TMT: The Next Generation of Discovery

Fengchuan Liu (Project Manager)

TIO Members

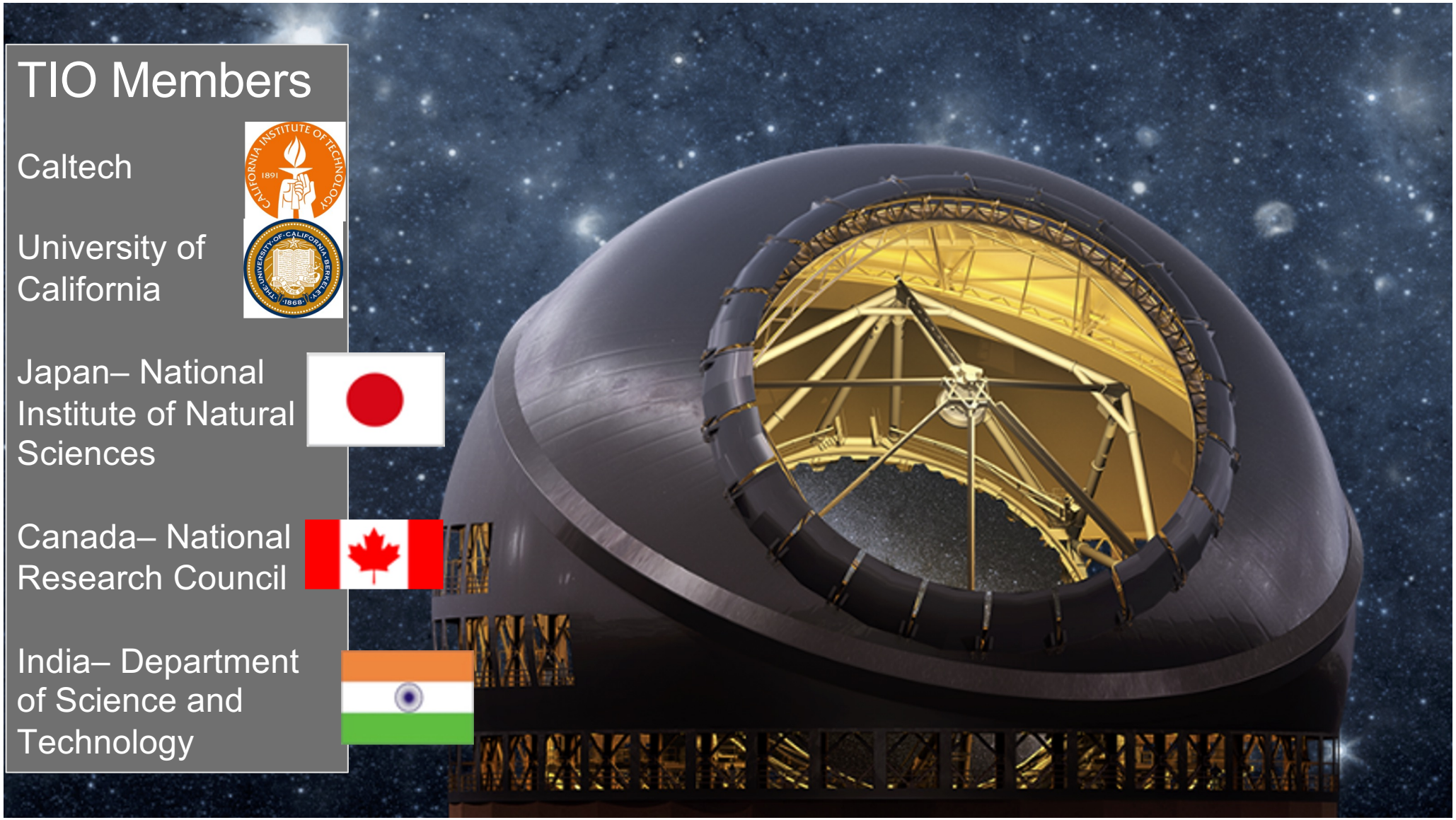
Caltech

University of California

Japan– National Institute of Natural Sciences

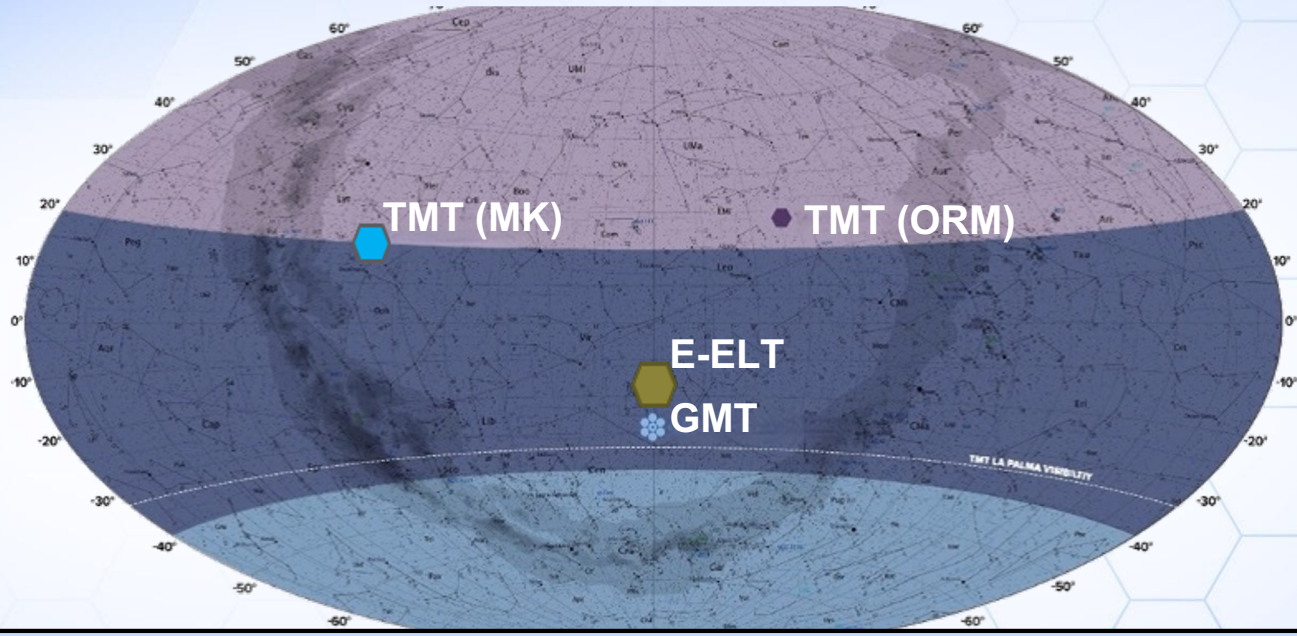
Canada– National Research Council

India– Department of Science and Technology



TMT: Only ELT in the Northern Hemisphere

TMT together with either GMT through US-ELT program or with E-ELT covers the whole sky



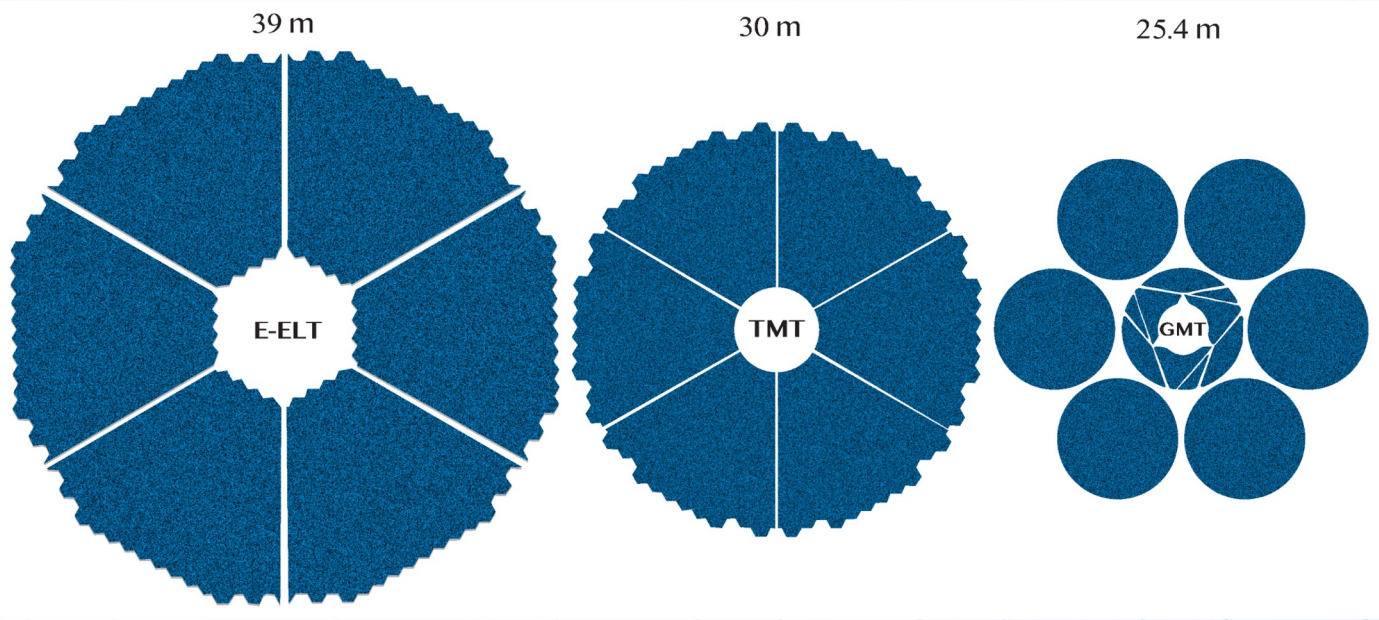
TMT with E-ELT or GMT can follow a single target for many hours because the observatories are at different longitudes

