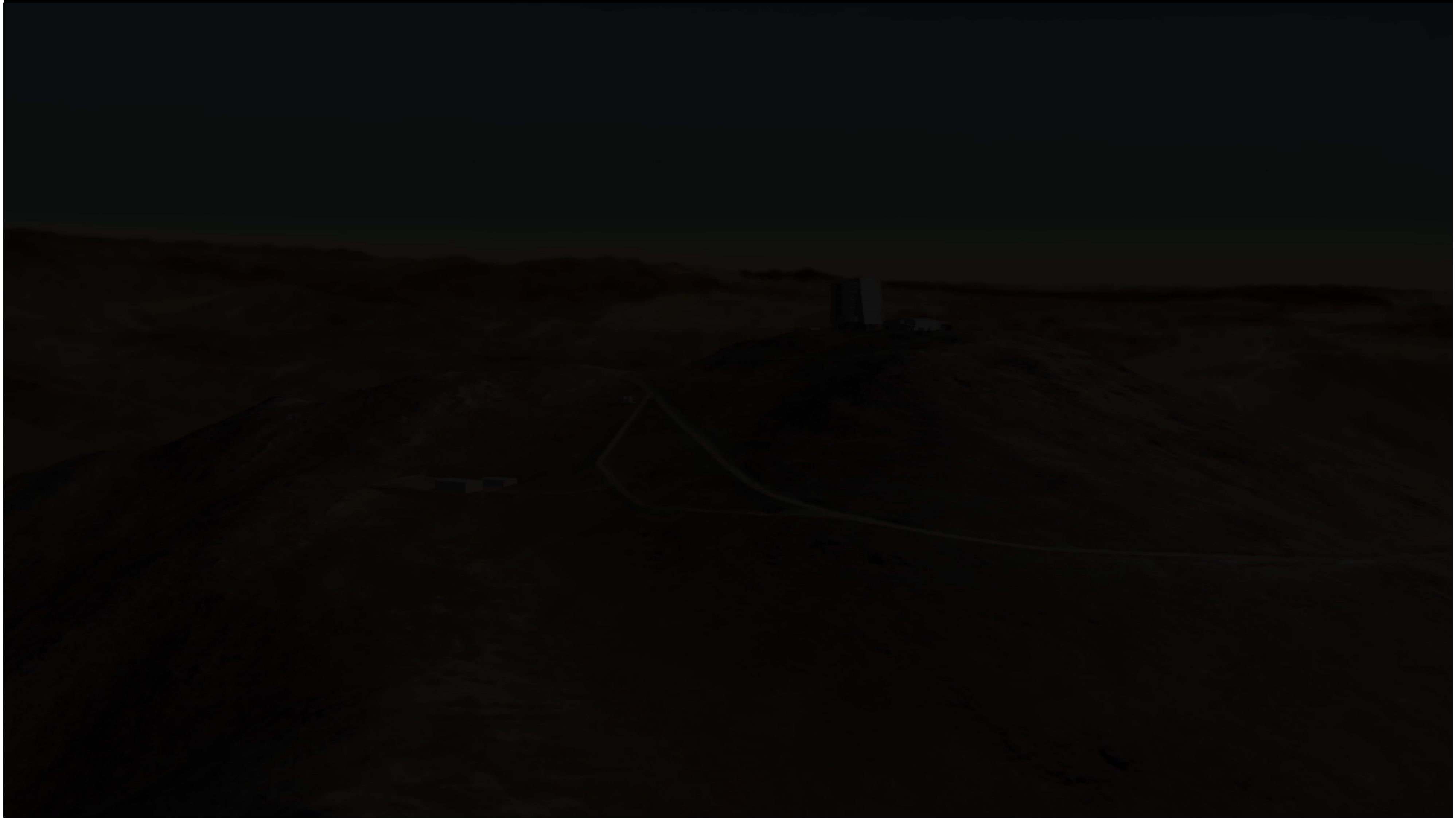
Giant Magellan Telescope

Project Status and Opportunities for Scientific Synergy

Patrick McCarthy
GMT Project Director

Outline

- Overview of Project
- Science, Organization and Technical Status
- Scientific Outreach
- Next Steps and Project Schedule
- Synergy and Cooperation

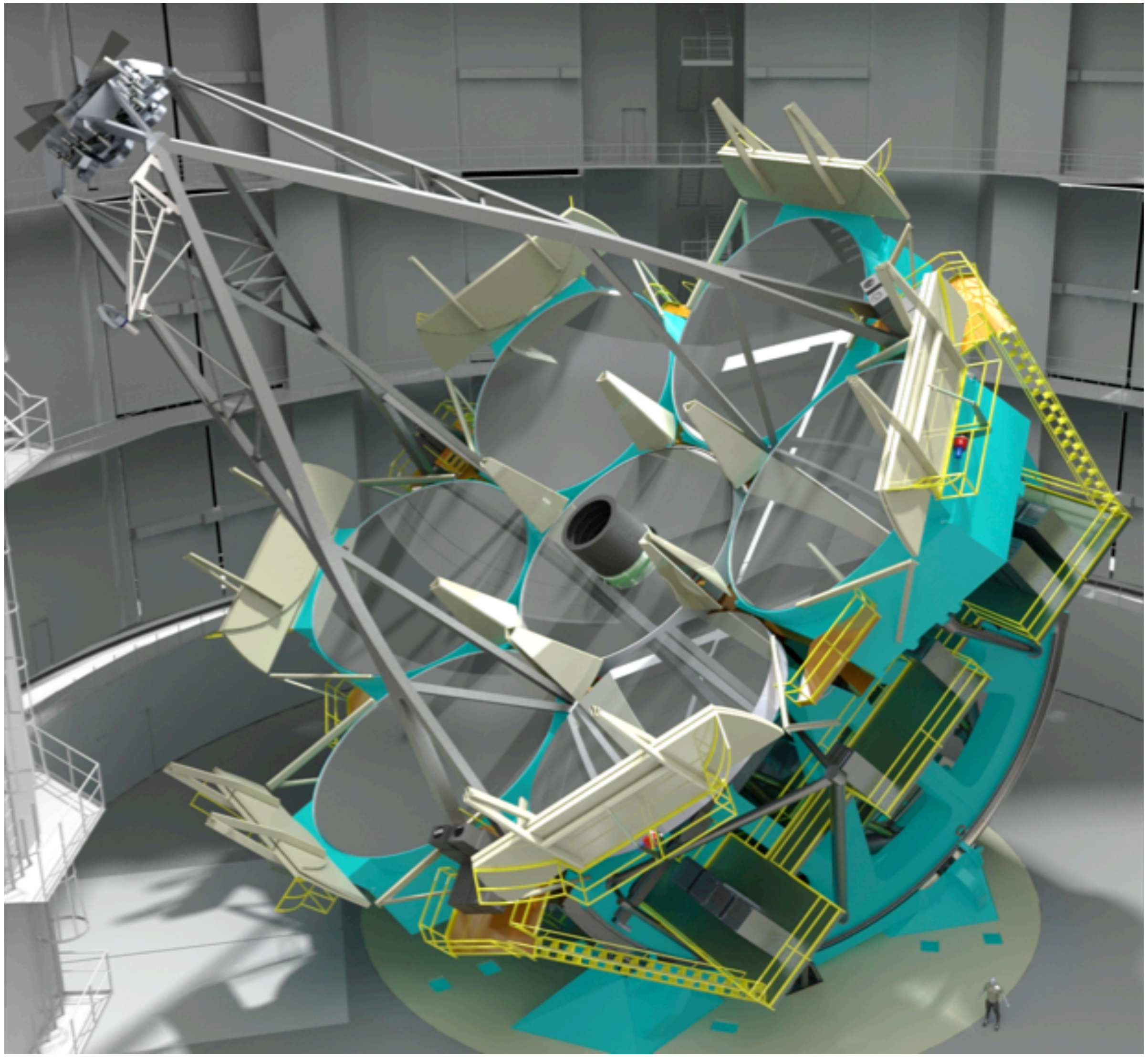


Observatory Overview

- Seven 8.4m segments
- 25.4 m diameter pupil
- f/8.2 system 1mm/arcsec
- 360 sq. meters area
- 2 Reflections to the focus
- 20’ corrected field of view
- Angular resolution:

  10 mas at 1 micron
- Site: Las Campanas, Chile

NB: Cost is ~$250,000 per night

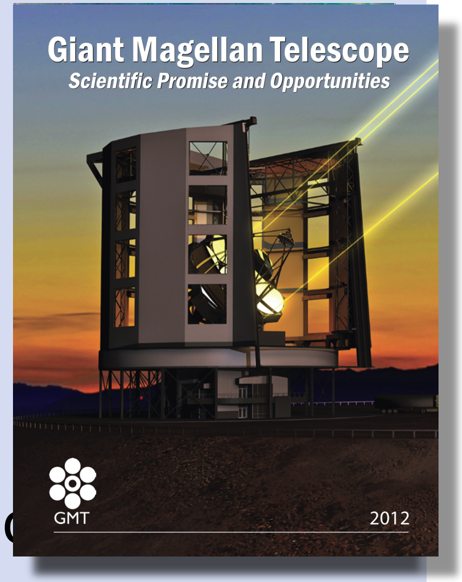


Science & Organization

Scientific Motivation

<u>Top-Level Science Areas</u>

- Extra-solar planets
- Stellar Populations and Chemistry
- Galaxy Building
- Black Hole Growth
- Cosmological Physics
- First-Light & Reionizati

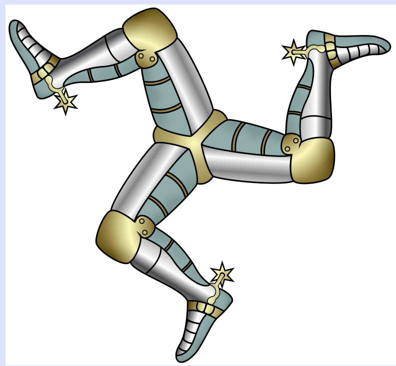


Three Legs of the GMT Science Case:

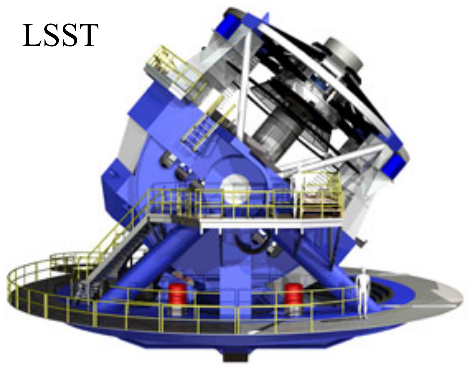
- Discovery Space

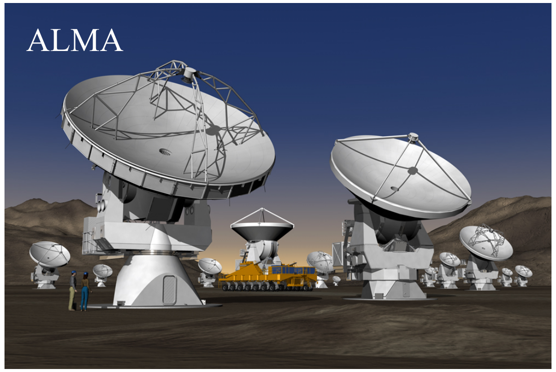
-Contemporary Science Goals

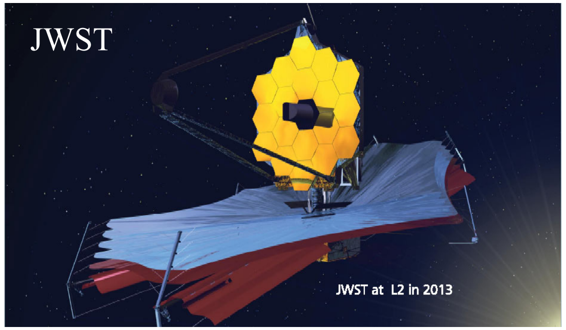
- Synergy



Scientific Motivation







Three Legs of the GMT Science Case:

