

Gemini North Visitor Observer's Guide

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Short link: <https://goo.gl/DoR7eB> - shared for viewing with all Gemini staff
(Old link was: <http://goo.gl/K5mP2m>, now marked obsolete in the document)

Externally-linked PDF for non-Gemini people:

<http://www.gemini.edu/sciops/visinfo/GeminiNorthVisitorObserversGuide.pdf>

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Welcome!

Welcome to Gemini Observatory! This guide will give you an introduction to observing with Gemini North telescope, provide general overview of basic observing tools and procedures, and list useful references to external and internal observatory pages where you can find detailed instructions and extensive manuals. Please note, that the links to internal pages will work only from Gemini observatory workstations.

Prior to your run. Starting with mid-November 2015 Gemini North telescope operations are carried out remotely from the [Gemini Hilo Base Facility](#) (HBF). Priority visitors (PVs) are encouraged to spend a day prior their observing run at the HBF, where they will be given preliminary training, and an introduction to observations technique and software.

Please check Gemini web pages for the latest updates on the [Large and Long Programs](#) and [Priority Visitor Observing](#) mode.

Observatory roles. At Gemini observatory, queue observations are performed by either a **Staff Astronomer** or a **Science Operations Specialist (SOS)**. Another SOS is acting as **telescope operator** and a safety officer. When priority observers are visiting, during the first nights of their run, a scheduled queue observer will introduce them to observing with Gemini telescope, and provide full assistance. However, over the rest of the PV run, only an SOS operating the telescope will be present at the control room. Thus the PVs should be able to perform both their own observations and run the queue independently, although with all the necessary help of telescope operator.

Queue coordinator (QC) is a person responsible for creating the Nightly Observing Plan ([Queue Plan](#)). The QC is on-call at night and should be contacted when significant departures from the plan occur, or instrument failures require plan revisions for the remainder of the night.

Whenever you require assistance while observing, please try the following:

1. Ask the SOS operating the telescope.
2. [Call the queue coordinator.](#)
3. If you are still in doubt, move on to another observation.

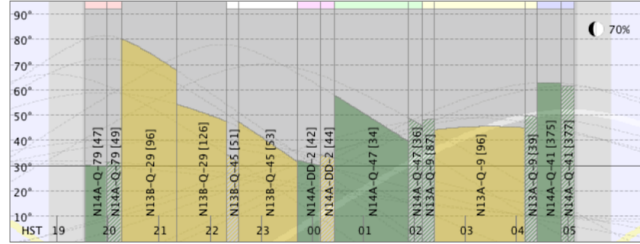
Queue Plan

Every day a scheduled QC prepares several variants (Fig. 1) of the [GN Nightly Queue Plan](#) for different sets of [observing conditions](#), e.g. photometric & good seeing (CC=50% IQ=70%),

cirrus, poor seeing, wet (CC=70% IQ=85% WV=Any), etc. Thus, the night is pre-planned not only for the most likely conditions, but also for changing conditions, should they happen. In the event of changing conditions, the observer will switch plan variant as needed to avoid taking

Good seeing, photometric

SB = unconstrained / CC = 50 / IQ = 70 / WV = any



Start	Dur	BG	Observation	Steps	Inst	Config	WFS	Target	IQ	CC	WV	BG	Rise	Trans	Set
18:50			Sunset												
19:30			Evening 12° Twilight												
19:33	00:25	80%	N14A-Q-79 [47]	1 - 28	GNIRS	0.45, 32, XD, SXD, SB, λ=1.65	PWFS2	PW-13-001396	70	50	A	A	17:00	18:25	19:51
19:58	00:17	50%	N14A-Q-79 [49]	1 - 8	GNIRS	0.45, 32, XD, SXD, SB, λ=1.65	PWFS2	HD 69220	70	50	A	A	16:46	18:55	21:04
20:15	01:04	20%	N13B-Q-29 [96]	1 - 10	GMOS-N	IFU-2, R400, CaT, E2V, No, No	OIWFS	NGC 2872	70	50	A	A	15:47	19:55	00:03
Warning: Multiple GMOS OIWFS options.															
21:20	00:58	50%	N13B-Q-29 [126]	1 - 9	GMOS-N	IFU-2, R400, CaT, E2V, No, No	OIWFS	NGC 2841	70	50	A	A	15:26	19:51	00:17

Fig. 1. An example of a queue plan variant, prepared for the case of good seeing and photometric conditions. A fragment of the observations' timeline with QC's notes is shown under the plan.

data in poorer conditions than required and to minimize time spent taking data in better than requested conditions.

At the very top of the [Nightly Plan page](#) you will find a collection of useful links and short guidelines on observing, instruments and LGS information, emergency home phone numbers, etc. Below this is where the nightly plan begins. The queue observer will need to choose the appropriate variant to follow based on the existing weather conditions. Following these plan variants, you will find a section containing fillers and calibrations (spectro-photometric and velocity standards) which might prove useful to fill holes in the plan or to observe during poor weather conditions. Useful information on twilight (end of night) observations as well as closed dome suggestions are listed at the very end of the plan.

At the end of this guide you can find some [suggestions](#) on the efficient use of the night plan.

Detailed information on the night's priorities is posted by the QC in the [Transition Wiki](#) before the end of each day. This page is also used to transfer any relevant information from the daytime telescope crew and day-SOS to the night crew. Make sure to read the Transition Wiki before the beginning of the night.

Nightlog

The [Nightlog](#) is filled in by the observer throughout the night. It is the central piece of information used by the QC, daytime SOS's, and many others at Gemini. There are many different styles of reporting what happened during the night, however, there are a few things that should be included in all nightlogs:

Time:

- At the beginning of the night, copy and paste the time information from the output of typing "**almanac**" in a terminal (sunset/rise, moonset/rise and 12-deg twilight times). Fill out the rest of the nightlog around these important time events.
- Accurate timing is nice, but just do your best. Having the time off by a few minutes is not a big deal.

Events:

- Program and observation ID, instrument, WFS, observing constraints.
- Time of slew.
- Time when you begin to take science.
- The step number or frame number that is affected by whatever event you are writing about will be very useful.
- If the acquisition takes longer than usual, please say so and why you think it is. (Anything from difficulty with finding source, confusing finding chart or instructions, etc.).
- If you pause the sequence (for other than normal acquisition pauses), please tell us why.
- If you check the cloud coverage or notice that the cloud situation has changed (via camera, etc.), please note this.
- If there is a fault, include the FR number in the body of the log with the affected step or frame number.
- Time when a problem appears (especially if it involves a fault or time loss to weather).
- End time when a problem has been resolved (and the time lost).

Additional Information:

- Anything that may be useful for the Gemini staff and which has not been filed in a fault report.
- There is never enough information on the current observing conditions (CC and IQ) through the night.

Please avoid the following:

- Target names. Instead, use "science object", "object", etc. Never put the target name in the nightlog.
- Long sentences. Please try to stay short and clear!

Detailed [Nightlog Guidelines](#) can be found on the top of the nightlog page.

A handy tool to use when filling out the nightlog is [Text queue plan](#). It provides all the queue plans for the night in text format, and includes the QC notes and some essential information on the observations (such as timing windows, average parallactic angle requirement, blind offset etc.). The relevant lines from the Text queue plan can be copied directly into the nightlog; add more information if necessary.

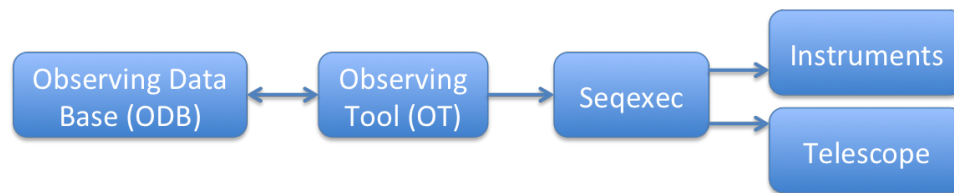
Some nightlog examples can be found [here](#).

Observing Tools and Software

During the night, observers at Gemini are using a variety of software tools to prepare and execute observations, monitor weather conditions, and assess image quality.

- ❖ **To open any observatory software**, either type its name at a command prompt of the observer's workstation terminal, or find it in the appropriate ["G" menu](#) from the bottom left of any monitor.

Observation sequences of science programs are set up and managed using a powerful graphical user interface - the [Observing Tool](#) . To execute the observations sequences we use another tool: [Seqexec](#) (Sequence executor).



These are the two central tools for the Gemini observer, but you will need to become familiar with many other scripts and windows in order to efficiently execute the observations. Below is an outline of the main software tools the observers are using at Gemini North.

Observing Software Overview

In the beginning of your run, you can bring up most of the software by simply typing "**startup astro**" in any terminal on the observer's workstation. This will open the following screens:

- **Instrument Status Display (ISD)** for each of four Gemini North instruments, and the [Instrument Manager GUI](#). The unused ISD can be closed and reopened at any time using Instrument Manager.
- **Telescope Status Display (TSD)**. Displays almost all of the feedback you will need to know in a moment's glance: the light path, the target name and coordinates, any offsets, the time (including local, UTC, and sidereal), the instantaneous values for seeing estimate and much more.
- **Data Handling System (DHS) console manager**. For the observers the main use of this console is to open the **QuickLook Tools** for both the [instruments](#) and the [WFSs](#), for displaying the images of wavefront sensors and instruments as they read out.
- **Observing Tool (OT)**. This is used to set up programs and their observations. It contains valuable information such as the configuration of the instrument, the observing conditions requested, plots of the target field, information about the observations and their purpose, etc.
- **Seqexec**. This is the sequence executor and is used by the observer to sequence the observation. It will control the instrument's configuration as well as the telescope via the OT program's file that gets loaded. It can also be used to pause and abort observations and has a few other features as well.

- **Firefox.** There is a substantial bookmark collection, containing useful links to the web-based tools and weather monitoring sites.
- **Pyraf.** This software package is used at Gemini to display and reduce images, and to acquire a source.
- **StripTools:** an application which acquires data from guiders and weather stations and plots it in real time as a strip charts. For chosen WFS it will display tip/tilt and astigmatism corrections, guide counts, focus value, and seeing estimate (the latter is reliable only for Altair). Select “GWS” and “Wind” to display the weather trends as well.
- CFHT/Gemini and UKIRT **weather alarms:** will warn you when the critical weather parameters are reached.
- Gemini Weather Server: real-time weather data from Gemini, CFHT and UKIRT weather sensors.

Other useful tools

QAP: image quality assessment pipeline. Automatically measures image quality for GMOS and NIRI imaging and outputs to [this page](#). To launch the automated reduction of incoming images, type “startqap” in the terminal (from telops), wait for the xterm to pop up, and type “autoredux”.

seqplot: quick-look IDL task for displaying images. To run it, type “idl” in the terminal, then “seqplot, YYYYMMDD*, *first_image*, *last_image*” (e.g. seqplot, 20091029, 293, 999).

* UT date

gdisplay: Pyraf task for displaying GMOS images. By default it performs a rough bias subtraction and runs imexam on the displayed image.

Usage: gdisplay *image ds9_frame* (e.g. gdisplay 250 1).

See “lpar gdisplay” for the list of parameters.

ndisplay: Pyraf task for displaying images from Gemini NIR instruments. By default it finds and subtracts the sky frame and runs imexam on the displayed image.

