Gemini Observing Opportunities for Semester 2006B

Taft Armandroff

The NOAO Gemini Science Center (NGSC) invites and encourages the US community to submit proposals for Gemini observing opportunities during semester 2006B. US Gemini observing proposals are submitted and evaluated via the NOAO Time Allocation Committee (TAC) process. Although the Gemini Call for Proposals for 2006B will not be released until 1 March 2006 for the US proposal deadline of March 31, the following are our expectations of what will be offered in semester 2006B. Please watch the NGSC Web page (*www.noao.edu/usgp*) for the Call for Proposals for Gemini observing, which will clearly list the capabilities that can be requested.

NGSC is pleased to inform the US community of the following suite of scientifically important instrumental capabilities to be offered in semester 2006B:

Gemini North:

- The integral-field infrared spectrograph NIFS will be offered for the first time in 2006B. See the article on NIFS by Bob Blum on the next page of this *Newsletter*.
- The NIRI infrared imager/spectrograph will be offered in 2006B. Both imaging mode and grism spectroscopy mode will be available.
- The ALTAIR adaptive optics (AO) system will be offered in natural-guide-star mode and, for the first time, in laser-guide-star mode in 2006B. Gemini plans to offer the following modes of ALTAIR in 2006B: AO-enhanced infrared imaging and spectroscopy using NIRI, and AO-enhanced integral-field spectroscopy with NIFS. Please note that the laser-guide-star system is still being commissioned, so prospective users should read the Gemini Call for Proposals and Web pages for the latest information.
- Michelle, the mid-infrared (8-25 micron) imager and spectrograph, will be available for imaging and for spectroscopy.
- The GMOS-North optical multi-object spectrograph and imager will be offered in 2006B. Multi-object spectroscopy and long-slit spectroscopy (both optionally with nod-and-shuffle mode), integral-field unit (IFU) spectroscopy, and imaging modes will be available.
- All the above instruments and modes are offered for both queue and classical observing. Classical observing will be offered only to programs with a length of three nights or longer.
- The TEXES high-resolution mid-infrared spectrograph will be offered as a visitor instrument. It will be scheduled for one observing block. For reference, an article on TEXES appeared in the December 2005 *NOAO/NSO Newsletter*.
- Time trades will allow access to HIRES on Keck and the Suprime-Cam wide-field imager on Subaru.

The laser-guide-star beacon at Gemini North. Laser-guide-star adaptive optics will be offered for the first time in semester 2006B. (Image Credit: Gemini Observatory)

Gemini South:

- The GMOS-South optical multi-object spectrograph and imager will be offered during semester 2006B. Multi-object spectroscopy, long-slit spectroscopy, IFU spectroscopy (all optionally with nod-and-shuffle mode), and imaging modes will be available.
- The T-ReCS mid-infrared imager and spectrograph will be available in semester 2006B.
- The GNIRS facility infrared spectrograph will be offered in semester 2006B.

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Gemini Observing Opportunities for Semester 2006B continued

- The bHROS high-resolution (R=150,000) optical spectrograph will be available in semester 2006B.
- The Phoenix infrared high-resolution spectrograph will be offered in semester 2006B. Phoenix is available only in classical mode (in whole nights, with no three-night minimum). NGSC Staff will provide training and start-up assistance to Phoenix classical observers.
- The Acquisition Camera will be available for time-series photometry in 2006B.
- All modes for GMOS-South, GNIRS, bHROS, and T-ReCS are offered for both queue and classical observing. Phoenix is available only for classical observing. Classical observing will be offered only to programs with a length of three nights or longer (except in the case of Phoenix).

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

The percentage of telescope time devoted to observations for science programs in semester 2006B is planned to be 90 percent at Gemini North and 75 percent at Gemini South.

We remind the community that US Gemini proposals can be submitted jointly with collaborators from another Gemini partner country. An observing team requests time from each relevant partner country. Such multi-partner proposals are encouraged because they access a larger fraction of the available Gemini time, thus enabling larger programs that are likely to have substantial scientific impact. Please note that all multi-partner proposals must be submitted using the Phase I Tool (PIT).

