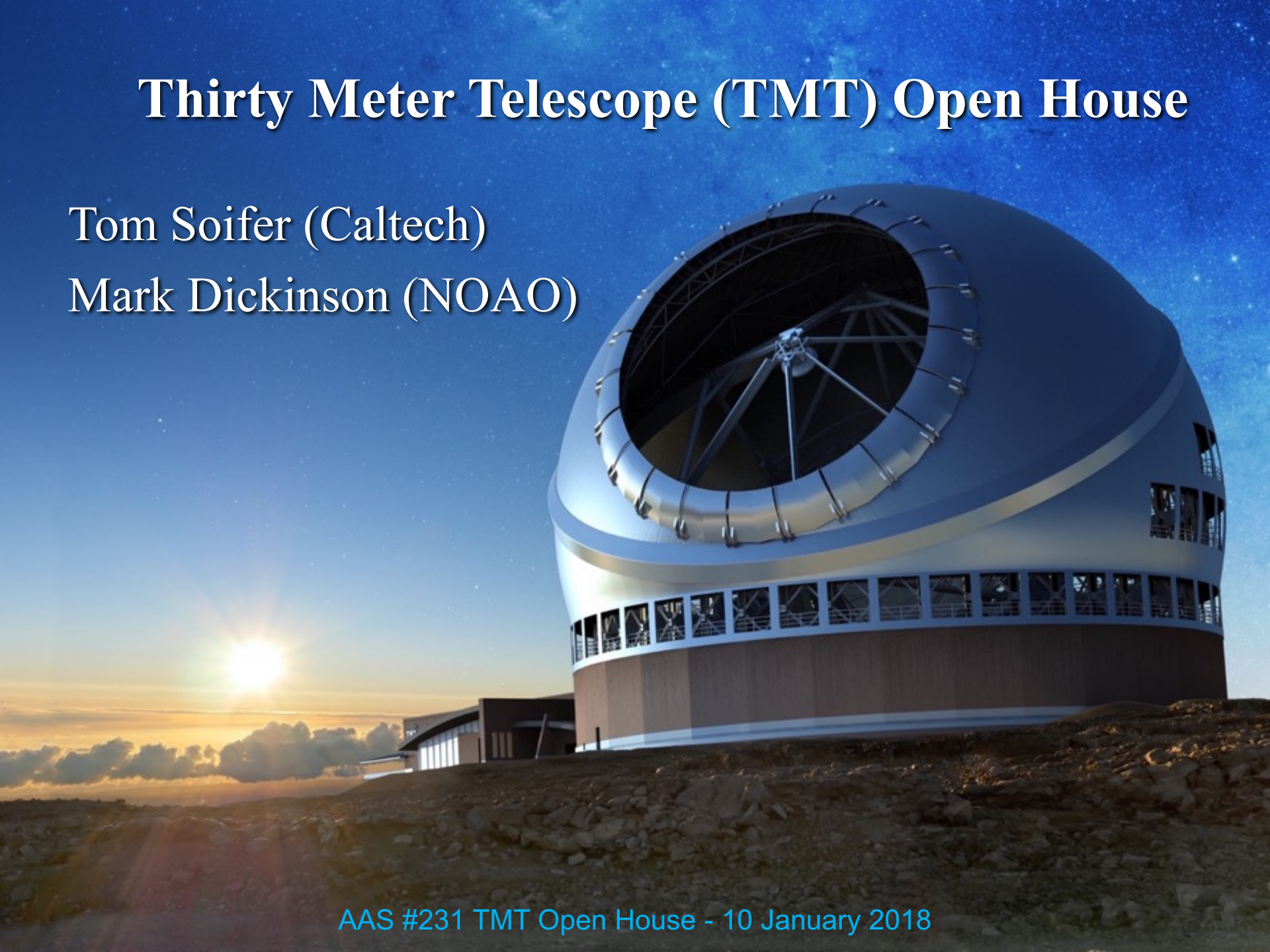
Thirty Meter Telescope (TMT) Open House

Tom Soifer (Caltech)
Mark Dickinson (NOAO)



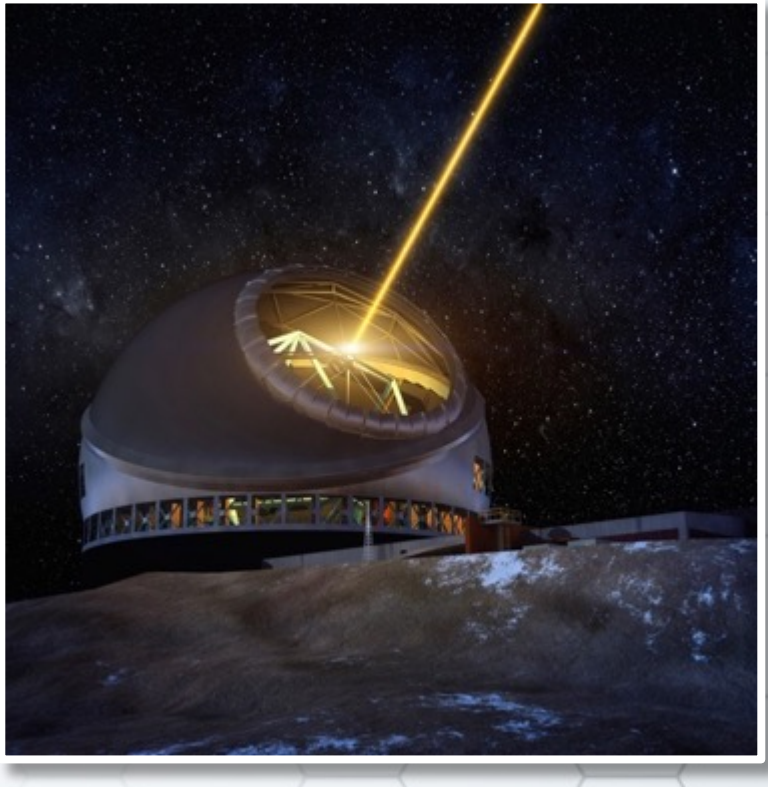
AAS #231 TMT Open House - 10 January 2018

Session Overview

- TMT status
  - Overview
  - Technical status
  - Location, location, location
    - Hawai'i
    - La Palma as alternative site
- US community engagement and the NSF-TMT cooperative agreement
- Q&A

