Dark Energy Camera Team Visits Chile

Timothy Abbott

Seven members of the Dark Energy Camera (DECam) team visited CTIO in October. Project director John Peoples, project manager Brenna Flaugher, camera and dewar specialist Greg Derylo, cryogenics and power specialist Del Allspach, mechanical designer French Leger, system integration specialist Peter Limon, and data acquisition specialist Todd Moore spent a week in La Serena and on Cerro Tololo.

The Dark Energy Camera will be a Blanco 4-meter telescope instrument. Photo credit: Milton Urzua/Gemini Observatory.

The team and local collaborators presented a briefing on the project to NOAO staff in Chile and engaged in extensive discussions. The instrument development team have considerable prior experience with the Sloan Digital Sky Survey telescope and instrumentation for it, and also draw on a large pool of expertise from high-energy physics. The latter is particularly relevant to building large detector systems and handling very high data throughput—the DECam will incorporate half a gigapixel of CCDs and be capable of producing an image in 17 seconds.

The camera will be integrated into Blanco telescope operations as a facility instrument and must be designed and built with this in mind. The DECam team's visit to La Serena has firmly established productive interaction with on-site staff and paved the way for evolution of the design according to the needs of both groups.

The visit included, of course, an inspection of the telescope and a tour of CTIO's facilities relevant to instrument construction. While our facilities cannot match those of Fermilab, from which most of the team's members originate, CTIO nevertheless expects to contribute to the program at a level more extensive than simply hosting the DECam. Our instrument construction and data management facilities and, of course, instrument design skills, provide considerable advantages to the project.

The DECam is the observational instrument for the Dark Energy Survey (DES) project, which has recently been assessed positively by the Blanco Instrument Review Panel (BIRP), led by George Jacoby and Constance Rockosi. This panel was assembled to review the responses to last year's Announcement of Opportunity to build new instruments for the Blanco telescope and to offer recommendations to the NOAO director. The DES was the only respondent and the panel recommended that the project proceed.

The DES aims to use 30 percent of the available Blanco time to pursue a high-precision, multibandpass survey of 5,000 square degrees of sky over the course of five years. The collaborating institutes are Fermilab National Accelerator Laboratory, the University of Illinois at Urbana Champaign, the University of Chicago, Lawrence Berkeley National Laboratory, NOAO, and the National Center for Supercomputer Applications. More information on the project can be found at *www.darkenergysurvey.org*.

SMARTS: Results and Upgrades

Alan Whiting

The Small and Medium-Aperture Research Telescope System (SMARTS) consortium will celebrate its second anniversary of operating telescopes on Cerro Tololo in February 2005. Scientific results from the initial period will be presented at a special session of the AAS meeting in San Diego, the month before. These presentations will range widely, from long-term photometry of distant asteroids and comets to determine their nature (binary? made of what materials?) to short-notice follow-up of gamma-ray bursts.

Immediately following the science session, there will be a planning meeting for future operations. The original SMARTS agreement expires in January 2006, and a new consortium proposal (perhaps with some new members) needs to be put together early in 2005.

In the shorter term, several of the SMARTS telescopes have upgrades planned or in progress:

- The ex-YALO 1.0-meter, which had not been used for many months, is now operating with a 512 × 512 CCD made by the Ohio State University group; late in 2004 a 4K CCD is scheduled for installation.
- CPAPIR (Camera Panoramique Proche Infra Rouge), a 2K infrared camera built by a group at the University of Montreal, is scheduled to undergo on-telescope tests in the north in November and to be installed on the 1.5-meter in early 2005. Its main task will be an infrared survey of the Milky Way plane (see *ftp.astro.umontreal.ca/cpapir*).
- Planning is in progress for a replacement to the venerable telescope control system of the 0.9-meter, to take place in early 2005.
- Neutral-density filters have been installed in ANDICAM on the 1.3-meter (ex-2MASS), allowing photometry of bright stars in four wavebands. We are ready for the next bright supernova!

