Classical Observing with Gemini

Sean Brittain (Clemson University) & Ken Hinkle (NGSC)

If your observing program has targets that can be observed over the course of an entire night, and the observing conditions required are not extreme, consider requesting a classical run. The minimum time request for a classically scheduled Gemini proposal is now one night.

Classical and queue observing have complementary advantages. In classical observing, you have the opportunity to observe directly with the 8.1-meter Gemini telescopes, and such real-time experience provides special insight into the capabilities of both the instrumentation and the telescope. The observing program can be tailored to match these capabilities, as well as to take advantage of results gleaned from the observations as they come in. In addition, you could visit the Gemini offices to interact with staff who have a great deal of experience and insight into the instruments, and learn more about reducing your Gemini data. In a series of articles, we will report on the experiences of several Gemini classical observers. Our first report is from Sean Brittain.

In March, doctoral student Matt Troutman and I [Sean Brittain] traveled from Clemson to observe two nights with Phoenix on Gemini South. I assumed overall responsibility for running Phoenix while Matt reduced the observations as they were taken. We learned that taking high-resolution CO spectra in the M-band presents a number of unique challenges.

For starters, the sky is bright, nearly 0th magnitude per square arcsec. Superimposed on the thermal continuum are water lines whose strength can vary on timescales of a few minutes. Finally, the slit of the Phoenix spectrograph is 0.34 arcsec, so the throughput of the instrument is extremely sensitive to the seeing. The observing strategy (integration time and setting choice) is tightly coupled to the observing conditions. We found that classical observing provides an important benefit in terms of fine-tuning our observing strategy to match the weather conditions. By reducing the data in real time, one can be sure to integrate until the requisite sensitivity has been achieved.

Steve Margheim (Gemini staff), Ken Hinkle (NGSC visitor), and Matt Troutman (Clemson thesis student) in the Gemini South control room. Photo credit: S. Brittain

In addition to determining how long to observe, we used real-time data reduction to decide what to observe. The spectral grasp of Phoenix at five microns is fairly small, 10 cm^{-1}, and our program requires several different grating settings.

In March, we undertook a survey of Herbig Ae/Be stars. After observing a few targets with the first grating setting, we used the reduced spectra data to select stars with CO detections that warranted further observations. This dramatically improved the efficiency of our survey. Such real-time decision making is very difficult to capture in queue observing, but it is routine during classical runs. The Gemini System Support Associate and staff scientist who were present at the telescope provided outstanding support for our decisions. Our run was an efficient use of the time awarded, and was highly productive scientifically.

The UK Status within the Gemini Partnership: Resolved through 2012

Verne V. Smith

The uncertain status of the United Kingdom (UK) as a Gemini partner, which began with a 16 November 2007 announcement from the UK Science and Technology Facilities Council (STFC), was resolved in statements released near the end of February 2008 from both the STFC and the Gemini Board. As part of our continuing effort to keep the US community abreast of this situation, we present the STFC announcement and a corresponding Gemini Board resolution:

STFC Announcement: 27 February 2008
(see *www.scitech.ac.uk/PMC/PRel/STFC/GemUpdate.aspx)*

"The Science and Technology Facilities Council has reaffirmed the UK's position as a full member of the Partnership under the terms of the current Gemini Agreement. The Gemini Board welcomes this statement. The Board acknowledges the STFC's need to address its

continued

UK Status within the Gemini Partnership continued

budgetary constraints and notes that, under the terms of the Agreement, the UK is entitled to seek to sell some of its telescope time both within the partnership and, subject to the approval of the Board, outside the current partnership. The Board has directed the Observatory to continue the UK as a full partner, participating in all subsequent observing semesters, and all relevant committees and functions of the Observatory."

