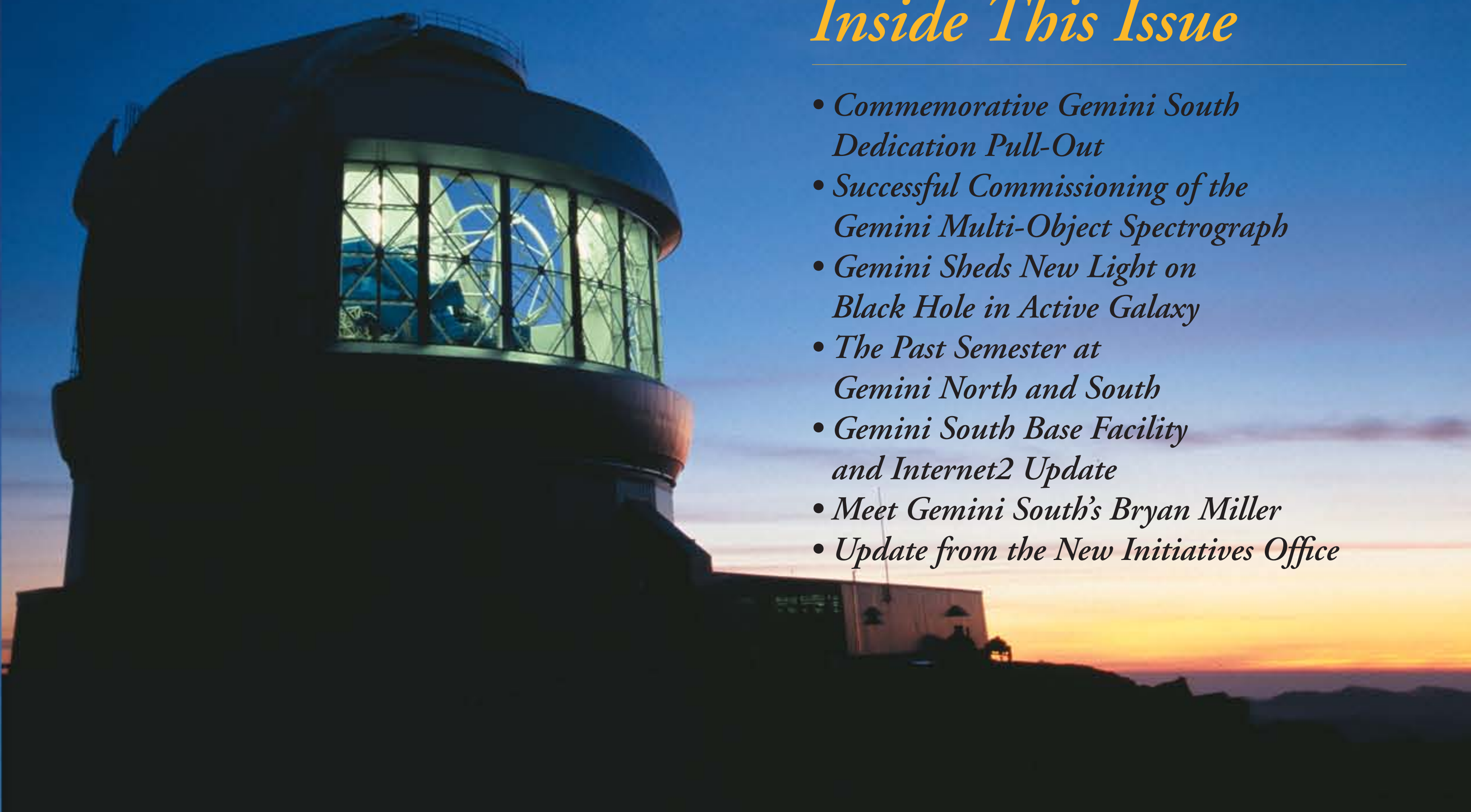
GEMINI OBSERVATORY NEWSLETTER

Issue 23

December 2001

Gemini South Dedication Issue



Inside This Issue

Gemini Captures the "Perfect Spiral"

Gemini Observatory/GMOS Team

After seven years of design and construction, but only two weeks of commissioning, this remarkable first light image was obtained with the Gemini Multi-Object Spectograph (GMOS) on the Gemini North Telescope. (see article on page 3)

The image of the large galaxy in Pisces called NGC 628 (or Messier 74) has been called the "Perfect Spiral Galaxy" due to its nearly ideal form, which is clearly revealed in this image. It is estimated that the galaxy is home to about 100 billion stars making it somewhat smaller than our Milky Way. NGC 628 is located about 30 million light years away.

GEMINI OBSERVATORY NEWSLETTER

Published twice annually in June and December.
Distributed to staff, organizations and others involved in the Gemini Observatory.
Worldwide Circulation 3,400

DIRECTOR'S REPORT

Matt Mountain

When we look at the scientific results that are already emerging from Gemini, the upcoming Gemini South dedication is especially exciting. We now have a clear glimpse of what Gemini is capable of doing and the future of Gemini is everything we had dreamed… The next decade is going to be dominated by 8 to 10 meter-class ground-based telescopes like Gemini using new detectors and technologies such as adaptive optics. I believe that it is also likely that the next generation of astronomers will look back at our collective effort as the foundation for astrophysics of the 21st century.

Star trails of the South Celestial Pole over Gemini South

This a great place to start a new journey. So, how do we plan for a journey that will take the staff and international partners of the Gemini Observatory through the next ten, twenty or even thirty years?

I just want to take a minute to transport us a decade into the future. With Gemini currently becoming operational, we now have to imagine what it will be like being an astronomer a decade from today, with the ambitious agendas that our communities have spread out before us.

Gemini, the VLT and the other large telescopes will have been operating for the past ten years. We are in the midst of a renaissance of observational and theoretical astronomy, though the "observing part" has radically changed. We have become accustomed to using sophisticated meteorological models, and detailed preplanning and coordination tools (drawing on globally accessible space-based and ground-based archives) to execute an observation. We now regularly use constellations of natural and laser guide stars that surround our objects to feed cameras and spectrographs with images of a quality that last decade were associated solely with space telescopes. An "observation" now involves a complex sequence of telescope, instrument, data reduction and storage tasks. We navigate through an apparent plethora of obstacles from varying atmospheric conditions to the avoidance of thin cirrus clouds, aircraft and satellites, all of which are repeatedly re-optimized throughout the night just to get our experiments done.

We have become accustomed to "sitting at home", and realize its probably only nostalgia that keeps us up late watching our observations progress thousands of miles away in Hawai`i or Chile. Our graduate students (who we sent to the telescopes for "training") are clearly visible on the video link, confidently uninhibited by the apparent complexity of rescheduling multi-beacon adaptive optics runs, the handling of Giga-byte data sets and protocols required to access the "Virtual Observatory" networks which now span the globe; they had all practiced on the simulators before they left home.

We have now also become adept at using the diverse group of telescopes started in the late eighties as elements in a nationally (and in some cases internationally) accessible "observing system". With this now quite natural approach (especially for those confident, "systems literate" graduate students), we will have studied the known Universe out at least a redshift of 4-5 along well-defined lines of sight. We have gathered an inventory of large planets and disc systems in our local neighborhood, which the Keck, VLT-I and ALMA interferometers now pick through on a regular basis.

The Southern Milky Way over Gemini South by Roger Smith.

Yet, times for our Optical/IR community (again a somewhat nostalgic group) are far from dull; the first Tera-byte data sets from the Large Synoptic Survey Telescope have been released, and the race is on between the privately-funded and federally-funded supercomputing centers to publish the first results. NASA is about to launch the "Next Generation Space Telescope", and the first two experimental teams (a decade ago they were called "instrument groups") of the soon-to-be-completed 30m Telescope are competing neck and neck to be the first to get their respective experiments through Critical Design Review. Both teams have swaths of graduate students eager to be released from the confines of only having access to 8m – 10m class telescopes, which for some of these young astronomers are the smallest ground-based telescopes they have ever used.

Today, we keep this exciting, if somewhat daunting, picture of a decade hence in our minds as we guide, build and develop the Gemini Observatory toward the future.

SUCCESSFUL COMMISSIONING OF THE GEMINI MULTI-OBJECT SPECTROGRAPH

Inger Jørgensen & Isobel Hook

The commissioning of the Gemini Multi-Object Spectrograph (GMOS) for Gemini North was started in early August. After some busy months preparing the instrument in the lab, GMOS was installed on the telescope in late July. On the night of August 3-4, 2001, GMOS saw first light at Gemini North. In the following five weeks, the commissioning team worked hard to get as much of the commissioning done as possible. In addition to many people on the Gemini staff, we had help on site during the commissioning from Rick Murowinski and David Crampton, both from Canada, and Jeremy Allington-Smith, Roger Davies and Chris Tierney, all from the U.K. Numerous requests for support were taken care of remotely by GMOS team members in both the U.K. and in Canada.

In a matter of a few nights, we were able to take guided exposures of very good quality with GMOS. The image of the galaxy NGC628, featured on the inside cover of this newsletter, was obtained after only seven nights of commissioning work.

GMOS has four main observing modes: imaging, longslit spectroscopy, multi-object spectroscopy (MOS) and integral field spectroscopy (IFU). The commissioning of all but the IFU mode was done during August and September. Due to bad weather in early of September, some work still remains on commissioning the IFU mode.

Commissioning Highlights

During the commissioning we obtained deep images of a field around the quasar PMN2314+0201 at redshift 4.1. The total exposure times were 1.75 hours and one hour in the g-filter and the i-filter, respectively. With these exposure times, limiting magnitudes of g=27.5 mag and i=26.3 mag were reached (5 sigma limits). The image quality for the co-added images is 0.44 arcsec in the i-filter and 0.65 arcsec in the g-filter. Image quality of this kind was achieved routinely during the commissioning in August and September. The images of the field around PMN2314+0201 reveal several candidate high redshift galaxies (g-band drop-outs). Two of the candidates are shown in *Figure 1*. These may be galaxies at the redshift of the quasar. Future imaging in the r-band may constrain the redshifts.

The MOS mode was commissioned by first observing stars in an open cluster. Having mastered these fairly easy observations, we obtained observations of galaxies in Abell 383, a rich galaxy cluster at a redshift 0.2 (*Figure 2*). The observations cover 20 galaxies (*Figure 3)*, with slit lengths of 9 arcsec and no blocking filter. Higher multi-plexing can be achieved for shorter slits and/or spectral blocking filters. With 5 arcsec slits and three banks of slits, GMOS masks can be designed to cover on the order of 180 objects.

The Current Status and Work Over the Next Few Months

In mid-October, we were back on the sky with GMOS. Our current work is focused on integrating GMOS with the high-level software and carrying out a number of System Verification programs. These programs will demonstrate the science capabilities of GMOS, and they will be carried out using the full system, including the planning of the observation sequences, obtaining the observations, and performing the pipeline data reductions used for assessing the quality of the data. All data taken as part of the System Verification programs will be made available to the community within a few months after the programs have been completed.

During the dark time in October, we obtained the required pre-imaging data for the MOS programs selected for the System Verification. These data are now being used for designing the masks. The plan for November and December is to finish the System Verification for the imaging mode, the longslit mode and the MOS mode. By November, we also plan to start obtaining the first observations for approved programs in the queue. The proposers of these programs are currently preparing their detailed observations using the Gemini Observing Tool. We will then translate the observing programs into observing sequences to be used when obtaining the observations.

In parallel, work is being done on the data processing software. This software will be made available to the community as part of the Gemini IRAF package; see http://www.gemini.edu/sciops/data/dataIndex.html for further information regarding the software. The software that is used for designing the masks for the MOS observations is also close to being available for the user community.

With the last problems being solved as the work progresses, we can now look forward to science observations being obtained with GMOS at Gemini North before the end of the year. For the semester of 2002A, the submitted proposals again show that GMOS is very popular with the community. More than half of the proposals submitted for time at Gemini North in 2002A are for GMOS observations.

For further information about the capabilities of GMOS and updates on the work, see the web pages at http://www.gemini.edu/sciops/instruments/gmos/gmosIndex.html.

