# Present and future activities of TMT's International Science Development Teams

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and

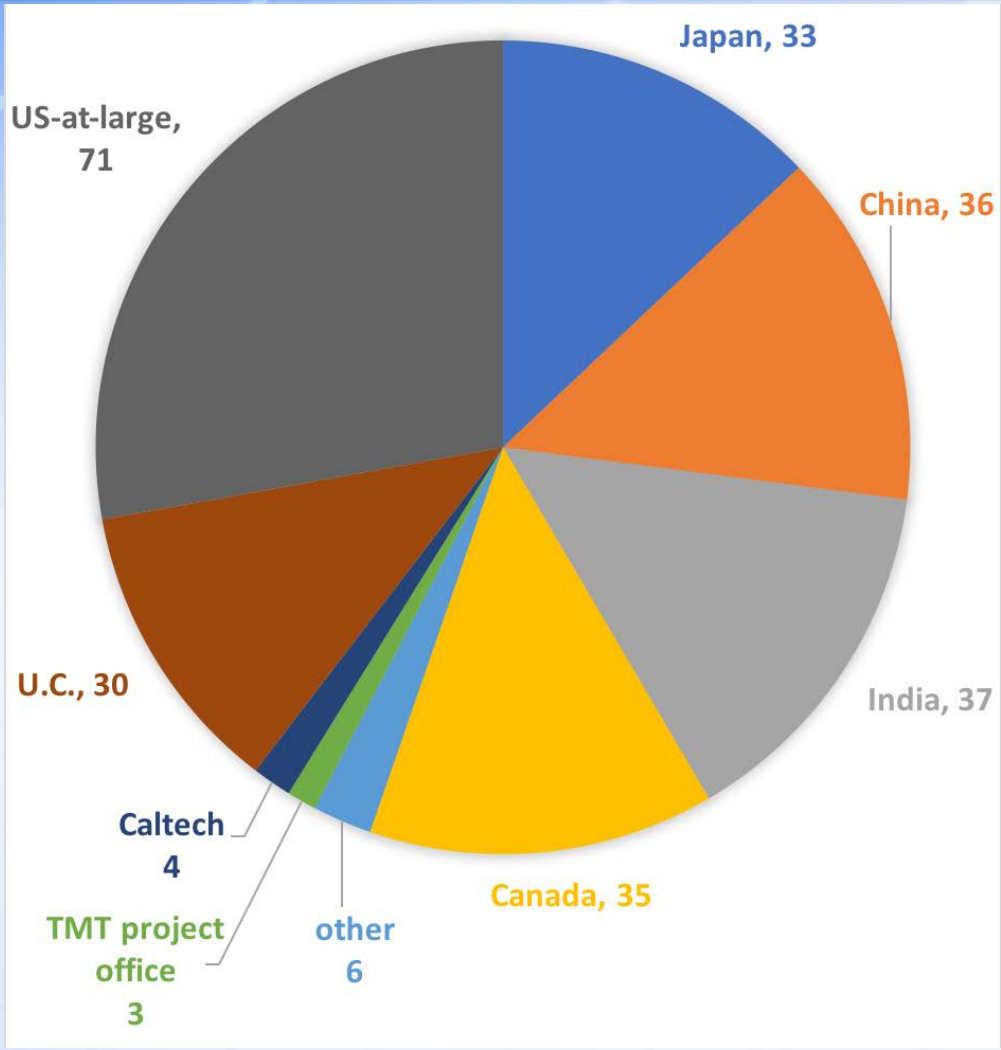
Warren Skidmore (TMT)

# TMT International Science Development Teams (ISDTs)

- Engage future science user community in TMT now
- Plan TMT science programs
- Provide scientific input & guidance to the TMT project
- Help define observatory capabilities & operations model
- Foster collaboration & cooperation between scientists in and beyond the international TMT partnership

| | |
|---|---|
| Fundamental Physics & Cosmology<br>Early Universe, Galaxy Evolution, and the IGM<br>Milky Way and Nearby Galaxies<br>Supermassive Black Holes<br>Stars, stellar physics, and the ISM | Formation of Stars & Planets<br>Exoplanets<br>Our Solar System<br>Time Domain Science |

