cherenkov telescope array

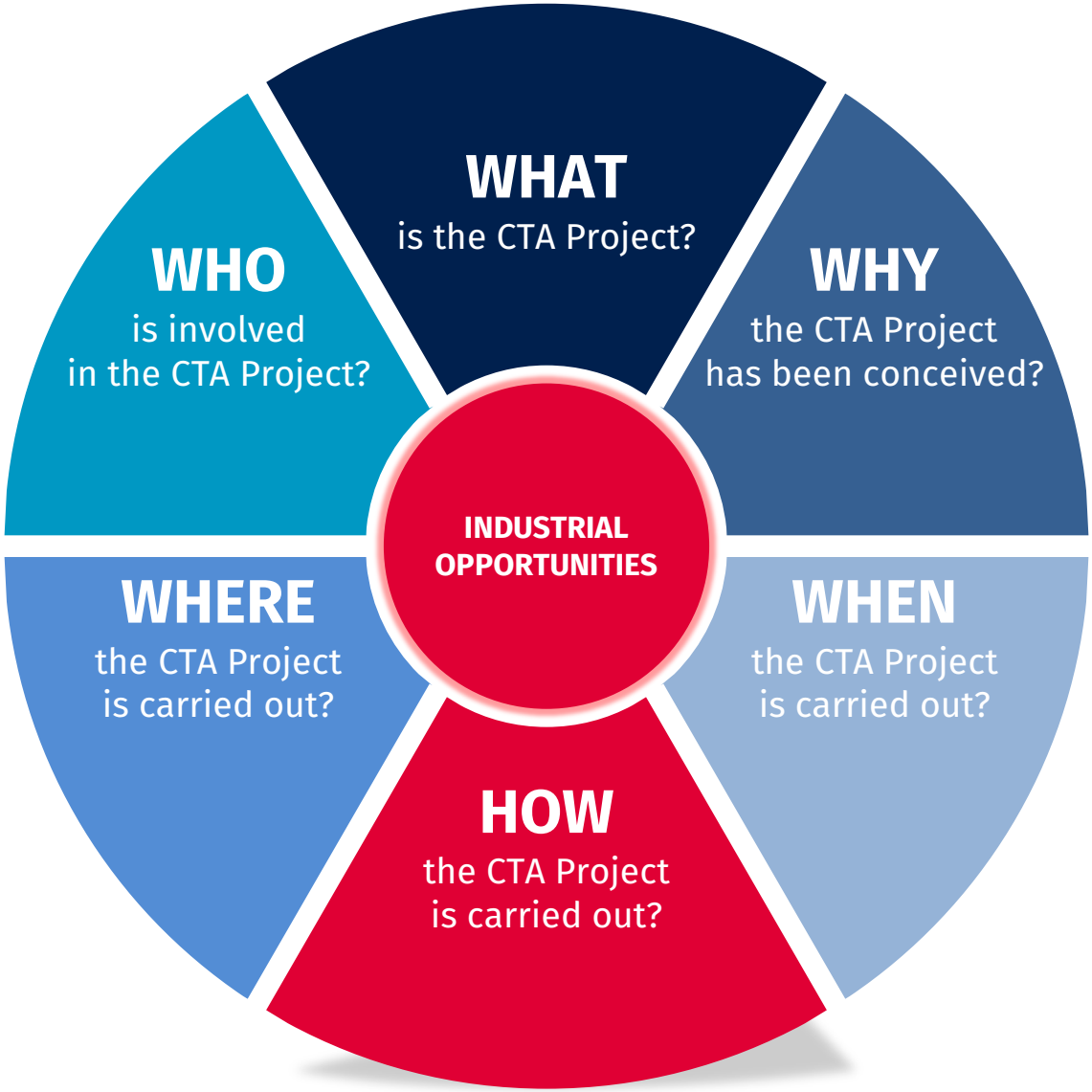
CTA Project

ILO Industrial Opportunities Days

INAF Capodimonte Astronomical Observatory - Naples, June 6th

Francesco Dazzi
Senior Systems Engineer

Outline


WHAT
is the CTA Project?
WHY
the CTA Project
has been conceived?
WHEN
the CTA Project
is carried out?
HOW
the CTA Project
is carried out?
WHERE
the CTA Project
is carried out?
WHO
is involved
in the CTA Project?
INDUSTRIAL
OPPORTUNITIES

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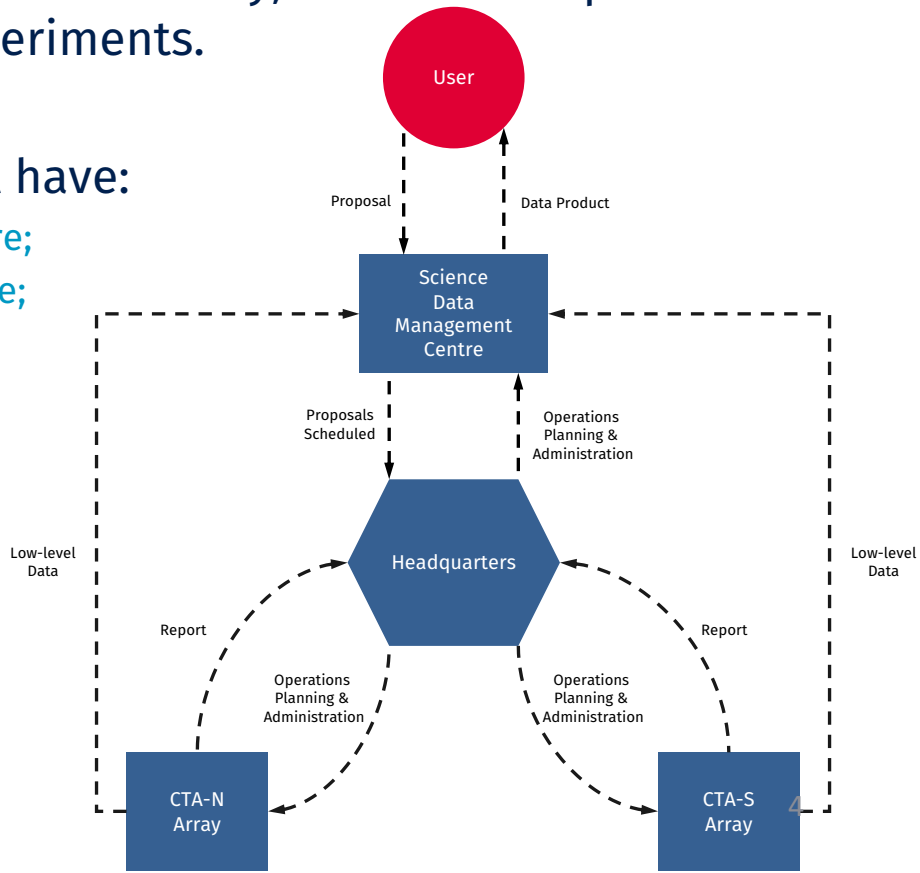
WHAT
is the CTA Project?

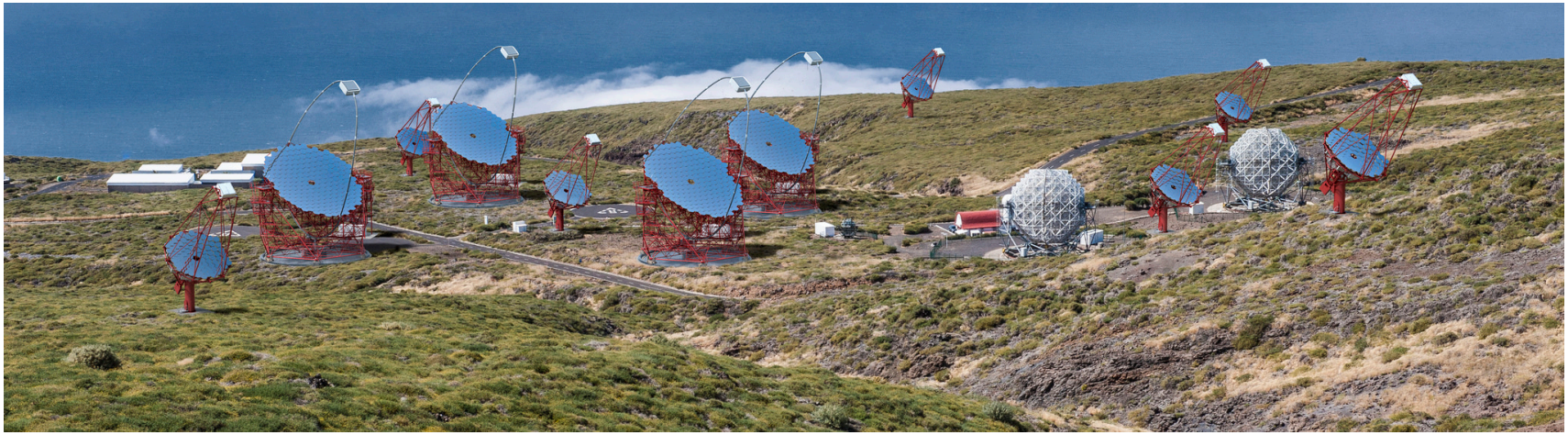
What is CTA?

- CTA (Cherenkov Telescope Array) is the next generation ground-based facility for gamma-ray astrophysics.
- It will be the first open gamma-ray observatory, because the previous and existing instruments run as experiments.
- This is a distributed facility that will have:
  - 99 telescopes in the Southern hemisphere;
  - 19 telescopes in the Northern hemisphere;
  - computing clusters / data centres;
  - archives;
  - web services;
  - offices;
  - etc.

