
GIANT MAGELLAN TELESCOPE
Giant Magellan Telescope
Presented by
Sam Chan
IT Director and GMTO CISO

Giant Magellan Telescope (GMT)

- What is GMT
- GMT Updates
- Network and Operations

GMTO Corporation

GIANT MAGELLAN TELESCOPE

US-ELT Program

The United States Extremely Large Telescope Program (US-ELTP) is a joint endeavor of:

GIANT MAGELLAN TELESCOPE

Giant Magellan Telescope

NOIR Lab

NSF's NOIRLab

TMT

Thirty Meter Telescope

The Giant Magellan Telescope

https://giantmagellan.org/explore-the-design/

GIANT MAGELLAN TELESCOPE

WORLD'S MOST POWERFUL TELESCOPE

The Giant Magellan Telescope is the largest Gregorian optical-infrared telescope in history. It will use seven of the world's largest mirrors to see farther into deep space than ever before. Its unique design will produce the highest possible resolution of the Universe over the widest field of view. This extraordinary image clarity will enable scientists around the globe to obtain new clues to the fundamental nature and evolution of the Universe — from searching for signs of life on distant exoplanets to investigating the cosmic origins of chemical elements.

Giant Magellan Telescope (GMT)

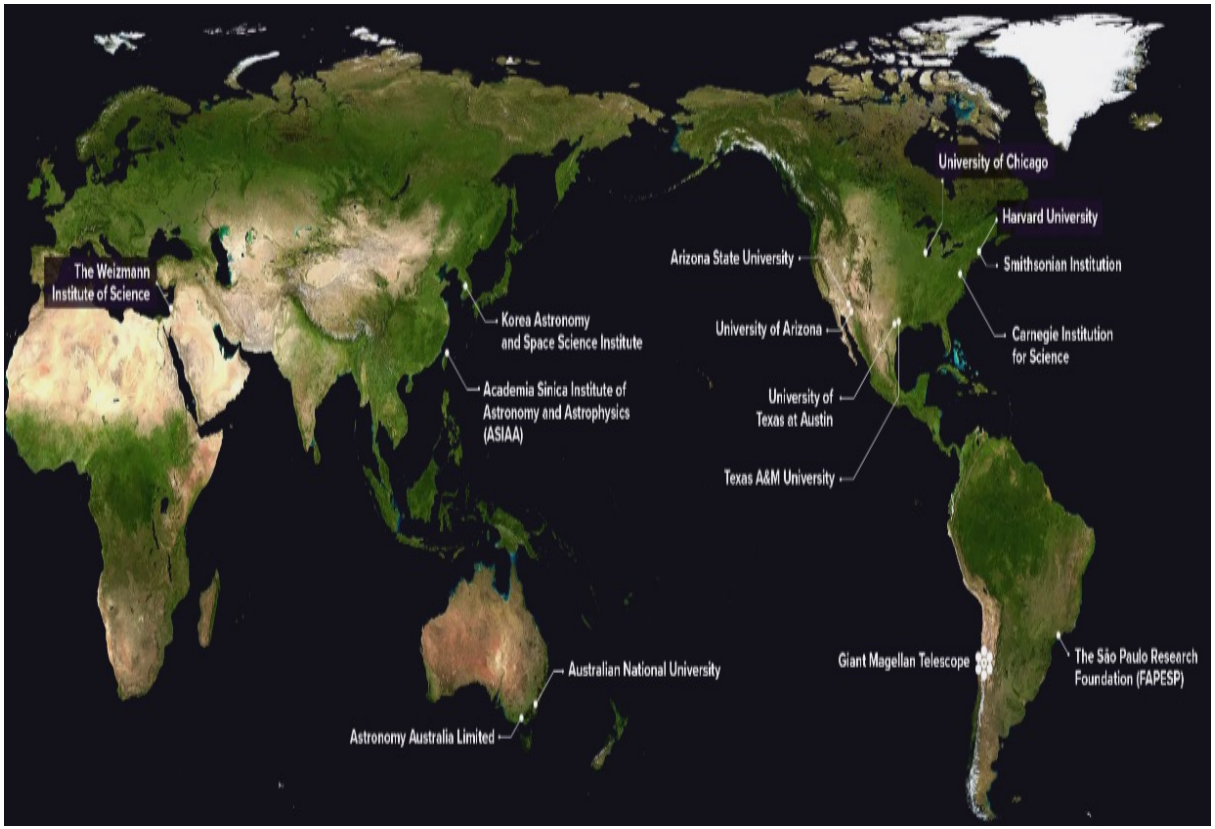
The Giant Magellan Telescope is the work of an international consortium of 14 leading research institutions representing Australia, Brazil, Chile, Israel, South Korea, Taiwan, and the United States.
https://giantmagellan.org/

Founders (14 institutions from 7 Countries)
International

- Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) (**Taiwan**)
- Astronomy **Australia** Limited
- **Australian** National University
- The São Paulo Research Foundation (FAPESP) (**Brazil**)
- **Korea** Astronomy and Space Science Institute
- The Weizmann Institute of Science (**Israel)**

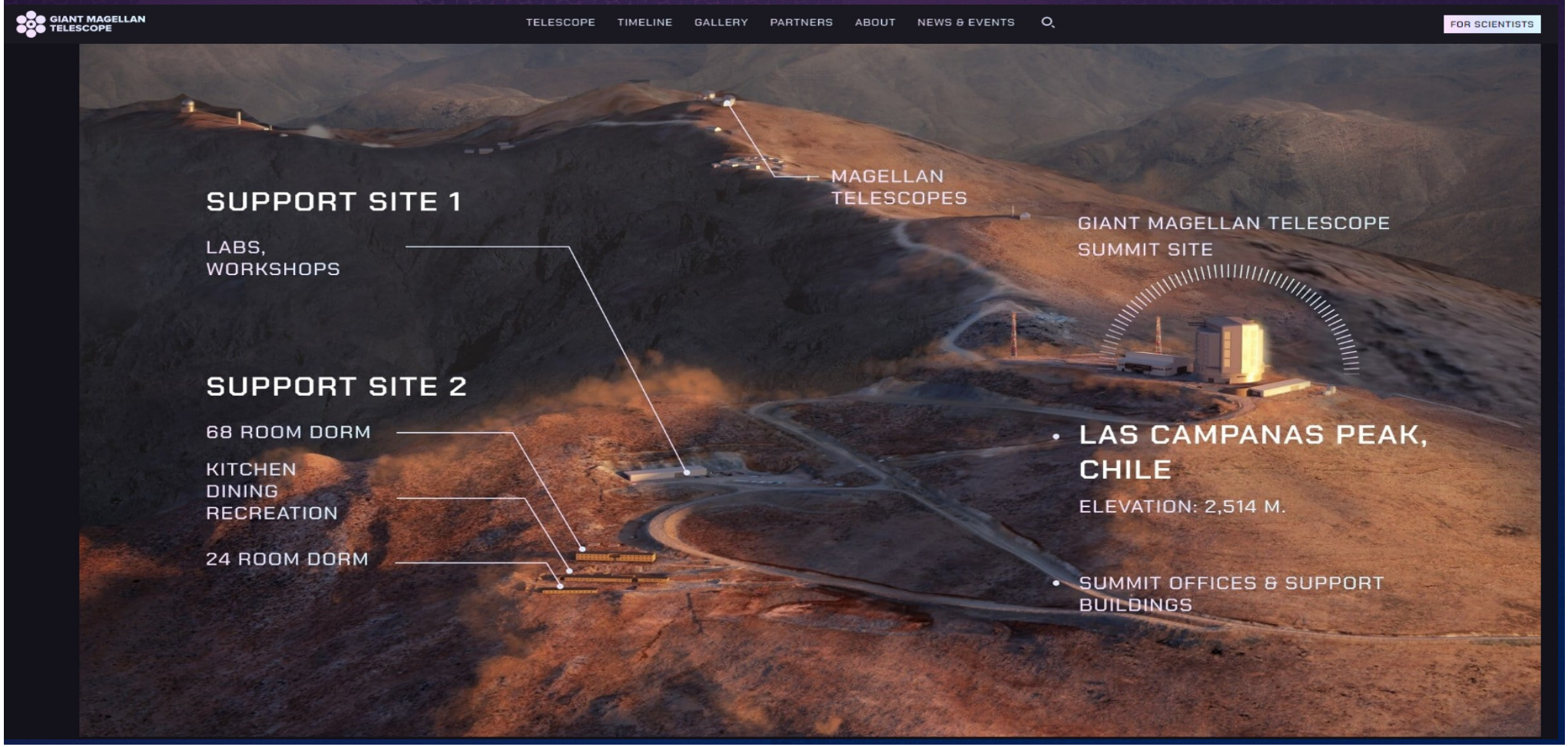
United States

- Arizona State University
- Carnegie Institution for Science
- Harvard University
- Smithsonian Institution
- Texas A&M University
- University of Arizona
- University of Chicago
- University of Texas at Austin



