GEMINI OBSERVATORY NEWSLETTER

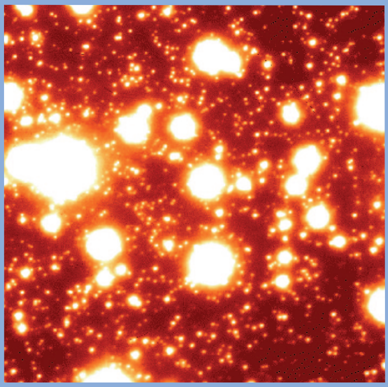
Issue 20 June 2000

Gemini South's Primary Mirror Transport Pictorial

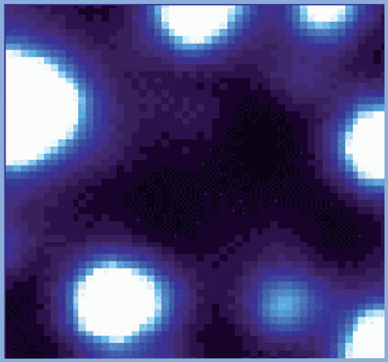
In This Issue:

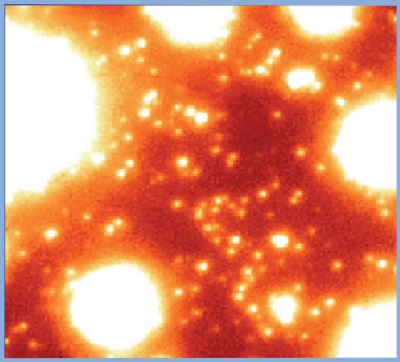
- *Early Science Plans for Gemini North*
- *Gemini Instrument Program*
- *Gemini North Mirror Coating Pictorial*
- *Gemini North Internet2 Upgrade*

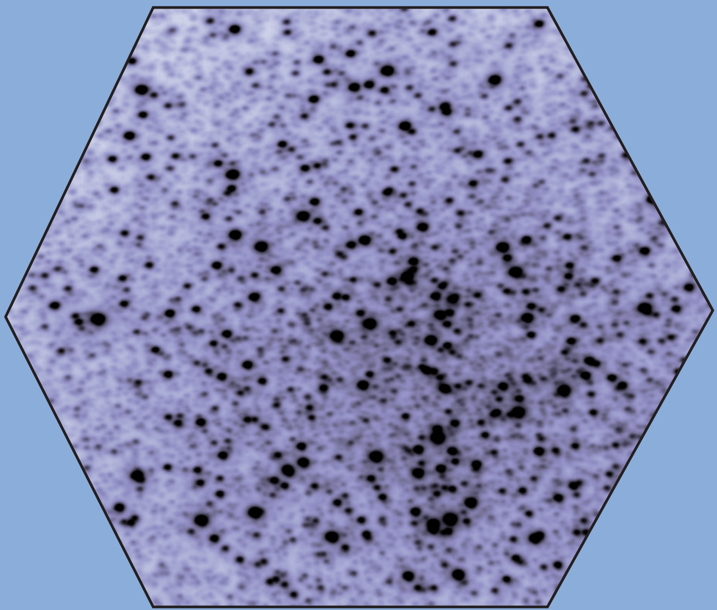
Globular Cluster M13
With Adaptive Optics on Gemini North



The image to the top left reveals the core of the globular cluster M13 and the dramatic gain in angular resolution obtained by using the Gemini-North telescope with the University of Hawaii's adaptive optics system named Hokupa'a. The image was taken using Hokupa'a with its near-infrared camera (QUIRC) at a wavelength of 2.2 microns and a 940 second integration time. The full-width half-maximum of the image is 0.09 arcseconds and the limiting magnitude in this image is 21.8. The field of view is approximately 20 arcseconds on each side. The image at lower right shows a small region of the core of M13 (approximately 5 x 5 arcseconds) taken with Hokupa'a at 2.2 microns. The integration time is 940 seconds. For comparison, the image on the lower left shows the corresponding field in a short exposure image at visible wavelengths (0.55 microns) taken with the Gemini acquisition camera. The visible wavelength image has a FWHM of 0.85 arcseconds. The adaptive optics corrected image shows the power of the telescope with adaptive optics to resolve and detect the many individual faint stars.







Acquisition camera image (Non AO) of globular cluster M13, taken at Gemini North in early March 2000.

The Gemini Observatory Newsletter

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On the Verge of Discovery!
Starting Early Science with Gemini North

Peter Michaud

During the second half of 2000, Gemini North will begin early science operations. Here is what to expect…

QuickStart

The proposal deadline for early science use of Gemini North has recently passed and the response from our community has been good.

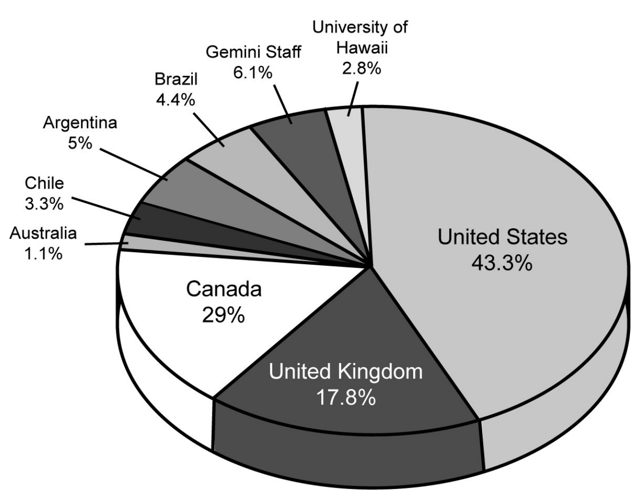


Figure 1: *Fraction of QuickStart service proposals submitted by partner or group.*

QuickStart early observing proposals were accepted from late March to mid-April 2000. When all the submissions were tallied, 180 proposals were received from across the 7-country Gemini partnership representing an average oversubscription ratio of more than 4:1.

We expect that QuickStart science will run from August 2000 through January 2001 with a nominal goal of one week per month devoted to science use of Gemini North. Given this time allocation, 420 hours of science observation time will be available to the Gemini partners during QuickStart.

During the entire QuickStart period, two visiting instruments will be available. For extremely high resolution infrared imaging, the University of Hawaii's Hokupa'a adaptive optics system will be combined with the University's QUIRC near infrared imager. For programs requiring 8-25μm imaging or 8-13μm low to moderate resolution spectroscopy, the University of Florida's OSCIR imager/spectrometer will be available as well. (*See* www.gemini.edu/sciops/instruments/instrumentIndex.html for more specifics on instrumentation.)

All QuickStart observations will be executed as service observations by Gemini scientific staff and subject to the normal Gemini proprietary data period of 18 months.

Gemini North Demonstration Science

Just prior to and possibly concurrent with the beginning of QuickStart service programs, two international Gemini led demonstration science programs will be executed on Gemini North. As press deadlines loomed for this newsletter, the selected science teams worked to iron out details, providing the following plans as of mid-May 2000.

Demo Science #1 – Galactic Core with Adaptive Optics

On a number of nights between July 15 - August 15, Hokupa'a and QUIRC will be aimed at the galactic center to take a series of deep high resolution infrared images of the Milky Way's core. This will be accomplished by taking deep (1-3 hours) H, K, and Narrow band filters of four, 20 X 20 arcsecond fields on the galactic center and 2 control fields a few arcminutes away.

Coordinated by Gemini's François Rigaut, the science goals of this program include:

- Better determination of stellar content and star formation history in the galactic center,
- Detection of Sagittarius A* counterpart, and
- Compilation of astrometric database of four fields for future reference.

Demo Science #2 – Gemini 10μm Deep Field

Led by Gemini scientist Phil Puxley, this demonstration science program will focus on producing a deep 10μm image of a selected region of the sky using the University of Florida's OSCIR 8-25μm imager/spectrometer. We anticipate making the observations during the first half of August 2000.

The science group is still working on target selection criteria and other details.

It is expected that data from both demonstration science programs will be released to the Gemini community by October 15, 2000.

Shared Risk Observations on Gemini North – Semester 2001A

Gemini North observation opportunities will expand in the first half of 2001. New instruments will include the Gemini Near Infrared Imager (NIRI) being built at the University of Hawaii, and the visitor instrument CIRPASS from the University of Cambridge. It is expected that the instrumentation available during QuickStart will continue to be available. (*See* the instrument WWW page listed earlier for more instrumentation specifics.)

Verification of instruments availability and dates for Semester 2001A will be confirmed at an external readiness review schedule for late August 2000. However, the tentative start date for semester 2001A is February 1, 2001 with the semester running until July 31, 2001.

	Number of Proposals	Requested Time (hours) Hokupa'a/QUIRC	Requested Time (hours) OSCIR	Oversubscription Ratio
United States	78	544	572	6.4
United Kingdom	32	179	82	2.8
Canada	29	104	120	4.1
Australia	2	56	0	3.1
Chile	6	15	5	1.1
Argentina	9	14	0	1.6
Brazil	8	10	6	1.8
Gemini Staff	11	52	52	2.5
University of Hawaii	5	58	0	1.4

Table 1: *Proposal statistics for QuickStart service observing with Gemini North. Assumes 420 hours available. Requested time is likely underestimated due to insufficient overhead in some proposals.*

Project Update

Jim Oschmann

During the last 6 months, the pace of excitement continues to accelerate as we prepare for initial operations at Gemini North. At the same time, excellent progress on Gemini South, continued work on future enhancements of the basic telescope and progress on the Gemini South Multi-Conjugate Adaptive Optics system are taking our activities to a new level. The Instrumentation Program has also received significant attention as we near delivery of our first facility instruments and several new efforts are initiated. Doug Simons reviews the Gemini instrument program in a feature article elsewhere in this issue.

Gemini North Commissioning

In the last project update article (December 1999), I highlighted the active optics work that followed last year's dedication. This work put us on track for meeting our most critical error budget goals, and since then we have continued to increase the reliability of many other systems. In the area of active optics, we have returned the secondary mirror to the telescope system in order to implement, measure, and adjust the active optics for performance at the Cassegrain focus.

Open loop control of the primary and secondary mirrors has been an involved process. We spent a considerable amount of time developing and adjusting the open loop look-up tables or models. We typically conduct a series of tests to measure the system wavefront with the telescope at different elevations. Polynomial fits of typical aberrations versus elevation were performed and the resulting model was implemented to remove these errors. An example of data from an elevation run is shown in Figure 1. Here, Zernike coefficients, a polynomial representation of the measured wavefronts, are plotted versus the cosine of the elevation angle. In figure 1, all terms are well within expected bounds except for 45 degree astigmatism (45Ast), which we subsequently corrected. The resulting open loop tables were simpler than originally envisioned. We control M2 (secondary mirror) motion to compensate for top end sag, which causes coma and focus errors. We control M1 (primary mirror) figure to compensate for astigmatism, trefoil, and small amounts of a couple of other Zernike terms.

Following the open loop work described above, we succeeded in implementing closed loop control of the active optics, which includes control of guiding, M2 position control (using coma and focus measurements), and active control of the primary mirror's shape. To do this, we used wavefront sensors positioned on off-axis guide stars while a science instrument looked at the on-axis field. These wavefront sensors are in the acquisition and guiding system at the back of the telescope. Since the last report, this system has gone through significant rework, including rewiring, mechanical work, and optical work (i.e., the plate scale of the wavefront sensors were changed). The result has been that all control loops have been working simultaneously with good servo performance, but some systematic errors still need to be calibrated for off-axis use. Figure 2 (next page) shows an image from one of the real-time active optics wavefront sensors.

Recently, initial work on the use of chopping for 10-micron instruments has begun. Tests were first conducted with a dummy mass for M2, and then with the Zerodur mirror. After just a day or two of work the performance was excellent, exceeding our hopes at this early stage. The former Lockheed Martin employees who designed the fast tilt/chopping mechanism, added one critical modification, namely, notch filters

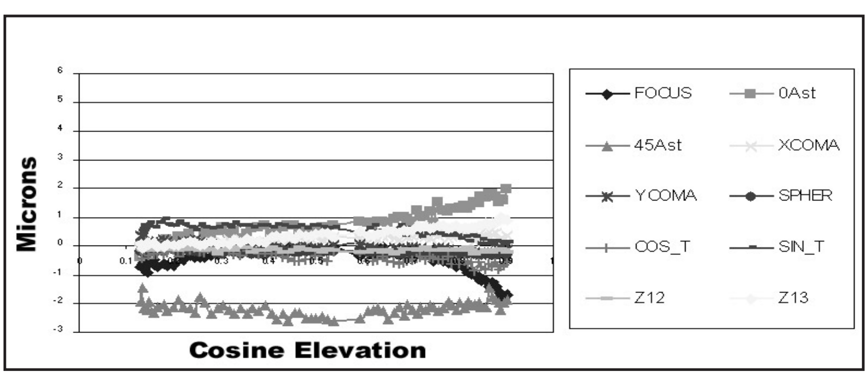


Figure 1: *Elevation test data example. Peak to valley coefficients are given.*

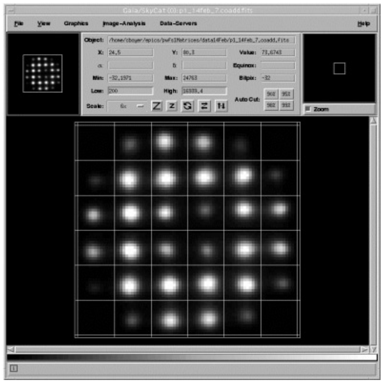
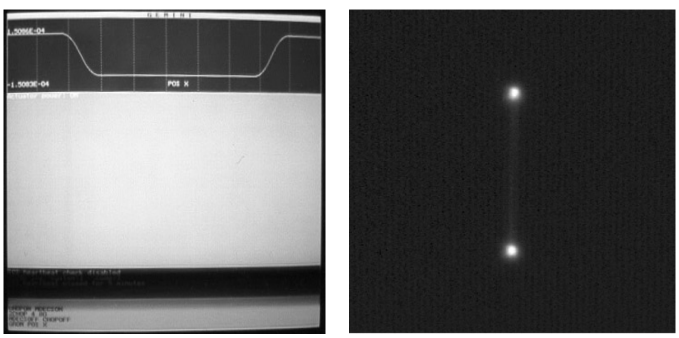


Figure 2: *A 6X6 Shack-Hartmann spot pattern form peripheral wavefront sensor. This is used to provide closed loop control of tilt, focus, and coma to the secondary mirror and to provide higher order wavefront corrections to the primary mirror. The wavefront sensor speed has now been increased to the specified 200 Hz for fast tilt correction.*

to counteract resonances in the secondary system. Rates from 2-8 Hz at typical chop throws of +/- 30 arcseconds (at M2) were achieved with 80-90% duty cycles for the required rate of 3 Hz. Figure 3a shows a sample of the chop form using read-back from encoders, and Figure 3b shows an image on the acquisition camera. These figures demonstrate the smooth response of the system with no sign of overshoot. Furthermore, the measured closed loop bandwidth of the chopping mechanism including the mirror was 25Hz, the designed specification. The system also maintains the chop waveform during telescope slews and long durations. We have yet to integrate the synchronization signal and closed loop tilt correction during chopping.



