National Optical Astronomy Observatory
Program Operations Plan
FY18

Submitted to the National Science Foundation

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28 September 2017
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Mission Statement

The National Optical Astronomy Observatory (NOAO) is the US national center for ground-based optical-infrared (OIR) astronomy.

The fundamental intellectual mission for NOAO is to enable discovery in ground-based OIR astronomy and astrophysics for all qualified researchers by facilitating open access to state-of-the-art observational facilities, data products, and data services provided by NOAO and the Gemini Observatory as well as other federal and non-federal entities within the US OIR System. To ensure continued research excellence for the community-at-large, NOAO also facilitates community-based planning for future facilities, instrumentation, and data services.

To fulfill its potential for broader impacts that benefit society, NOAO works to strengthen education and public awareness of astronomical sciences on local, national, and international scales as well as to inspire and train the next generation of scientists and engineers. These endeavors leverage strong collaborations with other federal centers, all levels of academic institutions, and community groups in Arizona and Chile.

NOAO is a Federally Funded Research and Development Center (FFRDC) sponsored by the National Science Foundation (NSF). It is managed and operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under a cooperative agreement with the NSF.
Executive Summary

This is the annual Program Operations Plan (POP) for the National Optical Astronomy Observatory (NOAO) covering Fiscal Year 2018 (1 October 2017–30 September 2018). The Association of Universities for Research in Astronomy, Inc. (AURA) operates NOAO under cooperative agreement AST-1546092 with the National Science Foundation (NSF).

From FY18 NSF base funding (AST-1421197), NOAO plans to deliver and/or enable:

- Operations and maintenance of the CTIO Blanco 4-m facility on Cerro Tololo, including the Dark Energy Camera (DECam)
- Operations and maintenance of the SOAR 4.1-m facility on Cerro Pachón on behalf of the SOAR partnership
- Scientific user support services for the US community users of the Gemini Observatory
- Further design of LSST community science support services consistent with the National Research Council OIR System Optimization Study report and subsequent NSF directives
- Science data management operations, including delivery of science-ready data products from wide-field imagers operating at the KPNO Mayall 4-m, KPNO WIYN 3.5-m, and CTIO Blanco 4-m telescopes, operation of a science data archive, and modernization and homogenization of back-end scientific computing and database systems
- Science data services including NOAO Data Lab operations, documentation, and user support with associated data sets (including FY18 release of Dark Energy Survey Public Release 1 and NOAO Source Catalog data sets) and operation of the Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES)\(^1\) on publicly available live alert streams with simple filters
- An Education and Public Outreach program that focuses on critical, local activities and needs in Arizona and Chile, including dark sky protection and the operation of visitor centers on Kitt Peak in Arizona and Cerro Tololo in Chile
- NOAO financial contribution to the operation and maintenance of the physical plant and IT infrastructure shared in Arizona and Chile with other AURA and non-AURA entities
- Budget and pay for AURA fees for corporate expenses as well as business and human relations services required to manage a geographically distributed organization with more than 250 employees
- Planning and reporting activities mandated by the NSF and (as necessary) other federal agencies
- Senior management team and associated administrative support personnel

\(^1\) ANTARES is being developed in collaboration with The University of Arizona Department of Computer Science and is supported by NSF award CISE AST-1344024.
From additional NSF funding under separate awards (as indicated below), NOAO plans to deliver and/or enable:

- With additional funding from the Department of Energy (DOE), operations and maintenance of the KPNO Mayall 4-m facility on Kitt Peak during Q1, transitioning into installation of the Dark Energy Spectroscopic Instrument (DESI) during the rest of the year (AST-1557260)
- With additional funding from the other WIYN institutions, operations and maintenance of the KPNO WIYN 3.5-m facility on Kitt Peak (AST-1559596)
- With additional funding from NASA, complete facility preparation and install the NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy (NEID) instrument at the WIYN 3.5-m (AST-1559596)
- Year 5 of a Thirty Meter Telescope (TMT) community engagement program, executed on behalf of a cooperative agreement between NSF and the Thirty Meter Telescope International Observatory (TIO) (AST-1241529)
- A two-week data science school in La Serena focused on applied tools for astroinformatics, biomedical informatics, and other data-driven sciences (AST-1637359)
- Additional data services: development and/or validation of Data Lab science analysis workflows and continued development to extend ANTARES to the LSST scale (AST-0950945)
- Continued modernization and extension of mountaintop public visitor centers in Arizona and Chile (AST-0950945)

On a cost-recovery basis, NOAO also plans to deliver and/or enable:

- Operations and maintenance of the SMARTS consortium small telescope constellation on Cerro Tololo
- Physical plant and IT infrastructure operation and maintenance services for tenant and/or partner observatories on Kitt Peak, Cerro Pachón, Cerro Tololo, and Cerro Las Campanas as well as within shared office and support facility compounds in Tucson, Arizona, and La Serena, Chile
1 Priorities, Organization, and Key Management for FY18

1.1 Priorities

The highest-priority NOAO activities for FY18 are shown in Table 1. These priorities were established after consideration of ongoing external commitments and the eight strategic initiatives defined in the NOAO Strategic Plan (2015, hereafter SP15) as well as agency-level programmatic and financial guidance. For reference, the SP15 strategic initiatives are repeated here:

1. Provide and continuously improve world-leading mountain research infrastructure in Arizona and Chile (i.e., telescopes, instruments, and services)
2. Lead and/or enable US OIR System optimization as directed by the NSF
3. Provide premier survey data products enabled by NOAO and its partners
4. Provide premier data services for the discovery, exploration, and analysis of those data products
5. Engage in Large Synoptic Survey Telescope (LSST) operations and deploy community research support services
6. Engage in Giant Segmented Mirror Telescope (GSMT) (a.k.a. Extremely Large Telescope, ELT) operations and deploy GSMT community research support services
7. Lead or enable strategic discussions for the era beyond LSST and GSMT
8. Engage the public in the NOAO science enterprise

Table 1

<table>
<thead>
<tr>
<th>SP15 Strategic Initiative</th>
<th>POP18 Section</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3</td>
<td>3.2</td>
<td>Mayall/DESI installation</td>
</tr>
<tr>
<td>1, 3</td>
<td>3.3</td>
<td>WIYN/NEID installation</td>
</tr>
<tr>
<td>1, 3</td>
<td>2.2</td>
<td>Blanco/DECam operations (for Dark Energy Survey &amp; community users)</td>
</tr>
<tr>
<td>4, 5</td>
<td>4.4</td>
<td>Data Lab operations</td>
</tr>
<tr>
<td>2, 4, 5</td>
<td>4.5</td>
<td>ANTARES event broker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Processing publicly available event streams with simple filters</td>
</tr>
<tr>
<td>3</td>
<td>DES: 2.2</td>
<td>DESI targeting survey data products, from Beijing-Arizona Sky Survey (BASS), Mayall z-band Legacy Survey (MzLS), and DECam Legacy Survey (DECaLS)</td>
</tr>
<tr>
<td></td>
<td>MzLS: 3.2</td>
<td>Dark Energy Survey (DES) Public Data Release 1</td>
</tr>
<tr>
<td></td>
<td>DECaLS: 4.4</td>
<td>NOAO Source Catalog</td>
</tr>
<tr>
<td>2</td>
<td>4.1, 4.5</td>
<td>OIR System Optimization program (with focus on development of end-to-end LSST follow-up observing system)</td>
</tr>
<tr>
<td>6</td>
<td>4.3</td>
<td>TMT Liaison</td>
</tr>
<tr>
<td>7</td>
<td>5.1</td>
<td>NOAO Director’s Office</td>
</tr>
<tr>
<td>8</td>
<td>5.3</td>
<td>Education and Public Outreach</td>
</tr>
</tbody>
</table>
Installation of the Dark Energy Spectroscopic Instrument (DESI) at the KPNO Mayall 4-m and NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy (NEID) at the KPNO WIYN 3.5-m have highest priority due to time-critical commitments to external project and/or science collaborations. Such modernization of mountain-based observational research infrastructure lies at the heart of SP15-1. Furthermore, thanks to well-defined surveys, DESI will enable the delivery of excellent data sets well suited for community research (SP15-3).

Operation of the Dark Energy Camera on the CTIO Blanco 4-m (Blanco/DECam) comes next, in recognition of its high scientific productivity as well as our obligations to the Dark Energy Survey (DES) Collaboration and other survey projects including the DECam Legacy Survey. Modern instrumentation (SP15-1) enabling excellent data products (SP15-3) is central to the ongoing NOAO program.

The NOAO Data Lab Public Release 2 follows in priority. The Data Lab lies at the center of the NOAO data product and services thrust (SP15-3 and SP15-4) initiated during FY16 as well as being a pathfinder for similar services required in the LSST era (SP15-5). Within the Data Lab environment, various high-value data sets will be released (or re-released) as well as relevant data product and services documentation. Of particular note:

- Dark Energy Survey (DES) Public Release 1, which will contain co-added images and associated source catalogs based the DES Y1 – Y3 observations;
- Legacy Survey Data Release 5+, which will contain the latest co-added images and associated source of the ongoing DES targeting survey projects Beijing-Arizona Sky Survey (BASS), DECam Legacy Survey (DECaLS), and Mayall Legacy Survey (MzLS).

The Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES) project will continue its design and development cycle with the delivery of a fully functioning system capable of processing live, public alert streams with simple filters. In the context of that release, NOAO will engage with the time-domain research community in a variety of ways in order to refine science-driven requirements for the production version of ANTARES at the LSST scale. Time-domain services and event brokers (SP15-4) were identified as high-priority community needs in the 2015 NRC OIR System Optimization Study report (SP15-2), particularly on the LSST scale (SP15-5).

Building on the 2015 NRC OIR System Optimization Study report, the NSF conveyed a set of implementation directives to NOAO. Some of those directives can be satisfied by activities already funded by the NSF (e.g., ANTARES event broker development) or other sources (e.g., the Kavli Foundation–sponsored 2016 community workshop jointly organized by NOAO and LSST). Other directives will be supported by new, supplementary funding received recently from NSF. During FY18, NOAO will be ramping up those activities.

Finally, NOAO will organize or co-organize at least three significant events: a public town hall at the January 2018 AAS meeting, a workshop on all-sky surveys in the 2020s, and a workshop on community-driven NOAO development projects.
The top-level NOAO organization chart for FY18 is shown in the above figure. Top-level programs are shown in the second column and major sub-activities are shown in the third column. Names of NOAO leadership team and key program managers are shown in parentheses.
2  NOAO South

The NOAO South (NS) division is responsible for operations, maintenance, and development for all NOAO activities in Chile. For program management purposes, these activities are separated into the following programs:

The Cerro Tololo Inter-American Observatory (CTIO) is a major activity within NOAO South. CTIO operates the Blanco 4-m telescope on Cerro Tololo and the SOAR 4.1-m telescope on Cerro Pachón. On a cost-recovery basis, CTIO also provides support to the Small and Moderate Aperture Research Telescope System (SMARTS) consortium, which operates the 0.9-m, 1.0-m, 1.3-m, and 1.5-m telescopes on Cerro Tololo. In addition, CTIO serves as host for 11 tenant facilities operating a total of more than 20 telescopes of various apertures. For programmatic purposes, CTIO activities are separated into four major work packages: Blanco Telescope Operations, SOAR Telescope Operations, Small Telescopes, and NS Engineering & Technical Services.

The NOAO South Facilities Operations (NS FO) division is another distinct activity. It is responsible for the operation and maintenance of the physical infrastructure shared by all the facilities hosted by the AURA Observatory (AURA-O) in Chile. This includes support buildings, housing, and miscellaneous other facilities in La Serena and on Cerro Tololo and Cerro Pachón, and critical supporting infrastructure such as mountain access roads, electric power lines, and the water systems. NS FO also provides services such as meals, lodging, and transport to all of the facilities operating on Cerro Pachón and Cerro Tololo. NS FO has direct performance and financial impact on the execution of mission-critical activities of all of the observatories at the sites, including CTIO, SOAR, Gemini, and most recently, LSST. All these services are performed on a full-cost-recovery basis.

The NOAO South Computer Infrastructure Services (NS CIS) group is the final distinct activity. It provides information technology (IT) support for NOAO personnel and facilities in Chile and supports the backbone communications and network infrastructure for all AURA-O facilities in Chile on a cost-recovery basis.
2.1 NS Associate Director’s Office

Program Overview

The NOAO South Associate Director’s Office (ADO) coordinates all activities of NOAO in Chile, including those on both Cerro Tololo and Cerro Pachón, and at the base facility in La Serena. This program includes the associate director (AD) and deputy director for NOAO South and administrative support for the ADO and observatory operations in Chile. The core of the NOAO South Safety Program is also included here, i.e., some of the time of the NOAO South safety engineer, who reports directly to the associate director of NOAO South. The costs directly associated with safety support to the various projects and programs are allocated in the corresponding work packages.

This program also includes activities that support scientific staff research and improve the scientific environment at NOAO South, including mentoring and in-house career development activities, support for scientific colloquia by visiting astronomers, and operation of the Olin Eggen library in La Serena.

The expansion of the La Serena headquarters complex required to serve current and future needs created by the ramp-up of LSST operations will continue to be a major activity in FY18. Rather than construct a separate stand-alone building, AURA, LSST, and NOAO are executing a joint project, including both remodeling of existing space and new construction, to provide the office and laboratory space needed to house their combined staff. The new facilities will include a modern petabyte-scale data center, one of the largest in South America, to accommodate the Chile node of the LSST data archive. The new building also features a lobby and exhibition hall, which will be used by EPO staff to showcase scientific and technical highlights from the different programs.

The remodeling and renovation of the existing buildings, to bring them to a standard similar to that of the new construction, began in March 2017 and is expected to be completed in FY18 Q3. The renovation includes the installation of a modern distributed heating and A/C system and upgrade of the data and VoIP networks. The construction of the new office wing and data center, and a major upgrade of the supporting power and communications infrastructure, will proceed in parallel; it is expected to begin in FY18 Q1 and to be completed in FY19 Q3. In the final phase, to be carried out once the data center is complete and operational, the existing NOAO South computer room will be repurposed to create a conference center, including a larger main conference room.

During Q4, the NS safety engineer will organize and carry out a review by an external panel of safety experts of workplace safety and procedures at all the facilities operated by NOAO South. This will include a walk-through inspection of the Blanco, SOAR, and SMARTS telescopes and the facilities (kitchens, dormitories, etc.) operated by NS FO on the mountains.
Milestones

2.1.1. Carry out an external review of workplace safety and procedures at all facilities operated by NOAO South. Due Date: 30 September 2018

Budget Summary

Table 2.1. Summary of NS Associate Director’s Office program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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<td>Director’s Office</td>
<td>2.5</td>
<td>379,257</td>
<td>218,281</td>
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<td>NOAO-S Associate Director’s Office</td>
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<td>Library</td>
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<td>Visitor Center</td>
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<td>Site Protection</td>
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<td>Scientist Research South</td>
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<td>NS Facilities Direct Support</td>
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<td>224,320</td>
<td>224,320</td>
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<td>NOAO-S LS Facilities &amp; Utilities</td>
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<td>136,661</td>
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<td>La Serena Vehicle Fleet</td>
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<td>30,521</td>
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<td>NS Academic Affairs</td>
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<td>NS Science Staff Support</td>
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<tr>
<td>SPRF South</td>
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<td>-</td>
<td>90,401</td>
<td>90,401</td>
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<td>90,401</td>
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<td>Total</td>
<td>3.3</td>
<td>421,255</td>
<td>695,281</td>
<td>1,116,536</td>
<td>171,061</td>
<td>945,475</td>
</tr>
</tbody>
</table>

Work Packages

NOAO-S Associate Director’s Office

The NOAO South Associate Director’s Office coordinates all activities of NOAO in Chile, including the activities on both Cerro Tololo and Cerro Pachón. This work package includes the associate director and deputy director for NOAO South, administrative support for the Associate Director’s Office and observatory operations in Chile, and supplies for the La Serena offices.

NOAO-S Safety

The core of the NOAO South Safety Program is included in this work package, i.e., some of the time of the NOAO South safety engineer, who reports directly to the Associate Director of NOAO South, additional training of the safety engineer, and some of the cost of safety equipment and supplies. The costs directly associated with safety support to the various projects and programs are allocated in the corresponding work packages.
Library
This work package includes all costs for the Olin Eggen library in La Serena (acquisitions, periodicals). It also includes non-base revenue from Gemini’s contribution to library operation.

Visitor Center
This work package includes the cost of operating the visitor center on Cerro Tololo, which provides an introductory talk and a tour of the Blanco 4-m and 1.5-m telescopes for the general public, free of charge. Costs include partial salary and shuttle transport costs for the tour guides. Non-base revenue comes from payment to recover the additional cost of special tours, mostly organized for cruise ship companies.

Site Protection
This work package covers the costs of efforts to educate the public and governments on the impacts of light pollution, as well as support for the enforcement and improvement of government rules and regulations regarding light pollution. This is primarily achieved through NOAO’s contribution to the Oficina de Protección de la Calidad del Cielo del Norte de Chile (OPCC), an organization created to protect the night skies of northern Chile with participation and funding from all the major observatories in Chile.

Scientist Research South
Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff who charge time to the NS Associate Director’s Office.

NOAO-S LS Facilities & Utilities
This work package includes the cost of metered utilities, including electricity, telephone, natural gas, and water, for the La Serena offices, laboratories, and workshops.

LS Building Maintenance
This work package includes base funding to cover the cost of maintenance and minor modification work for the La Serena offices, laboratories, and workshops. This work is carried out by NOAO South Facilities Operations (NS FO), or through sub-contracts managed by them. Payments for work by NS FO appear as a debit against the LS Building Maintenance account, offset by a corresponding credit in the appropriate NS FO account.

La Serena Vehicle Fleet
This work package includes base funding to cover the cost of maintaining and operating the light vehicles used by the La Serena–based staff.
NS Science Staff Support

This work package supports a variety of academic affairs activities in Chile including a colloquia series, scientific visitors, page charges, office supplies, etc. It also includes international travel costs and registration fees to attend conferences and scientific meetings in representation of the observatory as part of a staff member’s functional duties. The costs of recruitment and relocation for new members of the scientific staff are also included here.

SPRF South

Science Personal Research Fund. Individual research support funds allocated to each NOAO scientific staff member. For FY18, full-time astronomer-track and scientist-track staff at NOAO South are allocated $6,000 per person.

2.2 Blanco Telescope Operations

Program Overview

This program comprises all activities required for the scientific and technical operation and maintenance of the Victor M. Blanco 4-m telescope on Cerro Tololo. It also includes projects to improve the telescope and enhance its instrumentation.

In FY18, Blanco Telescope Operations will include support of the fifth season of the Dark Energy Survey (DES) scheduled for the equivalent of 105 nights from 15 August 2017 through 15 February 2018. It will also include support for the DECam Legacy Survey (DECaLS), which has been granted a total of 35 nights during FY18. In support of these surveys, as well as the use of DECam by the community, NOAO South scientific, engineering, and technical staff will continue to monitor performance and carry out preventative maintenance of DECam, its associated computer systems, and key supporting infrastructure. Specific tasks planned for FY18 include replacing the circulation pump and servicing the cold heads for its cooling system, preventative maintenance of the filter change mechanism, and replacing hard disks in the raid array used for short-term data storage.

Another major activity, planned for FY18 Q3, will be recoating the telescope primary mirror. We will also carry out two preventative maintenance tasks on the dome shutter, which were originally planned for FY17 but had to be postponed due to staff departures. The gearbox for the upper shutter drive mechanism will be evaluated to determine if it needs to be replaced, as was done during a similar upgrade of the KPNO Mayall 4-m telescope shutter, and a design study will be completed for improvements to the emergency brake system for the dome shutter, capitalizing on experience gained at the Australian Astronomical Observatory during an upgrade of its similar shutter.

Milestones

2.2.1. Complete the fifth season of the Dark Energy Survey (DES), which runs from mid-August 2017 through early February 2018. Due Date: 1 March 2018
2.2.2. Carry out the annual preventative maintenance of the DECam cooling system and of the filter change mechanism. Due Date: 30 June 2018

2.2.3. Realuminize the Blanco primary mirror. Due Date: 31 July 2018

2.2.4. Evaluate the drive mechanism for the upper shutter of the Blanco dome, develop a plan for its refurbishment/replacement, and hold a design review. (This milestone was transferred from FY17 Milestone 2.2.4.) Due Date: 31 March 2018

2.2.5. Complete development of the preliminary design for the upgrade of the Blanco shutter brake system and hold a design review. (This milestone was transferred from FY 17 Milestone 2.2.6.) Due Date: 30 September 2018

Budget Summary

Table 2.2. Summary of Blanco Telescope Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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<tr>
<td>Blanco Telescope Operations</td>
<td>29.1</td>
<td>2,284,303</td>
<td>1,886,060</td>
<td>4,170,363</td>
<td>5,000</td>
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<td>TelOps Home</td>
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<td>765,446</td>
<td>846,464</td>
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<td>Blanco Telescope Operations</td>
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<td>649,514</td>
<td>973,702</td>
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<td>Blanco Telescope Maintenance</td>
<td>14.7</td>
<td>1,006,718</td>
<td>268,996</td>
<td>1,275,714</td>
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<tr>
<td>Blanco Telescope Improvements</td>
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<td>124,402</td>
<td>466,729</td>
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<td>466,729</td>
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<tr>
<td>Site Monitoring</td>
<td>0.4</td>
<td>40,239</td>
<td>6,022</td>
<td>46,261</td>
<td>5,000</td>
<td>41,261</td>
</tr>
<tr>
<td>Blanco Science Staff Support</td>
<td>3.3</td>
<td>489,813</td>
<td>71,680</td>
<td>561,493</td>
<td></td>
<td>561,493</td>
</tr>
<tr>
<td>CTIO Scientist Research</td>
<td>2.3</td>
<td>317,766</td>
<td>36,660</td>
<td>354,426</td>
<td></td>
<td>354,426</td>
</tr>
<tr>
<td>Total</td>
<td>32.4</td>
<td>2,641,781</td>
<td>1,982,300</td>
<td>4,624,081</td>
<td>5,000</td>
<td>4,619,081</td>
</tr>
</tbody>
</table>

Work Packages

TelOps Home

This is the “home account” for the Telescope Operations group (TelOps) group based on Cerro Tololo. Labor costs include that part of the time of the TelOps manager spent on managing the group plus the time of an administrative assistant. Non-labor costs include meals, lodging, and shuttle transportation for all members of the TelOps group, fuel and maintenance costs of group vehicles, and miscellaneous supplies and services. The time of the NS safety engineer expended on activities on Tololo and safety supplies (personal protective equipment and foul weather gear) for the TelOps staff are also included.

Blanco Telescope Operations

This work package includes all costs associated with nighttime operation of the Blanco 4-m telescope and its instruments. Labor costs include the effort of telescope operators and
observer support staff. Non-labor costs include supplies, services, and utilities (notably electric power) required for operation of the telescope and facility.

**Blanco Telescope Maintenance**

This work package covers all costs associated with preventative and corrective maintenance of the Blanco 4-m telescope. Labor costs include the effort of mountain electronics staff and telescope mechanics drawn from the TelOps group and engineering and technical support drawn from the NS Engineering & Technical Services (ETS) and NS Computer Infrastructure Services (CIS) groups. Non-labor costs include the services, consumable spare parts, and maintenance contracts required for maintenance of the telescope and facility.

**Blanco Telescope Improvements**

This work package covers all costs associated with projects to improve the performance of the Blanco 4-m telescope and enhance its instrument suite.

**Site Monitoring**

This work package covers all costs for the operation and maintenance of site monitoring equipment including weather stations, seeing monitors, all-sky cameras, and atmospheric transmission monitors.

