

Cherenkov Telescope Array Observatory

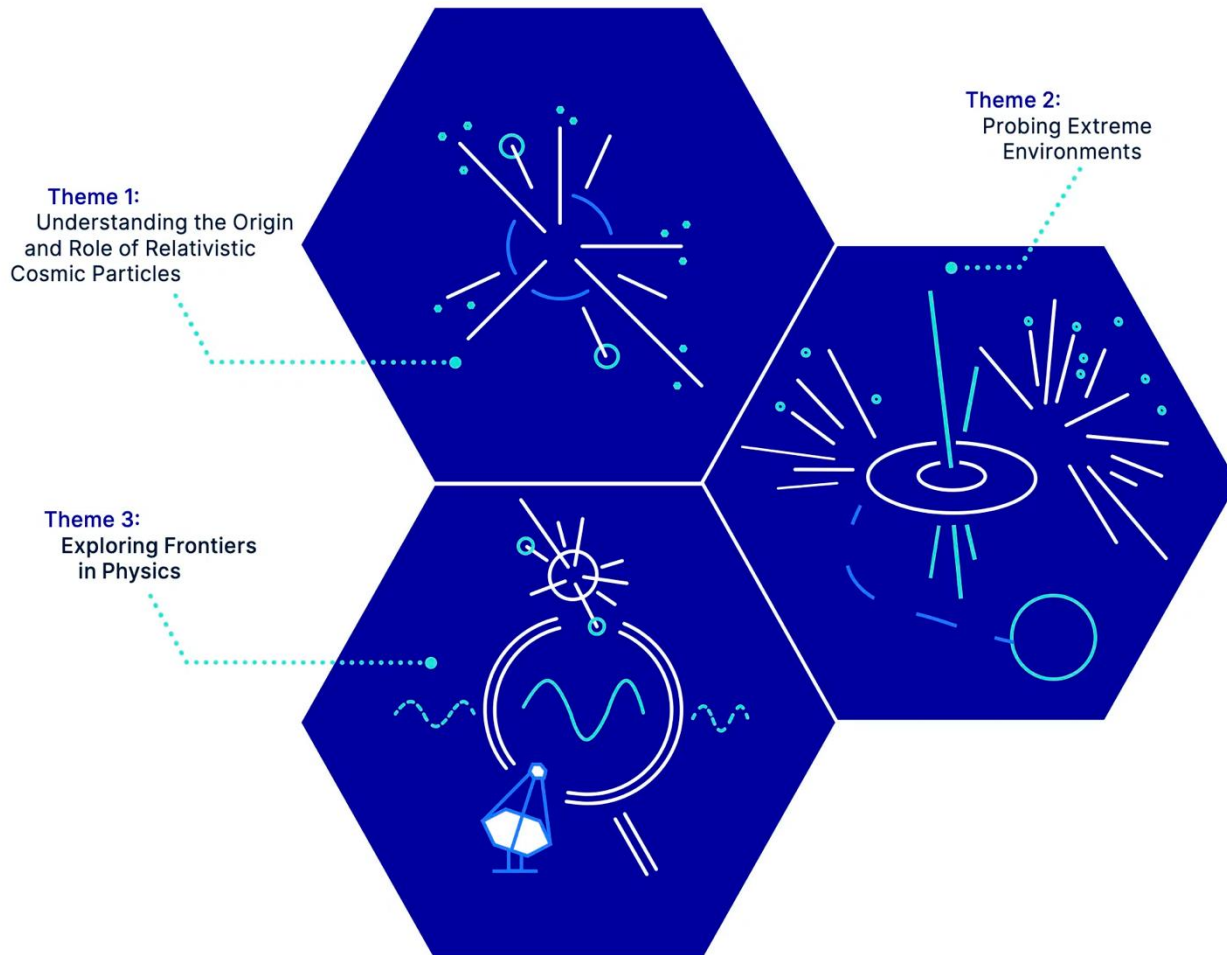
May 19, 2026

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Scientific Potential

Science Themes:



- Expanding the number of known gamma-ray objects by up to 1,000
- In-depth understanding of known objects
- Detection of new classes of gamma-ray emitters
- Great potential for fundamentally new discoveries

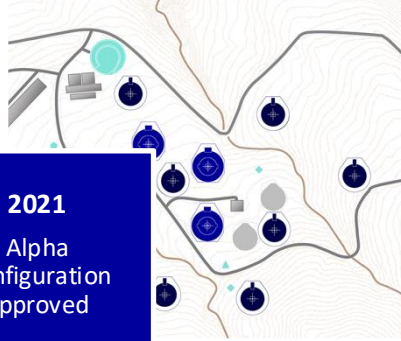
- Addressing a wide range of questions in astrophysics and fundamental physics

How we got here

The path to building the CTAO...



