GMT and the OIR System in the Era of the LSST

Presentation to the OIR System Panel

Patrick McCarthy – GMTO

October 12, 2014

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Outline

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- **GMT and the OIR System** 3 slides
- **An Integrated Approach to *NWNH* Science** 5 slides
- **Next Steps in the Dialog** 1 slide

Questions from the Chair

- **How are you building and managing large-scale instruments and associated data products?**
- **What do you think of the Kavli meeting outcome, that is, the need to have a coordinated and collaborative System and the need for some open access from GSMTs?**
- **How do you view GMT or TMT fitting in to the System?**

We will address these questions in the course of the presentation

Project Status

Design Development Phase completed…..

Ready to move to construction phase

2013 & 2014:

Technical and Cost Reviews completed

Sub-system PDR

System wide PDR

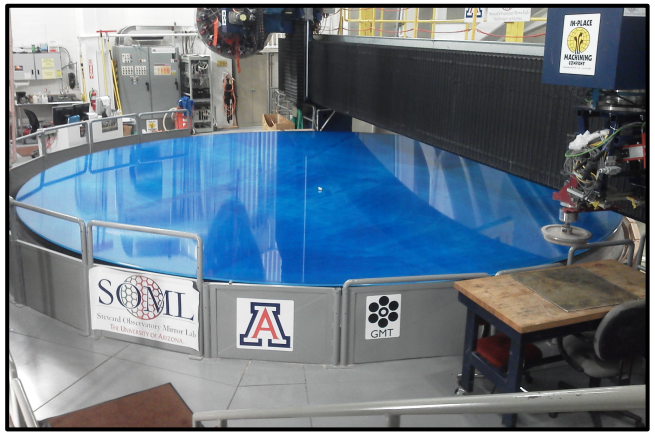
Cost and Organizational Review

2014:

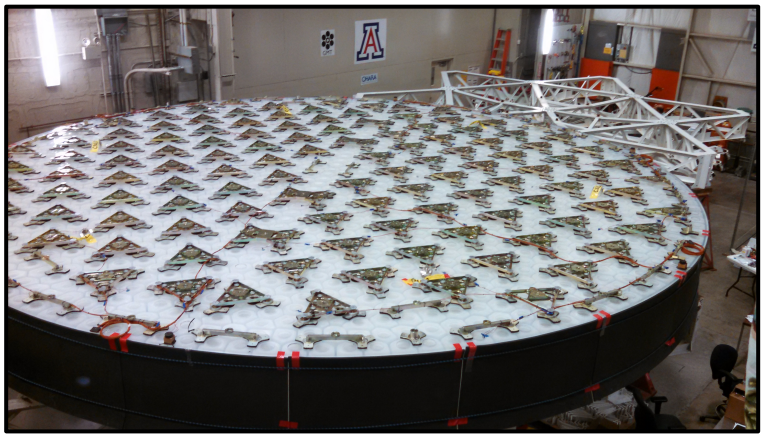
Financial and legal documents completed

Legal status in Chile finalized

Project Status – Early Construction



Segment 1



Segment 2

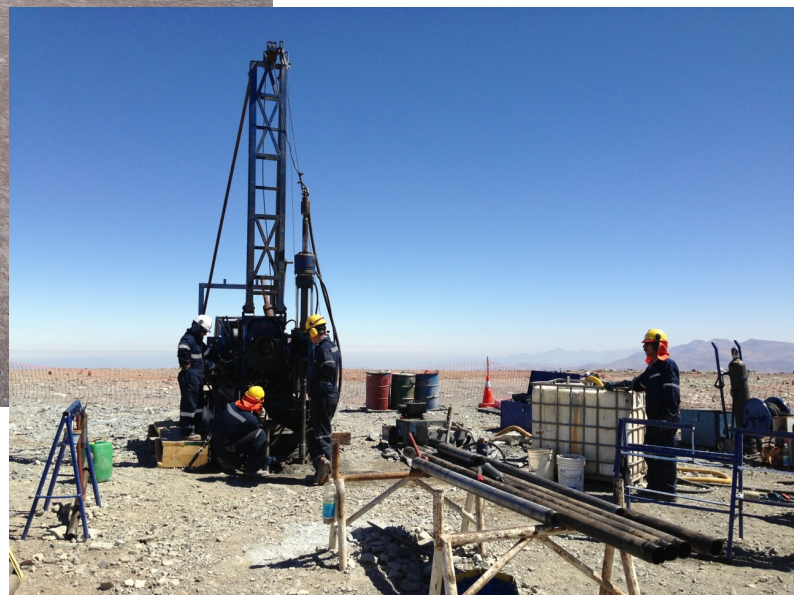
Segment 3

Segment 4

Segment 5

Project Status – Early Construction

2012: Site Cleared and Leveled, Road Graded



2013: Geotechnical Survey Completed

Community Engagement Paths

April 2012 GMTO Board Statement to the US Community:

We propose an alternative path that will engage the U.S. community in the GMT in the years before NSF is ready to take significant actions. We want to demonstrate to the NSF, to the US community, and to potential international partners that we are open to their participation and seek to align our actions with their goals.

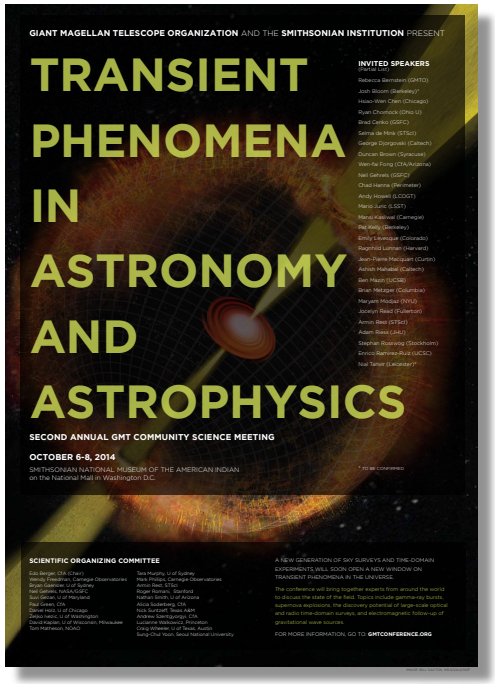
We have community representatives on our Scientific Advisory Committee to help shape the technical and scientific program for the GMT……We will use our own GMT funding, at the $250,000 scale proposed by the NSF, to enlist the participation of the broad and deep U.S. community.

Figure 1. New GMT community SAC members Bob Blum, Julianne Dalcanton and Megan Donahue (left to right).

Community Engagement Paths

Annual Community Science Meetings

2013: Galaxies and Cosmology
2014: Explosive Transients
2015: Near-Field Cosmology
2016: Exoplanet Science



No Conference Fees

Travel support for students & postdocs

Instrument Development

- **First generation instrument suite**
  - $125M cost-capped, as-spent dollars including contingency
  - Developed within the partnership
  - Collaborations encouraged
- **Second Generation and Beyond**
  - Funding from operations budget ($10M/yr in 2014$)
  - Selection process begins ~1 year after construction start
  - Participation from outside the GMT partnership welcome
  - Will actively seek federal funds and community engagement
- **Software, Data Products, Archive and Open Access**
  - Data processing pipelines developed with instrument teams
  - Modern data and software standards applied
  - 18 month proprietary period – then open access

Instrument Development

- **Management**
  - Each team has a professional project manager
  - Formal systems engineering and project management practices
  - GMTO instrumentation management team:
    - Richard Haley – Contracts officer
    - George Jacoby – GMT Instrumentation Scientist and principal contact at GMTO
    - Rebecca Bernstein – GMT Project Scientist and technical guidance for instrumentation
    - Brian Walls – Systems Engineer for instrumentation
- **Cost Estimates and Budget Control**
  - Conceptual and Preliminary Designs produce cost estimates
  - Contingency assigned using NSF Large Projects Office process
  - Contingency levels typically ~40-45% at this time