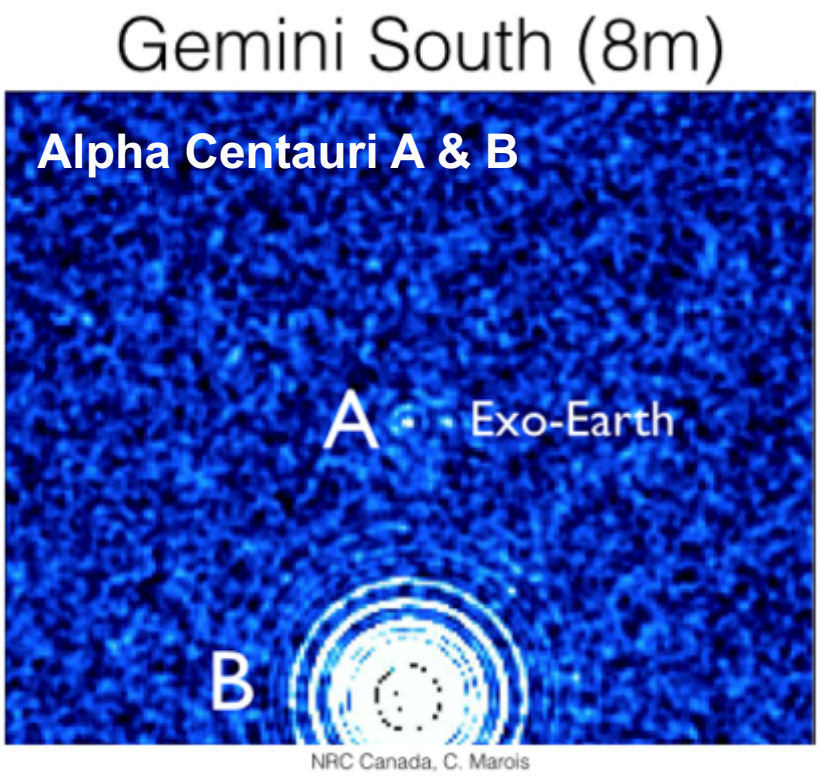
TMT in a nutshell

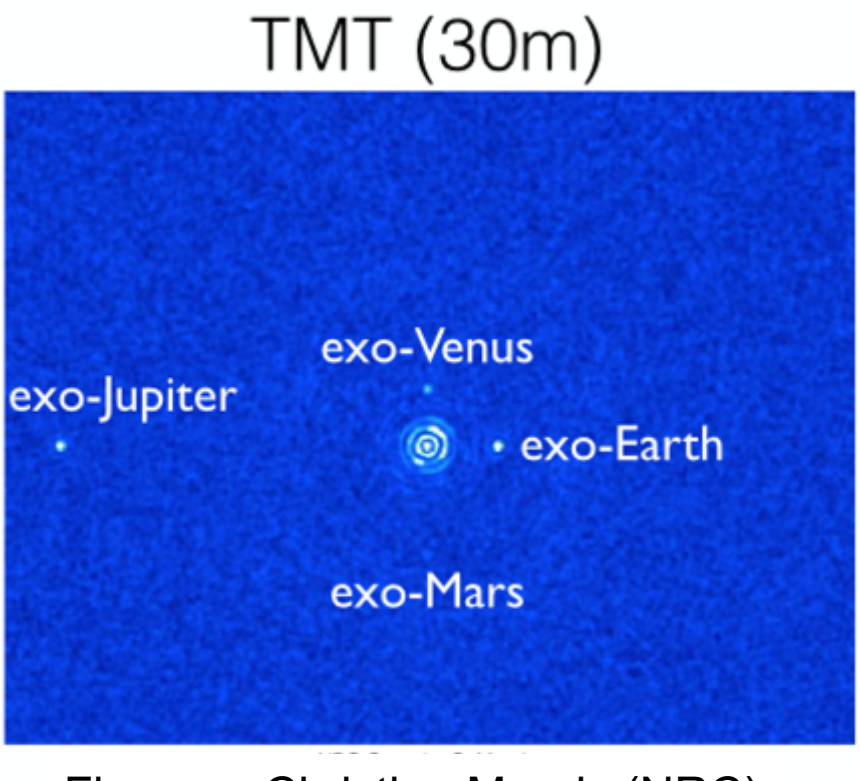
- Wide-field, Alt-Az Ritchey-Chretien telescope
- 30m diameter primary mirror (492 hexagonal segments, 1.44m across corners)
- Active secondary mirror (adaptive?)
- Flat tertiary mirror
- 2 Nasmyth platforms, up to 8 instruments, visible to IR wavelengths
- First-light AO system (NFIRAOS):
  - Laser Guide Star Facility Multi-Conjugate AO (MCAO)
  - Diffraction-limit at J, H, and K bands, can feed 3 instruments



Exo-Solar Systems

- 10 micron ExAO + coronagraphic imaging of terrestrial planets around nearby stars
- Spectroscopy to detect biomarkers (e.g., O_3, CH_4, CO_2)

