

NOAO-WIDE PROGRAMS

LARGE-APERTURE SYNOPTIC SURVEY TELESCOPE (LSST) PROGRAM

Milestones FY 2003

- Continue a prioritized set of engineering studies on high risk elements, including optics fabrication, detectors, and filters
- Conduct the Concept Design Review for the Gigapixel camera
- Establish the LSST project office to oversee the design efforts
- Hold the first meeting of the LSST Board

Science Requirements/Technical Requirements

In FY 2003, we will continue the Phase A studies of the Large-aperture Synoptic Survey Telescope (LSST), with the goal of completing a costed proposal by the end of 2004. By the end of FY 2002, we expect to have established the science requirements for the LSST and to have translated those requirements into technical requirements for the telescope, enclosure, site, instrument, and data management systems. In order to complete a costed proposal for the LSST, it is necessary to develop concept designs that will meet those requirements.

While a substantial amount of work has already been done by others outside NOAO on optical design, methods of optical test and fabrication, detector options, and so on, none of this work has been carried to the level of quantitative detail required to develop an auditable costing for the project. A project team will be required to carry out this step. A significant portion of the team will have to come from outside the current NOAO staff in order to obtain the requisite expertise.

LSST Science Working Group

The NSF AST Division has authorized NOAO to establish and maintain a Science Working Group (SWG) for the LSST. This group is intended to be the community-based body that will develop the science case and justification for federal investment in LSST by NSF, NASA, and other agencies. The SWG will represent the U.S. community in assembling relevant partnerships for describing and advocating the appropriate federal role in this project. This guidance is intended to be a product of all public, private and international groups that expect to play a role in the LSST. SWG members will participate actively in those technical, observational, and theoretical astrophysical studies which will be useful in defining and focusing the scientific objectives for the LSST. The LSST SWG has the following specific tasks (although the group is not limited to these tasks only):

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- Develop the science cases and scientific priorities for an LSST and refine the science goals outlined in earlier reports prepared by participating institutions. This includes evaluation of the likely impact that advances expected with existing and near-term studies will have on the science goals of LSST, along with consideration of the costs and benefits of alternative approaches. This effort also includes working with the scientific community to ensure that the goals continue to be exciting, important, and representative of the highest scientific priorities for a survey telescope.
- Develop a flow down from key science to top level engineering goals and requirements. Develop performance metrics for the LSST telescope, instrumentation, software, operations, data management, and other aspects of the program, and assess performance against these metrics.
- Identify the key instrumentation capabilities for an LSST. Review the current proposed survey camera and propose alternate designs or complementary instrumentation that would enhance scientific usefulness, improve observing efficiency, or lead to potential cost reduction.
- Prepare a Design Reference Mission (DRM) for a five-year LSST program. The DRM should be the optimum science program achievable with the LSST for the recommended design, cost, and schedule. The DRM should be planned in sufficient detail that it is possible to specify the total data product of the telescope, the parameter space surveyed, and the predictable discovery set.
- Establish the scientific relationship between LSST and other major facilities, e.g., Supernova Acceleration Probe (SNAP), Gemini, Palomar Optical Interferometer (POI), GSMT, Visible and Infrared Survey Telescope (VISTA), and so forth.
- Identify any priorities for technology development.
- Provide scientific assessments of design concepts and implementation plans for their impact on the overall scientific performance. This includes the calibration plan and the data management plan.
- Assemble appropriate community-wide partnerships for preparation of any proposals to NSF and NASA for funding activities related to LSST.

Incorporation

Following the models for WIYN and SOAR, we plan to establish an independent corporation to carry out the LSST project. The founding members will be Steward Observatory and NOAO or their parent organizations. Again following WIYN and SOAR, we expect all LSST staff members to be hired by one of the participating institutions and not by the LSST corporation directly. NOAO will therefore hire the project manager on behalf of the LSST corporation.

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Data Management, Precursor Experiments, Simulations

A. Connolly (U. Pittsburgh) has been given a contract to prepare the data management plan for the LSST proposal. We expect to hire a full-time staff member at NOAO to support his efforts.

It is likely that in the process of establishing the science requirements, we will identify a number of areas relating to data acquisition and management that require simulations, test observations, prototyping of data pipelines, and so on, in order to establish feasibility or proofs of concept. Some of this work will be contracted outside NOAO. In addition, NOAO itself is committed to undertaking and/or supporting and facilitating a variety of precursor experiments that will enable the progressive development and testing of the software required to schedule, acquire, reduce, and distribute data to the community. The first of these precursor experiments is the NOAO Deep Wide-Field Survey (NDWFS), which will result in pipelines for optical and infrared data, with a critical assessment of how much automation is possible, what quality assessment procedures are required, what the limitations on photometric accuracy are, and so on. This project will also be used to explore the issues associated with the archiving of ground-based data.

The second of these precursor programs is likely to be a combined SuperMACHO (Massive Compact Halo Objects) and supernova experiment, which will be conducted at NOAO South. C. Stubbs, K. Cook, and collaborators have been awarded time on the 4-m telescope for the next five years to search for MACHO events against the sheet of red dwarfs in the LMC plane. This project will find a large enough number of MACHO events to remove the ambiguity concerning the location of the lenses. Are these events dark matter in the halo of our own Galaxy, or are they located in a currently undetected thick disk in front of the LMC? A second proposal will search for supernovae to determine if the observed acceleration is consistent with a cosmological constant, or if there is a vacuum energy that is different from that associated with a simple cosmological constant. An equation of state of the Universe different from that given by a cosmological constant would imply a new scalar field due to an unknown particle, and a physics that is not predicted by the Standard Model. This project will require the discovery of a few hundred supernovae over redshifts of 0.3–0.9.

These two projects require many of the same software developments as the LSST, albeit for a much smaller data set, such as: the rapid reduction of photometry to discover variable objects; the distribution of information about variable events to the community in less than 24 hours to enable follow-up observations of the light curves and, for the SN, of their spectra; and the archiving of the data. During FY 2003, the LSST group will work with the SuperMACHO/ Supernova project team to ensure that the work done for this experiment benefits the prototyping and development of data management tools for the

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LSST. No funding for this science program has been requested as part of the current budget submission for the LSST.

LSST FY 2003 Budget and Major Work Packages

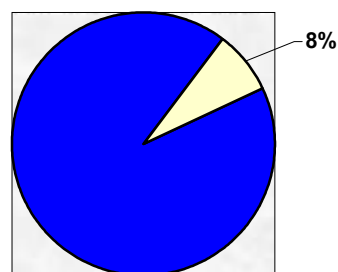
- **Engineering Studies:** Initial design work on the telescope, enclosure, focal-plane instrumentation (including the detector array and electronics), and site selection to the point where we have an auditable cost for the construction and initial operation of the LSST. Specifically, these engineering studies will: (1) use the science requirements to develop an error budget for the LSST system; (2) establish the optical design, including tolerancing; (3) develop a concept design for the telescope, including FEA (finite element analysis) to establish operational performance, settling time, and so on; (4) determine methods for fabricating and testing the optics; (5) design and analyze the methods for supporting the optics; (6) develop methods for maintaining optical alignment; (7) develop plans for the enclosure, including modeling of effects on image quality; (8) plan the support facilities, including mirror handling and coating; (9) select a site and develop a site plan; (10) develop a concept design for the instrument, including meeting the tolerances on image quality; (11) plan the operational strategy, including acquisition and guiding, quality assessment, estimates of overheads, calibration strategies, and delivery of data to the data management system; and (12) prepare written documentation and costing for all of the preceding.
- **Data Management:** Under the leadership of A. Connolly, the development program for data management will: (1) review the science drivers of the LSST and determine their impact on the data reduction and analysis plan; (2) review the focal plane design

TUCSON - LSST**
FY 03 Spending = \$1,692
(Dollars in Thousands)

Work Package	FTE	Total
Engineering Studies	8.7	1,286
Data Management	1.0	105
Project Science/Mgmt	3.3	301
Total LSST Tucson**	13.0	\$1,692

***Table shows LSST costs budgeted in NOAO-Tucson division only and does not include the \$53K allocated under "LSST" in the NOAO-S. (CTIO) budget. The total FY 03 cost of the LSST program is therefore estimated at \$1,745K (\$1,692K + \$53K)*

Tucson - LSST
FY 03 Spending = \$1,692K



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and determine its impact on data management requirements and expected functionality of the software; (3) review the operational plans for LSST observations and understand their implications for data management; (4) test the ability and scalability of current software designs and algorithms to meet the LSST requirements; (5) develop a quality assurance metric for defining when each subsystem meets its requirements; and (6) outline a baseline reduction system and a cost model for implementing it.

- **Project Science:** Involves the efforts of six NOAO astronomers (four Tucson-based and two in La Serena) in developing the science case and science requirements, and in evaluating engineering solutions as required for completion of the proposal.

AURA NEW INITIATIVES OFFICE (NIO) — GIANT SEGMENTED MIRROR TELESCOPE (GSMT)

Ten years after first light on the Keck Telescope—and in the same year as the dedication of Gemini South—the U.S. astronomical community has shown its enormous confidence in the potential of ground-based telescopes of extremely large aperture by commencing concept design work and technology studies for a Giant Segmented Mirror Telescope (GSMT). The GSMT represents a much larger relative scientific advance than the step from the 4-meter to the 8-meter era.

The GSMT report recently published by the New Initiatives Office (NIO) provides a fundamental reference point in this new engineering venture. Phase 2 of the California Extremely Large Telescope (CELT) project, which is being funded by University of California and the California Institute of Technology, is commencing. In Canada, the Hertzberg Institute for Astrophysics (HIA) has opened a project office. Other prominent AURA members have taken initial steps.