Instrument Development

GMT Instrument Development Path – First Generation

1) Identification of instrumentation needs

- SAC led flow-down of Science Requirements

2) Open call for proposals for Conceptual Design Development

- Letters of intent leading to invitations to submit proposals

3) Funded Conceptual Design Studies

- 18 month studies leading to External Design Reviews

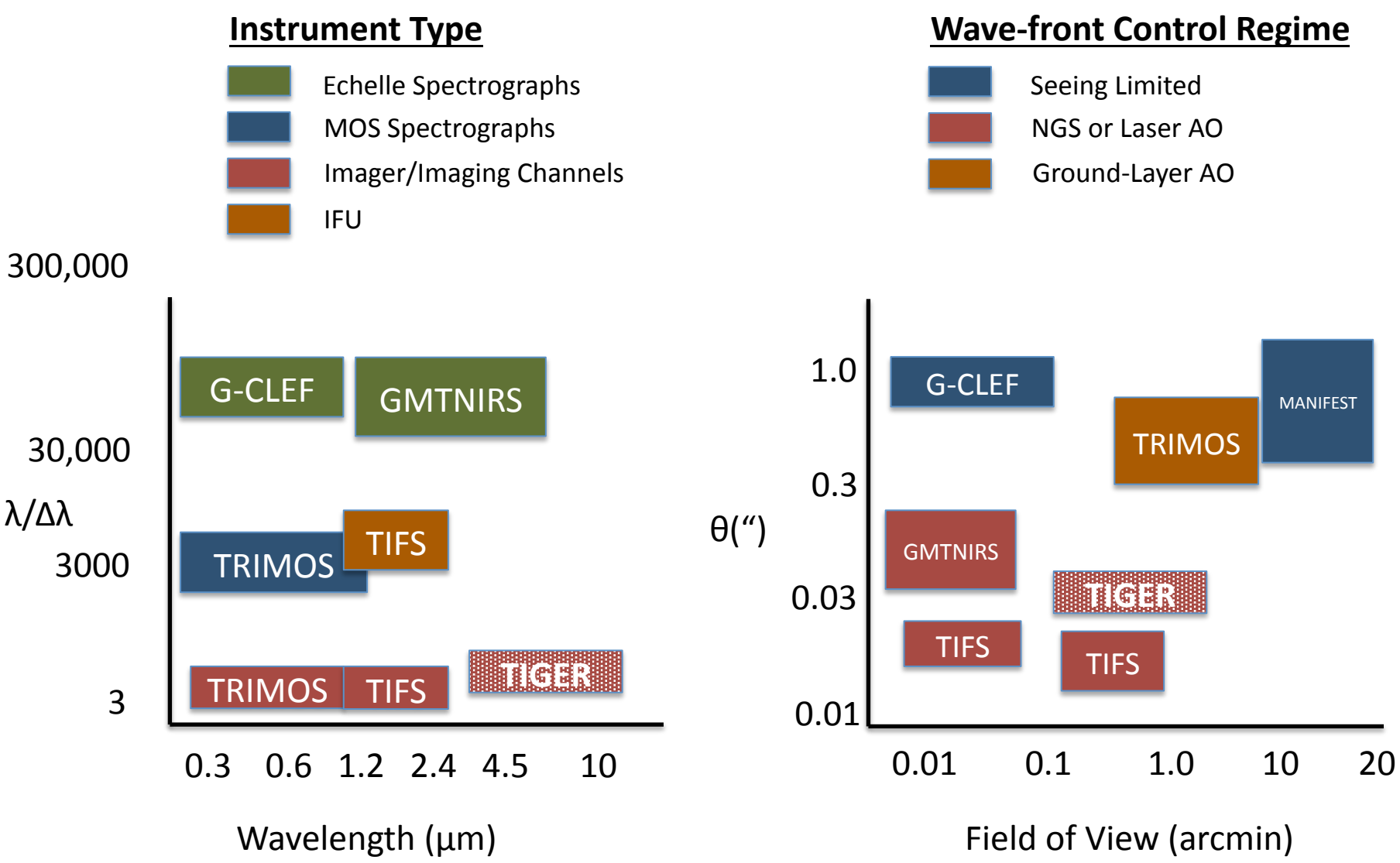
4) Selection of instruments to go forward