Figures 3a, left and 3b, right: *Initial chopping tests*

Because of this early work we can now operate the M2 tilt correction at higher bandwidths. By filtering out interactions with the top end, the notch filters have allowed a 4x increase in closed loop gain, an important factor for operating in high wind, though we have not had an opportunity to test this yet. Where is the high wind when you need it!

The repair of the coating chamber and subsequent recoating of the Gemini North primary mirror represent an outstanding recent accomplishment. The pictures featured on the inside back cover pages show the cleaning and coating process, which went very well and resulted in a good aluminum coating. We thank PPARC for the new magnetrons and Simon Craig for their installation and for leading the coating effort. We also thank the Gemini technicians and engineers, lead by Eric Hansen and NOAO's Gary Poczulp, for the first stripping and cleaning of the mirror, support of the chamber rework, and the coating efforts.

Gemini South

The Gemini South telescope structure has been completed and many systems have now been integrated. This process has resulted in "first oil" for the telescope, allowing it to be moved manually on its bearing system and then more recently to be moved both in azimuth and elevation under motorized control. Mike Sheehan has been in charge of the integration efforts on the mountain, with major work also managed by Larry Stepp. Paul Gillett has been busy supporting these efforts and working on both temporary and long term base facility designs and plans for La Serena.

The list of recent accomplishments includes the following:

- Hydrostatic Bearing system integrated and tested
- Gemini Interlock System integrated and tested for motion control
- M1 cell assembly integrated into telescope with dummy mirror
- M1 control system integrated and working with dummy mirror
- Mount Control System, low level integration with GIS
- Mount moved in both axes under hand paddle control, using the GIS and Mount Control systems
- Top end integrated and installed on telescope
- Cassegrain rotator and cable wrap installed and exercised over 100 times, full range, in order to test a solution for a problem with the MK wrap, which has now been implemented
- Instrument support structure and Instrument dummy masses installed.

Figure 4 (next page) shows the telescope tilted in elevation, a process done manually at first but now under low level electronic control with the drive system.

As one can see by the pictures on the front cover and in the center of this newsletter, the other major achievement in Chile has been the successful transportation and final acceptance of the second primary mirror (see figure 5). The mirror was finished in December 1998 and passed plant acceptance in January 1999. Under the direction of REOSC, the mirror was shipped in February and March from France to Chile after storage at REOSC for over one year. Since acceptance in Chile during March 2000, the surface heating electrodes have been bonded to the mirror, and it now awaits installation into the telescope at the end of May. Once the mirror has been installed, we will align, test, and adjust the support system/mirror combination with the same Prime Focus test equipment used on Mauna Kea (reported in previous Issue #19) to measure the wavefront coming from the mirror to prime focus.

Figure. 4: *Cerro Pachón telescope being tilted. Note the dummy mirror being held in the telescope with the mirror cell and support system.*

Facilities Development

The last newsletter included a major article by François Rigaut and Brent Ellerbroek on the Gemini adaptive optics program, particularly the Multi-Conjugate Adaptive Optics (MCAO) project. Work continues to proceed well on this effort and includes: (1) Production of hardware for ALTAIR by our Canadian partners at HIA; (2) Progress by the University of Hawaii team working on upgrades of Hokupa'a to an 85 element system by year end; and (3) Conceptual design and flushing out of details on a concept for the MCAO system slated for Gemini South. We are working toward a conceptual design review of the MCAO system scheduled for late May 2000.

Staff

As the construction phase of Gemini comes to a close and the operational phase begins, we have been experiencing a relatively large turnover in personnel. During the past year, we have lost a number of talented people who have done their jobs well. I would like to take the opportunity to thank all who have supported Gemini activities. The Human Resources Update article in this newsletter lists the people who have moved on over the last six months.

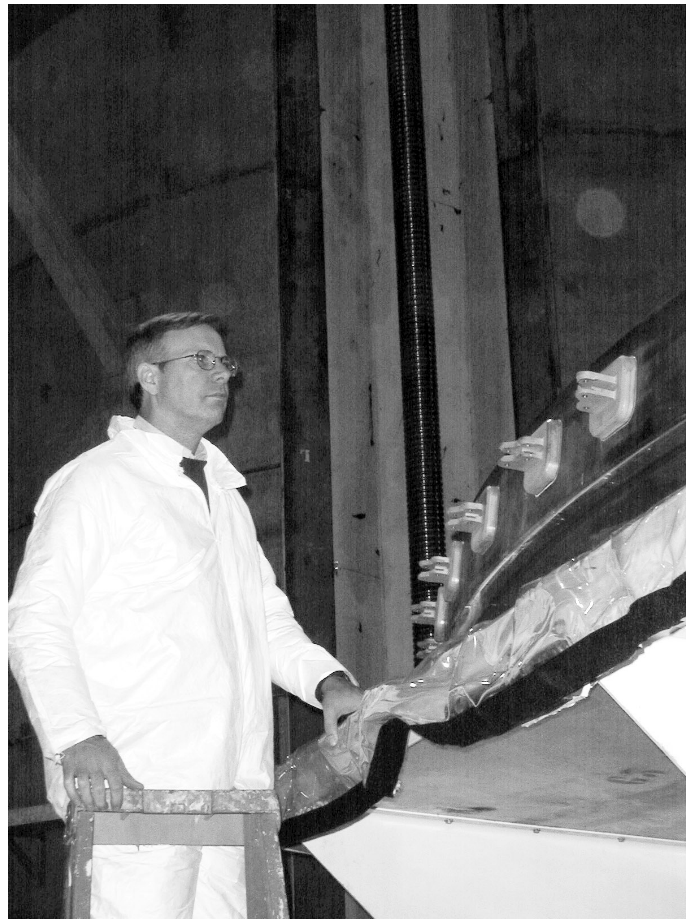


Figure 5: *Optics Group Manager Larry Stepp inspecting the Gemini South primary mirror shortly after unpacking it on the top of Cerro Pachón.*

Though we will miss the efforts of those who have left Gemini, we have been fortunate to hire talented newcomers for our operational staff. Software is the one area in which we are still behind and continue to recruit aggressively; we have hired a new software manager, Jacques Peysson, and are in the final stages of hiring two more software engineers. We have also solved some of the shortfall by hiring several contract employees. The Human Resources Update article also lists the new people hired since the last newsletter.

And Finally…

The next six months will be even more exciting as we enter our first science operations, at a low level, and proceed with commissioning Gemini South. We want to thank all of our partners who have been supporting these efforts, both directly and indirectly. As we engage in what is probably the most critical stage of the construction project—the final phases at both sites—the significant help by the partnership is greatly appreciated!

The Gemini Instrument Program

**Douglas A. Simons, Fred Gillett, Jim Oschmann,
Matt Mountain, Robert Nolan**

ABSTRACT

Building instruments suitable for the new 8-10 meter class of telescopes has been a major challenge, as specifications tighten, costs, scientific demands, and expectations grow, all while schedules remain demanding. This report provides an overview of the status of various elements in the Gemini instrument program, and touches on some of the problems common to the various teams building Gemini instruments. Despite these challenges, Gemini anticipates harvesting great scientific rewards from the combination of its observatory facilities and exciting complement of scientific instruments.

1. Instrument Program Overview

The Gemini instrument program is a large and diverse effort centrally managed by the Gemini Observatory. It is being executed by instrument teams in 15 time zones distributed around the world, all of which are members of the 7 nation Gemini partnership. It encompasses and in many cases defines the state-of-the-art in various technologies and engineering used in modern astronomical instrumentation. Grappling with the ever increasing demands for superior performance in ground-based instruments, in an environment of finite budgets and demanding schedules, naturally leads to complex trades of costs, scientific capability, and risks. Nonetheless, Gemini's instruments are at the dawn of a new era in astronomical instrumentation, and together with the Gemini telescopes, the instruments described below will provide a remarkable gateway to scientific discovery in the immediate future.

2. Phase 1 Instruments

This report builds on the Gemini instrument descriptions found in Simons et al.[1], which includes a description of the telescopes' Cassegrain environment and key features of the Gemini telescopes and support facilities. Instruments are described in the approximate order in which they are expected to enter science operations.

2.1. Near-Infrared Imager (NIRI)

NIRI is in the final stages of its integration and test phase, having completed several cold cycles at its place of fabrication, the University of Hawaii. Key features of its final opto-mechanical design are depicted in figure 1. NIRI is basically composed of two optical assemblies mounted on opposite sides of a central thick aluminum plate, which is suspended from the vacuum jacket with three large A-frame titanium trusses. This plate provides mechanically rigid coupling between the wavefront sensor and science detector. Since the wavefront sensor provides slow flexure compensation of the instrument with respect to the telescope, it is crucial that the wavefront sensor remain tied rigidly to the science channel to meet Gemini's standard 0.1 pixel per ~1 hour integration specification.

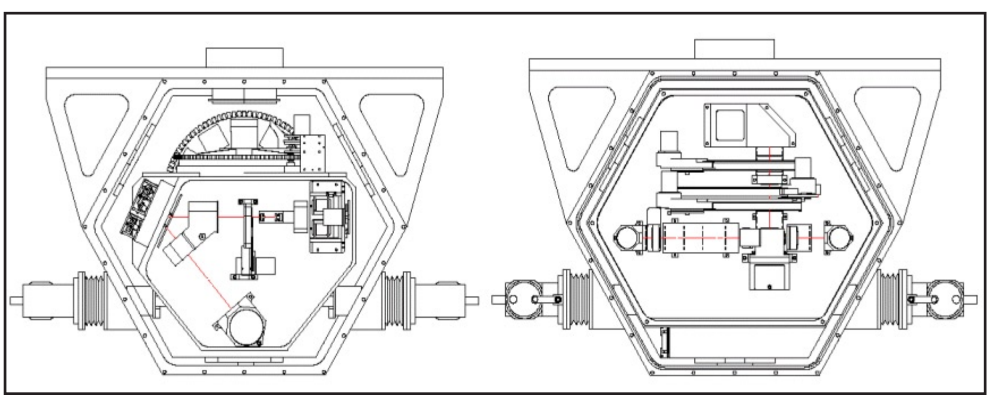


Figure 1: *Two perspectives of the inner cold structure and mechanisms in NIRI. The left illustration shows the built in near-infrared wavefront sensor, which occupies roughly half of the instrument. On the right, fold mirrors, filter and pupil wheels, lenses defining 3 cameras and the science detector focus stage are all present. A pair of 130W cryo-coolers are seen protruding from the vacuum jacket.*

Referring to figure 1, which shows the wavefront sensor half of the instrument, light enters through the window on the top and is diverted into the science channel half of the instrument by a large turret containing three different mirrors, one for each plate scale of the instrument. Light then passes through a wheel containing field stops or slits, before entering the science channel, where the light is reflected off a pair of mirrors, passed through a pair of filter wheels and a pupil wheel, and is then directed into either an f/32 (0.02 arcseconds/pix), f/14 (0.05 arcseconds/pix), or f/6 camera (0.12 arcseconds/pix), before reaching a 1024^2 ALADDIN 1-5μm detector. The near-infrared wavefront sensor patrols an area of sky defined on the outside by the window diameter (3.5 arcminute) and on the inside by the size of the turret-mounted pick off mirror, with the finest plate scales offering the greatest patrol field size. Figure 2 shows the fully integrated instrument. A steel space frame structure connects a pair of thermally insulated enclosures for instrument electronics, as well as an interface plate that connects the entire assembly

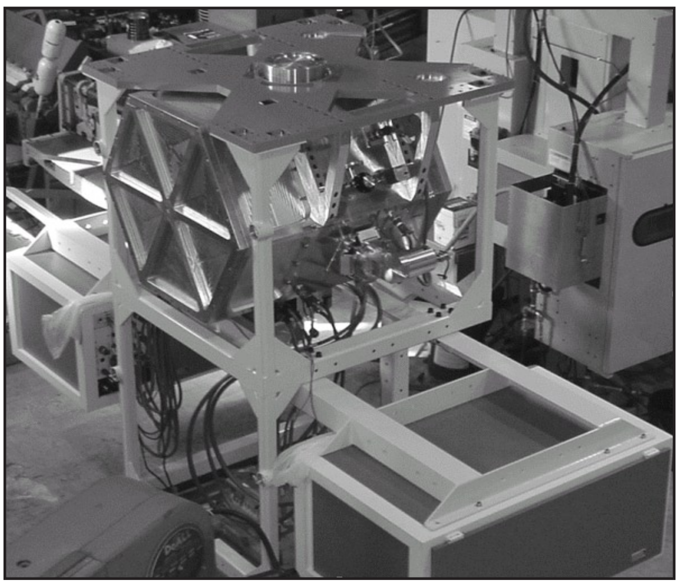


Figure 2: *The fully assembled NIRI. NIRI's vacuum jacket is suspended in an up-looking position in the space frame, which ties it to a pair of thermally insulated enclosures for its electronics.*

to one of the faces of the instrument support structure (ISS) cube on the telescope. Combined with ballast weights used to adjust the center of gravity of the assembly, the entire instrument weighs 2000 kg and is handled in either a side or up-looking fashion through facility air carts on the observatory floor.

Tests completed to date indicate that about 2 days are needed to pump NIRI down to levels where its pair of large 130W cold heads can be used. Once activated, NIRI's ~300 kg cold mass reaches its base temperature of 65 K in about 6 days. A network of resistors mounted around the cold structure, which are operated in conjunction with the detector temperature control system, permit warm-up periods of ~2 days. NIRI is expected to undergo first testing at Gemini-North during the second semester of 2000, at which time it will be commissioned as Gemini's first facility instrument.