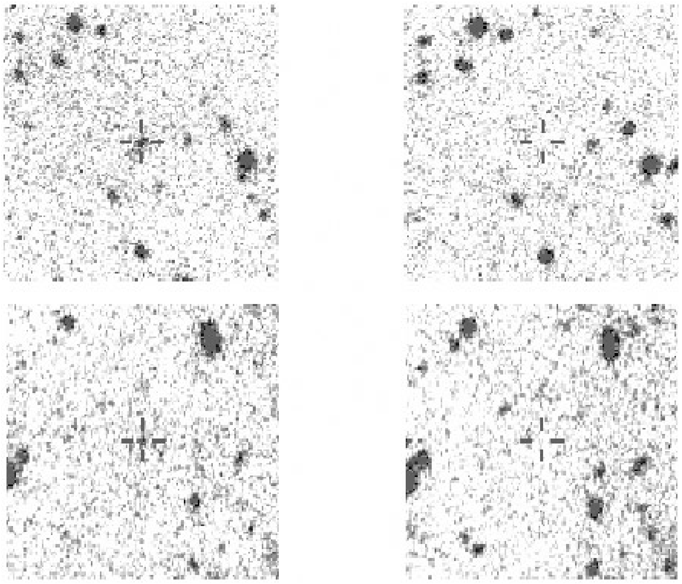


Figure 1: *Sub-images of the PMN2314+0201 observations. Each image is 20 arcsec x 20 arcsec. On the left the i-band observations, on the right the g-band observations. Candidate high redshift objects, which are not seen in the g-band observations are marked.*

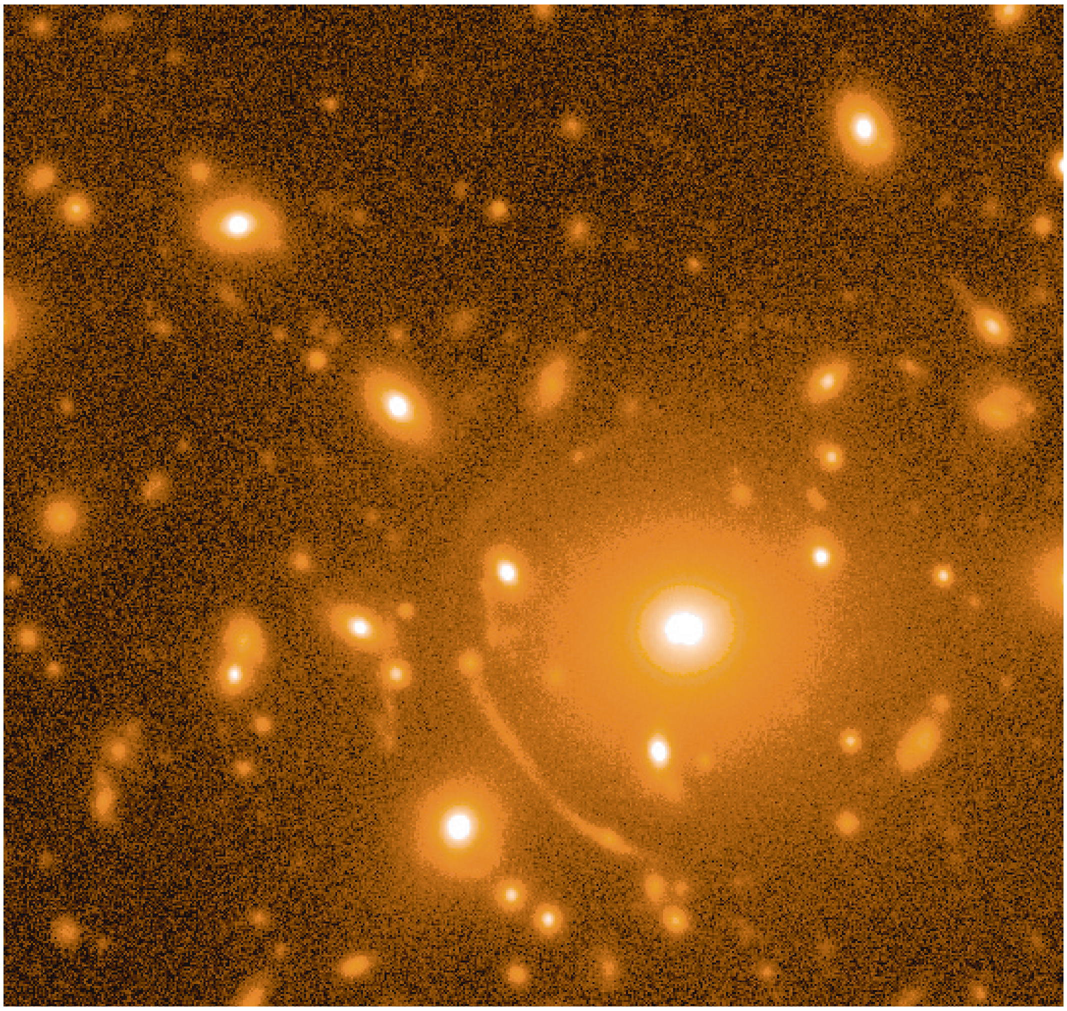


Figure 2: *GMOS image r-band of Abell 383 at redshift 0.2. This sub-image of the full imaging field covers the central 100 arcsec x 95 arcsec. With a total exposure time of 30min and an image quality of 0.67 arcsec, both giant gravitational arcs and small arclets can easily be identified in this image.*

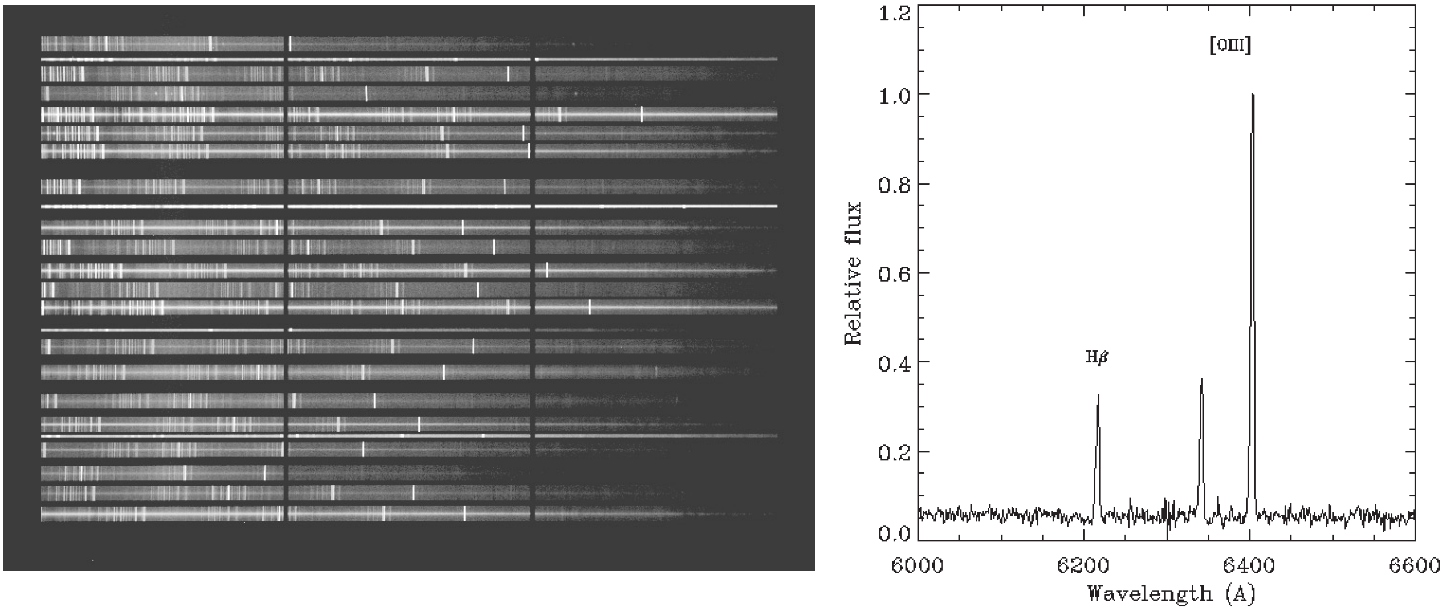


Figure 3: *The left panel shows a raw GMOS frame in MOS mode of the Abell 383 observations. Short wavelengths are to the right, and longer wavelengths are to the left in the raw frames. The right panel shows an example of an extracted spectrum of a galaxy with r=21.5 mag. The spectrum shows three emission lines at a redshift of 0.28. Thus, this galaxy is a background galaxy and not a member of the cluster.*

DEEPEST MID-INFRARED IMAGE THROWS DOUBT ON STRUCTURE OF ACTIVE GALAXIES

Eric S. Perlman {1,2}, William B. Sparks {3}, James Radomski {4}, Chris Packham {4}, John Biretta {3}, & R. Scott Fisher {5}

{1} Department of Physics, Joint Center for Astrophysics, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA, {2} Department of Physics and Astronomy, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, USA, {3} Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA, {4} Department of Astronomy, University of Florida, 211 SSRB, Gainesville, FL 32611, USA, {5}Gemini Observatory, 670 N. A'Ohoku Place, Hilo, HI 96720, USA

Due to the difficulties connected with observing in the mid-infrared, the thermal emissions from active galactic nuclei (AGN) are poorly understood. Yet understanding these same emissions must be considered one of the most important goals for ground-based and upcoming space telescopes which can observe at $\lambda \approx$ 5-30 µm.

Most theorists believe that AGN have a structure consisting of several elements (as shown in *Figure 1*) including a supermassive black hole orbited by an accretion disk (which radiates in the ultraviolet and X-ray) in its equatorial plane, a dusty region which both obscures high-energy emission and re-radiates the energy in the infrared, and energetic emission line regions where both broad and narrow emission lines in the optical and ultraviolet are generated. In addition, in radio-loud objects, which comprise about 15% of AGN, one sees powerful jets streaming out at nearly the speed of light. In this model, often called the "Unified Scheme", the properties of a given object depend strongly on the observer's viewing angle. Several components of this structure are believed to occur in galactic black-hole binary systems as well. However, in AGN, one has the extra task of separating these elements from normal galactic emissions.

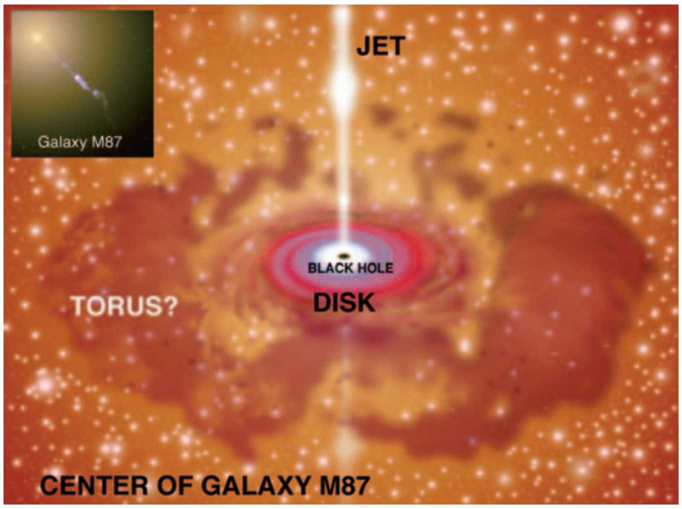


Figure 1: *Illustration of the environment around supermassive galactic black hole by Jon Lomberg.*

Mid-Infrared observations of AGN give us the opportunity to throw light on the most elusive part of the AGN structure, the obscuring regions. This obscuring region is often called the torus, after the morphology ascribed to it by unified schemes, which also predict a rough size scale of 10^5 - 10^6 times the radius of the black hole's event horizon. Due to its small size, the torus region of an AGN has never before been resolved, so that its real morphology and geometry are not constrained.

It was in the hope of actually resolving the torus region that we observed M87 at a wavelength of 10.8 microns with the Gemini Observatory 8m telescope. M87 is the nearest giant elliptical galaxy, at a distance of 16 megaparsecs, and is also the nearest and brightest object with a bright relativistic jet that is seen in the radio, optical and X-rays. Previous observations with the Hubble Space Telescope have revealed that its central black hole is particularly massive: about three billion times the sun's mass. The combination of an extremely massive black hole and its small distance would predict that emissions from the torus could be seen at radii of between 0.3-3 arcseconds.

We observed M87 on 3 and 10 May 2001 with Gemini North, using OSCIR, the University of Florida's mid-IR imager/spectrometer. We used a broad filter centered at a wavelength of 10.8 microns with a bandpass width of 5.3 microns. Because of the small size of the OSCIR detector, we used two pointing centers to capture emission from the nucleus and jet regions respectively. To subtract out the extremely high (thermal) sky background, which dominates mid-IR observations, we employed the usual strategy of chopping and nodding to a blank field. The observations required seven hours of telescope time, of which five were spent at the nuclear position and two at the jet position.

Figure 2 shows the final Gemini image, a mosaic of multiple images. For comparison, we also show in *Figure 2*, images of the M87 jet taken by the VLA (radio), Chandra X-Ray Observatory, and the Hubble Space Telescope (optical). As can be seen, the very high sensitivity and angular resolution (~0.45”) of Gemini have allowed us, for the first time, to resolve the nucleus of M87, as well as several regions of the jet. In *Figure 3*, we show a graph comparing the radial profile of the nucleus of M87 to that of a nearby star, observed the same nights under the same sky conditions. *Figure 3* shows that the nucleus of M87 appears to be surrounded by a faint nebulosity accounting for about 7% of the total nuclear flux.

