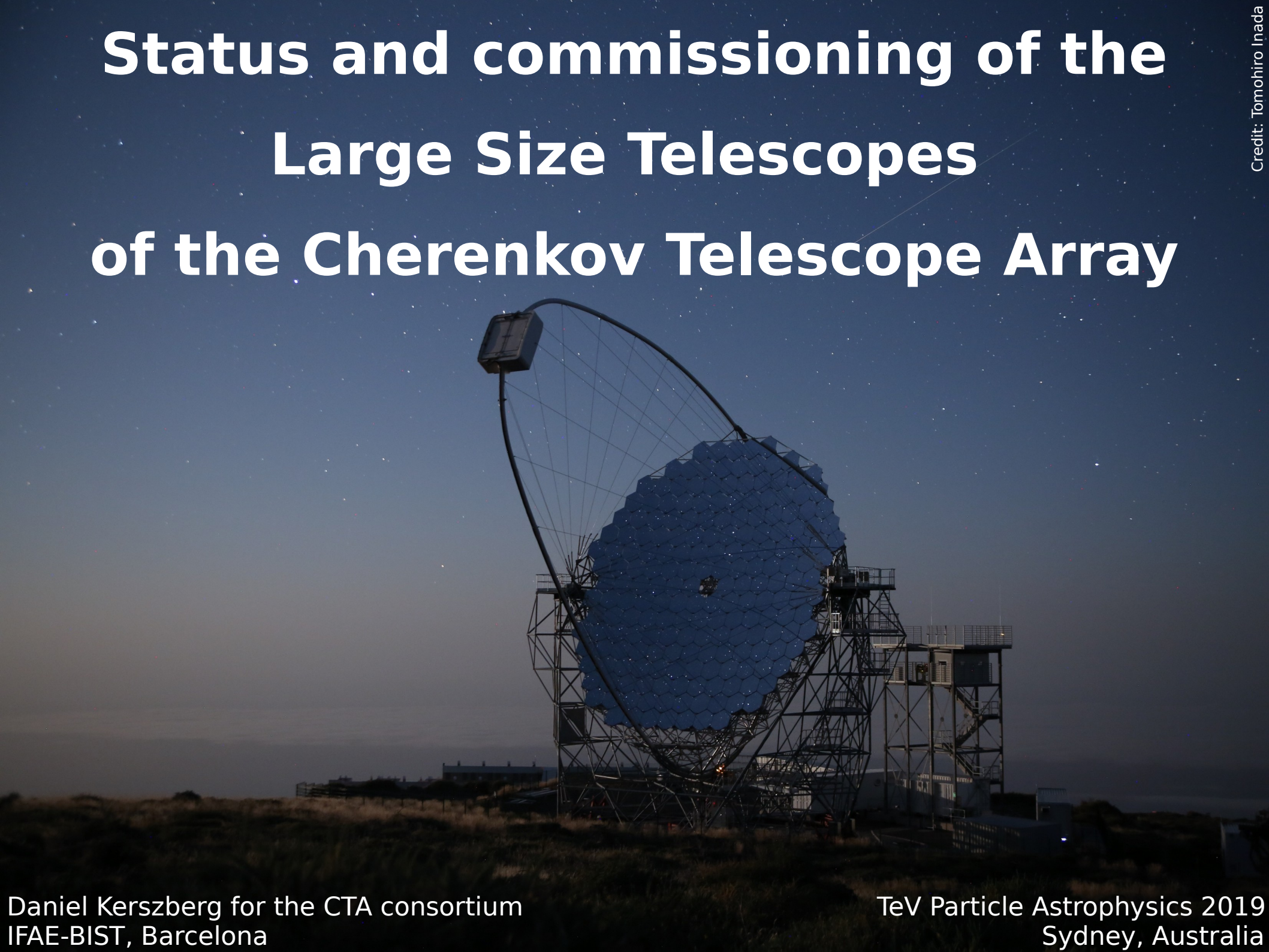
# Status and commissioning of the Large Size Telescopes of the Cherenkov Telescope Array

