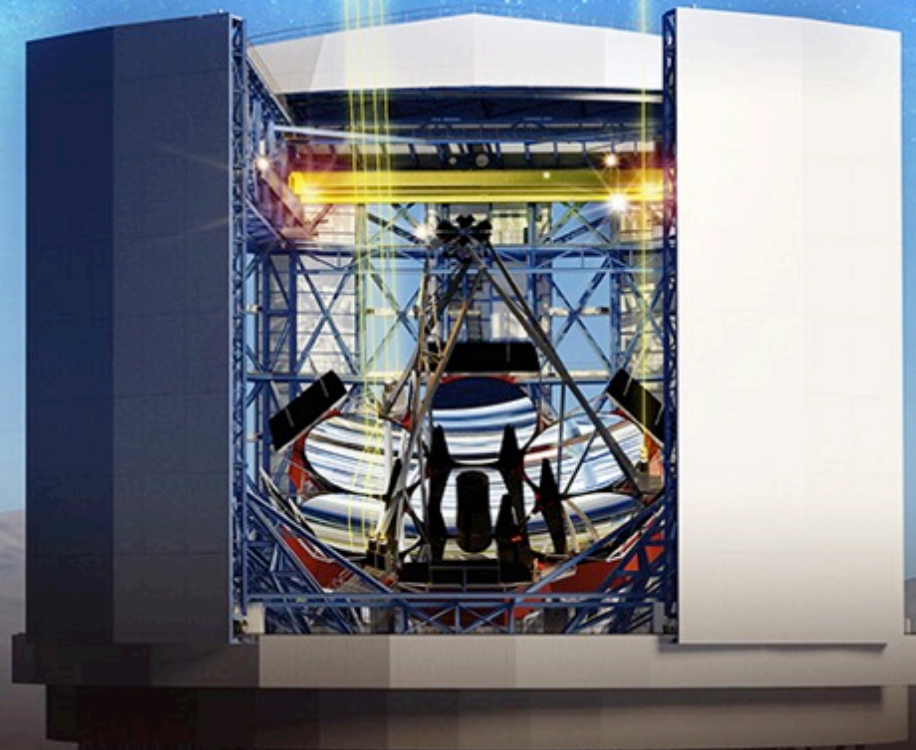


Giant Magellan Telescope Project

Overview and Relevance to LUVIOR



Patrick J. McCarthy
GMTO Director

Rebecca A. Bernstein
GMT Project Scientist



GMT Founder Institutions



Smithsonian
Institution



HARVARD
UNIVERSITY



Australian
National
University



CARNEGIE
SCIENCE



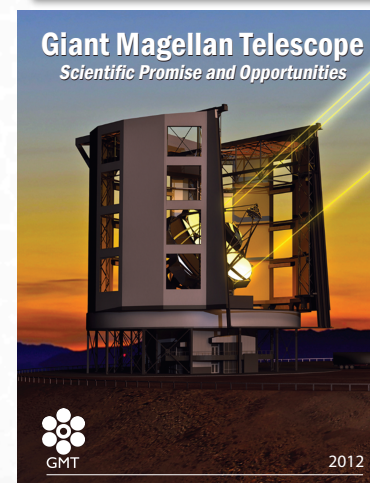
THE UNIVERSITY OF
TEXAS
AT AUSTIN



THE UNIVERSITY OF
CHICAGO

Top-Level Science Areas

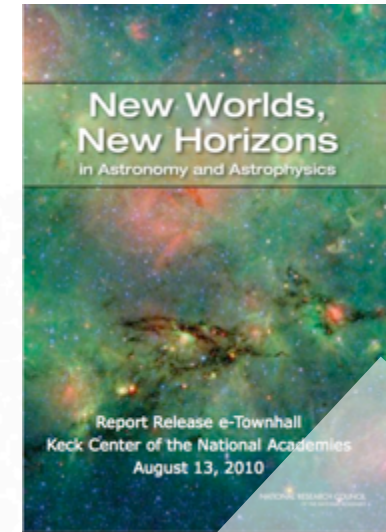
- **Extra-solar planets**
- **Stellar Populations and Chemistry**
- **Galaxy Building**
- **Black Hole Growth**
- **Cosmological Physics**
- **First-Light & Reionization**



Science Goals

What's New?

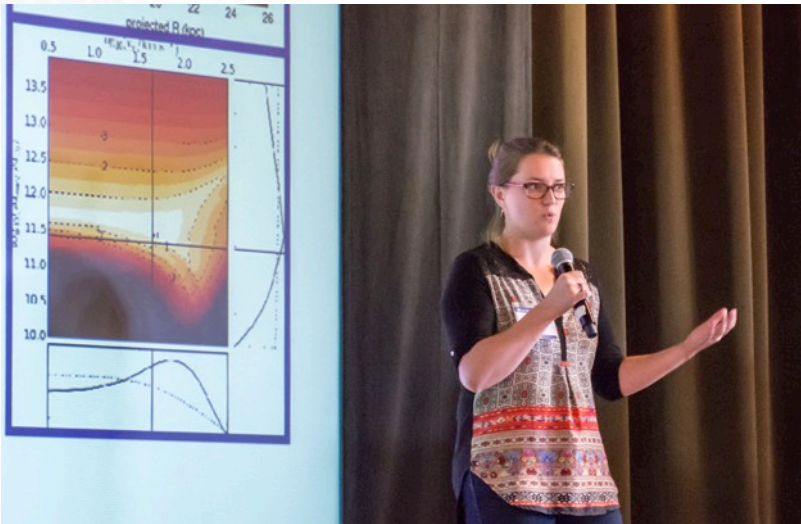
- Earth-like planets, visible AO...
- 2000+ Exoplanets, TESS in 2018
- Stars with $[Fe/H] < -7!$
- Black holes with $M > 10^{10} M_{\text{sun}}!$
- FRBs and other new transients
- JWST 2 years away
- LSST to start in 2020+
- LUVOIR only 20 years away!



