

# Project Overview

Steven M. Kahn  
LSST Director



# Congratulations!

- As I think all of you are now aware, this meeting comes right on the heels of a major event for LSST, the award from NSF to officially start the project construction.
- This could not and would not have happened without the combined heroic efforts of the people sitting in this room today.
- You should all pat yourselves on the back, and if you haven't already done so, go drink some champagne.
- But don't get too comfortable in your success – Now we actually have to build this thing! It is still a long road ahead, and I have no doubt we will face many challenges. But if we continue working together as well as we have to date, we will go down in history as having created what I believe will be one of the most important scientific experiments in human history!

# Outline

- Funding status and agency milestones
- Project organization
- Interactions with the community
- Foreign participation
- Key issues for the year ahead
- Conclusion

# LSST is a Public/Private, Interagency Project

- The National Science Foundation:
  - Support for the telescope and site facility construction, the data management system, and the education and public outreach components.
  - Funded under the Major Research Equipment and Facility Construction (MREFC) line. Total *not to exceed* cost is \$473M.
  - Prime contractor for this effort is the Associated Universities for Research in Astronomy (AURA), which also manages the National Optical Astronomy Observatory (NOAO), the Space Telescope Science Institute (STScI), and other facilities.
- The Department of Energy:
  - Support for the camera fabrication.
  - Funded as a Major Item of Equipment (MIE), through the Office of High Energy Physics in the Office of Science. Total *estimated* cost is \$165M. *Cost will be baselined at CD-2.*
  - SLAC National Accelerator Laboratory is the lead DOE lab for the LSSTcam project.
- Private Support:
  - Key donors include the Lisa and Charles Simonyi Fund for Arts and Sciences, Bill Gates, Richard Caris, the W.M. Keck Foundation, Research Corporation for Science Advancement, Wayne Rosing and Dorothy Largay, Eric and Wendy Schmidt, and Edgar Smith.
  - Total Support has been ~ \$40M.
  - Funded development of the primary/tertiary mirror, the secondary mirror blank, preliminary site preparation, as well as early sensor studies and some data management activities.
  - Responsible organization is the Large Synoptic Survey Telescope Corporation.
  - Key assets will be transferred to AURA for use in construction.



# LSST in the FY14 President's Budget

## NSF

“In FY 2014, NSF requests funding to continue construction of four projects: Advanced LIGO (AdvLIGO), Advanced Technology Solar Telescope (ATST), Ocean Observatories Initiative (OOI), and the National Ecological Observatory Network (NEON). **NSF is planning to begin construction of one new project in FY 2014, the Large Synoptic Survey Telescope (LSST).**”

“The FY 2014 Budget Request for the Large Synoptic Survey Telescope (LSST) is \$27.50 million. This is the first year of support for an eight-year project that will begin in July 2014. The total project cost to NSF is estimated at \$465.93 million. This project is being developed in partnership with the U.S. Department of Energy (DOE). “

# LSST in the FY14 President's Budget

## DOE

“The Large Synoptic Survey Telescope Camera (LSSTcam ) ... will open a new window on the universe and address a broad range of astronomical topics with an emphasis on enabling precision studies of the nature of dark energy. ... The project is carried out in collaboration with NSF, along with private and foreign contributions. **DOE will provide the camera for the facility. CD-1 for the LSSTcam project was approved in April 2012, with an estimated total DOE cost range of \$120,000,000–\$175,000,000 and estimated completion date of FY 2021.**”

# Omnibus Bill Budget Language

## **NSF:**

“This Act includes \$200,000,000 for Major Research Equipment and Facilities Construction. Funds are provided at the request level for all projects for which construction has already begun, and remaining funds are for the initiation of the Large Synoptic Survey Telescope (LSST) project. If NSF determines that LSST requires additional funding in fiscal year 2014, NSF may submit a transfer proposal to provide such funds.”

The FY15 President’s Budget Request indicated that we will indeed get the full \$27.5M planned for FY14.

## **DOE:**

LSST not called out explicitly, but full funding \$22M in FY14.

# LSST in the FY15 President's Budget

## LARGE SYNOPTIC SURVEY TELESCOPE

**\$79,640,000**

**NSF:**

The FY 2015 Budget Request for the Large Synoptic Survey Telescope (LSST) is \$79.64 million. This is the second year of support for a nine-year project that will begin in July 2014. The total project cost to NSF is estimated at \$473.0 million.