NOAO's goal in the NIO is to gain a place in this powerful new facility for the community NOAO serves. Publication of the GSMT Book (<http://www.aura-nio.noao.edu/book/>) has gained the national observatory the high moral ground in this enterprise. The NIO's goals for FY 2003 continue this approach by securing the following milestones and by serving as a truly expert communication forum between the fast-track CELT Phase 2 and other nuclei for the decadal survey's recommended public/private GSMT partnership.

Milestones FY 2003

- Understand the scientific context in which GSMT will operate and derive the key science drivers and resulting performance priorities; specifically, understand the role of GSMT in the era of Atacama Large Millimeter Array (ALMA) and Next-Generation Space Telescope (NGST).

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- Develop a “science merit function” via a community workshop and later consultation with a broadly-based Science Working Group (SWG), and use the merit function to explore cost-performance trade issues
- Develop the tools for “integrated modeling” of GSMT design concepts using the NIO point design as the initial starting point for understanding the response of the full GSMT system to various disturbances
- Build on FY 2002 cost estimating work and complete a framework for parametric cost estimation applicable to GSMTs of differing size and design
- Analyze the role of GSMT in the “integrated observing system” of U.S. ground- and space-based observatories in 2012, and from this, develop operational models
- Advance technical studies and develop tools common to all Extremely Large Telescope (ELT) efforts, such as: active optical systems and components; mirror segment fabrication and polishing; wind loading characterization; site evaluation and testing via remote sensing; modeling and selected in-situ measurements; instrument concepts; controls systems approaches; and modeling
- Organize workshops aimed at aligning technical studies needed by multiple ELT design efforts and developing complementary investments where possible
- Develop a road map to guide NSF investments needed to ensure that enabling technologies for ELTs and their instruments are in place
- Explore partnerships that will advance the design of a GSMT concept that serves community needs

Defining Science Drivers and Associated Priorities

Early in FY 2003, NIO will hold a community workshop to examine the unique and key roles that GSMT will play in the era of ALMA and NGST. The result of this large, broadly-based workshop will serve as input to a community-based SWG, which will develop a prioritized list of science drivers. In turn, these will serve as input to a quantitative “science merit function”—a tool to guide cost-performance trades for a variety of GSMT design concepts.

Developing a “Toolbox” for Analyzing GSMT Design Concepts

In FY 2003, NIO efforts will shift from analysis of the “point-design” concept used to identify key technical problems and possible solution paths, to the development of tools that will enable quantitative analysis of competing concepts. Specifically, NIO will develop capabilities to carry out: (1) integrated modeling of the complex GSMT system in order to understand the response of a design concept to external disturbances, and to use that

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understanding to identify advantageous system trades or areas where innovative solutions are needed; and (2) cost estimates for design concepts based on parametric cost estimators for key subsystems and components. The GSMT Book—a major FY 2002 accomplishment now available online at www.aura-nio.noao.edu—provides an overview of initial GSMT science requirements, analysis of a point design concept for a 30-m telescope (including initial instrumentation), and detailed summaries of technical studies common to all ELT design efforts.

GSMT Site Evaluation

Candidate sites in northern Chile and in the southwest United States and Mexico will be identified and evaluated using satellite imaging and numerical modeling of ground-level windflow and upper level turbulence patterns. These sites will be compared with a parallel study of the Mauna Kea 30-m site. We will also continue to develop the methodology and technology for in-situ testing programs, from sodium layer characterization to measurement of turbulence profiles. These studies will be carried out in close consultation with a broadly based international group, including representatives from CELT, Cornell, European Southern Observatory (ESO), Carnegie, Universidad Nacional Autonoma de Mexico (UNAM), and Instituto Nacional de Astrofisica, Óptica y Electrónica (INAOE). Pending arrangements with CELT, on-site testing of selected sites in Chile will be initiated.

Coordinated Studies

In FY 2003, considerable attention will be given to identifying and investigating low-cost design approaches to key subsystems and components of a GSMT. The areas of study will include mirror segment fabrication, enclosures, adaptive optics, telescope structures, and instruments. Initial cost-performance trades will be an integral part of these studies. NIO will work proactively to engage other groups involved in ELT studies with a goal of aligning efforts and investments where possible and mutually advantageous.

Community Involvement in Defining a Technology Road Map

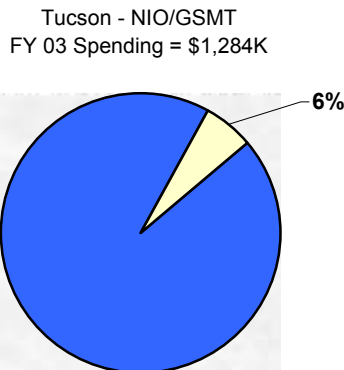
NOAO and the Center for Adaptive Optics jointly developed a strategic vision and implementation plan for advancing adaptive optics technology so that components and systems approaches critical to achieving GSMT performance goals are made available in a timely manner. A specific investment strategy for NSF was developed, along with a process for updating the strategy in light of technical breakthroughs. A similar effort is needed in order that critical technology—e.g., gratings and detectors—be in place to meet the demanding challenges of GSMT instruments and key subsystems. NIO plans to work with the community in FY 2003 to develop a technology road map.

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NOAO - TUCSON
Giant Segmented Mirror Telescope (GSMT)**
FY 03 Spending = \$1,284
(Dollars in Thousands)

Work Package	FTE	Total \$
Project Management	1.0	161
Project Science	1.5	285
Systems Engineering	2.2	445
Site Testing	1.6	162
Technology Development	1.2	192
Instrument Concepts	0.3	39
Total GSMT Tucson**	7.7	\$1,284

***Table shows GSMT costs budgeted in NOAO-Tucson division only, and does not reflect the \$325K allocated in the NOAO-South budget. The grand total cost of the GSMT program in FY 03 is therefore \$1,609K (\$1,284 + \$325)*



performance of multi-conjugate adaptive optics systems; characterization of wind loading of large telescopes; modeling the performance of the GSMT when subjected to dynamic disturbances and corrected by hierarchical control systems; development of parametric cost estimating relationships for ELTs; and collaboration with other groups developing models of GSMT performance.

Partnerships to Design and Build GSMT

NIO/GSMT will work actively to develop partnerships to accelerate multiple design efforts so that a GSMT design matching community aspirations is in place within the next three years.

GSMT FY 2003 Budget and Major Work Packages

- Project Management:** Costs of management and administration of NIO activities, including supervision of NIO staff, coordination of efforts by other NOAO and Gemini staff, liaison with outside organizations participating in GSMT studies, supervision of contractors, and control of schedules and budgets.
- Project Science:** Support of the GSMT Science Working Group; conducting astronomy community workshops to define the scientific context for GSMT and to explore synergies of GSMT with the NGST and the ALMA; development of GSMT science requirements and a science merit function; and liaison with other members of the scientific community regarding GSMT science goals.

- Systems Engineering:** In FY 2003, systems engineering activities will include development of tools and capabilities for creating end-to-end integrated models of the GSMT. These capabilities include:
 - development of methods to simulate the

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- **Site Testing:** Identification and evaluation of candidate sites for ELTs, including such activities as: remote sensing studies based on satellite data; calculation of wind flow characteristics over candidate sites using computational fluid dynamics; on-site measurements of meteorological conditions, turbulence profiles and seeing; and liaison with collaborating institutions.
- **Technology Development:** Cost-effective fabrication of large quantities of mirror segments; development of improved components for adaptive optical systems; and development of suitable components for the large instruments needed for the GSMT.
- **Instrument Concepts:** Several conceptual design studies of proposed GSMT instruments will be supported.

DATA PRODUCTS PROGRAM (DPP)

Milestones FY 2003

- Continued development of the NOAO Science Archive (NSA), with substantial progress on its evolution to a large-scale operation capable of extension to a scale appropriate for the LSST. Archive holdings should include all NOAO survey data that have been released to the community.
- Completion of the first stage of pipeline development, with demonstration of the ability to automatically process the data stream from the Stubbs et al. Large Magellanic Cloud (LMC) microlensing survey into an archived data set useful for time-domain studies.

In FY 2003, the Data Products Program (DPP) will give priority to projects that provide community access or add value to data products deriving from ground-based O/IR facilities. Compatibility and integration with National Virtual Observatory (NVO) efforts (at NOAO and community-wide) and extensibility to LSST will remain guiding principles for the development paths chosen. Additional activities will focus on: (1) tasks explicitly requested and funded by other NOAO programs (e.g., LSST data management concept development, data reduction software for NEWFIRM and/or Gemini) or through external grants (e.g., NVO infrastructure development); and (2) the creation of tools that will facilitate high priority projects, such as the Open IRAF (Image Reduction and Analysis Facility) project. An additional goal of the DPP is to develop a viable approach to managing a program with activities at both northern and southern sites.

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Archive for Data Products from Ground-Based O/IR Facilities

With the launching of the NOAO science archive, we now have a repository dedicated to data products from ground-based O/IR facilities. This archive is unique in providing access to a heterogeneous collection of data sets that are each internally homogeneous and complete. The challenge will be to identify and provide sensible tools for querying the archive and to facilitate access to the metadata that describe the characteristics of each data set. In addition, the archive provides a clear way to ensure that the return promised by the survey program is delivered to the community.

