
Thirty Meter Telescope (TMT) Open House

Fiona Harrison (Caltech)

Mark Dickinson (NOAO)

-
- TMT Status
 - Design and Fabrication
 - Hawai'i
 - NSF-TMT Cooperative Agreement Activities
 - Q&A



THIRTY METER TELESCOPE

TMT International Observatory LLC (TIO)

- TIO Members
 - California Institute of Technology
 - Canada, National Research Council
 - 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
- TIO Associate
 - NOAO/AURA consistent with the NSF Cooperative Agreement
- TIO Observer
 - University of Hawaii

TMT Status Summary

- For most major components and subsystems, design is at or near final stage, with much prototyping completed
- No significant technical hurdles remaining
 - Robust supply lines and quality control is the current emphasis for segment, actuator, and sensor production
- International management team and management processes in place
- *Ready for construction*

TMT Calotte Enclosure Final Design is Completed

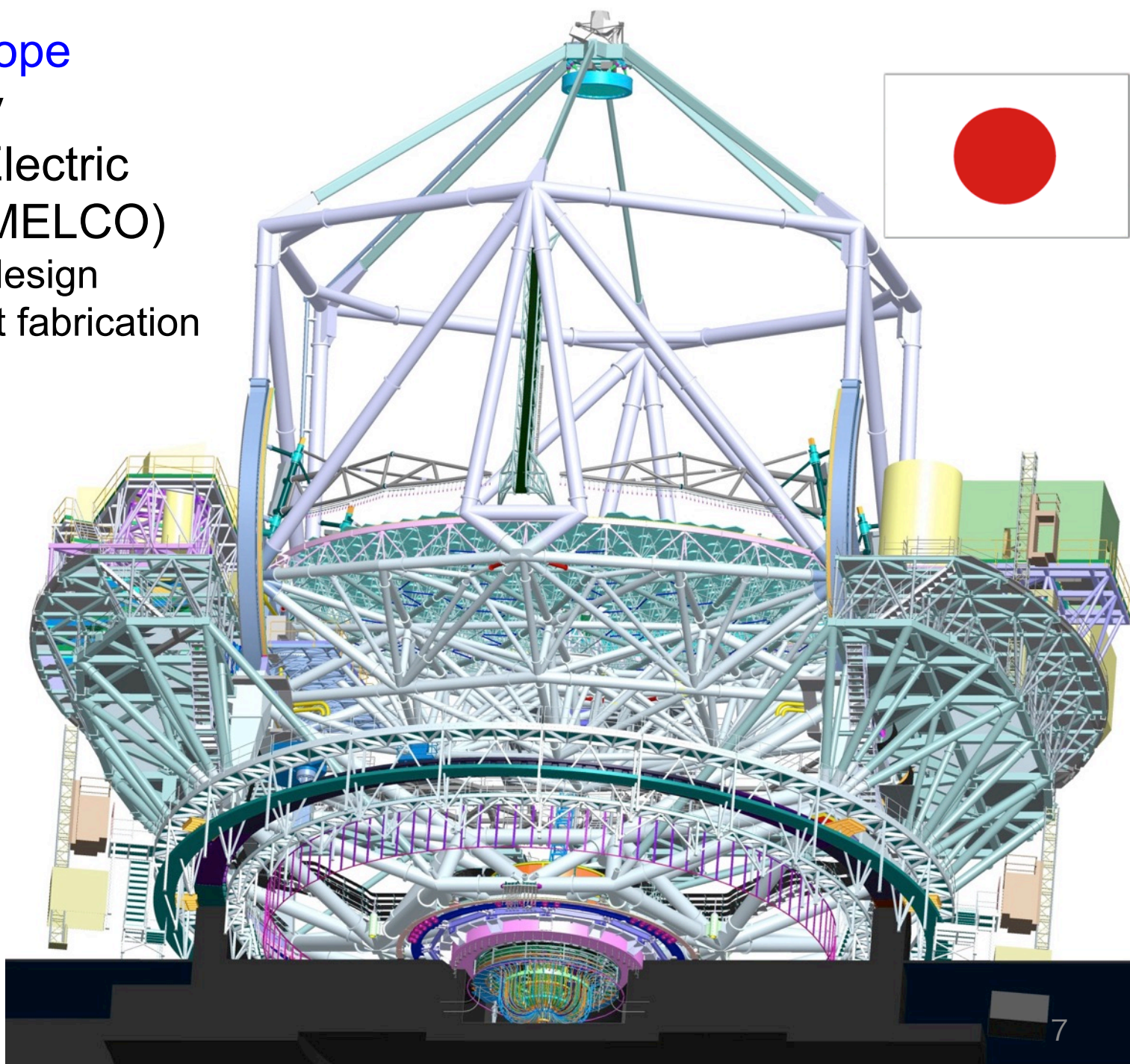
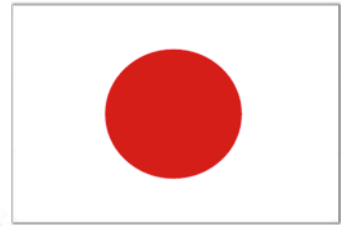


Enclosure Vent Door Prototypes



TMT Telescope Structure by Mitsubishi Electric Company (MELCO)

- Near final design
- Component fabrication starting!



Primary Mirror (M1) Segment Blank Production

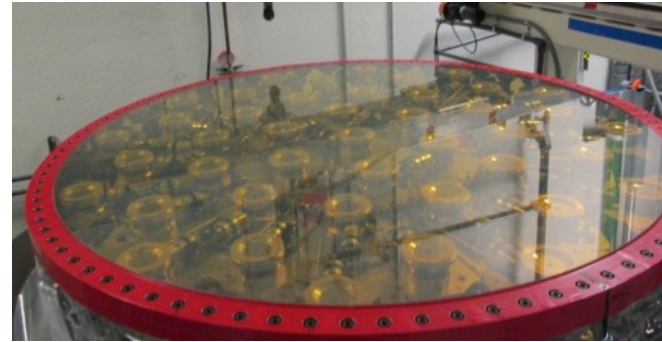
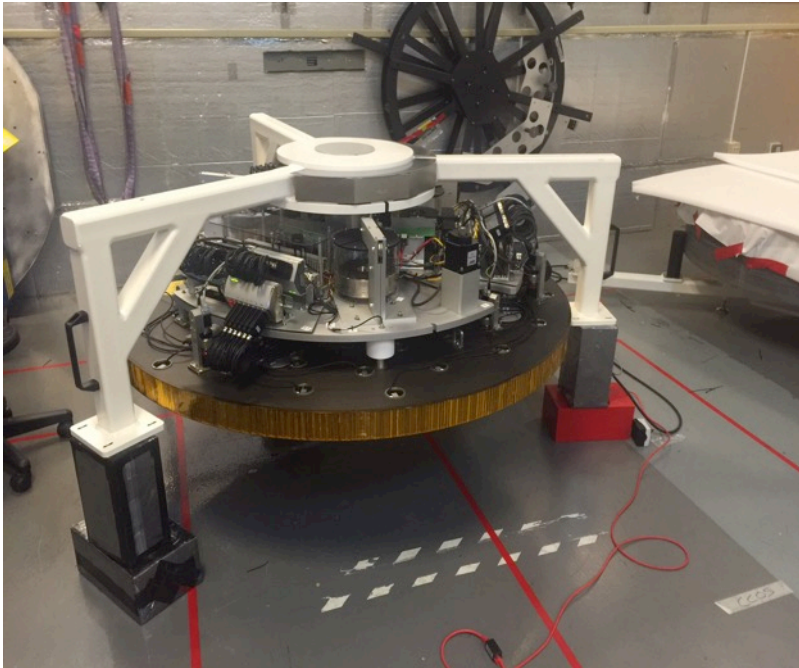
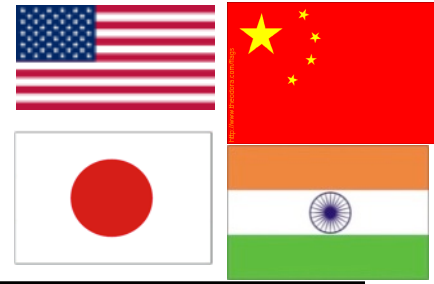


- Ohara will have produced 163 blanks by the end of March 2016; all meet our stringent requirements



107 blanks produced by October

Segment Polishing - Tinsley



Stressing Fixture

Segment polishing underway at four of the partners. Have demonstrated ability to manufacture most difficult segments.

