A Long-Range Plan for Optical/Infrared Ground-Based Facilities

Jeremy Mould

In the most recent decadal survey, *Astronomy and Astrophysics in the New Millennium*, the Astronomy and Astrophysics Survey Committee outlined the next generation of astronomical facilities and stressed that "effective national organizations are essential to coordinate, and to ensure the success and efficiency of, these systems. These national organizations should work with the universities and independent observatories in developing the next generation of telescopes."

This is elaborated upon in a later chapter: "Community participation in major national telescope initiatives must be led by an effective national astronomy organization working in concert with universities and similar institutions. Such an organization should in turn be subject to close community oversight with appropriate advisory bodies. It should:

- Lead the development of a strategic plan for the evolution of the capabilities of the system by organizing discussions involving the National Science Foundation (NSF), the independent observatories, the academic community, and industry.
- Be able to contribute to the scientific leadership and provide the technical expertise (e.g., professional engineering and system management), the administrative skills, and the management experience and infrastructure needed in the building of those facilities that are too large or expensive to fit within the resources of single institutions or small partnerships.
- Ensure that the United States enters international collaborations with a clear scientific purpose and a well-considered technical and administrative approach, and maintain these or modify them as appropriate for the duration of the project.
- Coordinate with the community to provide capabilities that support the suite of state-of-the-art large telescopes; such capabilities may include telescopes, instruments, archives, observing modes, and other channels for access to data."

Although there have been two other recent National Research Council studies focused on particle astrophysics and solar system astronomy, the science- and technology-based vision provided by *Astronomy and Astrophysics in the New Millennium* is particularly cogent to the National Optical Astronomy Observatory (NOAO).

Twenty-first century technology has finally surpassed Galileo in optics (ground-based telescopes can be diffraction limited, and performance gains can go like diameter of their primary mirror to the fourth power); amateur astronomy in real-time field of view; and, Kodak film in the ability to store information. The digital sky and the virtual observatory, in which data mining is an essential adjunct to new observing, will revolutionize optical/infrared (O/IR) astronomy. Realizing the scientific opportunities from these changes will fill NOAO's plate and that of its international comparator, the European Southern Observatory, beyond 2020.

Of course, it is sobering to recollect that 20 years ago, dark energy, galaxies in the reionization epoch, Gamma Ray Bursters, protoplanetary disks, and exoplanets were all unknown. However, the facilities and instruments that gave us these phenomena—Cosmic Microwave Background missions, Keck, Gemini, and the Very Large Telescope, NASA's Great Observatories, and calibration-stabilized, high-resolution spectrographs—were being confidently planned 20 years ago, with lead times as long as those we are now commencing. We should not hesitate to make long-term plans—indeed we must, to keep a steady advance of astronomical knowledge. We also should not hesitate to adjust them as required. "Plans are useless; *planning* is essential."

As intended by *Astronomy and Astrophysics in the New Millennium*, NOAO plans to submit, with university and independent observatory partners, proposals for two major new facilities before the end of the decade, one for the Large Synoptic Survey Telescope (LSST) and another for the Giant Segmented Mirror Telescope (GSMT). Recently, the Brinkman report (see *www7.nationalacademies.org/NSF-Priorities*) has charged the NSF to produce a roadmap for large research facility projects, covering the next 10–20 years, including ranking and sequencing.

NOAO serves the O/IR astronomy community and currently has the largest identifiable pool of resources (30 percent of what is required under decadal survey formulae) for operating LSST and GSMT. A requirement of the Cooperative Agreement between AURA and the NSF for managing NOAO is leadership of "community-based planning, design, and development efforts for proposed new federally-funded initiatives in ground-based optical and infrared astronomy, including the Telescope Systems Instrumentation Program, archiving of ground-based data for the National Virtual Observatory, LSST, and GSMT."

To plot out a deliberate path, as opposed to a random walk, NOAO has been asked by the NSF to convoke a community-based long-range planning committee. While it is important to carefully

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A Long-Range Plan continued

think through the membership of such a committee, it would necessarily include representatives of the essential specialist committees in the O/IR community, for example, a representative of the GSMT Science Working Group (SWG), a representative of the LSST SWG, and a representative of the System Committee. The plan should include the broader impacts of astronomy, and should outline appropriate processes for making community decisions at times when decisions need to be made.

The System Program of NOAO would support the secretariat of the committee. The committee may have a kick-off meeting as early as this summer. One or more meetings would be required specifically to maximize opportunities for input from the community at large. The January 2005 AAS meeting could provide one such opportunity. Input would be solicited from relevant international groups, e.g., the IAU Working Group on Large Scale Future Facilities. For coordination with space-based facilities, the NASA space science strategic plan is available.

Ideally, the length of such a report would not exceed the Brinkman report, *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*. The body of that report runs approximately 32 pages. The report would be submitted to the NSF division of astronomical sciences. Coordination of the plan in NOAO's area with any similar plans for NSO and NRAO is a subject well suited to the Committee on Astronomy and Astrophysics. If you are interested in contributing to this effort, please contact me at *jmould@noao.edu*.

