



NATIONAL SCIENCE FOUNDATION  
4201 WILSON BOULEVARD  
ARLINGTON, VIRGINIA 22230

NSF 15-115

## **Dear Colleague Letter: NSF/AST Response to the NRC Report "Optimizing the U.S. Ground-Based Optical and Infrared Astronomy System"**

---

September 1, 2015

Dear Colleague:

In the 1990s, as the Gemini 8-meter telescopes were being developed, it became clear that their availability would significantly change the portfolio of large ground-based optical and infrared telescopes available to the U.S. scientific community. At that time, NSF commissioned a National Research Council (NRC) study, delivered in 1995, entitled "A Strategy for Ground-Based Optical and Infrared Astronomy"; this report helped give rise to what is commonly referred to as the "Optical/Infrared (OIR) System." The advent of the Large Synoptic Survey Telescope (LSST) in the 2020s will cause a huge shift in the way optical astronomy is carried out. In its 2013 annual report, the Congressionally chartered Astronomy and Astrophysics Advisory Committee recommended that "NSF should request a report led by the National Research Council (NRC) Committee on Astronomy and Astrophysics (CAA) to help define a revised national ground based optical/infrared (OIR) system, with a focus on the required instruments, telescopes, and public access to enable both the best science and broadest community participation in the LSST era." Pursuant to this recommendation and to the compelling need to develop a strategic plan for OIR astronomy, the NSF Division of Astronomical Sciences (AST) commissioned such an NRC report, entitled "Optimizing the U.S. Ground-Based Optical and Infrared System," which was delivered in April 2015.

This Dear Colleague Letter summarizes the initial AST response to the recent NRC report, hereafter referred to as the "OIR System Report." In this Letter, following some general comments about the role of the National Optical Astronomy Observatory, AST responses to the NRC recommendations are presented in the order in which the recommendations appeared in the Executive Summary of the Report. Comments on some of the conclusions in the Report also are included with the most appropriate recommendation.

### **1. THE ROLE OF THE NATIONAL OPTICAL ASTRONOMY OBSERVATORY (NOAO)**

The OIR System Report includes recommendations for a number of significant activities to be carried out by the National Optical Astronomy Observatory (NOAO). Under the terms of the management cooperative agreement between NSF and the NOAO managing organization, the Association of Universities for Research in Astronomy, Inc., the purpose of NOAO is "To serve as the U.S. national center for ground-based OIR astronomy; to coordinate/integrate/operate observational, technical, and data-oriented capabilities available throughout the U.S. OIR system of federal and non-federal assets." In support and fulfillment of the purpose, NOAO's mission is "To enable discovery in ground-based optical and infrared (OIR) astronomy."

All of the Report recommendations and conclusions directed at NOAO, and several others as well, are

within the scope of NOAO's purpose and mission. Hence, in principle AST agrees with all instances in the Report which state that NSF should direct NOAO to carry out a specific task. Implementation will require a mix of considerations, some more complex than others, and some more costly than others.

The OIR System Report did not offer strong recommendations on sustaining or enhancing U.S. capabilities for instrumentation and data science, so NSF plans to fold these items into the NOAO-led community-wide planning process for critical capabilities that was recommended by the committee.

## **2. OIR SYSTEM REPORT RECOMMENDATIONS**

In this section, the verbatim recommendations of the OIR System Report are presented in boldface type, while AST responses and comments follow in regular type.

**RECOMMENDATION 1. The National Science Foundation (NSF) should direct the National Optical Astronomical Observatory to administer a new telescope time exchange with participating observatories of the U.S. Optical and Infrared System. Observatory representatives would barter facilities, swap instruments, or engage in limited term partnerships for telescope time or data access on behalf of their respective constituencies, as appropriate, and NSF would barter telescope time or data access or engage in limited term partnerships to carry out proposals competed through a system-wide time allocation committee.**

AST is aware that there is a large existing global marketplace for observing time currently operating, largely on a peer-to-peer basis. Access to telescope time in the system through a more comprehensive broker mechanism has the potential to be a valuable resource for those community members without ready access to telescope time. However, the demand and supply for a public exchange are currently unknown. There first needs to be an assessment of the existing market for observing time in order to inform how best to proceed. The market research should query current telescope operators in the system as to the level of interest and the terms and conditions on participating in such a brokering exchange. Creation of an exchange as recommended must include consideration of access to data as well as access to telescope time.