**Blanco Science Staff Support**

This package covers all costs associated with science staff support of the Blanco telescope. Labor costs include the effort of the telescope scientist, who has overall responsibility for scientific oversight and planning of activities related to the telescope, the instrument scientists responsible for each of the major instruments, and other members of the scientific staff who provide support to visiting astronomers before, during, and after an observing run. Non-labor costs include meals and lodging on Tololo and shuttle transportation for the scientific staff when performing support duties.

**CTIO Science Research**

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to Blanco Telescope Operations.

**CTIO User Support**

The CTIO User Support Office provides visiting observers, at all telescopes in Chile to which astronomers have access through NOAO, with pre– and post–observing run logistics support, including assistance with international travel, dormitory, and meal arrangements. This work package includes travel costs for graduate students doing approved thesis research and funding to cover costs for Chilean observers, per the AURA agreement with the Chilean community. Recording and calculation of statistical data are also covered.
2.3 SOAR Telescope Operations

Program Overview

The Cerro Tololo Inter-American Observatory (CTIO) operates the SOAR 4.1-m telescope on Cerro Pachón on behalf of the Southern Astrophysical Research (SOAR) consortium. NOAO is a partner in the SOAR consortium; the other members are the nation of Brazil, the University of North Carolina at Chapel Hill (UNC), and Michigan State University. NOAO contributes the effort needed for operation and routine maintenance of the telescope and its instruments. This effort is primarily provided by the mountain-based Telescope Operations (TelOps) group and by the scientific staff, with a small amount of additional engineering and technical support provided by the La Serena–based Engineering & Technical Services (NS ETS) and Computer Infrastructure Services (NS CIS) groups. The value of this effort, calculated on a full-cost-recovery basis, represents NOAO’s base-funded contribution to the SOAR consortium under the terms of the SOAR agreement. In exchange, NOAO obtains 30% of the time on SOAR for use by the US open-access community. CTIO also provides effort for repair and improvement projects, paid for on a full-cost-recovery basis using SOAR consortium funds.

The primary maintenance activity at SOAR during FY18 will be recoating of the primary, secondary, and tertiary mirrors, scheduled for November 2017.

SOAR development activities have two primary objectives:

- A general renewal of aging critical systems within the facility. Most of the facility control systems are obsolescent (approaching 15 years old, with even older technology). In undertaking this work, ways in which performance or reliability can be enhanced using technology that is more modern are also considered.

- Completion of the installation and commissioning of the SOAR instrument suite. The milestones listed below address one or both of these objectives.

Testing of a prototype wavefront sensing guide camera will also begin during FY18 Q2, accomplishing the next step in the project to enable closed-loop control of low-order aberrations (focus and astigmatism). The Astronomical Research using the Cornell InfraRed Imaging Spectrograph (ARCoRIS) will be reconfigured to allow its use on SOAR instead of Blanco. This involves both changes to the internal opto-mechanics of the instrument, to be carried out under contract by Cornell (the original builders), and to the external mechanical interfaces, which will be performed by NS ETS staff. As much preparatory work will be done as possible before starting the internal modifications in FY18 Q3, so as to minimize the time the instrument cannot be used on either telescope. The project to install the SOAR Telescope Echelle Spectrograph (STELES) on SOAR, begun in FY17, will also be completed during FY18 Q2. Finally, a project to upgrade the telescope mount control system will enter its first major phase during FY18, with the design and start of construction of a new sensor control system. The overall project will extend past FY18. This effort should be thought of as the low-level counterpart of the telescope control system upgrade that was completed in early FY17.
Milestones

2.3.1. Reccoat the SOAR primary, secondary, and tertiary mirrors. Due Date: 31 December 2017

2.3.2. Complete fabrication and laboratory testing of the prototype wavefront sensing guider ready for the start of testing at the telescope. Due Date: 31 March 2018

2.3.3. Complete all tasks preparatory to the start of modification of ARCoIRIS for use at SOAR. Due Date: 31 March 2018

2.3.4. Complete modification of ARCoIRIS so that it is ready for the start of commissioning on the SOAR telescope. Due Date: 30 September 2018

Budget Summary

Table 2.3. Summary of SOAR Telescope Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NOAO South (NS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOAR Telescope Operations</strong></td>
<td>22.5</td>
<td>1,736,924</td>
<td>546,714</td>
<td>2,283,638</td>
<td>370,397</td>
<td>1,913,241</td>
</tr>
<tr>
<td><strong>SOAR Telescope Operations &amp; Maintenance</strong></td>
<td>14.9</td>
<td>1,023,872</td>
<td>485,461</td>
<td>1,509,333</td>
<td>-</td>
<td>1,509,333</td>
</tr>
<tr>
<td><strong>SOAR Telescope Scientist</strong></td>
<td>1.0</td>
<td>124,922</td>
<td>19,094</td>
<td>144,016</td>
<td>-</td>
<td>144,016</td>
</tr>
<tr>
<td><strong>SOAR Science Support by NS Scientific Staff</strong></td>
<td>1.7</td>
<td>220,077</td>
<td>42,159</td>
<td>262,236</td>
<td>-</td>
<td>262,236</td>
</tr>
<tr>
<td><strong>SOAR Telescope Improvements</strong></td>
<td>4.9</td>
<td>368,053</td>
<td>-</td>
<td>368,053</td>
<td>370,397</td>
<td>(2,344)</td>
</tr>
<tr>
<td><strong>Sci Staff Research Time</strong></td>
<td>1.1</td>
<td>135,323</td>
<td>13,368</td>
<td>148,691</td>
<td>-</td>
<td>148,691</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23.6</td>
<td>1,872,247</td>
<td>560,082</td>
<td>2,432,329</td>
<td>370,397</td>
<td>2,061,932</td>
</tr>
</tbody>
</table>

Work Packages

**SOAR Telescope Operations & Maintenance**

This work package includes costs, primarily for labor, incurred by NOAO in the operation and maintenance of the SOAR 4.1-m telescope and its instruments. The value of this effort, calculated on a full-cost-recovery basis, represents NOAO’s base-funded contribution to the SOAR consortium under the terms of the SOAR agreement. Labor costs include the SOAR director and administrative assistant; the effort of the mountain-based TelOps group, including telescope operators, observer support, and technical staff who perform routine maintenance and first-tier diagnosis and resolution of problems; and engineering and technical support for operations and maintenance provided by the La Serena–based NS ETS and NS CIS groups. The only non-payroll expense included is the “mountain share fee,” which recovers the cost of maintaining shared infrastructure on Cerro Pachón such as access roads and power lines and providing emergency medical service by NOAO South Facilities Operations (NS FO). The remaining non-labor costs for operation of the SOAR telescope,
including payments for other services purchased from NS FO and the cost of utilities, supplies, and equipment, are paid for with SOAR consortium funds.

**SOAR Telescope Scientist**
This work package includes costs associated with the SOAR telescope scientist, the value of which is calculated on a full-cost-recovery basis from part of NOAO’s contribution under the SOAR agreement. Costs consist of labor charges for the functional and research time of the telescope scientist and non-labor costs of meals, lodging, and shuttle transportation required in performance of the position duties.

**SOAR Science Support by NS Scientific Staff**
This package covers costs associated with science support provided to the SOAR telescope by members of the CTIO scientific staff. Labor costs include the functional time of scientific staff used to (a) support NOAO users of the SOAR telescope and (b) meet NOAO’s commitment to provide scientist effort under the terms of the SOAR agreement. The latter includes the effort of the staff who serve as instrument scientists for those instruments for which NOAO has responsibility or are supporting SOAR development efforts. This package also includes the time of the NS associate director and deputy associate director and of scientific staff spent on SOAR governance (membership on SOAR Board and Science Advisory Committee).

**SOAR Telescope Improvements**
This work package tracks costs associated with projects to improve the performance of the SOAR 4.1-m telescope and its instruments requested by and coordinated with the SOAR director and paid for on a full-cost-recovery basis. SOAR relies upon the NS ETS group to execute significant upgrade projects and to support the installation, modification, and commissioning of instrumentation and other systems that are delivered by other SOAR partners.

**Scientific Staff Research Time**
Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to SOAR Telescope Operations.
2.4 NS Small Telescopes

Program Overview

NOAO South provides operational, technical, and logistical support to the small telescopes and other tenant facilities on Cerro Tololo. The Small and Moderate Aperture Research Telescope System (SMARTS) consortium operates the 0.9-m, 1.0-m, 1.3-m, and 1.5-m telescopes on Cerro Tololo. NOAO is a member of this consortium, providing community access to these small telescopes. In addition, CTIO serves as host for 11 tenant facilities operating a total of more than 20 telescopes of various apertures. The NS Small Telescopes program manages these activities, which are entirely paid for by non-base funds on a full-cost-recovery basis.

Milestones

There are no milestones for this work package.

Budget Summary

Table 2.4. Summary of NS Small Telescopes program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Telescope Operations</td>
<td>3.1</td>
<td>135,986</td>
<td>248,345</td>
<td>384,330</td>
<td>384,330</td>
<td>-</td>
</tr>
<tr>
<td>SMARTS Operations Direct Costs</td>
<td>2.0</td>
<td>81,509</td>
<td>248,345</td>
<td>329,853</td>
<td>329,853</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>3.1</td>
<td>135,986</td>
<td>248,345</td>
<td>384,330</td>
<td>384,330</td>
<td>-</td>
</tr>
</tbody>
</table>

Work Packages

SMARTS Operations Direct Costs

This work package includes all costs associated with the operation and maintenance of the SMARTS telescopes. All these costs are fully recovered from the SMARTS consortium. These include labor costs for the telescope operators / service observers who operate the telescopes and a small amount of technical support for their maintenance provided by CTIO TelOps staff, as well as non-labor costs such as meals, lodging, transport, utilities, and cryogens. Scientific support for NOAO visiting astronomers using the SMARTS telescopes is covered by base funds.
2.5 NS Engineering & Technical Services

Program Overview

The NS Engineering & Technical Services (NS ETS) group contributes engineering expertise and precision mechanical and electronic design and fabrication services spanning the full range of engineering disciplines, on an as-needed basis, to the other divisions of NOAO South. This depth and breadth of technical experience underpins preventative and corrective maintenance activities for the Blanco and SOAR telescopes and allows the development of small- and medium-scale projects to improve these telescopes. The group also participates in the design, fabrication, and installation of new instruments for SOAR and Blanco and helps maintain and enhance them once in operation. NS ETS increasingly provides engineering and technical support to the NS Facilities Operations program. A small but steady level of effort is also sold, on a full-cost-recovery basis, to Gemini, LSST, the SMARTS consortium, and other tenant facilities to support their activities.

The NS ETS staff is divided into four groups: computer applications, mechanics, electronics, and optics. NS ETS is based in La Serena, where facilities include a well-equipped modern machine shop, electronics and optics laboratories, and a clean room for work on detectors and small opto-mechanical assemblies. NS ETS staff regularly travel to the telescopes as needed where they work closely with the Telescope Operations (TelOps) group. The internal Advisory Committee on Technical Resources (ACTR) provides scientific oversight for NS ETS and advises the associate director for NOAO South on the prioritization of their effort.

The bulk of the effort of the NS ETS staff is employed for operational, maintenance, and improvement activities for the Blanco and SOAR telescopes and is described and accounted for under the corresponding work packages.

During FY18, NS ETS staff will complete two internal development projects. Laboratory testing of prototype control electronics for the axial actuators of the SOAR primary mirror will be completed during FY18 Q1. This will lead to a project to produce the new hardware in quantity and retrofit it at the telescope, allowing faster adjustment of mirror figure. The detector performance-monitoring tool is software that can be used to continuously monitor the health and performance of the CCD detectors in use on the telescopes operated by NOAO-S. This software will be deployed during FY18 Q2, and TelOps staff will be trained to use it, fostering a predictive, rather than reactive, response to detector problems and performance issues.

Milestones

2.5.1. Design and prototype an upgrade to the control electronics for the axial actuators of the SOAR primary mirror. Due Date: 31 December 2017

2.5.2. Deploy the detector performance-monitoring tool and train TelOps staff in its use. Due Date: 31 March 2018
Budget Summary

Table 2.5. Summary of NS Engineering & Technical Services program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETS General Operations NC5200000</td>
<td>3.1</td>
<td>264,989</td>
<td>273,233</td>
<td>538,222</td>
<td>-</td>
<td>538,221</td>
</tr>
<tr>
<td>LMCM Operations</td>
<td>0.2</td>
<td>6,882</td>
<td>-</td>
<td>6,882</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>3.3</td>
<td>271,871</td>
<td>273,233</td>
<td>545,103</td>
<td>6,882</td>
<td>538,221</td>
</tr>
</tbody>
</table>

Work Packages

ETS General Operations NC5200000

This work package includes

- all costs associated with management of the engineering and technical groups as well as the maintenance of the NS ETS working environment and operations. This includes time spent on management of the group by the head of program for ETS and the group leads of the computer applications, mechanics, electronics, and optics groups.
- management and maintenance of laboratories, including the optics lab, the detector lab, and clean room
- management of the instrument shop
- the effort for general documentation, as well as maintenance and cleaning of ETS equipment
- general laboratory supplies and materials
- software licenses and limited computer upgrades
- training for the NS ETS staff and recruitment costs

LMCM Operations

This work package covers the costs of operation and maintenance of the Laser Mask Cutting Machine (LMCM) that is used to prepare multi-slit masks for spectrographs on the Blanco, SOAR, Gemini-N, and Gemini-S telescopes. The cost of mask fabrication, calculated on a full-cost-recovery basis, is charged to the requesting organization. The cost of regular preventative maintenance of the machine is shared between users in proportion to the number of masks cut.
2.6 NS Facilities Operations

Program Overview

The NOAO South Facilities Operations (NS FO) program is responsible for operations, maintenance, and long-term stewardship of the physical infrastructure shared by programs hosted by AURA Observatory (AURA-O) in Chile, in La Serena, and on Cerro Tololo and Cerro Pachón. The program also provides and oversees a set of services available to the programs, such as restaurant and hotel services, medical emergency services, and security services. The activities of NS FO support all of the programs hosted by AURA in Chile, including CTIO, SOAR, Gemini, and most recently, LSST. NS FO has direct performance and financial impact on the execution of mission-critical activities of all of the observatories at the sites.

Costs are recovered through share charges, census charges, or per-use charges paid by the programs. These fees are paid by all programs that make use of FO services and are reflected as non-base revenue in this work package. In this respect NS FO is no different from any other program. So, for example, the costs of services in support of the Blanco telescope are expensed against base funds in the Blanco Telescope Operations work package, with corresponding credits reflected as non-base revenue in this work package.

The program’s mission is to provide cost-effective services to ensure safe and uninterrupted science operation for the programs and tenants at the AURA-O sites in Chile. The AURA-O property near Vicuña consists of 33,000 hectares of land with more than 100 km of unpaved roads, including the main road (50 km), secondary roads (approx. 10 km), and service roads (approx. 50 km). There are five large dormitory buildings, five houses, and several other buildings serving as workshops, offices, garage, and warehouses. In addition to maintaining the mountain roads and buildings, NS FO maintains the infrastructure to provide electricity, gas, water, and the radio communication on both mountaintops. This includes maintenance of more than 30 km of 23 kV power lines and maintenance of the Tololo power house. The water system includes pumps, storage, potable water treatment, transportation, and sewage. NS FO also provides restaurant, hotel and janitorial services, emergency medical services, and guard services.

The AURA compound in La Serena consists of 13.52 hectares of land (the recinto), which includes four office/laboratory buildings, two maintenance shop buildings, a warehouse, and a dormitory facility for visitors. NS FO maintains the common infrastructure on the AURA La Serena compound, which include a water system with a well, pump, storage tank, treatment, and distribution; sewage piping (for delivery to the municipal sewer system); propane gas tanks and piping; electrical distribution, transformers, and back-up generator; communications infrastructure; paved roads; and landscaped areas.

Major upgrade and improvement projects are included in the annual planning. The main project for FY18 is the expansion and remodeling of the kitchen / restaurant facilities on Cerro Pachón to be able to provide services for not only the existing programs on
Cerro Pachón (Gemini South and the SOAR telescope) but also LSST. In regular operations, the LSST day crew is expected to be on the order of 25 persons, increasing the usage of the Pachón dining facilities by 50%. Other projects include installation of extra guardrails and upgrades on the water supply system on the mountain.

**Milestones**

1. **Upgrade south wing of 20-unidades to be used during LSST construction.** Due Date: 31 December 2017
2. **Upgrade water supply system at guard house Control Puerta.** Due Date: 31 December 2017
3. **Replace 500-liter petrol tank serving generators on Cerro Tololo with a 3,000-liter tank.** Due Date: 31 March 2018
4. **Complete the upgrade of the Cerro Tololo power house (install protection cells).** Due Date: 30 June 2018
5. **Complete upgrade of the heating system in hotel on Cerro Pachón.** Due Date: 30 September 2018
6. **Complete the expansion of the kitchen and dining room facilities on Cerro Pachón.** Due Date: 30 September 2018

**Budget Summary**

*Table 2.6. Summary of NS Facilities Operations program budget*

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities Operations General Overhead</td>
<td>4.4</td>
<td>302,287</td>
<td>303,784</td>
<td>606,070</td>
<td>606,070</td>
<td>-</td>
</tr>
<tr>
<td>Infrastructure on Mountains and in La Serena</td>
<td>15.1</td>
<td>623,919</td>
<td>804,592</td>
<td>1,428,511</td>
<td>1,428,511</td>
<td>-</td>
</tr>
<tr>
<td>Services on Mountains and in La Serena</td>
<td>22.7</td>
<td>752,888</td>
<td>1,585,995</td>
<td>2,338,884</td>
<td>2,338,884</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42.2</strong></td>
<td><strong>1,679,094</strong></td>
<td><strong>2,694,371</strong></td>
<td><strong>4,373,465</strong></td>
<td><strong>4,373,465</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

**Work Packages**

**Facilities Operations General Overhead**

This work package covers general overhead for NS FO and management of the program, including business analytics. It also includes general management of mountain operations, support by the NS safety manager, and funds for expected severance payments during FY18.
Infrastructure on Mountains and in La Serena

This work package covers the shared costs of maintaining and operating all AURA-O common infrastructures, both on the mountaintops and in the La Serena compound. It includes road maintenance, power line maintenance, power generation, water and sewage system maintenance, and communication and telephone system maintenance. It also includes the garage and building maintenance and several upgrade and maintenance projects, such as repairing the roof of the Round Office Building on Cerro Tololo.

Services on Mountains and in La Serena

This work package covers the shared costs for all services provided to the programs hosted by AURA-O in Chile. This includes the reception, security both on the La Serena compound and on the mountain facilities, maintenance of the common areas on the La Serena compound, hotel and restaurant services on the mountains, hotel services on the La Serena compound, janitorial services on both locations, and emergency medical services on the mountain facilities.

2.7 NS Computer Infrastructure Services

Program Overview

The NOAO South Computer Infrastructure Services (NS CIS) group provides information technology (IT) support for NOAO personnel and facilities in Chile and supports the backbone communications and network infrastructure for all AURA-O facilities in Chile on a cost-recovery basis. Support is included for servers and the desktop computers for all NOAO South staff. In support of all facilities, including Gemini, SOAR, and the tenants, NS CIS provides the network infrastructure support necessary to maintain reliable connectivity between the mountaintops (Cerro Tololo and Cerro Pachón) and La Serena as well as between La Serena and the rest of the world. The NS CIS group also provides IT support at cost for Las Campanas Observatory and network support for NRAO/ALMA connectivity from Santiago to the US mainland. This work package also includes payments (and cost recovery) for Internet connectivity for NOAO South and all tenants.

Milestones

2.7.1. Put into operation at least one private 10GB virtual server network between La Serena and Cerro Tololo using the new La Serena–Cerro Pachón–Cerro Tololo fiber. (This milestone was carried over from FY17 milestone 2.7.2 due to delayed delivery and installation of the fiber-optic network hardware.) Due Date: 31 December 2017

2.7.2. Put into operation a Gluster file system on Cerro Tololo shared between CIS virtual servers in La Serena and Cerro Tololo. (This milestone was carried over from FY17 milestone 2.7.3 due to delayed delivery and installation of fiber optic network hardware.) Due Date: 31 March 2018
2.7.3. Refurbish “Back Blaze” disk server to provide centralized back-up facilities for users. Due Date: 30 September 2018

2.7.4. Complete the project to simplify the NS CIS computer infrastructure in La Serena. Due Date: 30 September 2018

Budget Summary

Table 2.7. Summary of NS Computer Infrastructure Services program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO-S CIS home NCA390000</td>
<td>0.2</td>
<td>34,679</td>
<td>44,889</td>
<td>79,568</td>
<td>-</td>
<td>79,568</td>
</tr>
<tr>
<td>NOAO-S CIS general NCA391000</td>
<td>4.6</td>
<td>262,128</td>
<td>194,194</td>
<td>456,322</td>
<td>-</td>
<td>456,322</td>
</tr>
<tr>
<td>AURA Network Backbone ZCP100001</td>
<td>0.6</td>
<td>61,475</td>
<td>431,421</td>
<td>492,896</td>
<td>-</td>
<td>492,896</td>
</tr>
<tr>
<td>AURA-O NCA370000</td>
<td>0.1</td>
<td>6,232</td>
<td>454</td>
<td>6,686</td>
<td>-</td>
<td>6,686</td>
</tr>
<tr>
<td>Las Campanas Support ZCP0000023</td>
<td>0.5</td>
<td>86,699</td>
<td>-</td>
<td>86,699</td>
<td>-</td>
<td>86,699</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6.0</strong></td>
<td><strong>451,213</strong></td>
<td><strong>670,958</strong></td>
<td><strong>1,122,171</strong></td>
<td><strong>586,281</strong></td>
<td><strong>535,890</strong></td>
</tr>
</tbody>
</table>

Work Packages

NOAO-S CIS Home NCA390000

This work package is the home account for the NS CIS group. It includes management of the group, office and general supplies, meals and lodging for group members working on the mountain, and travel and training costs for the group.

NOAO-S CIS General NCA391000

This work package covers all support for network and computer systems at NOAO South in La Serena and on Cerro Tololo, including systems used by major projects such as DES/DECam. This includes supplies and materials, maintenance contracts, and the new equipment needed to support the ever-expanding network and computing needs of all NOAO and affiliate (SOAR, LSST) activities in Chile.

AURA Network Backbone ZCP100001

This work package covers all activities related to the operations and maintenance of the core network backbone for all of the AURA operations in Chile and includes network support for the Las Campanas/Magellan observatories and NRAO/ALMA connectivity to the US mainland. This backbone includes the network links from Cerro Pachón to Cerro Tololo, from Cerro Tololo to La Serena (both via wholly owned and operated microwave links), from La Serena to Santiago (via REUNA, the Chilean equivalent of the US Internet2 educational and research network), and from Santiago to Miami (via collaboration with Florida International University and AMPATH, including significant support from NSF networking initiatives). The
revenue of this work package includes the charges to cover the cost of network services and the personnel required to maintain and operate this complex network while supporting all of its users.

**AURA-O NCA 370000**

The NS CIS group provides computer support for the office of the AURA-O director in La Serena and the AURA-O office in Santiago, including maintenance and problem-solving for their internal network, support for their Internet connectivity (particularly their secure link via a virtual private network, VPN, between La Serena and Santiago), and support for their computers running the Microsoft Windows operating systems. In addition, the NS CIS group provides limited support for the part of AURA Central Administrative Services (CAS) based in La Serena.