ELT Apertures

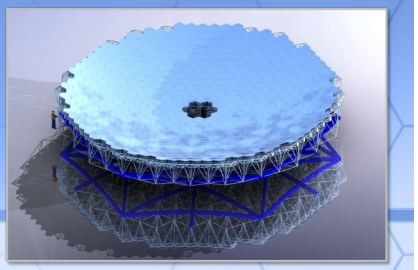
Each ELT has made design choices that can be seen in their clear apertures.

These shapes affect their Point Spread Functions (PSFs)

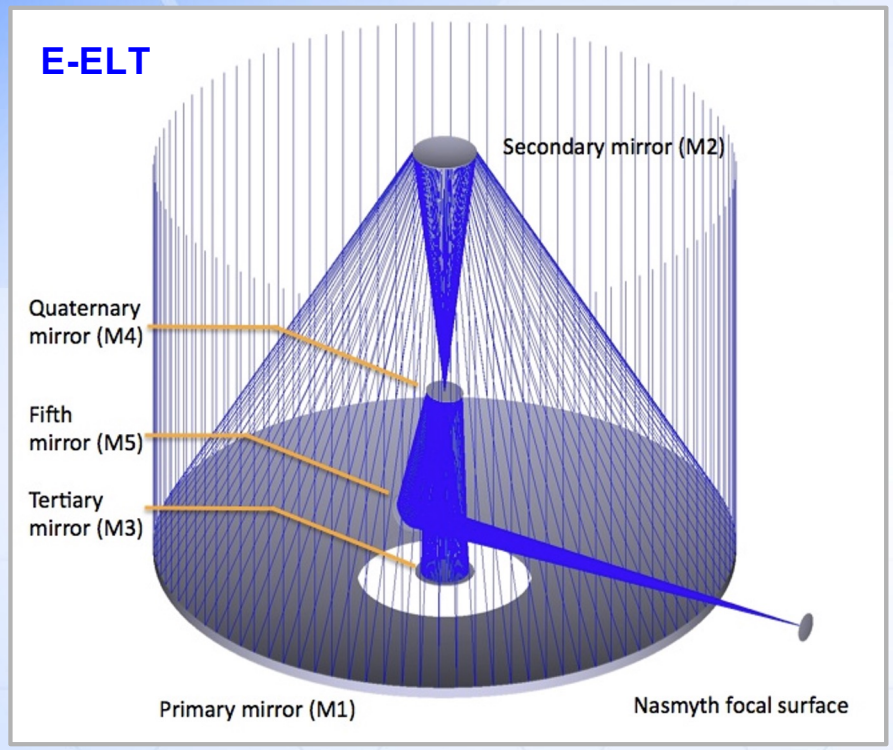
More uniformly filled apertures lead to cleaner PSFs and makes high contrast imaging easier

