Activities and Findings

Uncommitted Carry-forward of FY09 Base Funding
As of 30 May 2010, the uncommitted carry-forward from FY09 base funding is $349.6K. This funding is being held as a strategic reserve by the NOAO Director’s Office.

ReSTAR Funding Supplement
In August 2009 (FY09), NOAO received a supplemental award under SPO-1 (AST-0244680) from the NSF for $3 million to enlarge the number of 4-m-class telescope nights available to the US community and to improve the science instrumentation available on NOAO-owned 4-m facilities. After deduction of AURA management and F&A fees from the award, $1,697,353 was budgeted for FY10. This included $265,000 for the first year of the time-purchase agreement with Caltech Optical Observatories (COO) for nights on the Palomar Hale 200-inch telescope and $1,432,353 for ReSTAR Instrumentation projects. The remainder will be carried forward as planned and budgeted in FY11 and FY12. As of April 30, 2010 (the most recent accounting report available during this reporting period), a total of $628,419 had been expended, and an additional $421,549 has been encumbered. Expenditures include progress payments under a design contract with The Ohio State University (OSU) for the KOSMOS spectrograph, and new CCDs for the upgrade of the Mosaic-1 camera on the KPNO Mayall 4-m telescope. Encumbrances include payments for completion of the OSU design contract. Items still to be carried out during FY10 include the $265,000 payment for the first year of telescope time on the Hale 200-inch telescope (should be paid by the time this report is submitted), initial purchases of optics for the KOSMOS spectrograph following the design review, and purchase of a CCD for the Hydra-South instrument upgrade. Following are details of the progress related to the ReSTAR Instrumentation expenditures and encumbrances.

Status of FY10 Milestones

- KOSMOS: execute a formal partnership agreement with The Ohio State University (OSU).

  **Status:** Completed. NOAO entered into a sub-award agreement with OSU on 3 December 2009 to fund OSU’s activities under the design phase of the partnership to build the Kitt Peak Ohio State Multi-Object Spectrograph (KOSMOS).

- KOSMOS: complete a successful Critical Design Review.

  **Status:** Progressing. The design review is scheduled for 2–3 August 2010 in Columbus, Ohio. The review will concentrate on design changes from the original instrument (OSMOS) built for the Hiltner 2.4-m telescope at the MDM Observatory on Kitt Peak and on the plans for construction and commissioning of KOSMOS through an integrated partnership between NOAO and OSU.

- Mosaic-1 CCD and Controller Upgrade: complete a successful Design Review for the planned upgrade.
Status: Completed. The upgrade project went through a successful Preliminary Design Review on 20 January 2010. The review panel included members external to NOAO. There were two internal Final Design reviews for the electronics system changes on 15 April 2010 and for the mechanical design changes on 11 May 2010.

- Mosaic-1 CCD and Controller Upgrade: purchase new CCDs and integrate with TORRENT controllers, to be ready for commissioning early in FY11.

  Status: Progressing. The new CCDs were ordered on 3 December 2009 and were received on schedule in March 2010. Laboratory testing and characterization of the CCDs was underway at the end of the reporting period, using the older MONSOON controller design. In order to deliver the improved Mosaic-1 camera to KPNO as quickly as possible, the initial integration will be carried out with the original MONSOON controller design. This delivery is on schedule for October 2010. The MONSOON controller will be replaced by the newer TORRENT design during the 2011 summer shutdown, with no loss of observing time.

- CTIO-Hydra CCD and Controller Upgrade: complete a successful Design Review for the planned upgrade.

  Status: Deferred. In order to ensure that CTIO engineering and technical staff are properly concentrated on completion of SAM and preparations for the Dark Energy Camera (DECam), the redesign work needed to upgrade the Hydra-South spectrograph will be deferred at least one year.

- CTIO-Hydra CCD and Controller Upgrade: purchase a new CCD and integrate it with a TORRENT controller, to be ready for commissioning early in FY11.