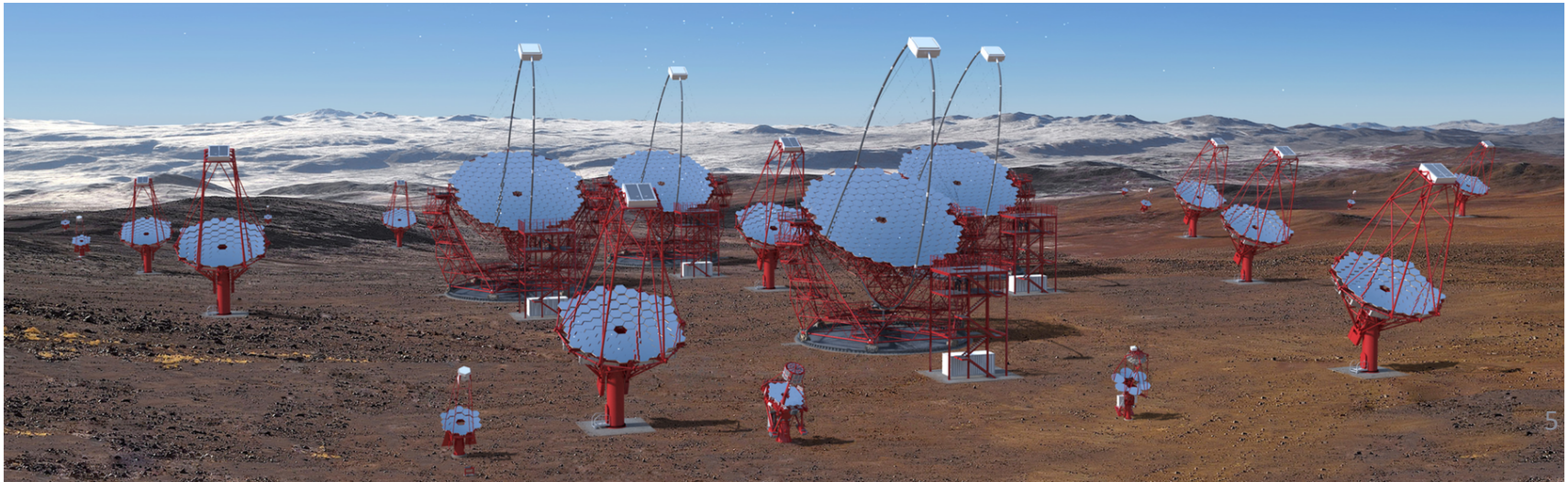


What is CTA?

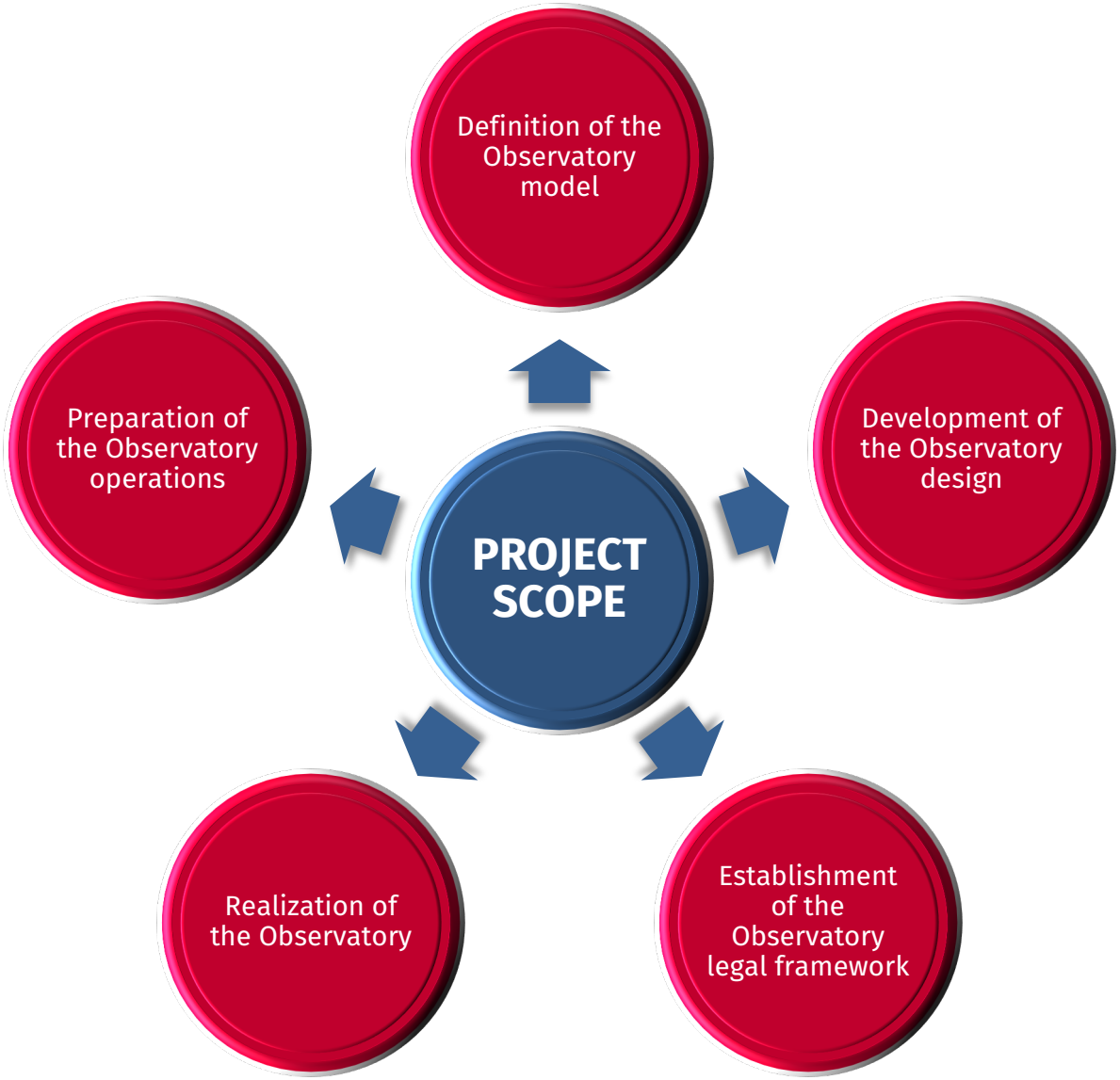
- North: 19 telescopes spread out over ~0.4km^2 (4 LSTs, 15 MSTs)



- South: 99 telescopes spread out over ~5km^2 (4 LSTs, 25 MSTs, 70 SSTs)



Which is the scope of the project?



The CTA Observatory (CTAO)

- In 2014, the CTA Observatory gGmbH was founded as interim legal entity, under German law to prepare the CTA implementation (select and prepare the two array sites + Science Data Management Centre)

- The final legal entity for the full construction and then operation will be an *European Research Infrastructure Consortium* (ERIC): https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/eric_en

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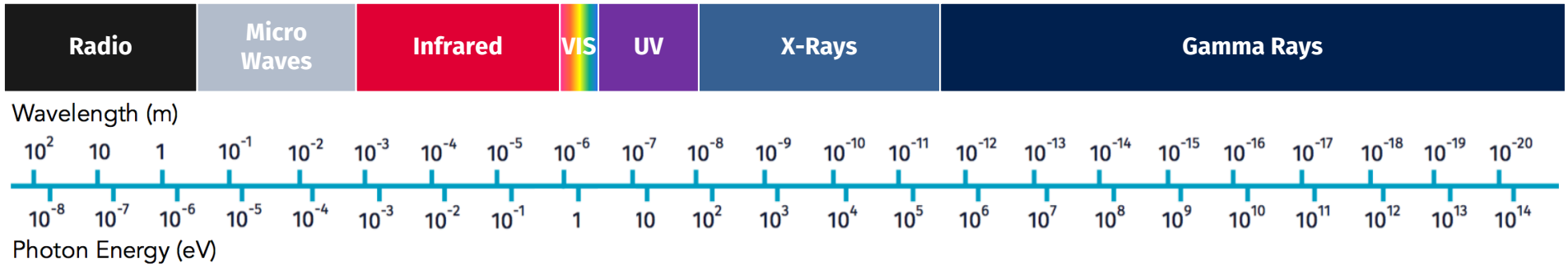
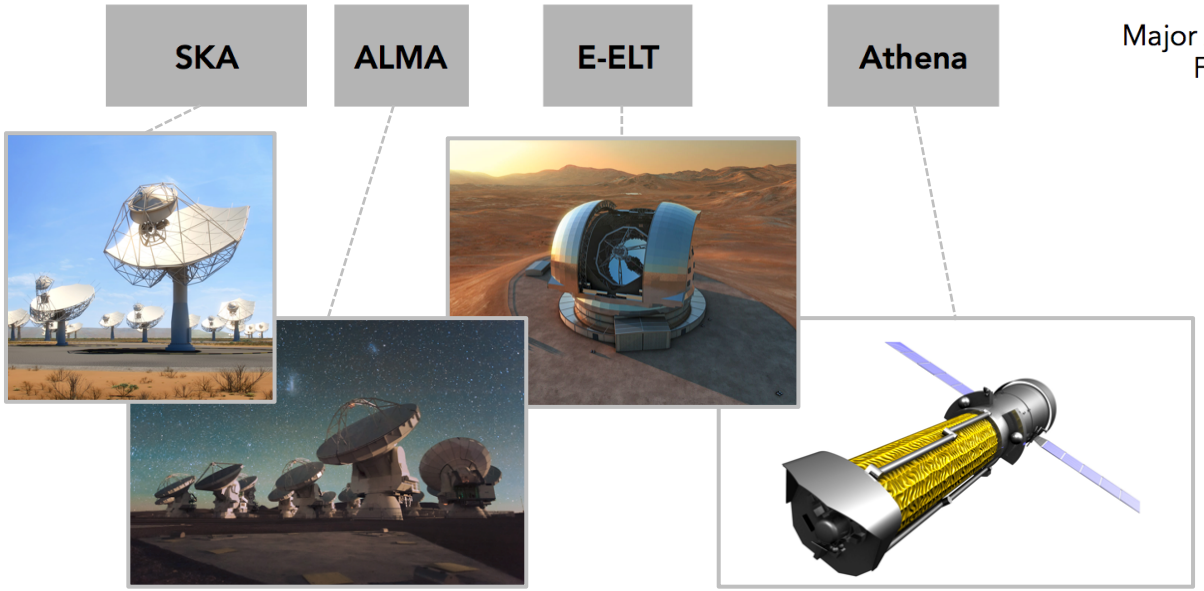
WHY
the CTA Project has been conceived?

