Large Synoptic Survey Telescope

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LSST Telescope and Optics Status

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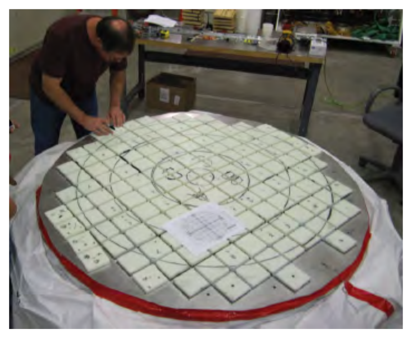
The LSST Project continues to advance the design and development of an observatory system capable of capturing 18,000 deg^2 of the sky in six wavebands over ten years. Optical fabrication of the unique M1/M3monolithic mirror has entered final front surface optical processing. After substantial grinding to remove 5 tons of excess glass above the M3 surface, a residual of a single spin casting, both distinct optical surfaces are now clearly evident. Loose abrasive grinding has begun and polishing is to occur during 2011 and final optical testing is planned in early 2012. The M1/M3 telescope cell and internal component designs have matured to support on telescope operational requirements and off telescope coating needs. The mirror position system (hardpoint actuators) and mirror support system (figure actuator) designs have developed through internal laboratory analysis and testing. Review of thermal requirements has assisted with definition of a thermal conditioning and control system. Precooling the M1/M3 substrate will enable productive observing during the large temperature swing often seen at twilight. The M2 ULE™ substrate is complete and lies in storage waiting for additional funding to enable final optical polishing. This 3.5m diameter, 100mm thick meniscus substrate has been ground to within 40 microns of final figure. Detailed design of the telescope mount, including subflooring, has been developed. Finally, substantial progress has been achieved on the facility design. In early 2010, LSST contracted with ARCADIS Geotecnica Consultores, a Santiago based engineering firm to lead the formal architectural design effort for the summit facility.