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



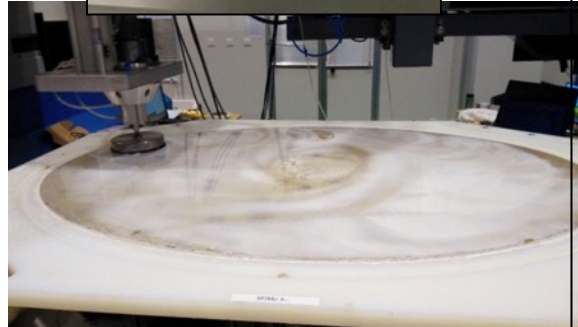
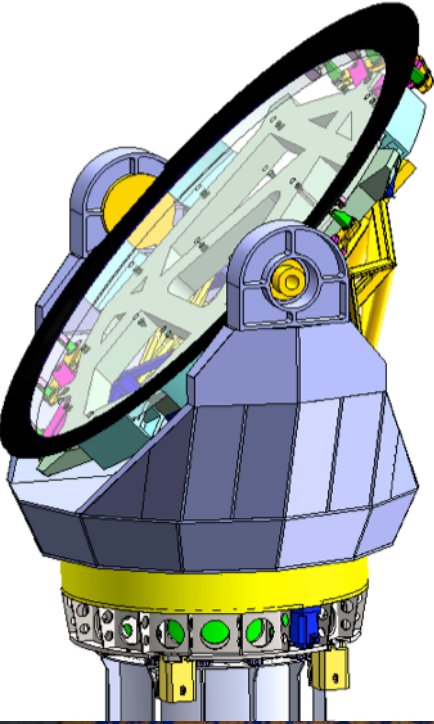
Actuator components



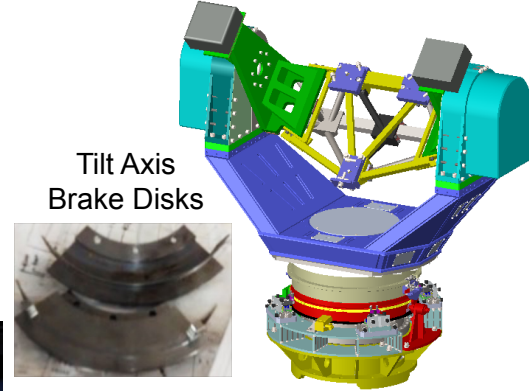
Edge sensors

M3 System at CIOMP, Changchun

1/4 scale functional prototype underway



Positioner CAD model and parts



Rotator Bearing Races

Cablewrap Pinon Gears



Yoke Assembly

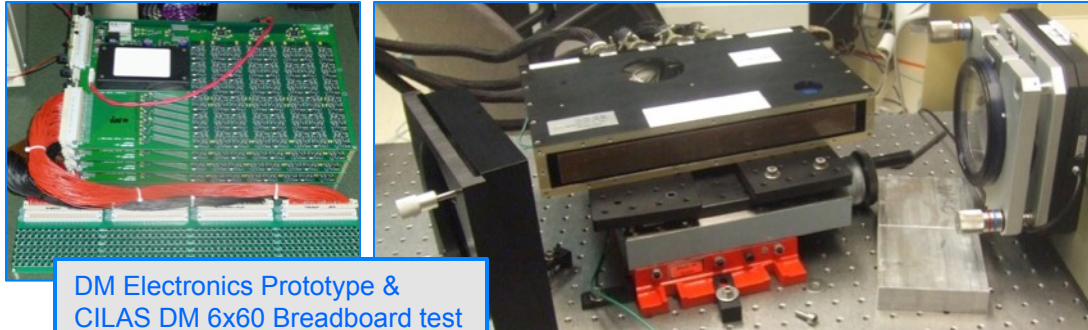


Stationary Middle Base

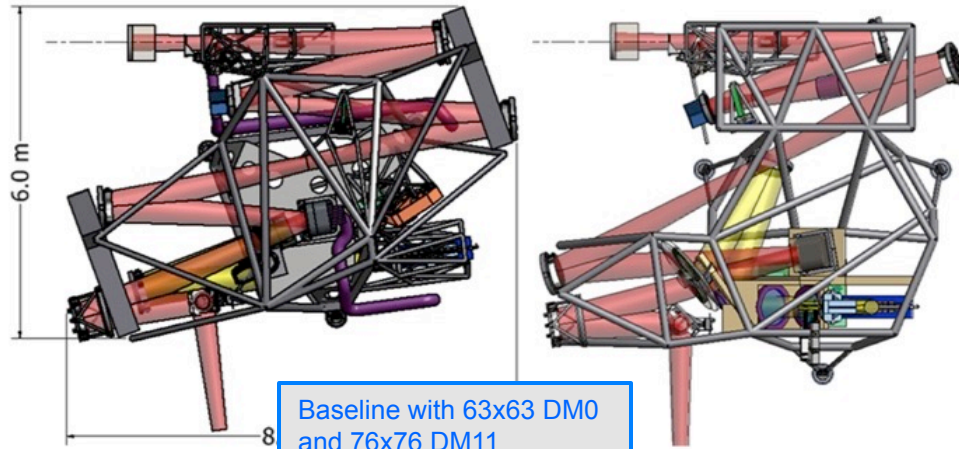
Tilt Axis Spindle



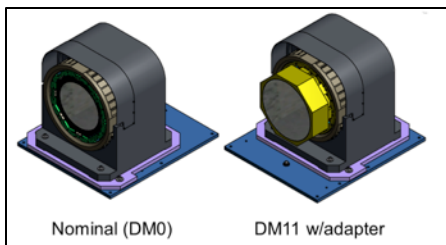
TMT Facility AO System NFIRAOS in Final Design Phase at NRC Herzberg



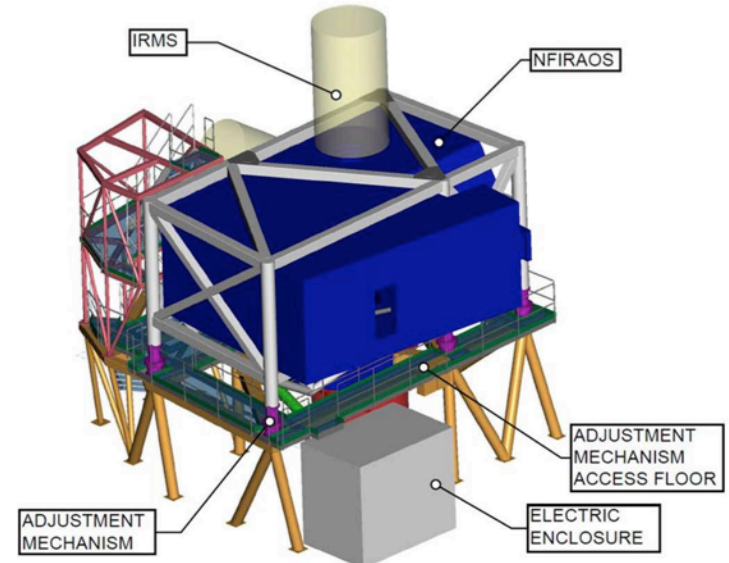
DM Electronics Prototype & CILAS DM 6x60 Breadboard test setup (warm) at NRC - Herzberg