- Instrument Development Advisory Panel with community representatives

-> Recommendations to GMTO Board

The US community was engaged at every step

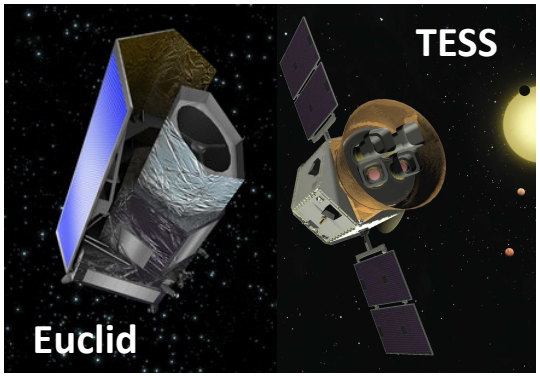
First Generation Instruments

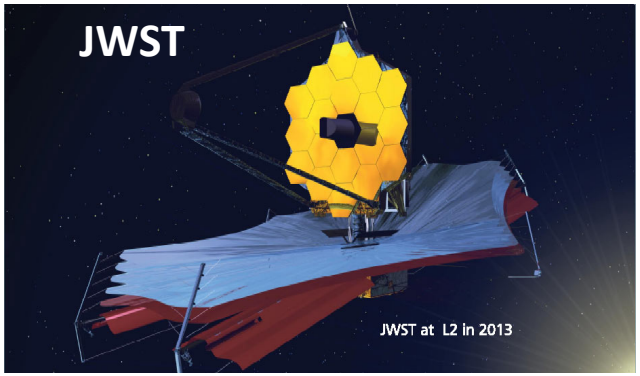


GMT and the OIR System

GMT will play a major role in leveraging the potential of US and world-wide astronomy facilities in 2020 and beyond

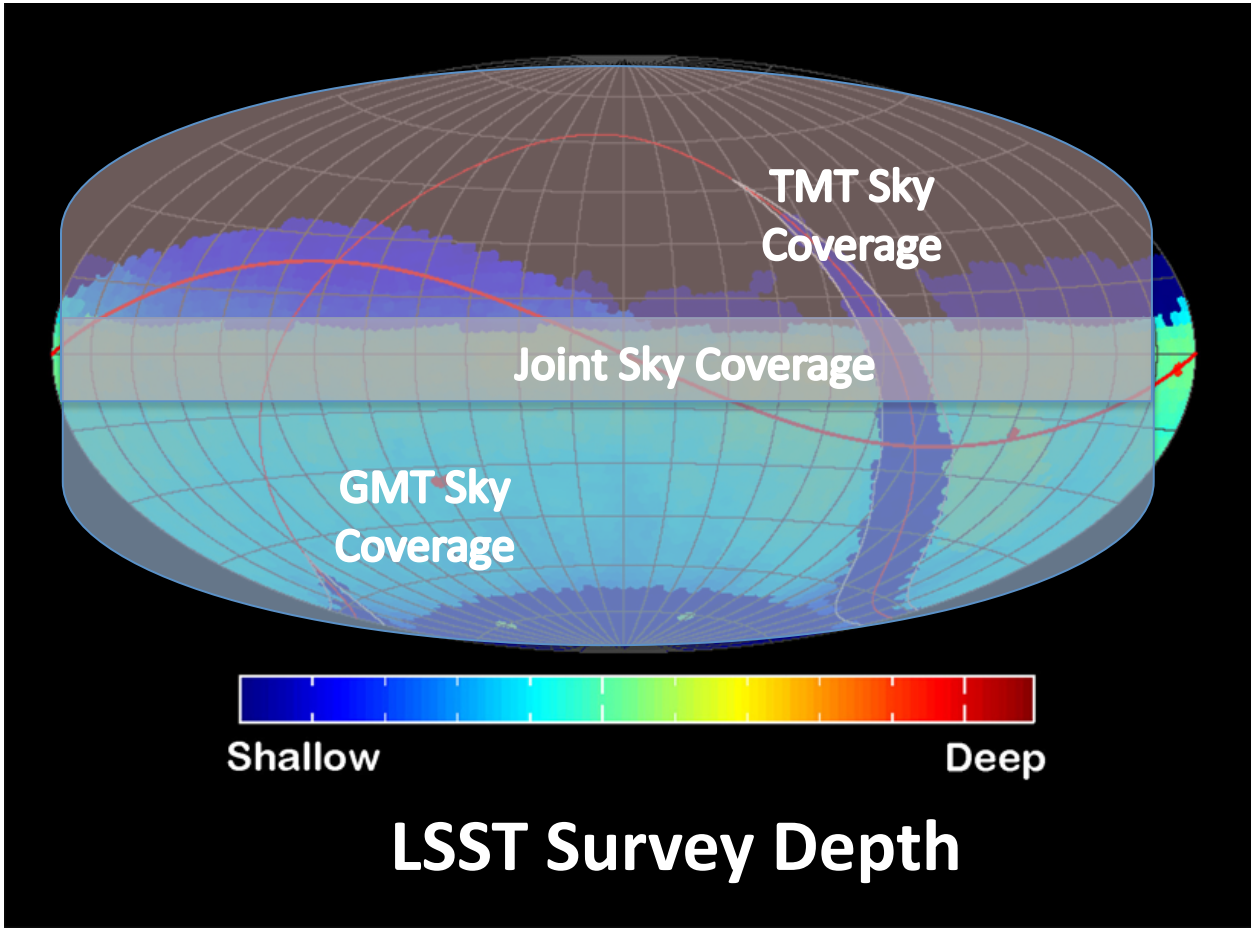
- Spectroscopy in the visible & IR ***- High spatial resolution*** ***- High sensitivity***