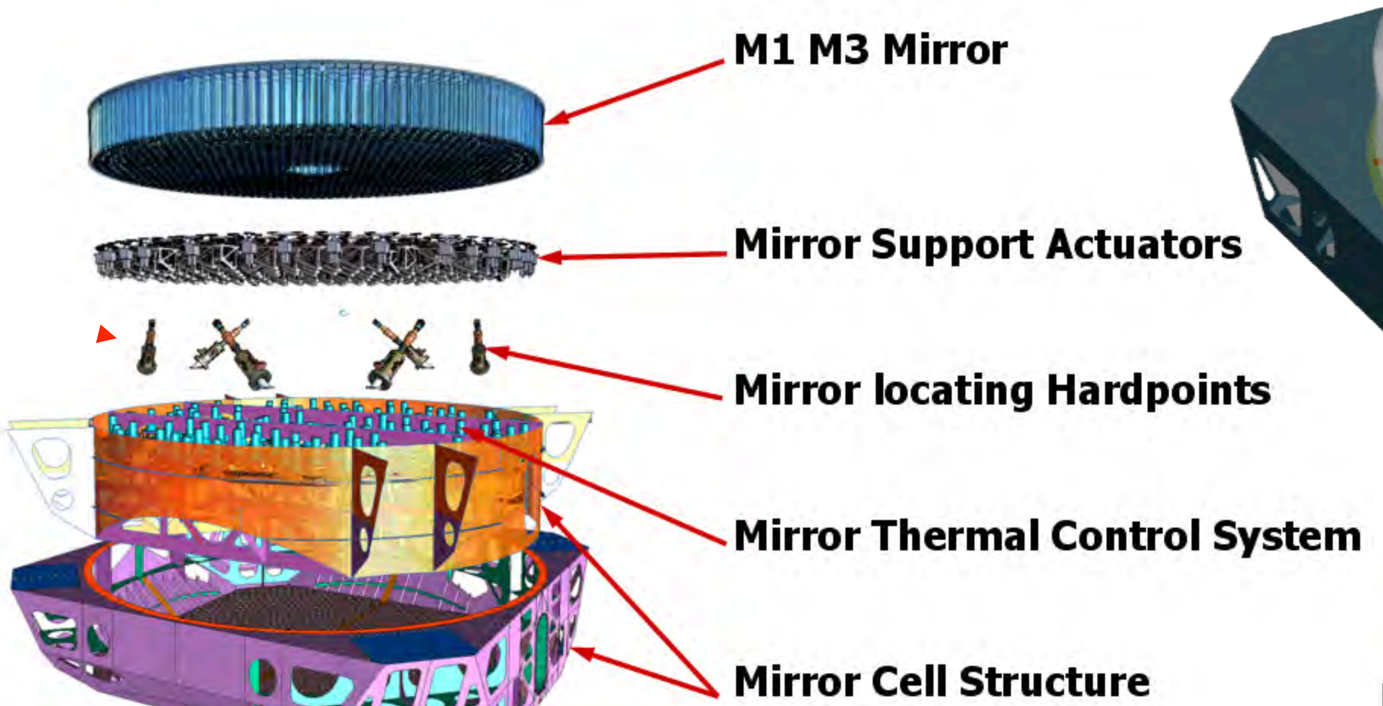
M1M3 MONOLITHIC MIRROR

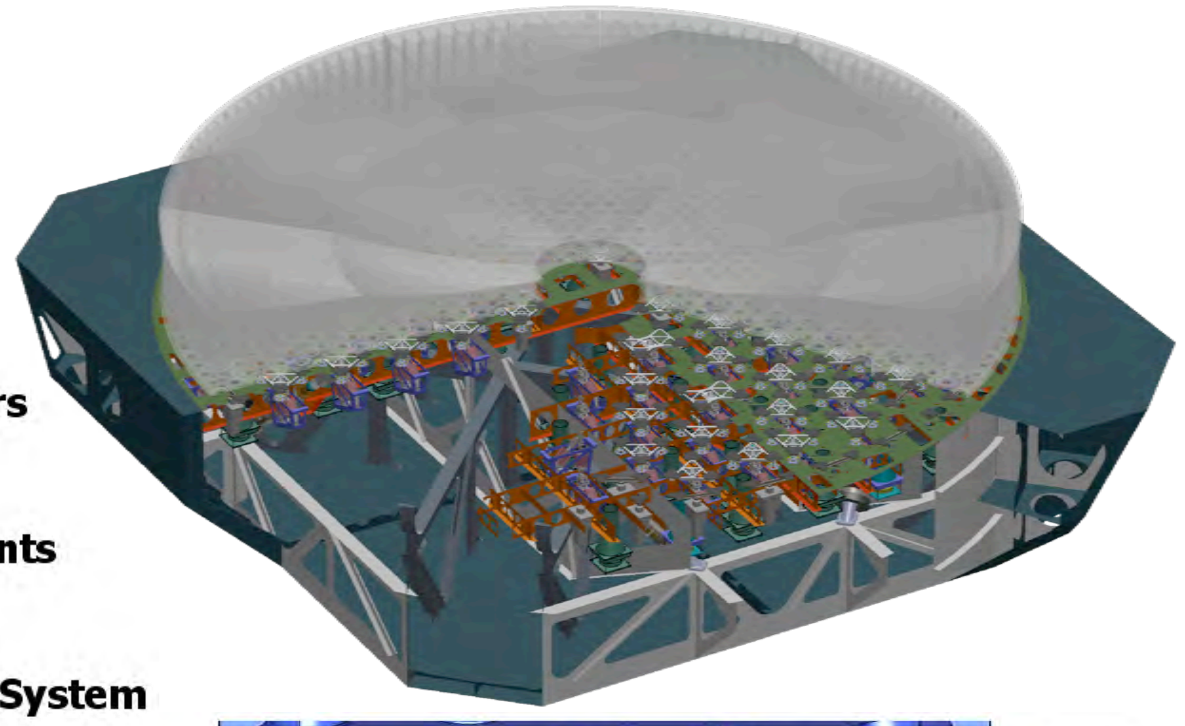


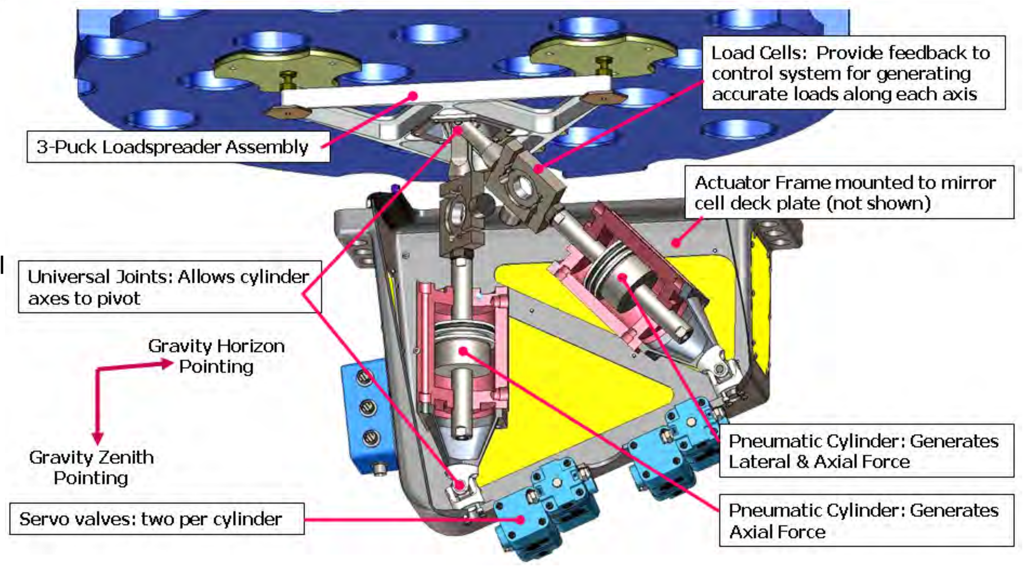
There has been significant progress with the fabrication of M1M3 monolithic primary mirror. Generous private donations to LSST have allowed the casting and optical fabrication of the primary monolithic mirror to begin at the University of Arizona Steward Observatory Mirror Lab (SOML). The single monolithic borosilicate mirror with both the primary and tertiary surfaces has been fabricated through completion of front surface generation. The figure (top left) shows the mirror and the dramatic difference in shape between the two surfaces. The SOML active lap is shown above (top and bottom right) being prepared for fine grinding of the LSST mirror. The mirror fabrication is on schedule for a mid 2012 completion.