Usage: ndisplay *image1 sky=image2* (e.g. ndisplay 200 sky=201)

Useful parameters (see “lpar ndisplay” for list of all parameters):

- Use **sub-** if sky subtraction is not needed
- If you need to adjust the grayscale stretch, use **z1=lowlimit z2=highlimit**
- To try to remove the pattern noise, use **clean+**

The most commonly used options for IMEXAM:

"r" radial profile plot;
 "e" contour plot;
 "a" radial profile text output;
 "x" print cursor coordinates;
 "l" line plot;
 "c" column plot;
 "m" statistics of a region centered at the cursor location;

"g" graphics cursor;
"j" fit 1-d gaussian to image lines;
"k" fit 1-d gaussian to image columns;
"egx" print cursor coordinates from the contour plot in graphics window.

Gemini Observing Tool

Gemini [Observing Tool](#) (OT) is a software designed for defining and pre-planning observations with Gemini facility instruments. Using OT graphical interface, the PIs define observing groups and observing sequences by setting up the instrument and guiding configuration, observing constraints, calibrations etc. Before executing the observation, the night-time observer makes some final modifications to the observation in the OT (e.g. sets up the Parallactic angle if needed, or selects a guide star). Then the observer "queues" the observation, making it available for loading into Seqexec to run it. After running the sequence in Seqexec, the OT marks the observed steps and provides corresponding file numbers.

❖ Opening science programs

1. On the startup screen click the "Open" button (or, if you already have a program open, select File -> Open from the main toolbar of the Science program editor).
2. Select the semester using the selection menu in the right bottom corner.
3. Use the Program type menu checkboxes (e.g. Queue or Classical) to limit the programs being displayed.
4. Download a program by either double-clicking on the row for the program or highlighting a row with a single click and then clicking Open.

The program then will be opened in the science program editor window. Its main components are shown in Fig. 2.

❖ Syncing programs in the OT

Science programs, that are retrieved from the Gemini Observing Data Base (ODB), are being stored in a local database on your hard disk. Whenever you make changes to your local copy of science program (e.g. edit an observation, add a comment), or someone else uploads this program's modified version to the ODB, you need to synchronize your version of the program with the ODB. This is done using the [Sync](#) button on the top right corner of the OT window (see Fig. 2). Every time a sync is required, a yellow message box will be displayed in the bottom of OT window, notifying you about the sync state (Fig. 2).

❖ Queueing observations

In order to be able to load and execute an observation using [seqexec](#), it first needs to be queued using the OT. To queue an observation, first select it in the Science program viewer and click the "Queue" icon on the Main toolbar of the Science program editor (Fig. 2). Note that the observation can be queued only if its Phase 2 status is set to "Prepared" (in this case the icon to the left of the observation ID is green). To [view](#) all the queued observations, click File -> Display Session Queue.

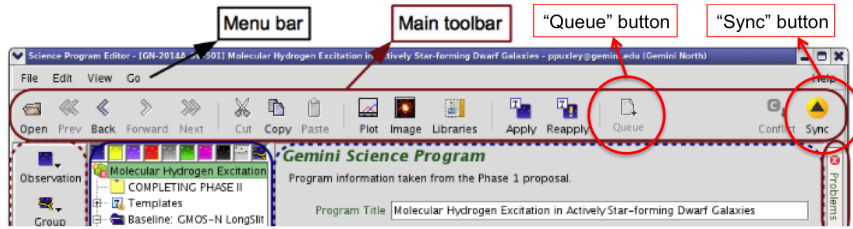


Fig. 2. Overview of the Science Program Editor.

Elements of a science program

In Fig. 3 the main elements of a science program are indicated on the left, while on the right the observation sequence of the science target is displayed. The Observation is normally the smallest schedulable element and corresponds to one telescope pointing. Science observations can be grouped into Scheduling Groups or Folders (e.g. Baseline calibration folder). All observations within a single Scheduling group should be executed either together with the science target observation, or, if it is a daytime calibration, during the following day. The special case are the before/after standards for the IR observations: if the total integration time on the science target is less than the time for which two baseline standards are required, then only one of them needs to be observed.

Components of an observation:

- **Observing Conditions:** describes the [observing condition constraints](#) (Sky background, Cloud Cover, Image quality and Water Vapor) for an observation.
- **Instrument** (GNIRS/GMOS/NIRI/NIFS): summarizes the instrument configuration for a particular observation. This window is frequently used by the observer for setting up the mean [Parallactic Angle](#) and adjusting the exposure time for an observation, if necessary.
- **Observing log:** lists the labels and corresponding filenames of already executed observations. During the observations this component is frequently used to add comments to the observed images. Also the [Quality Assessment states](#) for individual frames can be set in the “Data Analysis” tab of this section.

- **Target:** lists science and WFS targets (guide stars). For a graphical view of targets and guide star selection, the **Position editor** tool can be used (Fig. 4).
- **Sequence:** contains the sequence of operations that generates the observation's science data. Use this section to review all the useful information on the sequence steps, like the class of the observation, the offsets, exposure times etc. (see Fig. 3).

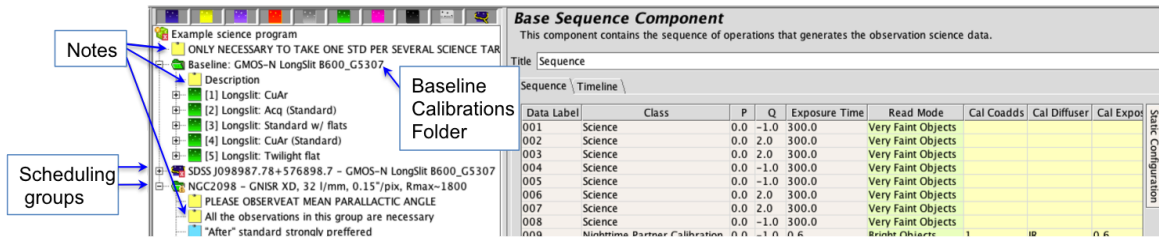


Fig. 3. Main elements of the Science program viewer.

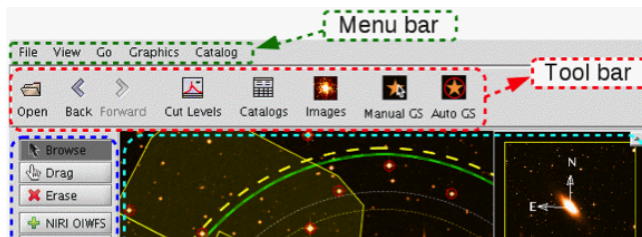


Fig. 4. Position editor window.

The **Position editor** provides graphical view of the observation and can interactively modify elements of it. During observations it's used to display the instrument and WFS fields of view, display positions of the science targets and guide stars, display on-line catalogue sources, download images and search for new guide stars. To launch it, select the Target component of an observation and then click the *Image* button on the main toolbar. More information on the Position editor usage can be found [here](#).

Seqexec

Seqexec, or Sequence executor (Fig. 5), is a tool, used by the observer to sequence an observation, and to take data during the night. It controls the instrument configuration, as well as the telescope, via the OT-generated file, that gets loaded into the Seqexec by the observer. It can also be used to pause and abort observations, and it has a few other features as well.

Using Seqexec

Be aware, that incorrect use of Seqexec might cause observing with wrong setup, loss of images and even instrument detector failure. Please be conscious when pressing Seqexec buttons, avoid double-clicking and always wait until the ongoing processes are finished (check the Seqexec status bar) before attempting the next step.

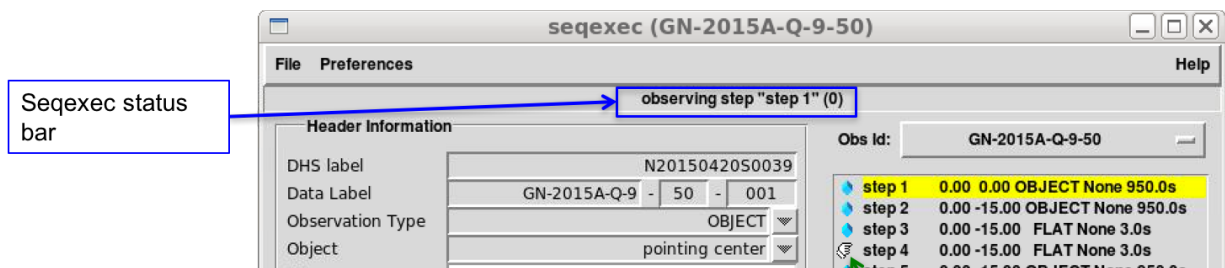


Fig. 5. A snapshot of the Seqexec window as it appeared during a GMOS sequence of observations. The first step of the sequence (highlighted in yellow) is being executed, and the breakpoint (pause) has been put on step 4.

When observing in **Nod and Shuffle** mode, please refer to the corresponding [section](#) of this manual, as Seqexec usage in this mode is significantly different.

Configuration

All the boxes under **Active subsystems** (TCS, GCAL, Instrument and DHS) must be selected at all times when observing.

Operation mode:

- “Queue” mode must be selected for the nighttime observing.
- “DayCal” mode must be selected when running morning calibrations and when checking seqexec in the beginning of the night.

Nighttime observing

1. While slewing, **load a sequence** into the Seqexec:
 - a. [Queue](#) the observation from the OT.
 - b. From the Seqexec menu toolbar select "File" -> "Load sequence from OCS..." and pick the sequence to be executed.
2. Check that the **Header Information** fields are filled out correctly. Keep "Raw Image Quality" and "Raw Cloud Cover" fields up-to-date; filling out the "Raw Water Vapour" and "Raw Background" fields is not necessary.
3. It is a good practice to start **configuring instrument** for the observation while still slewing. To do so, click on the first step of the sequence to be observed, and press the “INST” button under System Configuration.
4. After the operator tells you that the telescope is guiding and BEFORE starting the observation, click the “CONFIGURE FROM current TCS setup” button. This will pass the correct guiding configuration from the TCS to Seqexec. The information on the current guiding configuration is displayed right above this button.
5. Place **breakpoints (pauses)** in the sequence: if you wish to only take the first X number of steps, then a pause can be placed on step X+1 by middle-clicking on that step. This will display a hand icon on step X+1 step.

Running the sequence

Wait until configuring is finished (check the Seqexec status bar) and press “RUN” button to start the observation.

NB: when skipping steps, “Continue” button must be used instead!

Pausing and stopping observation early

- **“Pause Gracefully”**: if pressed while Seqexec is configuring for a step, the step will be paused after the configuring is done; if pressed while observing is in progress, the

sequence will be paused after the current step has been completed (this is equivalent to putting a breakpoint on the next step).

- **“Stop Immediately”**: stops the exposure immediately, reads out the frame and pauses the sequence.
- **“Abort”**: stops the exposure immediately and doesn’t read it out (the frame will be lost). **NEVER** attempt to abort the observation when detector is reading out!
- **“Pause immediately”** (GMOS only): pauses the exposure (closes the shutter) without reading it out (e.g. in case of clouds passing by). It’s not recommended to hold the charge for more than ~30 min due to accumulating cosmic rays.
- **“Resume”** (GMOS only): resumes the exposure after “Pause Immediately” button has been pressed.

