Program Plan
FY 2002

NSF Research Experiences for Undergraduate (REU) students in the KPNO summer program are given a demonstration of the new NOAO Gemini Remote Operations Center, August 2001.
# TABLE OF CONTENTS

- EXECUTIVE SUMMARY .......................................................... 1
- INTRODUCTION ................................................................. 2

## THE NOAO GEMINI SCIENCE CENTER (NGSC) ........................................ 4
- Milestones for FY 2002 .......................................................... 4
- Science Planning ................................................................. 4
- User Support ............................................................... 4
- Operations Support ............................................................. 5
- Instrumentation and Development ............................................ 5
- Outreach to the Astronomical Community .................................. 6
- Educational and Public Outreach ............................................ 7
- Gemini Telescope and Instrument Combinations FY 2002 .......... 7
- Estimated Program Costs for FY 2002 ..................................... 8

## CERRO TOLLO INTER-AMERICAN OBSERVATORY (CTIO) ......................... 9
- Southern Astrophysical Research (SOAR) Telescope .................. 9
- CTIO Telescopes ............................................................... 9
- CTIO Instrumentation ........................................................ 10
- CTIO Telescopes and Instrument Combinations FY 2002 .......... 10
- Estimated Program Costs for FY 2002 ..................................... 11

## KITT PEAK NATIONAL OBSERVATORY ............................................. 12
- Science Operations ............................................................ 12
- Mountain Facilities .......................................................... 13
- Estimated Program Costs for FY 2002 ..................................... 14
- KPNO Instruments Available for FY 2002 ................................ 15

## TUCSON HEADQUARTERS .......................................................... 16
- Science Operations ............................................................ 16
- Science Research ............................................................... 16
- Estimated Program Costs FY 2002 ......................................... 17
- Central Administrative Services (CAS) .................................... 18
- Central Facilities and Operations (CFO) .................................. 19
- Computer Infrastructure Support (CIS) .................................... 19
- Director’s Office (Tucson) ..................................................... 20
- Milestones for FY 2002 ........................................................ 20
- Estimated Program Costs FY 2002 ......................................... 20
- Servicing the System .......................................................... 20
- Milestones for FY 2002 ........................................................ 20
- Telescope System Instrumentation Program (TSIP) ................. 20
- Estimated Program Costs for FY 2002 ..................................... 21

## MANAGEMENT AND BUDGET ..................................................... 22
- Divisional Organization ........................................................ 22
- Work Breakdown Structure of Four NOAO Divisions ................. 23
- FY 2002 Level 2 Budget Summary .......................................... 25
- FY 2002 Level 3 Budget Summary .......................................... 26

## AURA NEW INITIATIVES OFFICE (NIO)/ GIANT SEGMENTED-MIRROR TELESCOPE (GSMT) ........................................... 27
- GSMT Milestones for FY 2002 .............................................. 27
- Organization ........................................................................ 27

---

NOAO Provisional Program Plan FY 2002: Table of Contents
Key Issues in Point Design ................................................................. 28
Key Technical Solutions ........................................................................ 28
Site Evaluation ..................................................................................... 28
Design-to-Cost Studies ......................................................................... 28
Community Involvement in Defining Scientific Context ......................... 28
Community Involvement in Defining Instrumentation Options and Technology Paths .......................................................... 28
Partnerships to Design and Build GSMT .............................................. 29
Estimated Program Costs for FY 2002 .................................................. 29

LARGE-APERTURE SYNOPTIC SURVEY TELESCOPE (LSST) ............. 30
Milestones for FY 2002 ....................................................................... 30
Science Requirements/Technical Requirements ................................... 30
Engineering Studies .............................................................................. 30
Project Managers ................................................................................ 30
Incorporation ....................................................................................... 31
Data Management/Precuror Experiments ............................................ 31
Estimated Program Costs FY 2002 ....................................................... 31

DATA PRODUCTS PROGRAM .................................................................. 32
Milestones for FY 2002 ....................................................................... 32
Creation of a Ground-Based O/IR Archive ........................................... 32
Preliminary Development of Software Pipelines ................................. 32
Development of a Concept for the LSST Data Management ................. 32
Estimated Program Costs FY 2002 ....................................................... 33

MAJOR INSTRUMENTATION PROGRAM ............................................... 34
Gemini Near Infrared Spectrograph (GNIRS) ......................................... 34
NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) .................. 34
Gemini South Adaptive Optics Imager ................................................ 35
Detector Program .............................................................................. 35
Estimated Program Costs FY 2002 ....................................................... 36

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH .......................... 37
Milestones for FY 2002 ....................................................................... 37
TLRBSE Program Enhancements ........................................................ 37
Project ASTRO ................................................................................... 37
Research Experiences for Teachers (RET) and Research
  Experiences for Undergraduates (REU) ............................................... 38
Kitt Peak Visitor Center Exhibits, Tours, and Building Renovations ....... 38
Kitt Peak Docent Program ................................................................... 38
Web Casting and Media Briefings ......................................................... 38
IGO Partner Outreach Meeting ........................................................... 38
NOAO Web Site .................................................................................. 38
Estimated Program Costs for FY 2002 ................................................ 39

NSF-FUNDED SCIENTIFIC STAFF ....................................................... 40
La Serena-Based Scientists .................................................................. 40
Tucson-Based Scientists ..................................................................... 56

APPENDIX A: STATUS OF FY 2001 MILESTONES .................................. A-1
APPENDIX B: TENANT FACILITIES ....................................................... B-1
EXECUTIVE SUMMARY

The National Academy of Science’s decadal survey report, *Astronomy and Astrophysics in the New Millennium* (National Research Council, 2001) has challenged NOAO to become a more effective national organization and to take on major leadership roles in ground-based astronomy. To accomplish this, we intend to re-align our priorities and to re-invest in cutting edge observing facilities for the future.

As laid out in the decadal survey, the science case for astronomy is a compelling one. High-priority achievable goals include: understanding how the Universe and its constituent galaxies, stars, and planets formed, and how these evolved. Our research will appeal to the public, as our facilities are brought to bear on questions of popular interest, such as: *Are we alone in the universe?*

NOAO’s strong commitment to merit-based research, its links to Gemini, its proven experience in forging international collaborations and domestic partnerships, and its continuing presence representing broad community interests are vital factors in the successful implementation of the decadal survey.

The key elements of NOAO’s program plan for FY 2002 are the following:

- Evolution of the US Gemini Project Office to the NOAO Gemini Science Center (NGSC), with a mission to provide the US community with superior user support as the Gemini telescopes enter their operations phase, and effective planning and delivery of next generation instruments.

- Highly productive national facilities at Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory operated at reduced cost levels more appropriate to their place in the “integrated observing system;” these efficiencies will be largely achieved through partnerships with universities.

- A new Data Products program that will ensure public ownership of, and access to, large surveys and other coherent databases, and that lays the groundwork for NOAO’s role in the Large-aperture Synoptic Survey Telescope (LSST).

- A design study program for the LSST that will enable early submission of a detailed proposal for the LSST telescope, camera, and data management system.

- A design program for the Giant Segmented Mirror Telescope (GSMT), with completed Phase A studies in 2006, supported by a cumulative funding line of $20M (FY 2001-2007)—an investment that appropriately represents the public interest in the decadal survey’s desired public/private partnership.

- A public affairs and educational outreach program that builds on the strong foundations of recent years, involves a diverse group of students in authentic research and development learning experiences, and takes full advantage of emerging communications technologies and partnership opportunities.

- A major instrumentation program focused on Gemini, other 8-m class telescopes, and later, on the GSMT, coupled with supporting detector/controller and technology programs.
INTRODUCTION

The coming year is one of the most significant in the 45 year history of the national observatory. This is the first year the National Science Foundation has competed the cooperative agreement to operate the observatory. The Association of Universities for Research in Astronomy (AURA) is one—but not the only—contender for the job. Through the NSF solicitation for the proposed cooperative agreement (NSF 01-80), the Foundation has requested NOAO to get to work implementing *Astronomy and Astrophysics in the New Millennium*, specifically by planning for public participation in the flagship projects of the next decade—the Large-Aperture Synoptic Survey Telescope (LSST) and the Giant Segmented Mirror Telescope (GSMT). We are also asked to assist the NSF with the National Virtual Observatory (NVO), the Telescope System Instrumentation Program (TSIP), and the US Gemini Program (USGP). The FY 2002 Provisional Program Plan is NOAO's immediate response to these new challenges.

Looking to the end of the decade 2001–2010, the National Optical Astronomy Observatory has three new top-level goals:

- Explore the Universe with unprecedented resolution and depth with a 30-meter class giant diffraction-limited optical/infrared telescope
- Survey the sky weekly with a large telescope with dramatically wider field and sensitivity for time-varying objects
- Utilize technological advances to provide access to real-time and archival databases on a scale never before possible.

This FY 2002 Provisional Program Plan sets in motion NOAO’s long march to reach these goals and hence become the effective national observatory described by the Astronomy and Astrophysics Survey Committee.

The FY 2002 Provisional Program Plan begins by developing NOAO’s plans for its role in Gemini. NOAO’s responsibility to NSF in the international Gemini Project is to be the interface between the operational telescopes and the US research community. Models for this function include the Space Telescope Science Institute (more accurately, STScI before flight operations were transferred there from Goddard) and the SIRTF Science Center (SSC). AURA pioneered the STScI model, but the right-sized model for the US Gemini program is closer to the SSC. For this purpose, NOAO plans a center with a scientific staff complement of five to ten FTE astronomers, able to call on the full resources of NOAO for support as required. The center is to be called the NOAO Gemini Science Center, and is an integral part of the national observatory. NGSC will offer a light and flexible service delivery model because of its embedding in NOAO.

Next, the 2002 plan describes how NOAO and Gemini will continue a partnership commenced early in 2001 to carry out pre-phase A studies for the decadal survey’s Giant Segmented Mirror Telescope (GSMT). This partnership is under the auspices of AURA’s New Initiatives Office (NIO). A strong engineering and science team is at work, with an Advisory Committee with representatives of all likely players in the public/private national/international effort to bring an extremely large, diffraction-limited, ground-based OIR telescope into operation contemporaneously with NGST and ALMA.
Planning for LSST will also be pursued aggressively in FY 2002. The goal this year is to solve the "tall poles" system issues so that a fully costed proposal can be submitted the following year by a consortium of institutions including NOAO, to the appropriate funding agencies.

FY 2002 is the inaugural year of NOAO's new Data Products Program. This is the national optical/infrared observatory's initial response to the cultural change which the National Virtual Observatory will bring about in astronomy. NOAO's recent investment in surveys is the first intellectual capital which the observatory can bring to the NVO. A strengthened NOAO software group with new leadership will be focused on making these data and future data archive-ready.

Although engineering effort is moving to next generation frontline facilities, CTIO and KPNO will see the fruit of recent investment in new instrumentation, as WIYN capitalizes on its superior seeing with a tip-tilt module, and SOAR nears first light. These are models for the university partnerships which will ensure the future of these observatory assets.

In FY 2002, NOAO's collective engineering expertise will be drawn together into the Major Instrumentation Program. The facility infrared spectrograph (GNIRS) will be delivered to Gemini; detailed design will be done for NEWFIRM, a new generation in infrared survey imagers. A scientific Head of Instrumentation will be sought to lead the program.

Educational programs will be strengthened in FY 2002, and public outreach will start to speak in the same terms from national ground-based facilities as we have become accustomed to from HST. FY 2002 will also see the launch of a new Work Breakdown Structure for NOAO which will offer oversight groups a tighter coupling between inputs and scientific outputs. Initiatives will be launched to strengthen the research and functional performance of scientific staff and their leadership and service roles in the community.

NOAO will strongly support the NSF's Telescope System Instrumentation Program (TSIP), a vital element in the international competitiveness of US astronomy.
THE NOAO GEMINI SCIENCE CENTER (NGSC)

Milestones for FY 2002

- Launch the NOAO Gemini Science Center with a prospectus and metrics; ensure that staffing is at the appropriate level.
- By the end of 2002, provide data reduction packages for Gemini facility instruments, particularly for AO, MOS, and IFU capabilities.
- Assist in the commissioning of Phoenix on Gemini South and work on possible demonstration science program.
- Provide support for the Quickstart Queue for Semester 2001B on Gemini South.
- Open and commission a remote operations center in Tucson.
- Complete the GNIRS Pre-Ship Acceptance Test by the end of FY 2002 with the cooperation of the NOAO major instrumentation program.
- Work with IGO and the University of Florida to commission T-ReCS and perform system verification in Q1 of FY 2002.
- Hold the Preliminary Design Review for the Near IR Coronagraphic Imager (NICI).
- Deliver CCDs and integrated controller package for the bHROS instrument in Q1 of FY 2002.
- Provide an Instrument Test Lab, complete with flexure test rig for Gemini facility instruments and other major instrumentation projects.

Science Planning

Within the structure of the International Gemini Observatory (IGO), each partner agency created a national project office to represent its participation in Gemini. NOAO is the home of the US national project office, and the director of the NGSC is the US project scientist for Gemini. In order to access and represent US interests, the NGSC director is assisted by a science advisory committee (US SAC) that consists of eight to ten prominent members of the US community. This committee meets annually to advise on science direction, operations models, instrumentation concerns, and the full variety of Gemini matters.

To mark the transition from project to operations, NOAO will re-launch the US national Gemini project office as a science center in the first quarter of FY 2002. The goals of the NGSC are to meet US community needs for 8-m aperture telescopes, to provide user support, including data reduction and analysis procedures, and to develop the input from the US perspective to the International Gemini Observatory in science planning, instrument development, and operations support.

User Support

User support at the NGSC starts with a group of more than a dozen instrument scientists, ranging from quarter-time to full-time, whose areas of scientific and technical expertise are matched to the diversity of Gemini instrumentation. These instrument scientists assist the US principal
investigators in preparing observing proposals and provide the first level of technical proposal evaluation for the telescope allocation process.

The complexity of the Gemini instruments and operations requires complex observing protocols and calibration observations. Observations with adaptive optics and the mid-IR are areas in which Gemini has the competitive edge; these will be specialist fields for the NGSC. NGSC staff will work closely with observers to develop and document observing procedures to assure that Gemini data are of the highest quality and that the data are both calibrated and documented to archival standards.

In order to attain Gemini science goals, data reduction, calibration, and analysis tasks need to be developed for the Gemini data products. The NOAO Data Products Program will strengthen these efforts, providing system enhancements and data quality and error mapping specifically for Gemini data. The reduction and analysis of adaptive optics images and spectra, multiple-object and integral field spectroscopy, and mid-IR images and spectra all require extensive software support, which is linked to ongoing IRAF development.

Operations Support

NGSC staff will provide support for the commissioning and operations of US instrumentation efforts. NGSC staff are also responsible for the coordination of shared Gemini instrument packages from the US, currently FLAMINGOS (a University of Florida instrument shared between KPNO and Gemini South) and Phoenix (an NOAO instrument shared with SOAR and Gemini South). NGSC staff will work with the instrument teams in the testing, maintenance, and calibration of these shared instruments, and provide documentation on performance, operation modes, and calibration procedures for the Gemini community. NGSC and CTIO staff are collaborating with IGO on the characterization of the sodium layer over Tololo and Pachón.

During Semester 2001B, the visitor instruments on Gemini South will be run in a Quickstart Queue Service observing program. NGSC staff will participate in this effort for OSCIR and FLAMINGOS support, and CTIO will host the staff from the other national project offices (Canada, Brazil, Australia, and Chile) who will also participate.

NGSC staff in Chile share many facilities with CTIO: a common base site in La Serena (the AURA compound), the mountain site (both Gemini South and SOAR are on Cerro Pachón), and shared network bandwidth and some computing facilities. Coordinated efforts by the AURA Observatories in Chile, with NSF support, will increase the bandwidth to the southern sites by a factor of >20 over current capacity by early 2002. This expanded capacity (initially ~10Mbits/s) will permit IP video and data links, and some remote observing options (e.g., eavesdropping) for all the southern sites. AURA has long-range plans for additional bandwidth improvements. A remote operations center will be established in Tucson with high-speed internet connections to the Mauna Kea and Cerro Pachón sites. The remote operations center will serve community observers as well as NGSC staff, enabling staff to support US observers and US instrumentation efforts on Gemini. NGSC staff will also use this center for training and for conducting engineering programs to enhance the productivity of Gemini observing.

Instrumentation and Development

NOAO is responsible for management oversight of all Gemini instruments built in the US. Approximately half of the US Gemini instrument work is carried out at NOAO, and the other half is performed in the US community with management oversight from NOAO. In collaboration with the NOAO major instrument program, we expect to conduct the pre-ship acceptance test for
the GNIRS spectrograph being built at NOAO. NOAO will also provide the detectors and
controller for the bHROS instrument for Gemini South.

In addition to the work ongoing at NOAO, Gemini instrument projects are in progress
elsewhere in the US. The mid-IR imager and spectrograph, T-ReCS, is being built at the
University of Florida. During FY 2002, we will work with U. Florida and IGO to commission T-
ReCS on the Gemini South telescope. The Near-Infrared Coronagraphic Imager (NICI) for Gemini
South is a dual-beam optimized coronagraphic imager. It is being built by Mauna Kea Infrared,
with funding from NASA. NOAO provides management oversight for both these contracts,
including quarterly reviews. During FY 2002, NGSC will conduct the Preliminary Design Review
for NICI.

Performance of large telescope instrumentation is often limited by differences between the
laboratory and telescope environment. Gemini places tight tolerances to eliminate any such
performance degradation, but for instrument suppliers such as NOAO, verification before
delivery to Gemini requires stringent testing. In FY 2002 NOAO will construct a test laboratory
and equip it with a flexure test rig. This will become a telescope simulator and an important
resource for US instrument suppliers in general. Such a facility will allow the simulation of the
telescope control and software system, permit full flexure and environmental testing, and perform
alignment and integration activities so as to minimize the amount of valuable telescope time that
would otherwise be spent on these activities.

The current set of instrument specifications and science goals was elaborated in an international
meeting ("the Abingdon Meeting") in 1997. In 2003, a second international meeting will be held to
explore the next generation of instrumentation and to develop the strategic plan for the IGO in the
coming decade, including the role of Gemini in the Next Generation Space Telescope (NGST) era.
As was also done prior to the Abingdon meeting, the NGSC will conduct community workshops in
the US to prepare the science cases and instrumentation opportunities that best satisfy the needs and
preferences of our community, and to coordinate the Gemini Observatory within the US system.

**Outreach to the Astronomical Community**

NGSC will communicate with the user community by means of articles in the *NOAO Newsletter*,
special brochures, "town meetings" and special sessions at AAS meetings, electronic
announcements, and Web-based information. Currently under exploration is the use of Web casts to
inform the users on specifics of Gemini instrumentation and to instruct them on the use of Gemini
queue-scheduling tools.

The NGSC intends to organize and conduct science workshops, in collaboration with the IGO and
partner countries, to highlight particular areas of Gemini science that are both timely and
productive. The NGSC will also sponsor technical workshops, like this year's Tucson workshop
on AO data reduction, to assist the community in obtaining the highest scientific return from
Gemini observations. Future workshops may focus on multiple object spectroscopy in the optical
and near-IR (with GMOS and FLAMINGOS), on integral field spectroscopy, or on other
specialized reduction and visualization tools and procedures.

To mark the launch of the NGSC, AURA plans to create a new postdoctoral program to encourage
young astronomers to utilize the Gemini telescopes for innovative science. This program will
complement AURA's Gemini Fellowships for graduate study.
Educational and Public Outreach

NGSC will work closely with both the NOAO and IGO Outreach groups to identify important Gemini science discoveries and to highlight these science stories for the public via press releases, media outlets, and the NOAO and Gemini Web sites. The Tucson-based remote operations center currently under development will also be a locus for public education programs tied to Gemini, and will include a public viewing gallery with video, audio, and computer monitors, and Web-based tours of the Gemini facilities, instruments, and science programs. Over time, these Gemini outreach efforts will bring the operations of the distant Gemini observatories home to the general public as a tangible and accessible achievement of astronomical discovery.

Gemini Telescope and Instrument Combinations FY 2002

<table>
<thead>
<tr>
<th>Gemini Telescope and Instrument Combinations FY 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gemini North:</strong></td>
</tr>
<tr>
<td>• Hokupa'a + QUIRC: 1 - 2.5 micron adaptive optics imager</td>
</tr>
<tr>
<td>• NIRI: 1 - 5 micron imager and grism spectrometer</td>
</tr>
<tr>
<td>• CIRPASS: 1 - 1.5 micron IFU spectrograph</td>
</tr>
<tr>
<td>• GMOS: 0.36 - 1 micron MOS spectrograph and imager</td>
</tr>
<tr>
<td><strong>Gemini South:</strong></td>
</tr>
<tr>
<td>• Flamingos I: 1 - 2.5 micron MOS spectrograph (after 6/02)</td>
</tr>
<tr>
<td>• Phoenix: 1 - 5 micron high-resolution spectrograph</td>
</tr>
<tr>
<td>• T-ReCS: 8 - 25 micron imager and spectrometer (est. after 5/02)</td>
</tr>
<tr>
<td>• Acquisition Camera: 0.35-1 micron rapid-read imager</td>
</tr>
</tbody>
</table>
### NOAO Gemini Science Center

**Est. Program Costs for FY 2002**

**Total = $ 1,095**  
(Dollars in Thousands)

<table>
<thead>
<tr>
<th>Work Package (Level 1)</th>
<th>FTE</th>
<th>Est. Cost</th>
<th>External Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gemini User Support(^1)</td>
<td>2.2</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Gemini S. Operations Support(^2)</td>
<td>2.7</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Director's Office(^3)</td>
<td>1.7</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>Data Products(^4)</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>NGSC Fellow(^5)</td>
<td>0.5</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Gemini Fellowships(^6)</td>
<td></td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>Instrument Development(^7)</td>
<td>2.3</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

**Total Program**  
9.4 $ 1,095 $ 24

---

### Notes to Table


3. The NGSC Director is supported by two-thirds of an administrative assistant in Tucson.

4. This work will be carried out by the Data Products Program.

5. Stipend and travel for this position will be provided by AURA; benefits will be paid by NOAO. It is assumed that the position will be filled at the start of the 3rd quarter 2002.

6. Selection of Fellows is by AURA.

7. Support for T. Armandroff (Project Manager), M. Trueblood, and a fraction of J. Elias.
CERRO TOLOLO-INTER-AMERICAN OBSERVATORY (CTIO)

Southern Astrophysical Research (SOAR) Telescope

- Final acceptance tests of the active optics system, including all three mirrors; ship to Chile and install in the telescope.

- Accept delivery of the Optical Imager, the commissioning and first science instrument.

- Complete integration of the SOAR telescope, ready for first light scheduled for October 2002.

The SOAR 4.2-m telescope installation and integration will be completed during FY 2002. This period begins with delivery of the dome and the telescope mount during September 2001 and ends one year later, with first light scheduled for October 2002. CTIO ETS, TELOPS and scientific staff will be participating fully in these phases, as part of an agreement between the SOAR partners to augment SOAR Project manpower in exchange for a reduction in the length of the period for which NOAO will operate the telescope. CTIO staff will also participate in the following period of commissioning of the telescope and instruments. The SOAR Optical Imager, with focal plane consisting of a 4K x 4K mosaic of blue-optimized Lincoln Labs CCDs, is being built at CTIO; the data system for all the SOAR optical instruments will consist of Leach controllers, with LabVIEW software running under Linux. Development of this data system is being carried out at CTIO.

CTIO Telescopes

- Simplify Blanco 4-m operations as a result of the completion of the installation of two permanently mounted instruments, Mosaic and ISPI.

- Locate and quantify remaining sources of man-made seeing in the Blanco telescope and dome.

- Transfer the 0.9-m CCD imaging system to the ex-2MASS 1.3-m telescope.

- Subject to AURA Observatory Council review, explore an operating partner for 10% of the Blanco telescope.

The Blanco 4-m will be operated with a suite of high-performance wide-field instruments, a CCD 8K Imager at prime focus (Mosaic II), a 2K IR imager at F/8 (ISPI), and a multi-object fiber spectrograph (Hydra), recently upgraded with a new camera and low noise SITE CCD. These instruments can all be mounted simultaneously, although we will continue to substitute Hydra with the RC and Echelle spectrographs a few times a semester until HROS on Gemini and the Goodman spectrograph on SOAR become available. The Ohio State University IR Spectrometer OSIRIS will move from the Blanco to SOAR during this period. This reduced instrument complement will allow us to remove several support subsystems and simplify cabling on the Blanco, which should increase reliability and decrease operational complexity. We will also upgrade and reorganize the Ethernet routing for the Blanco computer system, in recognition of the very high bandwidth demands made by some programs using the Mosaic Imager. Work will continue to optimize the performance of the Blanco telescope, principally by evaluation of man-made seeing within the telescope and dome, using a Micro-thermal sensor system and various fast-imaging techniques.

The University of Massachusetts 1.3-m telescope has been transferred to NOAO operation, following the completion of the 2MASS Survey. During FY 2002 we will move the CCD camera and data system from the 0.9-m to the 1.3-m, and subsequently close the 0.9-m. The 1.3-m is a
modern, high performance telescope that is simple to operate and maintain, and should allow CTIO to provide a small-telescope imaging capability at low incremental cost.

