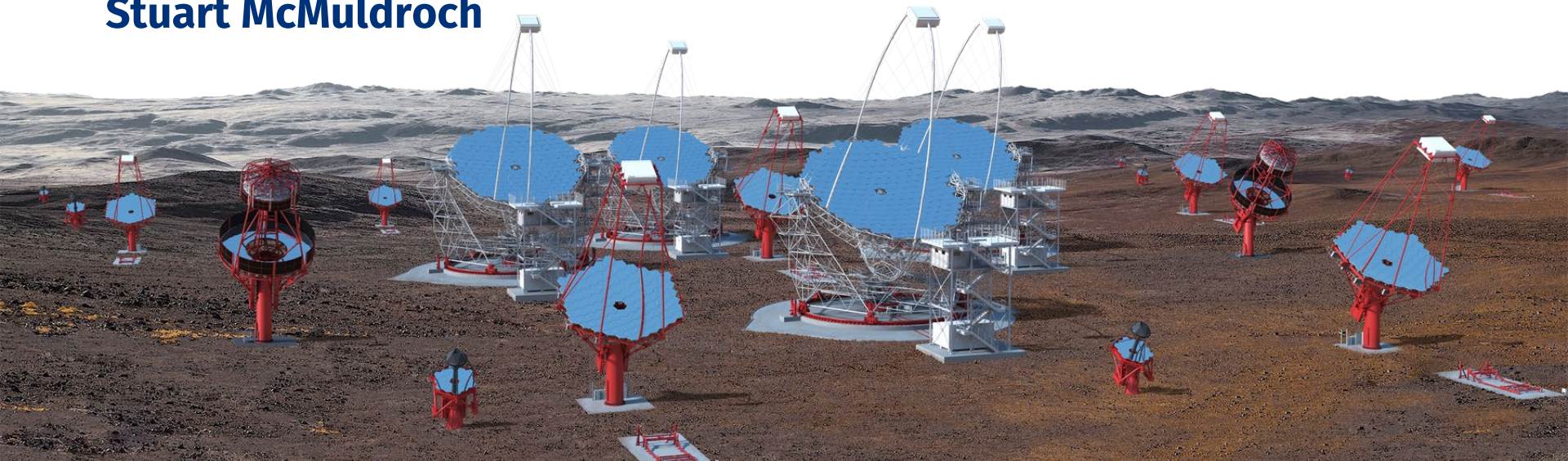


The Cherenkov Telescope Array Observatory Overview and Status

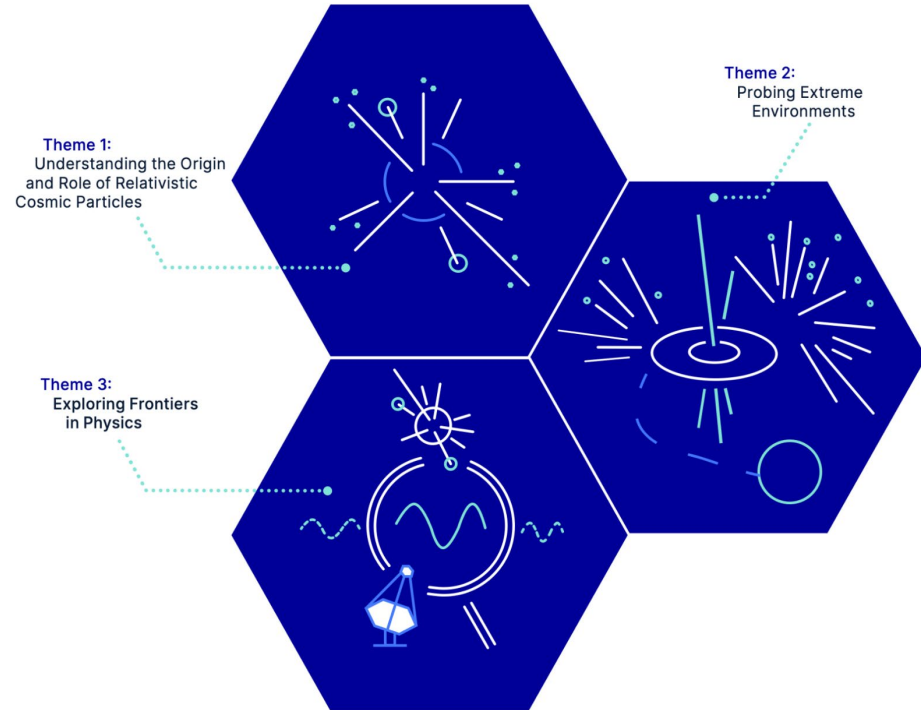
Stuart McMuldroy



The Cherenkov Telescope Array Observatory



- An astrophysics and particle physics scientific tool
- Observes the most extreme highest energy sources in the universe
- Increases understanding of astrophysical sources and is a lab reaching energies not possible in Earth's experiments like CERN