Data Reduction Pipelines with Emphasis on Time-Domain Studies

The time domain represents a driver for LSST in which there is relatively little experience. Perhaps the most important work that could be deemed a precursor to LSST is performing the several searches for microlensing events. One of these is currently being carried out on the Blanco telescope, and the survey team, led by C. Stubbs (University of Washington), has agreed to collaborate with the data products staff to build expertise in this area. Thus, our pipeline development effort will focus on this data stream, and will aim to broaden the usefulness of the data. This development will consider explicitly the question of providing a general-purpose CCD Mosaic reduction pipeline.

Data Products Program FY 2003 Budget and Major Work Packages

- **Program Management:** Planning, administration, and day-to-day management of the DPP for both NOAO North and NOAO South, including staff travel, recruiting, and training. Also includes capital equipment funds to purchase the DPP/IRAF Web server machine and a Sun work station for a new FY 2003 hire in Tucson, and to replace three older Sun workstations.
- **Archive Facility:** Costs associated with expanding the interim archive to include all data sets in the NOAO surveys program. Also includes design and initial implementation of a fully engineered archive facility for NOAO, and ongoing day-to-day management of the archive system, media, and user support. Non-payroll includes capital equipment costs for computer hardware for expanded data storage, and software for managing the data holdings at both NOAO-North and NOAO-South.
- **Instrumentation Software:** Detailed design of software for the acquisition, quick-look evaluation, and science processing of data for NEWFIRM, as well as partial implementation per the NEWFIRM program schedule. A modest amount (0.3 FTE) of software maintenance and enhancement for existing instrumentation on Kitt Peak (such as the improvement of the slit-mask design software begun in FY02) and minor upgrades to the Save-the-Bits archive utility and to M&E on the ICE data acquisition software.

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- **IRAF Support and Development:**

Cost of developing major IRAF system utilities that are funded externally under the “Open IRAF” grant. These utilities, which total nearly one FTE, include C language bindings, packaging of individual IRAF libraries for uses external to IRAF, and user documentation. Also included are core DPP funds for user support, minor bug fixes and enhancements to IRAF applications, and preparation of a minor IRAF release in FY 2003. Funding is included to upgrade the IRAF Web services (migration to a new server) and for documentation and system configuration.

TUCSON
Data Products Program (DPP)**
Est. FY 03 Spending = \$1,018
(Dollars in Thousands)

Work Package	FTE	Total
Program Management	1.6	270
Archive Facility	4.5	401
Instrumentation Software	0.3	24
IRAF Support & Devel. (NASA "Open IRAF" Grant)	2.7 -1.0	217 (89)
LSST Data Mgmt Planning	2.3	
NGSC Data Reduction Software	1.1	-
National Virtual Observatory (External: ITR Grant FY 02) (External: ITR Grant FY 03)	2.6	304 (46) (211)
Pipeline Development	0.9	148
Total Tucson**	15.0	\$1,018

** Table shows costs budgeted in NOAO-Tucson division *only*, and does *not* include est. \$70K allocated in the NOAO-South budget, largely for pipeline development. The total cost of the Data Products Program in FY 03 is therefore \$1,088K (\$1,018K + \$70K).

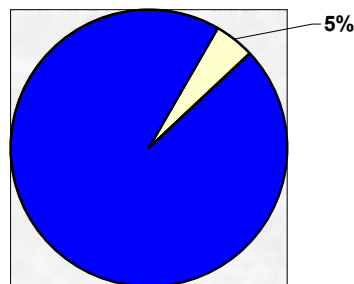
- **LSST Data Management**

Planning: Generation of a point design for the LSST data management system, high-level software and system requirements for the data processing facility, and various trade studies and experiments to flesh out critical elements of the system design. All costs for this work package are allocated to the LSST program budget.

- **NGSC Data Reduction Software:**

Funded in the NGSC program budget, this work package builds on existing modules, and is intended to produce software to enable the U.S. community to reduce data obtained with Gemini North and South instrumentation. Part of this effort will include the design and implementation of general IR processing

Tucson - Data Products Program
FY 2003 Spending = \$1,018K



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libraries applicable to the calibration of a broad range of IR imagers and spectrographs. Requires just over 1.0 FTE of effort from DPP staff members who are extremely knowledgeable in major astronomical instrumentation and detector technology.

- **NVO Development:** Includes most of the effort necessary to complete the definition of suitable data models and metadata standards for astronomical data (this effort having been initiated in FY 2002), and to implement a research prototype of a data access portal for the NVO. The effort also includes the development of a hardware test-bed for the evaluation of Grid, HPC, and other software for data mining and distribution. The 2.6 FTE of effort also supports the NVO project scientist D. De Young. Several experienced DPP software developers are required for this R&D project. The budget also includes travel and capital equipment for the NVO project; these expenses were included explicitly in the grant funding.
- **Pipeline Development:** Development of the capability to pipeline-process data from NOAO instruments for quick-look data quality evaluation and transient detection at the telescope, science-grade processing for inclusion in the NOAO archive, and post-archive processing in the context of NVO. A major focus in FY 2003 will be on the detection and processing of transients and variable objects in a time-sampled data stream, and on the inclusion of time-domain data products in the archive. This effort, which is slightly less than one FTE in FY 2003, is intended to be complementary to the LSST and NEWFIRM work packages, but with a short-term focus that will give the DPP practical experience in these data management efforts. A substantial fraction of this project will be conducted at NOAO South.

MAJOR INSTRUMENTATION PROGRAM (MIP)

Milestones FY 2003

Gemini Near Infrared Spectrograph (GNIRS)

- Complete pre-ship acceptance test early in FY 2003
- Deliver GNIRS to Gemini South in the first quarter of FY 2003
- Final acceptance test at the telescope
- Train site personnel in GNIRS maintenance and operation
- Close the GNIRS project

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Gemini South Adaptive Optics Imager (GSAOI)

- If NOAO is awarded a contract to design and fabricate the Gemini South Adaptive Optics Imager (GSAOI), continue the instrument design and complete a Preliminary Design Review prior to the end of the fiscal year, and order optics at the completion of the PDR

NOAO Extremely Wide-Field Infrared Imager (NEWFIRM)

- Complete Preliminary Design Review
- Complete Critical Design Review

NOAO Detector Program

- Receive, test, characterize, and optimize prototype 2K×2K RIO InSb Orion arrays
- Receive and test a prototype RIO MBE HgCdTe array at NOAO, when available from RIO

Monsoon Controllers

- Complete the prototype CCD Monsoon controller and evaluate using real CCDs in the NOAO test dewar
- Complete the prototype IR array Monsoon controller and evaluate using Orion arrays in the NOAO IR array test dewar

Gemini Near Infrared Spectrograph (GNIRS)

In FY 2003, NOAO will complete the pre-ship acceptance test of the Gemini Near Infrared Spectrograph (GNIRS). GNIRS is a long-slit spectrograph for the Gemini South telescope that will operate from 1 to 5 microns. The pre-ship acceptance test will demonstrate the functionality of the instrument prior to shipment to Gemini South. Testing will be performed with GNIRS mounted on the NOAO flexure test facility in Tucson, which was completed in FY 2002. A telescope simulator will provide the optical beam for testing.

Once GNIRS and handling fixtures have been delivered to Gemini South, the final Acceptance Test Procedures (ATP) will be performed with GNIRS on the telescope. Special training will be conducted on the hardware, electronics, and software for the Gemini staff. After all ATP and training are complete, the project design documents will be turned over to Gemini and the project will be closed.

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Gemini South Adaptive Optics Imager (GSAOI)

In January 2002, the Gemini Observatory awarded NOAO the concept design study for the GSAOI. In August 2002, NOAO will complete the design study and submit a fixed-price proposal for completing the instrument. In order to complete the instrument in the two years Gemini has allowed for the fabrication and integration, NOAO must move quickly from the concept design in the proposal into PDR. Long lead-time items, such as optics, must be ordered as soon as a successful PDR is completed.

NOAO Extremely Wide-Field Infrared Imager (NEWFIRM)

For its own 4-m class telescopes, NOAO is building instruments that take advantage of wide fields of view. Like most of the other large U.S. telescopes, Gemini offers only a small field of view, and the NOAO 4-m telescopes will play an essential role in defining samples and selecting objects to be observed with the 8- and 10-m telescopes. The science case for wide-field infrared imaging includes statistical studies of galaxies at high and low redshift, the study of regions of star formation to investigate star formation processes, the initial mass function, and the investigation of brown dwarfs. The instrument under development is NEWFIRM, a wide-field infrared imager. NEWFIRM will have $4K \times 4K$ pixels that will cover a 30×30 arcminute field; it is estimated to cost on the order of \$4 million. NEWFIRM capitalizes on the rapid advances that have occurred in infrared array technology, particularly the anticipated availability of $2K \times 2K$ buttable arrays.

NOAO Detector Program

The Orion project is a collaborative effort with NOAO, the U.S. Naval Observatory, NASA, and Raytheon Infrared Operations (RIO, formerly HUGHES/SBRC) to develop $2K \times 2K$ InSb array detectors suitable for ground-based astronomy at wavelengths from 0.9 to 5 microns. This advanced detector technology program will continue the efforts of the very successful ALADDIN $1K \times 1K$ InSb development effort, which has yielded a number of science-grade devices currently in use extensively at most major ground-based observatories. This effort benefits from a parallel effort to produce devices suitable for the NGST program. During early FY 2002, the first silicon readouts were produced by RIO and tested at both RIO and NOAO for operability and suitability. Upon demonstration of a successful readout design, the first hybrid arrays were produced at RIO and tested and characterized at NOAO. In addition to measurements of operability, read noise, dark current, full well capacity, image retention, and quantum efficiency, NOAO will explore new modes of array operation inherent in the Orion design. RIO was planning to hybridize prototype MBE HgCdTe arrays during FY 2002, but technical problems have delayed production of the prototypes. NOAO will test these prototype arrays when they become available.