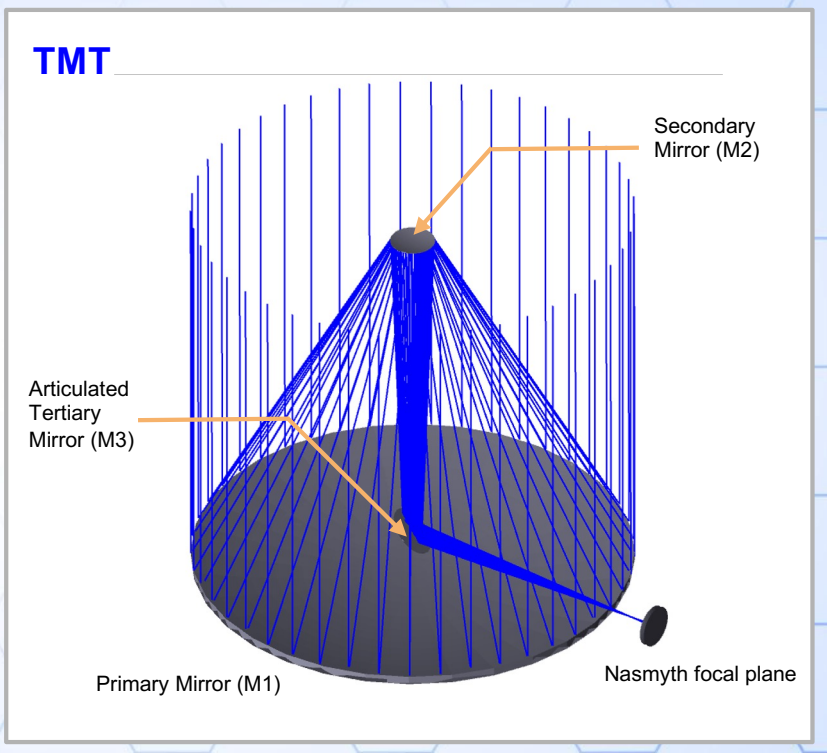


E-ELT 5 Mirrors Cost Light



Fewer mirrors makes TMT more efficient

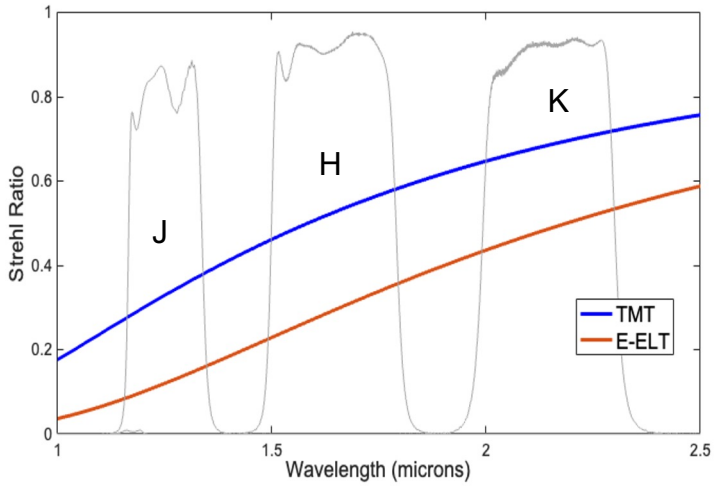


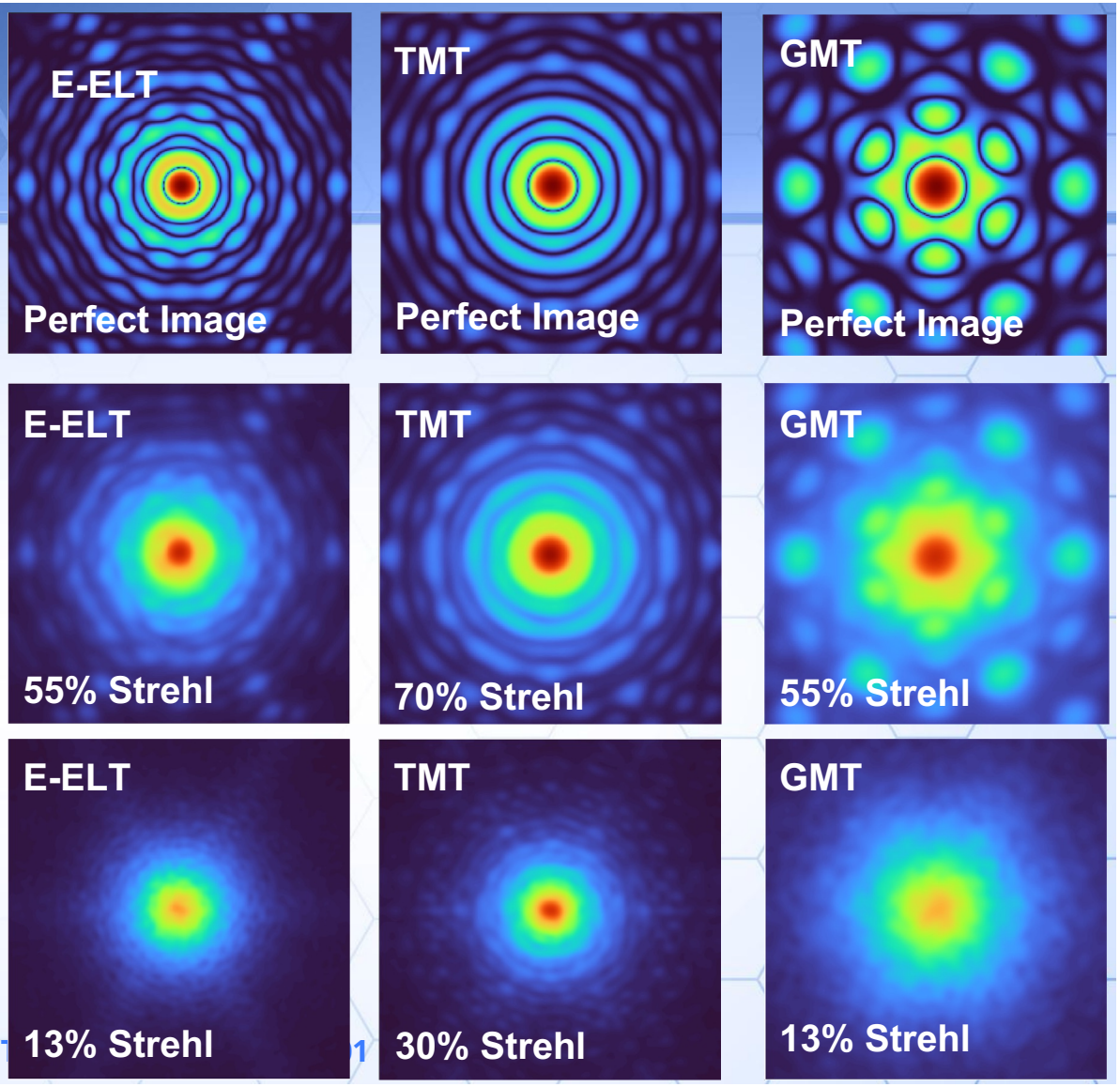


TMT
Thirty Meter Telescope

Strehl Ratio changes with wavelength. Ratio of Strehl increases for shorter wavelengths

Exposure time proportional to S^{-2}



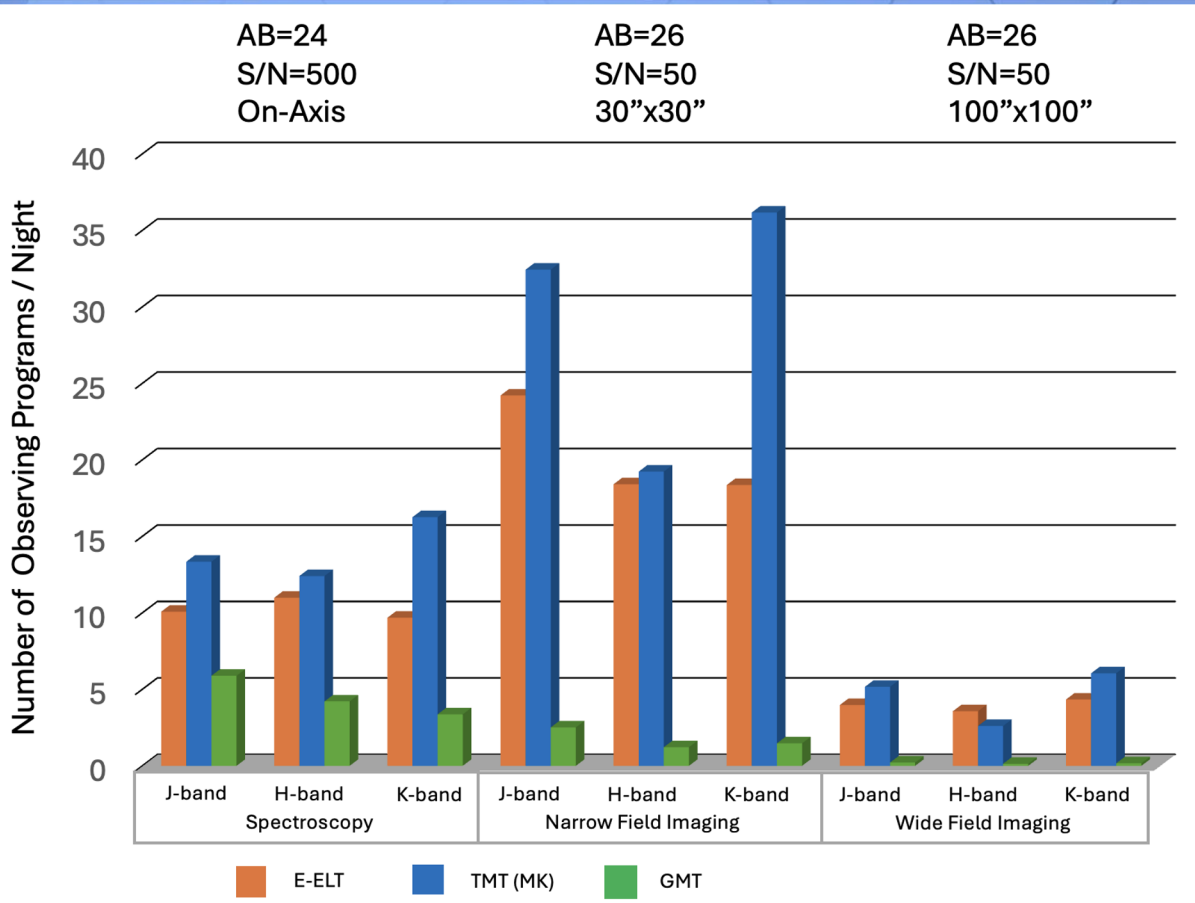


TMT Leads the Way in the Near Infrared

Because of superior AO performance TMT outperforms E-ELT in near infrared:

- Spectroscopy
- Narrow Field Imaging
- Wide Field Imaging

We consulted ESO on their Adaptive Optics performance, and also checked our estimates with GMTIFS exposure time calculator.



May 30, 2025

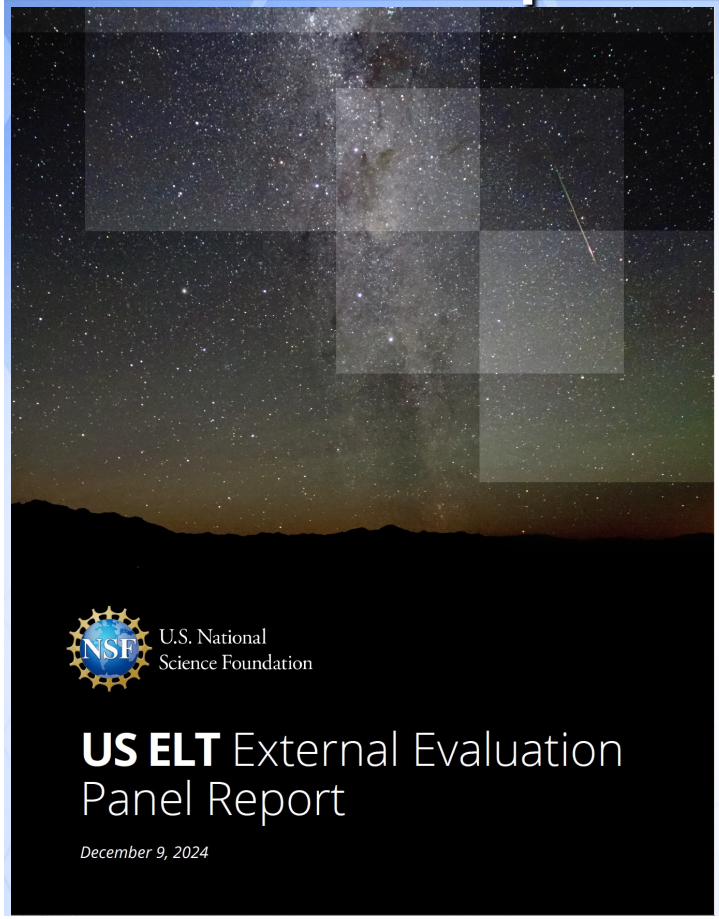
FY 2026 Budget Request to Congress

- **Mid-scale Research Infrastructure - Track 2**. See discussion above.

