The Thirty Meter Telescope: Progress, Challenges, and US National Participation

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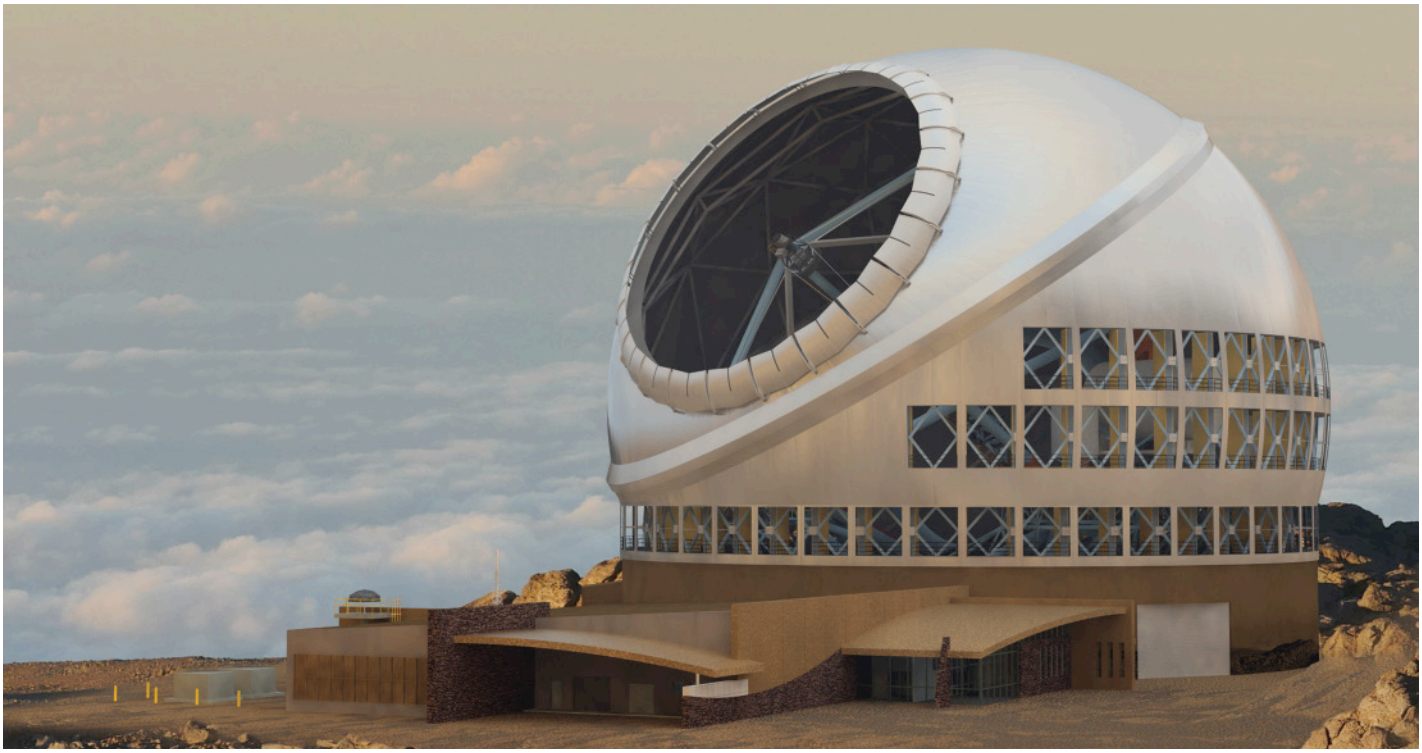

2015 was a year with great progress and significant challenges for the Thirty Meter Telescope (TMT) project. In April 2015, the Canadian government committed funding for the project, joining China, India, Japan, Caltech, and the University of California as full members of TMT International Observatory, LLC (TIO). The international management team and management processes are in place and functioning well. Most aspects of TMT are being developed internationally, with contributions from many partners and institutions, and this process is operating smoothly. Most major components and subsystems of the observatory are at or near their final designs, in many cases with completed prototypes. This includes TMT's unique Calotte enclosure, which will be built in Canada, where prototypes for the enclosure vent doors have been built. The telescope structure is nearing its final design at Mitsubishi Electric Corporation (MELCO) in Japan, and fabrication has begun for several telescope components. Also in Japan, the Ohara Corporation will have completed 163 primary mirror segment blanks by the end of March 2016, and segment polishing is now in preparation or underway in four international partners, who have demonstrated the ability to manufacture and figure the most difficult off-axis segments. The primary mirror control system is being designed at JPL, with India producing actuators, sensors, and electronics. A 1/4th-scale functional prototype of the tertiary mirror is being built at CIOMP in Changchun, China, while the Laser Guide Star Facility is in its preliminary design phase in China at IOE, Chengdu. TMT's facility AO system, NFIRAOS, is in its final design phase at NRC Herzberg in Canada, and prototypes are in hand and being tested for the deformable mirrors and other components. Design of the three first-light instruments is underway. Each one is an international effort, with participation by all TMT partners. In many respects, TMT is ready for construction.

