

TMT

Progress Report

Tomo Usuda (TMT-Japan Director)

Outline

- 0) Overview
- 1) International Status
- 2) FY2015 TMT-J activities

SDSS (2m)



Now



Subaru (8.2m)



Survey by small telescopes → Detail studies by large telescopes

Subaru (8.2m)



2020's



TMT(30m)



Survey by large telescopes → Detail studies by TMT

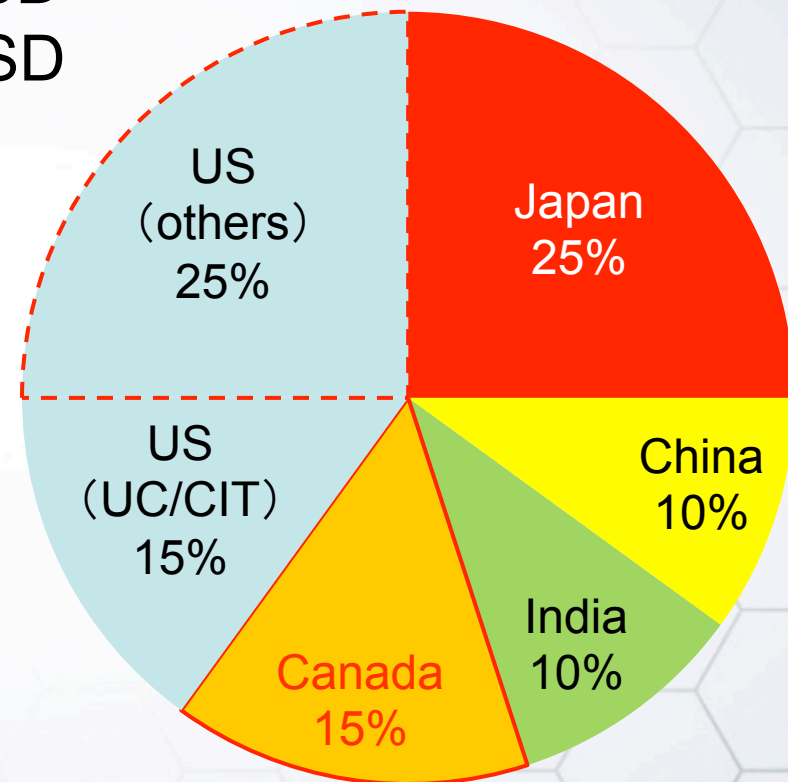
International collaboration

- Preconstruction (~2013): ~220M USD
- Construction (2014~24): ~1580M USD

Required budget for Japan's contribution in construction phase:

41.5 billion JPY

- 25% of construction : 37.5B JPY
- preparation for open-use: 4B JPY
(cf. ~1.9B JPY for preconstruction)
(cf. ~6B JPY has been allotted)



Members' contributions

1) International Status

- 2009 July: Mauna Kea (MK), Hawaii selected as site
- 2013 April: Conservation District Use Permit (CDUP) completed all court review successfully
- 2013 July: Scientific Authorities Sign the TMT Master Agreement
- 2014 May 6: TMT International Observatory (TIO) was formed as the legal entity
- 2014 May: Governing Board of TIO voted to start the Construction Phase
- 2014 July: Final Approval for sublease of the construction site at MK
- 2014 Oct 7: Ground Breaking Ceremony
- 2014 Dec 2: India becomes a full member at 10% level
- 2015 Mar-Apr: Major construction was started but suspended
- 2015 Apr 21: Canada becomes a full member with \$243.5M (CAD)
- 2015 Jun 24: Construction was stopped again by protestors
- 2015 Dec 2: Hawaii Supreme Court invalidated the CDUP issued by BLNR to the University of Hawaii - Hilo to build TMT on Maunakea

1) International Status Hawaii

Support Letter to Gov. Ige from Hawaii Chamber Business Coalition (Sep. 28)



September 28, 2015

Governor Ige,

On behalf of the business community of Hawaii Island and the State of Hawaii, we respectfully ask for your support for the Thirty Meter Telescope to begin its permitted construction under safe passage. We believe this is an urgent situation and any further delay could undermine the overall benefits of this project.

Hawaii's business community stands together in support of astronomy, science, culture and environmental stewardship. This stalemate has already wrought too much damage within the State of Hawaii.

Public Opinion Poll (Nov. 13)

November 13, 2015

We thought you would find yesterday's final poll results as exciting as we do!
Mahalo from all of us here at TMT as we continue to move forward.



Good: 86%

Premature (wait for court ruling): 10%

Bad: 4%

November 12, 2015

What do you think about Thirty Meter Telescope work resuming soon on Mauna Kea?

A. Good; about time (86%) - 3,995 votes

C. Premature; wait for court ruling (10%) - 462 votes

B. Bad; oppose TMT (4%) - 212 votes

Total Votes: 4,669

NOTE: This is not a scientific poll — results reflect only the opinions of those voting.

1) International Status Hawaii

Public Opinion Poll (Nov. 9)



WARD RESEARCH
INCORPORATED

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Dk/Refused
1. There should be a way for science and Hawaiian culture both to exist on Maunakea.	58%	30%	4%	6%	3%
2. TMT will help create good paying jobs and economic benefits for those living on Hawaii island.	35	39	11	10	4
3. TMT has followed a lengthy approval process, including permitting, community meetings and environmental impact statements so work should proceed.	44	31	10	12	4
4. Failure to move forward with TMT after following all regulations would hurt Hawaii's reputation as a place to	33	30	18	15	4

1) International Hawaii



January 18, 2016 | 80° | Check Traffic

Public Opinion Poll by Ward Research inc.

- ◆ Dec 28~ Jan 9
- ◆ Sample: 619 (almost same as in Oct)
- ◆ **Support: 62 → 67%**
- ◆ Support by Native Hawaiian: 44 → 39%
- ◆ Oppose by Native Hawaiian: 49 → 59%



QUESTION

Based on what you have heard, read or seen, do you support or oppose moving ahead with the construction of the Thirty Meter Telescope (TMT) on Mauna Kea?



The Hawaii Poll, conducted Dec. 28-Jan. 9 by Ward Research Inc. on cellphones and landlines, included 619 registered voters statewide. The margin of sampling error is plus or minus 3.9 points.

1) International Status Hawaii

Letter to President Obama



DEAR PRESIDENT OBAMA:

On behalf of the global astronomical community, we would like to thank you for recognizing during the October 19 Astronomy Night activities, the commitment by the Maunakea Observatories to open their doors and share the excitement of exploring the Universe with the public. Astronomy is sometimes referred to as a "gateway science." Observing the moon, stars, and planets is an excellent starting point for inspiring youth and adults alike to learn about how the Universe works and how the scientific process can be used to explore the natural world. We are very pleased to be part of your effort to stimulate interest in and passion for scientific discovery.

As the Honolulu Star-Advertiser notes in an editorial published on October 24, 2015, "the Hawai'i Island observatories together make Mauna Kea the most scientifically productive site for astronomy in the world, a significant achievement for our state." As the preeminent site for astronomical research in the United States, and in fact, the Northern Hemisphere, Maunakea is truly a national treasure. Stretching more than 30,000 feet from the ocean floor, Maunakea is one of the largest volcanoes in the solar system and is the highest point in the Pacific Basin. It is home to an incredible diversity of ecosystems and represents a cultural anchor for much of Polynesia. We are honored and thankful for the opportunity to study the heavens from its summit and to be entrusted by the people of Hawai'i as stewards of the science reserve.

Scientists from universities worldwide rely on the Maunakea observatories to advance their research. Our observatories have contributed to some of the most significant astronomical findings in the modern era, including those that earned the 2011 Nobel Prize for Physics.

KEY DISCOVERIES THAT RELIED ON DATA FROM MAUNAKEA INCLUDE:

- 1. Dark Energy and Cosmic Acceleration:** While studying Type Ia supernovas, astronomers revealed that the Universe's rate of expansion is accelerating. The repulsive force responsible for this acceleration is more commonly known as "dark energy." This discovery earned the 2011 Nobel Prize for Physics.
- 2. Supermassive Black Hole in the Milky Way:** By measuring the motions of stars at the heart of our Milky Way galaxy, researchers revealed a black hole that is 4.1 million times the mass of our Sun.
- 3. Extrasolar Planets:** The first images of a planetary system orbiting another star were recorded on Maunakea.
- 4. Killer Asteroids:** Telescopes on Maunakea and Haleakala are the world's leaders in detecting and studying near-earth asteroids, including those that may put the earth at risk.
- 5. Most Distant Galaxies:** Our cosmic frontier has been pushed to new extremes through the discovery of some of the most distant objects ever detected. Maunakea observatories helped astronomers reach back to a time when the universe was only five percent of its present age of 13.8 billion years.

Over the past 50 years, the observatories have contributed billions to the local economy, enriched STEM education options, created jobs, supported local businesses, and catalyzed improved infrastructure efforts, including widespread, high-speed internet. Hawai'i is our home and we are excited by the opportunity to deepen our connection to the community through the Kama'ehu Observatory Experience.

The rich tradition of celestial navigation and modern scientific exploration in Hawai'i provides a remarkable opportunity for our scientists and the local community to explore together how cultural tradition, scientific discovery and environmental stewardship intersect on Maunakea. We believe the launch of the Kama'ehu Observatory Experience is an important first step and we thank you for your acknowledgement of our efforts.

We cordially extend an open invitation to you and your family to come visit Maunakea to see this firsthand. In the meantime, we will continue to seek new ways to share our passion for astronomy and all the STEM fields among youth in Hawai'i, across the United States, and in all our partner countries.



