CONFIDENTIAL

TMT Progress Report

Tomo Usuda (TMT-Japan Director)

Outline

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

Subaru's Synergy with TMT

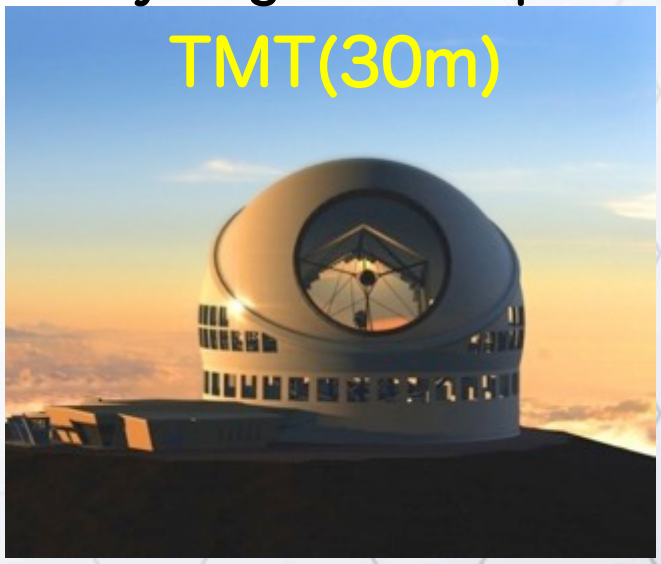
TMT Thirty Meter Telescope

NAOJ National Astronomical Observatory of Japan

Now

Survey by small telescopes → Detail studies by large telescopes

2020's



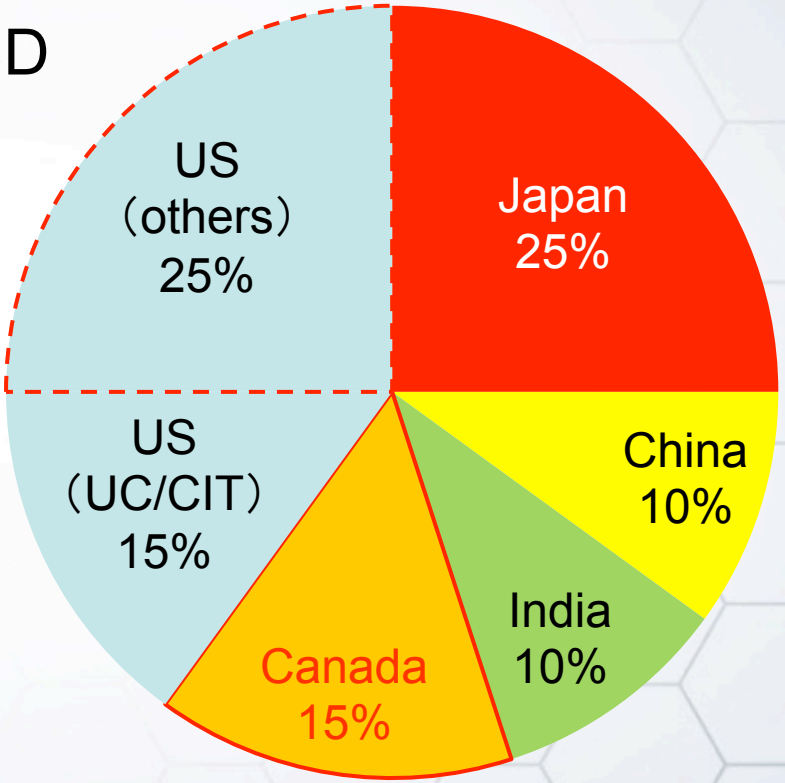
Survey by large telescopes → Detail studies by TMT

Members' contributions

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.

1) International Status 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.

Star Advertiser

The BIG Q

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)

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Dk/Re-fused
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

TMT
Thirty Meter Telescope

HONOLULU Star-Advertiser

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%

WARD RESEARCH INCORPORATED

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

TMT Thirty Meter Telescope

NAOJ National Astronomical Observatory of Japan

Letter to President Obama

MAHALO NUI,

Caltech Submillimeter Observatory, Sunil Golwala

Canada-France-Hawaii Telescope, Doug Simons

Simons

Gemini International Observatory, Markus Kissler-Patig

Kissler-Petig

James Clerk Maxwell Telescope (EAO), Paul Ho

NASA Infrared Telescope Facility, Alan Tokunaga

Subaru Telescope, Nobuo Arimoto

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

TMT International Observatory, Henry T. Yang

Yang

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

Hasinger

Very Long Baseline Array, Mark McKinnon

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

Lewis

International Astronomical Union, Norio Kaifu

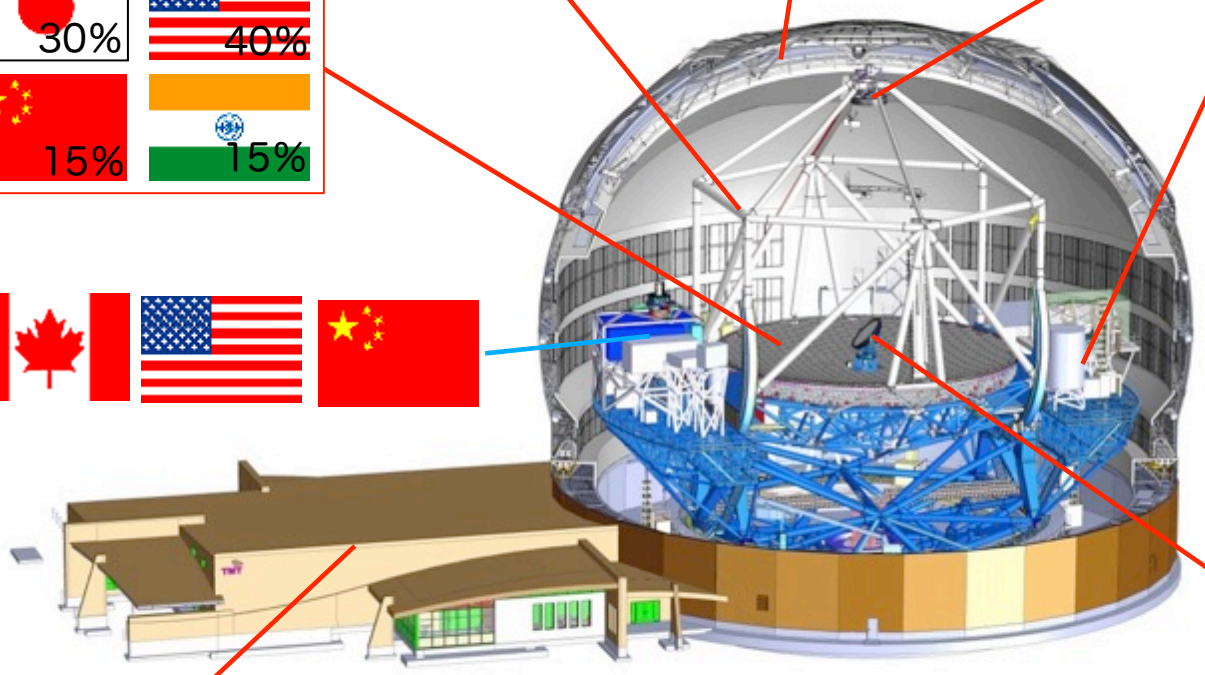
Kaifu

International Astronomical Union, Silvia Torres-Peimbert

Members' contributions

TMT Thirty Meter Telescope

NAOJ National Astronomical Observatory of Japan



Telescope 100%

Enclosure

M2

M1 blank 100%

M1 polish 30% 40% 15% 15%

Instruments

AO

M3

Facility

Control Systems & Software

1）International Status Canada

(1) Enclosure (100%)