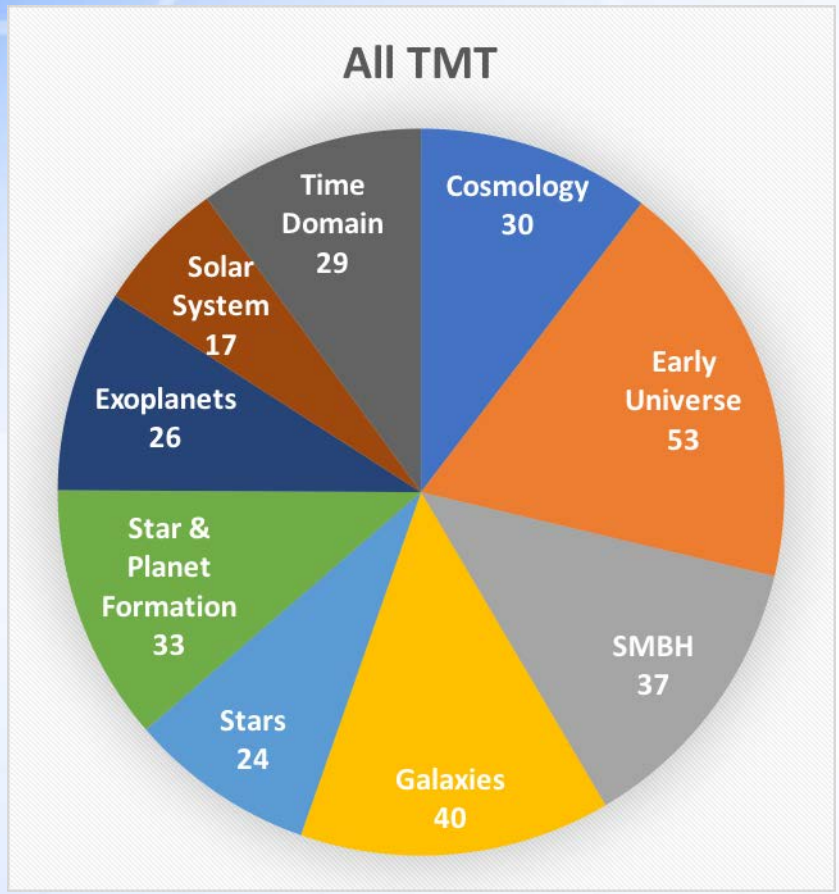
# ISDT membership by TIO Partner

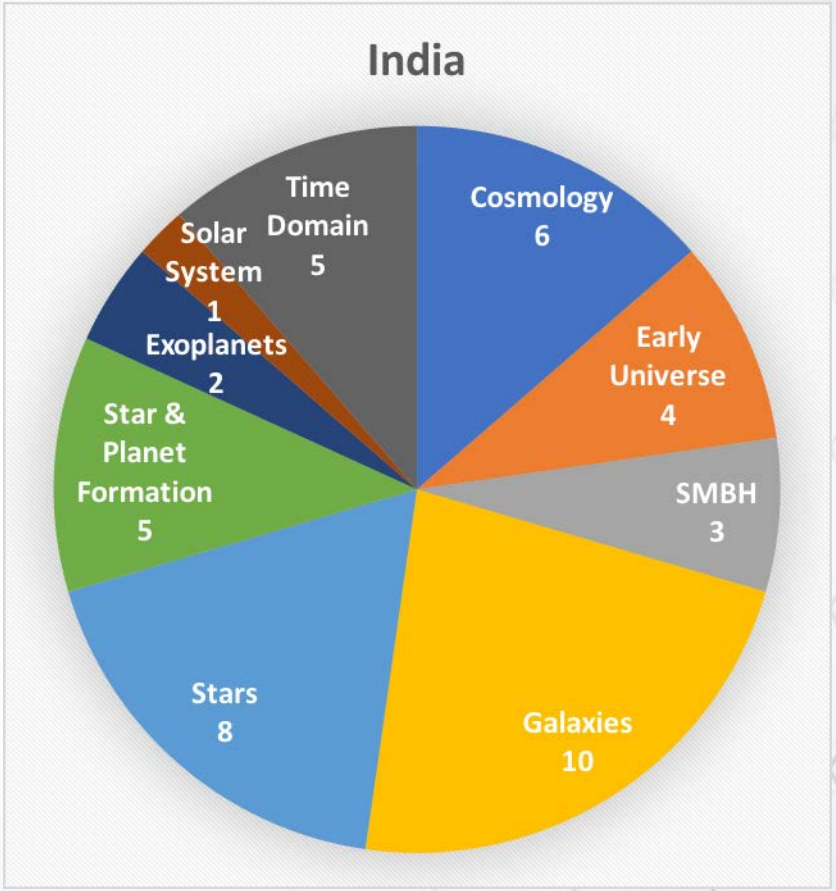



- ISDT membership is open to all PhD scientists
- Annual call for membership applications (usually due in January)
- ISDT membership requires a commitment of effort

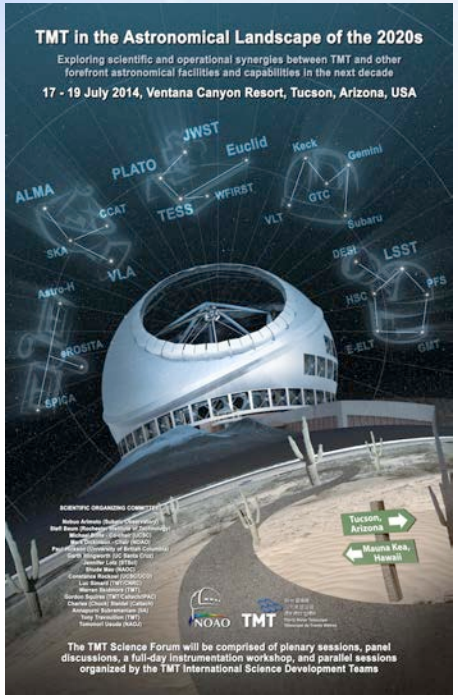
- Current membership: 255 astronomers worldwide