### Requested MREFC Funds for the Large Synoptic Survey Telescope

(Dollars in Millions)

FY 2014 Estimate	FY 2015 Request	FY 2016 Estimate	FY 2017 Estimate	FY 2018 Estimate	FY 2019 Estimate	FY 2020 Estimate	FY 2021 Estimate	FY 2022 Estimate	Total Project Cost
\$27.50	\$79.64	\$99.67	\$67.12	\$55.80	\$47.89	\$45.75	\$39.90	\$9.73	\$473.00

Totals may not add due to rounding.

#### Projects

This activity supports all costs for design and fabrication of Cosmic Frontier projects, including major items of equipment (MIEs) and small experiments. The FY 2015 Request supports the 3 billion pixel precision camera (LSSTcam), which is the DOE contribution to the DOE-NSF LSST Project.

**DOE:**

Large Synoptic Survey Telescope (LSSTcam) Camera<sup>a</sup>

Total	Prior Years	FY 2013 Current	FY 2014 Enacted	FY 2014 Current	FY 2015 Request	FY 2015 vs. FY 2014 Enacted
159,600	0	0	22,000	22,000	35,000	+13,000



# Follow-Up Within the Agencies: NSF

- Successful Final Design Review held in December, 2013.
- Approval by the National Science Board.
  - Occurred in May, “subject to resolution of substantive residual issues”.
- Internal review by NSF of the submitted construction budget.
  - Took longer than expected, because the reviewers delved into more detail than had been common practice in the past.
  - Resulted in a decrease in the official project cost by ~ \$6M.
  - Still some minor issues, mostly involving justification for the contingency, which will be resolved by the end of the fiscal year.
- Award became official on August 1, exactly one month later than initially planned.

# NSF Press Release



Press Release 14-095

## **TAKING ASTRONOMY TO THE NEXT LEVEL**

**Large Synoptic Survey Telescope gets funding to begin construction**



LSST was the highest-ranked ground-based large initiative in NAS' 2010 decadal survey.

**Credit and Larger Version**

**August 7, 2014**

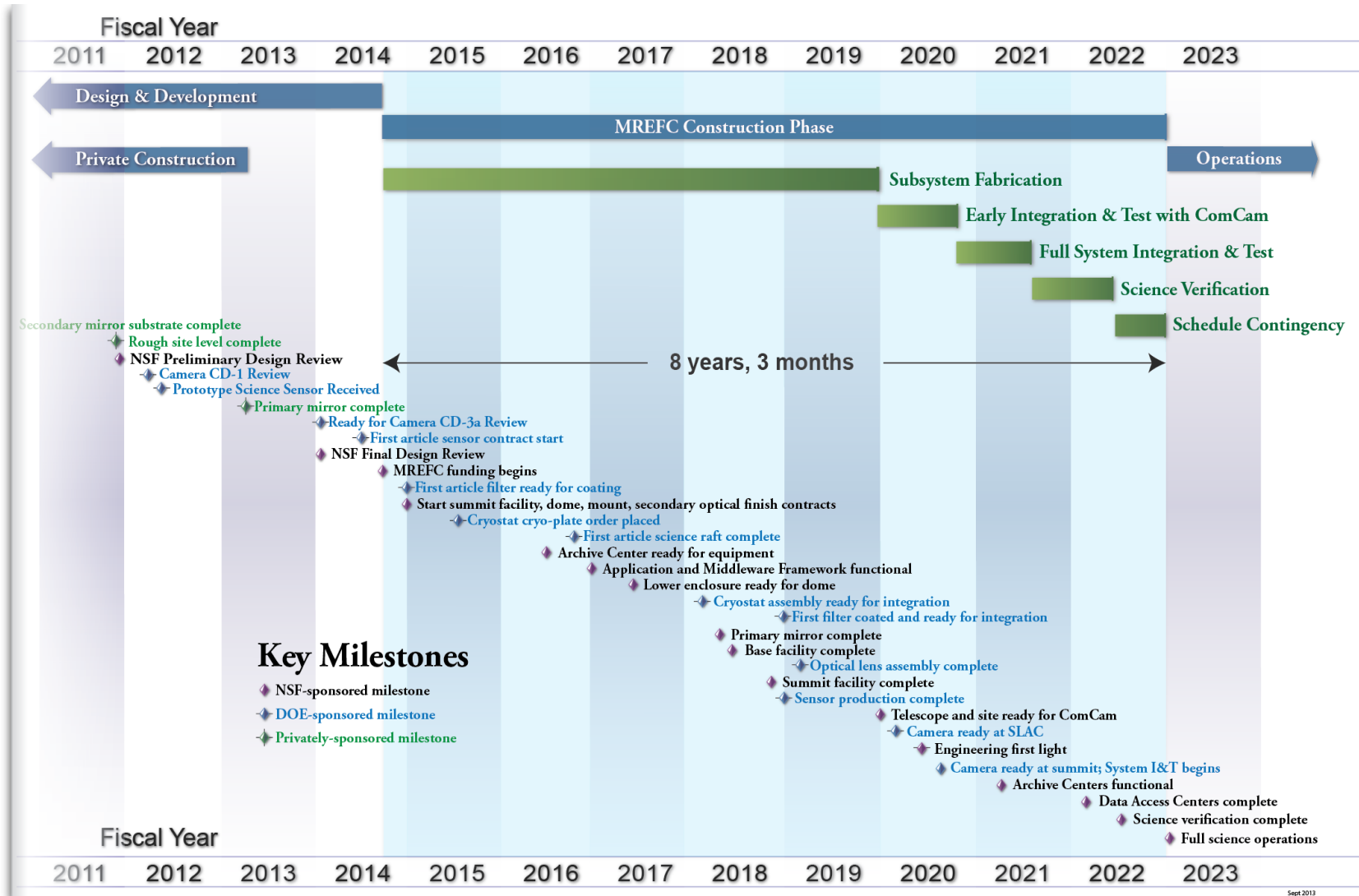
Construction of the highly anticipated Large Synoptic Survey Telescope (LSST) can begin now that the National Science Foundation (NSF) has finalized funding. To be located in Chile, LSST is a proposed 8-meter wide-field survey telescope that will image the entire visible sky approximately twice per week, providing an unprecedented amount of information while transforming the emerging discipline of data-enabled science.