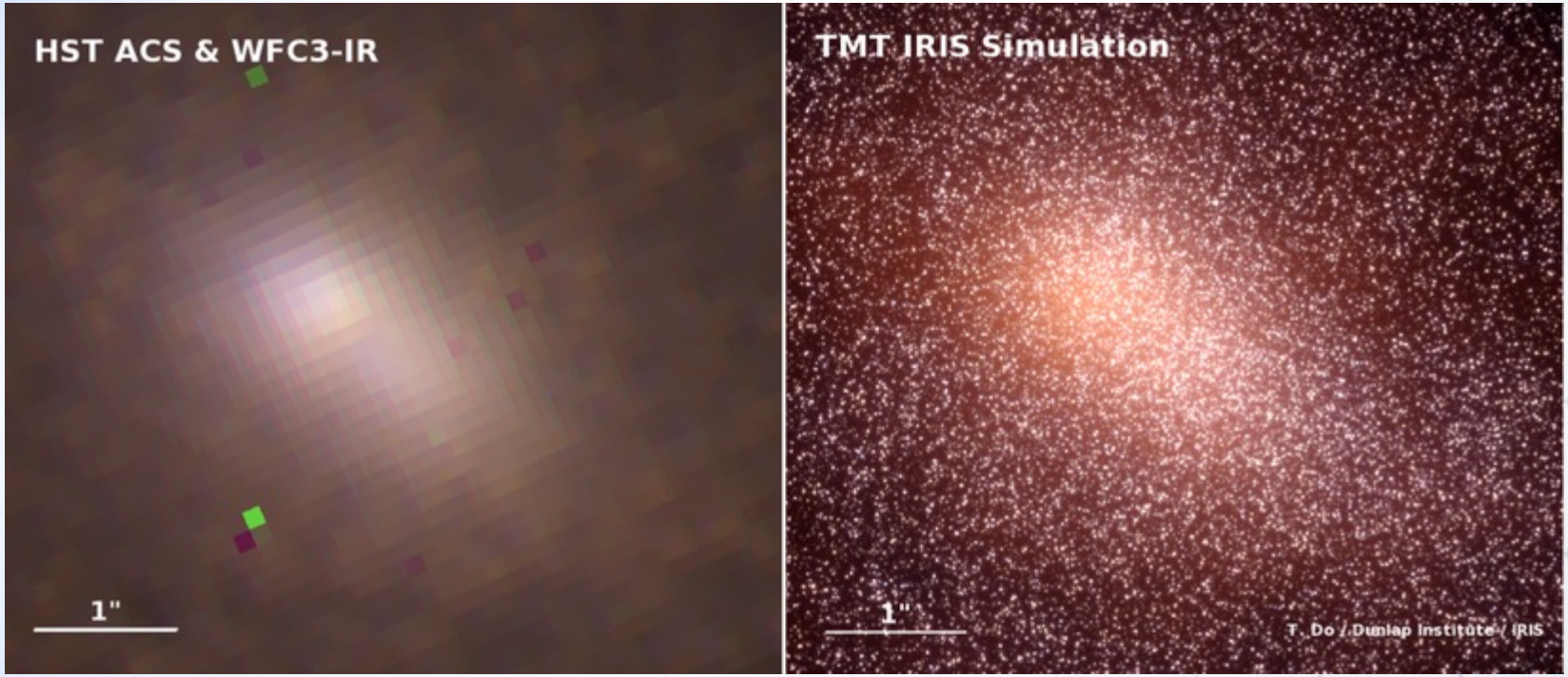




Figures: Christian Marois (NRC)

M31 nucleus

TMT will resolve stellar populations and stellar dynamics around the central supermassive black holes of nearby galaxies



TMT International Observatory, LLC

- Members
  - Canada, National Research Council
  - California Institute of Technology
  - China, Chinese Academy of Sciences
  - India, Department of Science and Technology and Department of Atomic Energy
  - Japan, National Institutes of Natural Sciences
  - University of California
- Associate
  - NOAO/AURA consistent with the US NSF Cooperative Agreement
- Observers
  - University of Hawai'i, Gordon and Betty Moore Foundation

