

NOAOGEMINISCIENCECENTER

TUCSON, ARIZONA • LASERENA, CHILE

Gemini Observing Opportunities for Semester 2005B

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2005B. US Gemini observing proposals are submitted and evaluated via the NOAO Telescope Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2005B will not be released until March 1 for the US proposal deadline of March 31, the following are our expectations of what will be offered in semester 2005B. Please watch the NGSC Web page (www.noao.edu/usgp) for the Call for Proposals for Gemini observing, which will clearly list the capabilities that one can request.

NGSC is pleased to inform the US community of the following suite of scientifically vital instrumental capabilities that will be offered in semester 2005B:

Gemini North

- The GMOS-North optical multi-object spectrograph and imager will be offered in 2005B. Multi-object spectroscopy and long-slit spectroscopy (both optionally with nod-and-shuffle mode), integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- The NIRI infrared imager/spectrograph will be offered in 2005B. Both imaging mode and grism spectroscopy mode will be available.
- The Altair adaptive optics (AO) system will be offered in natural-guide-star mode in 2005B. Gemini plans to offer the following modes of Altair in 2005B: AO-enhanced infrared imaging and spectroscopy using NIRI. The Altair/NIRI usable range for imaging has been extended to include the L band (3–4 microns).
- Michelle is a mid-infrared (8–25 micron) imager and spectrograph. Michelle will be available for imaging and for spectroscopy (with resolutions of $R = 200$ to $3,000$, and echelle spectroscopy at $R \approx 30,000$).
- Classical observing will be offered only to programs with a length of three nights or longer.

Gemini South

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2005B. Multi-object spectroscopy, long-slit spectroscopy, IFU spectroscopy (all optionally with nod-and-shuffle mode), and imaging modes will be available.
- The T-ReCS mid-infrared imager and spectrograph will be available in semester 2005B. Both the imaging and spectroscopic modes of T-ReCS will be available in 2005B.

- The GNIRS facility infrared spectrograph will be offered in semester 2005B. Four GNIRS observing modes will be available: long-slit spectroscopy with resolutions $R = 2,000$ and $6,000$; cross-dispersed spectroscopy at $R = 2,000$ (with continuous coverage from 1 to 2.5 microns) and $R = 6,000$ (noncontinuous coverage); higher-resolution mode with $R = 18,000$; and IFU spectroscopy ($R = 2,000$ and $6,000$). GNIRS will undergo a short-camera lens replacement and system maintenance starting in May, which will likely limit its availability early in semester 2005B (see the 2005B Call for Proposals for right-ascension limits).
- The Phoenix infrared high-resolution spectrograph will be offered in semester 2005B. Phoenix is available only in classical mode (in whole nights, with no three-night minimum). NGSC Staff will provide training and start-up assistance to Phoenix classical observers.
- The Acquisition Camera will be available for time-series photometry in 2005B.
- A new visitor instrument, Hokupa'a-85, may be available in semester 2005B. Hokupa'a-85 is an 85-element, curvature-sensing adaptive optics system. It was developed by the University of Hawaii, under the leadership of Mark Chun and Christ Ftaclas. Hokupa'a-85 would be offered for high-resolution infrared imaging, coupled to NOAO's ABU infrared imager. Please check the 2005B Call for Proposals.
- Classical observing will be offered only to programs with a length of three nights or longer (except in the case of Phoenix).

Detailed information on all of the above instrumental capabilities is available at www.us-gemini.noao.edu/sciops/instruments/instrumentIndex.html.

The percentage of time devoted to observations for science programs in semester 2005B is planned to be 70 percent at Gemini North and 70 percent at Gemini South. The primary use of the remainder of the time will be instrument commissioning and system verification of NIFS and the Laser Guide Star System at Gemini North, and NICI and bHROS at Gemini South.

