United States Gemini Program

Quarterly Review

of

The Gemini Near Infrared Spectrograph

(GNIRS)

Held

December 10, 2002

at

Tucson, Arizona

Distribution

NSF (Director, Division of Astronomical Sciences)
AURA President
NOAO Director
Gemini Associate Director for Instrumentation
US Project Scientist
Engineering and Technical Services Manager
Instrument Team Manager

USGP Report of the Quarterly Review for GNIRS

December, 2002

1. Meeting Background

A USGP Quarterly Review (QR) of GNIRS was held on December 10, 2002. The meeting was attended by Taft Armandroff (US Project Scientist) and Mark Trueblood (Work Package Manager) from the USGP, Larry Daggert (NOAO Engineering and Technical Services Manager) and members of the GNIRS team including Neil Gaughan (GNIRS Project Manager), Jay Elias (Instrument Scientist), and Dan Eklund (GNIRS Project Assistant). Wayne Van Citters and Eileen Friel (NSF) and Bernadette Rodgers (Gemini GNIRS Instrument Scientist) attended by videocon. The previous QR was held September 3, 2002.

The goal of the QR's is to evaluate each instrument project's overall status with respect to the entire project lifetime and to review and assess recent progress in a number of different areas on a periodic basis, with emphasis on management and high-level concerns. Specifically, the USGP uses a formal mechanism to determine whether a project is on track with respect to budget and schedule, and to identify potential problems before they significantly impact progress.

2. Major Findings

System integration (basic instrument assembly of mechanisms onto the bench and optical alignment) is complete. The project is now in the system test phase, in which the complete instrument is tested as a whole in both warm and cold cycles using the NOAO flex rig and other test facilities. Detailed reports of the first (diagnostic) cycle of warm and cold tests, including the thermal behavior of the instrument, are available on the GNIRS Web site.

Fixing detected problems is largely a serial process, in which each individual working on the instrument needs the instrument configured in a particular way, often differently from the way others need the instrument configured, so that usually one person must finish his task before another may begin his. This places each task on the Critical Path, and leaves little room for creative ways to shorten the schedule.

During the last quarter since the previous QR, significant progress has been made in system integration, which the Project Manager admitted took longer than planned. The team accomplished its first warm test and cooldown using a bare mux detector, and in the process uncovered and fixed a number of minor problems (discussed later). If the team had anticipated some of these problems better (e.g., the paint outgassing) and avoided the need to spend time on corrective action (e.g., removing material from the two optical surfaces coated by outgassed material, then testing the optics for damage), cost and schedule would be slightly improved.

Using some of the GNIRS team members as well as other personnel, the NOAO Major Instrumentation Program was able to complete all preparations in the NOAO Flexure Test

Facility, including installation of cryocooler compressors and lines, the Gemini near-infrared telescope simulator, and other upgrades and additions to the bare "as-delivered" flexure rig assembly in time to avoid any delay to the GNIRS Project.

The Work Package Manager (WPM) continues to believe that the instrument will not be ready to be shipped from Tucson before June 2003, due to the following reasons (mostly based on project history):

- Since the Project Restart, there has been a major unanticipated problem with the project every few months or so that set the project back (main bench design, bulkhead design, collimator design, radiation shields design, BaF_2 procurement, OIWFS delivery, mechanism testing); every time each major problem was solved, USGP was assured the rest of the project would proceed according to plan, yet it did not.
- Recent history at previous QR's has shown that about two-thirds of the milestones for a particular QR have been achieved, with about one-third outstanding; the previous WPM prediction that the Pre-Ship A/T would be pushed into May if no major problems occur is beginning to look more realistic at each passing QR.
- There is still considerable uncertainty in major risk areas, especially electronic noise and flexure, and to a lesser extent with light leaks. Although the bench design is more robust than other Gemini instruments, which will go a long way towards meeting the rigorous Gemini flexure requirements, until test results are in hand, there is substantial risk that additional time now not in the schedule will be required to address problems uncovered in tests yet to be performed. This is based on experience with other Gemini instruments.
- The collimator is designed to compensate for much of the residual flexure, but requires precise adjustment; although lab experiments have been performed to calibrate the optical figure changes versus counterweight placement on the collimator lever arms, the WPM predicts that more iterations of counterweight placement than currently scheduled will be needed to bring the flexure within specification.
- The current schedule shows four cool-down cycles; although the GNIRS team is performing a great deal of cold testing on individual mechanisms in the test dewar, the NIRI instrument amply demonstrated that this alone will not preclude the occurrence of other problems, and all other Gemini instruments have shown that four cold cycles is not enough to integrate and test an instrument of this size and complexity.