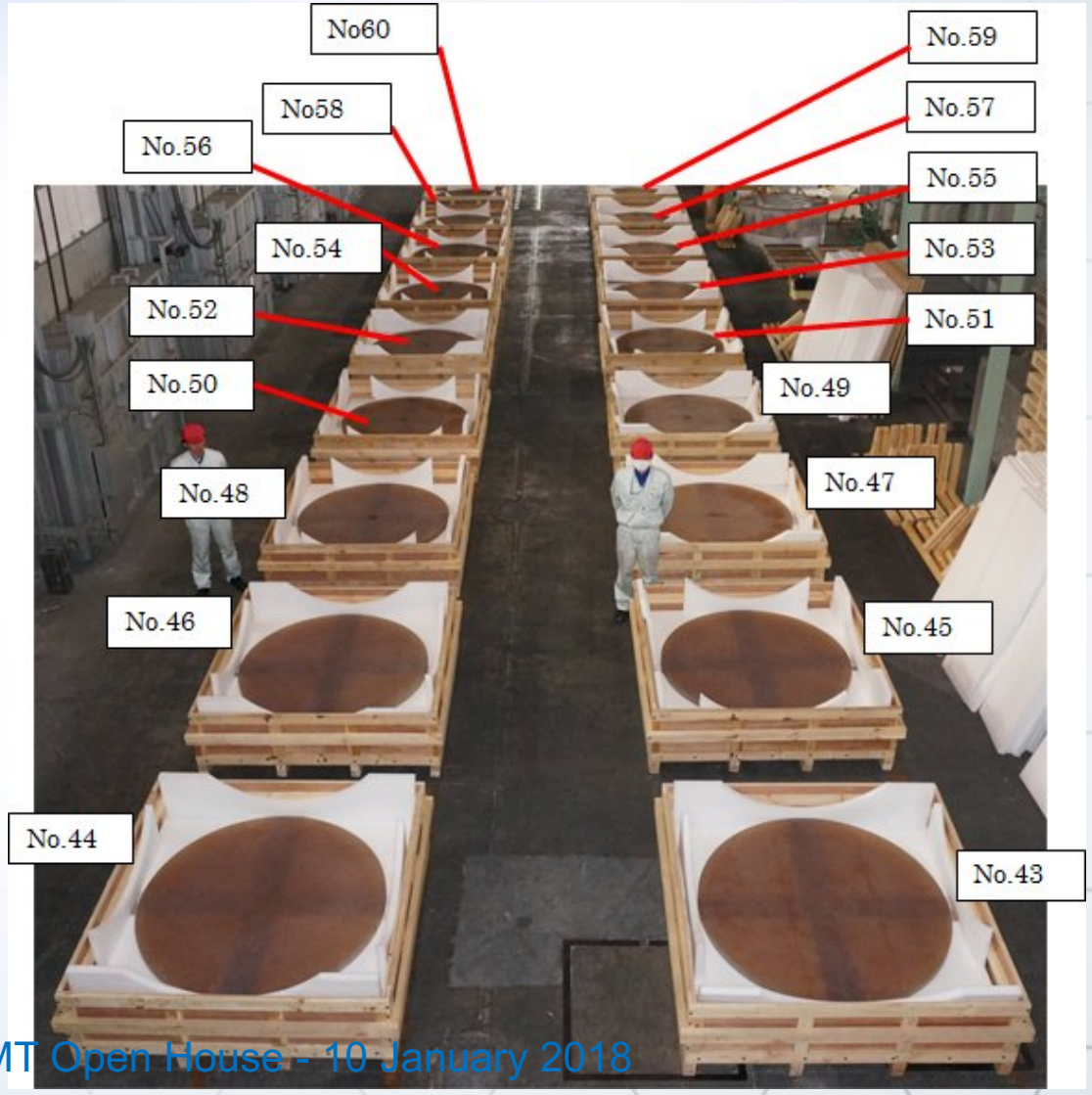
TMT Enclosure Final Design

TMT Telescope Structure by MELCO

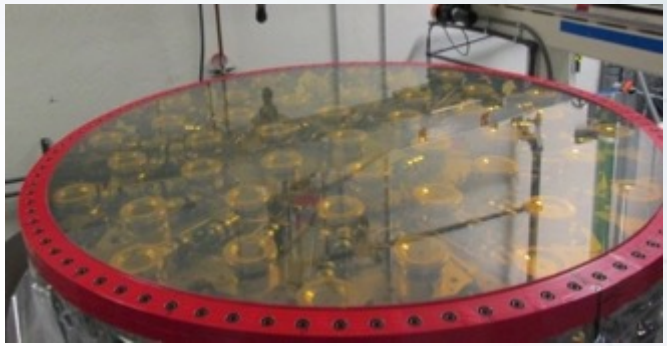
TMT Telescope Structure
Main Structural Node

M1 Segment Blank manufacturing is underway - Ohara

- Ohara is producing all of the 1.52 m diameter segment mirror blanks
  - Clearceram-Z HS zero expansion glass ceramic
- 213 blanks of the 574 have been completed to date
- **Production is underway!**



M1 Segment Polishing - Coherent



Stressing Fixture

Polishing the stressed segment with a spherical tool

Full production polishing contract signed!

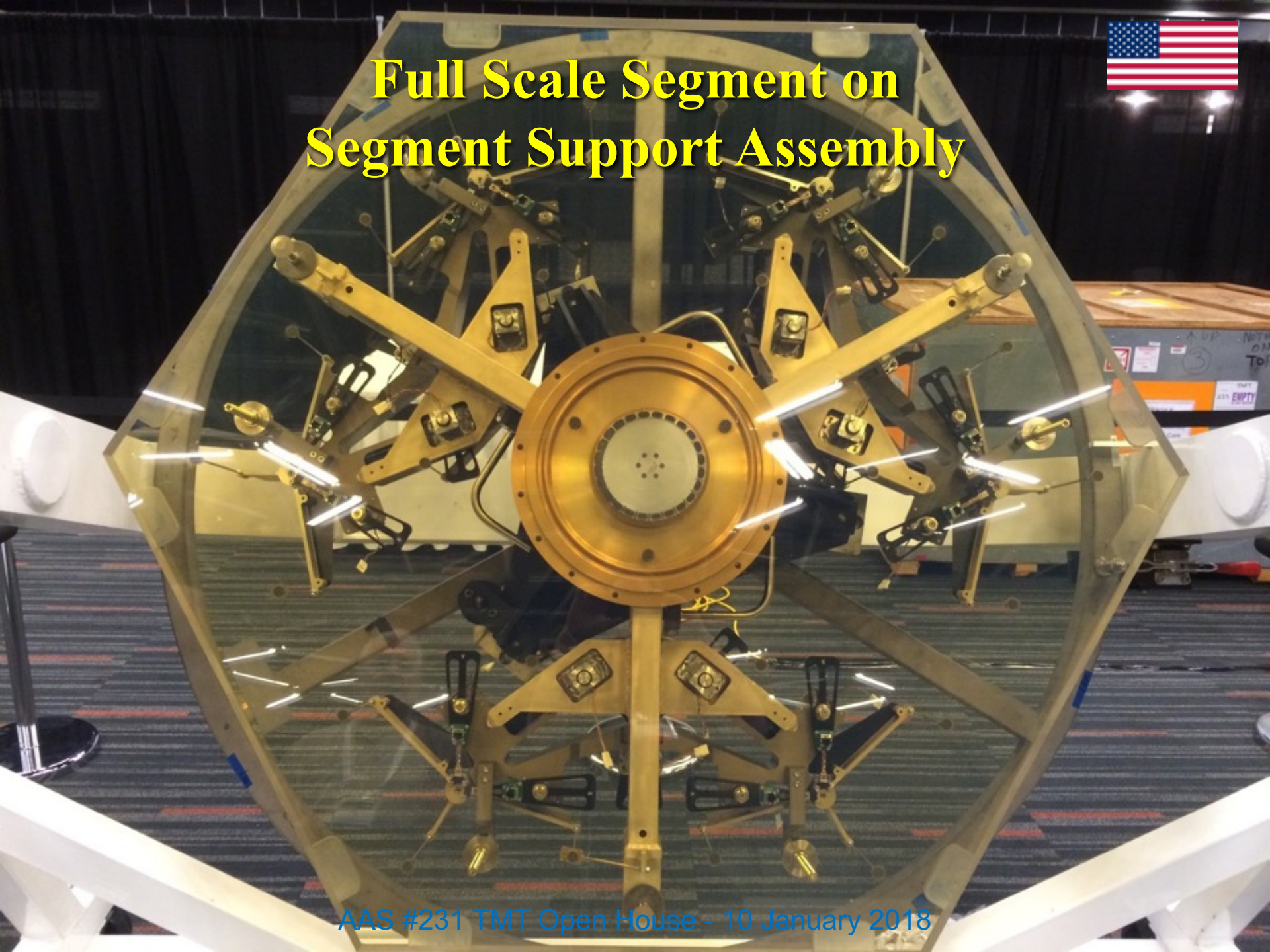
Primary Mirror Control System
JPL, TMT-India

- Jet Propulsion Laboratory is responsible for the system design
- India is responsible for production of actuators, sensors, electronics

