Large Synoptic Survey Telescope
E-News

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The Project Office welcomes you to the July 2009 issue of LSST E-News. The pace throughout LSST is intense and focused, with all our efforts directed toward moving along the path to funding and construction as described in the featured articles.

We draw your attention to another newsletter, a special edition of the Gemini Observatory newsletter which marks 400 Years of the Telescope by looking back at Gemini's history and its people. Included is Sidney Wolff, first director of Gemini and President of LSST Corporation.

In This Issue

Good Planning Leads to Informed Decisions

Suzanne Jacoby and Sidney Wolff

In these days of limited funds to pursue increasingly ambitious goals in scientific research, it is more important than ever to prioritize projects. And so the National Research Council (NRC) is again engaging the community in a review process to survey the field of space- and ground-based astronomy and astrophysics and recommend priorities that will influence funding decisions. Every ten years this Decadal Survey process unfolds, resulting in a concise report addressed to relevant funding agencies and read by Congressional committees with jurisdiction over those agencies, the scientific community, and the public. A high ranking in this survey is critical for projects seeking construction funding from the federal government in the next decade. The current decadal survey, Astro2010, is well into its mission of assessing activities in astronomy and astrophysics, including both new and previously identified concepts, and recommending priorities for the most important scientific and technical activities of the decade 2010-2020. LSST is participating fully in the process and made a presentation at the most recent meeting of the Optical and Infrared Prioritization Panel in Pasadena, CA.

Astro2010, the current astronomy and astrophysics decadal survey, is the latest in a series of surveys that are produced every 10 years by the National Research Council (NRC) of The National Academy of Sciences. The survey statement of task, structure, committee/panel membership, and community input processes are described online, along with an FAQ. Astro2010 is organized by the NRC's Board on Physics and Astronomy (BPA) in cooperation with the Space Studies Board (SSB). LSST has been assigned to the Optical and Infrared (O/IR) panel of Astro2010. As one of the four Astro2010 Program Prioritization

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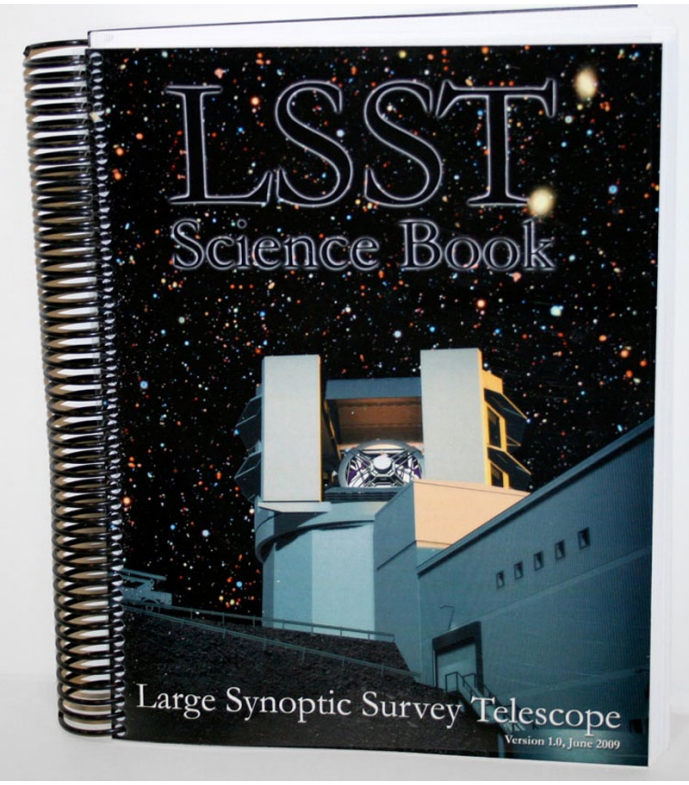

Version 1.0 of the LSST Science Book unveiled June 2009.

Panels (PPP), the O/IR panel is charged with recommending a prioritized, balanced, and integrated research program, which includes a rank ordering of research activities and a balanced technology development program for observatories and telescopes that primarily observe in the optical and infrared from the ground.

White Papers

In order to survey the community, the survey committee issued a solicitation in January for White Papers on science, facilities, and the state of the profession, resulting in more than 600 responses. Over 150 Notices of Interest for Activities were submitted, including one for LSST. This was followed by more than 320 Science White Papers in February, along with 69 State of the Profession Position Papers, and over 70 papers on Development Technology and Theory, Computation, and Laboratory Astrophysics. At least 17 Community Town Hall meetings held across the country have provided the astronomy and astrophysics community the opportunity to self-organize and develop coordinated input into the Astro2010 survey process. The input from these events has been very valuable to deliberations within the survey; all White Papers are available online.