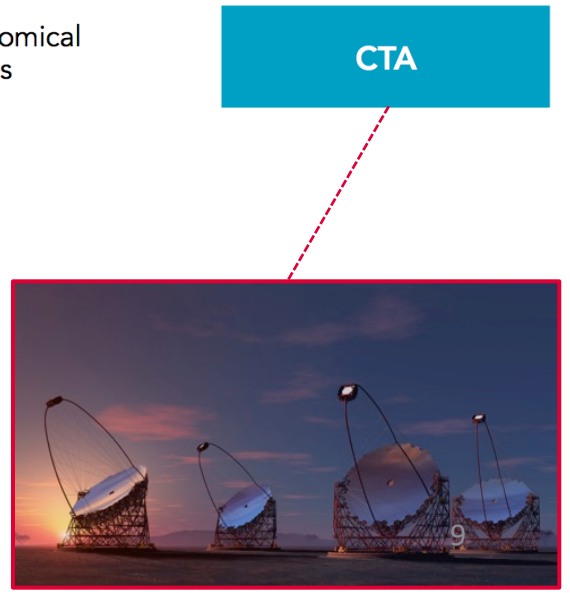
Waveband Coverage

- Understand the Universe by looking it with different “eyes”.
- The CTAO will look in the energy domain ~20GeV - 300TeV.





Major Astronomical Facilities

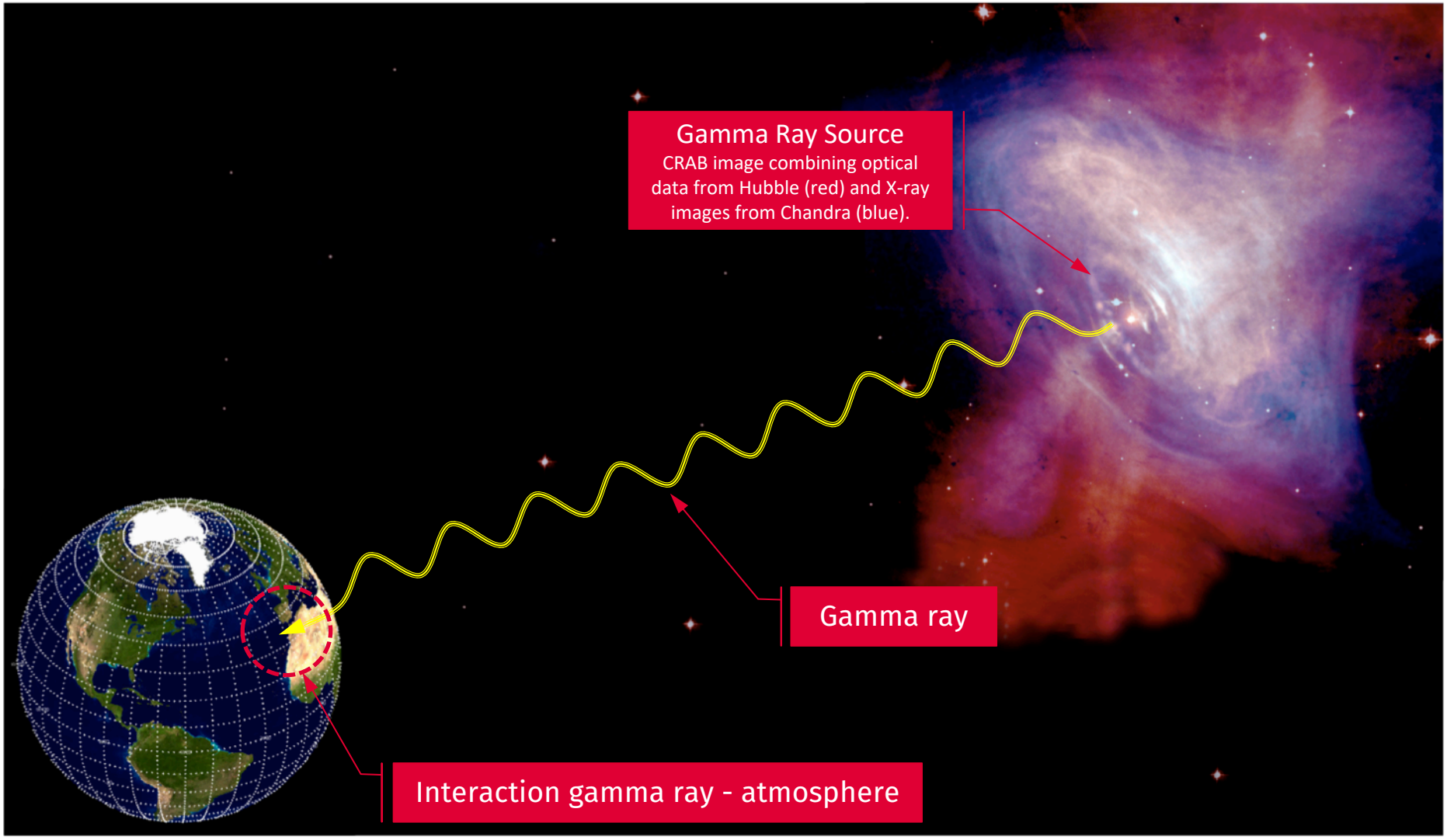


Scientific Targets

- The key gamma ray sources in the Universe are:

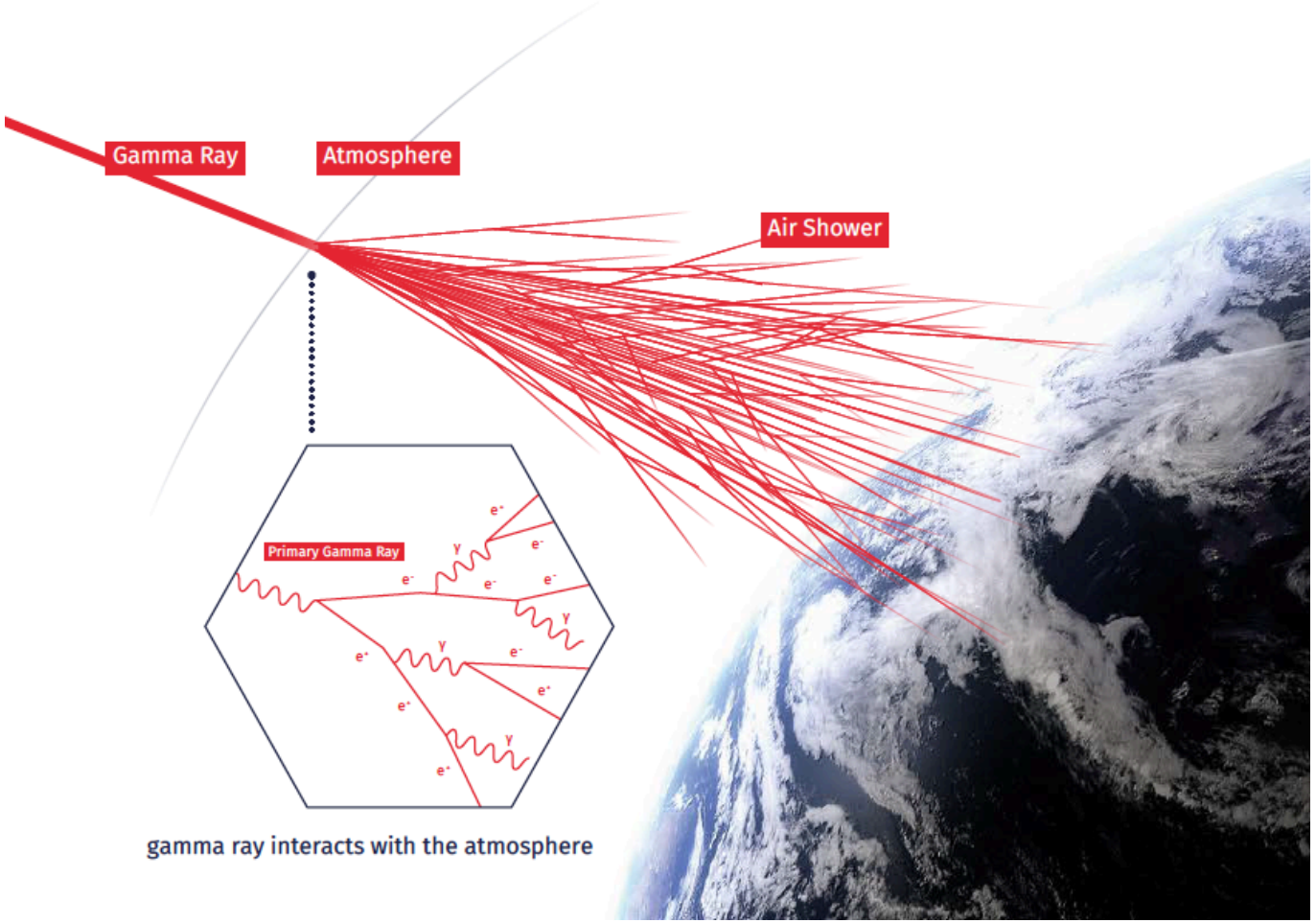
Pdf file: https://arxiv.org/abs/1709.07997
Hardcopy: World Scientific, ISBN 978-981-3270-08-4

Gamma Ray


Gamma Ray Source
CRAB image combining optical data from Hubble (red) and X-ray images from Chandra (blue).
Gamma ray
Interaction gamma ray - atmosphere