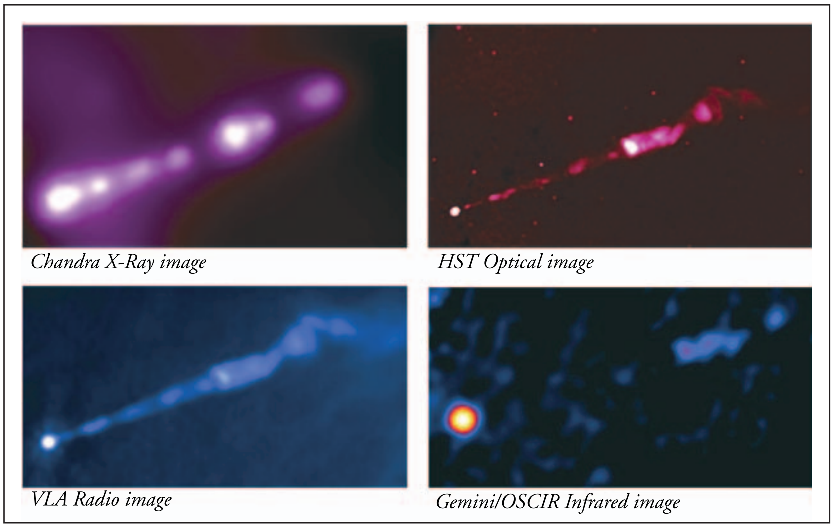
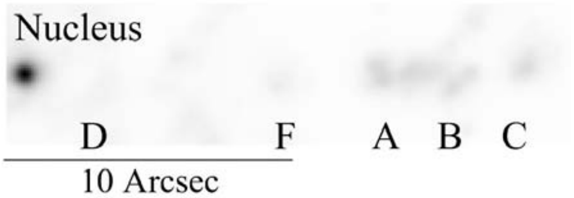


Figure 2: *The M87 jet shown at various wavelengths*

Until very recently, mid-infrared observations of M87 had only been able to detect (but not resolve) a faint flux which included contributions from various nuclear regions, the jet, and probably also, galactic components such as dust and stars. This mid-IR image of M87 is about a factor of 10 deeper than one taken by the Keck Observatory in 1999, which was recently published by D. Whysong and R. R. J. Antonucci of the University of California, Santa Barbara. The Keck image did not show jet emission and also was not deep enough to resolve the nucleus.

In order to figure out the nature of each emission component, it was necessary to compare the fluxes we detected with those seen in other wavebands. For the nuclear emission, we believed it was possible that several emission components could exist, including stars, synchrotron radiation from the innermost regions of the jet, and warm dust in the torus. Fortunately, each of these components would have a very different broadband spectrum. While the overall shape of stellar and torus emission might be similar, their temperatures would be very different: thousands of degrees for stellar emission compared to a few hundred degrees for dust emission. Synchrotron emission, by comparison, extends over a much larger range of frequencies, and has a characteristic, nearly power-law shape.



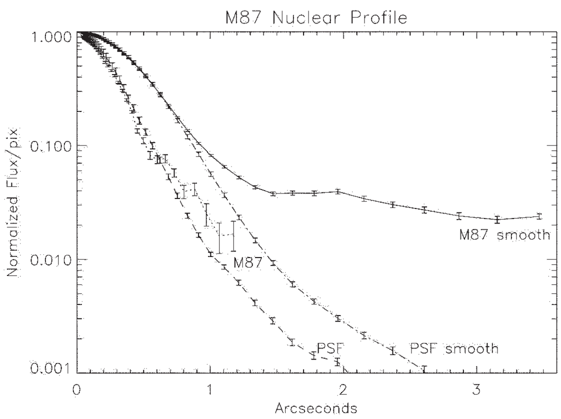


Figure 3: *A plot comparing M87’s radial profile to that of a nearby star.*

We compared the fluxes of each component to those observed in the radio, optical and X-rays. As expected, the mid-infrared emissions of each jet region we detect agree well with the predictions of synchrotron radiation. But surprisingly, the mid-infrared emissions of the nucleus agree extremely well with the prediction of a synchrotron radiation model fit to the previous radio, optical and X-ray flux measurements. Thus, any thermal emission due to warm dust in the torus must account for only a small fraction of the observed nuclear flux. It is possible that the faint extended emission could be due to torus dust; however, our current image is not deep enough to decipher the origin of this emission, which could also be from galactic stars or dust. Images in additional bands would also help, as they would allow us to fit a rough mid-infrared spectrum.

The Gemini data allows us to set an upper limit on the mid-infrared luminosity of the torus, which is orders of magnitude lower than that observed in other objects. For example, in Cygnus A and Centaurus A, two other radio galaxies, the ratio of torus luminosity to jet luminosity is about 1000 times higher. Each of those objects shows a tremendous excess of nuclear mid-infrared luminosity over the predictions of synchrotron models. Yet in all other bands, M87 appears intermediate in luminosity between
Continued on page 13

THE PAST SEMESTER AT GEMINI NORTH

Jean-René Roy - Associate Director, Gemini North

We have made remarkable progress on Gemini North during the last semester. First, the Gemini North Telescope has become more reliable. The down time due to failures of telescope/dome systems has fallen from ~20% to about 12%, making the telescope more effective for engineering tests on the sky and doing science, and the overall performance is getting closer to requirements (and even goals in some cases); for example, the pointing accuracy of both Gemini Telescopes is excellent (rms +/-0.9 arcsec over the sky). Second, the Gemini Multi-Object Spectrograph (GMOS-I), designed and built in Canada and the United Kingdom, was accepted and successfully commissioned on Gemini North during August, September and October. The first community GMOS science programs will be executed, with this facility instrument, in the queue mode starting during the second half of November. Third, Gemini-based science papers are beginning to be published. The output is still modest, but we expect a healthy growth of results appearing in the top refereed journals over the coming year.

On the negative side, the use of our first facility instrument, the Near Infrared Imager (NIRI) designed and build by the University of Hawaii, has been hampered by mechanical problems. The NIRI programs scheduled for 2001A had to be cancelled. Gemini has not yet accepted NIRI, and no science program will be executed before the final acceptance tests have been completed. The University of Hawaii Institute for Astronomy is taking steps to correct the problems. We do hope that these critical issues will be solved and that we will be able to start executing some science programs in the Queue before the end of the 2001B semester.

Early Science with the Gemini North Telescope

The Gemini North Telescope started operation in the Quick Start/Service mode in 2000B. In 2001A, the telescope was opened to visiting astronomers (Classical mode). Two visitor instruments were used: Hokupa'a/QUIRC, the Adaptive Optics System built and operated by the Adaptive Optics Group of the University of Hawaii, and OSCIR, the mid-infrared camera built and operated by the University of Florida. It is quite exciting to see the first science results from community use of these instruments on Gemini North.

The first science results from Hokupa'a/QUIRC are devoted to faint stellar companions, brown dwarf binaries, proto-planetary disks, binary asteroids, luminosity function of stars at the Galactic Center and the stellar content of the central region of M33 and QSO host galaxies. Works based on mid-infrared observations with OSCIR have included the nucleus/jet of M87, early stages of the evolution of starbursts, Seyfert galaxies, dust shells of Wolf-Rayet stars, proto-planetary nebulae and dust shells around young stars.

The main highlights from the published results are:

• In the deepest ground-based, mid-infrared image ever taken, Eric Perlman and his team have resolved the nucleus of the giant elliptical galaxy M87 and detected five optically bright knots of the synchrotron jet using OSCIR. Little, if any, evidence of thermal emission from a dusty torus was found (see article by Eric Perlman on page 6 of this Newsletter).
• In the first experiment ever to lock on a brown dwarf star, the star system 2M1426 was discovered by Laird Close and his team to be a very tight binary with a 3 astronomical units separation and a ~12 year period. The system has a M8.5 primary (0.074 solar mass) with a L1 secondary (0.055 solar mass), which is a fairly low mass companion for a brown dwarf (see *Figures 2 & 3*).
• Using Hokupa'a/QUIRC, Bill Merline and his team discovered a large companion to the Jupiter L5-Trojan Patroclus. The two components are of similar size, differing in brightness by about 0.2 mag. This is the first known binary among the Trojans.

Several early Gemini observers presented their preliminary results at the June 2001 198th AAS Meeting in Pasadena. A special 1.5-hour AAS June session on early science results from Gemini North was scheduled and it was attended by about 240 people. About half a dozen Gemini-based papers have been published, are in press or are being refereed. The main conclusions to draw from these early Gemini science results are:

1. Astronomers are exploiting the fine imaging capability of the Gemini Telescopes. At the June 2001 AAS meeting, all data shown were based on images finer than FWHM < 0.5 arcsec.
2. The users of Hokupa'a/QUIRC have had a larger number of successful science nights on the Gemini North Telescope

from the point of view of weather and technical reliability. The integration of OSCIR to the Gemini North Telescope has been challenging and several problems had to be solved; OSCIR has also suffered from more bad weather and high winds. In 2000B + 2001A, Hokupa'a was used successfully (excluding weather, telescope and instrument losses) for 370 hours on the sky versus 134 hours for OSCIR. Despite these differences, there are a surprising number of published results coming out from OSCIR.

Semester	2000B	2001A	Total
Hokupa'a/Quirc	151.42 hours	160.34 hours	312 hours
OSCIR	46.57 hours	87.3 hours	210 hours

The payback hours used are as follows

Semester	2000B	2001A	Total
Hokupa'a/Quirc	129*	100	229
OSCIR	36	75	111

(*) includes 10 nights for supporting Gemini North dedication imaging.

Figure 1: *Number of hours each visitor instrument was on the GN Telescope in 2000B and 2001A, excluding payback.*

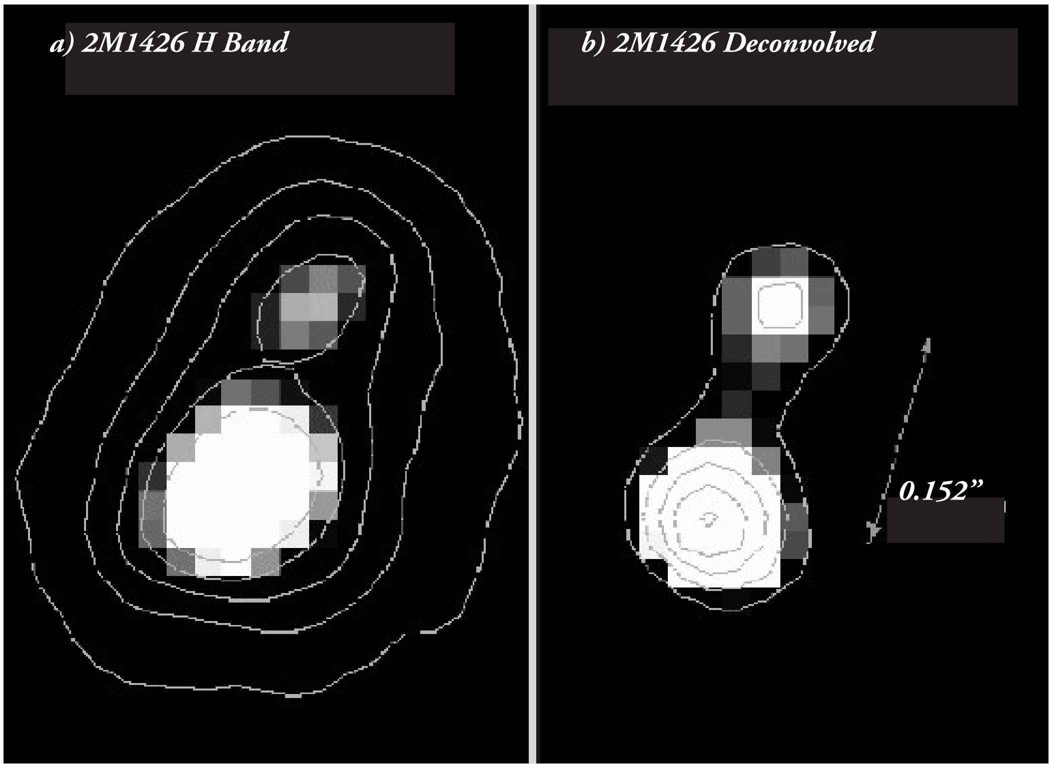


Fig.2: *(a) The brown dwarf binary, 2MASSJ1426316+155701 at H band resolution 0.131" obtained with Hokupa'a/QUIRC on Gemini North.*
(b) An image of the system after having been LUCY restored to 0.080" resolution (Close et al. 2001).

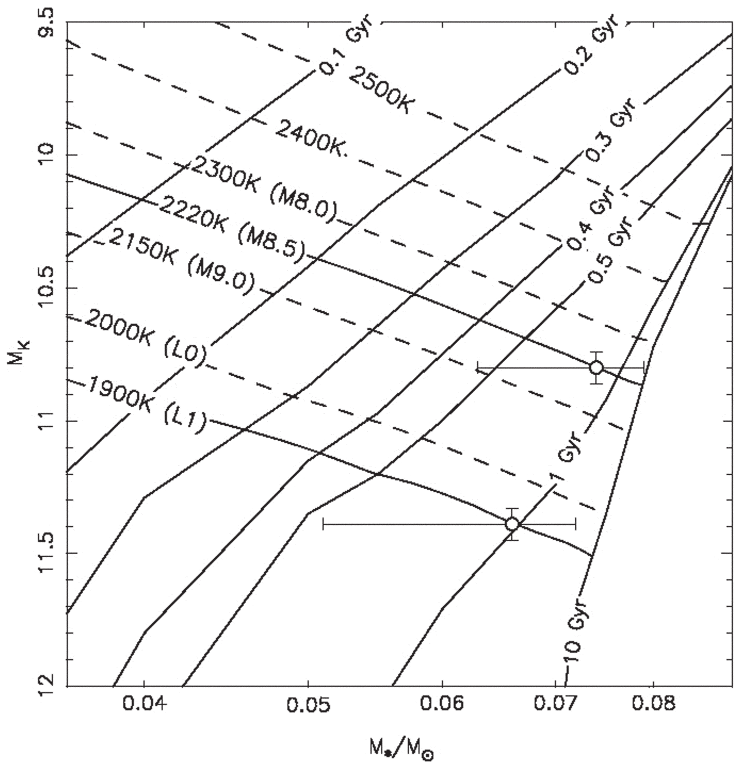


Fig. 3: *The latest Chabrier et al. (2001) DUSTY evolutionary models of low mass stars, and the temperature scale of Leggett et al. (2001). The locations of the 2 components of 2M1426 are indicated by the crosses. (Close et al. 2001).*

GMOS on Gemini North

GMOS arrived in Hilo in April 2001. The instrument was assembled and tested in the Hilo Base Facility Instrumentation Laboratory. This effort was led by Project Manager Richard Murowinski (NRC/HIA). The commissioning of the Gemini North Multi-Object Spectrograph (GMOS-N) started on the telescope on August 3rd and is nearly complete. The commissioning of GMOS is led by Inger Jørgensen (Gemini Observatory) and Isobel Hook (Gemini Observatory and Oxford University). Isobel is spending a year at Gemini to help with GMOS. The instrument scientists, David Crampton (NRC/HIA), Roger Davies (Durham University) and Jeremy Allington-Smith (Durham University) spent several weeks at Gemini to help with this effort. The imaging, long slit, multi-object and integral field unit modes of the instrument have been successfully commissioned. Most of the remaining work is devoted to completing the full integration of GMOS to the telescope and observatory environments. Several System Verification programs have been started with more to be executed. We expect to start executing 2001B Queue Programs in band 1 and 2 during the second half of November. The data obtained during commissioning or resulting from the System Verification will become available to the community starting in early 2002. The Gemini web site gives instructions on how to access and retrieve such data.

