Gemini Science Operations Plan

VERSION 2.0

Gemini Project Scientist Team

and

Gemini Operations Science Working Group

Contents

1. Introduction

1.1 Purpose and Scope

The design and construction of the Gemini telescopes have been predicated on achieving very ambitious scientific goals. The sense of this effort has been to build telescopes which do not substantially degrade the best conditions delivered by two superb astronomical sites. The science that the partner communities want to do with the Gemini telescopes depend on making effective use of those best conditions. However, at the same time, it must be recognized that the 10th percentile best conditions only occur 10% of the time, and that the telescopes must be used effectively a much larger fraction of the time. Moreover, the possible range of conditions seen by the observer will be much larger, representing now the true intrinsic range, rather than the convolution of the intrinsic range with a dominant telescope limit. Therefore, it has been realized by the scientific representatives of the partner countries and of the Gemini project that a new, non-traditional mode of operations is required in order to use these telescopes effectively.

This approach might be described most simply as optimizing the match between the current environmental conditions and the requirements of the program being executed. This does not have to be a win-lose decision, as a number of variables determine the desirability of executing an observation at a given time. Indeed, observations at 5-30 um will be diffraction-limited almost all the time, and won't care what the seeing is, while observations below 2um will not be sensitive to the atmospheric emissivity. As a result of consideration of issues such as these, the Gemini Science Committee and Board have established that the starting point for Gemini scientific operations should be aimed at a significant fraction of flexible-or queue-scheduling. There are many arguments for maintaining some fraction of the time for classically scheduled observations. Perhaps foremost among these is the idea that innovative experiments and improvements to the facilities are imagined by people who are both physically trying to use them and have a strong scientific interest in the results. By visiting the telescopes, these researchers can help incorporate this expertise within the observatory as well as foster a lively scientific culture.

This document presents a model for operations which is driven by the scientific aspirations of the partners. That partnership itself is a strong motivation for this approach. Flexible scheduling forces collegiality and collaboration, because the time is not scheduled *a priori* to one country, but is used for the most appropriate program in the queue. Decisions made on operations issues must benefit all the partners, not just those with the largest shares of time.

1.2 General Scientific Principles

In order to achieve the established scientific requirements for the International Gemini Project, the following principles will guide the development of a detailed plan for operations:

- Gemini will accept responsibility for correctly executing the proposers instructions, i.e., observing scripts, for queue mode observations.
- The Gemini telescopes will be operated such that the scientific output is *globally* optimized. The goal of Gemini operations is to maximize the time spent on programs with a high scientific ranking, consistent with the allocation of time among the partner countries, whilst ensuring a good match between requested and prevailing site conditions.

- The performance of the Gemini telescopes will be quantitatively predictable. Under a given set of environmental conditions, the quality of data which would be obtained by a specific observation will be known. The Gemini systems will be stable enough that all data may be calibrated.
- The probability that a scientific observation is executed successfully and within its time constraints or preferences will be commensurate with its scientific priority within the constraints of the division of time among the partner countries.
- Being in the queue does not guarantee success, but the Gemini operations team will try to ensure execution for a subset of highly ranked programs.
- Because of the complexity of the Gemini telescopes and instrument systems, visiting observers will not, in general, be expert in running them. Nevertheless, their observing efficiency will be increased by making full use of the observatory planning and scheduling tools. All proposers, regardless of their previous observing experience with the Gemini telescopes, will have an equal chance of obtaining sound data.
- It is recognized that the astronomical communities have concerns about submitting their observations to a queue. The queue will operate in such a way so as to address these concerns, in particular, allowing rapid feedback to proposers and the possibility of follow-up observations.
- A minimum standard calibration will be available for all scientific datasets. They may be shared among programs and will be charged to any observing program which makes use of them.
- All scientific and calibration observations will be archived.