Community Science Meetings



Keeping the science mission current



GIANT MAGELLAN TELESCOPE

ELT
(EXOPLANETS IN THE ERA OF EXTREMELY LARGE TELESCOPES)

FOURTH ANNUAL
GMT COMMUNITY SCIENCE MEETING
SPONSORED BY THE GIANT MAGELLAN TELESCOPE ORGANIZATION

NEW OBSERVING TECHNIQUES, INSTRUMENTATION, AND THEORETICAL UNDERSTANDING HAVE FUELED THE RECENT DRAMATIC GROWTH IN EXOPLANET DISCOVERIES AND THEORY. SCIENTISTS FROM AROUND THE WORLD WILL GATHER ON CALIFORNIA'S MONTEREY PENINSULA TO DISCUSS THE CURRENT AND FUTURE STATUS OF RESEARCH ON EXOPLANET DETECTION, TECHNIQUE CHARACTERIZATION, SYSTEM DYNAMICS, AND FORMATION MECHANISMS AND THE SCALES WITH A VIEW TOWARDS THE ROLES OF FUTURE OBSERVATORIES AND INSTRUMENTATION IN THESE AREAS.

THE CONFERENCE WILL INCLUDE A GALA BANQUET HELD AT THE MONTEREY BAY AQUARIUM.

INVITED SPEAKERS
REBECCA BERNSTEIN (CALTECH), JAYNE BIRBY (UCSD), ALAN BOSS (CORNELL), IAN CROSSFIELD (UCLA), RUOBING DONG (UC BERKELEY), KATE FOLLETTE (STANFORD), JONATHAN FORTNEY (UC SAN DIEGO), OLIVER GUYON (CEA), RAPHAELLE HAYWOOD (CEA), NICOLE LEWIS (UCSD), COLETTE SAKY (NASA), EVGENIA SERICAN (NASA), ANDREW SCHERER (UCSD)

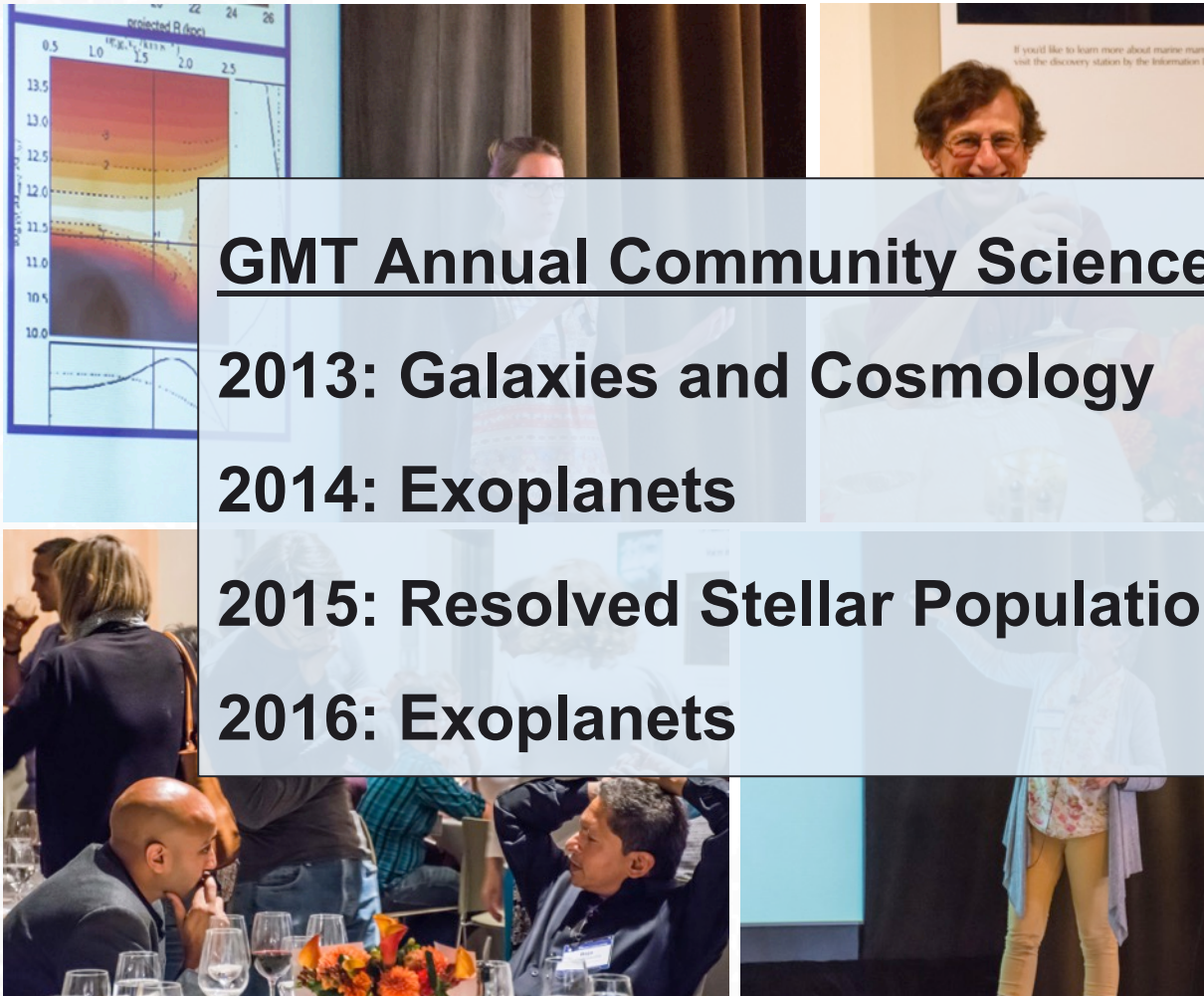
SCIENTIFIC ORGANIZING COMMITTEE
TRAVIS BARMAN (UCLA), ALYCA WEINBERGER (CORNELL), BRUCE MACINTOSH (STANFORD), BILL COCHRAN (UT TEXAS), JEFF CRANE (CORNELL), MERCEDES LOPEZ MORALES (UCSD), CHRIS TINNEY (UC BERKELEY), BEATHER KNUTSON (STANFORD), JOSH ESNER (UCSD), DAN FABRIKAY (UCSD), BETH MURPHY-CLAY (UCSD), ANDREW STEINBOCK (UCSD)

COMING TO ASILOMAR CONFERENCE GROUNDS IN PACIFIC GROVE, CALIFORNIA
SEPTEMBER 25-28, 2016
REGISTERED AT
GMTCONFERENCE.ORG

CONFERENCE WILL PROVIDE LIMITED TRAVEL SUPPORT AVAILABLE FOR STUDENT AND POSTDOCTORAL RESEARCHERS. PLEASE CONTACT GMTCONFERENCE.ORG FOR MORE INFORMATION.

