

NOAOGEMINISCIENCECENTER

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Gemini Update

Taft Armandroff

The year 2003 is proving to be an exciting one for everyone involved in Gemini. A number of new instruments are being successfully deployed at Gemini, and these are leading to promising scientific opportunities for astronomers in the Gemini communities. GMOS-South, the clone of the versatile optical multi-object spectrograph and imager GMOS-North, has been delivered to Gemini South and commissioned. In a following article, Marcel Bergmann describes progress in GMOS-South commissioning. Clearly, the commissioning of GMOS-South is proceeding well, thanks in part to lessons learned in commissioning GMOS-North. After commissioning and system verification are complete, Gemini will begin to execute GMOS-South science programs, with data flowing to users.

Another exciting milestone is the delivery to Gemini South of T-ReCS, the mid-infrared imager and spectrometer developed by the University of Florida. The process of integrating and acceptance testing T-ReCS has begun. Further news of T-ReCS, including photos at Gemini South, follows later in this section of the *Newsletter*.

Many in the US community are eagerly anticipating the performance of T-ReCS, an optimized mid-infrared instrument, on the infrared-optimized Gemini telescope.

With the delivery of GMOS-South and T-ReCS, Gemini South has two facility instruments. Considering also the availability of NOAO's Phoenix high-resolution infrared spectrograph and the Gemini Acquisition Camera, Gemini South now offers a substantial range of observing capabilities to the user community. In addition, delivery of GNIRS, the facility infrared spectrograph developed by NOAO, to Gemini South is expected soon (see the NGSC Instrument Program Update article).

On Gemini North, the Altair adaptive optics system is being commissioned in its natural guide star mode. Commissioning is proceeding well. A number of issues have been found as part of this commissioning, and efforts are underway to address them. For more information on Altair commissioning, see www.us-gemini.noao.edu/sciops/instruments/altair/Altair-news-2003mar03.html.

The NOAO Gemini Science Center (NGSC) saw an enthusiastic response from the US community to the Gemini Call for Proposals for 2003B. On Gemini North for 2003B, 60 proposals were received: 28 for GMOS-North, 21 for NIRI, and 13 for Michelle. Fifty-two US proposals requested Gemini South: 18 for T-ReCS, 17 for GMOS-South, 15 for Phoenix, and 2 for the Acquisition Camera. In total, 107 US Gemini proposals sought 215 nights on the two Gemini telescopes.

As the new instruments come on line, and as more Gemini data reach the US community, we expect the demand for various capabilities to evolve. We strongly encourage US community members to explore the capabilities of the new instruments on Gemini. Available resources include the Gemini and NGSC Web pages (www.us-gemini.noao.edu), questions via the Gemini HelpDesk (www.us-gemini.noao.edu/sciops/helpdesk/helpdeskIndex.html), and the NGSC contact scientist for each Gemini capability (www.noao.edu/usgp/noaosupport.html).

Queue Observing and Nod-and- Shuffle with GMOS-North

Chris Smith

Both as an NOAO Gemini Science Center (NGSC) instrument support scientist and as the program contact for a major queue observing block with the Gemini Multi-Object Spectrograph (GMOS) at Gemini North in December 2002. GMOS-North has exceeded expectations, turning out to be a workhorse instrument almost from the moment it was mounted on Gemini North. Commissioning of GMOS-North went smoothly and quickly, and it is now regularly scheduled for science observations. Indeed, it is racking up more science time than any of the other Gemini North

instruments. This is perhaps not surprising as it is both the only optical instrument available at Gemini North and one of the most flexible instruments, providing capabilities for optical imaging, long-slit spectroscopy, multiple object spectroscopy (MOS), and integral field unit (IFU) spectroscopy. For a full description of the extensive capabilities of GMOS, see www.us-gemini.noao.edu/sciops/instruments/gmos/gmosIndex.html.