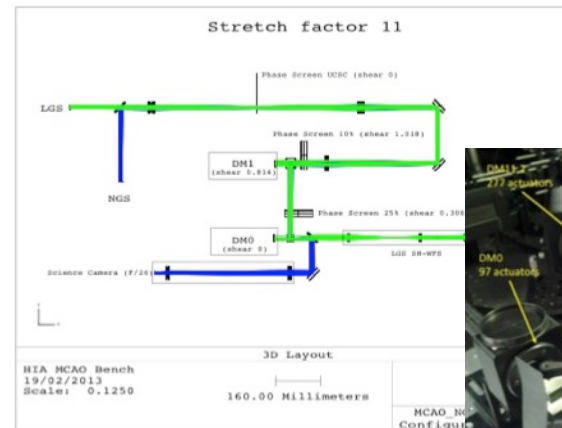
Baseline with 63x63 DM0 and 76x76 DM11



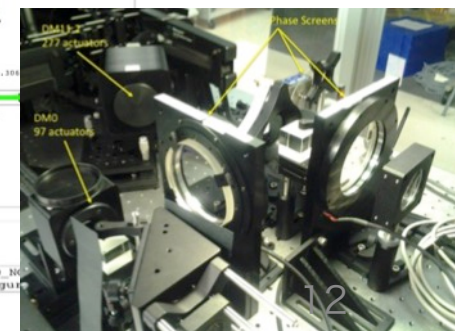
DM11 mounted on Tip/Tilt Stage for baseline configuration



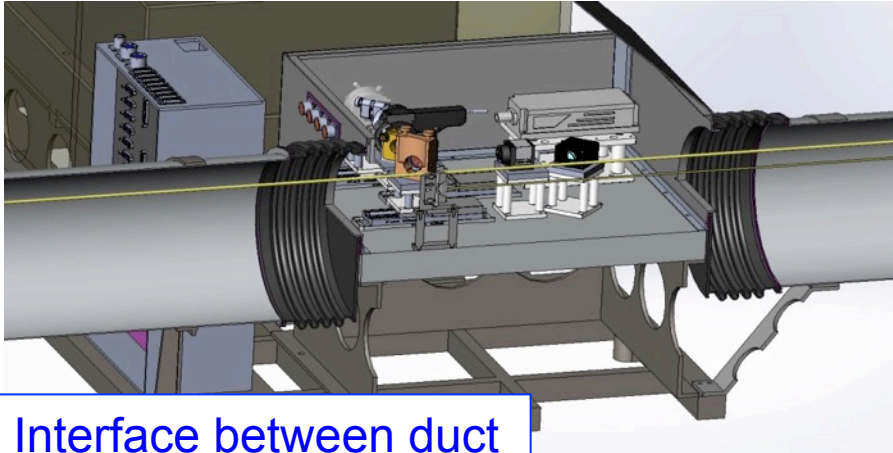
Interface with telescope structure



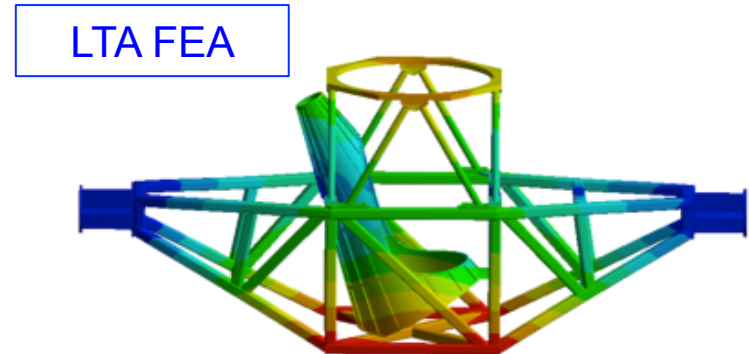
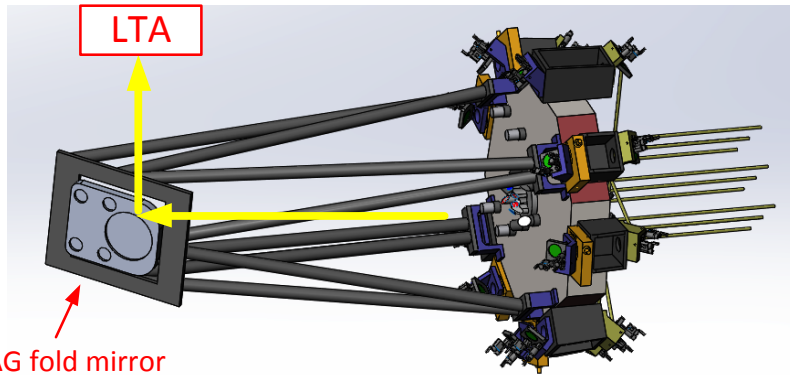
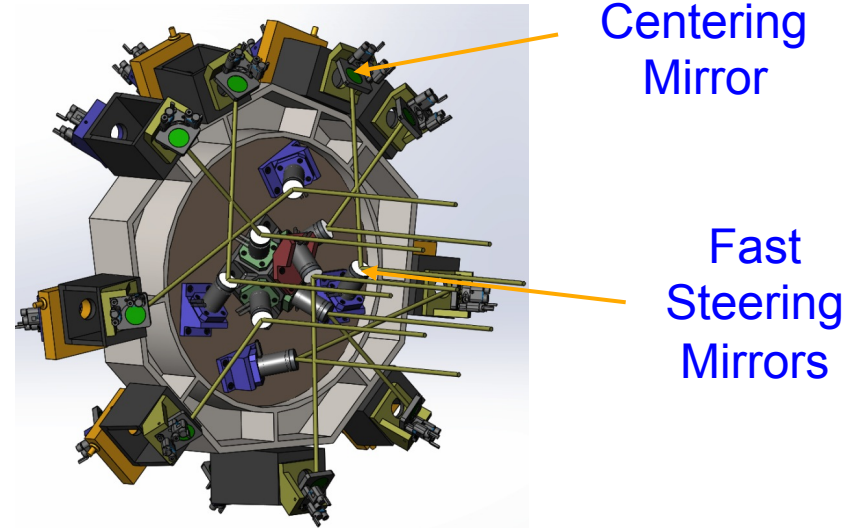
MCAO test bench



