



cherenkov  
telescope  
array

# Large Size Telescopes at the CTA-North Observatory

Ramón J. García López  
On behalf of the LST collaboration

Departamento de Astrofísica ULL  
Instituto de Astrofísica de Canarias

Ramón J. García López

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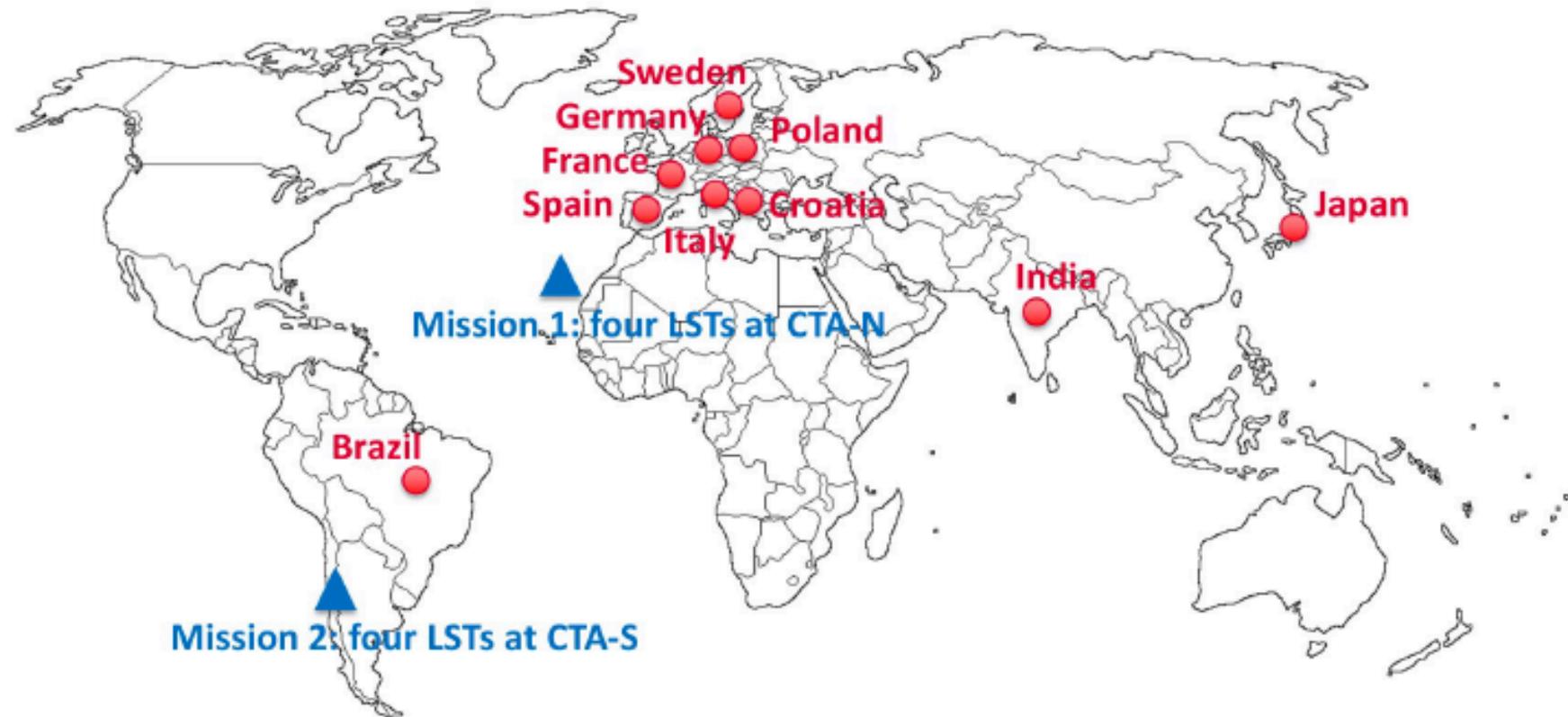