Community Science Meetings

Keeping the science mission current



GMT Annual Community Science Meetings

2013: Galaxies and Cosmology

2014: Exoplanets

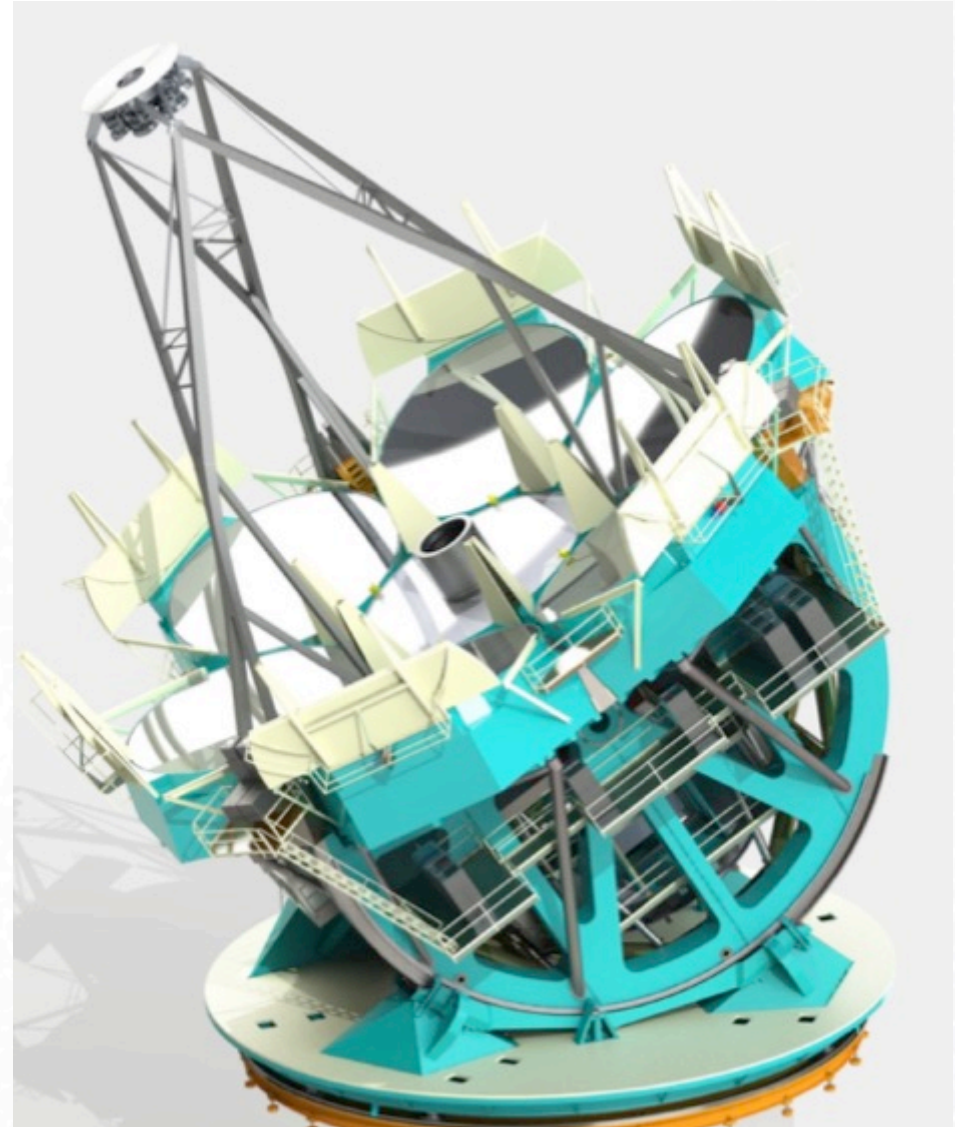
2015: Resolved Stellar Populations

2016: Exoplanets



Telescope Design Overview

- Doubly segmented
 - M1 – 8.4m segments
 - M2 – 1.1m segments
 - Aplanatic Gregorian configuration
 - M1:M2 segments are conjugate
 - f/0.7 primary
 - f/8 final focus – 1.0 mm/arcsec
- Compact structure
- Optimized for stiffness
- High throughput



GMT Primary Mirror Production

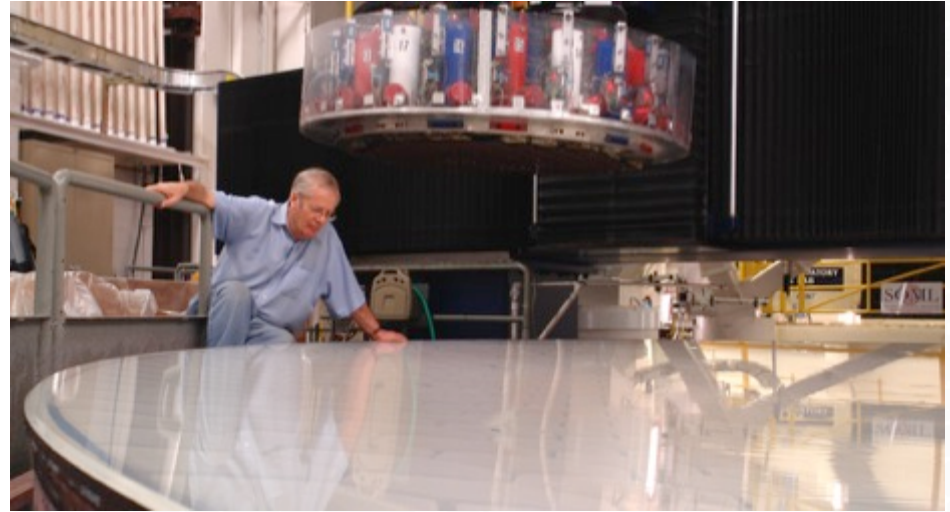
Segment #1:
Complete. Meets all specifications.

Segment #2:
Ready for front surface processing

Segment #3:
Rear surface complete.

Segment #4:
Casting/cleanout complete.