LSST was the highest-ranked ground-based large initiative in the 2010 National Academy of Sciences decadal survey in astronomy and astrophysics. The project is a partnership among NSF, the Department of Energy (DOE) and a number of private contributors. Additionally, researchers from around the world, not only the United States and Chile, will provide operational support to facilitate LSST's mission.

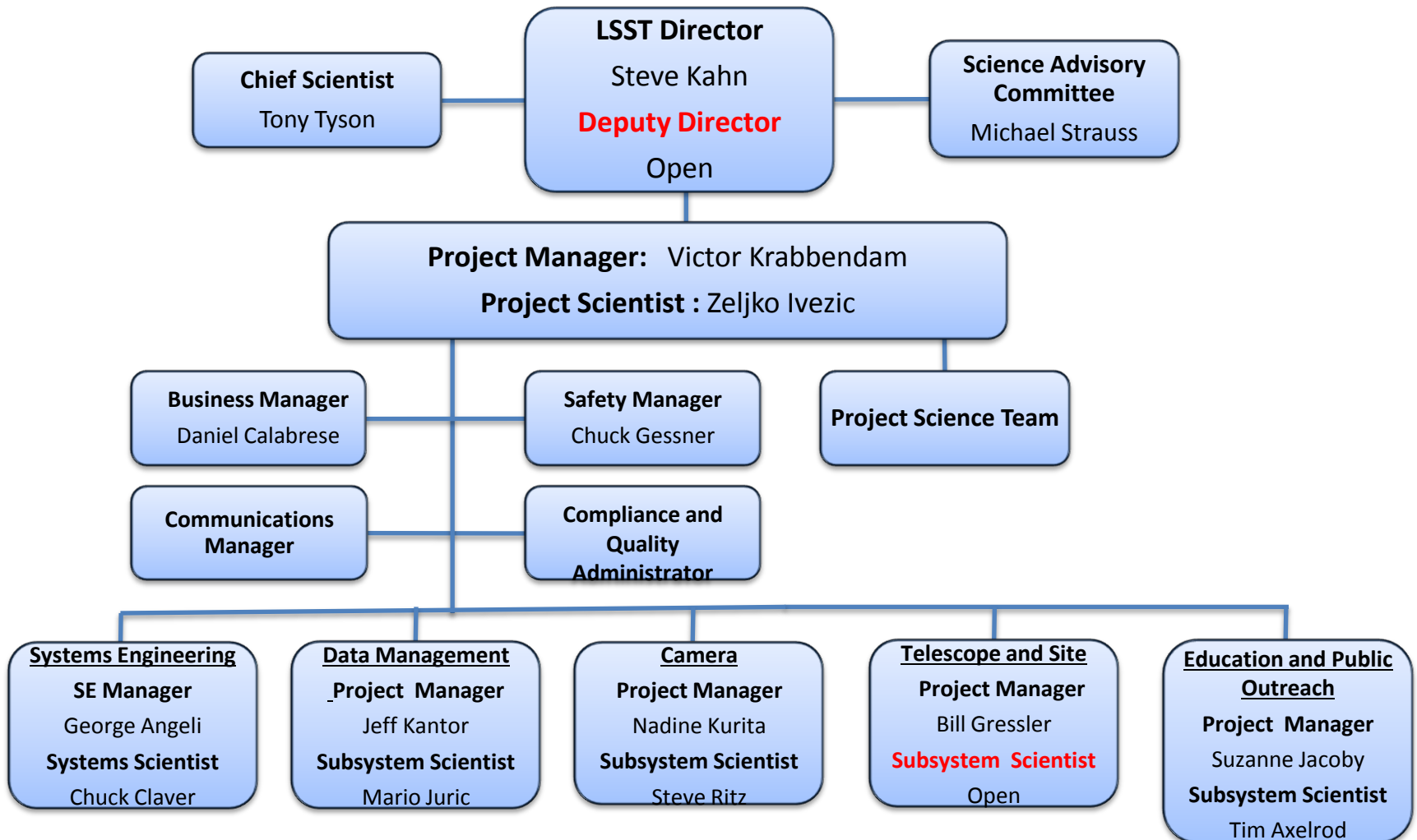
# Follow-Up Within the Agencies: DOE

- DOE approval on construction/fabrication projects proceeds via a series of steps called *Critical Decisions*.
  - CD-0 is a statement of “Mission Need”. Granted for LSST in March, 2011.
  - CD-1 is a selection of the alternative strategy to meet this need. At this stage a cost range is also established. Granted for the LSST Camera in April, 2012.
  - CD-2 is a review to determine the baseline total projected cost. The review will be held in November. The camera team is hard at work preparing for this review now.