Observatory Site (Las Campanas, Chile)

https://giantmagellan.org/location/



GMT Summit Site at Las Campanas

Summit Site (2514m)

- Enclosure
- Summit Support Building
- Summit Utility Building
- Summit Utility Tunnel
- Water Pad area
- Dry Coolers Platform

Giant Magellan Telescope (GMT) - Timeline

GIANT MAGELLAN TELESCOPE

- 2004 – GMT Conceptual Design
- 2005 – 1st Primary Mirror Cast
- 2007 – Site Selection (Atacama Desert, Chile)
- 2008 – Formation of Consortium (Australian National University, Carnegie Institution for Science, Harvard University, Smithsonian Institution, Texas A&M University, The University of Texas at Austin, and University of Arizona)
- 2009 – Korea Astronomy and Space Science Institute and Astronomy Australia Limited (Joins as Founder)
- 2010 – The University of Chicago (Joins as Founder)
- 2012 – 2nd Primary Mirror Cast and Start of Construction
- 2013 – 3rd Primary Mirror Cast
- 2014 – Design Finalized, Brazil's Sao Paulo Research Foundation (Joins as Founders)
- 2015 – 4th Primary Mirror Cast

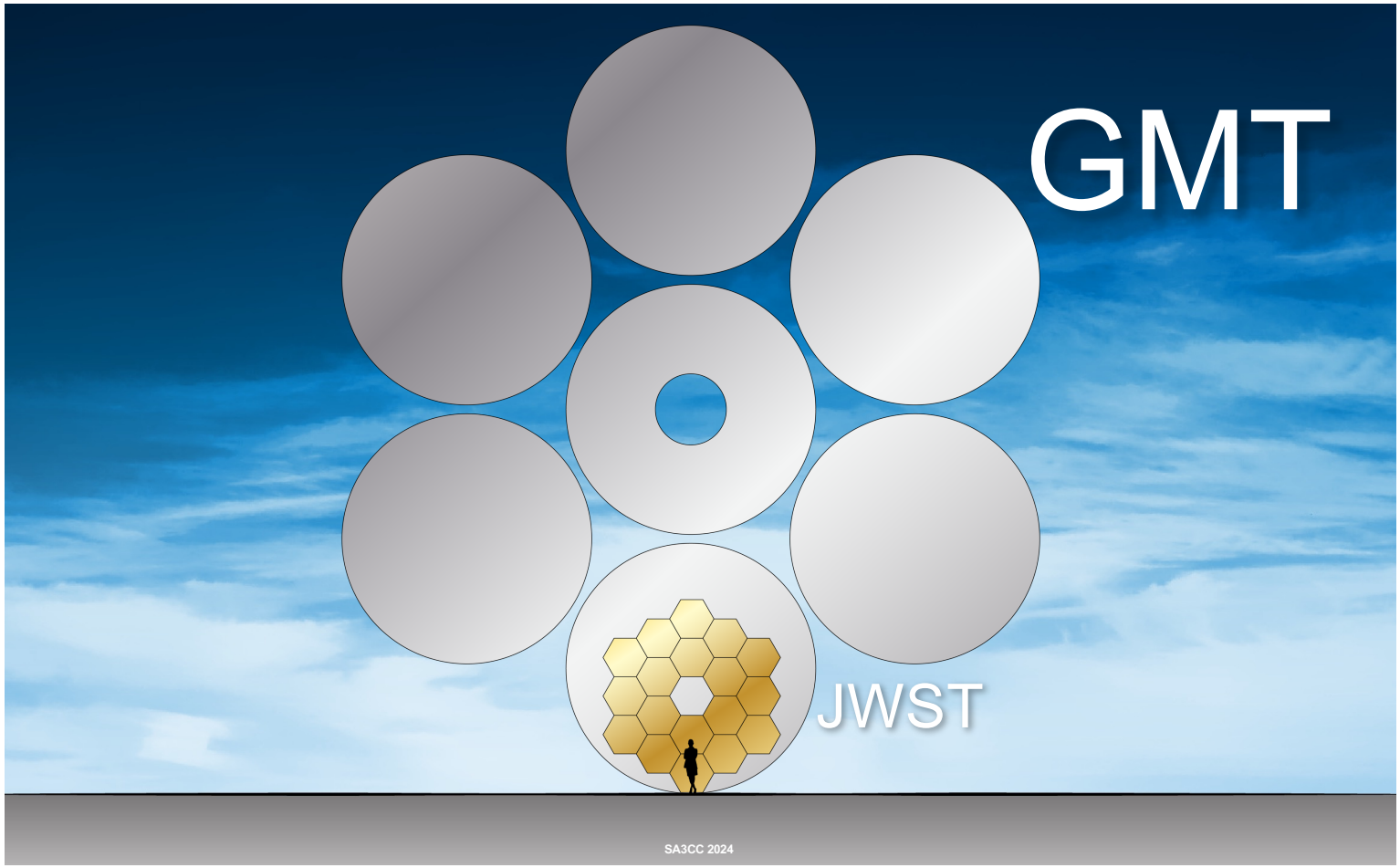
Giant Magellan Telescope (GMT) – Timeline continue

GIANT MAGELLAN TELESCOPE

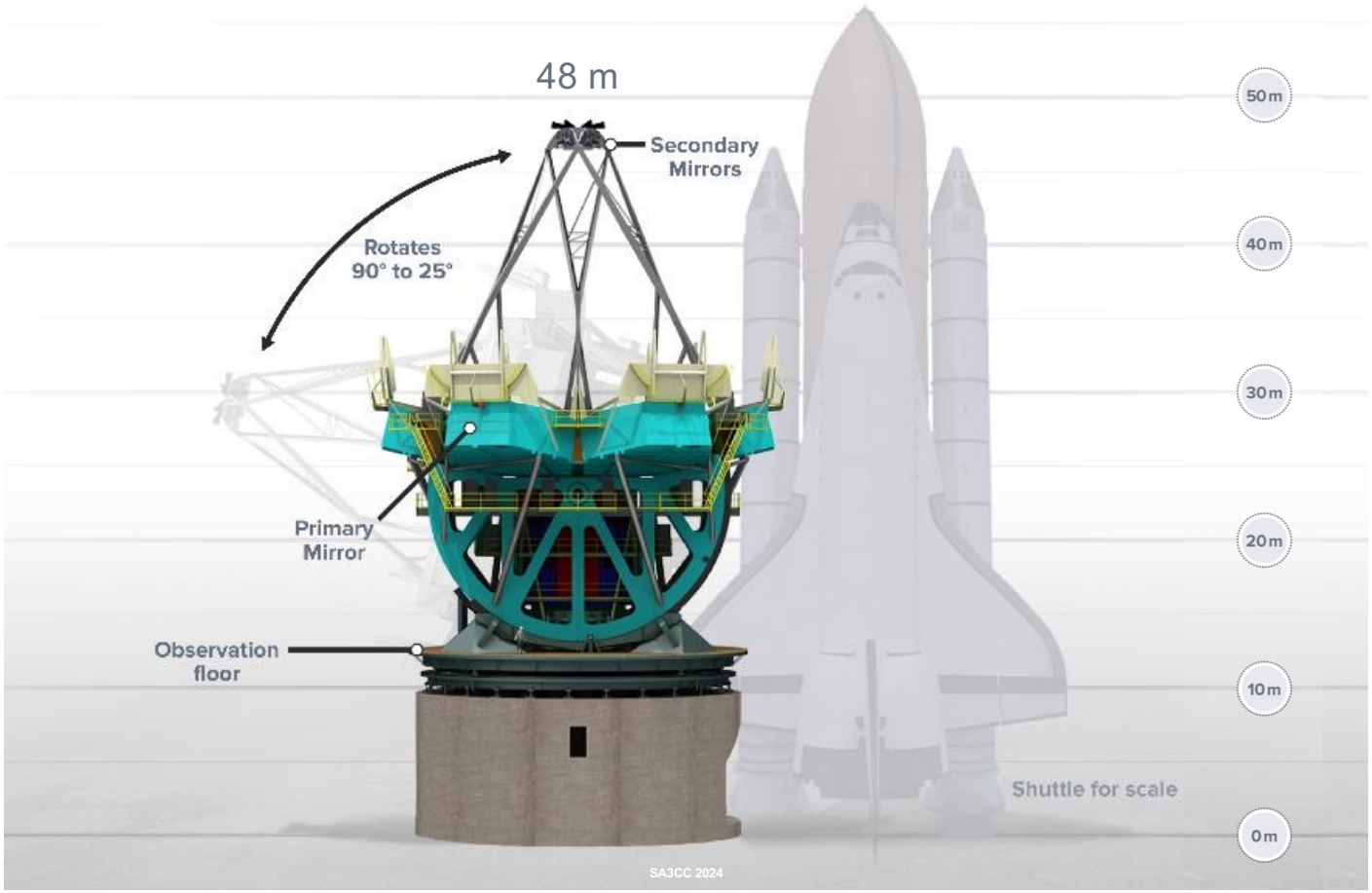
- 2017 – Arizona State University (Joins as Founder) and 1st Primary Mirror Finalized and Fifth Primary Mirror Cast
- 2019 – Site Excavation and 2nd Primary Mirror Finalized
- 2020 – NSF Grant Awarded (prototyping and testing of powerful optical and infrared technologies.)
- 2021 – 6th Primary Mirror Cast and Weizmann Institute of Science (Joins as Founder)
- 2022 – Facility Unveiled for Mount Fabrication
- 2023 – Final Primary Mirror Fabrication
- 2024 – Academia Sinica Institute of Astronomy and Astrophysics (Joins as Founder)
- 2024 – Final Design Review for Enclosure (End of May)
- 2030 – Complete in the early 2030's