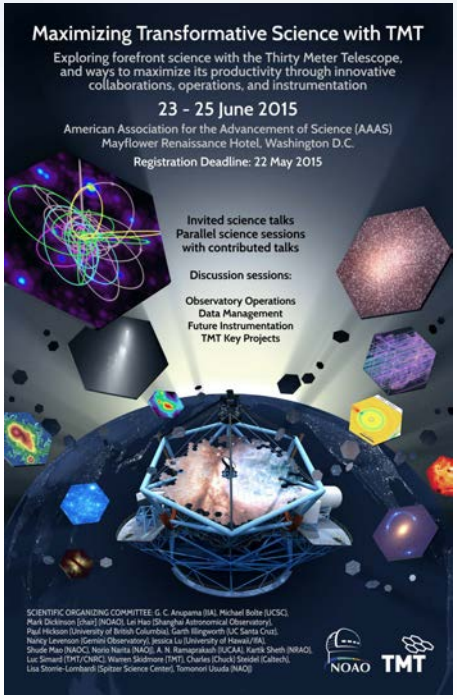
# ISDT membership by subject



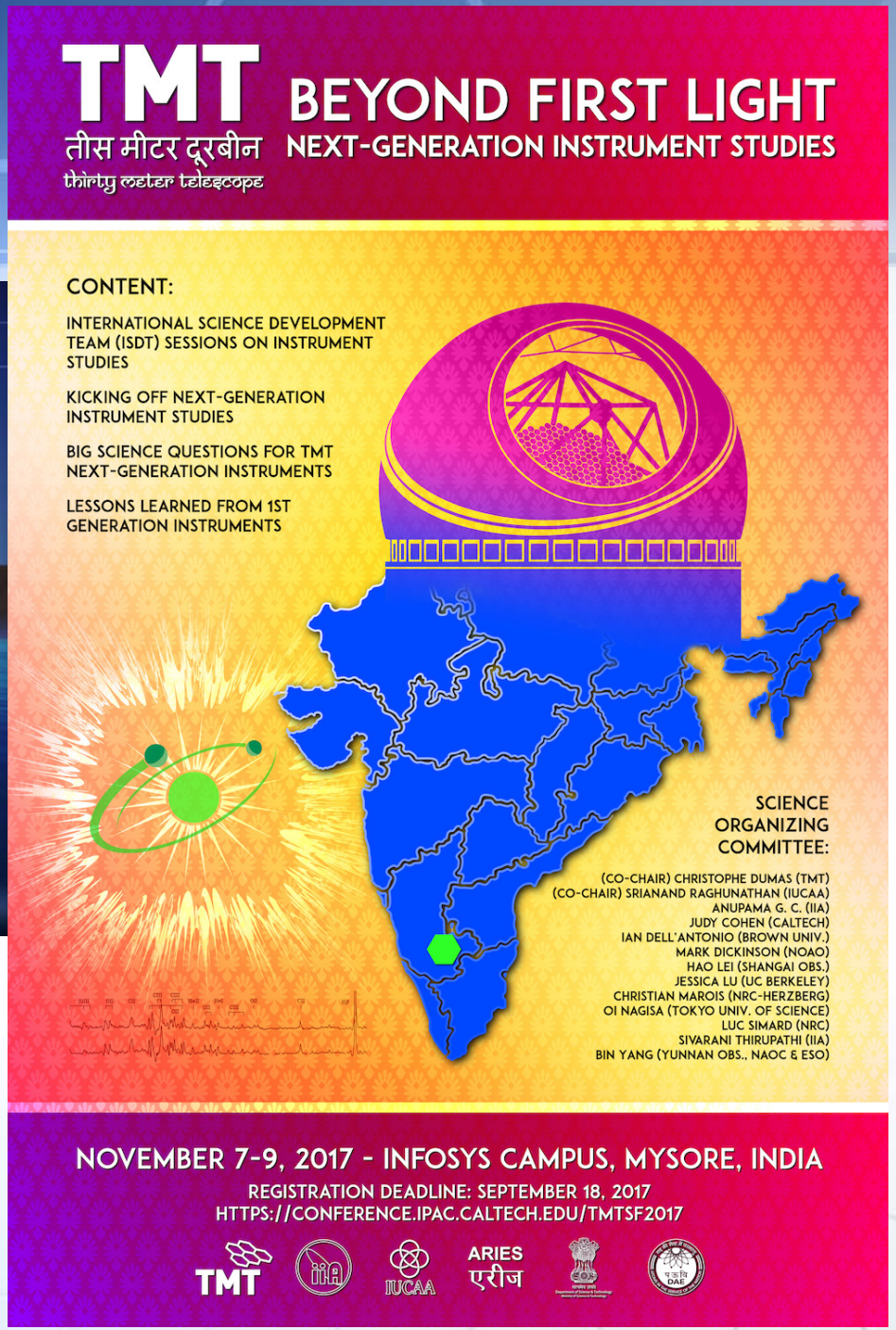



# The TMT Science Forum


TMT
Thirty Meter Telescope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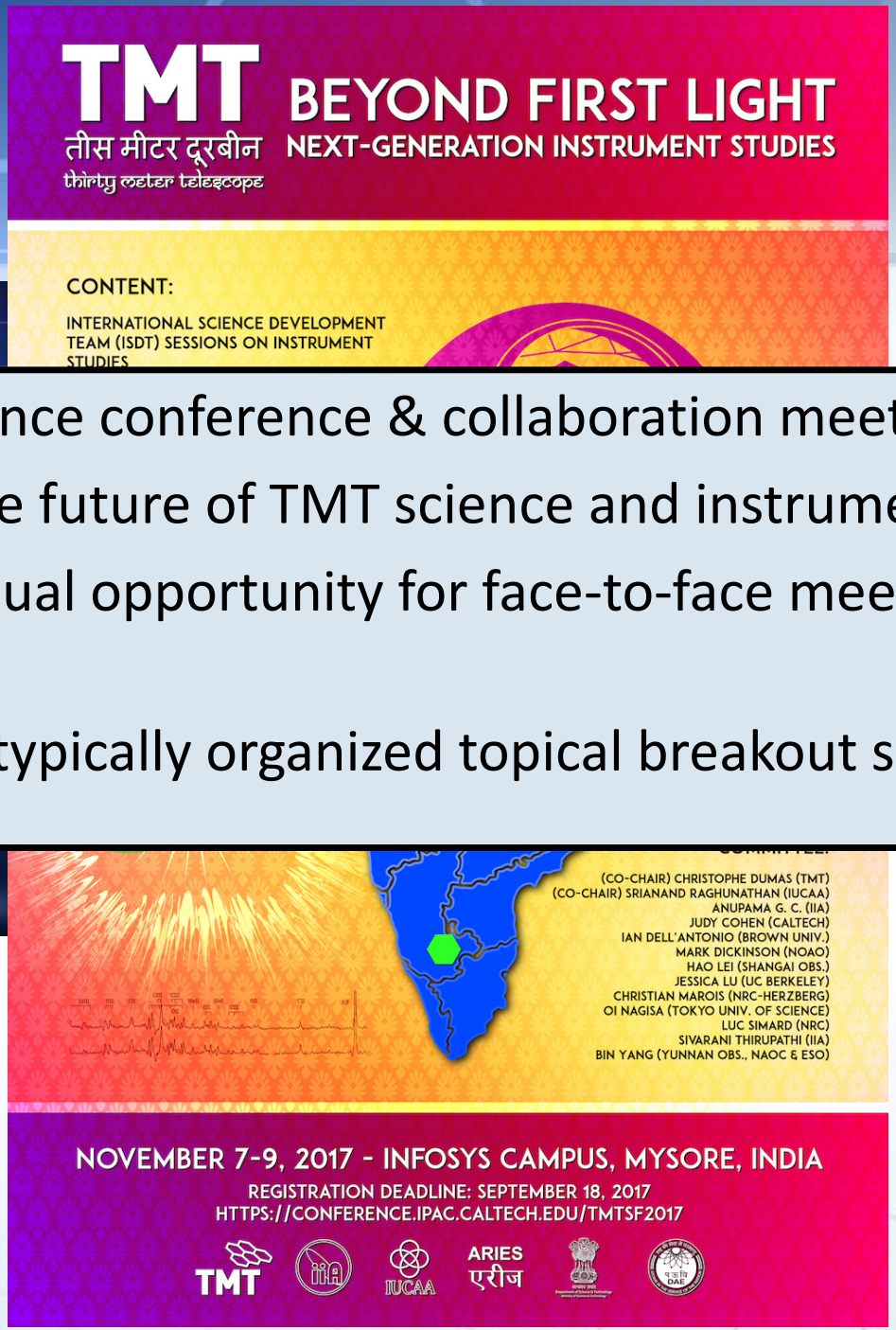



- Annual science conference & collaboration meeting
- Planning the future of TMT science and instrumentation
- Unique annual opportunity for face-to-face meetings of ISDT members
- ISDTs have typically organized topical breakout sessions