- Discovery Space

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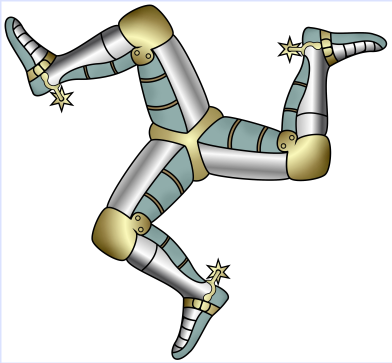
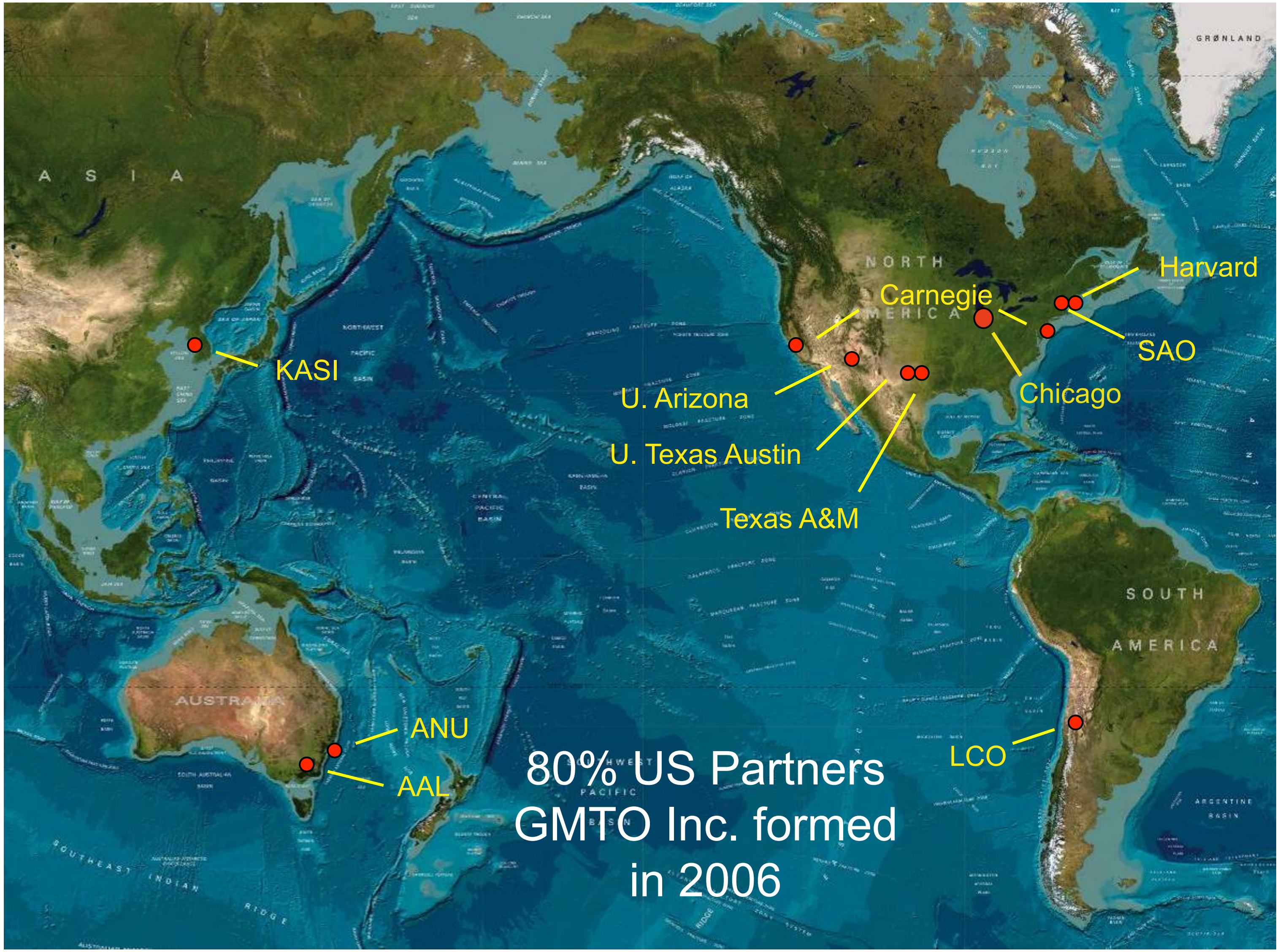
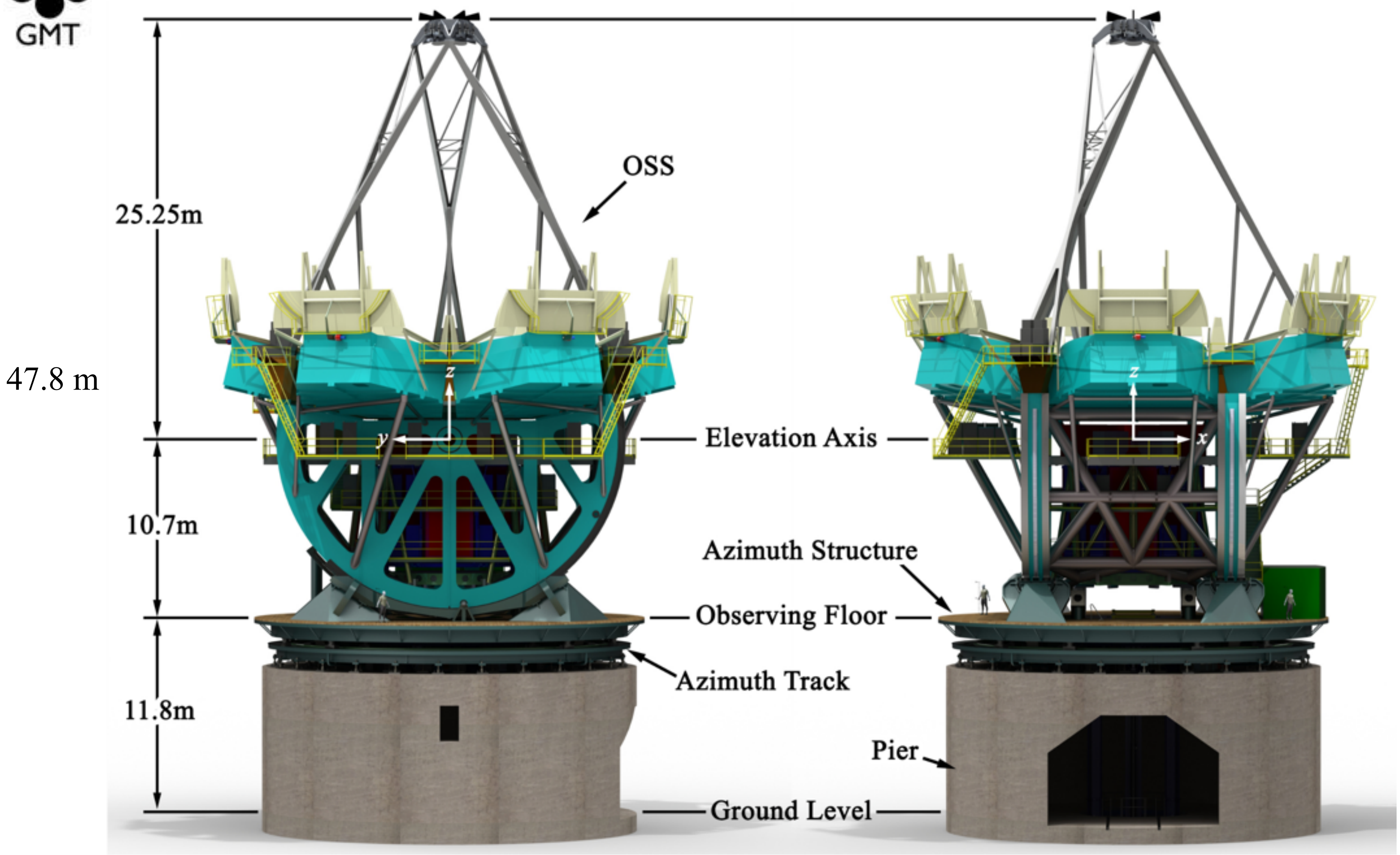