Gemini Board Resolution: 25 February 2008
"A written communication from the STFC Designated Member has recommitted the UK position as a full Partner under the Gemini Agreement, with all the rights, privileges, and responsibilities that membership brings. The Gemini Board recognizes and welcomes the UK position, its commitment to full participation in the Gemini Partnership and its intent that this commitment extend through to the end of the current Gemini Agreement. With respect to Aspen, the STFC has represented to the Board that the STFC is committed to providing its share of the currently approved program. Consequently, the Board directs the Observatory to continue the UK as a full partner, participating in all subsequent observing semesters, and all relevant committees and functions of the Observatory."

The current Gemini Agreement continues through 31 December 2012 and the STFC statement indicates that the UK will remain a full partner throughout this time period. We note, however, that the STFC statement includes a sentence acknowledging that the UK is entitled to sell some of its telescope time. Based on the stated intent from the UK, NOAO has begun to gauge community interest in the possibility of the US buying some fraction of any offered UK time. As a first step, we sought community input on two key questions using the April 2008 issue of the new NOAO electronic newsletter *Currents* (*www.noao.edu/currents/*):

- Bearing in mind that any purchase will need to be accompanied by a marginal budgetary commitment, is there a strong need for the US to acquire additional nights on Gemini and should this be set as a high priority for NSF?

- Is there a benefit in seeking to acquire these through an additional ***share*** of Gemini as an alternative to simply ***buying nights***?

The issue of possible increased US access to the Gemini telescopes will be part of the discussions that will be led by the newly formed Access to Large Telescopes for Astronomical Instruction and Research (ALTAIR) committee. This council is a large-telescope version of the ReSTAR committee, with ALTAIR convening community-wide discussion and soliciting input on the following point: What are the capabilities (instruments, observing modes, type of access, numbers of nights) that US observers need on the current generation of 6.5- to 10-meter telescopes, and how can Gemini and the non-federally-funded facilities best address these needs?

NOAO/NGSC encourages you to provide your views on what sorts of public-access capabilities, and in what amount, are needed on the current generation of large telescopes. Watch the NOAO Web site (*www.noao.edu*) for information on how to provide your input to the ALTAIR committee. As always, feel free to contact me (*vsmith@noao.edu*) with your thoughts or comments on any issues dealing with US access, current or future, to the Gemini telescopes.

The US Community and Their Gemini Usage: Some Results from the NGSC Questionnaire at the January 2008 AAS Meeting

Verne V. Smith

The NOAO Gemini Science Center conducted a survey via anonymous questionnaire at the January 2008 meeting in Austin, Texas. The intent was to sample community knowledge of, usage of, and level of satisfaction with US Gemini access.

A total of 219 meeting attendees completed the questionnaire. Of this number, 44 were either non-researchers or students who had not yet started observing programs, 14 were theorists who did not use telescopes, and 13 did not use ground-based optical/infrared (O/IR) data. That left a sample of 148 astronomers who observed with ground-based telescopes. This pool of astronomers who conduct ground-based observing programs were split almost evenly between those who had never applied for Gemini observing time and those who had: 69 had not applied for time and 79 had. Of the 69 non-Gemini using astronomers, the reasons for not having applied for Gemini time are distributed as follows:

If you have not applied for time, then why not? (69 respondents)

Most of their research is done on smaller telescopes	46%
They have access to other large telescopes	22%
The Gemini instrument complement lacks what they need	17%
The oversubscription factor is too large	15%

The range of responses above reflects the diversity of the US community of users, with a substantial fraction conducting research on smaller telescopes and another significant set of users with access to non-federally funded 6.5- to 10-meter class telescopes, as well as public TSIP access to these large telescopes.

The 79 astronomers who had applied for Gemini time consisted of 22 who had never gotten a proposal approved through the TAC and 57 who had a program (or programs) that had been scheduled on

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US Community and Their Gemini Usage continued

the Gemini telescopes. Given the historical oversubscription factors (by time) of ~3–5 for Gemini, the fact that some 72 percent of those who had applied were on at least one Gemini program attests to some tenacity among proposers. Of the 57 astronomers who had been on scheduled Gemini programs, 47 considered their programs to be "successful," nine said their programs had been "unsuccessful," and one just had their first program scheduled for Semester 2008A.