Skipping steps

1. Select the step you want to observe, then click “All” under System Configuration.
2. **Wait** until configuring is done (check the Seqexec status bar).
3. Click “Continue” (NOT “Run”) to start exposure.

Modifying and reloading sequences

Sequences can be modified (steps added, exp. times changed etc.) only from within the OT. After a sequence has been loaded into the Seqexec, it doesn’t “know” about any modifications made within the OT unless you reload it in the Seqexec. To reload the sequence, do the following:

1. After modifying the sequence, Sync the OT.
2. **Wait** until Seqexec finishes any current action (observation, instrument configuration etc.).
3. Reload the sequence using “Reload sequence” button.

Running morning calibrations

1. Select “DayCals” as an **Operation** mode on Seqexec.
2. In order to sequence multiple calibration sequences, from the Seqexec menu toolbar select "File" -> “Load multiple sequences from OCS”.
3. After telescope operator lets you know that you can start morning calibrations, hit “Run”.

GACQ (Gemini Acquisition tool)

Gacq is an interactive Pyraf script used for target acquisition for all Gemini instruments. When running gacq on the acquisition images, it will, among many other things, look for relevant sky and slit images, automatically perform sky subtraction (if needed), measure slit center, reconstruct dispersed IFU images, calculate offsets, and even advise you when the centering is

good enough, considering the configuration being used. Gacq is easy to use since it displays step-by-step instructions to guide you through the acquisition process.

Running gacq:

- In your Pyraf window type: **gacq filename** (eg. gacq 132). This is the default usage, where gacq automatically tries to figure out what to do.

Gacq syntax and useful options:

- If you need to adjust the **grayscale stretch**, use *z1=lowlimit z2=highlimit*
- For longlist alignment of **two objects in the slit**, use *two+*
- **Turn off the slit overlay** if it is blocking your view of the target: *showoverlay-*
- Tell gacq not to waste time searching for a **sky** that **doesn't exist**: *sky=0*

Step-by-step example of an acquisition using gacq (GMOS long-slit spectroscopy)

1. Take the first 2 images in the acquisition sequence (an image of the target field and an image of the slit).
2. gacq the image of the target field, specify the slit frame:
gacq image1 slit=image2 (e.g. gacq 165 slit=166)
3. You will need to confirm the slit center, automatically measured by gacq.
4. Next put your cursor on the object to be centered, press '**r**', '**a**', '**x**' or '**egx**':
 - Repeat if doing a two-target acquisition.
 - **Caution:** Only press either '**r**', '**a**' or '**x**' *once* or your target or your gacq offsets will be invalid and you will need to start over.
5. If you want the target positioned anywhere other than the center of the slit, put your cursor on the point at which that object should be placed, press '**x**' followed by '**q**'; otherwise just press '**q**'.
6. Confirm the offsets calculated by gacq make sense. If so send them to the TCC by typing '**y**'.
7. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
8. Copy and paste the offsets sent to the TCC into the OT observing log for the image you just gacq'd.
9. Take an image with the slit in the beam.
10. In most cases gacq will have saved the measured slit center and will confirm that you want to use this old value again. If this option is not available or appropriate, gacq will ask you to confirm the slit measurement again.
11. Gacq will display the image of the target through the slit; with wider slits you can tweak the offsets as above: '**r**', '**a**', or '**egx**' on the target (and on the second target if two-target acquisition) followed by '**q**' (or '**x**' then '**q**' if you want to move the target from the gacq default position).
12. If this time gacq advises you to ignore offsets – you are ready to start science; otherwise – take another through-slit image.

- ❖ Spectroscopic acquisition should always end with a final image through the mask so that the PI can see exactly what the spectrum is of. This does not apply to spectrophotometric standards or IFU acquisitions.

For a complete guide on gacq usage please visit [this page](#). When at Gemini prior to your run, you can try to run gacq acquisition yourself on real data, using the available tutorial pages for [GMOS](#), [GNIRS](#), [NIFS](#) and [NIRI](#).

General observing procedures

Setting Up for Observing

Beginning of Run

- Logout / re-login into the telops account on the observer's workstation.
- Bring up the following windows and software by typing "[startup_astro](#)" in terminal: Instrument Manager, ISDs, TSD, OT, DHS Connection Manager, Pyraf, Seqexec, StripTools, Mozilla Firefox browser, Gemini Weather Server, Weather Alarms.
- Launch DS9, [seqplot](#) and [QAP](#).
- Bring up Nightlog Tools GUI from "G" menu, and from it open:
 - Text queue plan;
 - Almanac;
 - Eavesdropping into tool;
- If it is an LGS night: bring up the lgsst from "G" menu.
- In Firefox open the following pages:
 - [Queue plan](#);
 - [Text queue plan](#);
 - [Nightlog](#);
 - [Finder chart page](#);
 - MKWC: [Satellite](#), [Current conditions](#);
 - CFHT: [Seeing tower](#), [Sky Probe](#), [Asiva](#);
 - [QAP](#).

Start of Night (before sunset)

- Read the [Transition wiki](#).
- Familiarize yourself with the [queue plan](#).
- Update [nightlog](#) with cloud cover / almanac times / environmental data.
- Check the night's eavesdropping programs.
- Check that the [QuickLook Tools](#) are displaying latest images:
 - Open up today's calibration program: in the OT select "File -> Open Calibration Program".
 - Queue up "Check-seqexec: GMOS" observation (on weekend copy this observation from the previous night's calibration program);
 - Select "DayCal" as operation mode in Seqexec.
 - Run the observation (one GMOS dark).
 - If the latest image did not appear in your [QuickLook Tools](#), let the operator know.
- Seqexec:
 - make sure seqexec is set back to "**Queue**" mode;
 - put in initial guess of current Raw CC and IQ observing conditions;
 - fill out observer / operator fields.
- Run ENG-101 tuning star sequence:

- Select “File->Open” in the OT.
- In the bottom right corner of “Open Program” window select current Semester and tick the “Eng” checkbox.
- Double click on GN-NNNNN-ENG-101 program to open it.
- If NIRI is on the telescope, open up a “NIRI - AO tuning star” scheduling group for the current month, otherwise open up a GNIRS group.
- Set the Phase 2 Status of any unexecuted (blue) observation in the group to “Prepared” and queue it up.
- Load the sequence into the Seqexec.
- After the telescope is [tuned](#), take the first step of NIRI sequence (or first 2 steps if using GNIRS) and center the star in the field.
- In any observer’s workstation terminal type “sv101reduce” to run the reduction script.
- Run the remaining steps of the ENG-101 sequence.
- Follow the instructions in the reduction script. Copy the output of the script to the nightlog (6 lines).

Tuning the Telescope (during twilight)

In order to get the primary and secondary mirrors in a reasonable shape at the beginning of the night, they are “tuned” using a wavefront sensor (normally Altair). This settles out any of the higher-order aberration terms (zernikes) that may be present at the beginning of the night (e.g., coma, trefoil, spherical, and higher-order; note that the lower order terms such as astigmatism, defocus, and tilt are corrected throughout the night while guiding). Tuning is also used to get a good estimate of the seeing so the observer may decide which queue variant to start with.

During Tuning:

- assess IQ, CC from Altair striptools.
- update “Observing conditions” fields in Seqexec.

After the operator lets you know that the telescope is tuned, execute ENG-101 sequence (see above).

Acquiring and Observing with Gemini Instruments

Acquiring: general guidelines

Before Slew:

- Verify observing conditions, especially BG near twilight (see QC notes in the queue plan).
- Read notes in the queue plan, the OT observation and top level of the OT.
- Bring up [finder chart](#).
- If spectroscopy, check for [parallactic angle](#).
- If solar system, [update coordinates / guide star](#).
- Queue the acquisition and science.
- Load acquisition into seqexec, insert pause(s).
- Have operator slew to science observation (not acquisition).

During Slew / While Establishing Guiding:

- [Configure instrument](#).
- Inform operator of unusual modes (blind offsets, off-axis LGS, non-sidereal).
- Help operator identify guide stars / targets.

Acquisition:

- After guiding established, check that the target name on the TSD is correct.
- Click “Configure from current TCS setup” on Seqexec, and run acquisition.
- Use finder / OT image to verify telescope position.
- Run gacq, put offsets into the OT obslog.
- If in doubt about target, abandon and ask for PI input.
- Check astigmatism trace on the [striptools](#) before starting science.

Immediately After Science Start

- Make sure science target is not saturated.
- For spectra, note peak counts for later reference.
- Check that correct guider and weather striptools are up.
- Update nightlog (faults, acq. notes, slew times, condition changes, etc.).
- Using acq. images, verify IQ, update seqexec.
- Verify all associated nighttime calibrations are queued:
 - imaging -> photometric standard;
 - NIR spectra -> telluric standard;
 - GMOS MOS -> MOS twilight flat.
- Queue / note daytime calibrations for later:
 - NIR spectra -> daytime flats / arcs / darks;
 - GMOS spectra -> arcs;
 - GNIRS -> xD pinholes;
 - NIFS -> flats / darks.

Regularly During Science

- Add comments to the nightlog & OT obslog needed by daytime staff / PI.
- After taking NIFS arc, check wavelength (displaying in [seqplot](#) and type “C”).
- After taking flat, check count level (use [seqplot](#)).
- Using science data, monitor: science IQ, spectral counts (recenter if needed).
- Using strip tools, monitor: guide counts, guider seeing (update Seqexec conditions).
- Check environmental webpages often.
- If clouds coming in, make sure all photometric standards are taken.
- 10 minutes before end of science, Do "[Before Slew](#)" checklist.

Observing at the Parallaxic Angle

- Some GMOS and GNIRS spectroscopic observations will request the observations be taken at the average parallactic angle (PA).
- To find out if the observation is supposed to be taken at the mean PA, look for notes in the OT and in the Night Queue Plan.
- To set the PA:
 - Select the Instrument component (GMOS/GNIRS) of the science observation, under Position Angle choose “Average parallactic” and set the approximate time of the beginning of science observation.
- Sometimes the guide star for OIWFS (GMOS) cannot be found automatically for the new PA. In this case you will need to select the guide star manually.
 - If you cannot reach any OIWFS guide stars, you can change the PA by 180 deg, the slit position on the sky will be equivalent.
- If you cannot guide within ~10 deg of the parallactic angle, and the airmass is significant, do not take the data.
 - For GMOS use the "gmospa" task in Pyraf to help decide whether or not the airmass is significant.

Observing Non-Sidereal Targets

Prior to slewing to a non-sidereal target, observer needs to *select a suitable guide star*, and sometimes *set the parallactic angle* for the time of observation. Before that, *the coordinates of the target have to be updated* in the OT as for the time of slew. Depending on the type of the program, this may be done in two ways:

1. For the vast majority of observations the coordinates are being updated from the JPL/Horizons database. To confirm this is the case, check if “Type” in the **General** section of **Target Environment** is set to “Nonsidereal Target” (see [example](#)). If so:
 - a. Update the coordinates of the object by setting the approximate time of slew in the **Scheduling** section, either using the drop-down “Set To” menu, or the calendar (make sure to select the correct date of observation, and time format).