GMT Size Comparison
(JWST = 6.5m; GMT = 24.5m ~ 80ft)

GIANT MAGELLAN TELESCOPE



Giant Magellan Telescope Configuration



GMT Size Comparison
(Rose Bowl Stadium)

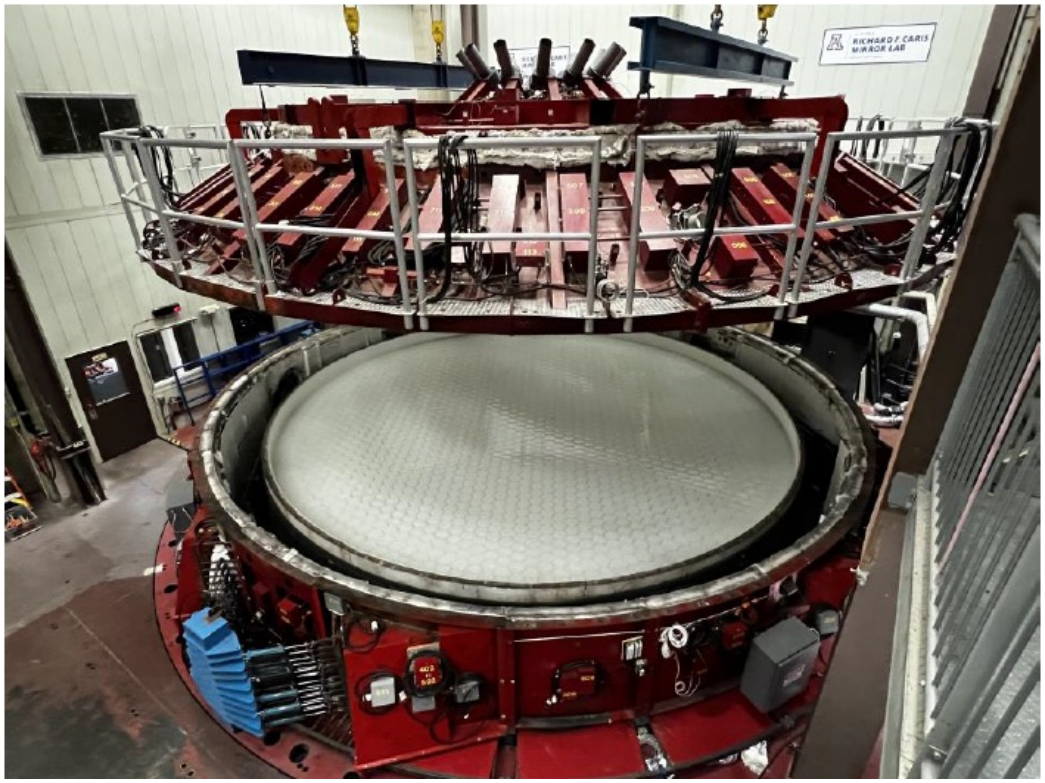
GIANT MAGELLAN TELESCOPE

Giant Magellan Telescope (GMT) - Updates

- M1 Optics Fabrication: S7 Casting
- M1 Subsystem
- Azimuth Track

M1 Optics Fabrication: S7 Casting

- Furnace lid removed Jan. 8, 2024
- Initial inspections indicate cast blank meets all requirements
- *“S7 is the best casting to date”*
  - Richard Wortley, RFCML Casting Manager
- Casting cleanout activities continue



Primary Mirror - M1 Optics (M1O) Status

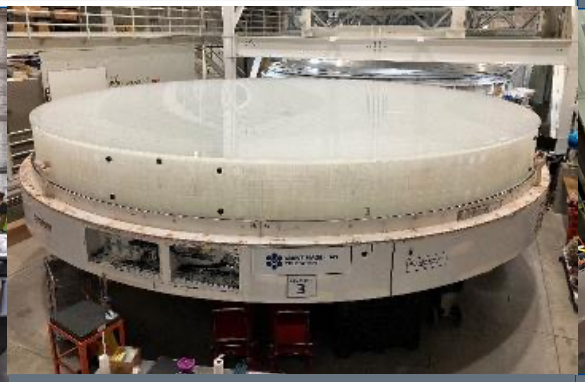
THE UNIVERSITY OF ARIZONA

GIANT MAGELLAN TELESCOPE

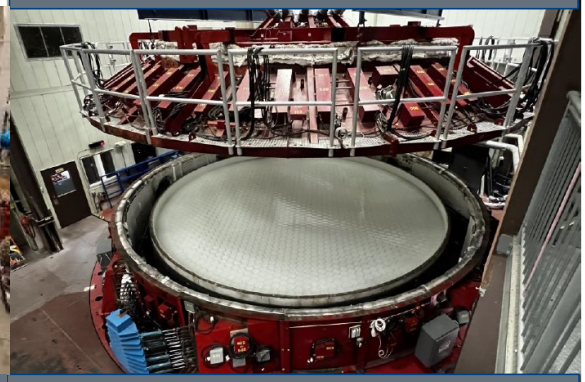
M1O	Config.	Mirror Segment Production Status
S1	Off-Axis	Complete – In Storage
S2	Off-Axis	Complete – In Storage
S3	Off-Axis	Complete – waiting for Test Cell for Active Optics demo
S4	On-Axis	Thermocouple installation – Front surface generating is next
S5	Off-Axis	Front surface fine grinding in progress – Polishing is next
S6	Off-Axis	Casting Complete – Rear surface generating is next
S7	Off-Axis	Casting Complete – Core Clean-out planned for June
S8	Off-Axis	Ohara Glass on order for potential spare segment

S6, S4 & S5 in UA RFCML Stacking Rack

S2 Joins S1 in Storage near Tucson Airport in 2019



S3 Polishing Complete November 2022



S7 Successfully Cast in January 2024

M1 Subsystem

- Now complete with M1S scope funded by NSF/AURA Subaward
  - Completed Optical Test Plan Review that leads to new work scope funded by NSF OPRR Award
  - Thermal control system construction complete and TCS testing has begun
- Transition to NSF OPRR work began with successful Tilt Test
  - Both HW and SW worked well, but also provided some “lessons learned” to be incorporated in the future
- GMTO is ready to move the Test Cell this Spring from UA Tech Park to UA RFCML for integration with S3 followed by optical testing under RFCML Test Tower

CO2 Piping in Test Cell TCS

Test Cell at 14 deg on tilt fixture

M1S Summary of Recent Accomplishments

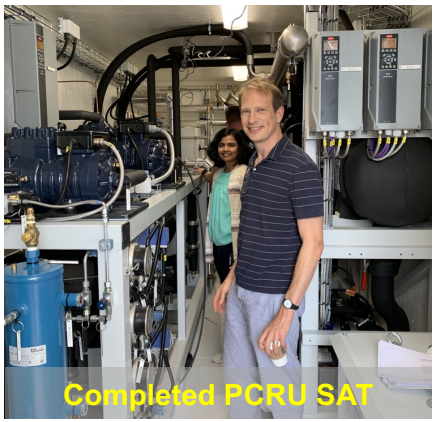
- **Continued tuning the active support system**
  - Developed a lead/lag controller that improved stability across Dead Band
- **Completed the Tilt Test and released Test Report**
- **Received the PCRU from SLS, worked through I&T issues, completed SAT**
- **Received the evaporators, completed all 14 AHU Assemblies**
- **Completed brazing the AHU control modules and manifold piping**
- **Completed utilities integration in Test Cell**
- **Completed Active Optics Test Plan Review**
- **Completed Hardpoint Testing over Temperature**