**Las Campanas Support ZCP000023**

Under a memorandum of understanding with Carnegie Observatories, the NS CIS group provides most of the networking and computer system support for the Las Campanas Observatory. This includes significant remote support of the systems on their mountaintop as well as occasional site visits when a physical presence is needed for repairs, maintenance, or hardware upgrades.
3 Kitt Peak National Observatory

Kitt Peak National Observatory activities are separated into the following programs:

3.1 KP Associate Director’s Office

Program Overview

Kitt Peak National Observatory (KPNO) operates the Mayall 4-m telescope and is a partner in the operation of the WIYN Observatory (3.5-m and 0.9-m telescopes). KPNO provides infrastructure for more than 20 tenant telescopes operated by institutions from around the world, including the NSO (National Solar Observatory) and NRAO (Very Long Baseline Array) telescopes that are on Kitt Peak. The primary focus of KPNO and hence the Associate Director’s Office is shifting toward major scientific programs centered on DOE and NASA projects. These include the Dark Energy Spectroscopic Instrument (DESI) for the Mayall and NEID (NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy; previously named EPDS) for the WIYN 3.5-m. These program efforts are described below under sections 3.2 and 3.3, respectively.

The KPNO Associate Director’s Office (ADO) also supports observatory planning and operations; outreach to government agencies (city, county, state, and federal); relations with the Tohono O’odham Nation, tenant observatories, and instrumentation and operations partners; and coordination with other divisions of NOAO.

The ADO consists of the associate director for Kitt Peak, an administrative assistant, and the KPNO safety manager.

Milestones

3.1.1. Complete a safety review of telescopes, labs, and shops on Kitt Peak. Due Date: 31 December 2017

3.1.2. Provide update on KPNO activities to Tohono O’odham tribal leadership. Due Date: 30 June 2018
Budget Summary

Table 3.1. Summary of KP Associate Director’s Office program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Director’s Office</td>
<td>2.7</td>
<td>395,234</td>
<td>73,831</td>
<td>469,065</td>
<td>-</td>
<td>469,065</td>
</tr>
<tr>
<td>ADO Scientist Research Time</td>
<td>0.7</td>
<td>130,602</td>
<td>13,148</td>
<td>143,750</td>
<td>-</td>
<td>143,750</td>
</tr>
<tr>
<td>Tohono O’odham Outreach</td>
<td>0</td>
<td>5,381</td>
<td>5,381</td>
<td>5,381</td>
<td>-</td>
<td>5,381</td>
</tr>
<tr>
<td>KP Site Protection</td>
<td>0.1</td>
<td>25,503</td>
<td>8,917</td>
<td>34,420</td>
<td>-</td>
<td>34,420</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.5</strong></td>
<td><strong>551,339</strong></td>
<td><strong>101,277</strong></td>
<td><strong>652,616</strong></td>
<td><strong>-</strong></td>
<td><strong>652,616</strong></td>
</tr>
</tbody>
</table>

Work Packages

**Associate Director’s Office**

This work package includes the payroll and non-payroll expenses to support management of Kitt Peak science, technical, and support activities. Administrative support is included.

**ADO Scientist Research Time**

Each NOAO scientific staff member is allocated some fraction of time for scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here for those staff members who charge functional time to the ADO.

**Tohono O’odham Outreach**

This work package supports outreach efforts from the ADO to the Tohono O’odham Nation in support of educational activities involving tribal members.

**KP Site Protection**

This work package includes a modest allocation of resources to cover consulting expenses for dark sky preservation. The consultant is charged with compiling and tracking information on outdoor lighting codes and sign codes in counties and municipalities surrounding Kitt Peak, as well as information on proposed state-wide legislation that would adversely affect dark skies over Arizona. This is a shared-cost activity in cooperation with other Arizona observatories.
3.2 Mayall Operations

Program Overview

Mayall Operations is responsible for operating the Mayall telescope for science observing, for preparing the Mayall telescope for the installation of the Dark Energy Spectroscopic Instrument (DESI), and for preparing DESI on the Mayall telescope. During the years FY16–FY18, KPNO operates the Mayall, prepares for DESI, and begins the installation process, supported by a combination of NSF and DOE funding. The NSF portion is conveyed via a supplemental funding award, AST-1557260, and not from NOAO’s base budget. The DOE portion is conveyed by a subcontract from the Lawrence Berkeley National Laboratory (LBNL), No. 7266036. LBNL is constructing DESI under DOE Prime Contract No. DE-AC02-05CH11231 and has issued the subcontract to NOAO under that DOE funding authority.

The Mayall Operations group consists of KPNO engineers and technicians who are assigned to supporting the Mayall and preparing for and installing DESI, along with three scientists who act as program manager, Mayall telescope scientist, and DESI/Mayall systems scientist, respectively. All these staff are budgeted fully (100% FTE each) within this program and are expected to spend essentially all their work time on Mayall and DESI tasks. This separation into a virtually stand-alone group is a necessary consequence of the funding arrangement: NOAO receives funding in specific amounts for specific activities, and both funding agencies require that those activities be accomplished without regard for what happens in other areas of activity on Kitt Peak. Nominal science operations at the Mayall are scheduled to end on 12 February 2018. On this date, the telescope will be shut down for the installation of DESI, a process that will take approximately 12 months to complete.

Milestones

3.2.1. DESI Installation: Complete installation of the spectrograph thermal enclosure in the large Coudé room. Due Date: 30 September 2018 (This milestone was transferred from FY17 and modified to reflect change in acquisition approach by DESI project.)

3.2.2. DESI Installation: Complete installation of the upgraded 10GB/sec Local Area Network within the Mayall building. Due Date: 31 January 2018

3.2.3. DESI Installation: Complete installation of the clean tent and other equipment in the Mayall ground floor garage, needed to support re-assembly of the DESI corrector barrel. Due Date: 15 February 2018 (This milestone was transferred from FY17 and modified to reflect additional details of preparation.)

3.2.4. DESI Installation: Complete pre-installation readiness review for installation and safety documentation. Due Date: 30 November 2017 (This milestone was carried over from FY17 Milestone 3.2.4, due to DESI project delays forcing delay of installation start.) Due Date: 31 December 2017

3.2.5. DESI Installation: Remove existing top rings and associated prime focus hardware from Mayall telescope. Due Date: 15 May 2018
3.2.6. DESI Installation: Complete installation of new DESI top ring with DESI prime focus corrector on the Mayall telescope. Due Date: 31 July 2018

3.2.7. Mayall Science Operations: Support observing for community observers and for extension of Mayall z-band Legacy Survey (MzLS). Due Date: 31 January 2018

3.2.8. Mayall Technical Operations: Complete installation and commissioning of Mayall pointing camera (small digital camera for automatically verifying telescope pointing). Due Date: 31 December 2017

Budget Summary

Table 3.2. Summary of Mayall Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
<th>Funding, NSF Supplemental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Operations</td>
<td>0.3</td>
<td>19,586</td>
<td>229,515</td>
<td>249,102</td>
<td>-</td>
<td>-</td>
<td>249,102</td>
</tr>
<tr>
<td>Mayall Science Operations</td>
<td>1.2</td>
<td>109,704</td>
<td>11,044</td>
<td>120,748</td>
<td>-</td>
<td>-</td>
<td>120,748</td>
</tr>
<tr>
<td>Mayall Technical Operations</td>
<td>2.4</td>
<td>258,404</td>
<td>350,746</td>
<td>609,150</td>
<td>-</td>
<td>-</td>
<td>609,150</td>
</tr>
<tr>
<td>DESI Installation</td>
<td>20.7</td>
<td>2,074,681</td>
<td>340,545</td>
<td>2,415,226</td>
<td>-</td>
<td>-</td>
<td>15,226</td>
</tr>
<tr>
<td>Science Research</td>
<td>0.5</td>
<td>96,099</td>
<td>9,675</td>
<td>105,774</td>
<td>-</td>
<td>-</td>
<td>105,774</td>
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<tr>
<td><strong>Total</strong></td>
<td>25.1</td>
<td>2,558,474</td>
<td>941,525</td>
<td>3,500,000</td>
<td>-</td>
<td>-</td>
<td>1,100,000</td>
</tr>
</tbody>
</table>

Work Packages

Administrative Operations

This work package includes labor and non-labor costs associated with administrative support of Mayall operations, including logistical support for visiting observers, scientists, and engineers; tracking of expenditures; coordination and scheduling of activities; and coordination with other NOAO divisions. This package also includes the payments that the Mayall is now required to make as a “tenant” observatory to support the Kitt Peak Mountain infrastructure.

Mayall Science Operations

This work package includes all of the labor and non-labor costs associated with the operation of the Mayall for science, both community observing and the observing for the MzLS survey. Nightly operations costs, startup and troubleshooting technical support, routine maintenance of the telescope and facility instruments, and support of visiting observers are all covered by this work package.

Mayall Technical Operations

This work package includes all of the labor and non-labor costs associated with routine maintenance and upgrades of the Mayall telescope and the facility instruments, as well as technical documentation and record-keeping in support of those activities.
DESI Installation

This work package covers the labor and non-labor costs associated with final preparations to the telescope and facility such as fabrication of the last remaining items of specialized work platforms and lifting fixtures. It covers all costs associated with removing from the telescope and facility all equipment that will not be used with DESI and with installing the DESI equipment on the telescope or in the building. The telescope will be closed to nighttime operations through this installation process. It also includes managerial oversight of all these activities and coordination with the rest of the DESI project.

Science Research

Each NOAO scientific staff member is allocated some fraction of time for scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here for those staff members who charge functional time to Mayall Operations.

3.3 WIYN Operations

Program Overview

Operations for the WIYN 3.5-m telescope are defined by the terms of the consortium agreement. The costs shown represent the entire WIYN Operations budget, including contributions from the WIYN Observatory partners. Also included are expenses for NOAO participation in WIYN Consortium activities such as Board and Science Advisory Committee meetings.

A joint NASA-NSF Exoplanet Observational Research (NN-EXPLORE) program for the advancement of exoplanet-related research is a major component of the WIYN program. The cornerstone of NN-EXPLORE will be the Extreme Precision Doppler Spectrometer, to be installed at WIYN in 2018 and to start operations in 2019. NASA selected a team at the Pennsylvania State University (PSU) to build the spectrometer, now called NEID (NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy). KPNO staff and management are working with NASA, NSF, and PSU to design, fabricate, and install two main subsystems at WIYN necessary to operate NEID. These are the fiber-optics feed (mounted on the telescope and called the NEID Port Adaptor) to the spectrometer and the enclosure to house it (referred to as the NEID Facility Modifications) on the WIYN observatory ground floor. While NEID is being built, community observers engaged in exoplanet research are using WIYN with its existing instrumentation through the NN-EXPLORE Guest Observer (GO) program, supported by WIYN scientific and technical staff.

WIYN general operations and management is funded jointly by the NSF and the WIYN partners. Activities related specifically to the NN-EXPLORE program, including NEID and development and support of the NN-EXPLORE GO program, are funded by NASA.
Figure 1. NEID Principal Investigator Dr. S. Mahadevan (PSU) with the NEID vacuum chamber. (Image credit: PSU.)

Milestones

3.3.1. Complete fabrication of all mechanical components for NEID port. Due Date: 31 March 2018

3.3.2. Complete major construction activities and enter environmental monitoring phase for NEID thermal enclosure. Due Date: 31 March 2018

3.3.3. Recruit and hire new WIYN Assistant Scientist. Due Date: 31 March 2018

3.3.4. Receive assembled and tested port assembly from University of Wisconsin. Due Date: 30 June 2018

3.3.5. Complete NEID installation; begin on-sky verification and commissioning. Due Date: 30 September 2018

Budget Summary

Table 3.3. Summary of WIYN Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
<th>Funding, NSF Supplemental</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIYN Operations</td>
<td>8.4</td>
<td>720,761</td>
<td>725,846</td>
<td>1,446,607</td>
<td>743,067</td>
<td>-</td>
<td>703,539</td>
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<tr>
<td>WIYN Administrative Operations</td>
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<td>42,328</td>
<td>555,899</td>
<td>598,227</td>
<td>307,131</td>
<td>-</td>
<td>291,095</td>
</tr>
<tr>
<td>WIYN Science Operations</td>
<td>7.9</td>
<td>678,433</td>
<td>169,947</td>
<td>848,380</td>
<td>435,936</td>
<td>-</td>
<td>412,444</td>
</tr>
<tr>
<td>Technical Operations</td>
<td>5.2</td>
<td>496,784</td>
<td>853,681</td>
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<td>1,134,036</td>
<td>-</td>
<td>216,062</td>
</tr>
<tr>
<td>WIYN Technical Operations</td>
<td>2.7</td>
<td>253,550</td>
<td>190,879</td>
<td>444,430</td>
<td>228,368</td>
<td>-</td>
<td>216,062</td>
</tr>
<tr>
<td>NN-EXPLORE</td>
<td>2.5</td>
<td>243,234</td>
<td>662,802</td>
<td>906,036</td>
<td>906,036</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Science Research</td>
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<td>9,000</td>
<td>116,628</td>
<td>59,929</td>
<td>-</td>
<td>56,699</td>
</tr>
<tr>
<td>Total</td>
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<td>1,588,527</td>
<td>2,913,701</td>
<td>1,937,400</td>
<td>-</td>
<td>976,300</td>
</tr>
</tbody>
</table>
Work Packages

WIYN Administrative Operations
This work package includes costs associated with administrative support of WIYN, including logistical support for visiting observers, scientists, and engineers; tracking of expenditures; scheduling of activities; and coordination with other divisions of NOAO.

WIYN Science Operations
This work package includes all of the costs directly associated with the operation of the WIYN 3.5-m telescope for science. Scientific staff support of visiting observers, instrument maintenance and support, nighttime operations, and troubleshooting are all covered by this package. Personnel include instrument scientists, telescope operators, and electronic technicians.

WIYN Technical Operations
This work package includes all of the costs directly related to the routine maintenance of the WIYN telescope, as well as major and minor telescope modifications. Scientific, engineering, and technical staff contribute to this package.

NN-EXPLORE
This package includes all costs directly associated with developing, installing, and commissioning the NEID spectrometer and part of the cost for scientific staff support of the GO program. The major NEID components are the design, fabrication, and integration of the fiber feed to be mounted on the WIYN telescope (called the NEID Port Adaptor) and the spectrometer enclosure (termed NEID Facility Modifications) to be situated on the ground floor of the observatory. Scientific, engineering, and technical staff contribute to this package. The design and fabrication of the fiber feed and the design of the facility modifications are to be carried out on external contracts.

Science Research
Each NOAO scientific staff member is allocated some fraction of time for scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here for those staff members who charge functional time to WIYN Operations.

3.4 KP Mountain Operations

Program Overview
KP Mountain Operations (KPMO) is responsible for operations, maintenance, and support of the various systems that support activities outside the telescope domes and tenant operations. This support encompasses roads and grounds maintenance, water plant operations, sanitary/refuse systems, electrical/telecommunication distribution, and maintenance of non-scientific support structures. It also includes operation of the
kitchen/cafeteria services and lodging facilities for visitors to the various observatories. This support is provided to all telescope facilities located on the mountain to enable their continued operations and is covered through NSF base funding, additional funding provided through an observatory/tenant joint use fee (JUF), and per-use revenues for food, lodging, and KPNO labor or equipment supplied to support observatory/tenant personnel or visitors.

**Milestones**

It is anticipated that the Mayall and WIYN telescope modifications being done in FY18 will place a significant demand on the skilled mountain operations staff for their support efforts on these projects throughout the year. These efforts will limit staff availability to address any major mountain projects beyond the routine operation and maintenance of the mountaintop facility so no milestones have been established.

**Budget Summary**

*Table 3.4. Summary of KP Mountain Operations program budget*

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Mountain Ops</td>
<td>7.2</td>
<td>385,743</td>
<td>507,008</td>
<td>892,752</td>
<td>284,510</td>
<td>608,242</td>
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<tr>
<td>Basic Mountain Services</td>
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<td>115,670</td>
<td>145,512</td>
<td>261,182</td>
<td>261,182</td>
<td>-</td>
</tr>
<tr>
<td>Food &amp; Lodging</td>
<td>6.5</td>
<td>272,627</td>
<td>219,870</td>
<td>492,497</td>
<td>320,000</td>
<td>172,497</td>
</tr>
<tr>
<td>Vehicle Services</td>
<td>0.9</td>
<td>47,716</td>
<td>95,976</td>
<td>143,692</td>
<td>86,000</td>
<td>57,692</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16.7</td>
<td>821,756</td>
<td>968,367</td>
<td>1,790,123</td>
<td>951,692</td>
<td>838,431</td>
</tr>
</tbody>
</table>

**Work Packages**

**General Mountain Ops**

This work package covers the majority of shared costs for operation of the infrastructure and facilities located on the Kitt Peak mountaintop. This includes costs for maintenance and general operations of non-telescope and non-tenant areas, mountain security, roads and grounds, water plant, electrical system maintenance, data and communication systems, and refuse removal. Costs for these activities in support of all of the hosted observatories are recovered through shared fees or per-use charges paid by the programs.

**Basic Mountain Services**

This work package covers the primary costs associated with the basic operation of the general mountain infrastructure systems and public facilities. This includes costs for land sublease, general utilities, roads and grounds, maintenance and operation of public areas, the mountain emergency response system, septic system, snow removal, main generator backup power
system, regulatory issues, cargo services, and refuse removal. Costs for these activities in support of all of the hosted observatories are recovered primarily through an observatory/tenant joint use fee (JUF) and per-use charges paid by the programs.

**Food & Lodging**

This work package covers the costs for operation of the Kitt Peak dining and lodging services provided to staff and visitors of all mountaintop facilities. Costs are recovered through per-use charges paid by participating groups, organizations, and visitors.

**Vehicle Services**

This work package covers the costs for operation of the KP vehicle pool and the KP bus and shuttle transportation system. Costs are recovered through shared-use fees paid by participating groups.

### 3.5 Kitt Peak Visitor Center

**Program Overview**

Serving about 50,000 visitors per year, the Kitt Peak Visitor Center (KPVC) runs the museum and gift shop on the mountaintop and is the starting point for docent-led guided daytime tours for the public. Evening guests can choose from the Nightly Observing Program (NOP), Dark Sky Discovery Program (DSD), and Overnight Telescope Observing Program (OTOP). The NOP is a beginner’s stargazing and telescope viewing program offered on a nightly basis from September 1 to July 15. The DSD is for intermediate-level enthusiasts seeking more time viewing through the eyepiece and greater interaction with staff. It is offered only during nights with no or very little moonlight. The OTOP is an all-night individualized telescope viewing and/or imaging experience tailored to the individual interests of the participant.

The Youth Group Overnight program (YGO) provides a focused educational program with telescope viewing, constellation locating, and other activities from late afternoon to late evening. Following these activities, the participants then “camp in” inside the Visitor Center or the Roll Off Roof observatory classroom. The YGO is offered to Scouting and school groups, rather than the general public. The evening programs are supported by three telescopes in separate enclosures ranging in aperture from 16 to 20 inches as well as by several small portable telescopes.

A variety of special daytime and evening public programs are offered throughout the year, usually focused around one or more central themes. We also produce special event programs centered on special or periodic astronomical events such as lunar eclipses and meteor showers throughout the year. Schools, youth groups, Scout troops, and other special groups have a variety of individualized programs available to them that are presented by staff or docents. These programs range in length from two hours to overnight programs that feature camping at the picnic grounds two miles from the summit. The KPVC program is intended to take in fees and revenues that cover most of its costs.
Our focus in FY18 will be designing and installing several new exhibits inside the Visitor Center. Two of the areas to be redeveloped include dark sky / light pollution and the exhibits focused on the Tohono O’odham Nation. The dark sky exhibits will be developed in cooperation with the International Dark-Sky Association, headquartered in Tucson. The O’odham exhibits will be developed in close cooperation with members of the tribe. Early 2018 will see a significant renovation of the admissions and gift shop desk area. This is a much-needed improvement that will enhance our capacity to serve large crowds and greatly improve the appearance of this highly visible area inside the Visitor Center. Funding for these upgrades has already been provided.

Milestones

3.5.1. Complete the installation of two new Point of Sale systems, the reconstruction of the front desk, and initial beautification of the Visitor Center gift shop. Due Date: 15 January 2018

3.5.2. Design and install new exhibits focused on the nature of light pollution, its impact on ground-based astronomy, and household solutions visitors can implement at home. Due Date: 15 September 2018

3.5.3. Design and install a set of exhibits that describe the Tohono O’odham Nation and develop a gallery area for rotating displays of O’odham art that focuses on the night sky, astronomy, Kitt Peak, and their creation mythology. Due Date: 30 September 2018

Budget Summary

Table 3.5. Summary of Kitt Peak Visitor Center program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visitor Center</td>
<td>9.4</td>
<td>486,626</td>
<td>416,841</td>
<td>903,467</td>
<td>802,409</td>
<td>101,058</td>
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<tr>
<td>Total</td>
<td>9.4</td>
<td>486,626</td>
<td>416,841</td>
<td>903,467</td>
<td>802,409</td>
<td>101,058</td>
</tr>
</tbody>
</table>

Per NSF guidance, the visitor center on Kitt Peak is sustained primarily through cost recovery from its programs.

Work Packages

Kitt Peak Visitor Center

This single work package for the KPVC includes all staff, expenditures, and revenues. It covers the tasks and responsibilities of the KPVC manager, the gift shop staff, and the program guides.
4 Community Science and Data Center

The NOAO Community Science and Data Center (CSDC) has two primary and interrelated mission components:

- Facilitate and support data-intensive astronomy
- Facilitate and support OIR system development and optimization

To advance this mission, the CSDC delivers a broad range of services to provide access to the telescopes and data archives of the US OIR system, to maximize the scientific output of the US astronomical community, and to develop new partnerships and institutional roles that increase the science capabilities available to US astronomers at all institutions. The CSDC operates a telescope time allocation process recognized nationally for its fairness and integrity that provides access to all NOAO-operated facilities and all facilities that offer open-access time via NOAO (e.g., Gemini, SMARTS). It supports users of non-NOAO facilities (with particular focus on Gemini) and connects the astronomical community to major external development projects (e.g., LSST, TMT). The CSDC also develops and operates a diverse suite of services for the management, archiving, distribution, and analysis of data obtained with NOAO telescopes and other major ground-based OIR facilities.

With the recent advent of wide-field imaging surveys using the Dark Energy Camera (DECam) on the Blanco 4-m telescope at CTIO, and in anticipation of the era of data-intensive astronomy to be defined by LSST, NOAO has established new programs within CSDC to enable the astronomical community to conduct diverse user-defined scientific research projects based on large public data sets in both the static-sky and time-domain regimes.

For program management purposes, CSDC activities are separated into the following programs:
4.1 CSDC Associate Director’s Office

Program Overview

The CSDC Associate Director’s Office (ADO) coordinates and manages all activities within the six component programs of the CSDC. The ADO includes the associate director for the CSDC, a deputy associate director for the CSDC at 50%, and an administrative assistant.

For FY18, the CSDC ADO will continue to give high priority to ensuring the success of NOAO’s data-intensive astronomy initiative, through management and coordination of the Data Lab, ANTARES, and Science Data Archive (SDA) development and operations efforts. ADO staff will also work with US NGO program staff to explore and prioritize opportunities for NOAO’s data-intensive astronomy programs to deliver new services to the US Gemini user community. Possible activities of interest include hosting of Gemini Large and Long Program high-level data products through the NOAO Data Lab, implementation of Gemini ToO programs in collaboration with ANTARES and DMO, and PI operation of Gemini data reduction software on virtualized computing platforms at NOAO.