  - CD-3 is the authority to begin the fabrication. For long-lead items, this can be granted in phases. We received CD-3a authority to procure the camera sensors in July of this year.
  - CD-4 marks the completion of the project.

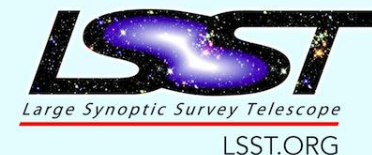
# Integrated Project Schedule



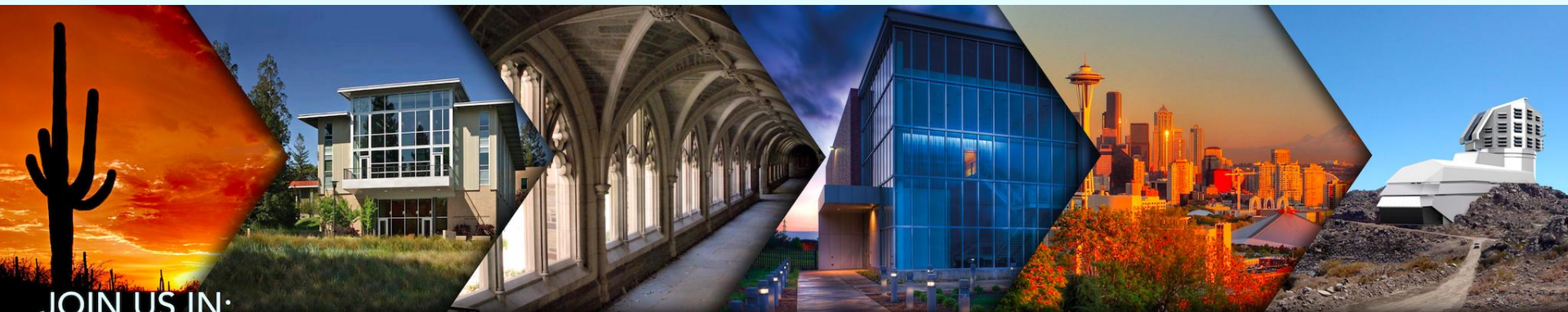
# LSST Project Organization Chart



# LSST IS HIRING



WE'RE SEEKING TOP TALENT TO WORK IN A TEAM ENVIRONMENT THAT INSPIRES EXCELLENCE.



## JOIN US IN:

LSST HEADQUARTERS  
TUCSON, AZ

SLAC/STANFORD  
MENLO PARK, CA

PRINCETON UNIVERSITY  
PRINCETON, NJ

NCSA / UIUC  
URBANA-CHAMPAIGN, IL

UNIVERSITY OF WASHINGTON  
SEATTLE, WA

LSST OBSERVATORY SITE  
CERRO PACHÓN, CHILE

## ABOUT US

LSST IS A PUBLIC-PRIVATE PARTNERSHIP AND THE TOP-RANKED LARGE-SCALE GROUND-BASED PROJECT FOR THE NEXT DECADE AS RECOMMENDED BY THE NRC'S ASTRO2010 DECADAL SURVEY. LSST WILL SCAN THE SKY FOR 10 YEARS, PRODUCING A PETABYTE-SCALE, NON-PROPRIETARY DATABASE DESIGNED TO ADDRESS THE MOST PRESSING QUESTIONS IN ASTRONOMY AND PHYSICS, WHILE DRIVING ADVANCES IN BIG-DATA SCIENCE AND COMPUTING.