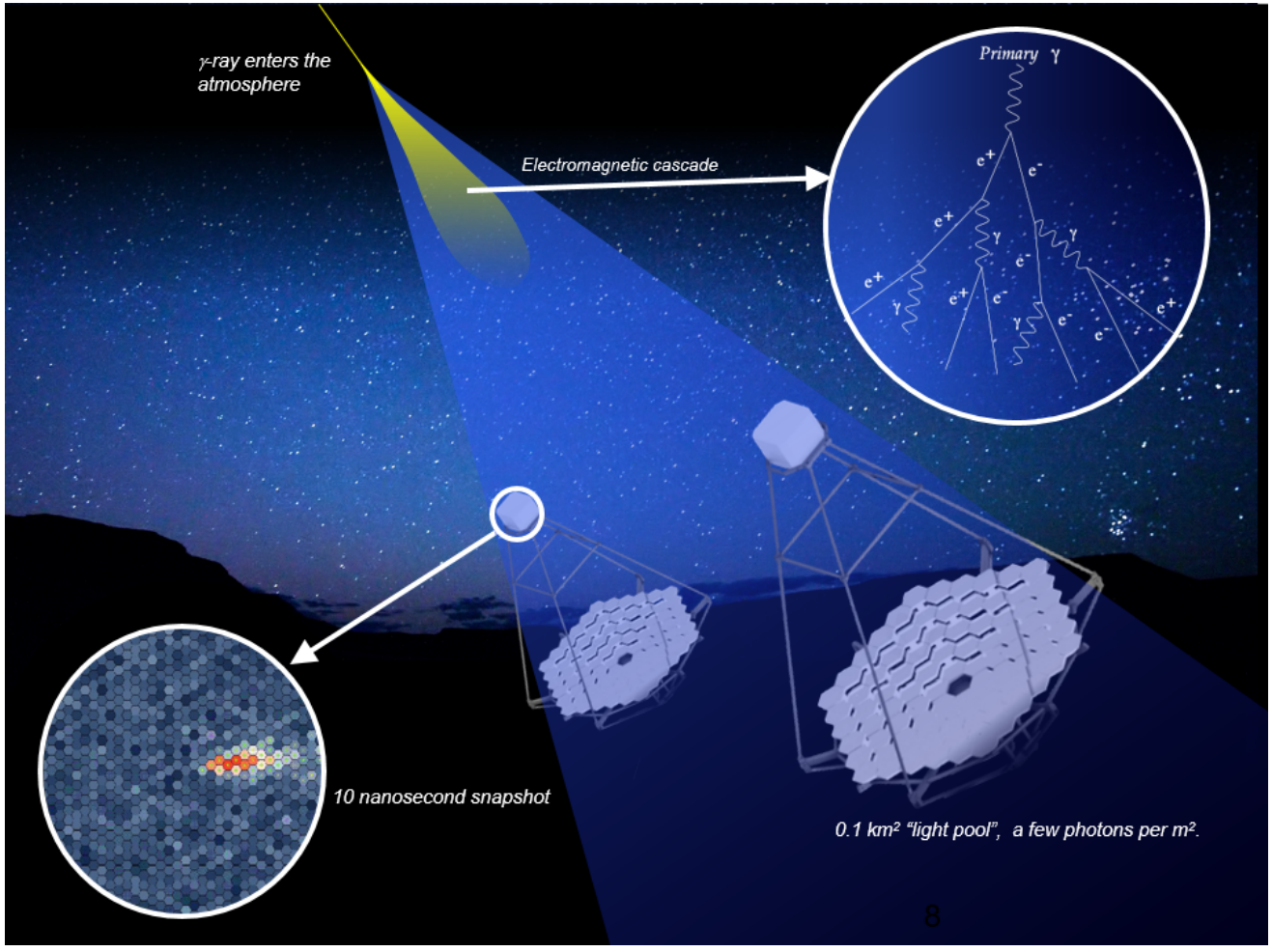
Extended Air Shower (EAS)

- An extended air shower is generated in the interaction between a primary gamma ray and the terrestrial atmosphere.



Detection Technique via Cherenkov Light

- Ultra relativistic charged particles of the EAS cause Cherenkov light emission when they cross the terrestrial atmosphere.



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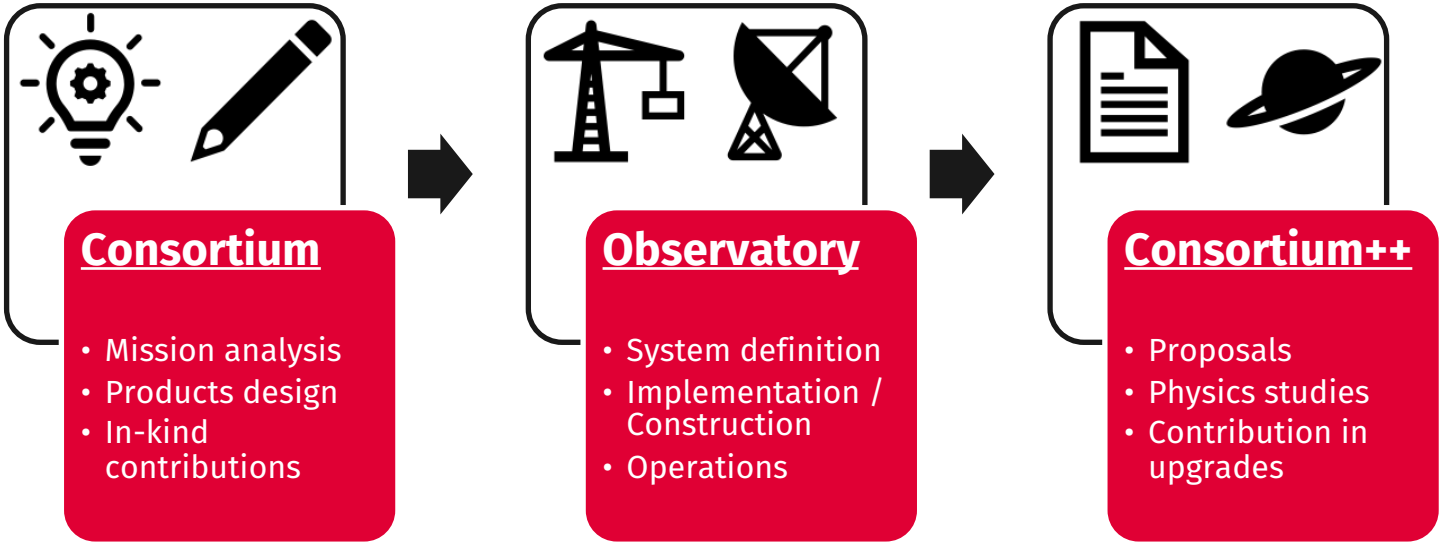
WHO
is involved in the CTA Project?

Principal Actors

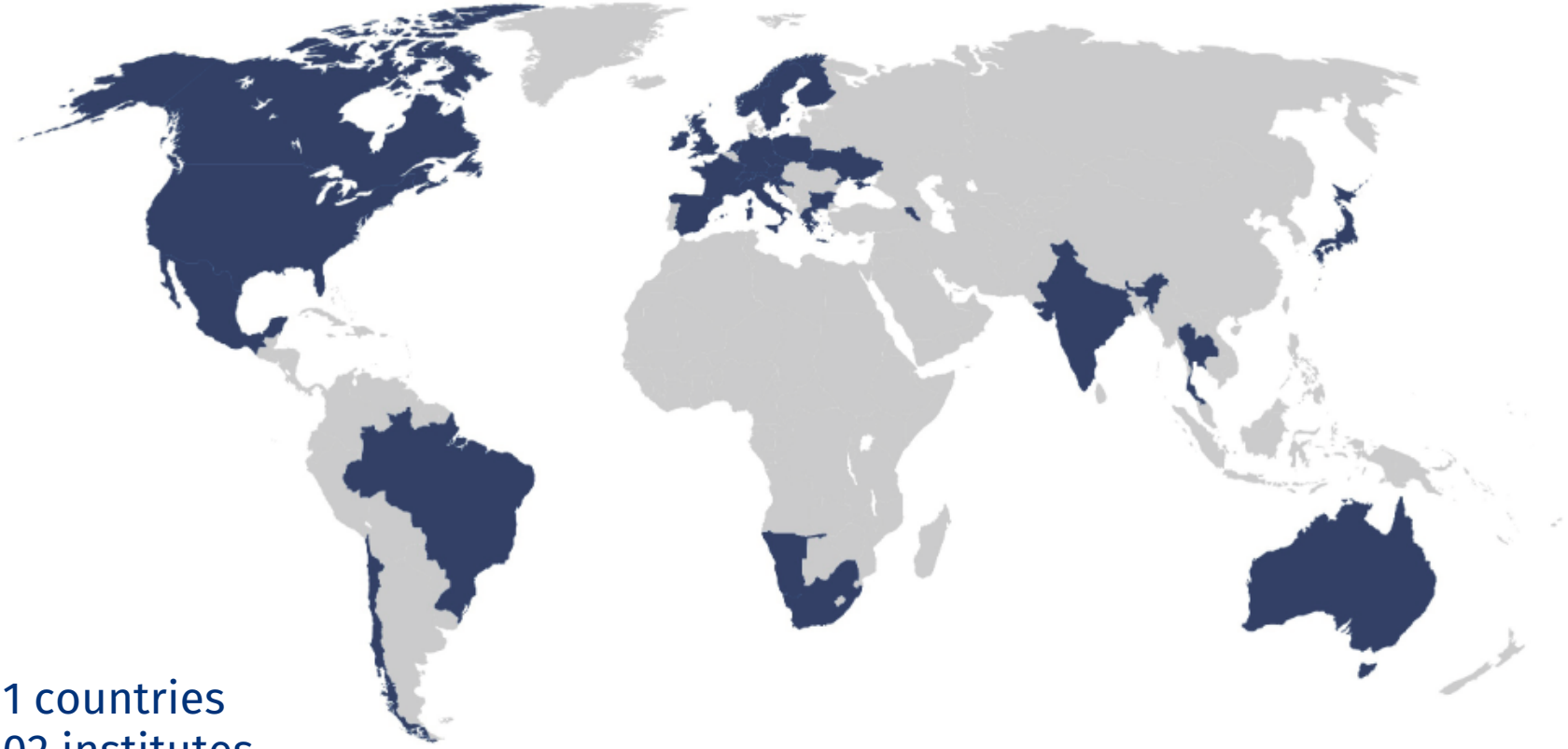
- It is designed and built in a large international collaboration.
- Principal actors:
  - » CTA Observatory (CTAO)
  - » CTA Consortium (CTAC)
  - » Scientific Community