In FY18, the CSDC will initiate a significant three-year program of OIR System Optimization activities that builds on current CSDC program areas. NSF supplemental funding to NOAO for these activities was approved in FY17 to enable progress in the pre-LSST years on key capabilities identified in the OIR System Optimization report of Elmegreen et al. (2015). The major components of this program are as follows, with the programmatic and collaborative focus of each component indicated in parentheses:

- Infrastructure to support science with survey-scale public data sets (NOAO Data Lab in coordination with NOAO Data Management Operations, LSST Project Data Management, and major spectroscopic survey projects such as SDSS and DESI)
- Community event-broking capabilities for LSST and other time-domain surveys (ANTARES project of NOAO and the University of Arizona, in coordination with LSST, Zwicky Transient Facility, and other time-domain surveys)
- Development of an end-to-end LSST follow-up observing system (NOAO in collaboration with Las Cumbres Observatory, SOAR, and Gemini)
- Community preparation for LSST and the development of an LSST Community Science Center (NOAO-CSDC in coordination with other LSST stakeholders, with key input from an LSST Community Science Center Working Group report expected in September 2017.)

Planning, hiring, and initial development activities in each area will take place in FY18, with a detailed and resource-loaded OIR System Optimization project plan to be completed by early in Q4. The finalization of this plan depends upon the hiring and onboarding of a CSDC Project Manager during FY18 and will be completed by an earlier date if possible.

Another significant focus of ADO activity in FY18 will be fostering closer coordination and collaboration between the various programs of the CSDC. While respecting the federation of responsibilities between programs, this effort will aim to increase interoperability
and knowledge-sharing between programs, to ensure that common challenges can be addressed with common technologies wherever possible, and to create a more unified experience for the CSDC and NOAO user community. This activity will center on semi-regular CSDC-wide meetings, as well as a multi-day off-site CSDC staff collaboration meeting in Q3.

In FY18, ADO staff will provide organizational leadership and NOAO sponsorship for a workshop, “Big Questions, Big Surveys, Big Data: Nighttime Astronomy and Cosmology in the 2020s.” This workshop will be held in March 2018 at Snowbird Resort in Utah, under the auspices of the SnowPAC workshop series. This workshop will bring together the NSF-funded astronomy and DOE-funded cosmology communities to produce science-driven white paper submissions to the upcoming Decadal Survey in Astronomy and Astrophysics that identify the most scientifically compelling telescopes, instruments, surveys, and data systems for interdisciplinary and inter-agency collaboration in the coming decade. Significant organizational support for this workshop will be provided by the University of Utah.

ADO staff will also continue to participate in the planning process for NCOA during FY18, both to provide input on the structure of the CSDC program within NCOA and to be able to effectively align the present-day CSDC organizational structure and program with its future NCOA context.

Milestones

4.1.1. Hold “Big Questions, Big Surveys, Big Data” Decadal Science workshop. Due Date: 15 March 2018

4.1.2. Complete detailed Project Plan for supplemental-funded OIR System Optimization activities. Due Date: 15 August 2018

Budget Summary

Table 4.1. Summary of CSDC Associate Director’s Office program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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<td>87,667</td>
<td>482,755</td>
<td></td>
<td>482,755</td>
</tr>
</tbody>
</table>
Work Packages

CSDC Associate Director’s Office

The costs of managing the CSDC and carrying out ADO services are in this work package and cover salaries for the associate director, deputy associate director, and administrative assistant.

CSDC-ADO Scientist Research Time

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the ADO.

4.2 Data Management Operations

Program Overview

Data Management Operations (DMO) is NOAO’s consolidated program for management of telescope data, serving KPNO, CTIO, and SOAR, as well as other programs within the CSDC. In this capacity, the DMO group develops and operates systems and software infrastructure for capture, processing, storage, and dissemination of telescope data.

Management of telescope data at NOAO facilities spread across Northern and Southern Hemispheres requires a distributed hardware infrastructure at summit and base facilities. In FY18, DMO will continue to maintain operational compute and storage systems installed at NOAO-North (Tucson/UITS) and NOAO-South (La Serena, Cerro Tololo, Cerro Pachón). These systems have a nominal lifespan of five years and therefore require that 20% of the resources be proactively renewed on an annual basis to mitigate data loss and service interruptions. This hardware renewal cycle allows DMO to leverage technological advances to facilitate continuous growth in data holdings and service capabilities.

As a service to PIs and survey teams, DMO will continue to support real-time archiving and distribution of data as it is delivered from telescopes and pipeline-reduction processes. To this end, the Telescope Automatic Data Archiver (TADA) has been implemented for KPNO, CTIO, SOAR, and SMARTS telescopes. TADA performs extract-transform-load operations on FITS files to normalize and remediate header keywords into valid fields within the NOAO Science Data Archive (SDA) database schema. Further, a Web service is maintained in the TADA framework to provide up-to-date schedule information needed for proper assignment of proposal identification (PROPID) information to the archive. TADA’s features are also currently being used to migrate data holdings contained within the obsolescent NOAO “Survey Archive.” The NOAO Deep Wide-Field Survey has been migrated, and additional surveys will be migrated in FY18 in anticipation of a coordinated re-release.
DMO staff will continue to develop and operate imaging pipelines in FY18 for NOAO wide-field imaging cameras (DECam, Mosaic-3, and Bok-90Prime). The DECam Community Pipeline (CP) represents the most high-profile activity in this area. The CP is currently used to provide DECam PIs with processed images (calibrations applied and instrumental signatures removed) on the timescale of one week post-observation. Improvements to the CP software stack will continue through FY18 in the areas of algorithm development, software portability, and documentation. Furthermore, in response to community interest in conducting large-scale uniform reprocessing of DECam data, DMO staff will collaborate with personnel at the National Center for Supercomputing Applications (NCSA) to develop automated DECam processing workflows based on the LSST software stack using NCSA’s Blue Waters supercomputer.

Via the SDA, DMO provides the astronomy community with access to raw and reduced image holdings of 14 million files with a volume of greater than 2.5PB (uncompressed). Public and proprietary observations taken from KPNO and CTIO telescopes from 2003 to present are available for download at http://archive.noao.edu. New SDA feature development has been mostly paused since FY16 as NOAO has shifted resources and priorities to support new large-catalog-oriented capabilities through the Data Lab program. Nevertheless, the SDA currently serves an average of 15TB per month (80,000 files) to approximately 1,700 unique users. Going into FY18, the SDA will continue to be the principal access point for public and proprietary image data from NOAO and partner telescopes.

For all major software projects such as the SDA, long-term growth in complexity eventually requires a major software re-factoring effort to reduce code overhead, apply cumulative lessons learned, and leverage new technological advances. To address this need, a fixed-term web developer has been hired with NCE funds through the end of FY18. Bringing the SDA back-end and middleware components up to modern standards will put the system on a more stable footing to both a) continue providing a standalone service for public and proprietary access to telescope data and b) collaborate with other CSDC software efforts (e.g., Data Lab) to enable improved access to public archive data and metadata. DMO plans to have an updated SDA software system ready for beta testing by mid-FY18 and a full production deployment by October 1.

In addition to the base-funded activities above, the DMO budget and scope of work for FY18 include NSF-supplemental-funded activities for database development and integration across the CSDC and for adaptation and deployment of spectroscopic data tools and services for the SDSS and DESI surveys data sets.

**Milestones**

4.2.1. Define and transfer representative sample of DECam raw data to NCSA for development of automated reprocessing workflow. Due Date: 15 November 2017

4.2.2. Re-release migrated NOAO “classic” survey data through SDA. Due Date: 15 February 2018
4.2.3. Prepare modernized SDA software system ready for operations. Due Date: 15 September 2018

Budget Summary

Table 4.2. Summary of Data Management Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
<th>Funding, NSF Supplemental</th>
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<td>DMO External Project-Funded Activities</td>
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<td><strong>Total</strong></td>
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<td><strong>98,272</strong></td>
<td><strong>956,404</strong></td>
<td><strong>183,451</strong></td>
</tr>
</tbody>
</table>

Work Packages

DMO Program Management

This work package covers day-to-day management activities, as well as staff training and professional development. Payroll costs reflect time spent on management activities, including planning meetings, program reports, and project-science support. Non-payroll budget items include staff business travel, desktop computing support, and office supplies.

Archive Infrastructure & Development

This work package includes payroll and non-payroll costs for all data management operations and development functions related to data cache/transport systems, data archive storage and curation, community-facing Web services of the SDA, and the user help desk. Package includes all computing systems infrastructure installed at Tucson, KPNO, and CTIO sites as required for reliable data transfer and replication between NOAO facilities and partners (e.g., Dark Energy Survey).

Pipeline Development & Operations

This work package includes payroll costs associated with pipeline software development for Mosaic, Bok, and DECam pipelines, as well as day-to-day operation of those pipelines, quality control, and data user support.
DMO Science Research

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the DMO.

Spectroscopic Data Tools

This NSF-supplemental-funded package encompasses payroll and hardware costs for development and adaptation of spectroscopic data-access tools and services for SDSS, DESI, and other spectroscopic surveys data sets.

Database Infrastructure

This NSF-supplemental-funded package encompasses payroll and travel costs for the CSDC database architect.

External Projects (DESI)

This work package covers on-project data-systems work for the DESI project carried out by NOAO staff supported by external (non-NSF) funding tied to this project.

External Projects (SDSS)

This work package covers on-project data-systems work for the SDSS-IV project carried out by NOAO staff supported by external (non-NSF) funding tied to this project.

4.3 Community Development

Program Overview

The Community Development (CD) program encompasses NOAO’s activities in developing new partnerships and institutional roles to expand the range of capabilities accessible to the US astronomical community through NOAO and the CSDC. For FY18, the funded activities within CD are the following:

TMT Community Outreach

The NSF and the Thirty Meter Telescope (TMT) Observatory Corporation are continuing activities under a Cooperative Agreement to engage the US astronomy community in planning for potential NSF investment and participation in the TMT project. AURA is an associate member of the TMT International Observatory (TIO), with representation on its Board of Governors and the TMT Science Advisory Committee (SAC). NOAO is charged with executing the responsibilities, privileges, and participation activities of AURA in TMT and has established a US TMT Liaison office for this purpose. NOAO formed and leads a US TMT Science Working Group (SWG) consisting of astronomers who span a range of scientific expertise, drawn from US non-TMT partner institutions. The SWG is charged to engage with others in the astronomical community about US participation in TMT. It consid-
ers models for that participation and how it may shape TMT operations, instrumentation, data management, and other issues. NOAO has also been instrumental in establishing and organizing TMT’s International Science Development Teams (ISDTs); engaging US community scientists to become ISDT members and to participate in ISDT activities; organizing the annual TMT Science Forum; and holding annual TMT Open House events at the January AAS meetings.

In May 2016, TMT submitted a draft of a US National Participation Plan to the NSF/AST. This includes the SWG’s report on the scientific case for national participation in TMT and on ways to maximize the scientific benefits from such a federal investment. The participation plan also includes a report on Workforce, Education, Public Outreach, and Communication (WEPOC), developed by an NOAO-led advisory committee, and a business and governance model presented by the TMT Observatory Corporation. NSF/AST is expected to review this draft internally and provide feedback; then a revised version of the report will be submitted and be reviewed by an external committee. However, NSF’s review of the participation plan is currently on hold, pending the resolution of TMT’s site issues. It is expected that the NSF-TMT cooperative agreement, which was scheduled to come to a close at the end of CY2017, will continue through CY2018 via a No-Cost Extension. Milestones below present a notional timeline that may change depending on the NSF’s response to the participation plan.

As part of the TMT Community Engagement process, the NOAO TMT representative will carry out the following activities in FY18:

New/developmental activities

- After receiving NSF feedback on its draft report for the US TMT Participation Plan, organize the effort of the US TMT SWG to revise the report and deliver it to TMT for resubmission.
- Participate in the organization of the annual TMT Science Forum, expected to be held in the US in summer or fall 2018. Working with the US TMT SWG, identify and encourage members of the US community to attend the Forum.
- Participate in the organization of a TMT Open House event at the January 2018 American Astronomical Society (AAS) meeting.

Ongoing/routine activities

- Lead the activities of the US TMT Science Working Group (SWG) by maintaining and updating the SWG membership, setting its agenda, and organizing teleconferences and face-to-face meetings.
- As TMT SAC co-chair for AURA, organize and attend quarterly TMT Science Advisory Committee (SAC) meetings and SAC co-chair telecons and participate in SAC activities, including oversight of TMT International Science Development Teams.
- Participate in teleconferences and other activities of the TMT-NOAO community engagement group.
La Serena School for Data Science

The La Serena School for Data Science (LSSDS) is an intensive week of interdisciplinary learning focused on applied tools for handling big data. The school aims to introduce advanced undergraduate students and beginning graduate students in astronomy, biomedicine, computer science, statistics, and mathematics to the tools and techniques currently available to make use of the large data sets of today and the extremely large data sets of tomorrow. These young scientists will be finishing their studies just in time to lead the exploration of the data coming from LSST and other large scientific projects in 2020 and beyond. With the experience coming out of this school, these students will have the foundation from which to explore the use of current and future massive scientific data sets in their future research.

The school will be taught by an international and interdisciplinary group of professors who use real data and examples. Participants will participate in lectures and hands-on activities with existing tools of big data, including training and access to the National Laboratory for High Performance Computing located at the University of Chile’s Center for Mathematical Modeling. The students will also work on team-based multidisciplinary projects together, using the tools and skills they’ve learned.

FY18 will be the second year of the LSSDS’s current five-year NSF-funded term. Planning for the school in FY18 will be informed by lessons learned in the FY17 organizational process. The school’s dedicated postdoctoral associate was hired in FY17 Q3 and will be available for organizational work throughout FY18.

NOAO Survey Data Development

NOAO scientific staff will continue to work in collaboration with DMO and Data Lab technical staff to migrate major data sets from past NOAO Survey programs into the current DMO-SDA and Data Lab frameworks. This effort requires significant scientific liaison activity with the PIs of these survey programs to ensure completeness and correctness of NOAO’s survey data holdings, to collect and curate the full documentation of the surveys and their data products, and to produce uniform summary overview documentation that will enable community users to discover and understand the survey data sets of greatest scientific interest to them.

Milestones

4.3.1. Hold 2018 La Serena School for Data Science. Due Date: 31 August 2018
Budget Summary

Table 4.3. Summary of Community Development program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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<tbody>
<tr>
<td>Community Science Center</td>
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<td>399,903</td>
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<td><strong>93,009</strong></td>
<td><strong>399,903</strong></td>
<td><strong>97,092</strong></td>
<td><strong>302,811</strong></td>
</tr>
</tbody>
</table>

Work Packages

**NOAO Survey Data Development**

This work package covers NOAO scientific staff effort for liaison activities with NOAO Survey Program PIs to curate and release NOAO Survey data products through current-generation NOAO data systems and services.

**TMT Community Engagement**

This work package contains all the salary and non-payroll costs to support the liaison activity between the TMT project and the US community.

**La Serena School for Data Science**

This work package covers the costs of travel for Data School participants, personnel costs of a postdoctoral associate in Chile engaged in organizational work for the Data School, and materials and supplies associated with the presentation of the Data School program.

**CD Science Research**

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the CD program.
4.4 Data Lab

Program Overview

Data Lab is NOAO’s program to enable efficient exploration and analysis of the large survey data sets now being generated by instruments on NOAO and other wide-field telescopes, with particular emphasis on DECam-based catalogs and images. The Data Lab program is motivated by the twin goals of maximizing the community science return on public NOAO survey data and preparing the community for data-intensive astronomy with LSST.

Functionally, the Data Lab aims to

- connect scientists to high-value catalogs from NOAO and external sources (e.g., SDSS, GAIA) and NOAO-based images linked to catalog objects
- enable scientists to discover the data that they need for their science
- empower scientists to develop intuition through interaction with selected catalog and image sets
- allow scientists to automate their analysis to enable discovery and inference in large data sets

Data Lab is being developed and operated as a flexible and interoperable platform for astronomical community users to implement a diverse set of access methods, tools, analyses, and workflows. To the greatest extent possible, Data Lab is employing existing protocols (e.g., Table Access Protocol, Simple Image Access) and technologies (e.g., Jupyter notebooks, Docker containers). The services available through Data Lab allow users to perform their analysis “close to the data” (that is, on the servers collocated with the catalogs and images), while also allowing transfer of data and results to their local hardware at any point during the process.

The Data Lab had its initial public release in June 2017, coincident with the 230th meeting of the AAS in Austin, Texas. Current Data Lab services include tools for sky exploration, authenticated access to Data Lab services, user authentication, large catalog queries, image queries and cutouts, query result storage, file transfer, and scientific analysis. Services under active development include a job-managed compute service, a data publication service, and a multipurpose catalog cross-match service. The services are available through both server-side and locally running clients, including Web-based interfaces, command-line tools, Python interfaces (including Jupyter notebooks), APIs, and legacy tools such as TOPCAT. They are supported by a community Help Desk, online documentation, and Jupyter Notebook examples of workflows.

Data Lab effort in FY18 is organized into five areas, with highest priority given to the first two:

1. Execution through Data Lab systems of data releases from large surveys: DES, DECaLS, and the NOAO Source Catalog (NSC: a single photometric catalog spanning all exposures and objects in the NOAO Science Data Archive)
2. Operations, including user support, completion of documentation, monitoring of services, and maintenance

3. Technical development, including completion of the Job Manager, development associated with the NSC, development needed for hosting the DESI Target Table, development of containerized tasks in support of the compute service, completion of the data publication service, completion of the cross-match service, and development of a “business model” to accommodate specific requests for data services from members of the community

4. Science development, including development of additional complete science examples and tools tailored to specific science cases

5. Training and communication activity, including additional tutorial development, participation in data science–oriented workshops and meetings, and development and participation in a “roadshow” to advertise Data Lab capabilities to members of the community

In FY18, Data Lab staff will also pursue increased coordination with LSST Project Data Management personnel, with the goal of identifying the path to technology sharing, interoperability, and user-experience convergence between Data Lab and the LSST Science Platform.

Milestones

4.4.1. Release NOAO Source Catalog through Data Lab. Due Date: 15 October 2017

4.4.2. Complete preparations to feature Dark Energy Survey DR1 Catalog through Data Lab at January 2018 AAS meeting. Due Date: 31 December 2017

4.4.3. Second major release of Data Lab system. Due Date: 15 June 2018

Budget Summary

Table 4.4. Summary of Data Lab program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>Community Science and Data Center (CSDC)</th>
<th>Data Lab FY 2018 Program Budget Summary</th>
<th>Community Science and Data Center (CSDC)</th>
<th>Data Lab FY 2018 Program Budget Summary</th>
<th>Community Science and Data Center (CSDC)</th>
<th>Data Lab FY 2018 Program Budget Summary</th>
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<tbody>
<tr>
<td></td>
<td>Budget, Labor Total FTE</td>
<td>Budget, Non-labor Total FTE</td>
<td>Funding, Other Total FTE</td>
<td>Funding, NSF Base Total FTE</td>
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<tr>
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<td>4.9</td>
<td>704,029</td>
<td>167,496</td>
<td>871,525</td>
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<td>704,029</td>
<td>167,496</td>
<td>871,525</td>
<td></td>
<td></td>
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</tbody>
</table>

46
Work Packages

Data Lab Management
This work package includes payroll costs for Data Lab program management, reporting, and planning.

Data Lab Development
This work package includes all payroll, supplies, and travel support associated with development of new features and capabilities for the NOAO Data Lab system.

Data Lab Operations
This work package encompasses payroll, supplies, and capital expenses associated with technical operations support for the Data Lab system.

Data Lab User Services
This work package includes payroll, supplies, and travel expenses associated with Data Lab user support, training, and communications activities.

Data Lab Science Research
Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the Data Lab program.

4.5 Time Domain Services

Program Overview
The Time Domain Services (TDS) group supports time-domain astronomy by the US astronomical community. The major focus of the group is the development of an “event broker” that will process alerts from LSST and other time-domain surveys. The group also supports development of other time-domain infrastructure for resource allocation and follow-up observations throughout the US OIR system. In FY18, NOAO scientists will continue to develop the Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES), in collaboration with personnel from the Department of Computer Science at the University of Arizona. ANTARES is designed to add value to alerts via annotation, characterize the alerts through algorithmic comparison with known/predicted objects, rank the alerts by significance for follow-up, and distribute alerts. The development goals for FY18 are to 1) complete a refactoring of the code base to improve functionality, 2) specify the design of the database used for comparison with known astronomical objects, 3) create template alert filters that employ contextual data stored in ANTARES’s “Astro-Object” catalog, and 4) run with simple filtering capability on live alert streams.
The refactoring of the code includes adding locus-association, upgrading the SciSQL version to enhance performance, adding new external catalogs to the Astro-Object catalog, enabling multiple users to run independent instantiations of the software, adding dashboard improvements (such as logging), and documenting the software development.

The ANTARES project received a positive external review in FY17. The prototype system is functional, but with limited astronomical breadth. Expanding the comparison data sets and adding contextual filters will begin to address this limitation.

The TDS group will also 1) engage in community outreach at various relevant meetings and 2) engage with current time-domain surveys and follow-up observing networks to further develop an integrated time-domain science system in advance of the LSST era. Particular focus will be on engaging with the Zwicky Transient Facility (ZTF) as a major pre-LSST provider of public alerts, with Las Cumbres Observatory as a key public-access partner in time-domain follow-up observing and with the NSF-funded OIR telescopes (SOAR, Gemini, and Blanco) as key public assets for southern LSST follow-up in the future.

The main ANTARES development effort is an NOAO base-funded activity with major support from the University of Arizona. This effort is further supplemented by the NCE infrastructure program, which will fund an ANTARES postdoctoral associate in FY18. This complementary source of support helps validate the prototype by enabling full execution on LSST precursor data sets.

Additional support for ANTARES will be available in FY18 through a recent NSF supplemental funding award. This funding is currently planned to support a full-time software systems engineer to manage and coordinate the ANTARES software development and operations effort. It is likely that support will also be available for 1) an additional ANTARES postdoc to pursue science-driven filter development, catalog curation, and engagement with ZTF and other alert providers and 2) additional project management and administrative support for the development, deployment, and integration of ANTARES within the broader US OIR time-domain astronomy system.

An emerging activity for FY18 and FY19 is the design and development of a comprehensive follow-up capability using the AURA telescope assets in Chile and the Las Cumbres Observatory (LCO) network. NOAO is partnering with Las Cumbres, SOAR, and Gemini in the early conceptual design of an end-to-end system that will connect the LCO and AURA telescopes via a dynamically scheduled system. Other elements like ANTARES will play a key role in this capability. The concept is being developed under a phased delivery of elements and capabilities. NOAO will report on progress in its FY18 quarterly reports. Ultimately the developed system will be open to non-federal resources that wish to collaborate in the network.

**Milestones**

1. **4.5.1** Complete code refactoring to ANTARES 2.0. Due Date: 30 November 2017
2. **4.5.2** Operate system on publicly available live alert streams with simple filters. Due Date: 30 March 2018
Budget Summary

Table 4.5. Summary of Time Domain Services program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>NSF Supplemental</th>
<th>NSF Base</th>
<th>Total Funding</th>
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<tr>
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Work Packages

**ANTARES Project**

This work package includes base-funded costs for payroll, travel, and supplies to support the ANTARES event-broker development project.

**ANTARES Supplemental**

This package covers NSF-supplemental-funded payroll expenses for ANTARES development and operations.

**Time Domain Services**

This work package includes payroll costs associated with the development of system-wide time-domain science capabilities.

**TDS Science Research**

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the TDS program.