1.3 Abbreviations and Acronyms

CS: Contact Scientist
IGO: International Gemini Office
NGO: National Gemini Office
NTAC: National Time Allocation Committee
OCS: Observatory Control System
OT: Observing Tool
GS: Gemini Scheduler

2. Proposal Preparation

2.1 Documentation and software required to prepare proposals

The following material is required to permit scientists to prepare proposals:

(a) The Proposal forms and software - Each NGO or NTAC will solicit and receive proposals from its community. The IGO will maintain uniformity in the information required and in the information made available to proposers. It is desirable to maintain all information concerning the proposed observations in a single database, so any proposals forwarded from the NGO's to the IGO will be submitted electronically, in a standard format.

(b) Facilities Manual - Describes the available configurations of telescopes and facilities.

(c) Instrument Manuals - In addition to “users manual”, contains enough information about capabilities and configurations of instruments to allow proposers to understand feasibility of proposed observations.

(d) Simulation software which can be used by proposer to predict S/N, velocity accuracy of data based on known instrument performance and input observational parameters (including proposed guiding and reference stars), and how long any given observation will take, including overheads.

(e) Software for locating acceptable guiding and adaptive optics reference stars. These choices must be fed back into the simulation software so that the proposer has a reliable indication of suitability of reference star choice.

(f) Software for pre-planning instrument and telescope configurations and sequencing observations.

(g) List of previously accepted/executed programs (including list of data contained in archive). The intent is to prevent duplication of past or ongoing programs because of ignorance.

(h) Expected distribution of classical and queue blocks and instrument availability.

2.2 Preparation of Phase 1 Proposals

Phase 1 proposals will be evaluated to establish their scientific merit as well as their technical feasibility. In order to serve this purpose, Phase 1 proposals must contain the following information:

(a) Scientific Justification (fixed maximum length)

(b) Information about the proposers:
- names and affiliations
- contact information for PI (mail, e-mail, FAX, phone)
- Recent publications for PI (with publications relevant to current proposal or involving Gemini observations indicated)
- Any additional publications for other members of team relevant to current proposal
- List of recent Gemini time awarded with current disposition of data

(c) Target list - includes: Object name, position, relevant magnitude [might be a little more complex - e.g., a larger list from which objects may be drawn, a prioritized list, etc.]

(d) Nature of observations: Spatial and spectral resolution required, expected exposure time, expected S/N, required lunar phase, required site conditions of image quality, infrared background, cloud cover, preference and justification for observing mode (queue/classical)

(e) Technical description of instrument: filters, gratings, slits required

(f) Availability of guide star(s) necessary to achieve desired image quality

2.3 Submission of Phase 1 Proposals

Proposals will be solicited by each NGO or NTAC from its own user community. Solicitations will take place twice a year and will be coordinated to occur simultaneously in all countries. Each NGO or NTAC will be responsible for collecting proposals from its own user community, and for ensuring that all proposals are complete and valid.

In addition, at their discretion and subject to the available Gemini support, each NGO or NTAC may solicit proposals more frequently for placement in pre-reserved classical or queue slots. The intent is to permit a quicker response than provided by the regular submissions process.

Also, the IGO will accept proposals at this time from its scientific staff. Following assessment of their scientific merit, awarding of telescope time to the staff will be at the discretion of the Gemini Director.

2.4 Technical Review

Each NGO or NTAC is responsible for the first level of technical review for the proposals from its community. This review will include confirmation of the predicted exposure times and availability of guiding or reference stars, the validity of the requested instrumental setup. The NGO will also confirm that the proposal is complete.

3. The TAC Process

3.1 The National TAC's

Although each community may run its NTAC in any way it deems appropriate, it is expected that the output of each NTAC will include the following:

(a) Two ranked lists of the proposals it would like to see scheduled in order of scientific priority, one for classical programs and one for queue programs. It is desirable that all countries use the same grading system for ease of comparison.

(b) A recommended amount of observing time for each program, together with an estimate of the minimum required to produce any meaningful scientific result. These times are based on the *scientific* judgment of the TAC combined with the data input from the technical review and the arguments put forward by the proposer.

(c) Logistical (as opposed to technical) Scheduling constraints - including preferred/acceptable mode of observation, preferred/acceptable dates, etc.

It is expected that the combination of the list and recommended times will substantially exceed the expected allocation, to allow some degree of flexibility in merging the national lists. In general, programs which require any environmental parameter to be better than its median value, should be queue-scheduled unless there is a scientific reason against this. One exception to this rule will be visitor instrument programs. It is expected that these will wish to exploit some aspect of Gemini's superb performance.