- b. Check the auto-selected guide star using the Position Editor.
 - c. Sync the OT.
2. Rarely, non-sidereal target observations may use a user-supplied ephemeris file. In this case the “Type” in the **General** section of the **Target Environment** will be set to “Sidereal Target”, and the “Name” will be the ephemeris file name (see the [example](#)). There will be also a note in the OT with instructions to the observer to use the ephemeris file for updating the coordinates . If this is the case:
 - a. Copy the coordinates for the expected time of slew from the note with ephemeris file. Make sure to use the UT date, not the local date!
 - b. Paste the coordinates to the **General** section of **Target Environment** of the observation.
 - c. Check the auto-selected guide star using the Position Editor.
 - d. Sync the OT.

Note that the TCS will NOT use the OT coordinates when slewing; the OT coordinates are updated only for observer to select the guide star.

More information on observing the non-sidereal targets can be found [here](#) and [here](#).

Targets of Opportunity (ToOs)

Note, that **Rapid Targets of Opportunity** can interrupt Priority Visitor nights, unless the Priority Visitor observation is time-critical.

Keep an OT window open at all times. When rapid ToOs are triggered, a pop-up window will appear in the OT. For rapid ToOs, you will need to act immediately. First read any accompanying notes which might specify when the PI would like the target observed and check the coordinates of the target. If the ToO is rapid, the target is above 2 airmasses, and the note specifies slew immediately or does not specify when to slew, you will need to stop/abort the current observation and slew to the target. All details on how to deal with an rToO observation are provided [here](#).

Competitive ToOs:

Since the LIGO experiment has come online, we may get competitive rToO triggers with the same target and similar instruments/ modes. When this happens, the observer should go by the following guidelines:

- Observer the first trigger that arrives, and then the next, etc. in order of first come/ first served.
- Avoid duplication of observations. So for two triggers coming in at nearly the same time asking for a near identical setup (i.e. same instrument, coordinates, filters, wavelengths), only the first trigger will be executed. There is a grey area here which may be difficult for

the observer to assess on-the-fly, but we will respect the decision taken by the Gemini Observer. If you are in doubt, call the QC.

- Communication with the PI will be done as is usually the case for ToO observations, i.e. send out an email notification.
- The Gemini Observer will record in the night log what has happened with the triggers, also those that were not executed, so that the day crew can analyze and take action.
- Data distribution will be dealt with on the next work day by the day crew (QC and/or daySOS). This can be a complex issue and should not become a concern of the night crew.

Data Quality Assessment

The PV observers are required to set the Quality Assessment (QA) states for all the Band-1 queue programs observed during the night. Setting the QA states for other programs (Band-2 and 3) is appreciated, but in case there is no time, they can be left as “Undefined”. Band-4 data doesn’t need to be checked, since it counts as weather loss. Setting the QA states on Visitor data is up to the Visiting Observer.

Before setting the QA states, the data has to be checked for sufficient counts, saturation, and constraints. The PI requested constraints can be found in the OT, under the “Observing Conditions” component of every observation.

To set the QA flags in the OT, use the “Data Analysis” tab of the “Observing Log” section of the observation.

The QA States have the following meanings:

“Pass” - meets all PI conditions requirements.

“Usable” - does not meet requirements but contains usable data.

“Fail” - completely useless.

Don’t forget to [Sync](#) the program in order to save comments and QA states in the ODB and update the headers.

If in doubt, observers should leave the QA State as “Undefined”. In this case please make a note in the nightlog and/or add a comment in the OT, with short explanation of what was your concern.

Tools and directions for weather conditions assessment

Image Quality (IQ)

- [Gemini IQ constraints](#) (at zenith).
- For estimation of airmass-corrected IQ: use [these plots](#).
- For GMOS and NIRI imaging: use the [QAP](#) seeing measurements.
- When observing with Altair: use Altair real-time seeing estimations (V-band).
- If measuring the FWHM directly from images: use pix2iq.py script (from any terminal), or IQTool (from “G” menu) to convert FWHM into seeing values.
- PWFS and OIWFS seeing measurements are not accurate, and should only be used to get a general idea of the seeing trends within a particular observation.
- [CFHT DIMM seeing](#).

Sky transparency: cloud cover (CC)

- [Gemini CC constraints](#).
- [Gemini Cloud Cams](#).
- [CFHT SkyProbe](#). Provides the atmospheric attenuation measurements in magnitudes, in the direction of CFHT current pointing.
- Mauna Kea [All Sky Infrared and Visible Sky Monitor](#) (ASIVA).
- [ASIVA with GN telescope pointing](#) and CloudCam position overlay.
- Latest [Satellite images](#).
- Watch guide counts monitors for drops. Note that, besides clouds, another common reason for drops in counts can be seeing deterioration.

Sky transparency: water vapor content (WV)

- [Gemini WV constraints](#).
- The [CSO 225 GHz optical depth](#), “tau”, is used to determine WV conditions. Current Gemini limits are: WV20: <0.057, WV50: <0.081, WV80: < 0.137, WVAny: <0.137.
- Mauna Kea [Opacity plot with Gemini constraints](#).

Sky background (BG)

- See the notes in the Night Queue plan.

Airmass (zenith distance)

- The elevation constraint of an observation can be found under the “Observing Conditions” component of the OT.
- Typical airmass constraint at Gemini is 2AM. Should a particular program have a different airmass constraint, a note will be added in the OT.
- For every particular observation read the notes in the Night Queue plan – sometimes the QC can push the airmass limit in order to stay longer on the object.
- To display the elevation constraints for a particular target in the OT, select the observation and click the “Plot” icon on the Main Toolbar. The elevation plot for the current date will pop-up; now tick the “Constraints” box right under the plot.
- The TSD displays time left before the 2AM limit will be reached for a particular target.

Observing with NIRI

Overview

Gemini's Near Infrared Imager and Spectrometer (NIRI) provides a range of imaging options in the 1-5 micron wavelength region. Please note that spectroscopy is no longer available with NIRI. NIRI has three cameras: f/32, f/14, and f/6. A large number of broad- and narrow-band filters are also available. Imaging with all cameras and all filters is possible (with the exceptions of the L' band at f/6 and the M band at f/6 and f/14 where the background saturates the array in the minimum exposure time). The Gemini facility adaptive optics (AO) system, ALTAIR, is available for use with NIRI at f/14 or f/32, either with a natural guide star or the laser guide star, for all imaging except in the M band.

Useful Instrument Info

- The NIRI **detector** is a 1024x1024 ALADDIN InSb array.
- Full imaging **field-of-view**:
 - f/32: 22"x22", pixel scale: 0.022"/pix
 - f/14: 51"x51", pixel scale: 0.050"/pix
 - f/6: 120"x120", pixel scale: 0.117"/pix

- **Orientation of NIRI images (PA=0):**
 - **In most cases:** North is up, East to the left.
 - **IF** installed on the bottom telescope port and used without Altair: North is up East is to the right.
- **Guiding options:** PWFSs (PWFS2 being preferred) and ALTAIR with a natural guide star (NGS) or with the laser guide star (LGS).

Acquiring

Typically acquisitions are not required for imaging because the telescope pointing is accurate enough to put the target in the field. However, when the imaging field is small, e.g. NIRI + AO, it may be necessary to take an acquisition image and issue an offset to center the target.

NIRI acquisition sequences are fairly straightforward. Targets are normally centered in the field using only one iteration. Therefore, for bright targets, you will only need to take one image of the field containing your object. For faint targets, you will need to take two images: the sky offset image will be defined as the first step (with typical offsets $P=0$, $Q=10''$), and the field image as the second.

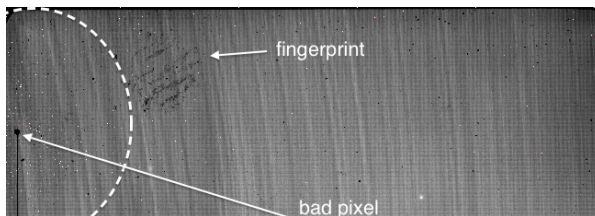


Fig 6a. Raw NIRI H-band image of faint objects, obtained with f/6 camera. The most prominent array features are labeled.

Fig 6b. Raw NIRI K-band image obtained with f/32 camera, using Gemini adaptive optics system ALTAIR.

❖ NIRI Imaging Acquisition

(see [GACQ reference page](#) and [NIRI tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Wait until focus and astigmatism have converged before starting observations.
3. If there is a sky-offset image first, observe the first two steps of the acquisition sequence, otherwise observe the first step.
4. Run gacq on the image of the field. If there is a sky image, include that as well:
No sky offset: **gacq image1** (eg. gacq 131)
With sky offset: **gacq image2 sky=image1** (eg. gacq 131 sky=130)
5. Follow gacq's instructions to center the object on the detector.
6. Send offsets to the TCC.
7. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
8. Start science.

Taking Science

Observe the steps listed in the "Steps" column of the "Plan for the night". Don't forget to observe the corresponding standard fields (will be scheduled in the queue plan, usually before or after the science).

NIRI Calibrations

❖ Night-time calibrations

Necessary photometric standard stars will be put into the queue plan for the night and are usually scheduled right before or after the science. Please take standards whenever the conditions are photometric. If they were accidentally excluded from the queue plan, check the science program in the OT for the necessary standard observations, to be taken with the science.

❖ Daytime calibrations

Daytime calibrations include all necessary flats and darks. Imaging flats and darks will likely be located in a separate observation within the same Observing group. Please queue them up and execute them in the morning.

NIRI Image Quality

- Make sure to check all NIRI frames in IDL using "[seqplot](#)". Any saturated pixels will show up red in the displayed image.

- If you wish to check the frames in PyRAF, use `ndisplay image1 sky=image2` (use **sub-** if sky subtraction is not needed).
- Sometimes NIRI detector controller superimposes vertical striping, horizontal banding, and quadrant offsets on the data. Please use `ndisplay` with the "clean+" parameter to attempt to remove [pattern noise](#) and judge whether the data are good.

Useful NIRI Links:

External

- [NIRI Public Page](#)

Internal

- [NIRI Instrument Information](#)
- [Instrument Checklist: NIRI](#)
- [NIRI Good Data Library](#)
- [Bad Data Library \(see links under NIRI section\)](#)

Observing with GMOS-North

Overview

The Gemini Multi-Object Spectrograph ([GMOS](#)) provides 0.36-1.03-micron spectroscopy and imaging over a 5.7'x5.7' field-of-view. For spectroscopy, there are both long-slit and multi-slit (MOS) options. GMOS is equipped with two Integral Field Units (IFU-R and IFU-2), making it possible to obtain spectra from a 35 square arcsec area with a sampling of 0.2". The Nod-and-Shuffle mode offers superior sky subtraction for most spectroscopic modes.