SOAR Update

Steve Heathcote

Since the dedication ceremony in April, the SOAR team has been busy preparing the telescope and its instruments in readiness for science operation. Unfortunately, in this process we have encountered a significant, but fixable, problem with the telescope's active optical system (AOS).

SOAR's thin meniscus primary mirror is supported by 120 axial actuators, which can be adjusted to maintain its precise figure as the telescope points to different positions on the sky, and six passive lateral links that are simply supposed to carry an increasing fraction of the mirror's weight as the telescope moves to lower elevation. Using the Calibration Wavefront Sensor (CWFS) mounted at one of the telescope's Bent Cassegrain Foci, it is possible to measure the form of the wavefront delivered by the telescope, and then to calculate the optimal set of forces to apply to each actuator to minimize the departures from the perfect form. This works very well indeed, allowing the shape of the primary mirror to be adjusted, at a given position and moment in time, to deliver images limited by the prevailing seeing.

However, it was intended that in normal operation, the SOAR AOS would work "open loop" with the forces to be applied to each actuator being set by lookup tables, derived from measurements made in advance with the CWFS at a grid of positions on the sky. In contrast, other telescopes based on similar technology, such as Gemini, use a wavefront sensing guider to close their control loop, allowing continuous optimization of the mirror figure while observing. This option was not open to SOAR, essentially because of its smaller aperture, which means that a guide star would only rarely be bright enough to use for wavefront sensing.

As we collected data to populate the lookup tables it quickly became apparent that astigmatism, by far the largest residual aberration, had strong and unexpected dependencies on elevation, azimuth, and especially temperature. While the azimuth and elevation dependence have proven to be straightforward to model and include in the lookup tables, the temperature dependence has not.

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SOAR Update continued

Subsequent analysis, aided by 20/20 hindsight, shows that the root cause of this problem are the lateral links, which over-constrain the mirror and warping it in response to tiny position- and temperature-dependent distortions of the telescope structure. Consequently, the SOAR team is working with outside contractors to design and develop active lateral links that should fix this problem, allowing the telescope to be used as originally intended. However, the implementation of this definitive solution is likely still 9 to 12 months away.

In the meantime, we have refined the lookup tables to the point where they can be used to largely correct the azimuth and elevation dependence of the astigmatism. As a result, it is now possible to observe by tuning the AOS using a bright star close to each science target, then rely on the lookup tables to adjust the solution as the telescope tracks.

We are still determining how often it is necessary to take CWFS measurements in order to maintain good image quality, but we expect that in the worst case it will be necessary to do this for each new science target, and about once per hour thereafter, depending on how fast the temperature is changing. Each calibration measurement takes 5–10 minutes. Thus, while the observing efficiency will be lower than we would like, it should be possible to begin shared-risk science operations on a part-time basis starting in 2005A, and continuing until we are ready to install and test the new active lateral links.

In parallel, we have made considerable progress in preparing the SOAR instrumentation for science. As of November, both the SOAR Optical Imager (SOI) and the Ohio State Infrared Imager/Spectrometer (OSIRIS) are on the telescope, and we are in the process of characterizing them and measuring their performance. The Goodman Spectrograph also had a successful first engineering run in late August using a provisional CCD camera; work continues to prepare the science CCDs for use, but we expect that this instrument will be available by the middle of 2005B.

Consequently, a call for proposals for shared-risk "Early Science" time at SOAR was included in the NOAO 2005A proposal round, and met with a gratifying response from the community. These programs will be executed in service mode by SOAR staff, with the exact schedule depending on the progress of ongoing commissioning work. Successful applicants will be provided with the latest information on the status of the telescope and instruments closer to the time of observation, and will have the opportunity to refine the technical details of their program accordingly, in consultation with the SOAR staff. Up-to-date information can also be found on the SOAR Web site at *www.soartelescope.org*.