Quick-response mode for triggered observations of targets such as gamma ray bursts is being enhanced. A new set of procedures and software is being implemented that will allow very rapid triggering. Allowing for time to interrupt the program being observed, the goal is to go from the trigger from an approved program to exposure start in less than 20 minutes. The instruments available for Quick-response programs are: GMOS-North, GMOS-South, NIRI, and GNIRS.

continued



Gemini Observing Opportunities continued

We remind the community that US Gemini proposals can be submitted jointly with collaborators in another Gemini partner country. An observing team requests time from each relevant partner country. Such multipartner proposals are encouraged because they access a larger fraction of the available Gemini time, thus enabling larger programs that are likely to have substantial scientific impact. Please note that, starting in semester 2005A, all multipartner proposals must be submitted using the Phase I Tool (PIT). The PIT software has been modified, and back end servers installed at each National Gemini Office, to allow automatic submission of the same proposal to multiple partners.

Proper operation of the Gemini queue requires that it be populated with programs that can profitably use the full range of observing conditions. Gemini proposers and users have become accustomed to specifying the conditions that are

required to carry out their observations, with the help of the Integration Time Calculators at the Gemini Web site. NGSC wishes to remind the US community that a program has a higher probability of being awarded time and being executed if the best observing conditions are not requested. The two conditions that are in the greatest demand are excellent image quality and no cloud cover. We understand the high demand for these excellent conditions, but wish to remind proposers that programs that make use of less-than-ideal conditions are also needed in the queue.

NOAO accepts Gemini proposals via the standard NOAO Web proposal form and the Gemini PIT software. We remind proposers that NOAO offers a tool to allow PIT submitters to view how their proposal will print out for the TAC (see www.noao.edu/noaoprop/help/pit.html).



GNIRS Key Science Opportunity in Semester 2005B

Taft Armandroff, Jeremy Mould & Steve Strom

Since semester 2004B, the Gemini Near-Infrared Spectrograph (GNIRS) has been in use for community science programs. NOAO seeks to enable the US community to further exploit the powerful capabilities of GNIRS for major scientific initiatives.

As announced in previous issues of the *NOAO-NSO Newsletter*, NOAO is conducting a program to enable observations with high scientific potential that require significant blocks of time with GNIRS on Gemini South (15 to 20 nights over the first two to three years of GNIRS use). Proposers must agree to make all Gemini data and ancillary information available publicly following a minimal proprietary period (less than six months). Please submit such proposals using the normal NOAO Time Allocation Committee (TAC) process, but indicate in the Abstract that your proposal is to be considered for the "GNIRS Key Science Opportunity." The TAC will evaluate the scientific merit of these proposals. In addition, because discretionary time from the NOAO Director will be used for this program, the Director will employ the following criteria in evaluating proposals:

- Intrinsic scientific merit as evaluated by the TAC
- Breadth and quality of the scientific team and its demonstrated track record
- Enhancement of undergraduate education through involvement in research
- Potential value of the archival database to other users
- Plans to manage data reduction and archiving, and deliver data products, in a timely fashion.

We recommend that you address the last three bullets explicitly in your proposal.

During the proposal review process for semester 2004B, NOAO selected the first program for GNIRS Key Science, "A Near-Infrared Kinematic Survey of Nearby Galaxies: Black Holes, Bulges, and the Fundamental Plane," by Karl Gebhardt (University of Texas) and colleagues. This program was continued in semester 2005A. In addition, a second program of GNIRS Key Science, "A GNIRS Survey of Massive Galaxies at $z \sim 2.5$: Stellar Populations, Kinematics, and Scaling Relations in the Young Universe," by Pieter Van Dokkum (Yale University) and colleagues was initiated. We wish these teams great success with their GNIRS programs, and we look forward to ambitious GNIRS Key Science submissions for semester 2005B.



Update on the Opportunity to Use Gemini to Observe the Deep Impact Comet Encounter

Verne Smith

The Gemini telescopes will be used to support observations of the Deep Impact encounter with Comet Tempel 1 in July 2005. The Deep Impact spacecraft is now well on its way to intercept the comet, having been launched successfully on 12 January 2005. The encounter with Comet Tempel 1 by the “fly-by” spacecraft, and impact by the “impactor,” are planned to occur on 4 July 2005. This means that both Gemini telescopes will be devoted to observing Comet Tempel 1 on the nights of 3–5 July 2005. Gemini will issue a “Call for Proposals” to observe the comet impact; keep an eye on the Gemini Observatory Web site (www.gemini.edu) for this call. More information and updates on the Deep Impact mission can be found at deepimpact.jpl.nasa.gov and deepimpact.umd.edu.