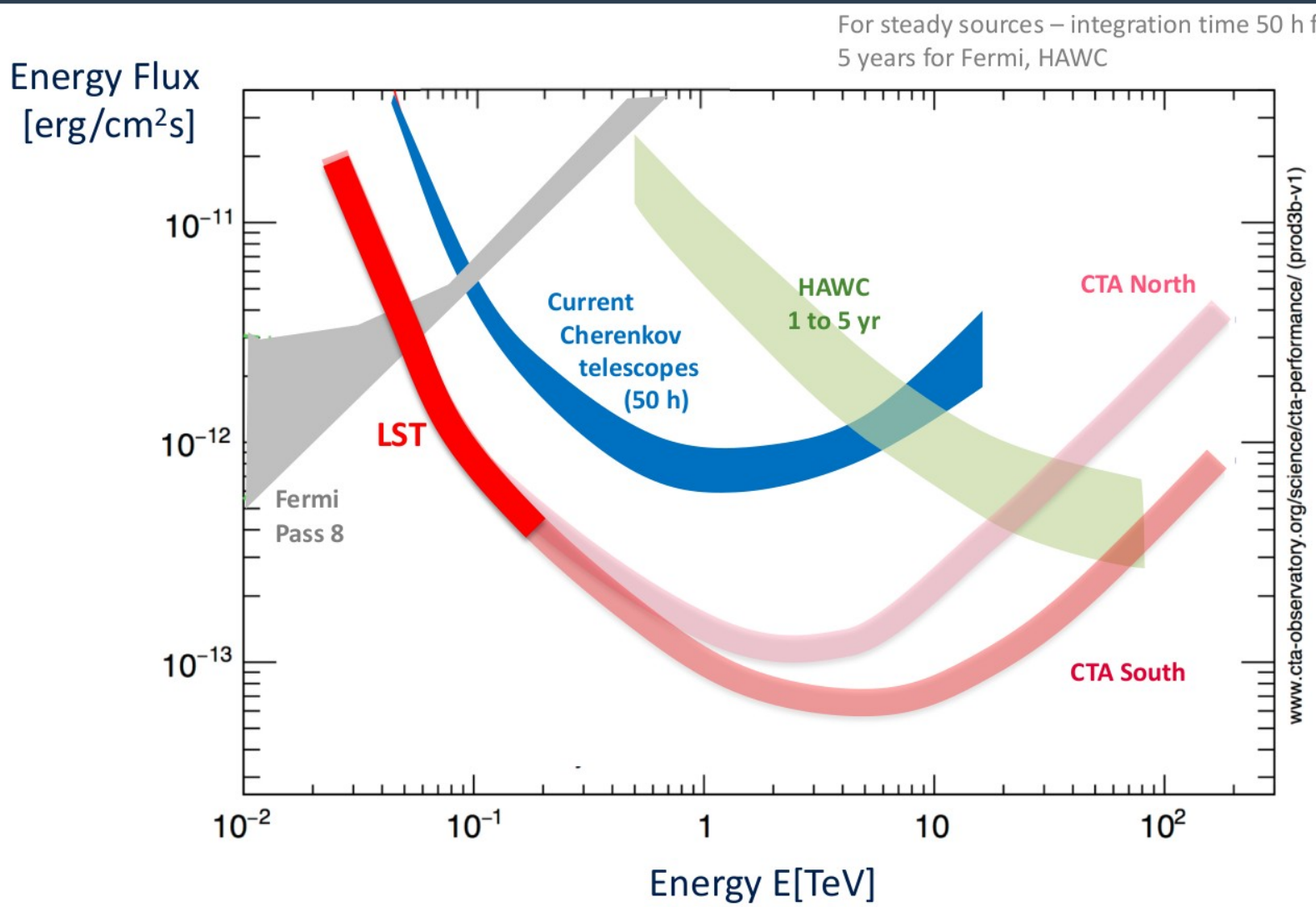


Credit: Tomohiro Inada

Daniel Kerszberg for the CTA consortium
IFAE-BIST, Barcelona

TeV Particle Astrophysics 2019
Sydney, Australia

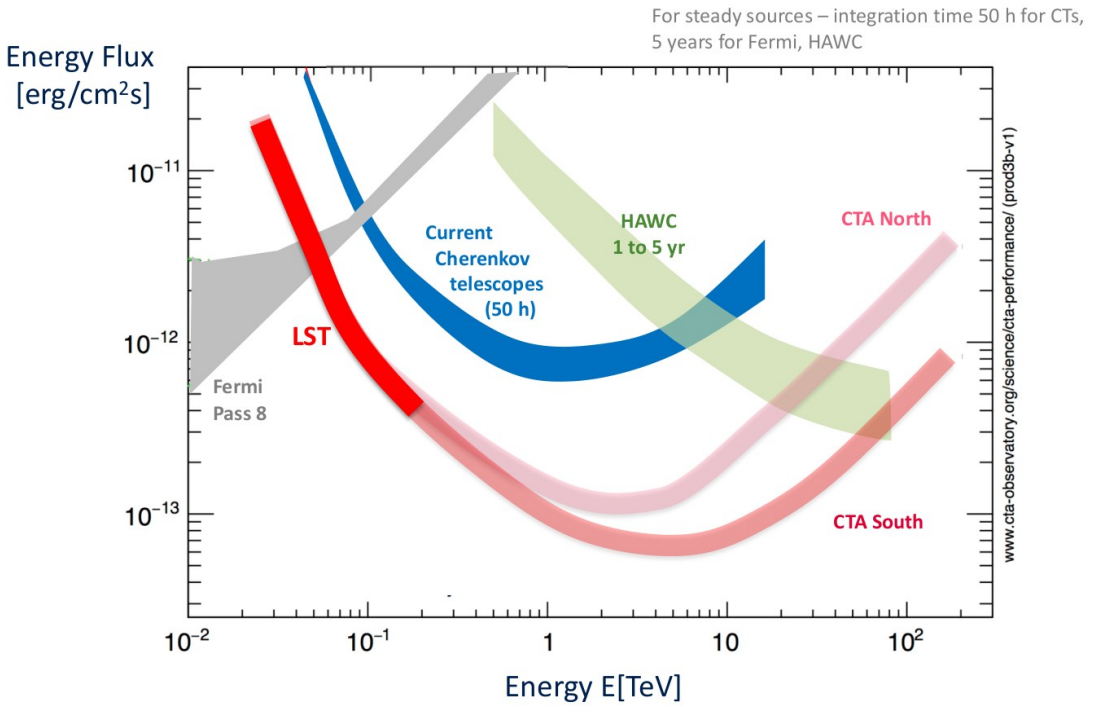
# CTA Large Size Telscopes (LSTs)




- **More on CTA in tomorrow's presentation by Roberta Zanin**

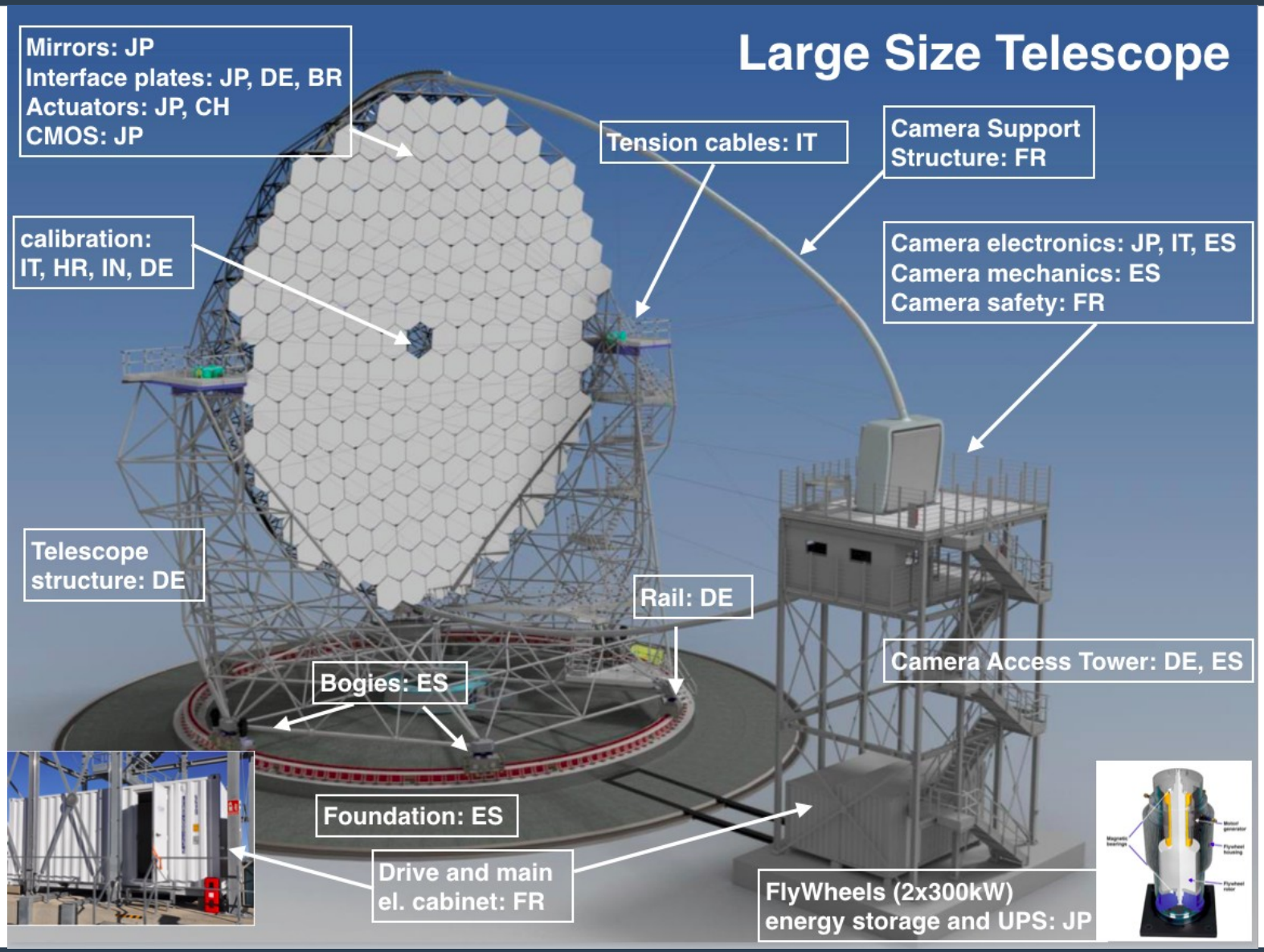
# CTA Large Size Telscopes (LSTs)

- **Science case for the LSTs:**
  - Transients:
    - GRBs
    - AGNs
    - Binaries
  - Pulsars
  - Extragalactic Background Light




- **Fast repositioning and large collection area is required!**

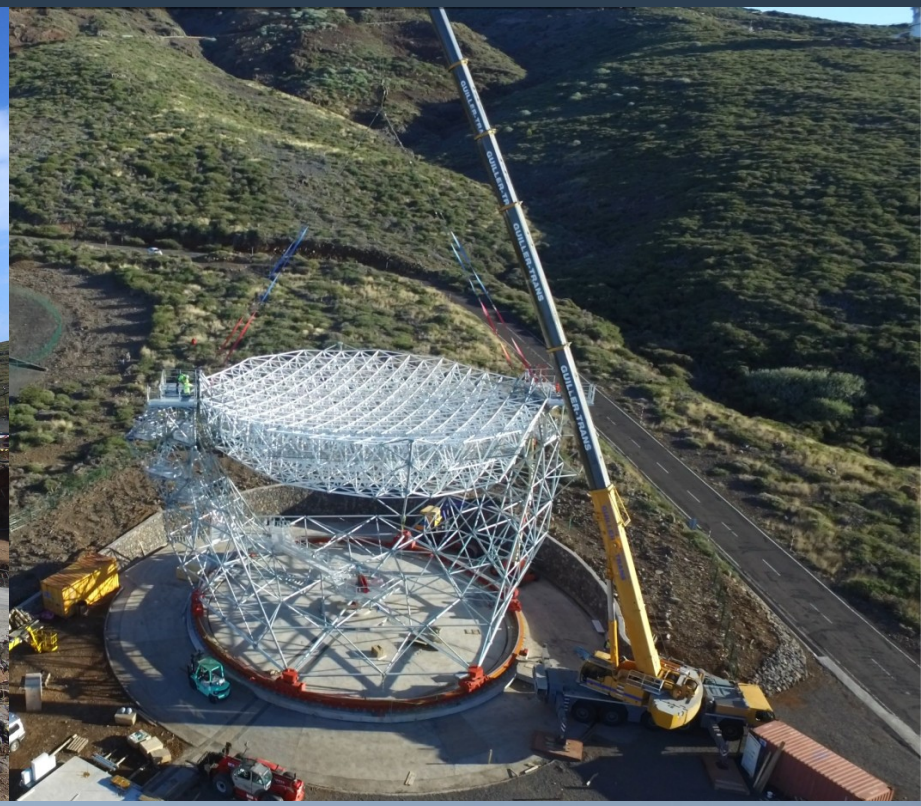
# LST design


Large Size Telescope
Mirrors: JP
Interface plates: JP, DE, BR
Actuators: JP, CH
CMOS: JP
Tension cables: IT
Camera Support Structure: FR
calibration: IT, HR, IN, DE
Camera electronics: JP, IT, ES
Camera mechanics: ES
Camera safety: FR
Telescope structure: DE
Rail: DE
Camera Access Tower: DE, ES
Bogies: ES
Foundation: ES
Drive and main el. cabinet: FR
FlyWheels (2x300kW) energy storage and UPS: JP