As one of the GMOS queue observers for the December observing block, I was welcomed to participate fully in the organization of

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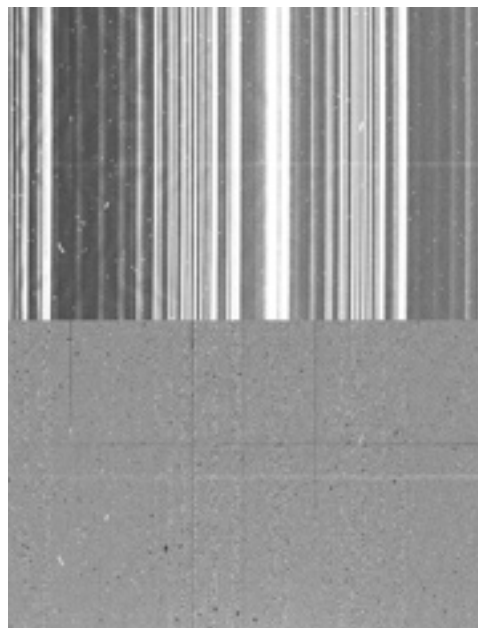
Nod-and-Shuffle continued

the run. Each night is prefaced by a Gemini crew meeting to coordinate the daytime work (maintenance, bug fixes, calibrations, etc.) with the observing to be done that night. This is followed by a discussion between the observers and the person in charge of the queue planning, usually the Gemini staff instrument scientist on duty in Hilo. The queue plan must span a range of both scientific priorities and observing conditions to cover the possibilities for the night. It is usually up to the observers to interpret the queue plan as the interplay of weather, seeing, and priorities play out as the night unfolds.

The “silent partners” in this process are the proposers, who generally only communicate with the observers through their Phase II submissions. Although the Gemini Observing Tool (OT) provides all of the necessary functionality to describe specific observations, it can still be challenging to describe one’s observations completely and clearly with the components provided, and even more challenging for both the queue planners and observers to make the critical decisions necessary based on the information in the Phase II file. Think carefully about the conditions you request, both during the proposal process and when completing the Phase II description of your observations. When filling out the Phase II, it is often best to resort to free-form explanations using the Notes component in the OT to convey information about the acceptable conditions and the instrumental setup for the observation in question. Such information can be useful for the Phase II review, which is done by the NGSC for US proposals, as well as for the queue planning and execution.

As the December queue run proceeded, the observations went fairly smoothly, with setup times that were, on average, consistent with the published overheads for GMOS imaging (15 minutes) and spectroscopy (30 minutes). The imaging overhead consists of slew, setup on guide stars, and then calculation of corrections to the shape of the primary mirror at the current position (required due to the thin, flexible mirror technology used in Gemini and several other 8-meter class telescopes). Guide star acquisition is fast with most bright ($V < 14$) stars, while setup on fainter guide stars can take a bit longer. Pushing to the published limit of $V \sim 16$ is unlikely to yield good results, since this limit is applicable for only the best of conditions. The primary mirror corrections, which use the guide star if it is bright enough, can take up to 5 minutes to iterate to an optimal solution (an overhead similar to that in other 8-meter thin-mirror telescopes). Clearly, if you can use brighter guide stars, do so!

The additional overhead quoted for spectroscopy involves centering the object(s) on the slit(s) by taking a setup image to identify the object (using finding charts provided by



(Top) The red portion (8,000–9,000 angstroms) of a spectrum taken with GMOS-North in December 2002, showing the faint object among the strong sky lines present. (Bottom) The same portion of the spectrum after nod-and-shuffle subtraction. The object shows up positive in one position, negative in the other, and the sky lines have been eliminated but for the residual Poisson noise they leave behind.

the proposer, if necessary). This image is taken in a filter matching the wavelength of the spectral observations and/or the mask image, and is usually taken binned and with fast readout to minimize the overhead. Although this image is shipped with the data distribution, it may not be of science quality due to the use of fast readout (high-noise) mode and lack of corresponding calibration frames. If the setup images would be of scientific use to your program, you should note this in your Phase II so that the images may be taken in such a way as to be scientifically calibrated and useful. For the observing program I was managing, we opted for unbinned longer exposures (300 seconds) with slow (low-noise) readout so that the images could be used in our scientific analysis of the targets. This increased our “setup overhead” slightly, but led to higher productivity for the science program overall.

After these setup images are obtained, the observer quickly analyzes the image to determine the correct alignment of the slit(s), the telescope is offset, and an additional through-the-slit image is usually taken to confirm that the object is well aligned before beginning the spectral observations. Although this process is being refined with experience,

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Nod-and-Shuffle continued

resulting in increased efficiency and the possibility of slightly reduced overheads, the many steps involved ensure the proper alignment of objects, and hence good data for Gemini users.