The available GMOS modes are covered in the following sections:

- [Imaging & Pre-Imaging](#)
- [Long-Slit Spectroscopy](#)
- [MOS \(multi-object spectroscopy\)](#)
- [IFU spectroscopy](#)
- [Nod and Shuffle \(N&S\)](#)

Useful Instrument Info

- GMOS-N **detector** is an array of three 2k x 4k CCDs, 4 amplifiers per detector;
- Full imaging **field-of-view**: 5.7' x 5.7';
- **Pixel scale** is 0.0807"/pixel (0.1614"/pixel if binning 2x2);
- **Orientation of GMOS images (PA=0)**: North down, and East left. In order to change the orientation of GMOS-N images in ds9 so that North is up and East is to the left, please do the following:

- Zoom --> **Invert Y**;
- Zoom --> Pan Zoom Rotate Parameters --> set the **Rotate** angle to equal the position angle (IPA value given on the TSD)
- GMOS-N **does not have an ADC** to compensate for atmospheric dispersion at this time;
- While observing with GMOS, it is possible to **hold the charge** without reading out the exposure. This can be done by pressing "Pause Immediately" button in seqexec. To resume observation, press "Resume" button. Due to cosmic rays' impact, the charge shouldn't be held for more than 20 min;
- **Guiding options** are On-Instrument Wavefront Sensor (OIWFS) and the telescope's Peripheral Wavefront Sensors (PWFSs):
 - OIWFS: recommended for all but non-sidereal objects.
 - PWFS2: has large patrol field, should be used for fast-moving non-sidereal objects or when the OIWFS guide star is not available.
 - PWFS1: is used only if PWFS2 is not available for any reason.

GMOS Imaging & Pre-Imaging

Acquiring

Acquisitions are normally not necessary for [GMOS imaging](#). Please check the Queue Plan and the program notes in case acquiring is necessary.

Taking Science

1. Follow the general [Acquiring guidelines](#).
2. Wait until focus and astigmatism on the [StripTools](#) graphs has converged; run observations.
3. Use [QAP](#) measurements for image quality assessment.

GMOS Spectroscopy

Long-Slit Spectroscopy

[GMOS Long-slit spectroscopy](#) can be obtained in either normal or [Nod and Shuffle](#) modes. The dispersion direction of GMOS is along the rows of the image. When the image has been displayed with either [gdisplay](#) or [seqplot](#), the longest wavelengths are to the left and the shortest wavelengths to the right.

Acquiring

Description. For most objects the long slit [acquisition sequence](#) consists of the following steps (see Fig. 7 for the snapshot of the Seqexec):

1. *Field image* (offsets: P=0, Q=0).

2. Off-object *Slit image* for measuring the slit center (typical offsets $P=10''$, $Q=0$).
3. Several *Through-slit images* of an object for fine centering on in the slit (offsets $P=0$, $Q=0$).

field image	step 1	0.00	0.00	OBJECT	r_G0303	1.0s
slit image (off-target)	step 2	10.00	0.00	OBJECT	r_G0303	20.0s
through-slit image	step 3	0.00	0.00	OBJECT	r_G0303	1.0s
through-slit image	step 4	0.00	0.00	OBJECT	r_G0303	1.0s

Fig. 7. GMOS acquisition sequence when loaded in Seqexec. The second image is a through-slit image taken off the target ($P=10''$), in order to precisely measure slit center position.

❖ On-axis long-slit acquisition

(see [GACQ reference page](#) and [GMOS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#) (don't forget to set the [Parallactic Angle](#) if needed).
2. Take the first two images of the acquisition sequence (the field and the slit image).
3. Once the images have been read out, run gacq on them as following:
gacq image1 slit=image2 (e.g. gacq 300 slit=301)
4. Follow gacq's instructions. During this acquisition step you will first need to [indicate the object](#) to be centered on the slit, and next confirm if gacq's [slit center measurement](#) is correct. When gacq asks whether the slit measurement is okay, look in the pink box and make sure that there are no objects which could affect the slit measurement; if there are, say "no" and manually measure the slit.
5. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
6. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
7. Observe step 3 of the acquisition sequence.
8. Run gacq on the image you just observed to verify the [centering of your target](#). If this time gacq advises you to ignore offsets – you are ready to start science; otherwise – take another acquisition image.
9. In case you are doing an acquisition with [BLIND OFFSET](#) – ask the telescope operator [to swap to science target](#) before running the science sequence!

❖ Off-axis long-slit acquisition

This is just like a normal [long-slit acquisition](#), except that if the Q-offset is larger than 5", gacq will ask the following question:

? Should the target be centered along the length of the slit ?

For off-axis acquisitions, you should answer "NO". gacq will then measure the slit center at the position of the science target, and only the P-offset will be sent to the telescope, thereby centering the target in the slit at its current position along the slit.

❖ Two target long-slit acquisition

This is just like a normal [long-slit acquisition](#), except that when running gacq, the two target mode must be enabled using the *two+* keyword:

```
gacq image1 slit=image2 two+
```

After displaying the image, gacq will ask you to mark **two** targets.

Caution: If the two targets are very close together the calculated rotation will be very sensitive to the exact target centers and may not converge.

Caution: If the initial rotation is > 1 degree, it is recommended to take another field image (without the slit).

❖ Acquisition with Blind offset

In case of a very faint science target, the acquisition is done on a brighter [reference star](#), using one of the methods described above. After acquiring, the telescope is being offset to the science target.

- Before slewing to the target, let the telescope operator know that you are going to do the acquisition with a Blind offset.
- Acquire on the reference star as normal.
- After acquisition is done and prior to running the science observation, ask the telescope operator to swap to the science target.

MOS (Multi-Object Spectroscopy)

The [MOS mode](#) of GMOS allows one to obtain spectra of several hundred objects simultaneously. Pre-images of a field are taken and sent to the PI who later creates a mask design that places slits over the objects of interest. Typically 30-60 slits can be cut onto a single mask, with a maximum of several hundred slits when narrow-band filters are used.

Acquiring

MOS masks are acquired by centering 2-5 objects in 2" x 2" alignment holes (acquisition boxes) spread over the mask. Depending on the way the mask has been designed, the MOS acquisition can either start directly with the MOS mask in the beam or, in some cases, the full frame field image with MOS mask out of the beam needs to be taken first. When the mask is in the beam, the observations are set up to use the Custom Regions of Interest (ROI), where only the pixels imaging the acquisition box are read out.

MOS acquisition starting with mask OUT OF the beam

(see [GACQ reference page](#) and [GMOS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Take the first image of the acquisition sequence (MOS mask out of the beam).
3. Once the image has been read out, run gacq on it and follow gacq's instructions.
ADVICE: While gacq is loading the image, click "INST" on the Seqexec to configure the instrument for the next step (inserting the mask into the beam has quite large overhead).
4. Gacq will ask you to provide the "MOS Mask Number or Custom Mask MDF" - this you can [find in the OT](#): click the GMOS-N component of the observation and look for the "Custom Mask MDF" name.
5. During this step of acquisition you will have to confirm the auto-measured positions of acquisition boxes and acquisition stars (gacq will cycle through all of them).
6. If the automatic measurement failed, follow gacq's instruction to manually measure the box/star's position.
7. If there is no star in the box, you can skip it by pressing "q".
8. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
9. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
10. Take step 2 of the acquisition sequence (this time with the MOS mask in the beam).
11. Run gacq on the image you just taken. You will have to confirm the auto-measured positions of [acquisition boxes](#) and acquisition stars are accurate.
12. Send offsets to the TCC, copy offset values to the OT.
13. Observe step 3 of the acquisition sequence and run gacq on it. This step is to confirm the centering of the acquisition stars.
14. If gacq advises you to ignore the offsets – you are ready to start science; otherwise – take another acquisition image.

If you encounter any issues during MOS acquisition, please refer to the [GACQ reference page](#) for detailed guidelines and troubleshooting advices.

MOS acquisition starting with mask IN the beam

(see [GACQ reference page](#) and [GMOS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Take the first image of the acquisition sequence (MOS mask in the beam).
3. During this step of acquisition you will have to confirm the auto-measured positions of acquisition boxes and acquisition stars (gacq will cycle through all of them).
4. If the automatic measurement failed, follow gacq's instruction to manually measure the box/star's position.
5. If there is no star in the box, you can skip it by pressing "q".
6. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).

7. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
8. Take step 2 of the acquisition sequence.
9. Run gacq on the image you just taken. This step is to confirm the centering of the acquisition stars.
10. Confirm the auto-measured positions of [acquisition boxes](#) and acquisition stars are okay.
11. If gacq advises you to ignore the offsets – you are ready to start science; otherwise – take another acquisition image.

Integral Field Spectroscopy

[GMOS IFU](#) can be used in either two-slit (IFU-2) or one-slit (IFU-R) mode, in the first case providing the full coverage of the IFU field-of-view, but limited spectral coverage, as opposite to the second case, when only half of the fibers and FOV are used, allowing the wavelength coverage to be extended.

Acquiring

The acquisition process is similar for both IFU-2 and IFU-R modes: first the full-frame field image is taken and the offsets calculated using gacq, in order to place the target in the IFU science field. This is followed by a series of images taken with IFU unit in the beam. The reconstructed 2-dimensional IFU field image is displayed using gacq, and the object's centering is adjusted in several iterations on reconstructed image. Since our IFU fields are several arcseconds wide, the centering is not critical, and the goal is to get the target within ~0.1" of the center.

IFU-2 and IFU-R acquisition

(see [GACQ reference page](#) and [GMOS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Take the first image in the acquisition sequence (IFU out of the beam).
3. Once the image has been read out, run gacq on it and follow gacq's instructions.
ADVICE: While gacq is loading the image, click "INST" on the Seqexec to configure the instrument for the next step (inserting the IFU into the beam has large overhead).
4. Gacq will ask you to specify the configuration used for this observation (either IFU-2 for two-slit or IFU-R for one-slit observations). This can be determined from the GMOS-N component of the observation in the [OT](#): look for the value in the Focal Plane. The plan for the night should also list which IFU is in use.
5. In the ds9 window a [full frame image](#) will be displayed, centered on the target (marked with a pink cross). The IFU science and sky fields will be drawn as blue boxes ~30" to the right and left of the image center. You will have to indicate the object to be centered in IFU field (use "r", "x" or "e-g-x").
6. Send the offsets to TCC, copy offset values to the OT (Observing Log -> Comments).

7. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
8. Observe step 2 (this time with IFU unit in the beam).
9. Run `gacq` on the next image and follow the instructions. In this step, for the image reconstruction purposes, you will first need to indicate the [top fiber](#) of the bottom bundle (approximately marked with the pink circle). Next, the [reconstructed science IFU field](#) will be displayed, on which you will be centering your object.
10. Send offsets to the TCC and observe step 3 of acquisition sequence.
11. Repeat steps 8-9 until `gacq` advises you to ignore offsets and start science.
12. In case you are doing an acquisition with BLIND OFFSET – ask the telescope operator to swap to the science target before running the science sequence!

Nod and Shuffle (N&S) mode

Acquiring

For both long-slit and MOS [N&S](#) observations, the acquisition process is similar to those of normal [long-slit](#) and [MOS](#) observations.

[Displaying N&S GMOS Spectra](#)

- Use the IRAF task `nsfast` to do a quick sky subtraction, and look at GMOS N&S spectral data. The syntax for use when observing is:
`nsfast filename rootname=NYYYYMMDDS rawpath=adata$` (e.g. `nsfast 334 rootname=N20091113S rawpath=adata$`).
- Note you can also use the “S” key in [seqplot](#) to perform a quick sky subtraction of N&S frames.

Pausing and Aborting N&S Observations

When observing in N&S mode, it is important to remember that pausing and aborting the N&S sequences is done in a **different way** than for any other observing mode.