GMT Institutions

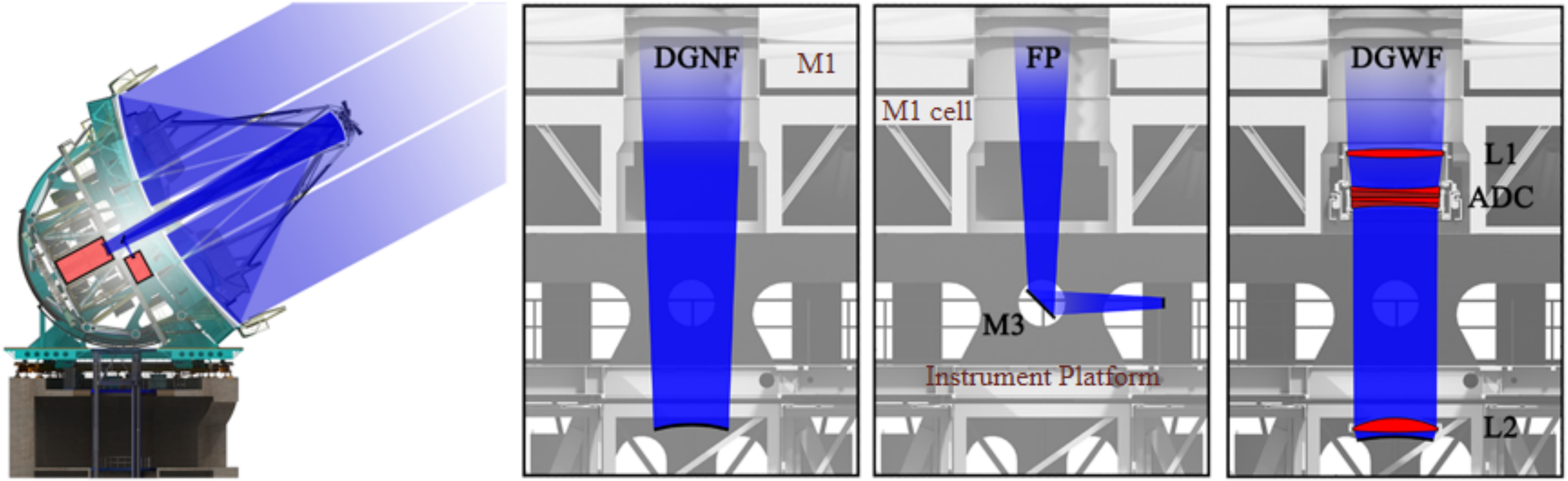


Telescope



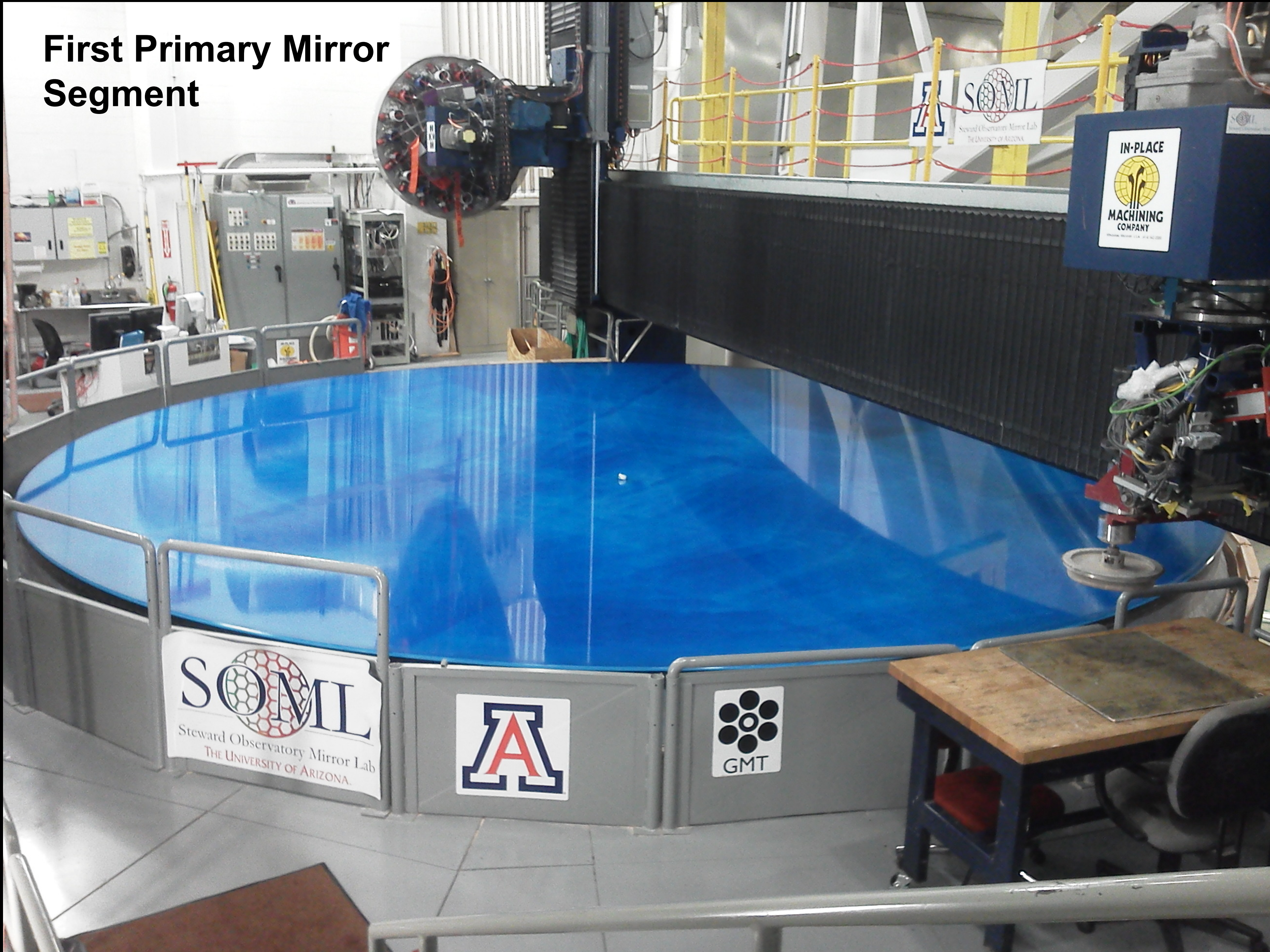
Moving mass (azimuth + elevation) = 1,261 metric tons
Fixed mass (track) = 168 metric tons

Telescope Optics: 3 configurations



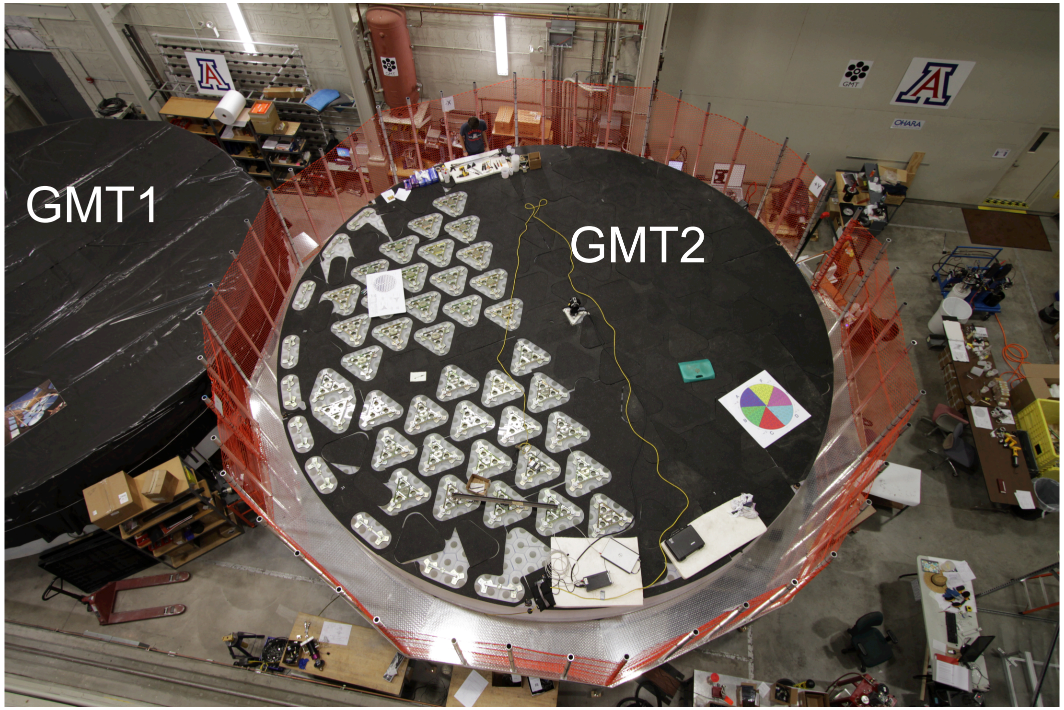
Configuration	Field of view	Instruments
Direct Gregorian Narrow Field	10 arcmin	Wide-field spectrograph
Folded Port	3 arcmin	High-resolution spectrograph Adaptive optics instruments
Direct Gregorian Wide Field	20 arcmin	MANIFEST fiber feed

First Primary Mirror Segment

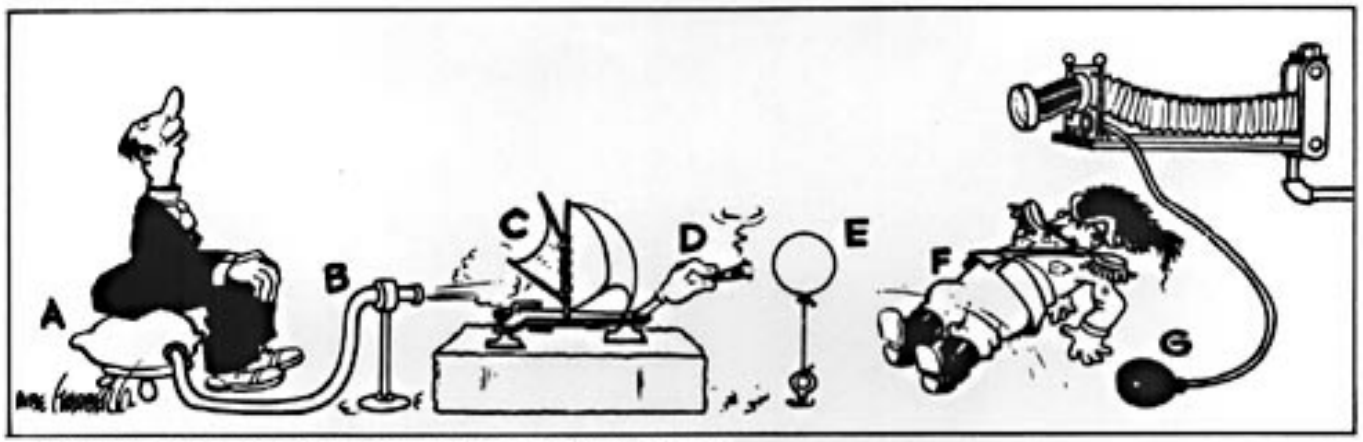


Primary Mirror Segment Production

- GMT2
  - Rear surface processing completed
- GMT3
  - Clean out of core materials completed
  - Rear surface generating to start soon
- GMT4
  - Casting date: March 2015
- GMT5
  - Glass deliveries begun