CTAO Personnel

32 members
8 countries
14 females

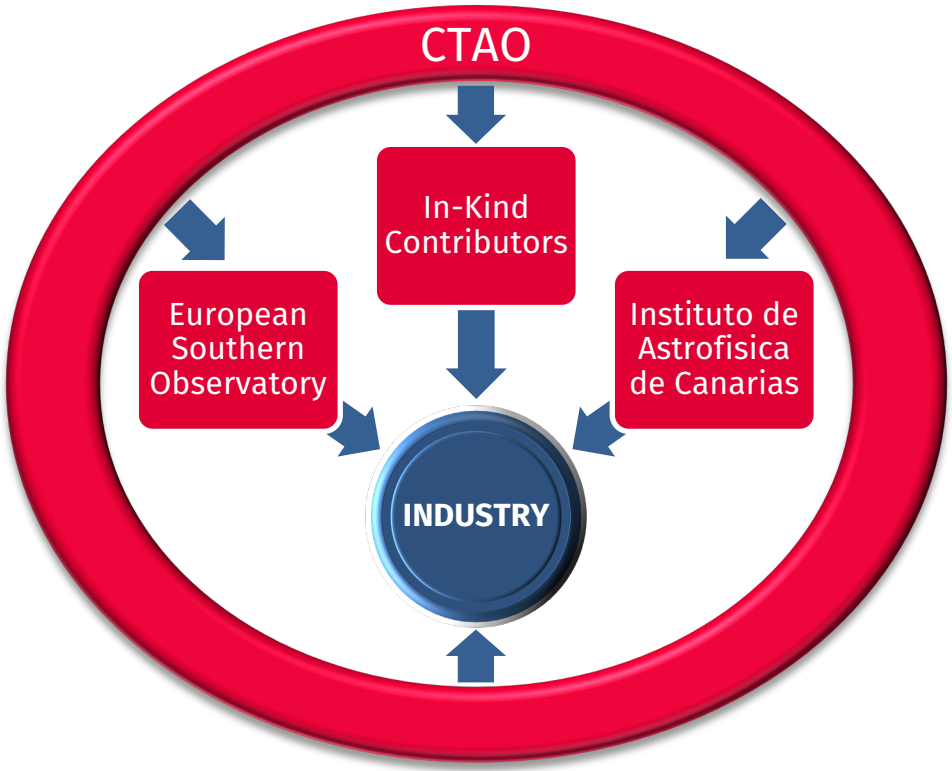
The CTA Consortium (CTAC)



31 countries
202 institutes
1451 members

Other Actors

- CTAO ←→ INAF: Headquarters
- CTAO ←→ DESY: Science Data Management Centre
- CTAO ←→ IAC: Northern Observation Station
- CTAO ←→ ESO: Southern Observation Station
- The industry will play a central role during the construction phase!!!



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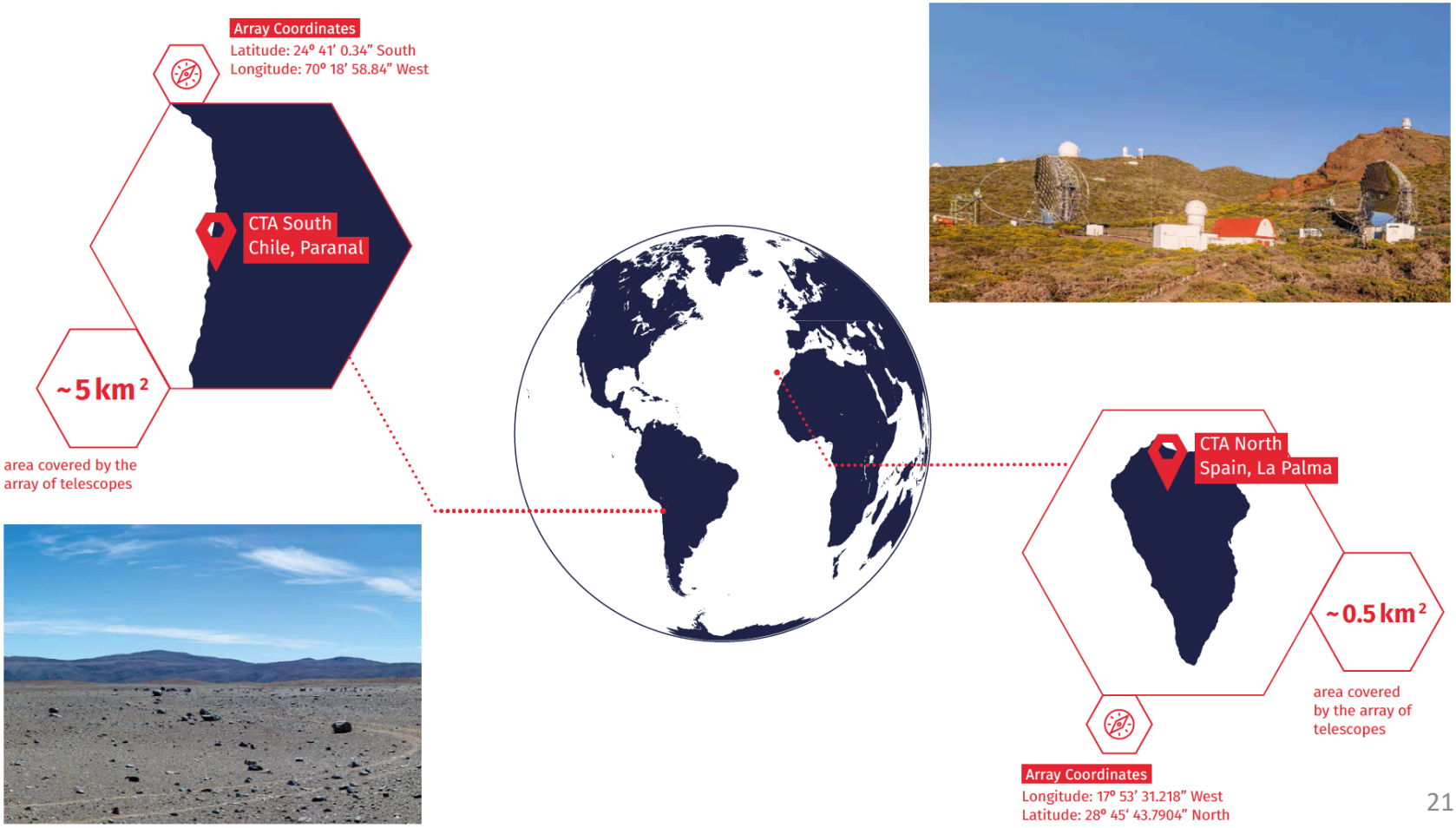
WHERE
the CTA Project is carried out?

CTA Sites


Heidelberg
MPIK
Zeuthen
DESY
Spain
La Palma
Bologna
INAF
northern hemisphere
southern hemisphere
Chile
Paranal
Array Sites
CTAO Offices
Science Data Management Centre
User
Proposal
Data Product
Science
Data
Management
Centre
Proposals
Scheduled
Operations
Planning &
Administration
Low-level
Data
Headquarters
Report
Operations
Planning &
Administration
CTA-N
Array
CTA-S
Array

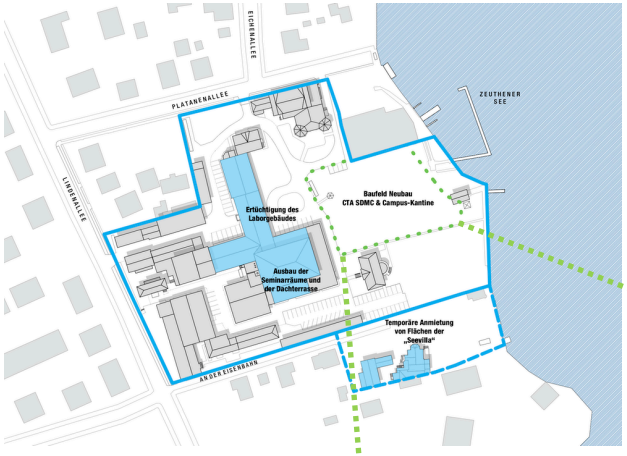
Sites of the Observation Stations

- Two “eyes” (arrays of Cherenkov Telescopes) on the sky



Headquarters and SDMC

- In 2017, the headquarters has been moved to Bologna (IT).
- Heidelberg offices will run until the CTAO becomes an ERIC.
- The Science Data Management Centre (SDMC) will be built up at DESY in Berlin-Zeuthen (Germany) in a new building.