Design of Potential New Major Facility Construction Project. Given the unaffordability of continuing funding two different multi-billion dollar telescopes, NSF will advance the Giant Magellan Telescope (GMT) into the Major Facility Final Design Phase, but the Thirty Meter Telescope (TMT) will not advance to the Final Design Phase and will not receive additional commitment of funds from NSF. NSF has received assurances from the GMT project that it can complete the final design phase without further investments. Moving into the final design phase does not guarantee that a project will be approved for construction, and doing so does not obligate the agency to provide any further funding. The FY 2026 Request supports continued design of a single telescope within the U.S. Extremely Large Telescope (ELT) program.

But, TIO has provided the same assurance to NSF, in writing, that we do not ask for new NSF funding in the Final Design phase.

NSF has a time-honored reputation for making fair and thoughtful decisions, based on open, transparent reviews with clear selection criteria



TMT has participated in rigorous scientific and programmatic NSF review processes to date, Including the latest “US ELT External Evaluation”

US ELT External Evaluation Panel Report

— Embargoed until 11 am EST December 9 —

In conclusion, the success of the US-ELT Program hinges on securing the necessary resources from Congress, with NSF funding being critical to both projects. Both GMTO and TIO have strong proposals with distinct strengths and challenges, and the panel recommends careful consideration of their Risk Management Plans and the security of partnership commitments as decisions about advancing either project are made. The panel advises the Director to optimize the use of taxpayer funding to ensure that both projects have the opportunity to succeed in FDR.

Yet, the rationale in the PBR on USELT is opaque

TIO Response to FY2026 PBR

tmt.org/news/692

- TIO members are firmly committed to finding a path forward
- The Senate Appropriations language strongly supports TMT entering NSF Final Design process, but the government shut down makes it hard to predict the FY2026 appropriations process
- The Gov. of Japan, NINS and NAOJ have been working tirelessly on advocacy in DC and in Hawaii, including the possibility of building TMT on a decommissioned site

Since 2017, TIO has designated ORM in Spain as an alternate site if the primary site on Mauna Kea does not work out

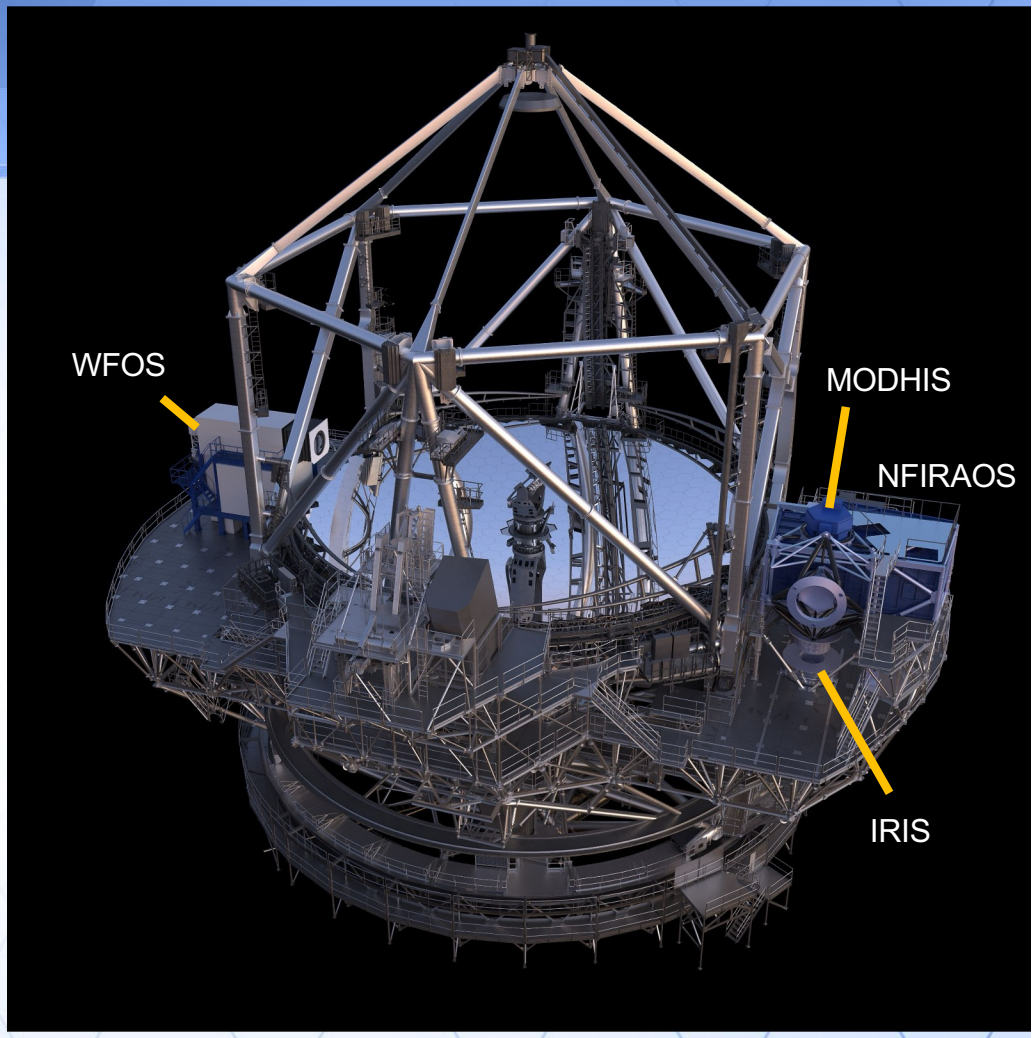
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
CDTI INNOVACIÓN

- On July 23, 2025, Science Minister of Spain Diana Morant sent a proposal to TMT and publicly announced the invitation with the opportunity for up to €400M through CDTI.
- All major political parties across Spain— national, regional, and island governments— have called for bringing TMT to La Palma
- TIO Board, with deep appreciation, is exercising due diligence to carefully study this generous offer