EXCELENCIA  
SEVERO  
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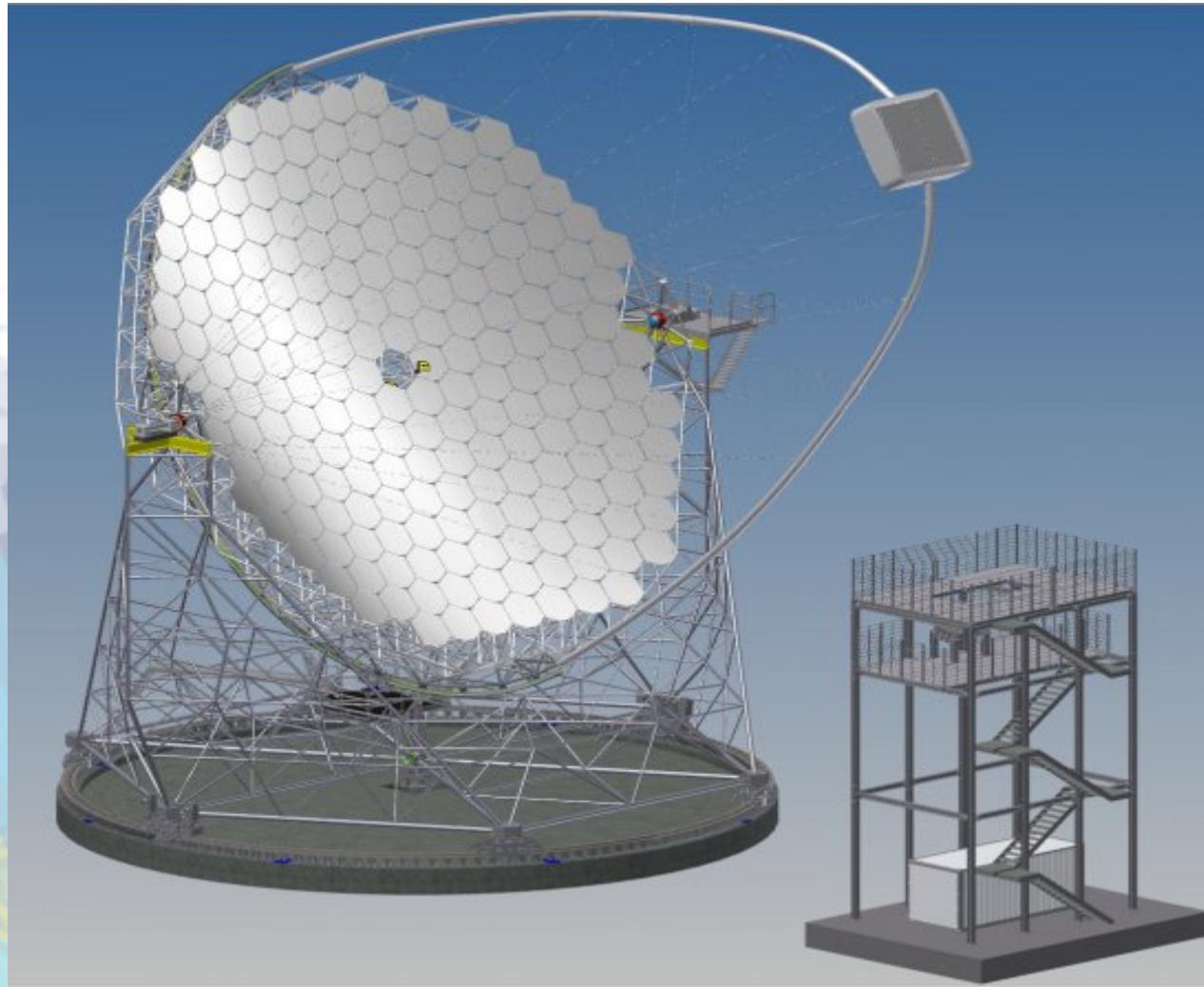


# The LST project team

More than 100 scientists and technicians  
from 10 countries, 37 institutions, 8 telescopes.