## CAREERS

LSST IS A NEW PARADIGM FOR LARGE SCIENTIFIC FACILITIES: OPEN SOURCE, OPEN DATA, AND AN OPEN, FLEXIBLE WORK ENVIRONMENT. ALL LSST WORK SITES OFFER EXCEPTIONAL BENEFITS PACKAGES AND ROOM FOR PROFESSIONAL GROWTH.

## OUR TEAM

PROJECT OFFICE  
DATA MANAGEMENT  
TELESCOPE & SITE  
CAMERA  
EDUCATION & PUBLIC OUTREACH  
SYSTEM ENGINEERING



@LSST @mjuric

LSST.ORG/HIRING



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

CHARLES AND LISA SIMONYI FUND  
• • • FOR ARTS AND SCIENCES • • •



# The Project Science Team

- The Project Science Team (PST) serves as an operational unit, within the Project, that carries out specific scientific performance investigations as prioritized by the Director, the Project Manager, and the Project Scientist. Its membership includes key scientists on the Project who provide specific necessary expertise. The Project Science Team provides required scientific input on critical technical decisions as the project construction proceeds.
- The PST advises the Director, but is Chaired by the Project Scientist.
- Membership includes: Chuck Claver, Andrew Connolly, Zeljko Ivezic, Mario Juric, Steve Kahn, Robert Lupton, Steve Ritz, Christopher Stubbs, Tony Tyson. George Angeli and Victor Krabbendam.
- The Deputy Director and the Telescope Scientist are expected to join this team when they are appointed.

# The Science Advisory Committee

- The SAC provides a two-way connection between the LSST Project Office and the external science community served by LSST. Meetings occur monthly by phone and twice a year in person.
- Minutes of all meetings, including presentations will be distributed through the LSST website.
- Input from the community is strongly encouraged by contacting the committee members.
- Current members include: Niel Brandt (PSU), Harry Ferguson (STScI), Chris Hirata (OSU), Lisa Hunter (UCSC), Bhuvnesh Jain (UPenn), Jason Kalirai (STScI), Mansi Kasliwal (Carnegie), David Kirkby (UC Irvine), Renu Malhotra (UA), Rachel Mandelbaum (CMU), Dante Minniti (U Catolica de Chile), Ricardo Muñoz (U. Chile), Lucianne Walkowicz (Princeton), Beth Willman (Haverford) and Michael Wood-Vasey (U. Pittsburgh).
- Michael Strauss (Princeton) serves as chair.



# LSST and the Community: Science Collaborations

- A set of science collaborations was formed by the project in 2006. The intent was to provide a forum to engage the community in interacting with the project team to refine our understanding of the science opportunities and challenges in each of the main science areas that LSST will address.
- Early on, the project and NOAO exercised leadership roles in establishing criteria for collaboration membership and for collaboration governance.
- The collaborations played an essential part in the drafting of the LSST Science Book in 2009, which was instrumental to our achieving the top ranking by the Decadal Survey Committee in 2010.
- Over time, there has been some evolution in the configuration of the collaborations and their degree of independence from the project. A key development was the formation of the Dark Energy Science Collaboration in 2013, which operates more in the mold of a typical high energy physics collaboration than as a loose confederation of astronomers.
- At this stage, the Project will no longer take any oversight role for the collaborations. They are free to set their own policies for admission, governance, publication, etc. Our only constraint is that they not admit members from foreign institutions that have not yet established partnerships with LSST for a role in operations.



# LSST Science Collaborations

- **Supernovae:** [Richard Kessler\(University of Chicago\); Tom Matheson\(NOAO\);](#)
- **Weak lensing:** [Bhuvnesh Jain\(University of Pennsylvania\); David Wittman\(University of California Davis\);](#)
- **Active Galactic Nuclei:** [Niel Brandt\(Pennsylvania State University\);](#)
- **Solar System:** [Michael Brown\(Caltech\); Lynne Jones\(University of Washington\);](#)
- **Galaxies:** [Michael Cooper\(UC Irvine\); Brant Robertson\(University of Arizona\);](#)
- **Transients/variable stars:** [Ashish Mahabal\(Caltech\); Lucianne Walkowicz\(Princeton University\);](#)
- **Large-scale structure/baryon oscillations:** [Eric Gawiser\(Rutgers The State University of New Jersey\); Shirley Ho\(Carnegie Mellon University\);](#)
- **Stars, Milky Way and Local Volume:** [John Bochanski\(Haverford College\); Nitya Jacob Kallivayalil\(University of Virginia\); Beth Willman\(Haverford College\);](#)
- **Strong Lensing:** [Phil Marshall\(KIPAC\);](#)
- **Informatics and Statistics:** [Kirk Borne\(George Mason University\);](#)
- **Dark Energy (DESC):** [Bhuvnesh Jain \(University of Pennsylvania\)](#)



