The GMT Enclosure Design

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GMT Project Overview

Agenda:
- What is GMT?
- Project Location & Access
- Site Masterplan Overview
- Site Work Completed to Date
- GMT Enclosure Design
- A&E Procurement Schedule

July 2020
The GMT Partnership

- GMTO is an international collaboration of academic and research institutions (not governments)
- GMTO Corp is a US non-profit formed in 2006 for the purpose of building and operating the GMT.
GMT Mission – Forefront Science for the Next 50 Years

- GMT Science Book: science goals for the next decade

- Top-Level Science Areas
  - Formation & Properties of Extra-solar planets
  - Stellar Populations and
  - Chemical Evolution
  - Galaxy Assembly and Evolution
  - Black Hole Growth
  - Dark Matter, Dark Energy and Fundamental Physics
  - First-Light & Reionization
  - Transient Phenomena
GMT Project Location

- GMT Project Location
  - Las Campanas Observatory, Chile

- Summit Site Elevation
  - 2,514m (8,250 ft)
GMT Project Access

- **Vehicular Access**
  - Pan American Highway
  - ~160km N.E. of La Serena, Chile

- **Location Benefits**
  - High Altitude
  - Dry Environment
  - Minimal Light Pollution
  - 300+ Viewing Nights / Year
Site Masterplan Overview - Campus

Overall Site Plan

A  Summit Site (2514m)
   - Enclosure
   - Summit Support Building
   - Summit Utility Building
   - Summit Utility Tunnel
   - Summit Office Building

B  Support Site No. 1 (2426m)
   - Shop Building
   - Warehouse Building

C  Support Site No. 2 (2385m)
   - Contractor Lodge
   - Cafeteria / Kitchen
   - Recreation Center
   - GMT Lodge
Site Masterplan Overview - Summit

Summit Site Plan:
- Enclosure
- Summit Support Building
- Summit Utility Building
- Summit Office Building
- Water Pad

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Site Masterplan Overview – SS1

Support Site No. 1 Plan

- **A** Warehouse Building
- **B** Shop Building
- **C** Equipment / Utility Yard
- **D** Fuel Storage & Tanks

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Site Masterplan Overview – SS2

Support Site No. 2 Plan

A Contractor Residence
- 68 Rooms (x1, 2, or 3 Occupants)

B Cafeteria / Kitchen

C Recreation Center

D GMTO Residence
- 24 Rooms (1 Occupant Each)
Work Complete to Date
Work Complete to Date

[Image of a construction site on a mountainous terrain]

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Work Complete to Date
The GMT Enclosure

**Enclosure Overview**

- Independently rotating cylindrical (carousel type) structure with faceted vertical walls
- Rounded edges for smooth air flow
- Overall height (~64m) and diameter (~60m) determined by:
  - Telescope swept volume
  - Seismic isolation movement
  - Overhead bridge crane requirement
  - Observing level floor hatch
- Shutter size is based upon the telescope viewing angles and required aperture width
- Enclosure rotation mechanisms are attached to the Upper Enclosure (rotating) and ride upon a stationary rail on the Lower Enclosure
The GMT Enclosure

- Enclosure Configurations

  - Closed
  - Open
  - Open with Windscreen Deployed
Enclosure

- Enclosure Volume & Aperture

Enclosure – Closed w/ Telescope Swept Volume

Enclosure – Open w/ Telescope Swept Volume
Enclosure

- **Enclosure Subsystems**
  - **Upper Enclosure**
    - Bi-Parting Shutters
    - Wind Vents
    - Windscreen
    - Vertical Circulation
    - Overhead Bridge Crane
    - Upper Enclosure Air Conditioning System
    - Mechanical (Bogie) Corridor
  - **Lower Enclosure**
    - Observing Level Floor
    - Floor Hatch
  - **Telescope Pier**
    - Seismic Isolation System
    - Pier Lift Platform

- Enclosure – Section / Perspective w/ Critical Elevations

- **Enclosure – Section / Perspective w/ Critical Elevations**

- July 2020
Lower Enclosure Floor Plans

- Grade Level (0.0m)
  - Entrance Lobby
  - Instrument Bays – 563m² (6,060sf)
  - Shipping & Receiving – 174m² (1,880sf)
  - Open Storage – 647m² (6,970sf)
  - Utility Room – 242m² (2,600sf)
  - Utility Shaft Entrance
  - Seismic Loops for Utilities
Lower Enclosure Floor Plans

- Control Level (5.3m)
  - Vestibule
  - Control Room – 93m² (1,000sf)
  - Operations Room – 30m² (320sf)
  - Computer Room – 92m² (990sf)
  - IT Room – 25m² (270sf)
  - Offices (x2) – 14m² (150sf) ea.
Enclosure Architecture