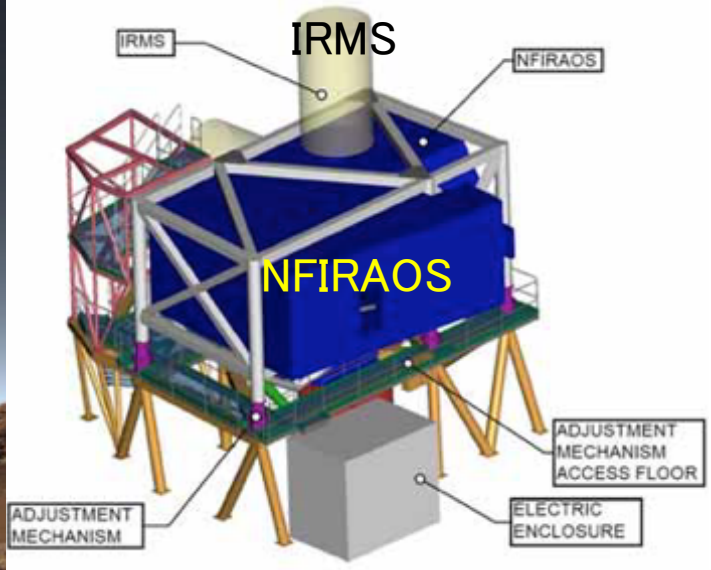
- Final Design: done
- Preparation of fabrication has been started in FY2015

(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

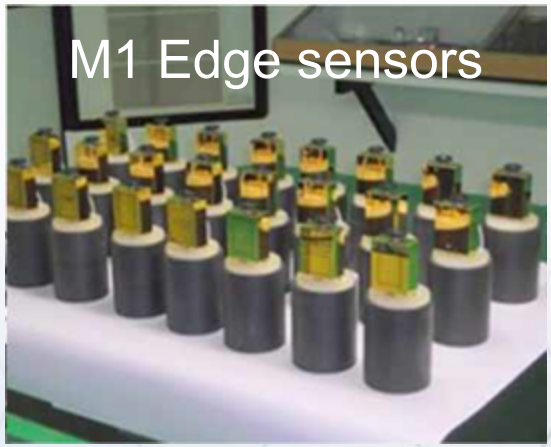
(3) M1 Actuators, Edge sensors, etc.

- Prototype and test, Preparation for mass production

(4) Control Software for early light science instruments

- Conceptual design works for WFOS


M1 SSA prototype


M1 Edge sensors


M1 Actuators

1）International Status USA

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

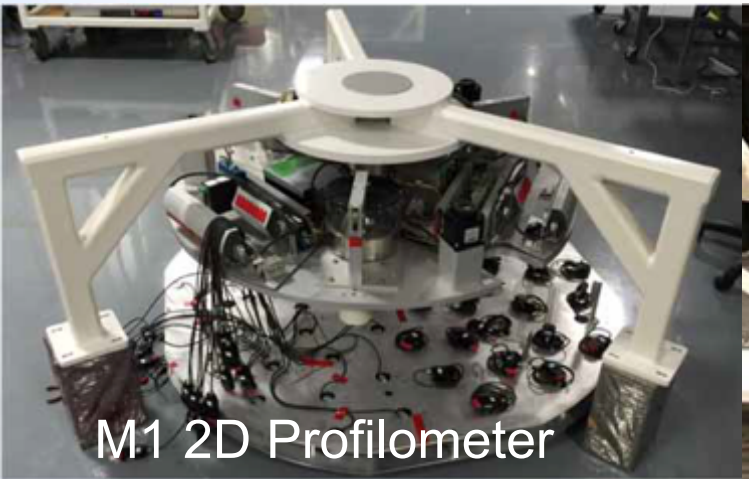
- Prototype and test at Coherent (Tinsley) & Harris (ITT). Preparation for mass production which will be started in 2018.

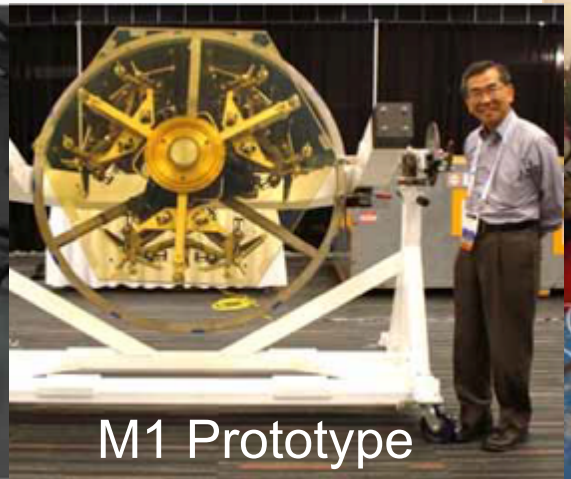
(2) M1CS (Control System: 100%)

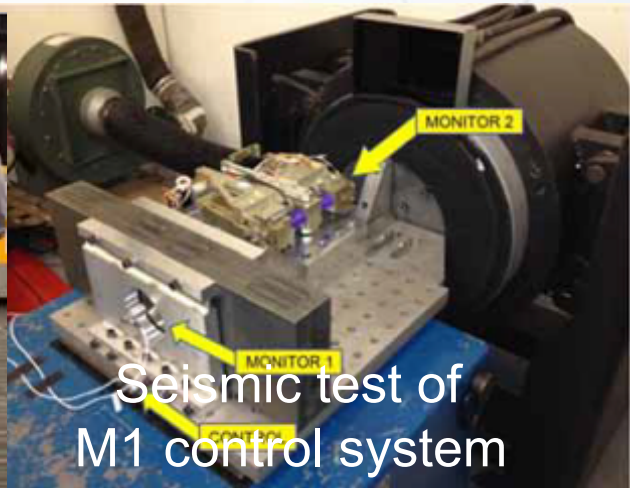
- Design, Prototype and test are on going. Mass production in India.

(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

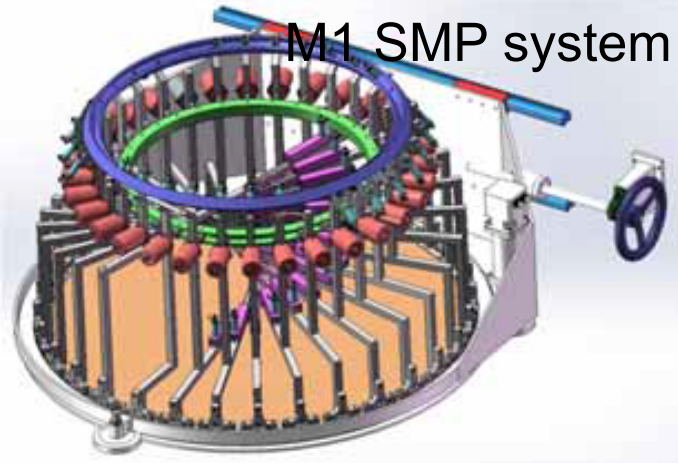
(3) LGS (Laser Guide Star)

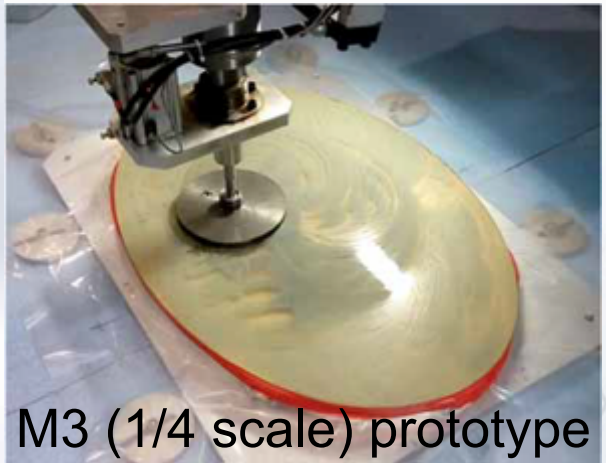
- Prototype and test, Preparation for mass production (6 for 1st light & 3)