If you have been granted Gemini telescope time, were the observations successful? (57 respondents)

Successful	82%
Unsuccessful	16%
Awaiting 2008A	2%

The definition of "successful" certainly varies from one user to another, but one part of everyone's definition would presumably include a complete, or nearly complete, data set meeting the quality specifications of the proposer. The successful versus unsuccessful rates should then map approximately into the Gemini Observatory program completion statistics, which are presented in considerable detail at *www.gemini.edu/sciops/statistics*.

Using Gemini's condensed compilation of completion rates averaged over Semesters 2005A–2007A, the average completion rate for Band 1 programs was 86 percent, Band 2 was 64 percent, and Band 3 was 35 percent, with the time breakdown within the bands being 30 percent, 30 percent, and 40 percent for Bands 1, 2, and 3, respectively. The definition of "completion" from Gemini is 100 percent of program data for Bands 1 and 2, and 75 percent for Band 3. Using these completion statistics over the 2005–2007 timeframe, the global program completion rate, across all bands, was about 60 percent. This completion rate is less than the fraction of Gemini users who said that they had had successful programs, which may suggest that some fractional datasets, not counted as complete programs by Gemini, are useful to the astronomers.

If your program was unsuccessful, then why? (9 respondents)

Scheduled in Band 3 (or 4):	78%
Weather (on classical runs):	22%

The responses to this question bear out the fact that Band 3 programs have the lowest completion rates, while the biggest threat to classical programs is the weather.

If you consider that one, or more, of your programs was successful, has it led to a peer-reviewed paper? (48 respondents)

Yes:	75%
No:	25%

Among those who considered themselves to have had successful programs carried out, but who had not published a paper, the most common reason given was simply not enough time to have completed the analysis and then written a paper. Nonetheless, the fact that 75 percent of Gemini users who had successful programs also were on published papers that were based on their Gemini observations indicates a healthy use of the data.

Astronomers who observe with Gemini, whether queue or classical, must complete Phase II files. These files, which specify the details of their observations, are passed directly to the telescope and instrument during the execution of the program. The Phase II process involves interactions between the program Principal Investigator, and both NOAO/NGSC staff and Gemini staff. These interactions usually take place via email. One question asked whether user concerns that were raised with either NOAO/NGSC or Gemini staff were answered adequately.

If you have communicated comments to NOAO, NGSC, or Gemini, were they addressed satisfactorily? (41 respondents among users who had Gemini programs or who had applied for time)

Yes:	83%
No:	17%

Among the group of respondents who had never applied for Gemini time, 17 reported that they had sent comments or questions to Gemini, NGSC, or NOAO on Gemini-related matters and 14 (82 percent) reported satisfactory responses, while three (18 percent) reported unsatisfactory responses: similar to the experiences of the Gemini users. While the rate of satisfied questioners is good, the 17–18 percent of those who feel that their questions or comments were not addressed is of concern. A formal, but simple, process by which Gemini users can quickly communicate their experiences, questions, and problems to both NGSC and Gemini is under development and will be introduced for programs in Semester 2008B.

One of the major resources of Gemini is the Science Archive. It is important that the community be aware that all Gemini data are available after a proprietary period (*www.gemini.edu/sciops/data/dataSciArchIndex.html*). One question dealt with community awareness of the archive.

Are you aware of the Gemini Science Archive?