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LBL has undertaken an innovative approach to developing high-performance CCDs with excellent quantum efficiency (QE) across the spectrum, particularly in the red spectrum. The devices use a high-resistivity material, allowing deep-depletion wells yielding excellent red QE response without the associated “fringing effects” of thinned CCDs. Furthermore, the devices offer the promise of lower fabrication costs because of the removal of the need to “thin” the CCD. NOAO will be building a mini-mosaic of two (possibly four) $2K \times 2K$ CCDs provided by LBNL. This will test the new “buttable” package under development at LBNL and provide valuable on-sky device performance data. Additional efforts are under way to explore other novel detector technologies such as CMOS (complementary metal oxide semiconductor) active pixel sensors to provide a forward look into the problems raised by the massive focal planes proposed for next-generation telescopes and instruments. These systems will benefit from lower power dissipation, lower component cost, and increased integration of signal processing functions on the detector, which CMOS technology promises.

Monsoon Controllers

In FY 2002, NOAO began the development of a prototype multi-purpose array controller for both IR and CCD applications to support the ever increasing array size and speed requirements. The development has progressed well and prototype board sets have been designed. During FY 2003, the prototype boards will be tested in the NOAO array labs. The output of the Monsoon development program will provide array controllers to NEWFIRM and QUOTA, as well as for GSAOI, if NOAO is awarded the production contract for the latter. The CARA/Caltech/UC Asteroid project is also baselining Monsoon as the controller of choice; we hope to collaborate on the project, although details of the collaboration have not been finalized. The Monsoon controller is designed to be scalable to ever larger array formats without having to do redesign.

SOAR Adaptive Optics Project

NOAO is undertaking a complete conceptual design study of an AO system for the SOAR 4.2-m telescope, in the context of a call for second-generation instrumentation. The aim is to produce a scientifically compelling facility that complements systems on the 8-m telescopes at relatively low cost. The initial concept being developed is for a dual mode system: a high resolution, small field mode, operating in the optical pass bands, and a wide-field seeing-improvement mode that only compensates the ground layer of turbulence. The latter AO mode is one that has been proposed for GSMT and could thus serve as a prototype. Initial implementation would be using natural guide stars, followed by an upgrade using a Rayleigh laser. This project will undergo a conceptual design review in FY 2003. This project is budgeted in the Major Instrumentation work package of NOAO South (CTIO).

NOAO-WIDE PROGRAMS

MIP FY 2003 Budget and Major Work Packages

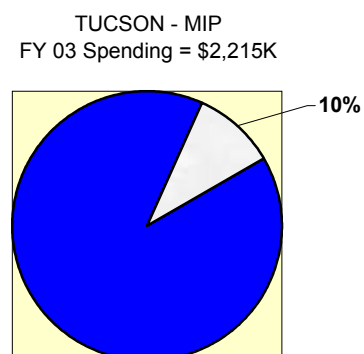
- **GNIRS:** Work completed in FY 2003 will successfully conclude a multi-year effort on this instrument.
- **NEWFIRM:** Wide field survey camera for the 4-m telescopes on Kitt Peak and at CTIO.
- **GSAOI:** Assuming NOAO wins the competition and Gemini awards NOAO the contract starting in January 2003, the projected work will be for a two-year design and construction project. Gemini will fully fund the project, including burden. The expected spend rate will be about \$2 million per project year. The completion schedule is the critical part of this project.
- **Monsoon Controllers:** Development of a multi-purpose array controller for both IR and CCD application. The output of the program will provide an array controller to NEWFIRM. The CARA/Caltech/UC Asteroid Project is also baselining Monsoon collaboration on the project, although details of the collaboration have not been worked out.
- **LSST:** Work performed for the LSST program to study array technology and focal plane designs for the LSST camera.
- **Technical Development:** A variety of small projects, such as Orion array testing and optimization of the operating modes, LBNL array tests, ODI design concepts and planning, grating development with S. Barden, and other small research opportunities as they develop.
- **NSO Support:** Represents about 1.5 FTE support.

TUCSON MAJOR INSTRUMENTATION PROGRAM (MIP)** FY 2003 Spending = \$2,215 (Dollars in Thousands)		
Work Package	FTE	Total
GNIRS	2.3	285
(GNIRS Cost Recovery)		(760)
NEWFIRM	10.1	1,003
GSAOI-est	6.0	1,115
(GSAOI Cost Recovery-est)		(1,115)
Monsoon Controllers	7.5	645
LSST	1.8	-
Detector Program	2.2	545
(Detector Cost Recovery)		(289)
NSO Support (GONG)	1.1	60
ETS Support to KPNO	4.5	-
Maintenance & Infrastructure	5.2	560
Support to CIS	0.8	-
Program Management	1.0	166
Total MIP Tucson**	42.4	\$2,215

*** Table shows Major Instrumentation costs budgeted in NOAO-Tucson division only; it does not include the \$574K allocated in the NOAO South budget under "Major Instrumentation," nor the \$307 budgeted in the NGSC for "Instrument Development." The total cost of the NOAO Major Instrumentation Program in FY 03 is therefore \$3,096K (\$2,215K + \$574K + \$307K).*

NOAO-WIDE PROGRAMS

- **KPNO Support:** Three programmers and two additional FTEs (engineers, scientists, and technicians) to provide support for the instruments on Kitt Peak.
- **Maintenance, Infrastructure, and CIS:** Optics shop, machine shop, staff shop, drafting room equipment, electronics shop, dewar labs and clean rooms, coating lab, electronics stockroom, PC purchases, software, maintenance and repairs. (Support to CIS and the NOAO computer infrastructure structure is allocated in the CIS budget.)



PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH (PAEO)

Milestones FY 2003

Educational Outreach

- Conduct the second distance learning course for the Teacher Leadership in Research Based Science Education (TLRBSE) program participants in winter/spring 2003; conduct teacher leadership meetings, workshops, and possibly a booth for the first-year class of TLRBSE at the spring 2003 National Science Teachers Association convention; hold the second summer institute for TLRBSE; recruit the third TLRBSE participant class; and publish the yearly *RBSE Journal* featuring research findings of TLRBSE teachers' students
- Organize and conduct the fall 2002 training workshop for new astronomer and teacher partners in Project ASTRO-Tucson, the spring 2003 follow-up workshop for Project ASTRO-Tucson participants, and the 2003 meeting of the National Network of Project ASTRO site leaders
- Complete and publish the first issue of the new *Astronomy Education Review*; establish a mailing list of (free) subscribers who will receive electronic summaries of journal content and other relevant items; develop a template for submissions to facilitate the publishing process; and develop a database of contact information for referees
- Help "jumpstart" a Project ASTRO-like educational outreach effort in Chile with the assistance of CTIO and its local community

NOAO-WIDE PROGRAMS

- Submit and win five-year Research Experiences for Undergraduates (REU) proposal for site funding at KPNO

Media and Public Outreach

- Publicize in the media and within the scientific community the key elements of ground-based infrared astronomy that support NASA's SIRTf mission and the early use of the HST Advanced Camera for Surveys
- Produce the traveling NASA Space Weather exhibit at the Kitt Peak Visitor Center as a "beta test" of admissions fees and the feasibility of other temporary shows
- Increase the number and variety of specialized educational classes offered to schools and the general public via the Visitor Center and the NOAO Public Outreach department
- Add two or three new interactive exhibits to the Visitor Center (depending on available funding); implement new docent-led, hands-on science demonstrations for visitors
- Implement an additional Nightly Observing Program/Advanced Observing Program telescope site for public viewing
- Assist CTIO with the redesign of its main Internet home page and continue the evolution of the NOAO home page, while providing creative Web support to the evolution of the NOAO Surveys Archive and the Data Products Program

Teacher Leadership in Research Based Science Education (TLRBSE)

Late in fall 2002, a maximum of 24 teachers will be accepted into the TLRBSE program as the second group of Teacher Leaders. Their tenure begins in January 2003 with a 16-week distance learning course designed to prepare them first as leaders to mentor novice teachers, and second as researchers for the hands-on research experience during the summer institute at Kitt Peak or Sac Peak. The distance learning course concentrates on topics of leadership, pedagogy, research, astronomy content, and image processing. Based on the successful outcome of the first distance learning course, held in spring 2002, a second successful course is anticipated. Additions to the distance learning course may include more assessment among the Teacher Leaders on the understanding of course content. In addition, NOAO Educational Outreach (EO) staff will participate in the March 2003 National Science Teachers Association convention, given that the 2002 convention proved to be a valuable capstone experience for the current Teacher Leaders and a means of recruitment of future Teacher Leaders. EO staff will also continue to offer the RBSE Journal, which has proved to be a very useful resource for the students of TLRBSE teachers, who have published 44 refereed articles in the last three years.

NOAO-WIDE PROGRAMS

Project ASTRO

Project ASTRO enters its seventh year at the start of FY 2003, as it begins a transition to a core program within NOAO. Using the Moon as the thematic focus, new features of the Fall 2003 workshop will include a component of the NASA Educator's Workshop (N.E.W.) on lunar rocks. An N.E.W. representative will give an afternoon workshop on the Moon using real lunar rock samples; these samples go on loan across the country for teachers to use in their classrooms with prepared curricula. We will once again travel to Kitt Peak for inspiration. Scheduled speakers include Dr. William Hartmann, noted astronomer, painter, and writer, and well-known amateur astronomer/writer David Levy.