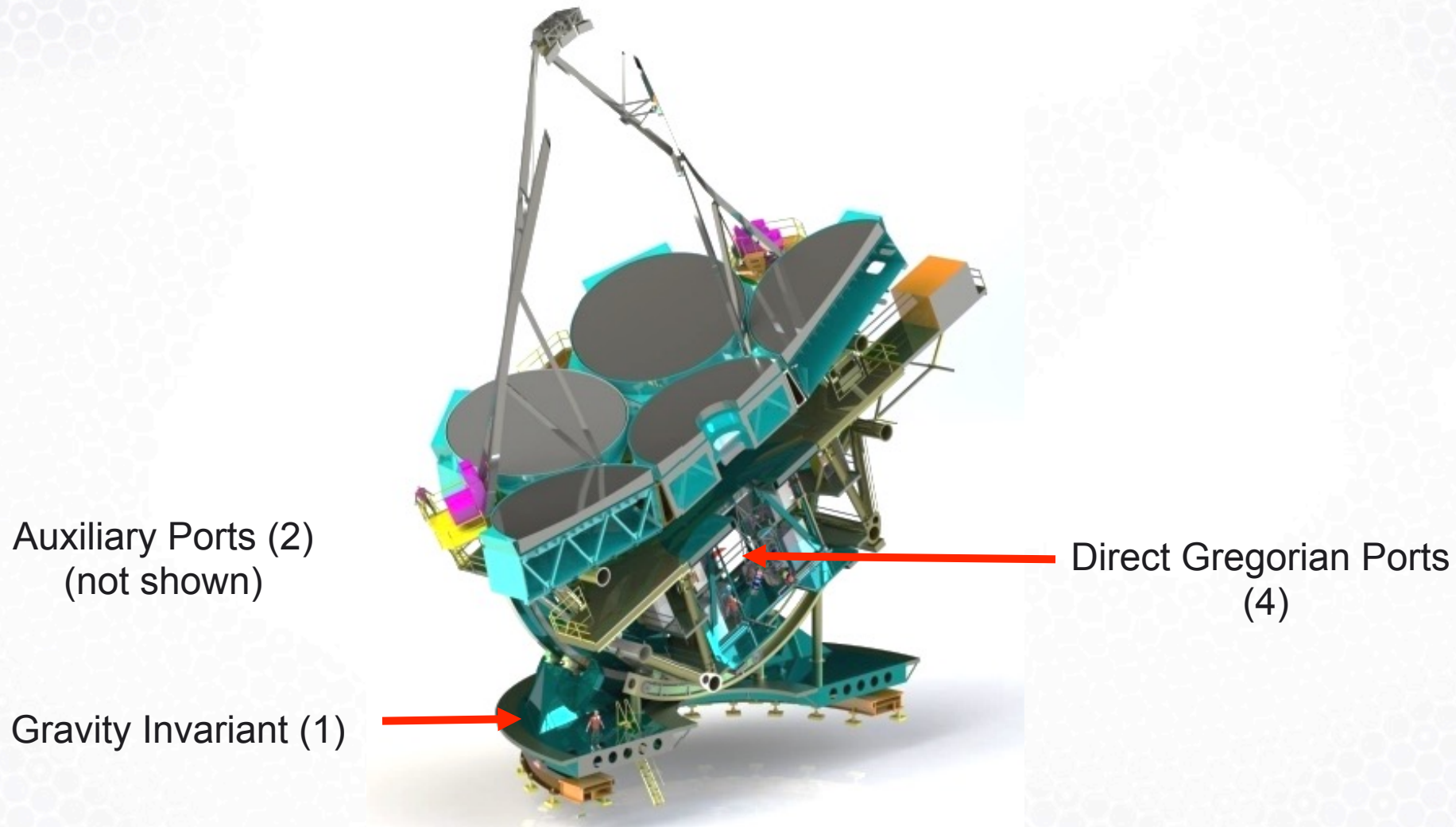
Segments #5 & #6:
Materials purchased.