DEAR PRESIDENT OBAMA:

MAHALO NUI,


Caltech Submillimeter
Observatory, Sunil Golwala

Simons

Canada-France-Hawaii
Telescope, Doug Simons

Kissler-Patig

Gemini International
Observatory, Markus
Kissler-Patig


James Clerk Maxwell Telescope
(EAO), Paul Ho


NASA Infrared Telescope
Facility, Alan Tokunaga

Arimoto

Subaru Telescope,
Nobuo Arimoto


Submillimeter Array,
Raymond Blundell



UKIRT Observatory,
Richard Green


University of Hawai'i Hilo
Educational Telescope,
Pierre Martin


University of Hawai'i 2.2 m
Telescope, Colin Aspin

Yang

TMT International
Observatory, Henry
T. Yang


University of Hawai'i,
Institute for Astronomy,
Günther Hasinger


Very Long Baseline Array,
Mark McKinnon


W.M. Keck Observatory
(Keck I and Keck II),
Hilton Lewis


International Astronomical
Union, Norio Kaifu

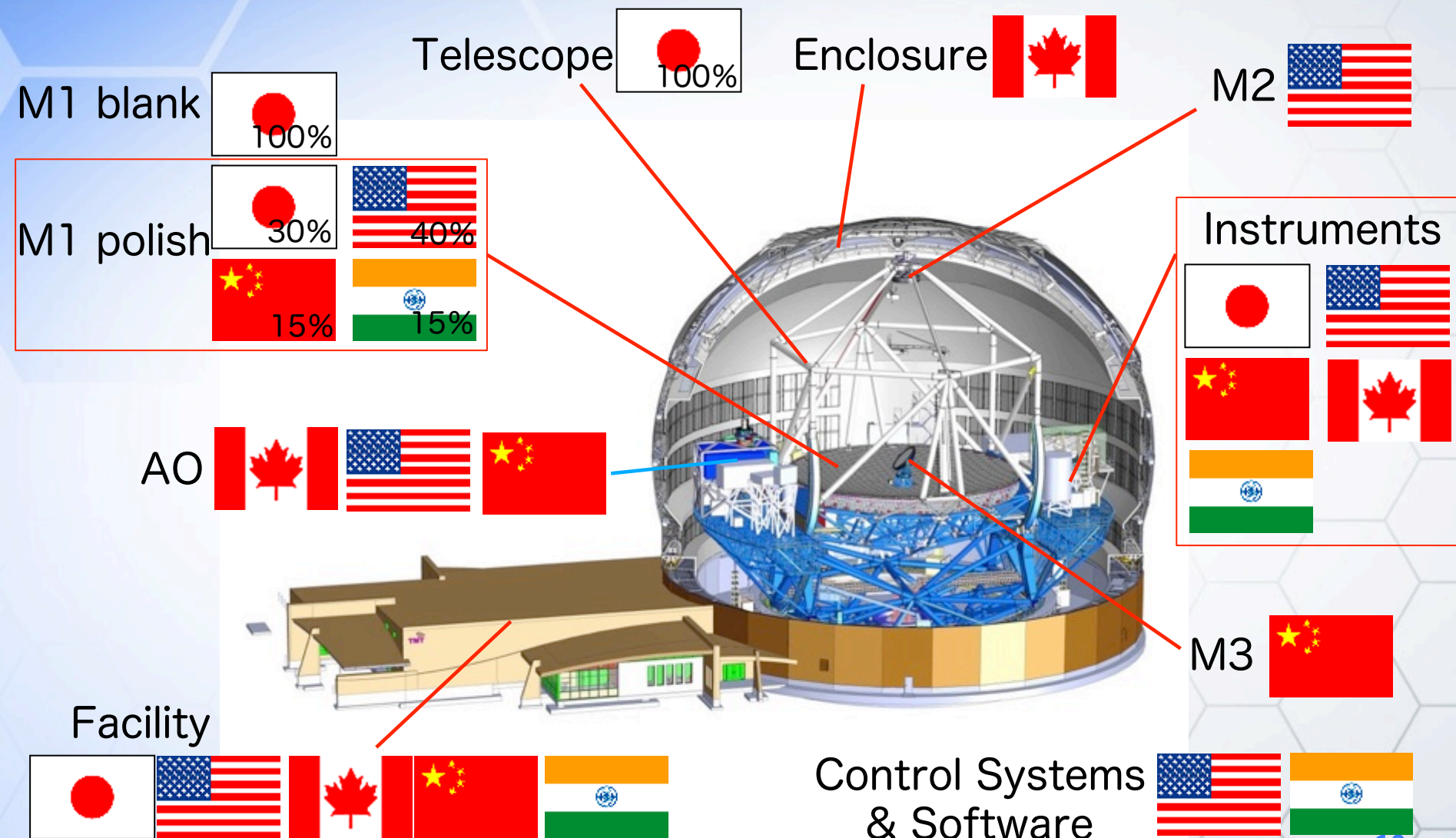

International Astronomical
Union, Silvia Torres-Peimbert

Hasinger

Lewis

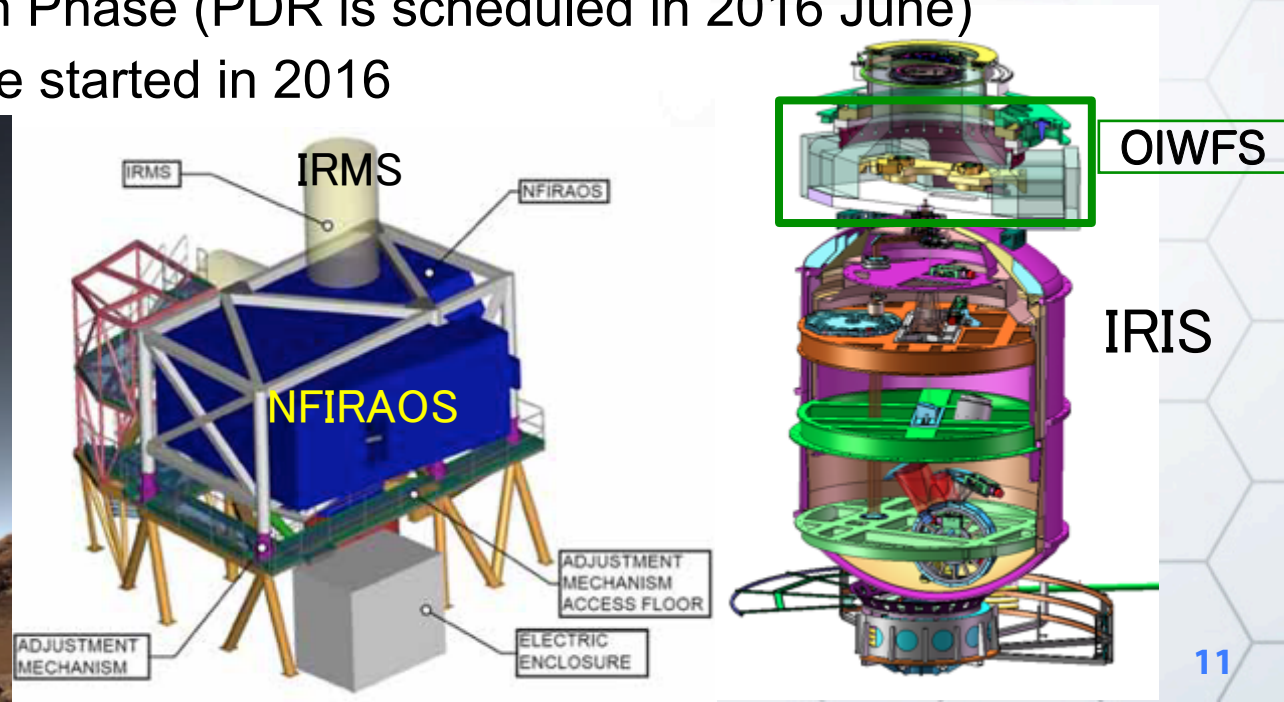
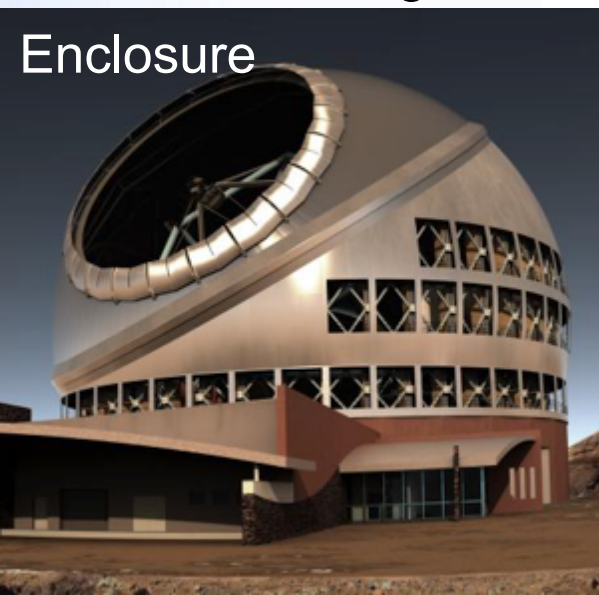
Kaifu

Members' contributions



1) International Status Canada

- (1) Enclosure (100%)
 - ◆ Final Design: done
 - ◆ Preparation of fabrication has been started in FY2015
- (2) NFIRAOS (100%)
 - ◆ Final Design Phase (FDR is scheduled in 2017 February)
- (3) IRIS: On the Instrument Low-order Wavefront Sensor (OIWFS)
 - ◆ Preliminary Design Phase (PDR is scheduled in 2016 June)
 - ◆ Final Design will be started in 2016



1) International Status India

(1) M1 Polishing (15%)

- ◆ Licensing technology with Coherent (Tinsley) in US. Mass production will be started in 2017 in India

(2) M1 SSA (Segment Mirror Support Assembly: 100%)