Among the Gemini users (anyone who has requested time—79 respondents):

Yes:	78%
No:	22%

Among the non-Gemini users who are ground-based observers (63 out of 69 replied to this question):

Yes:	36%
No:	64%

Among the non-Gemini users who are not ground-based observers (25 out of 27 replied to this question):

Yes:	32%
No:	68%

Among the non-Gemini users who are primarily students who have not yet begun observing programs, or "others" who are not observers (37 out of 44 replied to this question):

Yes:	30%
No:	70%

continued

US Community and Their Gemini Usage continued

The responses to this question are interesting; the veteran Gemini users contain a healthy fraction who are aware of the Gemini Science Archive, although it will be useful to educate the 22 percent of this group who were not yet aware of the archive's existence. What is perhaps somewhat surprising is the result that the groups who do not conduct ground-based observing, mostly beginning students or educators, are nearly as aware of the Gemini Archive as the die-hard ground-based observers who do not use Gemini. It is clear from the responses to this question that it will be useful to work to engage the user community in taking advantage of the Gemini Archive.

On a final note, the question was asked "Is there some type of observational capability that you would like Gemini to offer?" This question resulted in 30 responses from ground-based observers, with a considerable variety of suggestions. The most requested capability, based on multiple specific responses, was for high-resolution spectroscopy, both optical and near-infrared, with 18 requests out of a total of 30 (10 requests for optical and 8 for infrared). Perhaps this is not too surprising, as the only high-resolution optical or near-IR spectrograph that is offered on Gemini is Phoenix, which is an NOAO visiting instrument on Gemini South, and is a single-order echelle with limited wavelength coverage in one integration.

Surveys such as this one, although non-scientifically sampled, do provide some insight into the collective thoughts of the user community. NGSC staff will use the results to help us define topics of interest to the community, to better understand complaints that should be addressed, and to guide discussions on the future of US access to Gemini. NL

Consider a Poor Weather Proposal

Katia Cunha & Ken Hinkle

To most efficiently operate its telescopes, Gemini Observatory needs programs that can be observed under the full range of usable observing conditions. For obvious reasons, most proposers do not request the poorest conditions. To use this telescope time, Gemini created a category of "Poor Weather Proposals." Cursory information on what constitutes poor weather proposals and how to submit them are listed here.

Poor weather programs must have conditions matching the following observing constraints:

Image Quality (IQ) of "any" and Cloud Cover (CC) of 70 percentile (non-photometric).

Cloud Cover of 90 percentile (typically 2 magnitudes of cloud cover) with no restriction on IQ conditions.

In addition, all poor weather queue programs must have the Water Vapor (WV) set to "any." However, the Sky Brightness (SB) can be specified and poor weather programs can therefore request dark time.

Poor weather programs can be submitted at any time during the semester. They must be submitted using the Phase I Tool (PIT). In the PIT, select "Poor weather" from the dropdown menu in the "Submit" tab. These proposals are submitted directly to Gemini and reviewed by the Gemini Head of Science Operations, not by the national Time Allocation Committees. The Poor Weather Queue is reset at the start of each semester, thus a program is usually activated for one semester only.

Additional information about Poor Weather Proposals is available on the Gemini Current Call for Proposals Web page (click the link to Poor Weather under General Highlights) and on the Current Queue page (click a link under Poor Weather Queue Summary on the left). The URLs of these Web pages are: *ww.gemini.edu/sciops/ObsProcess/ObsProcIndex.html* and *www.gemini.edu/sciops/schedules/schedCurrQueueIndex.html.*