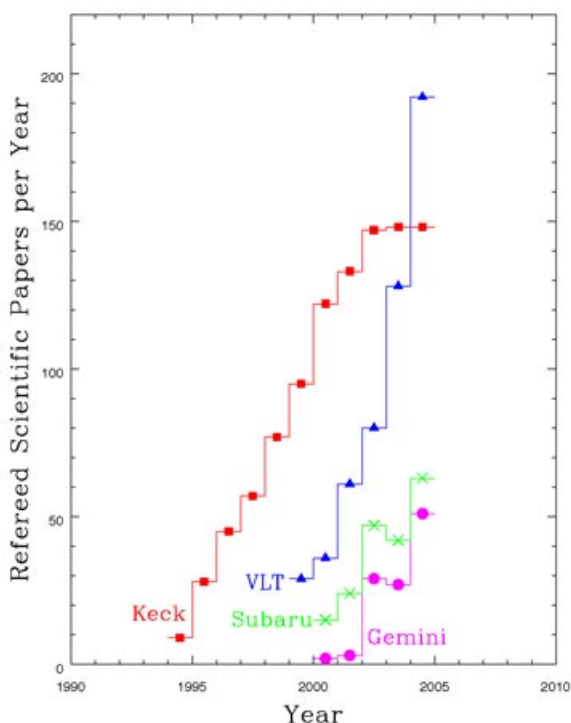
Gemini Publications

Verne Smith

Science observing with the Gemini telescopes is increasing rapidly in terms of percentage of time devoted to the scientific programs of users, as well as in the number of instruments supported. This increase in collected scientific data should be followed by an increasing amount of published results from Gemini observations. With 2004 just ended, it is an opportune time to chart the Gemini telescopes’ scientific productivity over time, especially in relation to other large, ground-based telescopes.

There are various ways to measure scientific productivity, but one straightforward method, which is also relatively easy to track and compare, is to catalog papers published in major peer-reviewed journals. The Gemini Observatory maintains a Web page that lists such papers that are based on observations taken with the Gemini telescopes (see www.gemini.edu/science/publications/users.html).

The accompanying figure shows a graphical view of the Gemini papers, with the number of refereed papers per year plotted versus the year published. In addition to Gemini, refereed publications from the other large, ground-based telescopes (Keck, the Very Large Telescope, and Subaru) are shown. The compilation of papers used in this display was obtained from the Astrophysics Data System by searching for the respective observatory telescope name or acronym. The major journals considered include *Astronomy & Astrophysics*, the *Astrophysical Journal* (including the *Letters*), the *Astronomical Journal*, *Astronomische Nachrichten*, *Icarus*, *Publications of the Astronomical Society of Australia*, *Publications of the Astronomical Society of Japan*, *Publications of the Astronomical Society of the Pacific*, *Nature*, *Science*, as well as the major physics and geophysics journals. Possibly some papers are missed in the name searches, so these numbers are, if anything, lower limits.



Publishing rates, measured as number of refereed journal papers per year versus the year published, for four observatories with 8- to 10-meter-class telescopes.

There are a few points worth mentioning about the figure. The number of papers published per year increases from first light in a similar way for all four observatories, but note that Keck consists of two 10-meter telescopes, the VLT has four 8.2-meter telescopes, Subaru has one 8.2-meter telescope,

continued



Gemini Publications continued

and Gemini has two 8.1-meter telescopes. If one is interested in the number of papers per telescope, the appropriate normalization must be applied. The shifts in time between the various observatory curves are due primarily to different commissioning times. If this is taken into account, and the curves plotted over each other, the early post-commissioning behaviors are similar for all of these telescopes. Along this same line, the oldest of these big telescopes, Keck, displays an interesting effect over the last three years, with a nearly constant rate of about 150 papers published per year. This may indicate that the Keck Observatory is a “mature” facility, with a veteran user community who are well educated in the available instrument suite. If this is true, then it would be expected that VLT will level off near 300 papers published per year within the next few years.