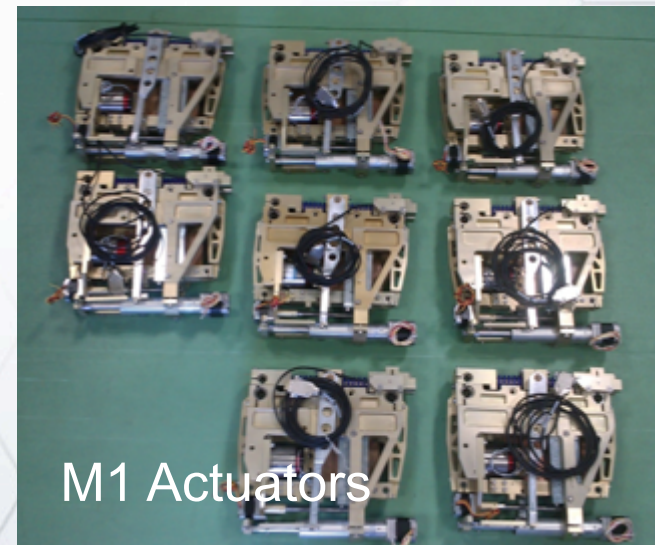
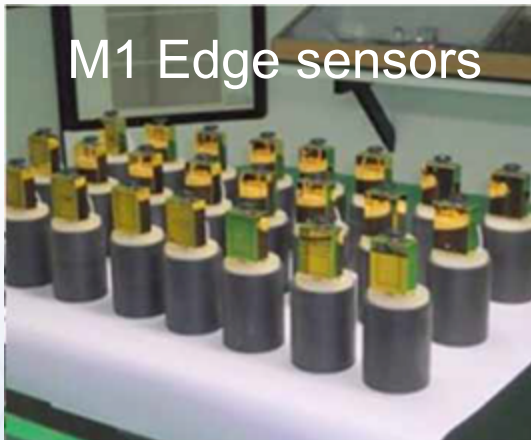
- ◆ Prototype and test, Preparation for mass production

(3) M1 Actuators, Edge sensors, etc.

- ◆ Prototype and test, Preparation for mass production

(4) Control Software for early light science instruments

- ◆ Conceptual design works for WFOS



1) International Status USA

(1) M1 Polishing (40%), IBF & Final check (100%)

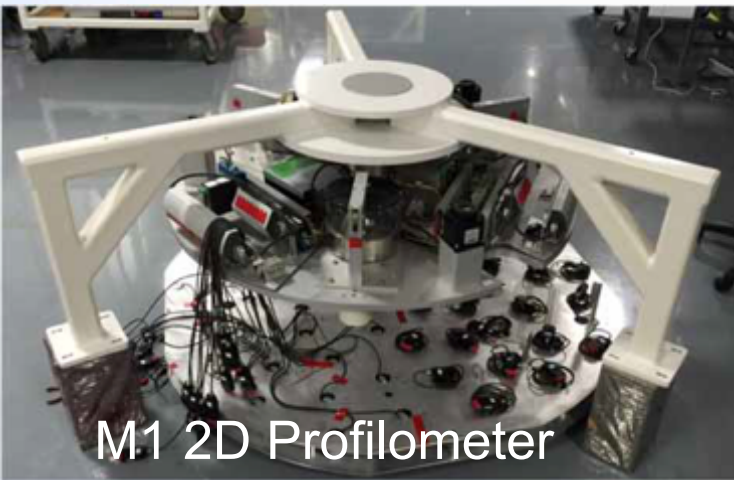
- ◆ Prototype and test at Coherent (Tinsley) & Harris (ITT). Preparation for mass production which will be started in 2018.

(2) M1CS (Control System: 100%)

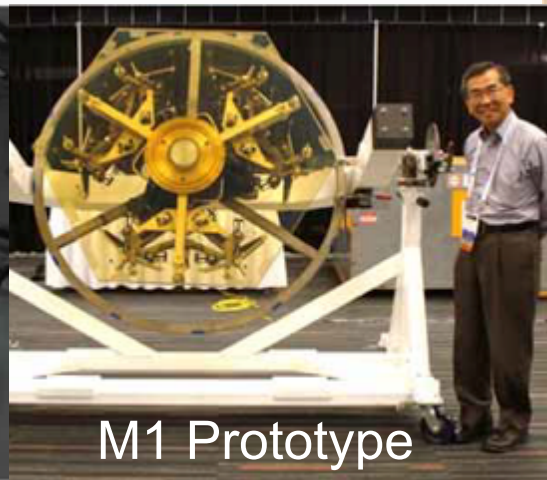
- ◆ Design, Prototype and test are on going. Mass production in India.

(3) Early Light Science Instruments

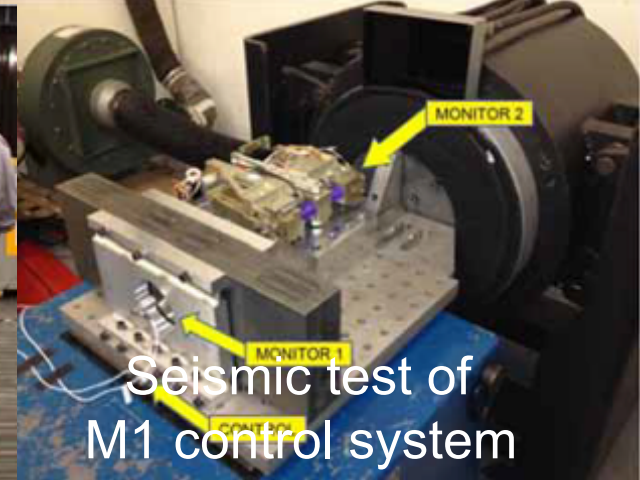
- ◆ IRIS: IFU mode. Preliminary Design phase
- ◆ IRMS: Clone of MOSFIRE developed by UCLA/Caltech
- ◆ WFOS: System design and Optics design. PI/PM recruiting now.



M1 2D Profilometer



M1 Prototype



Seismic test of
M1 control system

1) International Status China

(1) M1 Polishing (15%)

- ◆ Subscale (1.1m) test was successfully done. Design of M1 SMP system was done. Mass production will be started in 2017.

(2) M3 system (100%)

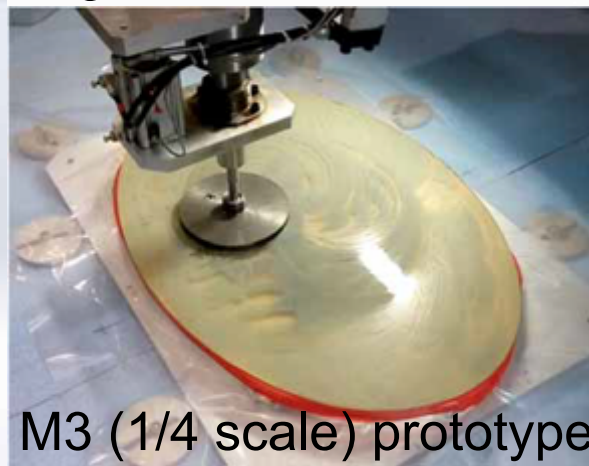
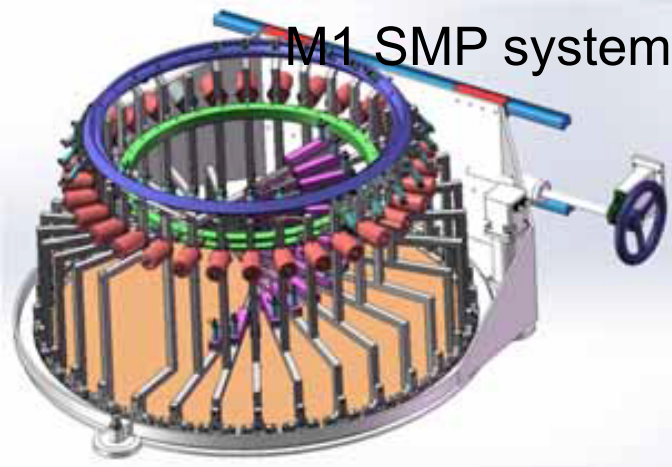
- ◆ 1/4 scale Prototype and testing

(3) LGS (Laser Guide Star)

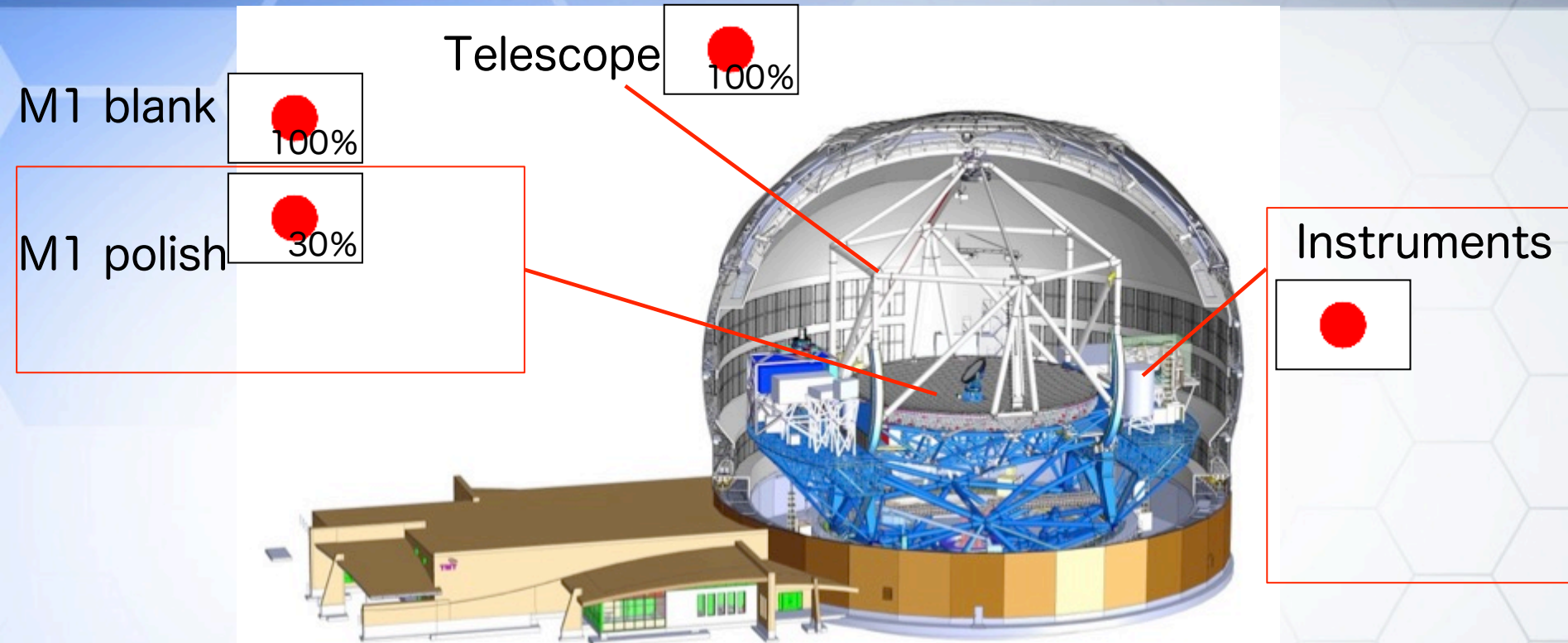
- ◆ Prototype and test, Preparation for mass production (6 for 1st light & 3)