Hardpoints Testing in Thermal Chamber


Completed CO_2 Distribution Piping

Completed Tilt Test


Completed CO_2 Control Cabinet


Completed PCRU SAT

M1 Subsystem

Cross Section

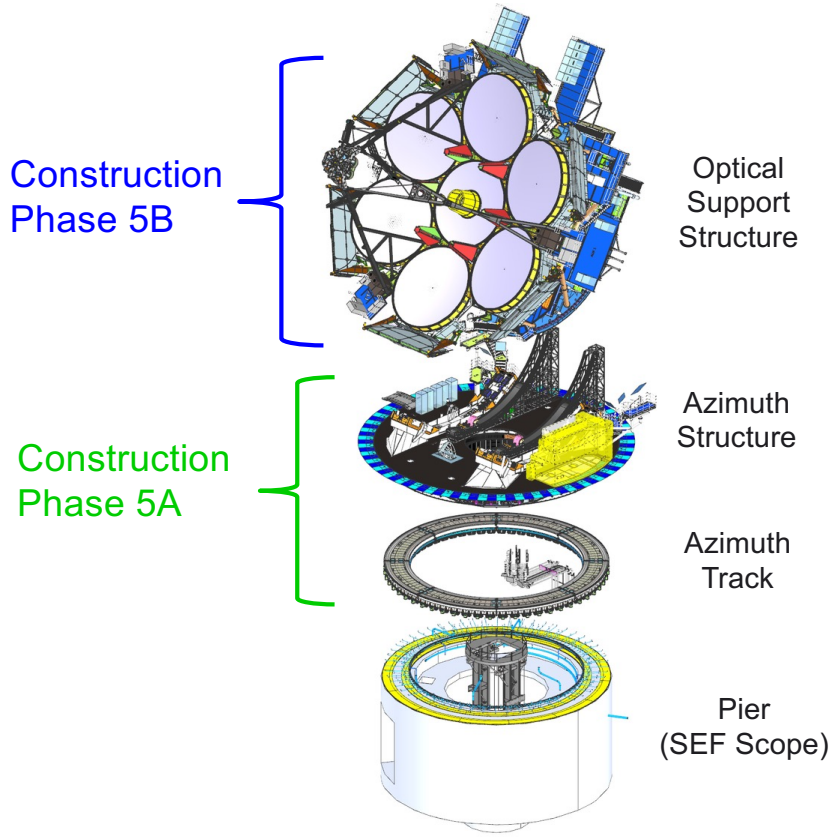
https://giantmagellan.org/gallery/telescope-renderings/#data-fancy

Cross section rendering of the telescope enclosure, pier, and mount. Image credit: Giant Magellan Telescope – GMTO Corporation.

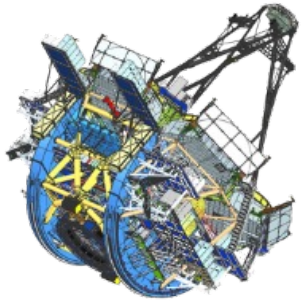
GIANT MAGELLAN TELESCOPE

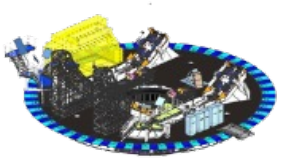
Technical Overview

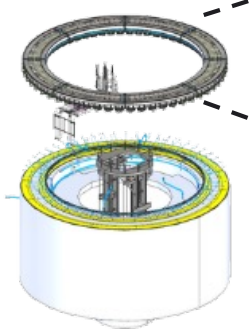
- Telescope Mount Functions
  - Structural Support, Alignment, and Interchangeability of Optics, Instruments and Payloads
  - 3 axes of rotation: AZ (vertical), EL (horizontal), GIR (rotation)
  - Pointing/Tracking Stability
  - Seismic Survivability
- Mount Construction Scope does not include optics and payloads
  - Mass simulators will be used during construction and testing



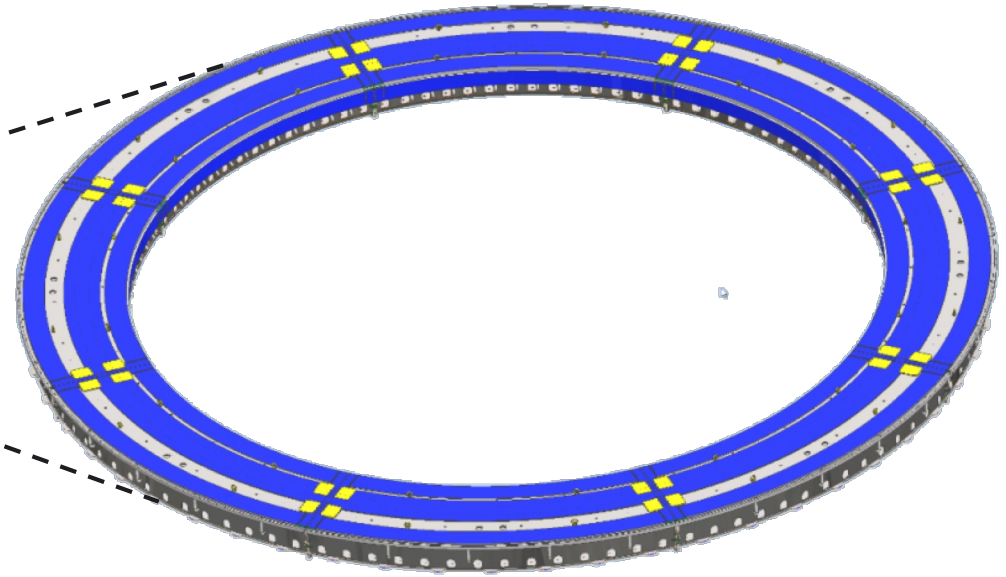
Azimuth Track







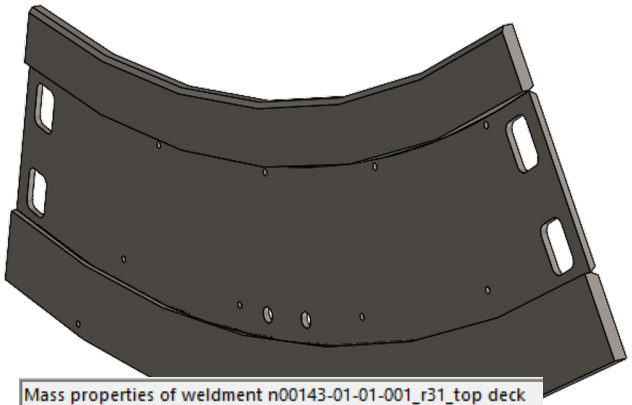
- Azimuth Track is made of 8 Sections
- Weighs 172,000 kg
- ~21.5 meters OD, 770mm thick



GMT Mount - Phase 5a Manufacturing

Azimuth Track Fabrication

Stepping through “welding” process of the top deck

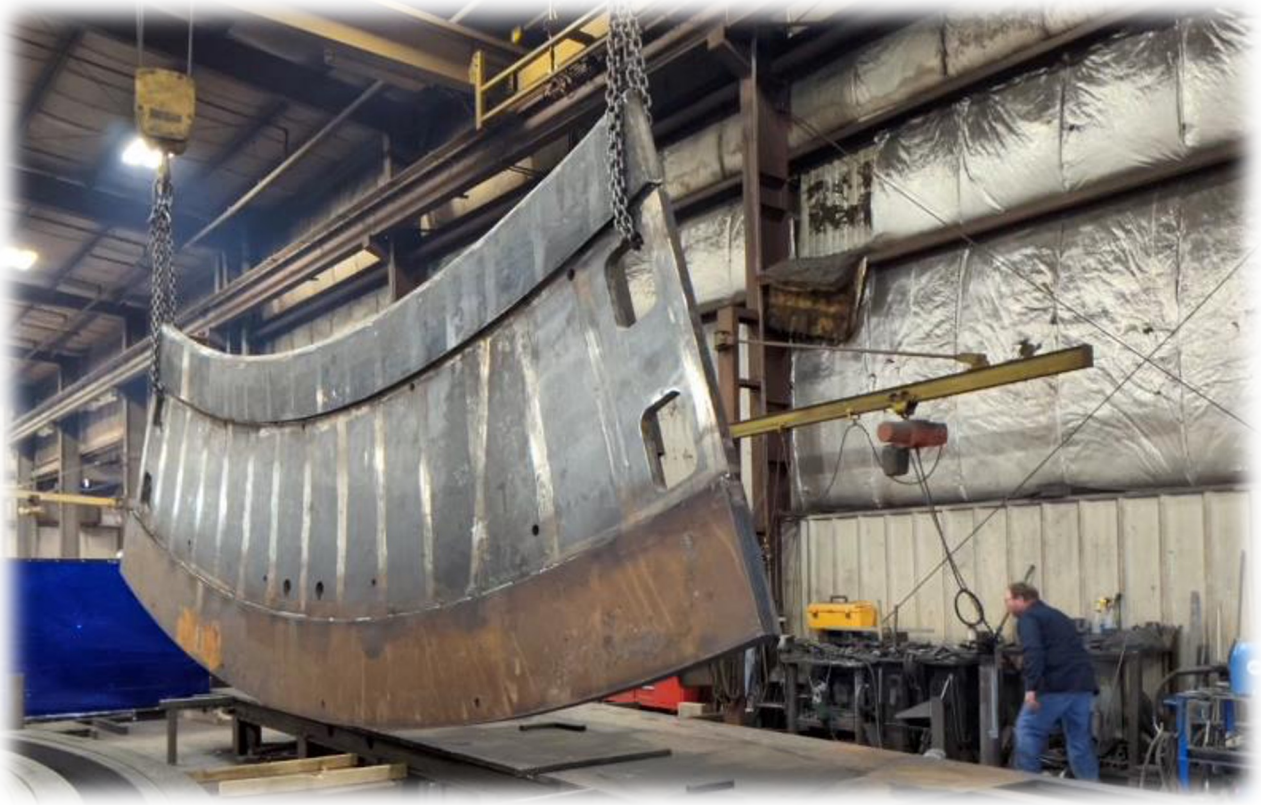


Mass properties of weldment n00143-01-01-001_r31_top deck
Configuration: DEFAULT
Coordinate system: -- default --

