

CTAO 報告 249 : 小口径望遠鏡の開発状況

CTA Report 215: Development status of the Small-Sized Telescopes

Akira Okumura ^{1, 2, 3}

Daichi Ando ¹, Bang Sunghyun ¹, Kazuhiro Furuta ¹,
Ryu Kawarasaki ¹, Hiroyasu Tajima ^{1, 2, 3},

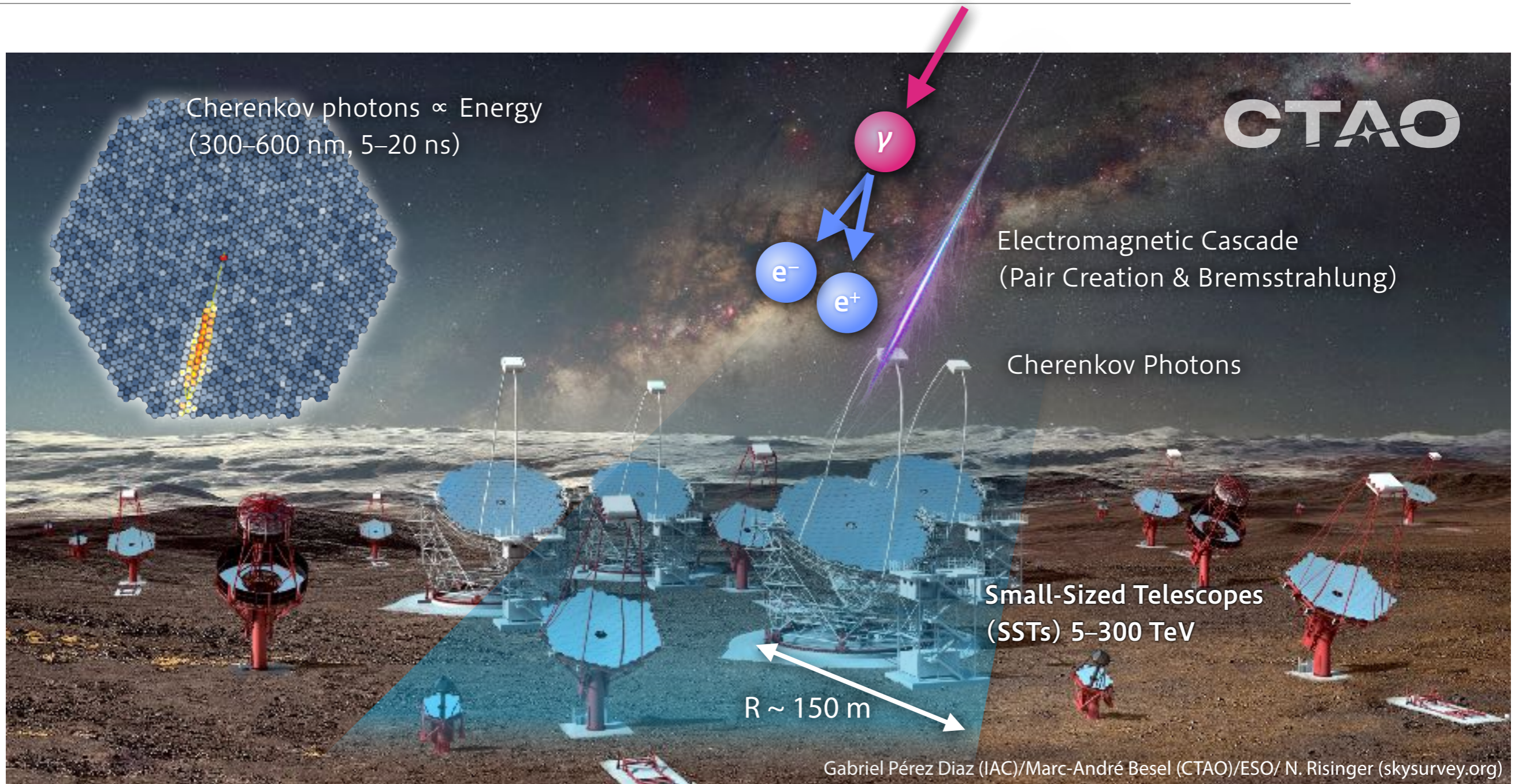
¹ Institute for Space–Earth Environmental Research (ISEE)

² Kobayashi–Maskawa Institute for the Origin of Particles and the Universe (KMI)

³ Nagoya University Southern Observatories
Nagoya University

JPS Annual Meeting Spring 2026
Mar 24, 2026

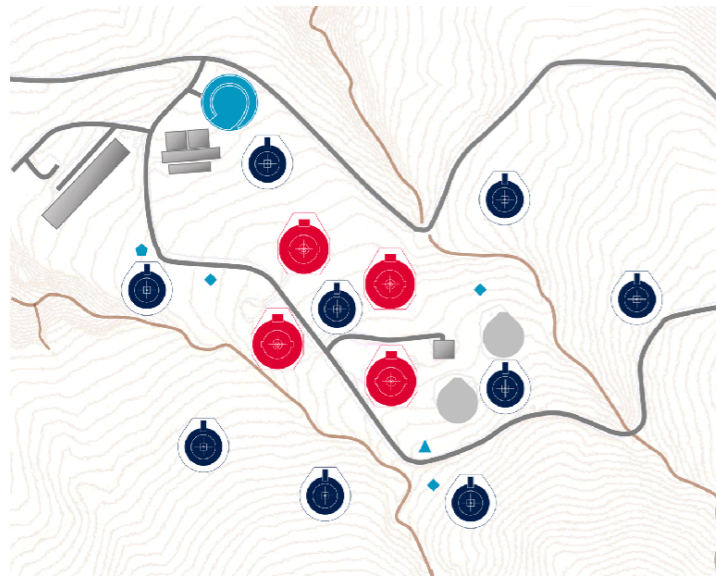
Cherenkov Telescope Array Observatory (CTAO)



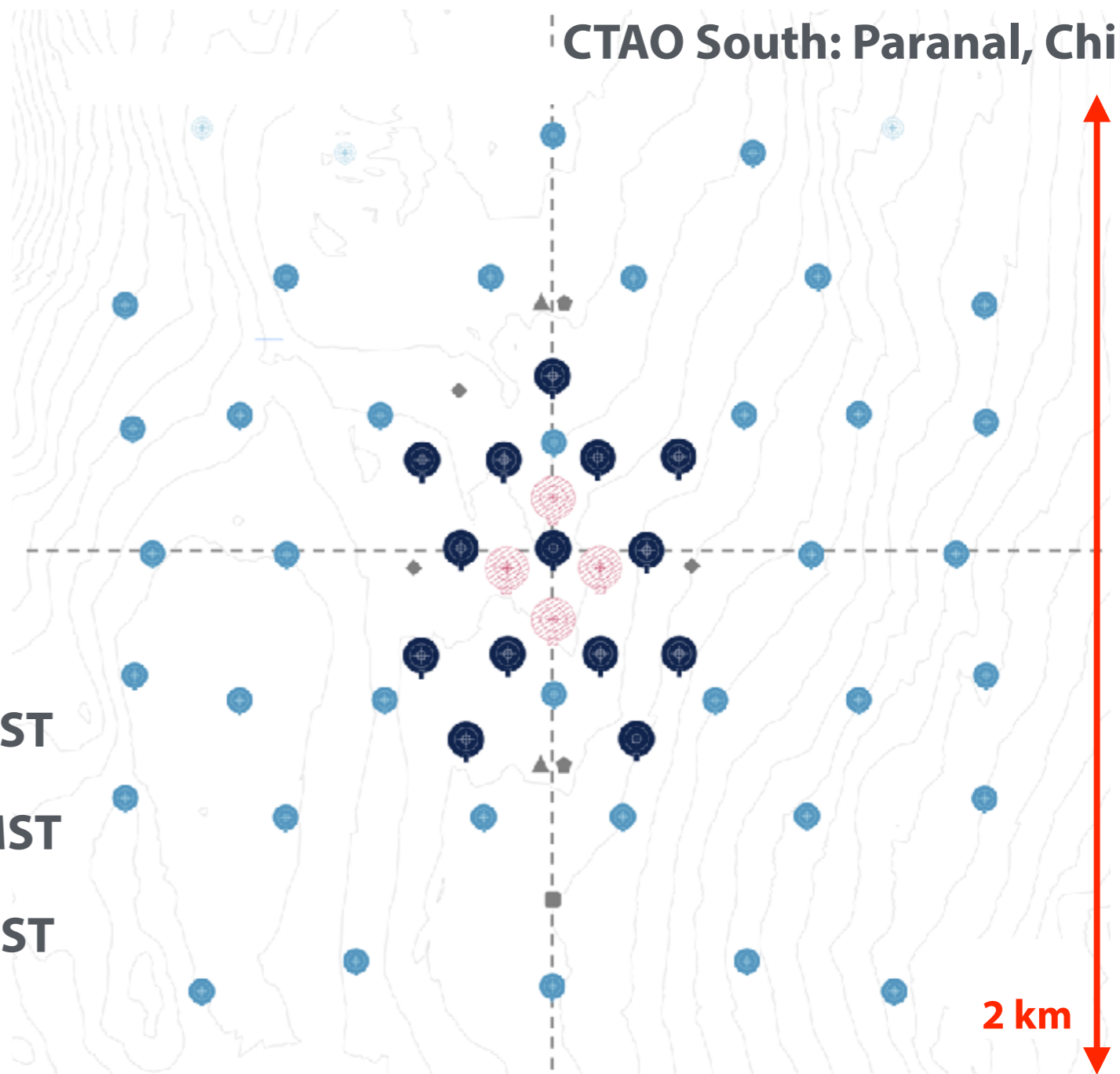
- Very-high-energy gamma rays generate electromagnetic cascades and Cherenkov emission in the atmosphere
- CTAO will observe the 20 GeV–300 TeV gamma-ray sky with ~ 100 telescopes of three designs
- The energies and arrival directions are reconstructed from 2D-projected Cherenkov angles
- The highest-energy band of CTAO, 5–300 TeV, is covered by **Small-Sized Telescopes (SSTs)**