Proper operation of the Gemini queue requires that it is populated with programs that can profitably use the full range of observing conditions. Gemini proposers and users have become accustomed to specifying the conditions required to carry out their observations, with the help of the Gemini Integration Time Calculators (ITCs). NGSC wishes to remind the US community that a program has a higher probability of being awarded time, and of being executed, if ideal observing conditions are not requested. The two conditions that are in the greatest demand are excellent image quality and no cloud cover. We understand the high demand for these excellent conditions, but wish to remind proposers that programs that make use of less than ideal conditions are also needed in the queue.

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

NIFS Commissioning at Gemini North

Robert Blum

In October and November 2005, the Gemini Near-infrared Integral Field Spectrograph (NIFS) was successfully commissioned on the Fredrick C. Gillett telescope at Gemini North. The commissioning was so successful that the call for NIF System Verification observations followed within just two weeks. These observations are being carried out as of the writing of this article in January 2006.

NIFS is a near-infrared spectrometer that simultaneously observes a 3-arcsec by 3-arcsec field of view. The field is sliced by a fully cryogenic reflective image slicer, which produces 29 segments of the field. Each segment is a 3-arcsec by 0.1-arcsec spectrum covering one of the Z, J, H, or K bands at spectral resolutions of about 5000 (two pixels). A NIFS observation thus results in a three-dimensional data cube. NIFS was designed to work with the Gemini facility adaptive optics (AO) system, Altair, to produce near-diffraction-limited observations. The NIFS image slices correspond to 0.1-arcsec slits and each is sampled in the spatial dimension at 0.043 arcsec/pixel. This is just undersampled with respect to the 8-meter diffraction limit in the spatial dimension at two microns.

Currently, there are at least three main modes in which NIFS will see normal operations. These have all been commissioned, with System Verification observations underway for each of the three.

By far the most common mode is NIFS with Altair AO correction. Using Altair with a bright "natural" guide star (NGS) is often referred to as NGS AO. With a bright guide star (R < 12 for full AO correction), one observes on-axis (usually the science target) or with an off-axis star within the Altair patrol field (up to about 25 arcsec from the science target). Off-axis stars should be as close as possible and bright. Details for selecting and configuring NIFS/Altair in this mode are available on the Gemini NIFS pages at *www.gemini.edu/sciops/instruments/nifs/NIFSIndex.html*. A useful option in this mode is to use the near-infrared on-instrument wavefront sensor (OIWFS) with a second (fainter, K<14) guide star. By tracking the relative

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NIFS Commissioning at Gemini North continued

positions of the AO and OIWFS guide stars, differential flexure between NIFS and Altair can be accounted for. An option for K-band polarimetry is currently not commissioned.

The second main mode is NIFS without AO. This mode might be useful under good-to-excellent image quality conditions for science targets that have no suitable AO guide stars. The guiding in this case is done by the peripheral wavefront sensor, which patrols a 6-arcmin field around the NIFS science field. It is expected that this mode will be used infrequently.

The final commissioned mode is NIFS/Altair with a focal plane coronagraphic mask. NIFS has three masks with focal plane diameters of 0.1, 0.2 and 0.5 arcsec, respectively. This mode will be useful in searching for faint companions near bright central sources. Commissioning observations suggest that using the OIWFS in this mode can help keep the spot well centered when moving between science and sky positions. It is expected that the 0.2-arcsec and 0.5-arcsec masks will be used most often.

A fourth mode for NIFS will hopefully be commissioned toward the end of semester 2006A. This is the use of NIFS/Altair in conjunction with the sodium laser guide star (LGS). The Gemini North LGS+Altair facility is partially commissioned at this time, following excellent progress in 2005B. The system uses a 14-watt laser, which is launched from a small telescope behind the secondary mirror of the Gemini telescope. This laser beam excites a naturally occurring layer of sodium atoms in the atmosphere at about 90 kilometers altitude. To date, the LGS has been in use with Altair and NIRI (the Gemini facility infrared imager). The system has locked on the LGS while properly interfacing with the other telescope systems for fully functional NIRI/Altair observations. Further work will involve making this process more fully automatic and more robust. Improvements to the optics of the launch telescope are expected in 2006A that will produce as-designed image quality of the sodium spot (i.e. the LGS).

