Dome System Overview

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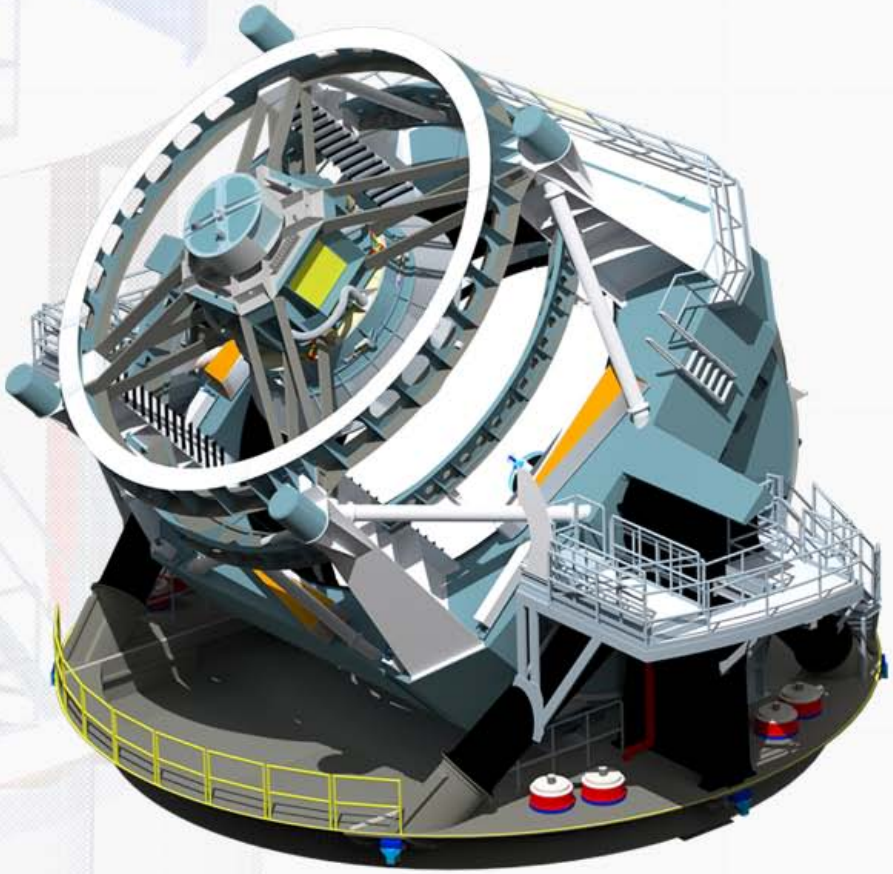
Design by: Joe DeVries and Ed Hileman

April 10, 2014



Dome Summary

- 30m Diameter Dome based on Carousel design used by previous telescope projects (non co-rotating with telescope)
- Oversized (11M) clear aperture relaxes dynamic requirements
- Large bi-parting shutters secure clear aperture
- Light/wind screen provided for stray light control
- Fixed azimuth drives allow thermal control & capacitor banks
- Conventional bogie system
- Louvered Light Baffling Vents provide for natural ventilation
- Dome interacts with facility HVAC system during daytime to match anticipated initial observing ambient air temp
- Dome designed and sized to support all required handling (includes 20T dome crane and rear doors)
- Dome designed to safely facilitate maintenance (Platforms, ladders, walkways, manlifts)

Dome Design

- Design incorporates lessons learned from previous telescopes

VLT Dome

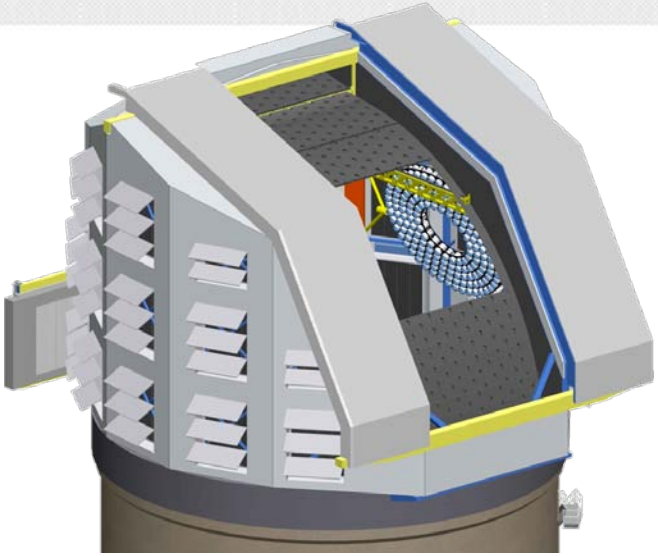
Gemini Windscreen

Dome (rotating enclosure) Includes fixed drive and bearing components

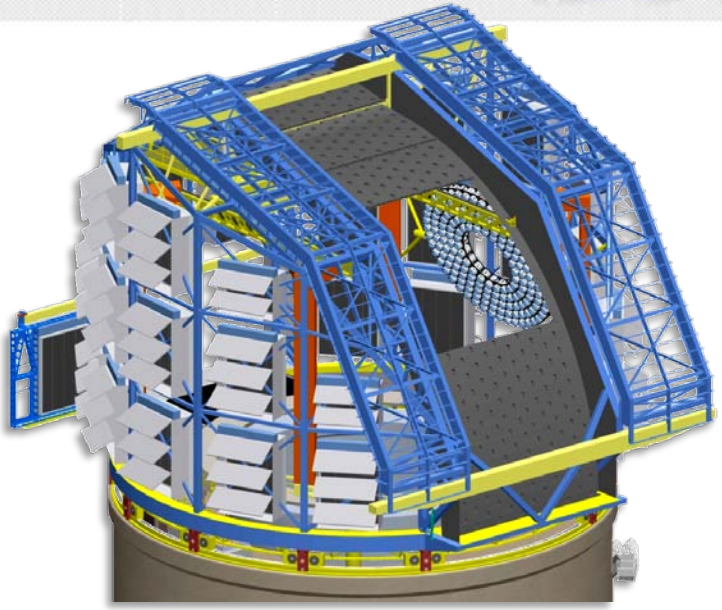
Lower Enclosure Ring Wall

Summit Support Facility showing rotating enclosure (dome) atop fixed lower enclosure