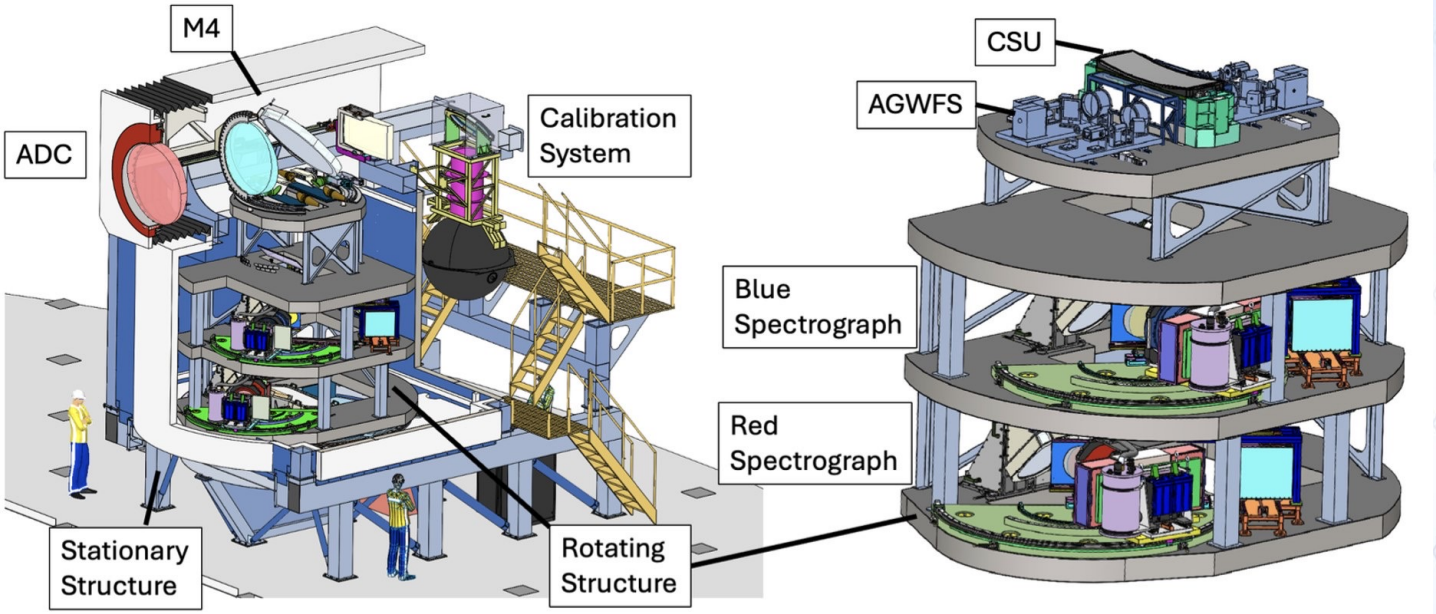
TMT Project Status and Recent Progress

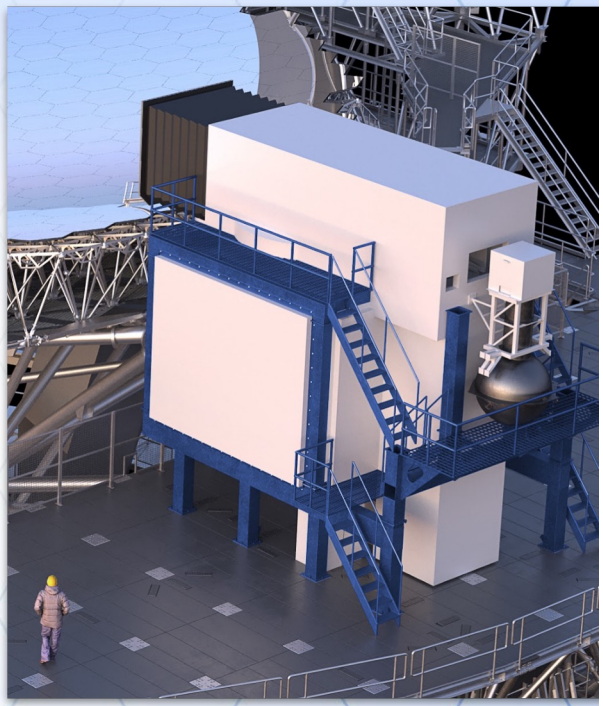
TMT Instruments

- TMT has 2 large Nasmyth Platforms
  - Gravity Invariant Instrument Ports
  - Strict Vibration Requirements
  - Room for ~8 facility instruments
- First Light Instruments
  - **NFIRAOS:** Facility LGS AO system
    (Already completed final design)
  - **IRIS:** Imaging Near Infrared (NIR) Integral Field Spectrograph (Final Design in Dec2025)
  - **WFOS:** Wide Field Optical Spectrograph
  - **MODHIS:** AO fiber fed high-resolution NIR spectrograph

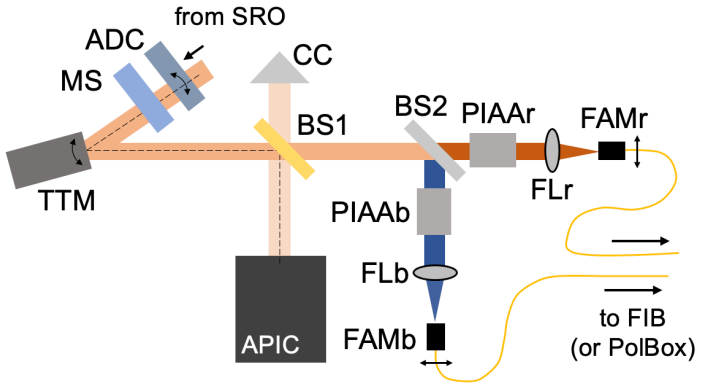


WFOS is in Preliminary Design
(Passed Conceptual Design Review CoDR in July 2025)

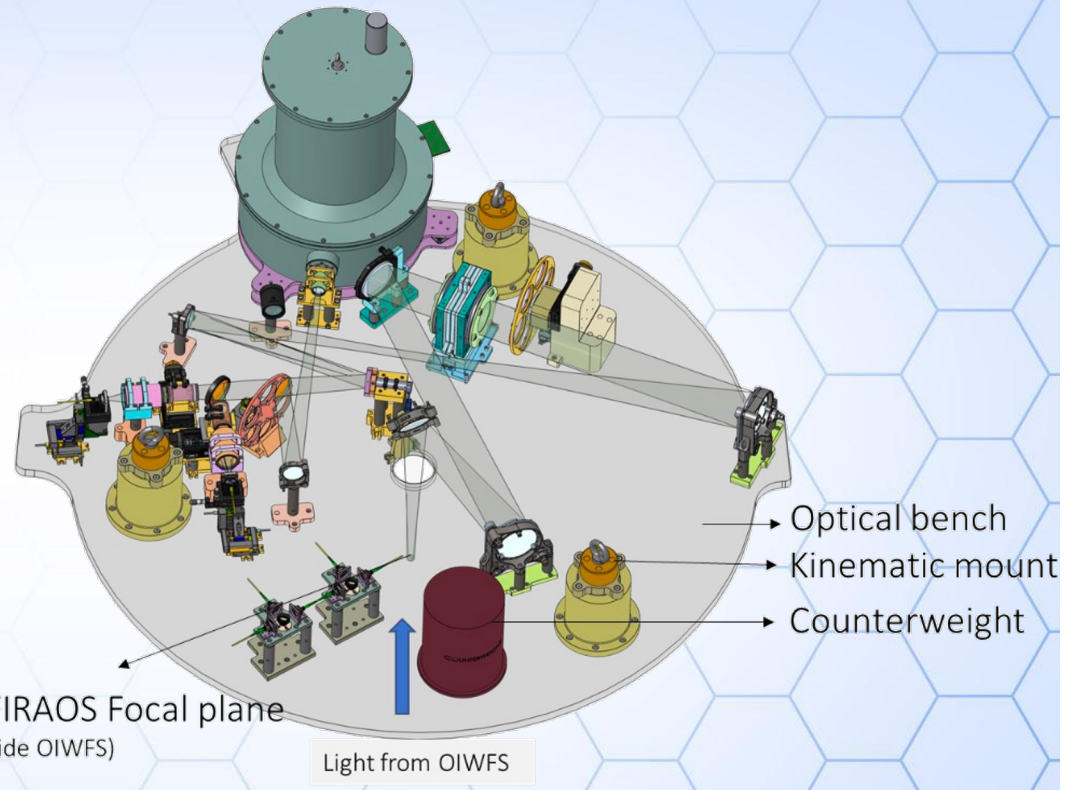




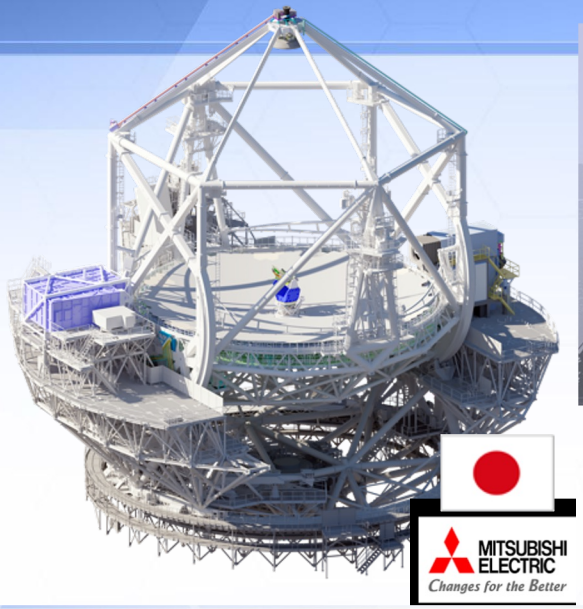
MODHIS is also in Preliminary Design (Passed Conceptual Design Review CoDR in Sept 2025)

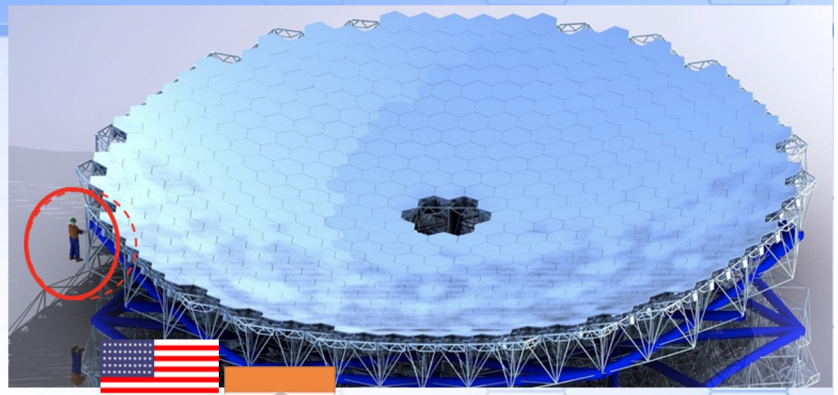


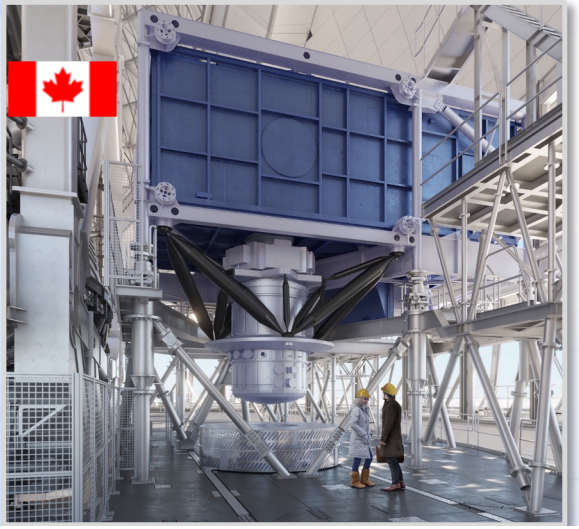
ADC - Atmospheric dispersion compensator	APIC - Acquisition/tracking, and pupil imaging camera
MS - Mask selector	PIAA(b/r) - Phase induced amplitude apodizer
TTM - Tip/tilt mirror	FL(b/r) - Focusing lens
BS - Beam splitter (dichroic)	FAM(b/r) - Fiber alignment mechanism
CC - Corner cube (retroreflector)	

