TMT Open House

Michael Bolte (UCSC), Mark Dickinson (NOAO)
AAS #225, Seattle, 5 January 2015

Please get a drink and something to eat! Presentations will start at 5:35
Thirty-Meter Telescope

- 30m filled aperture primary composed of 492 1.44m hexagonal segments located on Mauna Kea
- All instruments on Nasmyth platforms fed by articulating tertiary
- Requirements for segment figure, control system, vibration control driven by desire for high-strehl AO performance
- 30m selected as the right balance of cost, risk, scientific reach, AO match
- Official project start in 2004; 1st light 2023/4

9x collecting area of a Keck telescope
12x better angular resolution than HST

Vast new science opportunities, from the solar system to cosmology

See the TMT Detailed Science Case:  http://www.tmt.org/science-case
Spring 2014: TIO, LLC formed to construct and operate the TMT. Caltech, China, India, Japan, University of California are Members. Canada is a TIO Associate awaiting funding decisions at government level. AURA is a TIO Associate under an NSF-TMT cooperative agreement.
Final legal steps for Mauna Kea site access completed in July 2014

- Environmental Impact Statement, Permit, Sublease with the University of Hawaii all completed and accepted.
- Initial construction phase has begun!
TMT: Technical Status

- Design is at build stage for telescope, mirrors and control systems, enclosure and summit facilities
- Very rigorous project management procedures and tools in place
- Project has undergone multiple, extensive external reviews for technical readiness, and cost and contingency fidelity
The US community and TMT

- 2000 & 2010 Decadal Surveys identified the need for US national participation in a Giant Segmented Mirror Telescope
- 2013: 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 the TMT International Observatory
  TIO Board: David Silva (NOAO), Caty Pilachowski (Indiana)
  TMT Science Advisory Committee: Mark Dickinson, Jen Lotz, Ian Dell’Antonio
    - Dickinson (NOAO) is currently TMT SAC Chair
- NOAO executes the responsibilities and participation activities of AURA, representing the US-at-large community
US TMT Science Working Group

- Engages with the US community to understand its interests and aspirations for TMT
- Represents those interests to the TMT project, SAC, and Board
- Works with TMT to develop a *US TMT Participation Plan* for the NSF
  - To be delivered by end of 2015

* 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 (NRAO)  
* Lisa Storrie-Lombardi (IPAC)

*TMT Science Advisory Committee or Board member*
Annual TMT science workshop + international collaboration meeting
Learn about TMT & instruments, get involved in science planning, meet & join science development teams.

**2014 Forum, Tucson:** >50% of participants came from US-at-large institutions (outside Caltech+UC)

**2015 TMT Science Forum:** stay tuned for announcement soon!
TMT International Science Development Teams (ISDTs)

- Open to all PhD astronomers
  - 166 scientists worldwide, **42 from US-at-large community**

<table>
<thead>
<tr>
<th>Fundamental Physics &amp; Cosmology</th>
<th>Formation of Stars &amp; Planets</th>
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<td>Early Universe, Galaxy Evolution, and the IGM</td>
<td>Exoplanets</td>
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<td>Milky Way and Nearby Galaxies</td>
<td>Our Solar System</td>
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<td>Supermassive Black Holes</td>
<td>Time Domain Science</td>
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- Provide **scientific input & guidance** to TMT
- Help define observatory capabilities & operations model
- Plan for **future TMT science programs**
- Foster **collaboration & cooperation** between scientists in and beyond the international TMT partnership

Call for new members is now open! Applications due Friday 16 January

  - Results inform the SWG’s report to the NSF

467 responses, 364 (78%) from US scientists outside the TMT member institutions (UC+Caltech). Thank you!

140 “essays” with example science programs
  - Solar system, exoplanets, star & planet formation, stellar physics, stellar populations, galaxies & AGN, high-z galaxy evolution, first-light & reionization, fundamental physics, cosmology, time domain

Discussion groups after this presentation will focus on these survey topics.
Wide interest in all 3 first-light instruments:

- **55%** IRIS – Near-IR diffraction-limited IFU
- **44%** WFOS – Wide-field optical multi-object spectrograph
- **37%** IRMS – Near-IR multi-object spectrograph
- **18%** *TMT first-light instruments are not suitable for my science*

Diverse priorities for future-generation instrumentation

- Strong interest in high-resolution spectroscopy (not part of current TMT 1st-light instrument suite)

**Discussion session:** Luc Simard (TMT instrumentation group lead)
Respondents put high priority on support for data reduction & analysis:

- High quality data reduction software & pipelines viewed as very important (70-80%)
- 39% feel that TMT should routinely process & archive most science data

86 detailed, articulate comments from users:

- Many remark that high quality data support is essential to realize the scientific return from TMT for the US community
- Frequent comparisons of data management support to that for space observatories (e.g., HST, Chandra, Spitzer)
- But, recognition of the challenges (& costs) of doing this for ground-based O/IR

**Discussion session:**  Mark Dickinson (US TMT SWG and SAC)
Current TMT operations model plans for mainly classical observing (initially)

- Allows partners to run their own queues within their time allocations if desired

“How important is it for the US community to use queue scheduling for part or all its time?”

<table>
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<tr>
<th>Importance</th>
<th>Percentage</th>
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<tr>
<td>Not important</td>
<td>6%</td>
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<tr>
<td>Somewhat important</td>
<td>23%</td>
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<tr>
<td>Very important</td>
<td>38%</td>
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<tr>
<td>Essential</td>
<td>33%</td>
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- 66% of respondents felt that TMT should have an observatory-run, partnership-wide queue for some (39%) or all (28%) of its observing time.