Recently, while educating colleagues about GMOS, David Crampton (NRC/HIA) came to appreciate some of its features and attempted to address the question: "How is it better than Keck LRIS?" Since Keck is bigger and LRIS has a bigger field, the answer is not immediately obvious. We are likely to encounter some of the same questions; so, here are the thoughts put forward by David in regards to GMOS:

First, the Gemini telescope/spectrograph combination acts as a complete system to exploit the large 8m aperture and improve image sharpness. Instruments for large telescopes are challenging because they must be correspondingly larger, while at the same time, being more precise (to take advantage of the smaller images). GMOS accomplishes this through carefully-engineered design of the structure and its many mechanisms, as well as, continually compensating for variations due to changes in temperature and orientation of the instrument as the telescope moves. The entire GMOS system (optics, mechanics, software, detectors) was designed to take advantage of the best images that the Gemini telescope produces. Furthermore, its wavefront sensor allows the telescope to quickly point at an object, optimize its focus, and then track it precisely for many hours. It even maintains perfect focus and corrects for possible movements of the image. As a result of the above, GMOS on Gemini is able to obtain extremely deep observations of very faint targets with a precision that has not previously been possible with any telescope.

GMOS innovations:

• New optical coating technology: Specially designed coatings, that are arguably the best in the world, give very wide-band panchromatic performance and very high throughput.

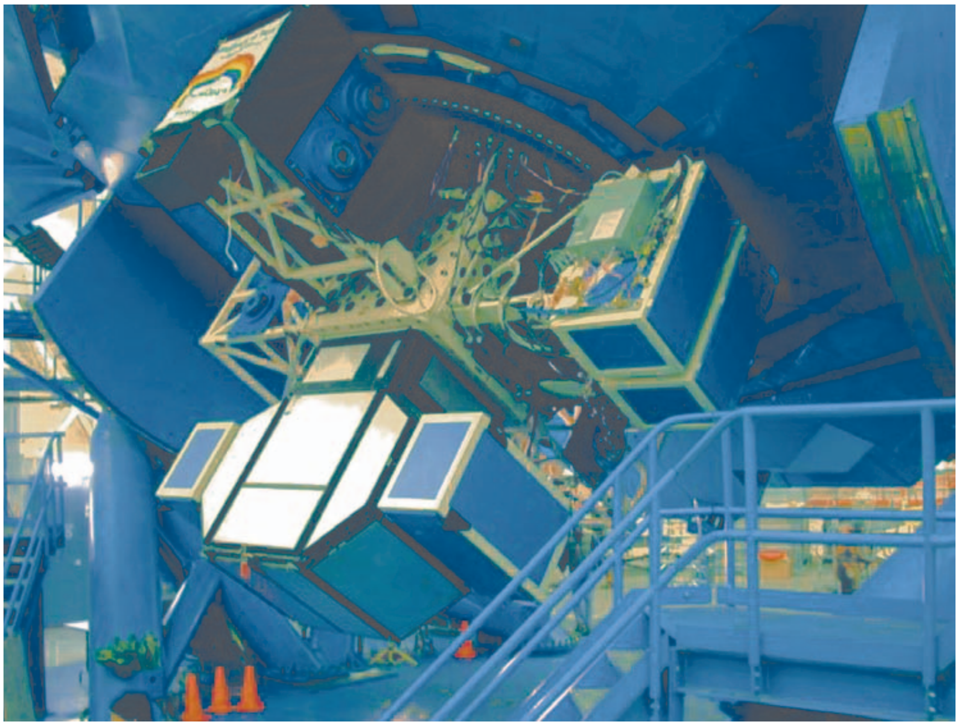


Figure 4: *GMOS mounted on the up-looking port of Gemini North.*

• New mask-making technology: Extremely precise slits can be quickly cut by a laser in special three-layer carbon fiber mask material.

• Continuous flexure control: The internal focus and detector position are automatically adjusted to correct for residual flexure, or expansion and contraction of the two-tonne instrument.

• OIWFS: A "fine-guidance sensor" that allows targets to be precisely positioned to ~10mas accuracy and, effectively, locks on to them. Even more, it automatically adjusts the focus and compensates for any vibrations (due to windshake, for example).

• Integral Field Unit (IFU): First spectrograph on an 8m-class telescope that incorporates a device that allows spectral information to be obtained from more than a thousand bits of an object simultaneously.

• Detector: First spectrograph to use a mosaic of CCD detectors to record as much data as possible simultaneously (28 megapixels) with superb resolution.

• Atmospheric Dispersion Compensator: In light of the fine image scale, the ADC will ensure that the spectral elements correspond to the same spatial sky portion for a large range of zenithal distances.

VLT/VIMOS and Keck/DEIMOS will have larger fields. VIMOS will be mostly a survey instrument, whereas we believe GMOS will let us get to the astrophysics. An important thing to remember is that it is crucial to get targets onto the slits and keep them there. Putting targets where one wants them and keeping them there, in focus, sounds trivial but it is major in terms of efficiency. We believe we will do better in that area than our competitors; we are the only ones with an On-Instrument Wavefront Sensor.

Science with NIRI

It appears that the newly designed steering mirror mechanisms have resolved the sudden flexure problems that had been affecting NIRI. While the mechanisms were designed, built and tested, NIRI was used for further commissioning work and to carry out a few of the System Verification (SV) programs. Exposures of a field containing a distant type 1a supernova and another field with a distant cluster were obtained as part of SV. These data have allowed us to verify the performance of NIRI under long exposures and to check the exposure time predictions of the Integral Time Calculator. The data are now available to the community; the Gemini web page (www.gemini.edu) describes how to access and retrieve this data.

Meanwhile, NIRI continues to have problems. Before starting the execution of Queue programs scheduled for 2001B, these problems will need to be solved. Commissioning and SV work will have to be completed. At this writing, we are looking at a slippage of several weeks. NIRI Queue programs are unlikely to be executed before the very end of November or in December 2001.

An Update on the MCAO Science Case

Francois Rigaut and Jean-René Roy have completed the final version of The Science Case for the MCAO System on Gemini South. A draft version of the document was presented at the May 2001 Gemini Board meeting and at the July 2001 GSC meeting. Furthermore, we received numerous comments from members of the Gemini community that helped to improve the science case. The 17th Gemini Science Committee (July 10-11, 2001) Report to the Gemini Director states: "it is by far the best document on this subject in existence today". The GSC recommended that the Observatory make public the present document as soon as possible. We have finalized the MCAO document. The MCAO science case document will be distributed to the participants of last fall's Santa Cruz MCAO Science Workshop, to the members of the Gemini Board and Gemini Science Committees and to observatories that have undergoing Adaptive Optics programs. Send your request to Francois Rigaut (frigaut@gemini.edu), if you wish to receive a copy of the MCAO Science Case.

*The document is also available on line as a *.pdf file at http://www.gemini.edu/documentation/webdocs/mcao_zip.*

GEMINI SOUTH ASSOCIATE DIRECTOR'S REPORT

Phil Puxley - Associate Director, Gemini South

On the night of October 4, 2001 Gemini South achieved a major milestone when the first community science observations were taken. These first data were followed by a very successful 16-night queue campaign using the University of Florida Flamingos-I near-IR imager/spectrograph and the facility Acquisition Camera visible CCD. The data have spectacular image quality with a median size of better than 0.5 arcsec clearly demonstrating that the telescope and systems are well on-track for meeting the stringent science requirements.

Of course these wonderful results are the result of a great deal of hard work by the engineering and science support staffs during 2001. A significant part of the telescope engineering work concentrated on calibrating the 6x6 Shack-Hartmann peripheral wavefront sensor (PWFS1) for closed-loop, active optics corrections. This involved comparison of the corrections measured by PWFS1 over the entire focal plane with the corrections measured on-axis using a high-resolution, 18x18 lenslet, Shack-Hartmann sensor.

Figure 1: Flamingos being mounted on Gemini South, by Christian Aguilar, Manuel Lazo and Nick Raines (left to right).

This also allowed construction of an accurate open-loop model of the lower-order terms that determine the primary mirror figure. By May we were able to demonstrate full close-loop control of tip/tilt, focus, and coma of the secondary mirror (M2) and astigmatism and trefoil terms of the primary mirror (M1). A campaign using the NOAO near-infrared commissioning camera ABU to quantify the telescope performance routinely demonstrated images with image quality around 0.4 arcsec; the best achieved was 0.25 arcsec FWHM in the K waveband (2.2um). This campaign produced some beautiful images for release at the Gemini South dedication. All of the Flamingos science data were obtained with closed-loop fast tip/tilt, focus, M2 position and M1 active optics.

Work is now proceeding on calibrating the 2x2 Shack-Hartmann peripheral wavefront sensor (PWFS2) to add a closed-loop astigmatism capability in addition to its existing tip/tilt and focus corrections. Since most of the on-instrument wavefront sensors for the facility instruments are very similar to PWFS2, this work will allow us to actively correct the largest aberrations during the majority of observations. This will reduce our reliance on open-loop models and will result in higher and more consistent image quality.

There has also been significant work to prepare the secondary mirror chopping system for science use with the T-ReCS facility mid-infrared camera/spectrograph. During September 2001 the University of Florida's OSCIR mid-infrared imager, previously used for science observing at Gemini North, was operated at Gemini South for the first time.

The installation of OSCIR on Gemini South was a straightforward process, and after acquiring and focusing on the first star of the run with the Gemini Acquisition Camera, a well-focused stellar image immediately appeared near the center of the OSCIR detector. The OSCIR dewar and on-telescope electronics were installed at the Gemini South Cassegrain cluster using the same mounting equipment as used on Mauna Kea without any modifications, demonstrating the compatibility of the mechanical interfaces at the two telescopes. The electrical interface used to control the chopping secondary from the OSCIR instrument electronics, as well as the Visitor Instrument Interface used by visiting instruments such as OSCIR to command telescope motions and read telescope pointing data, also functioned identically to their Gemini North counterparts. OSCIR quickly obtained images of stars that were nearly diffraction-limited. Unfortunately, poor weather during most of the run limited further careful testing of the image quality and instrument sensitivity.

The testing has been valuable in revealing a problem with the M2 system. The chopping secondary waveform proved to be of very high quality at duty cycles (percentage of the chop cycle for which the waveform is flat) up to 60%. However, at higher duty cycles the waveform required several tens of seconds to stabilize after the chopping was activated, an undesirably long period of time. The Gemini North chopping system typically stabilizes in a few seconds at duty cycles of about 80%, so there is a clear difference between the two systems that is now being investigated. Timely resolution of the problem should see community science observations taken with OSCIR before it is removed from the telescope to make way for its 'big brother', T-ReCS, expected to arrive in early 2002.

Figure 2: *Inspection of Flamingos beam entrance window prior to mounting on Gemini South by Manuel Lazo and Nick Raines. Photo: Neelon Crawford*

The problems with the chopping system did not affect the Flamingos science observations that commenced a few days after the OSCIR engineering run. Flamingos observations had been delayed by about two months due to repairs needed after one lens was shattered and the detector damaged during shipment to Chile. Fortunately an identical lens, due to be installed in the ISPI camera at CTIO, was made available at very short notice; we take this opportunity to extend our thanks to NOAO for their invaluable help in rescuing this science run. The damage was repaired and after a short commissioning period queue observations began on October 4. Over a period of 12 nights targets from 7 programs in the top Scientific Ranking Bands in the queue were observed. The data is currently undergoing final processing and quality assessment before being shipped to the PIs.

Science with the Acquisition Camera optical imager began immediately after the Flamingos queue. Data were acquired for several programs, including the first "Quick Response" observations of recently discovered supernovae, thereby testing the process of rapid follow-up of two "trigger" events received the same day.

Over the coming months, work will continue on improving the already impressive system reliability. Other major activities include commissioning the Phoenix near-IR high-resolution spectrograph, to be used for science observations in 2002, and preparing for the arrival of the first facility instrument, T-ReCS. The new proposals for semester 2002A show that the community eagerly awaits both of these instruments.