In addition, the NTAC's may designate certain programs in the previous semester's queue or classical schedule for inclusion in the new semester's queue or schedule. Upon completion of the NTAC meetings, their output, including the recommended programs, will be forwarded to the IGO for preliminary merging into a schedule.

3.2 Preliminary Merging

The various lists will be merged into a draft classical schedule and draft queue with a number of constraints involving the fractional allocation to the different partner countries, the host institutions, the IGO scientific staff, and an allowance for director's discretionary and engineering time. The schedule will consist of specific blocks assigned to proposers for classically scheduled observations and additional blocks which are denoted Queue. In both classical and queue blocks, the instrumental complement will be indicated.

The draft queue must contain a reasonable distribution of programs requiring different conditions - i.e., it cannot contain only programs which require photometric conditions or 10th percentile seeing. The queue may contain some programs from the previous semester queue which may not be completed if the national TACs indicate this desire. The initial fraction of queue-scheduled time should be a rational balance between what Gemini may be able to support and a minimum number of nights needed for the queue to sample the distribution of conditions. It is unknown how this balance will compare with the desires of the proposers from the various communities. Programs may have to be moved from one mode to the other based on the best scientific judgment of the TAC's and of the IGO.

3.3 The International TAC

The International TAC consists of representatives from the NTAC's, as well as the IGO itself. It is chaired by a member of the IGO scientific staff, and its recommendations are advisory to the Gemini Director at the two sites. It meets to consider modifications to the draft schedule and the draft queue required by conflicts identified in the merging process.

3.4 The Final Schedule

The final schedule and queue, including the recommendations of the international TAC, are prepared and approved by the Director.

4. Preparation for Observing

4.1 Notification/interaction for queue-scheduled programs - Phase 2 Proposals

Proposers whose programs are accepted for the queue are notified. Each program is assigned a contact scientist (CS) who is a Gemini representative for that program. The CS is responsible for ensuring that all information required to execute the program is available to the observer. This information is submitted in Phase 2 of the application process. This information includes:

(a) program object list - with appropriate positional information. In the case of a program involving, e.g., multi-slit spectroscopy, where images of the field must first be obtained and then precise positional information to produce a slit mask, the CS is the liaison between the proposer and the observer or the queue as a whole. Programs may be moved out of the queue while awaiting this information to be provided by the proposer through the CS.

(b) acquisition information, e.g. finding charts - optional depending on program

(c) the specific instrument configuration(s), sequencing of telescope motions and observations

(d) guide stars or adaptive optics reference stars

(e) magnitudes and quality assurance recommendation. This may include S/N requests, identification of specific spectral or morphological features, etc.

Once all of this information has been entered by the proposer, the program is verified by IGO staff and placed into the queue. Phase 2 proposals are developed and verified using the Observing Tool (OT) developed by the Gemini Controls group and distributed to all proposers. The output of the OT is an executable script which can be run by the Observatory Control System.

4.2 Notification/interaction for classically scheduled programs

As in the queue-scheduled case, each program is assigned a contact scientist (CS). In this case, the CS is responsible for assisting the proposer to prepare for the observing run. Such preparation might reasonably include assembling all the information which is required to be supplied for queue-schedule programs, e.g. using the OT to pre-plan the observations. In addition, the CS is responsible for ensuring that appropriate personnel are available to assist the proposer when he/she arrives for the scheduled telescope time, and for on-site, post-observation data processing.

4.3 Logistical Support

Both Gemini sites should offer some support to visitors in areas of local travel and accommodation arrangements.

5. Quick-Response Observations

Among the advantages of queue-scheduled observing is the ability to enable a more diverse set of program types than can classical scheduling. Most obvious is the ease with which short programs (<<1 night) can be accommodated because the overhead of bringing the proposer out to the telescope is eliminated. The ability to schedule short programs also addresses one of the most common complaints about queue scheduling, the loss of freedom to devote a small fraction of one's allocated time to follow-up or exploratory observations.