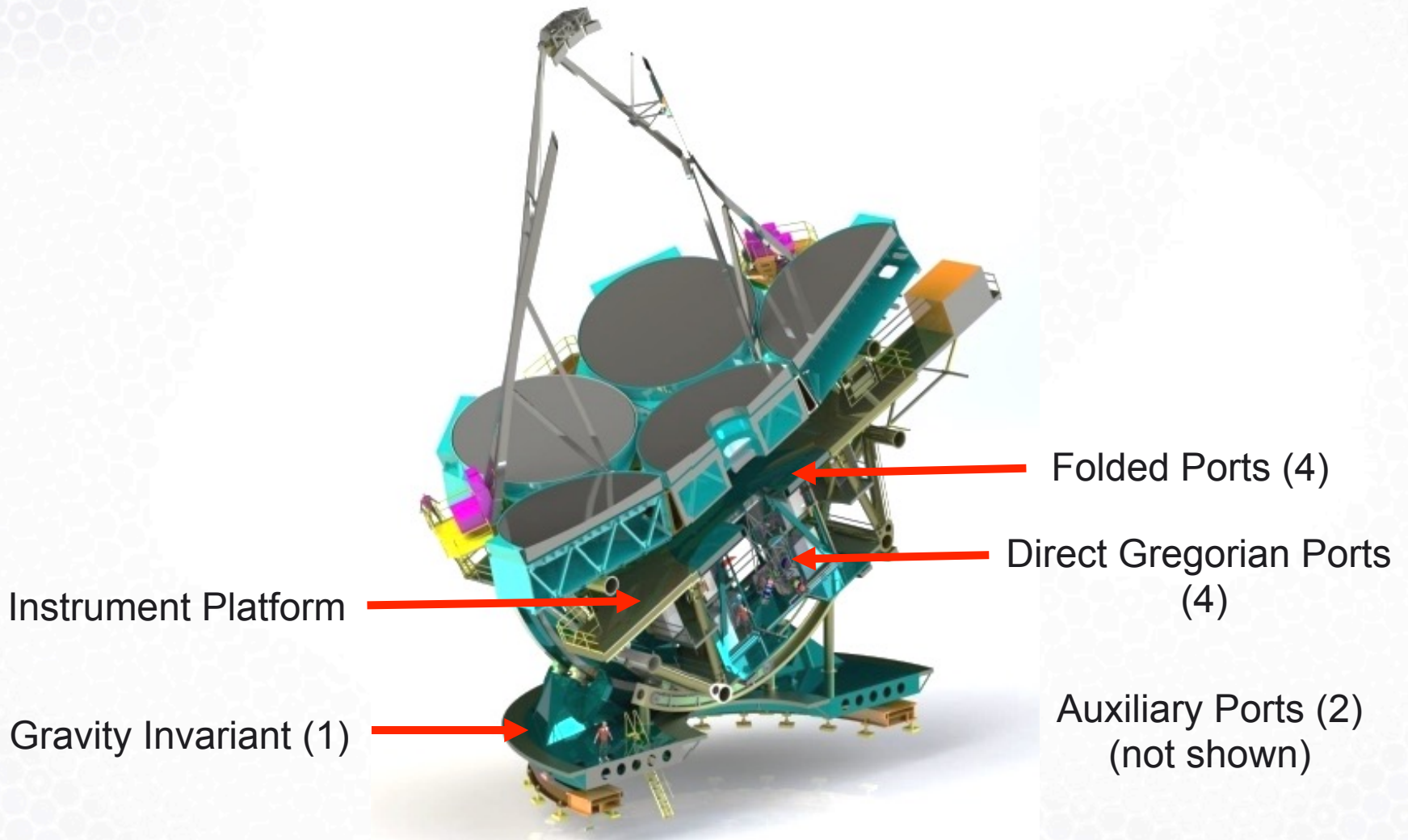
GMT Site Development Well Underway



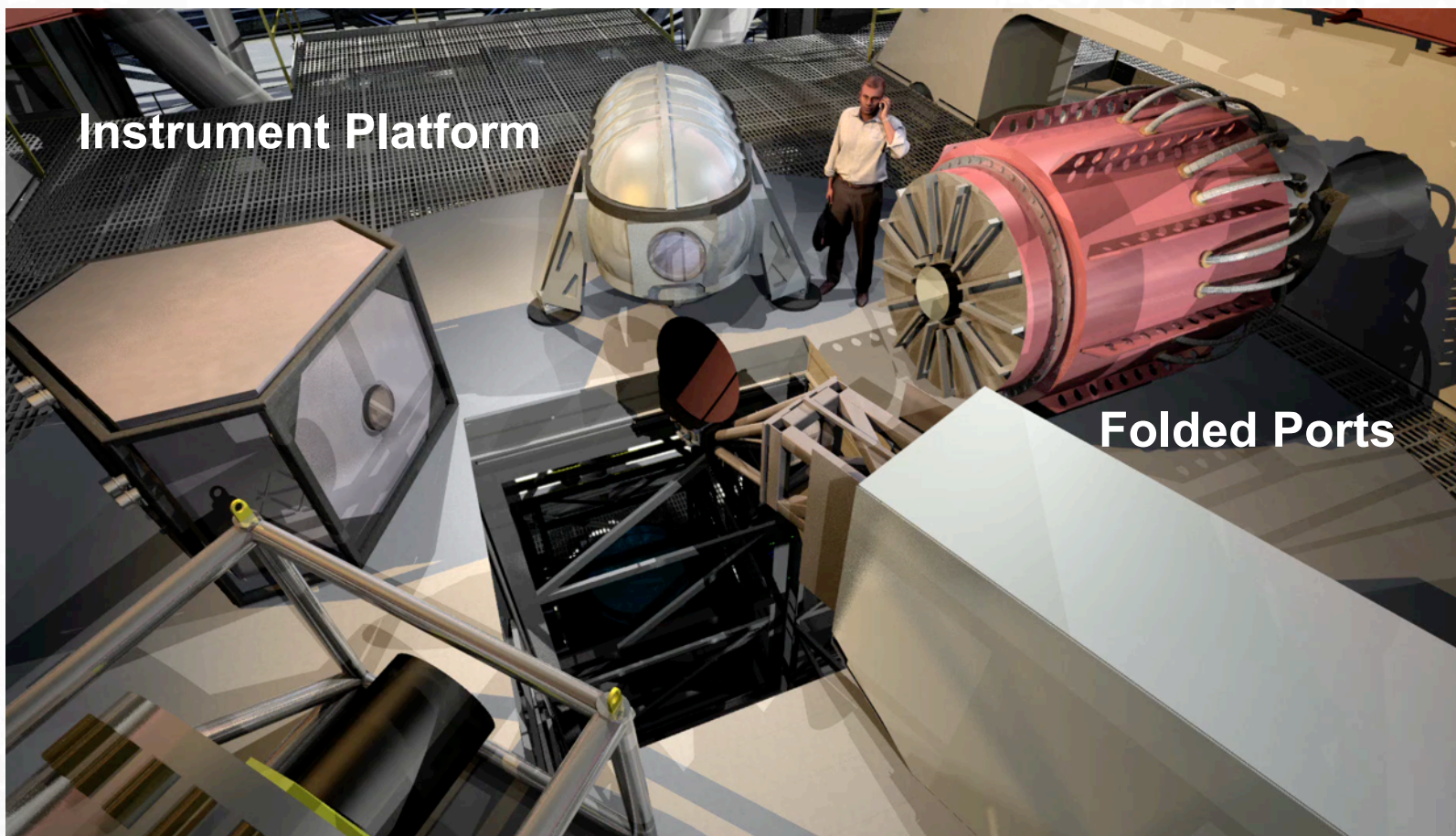
Instrument Mount Locations



Instrument Mount Locations



Instrument Mount Locations

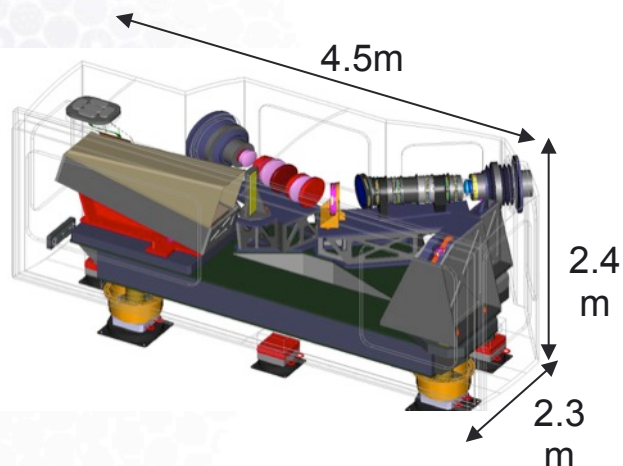


First Generation Instrument Status

Instrument / Mode	Capabilities	λ Range, μm	Resolution	Field of View
G-CLEF / NS, GLAO, NGS AO	Optical High Resolution Spectrograph / PRV	0.35 – 0.95	19,000 – 108,000	7 x 0.7, 1.2" fibers
GMTIFS / LTAO, NGS AO	NIR AO-fed IFS / Imager	0.95 – 2.5	5,000 & 10,000	10 / 400 arcsec ²
GMACS / NS, GLAO	Wide-Field Optical Multi-Object Spectrograph	0.35 – 0.95	1,000 – 6,000 (8K with MANIFEST)	7.5' diameter
ComCam / NS, GLAO	Optical Imager	0.34 – 1.0	0.06 arcsec/pix	6 x 6 arcmin
GMTNIRS / NGS AO, LTAO	JHKLM AO-fed High Resolution Spectrograph	1.1 – 5.3	50,000 / 75,000 (JHK / LM)	1.2" long-slit
MANIFEST / NS, GLAO	Facility Robotic Fiber Feed	0.36 – 1.0		20' diameter