- Builds on the success of smaller existing arrays - HESS, MAGIC, and VERITAS



CTA Development is an International Collaboration with Four Observatory Locations

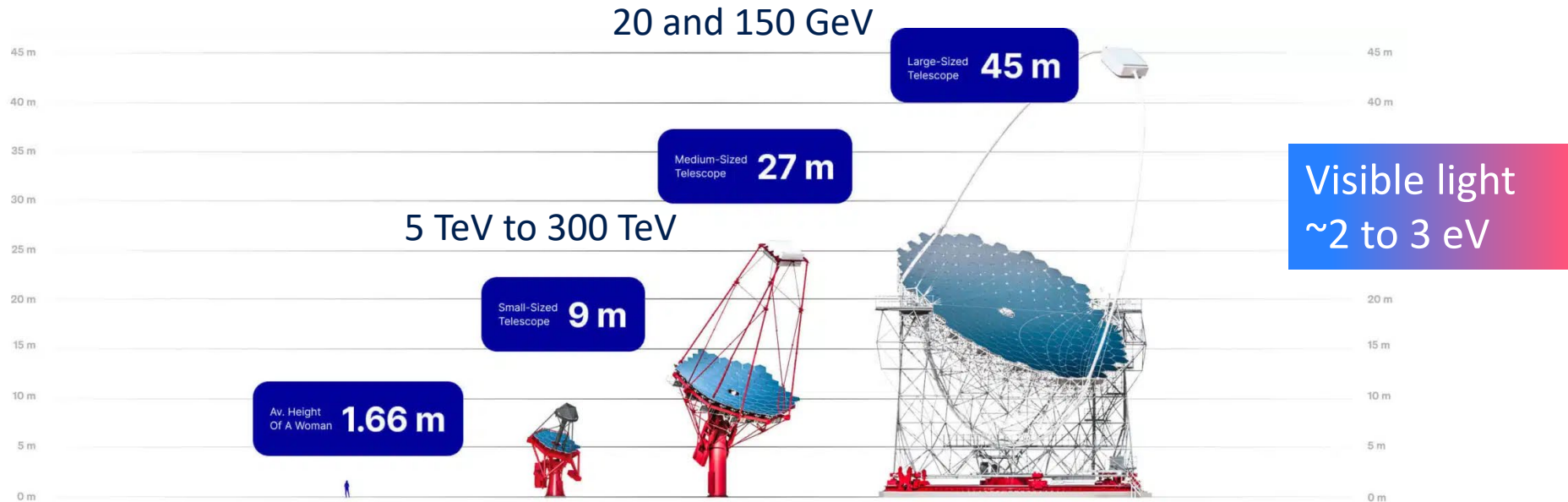


Shows formal participants –
other countries participate e.g. Brazil, USA

Sites Consist of Different Size Telescopes - Detect Different Energy Ranges



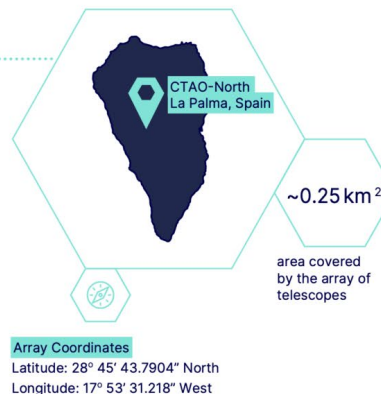
- Higher energies detected by smaller telescopes
- Largest telescopes detect lower energies with weaker signal



