



Table of Contents and Executive Summary Final Report, ReSTAR Committee Renewing Small Telescopes for Astronomical Research (ReSTAR)

**For the complete report and more information about the ReSTAR committee,
please see <http://www.noao.edu/system/restar>**

The ReSTAR committee was formed in early 2007 by the National Optical Astronomy Observatory (NOAO) as part of its response to the 2006 Senior Review of NSF Astronomical Facilities report. The committee was asked to focus on telescopes in the range 1 to 6 meters, and to create a blueprint for developing a system of small and mid-sized telescopes, including the specific instrumentation and operational capabilities that will enable front-line science with such telescopes and maximize their scientific productivity.

The Table of Contents and Executive Summary of the ReSTAR final report are hereby provided as information for the deliberations of the Astro2010 State of the Profession Study Groups.

NOAO has developed a ReSTAR recommendation implementation plan. A discussion of that plan can be found on the NOAO ReSTAR Web site. NOAO has requested supplementary funding from the National Science Foundation for the first 3-year phase of that plan. That funding request is currently under review.

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Executive Summary, Findings, and Recommendations

The ReSTAR Committee was convened by NOAO in response to the Report of the Senior Review of the NSF Division of Astronomical Sciences, to consider the system of telescopes available to the U.S. community in a comprehensive way, such that the suite of large, moderate, and small aperture telescopes can work together to achieve the scientific goals of the community. The charge to the ReSTAR Committee was to focus on telescopes in the range 1 to 6 meters, and to create a blueprint for developing a system of small and mid-sized telescopes, including the specific instrumentation and operational capabilities that will enable front-line science with such telescopes and maximize their scientific productivity. With the assistance of the community through an online survey, a representative subset of the important observational research to be carried out on small and mid-size telescopes was identified and the instrumental and operational capabilities needed for the science were characterized.

The ReSTAR Committee endorses the following findings and recommendations.

Findings

- 1. The science to be done with small and mid-size telescopes remains compelling and competitive in the era of big telescopes. Small and mid-size telescopes continue to produce innovative science in themselves, and to provide precursor and followup observations that enhance the scientific productivity of larger telescopes. Small and mid-size telescopes also enable scientific investigations that are not possible on larger telescopes. (Section III.J)*
- 2. Specific instrumental capabilities on small and mid-size telescopes stand out as being essential to the progress of a wide range of research topics: optical spectroscopy at both high and low spectral resolution, and near-infrared spectroscopy at both high and low spectral resolution, optical imaging, and near-infrared imaging. The need for significant amounts of observing time with these capabilities dictates that such instrumentation should be available on national facilities. Moreover, the instrumentation available on small and mid-size telescopes at national facilities should be competitive with the best instruments available elsewhere. State-of-the-art instruments are important at all apertures. (Section IV.A)*
- 3. Small and mid-size telescopes contribute additionally to the discipline through their training and education functions and as test beds for innovative new instrumentation and techniques. (Section V)*
- 4. A system of small and mid-size telescopes comprising federal facilities and public access to non-federal facilities will provide a cost effective mechanism to meet the needs of the discipline for observations and also provide a more diverse set of instrumental capabilities and operations modes than can be offered through federal facilities alone. (Section VI)*

5. *NOAO, on behalf of the community, is the appropriate organization to select and negotiate with non-federal observatories participating in the ReSTAR System of small and mid-size telescopes, in cooperation with the NSF. (Section VI)*

Recommendations

1. *The continued operation of small and mid-size telescopes at the national observatories should be based primarily on the value of science produced, and publicly available time on telescopes in the ReSTAR system should be awarded on the basis of competitive review and scientific merit. (Section VI)*
2. *The number of nights needed in the system of small and mid-size telescopes can be estimated in several ways. Various approaches involving conservative assumptions consistently suggest that the equivalent of at least eight 2- to 4-m class telescopes should be available to the community for classically scheduled PI and survey programs. Telescopes in the ReSTAR System should include a mix of smaller apertures and the mix should evolve toward larger apertures over time as funding permits. (Section IV.E)*
3. *Oversubscription factors on current facilities should be monitored as new instrument capabilities come online to evaluate the ongoing need for new facilities. For key major instrument capabilities identified for the system, oversubscription factors should not exceed a factor of two for extended periods. If oversubscription factors regularly exceed two, new facilities should be considered. (Section IV.E)*
4. *In establishing the ReSTAR System, priority for funding should be provided first to assure that telescopes in the system are functioning in a safe, reliable, and efficient manner, and then that competitive instrumentation and associated software are available. Next, adding three or four 2- to 4- meter class telescopes to the system, both new and existing, and specialized time domain facilities should receive priority. (Section VI)*
5. *The specialization of both federal and non-federal 2-4 meter class telescopes should be encouraged. Specialization will provide a more limited set of observing capabilities on each telescope but should preserve a breadth of capability across the ReSTAR System. Thus, total costs for instrumentation and operation of small and mid-size telescopes could be reduced. (Section VII-A)*
6. *Additional instrumental capabilities utilized more selectively for a smaller range of science programs should be accessible for public use preferentially on non-federal facilities. (Section VI)*
7. *Access to a global network of telescopes for time-domain investigations should be made publicly available. The global network should include multiple 1-m telescope spaced around the globe for photometric monitoring and a small number of 2-m telescopes for spectroscopic monitoring. These telescopes may also contribute to*

other PI science programs that can be carried out in queue mode. Such a network should be developed in collaboration with non-federal partners. (Section IV-B)

- 8. We recommend further investment in remote observing to allow greater flexibility in telescope scheduling that will enable new observing modes. Options like short programs, snapshot modes, and some synoptic observations may be possible through more flexible scheduling. The implementation of observing scripts on small and mid-size telescopes would also permit a limited use of "queue" observations carried out by classically scheduled observers. The implementation of observing templates will improve efficiency for both classical and remote observers. (Section IV.C)*
- 9. Non-federal facilities contributing to the pool of publicly available time should meet standards of efficiency, reliability, performance, documentation, usability, and data quality that will allow investigators to obtain data with the same assurance of success that they expect at federal facilities. Non-federal facilities should be supported to achieve these levels of user services if such facilities participate in the System. (Section IV.D)*
- 10. All facilities participating in the system of small and mid-size telescopes, including both national facilities and non-federal telescopes, should provide data that can be reduced using standard systems and the data should be made publicly available after an appropriate proprietary period. Pipeline reduction of data is encouraged, if appropriate. (Section IV.D)*
- 11. We recommend that NOAO maintain a database of current capabilities on publicly accessible telescopes. This database should be easily accessed in electronic form and provide sufficient information for proposal development. (Section IV.D)*
- 12. The role of AO on small and mid-size telescopes should be considered in the development of the next AO roadmap by ACCORD and NOAO. (Section IV.A)*
- 13. Access to O/IR interferometry should also be publicly available, and the System should provide a funding support structure to enhance the efficiency and user base commensurate with the promise of recent advances in interferometric techniques and results. In the short term, partnership with existing or developing facilities is encouraged. (Section IV.B)*
- 14. The ReSTAR System of national access to federal and non-federal telescopes will evolve with time as it responds to changing scientific priorities and opportunities. A mechanism for regularly monitoring the success of the ReSTAR System and for reviewing the capabilities offered by the system through community oversight must be put in place. (Section VII.B)*