2019
CTAO hosts first science symposium



2021
Alpha Configuration approved



2023
CTAO ranked highest priority by ASTRONET



2023
Governing bodies invest ~30M Euro



2024
CTAO hosts second science symposium



2024
The Science Data Management Centre is opened



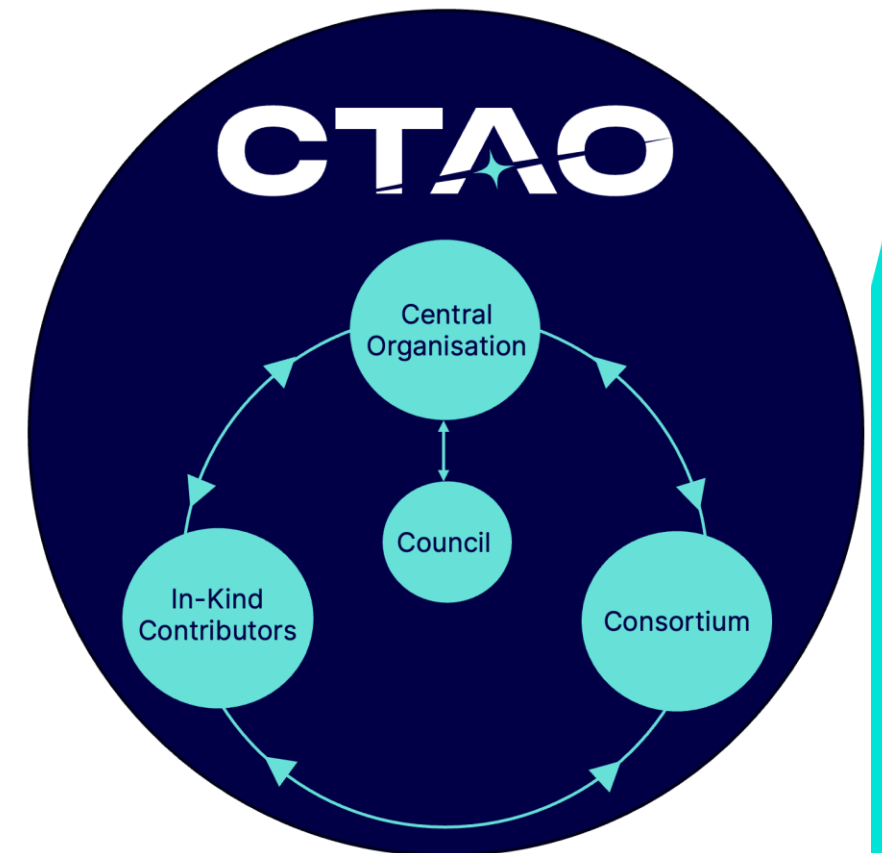
2025
The CTAO ERIC is established



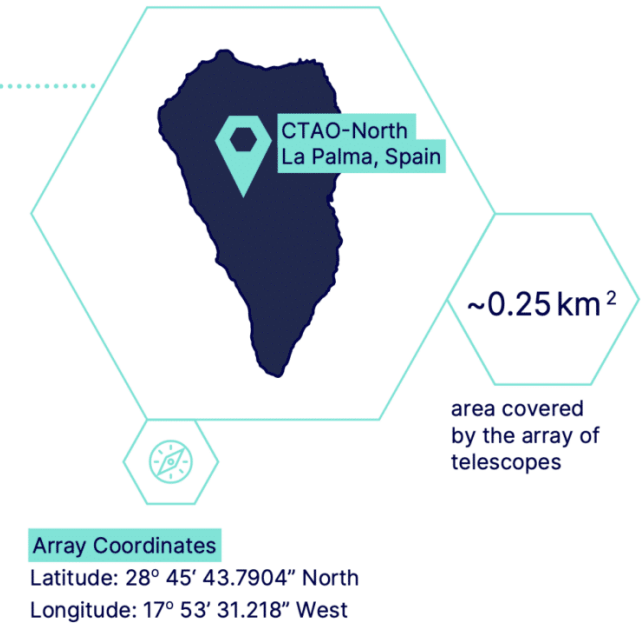
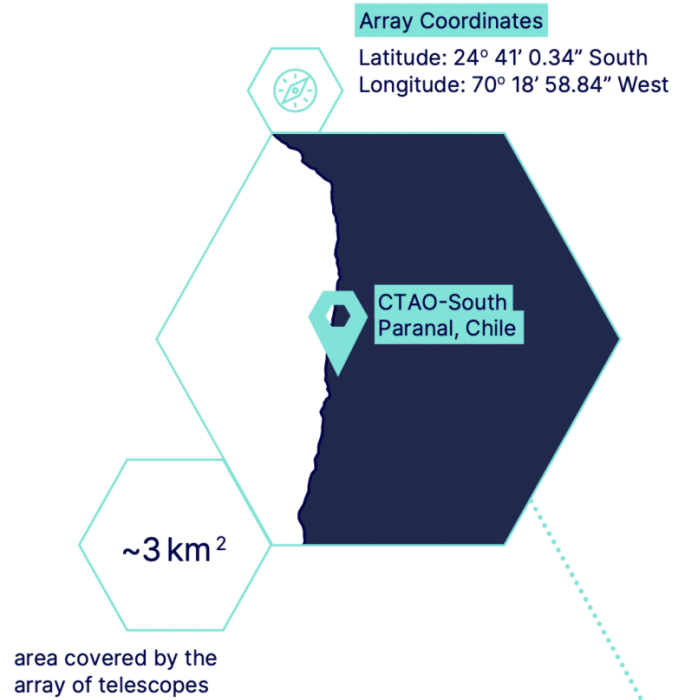
2025
The CTAO ERIC Council is formed

CTAO Partnerships

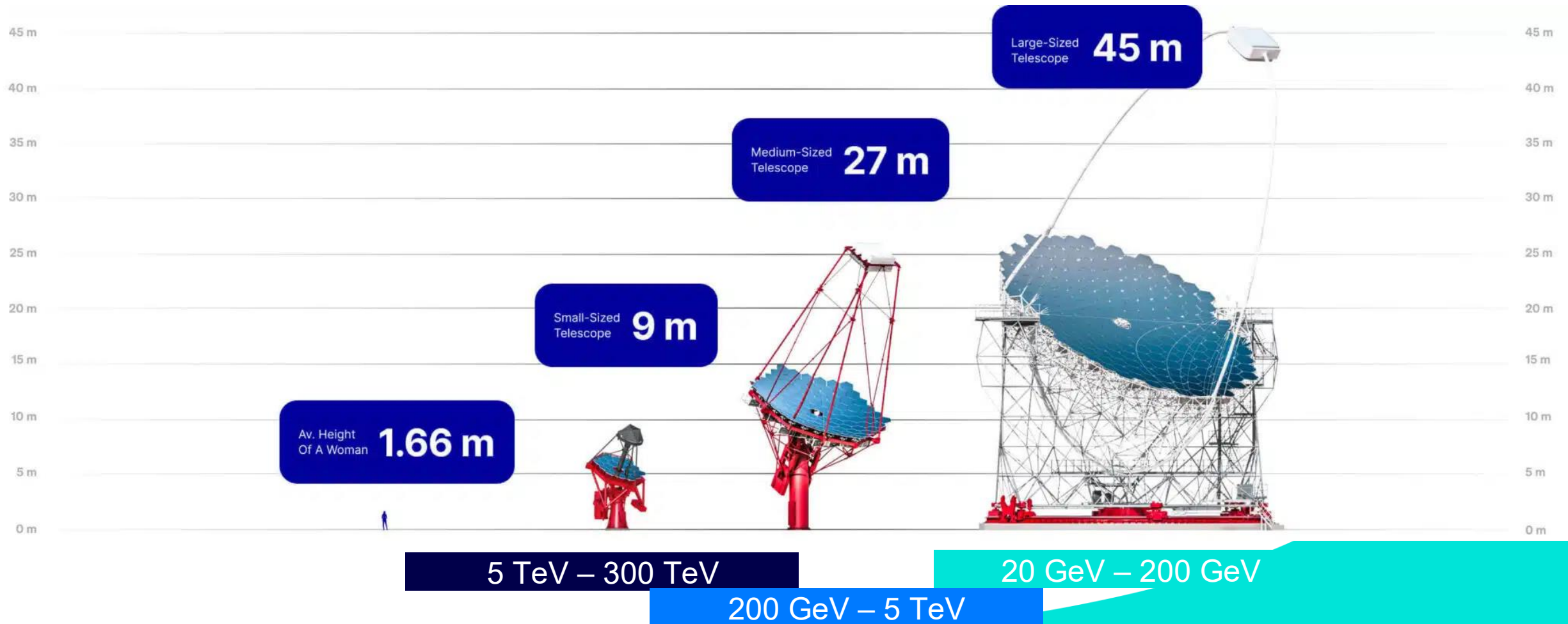
- Consortium consists of >1500 scientists and engineers who devised the CTAO concept in the past decade (focusing now more on science exploitation of the Observatory)
- IKCs providing goods and services to the CTAO Central Organisation (e.g. hardware, software, or services)