Adaptive Optics & Scientific Instruments



Picture-Snapping Machine RUBE GOLDBERG (tm) RGI 074

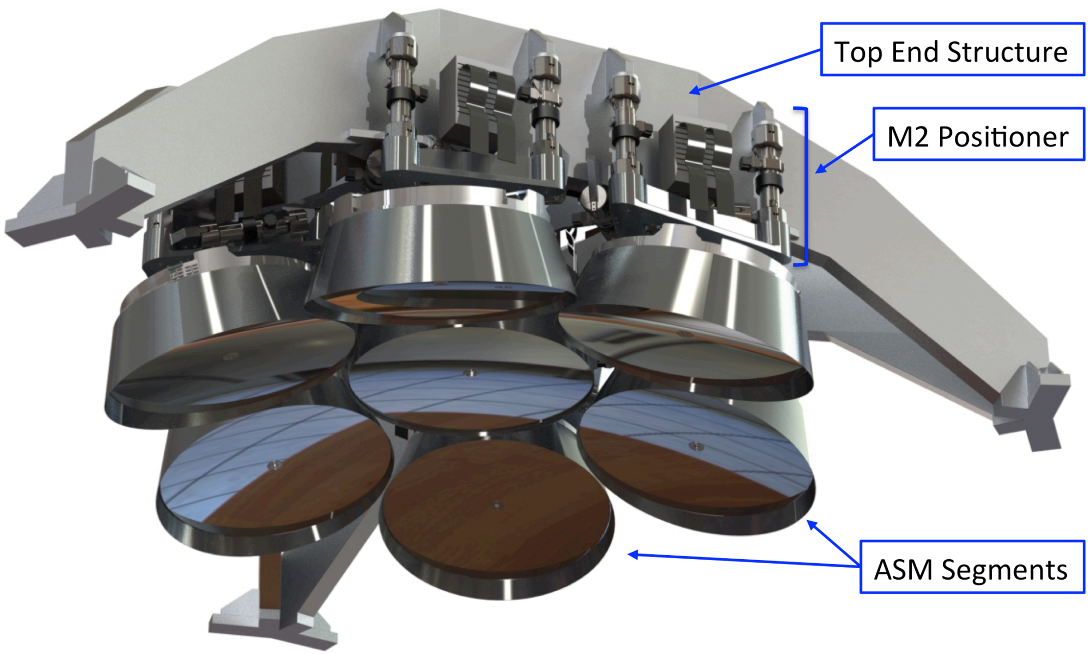
Adaptive Optics Strategy

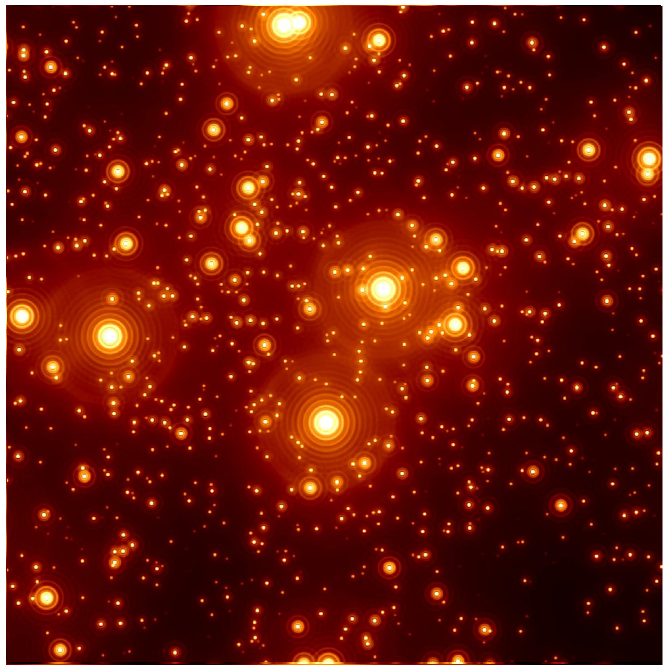
GMT

Integral to the telescope: No extra reflections, no extra background

Adaptive Optics Modes:

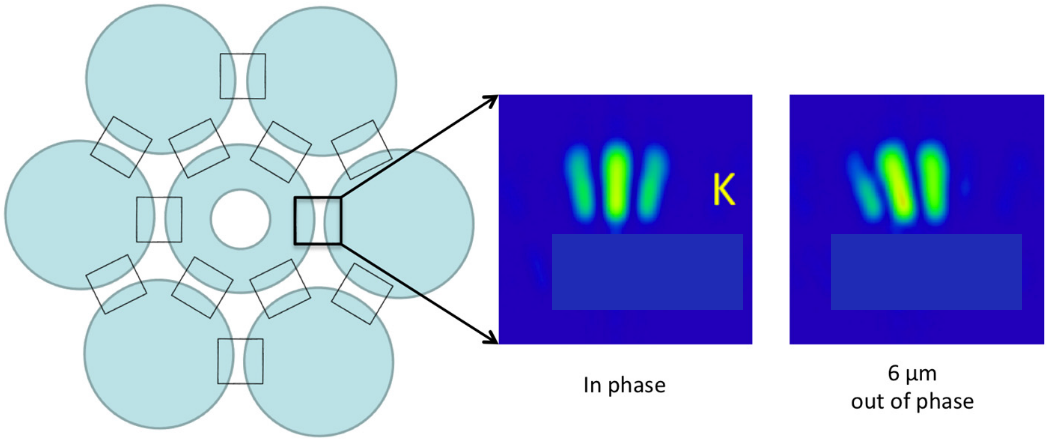
- Natural guide star high-Strehl (95% Strehl)
- Laser guide star high sky coverage
- Ground layer correction with natural guide stars

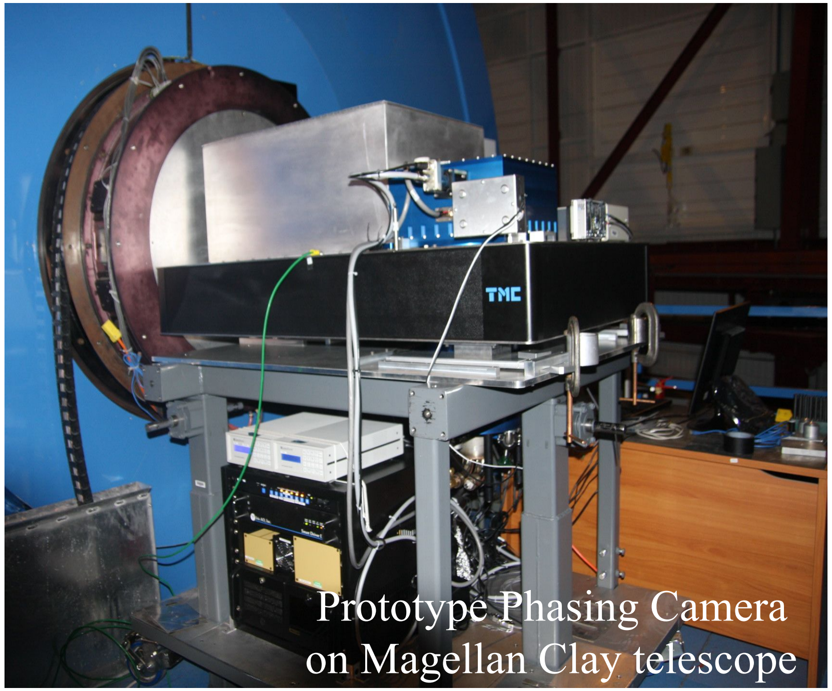




Phasing the GMT Mirrors

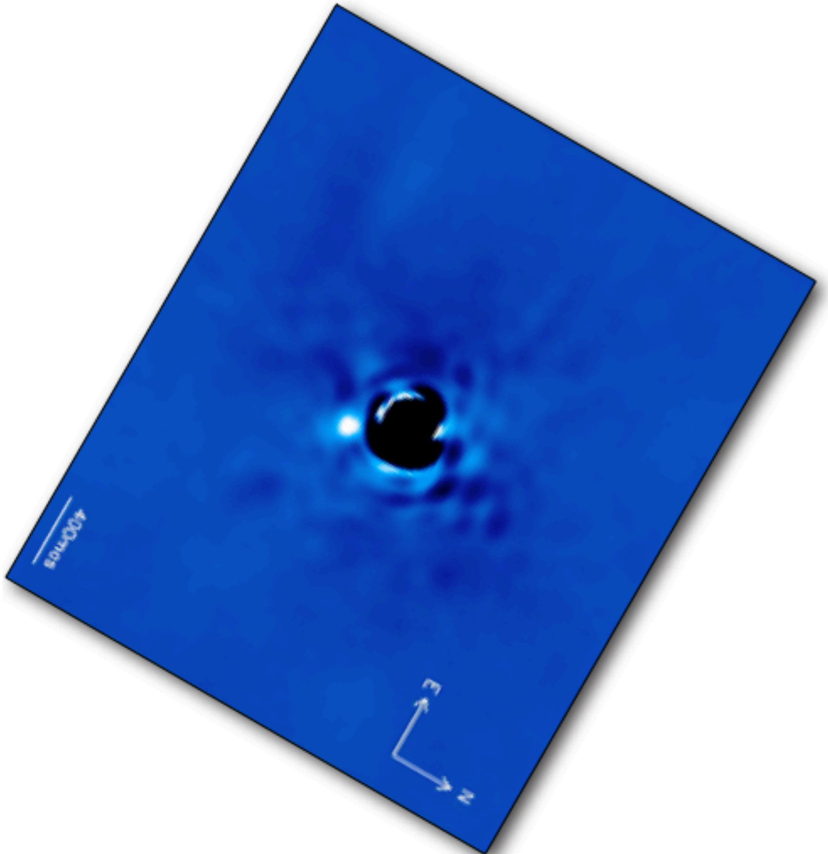
- Phasing Camera senses fringes across the segments gaps in the IR
- Achieves 50nm rms precision
- Continuous observation of natural guide stars
- 97% sky coverage at the galactic poles