Specific to the program I managed for this queue run was the use of the newly commissioned “nod-and-shuffle” mode of spectroscopy with GMOS. This mode allows for very accurate subtraction of sky lines, providing especially good results in the red portion of optical spectra (see www.us-gemini.noao.edu/sciops/instruments/gmos/gmosNodShuffle.html for more information). An example of the clean subtractions in the wavelength range of 8,000 to 9,000 angstroms obtained using GMOS nod-and-shuffle long-slit spectroscopy is shown in the figure. Such subtractions have allowed absorption line redshifts to be determined for objects as faint as $i' \sim 24.7$ by the GMOS nod-and-shuffle commissioning team.

Of course, you don't get anything for free. The nod-and-shuffle mode carries with it increased observational overheads ranging from a minimum of about 25 percent to more than 50 percent, depending on the details of the observations. However, the payoff can range from much better signal-to-noise in the sky lines with simple long-

slit observations (~25 percent overhead) to much denser packing of multislit objects on a mask—with overheads up to 150 percent, compensated by the fact that spectra of more than twice as many objects are obtained with one exposure! For our program, the long-slit nod-and-shuffle mode enabled us to obtain very high-quality spectra of faint objects ($R \sim 23$) out to $z \sim 0.6$ with only nominal investment of telescope time (about 2 hours, including the approximately 25 percent overhead).

GMOS is clearly a world-class instrument that provides a deeper and crisper view of the Universe for the US astronomical community. With the addition of GMOS on Gemini South, this view is extended to the full sky, a unique aspect available only to Gemini users. While queue observations allow users to tap into this new resource from the comfort of their offices, the Phase II planning must be done with care. Take advantage of the information on the GMOS Web pages, ask questions through the HelpDesk, and don't be shy about explaining the details of your observations via a Note in your Phase II so that the support astronomers, both in the NGSC and at Gemini, can better understand not only what you're asking for, but what you really want and/or need to accomplish your science.

GMOS-South Commissioning Report

Marcel Bergmann

The New Year brought a new instrument for Gemini South: its very own Gemini Multi-Object Spectrograph (GMOS). GMOS-South is a duplicate of the instrument in the North (see previous article for a description of observing with GMOS-North), and is the first facility instrument to arrive at the telescope on Cerro Pachón. Instrument commissioning began in January, and NOAO Gemini Science Center (NGSC) staff worked hard to help out as members of the instrument commissioning team.

First light was achieved on the evening of January 18; the first image was of the globular cluster Hodge 11 in the Large Magellanic Cloud, and sported

a PSF with 0.9 arcsec FWHM, limited by atmospheric seeing. After a round of congratulations to the instrument building team, the commissioning work commenced. Initially, we focused on imaging performance, tweaking the on-instrument wavefront sensor (OIWFS) feedback loop to achieve optimal image quality, testing the various filters, and determining the absolute sensitivity of the system. These last measurements were incorporated into the Integration Time Calculator used for the 2003B proposal round. The first commissioning run also served to familiarize all of the commissioning team with the facility software that provides the interface between the observers, GMOS, and the telescope itself, allowing the efficient execution

of observation sequences. Toward the end of the January commissioning run, we started our first tests of long-slit spectroscopy. The throughput appeared to be competitive with GMOS-North, and we looked forward to grabbing more photons in February, when we would more fully commission the spectroscopic modes.

Prior to the second commissioning run in late February, GMOS was moved from the up-looking instrument port, where it had been in January, to one of the side-looking ports, its permanent home. We started the second commissioning run by adjusting the OIWFS parameters for the new orientation, and we confirmed that everything else was working as it should

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GMOS-South continued

be after the move. Then we focused on spectroscopic commissioning. We tested the reliability and repeatability of the wavelength setting and slit insertion, and the throughput of each of the grating and filter combinations. The whole commissioning process has been running very smoothly, a testament to the benefits of designing twin spectrographs for the twin North and South telescopes.

Many of the pitfalls of GMOS commissioning were encountered and solved on the North telescope a year and a half ago, and we knew what to expect and keep a lookout for with the second instrument. This was especially true when it came time to commission the nod-and-shuffle spectroscopy mode for GMOS-South. The nod-and-shuffle mode puts much more stress on the instrument and telescope than traditional optical observing techniques. The telescope must offset between nod positions accurately and frequently, all the while maintaining a good lock on the guidestar with the OIWFS. We had to optimize the sequences of turning various mechanisms on and off as the telescope nodded.

This set of commissioning tasks was greatly aided by the virtual presence of several Gemini North staff who joined us each night via videoconferences between the telescope control room and the Hilo sea-level base facility. The nod-and-shuffle commissioning proceeded without a hitch and, after two nights of optimizing the sequencing software, we were performing as well in the South as GMOS does in the North.

