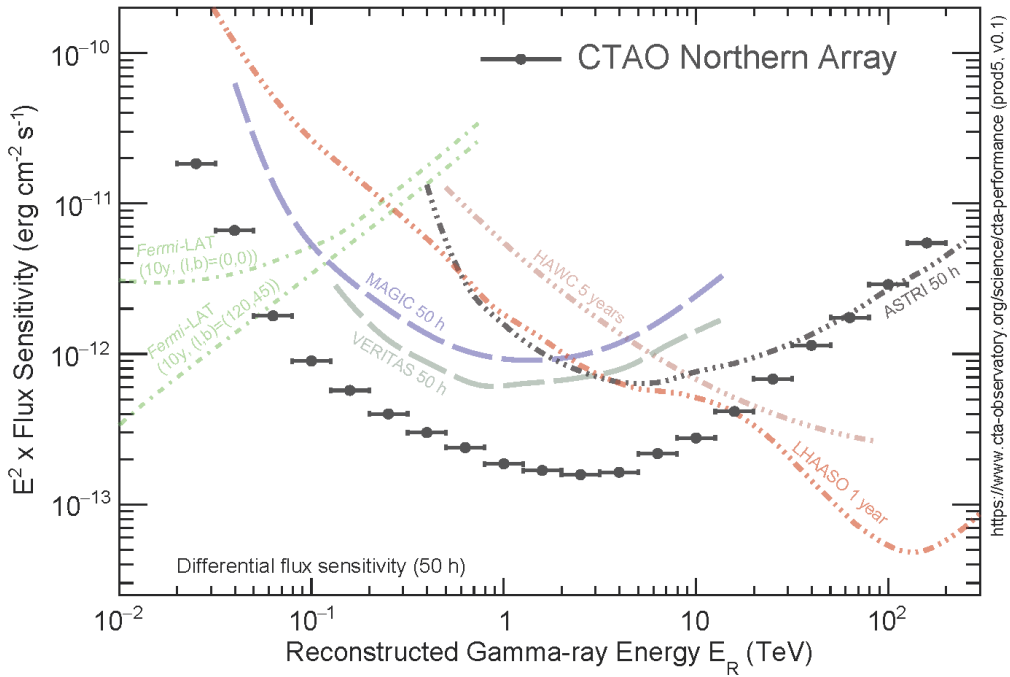


# Status, performance and results of the Large-Sized Telescope prototype for the Cherenkov Telescope Array

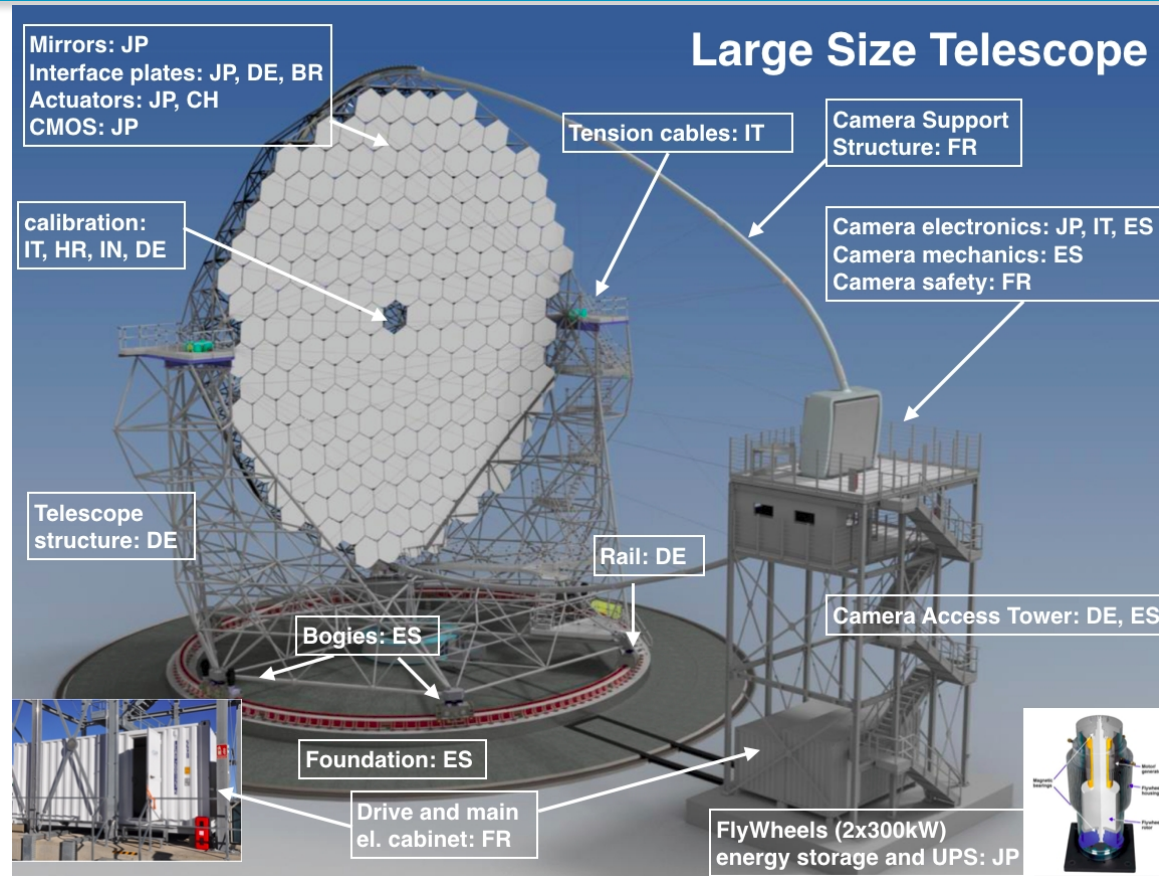
Daniel Kerszberg (IFAE-BIST) for the CTA LST project

# The LSTs of CTA

- CTA will consist of 2 sites:
  - La Palma, Spain.
  - Paranal, Chile.
- And 3 telescope types:
  - SST: Small-Sized Telescope
  - MST: Medium-Sized Telescope
  - LST: Large-Sized Telescope
- The LSTs are designed to cover the lowest energies.



