Large Synoptic Survey Telescope
E-News

March 2008 Issue 1

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FROM THE EDITOR…

Suzanne Jacoby

On behalf of the LSST Project Office I'd like to welcome you to the first issue of our newsletter. Our goal is to raise public awareness of the project and keep interested parties, including our distributed project staff, informed of progress. At the moment, it feels like the project is on fire—figuratively and literally! We're riding the wave of publicity from the generous $30M donation from Charles Simonyi's fund and Bill Gates, recovering from a most successful AAS Meeting with a gauntlet of 28 science posters and an exhibit featuring Todd Mason artwork, and preparing for HIGH FIRE of the primary/tertiary mirror at the University of Arizona Steward Observatory's Mirror Lab scheduled for late March. There's never been a better time to launch a newsletter—all we need is the time to write it! We anticipate a quarterly production schedule as we start out and welcome your comments to make the LSST Newsletter as informative as possible.
Contact: enews@lsst.org

PROJECT MANAGER'S CORNER

Don Sweeney, LSST Project Manager

With the successful completion of our Conceptual Design Review last September, LSST moved substantially closer to beginning construction. To make the plans for construction and mirror casting a reality, LSST management continued to work on major fund raising. We are pleased to announce that this January the Charles Simonyi Fund for Arts and Sciences provided $20 million and Bill Gates gave $10 million to support the LSST Project. This major joint gift keeps the project on schedule by enabling early fabrication of LSST's large optics and manufacture

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of other long-lead components of the LSST system. The mirror casting is scheduled for March 2008 (see accompanying article) and is our major milestone for the spring.

Over the last six months we have continued to build the LSST team. Carnegie Mellon University is our newest institutional member bringing our growing membership to twenty-three. With CMU, the University of Pittsburgh and Google-Pittsburgh form a strong local node of collaboration. LSST is also building international partnerships. The camera system collaboration with Institute National de Physique Nucleaire de Physique des Particules (IN2P3) is moving forward. At the May All-Hands meeting LSST will bring all team members together for discussions of science, working group meetings and tours hosted by National Center for Supercomputing Applications (NCSA). A key agenda item will be preparation for the upcoming Preliminary Design Review.

Tony Tyson, LSST Director, testified to the House of Representatives Committee on Science and Technology, Subcommittee on Space and Aeronautics on November 8, 2007 about the status of the survey program for near-Earth objects (NEOs).

This January LSST scientists and engineers presented a poster session at the American Astronomical Society meeting in Austin, Texas. We were able to bring the conference goers up-to-date on the project progress and discuss both the technical aspects and scientific plans for the project. For example, the project has completed the preparation of the Request for Proposals (RFP) for sensor development, which will be released this month

Tony Tyson, LSST Director

SCIENCE UPDATE

LSST to Solicit Applications for Scientists to join Science Collaborations

LSST will have a scientific impact on fields ranging from studies of asteroids in the Solar System to the nature of dark energy. To manage the science investigations, LSST established a series of *Science Collaborations*, semi-autonomous groups of scientists drawn from the astronomy and high-energy physics communities. 179 scientists from the LSST project team and member institutions have signed on already. They are laying the detailed groundwork to carry out scientific investigations once LSST commissioning begins in 2014. This spring LSST will begin to solicit applications for additional scientists to join the existing science collaborations. Membership in these collaborations is open to the US astronomical and high-energy physics communities. The National Optical Astronomy Observatory (NOAO) and Stanford Linear Accelerator Center (SLAC) will oversee the proposal process.

The *Science Collaborations* work with the LSST team on various aspects of survey design, science tradeoffs, software pipelines and database design. Together they are developing code and other analysis

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techniques to allow them to take full advantage of the data once it starts to flow, and are planning precursor or follow-up observations using other facilities needed to meet their scientific goals. The collaborators will take the lead in carrying out science investigations with early data from the LSST, to commission the system and reveal subtle problems in the data.