Actuator components

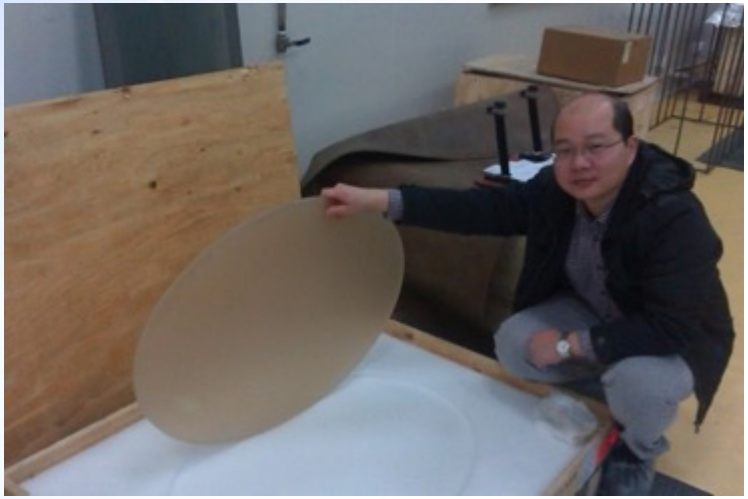
Edge sensors

Full Scale Segment on Segment Support Assembly

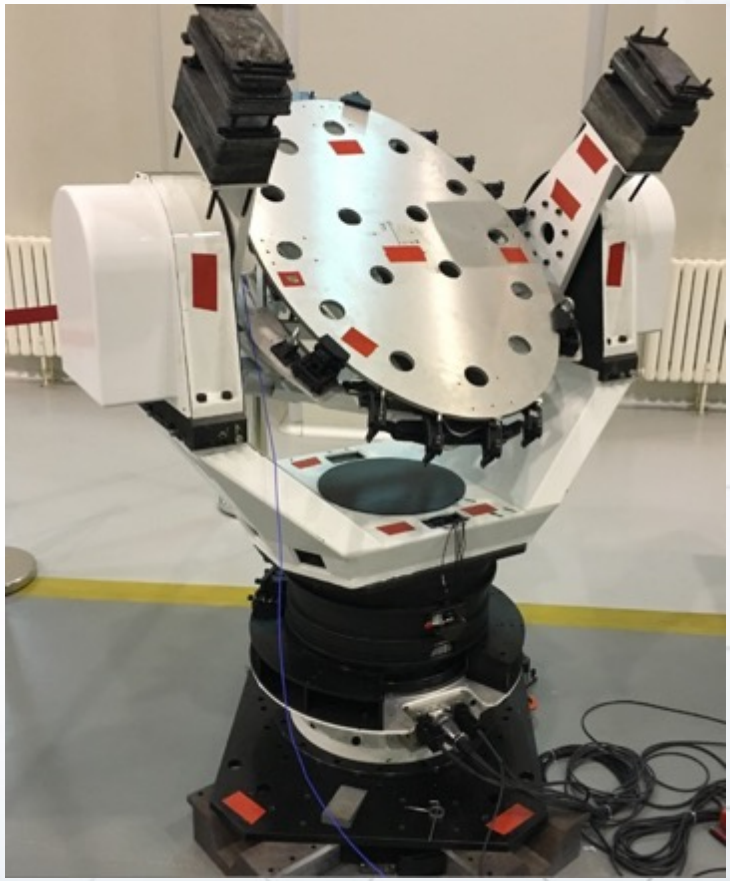


Tertiary Mirror System (M3) – CIOMP, Changchun

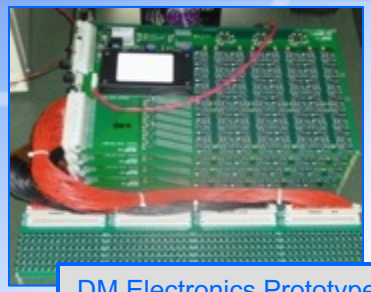
- The full-scale M3 system is in preliminary design phase
- In parallel, CIOMP has completed a ¼-scale prototype M3 system