Two Array Sites in North and South Hemispheres Provide Full Sky Coverage

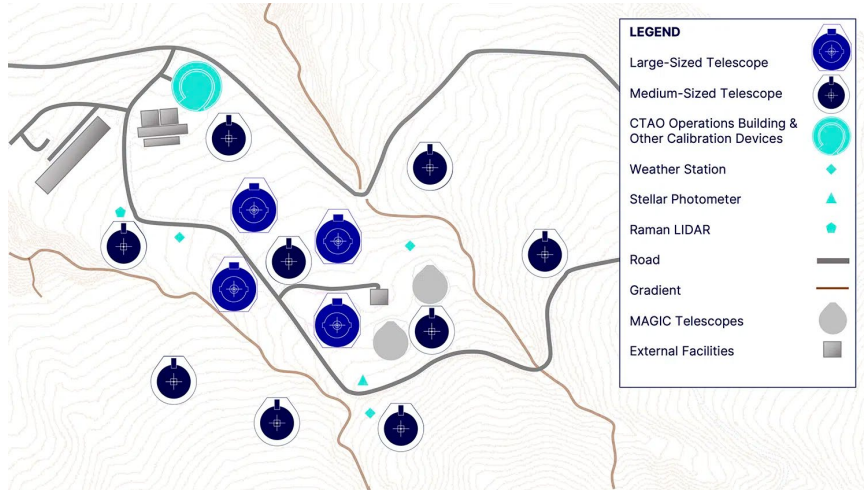


Northern Array in La Palma – LSTs and MSTs



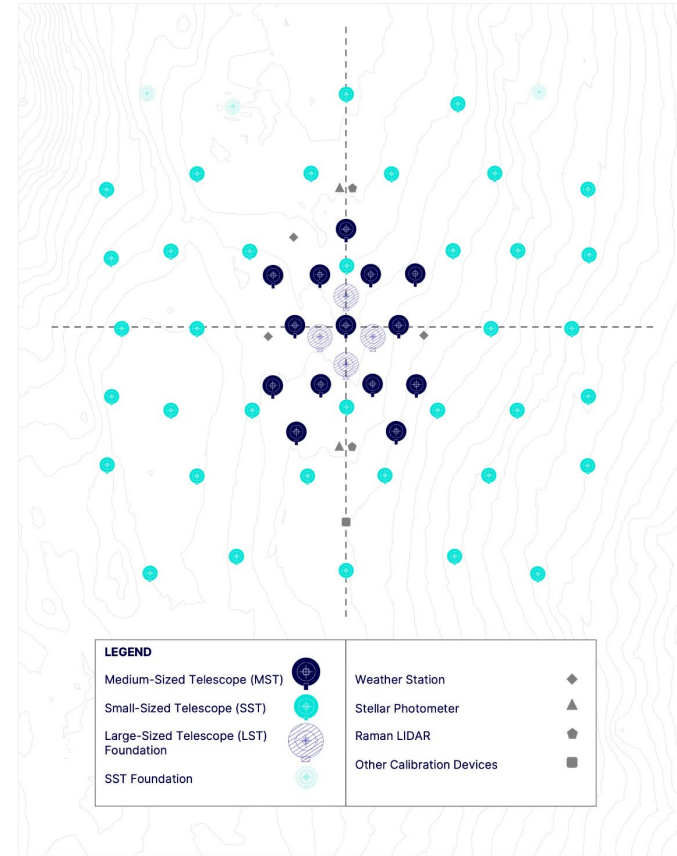
Southern Array in Chile
– SSTs, MSTs, and
potentially LSTs