  Status: Progressing as to CCD selection. Internal review of the future science applications for the Hydra-South spectrograph strongly indicates that the instrument will be best served by a very red-sensitive, deep-depletion CCD that also supports nod-&-shuffle operation for accurate sky line subtraction. A suitable CCD from the detector development program at Lawrence Berkeley National Laboratory (LBNL) has been identified, and one science-grade detector for Hydra-South will be included in a purchase arrangement with LBNL that will also provide a second detector for KOSMOS. Further work on integration with the TORRENT controller has been deferred for at least one year to avoid possible interference with SAM and DECam.

ODI In-kind Contribution Carry-forward

Three hundred thousand dollars were allocated from the FY09 budget to be used as carry-forward funds that could be applied toward the cost of covering the in-kind work carried out by NOAO staff in the construction of ODI (the one-degree-imager) for the WIYN 3.5m telescope. These funds (part of the $608,000 shown in the following budget table under KPNO Tele. Improvements/Inst. Development) were used to cover a portion of the labor costs during FY10 of Systems Instrumentation and KPNO staff working on the ODI instrument. In addition to the carry-forward funding, FY10 base funding awarded under CSA (AST-00950945) in the KPNO Telescope Improvements and Instrumentation Development work package was used to cover the cost of this work. Of the approximately $470K budgeted for Telescope Improvements and Instrumentation Development for FY10 ($300K of SPO-1 funds plus approximately $170K of CSA funds), $382K were expended through 30 April 2010 on the labor associated with fabrication and assembly of the ODI Dewar and associated hardware. Thermal testing on the Dewar was started in the second quarter. The funds expended included the entire amount of the FY09 ODI in-kind contribution carry-forward funds. This work closes out this carry-forward account of SPO-1 funds.
**ODI Cash Contribution Carry-forward**

Three hundred thousand dollars were allocated from the FY09 budget to be used as carry-forward funds that could be applied toward the cost of covering NOAO’s cash obligation to the WIYN ODI project. As of the most current accounting statement, 30 April 2010, these funds (part of the $608,000 shown in the following budget table under KPNO Tele. Improvements/Inst. Development) have not yet been applied to the ODI project. It is anticipated they will be used during the fourth quarter of FY10 to cover the cost of some in-kind work and some cash payments for the instrument.

**KPNO FY10 Mirror Coating Prepayment**

Observatories needing a mirror coated by KPNO using our facilities, including KPNO, pay a fee for the coating of their mirror. These funds cover the typical cost of cleaning and recoating the mirror as well as the maintenance costs of the equipment. Any funds remaining in this account are carried forward to the next financial year and are used to cover maintenance and improvement costs to the equipment used to coat the mirrors. The majority of the mirror coating work and coating chamber maintenance takes place during the fourth quarter of each year. During the first three quarters of the year some minor upgrades to the coating chamber control system were implemented, costing $9,179 in labor and $1,475 in non-payroll. These activities expended the carry-forward balance of $8K (part of the $608,000 shown in the following budget table under KPNO Tele. Improvements/Inst. Development) and began the expenditure of FY10 revenue to the CSA (AST-00950945) from mirror coatings being done this year. The mirror coated was the MDM 2.4-m primary mirror. This work closes out this carry-forward account of SPO-1 funds. The Brashear M2, Brashear M1, Brashear M3, and the SDSS 2.5-m primary mirrors are scheduled to be coated during the fourth quarter of FY10. The costs associated with coating those mirrors will be from the FY10 revenue to the CSA (AST-00950945)

**KPNO FY10 Tenant Support Prepayment**

The tenant observatories and KPNO pay a joint use fee to cover their share of infrastructure maintenance and improvements. Costs are charged against the collected funds as work is carried out. The fees collected are determined by a best estimate of what the actual costs will be during the year. At the end of each year, any unused funds are carried forward to the next financial year to be applied to subsequent work. A total of $75K was carried forward from FY09 into FY10. During the first quarter of FY10, $68,859 of these funds was expended on the labor and non-labor expenses associated with shared infrastructure maintenance and operations. During the second quarter, approximately $37K was expended in Tenant Support, exhausting this prepayment account and starting to expend the FY10 revenue. Tasks completed with these funds included cargo transport, maintenance of grounds, and general operations. This concludes the reporting on these carry-forward funds.