3. Project Summary

3.1 Project Overview and Key Accomplishments

The key accomplishments since the last QR have been:

- Completed mechanism testing and integration.
- Completed OIWFS integration.
- Completed internal dewar wiring and checkout.
- Completed warm testing with mux.
- Completed a cold test that verified vacuum, cooldown, and thermal control.

- Delivered the Software Maintenance Manual in November.
- Delivered the As-built Fabrication Drawings at the subject QR.

3.2 Project Status and Plans

The Project Manager stated he was about a week behind the detailed milestone schedule for GNIRS cold testing. The project has ceased the previous practice at recent QR's of revising its master schedule at each QR, which led to confusion as to whether or not the project was "on schedule". The schedule updated at the September QR currently shows the project to be ahead of schedule. This is a quirk of MS Project resulting from the various re-planning activities that occurred that pushed travel and reviews out into the future, then some of that activity was accomplished and claimed ahead of schedule. Another contributing factor to this distorted view is that the schedule does not reflect the fact that the instrument will be sent to Chile instead of Hawai'i. This will be corrected when Change Order No. 11 is negotiated and ratified, which is now in process. The net effect is that according to the latest revised schedule shown at the September QR, the project is approximately on schedule, but is several months behind the schedule presented at the Restart Review.

Despite being on schedule now, the WPM believes the instrument will be delivered (will pass the Pre-Ship A/T) about 11 months later than the date predicted at the Restart Review for the reasons given in Section 2 above. If major problems with flexure are not detected until system testing is well under way (drawing a parallel with NIRI, T-ReCS, and other Gemini instruments), the integration and testing phase could be drawn out significantly longer than currently planned. By the next QR, the scheduled flexure tests should have been completed, and schedule projections for delivery of the instrument will then be on much firmer ground.

The following goals for this December 2002 QR that *were* met are (some of these are from previous QR's):

- Complete manual outlines
- Deliver design documentation (as-built fabrication drawings)
- Complete all mechanical parts rework
- Receive, test, and install the short red camera BaF_2 lens, and verify it meets the image quality goals that Gemini accepted
- Verify vacuum integrity of the dewar and demonstrate it can reach acceptable vacuum levels in a reasonable time
- Verify cooldown time of the assembled instrument and demonstrate that it can reach acceptable temperature levels within a reasonable variance of the estimates provided at the design reviews
- Verify thermal stability of the optical bench and demonstrate that it can keep temperature variations within design limits

The following goals for this December 2002 QR that were not met are (some of these are from previous QR's):

- *Complete flexure testing* (will be done in Cold Cycle 1, with GNIRS cooling down in December)
- *Complete two cold test cycles* (Diagnostic cycle and Cycle 1)
- *Complete final manuals and deliver them to Gemini for review* (expect complete in mid-December)
- *Complete fabrication or procurement of the shipping container* (expect complete in mid-December)
- *Verify performance of the collimator mechanical flexure compensation system, and demonstrate that it can correct for flexure within design limits* (scheduled for Cycle 1)

The Project Manager listed the following goals for the next QR, nominally to be held in March 2003:

- Complete initial flexure testing
- Complete two cold test cycles (Cycle 1 and Cycle 2 with the science array)
- Complete all manuals
- Complete shipping container

In addition to these items, the USGP would add the following goals for the next QR:

- Diagnose and repair all problems detected in the Diagnostic Cold Cycle, including optics issues (e.g., astigmatism in the acquisition mirror)
- Close out the OIWFS account and prepare an invoice to Gemini

The project is 94% complete from the Restart Review to the completion of the Pre-Ship Acceptance Test, now scheduled for late April 2003, compared to 92% at the QR held September 2002.

3.3 Project Problems and Concerns

At the December 2002 QR, the Project Manager did not list any problems or concerns. He did note that work on the instrument at this stage must proceed in a serial manner instead of in parallel, due primarily to the fact that each person working on the instrument needs it configured (e.g., electronics, software, or mechanical access) in a way different from others who also need to work on the instrument.