The center of mass in ground-based astronomy is now south of the equator

Sky Coverage – Overlap with LSST



GMT has complete sky coverage overlap with LSST, TMT has partial overlap

At the equator, GMT, TMT and LSST can all operate for maximum synergy

GMT and the OIR System

GMT will play a unique role in enabling the NWNH science program on its own and through the OIR System

- Spectroscopy of faint and rare objects from large area surveys
  - Z > 7 QSOs from LSST & WFIRST
  - Distant clusters of galaxies from SPT, DES, WFIRST
  - Extreme metal poor stars from SkyMapper, LSST and other surveys
- Time-Domain Spectroscopy and AO Imaging
  - Rare and rapid bursts from LSST, γ and x-ray missions, fast radio bursts, ALIGO
  - Typing and diagnostics of SNe
  - Late time photometry of distant SNe for cosmological studies
- High Precision Studies of Exoplanets
  - Precision RV studies of select exoplanet systems
  - Transmission spectroscopy of exoplanets from TESS and other surveys
  - AO imaging of young Exoplanets and disks in concert with NIRCAM on Webb
- Many more….

GMT and the OIR System

We need a practical approach to providing open access to GMT and TMT

- MSIP and TSIP could provide a funding channel for open access

TSIP is dormant and MSIP is vastly oversubscribed by pent up demand

A suggestion for an alternative path:

Integrated science and technology programs targeted at key science goals from the NWNH survey and the 2020 Decadal Survey

- Competitively selected
- Open to anyone in the US
- Coordinated with the project's technical and budget plans

Proposals generated by, and peer-reviewed by, the Community – not by GMT or TMT

A Coordinated and Collaborative System

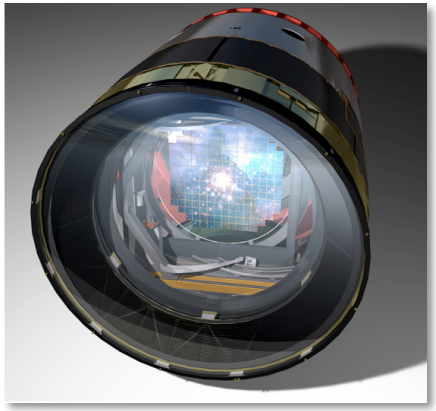
The GMT partners would look favorably on a significant investment of GMT time (e.g. 20%) towards community science goals if a satisfactory economic model can be developed

Illustrative Examples

Spectroscopic Support for LSST:

- 500 hours of time per year on GMT and TMT to support LSST Science
- Open call for proposals, peer-review managed by LSST operating organization
- Integrated “System” programs – can access Gemini, CTIO etc in same proposal