Project ASTRO follow-up workshops are expected to diversify during FY 2003 to accommodate the varied needs of the participants. In addition to a possible expansion to Chile and potentially interesting adaptations to the programs in terms of language and culture, we are considering offering smaller follow-up workshops as means of outreach to the Tohono O'odham Indian Nation, the Girl Scouts of America, Project ACCESS (for children with disabilities), and/or the Arizona School for the Deaf and Blind. Smaller follow-up workshops would also allow us to concentrate on single topics of interest to teachers and their students, and could bring the workshop to a school closer to most of the teachers. NOAO will again be hosting the spring 2003 Site Leaders Meeting for the National Network of Project ASTRO.

Astronomy Education Review

NOAO has recently launched the *Astronomy Education Review*, an electronic journal designed for those working in astronomy and space science education. The journal, which can be viewed at <http://aer.noao.edu>, has received the endorsement of both the American Astronomical Society and the Astronomical Society of the Pacific. *AER* combines features of a journal and a magazine, publishing refereed research on education in astronomy and space science, short reports on innovative techniques, approaches, activities, and materials, as well as annotated lists of useful resources, editorials, reviews, opinion pieces, and interactive discussions. It also includes announcements of opportunities, workshops, jobs, conferences, grants, materials testing, and similar items of interest to professionals in this field.

In order to minimize start-up costs for this new venture, NOAO is able to take advantage of its existing capabilities and expertise in such areas as Web publishing and electronic processing of observing proposals. Small extensions or modifications of existing programs, formats, and procedures are being applied to the AER. NOAO will continue to publish the journal for at least three years in order to (1) create a robust infrastructure with an increasingly efficient operational cost structure; (2) establish the level of effort and cost required to sustain the journal; and (3) evaluate its impact and effectiveness as an educational medium. At the end of that period, NOAO will determine whether to continue

NOAO-WIDE PROGRAMS

to support publication or to transfer the journal to another organization (possibly one of the professional societies or a university) with an ongoing commitment to support of science education.

Research Experiences for Undergraduates (REU) Site Program

The REU grant for the KPNO summer program comes up for renewal in September 2003. Under the able direction of the site director, K. Mighell, NOAO will submit a proposal for a five-year continuation of this important program.

Public and Media Outreach

PAEO will continue its strong working relationship with the International Gemini Observatory in support of media activities, including possible news-related Webcasts, and PAEO staff will begin discussions with Gemini on ways to serve as an active continental U.S. node for educational outreach.

The Tucson-based staff of PAEO will also pursue greater support for outreach activities in Chile through its Project ASTRO expertise, coordinating efforts with the quarter-time commitment of D. Norman in La Serena.

In FY 2003, Public Outreach will offer a series of new public programs in addition to the successful Nightly and Advanced Observing Programs (NOP/AOP) programs. These new programs include special nights and weekends, and will be designed for the general public and amateurs. A special focus will be placed on school programming in an effort to increase the number of schoolchildren visiting Kitt Peak mountain.

In order to enhance the general visitor experience on the mountain, Public Outreach plans to implement docent-led, hands-on science demonstrations throughout the day between tours. These demonstrations would be related to exhibits and concepts taught on the mountain. The related activity carts would be supervised and highly interactive, and not in the form of lectures.

Due to public demand, NOAO Public Outreach is working with KPNO operations to initiate an additional site to run the AOP/NOP. This site would be temporary until fund-raising efforts could support the construction of another public observatory next to the Visitor Center.

NOAO-WIDE PROGRAMS

PAEO FY 2003 Budget and Major Work Packages

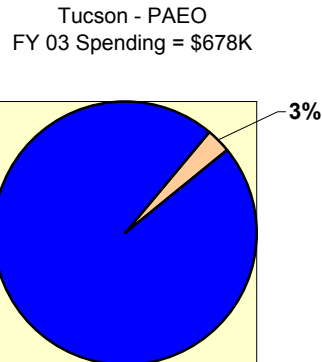
- Educational Outreach:** Supports core staff education efforts in the areas of local and national outreach, teacher professional development workshops and supporting materials, curriculum and instructional materials development, family and community-based programs, and research-based programs for students and teachers. Includes the TLRBSE program, Project ASTRO–Tucson, and the Research Experience for Undergraduates (REU) program, and supports astronomy education through educational Web pages and the development of the electronic *Astronomy Education Review* edited by S. Wolff.

TUCSON PUBLIC AFFAIRS & EDUCATIONAL OUTREACH FY 03 Spending = \$678 <i>(Dollars in Thousands)</i>		
Work Package	FTE	Total \$
Educational Outreach**	4.3	250
Program Management		250
TLRBSE Program		203
(TLRBSE Grant)		(203)
REU Program		46
(REU Grant)		(46)
Project ASTRO		30
(ASTRO Grant)		(30)
Kitt Peak Visitor Center	8.9	209
Programming & Operations		606
(Revenues from VC Programs)		(397)
Public Information & Media Outreach	1.7	133
Photo Lab & Graphic Arts	1.9	128
NOAO/NSO Newsletter	0.6	42
(Cost Recovery from NSO)		(84)
Total Tucson PAEO**	17.4	\$678

*** No PAEO educational activities/costs for NOAO South are included in this budget; see CTIO budget table for educational/public programs at NOAO South.*

- Public Outreach:** Operations of the Kitt Peak Visitor Center, its popular fee-based public observing programs, and informal community education efforts such as “star parties” at local attractions and schools. The FY 2003 budget includes an additional part-time Visitor Center staff person to handle the time-consuming tasks of scheduling the thousands of nighttime program attendees and the new amateur astronomy classes. A new public outreach database and increased support and training for the volunteer docents are planned for FY 2003.
- Media and Public Information:** Costs involved in the generation and distribution of NOAO-related news releases and images to the media (and to the general public via the NOAO home page), including a very active presence at the biannual meetings of the American Astronomical Society. Includes payroll for the PAEO manager/public information officer and the PAEO Webmaster.

NOAO-WIDE PROGRAMS



- **Photo Lab:** The NOAO Photo Lab (1.7 FTE) provides a variety of professional-quality graphics and poster production services to NOAO and NSO–Tucson, including support for the twice-yearly AAS meetings, traveling exhibits, brochure design, handouts, and internal photographic services.
- **Newsletter:** Production and printing costs for the quarterly 48-page color *NOAO/NSO Newsletter*, and a .3 FTE managing editor to assist with the production process and copyediting. This work package was formally transferred to the PAEO budget in FY 2002.

MANAGEMENT AND BUDGET

Divisional Organization

Each of the NOAO's four divisions—CTIO, KPNO, the NGSC, and the NOAO-Tucson headquarters—is led by a scientist.

The principal business of KPNO and CTIO is the operation of the telescopes of those observatories. The business of NGSC is user support, operational support, and instrument development. The business of NOAO-TUCSON is leadership of a number of cross-divisional programs.

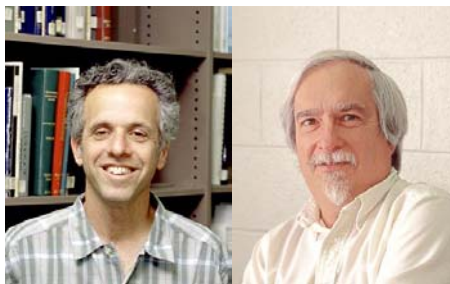
Cross-Divisional Programs

Seven NOAO programs function across divisional lines:

- Science Research
- Major Instrumentation Program
- Data Products Program
- LSST Program
- New Initiatives Office/GSMT
- Central Administrative Services
- Public Affairs and Educational Outreach

Three of these cross-divisional programs are headed by NOAO associate directors: Science Research (S. Strom), Major Instrumentation (search in progress), and the Data Products Program (T. Boroson). The heads of all seven of these programs and the division heads meet monthly in the Committee of Directors.

FY 2003 Budget and Work Breakdown Structure



Associate Directors and Program Managers: T. Boroson (Data Products Program) and S. Strom (Science Research Program). Boroson is also Deputy Director of NOAO and manager of the new NSF-funded Telescope System Instrumentation (TSIP) program. Strom is head of the New Initiatives Office GSMT program. Photo courtesy: M. Hanna, NOAO.



Directors of Four NOAO Divisions

Clockwise from top: J. Mould (Director, NOAO), M. Smith (Director, CTIO), T. Armandroff (Acting Director, NGSC), R. Green (Director, KPNO). Photo courtesy: M. Hanna, NOAO

MANAGEMENT AND BUDGET

FY 2003 is the second year in which the individual and total program budgets for the four NOAO divisions and 19 program functions have been constructed using the new Work Breakdown Structure (WBS). The aggregated costs of functional program areas seen in the table below have been calculated consistently for both years. The WBS components of KPNO and CTIO are designed for easy comparison and for the interchangeability of best practice from one to another.