When taking into account the 10-percent time awarded to the hosts for each Gemini telescope, plus the approximately 10-percent time assigned to International Gemini Staff, the

United States share of the total time is about 40 percent. If a major country is assigned to the published Gemini papers based upon such criteria as lead author, or fraction of coauthors, the United States share of published papers is within a percent or two of 40 percent, which shows the expected balance between time assigned to US community users and research papers published.

Gemini remains a young observatory with an increasingly seasoned group of users. We expect the scientific output from the Gemini telescopes to continue to increase, especially as the user community becomes more experienced with the set of available instruments. Already in the first month of 2005, seven Gemini papers appeared. We urge those Gemini users who have obtained Gemini data to follow through with subsequent data reduction and analysis and, of course, to publish their results. The NOAO Gemini Science Center staff are committed to help the community at every step along the way.

Gemini/IRAF Project Update

Mike Fitzpatrick for the Gemini/IRAF Team

The Gemini/IRAF Project is a collaboration between Gemini Observatory and NOAO with the twin goals of improving and enhancing both the GEMINI data reduction software and the underlying IRAF system that it uses. The next few months will see at least two releases of the GEMINI package timed to support new instrument modes, and at least one core IRAF release needed to support the release of new applications and system software.

The V1.8 release of the GEMINI package should be available at about the time of publication of this newsletter and is the fourth major release of the package under this collaboration. This release is focused largely on improvements to the GNIRS package and specifically adds support for GNIRS IFU reductions.

Work on a new MOS/Long-slit package has already begun in Hilo, and a series of internal testing releases will occur before it is made more generally available. Work on this package is expected to continue throughout the year; the resulting package will support a wide range of current Gemini instrumentation and be easily extensible to next-generation MOS/Long-slit instruments. The design of a Generic IFU package was only just completed and implementation has now begun with similar goals of providing a common reduction package for IFU instruments. A GEMINI V2.0 release planned for this summer will make available the first installments of both packages as well as other compiled and script-task modifications aimed at improving processing efficiency and meeting the project's goals of a more robust package.

A new version of the IRAF Command Language with error-handling capabilities has also been released for testing and development use by the project and will become part of the core IRAF system in a future release. The ECL, as it is known, provides a more complete and accurate reporting of errors from script tasks as well as the ability for a script to trap and recover from errors. GEMINI tasks using the ECL should be more resilient to crashes, or if they do fail, can at least be more descriptive about what happened. Many other enhancements to the ECL have either already been implemented or are planned as part of future ECL development (see the IRAF Web site for details).

A new header-editing task, called NHEDIT, has also been developed to simplify the job of updating MEF image headers during many stages of GEMINI reductions. It features the ability to do multiple edits of an image from a single call, as well as the ability to add and edit keyword comments, making it useful in a wide variety of applications. This task, available in the FITSUTIL external package, will also see future enhancements.

New releases of Gemini/IRAF software will be announced on the Gemini, NGSC, and IRAF home pages as they become available. For more information and progress reports, please see iraf.noao.edu and www.gemini.edu/sciops/data/dataSoftwareReleases.html.



Following the Aspen Process: The Gemini Wide-Field Multi-Object Spectrograph (WF MOS)

Arjun Dey (NOAO), Daniel Eisenstein (University of Arizona), Rosie Wyse (Johns Hopkins University) & Sam Barden (Anglo-Australian Observatory), for the WF MOS Team

Wide-field spectroscopic surveys have the potential to revolutionize our understanding of the Universe and its contents. Spectroscopy provides a powerful observational tool with which to probe the physical processes that shape the Universe, and to measure fundamental properties of astronomical objects, for example, distances, dynamics, kinematics, chemistry, temperatures, densities, metallicities, stellar content, and masses. As a result, large spectroscopic surveys provide unique probes of cosmology, galaxy formation, evolution and dynamics, and stellar astrophysics. Such surveys can address some of the really BIG questions in astrophysics: What is the equation of state of dark energy? Does it change with time, and if so, how? What is the nature of dark matter on large and small scales? How do galaxies form and evolve? What is the history of our Galaxy? Are there common threads to the formation of our Galaxy's different dynamical components?