**TDS Grant-Supported Research**

This work package covers payroll costs of grant-supported postdoctoral researchers supervised by TDS scientific staff members.
4.6 US National Gemini Office

Program Overview

Through the NOAO TAC, the US community has NSF-funded access to approximately 150 nights per year on each of the twin 8.2-m Gemini telescopes. The US National Gemini Office (NGO) supports US Gemini users in the various phases of science program planning and execution through the following activities:

- Provide support to users through the Gemini proposal process
- Triage all US Helpdesk requests
- Liaise with Gemini instrument scientists for problem-solving activities
- Support the NOAO TAC panels and Merging TAC in addressing Gemini-related issues
- Represent the interests of US TAC-approved programs and liaise with Gemini to draft the final observing schedule at the International Telescope Allocation Committee (ITAC) level
- Inform the US community of new Gemini-related software or data reduction procedures
- Keep the US community informed about Gemini opportunities and new observing capabilities through the NOAO Newsletter, the NOAO Currents e-newsletter, and direct email messages

All these activities are publicized and supported though the US NGO web page, which is updated frequently. NGO staff also organize regular workshops at the AAS winter meetings on specific topics that are of interest to the Gemini US community.

NGO staff also represent US community interests at the semi-annual meetings of the Gemini Operations Working Group (OpsWG). For FY18, these meetings will be held February 2018 (for 18B) and August 2018 (for 19A). OpsWG meetings address instrument scheduling, the call for proposals, ITAC process scheduling, and many other operation issues for each coming semester.

NGO staff are furthermore responsible for specific work packages to support the Gemini community in planning observations and reducing Gemini data. Six-month work packages are developed in discussion with the Gemini Observatory and agreed upon at the OpsWG meetings. Typical work packages are expected to include data reduction manuals, cookbooks for specific Gemini instruments, data reduction examples, Question & Answer forums, and organization and support for Gemini-specific workshops or meetings.

For FY18, US NGO staff will also carry out the following specific activities:

- Organize and host a splinter meeting at the 2018 AAS winter meeting focusing on the theme of target-of-opportunity observations with Gemini.
- Provide scientific organizational leadership for the triennial Gemini Science Meeting, to be held in San Francisco, California, in July 2018. The meeting will be focused primarily on showcasing recent Gemini science results and will also include
theme sessions on current and future Gemini instrumentation (including visitor instruments), observing and proposing modes available with Gemini, science metrics, and synergies between Gemini, NOAO, and LSST.

- Propose to offer and support Phoenix as a visitor instrument at Gemini in FY18. (This instrument has been well subscribed in recent semesters.)

**Milestones**

4.6.1 Hold the NOAO/Gemini Mini-workshop, “Target of Opportunity Observing,” as Splinter Meeting at the AAS 2018 winter meeting. Due Date: 15 January 2018

4.6.2 Complete preparations for 2018 Gemini Science Meeting. Due Date: 30 June 2018

**Budget Summary**

*Table 4.6. Summary of US National Gemini Office program budget*

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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<td><strong>548,014</strong></td>
<td>-</td>
<td><strong>548,014</strong></td>
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</tbody>
</table>

**Work Packages**

**US NGO Support**

This work package covers payroll, supplies, and travel for US NGO staff activities related to Gemini science operations and user-community support.

**Staff Science Research**

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the US NGO.

**NGO Committee Support**

This work package covers costs of committee travel budgeted under the US NGO program.
Workshops

This work package includes organizational costs and speaker travel for workshops at AAS meetings organized by the US NGO staff.

4.7 Time Allocation Committee

Program Overview

NOAO-managed open-access observing time on federal and non-federal telescopes is allocated by NOAO through the telescope allocation process, referred to as “Phase I.” Proposals are solicited twice per year by NOAO through a Call for Proposals issued in early March and early September. The September call covers observing time from February 1 to July 31 of a given year (the “A semester”), while the March call covers observing time from August 1 of that year to January 31 of the following year (the “B semester”). All of the information needed to plan and propose for observing programs can be found on the NOAO web pages and in a self-contained, downloadable PDF file with active links to relevant websites and documents. NOAO manages the proposal submission process (both Web and email based) and keeps the information up-to-date based on evolving telescope-plus-instrument combinations that are available for open access during a given semester.

Submitted proposals are reviewed by a Telescope Allocation Committee (TAC), which is convened by NOAO and consists of eight science-based panels: three Extragalactic, three Galactic, one Solar System, and one NASA-WIYN. The NASA-WIYN panel was added in 2015B and resulted from the NASA-NSF Exoplanet Observational Research (N-EXPLORE) program. The TAC panels meet over a one-week period twice a year at NOAO headquarters in Tucson, Arizona (usually in early May and at the end of October or early November) to rank-order the proposals on the basis of scientific justification and technical/experimental feasibility. The rankings of each panel are merged and discussed by a Merging TAC, which provides final recommendations to the NOAO Director. Once approved by the Director, the ranked proposals are forwarded to their respective observatories for scheduling. Schedules are finalized by December 15 for the A semester and June 15 for the B semester. The proposers are notified after the schedules have been finalized.

In addition to the regular A- and B-semester proposals described above, NOAO issues a Call for Survey Proposals approximately once every year and convenes a Survey panel to review these proposals. Currently, up to 20% of time on NOAO-managed telescopes can be allocated to surveys. NOAO negotiates a memorandum of understanding with the proposing teams of all Survey proposals granted time to ensure the timely completion of the project and the public availability of data products or other community benefits.

In addition to the Regular and Survey TACs, NOAO manages, on behalf of the Gemini Observatory, a Gemini Large Program Time Allocation Committee (LPTAC) panel that reviews proposals submitted to Gemini for programs that either are for larger amounts of time than normally requested or that span a longer length of time (up to six semesters).
Participating Gemini partners (currently, the US, Canada, and Argentina) offer up to 20% of their Gemini telescope time to be placed in this large-program pool. The convened LPTAC panel that reviews these proposals consists of six members from the US community, two from Canada, and one from Argentina. This NOAO-managed committee sends a science-ranked list of proposals back to Gemini for possible scheduling.

Starting in FY17, the NOAO TAC began allocating public access time on Las Cumbres Observatory (LCO) telescopes. This time has been made available through an NSF MSIP grant covering a total of seven semesters. Open-access time at LCO offers unique capabilities for flexible real-time scheduling of observations, and CSDC staff are working with LCO in the context of this public-access time to develop the broader time-domain follow-up observing system infrastructure that will be needed for the LSST era.

In addition to the regular operational activities described above, the TAC program encompasses development activities for the continuous improvement of the NOAO time allocation process. For FY18, technical development will focus on modernization of the information-processing systems that support the TAC process, with the assistance of a CSDC database architect hired in FY17 under NSF supplemental funding. TAC process development in FY18 will focus on continued activities to identify and mitigate the effects of unconscious bias upon proposal review and will inform the specification and development of potential new features in the TAC information processing system (such as staged withholding of proposal investigator names).

Staff in the TAC program include a head of program, who also serves as chair for both the NOAO Survey and the Gemini Large Program panels, a software support manager, and a TAC program coordinator.

For FY18, the NOAO TAC staff will carry out the following regular activities:

- Issue two Call for Proposals (CfP) in FY18, for semesters 2018B (on 1 March 2018) and 2019A (on 1 September 2018).
- Convene two Regular TAC meetings for semesters 2018A (during early November 2017) and 2018B (during early May 2018).
- Convene and manage a Gemini Large Program TAC in late April 2018 for programs beginning in semester 2018B.

Furthermore, the NOAO TAC will also perform the following FY18-specific tasks:

- Evolve membership on TAC panels to include adequate expertise in time-domain observations needed to evaluate the incoming LCO proposals, especially as related to providing the US community with the opportunities to prepare for future follow-up programs in the LSST era.
- Ensure that the TAC panels have the necessary expertise to review CHARA proposals, given the increasing open-access time to the CHARA facility that has begun in semester 2017B.
- Evolve membership on the NASA-WIYN NN-EXPLORE panel to prepare for the arrival of the precision radial-velocity spectrometer, NEID, set for delivery to the WIYN telescope in FY18 Q3. It is expected that essentially all open-access time on
WIYN will be devoted to NEID observations, which will likely emphasize exoplanet studies that will focus on precision radial-velocity observations, precision stellar astrophysics, and exoplanet atmospheric transmission spectroscopy.

- Work with other CSDC programs, as well as the NOAO Directorate, to plan the future of the NOAO Survey program. This topic is timely given the impending conclusion of the Dark Energy Survey at the Blanco 4-m telescope at CTIO.

Milestones

4.7.1. Issue new call for NOAO Survey Program Letters of Intent. Due Date: 15 December 2017

4.7.2. Version 1 of new TAC information-processing system ready for parallel operations alongside existing system. Due Date: 30 July 2018

Budget Summary

Table 4.7. Summary of Time Allocation Committee program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Community Science and Data Center (CSDC)</th>
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<td>Time Allocation Committee</td>
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<td>FY 2018 Program Budget Summary</td>
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</table>

Work Packages

TAC Support

This work package encompasses support of the NOAO time allocation process and TAC meetings. This includes salaries, travel, supplies, and required services to support the TAC meetings.

Science Research

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to the TAC program.
5 NOAO Core

5.1 NOAO Director’s Office

Program Overview

The NOAO Director’s Office (NDO) provides high-level leadership, management, and budgetary control for the ensemble NOAO program. It is the main programmatic interface between NSF, AURA, and the rest of the NOAO management team. NDO is responsible for the production and delivery of NSF-required reports such as the Program Operations Plan and the Long Range Plan. NDO is also responsible for NOAO-wide programs such as broadening participation and the NOAO Users Committee. Finally, NDO manages and develops high-level partnerships with projects, observatories, and organizations such as the Gemini Observatory, Giant Magellan Telescope Observatory, LSST Corporation, and Thirty Meter Telescope International Observatory.

The NDO is led by the NOAO director and deputy director, who are supported by an administrative assistant, a program manager, and a full-time librarian / publications coordinator. When appropriate, various NOAO scientists are assigned part-time to the NDO to execute specific functions (e.g., academic affairs, diversity advocacy, scientific staff promotion, and tenure reviews).

During FY18, the NDO team will lead or participate in a number of specific activities, including LSST operations development, 2020 Decadal Survey input development, NOAO program management process improvements, and further development of the plan for the National Center for Optical-Infrared Astronomy (NCOA) containing the program elements of Gemini, LSST, and NOAO in the LSST era.

In preparation for the upcoming Decadal Survey, we have invited community input, via the NOAO e-newsletter Currents, regarding scientific opportunities in areas in which NOAO can provide critical resources and/or areas that will strengthen the US ground-based OIR system in the coming decade. A community workshop will be held in Tucson (20–21 February 2018) to
discuss the input received and to work toward an integrated development program that NOAO will present to the Decadal Survey committee. Further details about the goals and process are available at https://www.noao.edu/currents/201708.html#letter.

Observatory Management

Milestones

5.1a.1. Deliver Program Operating Plan Progress Report (POPPR) for FY17 as required by NSF under the terms of its Cooperative Agreement with AURA for the management and operations of NOAO. Due Date: 1 December 2017

5.1a.2. Organize and complete the annual NOAO Users Committee meeting. Due Date: no later than 1 July 2018

5.1a.3. Organize and complete NOAO Decadal Survey Workshop. Due Date: no later than 31 March 2018

5.1a.4. Deliver FY19 Program Operations Plan (POP) as required by the NSF under terms of its Cooperative Agreement with AURA for the management and operations of NOAO. (This milestone may go away, if NCOA progresses on schedule and a NCOA Program Operating Plan is submitted [see milestone 5.1c.4.]) Due Date: 30 September 2018

5.1a.5. Constitute a new milestone change control process/board. Due Date: 31 December 2017

Diversity Program

The Diversity Advocates (DA) work closely with human resources and other staff to maintain awareness of and implement changes related to diversity and inclusion in all aspects of NOAO. DA activities fit into three overall types of goals: 1) goals that are related to external stakeholders and community impact; 2) goals that improve internal processes and policies; and 3) goals that improve workplace culture. The milestones listed below are designed to advance NOAO in each of these three areas.

Milestones

5.1b.1. Develop plan for informing visitors of NOAO policies on sexual harassment and other workplace culture issues. Design content and strategy for publication and posting in appropriate physical and virtual locations. Due Date: 30 September 2018

5.1b.2. Extend “Diversity in the Cosmos and in the Workplace” poster series for a full year, providing a mix of astronomy and diversity information and news in a compact and interesting format. Due Date: 30 September 2018
5.1b.3. Organize a meeting with early career staff to present and discuss the NOAO commitment to career development as a staff privilege and responsibility. Review with HR proposed policy updates developed during this process. Due Date: 31 December 2017

5.1b.4. Develop a plan for the implementation of a mentoring/“buddy” program for staff on KPNO. Due Date: 30 June 2018

National Center for Optical-Infrared Astronomy (NCOA) Project Office

Milestones

5.1c.1. Complete the NSF AST panel review of NCOA plan. Due Date: 31 October 2017

5.1c.2. Appoint an Interim NCOA Executive Council. Due Date: 31 March 2018

5.1c.3. Complete the NCOA workforce transition and management plans. Due Date: 30 June 2018

5.1c.4. Submit to the NSF the NCOA Program Operating Plan for FY19. Due Date: 30 September 2018

Budget Summary

Table 5.1. Summary of NOAO Director’s Office program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
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</tr>
<tr>
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<td>206,043</td>
</tr>
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<td>13,224</td>
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<tr>
<td>Broadening Participation Program</td>
<td>0.3</td>
<td>47,429</td>
<td>8,821</td>
<td>56,250</td>
<td>-</td>
<td>56,250</td>
</tr>
<tr>
<td>Academic Affairs</td>
<td>0.4</td>
<td>67,692</td>
<td>154,997</td>
<td>222,689</td>
<td>-</td>
<td>222,689</td>
</tr>
<tr>
<td>SPRF North</td>
<td>-</td>
<td>-</td>
<td>122,687</td>
<td>122,687</td>
<td>-</td>
<td>122,687</td>
</tr>
<tr>
<td>Total</td>
<td>7.2</td>
<td>1,129,539</td>
<td>1,229,375</td>
<td>2,358,913</td>
<td>817,658</td>
<td>1,541,255</td>
</tr>
</tbody>
</table>

Work Packages

NOAO Director’s Office

The NOAO Director’s Office coordinates all high-level program planning and execution. Reporting to NSF and AURA is the responsibility of this office. The office consists of the
director, deputy director, program manager, and NDO administrative assistant. Several other people provide part-time support for specific functions, e.g., production of reports required by NSF. This work package includes a portion of the overhead for NOAO management of grant recipients.

**NCOA Project Office**

In partnership with NSF, AURA is developing the National Center for Optical-Infrared Astronomy (NCOA) to enable NSF-sponsored world-level scientific leadership in observational OIR astronomy during the 2020s and beyond. NCOA will be formed by restructuring within a single organizational framework the Gemini Observatory, Large Synoptic Survey Telescope (LSST) Operations, and the National Optical Astronomy Observatory (NOAO). During FY17, AURA created and submitted the *NCOA Organization, Management and Operations (OMO) Plan* to NSF. If all goes well, the National Science Board (NSB) will approve the creation of NCOA during FY18 Q2 and initial NCOA operations will begin during FY19 Q1. The NCOA Project Office is led by the NCOA Project Director. During FY18, the NCOA Project Office has two highly entangled missions: a) work with other AURA groups and NSF to deliver materials needed to support the NSF review and approval process; and b) work with other AURA groups on preparations for initial NCOA operations in FY19.

**Tucson Library**

This work package covers funding for the Tucson library (librarian, acquisitions, periodicals, and one conference trip). Also included are the indirect revenue contributions from NSO for operation of the library.

**NDO Science Research**

Each NOAO scientific staff member is allocated some fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here proportionally for those staff members who charge functional time to NDO.

**NOAO Advisory Committees Meeting Support**

Funding for an annual EPO Advisory Committee meeting (mainly committee member travel support) is included in this work package. Funding for an annual Users Committee meeting (mainly committee member travel support) is included in this work package.

**Broadening Participation Program**

This program has three key focal points: 1) mission goals, which are those related to external stakeholders and community impact, particularly in support of underrepresented individuals throughout the STEM educational pipeline; 2) goals that improve internal processes and policies; and 3) goals that improve workplace culture. Two NOAO scientific staff (Diversity Advocates) support this program part-time, supported by other NOAO staff as required. Funding is provided for attending AURA meetings, conferences, and professional meetings of underrepresented groups.
**Academic Affairs**

This work package supports a variety of academic affairs activities in Arizona, including a colloquia series, scientific visitors, page charges, office supplies, etc. One NOAO scientist is assigned to this work package to oversee this activity on behalf of the director.

**SPRF North**

Science Personal Research Fund. Individual research support funds allocated to each NOAO scientific staff member. For FY18, full-time astronomer-track and scientist-track staff at NOAO North are allocated $4,000 per person.

### 5.2 External Project Technical Services

**Program Overview**

The core external projects group retains key capability in the NOAO optics and Tucson machine shop as well as high-level engineering for telescope advanced secondary mirrors. The group is committed to 100% external funding for FY18, primarily for GMT and LSST activities but also several smaller jobs.

**Milestones**

There are no milestones for this program.

**Budget Summary**

*Table 5.2. Summary of External Project Technical Services program budget*

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO External project technical support</td>
<td>2.8</td>
<td>350,183</td>
<td>57,473</td>
<td>407,656</td>
<td>386,151</td>
<td>21,505</td>
</tr>
<tr>
<td>NOAO-N Instrument Shop Operations</td>
<td>1.0</td>
<td>90,780</td>
<td>34,193</td>
<td>124,973</td>
<td>116,816</td>
<td>8,157</td>
</tr>
<tr>
<td>NOAO-N Optics Shop Operations</td>
<td>0.8</td>
<td>78,964</td>
<td>12,979</td>
<td>91,943</td>
<td>79,113</td>
<td>12,830</td>
</tr>
<tr>
<td>Design &amp; Analysis Group Contracts</td>
<td>1.0</td>
<td>180,440</td>
<td>10,300</td>
<td>190,740</td>
<td>190,222</td>
<td>518</td>
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<tr>
<td>Total:</td>
<td>2.8</td>
<td>350,183</td>
<td>57,473</td>
<td>407,656</td>
<td>386,151</td>
<td>21,505</td>
</tr>
</tbody>
</table>

**Work Packages**

**NOAO-N Instrument Shop Operations**

The NOAO North instrument shop retains capability to execute a host of precision machining and fabrication jobs. In FY18 the planned effort includes mainly support for LSST.
NOAO-N Optics Shop Operations

This work package provides support for the NOAO optics shop. Mainly support for LSST and modest support for WIYN and other small jobs.

Design & Analysis Group Contracts

This work package contains activity supporting external engineering design and development for large telescope secondary mirrors and other engineering support.

5.3 Education and Public Outreach

Program Overview

The FY18 Education and Public Outreach (EPO) program is designed to educate and support diverse and often-underserved audiences as well as to attract members of underrepresented groups to our field. The EPO group’s innovative, effective, and well-evaluated programs address the development needs of the next generation of science, technology, engineering, and mathematics (STEM) professionals (including professional astronomers) through programs that support undergraduate STEM students, science outreach practitioners, teachers and museum educators, K-12 students, and the general public. NOAO uses the “Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan” (2013) to guide and inform the development of the programs used to achieve these high-level deliverables. Our overall approach to these deliverables is congruent with the goals of that plan.

The EPO program supports and provides leadership to the national astronomy education “system” by identifying key needs and by forming strategic partnerships that utilize NOAO’s areas of expertise, including its recognized experience in reaching underserved and/or underrepresented groups. The program focuses on NOAO’s research strengths in astronomical surveys and data, data tools, observational astronomy, and technology. The NOAO EPO staff has expertise in key astronomy education areas such as instructional materials development, teacher professional development, optics and technology education, data-enabled science education, science education in informal environments, and science identity formation in girls. Using this skill set and the skills sets of the larger NOAO staff, NOAO contributes to critical national efforts to improve science literacy and to support the pipeline to careers in STEM. The NOAO EPO programs use astronomy and related disciplines such as optics and illumination engineering to encourage children to pursue science, math, computing, engineering, and other technological careers.

EPO staff members have played national and international leadership roles in many NSF-funded education and outreach projects. NOAO plays an active role in the continued dissemination and educational use of the instructional materials (e.g., Quality Lighting Teaching Kits) created in these programs. EPO is committing to providing innovative educational programs for the Tohono O’odham Nation on whose property Kitt Peak National Observatory is located. The EPO group in Chile plays an important outreach role in IV...
Región de Coquimbo (Region IV), Chile, with a strong dark skies education program and programs to train guides and educators in the municipal and tourist observatories in Chilean towns around NOAO facilities.

NOAO North and South EPO programs place an additional emphasis on rural populations. The EPO North group also has a well-respected outreach program using undergraduate students from the University of Arizona. The undergraduates are trained in general outreach and on specific educational programs. While graduates of this program have gone on to doctoral degrees in astronomy and related science fields, the main intention of the program is to support the undergraduates in their science and engineering-related studies. EPO has a strong role in the public information area and is in charge of Web, print, and exhibit materials to better educate the astronomical community on NOAO’s role as the institution that guides the evolution of the ground-based OIR system of telescopes in the US.

**Milestones**

5.3.1. Organize and deliver three global Globe at Night citizen-science campaigns per quarter. Due Date(s): 31 December 2017, 31 March 2018, 30 June 2018, 30 September 2018

5.3.2. Design and provide the NOAO booth for the winter American Astronomical Society meeting. Due Date: 31 March 2018

5.3.3. Create and staff an NOAO exhibit for the Tucson Festival of Books. Due Date: 31 March 2018

5.3.4. Conduct a fall and spring professional development workshop for Project ASTRO teachers and astronomers. Due Date: 30 June 2018

5.3.5. Organize and deliver three Big Data Science Café programs for high school students. Due Date: 30 June 2018

5.3.6. Organize and complete the annual EPO Advisory Committee meeting. Due Date: 30 September 2018

5.3.7. Coordinate and participate in at least three joint science education programs with Chilean collaboration institutions such as CEAZA, Universidad Santo Tomás, Explora-Conicyt, or other collaborators in the Region of Coquimbo. Due Date: 30 September 2018

5.3.8. Work with the regional organizing committee to produce a coordinated educational outreach program plan (including planning for the web page, activities, and workshops) for the total solar eclipse, which will occur in the Region of Coquimbo in 2019. Due Date: 30 September 2018
Budget Summary

Table 5.3. Summary of Education and Public Outreach program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Total Funding</th>
<th>Other Funding</th>
<th>NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO CORE (NC) Education and Public Outreach FY 2018 Program Budget Summary</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC-EPO</td>
<td>10.4</td>
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<td>241,925</td>
<td>1,114,752</td>
<td>32,000</td>
</tr>
<tr>
<td>Public Information</td>
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<td>108,585</td>
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</tr>
<tr>
<td>Photo Lab</td>
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<td>15,531</td>
<td>98,363</td>
<td>32,000</td>
</tr>
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<td>Newsletter</td>
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<td>35,010</td>
<td>11,058</td>
<td>46,068</td>
<td>-</td>
</tr>
<tr>
<td>Web Support</td>
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<td>90,293</td>
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</tr>
<tr>
<td>Educational Outreach</td>
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<td>216,575</td>
<td>-</td>
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<tr>
<td>Dark Skies Education</td>
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<td>6,331</td>
<td>58,526</td>
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<td>Project ASTRO</td>
<td>0.2</td>
<td>19,202</td>
<td>6,077</td>
<td>25,278</td>
<td>-</td>
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<tr>
<td>Tohono O’odham Outreach</td>
<td>0.2</td>
<td>19,202</td>
<td>4,150</td>
<td>23,352</td>
<td>-</td>
</tr>
<tr>
<td>AAS Meeting Support</td>
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<td>-</td>
<td>23,057</td>
<td>23,057</td>
<td>-</td>
</tr>
<tr>
<td>Science Research</td>
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<td>Big Data Academy</td>
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<tr>
<td>Total</td>
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<td>872,827</td>
<td>241,925</td>
<td>1,114,752</td>
<td>32,000</td>
</tr>
</tbody>
</table>

Work Packages

Public Information

This work package covers partial payroll costs of the EPO Program Head and Public Affairs administrative coordinator who work on media activities (including those for Kitt Peak), requests for use of NOAO imagery, and responses to public inquiries. The work package also pays for other staff who assist with media activities as needed.