The survey committee responded with a Request for Information about each project, including LSST, and so teams of LSST scientists and engineers prepared a 19-page response, which was followed by more detailed answers to eight questions posed by the Astro2010 O/IR Panel. These questions ranged from the scientific importance of the u-band to our plans for data distribution. This response was provided in writing and also orally to the O/IR panel in Pasadena in June.

Science Book

Parallel to this effort of supplying information to the Astro2010 committees, LSST science collaboration teams have been working for months on the LSST Science Book under the leadership of Michael Strauss, Science Committee Chairman, and LSST Director, Tony Tyson. As described in the December 2008 issue of E-News, authoring the book began in earnest with a meeting in Friday Harbor, San Juan Island, Washington, with Zeljko Ivezic, Chair of the LSST Science Council, organizing the meeting and keeping all attendees hard at work. The purpose of the book is to lay out some of the important scientific problems that can be addressed only through the rich data set that will be provided by LSST. Many of these ideas originated at the June 2008 All Hands Meeting in Urbana-Champaign, where each science collaboration team reported on ten science initiatives that require LSST. Considerable collaborative work over the ensuing months resulted in the Science Book, with over 500 pages and an author list of 194 individuals. Version 1.0 of this extraordinary work was presented to the O/IR panel during the LSST response.

AAS Meeting

The 214th meeting of the American Astronomical Society took place June 7-11 in Pasadena, CA, concurrent with meetings of the four Astro2010 Program Prioritization Panels. Tony Tyson, speaking on behalf of the LSST team, made a presentation to the O/IR panel. The written submissions will be made public on a short time scale by the Astro2010 committee at the URL mentioned previously.

In an email addressed to the Science Collaborations, Tony reported that “a vivid part of our presentation

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was the unveiling of our 195-author 554-page Science Book, which clearly demonstrated that LSST will be a survey by the community for the community. I would like to use this opportunity to thank you all for your hard work on the Book and your support for LSST. We should all be especially appreciative of the enormous amount of dedicated work by Michael Strauss and our editorial team to produce this initial version in time to present it to the Astro2010 committee. With additional analysis and improvements to be incorporated over the summer, we expect to announce the first publicly distributed version this fall."

Next Steps

Work on the LSST Science Book continues this month, with team members participating in the Aspen Center for Physics summer workshop on Wide-Fast-Deep Surveys: New Astrophysics Frontier. We continue to prepare for our Preliminary Design Review, which will be conducted by the National Science Foundation. Results of the Decadal Survey process will be made public in the summer of 2010.

From LSST Science Requirements to an Engineering Design

Don Sweeney, Project Manager, and Chuck Claver, LSST System Engineer

Right down to the nuts-and-bolts, how many millions of parts will there be in the LSST Observatory? We don't really know nor does it actually matter. What does matter is our confidence that these parts come together as a system to perform the scientific mission of the LSST. This brief article introduces the way the LSST Systems Engineering Team is doing this job.

The value of the LSST is its ability to do produce scientifically valuable data. The project has captured literally hundreds of important scientific missions in the LSST Science Book (see picture in the previous article.) These scientific missions in-turn lead to a formal document called the Science Requirements Document (SRD) that itemizes the specific scientific requirements that a telescope, camera, and data management system need to have to perform these missions. The LSST SRD is available on the public web site. Beginning with the SRD, the LSST scientific and engineering staff must take this high-level document and create a specific engineering design that we can build.

It's easy to appreciate that this is an extremely complex task with thousands of interrelated requirements as inferred by the construction cost of the LSST system complex approaching $500M. Adding to this are the additional requirements that

- we must be able to document and trace the entire system design flowdown;
- communicate the system architecture in a common format with the entire team that is distributed around the United States and parts of Europe;
- maintain an ability to change the design and refine requirements while understanding the complex interactions of those changes.

The basic process of going from the scientist's idea to the finished observatory is captured in the figure.