CTAO Northern & Southern Sites (Initial Configuration)

CTAO North: La Palma, Spain

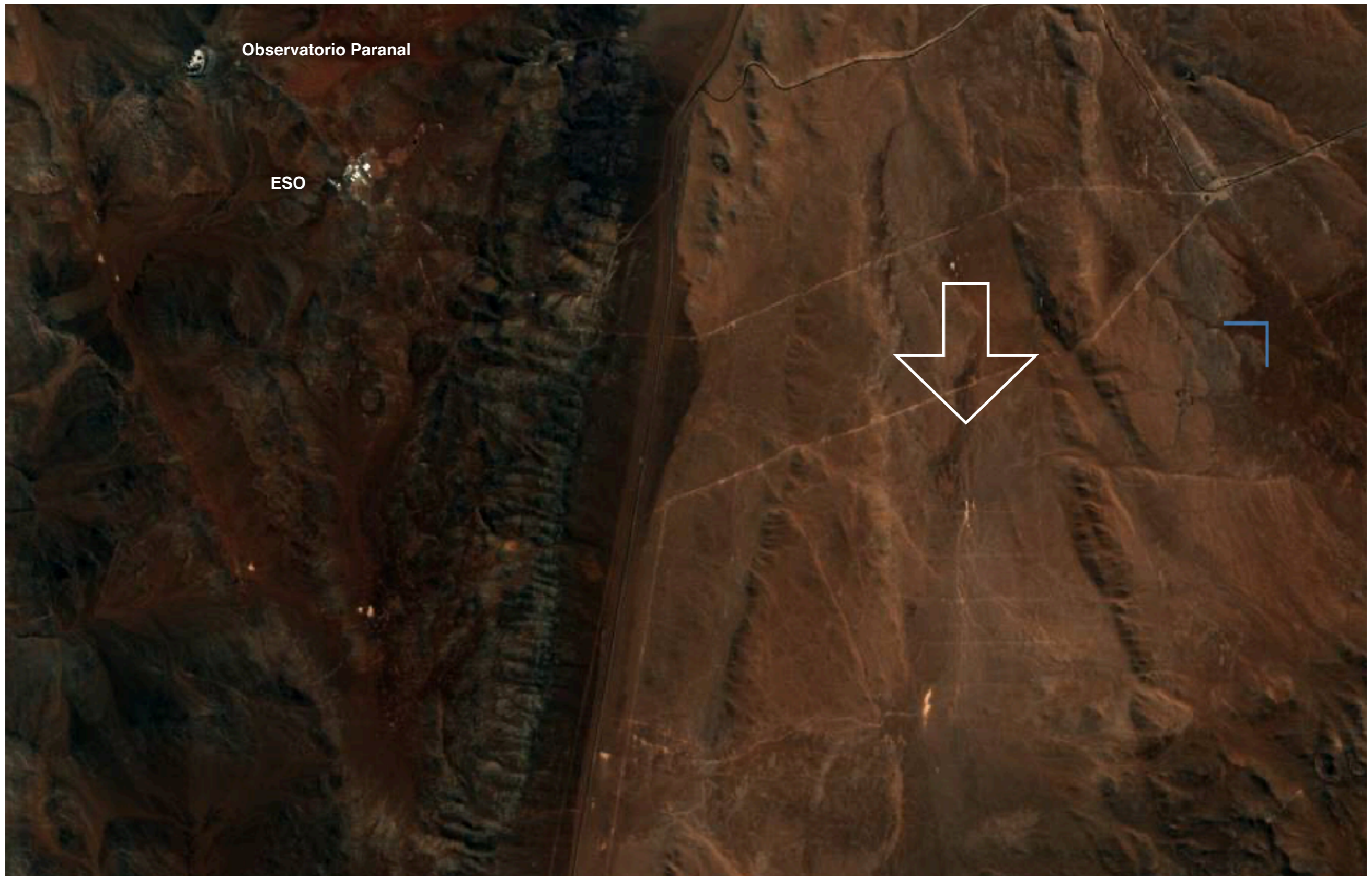


CTAO South: Paranal, Chile



- Wide energy coverage of 20 GeV–300 TeV with three telescope sizes
- Spread over a few km² area to catch Cherenkov photons anywhere in the circle
- Construction phase to start with 4 LSTs + 9 MSTs (north) and 14 MSTs + 37 SSTs (south)

CTAO South in Paranal Chile (Jul 25, 2021)



CTAO South in Paranal Chile (Jul 5, 2025)



CTAO South in Paranal Chile (Jul 29, 2025)



CTAO South in Paranal Chile (Sep 22, 2025)



CTAO South in Paranal Chile (Oct 12, 2025)



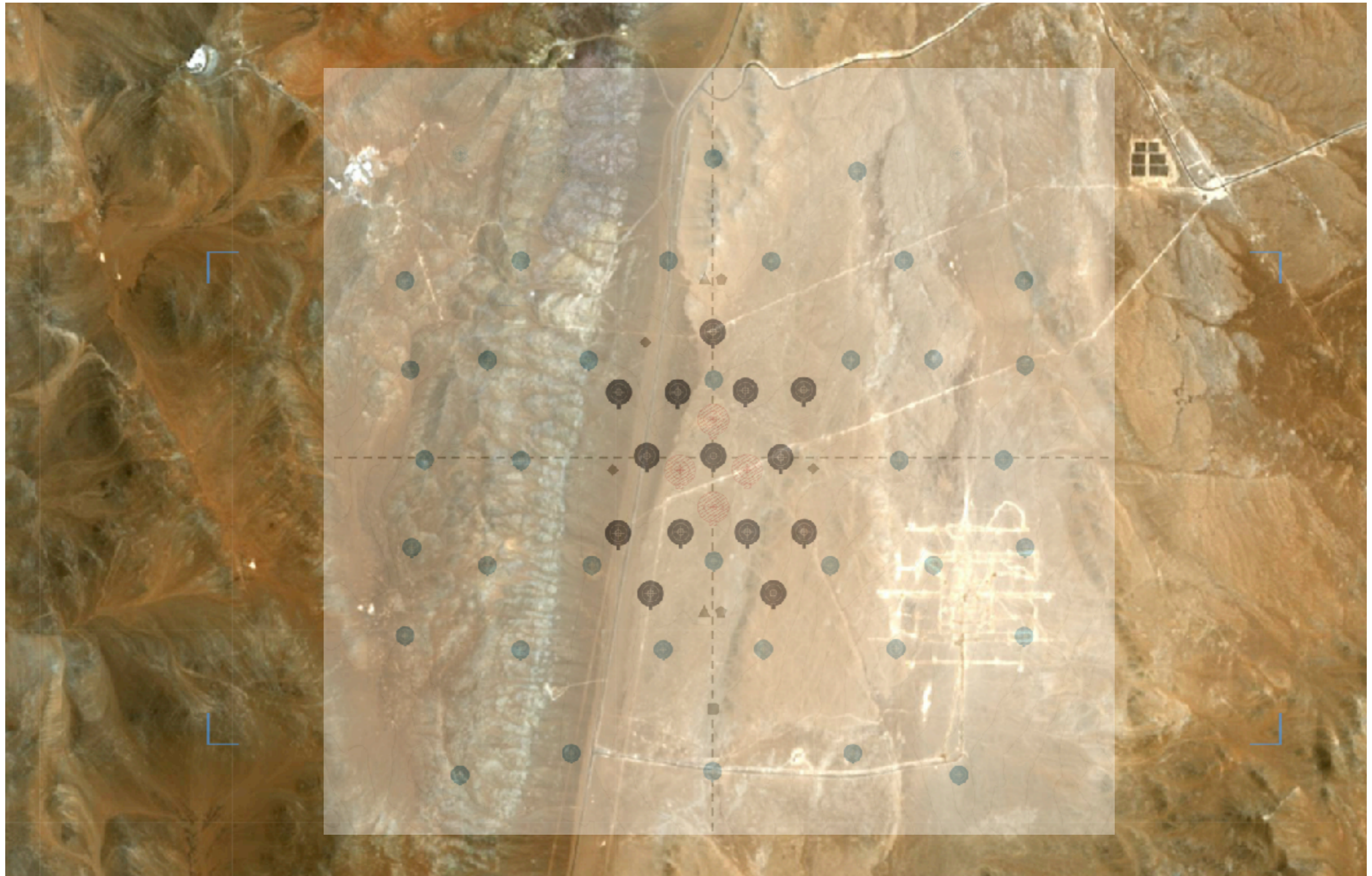
CTAO South in Paranal Chile (Nov 21, 2025)