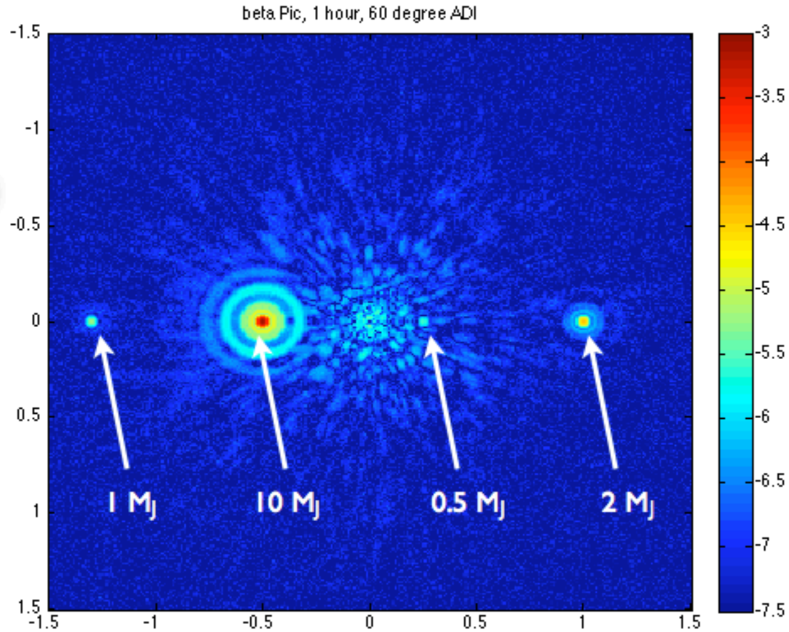


Prototype Phasing Camera
on Magellan Clay telescope

Simulated GMT Imaging of Exoplanets



VLT L' observation



GMT L' simulation

GMT will image giant planets to ≈150 pc and Earth analogs at < 10pc

First Generation Instruments

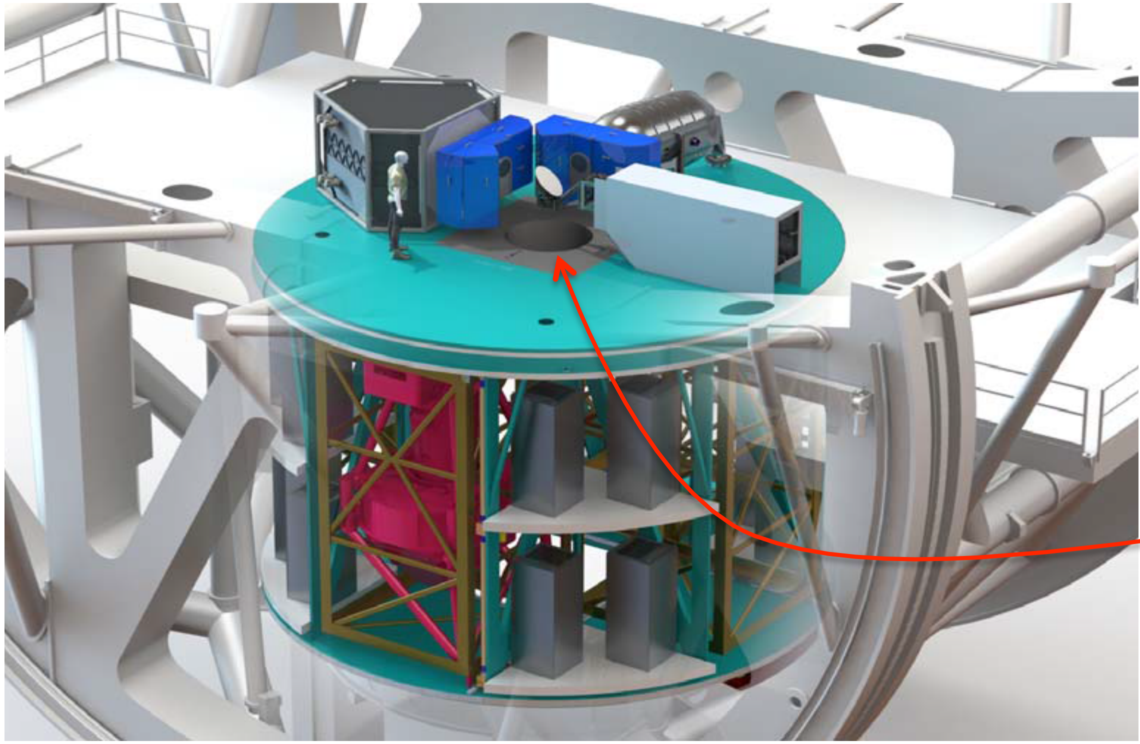
Instrument / Mode	Capabilities	λ Range, μm	Resolution	Field of View
G-CLEF / NS, GLAO	Optical High Resolution Spectrograph / PRV	0.35 – 0.95	20 – 100K	7 x 0.7,1.2” fibers
GMACS / NS, GLAO	Wide-Field Optical Multi-Object Spectrograph	0.36 – 1.0	1,500 – 4,000 (10K w/ MANIFEST)	40-60 $arcmin^2$
GMTIFS / LTAO, NGSAO	NIR AO-fed IFS / Imager	0.9 – 2.5	5,000 & 10,000	10 / 400 $arcsec^2$
GMTNIRS / NGSAO, LTAO	JHKLM AO-fed High Resolution Spectrograph	1.2 – 5.0	50K, 100K	1.2” long-slit
MANIFEST* / NS, GLAO	Facility Robotic Fiber Feed	0.36 – 1.0		20’ diameter

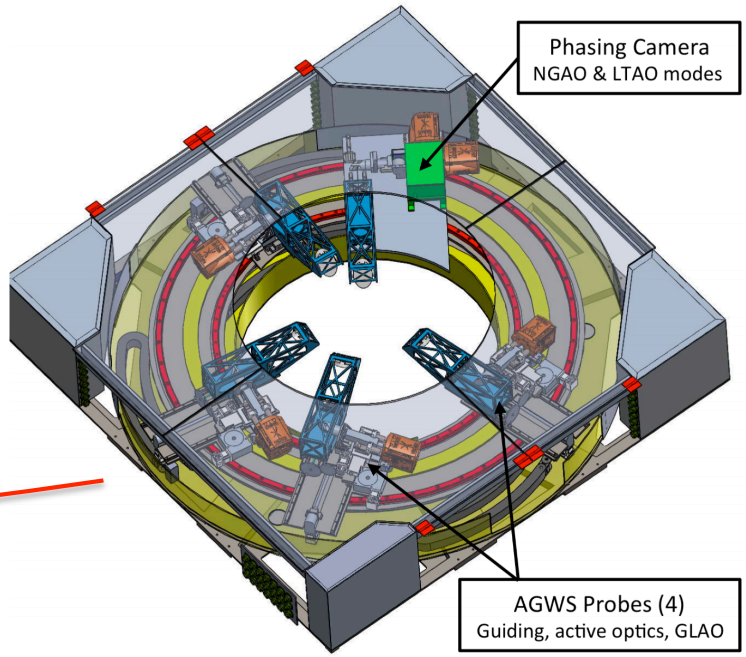
Telescope Structure: Instrument Mounting

Instrument are mounted below the central primary mirror segment

Exception: Gravity invariant focal station on the azimuth disk

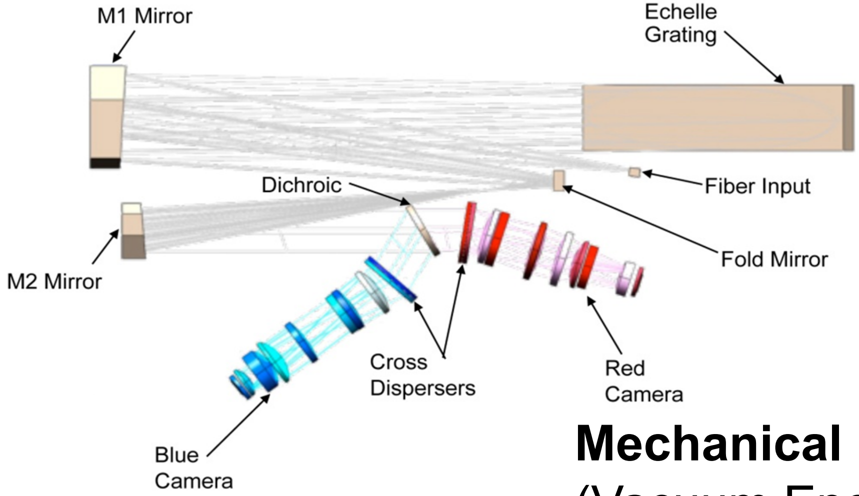
Guiders, WFS, & phasing cameras





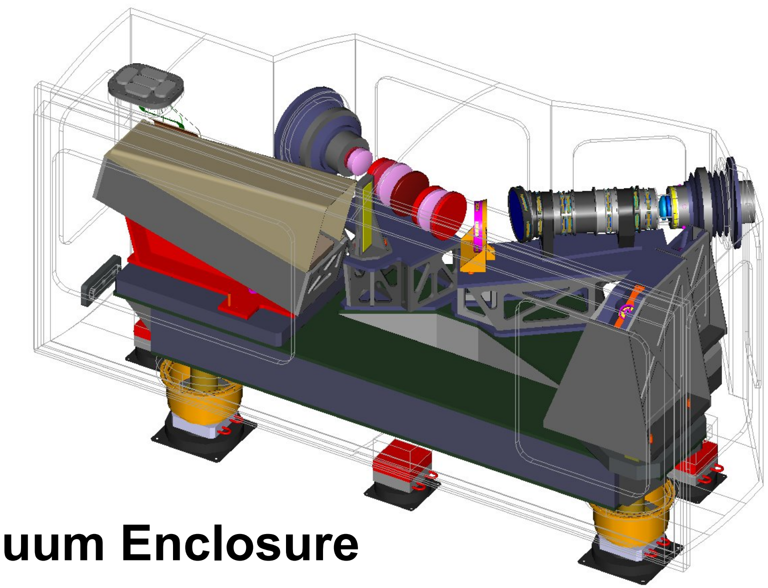
The G-CLEF Spectrograph

Optical Layout

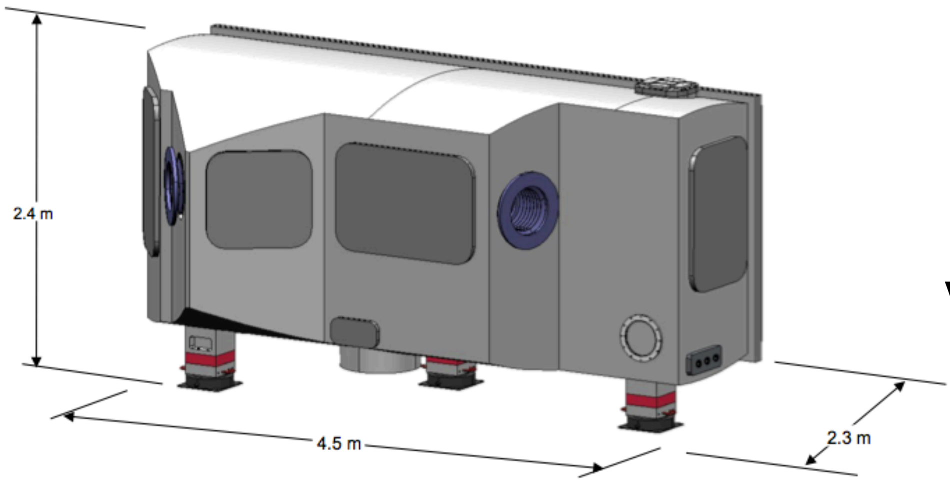


In Preliminary Design Phase

Mechanical Layout
(Vacuum Enclosure in Outline)



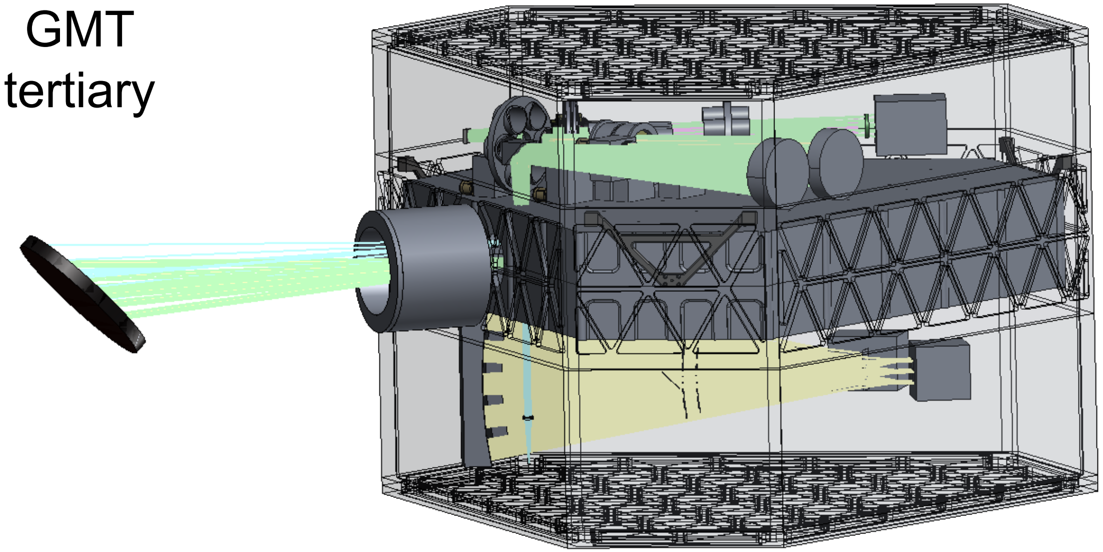
Vacuum Enclosure

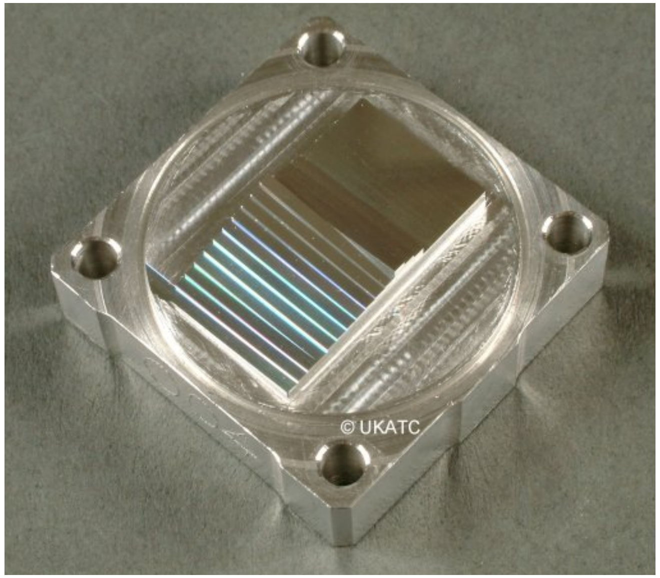


Smithsonian, Carnegie, KASI, Chicago, Chile

GMTIFS AO Imager & IFU

GMT tertiary





- Example Imager Slicer
- From MIRI (JWST)