(4) Early Light Science Instruments

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

M1 SMP system

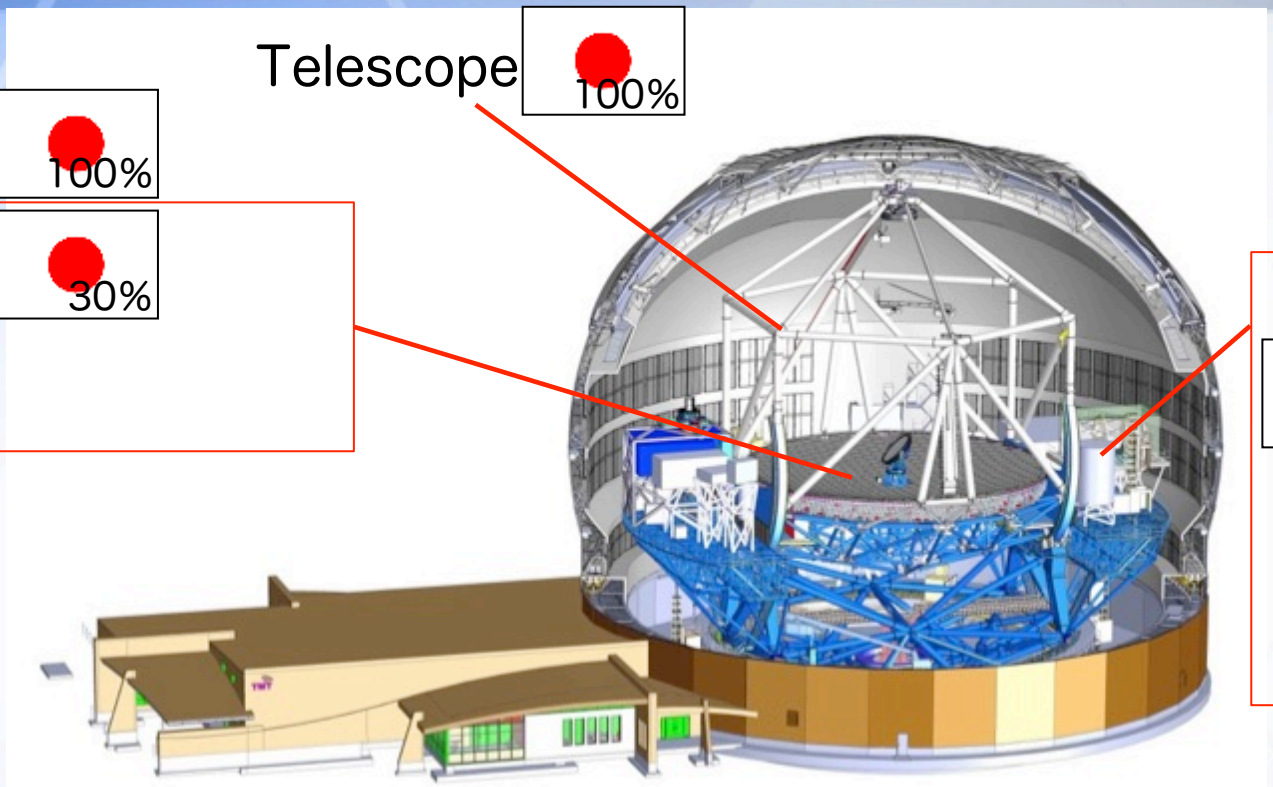




M3 (1/4 scale) prototype

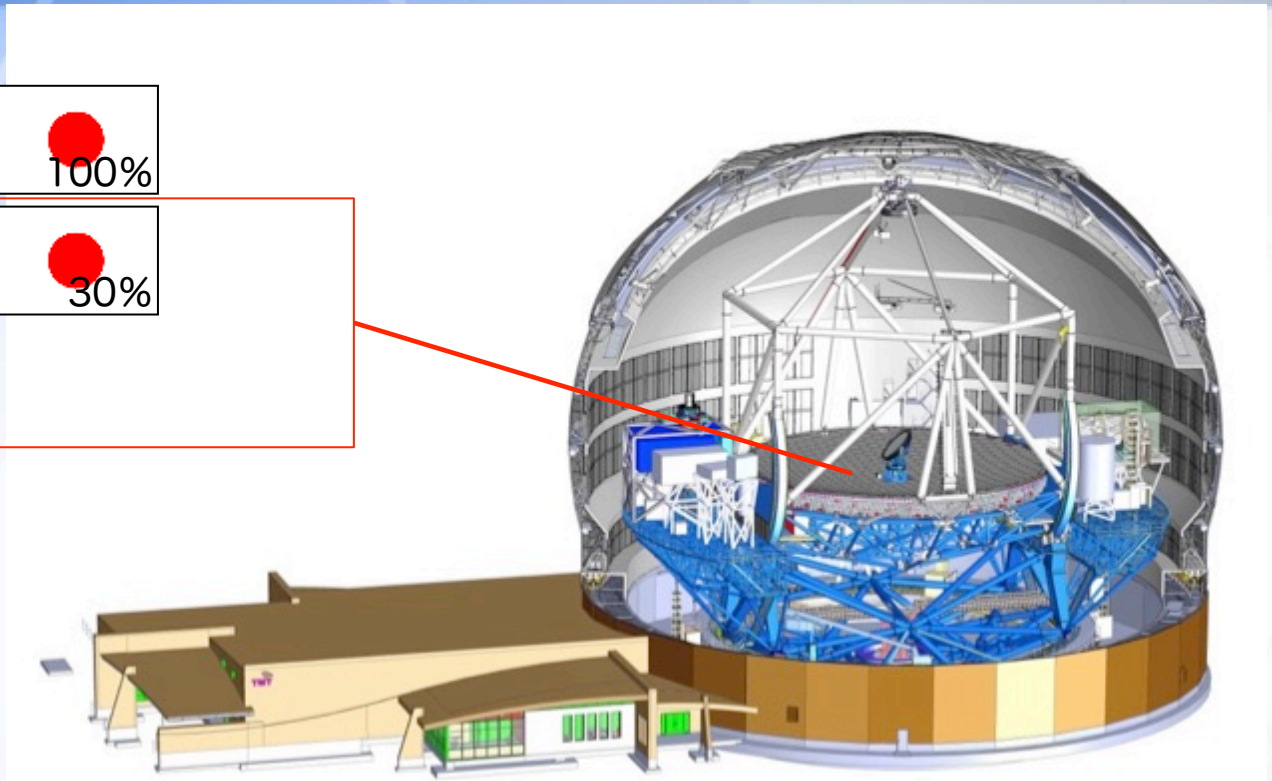
LGS prototype

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



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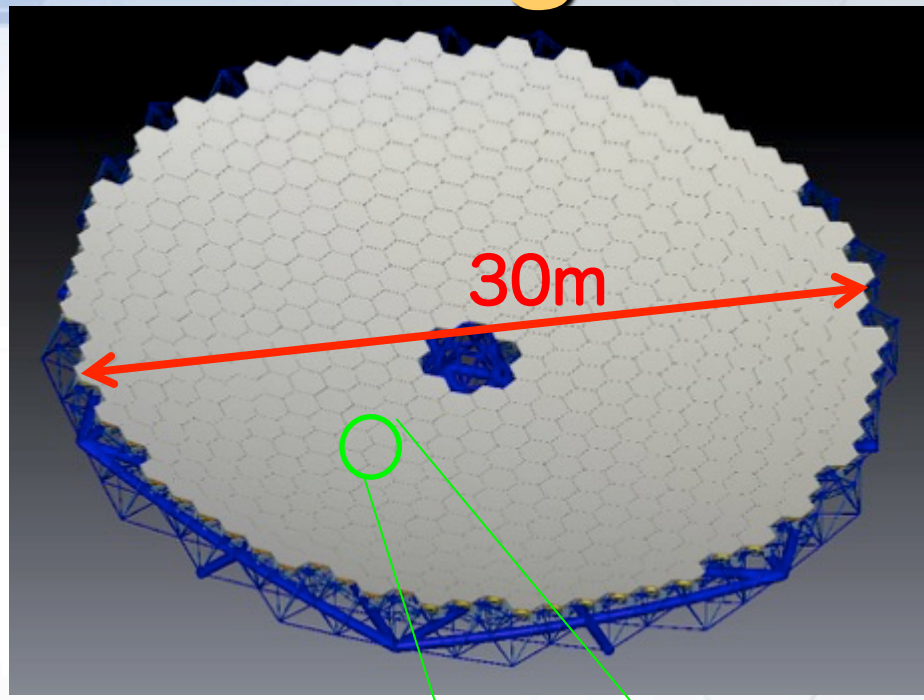
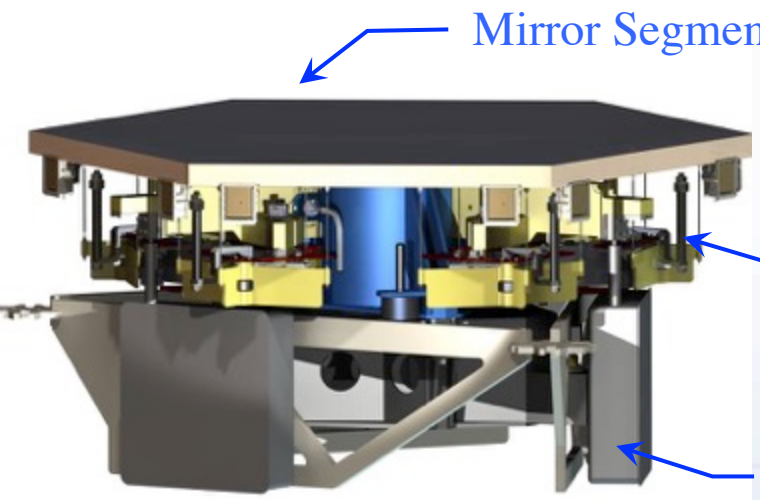
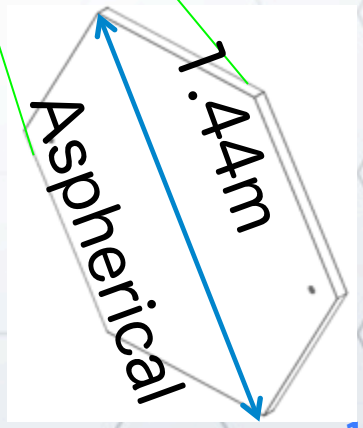