Two Array Sites Home to Over 60 Telescopes – Alpha Configuration



North Site – LSTs and MSTs

South Site – SSTs, MSTs



Partners (In-kind Contributors) Build Telescopes, Some Software, North Site Infrastructure



- The **Large-Sized Telescope (LST)**
 - **67 different institutions** across twelve countries: Brazil, Bulgaria, Croatia, Czech Republic, France, Germany, Italy, Japan, Poland, Spain and Switzerland
- The **Medium-Sized Telescope (MST)**
 - international collaboration of organizations from Austria, Brazil, France, Germany, Italy, Poland, Spain and Switzerland
- The **Small-Sized Telescope (SST)**
 - international collaboration of organizations from Australia, Brazil, France, Germany, Italy, Japan, Netherlands, Switzerland

Central Organization Aims to Bring System and Partners Together



- Many partners contribute to developing the observatory
 - Building telescopes and other instruments
 - Developing software
 - Constructing site infrastructure
- Central organization provides a key role
 - Develops the requirements, specifications, and interfaces for the Observatory
 - Supports partners in achieving their goals
 - Develops system level software
 - Builds infrastructure at the Southern Sites
- Recently changed organizational structure to increase communication and be more deliverable focused as we prepare for the construction phase

Central Organization Team Will Double in Next Year



- Increasing team across all locations supporting multiple goals:
 - Systems engineering knitting together everyone's contributions
 - Growing team on both sites
 - Software control, data processing, and user interface efforts
 - Administration and project management



Project is Growing Towards A New Phase



- Up to now, we have been
 - Developing prototypes and pathfinders
 - Completing remaining designs
- Now starting to
 - Build additional telescopes
 - Preparing infrastructure for the North Site MSTs and for South Site
 - Increasing central organization capability and staff size
- Transitioning to planning small pathfinder arrays – subsets of the eventual Alpha Configuration
 - **Achievable by 2027**
 - **Reduces risk, produces first data**