**CTIO Instrumentation**

- Deliver the Optical Imager to SOAR, and complete a duplicate dewar and focal-plane assembly for the Brazilian IFU Spectrograph.
- Commission the Infrared Sideport Imager (ISPI) with 2K HgCdTe array on the Blanco telescope.
- Complete the two Nasmyth Instrument Support Boxes.
- Begin integrating the CTIO ETS Group with their Tucson equivalents as part of the NOAO Major Instrumentation Program

Following completion of ISPI, the SOAR Optical Imager, and the SOAR Instrument Support Boxes, only minor upgrades to present facilities are scheduled, due to the heavy manpower demands of SOAR. CTIO will provide some ETS support for the NIO/GSMT Site Survey, principally in the construction and testing of the Turbulence Profilometer, and in the maintenance of equipment used for site testing in Chile. The CTIO ETS group will begin a multi-year process of integrating its operation with its Tucson counterpart to form the Major Instrumentation program. In FY 2002 approximately 25% of ETS manpower will be integrated into the Major Instrumentation program.

---

<table>
<thead>
<tr>
<th>CTIO Telescopes and Instrument Combinations FY 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>See also: <a href="http://www.ctio.noao.edu/telescopes/TheFuture/crystal_ball.html">http://www.ctio.noao.edu/telescopes/TheFuture/crystal_ball.html</a></td>
</tr>
</tbody>
</table>

**Blanco 4-m**
- Hydra Multi-Object Spectrograph + Hydra Camera + SITe 2K × 4K CCD
- R-C Spectrograph + Blue Air Schmidt Camera + Loral 3K × 1K CCD
- Echelle Spectrograph + Long Camera + SITe 2K CCD
- Prime Focus Camera + Mosaic Imager + SITe 8K Mosaic
- ISPI IR Imager + 2K HgCdTe
- OSIRIS, OSI Imaging Spectrometer, 1K HgCdTe (1st semester only)

**1.5-m**
- Cass Direct + SITe 2K CCD
- Cass Spectrograph + Loral 1200 × 800 CCD

**1.3-m (0.9-m for 1st semester)**
- Cass Direct + SITe 2K CCD

**1.0-m YALO**
- ANDYCAM dual channel IR (1K HgCdTe) + CCD (2K Loral) Imager
### Cerro Tololo Inter-American Observatory
#### Est. Program Costs FY 2002
##### Total Program = $6,180

<table>
<thead>
<tr>
<th>Work Packages (Level 1)</th>
<th>FTE</th>
<th>Total</th>
<th>External*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Operations</td>
<td>0.3</td>
<td>$90</td>
<td></td>
</tr>
<tr>
<td>Pre &amp; Post Observer Support</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queue &amp; Service Observing</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument Upgrades</td>
<td>7.0</td>
<td>$427</td>
<td></td>
</tr>
<tr>
<td>Blanco Telescope</td>
<td>17.0</td>
<td>$984</td>
<td></td>
</tr>
<tr>
<td>Telescope Ops</td>
<td>869</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Support</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telescope Upgrades</td>
<td>67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOAR Telescope</td>
<td>19.7</td>
<td>$1,105</td>
<td></td>
</tr>
<tr>
<td>Integrate, commission</td>
<td>1,105</td>
<td></td>
<td>215</td>
</tr>
<tr>
<td>Small Telescopes</td>
<td>5.5</td>
<td>$358</td>
<td></td>
</tr>
<tr>
<td>Telescope Ops</td>
<td>312</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Support</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telescope Upgrades</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain Facilities [AOSS]*</td>
<td>16.5</td>
<td>$924</td>
<td></td>
</tr>
<tr>
<td>Roads</td>
<td>148</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilities, communications</td>
<td>123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>118</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Visitor Center</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warehouse</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety, medical; security</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td>243</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dormitory</td>
<td>83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicles, transportation</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td>1.0</td>
<td>$60</td>
<td></td>
</tr>
<tr>
<td>Director's Office</td>
<td>5.0</td>
<td>$467</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>394</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Administrative Support*</td>
<td>73</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Headquarters [AOSS]*</td>
<td></td>
<td>$305</td>
<td></td>
</tr>
<tr>
<td>Safety; security</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warehouse; Ship/Receiving</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilities; communications</td>
<td>69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicles, transportation</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admin. Services [AOSS]*</td>
<td>13.0</td>
<td>$559</td>
<td></td>
</tr>
<tr>
<td>General administration</td>
<td>266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounting, payroll</td>
<td>212</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel office</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Resources</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAEO</td>
<td>1.0</td>
<td>$99</td>
<td></td>
</tr>
<tr>
<td>Light pollution education</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational programs</td>
<td>39</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>NIO/GSMT</td>
<td>2.3</td>
<td>$532</td>
<td></td>
</tr>
<tr>
<td>Major Instrumentation</td>
<td>3.5</td>
<td>$270</td>
<td></td>
</tr>
<tr>
<td>Total Program</td>
<td>92</td>
<td>$6,180</td>
<td>$390</td>
</tr>
</tbody>
</table>

* External funds include indirect cost recovery from scientific staff grants and REU program funding.

*Mountain Facilities, Headquarters, and Admin. Services are supplied as a service package by AOSS and purchased by CTIO. Est. AOSS costs were calculated by multiplying FTE in AOSS categories by percentage of AOSS budget paid for by CTIO and SOAR.
KITT PEAK NATIONAL OBSERVATORY

Science Operations

➤ Commission wavefront camera in 4-meter Cass guider assembly
➤ Integrate f/8 active support with 4-meter active primary support system (4MAPS)
➤ Complete commissioning of upgraded Cryogenic Camera
➤ Commission WIYN Tip/Tilt fast-guiding module
➤ Achieve first-light with Goddard IRMOS at the 2.1-meter
➤ Integrate CCD Mosaic imager with new WIYN 0.9-m control system
➤ Complete enclosure for new aluminizing facility in 4-meter dome
➤ Subject to AURA Observatory Council review, explore an operating partner for 10%-20% of the Mayall telescope

Wavefront Camera

This permanently mounted imager will allow nightly adjustment of the zero-point for the actuators of the 4-m optical system, both primary and f/8 secondary. The installation is scheduled for summer shutdown in FY01, with operational commissioning in FY02.

Active f/8 Integration

In FY01, the f/8 secondary mounting system was upgraded for precision drives and encoders. The effort will be to institute and calibrate tilt compensation to reduce coma in an integrated division of the wavefront error budget with 4MAPS.

CryoCam Upgrade

The Cryogenic Camera spectrograph was upgraded with a new Lawrence Berkeley Labs red-sensitive CCD, high-efficiency optical coatings, a low-profile CCD mount, a new field lens, and a VPH grating. The first T&E run is in September, 2001; the FY02 effort will be final commissioning of the instrument along with upgraded operational procedures for target acquisition and sky cancellation (charge shuffling). The efficiency improvement will be >50 percent overall (and gain factors of 2 to 10 redward of 8000 Å). This will greatly improve the spectroscopic capabilities offered at the Mayall and will make it possible to explore the redshift range 1< z < 2 with high efficiency, while reserving GMOS on Gemini for fainter objects.

WIYN Tip/Tilt Module

This rapid guiding capability is completing its development with fabrication and integration, and is scheduled for its first on-telescope testing in January. It will be provided with an LBNL red-sensitive CCD, and will also accommodate the loaned near-IR camera available at WIYN.

Goddard IRMOS

This instrument employs a digital micro-mirror array as a cold, programmable slit mask for multi-object spectroscopy in the near-IR, as a prototype for NGST technology. It complements the
capabilities of FLAMINGOS, and will receive the f/15 beams of the 4-m and 2.1-m. Its first run on the 2.1-m is planned for Summer 2002.

**Mosaic at the WIYN 0.9-m**

The software interfaces for the NOAO CCD Mosaic must be rewritten to operate with the new telescope control system being provided for the 0.9-m by the new WIYN operations consortium. Integration is planned for late October, with scientific operations to resume shortly afterwards.

**4-M Aluminizing Tank Enclosure**

The 4-M aluminizing facility is the only large coating chamber that is routinely available to astronomy-related organizations. The tank is built into the ground floor of the 4-m building within a large open space. The task this year is to complete the enclosure of the clean area for coating the mirrors.

**Mountain Facilities**

- Replace/repair water, sewer, power, and telephone lines
- Control and manage energy usage to reduce costs
- Water plant/System improvements
- Vehicle replacement
- Tribal skills outreach
- Emergency services support

**Replacement of Water, Sewer, Power, and Telephone Lines**

Large portions of the underground utilities were installed in the early 1960’s and are well past their expected lifetime. Telephone lines are in the worst condition with evidence of water intrusion and the associated static. Water lines are being patched and main valves are in need of replacement or corrective action.

**Energy Management**

Controlling energy usage is critical to reducing operating costs for the Kitt Peak facility. Within all occupied structures, lighting changes are being implemented in conjunction with the replacement of old inefficient equipment and revisions to operating procedures.

**Water Plant/System Improvements**

The collection system is being reviewed to implement improvements and identify locations or changes which may help to increase the collection capacity. New EPA standards will require upgrading the 25+-year-old processing plant. Our improvements will continue to be based on the recommendations made in a consultant study of the water system in FY00.

**Vehicle Replacement**

Efforts have been ongoing to upgrade and replace the old high maintenance vehicles utilized on the summit. In addition, the large heavy equipment vehicles are 20 or more years old and parts
are difficult to acquire. Through GSA surplus and targeted acquisitions we plan to upgrade our mountain based fleet and reduce operating and repair costs.

Tribal Skills Outreach
KPNO facilities staff continue to work with the Tohono O’odham Tribal Skills Center to develop training opportunities for tribal members. Individuals are employed within the facilities group on a temporary part-time basis to supplement their classroom training. This helps to enhance skills and increase the tribal labor pool.

Emergency Services Support
In accordance with regulatory requirements, medical and fire skills training is conducted on a scheduled basis. Improvements and repairs are also required on our mountain wide fire alarm system.

Notes

a WIYN-NOAO external funds ($635K) consist of the total FY contributions of the consortium partners, excluding NOAO’s partner contribution. WIYN-NOAO net costs ($701K) include the NOAO base obligation, as well as the cost of actual in-kind contributions to NOAO’s share of the operating agreement and the NOAO scientific staff and observing support.

b Mountain Facilities ($790K) are the net costs of supporting KPNO’s share of the infrastructure. The total cost has been reduced by $702K; i.e., by the revenues from tenant observatories, observer payments for meals and lodging, and indirect cost recovery.
### KPNO Instruments Available for FY 2002

#### SPECTROSCOPY

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Instrument Type</th>
<th>Detector</th>
<th>Resolution</th>
<th>Slit</th>
<th>Multi-object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayall 4-m</td>
<td>R-C CCD Spectrograph</td>
<td>T2KB/LB1A CCD</td>
<td>300-5000</td>
<td>5.4'</td>
<td>single/multi</td>
</tr>
<tr>
<td></td>
<td>Cryogenic Camera Spectrograph</td>
<td>LB CCD</td>
<td>300-1500</td>
<td>5.4'</td>
<td>single/multi</td>
</tr>
<tr>
<td></td>
<td>Echelle Spectrograph</td>
<td>T2KB CCD</td>
<td>18000-65000</td>
<td>2.0'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FLAMINGOS (^3)</td>
<td>HgCdTe (2048x2048, 0.9-2.5(\mu)m)</td>
<td>1000-3000</td>
<td>10'</td>
<td>single/multi</td>
</tr>
<tr>
<td>WIYN 3.5-m</td>
<td>Hydra + Bench Spectrograph</td>
<td>T2KC CCD</td>
<td>700-22000</td>
<td>NA</td>
<td>~100 fibers</td>
</tr>
<tr>
<td></td>
<td>DensePak (^2)</td>
<td>T2KC CCD</td>
<td>700-22000</td>
<td>IFU</td>
<td>~90 fibers</td>
</tr>
<tr>
<td>2.1-m</td>
<td>GoldCam CCD Spectrograph</td>
<td>F3KA CCD</td>
<td>300-4500</td>
<td>5.2'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FLAMINGOS (^1)</td>
<td>HgCdTe (2048x2048, 0.9-2.5(\mu)m)</td>
<td>1000-3000</td>
<td>20'</td>
<td>single/multi</td>
</tr>
</tbody>
</table>

#### IMAGING

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Instrument Type</th>
<th>Detector</th>
<th>Spectral Range</th>
<th>Scale (&quot;/pixel)</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayall 4-m</td>
<td>CCD Mosaic</td>
<td>8Kx8K</td>
<td>3500-9700(\AA)</td>
<td>0.26</td>
<td>35.4'</td>
</tr>
<tr>
<td></td>
<td>SQIID</td>
<td>InSb (4x512x512, 0.9-3.3(\mu)m)</td>
<td>JHK + L(NB)</td>
<td>0.39</td>
<td>3.3' circular</td>
</tr>
<tr>
<td></td>
<td>FLAMINGOS (^1)</td>
<td>HgCdTe (2048x2048, 0.9-2.5(\mu)m)</td>
<td>JHK</td>
<td>0.3</td>
<td>10'</td>
</tr>
<tr>
<td>WIYN 3.5-m</td>
<td>Mini-Mosaic</td>
<td>4Kx4K CCD</td>
<td>3300-9700(\AA)</td>
<td>0.14</td>
<td>9.3'</td>
</tr>
<tr>
<td>2.1-m</td>
<td>CCD Imager</td>
<td>T2KA CCD</td>
<td>3300-9700(\AA)</td>
<td>0.305</td>
<td>10.4'</td>
</tr>
<tr>
<td></td>
<td>SQIID</td>
<td>InSb (4x512x512, 0.9-3.3(\mu)m)</td>
<td>JHK + L(NB)</td>
<td>0.68</td>
<td>5.8' circular</td>
</tr>
<tr>
<td></td>
<td>FLAMINGOS (^1)</td>
<td>HgCdTe (2048x2048, 0.9-2.5(\mu)m)</td>
<td>JHK</td>
<td>0.6</td>
<td>20'</td>
</tr>
<tr>
<td>WIYN 0.9-m</td>
<td>CCD Mosaic</td>
<td>8Kx8K</td>
<td>3500-9700 (\AA)</td>
<td>0.43</td>
<td>59'</td>
</tr>
</tbody>
</table>

\(^1\) Available February-May only.  \(^2\) Integrated Field Unit: 30" x 45" field 3" fibers, 4" fiber spacing.  \(^3\) Shared risk.
Science Operations

➢ Hold two Time Allocation Committee meetings and one Users’ Committee meeting
  Total estimated cost = $145K

Science Research

➢ Hold a staff development retreat in Chile in October 2001
➢ Establish a new postdoctoral program and award the first fellowship
➢ Establish an extended staff opportunity program and negotiate the first arrangements
➢ Establish a mentoring program
➢ Develop metrics for assessing staff productivity

Science Directorate

A core mission of NOAO is to enable research and discovery in US ground-based astronomy. The *sine qua non* to achieving this mission is a scientific staff committed to excellence in research, service, and community leadership.

Excellence in research is essential to setting the overall standards of the institution: the quality of current research capabilities, the ability to anticipate future research needs and to plan and innovate to meet them. Excellence in service is required in order that NOAO continue to enable the best researchers with the best ideas in the community to have access to smoothly functioning, efficiently operated state-of-the-art facilities, instruments, and software tools. Excellence in leadership is needed in order to work successfully with the community to develop common strategic visions for the future, to articulate those visions to funding agencies, and to evolve the fair processes and community partnerships fundamental to achieving these visions.

To recruit and retain individuals with the unusual blends of talents and temperaments needed at NOAO has always been a challenge, but perhaps never more so than the present—as the observatory enters an era of rapid evolution from its focus on 4-m class telescopes to Gemini, and soon to the era of LSST and GSMT.

The need to address simultaneously the ongoing operations at CTIO and KPNO—the gateways to the Gemini telescopes—as well as planning for LSST and GSMT, has required that a staff of very modest size (with more than 20% of staff slots currently open) assume both service and community leadership functions that now take up most available creative cycles. The inevitable result has been that time available for research has now dropped to perilously low levels for nearly all staff members.

The Provisional Program Plan for FY 2002 places high priority on reversing these recent trends and re-establishing an environment at NOAO with:
• Sufficient “quality time” for science
• More balanced alignment of research and functional requirements
• Predictable scheduling of science and functional time so as to enable coherent and effective research time, as well as effective management of complex projects or operations
• Quantitative assessment of service/functional contributions in order to ensure efficient deployment of our staff to meet functional needs, while protecting them from over-scheduling and an “interrupt-driven” environment
• Recognition and reward for research productivity (through increased internal support)
• Staff performance review at all levels (tenured, tenure-track, and non-tenure track) on a regular basis using well-understood criteria, in service of providing feedback and guidance to the staff

To provide visibility and focus to these activities, NOAO has appointed an Associate Director for Science, Steve Strom. Steve is charged with working with the staff as well as the NOAO Associate Directors to develop the detailed implementation plans and strategies.

Near-Term Plans for Staff Development

The Provisional Program Plan for FY 2002 places a high priority on establishing an environment at NOAO that:

• Enables effective research by individuals and teams by providing both sufficient time and support for such research
• Provides a stimulating environment through funding of visits by active and provocative visitors, re-establishing a vigorous post-doctoral fellowship program, providing support for long-term visits by graduate students involved in collaborative research programs, and holding workshops and larger meetings focused on developing problems
• Encourages research programs of high impact and visibility using the NOAO + Gemini system—both those programs carried out by individual staff members as well as those carried out by staff/community teams—through financial support of such programs and through judicious use of the Director’s discretionary time
• Provides staff mentoring to ensure that all levels of staff continue to evolve their skills.

<table>
<thead>
<tr>
<th>Science Research (Tucson)</th>
<th>Est. Program Costs FY 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Total = $ 797)</td>
<td>(Dollars in Thousands)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Package</th>
<th>FTE</th>
<th>Est. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff Salaries</td>
<td>5</td>
<td>$ 645</td>
</tr>
<tr>
<td>Administrative Support</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>Science Travel</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>Publications</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Tucson Library</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Staff Development</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal Program</strong></td>
<td><strong>$ 1,082</strong></td>
<td><strong>(Indirect Cost Return))</strong></td>
</tr>
<tr>
<td><strong>Program Total</strong></td>
<td>7</td>
<td><strong>$ 797</strong></td>
</tr>
</tbody>
</table>
Specific investments in FY 2002 include:

- Funds ($15K for fourth quarter support of one Fellow) for a new postdoctoral program that would offer highly attractive five-year fellowships to outstanding candidates. These fellows would have a time-averaged service obligation of 25% over the first three years of the fellowship, and would thus be able to work closely with the core NOAO staff to meet our obligations to advanced planning and ongoing operations. The last two years of the fellowship would be spent focused on research, enabling the fellow to synthesize work carried out during the previous three years, and to define future programs. The final year of the fellowship could be spent at a university or split between a university and NOAO.

- Funds ($40K) for “extended staff”—drawn from the community and serving as partners integral to planning new initiatives (e.g., LSST; GSMT) or new instruments (NEWFIRM), and carrying out major research programs in collaboration with the NOAO staff. NOAO would provide salary support for such individuals, who would spend periods between six months and two years primarily at NOAO.

- Funds ($20K) for visiting scientists and graduate students.

- Funds ($10K) to provide professional mentoring and skills enhancements for scientific staff

- Funds ($20K) for scientific workshops and meetings

Central Administrative Services (CAS)

<table>
<thead>
<tr>
<th>Work Package</th>
<th>FTE</th>
<th>Est. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resources</td>
<td>3.5</td>
<td>222</td>
</tr>
<tr>
<td>Procurement</td>
<td>9.0</td>
<td>548</td>
</tr>
<tr>
<td>Accounting</td>
<td>6.5</td>
<td>468</td>
</tr>
<tr>
<td>Payroll</td>
<td>3.3</td>
<td>203</td>
</tr>
<tr>
<td><strong>Subtotal Program</strong></td>
<td><strong>22.3</strong></td>
<td><strong>$1,441</strong></td>
</tr>
<tr>
<td>(Recovery from NSO share and indirect costs)</td>
<td></td>
<td>(685)</td>
</tr>
<tr>
<td><strong>Net Program Total</strong></td>
<td><strong>22.3</strong></td>
<td><strong>$756</strong></td>
</tr>
</tbody>
</table>
Central Facilities and Operations (CFO)

<table>
<thead>
<tr>
<th>Work Package</th>
<th>FTE</th>
<th>Est. Cost</th>
<th>External Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bldg. Maintenance</td>
<td>4.5</td>
<td>$334</td>
<td></td>
</tr>
<tr>
<td>Vehicles</td>
<td>0.7</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>0.6</td>
<td>283</td>
<td></td>
</tr>
<tr>
<td>Support Services</td>
<td>3.3</td>
<td>375</td>
<td></td>
</tr>
<tr>
<td>Roads &amp; Grounds</td>
<td>0.4</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>Instrument Test Lab</td>
<td></td>
<td></td>
<td>200*</td>
</tr>
<tr>
<td><strong>Subtotal Program</strong></td>
<td>9.5</td>
<td>1,302</td>
<td>(520)</td>
</tr>
<tr>
<td><strong>Net Program Total</strong></td>
<td>9.5</td>
<td>$782</td>
<td>$200*</td>
</tr>
</tbody>
</table>

* $200K for Instrument Test Lab funded from carryover in FY 2001 Budget

Computer Infrastructure Support (CIS)

CIS provides computer and networking infrastructure support for the NOAO-Tucson facility. The major tasks are:

- Maintenance and improvement of the facility network and of a secure connection of the facility network to the Internet
- Maintenance and improvement of a secure software infrastructures providing services to the NOAO-Tucson facility including email, the www, ftp and remote access
- Configuration and connection to the network, support and maintenance of computers (including scientific workstations and office PCs) used in the facility

<table>
<thead>
<tr>
<th>Work Package</th>
<th>FTE</th>
<th>Program Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS</td>
<td>6.5</td>
<td>$645</td>
</tr>
<tr>
<td>(NSO Recovery)</td>
<td></td>
<td>(70)</td>
</tr>
<tr>
<td><strong>Program Total</strong></td>
<td>6.5</td>
<td><strong>$575</strong></td>
</tr>
</tbody>
</table>
Director's Office (Tucson)

Milestones for FY 2002

➢ Recruit a scientific Head of Instrumentation by July 2002

The scientific Head of Instrumentation is a key position at NOAO for which a high-profile search will be conducted in FY 2002. A search committee will be empanelled with the assistance of the AURA Observatories Council. The budgetary provision is for filling this position towards the end of FY 2002.

➢ Record time spent by NOAO scientific staff in NOAO work packages and in other areas.

➢ By the end of the year, evaluate the new WBS introduced in FY 2002 with a view to further improvements in accountability and optimum use of resources.

Servicing the System

Milestones for FY 2002

➢ 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).

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

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

Telescope System Instrumentation Program (TSIP)

TSIP is the first piece of the framework for the channeling of new resources to the independent observatories. As proposed in the decadal survey, TSIP would be a $5 million per year program that funds the development of facility-class instruments for the telescopes of the independent observatories and provides time on these telescopes to the community, thus simultaneously enhancing the capabilities within the system and broadening the access to its elements. NOAO will support NSF in the development and operation of TSIP and will administer the program, if required. Funding for TSIP is not shown in the current plan, but the program is included in the WBS for future development.

Community access to the independent observatories through TSIP may well impose requirements for user support that are beyond those available to regular observers. NOAO could provide documentation, staff to answer technical questions, assistance in preparing and carrying out observing programs, and software and support for data reduction in order to ensure that these new observing...
opportunities are used effectively. This support would be provided in a manner that makes the most sense to each independent observatory. NOAO's investment will be proportional to the value of the telescope time being provided in order to ensure that the investment does not outweigh the return.

The decadal survey recommended that we move beyond TSIP to formulate a strategic plan for US ground-based astronomy. In order to explore the issues and make progress toward this goal, NOAO will organize and support the activities of a “System Committee,” which will initially be composed of the individuals who organized the Scottsdale workshop in 2000. This committee will report directly to the AURA president to preclude the perception of any conflict of interest with NOAO, and its members have been chosen to be as free from conflict of interest as possible. The charge to this committee will be to: 1) assist with the planning and organization of community meetings; 2) maintain an overview of the ground-based O/IR system, its needs and constraints; 3) help formulate the community-based discussion into a strategic plan; and 4) advocate that plan.

<table>
<thead>
<tr>
<th>Servicing the System</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Program Costs FY 2002</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$ 205</td>
</tr>
<tr>
<td>(Dollars in Thousands)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Package (Level 1)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Committee</td>
<td>$ 80</td>
</tr>
<tr>
<td>KPNO Support for NSO</td>
<td>115</td>
</tr>
<tr>
<td><strong>Total Program</strong></td>
<td>$ 205</td>
</tr>
</tbody>
</table>
MANAGEMENT AND BUDGET

Divisional Organization

A moderate amount of re-structuring in FY 2002 will simplify the reporting to the NOAO Director, as shown in the accompanying chart. The six programs shaded in the management matrix below are led by individuals who report to the NOAO Director, as do the directors of the two observatories and the NGSC.