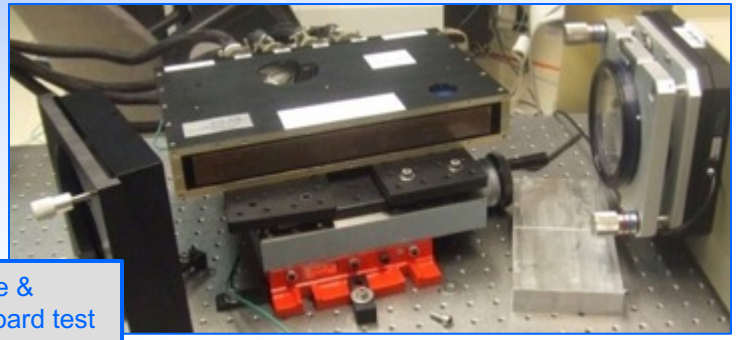


Zerodur blank for subscale prototype mirror

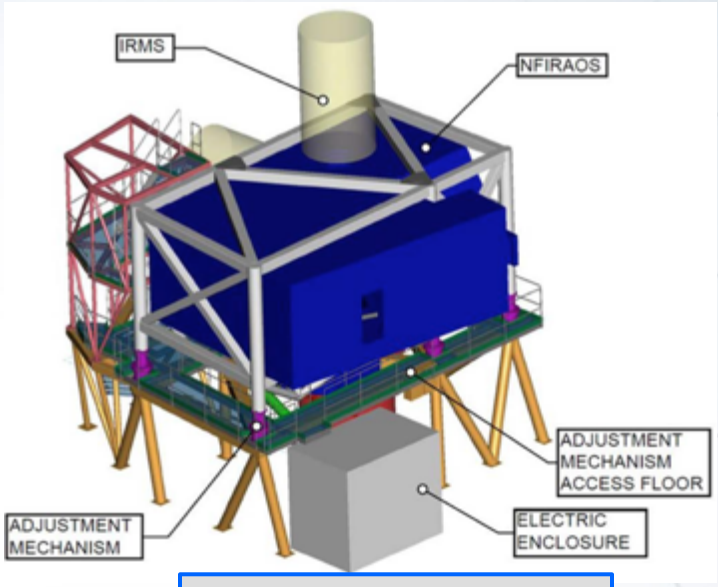


TMT Facility AO System NFIRAOS in Final Design Phase at NRC Herzberg

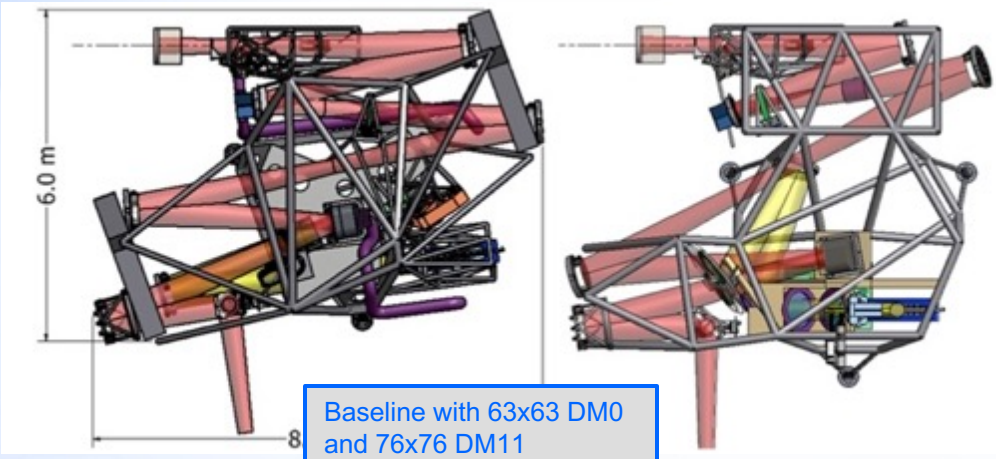




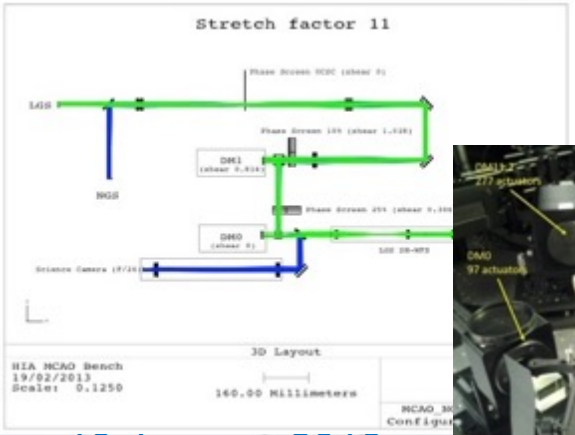
DM Electronics Prototype & CILAS DM 6x60 Breadboard test setup (warm) at NRC - Herzberg