Builds on successful NIFS and GSAOI instruments on Gemini

Australia

In Preliminary Design Phase

Visible Light Multi-Object Spectrograph

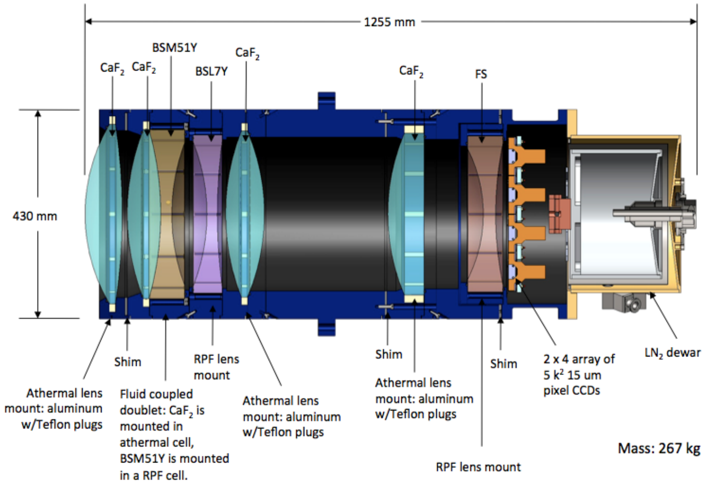


Figure 9-46. Detailed optical layout for the blue camera. The final element (labeled FS, for fused silica) serves as the window to the CCD Dewar.

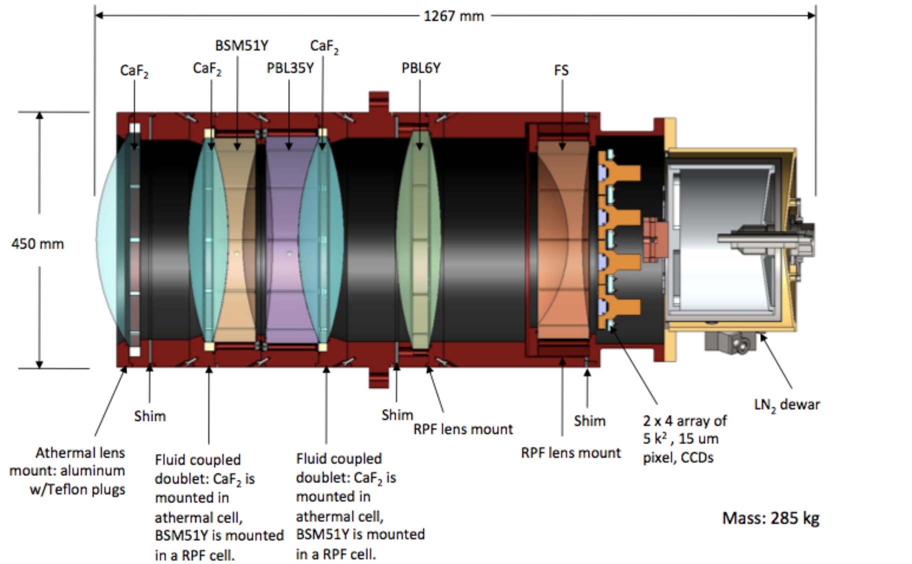


Figure 9-47. Detailed layout for the red camera. As in the blue camera, the final element (FS) is also the Dewar window.

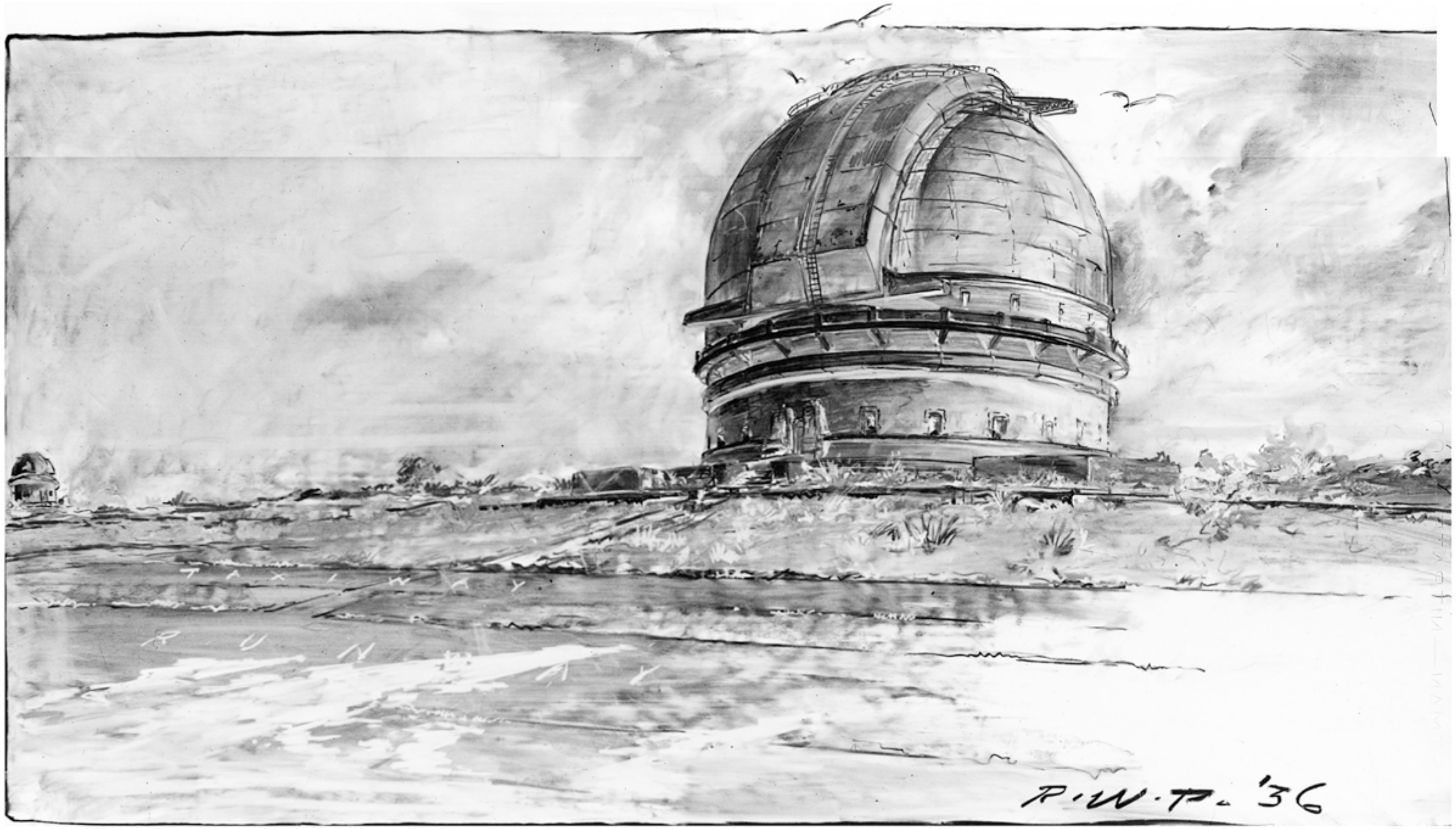
In Conceptual Design Phase

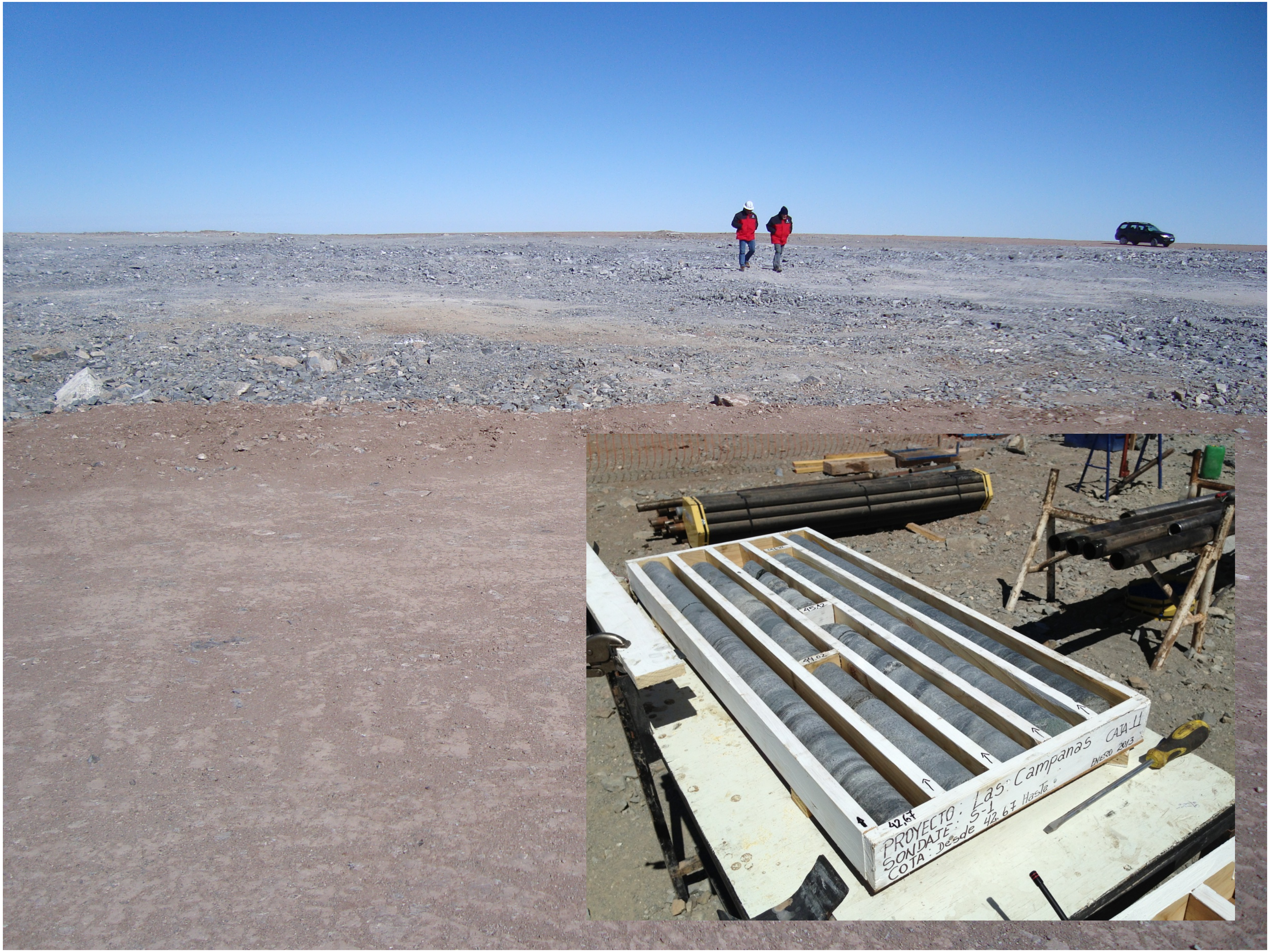
Texas A&M, Carnegie

R = 1,000 – 5,000
Multi-Object Spectrograph

Core Science:
Galaxy evolution, First-light, Transient Sources, IGM/ICM, Dwarf Galaxy Dynamics

Site




PROYECTO: Las Campanas
CAJA 11
SONDAJE: S-1
COTA: Desde 42.67 Hasta
ENERO 2013
42,67
44,02
45,12

Scientific Outreach

GMTO Board Statement to the 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.