The Array Sites



The Telescopes



CTAO

CTAO-N

Alpha Configuration

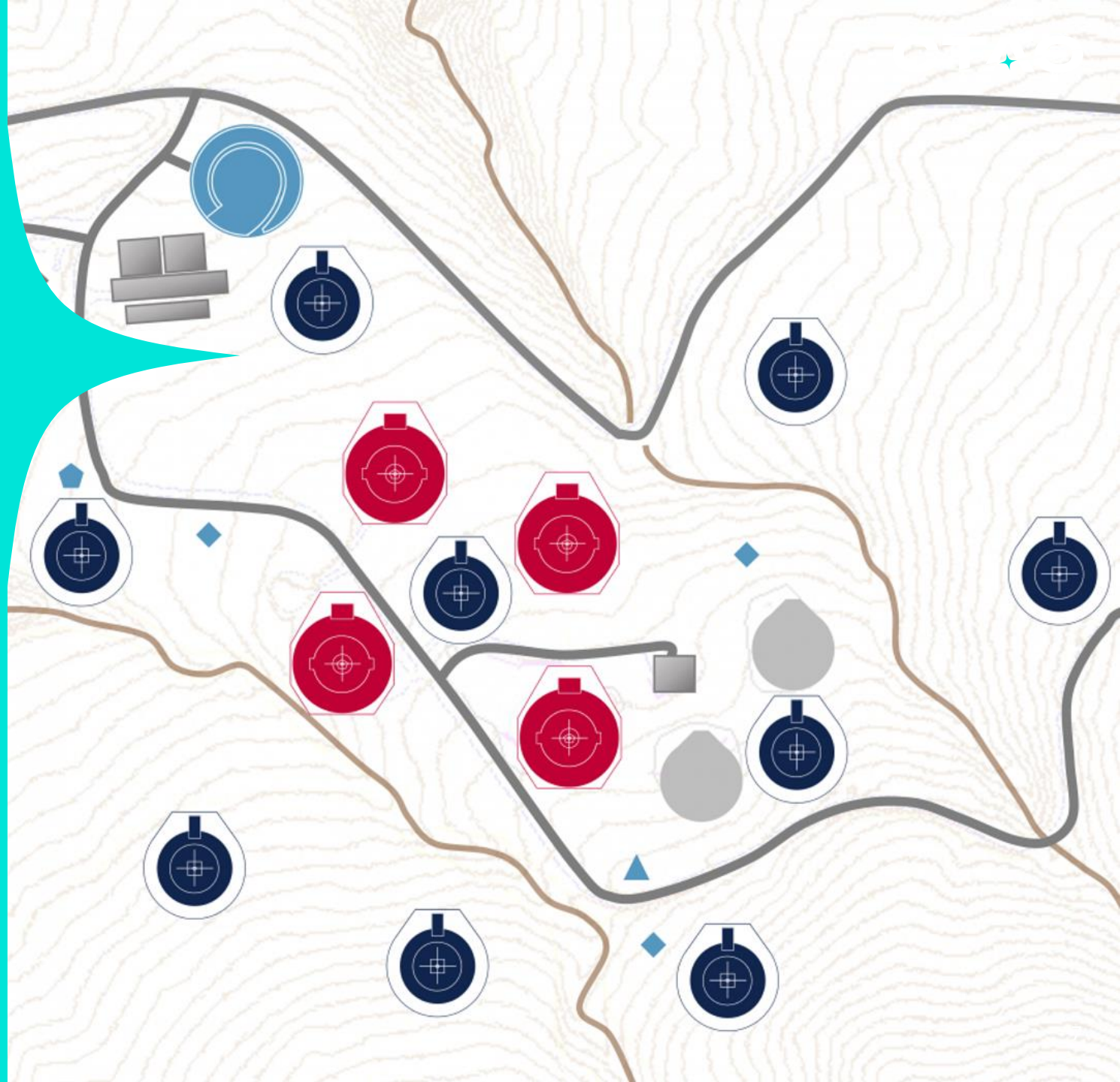
North

Observatorio del Roque de los Muchachos
Longitude: 17° 53' 31.218" West
Latitude: 28° 45' 43.7904" North



LEGEND	
Large-Sized Telescope (LST)	
Medium-Sized Telescope (MST)	
CTAO Operations Building & Other Calibration Devices	
Weather Station	
Stellar Photometer	
Raman LIDAR	
Road	
Gradient	
MAGIC Telescopes	
External Facilities	

4 LSTs + 9 MSTs



CTAO

CTAO-S

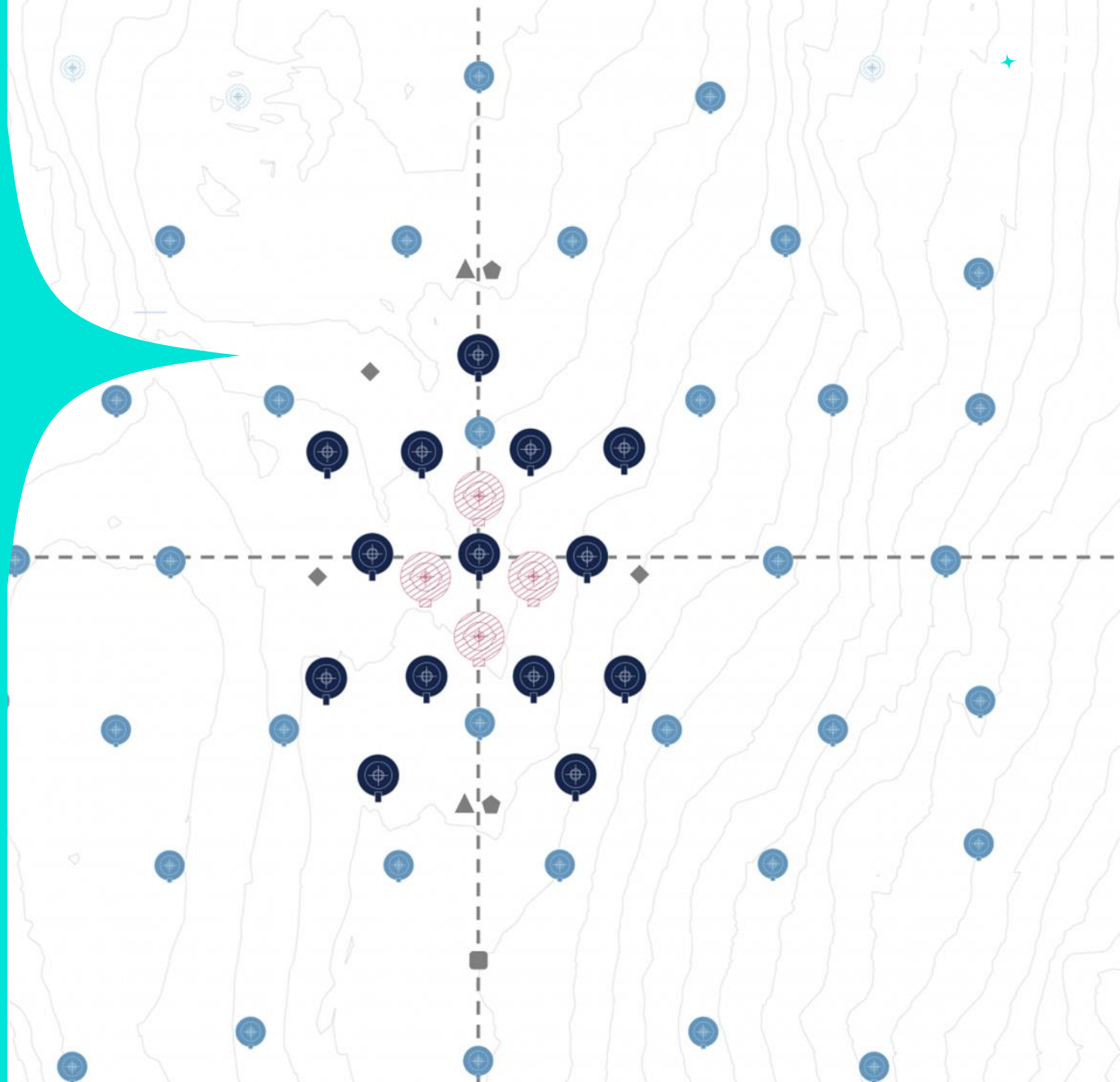
Beta Configuration



South

Paranal Observatory
Latitude: $24^{\circ} 41' 0.34''$ South
Longitude: $70^{\circ} 18' 58.84''$ West