2.2. Gemini Multi-Object Spectrographs (GMOS)

In its initial complement of instruments, Gemini is relying on a pair of essentially identical instruments to meet all of its demands for optical imaging and low to medium resolution spectroscopy. These important instruments are currently being fabricated in Victoria, Canada at the Herzberg Institute of Astrophysics (HIA) and the United Kingdom at the Astronomy Technology Centre (ATC) in Edinburgh, Scotland. They are scheduled for first scientific use on the telescopes in 2000 (Gemini North) and 2001 (Gemini South). Figure 3 shows the Instrument Support Structure (ISS) with GMOS mounted on a side port and the space envelope for the instrument and its electronics boxes outlined. GMOS offers spectral resolutions of up to ~10,000 and an unvignetted field of ~5.5 × 5.5 arcminutes. Its transmissive optical train is effective from ~0.36 - 1.10μm, and has exceptionally high throughput due to the use of a combination of MgF and SolGel coatings used in its optics. Prominent in figure 3 are the pair of ~1 m diameter

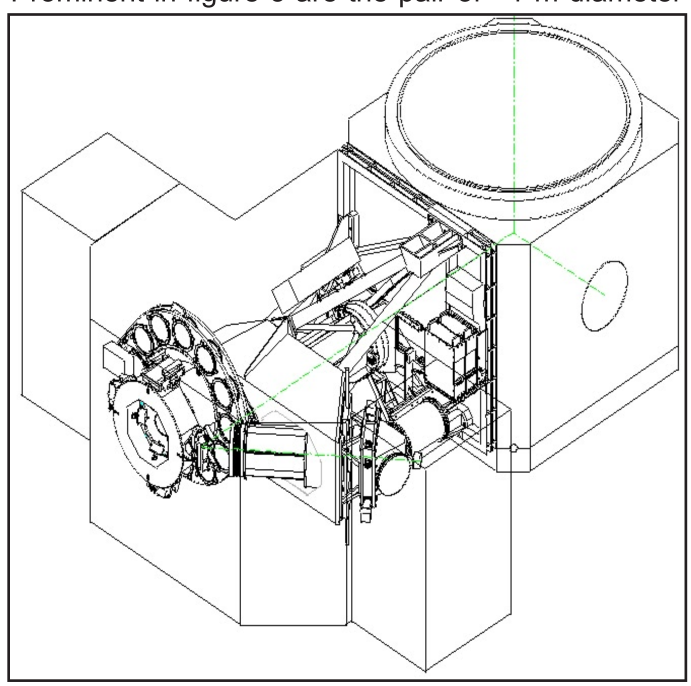


Figure 3: *GMOS attached to a side port of the telescope's instrument support structure. The outline of the instrument surrounds the GMOS opto-mechanical assembly.*

Prominent in figure 3 are the pair of ~1 m diameter filter wheels mounted concentric with the rear grating drum assembly. Figure 4 shows the actual corresponding parts, in a frame supported by an air pallet in the GMOS lab at the ATC. The opto-mechanical assembly is suspended from the ISS through a set of nested trusses. A wavefront sensor located in the pre-focal plane assembly will patrol the entrance field for stars that can provide a reference tip/tilt guide signal for the telescope's active secondary, and slow-guiding corrections for the telescope's mount. Unlike NIRI, which relies on rigid coupling between its wavefront sensor and science detector, GMOS achieves its flexure compensation between the slit and detector through a look-up table and an X-Y stage holding the detector package. The instrument bound for Mauna Kea will use a mosaic of three 2048 × 4608 pixel CCDs that have red optimized coatings. The Cerro Pachón twin instrument will be identical in all respects except that it will use blue optimized CCDs. The science detector systems used in GMOS are integrated and tested at the CCD laboratory at NOAO, Tucson.

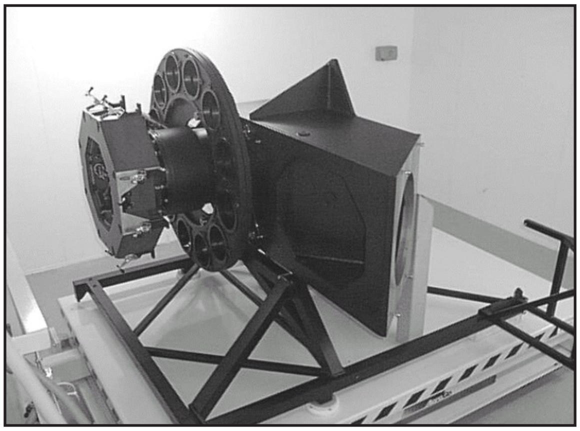


Figure 4: *Much of the post focal plane assembly in GMOS, in a perspective similar to that portrayed in figure 3. The ~1 m diameter filter wheels are prominent, as well as the pneumatically driven grating drive mechanism at the far left of the assembly.*

GMOS masks will be cut from a multi-ply carbon fiber material using a YAG laser and precision X-Y cutting stage at Gemini's Northern Operations Center. Before spectra are recorded, images of target fields will be recorded through each GMOS running in its imaging mode. Targets will then be selected by astronomers responsible for GMOS science programs. Once identified, slit locations within fields will be electronically transmitted to the Gemini operations center, where they will be translated into files that can drive the mask cutting machine. Finished masks will then be sent to either Gemini North or South, loaded into GMOS, and used to record spectra. Each instrument can hold enough masks to support several science programs and any mask can be remotely deployed within the instrument. The entire process will be managed by rigorously tracking the locations of masks through UPC labels and scanners both at the laser cutting machine and in each GMOS.

Though GMOS is primarily a multi-object slit spectrometer, a 1000 fiber integral field unit (IFU) will be delivered with the first GMOS to provide spectro-imaging across a ~5 arcsecond field. Sky reference spectra will be provided through an adjacent 500 fiber IFU. The IFU combination can also be used to support a nodding mode between IFU bundles, further improving sky subtraction, which will be important for the faint high-z targets that will likely be observed with this mode. The IFU assembly fits within the same exchange mechanism used for masks and is therefore also remotely deployable. Long term, it is expected that various IFUs with custom design features, will be used with GMOS just as different gratings and filters are commonly exchanged within optical spectrometers today.

2.3. Mid-infrared Imager: Thermal Region Camera and Spectrograph (T-ReCS)

The next instrument planned for delivery in Gemini's instrument suite will be its facility mid-infrared imager, T-ReCS, built by the University of Florida. This instrument will be the first on Gemini South, with deployment currently expected in mid-2001. Though originally planned to be an imager only, T-ReCS will be built with a modest spectroscopy capability, yielding resolutions of ~100 at 10 and 20μm, and R~1000 within narrow regions of the 10μm atmospheric window. With facility tip/tilt compensation, T-ReCS is expected to provide diffraction limited images essentially all the time and, in this manner, will be unique among all of Gemini's facility instruments. T-ReCS will use a Raytheon 240×320 Si:As IBC detector which, combined with its 0.09 arcsecond/pixel plate scale, will yield a 22 × 31 arcsecond field of view. Running T-ReCS on a queue scheduled telescope such as Gemini South will permit 20μm science programs to be run with much higher efficiency than is typically achieved, since these programs are extremely sensitive to atmospheric water vapor and can be executed quickly when otherwise rare conditions exist.

Figure 5 depicts the optical design of T-ReCS. Mechanically, the instrument is similar to NIRI, with a central thick plate that acts as an optical bench upon which everything is mounted. For clarity, figure 5 does not show this aspect of the design. Light first passes through one of several remotely deployable windows, then through an aperture stop, a series of filter and pupil stop wheels. Then the light forms a

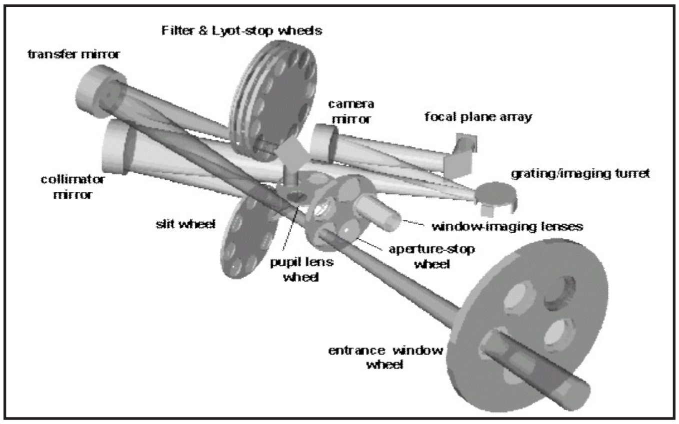


Figure 5: *The filter wheels, aperture wheel, windows, grating turret, various reflective optics, and detector which together compromise the T-ReCS optical assembly are shown.*

reimaged focal plane at a slit wheel, is collimated by an off-axis parabolic mirror, bounces off a grating drum that has a simple fold mirror on it to support imaging, then strikes another off-axis parabola that acts as a camera, and finally it strikes the science detector. Excluding the filters and detector, this reflective design should have >75% optical throughput.

Figure 6 shows the instrument in an up-looking mode, mounted within a steel space frame, like NIRI. Two thermally insulated enclosures will be used to house all of the array controller and mechanism control electronics. The vacuum jacket is the small hexagonal structure in the center of the space frame. Unlike most other facility instruments, T-ReCS will not use an on-instrument wavefront sensor, instead relying on the peripheral sensors built into the facility Acquisition and Guidance (A&G) Unit to provide fast tip/tilt compensation signals to the telescope's secondary mirror. Accordingly, T-ReCS is designed to be small, relatively light weight, and intrinsically very stiff, to prevent significant differential flexure between the instrument and peripheral wavefront sensors. Figure 7 shows an interesting feature of the instrument: a remote window exchange mechanism based upon a large ferrofluidic feed-through in the front of the vacuum jacket. A total of five windows will be mounted in this mechanism, which will have a sealed cover under positive dry-air pressure to keep dust and moisture away from the hygroscopic windows. The windows mounted within this assembly

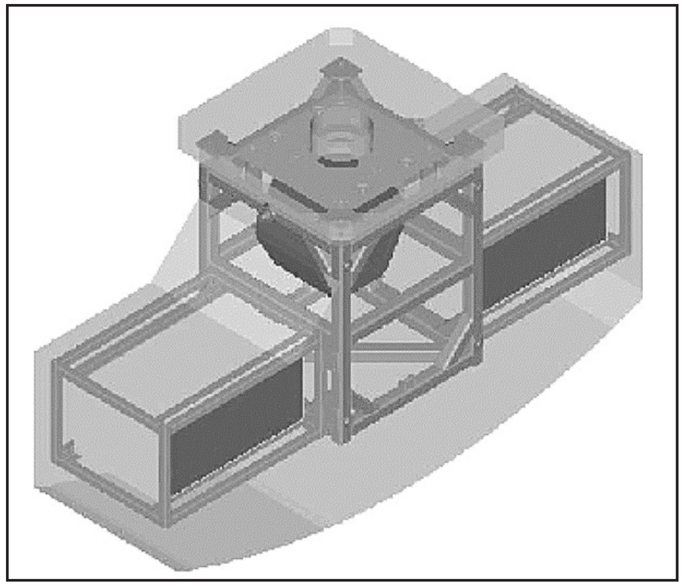


Figure 6: *The T-ReCS space frame, outrigger electronics enclosures (similar to NIRI's configuration), and instrument package. Unlike most other Gemini instruments, the opto-mechanical assembly actually occupies a fairly small portion of the available space.*

will be made of KRS-5, KBr, or ZnSe, and will be optimized for 10 or 20μm performance with custom AR coatings. Given the extremely low emissivity expected of the Gemini telescopes, such measures are necessary to ensure that T-ReCS always has a clean, low emissivity window available, allowing the T-ReCS/telescope system to provide maximum sensitivity on a reliable basis.

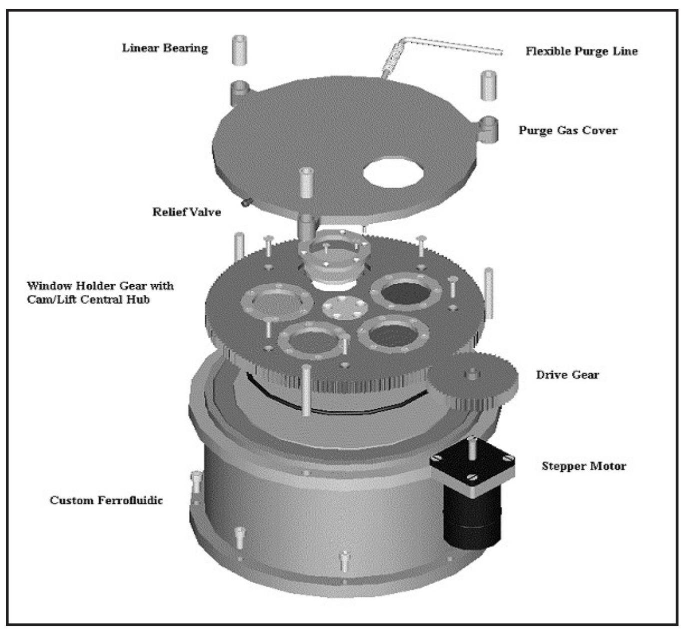


Figure 7: *One of the most unique aspects of the T-ReCS design is the remote controlled window exchange mechanism, which is mounted on a large ferrofluidic feed-through in the vacuum jacket.*

2.4. High Resolution Optical Spectrograph (HROS)

The only UV optimized instrument in Gemini's instrumentation program is HROS, which is being built by University College London. HROS is currently scheduled to be deployed in 2002 on Cerro Pachón. This instrument is also the highest resolution spectrograph (R~50,000) of any being built for Gemini, thereby providing an important element in the overall scientific capabilities of the observatory. HROS is designed to function from 0.3-1.0µm and, as seen in figure 8, relies on large pieces of fused silica throughout much of its optical train. Given the sizes of the optical elements in HROS, combined with the demanding specifications of a high resolution spectrometer (flexure <0.05 of a resolution element over a 1 hour integration), HROS is arguably one of the most complex opto-mechanical systems in the entire instrument program. When combined with aluminum telescope coatings on Gemini South and state of the art UV optimized detectors, HROS is expected to be one of the world's most sensitive spectrometers at UV wavelengths.

Figure 8: *Large rough-cut fused silica intended for use in HROS.*

Figure 9 illustrates the optical path of light when it enters the instrument. Specifically, light passes through the slit assembly, which includes an adjustable slit, shutter, and filter wheel, then strikes a combination folding prism/lens assembly that directs the beam back toward the ISS where it strikes the collimator mirror. This mirror is on actuators and is an important part of the flexure compensation system. Light then passes through a pair of massive fused silica grisms, then bounces off an immersed echelle grating, through a set of large camera lenses, then a camera mirror, before falling on the detector mosaic, which is mounted on-axis with the final camera mirror. Of all the elements in the instrument, probably the most challenging from an opto-mechanical perspective is the immersed echelle, illustrated in figure 10. Essentially, this is a standard echelle grating with a large multifaceted fused silica prism floated on top of the echelle by a thin layer of oil, which has been carefully selected to provide optimal transmission properties across the prism/grating interface. Like the collimator, actuators are located along the edge of the immersed echelle assembly to form part of the flexure compensation system. The entire package is expected to flex as it changes attitude on the back of the telescope. HROS's approach to maintaining adequate slit-to-detector alignment under all gravity vectors is to use an infrared laser, shining backwards through the optical train, where it will be detected by a small commercial infrared array mounted at the slit. A servo loop will preserve the correct system alignment, again using degrees of freedom built into the collimator and echelle mounts. Like T-ReCS, HROS has no built in wavefront sensor. The combination of relatively large slit sizes and minimal differential flexure expected between the facility peripheral sensors and slit assembly should permit slow guid-

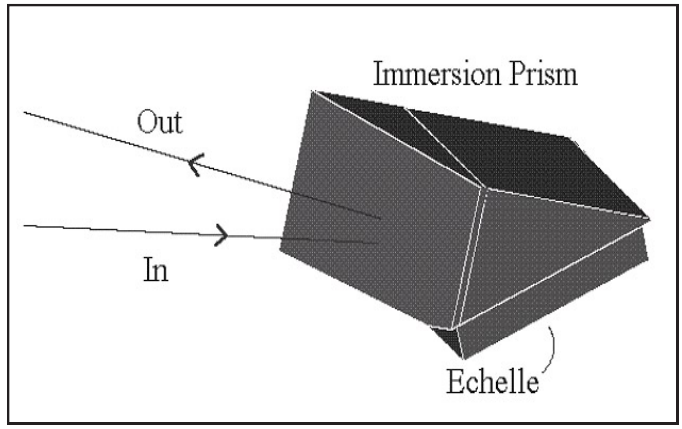


Figure 10: *The immersed echelle used in HROS is seen in greater detail. The grating is optically coupled to a large fused silica prism through a thin oil layer.*

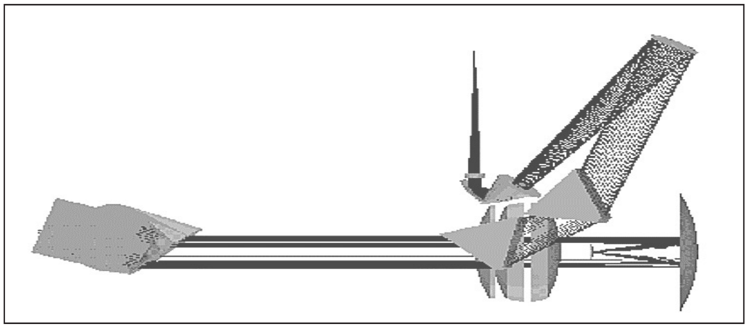


Figure 9: *The HROS optical design, including the actuated collimator at upper right, immersed echelle grating at left, and the camera mirror on the lower right.*

ing corrections with only the peripheral sensors.