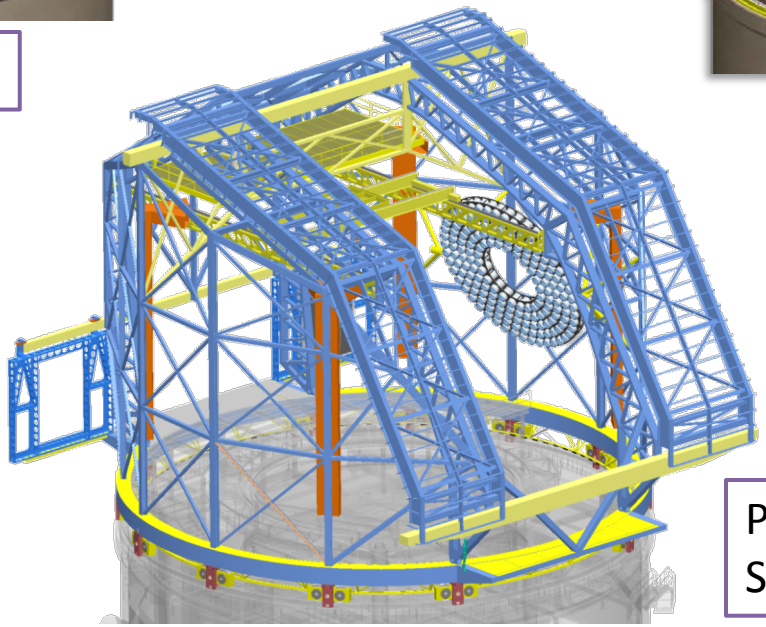
Dome visualization sequence



Complete dome

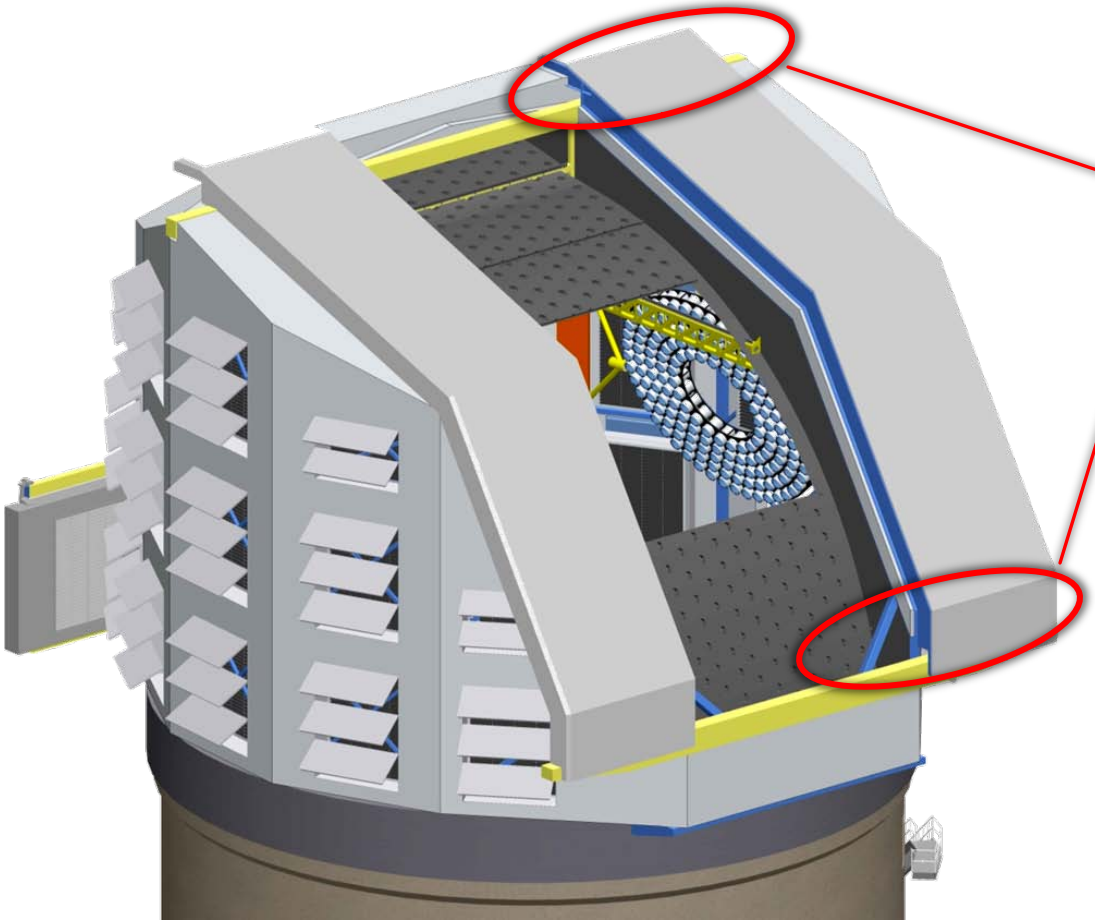


Paneling Suppressed



Paneling and Vents Suppressed

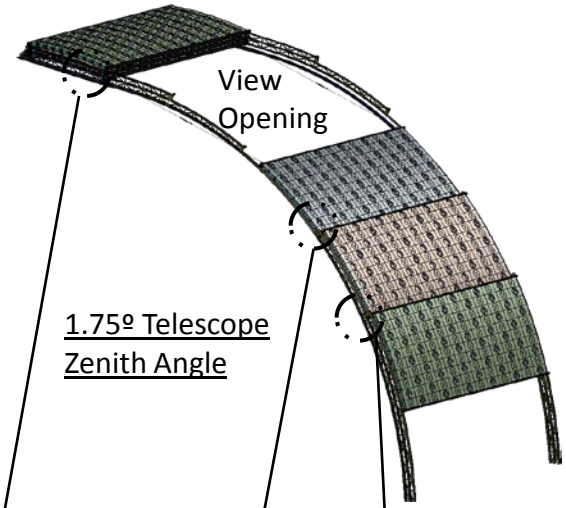
Bi-Parting Shutters

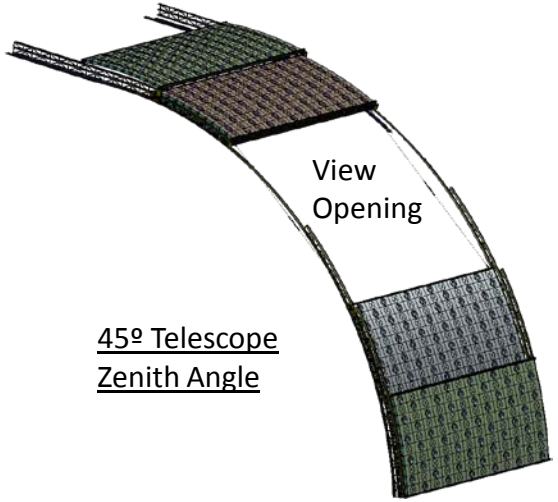


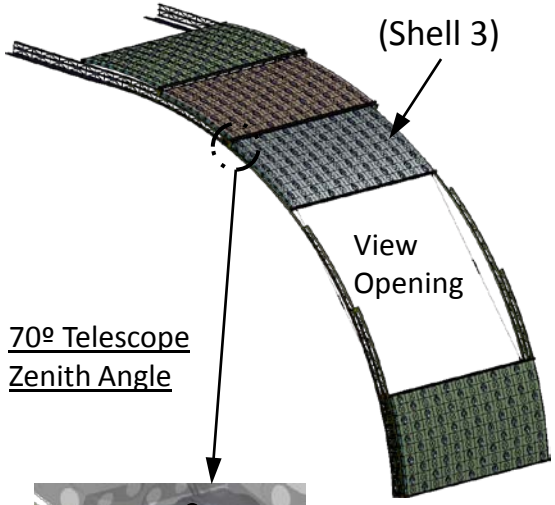
- Horizontal motion reduces risk
- Drive units required at top and bottom of each shutter
- Roller system required at top and bottom of each shutter
- Latch open and shut system required at top and bottom of each shutter
- Additional roller and latches may be used
- Secondary closure methods required
    - Manual method
    - Local control panel

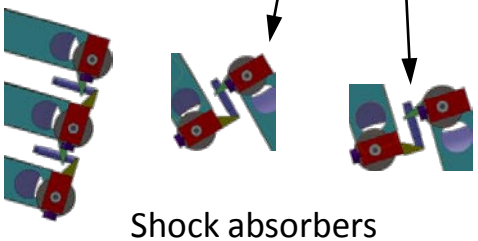
Shutter Doors Assemblies shown in context with the dome structure