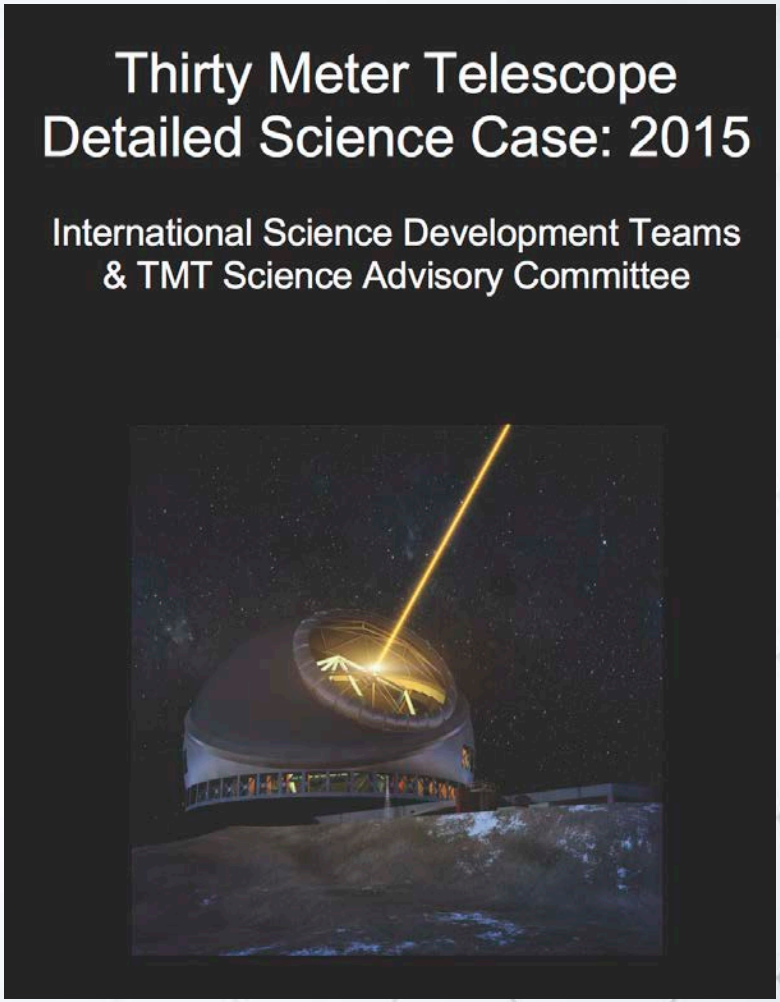
# Topical conferences

ISDTs are starting to organize new workshops!

# Recent ISDT activities

**2015 TMT Detailed Science Case**
Newly updated, with contributions from 150+ scientists

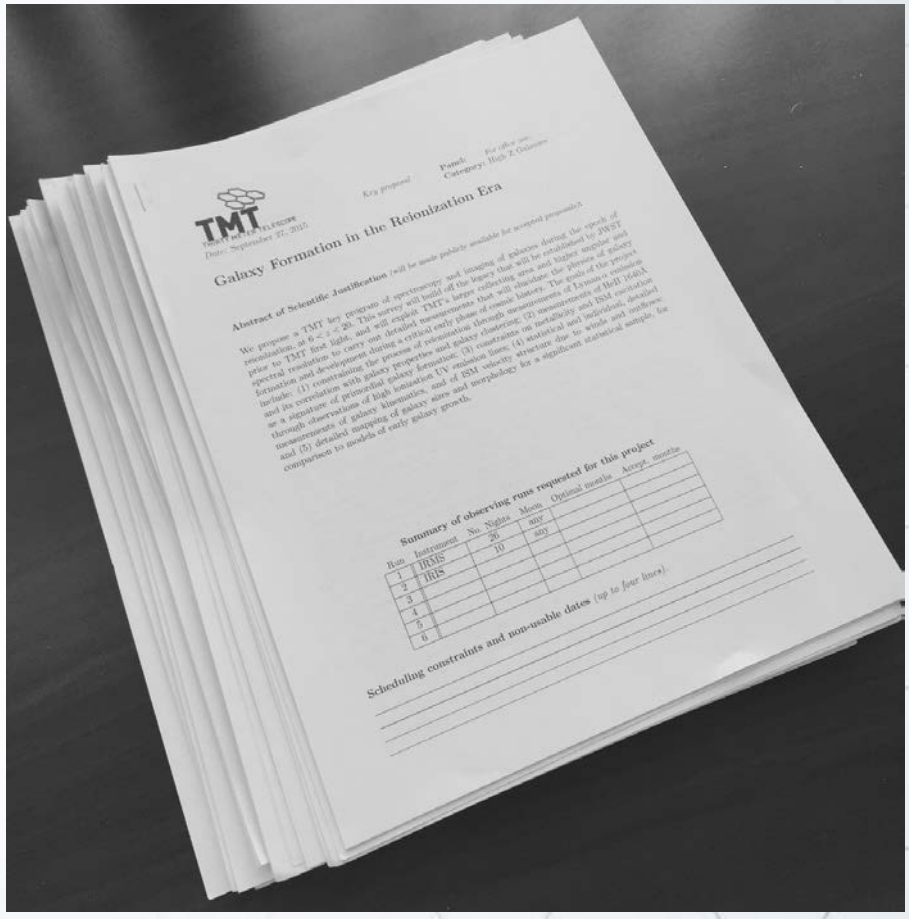
Skidmore et al. 2015, RAA, 15, 1945
(http://arxiv.org/abs/1505.01195)



# Recent ISDT activities

**TMT "Key Project" concept proposals**

- 23 proposals
- >1100 nights of observing time requested (!)
- 70% of proposals written by international teams



# Ongoing / future ISDT activities

- Science flow-down from DSC-2015
  - Warren will discuss …
- Future-generation instrumentation planning
  - TMT and SAC hopes the ISDTs will actively contribute to planning for TMT's future capabilities beyond first light
  - ISDT telecons, discussions at Forum, contributing to white papers....