Photo Lab

This work package provides salary and equipment support for one FTE in the NOAO Photo Imaging Lab. This operation furnishes high-quality graphics and image-production services to all NOAO North and NSO-Tucson staff on a daily basis, with great flexibility and ease of access, while working at less than one-fifth of the commercial rate. The Photo Imaging Lab also produces a variety of multimedia products, electronic newsletters, and other tools to aid NOAO’s efforts to better engage the astronomical community.

Newsletter

This work package supports the production and distribution of the NOAO Newsletter, including full in-house editorial production and graphic design.
**Web Support**

This work package covers payroll costs of the webmaster, who works on the NOAO website, maintains and develops the popular NOAO Image Gallery, and may respond to public inquiries. It also serves as the coordination point with similar offices at other observatories and AURA centers. This work package reflects time spent by EPO staff on high-priority NOAO organizational items such as the *Currents* e-newsletter and public web pages.

**Educational Outreach**

This work package provides staff and supporting funds to prepare and conduct NOAO’s non-grant-funded educational programs for teachers, museum and planetarium educators, and students. It is the central source of non-salary support funds for the general activities of NOAO EPO, such as travel and supplies. Major projects include the flagship Project ASTRO program, support for meetings and conferences such as the biannual AAS meetings, local and regional outreach in formal and informal science education venues (such as the Arizona-Sonora Desert Museum and with the UA MESA program), and new brochures, posters, and handout materials. It also includes partial support for the Undergraduate Mentoring and Outreach program.

**Dark Skies Education**

Dark Skies Education now incorporates the Globe at Night program and includes increased efforts to protect observatory sites at both NOAO North and NOAO South. It includes support for regional distribution of the very successful Dark Skies Teaching Kit developed during IYA2009 and for training of teacher and museum dark sky teaching ambassadors. The program works with the Cooper Center for Environmental Learning in Tucson and a number of nature centers in Chile as well as schools in both the US and Chile.

**Project ASTRO**

This work package supports this very successful and nationally recognized Arizona implementation of a program started by the Astronomical Society of the Pacific that emphasizes teacher-scientist partnerships. The program pairs Arizona teachers of grades 3-9 with volunteer amateur or professional astronomers and engineers with an interest in astronomy. The goal is to build long-lasting partnerships that enrich science education in schools. The program has expanded into a regional program.

**Tohono O’odham Outreach**

This work package builds on our expanding relationship with the Tohono O’odham through support of a variety of formal and informal education programs on the Nation. Examples include programs at community and recreation centers and schools, the Tohono O’odham Community College, star parties, and professional development workshops for teachers. This work package also supports all NOAO Tohono O’odham education efforts conducted on Kitt Peak.
AAS Meeting Support

This work package provides primary support of the twice-yearly AAS meetings to pay for booth space, Internet, exhibit space resources, relevant print jobs related to handouts, and exhibit production and shipping costs.

Science Research

Each NOAO scientific staff member is allocated a fraction of time that includes scientific and/or technical research, professional development activities, and external service (e.g., membership on committees whose activities benefit the astronomical community). That time is collected here for those staff members whose home program is EPO.

CTIO Outreach

This work package includes the cost of CTIO EPO staff to conduct outreach and includes the management of the Centro de Apoyo a la Didáctica de la Astronomía (CADIAS), a community astronomy teaching center outside of La Serena, which also includes an Internet-connected public library. CADIAS has proven to be a highly productive small astronomy education center. The work package also includes support for the traveling planetarium program, annual rental and gasoline costs for an AURA vehicle for official local use, liaison activities to conduct training of the staff at the small observatories built by municipalities near La Serena to attract local tourists, and miscellaneous non-payroll support for outreach by CTIO staff. It also includes some support for undergraduate student work, such as work on the Hugo Schwartz robotic telescope with students of the Universidad de La Serena.

Big Data Academy

This work package supports NOAO’s effort to connect teachers, museum educators, classes, and out-of-school programs with astronomical data sets and data tools.

EPO Student Mentoring

This work package is for our program to hire, train, support, manage, and mentor undergraduate students who do outreach work in support of NOAO programs in Tucson and the region.

Figure 2. Big Data Academy students on Kitt Peak. (Image credit: C. Walker, NOAO/AURA/NSF.)

5.4 Central Facilities Operations

Program Overview

The NOAO North Central Facilities Operations (CFO) program provides support services for the NOAO North divisions as well as administrative and limited technical support for the
Kitt Peak Mountain Operations group. The program support encompasses all phases of building operation and maintenance, utilities, telecommunications, vehicle fleet operations, and property management. This support is provided to all occupants of the Tucson facilities, including NSO, DKIST, WIYN, AURA Corporate, and LSST, with funding provided through a square-foot rate revenue process for non-NOAO base-funded programs. CFO also receives revenue from Gemini for providing limited remote operations support for the Gemini–Hilo building access-control system.

During FY18, CFO will continue to address maintenance issues and building deficiencies inherent to the 55-plus-year-old NOAO headquarters facility. Core systems will continue to be updated where reasonable, and space renovations will focus on cleanout of decommissioned areas to accommodate program demands as well as improvements to the staff workspace areas. Staff will continue to provide limited technical support to the KP Mountain Operations group in various areas.

Milestones

5.4.1. Complete design, planning and refurbishment documents to prepare for updating and/or replacement of the building cold and hot water piping systems. Due Date: 30 March 2018

Budget Summary

Table 5.4. Summary of Central Facilities Operations program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Facilities Operations</td>
<td>8.9</td>
<td>629,690</td>
<td>991,971</td>
<td>1,621,664</td>
<td>780,000</td>
<td>841,662</td>
</tr>
<tr>
<td>NOAO North Tucson Program Management and Support Services</td>
<td>4.2</td>
<td>315,820</td>
<td>271,511</td>
<td>587,331</td>
<td>282,500</td>
<td>304,831</td>
</tr>
<tr>
<td>NOAO North Tucson Utilities</td>
<td>0.4</td>
<td>29,354</td>
<td>420,791</td>
<td>450,145</td>
<td>216,514</td>
<td>233,631</td>
</tr>
<tr>
<td>NOAO North Tucson Safety and Security</td>
<td>0.4</td>
<td>29,625</td>
<td>117,050</td>
<td>146,675</td>
<td>70,549</td>
<td>76,126</td>
</tr>
<tr>
<td>NOAO North Tucson Vehicle Fleet</td>
<td>0.8</td>
<td>48,642</td>
<td>90,019</td>
<td>138,661</td>
<td>66,694</td>
<td>71,967</td>
</tr>
<tr>
<td>NOAO North Tucson Roads and Grounds</td>
<td>0.3</td>
<td>23,212</td>
<td>16,327</td>
<td>39,539</td>
<td>19,018</td>
<td>20,521</td>
</tr>
<tr>
<td>NOAO North Tucson Building Maintenance</td>
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<td>147,586</td>
<td>45,799</td>
<td>193,385</td>
<td>93,016</td>
<td>100,369</td>
</tr>
<tr>
<td>NOAO North Building Modification</td>
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<td>12,179</td>
<td>47,631</td>
<td>22,910</td>
<td>24,721</td>
</tr>
<tr>
<td>Facility Projects</td>
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<td>-</td>
<td>18,295</td>
<td>18,295</td>
<td>8,800</td>
<td>9,495</td>
</tr>
<tr>
<td>Total</td>
<td>8.9</td>
<td>629,690</td>
<td>991,971</td>
<td>1,621,664</td>
<td>780,000</td>
<td>841,662</td>
</tr>
</tbody>
</table>

Work Packages

The CFO program includes revenue through indirect payments for facility support from various program occupants (NSO, DKIST, AURA Corporate, WIYN, and LSSTC). Also included is a portion of the indirect revenue (general and administrative fees) received for facilities support provided to grantees such as individual astronomers and other consortia.
NOAO North Tucson Program Management and Support Services
This work package is the primary management support package, which incorporates the primary staff administration effort, oversight of the telecommunications and call accounting systems, minor facility engineering services, general support labor and equipment, travel to other sites for support issues, subcontracted custodial services, and other general administrative facility functions.

NOAO North Tucson Utilities
This work package includes various utility costs for the Tucson facility (electrical, water, sewer, gas, trash, and recycling services) and record-keeping and reporting requirements.

NOAO North Tucson Safety and Security
This work package includes contracted fire watch and off-hours security contracts, regulatory and industrial waste removal fees and efforts, and miscellaneous building access-control efforts.

NOAO North Tucson Vehicle Fleet
This work package includes operation and maintenance of the Tucson vehicle fleet including fuel, maintenance, repairs, and replacements. High-mileage vehicles are replaced with hybrids or other fuel-efficient vehicles to conserve and reduce fuel costs.

NOAO North Tucson Roads and Grounds
This work package includes contracted landscaping and grounds maintenance efforts.

NOAO North Tucson Building Maintenance
This work package includes all operations, maintenance, and repairs to the NOAO North Tucson buildings and their infrastructure systems. This generally includes painting, equipment repairs and replacement, roofing, energy conservation, internal improvements, and relocation of offices.

NOAO North Building Modification
This work package includes minor building modifications, construction, demolition, and remodels. Efforts are also targeted toward energy-efficiency improvements to the facility.

Facility Projects
This work package includes major infrastructure renovation, replacement, and/or improvement projects. In FY18, these projects include targeted building improvements to meet occupant requirements and energy efficiency modifications to the facility. This area also includes general updates and improvements to the conference and meeting room spaces.
5.5 Computer Infrastructure Services

Program Overview

The function of NOAO North Computer Infrastructure Services (CIS) is to provide computer infrastructure support to NOAO and its tenants and collaborators in Arizona: NSO/DKIST, LSST, WIYN, AAS-publications, and other organizations. Revenue is generated through a square-foot rate to recover the cost of IT support for non-NOAO base-funded programs.

IT managers from Gemini, LSST and NOAO, representing La Serena, Hilo and Tucson, have formed an IT working group to advise NCOA project management on short, medium and long term IT issues involved with the new organization. Planning has begun for projects to address the short-term issues.

Milestones

5.5.1. Complete the short-term IT plan for the establishment of NCOA (domain name, Web presence, email, telecommunications, and identity management). Due Date: 30 September 2018

Budget Summary

Table 5.5. Summary of Computer Infrastructure Services program budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO North Computer Infrastructure Services</td>
<td>5.4</td>
<td>596,728</td>
<td>153,017</td>
<td>749,744</td>
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<tr>
<td>Total</td>
<td>5.4</td>
<td>596,728</td>
<td>153,017</td>
<td>749,744</td>
<td>320,780</td>
<td>428,964</td>
</tr>
</tbody>
</table>

Work Packages

NOAO North Computer Infrastructure Services

This work package includes

- maintenance and improvement of the Tucson and Kitt Peak facility networks and of a secure connection for the networks to the Internet;
- maintenance and improvement of a secure software infrastructure providing services to the NOAO Tucson facility, including email, World Wide Web, FTP, and remote access;
- configuration of and connection to the Tucson and Kitt Peak networks;
- support and maintenance of computers (including scientific workstations and office computers) used in the Tucson facility.
Revenue includes indirect payments from NSO, LSST, WIYN, AAS-publications, and other tenant organizations for computer infrastructure support.

5.6 Infrastructure Programs

Program Overview

The infrastructure program uses carry-forward funds from AURA’s prior cooperative agreement, CA-0809409, to accomplish “brick and mortar” refurbishment and long-term maintenance as well as scientific infrastructure begun under the prior CA but not completed. The full infrastructure program is described in separate documents laying out the timing and scope of activities that have been approved by NSF and AURA.

Briefly, this program uses the carry-forward funds as a resource to enable complementary effort throughout the NOAO program that makes the base program described in this POP18 even more effective. In some cases, the infrastructure renewal supports deferred maintenance in NOAO divisions (such as Blanco or Kitt Peak Mountain Operations) as direct projects or activity to replace or refurbish an otherwise integral operational system. For example, water tanks on Kitt Peak are being refurbished as part of this plan. These tanks are a critical piece of the operational system to collect, filter, and store water on Kitt Peak, a fundamental service supplied to all tenants on the mountain (see section 3.4). On the other hand, some resources in this infrastructure program are being used to hire scientists and software experts to extend the reach of new data science capabilities. These resources don’t replace base funding, but rather complement and add to tools and systems that will make the data science infrastructure available even more powerful than the base program alone would allow (see sections 4.4 and 4.5).

The complete program is designed for four years. Year one was FY16, and the corresponding activities are described in the POP16. Years two through four are designed for POP17, POP18, and POP19. The program for year three is outlined below and concentrates mostly on science (see sections 4.4 and 4.5) and outreach infrastructure (see section 3.4). The bulk of the “brick and mortar” programs were part of the POP16 plan.

Milestones

Milestones related to NCE-funded programs are included in the appropriate work packages above.
Budget Summary

Table 5.6. Summary of Infrastructure Programs budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
<th>Funding, NSF Supplemental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure Renewal Programs Tucson</td>
<td>5.1</td>
<td>531,655</td>
<td>237,489</td>
<td>769,144</td>
<td>-</td>
<td>-</td>
<td>769,144</td>
</tr>
<tr>
<td>Infrastructure Kitt Peak (Safety)</td>
<td>1.0</td>
<td>59,724</td>
<td>6,013</td>
<td>65,736</td>
<td>-</td>
<td>-</td>
<td>65,736</td>
</tr>
<tr>
<td>Infrastructure Tucson</td>
<td>4.1</td>
<td>471,931</td>
<td>96,950</td>
<td>568,882</td>
<td>-</td>
<td>-</td>
<td>568,882</td>
</tr>
<tr>
<td>Infrastructure Tololo (Visitor Center)</td>
<td>-</td>
<td></td>
<td></td>
<td>80,715</td>
<td>-</td>
<td>-</td>
<td>80,715</td>
</tr>
<tr>
<td>Infrastructure Kitt Peak (Visitor Center)</td>
<td>-</td>
<td></td>
<td></td>
<td>53,810</td>
<td>-</td>
<td>-</td>
<td>53,810</td>
</tr>
<tr>
<td>Total</td>
<td>5.1</td>
<td>531,655</td>
<td>237,489</td>
<td>769,144</td>
<td>-</td>
<td>-</td>
<td>769,144</td>
</tr>
</tbody>
</table>

Work Packages

Infrastructure Kitt Peak (Safety)
This package includes support for Mayall DESI safety documentation, planning, and execution.

Infrastructure Tucson
This work package includes management and oversight of the overall infrastructure program, program management of the individual program activities as appropriate, and effort for Data Management Operations, Data Lab, and ANTARES development. Program-specific milestones are tracked under the Community Science and Data Center (CSDC).

Infrastructure Tololo (Visitor Center)
This work package includes planning, management, and oversight of the CTIO infrastructure program for FY18. CTIO Visitor Center upgrade planning and construction efforts are included in this package. Program-specific milestones are tracked under NOAO South (NS).

Infrastructure Kitt Peak (Visitor Center)
This work package includes planning, management, and oversight of the Kitt Peak infrastructure program for FY18. Kitt Peak Visitor Center enhancements are included in this package. Program-specific milestones are tracked under Kitt Peak National Observatory (KPNO).

5.7 AURA Support and Services

Program Overview
In past years, indirect charges to cover AURA Central Administrative Services (CAS) and Human Resources (HR) were described and budgeted in this program. The charges cover the cost of CAS accounting and financial management, procurement, payroll, logistics, and HR services. In FY18 the indirect charges are distributed in each division/program/package.
The same is true of the AURA facilities and administrative charges on new funds that support the AURA Corporate office.

In FY18, the CAS indirect rate (applied to all direct costs) is 4.8%, and the HR indirect rate (applied to salary without benefits) is 3.1%. The AURA F&A rate (applied to all expenses less revenue and the CAS and HR charges) is 2.37%. This program includes the AURA management fee, certain direct charges to support AURA oversight (committee meetings), and certain AURA services such as Ultimate software licenses.

Milestones

This activity has no programmatic milestones.

Budget Summary

Table 5.7. Summary of AURA Support and Services budget

<table>
<thead>
<tr>
<th>Work Packages</th>
<th>FTE</th>
<th>Budget, Labor</th>
<th>Budget, Non-labor</th>
<th>Budget, Total</th>
<th>Funding, Other</th>
<th>Funding, NSF Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>AURA Management Fee Allocated to NOAO</td>
<td>-</td>
<td>-</td>
<td>29,650</td>
<td>29,650</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AURA CAS</td>
<td>-</td>
<td>-</td>
<td>58,750</td>
<td>58,750</td>
<td>-</td>
<td>58,750</td>
</tr>
<tr>
<td>Observatory Council</td>
<td>-</td>
<td>-</td>
<td>25,495</td>
<td>25,495</td>
<td>-</td>
<td>25,495</td>
</tr>
<tr>
<td>UltiPro</td>
<td>-</td>
<td>-</td>
<td>33,255</td>
<td>33,255</td>
<td>-</td>
<td>33,255</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>-</td>
<td>88,400</td>
<td>88,400</td>
<td>29,650</td>
<td>58,750</td>
</tr>
</tbody>
</table>

Work Packages

AURA Management Fee Allocated to NOAO

As specified in the cooperative agreement between NSF and AURA for the management and operations of NOAO, AURA collects an annual management fee. These funds are used for expenses that are unallowable under NSF program funds (e.g., staff events, staff awards, certain meal expenses, and public advertising). The funds are never used to purchase alcoholic beverages.

Observatory Council

The AURA Observatory Council (OC) meets twice a year to provide financial and programmatic oversight of NOAO on behalf of the AURA Board. Funding for those two meetings (mainly committee member travel support) is included in this work package.

UltiPro

This work package includes a direct charge ($33K) for a NOAO-specific site license for the UltiPro software package used by AURA HR.
6 FY18 Budget Summary

6.1 Summary of FY18 Expenditures

The FY18 NOAO spend plan is summarized in Table 6.1 and illustrated in the following three pie charts. The first and second pie charts show the breakdown by program of the NSF base and total funding (respectively) in terms of percentages.

**FY 2018 NSF Base Funding**

Spend plan as a percentage of NSF base funding by program

**FY 2018 Total Funding**

Spend plan as a percentage of total funding by program.
The third pie chart (below) illustrates the percentage breakdown of the total funding by expense category. Payroll is for NOAO employees. Services is for contracted activity to outside vendors, for example, janitorial (Arizona) and security (Arizona and Chile). Supplies includes non-capital furnishings and some computing equipment. Capital is for items in excess of $5000 USD.
Table 6.1 and its key summarize the NOAO FY18 budget allocation. The table rolls up the individual budget tables provided in the previous section for each program.

### Table 6.1. FY18 NOAO Budget Allocation Summary Rollup

<table>
<thead>
<tr>
<th>NOAO DIVISION</th>
<th>NOAO South (NS)</th>
<th>Kitt Peak National Observatory (KP)</th>
<th>Community Science and Data Center (CSDC)</th>
<th>NOAO CORE (NC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>FTE</strong></td>
<td><strong>Budget, Total</strong></td>
<td><strong>Funding, Other</strong></td>
<td><strong>Funding, NSF Base</strong></td>
</tr>
<tr>
<td>NOAO South (NS)</td>
<td>3.3</td>
<td>1,116,536</td>
<td>171,061</td>
<td>945,475</td>
</tr>
<tr>
<td>NS Associate Director’s Office</td>
<td>3.3</td>
<td>1,116,536</td>
<td>171,061</td>
<td>945,475</td>
</tr>
<tr>
<td>Blanco Telescope Operations</td>
<td>32.4</td>
<td>4,624,081</td>
<td>5,000</td>
<td>4,619,081</td>
</tr>
<tr>
<td>SOAR Telescope Operations</td>
<td>23.6</td>
<td>2,432,329</td>
<td>370,397</td>
<td>2,061,932</td>
</tr>
<tr>
<td>NS Small Telescopes</td>
<td>3.1</td>
<td>384,330</td>
<td>384,330</td>
<td>-</td>
</tr>
<tr>
<td>NS Engineering &amp; Technical Services</td>
<td>3.3</td>
<td>1,545,103</td>
<td>6,882</td>
<td>538,221</td>
</tr>
<tr>
<td>NS Facilities Operations</td>
<td>42.2</td>
<td>4,373,465</td>
<td>3,061,932</td>
<td>838,431</td>
</tr>
<tr>
<td>NS Computer Infrastructure Services</td>
<td>6.0</td>
<td>1,122,171</td>
<td>586,281</td>
<td>535,890</td>
</tr>
<tr>
<td>NS Subtotal</td>
<td>113.9</td>
<td>14,598,015</td>
<td>5,897,416</td>
<td>8,700,599</td>
</tr>
<tr>
<td>Kitt Peak National Observatory (KP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Key to Table 6.1. FY18 NOAO Budget Allocation Summary Rollup

**NOAO South (NS)**

- **NOAO South (NS)**: This NOAO division focuses on the administration, facilities, and IT support services for NOAO activities based in La Serena, Chile.

- **NS Associate Director’s Office (ADO)**: This program is responsible for overall management and performance of NOAO South. It includes academic affairs for Chile-based operations and facilities costs for NOAO-only buildings in La Serena.

- **Blanco Operations**: This program includes all effort to operate and maintain the Blanco 4-m telescope, including major instruments such as DECam.

- **SOAR Telescope Operations**: This program includes all effort to operate and maintain the SOAR telescope.

- **NS Small Telescopes**: This program includes support for the SMARTS consortium. Funding is provided through SMARTS partner institutions outside NOAO’s base budget.

- **NS Engineering & Technical Services (ETS)**: This program includes design, fabrication, installation, and operations support for the telescopes and instrumentation on Cerro Tololo and Cerro Pachón.

- **NS Facilities Operations (FO)**: The program includes all the La Serena and Tololo/Pachón facilities shared services provided by NOAO to all AURA observatories and other tenants in Chile.

- **NS Computer Infrastructure Services (CIS)**: This program includes all the effort to operate and maintain the NOAO networks in La Serena and on the mountaintops as well as services to the outside world. The program includes funding from outside sources to cover the cost of shared services for other US-based observatories in Chile (e.g., Gemini, Las Campanas, and ALMA).

**Kitt Peak National Observatory (KP)**

- **Kitt Peak National Observatory (KP)**: This NOAO division focuses on the administration, facilities, and support services for NOAO activities based on Kitt Peak in Arizona.

- **KP Associate Director’s Office (ADO)**: This program is responsible for overall management and performance of Kitt Peak National Observatory.

- **Mayall Operations**: This program includes all effort to operate and maintain the Mayall 4-m telescope and includes effort to plan for and implement DESI on the Mayall. This program include revenue from the DOE via LBNL.

- **WIYN Operations**: This program includes all effort to operate and maintain the WIYN telescope and includes effort from partner institutions. This program includes revenue from NASA.

- **KP Mountain Operations (KPMO)**: The program includes all the support services provided by NOAO to all tenant observatories on Kitt Peak (including Mayall and WIYN).