HROS will use a pair of 2048 × 4608 pixel CCDs in a compact dewar to form a square-shaped detector plane. The use of closed cycle coolers is under investigation as a means of efficiently cooling this package, which will be thermally connected through a fairly long cold strap since the package profile has to be minimized to reduce vignetting of the on-axis reflective camera mirror. Thanks to its cross-dispersed design and large detector area, HROS will be able to record the majority of its echellogram in a single integration, again keeping with the spirit of making the instrument as efficient overall as possible.

2.5. Gemini Near-infrared Spectrograph (GNIRS)

The final instrument planned for deployment as part of the Phase 1 set is GNIRS, which should enter science operations by late 2002 or early 2003. It is being designed and built at NOAO in Tucson, Arizona. GNIRS has recently undergone a major redesign because of problems with excess mass and flexure discovered with the previous design. A newly formed management and engineering team is redesigning the instrument. Figures 11 through 13 show the team's innovative design.

Referring to figure 11, GNIRS is mechanically coupled to a central rigid bulkhead structure, which connects to its optical bench, cryo-coolers, and support frame. Like NIRI and T-ReCS, the array controller electronics and mechanism control electronics are housed in a pair of thermally insulated enclosures.

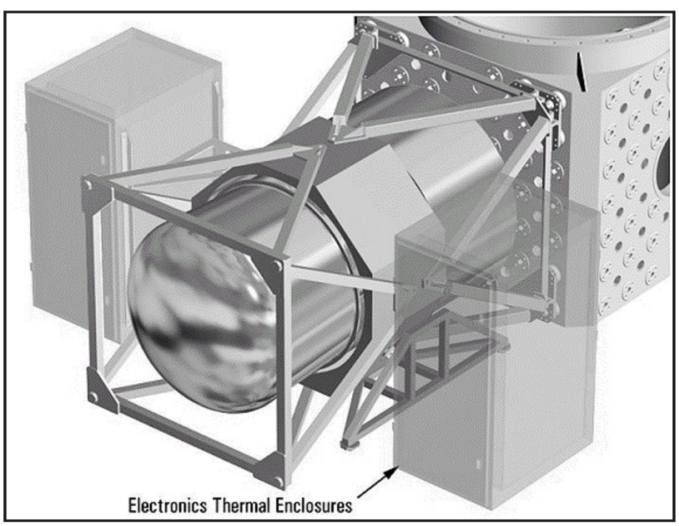


Figure 11: *The GNIRS assembly, including vacuum jacket (center), truss structure, and pair of thermally enclosed cabinets is attached to a side ISS port.*

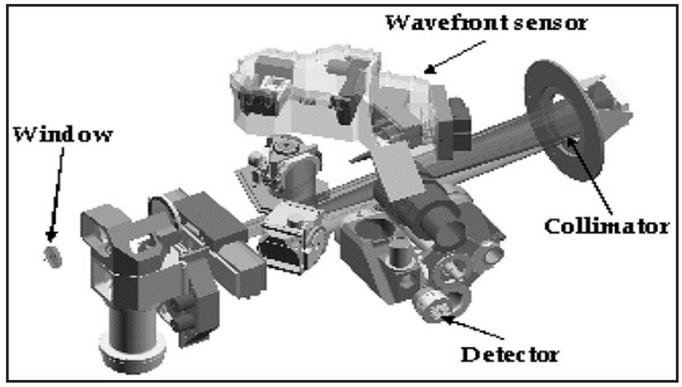


Figure 12: *The modules that define the GNIRS opto-mechanical assembly, including the Offner pre-slit optics at far left, rear-mounted collimator, wavefront sensor package, and detector system. A pair of cryo-coolers, in conjunction with an LN2 precharge system will accelerate GNIRS cooldowns.*

A non-structural vacuum jacket will enclose the cold structure. Figure 12 shows the preliminary layout of the primary components in GNIRS, including the window, Offner relay fore-optics, slit/decker/IFU assembly, cross dispersion prism and Wollaston prism turret, camera lens turret (figure 13), grating turret, collimator, and on-instrument near-infrared wavefront sensor. The wavefront sensor package is being built at the University of Hawaii, given that it is essentially identical to that used in NIRI. Also like NIRI, GNIRS will use an ALADDIN 1024^2 detector. A combination of three gratings and two pairs of cameras (1-2.5µm and 3-5µm optimized) provide spectral resolutions of approximately 700, 2000, 6000, and 18,000. The cameras yield either 0.05 (50 arcsecond long slit) or 0.15 arcsecond (100 arcsecond long slit) sampling, providing either adaptive optic or tip/tilt optimized spatial sampling. Given its ability to provide 1-5µm slit or integral field spectroscopy, cross dispersion, spectro-polarimetry, and plate scales tuned to match various seeing conditions, GNIRS is intended to act as a "work horse" multi-mode instrument capable of supporting a variety of

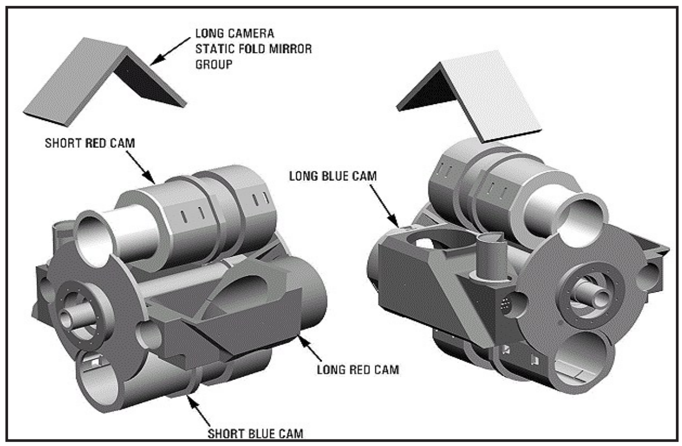


Figure 13: *The GNIRS 4-camera turret assembly.*

science programs.

One of the more interesting aspects of GNIRS is the pair of integral field units being designed at the University of Durham and scheduled to be delivered as part of the final instrument configuration. The IFUs will be mounted in the GNIRS slit/decker assembly, which yield either 0.04 or 0.12 arcsecond sampling and reformat the entrance focal plane into many pieces that are passed into the GNIRS post-slit environment, dispersed, and recorded as closely packed spectra on the detector. When reconstructed through post-processing, a data cube containing both spatial and spectral information is produced. The IFUs will be made of diamond machined thin slices of metal, stacked and aligned to preserve proper pupil transfer into the GNIRS post-slit system. The IFUs are arguably the most complex and technically challenging aspects of the GNIRS optics, but promise to provide a powerful capability, particularly when used with the facility adaptive optics systems planned for Gemini.

3. Calibration, Polarization, and Adaptive Optics Facilities

Beyond the aforementioned Phase 1 instruments, the Gemini instrument program is funding several common-use facilities to complement the instrument set. These facilities include a polarization modulator, which supports imaging and spectro-polarimetry from UV to near-infrared wavelengths; a calibration unit, which provides flat fielding and spectral calibration for all instruments except T-ReCS; and an adaptive optics system, which can feed the entrance port to any instrument mounted on Gemini-North. The following paragraphs include a description of the facility instruments in the order in which they are expected to be completed.

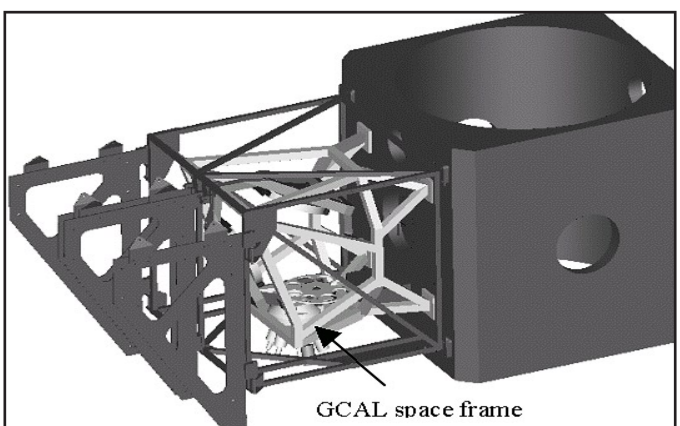


Figure 14: *The ISS and support structure for A&G electronics is shown with the GCAL space frame in between.*

3.1. Gemini Calibration Unit (GCAL)

The UK's ATC is building a pair of facility calibration units for Gemini, which are nominally scheduled to be installed on Gemini North and South during 2000. The calibration units are designed to replicate the telescope's beam and send an extremely flat field of illumination into instruments mounted on the ISS.

As seen in figures 14 and 15, GCAL mounts on the side of the ISS in a space between the electronics racks used for the A&G system. The central science fold mirror in the A&G Unit directs GCAL's beam into any of the three facility instruments mounted on the telescope at one time. GCAL is intended to provide the calibration needs of all but the thermal infrared instruments, which normally use either the sky or a built-in calibration system. A combination of quartz halogen, grey body, gas lamps, and hollow cathode lamps act as flat fielding and spectral calibration flux sources. These lamps are projected into a clever reflecting hemisphere chamber which illuminates either an optical or infrared optimized diffusing screen (remotely selectable). This system is estimated to yield an output beam that is ~20 times greater than would be achieved by a conventional integrating sphere. Light emerges from the hemisphere and passes through a single filter wheel that houses neutral density filters and color balancing filters. From there the beam is reflected off a pair of large diamond turned projection mirrors which yield an f/16 beam that passes into the ISS, where it is directed into an instrument of choice. This beam is expected to be uniform in illumination to the ~1% level across the central 3 arcminutes of the telescope's field of view. The entire system is mounted

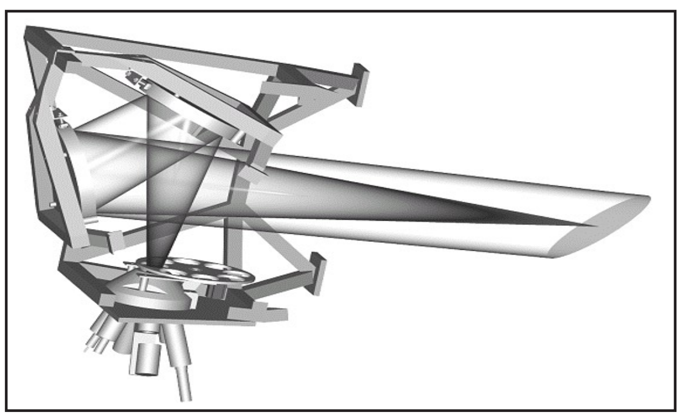


Figure 15: *GCAL uses a series of lamps, seen at the bottom, that are projected into a novel hemispherical reflecting dome, together with a pair of large mirrors that project an extremely uniform beam which simulates the telescope's beam into any of the facility instruments.*

in a lightweight frame which is adequate given the large opto-mechanical flexure tolerances that are intrinsic to the design of GCAL. Though this calibration unit is certainly the least complicated of any of the facility instruments, it is expected to have the longest lifetime because of the flexible nature of its design, which can accommodate many different types of flux sources in the future, and it will play a key role in essentially all data recorded with the Gemini telescopes.

3.2. Gemini Polarization Unit (GPOL)

The UK's ATC is also building a pair of polarimetry units that will permit observations through λ/2 waveplates from ~0.3 to ~4μm for instruments mounted on the up-looking port of the telescopes. GPOL is being designed as a retrofit in space remaining in the bottom module of the A&G unit, as shown in figures 16 and 17. Each telescope will receive a GPOL unit, though initially only a single set of the rather costly waveplates will be purchased and shared between Gemini North and South, as science programs demanding polarized observations are block-scheduled. Both GPOL's are currently scheduled to be commissioned during the first semester of 2001. Each GPOL consists of a set of three deployable trays, each of which has a motor driven turntable to permit rotation of the waveplate to various position angles on the sky. The upper tray has three smaller calibration waveplates held at fixed angles with respect to the instrument and telescope. The lower two trays have ~95 mm diameter waveplates that support unvignetted polarimetric observations in the narrow field modes of all instruments having corresponding analyzers. Each waveplate is mounted in an annulus of fused silica, allowing on-instrument wavefront sensors mounted in instruments to patrol the field outside the waveplate for guide stars. The fused silica has an identical optical depth as the waveplate, in order to yield a common telescope focal plane in the instrument when deployed.

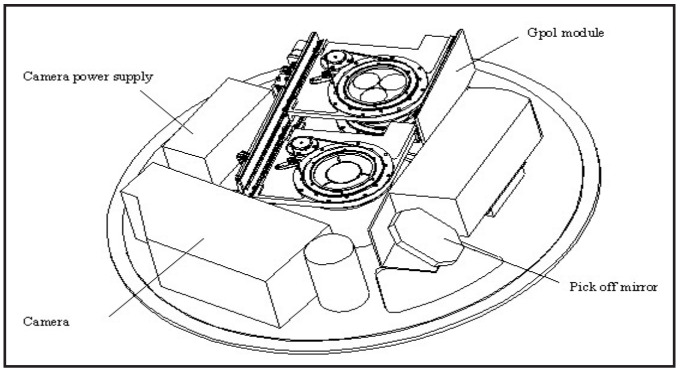


Figure 16: *GPOL, as seen in the base of the A&G.*

The analyzers mounted in instruments are, in general, Wollaston prisms. They have varying compositions within the facility instruments, including MgF2 for NIRI and Calcite for HROS. The Wollaston prisms provide efficient dispersion for orthogonal polarization states of transmitted flux and, when used in conjunction with a field mask in the instrument, generate a pair of images in the focal plane, the relative intensities of which map into the degree to which the target's light is polarized.