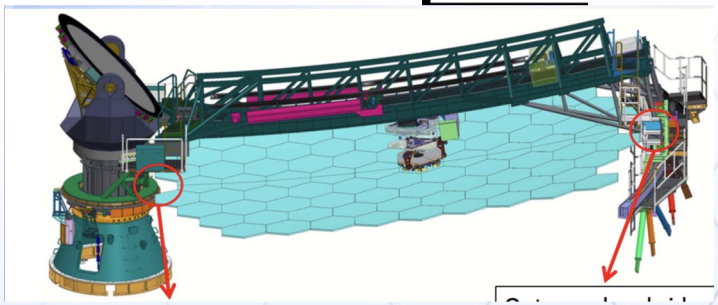


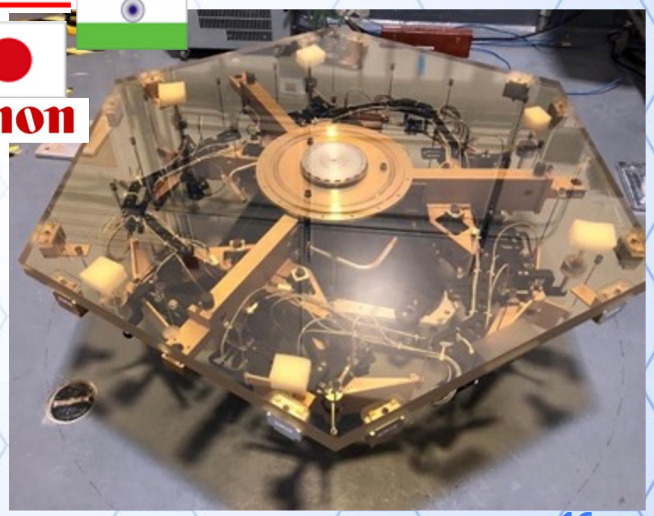
86% of systems are in Final Design or Fabrication







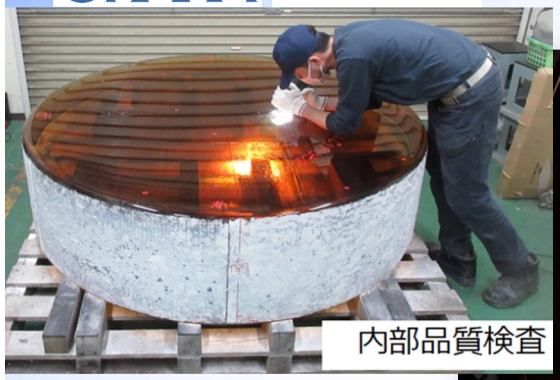


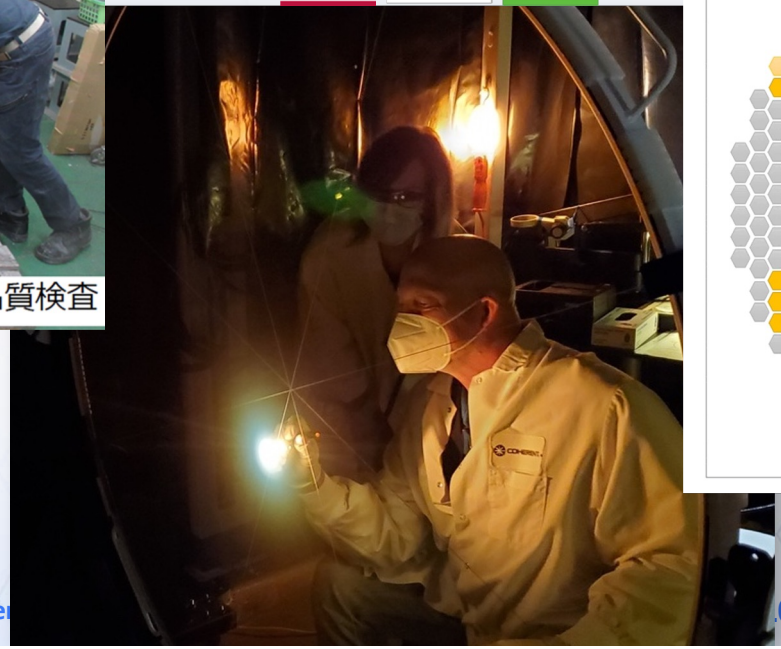


Primary Mirror Segment Production

- Japan delivered 336 blanks (~60%)
- 165 roundels polished

OHARA Okamoto

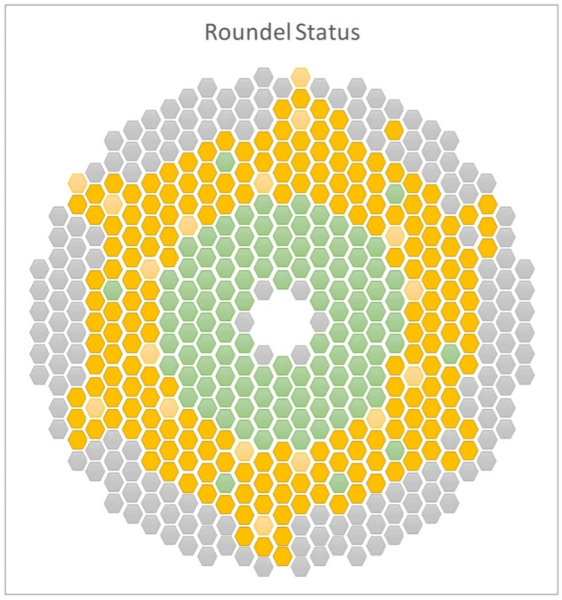




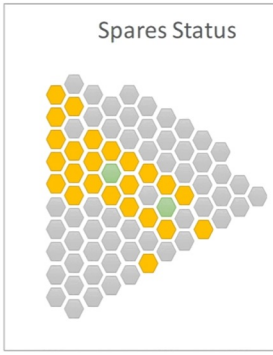
TMT THIRTY METER TELESCOPE

DECEMBER 2020

ACCEPTED Roundels = 0

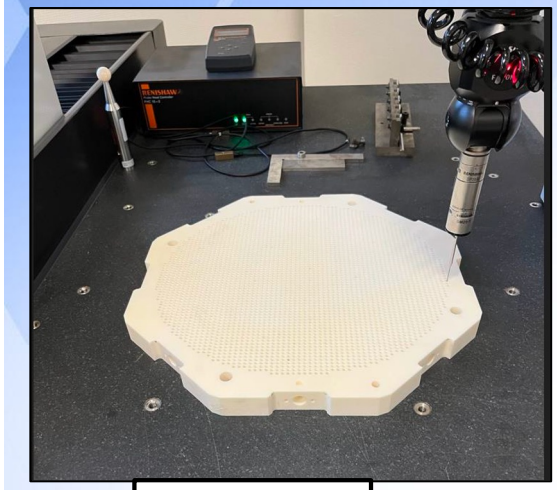


223	Planned
17	In-Work Blank
218	Accepted Blank
116	In - Work Roundel
0	Accepted Roundel



India TMT Optical Fabrication Facility (ITOFF, End-to-End Capability)

