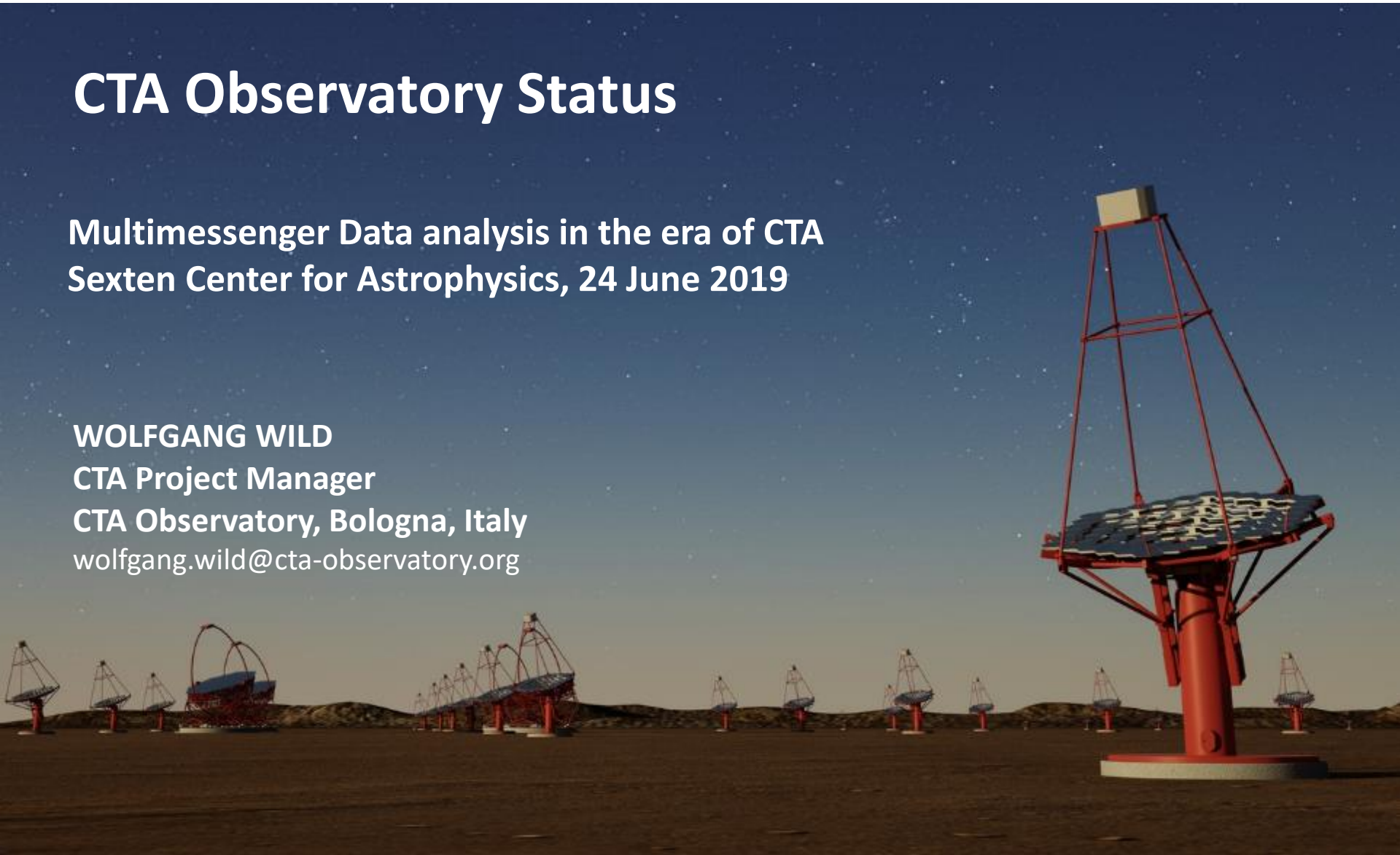
CTA Observatory Status

Multimessenger Data analysis in the era of CTA
Sexten Center for Astrophysics, 24 June 2019

WOLFGANG WILD
CTA Project Manager
CTA Observatory, Bologna, Italy
wolfgang.wild@cta-observatory.org



CTA – a new Observatory

- Design and construct the *Cherenkov Telescope Array* (CTA) as an international observatory for ground-based gamma-ray astronomy
  - With much increased performance over existing instruments
  - Up to 118 telescopes on two observation sites, one in each hemisphere
  - CTAO Headquarter in Bologna (IT), hosted by INAF
  - Science Data Management Centre (SDMC) in Zeuthen (DE), hosted by DESY
- Operate the observatory for an envisaged lifetime of 30 years
  - Data preservation at least until 10 years after CTA decommissioning
  - Major upgrades expected on a timescale of 10 to 15 years
- Construction and operation is the responsibility of the CTA Observatory (CTAO)
  - With many in-kind contributions (IKCs) from project participants