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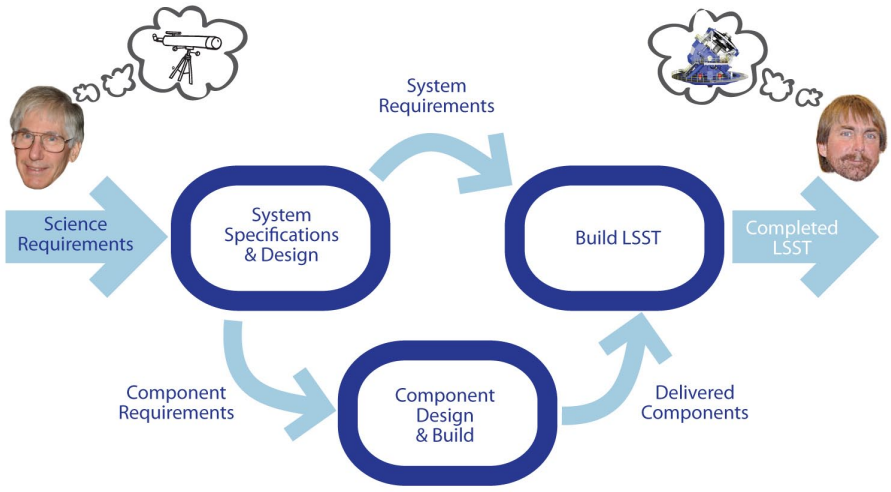

The LSST System Engineer (Chuck Claver) takes the scientific description provided by the astronomers (eg, Tony Tyson) and follows a formal process (SysML) to design an architecture that meets all the scientific requirements.

To do all this, the LSST Project has adopted a model based systems engineering (MBSE) approach. Central to the LSST's MBSE effort is the recently released modeling language called the Systems Modeling Language (SysML), an open-source standard developed and managed by the Object Management Group. SysML is a formal, computer-based language to model all of the different factors in the course of engineering complex systems like the LSST, including requirements flow down, information flow, system states, activity sequencing, component behavior, and software. The purpose is to expose, control, and validate the complex LSST system in the face of changing schedules, budgets, and even technical requirements.

Today any engineer or scientist working on the project with web access can query the configuration of the LSST no matter where they are.

Our system modeling with SysML is part of an ongoing process that has yet to reach completeness. In fact the MBSE process will evolve throughout the lifecycle of the project, from design and development, to construction, to integration and testing, through commissioning of the LSST. Today we are in the process of having all subsystem requirements and interfaces along with their traceability fully modeled and translated into the SysML. Also, we are actively implementing within the SysML model end-to-end dynamic relationships that characterize the quantitative interactions between various design choices.

This is a substantial resource investment by the Project but an investment that we believe will pay off in a world class observatory that meets all its technical requirements on-schedule and on-budget.

Phil Marshall- New Royal Society University Research Fellow

Anna H. Spitz

The LSST Science Collaboration Teams consist of more than 230 members. Here we profile Phil Marshall, chair of the strong lensing team, prompted by his being chosen as one of thirty University Research Fellows of the Royal Society, the national academy of science of the UK and the Commonwealth. This prestigious fellowship is a research-only position, which Phil plans to take up at Oxford University in 2010.

The Royal Society University Research Fellows are young scientists across all natural scientific disciplines with the potential to become leaders in their chosen field. Phil's outstanding work on gravitational lensing, first as a graduate student at the University of Cambridge and then in California, earned him the distinction of being one of a handful of University Research Fellows with a specialty in astronomy selected this year. This fellowship is highly competitive with an acceptance rate of just 5%. The fellowships generally run for five years with the possibility of a three-year extension. Fellows are strong candidates for permanent posts at the end of their fellowships.

Since September 2006 Phil has been the TABASGO prize postdoctoral research fellow in the astrophysics group at the University of California at Santa Barbara. As TABASGO fellow he is paid by and thus affiliated with the Las Cumbres Observatory (LCOGT). Prior to his current appointment and after completing his PhD

Phil Marshall will spend one more Christmas in Northern California as Kavli Fellow at Stanford before returning to his his native England as Royal Society University Research Fellow.

in 2003, Phil was one of the first generation of postdocs at the newly-formed Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) at Stanford.

Phil's principal research interest is gravitational lensing. With Tommaso Treu, Marusa Bradac, Raphael Gavazzi, and Matt Auger at UCSB he is working on a number of observational projects on galaxy-scale lens systems, investigating the use of adaptive optics, and calibrating samples of standard masses for cosmology. He is very interested in statistical studies of large samples of gravitational lenses. He leads the

Phil Marshall (cont.)

Hubble Space Telescope (HST) Archive Galaxy-scale Gravitational Lens Search, which is combing hundreds of HST images for gravitational lenses, and he is also a member of the Strong Lens Legacy Survey, an international project to find and follow-up lenses in the Canada France Hawai'i Telescope (CFHT) legacy survey. These are precursor surveys for LSST.