After the diagnostic cold cycle, the Instrument Scientist reported several anomalies discovered during the tests. It is natural to discover a few such items – after all, that is the reason for performing the test. However, the nature of some of the items is disturbing, and reflects either questionable engineering choices or poor manufacturing or handling processes in earlier steps. For example, significant outgassing was detected during the pumping stage, and upon opening the instrument after the diagnostic cycle, it was discovered that the collimator and OIWFS gimbal mirrors had been coated with a foreign substance. The optics were cleaned and tested and found to have the proper emissivity. Further analysis points towards the Aeroglaze paint as the most likely source of the outgassing, yet this paint is used extensively in infrared instruments

worldwide. In retrospect, a step that involved assembling the dewar and bench without any optics or the mux, closing it up, pumping it down, and cooling it would have been a sufficient and considerably safer diagnostic check.

Also reported after the diagnostic cold cycle was chipping of mirror on the prism turret (used in long slit mode) due to relative contraction of the mask, requiring rework of the mirror. This sometimes happens on large instrument projects, especially with engineering teams with little or no cryogenic experience. This highlights the need for strong communication between those who have such experience, such as the systems engineers (in this case Jay Elias and Dick Joyce), and the opto-mechanical engineer designing the mechanisms (in this case Gary Muller). At this stage of this project, the point is now moot, but should be borne in mind for future projects.

As noted above, the WPM believes that, despite the current "on-schedule" status depicted by the latest MS Project schedule, the project is now 11 months behind the Restart Review schedule (showing delivery to Hawai'i in July 2002) in a way that cannot be recovered, and that this will result in late delivery of the instrument by that amount. This conclusion is supported by the fact that the Project Manager revised his delivery date at the December 2002 QR and now shows the Pre-Ship Acceptance Test beginning in late April. Furthermore, until the upcoming flexure test is complete, the schedule could be at considerable risk if several weeks are needed to correct a major flexure problem.

In the two previous QR reports, the USGP recommended that the Project Manager closely monitor the integration phase. This advice was heeded during the beginning of the testing phase, and daily meetings were instituted to ensure that everyone working on the instrument knew what they were supposed to do, and that the Project Manager understood the status of the instrument. Furthermore, the Instrument Scientist began distributing brief daily emails summarizing the instrument progress and status. These steps have strengthened both internal and external communication, which should reduce the number of errors made, and increase visibility into and confidence in the project.

3.4 Project Schedule

The summary-level project schedule is available on the GNIRS Web site (a copy is attached to this report). An analysis of the schedule performance of each major engineering discipline appears below. Now that the project is in the Test and Checkout phase, the Critical Path is occupied by a limited number of sequential tasks performed by a very limited number of people, increasing the need for the Project Manager's close scrutiny and active involvement in problem identification and solution. This need is being met through the use of the daily morning meetings.

3.5 Project Milestones, Cost, and Manpower Charts

A summary-level Microsoft Project schedule is attached as an appendix. This reporting category is not repeated for each work area below, since all work areas are represented in the project schedule and manpower charts. The manpower charts were presented in the handouts and will not be repeated in this report, except at a summary level.

3.6 Project Budget and Expenditures to Date

The estimated cost (from January 1999 forward) increased for the fourth straight QR, this time by about $584k from the October 2001 QR value and by about $179k from the September 2002 QR value. The estimated cost of the project from January 1999 forward is now almost $4.7 million.

The cost of the entire project is now estimated to be over $7.0 M, including the $2.4M spent between the project start in October, 1995 and December 31, 1998 when the current management assumed control. Unfortunately, this estimate has already been exceeded. As of October 2002, the project had spent a total of $7,073,317 against a planned value of $6,862,337 yielding an overrun of $210,980. For this December 2002 QR, USGP requested and received in the handout a forecast of FTE's and direct labor dollars for the balance of the project through May, assuming delivery to Hawai'i and no commissioning. If Change Order No. 11 is negotiated and signed by the next QR, then this plan should be updated and presented at the next QR, along with a revised schedule that reflects results of the flexure testing.