<table>
<thead>
<tr>
<th>Program</th>
<th>KPNO</th>
<th>CTIO</th>
<th>NGSC</th>
<th>TUCSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Operations/ User Support</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Science Research</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Education &amp; Outreach</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Data Products</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NIO/GSMT</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSST</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Instrumentation</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Mgmt./ Administration</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOAO Director's Office

J. Mould
Director

T. Boroson
Deputy Director and Associate Director for Data Products

D. Isbell
Manager
Public Affairs & Education Outreach

K. Wilson
Financial Manager

M. Smith
Associate Director
CTIO

R. Green
Associate Director
KPNO

R. Schommer
Associate Director
NGSC

S. Strom
Associate Director
for Science and Project Scientist NO

[vacant]
Associate Director
for Instrumentation

S. Wolff
Project Scientist
NOAO LSST Program

L. Daggert
Manager
Major Instrumentation Program

A. Walker
Deputy Director
CTIO
Work Breakdown Structure of Four NOAO Divisions

Details of the Work Breakdown Structure (WBS) for each of the four NOAO divisions is shown in the following charts. The WBS components of KPNO and CTIO are designed for easy comparison and for the interchangeability of best practice from one to another.
The NOAO Gemini Science Center is a distributed center with nodes in La Serena and Tucson; conceptually there is provision for an extension to Hilo which would formalize the cross-training of instrument scientists in operations. Management of NGSC, however, follows functional, rather than geographic lines. The three functional areas are user support, operations, and development.

NGSC by Work Package

<table>
<thead>
<tr>
<th>Work Package</th>
<th>Director/Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director's Office</td>
<td>R. Schommer</td>
</tr>
<tr>
<td>User Support</td>
<td>Ex-C. Pilachowski</td>
</tr>
<tr>
<td>Gemini South Support</td>
<td>R. C. Smith</td>
</tr>
<tr>
<td>Development</td>
<td>T. Armandroff</td>
</tr>
<tr>
<td>Outreach</td>
<td></td>
</tr>
<tr>
<td>Scientific Research</td>
<td>NGSC Fellow</td>
</tr>
<tr>
<td>Software Support</td>
<td>Data analysis</td>
</tr>
</tbody>
</table>

Those work packages that are most efficiently managed centrally are located in NOAO headquarters in Tucson. As seen in the following chart, Central Administrative Services (CAS) is the largest unit in Tucson headquarters, with the following functions: financial management, budget, contracting, human resources, procurement, and payroll. Central Facilities and Operations (CFO) handles building maintenance, vehicles, utilities, and communications. Computer Infrastructure Support (CIS) includes both network support and all the computer hardware comprising the network. Although Tucson is the largest division of NOAO, it is also the one where the bulk of the creative work implementing the AASC decadal plan will be done, specifically in the LSST, Data Products, and NIO/GSMT programs.

Tucson Headquarters Work Breakdown Structure

<table>
<thead>
<tr>
<th>Work Package</th>
<th>Director/Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director's Office</td>
<td>J. Mould</td>
</tr>
<tr>
<td>Science Operations &amp; System Support</td>
<td>T. Boroson</td>
</tr>
<tr>
<td>Science Research</td>
<td>S. Strom</td>
</tr>
<tr>
<td>Financial Manager</td>
<td>K. Wilson</td>
</tr>
<tr>
<td>Public Affairs, Education and Outreach</td>
<td>D. Isbell</td>
</tr>
<tr>
<td>Head of Instrumentation</td>
<td></td>
</tr>
<tr>
<td>Computer Infrastructure Support</td>
<td>S. Grandi</td>
</tr>
<tr>
<td>Central Administrative Services</td>
<td>L. Klose</td>
</tr>
<tr>
<td>Central Facilities Operations</td>
<td>J. Dunlop</td>
</tr>
<tr>
<td>Major Instrumentation</td>
<td>Larry Daggert</td>
</tr>
</tbody>
</table>

24 NOAO Provisional Program Plan FY 2002: Management and Budget
FY 2002 Level 2 Budget Summary

The following table summarizes the NOAO FY 2002 budget by individual program and division.

<table>
<thead>
<tr>
<th>Work Packages (Level 2)</th>
<th>KPNO (Dollars in Thousands)</th>
<th>CTIO</th>
<th>NGSC</th>
<th>Tucson</th>
<th>Total Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Operations</td>
<td>94</td>
<td>90</td>
<td>145</td>
<td>329</td>
<td></td>
</tr>
<tr>
<td>Instrument Upgrades</td>
<td>368</td>
<td>427</td>
<td></td>
<td>795</td>
<td></td>
</tr>
<tr>
<td>Computer Infrastructure Support (CIS)</td>
<td>575</td>
<td>575</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telescope A</td>
<td>1,339</td>
<td>984</td>
<td>240</td>
<td>2,563</td>
<td></td>
</tr>
<tr>
<td>Telescope B</td>
<td>701</td>
<td>1,105</td>
<td>240</td>
<td>2,046</td>
<td></td>
</tr>
<tr>
<td>Telescope C</td>
<td>386</td>
<td>358</td>
<td></td>
<td>744</td>
<td></td>
</tr>
<tr>
<td>Mountain Facilities</td>
<td>790</td>
<td>924</td>
<td></td>
<td>1,714</td>
<td></td>
</tr>
<tr>
<td>Science Research</td>
<td>118</td>
<td>60</td>
<td>7</td>
<td>982</td>
<td></td>
</tr>
<tr>
<td>Director's Office</td>
<td>333</td>
<td>467</td>
<td>153</td>
<td>658</td>
<td>1,611</td>
</tr>
<tr>
<td>Headquarters</td>
<td>305</td>
<td></td>
<td>782</td>
<td></td>
<td>1,087</td>
</tr>
<tr>
<td>Administrative Services</td>
<td>559</td>
<td></td>
<td>756</td>
<td>1,315</td>
<td></td>
</tr>
<tr>
<td>Public Affairs &amp; Outreach</td>
<td>2</td>
<td>99</td>
<td></td>
<td>445</td>
<td>546</td>
</tr>
<tr>
<td>LSST</td>
<td>793</td>
<td></td>
<td></td>
<td>793</td>
<td></td>
</tr>
<tr>
<td>Data Products</td>
<td>100</td>
<td></td>
<td>689</td>
<td>789</td>
<td></td>
</tr>
<tr>
<td>NIO/GSMT</td>
<td>532</td>
<td></td>
<td>1,376</td>
<td>1,908</td>
<td></td>
</tr>
<tr>
<td>Major Instrumentation</td>
<td>270</td>
<td>250</td>
<td>3,459</td>
<td>3,979</td>
<td></td>
</tr>
<tr>
<td>Servicing the System</td>
<td>125</td>
<td></td>
<td>80</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>AURA Management Fee</td>
<td>105</td>
<td></td>
<td>473</td>
<td>578</td>
<td></td>
</tr>
</tbody>
</table>

Total Program: $4,256, $6,180, $1,095, $11,029, $22,560

- "Telescope A" is the Mayall at KPNO, the Blanco at CTIO, and user support for Gemini N.
- "Telescope B" is the WIYN at Kitt Peak, SOAR at Cerro Pachón, and operations support for Gemini S.
- "Telescope C" is the 2.1-meter at KPNO, and the telescopes smaller than 4-m aperture at CTIO.
- "Staff Research" supports the 6.6 FTE scientists serving KPNO, pays for the Library at CTIO, and includes the salaries of 5 FTE scientists and the Library in Tucson.
- "Servicing the System" supports NSO with shares of technicians' time on Kitt Peak and also covers the activities of the System Committee that will advise on TSIP Program.
- The AURA management fee ($473,000) is approximately 2% of the budget and is NOAO's share of corporate administration. The Gemini Fellowship program ($105,000) is operated by AURA but financially managed by NOAO.
FY 2002 Level 3 Budget Summary

The table below shows the Level 3 aggregation of FY 2002 costs by four main categories: Science, Planning, Development, and Support.

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>$8,795</td>
</tr>
<tr>
<td>Major Telescopes</td>
<td></td>
</tr>
<tr>
<td>Science Operations, Instrument upgrades, &amp; Telescopes A+B</td>
<td>5,734</td>
</tr>
<tr>
<td>Minor Telescopes</td>
<td></td>
</tr>
<tr>
<td>Telescope C</td>
<td>744</td>
</tr>
<tr>
<td>PAEO</td>
<td></td>
</tr>
<tr>
<td>Education &amp; Outreach</td>
<td>546</td>
</tr>
<tr>
<td>Data Products</td>
<td></td>
</tr>
<tr>
<td>Science Research</td>
<td>789</td>
</tr>
<tr>
<td>Planning</td>
<td>$2,701</td>
</tr>
<tr>
<td>LSST</td>
<td>793</td>
</tr>
<tr>
<td>GSMT/NIO</td>
<td>1,908</td>
</tr>
<tr>
<td>Development</td>
<td>$3,979</td>
</tr>
<tr>
<td>Major Instrumentation</td>
<td>3,979</td>
</tr>
<tr>
<td>Support</td>
<td>$7,085</td>
</tr>
<tr>
<td>Mountain Facilities</td>
<td>1,714</td>
</tr>
<tr>
<td>HQ + CIS</td>
<td></td>
</tr>
<tr>
<td>Computer Infrastructure Support &amp; Headquarters</td>
<td>1,662</td>
</tr>
<tr>
<td>Directors' Offices</td>
<td></td>
</tr>
<tr>
<td>Administrative Services; Servicing the System; AURA Management Fee</td>
<td>2,098</td>
</tr>
<tr>
<td>Administration</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$22,560</td>
</tr>
</tbody>
</table>
AURA NEW INITIATIVES OFFICE (NIO)/
GIANT SEGMENTED-MIRROR TELESCOPE (GSMT)

GSMT Milestones FY 2002

- Analyze key issues raised by the point design: wind-buffeting; layered control system
- Develop key technical solutions: adaptive secondary; active structures
- Establish site selection criteria
- Conduct design-to-cost studies and bound costs for GSMT
- Involve the community in defining science-based performance requirements for GSMT
- Involve the community in defining instrumentation options and technology paths
- Continue conceptual design activities that support and complement other efforts (e.g., CELT; 20-20).
- Explore partnerships to design and build GSMT.

Organization

The AURA New Initiatives Office was formally established in January 2001. It is led scientifically by a Project Scientist and Systems Scientist and managed by a Program Manager. Key technical staff includes a core group assigned full time to the NIO plus a number of NOAO and Gemini staff supporting the work on a part time basis. The NIO office suite has been established in the annex on the roof of the NOAO building in Tucson.

The following staff members have been recruited this year to form the core group.

AURA New Initiatives Office

[Diagram of organizational structure]

Opto-Mechanics
M. Cho

Mechanical Designer
R. Robles

Controls
G. Angeli

Structures
P. Gillett

Adaptive Optics
Ellerbroek/Rigaut

Site Testing
A. Walker

Instruments
S. Bürden

Contracted studies

Part time support
NOAO & Gemini

Administrative Assistant
J. Purcell

Program Manager
L. Stepp

Systems Scientist
B. Gregory

Project Scientist
S. Strom

Engineering Oversight
J. Oschmann

Management Board
M. Mountain
J. Mould
W. Smith
Key Issues in Point Design
Some of the studies begun in FY01 will continue in FY02, including random vibration analysis of
the telescope structure subjected to wind buffeting, and end-to-end modeling of the performance
of the telescope control systems.

Key Technical Solutions
Work will continue on solutions to key technical problems. These include compensation of wind
buffeting effects by active structural members and compensation of atmospheric and local seeing
using adaptive optical systems.

Site Evaluation
Candidate sites will be identified and evaluated using satellite imaging and numerical modeling.
We will also continue to develop the methodology and technology for in-situ testing programs.

Design-to-Cost Studies
Considerable attention will be given to identifying and investigating low-cost design approaches.
The areas of study will include: (1) mirror segment fabrication; (2) enclosures; (3) adaptive
optics; (4) telescope structures; (5) instruments. Initial cost-performance trades will be an integral
part of these studies.

Community Involvement in Defining Scientific Context
To identify the key science drivers and performance requirements for GSMT, it will be necessary
to understand how it fits in the broader environment that includes NGST, ALMA, and SKA. We
must understand how the major astronomical facilities will address the most important science
themes of the next decade, and consider how to tailor the performance of GSMT to best fulfill its
role. These issues will be addressed by a series of science studies and workshops involving a
broad sample of the astronomical community. One result of this work will be an enhanced
science requirements document for GSMT.

Community Involvement in Defining Instrumentation Options and Technology Paths
The instrument conceptual design activities begun in FY01 will be continued in FY02, but there
will be increased involvement of scientists from the broader community. Two or more instrument
science working groups will be established to evaluate the science drivers and technical issues for proposed GSMT instruments. Through these groups, needed studies will be identified and NIO will fund several studies as resources permit.

Early in FY 2002, NIO will release a “green book” summarizing the results of science cases, instrument concepts, and the initial analysis of the point design. The book will also summarize the next steps critical to refining engineering requirements based on key science drivers, along with the system- and subsystem- level technical issues that must be addressed in order to design a high performance GSMT.

**Partnerships to Design and Build GSMT**

The New Initiatives Office will work actively to develop partnerships to initiate the design and construction of the GSMT.

<table>
<thead>
<tr>
<th>Work Packages (Level 1)</th>
<th>NOAO Funds</th>
<th>Gemini Funds</th>
<th>Total AURA Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>100</td>
<td>55</td>
<td>155</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>-</td>
<td>152</td>
<td>152</td>
</tr>
<tr>
<td>Project Scientist Activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>81</td>
<td>-</td>
<td>81</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>159</td>
<td>-</td>
<td>159</td>
</tr>
<tr>
<td>Systems Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>115</td>
<td>-</td>
<td>115</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>37</td>
<td>60</td>
<td>97</td>
</tr>
<tr>
<td>Optomechanical Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>130</td>
<td>39</td>
<td>169</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>79</td>
<td>3</td>
<td>82</td>
</tr>
<tr>
<td>Adaptive Optics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>-</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>170</td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>114</td>
<td>-</td>
<td>114</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>14</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Telescope Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>99</td>
<td>39</td>
<td>138</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>47</td>
<td>9</td>
<td>56</td>
</tr>
<tr>
<td>Enclosure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>35</td>
<td>-</td>
<td>35</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>46</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>Instrument Concept Studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>161</td>
<td>-</td>
<td>161</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>139</td>
<td>-</td>
<td>139</td>
</tr>
<tr>
<td>Site Testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll</td>
<td>283</td>
<td>-</td>
<td>283</td>
</tr>
<tr>
<td>Other expenses and contracts</td>
<td>147</td>
<td>-</td>
<td>147</td>
</tr>
<tr>
<td>Total</td>
<td>$1,956</td>
<td>$400</td>
<td>$2,356</td>
</tr>
</tbody>
</table>
LARGE-APERTURE SYNOPTIC SURVEY TELESCOPE (LSST)

In FY 2002, we will initiate the Phase A studies of the LSST, with the goal of completing a costed proposal by FY 2004.

Milestones for FY 2002

➢ Define the science requirements for telescope, instrument, operations, site characteristics, and data handling.
➢ Translate the science requirements into technical requirements for telescope performance, an operations model, and data management systems
➢ Initiate a prioritized set of engineering studies on high risk elements, including optics fabrication, detectors, and filters
➢ Hire project managers to oversee community-based design efforts for both hardware and software
➢ Establish an LSST corporation.

Science Requirements/Technical Requirements

In order to complete a costed proposal for the LSST, it is necessary to establish the science requirements and then to develop concept designs that will meet those requirements. The recent Aspen workshop developed the scientific case for the LSST. We propose to bring together three small working groups to define the requirements imposed by three distinct types of science that were highlighted in Aspen: 1) the rapid detection of moving objects (i.e., asteroids and Kuiper Belt objects); 2) the detection of variable objects, such as supernovae, variable stars, burst sources, etc; and 3) deep imaging in order to study weak lensing, galaxy clustering, etc. A management team will then optimize the sets of requirements into a single set of specifications, which will be used to develop a flow down into each telescope subsystem.

Engineering Studies

A meeting has been scheduled for late September, 2001, of individuals from those institutions that are interested in contributing to the conceptual design phase of the LSST project. The purpose of this meeting is to identify the technical “tall poles” along with the resources available within each of the participating institutions, including most notably NOAO and Steward. We will then prioritize the work according to technical and cost risk. It is likely that Steward will take the lead on optical design, mirror fabrication, and telescope mount, and that NOAO will take the lead on developing design reference missions, data management plans, instrument concepts, and site development. Selection of the site, design of the enclosure, and specification of the control system are likely to be shared responsibilities. We will involve other members of the community when and where we can.

Project Managers

Since the concept design phase will involve multiple institutions, it will be necessary to have a project manager to oversee and track the distributed effort. NOAO will hire that project manager on behalf of the corporation; again, following the WIYN and SOAR models, we expect all LSST staff members to be hired by one of the participating institutions and not by the corporation directly. NOAO will also hire someone with expertise in the handling of large data sets to develop the data management plan.
Incorporation

We plan to establish an independent corporation, following the models for WIYN and SOAR, to carry out the LSST project. The founding members will be Steward Observatory and NOAO (or their parent organizations), and we will draft incorporation papers during FY 2002. Other institutions will be invited to join as the project develops.

Data Management/Precursor Experiments

Cost effective data management is likely to be the most challenging aspect of the LSST program. For this reason, NOAO will undertake 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 Survey, 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, etc. This project will also be used to explore the issues associated with archiving of ground-based data.

The second of these precursor programs is likely to be a combined SuperMacho and supernova experiment which will be conducted at CTIO. Chris Stubbs, Kem 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 be submitted to the TAC in FY 2002 to 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: 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, spectra; and the archiving of the data. During FY 2002, the LSST group will work with the SuperMacho/Supernova project team in order to ensure that the work done for this experiment benefits the prototyping and development of data management tools for the LSST.

<table>
<thead>
<tr>
<th>LSST Program</th>
<th>Est. Program Costs FY 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Program</strong></td>
<td>$793</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Package (Level 1)</th>
<th>Est. Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical studies¹</td>
<td>$160</td>
</tr>
<tr>
<td>Project management</td>
<td>228</td>
</tr>
<tr>
<td>Planning/meetings for</td>
<td>60</td>
</tr>
<tr>
<td>scientific case, technical and data management studies</td>
<td></td>
</tr>
<tr>
<td>Science simulations²</td>
<td>90</td>
</tr>
<tr>
<td>Design studies/consultants³</td>
<td>155</td>
</tr>
<tr>
<td>Data Management Studies⁴</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total Program</strong></td>
<td>$793</td>
</tr>
</tbody>
</table>

¹ Design study performed by Major Instrumentation program.
² Science simulations to be performed by D. De Young.
³ Assistance with defining and monitoring external studies to be provided by C. Claver.
⁴ Study to be performed by Data Products program starting in June 2002.
DATA PRODUCTS PROGRAM

The Data Products program builds on NOAO’s heritage in astronomical software and data analysis, establishing a new emphasis on creating and distributing data products to the community and providing tools for their exploration. This program will be carried out through the natural evolution of the IRAF Group into a group of scientists and programmers with a broader perspective.

Initially, priority will be given to the creation of a node for the National Virtual Observatory (NVO) that acts as a repository for ground-based O/IR data. This includes both archive services—i.e., storage and tools for queries, access, and data mining—and data reduction pipelines to facilitate the rapid incorporation of new data sets into this repository. To help the Data Products group focus their attention on these new priorities, planned work on IRAF will highlight changes to enable the user community to become more self-sufficient.

Milestones for FY 2002

➢ Creation of a ground-based O/IR archive, initially populated with reduced data replicated from the NOAO survey teams
➢ Preliminary development of software pipelines with the goal of automatic processing of data taken with the NOAO instruments that produce large coherent data sets
➢ Development of a concept for the LSST data management

Creation of a Ground-Based O/IR Archive

The surveys that are currently being carried out on NOAO telescopes provide the ideal uniform coherent data sets with which to begin the ground-based O/IR archiving effort. This work has already begun with the first two releases of data from the NOAO Deep Wide Field Survey. In FY 2002, this archive activity will increase substantially as reduced data from a number of surveys is ingested and released to the community. The archive will provide a uniform NVO-compliant interface for all NOAO survey data.

Preliminary Development of Software Pipelines

Additional value will be provided to the community as survey and other data are automatically incorporated into the archive through a pipeline data reduction capability. The FY 2002 goal is to identify a pipeline management structure including database tools and to begin to assemble reduction modules for the CCD Mosaic. This will ultimately allow all CCD Mosaic observations from both CTIO and KPNO to become available to the community after a proprietary period.

Development of a Concept for the LSST Data Management

Future steps in the development of the O/IR node will be guided by the need to handle the large amount of data from LSST. Work will begin in FY 2002 to understand this need, both to get an early start at addressing areas of risk or required technical development and to ensure that Data Product group efforts in areas such as pipelines and archives are extensible to LSST. This activity will begin with the establishment of a community-based committee with expertise in management of large data sets and will proceed through the development of a system overview of LSST data.
management in response to the requirements and goals emerging from the LSST science discussions. Potential LSST precursor experiments will be defined.

**Estimated Program Costs FY 2002**

Budget amounts are primarily payroll and support for personnel, with the exception of archive development, which contains $50,000 for purchase of hardware and software. IRAF support and development activities are focused on the specific tools needed for the core data product tasks and on those that will allow the community to become more self-sufficient, including "Open IRAF." Instrumentation, LSST, and NVO activities are funded primarily from NOAO budgets external to the Data Products program (NGSC, LSST) or by external grants (NVO).

<table>
<thead>
<tr>
<th>Work Packages (Level 1)</th>
<th>Est. Total</th>
<th>External Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRAF Support &amp; Development</td>
<td>$305</td>
<td>45♦</td>
</tr>
<tr>
<td>Archive Development</td>
<td>192</td>
<td></td>
</tr>
<tr>
<td>Pipeline Development</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Instrumentation Software</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>NGSC Instrumentation Software*</td>
<td>100♦</td>
<td></td>
</tr>
<tr>
<td>LSST Data Mgmt Planning*</td>
<td>♦</td>
<td></td>
</tr>
<tr>
<td>NVO Activities</td>
<td>—</td>
<td>244*</td>
</tr>
<tr>
<td><strong>Total Program</strong></td>
<td><strong>$789</strong></td>
<td><strong>$289</strong></td>
</tr>
</tbody>
</table>

Key to Symbols:

♦ $45K from the NASA "Open IRAF" grant.

♦ $100K from the NGSC Program FY 2002 budget.

♦ $100K from the LSST Program FY 2002 budget.

* Anticipated grant funds from the NSF ITR program.
MAJOR INSTRUMENTATION PROGRAM

Gemini Near Infrared Spectrograph (GNIRS)

➢ Complete fabrication, integration, and warm tests by March 2002.
➢ Complete Pre-Ship Acceptance Test by the end of FY2002

In FY 2002, NOAO will complete the construction 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 and will offer two plate scales and a range of dispersions.

All parts fabrication is to be completed by November 2001. The final assemblies and component parts to be fabricated are trusses, brackets, plates, etc., which are not critical to integration and test, but are needed to mount external hardware such as the Electronics Thermal Enclosures.

Integration will be complete when all mechanisms have been successfully integrated onto the benches, the benches installed into the Bulkhead Assembly, all dewar wiring completed, front and rear dewar shells installed, and the detector installed. Electronics will be installed, on their mounting trusses and in place for flexure testing. Optical alignment will be complete and basic functional tests will have been conducted to insure instrument functionality. This milestone is due to be completed in March 2002.

Completion of warm tests is closely coupled to the instrument integration milestone. Warm tests will consist of as much functionality testing as possible without risk to the mechanisms, which are designed to operate cold. Software integration with the electronics will have been demonstrated and be working. Alignment will be completed, but will be checked again at cold temperature. This milestone is scheduled to be completed in March 2002.

The Pre-Ship Acceptance Test will demonstrate the functionality of the instrument prior to shipment to Gemini South.

NOAO Extremely Wide-Field Infrared Imager (NEWFIRM)

➢ Complete conceptual design review
➢ Complete detector array selection and procurement
➢ Complete preliminary design review
➢ Order filters and optical element materials

For its own 4-m class telescopes, NOAO is building instruments that take advantage of wide fields of view. Like most of the other US large 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 and 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 x 4K pixels that will cover a 30 x 30 arcminute field; it is estimated to cost on the order of $4M. NEWFIRM capitalizes on the rapid advances that have occurred in infrared array technology, particularly the anticipated availability of 2K x 2K buttable arrays.
Conceptual Design Review
Present system conceptual design, including controllers, data processing, handling equipment, and cost for design, fabrication, integration test and delivery.

Detector Array Selection and Procurement
Select either HgCdTe or InSb 2K x 2K detector arrays (to be mosaiced into a 4K x 4K array) based on projected availability, yield, uniformity, performance, cost and other characteristics. Selection during the preliminary design effort is necessary so that the instrument optical train can be optimized to the appropriate pixel size. Because these arrays are likely to be long lead items, their procurement process also will begin in FY2002.