The development of end-user data reduction tools is critical to NIFS commissioning, System Verification, and community science aspirations. A NIFS IRAF package, based in part on the Gemini GNIRS package, has been developed and will be released to the community. Current plans call for an initial release shortly after the System Verification observations are complete in early 2006A. The development package handles basic Gemini processing of header information and tracking/propagating multi-extension FITS (MEF) files with science, variance, and data-quality data planes. Other included tools handle wavelength calibration, rectification of the spatial distortion along each image slice, construction of a data cube, and tools to extract one-dimensional spectra from data cubes. NOAO IRAF developers have worked with their Gemini counterparts and NIFS team astronomers to help build this initial

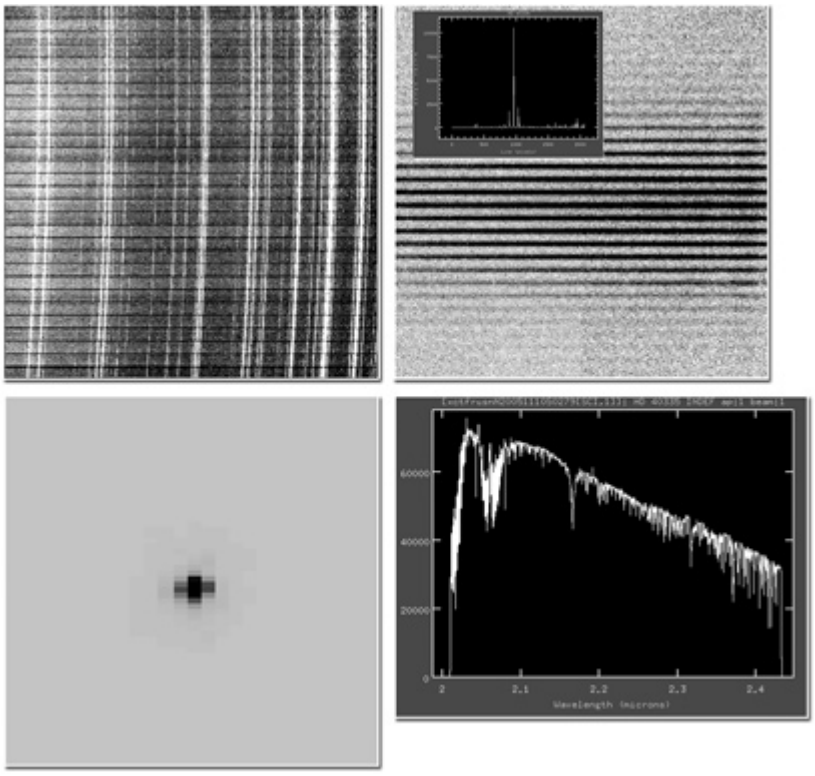

Figure 1: Fully reduced images and spectrum from NIFS. The upper left image is a K-band Xe-Ar lamp image showing the characteristic NIFS curvature and effect of the staircase slit (see text). The upper right image is a flat fielded, sky subtracted, wavelength calibrated, and rectified image of standard star HD40335, showing each of the NIFS 29 spatial slices. The inset testifies to the excellent image quality on this night. The lower left image is the spatial reconstruction of HD40335, showing the 3 arcsec × 3 arcsec field and the 0.043 arcsec × 0.1 arcsec pixels. Finally, a summed spectrum of HD40335 is shown in the lower right panel from a software aperture of the central 0.5 arcsec (diameter).

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NIFS Commissioning at Gemini North continued

package. While significant checking and documentation are still necessary, the full framework of an end-to-end IFU processing package is in hand.