Density = 7800.00 kilograms per cubic meter

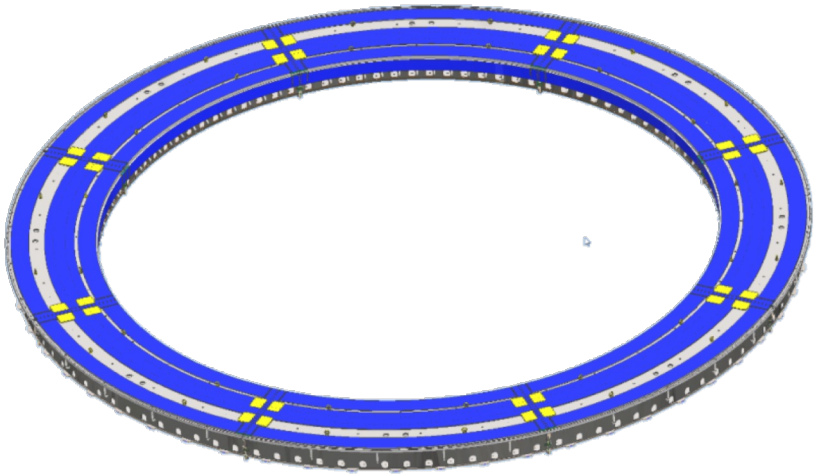
Mass = 10294.48 kilograms 22,700#

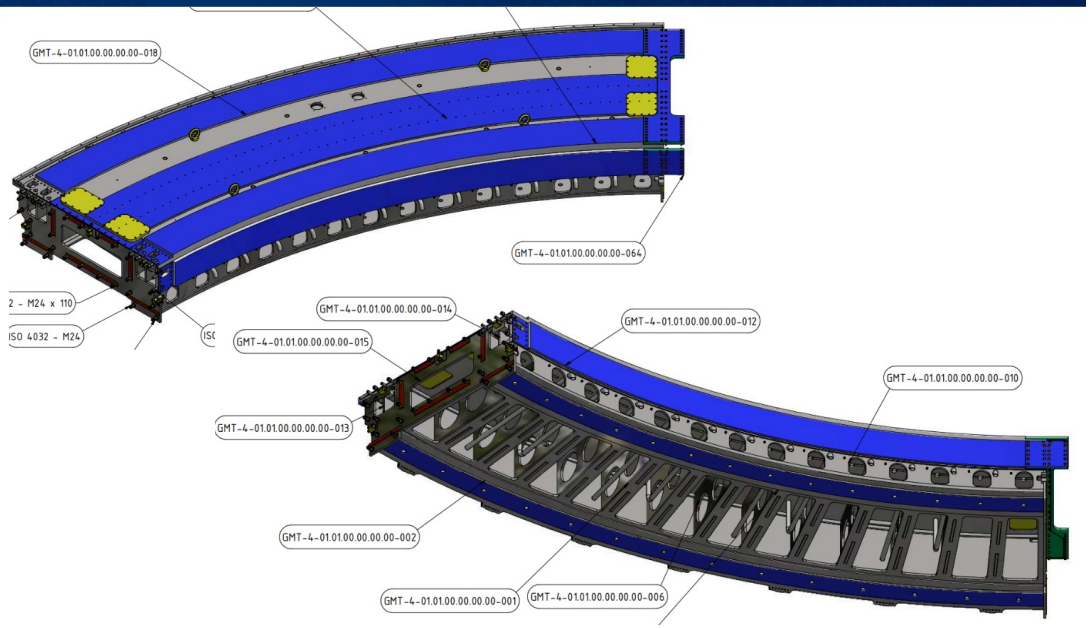
Volume = 1.32 cubic meters



4 of 8 Track sections welded up

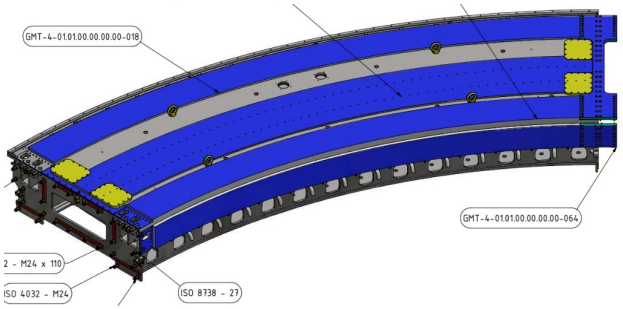
GMT Mount Azimuth Track

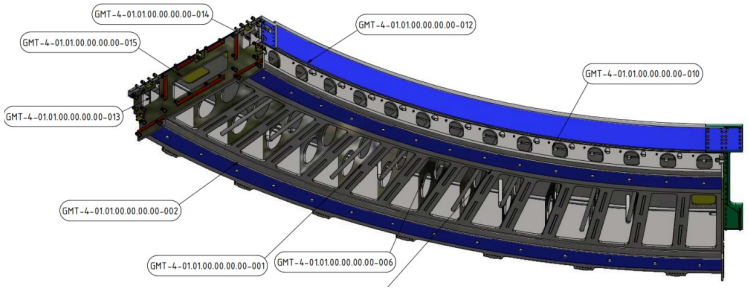




- Azimuth Track is made of 8 Sections
- Total Weight ~172 metric tons
- ~21.5 meters OD, ~2.4 meters wide, ~0.77 meters thick

Azimuth Track Section Fabrication at Comet Fabricating & Welding



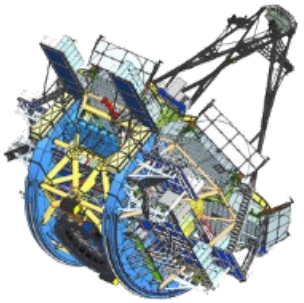


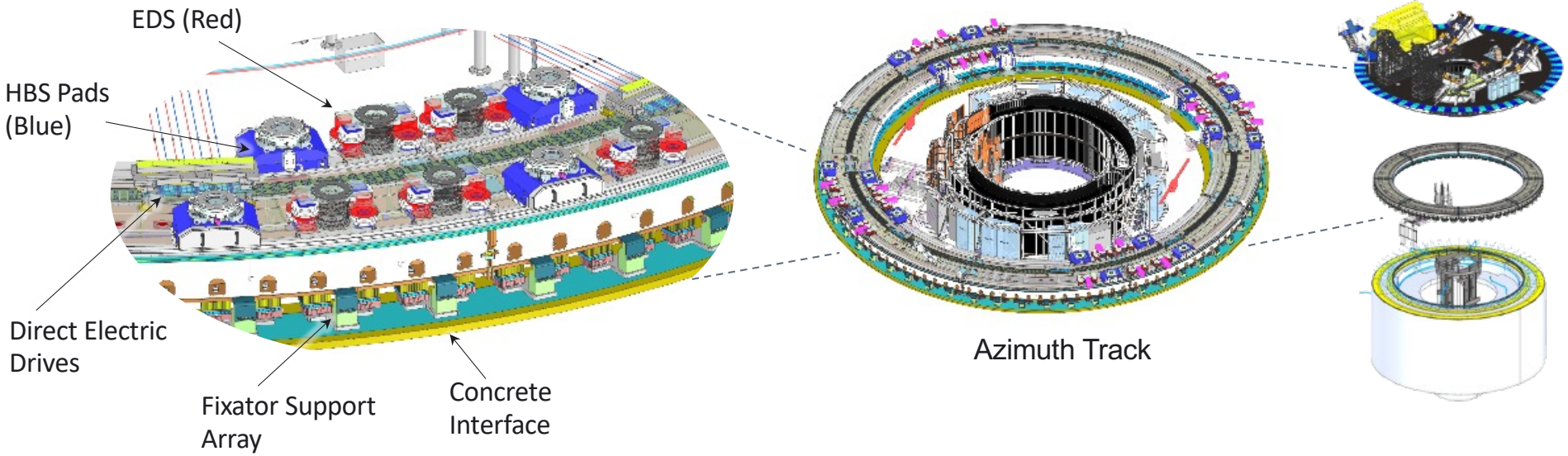
Sections 1 & 2 – Nearly complete

Sections 3 & 5 – Beginning work

Mount Design Features: Azimuth Track and Drives

- Hydrostatic Bearings (HBS) and Non-contact Electric Drives
- Earthquake Damping System (EDS) provides Vertical attenuation
- Seismic Isolation System (SIS) at base of pier provides Lateral attenuation (SEF Scope)



