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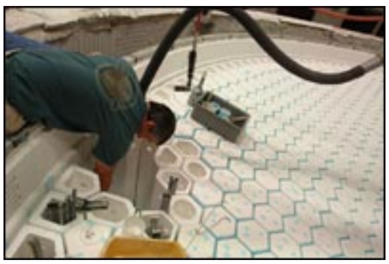
FOCUS ON...

STEWARD OBSERVATORY MIRROR LAB READY TO CAST LSST M1/M3 MONOLITH MARCH 2008



A Steward Observatory Mirror Lab technician loads the cores into the MI/M3 mold.

Casting of LSST's unique M1/M3 mirror is underway! In January 2005 LSST Corporation awarded the contract to the University of Arizona Steward Observatory Mirror Lab (SOML) to purchase the glass and begin engineering work for the M1M3 monolith for the Large Synoptic Survey Telescope (LSST). The primary (M1) and tertiary (M3) mirrors are designed as one block of glass: vertically continuous but with different radii of curvature so that their surfaces form a cusp at their intersection. This design allows them to be fabricated from a single casting. The mirrors will be spun cast in a parabola consistent with the primary mirror surface. After casting, 2.1 cubic meters of glass will be ground out of the center to form the tertiary surface. LSST Corporation and SOML have conducted extensive design reviews and on November 9, 2007 determined that M1M3 casting could proceed. At the end of March 2008, SOML will begin casting this distinctive mirror.

SOML has a unique mirror casting process developed from early experiments in Roger Angel's backyard kiln in 1982 through the 8.4-meter honeycomb mirrors cast for the Large Binocular Telescope in the late 1990s. There are 275 unique cores in the LSST mold and a total of 1650 cores to be installed. View current photos of construction.

The cores are made of aluminum silicate and bolted down using silicon carbide nuts and bolts to secure the cores to the floor of the mold. The LSST casting will require 23.5 metric tons of glass. Each piece (4-5kg) of this borosilicate glass from Ohara Corporation in Japan is inspected prior to loading it in the mold with only 2-3% of the pieces rejected. The lower quality or high seed glass is placed in the mold first with the low seed or higher quality placed in last. This results in the better quality glass at the faceplate of the mirror. Cast silicon carbide tub walls are positioned around the outer floor tiles and inside the central hole. Inconel bands are installed around the outer tub walls to hold them together and balance the hydrostatic pressure of the glass during casting.

The LSST casting cycle is about four months long, somewhat longer than previous castings due to the special features of the LSST design. At the end of March 2008, the furnace temperature will rise to 1180°C and maintain a rotation speed required for the LSST blank (M1's radius of curvature) calculated at 6.7 revolutions per minute (RPM). The M1M3 monolith will spin in accordance with the specifications of the longer radius of curvature of the M1 surface, leaving excess glass over the more deeply curved M3 surface. The furnace has 270 heaters and over 600 thermocouples. Seven CCD cameras mounted in the furnace lid monitor for glass melt (flow and depth) and record leaks and excessive bubbles on the mirror faceplate.

"Oven pilots" will track the progress twenty-four hours per day for four months. The critical month long annealing period will occur when the temperature decreases 2.6°C per day from 530°C to 450°C to stay within pressure limitations. When compared to previous mirrors, the LSST's extra glass extends the annealing time required to minimize unwanted stress in the casting by a factor of two. The thermal uniformity in the glass defines the residual stress in the mirror. Further cooling, from 400°C to 20°C, will take approximately 100 days.

As technicians load the cores and then glass, engineers are busy with the design and fabrication of the substrate support equipment such as the casting lifting fixture and the polishing cell design to be ready when casting is done. After the casting is complete, SOML personnel will move the mirror into the mirror handling ring where they turn it on edge to be cleaned prior to grinding and polishing steps.

The unique design of M1M3 monolithic mirror provides permanent alignment between the primary and tertiary mirrors and will reduce the complexity of alignment at the telescope site. This design does pose challenges, however: very tight tolerances on centering the optical axes and aspheric profiles. These challenges add to the excitement of project—the cutting-edge development of this unique and reliable instrument fits well with the University of Arizona mission as well as providing LSST with an outstanding set of optics. Stay tuned for updates on the mirror progress with LSST Newsletter articles about the clean-out, grinding and polishing over the next two years.

For more information, contact Deputy Project Manager, Victor Krabbendam.