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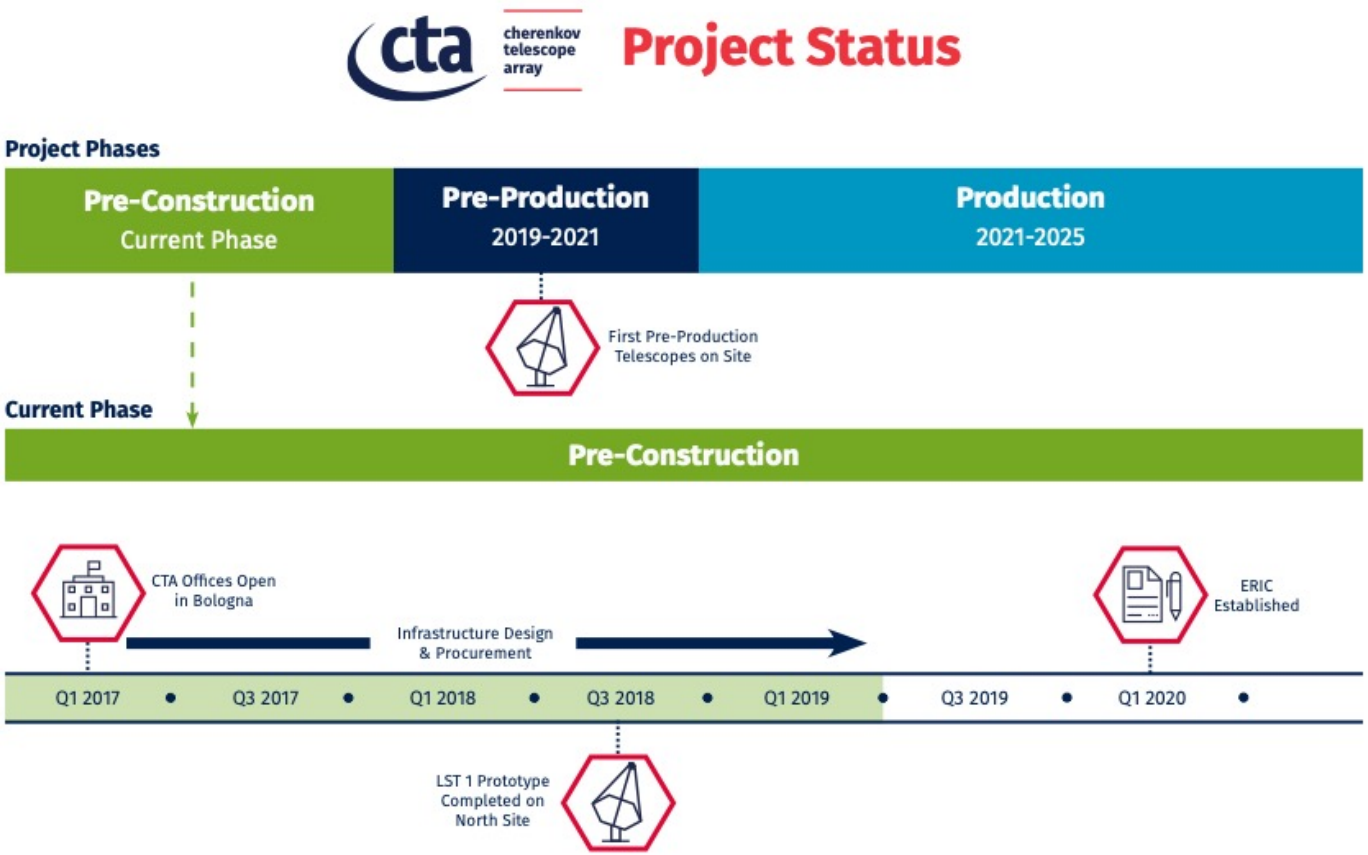
WHEN
the CTA Project is carried out?

Timeline

- The complete CTA timeline is available here:
  - » https://www.cta-observatory.org/project/status/



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HOW
the CTA Project is carried out?

Strategy

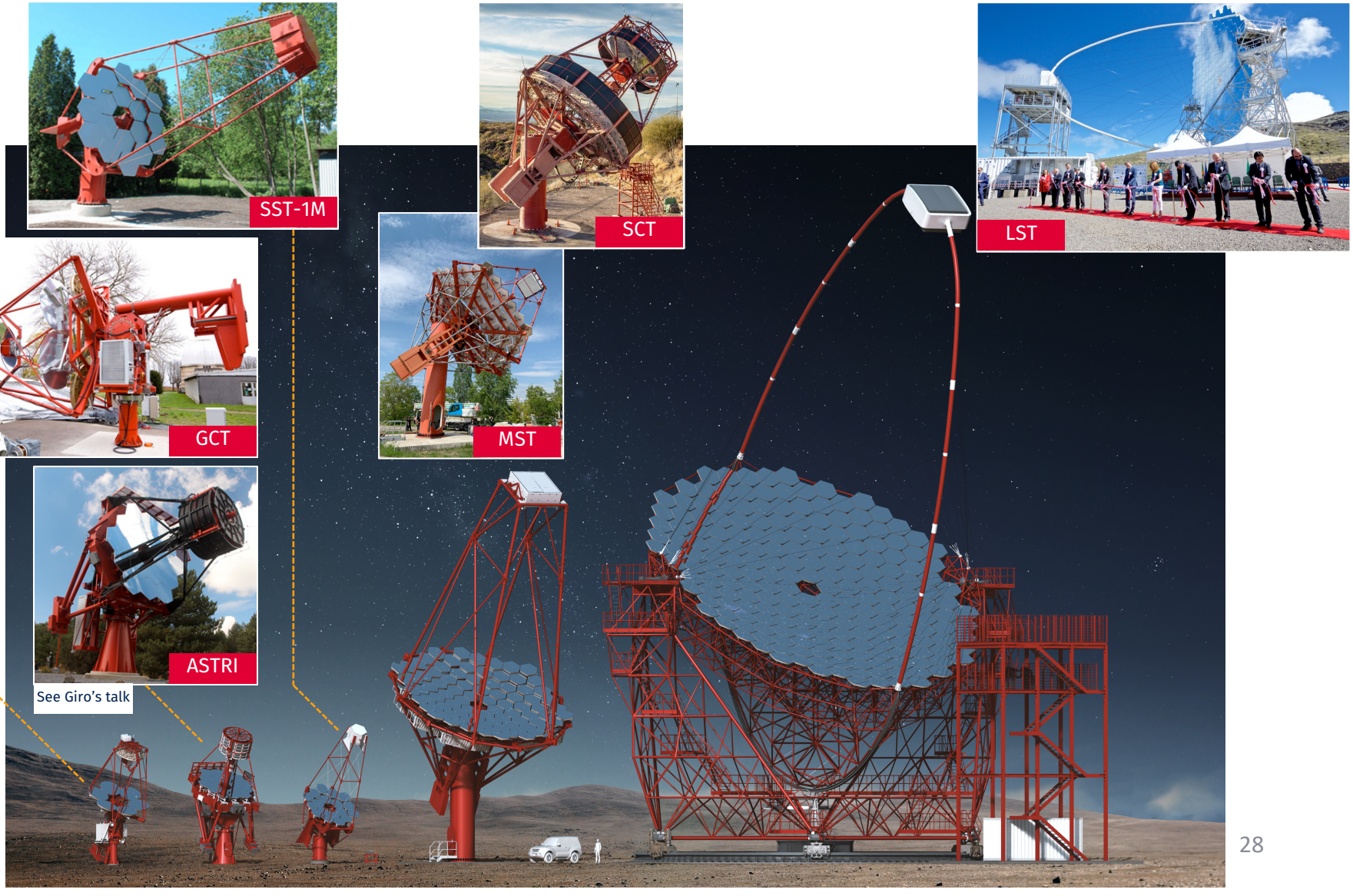
- So far there has been an intensive use of in-house resources for:
  - planning,
  - designing,
  - prototyping, and
  - testing.

- For the upcoming construction phase it is reasonable to change strategy towards an industrialization that heavily involves:
  - manufactures,
  - site services and installation firms,
  - power and data specialists,
  - technology systems vendors,
  - software and ICT service providers,
  - consulting companies, and
  - other industrial sectors.

CTA Technology

- 3 alt-azimuth telescope types to cover the wide CTA energy range:
  - Large Sized Telescopes (23m),
  - Medium Sized telescopes (12m), and
  - Small Sized Telescopes (~4m).
- Sensitive photosensor cameras (PMTs & SiPMs) to image very faint nanosecond long bluish light flashes (Cherenkov light).
- Accurate timing and clock over the whole array of telescopes.
- Challenging calibration techniques and algorithms.
  - The terrestrial atmosphere is part of the detector!
- Substantial software development and “Big Data” management.
  - Expect 3.7 PB (reduced) raw data volume and ~10-100 TB of scientific data products per year.

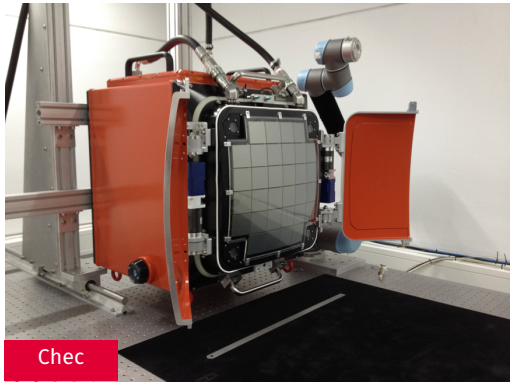
CTA Telescopes

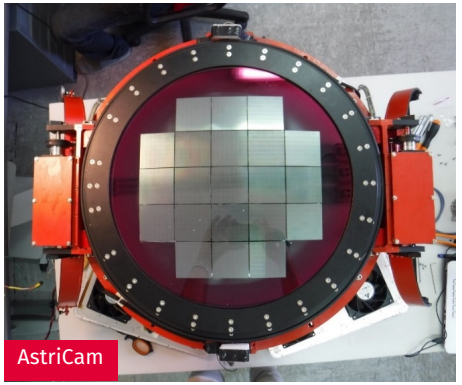


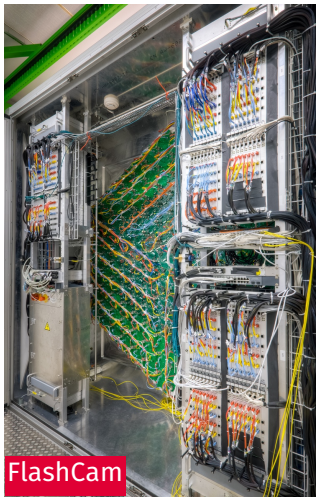
CTA Photosensor Cameras

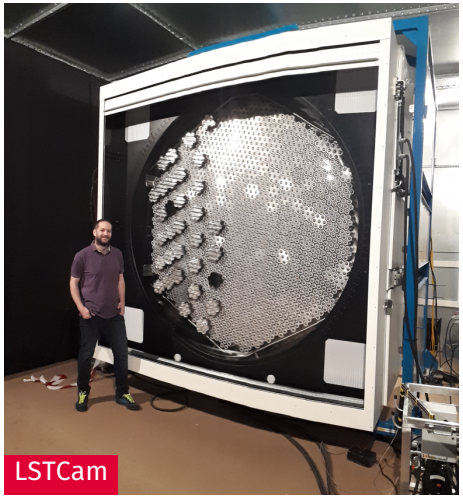
- Specific cameras for each telescope size and type.
- Both PMTs and SiPMs photosensors adopted.