Preliminary Design Review
Present system preliminary design, including detector array, controllers, filters, data processing, etc. Particular attention will be paid to interface descriptions and to system test requirements and methods.

Order Optical Element Materials
Based on preliminary quotes and delivery times from potential vendors, optical material procurements are also long lead. Therefore, the NEWFIRM project will order these items in a time period compatible with delivery of the finished parts for system integration and test. Bids for the filters will be obtained not later than PDR.

Gemini South Adaptive Optics Imager
- If NOAO is awarded a contract for a conceptual design study for the Gemini S. Adaptive Optics Imager, carry out the design study, produce the conceptual design documentation, and submit a fixed-price proposal for completing the instrument.

In June 2001, Gemini Observatory announced the opportunity to conduct conceptual design studies of a near-infrared imager that will be used in conjunction with the planned adaptive optics system on Gemini South. Gemini plans to pursue the phased development of multi-conjugate adaptive optics on Gemini South. Thus, the GSAO Imager is planned to deliver a relatively uniform point-spread function over a 1-2 arcminute adaptive-optics corrected field. During FY 2001, NOAO plans to submit a proposal for the GSAO Imager conceptual design study. If NOAO is selected to carry out a design study, the conceptual design effort will occur during FY 2002. The required deliverables are a documented conceptual design for the Gemini South Adaptive Optics Imager, an initial Operational Concept Definition Document, an initial Functional and Performance Requirements Document, a Work Breakdown Structure and proposed Project Schedule, a proposed Management Plan, and a budget and total price proposed for completing the instrument.

Detector Program
- Receive and test 2K x 2K bare RIO Orion readout at NOAO
- Receive, test, characterize, and optimize a prototype 2K x 2K RIO InSb Orion array at NOAO
- Receive and test a prototype RIO MBE HgCdTe array at NOAO, when available from RIO.
The Orion Project is a collaborative effort with NOAO, the US Naval Observatory, NASA, and Raytheon Infrared Operations (RIO, formerly HUGHES/SBRC) to develop 2K x 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 x 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 will be 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 will be 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 is planning to hybridize prototype MBE HgCdTe arrays if they find seed money for the project. NOAO will test these prototype arrays when they become available.

LBNL has undertaken 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 x 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 underway to explore other novel detector technologies such as CMOS 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.

<table>
<thead>
<tr>
<th>Major Instrumentation Program</th>
<th>Person Yrs.</th>
<th>Est. Costs</th>
<th>External Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNIRS</td>
<td>10.4</td>
<td>$ 748</td>
<td></td>
</tr>
<tr>
<td>NEWFIRM Design</td>
<td>11.7</td>
<td>1,018</td>
<td></td>
</tr>
<tr>
<td>Detectors/Controllers</td>
<td>9.2</td>
<td>915</td>
<td>200#</td>
</tr>
<tr>
<td>Management</td>
<td>1.3</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>6.5</td>
<td>485</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCAO Imager Design Study</td>
<td>2.4</td>
<td>162</td>
<td>130*</td>
</tr>
<tr>
<td>NSO Support</td>
<td>1.2</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>NGSC Instrumentation</td>
<td>3.0</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>LSST Design Study**</td>
<td>2.0</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Technology Development</td>
<td>0.3</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Total Program</td>
<td>48.0</td>
<td>$3,979</td>
<td>$330</td>
</tr>
</tbody>
</table>

# $200K in external funds from USNO for Orion IR array program.
* $130K in external funds: anticipated cost recovery from Gemini.
** $160K for LSST design study from LSST program budget
PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH

FY 2002 marks the debut of a re-structuring and consolidation of efforts in this important program, bringing together educational outreach, visitor center programs, and public information activities under one active, crosscutting manager.

Milestones for FY 2002

➤ Launch the Beta version of the Teacher Leaders in Research Based Education (TLRBSE) online Distance Learning course in Spring 2002.

➤ Conduct sixth annual Project ASTRO-Tucson Follow-up Workshop in Spring 2002, followed by the seventh annual Training Workshop in Fall 2002.

➤ Resume involvement the NSF Research Experiences for Teachers (RET) program; on-going participation in the Research Experiences for Undergraduates summer 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.

➤ 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.

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

➤ 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.

➤ Expand the upgraded design of the main NOAO home page on the Internet to include the home pages of KPNO and CTIO.

TLRBSE Program Enhancements

NOAO Educational Outreach has been awarded up to $1.8M over the next five years by the NSF Educational and Human Resources Directorate to develop Teacher Leaders in Research Based Science Education (TLRBSE). This program includes a Summer Institute and year-round Distance Learning Course that promote skills in leadership, inquiry-based pedagogy, and authentic research experiences for middle and high school teachers. NOAO will also have a strong exhibit presence at the March 2002 meeting of the National Science Teachers Association in San Diego, CA. and the second TLRBSE Summer Institute will be held in July 2002.

Project ASTRO

Project ASTRO continues strong into its sixth year at NOAO/Tucson, having formed more than 250 ongoing partnerships between astronomers and teachers to bring hands-on activities into science classrooms. The Fall 2001 workshop will be held in September, using the facilities of NOAO downtown headquarters and the Kitt Peak Visitor Center. For the third consecutive year, Joni Chancer and Gina Rester-Zodrow, authors of "Moon Journals - Writing, Art, and Inquiry through Focused Nature Study" will be featured presenters at the workshop. PAEO will also attend the Project ASTRO National Network Site Leaders meeting in Spring 2002 in New Mexico.
Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU)

NOAO continues its commitment to the NSF-funded RET and REU programs, with the goal of preparing future professionals who will sustain US preeminence in astronomy and contribute to a scientifically literate nation. Participating teachers and undergraduate students will work closely with NOAO staff for a 10-12 week period during the summer of 2002 to develop skills as scientific researchers and further their professional development. Activities in the RET program emphasize transferring the experience to the classroom, and will include building current scientific research data and products into the TLRBSE program and the production of classroom materials.

Kitt Peak Visitor Center Exhibits, Tours, and Building Renovations

FY 2002 efforts will focus on a new Gemini Observatory exhibit, repair of a major model of the McMath-Pierce solar telescope, and possible renewal of an older, currently unused exhibit on spectroscopy. A prototype audio kiosk for visitor interpretation was installed in late FY 2001; such devices are more flexible than portable audio headsets, and offer less overhead costs. Repairs and capital improvements to the Visitor Center will include completion of the renovation of the outside patio area, a variety of re-painting and new signage, more cost-efficient interior lighting, and more attractive interior wall coverings.

Kitt Peak Docent Program

The Kitt Peak Docent training program is in the process of being enhanced to reflect current trends in volunteer utilization. The program has been expanded to a formal seven-week intensive course. Topics such as basic astronomy, the natural/cultural history of the mountain, customer relations, and interpretation have been added to the training curriculum. This training will be augmented with exchanges between Kitt Peak and educational outreach staff at other Tucson area attractions and museums.

Web Casting and Media Briefings

NOAO purchased multipurpose web casting hardware and software in FY 2001 and conducted initial tests. Media briefings will be patterned after the much more costly and time-intensive Space Science Updates presented by NASA Headquarters.

IGO Partner Outreach Meeting

This meeting will be the first complete gathering of the international Gemini outreach community, and will serve as a valuable organizational "jumpstart" to the operational era of Gemini.

NOAO Web Site

The new KPNO and CTIO pages will reflect the style and organizational structure of the main NOAO home page to the extent practicable, with greater emphasis on information for visiting observers and professional users.
### Public Affairs and Educational Outreach

**Est. Program Costs FY 2002**

Total Program = **$546**  
*(Dollars in Thousands)*

<table>
<thead>
<tr>
<th>Work Package (Level 1)</th>
<th>Est. Total</th>
<th>External Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Outreach*</td>
<td>$173</td>
<td>$622*</td>
</tr>
<tr>
<td>Public Outreach*</td>
<td>199</td>
<td>60*</td>
</tr>
<tr>
<td>Public Information &amp; Media Outreach</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Photo Lab &amp; Graphic Arts</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>NOAO/NSO Newsletter</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>KPNO Support to Visitor Center*</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CTIO Outreach Programs*</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td><em>Subtotal Program</em></td>
<td>$731</td>
<td></td>
</tr>
<tr>
<td>(PAEO work for NSO)</td>
<td>(115)</td>
<td></td>
</tr>
<tr>
<td>(Indirect cost return)</td>
<td>(100)</td>
<td></td>
</tr>
<tr>
<td><strong>Net Program Total</strong></td>
<td><strong>$546</strong></td>
<td><strong>$682</strong></td>
</tr>
</tbody>
</table>

* KPNO Support to Visitor Center ($2K) in KPNO division budget for PAEO
* CTIO Outreach funds ($99K) in CTIO division budget for PAEO
* External funds in Educational Outreach ($622K): $546K (TLRBSE) + $46K (KPNO REU program) + $30K (Project ASTRO).
* Cost of Visitor Center operations ($199K) is net of approximately $60K revenues from fee-based public observing programs.
NSF-FUNDED SCIENTIFIC STAFF

LA SERENA-BASED SCIENTIFIC STAFF

Robert Blum, Assistant Astronomer

Areas of Interest
High Mass Star Formation, Stellar Populations at the Galactic Center, Infrared Instrumentation, Telescope Site Characterization.

Recent Research Results
Blum’s current work centers on near infrared studies of massive stars. Blum is particularly interested in the youngest massive stars and young stellar objects (YSOs) associated with Galactic giant HII regions. This project is being carried out primarily with the Ohio State InfraRed Imager and Spectrometer (OSIRIS) at CTIO and in collaboration with Peter Conti (U. Colorado) and Augusto Damineli (U. Sao Paulo, Brazil). The group was awarded Gemini+NIRI queue time for this project in 2001, though data have yet to be taken. Blum also went to Hawaii in the last year and participated in two weeks of observing and a third week of data reduction for the Gemini Demonstration Science project using the adaptive optics system Hokupa’a and near infrared imager QUIRC to observe the Galactic center.

Recent results include new spectroscopic classifications for OB stars in the obscured HII regions W42 and W43 by Blum and collaborators. This work includes characterization of the stellar initial mass function and investigation of high mass young stellar objects (YSOs).

Blum is also collaborating with K. Sellgren (Ohio State U.) and S. Ramírez on measuring the first stellar abundances in M giant and supergiant stars in the central parsec of the Milky Way. The majority of this work to date comprised the Ph.D. thesis of Ramírez (who graduated in 2000 and has taken a postdoctoral research position at CalTech with J. Cohen). The main result is that the sample of about a dozen stars studied in the central parsec of the Galaxy has (perhaps surprisingly) solar iron abundance. The group hopes to continue this work using Phoenix on the Gemini South telescope and NIRSPEC on the Keck telescope. A related, on-going project is the study of the star formation history in the Galactic center which utilizes moderate resolution spectroscopy of late type stars obtained on the Blanco telescope at CTIO.

Future Research
Blum’s project on the stellar content of giant HII regions continues to occupy most of his research time. To date, the group has high angular resolution images (~ 0.4 - 0.8 arcsec FWHM) in about twelve target HII regions. The group continues to obtain 4-m spectra of the brightest objects with an eye toward Gemini observations for fainter targets. Infrared spectroscopy will provide the first detailed look at the upper end of the mass function in the youngest/largest galactic star forming regions. As mentioned above, the group hopes to obtain spectra of fainter targets in several clusters (W31, W51) in queue scheduled observations at Gemini North.

Blum has joined the science team of the NIFS spectrometer to be deployed as a facility instrument on the Gemini North telescope. NIFS is an image slicing integral field unit grating spectrometer being built by Peter McGregor of the Research School for Astronomy and
Astrophysics at Mount Stromlo and Siding Springs Observatory in Australia. This near infrared instrument will be used to make high spatial resolution images of the Galactic Center and to search for massive black holes (via dynamical signature) in a sample of nearby galaxies.

Service
Blum’s primary duties at the observatory involve all aspects of support for the infrared spectrometers and imagers at CTIO for visiting astronomers. Blum participates in new IR instrument development activities as well. Currently this includes a modest role in planning and managing the new wide field Infrared Side Port Imager (ISPI) for the Blanco 4-m.

Blum has primary responsibility at CTIO for the OSIRIS infrared imager/spectrometer. This is a collaborative effort between CTIO and the Ohio State University (OSU) Astronomy department to bring a versatile infrared imager/spectrometer to CTIO. This is an upgrade to an existing Ohio State instrument. OSIRIS employs a new generation array (1024 x 1024 format HgCdTe from Rockwell, purchased/owned by NOAO) and provides for multiple pixel scales in real time to take advantage of the best delivered image quality from the new tip-tilt system and provide a larger field of view. OSIRIS is currently in its final year of a three-year agreement between OSU and CTIO. Blum is negotiating the future use of OSIRIS on the SOAR telescope to provide moderate resolution spectroscopy for first light operations.

Blum has joined the CTIO telescope site survey group. Working under group leader A. Walker (CTIO), Blum led a successful first site excursion to the Chajnantor region of Northern Chile to test CTIO’s newly developed seeing telescope (RoboDIMM) and remote weather station. Blum will participate in upcoming expeditions as well as analysis of the site characterization data, as this group moves ahead with the task of selecting the best sites for future 30- to 100-m ground-based telescopes.

Like most of the scientific staff at CTIO, Blum has been participating in the development of new instrumentation initiatives for the SOAR telescope and expects to join in the commissioning aspects of the telescope over the next few years.

Blum is also participating as a mirror scientist for the Gemini NIRI instrument. The mirror scientists are charged with interfacing the US community to Gemini facilities under the guidance of the US Gemini Project office.

Blum sits on the CTIO instrumentation Advisory Committee on Technical Resources (ACTR), the joint NOAO Instrumentation Program Advisory Committee (IPAC), and the SOAR Science Advisory/Instrument Committee (SIC).

Patrice J. E. Bouchet, Associate Scientist

Areas of Interest
Mid and Near-Infrared Instrumentation, Adaptive Optics, Dust in Supernovae, SN1987A, Cobalt in Galaxies, and Vega-like Disks around Nearby Main-Sequence Stars.
Recent Research Results
Near-IR observations of SN1987A and its inner ring: new “hot spots” discovered in the HeI (1.08-micron) line with the Blanco 4-m and tip/tilt system at CTIO.

Ten-micron observations of SN1987A: recent data obtained with OSCIR show that dust is still present and that the energy radiated at 10 and 20 microns still contributes far more than 90% of the total observed UVOIR bolometric flux. Bouchet has also been performing IR observations of cold disk of dust around solar type stars, from ISO and OSCIR at 10 and 20 microns.

Future Research Plans
Bouchet will continue the monitoring in the infrared of supernova SN1987A, and model the dust observed around it, as well as the shock of the ejecta with the inner ring. His high spatial resolution near-infrared images obtained at the Blanco with the tip/tilt system, reduced through a wavelet deconvolution method with a multi-scale maximum entropy algorithm, proved to be of similar quality (same spatial resolution, higher signal-to-noise ratio) than the very scarce HST data. Bouchet intends to pursue actively this research, and so to monitor the birth of this “special” supernova remnant.

Also, Bouchet has the privilege of being the owner of the most complete data set obtained in the near and mid-IR, from outburst until now, which proves the evolution of supernova SN1987A. These data are being re-reduced in a "homogeneous" way, the end product of which being the production of an unique real time movie about this “once-in-a-life” event. He intends also to use the OSCIR instrument at Gemini North (i) to look for more dust disks around nearby main-sequence stars and compute models for the observed dust, and (ii) using SN1987A as a template, proposes to derive the mass of radioactive 56 Cobalt produced in other type II supernovae, from the observation of the [Col] 10.52-micron line. Since it is virtually the end point of element production by thermonuclear reactions, it can indicate the nature of the explosion, the nature of the ejecta, and the mass cut which defines how much material falls back to form a compact object, be it a neutron star or a black hole. Bouchet thinks that it is also of prime importance for understanding the chemical evolution of galaxies, because type Ia and type II's evolve on different time scales.

Service
As a member of the CTIO infrared team, Bouchet is actively involved with the setting up of the instruments and provides assistance to observers, before and after the observing runs. As the project manager for the tip/tilt system at the Blanco telescope, Bouchet is taking care of (i) the monitoring of the instrument performances, (ii) the characterization of it, (iii) the maintenance of various documentation (Users Manual, Technical Manual, Operator Manual), and (iv) the support to observers, before, during and after their observing run. Finally, most of Bouchet’s time this year (at least 75%) has been spent fulfilling his functions as the USGP support scientist for OSCIR and T-ReCS, which involved a two-month stay in Hilo for the Demo Science program and then the first QuickStart Observing program. This also involved supporting the community when preparing proposals, carrying out the observations, and data reduction support. Bouchet has developed some routines for mid-IR data reductions, which are presently used by most of Gemini-OSCIR observers for analyzing their data.
James M. De Buizer, Research Associate

Areas of Interest
Massive Star (Binary Star) Formation; Massive Young Stellar Objects and Protostars; Galactic Maser Observations and Modeling; Radio UCHII and Galactic HII Regions; Molecular Clumps and Hot Cores; Protostellar Outflows, Jets, and Winds; Mid-Infrared Astronomy and Instrumentation.

Recent Research Results
De Buizer, in collaboration with R. Piña and C. Telesco (U. Florida), undertook a mid-infrared imaging survey of massive star forming regions containing methanol maser emission. This survey was performed at the CTIO Blanco 4-m with the mid-infrared imager/spectrometer OSCIR. This survey is the first to discover circumstellar disks around massive stars, and helped to characterize the conditions necessary for maser emission near forming massive stars. The results were recently published in the *Astrophysical Journal.*

In collaboration with R. Piña and C. Telesco, De Buizer also performed a mid-infrared imaging survey of massive star forming regions containing water masers. This survey was performed at the IRTF telescope using OSCIR. These observations led to the first images of a molecular core at mid-infrared wavelengths. These cores are thought to be the earliest observable stages of star formation. The mid-infrared fluxes are being used by collaborator A. Watson (UNAM) to constrain models of the evolution of protostars embedded in molecular cores.

De Buizer, along with R. Piña and C. Telesco, performed several mid-infrared follow-up observations of the above two surveys at the W.M. Keck II telescope using OSCIR. These observations were used to image at higher resolution the more interesting objects found in the original surveys. This included the imaging of one of the circumstellar disks, which is presently being modeled. Some results from these observations have been presented at an IAU symposium on maser emission and will be published shortly.

Future Research Plans
De Buizer will continue his studies of galactic masers and their relationship to massive star formation. An upcoming observing run on the Gemini North telescope will expand the high-resolution imaging set on the massive star circumstellar disk candidates. Imaging will be performed with several narrow bands in the 10-micron silicate feature, allowing us to understand the nature and chemical composition of the disks. A second observing run on IRTF will be utilized to search for more embedded sources associated with masers, and to image outflows from young stellar sources that are believed to have disks and be actively accreting.

In the fall call for proposals, effort will be made to acquire telescope time to expand the mid-infrared methanol maser survey using OSCIR or T-ReCS at Gemini South. Further proposals will be made to map the possible outflows from several disk candidates in the submillimeter.

Service
De Buizer is the Colloquium Director at CTIO (with K. Olsen); this involves scheduling scientific talks for the staff of CTIO and arranging the stay and travel to CTIO by the guest speakers.

De Buizer has also served as a guest US Gemini Project astronomer and performed tasks relevant to the testing and development of the Gemini South telescope.
Brooke Gregory, Senior Support Scientist

Areas of Interest
Gregory is an instrument physicist who works primarily in the area of development of IR instrumentation and telescope optics.

Recent Research Results
Gregory has recently acted as a consultant on two projects: The Gemini Near-Infrared Spectrometer (GNIRS) and the MODS optical spectrometer for the Large Binocular telescope (for the Ohio State University team that is building it). He has been the contract manager for the development of the SOAR Calibration Wavefront Sensor. He has also been supervising the effort to maintain and improve the image quality on the 4-m telescope.

Future Research Plans
Gregory is interested in playing a role in the development of AO systems at NOAO. He has been participating in the Gemini-led measurements of the Sodium layer above Cerro Tololo, which is part of the development of laser guide-star Adaptive Optics systems for the Gemini South and the SOAR telescopes.

Service
Gregory spends 2/3 of his time serving as System Scientist for the New Initiatives Office GSMT project. He is also manager of the Engineering and Technical Resources (ETS) group at CTIO; and serves as liaison to Gemini in the development of a plan for sharing technical resources between Gemini and CTIO.

Knut Olsen, Assistant Astronomer

Areas of Interest
Stellar Populations, Magellanic Clouds, Nearby Galaxies, Massive Stars and their Interaction with the ISM.

Recent Research Results
Olsen's research continues to focus on the very youngest and the very oldest stellar populations in nearby galaxies. Olsen, S. Kim (CfA), and ex-REU student J. Buss (U. Wisconsin, Oshkosh) have finished their work on the LMC OB association LH 72. LH 72 lies in the interior of the kpc-sized supershell LMC-4. Their study, which includes analysis of optical imaging and spectroscopy data from the CTIO 1.5-m telescope and 21-cm maps from the ATCA, concludes that LH 72 formed within LMC-4's interior on the rim of a swept-up shell of gas of unknown origin. This result suggests that LMC-4 did not form as a single unit as commonly supposed, but instead piecemeal through smaller overlapping shells.

Olsen, in collaboration with B. Miller (Gemini), R. Schommer (CTIO), N. Suntzeff (CTIO), and J. Bright (CfA, ex-REU student) continues to study the globular cluster systems of the late-type spiral and dwarf galaxies of the Sculptor Group. Olsen et al. have observed six of the brightest galaxies with Mosaic II on the CTIO 4-m, and also have data from the LCO 2.2-m telescope. Analysis of the Mosaic II images has generated ~<100 candidate clusters per galaxy, selected on the basis of color and morphology. Spectroscopic confirmation is needed to exclude
contaminating background galaxies, which account for ~50% of the candidates. An oral report on the status of the work will be given at IAU Symposium 207, Extragalactic Star Clusters.

Olsen has joined the team led by P. Massey (Lowell Obs.), which is performing a “Survey of the Resolved Stellar Content of Nearby Galaxies Currently Forming Stars.” The other team members are P. Hodge (U. Washington), G. Jacoby (WIYN), N. King (STScI), A. Saha (NOAO), and C. Smith (CTIO). Olsen and Smith are jointly supervising REU student Shay Holmes (U. South Carolina) in a project to study the HII regions in the southern galaxy data. The data are now nearly completely reduced and ready for analysis.

**Future Research Plans**

Olsen will continue to seek spectroscopic confirmation of globular cluster candidates in the Sculptor Group. Such spectroscopy will be used to estimate ages and metallicities of confirmed clusters and to measure their kinematics. Hydra, with its upgraded camera having improved image quality and lower read noise than the old Air Schmidt, will continue to be an excellent match to this project.

Olsen will also continue to explore the relationships of the ionized and neutral gas with the embedded massive stars in supergiant shells in the LMC. Olsen has joined a project, led by P. Massey and including collaborators J. Harris (STScI), N. King (STScI), R. Kudritzki (IfA, U. Hawaii), S. Oey (STScI), J. Parker (SRI), and D. Zaritsky (Steward Observatory), to survey the massive star population of the Magellanic Clouds. If approved, the survey will produce spectral classifications and velocities of a uniform sample of stars in the Clouds, including stars within supergiant shells.

Olsen plans to participate in an effort to compare codes designed to extract star formation histories from color-magnitude diagrams of nearby galaxies. The project, which is being organized by Carme Gallart (U. de Chile and Yale U.), will examine the biases and errors involved in deciphering the mix of ages and abundances present in the CMDs.

**Service**

Olsen’s service work focuses most heavily on the Blanco 4-m telescope instruments. He is part of the Mosaic II camera team (CTIO members are A. Walker, C. Smith, and Olsen), where his main duties lie in addressing issues involved with the data reduction. His recent work in this area includes deriving photometric zero points and color coefficients for each CCD, writing a task to compute and correct for crosstalk in 16-channel mode, and helping to monitor the astrometric stability of the camera.

Olsen has helped T. Ingerson (CTIO) and N. Suntzeff to support the Hydra spectrograph. His involvement to date has been mainly in the areas of introducing the system to visiting astronomers and verifying that the system works properly and produces useful astronomical data. An example of a specific contribution made by Olsen is the writing of a graphical user interface to calculate the accuracy of fiber positioning. This interface is regularly used during engineering nights.

In February 2001, Hydra was upgraded with a new camera, providing higher resolution and lower read noise. While the successful use of the new camera shows that Hydra is reaching maturity, some chronic problems remain, in particular associated with the positioner. An IFU feeding the Hydra bench spectrograph has also been installed, but is not yet ready for use by visitors. With
Ingerson leaving CTIO, Olsen and Suntzeff will share responsibilities for leading the continued development of Hydra and the IFU.

Olsen is the instrument scientist for the 1.5-m Cassegrain spectrograph. Olsen has produced new efficiency measurements for many of the gratings and plans to update the manual. However, because this simple instrument requires very little maintenance, most of Olsen’s time as instrument scientist is spent answering questions from visiting astronomers.