Bologna – Project Headquarters

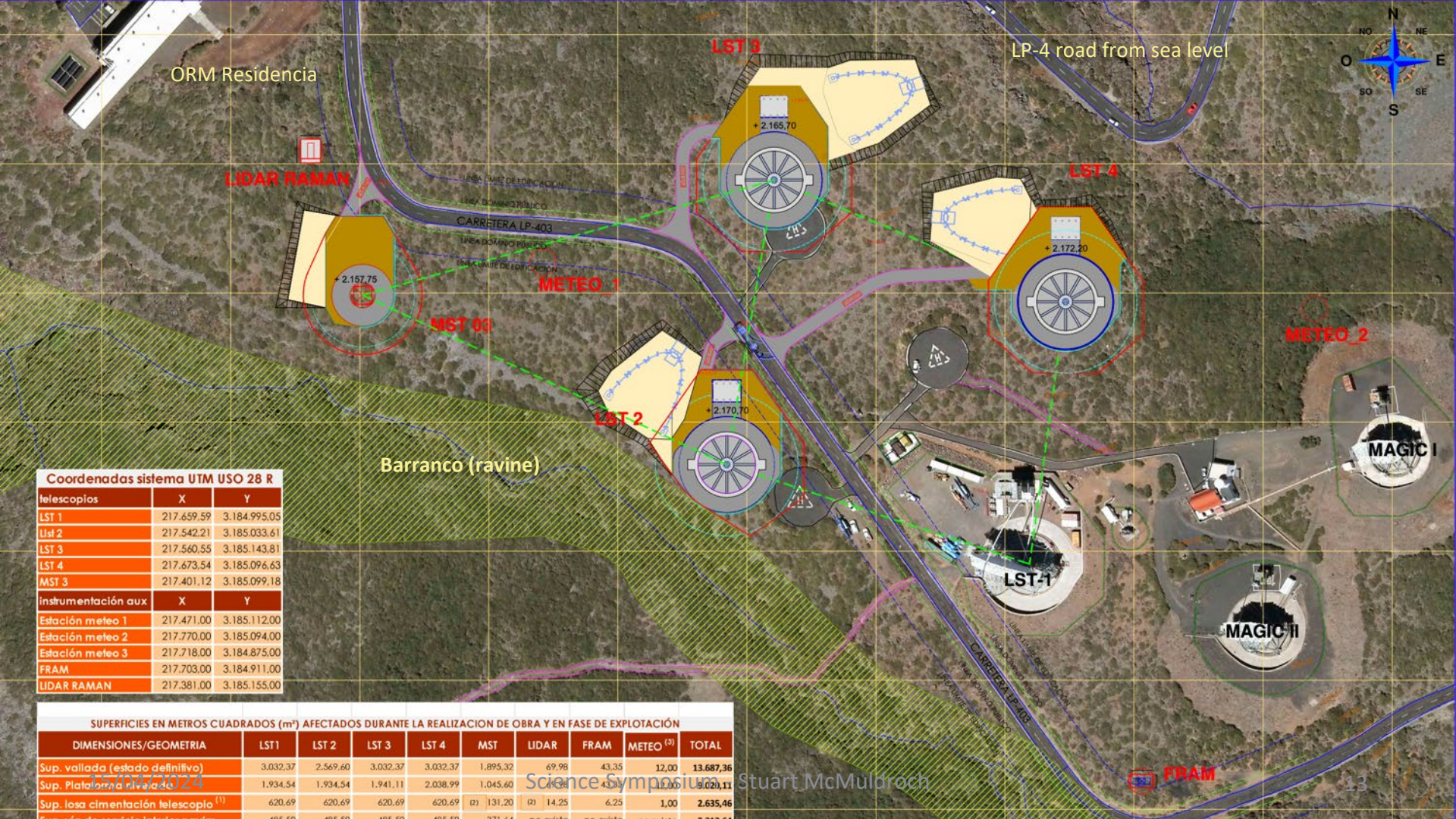


- Housed in INAF facilities in north Bologna next to CNR
- Home for project administration, systems engineering, project management
- Will add ~20 staff by end of the year



North Site Status on La Palma





Coordenadas sistema UTM USO 28 R

telescopios	X	Y
Lst 1	217.659,59	3.184.995,05
Lst 2	217.542,21	3.185.033,61
LST 3	217.560,55	3.185.143,81
LST 4	217.673,54	3.185.096,63
MST 3	217.401,12	3.185.099,18
Instrumentación aux	X	Y
Estación meteo 1	217.471,00	3.185.112,00
Estación meteo 2	217.770,00	3.185.094,00
Estación meteo 3	217.718,00	3.184.875,00
FRAM	217.703,00	3.184.911,00
LIDAR RAMAN	217.381,00	3.185.155,00

SUPERFICIES EN METROS CUADRADOS (m²) AFECTADOS DURANTE LA REALIZACION DE OBRA Y EN FASE DE EXPLOTACIÓN

DIMENSIONES/GEOMETRIA	LST1	LST 2	LST 3	LST 4	MST	LIDAR	FRAM	METEO (3)	TOTAL
Sup. vallada (estado definitivo)	3.032,37	2.569,60	3.032,37	3.032,37	1.895,32	69,98	43,35	12,00	13.687,36
Sup. Plataforma vallada	1.934,54	1.934,54	1.941,11	2.038,99	1.045,60	69,28	43,35	11,00	9.020,11
Sup. losa cimentación telescopio (1)	620,69	620,69	620,69	620,69	131,20	14,25	6,25	1,00	2.635,46
Sup. de la zona de trabajo	185,50	185,50	185,50	185,50	271,64	no aplica	no aplica	no aplica	7.203,64