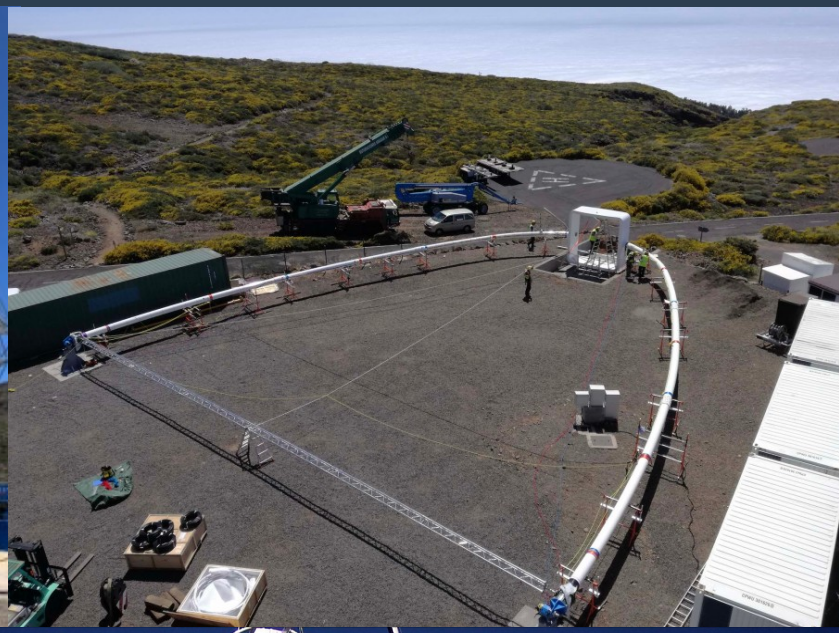
# LST characteristics

- **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 m²
- **Focal plane:**
  - Made of 1855 PMTs
  - Pixel field of view of 0.1°
  - Total field of view of 4.5°
- **Structure:**
  - Alt-az mount
  - Maximum time for repositioning is 20 seconds
  - Total weight of the telescope is ~120 tons