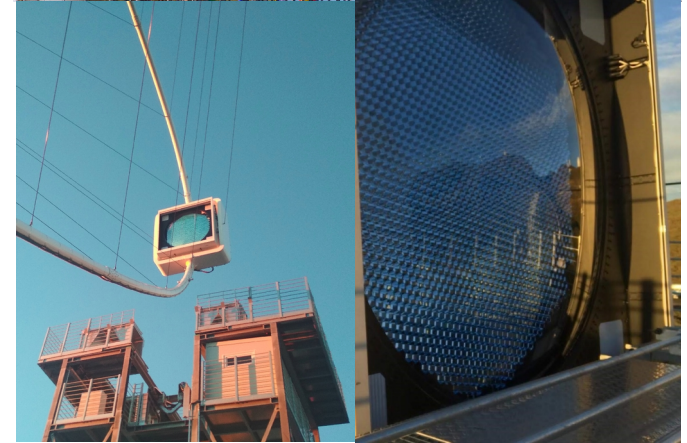
# LST design



# LST characteristics



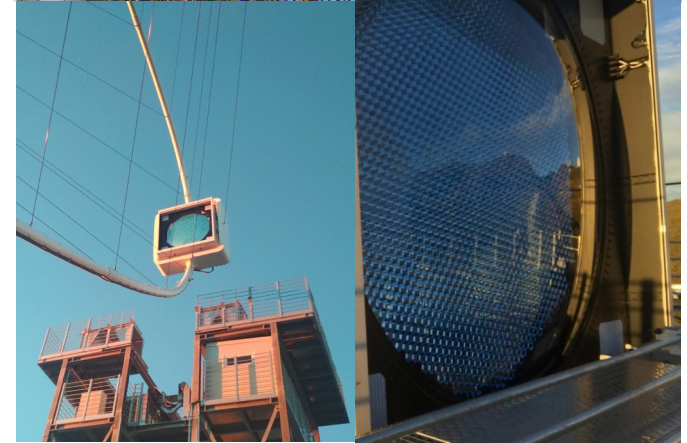
- Optics:
  - Parabolic primary mirror of 23 m diameter and 28 m focal length.
  - Primary dish made of 198 hexagonal segments.
  - Effective mirror area is 368 m<sup>2</sup>.
- Focal plane:
  - Made of 1855 PMTs.
  - Pixel field of view of 0.1°.
  - Total field of view of 4.5°.



# LST characteristics



- Structure:
  - Alt-az mount.
  - Maximum time for repositioning is 20 seconds.
  - Total weight of the telescope is ~120 tons.



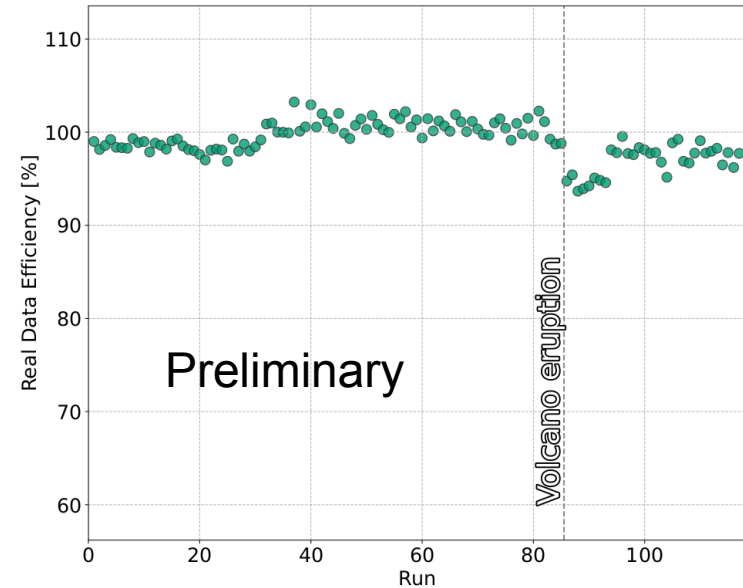
- First telescope built on the CTA-North site (La Palma, Spain).
  - Inaugurated end of 2018.
  - Commissioning trough/despite pandemic, volcanic eruption, electronic components and shipment crises...
  - Taking scientific data since January 2020.
    - More than 800 hours of data accumulated already.
- Performance evaluation and first science results!