Continued from page 7

Cygnus A and Centaurus A. Thus the torus of M87, if it exists, must contain far less material than that of either Cygnus A or Centaurus A.

The lack of bright torus emission from M87 in the infrared has important implications for our view of the inner regions of AGN. Is there a class of AGN which do not have significant amounts of obscuring material in their inner regions? If so, what are the characteristics of these objects and how do they differ from other AGN? These questions cry out for deep, high-angular resolution mid-IR observations of a large sample of AGN. As a telescope which is optimized for infrared observations, Gemini can make a unique contribution in this area. While R. R. J. Antonucci and his group are already conducting a mid-IR survey of 3CR radio galaxies with the LWS instrument on Keck, the example of M87 shows that those observations will not be deep enough to constrain well the dust emissions from AGN which have either very faint tori or no tori at all.
email perlman@jca.umbc.edu

PROJECT UPDATE

Jim Oschmann & Eric Hansen

The construction phase of the project was declared complete with the approval of the Gemini Board in its May meeting. This marked a major milestone for the project and it continued to shift the focus of the project to operations and science use of both telescopes. Since that announcement, a number of other important events have happened at both telescopes. In the south, progress on commissioning has continued and has brought Gemini South to parity with its twin in the north. Closed-loop active-optics control of the primary mirror figure is now used regularly at both telescopes. Demonstration of the importance of that technique came in the south on the second night dedicated to use of ABU, a near-infrared imager borrowed from CTIO, when we were able to take star images with a FWHM as low as one quarter of an arc-second. Soon after, science use of Gemini South began at the 30% level. Although hampered by instrument problems and bad weather during the southern winter, recent results from Flamingos are encouraging.

In the north, a major milestone was GMOS first light. This achievement was a great success and the GMOS team is to be commended for their hard work during the commissioning process (see article on page 3).

Science use in the north continue through the current semester, with the focus shifting from commissioning the telescopes to commissioning instruments and science use. Engineering priorities are also being redirected based on improvements made in data-collection efficiency. This is now a very high priority with work on data collection efficiency occurring at several levels of our high-level software as well as automation of critical areas of real-time systems.

Gemini North

This summer (northern hemisphere), initial tests of high-level sequencing were done at Gemini North using NIRI. The Observing Tool was used to generate observing

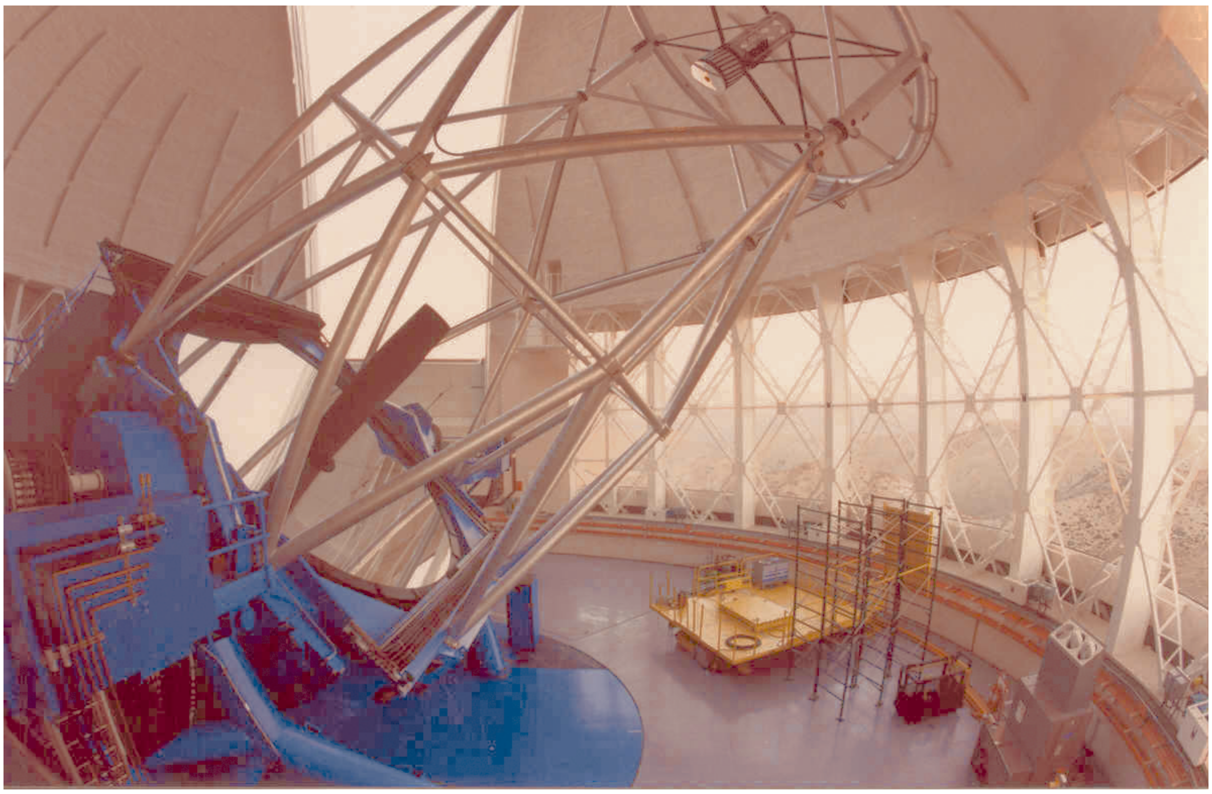


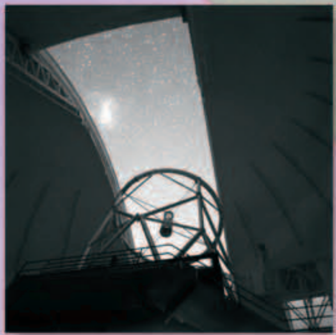
Figure 1: *Gemini South Telescope*

Gemini Photo: Kirk Pu'uohau-Pummill

Gemini South Dedication • January 18, 2002

Photo: Neelon Crawford

Round Photo: Neelon Crawford, Gemini Photos: Peter Michaud

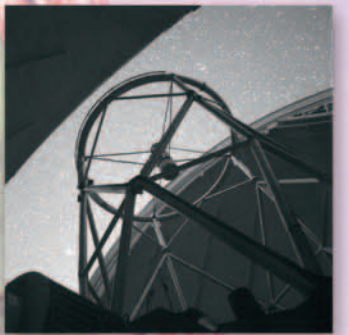


Gemini South by Starlight

The black & white images to the right were produced by Roger Smith using a thermoelectrically cooled CCD camera that he developed with support from CTIO. The camera has a resolution of 1024X1024 pixels and uses various camera lenses made for commercial cameras. These images have been selected from the frames of several time-lapse movies he made in August 2001 of Gemini South using only starlight for illumination.

To see more of Roger's work and learn more about his technique see:
http://www.ctio.noao.edu/~roger/pachon/

All black and white images Roger Smith, Cerro TololoInter-AmericanObservatory,



Gemini Photo: Kirk Pu'uohau-Pummill

sequences, which were then executed to generate science data. The sequence executor successfully controlled the telescope and NIRI. It also gathered header information for each science frame and passed it to the Data Handling System. Following these tests, the sequence executor was used for GMOS commissioning. This process demonstrated observing efficiencies in the 80% range (shutter open time versus elapsed time).

The time loss statistics show significant improvement in telescope failure rates when compared to earlier periods in the north. This is due to continuing efforts to improve problem systems. Last semester, there was 16% of the total time lost to telescope problems – over 20% when weather is backed out. This loss is currently at about 11-12% for this semester at Gemini North and we are now tracking this on a daily basis. *Figure 2 & 3* show the performance for the current semester.

One example of this is the rework done to the secondary system. The system was removed from the telescope in July for maintenance and replacement of problem sensors. Maintenance is becoming key to the successful operation of the observatory and much of the future engineering time will be devoted to maintenance and calibration of critical subsystems.

Gemini South

The southern winter has caused us problems again this year. Because of upgrades done to our electrical utilities and emergency generator, the power outages that plagued us last year have not been a problem this year. However, the weather has cost us a great deal of potential observing time. Since August 1, almost 37% of telescope time has been lost to weather. The good news is that of the usable time since August 1 only 12% has been lost to telescope or related failures. This compares to 11% over the same period in the north. A detailed listing of lost time for both sites is shown in *Figure 3*. While we will continue to try and reduce this failure rate, it once again demonstrates that the greatest science gains can be had by improving data-collection efficiency.

Major changes have occurred over the last three months as telescope commissioning approached completion, but none rivals the changes seen in the instrument lab. Four separate instruments, each with their own support teams have arrived on Cerro Pachón and been fitted on the telescope, ABU mentioned earlier, Phoenix, University of Florida's Flamingos and OSCIR. OSCIR most recently underwent an engineering session on the telescope and has helped us to diagnose additional tuning work needed on the M2 system.

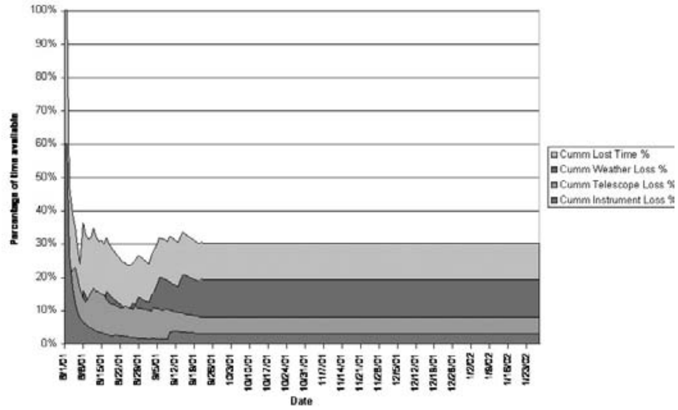


Figure 2: *Ongoing cumulative plot of lost time for Gemini North during semester 2001B. In terms of total time lost, we are at 8% for the telescope component. Once the weather lost time is taken out, this is about 11-12%. During the previous semester, the lost time was over 20% of usable time (weather taken out). We are continuing to push this to lower values.*

Location	Weather Losses (hrs)	Instrument Losses (hrs)	Telescope Losses (hrs)	Total Time Lost (hrs)	Total time available (hrs)	Largest Subsystem Failures (hrs)
North	112	17	53	183	594	SCS: 8.9 ECS: 8.8
South	286	32	61	380	783	Network: 13.8 SCS: 11.5 WFSs: 12.0

Figure 3: *Time Loss Chart*

Summary

Clearly there is much more work be done, but the signs of success are equally visible. Starting with this semester we have achieved a goal envisioned more than a decade ago; we have begun operating both Gemini telescopes as a single observatory. My thanks go out to everyone at Gemini and the partners who have helped to make this a reality. That having been said, we also need to maintain our enthusiasm and divide it between operational support, continued improvement of our current systems and commissioning of new systems such as ALTAIR and additional instruments that will soon be arriving at both sites.

GEMINI SOUTH
BASE FACILITY & INTERNET2

Jim Kennedy

Gemini's Southern Base Facility

The Gemini South staff is currently occupying temporary working quarters, a situation previously experienced by their counterparts at Gemini North. In this case, the Gemini South staff is momentarily in the AURA recinto it shares with CTIO. However, in the next year or so they will move into much more comfortable quarters when Gemini's Southern Base Facility (SBF) is completed.

It will be located in the AURA compound adjacent to the CTIO and AOSS administration buildings in La Serena. The two-story building will provide office and laboratory space for at least 60 Gemini South staff and visitors.

The SBF will include a major instrument lab designed to permit the handling of the very large instruments used on Gemini telescopes. This lab will be shared with CTIO and SOAR. The SBF will also house a 48-seat lecture theater that will also be shared with CTIO and the other programs in the compound. When fully outfitted, the SBF will cost about $2.3M.

Gemini has selected a Chilean construction firm to do the major portion of the work on the 16,300-square-foot facility, with Gemini itself doing a number of critical phases of the work with its own staff. Construction work actually began in October 2001 with initial site preparation. The construction contractor will begin work in December. Completion is expected by January 2003.

Figure 1: *Rendering of the planned Gemini South Base Facility.*

Internet2 Comes to Gemini South and CTIO

Thanks to NSF grants to Gemini totaling $1.7M over a four-year period, in early 2002 Gemini and CTIO will enjoy access to the high-performance research Internet called Abilene, sponsored by the Internet2 consortium at an initial bandwidth of at least 10 Mbps.

Working together, Gemini and CTIO have already used the grants to install a 155 Mbps microwave network between Cerro Pachón, Cerro Tololo, and the AURA base facilities in La Serena. This segment of the network will permit very high-speed data transfers between the Gemini South and CTIO La Serena bases and their respective telescopes.

In addition, Gemini and CTIO have selected an Internet Service Provider to connect the La Serena end of the AURA network to the AMPATH network center in Miami Florida, with at least 10 Mbps. AMPATH will then complete the connection from La Serena to the Abilene backbone in Atlanta Georgia.

AMPATH is a Florida International University project that provides high-speed research Internet connectivity to research and education programs in South and CentralAmerica.