15/04/2024

Science Symposium Stuart McMuldloch

LSTs and Site Development Are Moving Ahead



- Construction of 3 more LST telescopes, led by the IAC and the LST Consortium is progressing rapidly
 - **LSTNs foundations:** completed!
 - **LSTN-02:** azimuth ring, pins and boogies completed
 - **LSTN-03:** most of the mount completed
 - **LSTN-04:** mount and receiver tower complete. Primary support structure almost complete
 - **MSTNs:** planning foundation work
 - **Infrastructure:** almost complete
 - **Array Common Elements (ACE) foundations:** complete

LSTN-02 Foundation and Bogies in Place



LSTN-03 Under Assembly



15/04/2024

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LSTN-04 Moving Forward



CTAO-South Site Staring Development

Getting ready for construction



South Site Infrastructure Has Started With Major Expansion Planned for Next Year



- Topographical Surveyery Complete
- Geotechnical study and earthing grid design Nearly Complete
- 23kV electrical Overhead Line (OHL) Negotiating
- 10 kV Power Conditioning System (PCS) Out for tender
- Array Roads and Telescope Foundations Contract late this year

South Site Initial Preparations Underway – Array Layout and Ground Characterization



Geotechnical Study

**Boreholes to find
bedrock**



**Trial pit for soil
parameters**



Soil Resistivity

**Preparing Telescope
Positions and
Topography
Assessment**



Science Data Management Centre In Zeuthen Near Berlin – Home for CTAO Software Development



- Home for science data processing and distribution
- Purpose built new building being inaugurated this October
- Room for 33 CTA Central Organization staff members



Software Infrastructure Development – A Collaborative Effort Led By Central Organization



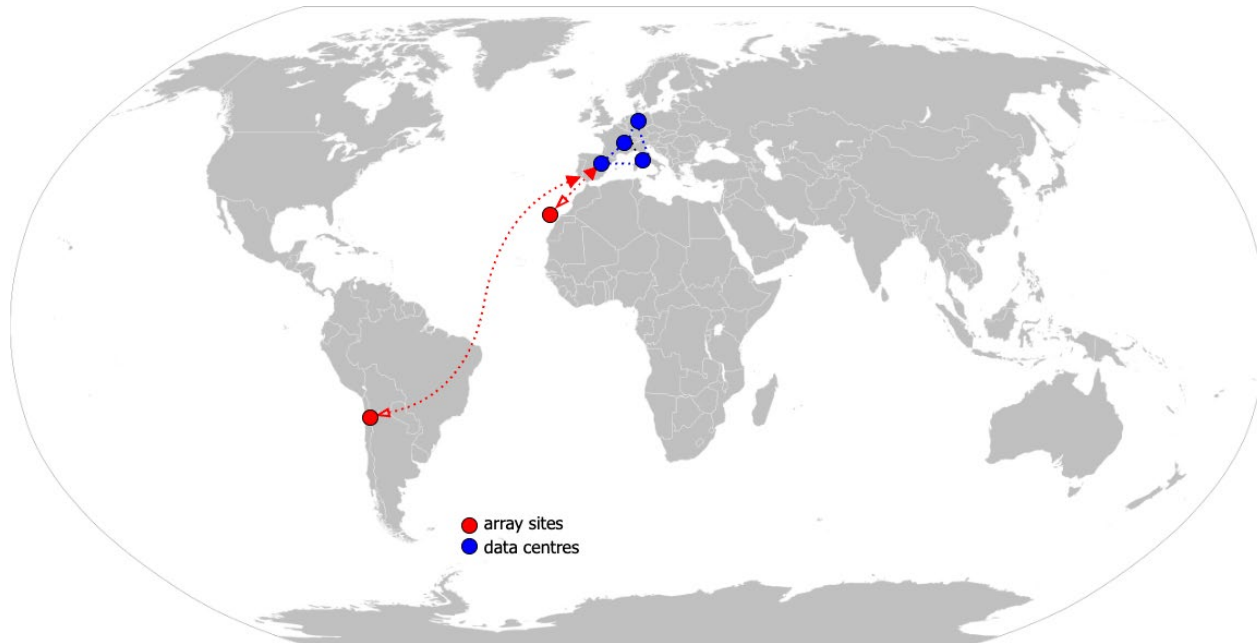
Central organization is responsible for the CTA data processing and science product delivery (working closely with partners)