**LSST FY09 Base and FY09 Supplement Carry-forward**

SPO-1 work packages mirror those of the LSST Telescope and Site Team program plan. The efforts and carry-forward funding under SPO-1 augment the activities summarized in section 2.4.4 of the NOAO Annual Progress Report FY 2010 for Cooperative Support Agreement (CSA) No.AST-0950945. While the CSA base funds and SPO-1 supplement funds are accounted for separately, the project is managed and reported as a single effort.

FY09 base funds awarded under SPO-1 (AST-0244680) of Cooperative Agreement AST-0132798 in the amount of $650,000, which were carried forward into FY10, were fully encumbered during FY10 for the A&E design contract awarded to ARCADIS Geotecenica on a portion of the site
and facility activities noted below (first bullet item). As of 30 April 2010, $795,624 of the $1,125,085 supplement funding carried forward from an FY09 SPO-1 (AST-0244680) supplement along with $924,535 awarded for FY10 base funding under this CSA (AST-0950945) were expended or encumbered on work noted below (second through last bullet item). The level of effort and funds expended to achieve the progress reported is split somewhat equally between SPO-1 FY09 supplement carry-forward funds and CSA (AST-0950945) base funds for FY10 with the primary difference found in the additional work on the primary mirror and operation simulation activities performed under the CSA.

Status of FY10 Milestones

- Site and Facility:
  - complete the procurement process initiated in FY09 and award the contract for A&E services;
  - complete the initial design phase with the A&E firm;
  - upon delivery, install and test the updated IR all-sky camera;
  - install a forecast compatible weather station and evaluate preliminary data for operational planning and scheduler requirements; and
  - complete the site and building CFD analysis to support the facility A&E effort.

Status: The procurement process for the A&E services of the Summit Facility was completed and a contract was awarded to ARCADIS Geotecnica. The first phase of the contract is funded through the $650,000 of FY09 carry-forward funds from SPO-1 (AST-0244680). The first and second phases of the effort were authorized for the completion of the initial design phase. Following the kick-off of the contract, the ARCADIS and LSST teams have completed numerous technical interchange meetings to begin the facility design process.

The updated IR All Sky camera (ASIVA) was received after a successful final acceptance test at the vendor facility. The camera was installed for a temporary commissioning run at the Calypso telescope where comparisons with optical imaging can be done.

The weather station data system was updated for storage of data in a single database with other astro-climate data being collected on Cerro Pachón. This data is now available through Web pages that are in the process of being completed.

An updated model of the facility was completed and new baseline runs of the computational fluid dynamic analysis are now in progress.

- Dome:
  - initiate the redesign of the preliminary design to accommodate the calibration projection system and
  - complete the initial Dome-Facility Interface Control Document.

Status: The dome design was modified to provide a space for the calibration screen in the upper section where it does not impact the ventilation.

The Dome-Facility interface design was updated to provide load and dimensional detail for the facility designers. The facility interface continues to allow some flexibility in the final dome design details but gives the facility designers the necessary interface information.
• Telescope Mount:
  – complete the earthquake modal analysis of the structure and the resulting acceleration forces for critical element in the system and
  – develop the test plans and hardware to evaluate the prototype hexapod actuator.

**Status:** A review of the earthquake requirements for LSST was completed in the wake of the February Chilean earthquake. The data from the earthquake was reviewed and the current design requirements used by LSST were confirmed to be consistent with the magnitude and power spectrum of the recent seismic event.

The finite element model for the detailed modal analysis is nearly complete and the evaluation of the earthquake input power spectrum will be completed by mid August. Results from all analysis completed to date indicate that the design values in use for LSST are consistent with the expected forces and accelerations. The August analysis is expected to provide further detail and have fidelity to assess specific hardware components.

• Reflective Optics:
  – collaborate with the LSST primary mirror vendor to evaluate the front surface optical processing readiness,
  – monitor and evaluate the support hardware installation process at the site of the LSST primary mirror vendor,
  – collaborate with LSST Corporation (LSSTC) to evaluate the final acceptance test data for the secondary mirror substrate,
  – continue the prototype testing and design work for the primary and secondary mirror support hardware, and
  – complete the procurement package for the optical finishing of the secondary mirror.