DigiCam

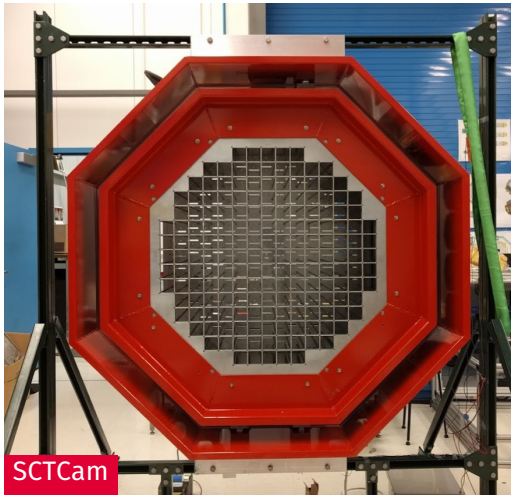

Chec


AstriCam

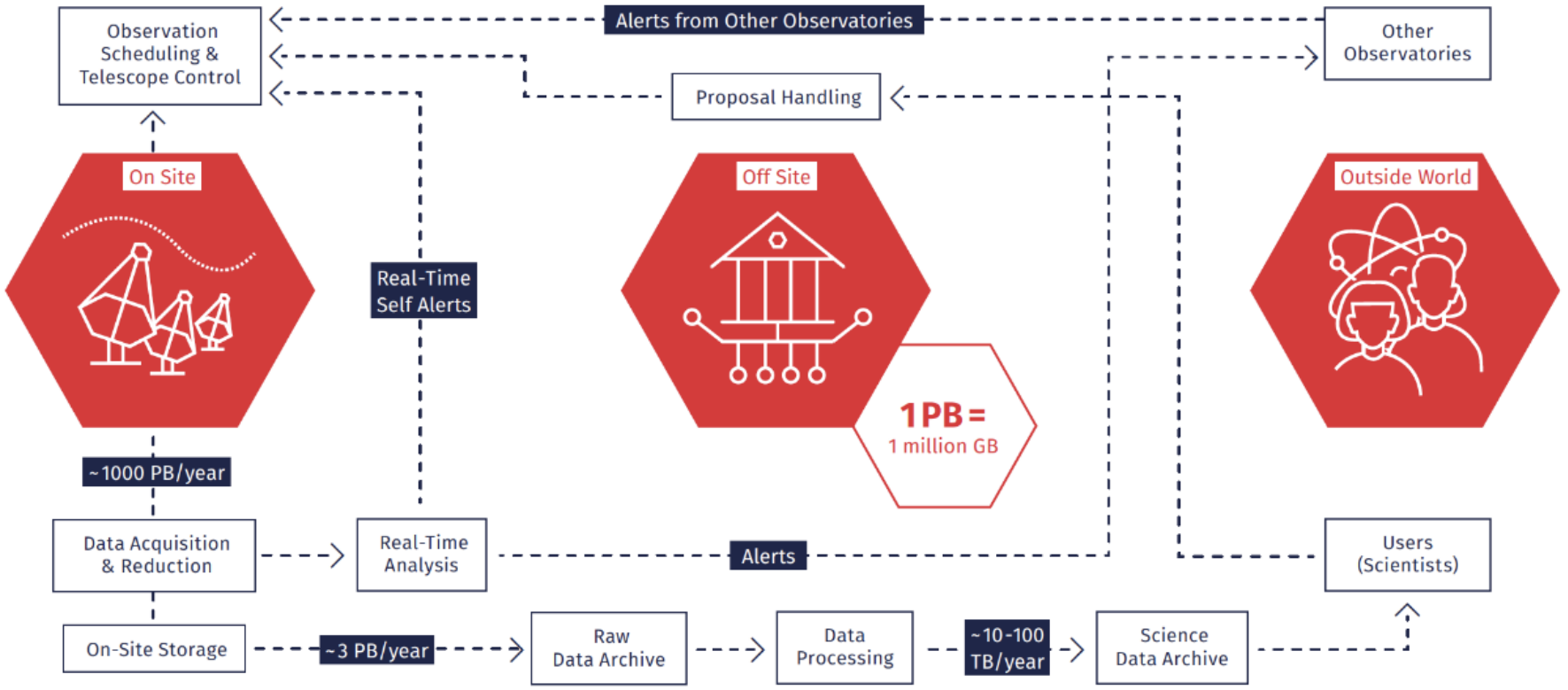

FlashCam


LSTCam

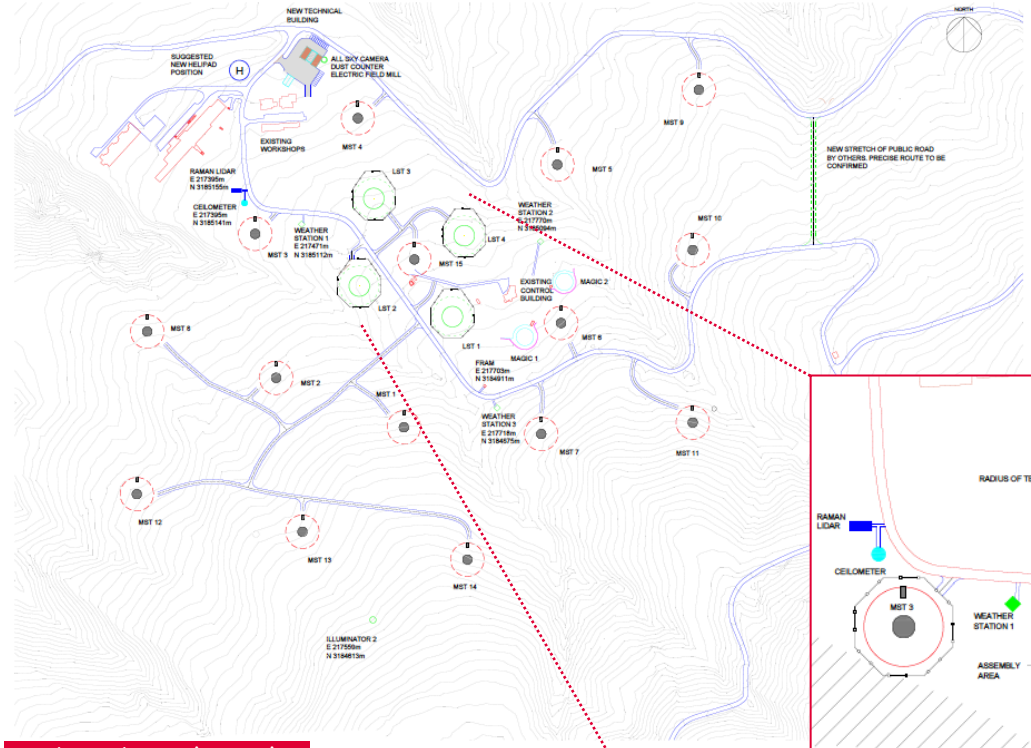

NectarCam


SCTCam

CTA Data Volume

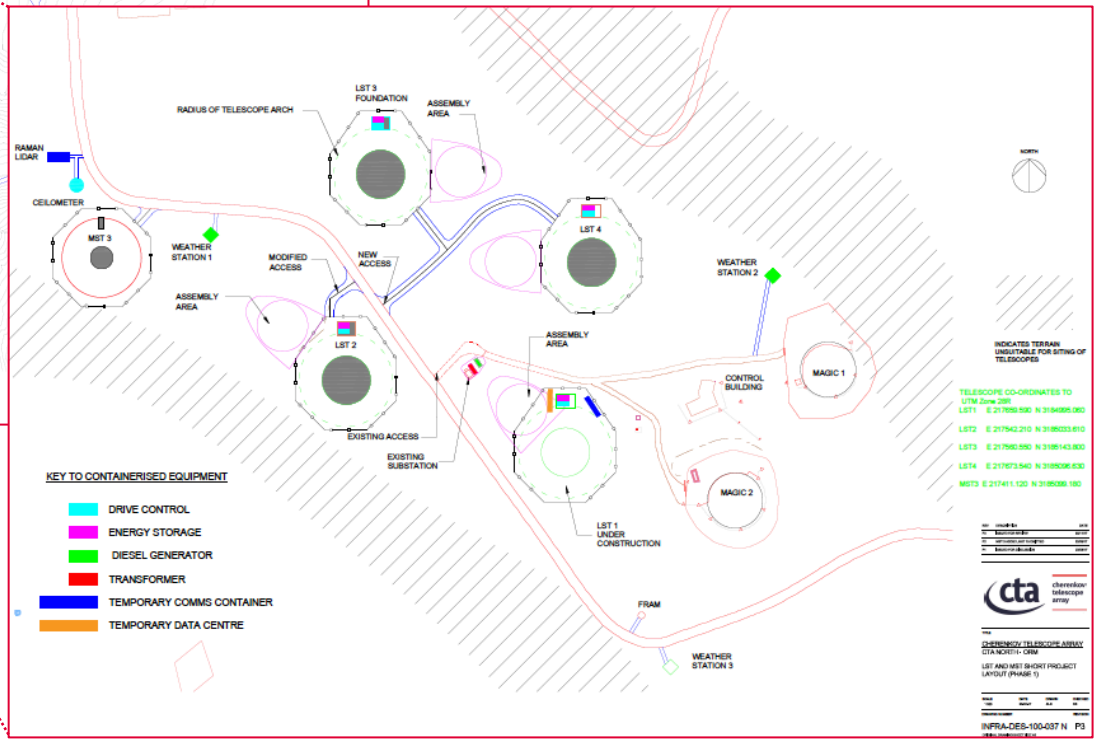


CTA Civil Structures & Infrastructures



Northern Observation Station

The Southern Observation Station is similar, but 5 times bigger.