# LSST and the Community: The LSST Corporation

- LSSTC was formed in 2003 as a non-profit 501C(3) organization to further the development of the LSST Concept.
- It provided funding through the collection of annual dues from its member institutions, and through the solicitation of gifts from private donors. As indicated earlier, this was extremely successful, resulting in ~ \$40M of private funding, which enabled the fabrication of the M1/M3 mirror, the procurement of the M2 blank, and the leveling of the site on Cerro Pachon.
- It was initially envisioned that LSSTC would also be the organization that would receive the cooperative agreement from NSF for the LSST construction. This did not work out, largely for technical reasons, so the construction proposal was resubmitted with AURA as the official proposing institution.
- With the onset of construction, LSSTC is no longer officially engaged in the project oversight. Nevertheless, the project team meets regularly with the LSSTC Board to keep them apprised of progress. We also consult LSSTC on key appointments, any potential changes to the Science Requirements Document, and other major system level issues.
- From here on in, LSSTC will be primarily concerned with enabling LSST science. Their intent is to use the money they have available, through dues and a reinvigorated fundraising campaign, to host workshops, conduct training programs, and support student and postdoctoral fellowships as prioritized by its member institutions.
- Per agreement with the agencies, LSSTC is also the vehicle through which foreign partner institutions will contribute to operations funding. LSSTC is in the process of negotiating Memoranda of Agreements with such organizations to solidify these commitments.

# Foreign Participation in LSST

- LSST is essentially a US Project, with the lion's share of support for its construction coming from US federal agencies: the National Science Foundation and the Department of Energy Office of High Energy Physics. It is designed to be a public project, with full access to all data and data products open to the entire American scientific community, as well as the public at large.
- Because the telescope will be sited in Chile, we have entered into an agreement with the Chilean astronomical community to give them full participation in the Project, with equal status and data access as Americans. In addition, a limited number of French scientists (from laboratories associated with IN2P3) have been granted access in view of French contributions to the development of the LSST camera.
- However, we believe that as a *world unique* scientific facility, the scientific exploitation of LSST data would certainly benefit from greater international participation. That has been amply demonstrated by a workshop we held in Cambridge last Fall. Foreign collaborators from Europe and elsewhere bring:
  - New creative ideas for innovative investigations with LSST.
  - Access to corollary facilities that can enhance the science of LSST.
  - Key skills to collaborations that are preparing for some of the more challenging LSST analyses.

# Will new foreign partners contribute to the design and construction of LSST?

- At an earlier stage in the LSST development, we did consider partnering with additional foreign institutions in the design and construction of the facility. (The French IN2P3 involvement came in at that stage.)
- However, the Project is now beginning construction. Construction proposals have been submitted and approved by the two US federal agencies, and the appropriate funding profiles have been defined to complete the Project. *We are therefore no longer considering “in-kind” contributions to the LSST construction.*
- On the other hand, there are various activities underway which could benefit from international involvement. These are less directly coupled to the production of the “project deliverables”, but are related to optimizing the scientific return from LSST. Examples include:
  - Helping us to understand the detailed performance of the as-built hardware/software.
  - Modeling activities to optimize LSST operations planning.
  - Shared development of “Level 3” software for carrying out specific LSST scientific programs.
- Contributions of this kind bring “added value” and are encouraged, but they will not be considered in lieu of the financial contributions to operations that we are seeking, as described on the next few slides.

# Why are we seeking support for operations?

- The construction budget for LSST comes out of the Major Research Equipment and Facility Construction line in the NSF budget, and out of a specific line item for a Major Item of Equipment in the DOE budget.
- These line items cover project construction/fabrication costs only. The money allocated cannot be used for operations or for the conduct of science with the facility.
- Instead, operations funding comes from the Astronomical Sciences division budget at NSF, and from core science funding in HEP at DOE. In both cases, there is significant competition with other projects for those resources, and it is unclear that we will have available the total support we will need to operate LSST.
- Our current estimate for the annual operations costs of LSST is ~ \$37M/yr in 2011 US\$. This covers mountain and base facility operations, as well the costs associated with the data processing and data access performed at NCSA in Illinois. It does not include costs for “doing science” with LSST data. Those will come from the grants programs at the two agencies.
- While we are still several years away from incurring significant operations costs for LSST, it is already clear that we can benefit from additional sources of funding. In particular, we are targeting a number ~ \$10M/yr, again in 2011 US\$.
- The LOIs that we solicited several years ago were meant to demonstrate that we had a good chance of raising this money internationally. We are tremendously thankful to those who responded positively to our requests and submitted LOIs on the timescale we needed them.