- **Kitt Peak Visitor Center (KPVC)**: This program operates the public visitors program on Kitt Peak.
### Community Science and Data Center (CSDC)
This NOAO division includes NOAO’s data mission and community interface for telescope and data access. It includes support to provide US community access and user support to the two Gemini telescopes. Support is provided for NOAO North and South data management. The division includes new mission-critical activities under the Data Lab and ANTARES event-broker programs.

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSDC Associate Director’s Office (ADO)</td>
<td>This program is responsible for overall management and performance of the CSDC.</td>
</tr>
<tr>
<td>Data Management Operations (DMO)</td>
<td>This program handles all data capture, transport, and archiving of NOAO science data from all NOAO telescopes/programs. DMO is also responsible for serving all raw data and pipelined imaging data to PIs and all data products to the community after appropriate proprietary periods.</td>
</tr>
<tr>
<td>Community Development (CD)</td>
<td>This program includes all effort for science user community engagement on new major initiatives (inside or outside of NOAO) relating to OIR system development.</td>
</tr>
<tr>
<td>Data Lab (DL)</td>
<td>This program includes development of new tools for discovery and analysis using NOAO data sets.</td>
</tr>
<tr>
<td>Time Domain Services (TDS)</td>
<td>This program includes effort for the ANTARES event-broker project done in collaboration with the University of Arizona and for a community workshop on event brokers.</td>
</tr>
<tr>
<td>US National Gemini Office (US NGO)</td>
<td>This program includes management of US community access to Gemini and other System telescopes, including periodic meetings of NOAO user constituencies, other informational workshops and committees, and the annual meeting of the Gemini long and large programs survey teams. It also includes user support for observing proposal preparation and submission for all System facilities, as well as post-observing data processing.</td>
</tr>
<tr>
<td>Time Allocation Committee (TAC)</td>
<td>This work package encompasses support of the NOAO telescope allocation process and TAC meetings, including salaries, travel, supplies, and services required to support the TAC meetings.</td>
</tr>
</tbody>
</table>

### NOAO Core (NC)
NOAO Core includes overall management of the NOAO program, central facilities operations and IT support in Tucson, Academic Affairs, and Education and Public Outreach.

<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO Director’s Office</td>
<td>This program is responsible for overall management and performance of NOAO.</td>
</tr>
<tr>
<td>External Projects Technical Services</td>
<td>This program retains mechanical shop and optics shop expertise in NOAO. The FY18 plan is nearly entirely based on external funding sources.</td>
</tr>
<tr>
<td>Education and Public Outreach (EPO)</td>
<td>This program contains the NOAO North and South education and public outreach programs, public affairs, and graphic arts.</td>
</tr>
<tr>
<td>Central Facilities Operations (CFO)</td>
<td>This program includes the NOAO North facilities operation costs of Tucson building maintenance, roads and grounds, utilities, vehicles, and the computer network in Tucson.</td>
</tr>
<tr>
<td>Computer Infrastructure Services (CIS)</td>
<td>This program includes computer system support for all programs in Arizona including LSST, NSO/DKIST, and WIYN as well as NOAO. This program includes some NOAO-wide support activity.</td>
</tr>
<tr>
<td>Program</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Infrastructure Programs</td>
<td>This program includes an above–base funding set of activities to be accomplished in FY18 using carry-forward funds from NOAO’s prior Cooperative Agreement.</td>
</tr>
<tr>
<td>AURA Support &amp; Services</td>
<td>This program includes costs for AURA management, business services, human resources, and oversight committees for all of NOAO’s program except Mayall, WIYN, and the Infrastructure Programs, where these analogous costs are budgeted separately.</td>
</tr>
<tr>
<td>FY18 Total</td>
<td>This total includes the full costs of NOAO programs.</td>
</tr>
</tbody>
</table>
6.2 Sources of FY18 Revenue

The following Table 6.2 and its key summarize the other revenue—non-NSF base funding—received for each program.

Table 6.2. FY18 NOAO Other Revenue Summary Rollup

<table>
<thead>
<tr>
<th>NOAO DIVISION</th>
<th>FY 2018 Other Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS ADO</td>
<td>160,784</td>
</tr>
<tr>
<td>NS ADO Gemini Library Support</td>
<td>5,150</td>
</tr>
<tr>
<td>NS ADO Visitor Center</td>
<td>5,127</td>
</tr>
<tr>
<td>NS Blanco Site Monitoring SOAR Contribution</td>
<td>5,000</td>
</tr>
<tr>
<td>NS Small Tel SMARTS Operations Direct Costs</td>
<td>384,330</td>
</tr>
<tr>
<td>NS SOAR Telescope Improvements</td>
<td>370,397</td>
</tr>
<tr>
<td>NS Pac Ops Mountain Facilities Operations</td>
<td>3,012,857</td>
</tr>
<tr>
<td>CTIO</td>
<td>910,684</td>
</tr>
<tr>
<td>SMARTS</td>
<td>109,438</td>
</tr>
<tr>
<td>Gemini</td>
<td>1,028,473</td>
</tr>
<tr>
<td>LST</td>
<td>505,773</td>
</tr>
<tr>
<td>Other Tenants</td>
<td>457,062</td>
</tr>
<tr>
<td>NS Pac Ops La Serena Facilities</td>
<td>1,069,608</td>
</tr>
<tr>
<td>CTIO</td>
<td>365,952</td>
</tr>
<tr>
<td>SMARTS</td>
<td>3,875</td>
</tr>
<tr>
<td>Gemini</td>
<td>357,939</td>
</tr>
<tr>
<td>LST</td>
<td>86,732</td>
</tr>
<tr>
<td>Other</td>
<td>218,185</td>
</tr>
<tr>
<td>NS CIS</td>
<td>586,281</td>
</tr>
<tr>
<td>NS ETS LINC/CM Operations</td>
<td>6,882</td>
</tr>
<tr>
<td>NS Subtotal</td>
<td>5,897,416</td>
</tr>
<tr>
<td>KP</td>
<td>2,400,000</td>
</tr>
<tr>
<td>KP Mayall Operations</td>
<td>1,937,400</td>
</tr>
<tr>
<td>KP WIYN Operations</td>
<td>284,510</td>
</tr>
<tr>
<td>KP MO General Mountain Operations</td>
<td>802,409</td>
</tr>
<tr>
<td>KP MO Joint Use Fee</td>
<td>261,182</td>
</tr>
<tr>
<td>Mayall</td>
<td>33,000</td>
</tr>
<tr>
<td>WIYN</td>
<td>19,900</td>
</tr>
<tr>
<td>2.1m</td>
<td>9,750</td>
</tr>
<tr>
<td>NDO</td>
<td>50,000</td>
</tr>
<tr>
<td>Other</td>
<td>148,912</td>
</tr>
<tr>
<td>KP MO Food and Lodging</td>
<td>320,000</td>
</tr>
<tr>
<td>KP MO Vehicle Services</td>
<td>86,000</td>
</tr>
<tr>
<td>KP Subtotal</td>
<td>6,091,501</td>
</tr>
<tr>
<td>CSDC</td>
<td>97,092</td>
</tr>
<tr>
<td>CSDC CD La Serena School for Data Science</td>
<td>86,711</td>
</tr>
<tr>
<td>CSDC EXO External Projects (EXOS)</td>
<td>6,119</td>
</tr>
<tr>
<td>CSDC TDS Grant-Supported Research</td>
<td>11,561</td>
</tr>
<tr>
<td>CSDC Subtotal</td>
<td>201,483</td>
</tr>
<tr>
<td>NC NDO</td>
<td>525,000</td>
</tr>
<tr>
<td>NC NDO TUCAS Project Office</td>
<td>229,858</td>
</tr>
<tr>
<td>NC NDO Tucson Library</td>
<td>63,000</td>
</tr>
<tr>
<td>NC EXP Instrument Shop Operations</td>
<td>116,816</td>
</tr>
<tr>
<td>NC EXP Design &amp; Analysis Group</td>
<td>190,222</td>
</tr>
<tr>
<td>NC EXP Optics Shop Operations</td>
<td>79,113</td>
</tr>
<tr>
<td>NC EPV Photo Imaging</td>
<td>52,000</td>
</tr>
<tr>
<td>NC EXP</td>
<td>780,000</td>
</tr>
<tr>
<td>NC CIS</td>
<td>320,780</td>
</tr>
<tr>
<td>NC ALMA</td>
<td>29,650</td>
</tr>
<tr>
<td>NDO Subtotal</td>
<td>2,366,239</td>
</tr>
</tbody>
</table>

FY 2018 TOTAL: 14,556,639
<table>
<thead>
<tr>
<th>NOAO South (NS)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NS ADO</td>
<td>Labor burden on effort from AURA backbone services from NS CIS; effort performed by NS CIS for IT support to Las Campanas; effort on SOAR operations; and effort on SMARTS operations.</td>
</tr>
<tr>
<td>NS Gemini Library Support</td>
<td>Contributions for support of the La Serena library from Gemini</td>
</tr>
<tr>
<td>NS ADO Visitor Center</td>
<td>Visitor Center revenues from weekly tour program at CTIO</td>
</tr>
<tr>
<td>NS Blanco Site Monitoring SOAR Contribution</td>
<td>SOAR contribution to support site monitoring</td>
</tr>
<tr>
<td>NS Small Tel SMARTS Operations Direct Costs</td>
<td>Funds provided by the SMARTS consortium to operate the 0.9m, 1.3m, and 1.5m</td>
</tr>
<tr>
<td>NS SOAR Telescope Improvements</td>
<td>Funds to support direct NOAO labor costs for above base SOAR projects (e.g. move ARCoIRIS from Blanco to SOAR)</td>
</tr>
<tr>
<td>NS Fac Ops Mountain Operations</td>
<td>Cost recovery for infrastructure maintenance and projects from tenant observatories on Cerro Tololo and Pachón including Gemini, SOAR, LSST, and Small Telescopes</td>
</tr>
<tr>
<td>NS Fac Ops La Serena Facilities</td>
<td>Cost recovery for services provided to tenant observatories including Gemini, SOAR, LSST, and SMARTS</td>
</tr>
<tr>
<td>NS CIS</td>
<td>Funds from other AURA centers and North American observatories in Chile to recover cost of providing Internet access</td>
</tr>
<tr>
<td>NS ETS LMCM Operations</td>
<td>Cost recovery for operating laser mask cutting machine for non-NOAO programs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kitt Peak National Observatory (KP)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>KP Mayall Operations</td>
<td>DOE supplemental funding for Mayall operations related to DESI preparation and installation. Provided through contract with LBNL.</td>
</tr>
<tr>
<td>KP WIYN Operations</td>
<td>Supplemental funding from NASA for NN-EXPLORE exoplanet instrument interface development</td>
</tr>
<tr>
<td>KP VC Sales Revenue &amp; Memberships</td>
<td>Revenue from Visitor Center, sales, night observing programs, and the Friends of Kitt Peak program</td>
</tr>
<tr>
<td>KP MO General Mountain Operations revenues</td>
<td>Cost recovery from gas cylinders, utilities, and data link</td>
</tr>
<tr>
<td>KP MO Joint Use Fee</td>
<td>Tennant fee to recover cost of mountain wide infrastructure maintenance including contributions from Mayall, WIYN, 2.1m, and NSO</td>
</tr>
<tr>
<td>KP MO Food and Lodging</td>
<td>Cost recovery for food service and lodging supplied to staff and visitors</td>
</tr>
<tr>
<td>KP MO Vehicle Services</td>
<td>Cost recovery for shuttle services</td>
</tr>
</tbody>
</table>
**Community Science and Data Center (CSDC)**

<table>
<thead>
<tr>
<th>Description</th>
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**NOAO Core (NC)**

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<td>Library share of indirect recovery from facility square-foot fee paid by AURA CAS/HR, NSO, LSST, WIYN, Mayall</td>
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<td>NC EXP Design &amp; Analysis Group</td>
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6.3 Division of Effort—NOAO Scientific/Management Staff

Per the reporting requirements for the NOAO Program Operations Plan defined by the NSF/AURA Cooperative Agreement effective 1 October 2016, the fractional division of effort for each NOAO scientific staff member across FY18 budgeted programs is shown in Table 6.3 on the following pages.

Scientific staff members and programs shown in Table 6.3 are those funded under NSF funds allocated to the FY18 NOAO base budget. Programs and scientists funded under external grants or non-AST/NSF sources also are included. The FTEs are shown by program. Table 6.3 also includes technical, engineering, and other staff who are either partially or totally funded by other funding as defined by the Cooperative Agreement. Table 6.3 provides a breakdown of the sources of other funding by FTE.

Under AURA policy, astronomer-track scientists at NOAO are accorded 50% personal research time; scientist-track staff are granted 20% research time. Scientists and/or astronomers who perform administrative and management duties are granted research time appropriate to their track (to a max of 50%). This personal science research time is allocated to staff within each program as a maximum possible, based on position, following fulfillment of the individual’s functional duties within the program. Beside each name in parentheses are the letter abbreviations defined below to show staff positions. Exceptions to the percentage allocated for personal science research time and grant funding are noted in the table footnotes. The percentage of time accorded by position follows:

- Director, Deputy Director, and Associate Director (D): max of 20%
- Head of Program (H): max of 20%
- Full, Associate, and Assistant Astronomer (A): max of 50%
- Senior, Observatory, Full, Associate, and Assistant Scientist (S): max of 20%
- Postdocs and Goldberg Fellows (P): max of 100%
### Table 6.3. FY18 Fractional Division by Budgeted Program of Effort of NOAO Scientific Staff and Key Management and of Technical, Engineering, and Other Staff with Non-Base Funding

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Sci. Staff FTE Totals     | 12.6 | 8.5 | 0  | 2.9 | 0.5 | 1.75| 0.95| 0.7 | 1  | 1.25| 1.8 | 2.3 | 2.2 | 6.05 | 42.5 |
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## Technical, Engineering, and Other Staff with External Funding

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<th>Name</th>
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¹ DESI support for Mayall from Department of Energy
² NN-EXPLORE Support for WIYN from NASA
³ SMARTS consortium support for Small Telescopes
⁴ Giant Magellan Telescope and LSST support
⁵ NASA support
⁶ LSST support to NOAO Core External Projects
⁷ Las Campanas Observatory support for IT and system administration support to NS CIS. AURA-O Network Backbone support to NS CIS.
7 Risk Register

In coordination with AURA Corporate, NOAO maintains a high-level risk register. Two classes of risk have been defined:

**Enterprise** – strategic risks that are long-term, continuous, and/or may or may not have the potential to damage AURA as a corporate entity.

**Programmatic** – risks that are connected to NOAO deliverables and/or activities as defined in its annual program plans and/or 5-year long-range plans.

In this section, the AURA/NOAO risk register as of 1 September 2017 is presented.

7.1 METHODOLOGY

Within each class, each risk is assigned a severity (S) and likelihood (L) rating in the range of 1 – 5 as defined in the tables below.

<table>
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<tr>
<th>Rating</th>
<th>Severity (S)</th>
<th>Likelihood (L)</th>
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<tbody>
<tr>
<td>1</td>
<td>Immeasurable</td>
<td>Highly unlikely (≤ 5%)</td>
</tr>
<tr>
<td>2</td>
<td>Nuisance</td>
<td>Rare (5 – 10%)</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Reasonable (10 – 25%)</td>
</tr>
<tr>
<td>4</td>
<td>Major</td>
<td>High (25 – 50%)</td>
</tr>
<tr>
<td>5</td>
<td>Existential</td>
<td>Near certain (&gt; 50%)</td>
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</table>

Aggregate risk is defined as $S \times L$, where the maximum value is 25. Normalized aggregate risk is $S \times L$ normalized to a maximum value of 10, i.e., aggregate risk $\times 0.4$.

Both risk classes are presented regularly to the AURA Observatory Council and Board of Directors for review and discussion as appropriate.

7.2 ENTERPRISE RISK

AURA has identified 28 high-level enterprise risks for NOAO that require continuous monitoring and mitigation. Their risk scores and mitigation plans are reviewed on a semi-annual basis. The table below summarizes all 28 enterprise-level risks, ranked by their current (September 2017) aggregate scores.

Following the table, all high-risk items (aggregate ≥ 10) are discussed in more detail.
<table>
<thead>
<tr>
<th>ENTERPRISE RISK ITEM</th>
<th>AGGREGATE RISK</th>
<th>NORM</th>
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<tr>
<td><strong>High risk</strong></td>
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<tr>
<td>NOAO Facilities obsolescence</td>
<td>20</td>
<td>8.0</td>
</tr>
<tr>
<td>NOAO Light pollution at mountain sites</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>NOAO Fire</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>NOAO Funding reduction</td>
<td>16</td>
<td>6.4</td>
</tr>
<tr>
<td>AURA fails Year 4 “comprehensive performance review”</td>
<td>10</td>
<td>4.0</td>
</tr>
<tr>
<td>AURA performs poorly during annual performance reviews</td>
<td>10</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Medium, low risk</strong></td>
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<tr>
<td>NOAO Customer dissatisfaction</td>
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<td>3.6</td>
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<td>NOAO Financial exigency</td>
<td>8</td>
<td>3.2</td>
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<tr>
<td>NOAO Loss of key personnel to other programs</td>
<td>8</td>
<td>3.2</td>
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<tr>
<td>NOAO Loss of agency confidence</td>
<td>8</td>
<td>3.2</td>
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<tr>
<td>NOAO Accident and injury to personnel and assets</td>
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<td>3.2</td>
</tr>
<tr>
<td>NOAO Retaining key personnel</td>
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<td>3.2</td>
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<tr>
<td>NOAO Damage to assets</td>
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<td>3.2</td>
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<td>NOAO Earthquake/tsunami</td>
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<td>NOAO Physical security</td>
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<td>NOAO Loss of observing time</td>
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<td>NOAO IT security</td>
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<td>NOAO Cost/schedule overruns</td>
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<td>NOAO Peso exchange rate fluctuation, foreign inflation</td>
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<td>NOAO Failure to maintain training</td>
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<td>NOAO Succession planning</td>
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<tr>
<td>NOAO Disruption of federal government</td>
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<td>Relationship with Chilean Union deteriorates badly</td>
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<td>2.0</td>
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<td>NOAO Re-competition, FY20</td>
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<td>NOAO Default</td>
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<td>NOAO Degradation of workplace culture</td>
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<td>NOAO Damage to public</td>
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<td>Risk</td>
<td>NOAO Facilities obsolescence</td>
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<td><strong>Severity</strong></td>
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<td><strong>Aggregate (S × L)</strong></td>
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<td><strong>Norm Aggregate</strong></td>
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<tr>
<td><strong>Discussion</strong></td>
<td>Without constant renewal, facilities will become obsolete, resulting in funding reduction or elimination.</td>
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<tr>
<td><strong>Mitigation</strong></td>
<td>Within NSF funding and programmatic guidance, maintain continuous modernization program for scientific capabilities and infrastructure.</td>
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<table>
<thead>
<tr>
<th>Risk</th>
<th>NOAO Light pollution at mountain sites</th>
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<td><strong>Severity</strong></td>
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<tr>
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<td><strong>Aggregate (S × L)</strong></td>
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<tr>
<td><strong>Norm Aggregate</strong></td>
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<tr>
<td><strong>Discussion</strong></td>
<td>Unmitigated increase in light pollution could lead to loss of ability to remain competitive as sites for research.</td>
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<tr>
<td><strong>Mitigation</strong></td>
<td>Advocate for light pollution control with local, county, and state governmental agencies in concert with other interested parties.</td>
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<th>Risk</th>
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<td><strong>Likelihood</strong></td>
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<tr>
<td><strong>Aggregate (S × L)</strong></td>
<td>12</td>
</tr>
<tr>
<td><strong>Norm Aggregate</strong></td>
<td>4.8</td>
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<tr>
<td><strong>Discussion</strong></td>
<td>NOAO must manage risks from internal fires in all facilities in all locations. NOAO must also manage risks from external (“brush”) fires at Kitt Peak and the AURA recinto in La Serena. NOAO facilities on Cerro Tololo and Cerro Pachón are not at risk from brush fires due to lack of significant vegetation.</td>
</tr>
</tbody>
</table>
| **Mitigation**           | Internal: fire alarms, fire suppression systems, etc., along with availability of local fire companies  
                                      External (Arizona/Kitt Peak): brush clearing on regular basis, fire response truck on-site, local fire responder (Tohono O’odham Nation) |
<table>
<thead>
<tr>
<th>Risk</th>
<th>NOAO Funding reduction</th>
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</thead>
<tbody>
<tr>
<td>Severity</td>
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<tr>
<td>Likelihood</td>
<td>4</td>
</tr>
<tr>
<td>Aggregate (S × L)</td>
<td>16</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>6.4</td>
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<tr>
<td>Discussion</td>
<td>Actual annual funding not guaranteed to be consistent with project funding and is subject to internal NSF prioritization.</td>
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<tr>
<td>Mitigation</td>
<td>Maintain fluidity across FY boundaries; restrict non-labor expenditures during early months of FY; restrict new hires in early months of fiscal year.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>AURA fails Year 4 &quot;comprehensive performance review&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>5</td>
</tr>
<tr>
<td>Likelihood</td>
<td>2</td>
</tr>
<tr>
<td>Aggregate (S × L)</td>
<td>10</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.0</td>
</tr>
<tr>
<td>Discussion</td>
<td>AURA/NOAO will be reviewed in Year 4 (FY19) of the current CA. Failing the review would trigger a CA re-competition.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>Work closely with NSF during annual reviews to prepare for and shape Year 4 &quot;comprehensive&quot; review outcome.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>AURA performs poorly during annual performance reviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>5</td>
</tr>
<tr>
<td>Likelihood</td>
<td>2</td>
</tr>
<tr>
<td>Aggregate (S × L)</td>
<td>10</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.0</td>
</tr>
<tr>
<td>Discussion</td>
<td>Per CA, AURA is required to submit an annual Management Report, which will be reviewed by an external panel.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>Bound NSF expectations by PEMP, execute well to PEMP.</td>
</tr>
</tbody>
</table>
### 7.3 PROGRAMMATIC RISK

NOAO has identified 23 programmatic risks that require continuous monitoring and mitigation. Their risk scores and mitigation plans are reviewed on a semi-annual basis. The table below summarizes all 23 programmatic risks, ranked by their current (September 2017) aggregate scores.

Following the table, all high-risk items (aggregate ≥ 10) are discussed in more detail.