Light/windscreen assembly design based upon approach used at Gemini

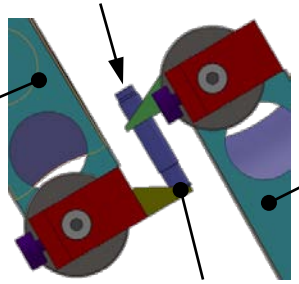




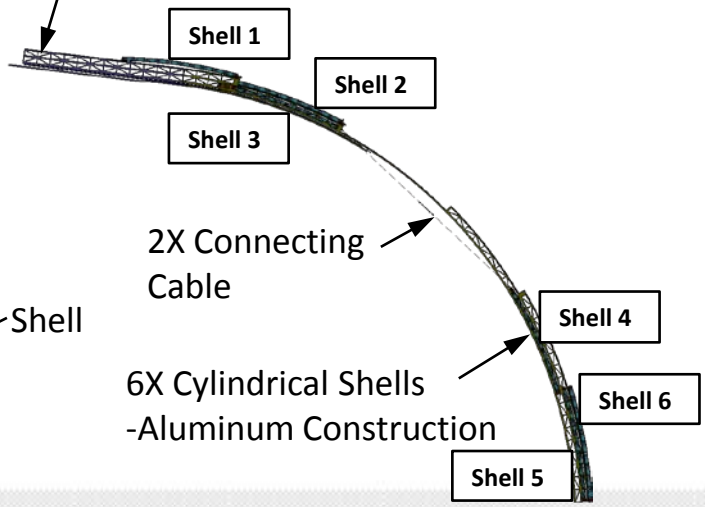


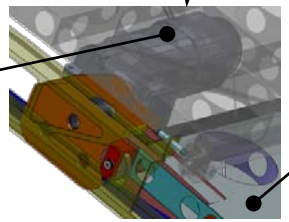


Shock absorbers



2X Guiderail Assembly





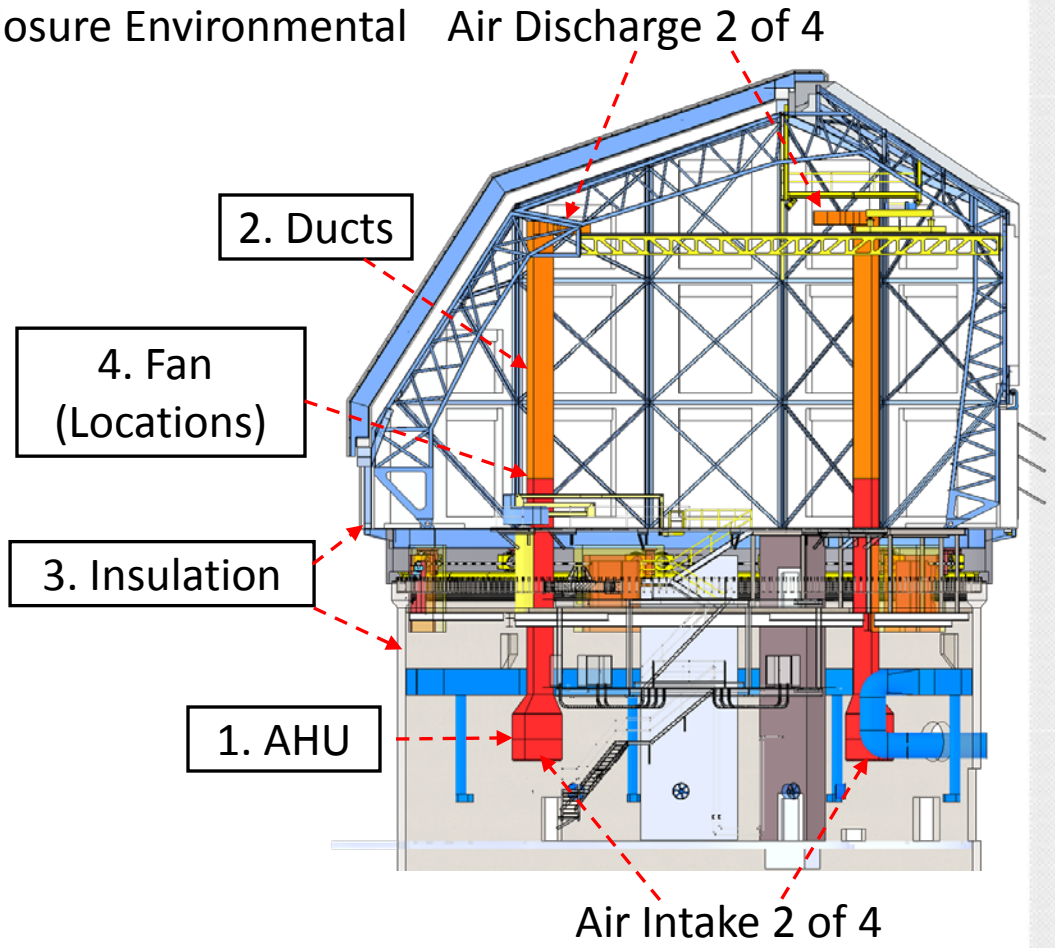
2X Drive Gearmotor (attached to upper corners of Shell 3)

Total Weight:
124 kN (27.9 kips) - Includes 10% buffer for additional Dome structure for mounting
Moving Weight:
83 kN (18.7 kips)

Daytime Preconditioning of Dome Interior

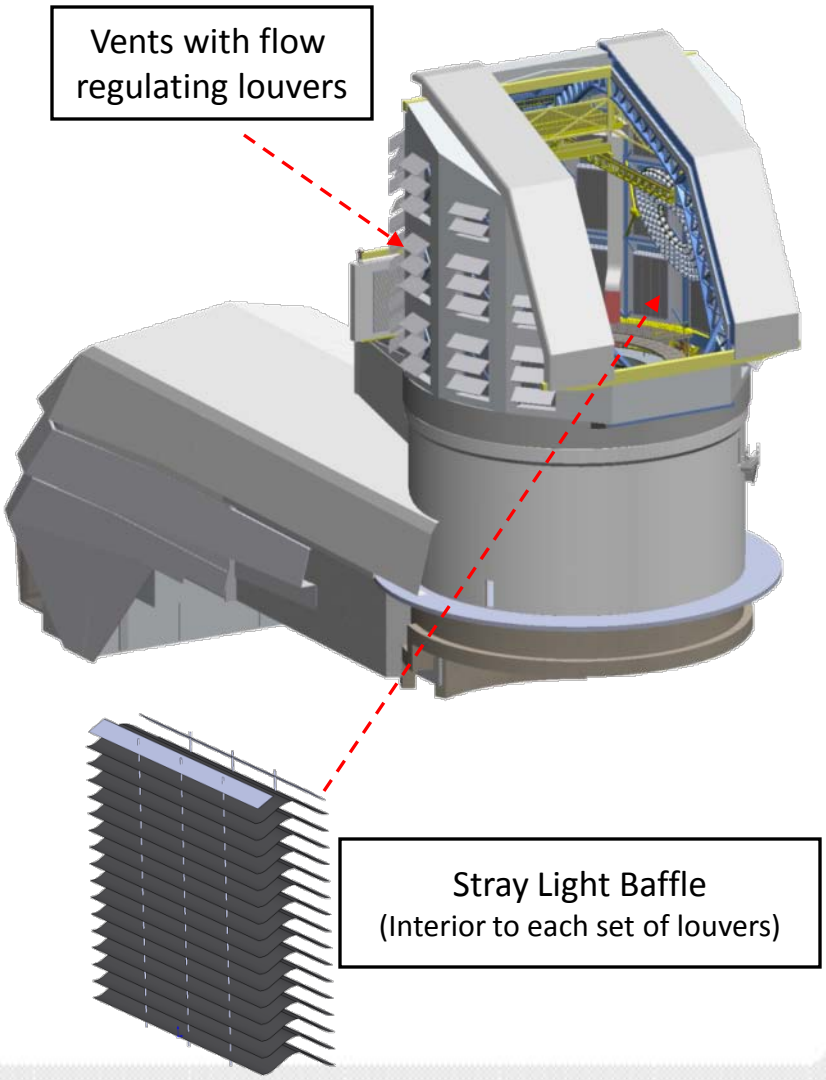
- The combined dome and lower enclosure Environmental Control System (ECS) consist of:

1. Air handling units (AHU) with intakes in the lower enclosure
2. Ducts with discharges to the dome
3. Insulation of both the upper and lower enclosure
4. Fans in the dome ducts (not shown)
5. Fans in the telescope pier wall



Night time – Natural Ventilation

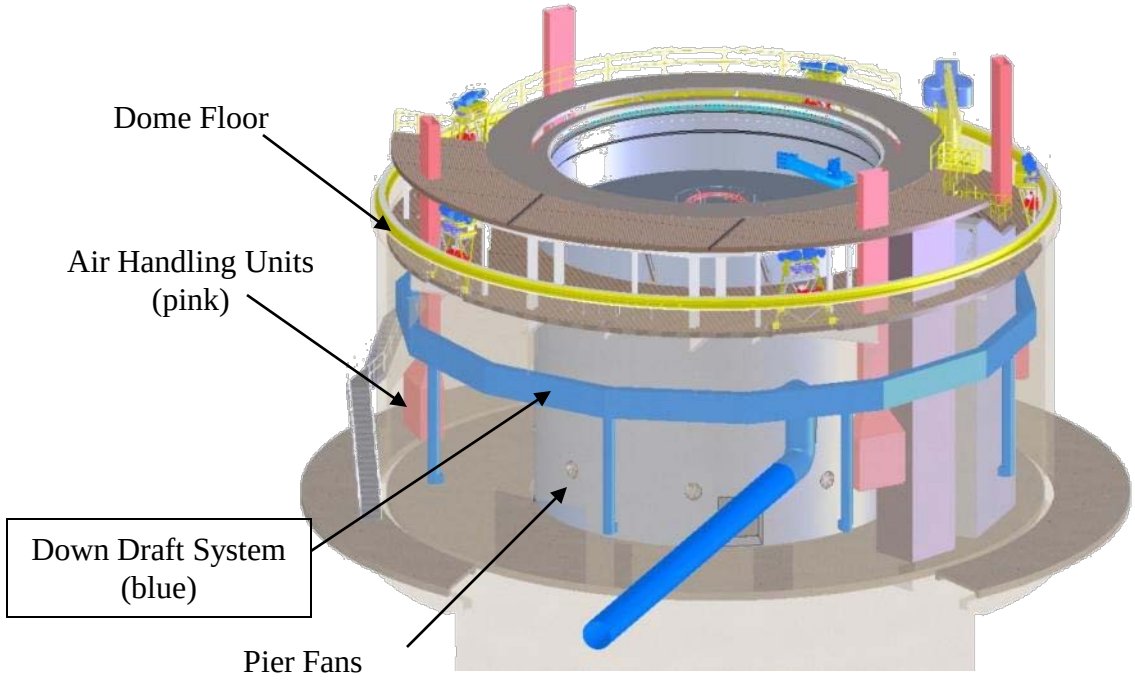
- During observing natural ventilation principally used for thermal control
- Natural ventilation provided by numerous Louvered Light Baffling Vents (LLBV), clear aperture and L/W screen permeability.
- Vent flow is regulating by actively controlling it's louvers to balance the effect of dome flushing and wind shake
- Each vent has a light baffle to prevent stray light from entering the enclosure



Night time – Supplementary Down Draft System

- Supplementary down draft ventilation system removes air from the lower enclosure which sucks air through the dome vents