(4) Early Light Science Instruments

- ◆ IRIS: Optical dispersion components
- ◆ WFOS: Conceptual design works for several subsystems





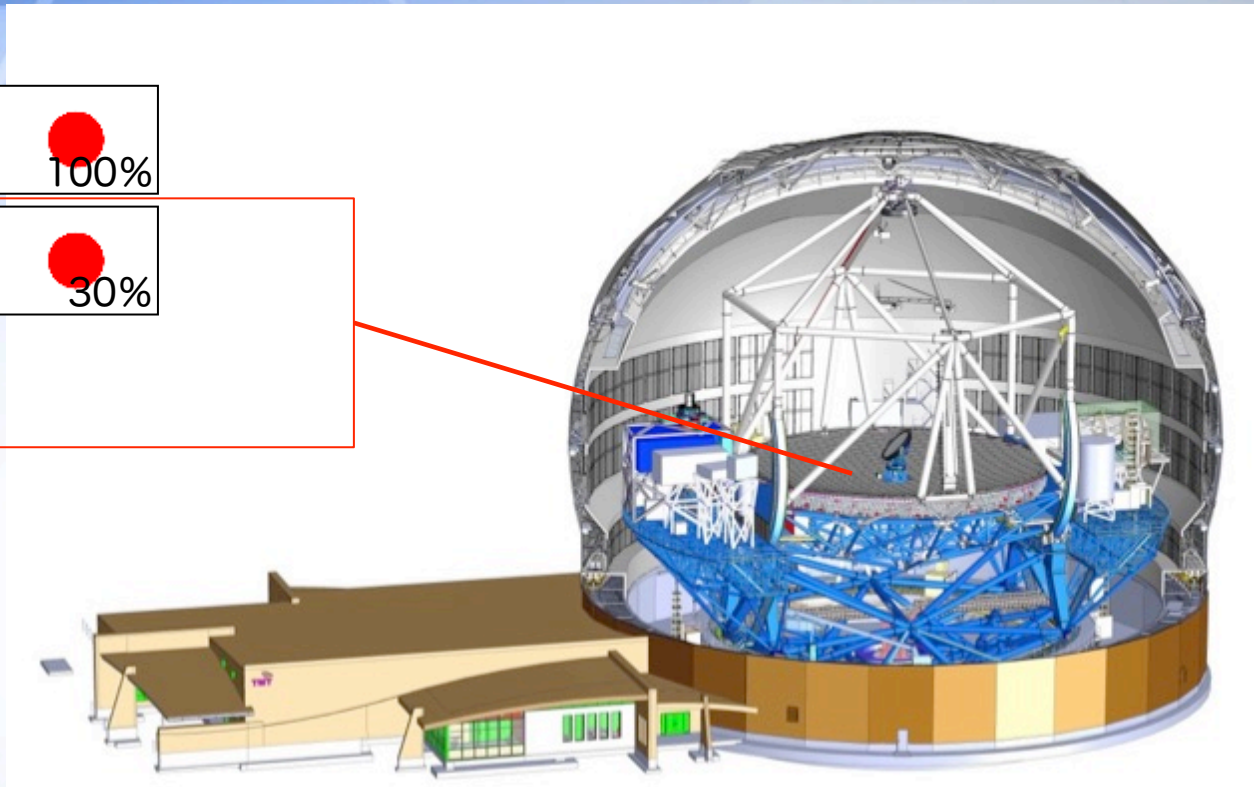
2) Japan's Contributions



- 1) Design fabrication / installation of the telescope structure,
- 2) Providing all the primary mirror segment blanks,
- 3) Polishing 30% of the primary mirror blanks,
- 4) Developing part of the First Generation Instruments, and
- 5) Cash contributions to cover common expenses etc.

2) Japan's Contributions

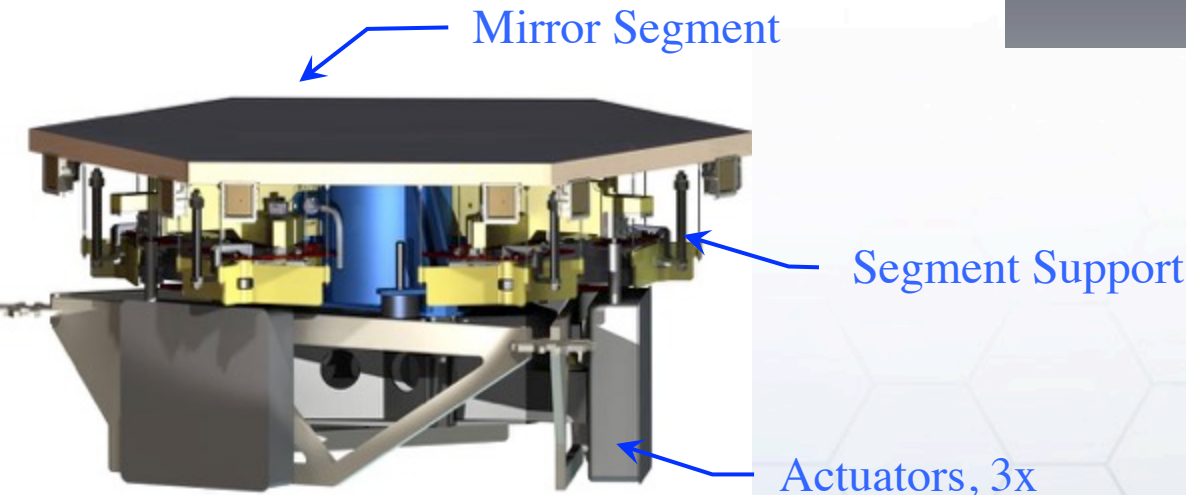
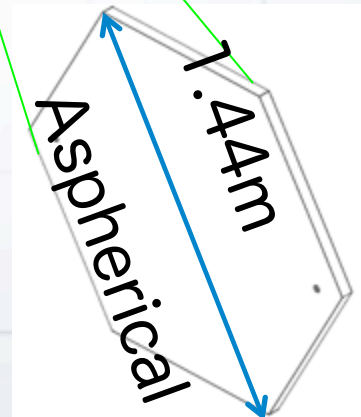
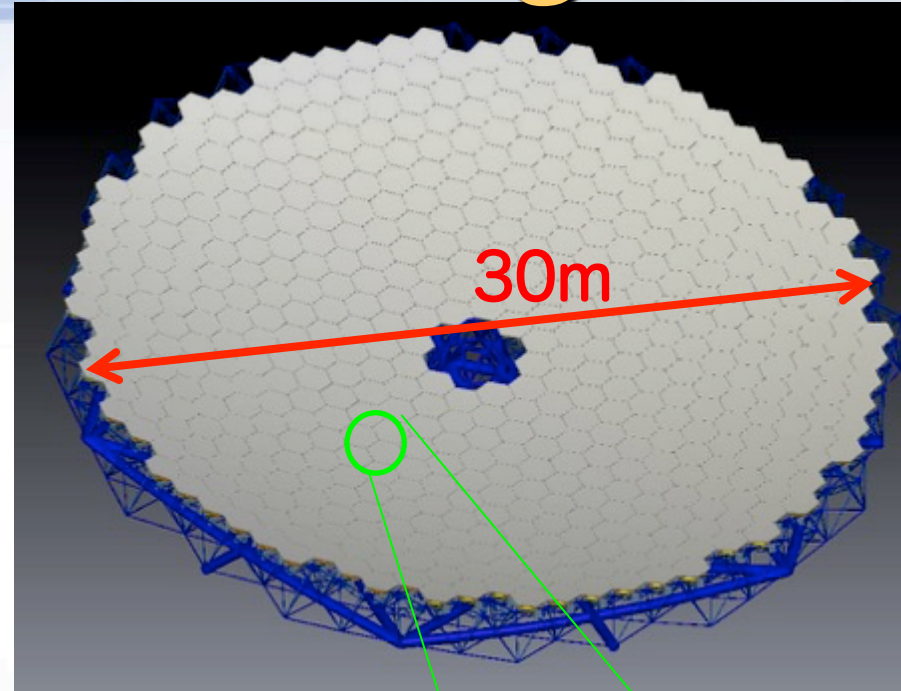
M1 blank	 100%
M1 polish	 30%