3.7 Organization

The project appears to be staffed with a sufficient number of competent staff. A change from the previous QR is that Mr. Davis, the project procurement liaison representative, has been released from the project, and has left AURA's employment.

4. Project Management

4.1 Project Management Overview and Key Accomplishments

The Project Manager continues to exert management control over the project. Since the previous QR, the major accomplishment in project management was the institution of daily morning meetings to coordinate staff activities on the instrument each day, and to keep the Project Manager informed of instrument status and progress. Another accomplishment was to have the Instrument Scientist begin distributing daily emails on instrument status. Though these measures appear quite simple, their effect in ensuring good communication and in preventing costly errors and in increasing efficiency and productivity should not be underestimated.

4.2 Project Management Status and Plans

In the previous QR report, it was noted how the project had suffered a series of schedule slips and delays. Most recently, instrument integration took far longer than scheduled. The project is now past this milestone, and USGP notes that for the first time in several QR's, there is no major slip in delivery date with respect to the estimate made at the previous QR.

It appears that the Project Manager plans to continue the daily meetings and other recently instituted measures as long as they prove effective in promoting communication within the instrument team and in keeping him informed of status and progress.

4.3 Project Management Problems and Concerns

In previous QR reports, USGP raised the issue of involvement of the Project Manager in the day-to-day activities of the Team in system integration. This issue appears to have been resolved by the morning meetings and other steps taken by the Project Manager to become better informed of the instrument status and to exert control over the daily activities of the project.

Another issue raised in previous QR reports was documentation. The Project Manager also appears to have addressed this issue, first with the appointment of Roy Autry to head the documentation effort, then assuming the lead himself when Roy became unavailable for health reasons. The result was the delivery of the Software Maintenance Manual and the As-built Fabrication Drawing Sets, and significant progress on the User's Guide and the Calibration and Maintenance Manual. It now appears that the team will deliver all manuals by the end of CY 2002.

However, the issue of documentation merits continuous involvement and diligent scrutiny. Quite recently, manuals were delivered prematurely before they were in final form or had been properly reviewed internally. USGP hopes the measures now in place will prevent a reoccurrence of these unacceptable and easily preventable mistakes.

4.4 Project Management Schedule

The Project Manager usually delivers reports on schedule and meets his other schedule obligations. Project Management is a level of effort activity that is 92% complete.

4.5 Project Management Budget and Expenditures to Date

The GNIRS Statement of Work does not require this WBS element to be reported separately to the USGP.

4.6 Project Management Organization

The GNIRS Project Management organization consists of Neil Gaughan (Project Manager), Dan Eklund (assigned half time as Project Assistant), and Melissa Bowersock (Administrative Assistant to the Project Manager).

5. Systems Engineering

Systems engineering is complete. All further systems engineering work is in the area of optical alignment, subsystem integration, system integration, and testing.

6. Optics Design

The optics design is complete. All further optical work is in the area of procurement, installation, alignment, and integration.

7. Optics Fabrication

All optics fabrication is being performed by outside contractors. All GNIRS instrument optics are in hand and are installed. Furthermore, the telescope simulator optics are installed on the flexure rig.

In the previous QR report, it was noted that the Short Red Camera front BaF_2 lens had developed a crack along one edge. This lens was returned to the vendor (Janos) to have the crack removed by stoning. The lens was received, tested, assembled into the camera, and the issue is considered closed.

8. Mechanical Design

Mechanical design work is complete.

9. Mechanical Fabrication

9.1 Mechanical Fabrication Overview and Key Accomplishments

Fabrication is complete except for the shipping container, which is on schedule.

9.2 Mechanical Fabrication Status and Plans

Fabrication status is not reported separately from design. The overall mechanical design and fabrication effort stands at 96% complete. By the next QR, the shipping container should be complete, and all mechanical fabrication should be done.

9.3 Mechanical Fabrication Problems and Concerns

None

9.4 Mechanical Fabrication Schedule

Mechanical fabrication is complete, except for the shipping container.

9.5 Mechanical Fabrication Budget and Expenditures to Date

The GNIRS Statement of Work does not require this WBS element to be reported separately to the USGP.

9.6 Mechanical Fabrication Organization

Mechanical parts fabrication is performed by a combination of outside machine shops and the NOAO instrument shop. NOAO instrument makers assemble and check out each subassembly. The NOAO instrument maker assigned to GNIRS is John Stein.