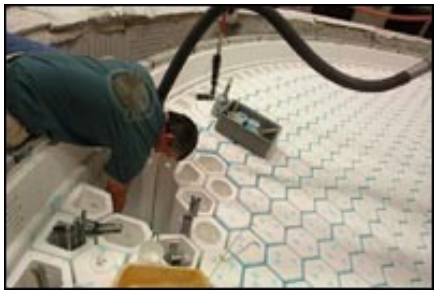
There currently are ten science collaborations chaired by researchers of the member institutions:

- **Supernovae:** M. Wood-Vasey (CfA)
- **Weak Lensing:** D. Wittman (UC Davis) and B. Jain (UPenn)
- **Stellar Populations:** Abi Saha (NOAO)
- **Active Galactic Nuclei:** Niel Brandt (Penn State)
- **Solar System:** Steve Chesley (JPL)
- **Galaxies:** Harry Ferguson (STScI)
- **Transients/Variable Stars:** Shri Kulkarni (Caltech)
- **Large-scale Structure/Baryon Oscillations:** Hu Zhan (UC Davis)
- **Milky Way Structure:** James Bullock (UC Irvine)
- **Strong Gravitational Lensing:** Phil Marshall (UCSB)

Michael Strauss

LSST also invites the scientific community to submit ideas for additional science collaborations. Please contact Michael Strauss strauss@astro.princeton.edu to do so.

For more information, contact
Michael Strauss, Chair Science Advisory Committee.



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

FOCUS ON…

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

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.

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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. Current construction photos can be viewed at http://www.lsst.org/

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.

DATA MANAGEMENT AND THE GOOGLE PARTNERSHIP

Jeff Kantor

LSST presents immense and stimulating challenges in data management. LSST will collect, process and store more than 1000 times the data of any existing optical telescope each night. LSST will take over 1000 panoramic images per night, 30 terabytes of data in a ten-hour winter night. The data management system (DMS) will compare new with previous images to monitor change. Multiple Data Challenges, prototypes of the full DMS, take place during the Design and Development phase of the project.

Each data challenge validates a different aspect of the system. DC1, completed in 2006, tested the scalability of the overall processing architecture and data flows. DC2, just completed, prototyped the nightly processing pipelines that produce transient alerts and the middleware that supports them. DC3 will prototype the data release pipelines in 2008. Finally DC4 will examine data access by the astronomical community and the data processing that supports scientific use of the LSST data.

Tim Axelrod

The data management challenges and the information LSST will gather have attracted Google to the partnership. LSST and Google staff had a face-to-face meeting in October at Google headquarters in Mountain View, CA. Approximately fifty people attended with representatives from all data management partners and LSST project management, Royal Edinburgh Observatory and Google. Principals of Sky and Google Earth attended as well. Google presented information on Google technologies that may be useful to DMS. The group established the basic scope for the Data Challenge 3 (DC3) and identified areas for exploring open source versions of Google map reduce, bigtable, and file system technologies in DC3.

For more information, contact
Tim Axelrod, Data Management Scientist and
Jeff Kantor, Data Management Manager

SITE VISIT UPDATE

In May 2006 LSST Corp selected 2,682-meter (8,800-foot) Cerro Pachón in northern Chile for the site of the LSST Observatory. This selection followed two years of in-depth testing and analysis of the atmospheric conditions and utility for hosting the LSST. From numerous worldwide sites candidates, the project team narrowed the selection to four finalists, sites in Chile, Mexico and the Canary Islands, and then settled on Cerro Pachón as the best choice. With the selection made, work has continued to characterize the site and 2008 will see the start of rough excavation. 2008 will also see the selection of an architecture & engineering firm.

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L-R: Chuck Claver, Victor Krabbendam, Don Sweeney and Steve Kahn.

An ongoing data-taking and evaluation campaign continues. Instrumentation on the site includes two all-sky cameras (infrared and visible), a differential image monitor (DMM). Future newsletter issues will highlight the instruments and results of the analyses.

Structural analysis of the telescope also continues. One aspect that must be taken into account is the impact of seismic events at the site. Chilean observatories have experienced earthquakes of over 7.0 magnitude on the Richter Scale and are frequently jostled by smaller magnitude tremors. Observatories in Chile, as elsewhere, have long-established systems for design and operations in an earthquake zone. In December, these observatories hosted an earthquake conference to address design and operational needs due to earthquakes.

LSST modal analysis has been developed in steps and now includes the concrete pier and rock base. The results led to a design of a wide pier with stepped thickness to provide stiff support for the telescope. The detailed analysis of the telescope top end showed a factor of 10 safety margin for buckling under maximum operations and earthquake transverse and vertical loading.

Victor Krabbendam

For more information on Data Management or Site, contact Victor Krabbendam, Telescope and Site Manager.

UPCOMING ISSUES

Our next issue will provide updates about M1/M3 casting progress, the All-Hands Meeting in May 2008, sensor and camera development, and a feature which highlights one of the LSST team members and his/her work.

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