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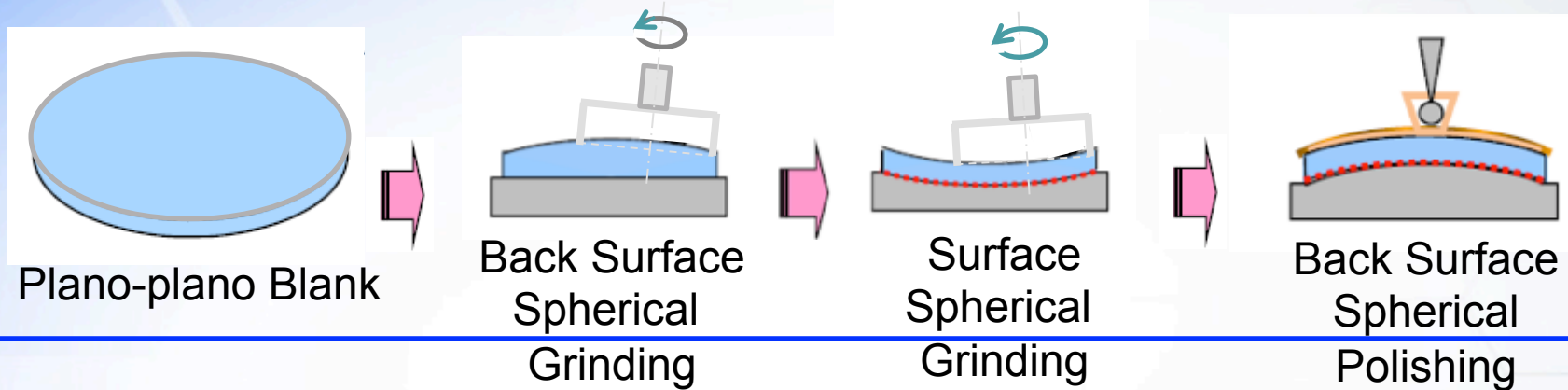
2) FY2015 TMT-J activities: M1 Blank & Polishing

- 492 Segments
 - ◊ 574 with spares
- 1.44m across corners
- 45mm thick glass ceramic
- 82 different types
- 2.5mm gaps (0.6% lost area)
- Protected silver coating

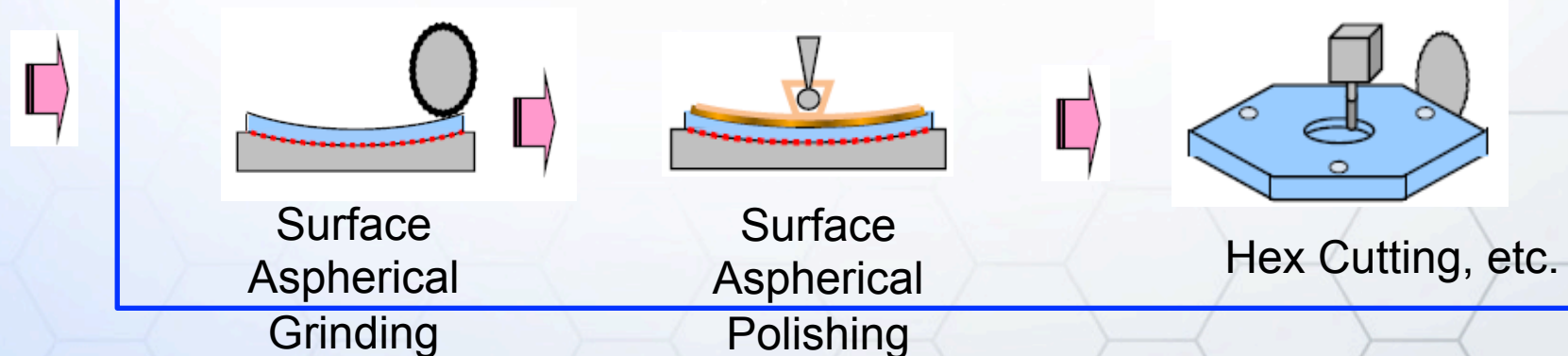


2) FY2015 TMT-J activities: M1 Blank & Polishing

M1 Blank (total 574) for both Japan and foreign partners



M1 Polishing, Hex cutting, & SSA mounting (30%)



2) FY2015 TMT-J activities: M1 Blank & Polishing

Process of works	FY2013	FY2014	FY2015
M1 Blank (plano-plano)	60	39	65
Spherical Grinding	12	19	63
Aspherical Grinding	12	16	31
Aspherical Polishing			7
Hex Cutting			0



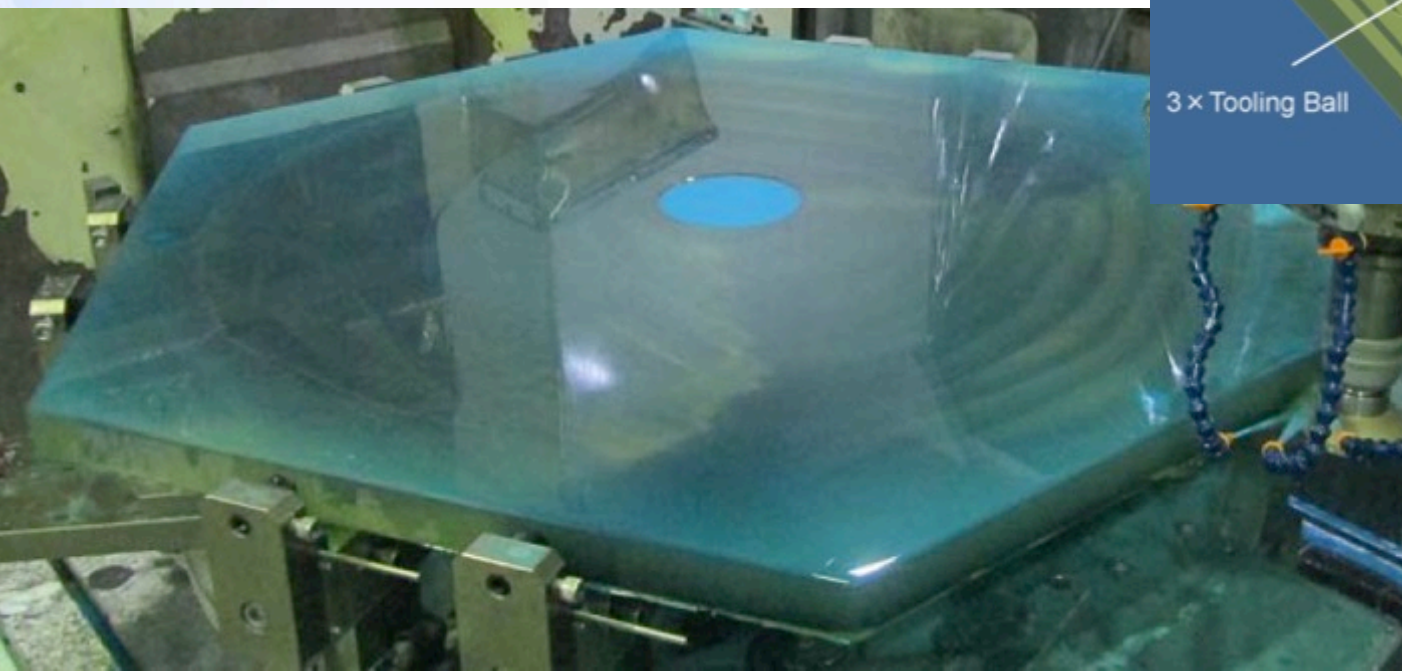
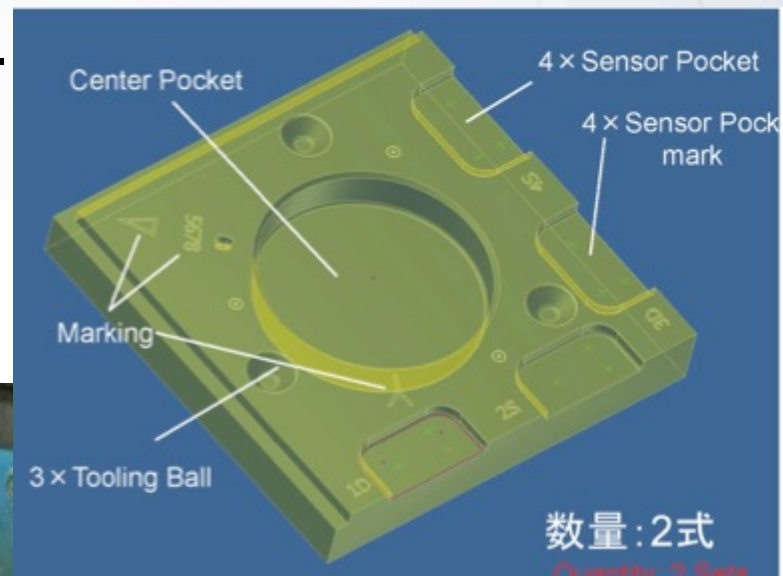
50th Blank backside Polished



