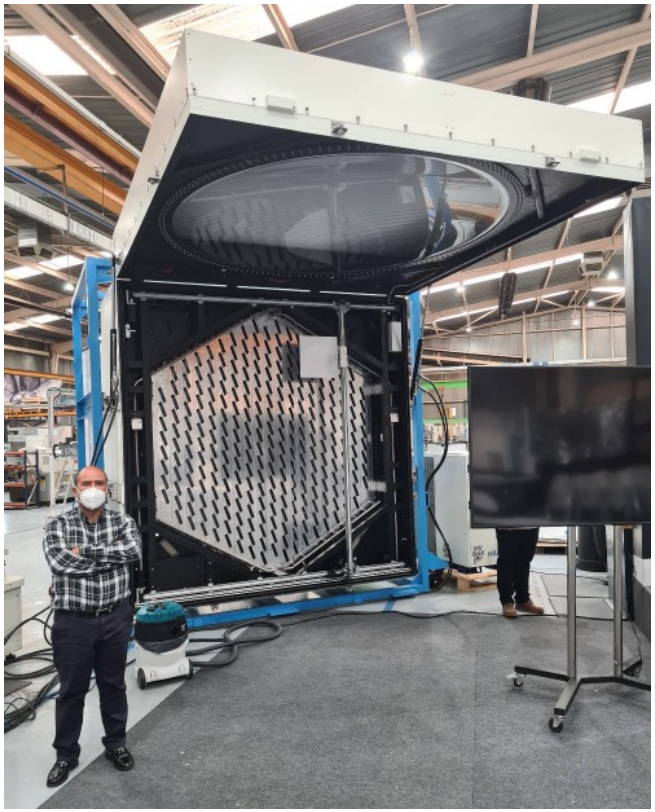
- Progress in tenders and procurement
  - Structure and mechanism in various stage of production, various parts already shipped to La Palma, production distributed (IAC, LAPP, MPP, INFN.....)
  - CFRP arch tubes and cables in production



LST-2 to 4 Production (II)

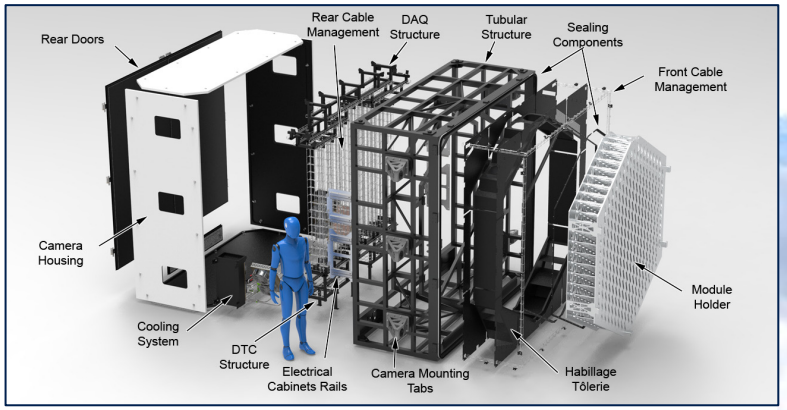
- Mirrors and cameras progressing well
  - 600+ mirrors and AMC boxes (Japan) in La Palma
  - 1200+ AMC actuators (MPP) in production (completed in 2023)
  - Camera mechanics (IAC) finished for LST2, LST3 and in production for LST4
  - Camera integration LST2 started (Spain)
  - 3 Calibration Boxes plus spare (INFN) before 2023
  - 3 Embedded Controller ECCs (LAPP) ready