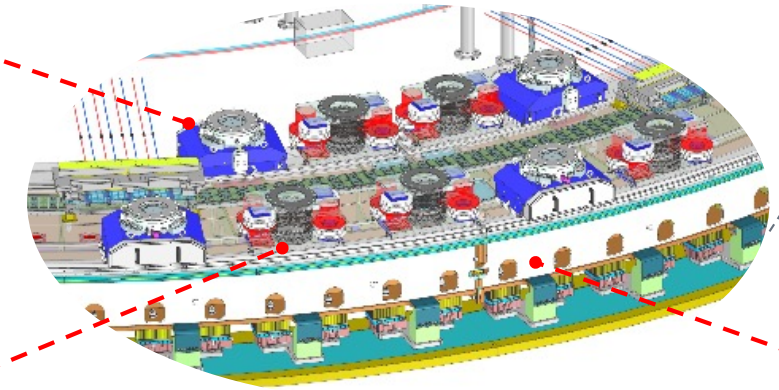


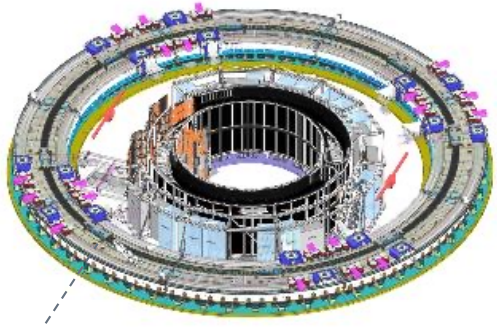
HBS, EDS, and Spring Plates

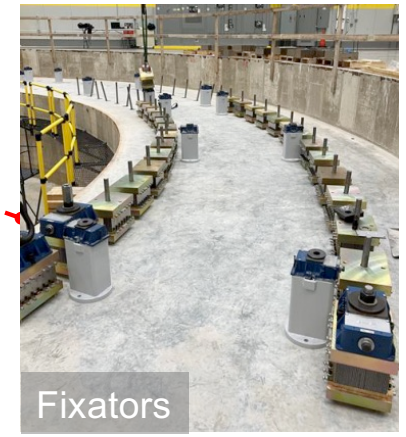
- The first production batches of components that connect the AZ Disk to the AZ Track are complete


HBS Pads


EDS Damper

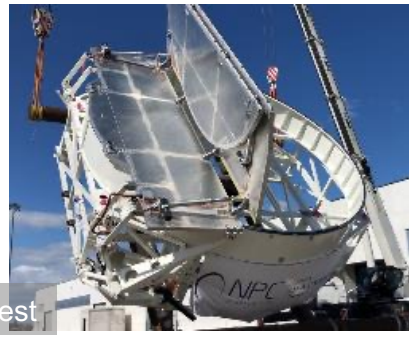
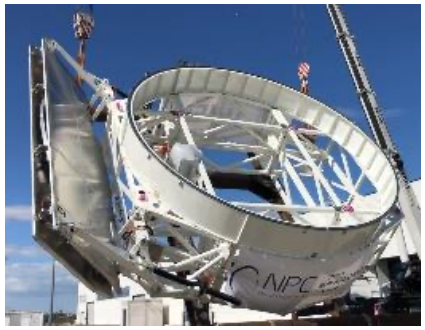


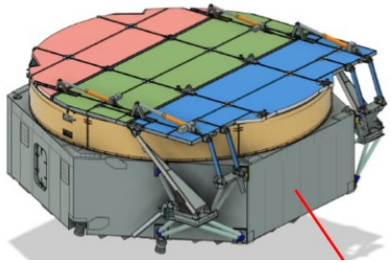



Fixators

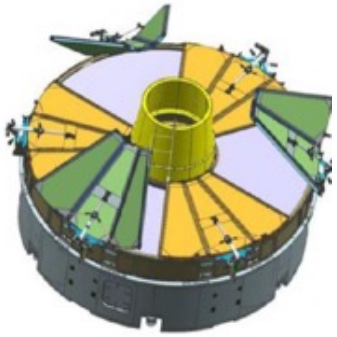
Mirror Cover Risk Mitigation Prototype Tests

- Full-Scale Mirror Cover Prototype Tests completed




Off-Axis Functional and Drop Test

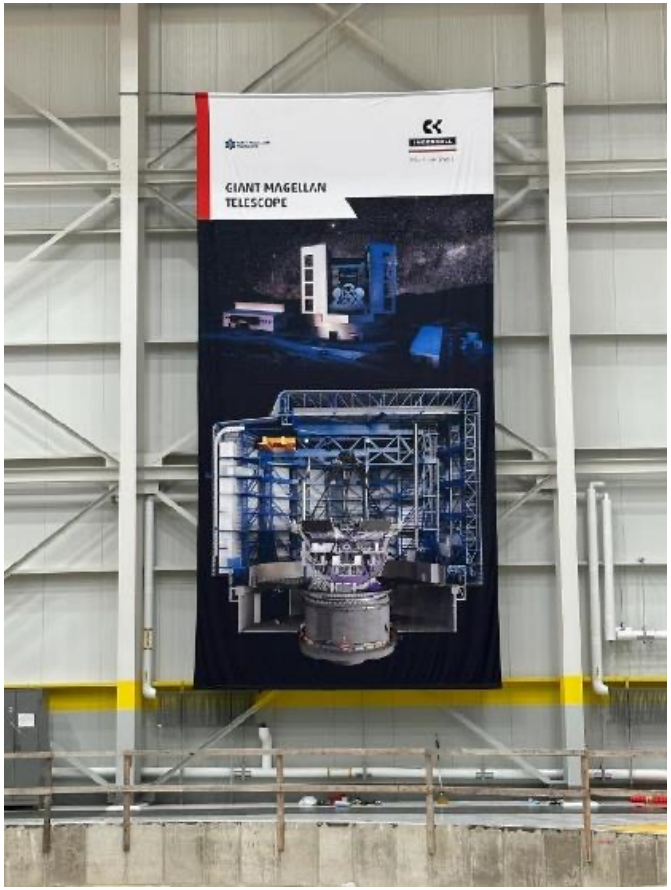




Center Cover Deployment Test

Ingersoll Machine Tools Factory Rockford, IL

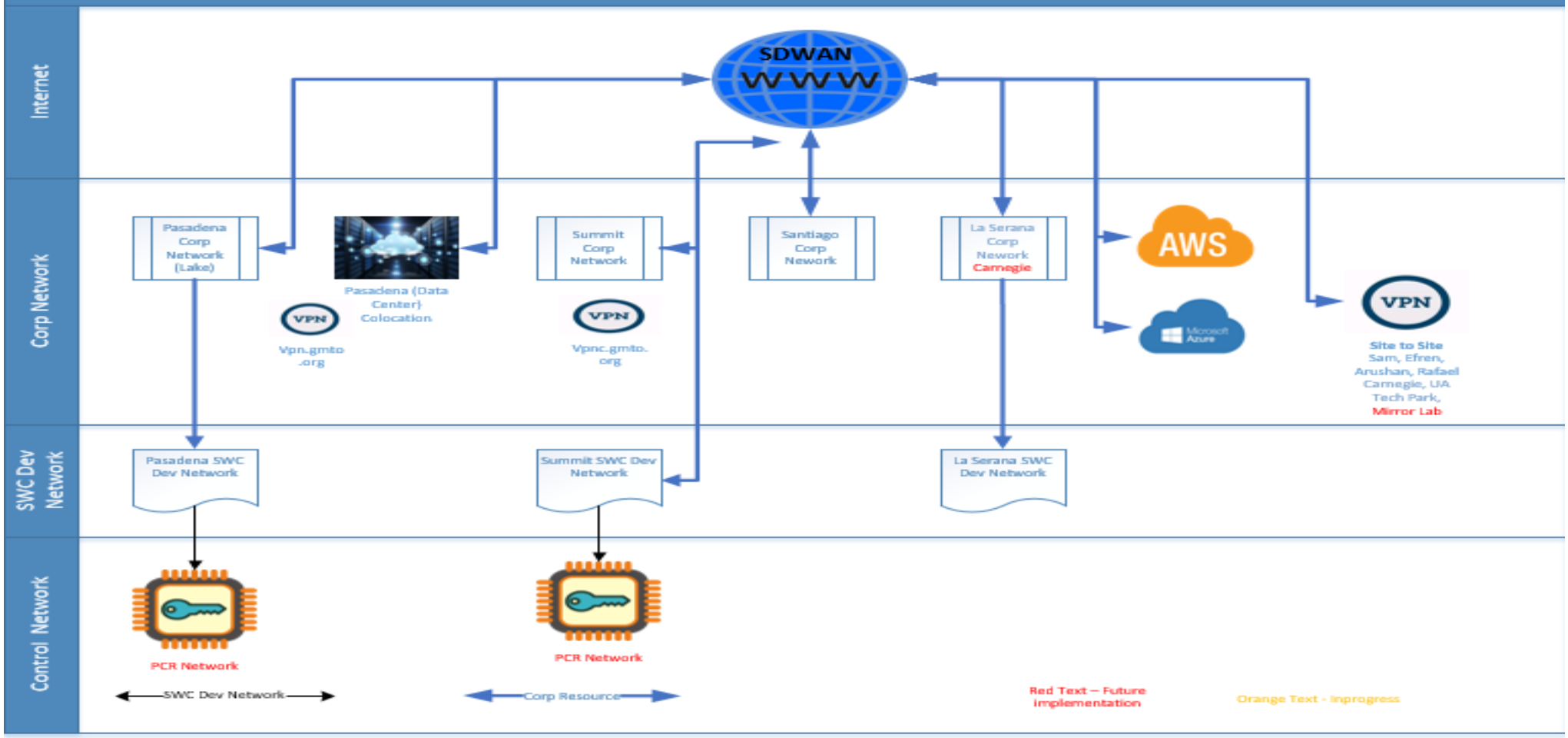
- IMT Facility ready for Fabrication and Assembly
- Concrete Pit and High Bay complete
- Precision 5-axis Gantry Mill ready