In order to take advantage of this opportunity, Gemini will provide an alternate route by which proposers can obtain small amounts of telescope time relatively quickly. These quick-response programs will work as follows:

(a) Quick-response proposals will require a maximum of three hours of observing time including calibration exposures and all sources of overhead (e.g., slewing time, detector readout time).

(b) Each partner country will have its own process for receiving and reviewing quick-response proposals. One possibility is to accept them with one month deadlines. Another possibility is to accept them continuously.

(c) After receipt, that country's NGO or NTAC is responsible for acceptance. Hopefully, this can be accomplished without frequent physical meetings, but rather by teleconference or by designation of one member of the TAC as a responsible agent. The NGO or NTAC is also responsible for the technical evaluation of the proposal before it is submitted to the IGO.

(d) Accepted quick-response programs will be forwarded to the IGO for insertion into the queue or classical schedule. The quick-response classical process represents a "classical service" mode. The observations would be executed by visiting astronomers, perhaps from the NGO's. Just as for regular queue programs, a CS is assigned to each program. The CS informs the proposer that his/her program has been accepted and obtains the necessary phase 2 information.

(e) Programs which are executed as part of the quick-response mechanism are counted against the country from which they originate. Thus, it should be recognized that for every hour of a quick-response program executed, that country will obtain one hour less of exposure on its regular programs. Also, it is intended that the quick-response programs total only a small fraction of a partner's allocation of time; however, it will be the responsibility of each country to decide this for its own programs.

6. Operation of the Queue

6.1 Eavesdropping

It is hoped that proposers choose to involve themselves in the operation of the Gemini telescopes in a way which is both consistent with the effective use of the queue and also encourages scientific improvement of the facilities. One way that this can take place is through "almost-real-time" (next day) monitoring of observations and feedback. The two requirements for this activity are (a) that is be set up such that it makes effective use of the proposer's time and (b) that is does not interfere with the running of the queue. Specifically, this latter constraint means that there is no way for a proposer to interact with the observer during the night. Following is a proposed process for handling this interaction.

(a) At the time of Phase 2 proposal submission, the proposer indicates whether he/she is potentially interested in participating in eavesdropping. The CS should have some input here, particularly if he/she believes that eavesdropping would significantly improve the chance of success for a program.

(b) Software is made available to the proposer, which will allow him/her to view the data from his/her home institution. This software may be tested with some simulated or public data which is maintained at the Gemini site.

(c) The proposer is notified two weeks before the first time that the program could be executed. This requires a level of scheduling which allows prediction this far into the future. This establishes a short term interface between the CS and the proposer. The proposer's personal schedule can thus be made available.

(d) The proposer is notified during the day before the first night that the program could be executed. If the program is not executed that night, this communication is repeated each day following until the program is executed or until the program is no longer viable.

(e) If the program is executed (or begun), the proposer is notified how to inspect the data.

(f) The proposer is urged to e-mail or phone comments to the CS to be relayed to the observer. This is potentially very important if some problem is seen in the data. By the same token, if there is some question about the data, the CS may require the proposer to inspect it and comment on it before the remaining observations in the program may proceed.

6.2 Accounting

Classically schedule programs will be counted as nights scheduled.

Queue scheduled programs will be counted as hours used including all overheads and calibration. Time to slew from the last object of the previous program to the first object of the next program is not counted against any program.

In the case of the queue-scheduled programs, it will be impossible to predict ahead of time how many hours will go to each partner, because selection of the program to be executed will depend on the changing condition. It is not necessary that the agreed fractional allocations be satisfied every scheduling period, only that they approach these values over the longer term. However, there is a given amount of observing time, and if one partner exceeds its allotment, another one will fall behind its allotment. Therefore, the queue should be adjusted periodically throughout the semester to ensure that no partner seriously deviates from its allotment.

To incorporate possible preferences amongst the partners for different site conditions, the queue scheduled time will be accounted separately for the best conditions (of image quality and IR background), median or better conditions (in any category) as well as the total usage.