2) FY2015 TMT-J activities: M1 Blank & Polishing

- 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

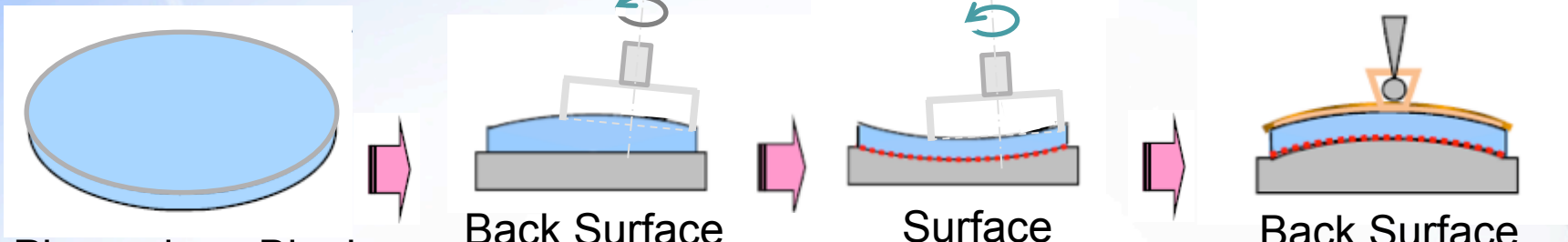




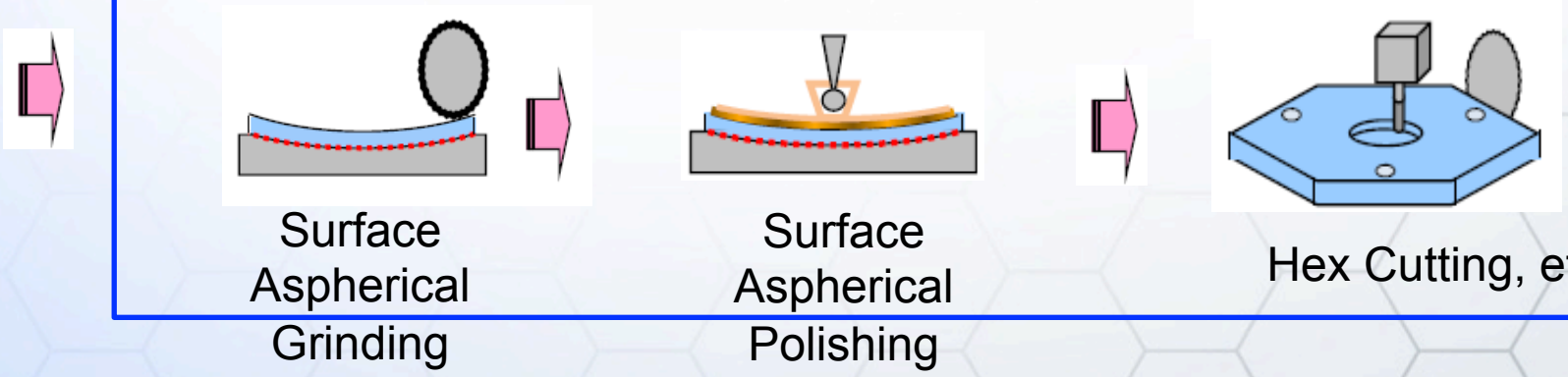


2) FY2015 TMT-J activities: M1 Blank & Polishing

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

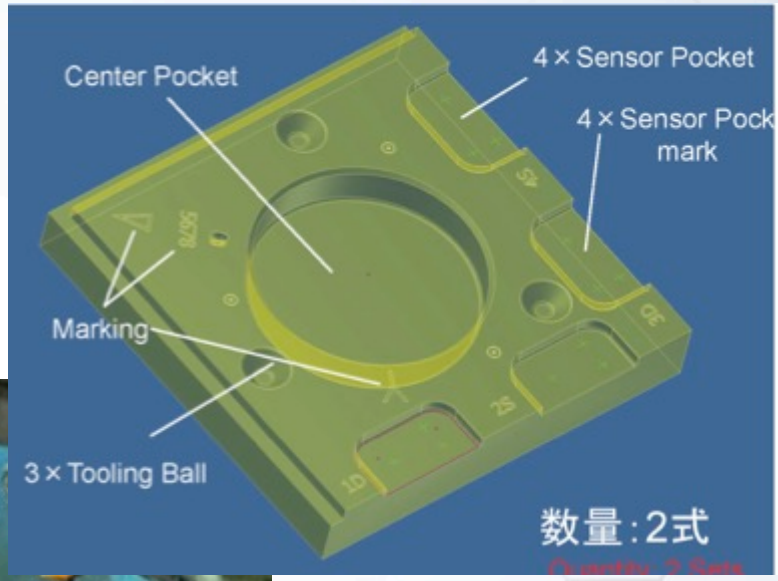
Process of works	FY2013	FY2014	FY2015
M1 Blank (plano-plano)	60	39	65
Spherical Grinding	12	19	63
Aspherical Grinding	12	16	31
Aspherical Polishing			7
Hex Cutting			0