Approximate Cost: $15-25M



A Coordinated and Collaborative System

1) LSST Super Nova Cosmology Key Project

- Spectroscopy of 100 SNe events from LSST over 2-3 years
  - Pre-selection of z > 0.5 events based on LSST colors
  - 100 hours of Gemini time for pre-maximum and maximum light spectra
  - 100 hours of GMT TRIMOS time for faint and late-time spectra
  - 50 hours of TMT IRMOS time for JHK spectroscopy

Cost: $6M – *Comparable to or less than an HST Treasury Program*

2) Exploring Reionization with WFIRST and LSST

- Red to Near-IR spectroscopy of 25 QSOs at z > 8
  - Pre-selection of targets based on grism and color-color space
  - 200 hours of GMT TRIMOS for spectra to 1.25 microns

- Cost: $7M

A Coordinated and Collaborative System

3) Characterization of Habitable Exoplanets

- Transmission spectroscopy of transiting exoplanets from TESS
  - Support for fabrication of GMT PRV echelle
  - 100 hours of GMT time for transit spectroscopy
  - 150 hours of GMT Time for precision radial velocity mass determinations
  - 50 nights of Magellan PFS time or Keck Hires time

Cost: $20M – *Inexpensive for a NASA level 1 mission-critical support program*

4) Structure and Clearing in Proto-planetary Disks

- High Spatial Resolution Imaging of Protoplanetary Disks from JWST
  - Disks discovered in NIRCAM and MIRI programs on Webb
  - AO imaging with GMT in the mid-IR will have 3.5 x better resolution
  - 50 hour GMT program to image 25-30 disks with high resolution
  - 50 hours with GPI for short wavelength images

Cost: $1.7M – Cheap!

A Coordinated and Collaborative System

GMT and TMT have distinct strengths and great potential for synergy

By operating in an integrated OIR system they can more effectively further the NWNH and 2020 decadal survey goals

- Partially overlapping sky coverage – together we cover the full sky
  - Some special objects can only be reached by one
  - *Transients and TOOs happen everywhere*
- Distinct, but overlapping, instrument suites
  - Differing wavelength and resolution coverage
- Distinct, but partially overlapping science communities
  - Many collaborations naturally cross institutional boundaries

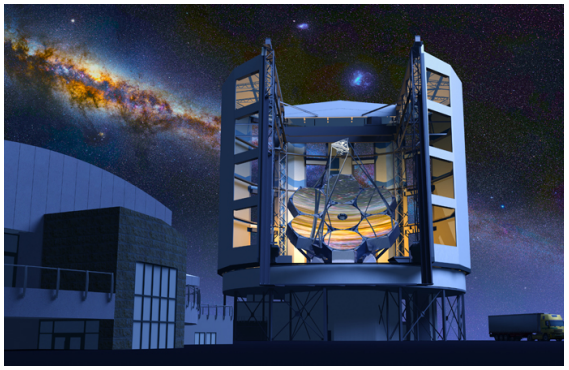
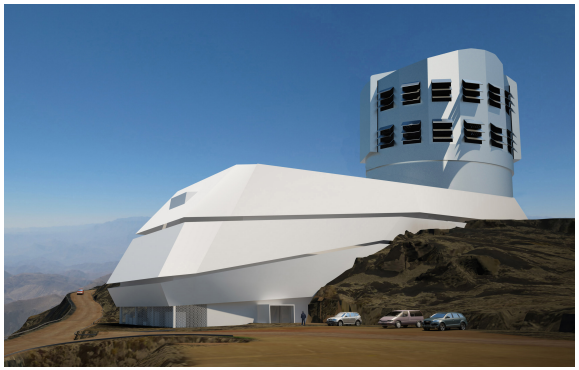
It is easier to move astronomers and data than instruments or facilities
The OIR System can facility mobility of scientists and data

Next Steps

The GMT Partners have demonstrated an on-going commitment to engagement with the community

Potentially productive next steps:

- Joint meetings of GMT, TMT and LSST Science Committees
- Community science meetings focused on key science questions
- Continued engagement with this committee and Agency leadership

Thank you