# The first step: from here...

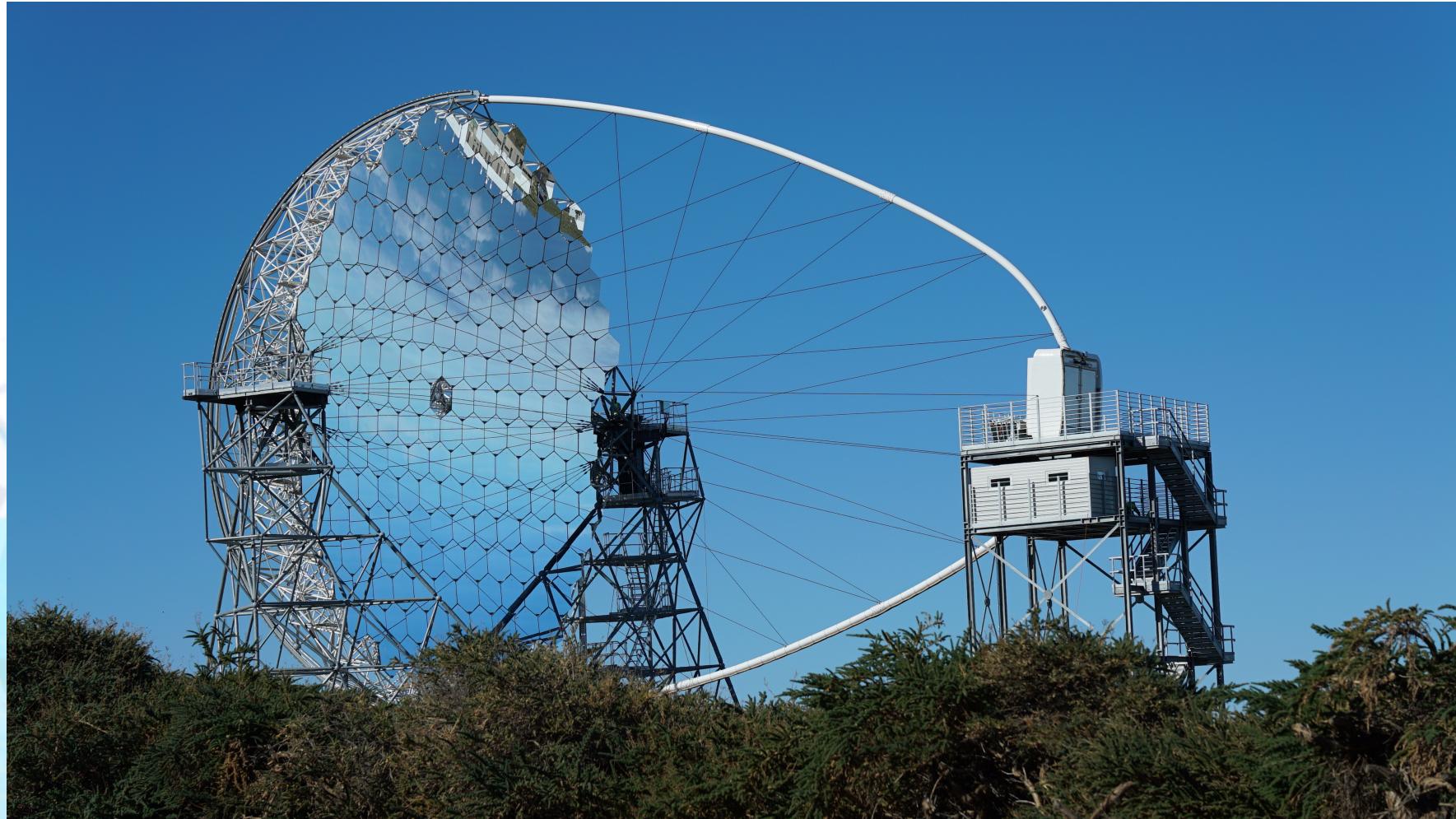


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# To here: a working prototype



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# Agreements to install the LSTs

March 18, 2015

AGREEMENT  
BETWEEN THE  
CTA-LST COLLABORATION  
AND THE  
INSTITUTO DE ASTROFÍSICA DE CANARIAS  
ON THE INSTALLATION AND THE OPERATION OF  
A CTA-LST PROTOTYPE CHERENKOV  
TELESCOPE  
AT THE  
ROQUE DE LOS MUCHACHOS OBSERVATORY



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April 14, 2016

Agreement to install 4 LSTs at Roque de los  
Muchachos observatory





# LST prototype ground breaking ceremony, October 9, 2015



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# Happiness at the ground breaking ceremony



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# CTA-North Host Agreement

## September 19, 2016

The Observatorio del Roque de los Muchachos (ORM) is the site selected to host the CTA-North observatory



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# Chronology of building the LSTs at CTA-North observatory