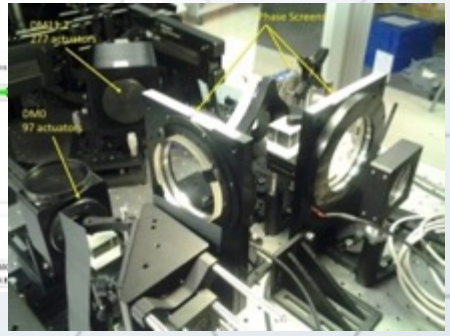
Interface with telescope structure

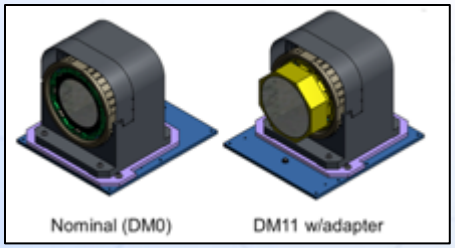


Baseline with 63x63 DM0 and 76x76 DM11



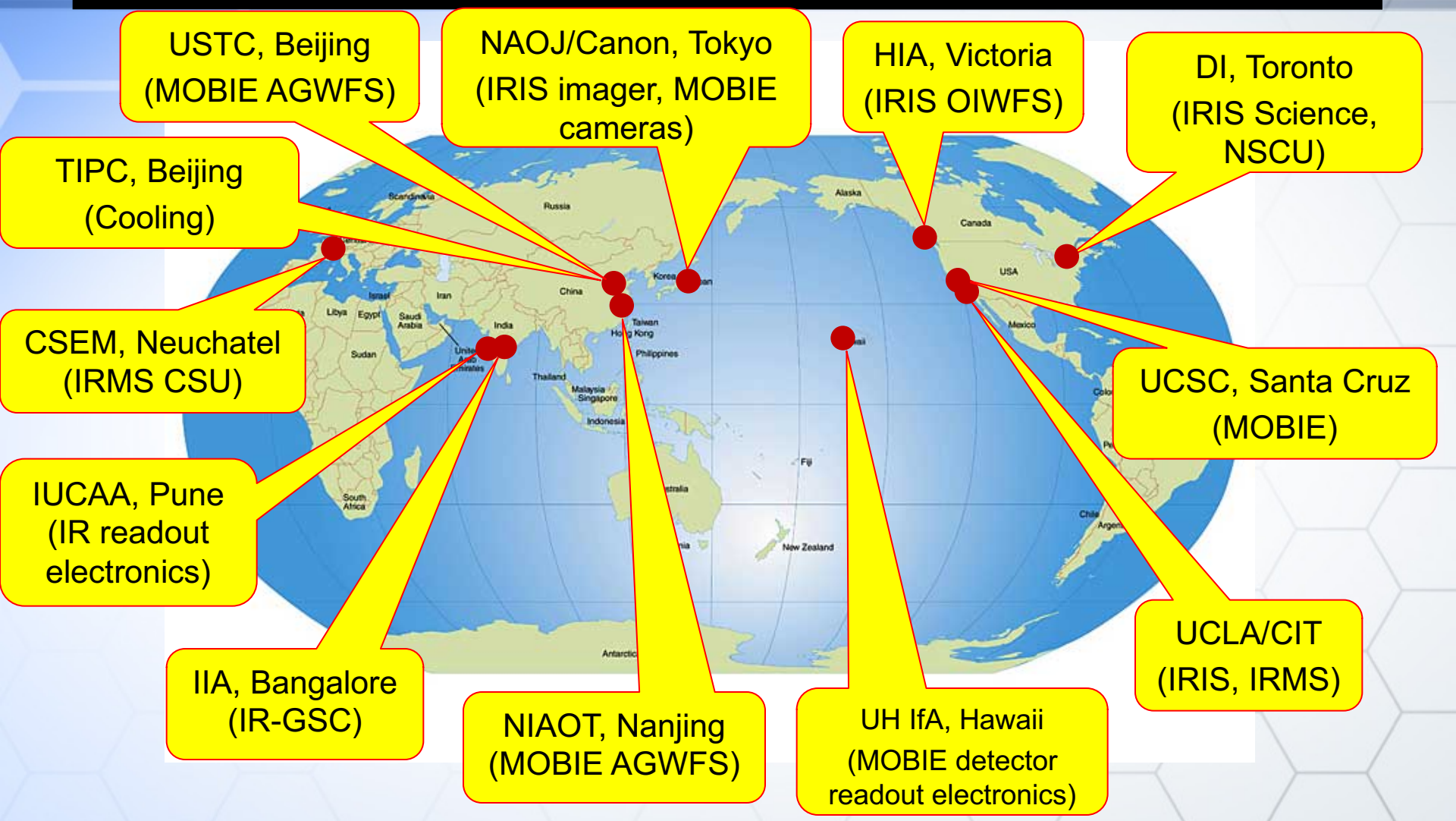
MCAO test bench





DM11 mounted on Tip/Tilt Stage for baseline configuration

TMT Global Participants
First Light Science Instruments



Hawai'i History

- After 7 years of work all legal steps were completed for construction on July 23, 2014
- With permit and sublease in place, construction was to be initiated in Spring 2015
- Protests stopped construction vehicles on three occasions
- December 2, 2015 Hawai'i Supreme Court vacated the permit on procedural grounds
- A second Contested Case hearing and a second vote by the State of Board of Land and Natural Resources (BLNR) was required to get new permit

Contested Case II - CDUP

- Second contested case got underway in Oct 2016
- Following 44 days of testimony by 71 witnesses over five months, the hearing concluded in March 2017
- Oral arguments before the BLNR on Sep 20, 2017

Contested Case Hearing Officer: Findings of Fact, Conclusions of Law and Recommended Decision and Order

BOARD OF LAND AND NATURAL RESOURCES
STATE OF HAWAI`I

IN THE MATTER OF

Contested Case Hearing Re Conservation District Use Application (CDUA) HA-3568 For the Thirty Meter Telescope at the Mauna Kea Science Reserve, Ka`ohe Mauka, Hamakua, Hawai'i
TMK (3) 4-4-015:009

CASE NO. BLNR-CC-16-002

PROPOSED FINDINGS OF FACT, CONCLUSIONS OF LAW AND DECISION AND ORDER

RECOMMENDED DECISION AND ORDER

Based on the foregoing findings of fact and conclusions of law, the CDUA and the TMT Management Plan is recommended for approval. A CDUP should be issued by the BLNR, subject to the following conditions:

(1) UH Hilo shall comply with all applicable statutes, ordinances, rules, regulations, and conditions of the Federal, State, and County governments, and applicable parts of the HAR § 13-5 et seq.;

(2) UH Hilo shall obtain appropriate authorization from the Department for the occupancy of stat

(3) UH Hilo shall co rules;

(4) Any work done o two (2) years of t that have been si be completed wit

Failure to comply with any of these conditions shall render this Conservation District Use Permit null and void.

DATED: Honolulu, Hawai'i, July 26, 2017.

Judge Riki May Amano (ret.)
Hearing Officer

Status in Hawai'i

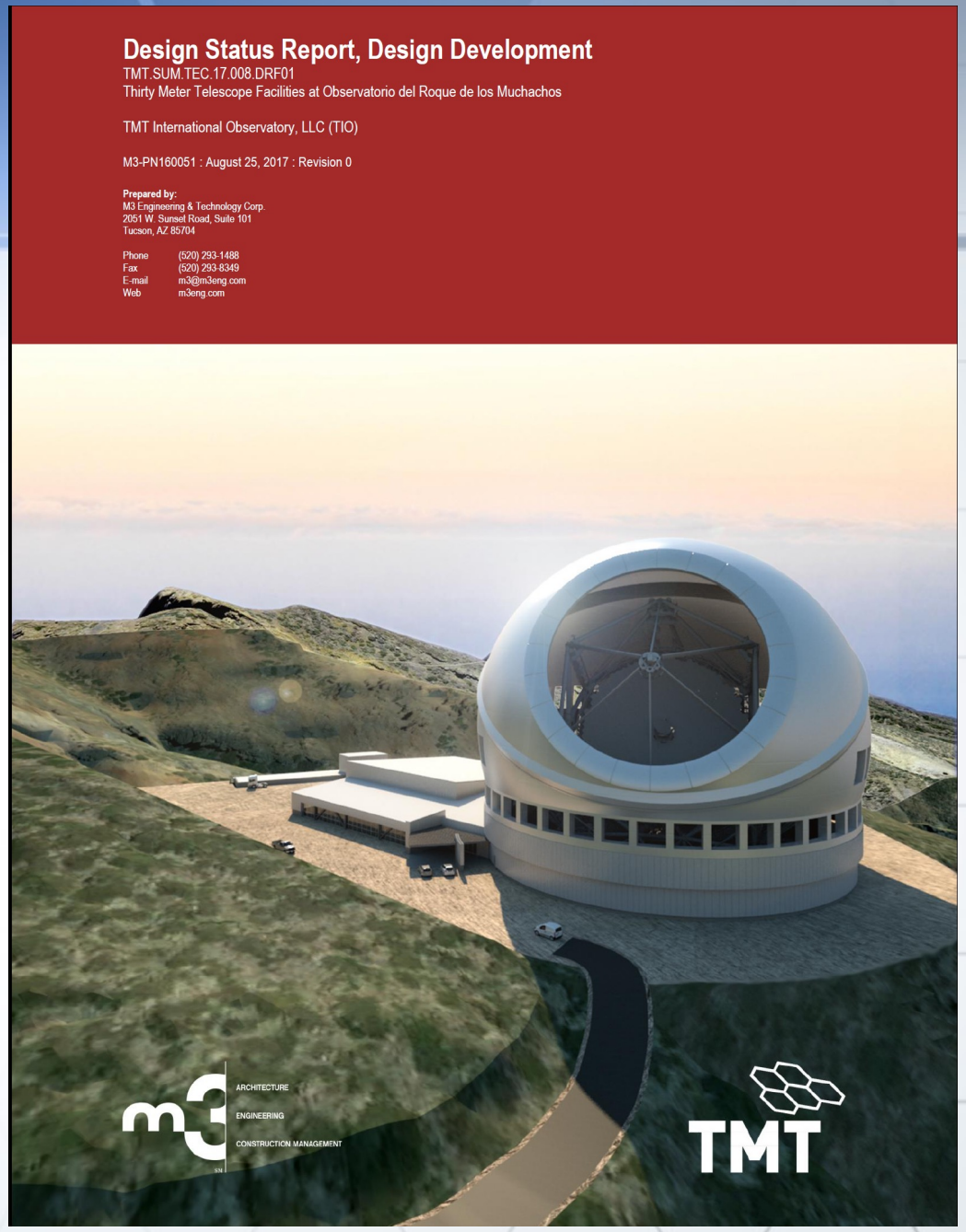
- BLNR issued new CDUP for TMT on 9/28/17
- Motion to reconsider by opponents denied
- Appeals of BLNR decision filed in Hawai'i Supreme Court on 10/30/17 and 11/2/17
- On parallel track, the State is appealing a district court decision allowing a contested case for the BLNR concurrence to the sublease to TMT


Maunakea remains the preferred site, and
all efforts are being made to regain access

La Palma

- Because of uncertainties in the outcome and pacing in Hawai'i, TIO decided to evaluate potential alternative sites and select one.
- After 10 months of intense activity, Observatorio del Roque de los Muchachos (ORM) on La Palma, Canary Islands, was selected as the single alternative site.