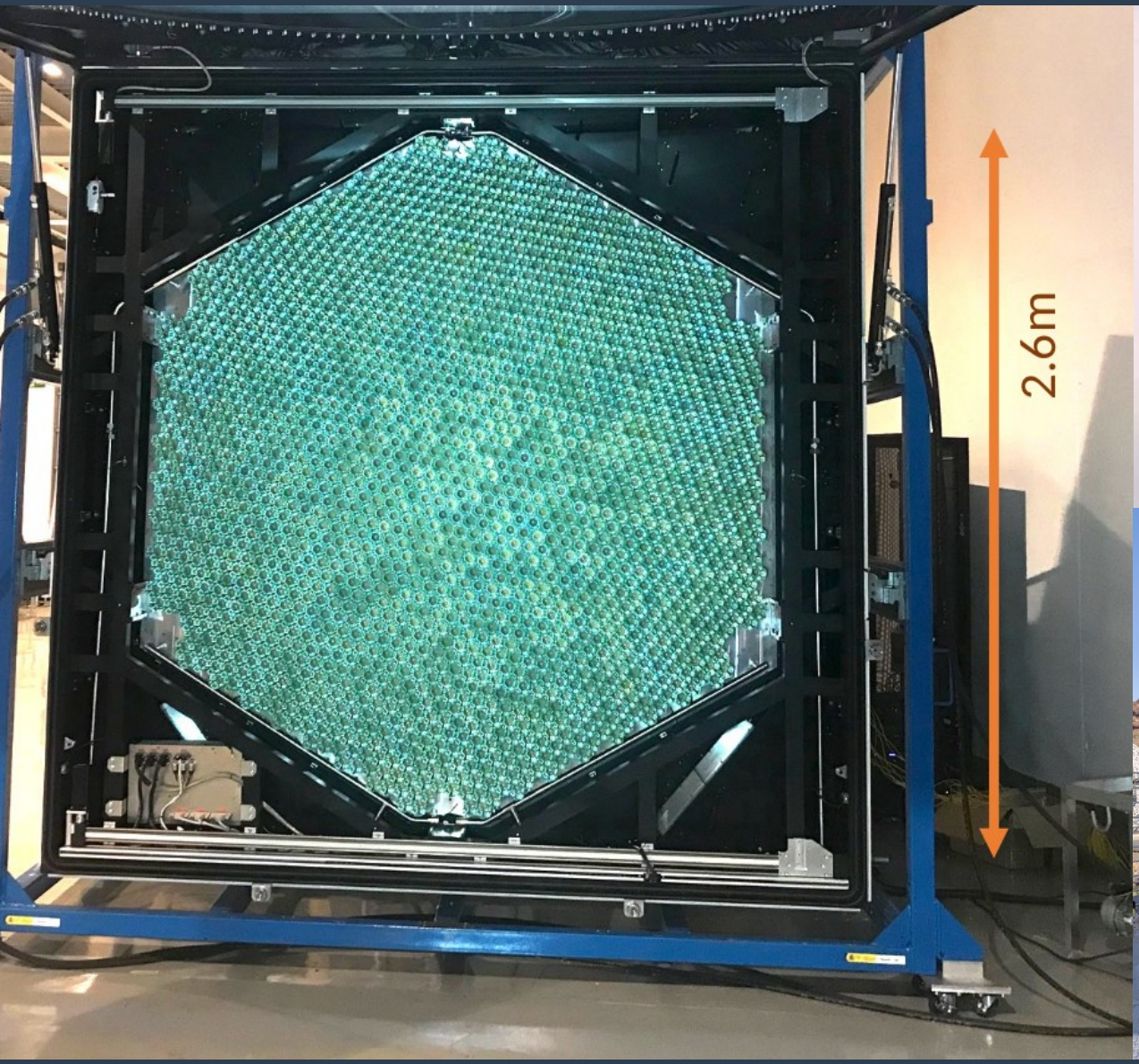
# First LST (LST1) construction

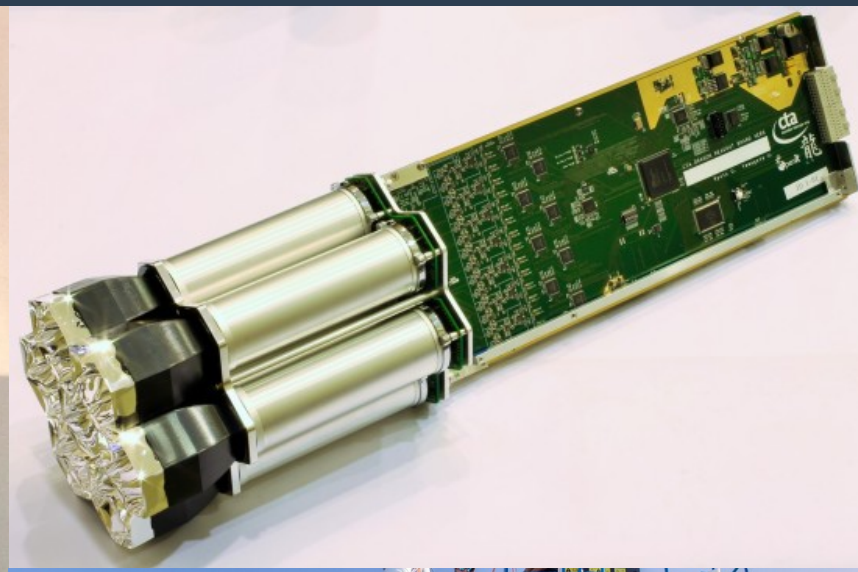


# Mirrors and arch installation



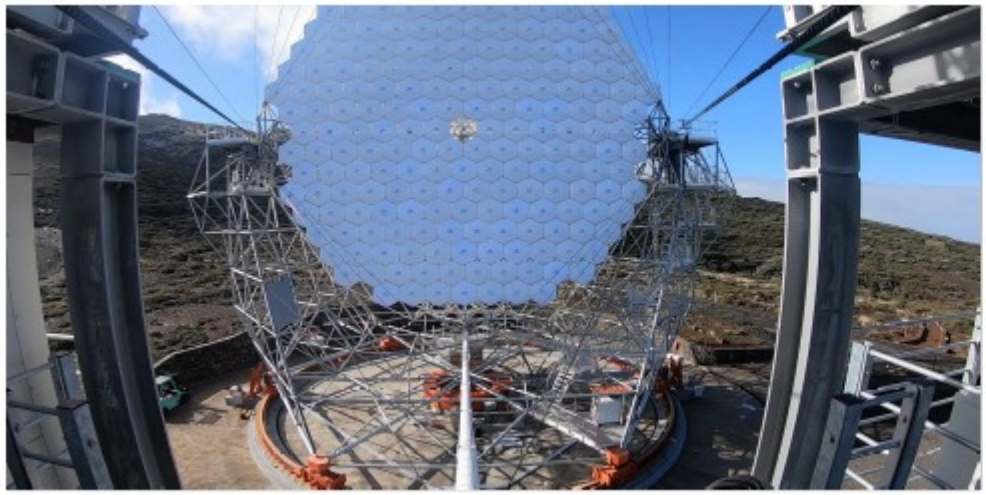
# Camera integration and installation



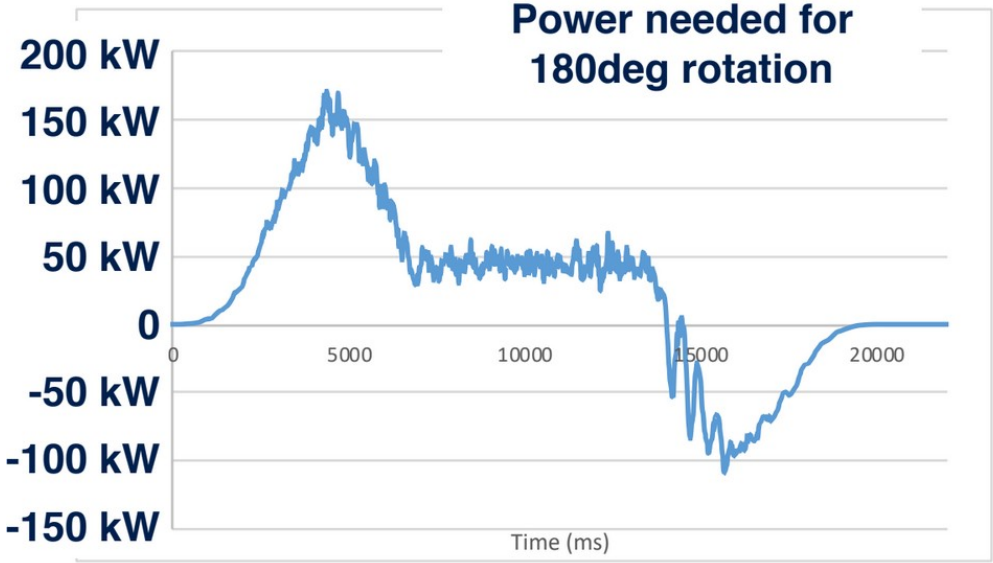



# Inauguration on 10th October 2018

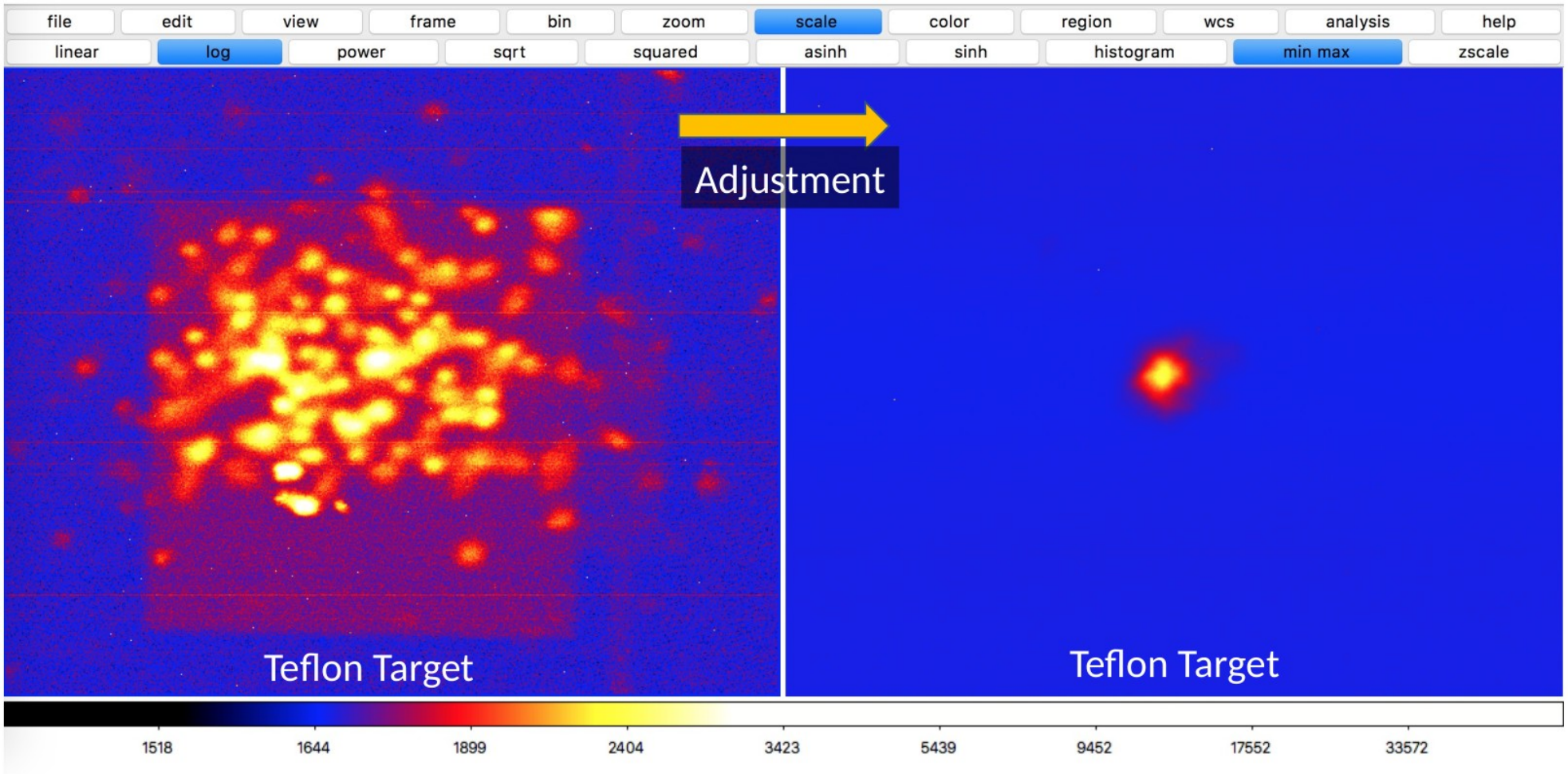
# LST1: Fast repositioning



- **20 seconds for 180° rotation in azimuth (33 seconds for 360°)**
- **Drive speed regulation working as expected**
- **Emergency stops tested and correctly handled**
- **Fulfills the requirements**