The instrument commissioning process is followed by and intertwined with the system verification (SV)

process. While the commissioning is designed to test specific functionalities of the instrument, its software, or the telescope, SV is a test of all the many pieces as a whole to produce scientifically valuable results. SV proposals were submitted by Gemini and National Project Office staff; were reviewed by instrument specialists, Gemini senior staff, and the National Gemini Scientists; and were approved by the Gemini Director.

The proposers are required to put together full Phase II plans that are executed at the telescope as part of a queue. SV projects are executed with the expectation that the data will be

The whole commissioning process has been running very smoothly, a testament to the benefits of designing twin spectrographs for the twin North and South telescopes.

quickly reduced and analyzed by the proposing team, and the data will be made public only months after the observations are completed. A list of the SV projects granted time on GMOS-South can be found at www.us-gemini.noao.edu/sciops/instruments/gmos/gmos_south_SVPlan.html. The public data release for the first of the GMOS-South SV data sets should occur sometime in June. Keep an eye on the above Web page for notice of the data release.

Based on the success of the commissioning through March, Gemini felt confident that the instrument would be ready in August, and therefore included GMOS-South in the 2003B call for proposals. This call has been met with an enthusiastic

response, ensuring that GMOS-South will be a workhorse for producing science from Gemini South in the near future.

However, there is still much commissioning work to be done before the instrument is ready for the 2003B queue. During March and early April, a new CCD was installed to replace one of the three CCDs in the GMOS mosaic, which had a faulty amplifier. During the CCD swap, improvements were also made to the electronic isolation of the CCDs to improve their noise characteristics. The new CCD was tested on the sky during a short commissioning run in late April. We will also begin commissioning the multi-object spectroscopy (MOS) and MOS nod-and-shuffle modes. Finally, there is a scheduled observing run in late May when we will complete the commissioning and SV observations for all of the GMOS modes offered for the 2003B semester. The integral field unit (IFU) for GMOS-South is scheduled to arrive early this fall (September/October), and will be commissioned shortly thereafter. It should be available for general proposals in the 2004A semester.

Throughout the GMOS-South commissioning process, the close involvement of NGSC scientists with the Gemini staff has been of great benefit to both groups. The NGSC staff have developed intimate knowledge of the instrument, necessary for us to effectively support our users, answer HelpDesk questions, and review proposals. At the same time, the Gemini Observatory has gained by drawing on a larger group of experienced observers to test and optimize the new GMOS.



Two NGSC Fellowships

Taft Armandroff

The NOAO Gemini Science Center (NGSC) is pleased to announce the award of two fellowships for innovative research using the Gemini telescopes. Katia Cunha is the recipient of the US Gemini Fellowship, and Rachel Mason is the recipient of the NGSC Postdoctoral Fellowship.

US Gemini Fellowships provide South American students and educators from Argentina, Brazil, and Chile with opportunities to study, conduct independent research, work, and teach in the United States at universities and similar research institutions of their choice. The recipient of the US Gemini Fellowship for the 2003–2004 cycle is Katia Cunha, currently at the Observatorio Nacional in Rio de Janeiro, Brazil. Dr. Cunha will take her US Gemini Fellowship to the University of Texas at El Paso. Her research plan addresses the chemical evolution of Local Group galaxies via high-resolution infrared spectroscopy. Cunha plans to use the Gemini South Telescope and Phoenix, NOAO's high-resolution infrared

spectrograph, in her research. The US Gemini Fellowship is carried out as a partnership between AURA and NGSC, with funding from the National Science Foundation, and provides research support for up to two years.

The NGSC Postdoctoral Fellowship encourages innovative science programs with the Gemini telescopes and includes a component of service to the NGSC community. AURA contributes to the funding of this fellowship. Rachel Mason was selected as the inaugural NGSC Postdoctoral Fellow. She expects to arrive in September 2003 (from the University of Edinburgh) and will spend part of her three-year fellowship at each NGSC site (both La Serena and Tucson). Mason plans to use the mid-infrared spectrum as a diagnostic of dust properties in both active galactic nuclei and the Galactic interstellar medium. The T-ReCS and Michelle instruments on Gemini represent opportunities to further this research.