Current Phase	Next Phase
Final Design	Fabrication
Preliminary Design	Final Design
Conceptual Design	Preliminary Design
Silicon Grating Technology Development	Preliminary Design
Science demonstrator closeout	Concept Design

Natural Seeing Optical (350-950 nm) Spectrographs

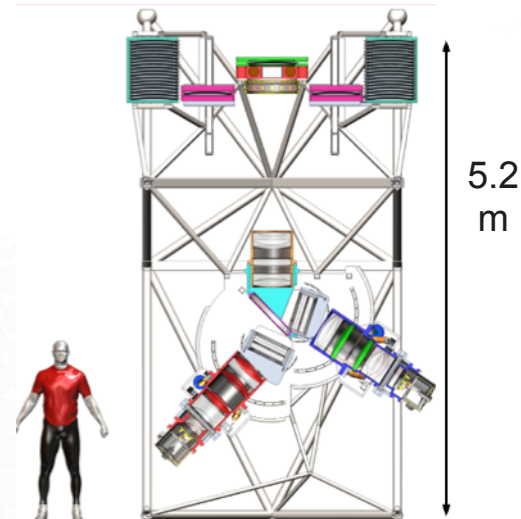


G-CLEF

PI: Andrew Szentgyorgyi, Smithsonian

Stabilized, fiber-fed, dual channel echelle
 $R = \lambda/\Delta\lambda = 19,000 - 35,000 - 108,000$
 $< 50 \text{ cm/s}$ per observation

- Exoplanets PRV ($< 10 \text{ cm/s}$) & chemistry
- Stellar abundances, esp. $[\text{Fe}/\text{H}] < -4$
- Dark matter distribution in dwarf galaxies



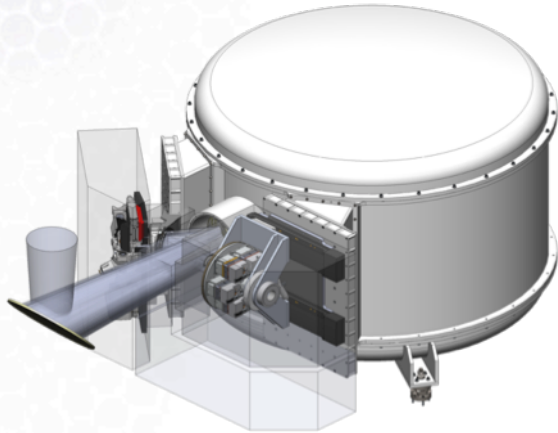
GMACS

PI: Darren DePoy, Texas A&M

Multi-object, dual channel
 $R = \lambda/\Delta\lambda = 1,000 - 6,000$
 $7.5'$ diameter FoV spectroscopy / imager

- Stellar evolution & abundances
- ISM & IGM abundances
- Galaxy chemical evolution, Ly α systems

AO-Fed Spectrographs



GMTIFS

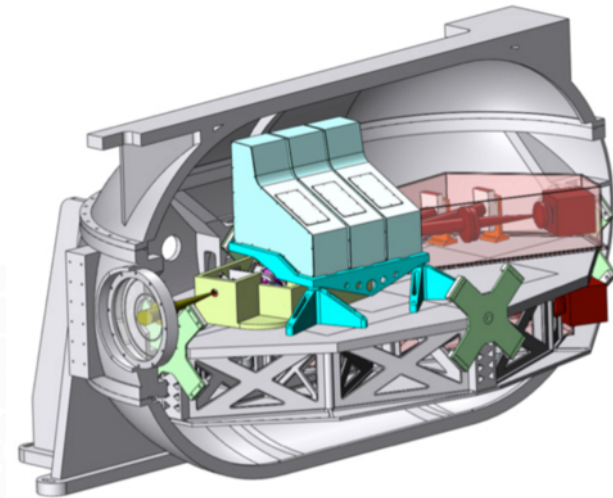
Rob Sharp

Diffraction-limited yJHK IFU / imager (20.4")

$R = \lambda/\Delta\lambda = 5,000$ or $10,000$

Spaxels: 6, 12, 25, or 50 mas

- Galaxy chemical enrichment history
- First galaxy structure and assembly
- Black hole masses
- IGM at high redshift



GMTNIRS

Dan Jaffe

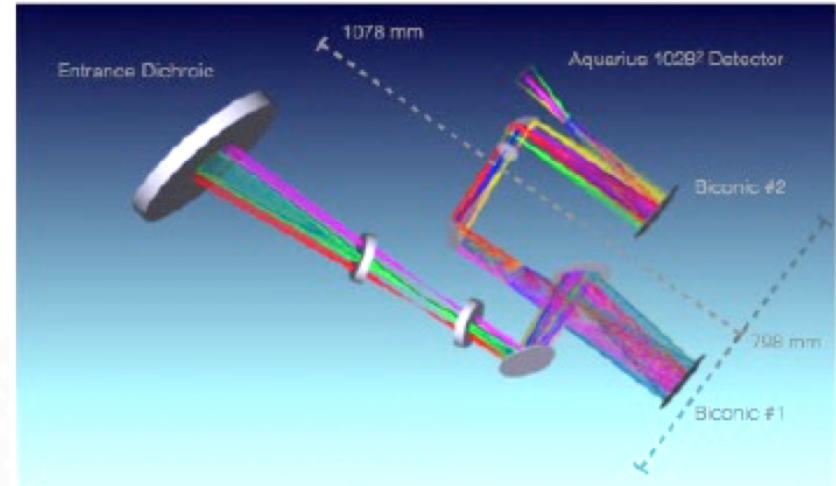
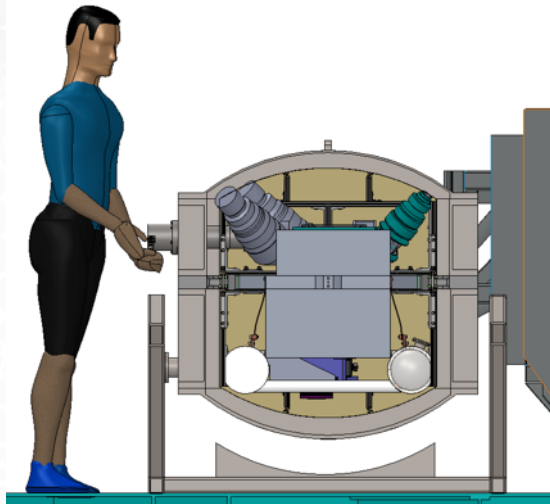
Near-diffraction limited JHKLM echelle