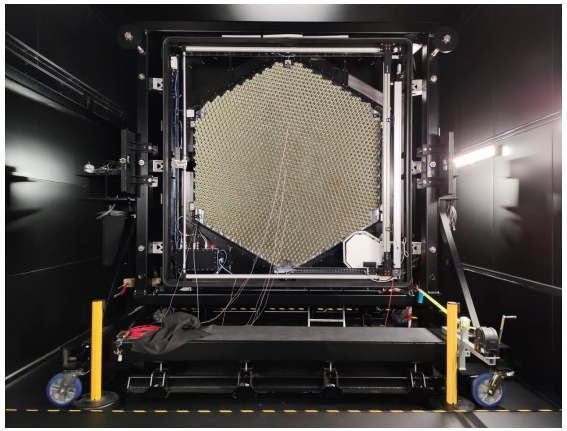




Medium-Sized Telescope (MST)

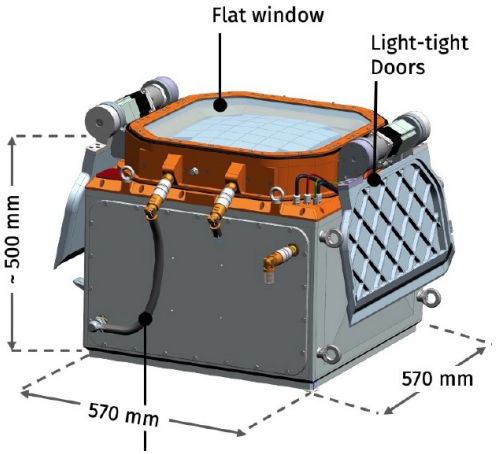
- 14m prototype MST has been built and tested in Berlin (Germany)
  - Telescope structure from DESY (Germany)
  - Two camera models: one from MPIK (Germany) and one from CEA (France)
- Now ramping up for series production for the North and South sites

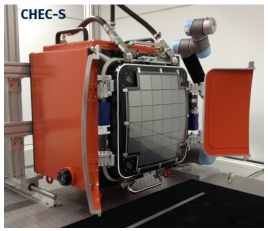


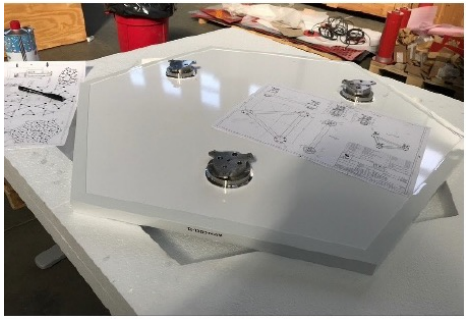


Small-Sized Telescope (SST)

- 4m dual-mirror prototype built and tested at mount Etna, Sicily
- Precursor SSTs being built in Tenerife (ASTRI mini-array of 9 telescopes)
- 37 SSTs to be built at CTAO-South in Chile
  - SST design for Chile to be finalized
  - Telescope structures to be tendered by INAF (Italy)
  - Cameras from consortium led by MPIK (Germany)

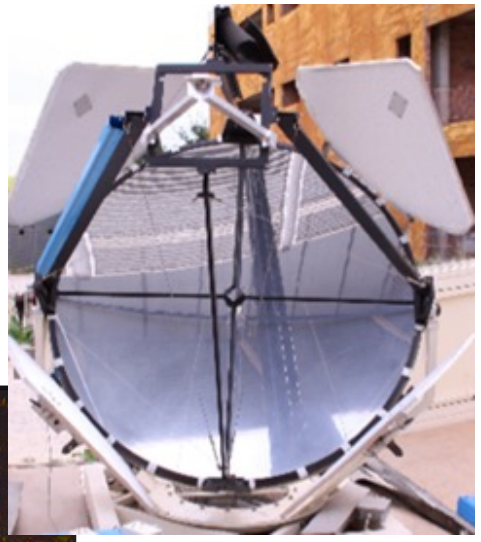






CTA Calibration and Monitoring

- The CTA Observatory will install calibration and weather monitoring equipment at both array sites
- This includes LIDARs, All-Sky cameras, illuminators and weather towers
  - Some custom-made by scientific institutes, some industry-made