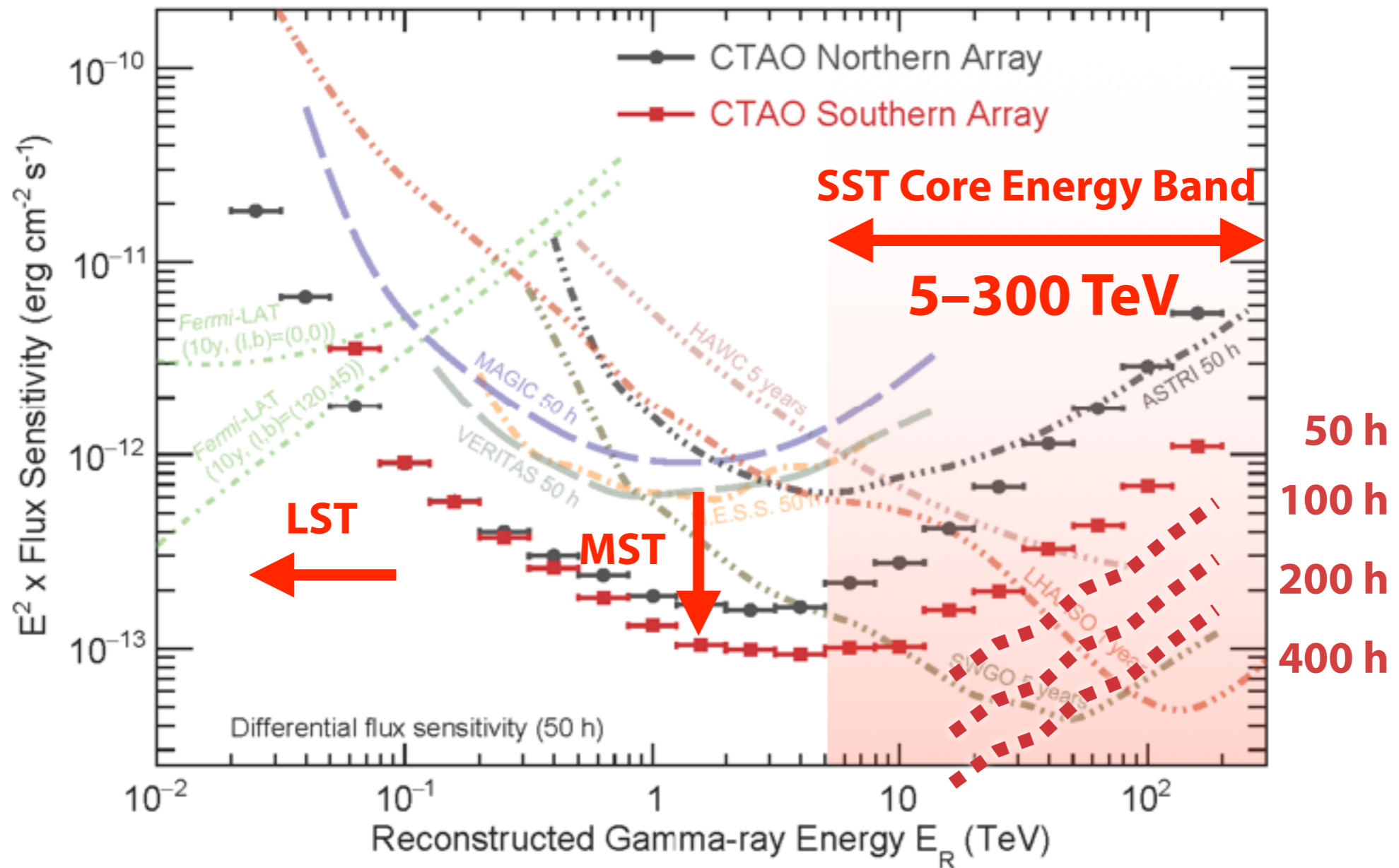
CTAO South in Paranal Chile (Dec 31, 2025)



CTAO South in Paranal Chile (Feb 16, 2026)



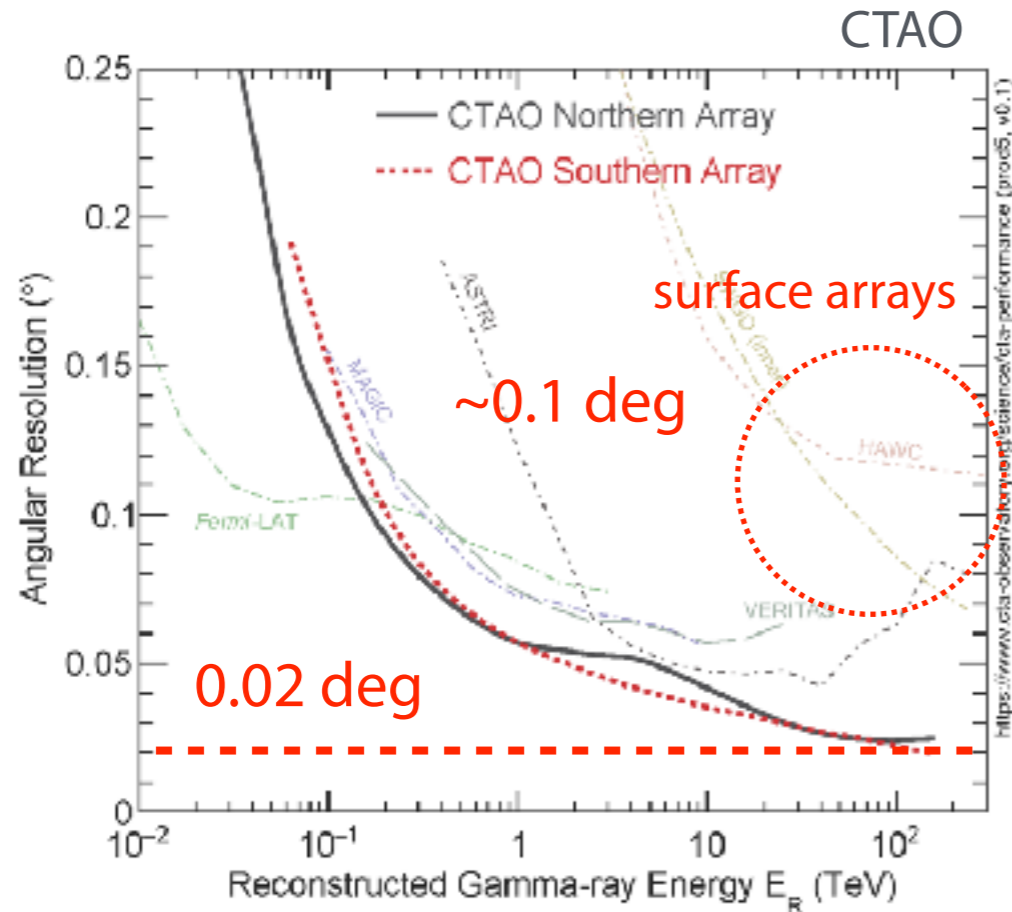
High-energy Frontier by CTA SSTs (Initial Configuration)