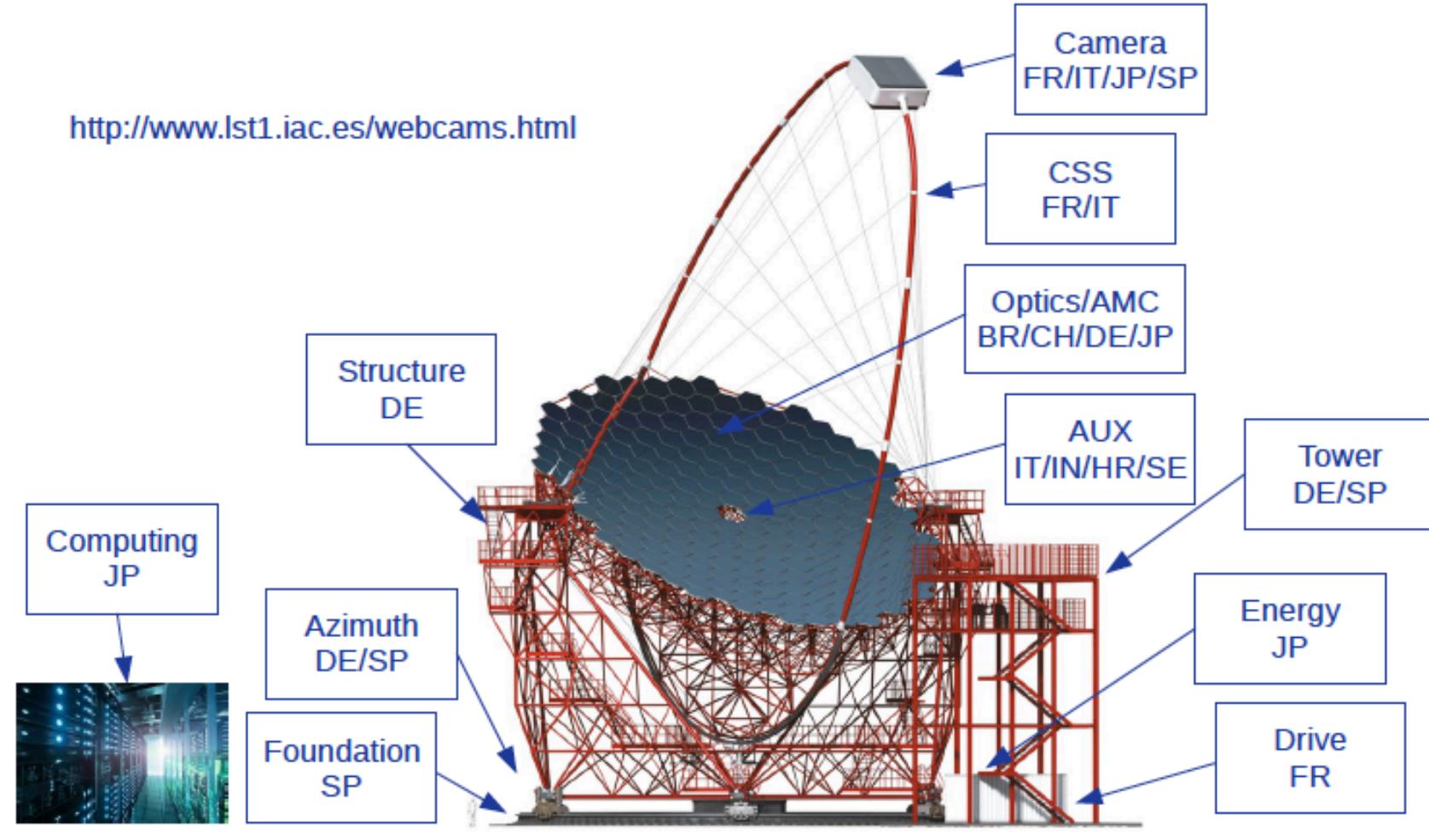
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- Foundation of the LST prototype finished in February 2017.
- Installation of the LST prototype started in June 2017.
- Sixteen months to have a working prototype.
- The LST prototype shall become the LST-1 in the CTA-North observatory after an acceptance process by CTA Observatory (CTAO).
- LST-2, LST-3 and LST-4 will follow in 2019 after design review.

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# Overview and contributions