**Status:** The NOAO Telescope and Site team continued to support reviews of the primary mirror fabrication effort. During this period the load spreader attachment was completed and inspected along with all the thermal couples needed to support the NOAO mirror system design. Two biannual reviews of the primary mirror optical fabrication status were completed including specific sessions on the metrology design. The metrology design continues to mature but is not yet completed. NOAO and the University of Arizona continue to discuss the details of the design, focusing on proven approaches and redundant measurements. Both surfaces of the M1M3 mirror were generated, and the mirror continues to progress on schedule.

LSSTC’s contractor, Corning Incorporated, completed the secondary mirror substrate this period. The 100-mm-thick, 3.5-m-diameter secondary met all dimensional requirements with the convex contour generated within 40 μ of the final mirror surface. All other surfaces are ground and acid etched. NOAO engineers evaluated the data and observed the transport of the mirror to storage in Cambridge, Massachusetts.

The hardpoint stiffness test stand design was completed and is out for fabrication. The prototype electromechanical figure actuator and its test stand were assembled and testing begun. An alternate pivoted actuator design concept was developed that eliminates the heavy and expensive ball decoupler in the baseline design. The analysis of the static supports was completed to determine an optimum wire rope isolator. The computer model of the as-built load spreader was completed to include final positions of the hardware on the back of the mirror.
The pneumatic cylinder tests for the baseline axial actuator design led to the selection of a primary candidate, and the testing of the pneumatic valves also led to the selection of a baseline model.

- **WFS Alignment and Calibration:**
  - support calibration observing runs to validate calibration plans,
  - operate LSST telescope assets to conduct calibration validation experiments,
  - complete designs for the calibration spectrograph,
  - complete designs for prototype calibration screen projectors and consult on the development and testing completed by LSST, and
  - continue the AOS curvature algorithm development and reconstruction algorithm testing.

**Status:** The Calypso telescope operation continued as planned. A 5-night observing run was completed on Kitt Peak to collect imaging data on Calypso with a Y filter and simultaneously collect spectroscopic data on the 2.1-m telescope. Weather hampered the start of the run, and despite successful preparations, minor technical issues kept the imaging portion of the test off line. The spectrographic data was collected to support calibration tests independent of the imaging and will be analyzed. Another combined test is planned for September 2010. The LSST 4K × 4K camera built by LSSTC’s partner SLAC National Accelerator Center and installed along with new Y3 and Y4 filters. Testing was begun to commission the camera and determine detailed operating characteristics and to measure the calibration characteristics of the two different Y filters.

The designs for calibration screen prototypes were completed and scaled down designs that use off-the-shelf optics for three versions of a projection system were completed as well. Hardware for the prototype testing was acquired and is now being assembled at LSSTC’s partner and collaborator, Harvard University, to further test and evaluate the components and design performance.

On May 12 and 13 a Wavefront Sensing and Reconstruction workshop was held at Purdue University. This successful meeting was organized to review the progress of various design and testing efforts throughout the LSST project, organize plans to continue development, and explore new collaborations with the Purdue Team.

- **Software and Control:**
  - complete subsystem specific middleware prototypes and
  - develop the primary mirror control system framework.

**Status:** The middleware design and testing continues. The open source, data distribution service (DDS) software, OpenSplice DDS, was successfully tested and incorporated into the baseline design and the prototype systems. This replaces the Real-Time Innovations, Inc. commercial product. A Society of Photo-optical Instrumentation Engineers (SPIE) paper summarizing the work to date was written for the June 2010 Large Telescopes Conference.

Several meetings and interactions focused on the control architecture of the mirror control system. The mechanical, electrical, and software engineers developed the baseline plans for the framework to fit into the system control architecture and satisfy the technical needs of the subsystem.
• Utility Systems:
  – complete the second phase of reflective coating single and multiple layer deposition tests and
  – develop the detailed designs for the telescope system electronics layout and the summit facility electrical distribution system.