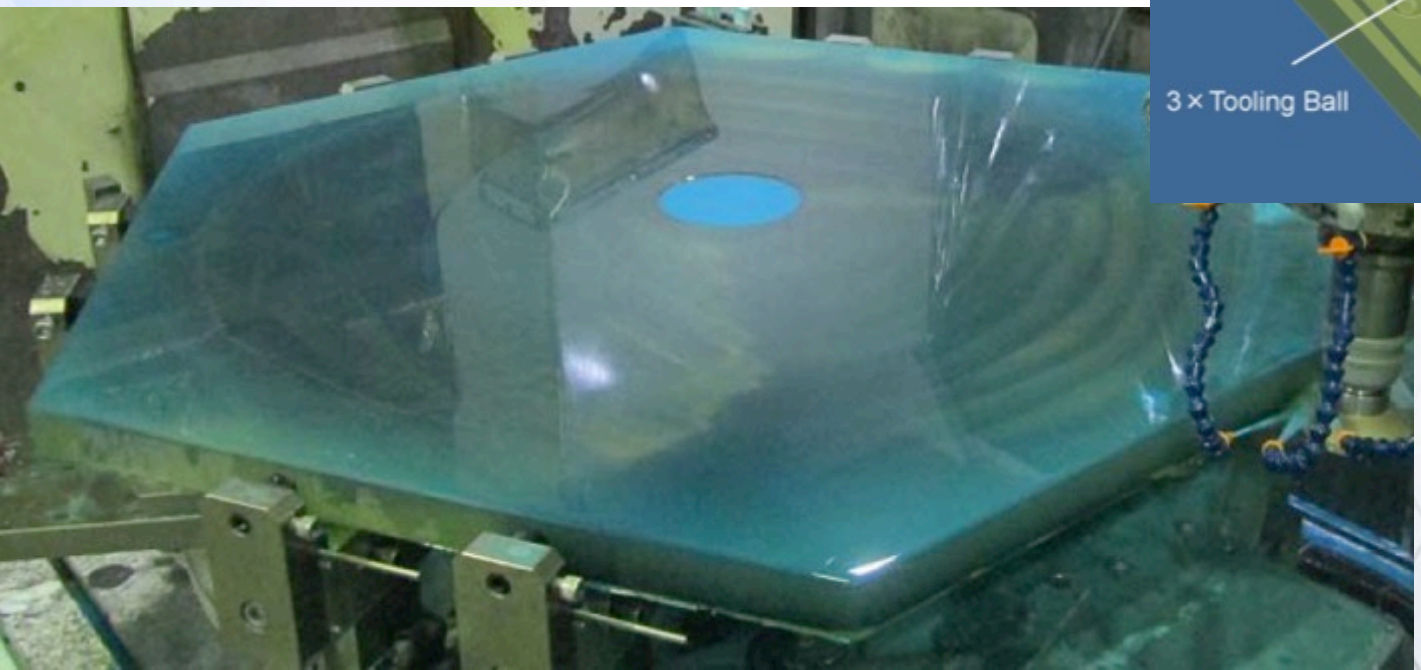
50th Blank backside Polished

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

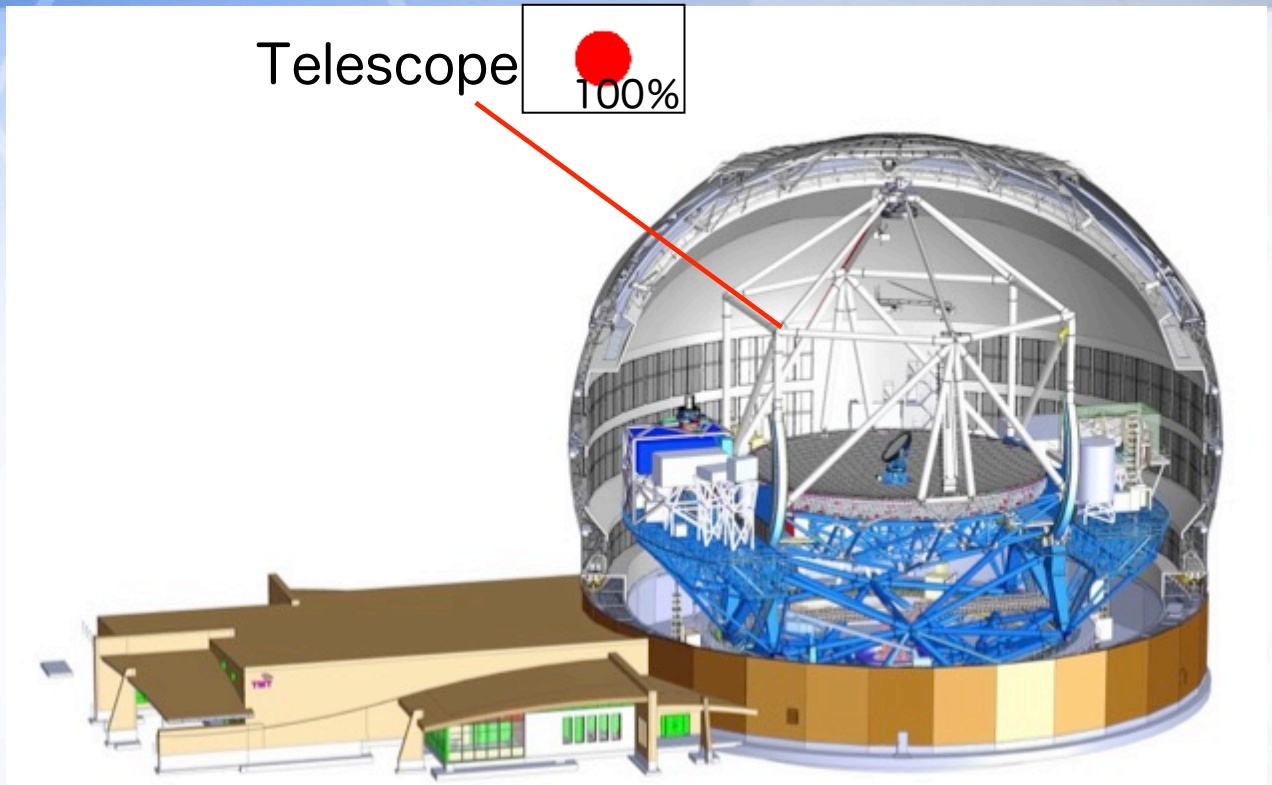




SHIBA R&D

Canon

2) Japan's Contributions



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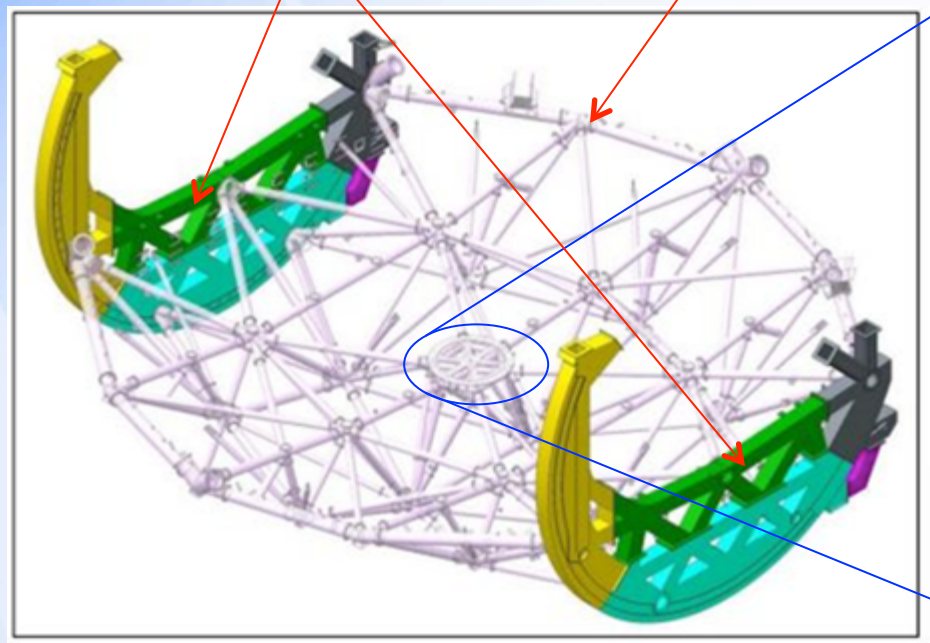
5) Cash contributions to cover common expenses etc.