10. Electronics Design

Electronics design is complete.

11. Electronics Fabrication

Electronics fabrication is complete.

12. Software Design

The software design is complete.

13. Software Fabrication

Software fabrication is complete.

14. Subsystem Integration

Subsystem integration is complete.

15. System Integration

System integration is complete.

16. Test and Checkout

16.1 Test and Checkout Overview and Key Accomplishments

The Test and Checkout set of tasks is well behind schedule, according to the payment milestone schedule in the Work Scope. However, the team is now about one week behind the detailed milestone schedule for integration and test activities given in September 2002 to USGP, the NOAO Director, and the NSF for tracking GNIRS activities.

16.2 Test and Checkout Status and Plans

Test and Checkout is on schedule according to the September QR schedule, and about 11 months late according to the Restart Review schedule.

The Team plans to weigh the instrument using the Gemini load cell scale in January. Cold Cycle No. 2 (as defined in the schedule, actually the third cold cycle including the Diagnostic Cold Cycle) will include checks of performance against the Pre-Ship Acceptance Test Plan.

16.3 Test and Checkout Problems and Concerns

Other Gemini instruments have endured protracted Test and Checkout periods that have delayed instrument delivery, despite mechanism cold testing and other precautions. Although the GNIRS team has endeavored to avoid the mistakes of other teams to date, and has scheduled several months for Test and Checkout, the compacted schedule and the elimination of schedule contingency have made it unlikely that the instrument will be delivered on schedule. It remains to be seen if the GNIRS team will fare better than others in terms of problems they encounter during the Test and Checkout phase of the project, especially after flexure testing. The team has already demonstrated that it underestimated the amount of time required for system integration. A well-planned and coordinated approach to Test and Checkout, and to managing the resulting fixes to problems that are discovered, is essential to maintaining control of the schedule.

16.4 Test and Checkout Schedule

The recently-revised schedule shows the following status of “Alignment and Integration”:

Activity	9/02	12/02
Overall	57%	66%
Dewar and structure	31%	100%
Mechanism integration	94%	100%
Warm tests	0%	100%
Cold tests	0%	0%

Note that the diagnostic cold cycle performed in October 2002 does not count as a cold test on this schedule.

16.5 Test and Checkout Budget and Expenditures to Date

The GNIRS Statement of Work does not require this WBS element to be reported separately to the USGP.

16.6 Test and Checkout Organization

Various engineers and technicians perform test and checkout. The primary personnel leading the effort are Jay Elias and Dick Joyce.

17. Documentation and Training

17.1 Documentation and Training Overview and Key Accomplishments

The Software Maintenance Manual was delivered in November and the As-built Fabrication Drawing sets were delivered on the day of the December 10, 2002 QR.

17.2 Documentation and Training Status and Plans

Documentation is on schedule according to the current schedule, but is seriously behind schedule as measured by meeting Work Scope payment milestones. As noted above, the Software Maintenance Manual was delivered in November and the team is waiting for comments from Gemini. The As-built Fabrication Drawing sets were delivered on the day of the most recent QR, and preliminary feedback from Gemini is favorable.

The team anticipates completing delivery of the remaining manuals (User's Guide and the Calibration and Maintenance Manual) in January 2003.

17.3 Documentation and Training Problems and Concerns

USGP concerns over lack of progress in documentation expressed in previous QR reports appear to have been addressed. However, USGP will reserve judgment until all the manuals are delivered and we see the quality and content level of the delivered product.

17.4 Documentation and Training Schedule

The documentation task completion status is:

- electronics -- 100% complete
- test plans – 99%
- manuals – 61% (22% in September 2002)
- as-built fabrication drawings – 100%

17.5 Documentation and Training Budget and Expenditures to Date

The GNIRS Statement of Work does not require this WBS element to be reported separately to the USGP.

17.6 Documentation and Training Organization

For electronics documentation, the responsible parties are the GNIRS electrical engineer, Jerry Penegor, assisted by electronics technician Ron George. Manual preparation is being managed by Neil Gaughan. Manual text is being prepared by Jay Elias, Dick Joyce, and Peter Ruckle.

18. Other Activities

No tasks for other activities were scheduled to begin before the Quarterly Review.