Implementation of this recommendation is a natural community leadership role for NOAO and fits well within its purpose. AST will task NOAO to do the market research as the first step for assessing how this recommendation might be effectively implemented. AST also will task NOAO for an estimate of the in-house resources required to operate an exchange and for an estimate of the level of NSF incentives required.

**RECOMMENDATION 2. The National Science Foundation should direct the National Optical Astronomical Observatory (NOAO) to administer an ongoing community-wide planning process to identify the critical Optical and Infrared System capabilities needed in the near term to realize the decadal science priorities. NOAO could facilitate the meeting of a system organizing committee, chosen to represent all segments of the community, which would produce the prioritized plan. NSF would then solicit, review, and select proposals to meet those capabilities, within available funding.**

The OIR System Report provided an initial priority list of capabilities in Recommendations 3 and 4, but without specifics. The community planning group recommended here should factor report Recommendations 3 and 4 (see below) into the planning process. NOAO is the natural focus for organizing and administering the community-wide planning process. AST will task NOAO to prepare an inventory of the stakeholders and to plan for a meeting of a System organizing committee, including engagement of appropriate representatives of the LSST science collaborations, as the first step in considering the implementation of a response to this recommendation. AST also will need to consider how the priorities for system-wide OIR capabilities relate to the existing Mid-Scale Innovations Program

(MSIP) in AST.

MSIP was deliberately not structured to focus on strategic decisions because excellent new ideas and technologies arise between strategic planning points. Proposers were encouraged to identify when and how their proposal addressed decadal survey science frontiers and priorities. A new MSIP solicitation (NSF 15-580, available at [http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=nsf15580](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf15580)) has been released for FY2016/2017 funding. Preliminary proposals are due September 16, 2015. Full proposals are by invitation only and will be due February 22, 2016.

**RECOMMENDATION 3. The National Science Foundation should support the development of a wide-field, highly multiplexed spectroscopic capability on a medium- or large-aperture telescope in the Southern Hemisphere to enable a wide variety of science, including follow-up spectroscopy of Large Synoptic Survey Telescope targets. Examples of enabled science are studies of cosmology, galaxy evolution, quasars, and the Milky Way.**

AST recognizes the priority assigned to a spectroscopic capability in the Southern Hemisphere. The community planning group in Recommendation 2 is needed to define the instrument requirements based on the science case. Thus, the response to Recommendation 2 must be implemented in some fashion as a prerequisite to determining a response to this recommendation.

**RECOMMENDATION 4a. The National Science Foundation should help to support the development of event brokers, which should use standard formats and protocols, to maximize Large Synoptic Survey Telescope transient survey follow-up work.**

The development of event broker systems for transient follow up is a recognized need as major surveys are being planned and carried out, leading eventually to the needs of LSST. Efforts are ongoing on several fronts to serve different purposes. NSF is funding the Zwicky Transient Facility (ZTF) through MSIP as a source of transient events, and the Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES), a collaborative event broker development effort of NOAO and the University of Arizona. AST recognizes the need for coordination of the development efforts to facilitate standard formats and protocols. NOAO is the logical focus for such coordination and the logical entity to gather the needed inventories of development efforts and survey operators with data willing to participate in event broker testing.

"Event Brokers" is a special instance of a need for a more global and systematic approach to extracting science from LSST, including the development of so-called "Level 3" data products. AST believes that this larger issue needs exploration, and that a more mission-oriented approach may be necessary to fully exploit the science capabilities of LSST. Thus, AST will discuss with NOAO and LSST how the community planning effort of Recommendation 2 can be engaged to include a consideration of the data-product development that will be needed to maximize LSST science.