<http://www.lst1.iac.es/webcams.html>

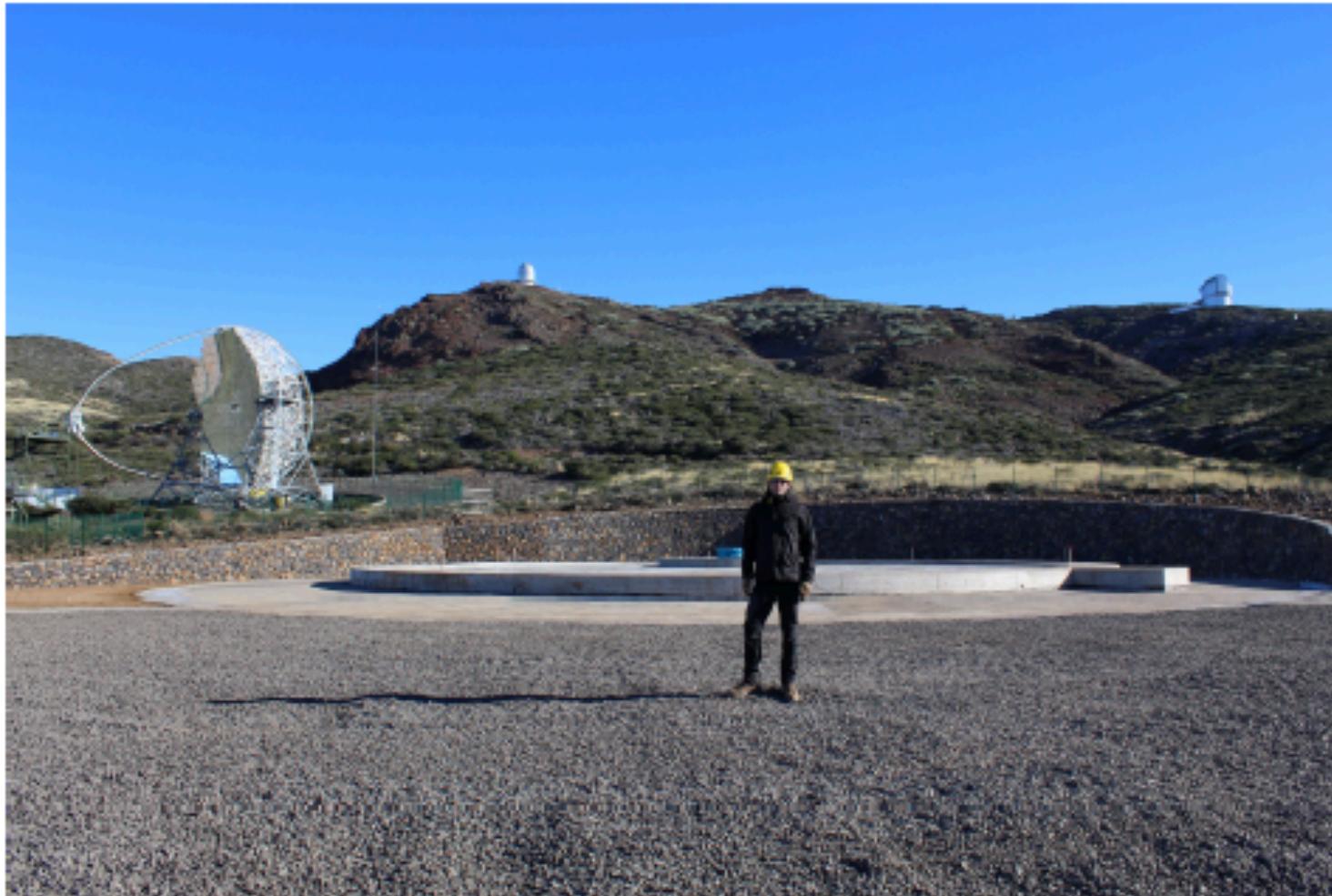


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# Foundation



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- Azimuth system:
  - Rail, 6 bogies and central pin
  - Anti-uplift system
  - 4 motors for fast repositioning
  - 2 azimuth lockings
- Lower structure
  - Tubular steel structure
  - Two elevation bearings
- Optical Support Structure
  - Tubular space frame of CRCF
  - 2 motors for elevation

<https://youtu.be/Qm-QI50TovE>

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- Not scheduled load test of the structure in February.

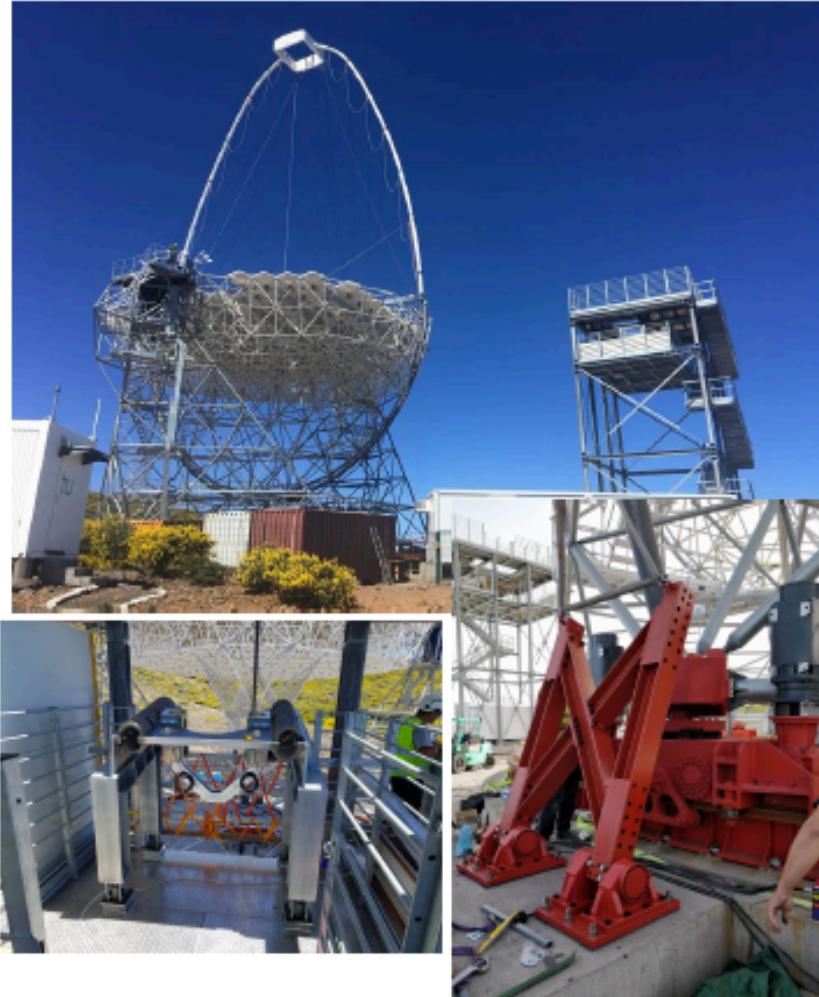


- Camera Access Tower
  - Movable scaffolding
  - Service of the camera
  - Locking of the CSS
- Camera Support Structure
  - Arc of CRCF tubes
  - CRCF tensioning cables
- Locking systems
  - 1 elevation at the tower
  - 2 azimuth at the heavy bogies