The easiest way to pause a N&S sequence is to apply the "Pause Gracefully" button.

If you cannot wait until the end of the current step and need to pause/stop the observation early, see the below instructions on how to do it from `Seqexec`.

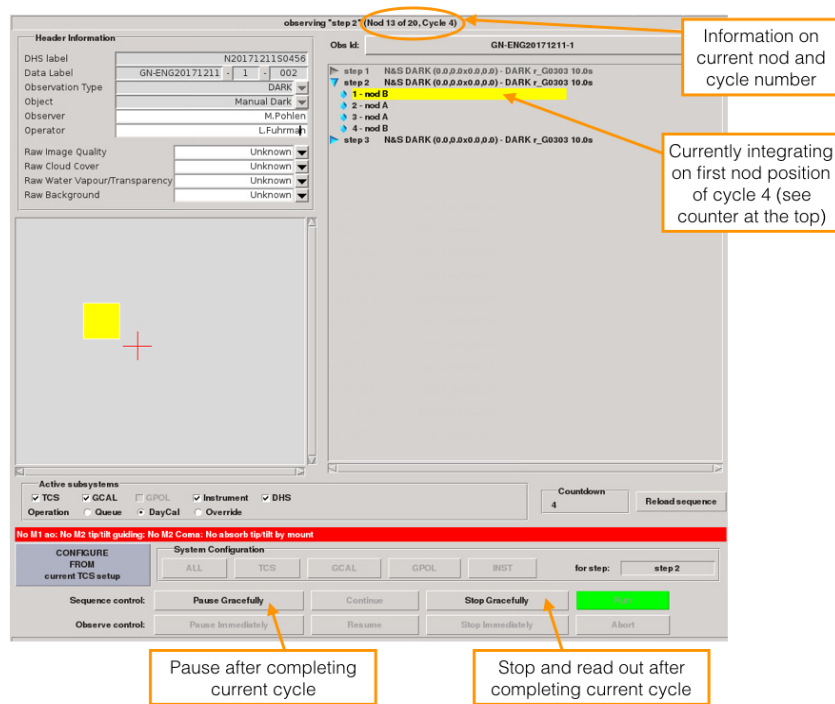


Fig. 8. Seqexec with a N&S dark sequence loaded, integrating on the first nod position of cycle 4.

Pause/stop at the end of BAAB nod cycle

Pause Gracefully: pauses the sequence at the end of the current BAAB nod cycle. If pushed on the last nod cycle, the exposure finishes, the sequence pauses on the next step.

Used when the exposure needs to be paused but you anticipate being paused for a while, so you wish to preserve the sky subtraction and the shutter cadence. To continue the exposure use the **Continue** button.

Continue: resumes a paused sequence. It is only active when the sequence is paused.

Stop Gracefully: reads out after the current BAAB nod cycle is complete and the sequence pauses on the next step.

Used when the exposure needs to be read out quickly, but the exposure is likely useful and should be read out after a complete BAAB nod cycle in order to preserve the sky subtraction. An example of when this option is used is when you get a rapid ToO.

Run: starts the sequence from the first unexecuted and unskipped step.

Pause/stop immediately

Pause immediately: closes the shutter immediately.

Used when the exposure must be paused right away, the sky subtraction may be compromised if the exposure is paused too long. Also, Pause Immediately will lose the cadence of the shutter, so this command should be issued in pairs. An example of when this option is used is when you lose guiding. To continue the exposure use the **Resume** button.

Resume: resumes a paused exposure. It is only active when the exposure is paused.

Stop Immediately: closes the shutter immediately, reads out the exposure, and the sequence pauses.

Used when the exposure must be read out right away, the exposure may or may not be useful. An example of when this option is used is when it starts raining or snowing or any other time when it is absolutely impossible to take data for any longer.

Abort: aborts the exposure, no file is saved, and the current step in the sequence remains unobserved.

GMOS calibrations

Recommended order for end-of-night calibrations:

- 20-25 minutes before twilight: slew to a spectrophotometric standard.
- 5 minutes before twilight: slew to a photometric standard (if PHOTOMETRIC and imaging DONE).
- 10 minutes after twilight: slew to blank field and start imaging twilights.
- 50 minutes after twilight: start the spectral/IFU twilight observations.

Photometric calibrations

It is very likely that the calibrations **will not** be defined within the OT program for GMOS imaging. You will need to prepare all the necessary twilight calibration observations using the provided template observations from the *GN-CAL-GMOSBaseline-Ham (12amp)* program.

Photometric Standards

If there is a program standard, it should be scheduled in that night's Queue Plan. However even if there is no program standard defined, you will almost always need to take a photometric standard if imaging was taken in CC50, even if the program doesn't request it (exceptions: any narrowband filter, i.e., H-alpha, OIII). If science was taken in CC70 or worse, then do not take a standard. If the conditions are stable CC50, you can wait until morning twilight to take it. But if you expect clouds to show up later, take the standard at a good point after the science.

- To take a photometric standard, choose one from the GN-CAL-GMOSBaseline-Ham (12 amp) program. Under "Photometric Standards", chose an observation with an RA close to the sidereal time for when you run the observation. Copy and paste the observation to the Daily Calibration Program and run from there (to open Daily Calibration Program, in the OT select *File -> Open Calibration Program*).
- There is no need to worry about saturation as fainter stars in the field should be useful.

Twilight Flats

Twilight flats are only taken in morning twilight at Gemini North. Counts should be above 5000 and below ~58000 for 2x2 binning, or below ~45000 for 1x1 binning. In general, aim for counts to be about 20000-30000.

Observing Imaging Flats

- Please check the [GMOS cal report](#) to see which filters require twilight flats (i.e., any with fewer than 25 per filter).
- In the OT, open up the "GMOS Baseline Calibrations - Ham (12 amp)" program. Under "Twilight Flats", copy the desired band for which twilight flats are needed and paste it into the Daily Calibrations Program (to open Daily Calibration Program, in the OT select *File -> Open Calibration Program*).
- The Twilight Flat observations don't have a Target component. Copy it from the appropriate "Blank field" observation, which you can find in the same GMOS program.
- Modify the Blank field coordinates by a few arcseconds.
- Load the sequence, place a pause on the second step, and run step 1 (10-second central stamp).
- Check the counts for the obtained image in [seqplot](#), and use this value to determine the exposure time for the next frame (aim for ~20 000 counts).
- Select the step with the appropriate exposure time, then in Seqexec click "Configure All" and "Continue". Be sure to pause if the counts are too low, or skip a few steps if the counts are too high (when [skipping steps](#), always do "**Configure All**" and "**Continue**").

Daytime calibrations

Biases: a full set of biases should be run at the end of the night. Find these within the daily calibration program ("GMOS Bias Complete Set").

Spectroscopic calibrations

On-sky calibrations:

- **GCAL Flats** – are part of the science sequence and should always be taken during the night. Please check that they are not saturated (below ~58k counts).
- **CuAr Arcs** – IF defined within the science observation, should be taken together with science at the object position.
- **Spectrophotometric** or **RV standards:** IF defined within the science observation group, should be taken together with science.

Morning calibrations:

1) Baseline Spectrophotometric Standards (once per semester per program config.)

- The spectrophotometric standard sequences (if any) are located in the Baseline Calibrations folder within the particular science program;
- Spectrophotometric standards are to be obtained ONCE during a semester per program configuration (unless they are defined WITHIN the science observation group);
- Copy the appropriate target from the “GMOS Baseline Calibrations – Ham (12 amp)” OT program. These are found in the folder entitled "SpecPhot Standard Targets";
- If possible observe the standard at the parallactic angle.

Recommended Counts:

- Longslit: at least 3000 counts above bias in the peak. If conditions are very poor, at least 1500 counts above bias in the peak;
- IFU: At least 500 counts above bias in the peak. If conditions are very poor, at least 250 counts above bias in the peak.

2) Baseline Spectroscopic Twilight Flats (once per semester per program config.)

- These sequences will be part of the science program. They are NOT supposed to be copied to the Daily Calibration Programs.
- Only ONE good spectral twilight is needed for any set of small wavelength shifts in a given program (unless explicitly stated). If there are no spectral twilights defined in the program (or the plan), then they are NOT NEEDED;
- Adjust the exposure time as necessary to get a minimum of 2000 ADU/pix in each flat. Make sure there is no saturation (use [seqplot](#) and [gdisplay](#));
- If spectral science observations are obtained and the twilight flat has not yet been observed, try to also take the flat. This is particularly important if you have finished a MOS mask or an IFU observation so that the mask can be removed from the instrument or the IFU configuration changed;
- If observing several spectral twilight flats in the same night, one should start with the wider masks/slits, coarser gratings, and bluer setups and move to the setups that will need brighter sky conditions to saturate;
- IFU spectral twilights can be done after sunrise.

Daytime calibrations:

- **CuAr Arcs** should be queued up in the morning from within the science programs observed during the night, as part of the daytime calibrations;
- **Biases:**
 - A full set of GMOS biases should be always obtained as part of daytime calibrations;
 - There should be a "GMOS Bias Complete Set" observation in the daily calibrations program;
 - On weekends you can find this observation in the “GMOS Baseline Calibrations – Ham (12 amp)” OT program, copy it into the daily calibrations program;

- This observation should be queued up in the morning as part of the daytime cals, it is best to put it last in the list.

Bad weather calibrations

Nod & Shuffle Darks are taken in order to remove the horizontal low level defects that appear to be exaggerated by the shuffling process. These darks are normally taken during poor weather when queue observations cannot be obtained.

GMOS Image Quality

- To interactively check GMOS images in Pyraf, use [gdisplay](#) *filename framenum* (*framenum* specifies the ds9 frame).
- Use [QAP](#) data for quality control of imaging data.
- [segplot](#) makes it easy to check for saturation in all data - the saturated pixels are shown in red.

Specific Checks

Long-Slit Spectroscopy:

- Check the IQ in the acquisition image (using [QAP](#) or [gdisplay](#)).
- Compare different frames to see if clouds may have affected the counts in the spectra.

MOS:

- Check the IQ of the acquisition image using the stars in the acquisition boxes.
- Check for saturation in the science frames and spectral flats. It is OK for the alignment stars spectra to saturate (both in science frames and flats).

IFU:

- Most IFU spectra are of diffuse or extended targets. Look for very dim continuum or emission lines.
- If you see binning in the spatial direction for IFU spectroscopy, please contact the QC (only done in very unusual cases).

Useful GMOS Links

External:

- [GMOS Public Page](#)

Internal:

- [Internal GMOS Instrument Information](#)
- [GMOS Good Data Library](#)
- [Bad Data Library \(see links under GMOS section\)](#)
- [Instrument Checklist: GMOS](#)

Observing with GNIRS

Overview

The **G**emini **N**ear-**I**nfrared **S**pectrograph (GNIRS) offers a wide variety of spectroscopic capabilities including long-slit (single order) spectroscopy and cross-dispersed spectroscopy. The different pixel scales are achieved with four cold-changeable cameras of "long" and "short" focal lengths optimized for "blue" (0.9-2.5 microns) and "red" (2.8-5.4 microns) wavelengths. GNIRS also has limited imaging capabilities. The instrument can be used with adaptive optics over most of its wavelength range.