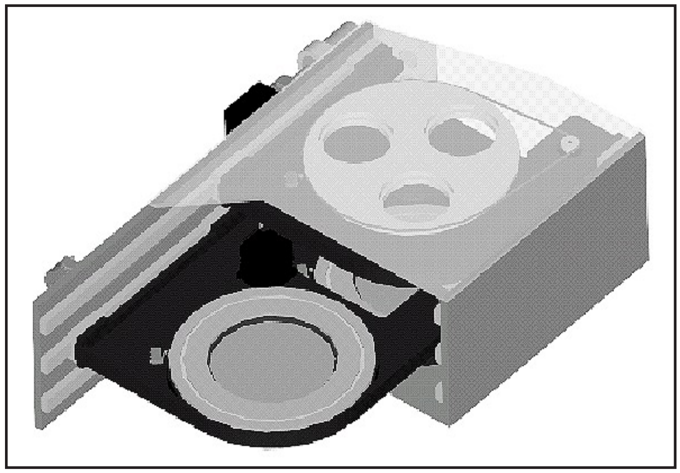


Figure 17: *The facility polarization unit, mounted in the base of the A&G, uses linear slides to insert waveplates or polarimetry calibration plates into the telescope beam.*

3.3. Adaptive Optics System: ALTitude Conjugated Adaptive Optics for InfRared (ALTAIR)

Gemini North will have a facility adaptive optics system capable of feeding any instrument on the ISS with an AO corrected beam. This system is being built in Canada by the Herzberg Institute of Astrophysics (HIA). ALTAIR will initially be used in a natural guide star mode but will be delivered laser guide star ready in order to take immediate advantage of a planned sodium laser launch system for the telescope. ALTAIR is optimized for ~0.85 - 2.5μm use and is predicted to deliver end-to-end system strehls of ~40% at H on bright guide stars, this strehl includes wavefront degradations due to the telescope and instrument optics. ALTAIR preserves the telescope focal plane location, as well as the pupil, making it essentially "transparent" to the instrument when deployed. An unvignetted 2 arcminute field will be used to acquire guide stars, with a low noise 802 frame transfer CCD being used as the wavefront sensor detector. ALTAIR is capable of working with the tip/tilt signal of the wavefront sensors located in instruments to correct for atmospheric and telescope gitter. When used in its laser guide star configuration, the combination of ALTAIR's 12x12 Shack-Hartmann facility wavefront sensor and the near-infrared tip/tilt sensor in instruments such as NIRI and GNIRS leads to AO corrected observations across much of the sky, including dark cloud regions.

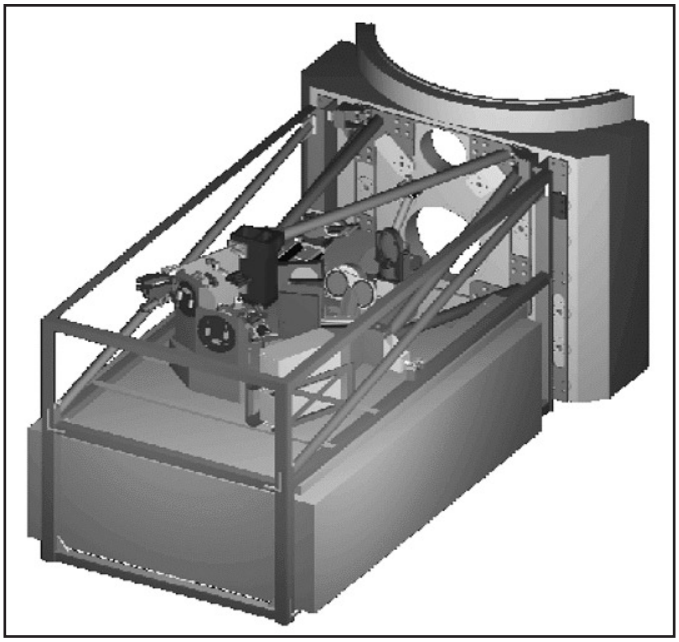


Figure 18: *ALTAIR with the nested truss mechanical system used to tie the optical bench to the ISS and a custom thermally enclosed electronics package below the bench.*

Referring to figure 18, the ALTAIR opto-mechanical assembly is mounted on a stiff bench that is suspended from the ISS through a series of nested trusses, similar to the strategy used for GMOS. Coupled independently to the ISS is a frame that supports a custom thermally insulated electronics cabinet, which contains a variety of electronics including the high voltage drivers needed for the deformable mirror. A single Reduced Instruction Set Computing (RISC) processor is dedicated to reconstructor processing tasks while three other high performance processors take care of the rest of the control system, various housekeeping functions, etc.

The most unique aspect of ALTAIR, compared to other AO systems, is that its deformable mirror is optically conjugated to a turbulence layer ~6.5 km above Mauna Kea, which past tests have indicated forms the dominant turbulence layer in the optical path of the telescope. This approach significantly increases the complexity of the ALTAIR control system, compared to conventional AO systems which typically conjugate to the exit pupil of the telescope, but promises to provide a corrected field that is nearly twice the size of comparable conventional AO systems. The key to making this system work is the multiple dome and local seeing reduction strategies used in the observatory.

4. On-Going Instrument Program

Beyond the previously summarized Phase 1 instrument program, a variety of instruments in an early conceptual design stage represent the next generation of instruments for the Gemini Observatory. While the Phase 1 instruments typically consist of multi-mode general purpose instruments, many of the instruments in the on-going program represent more specialized systems that fill unique scientific niches that Gemini Observatory is poised to offer its community. These include a coronagraph, which is intended for use on Gemini South around 2003. This will be Gemini's first dual-channel instrument with a built-in adaptive optics unit. This system will permit differential imaging of the environments immediately surrounding stars when searching for low mass companions, orbiting material, etc. When combined with the exceptionally smooth telescope optics, thin secondary mirror support structure, and a telescope enclosure that minimizes dome seeing, the new coronagraph represents a unique merger of instrumentation and telescope systems that will support searches for faint companions to bright stars at an unprecedented level of sensitivity.

Another example of an instrument that fills a niche within the “work horse” environment of instruments like NIRI and GNIRS is the near-infrared integral field spectrograph (NIFS). Currently, NIFS is undergoing the conceptual design phase at the Australian National University's Research School of Astronomy and Astrophysics (RSAA). NIFS is a mono-mode instrument, intended to be used with ALTAIR to provide integral field spectroscopic observations of galactic nuclei, Young Stellar Objects (YSOs), and complex compact fields. Figure 19 (next page) shows a cross sectional view of NIFS. Comparing this to figure 1 reveals a common design theme between NIFS and NIRI. In order to accelerate the NIFS and reduce its costs, this instrument will use hardware and software from NIRI to the extent practical. For example, the same vacuum jacket, wavefront sensor, and some of the mechanisms and software from NIRI will be duplicated for NIFS.

Another instrument currently in a competitive design study phase at the University of Florida and Anglo-American Observatory (AAO) is a near-infrared multi-object spectrograph. This instrument will provide

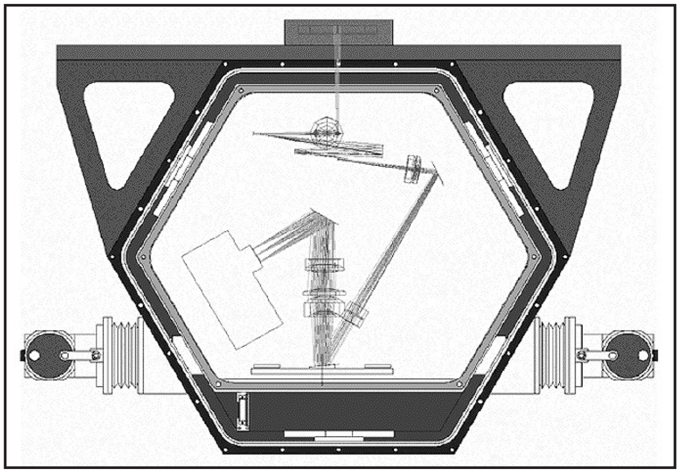


Figure 19: *The science channel in NIFS. Comparing this to figure 1 reveals the use of common components between NIRI and NIFS, which is part of Gemini's effort to recycle elements of instruments in successive generations to accelerate fabrication times and reduce costs.*

1-2.5µm direct imaging as well as multi-slit spectroscopy across a ~3-4 arcminute field of view. The 2-pixel spectral resolution will be enough to permit observations between OH emission lines in recorded spectra. A cold slit environment that is capable of rapid thermal cycles will permit the deployment of enough cold slits in the instrument to easily support a full night of spectroscopic observations. Again, in order to reduce costs and accelerate fabrication times, this instrument will build upon the designs of IRMOS which is being fabricated now with similar basic capabilities (FLAMINGOS and IRIS2). Like GMOS, the new IRMOS will have its slits cut with Gemini's facility laser milling machine.

Beyond developing a new IRMOS, Gemini's instrument program is funding technology studies at AAO and within the UK (ATC and University of Durham) that will feed into the development of an advanced cryogenic near-infrared spectrometer designed to exploit the output of a facility adaptive optics system on Cerro Pachón. The design studies include tests of the cryogenic performance of various types of fibers, mechanical deployment schemes of bundles of cold fibers within an instrument, micro-lens array alignment and mounting schemes when used with fibers in a cryogenic instrument, and deployable integral field unit opto-mechanical schemes. This work also includes studies of the cryogenic application of volume phase holographic gratings in order to significantly increase spectral resolution and throughput with these advanced dispersion elements.

Finally, Gemini has an on-going detector development program, which supports the use of state-of-the-art detectors in all of its facility instruments.

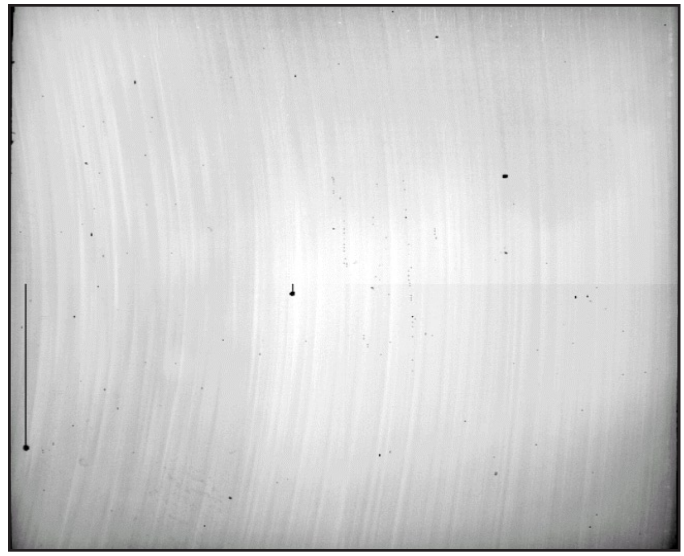


Figure 20: *The 1024^2 InSb ALADDIN science detector intended for NIRI, shown using flat field illumination.*

Perhaps the most successful element of the entire instrument program has been the 1024^2 InSb detector procurement, which yielded a total of 12 detectors, 10 of which have 4 operable quadrants and many of these are science grade devices. Figure 20 shows the detector that is destined for NIRI. These detectors will act as the cornerstone in many of Gemini's facility infrared instruments, including NIRI, GNIRS, and the coronagraph. In the optical, Gemini is pursuing advanced UV optimized CCDs, generated with molecular beam epitaxy, as upgrades to the baseline detectors in HROS. When combined with the highly UV optimized design of that instrument and high quality aluminum coatings anticipated with Gemini's sputtering coating plant, HROS should be one of the most UV sensitive ground-based astronomical instruments in the world.

5. Challenges: Past and Future

The previous description of Gemini's instrument program illustrates how a complex balance between science considerations, budgets, engineering disciplines, and international management structures must be achieved in order to satisfy the Gemini astronomical Community. This is obviously not a trivial task, and a number of valuable lessons have been learned while building all of these instruments. As the instrument program continues to mature and develop, these lessons are incorporated into the principles defining Gemini partnership interactions and in many cases provide a guiding light for keeping the overall program on course.

While the challenges of developing and maintaining a robust instrument program for the Gemini Observatory have been great, they have certainly not been overwhelming as shown by the previous descriptions of the remarkable technical achievements made by Gemini's instrumentation teams. Combined with the fantastic platforms the Gemini telescopes offer, these instruments will probe observing parameter space in terms of wavelength coverage (0.3 - 30 μm), spatial scales (~5 arcminutes to ~30 mas), sensitivity (e.g., a few percent total system emissivity at thermal wavelengths), and spectral resolution (broadband to R ~ 50,000) in a manner consistent with the far reaching scientific ambitions and expectations of Gemini's astronomical community. We eagerly await their arrival and look forward to the scientific discoveries these instruments will bring.

6. References

1. D. A. Simons, F. C. Gillett, and R. J. McGonegal, "Gemini Instrumentation Program Overview", SPIE, 2871, pp. 1070-1081, 1996.

Estimated Telescope Time Allocations in Steady State Operations

Matt Mountain, Director

Moving into the first phase of shared risks operations on Gemini North and with the addition of Australia to the Gemini partnership, our various communities have been discussing the allocation of partner shares for available nights once both Gemini telescopes are in steady state operations. In this spirit I thought I would demonstrate how telescope time is likely to be divided up in table 1, which estimates:

For details of how an individual National TAC functions, contact your National Gemini Office. For an explanation of how the Observatory Staff TAC functions and the principles and guidelines that will be used by the International TAC to synthesis recommendations from all the TAC's to produce the final recommendations for an integrated Gemini Observatory schedule for both telescopes, consult the Gemini Science Operations Plan (Version 3.0).

1. The national allocations made available to each National Time Allocation Committee (NTAC) as defined by the international Gemini agreement, once we are in steady state operations.

2. The time that will probably be allocated to our Hosts, the University of Hawaii and CONICYT.

3. The amount of time required for engineering and discretionary time and the amount of TAC awarded time to Gemini Observatory Scientific Staff.

Gemini North		Gemini South	
Country	**Nights+**	**Country**	**Nights+**
US	**116.2**	**US**	**116.2**
Host - UH	**31.0**	**Host - Chile**	**31.0**
UK	**61.4**	**UK**	**61.4**
Canada	**36.9**	**Canada**	**36.9**
Australia	**12.3**	**Australia**	**12.3**
Chile	**12.3**	**Chile**	**12.3**
Argentina	**6.1**	**Argentina**	**6.1**
Brazil	**6.1**	**Brazil**	**6.1**
Gemini Staff*	**27.9***	**Gemini Staff**	**27.9***
Engineering/DD*	**54.8***	**Engineering/DD***	**54.8***

Table 1: *Estimated annual allocations, in nights, on both Gemini telescopes.*

+ Once both telescopes are in steady state operation, at least half of the time allocated on the Gemini telescopes will be for queue-based observations, and allocations will be made in units of hours, not in integral nights. Even in classical observing, the minimum unit of allocation will be half nights.