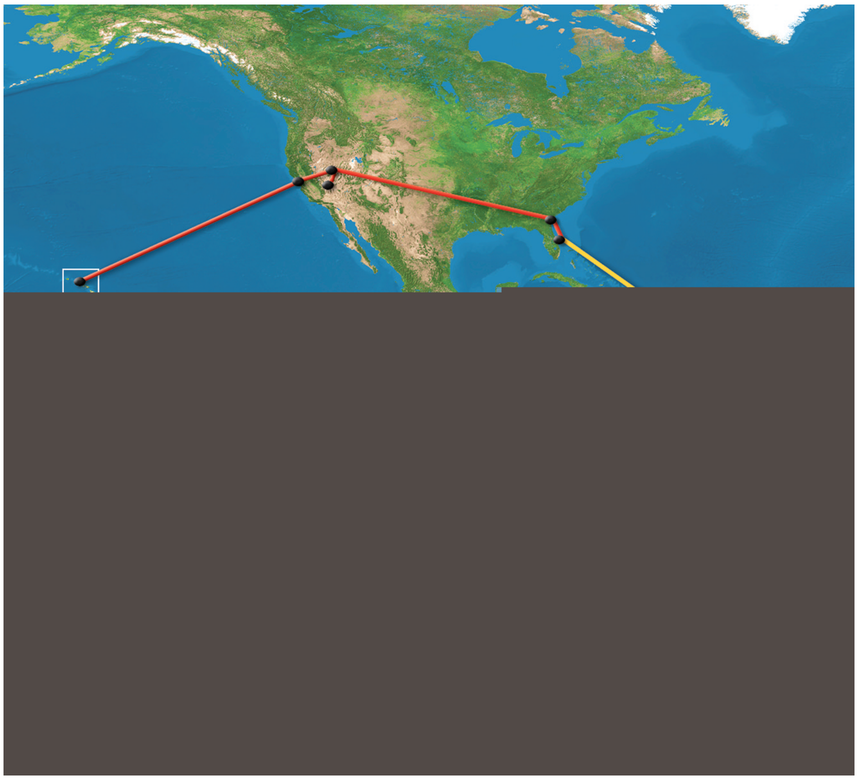


Figure 2: *The Gemini Internet2 network showing (yellow) the new connections made possible by the Gemini NFS grants. The Abilene Internet2 network is shown in red.*

The end-to-end Internet2 circuit runs from the Gemini South telescope on Cerro Pachón to Cerro Tololo and the AURA facilities in La Serena. From La Serena, the circuit travels by optical fiber as an ATM Permanent Virtual Circuit southward to network facilities in Santiago. In Santiago, the connection is made to an international fiber system which goes eastward over the Andes to Argentina, and then into the Atlantic Ocean where it travels northward until finally landing at AMPATH's facility in Miami. The circuit will then go north to Atlanta to join the Abilene network backbone. In addition, Gemini and CTIO will continue to maintain their shared current and separate 2 Mbps commodity Internet connection.

The Gemini North facilities in Hawaii, and the Gemini and NOAO facilities in Arizona, are already connected to the Abilene backbone. Thus, this will permit enormously improved connectivity between all the Gemini operational sites, and do the same for all the NOAO sites as well. Gemini's international partners around the world will also be able to achieve greatly improved performance to Gemini by way of the research Internet international exchange point in Chicago called STAR TAP, which is also connected to Abilene. Completions of the various connections are expected in January of 2002.

GEMINI SOUTH'S ASSISTANT ASTRONOMER – BRYAN MILLER

Nathan McKinney

"My bias is to the southern hemisphere," admits Bryan Miller in his normal concise, thought-out manner, so it works out well that he is Gemini South's new Assistant Astronomer and Science Operations Coordinator. Bryan brings to Gemini a background in integral field technology, which already has been put to work in preparing the new GMOS instrument.

Bryan considers himself a "pure observer" who works as a "kind of a historian as well as a detective." It's "the nature of the universe, you have to study it by looking back in time [rather than] watching a single object evolve. You look at things that you think are very similar and piece the history together."

Bryan Miller

Bryan's own history began in September of 1966 in the small town of Decatur, Illinois, and his astronomical-detective work saw its first manifestations early at the age of three.

About this initial spark, Bryan says, "One of my earliest memories is of watching the Apollo moon launches on TV. I was three when Apollo 11 launched. I have always been interested in space ever since then."

By high school, Bryan had developed a strong interest in astronomy and good experiences with physics and math teachers only solidified his intent to pursue those interests.

Bryan graduated from Carleton College in 1989 and five years later, he received his doctorate from the University of Washington in Seattle. There he studied the formation of stars within dwarf galaxies and gained an appreciation for city life. Bryan acknowledges, "I prefer bigger cities … I got used to living in Seattle, Washington."

For his post-doc research, he stayed away from small towns, instead moving to Washington D.C. and Maryland where he held joint positions at the Carnegie Institution of Washington in the Department of Terrestrial Magnetism and the Space Telescope Science Institute in Baltimore. Two main topics dominated his research. In one, he observed galaxies with kinematically distinct cores where the center of the galaxy rotates along a different plane from the rest of the galaxy. In the other, he studied star clusters in galaxies that are currently merging or have merged at some point in the past. Of this latter area of research, Bryan recalls, "I actually thought about doing a thesis on something like this in grad school and got into dwarf galaxies instead, so this was like being able to do the thesis I hadn't been able to do."

Like many of the galaxies he was studying, two of Bryan's main interests eventually merged and he began looking at star clusters in merging dwarf galaxies searching for clues as to how larger galaxies may be formed by the merging of smaller ones.

In 1997, his post-doc work took him to Leiden University in the Netherlands. There he worked on the commissioning of the SAURON instrument, a panoramic integral field spectrograph build by groups at Leiden, the University of Lyon, France, and the University of Durham, United Kingdom. SAURON saw first light during February 1999 on the William Herschel telescope on the island of La Palma, Spain. There, he observed elliptical galaxies in order to study their kinematics and determine their intrinsic shapes and mass distributions. Also, integral field spectrographs are ideal for studying kinematically distinct cores, which may be produced by galaxy mergers.

During his two and a half years in Leiden, Bryan enjoyed the Netherlands's high quality of life and great Indonesian food, but experienced a peculiar difficulty at learning their language. Bryan explains, "I learned a little bit of Dutch, but I never got very good at it because they speak English so well."

Bryan made his move to Chile in July of 2000. At Gemini South, he is responsible for a variety of tasks such as writing data reduction software, and implementing procedures for taking and processing data, supervising the Gemini South System Support Associates, and participating in the first Gemini South queue observations. For the moment, GMOS has garnered much of his attention. The integral field unit for GMOS on Gemini North, the first such device on an 8-m class telescope, was commissioned in September 2001.

However, Bryan brings more than just astronomical knowledge to Chile. Through the many years of studying and research, Bryan has acquired several interests outside of astronomy. Sometimes his interest is anything but astronomy. When asked about his reading habits, Bryan replies, “Lately, I tend to find myself avoiding the astronomy articles … Since I’m doing astronomy 12 hours a day anyway, I use [my reading time] to expand my knowledge of other things.” For Bryan, those other things include classic American literature, dancing, ultimate Frisbee, and mountain biking.

In fact, the generally soft-spoken Bryan is so adamant about biking that when the topic comes up, he exclaims, “Bikes rule in the Netherlands! They have bike paths everywhere!” His travels obviously haven’t hampered that particular recreation and his love of ultimate Frisbee has continued unabated. Dancing, on the other hand, has required him to change styles as he changes location.

In D.C., he fell in love with swing dancing. Unfortunately, his move to the Netherlands occurred moments before the swing-dance craze struck the U.S. To his dismay, Bryan discovered that, “In the Netherlands, there’s not much [swing dancing],” however Bryan did find that, “There is a lot of salsa … and that’s useful in Chile.”

Returning the conversation to astronomy, Bryan speaks of another thing he finds useful in Chile -- a big telescope. “Astronomy is unique from the other sciences. The nature of experiments is different because you can’t manipulate what you’re studying. You have to use other techniques. Working within those restrictions is why you build massive telescopes.”

However, this is not Bryan’s first experience observing in Chile. Since 1992, he has been making regular trips to Chile to collect data for his Ph. D. thesis, so he says, “I knew exactly what I was getting into.” Now, however, he must deal with a very new telescope and the problems one finds with any new technological operation. But, when asked if he would prefer to have joined on later, Bryan responds, “Oh, no! It’s perfect to come in at the beginning and see everything from the ground up.”

As to his future, Bryan, in his normal concise, thought-out answer, says, “I’m just getting my feet on the ground. Everything is so new; everything is just getting started.”

AURA NEW INTIATIVES OFFICE GEMINI REPORT

Larry Stepp

Even as Gemini South begins science operations, astronomers around the world are planning the next generation of ground-based observatories. The need for still larger facilities is becoming clear, and in order to have next-generation facilities in place by about 2015, preparations must begin now.

Just as present 8- and 10-meter telescopes have studied high-redshift galaxies first detected by the Hubble Space Telescope, future large ground-based telescopes will be needed to study objects detected by the Next Generation Space Telescope (NGST). Giant ground-based optical-infrared telescopes will fill an important niche in a multi-spectral suite of facilities that includes not only NGST but also the Atacama Large Millimeter Array (ALMA) and the Square Kilometer Array (SKA). This was recognized last year by the US astronomy decadal review committee, which made the construction of a 30-meter Giant Segmented Mirror Telescope its highest priority large ground-based facility for this decade.

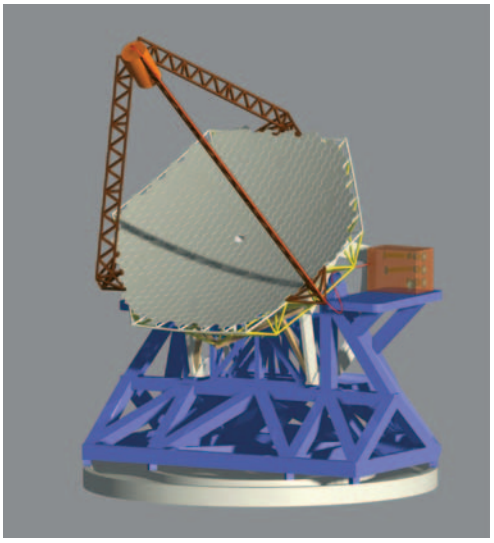


Figure 1: *Artist's conception of one version of the GSMT.*

The 8- and 10-meter telescopes of the current generation are playing a key role in advancing our understanding of the Universe, but we already know that many questions can only be answered by telescopes with greater sensitivity combined with higher angular resolution.

There is an era encompassing the first few billion years of the history of the Universe that is beyond the reach of current telescopes. During that period, the distant stars and galaxies visible with today's most powerful telescopes were formed, but to see that far back in time we need to observe very faint objects with unprecedented resolution. Other studies require spectroscopy of large numbers of galaxies that can only be reached efficiently by larger telescopes.

Questions that a next-generation telescope will help answer include:

- What is the large-scale structure of the Universe, and how did it form?
- How did early galaxies form and evolve over time?
- What laws govern the gas and stellar dynamics within galaxies?
- How do stars and planetary system form and evolve?

In response to this need, early in 2001 AURA president William Smith formalized the establishment of the AURA New Initiatives Office as a partnership between the National Optical Astronomy Observatory and the Gemini Observatory. A number of Gemini scientists, engineers and administrative staff have been assigned to NIO or are supporting this effort part time, joined by scientists and engineers from NOAO.

The mission of the New Initiatives Office is to ensure broad astronomy community access to a 30m telescope contemporary in time with ALMA and NGST, by playing a key role in scientific and technical studies leading to the creation of a GSMT.

From these scientific and technical studies, an exciting picture of the GSMT is beginning to emerge. While the technical challenges are still daunting, it is becoming increasingly clear that a diffraction-limited 30-meter telescope will be feasible and most likely affordable.

One concept for the GSMT is shown in *Figure 1*. This concept is what the NIO calls its "point design", meaning that it is a design exercise intended to highlight key technical issues and indicate areas of technical opportunity. The point design concept is based on our initial understanding of the scientific requirements, and while it is not in any way the "chosen" design for GSMT, it has a number of promising features.

The point design looks more like a radio telescope than a traditional optical telescope. This gives it the advantage of providing a very direct load path from the telescope down to the base, with closely spaced elevation bearings located behind the primary mirror. The design also provides a number of different locations for science instruments, including prime focus, Nasmyth focus, a co-moving Cassegrain focus and a fixed-position Cassegrain focus.

The total weight of the telescope above the elevation bearings is approximately 700 metric tonnes. The mount base above the azimuth bearings has a similar mass, leading to a total moving mass of about 1500 metric tonnes.

The primary mirror is quite fast, with an f/1 focal ratio. In contrast to a number of other concepts for extremely large telescopes, the primary mirror is paraboloidal rather than spherical, which allows the formation of a well-corrected image after just two reflections. This will be important for infrared applications, where it is important to limit the number of reflections to minimize telescope emmissivity.

The design incorporates hexagonal segments that are 1.15 meters across flats, spaced 2 mm apart. At this size, it takes 618 segments to fill the 30-meter aperture.

The secondary mirror has intentionally been kept small to minimize the central obscuration of the telescope and to keep fabrication and testing of the mirror within the current state of the art. The secondary mirror will be adaptive, which will allow diffraction-limited images at wavelengths of 5 microns and above. For shorter wavelengths, the secondary mirror will serve as the first stage in a higher-order adaptive optics system.