Useful Information:

- The GNIRS **detector** is a 1024x1022 Aladdin III InSb (Hughes SBRC)
- Full **field-of-view (spectroscopy)**:
 - Long camera: 49"x49", pixel scale: 0.02"/pix
 - Short camera: 99"x99", pixel scale: 0.15"/pix
- **Imaging field-of-view**: see Fig. 14.
- Changing the orientation of GNIRS keyhole images in ds9 so that North is up and East is to the left:
 - Zoom --> **Invert Y**;
 - Zoom --> Pan Zoom Rotate Parameters --> set the **Rotate** angle to equal the PA-90.
- Often spectroscopic observations with GNIRS are required to be taken at [parallactic angle](#).
- **Guiding options**: PWFSS (PWFSS2 being preferred) and ALTAIR with a natural guide star (NGS) or with laser guide star (LGS).

GNIRS Spectroscopy

The most common use for the GNIRS is as a spectrograph. It has two basic spectroscopic modes:

- **Long-slit**: 1.0-5.4 μm spectroscopy of any individual window (X, J, H, K, most of L, or M) at R up to $\sim 1,800$, or of any portion thereof at R up to $\sim 18,000$.
- **Cross-dispersed**: 0.85-2.5 μm short slit spectroscopy with full spectral coverage at R up to $\sim 1,800$ and partial coverage (disjoint 0.1-0.2 μm segments) at R up to $\sim 6,000$.

Acquiring

For most objects, the acquisition sequence is as follows:

- Off-object *Slit image* (typical offsets: P=10", Q=0)
- (optional) *Sky background image* (typical offsets: P=0, Q=2")

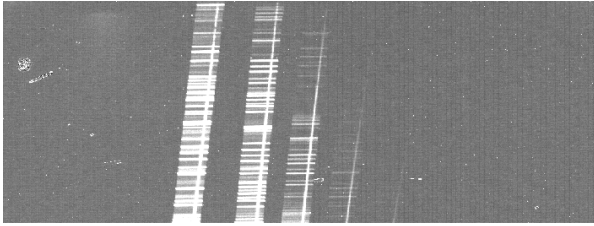


Fig. 9. Example of cross-dispersed data obtained with the 32 l/mm grating and the short blue camera. Orders 3-8 are visible (left to right, with wavelength increasing downwards), with orders 3-6 corresponding to K,H,J and X-bands accordingly.

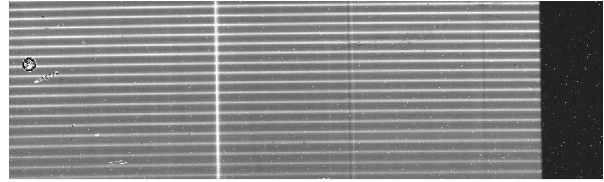


Fig. 10. Raw L band spectral image of a telluric standard star, obtained using the 111 l/mm grating, long red camera, and 0."10 x 49" long slit. Sky emission lines are roughly horizontal. Wavelength increases downward.

- Two *Field images* (offsets: P=0, Q=0)
- (optional) *Sky background through-slit image* (typical offsets: P=0, Q=2")
- Two *Through-slit images* (offsets: P=0, Q=0)

If the acquisition sequence is for a bright object ($H < 16$ mag), then there are no sky background images defined in the sequence. Figures 11 and 12 show the recommended break-point placement in Seqexec for both faint and bright target acquisitions.

❖ Spectroscopic Acquisition

(see [GACQ reference page](#) and [GNIRS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#) (don't forget to set the [Parallactic Angle](#) if needed);
2. If the sky offset is defined, take the first three images of the acquisition sequence; otherwise take the first two images.
3. Once the images have been read out, run gacq on them as follows:
 - With sky subtraction: `gacq image3 slit=image1 sky=image2` (e.g. `gacq 302 slit=300 sky=301`)
 - No sky subtraction: `gacq image2 slit=image1`

slit image (off-target)	step 1	10.00	0.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	SCXD
sky image	step 2	0.00	2.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	Acq
field image	step 3	0.00	0.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	Acq
field image	step 4	0.00	0.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	Acq
through-slit sky image	step 5	0.00	2.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	SCXD
through-slit on-target im.	step 6	0.00	0.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	SCXD
through-slit on-target im.	step 7	0.00	0.00	OBJECT Open H 1.65 in 2.0s ShortBlue 32/mmSB	SCXD

Fig. 11. GNIRS faint target acquisition sequence when loaded in Seqexec. The through-slit images can be recognized by decker being in the “SCXD” position.

step 1	10.00	0.00	OBJECT Open H 1.65 in 1.0s ShortBlue 32/mmSB	SCXD
step 2	0.00	0.00	OBJECT Open H2 1.65 in 1.0s ShortBlue 32/mmSB	Acq
step 3	0.00	0.00	OBJECT Open H2 1.65 in 1.0s ShortBlue 32/mmSB	Acq
step 4	0.00	0.00	OBJECT Open H2 1.65 in 1.0s ShortBlue 32/mmSB	SCXD
step 5	0.00	0.00	OBJECT Open H2 1.65 in 1.0s ShortBlue 32/mmSB	SCXD

Fig. 12. GNIRS bright target acquisition when loaded in Seqexec (with no sky offsets).

4. Follow gacq’s instructions. Gacq will ask you to mark one end of the slit with “x” (for long slit pick the non-truncated end, if possible). Then gacq will ask you to confirm if its slit center measurement is correct. Next, indicate the object to be centered in the slit.
5. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
6. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
7. Take the next step of the acquisition sequence (second field image).
8. Run gacq on the image you just observed to verify the centering of your target. From this point on answer “yes” when gacq asks if you want to use the previous slit center measurement (unless something was wrong). If the centering is fine, gacq will advise you to ignore offsets and take the through-slit image. (If more offsets are required – you will need to add more steps to the acq. sequence and repeat this step).
9. If sky offset is defined, take the next two images, otherwise – take the next image (through-slit image).
10. Run gacq on the image(s) you just observed to verify the centering of your target in the slit. If this time gacq advises you to ignore offsets – you are ready to start science; otherwise – take another through-slit image.
11. In case you are doing an acquisition with a BLIND OFFSET – ask the telescope operator to swap to the science target before starting the science sequence!

❖ Two-target acquisition

This is just like a normal [spectroscopic acquisition](#), except that when running gacq, the two target mode must be enabled using the *two+* keyword:

gacq image two+

After displaying the image, gacq will ask you to mark **two** targets.

Caution: If the two targets are very close together the calculated rotation will be very sensitive to the exact target centers and may not converge.

❖ Off-axis acquisition

This is just like a normal [spectroscopic acquisition](#), except that the acquisition is done using an “acquisition star”.

- Before running acquisition, ask the operator to offset to the acquisition star.
- Acquire on the acquisition star as normal.

- After acquisition is done and prior to running the science observation, ask the telescope operator to swap back to the science target.

❖ Acquisition with Blind offset

In case of a very faint science target, the acquisition is done on a brighter [reference star](#), using one of the methods described above. After acquiring, the telescope is offset to the science target.

- Before slewing to the target, let the telescope operator know that this is a Blind offset acquisition.
- Acquire on the reference star as normal.
- After acquisition is done and prior to running the science observation, ask the telescope operator to swap to the science target.

Taking Science

You are now ready to take the science. Observe the steps listed in the "Steps" column of the "Plan for the night". Don't forget to take the on-sky calibrations if you cut the sequence short.

Re-centering During Spectroscopic Observation

Because of relative flexure between GNIRS and PWFS2, it is recommend that observers watch the counts in the spectra and check the target centering as necessary. In cases where this is not possible (faint object, variable counts due to clouds or seeing), re-centering every ~45 minutes is recommended. The easiest way to do this is to clone the acquisition in the OT and start again from the beginning.

- ❖ How to clone the acquisition: click on Acq. observation -> Copy -> click on the Observation Group -> Paste -> change the "Phase 2 Status" to "Prepared" -> Queue.

GNIRS Spectroscopic Calibrations

Telluric standards

All GNIRS science observations require a telluric standard star to be taken close in time and at similar airmass. Normally one telluric standard is required for every 1.5h of science observations (for L/M band observations, every 1h). Follow the night plan and QC/PI's instructions.

Check the telluric spectra for saturation (using [seqplot](#)) before slewing to another target. If the spectra need to be re-taken, please reduce the exposure time accordingly.

On-sky calibrations

- Most of the GNIRS science observations include on-sky flats and arcs. They are embedded in the science observations and are obtained at night, near-simultaneously with science observations

- No arc spectra are taken in the L and M bands; sky lines can be used for wavelength calibration instead.
- The telluric standards don't usually have flats or arcs embedded.
- Flat-fielding and arc lamp wavelength calibrations for GNIRS are obtained with the facility calibration unit, [GCAL](#).
- Please do keep an eye on all GNIRS calibrations, as the mechanisms don't always go into place properly. Use the [Bad data](#) and [Good data library](#) for reference.
- The motion of the science fold is not repeatable, and if moved for taking calibrations, it won't necessarily direct the science target light through the slit afterwards. Therefore if resuming observations after taking calibrations, the science target centering should be checked first.

Daytime calibrations

- All cross-dispersed observations require a daytime pinhole spectrum observation (to trace the spectrum on the array). Queue them up from within the observing group you have observed at night, and execute in the morning.
- Sometimes the PI may request other calibrations (darks, extra arcs, ...), please queue those up too and execute them in the morning.

GNIRS Imaging

GNIRS can be used as a near-infrared (1.0-2.5-micron) imager and is offered as such for rapid ToOs and time-critical targets, when NIRI is not available. For the most part, however, the limitations of using GNIRS for imaging (mainly the small selection of filters, and the small and oddly shaped field of view) mean it is not commonly used.

Acquiring

GNIRS imaging acquisition sequences consist of the first image of the keyhole, taken with offsets (typical offsets P=0, Q=10"), followed by several field images taken without offsets. The acquisition script will center the target in the middle of the rectangular portion of the GNIRS field.

❖ GNIRS Imaging Acquisition

(see [GACQ reference page](#) and [GNIRS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Wait until focus and astigmatism have converged before starting observations.
3. Take the first two images of the acquisition sequence.
4. Once the images have been read out, run gacq on them as following:
gacq image2 slit=image1 (e.g. gacq 301 slit=300)

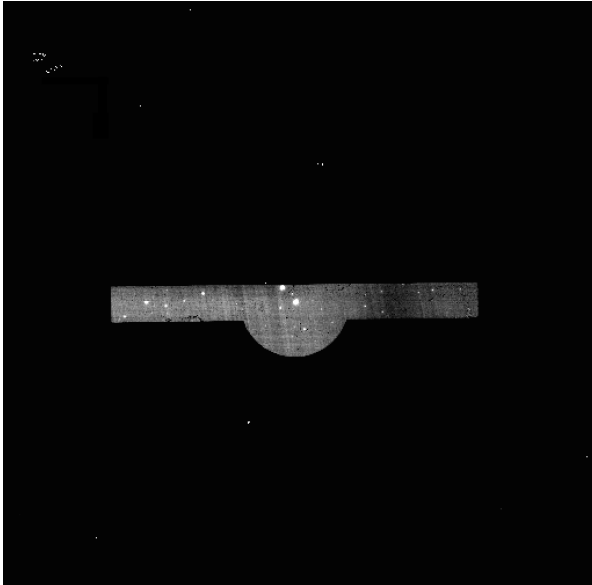


Fig. 13. Example of GNIRS imaging/acquisition raw image, taken with the short camera.