Recognizing the importance of these questions, and the power of wide-field spectroscopy to address them, the 90 members of the astronomical community attending the Gemini Aspen Instrumentation Workshop in June 2003 recommended that the Gemini Observatory pursue the development of a wide-field fiber-fed optical multi-object spectrometer. As a result, the Gemini Observatory commissioned a feasibility study of a highly multiplexed (~5,000-fiber), very wide-field (~1.5-degree-diameter) spectrometer. Such an instrument would afford more than an order-of-magnitude gain over any existing or planned multi-object capability on a large-aperture telescope.

NOAO is participating in this feasibility study, which is being led by the Anglo-Australian Observatory and involves an international team: Johns Hopkins University, Oxford University, University of Durham, University of Portsmouth, and the Canadian Astronomy Data Centre. The results of our team's feasibility study will be presented to the Gemini Observatory in a few months. An early discussion of the primary scientific case and basic design can be found in the July 2004 issue of the *AAO Newsletter* (see www.aao.gov.au/AAO/local/www/lib/newsletters/jul04/jul04.pdf).

Here, we briefly highlight the two key science drivers and provide a description of the instrument.

Dark Energy and Cosmic Sound

Recent results from the Sloan Digital Sky Survey (SDSS) and the Two-Degree Field Survey (2DF) demonstrate the power of wide-field imaging and spectroscopic surveys to shape our understanding of the Universe. For example, the recent observational confirmation of the presence of acoustic oscillations in the power spectrum of the galaxy distribution not only reinforces both our fundamental understanding of the physical conditions in the pre-recombination universe and the underlying assumptions in our current structure-formation paradigm, but also unlocks a powerful cosmological tool. Since the oscillations are signatures imprinted on the baryonic power spectrum at the epoch of recombination, their wavelength provides a robust standard ruler for cosmography.

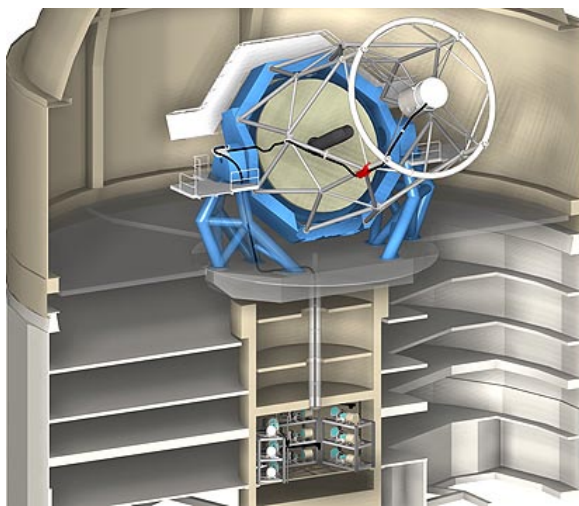


Illustration of the WF MOS instrument concept on the Gemini telescope (illustration by NOAO).

The Gemini Wide-Field Multi-Object Spectrograph (WF MOS) will be able to measure the wavelength of the acoustic oscillations in the galaxy power spectrum in a range of redshifts ($z \sim 1$ and $z \sim 3$). A precise measurement (<3 percent in the angular diameter distance) requires redshift surveys of large galaxy samples (~million galaxies) over a large volume ($\sim 1h^{-3} \text{Gpc}^3$; i.e., several hundred square degrees), and is therefore only feasible with this instrument. Compared with other probes of dark energy (e.g., weak lensing,

continued



Following the Aspen Process: WFMOS continued

supernovae, and cluster methods), the acoustic oscillations provide an independent and less model-dependent probe whose sole reliance on redshift measurements is potentially more robust against systematic errors.