M1M3 MIRROR SUPPORT

Full size, fully functional prototype mirror hardpoint being testing at NOAO

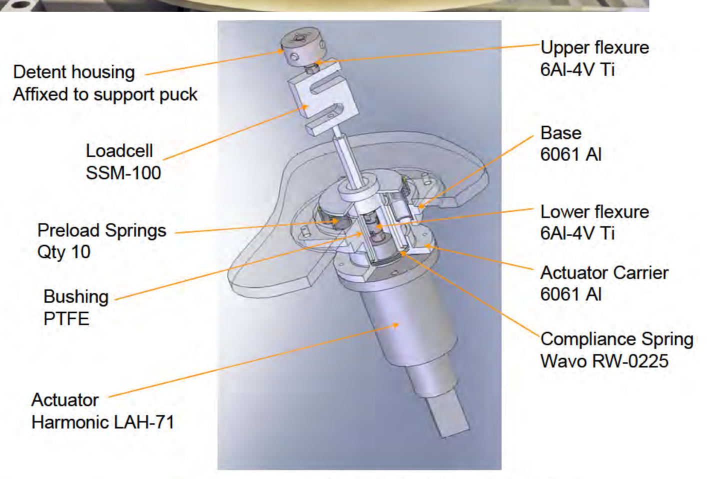


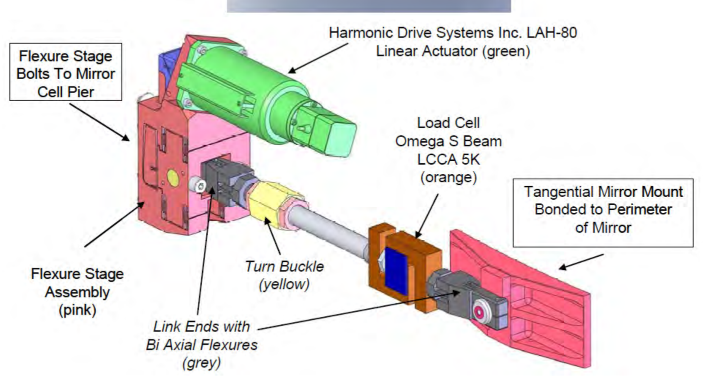


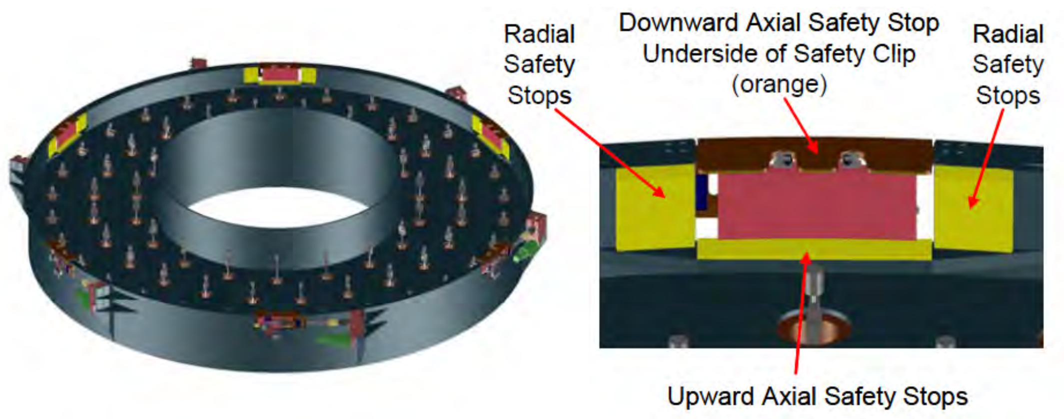


The M1M3 support system preliminary design has been completed. This complex system, shown in exploded view above and in a cutaway view above right, has been designed to satisfy the demanding LSST survey cadence positional requirements, the delicate mirror support functions, uniform thermal control, and optical coating vacuum loads. The support actuators (cutaway on right) meet stringent force accuracy and response specifications. For LSST's fast slewing, the reaction time for these pneumatic cylinders is a key specification that has been the subject of significant lab testing. The "Hardpoints", six actuated struts which define a hexapod, have been designed to position the mirror while incorporating force limiting breakaway mechanisms. A prototype has been built (above left) to fully test this critical component. The thermal system to control the borosilicate glass temperature will utilize chilled glycol distributed to 88 fans in the cell. Finally, the structural cell meets both its 1.5 mm static deflection requirement to support the glass in the telescope as well as when in use as the bottom of the coating vacuum chamber.