Full 5 band coverage simultaneously

$R = \lambda/\Delta\lambda = 50,000$ (JHK) – $75,000$ (LM)

- Exoplanet structure and atmospheres
- Star and planet formation
- Composition of stars & nebulae
- Galaxy chemical evolution history

Future Instruments SuperFIRE & TIGER



Super FIRE

Rob Simcoe

IR echelle spectrograph
 3-channel JHK simultaneous
 $R = \lambda/\Delta\lambda \sim 6,000$
 8" slit length

Derives from FIRE on Magellan

TIGER

Phil Hinz

Dual channel ExAO imager
 1.5-5 μm ; 7-14 μm
 $R = \lambda/\Delta\lambda \sim 300$; Spatial ~ 7 mas / pixel
 30" Field of view
 Contrast: $\sim 10^{-6}$ in L band @ 3 λ/D

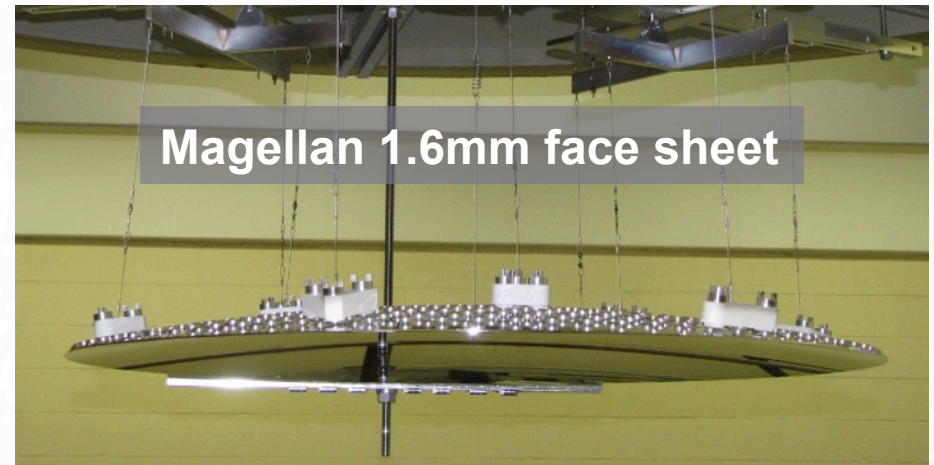
Adaptive Optics with the GMT

GMT uses a segmented Adaptive Secondary Mirror with a direct-feed architecture

Builds on success of LBT, Magellan and VLT systems

Low background, 10 mas resolution at 1 micron

4700 actuators



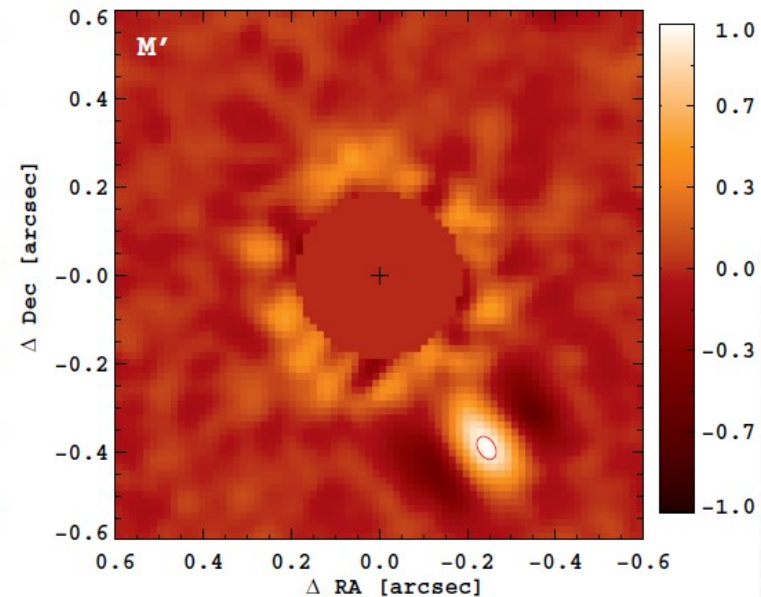
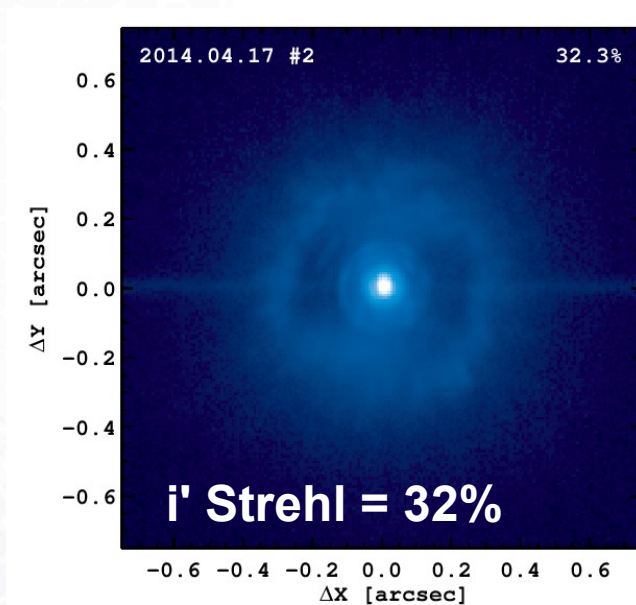
Adaptive Optics with the GMT

Magellan AO system achieves 32% Strehl in the i-band
Has reached 40% in R-band (at H α)!