** Estimates of required engineering time, discretionary time and awarded scientific staff time during steady state operations. Each function might be somewhat higher or lower, but the combined total will normally not exceed 25 percent.*

ERRATA TO TIME ALLOCATION ARTICLE AND TABLE

Estimated Telescope Time Allocations in Steady State Operations

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2. The time that will probably be allocated to our Hosts, the University of Hawaii and CONICYT.
3.The amount of time required for engineering and discretionary time and the amount of TAC awarded time to Gemini Observatory Scientific Staff.

Gemini North			Gemini South		
Country	**Fraction**	**Nights+**	**Country**	**Fraction**	**Nights+**
US	**41.6%**	**116.6**	**US**	**41.6%**	**116.6**
Host - UH	**10.0%**	**31.0**	**Host - UH**	**10.0%**	**31.0**
UK	**22.05%**	**61.6**	**UK**	**22.05%**	**61.6**
Canada	**13.2%**	**37.0**	**Canada**	**13.2%**	**37.0**
Australia	**4.4%**	**12.3**	**Australia**	**4.4%**	**12.3**
Chile	**4.4%**	**12.3**	**Chile**	**4.4%**	**12.3**
Argentina	**2.2%**	**6.2**	**Argentina**	**2.2%**	**6.2**
Brazil	**2.2%**	**6.2**	**Brazil**	**2.2%**	**6.2**
Gemini Staff*		**27.9****	**Gemini Staff***		**27.9****
Engineering/DD*		**54.3**	**Engineering/DD***		**54.3**

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*****Estimates of required engineering time, discretionary time and awarded scientific staff time during steady state operations. Each function might be somewhat higher or lower, but the combined total will normally not exceed 25 percent.*

***Awarded staff time is taken "off the top" after the allocations for Engineering and Host time have been made.*

National Science Foundation Supports Internet2 Access on Mauna Kea

Tod Fujioka & Peter Michaud

Thanks to the financial support of the National Science Foundation (NSF) and the efforts of the Association of Universities for Research in Astronomy (AURA) and the University of Hawaii, astronomers at Gemini and on top of Mauna Kea have significantly increased their Internet connections to the rest of the world.

Since high speed networking is critical to Gemini operations, increasing the available bandwidth from the University of Hawaii to the Mauna Kea observatories and their base stations is a key element necessary for remote operations and queue scheduling. Another vital element is having an un-congested, high speed Internet backbone that connects many of the research partners. Internet2 promises to be that backbone. According to Gemini Operations Manager, Dr. Jim Kennedy, "the new link will be crucial in coordinating advanced communications and scientific activities when our high-performance connection is completed to the Gemini South facility in Chile."

The new, high speed connection came from a National Science Foundation grant that was written by Gemini and submitted by AURA to supplement existing University of Hawaii Internet upgrade funding. The connection benefits not only Gemini but also all of the observatories atop Mauna Kea and their base facilities that are connected to the Hilo Technology Park Network via the Mauna Kea Observatories Communication Network (MKOCN). (See Figure 1.) With a capacity of 45 million bits per second, the new connection is almost one thousand times faster than a typical modem!

Before this upgrade, Mauna Kea shared a 1.5Mbps connection to UH Manoa in Honolulu. With the upgrade, the observatory community on Mauna Kea now shares a 35Mbps connection to UH Manoa. Gemini's Hilo Base Facility also has a dedicated 10Mbps virtual circuit to UH Manoa that can reach burst rates of up to 45Mbps.

Presently UH Manoa has a 10Mbps US west-coast connection to Abilene Internet2. Relatively soon, we plan to upgrade this US west-coast connection to 155Mbps and add a second 155Mbps circuit to the far east. Hawaii's present connection to Abilene, the Internet2 backbone network, is through the Department of Defense's Research and Engineering Network (DREN). DREN provides a 45Mbps link between Hawaii and California through a special agreement between the University of Hawaii, DREN, and NSF

"This network connection is a result of a partnership that shows what is possible when you combine resources to solve common problems," said Dr. David Lassner, director of the University of Hawaii's Information Technology Services. "This would have been prohibitively expensive if we tried to work independently or without the help of several federal agencies."

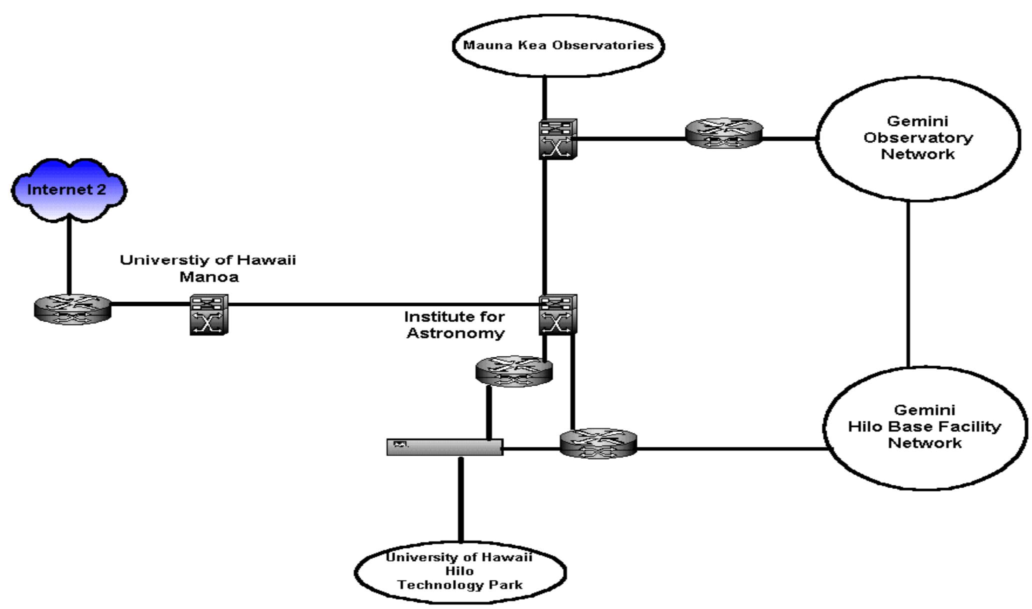


Figure 1: *Internet2 network diagram for Mauna Kea observatories and support facilities.*

A $340,000 High Performance Connections grant from the National Science Foundation (NSF) to the University of Hawaii Information Technology Services supported a new internet connection, as did a $600,000 NSF grant to the Association of Universities for Research in Astronomy (AURA) to connect Gemini and the other Mauna Kea Observatories.

The new link also brings educational benefits. The high-performance connection allows Gemini to share more of its findings with the public through techniques such as virtual observatory tours and live video links from Mauna Kea to museums, planetaria, and classrooms throughout the partnership.

Public Information and Outreach Update

Peter Michaud

As Gemini North rapidly approaches scientific operations with both QuickStart and Demo Science slated for the second half of 2000, the first half of the year produced an unprecedented level of activity in the Gemini Public Information and Outreach Office.

As the year began, efforts concentrated on documenting the Gemini South mirror move from France to Cerro Pachón. In addition to the extensive video and still photography that was funded though a supplemental NSF grant, a film crew from the educational television program NOVA documented much of the mirror move. These efforts produced spectacular results, and some of the images can be seen in the covers and center pages of this newsletter. Selected images and video footage, including aerial pictures, are available to Gemini partner offices upon request.

Immediately after the mirror's arrival in Chile, photographer Neelon Crawford began an extensive photo shoot of Gemini South that included an impressive set of aerial images. These images will serve as a key element in "Tools of Vision," a photo exhibition that will open at the National Academy of Sciences in September of this year. We are working on a proposal that would allow the exhibition to travel to many venues over a period of 5 years, including museums and visitor's centers throughout the Gemini partnership starting in 2001.

Another project that is almost finished involves a set of animations illustrating several aspects of the Gemini Observatory. The first set, which should be completed by the 3rd quarter of 2000, begins with a CAD-based animation of the Gemini enclosure and telescope operation and ends with a simplified animation of adaptive optics principles. Selected

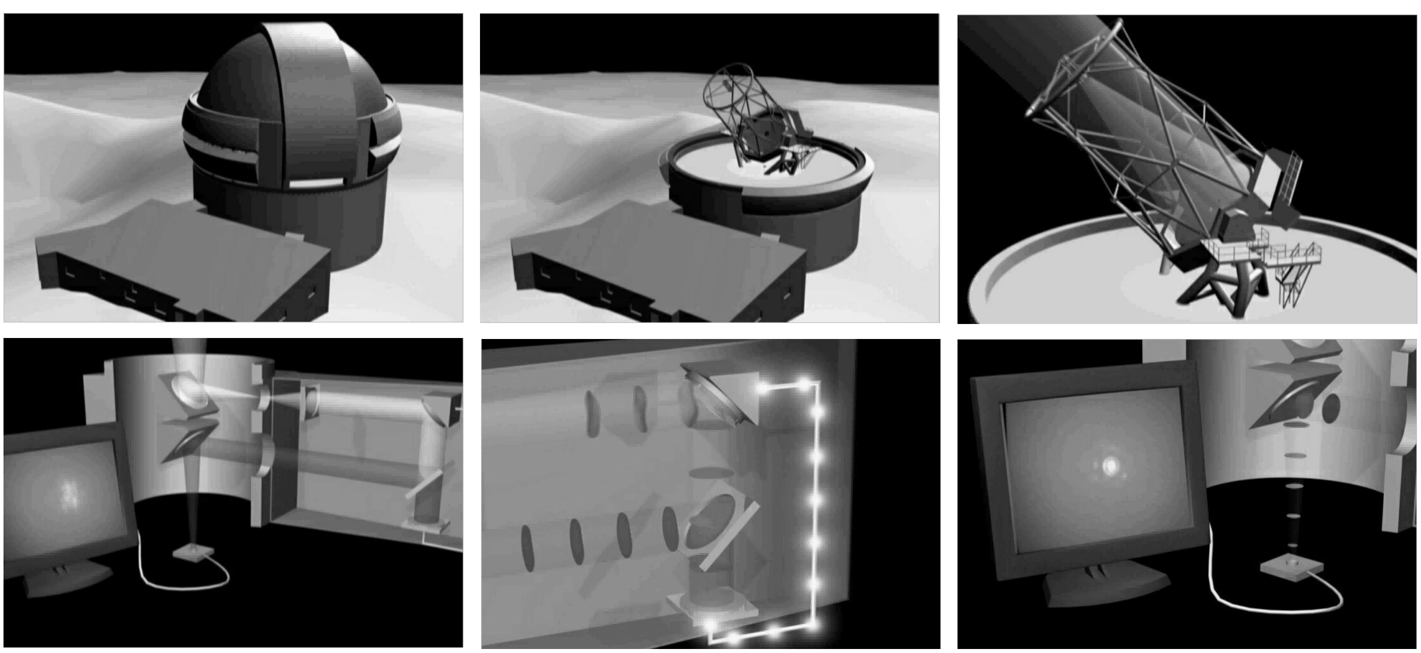


Figure 1: *Excerpts from Gemini animation showing operation of the dome, telescope and generic AO system.*

frames are shown in figure 1.

The Space Telescope Science Institute has also been contracted to develop a pair of animations that illustrate infrared radiation escaping from a gas cloud and a generic view of the star and planet formation process. It is expected that these animations will be completed by the end of calendar year 2000.

Local outreach has continued to expand during the first half of 2000, necessitating the hiring of a 0.25 FTE Outreach Assistant, Janice Harvey. Ms. Harvey assists with local outreach efforts as well as local media relations and office coverage.

One particularly successful outreach program, which partnered Gemini with the University of Hawaii at Hilo, involved Gemini outreach staff presenting programs to local schools using the University's portable StarLab planetarium. The success of this program prompted Gemini to purchase a StarLab portable planetarium and present it as a gift to the students of La Serena during a sister city teleconference between Hilo and La Serena held late in 1999. Work is progressing to establish a partnership with CTIO and Gemini in order to use the StarLab equipment most effectively in Chile. (See figure 2.)

We anticipate that the second half of 2000 will continue the expansion of many of the programs described above as well as several new initiatives that will support upcoming demo science, full scientific operations, and the Gemini South dedication later in 2001.

Figure 2: *Students entering the StarLab portable planetarium at Waiakea Elementary School in Hilo, Hawaii (left), and students in La Serena, Chile after touring the night sky inside the planetarium during a demo for several schools in February 2000 (right).*

Human Resources Update

Melissa Welborn

Gemini Observatory is very pleased to announce that Dr. Brent Ellerbroek and Dr. François Rigaut have each received the 1999 AURA Science Award for outstanding service to AURA and to Astronomy. Both awards were presented during the AURA Oversight Committee meeting held in Hilo, Hawaii, May 5, 2000. Drs. Ellerbroek and Rigaut were given these awards for their work on Multi-Conjugate Adaptive Optics (MCAO) which established the feasibility of MCAO for Gemini South and its role as a key technology for future extremely large telescopes. They are now continuing work on the design of the MCAO system for Gemini South, with a conceptual design review scheduled for May 30 and 31 in Hilo.

Dr. Claudia Winge, formerly of Universidade Federal do Rio Grande do Sul in Brazil has joined the Gemini Observatory as a Gemini Fellow and is currently working at Gemini South. Recruiting continues to be a major activity for the Human Resources

Department. We have also welcomed the following people into the Gemini North fold since the last newsletter: David Melder, Computer Network Assistant; Robert Nolan, Instrumentation Engineer; Jacques Peysson, Software Group Manager; Janice Harvey, Outreach Assistant; Pablo Prado, System Support Associate; Marie-Claire Hainaut-Rouelle, System Support Associate; Helen Smith, Assistant Librarian; and Anne Pearson, Administrative Assistant. In addition, we have welcomed the following employees to Gemini South: Rolando Rogers, Sr. Electronics Engineer; Nelson Saavedra, Computer Programmer.

We would like to take this opportunity to express our thanks to the following former employees who have moved on to other challenges: Darrell Denlinger, Dave Montgomery, John Maclean, Gil Moretto, Kalena Quinones, John Roberts, Shane Walker, and John White.

As we look to the future during this period of rapid growth, the Human Resources Department has undertaken to engage in strategies that support near-term and long-term goals of the Observatory. As we plan for the future, we appraise frequently external trends, workforce changes, technological advances, and issues of succession planning.

Partner Office Updates

US Gemini Project Office

In early May 2000, the NOAO TAC began reviewing the first Gemini proposals and the Demonstration Science teams continued developing their observing programs. NOAO received 78 proposals for Gemini QuickStart observations, almost evenly divided among the two available instruments, OSCIR and Hokupa'a. The proposals requested a total of 112 nights, oversubscribing the available 175 hours by a factor of 6.4! The requested time ranged from a short 2.5 hours to a full 5 nights.

NOAO and the USGP will be providing a commissioning imager for Gemini S (Abu) and also Phoenix, the mid-IR high resolution spectrograph, will be shared with CTIO/SOAR and Gemini-S (see the related instrumentation articles).

Our next call for proposals, which we hope will include the Near Infrared Imager (NIRI), has a September 30, 2000 deadline for the 2001A semester.