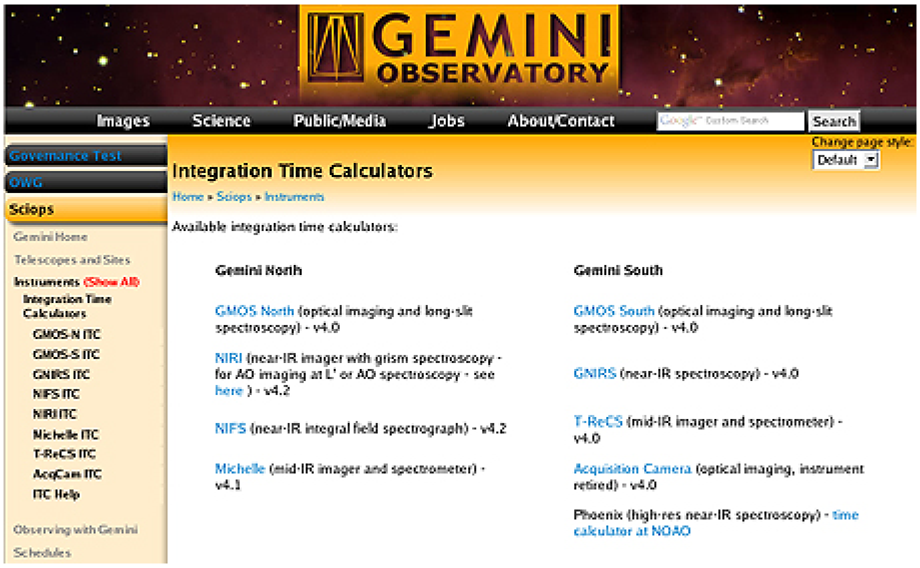
Detailed Aspects of Technical Reviews for GMOS, NIRI, and NIFS

Bob Blum & Tom Matheson

All proposals for use of the Gemini telescopes that request some portion of their time from the US share of the partnership are submitted to the NOAO Time Allocation Committee. Each of these proposals is reviewed by a member of the NOAO Gemini Science Center (NGSC) staff for technical feasibility. A general description of the process can be found in the June 2007 issue of the *NOAO/NSO Newsletter* on page 15 (*www.noao.edu/noao/noaonews/jun07/pdf/90ngsc.pdf*). Proposals should include detailed descriptions of the observations in the Technical Description section (and possibly the Experimental Design section) of the NOAO proposal form or the Technical Justification section of the Gemini Phase I Tool.

There are four main areas to consider for the technical justification: instrument configuration, source magnitudes and spectral energy distribution, expected signal-to-noise ratio (S/N) based on exposure time and observing constraints, and telescope/instrument overhead. All of these issues except the overhead are included in the Gemini Integration Time Calculator (ITC) for each instrument, so that can be a guide to the information that should be included in the technical section of a proposal. The overhead necessary for observations for each instrument is described in the instrument pages on the Gemini Web site. Beyond these broad areas of discussion, if there is some other part of the design of your program that is crucial to the success or failure of the observations, please include that in the technical description as well.

In this first of a series of articles on detailed aspects of technical reviews, we will describe some of the main points that should be addressed for GMOS, NIRI, and NIFS. Other instruments will be discussed in future articles.



Integration time calculators available at the Gemini Web site. These should be used when developing the technical justification for a proposal.

Gemini Multi-Object Spectrograph (GMOS)

For GMOS, the chief concern of the technical review is whether or not the observations described can be done in the requested amount of time. To determine this, the ITC is the best guide. Proposals will often contain justifications based on "previous experience" with large telescopes. While this experience is certainly valuable, the relative efficiencies of the telescope/instrument combinations at Gemini will not be the same as at other facilities. This is especially true given the control over observing conditions allowed by the queue-based schedule. Proposals should include a discussion of results from the ITC.

In order to replicate the ITC results of the proposal, the inputs used with the ITC should be part of the technical discussion. The nature of the source is important. This includes magnitude (and filter in which the magnitude is measured) and how this brightness is distributed (point source or extended). In addition, the assumed spectral energy distribution should be described. For line-emission sources, the line flux, line width, and background need to be included. The instrumental configuration is called for in other parts of the proposal, but gratings, filters, slit widths (or IFU), and central wavelengths should still be described. The binning of the CCD is also important.

The description of observational constraints is critical to the technical evaluation of the proposal. Make sure that the constraints chosen for the program are the ones used when experimenting with the ITC. Image quality (IQ), cloud cover (CC), and sky background (SB) should all be specified. Note that for GMOS, water vapor (WV) should be set to "any" as it is not significant for optical observations (and you don't want to restrict your program to a specific WV constraint for no reason).