14 MSTs + 37 SSTs
+ 2 LSTs



LEGEND

Medium-Sized Telescope (MST)



Weather Station



Small-Sized Telescope (SST)



Stellar Photometer



Large-Sized Telescope (LST)
Foundation



Raman LIDAR

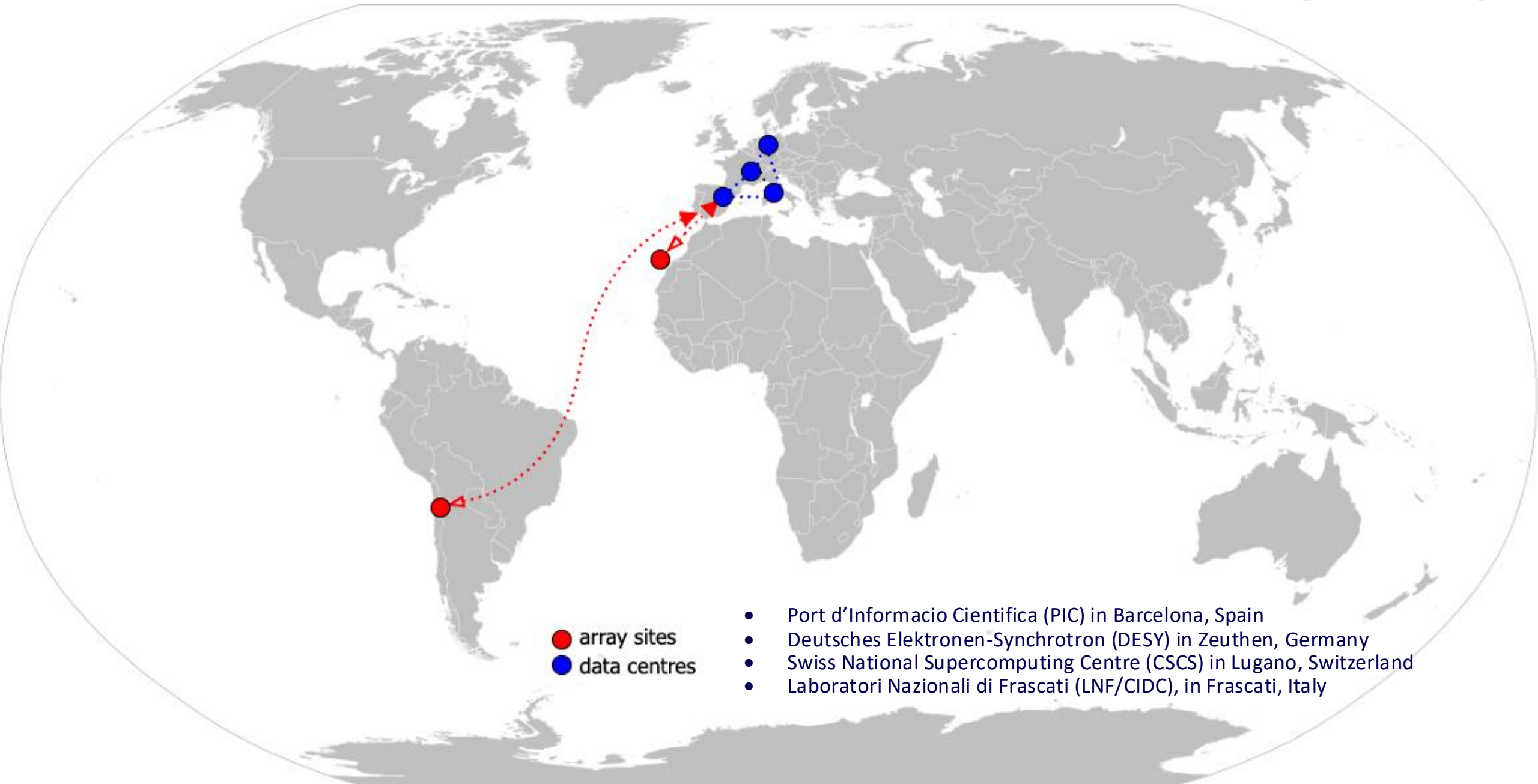


SST Foundation



Other Calibration Devices

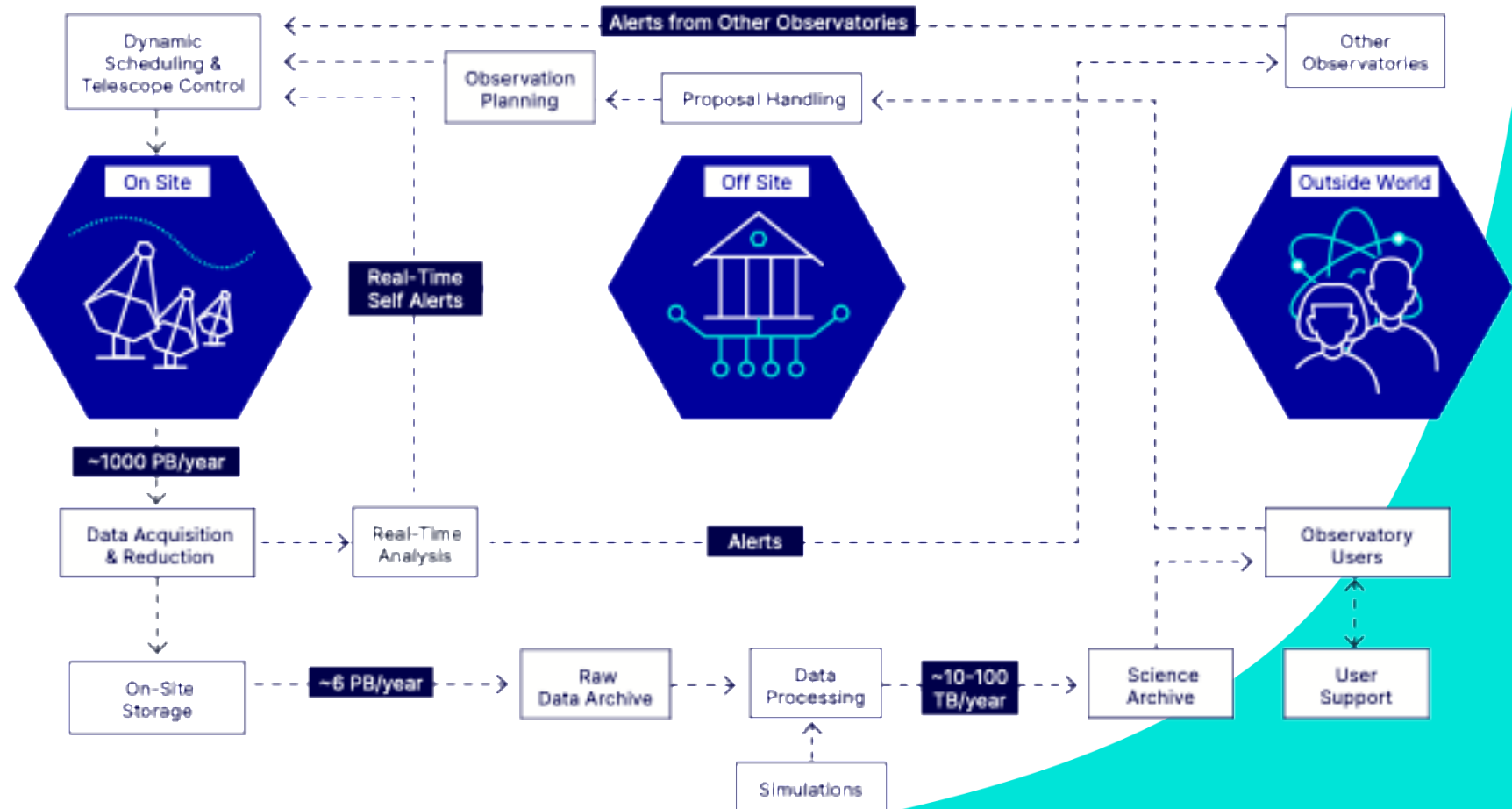




Data and Computing

The CTAO is a data-driven project.

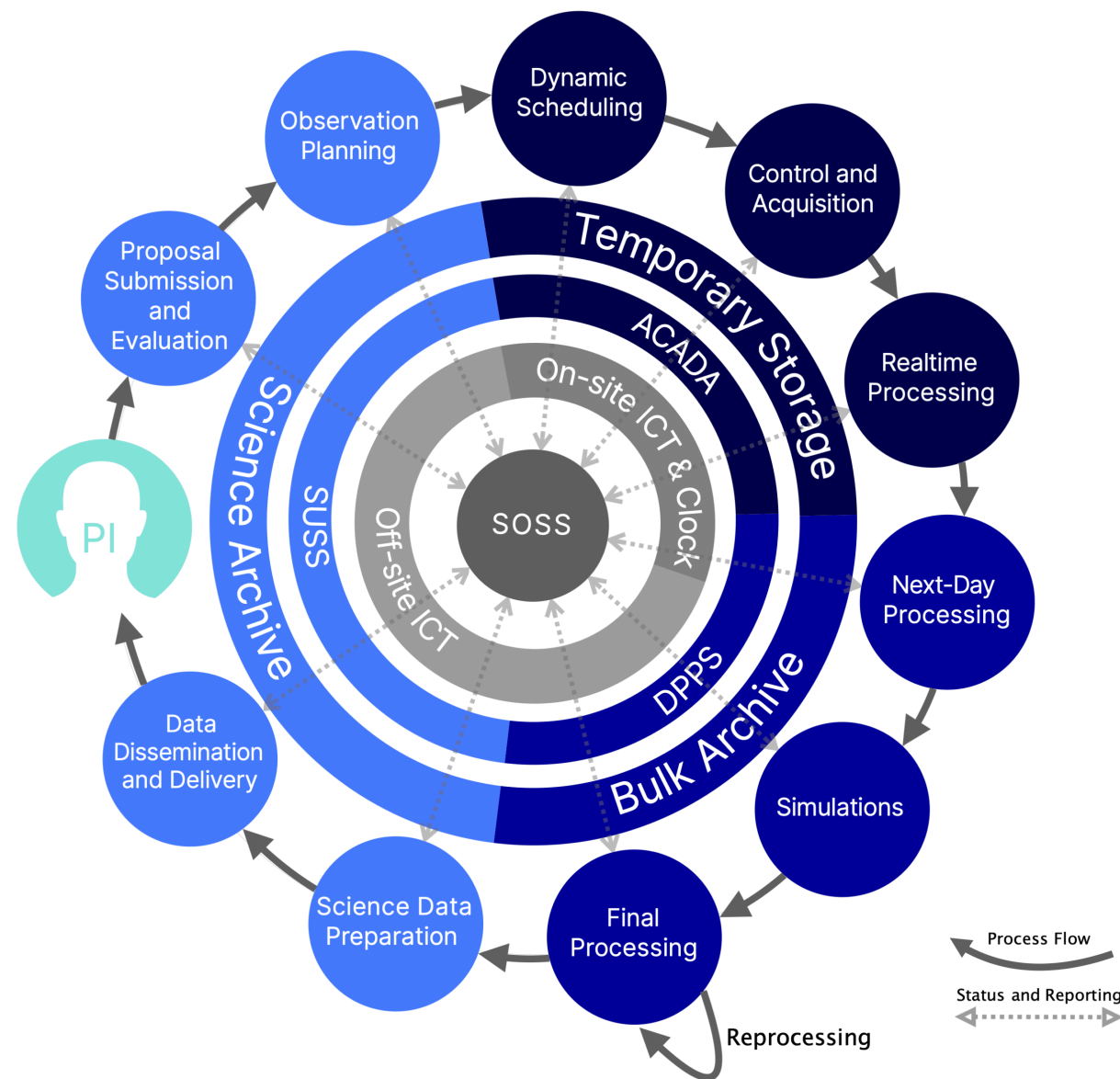
- Generates hundreds of petabytes (PB) of data in a year (~6 PB after compression)
- Computing team + IKC teams develop hardware and software products to deal with the data flow (from proposal handling to data dissemination)



Data and Computir

Deliver the **central software and computing infrastructure** required to operate the CTAO

- Involving In-kind contributors (IKCs) and industrial partners
- Deliver products versions with incremental capabilities to support the Observatory deployment
- Set up agreements Central Organization – contributing partners (MoUs, Lols, SLAs, etc.)
- Provide standards, guidelines, and procedures that impact other software products within the CTAO, such as software elements of telescopes and other array elements.