# LST-1 performance: optical efficiency

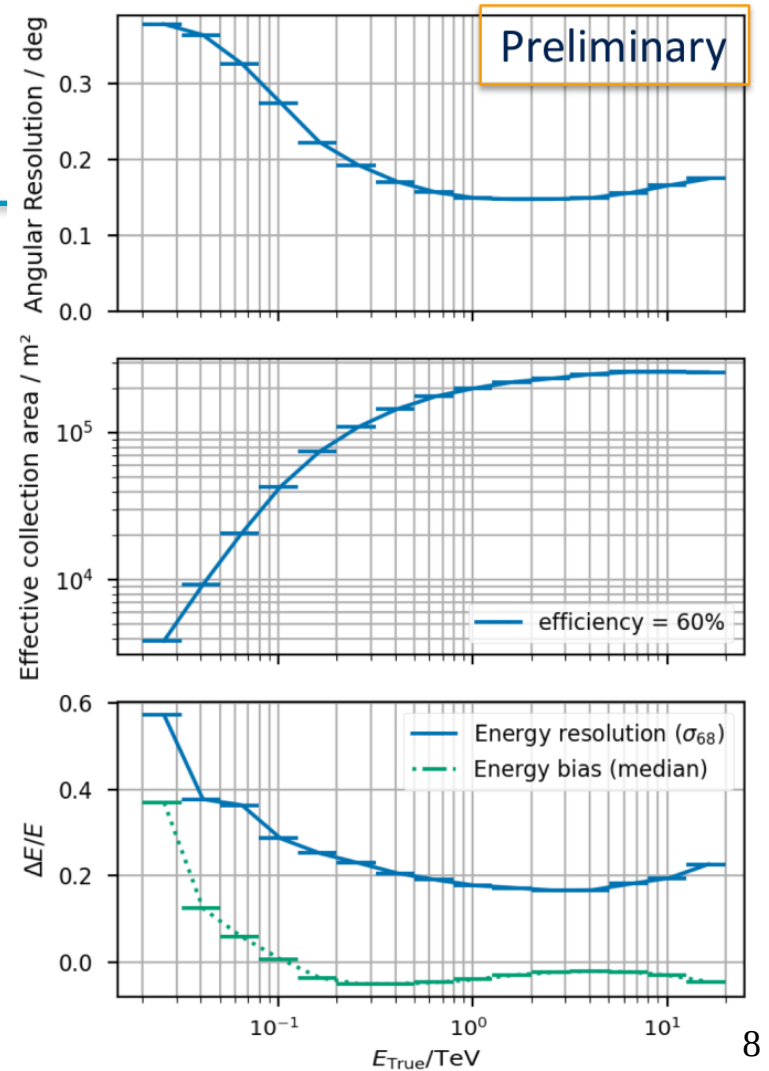


- “Optical efficiency” includes both mirror reflectivity and mirror focusing.
- It’s stable from November 2020 to March 2022:
  - maximum spread of 8%.
  - much of the variation is due to measurement uncertainties and episodes of dust deposition.
- No long-term effect of volcano: rain cleaned mirrors of volcanic ash.



# LST-1 performance: effective area, angular and spectral resolution

- Here:
  - zenith angle = 10deg
  - gamma-ray efficiency = 60% (due to gammaness cut)
- Effective area  $>10^3$  m<sup>2</sup> down to  $\sim 20$  GeV.
- LST-1 is a single telescope so one cannot expect a great angular or spectral resolution. Still they are competitive down to 100 GeV.