See the U.S. Gemini Instrumentation Program Update article by Taft Armandroff and Mark Trueblood for the rest of the U.S. Gemini Program news.

I would like to take this opportunity to thank the instrument teams from University of Hawaii (Buzz Graves, Malcolm Northcott, and company) and University of Florida (Charlie Telesco and company) for providing their instruments for visitor use and supporting early science on Gemini North. The U.S. and international Gemini communities owe them a great debt, as they have enabled our first use of this important international telescope. I also want to welcome Taft Armandroff as the U.S. Gemini Project Manager. Taft has ably taken responsibility for Gemini instrument packages assigned to the U.S. and will coordinate U.S. activity for new Gemini instrumentation, as well. Finally, I would like to thank my predecessor, Todd Boroson, for his six years of service as U.S. Gemini Project Scientist and all the help he has given me over the past 6 months. Todd's tireless work and attention to an amazing number of details have greatly helped me by providing an encyclopedic resource for everything happening now in Gemini, as he patiently explained the history, rationale, and options that have been considered. I am sincerely grateful for his expert advice.

Bob Schommer

UK Gemini Project Office

Activity in the U.K. Gemini Support Group (UKGSG), has been significant in recent months in light of the March 31, 2000 semester 2000B QuickStart deadline. This comes in addition to the task of keeping abreast of progress with Gemini and its instrumentation and passing on this and other relevant information to the U.K. community. Colin Aspin has been based in Hawaii at the Gemini Observatory since August 1999 and has contributed effort to the Gemini web site, the HelpDesk, the Phase I Submission Tool and nighttime astronomer support of engineering work. He has also continued to support the UKGSG web site. Isobel Hook, based at the Astronomy Technology Centre (ATC) in Edinburgh, has been working with the GMOS group as they integrate and test this Gemini common-user instrument. In June 2000 we will welcome Eline Tolstoy, currently at ESO Garching, to the group and in subsequent months, we will be advertising for a fourth member of the UKGSG.

At the Gemini semester 2000B QuickStart proposal submission deadline, a total of 32 proposals had been submitted to the UKGSG. The proposals were submitted using the new Gemini Phase I Tool (PIT), distributed to the community from the U.K. Starlink Office or by direct downloading from the Gemini Observatory mirror web site in Cambridge. Proposal reception software, written by Dr. Stuart Lumsden of Leeds University, was successfully installed on the Oxford computer system to accept, check, and file the submitted proposals. This software was also installed at the Canadian and Australian National Gemini offices to receive their proposals from the PIT.

Of the 32 proposals submitted, approximately 2/3 requested Hokupa'a and QUIRC, the near-IR 1-2.5 micron AO imager, and the remaining 1/3 requested OSCIR, the mid-IR imager/spectrometer. The nominal U.K. allocation of observing time, for the 2000B QuickStart semester of August 1, 2000 to January 31, 2001, is 92 hours. In total, the requested time for this period totals 402 hours or a factor about 4.4 over-subscribed. These numbers include the observation overheads defined by Gemini for both instruments.

Technical assessment of the proposals was divided between the UKGSG staff members. During technical assessment, the most consistent problem area related to AO guide star selection for Hokupa'a and QUIRC and the inclusion of observation overheads in the total requested time. Proposal PIs were contacted via e-mail to clarify all technical points raised by the assessment.

Scientific assessment is being performed by the U.K. Gemini Time Allocation Group (TAG) under the Chairmanship of Dr. Dave Axon of the University of Hertfordshire. The process of scientific assessment involves expert referees selected from the U.K. community. The U.K. TAG meeting, to produce a final ranked list of proposals, is scheduled for May 22, 2000.

Use of the PIT for proposal submission was a radical change from the usual U.K. proposal submission mechanism and did not proceed without problems. During the four weeks between the issuance of the Call for Proposals and the 2000B QuickStart deadline, the U.K. encountered a number of issues with both the installation and use of the PIT and in understanding the requirements for a QuickStart observing proposal created using PIT. To better assess the level of problems encountered throughout the community, we created a survey web form for the proposal PIs to send feedback with their thoughts and views on the proposal submission process in general, use of the PIT, and availability of necessary information. The returned comments spanned the full range of possible views from extolling PIT as the way forward for proposal submission to extreme dislike. In general, however, the consensus found the PIT and the proposals submission process currently implemented on the right track, though further development is certainly required. Complete results of the survey will be posted (anonymously!) on the UKGSG web site.

In conclusion, we eagerly await the results of the first round of applications for Gemini observing time and look forward to the exciting science involving U.K. astronomers that will undoubtedly be performed.

Colin Aspin
Alison Toni

Canadian Gemini Project Office

The Canadian Gemini Office (CGO) gave presentations on Gemini at eight Universities soon after the first Call for Proposals was issued. The CGO received 29 proposals (18 for OSCIR and 11 for Hokupa'a) for the QuickStart semester. The total time requested was 224 hours, providing an oversubscription factor of 4.1 for the nominal 55 Canadian hours available. Canadian proposals allowed LaTeX for mathematics, tables, etc. The received XML files plus attachments were converted into LaTeX and processed into a PostScript file. Canadian Time Allocation Committee (CTAC) members received a hardcopy of the LaTeX version while the PostScript file was sent to external referees.

The first Gemini Multi-Object Spectrograph (GMOS), destined for the Mauna Kea telescope, made significant strides toward completion and achieved a number of major milestones in the past year. The instrument optical barrels, assembled and tested by Fletcher and Stilburn, delivered exquisite throughput and an image quality that fully met the demanding specification. The barrels were delivered to the Royal Observatory, Edinburgh (ROE) in October 1999. The second major contribution to GMOS, the prefocal assembly, was completed in February 2000 and represents the unified effort of most of the Optical Instrumentation Group. The prefocal assembly has also been shipped to ROE for integration with the rest of the instrument. GMOS should be completely integrated before June 2000 and testing will take place through the summer. We continue on a course toward delivering GMOS this year.

The second GMOS, destined for the Cerro Pachon telescope, received most of its parts in the past year. Since integration and testing of the first GMOS had a higher priority, we made no plans to start any major integration of the second GMOS last year. However, we anticipate that the second GMOS optical barrels and prefocal assembly will be shipped to ROE in the last quarter of 2000. We have had good progress on optics. All the cell lens rings are fabricated and the lenses are now being mounted in the lens rings. The Camera barrel is fabricated and collimator barrel fabrication is underway. Less progress has been made on FOSS because of heavy machine shop loading. However, the major structural parts are fabricated, inspected, and ready to be assembled once the shop is free next month. Fabrication on focal plane components is also well underway.

Altair, the adaptive optics system for the Gemini North telescope, after passing a successful critical design review in early 1999, is now in construction at the Herzberg Institute of Astrophysics in Victoria, Canada.

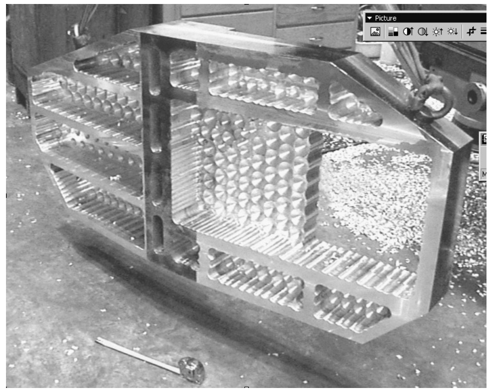


Figure 1: *Altair optical bench after rough machining.*

Altair's optical bench has been rough-machined and sent out for heat treatment to increase its micro-yield strength so that optics will stay in alignment throughout its lifetime. The trusses that support the optics on the telescope are underway at an outside welding shop. Our shops are machining the adjustable mirror mounts. The frame for the light-tight enclosure is finished, and we are working on its insulating covers.

Altair has a demanding requirement to reproduce the telescope beam f/ratio, exit pupil, and focus location. Thus, the beam leaving Altair must be larger than the 177-actuator deformable mirror. A convex mirror expands the light and a camera mirror reimages it on the instrument focal plane. The Invar box that supports these mirrors in position within 50 microns has been sent for light-weighting by cutting holes in 9-mm thick plates by water-jet! We expect these off-axis conic mirrors, as well as the tip/tilt mirror, by the end of June 2000. The deformable mirror is four months late and is now promised for the end of August 2000.

To move the electronics off the critical path, we built plywood mockups of the optical bench and electronics cabinets. Then we worked on two wiring harnesses in parallel: one inside the cooled electronics enclosure, and the other for the optical bench. We wired and debugged 300 circuits up to connectors for individual mechanisms such as the atmospheric dispersion compensator. These circuits provide optical isolation, noise suppression, and interlock protection between the VME instrument control computer and the rest of Altair.

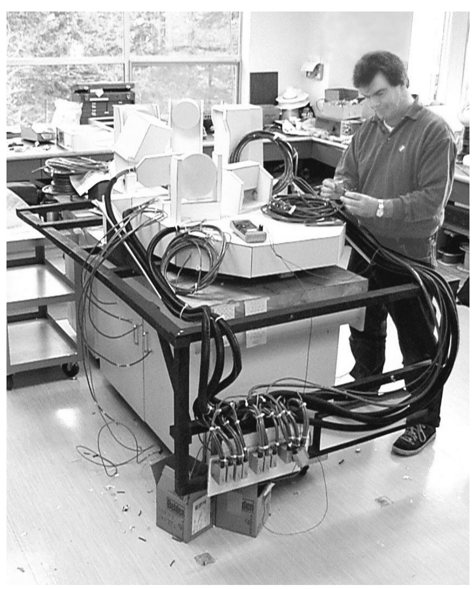


Figure 2: *Plywood mockups of the optical bench and electronics cabinets being* wired.

Two teams are developing software. The conventional instrument control software under EPICS runs the mechanics and provides the interface to the Gemini telescope control system. One of the software's most difficult tasks is to nod on the sky, when two gimbal mirrors in the wavefront sensor acquisition optics must tilt in concert. Software, as well as the actual Altair electronics, will be tested in early May 2000 when we control real actuators with the nodding software.

The second software team is programming the wavefront correction system (WFCS) that runs the high-speed servo loop using wavefront sensors to control the deformable mirror. We are pleased to report that the production software runs at the loop rate of 1.2 kHz predicted by the CDR benchmarks. The WFCS also has many supervisory tasks such as blending in signals from the on-instrument wavefront sensor, and most importantly, optimizing the correction for variations in seeing.

The highest priority is to run the WFCS with the servo loop closed optically this year. Therefore, we will assemble a minimum subset of the optics on a lab bench and attach the electronics. Meanwhile, off the critical path, we will debug various jigs and carts for assembly and handling of the heavy mechanics. We will also perform preliminary flexure and light-tightness testing off-line.

In early 2001 we will put all the pieces together, align optics, debug software, flex and cold test Altair, and ship it in late summer.

The Gemini Science Archive Conceptual Design Study workscope was signed in January, and work began in February of this year. This is the first phase of the Gemini Science Archive project, which will be followed by the Development phase and the Operations phase. The first phase is scheduled for completion in December 2000. The Conceptual Design Study work package involves Canada (NRC) and Chile (CONICYT) and is being done at the Canadian Astronomy Data Centre at HIA in Victoria. The CADC is hosting one Chilean software engineer as well as contributing its own personnel to work on this project. Chile has also appointed an Archive scientist.

Dennis Crabtree

Australian Gemini Project Office

The past six months have been an active period for the Australian Project Office as we moved through the November 1999 Readiness Review process and outcome, to the activation of the HelpDesk support process, and on to the development and implementation of procedures for the QuickStart Service Observing and Demonstration Science programs. In particular, the Gemini Phase-I proposal tool was successfully installed at a number of different institutions. Further, the proposal backend processing code was successfully installed at the Anglo-Australian Observatory, which is the service organization for the Australian Time Allocation Committee (ATAC). The proposal technical evaluations, however, are the responsibility of the Australian Gemini Office. The QuickStart Service Observing proposal submission process went smoothly and the submitted proposals are now being evaluated by ATAC members.

The beginning of the year also saw the receipt of the first funds from the Australian Research Council (ARC) to operate the Australian Gemini Office. These funds are currently for calendar year 2000 only but we expect annual renewal. The ARC funds primarily support Australian Gemini proposals. Though we have not hired any new employees, the funds permit, in addition to myself, Dr. Peter Wood of the Research School of Astronomy & Astrophysics, at the Australian National University (ANU), to spend a fraction of our time on Gemini support duties. We have also funded software support to maintain the local mirror (www.gemini.anu.edu.au) of the Gemini website and for activities associated with the proposal process (e.g., Phase-I tool installations).

Some funds are also available for outreach activities. For example, ARC has generously funded a significant Gemini display as part of its commitment to the "Australian Science Festival," which occurs in early-May. The "Amazing World of Science" exhibition runs over four days in Canberra and attracts approximately 40,000 people, including school groups, science educators, overseas delegations, and of course the general public. The displays include a Gemini presentation featuring information on the Project, the partnership, and the telescopes on a large high quality, full color wall panel fronted by two iMacs running the Gemini-North Virtual Tours, to provide an "interactive feel." The display makes extensive use of material provided by the Gemini Public Outreach Office and we are grateful to them for making it available.

Regarding instrumentation project news, the Near-infrared Integral Field Spectrograph (NIFS) had a very successful Concept Design Review meeting in mid-March. (See the NIFS home page at www.mso.anu.edu.au/nifs.) Documents available at the NIFS web site include the Operational Concepts Definition Document (OCDD) and the Functional Performance Requirements Document (FPRD). The Anglo-Australian Observatory completed the concept design study for IRIS2-g, a development of an AAT instrument (IRIS2-a), which could provide near-IR imaging and multi-object slit spectroscopy capabilities on the Gemini telescopes. The Concept Design will be reviewed in Hilo at the end of April 2000.

Finally, it is a pleasure to report that the International Gemini Project Board met Australia for the first time in May 2000. The board meeting was followed by a one-day workshop on "Future Large-Scale Astronomy Facilities," which featured speakers from both the Gemini partners and the local Australian astronomy community.

Gary DaCosta

Chilean Gemini Project Office

Oscar Riveros left the Chilean Gemini Office after serving for several years as Project Manager. Luis Campusano will be coordinating all the activities of Chilean Gemini Project Office (at CONICYT), and a new person arrived to support management duties. On May 1, 2000 Felipe Barrientos joined the Chilean Gemini Office as a part-time support astronomer, whose main responsibility will be the workpackage on the Gemini Science Archive (Phase I) that is being conducted through a partnership with the Canadian National Research Council (NRC). Felipe has a Ph.D. from the University of Toronto, and his scientific interests focus on the properties of early-type galaxies in galaxy clusters. He is currently Assistant Professor in the Astronomy and Astrophysics Department of the Pontificia Universidad Catolica.

Consultations to the Chilean office should be addressed to its secretary, Ms. Maria Elena Diaz (mdiaz@conicyt.cl).

Gemini QuickStart Program 2000B

The submission process of Chilean proposals for telescope time on Gemini North successfully closed on April 14, 2000. Our office received six proposals via e-mail in the form of XML files and their corresponding attachments. The total requested telescope time was 15.1 hours for Hokupa'a and QUIRC, and 5.3 hours for OSCIR.