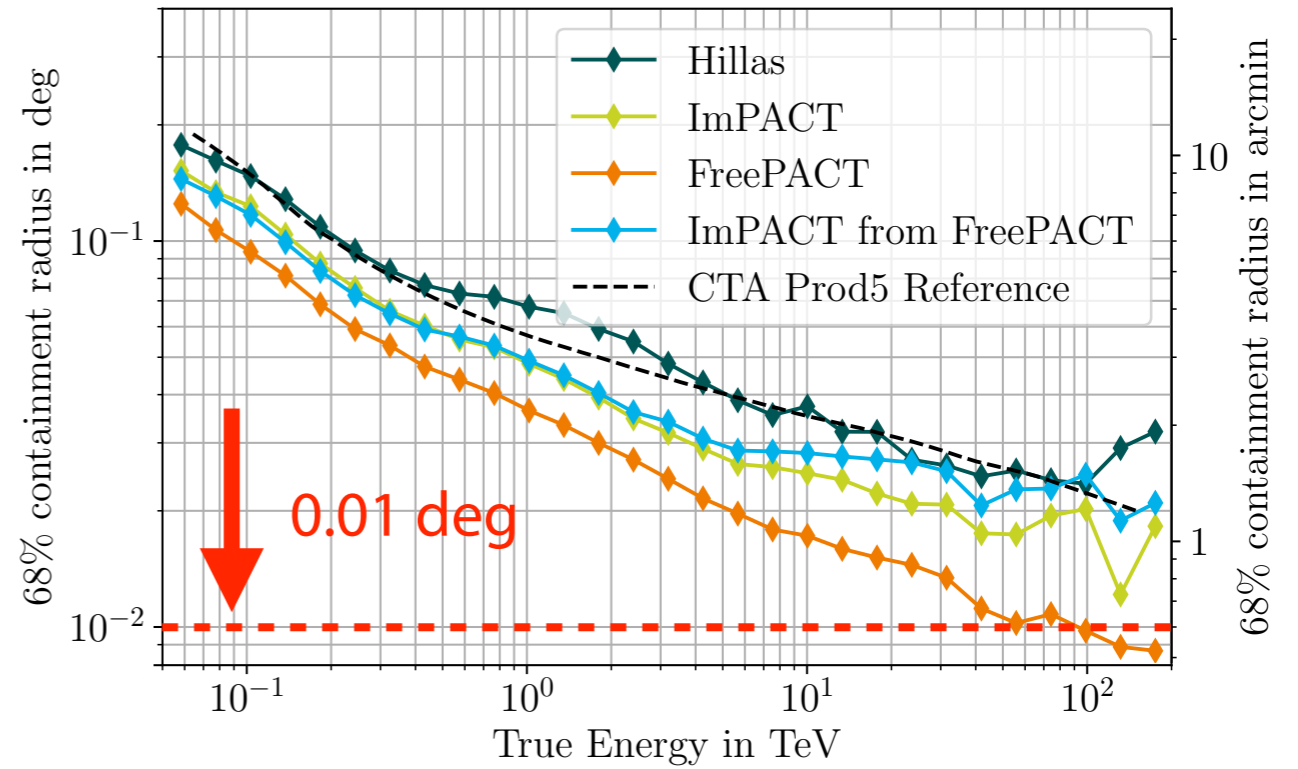
<https://www.cta-observatory.org/science/cta-performance> (prod5, v0.1)

- Covering up to 100–300 TeV is a key for PeVatron search
- Long observations of selected candidates (e.g., Gal. Center, microquasars)
- Observations under bright moon conditions will double the duty cycle

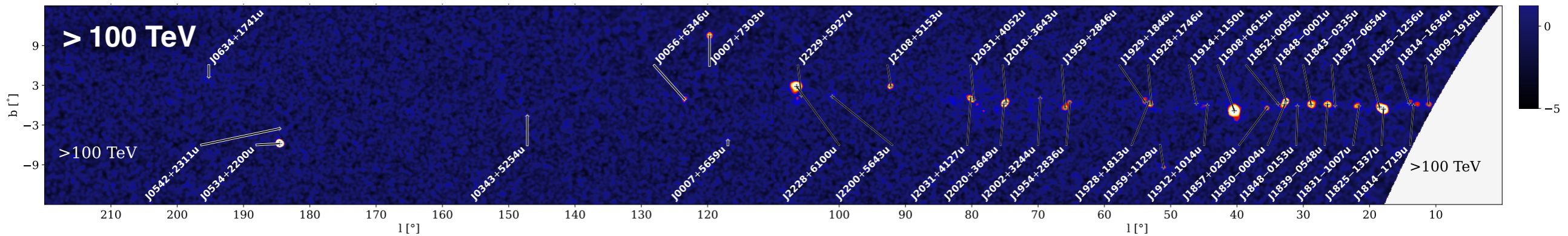
Angular Resolution



Schwefer et al. (2024)



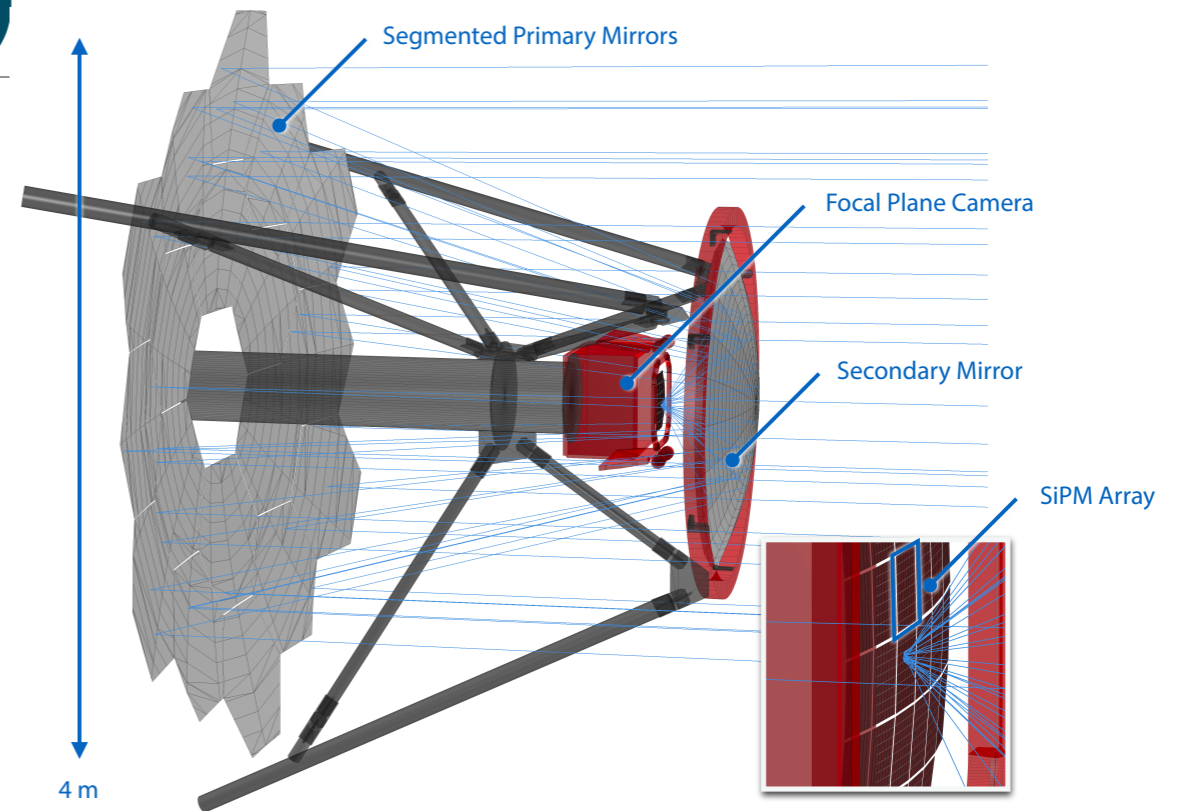
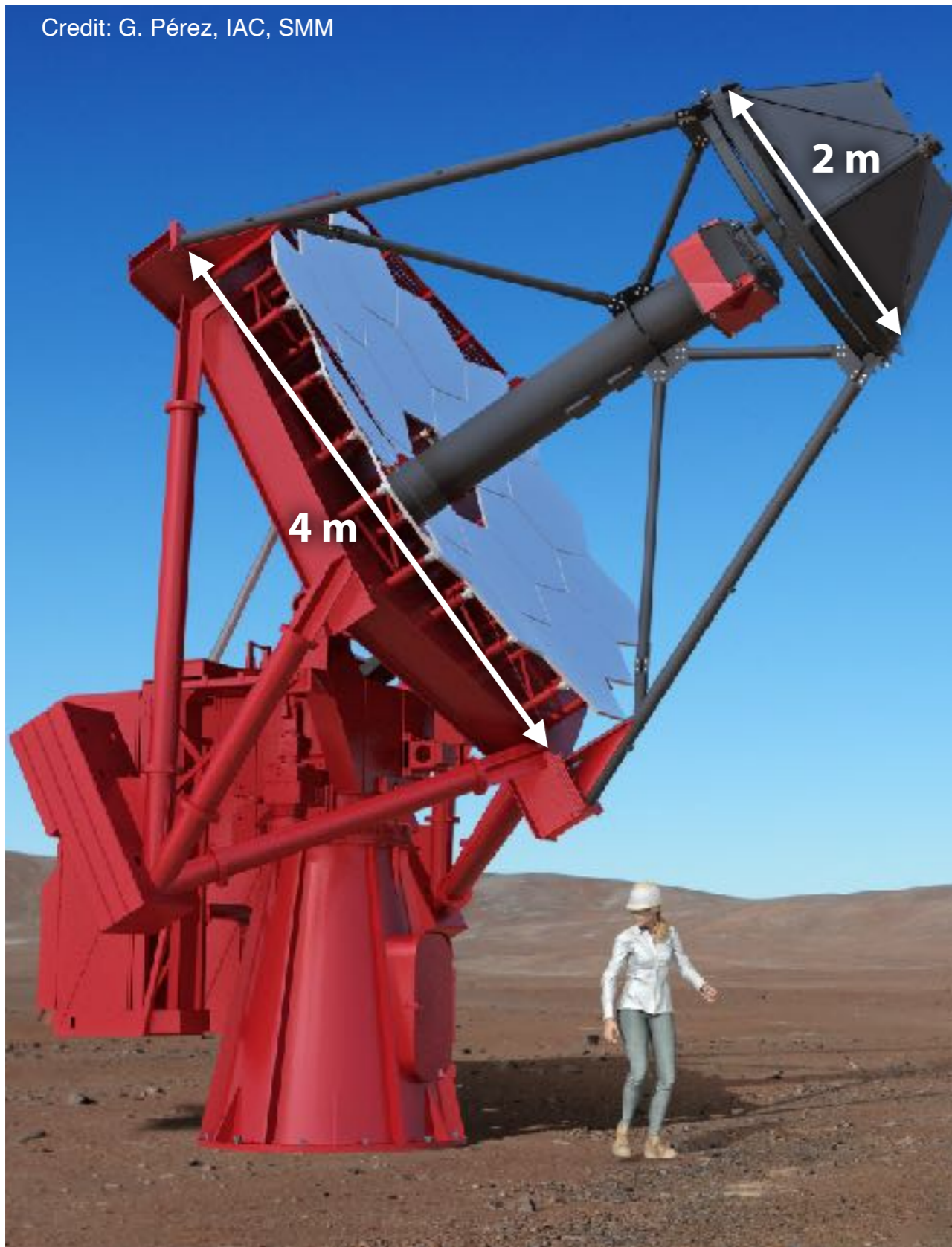
LHAASO (2023)