<https://youtu.be/gzaHyWWuOio>

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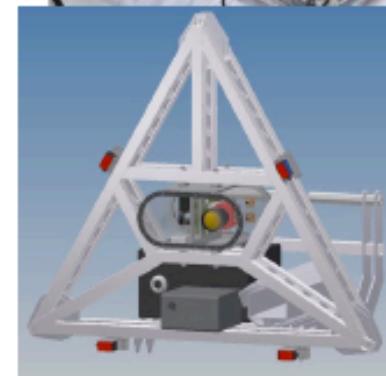
- Drive
  - 4 motors for azimuth, 2 in each heavy bogie
  - 4 motors for elevation
  - Drive control container installed below the camera tower
  - Tests of telescope movements starting in October after inauguration



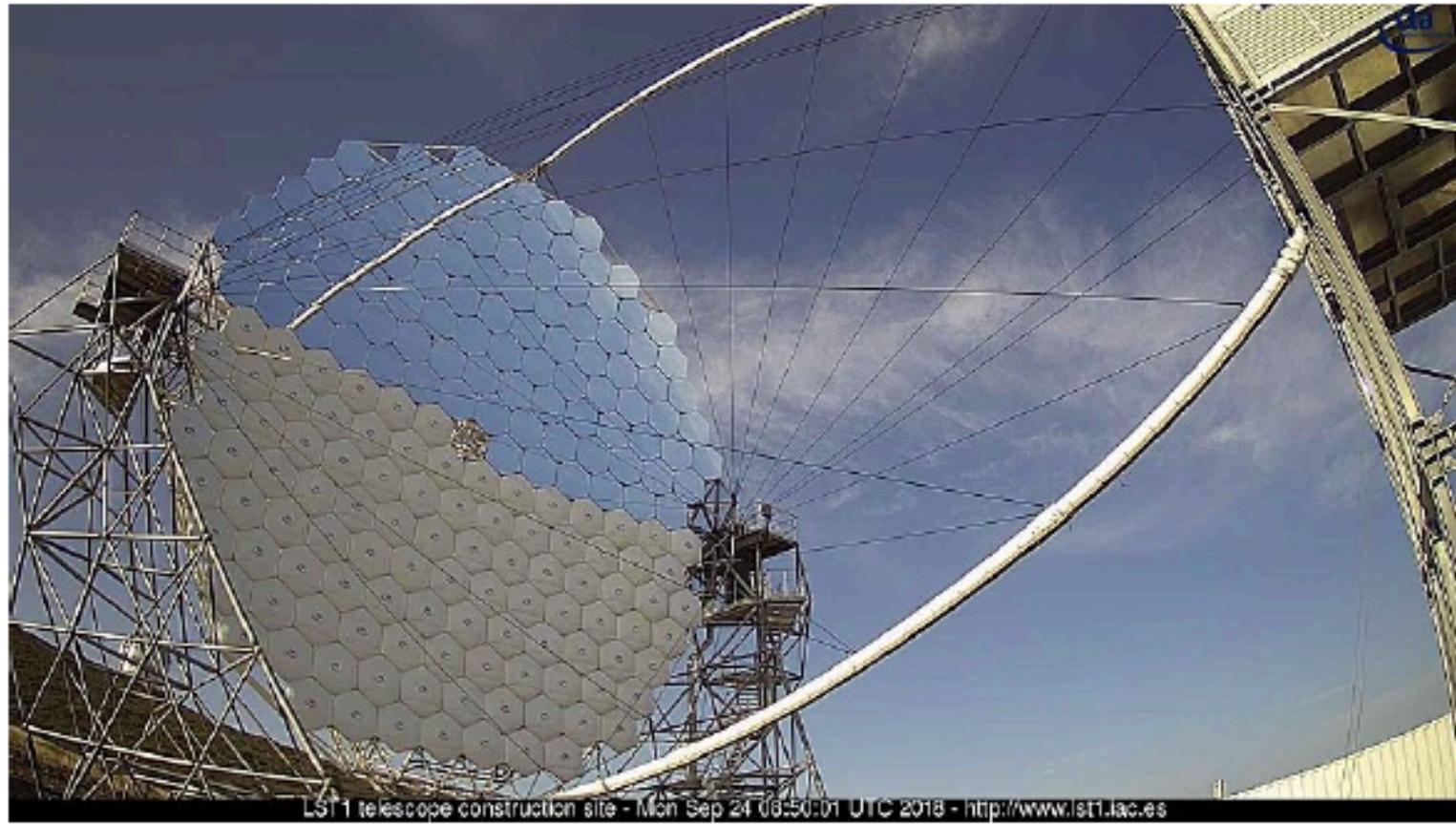
- Reflector
  - 23 m tesellated mirror
  - Quasi parabolic shape  $400 \text{ m}^2$
  - 28 m focal length
- Mirror facets
  - ~200 1.5 m spherical mirrors
  - 6 different radii
  - Cheap and light-weight (~50 kg)
  - Cold-slumped multi-layer sandwich
  - Multi-layer reflecting surface