US Members of the Gemini Board

Taft Armandroff

Under the terms of the international Gemini agreement, the Gemini Board of Directors represents all of the Gemini partners (United States, United Kingdom, Canada, Chile, Argentina, Australia, and Brazil), carries out broad oversight functions, and sets budgetary and policy bounds for the Gemini Observatory. The US Board appointments are made by the National Science Foundation (NSF) at the level of the Assistant Director for Mathematical and Physical Sciences. The Gemini Board term of Gus Oemler ended in March. All of us sincerely thank Dr. Oemler for his valuable contributions while representing the United States on the Gemini Board. Oemler brought with him the experience and perspective of the director of a major US observatory. Replacing Oemler is Professor Gillian Knapp of Princeton University. Knapp's scientific specialties include observational studies of the interstellar medium in galaxies and mass loss from evolved stars.

The other members of the Gemini Board from the United States are Bruce Carney of the University of North Carolina at Chapel Hill; Chick Woodward of the University of Minnesota; and Wayne Van Citters, who is the Director of the Division of Astronomical Sciences at the NSF and represents the foundation as the US-designated member. See www.us-gemini.noao.edu/science/#gbod for the full international Gemini Board membership.



NGSC Instrumentation Program Update

Taft Armandroff and Mark Trueblood

The NOAO Gemini Science Center Instrumentation Program continues its efforts to provide highly 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 March 2003 *NOAO/NSO Newsletter*.

T-ReCS

The Thermal Region Camera and Spectrograph (T-ReCS) is a mid-infrared imager and spectrograph for the Gemini South telescope, developed at the University of Florida by Charlie Telesco and his team.

In late November, T-ReCS passed the optical performance portion of its pre-shipment acceptance testing. Gemini, NGSC, and University of Florida personnel carried out the remaining electronic, mechanical, and software acceptance tests in February. After a few adjustments and fixes, T-ReCS was judged to have achieved all of the pre-shipment performance requirements by late March. On April 9, T-ReCS was shipped from the University of Florida to Chile, and it arrived at Cerro Pachón in good condition on April 12. T-ReCS has been reassembled and successfully test fitted to the Gemini South telescope. Next, it will be fully integrated with the Gemini South control systems and hardware interfaces, followed by final acceptance testing. This acceptance testing will include on-sky observations.

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The T-ReCS Team appears with the completed instrument.



NGSC Instrumentation continued



T-ReCS being lifted onto a truck at the University of Florida for its trip to Cerro Pachón (9 April 2003).

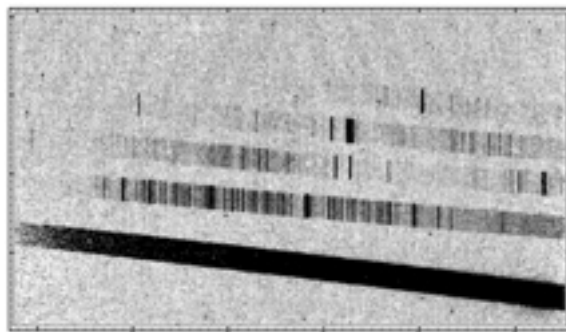


T-ReCS attached to the Gemini South telescope, with T-ReCS principal investigator Charlie Telesco (right) and T-ReCS mechanical engineer Jeff Julian (left) making adjustments (22 April 2003).

GNIRS

The Gemini Near-InfraRed Spectrograph (GNIRS) is an infrared spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales, a range of dispersions, as well as long-slit, cross-dispersed, and integral-field modes. The project is being carried out at NOAO in Tucson under the leadership of Neil Gaughan (Project Manager), Jay Elias (Project Scientist), and Dick Joyce (Co-Project Scientist).

In March, the third cycle of GNIRS cold testing was carried out. A number of issues discovered during the previous cycle were addressed before this cycle began. The science-grade infrared array was installed before this cold cycle, allowing detailed tests of the spectroscopic performance in various modes. The results of these cold tests are encouraging. In addition, flexure testing was performed using the NOAO Flexure Test Facility, and these results are also encouraging. As of mid-April, GNIRS has been warmed up, and some adjustments and fixes have been made. Once these are complete, the GNIRS Team will begin another cold cycle that is designed to test compliance with all instrument performance requirements. Then, after Gemini agrees that all of the GNIRS pre-shipment performance tests have been successfully completed, GNIRS will be shipped to Gemini South. The project schedule indicates that 99 percent of the work to GNIRS pre-shipment acceptance has been completed.



A cross-dispersed spectrum of the Tucson night sky from GNIRS with its short blue camera. It covers the wavelength interval from 0.87 to 2.5 microns and has a spectral resolution of $R \approx 1800$. The lowest order (3rd) corresponds to the K band, with successive orders covering H, J, and shorter wavelengths.