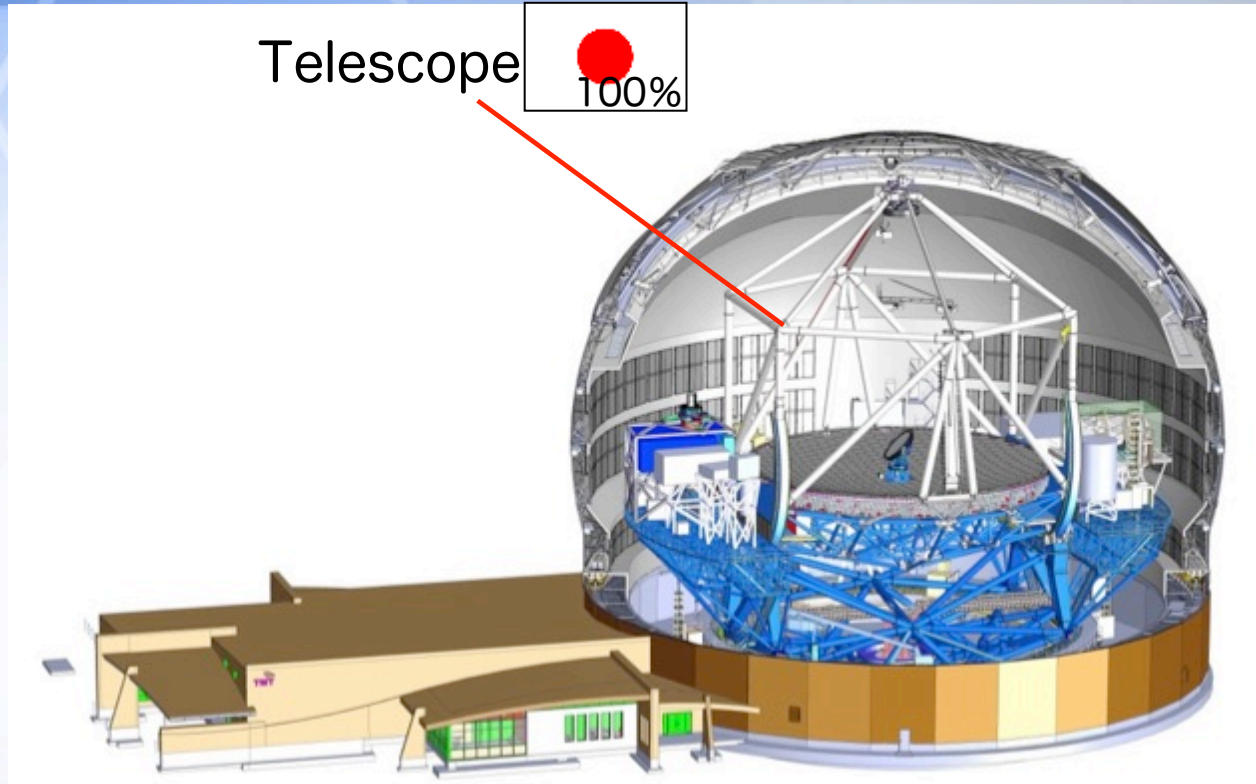
107 Blanks produced (2015 Oct)

2) FY2015 TMT-J activities: Hex Cutting

- ◆ Glass machining demonstrated on 300mm prototype
- ◆ SSD depth, Marking method, etc.
- ◆ Full scale test is under going









2) Japan's Contributions



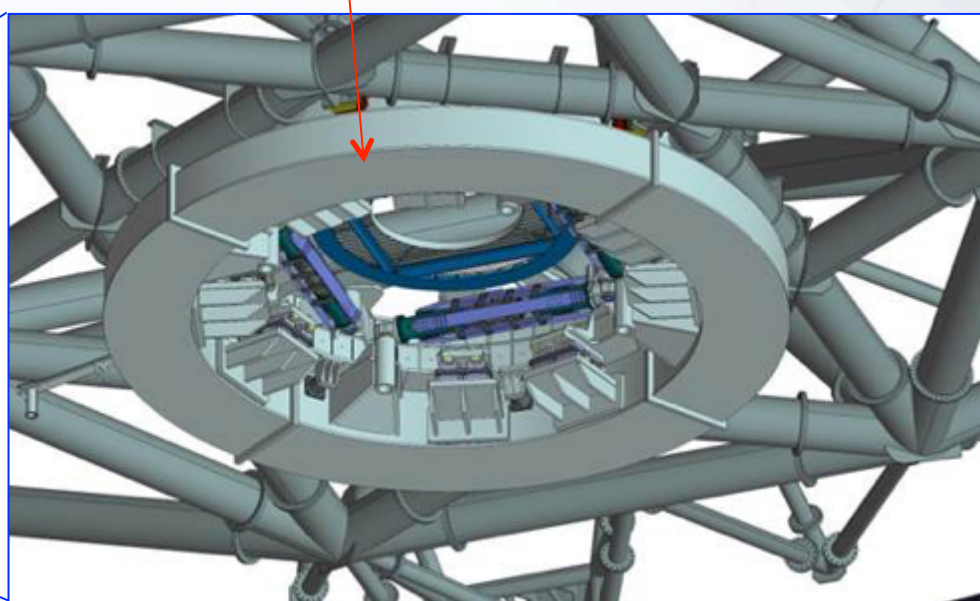
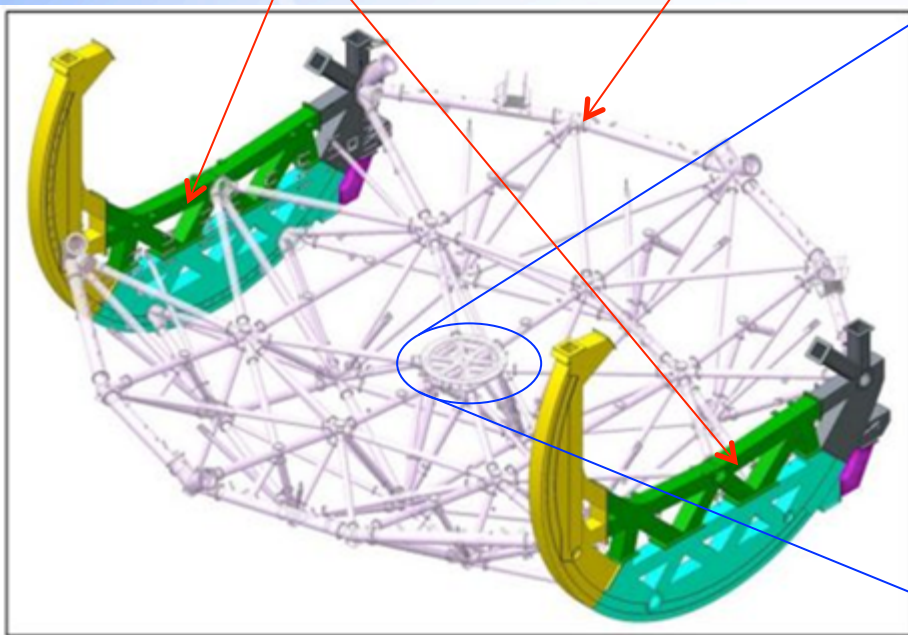
- 1) Design fabrication / installation of the telescope structure,
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2) FY2015 TMT-J activities: Telescope Structure (STR)

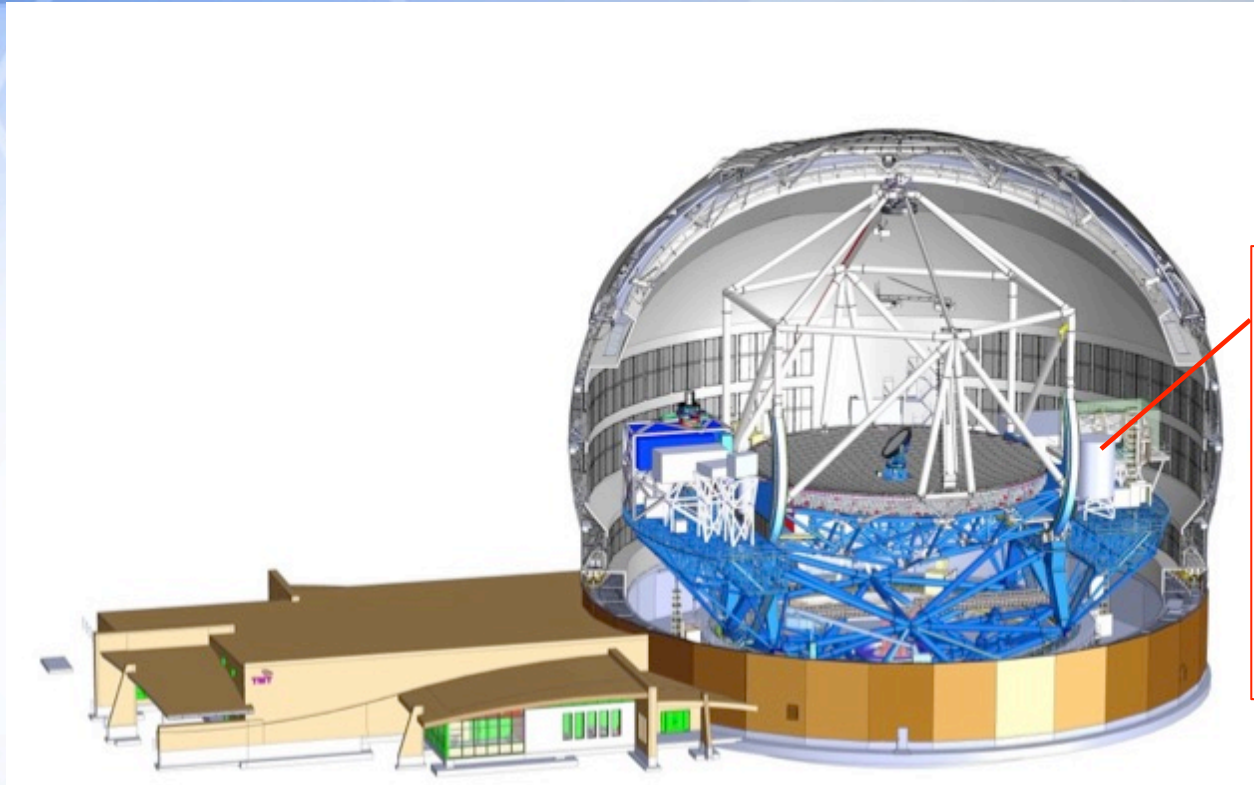
- 2013 Nov 12~14: PDR 
- 2014 Apr 15~16: PDR for STR control system 
- 2014 Nov 18~21: PDR for M1 Segment Handling System 
- 2015 Feb 17~20: FDR-P1 for STR mechanical system 
- 2015 Jul 27~29: FDRP2 for STR control system 
 - “FDR design of telescope software and control system is progressing well in many areas, but has not yet reached FDR level” → “A delta review will be required”*
- 2015 Oct 8~9: Long-lead Procurement Review (LPR) for EL-Journal, Lower-tube, Az Pintle bearing 
- 2016 Feb 24~25: delta-FDRP2 for STR control system
- 2016 March: Production Readiness Review
- FY2016: FDRP3 and FDRC