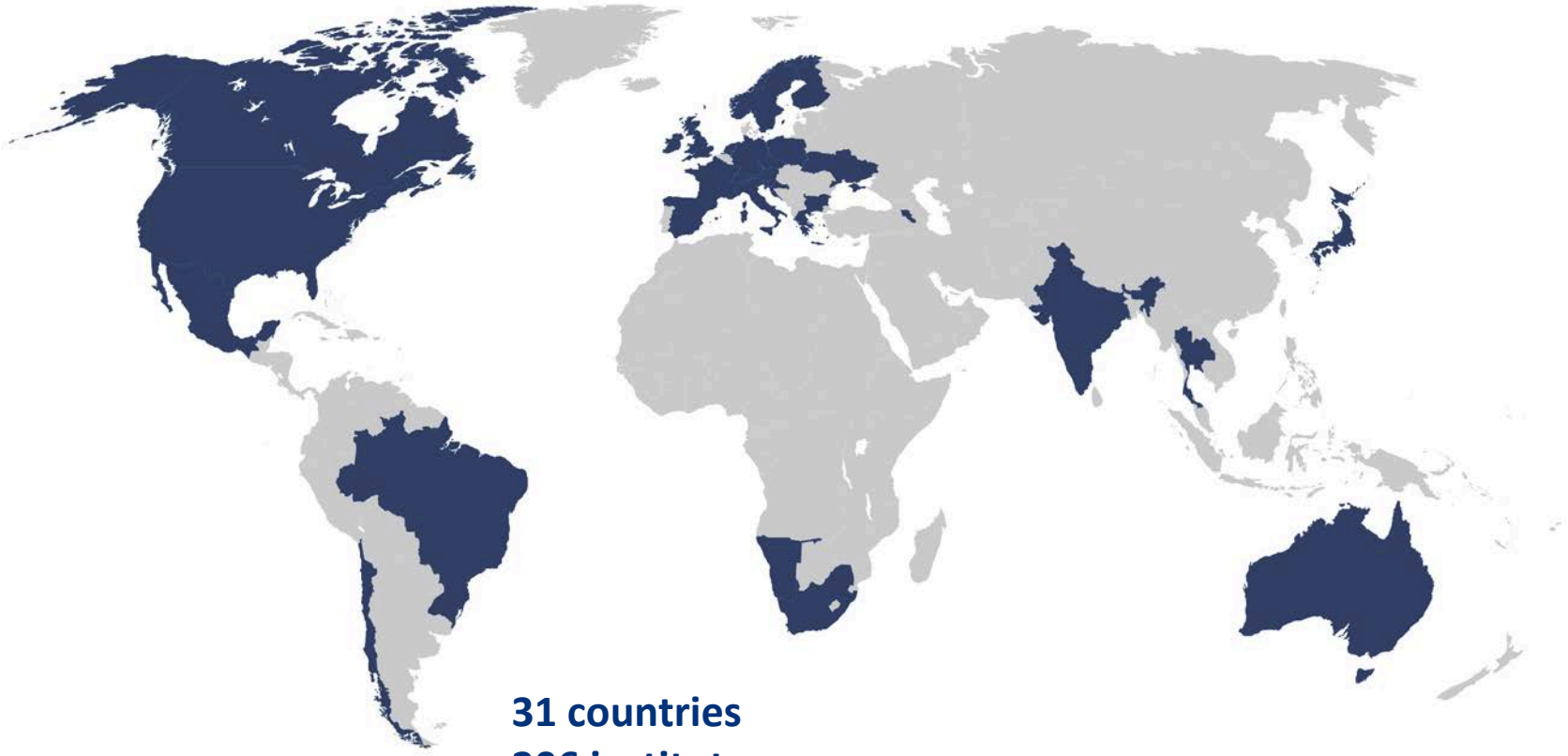
CTA sites: Arrays, Headquarter, SDMC

CTA Construction and Operation

- CTA is a BIG project
  - With 118 telescopes on two sites, CTA is larger than any existing observatory
  - For comparison: largest observatory in existence has 66 telescopes (ALMA)
- CTA is an IMPORTANT project
  - It will define gamma-ray astronomy for many decades to come
  - CTA included in the ESFRI roadmap and declared landmark in 2018
  - Ranked highly in the 2010 US Astronomy & Astrophysics Decadal Survey
- CTA will be a big *observatory,* not an *experiment*
  - This has important consequences for construction and operation, incl.
    - Operations staff will be different from construction staff
    - Organization and approach adapted to a large distributed project
      - Need of good systems engineering (Requirements, interface management, configuration control, acceptances, integration & verification, …)
    - System simplicity and standardization of components are important
    - High reliability and availability required

The CTA Consortium (CTAC)

- CTAC is a MoU based collaboration
- CTAC formed in 2008 to develop the CTA concept



31 countries
206 institutes
1501 members

The CTA Observatory (CTAO)

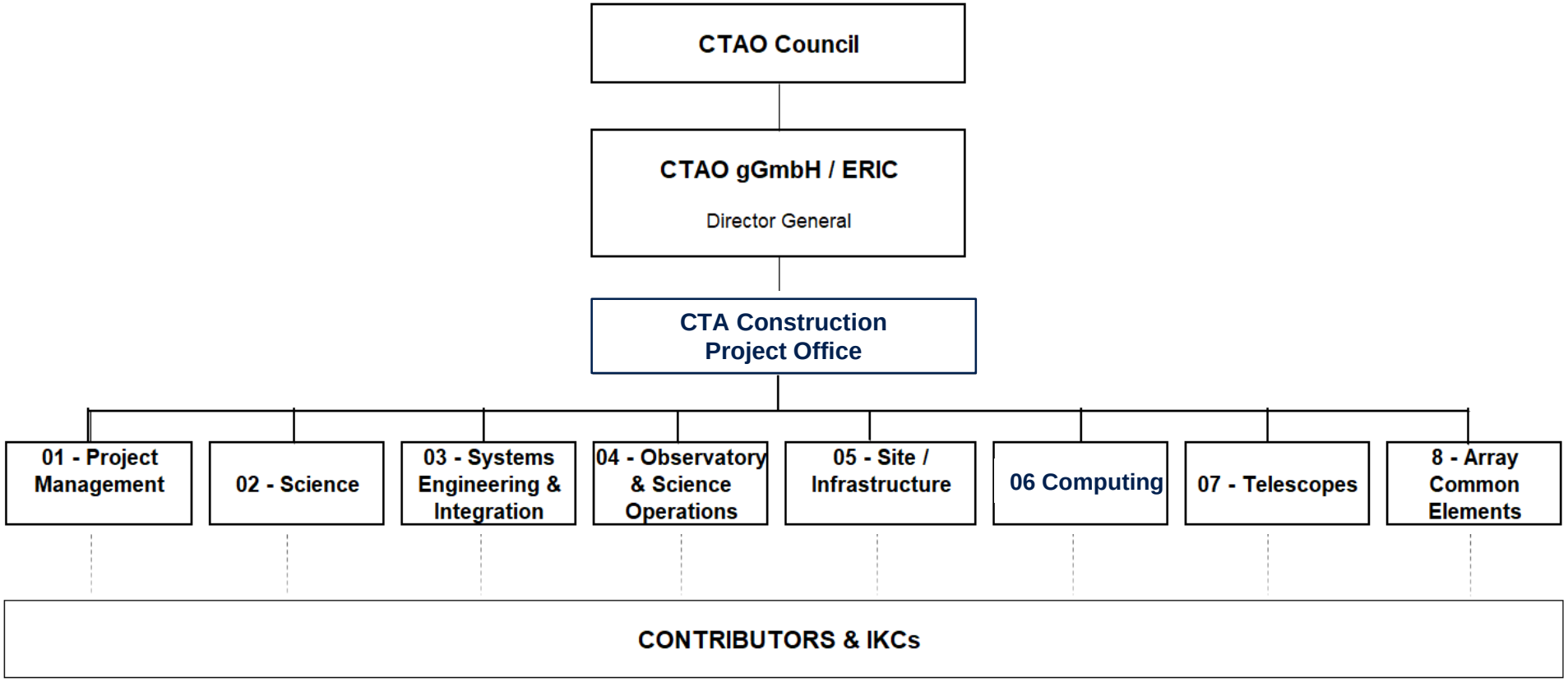
- A large project like CTA needs an organization to build and operate it
- In 2014, the CTA Observatory gGmbH was founded as interim legal entity, under German law
- The final legal entity for full construction and operation, a *European Research Infrastructure Consortium* (ERIC), is being set up
- During 2017 the CTA Project Office moved to Bologna (Italy)
  - Currently 25 staff, further growing
- The *Science Data Management Centre* (SDMC) will be built up at DESY in Zeuthen (Germany) in a new building
  - Currently 3 staff for CTAO Computing