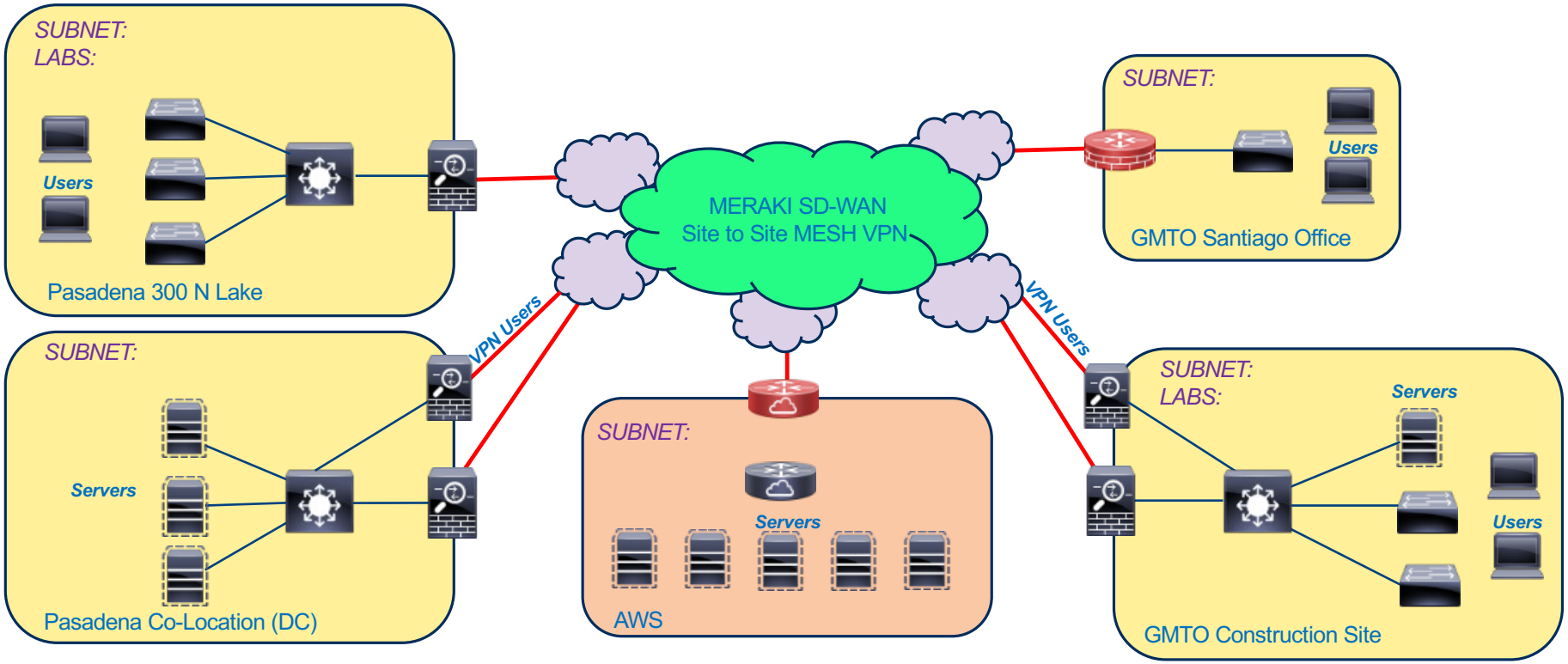
Network Infrastructures and Operations

- Network Infrastructure
- Network Diagrams
- Data and Operations

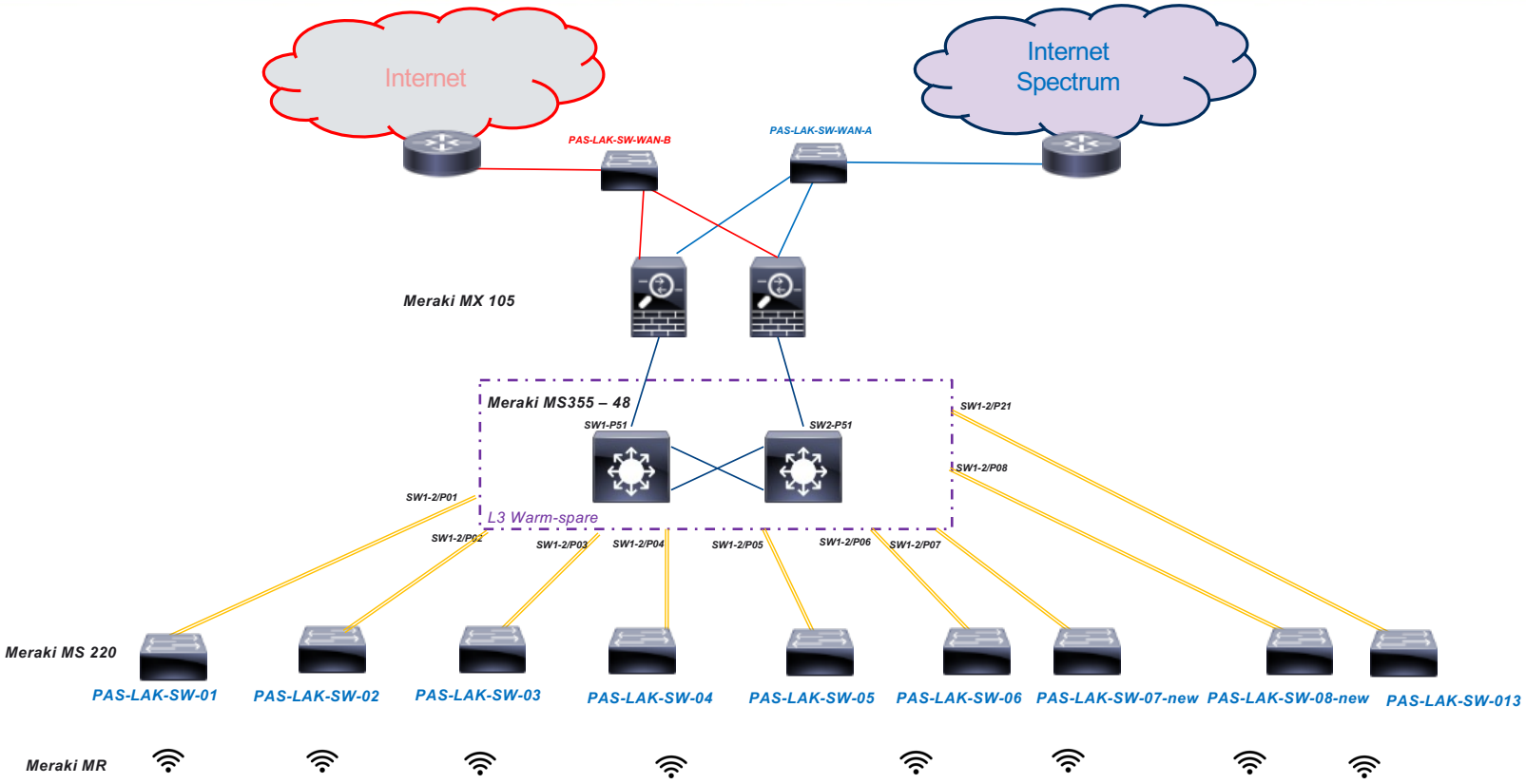
GMTO Infrastructure



GMTO Network – Logical diagram



GMTO 300 N Lake current network – Physical diagram



IT Infrastructure Requirement (Fiber Runs - Summery)