Olsen provides backup support for C. Smith for issues relating to the 4-m R-C and Echelle Spectrographs. His work has consisted of aiding in instrument checkout during engineering nights and answering questions from visitors when Smith has been unavailable.

In September 2000, Olsen served as the NOAO representative to the panel charged with identifying stellar populations science-motivated requirements for the planned GSMT. Olsen’s main contributions were to explore the effects of crowding on tracer populations and to investigate the required photometric accuracy needed to answer particular questions. Olsen has helped R. Wyse (JHU) in drafting a summary of the panel report.

Along with J. De Buizer and N. Suntzeff, Olsen serves on the committee that organizes colloquia at CTIO. Olsen served as the CTIO section editor of the NOAO Newsletter from March 2000 through March 2001. Olsen was a member of the LOC and SOC of the joint CTIO/ESO/LCO workshop “Stars, Gas, and Dust in Galaxies: Exploring the Links,” held in La Serena in March 2000. The proceedings of the workshop, for which Olsen was co-editor, were published recently by the ASP.

Robert A. Schommer, Director, NOAO Gemini Science Center; Associate Director, NOAO

Areas of Interest
Stellar Populations, Magellanic Clouds, Galaxy Dynamics, Large-Scale Structure, Cosmology.

Recent Research Results
Schommer is a member of the high-z supernova team, which has discovered more than 70 SNe Ia over the past five years. Current results continue to favor a cosmology with \( \Omega_{\text{matter}} = 0.2-0.3 \) and a significant cosmological constant. Several SNe IA beyond \( z=1 \) have been found by his group. Schommer is continuing work with Suntzeff and Phillips (Las Campanas Obs.) on the Hubble diagram of SNe Ia, focusing on calibration issues and the removal of reddening effects. Current determination of the Hubble constant remains in the mid-60s, and the LG motion is within one sigma of the CMR vector. Schommer is working with Winn and Schechter (MIT) on searches for lensed quasar systems in the southern sky; they have recently reported on J2004-1349.

Future Research Plans
Future work on the old populations of Local Group galaxies includes continuing studies of field populations in the outer regions of the LMC and M33, using photometry, abundances, and velocities, with both ground-based and HST data. Schommer is currently analyzing velocities for a sample of C stars in the LMC, with Suntzeff, Hardy (NRAO), and Alves (STScI), in an attempt to understand the velocity dispersion profiles and thus the thickness of the LMC for self-lensing. Schommer continues his role in the high-z SNe searches, and plans for additional searches out to \( z = 1 \) (and beyond) are underway. Schommer is working with C. Smith, Suntzeff, and Phillips on
searches for nearby supernovae, in order to understand the range of astrophysical parameters of the explosions and to characterize more completely the scatter in the magnitude-light curve width relation. He continues as a member of the NOAO Deep Wide-Field Survey Team. Schommer is a member of the Deep Lens Survey project of Tyson and Wittman (Bell Labs.), studying mass tomography in the universe via weak lensing and searching for transients in that database.

Service
As of 1 February 2000, Schommer became the US Gemini Project scientist and an Associate Director of NOAO. As such, he is responsible for coordinating the US Gemini program, including visitor support, proposal preparation, and reduction of the scientific data from the Gemini Observatory. He also presents to the Gemini Project the US position with respect to the operation and instrumentation of the Gemini telescopes.

Hugo E. Schwarz, Associate Astronomer

Areas of Interest
Late Stages of Stellar Evolution, AGB Stars, Planetary Nebulae, Symbiotic Stars; Polarimetry, Coronography and Associated Instrumentation, Site Testing and Man-Made Seeing, Light Pollution Control.

Recent Research Results
During the last few years, the main research of Schwarz has been on the nature of bipolar planetary and symbiotic nebulae. These objects straddle the tip of the AGB and the PNe locus in the HR diagram, and form an enigmatic and heterogeneous group of binary and single stars in the process of blowing off their outer envelopes, creating complex nebulae containing a mixture of photo-ionization and shocks which heat the often fast moving gas and dust. Key observational characteristics are: strong (forbidden) emission lines, highly asymmetrical morphologies, strong IR and some X-ray emission, very short lifetimes, and uncertain distances. In recent papers, Schwarz and collaborators have shown that bipolars have different physical parameters than general PNe: they are more concentrated in the Galactic plane; have larger WD masses, outflow velocities, and sizes; and their abundances are different. For M2-9 a hard distance and the system’s physical parameters have been determined. Some other questions addressed by Schwarz and collaborators are: how do essentially spherical stars produce such asymmetrical nebulae; are all true bipolars binary systems; are point symmetric nebulae due to precession in binaries?

Another recent study concerns the mass loss of carbon stars. By developing and applying special observational techniques, Schwarz et al. have optically imaged faint mass loss shells around R Scl and U Ant, two bright, nearby C-stars. Millimeter-wave radio observations of CO show similar structures; by applying a simple resonance scattering model, the authors have been able to compute the number of shells, their sizes, density, and ionization parameter, as well as the dust scattering fraction. Rayleigh scattering for the dust fits the data well, and is shown to be a reasonable assumption as the particle size is <0.03 microns. The dust shell extends beyond the gas, which is interpreted as a drift effect.

Finally, Schwarz participates in a survey of nearby galaxies for AGB stars using Wing filter photometry to detect and separate M- and C-stars. The method consists in taking four CCD frames through V and I filters and two narrow filters, one centered on an absorption band in M-
stars, the other on a band in C-stars. The contrast between O-rich and C-rich stars is thus increased, and carbon stars are separated from M-stars in the color-color diagram by up to a magnitude. Preliminary results show that the method is efficient, and in a field of a few arcminutes diameter, about 1000 O-rich AGB stars and 80 C-stars were found in M31, a galaxy of which only about 0.5% has been surveyed in this manner.

**Future Research Plans**

Future research plans are to continue with the nebular research described above, and additionally to use IR instrumentation to study the key question of binarity in bipolar planetary and symbiotic nebulae. To get direct information on the nature of the heavily obscured central objects and regions of these nebulae, IR techniques are needed to penetrate the optically thick gas and dust shells. High resolution IR spectroscopy can provide direct evidence of orbital motion in binaries, if they are what produces the nebulae. So far it has only been able to make the binary model plausible by showing that precessing disks can produce the often point symmetric and highly collimated nebulae, and by other, also indirect, methods.

The study of the outer and very faint parts of several of these nebulae is of importance to constrain the parameters of the central objects, in some cases by reflected light. Spectropolarimetry is a useful tool; combined with a large telescope, it may be possible to make these demanding observations.

The AGB project has been started only recently, and very much work remains: spectroscopic follow-ups have to be done to actually classify a sample of the photometrically detected stars, an attempt will be made to measure abundance gradients in several galaxies, and C- to O-star ratios are to be determined.

**Service**

Schwarz's prime service function will be to assist in the integration, commissioning, and operation of the new 4.3-m SOAR telescope, under construction on Cerro Pachón, Chile. This work is just starting at the time of writing.

Schwarz is in charge of a project to build a fully automated seeing monitor and weather station to be placed on El Peñón, a potential site for the GSMT or LSST, which is to be characterized.

Part of Schwarz's time is spent on the work of the combined observatories and CONAMA to control and reduce light pollution in the north of Chile. Schwarz is also a member of the SOAR Operations Working Group (OWG) and the CTIO ACTR.

**Malcolm Smith, Director, CTIO; Associate Director, NOAO; Director, Aura Observatory in Chile**

**Areas of Interest**

Quasars, Active Galactic Nuclei.

**Recent Research Results and Future Research Plans**

Smith is following up on a number of complementary, collaborative surveys aimed at discovery of quasars at z>5 and characterization of the quasar luminosity function at such redshifts.
The search for such AGN should also give clues as to their nature and early environments, as well as provide a list of individual, distant objects to be used in subsequent work such as absorption-line, emission-line ratio, and gravitational lensing studies. Normal galaxies as well as quasars are now being found at z>5, which is a necessary first step towards understanding the relationship between quasars and more normal galaxies close to their epochs of formation. This work has the potential to contribute to an improved understanding of the early formation of galaxies, given recent evidence for a strong correlation between the mass of the central black hole in galaxies at low redshifts and the velocity dispersion in their stellar envelopes.

This is a long-term project involving quite large and distributed teams doing extensive calibration work, surveys, and data reduction. The surveys at the prime focus of the Blanco 4-m telescope have been based on selecting such high-redshift quasars by means of their very red V-I colors and blue I-Z colors.

As an example of some of this work, Smith, Kennefick (Oxford U.), Hall (Princeton U.), Green (NOAO), Osmer, Monier, and Conti (Ohio State U.), have imaged 40 sq. deg. through B,V,I and Z filters with the aim of detecting faint quasars at z>5 and I<22 (as well as gravitational lenses, and z>0.6 clusters of galaxies). This imaging provides an unprecedented data set in terms of magnitude and area coverage for the rare objects they are seeking.

Spectroscopic follow-up of the brightest candidates for quasars from the 40 sq. deg. survey has already resulted in the discovery of quasars with redshifts of 4.6 and 4.8 and magnitudes near the limit of the Sloan survey. With an appropriate spectrometer on the Gemini telescopes, it will be straightforward to reach fainter magnitudes and complement the Sloan hemispheric-scale survey work on brighter quasars (and thus provide key information on the fainter end of the luminosity function at these high redshifts).

Service
Smith has multiple service duties as director of CTIO, in addition to serving as the Head of AURA's Observatory in Chile (AURA-O), of which CTIO is one of the major units (along with the Gemini South and SOAR telescopes, which are currently being completed on Cerro Pachón). The Observatory is working on three aspects of sites in Chile: (1) discovery and selection, (2) characterization, and (3) protection. Smith has continued his work on an extensive program to combat light pollution in Chile. He has recently taken on a wider role, following his appointment as vice-president of IAU Commission 50 "Protection of Existing and Potential Observatory Sites." For a summary of this and associated outreach work in Chile, see the pictures and notes (button "A") at http://www.ctio.noao.edu/light_pollution/iau50/lpppt/index.htm.

R. Chris Smith, Assistant Astronomer

Areas of Interest
Supernovae, Supernova Remnants, Interstellar Medium, and the Magellanic Clouds.

Recent Research Results
The majority of Smith's research time is invested in leading two large projects, the Magellanic Cloud Emission-Line Survey (MCELS) and the Nearby Galaxies Supernova Search (NGSS).
MCELS is a complete survey of both the Large and Small Magellanic Clouds in the optical emission of Hydrogen (H-alpha 6563), Sulfur ([S II] 6724), and Oxygen ([O III] 5007). The survey will provide a complete picture of the ionized component of the interstellar medium and its components, such as planetary nebulae, HII regions, supernova remnants (SNRs), and superbubbles in the Magellanic Clouds. Smith is working with a group that includes J. Bregman (U. Michigan), Y.-H. Chu (U. Illinois), R. Ciardullo (Pennsylvania State U.), G. Jacoby, R. Kennicutt (U. Arizona), F. Winkler (Middlebury College), and others to take advantage of the many areas of interstellar medium research touched by the survey. Specific portions of the MCELS data set have already been analyzed, leading to numerous publications.

Together with L. Strolger, a graduate student from U. Michigan, and the CTIO SN Group (including N. Suntzeff and B. Schommer), Smith is also leading the CTIO/LCO Nearby Galaxies Supernova Search (NGSS), a search for relatively nearby supernovae (z<0.1) using the KPNO 0.9-m with the NOAO Mosaic, in order to provide a systematic and statistically complete sample of SNe for detailed study at both optical and infrared wavelengths. Smith is serving as thesis advisor to Strolger, who will base his thesis research on the detailed study of the supernovae discovered in this new NOAO SN search. In the four NGSS campaigns which made up this project, a total of 47 supernovae were discovered, of which ~20 have been followed with detailed optical photometry and one with additional IR photometry. Strolger has now moved back to U. Michigan after spending two years at CTIO, and will continue to work with Smith to publish the results of the NGSS project. Smith is also a member of the High-z Supernova Search group, together with CTIO staff members N. Suntzeff (co-PI of the High-z team) and B. Schommer.

Future Research Plans
As observations for the MCELS project come to a close, Smith will be focusing efforts both on undertaking analysis of the extensive data set and providing public access to the data. Smith is especially interested in identifying SNRs in the Magellanic Clouds and studying the way these remnants interact with, and shape, the interstellar medium. In addition to these studies of Magellanic Cloud SNRs, Smith will continue to pursue investigations of Galactic remnants, such as his work on RCW 86 with K. Long (STScI) and the Vela SNR with F. Winkler (Middlebury College).

Together with Strolger, Smith will also be pursuing detailed studies of the SNe discovered in the NGSS project. The observations for this project are currently complete, so that Strolger and Smith can now focus on the detailed analysis, both of the individual supernovae and of the sample. Smith also will continue to play a supporting role in the High-z Supernova Search group.

Smith is also a member of two NOAO Survey projects, the SINGG project and the Local Group Survey. The SINGG project, Survey for Ionization in Neutral Gas Galaxies, is a project to measure ionized hydrogen in a sample of 500 galaxies selected via their 21-cm neutral hydrogen emission. Our aim is to better understand the global physics of star formation in galaxies and to improve our estimates the total rate of star formation in the nearby universe. The Local Group Survey is a survey of the resolved stellar content and gas content of nearby galaxies currently forming stars. In both projects, Smith is interested in studying the interstellar medium in the galaxies observed, to better understand the interactions between the stellar components and gaseous components of these galaxies.
Service
Smith has taken up lead support on several instruments. He is the principal contact scientist for the Blanco 4-m RC spectrograph and the Echelle spectrograph (with help from K. Olsen), and helps support the 1.5-m Cassegrain spectrograph. He also serves as one of the three support scientists for the Mosaic II imager, and is the scientific staff contact for the Arcon CCD controller (which runs all of the scientific CCD cameras at CTIO). Although he handed over support of the Curtis Schmidt to U. Michigan two years ago, he continues to serve as the local authority on its use.

In La Serena, Smith oversees the CTIO computer support group, serving both as manager of the group and as scientific staff contact for all computer problems and suggestions. Smith also continues to provide overall supervision of the CTIO student program, working with REU Site Director D. Hoard to promote and continue not only the CTIO REU program, but also the parallel Chilean PIA program (Prácticas de Investigación en Astronomía), and other visiting student activities.

Outside of CTIO, Smith serves as principal US Gemini Project (USGP) contact for the Gemini Multiple Object Spectrograph (GMOS). He also provides general scientific computing support and advice for the USGP. In addition, Smith is participating in the development of data management models for NOAO participation in the combination of LSST and NVO.

Nicholas B. Suntzeff, Astronomer

Areas of Interest

Recent Research Results
Suntzeff’s major research project continues to be the study of the geometry of the Universe as measured by the distances to Type Ia supernovae. In 1999, the High-Z Supernova Search Team that he co-founded with Brian Schmidt (MSSSO) announced its results: the Type Ia supernovae at z = 0.5 are fainter by about 0.2 mag than expected for a universe with no deceleration. The results strongly rule out a flat $\Omega_{\text{matter}} = 1$ universe and are consistent with a flat universe with a matter component of $\Omega_{\text{matter}} = 0.3$. This would imply a “dark energy” which has its simplest parameterization as the Cosmological Constant of Einstein. These results imply that the Universe is actually approaching the free expansion state modeled by de Sitter, where the vacuum energy of repulsion has overcome the gravitational attraction of all forms of matter. In astronomical units, the results show that $q_0 < 0$ at the 3-sigma level. An independent group—the Supernova Cosmology Project—has also found a similar faintness in their independent Type Ia sample.

In the year 2000, the group searched for a few SNe at z = 0.5 with the goal of obtaining very accurate colors to test the level of reddening. Alternative explanations to the observations of distant supernovae hypothesize that the observed dimming is due to dust and not cosmology. The group had a successful run in Sep/Oct/Nov 2000 at CTIO and the CFHT. The supernovae have been followed with Keck, the IRTF, VLT, and HST. The data will be reduced to photometry at the CfA by S. Jha as part of his Ph.D. thesis.
Suntzeff is also continuing to study local supernovae. In the past two years he has published papers on SN 1990N, 1991T, 1992ar and 1998bu in collaboration with M. Phillips, R. Schommer and R.C. Smith, J. Maza (U. de Chile), M. Hamuy (U. Arizona), A. Clocchiatti (P. U. Católica), and many others. He will also continue to collaborate on the observation of these and other local supernovae through the HST Supernova Intensive Study (SnS) collaboration of R. Kirshner (CfA), and in particular on SN 1987A. He is presently working on SN 1999ac, SN 1999em, and SN 2000cx, SN 2000do, and SN2000dr. In particular, he is using the YALO telescope to observed near-infrared colors of supernovae to characterize the progenitors.

Suntzeff is collaborating with R. Cavallo (LLNL) using CTIO 4-m Hydra data on the Na/Al abundances of giants in Galactic globular clusters.

**Future Research Plans**

The future research plans of Suntzeff are to continue to find and study supernovae to prove, or disprove, the conclusions of the acceleration of the Universe. In 2001, he will collaborate with the High-Z supernova team to find Type Ia supernovae at higher redshifts. The maximum effect of the dimming of distant supernovae happens at \( z=0.9 \) for a cosmological constant with \( \Omega_\Lambda = 0.75 \). At higher redshifts, the luminosity distance of the supernovae will no longer be affected by a cosmological constant. Thus, by going to higher redshifts, one will be able to see if the luminosity distance follows a single cosmological parameterization, or if other systematic effects (evolution, dust) are corrupting the interpretation. The group will propose to find SNe at CFHT (J. Tonry, UH) and CTIO in Oct 2001 to find SNe at \( z = 1.2 \) to test this hypothesis. The supernovae will be followed at CTIO, Keck, CFHT, VLT, UKIRT, and HST. It is expected this will be a 2-3 year project.

Suntzeff will continue to collaborate with Phillips, Hamuy, Clocchiatti, and Maza on supernovae in the nearby Hubble flow. He has funded a postdoc at CTIO, K. Krisciunas, to work on the study of the infrared properties of supernovae. These data will be used to better characterize the intrinsic colors of supernovae. For Type Ia supernovae, the intrinsic colors are still poorly understood, yet they are critical to the use of the objects as distance indicators. The early time IR light curves are also may help in determining the nature of the progenitor. The IR data for Type II supernovae are being used by M. Hamuy as part of his Ph.D. thesis on the measurement of direct distances using the “Expanding Photosphere Method.”

He is a member of the Willick/Hudson team which has an NOAO survey proposal to use fundamental plane distances to elliptical galaxies out to redshifts of 0.03 to test for flows at the largest scales near the depth of convergence to the COBE dipole.

Suntzeff will also continue in stellar astronomy projects. With V. Smith (U. Texas), he will finish the study of abundances of RGB stars in NGC 288/362. He is also collaborating with Wallerstein (U. Washington) on chemical abundances of giants in NGC 3201. Along with Olsen and Schommer he is collaborating on a study of the globular cluster population of the Sculptor group of galaxies. He will sponsor a graduate student for three months in 2001 to produce a spectro-photometric atlas of photometric standards in the optical and near infrared.
Service
Suntzeff will continue in a multi-faceted program of service to CTIO. He is the support astronomer for the Hydra fiber spectrograph. He will continue to work with M. Boccas (CTIO) to improve the image quality on the smaller telescopes. Suntzeff will continue to serve on the NOAO TAC and the CTIO ACTR committees. He is in charge of the CTIO Library. He continues to advise the site monitoring at CTIO—the seeing and basic environmental data collection. With Walker and Blum, he has begun a site survey of northern Chile for possible sites for a US MAXAT/ELT large telescope project. He has served on the Chilean TAC, and also on the NOAO Director’s Search Committee. He participates in the NSF REU program every year where he directs 1-2 students in research projects.

During 2001, he is the manager of the R2D2 project to measure the quantum efficiencies of the facility CCDs, and the focus motor upgrades at the small telescope. With the departure of T. Ingerson, Suntzeff will help manage the Hydra and Integral Field Unit projects.

Andrei Tokovinin, Associate Astronomer

Areas of Interest

Recent Research Results
Commenced working at CTIO on February 1, 2001.

Future Research Plans
During 2001, the results of previous observations (radial velocities of multiple stars, coronagraphic observations of young B-type stars with adaptive optics) will be interpreted and brought to publication. The methods of measuring vertical turbulence profile will be further explored and implemented in the MASS instrument, to be used in test observations at CTIO during the first half of 2002. This instrument will hopefully be heavily used in the future site characterization campaigns in the framework of the GSMT. Theoretical research on Multi-Conjugate Adaptive Optics will be continued.

Service
Tokovinin is participating in the Gemini-CTIO sodium measurement campaigns and in the fabrication of the MASS instrument, and is contributing to the GSMT design and to the development of the Adaptive Optics for SOAR concept.

Nicole Van Der Bliek, Assistant Scientist

Areas of Interest
Stellar Colors: Observed and Synthetic; Star Formation Regions: IMF – Extinction; Infrared Instrumentation: Near IR and Thermal IR.

Recent Research Results
As part of the ISO Central Program, Olofsson and Nordh (Stockholm U.) and their group have surveyed nearby star formation regions. One of the goals of this project is to obtain more and
better data of Young Stellar Objects (YSOs) in these regions in order to study the shape of the Initial Luminosity Function (IFM) and the Initial Mass Function (IMF). A number of projects have been initiated to interpret these ISOCAM data and to supplement the survey with near infrared data and to obtain additional 10-micron data, van der Bliek is participating in these.

When studying the luminosity distribution of the YSOs in a star-forming region, one should be able to distinguish between YSOs and background objects. A way to identify background objects is to compare the observer ISOCAM color-color diagrams with a reference color-color diagram representative for the most common stars in the field, i.e., main sequence stars of type A to M and cool giants. Van der Bliek is constructing such a reference color-color diagram in two different ways: (i) an observed color-color diagram, using the ISOCAM data of a set of reference stars of spectral type A to K and luminosity class V and III, and (ii) a synthetic color-color diagram, using the colors calculated from synthetic spectra generated for a small grid of model stellar atmospheres.

Van der Bliek participated in the testing and commissioning of the Stockholm InfraRed Camera, as well as in the 10-micron observations obtained with this camera to supplement the ISOCAM survey.

**Future Research Plans**

Van der Bliek will continue working on the follow-up projects for the ISOCAM survey of star forming regions. As a by-product of identifying the background sources in the star forming regions of the ISOCAM survey, a very detailed map of the extinction in these regions will be obtained, and with this information the structure of the clouds will be studied. Van der Bliek will also be participating in the near infrared follow-up observations to (i) determine the luminosities and masses of the YSOs observed with ISOCAM; (ii) identify low-luminosity YSOs, to extend the IMF to the low mass end, and (iii) study the variability of low-luminosity YSOs.

**Service**

Van der Bliek carries out part of the support for the IR imager and spectrograph OSIRIS at the Blanco 4-m and the 1.5-m telescope. She is involved in development of the Infrared SidePort Imager (ISPI) for the 4-m Blanco telescope. She participates in the testing of the multiplexor and the engineering and science grade arrays, and will be involved in the development of the user interface.

Van der Bliek is the editor of the CTIO section of the *NOAO Newsletter*.

**Alistair Walker, Deputy Director, CTIO**

**Areas of Interest**

Stellar Populations, Magellanic Clouds, Distance Scale, Stellar Photometry.

**Recent Research Results**

Walker, with G. Kovács (Budapest), has revised empirical relations between the light curve parameters of RR Lyrae variables and their fundamental physical properties, based on a much larger sample of stars than their earlier investigation. Related work has focused on the properties of double-mode RR Lyraes, from which the luminosity can be derived directly.

Walker, as PI, has been working with A. Dolphin (NOAO) on the analysis of HST WFPC2 data for the oldest Small Magellanic Cloud cluster NGC121. Together with shallower, but covering a
much greater area, photometry from the CTIO 4-m and 0.9-m telescopes, analysis of the ages and evolutionary history of this remote part of the SMC has been completed.

Walker is PI of a Cycle 8 HST program to test stellar evolutionary theory using the very rich young LMC cluster NGC 1866, by analysis of the color-magnitude diagram and luminosity function, which for the first time will include all the luminous evolved cluster stars. The very deep and internally accurate CMD has been calibrated from extensive ground-based photometry; initial work has focused on deriving an accurate distance by comparing the ZAMS to the Hyades, after metallicity adjustments, thus calibrating the luminosities of the many Cepheids in the cluster. The distance to the LMC is now one of the major uncertainties in the cosmic distance scale.

Together with H. Smith (Michigan State U.) and E. Brocato, F. Caputo, and V. Castellani (Italy), Walker is collaborating in a comprehensive survey of the variable star population of the Carina dwarf galaxy, using the Blanco telescope with Mosaic imager and the WFI instrument on the ESO 2.2-m telescope. All observations have been reduced, and comparisons with extensive sets of evolutionary and pulsation models applicable to the wide ranges of metallicity and mass expected, are getting underway. These will both test the models exhaustively and probe in detail the properties of the older stars in Carina.

Future Research Plans
D. Terndrup (Ohio State U.) and R. Peterson (Lick Obs.) are leading a team, of which Walker is a member, to survey for hot evolved stars in the Galactic Bulge using the Mosaic II imager, with follow-up spectroscopy. This multi-year survey will characterize the space density of hot Blue Horizontal Branch stars, which are likely to be responsible for the UV excess in elliptical galaxies. Results from a shallower survey, made with the Schmidt telescope, have been published.