- Thanks to wide FOV ($\sim 8^{\circ}$) of MSTs and SSTs, and recent software development, CTAO South angular resolution will reach down to 0.01° at 100 TeV
- Discoveries by ALPACA (exposure) and SSTs (follow up and resolution) are expected

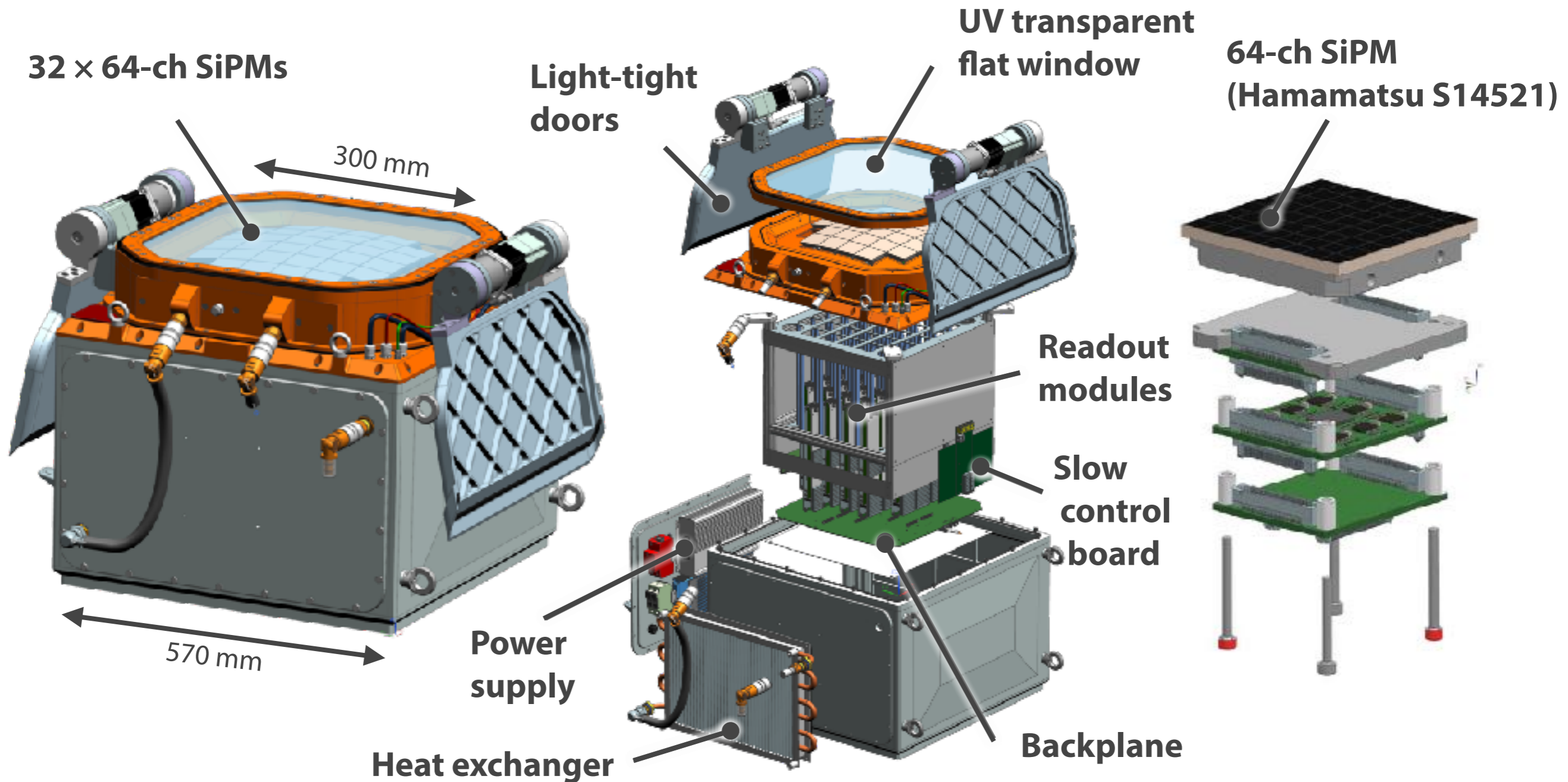
Small-Sized Telescopes (SSTs)