Phil says that, like all astrophysicists, he works in the low signal-to-noise regime where information is at a premium and prior knowledge inevitably becomes important at some stage - developing probabilistic methods for data analysis is a continuing theme in his work. He is especially interested in the problem of extracting the maximum amount of information from LSST's survey imaging, given how expensive it would be to follow up the huge samples of interesting things it will discover. The LSST data analysis challenge is big enough that he is starting work on it now: Phil has opted to defer his Royal Society position for a year, and spend that time as Kavli Fellow at the KIPAC laboratory at Stanford University, preparing the software development environment so that he can continue work on it from the UK.

Kudos and continued success to Phil.

LSST-NCSA: A Partnership to Change the Way Science is Done

Anna H. Spitz

LSST is partnering with the University of Illinois at Urbana-Champaign's National Center for Supercomputing Applications (NCSA) to design large-scale computing, storage and networking infrastructure for the Data Management (DM) system. Since its opening in 1986, NCSA has made significant contributions to the growth of cyber infrastructure for science and engineering. NCSA provides the design of infrastructure and middleware for LSST, and it will host the archive. The partnership of LSST and NCSA experts will make possible LSST's ability to process the expected 15 terabytes of raw data and more than 100 terabytes of processed data each night.

NCSA is a unique state-federal partnership to develop and deploy national-scale cyber infrastructure that advances science and engineering. NCSA is one of the original National Science Foundation (NSF) Supercomputer Centers. Funding now comes from the state of Illinois, the University of Illinois, private sector partners, NSF and other federal agencies.

The building that will house Blue Waters, the Illinois Petascale Computing Facility, is one of the many elements of the project on the leading edge of innovation. Construction began in October 2008, and is on schedule for completion in 2010. In keeping with Illinois's commitment to environmental stewardship and infrastructure sustainability goals, Leadership in Energy and Environmental Design (LEED) certification is planned. The Blue Waters system itself will use water-cooling rather than the air-cooled method typically used for supercomputers. IBM expects water cooling to reduce energy consumption by approximately 40 percent. Planners expect a similar increase in energy efficiency. Such attention to sustainability is expected to reduce electricity required for cooling and lessen annual operating costs.

Who is making it all happen?

Currently six NCSA-ers are involved in the LSST project. They are engaged on two fronts with the LSST effort: middleware design and development and archive design. Ray Ray Plante is head of the NCSA LSST team and leading the middleware design for the LSST DM. He has an amazing combination of skills: he is an astronomer by training, and has enormous experience with software design and development. The NCSA personnel effort will increase

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to about ten FTE per year once the LSST enters its construction phase.

Cristina Beldica, initial project manager for the LSST effort, has an interest in the project typical of many participants: "I came to work with LSST in 2004 after finishing the NEESgrid earthquake engineering project. My experience there with a large NSF effort was a perfect match for LSST. Plus, I also had experience with working with diverse, geographically distributed teams. I think what makes LSST so exciting are its ambitious science goals; from the DM perspective it's probably the sheer amount of data and derived from this, the degree of precision and automation that the DM system requires. There are all these checks and balances that need to be in place to make sure every bit of information goes where it is supposed to go."

The Blue Waters Project

LSST is certainly not the only cutting edge activity underway at NCSA. With the advent of the Blue Waters system, due online in 2011, NCSA will be home to the first computer system dedicated to open scientific research sustaining more than one petaflops (one quadrillion calculations per second). Blue Waters, a supercomputer of unprecedented power, is a joint effort of NCSA, the University of Illinois at Urbana-Champaign (an LSST institutional member), IBM, and the Great Lakes Consortium for Petascale Computation.

NCSA is creating teams with great breath and depth of expertise for this project. Currently approximately eighty people at University of Illinois are directly involved in the Blue Waters project at least part-time. Other people working on the project include staff from the University of North Carolina, Louisiana State University, Los Alamos National Laboratory, University of Michigan, and Shodor Foundation. The number of people involved in the project will increase as it engages with more potential users of the system, and for the deployment and commissioning phase. "We expect to have around seventy FTEs during the production stage," says Beldica, Senior Program Manager of Blue Waters.

Success of a project as large and ambitious as Blue Waters requires special management attention and expertise. This is a large and complex project that involves not only construction of a building and the deployment of hardware and equipment (as if that weren't enough!), but also software development (NCSA is working on this in partnership with IBM), application support, and education and outreach. Beldica became involved with the Blue Waters project during the proposal writing. NCSA needed to convince NSF and the reviewers that the team knew how to manage such project. Therefore the proposal included a detailed management plan. After winning the award, it came time to implement this plan and to execute it. The team understood that Blue Waters is not one of the typical research projects that one expects to find at a university. Instead, it requires a greater degree of discipline and formal project management. The challenge is to implement all the controls needed in a project of this magnitude without making it a burden for the team. "So far, I think we're doing a good job!" says a cautiously optimistic Beldica.