In Hawai'i, work at the TMT site on Maunakea has been halted since March 2015, when demonstrators blocked access. The governor of Hawai'i has taken steps to address the issues at Maunakea and in particular asked the University of Hawai'i to undertake a set of actions related to its stewardship of Maunakea. In December, the Hawai'i Supreme Court ruled that the State's process in granting the Conservation District Use Permit for TMT construction in 2011 was flawed, in that the Board of Land and Natural Resources (BLNR) gave preliminary, conditional approval for the permit before holding contested case hearings for challenges to the permit. The Court vacated the permit and will remand the case back to the circuit court and the Land Board to redo the contested case hearing and the permit vote. At the present time, the TIO Board and the University of Hawai'i (the applicant for the permit) and all others involved in the legal actions are waiting for a definitive statement from the Department of Land and Natural Resources about the details and timeline of the process going forward. In the meantime, the TMT project is undergoing a replan that does not include summit activities for at least one year to minimize the effects of this delay and to understand the ramifications for cost and schedule. The TIO Board has stated: "At this time, Hawaii remains our first choice for the location of TMT, and we are very grateful for all of our supporters. Given the enormous investment and potential challenges ahead, it is necessary to also carry out a review of alternate sites."

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The Thirty Meter Telescope continued

Meanwhile, work continues on the development of a plan for possible US national participation in TMT, under the auspices of the NSF's cooperative agreement with TMT. The US TMT Science Working Group (SWG), organized by NOAO, has gathered extensive input from the US astronomical community through its survey in 2014, the AAS TMT Open House events, three TMT Science Forum conferences, the activities of US members of the TMT International Science Development Teams (ISDTs), and more than 65 visits by TMT staff astronomers to university departments and other astronomy institutions around the country. The SWG has completed a draft report for the NSF, which emphasizes several benefits of US national participation as a partner in TIO. These include the following:

- Consistent, long-term open access to TMT observing time, allowing US astronomers to create and lead scientific programs. This will be critical for US scientific competitiveness in the worldwide era of giant telescopes in the next decade.
- Full participation in observatory governance and scientific planning. As a TIO partner, the US community would participate in the definition and prioritization of future instrumentation and AO systems, and in the development and evolution of TMT's observing modes, data management and archives, and other aspects of its operations model.
- Access to archived TMT data, enabling scientific exploitation by a wider community, beyond the original proposing team.
- The opportunity to participate in international TMT "Key Projects"—large-scale, cross-partnership science programs that might be difficult to accomplish within a national share of TMT time alone.
- Enhanced opportunity to participate in developing TMT instrumentation.

The SWG's draft report recommends a US national TMT participation share of 20% or greater, similar to the 25% recommendation of the 2010 Astronomy and Astrophysics Decadal Survey, with a minimum share of 10%. This would allow a robust PI science program, while enabling significant US participation in collaborative Key Project science. These cross-partnership projects are themselves another SWG recommendation and have been a topic of discussion at the TMT Science Forum. Scientists in TMT's ISDTs recently developed 23 "observing proposals" as Key Project concept studies, requesting more than 1100 nights of TMT observing time (with infinite oversubscription, alas, as no time is being awarded yet!). The SWG's report also stresses the need for an observatory-run plan for instrument calibration, metadata logging, and collection of environmental information, with an eye toward enabling robust TMT data processing for archival use. It emphasizes the value of high-quality data reduction software and pipelines, and of archives and user support to ensure the long-term value of TMT data for a wide user community. The SWG also discusses the benefits of flexible, condition-adaptive scheduling to benefit the diffraction-limited AO-driven science that is one forte of giant-aperture telescopes and to maximize TMT's responsiveness for time-domain science in the era of LSST, WFIRST, and other next-decade facilities. The SWG envisions an evolving mix of classical and queue observing, guided above all by scientific productivity.

The US TMT SWG continues to welcome your ideas and input on these recommendations. Please write to us at *tmt@noao.edu*, and see the NOAO TMT Liaison web page (*http://ast.noao.edu/system/us-tmt-liaison*) for more information. The upcoming TMT Science Forum in Kyoto, Japan (see inset box) will be an excellent and enjoyable opportunity to catch up with the rapidly evolving state of the project and to get involved in science planning for TMT.

The TMT Science Forum, Kyoto, Japan, 24–26 May 2016 International Partnership for Global Astronomy

The annual TMT Science Forum gathers members of the international astronomical community to meet, collaborate, and plan for future TMT science programs. It is the premier opportunity to learn about the status of the observatory and its instrumentation and adaptive optics systems and to become involved in shaping TMT's future.

This year's Forum will be held in Kyoto, Japan, and its theme is "International Partnership for Global Astronomy." Discussions will focus on international collaboration, cooperation, and coordination within and beyond the TMT partnership, with sessions on
- international TMT Key Project science;
- cross-partnership scientific collaboration;
- second-generation TMT instrumentation and AO development;
- effective strategies for observatory operations; and
- coordinating science planning with other observatories and facilities within the TMT partnership.

There will be invited science talks, as well as topical parallel sessions organized by TMT's International Science Development Teams, with opportunities for contributed talks and posters. On May 23, before the main Forum, there will be an open meeting for astronomers interested in thermal-IR science and instrumentation for TMT. Registration for the Forum is now open, and details about the science program, hotels, and other local information are available at the conference web site (*https://conference.ipac.caltech.edu/tmtsf2016*).

The National Science Foundation provides travel support for US community astronomers to attend the TMT Science Forum. To be considered for support, please write to the US TMT Science Working Group at *tmt@noao.edu*. Funding is limited, and it is important to plan travel to Japan promptly, so early requests will be given strong consideration.