M2 DEVELOPMENTS



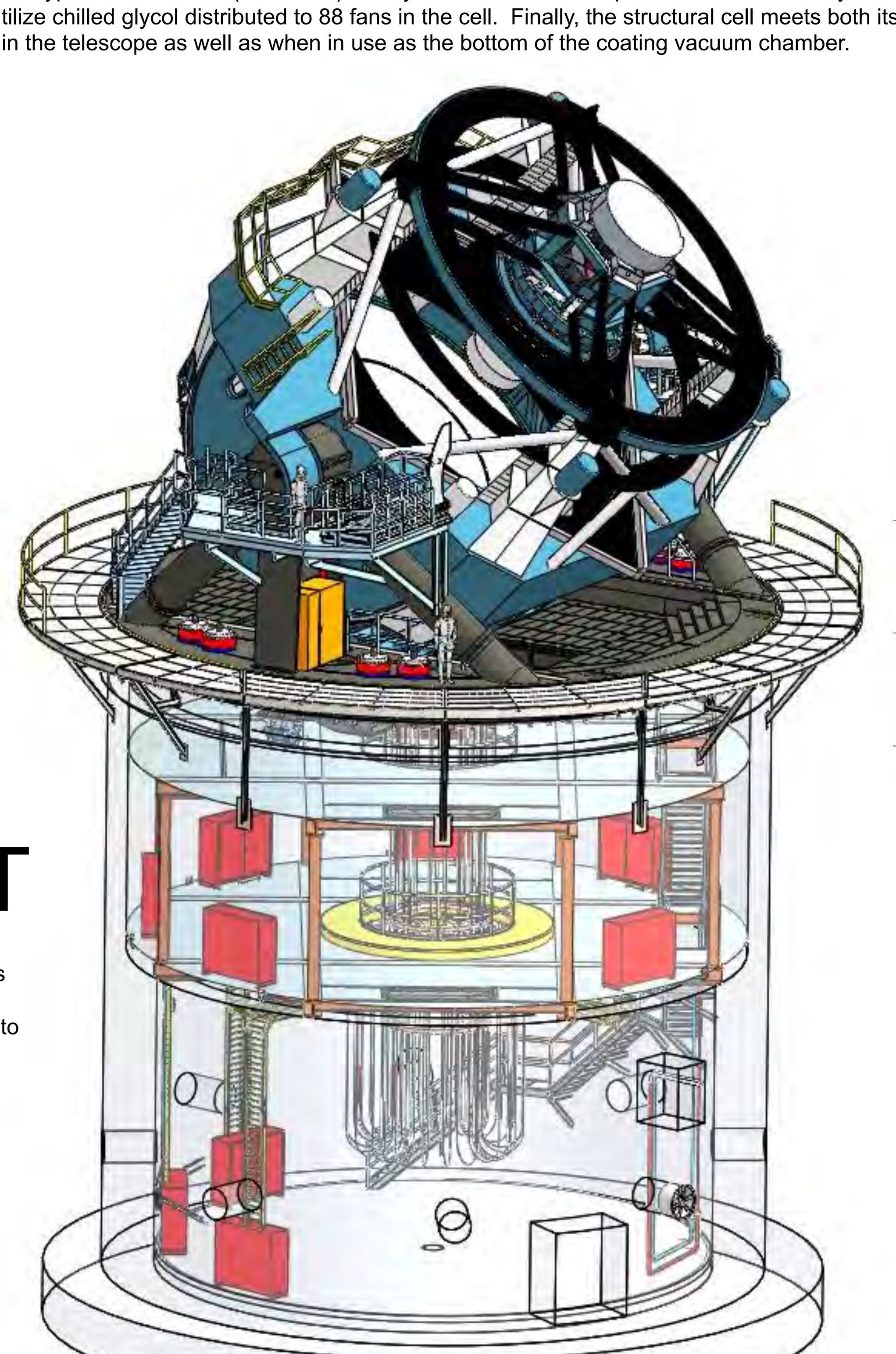


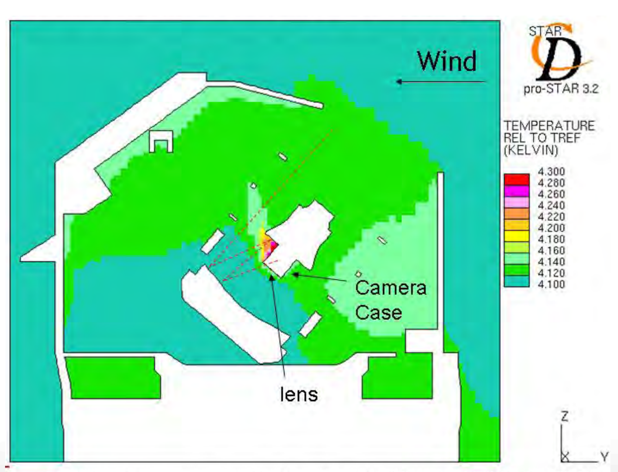


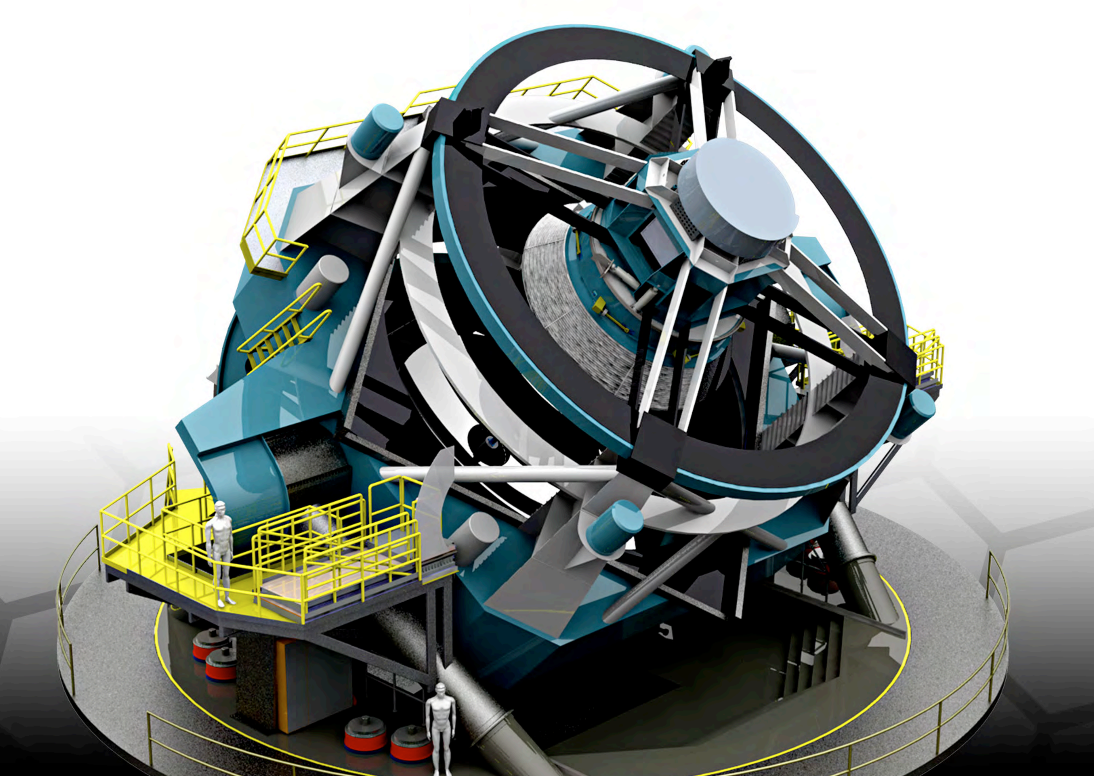
The LSST secondary mirror (M2) substrate was fabricated in ULE™ by Corning Incorporated in 2009. This 3.5-meter diameter, 10 cm thick solid meniscus has been ground to within 40 microns of the optical prescription with all other surfaces acid etched. The blank awaits final optical fabrication that will occur immediately with Government Construction Authorization. The support system for the mirror has matured to a preliminary design level in 2010. The 72 electro-mechanical force actuators that support the mirror axially are designed (middle left) and the 6 active lateral linkages (lower left) have been developed. Both of these designs take full advantage of similar hardware built recently for the SOAR and Discovery Channel telescopes. The design has developed to include the structural support cell (above center) and the many brackets, stops, and alignment aides necessary to safely operate the mirror on the telescope.

TELESCOPE MOUNT

Developments on the telescope mount have focused on the interfaces and the details that capture the full system scope. The hydrostatic azimuth bearing, the drives, the cable drape, and the access platforms have all been designed and modeled in detail to provide the summit support facility designers the necessary interface specifications. The structural details of the azimuth floor have been fully developed through finite element analysis to include the robust azimuth over travel limits underneath and the support necessary for required floor loading.