- Prevents heat released by natural cooling from rising into the light path

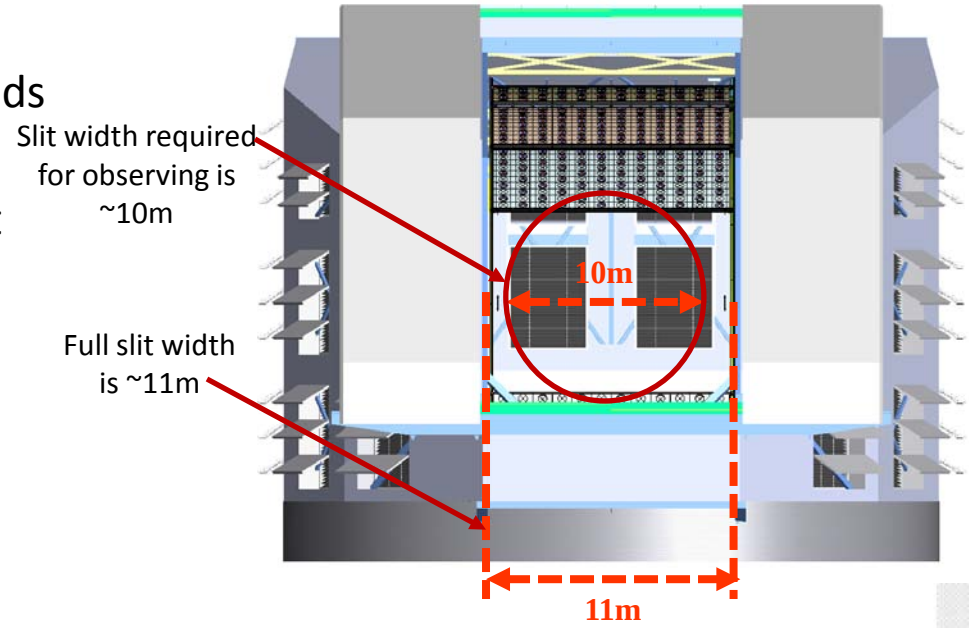


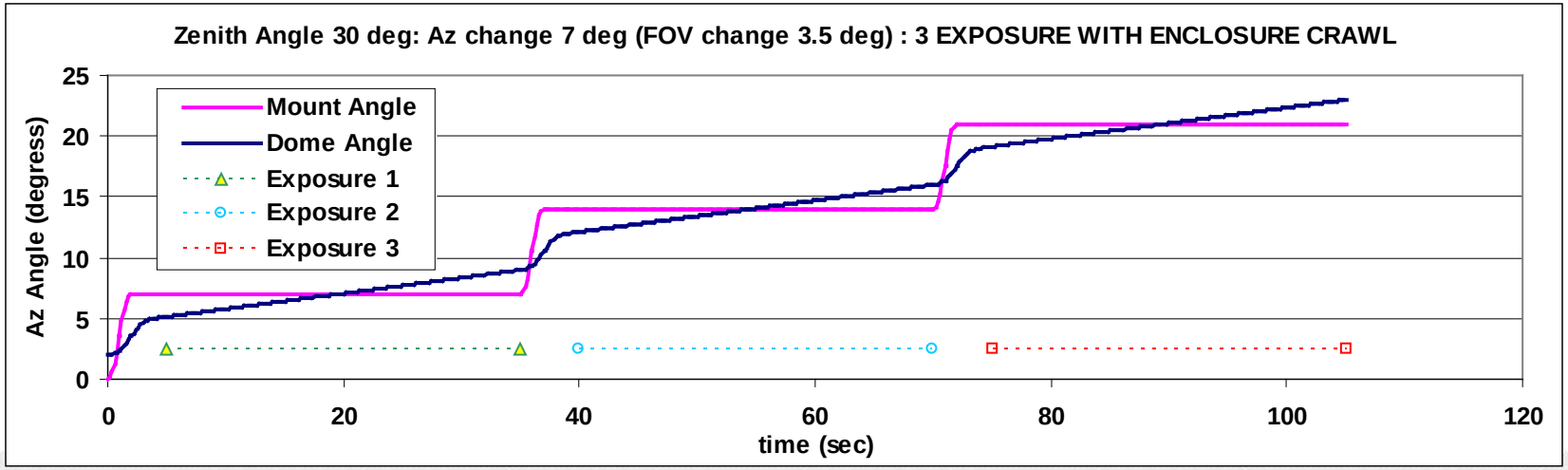
Down Draft System

Dome Crawl

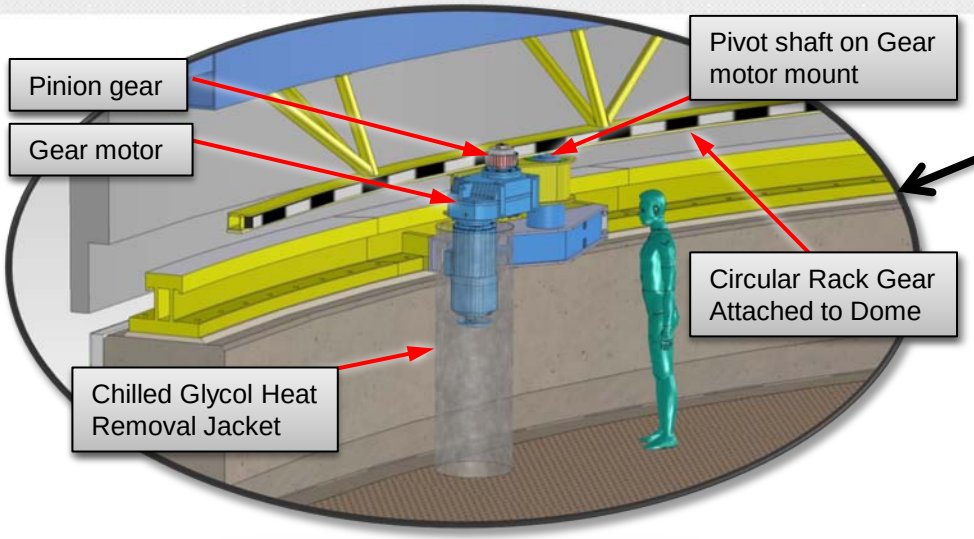
- Oversized clear aperture allows Dome to "crawl" in azimuth between adjacent fields during exposure
- Minimizes power requirements and heat dissipation

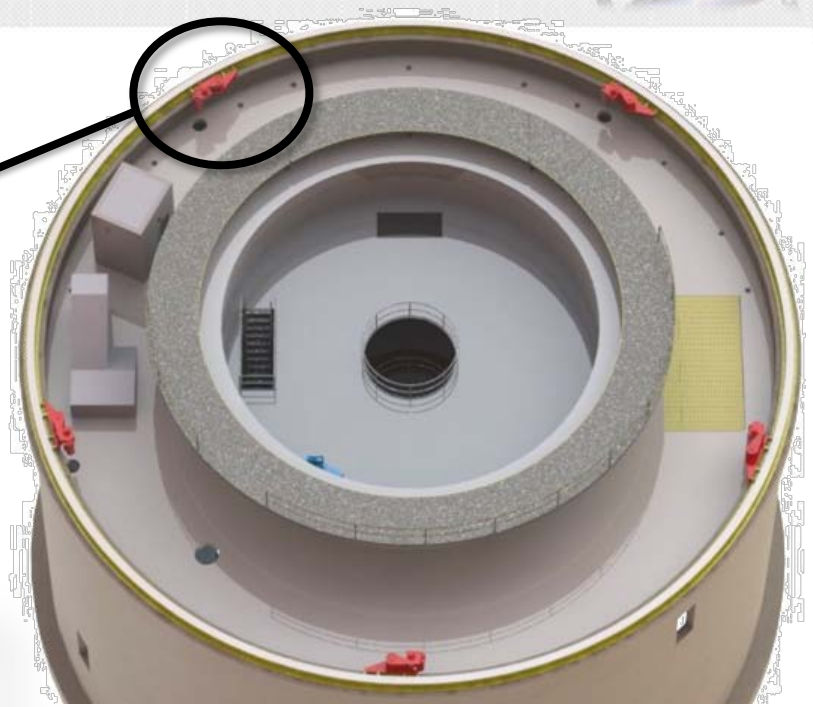
LSST Dome Elevation Motion Requirements		
Acceleration	0.875	Deg/sec^2
Vel Max	1.75	Deg/sec