2) FY2015 TMT-J activities: Telescope Structure (STR)

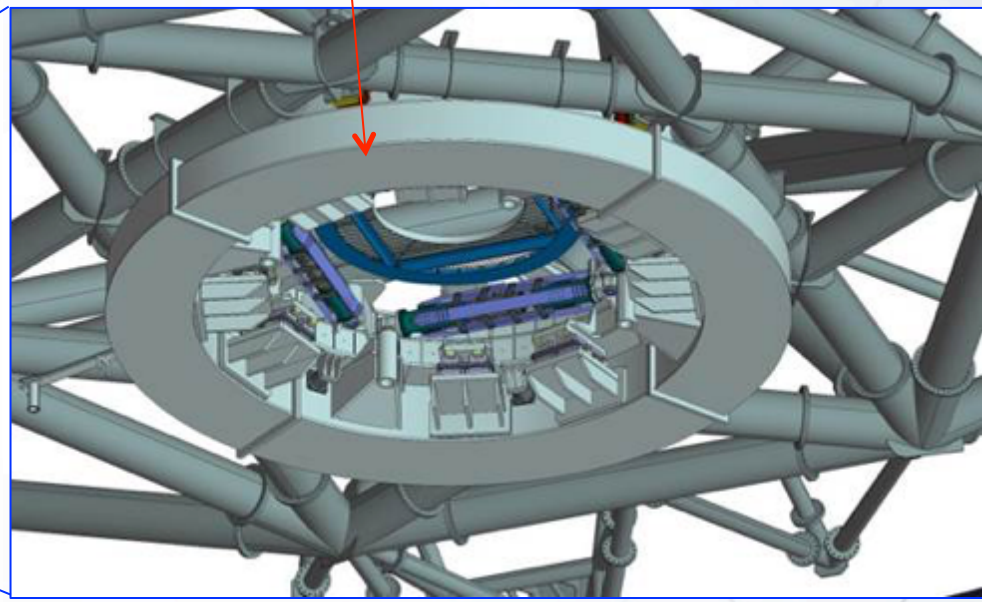
- 2013 Nov 12~14: PDR PASS
- 2014 Apr 15~16: PDR for STR control system PASS
- 2014 Nov 18~21: PDR for M1 Segment Handling System PASS
- 2015 Feb 17~20: FDR-P1 for STR mechanical system
- 2015 Jul 27~29: FDRP2 for STR control system
  - *"FDR design of telescope software and control system is progressing 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 PASS
- 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



MITSUBISHI ELECTRIC



MITSUBISHI ELECTRIC

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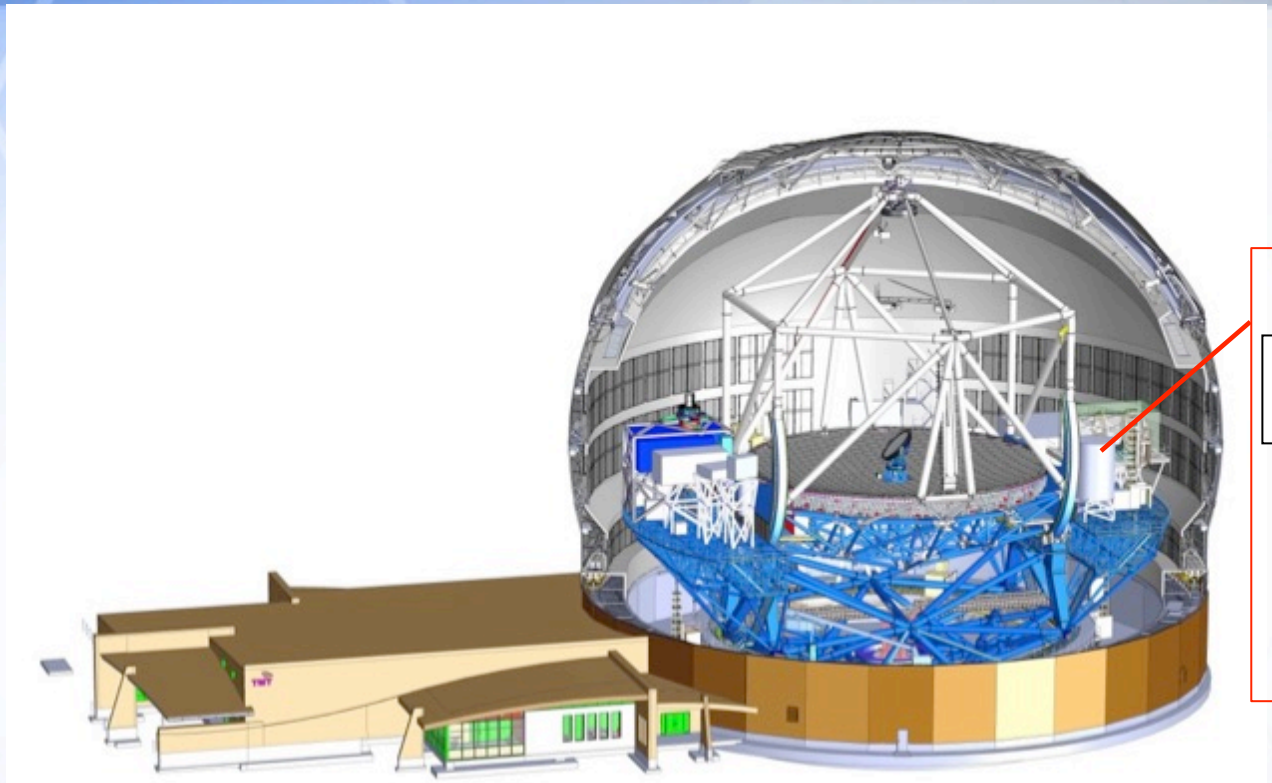