# How will operations contributions be collected?

- The governance of the LSST Project is somewhat complicated, given that it is a multi-agency, public/private partnership:
  - The prime contractor for the NSF construction project is AURA. AURA oversees this work through an AURA Management Council for LSST (AMCL).
  - The DOE LSSTcam fabrication project is managed by SLAC National Accelerator Laboratory, which is operated by Stanford University.
  - The primary/tertiary mirror (M1M3) and the secondary mirror blank are owned by the LSST Corporation (LSSTC), since these were procured using private funding secured by LSSTC. LSSTC has a set of member institutions (mostly universities), each with a member representative, and a Board of Directors, made up of a subset of those representatives.
- During operations, we expect this general partnership (AURA/SLAC/LSSTC) to continue. LSSTC will have as its primary focus the optimization of the science performed by LSST. Therefore, we have decided that it is appropriate for LSSTC to be the primary agent in soliciting and receiving international contributions to the operations phase of the project. This general arrangement has been blessed by the agencies.

## What are the costs, and how will this work in practice?

- Given our guess as to the size of the relevant user communities for LSST, we have come up with a cost estimate of \$20K per senior scientist per year, as an appropriate amount to charge. (Again, this is in 2011 US\$).
- The charge is only for senior scientists (i.e. permanent personnel). Postdocs (~ two per senior scientist) and graduate students come for free.
- We are looking for the full ten-year commitment for each of these senior scientists, but the payout can be annual at the above rate.
- Funding must begin by 2019. We are willing and able to collect money earlier, if that is more convenient for particular institutes. Such “prefunded” contributions will be placed in escrow in a US bank. If for any reason, the project does not proceed into construction as planned, that money would then be returned to its original contributors.



# We are looking for partners, we are not selling data!

- We believe that the full exploitation of the scientific content of the LSST database will require the best minds all over the world. We are looking for partners as colleagues to help bring this about. We hope you will agree that helping to share in the costs of operating this magnificent facility is a small price to pay for participation in that enterprise.
- It is our intention to treat all foreign partners on the same basis as Americans. There will be no “second class” citizens. We hope to form one world-wide LSST scientific community, with scientific leadership coming from all quarters.
- Nevertheless, we do not want to in any way reduce the opportunity for US investigators to engage with LSST data through the expansion of LSST users. That has some implications for data access. At present, we are planning the construction of two data access centers, one at NCSA and one in La Serena in Chile. These have been sized to handle the expected number (and spectrum) of scientific queries from the US and Chilean communities. If we expand the user base, we will need to expand these facilities (and charge for it), or have international partners build their own data access centers to serve their own communities.
- Rough costs are as follows: \$1500 per year per senior investigator for US-based data access.  
~ \$3.5M to set up an independent data access center from scratch, using software from us.

## Access to LSST simulations, software, etc.

- Once an agreement is signed (or that it is clear that it will be signed), we will welcome investigators from a foreign institution into the LSST community. This will give them full access to our websites, to our simulations, to our software, etc.
- We would expect foreign collaborators to get engaged early. Preparing for LSST science is a major effort over the next few years. Waiting for operations to begin before getting engaged will probably not be a successful path to scientific leadership in LSST science.
- To facilitate preparation for LSST science, we have formed scientific collaborations in most of the key science areas. These collaborations are largely independent of the Project, and they are fairly heterogeneous in activity and style at present. We have encouraged them to consider and to accept membership from foreign collaborators after the agreements are signed. This is probably the best route to engagement, since scientist-to-scientist direct communication is the best route to interaction.
- However, there is no requirement against the formation of new collaborations in new areas, or even multiple competing collaborations in the same areas. We will let the community figure out how best to work with one another in preparing for LSST science.