High spatial resolution Exoplanet imaging over a wide range of wavelengths

0.8 microns

4.6 microns

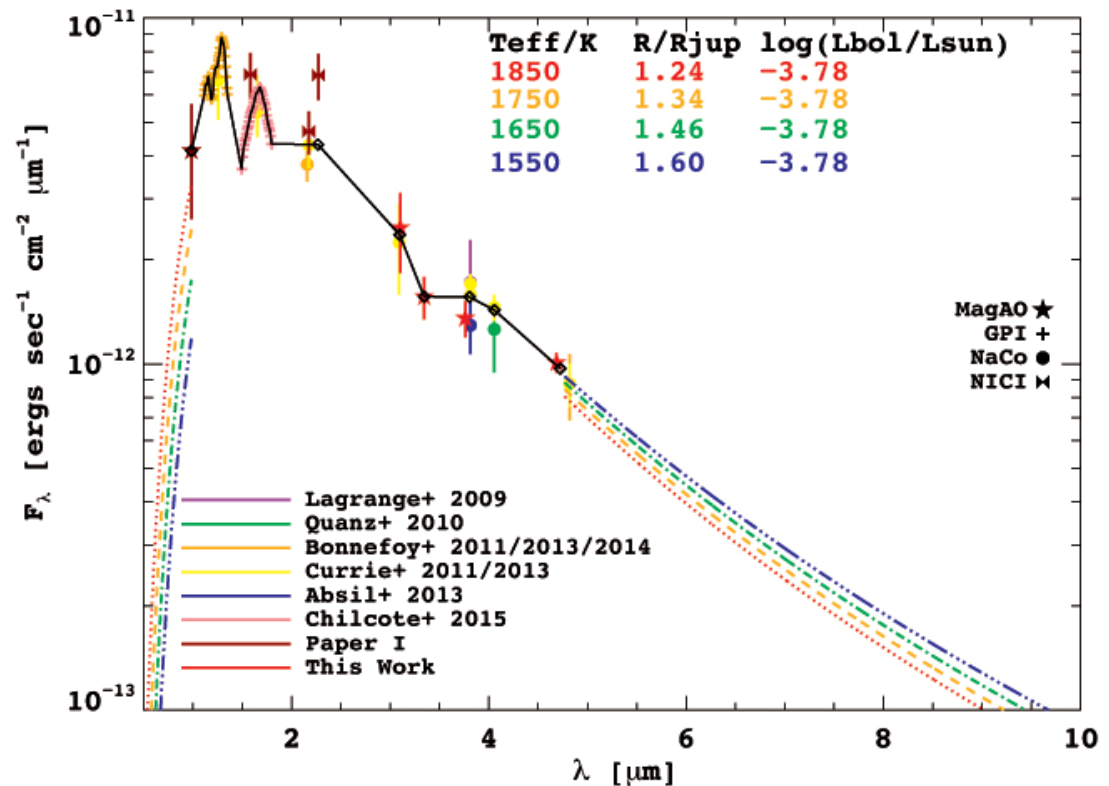


Adaptive Optics with the GMT

High spatial resolution Exoplanet imaging over a wide range of wavelengths

GPI, MagAO, and other systems are enabling physical studies of exoplanets

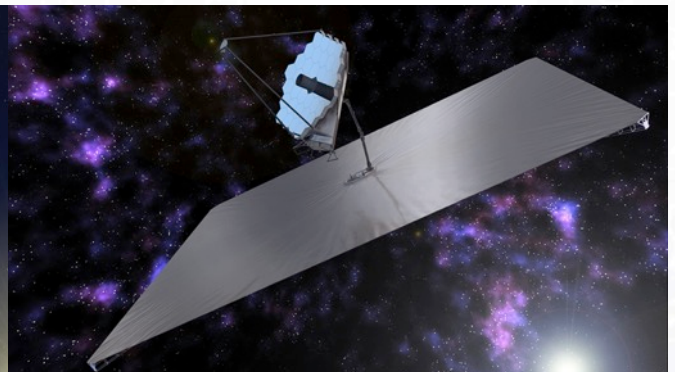
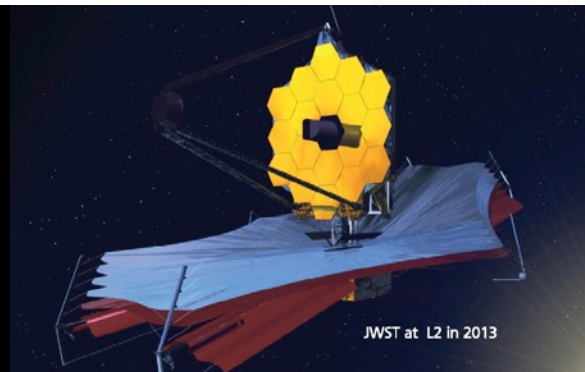
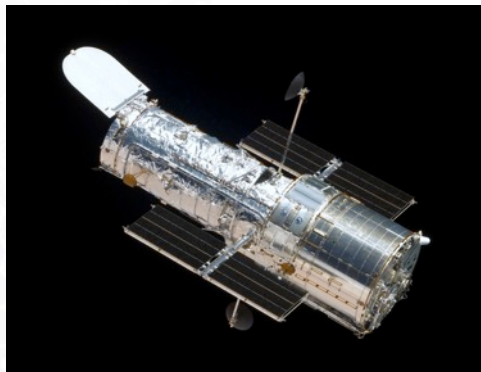
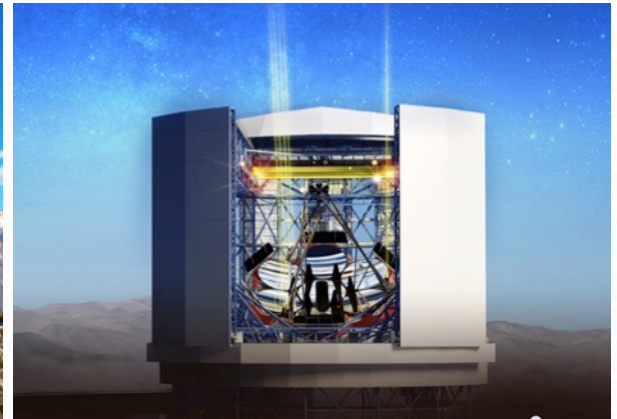
These are forerunners of the ELT AO systems



The ELTs and LUVOIR

The ELTs are the next generation ground-based observatories
Analogous to JWST and LUVOIR in the evolution of space telescopes

The ELTs will reach their zenith in the period between JWST and LUVOIR



The ELTs and LUVOIR

The ELTs are the next generation ground-based observatories
Analogous to JWST and LUVOIR in the evolution of space telescopes

The ELTs will reach their zenith in the period between JWST and LUVOIR

- Characterization of habitable planets
 - Atmospheric chemistry, orbits and masses, direct imaging
- Exploration of Cosmic Dawn
 - Spectroscopy, abundances, dynamics, clustering
- New Discovery Space
 - The unknown!