Galaxy Genesis

Models dominated by Cold Dark Matter have found considerable success in simulating the large-scale structure of the Universe, but have been challenged by observations on the smaller scales of galaxies and their satellites. For example, standard models vastly over-predict the number of satellites, predict very cuspy dark matter distributions in the central regions of galaxies, and predict more late-time merging in disk galaxies than is likely, given the stability of disks. The most robust way of understanding both the small-scale structure of dark matter and the evolutionary history of a galaxy is to observe the former directly (through its influence on stellar kinematics) and infer the latter from the chemical and dynamical fossil record encoded in the light of the old stars.

Through high-resolution spectroscopy, WFMOS will provide detailed kinematics and elemental abundances for hundreds of thousands of representative stars in our Galaxy and our Local Group (disk galaxy) neighbors, which when coupled with models, will allow us to trace chemical evolution, star formation, and mass assembly in these systems. In its low-resolution mode, WFMOS spectroscopy of even larger samples of thick disk and halo stars will constrain the merger history and substructure in these components.

The Instrument

The instrument design for WFMOS is based on that for the Kilo-Aperture Optical Spectrograph (KAOS; see www.noao.edu/kaos). WFMOS is a prime-focus instrument covering a field of view 1.5 degrees in diameter. The optical design delivers ~0.5-arcsec images to the 1-arcsec-diameter fibers, and provides fast guiding through a wobble-plate. The focal plane is populated by nearly 5,000 fibers, positioned by

means of piezoelectrically controlled tip-tiltable spines. This concept was developed by the AAO and is being implemented for the FMOS spectrograph on Subaru. The fibers feed 12 low-resolution spectrographs, based on either existing Sloan Digital Sky Survey (SDSS) or AAOmega designs, and at least one high-resolution spectrograph. The goal is to provide both low-resolution ($R < 1,500$) and high-resolution ($R \sim 30,000$) spectroscopy across as much of the field as possible.

Currently, it is not clear which telescope will host the instrument. The Gemini Observatory has requested that the Feasibility Study Team detail the spectrograph for Gemini, but to also investigate the feasibility of the instrument at the prime focus of the Subaru telescope.

Legacy Data and Community Science

The only way for WFMOS to tackle the key projects described above in a timely manner is for it to be operated in campaign mode. However, we have considered multiple paths through which community involvement can be ensured. First, the community is invited to participate in the key science projects. Second, the key projects may not fill all the fibers, and there will be the possibility of assigning fibers to other sources in the regions of the sky targeted by the key projects. Third, the data products from the key projects will clearly be of invaluable use for a plethora of other projects (galaxy evolution, galactic dynamics, stellar populations, to name a few), and the databases will be open to the public. Fourth, the instrument will be available as a standard user instrument. After all, even a single observation results in spectroscopic observations of a sample of approximately five thousand objects!

The Future

Contingent on a successful review of the feasibility study, we anticipate that this instrument will enter a conceptual design phase during the latter part of 2005. In an optimistic funding scenario, we envision WFMOS to be operational on a telescope by the beginning of the next decade.

Notable Quotes

“There were a total of 2,947 first-year graduate physics and astronomy students in 2002, and 3,076 in 2003, the highest level since 1994.

For US students, the most popular subfields are astronomy and astrophysics (16%), condensed matter (14%), and particles and fields (11%). Among foreign students, condensed matter (22%) is first, followed by particles and fields (10%). A quarter of all students had not yet chosen a subfield by the end of their first year.”

—*American Institute of Physics “AIP Report,” October 2004*



NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the United States, with progress since the December 2004 *NOAO-NSO Newsletter*.

NICI

The Near Infrared Coronagraphic Imager (NICI) will provide a 1- to 5-micron dual-beam coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared (MKIR) in Hilo is building NICI, under the leadership of Doug Toomey.