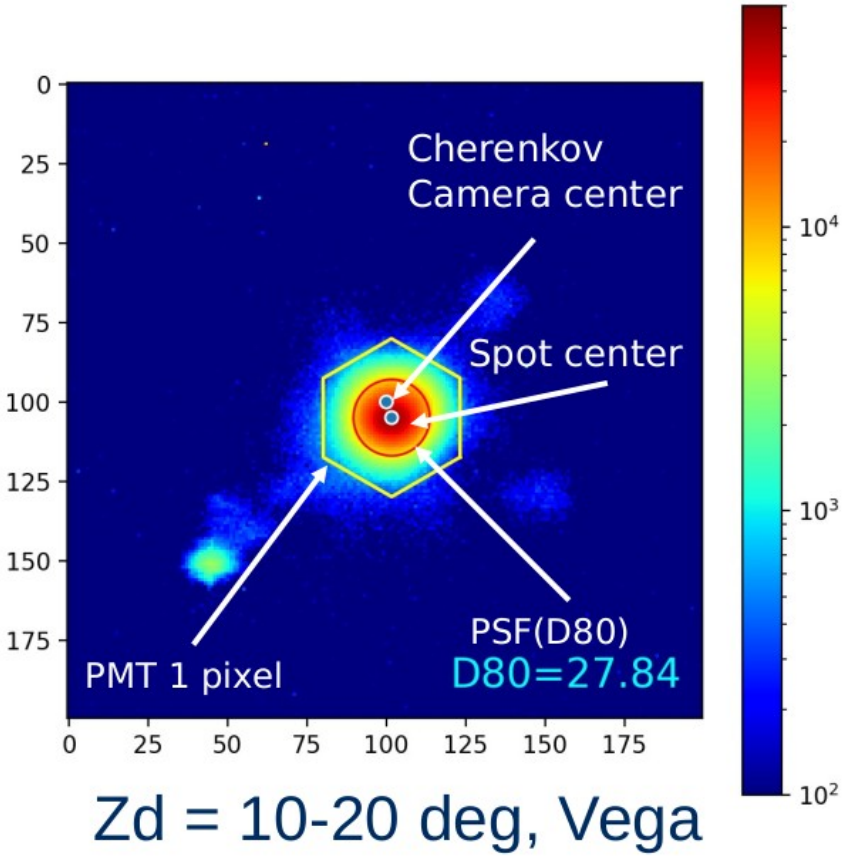


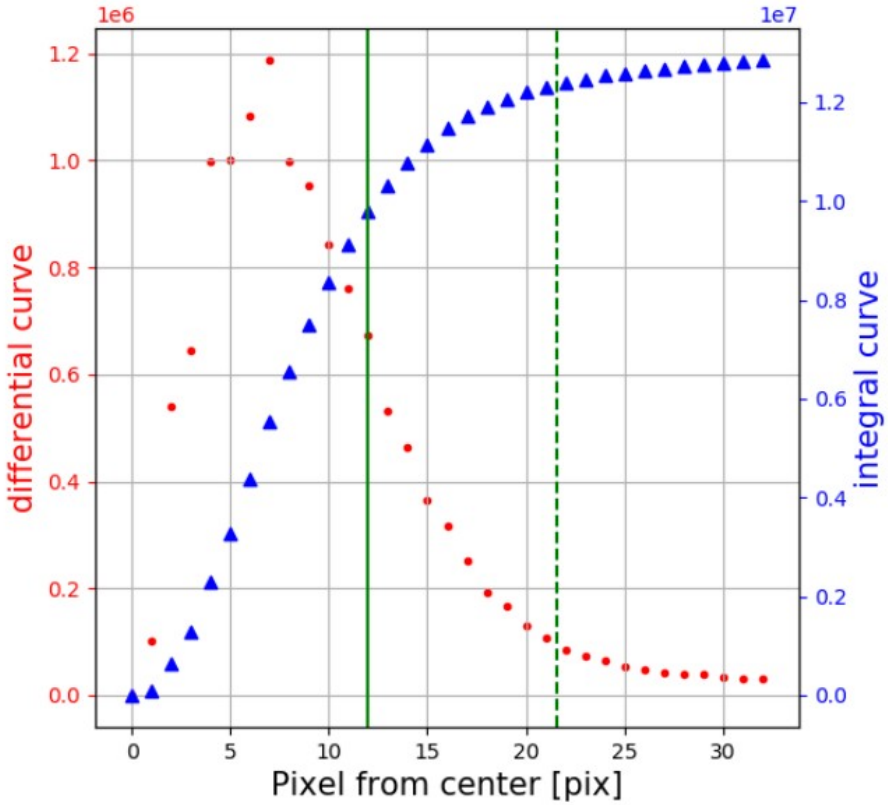
# LST1: Active Mirror Control




- **Active Mirror Control (AMC) allows to focus and defocus the mirrors for observations at night and safety reasons during day time respectively**

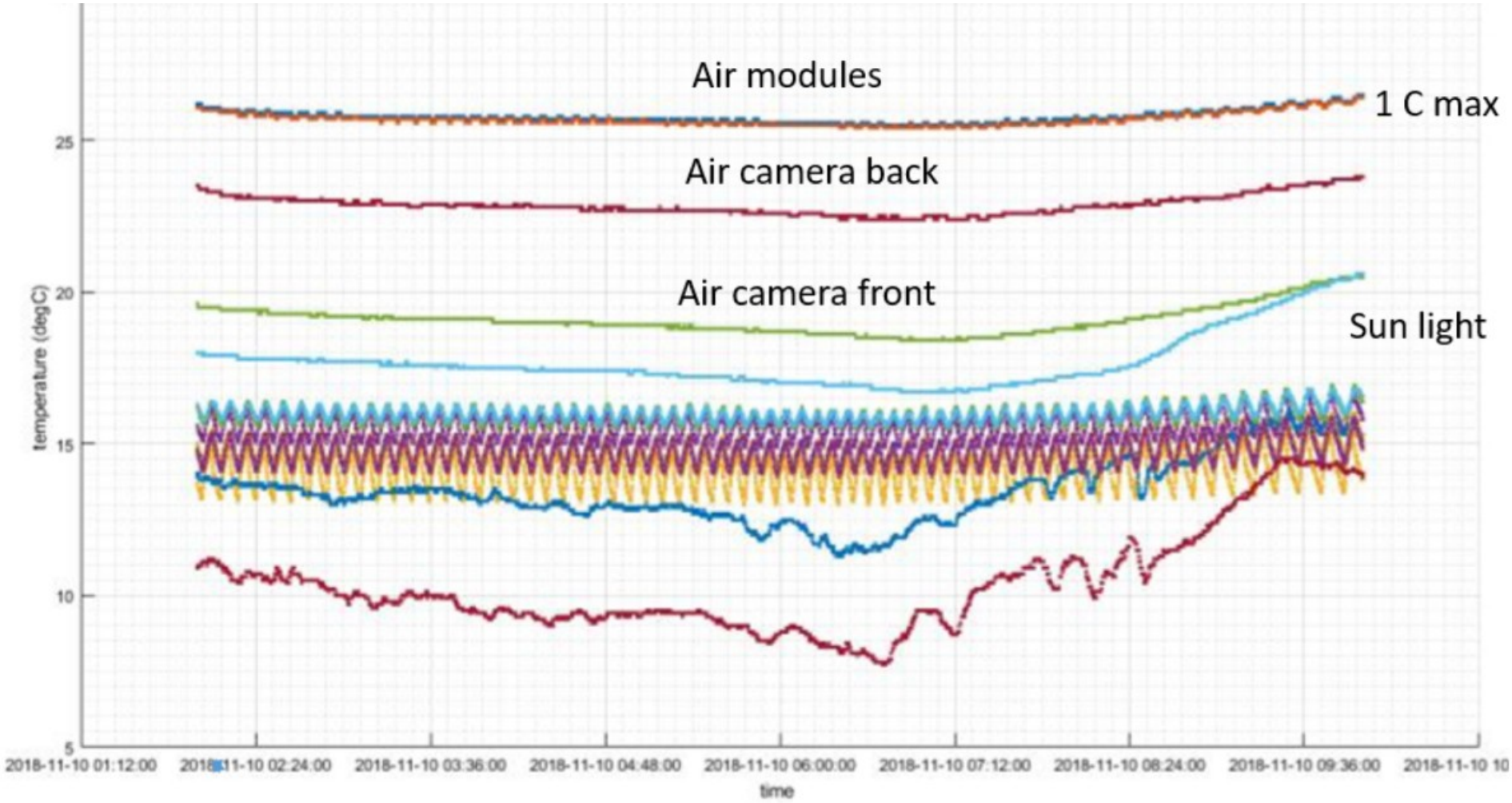
# LST1: Point Spread Function



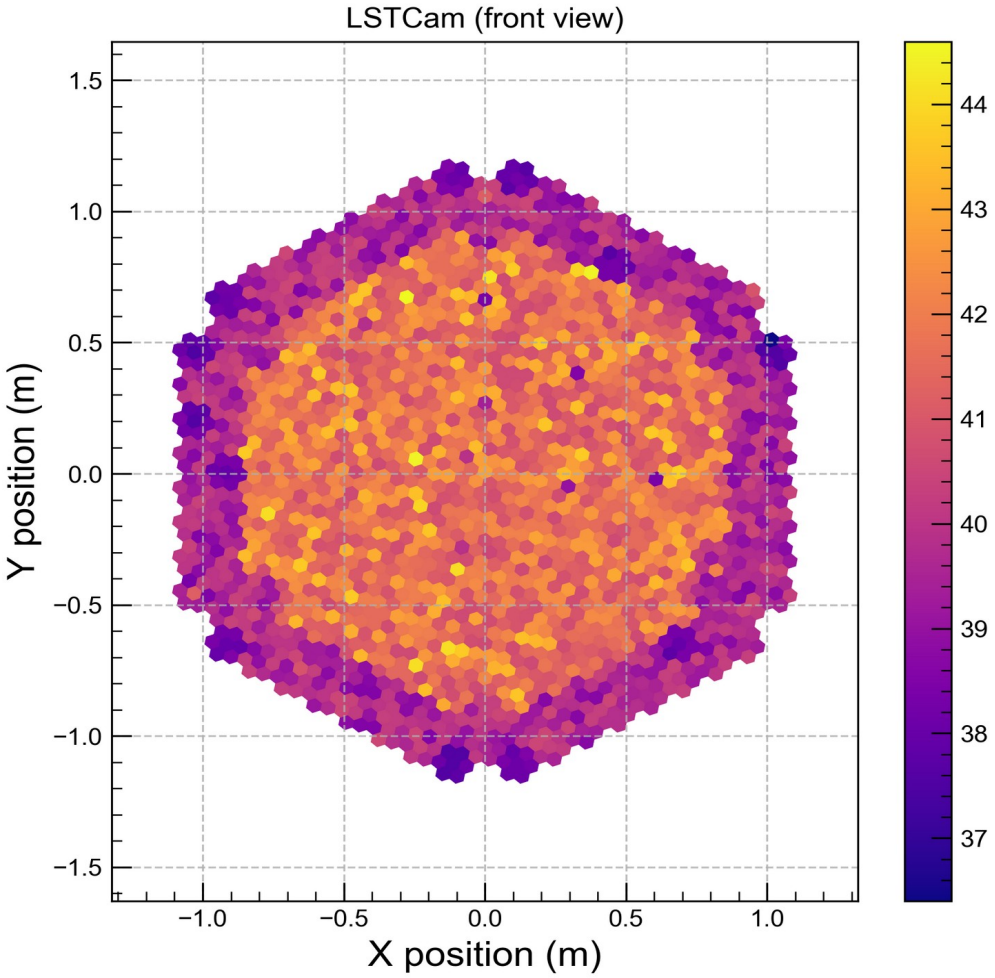

- **D80 is 27.84 mm (~0.055°)**
- **Needs further fine tuning to reach requirement D80 < 25 mm (~0.05°)**