Two Deformable Mirrors In Production at CILAS



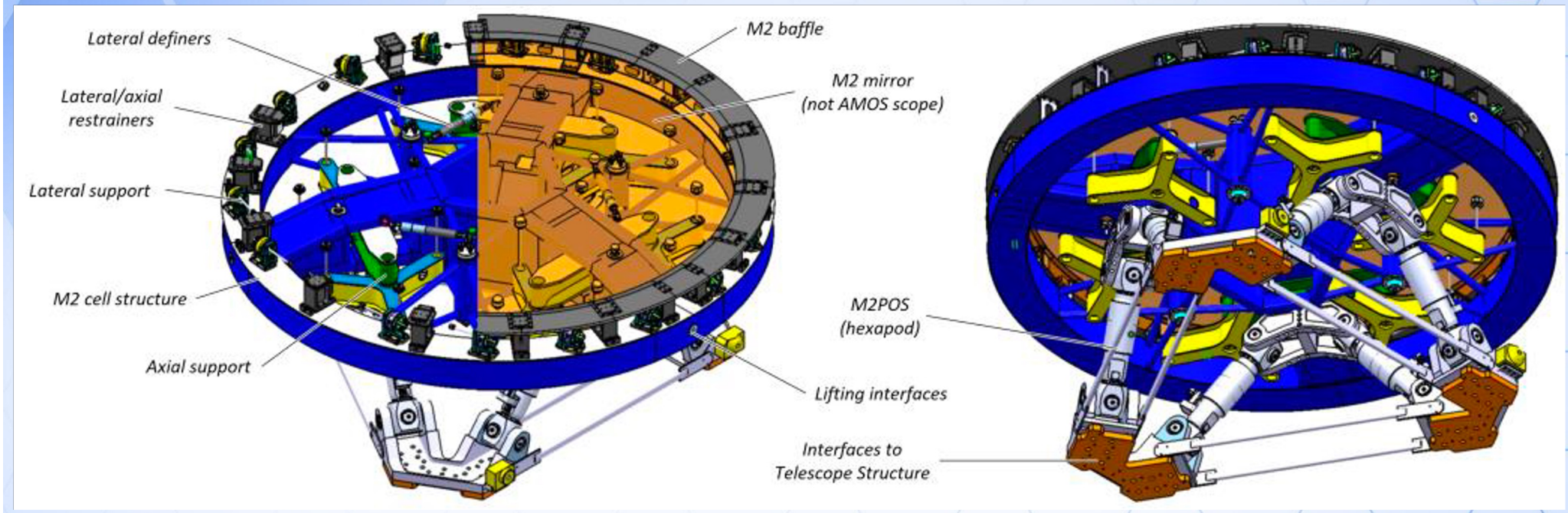
baseplate

Batches of actuators

Assembly tool being validated

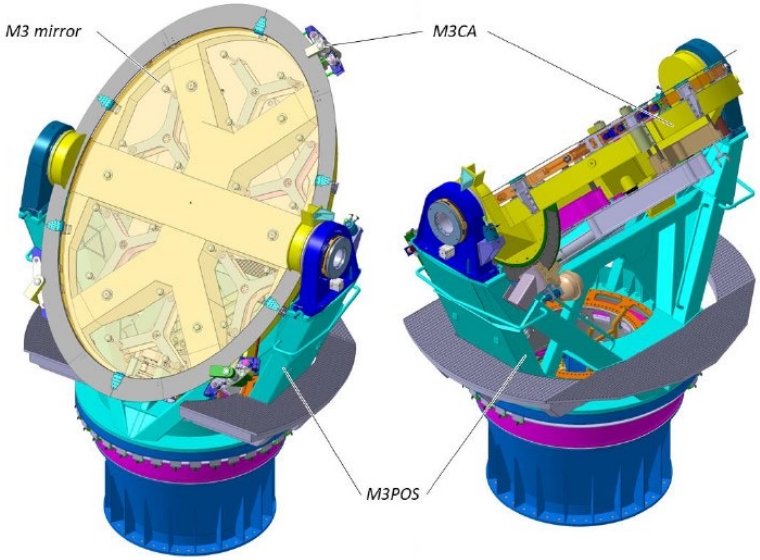
NSF DD1 ($6.5M, 2023) - Funded Task: Secondary Mirror Support System and Positioner (M2SSP)

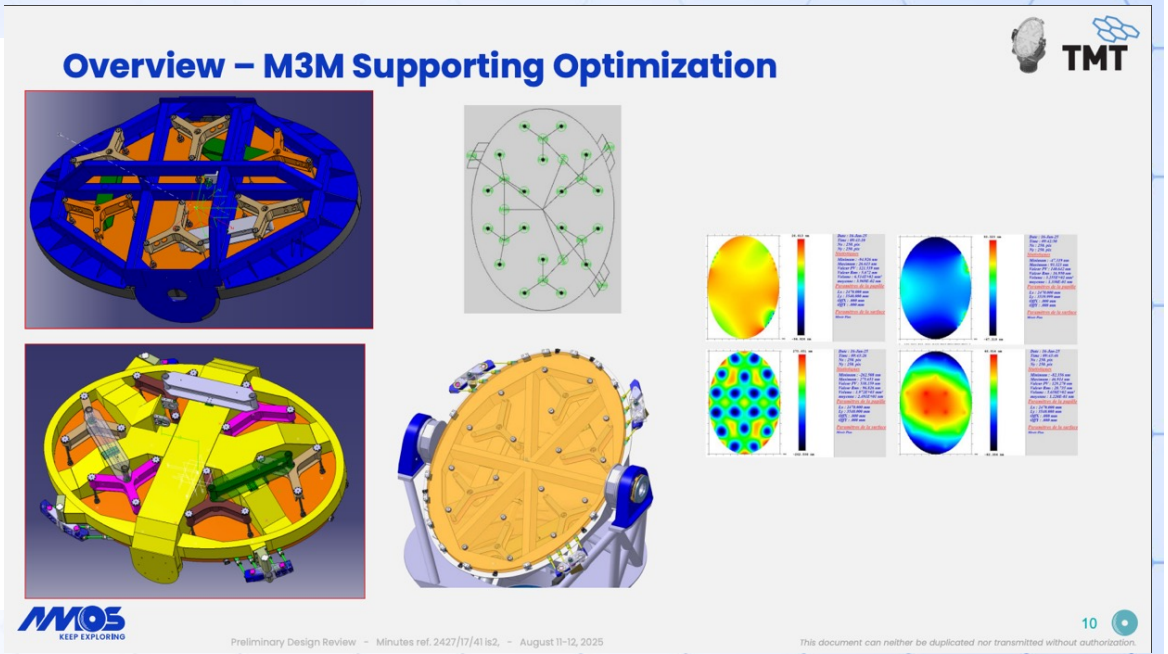
- Passed Final Design Review (FDR) in June 2025 at AMOS/ADS (Belgium)



NSF DD1 ($6.5M, 2023) - Funded Task: Tertiary Mirror Support System and Positioner (M3SSP)

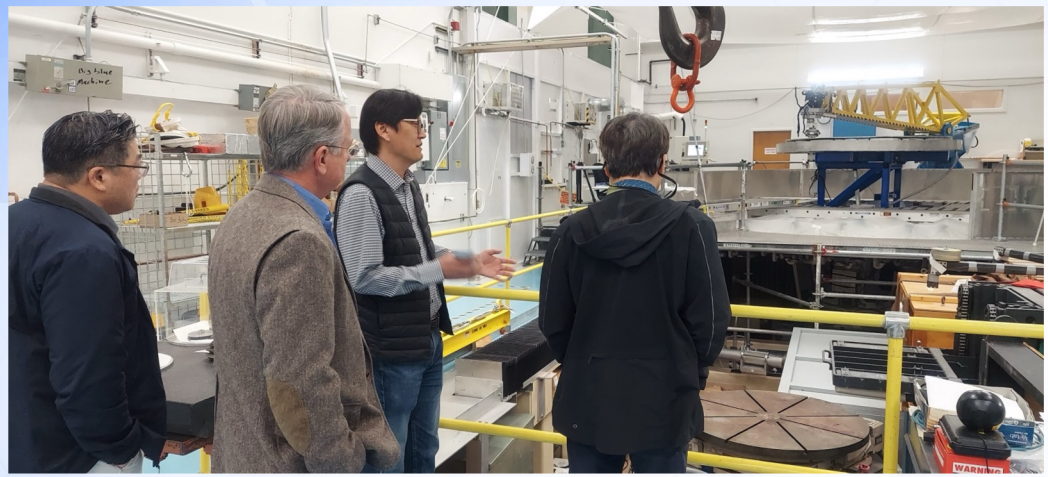
- Passed Preliminary Design Review (PDR) in August 2025, also with AMOS/ADS