# Science Flowdown of technical requirements from the 2015 Detailed Science Case

## TMT Future Leaders Workshop:

- Future Instrument micro-studies
- Combined DSC update and Science Flowdown process

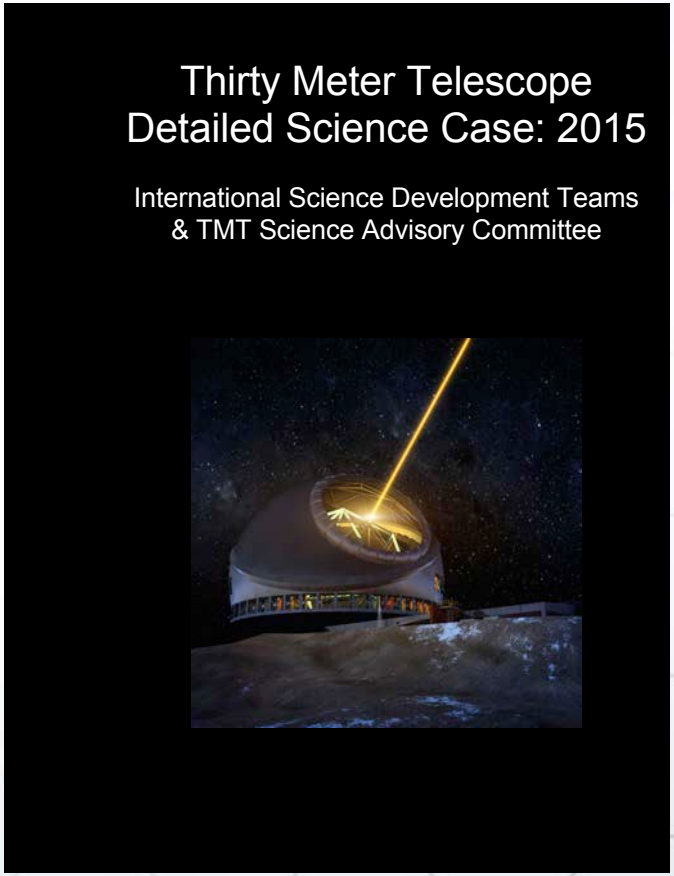
Warren Skidmore

November 7, 2017

TMT Science Forum, Mysore

# Science Flowdown of technical requirements from the 2015 Detailed Science Case

- 277 individual observing programs identified
- Input gathered for 214 programs from about 92 ISDT members



# Science Flowdown of technical requirements from the 2015 Detailed Science Case

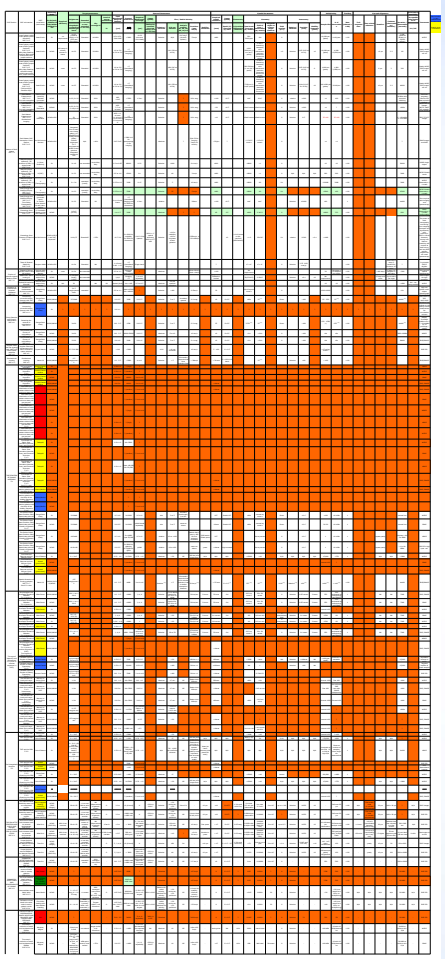
| DSC Section | DSC sub-section | ISDT contributor (Add name) | Observing Mode | Required efficiency | Target parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | SL/SL(AcO)/NGSAO/MCAO/MOAO/MIRAO/ExAO | | Brightness | Extended (>1 arc sec) or non extended <1 arc sec) | Sky coverage % | Level of source polarization | |
| | | | | | Magnitude in specified wavelength band | | | % | |

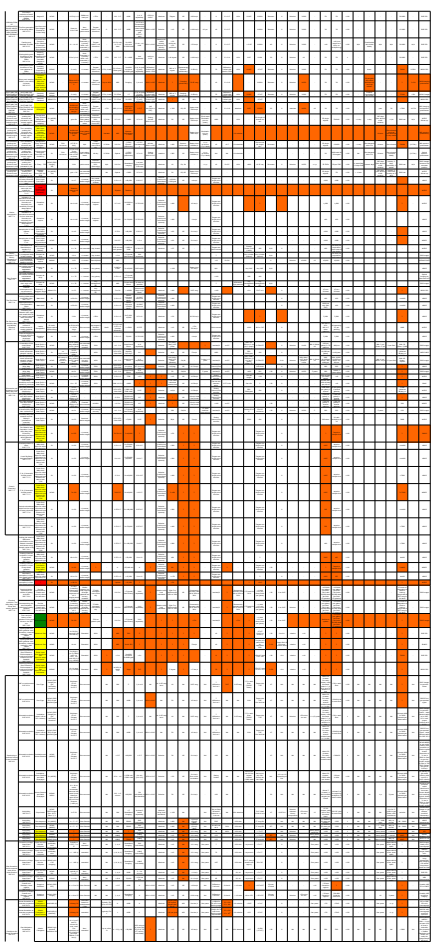
| Spectral Parameters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Total Wavelength Range of Interest | Spectral Resolution | Required Wavelength Coverage | Image Quality | Flux / Radial Velocity | | | | | |
| (μm) | (λ/Δλ) | (μm) | Radius for specified encircled energy (X% in Y arc sec) | Relative/ absolute | S/N per element | Analysis method AP, OP, SS, OS, CA, PA | Precision (mag, km/s) | Stability timescale | |