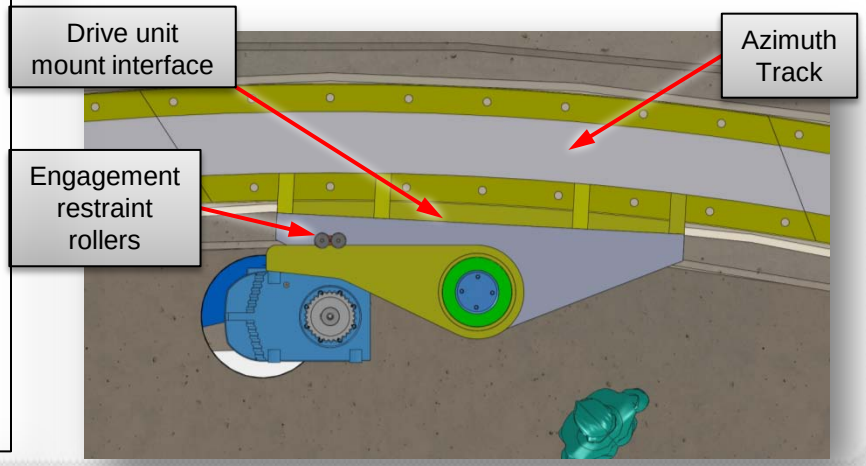


Azimuth Drive System



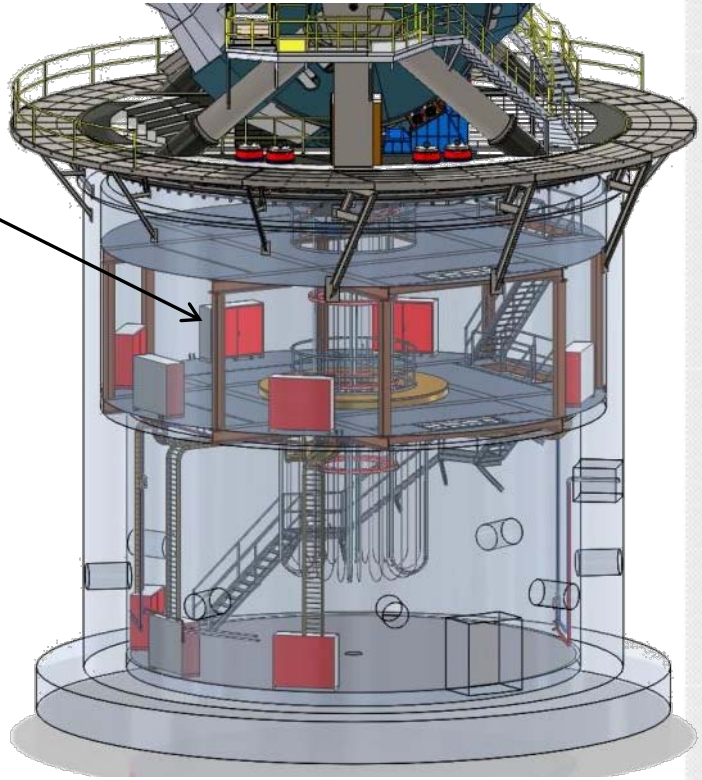


- Rack and Pinion design using five drive units attached to fixed enclosure
- Pivoted system maintains correct gear contact
- Drive unit is mounted off Azimuth track
- Either a conventional induction gear motor (baseline) or a direct drive DC motor
- Motors are active cooled by facility glycol/water



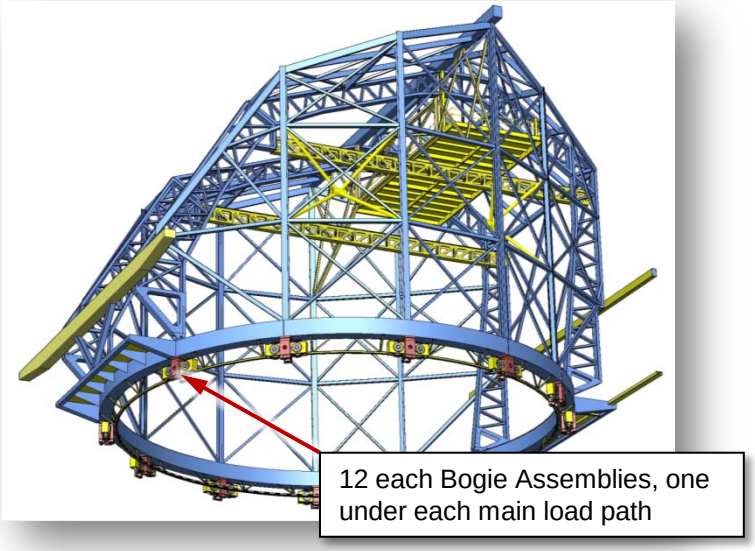
Azimuth Drive System - Electrical equipment

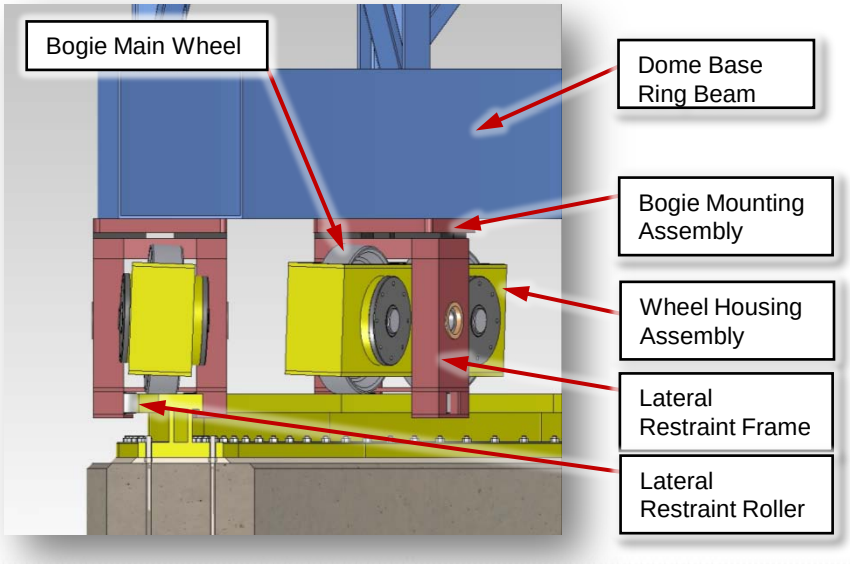
- Control panels with variable frequency drives located inside telescope pier:
  - Central location is ideal for using single capacitor bank and favors relatively short runs of power cables
- Capacitor bank inside telescope pier receives 3-phase AC power and delivers DC power to motor drives:
  - DC power route as brief as possible
- Azimuth motion is commanded remotely via TCS or locally



Bogies – Design

- Conventional bogie design
  - Conical bogie wheel for constant turn
  - Two wheels per bogie
  - Repairable in place
  - Axial (main wheel) and lateral wheels (restraint roller)
  - Vertical (seismic) restraints)