Laser Guide Star Facility in Preliminary Design at IOE, Chengdu

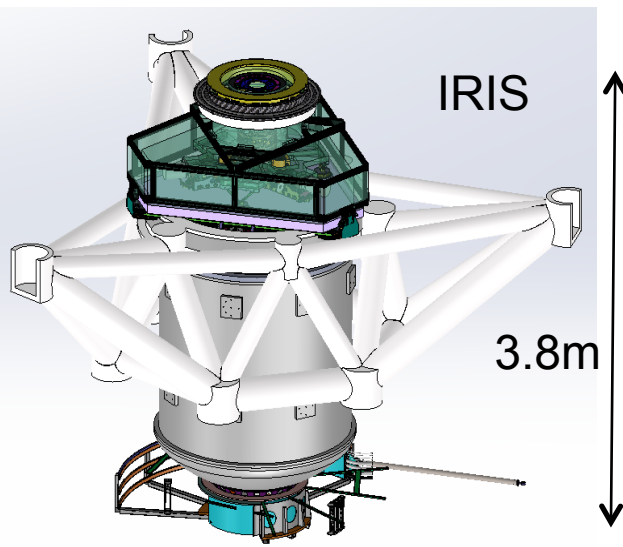


Interface between duct
and laser bench



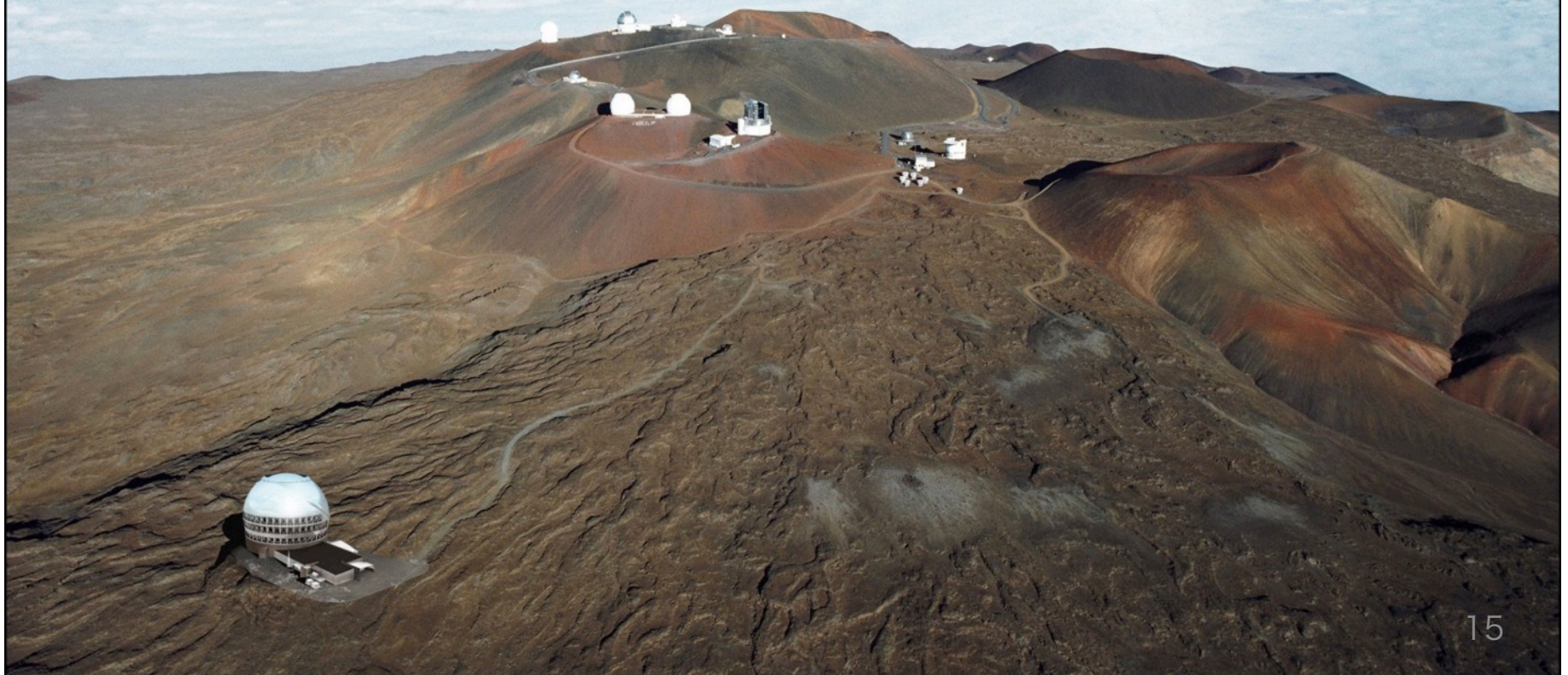
Instruments

- Design of three 1st – light instruments underway
- Each is an international effort with participation from all TMT partners



TMT Instrument meetings in India, China and US

TMT on Maunakea



Hawaii Supreme Court Decision

- HSC ruled that the State’s process in granting the permit in 2011 was faulty.
 - Preliminary issuance of the permit followed by a Contested Case hearing “put the cart before the horse”, although this has been a common practice of the State in the past.
 - HSC “vacated” the permit and remanded the case back to the Land Board to redo the Contested Case hearing and Land Board vote on the permit after the hearing.
- TMT response: “We thank the Hawaii Supreme Court for the timely ruling and we respect their decision. TMT will follow the process set forth by the state, as we always have. We are assessing our next steps on the way forward. We appreciate and thank the people of Hawaii and our supporters from these last eight-plus years.”

What next?

- TIO Board is waiting to have a definitive statement from Hawai'i Attorney General and the Governor about the details of the process and estimated timeline going forward.
- Project is undergoing a replan that does not include activities at the summit for at least one year to minimize effects of delay and understand the ramifications.
- Information about TMT and Maunakea has been gathered here:

<http://www.maunakeaandtmt.org>

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

In response to a call for proposals, NSF and TMT entered into a cooperative agreement to engage the US community in TMT planning and 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, LLC
- NOAO executes the responsibilities and TMT participation activities of AURA, representing the US-at-large community

- NOAO established a US TMT SWG to engage with the US community and to understand its interests and aspirations for TMT
- SWG represents those interests to the TMT project, SAC, and Board
- SWG is helping to develop a *US National TMT Participation Plan* for the NSF

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 (Hawaii/IfA)

Susan Neff (GSFC)

Deborah Padgett (GSFC)

Caty Pilachowski* (Indiana)

Kartik Sheth (NASA)

Lisa Storrie-Lombardi (IPAC)

* TMT Science Advisory Committee or Board representative

- AAS TMT Open House events (+ Nov. 2015 DPS meeting)

**Tomorrow: TMT Thermal-IR Science & Instrumentation Workshop
(Thurs. 7 Jan., 5:30-7:30 pm, St. George 108)**

Exploring the science case and design parameters for a Thermal IR imager and spectrograph as possible 2nd-generation TMT instrument
Organized by Chris Packham (UTSA)

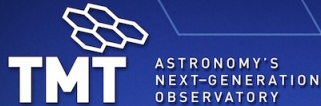
- Community engagement visits & presentations
 - TMT project astronomers visit universities & astronomy institutions for 1-2 days, meet local scientists, and give TMT colloquium/seminar presentations
 - Gather community input on US participation and scientific priorities
 - 65 visits so far (2013-2015), with more scheduled in 2016
 - **Contact Warren Skidmore (was@tmt.org) to arrange a visit!**

Annual TMT science workshop + international collaboration meeting

2013: Waikoloa, HI

2014: Tucson, AZ

2015: Washington, D.C.



Thirty Meter Telescope Science Forum

Save the Date: The Thirty-Meter Telescope observatory will host the inaugural "TMT Science Forum" on

July 22 and 23, 2013

at the

Waikoloa

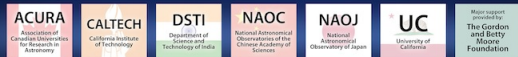
Resort on the island of Hawaii.



The TMT is an international project to build and operate a 30-m telescope located on Mauna Kea, HI. The program will consist of talks and workshop discussions exploring science, first-light and future instruments, observatory operations, archiving and data products, key projects and cross-partnership collaborations, astronomy education and science, technology, engineering, and math (STEM) opportunities.

More information and the Forum program can be found at <http://conference.ipac.caltech.edu/tmfts>

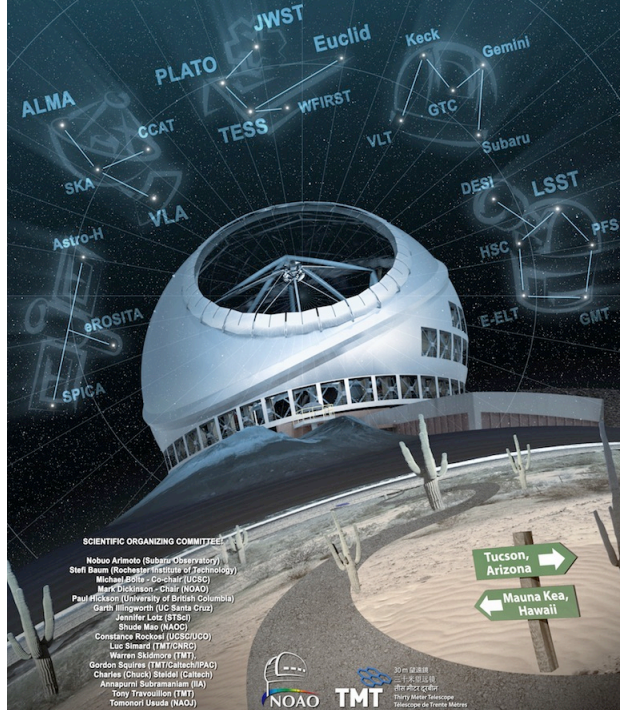
If you are interested in attending the Forum, register at the conference website. As part of the NSF-TMT agreement, some travel funding will be available for U.S. community members (who are not at TMT institutions) to attend the forum. To request consideration for travel funding, send an email to TMT@noao.edu with your name, institutional affiliation, and areas of interest relevant to TMT.