With Y.-W. Lee, S.-C. Rey (Yonsei U.) and S. Baird (Benedictine College), Walker plans to study the RR Lyrae variable stars in the Galactic globular cluster M22. The team has completed studies of the cluster Omega Centauri, obtaining accurate abundances for the RR Lyraes and a CMD for the whole cluster, showing that there are multiple populations and an age spread. The similarity to a CMD for the Sagittarius Dwarf Galaxy suggests that Omega Cen is the remnant nucleus of a dwarf galaxy that was accreted by our own galaxy many Gyr ago. M22 is probably the only other globular cluster in our Galaxy with a metallicity spread, and so will be subject to an analysis similar to that for Omega Cen.

Service
Walker is Deputy Director of CTIO. He is also chair of the Advisory Committee on Technical Resources (ACTR), which oversees the observatory instrumentation program and telescope operations. He is a member of the NOAO major instrument oversight committee IPAC. Walker directs and coordinates CCD operations and upgrades, and supervises the operation of the CCD laboratory. He is the project scientist/manager for the SOAR optical imager, the SOAR commissioning instrument, and he is also a member of the SOAR Science Advisory Committee. He is chair of the “sites” working group as part of the NOAO-Gemini New Initiatives Office-led effort to develop plans for building the next-generation extremely large telescope, and is in charge of the CTIO site campaign in northern Chile. Walker also serves on the HST Wide Field Camera 3 Science Oversight Committee, the CTIO-Chile and Las Campanas-Chile Time Assignments Committee, and the Local Organizing Committee for IAU Symposium 207, in Pucón Chile.
TUCSON-BASED SCIENTIFIC STAFF

Taft Armandroff, Astronomer; USGP Instrumentation Program Manager

Areas of Interest
Stellar Populations in the Galaxy and Nearby Galaxies; Dwarf Spheroidal Galaxies; Globular Clusters.

Recent Research Results
Armandroff has been studying the dwarf spheroidal satellite galaxies of M31, in collaboration with Da Costa (Mt. Stromlo), Caldwell (SAO), and Seitzer (Michigan). This was motivated by the opportunity to increase the number of galaxies defining the properties of dwarf spheroidals, and by the fact that the somewhat different environment of the M31 dwarfs compared to those of the Galaxy allows a first look at how dwarf spheroidal properties change with environment. Images were obtained with the HST WFPC2 camera of And I and II, dwarf spheroidal (dSph) galaxies located in the outer halo of M31. The resulting color-magnitude diagram reveals for the first time the morphology of the horizontal branch in these galaxies. They find that, in a fashion similar to many of the Galactic dSph companions, the horizontal branch (HB) of And I and II is predominantly red. Combined with the metal abundances of the dSphs, this red HB morphology indicates that And I and II can be classified as "second parameter" systems in the outer halo of M31. This result then supports the hypothesis that the outer halo of M31 formed in the same extended chaotic manner as is postulated for the outer halo of the Galaxy. In addition to the red HB stars, blue HB and RR Lyrae variable stars are also found in the And I and II color-magnitude diagrams. The presence of these stars indicates that And I and II contain a minority population whose age is comparable to that of the Galactic globular clusters. Thus, again like many of the Galactic dSphs, there is clear evidence for an extended epoch of star formation in And I and II. The most recent of this research is published in the Astronomical Journal (2000, 119, 705).

Future Research Plans
Pursuing the theme described above of studying the properties of dwarf spheroidal galaxies as a function of environment represents a significant portion of Armandroff’s research agenda for the coming year. WFPC2 observations of three other M31 dwarf spheroidals, And III, V, and VI, have been obtained. From these data, he hopes to learn whether these three galaxies resemble their Galactic counterparts as much as do And I and II.

Service
Armandroff serves as US Gemini Instrumentation Program Manager. In this capacity, he is responsible for the US contributions to instrumentation for the Gemini telescopes. Armandroff is a member of the Committee of Gemini Offices and the Gemini Science Committee. Armandroff also chairs NOAO’s instrument projects advisory committee (IPAC). Finally, Armandroff serves as a WIYN Consortium Board member and is the Board Secretary.

Samuel C. Barden, Senior Scientist

Areas of Interest
Stellar Physics and Dynamics, Binary Stars, Spectroscopic Instrumentation.
Recent Research Results
Barden has focused his research on the evaluation of a new type of diffraction grating technology through an NSF-funded research grant. The gratings (volume-phase holographic, or VPH) diffract light from modulations in the refractive index of the grating material, rather than by surface modulations as in classical gratings. These new gratings have the potential for higher diffraction efficiencies than classical gratings, along with many other benefits. Eight gratings were fabricated by Kaiser Optical Systems, Inc. (KOSI), Barden’s collaborators on the grant, and have been evaluated at NOAO by Barden and J. Williams (a student hired by the grant). A 1200 line grating shows peak efficiency of 87%, and a “complex” grating (actually two gratings in the same structure) shows a peak efficiency of 93% for one of the grating components. This study has helped spawn a new generation of spectrograph design. Many astronomical observatories (NOAO, AAO, Magellan, SOAR, ESO) are currently investigating spectrograph concepts that will utilize these novel gratings.

Barden is continuing to work with KOSI to enhance their fabrication facilities for the production of large-format gratings with sizes up to at least 200 mm. This effort is also being supported by the Department of Astronomy at U. Michigan, as they anticipate using this grating technology in an instrument for the Magellan II telescope.

Future Research Plans
Barden will continue to focus on evaluation of this new grating technology and on spectrograph designs that exploit its unique characteristics.

Service
Next Generation Optical Spectrograph (NGOS). Barden is leading the development of a wide-field, high-efficiency spectrograph based upon volume-phase holographic gratings. The design will serve as a technological stepping stone for similar types of instruments that will exploit wide-field spectroscopic surveys on large aperture telescopes (8 to 30 meters).

Cryocam Upgrade. Barden is assisting with an effort to fix and enhance the performance of the 4-meter Cryocam instrument. The upgrades will include new optical coatings, volume-phase holographic gratings, and a new high-resistivity CCD. Many of the efforts will provide invaluable experience for items critical to the development of the NGOS.

Barden currently serves on the NOAO Instrumentation Project Advisory Committee (IPAC), which provides counsel to the NOAO director for instrumentation projects within NOAO.

Todd A. Boroson, Deputy Director, NOAO; Associate Director, Data Products Program

Areas of Interest
Quasar Host Galaxies, Quasar Spectral Properties, Stellar Populations, and Optical/IR Instrumentation.

Recent Research Results
Boroson has continued his work on the relationship between quasar host galaxies and nuclear spectral properties. Following Laor’s (2000) finding that emission-line width and bolometric luminosity can be used to predict a quasar’s black hole mass, it is found that the sequence of
spectral properties known as Eigenvector 1 (Boroson and Green 1992) is likely due to a variation in the ratio of accretion rate to the Eddington rate.

**Future Research Plans**
Boroson plans to continue his work on quasar host galaxies, in collaboration with Richard Green, using AO-corrected IR images of the PG quasars obtained with the Gemini North telescope. This study will attempt to extend recent studies of nearby galaxies that find a linear correlation between the mass of a nuclear black hole and the mass of the galaxy spheroid. In addition, Boroson intends to enlarge the sample of quasars for which these spectral correlations have been analyzed, in order to extend the result in the context of radio-loudness.

**Service**
Boroson organized and co-chaired the first workshop on the Ground-based O/IR System held in Scottsdale, Arizona, in October 2000. He leads the NOAO Surveys and Data Management Group, which will provide technical expertise for NOAO’s participation in initiatives such as the NVO and data management for LSST.

**Charles F. Claver, Associate Scientist**

**Areas of Interest**

**Recent Research Results**
Claver’s research has focused mainly on two observational projects addressing stellar ages in the Galaxy. Specifically he has been investigating the necessary age concordance between two different techniques, white dwarf cooling times and main sequence turn-off ages. This is part of an effort to pursue a reliable age estimate for the galactic disk using white dwarf cooling times and the “cut-off” found in the white dwarf luminosity function.

Claver has also recently presented first results from Hydra spectroscopy of white dwarf candidates in the TDSS. These results show for the first time that the photometric selection of cool degenerate stars is possible. At least three objects and a possible fourth from the first field are bona fide degenerates.

**Future Research Plans**
Over the next several observing seasons, Claver plans to continue spectroscopic follow-up observations with WIYN Hydra of his cool white dwarf photometric survey. The cool white dwarfs identified will be used to redefine the cool part of the white dwarf luminosity function (WDLF). These data are important not only for estimating the Galaxy’s age, but also for placing an observational constraint on the importance of phase separation of a carbon-oxygen mixture in crystallization of white dwarf cores. Phase separation, if it happens, releases additional energy into the white dwarf core, further delaying the cooling process beyond the delay caused by the release of latent heat. The exact nature of white dwarf crystallization causes observable features in the WDLF and has a large effect on the inferred white dwarf cooling ages. He will also work toward increasing the area of his survey in order to increase the detection sensitivity of older-cooler white dwarfs belonging to the Galactic Halo.
Also, Claver plans to extend his work on calibrating the stellar chronology in star clusters to ages older than three billion years. Specifically, in collaboration with D. Winget (U. Texas), M. Bolte (Lick Obs.), and M. Wood (FIT), he plans to search for and identify the oldest white dwarfs in the clusters NGC-188 and Berkeley-17 in the North and IC-4651 and NGC-3680 in the South using both ground- and space-based telescopes. These clusters will extend the calibration to roughly eight billion years, which is sufficient to constrain the source of the present differences in the universe’s expansion age and its oldest stars. In addition, the southern two clusters bracket the age and turn-off masses where Claver suspects a change in the Initial-Final mass relation. Claver plans to obtain high signal-to-noise spectroscopy of the white dwarfs in these clusters in order to obtain model atmosphere fits, which will allow further assessment of the Initial-Final mass relation.

Service
Within the Kitt Peak scientific staff, Claver holds the title of Imaging Scientist. As part of his service activities he has begun and continues a coherent comprehensive look at the imaging quality produced by Kitt Peak telescopes with the aim of having all Kitt Peak telescopes deliver the excellent seeing of which the site is capable. To this end, Claver has taken on the responsibility of overseeing and maintaining optical alignment of Kitt Peak telescopes, as well as debugging problems when they occur.

As a member of the 4-m imaging improvement group, Claver is investigating the performance of the 4-m primary support system to determine if and where significant improvements can be made in the delivered image quality of this valuable telescope. Claver’s efforts, as project scientist, have resulted in a major improvement project to install an active back support system for the 4-m primary mirror.

Claver has also conducted a study of high frequency image motion at WIYN. This study has shown that high-speed tip/tilt compensation will result in 0.1-0.2 arcsecond improvements in delivered FWHM over moderate fields with the WIYN telescope. The WIYN consortium has approved a project to design, build, and commission a tip/tilt compensating imager with Claver as the NOAO project scientist. The WIYN Tip/Tilt Module (WTTM) expects first light with an optical imager in the Spring of 2002.

Arjun Dey, Assistant Astronomer

Areas of Interest
Galaxy Formation and Evolution, Distant Galaxies, Large-Scale Structure, Active Galactic Nuclei.

Recent Research Results
Starting in 1997, Dey and Jannuzi have been carrying out a deep survey (the NOAO Deep Wide-Field Survey, hereafter NDWFS) of two 9-square-degree regions of sky with the primary goal of studying the evolution (with redshift) in the large-scale clustering properties of galaxies. The optical and near-infrared imaging observations for the NDWFS will be completed by mid-2002, when it will be possible to use the full data set to study the galaxy clustering out to large redshift and on large angular scales. The NDWFS data will enable a number of investigations of galaxy evolution in the context of large-scale structure evolution. We have already begun studying the evolution and clustering properties of the elliptical galaxy population and are undertaking spectroscopic follow-up
programs using telescopes at Kitt Peak and Mauna Kea. Dey is also a Co-I on a project to map the NDWFS Bootes field using the VLA and WSRT telescopes and on a SIRTF GTO project to map the NDWFS Bootes field using MIPS and spectroscopically follow up sources using IRS.

With W. van Breugel (IGPP/LLNL), Dey is studying the properties of large gaseous halos around a small sample of high-redshift radio galaxies.

**Service**

Dey and Jannuzi are co-PIs of the NOAO Deep Wide Field Survey project which aims to map two 9 square degree fields to study the evolution and clustering of the galaxy population at large look-back times. The project is a test bed for how NOAO may carry out large surveys in the future and make the data available for broad use by the astronomical community. Dey and Jannuzi have worked with members of the IRAF group to create observing reduction scripts for use in a reduction pipeline. The first data from the survey was released shortly following the January AAS meeting.

Dey, Roger Lynds, Rich Reed, Sam Barden, Bill Ditsler and Rick Blakely are upgrading Cryocam by fixing the dewar, recoating the Schmidt camera mirror, equipping it with a new high-resistivity CCD from LBNL and a new volume phase holographic grism, and implementing a charge-shuffled mode with the new CCD. The upgraded Cryocam should improve on the current spectroscopic capabilities at the Mayall by providing an order-of-magnitude better sensitivity at red wavelengths.

Dey, Rich Reed, and Roger Lynds worked on the implementation of a nod-and-shuffle mode on the RC spectrograph at the Mayall 4m telescope. This mode results in excellent sky subtraction and enables spectroscopy at the shot noise limit. This spectroscopic mode is critical for efficient faint-object spectroscopy in the red and for multiobject spectroscopy in crowded regions. The observing mode will be available for general use in Fall 2001.

Tiede and Dey have determined the non-linearity correction coefficients for the InSb arrays in the ONIS IR camera, and are currently working on the calibrations for SQIID.

**David S. De Young, Astronomer**

**Areas of Interest**

Active Galaxies, Galaxy Clusters, Galaxy Evolution, Radio Sources, Hydrodynamics.

**Recent Research Results**

Much of De Young’s research in recent years has revolved around the common theme of astrophysical outflows and their interaction with the environment. This is a basic problem in nonlinear physics, many aspects of which are poorly understood or not understood at all. This is especially true for highly supersonic and relativistic outflows for which there is little or no experimental data. For these flows, the only accessible laboratory often lies in distant galaxies, where the interpretation of the data is often ambiguous. Nonetheless, such outflows can reveal characteristics of a large variety of astronomical objects, from proto-stellar jets and HH to starbursts in galaxies and the creation of megaparsec scale radio sources the largest single coherent objects in the universe.
Future Research Plans

Galaxy Evolution. In collaboration with C. Norman (STScI), De Young is investigating the fate of hot, metal-rich gas that is injected into galactic halos by OB associations and supernova remnants. It has been widely conjectured, but never demonstrated, that this debris causes the halo gas to cool and condense into clouds which then settle back into the galactic disk. Testing this model requires accurate modeling of the thermal instability in three dimensions in its non-linear phase. The basic computational tools are now in place, and detailed calculations are commencing. In a related project with T. Heckman (Johns Hopkins U.) and C. Martin (STScI), an extended study of mass loss from dwarf galaxies due to starburst activity is being initiated. The issue is that of possible re-collapse of an inflated ISM in the galaxy versus complete dispersal of the ISM due to energy injection from the starburst event, and the object is to reproduce the observed low metallicities in these objects together with their observed stellar populations.

More recent collaborations have been initiated with M. Corbin (U. Arizona) in modeling the wind-torus interface in BAL QSO’s to see if mass entrainment from the torus into the wind can reproduce the emission line signatures, and with J. Bally (U. Colorado) in modeling the time variations of collimated outflows from young stellar objects. The latter study involves the modulation of outflows with radiative cooling, coupled with observations of HH objects in order to constrain the basic mechanisms that regulate the outflow itself. De Young is also working on a book, entitled The Physics of Extragalactic Radio Sources, to be published by the University of Chicago Press.

Service

De Young’s service activities to NOAO include acting as Coordinating Chairman of the telescope time allocation process for all telescopes that can allocate time to NOAO programs. This includes facilities at CTIO, KPNO, Gemini, MMT, and the HET. In addition, De Young serves as Chair of three of the seven allocation committees and is a member of the Merging TAC. De Young has also become the coordinator for NOAO participation in the National Virtual Observatory (NVO) initiative and is a member of the NVO interim Steering Committee; he authored a major portion of the NVO White Paper that was presented to NASA and NSF in May 2000.

Other service activities include membership on the NOAO Management Committee, supervisor of the NOAO Tucson library, member or chairman of ad hoc KPNO Personnel and Post Doctoral Selection Committees. De Young is carrying out numerical modeling of air flows associated with possible sites for the Advanced Solar Telescope of the National Solar Observatory, and is initiating preliminary studies for similar modeling of possible sites in northern Chile. De Young is President of the Board of Trustees of the Aspen Center for Physics and is the coordinator of the NOAO membership in the National Partnership for Advanced Computational Infrastructure (NPACI). At the request of the NPACI Director, De Young is also acting as the NPACI Liaison to the NVO initiative.

Jonathan Elias, Astronomer

Areas of Interest

Star Formation and Evolution, Magellanic Clouds, Infrared Instrumentation.
Recent Research Results
Elias’s most recent research project has been an investigation of stellar mass loss in the Magellanic Clouds. In the later stages of their evolution, stars become red giants and lose mass. As material flows out from the star, it cools and dust forms. The dust is detectable at infrared wavelengths (if there is enough of it); it will also hide the star itself from view. The abundance of dust in the circumstellar material and the rate and velocity of mass loss may all depend on the abundance of heavy elements in the star losing mass, but it is not known in which ways. In order to see what actually happens, it is necessary to compare observations of stars with different heavy element abundances. As stars in the Magellanic Clouds have lower abundances than similar stars in the Galaxy, and since these galaxies are close enough for individual stars to be readily observable, they provide a useful basis for comparison.

Service
Elias’s activities are primarily as project scientist for the Gemini Near Infrared Spectrograph. This work includes acting as systems engineer. He is also the KPNO staff scientist for Flamingos, the University of Florida Imager/Spectrometer.

John Glaspey, Supervisor, Mountain Scientific Support

Areas of Interest
Blue Stragglers, Stellar Abundances, Astronomical Instrumentation.

Recent Research Results
Glaspey and collaborators have shown that lithium is significantly depleted on the surface of Blue Straggler Stars in stellar clusters, implying that whatever physical process creates BSSs involves mixing surface matter into the lower stellar layers that destroy lithium. Follow-up work with field AF stars revealed a significant component of BSSs in what appear to be halo and thick-disk, as well as a thin disk component.

Future Research Plans
Since some of the field AF star Li-abundance work involved only limited statistical samples, it would be reassuring to enlarge the size of the samples.

Service
As Supervisor of Mountain Scientific Support, Glaspey is in charge of insuring that the telescopes and instrumentation are maintained to provide maximum data quality. Part of these duties involve supervision of the Observing Assistants, who operate the 4-m and WIYN telescopes and interact nightly with the observers. The Electronic Maintenance group is also under his supervision. After the OAs, the EM staff is the next level of response to problems with the scientific equipment.

Glaspey is also supervisor for the remaining members of the Instrument Support group, who introduce the visiting observers to the telescope and scientific instruments to be used during their runs.

With his presence on Kitt Peak, Glaspey maintains contact with visiting observers to monitor overall system performance of observing capabilities. He then provides some of the liaison with the Tucson-based scientific and technical staff.
Glaspey is also the Telescope Scheduler for Kitt Peak, and as such, interacts with the NOAO proposal staff each semester. Glaspey is also in charge of the KPNO Web pages, although much of the content is supplied by other staff members.

Richard F. Green, Director, KPNO; Associate Director, NOAO

Areas of Interest
Active Galactic Nuclei, Chemical Abundance Evolution, Galaxy Nuclear Dynamics.

Recent Research Results
Green is a member of the science team for the Far Ultraviolet Spectroscopic Explorer (FUSE) satellite, which was launched on 24 June 1999. He is working with a subgroup of the team in studying a large number of AGN spectra for their spectral energy distributions; the objects are observed as D/H probes. The group has analyzed the FUSE spectra of several well-known Seyfert galaxies for the properties of their intrinsic absorption, including Mk 509, NGC 3516, and NGC 5548. All were caught in low states, with narrow O VI emission and substantial associated O VI absorption.

Future Research Plans
Green has Instrument Team guaranteed time for the Space Telescope Imaging Spectrograph. He leads an Internal Key Project to perform a census of super massive black holes in the nuclei of early-type galaxies. He is also a member of the “Nuker” proposal team that won a number of orbits in Cycles 7 and 9 to perform a complementary survey. The two teams have confirmed a tight correlation between measured black hole mass and global bulge velocity dispersion, implying coeval build-up of the black hole and bulge during dissipative collapse. Green is analyzing NGC 4486B, the dwarf companion to M87, with a double nucleus and complex internal velocity structure. He is also collaborating on observations of host bulges with the 4-meter RC spectrograph and the Gemini/U. Hawaii adaptive optics imaging system.

Service
Director, KPNO; Board of Directors, WIYN Consortium; Chair, Staff Search Committee. National: Council Representative, Astronomy Section, AAAS; Sloan Digital Sky Survey Data System Review; LSST Science Working Group co-chair; Special Session Organizer, AAS Meeting 196; Scientific Organizing Committee and Proceedings Editor, IAU Colloquium 184.

Kenneth H. Hinkle, Associate Scientist

Areas of Interest
Circumstellar and Interstellar Matter, Molecular Spectroscopy, Peculiar Stars and Late-Type Stars, Instrumentation.

Recent Research Results
Over the last year Hinkle authored publications in five separate areas. His largest single effort, with coauthors L. Wallace (NOAO), J. Valenti (STScI), and D. Harmer (NOAO), was the “Visible and Near Infrared Atlas of the Arcturus Spectrum 3727 - 9300 A,” a 375-page book published by ASP. Hinkle also collaborated with Wallace on an atlas of the visible region sunspot spectrum (NSO Technical Report #00-001) and a paper on J band spectra of MK standard stars.
The former paper included coauthor W. Livingston (NSO) and the latter included coauthors M. Meyer (U. Arizona) and S. Edwards (Smith).

Hinkle collaborated with R. Joyce (NOAO) and F. Fekel (Tennessee State) on three papers on the orbits of symbiotic stars. This work was the result of a long term observing program at the coudé feed using a NICMOS array provided by M. Skrutskie (U. Mass). This series of papers describes the majority of the known orbits for these systems.

Hinkle and Joyce published a paper with their REU student A. Hedden (Carleton) on V605 Aql, a final flash, post AGB star. Hinkle also presented results on V605 Aql and Sakurai’s star at a special colloquium at Keele University on this topic. Hinkle wrote a paper with Joyce, Hedden, and Wallace on wavelength calibration of cryogenic grating spectrographs in the 1-5 micron region of the infrared. Hinkle presented these results and other work on infrared instrumentation in an invited paper at the symposium for the retirement of R. Tull. Both REU projects were presented at the January 2001 AAS.

Hinkle also continued his work on variable stars by publishing a lengthy paper on H2 in the spectrum of mira variables. This was in collaboration with T. Lebzelter and B. Aringer (U. Vienna) and S. Ridgway (NOAO). Hinkle was a coauthor on a paper with Lebzelter on comparing velocity and light variations in semiregular variables. Hinkle coauthored a paper with N. Ryde, B. Gustafsson, and K. Eriksson (Uppsala) that probed Mira’s circumstellar shell using CO resonance scattering.

**Future Research Plans**

Considerable effort has already been invested in a ultraviolet atlas of Arcturus. Hinkle and collaborator Wallace (NOAO) are waiting on the HST observations needed to finish this book. Several other papers with Wallace are in progress, including an atlas of the infrared spectra of sunspots with different temperatures and an atlas of M dwarf spectra obtained with Phoenix. T. Tsuji (Tokyo) and J. Valenti (STScI) are coauthors on the latter work.

Hinkle is continuing research on various post-AGB objects. HST and Gemini (Hokupa’a) observations are scheduled of the final flash star V605 Aql. A paper on the red rectangle has been partly completed with REU student A. Hedden. Infrared CO and H2 spectra of a number of post-AGB stars have been obtained in collaboration with B. Hrivnak (Valparaiso) and S. Kwok (Calgary).

Hinkle, F. Fekel (Tenn. State), R. Joyce (NOAO), and M. Skrutskie (Univ. Mass.) have obtained telescope time at Mt. Stromlo in collaboration with P. Wood (Mt. Stromlo) to measure the orbits of southern symbiotic stars. 2001 is the first year for this project and due to the long periods of these systems results are not expected for three to four years.

**Service**

Hinkle is the project scientist and support scientist for the Phoenix spectrograph. NOAO has signed a contract with Gemini to provide Phoenix at Gemini South for five years and Hinkle will support Phoenix at Gemini South. Hinkle is the US mirror scientist for the Gemini instrument Michelle and mirror scientist for the KECK instrument NIRSPEC. Hinkle is working on two proposed instruments for the GSMT, a high spectral resolution 2-10 micron spectrograph and a medium resolution 1-2.5 micron integral field spectrograph.
Buell T. Jannuzi, Associate Astronomer

Areas of Interest
Cosmology, Evolution of Large-Scale Structure, Quasar Absorption Line Systems, Active Galaxies

Recent Research Results and Future Research Plans
Jannuzi's current research activities are mainly in two areas: 1) studies of galaxies and large-scale structure at redshifts between one and four as traced by the distribution of individual, groups, and clusters of galaxies; and 2) studies of the properties of the inter-galactic medium and the gaseous content of the universe as probes of the formation and evolution of structure in the universe. He also continues to be involved in studies of various classes of active galaxies and other projects.