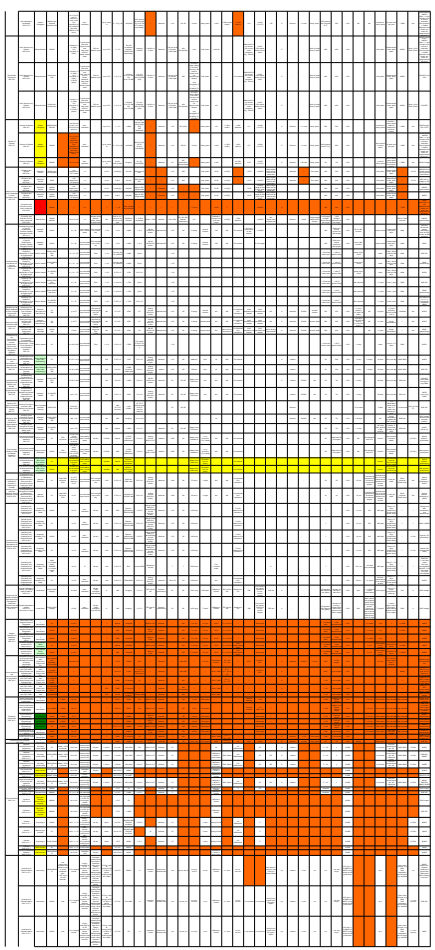
| Spatial Parameters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Required spatial resolution | Image Quality | Photometry | Geometry | | | | Astrometry | | |
| (mas) | Strehl (S) /Contrast (C) ratio | % Precision (differential /absolute) | Total Areal Coverage (sq. arcmin) | Field of view / observation (sq. arcmin) | AO guide object to science target distance (arcsec) | Field overlap (0-1) | Relative/ absolute | Precision (mas) | Stability timescale (years) |

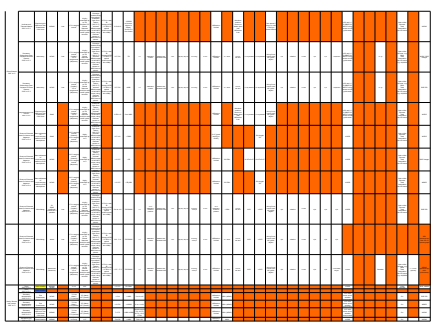
| Multiplexing | | Tracking | Synoptic Signature | | | | | Polarimetric sensitivity | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Size | # of observations | Rate (sidereal = 1.00) | ToO response time | Time critical tolerance | Baseline | Cadence (observations / baseline) | Duration / observation (seconds) | Acceptable polarization error | Comments |
| | | | | | | | | %L/%C | |

# Science Flowdown of technical requirements from the 2015 Detailed Science Case









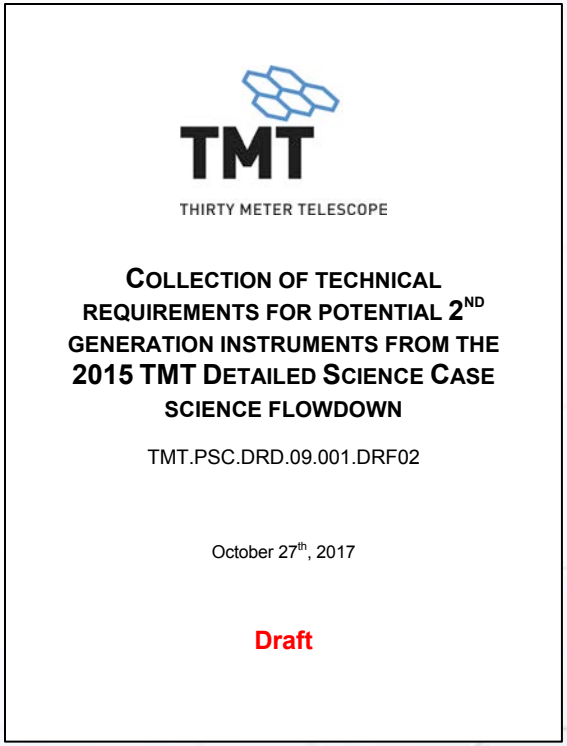
# Science Flowdown of technical requirements from the 2015 Detailed Science Case

- 277 individual observing programs identified
- Input gathered for 214 programs from about 92 ISDT members
  - ~9x increase in information compared to 2009
  - Need to gather more information
    - Turn orange cells to white
  - Continuing communication with some ISDTs and with individuals

# Science Flowdown of technical requirements from the 2015 Detailed Science Case

- Developed document to support development of ideas for 2nd generation instruments

| Instrument capability | Number of programs |
|---|---|
| IRIS imager | 36 |
| IRIS IFU | 63 |
| WFOS | 46 |
| IRMS | 22 |
| IRMOS | 19 |
| HROS | 45 |
| MICHI | 30 |
| PFI | 14 |
| Others | 22 |