Workshop Updates Adaptive Optics Roadmap

Steve Ridgway

The Adaptive Optics Development Program (AODP) held a Roadmap Update Workshop 26–27 April 2004 in Tucson.

Panel Members
Laird Close, Univ. of Arizona
#Richard Dekany, Caltech
Brent Ellerbroek, NOAO
*James Graham, UC Berkeley
Robert Johnson, Kirtland
#Edward Kibblewhite, Univ. of Chicago
Bruce Macintosh, LLNL
#Guy Monnet, ESO
Paul Schechter, MIT
#Andrei Tokovinin, NOAO
Peter Wizinowich, Keck

Participants
Sean Adkins, Keck
#Roger Angel, Univ. of Arizona
#Jacques Beckers, Univ. of Chicago
John Codova, Univ. of Arizona
**Craig Foltz, NSF
Paul Hillman, Kirtland
#Matt Johns, Carnegie
Michael Lloyd-Hart, Univ. of Arizona
#Claire Max, LLNL, UCSC
Ken Mighell, NOAO
#Tom Rimmele, NSO
Gary Sanders, Caltech
Mark Trueblood, NOAO

Co-Secretaries and Scribes
Steve Ridgway, NOAO
Steve Strom, NOAO

* absent
** by diveo, intermittently
# speaker

The panel report will be published shortly. The panel found that the current roadmap still provides a sound description of decadal needs. However, a number of new systems concepts have been developed in the four years since its completion:

- Ground layer adaptive optics (GLAO)
- Extreme adaptive optics (ExAO)
- Multi-object adaptive optics (MOAO)
- Optically powered deformable mirrors
- Alternative wavefront sensors
- Mid-infrared adaptive optics

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Workshop Updates Adaptive Optics Roadmap continued

Recommended AODP Priorities for the Next Funding Opportunity
(in priority order)

- Concept validation by laboratory and on-telescope testing of critical ELT technologies such as the following (in arbitrary order) with example technologies:
  - —GLAO—e.g., atmospheric measurements
  - —MCAO—e.g., tomography, low-order NGS WFS
  - —MOAO—e.g., open-loop tomography, low-order NGS WFS, hi-actuator count MEMs
  - —LTAO
  - —ExAO—e.g., WFS, coronagraphs/nullers (for segmented-pupil ELTs, moderately to massively segmented), Hi-actuator count MEMs
  - —Optically powered DFMs—e.g., deformable secondary mirrors
  - —Alternative wavefront analyzers—e.g., pyramid, interferometric
  - —MID-IR AO
- Small/low-cost and/or risky developments with potential high leverage
- Engineered components/subsystems

The Cycle 2 funding opportunity will be announced shortly.

NOAO Astronomer and Tohono O'odham Schools Official Honored by IDA

Douglas Isbell

Hugo Schwarz of the NOAO South scientific staff and Jerry Carlyle, director of operations for Indian Oasis-Baboquivari Unified School District No. 40, were each honored with an Executive Director's Award at the 2004 Annual Meeting of the International Dark-Sky Association (IDA) in Tucson on March 12.

Schwarz received the award for developing an effective civic lighting "luminescence interference index" and for his work to deploy all-sky cameras on Cerro Tololo and Cerro Pachón, which can be used to measure artificial light pollution near their observatories.

"One of the problems with lighting codes is that people feel we are prescribing the law and telling them exactly what fixtures must be in place and where," Schwarz explains. "By applying the formula for the index, you can use a mixture of luminaries. Within that cap, it allows you to do just about anything that you would like—within reason!"

Carlyle demonstrated a special concern for the environment around Kitt Peak when he discovered that lights from an existing football field at the high school in Sells, Arizona, were so bright that they cast shadows on building walls at Kitt Peak National Observatory, 15 miles away. School District No. 40 was preparing to swap campuses of the intermediate school in Topawa (17 miles from Kitt Peak) and the high school in Sells, with the intent to set up an entirely new sports field at Topawa after the move. Carlyle contacted Kitt Peak for information on how to improve the situation.

Once the move occurred, a demonstration of the new lights at Topawa was arranged. "The lights from the Topawa campus were impressive when they came on," says John Glaspey, Supervisor of Scientific Support on Kitt Peak. "They were well-aimed and well-shielded. The field was obviously lit very well, but its appearance from Kitt Peak was not objectionable at all."

"This was an excellent 'good neighbor' experience," says Kitt Peak Director Richard Green. "An organization wanted to respect the night sky around the observatory, so it asked for information, and followed through by applying it effectively. We really appreciate their efforts, and so should our visiting observers."

(For more information on the IDA, see "The International Dark-Sky Association: A Critical Resource for Astronomy" in the Kitt Peak National Observatory section.)