Jannuzi, together with A. Dey, is Co-PI of the NOAO Deep Wide-Field Survey, a deep optical (Bw,R,I) and near-infrared (J,H,K) imaging survey that will sample the sky in two 9-square-degree fields. The survey is designed to: 1) investigate the existence and evolution of large-scale structures at redshifts z > 1 as sampled by a diverse set of objects; and 2) provide the astronomical community a sensitive multicolor database of objects from which samples may be selected for the study of other interesting problems and for follow-up with the Gemini telescopes. Further details and survey status updates can be found on the NOAO Deep Wide-Field Survey Web page. The optical imaging portion of the survey should be completed during the first half of 2002. The survey fields will also be the target of SIRTF and VLA surveys and Jannuzi is a Co-I in these investigations. These data will be used to study a very diverse set of astronomical topics in the years to come, and will be available to the entire astronomical community. The first data release from the NDWFS was made in January of 2001 and can be obtained via the NOAO Web pages.

Lyman-alpha absorbers are observable from redshifts of zero to five, spanning most of the age of the universe. Understanding how they relate to large-scale structures at low redshift will facilitate using studies of absorbers to understand the formation and evolution of structure in the universe. Jannuzi was the coordinator of the Quasar Absorption Line Key Project Team during the last six years of that project. That project used the Faint Object Spectrograph of the Hubble Space Telescope to obtain ultraviolet spectra of quasars during the first four cycles of HST operations. The large and homogeneous catalogue of low redshift absorbers that resulted from this work is being used for a wide variety of studies. Recent results include evidence for clustering of some low redshift Ly-alpha absorbers near metal line systems (Jannuzi 1998, in Proceedings of the 13th IAP Astrophysics Colloquium, "Structure and Evolution of the Intergalactic Medium From QSO Absorption Line Systems," ed. P. Petitjean and S. Charlot, p. 93) and for a change in the nature of the evolution of the number of these systems as a function of redshift from near the beginning of the universe to the present. This observational result is being further analyzed in the light of recent cosmological simulations, and is yielding insights into the formation and evolution of large-scale structure. Jannuzi is the PI of a limited program using HST and STIS to further investigate the properties of Lyman-alpha absorbers between redshift 1 and 1.5. This work will be undertaken during 2001.

Service
Jannuzi has responsibilities for both KPNO (R. Green, Director) and the NOAO Surveys and Data Management group, which is led by T. Boroson. Jannuzi is the KPNO Mosaic-I instrument
Richard R. Joyce, Scientist

Areas of Interest
Late-Type Stars; Mass Loss; Infrared Detector and Instrumentation Development.

Recent Research Results
In collaboration with K. Hinkle (NOAO), Joyce has continued monitoring the evolution of Sakurai’s Object, a star now recognized as a prototype final helium flash shell object. Since its outburst in 1996, the star had begun to fade visually due to the ejection of a dust shell in 1997, and is now detectable only in the infrared. In June 2000 the infrared spectrum was a featureless continuum (T ~ 600 K), except for a strong HeI 10830 emission line. This line had changed considerably since its previous observation in 1999, suggesting changes in the excitation of the circumstellar material. The star V605 Aql, which underwent a final helium shell flash in 1919 (but was not recognized as such an object until recently), was unambiguously recovered in the infrared using SQIID, and its IR spectrum displays HeI 10830 emission similar to that seen in Sakurai’s star.

Joyce and Hinkle sponsored a summer intern student, A. Hedden (Carleton), who was involved in the reduction and publication of the Sakurai and V605 Aql imaging and spectroscopy. In addition, she carried out a project on wavelength calibration of high-resolution PHOENIX spectra, the results of which have been accepted for publication.

Future Research Plans
Joyce, Hinkle, and Fekel are continuing the highly successful symbiotic star radial velocity program from the Southern Hemisphere, using the same NICMASS IR camera system at the Mt. Stromlo coude spectrograph. Peter Wood (MSSSO) is the local collaborator on this program, which will begin in March 2001. Almost no information exists for the larger sample of southern symbiotics. Joyce and Hinkle plan to continue spectroscopic monitoring of Sakurai’s Object and V605 Aql. Both HST and Gemini North (Hokupa’a) time have been awarded to study the spatial extent of the V605 Aql circumstellar shell, which is anticipated to be on the order of 1 arcsec diameter. Comparison of the infrared (dust) and optical (ionized gas) morphology can discriminate between bipolar and lumpy models of the circumstellar shell.

Service
A significant fraction of Joyce’s time is spent in providing observing support to visiting observers using the facility instruments CRSP (a low-resolution IR spectrograph), SQIID (IR imager), and Phoenix (high-resolution IR spectrograph). He will also be involved in visitor support with the new FLAMINGOS (U. Florida multiobject imaging spectrograph) as it comes on-line. This includes direct support such as checking out the instruments after installation, providing instruction to observers, training the Kitt Peak mountain staff in technical issues associated with these instruments, off-line support in providing advice to prospective observers, and assistance with data reduction.
Almost half of his time is devoted to the Gemini Near Infrared Spectrograph (GNIRS) project, on which he is a Project Support Scientist. His extensive involvement in this project has consisted of systems engineering efforts during the concept and design state and the testing of prototypes; he will be heavily involved in the assembly and testing of the instrument prior to its scheduled delivery to Gemini in 2002.

Joyce has also been involved in the concept definition of the next-generation wide-field IR imager for NOAO (NEWFIRM) and is a member of the working team for that instrument. He is also involved in IRMOS project, a collaborative effort of NOAO, STScI, and NASA Goddard to develop an IR multi-object spectrograph utilizing digital multimirror technology. He has committed significant effort in the upgrade of SQIID (now on-line with InSb arrays) and the Phoenix upgrade for Gemini South.

Other service areas include continuing to assist with the scheduling of Kitt Peak telescopes, serving on the Galactic TAC (2001A semester), the NOAO IPAC, and NOAO Safety Committee.

**Tod R. Lauer, Associate Astronomer**

**Areas of Interest**

**Recent Research Results**
With M. Postman (STScI), Lauer has measured the I-band galaxy-galaxy correlation function from a large (16 square degree) survey. This work significantly improves knowledge of the correlation function down to faint limiting magnitudes and helps to constrain how structure within the universe evolved since $z = 1$. They also produced a catalog of galaxies from the same survey, which will allow them to observe how the cluster-cluster correlation function evolves.

**Future Research Plans**
The major work that Lauer is undertaking now is completion of the Lauer, Postman, and Strauss survey of nearby brightest cluster galaxies to look for an end to the large bulk flow inferred from the earlier survey. They are also starting to obtain cluster redshifts from a deep I-band survey to measure the cluster-cluster correlation function.

**Service**
Lauer's major present service activity is developing the NOAO Mosaic Archive. This will be a prototype archive that will make all NOAO Mosaic images available to the astronomical community. A key part of the archive is developing a pipeline to enable automatic reduction and characterization of the entire Mosaic data stream. He also continues to run the colloquium and science lunch series, and chair the postdoctoral fellow selection committee.

**C. Roger Lynds, Astronomer**

**Areas of Interest**
Galaxy Evolution and Cosmology.
Recent Research Results
Lynds has been studying the interacting galaxy NGC 6745, a galaxy in which the interaction has evidently triggered abundant new star formation. HST images delineate the regions of star formation particularly well and provide a first guess as to the geometrical and dynamical nature of the interaction. Some of the new star formation has undoubtedly been induced by shock wave propagation but some, in the most luminous regions, has certainly been triggered by ram pressure in volumes where the interstellar media in the two galaxies have suffered direct collision. Surface and object four-color photometry have been performed and compared with theoretical models of evolved galactic subsystems. The agreement is very good. Lynds and E. O’Neil have observed the galaxy at 21 cm with the VLA C-array and have obtained an HI velocity map that confirms the preliminary model for the interaction. In addition, L-band continuum observations with the VLA B-array have yielded a map of the synchrotron emission, which beautifully traces the distribution of active star-forming regions. In May 2000, Lynds mapped the region in the C-band with the C-array (at the same resolution as the L-band observations). There are preliminary indications that he will obtain revealing spectral index variations and perhaps some information on polarization.

Future Research Plans
A long-term investigation concerns photometric population separation for galaxies in the Hubble Deep Fields (north and south) and other HST survey fields. One of the purposes of the study is to document the relative cosmological evolution of star-forming subsystems and evolved populations.

Service
Lynds has been an active member of the NOAO Planning and Development Office (PDO), the NBT Site subcommittee, and the NGOS instrument project (now terminated). Together with S. Barden and A. Dey, he has been working on the reincarnation of CryoCam as a front-line KPNO instrument and on the implementation of charge-shuffling for the 4-meter spectrograph. Lynds and A. Dey have been working collaboratively with Lawrence Berkeley National Lab to implement their developmental deep-depletion CCDs in the refurbished Cryocam and in other applications. Lynds has been an active member of the Observatory Safety Committee.

K. Michael Merrill, Associate Scientist

Areas of Interest
Star Formation, Young Stellar Objects, Interstellar Medium, Circumstellar Envelopes, Infrared Instrumentation, Array Technology, Data Acquisition and Reduction

Recent Research Results
Observations of NGC6334 using SPIREX/Abu from the South Pole during the past two seasons reached unprecedented levels of sensitivity within the 3-4 micron region. In conjunction with J. Jackson and colleagues (Boston U.) and I. Gatley (RIT), Merrill will be reporting on observations of diffuse 3.28-micron particulate emission and Brackett emission from ionized gas, which together track the UV flux within the region, and L band observations of the stellar content of the cloud. In combination with prior observations at JHK and long wavelengths, this study promises to shed new light on the star formation process and the early evolution of stars and their attendant circumstellar disks.

Using observations from SPIREX/Abu at the South Pole, supplemented with KPNO observations using SQIID, Merrill will explore the spatial distribution of the 3.28-micron emission within the
Galactic Center region to establish the excitation mechanism for the molecular hydrogen emission from the neutral material within the 80-arcsec-diameter circum-nuclear ring surrounding the central engine of our Galaxy. Within diverse environments, UV excited fluorescent molecular hydrogen emission has been found to be intimately associated with 3.28-micron emission. Off-band observations at L would provide a sensitive search for the IR counterpart of the central engine itself, Sgr A*.

**Future Research Plans**

The cosmic interface between stellar systems engineering and practical astrophysics, which conspires to produce a continual supply of new stars, has been the object of continued fascination to astronomers for many decades with each new discovery somehow whetting the appetite for more. Exploiting the recent SQIID upgrade, Merrill will resume the pioneering study of regions of active star formation which has awaited extension to a significantly wider field of view (4 area) and higher sensitivity (20) with high relative stability. The unprecedented ability to survey large regions with absolutely registered JHK(L) imaging will give renewed impetus to systematic studies of the more global aspects of the star formation process, which had heretofore been stalled by the complexity of the observations and the attendant data reduction required to adequately sample the full luminosity range over a FOV measured in tens of arcminutes in the presence of heavy, patchy extinction. Statistically significant star counts, with derived mass and luminosity functions, and the detailed distribution of the attendant gas and dust will all be amenable to careful study for regions of star formation covering a wide range in distance, total mass, and age.

**Service**

As Infrared Imaging Scientist at KPNO, Merrill oversees the IR imagers and attendant visitor support at KPNO, including instrument setups and observer checkouts, and is a point of contact on performance issues for both proposers and the TAC during the proposal cycle. On assignment to ETS, he oversees NOAO (non-Gemini) IR instrumentation efforts and the IR R&D lab. He is project scientist for the KPNO SQIID upgrade to ALADDIN 512512 InSb, which went into active service in the 2000A semester. As package scientist for the Gemini/NOAO Array Controller project and responsible scientist for the ALADDIN InSb 1024X1024 IR array and the Orion InSb 2048X2048 IR array R&D efforts, Merrill plays a significant role in developing and deploying state-of-the-art IR detection capability to the wider community. As "mirror scientist" for the Gemini near-IR imager (NIRI), he will be assisting the community with operations issues during the proposal cycle and assisting Gemini with the overall development of NIRI as a facility instrument. As the scientist responsible for user support of IR data reductions, he advises observers, programs and supports data reduction scripts, and interacts with the IRAF programming group to improve and extend IR-specific capabilities within IRAF. In support of the opportunity for community observations at 3-5 microns from SPIREX/Abu at the South Pole, Merrill has been actively involved in data quality assessment, has established the data pipeline in conjunction with colleagues at RIT, has served on the TAC, and has overseen the execution of observations on behalf of the wider community. He has been an active participant in outreach activities within the local schools (including teaching classes and coaching Science Olympiad teams), at scientific meetings, and by providing images on request for assorted publications and for advocacy of community-wide efforts such as SIRTF, SOFIA, and the Antarctic Infrared Observatory.
Jeremy R. Mould, Director, NOAO

Areas of Interest
Observational Cosmology and the Late Stages of Stellar Evolution.

Recent Research Results
Recent results include principally the determination, in collaboration with the HST Key Project team, that the Hubble Constant is 72 km/sec/Mpc with an uncertainty of 10%.

Future Research Plans
Mould plans to continue his work on the extragalactic distance scale in collaboration with J. Tonry (U. Hawaii) and L. Ferrarese (Rutgers U.). The HST cycle 10 program will concentrate on improving the calibration of surface brightness fluctuations, a measurement of the resolvability of the stellar population of early type galaxies. Mould will also work with members of the MACHO collaboration to test their hypothesis that the microlensing objects in the halo of our Galaxy are old white dwarfs. An additional interest to be explored in the coming year is Long Period Variable stars in M31, discovered by Mould and Hughes using the Palomar 60-inch telescope. Infrared photometry is planned from KPNO. Mould is a member of the MIPS team for SIRTF, and his special interest in that team is in the cosmic infrared background.

Service
Mould’s service in FY 2002 will focus on leadership of the National Optical Astronomy Observatory following renewal of AURA’s cooperative agreement with NSF to manage NOAO.

Joan Najita, Assistant Astronomer

Areas of Interest
Star and Planet Formation, the Low-Mass Initial Mass Function of Stars, IR Spectroscopy, Galaxy Formation and Evolution.

Recent Research Results
The Low-Mass End of the IMF. A direct measurement of the low-mass end of the IMF is fundamental to our understanding of the relationship between star, brown dwarf, and planet formation. J. Najita, G. Tiede, and J. Carr have used a new technique based on HST/NICMOS filter photometry to measure spectral types for late-type stars in the young cluster IC348. Due to the efficiency of the spectral classification technique, they have derived the first IMF complete to the deuterium burning limit, a fiducial boundary between brown dwarf and planetary mass objects. The derived IMF is significantly more abundant in brown dwarfs than the mass function for companions to nearby Sun-like stars. This provides compelling observational evidence for different formation and evolutionary histories for substellar objects formed in isolation vs. as companions.

Dynamics of Planet Formation Environments. The formation of stellar and planetary companions in disks is expected to alter disk structure, creating a “gap” at the orbital distance of the companion. J. Carr, R. Mathieu, and J. Najita have obtained robust, kinematic evidence for this process from the discovery and high-resolution spectroscopic study of 4.7-micron CO fundamental emission from AU binaries, where the line emission arises from residual gas in the gap, which appears bright in contrast against the dark (absent) continuum background. A similar

70 NOAO Provisional Program Plan FY 2002: NSF Funded Scientific Staff
study of systems without known stellar companions is in progress. This is one of the few techniques currently capable of diagnosing ongoing planet formation and observationally determining the formation distances of planets.

**X-Ray Induced Molecular Chemistry.** In collaboration with A. Glassgold (NYU), Najita is investigating the chemical structure of disk atmospheres. The expectation is that surface X-ray irradiation is significant in determining the column densities and molecular content as a function of height in the disk atmosphere. These results will be used to interpret the infrared spectroscopic measurements discussed above.

In collaboration with T. Bergin (CfA), Najita has also been exploring the utility of stellar X-rays as a molecular desorption mechanism in protoplanetary disks. "Spot heating" of grains by X-rays is found to be quite efficient at desorbing molecules such as CO from grains. These results may explain the measured depletion of CO in outer protoplanetary disks. This bears on the larger issue of the gas content of outer disks and the timescale for giant planet formation.

**Galactic Structure with the NOAO Deep Wide-Field Survey.** In collaboration with REU student Michael Cooper (Grinnell), Najita examined the star counts in the NOAO Deep Wide-Field survey data. The results indicate that the metallicity of the thick disk is within $\Delta[Fe/H] = 0.5$ of the metallicity of the thin disk.

Najita is also a member of a SIRTF Legacy team to study the evolution of planet forming disks and thereby put the solar system in context.

### Service

Najita is working on the science case for the GSMT. With Dey, she organized a workshop on this topic in Fall 2000. The results of the workshop are being used to identify and fund specific scientific and technical studies needed to refine the science case and telescope point design. During the past year, Najita also refereed papers for *Nature, Science, and PNAS*. She also continued to help the SIRTF IRAC and IRS GTO teams in defining their star and planet formation science goals.

### Ron Probst, Associate Scientist

**Areas of Interest**


**Recent Research Results**

Together with M. Rubio (U. de Chile) and collaborators in the US, France, and Argentina, Probst has been investigating star formation regions in the Large and Small Magellanic Clouds. This group has combined high sensitivity CO observations, high spatial resolution imaging in the 2.12-m $H_2$ line, and continuum observations in the near- and mid-IR with ground-based facilities and ISO to study the morphological and physical relationships between molecular gas, photo-dissociation interfaces, and very young stars. Recent results for N66 in the SMC (A&A 359, 1139, 2000) suggest three stellar generations have taken place in less than 3 million years. A similar dataset for 30 Dor has allowed definition of a multicomponent grain model for the dust emission in the near and mid...
Previous CO and IR imaging data for 30 Dor are also suggestive of a new generation of very young, high-mass stars formed on the periphery of the R136 starburst.

**Future Research Plans**
Probst and his collaborators are following up their IR imaging results for 30 Dor with infrared spectroscopy to establish the nature of embedded young objects often associated with spectroscopically confirmed O stars. The brightest sources are being observed with the CTIO 4-m; fainter ones will be 8-m GNIRS targets. Careful slit placement also allows investigation of the nature of associated molecular gas revealed in H2 images. Fluorescently excited surfaces of molecular clouds may be tracing the actual spatial extent of cold gas. Alternatively, the H2 emission may be shock excitation, with a distinctive spectral signature.

**Service**
The bulk of Probst's activities are devoted to observatory service. After several years on staff at CTIO, he returned to NOAO-Tucson in January 2000. While on staff at CTIO, Probst initiated a project to provide a new wide-field IR imager for the Blanco, which will be a permanently mounted facility instrument. He is continuing to act as project scientist and manager in the build phase, with regular trips to Chile, consistent with a more site-integrated approach to IR instrumentation within NOAO. Since his return to Tucson, Probst has focused on the NOAO IR instrument program and interactions with other AURA facilities. He is Co-Project Scientist on a NASA-funded, USGPO proposal to build a coronagraphic imager for Gemini South. This project is now being managed jointly by NOAO and International Gemini Project staff forming a single project team. The instrument is being built under contract by a commercial vendor. Probst has also led an effort to build an extremely wide field IR imager which may be shared between KPNO and CTIO. As part of this activity, he organized a workshop on IR imaging capabilities which brought together several groups with similar interests and identified key technology development activities. This led to a proposed collaborative effort between NOAO, U. Colorado, and Ball Aerospace and Technologies Corporation to build a wide field imager. Such collaborations offer a new path to create the powerful (and expensive) instruments needed to make best use of the new generation of 8-m class telescopes.

**Stephen T. Ridgway, Astronomer**

**Areas of Interest**
Stellar Astronomy, Advanced Instrumentation.

**Recent Research Results**
In collaboration with colleagues from the U. Paris Meudon Observatory and the Harvard-Smithsonian Center for Astrophysics, Ridgway continues to employ the optical fiber detection system FLUOR at the Infrared Optical Telescope Array on Mt. Hopkins. Multi-baseline studies are directly revealing the complex structure of mira star atmospheres, with evidence for a thick, partially transparent layer surrounding a bright core. At the Center for High Angular Resolution Astronomy, Ridgway continues to serve (part time) as the technical lead. First fringe in 1999 has been followed by the first science observations, which are on-going. Multi-wavelength infrared measurements are being used to determine stellar angular diameter and limb darkening for a variety of evolved stellar types.
**Future Research Plans**

At CHARA, additional baselines will be brought into operation, with more sensitive detectors. These will enable study of angular diameters of main sequence and pre-main sequence stars, as well as many specific projects such as Cepheid angular diameters. Ridgway is lead scientist on a Terrestrial Planet Finder study team, under contract to JPL. The team has identified several architectures for detailed study. In 2001, the team will construct end-to-end models of two non-redundant hyper-telescope arrays, and conduct a requirements and technology readiness study for an apodized square aperture. Both architectures were invented by the team. Ridgway is a collaborator in the OHANA project to couple existing Mauna Kea telescopes with optical fibers to form a uniquely sensitive and high-resolution interferometer. In 2001, the project will begin Phase 1, with fabrication and test of equipment for extracting coherent beams from existing adaptive optics systems on several telescopes. Ridgway will continue his collaboration with the FLUOR project for interpretation of near and mid-infrared spatial measurements of evolved stars.

**Service**

Ridgway provides technical advice to the NOAO/Gemini community on adaptive optics and optical interferometry, works with the NOAO Program Development Office and the AURA New Initiatives Office, participates with the Adaptive Optics Roadmap team, and is a member of the core GSMT team. He is a member of various NASA advisory groups on Keck and space interferometry. He serves on the NOAO Telescope Allocation Committee, and he is the KPNO 4-m telescope scientist.

**Abhijit Saha, Associate Astronomer**

**Areas of Interest**

Distance Scale, Cartography of Nearby Galaxies, Stellar Populations, Galactic Structure, Variable Stars, Photometric Techniques.

**Recent Research Results**

Saha has been continuing with the HST-based distance scale program in collaboration with Sandage et al., which seeks to establish the absolute peak brightness of type Ia supernovae. Work has been completed in the galaxy NGC-3982, which was the host galaxy for the type Ia supernova SN 1998aq. This calibration establishes a Hubble constant of ~ 60 km/s/Mpc with internal uncertainty of 4 km/s/Mpc, modulo re-calibration of the Cepheid distance scale and any metallicity effects therein. The “Key Project group,” a collaboration of which Saha has also been a member, has completed its work based on obtaining Cepheid distances to about 20 galaxies to calibrate additional secondary distance indicators such as the Tully-Fisher and Fundamental Plane relations. In a ground-based effort, Saha and Hoessel have obtained Cepheid distances to seven nearby galaxies (Local group and out to 7 Mpc), and work is underway on several more. The grand aim of this project is to both map the local Universe and define galaxy groups more precisely, as well as to use such galaxies as ‘test particles’ to probe the local dynamics and deduce the mass of the Local Group and the gravitational effect of neighboring groups such as the M81 group, CVn group, M101 group, and the IC342/Maffei group on the Local Group. Another important function of this study is to enable analysis of the stellar populations in these galaxies from color-magnitude diagrams (obtained from the ground as well as from HST), since such methods rely heavily on independent estimates of the distance. Saha is also involved in such stellar population studies and has contributed photometric techniques and Bayesian analysis methods in collaborations with Skillman, Gallagher, Hoessel, and Tolstoy. HST-based observations are being used to investigate...
the star formation histories in nearby galaxies from the fossil record of their stars, as manifest in the Hess diagrams (color-magnitude diagram plus relative frequency of stars as a 3rd dimension). Of particular interest is the question: do all galaxies have an old population of stars corresponding to the ages of the globular clusters in our Galaxy?

Future Research Plans
The HST-based study to calibrate the luminosities of type Ia Supernovae and hence obtain the value of the Hubble constant is expected to conclude within the next year. The ground-based distance-mapping project for nearby galaxies is expected to continue as a long-term effort. Saha and Hoessel will also seek to extend the effort to reach southern galaxies, particularly the Sculptor group, and also to monitor long period variables among the supergiants in some of these nearby galaxies. Data have been obtained with the WIYN telescope to search for RR Lyrae stars in the Leo A dwarf galaxy, in order to probe for stars with ages as old as those in the globular clusters of our own Galaxy. A first look at the results shows that there are a very large number of very short period Cepheids, a consequence of the rather unique star formation history in this galaxy, as gleaned from the HST-based color-magnitude data. Saha plans to return to the problem of understanding the halos of large galaxies, specifically by using the HST image archive with projected future deep observations in the M31 halo. This provides the only chance of studying a complete in-situ sample of stars in the halo of a large galaxy, where photometric methods should reveal much of the age and metallicity structures. Saha has been working on a Baade-Wesselink study of RR Lyraes. A photometric and spectroscopic analysis of ~30 RR Lyrae stars in the globular cluster M3 is underway (in collaboration with Pilachowski at NOAO), with the experiment designed to shed light on some long standing methodological issues. This experiment will allow error estimates for the B-W method to be compared to the real scatter of luminosities among M3 RR Lyraes, thereby providing a reality check on the method for the first time. Driven by the need for faint photometric sequences, particularly for use with HST, Saha is also involved in an effort to calibrate fields observed repeatedly with the HST by using ground-based good seeing observations with the WIYN telescope.