Overheads for various aspects of GMOS observation can be found on the GMOS Web pages (e.g., *www.gemini.edu/sciops/instruments/gmos/sensitivity-and-overheads*). The main source of overhead is acquisition. There are also overhead considerations for read-out and instrument configuration changes. Overhead for acquisition is charged each time the object is observed. For long series of exposures (over four hours), reacquisition is necessary, so more acquisition time should be included in the program budget. For masks, another potential source of overhead is pre-imaging done with GMOS. If images from other sources are available, they can be used under some circumstances. If the goal is multi-object observations, then pre-imaging should either be included in the time request, or a description of existing images is necessary. Some calibrations should be included in the overhead. Others, such as special standard stars, need to be included as separate observations. Look at the baseline calibrations provided for GMOS to see if there is anything

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Detailed Aspects of Technical Reviews for GMOS, NIRI, and NIFS continued

else needed (*www.gemini.edu/sciops/instruments/gmos/calibration*). If so, it should be included explicitly.

Nod-and-shuffle observations add some complications. The time to nod the telescope and shuffle the frames electronically adds overhead to the observation, typically about a 25 percent increase in observation time. Longer nods may require more overhead. Consult the nod-and-shuffle Web pages for more information (*www.gemini.edu/sciops/instruments/gmos/nod-and-shuffle*).

The S/N calculation for nod-and-shuffle is also slightly different. The 'sky aperture' used by the ITC should be set to 1 to reflect the pixel-by-pixel subtraction used by nod-and-shuffle. The gain of nod-and-shuffle is a tremendous reduction of systematic residuals around night-sky emission lines, but this comes at the cost of a slight increase in noise from the sky subtraction overall as the sky subtracted is a single pixel, not the average of many as it is with traditional long-slit spectroscopy.

Near-Infrared Imager (NIRI)/ Near-Infrared Integral-Field Spectrograph (NIFS)

For NIRI and NIFS, the key input for a technical review is similar to other instruments: accurate line fluxes and/or magnitudes with which to compute S/N with the ITCs. Observers should explicitly state the inputs they used for the ITC. This includes whether or not the source is a point source. If not, describe the source in terms of a uniform surface brightness or a Gaussian (don't forget the FWHM) and total integrated magnitude. For lines, the total line flux must be given (integrated over wavelength or velocity) and the level of background as well. The latter should be given as flux density and the former should include a line width (preferably an FWHM in kilometers per second).

Often, observers expect a line to contribute the entire broadband magnitude flux. This should be made clear so that a proper source spectral energy distribution can be used, for example an H II region. Alternately, express the magnitude in a total line flux as mentioned above, but be clear about the expected continuum contribution.

For adaptive optics observations (NIRI/NIFS + ALTAIR), the resulting quality of the observation will depend critically on the brightness of the natural guide stars (NGS) and their position. If the laser guide star (LGS) is to be used, the NGS will only be used for tip-tilt (TT) correction and can be much fainter. In all cases, NGS or LGS, the guide star should be within 25 arcsec of the target. It is important at the technical review phase to identify actual stars that will be used to demonstrate that the observations are feasible. Check the ALTAIR Web pages (*www.gemini.edu/sciops/instruments/altair/?q=sciops/instruments/altair*) for the details of the guide star brightness ranges of NGS stars (R < 15 for NGS, R < 18 for LGS). Always remember to check the guide star brightness in combination with the requested observing conditions.

For AO observations with the LGS, the user must select CC=50 and IQ=70. Worse conditions will not allow stable use of the LGS. The NGS can be used under heavier cloud and worse IQ, but may have stability issues. For lower Strehl images with NGS, one could pick either IQ=85 or CC=90, but not both and only for very bright guide stars.

If AO is not used, it is still important to consider the brightness of guide stars with respect to the requested observing conditions. Faint stars won't work in bad seeing or with thick cloud. Faint guide stars may need gray time sky background (SB=80) in order to be used (this applies to both AO and non-AO observations). Apart from this, SB=ANY is the default for all NIR observations.