CTA Construction Status Summary

- CTA design and prototyping
  - Subsystem design and prototyping almost finished
    - Multiple prototypes for telescope structures and cameras existing
  - System design being finalized
- CTAO-North Site (La Palma, Spain)
  - LST1 being commissioned – LST2-4 production started
  - Infrastructure phase 1: detailed design in progress, preparing Call for Tenders
- CTAO-South Site (Chile)
  - Geotechnical and seismic studies completed
  - Access road being built, other infrastructure being designed
  - First telescopes expected on-site in 2024/25

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Major CTAO Partners

Significant hard- and software **in-kind contributions** are expected from the major CTA Observatory partners, including the following:

- **Italy –** INAF, INFN
- **Germany –** DESY, MPIK (Heidelberg), MPP (Munich)
- **France –** CNRS, CEA, OBSPM
- **Spain –** IAC, CIEMAT, IFAE, PIC, ICE/CSIC, UAB
- **Japan –** University of Tokyo
- **Switzerland –** University of Geneva
- **Czech Republic –** Institute of Physics of the Academy of Sciences
- **Slovenia –** University of Nova Gorica
- **UK –** UKRI
- **Austria –** Leopold Franzens Universität
- **The Netherlands –** NWO

Major Technology Expertise/distribution *(non exhaustive...)*

- Mirror technologies
  - France
  - Italy
  - Poland
  - Czech Republic
- Telescope structures
  - Italy
  - Germany
  - France
  - Poland
- Cherenkov cameras
  - France
  - Spain
  - Japan
  - Germany
  - Italy
  - UK
  - Netherlands
- Control systems
  - France
  - Italy
  - Germany
  - Slovenia
- Calibration technologies
  - Czech Republic
  - Slovenia
  - Germany
  - Italy
  - Spain
  - France
- Electronics
  - Various countries

Procurement Key Points

- No central CTA procurement scheme
  - Infrastructure South procured by CTAO, mostly via ESO *(it includes power distribution)*
  - Some (smaller) items procured directly by CTAO
- CTA is one of the largest In-Kind Contribution projects
  - Procurement money is spent by the IKC institutions
  - Some contracts were / will be awarded to industry, other may involve scientific institutions together with industrial partners
- Public funding
  - All relevant procurements within Europe will have to follow European Tendering rules
- No geographical Fair Return rule
  - Geographical distribution “plays” some role *(often dealt with via generation of international consortia)*

Invitation to Tender (CTAO gGmbH)

- CTAO gGmbH have to comply with EU Directive2004/18/EC and special German provisions for public procurement, including
  - Principles applied are non-discrimination and equal treatment, competition, transparency, best value-for-money.
  - Based on this legal framework internal procurement procedures are established.
- Contract value of €30.000 - €221.000 > National Call for Tender (German law applies – publication on portal www.bund.de).
- Contract value of over €221.000 > European Call for Tenders (EU Procurement Directive n. 24/2014 applies – publication on OJEU/Ted portal).

- For information about procurement at CTAO gGmbH: ctao-procurement@cta-observatory.org

Invitation to Tender

- IAC
  - All the information about contracts and tender calls is published at the IAC Contractor's profile available through the Spanish Public Sector Contracting Platform: https://contrataciondelestado.es/wps/portal/!ut/p/b0/04_Sj9CPykssy0xPLMnMz0vMAfIjU1JTC3Iy87KtClKL0jJznPPzSooSSxLzSlL1w_Wj9KMyU5wK9CPT3d2Cc8vNLUvNHW31C3JzHQHrum6M/
- ESO
  - In general tendering process largely based on most competitive compliant tender and where possible and carried out within the ESO Member States.
  - Information about ESO procurement under https://www.eso.org/public/industry/cp.html
- (Potential) In-Kind contributors
  - Those interested in opportunities with the IKC teams are encouraged to contact the regional industry contacts listed on the CTAO webpage https://www.cta-observatory.org/project/industry/#1535533438154-65d5d2fa-6b2f

Thank You !

cta OBSERVATORY