2) FY2015 TMT-J activities: STR LPR

◆ EL Journal, Lower-tube Structure, Azimuth Pintle Bearing



2) Japan's Contributions



Instruments

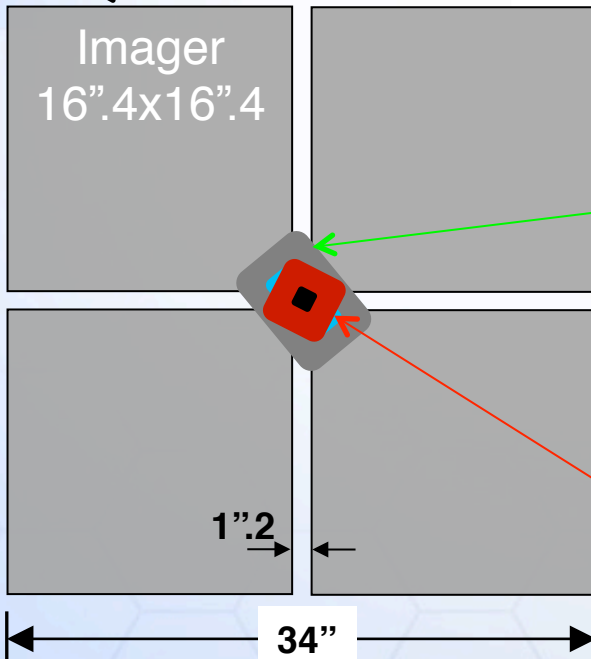
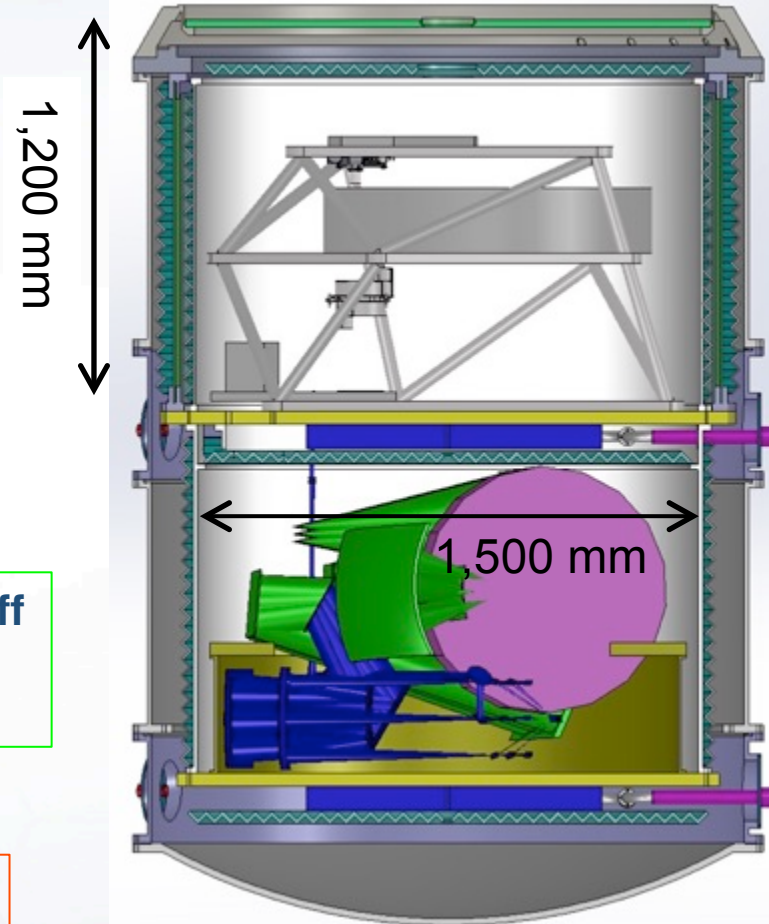
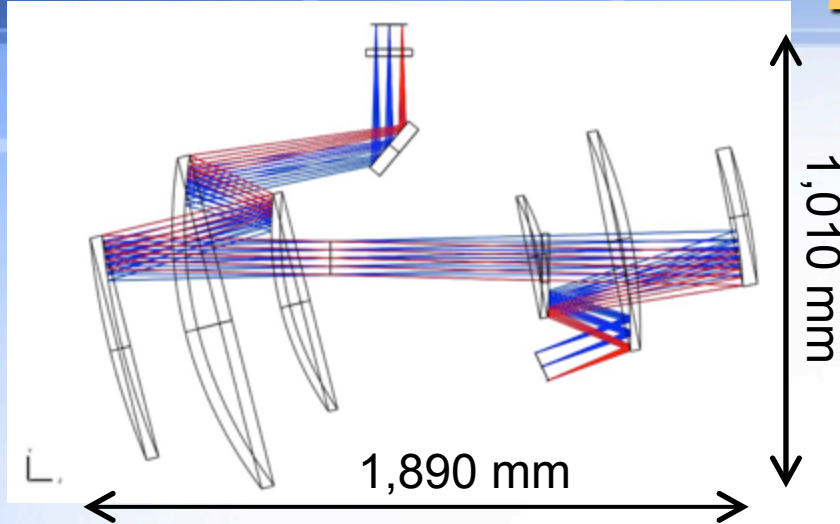


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2) FY2015 TMT-J activities: IRIS

TMT
Thirty Meter Telescope

NAC
Natl
Obs
IRIS
Infrared Imaging Spectrograph



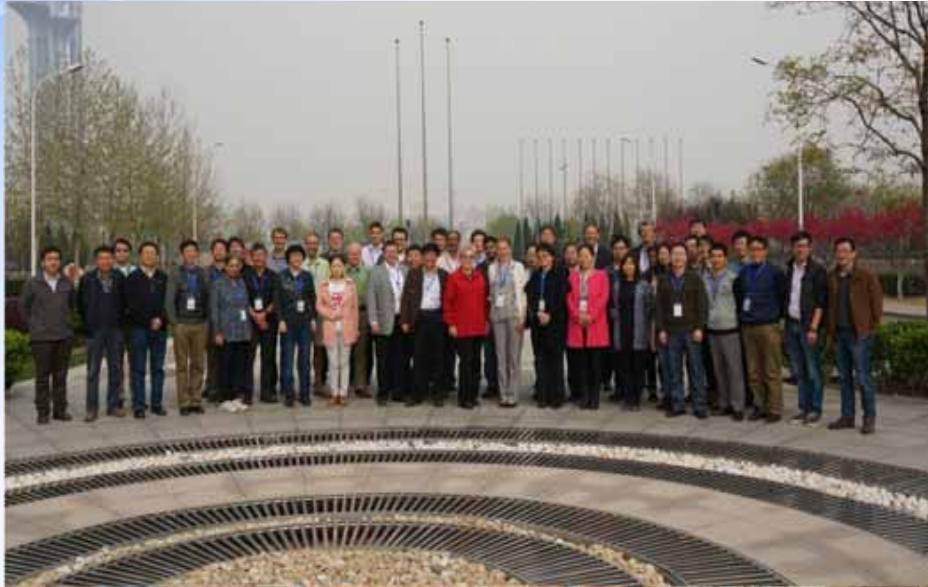
**Deployed Slicer Pickoff
and max field
(4''.4x2''.25)**

**Fixed Lenslet Pickoff
and max field
(1''.01x1''.15)**

IRIS imager in the dewar

FY2015 TMT-J activities: WFOS

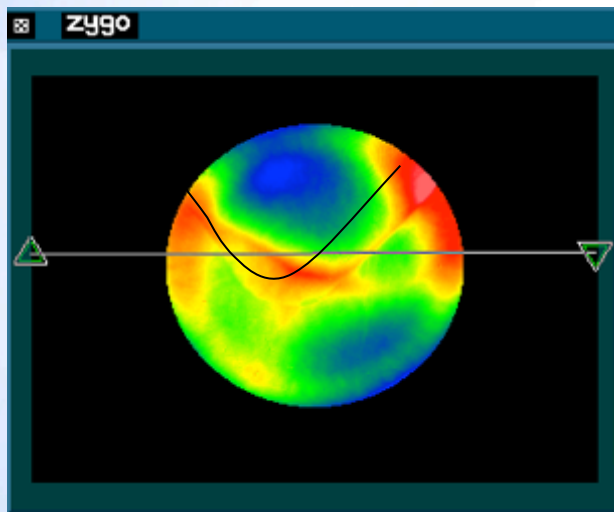
- ◆ mini-Review of Conceptual design @Beijing in April 14~16



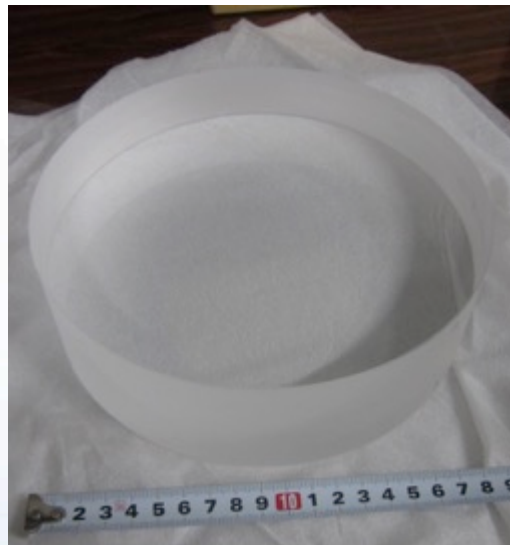
2) FY2015 TMT-J activities: WFOS status

CONFIDENTIAL

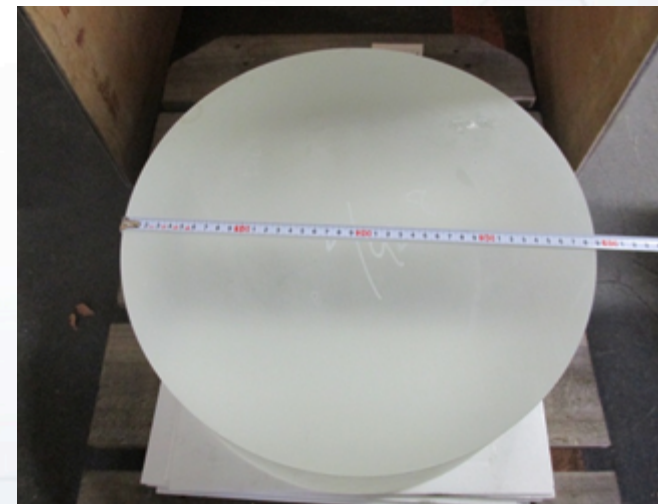
- ◆ Conceptual design studies of Camera lens system
 - Large CaF₂ glass polish tests
 - Procurement of large glass material (e.g., $\Phi 440\text{mm}$)
 - Optical design impact with un-uniformity of refraction
- ◆ S. Miyazaki is working in WFOS steering committee
- ◆ Waiting for new management team (cf. PI/PM) to start PD phase



CaF₂ polish test ($\Phi 70\text{mm}$)
Surface roughness: 139 nm PV,
26 nm RMS



Sample CaF₂
 $\phi 200 \times t59$



Large Glass material (Ohara
S-FPL51 $\phi 390 \times t128$)

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/tmts4>

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.