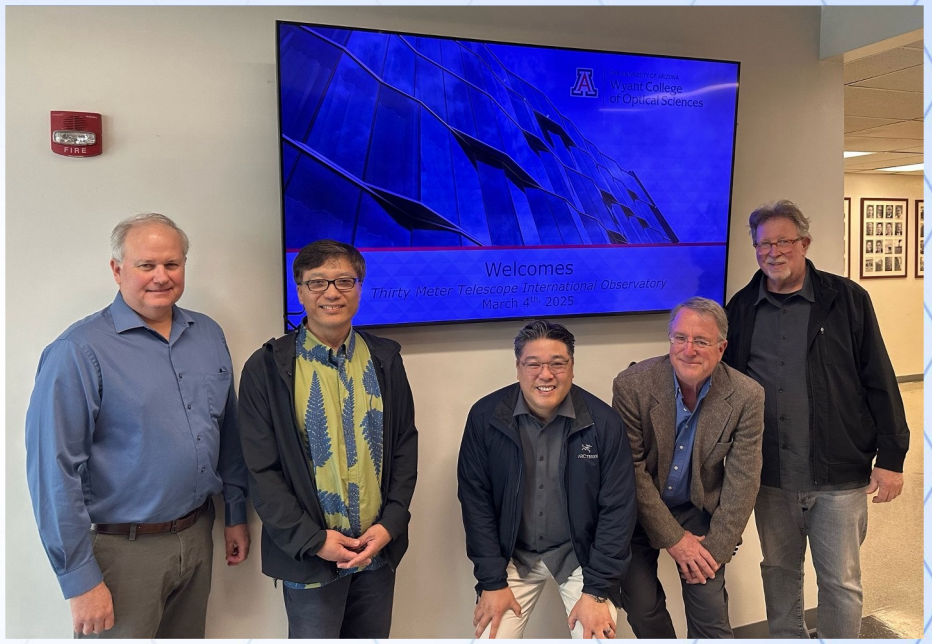




NSF DD2 ($6.5M, 2024)-Funded Tasks: Secondary Mirror (M2) Metrology & Polishing Design

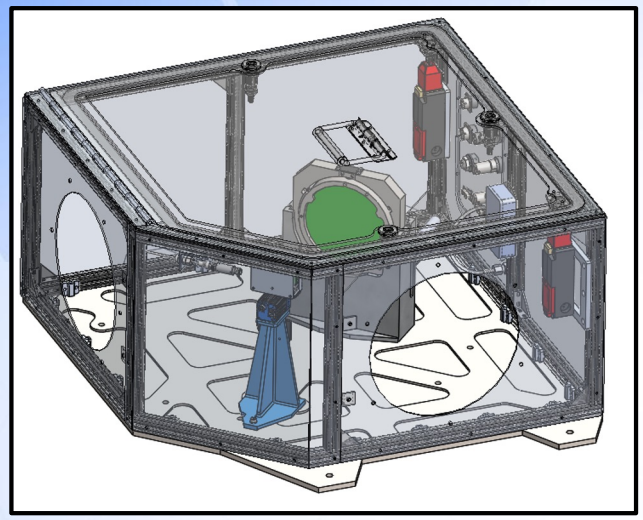
- On contract with UofA College of Optical Sciences
- Unique capability



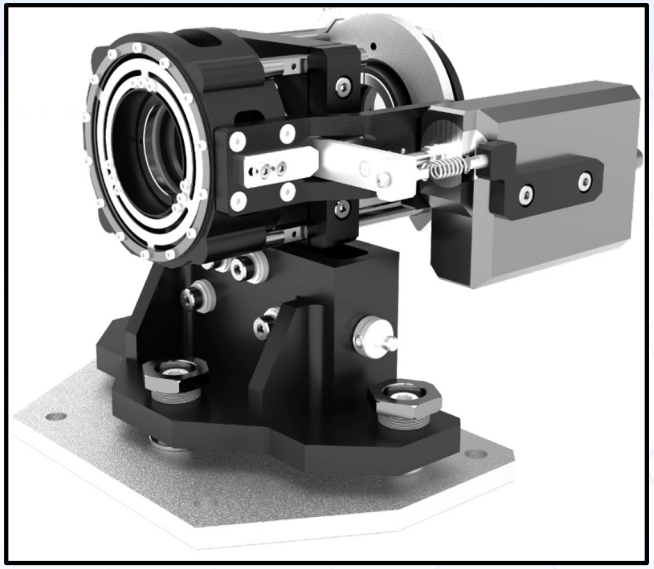


NSF DD2-Funded (in-house) Task: LGSF and AO Sequencer

- Laser Guide-Star Facility (LGSF) FDR in Jan. 2026
- AO Sequencer PDR in Dec. 2025

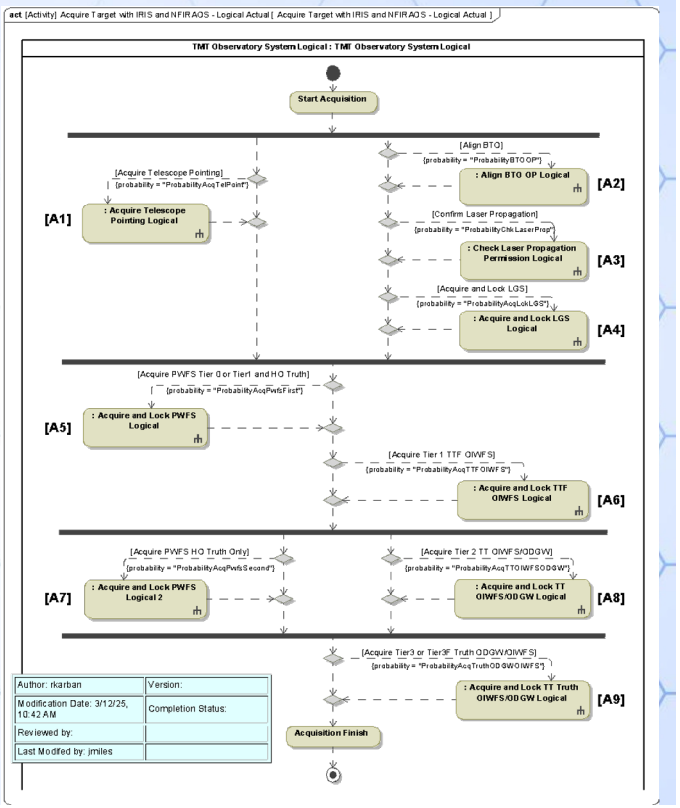


Relay Lens Final design. The Relay Lenses are located on the laser benches and are used to expand the laser beam waists. The Relay Lenses also compensate for slow thermal gradients and CTE mismatches over the optical path.



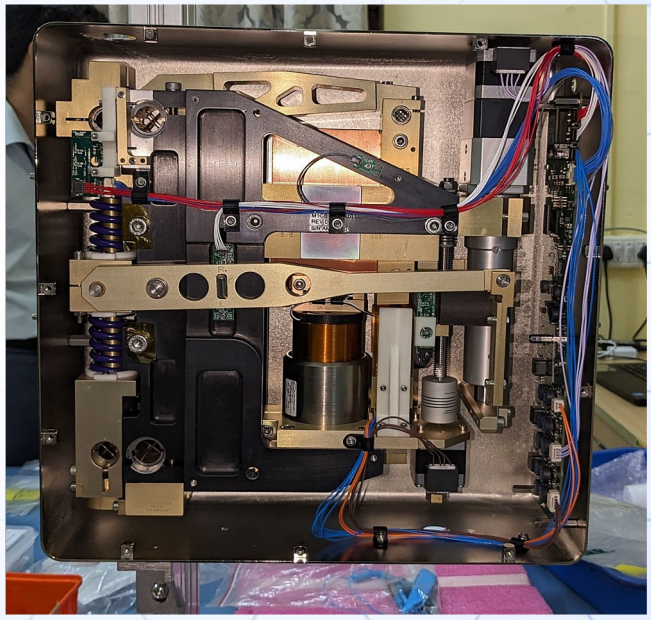
Hexapod Fold Assembly 1 with Gimbal Mount, Pre-alignment camera and all environmental and safety sensors.

Overall acquisition sequence for NFIRAOS and IRIS in LGS MCAO mode



NSF DD2-Funded Tasks: Telescope Alignment and Phasing System (APS), Primary Mirror Control System (M1CS)

- APS FDR November 19-21, 2025
- M1CS Global Loop Controller System (GLCS) PDR on November 17-18, 2025



TIO Monrovia Lab - North Side

(10/16/2025; 150 Polished Roundels and 30 Blanks)

TMT: The Next Generation of Discovery

- **TMT is the only ELT that will cover the northern skies you can't reach from Chile**. Through US-ELT, TMT will enable coverage of the whole sky.
- **TMT meets or exceeds E-ELT in sensitivity, speed and performance**.
- **TMT is the only project based on the proven design** pioneered by the Keck Observatories.
- **TMT is a public-private partnership** with significant nations around the Pacific who are key strategic allies: Canada, India, Japan, and the US.

Acknowledgments

The TMT International Observatory (TIO) gratefully acknowledges the support of the TIO Members and the Gordon and Betty Moore Foundation. The Members and their respective collaborating institutions are as follows: California Institute of Technology (Caltech); the National Research Council of Canada (NRC-CNRC); the Association of Canadian Universities for Research in Astronomy (ACURA); the Department of Science and Technology, Government of India (DST); the Department of Atomic Energy of India (DAE); the National Institute of Natural Sciences of Japan (NINS); the National Astronomical Observatory of Japan (NAOJ); and the Regents of the University of California (UC). This work was supported as well by the Association of Universities for Research in Astronomy (AURA) and U.S. National Science Foundation (NSF).