6.3 Daytime activities

It is desirable to do as much as possible of the decision-making and consideration of options during the daytime ahead of observing. The Gemini Scheduler (GS) is responsible for identifying the likely programs for the next few nights with a rough extrapolation of the schedule over two weeks. In order to do this, the GS must be familiar with the current instrument complement as well as requirements for the programs near the top of the queue. In addition, the GS will receive input from the observer, detailing the previous night's activities and from the CS's who will be reporting feedback from eavesdropping proposers as well as their own quality assessment on programs they represent.

The GS will use a scheduling program which accesses the queue database and forecast or statistical expectations of conditions. The GS may run this program for a number of different possible sets of conditions and "policies" describing the combination of parameters affecting queue execution. The GS then inspects and modifies the schedule. The CS for any program which may be executed is notified, and the CS is responsible for ensuring that the observer knows how to execute the program. A close working relationship among the GS, the observer, and the various CSs is envisioned.

6.4 The Observing

The observer is responsible for taking the schedules worked out by the GS, and, after evaluating the current environmental conditions, deciding what observation to execute. The observer is guided in this decision by an understanding of the rules governing the scheduling as well as additional rules about, e.g., the desirability of completing programs once they are started. The observer has the minute-by-minute responsibility for the decision, however, and if an instrument is malfunctioning, the observer may choose to switch programs in a way not reflected by the possible schedules. The observer is also responsible for understanding the programs in sufficient depth to know how to make the observations and how to evaluate the success of the observations.

6.5 Calibration

Every mode of every instrument will have an accepted calibration sequence which must be obtained to make science observations meaningful. In order to ensure the usefulness of the archive, this calibration data must be obtained for all observations whether scheduled in queue or classical mode. Calibration data may be shared among different programs executed in queue mode. Depending on the stability and repeatability of setting of the instruments, it may be necessary to take calibration exposures during the night or it may be possible to take them in the daytime. If they are taken in the daytime, it will be the responsibility of the daytime observer to see that they are taken properly.

Calibration data must be unambiguously associated with the scientific data to which it is applicable. This is necessary both to ensure proper quality assessment and to ensure that the data in the archive can be reduced appropriately.

6.6 Quality Assessment

After each exposure, the observer is responsible for a low level of quality assessment. Was the sky brightness level as expected? Is the telescope in focus? Is the object producing approximately the expected number of counts?

As the execution of the observation proceeds, and especially with regard to the start of a new program, a higher level of evaluation is required. A pipeline process will take each science frame and reduce it using default or standard parameters. Given the criteria submitted by the proposer (and discussed between the CS and the observer) does the proposed exposure time achieve the required S/N? If there is a small discrepancy, the program parameters may be adjusted. If there is a large discrepancy, the problem should be flagged for discussion between the CS and the proposer tomorrow. In this case, the observer should proceed to another program.

Each day, for each program for which observations have been made, the CS should perform an even higher level of quality assessment. By this time, the proper calibration frames should be available. The CS will confirm that the data obtained are acceptable considering his/her understanding of the proposer's requirements. In cases of uncertainly or potential error, the CS will attempt to contact the proposer to get questions answered.

In these time-critical interactions, the difference in time-zone between the sites and the proposer may produce a delay while problems are sorted out. The worst case is between the UK and Mauna Kea, 11 hours. In these cases, there will be an additional lag of one day in communications.

6.7 Data Distribution

Data will normally be delivered to the PI for a program the day following completion of the observation. Both raw and pipeline-reduced data will be shipped, nominally on a standard removable medium. Electronic transfer of data will be available for small data sets.

7. The Archive

Archiving serves two purposes: (a) as a backup and record of the data taken with the Gemini telescopes, and (b) as a database for future scientific studies.

In its first role, all raw data should be written to an archive as it is taken. All instrument settings must be encoded and written into the headers of data frames. All engineering and environmental variables must be recorded as well, in a manner which permits their association with the scientific data.

In order to be useful for future scientific studies, reduced data as well as raw data must be saved. It is acknowledged that the ultimate data reduction will involved precise adjustment of the parameters and algorithms, but a very large fraction of the data can be effectively reduced using a standard pipeline procedure and "default" parameters. Because the appropriate calibration data may be taken well after the science observation, it will be a responsibility of the CS to ensure that data reduced with the proper calibration is written into the archive.