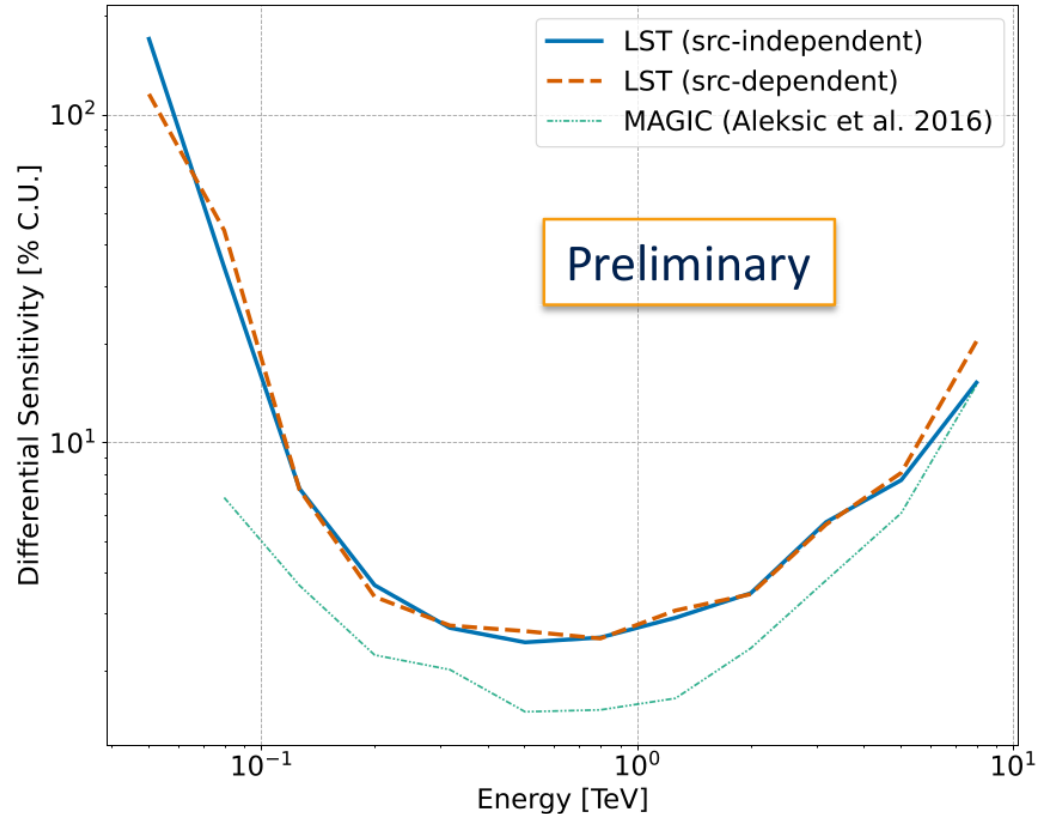




# LST-1 performance: sensitivity



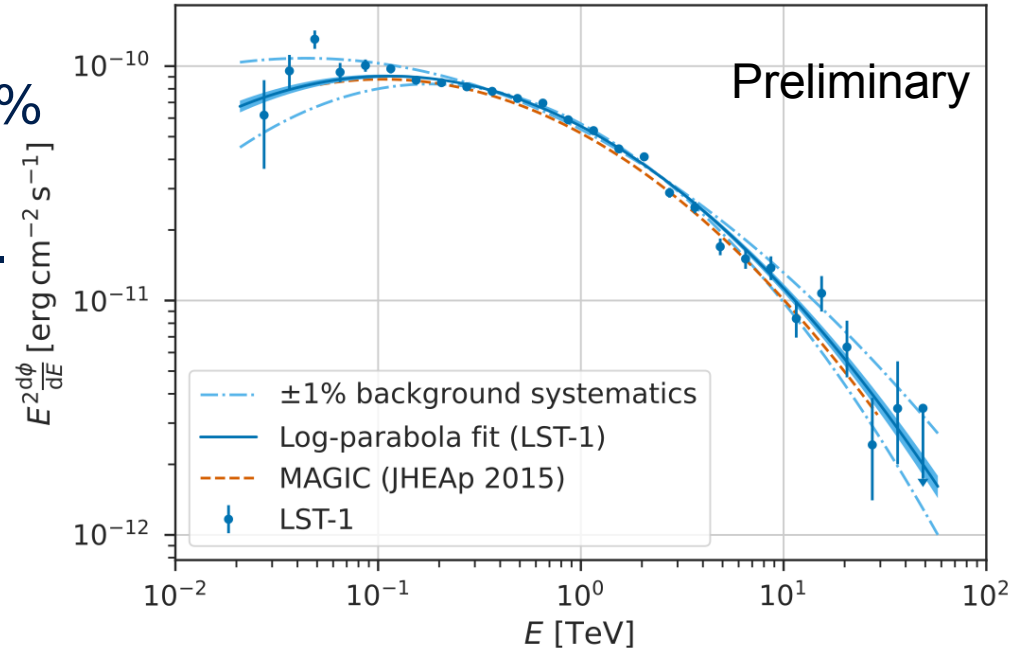
- Consistent sensitivity for source-dependent and source-independent analyses.
- Extending down to  $\sim 50$  GeV.