Computing View

A distributed environment

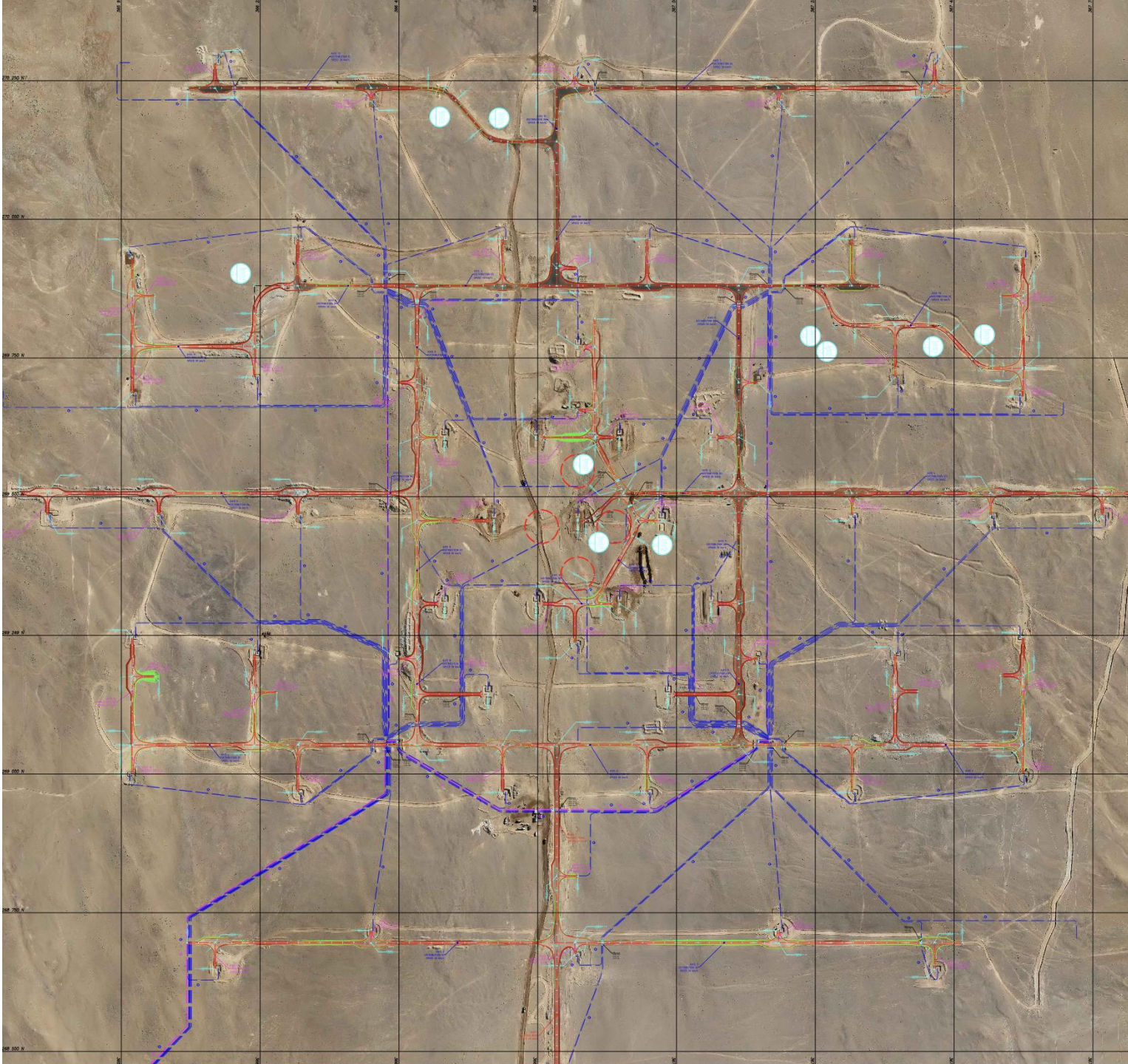
- Telescopes and other array elements on Chile and La Palma site
- Operate array elements
- Collect and process data in two on-site data centres (DCs)
- Data transfer → Europe → off-site DCs → data processing and preservation
- Data processed, preserved in science archive in one(two) off-site DCs
- Monitoring and oversight in Science Data Management Centre
- Science users get access through a portal for observation proposals, and high-level data and software and status messages...