CTAO gGmbH Membership Status

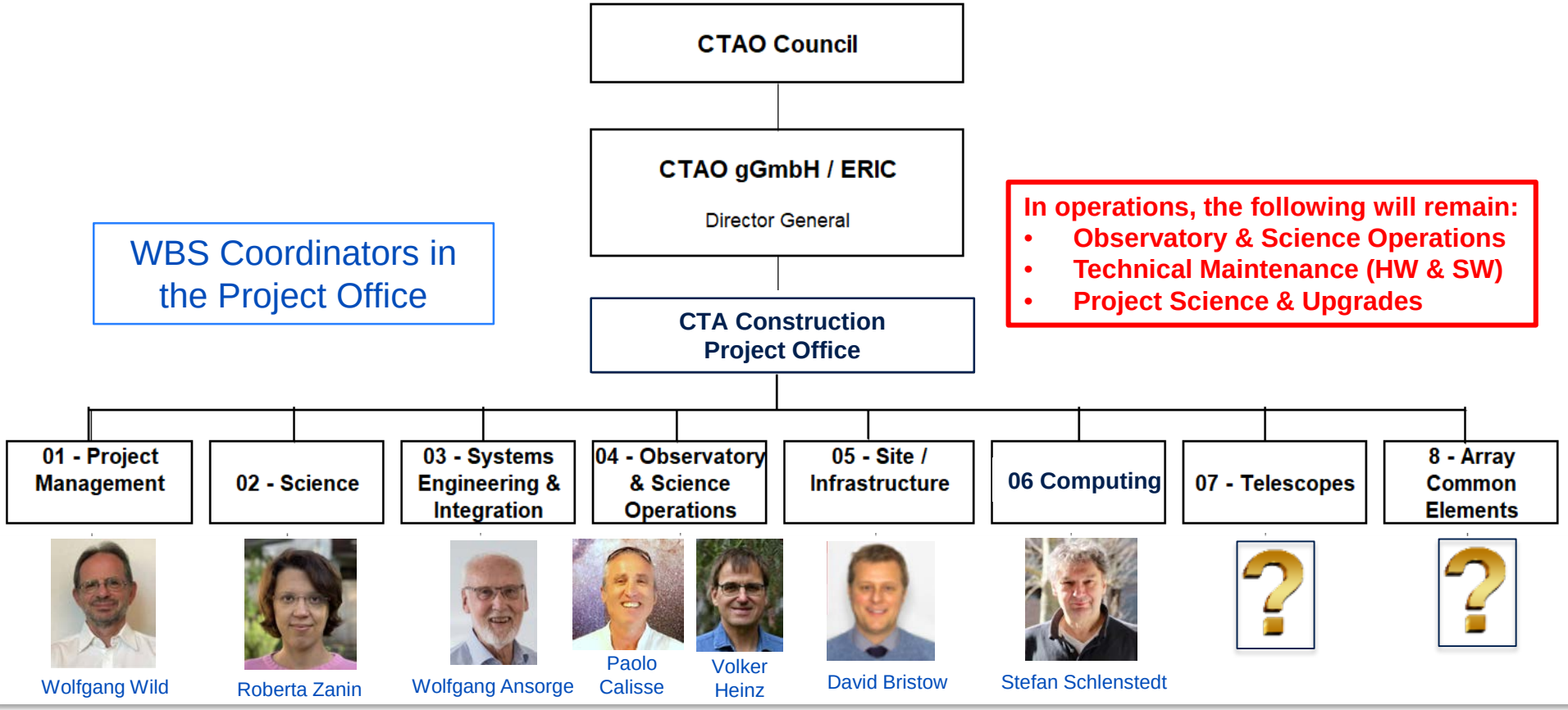
- CTAO gGmbH has currently 12 shareholders of which eight have signed the CTA Construction MoU (i.e. committed funds)

Country	Shareholder	Associate Member	MoU signature	Observer
Australia	X		on going	
Austria	X			
Brazil/Sao Paolo State				X
Czech Republic	X		X	
ESO	X			
France	X			
Germany	X		X	
Italy	X		X	
Japan	X		X	
Poland			X	X
Slovenia	X			
South Africa		X		
Spain	X		X	
Switzerland	X		X	
The Netherlands		X		
United Kingdom of Great Britain and Northern Ireland	X			
Kingdom of Thailand			X	
NSF/United States of America				X