Credit: G. Pérez, IAC, SMM

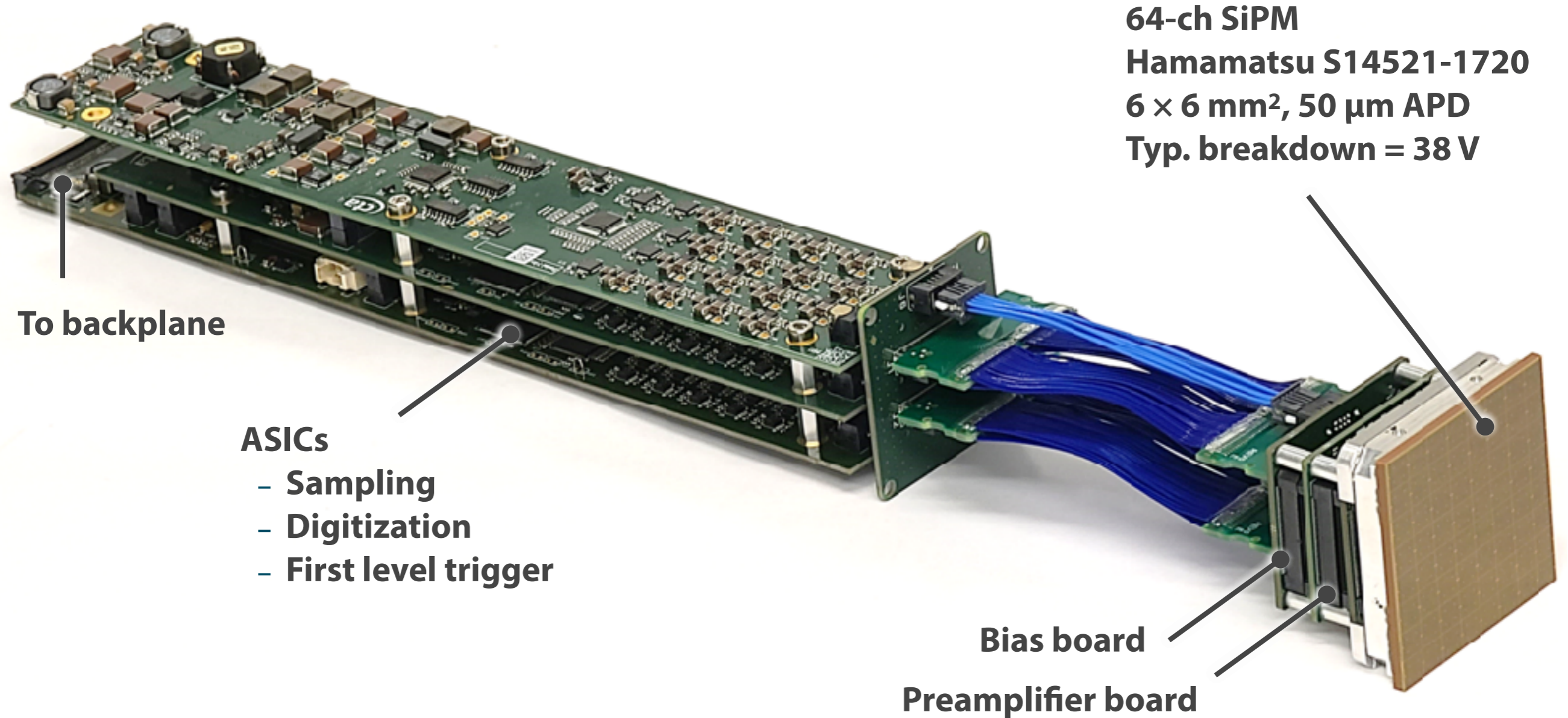


- Schwarzschild–Couder optical system
 - ▶ 4 m aspherical primary mirrors (segmented)
 - ▶ 2 m monolithic secondary mirror (monolithic)
 - ▶ $\sim 0.15^\circ$ PSF diameter over $\sim 9^\circ$ FOV
- Compact focal-plane camera
 - ▶ 2048 SiPM pixels to form 300 mm focal plane
 - ▶ 32×64 -ch camera modules with dedicated ASICs
 - ▶ Large contributions from Nagoya University

Camera Design



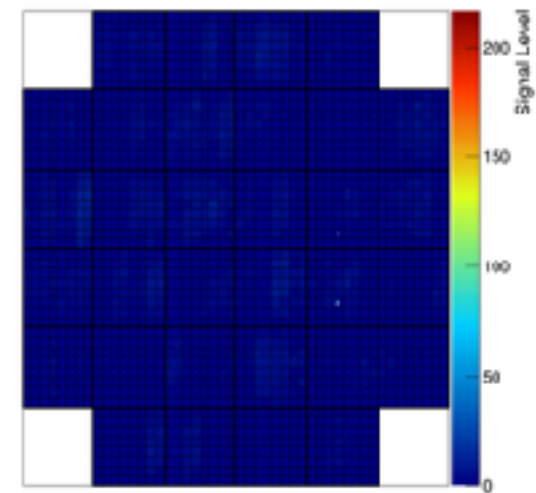
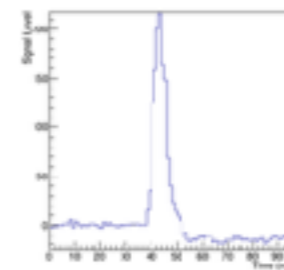
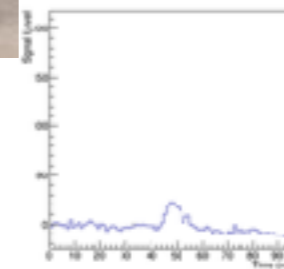
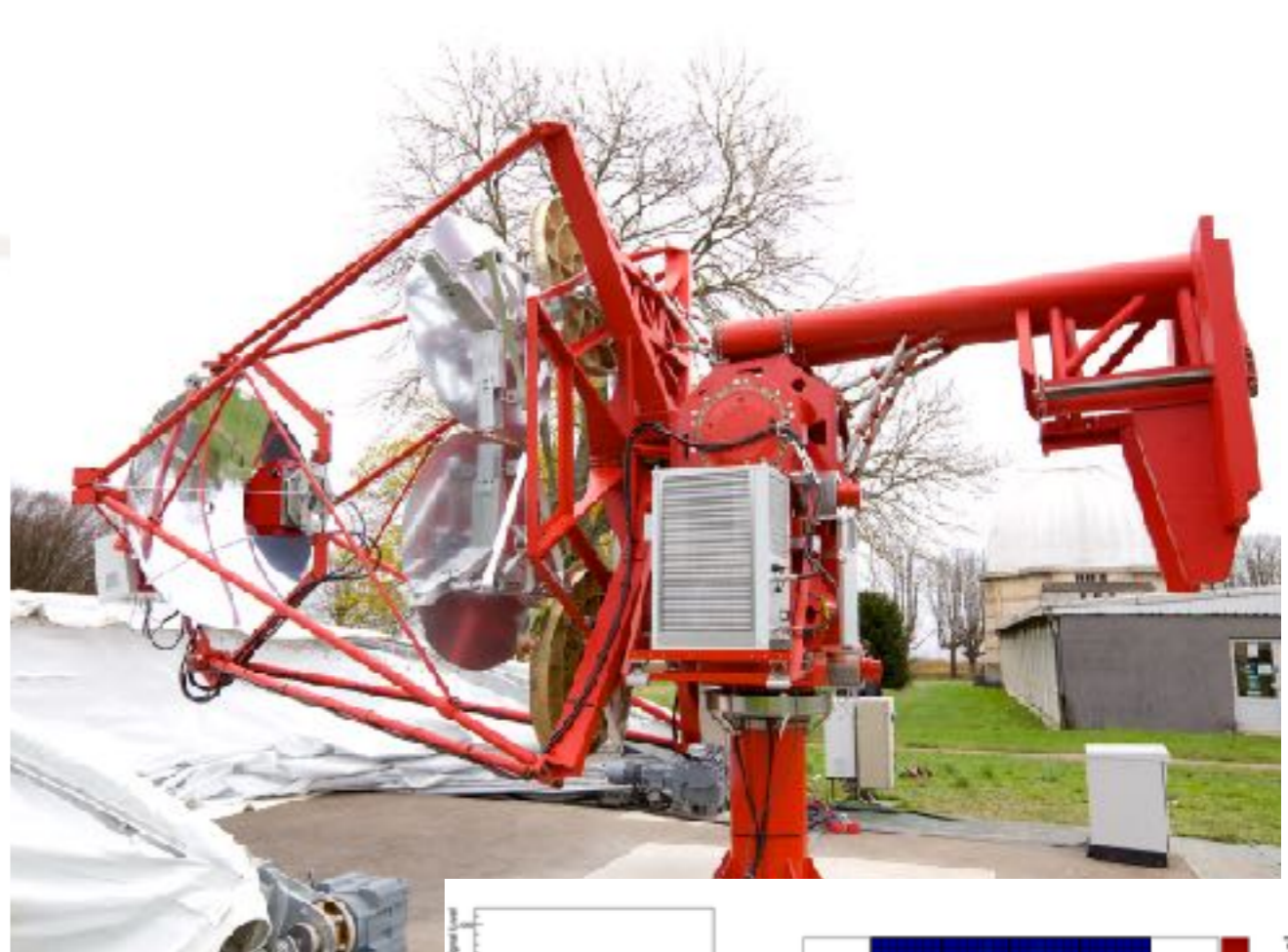
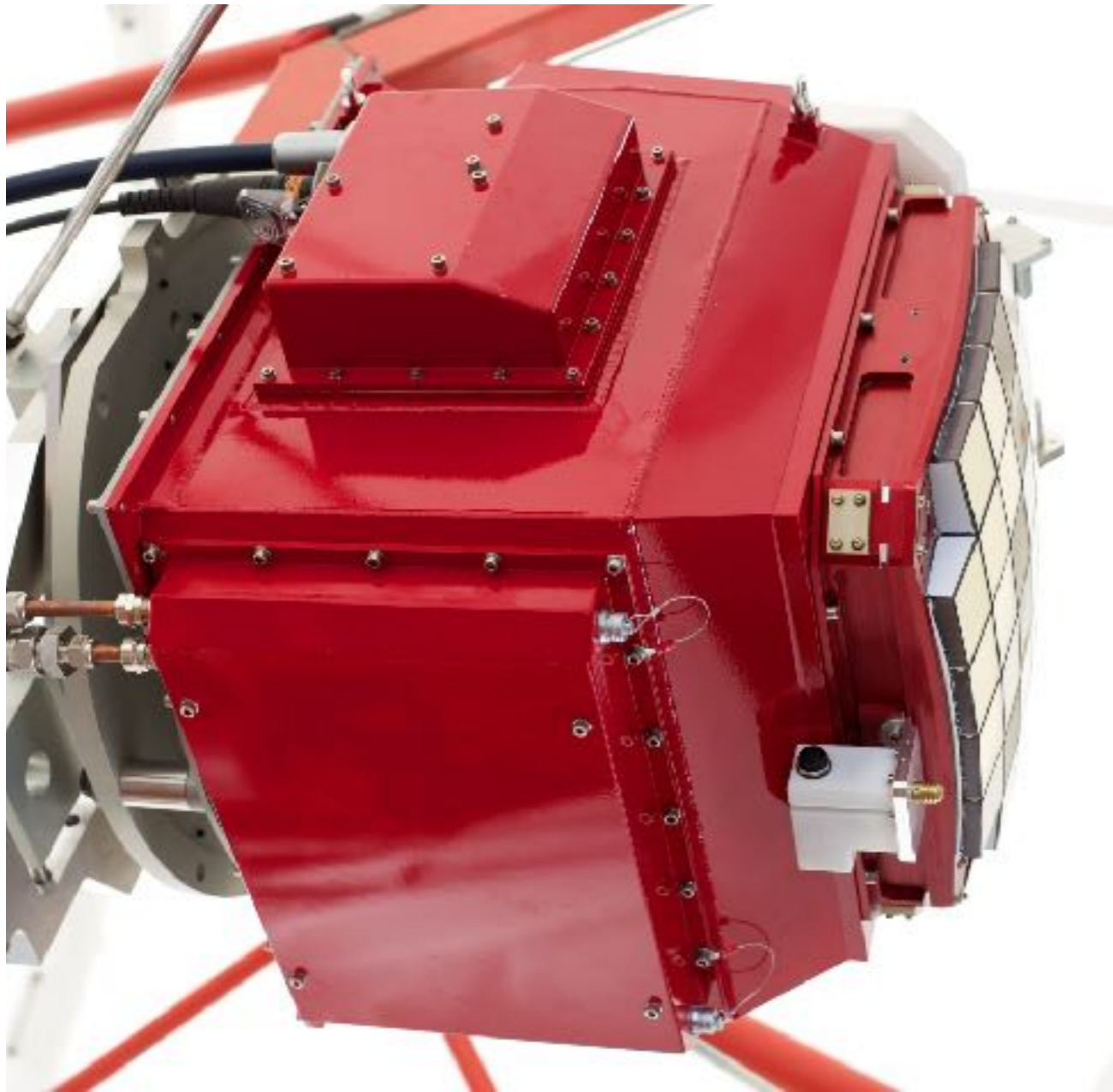
- The same concept: 32 × 64-ch SiPMs to form the spherical focal plane, read and triggered by dedicated ASICs (TARGET series), and controlled by backplane
- After the experience of two prototypes, the design is being finalized now