NOAO FY 2003 BUDGET SUMMARY
By Division & Program
Total Budget = \$22,030
(Dollars Rounded to Nearest Thousand)

<i>Program/Division</i>	KPNO	CTIO	NGSC	NOAO - TUCSON	TOTAL
Science Operations	107	220		332	659
Instrument Upgrades	131	21			152
Telescope A	1,252	1,065	197		2,514
Telescope B	821	1,251	277		2,349
Telescope C	343	289			632
Mountain Facilities	668	577			1,245
Major Instrumentation		574	307	2,215	3,096
Science Research	163	258	30	652	1,103
LSST		53		1,692	1,745
NIO/GSMT		325		1,284	1,609
Data Products Program		70		1,018	1,088
Director's Office	248	322	260	627	1,457
Public/ Educ.Outreach		57		678	735
Computer Infra. Svces.		456		374	830
Central Facilities Ops.		189		819	1,008
Central Admin. Svces.		344		800	1,144
AURA Mgmt Fee				459	459
AURA Gemini Fellowship			100		100
NSO Facilities Support	105				105
TOTAL	\$3,839	\$6,071	\$1,171	\$10,950	\$22,030

Telescope A = Mayall 4-m (KPNO); Blanco 4-m (CTIO); Gemini N. (NGSC)

Telescope B = WIYN (KPNO); SOAR (CTIO); Gemini S. (NGSC)

Telescope C = Small telescopes at KPNO and CTIO

MANAGEMENT AND BUDGET

Financial reports based on the WBS established for each NOAO division are provided to the NOAO Management Committee on a quarterly basis by the Financial Manager

Anticipated FY 03 Revenue from External (Non-NSF/MPS) Sources

The following table lists the sources of external revenue anticipated in FY 2003 from non-NSF sources, including grants, inter-agency funds, indirect cost recovery, and revenue from fee-based programs and external work.

NOAO FY 2003 BUDGET
Anticipated FY 03 Revenue from External Sources
By Program Area and Division
(Dollars Rounded to Nearest Thousand)

<i>Program/Division</i>	KPNO	CTIO	NGSC	Tucson	Total
WIYN Partner Contributions	314				314
Tenants and Observer Fees; Revenue from External Work	653	210			863
PAEO: REU Grant		60		46	106
PAEO: TLRBSE Grant				203	203
PAEO: ASTRO Grant				30	30
PAEO: Revenue from KP Visitor Ctr & Fee-based Public Programs				397	397
Data Products Program: NASA "Open IRAF" Grant				89	89
Data Products: ITR Grant (02)				46	46
Data Products: ITR Grant (03)				211	211
MIP: USNO Support: Orion				300	300
MIP: Gemini Support: MCAO Imager Design Study (GSAOI)				760	760
NSF TSIP Program				4,000	4,000
HST Grants		58	5	635	698
NASA Grants	630		200	352	1,182
Total External Funds	\$1,597	\$328	\$205	\$7,069	\$9,199

MANAGEMENT AND BUDGET

FY 2003 Top Level Budget Summary

NOAO FY 2003 Budget (\$22,030)
Vs. FY 2002 Budget (\$22,560)
By Top-Level Work Breakdown Structure
(Dollars in Thousands)

WBS Program Area	FY 03	FY 02
SCIENCE	\$9,332	\$8,795
Science Operations/System Telescopes A + B	5,674	5,734
Instrument Upgrades		
Minor Telescopes (Tel. C)	632	744
Public Affairs/Educ. Outreach	735	546
Data Products Program	1088	789
Science Research	1103	982
AURA Gemini Fellowship	100	100
PLANNING - NEW INITIATIVES	3,354	2,801
LSST	1,745	793
GSMT/NIO	1,609	1,908
MAJOR INSTRUMENTATION	3,096	3,979
Instrument Development	3,096	3,979
INFRASTRUCTURE SUPPORT & ADMINISTRATION	6,248	6,985
Mountain Facilities	1,245	1,714
Central Facilities Operations	1,838	1,662
Computer Infra. Services		
Directors' Offices	1,457	1,611
Central Administrative Svces	1,708	1,998
NSO Support		
AURA Management Fee		
TOTAL NOAO	\$22,030	\$22,560
Total Award Adjusted for FY02 Mid-Year Supplement	\$21,330	\$23,260

The adjacent table shows the highest level aggregation of FY 03 program costs by four main categories: (1) *Science*, (2) *Planning /New Initiatives*, (3) *Major Instrumentation Development*, and (4) *Infrastructure Support and Administration*. Comparison of the FY 03 budget with the previous year shows that we are planning a 6% increase in funding for the broad science areas (\$9.3 mil. vs. \$8.8 mil), with an 11% decrease in infrastructure support and administrative costs (\$6.2 mil vs. \$6.9 mil). An increase of 21% (to \$3.4 mil.) in planning work for the decadal survey initiatives will occur at the expense of major instrumentation (down 22%).

The \$22.03 mil. bottom line shown here as the total cost of the FY03 NOAO program actually consists of two components: (1) the \$21.33 mil. awarded for FY 2003 and (2) a supplemental award of \$0.70 mil. made in FY 02, which is to be carried over to FY03.

Overall, the NOAO budget is slated to decline in FY 2003 by 2.3% in dollar terms, which is about 5% in real terms. This is not a sustainable trend, and in the out years we need to realize the budget growth projected in the NOAO Long Range Plan. It is only in this way that NOAO can play its part in implementing the plans the community has outlined in the decadal survey.

STATUS OF FY 2002 MILESTONES

NOAO GEMINI SCIENCE CENTER (NGSC)

- Launch the NOAO Gemini Science Center with a prospectus and metrics; ensure that staffing is at the appropriate level
The NOAO Gemini Science Center will be announced to the community and launched before the end of FY 2002.
- Issue calls for proposals for semesters 2002A and 2002B for Gemini North and Gemini South for US observers
The calls for proposals were issued in September 2001 and March 2002. The US received 113 proposals for the Gemini telescopes in semester 2002A and 103 in semester 2002B.
- By the end of 2002, provide data reduction packages for Gemini facility instruments, particularly for AO, MOS, and IFU capabilities
As of early May 2002, work is in progress to define the requirements for and functionality of the reduction packages for the facility instruments NIRI and GMOS. This effort is a collaboration between NGSC, the Data Products Program, and Gemini. The data reduction packages will build on the infrastructure and code that exist in IRAF for the current NOAO data reduction packages.
- Assist in the commissioning of Phoenix on Gemini South and work on possible demonstration science program
Phoenix has been successfully commissioned on Gemini South and is in regular use for science observing. Observing for the demonstration science program “Determining the Oxygen to Iron Abundance Ratio in the Large Magellanic Cloud” took place in February 2002. Several NGSC staff members were involved in the commissioning and demonstration science activities at Gemini South, including Ken Hinkle, Bob Blum, and Nicole van der Bliik.
- Provide support for the QuickStart Queue for Semester 2001B on Gemini South
NGSC did provide support for OSCIR QuickStart Observing on Gemini South in 2001B. In addition, NGSC staff members participated in Phoenix commissioning and some Phoenix demonstration science observing on Gemini South in Semester 2001B.
- Open and commission a remote operations center in Tucson
The Gemini Remote Operations Center (GROC) has been opened in Tucson. GROC has been used to troubleshoot remotely the NGSC-provided instruments Abu and Phoenix, which are in use on Gemini South, and is expected to perform a similar function for

STATUS OF FY 2002 MILESTONES

GNIRS when it is delivered. Because Gemini is being run in queue mode for semesters 2002A and B, there is no demand for Gemini remote observing capability at this time.

- Complete the GNIRS pre-ship acceptance test by the end of FY 2002 with the cooperation of the NOAO major instrumentation program
GNIRS has completed the fabrication phase and has entered the test and integration phase. As of early May, all but one of the GNIRS mechanisms have been successfully cold tested. Once that mechanism passes its cold test, the instrument will be assembled and will begin its first complete vacuum and cold tests.
- Work with IGO and the University of Florida to commission T-ReCS and perform system verification in Q1 of FY 2002
As of early May 2002, T-ReCS had not begun its pre-ship acceptance test at the University of Florida. Thus, no T-ReCS commissioning or system verification activities have occurred.
- Hold the Preliminary Design Review for the Near IR Coronagraphic Imager (NICI)
The NICI Preliminary Design Review (PDR) took place on April 2-3, 2002. The PDR Committee issued its report on April 26, and NICI was judged to have passed its PDR..
- Deliver CCDs and integrated controller package for the bHROS instrument in Q1 of FY 02
The delivery of the dewar for bHROS was delayed by University College London until October 2001 (approximately five months late). During the initial installation of the CCDs into the bHROS dewar, two of the CCDs were damaged, which resulted in further delays. It is expected that this work will be successfully completed before the end of FY 2002.
- Provide an Instrument Test Lab, complete with flexure test rig for Gemini facility instruments and other major instrumentation projects in the US system.
The Instrument Test Lab has been constructed. The flexure test rig has been ordered and is near completion at the vendor; its delivery and installation are expected to occur in June 2002.

STATUS OF FY 2002 MILESTONES

CERRO TOLOLO INTERNATIONAL OBSERVATORY (CTIO)

Southern Astrophysical Research (SOAR) Telescope

- Perform final acceptance tests of the active optics system, including all three mirrors; ship to Chile and install in the telescope
The contractor, B.F. Goodrich, has experienced significant delays, and the active optics system is not expected in Chile before January 15, 2003.
- Accept delivery of the Optical Imager, the commissioning and first science instrument
The SOAR Optical Imager is expected to begin integration with the SOAR environment and on-telescope testing in September 2002.
- Complete integration of the SOAR telescope, ready for first light scheduled for October 02
A delay in delivery of the telescope optics has forced postponement of first light to April 1, 2003.