# LST1: Camera thermalization

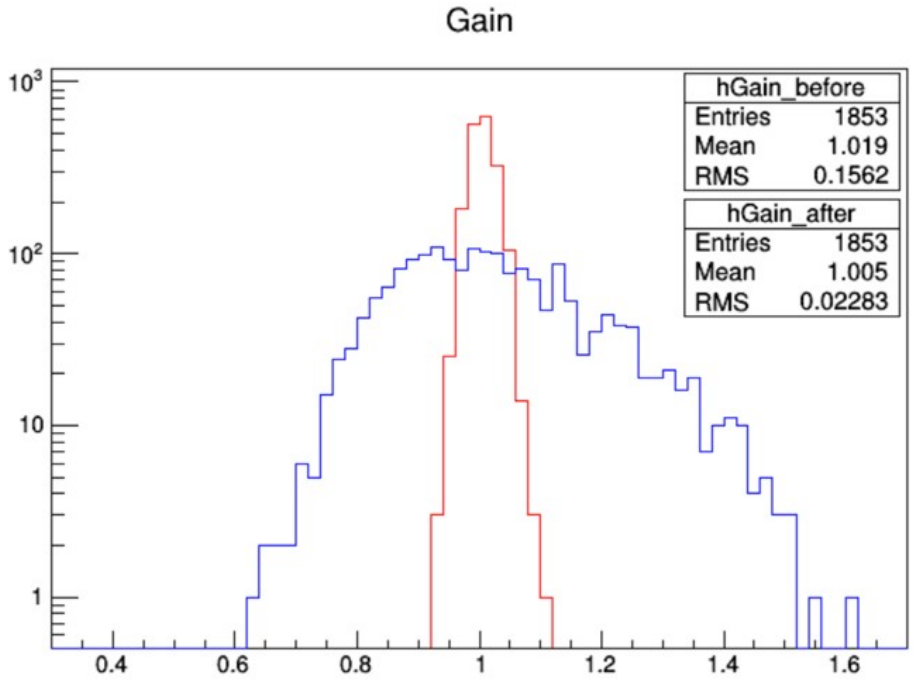



- **Temperature near PMTs is stable within 1 °C during operation**

# LST1: Charge flatfielding

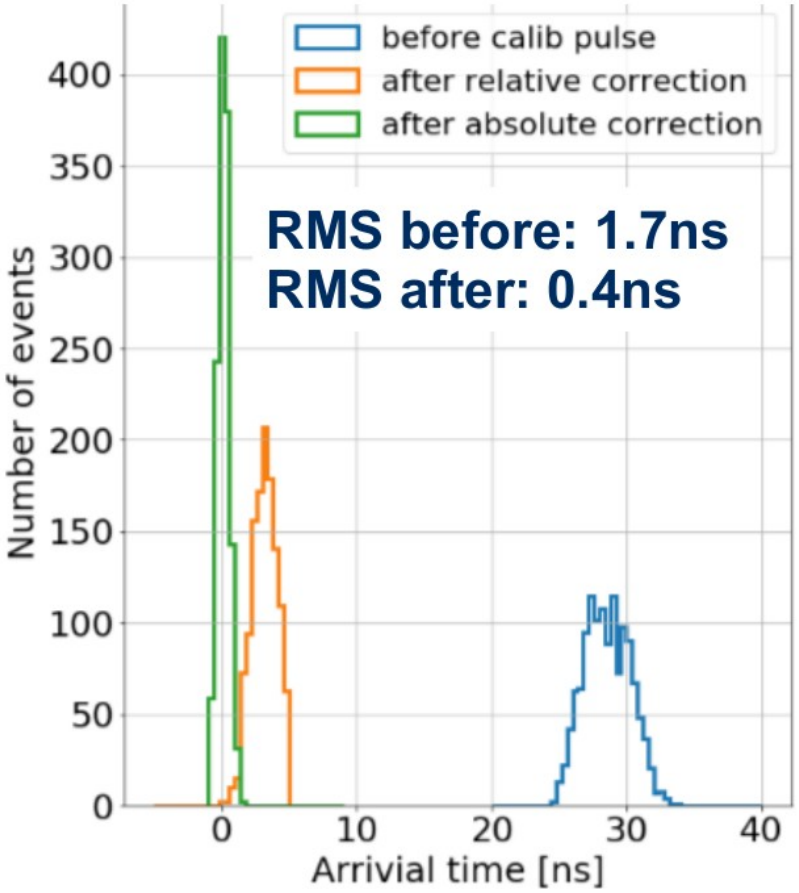


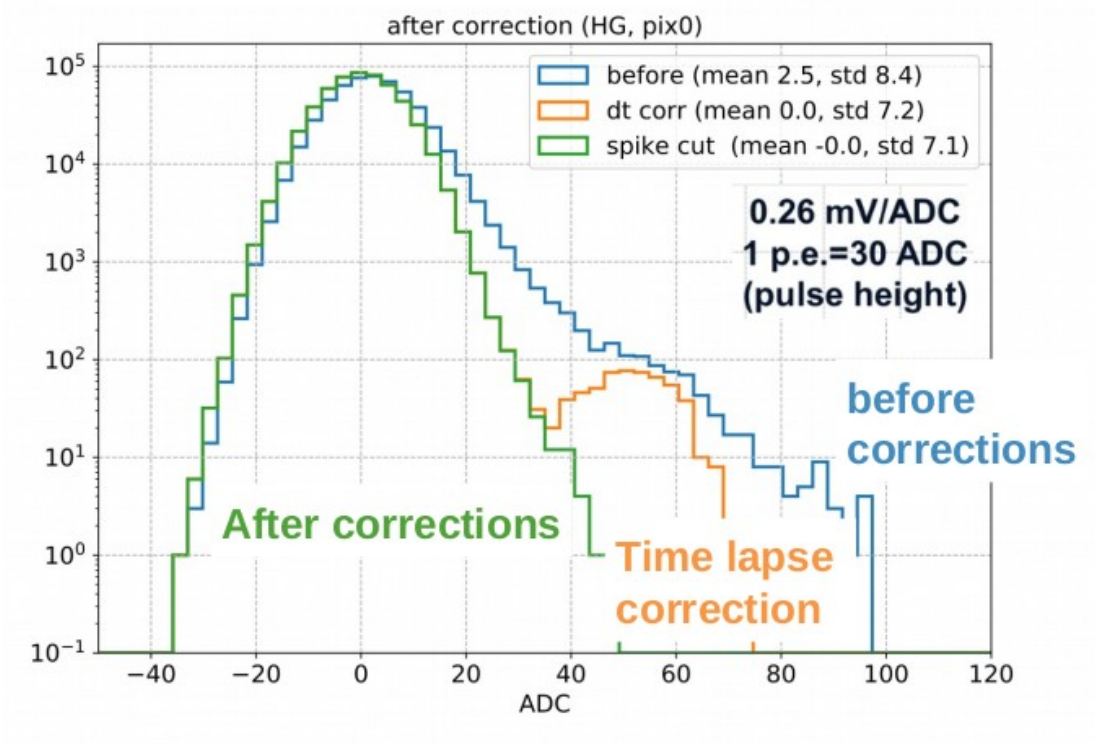

**PMTs quantum efficiency**




- **The blue distribution is the charge distribution relative to the mean before flatfielding (performed using calibration laser)**
- **After calibration the RMS of the distribution is 2% (without 2 outliers)**