<table>
<thead>
<tr>
<th>PROGRAMMATIC RISK ITEM</th>
<th>AGGREGATE RISK</th>
<th>NORM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOAO funding “transferred” to DKIST and LSST ops</td>
<td>20</td>
<td>8.0</td>
</tr>
<tr>
<td>NOAO South Fac Ops does not meet customer satisfaction</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>NOAO funding “transferred” to grants program</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>NSF eliminates funding for SOAR</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>KPNO tenant population declines, raising costs to NOAO</td>
<td>10</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Medium, low risk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DECam refrigeration system maintenance issue unresolved</td>
<td>9</td>
<td>3.6</td>
</tr>
<tr>
<td>EPDS-related NOAO milestones not completed on-time</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>DESI: targeting surveys do not meet requirements</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>DataLab Release 1 late and/or community uptake weak</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Major system failure at Blanco</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Major system failure at Mayall</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Major system failure at SOAR</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Major system failure at WIYN</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>DESI: ops costs larger than planned</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>WIYN partnership fractures, WIYN non-viable</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>CTIO tenant population declines, raising costs to NOAO</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>SOAR partnership fractures, SOAR non-viable</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>Main Tucson building maintenance costs climb</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>DESI: instrument delivery late to Mayall</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>DESI: Mayall prep milestones not completed on time</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Major system failure with DECam</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>NOAO does not perform well to program plan</td>
<td>3</td>
<td>1.2</td>
</tr>
<tr>
<td>KPNO Mountain Ops do not meet customer satisfaction</td>
<td>3</td>
<td>1.2</td>
</tr>
<tr>
<td>Risk</td>
<td>NOAO funding “transferred” to DKIST and LSST ops</td>
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<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Severity</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Likelihood</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Aggregate (S x L)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td>NSF MPS AST has been flat-funded in purchasing power for the last few years. Pressure is growing to maintain and/or increase percentage of AST funding to grants while also accommodating new operations costs for new facilities such as LSST and DKIST. If AST situation remains a zero-sum game, transfers are likely from more mature activities such as NOAO.</td>
<td></td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td>No direct mitigation is possible. The best indirect mitigation is to execute current program well and continue to provide services deemed high priority by the research community.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>NOAO South Facilities Ops do not met customer satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>3</td>
</tr>
<tr>
<td>Likelihood</td>
<td>4</td>
</tr>
<tr>
<td>Aggregate (S x L)</td>
<td>12</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td>Over several years, NS FO customers have expressed dissatisfaction with services received as well as lack of planning and reporting clarity.</td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td>Since FY16, NS FO has focused on improvements on team skill mix, service delivery, and planning/reporting clarity. The first two areas have significantly improved; the completion of improvements in planning/reporting will remain a high priority for FY18.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>NOAO funding “transferred” to grants program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>4</td>
</tr>
<tr>
<td>Likelihood</td>
<td>3</td>
</tr>
<tr>
<td>Aggregate (S x L)</td>
<td>12</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Discussion</strong></td>
<td>NSF MPS AST has been flat-funded in purchasing power for the last few years. Pressure is growing to maintain and/or increase percentage of AST funding to grants while also accommodating new operations costs for new facilities such as DKIST and LSST. If AST situation remains a zero-sum game, transfers are likely from more mature activities such as NOAO.</td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td>No direct mitigation is possible. The best indirect mitigation is to execute current program well and continue provide services deemed high priority by the research community.</td>
</tr>
</tbody>
</table>
### NSF eliminates funding for SOAR

<table>
<thead>
<tr>
<th>Risk</th>
<th>NSF eliminates funding for SOAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>4</td>
</tr>
<tr>
<td>Likelihood</td>
<td>3</td>
</tr>
<tr>
<td>Aggregate ((S \times L))</td>
<td>12</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.8</td>
</tr>
</tbody>
</table>

**Discussion**

NSF MPS AST has been flat-funded in purchasing power for the last few years. Pressure is growing to maintain and/or increase percentage of AST funding to grants while also accommodating new operations costs for new facilities such as LSST and DKIST. If AST situation remains a zero-sum game, transfers are likely from more mature activities with relatively lower research productivity such as SOAR.

**Mitigation**

Working closely with SOAR partners to prepare SOAR for a leadership role in an LSST time-domain follow-up system.

---

### KPNO tenant population declines, raising costs to NOAO

<table>
<thead>
<tr>
<th>Risk</th>
<th>KPNO tenant population declines, raising costs to NOAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>5</td>
</tr>
<tr>
<td>Likelihood</td>
<td>2</td>
</tr>
<tr>
<td>Aggregate ((S \times L))</td>
<td>10</td>
</tr>
<tr>
<td>Norm Aggregate</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Discussion**

Current cost-sharing model assumes approximately $0.7M per year in revenue from non-NSF tenants, some of which are financially unstable. NOAO does not have the financial resources to cover these costs without damaging other aspects of its program.

**Mitigation**

Contain share costs so as not to inadvertently trigger tenant closures.
## 8 Appendix: Milestone Summary Table

<table>
<thead>
<tr>
<th>Division</th>
<th>Program</th>
<th>Milestone Number</th>
<th>Milestone Text</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOAO South</td>
<td>Associate Director's Office</td>
<td>2.1.1</td>
<td>Carry out an external review of workplace safety and procedures at all facilities operated by NOAO South.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Blanco Telescope Operations</td>
<td>2.2.1</td>
<td>Complete the fifth season of the Dark Energy Survey (DES), which runs from mid-August 2017 through early February 2018.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>2.2.2</td>
<td>Carry out the annual preventative maintenance of the DECam cooling system and of the filter change mechanism.</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>2.2.3</td>
<td>Realuminize the Blanco primary mirror.</td>
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<tr>
<td></td>
<td></td>
<td>2.2.4</td>
<td>Evaluate the drive mechanism for the upper shutter of the Blanco dome, develop a plan for its refurbishment/replacement, and hold a design review. (This milestone was transferred from FY17 Milestone 2.2.4.)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2.2.5</td>
<td>Complete development of the preliminary design for the upgrade of the Blanco shutter brake system and hold a design review. (This milestone was transferred from FY17 Milestone 2.2.6.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOAR Telescope Operations</td>
<td></td>
<td>2.3.1</td>
<td>Reccoat the SOAR primary, secondary, and tertiary mirrors.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2.3.2</td>
<td>Complete fabrication and laboratory testing of the prototype wavefront sensing guider ready for the start of testing at the telescope.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2.3.3</td>
<td>Complete all tasks preparatory to the start of modification of ARCoIRIS for use at SOAR.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.3.4</td>
<td>Complete modification of ARCoIRIS so that it is ready for the start of commissioning on the SOAR telescope.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Division</td>
<td>Program</td>
<td>Milestone Number</td>
<td>Milestone Text</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
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</tr>
<tr>
<td>NS Engineering &amp; Technical Services</td>
<td>2.5.1</td>
<td>Design and prototype an upgrade to the control electronics for the axial actuators of the SOAR primary mirror.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.5.2</td>
<td>Deploy the detector performance-monitoring tool and train TelOps staff in its use.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Facilities Operations</td>
<td>2.6.1</td>
<td>Upgrade south wing of 20-unidades to be used during LSST construction.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2.6.2</td>
<td>Upgrade water supply system at guard house Control Puerta.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>2.6.3</td>
<td>Replace 500-liter petrol tank serving generators on Cerro Tololo with a 3,000-liter tank.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.6.4</td>
<td>Complete the upgrade of the Cerro Tololo power house (install protection cells).</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.6.5</td>
<td>Complete upgrade of the heating system in hotel on Cerro Pachón.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.6.6</td>
<td>Complete the expansion of the kitchen and dining room facilities on Cerro Pachón.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS Computer Infrastructure Services</td>
<td>2.7.1</td>
<td>Put into operation at least one private 10Gb virtual server network between La Serena and Cerro Tololo using the new La Serena–Cerro Pachón–Cerro Tololo fiber. (This milestone was carried over from FY17 milestone 2.7.2 due to delayed delivery and installation of the fiber-optic network hardware.)</td>
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<tr>
<td></td>
<td>2.7.2</td>
<td>Put into operation a Gluster file system on Cerro Tololo shared between CIS virtual servers in La Serena and Cerro Tololo. (This milestone was carried over from FY17 milestone 2.7.3 due to delayed delivery and installation of fiber optic network hardware.)</td>
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<tr>
<td></td>
<td>2.7.3</td>
<td>Refurbish “Back Blaze” disk server to provide centralized back-up facilities for users.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.7.4</td>
<td>Complete the project to simplify the NS CIS computer infrastructure in La Serena.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Division</td>
<td>Program</td>
<td>Milestone Number</td>
<td>Milestone Text</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
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</tr>
<tr>
<td>Kitt Peak National Observatory</td>
<td>KP Associate Director’s Office</td>
<td>3.1.1</td>
<td>Complete a safety review of telescopes, labs, and shops on Kitt Peak.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.1.2</td>
<td>Provide update on KPNO activities to Tohono O’odham tribal leadership.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mayall Operations</td>
<td></td>
<td>3.2.1</td>
<td>DESI Installation: Complete installation of the spectrograph thermal enclosure in the large Coudé room. Due Date: 30 September 2018 (This milestone was transferred from FY17 and modified to reflect change in acquisition approach by DESI project.)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.2.2</td>
<td>DESI Installation: Complete installation of the upgraded 10Gb/sec Local Area Network within the Mayall building.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.2.3</td>
<td>DESI Installation: Complete installation of the clean tent and other equipment in the Mayall ground floor garage, needed to support re-assembly of the DESI corrector barrel. (This milestone was transferred from FY17 and modified to reflect additional details of preparation.)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.2.4</td>
<td>DESI Installation: Complete pre-installation readiness review for installation and safety documentation. (This milestone was carried over from FY17 Milestone 3.2.4, due to DESI project delays forcing delay of installation start.)</td>
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<tr>
<td></td>
<td></td>
<td>3.2.5</td>
<td>DESI Installation: Remove existing top rings and associated prime focus hardware from Mayall telescope.</td>
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<tr>
<td></td>
<td></td>
<td>3.2.6</td>
<td>DESI Installation: Complete installation of new DESI top ring with DESI prime focus corrector on the Mayall telescope.</td>
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<tr>
<td></td>
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<td>3.2.7</td>
<td>Mayall Science Operations: Support observing for community observers and for extension of Mayall z-band Legacy Survey (MzLS).</td>
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</tr>
<tr>
<td>Division</td>
<td>Program</td>
<td>Milestone Number</td>
<td>Milestone Text</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
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</tr>
<tr>
<td>Mayall Operations</td>
<td></td>
<td>3.2.8</td>
<td>Mayall Technical Operations: Complete installation and commissioning of Mayall pointing camera (small digital camera for automatically verifying telescope pointing).</td>
<td></td>
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</tr>
<tr>
<td>WIYN Operations</td>
<td></td>
<td>3.3.1</td>
<td>Complete fabrication of all mechanical components for NEID port.</td>
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<tr>
<td></td>
<td></td>
<td>3.3.2</td>
<td>Complete major construction activities and enter environmental monitoring phase for NEID thermal enclosure.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>3.3.3</td>
<td>Recruit and hire new WIYN Assistant Scientist.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.3.4</td>
<td>Receive assembled and tested port assembly from University of Wisconsin.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3.3.5</td>
<td>Complete NEID installation; begin on-sky verification and commissioning.</td>
<td></td>
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</tr>
<tr>
<td>Kitt Peak Mountain Operations</td>
<td></td>
<td></td>
<td>There are no milestones for this program. See text.</td>
<td></td>
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</tr>
<tr>
<td>Kitt Peak Visitor Center</td>
<td></td>
<td>3.5.1</td>
<td>Complete the installation of two new Point of Sale systems, the reconstruction of the front desk, and initial beautification of the Visitor Center gift shop.</td>
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<td>3.5.2</td>
<td>Design and install new exhibits focused on the nature of light pollution, its impact on ground-based astronomy, and household solutions visitors can implement at home.</td>
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<td>3.5.3</td>
<td>Design and install a set of exhibits that describe the Tohono O’odham Nation and develop a gallery area for rotating displays of O’odham art that focuses on the night sky, astronomy, Kitt Peak, and their creation mythology.</td>
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<tr>
<td>Community Science and Data Center</td>
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<tr>
<td>CSDC Associate Director's Office</td>
<td></td>
<td>4.1.1</td>
<td>Hold “Big Questions, Big Surveys, Big Data” Decadal Science workshop.</td>
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<tr>
<td>CSDC Associate Director's Office</td>
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<td>4.1.2</td>
<td>Complete detailed Project Plan for supplemental-funded OIR System Optimization activities.</td>
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<tr>
<td>Division</td>
<td>Program</td>
<td>Milestone Number</td>
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<tr>
<td>Data Management Operations</td>
<td>4.2.1</td>
<td>Define and transfer representative sample of DECam raw data to NCSA for development of automated reprocessing workflow.</td>
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<td>4.2.2</td>
<td>Re-release migrated NOAO “classic” survey data through SDA.</td>
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<td>4.2.3</td>
<td>Prepare modernized SDA software system ready for operations.</td>
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<tr>
<td>Community Development</td>
<td>4.3.1</td>
<td>Hold 2018 La Serena School for Data Science.</td>
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<tr>
<td>Data Lab</td>
<td>4.4.1</td>
<td>Release NOAO Source Catalog through Data Lab.</td>
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<td></td>
<td>4.4.2</td>
<td>Complete preparations to feature Dark Energy Survey DR1 Catalog through Data Lab at January 2018 AAS meeting.</td>
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<td></td>
<td>4.4.3</td>
<td>Second major release of Data Lab system.</td>
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<tr>
<td>Time Domain Services</td>
<td>4.5.1</td>
<td>Complete code refactoring to ANTARES 2.0.</td>
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<td></td>
<td>4.5.2</td>
<td>Operate system on publicly available live alert streams with simple filters.</td>
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<tr>
<td>US National Gemini Office</td>
<td>4.6.1</td>
<td>Hold the NOAO/Gemini Mini-workshop, “Target of Opportunity Observing,” as Splinter Meeting at the AAS 2018 winter meeting.</td>
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<td></td>
<td>4.6.2</td>
<td>Complete preparations for 2018 Gemini Science Meeting.</td>
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<td>Time Allocation Committee</td>
<td>4.7.1</td>
<td>Issue new call for NOAO Survey Program Letters of Intent.</td>
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<td>4.7.2</td>
<td>Version 1 of new TAC information-processing system ready for parallel operations alongside existing system.</td>
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<tr>
<td>NOAO Core</td>
<td>5.1a.1</td>
<td>Deliver Program Operating Plan Progress Report (POPPR) for FY17 as required by NSF under the terms of its Cooperative Agreement with AURA for the management and operations of NOAO.</td>
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<td>Division</td>
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<td>5.1a.2</td>
<td>Organize and complete the annual NOAO Users Committee meeting.</td>
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<td>5.1a.3</td>
<td>Organize and complete NOAO Decadal Survey Workshop.</td>
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<td>5.1a.4</td>
<td>Deliver FY19 Program Operations Plan (POP) as required by the NSF under terms of its Cooperative Agreement with AURA for the management and operations of NOAO. (This milestone may go away, if NCOA progresses on schedule and a NCOA Program Operating Plan is submitted [see milestone 5.1a.9].)</td>
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<td>5.1a.5</td>
<td>Constitute a new milestone change control process/board.</td>
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<td>Diversity Program</td>
<td></td>
<td>5.1b.1</td>
<td>Develop plan for informing visitors of NOAO policies on sexual harassment and other workplace culture issues. Design content and strategy for publication and posting in appropriate physical and virtual locations.</td>
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<td>5.1b.2</td>
<td>Extend &quot;Diversity in the Cosmos and in the Workplace&quot; poster series for a full year, providing a mix of astronomy and diversity information and news in a compact and interesting format.</td>
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<td>5.1b.3</td>
<td>Organize a meeting with early career staff to present and discuss the NOAO commitment to career development as a staff privilege and responsibility. Review with HR proposed policy updates developed during this process.</td>
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<td>5.1b.4</td>
<td>Develop a plan for the implementation of a mentoring/“buddy” program for staff on KPNO.</td>
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<td>NCOA Project Office</td>
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<td>5.1c.1</td>
<td>Complete NSF AST panel review of NCOA plan.</td>
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<td>5.1c.2</td>
<td>Appoint an Interim NCOA Executive Council.</td>
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<td>5.1b.4</td>
<td>Develop a plan for the implementation of a mentoring/“buddy” program for staff on KPNO. Due Date: 30 June 2018</td>
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<td>5.1c.3</td>
<td>Complete the NCOA workforce transition and management plans.</td>
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<td>5.1c.4</td>
<td>Submit to the NSF the NCOA Program Operating Plan for FY19.</td>
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<td>Division</td>
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<td>Milestone Number</td>
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<td>Education and Public Outreach</td>
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<td>5.3.1</td>
<td>Organize and deliver three global Globe at Night citizen-science campaigns per quarter</td>
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<td>5.3.2</td>
<td>Design and provide the NOAO booth for the winter American Astronomical Society meeting.</td>
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<td>5.3.3</td>
<td>Create and staff an NOAO exhibit for the Tucson Festival of Books.</td>
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<td>5.3.4</td>
<td>Conduct a fall and spring professional development workshop for Project ASTRO teachers and astronomers.</td>
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<td>5.3.5</td>
<td>Organize and deliver three Big Data Science Café programs for high school students.</td>
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<td>5.3.6</td>
<td>Organize and complete the annual EPO Advisory Committee meeting.</td>
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<td>5.3.7</td>
<td>Coordinate and participate in at least three joint science education programs with Chilean collaboration institutions such as CEAZA, Universidad Santo Tomás, Explora-Conicyt, or other collaborators in the Region of Coquimbo.</td>
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<td>5.3.8</td>
<td>Work with the regional organizing committee to produce a coordinated educational outreach program plan (including planning for the web page, activities, and workshops) for the total solar eclipse, which will occur in the Region of Coquimbo in 2019.</td>
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<td>Central Facilities Operations</td>
<td></td>
<td>5.4.1</td>
<td>Complete design, planning and refurbishment documents to prepare for updating and/or replacement of the building cold and hot water piping systems. Due Date: 30 March 2018</td>
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<td>Computer Infrastructure Services</td>
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<td>5.5.1</td>
<td>Complete the short-term IT plan for the establishment of NCOA (domain name, Web presence, email, telecommunications, and identity management).</td>
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### Acronyms and Abbreviations

AAS — American Astronomical Society
ACTR — Advisory Committee on Technical Resources (CTIO)
AD — Associate Director (NOAO)
ADO — Associate Director’s Office (NOAO)
ALMA — Atacama Large Millimeter Array
ANTARES — Arizona-NOAO Temporal Analysis and Response to Events System
API — application programming interface
ARCoIRIS — Astronomical Research using the Cornell InfraRed Imaging Spectrograph
AST — Astronomical Sciences (Division of NSF)
ASTRO — (Not an acronym)
AURA — Association of Universities for Research in Astronomy
AURA-CAS — AURA Central Administrative Services
AURA-O — AURA Observatory in Chile
CA — Cooperative Agreement
CADIAS — Centro de Apoyo a la Didáctica de la Astronomía
CAS — Central Administrative Services (AURA department)
CEAZA — El Centro de Estudios Avanzados en Zonas Áridas
CfP — Call for Proposals
CHARA — Center for High Angular Resolution Astronomy
CIS — Computer Infrastructure Services (NOAO)
CP — Community Pipeline
CSDC — Community Science and Data Center (NOAO)
CTIO — Cerro Tololo Inter-American Observatory
DA — diversity advocate
DECaLS — Dark Energy Camera Legacy Survey
DECam — Dark Energy Camera
DES — Dark Energy Survey
DESI — Dark Energy Spectroscopic Instrument
DKIST — Daniel K. Inouye Solar Telescope
DL — Data Lab (NOAO)
DMO — Data Management Operations
DOE — Department of Energy
DR — data release
EPDS — Extreme Precision Doppler Spectrograph (now NEID)
EPO — Education and Public Outreach (NOAO)
ETS — Engineering & Technical Services (NOAO)
F&A — Facilities and Administrative
FITS — Flexible Image Transport System
FO — Facilities Operations (NOAO-S)
FY — fiscal year
GB — gigabytes
HQ — Headquarters
HR — Human Resources
IT — information technology
ITAC — International Telescope Allocation Committee
IYA — International Year of Astronomy
JUF — joint use fee
KP — Kitt Peak
KPMO — Kitt Peak Mountain Operations
KPNO — Kitt Peak National Observatory
KPVC — Kitt Peak Visitor Center
LS — La Serena
LBNL — Lawrence Berkeley National Laboratory
LCO — Las Campanas Observatory
LCO — Las Cumbres Observatory
LMCM — Laser Mask Cutting Machine
LPTAC — Large Program Time Allocation Committee (Gemini)
LSSDS — La Serena School for Data Science
LSST — Large Synoptic Survey Telescope
MESA — Math, Engineering, and Science Achievement
MSIP — Mid-Scale Innovations Program
MzLS — Mosaic z-Band Legacy Survey
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NC</td>
<td>NOAO Core</td>
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<tr>
<td>NCOA</td>
<td>National Center for Optical-Infrared Astronomy</td>
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<td>NCSA</td>
<td>National Center for Supercomputing Applications</td>
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<td>NDO</td>
<td>National Optical Astronomy Observatory’s Director’s Office</td>
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<td>NEID</td>
<td>NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy</td>
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<tr>
<td>NN-EXPLORE</td>
<td>NASA-NSF Exoplanet Observational Research program</td>
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<td>NOAO</td>
<td>National Optical Astronomy Observatory</td>
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<td>NOAO-N</td>
<td>National Optical Astronomy Observatory-North</td>
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<td>NOAO-S</td>
<td>National Optical Astronomy Observatory-South</td>
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<td>NRAO</td>
<td>National Radio Astronomy Observatory</td>
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<td>NS</td>
<td>NOAO South</td>
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<td>NSC</td>
<td>NOAO Source Catalog</td>
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<td>NSF</td>
<td>National Science Foundation</td>
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<td>NSB</td>
<td>National Science Board</td>
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<td>NSF AST</td>
<td>National Science Foundation, Division of Astronomical Sciences</td>
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<td>NSO</td>
<td>National Solar Observatory</td>
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<td>OIR</td>
<td>optical infrared</td>
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<td>OC</td>
<td>Observatory Council</td>
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<td>OPCC</td>
<td>Oficina de Protección de la Calidad del Cielo del Norte de Chile</td>
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<td>OpsWG</td>
<td>Operations Working Group (Gemini)</td>
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<td>PB</td>
<td>petabyte</td>
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<td>PI</td>
<td>principal investigator</td>
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<td>POP</td>
<td>program operations plan</td>
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<td>POPPR</td>
<td>program operations plan progress report</td>
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<td>PROPID</td>
<td>proposal identification</td>
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<td>Q</td>
<td>quarter</td>
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<td>REUNA</td>
<td>Red Universitaria Nacional (National University Network; Chile)</td>
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<td>SAC</td>
<td>Science Advisory Committee</td>
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<td>SDA</td>
<td>Science Data Archive (NOAO)</td>
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<td>SDSS</td>
<td>Sloan Digital Sky Survey</td>
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<td>SOAR</td>
<td>Southern Astrophysical Research (a 4.1-m telescope)</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>SPRF</td>
<td>Science Personal Research Funds</td>
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<td>STELES</td>
<td>SOAR Telescope Echelle Spectrograph</td>
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<td>STEM</td>
<td>science, technology, engineering, and mathematics</td>
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<td>SWG</td>
<td>Science Working Group</td>
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<td>TAC</td>
<td>Time Allocation Committee</td>
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<td>TADA</td>
<td>Telescope Automatic Data Archiving</td>
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<td>TB</td>
<td>Terabytes</td>
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<td>TDS</td>
<td>Time Domain Services (NOAO)</td>
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<td>TelOps</td>
<td>Telescope Operations (NOAO)</td>
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<td>TIO</td>
<td>Thirty Meter Telescope International Observatory</td>
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<td>TMT</td>
<td>Thirty Meter Telescope</td>
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<td>ToO</td>
<td>Target of Opportunity</td>
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<td>UA</td>
<td>University of Arizona</td>
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<td>UITS</td>
<td>University IT Services (U. of Arizona)</td>
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<td>US</td>
<td>United States of America</td>
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<td>US NGO</td>
<td>US National Gemini Office</td>
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<td>VC</td>
<td>Visitor Center (NOAO)</td>
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<td>VoIP</td>
<td>Voice over Internet Protocol</td>
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<td>WEPOC</td>
<td>Workforce, Education, Public Outreach, and Communication</td>
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<tr>
<td>WIYN</td>
<td>Consortium consisting of the University of Wisconsin, Indiana University, NOAO, and the University of Missouri (previously Yale University was a member)</td>
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<td>ZTF</td>
<td>Zwicky Transient Facility</td>
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