CTA Construction Project Organization

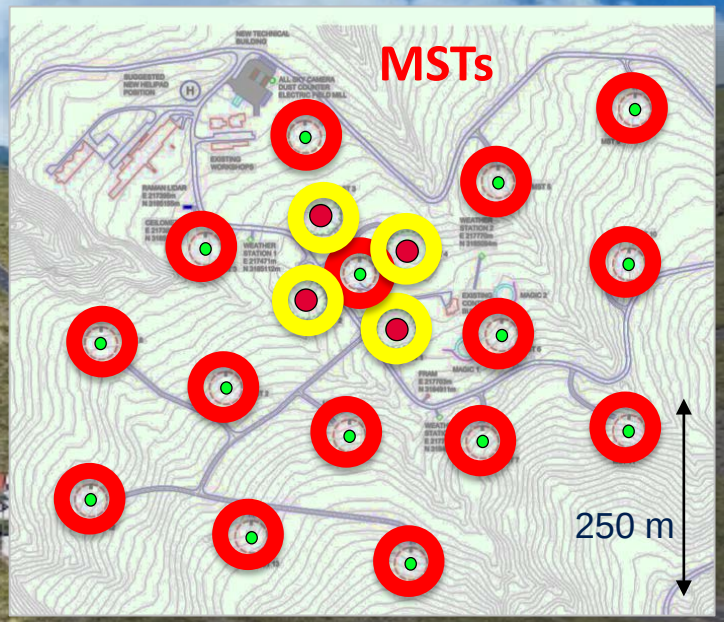


CTA Construction Project Organization



CTA-North Site

Observatorio
Roque de los Muchachos
La Palma, Spain



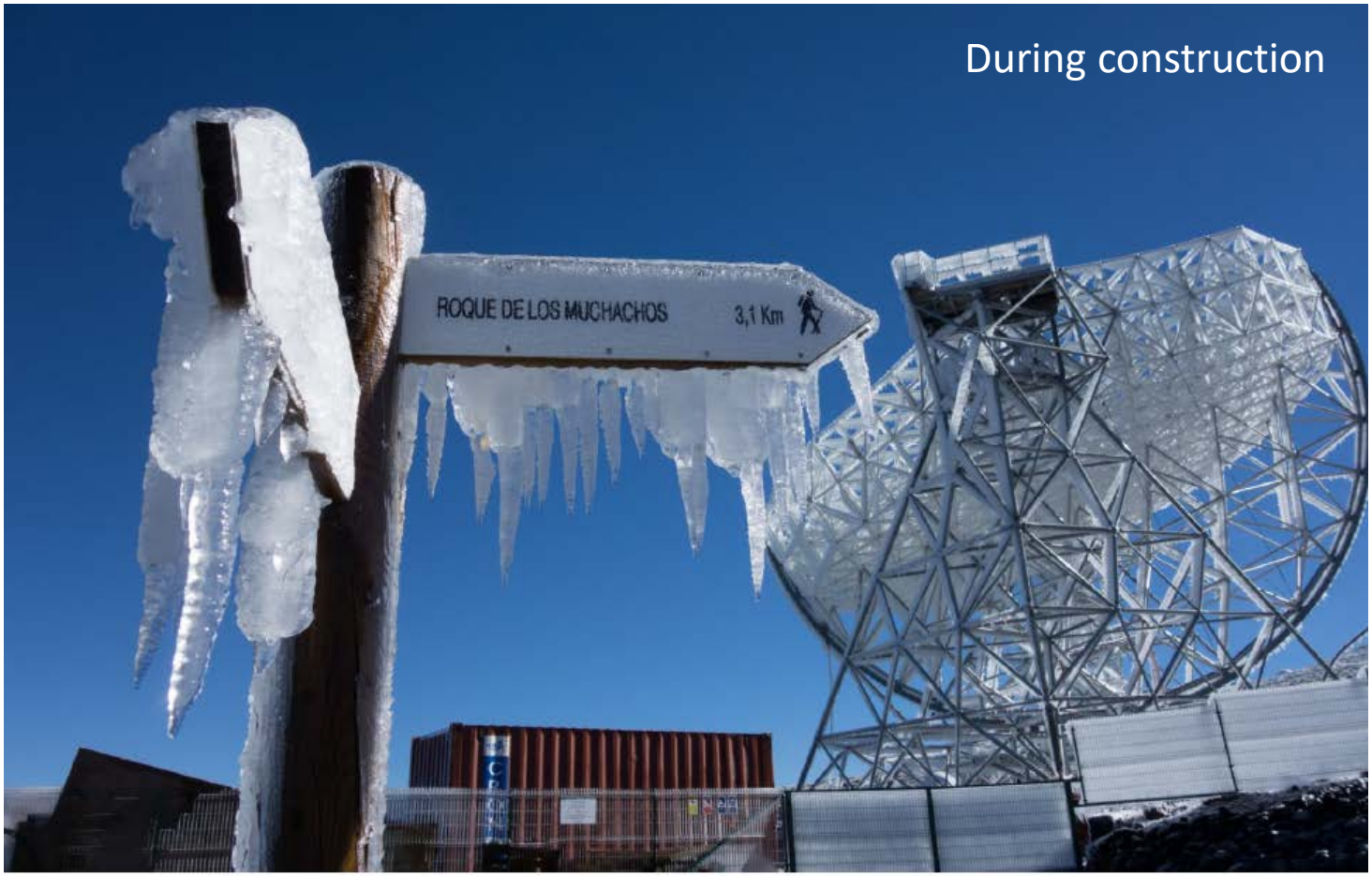
LST1

LST Inauguration on 10 Oct 2018

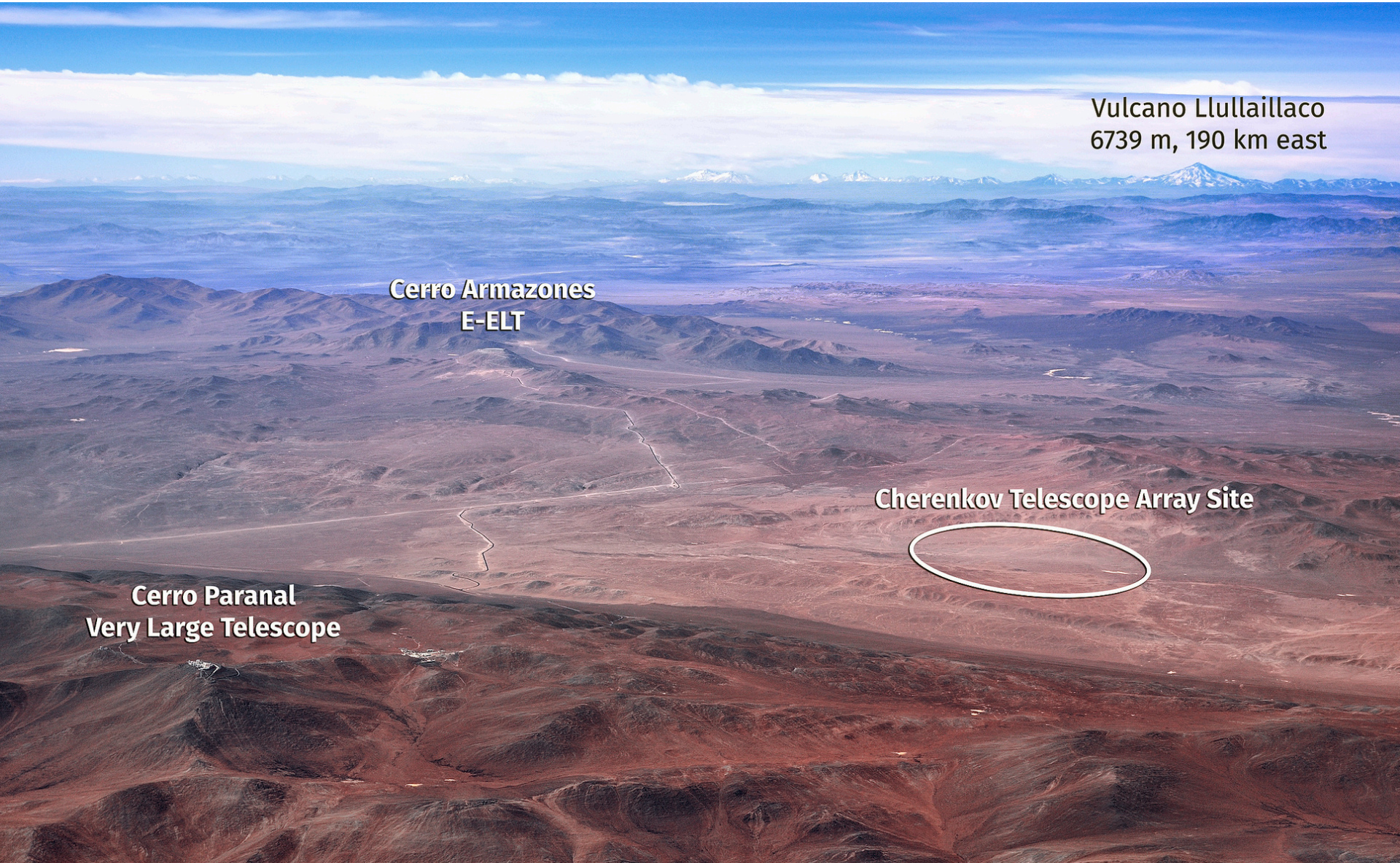
CTA-North Status

- LST-1 being commissioned by LST consortium
- Infrastructure construction (phase 1) initiated
  - Three more LST foundations, one MST foundation
  - Roads, data and power network
  - Tendered by *Instituto de Astrofisica de Canarias* (IAC) in collaboration with CTAO
- CTAO building up its organization on La Palma
  - North Site Manager in place since 1 Jan 2019
  - Setting up CTAO Low Elevation Office (LEO), for up to 14 people
- CTAO Systems Engineering very busy with detailed system design
  - Addressing all system level details
  - Up to 70% of the CTA-North definition applicable to CTA-South