52 comments, often quite detailed, ranging from strong advocates for queue/flexible scheduling to strong reservations.

Discussion session: Warren Skidmore (TMT), Mike Bolte (UCSC)
• Current TMT operations model has independent time allocation for all partners (like Keck).
• Survey asked how US time should be used to maximize the scientific return from TMT for the US community.

“If the US were a TMT partner, how should it allocate its time?”

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<th>Percentage</th>
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<tr>
<td>44%</td>
<td>Mainly PI-led regular observing programs</td>
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<tr>
<td>53%</td>
<td>20-50% for large or survey programs</td>
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<tr>
<td>2%</td>
<td>50-100% for large or survey programs</td>
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TMT may implement large/survey programs (“key projects”), involving shared/coordinated time allocation from multiple partners.

“Would US participation in multi-partner TMT large/survey programs be important?”

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<tr>
<td>10%</td>
<td>Not important</td>
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<tr>
<td>35%</td>
<td>Somewhat important</td>
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<tr>
<td>41%</td>
<td>Very important</td>
</tr>
<tr>
<td>14%</td>
<td>Essential</td>
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Discussion session: Jennifer Lotz (US TMT SWG)
“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?”

**Minimum share for full membership**
- (i.e., governance representation, data access, etc.)

**Approx. range for current partners**
- More than currently available

**Discussion session:** Caty Pilachowski (TIO Board; US TMT SWG)
Enthusiasm:

“Crucial to remain competitive.”

“What I MOST see as a continued need is access to QUALITY facilities for students and faculty not associated with the large institutions!”

“Large aperture absolutely needed to go beyond what JWST can do in terms of raw sensitivity and resolution.”

“The United States should aspire to a role of leadership. Therefore it is important that its share be approximately equal to that of the largest partners.”

“This is roughly the size of the US (NASA) access (18%) to Keck, and it's working out.”

“Community access to the data archive is key.”

Concerns:

“Mostly, I worry that time on it would just be too difficult to get!”

“Depends on capabilities and amount of time available. 1 hour per year is not useful.”

“Only if available in large enough amounts of time to compete with the large share holders.”

“Only if it also includes a high dispersion spectrograph.”

“The best thing for most of the community would be significant access to medium and large class telescopes, not a very large telescope with minimal time available.”

“I would prefer the US community did not get involved in this, when we can't even afford to keep Kitt Peak operating.”
Discussion groups with experts from TMT staff, US TMT Science Working Group, Science Advisory Committee, etc.

1. **Instrumentation & AO** – Luc Simard
2. **TMT operations & observing modes** (e.g., queue / classical, etc.) – Warren Skidmore, Mike Bolte
3. **Data management & archives** – Mark Dickinson
4. **Optimizing a US TMT share to maximize science** (e.g., small vs. large/ survey programs, etc.) – Jennifer Lotz
5. **Workforce, Education, Public Outreach** – Gordon Squires
6. **TMT in US O/IR System of the mid-2020s** – Caty Pilachowski

Ask questions, discuss, make suggestions, **enjoy the refreshments**! Your input will inform the SWG’s report to the NSF.

*For more information:*

- **NOAO TMT liaison office:** [http://ast.noao.edu/system/us-tmt-liaison](http://ast.noao.edu/system/us-tmt-liaison)
- **TMT Information & FAQ:** [http://ast.noao.edu/system/us-tmt-liaison/survey-faq](http://ast.noao.edu/system/us-tmt-liaison/survey-faq)
- **US TMT SWG on Facebook:** [https://www.facebook.com/USTMTSWG](https://www.facebook.com/USTMTSWG)
We thank the Gordon and Betty Moore Foundation for its generous support of the TMT Project, and the National Science Foundation who support the US TMT liaison activities under a cooperative agreement with TMT.

We recognize and acknowledge the very significant cultural role and reverence that the summit of Mauna Kea has always had within the indigenous Hawaiian community. We are most fortunate to have the opportunity to conduct observations from this mountain.
BACKUP SLIDES
Capabilities for 1st light

- **Wide-Field Optical Spectrometer (WFOS)**
  - 50 square arcmin (9’-long slit), up to R=7500 multi-object optical spectroscopy to R~26 (60 minutes/5σ)

- **AO + IFU and imager (diffraction limited) (IRIS)**
  - 0.007″- 0.015″ resolution imaging at high sensitivity (34″ field)
  - 0.007″- 0.015″ resolution J,H,K IFU spectra
  - 30 micro-arcsec astrometry

- **JHK multi-object spectroscopy (IRMS)**
  - 4 sq arcmin field, 2´-long slit, R=3500, n=46 working behind partially-corrected field
Adaptive Optics

- Laser tomography MCAO system (34″ field)
- 187nm RMS wavefront error (1st light) k-band strehl~0.75
- Diffraction Limit: 0.007″ @ 1μ (0.05kpc @ z=5)
- 50% sky coverage at Galactic Pole
Project Status

• **Schedule:**
  – May 6, 2014: Formed TIO, LLC
  – May 21, 2014: Decision to Proceed with construction pending sub-lease approval
  – July 28, 2014: TMT sublease signed by University of Hawaii
  – Early 2020s: First light

• **Cost:**
  – Construction: $1256M (FY13 US$, including 26% reserve)
  – Operations: $41M/year (FY13$)
  – Construction 80% funded by six current partners