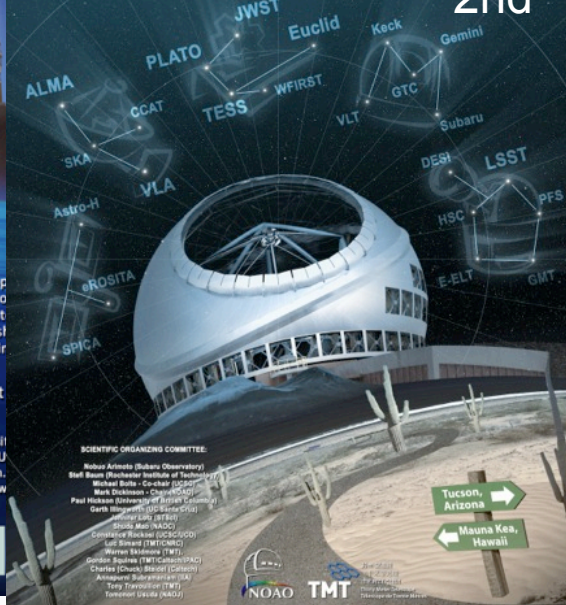


TMT in the Astronomical Landscape of the 2020s

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

2nd



SCIENTIFIC ORGANIZING COMMITTEE:

Nobuo Arimoto (Shanghai Observatory)
Bill Bottlinger (University of Hawaii)
Michael Bolte (UCSC)
Mark Dickinson (University of Hawaii)
Paul Hickson (University of British Columbia)
Garth Illingworth (University of Hawaii)
Shude Mao (NAOC)
Constance Rieke (UCSC)
Jeff Rouse (TMT/NAOJ)
Warren Skidmore (TMT)
Charles (Chuck) Steidel (Caltech)
Kiyomasa Tanihara (TMT)
Taty Tsvetanov (TMT)
Tomonori Usuda (NAOJ)

Maximizing Transformative Science with TMT

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

3rd

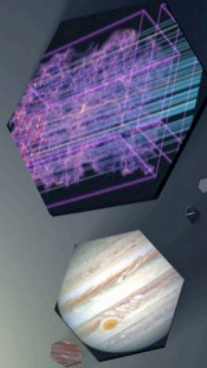
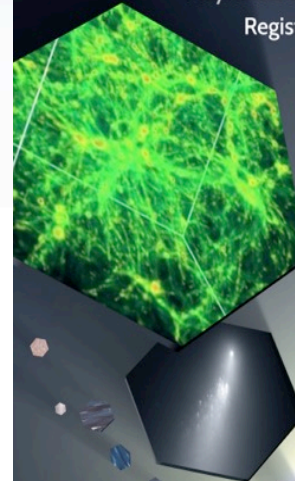
23 - 25 June 2015

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

Registration Deadline: 15 May 2015

SCIENTIFIC ORGANIZING COMMITTEE

G. C. Anupama (IIA)
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/IfA)
Shude Mao (NAOC)
Norio Narita (NAOJ)
A. N. Ramaprakash (IIA)
Kartik Sheth (NRAO)
Luc Simard (TMT/CNRC)
Warren Skidmore (TMT)
Charles (Chuck) Steidel (Caltech)
Lisa Storrie-Lombardi (Spitzer Science Center)
Tomonori Usuda (NAOJ)



4th TMT Science Forum @Kyoto on May 24~26!!



2015 June 23~25 @Washington DC

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



30 m 望遠鏡
三十米望遠鏡
तीस मीटर दूरबीन
Thirty Meter Telescope
Télescope de Trente Mètres

4th TMT Science Forum

May 24~26 @Kyoto

- ◆ Kyoto International Community House (<http://www.kcif.or.jp/>)
- ◆ Eight facilities available for rent such as the Event Hall, the Special Conference Room, the Conference Room 1,2,3,4, the Seminar Room and the Annex
- ◆ Facilities with beautiful views. You can enjoy the four beautiful seasons of Kyoto.



- ◆ ~50 lectures in science museums, schools etc. in every year
- ◆ Request for lectures is available from the TMT-J web page

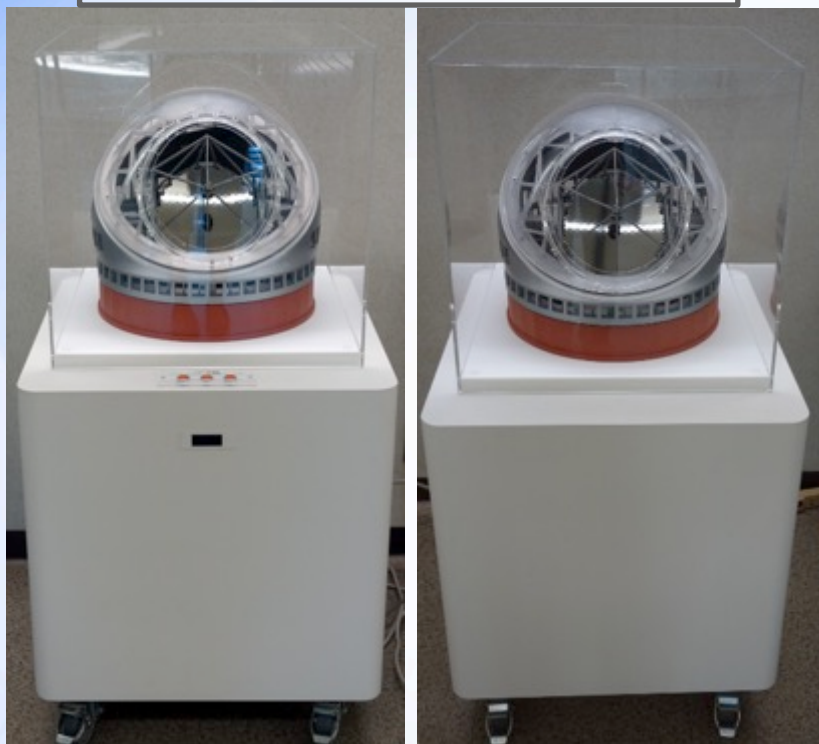


Radio broadcast
on nationwide



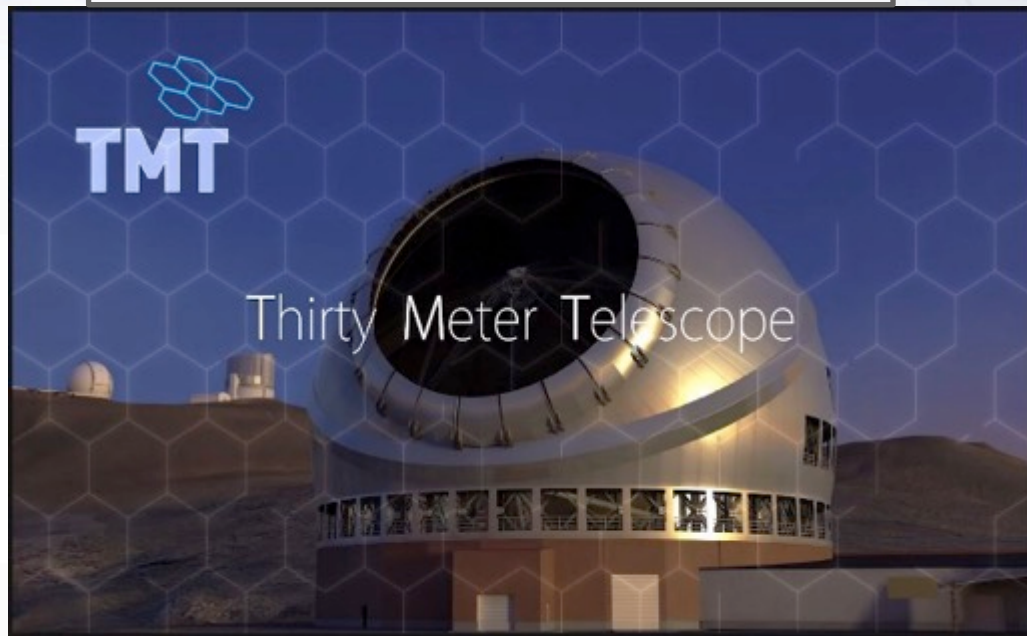
Public Outreach in FY2015

1/150 scale model



- movable & stable
- Loan service

TMT movie (2'20")



ダウンロード:

[480 x 270pixel](#) (低解像度、17MB)

[1280 x 720pixel](#) (高解像度、89MB)

Summary

- NAOJ appreciates Hawaii to build Subaru Telescope and TMT on Maunakea
- Construction schedule will be updated soon which will be approved by TIO board in Feb 3~4
- The first light is delayed likely to 2026 from 2024
- Community supports are important for TMT and Maunakea observatories