Service
Saha is serving as the telescope scientist for WIYN. He is also the NOAO representative on the WIYN Science Advisory Committee (SAC) (which he chaired from 1999-2000), and a member of the WIYN board. In the role of telescope scientist, he has worked on the testing and commissioning of the mini-mosaic CCD camera, which covers a wider imaging field at the high spatial resolution that the excellent seeing at WIYN demands. He has pursued several areas of general improvement in telescope performance, including implementation of the auto-correction of focus drifts using real-time Shack-Hartmann measurements, and investigating the optimal parameters for the guider software. The combination of the net improvement in imaging with WIYN, and the photometric performance of the Mini-Mosaic camera was the subject of a poster paper at SPIE meeting in March 2000.

Saha is also in charge of the imaging camera on the 2.1-m telescope. Saha has served on the NOAO Time Allocation panels and is also on the (NASA) Science Oversight Committee for the HST Wide Field Camera 3, which is scheduled to replace WFPC2 in 2004.
Nigel Sharp, Associate Scientist

Areas of Interest
The distribution, formation, and dynamical evolution of galaxies, binary galaxies, and galaxy clusters; the effects of black holes on their environment; image processing and enhancement in optical astronomy; the Galactic Center and its infrared appearance.

Recent Research Results
The first result from the South Pole collaboration on the star formation region NGC 6334 was published; some preliminary results for NGC 3310 were presented at the January 2001 AAS meeting. Some variable star results obtained with a summer REU student were also presented at that meeting and will shortly be published.

Future Research Plans
A double galaxy atlas and some dynamical analyses of double galaxy samples; work in numerical hydrodynamics as part of a proposed collaboration.

Service
Major responsibilities are operations scientist for the Kitt Peak Mayall 4-m telescope and NOAO’s loan of imagers to WIYN’s 0.9-m telescope. Sharp also provides programming and occasionally technician help to the principal systems programmer for NOAO’s suite of infrared instruments in support of the instrument scientists.

Stephen Strom, Associate Director for Science; Project Scientist, GSMT

Areas of Interest

Recent Research Results
Strom, in collaboration with Wolff, Rebull, and Makidon, is engaged in a study aimed at understanding the early angular momentum evolution of solar-like stars. From periods derived from spot-modulated light curves for more than 300 stars in the Orion and NGC 2264 star-forming complexes, we show that low mass PMS stars—both those surrounded by circumstellar accretion disks and those that lack disks—apparently do not conserve stellar angular momentum as they evolve down their convective tracks, but instead evolve at nearly constant angular velocity. This result is inconsistent with expectations that convective stars lacking disks should spin up as they contract, but paradoxically consistent with disk-locking models.

Strom, in collaboration with Rebull and Makidon, report results of an optical and near-infrared photometric study of the PMS population associated with NGC 2264. Their results enable estimates of mass accretion rates for circumstellar disks spanning stars ranging in mass from 0.1 to 2 solar masses and in age from 0.1 to 3 Myr. They conclude that accretion rates span more than 1.5 dex at all ages and masses, but that these rates are systematically higher among the youngest, most massive stars in the sample.
Future Research Plans
Strom plans to carry out studies of rotational velocities among PMS stars in the critical age range 3 to 30 Myr, using as a sample a set of objects identified by Mike Meyer and collaborators in preparation for a SIRTF Legacy Program. These observations are aimed at providing empirical constraints on angular momentum evolution following early PMS phases, and should provide critical insight into the paradox described above.

Service
Strom is chair of the SIRTF Users Panel, and Senior Advisor for the Large Millimeter Telescope project.

Sidney C. Wolff, Astronomer

Areas of Interest
Star formation, rotation, surveys, education

Recent Research Results
Wolff, in collaboration with L. Hillenbrand and S. Strom, is completing a paper on the evolution of angular momentum from the birth line to the main sequence for stars with masses greater than about half a solar mass. They find that: 1) the observed rotational velocities of pre-main sequence stars in Orion plus conservation of angular momentum along evolution tracks can account for the variation in $v \sin i$ with mass observed along the main sequence; 2) that stars cannot maintain solid body rotation when they make the transition from the convective to radiative tracks; 3) that the specific angular momentum is a slowly varying function of mass for masses in the range 0.3-10 solar masses along the main sequence, if allowance is made for differential rotation; and 4) that the trend in $J/M$ can be accounted for by models for disk-locking.

Future Research Plans
In the future, Wolff expects to work with J. Najita on the classification of isolated brown dwarfs and planetary mass objects in star forming regions; and with B. Jannuzi, A. Dey, and others on the spectroscopic follow up of the NOAO Deep-Wide Survey.

Service
Wolff is currently leading NOAO's contributions to the effort to develop a costed proposal for the LSST. She also plans to work with A. Fraknoi and others to establish the long-discussed electronic journal to support education efforts in astronomy. She is assisting with the management of the NOAO Deep-Wide Survey and will chair some of the TAC meetings. She is also serving on a number of external committees, including a review of NSERC (Canadian) funding priorities; the External Advisory Board for the Center for Adaptive Optics; an NRC committee on the accessibility of NASA data; a review of three University of California research labs, including Lick Observatory; and the Board of Trustees and Presidential search committee for Carleton College.
STATUS OF FY 2001 MILESTONES

NOAO GEMINI SCIENCE CENTER (NGSC)

➢ Issue call for proposals for Semester 2001A with a facility instrument (NIRI) and Semester 2001B (with GMOS) for Gemini North.

   The calls for proposals were issued in September and March, including NIRI and GMOS. The US received 77 proposals for 2001A and 79 for 2001B on the Gemini telescopes.

➢ Provide USGPO help for Gemini to implement the QuickStart process, including two staff-months spent in Hilo.

   QuickStart queue completed and Patrice Bouchet, Stefanie Wachter, and Bob Blum from USGP participated, spending about three staff-months total in Hilo.

➢ Work on the proposal process and forms to evolve to the Gemini phase I tool if resources permit its extension to multiple telescope implementation.

   US proposers now have the option of NOAOprop or the Phase I tool for single telescopes. Extension to multiple telescopes is still a goal.

➢ Allocate software resources to work on Gemini data reductions, particularly for AO, and for multi-object and IFU spectroscopy.

   Software resources for these tasks are still being sought. Work on IRAF extensions for Gemini data formats and quality specifications has proceeded.

➢ Work with the US instrument teams to deliver T-ReCS (U. Florida) and visitor instruments FLAMINGOS (U. Florida), and Phoenix and Abu (NOAO).

   Current schedules have T-ReCS shipping to Gemini South in October 2001 and FLAMINGOS in June. Abu was shipped in April 2001, and Phoenix will be shipped in September.

➢ Provide a wide-field IR MOS (FLAMINGOS II) for Gemini, perhaps through partnership with SOAR.

   Gemini is now prepared to fully fund FLAMINGOS II. The detailed work scope is being negotiated and a contract is expected to be let in the near future.

➢ Assist in the development of a management plan for starting the Coronagraph/Imager (NICI) contract.

   Extensive work has been done by the USGP in collaboration with IGO and the NICI team. A contract has been let and work has started.

➢ Start science operations and issue call for 2001B proposals for Gemini South.

   The 2001B call for proposals included Gemini S. at the level of 25% science operations.
Provide NOAO/USGPO support for visitor instruments on Gemini South and assist in the commissioning.

NOAO/USGPO staff have been assisting with Gemini South commissioning and will work with OSCIR, FLAMINGOS, and Phoenix on Gemini South.

Participate in the planning and implementation of the workshop to explore the science and instrumentation for MCAO.

There was extensive community and USGP participation in the MCAO workshop, and a significant number of science cases for MCAO imaging have been presented.

Continue to engage the US community in Gemini, both with talks and workshops, and by producing instruments and dedicated support teams for those.

USGP/NOAO conducted a workshop in Tucson on AO capabilities data reduction for Hokupa'a/QUIRC in February 2001. A special session of the AAS on First Science with Gemini was held on June 4 in Pasadena. A USGP public talk is available on the Web, and a brochure for the USGP has been prepared, distributed at the AAS meetings, and sent out with the NOAO Newsletter.

Complete prototype testing and begin fabrication of GNIRS.

Prototype testing is complete and the GNIRS team is deep into the fabrication tasks.

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

Since its formal inception in January 2001, the AURA New Initiatives Office has made significant progress toward achieving its primary goal, which is:

"...ensuring broad community access to a 30-m telescope, contemporary in time to ALMA and NGST, by playing a key role in scientific studies leading to the creation of a GSMT."

We have begun to involve a broad cross-section of the community in identifying the key scientific drivers for a GSMT and the technologies needed to enable the challenging instruments critical to achieving GMST goals. In parallel, a core NIO engineering and science team comprising 10 FTEs is in place and working in Tucson, Hilo, and La Serena. For much of the past six months, the NIO team has been focusing its energy on a system analysis of a "point design" concept for GSMT with a goal of understanding the technical and cost issues that are central to successful design of an affordable telescope.
Status of FY 2001 Milestones

- Hold community workshops aimed at developing a Science Reference Mission for a 30-m class telescope. A key product of the exercise will be a flow-down from science to top-level requirements for the GSMT.

  *Three workshops were held in Tucson during September 2000: (1) large-scale structure and galaxy evolution; (2) stellar populations; (3) formation of stars and planetary systems. The results of these workshops were synthesized by Joan Najita, posted on the NOAO Web site in February 2001, and used to develop straw man requirements for the GSMT point design currently under study by the NIO. In June 2001, NIO sponsored a small workshop aimed at deeper understanding of the potential synergies between ALMA and GSMT. The participants in the workshop urged following this meeting with a much broader community workshop structured so as to understand GSMT's role in the era when not only ALMA, but SKA, NGST, SIM, and later TPF will be available.*

- Support two to three community-based studies of instrument concepts for the GSMT. These studies will produce a list of technology issues and challenges as well as requirements on telescope performance.

  *Larry Ramsey (Penn State) summarized technology issues and design challenges for generic GSMT instrumentation. Sam Barden, NIO, and NOAO staff are in the process of developing concepts for five GSMT instruments.*

- Support community and private-sector studies of optical and structural design concepts. These will culminate in a straw man point design for other key studies.

  *Simpson, Gumpertz, and Hager delivered a structural design concept for GSMT, based on a straw man optical design provided by Oschmann of NIO. This structural design has served as a "point design" for GSMT aimed at eliciting understanding of system and subsystem design challenges.*

- Support community- and private sector-based studies of the active and adaptive controls systems for NBT. These studies will lead to an understanding of the key technical challenges in compensating for the effects of gravity, temperature, and wind buffeting, as well as wavefront distortions introduced by the atmosphere.

  *David Smith of U. Mass-Lowell, in collaboration with NIO staff, carried out an extensive study of the effects of wind buffeting on the Gemini South telescope. These data have been made available on a CD and on the NIO Web site and can serve as a key database for other Extremely Large Telescope Studies. NIO recently (June 2001) hired a controls engineer to concentrate effort on fundamental controls issues and solutions.*

- Support community- and private sector-based studies of mirror fabrication and polishing concepts.

  *Larry Stepp of NIO visited potential suppliers of high-quality optical glass in conjunction with members of the CELT project. Because CELT is focusing resources on this issue, NIO has chosen to stay abreast of developments rather than making significant investments at this time.*
Develop a site-testing plan for locating GSMT.

Alistair Walker at CTIO has developed a template for preliminary evaluation of sites in northern Chile, along with a straw man list of needed measurements. A site-testing group in Chile will initiate the next stage of site evaluation during FY 2002, when NIO anticipates investing $450K in this effort. NIO has also established a working relationship with a site-testing group at UNAM in Mexico. The NIO-UNAM group plans to extend site evaluation, based on uniform criteria, to sites in Mexico.

Produce a short list of potential sites in northern Chile based on archival satellite cloud cover analyses, terrain analyses and modeling, and meteorological measurements (where available). A long-term testing plan will be finalized with US and international (Gemini, ESO) collaborators, and then implemented.

A site list in Northern Chile has been derived from analyses of terrain and archival satellite data. [See previous milestone.]

CERRO TOLOLO INTER-AMERICAN OBSERVATORY (CTIO)

CTIO Instrumentation

- Complete construction of the SOAR Optical Imager; begin full system tests.

The SOAR Optical Imager, the commissioning instrument for the SOAR telescope, passed its Pre-Fabrication Design Review in December 2000 and is on schedule for completion of construction by the end of the FY. The subsequent test phase will last two months, which still leaves several months of contingency prior to SOAR first light. The specified (high UV sensitivity) CCDs are likely only to be delivered around first light, thus the instrument will initially be fitted out with red-optimized CCDs. The data system, which utilizes a Leach controller operating in a Linux/Lab VIEW environment, is well-advanced, and is common to new instrumentation being built for both SOAR and Blanco.

- Complete construction of the Blanco IR Sideport Imager, and begin in-situ array characterization.

The Blanco IR Sideport Imager (ISPI) is on schedule for completion shortly after the end of the FY. A successful Pre-Fabrication Design Review was held in November 2000, and subsequent progress has been rapid. An engineering grade 2K HgCdTe array has been received and tests are proceeding. The final version of the high-level software is late, but is not on the critical path, and it is expected that commissioning will take place, as planned, in late 2001.

- Install and test the Blanco Integral Field Unit, which feeds the Hydra bench spectrograph.

The Blanco Integral Field Unit was successfully tested during an initial engineering run; however the project was re-evaluated in the context of a revised long-term instrumentation plan, and has been cancelled.

- Upgrade the Tololo Arcon CCD controllers with revised boards, and complete the 16-channel read-out upgrade for the Mosaic I (Mayall) and Mosaic II (Blanco) CCD imagers.

A-4 NOAO Provisional Program Plan FY 2002: Status of FY 2001 Milestones
The Mosaic II (Blanco) CCD Imager has been upgraded to 16-channel read-out, which now is the default operational mode. The equivalent upgrade was not possible for the Mosaic I (Mayall) Imager as two of the eight CCDs in this instrument were found to each have only one operative amplifier, and no replacement SITe CCDs are available. The upgrade of the Tololo Arcon CCD controllers with revised boards has been delayed due to higher priority projects, but is still expected to be completed by year end.

- Begin building the Nasmyth Instrument Support Boxes, comparison system, and tip/tilt support stages for the SOAR Project, under contract.

  The contract between SOAR and NOAO is about to be let, in order to begin this project, which will be under the management of ex-CTIO instrumentalist Thomas Ingerson. A concern is the delay of several months in the supply of the Instrument Support Box’s structure from RSI, although the final delivery date is still not compromised. The design work already carried out as part of the costing and feasibility study was very extensive, almost to Conceptual Design Review standard, and the project should proceed rapidly once initiated.

- Begin adapting the CTIO Infrared Spectrograph for use on SOAR, or alternatively partner with an external group to build a multi-object IR spectrograph.

  It was instead decided, in a collaboration with Ohio State University, to install the imaging spectrometer OSIRIS at SOAR. OSIRIS is presently scheduled on the Blanco and the 1.5-m, its use on SOAR is regarded as an interim solution to SOAR’s IR spectroscopy requirements. The SOAR second-generation instrument complement is presently under discussion, one possibility is for Brazil and CTIO to collaborate on building a new multi-object spectrograph.

- Start ramping up on a major new project, nominally a laser guide-star adaptive optics system to be installed on SOAR.

  This project is being evaluated, with a view to presenting a proposal to the SOAR Board in September 2001

CTIO Instrumentation

- Blanco 4-m: Complete present phase of thermal performance modifications, which involves replacing the primary mirror cover with one that provides little restriction to wind-flow when open, and implement a new thermal control system.

  The Blanco primary mirror cover has been replaced, and the new thermal control system is in operation. Tuning and optimization of the system is now underway, a series of controlled tests are scheduled for the next several months; these will quantify the sources and amount of any remaining image degradation generated within or in the immediate vicinity of the Blanco telescope, and allow us to establish procedures that minimize or eliminate them.
Kitt Peak National Observatory (KPNO)

KPNO Instrumentation

- Complete assembly and integration of WIYN Tip/Tilt Imager
  
  On schedule. We are awaiting the final mirror, which failed twice at the diamond-turning vendor. Delivery is now anticipated by the end of August 2001. Assembly and integration scheduled to be nearly complete by early FY 2002.

- Upgrade the Cryogenic Camera with a new red-sensitive CCD, Volume-Phase Holographic grisms, recoated optics, and repaired dewar
  

- Complete commissioning of FLAMINGOS, an IR multi-object spectrograph and wide-field imager being produced in partnership with University of Florida.
  
  The instrument was offered for shared-risk observations in Semesters 2001A and B. The commissioning phase will extend to correct some optics issues and to accommodate the multi-slit spectroscopic mode.

Mayall 4-m Telescope

- Achieve routine operation of active f/8 secondary control to cancel tilt-induced coma
  
  Delivered system works for improved focus accuracy, but required further modification for higher precision than originally specified. Hardware modifications will be complete in FY01, commissioning scheduled for FY02.

- Install and commission wavefront camera for tuning up active primary performance
  
  Mechanical installation scheduled for Summer 2001; camera integration deferred to FY02 for lack of resources.

- Develop concept and design for rapid guiding of f/8 secondary.
  
  Deferred for lack of resources.

WIYN Telescope

- Upgrade Instrument Adaptor System to accommodate WIYN Tip/Tilt Module (WTTM).
  
  On schedule.

- Complete integration of Modified Cassegrain focus adaptor produced by Wisconsin.
  
  Delivery delayed due to re-scope of project.

KPNO 2.1-m Telescope

- Begin modification of telescope to support wide-field infrared imaging surveys and to serve as test bed for new IR instruments.
FLAMINGOS adapter and handling equipment constructed; Goddard IRMOS conceptual interface design developed.

- Implement improvements to the RA drive and focus stability.
  - RA and Dec drive motors to be overhauled in Summer 2001; focus stability issue deferred for lack of resources.

LARGE APERTURE SEGMENTED SURVEY TELESCOPE (LSST)

- Hold a community workshop to determine the science requirements and observing protocols for the diverse set of science programs (discovery of near-Earth objects, discovery of supernovae, measurements of gravitational lensing) proposed for the LSST and determine a prioritized set of science requirements for the facility.
  - An Aspen workshop on the LSST brought the community together for an in depth discussion of the scientific case and requirements for the LSST. Small working groups on three areas of science (deep imaging, detection of moving objects, and detection of variable objects) will meet this fall to quantify the outcomes of these discussions in order to translate them into performance requirements for the telescope, instrument, and data management.

- Establish a core working group with the goal of developing a preliminary proposal, including costing, for the telescope, instrument, data handling and distribution, and operations.
  - The core technical working group will meet at the end of September 2001 to cover all areas other than data management. A separate data management working group will be established after the science requirements in this area are formulated.

NATIONAL VIRTUAL OBSERVATORY (NVO)

- Work with the NVO interim steering committee to prepare the proposals necessary to implement NVO.
  - Participation in NVO interim steering committee activities continued through FY 2001, culminating in proposal to NSF Information Technology Research program to establish framework of NVO. NOAO is a significant partner in this proposal. No word on the success of this proposal has been received at this time.

- Develop one or more proposals to support funding of collaborations leading to an NOAO “node” for NVO. The proposal(s) will focus on developing the pipelines, archives, and archive access tools necessary for making NOAO Deep-Wide Survey and Mosaic images accessible to the community and to the NVO infrastructure.
  - An NSF pre-proposal (medium-size funding) was developed to fund work needed to establish O/IR node for NVO. Pre-proposal was not successful. Planning for FY 2002 activities in Data Products group will nevertheless focus on initiating these activities at the expense of traditional data reduction and support work.

- Work with the community to develop a Science Reference Mission for the NVO, in order to provide a flow down from science requirements to functionality and cadence.
Although this milestone was not reached, a science workshop was held (March 2001) at NOAO to consider the relationship of theory and simulations to the large data sets and the tools that the NVO will provide. Participation in work on NVO science continues with the hope of making definition and support of NVO science a high-visibility activity within NOAO.

SURVEYS AND DATA MANAGEMENT

➢ As part of a larger effort to develop expertise in handling massive databases, initiate data releases for the NOAO Deep-Wide Survey, and provide access to the data and rudimentary tools.

First data release for the NOAO Deep-Wide Survey took place in January, 2001. Through the Web-based interface, tools are available to download “cutouts” of arbitrary size from the released images.

➢ Develop a plan for the management of data from the Large Synoptic Survey Telescope, possibly including the initiation of a precursor project aimed at handling a slower data stream in real time.

The performance requirements for the LSST data management activity continue to be refined through ongoing work on the science requirements. A survey project that may constitute a precursor (“A Next Generation Microlensing Survey of the LMC.” PI Christopher Stubbs) was granted time by the TAC.

➢ Complete data processing pipeline and begin routine archiving of NOAO Mosaic Imager data.

Work on the data processing pipeline continues with initial emphasis on processing data for the ongoing survey projects.

PUBLIC AFFAIRS AND EDUCATIONAL OUTREACH

➢ Consolidate and restructure outreach programs to make more effective use of the Web.

An entirely new streamlined and simplified NOAO home page debuted to positive reviews in April 2001. It features 13 primary links versus the four dozen found on the old page, with the top five links grouped to attract the casual Web surfer from the general public.

The Project Astro Web pages were completely redone to greatly improve their usability and begin to provide classroom resources such as MPEG video clips of planetary cratering experiments.

➢ Refine and streamline the process for issuing press releases.

NOAO hired a new public information officer/science writer in August 2000. Since then, we have issued a dozen press releases and several special astronomy image releases that have produced steady news coverage.

NOAO has established a clear policy with the Gemini Observatory to support their issuance of press releases via text writing support and our strong working relationship with continental US media and the American Astronomical Society press operations.
➢ Develop new initiatives in pre-college education that are highly leveraged through the support of partner organizations.

The newly funded TLRBSE program leverages off the success of its predecessor, The Use of Astronomy in Research-Based Science Education (RBSE). TLRBSE will reach a much larger number of teachers with more diverse needs, while facilitating authentic research in classroom settings and addressing the national concern of "Teacher Retention and Renewal." Co-investigators on the TLRBSE program include Donald McCarthy from UA/Steward Observatory and Jeffrey Lockwood from TERC.

➢ Generate a new business plan for Visitor Center activities on Kitt Peak.

This action has been superseded by the hiring of a new Kitt Peak Public Outreach Manager with strong ties to the Tucson museum community. In less than four months on the job, the new manager has revitalized numerous aspects of the Visitor Center program; he will be developing and implementing an Interpretive Master Plan for the visitor center and grounds in FY 2002.

➢ Enlarge the scope and depth of the NOAO Image Gallery on the Web.

The Image Gallery page was redone in concert with the new NOAO home page to make it more attractive and user-friendly, including a more prominent Search function.

The NOAO Image Use policy was rewritten to make it more readable and to provide some common examples of usage to reduce the number of related questions.

More than 60 images were added to the Gallery in the first nine months of FY 2001.
TENANT FACILITIES

Kitt Peak Mountain (KPNO)

National Radio Astronomy Observatory (NRAO)
  • 25-m Telescope - Component of Very Long Baseline Array network

Steward Observatory (University of Arizona)
  • 2.3-m Bok Telescope
  • 0.9-m Telescope - Spacewatch survey for near-earth asteroids
  • 1.8-m Telescope - Spacewatch survey instrument in commissioning
  • 12-m Telescope - Millimeter Wave spectroscopy and mapping

MDM Observatory (Consortium: Michigan, Dartmouth, Columbia, and Ohio State Universities)
  • 2.4-m Hiltner Telescope
  • 1.3-m McGraw-Hill Telescope

RCT Observatory (Consortium: Western Kentucky U., Boston U., South Carolina State U.)
  • 1.3-m Telescope

Warner and Swasey Observatory ((Consortium Led by Case Western Reserve University)
  • Burrell Schmidt Telescope (0.6/0.9-m)

Southeastern Association for Research in Astronomy (SARA) (Consortium: Florida Institute of Technology, East Tennessee State, Florida International, Georgia, and Valdosta State Universities)
  • 0.9-m Telescope

WIYN Telescopes (Consortium: Wisconsin, Indiana, Yale, NOAO)
  • 0.9-m Telescope
  • 3.5-m Telescope

Wisconsin H-Alpha Mapper Project

Calypso Telescope — Edgar O. Smith
  • 1.3-m Telescope for high resolution imaging in commissioning

NASA-MIT Optical Transient Experiment

Cerro Tololo And Cerro Pachón (AOSS-CTIO)

Gemini South 8-m

SOAR 4-m (NOAO, University of North Carolina, Michigan State University, Brazil)

YALO 1-m

3-cm Robotic Emission-line Survey (Swarthmore)

GONG Helioseismic Observing Station (National Solar Observatory)