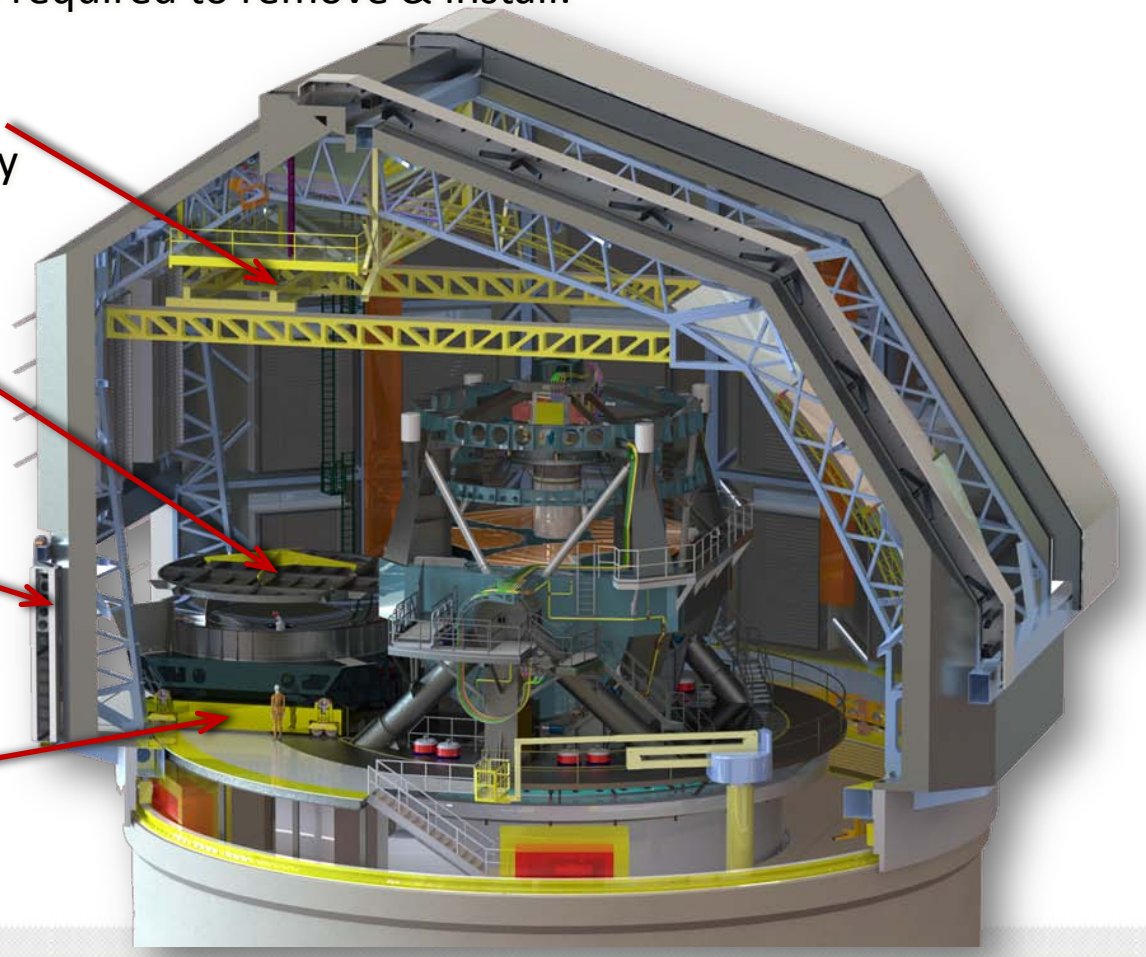




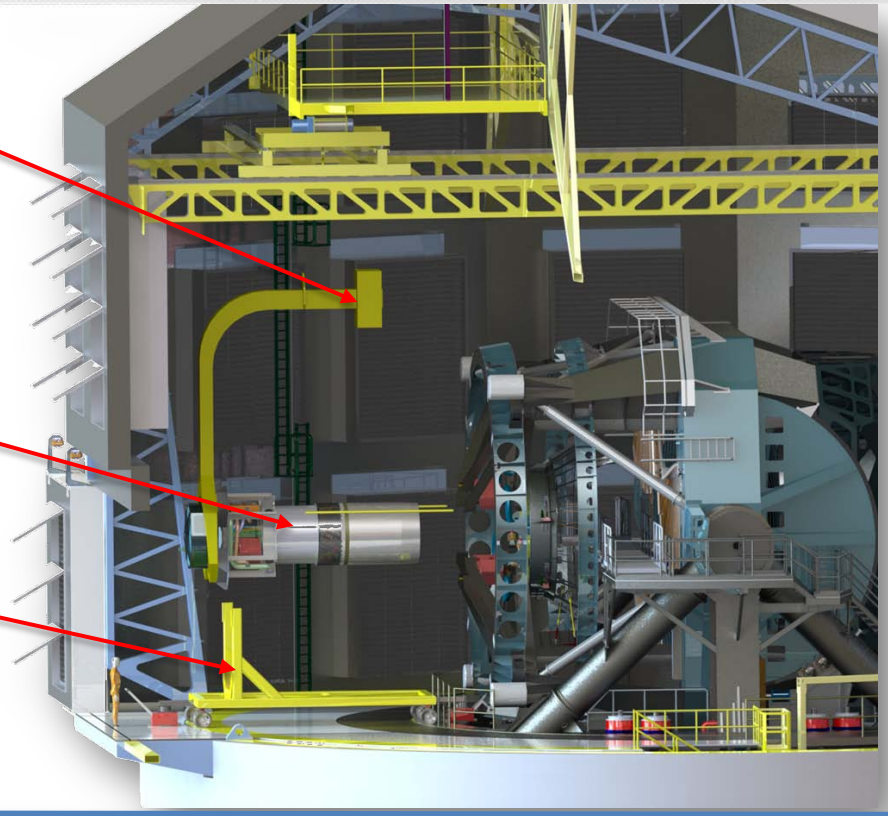
Handling Operations

- Dome designed and sized to support all handling operations via dome 20-ton crane and rear door access doors / platform lift

Overhead bridge crane is required to remove & install:
M1M3 mirror cover
M2 mirror cell assembly
Camera support assembly



Handling Operations- Camera installation and removal

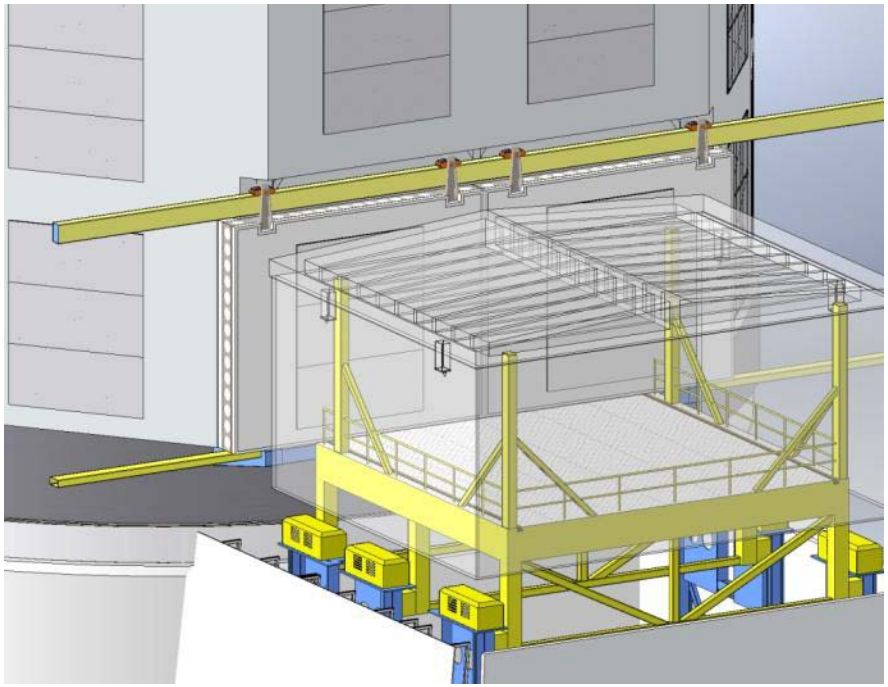


Crane has adequate travel and headroom to install or remove Camera Support Assembly from Telescope Mount Assembly (TMA)

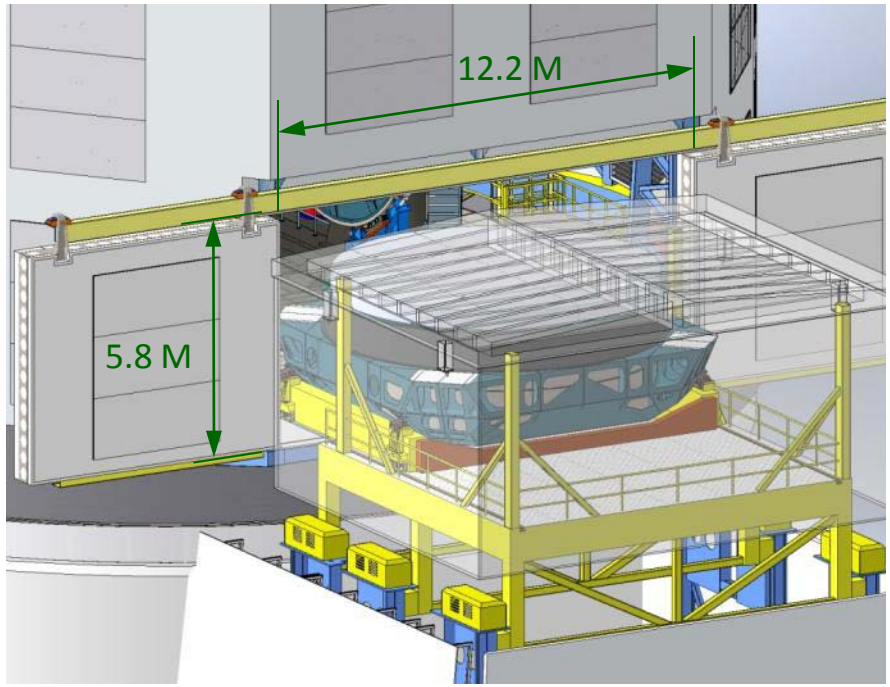
Vista Camera Handling

Handling Operations - Rear Access Doors / Platform Lift

- Rear doors provide access to platform lift for transfer of camera support assembly and mirror assemblies between telescope and facility



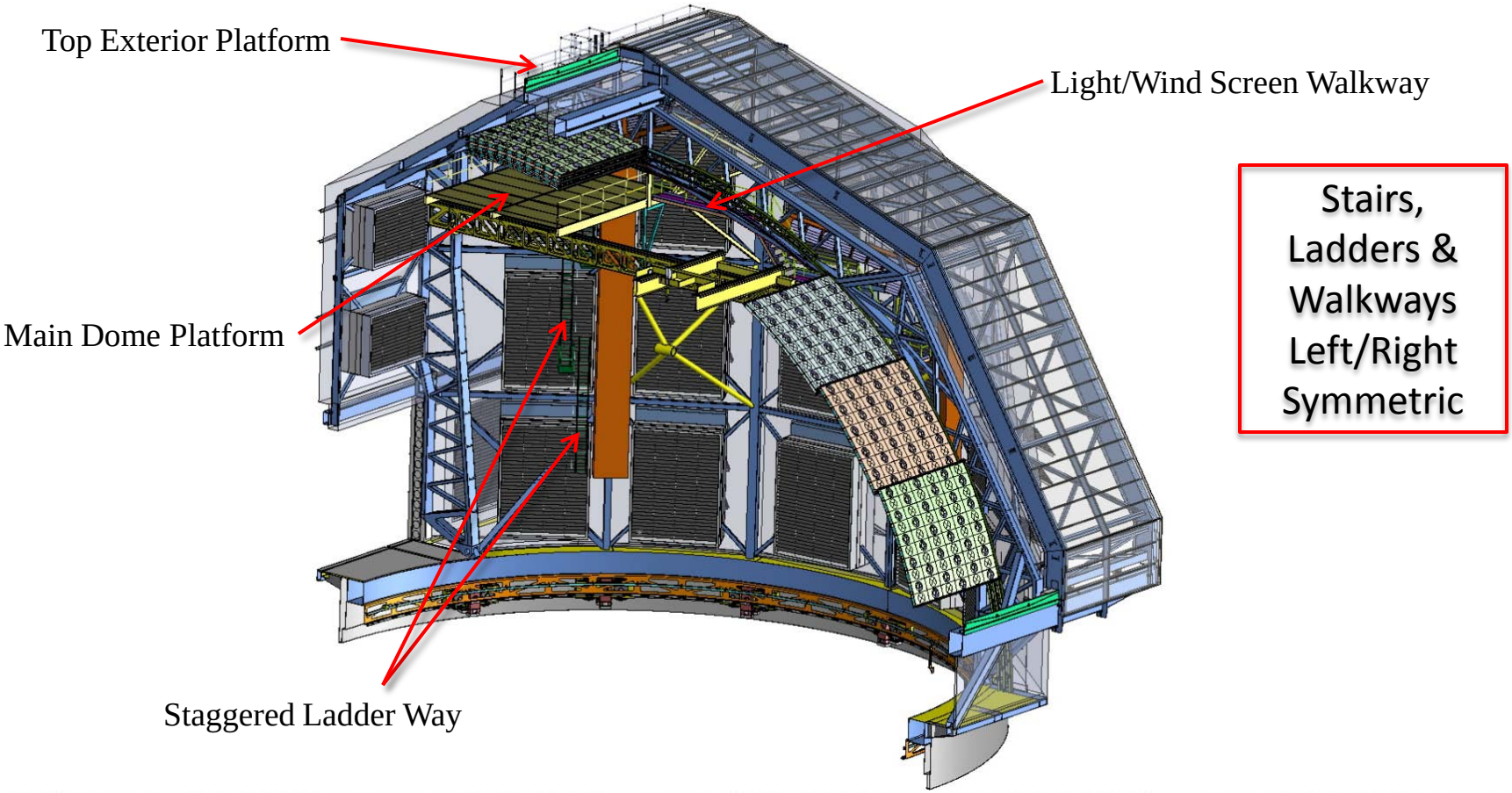
Rear access doors (RAD) remains closed when lift is raised. Interlocks with vents, dome & lift prevent damage and avoid unsafe conditions.