**RECOMMENDATION 4b. The National Science Foundation should work with its partners in Gemini to ensure that Gemini South is well positioned for faint-object spectroscopy early in the era of Large Synoptic Survey Telescope operations, for example, by supporting the construction of a rapidly configurable, high-throughput, moderate-resolution spectrograph with broad wavelength coverage.**

The "Generation 4, Number 3" (Gen 4#3) instrument for Gemini currently in the feasibility study stage may satisfy this recommendation, depending on the outcome of the Gen 4#3 feasibility studies. Implementation of this recommendation would then depend on the approval of an instrument procurement by the Gemini Board and the availability of funding.

**RECOMMENDATION 4c. The National Science Foundation should ensure via a robustly organized**

**U.S. Optical and Infrared (OIR) System that a fraction of the U.S. OIR System observing time be allocated for rapid, faint transient observations prioritized by a Large Synoptic Survey Telescope event broker system so that high-priority events can be efficiently and rapidly targeted.**

The statement that the NSF should "ensure via a robustly organized... System" ties this recommendation closely to Recommendations 1 and 2 for organization of the OIR System.

The activity recommended here would need to be led by an OIR System coordinator. NOAO is the logical coordinator, but it cannot "ensure" the availability of non-federal telescopes unless they have agreed to make observing time and data access available in the System.

**RECOMMENDATION 4d. The National Science Foundation should direct its managing organizations to enhance coordination among the federal components of medium- to large-aperture telescopes in the Southern Hemisphere, including Gemini South, Blanco, the Southern Astrophysical Research (SOAR) Telescope, and the Large Synoptic Survey Telescope (LSST), to optimize LSST follow-up for a range of studies.**

AST will engage the responsible managing organizations to 1) review how the NSF-supported facilities on Cerro Pachón and Cerro Tololo (Gemini, SOAR, LSST, Blanco), each of which is operated as a separate entity, can coordinate their operations to achieve efficiencies and scientific synergies that benefit all; and 2) investigate whether there are any operational advantages or scientific synergies to be gained in coordinating with non-Federal facilities in the La Serena area (Las Campanas Observatories, GMT, SMARTS).

In addition to Recommendation 4d, the OIR System Report included the following conclusion with respect to the position of SOAR in the era of LSST: "SOAR, with its 4-meter aperture, rapid response, and Southern Hemisphere location, could play an important role (with appropriate spectroscopic capabilities) in follow-up observations of moderate-brightness LSST transients." AST expects to utilize the community-based planning process (see Recommendation 2 above) to evaluate the opportunity to use SOAR to maximize the science impact of the LSST transient survey. AST also will assess the science productivity of public-access time on SOAR and evaluate its priority relative to other funding needs that are identified by the planning process.

The OIR System Report also had two conclusions on LSST-related utilization of the existing Dark Energy Camera (DECam) and the Dark Energy Spectroscopic Instrument (DESI) under development by the Department of Energy (DOE); these relate to the coordination of OIR capabilities in the Southern Hemisphere. These OIR System Report conclusions will be high on the agenda for discussions among NSF, NOAO, and DOE for future uses of DESI and DECam beyond their initial terms of service on the Mayall and Blanco telescopes, respectively.

**RECOMMENDATION 5. The National Science Foundation should plan for an investment in one or both Giant Segmented Mirror Telescopes in order to capitalize on these observatories' exceptional scientific capabilities for the broader astronomical community in the Large Synoptic Survey Telescope era, for example, through shared operations costs, instrument development, or limited term partnerships in telescope or data access or science projects.**

The provision of useful engagement of the broad U.S. astronomical community in a Giant Segmented Mirror Telescope (GSMT) program has the highest potential cost of any of the recommendations in the OIR System report. The current budget outlook in AST is not favorable for NSF participation in a GSMT for the rest of this decade. Nevertheless, NSF is exploring the potential for a partnership.