## Joining LSSTC

- Individual foreign institutions, with sizable participation in LSST, might also consider applying to join LSSTC as a member institution.
- The costs are: An initial fee of \$75K, and an annual dues payment of \$25K.
- Membership will entitle that institution to have a representative attend LSSTC Board meetings (monthly telecons + 2 face-to-face meetings per year). Attendance at those meetings gives the members institutions a significant role in the oversight of the project, and particularly over science planning associated with the project.
- LSSTC will have a significant annual budget that can be used during the construction phase “for the scientific optimization” of LSST. The details are still be worked out, but expected activities include:
  - Workshops on selected LSST-related science topics.
  - Training programs for students and postdocs to familiarize them with LSST software and data analysis tools.
  - Fellowships in LSST science.
- Application for membership is via a letter explaining the interests of and capabilities of the institute staff in LSST science, and a commitment to the initial and annual dues payments.

# Key Issues for the Coming Year

- Maintaining the technical development schedule:
  - Now that we are in construction, it is essential that we stay on course to maintain our technical development schedule.
  - To track that, we invoke a process called *Earned Value Management*. This is essentially an accounting tool which assigns value to the completion of technical work, and assesses that value against the spending profile. Variances, in either cost or schedule or both are reported to the agencies on a monthly basis.
  - For many on the project team, working with EVMS will be a new experience. However, it is crucial to the success of the project, and it needs to be taken seriously by all members of the technical teams.

# Key Issues for the Coming Year

- Preparing for the transition to operations:
  - At present, we have only submitted formal proposals for the construction of LSST, not for operations
  - However, the agencies have informed us that they will request a proposal from us for early operations. We expect to submit that to NSF sometime in 2016. On the DOE side, the process is somewhat less formal, but we have already discussed with them potential operations profiles.
  - Operations will involve a partnership between AURA, SLAC and LSSTC. There are a number of issues that are unresolved involving governance, division of responsibility, etc.
  - We formed a Task Force last February to begin addressing some of those issues. We did make some progress, but it is clear that there is still a lot of work to do before we have a fully fleshed out operations plan.
  - On the technical side, a Technical Operations Working Group has been formed to map out operational scenarios, with particular attention to details that can affect the facility construction and camera fabrication.



# Key Issues for the Coming Year

- Understanding the constraints on the observation scheduler:
  - The scheduling of individual LSST visits (pointing, filter choice) as a function of time can have a major impact on LSST science in various areas.
  - This is a complex problem, and we have only begun to think about technical strategies for optimizing the scheduler.
  - Up until now, we have been working with default strategy that uniformly tiles the sky aiming for the desired number of visits in each filter band, while maximizing observing efficiency.
  - It is clear already that this may not be optimal for certain science areas. In collaboration with NOAO, we are co-sponsoring a workshop that begins here tomorrow, running in parallel with our technical sessions, to address these issues.
  - Our intent is that in collaboration with the community, we will arrive at a quantitative metric that can be optimized by a scheduler, subject to some technical and environmental constraints. It then remains to be seen whether such a scheduler can be developed within the resources we have allotted to it. This will require serious attention over the next year.



# Key Issues for the Coming Year

- Preparing for LSST Science:
  - The LSST Project will deliver generic data products that should enable a wide array of scientific investigations in astronomy and physics.
  - However, we will not deliver all of the tools the community will need to write papers on LSST results. It is already clear that a vast amount of analysis-specific *Level 3* software will also be required to maximize the scientific return from the facility.
  - The community needs to begin now to address this need. We see that happening through the science collaborations, with potential support from LSSTC. The Dark Energy Science Collaboration, in particular, has already made a good start at this through the drafting of a detailed white paper that lays out a suite of concrete tasks.
  - The Project will work with the collaborations to help facilitate this effort. But it is a community responsibility to take ownership of the science they hope to perform with LSST.

# Key Issues for the Coming Year

- Understanding the synergy between LSST and other major observing facilities:
  - An important aspect of preparing for LSST science will involve better clarifying how corollary observations with other facilities will augment the science return.
  - This is a very timely topic, given that a range of facilities are laying out their science plans for the next decade, and LSST figures prominently in those discussions.
  - In fact, the Board on Physics and Astronomy of the NAS has just convened a task force on “A Strategy to Optimize the U.S. Optical and Infrared System in the Era of the Large Synoptic Survey Telescope (LSST)”.
  - I believe that we should be thinking of entire set of astronomical facilities, including LSST, as a system, and we should study in detail how to optimally utilize that system to address a specific set of well-formulated scientific problems. There are a variety of workshops being organized now to try to do this. I would encourage those of you active on the LSST Project or in the science collaborations to play an active role in those discussions.



# Conclusions

- It has been a tremendously exciting year for those of us involved in LSST. We have much to be proud of and much to be thankful for.
- However, now is not a time to rest on our laurels. This is a fantastically complex facility we are aiming to build. It will not be easy. And we cannot afford to fail.
- Active and vibrant communication will be key to our mutual success. Meetings like this one are vitally important.
- So let's get on with it!