TMT in the Astronomical Landscape of the 2020s

Exploring scientific and operational synergies between TMT and other forefront astronomical facilities and capabilities in the next decade

17 - 19 July 2014, Ventana Canyon Resort, Tucson, Arizona, USA



- SCIENTIFIC ORGANIZING COMMITTEE:
- Nobuo Arimoto (Subaru Observatory)
 - Steff Baum (Roberts-Bernstein Institute of Astrophysics)
 - Michael Bolte (UCSC)
 - Mark Dickinson - Chair (NOAO)
 - Paul Hickey (University of British Columbia)
 - Garth Illingworth (UC Santa Cruz)
 - Jennifer Lotz (STScI)
 - Shude Mao (NAOJ)
 - Constanza Rodríguez (UCSD/UCO)
 - Luigi Steward (TMT/UCO)
 - Warren Skidmore (TMT)
 - Gordon Squires (TMT/Caltech/IPAC)
 - Charles (Chuck) Steidel (Caltech)
 - Anupama Subramanian (IA)
 - Tommy Travers (TMT)
 - Tomonori Usuda (NAOJ)



The TMT Science Forum will be comprised of plenary sessions, panel discussions, a full-day instrumentation workshop, and parallel sessions organized by the TMT International Science Development Teams

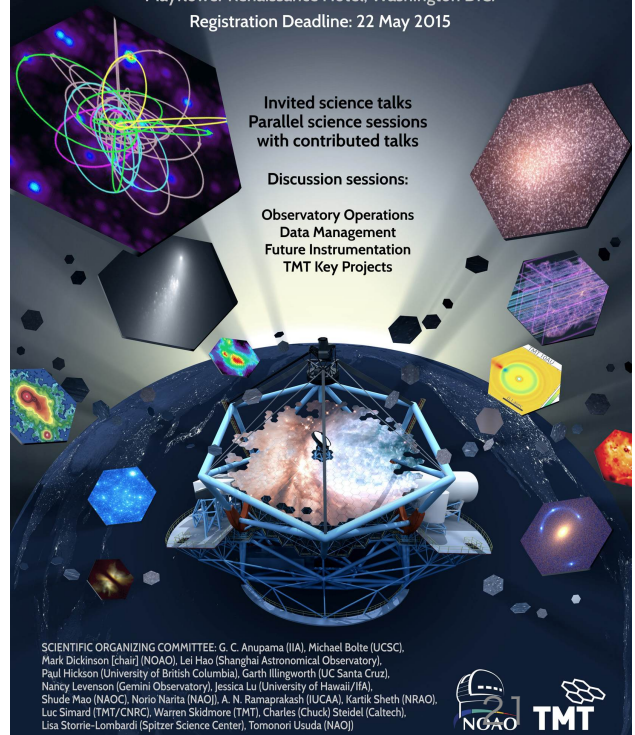
Maximizing Transformative Science with TMT

Exploring forefront science with the Thirty Meter Telescope, and ways to maximize its productivity through innovative collaborations, operations, and instrumentation

23 - 25 June 2015

American Association for the Advancement of Science (AAAS)
Mayflower Renaissance Hotel, Washington D.C.

Registration Deadline: 22 May 2015



Invited science talks
Parallel science sessions
with contributed talks

Discussion sessions:

- Observatory Operations
- Data Management
- Future Instrumentation
- TMT Key Projects

- SCIENTIFIC ORGANIZING COMMITTEE: G. C. Anupama (IA), Michael Bolte (UCSC), Mark Dickinson (Chair) (NOAO), Lei Hao (Shanghai Astronomical Observatory), Paul Hickson (University of British Columbia), Garth Illingworth (UC Santa Cruz), Nancy Levenson (Gemini Observatory), Jessica Lu (University of Hawaii/IA), Shude Mao (NAOJ), Norio Narita (NAOJ), A. N. Ramaprakash (IUCAA), Kartik Sheth (NRAO), Luc Simard (TMT/CNRC), Warren Skidmore (TMT), Charles (Chuck) Steidel (Caltech), Lisa Storrie-Lombardi (Spitzer Science Center), Tomonori Usuda (NAOJ)



Coming soon: 24 – 26 May 2016, Kyoto, Japan

TMT and International Cooperation

- **Selecting & developing TMT's second-generation instruments**
- **International TMT Key Project science**
- **The TMT International Science Development Teams**
- **Coordinating international observatories in the TMT era**
- **...and more!**

**NSF travel support is available for US community participants.
Contact the US TMT SWG (tmt@noao.edu) for information.**

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 Lee Sparrow (TMT/NOAO)
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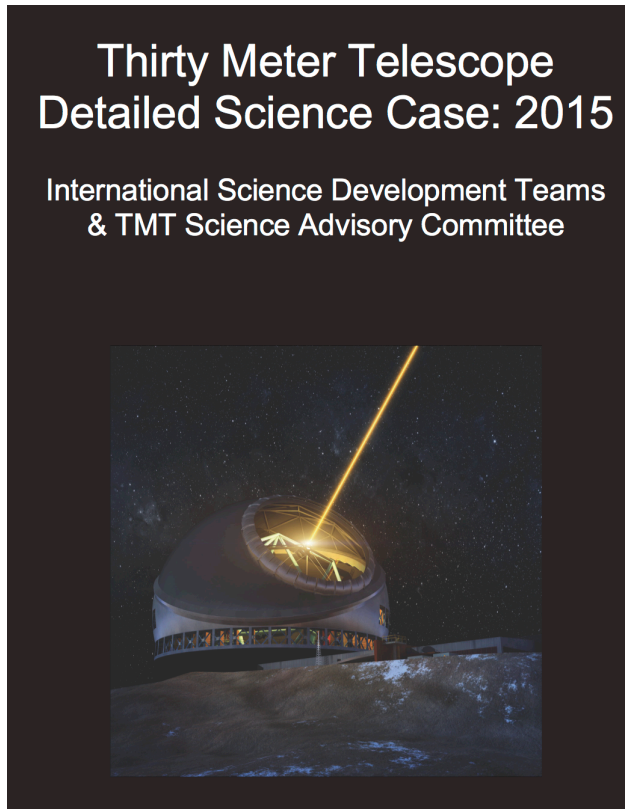
- Provide scientific input & guidance to the TMT project
- Help define observatory capabilities & operations model
- Plan for future TMT science programs
- Foster collaboration & cooperation between scientists in and beyond the international TMT partnership

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
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- Open to all PhD astronomers
 - 199 scientists worldwide, **56 from the US-at-large community**

2015 TMT Detailed Science Case
Newly updated, with contributions
from 150+ scientists
(<http://arxiv.org/abs/1505.01195>)