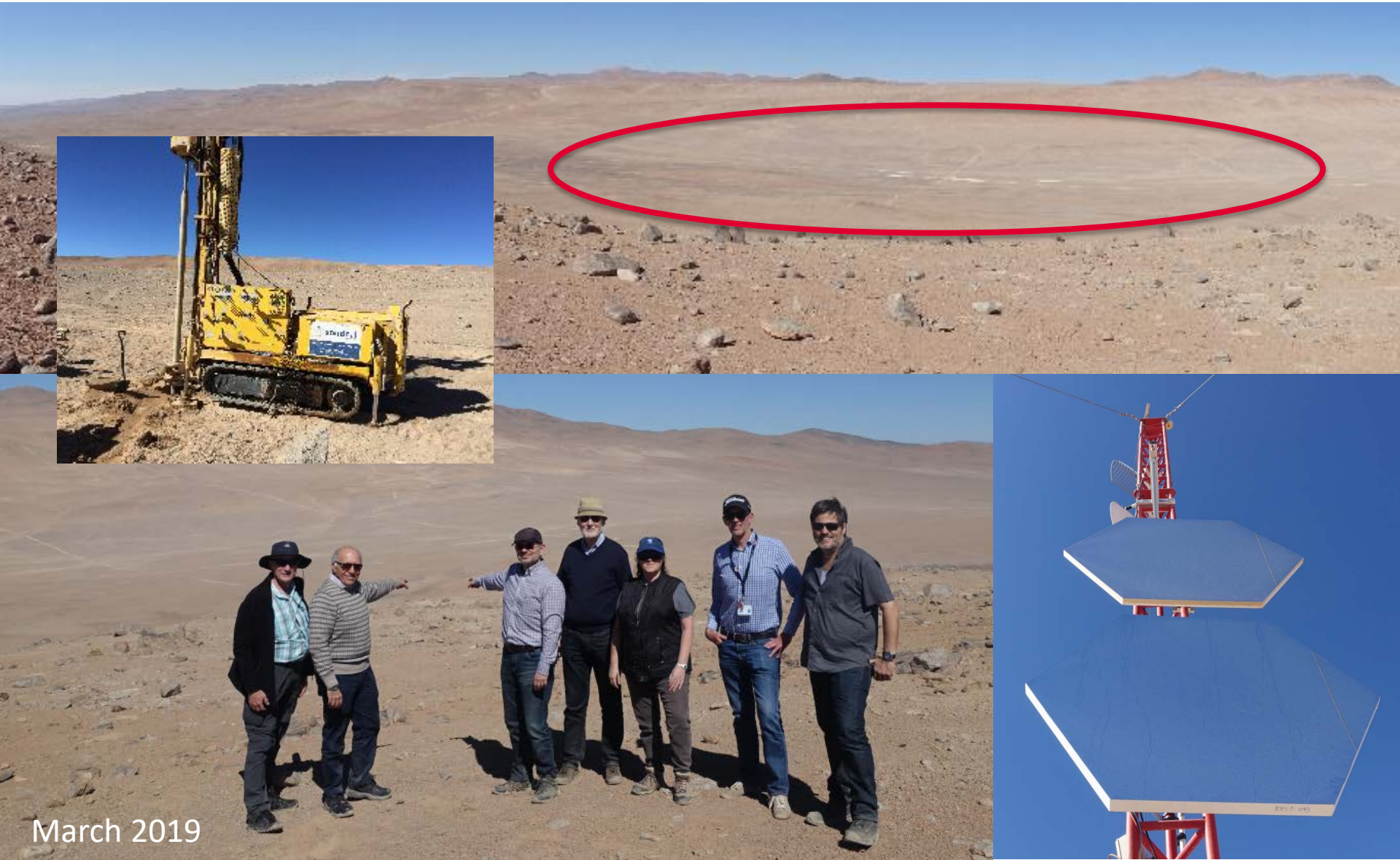
Harsh Conditions – LST1 on 6 feb 2018



CTA-South Site – ESO (Chile)



CTA-South Site



March 2019

CTA-South Status

- Hosting agreements between Republic of Chile, ESO, CTAO and CONICYT were signed in Dec 2018
- In March 2019, CTAO delegation visited Chile
  - CTAO-ESO Kick-off meeting for CTA-South implementation
  - 1st CTAO-Chile Workshop with Chilean universities
- CTA-South Site Manager appointed (starting 1 July 2019)
- Seismic investigation for the specific site underway
  - CTAO can resuse some of ESO-ELT site related data
  - CTA-South specific seismic investigation to complement available data
- CTAO wants to construct CTA-South infrastructure as soon as possible
  - Foundations, roads, power and data network
  - Depends on available funding

Science Data Management Centre (SDMC)

- In 2016, the CTAO Council, selected DESY in Berlin-Zeuthen (Germany) to host the SDMC
- The SDMC will be responsible for CTA science operations and make the science products available to the worldwide community
  - With an estimated 20 staff in a new building
  - Expect ~5 PB of data per year

Credit: Heinle Wischer und Partner Freie Architekten GbR, Berlin, with Ulrich Krüger Landschaftsarchitekten, Dresden

CTA Technology Overview

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

- Three telescope diameters to cover the CTA energy range from 20 GeV to 300 TeV
  - Large-Sized (23m), Medium-Sized (12m) and Small-Sized (4m) Telescopes
- Very sensitive cameras with many pixels (~$2x10^3$), using both photomultiplier tubes (PMTs) and silicon photomultipliers (SiPMs)
- Accurate timing & clock over the whole array
- Challenging calibration techniques and algorithms
  - Earth atmosphere is part of the detector
- Substantial software development, “Big Data”

Telescope Prototypes

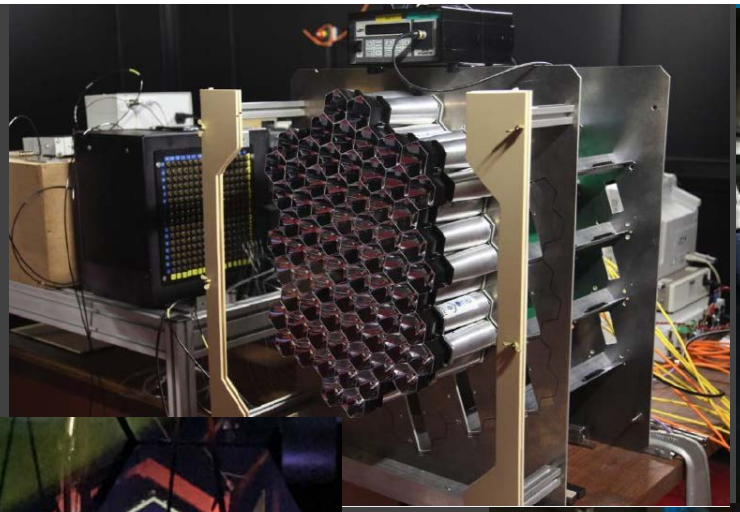
CTA will implement a single CTA-SST design, based on ASTRI-CHEC

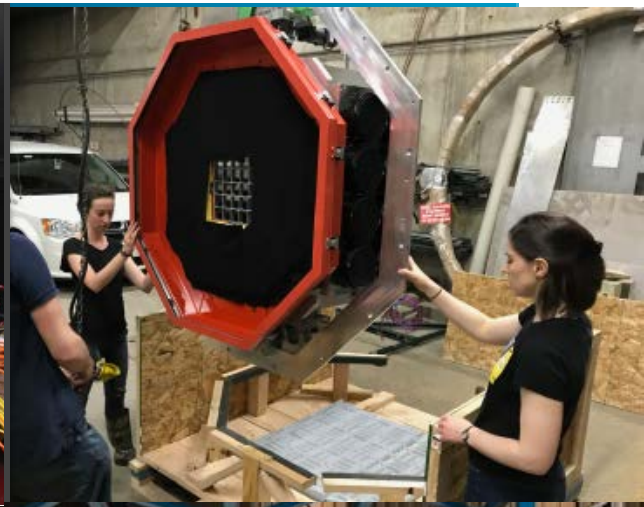
(Council decision 18 June 2019)

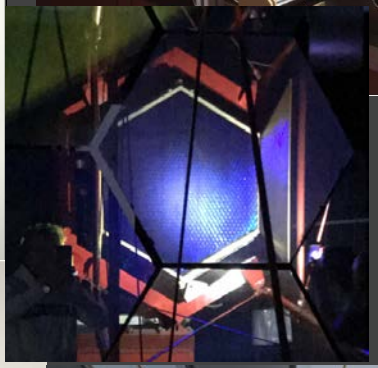
MST Harmonization will be addressed

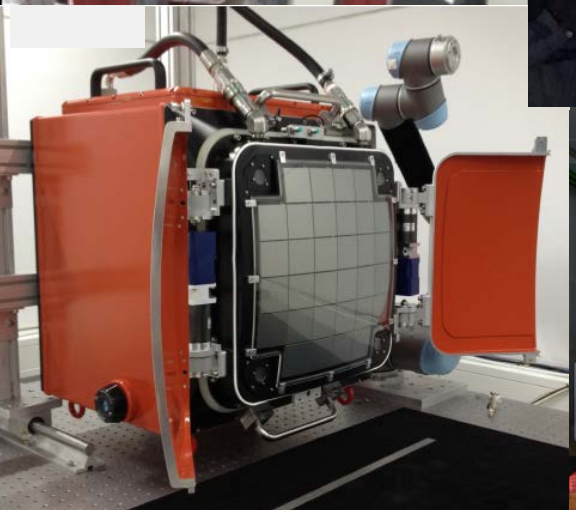
Telescope Prototypes

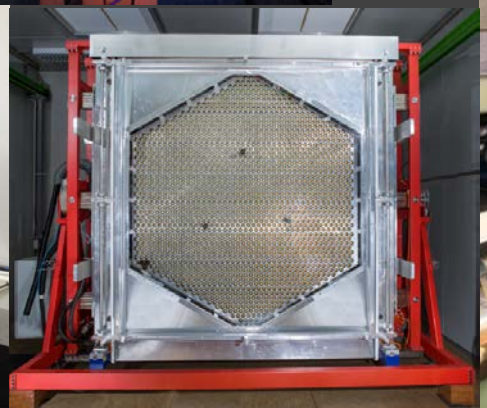
7 Camera prototypes (LST, MST and SST)