Finally, check the declination of your target for use with the LGS. Only declinations which give telescope elevations > 40 degrees are allowed (for example, the Galactic center cannot be observed with the LGS since its elevation is only ~30 degrees). The limit is imposed by the LGS zoom assembly, which keeps the laser spot focused as the apparent altitude of the sodium layer changes with telescope zenith distance. See the ALTAIR pages for more details (www.*gemini.edu/sciops/instruments/altair/use-lgs#Elevation*). NL

NGSC Instrumentation Program Update

Verne V. Smith & Mark Trueblood

FLAMINGOS-2

> *FLAMINGOS-2 is a near-infrared multi-object spectrograph and imager for the Gemini South telescope. FLAMINGOS-2 will cover a 6.1-arcmin-diameter field at the standard Gemini f/16 focus in imaging mode, and will provide multi-object spectra over a 6.1 × 2-arcmin field. It will also provide a multi-object spectroscopic capability for Gemini South's multi-conjugate adaptive optics system. The University of Florida is building FLAMINGOS-2 under the leadership of Principal Investigator Steve Eikenberry.*

The NGSC scheduled a quarterly review of the FLAMINGOS-2 instrument at Gainesville with the University of Florida team on May 7. Shortly before this meeting, the Instrument Team reported progress in integration and testing of the instrument.

Work on the detector readout electronics and camera Dewar wiring has lowered the overall noise figure to acceptable levels. The University of Florida team reports achieving a median read noise of approximately 9.7 electrons RMS for a single read referenced from a CDS pair. The work on grounding also eliminated other problems the team had been experiencing with the detector readout electronics.

After receiving the high resolution (~3000) grating for the grism, the team performed various tests on the grating. Extensive arc lamp and continuum source data were taken, and analysis is under way. Preliminary results indicate that the central wavelength and resolution match expectations in all orders of interest (3, 4, 5, and 6 corresponding to the use of Ks, H, J, and J-lo filters).

Since the previous *Newsletter* article, the Instrument Team has continued to experience problems in cooling the Multiple Object Spectroscopy (MOS) Dewar. Although a probable cause for the lack of cooling

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NGSC Instrumentation Program Update continued

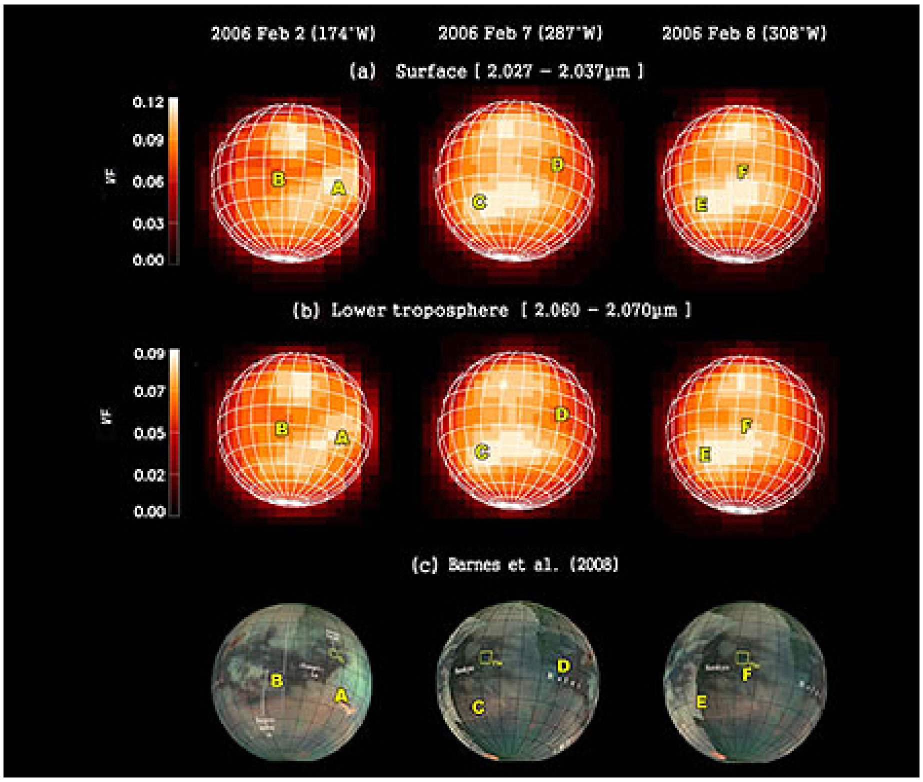
was previously found in an unexpectedly high thermal conductivity of the G-10 thermal isolation system, the steps to rectify this situation permitted the MOS Dewar to achieve the desired temperature but not to maintain it, indicating other problems could remain. To address the issue, the team is adding a second cold head to the MOS Dewar to increase the overall cooling capacity of this fast-turnaround element of the system.