The NICI cryostat, adaptive optics (AO) bench, mounting plate to the Gemini telescope, cooled enclosure mounting frame, and one of the two cooled electronics enclosures have been integrated for the first time. Progress on the NICI AO system continues. The University of Hawaii Institute for Astronomy (IfA), which is providing the components for the AO system, has produced a new batch of 85-element deformable mirrors that are intended to meet the stringent NICI requirements. IfA has also delivered the fiber lenslet array for integration into the instrument. In addition, MKIR has delivered drafts of the NICI *Users Manual* and *Service Calibration Manual* that are approximately 80 percent complete.

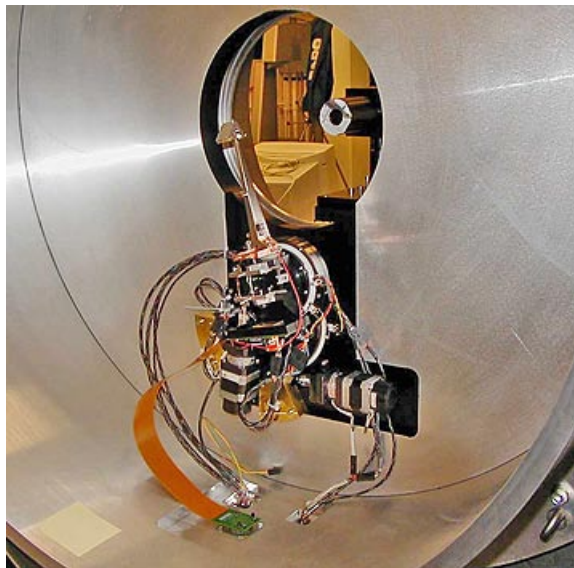
At the end of December 2004, MKIR reported that 96 percent of the work to NICI final acceptance by Gemini had been completed. NICI is expected to be deployed on Gemini South in 2005.



This image of NICI from December 2004 shows progress in integrating the instrument.

FLAMINGOS-2

FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini telescopes; it will be commissioned at Gemini North and used there for some period before being relocated to Gemini South. It will cover a 6.1-arcmin-diameter field at the standard Gemini $f/16$ focus in imaging mode, and will provide multi-object spectra over a 6.1×2 -arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multiconjugate adaptive optics system. The University of Florida is building FLAMINGOS-2, under the leadership of Principal Investigator Steve Eikenberry.



The FLAMINGOS-2 OIWS being tested at HIA.

continued



NGSC Instrumentation Program Update continued

FLAMINGOS-2 is in the early part of the integration phase of the project. Over the last quarter, Florida received several key flat mirrors and lenses from its optics vendors. The On-Instrument Wavefront Sensor (OIWFS) is being provided by the Herzberg Institute of Astrophysics (HIA), which based the FLAMINGOS-2 OIWFS on the OIWFS that they developed for the two GMOS instruments. The FLAMINGOS-2

OIWFS has undergone testing at HIA. FLAMINGOS-2 mechanical fabrication is 95 percent complete; parts are being assembled for system integration and testing. Dewar wiring is underway. At the end of December 2004, 65 percent of the work to FLAMINGOS-2 final acceptance by Gemini had been completed.

NGSC Booth at the AAS Meeting in San Diego

The NOAO Gemini Science Center booth at the January 2005 AAS meeting generated a lot of discussions with the community. NGSC staff answered questions about how to apply for time on the Gemini telescopes and about instrument capabilities, and provided tutorials on the Phase II process. Brochures were also available on the Gemini instruments, the Gemini Science Archive, and how to propose for Gemini time.



Top left: Tom Matheson (NGSC) and Alceste Bonanos (Harvard University). Top right, foreground: Taft Armandroff (NGSC), Bruce Carney (University of North Carolina), Nancy Levenson (University of Kentucky) and Verne Smith (NGSC). Center: Jay Frogel (AURA), Bill Smith (AURA), Taft Armandroff (NGSC), and Verne Smith (NGSC). Bottom left: Robin Ciardullo (Penn State University), Taft Armandroff (NGSC), and Chick Woodward (University of Minnesota). Bottom right: Todd Boroson (NOAO) and Keivan Stassun (Vanderbilt University).