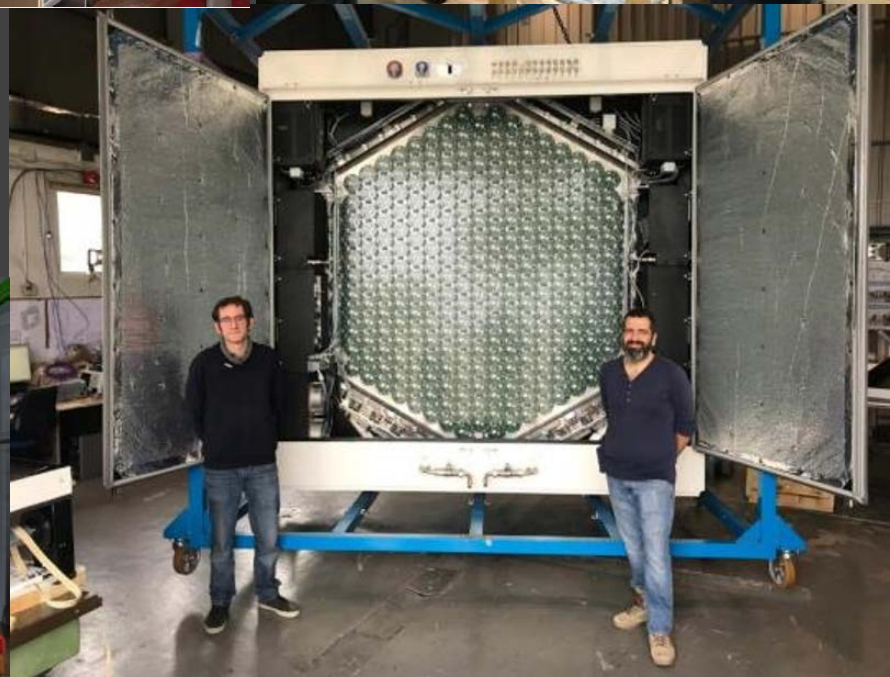












Towards CTA Construction

In order to build the CTA observatory, we need

1. An exact definition of what to build (= " the CTA configuration") and knowledge about how much it will cost (the "CTA Cost Book")
2. The funds to build it
3. The organization to build it, both CTAO and in-kind contributors

Ad 1: The configuration obviously depends on its cost and the available funding. Cost Book update is underway – finalize by end 2019.

Ad 2: Partial funds are available – not sufficient to start.

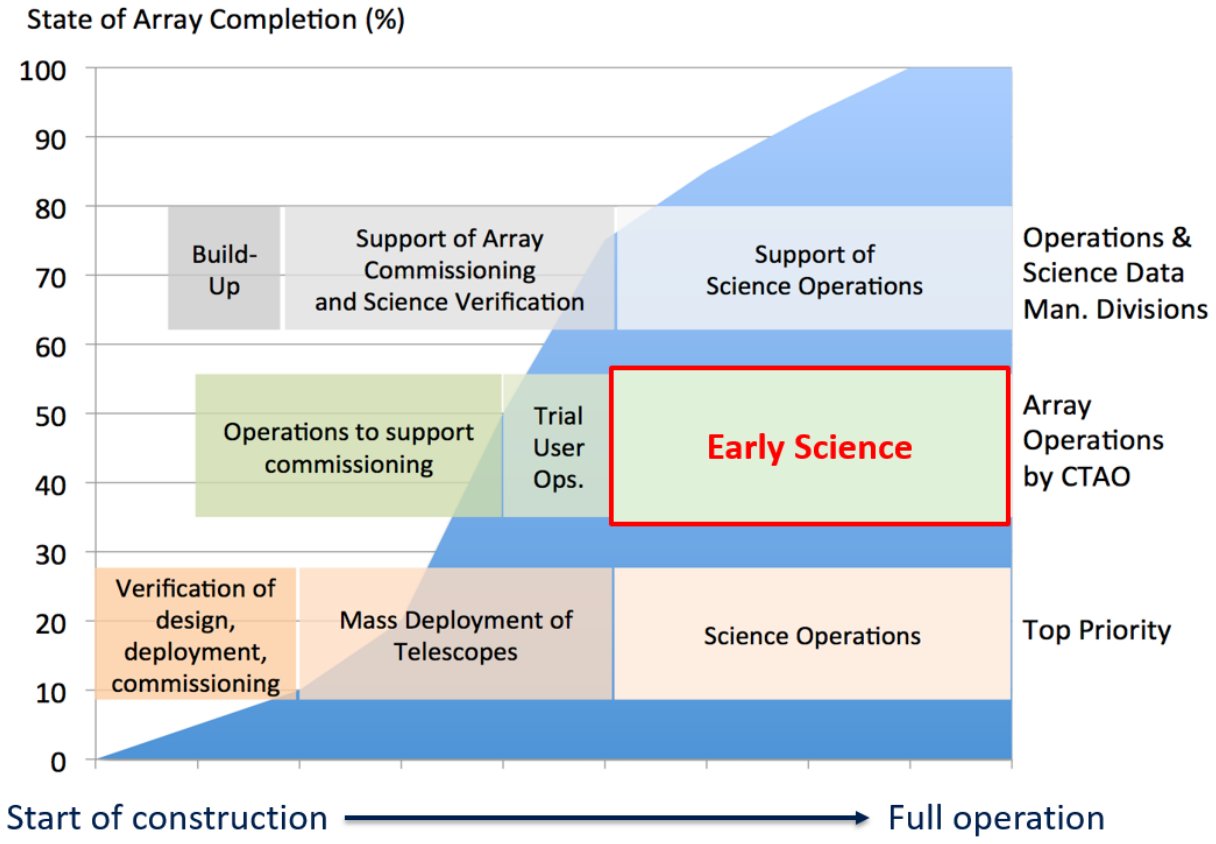
Ad 3: CTAO is being built up – final legal entity (ERIC) to be in place in 2020. Framework for in-kind contributions is in place.

Two CTA phases are foreseen:

- Phase 1: Build "Phase 1 Configuration" at TBD cost
- Phase 2: Operate Phase Configuration and build more if possible