If testing demonstrates that this approach resolves the MOS Dewar issue, then the team will make some final adjustments before performing the tests required for the Pre-ship Acceptance Test. Assuming these go well, Pre-ship Acceptance Testing will then proceed later this summer.

As of April, the University of Florida team reports that 96 percent of the scheduled work to FLAMINGOS-2 final acceptance by Gemini has been completed.

Does Methane Rain Down on Titan?

A team of astronomers has used infrared spectral images of Saturn's moon Titan, acquired with the Gemini North 8-meter telescope, to dispute an earlier claimed detection of widespread morning methane drizzle.



This figure shows infrared images of Titan observed on February 2, 7, and 8, 2006 with the Near-infrared Integral Field Spectrograph (NIFS) on Gemini North. The images in the first row are at 2.027-2.037 microns, where Titan's atmosphere is nearly transparent and surface features are thought to be revealed clearly. The second row of images covers 2.060-2.070 microns, where the atmosphere is less transparent and absorption by haze and liquid methane could be influential. The images in the third row, made from a Mercator map of observations by the Visual and Infrared Mapping Spectrometer (VIMS) on the Cassini spacecraft in orbit around Saturn (Barnes et al.,2008), correspond to views of the surface of Titan from Earth at the times of the Gemini observations.

Major geologic features (marked A through F) on the NIFS images are seen to occur at the same places on the VIMS images. The pairs of images in the top two rows illustrate the difficulty of detecting temporal atmospheric effects such as variable haze and localized methane drizzle.

Astronomers at the University of California at Berkeley recently reported direct detections of methane drizzle over a large region of Titan, based on comparisons of infrared images of the moon made in 2005 at the Very Large Telescope and in 2006 at the W.M. Keck Observatory on Mauna Kea.

Independently, a team including Sang Joon Kim (Kyunghee University, Korea), Laurence Trafton (University of Texas), and Tom Geballe (Gemini Observatory) were interested in studying other aspects of the atmosphere of Titan. This group used NIFS and the adaptive optics system Altair.

Using the same comparison technique as the Berkeley team, they too found regions of apparent excess absorption at some locations on Titan. However, in their data set, these regions—some of which were the same as seen by the Berkeley team—were now afternoon locations and also were locations on which the surface of Titan is bright. The team also found that excess emission tended to be correlated with regions on Titan where the surface is darker.

They concluded that there is no spectroscopic evidence for widespread methane drizzle, or that such drizzle is a morning phenomenon. This does not mean that drizzle does not occur, but rather that remote detection of it, particularly via this technique, is much more difficult than first thought.

For more details, see "No Evidence of Morning or Large-scale Drizzle on Titan," by Sang J. Kim, Laurence M. Trafton and Thomas R. Geballe, 20 May 2008, *ApJL* 679, L53-L56.

Graphic credit: Gemini Observatory