- Started with the first TARGET ASIC (16-ch sampling and trigger), and 64-ch MAPMTs in 2009
- Latest module uses 4 × sampling ASIC (TARGET-CTC) and 4 × trigger ASIC (TARGET-CT5TEA)
- UV-sensitive and uncoated low-optical-crosstalk 64-ch SiPMs

First SST Camera Prototype (CHEC-M)

2015



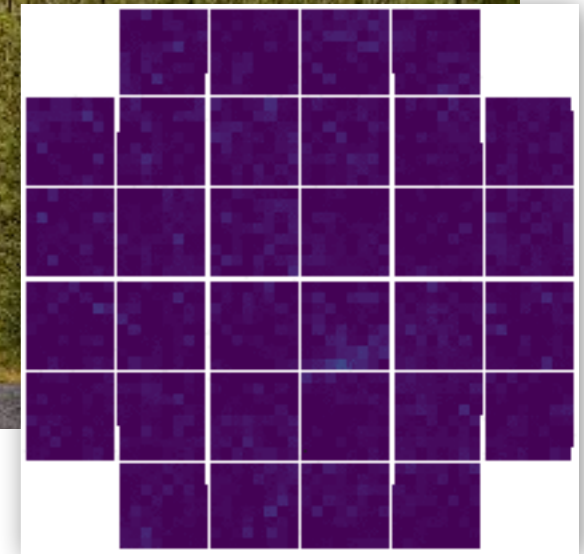
- TARGET 5 and multianode PMTs (MAPMTs)
- The very first CTA first light was achieved on a prototype optics in Paris in 2015

Second SST Camera Prototype (CHEC-S)

2019



Credit: Christian Föhr (MPIK)



- TARGET 7 and SiPMs
- Test observation campaign with the Italian optics design was held at Mt Etna, Sicily in 2019
- Chosen to be the final SST design from 3 camera and 3 optics designs in 2019