Figure 1 shows a sample NIFS observation with associated calibrations and reduced frames. In the upper left, a K-band Xe-Ar arc lamp image depicts the sliced field and line curvature due to anamorphic demagnification in the spectrograph. The effect of the "staircase" long slit that feeds the spectrograph is also seen as each slice has slit images (i.e., emission lines) which step up and right in each successive slice (starting from the bottom). Another way to think of this is that a NIFS slit image would show a long slit from top to bottom of the image, but instead of being straight along the Y-axis, it would step a few pixels in X for each slice in Y in order to separate each slice on the sky. The upper right image shows a full K-band image of HD40335 that has been sky subtracted, flat fielded, corrected for distortion, and wavelength calibrated. Light from the wings of this bright star spills over into many of the off-center slices, but the inset image testifies to the good image quality on this night. Most of the light is clearly in the central 0.1-arcsec slice. The lower left image shows the NIFS imaging field for this same observation. This image was constructed by collapsing each slice along the wavelength direction. The final image in the lower right shows an extracted spectrum of HD40335. This spectrum is comprised of a sum of all the IFU pixels in a 0.5-arcsec-diameter aperture. This A-type star shows strong Brackett gamma absorption near 2.17 microns and many telluric absorption features. The signal-to-noise ratio in regions near 2.1 microns is in excess of 300.

The author would like to thank NIFS Principal Investigator Peter McGregor and Gemini NIFS scientist Tracy Beck for their invitation to participate in NIFS commissioning and System Verification, their explanation and help with NIFS data reduction, and their useful input for this article.

NGSC Staff Comings and Goings

Taft Armandroff & Verne Smith

Adwin Boogert Joins NGSC as Assistant Astronomer
Adwin Boogert joined the NOAO Gemini Science Center (NGSC) as an Assistant Astronomer, based at NOAO South, on 23 December 2005. Adwin comes to NOAO following postdoctoral fellowships at the Caltech Submillimeter Observatory and the Owens Valley Radio Observatory. He is an expert on molecular clouds and star-forming regions, the abundances and physical conditions of interstellar molecules, and infrared observations. A recent example of his work is the detection of molecules that are precursors to proteins in the planet-forming disk around a young star. Already a user of Michelle on Gemini, Adwin has assumed support responsibilities for US users of the Gemini mid-infrared instruments T-ReCS and Michelle. Please join us in welcoming Adwin to NGSC, and see the Director's Office section of this *Newsletter* for an interview with him.

Knut Olsen Joins NGSC
Knut Olsen shifted his service responsibilities from CTIO to NGSC, beginning dedicated effort for NGSC in mid-September. Knut has experience with several Gemini instruments, and his initial responsibilities with NGSC involve supporting the US NIRI/ALTAIR and GMOS programs. He is expert in the area of resolved stellar populations. One notable example of his recent work is a study of the stellar populations in M31 using high-resolution infrared imaging from the Gemini North telescope and NIRI/ALTAIR. We are very glad to have Knut as part of the NGSC Team!

Rachel Mason Transitions to Science Fellow at Gemini Observatory
Rachel Mason has transitioned from her position with the NOAO Gemini Science Center to become a Science Fellow at the Gemini Observatory in Hilo as of mid-February. Rachel joined NGSC in September 2003 as the first NGSC Postdoctoral Fellow. She began her NGSC position in Tucson and later relocated to NOAO South in La Serena. She has become expert in the use of the Gemini mid-infrared instruments T-ReCS and Michelle, and has ably supported US users of these instruments. Rachel has used the Gemini telescopes and instrument complement to address a number of compelling scientific issues for her own research, and recently published a paper on Michelle observations of NGC 1068 that allowed her to probe the central torus of this active galaxy and its more distant heated dust. We wish Rachel every success at Gemini, and look forward to our continued association with her.

National Gemini Offices & Gemini Staff Meeting

Taft Armandroff

The NOAO Gemini Science Center hosted a meeting of the Gemini and National Gemini Offices (NGO) staff on 29-30 November 2005, in Tucson, AZ. Select Gemini staff and almost all staff members of the National Gemini Offices of the US (NGSC), UK, Canada, Australia, Brazil, University of Hawaii, and Chile attended. The meeting focused on training and idea sharing for the support of Gemini observing, instruments, and users, and builds on the May 2004 meeting held in Victoria, Canada. These meetings seek to optimize NGO staff training and interchange with Gemini staff in support of a highly effective Gemini distributed support model.