- Buildings
- Transport Infrastructures
- Underground Services
- Power/Network Distribution
- Water Supply

Invitation to Tender - Channels

- CTAO gGmbH:
  - All opportunities are advertised on our portal:
    https://www.cta-observatory.org/project/industry/#1535533445429-6be9ead5-4ca7
  - Tender processes > 209 k€ → EC portal
    https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home
  - Tender processes < 209 k€ →
    https://www.bundesanzeiger.de/ebanzwww/wexsservlet?global_data.language=en&session.sessionid=50815599e9404c0483dfecaa4ef79fcc&page.navid=gotolastpage
- IAC:
  - Spanish public tender platform:
    https://contrataciondelestado.es/wps/portal/!ut/p/b1/jY_LDoIwEEW_yMy0QAvLIq8aozy0SjeGRDRNLGyMMX69SNyCzm6Sc-bOBQ01CTjnDnORwBF01zzMtbmbvmtuUIPW_CRUXAgZOJiWeYw0LDlzk-2wIijbPI01r_YMO6jjzwHNJgWkA1APAE6MwNEPK98XIRHo8zBCwWKHeQWhmLKv7zlLV61UziqZIsosidZ74mFK2X_5MwE__APoEZn7YATmKs6HIGyy3rZgtVnosrxUciHeg2cR5g!!/dl4/d5/L2dBISEvZ0FBIS9nQSEh/pw/Z7_AVEQAI930GRPE02BR764FO30G0/act/id=0/p=javax.servlet.include.path_info=QCPjspQCPreasigProcQCPAdminAOCReasigProcPortletAppView.jsp/420893650043/-/
- ESO:
  - Tender processes > 150 k€ → http://www.eso.org/public/industry/cp.html
- (Potential) In kind contributors from CTAC:
  - Contact names in the CTAO portal.
  - IKC portal and National tender portals
    https://ec.europa.eu/info/policies/public-procurement/support-tools-public-buyers/public-procurement-eu-countries_en

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THANK YOU!

Email: francesco.dazzi@cta-observatory.org

CTAO and the international CTA collaboration gratefully acknowledge financial support from the CTAO Shareholders and agencies and organizations listed at http://www.cta-observatory.org/consortium_acknowledgments

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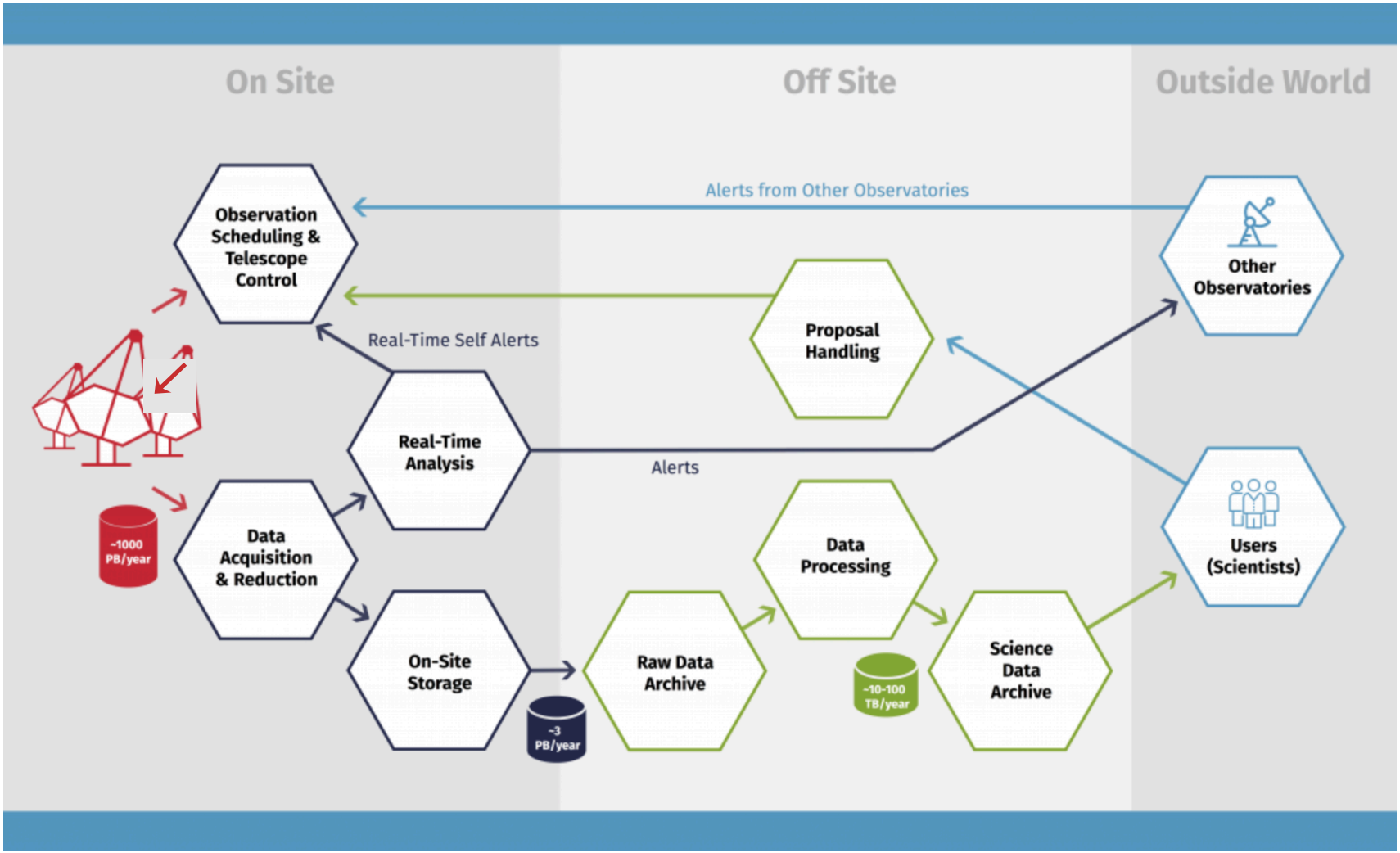
Backup

CTA Scientific Themes

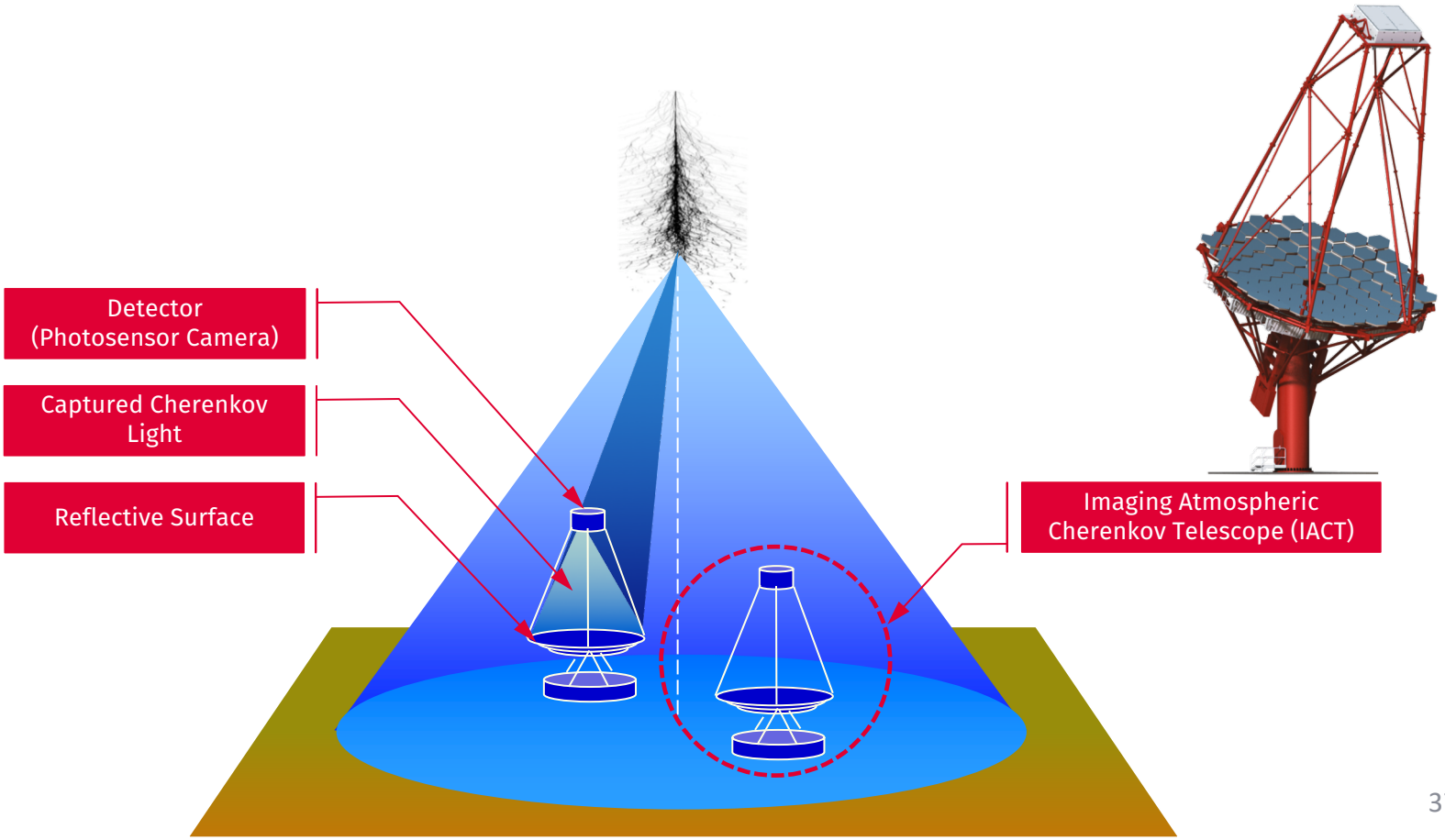
- Some Fundamental Questions:
  - Cosmic Particle Acceleration
    - How and where are particles accelerated?
    - How do they propagate?
    - What is their impact on the environment?
  - Probing Extreme Environments
    - Which/how are processes close to neutron stars and black holes?
    - What physical processes are at work close to neutron stars and black holes?
    - What happens in the relativistic jets, winds and explosions?
  - Physics Frontiers
    - What is the nature of dark matter?
    - How dark matter is it distributed?
  - … and many others…

CTA Functional Model



EAS Cherenkov Light Capture

- The telescope reflective surface (dish + mirrors) captures the Cherenkov light produced by an EAS and focuses it towards the detector (photosensor camera).



EAS Cherenkov Light Detection

- The photosensor camera detects the EAS Cherenkov light by converting the light into electrical signals.