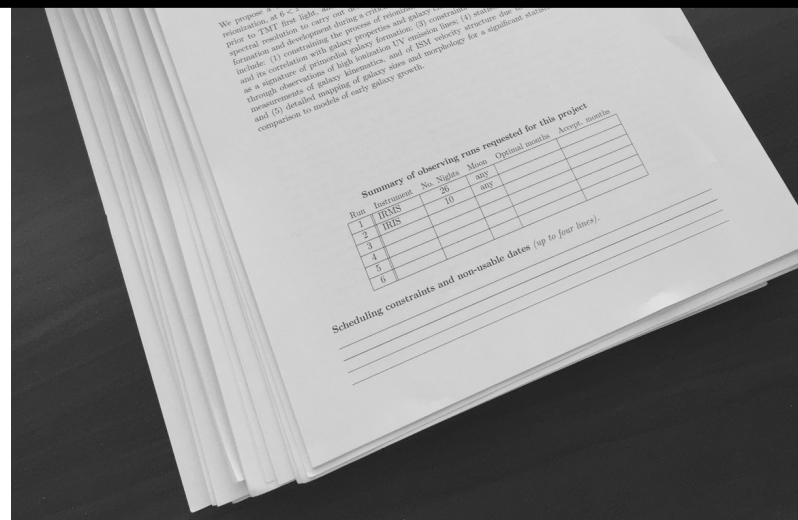
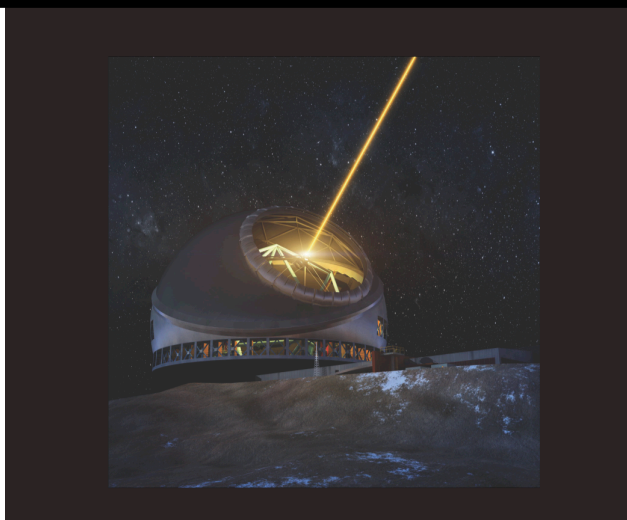
TMT “Key Project” concept proposals
requesting >1100 nights of observing time.
Written by international teams; 43% led by
US-at-large PIs



**Annual call for ISDT membership is open now!
Applications are due *15 January 2016***

Information and instructions at:

**<http://www.tmt.org/about-tmt/international-science-development-teams>
(Google: "TMT ISDT")**



- A draft plan for US national participation in TMT has been developed, based on community input.
- This plan includes:
 - Science case for US participation in TMT
 - Flow-down from science to instrumentation capabilities & operations
 - The SWG’s report emphasizes ways to maximize scientific benefits of TMT for the US national community
 - Workforce, education, public outreach & communication plan
 - Business and governance model for US TMT participation

- Consistent, long-term open access to TMT observing time
 - US astronomers may create & lead observing programs, not just participate via collaboration
 - Critical for US scientific competitiveness in the worldwide GSMT era
- Full participation in TIO governance and scientific planning
 - Definition & prioritization of instrumentation and AO systems
 - Evolution of operations model, observing modes, data management
- Access to archived TMT data
- Opportunity to participate in international TMT key projects
- Enhanced opportunity to participate in developing TMT instrumentation

SWG recommendations in its draft report to NSF

- US national participation share in TMT
 - SWG recommends a participation share of 20% or greater (60 nights/year), with a minimum share of 10%.
 - This would allow a robust PI science program, while enabling significant US participation in large “key program” science projects.
- Cross-partnership TMT large projects / key programs
 - Enable large-scale science that would be difficult to accomplish within a US share alone.
 - Generate large, coherent data sets with high archival re-use value by a broader science community.
- Instrument calibration, data management, and archival re-use
 - TMT data should be readily useful to PI observing teams and to an archival user community.
 - This requires good observatory instrument calibration, metadata and logging, pipelines & reduction software, archive, and user support.

SWG recommendations in its draft report to NSF

- Flexible, condition-adaptive scheduling:
 - Can benefit AO-critical science and other programs that depend strongly on observing conditions
 - Facilitates time-domain science in the era of LSST, WFIRST, etc.
 - Enable a broad mix of observing program sizes

A mix of visitor- and service/queue-mode observing can enhance the scientific productivity of TMT for US astronomers
- Other topics include:
 - Pre- and post-observing support for US community TMT users
 - Research & data analysis funding for US PI science teams
 - Support for US groups to participate in TMT instrument development

The TMT Project gratefully acknowledges the support of the TMT collaborating institutions. They are the Association of Canadian Universities for Research in Astronomy (ACURA), the California Institute of Technology, the University of California, the National Astronomical Observatory of Japan, the National Astronomical Observatories of China and their consortium partners, and the Department of Science and Technology of India and their supported institutes. This work was supported as well by the Gordon and Betty Moore Foundation, the Canada Foundation for Innovation, the Ontario Ministry of Research and Innovation, the National Research Council of Canada, the Natural Sciences and Engineering Research Council of Canada, the British Columbia Knowledge Development Fund, the Association of Universities for Research in Astronomy (AURA), the U.S. National Science Foundation and the National Institutes of Natural Sciences of Japan.