- M3 Engineering delivered 60% complete facilities design for La Palma in August
- Final construction documents to support contractor bidding will be complete by January 2018



ORM on La Palma

- Similar CN^2 profile and τ_0 values as Maunakea (relevant to AO correction)
- Similar fraction of clear nights as Maunakea
- Lower elevation (2400m vs 3960m)
- Higher latitude (28.9° vs 19.8°)
- Higher mean temperature

Observations are compromised for longer wavelengths because of the lower elevation and higher temperature

Canary Islands Status

- Hosting Agreement MOU between TIO and Institute of Astrophysics in the Canary Islands (IAC) is signed
  - It becomes effective if TMT formally informs IAC that La Palma will be the location for TMT
- Collaboration agreement between TIO, IAC, La Palma government, municipality of Puntagorda signed, defining cooperation
- Environmental Impact Assessment draft has been submitted to government to begin second round of public comment
  - Process should conclude by February/March 2018

Where is this heading?

- Maunakea remains the preferred site for TMT.
- ORM is an excellent alternative should MK prove impractical for any reason.
- TIO board will make a decision about the site in the spring of 2018, with the plan to initiate construction as soon as possible thereafter.

The US Community and TMT

- 2000 & 2010 Decadal Surveys highlighted the importance of US national participation in a Giant Segmented Mirror Telescope (GSMT)
- Reaffirmed in 2015 NRC report on the US Ground-based OIR System

Since 2013, NSF and TMT have participated in a cooperative agreement to engage the US community in TMT development.

"The primary deliverable of this award is to be a partnership model…in which NSF might join the TMT Project on behalf of the US astronomical community."

- AURA is an Associate Member of TMT International Observatory
- NOAO executes the responsibilities and TMT participation activities of AURA, representing the US-at-large community

US TMT Science Working Group

- The US TMT SWG represents the interests of the US astronomical community to the TMT project, SAC and Board

US TMT SWG:

Ian Dell'Antonio (Brown)
Mark Dickinson (NOAO, chair)
Anthony Gonzalez (Florida)
Stephen Kane (SFSU)
Jamie Lloyd (Cornell)
Jennifer Lotz (STScI)
Lucas Macri (TAMU)
Karen Meech (U. Hawaii/IfA)
Susan Neff (NASA-GSFC)
Deborah Padgett (NASA-JPL)
Catherine Pilachowski (Indiana)
Kartik Sheth (NASA-HQ)
Lisa Storrie-Lombardi (IPAC)

AURA reps. to TMT SAC:

Mark Dickinson (NOAO)
Karen Meech (U. Hawaii/IfA)
Ian Dell'Antonio (Brown)

AURA representatives to TIO Board:

Catherine Pilachowski (Indiana)
David Silva (NOAO)

US TMT Participation Plan

- US TMT SWG has worked with TIO to develop a *US National TMT Participation Plan* for the NSF.
  - Draft delivered in May 2016. NSF review is on hold until the TMT site situation is clarified.
- **Principal recommendations:**
  - ≥ 20% TMT participation share (≥ 60 nights/year), with a minimum of 10%
  - Implement cross-partnership TMT large / key projects
  - Ensure wide use and re-use of TMT data through high-quality archives & pipelines
  - A mix of classical and condition-adaptive queue scheduling

Benefits of US National Participation

- Consistent, long-term, open access to TMT observing time
  - Create & lead observing programs
  - Remain competitive in the forthcoming worldwide era of new, giant telescopes
- Full participation in observatory governance and scientific planning
- Partnership & leadership in international TMT key projects
- Access and support for using archived TMT data
- Enhanced opportunity to participate in developing TMT instrumentation

TMT International Science Development Teams (ISDTs)

- Open to all PhD astronomers
  - 255 scientists worldwide, **71 from the US-at-large community**

Fundamental Physics & Cosmology Early Universe, Galaxy Evolution, and the IGM Milky Way and Nearby Galaxies Supermassive Black Holes Stars, stellar physics, and the ISM	Formation of Stars & Planets Exoplanets Our Solar System Time Domain Science

- Recent ISDT activities include:
  - Updating the TMT Detailed Science Case
  - Developing ideas for future TMT Key Programs
  - Planning future TMT instrumentation
  - Organizing workshops and conferences

TMT International Science Development Teams (ISDTs)

Annual call for ISDT membership now open!

Applications due 26 January 2018

Information and instructions at:

http://www.tmt.org/page/isdt

US community members welcome!

- Recent ISDT activities include:
  - Updating the TMT Detailed Science Case
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  - Planning future TMT instrumentation
  - Organizing workshops and conferences


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UCLA PARTICIPANTS
ORGANIZERS
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https://conferences.pa.ucla.edu/dark-universe/index.html
Shedding Light on the Dark Universe with Extremely Large Telescopes
Asia/Australia meeting in Lanzhou, China from Aug 30-Sept 2, 2017
Americas meeting at UCLA, April 2-6, 2018
Trieste Italy, hosted by ICTP (International Center for Theoretical Physics), July 2-6 2018

TMT Science Forum
Mysore, India, November 2017

- Call for white papers for future TMT instruments & AO systems:
  - https://www.tmt.org/announcement/call-for-tmt-instrumentation-white-papers
  - **Due 21 March 2018**
- TMT SAC will review and recommend a subset of these for feasibility study funding.

https://www.noao.edu/meetings/2020decadal/

Acknowledgments

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