GIANT MAGELLAN TELESCOPE

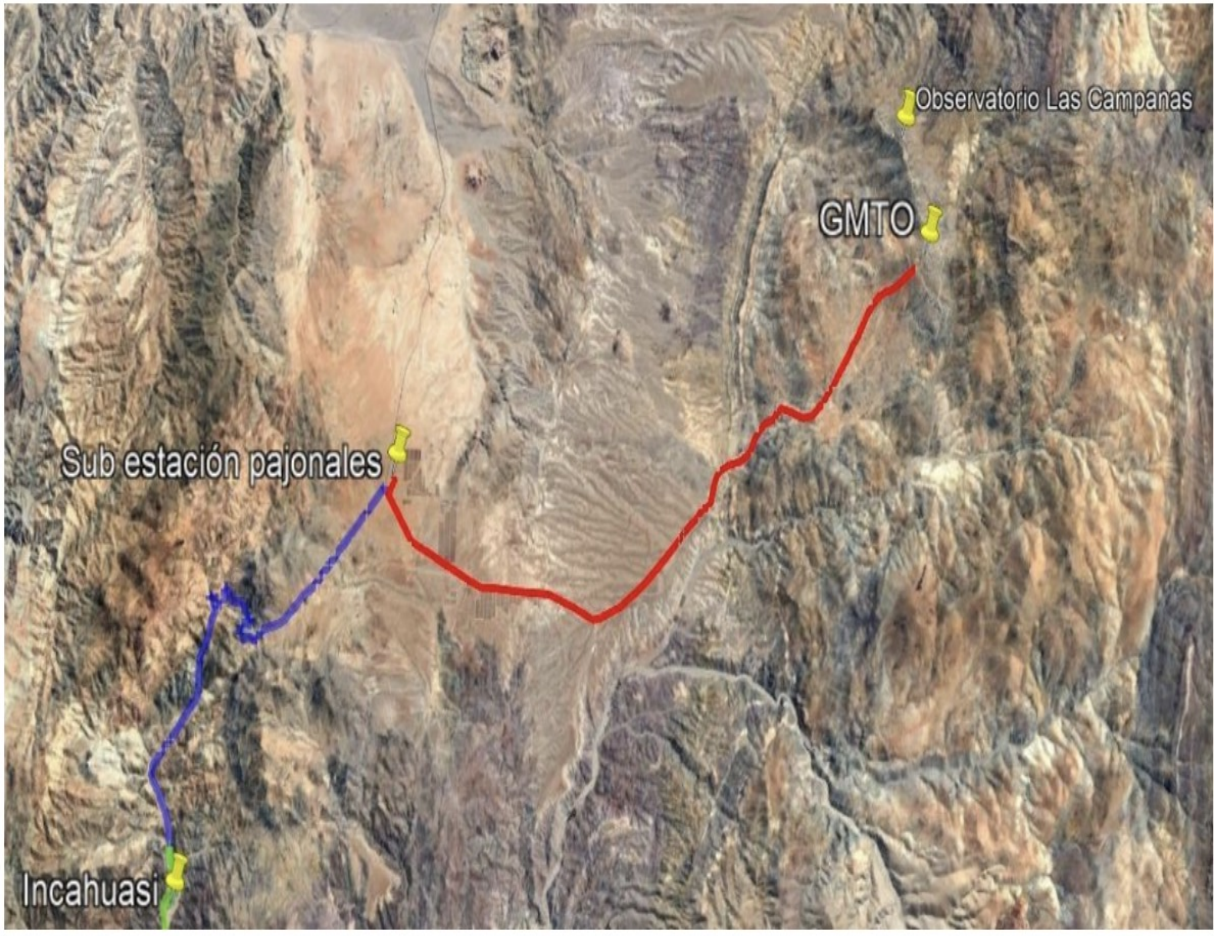
- MDF to (2 X 48 Strands) SWC Computer Room
  - *SWC Computer Room to Elements (accounted for in fiber documentation)*
- MDF to (1 X 48 Strands) IT Computer Room in Enclosure
  - IT Computer Room to (1 X 12 Strands) to each IDF in the Enclosure building
  - Plus 2 more buildings in the summit
- MDF to (1 X 48 Strands) Each building in Support Site 2 (4 buildings)
- Basically 1 x 48 strands from MDF to each building

- 1x24 Strands from LCO to MDF
- MDF to (1 x 24 Strands) Closest provider
  - New 24 Strand Fiber via powerline

New Fiber - Reuna

- The red line in Figure represents the preliminary layout that the new posts would have for laying the 23 kV MV power line, and therefore the laying of the fiber optic cable. This line would extend for approximately **30 km** from the GMT site to the **Pajonales** substation.

- The blue line in Figure 4 represents the layout of the fiber optic cable from post # 564 to the technical office located in the town of **Incahuasi**. This line would extend for approximately **22 km**



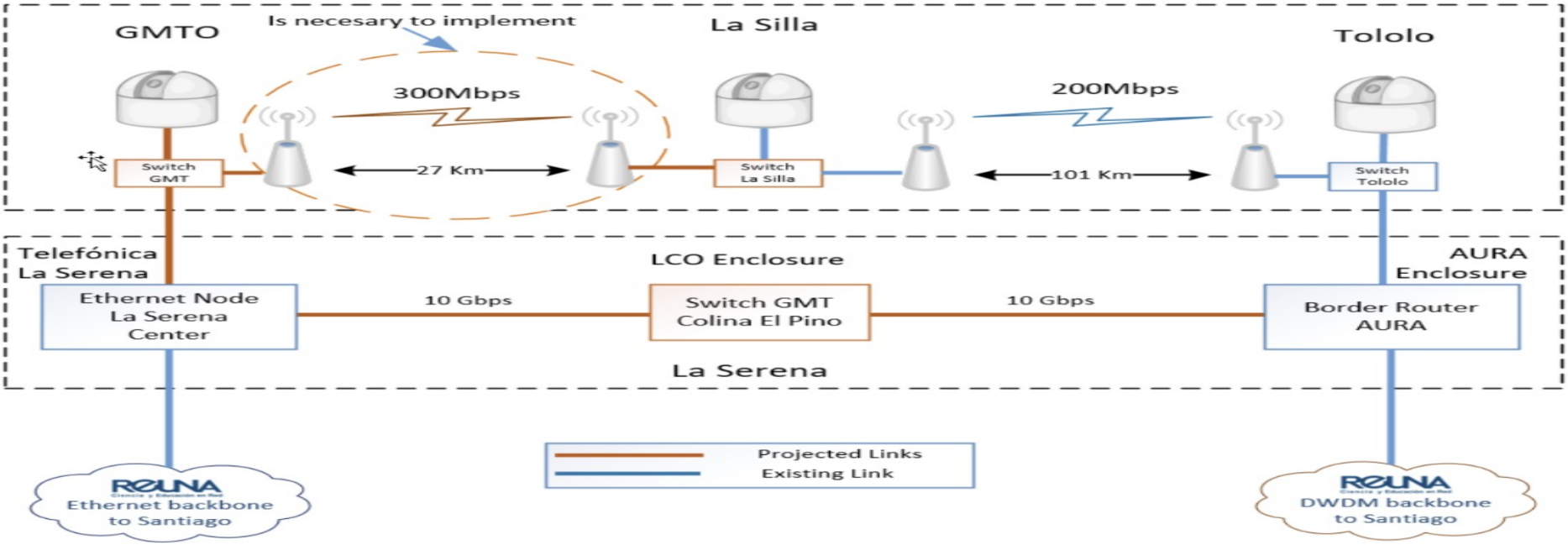
New Fiber – Reuna Continue

- **The town of Incahuasi will be the point of union of the fiber coming from Cerro Las Campanas with La Serena**

Conceptual Wireless - Reuna

Stretch	Guy	Construction / Operational
GMT - La Silla	Wireless	Construction
La Silla - Cerro Tololo	Wireless	Operative
Cerro Tololo - AURA Campus	Land	Operative
Enclosure AURA - GMT (Enclosure LCO)	Land	Construction

The illustration regarding the expected network ring through the Lyra project is as follows:



Science Data

- Projected ~ 8 TB per night ~ 2.9 PT data per year
- Projected ~ 31 TB Per year of Science data
- Complete Early 2030s
- Leverage nearby data center (NSF research/education network)
- Fiber from Summit to La Serena through new power lines
- Data Location? NOIRLab?

GMTO Cybersecurity – Data Center

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Pasadena Data Center

- Data
  - Backup locally every hour
  - Backup to Backblaze Nightly (cloud)
- Pasadena Data Center replicate LCO for DR

AWS Services

- Data are backup nightly to AWS

Office 365

- Data are backup to Pasadena Data Center nightly


Thank You!
https://www.giantmagellan.org