The M1M3 mirror cell assembly is loaded onto the platform lift through the rear access doors.

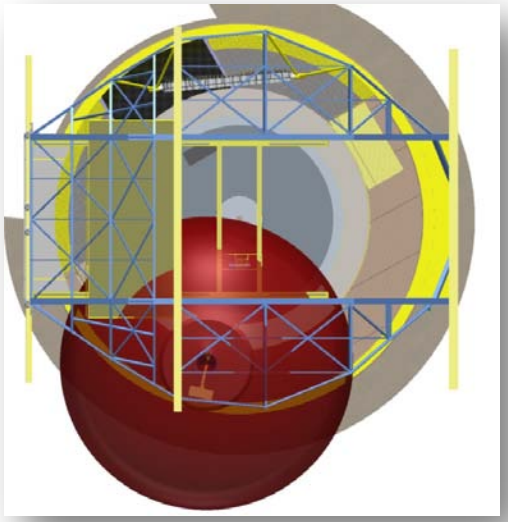
Maintenance Access – Ladders, Stair, Platforms

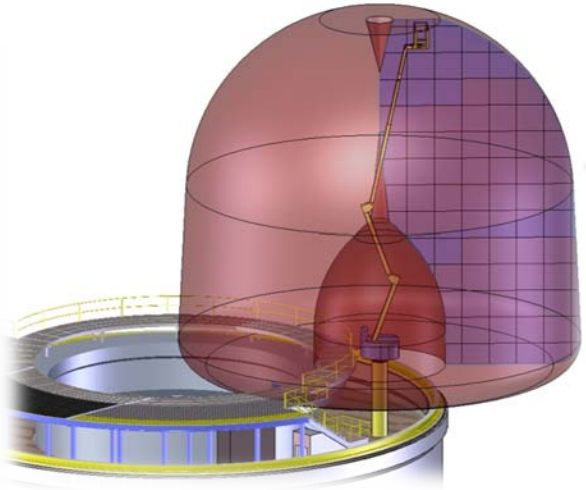
- Series of platforms, stairs, ladders and walkways provides safe and convenient access for maintenance and repairs

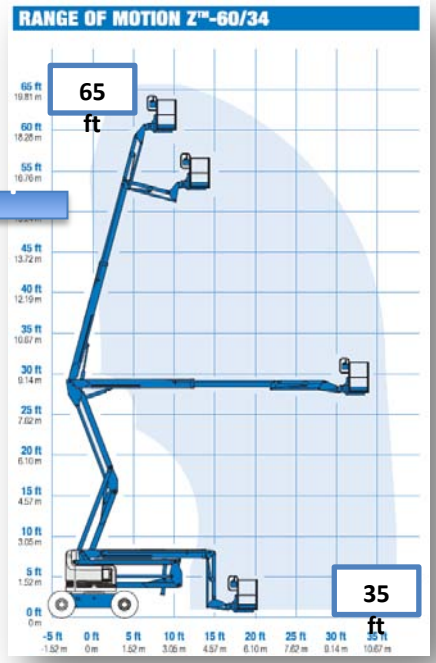


Maintenance Access - Manlift

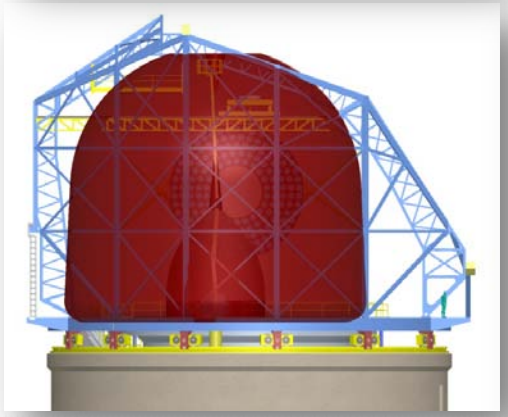
- Dome maintenance access via Manlifts (one fixed and one portable)

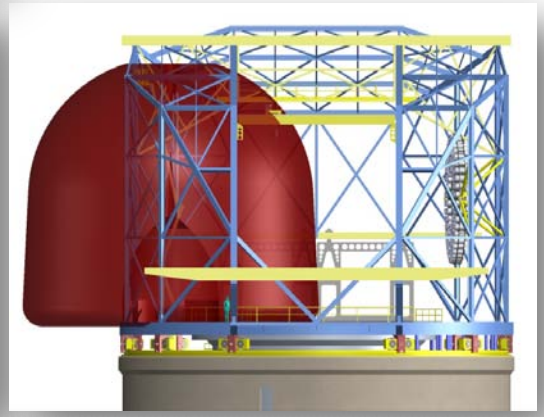






Basket range of motion





Used for Vent Louvers and Calibration Screen

Electrical and Controls - General

- Light/wind screen, dome vents, rear access doors, bridge crane and lights receive power via slip ring
  (everything but azimuth drives)

- Lightning protection uses separate grounding system

- Communications between rotating dome and TCS uses industrial grade Wireless Ethernet for reliability

- Bridge crane comes equipped with its own radio operated control station

- Three separate levels of lighting provided
  - High intensity – Major maintenance and repairs
  - Mid Level – Routine maintenance
  - Low Level – Optical testing