# LST1: Camera performance

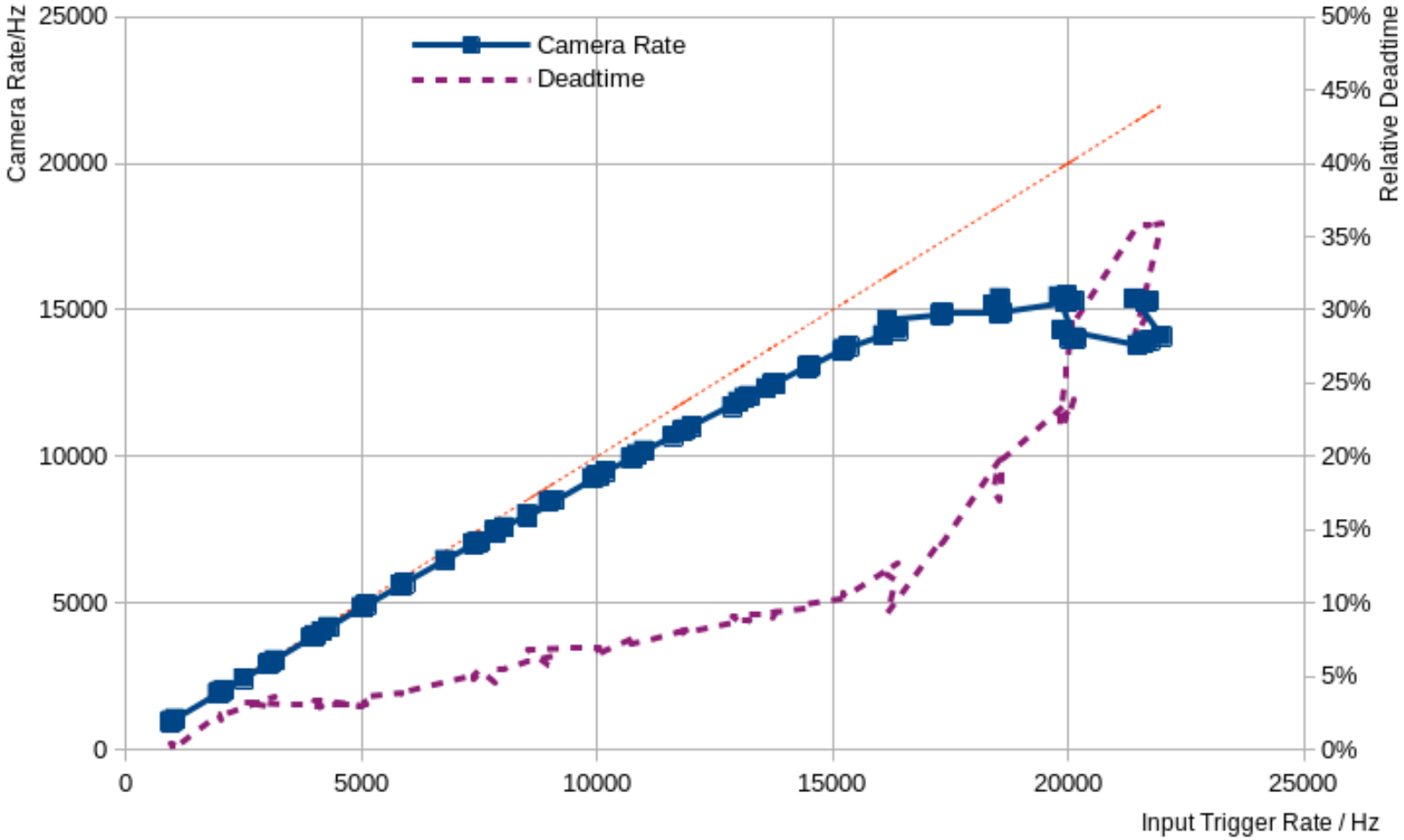



- **Time resolution of 400 ps**
  - obtained with calibration pulses of 80 p. e.

- **Noise level**
  - 5.9 ADC (0.20 p.e.) due to electronic noise
  - 29.5 ADC (0.98 p.e.) with HV on a dark patch (NSB dominated)

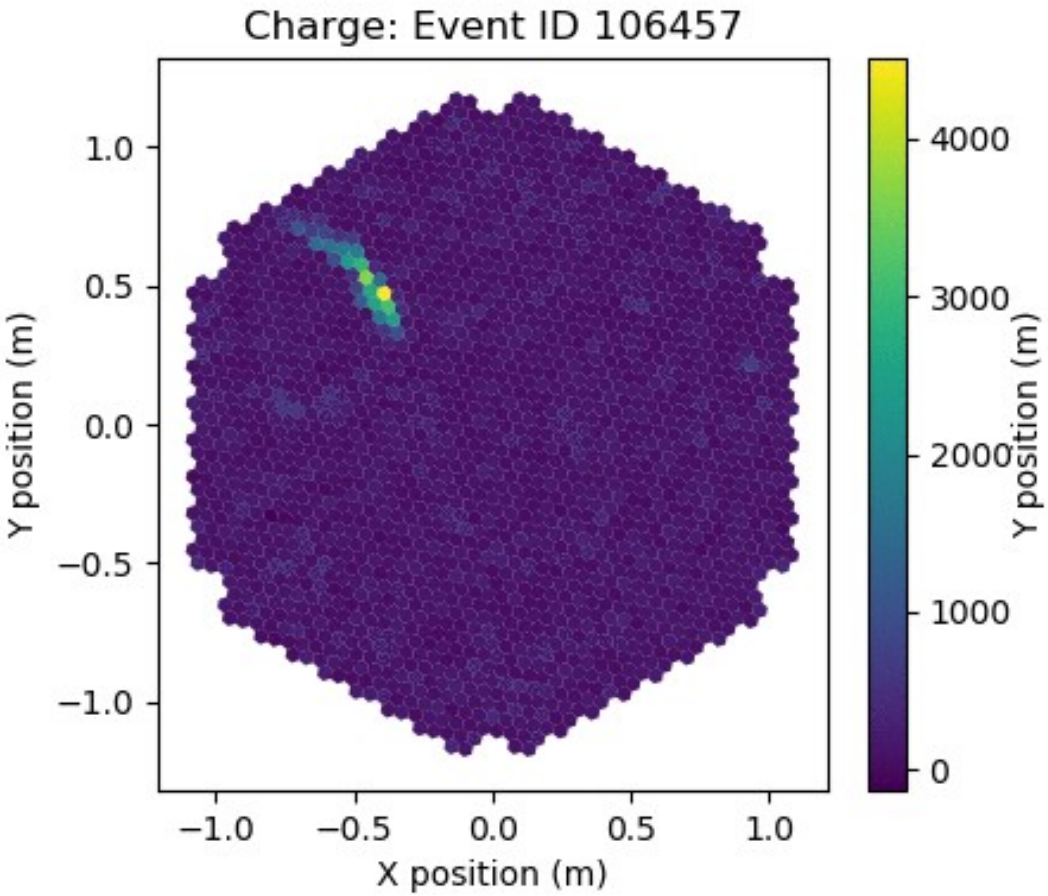
# LST1: Camera performance



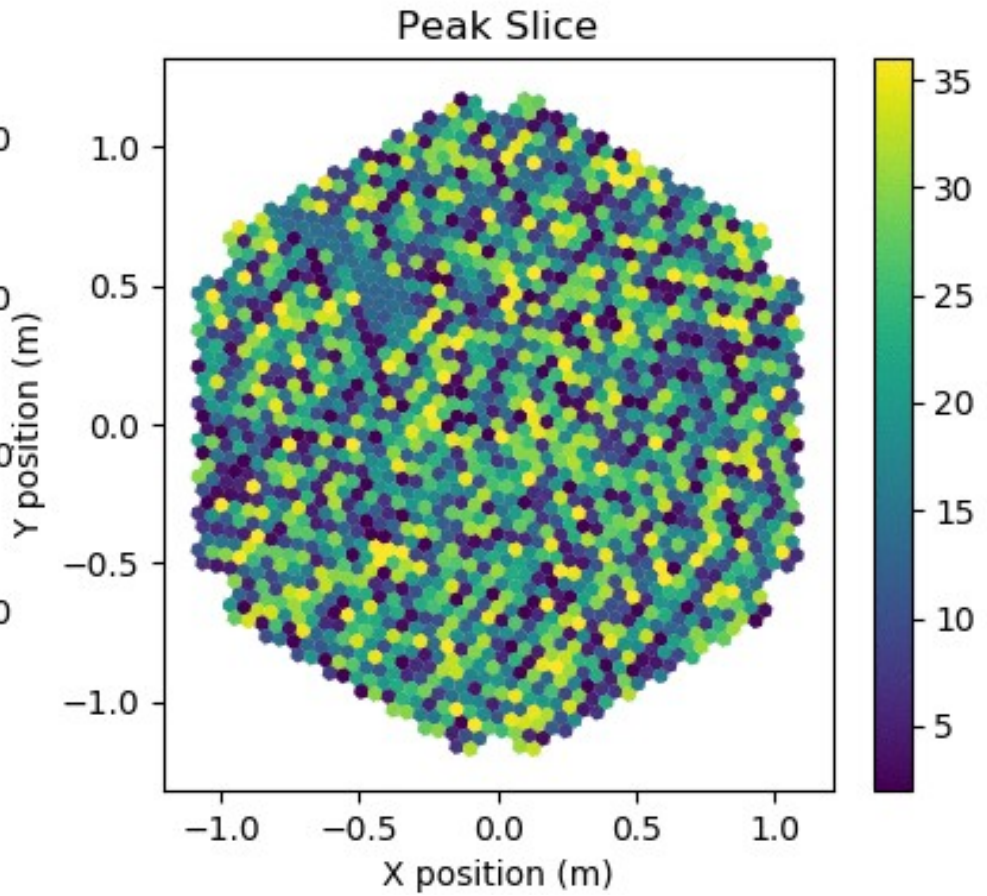

- **Acquisition rate reaches 15 kHz with random trigger**
- **Deadtime is 5% at 7.5 kHz**