How could LSST and Blue Waters Interface?

LSST will have its own dedicated computers, disks and archive for storing and processing the data that comes from the telescope. But in addition to the nightly processing, LSST DM will periodically reprocess the entire data set collected to that point. It is possible that such massive tasks could exceed the capability of the dedicated LSST resources (or require a long processing time). In these situations, running these pipelines on the Blue Waters system could not only save time, but enable some types of processing that might otherwise be prohibitive or even impossible.

Large simulations and computationally intensive science applications (astronomy, high-energy physics) that use LSST data could benefit from the use of the Blue Waters system. Petascale Computing Resource Allocations (PRAC awards) from the NSF allow research teams to work closely with the Blue Waters project team in preparing their codes to run on Blue Waters. In order to receive an award of time on Blue Waters when it comes online in 2011 through the NSF allocation process, teams must receive a pre-allocation through the current PRAC process. Both PRAC awards and allocations of time on Blue Waters will be based on peer-review. LSST-related projects would use this mechanism to obtain time on the system.

The initial set of PRAC awards that were recently announced (six so far) includes two astronomy applications. (see Petascale Computing Resource Allocations at nsf.gov). Beldica says, "In my opinion this is a good indicator that NSF recognizes the potential of Blue Waters for enabling astronomy research."

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The building for the Blue Waters project is scheduled for completion in 2010.

The Blue Waters consulting office responds to questions from prospective users of the system. Interested parties can contact the office at bwconsult@ncsa.uiuc.edu.

A strong and growing collaboration

From both NCSA and LSST, come praise for the collaboration and ideas for even more exchanges: "The experience that we are gaining from the Blue Waters will help us in the design and deployment of the LSST Archive Center. For example, in the early stages of LSST, the size of the LSST archive seemed quite daunting. However, now it appears rather reasonable compared to the archive that will support Blue Waters (currently estimated at 500 petabytes)," according to Beldica.

"NCSA's deep experience in developing and operating supercomputing facilities is considered critical to the success of the DM project. NCSA's October 1, 2008 NSF award to host the Tier 1 Petascale Facility (Blue Waters) is very important to LSST DM, as the LSST Archive Center is scheduled to be hosted in that facility, given its advanced design, connectivity, and capacity," says Jeffrey Kantor, LSST Data Management Project Manager.

The LSST-NCSA collaboration is unique: "In terms of the collaboration model, I believe that the collaboration with LSST is much stronger than what we plan for Blue Waters. The way I see it the NCSA team is an intrinsic part of LSST. In Blue Waters, as expected, a great part of our efforts is focused on getting the system ready for production. At the same time, we are fully aware that the system itself is not worth much unless there are codes ready to take advantage of its capabilities from the very first day of production. Therefore, we have devised an application and user support plan that includes engagement with the PRAC awardees and the formation of PACTs (Petascale Applications Collaborations Teams). The goal is to provide the science and engineering research teams with the resource and knowledge to help them scale up their applications for running on Blue Waters. In these early stages, since the actual hardware is not yet available, the teams use simulators and emulators to analyze and tune the codes." The Blue Waters project offers even more potential for evaluation of LSST data through the mechanism of PRAC awards.

The partnership of LSST and NSCA on data management research creates a collaborative effort with great personal talent and commitment to employ unprecedented supercomputing capabilities. This collaboration is changing the way science is done.

For more information about NCSA, see http://www.ncsa.illinois.edu/.

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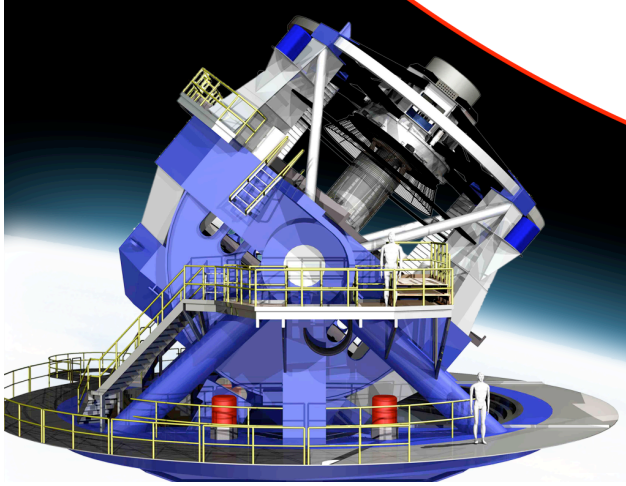

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