- Active Mirror Control
  - Correct the reflector deformations
  - 2 actuators adjust mirror orientation
  - 1 CMOS camera observes IR laser as reference
- Auxiliary systems
  - Star-guider, displacement and PSF cameras
  - Calibration box
  - Optical Axis referece laser
  - Inclinometers ad distometers



- Uncovering the mirrors

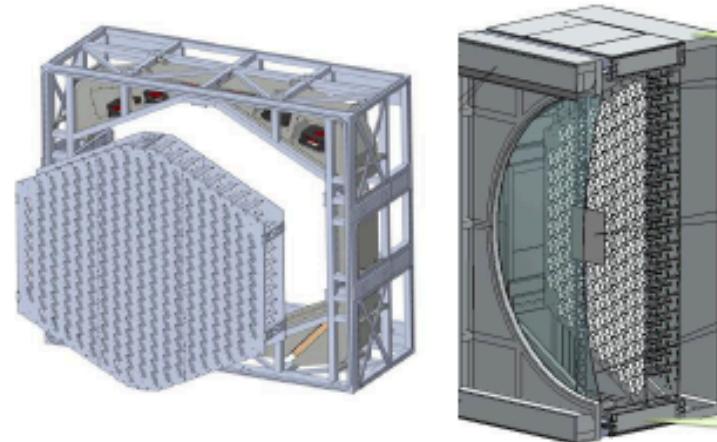


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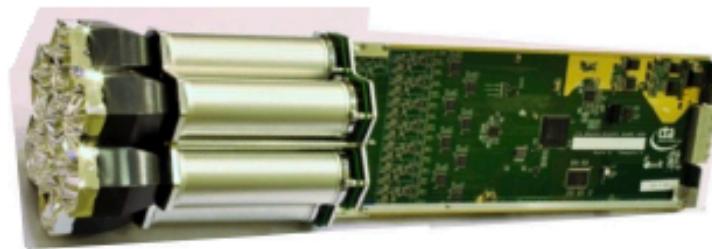
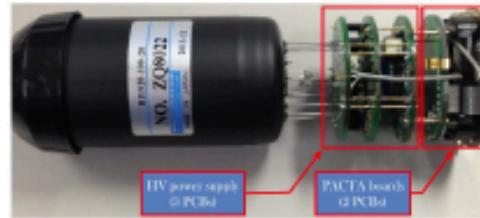
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- Mechanical structure
  - Light-weight ~3x3x2 m envelope with entrance window
  - Camera front plate modular design for clusters of 7 PMTs and readout
  - Backplane for trigger and data distribution
- Cooling
  - Cold fluid support front plate
  - Air-flow + heat-exchangers



- Focal plane
  - 1855 PMTs (QE ~0.4) with light concentrators and slow control
  - Wide dynamic range based on PACTA amplifier
  
- Readout and trigger
  - Based on DRS4 chip at 1 Gs/s
  - Analog sum-trigger in mezzanine board
  - Trigger and clock distribution in backplane
  - Stereo trigger of 4 LSTs





# Camera installed!



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# Computing and energy storage