CTIO Telescopes

- Simplify Blanco 4-m operations as a result of the completion of the installation of two permanently mounted instruments, Mosaic and ISPI (Infrared Sideport Imager)
ISPI is scheduled for commissioning in July 2002 and will be permanently mounted on the Blanco telescope with Mosaic.
- Locate and quantify remaining sources of man-made seeing in the Blanco telescope and dome
The start of this program was delayed until a Blanco telescope scientist was appointed in mid-2002.
- Transfer the 0.9-m CCD imaging system to the ex-2MASS 1.3-m telescope
Consortium operation of the suite of small telescopes announcement was issued. Telescope-instrument configurations have been frozen until the results of the competition are known.
- Subject to AURA Observatory Council review, explore an operating partner for 10% of the Blanco telescope
A review led to the decision not to proceed with selling off Blanco time. The over-subscription rate for semester 2002B exceeds 4.0.

STATUS OF FY 2002 MILESTONES

CTIO Instrumentation

- Deliver the Optical Imager to SOAR, and complete a duplicate dewar and focal-plane assembly for the Brazilian IFU Spectrograph
Delivery of the Optical Imager will take place at the end of FY 2002. Work on the Brazilian IFU spectrograph will start late in FY 2002.
- Commission the ISPI with 2K HgCdTe array on the Blanco telescope
Work on this project has been delayed by the loan of two lenses to FLAMINGOS (University of Florida). Commissioning, followed by shared risk science operations, is planned toward the end of FY 2002.
- Complete the two Nasmyth Instrument Support Boxes
The schedule for this project was revised due to the delay in SOAR first light, and delivery is now scheduled for FY 2003.
- Begin integrating the CTIO ETS Group with their Tucson equivalents as part of the NOAO Major Instrumentation Program
Members of the CTIO ETS (Engineering and Technical Services) group are working on the Gemini South Adaptive Optics Imager (GSAOI) and the advanced array controller (Monsoon), both NOAO major instrumentation programs.

KITT PEAK NATIONAL OBSERVATORY (KPNO)

Science Operations

- Commission wavefront camera in 4-meter Cass guider assembly
Planned for summer shutdown.
- Integrate f/8 active support with 4-meter active primary support system (4MAPS)
In progress through scheduled T&E nights. Fully operational mode anticipated for summer.
- Complete commissioning of upgraded Cryogenic Camera
Phase 1 complete and scheduled for observing. Phase 2 includes CCD replacement and optics upgrade to be completed by the end of summer.
- Commission WIYN Tip/Tilt fast-guiding module
On schedule. Loop closed on first-light run. Typical image quality improvement of 0.15"; best long exposure delivered 0.33" FWHM. Science verification is under way,

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to be completed during the summer. Upgrade to science-grade CCD detector planned for fall.

- Achieve first-light with Goddard IRMOS at the 2.1-meter
Delay of instrument project at GSFC. First light expected early in CY 2003.
- Integrate CCD Mosaic imager with new WIYN 0.9-m control system
Completed. First scientific observations in November 2001.
- Complete enclosure for new aluminizing facility in 4-m dome
On schedule and near completion at this writing.
- Subject to AURA Observatory Council review, explore an operating partner for 10%–20% of the Mayall telescope
With NSF and AURA approval, solicitation is now under way for partnership proposals aimed at development of new instrumentation for the Mayall 4-m. Review and selection anticipated for August.

Kitt Peak Mountain Facilities

- Replace/repair water, sewer, power, and telephone lines
Completed and activated new high speed DS3 fiber link between Kitt Peak and Tucson.
- Control and manage energy usage to reduce costs
Upgraded staff dorms to incorporate dual-pane windows and blackout shades.
- Water plant/system improvements
No major projects undertaken.
- Vehicle replacement
Evaluating one new purchase with 4WD capability for local mountain use.
- Tribal skills outreach
Tribal skills training within the Tohono O’Odham Nation is shifting emphasis from crafts to office clerical skills at reservation community college; hence the Nation did not provide any new crafts interns.

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➤ Emergency services support

Replaced and upgraded central fire alarm receiver/notification system. Evaluated Kitt Peak security issues. Upgrades to existing gate system are anticipated in FY 2003.

NOAO – TUCSON DIVISION

SCIENCE OPERATIONS - INTEGRATED OBSERVING SYSTEM

➤ A second meeting of the Scottsdale “system” workshop committee will be held and will address issues arising from NSF’s implementation of the Telescope System Instrumentation Program (TSIP)

This meeting is tentatively planned for the summer, following review and negotiation of the first round of TSIP proposals.

➤ A second community-based “system” workshop will be organized and conducted

This workshop is postponed until after the first round of TSIP are contracts in place.

➤ If and when requested by NSF, NOAO will issue a call for proposals to the TSIP program

NOAO developed TSIP solicitation, iterated details and process to convergence with NSF/AST and ACCORD, and issued call for proposals on December 5, 2001. Proposals were received by the end of March. The review process is scheduled for mid-May.

➤ Hold two Time Allocation Committee meetings and one Users’ Committee meeting.

Time Allocation Committee meetings were held October 31–November 9, 2001, and April 25–May 14, 2002. Users Committee meeting planned for early summer.

SCIENCE RESEARCH

➤ Hold a staff development retreat in Chile in October 2001

A retreat (2.5 days) was held at Airlie Conference Center following the January 2002 meeting of the AAS. Staff achieved a strong consensus on the future directions of NOAO, key communication issues, and priorities for improving the scientific culture at NOAO.

➤ Establish a new postdoctoral program and award the first fellowship

A five-year postdoctoral fellowship program was established and awarded to L. Macri (CfA), who will join NOAO in Fall 2002. NOAO intends to advertise another five-year fellowship in early 2003.

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- Establish an “extended staff” opportunity program and negotiate the first arrangements
A. Connolly (U. Pittsburgh) and C. Stubbs (U. Washington) were appointed as extended staff members. Connolly will lead the effort to define the data management requirements for LSST. Stubbs will lead major survey programs and, as practicable, will integrate his efforts with ongoing activities in the Data Products Program.
- Establish a mentoring program for scientific staff
As part of the annual review process, staff were asked to identify mentoring needs or requests. The Science Research Directorate will support one-on-one mentoring sessions for two members of the staff during spring 2002.
- Develop metrics for assessing staff productivity
Initial productivity and research metrics were prepared by the NOAO Director’s Office. These metrics will be reviewed with the staff during spring 2002.

DIRECTOR’S OFFICE

- Recruit a scientific Head of Instrumentation by July 2002
The Search Committee will meet to select one of three short-listed applicants in June 2002.
- Record time spent by NOAO scientific staff in functional work packages and other areas
A six-month report based on scientific staff electronic timecards will be available to the Observatory Visiting Committee (OVC) in May 2002.
- By the end of the year, evaluate the new Work Breakdown Structure (WBS) budget planning system introduced in FY 2002, with a view to further improvements in accountability and optimum use of resources
This review will be conducted by the financial manager in September 2002.

LARGE-APERTURE SYNOPTIC SURVEY TELESCOPE (LSST)

- Define the science requirements for telescope, instrument, operations, site characteristics, and data handling
Meetings of science working groups in the areas of deep imaging, including lensing, transients, and solar system problems, are being held in spring 2002. A Science Working Group for the project as a whole will be appointed in early summer, and will integrate the results of the separate working groups into a set of science requirements.

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- Translate the science requirements into technical requirements for telescope performance, an operations model, and data management systems
Translation of the science requirements into technical requirements will be the task of the project manager and his team. This work is expected to begin in summer 2002.
- Initiate a prioritized set of engineering studies on high risk elements, including optics fabrication, detectors, and filters
Studies of a number of the subsystems of the LSST have been initiated at the University of Arizona, the Lawrence Livermore National Laboratory, and elsewhere. The optics design is nearly complete, and a number of instrument concepts have been explored.
- Hire project managers to oversee community-based design efforts for hardware and software
A. Connolly (U. Pittsburgh) has received a contract to lead the effort to design the requirements for the LSST data management system. Recruitment for a project manager has been initiated now that negotiations to continue AURA management of NOAO have begun.
- Establish an LSST corporation
Incorporation was deferred pending the outcome of the re-competition of the AURA management contract. Discussions will likely be resumed in summer 2002.

AURA NEW INITIATIVES OFFICE (NIO)/ GIANT SEGMENTED-MIRROR TELESCOPE (GSMT)

- Analyze key issues raised by the point design: wind-buffeting; layered control system
Wind data from Gemini South were analyzed and used to develop an understanding of the role of wind-driven disturbances on the GSMT point design. A framework for a hierarchical control system was developed and analyzed. The wind and control studies are summarized in the GSMT "Green Book," the comprehensive online compendium of FY 2002 studies of GSMT science requirements; analysis of the "point-design" concept for a 30-m telescope, including initial instrumentation; and detailed summaries of technical studies common to all Extremely Large Telescope (ELT) design efforts. (See <http://www.aura-nio.noao.edu>)
- Develop key technical solutions: adaptive secondary; active structures
An adaptive secondary mirror is a key feature of the initial NIO point design. Requirements for the adaptive secondary have been defined, and preliminary

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discussions have been held with an experienced design group in preparation for design studies to be initiated in the last half of FY 2002. Active control of primary mirror segments, as well as active figure control for individual segments, has also been studied as part of the NIO point design.

➤ **Establish site selection criteria**

Early in FY 2002, NIO sponsored a successful site-testing workshop involving representatives from ESO, CELT, Cornell, UNAM, and NOAO. Key outcomes of the meeting included: agreement on site evaluation criteria; initiation of site evaluation in northern Chile based on remote sensing and numerical modeling studies; extension of initial site evaluation to the southwestern US and Mexico; discussion of desirable in-situ measurement; and comparative analysis of different site-testing methods. A follow-up workshop is scheduled for July 1–2, 2002.