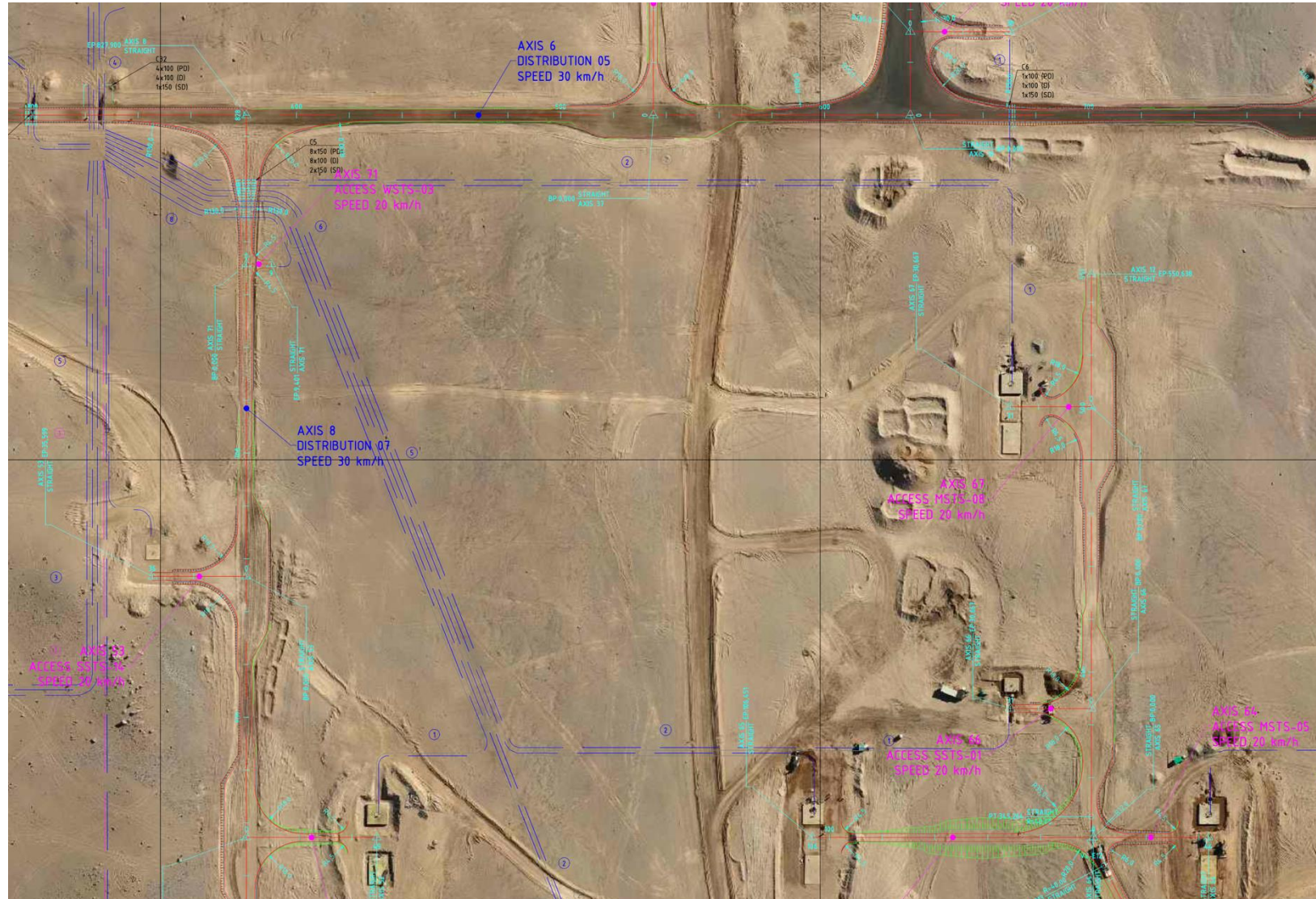


South site
access road
<2025

Roads and foundations construction is under way

Start deploying telescopes in 2026





Roads and foundations construction is underway

Start deploying telescopes in 2026

Data Distribution Network South

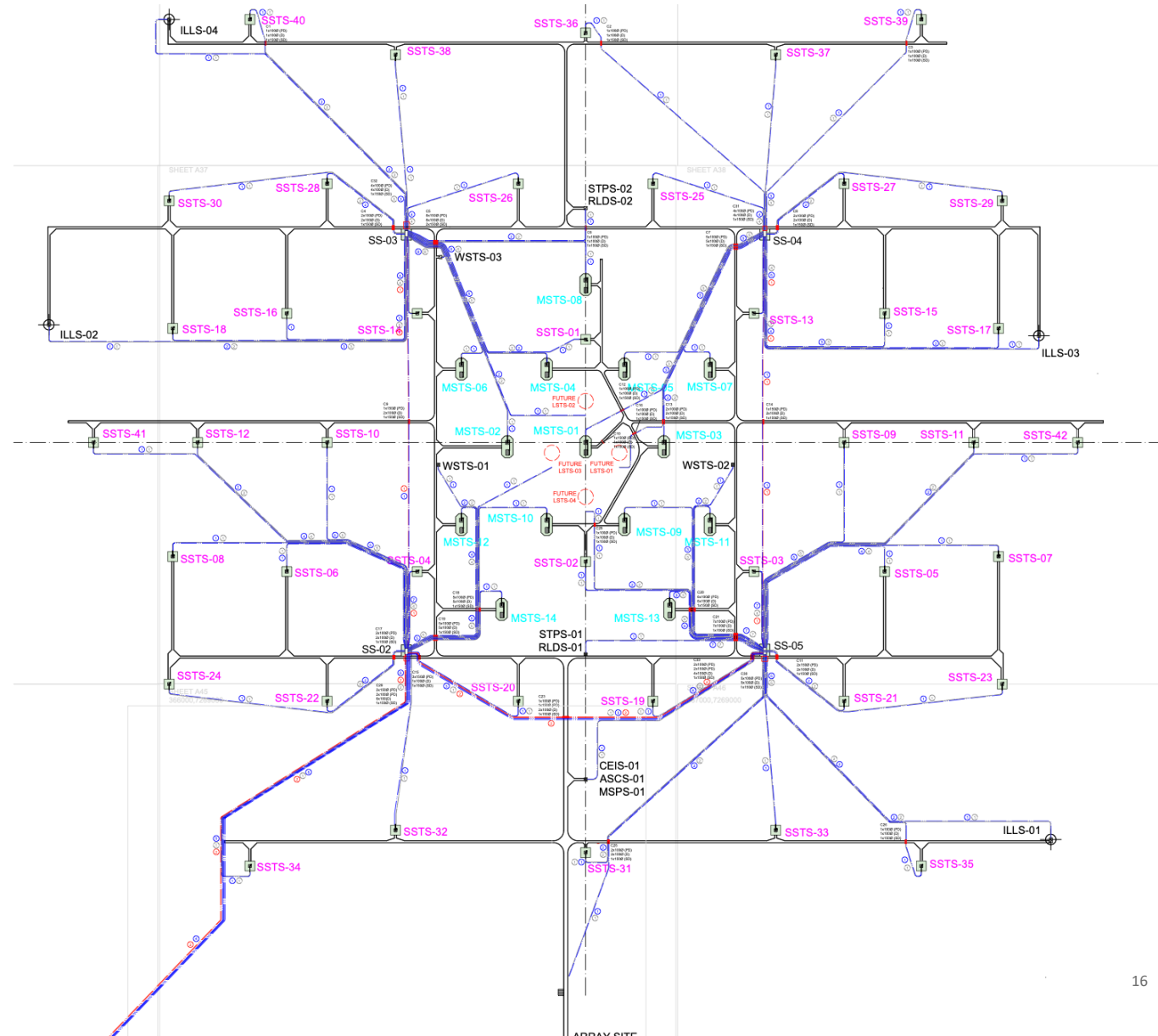
Multiple Star-like network

Data Centre located in the Operation Building at Support Site

Array Site

Array Elements

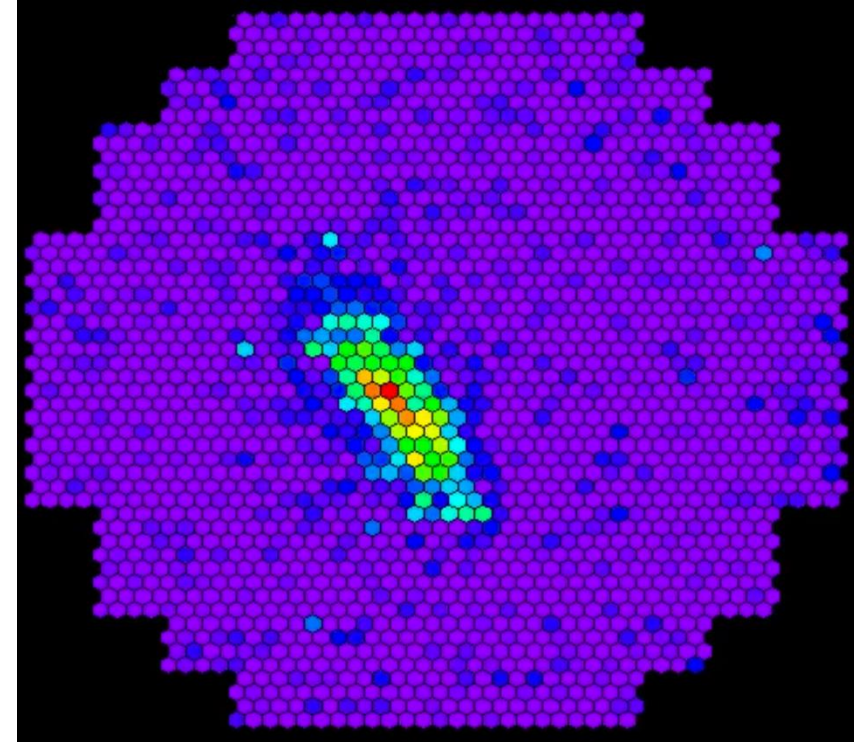
Sub-stations / Splice Points



- Defines the data and processing workflows from
 - the data acquisition sites at CTAO-North and CTAO-South to
 - the different CTAO off-site Data Centres
- It specifies
 - number of versions of the data products per data type
 - number of replicas for each
 - storage Quality of Service (performance, access latency, reliability...)
- It uses
 - simulation and measurements of telescopes
 - data models and formats
 - data volume reduction of site

Data Rates

- Maximum Rates
 - LST: 12 Gbps
 - MST: 6 Gbps
 - SST : 2 Gbps
- Expected Rates
 - LST: 5 Gbps
 - MST: 2 Gbps
 - SST: 1.5 Gbps
- **Beta Configuration (South): 2 LSTs 14 MSTs 37 SSTs -> 56 Gbps**
- **Data Volume Reduction**
Online removal of camera pixels that do not take part in events
Without losing performance