Recent SST Camera Activity

2025

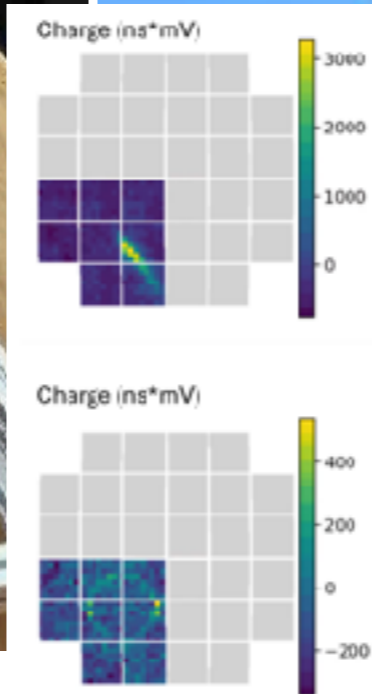
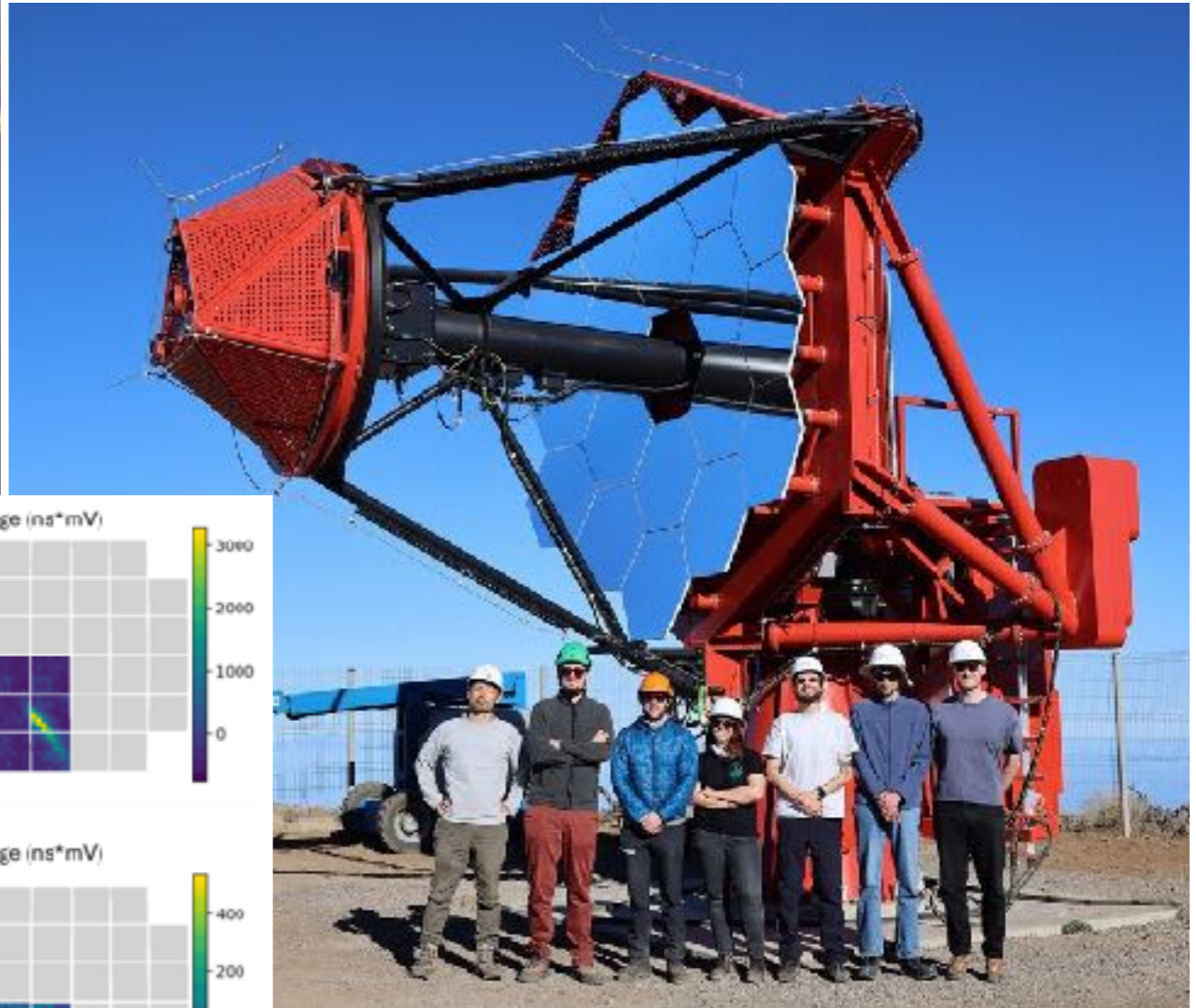
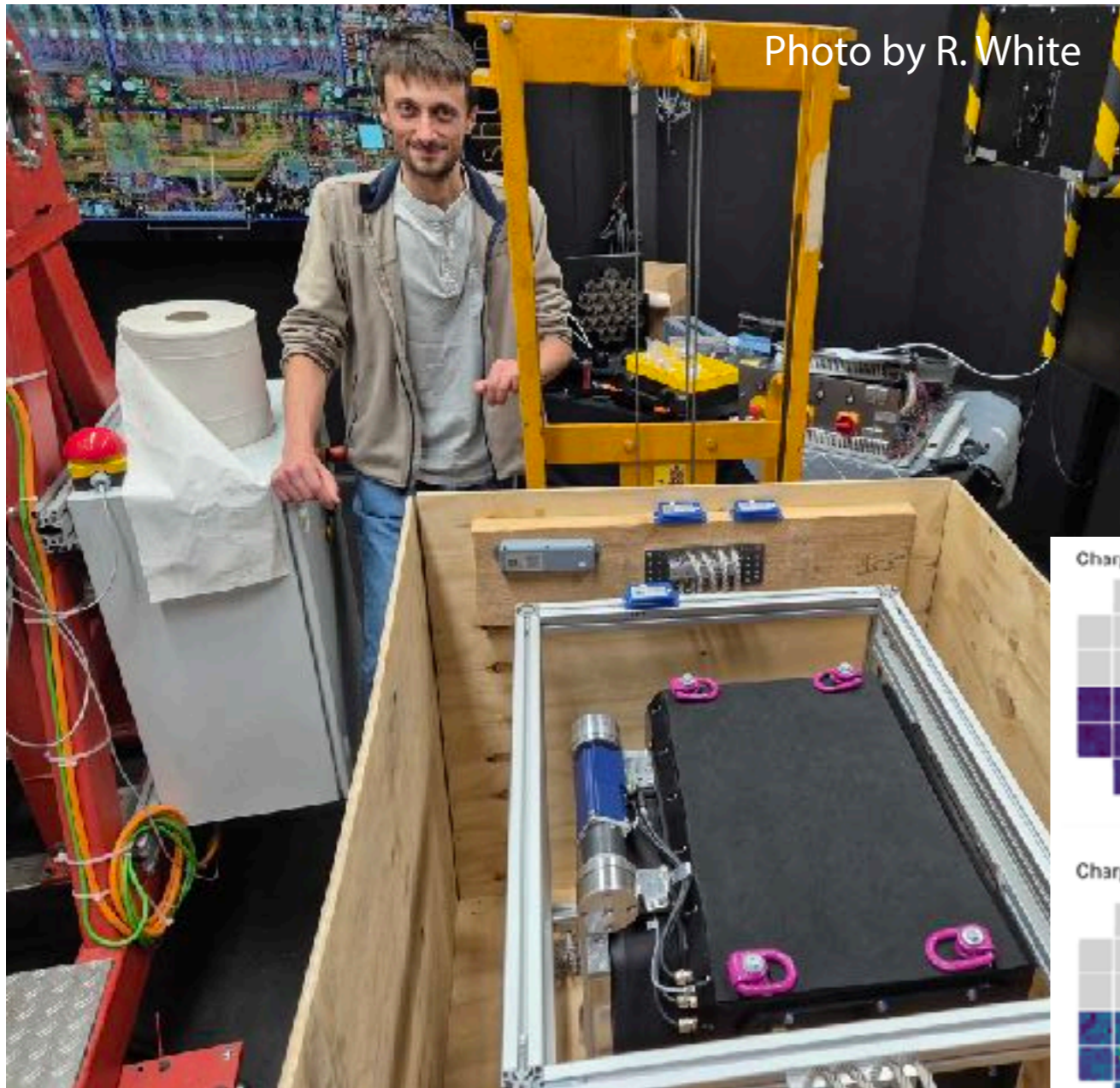
Camera Integration at MPIK (Mar 2025)



- Populated only 8 camera modules out of 32 (“quarter camera”)
- Waiting for the full backplane board to be delivered in 2026

Another Campaign at Teide Observatory, Tenerife

2025



- Shipped the camera to Tenerife on July 8, 2025
- Two-week test observation campaign was held at the Tide Observatory, Tenerife

Mass Production and Beyond

Jun 2025

Dec 2025

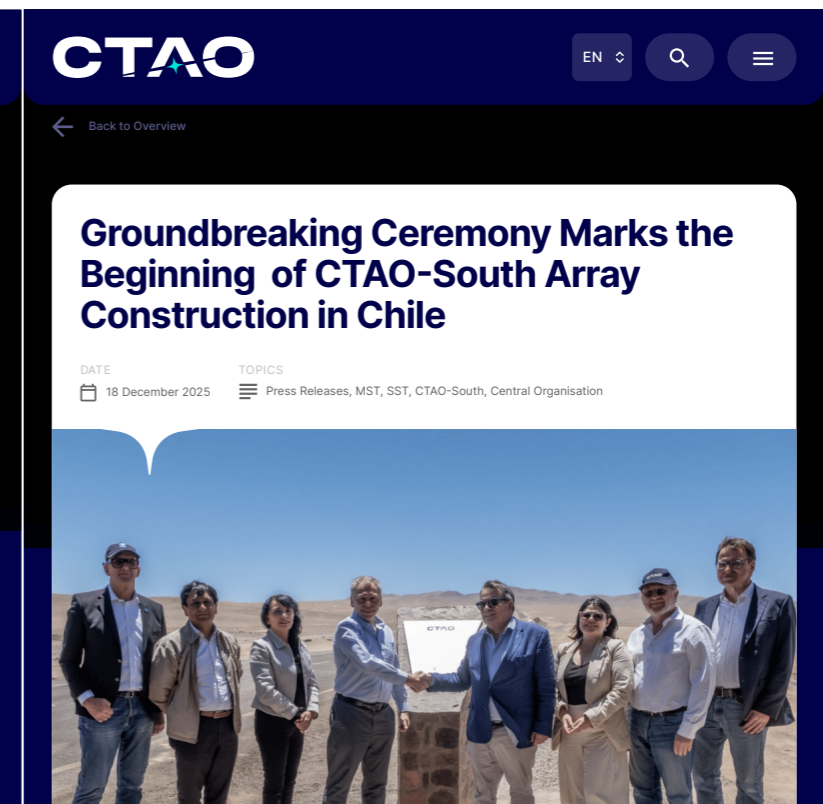
Dec 2025



On 5 June, a delegation from the [CTAO SST Collaboration](#) and the [CTAO Central Organisation's](#) Telescope team visited the facilities of the Italian company Dal Ben, located in the Veneto region, to inspect the progress of the [Small-Sized Telescope \(SST\)](#) electromechanical structures' production. In a significant step forward, the



CTAO Central Organisation and SST Collaboration representatives pictured with the SST at the Dal Ben facility in the Veneto region, Italy. Credit: INAF/G. Tagliaferri



Italian Minister of University and Research Visits the CTAO-South Site in Chile

DATE: 13 March 2026
TOPICS: Announcements, Central Organisation



From left to right: Gianluigi Consoli (Directorate General for Internationalization, MUR), Massimo Rubechi (Head of Cabinet, MUR), Bernhard López (CTAO-South Systems Engineer), Xavier Barcons (ESO Director General), Anna Maria Bernini (Minister of University and Research), Roberto Pavesi (CTAO President), Marco Miceli (Academy of Sciences of Chile)

Mar 2026

- Initial mass production of SST telescopes and site prep. started in 2025
- First telescope to be built in Paranal in mid 2026
- Proto engineering camera (ECAMi) to be installed in Chile in 2026
- Engineering camera (SST Cam 1) and mass production will follow in 2026 and 2027
- Completion of 5 SSTs is expected in 2027, and 37 SSTs in 2029
- Full CTAO South configuration (37 SSTs + 14 MSTs) in 2030