➤ **Conduct design-to-cost studies and bound costs for GSMT**

Efforts focused on developing parametric cost models for key subsystems of the GSMT point design. An initial cost range based on these models will be available by third quarter FY 2002. A key effort in FY 2003 will be to refine these efforts and to develop an understanding of cost-performance trades in the context of a “science merit function.”

➤ **Involve the community in defining science-based performance requirements for GSMT**

The initial GSMT point design developed by NIO is based on a set of performance requirements developed from a two-year effort involving more than sixty members of the US and international science community. In fourth quarter FY 2002 or early FY 2003, NIO will sponsor a broad community workshop aimed at refining the science goals for GSMT by understanding in depth the key roles it will play in the era of Atacama Large Millimeter Array (ALMA) and Next Generation Space Telescope (NGST). A Science Working Group will use the results of this workshop to refine the current performance requirements and to develop a “science merit function” to guide cost-performance trade studies.

➤ **Involve the community in defining instrumentation options and technology paths**

An initial suite of instrument concepts has been developed. The designs are described in the GSMT book (<http://aura-nio.noao.edu>). The initial concepts were selected following an instrumentation workshop, held in February 2001, that defined key technology investments needed to enable a GSMT.

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- Continue conceptual design activities that support and complement other efforts (e.g., CELT; 20-20)
Wind-buffeting, adaptive optics, instrumentation, optical fabrication, and site-testing activities represent study areas that benefit all ongoing ELT programs. Results of these studies have been posted on the NIO Web site as they become available, and are included in the comprehensive GSMT book that was posted in mid-March 2002. A series of workshops on issues such as site selection and mirror segment fabrication will be held in the second half of FY 2002 to encourage collaborations among ELT groups.
- Explore partnerships to design and build GSMT
Discussions were held with Carnegie Institution of Washington, Herzberg Institute for Astronomy, Center for Astrophysics, UNAM, and INAOE (Mexico) to explore ways in which shared interests in participating in an ELT project could be aligned, and joint studies funded.

DATA PRODUCTS PROGRAM

- Creation of a ground-based optical/infrared archive, initially populated with reduced data replicated from the NOAO teams
The NOAO Science Archive was officially released on April 8, 2002. It was initially populated with reduced data from three of the projects from the NOAO Survey Program and had a limited set of query and search tools for accessing those data sets. Phase 2 of development for the archive is under way.
- Preliminary development of software pipelines with the goal of automatic processing of data taken with the NOAO instruments that produce large coherent data sets
The Time-Domain Data Processing project has been initiated with the intent of developing a software pipeline to process the data from the Stubbs et al. LMC microlensing survey into a useful time-domain data set in the NOAO Science Archive. This work is being done in collaboration with the Stubbs et al. team, and will utilize OPUS, a pipeline management product developed at STScI.
- Development of a concept for the LSST data management
A contract is now in place with A. Connolly at the University of Pittsburgh to lead this effort. It is envisioned as a two-year study, with one FTE of support to be provided by NOAO Data Products staff (a hiring offer is now outstanding) and support for a graduate student at the University of Pittsburgh.

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MAJOR INSTRUMENTATION PROGRAM

Gemini Near Infrared Spectrograph (GNIRS)

- Complete fabrication, integration, and warm tests by March 2002
Complete fabrication, integration, and warm tests will be completed by June 2002. The warm tests will be followed by cold testing and cold flexure tests in the new NOAO flexure test facility.
- Complete pre-ship acceptance test by the end of FY 2002
Completion date for the pre-ship acceptance test has slipped into October 2002. Delivery of the GNIRS to Gemini South has now been forecast for December 2002.

NOAO Extremely Wide-Field Infrared Imager (NEWFIRM)

- Complete conceptual design review
The conceptual design review was completed in FY 2002.
- Complete detector array selection and procurement
The array selection has been made in favor of the InSb arrays due to funding problems. The first arrays for use in NEWFIRM will come from the Orion program. Additional science grade arrays will be procured when NSF funding becomes available.
- Complete preliminary design review
The preliminary design review will be completed in October 2002. The change in detector pixel size and implementing suggested changes from the CoDR have required significant redesign in both optics and mechanical systems.
- Order filters and optical element materials
The broad band filters have been ordered. The optical elements will be ordered prior to the end of the fiscal year.

Gemini South Adaptive Optics Imager

- If NOAO is awarded a contract for a conceptual design study for the Gemini South Adaptive Optics Imager, carry out the design study, produce the conceptual design documentation, and submit a fixed-price proposal for completing the instrument
NOAO was awarded the contract for a conceptual design study. The Statement of Work was signed in January. The project is on schedule and doing well.

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Detector Program

- Receive and test $2K \times 2K$ bare RIO Orion readout at NOAO
NOAO has reviewed a bare RIO Orion readout and testing is under way.
- Receive, test, characterize, and optimize a prototype $2K \times 2K$ RIO InSb Orion array
RIO has produced two prototype arrays that will be sent to NOAO for testing. Additional science grade arrays are in the queue to be manufactured this fiscal year.
- Receive and test prototype RIO MBE HgCdTe array at NOAO, when available from RIO
RIO has not succeeded in producing an HgCdTe array. NOAO is prepared to invest in and test arrays if the technology problem can be resolved. LBNL has undertaken an innovative approach to developing high-performance CCDs with excellent quantum efficiency (QE) across the spectrum, particularly in the red spectrum. The devices use a high-resistance material, allowing deep-depletion wells yielding excellent red QE response without the associated “fringing effects” of thinned CCDs. Furthermore, the devices offer the promise of lower fabrication costs because of the removal of the need to “thin” the CCD. NOAO has tested several of the LBNL devices in the NOAO CCD Lab. Additional devices will be tested when available.

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH

- Launch the Beta version of the Teacher Leaders in Research Based Education (TLRBSE) online Distance Learning course in spring 2002
The TLRBSE Distance Learning course, accredited by the University of Arizona, debuted to strong positive reviews by participants, who are learning to navigate the WebCT environment and to build an online community.
- Conduct sixth annual Project ASTRO-Tucson Follow-up Workshop in spring 2002, followed by the seventh annual Training Workshop in fall 2002
The follow-up workshop for Project ASTRO-Tucson partners, held at David Levy’s home-based observatory in Vail, Arizona on February 17, included sunspot observing techniques, where the Sun sets on the horizon, the phases of the Moon, and other wonders of the night sky. Poor sky-viewing conditions failed to dampen the valuable personal interactions and exchange of ideas among the thirty attendees. Preparations for the fall 2002 workshop are under way.

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- Resume involvement in the NSF Research Experiences for Teachers (RET) program; ongoing participation in the Research Experiences for Undergraduates summer program

Delayed due to staff focus on ensuring the successful start of TLRBSE; will be reconsidered for summer 2003 part of overall renewal of the NOAO REU/RET program.

- At the Kitt Peak Visitor Center, complete exterior and interior renovation; install several new exhibits; and inaugurate audio kiosks as an enhanced feature of the self-guided walking tour for visitors

Major progress toward these improvements has been made, including a more expansive and safer patio surface with new outside furniture and lighting, a reshaped theater space with a wide-screen television, a newly encased Gemini telescope model, repairs and removals of several aging exhibits, installation of a temporary wall for added exhibit space, replacement of the 2.1-meter telescope lobby display, and initial beta testing of an audio kiosk that explains the historic Native American mural on the side of the Visitor Center.

- Improve the Kitt Peak docent training program with a new recruiting class and a more formal, in-depth training course; Nightly Observing Program (NOP) personnel to receive more uniform training and supporting materials

A comprehensive overhaul of the Kitt Peak docent program has been achieved, including: a detailed docent manual (which has drawn the interest of other southwest US observatories); a new, intensive seven-week training course; new docent staff clothing for easier identification by mountain guests; and formal performance evaluations and ongoing enrichment lectures regarding new developments and the latest astronomical research.

- Conduct two live, Web-based media events and release at least three other news items of national interest

Good progress has been made on regular NOAO/USGP news releases of interest to the space/astronomy media, with some initial breakthroughs into items of national interest (examples: the largest KBO discovered to date; Gemini adaptive optics-related science news at the January 2002 AAS meeting). Web-based press conferences remain in the planning and testing phase, pending news of sufficient significance and media appeal.

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- Organize and co-sponsor first formal meeting of the International Gemini Observatory partner outreach offices, tentatively scheduled to be held in Cerro Pachón in spring 2002
This meeting was held successfully in La Serena, Chile, on March 8, 2002. It included presentations by all seven Gemini partner representatives and NSF OLPA (and related one-on-one networking), detailed discussion of the Gemini news release production process, and an exchange of media training information gathered by NOAO PAEO. The next meeting, targeted for Summer 2003, will likely have a greater focus on educational outreach.
- Expand the upgraded design of the main NOAO home page on the Internet to include the home pages of KPNO and CTIO
The home page for Kitt Peak National Observatory was upgraded on schedule and debuted successfully with no problems. The main NOAO home page underwent a “2.0”-style revision in April 2002 that added major new top-level categories such as “Data Products” and “Major Instrumentation.” This update also removed the remaining secondary list of links in favor of pop-up menus. Again, this update encountered no operational issues or problems. CTIO is not able to dedicate an entire person to maintaining its Web presence, so its upgrade work has gone more slowly. However, it should be accelerated by a month-long residence of the main CTIO Webmaster at NOAO Tucson in summer 2002.