From construction to operation

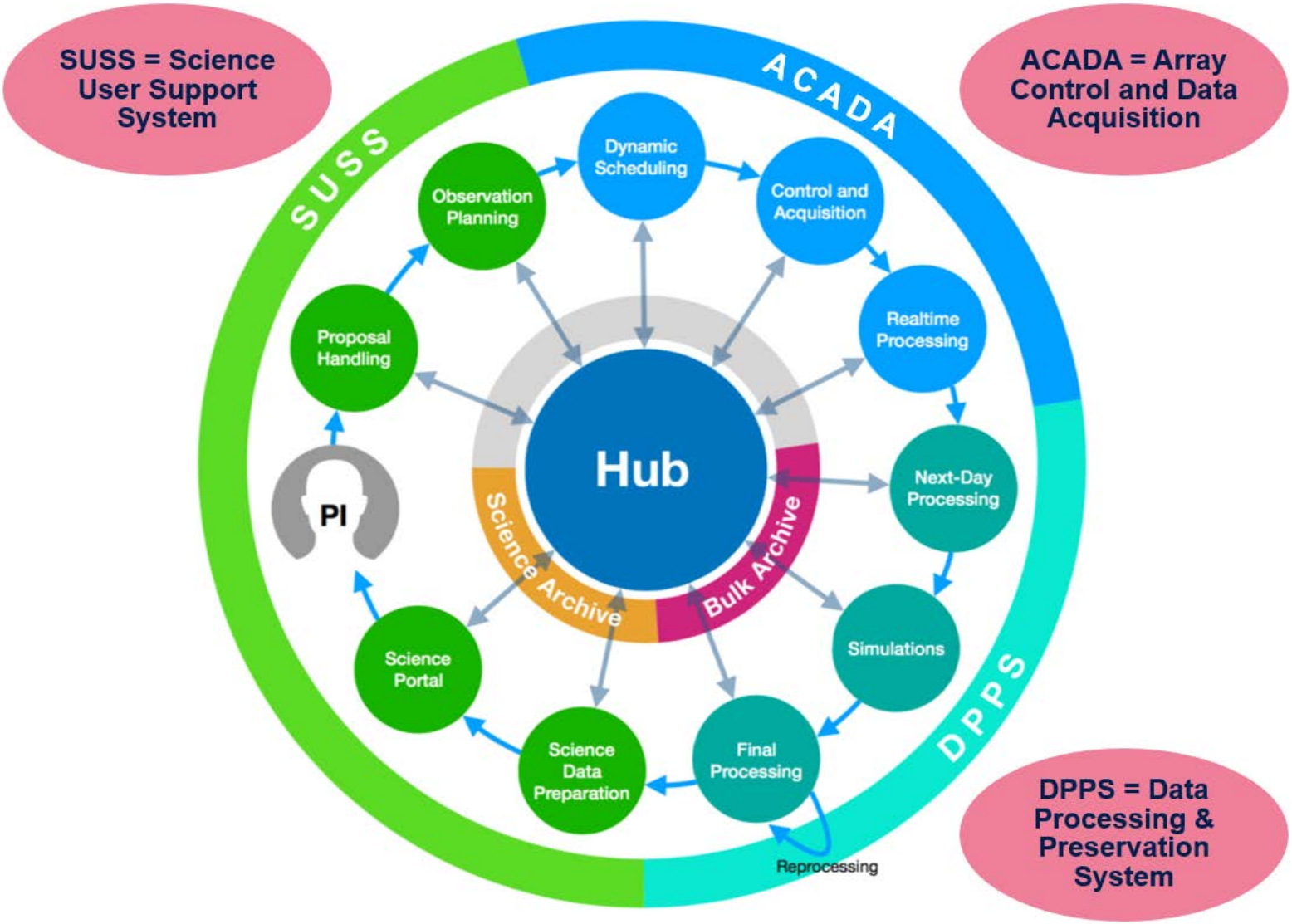
- Co-existence of construction, commissioning and Early Science during several years
- CTAO aims to produce science data as soon as possible
- Many skilled people needed in construction and transition to operations



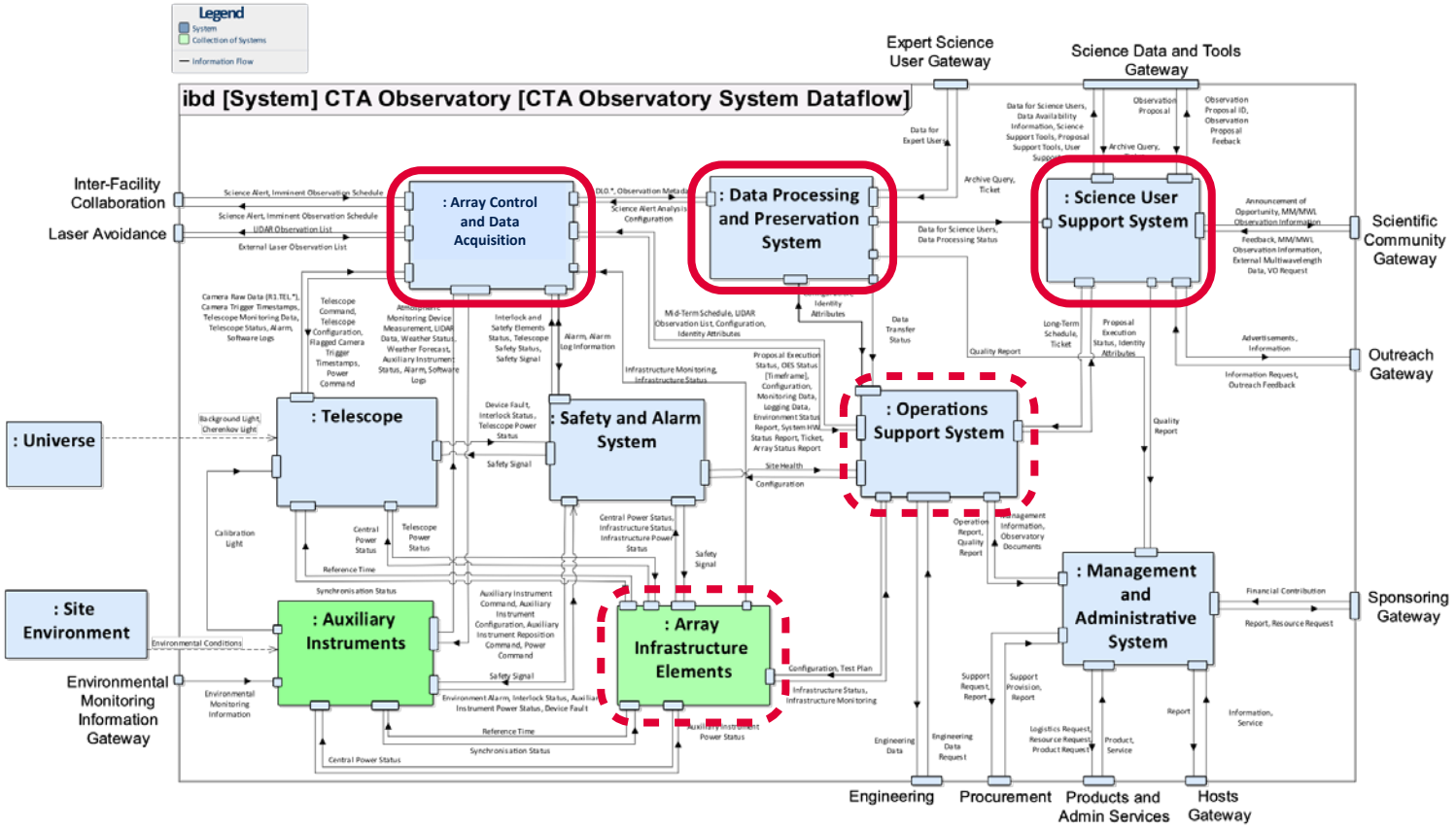
Observatory Operations

- CTA will be the first open gamma-ray observatory ever
  - "Phase transition" from experiments to observatory
- CTAO is responsible for CTA operations and data delivery
  - Science operations: on-site and off-site
  - Technical operations: preventive and corrective maintenance
- CTA-South array will be operated by ESO on behalf of CTAO
  - As specified in CTA-South Hosting Agreement
- CTA science time users
  - CTA Consortium (Key Science Projects)
  - Open time, proposal based
  - CTA hosts (IAC, ESO, Chile)