The meeting included eleven talks on developments with, and support of, Gemini instrument capabilities. Of particular interest were presentations on the new instruments NIFS, bHROS, TEXES, and NICI. There were also four talks on Gemini data reduction and archiving. Several round table discussions served as forums on the best ways to support the community of Gemini users through international teamwork. A number of recommendations resulting from the meeting will be presented to the Gemini Operations Working Group for implementation.

Greg Doppmann (Gemini Observatory) gives a presentation on GNIRS new features and user support at the Gemini Staff/ NGO Staff meeting.

Participants in the meeting of Gemini staff and National Gemini Offices staff held in Tucson, AZ, 29-30 November 2005.

Probing the Dark Universe with Subaru and Gemini

Arjun Dey (NOAO), Naoshi Sugiyama (Subaru) & Joe Jensen (Gemini)

In early November 2005, a group of astronomers from the Gemini and Subaru user communities met on the Big Island of Hawaii to discuss the joint use of future instrumentation on their telescopes to investigate one of the outstanding and mysterious questions of our decade: the origin and nature of dark energy.

The meeting, which was attended by approximately 80 astronomers from Japan and the Gemini partner countries, was motivated primarily by the perceived synergies between two ambitious future instruments: HyperSuprime Camera, the next generation two-degree field imager currently being designed for Subaru; and the Wide-Field Fiber Multi-Object Spectrometer (WFMOS) that resulted from the Gemini Aspen future instrument selection process. The two observatories are engaged in discussions on how to economize on these instruments by sharing a common telescope platform (Subaru) and design elements (e.g., top-end telescope modifications and wide-field corrector elements), as well as shared intellectual and monetary resources in carrying out the ambitious key scientific projects.

The meeting in Hawaii provided a broad overview of the various innovative observational strategies for investigating the nature of dark energy, particularly weak lensing and

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Probing the Dark Universe with Subaru and Gemini continued

Participants in the workshop "Probing the Dark Universe with Gemini and Subaru," held 6-9 November 2005 in Waikoloa, Hawaii.

baryon oscillation surveys. Many surveys aimed at constraining w(z) are in their planning stages, and a few are already underway. The meeting provided a frank discussion of the relative merits of many different strategies, and most compellingly underscored the need to follow many different and complementary approaches (with different inherent systematics) to the problem. Supernovae studies have provided the most robust constraints to date and, as the most mature approach, provide valuable lessons in the importance (and difficulties) of constraining systematic errors. There was also an obvious need for the proponents of different strategies to calculate performance metrics using a similar set of assumptions.

The meeting demonstrated that both the baryon oscillation and weak-lensing methods are quite developed as cosmological probes. An attractive aspect of both the weak-lensing and baryon-oscillation approaches to measuring dark energy is that they naturally provide exquisite datasets for the investigation of a myriad of other astrophysical problems. For example, the joint capability of a very wide-field imager and a hugely multiplexed multi-object spectrometer on a large-aperture telescope will enable studies of Galactic structure and galaxy evolution of unprecedented scale and detail. At the meeting concerns and support were voiced variously about the sociology of doing science on a large scale. The scientific gains are large, but the observatories have to ensure that their resources are still available for smaller-scale, Principal Investigator-driven experiments.

Our astronomical ambitions in investigating dark energy are limited only by the cost of these projects, and the most ambitious studies will undoubtedly require multinational collaborations. The Gemini and Subaru observatories are taking the first steps in this direction by investigating a possible partnership to build HyperSuprime Camera and WFMOS. The Gemini Observatory has now commissioned two competing Conceptual Design Studies for WFMOS on Subaru. The Subaru Observatory has also designated resources and started an investigation of modifications to the telescope top end and to the design of HyperSuprime Camera. The two observatories are committed to working together to investigate the feasibility, benefits, and risks of jointly undertaking these ambitious projects. The November meeting in Hawaii was but one important step in this direction.