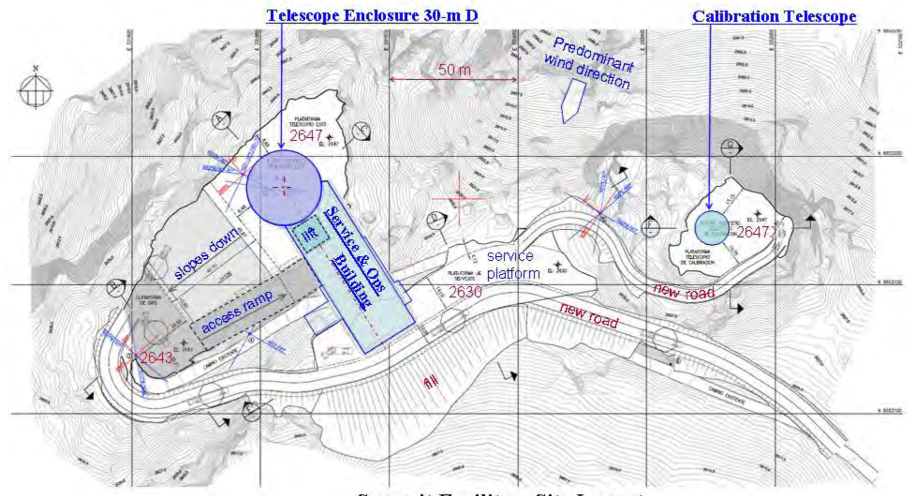






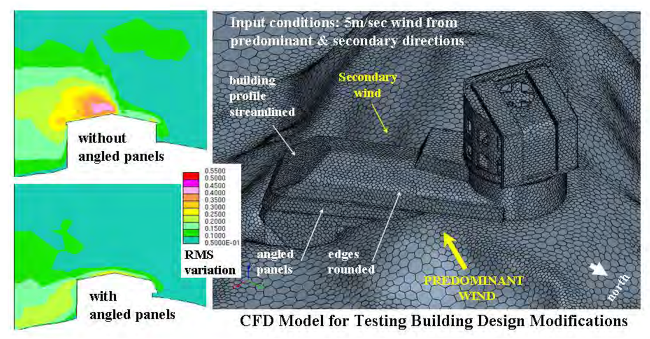
The Solid Works model of the telescope mount is shown above with a transparent pier to see some of the interior details of the system. The red cabinets are electrical cabinets with local glycol heat exchangers for remove heat from local sources. An analysis of the camera temperature has been completed to determine the allowable exterior temperature of the camera skin. An image (left) shows the CFD model used to assess the imaging impact of a temperature difference.

LSST SITE DEVELOPMENTS

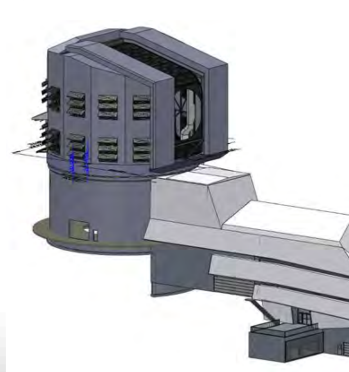


Summit Facility – Site Layout

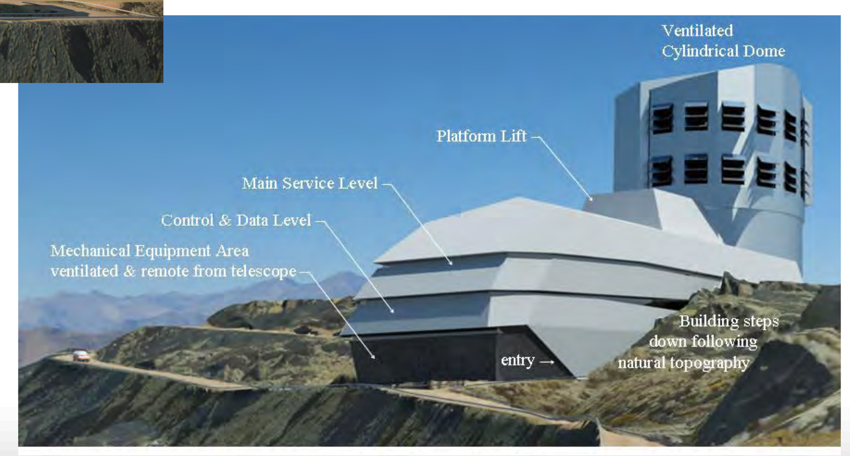
In early 2010 LSST contracted with ARCADIS Geotecnica Consultores, now ARCADIS Chile, a Santiago based engineering firm, to lead the formal architectural design effort for the summit facility. The effort has focused on 1) the interior layout of the facility space to satisfy the construction, operations and maintenance requirements and 2) the outer form to improve the air flow over the building while providing some aesthetic composition. Computational fluid dynamics (CFD) analysis is used (directly below) to inform the designers on the macro and micro impact of the design on shedding wind over the building without impacting the air the telescope The site design (top left) has been revised to more efficiently reach the calibration plateau and to match the current building design.



CFD Model for Testing Building Design Modifications



The current exterior design of the summit facility is shown above and right. The sloped panel system provides smooth wind flow over the building minimizing air turbulence in the telescope viewing column.



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