THIRTY METER TELESCOPE

COLLECTION OF TECHNICAL REQUIREMENTS FOR POTENTIAL 2ND GENERATION INSTRUMENTS FROM THE 2015 TMT DETAILED SCIENCE CASE SCIENCE FLOWDOWN

TMT.PSC.DRD.09.001.DRF02

October 27th, 2017

Draft

- Informing WFOS slicer/fiber downselect process

# TMT Future Leaders Workshop
# Future Instrument micro-studies

- Develop instrument ideas
  - 6 teams of 7 people developed instrument science cases and architectures
- Downselect by the SAC
  - Mini-SAC of 7+ establish science priorities and carry out instrument downselect
- Feasibility, requirements and science cases
  - Teams reformed to develop 3 selected ideas

- A lot of overlap and ideas that mesh with 2nd Generation Instrument White Paper development

# TMT Future Leaders Workshop
# Future Instrument micro-studies

- **MPICS** – Multi-Purpose Infrared Configurable Spectrograph
  - 30" FOV@0.01", R~5000, 0.7-2.4μm, IFU fiber bundle + single fibers
- **HRNIISpec** – High Resolution Near-IR Imaging Spectrograph
  - 1.5"x1.5" IFU@0.01", R~75,000, 1-2.5μm, exAO coronagraph, high throughput
- **MOHRIS** – Multi-object Optical High Resolution Imaging Spectrograph
  - 0.3-1μm, many-IFUs 1'x1'FOV@0.01", R~5000, optical AO
- **TREXS** – TMT high Resolution EXoplanet Spectrograph
  - 0.8-5um, R~100K (3km/s), 10"x10" FOV with 0.05" fibers
- Wide Coverage Spectrograph for Transient Objects
  - 0.3-2.4μm, 8"x8" IFUs with ~0.3", multiple spectroscopic channels, ~1 min cadence
- **UFS** – Ultra-Fast Spectrograph
  - 0.3-1μm, R~5000, ~few ms cadence, set up <10 min, single object, no AO

# TMT Future Leaders Workshop
# Future Instrument micro-studies

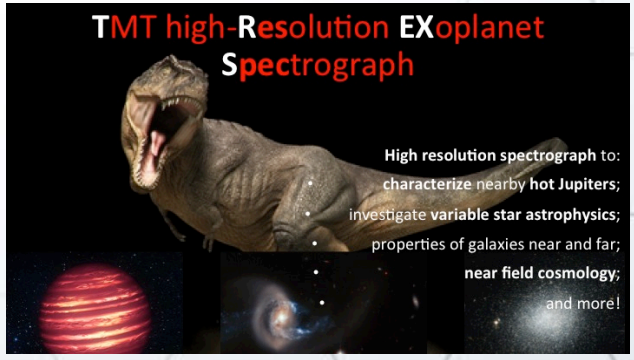
- Science priorities
  - Exoplanet atmospheres with IFUs, surface mapping of hot Jupiters, cloud structure and biomarkers and biosignatures of exoplanets around M stars
  - Globular clusters and dwarf galaxies through the nearby universe, resolved stars in the nearby systems, the bulk properties of distant unresolved systems in environments different than the nearby volume
  - Are GCs in the local group the same as those in the very local volume and can GCs give us information on the conditions in the primordial universe and early universe?
  - Galaxy formation and evolution for z~1-2, decomposing the bulge and disk for low surface brightness targets
  - Gas outflows and inflows, the relation to AGN activity and star formation and enrichment of the CGM for galaxies at redshifts of z~1-4
  - Stellar evolution and the lives of stars. Dust production around stars, star formation
  - Time domain faint transients
- Notably missing from these priorities
  - Properties of Dark Matter and Dark Energy, Evolution of the Fundamental Constants, Solar System Science

# TMT Future Leaders Workshop
# Future Instrument micro-studies

Splinter session

- **Fast-SHOOTER**
  - 1ms (optical), 1s (NIR)
  - 0.3-2.4µm, R~5000 (goal 10,000)
  - GLAO ready for single object
- **MOHRIS**
  - 0.3 - 1 µm MOAO, 1000 R~5000 IFUs
  - FOV: 1'x1', ~0.01" spatial resolution
- **TREXS**
  - exAO, 0.8-4 microns
  - R ~ 100,000 (~3 km/s) echelle
  - 10" diameter FOV seeing limited
  - single and multimode fiber bundles combinations





# TMT Future Leaders Workshop
# Combined DSC update and Science Flowdown process

- Design a template to collect science case and technical requirements
  - Web based wiki for DSC text and structure, including drop down menus for technical parameters
- Devise a process to develop a science case that includes equitable input from across the partnership
  - Process preparation includes:
    - ISDT recruitment across the partnership, science areas and career levels
    - Prepare supporting descriptions of instruments, operations, etc.
    - Each partner produces internal science case and cases brought together at a cross partner meeting or forum
    - Tools to support activities by each ISDT
    - Tiered reviews – each chapter by the relevant ISDT, cross ISDTs, instrument teams, SAC and Board
- Ideas that are being considered by the project office