- Several major software components
 - Array Control and Data Acquisition System (ACADA)
 - Data Processing and Preservation System (DPPS)
 - Science User Support System (SUSS)
- Other critical infrastructure
 - Data centres and data distribution networks on CTAO-S/N
 - Array Clock System

Software Runs In A Distributed Environment



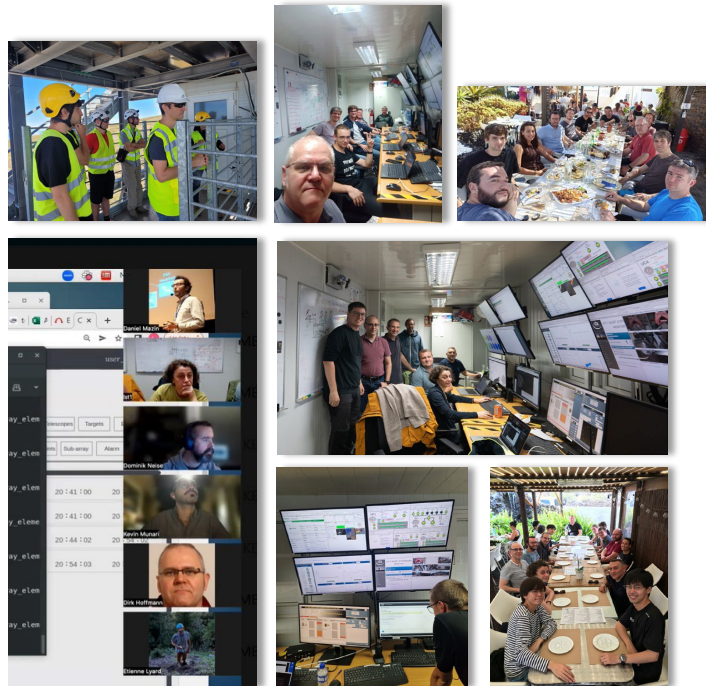
- **ACADA** and **DPPS** run in on-site data centres on the array sites
- **DPPS** and **SUSS** run in off-site data centres



ACADA First Release Tested Successfully



- Array Control and Data Acquisition System (ACADA):
 - Two versions of ACADA released
 - REL1 successfully tested with the LST1 in La Palma in Oct 2023
 - Critical Design Review (CDR) in Jan 2024.
 - Very positive review
 - Addressing last set of recommendations
- REL2 will support multi-telescope operations and different telescope types



[ACADA-LST1 Integration: A major milestone, thanks to the successful joint effort of the LST, Tokyo Cluster and CTAO Computing Department](#)

Other Software Efforts Progressing At Earlier Stages



- Documentation ready and collaborating with partners on:
 - Data Processing and Preservation System (DPPS) towards first release
 - Science User Support System (SUSS)
 - Data centres and data distribution networks on CTA-S/N
 - Array Clock System
- Setting up Science Operation Support System
- Four data centres already involved in MC data production

Producing Ground-Breaking Science Is The End Goal



- Partner individual telescopes already showing future potential
- The CTA Science data will be shared amongst the CTA Science Consortium and the wider astrophysics community

Dec 2023 - LST-1 detected source OP 313 at very high energies above 100 GeV. This makes OP 313 the most distant Active Galactic Nuclei (AGN) ever detected by a Cherenkov telescope.

Credit: LST Consortium at the CTA-North Site on La Palma, Spain



Why Have This Symposium Now?



The project is moving towards a new phase

- Have been focused on telescopes – now planning on increased site and software development, preparing for installation/arrays on site
- Will have sub-arrays arrays along the path to the Alpha Configuration

Real data will be available in a few years and we need to be ready

- Examine how to maximize the Observatory's science impact
- Maximize the involvement of high energy scientists
- Engage scientists beyond our regular community to achieve true multi-messenger science