Science Operations – Primary Processes

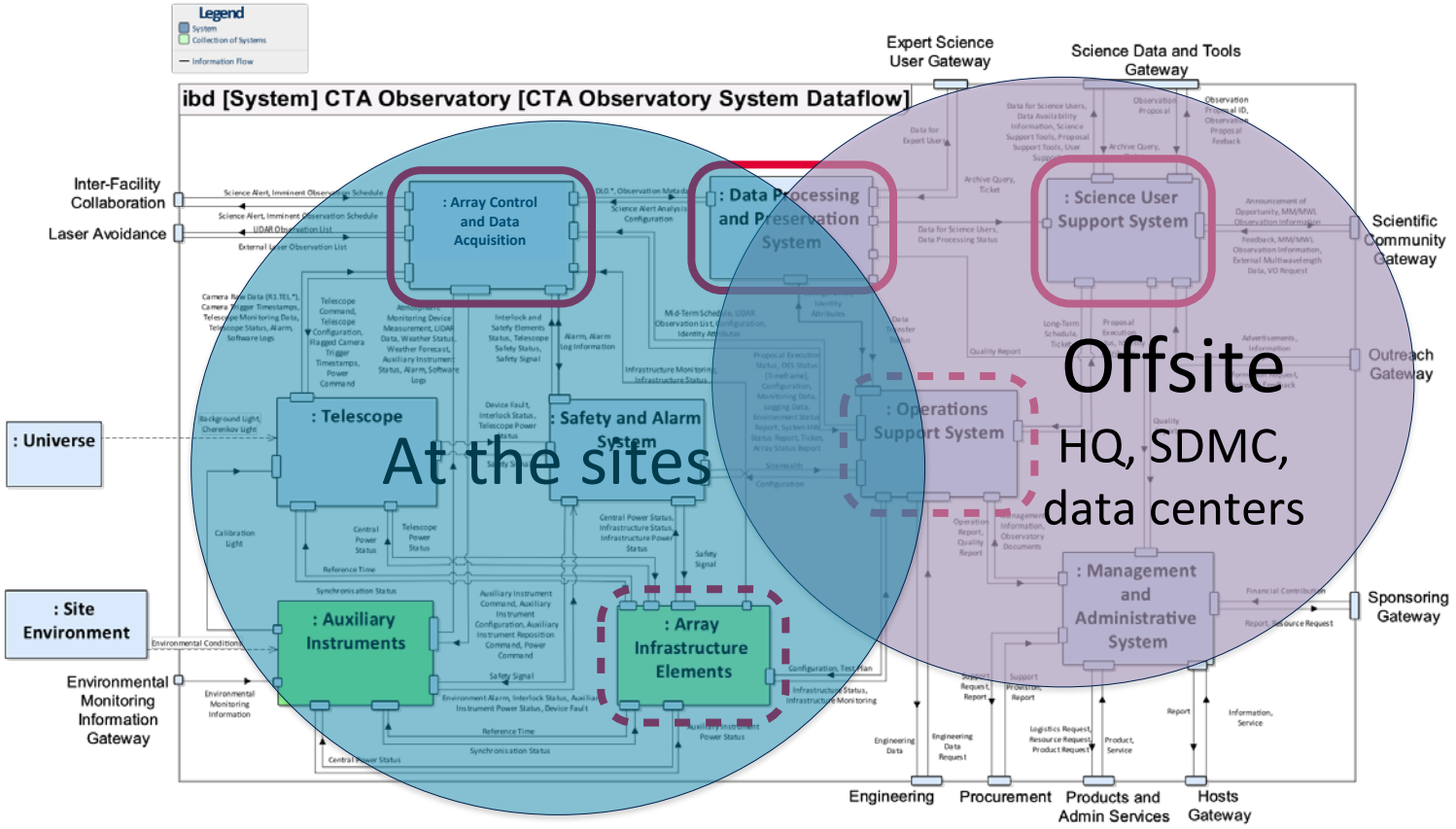


The CTA System Structure



- ACADA – Array Control and Data Acquisition
- DPPS – Data Processing and Preservation System
- SUSS – Science User Support System

The CTA System Structure



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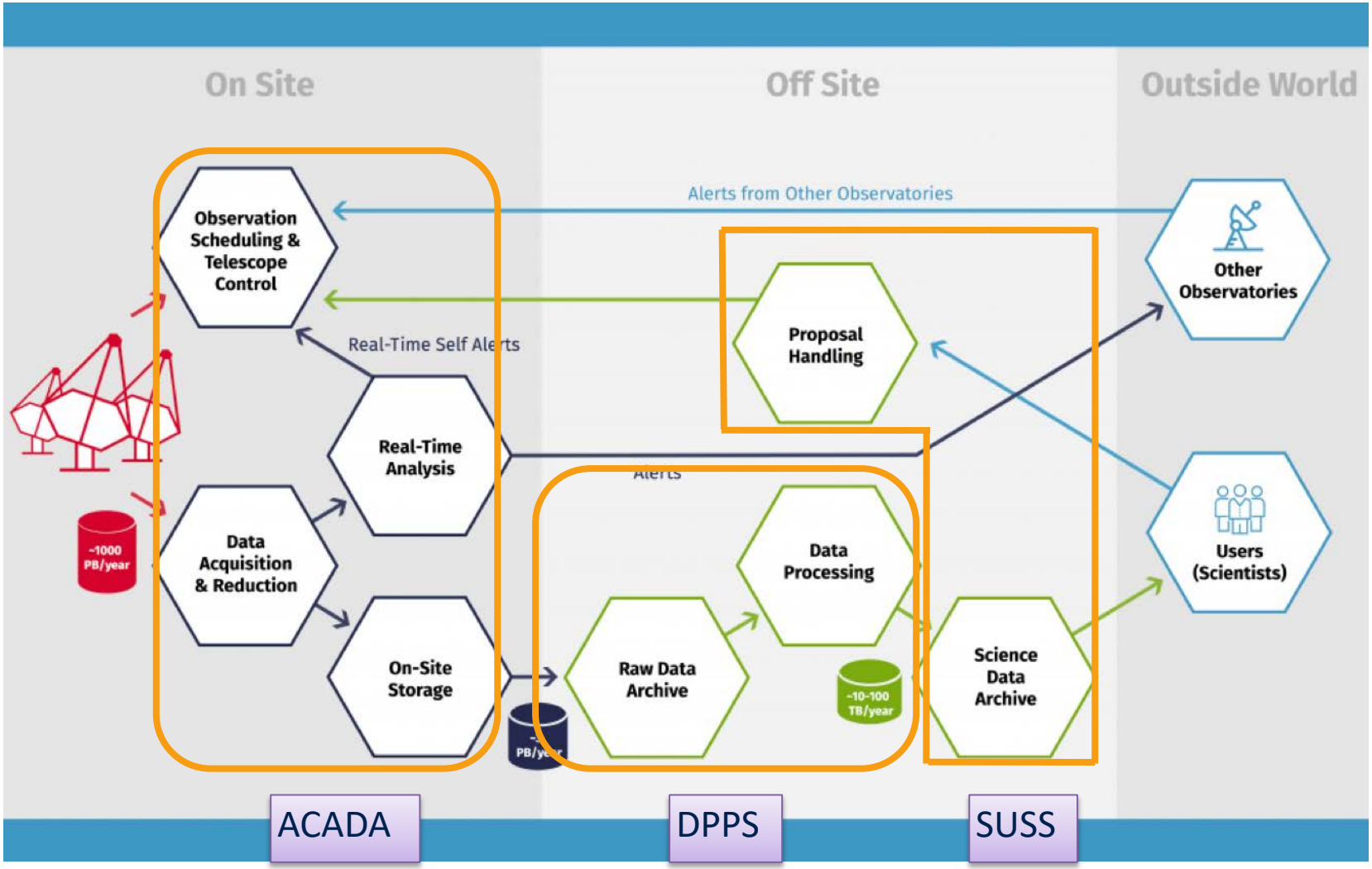
CTA Data Flow and Software Systems



Summary

- CTA will be the first gamma-ray observatory, ramping up to full construction
  - Started on North site
  - Soon to start on South site
- Many prototypes exist for telescopes, cameras, calibration devices, software elements, etc.
  - Activities are underway to harmonize and simplify the CTA system
- A dedicated organization, the CTA Observatory (CTAO), has been created to build and operate CTA
  - Transition to final legal form expected in 2020
- Many years of CTA construction, commissioning and science verification lie ahead of us


Thank You !