- **Lower Enclosure Floor Plans**
  - Observing Level (11.8m)
    - Provides the main floor level for maintaining and servicing the telescope
    - Located 11.8m above grade
    - Egress through 2 stairs and 1 elevator
    - An 11.0 m square operable floor hatch is provided to allow mirrors and telescope equipment into the observing chamber
Enclosure Functions

- **Main Enclosure Functions:**
  - Protection of the telescope from:
    - Inclement weather, wind and daytime light
    - Seismic activity
  - Support telescope science operations:
    - Track with the telescope while observing
    - Modulate and control air flow and wind speed within the enclosure while observing
    - Block some light sources
    - Must not negatively affect science operations (seeing)
  - Environmental control of the observing chamber:
    - Prevent excessive daytime temperature variation within the enclosure to prevent damage to the mirrors
    - Pre-condition to nighttime temperatures to reduce acclimation time of the equipment
    - Exhaust waste heat away from the telescope
Enclosure Functions

- **Other Enclosure Functions:**
  - Provide a dark daytime calibration environment
  - Support maintenance activities
    - Removal and reinstallation of mirror cells for recoating using the overhead crane
    - Instrument installation
    - Rotation of the enclosure to support snow removal and other operations tasks
  - Access to all equipment within the enclosure
  - Provide workspaces:
    - Office space with all associated infrastructure
    - Lab spaces for instrument maintenance
  - Provide a telescope control room
  - Provide a computer server room
  - Provide storage areas for mirror cells and equipment

Section at Enclosure Bridge Crane

Control & Computer Rooms
Enclosure Functions

- Other Enclosure Functions:
  - Provide and/or distribute utilities for the telescope:
    - Compressed Air
    - Cooling fluids
    - Cyrogenic cooling system (compressed helium)
    - CO2 refrigeration system
    - Telescope hydraulic system
  - Power conditioning and generation (at SS1 yard)
Technical Challenges

- **Major technical challenges:**
  - **Mechanisms:**
    - Existing observatories have notoriously unreliable kinetic architecture
    - Two high-mass movable structures
      - Upper enclosure excl. shutters: ~3400MT
      - Upper enclosure shutters: ~430MT/each
      - Upper enclosure total: ~4260MT
    - ~70 individually controlled wind vents
    - Floor Hatch
  - **Environmental Design:**
    - HVAC system for observing chamber
    - Seal designs to provide a light and weather tight enclosure
More technical challenges:

- Seismic Design:
  - Seismically active area
  - Seismic isolation system must provide stiffness and resist normal telescope accelerations
  - Flexible utility transitions between fixed vs isolated structures

- Controls Design
  - Controls interfaces with many subsystems
  - Reliable communications through conductive rail

- Electrical Design
  - Reliable power through conductive rail
  - Power conditioning/backup generator system

- Infrastructure Design
  - Compact, modular telescope utility designs
Reference Design

Reference Design Maturity:

- Critical (60%) design:
  - Enclosure Concrete and Under-slab Utilities
- Preliminary (30%) design:
  - Enclosure structure
  - Mechanisms
    - Enclosure Rotation System
    - Shutter Machinery
    - Floor Hatch Machinery
    - Pier Lift Machinery
    - Wind Screen
    - Wind Vents
- Conceptual (5%) Design
  - Seismic Isolation System
  - Utilities design

Observing floor level framing plan
Summit Utility Building & Utility Tunnel

- Summit Utility Building
  - Mechanical Room
  - Gas Refrigeration & Cryogenics
  - Hydrostatic Bearing Room
  - Exhaust Fan Room
  - Electrical Room
  - IT & Communication Room
  - Miscellaneous Spaces
    - Storage
    - Restroom
    - Fire Riser Room
Summit Utility Building & Utility Tunnel
Summit Utility Building & Utility Tunnel

- **Summit Utility Tunnel**
  - The Summit Utility Tunnel connects the Enclosure to the Summit Utility Building
  - Two Primary Purposes
    - Utility Corridor
    - Ventilation Corridor (Duct)
Support Site No. 1 – Utility Yard

Support Site No. 1 Plan

A. Warehouse Building
B. Shop Building
C. Equipment / Utility Yard
D. Fuel Storage & Tanks
Support Site No. 1 – Utility Yard

- Exterior Equipment Yard
  - Main electrical hub for the entire GMT site
  - Major Equipment
    - Electrical
      - Meter, switch gear, transformers
      - DRUPS units
      - E-house
    - Mechanical
      - Fluid Coolers
      - Diesel Fuel Tanks