# Crab Nebula spectrum



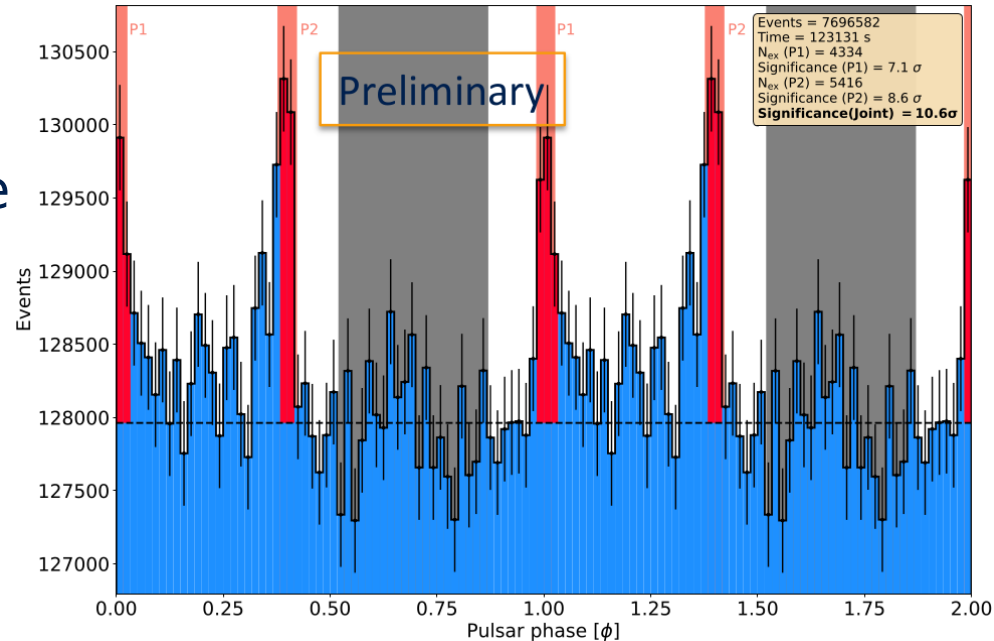
- 34.2 hours of effective time
- Gamma-ray efficiency: 70% from gammaness cut and 70% from  $\theta^2$  cut
- Error bars are only statistical.
- Systematic errors: blue lines correspond to the effect of  $\pm 1\%$  background.
- Consistent with MAGIC and Fermi-LAT.
- Lowest data point at 25 GeV!



# Crab pulsar phaseogram



- Data from Nov 2020 to March 2022
- Data selection: cut in rate + no technical issues (more strict than previous analyses)
- Highly significant detection down to few tens of GeV.
- P1/P2 ratio tends to 1 at low energies

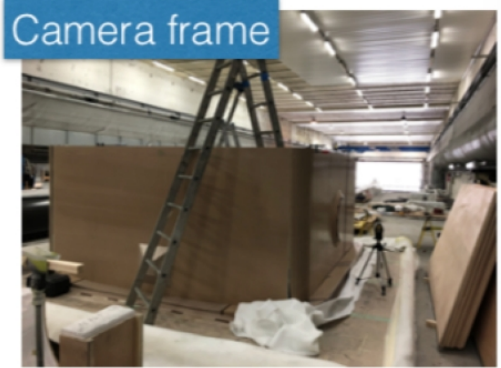
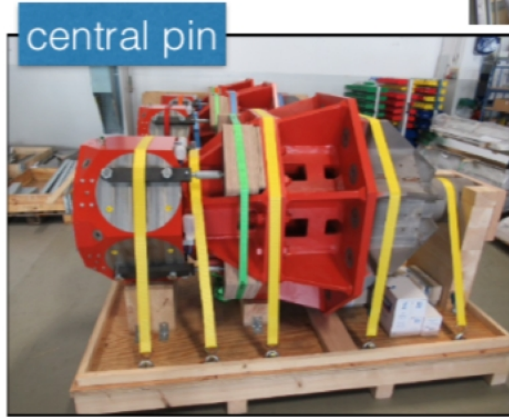
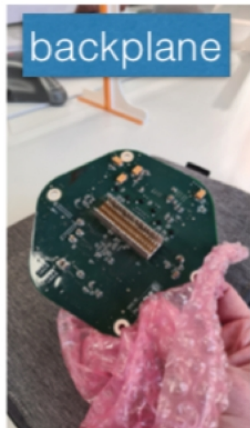