# First observations

**LST1 is performing regular test observations (here August 2019):**

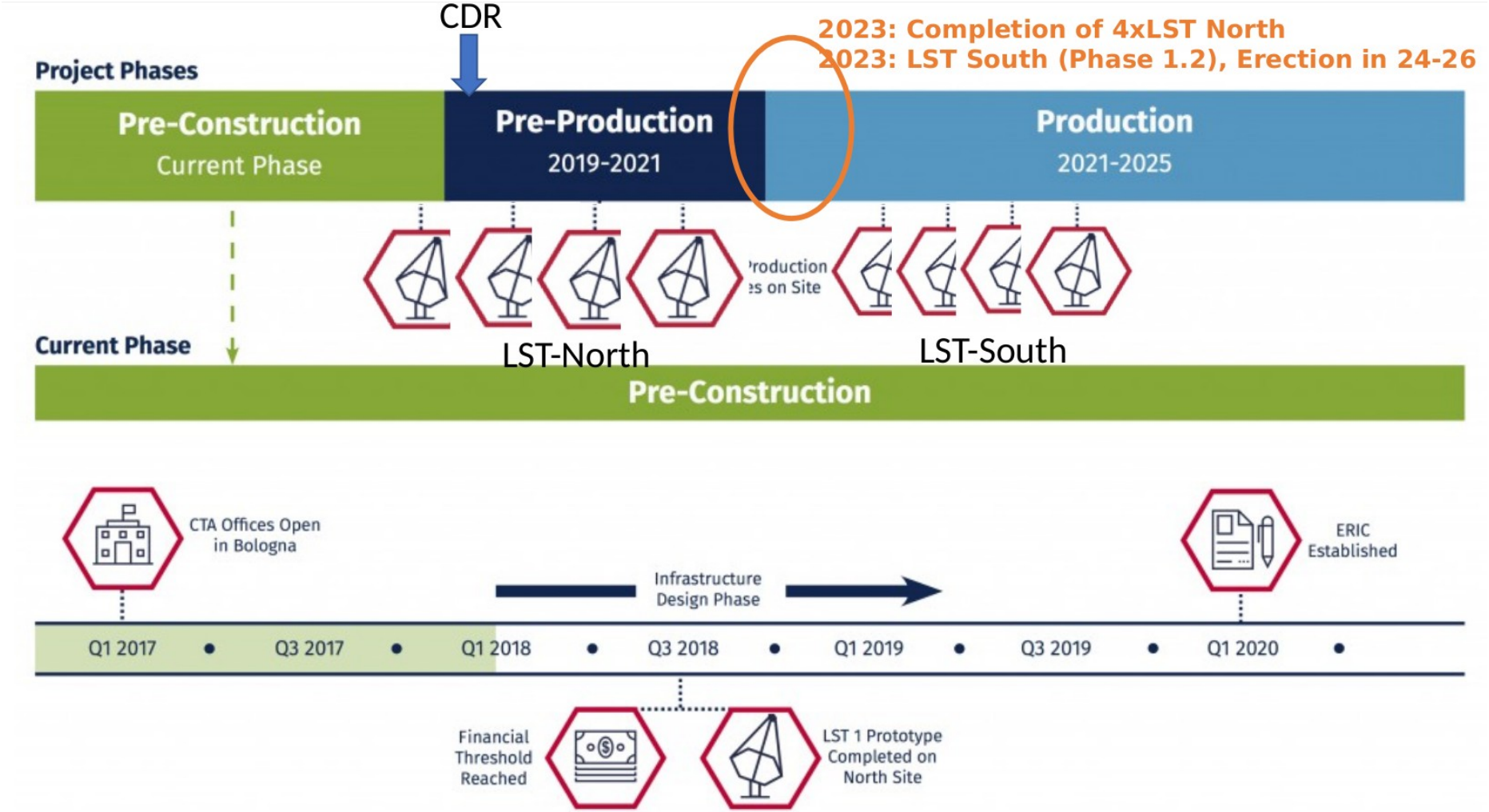



**Charge**



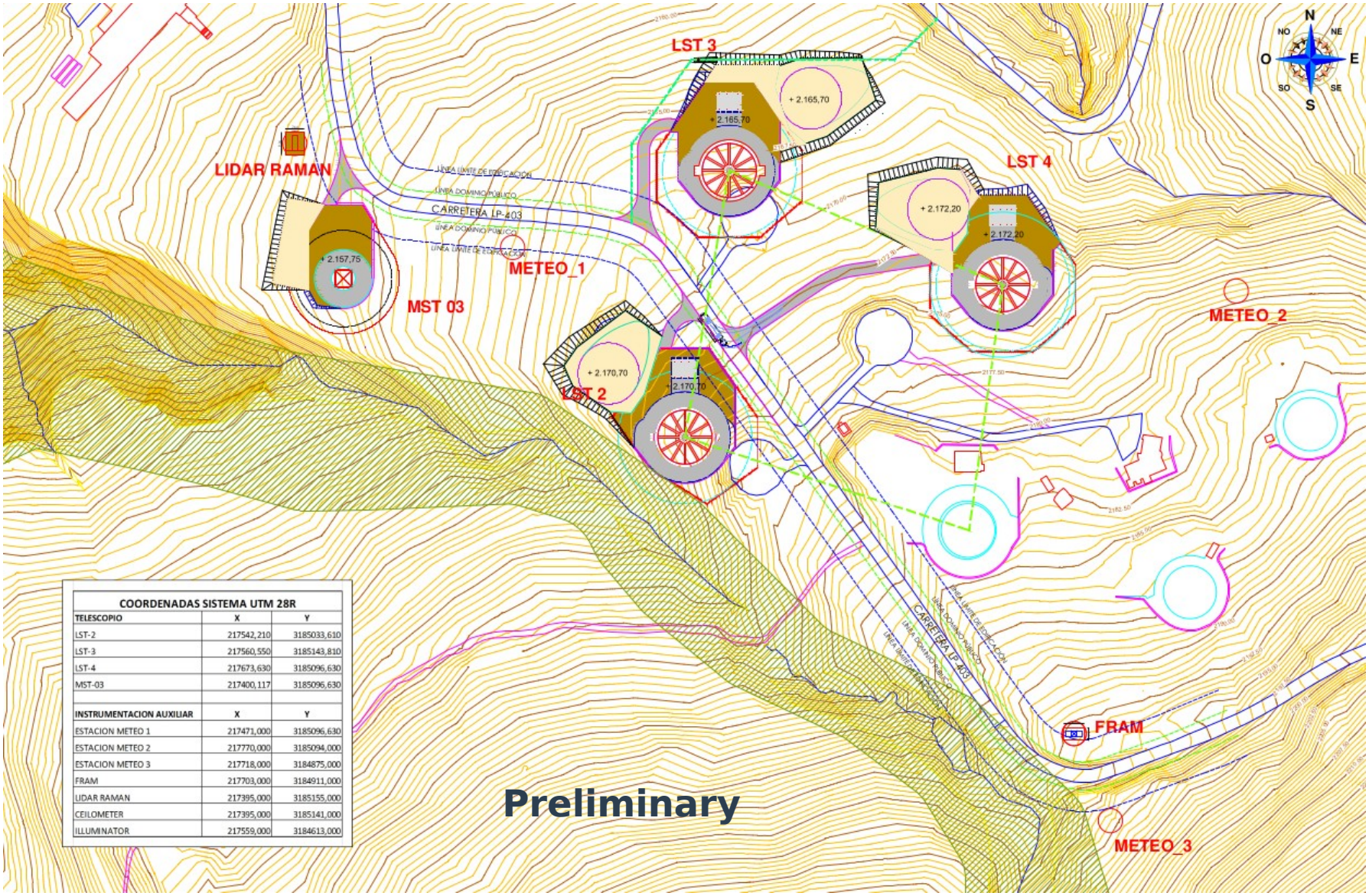

**Timing**

# Planning for the LSTs




- **LST just completed its Critical Design Review (CDR) last November**

# Plans for LST 2-4




| COORDENADAS SISTEMA UTM 28R | | |
|---|---|---|
| TELESCOPIO | X | Y |
| LST-2 | 217542,210 | 3185033,610 |
| LST-3 | 217560,550 | 3185143,810 |
| LST-4 | 217673,630 | 3185096,630 |
| MST-03 | 217400,117 | 3185096,630 |
| | | |
| INSTRUMENTACION AUXILIAR | X | Y |
| ESTACION METEO 1 | 217471,000 | 3185096,630 |
| ESTACION METEO 2 | 217770,000 | 3185094,000 |
| ESTACION METEO 3 | 217718,000 | 3184875,000 |
| FRAM | 217703,000 | 3184911,000 |
| LIDAR RAMAN | 217395,000 | 3185155,000 |
| CEILOMETER | 217395,000 | 3185141,000 |
| ILLUMINATOR | 217559,000 | 3184613,000 |

# Conclusion

- **LST1:**
  - **Built in 15 months in La Palma Spain**
  - **Inaugurated in October 2018**
  - **Currently completing the commissioning phase**
  - **Cross-calibration engineering runs with MAGIC to start soon**
  - **Scientific operation will start at the same time**

- **LST 2-4:**
  - **Many of the elements already built (PMTs, mirrors...)**
  - **Civil works expected to start mid 2020**
  - **Completion of the northern site LST sub-array foreseen in 2023**

- **LST South (LST 5-8 in Paranal Chile):**
  - **Program to be started in 2022-2023 (TBC)**