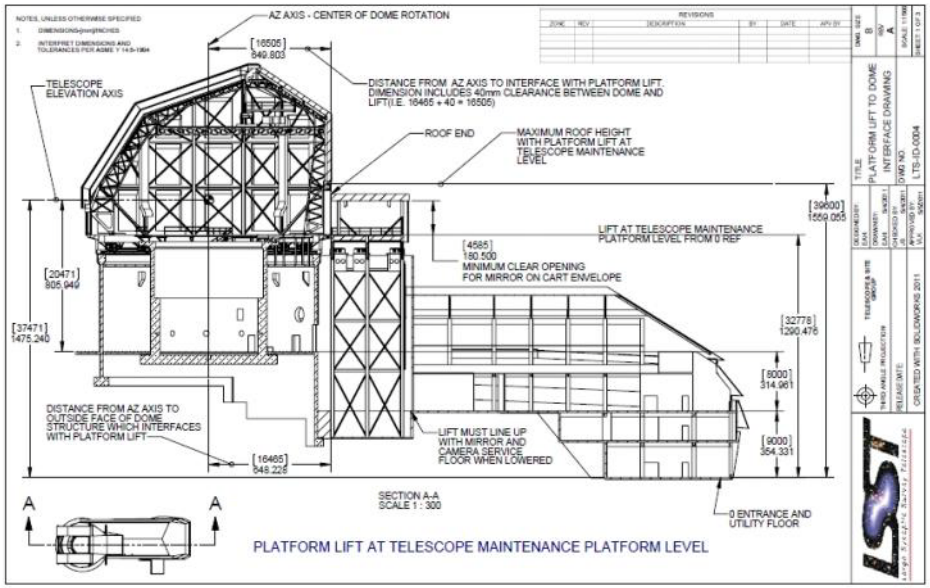
Mass Estimate

- Rotating mass 617 Tons

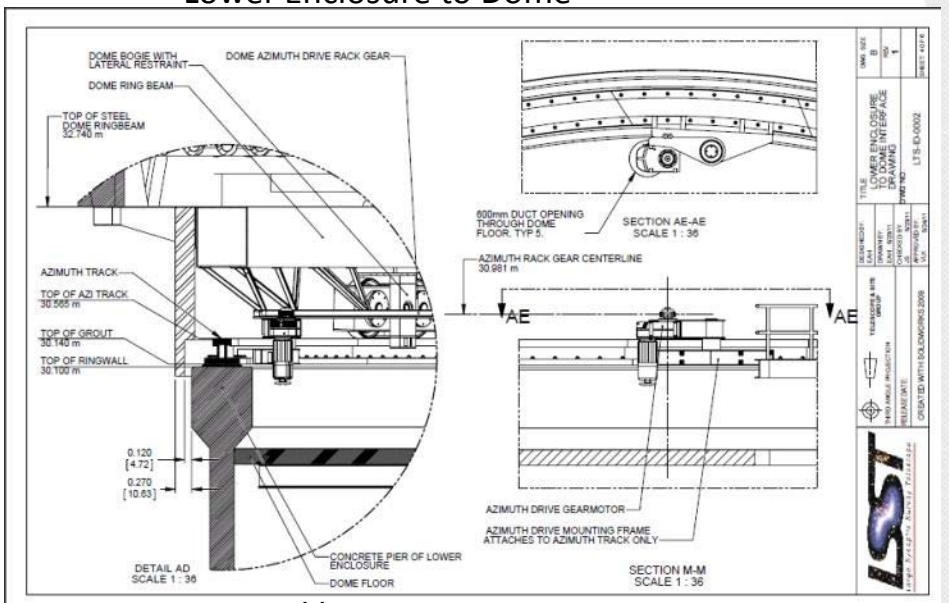
LSST ROTATING DOME WEIGHT ESTIMATE (6/14/2011)					
		Quan:	Weight:	Total Weight	
		each	kips	kips	metric tons (1000 kg)
Structure:	Ring beam	1	160.0	160.0	72.7
	Arch Girders	2	37.8	75.6	34.4
	Crane Runway	2	17.3	34.6	15.7
	Framing and Shutter Beams	1	183.7	183.7	83.5
	Maint. Platform + Lateral Truss	1	30.5	30.5	13.9
	Subtotal:			484.4	220.2
Shutter Doors:	Framing and paneling	2	70.0	140.0	63.6
	Mechanical Drives	2	10.0	20.0	9.1
	Subtotal:			160.0	72.7
Rear Doors:	Framing and paneling	2	16.0	32.0	14.5
	Mechanical drives	2	2.0	4.0	1.8
	Subtotal:			36.0	16.4
Bogies:		12	8.0	96.0	43.6
Ventilation Assemblies:	Light Baffle Louvers	30	1.2	36.0	16.4
	Aluminum Frame	30	3.1	93.0	42.3
	Drive	30	0.5	15.0	6.8
	Subtotal:			144.0	65.5
20T crane:		1	20.5	20.5	9.3
Calibration Screen:	screen with support steel	1	17.0	17.0	7.7
	tilt drive actuator	1	1.0	1.0	0.5
	Subtotal:			18.0	8.2
Wind/Light screen		1	73.0	73.0	33.2
Dome skin paneling + Secondary framing (12 psf)		16800 ft^2	0.012	201.6	91.6
Total:				1234	561
Total with 10% Contingency:		(+10%)		1357	617

Interface drawings

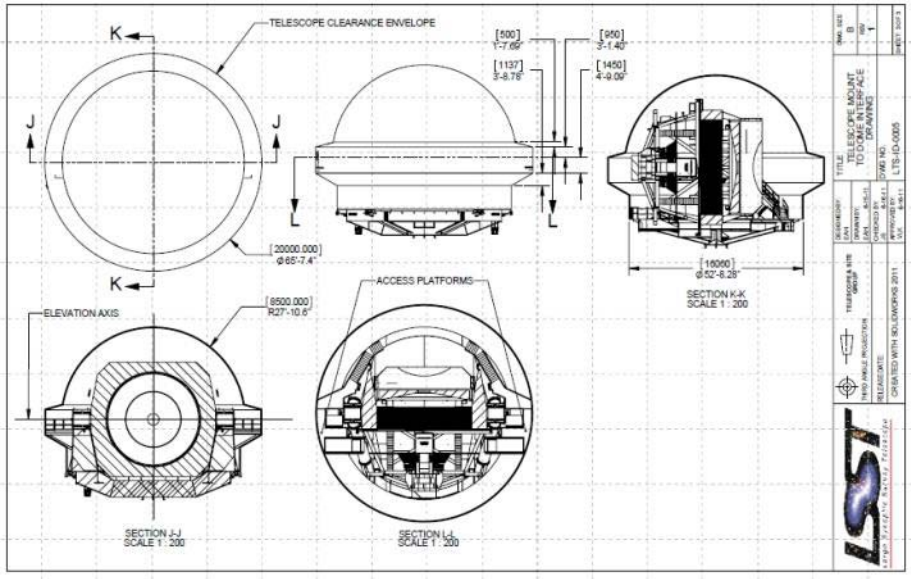
Platform Lift to Dome



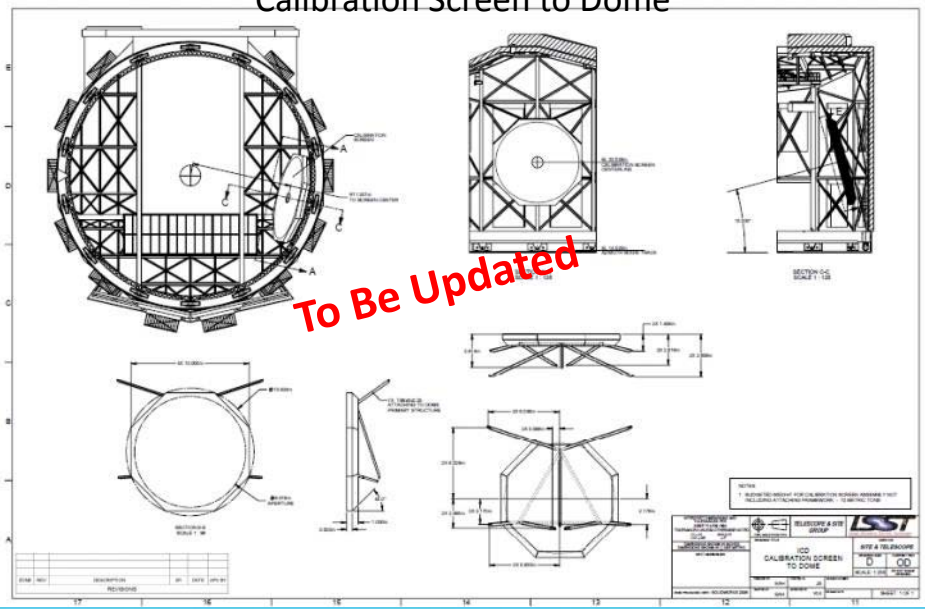
Lower Enclosure to Dome



Telescope to Dome



Calibration Screen to Dome



Basic Safety Features

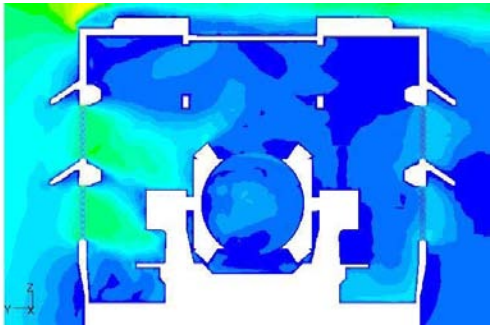
- Potentially hazardous motions controlled
  - Azimuth drive motion unlimited rotation
  - L/W screen: Software, limit switches and hard stops prevent over travel
  - Azimuth and Elevation separate tachometers limit speed
  - Azimuth and Elevation software limits acceleration
  - Power off brakes
- Except for dome to lift interface, interference / collision possibility removed by design
- Capacitor banks – maintenance free and access limited
- Safety interlocks for system maintenance
- OSHA compliant platforms, stairs, ladder and fall protection

Backup Slides

- CFD analysis provided in following backup slides

Dome Flushing

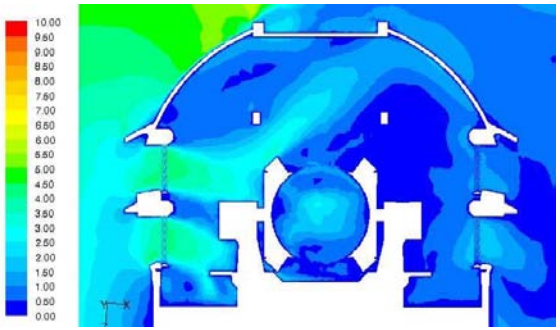
Dome ventilation comparison using CFD analysis shows better flushing performance for Carousel Dome

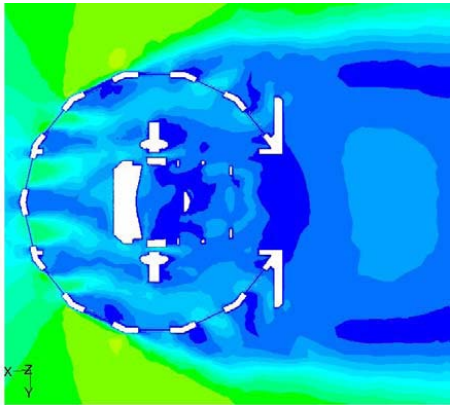


Pointing perpendicular to the wind direction

(Similar Performance)

	Carousel	Spherical
5m/sec	157	143
1m/sec	33	30





Pointing opposite from the wind direction

(Carousel has better performance)

	Carousel	Spherical
5m/sec	93	42
1m/sec	19	9