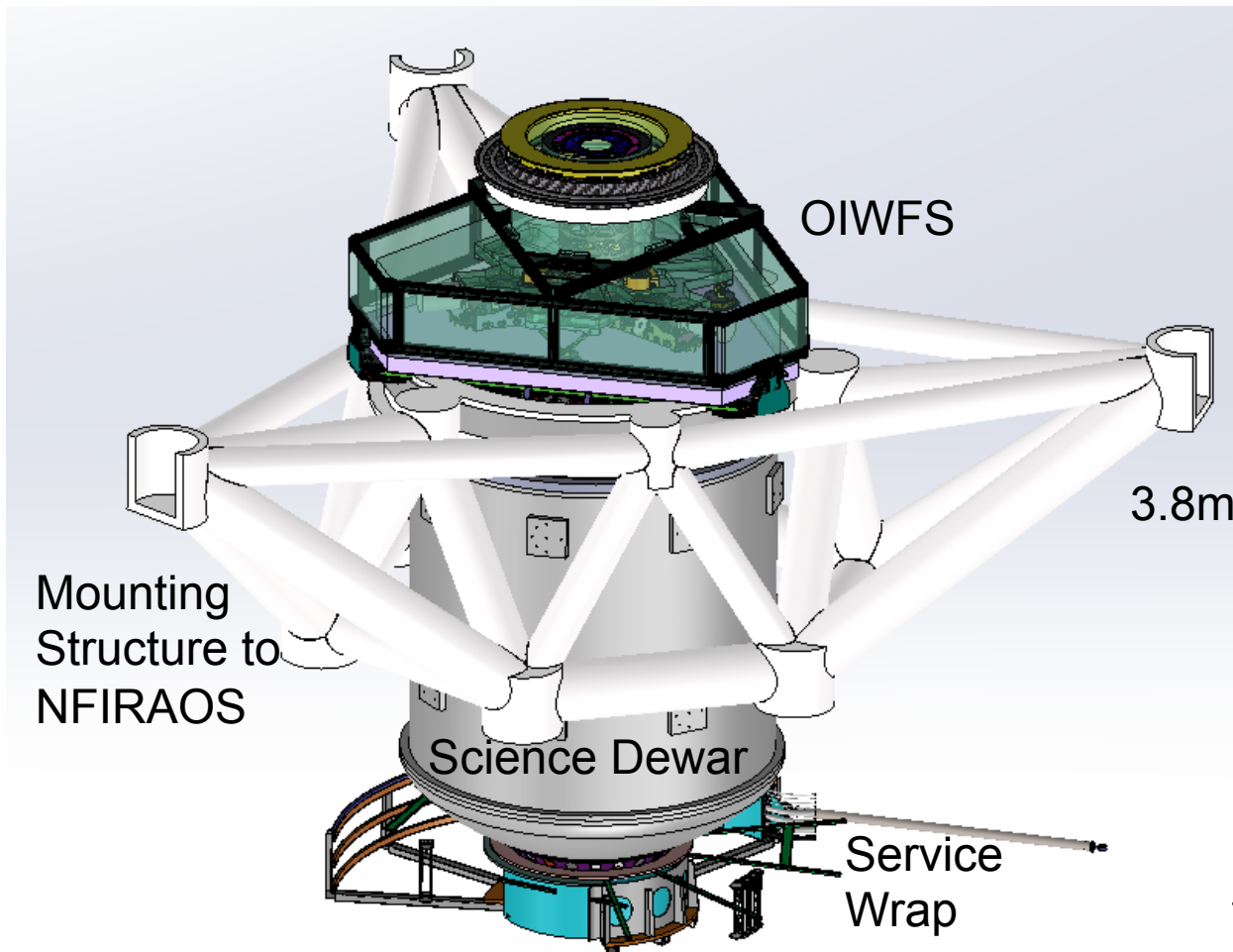


TMT

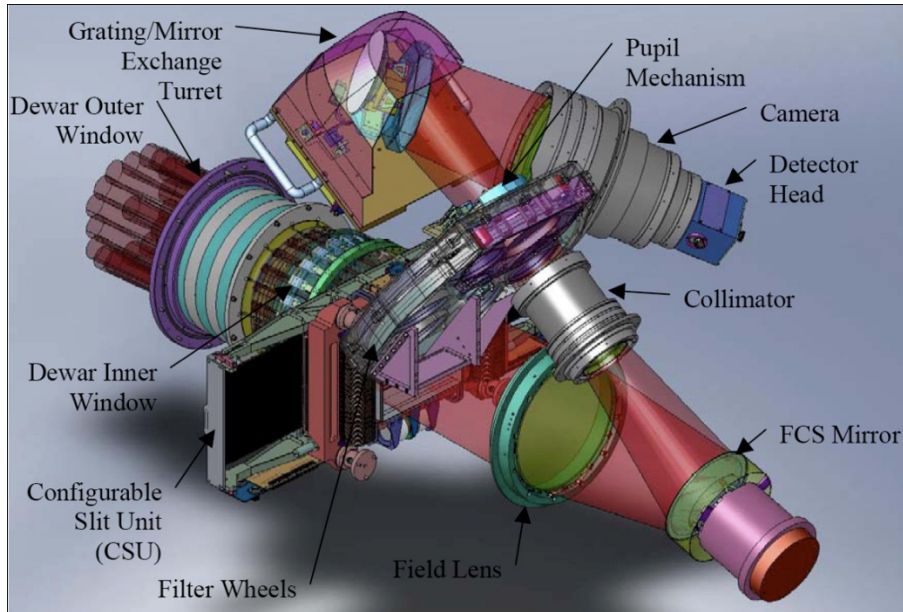
THIRTY METER TELESCOPE

Additional slides

Infrared Imager and Spectrometer (IRIS)



InfraRed Multi-slit Spectrometer (IRMS)

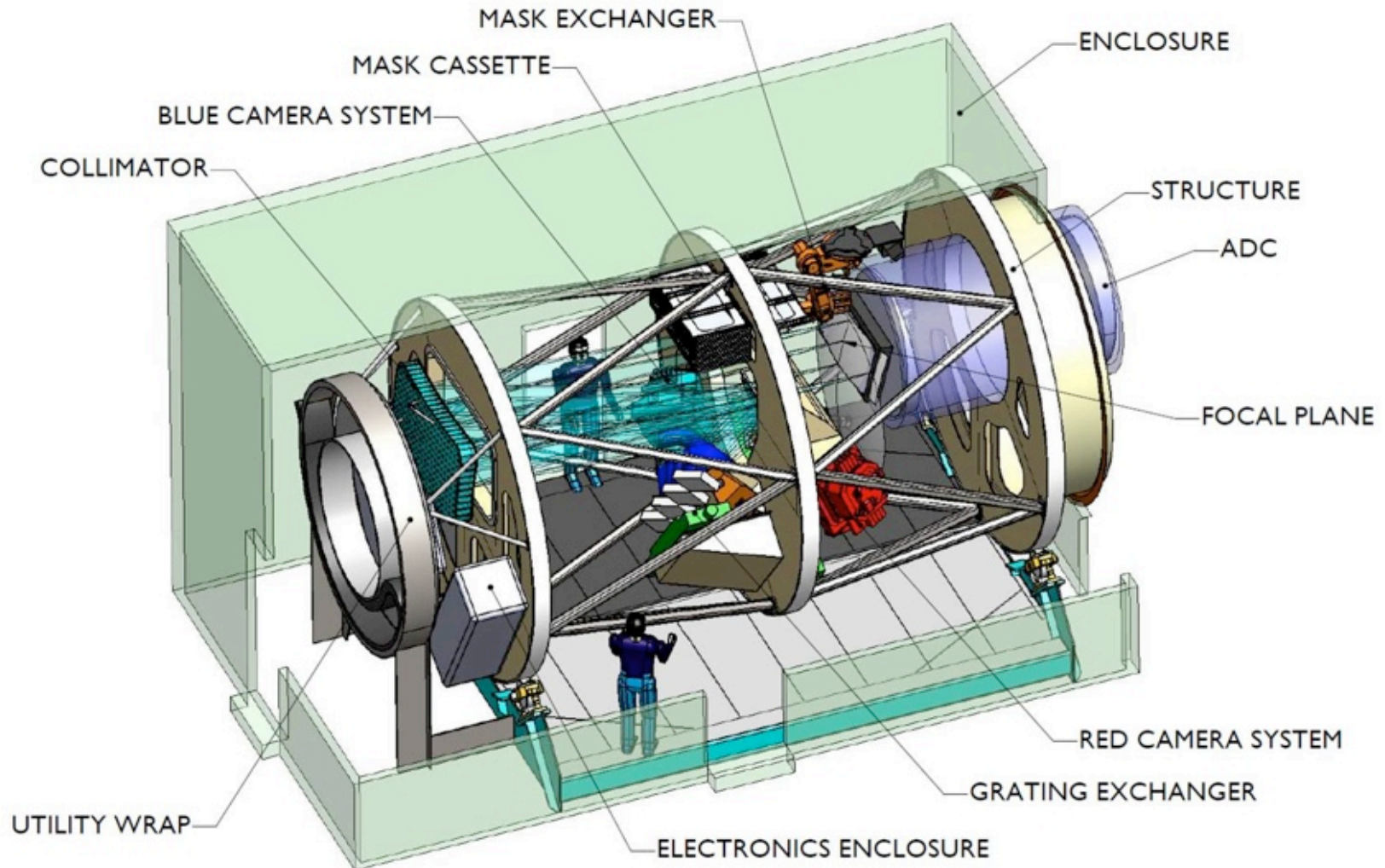


TMT/IRMS
=
Keck/MOSFIRE clone!