Figure 2 shows the layout of one concept for such a higher-order system. This is a multi-conjugate adaptive optics (MCAO) system, which will be able to produce diffraction-limited images in the near infrared over a field of view of approximately 2 arcminutes diameter. This system, designed by Brent Ellerbroek and Dick Buchroeder, employs three deformable mirrors that are conjugate to different layers in the atmosphere. The corrected f/38 beam feeds instruments at one of the Nasmyth foci.

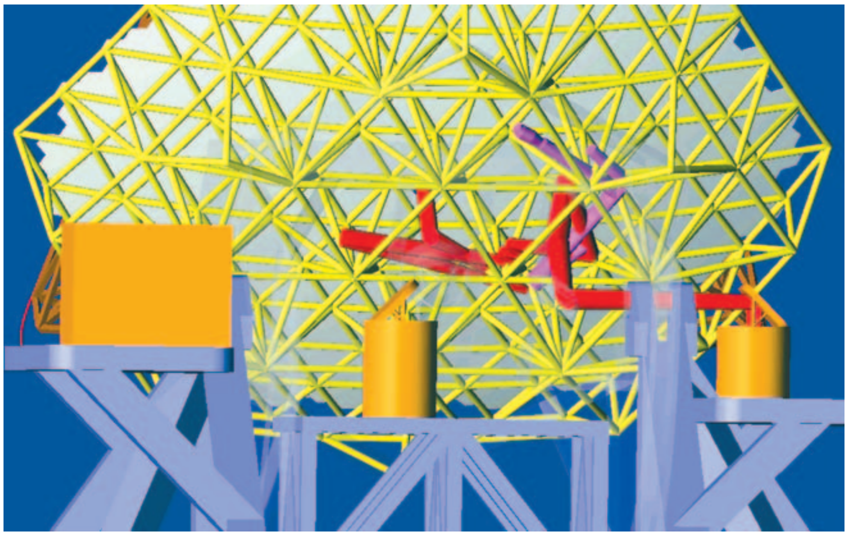


Figure 2: *The rendering shows the light path for a high order multi-conjugate adaptive optics (MCAO) system on the GSMT.*

Another key feature of this point design is that it accommodates a wide-field prime-focus instrument, which is envisioned as a multi-object multi-fiber optical spectrograph, called MOMFOS. The current conceptual design provides approximately 700 fibers in a 20-arcminute-diameter field of view. Each fiber can be positioned independently to collect and transmit the light from a single object to a trio of multi-object spectrographs on the Nasmyth platform. MOMFOS incorporates a prime-focus corrector that includes a deformable mirror conjugate to the primary. This allows partial correction of atmospheric seeing effects as well as correction of low-order aberrations of the primary mirror that might be caused by wind buffeting.

Locating MOMFOS at prime focus provides a convenient plate scale for seeing-limited observations, and allows an instrument of practical size. The size of a 20-arcminute field at the f/1 prime focus is 175 mm; at the f/18.75 Cassegrain focus it would be 3.27 meters, and at the f/38 Nasmyth focus it would be 6.6 meters in diameter.

Current studies indicate the GSMT point design can provide a wide range of capabilities including: wide-field fiber-fed optical spectroscopy; diffraction-limited imaging in the near infrared using multi-conjugate adaptive optics; high resolution spectroscopy in the mid-infrared; and high-dynamic-range imaging in the near infrared, using high-order adaptive optics combined with coronagraphy.

Reports on these studies are available from the New Initiatives Office, and a lot of information is accessible on the Web at: www.aura-nio.noao.edu.

UNITED STATES PROJECT OFFICE

Bob Schommer

The proposals from the U.S. community for 2002A time on Gemini have now been received in Tucson. There were 113 total proposals received, 70 for time on Gemini North and 43 for Gemini South. The U.S. time was oversubscribed by a factor of 4.5 and 3.2 for Gemini North and South, respectively. GMOS was the most popular instrument, with 37 proposals requesting more than 84 nights, followed by NIRI (27 proposals, 41 nights) and Phoenix (20 proposals, 38 nights).

In 2001B, the U.S. is running a mini-queue with Hokupa'a for four proposals over three nights. Support from the U.S. for the 2001B Quickstart Queue on Gemini South in Chile is being provided by Patrice Bouchet and Jim DeBuizer with OSCIR. CTIO has also assisted in the recovery efforts after Flamingos 1 was damaged in shipping, by providing a replacement optical element and additional spare parts. During 2002A, Ken Hinkle and his team from NOAO will provide support for queue observing on Phoenix at Gemini South.

A Gemini remote operations center has been started in Tucson, with video and computer links to both Mauna Kea and Cerro Pachón. Its first use has been to support the commissioning imaging with ABU on Cerro Pachón, and we expect that this facility will aid in the commissioning and support of NOAO instruments on the Gemini telescopes. Early use will also be to aid in the execution of queue observations by the U.S. support teams. We intend to develop this capability and eventually offer true remote observing options for our community.

In one final note, Caty Pilachowski has left NOAO to accept a professorship at Indiana University. Her Gemini support role in Tucson will be taken up in part by Ken Hinkle and Mike Merrill. We will all miss Caty's thoughtful and dedicated work in the USGP over the past several years, and wish her well in her new position.

UNITED KINGDOM PROJECT OFFICE

Pat Roche

In August, GMOS-N took its first images on the telescope, and since then it has undergone intensive commissioning. The instrument, supported by staff from Canada and the UK as well as observatory personnel, has performed very well. It will shortly start its system verification programme before starting science observations. The smooth progress through commissioning is a testament to the careful planning and support provided for GMOS and sets a model for future instruments. The second GMOS is being integrated in Edinburgh before being shipped to Chile. It is expected to have some differences from its northern twin, including a closed-cycle refrigerator to cool the CCDs, which are likely to be MIT/LL devices rather than the EEV chips currently installed in GMOS-N. Delivery to Chile is scheduled for the middle of 2002.

A second major instrument was shipped from the ATC in Edinburgh in June. Michelle, the mid-infrared imager-spectrometer which will be shared between UKIRT and Gemini North, has nearly completed its commissioning programme on UKIRT. This too has gone smoothly, with only a few instrument 'features' revealed, which bodes well for the transfer to Gemini North anticipated around the end of Quarter 3 2002.

Steady progress with bHROS has continued at UCL. The instrument will be fed by a fibre bundle mounted in the GMOS-S pre-focal plane assembly. Plans for a low-resolution (R~ 34,000), broad wavelength coverage mode are being developed. The near-infrared integral field spectrograph, CIRPASS, has passed its acceptance tests and is scheduled to be installed on Gemini-N in January 2002.

CANADIAN PROJECT OFFICE

Dennis Crabtree

The Altair team demonstrated two major accomplishments last summer. On a lab bench, the team exercised the majority of the electronics and opto-mechanics to control the Deformable Mirror (DM) and measure the closed-loop bandwidth. This test verified our servo-models. Then, the team controlled the gimbal mirrors that acquired a near-axis guide star and steered it into the Wave-Front Sensor (WFS). The real challenge came when we perturbed an artificial star, while Altair was running, and showed that the WFS kept itself centered and in-focus. This process is an important part of flexure compensation. In operation, Altair treats measurements from an on-instrument wavefront sensor as the truth, and adjusts its own WFS to suit. This is particularly tricky with an altitude-conjugated AO system because the illuminated portion of the DM and WFS varies with field position of the guide star, yet the WFS must keep looking at the same place on the DM.

Meanwhile, the major structural components, the optical bench and enclosure for the optics and electronics were light-leak tested on a tilting and rotating table. Then, on Altair's real optical bench, we aligned the exit optics, (which reproduce the telescope beam including exit pupil, f/ratio and focal plane) to give superb images in the correct location. This convex and camera mirror pair are mounted in an invar box suspended on flexures below the optical bench.

Once we had the exit optics aligned, and the gimbals running, we "pulled the plug" on the control system testing, and transferred the opto-mechanics onto the topside of the real optical bench. At the same time, we stuffed the electronics into its cooled enclosure and installed the wiring harnesses.

Concurrent with the publication of this newsletter we expect to have the optical bench nestled into the Altair enclosure with the control loops running and demonstrating guide star acquisition throughout the field.

In a follow-up to the article published in the June 2001 edition of the Gemini Newsletter (No. 22, pg. 19), the Conceptual Design Document (CDD) was released to Gemini in August. The design is based on an incremental effort to the existing Canadian Astronomy Data Centre (CADC) archiving infrastructure allowing the Gemini Science Archive (GSA) to be brought online in less time and with less effort. The formal review of the Conceptual Design was scheduled to take place at HIA in Victoria on November 1 and 2. The review committee included Jean-René Roy, Inger Jørgensen, Colin Aspin, Kim Gillies, Phil Puxley from Gemini, plus two external reviewers.

The CADC and CONICYT are currently finalizing the Phase II Proposal Document, which will be released prior to the CDD review. This document will contain two proposals:

- A development plan for the GSA including schedule and costing. The development effort itself is further broken down into Basic Capabilities and Advanced Capabilities.
- A multi-year operations plan including staffing and equipment.

The current versions of the GSA documents can be found at the GSA web site http://www.hia.nrc.ca/pub/Gemini_HIA/GSA.

A Canadian "mini-queue" run with Hokupa'a was scheduled for September 14/15. Due to the tragic events of September 11, Tim Davidge and Dennis Crabtree were unable to travel to Hawaii for these two nights of observation. Instead, they hooked up to the Gemini summit via videoconferencing for two nights of remote "eavesdropping" observations. Kathy Roth, Olivier Guyon, Pierre Baudoz, Brian Walls and the "Singing Cactus" handled observing at Gemini in Hawaii.

The first night was lost to weather and they were two hours late opening the second night due to high humidity. Gemini and Hokupa'a worked flawlessly, and data was acquired for all three scheduled programs. This mode of observing worked quite well, and they felt well-connected to the Gemini operations. They felt this "experiment" demonstrated the feasibility of remote observing with Gemini from HIA Victoria. However, higher network bandwidth would be needed for observing with GMOS in this manner, in order to download the data in a timely manner.

The Canadian Gemini Office received 40 Gemini proposals for Semester 2002A. There were 27 proposals for Gemini North and 13 for Gemini South. GMOS was the most popular instrument with 16 proposals, followed by TReCS with eight. The over-subscription factor for the time was 3.0, with Gemini North time over-subscribed by a factor of 3.9 and Gemini South by 1.9. This was the first semester for which there were more Gemini proposals than CFHT proposals. Canada has a 42.5% share of CFHT.

AUSTRALIAN PROJECT OFFICE

Warrick Couch

It has been an eventful six months for the Gemini community in Australia, with significant developments in the areas of funding and instrumentation. In August, the Australian Federal Government announced the award of A$23.5M to a funding request submitted by the astronomical community to both increase its share in Gemini and to further its involvement in the planned international radio project, the Square Kilometer Array. On the Gemini front, negotiations are now underway with the IGP as to how this funding, within the constraints under which it was awarded, can be best used to not only expand Australia's share but also benefit the entire partnership.

There have also been significant steps forward in the construction of our first instrument for Gemini, the Near-infrared Integral-Field Spectrograph (NIFS), at Mt. Stromlo Observatory. In August, NIFS passed a major milestone in successfully completing its first cool-down. This was achieved with the cold work surface plate and radiation shields contained within the cryostat, but not the spectrograph nor On-Instrument Wavefront Sensor (OIWFS). The cryo-coolers managed to cool the system down to ~46 K in 40 hours, and then keep it stable at this temperature for 20 hours, after which various tests of the temperature servo system were performed.

Peter Conroy lowering the cold work surface plate into the cryostat.

In addition, the pupil mirror array for NIFS has been successfully manufactured by the University of Bremen. This monolithic array of twenty-nine 2mm-wide toroidal mirrors is the key component within the integral field unit, and the smoothness of its mirror surfaces is crucial to minimizing scattered light, and hence, allowing spectral observations close to the strong terrestrial OH emission lines. Initial measurements, in this context, are very encouraging, with the surface roughness of the central element of the array having an RMS value of just ~7.6nm. Finally, the manufacturing and acquisition of components and lenses for the OIWFS are essentially complete, and the dewar that will be used to test the Rockwell HAWAII-2 detector has been assembled and is being used to test the first Phytron cryogenic stepper motor.

The 2002A proposal deadline has just passed, and there was a significantly increased response in comparison to the previous two semesters. The total number of proposals received almost doubled, with much of the demand focused on GMOS. Of the 12 proposals received for Gemini North, eight were for GMOS. There were also two for NIRI and one each for CIRPASS and Hokupa'a. The oversubscription factor for Gemini North was 2.4. There was less demand for time on Gemini South, with only six proposals received for this telescope. Half of these were for Phoenix, while the remainder was spread evenly over the other available instruments. The time was oversubscribed by only a very small fraction.

There have been some changes and additions to Gemini personnel within Australia. In July, Dr. Gary Da Costa - Australia's first Project Scientist - became our Gemini Board member, replacing Prof. Lawrence Cram. Lawrence did an outstanding job as our inaugural Board member and, fortunately for us, will continue to have a very active interest in Gemini. Drs. Stuart Ryder and Joss Bland-Hawthorn from the Anglo-Australian Observatory have joined the Sydney-wide team, which assists the National Office through providing HelpDesk support and technical assessments of Gemini proposals. Dr. Matthew Whiting from Melbourne University has just departed for Gemini South, where he will spend three months assisting with instrument commissioning and the Quick Start Science programs.