Assumptions



Alpha Configuration: 14 MSTs + 37 SSTs + 2 LSTs



Addition of 25 TB /year /Tel data for monitoring and service data



Total Observation Hours 2000 North and **2100 South** per year



Max 12 hours of data acquisition per day

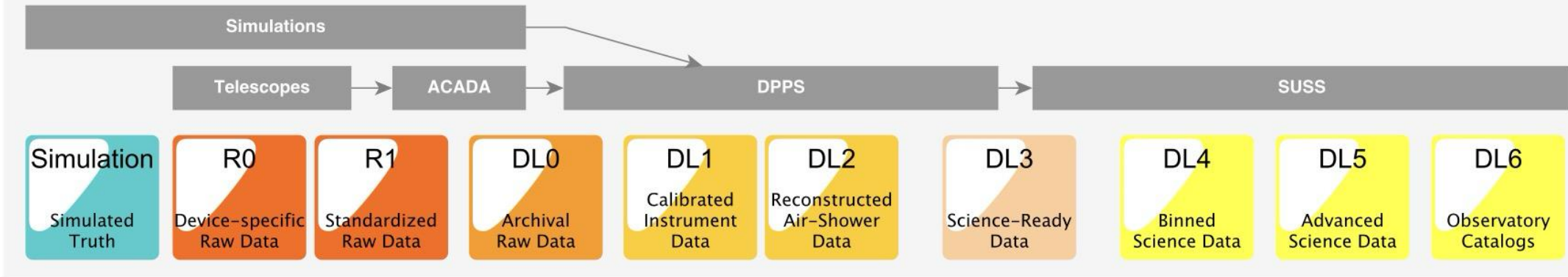


10 Gbps link operating for 24 hours per day at 75% efficiency

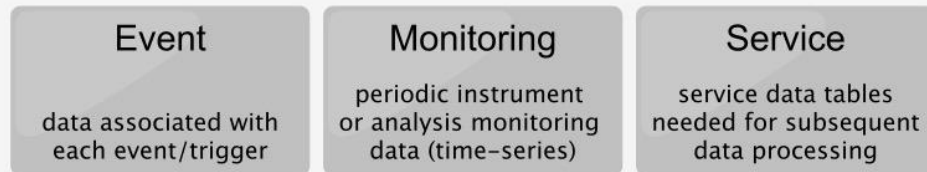
→ Integrated 56 Gbps on South site → 6 PB/yr to Europe

Data Levels

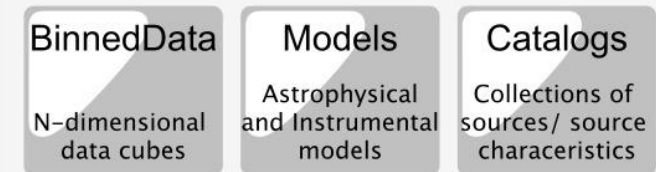
Science / [Data Level]



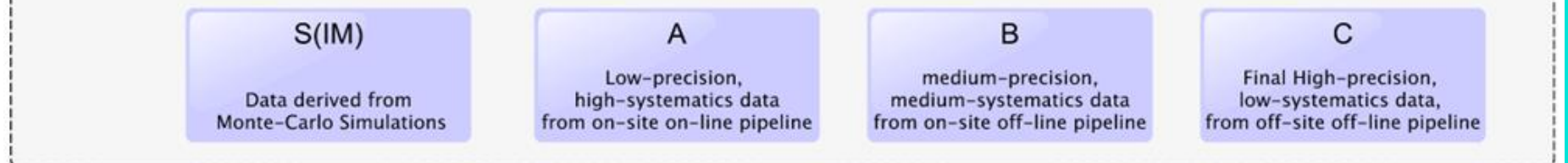
Sub-package



Sub-package



Data Category



Storage Model

- Raw Data will be storage twice before removal on-site
- Data will be processed during the night, the next day and to final science data products
- Large volumes of simulations are required to provide instrument response to scientists (up to 45 PB)
- We expect to reprocess the data once per year
- Each data level will have its own retention policy

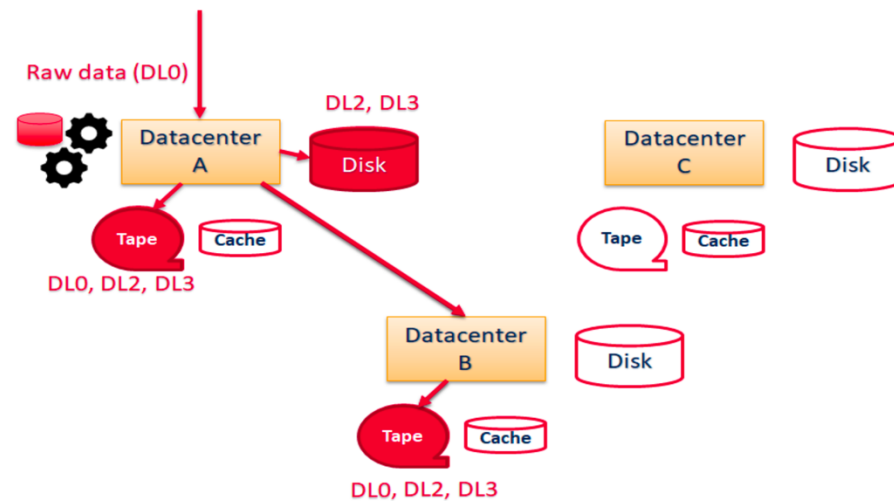
- CTAO-S Connectivity: 12km fibre from on-site data centre
 - → Connection to ESO Paranal
 - → use ESO Network connectivity using REUNA to Santiago/Antofagasta
 - → continental (RNP discussion ongoing) and intercontinental Network Service Provider (BELLA) for Chile
- Pan-European Network Service Provider: GEANT (≥ 10 Gbps bandwidth)
- CTAO coordination, control and monitoring at a CTAO site: the Science Data Management Centre (Zeuthen, Germany)
- The four Data Centres provide high-performance LAN and high-bandwidth connectivity to their NREN:
 - RedIRIS for Spain, DFN for Germany, SWITCH for Switzerland and GARR for Italy

Data Links to Europe

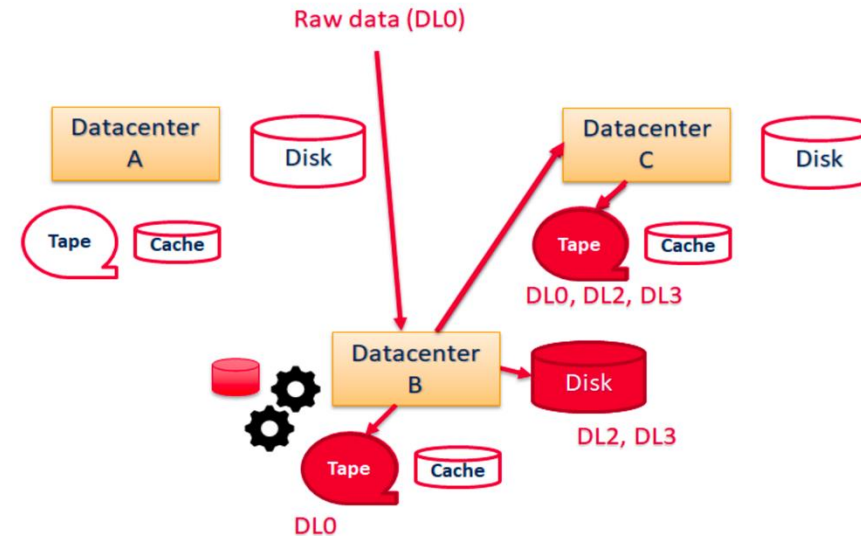
One Option



Data Flow for Raw Data Processing



Day 1



Day 2

Status and Next Steps

- CTAO-South construction has begun
- Initial Intermediate Array ~7 early Telescopes
- Build on-site data centre and site network within the next year

- Small number of telescopes can produce large amounts of data
- Replication policies adds to this
- Expect to transfer >~6 PB/year/site

- IKC agreements with off-site data centres
 - schedule aligned with CTAO integrated project schedule
- Data link agreements (including agreement with GEANT)
 - CTAO-S: ESO, REUNA and possibly other NRENs
- Begin to take data ...