As a result of solicitation [NSF 12-526](#) "Planning a Partnership Model for a Giant Segmented Mirror Telescope", NSF and the TMT Observatory Corporation signed a cooperative agreement in 2013

initiating a five-year planning study to examine potential models for NSF participation in the Thirty Meter Telescope (TMT) for the benefit of the U.S. astronomical community. NOAO is leading TMT participation planning activities under the cooperative agreement, engaging the U.S. astronomical community, and it has established a U.S. TMT Liaison office and a U.S. TMT Science Working Group (SWG). This planning effort will lead to a set of reports based on input solicited from the scientific community that will constitute a plan with options for possible U.S. participation in TMT. The planning process must run its course before NSF will even consider potential participation in TMT.

The participation study for TMT should help inform the level of federal involvement that would be meaningful to the community. At a lower cost level, proposals for GSMT instruments are eligible for the MSIP competition, although it would be very difficult to fund the full cost of a GSMT instrument out of the MSIP funding alone.

**RECOMMENDATION 6. The National Science Foundation (NSF) should continue to invest in the development of critical instrument technologies, including detectors, adaptive/active optics, and precision radial velocity measurements. NSF should also use existing instrument and research programs to support small-scale exploratory programs that have the potential to develop transformative technologies.**

This recommendation is tied to the community planning process of Recommendation 2. Discussion is currently underway within NSF concerning the scope and balance among AST's instrumentation programs: Advanced Technologies and Instrumentation (ATI), Major Research Instrumentation (MRI), and MSIP. NSF already is engaged in a collaboration with the National Aeronautics and Space Administration (NASA), the NASA-NSF Exoplanet Observational Research (NN-EXPLORE) partnership, which will result in the installation of a NASA-funded Extreme Precision Doppler Spectrometer as a facility instrument on the WIYN telescope.

**RECOMMENDATION 7. The National Science Foundation (NSF) should support a coordinated suite of schools, workshops, and training networks run by experts to train the future generation of astronomers and maintain instrumentation, software, and data analysis expertise. Some of this training might best be planned as a sequence, with later topics building on earlier ones. NSF should use existing instrument and research programs to support training to build instruments.**

This recommendation is a useful step, but does not fully address the issue of sustaining and enhancing core expertise in instrumentation and data-enabled science. That issue needs additional study to assess the importance of this activity relative to MSIP and to long-term support for a small number of groups.

Associated with this recommendation, the Report draws the conclusion: "Making effective use of petabyte-scale databases ("big data") requires new skills, and the astronomical community working in this area needs to continue to develop algorithms and procedures for data processing and analysis to take advantage of the next generation of data sets." NOAO Data Science initiatives, especially its Data Lab Project, are already underway in this general area with high priority.

The Report also draws the related conclusion: "The scientific return from large surveys (both ground- and space-based) would be maximized if their data and catalogs were made widely available using standard protocols, with appropriate data products made available for copying or downloading when possible. Because of the volumes of data involved, the centers serving the data would be most useful if appropriate public computing cycles and storage were available to users to take data-intensive analysis to the data instead of requiring redundant copies of the data on local computing resources." In the new era, NOAO is placing strong institutional emphasis on serving science-ready data products to the community and in training the community on accessing and utilizing the data. For example, NOAO already is serving data from the NOAO Deep Wide Field Survey and the Deep Lens Survey, and also will

be serving the Dark Energy Survey after its first public data release. NOAO also will be serving data products from the DECam Legacy Survey (DECaLS) and the Mayall z-band Legacy Survey (MzLS). When combined with DES, NOAO will be serving deep, multi-color images and object catalogs over approximately 20,000 square degrees in the Northern and Southern skies.

### **3. CONCLUSION**

---

The OIR System Report makes a number of important recommendations to the NSF, for which we thank the committee and the NRC. However, we note that meaningful responses to most of the recommendations will have an associated cost, and the activities recommended for NOAO are beyond the planned scope and budget that is to be funded by NSF starting in FY 2016. Thus, augmentations to NOAO's budget and scope would be required, after consideration of tradeoffs with other funding needs.

All of the recommendations of the OIR System Report are actionable, in principle, and will be given very careful consideration. AST has access to the White Papers that were submitted to the NRC committee, and will consult those (and the community) as it continues to develop the means of implementing responses to the report recommendations and conclusions.

Sincerely,

James S. Ulvestad  
Division Director, MPS/AST