ARGENTINE PROJECT OFFICE

Nidia Morrell

The Argentine Gemini Office has undertaken diverse outreach activities since the last issue of the Gemini Newsletter. Several notes have been published in major newspapers and members of the Office offered popularization talks about the Gemini Observatory at various institutions, sucah as the Planetarium of Buenos Aires City. Gemini press-releases are translated to Spanish and posted on the web.

We have received 12 observing proposals for semester 2002A, leading to oversubscription factors of 2.4 for Gemini North and 1.2 for Gemini South.

The breakdown of requested observing time is as follows:

Gemini North	*GMOS*	*10.22*
	NIRI	*26.33*
	Hokupa'a	*4.67*
	Total *41.22/17 = 2.42 oversubscription rate*	
Gemini South	*Flamingos*	*14.33*
	Total *14.33/12 = 1.2 oversubscription rate*	

Since the last issue of the newsletter, some changes have occured at the Argentine Gemini Office. Dr. Jorge Sahade has resigned his role as Gemini coordinator for Argentina, and our present representatives are as follows: Hugo Levato, Argentine representative to the Gemini Board, Nidia Morrell, Argentine Project Manager, Guillermo Bosch, Argentine Project Scientist, Marta Rovira, Argentine PR/Outreach repesentative

The Argentine Gemini Office and all our astronomical community is deeply indebted to Jorge Sahade for enthusiastically leading our participation in Gemini over the preceding years.

BRAZILIAN PROJECT OFFICE

Albert Bruch

As part of a strategic effort by the Brazilian astronomical community to take an active part in the development of scientific instrumentation, Brazil has proposed a (comparatively) low-resolution module for the Gemini bHROS. It will enable scientists to obtain spectra with a resolution of 32K, an option which is not only particularly interesting for a significant fraction of the Brazilian Gemini users, but also for many scientists from other partner countries. Brazil's participation in the Gemini Observatory and the SOAR project have strengthened their development capabilities and this initiative has found ample support from the responsible Gemini staff, as well as, from individuals from partner countries who actively support the Brazilian community's opportunity to realize their plans. Funding of the project is at least partly covered by a grant from the Brazilian government within an encompassing effort to strengthen scientific and technological progress, backed by the IMF (Millennium Institutes).

The Call for Proposals for semester 2002A has resulted in a positive response by the Brazilian community. The 17 total submitted proposals represent an increase of more than 50% with respect to semester 2001B. This is mostly due to the full availability of GMOS in all its observing modes at Gemini North. But there is evidently also trust in the community that NIRI will finally be able to deliver optimal astronomical results. Consequently, the pressure factor for Gemini North attained a record value of 3.1, almost twice as high as in past semesters. In contrast, the pressure factor for Gemini South of 1.4 remains low, with only three proposals having reached the NGO. This may be due to scientists waiting for instrumentation that is more adequate for their scientific interests, particularly for GMOS South.

In order to support and facilitate the work of the Brazilian NTAC, the NGO has initiated a web-based data bank, only accessible for the NTAC members, containing the complete information about past projects. This includes items such as the html pages of the original observing-time applications, reports of the reviewers, observing time effectively spent on projects, scientific results (publications), etc. Lists of projects into which individual PIs or Co-PIs are involved, and projects submitted in different semesters but are part of the same long-term project complete the website. All of these lists are cross-linked. While it is recognized that the utility of such a database after only a few semesters of Gemini operations is limited, it is believed to be an important tool for the NTAC in order to evaluate the success of past projects once science with Gemini has reached a "steady state".

CHILEAN PROJECT OFFICE

Luis Campusano

A total of 92 hours were requested in 2001B for the use of the Gemini-South telescope representing an over-subscription factor of 2. This over-subscription is the highest attained so far. Of the requests, 70% were for use of Flamingos I. For 2002A, the submissions to CONICYT continued to be by email and for use only of Chile's time on Gemini-South as host country. The deadline was October 19, so as to keep it separate from the deadlines of other observatories accessible to Chilean astronomers.

During July, we had several activities related to the Gemini Science Archive (GSA) Phase I. David Schade (Head of CADC) visited Santiago to coordinate our program of activities on the GSA. We also held a Workshop in CONICYT on Large Astronomy Databases having approximately 30 participants from Chilean Universities, the observatories in the country and from abroad. We had discussions on data-mining techniques, the need for high-speed networks and virtual observatories. The talks can be found at http://www.concyt.cl/gemini/archivo.htm. The continuation of the involvement of Chile in the GSA and the incorporation eventually to other archive initiatives will depend on individual groups in Chilean universities. Felipe Richardson finished his work with GSA Phase I.

Gemini and the rest of the astronomical projects in the country are a challenge to Chile, in the sense of urging the development of a strong astronomical community to make the best use of these unsurpassed tools to perform world-class science and to contribute to the understanding of fundamental astrophysical questions. Currently, there are about 30 astronomers working in permanent positions in Chilean institutions and 18 researchers in non-permanent positions. However, the proper use of ten percent of the observing time in all telescopes operating in Chile requires some 150 astronomers.

With CONICYT having completed its financial contribution to the construction of the Gemini Observatory, the NCHO continued to work on the preparation of a plan for the development of Chilean astronomy and closely related sciences, to be implemented under a forthcoming cooperative agreement between Gemini and CONICYT. As of this writing, the CONICYT Program of Centers of Excellence has selected, with the collaboration of NSF and CNRS, the proposal for a Center for Astrophysics. This initiative will be led by the Department of Astronomy of the Universidad de Chile, in association with the corresponding units of the Pontificia Universidad Cat'olica de Chile and the Universidad de Concepci'on.

The above developments will place Chilean astronomy, and thus the participation of Chile in Gemini, as in all the other observatories in our territory, under new light starting next year. A milestone will certainly be the dedication of the superb Gemini South telescope in Cerro Pachón, on January 18th, 2002.

UNITED STATES GEMINI INSRUMENTATION REPORT

Taft Armandroff & Mark Trueblood

Much activity is underway in the U.S. on instrumentation for Gemini, both at NOAO and in the broader U.S. community. This article gives a status update as of early October.

T-ReCS

T-ReCS, the Thermal Region Camera and Spectrograph, is a mid-infrared imager and spectrograph for the Gemini South telescope, under construction at the University of Florida by Charlie Telesco and his team. T-ReCS has been completely assembled. Its mechanisms have been operated successfully at cryogenic operating temperature and under software control. The science detector, a Raytheon 320x240-pixel Si:As BIB array, has imaged successfully and has revealed good optical performance. The team is in the midst of system testing and optimization, which will culminate in T-ReCS's Pre-Ship Acceptance Test. T-ReCS is planned to be offered as a facility instrument on Gemini South in late semester 2002A.

GNIRS

The Gemini Near-Infrared Spectrograph is a long-slit spectrograph for the Gemini South telescope that will operate from 1 to 5 microns and will offer two plate scales and a range of dispersions. The project is being carried out at NOAO in Tucson under the leadership of Jay Elias (Project Scientist) and Neil Gaughan (Project Manager). Optical bench fabrication is complete, and the benches and key mechanisms were assembled for a fit check before painting (see photo). Mechanism assembly and testing is underway. The parts for the GNIRS on-instrument wavefront sensor were delivered by the University of Hawaii's Institute for Astronomy in July. GNIRS subsystem integration and testing has begun, with integration of subsystems into the instrument beginning in November. Overall, 80% of the work to delivery has been completed. The team expects to begin warm-imaging tests January, with GNIRS delivery expected in autumn of 2002.

The GNIRS Optical Bench fit check, with team members (from left to right) Al Davis, Randy Bennett, Dick Joyce, Gary Muller, and Jay Elias.

NICI

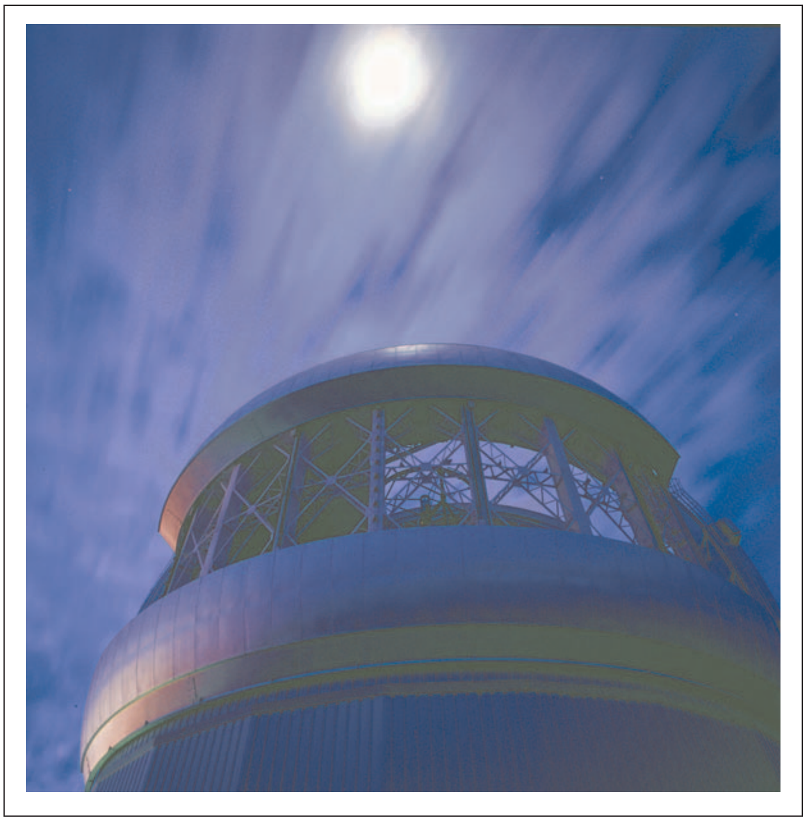
The Near Infrared Coronagraphic Imager (NICI) will provide a 1-5 micron dual-beam coronagraphic imaging capability on the Gemini South telescope. NICI is being built by Mauna Kea Infrared (MKIR) in Hilo, under the leadership of Doug Toomey. The NICI team has made significant progress in the areas of optical design, mechanical design, electronics design, systems engineering, and software design. In particular, the optical layout of the instrument and the opto-mechanical error budget are complete. The NICI Preliminary Design Review is scheduled for March 2002.

Phoenix

Phoenix is a high-resolution near-infrared spectrograph that has been in productive scientific use on the KPNO 4m and 2.1m telescopes. Phoenix yields spectra with resolution up to R=70,000 in the wavelength range 1 to 5 microns. Phoenix will be shared equally between Gemini South and CTIO/SOAR. Phoenix has been modified by NOAO for use on Gemini South. Modifications include the installation of a high-quality ALADDIN InSb array and provisions for mounting to the Gemini Instrument Support Structure. The Phoenix modifications have been completed, and it arrived at Cerro Pachón on September 10. Cooldown, checkout and operation of Phoenix in the instrument lab by NOAO Instrument Scientist Ken Hinkle and his team revealed that Phoenix suffered no damage during its journey. Phoenix was briefly mounted on Gemini South in October in order to perform a test fit, which was successful. Phoenix will be offered as a Visitor Instrument on Gemini South in semester 2002A.

Abu

Abu is an infrared imager that has been used on the NOAO telescopes and at the SPIREX facility at the South Pole. NOAO has modified Abu for use as a commissioning imager on Gemini. In particular, a Gemini-provided ALADDIN InSb array has been installed in Abu. Abu was shipped to Gemini South in April 2001. Nigel Sharp and Bill Ball of NOAO worked with Gemini staff to install Abu and integrate it with the Gemini South telescope systems. Abu was then used to obtain the first infrared images from Gemini South. Several spectacular images have been obtained with Abu.



Gemini photo: Kirk Pu'uohau-Pummill

Gemini Spies Strong Stellar Gusts in Massive Star

Gemini Observatory/Colin Aspin

This dramatic infrared 3-color composite image sheds new light on the early stages of the formation of giant stars in our galaxy. This image reveals remarkable details in a nebula of gas and dust expelled from AFGL 2591. This expulsion is a common feature in the formation of stars similar in size to the Sun, but it is far less common in their massive counterparts. The resolution of this image is 0.4 arcseconds and was obtained during commissioning of the Gemini Near Infrared Imager on Gemini North.

GEMINI OBSERVATORY

NEWSLETTER

THE GEMINI 8-METER TELESCOPES PROJECT
is an international partnership managed by the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation.

Gemini Observatory
Northern Operations Center
670 North A'ohoku Place
Hilo, Hawai'i 96720, USA
Phone (808) 974-2500 / Fax: (808) 935-9235

Gemini Observatory
Southern Operations Center
c/o AURA, Casilla 603
La Serena, Chile
Phone 011-5651-205-600 / Fax: 011-5651-205-650

Gemini Observatory - Tucson Project Office
950 N. Cherry Ave., P.O. Box 26732
Tucson, Arizona 85762-6732, USA
Phone: (520) 318-8545 / Fax: (520) 318-8590

e-mail: gemini@gemini.edu ***url:WWW: http://www.gemini.edu***

UNITED STATES • UNITED KINGDOM • CANADA • CHILE • AUSTRALIA • ARGENTINA • BRAZIL

Gemini Base Facility September 11, 2001

Cover photos: Neelon Crawford and Kirk Pu'uohau-Pummill