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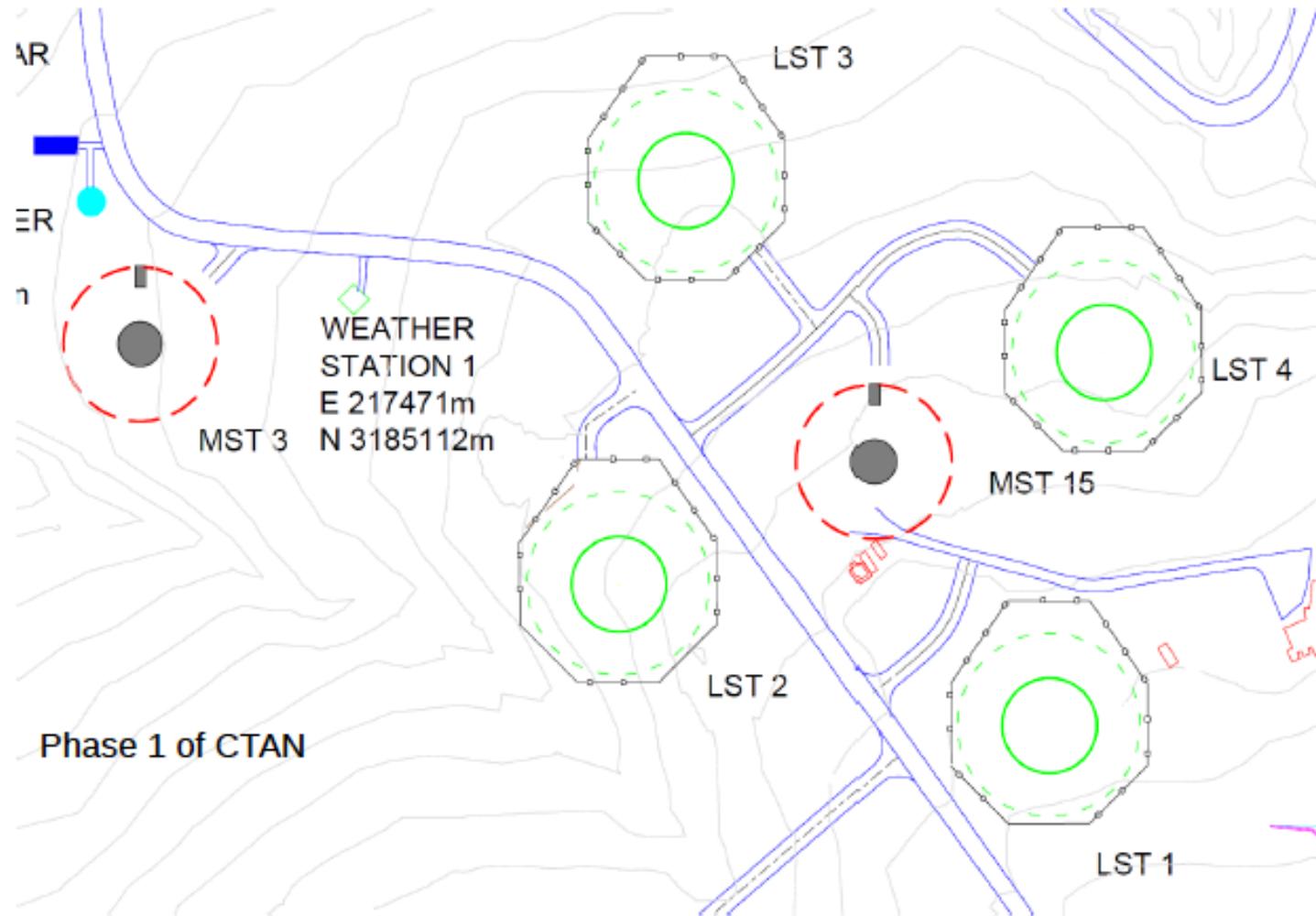
# Next steps with the LSTs at CTA-North observatory

- A local project office opened at the IAC to manage the Spanish FEDER funds.
- Preparing all tendering documents following the technical instructions of the working groups designing the different work packages.
- Close interaction with other institutes collaborating in erecting the telescopes.
- Close contact with the project office of CTAO.



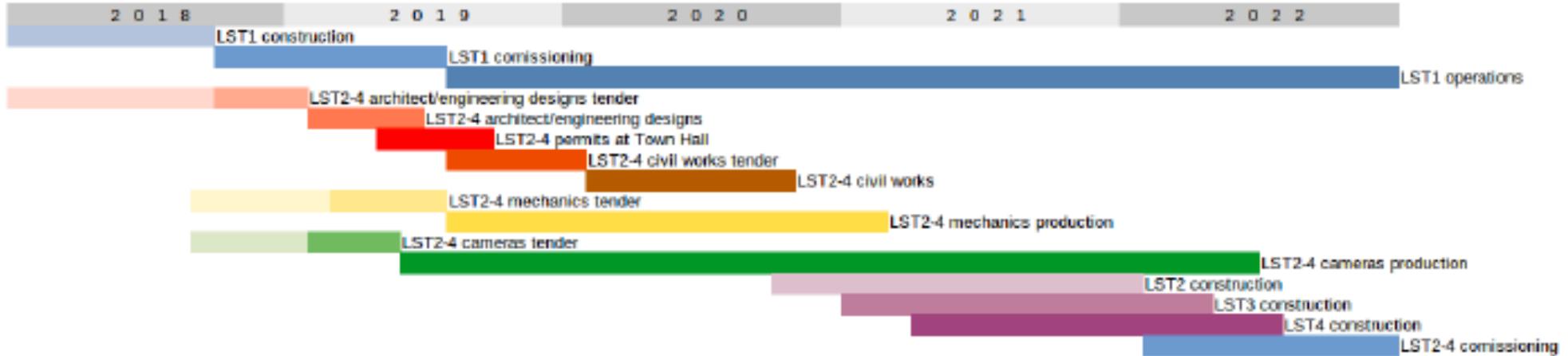
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# LST-2 to LST-4 locations



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# Next steps



- Open tenders for the Spanish contribution to LST-2, LST-3 and LST-4 shall be launched by IAC during 2019.
- Production and installation will be coordinated with other main contributors of the project.



## Next steps

- There are, still, a lot of things to do. Not only on the technical side.
- It will not be easy to satisfy the calendar associated with the Spanish FEDER funds.
- All of the partners in the project have their own constraints in funding and construction.
- Unpredictable things will happen...

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But, we are a team engaged in  
this project!



**El primer LARGE SIZE TELESCOPE de la red de telescopios Cherenkov financiado por:**

The first **LARGE SIZE TELESCOPE** of the Cherenkov Telescope Array funded by:



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This is the first step of CTA!  
Thanks



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