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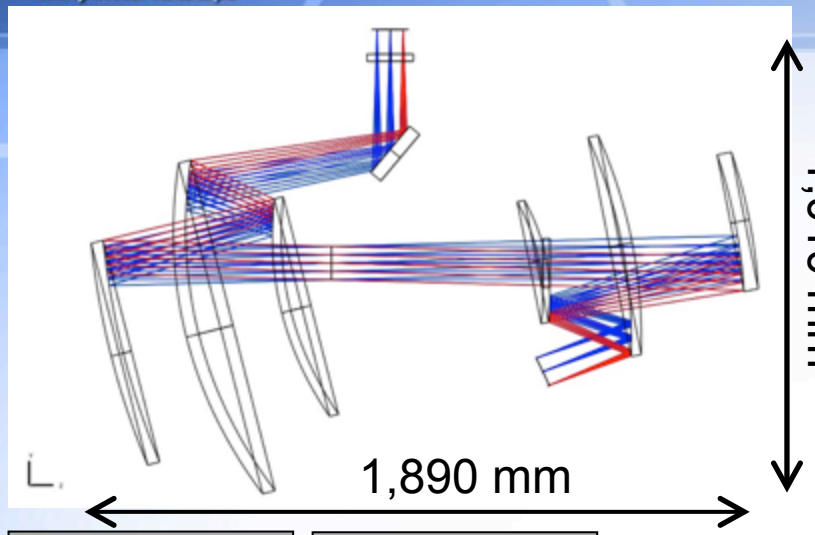
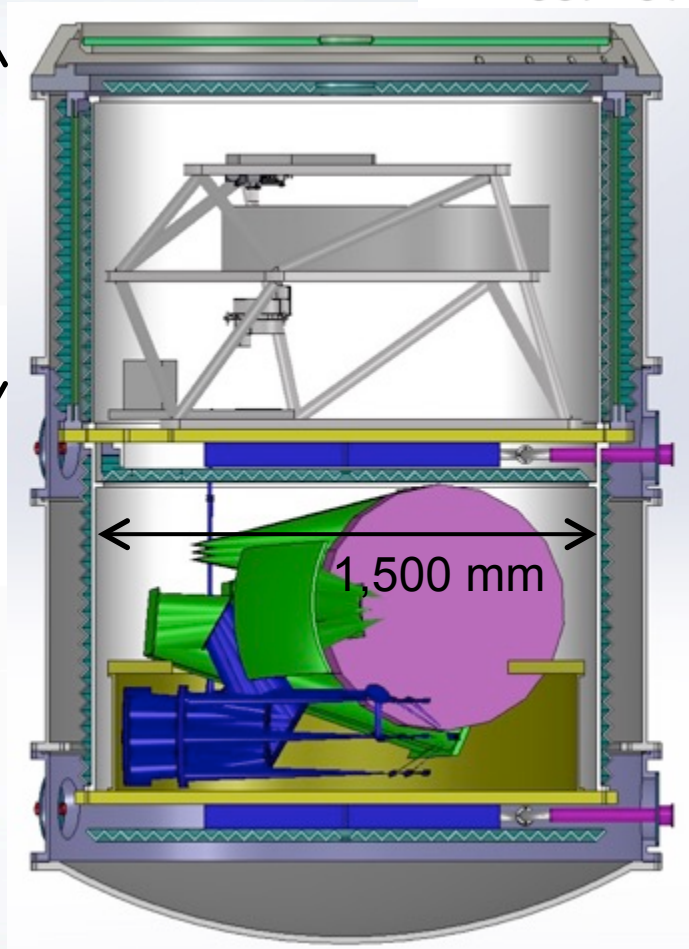
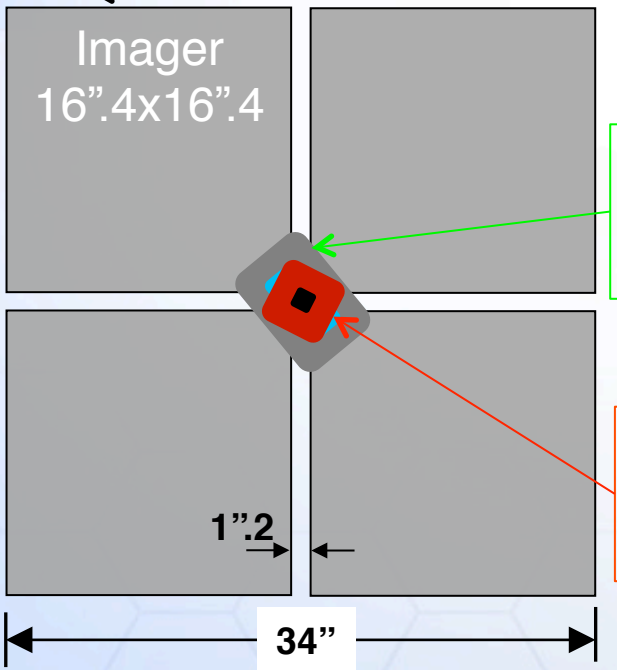
2) FY2015 TMT-J activities: IRIS







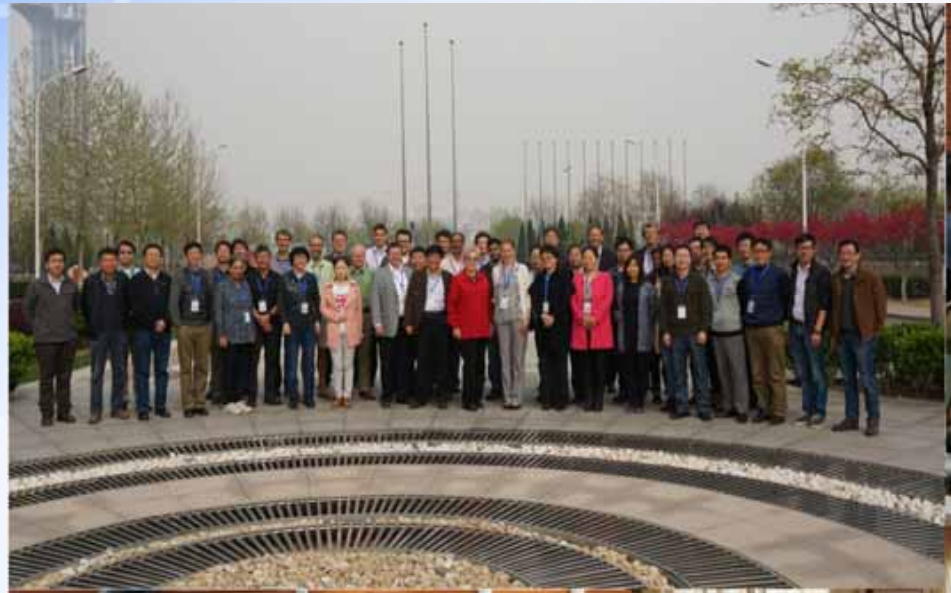
Deployed Slicer Pickoff and max field (4".4x2".25)

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

IRIS imager in the dewer

2) FY2015 TMT-J activities: WFOS

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





2) FY2015 TMT-J activities: WFOS status

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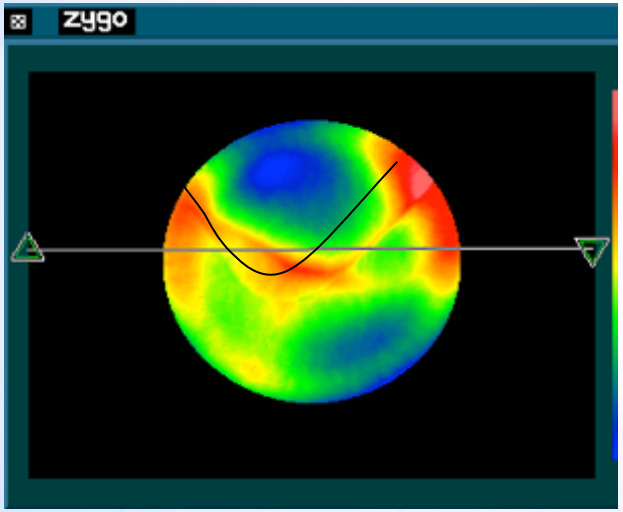
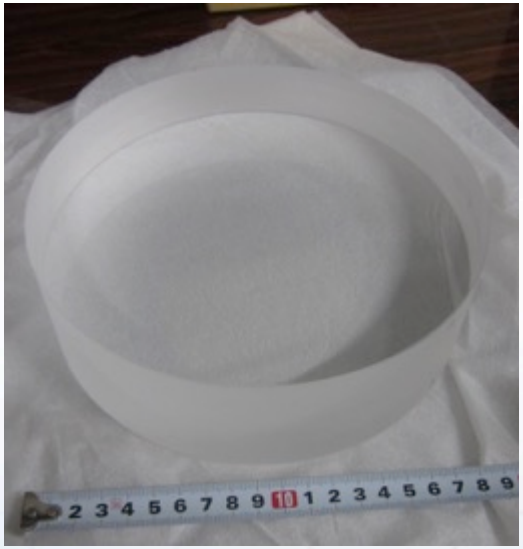
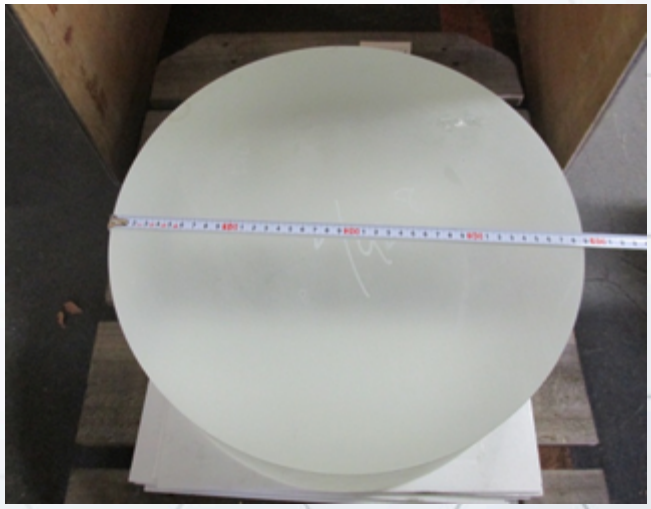
- Conceptual design studies of Camera lens system
  - Large CaF2 glass polish tests
  - Procurement of large glass material (e.g., Φ440mm)
  - Optical design impact with un-uniformity of refraction
- S. Miyazaki is working in WFOS steering committee
- Waiting for new management team (cf. PI/PM) to start PD phase