The presentations from the November meeting and other details can be found at *www.noao.edu/meetings/subaru/* and *www.naoj.org/Information/News/*, respectively. Financial support for the meeting was generously provided by Gemini, Subaru, PPARC, the NOAO Director's Office, and the NOAO Gemini Science Center.

NGSC Booth at the AAS Meeting in Washington, DC

The NOAO Gemini Science Center hosts an exhibit booth at the winter American Astronomical Society (AAS) meetings so that you can meet our staff and we can answer your questions about our mission as the gateway to Gemini for US astronomers. The booth, usually located between the NOAO and Gemini Observatory booths, features information on how to apply for time on the Gemini telescopes, their currently available instrument capabilities, and the Phase II process, including one-on-one tutorials. Brochures are available on the Gemini instruments, the Gemini Science Archive, and how to propose for Gemini observing time. Look for us at the January 2007 meeting in Seattle.

NGSC booth at the January 2006 AAS meeting in Washington: Top row, left to right: Bruce Carney (University of North Carolina at Chapel Hill) and Taft Armandroff (NGSC) with back to camera; Taft Armandroff and Jean-René Roy (Gemini Observatory); John Rayner (NASA-IRTF) and Ken Hinkle (NGSC). Bottom row, left to right: Eric Gawiser (Yale University), Taft Armandroff, and Bill Smith (AURA); Doug Simons (Gemini Observatory) and Taft Armandroff; John Lacy (University of Texas at Austin).

NGSC Instrumentation Program Update

Taft Armandroff & Mark Trueblood

The NGSC Instrumentation Program continues its mission to provide innovative and capable instrumentation for the Gemini telescopes in support of frontline science programs. This article gives a status update on Gemini instrumentation being developed in the US, with progress since the December 2005 *NOAO/NSO Newsletter*.

NICI

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

NICI is in the final assembly and testing phase of the project. In particular, the integration and testing of NICI's adaptive optics (AO) system is receiving a great deal of attention. Extensive optical tests of the AO system have been undertaken and are being used to optimize the focal positions of the camera and wavefront sensor. The resulting image quality, in both the cryostat and AO portions of the instrument, is within specification. MKIR has also been working to eliminate excess array noise.

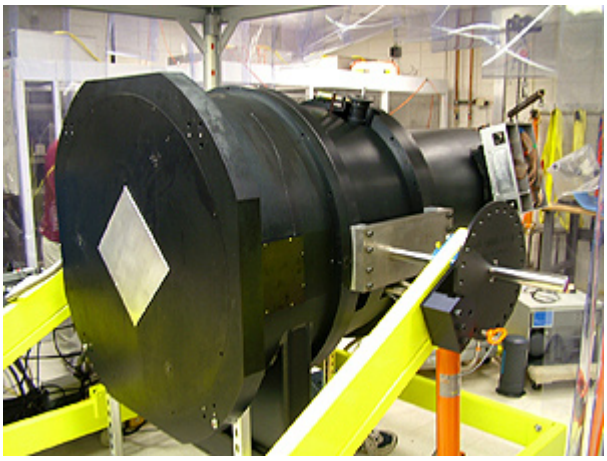
As of the end of December, MKIR reports that 99 percent of the work to NICI final acceptance by Gemini has been completed.

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 FLAMINGOS-2 Team is continuing with the integration and testing phase of the project. Alignment of the FLAMINGOS-2 imaging optical train is now complete. The camera dewar was cooled down to operating temperature with all components installed (including lenses, but not grisms) and then warmed back to room temperature. No adverse effects resulted from this thermal cycling. The grism vendor delivered the completed JH grism in January, and its transmission curve exceeded the FLAMINGOS-2 requirements. As of this writing in late January, the instrument is integrated and is being tested using an engineering-grade HAWAII array.

As of mid-January, Florida reports that 90 percent of the work to FLAMINGOS-2 final acceptance by Gemini has been completed.



The integrated FLAMINGOS-2 instrument in late January.