A first technical review of the received proposals detected some problems in the technical description. Most of these mistakes arose from mishandling the Gemini Phase I Tool used to generate the XML files; others, though, originated in the observing constraints required by Gemini, such as the proper description of the OIWFS star for Hokupa'a, realistic estimates of the time overheads, and weather conditions linked with a proposed program. Therefore, the general policy of this office was to show flexibility given that this was the first round of a new process.

The Chilean National TAC met on May 8, 2000, to discuss the QuickStart program proposals and rank them. All the proposals were deemed worthy of receiving telescope time. The oversubscription factor, after correcting for underestimations of the time needed to obtain the science, was 1.3. We expect that the response of our community to future calls for proposals shall increase considerably as Gemini North offers new instrumentation (e.g., NIRI).

The Chilean TAC is composed of Leonardo Bronfman (Universidad de Chile), Douglas Geisler (Universidad de Concepcion), Leopoldo Infante (P. U. C.), Patrick Osmer (Ohio State University), Mark Phillips (Carnegie Institution of Washington), Maria Teresa Ruiz (Universidad de Chile, Chair), and Charles Steidel (California Institute of Technology). Sebastian Lopez acted as the TAC's technical secretary.

Science Archive WorkScope

Phase I of the Gemini Science Archive is a collaboration between CONICYT and NRC at the Canadian Astronomy Data Center (CADC). In February 2000, CONICYT sent a software engineer, Mr. Felipe Richardson, to Victoria to work on this project. A Chilean student pursuing a Master's of Computing Science will soon join Mr. Richardson at CADC to work on a thesis related to the WorkScope. Felipe Barrientos, working from Chile, is part of the Chilean archive team. Ricardo Baeza, from the Department of Computing Science of the University of Chile, is advising the Chilean office on software and archiving matters.

Luis Campusano
Sebastian Lopez

Brasilian Gemini Project Office

The submission of QuickStart proposals in Brazil went smoothly thanks to the efforts of many people, but mostly Dr. Albert Bruch from our National Office at Laboratorio Nacional de Astrofisica, and Dr. Claudia Winge from Instituto de Fisica, UFRGS, Porto Alegre. Eight proposals were submitted, six for Hokupa'a and QUIRC, and two for OSCIR.

Brazil is going to join the Gemini Demonstration Science Team to investigate a 10 microns Deep Field. A team led by Dr. Miriani Pastoriza from Instituto de Fisica, UFRGS, Porto Alegre, submitted a successful letter of intent.

The Brazilian project office has nominated the following members for the National Gemini Committee for 2000-2002: Beatriz Barbuy, who will continue as the Brazilian representative on the board, with Paulo Pellegrini as substitute; Francisco Jablonski, who will be the project scientist, with substitute Augusto Daminelli; and Thaisa Storchi Bergmann, who will continue as the project manager.

Claudia Winge, selected as a Gemini Science Fellow, will work at Gemini South for an initial period of three years. She has already moved to La Serena to support the prime focus tests with Gemini South, and can be reached at cwinge@gemini.edu. Cristina Chiappini, who graduated at Instituto Astronomico e Geofisico, USP, was awarded a Gemini fellowship for the 2000-2001 cycle. She will work at the University of Arizona Steward Observatory with Dr. R. Kennicutt.

Soar Project News

Work began on the SOAR telescope foundation at Cerro Pachon. The construction can be followed through a webcam installed at the Gemini South dome, which delivers images to the URL address: http://www.physics.unc.edu/~evans/soarcam/soarcam.html. The contract to construct the 30 meter SOAR dome was awarded to Brazilian company: Equatorial Sistemas Ltda from Sao Jose dos Campos, Sao Paulo, which, with the participation of the company Santin of Piracicaba, Sao Paulo, will build the mechanical and control systems of the SOAR dome.

Thaisa Storchi Bergmann

Argentine Gemini Project Office

The Argentine TAC is ready to evaluate the observing proposals that have been received for the first round of observations with the Gemini North telescope. With a total of nine proposals, all aimed at the Hokupa'a and QUIRC equipment, six came from the Astronomical Observatory of the University of Cordoba, two from the Faculty of Astronomical and Geophysical Sciences of the University of La Plata, and one from the Institute of Astronomy and Space Physics (IAFE), Buenos Aires. Dr. Juan Carlos Forte, Chairman of the National Time Allocation Committee (NTAC), has been proposed as the Argentine member of the International Time Allocation Committee (ITAC). At the May 17, 2000 Gemini board meeting in Sydney, Australia, we will present an outlined plan for the future of Argentine Astronomy.

Jorge Sahade

US Instrument Program Update

The U.S. Gemini Instrumentation Program (USGP) is working hard, both in-house at NOAO and in the wider community, to help equip the Gemini telescopes with instruments. This article provides a snapshot of their status as of late April 2000.

<u>NIRI</u>
The Near Infrared Imager (NIRI) is a 1-5 micron imager with three pixel scales. NIRI has been undergoing a series of cold cycles to carry out tests and check corrections to problems discovered in previous tests. NIRI began its sixth cold cycle in mid-April 2000 and is expected to be cold by early May 2000. During the fifth cooldown, solutions to several previous problems were verified, but the test was interrupted when the science array controller stopped producing images. An anomaly inside the dewar was subsequently discovered and fixed, and the controller then began producing images. The next cold cycle was then begun and is expected to allow further testing and diagnostics by Klaus Hodapp, PI at the University of Hawaii, and the NIRI Team.

<u>T-Recs</u>
The Thermal Region Camera and Spectrograph (T-Recs) 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. This 8-26 micron instrument passed its CDR in July 1999 and is far along in parts fabrication and procurement. The team is on schedule to commission T-Recs in June 2001.

<u>GNIRS</u>
The Gemini Near-Infrared Spectrograph (GNIRS) is a long-slit spectrometer for the Gemini North telescope that will operate from 1-5 microns and offer two plate scales and a range of dispersions. Following the Restart Review in July 1999, three-dimensional design and engineering analysis activities have been progressing well. Likewise, prototype testing proceeds as part of the overall risk-reduction strategy. Prototypes of motor drives and optics mounts have been fabricated and tested. Neil Gaughan (Project Manager) and Jay Elias (Project Scientist) and their team presented the engineering results at a Pre-Fabrication Review on May 11 and 12, 2000. After the successful completion of that review, mechanical fabrication will begin. A software plan has been written. Optics fabrication is proceeding on schedule. Delivery is planned for July 2002.

<u>GMOS CCDs</u>
For the two GMOS spectrographs, NOAO is responsible for the CCDs, CCD controllers, related software, and systems integration. For GMOS I for Gemini North, the CCDs, controller, and related software were delivered in November 1999 and passed their acceptance tests. Currently the NOAO team, including Rich Reed, Tom Wolfe, and Richard Wolff, is testing CCDs for GMOS 2, destined for Gemini South.

<u>NICI</u>
The Near Infrared Coronagraphic Imager (NICI) is funded by the NASA Origins Program. NICI will provide a 1-5 micron infrared coronagraphic imaging capability on the Gemini South telescope. Mauna Kea Infrared was the successful competitive bidder for the NICI conceptual design study and the only respondent to an RFP for building the instrument. Because of these circumstances, a conceptual design review of their concept for NICI, followed by a procurement review of their proposal, was conducted with a single committee in Hilo on April 18 and 19, 2000. The review committee, chaired by Chick Woodward of the University of Wyoming, included scientific, technical, and managerial expertise.

<u>Flamingos 2</u>
Flamingos 2 is a concept for a near-infrared multi-object imaging spectrograph for the Gemini South telescope being developed by Richard Elston and his team at the University of Florida. The Flamingos 2 concept builds on the heritage of the Flamingos imaging spectrograph, cur-

rently in final assembly. Flamingos 2 has been developed in response to the “gap filler” opportunity for Gemini South, which seeks the relatively rapid deployment of a near-infrared spectroscopy and imaging capability. A conceptual design review of Flamingos 2 was held on April 28, 2000. The results of this review will be compared with those for a competing instrument, IRIS2G. If the International Gemini Project Office (IGPO) decides to select Flamingos 2 for construction, the Florida team plans to commission Flamingos 2 on Gemini South in May 2003.

Phoenix

Phoenix is a high-resolution near-infrared spectrometer that has been in productive scientific use on the KPNO 4-m and 2.1-m telescopes. Phoenix yields spectra with resolution up to R=70,000 in the wavelength range 1-5 microns. Our intent is to make Phoenix available on the Gemini South telescope at its inception of scientific use. Phoenix would be shared equally between Gemini South and CTIO/SOAR. An agreement in the final stages of negotiation between NOAO/USGP and IGPO specifies the modification of Phoenix for Gemini and how the instrument will be supported and maintained. Ken Hinkle will be the NOAO Instrument Support Scientist for Phoenix.

Taft Armandroff
Mark Trueblood

United Kingdom GMOS Update

The last six months brought significant progress on GMOS. UKATC in Edinburgh has been integrating and testing the first of the two GMOS instruments.

In December 1999 the Conceptual Design Review (CDR) for the GMOS integral field unit (IFU) was held in Durham, where the unit will be built. The IFU is a lenslet-fibre system that will give GMOS the capability of integral field spectroscopy over a 5 by 7 arcsecond rectangular region of sky, with 1000 spatial samples. The GMOS IFU will have a separate background field of 3.5 by 5 arcsec, one arcminute from the main field.

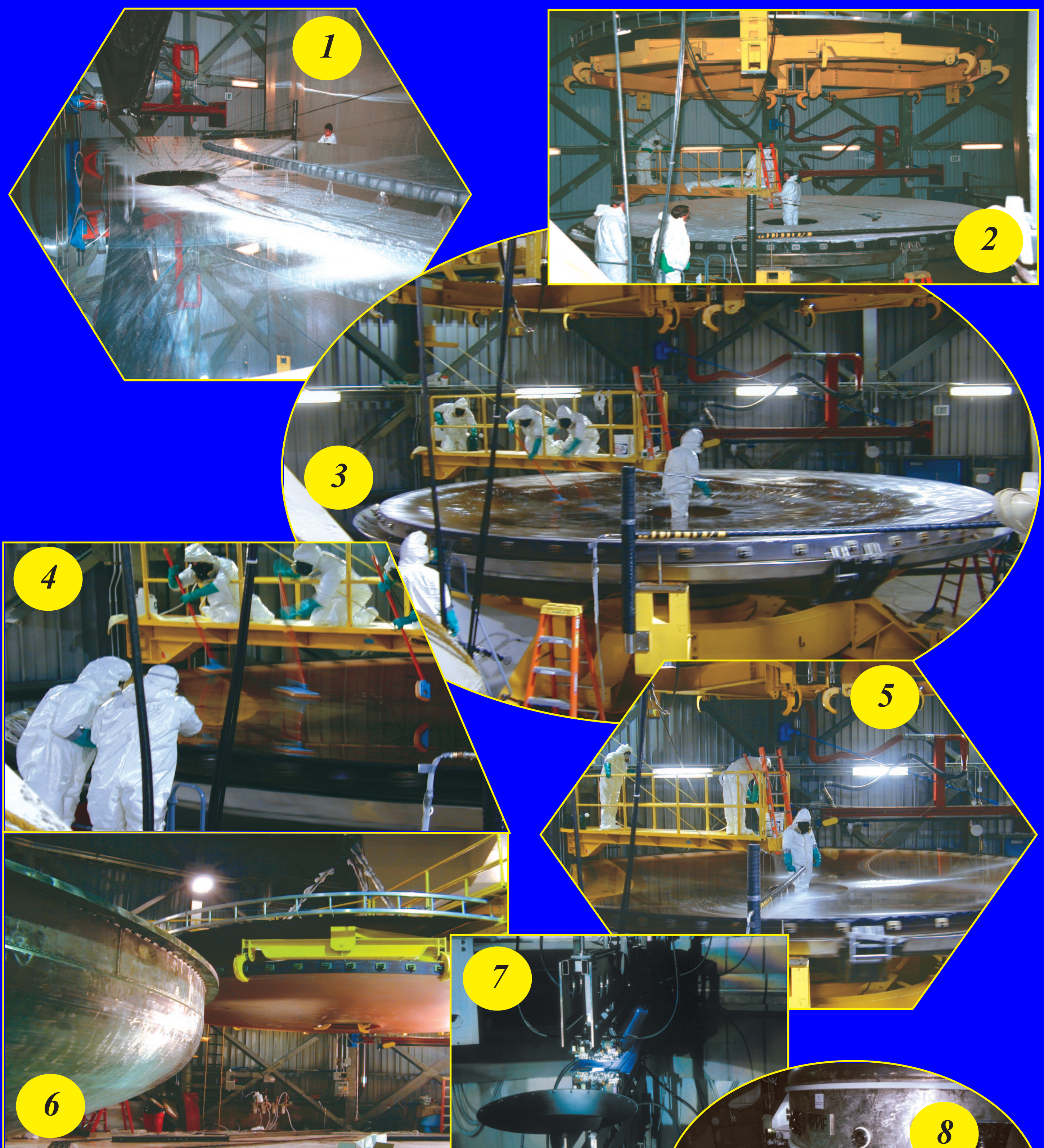
The pre-focal plane hardware, which includes the mask exchange mechanism and on-instrument wavefront sensor, has recently been delivered to the UKATC from HIA, Canada. At the start of May 2000, the pre-focal plane hardware was successfully joined to the post-focal plane hardware, which now includes the collimator and camera optics (also recently delivered from HIA) plus the grating turret and filter wheels. Meanwhile the control software for the two halves has also been merged, and the entire outer enclosure has been flexure-tested successfully.

Tests have been carried out on the individual subsystems, most recently on the flexure compensation stage on which the CCDs are mounted. The instrument tests are being carried out using science-grade CCDs, which were fitted into the first dewar at NOAO. The current CCDs will be replaced by red-sensitive science-grade CCDs before the first instrument is shipped to Hawaii.

The main components of GMOS should be integrated by June 2000. Following integration, tests of the whole instrument will be conducted, including flexure tests and cold tests. Delivery of the first GMOS to Hawaii is still anticipated for December 2000.

Colin Aspin

Successful Recoating of Gemini North Primary Mirror



1. The initial water rinse of the mirror 2. Covering the mirror with Kimwipes prior to the first acid wash. 3. Scrubbing the surface with calcium carbonate. 4. A final nitric acid rinse. 5. The final water rinse; the mirror coating is now stripped. 6. Transferring the mirror from the wash cart to the coating plant. 7. The magnetron in operation, putting a fresh coat of aluminum on the mirror. 8. The recoated mirror being taken frm the coating plant.

Photos by C. Carter and R. Kneale.

Aerial photo of Gemini South - April 2000

Photo by Neelon Crawford - Polar Fine Arts

The Gemini 8m Telescopes Project
950 N. Cherry Ave., P.O. Box 26732
Tucson, Arizona 85762-6732, USA
Phone: (520) 318-8545 / Fax: (520) 318-8590

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

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

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