CaF2 polish test (Φ70mm)
Surface roughness: 139 nm PV, 26 nm RMS



Sample CaF2
ϕ200 x t59



Large Glass material (Ohara S-FPL51 ϕ390 x t128)

TMT Science Forum

1st

TMT ASTRONOMY'S NEXT-GENERATION OBSERVATORY

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 telescop located on Mauna Kea, HI. The program will consist of talks and worksho discussions exploring science, first-light and future instruments, observat operations, archiving and data products, key projects and cross-partnersh collaborations, astronomy education and science, technology, engineerir and math (STEM) opportunities.

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

If you are interested in attending the Forum, register at the conference websi As part of the NSF-TMT agreement, some travel funding will be available for U 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 w your name, institutional affiliation, and areas of interest relevant to TMT.

ACURA CALTECH DSTI NAOC NAOJ UC

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

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

NOAO TMT

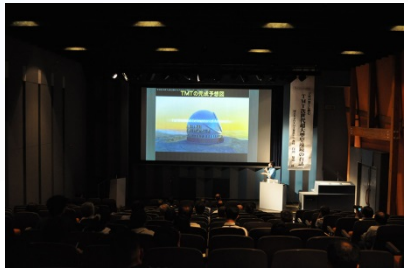
30 m 望遠鏡
三十米望远镜
तीस मीटर दूरबीन
Thirty Meter Telescope
Télescope de Trente Mètres

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.

Public Lectures in FY2015

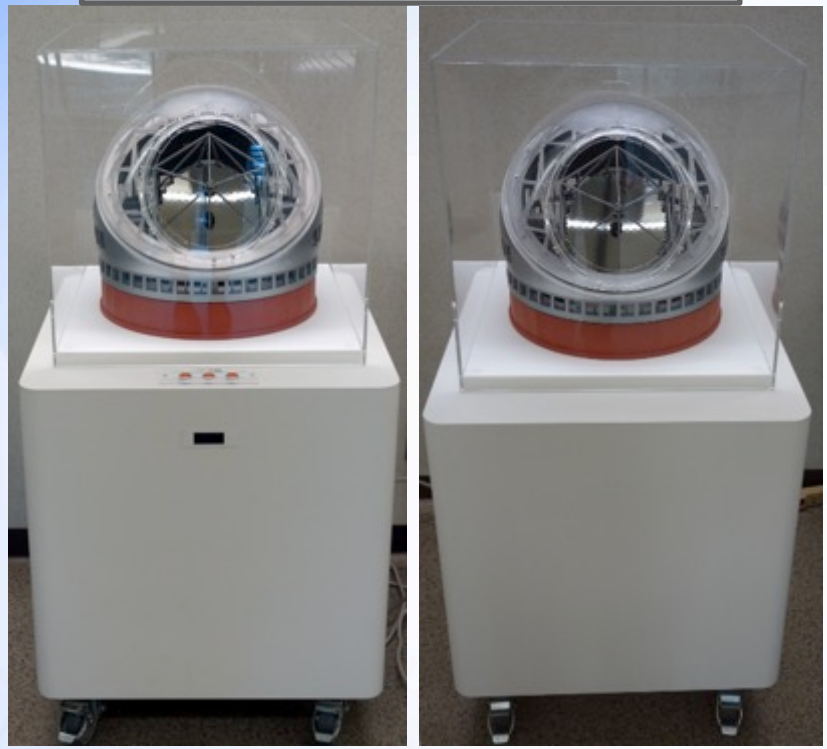
- ~50 lectures in science museums, schools etc. in every year
- Request for lectures is available from the TMT-J web page



Radio broadcast on nationwide

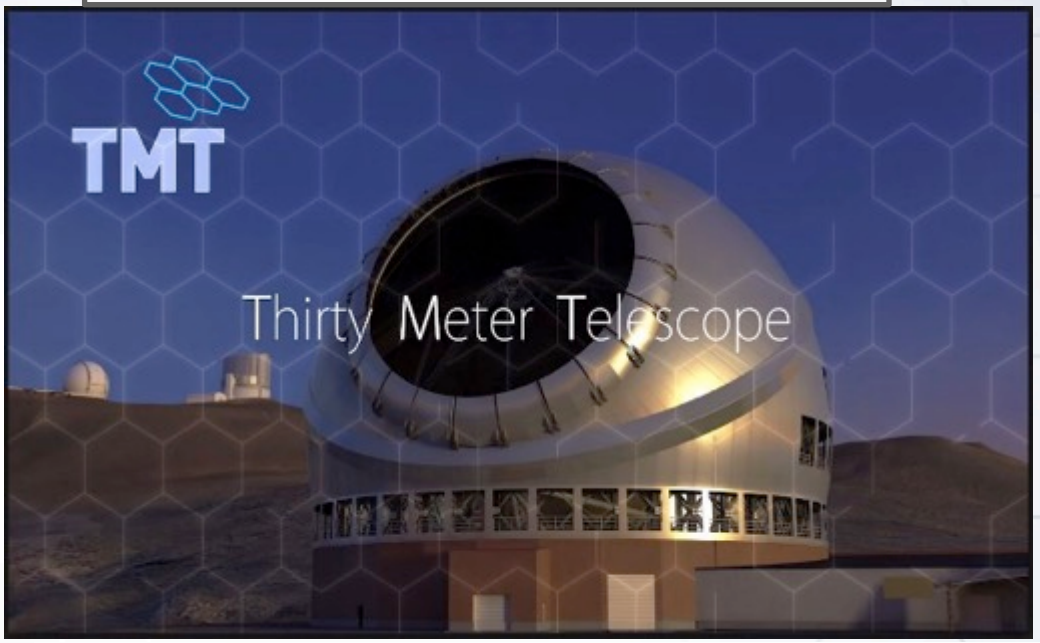
Public Outreach in FY2015

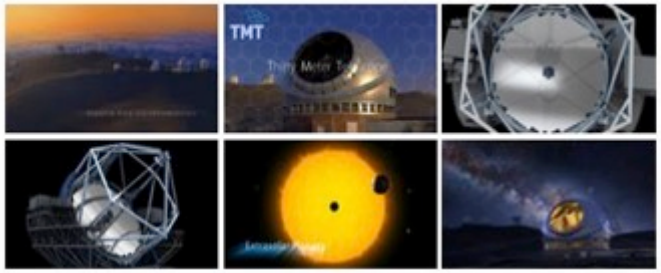
1/150 scale model



- 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