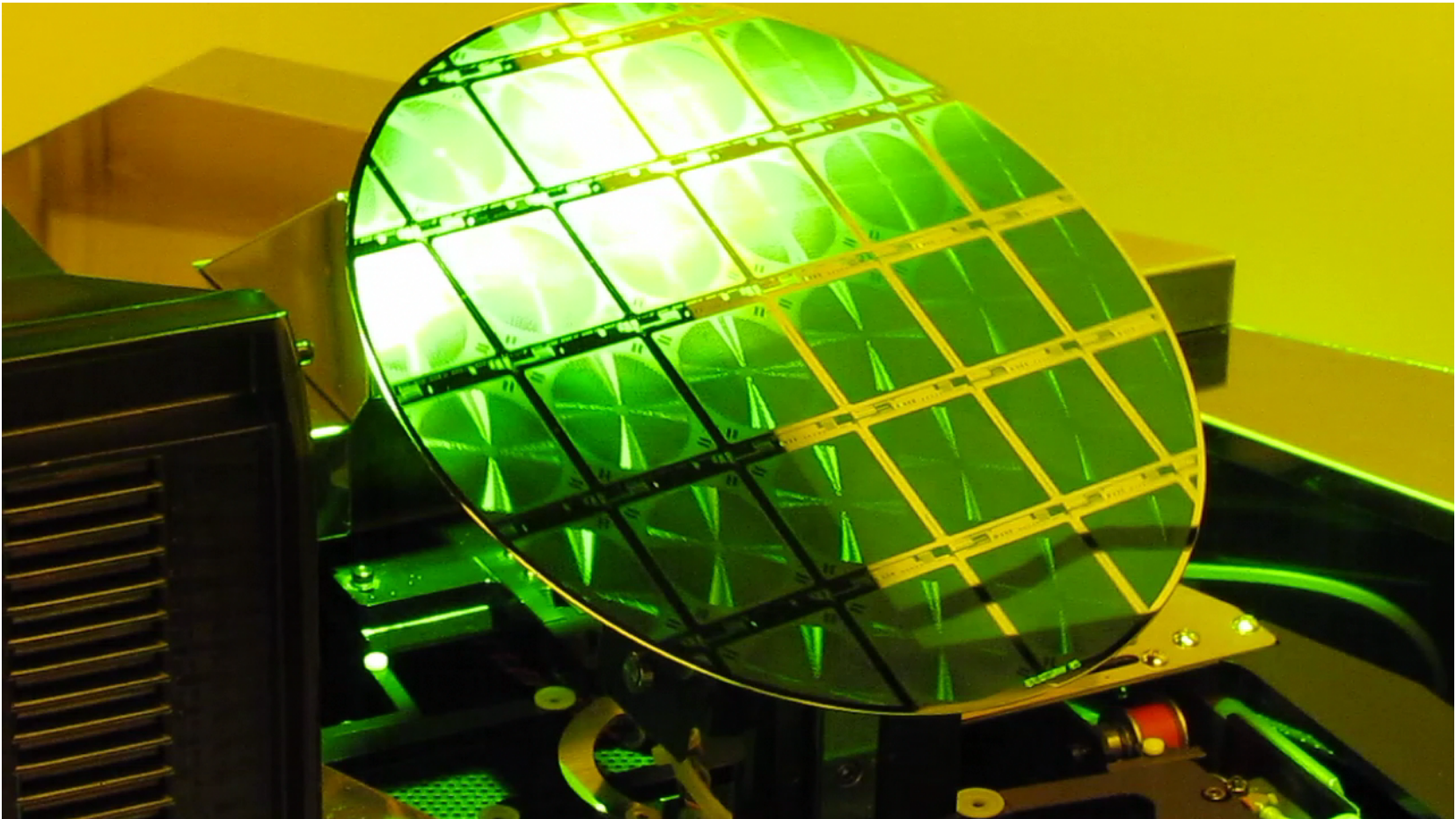
Keck, February 2012



Wide Field Optical Spectrometer (WFOS)



AO: NFIRAOS Visible WFS Camera CCD Fabricated at MIT/LL

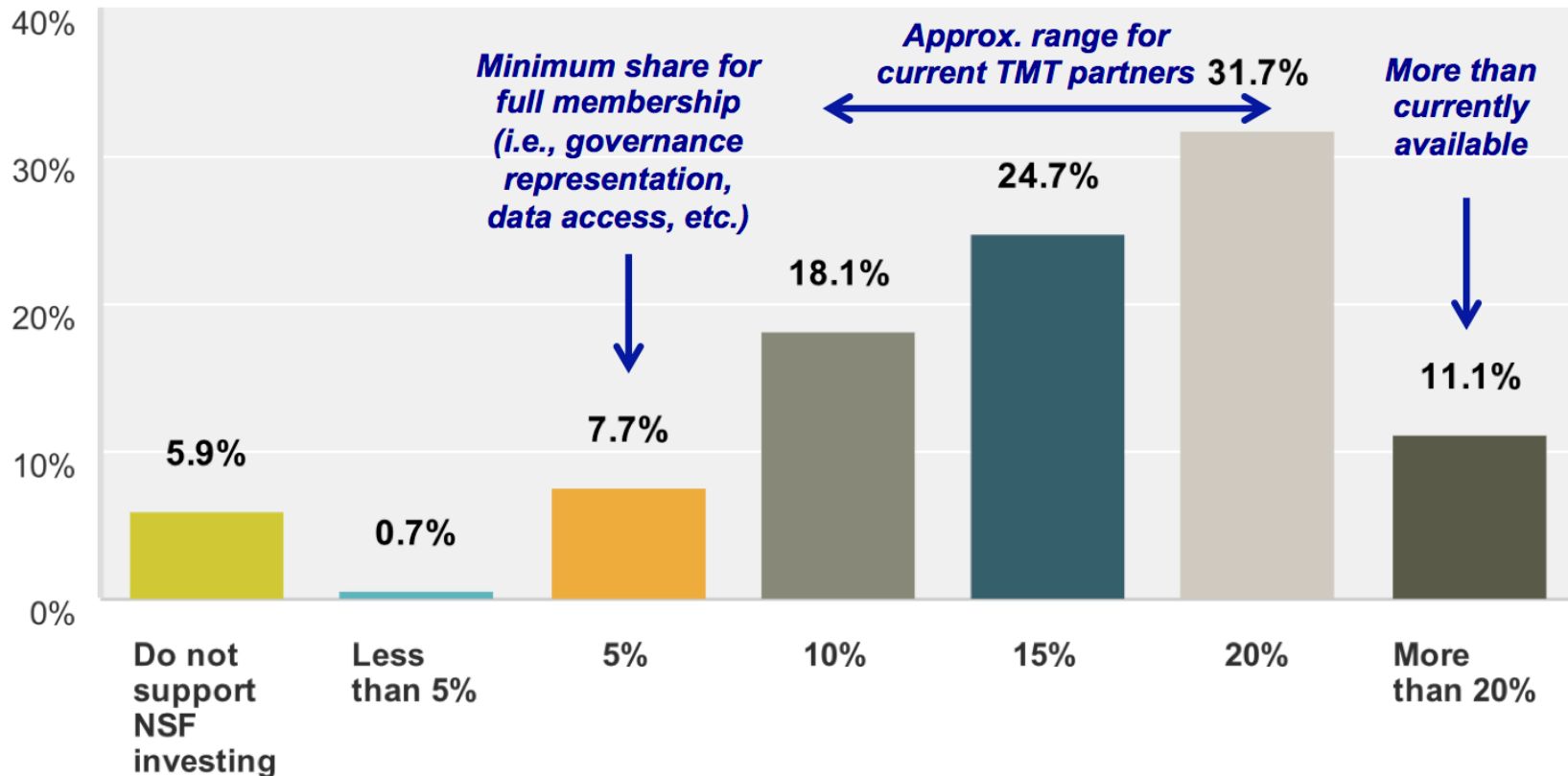


- Fall 2014: US TMT SWG carried out an on-line community survey
- 467 responses, 364 (78%) from US scientists outside the TMT member institutions (UC+Caltech)
- Some results:
 - “Would an O/IR GSMT be useful for your research?": 79% said “yes”
 - “Which of the three 1st-light TMT instruments would be useful for your research?" Responses were evenly split among instruments.
 - Of 18.5% who replied “none”, many favor high resolution spectroscopy or extreme high contrast imaging as top priority for 2nd-generation capabilities
 - Good pre- and post-observational planning and data analysis tools were identified as “very important” or “essential” by ~75% of respondents
 - Archival access to raw and pipeline-processed data products was identified as “very important” or “essential” by ~65% of respondents
 - Availability of a queue scheduled / service observing modes was considered “very important” or “essential” by 72% of respondents
- Results of the survey inform the SWG’s report to the NSF in the US National TMT Participation Plan

US Federal Participation in TMT

from the SWG's 2014 US community survey

“In your opinion, what minimum partner share in TMT does the US community (outside the current partners) need in order to conduct globally competitive science programs?”



Astro-2010 and the 2015 US O/IR System Report

- The Astro-2010 Program Prioritization Panel on Optical and Infrared Astronomy from the Ground ranked a GSMT as its top priority, stating that a GSMT provides “...*exceptionally broad and powerful ability over the whole range of astrophysical frontiers.*”
- For Astro-2010 key science programs identified as requiring a 30m-class O/IR telescope:
 - 23 out of 27 could be carried out using TMT’s first-light instrumentation suite.
 - 27 out of 27 could be carried out using TMT’s first-decade instrumentation suite.
- 2015 NRC report on the US O/IR System recommended that NSF plan for investment in one or more GSMTs
 - Describes a major role for NOAO in managing the US O/IR System.
 - Making a detailed plan to meet these recommendations is the major activity of the 5-year TMT-NSF Cooperative Agreement.