The UNC Burch Program Brings Astronomy Students to La Serena

Carrie Sweet & Bryan Zandt (University of North Carolina)

A little over a decade ago, University of North Carolina (UNC) alumnus Lucius E. Burch III initially funded the Burch Fellows Program, which continues to provide UNC undergraduate students with unique opportunities to study abroad. The vision of the Burch program is quite simple: to provide students with the resources required to spend a semester away from campus and delve into a specific field of interest. The Burch Field Research Seminars grant a small group of students time to research and "live" their passion in a manner that would be impossible in a normal classroom setting. The students are led by UNC professors in their curricular endeavors in a combination of course work and hands-on experience. Burch Field Research Seminars have taken students around the world to study Mandarin in Beijing, the cultural role of food in Dijon, France, and documentary filmmaking in Bangkok. For a few students at UNC, one Burch Program integrated their course of study perfectly, satisfying interests in both astronomy and Spanish culture. This special program, titled "SOARing the Southern Skies of Chile," chose as its headquarters the beautiful seaside town of La Serena, Chile, because of its close proximity to the Cerro Tololo Inter-American Observatory.

Early this spring, 11 undergraduate students, one graduate student, and two UNC professors—Wayne Christiansen and

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The UNC Burch Program continued

Gerald Cecil—began their extraordinary journey to Chile. "Not only is this the first year for this particular Burch program, but this is the first science study abroad program from UNC," says Christiansen. "We're trying to offer a solid science-based program along with the cultural aspects of living in a society different from the United States. We're very excited about it."

The goal of this program is to provide the students with the chance to dive into the fascinating world of pure, unadulterated astronomical observation, including both the early science of SOAR and the initial phases of the configuration of the PROMPT project. PROMPT, or Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes, will consist of an array of six telescopes used in conjunction with NASA's SWIFT satellite and SOAR for quick detection and the study of gamma-ray bursts. "PROMPT is UNC's effort to leverage our part in SOAR in a very special way, by chasing gamma ray bursts," explains Christiansen. "We know that SOAR can't be on line all the time for gamma ray bursts, so PROMPT is able to act quickly to identify them and then interrupt SOAR for a 'target of opportunity observation,' if it is needed. The pot of gold at the end of the rainbow in SOAR and PROMPT is finding gamma ray bursts at very large distances, with redshifts on the order of 10."

The Burch students are taking three courses to supplement their research in Chile. One physics class focuses on the current oil-supported economy and the forms of nonrenewable/renewable resources in our society that we may be forced to develop in order to sustain an ever-increasing population when world oil reserves run dry. The program focuses on astronomical studies through two classes, one focusing on cosmic evolution, and the other geared toward observational astronomy. The observational astronomy course introduced and led students through the process of how astronomers collect and process data, in preparation for their use of the data they will gather with PROMPT and SOAR.

Besides course work and spending time on Cerro Tololo and Cerro Pachón, the Burch participants have traveled to other important astronomical sites, such as the twin Magellan Telescopes on Las Campanas and the VLT/VLTI on Cerro Paranal, on a trip through the Atacama Desert to San Pedro. The students are grateful to VLT and Las Campanas site directors Drs. Gilmozzi and Phillips for their support of these visits. They received superb technical briefings by Dr. Seifert (VLT) and Mike Fischer (VLTI), as well as an excellent lunch at the amazing residencia.

One of the PROMPT domes with SOAR and Gemini South in background. Photo credit: Gerald Cecil.

Student Anjni Patel comments, "This program has given me a unique opportunity to immerse myself in Chilean culture and explore the country. From mountains to oceans, deserts to glaciers, Chile could not offer more natural beauty." Professors Christiansen and Cecil hope to extend the program into the future, as PROMPT construction completes and will offer a whole new range of possibilities for students. "I couldn't think of a better place to spend a semester abroad," says student Adam Robert. "The skies of Chile are unparalleled in the world of astronomy."

The Burch program will conclude with a field trip in early December to the Patagonian region of southern Argentina, before the students return to the United States.