# Science results with the LST-1



- Performance paper to be published soon, including results shown here and more.
- ~800 hours of data taken since 2020 on many sources:
  - RS Ophiuchi      Talk by Y. Kobayashi (Thu. 11<sup>th</sup> at 16:50)
  - LHAASO J2108+5157      Talk by J. Jurysek (Wed. 10<sup>th</sup> at 16:10)
  - AGNs: BL Lac (including a strong flare in 2021!), Mrk 421 and 501, 1ES 1959+650, PG 1553+113...
  - Transients      Talk by D. Green (Tue. 9<sup>th</sup> at 15:50)
- Several publications planned on these observations.

# Next 3 LSTs in CTA-North





# Next 3 LSTs in CTA-North

tensioning cable parts



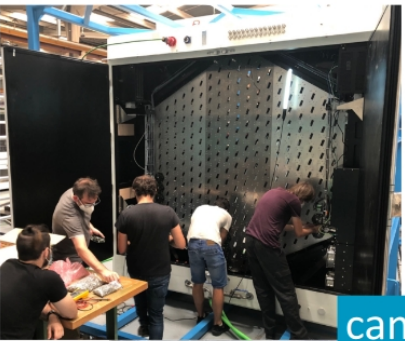
camera access tower



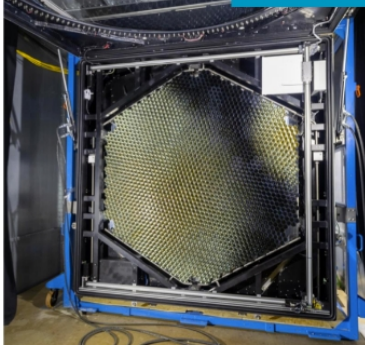
Elevation drive



cameras



camera arch



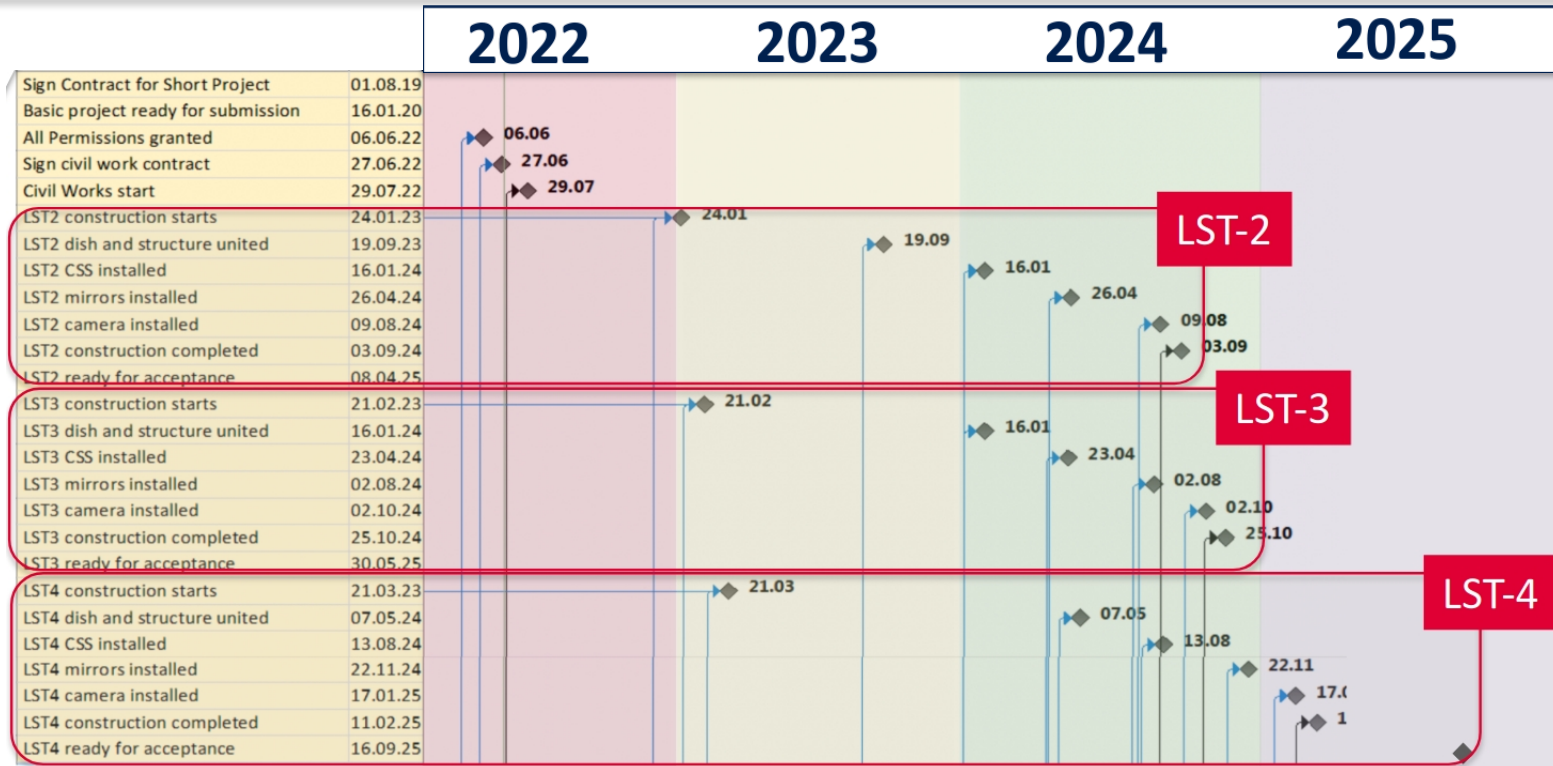
# Next 3 LSTs in CTA-North



- Almost all parts manufactured and stored, ready for installation.
  - Most of them already in La Palma.
  - Few parts missing, e.g. mirror actuators.
  - LST-2 camera already integrated (arrived in the Canaries in July of this year), LST-3 camera currently being integrated, LST-4 camera to follow end of 2022/beginning of 2023.
- Next steps on site:
  - Environmental study approved end of June, permit for construction coming soon.
  - Civil work about to start (time scale of a few weeks).



# LST2-4 schedule in CTA-North



- + a few weeks of delay due to construction permit.

- LSTs allow the detection of the lowest energies, in CTA-South especially relevant for:
  - GRBs, AGN flares, transients.
  - Dark Matter searches.
- No LSTs included in the “alpha” configuration but our Italian colleagues (INAF+INFN) have secured fundings for 2 LSTs.
  - Manufacturing of the telescope parts must happen before the end of 2025.
- The goal is still to build all 4 telescopes!

# Conclusions



- The prototype telescope LST-1 was installed on the CTA-North site (La Palma, Spain) in 2018.
  - Performances of the telescope within requirements.
  - Taking scientific data since 2020.
  - First papers, starting with performance paper, to be published soon.
- Construction and commissioning of remaining LSTs in CTA-North (LST-2 to LST-4) should be complete by 2025.
  - Production of all parts almost completed, assembly of all the cameras to be completed by beginning of 2023.
  - Civil works to start in the next weeks.
- Funding secured for 2 LSTs in CTA-South.