Status: Coating deposition tests continue. Results have been mixed for the monolayers necessary to complete a broadband silver/aluminum hybrid coating.

A detailed analysis of the AURA electrical power distribution system was completed and was presented to AURA, CTIO, Gemini, and SOAR representatives at meetings in La Serena on May 25. Additionally, the details of the plan and the existing constraints were discussed with the architect and engineering firm.

Analysis of the AURA recinto utilities was completed for the base facility and computer facility planned to be located in La Serena.

• System Engineering:
  – complete the first phase of telescope system modeling in SysML,
  – develop and implement the hazard analysis process,
  – complete critical level of stray light analysis, and
  – complete the requirements document for the secondary mirror.

Status: Members of the Telescope and Site Team participated in an LSST Systems Engineering meeting held on April 20–23 at SLAC National Accelerator Laboratory to review the development of the SysML model and the plans for completion. The new model is well underway with all elements from the old model migrated into the new system.

A draft Hazard Analysis Process was developed for use in the project. It follows standard Mil Spec. approaches and processes used at other LSST partner institutions working within the DOE complex. Tools to implement the process were evaluated and biweekly Hazard meetings were started to initiate the process and refine the plan.

The stray light analysis is nearing completion. The focus of activity is on the latest detailed design elements in the camera and the calibration screen.

The secondary mirror requirements document is in draft form.

• Project Management:
  – develop the detailed final design phase plan for the telescope and site system,
  – support and participate in the LSST preliminary design review, and
  – support the LSST project with oversight of image simulation efforts.

Status: Management of all aspects of the telescope and site team, image simulation team, and operations simulation team continues. The Final Design Phase plan was developed fully in the LSST Primavera-based Project Management Control System (PMCS II) to be consistent with the results and findings of the ongoing development effort. The NSF review of the 30-month phase to continue the design and development work was also supported on December 15–17. The preliminary design review is delayed pending the results of the Astro2010 report.
Personnel supported an LSST meeting to review the validation plans for the image simulation effort. This meeting was held in Seattle on March 3. LSST is planning unit testing and output tests of the image simulation code as well as the input catalog models and hardware models.

- Science Mission and Requirements:
  - provide a telescope and site representative to the LSST Science Council and
  - evaluate simulated and on-sky data to evaluate LSST science objectives.

  **Status:** NOAO and telescope and site representatives continued to participate in Science council activities. Several members of the team participated in a Science requirements meeting in Seattle on March 2 and in the recent full review of the controlled Science Requirements Documents. NOAO scientists are directly involved in the planning of observations at Calypso and in the proposals for time to support the joint operations tests described above.

- Operations Simulator:
  - lead the operation simulation group and
  - complete sensitivity analysis of operational parameters that support the operation simulation tool.

  **Status:** The operations simulations team continued its development of the simulator and the post processing tools. The team worked with LSSTC to establish a support contract with Dr. Kem Cook, who is now a private consultant to LSSTC. The team also formed an internal project to formally start developing additional scientific metrics to evaluate the simulation results against specific science programs.

  An effort to establish detailed scientific metrics to evaluate the detailed performance of simulated survey runs was initiated. A kick-off to the effort occurred at an LSST collaboration meeting held in conjunction with the January 2010 AAS meeting and was followed by the start of algorithm and code development. These metrics will focus on details in the survey specific to the individual science collaborations.

**GSMT Site Testing Carry-forward**

Portions of the close-out of the site testing effort were funded by carry-forward, primarily contracts for equipment removal that were originally planned for the end of FY09. These efforts were completed during the early part of FY10. All operations are complete, all equipment removed or donated, and all data now public. There remains a small amount of additional effort inspecting and repairing equipment before it can be shipped back to TMT.

**Status of FY10 Milestones**

- Complete the close-out of the site survey in Chile.

  **Status:** Work on the site survey is now complete and data are now public, as outlined in the NOAO Quarterly Scientific Report (1) FY10 submitted under SPO-1 (AST-0244680). Some TMT-owned site survey equipment is in storage in Chile and will need to be returned, once TMT determines where it should go.
### NOAO

**NOAO (AST-0244680) Base Programs**

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