Community Reps on the GMT SAC

WINTER 2013

POSTED ON JANUARY 1, 2013

GMTO Welcomes New Community SAC Members

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

GMT welcomes Bob Blum (NOAO), Julianne Dalcanton (U. Washington) and Megan Donahue (Michigan State) to the Scientific Advisory Committee. They provide fresh perspective on key scientific issues, broaden participation from the larger community, and spread the word about progress with GMT outside the partner institutions. Their areas of interest include massive star formation, stellar populations in external galaxies, and x-ray studies of galaxy clusters.

2014 Community Science Meeting

Transient Phenomena in Astronomy & Astrophysics

Dates: October 6-8, 2014

Venue: Washington, DC

Smithsonian Museum of the American Indian

Banquet at Willard's Hotel

No Conference or Banquet Fee!

Travel support for students & postdocs

www.gmtconference.org

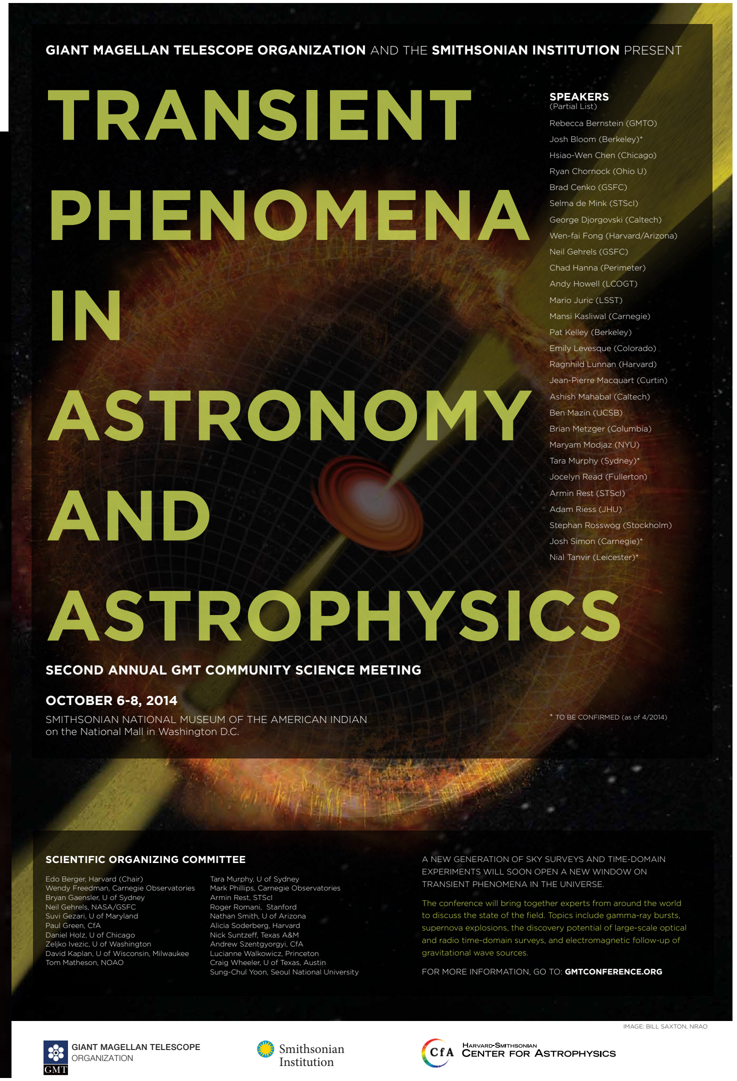
2014 Science Meeting

SPEAKERS
(Partial List)

Rebecca Bernstein (GMTO)
Josh Bloom (Berkeley)*
Hsiao-Wen Chen (Chicago)
Ryan Chornock (Ohio U)
Brad Cenko (GSFC)
Selma de Mink (STScI)
George Djorgovski (Caltech)
Wen-fai Fong (Harvard/Arizona)
Neil Gehrels (GSFC)
Chad Hanna (Perimeter)
Andy Howell (LCOGT)
Mario Juric (LSST)
Mansi Kasliwal (Carnegie)
Pat Kelley (Berkeley)

October 6-8, 2014

Emily Levesque (Colorado)
Ragnhild Lunnan (Harvard)
Jean-Pierre Macquart (Curtin)
Ashish Mahabal (Caltech)
Ben Mazin (UCSB)
Brian Metzger (Columbia)
Maryam Modjaz (NYU)
Tara Murphy (Sydney)*
Jocelyn Read (Fullerton)
Armin Rest (STScI)
Adam Riess (JHU)
Stephan Rosswog (Stockholm)
Josh Simon (Carnegie)*
Nial Tanvir (Leicester)*



Schedule

Review Process

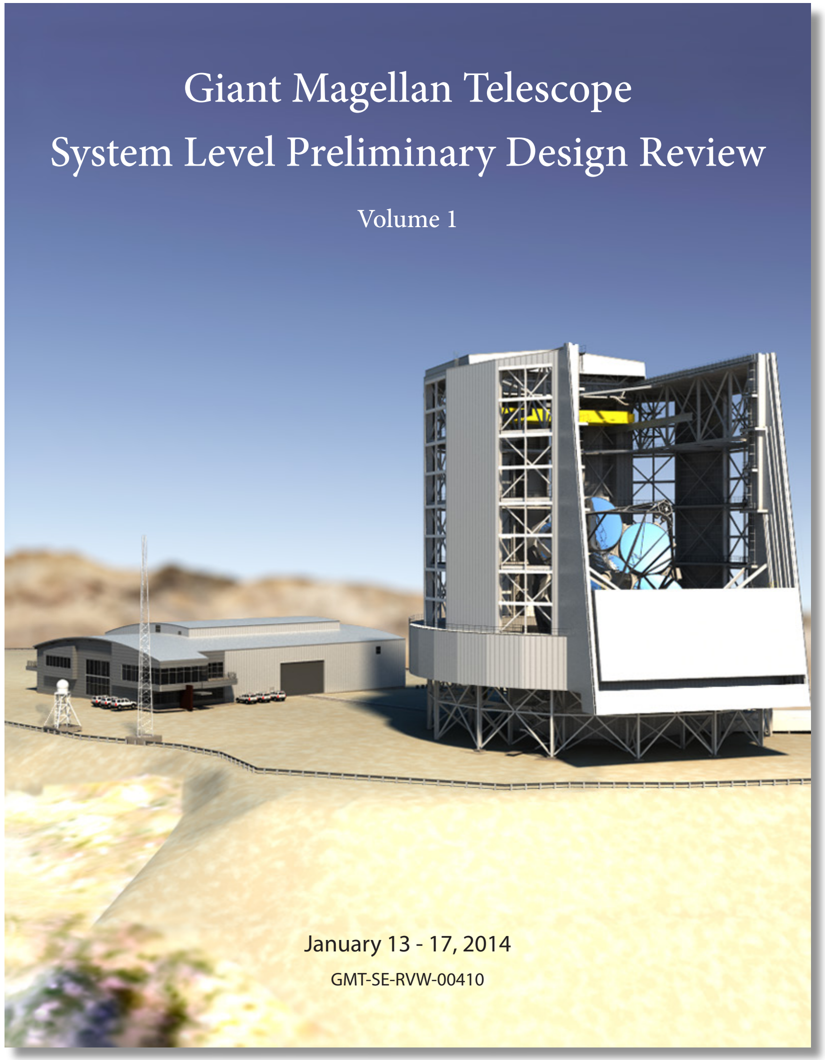
Five independent reviews in 12 months

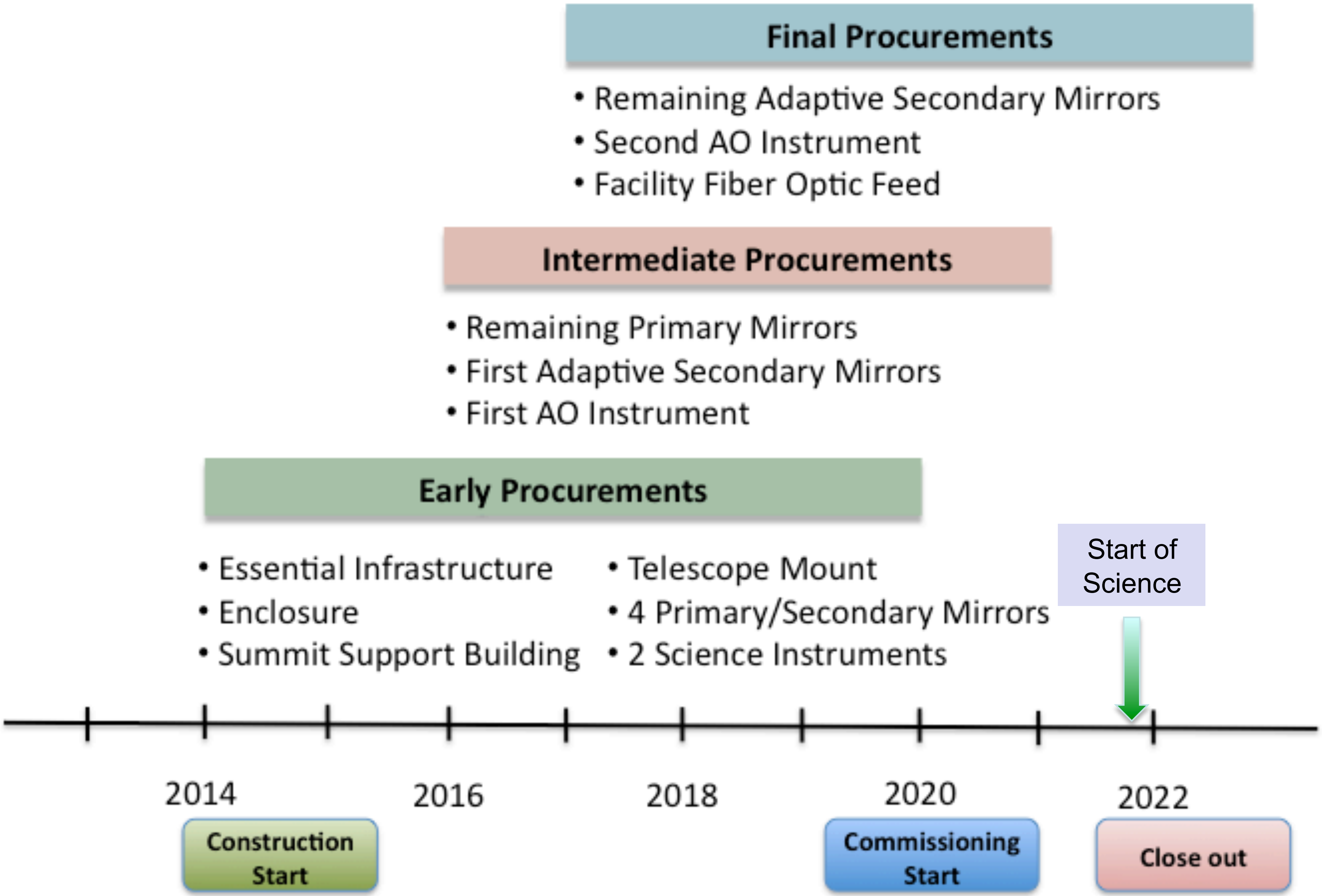
- Enclosure & Facilities PDR
- Adaptive Optics PDR
- Telescope System PDR
- GMT System Level PDR
- Cost and Organizational Review

System Preliminary Design Review

"Proceed to the construction phase as soon as possible"

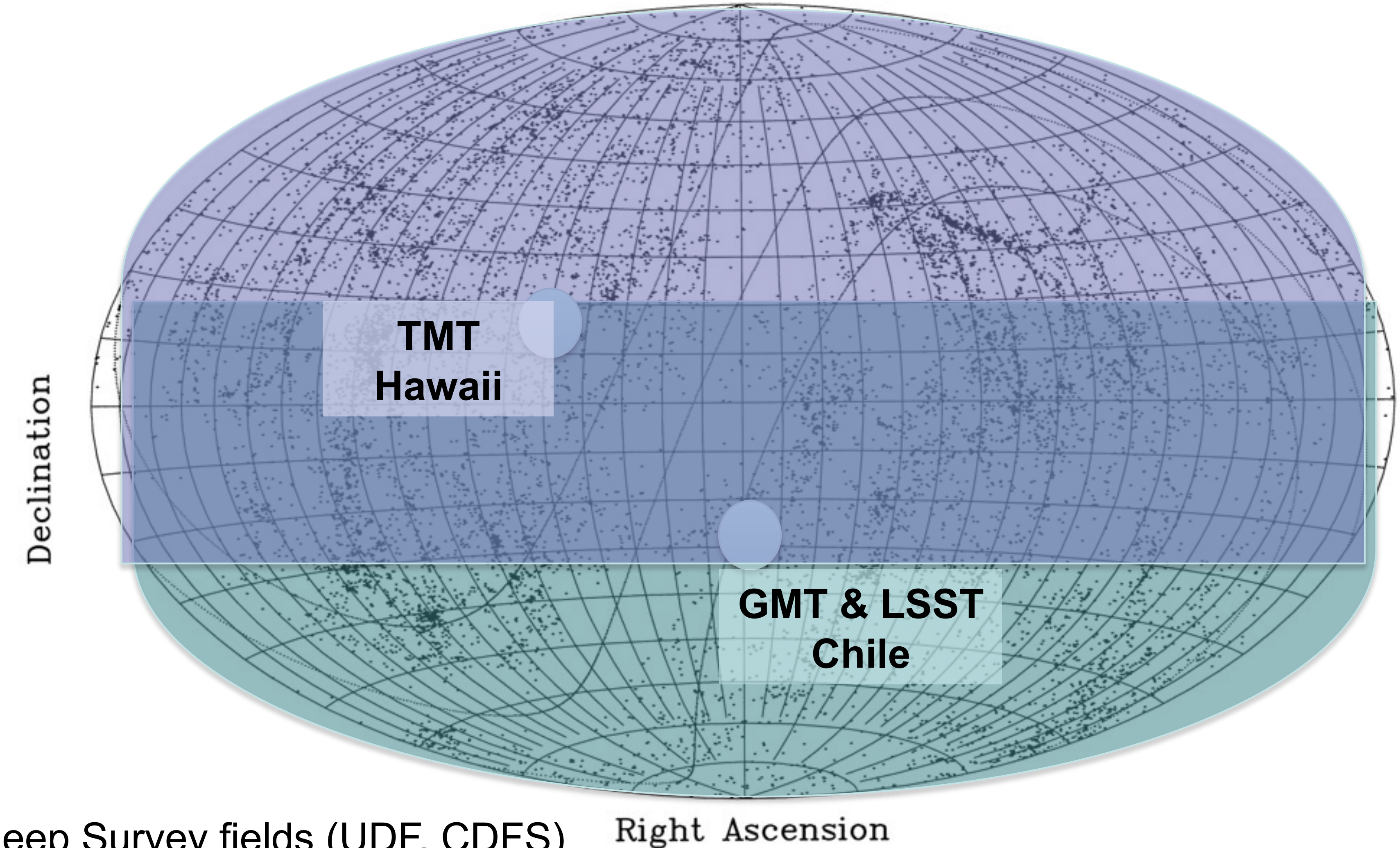
Construction phase to start shortly


Giant Magellan Telescope
System Level Preliminary Design Review
Volume 1
January 13 - 17, 2014
GMT-SE-RVW-00410


Final Procurements
• Remaining Adaptive Secondary Mirrors
• Second AO Instrument
• Facility Fiber Optic Feed
Intermediate Procurements
• Remaining Primary Mirrors
• First Adaptive Secondary Mirrors
• First AO Instrument
Early Procurements
• Essential Infrastructure
• Enclosure
• Summit Support Building
• Telescope Mount
• 4 Primary/Secondary Mirrors
• 2 Science Instruments
Start of Science
2014
2016
2018
2020
2022
Construction Start
Commissioning Start
Close out

Synergy & Cooperation

Sky Coverage



- Deep Survey fields (UDF, CDFS)
- Special objects (M31, GC, LMC/SMC)
- All Sky surveys (TESS, GRBs)

ELT Instruments

Instrument Type	GMT	TMT	E-ELT
Visible Echelle	G-CLEF	HROS	CODEX
Near/Mid IR Echelle	GMTNIRS	MIRES	METIS
AO Imager and IFU	GMTIFS	IRIS	HARMONI
Near-IR MOS	NIRMOS	IRMS	
Near-IR AO Imager	Covered by IFU instrument		MICADO
Planet Imager	TIGER	PFI	EPICS
Visible MOS	GMACS	MOBIE	
Wide-Field	MANIFEST		

First Generation

Future Generation

Synergy and Cooperation

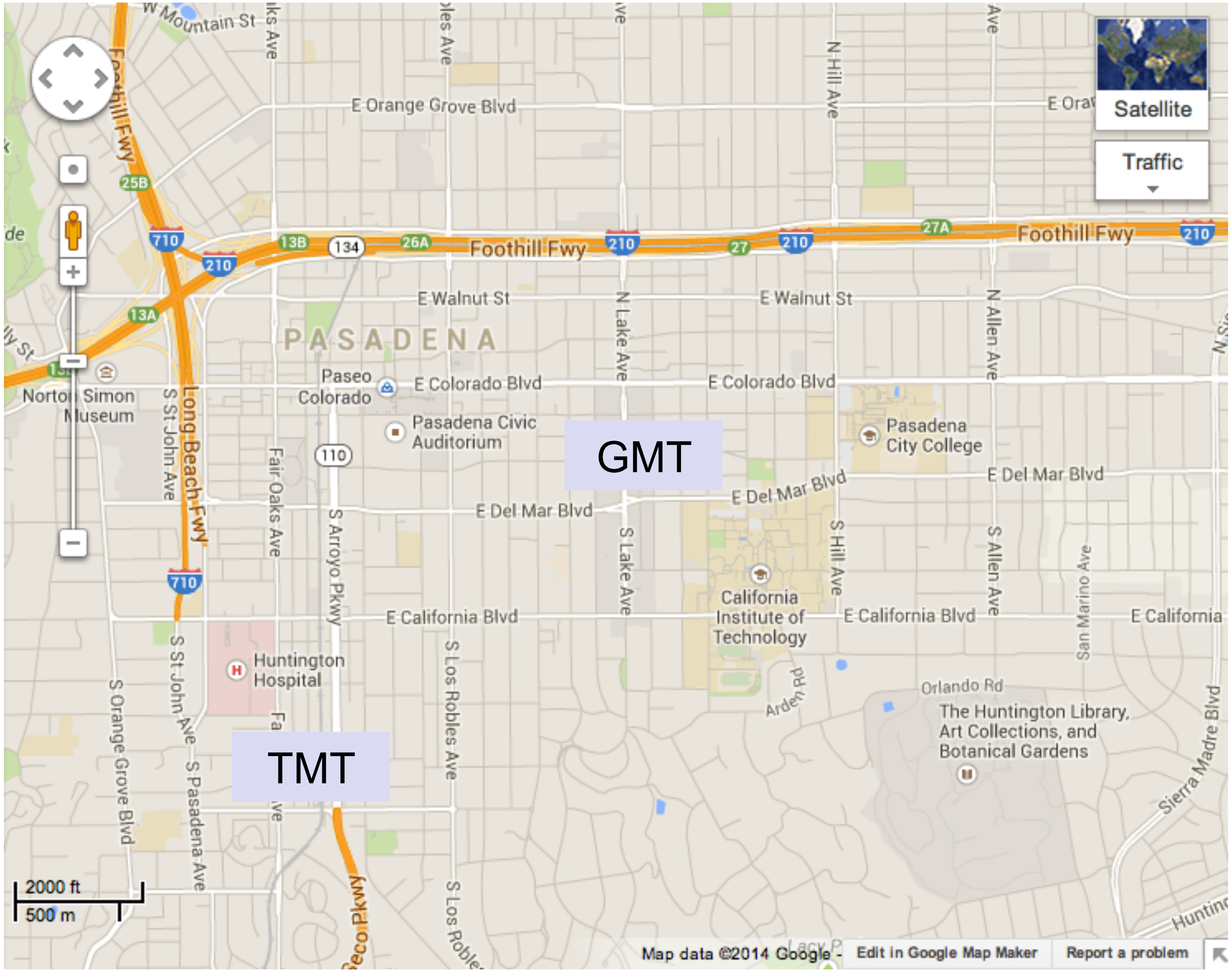
- TMT and GMT have distinct, but overlapping, sky coverage
- Some special objects can only be reached by one
- *Transients and TOOs happen everywhere*

- TMT and GMT have distinct, but overlapping, instrument suites

It is easier to move astronomers and data than instruments or facilities

Time swaps and open-access coordinated by NOAO as part of the now nearly deceased “system”?

Being Better Neighbors



Being Better Neighbors

Synergy and Cooperation

- Short Term
  - Joint technical and scientific discussions
  - AO4ELT4 in California?
  - Common technology development
    - TOPTICA Laser development provides a good template
- Medium Term
  - Thinking about requirements (e.g. TT stars) for preparatory survey fields
  - Planning joint open access key-projects
- Long Term
  - Swapping nights
  - Loose coordination on instrumentation development