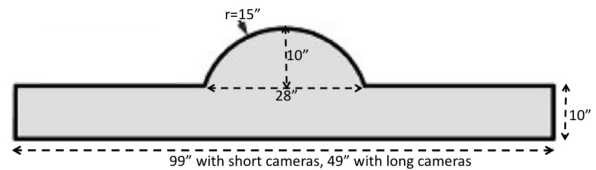


Fig. 14. GNIRS keyhole dimensions.

5. Follow gacq's instructions. First gacq will ask you to point to the bottom edge of the keyhole semi-circle in order to define the keyhole's center. After that gacq will display the field image with a schematic keyhole overlay, asking you to indicate the object to be centered in the field.
6. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
7. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
8. Take the next step in the acquisition sequence (second field image).
9. Run gacq on the image you just observed to verify the centering of your target. If gacq advises you to ignore offsets – you are ready to start science; otherwise – take another field image.

GNIRS Image Quality

- Make sure to check all GNIRS frames using [seqplot](#). Any saturated pixels will be red in the displayed image.
- Often GNIRS targets will only be visible after subtracting a pair of dithered images.
- GNIRS data sometimes suffers from pattern noise. Please use [ndisplay](#) with the "clean+" parameter to attempt to remove pattern noise and judge whether the data are good.

Displaying GNIRS Data

Use the [ndisplay](#) PyRAF task to display GNIRS data: `ndisplay image1 sky=image2`

Useful ndisplay options:

- Use **sub-** if sky subtraction is not needed
- If you need to adjust the greyscale stretch use **z1=lowlimit z2=highlimit**
- To remove the pattern noise use **clean+**

Useful GNIRS Links:

External:

- [GNIRS Public Page](#)

Internal:

- [Internal GNIRS Instrument Information](#)
- [GNIRS Good Data Library](#)
- [Bad Data Library](#)
- [Troubleshooting GNIRS](#)
- [Instrument Checklist: GNIRS](#)
- [GACQ Tutorial for GNIRS](#)

Observing with NIFS

Overview

The **Near-Infrared Integral Field Spectrometer (NIFS)** provides 3D imaging spectroscopy with spectral resolving power of $R \sim 5000$ in the Z through K-band spectral regions (0.95 to 2.40 μm). NIFS is an image slicing IFU, where the 3" x 3" science field is sliced into 29 different 0.1" x 3" slitlets. It is designed to be fed by the Gemini North Adaptive Optics system, ALTAIR, hence it is possible to achieve spatially resolved spectroscopy on scales as small as 0.1" using Natural or Laser guide stars. Coronagraphic spectroscopy can also be performed through use of an occulting mask.

Useful Information:

- The NIFS **detector** is a 2048x2048 Rockwell HAWAII-2RG HgCdTe
- IFU **field-of-view**: 3" x 3"
- **Non-linearity** begins at 35,000 ADU. **Complete saturation** occurs at 47,000 ADU.
- **Spaxel size**: 0.1" x 0.04"
- **Pixel size on reconstructed image**: 0.02"/pix

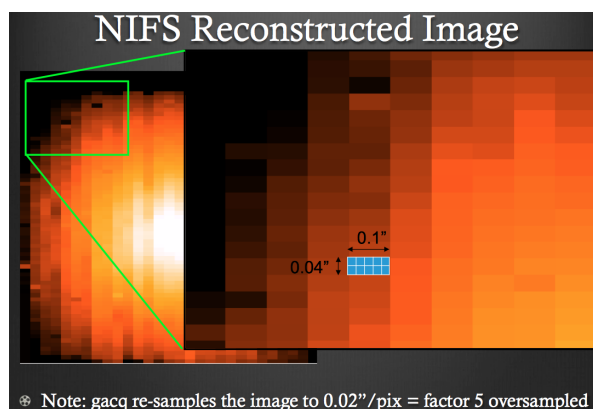
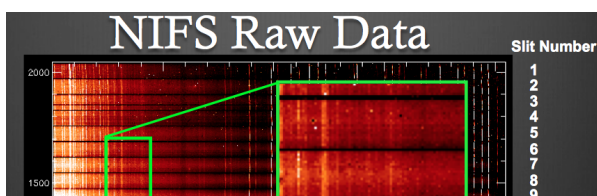


Fig. 15. The NIFS data structure on the raw images: the 29 slitlets are stacked one on top of the other in the y dimension, and the x dimension in the image is the dispersion axis. Wavelength increases to the left in the x dimension. (both images by R. McDermid)

Fig. 16. Reconstructed NIFS IFU field image. The pixel scale in the reconstructed image is 0.02 per pix in the x and y dimensions on the image (though the flux appears in a rectangular pattern because the formal NIFS image structure is 0.1 by 0.04 pixels - the 0.02 pixels are a result of rebinning the image to a square pixel grid).

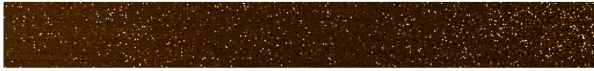


Fig. 17. NIFS RAW acquisition image taken with the imaging mirror flipped out (a dispersed IFU image).

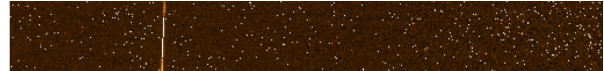


Fig. 18. NIFS RAW acquisition image taken with the imaging mirror flipped in (the illuminated slits of the image slicer are visible).

NIFS IFU Image Reconstruction

The IFU image can be reconstructed from the dispersed NIFS spectra by collapsing the data in the wavelength dimension and pasting the slits together side-by-side (Fig. 16). This is extremely useful to monitor image quality in the data, and/or verify the target centering. This should always be done for targets that can be seen in dispersed data.

Acquiring with NIFS

Typical NIFS acquisition sequence consists of a series of IFU field images, preceded by a sky-offset image in case the object is not bright enough. Depending on the brightness of the acquired object, the acquisition images can be taken through the grating, or bypassing it via flipping in the Imaging Mirror.

❖ Bright and intermediate target acquisition

Description: The field image is obtained **through the grating** (Imaging Mirror flipped out), therefore the raw image is a dispersed IFU image (Fig. 17). If the acquisition sequence is for an intermediate brightness object ($9 < H \leq 12$) the sky-offset image is taken first (Fig. 19).

(see [GACQ reference page](#) and [NIFS tutorial](#) for detailed step-by-step instructions)

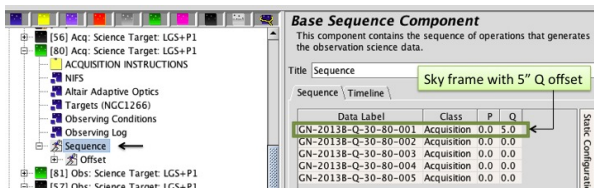


Fig. 19. NIFS target Acquisition sequence in the OT: the first step is a sky frame with 5" Q offset.

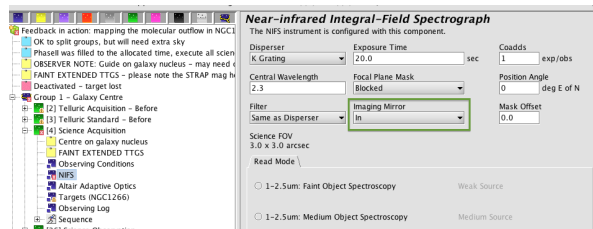


Fig. 20. Instrument configuration component for a NIFS Acquisition observation, showing the Imaging Mirror in "flipped in" position.

1. Follow the general [Acquiring guidelines](#).
2. If sky offset is defined, take the first two images of the acquisition sequence; otherwise take the first image.
3. Once the images have been read out, run gacq as follows:
 With sky subtraction: **gacq image2 sky=image1** (e.g. gacq 302 sky=301)
 No sky subtraction: **gacq image1**
4. Follow gacq's instructions. Gacq will display the [reconstructed IFU image](#) and you will have to indicate the object to be centered in the field.
5. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
6. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
7. Take the next step in the acquisition sequence.
8. Run gacq on the image you just observed to verify the centering of your target in the IFU field. If gacq advises you to ignore offsets – you are ready to start science; otherwise – take another acquisition image.
9. In case you are doing an acquisition with a **BLIND OFFSET** – ask the telescope operator to swap to the science target before running the science sequence!

❖ Faint target acquisition (H>13)

Description: The sky frame is taken first. The **Imaging Mirror is flipped in**, in order to bypass the disperser. The raw image shows a bright "staircase" pattern of light from the illuminated slits of the image slicer (seen to the left of the detector center, Fig. 18).

(see [GACQ reference page](#) and [NIFS tutorial](#) for detailed step-by-step instructions)

1. Follow the general [Acquiring guidelines](#).
2. Take the first two images of the acquisition sequence.
3. Once the images have been read out, run gacq as follows:
gacq image2 sky=image1 (e.g. gacq 302 sky=301)
4. Follow gacq's instructions. In this step you will first need to indicate the center of the upper slit, and the position of the gap between [the first and the second slits](#) (this is

needed for image reconstruction purposes). After that you will need to indicate the object to be centered in the field, using the [reconstructed field image](#).

5. Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
6. Let the operator know that the offsets were sent. Wait for the operator to confirm, that the offsets were applied.
7. Take the next step of the acquisition sequence.
8. Run gacq on the image you just observed, to verify the centering of your target in the IFU field. If gacq advises you to ignore the offsets then you are ready to start science; otherwise, take another acquisition image.
9. In case you are doing an acquisition with BLIND OFFSET, ask the telescope operator to swap to the science target before running the science sequence!

❖ Acquisition with Blind offset

In case of a very faint science target, the acquisition is done on a brighter [reference star](#), using one of the methods described above. After acquiring, the telescope is offset to the science target.

- Before slewing to the target, let the telescope operator know that you are going to do the acquisition with a Blind offset.
- Acquire on the reference star as normal.
- After the acquisition is done and prior to running the science observation, ask the telescope operator to swap to the science target.

❖ LGS Faint target acquisition using SFO open loop model

When performing observations using a Laser Guide Star (LGS), the real-time focus corrections are typically done using a tip/tilt reference star. However, in the case of a faint guide star, the real-time focus correction might be difficult or impossible. In this case, prior to slewing to the science target, the telescope operator tunes the LGS focus on a brighter reference star.

- Before slewing, inform the telescope operator that the observation should be performed using the open loop SFO model.
- After the operator tunes the LGS focus and tells you that the telescope is guiding, proceed normally with the acquisition, using one of the methods described above.

❖ Coronagraphy with NIFS

Typically the observations in coronagraphic mode are executed by experienced observatory staff. The detailed instructions on occulting disk acquisition and observing can be found [here](#).

NIFS Calibrations

On-sky Calibrations

- **On-sky arcs** must be taken at the end of each science sequence, before the grating turret is moved.
- Arcs should be observed every time science exposures are observed. If the sequence you are executing does not have an arc merged in, please edit the sequence to observe an arc before you slew to a different target.
- Arcs do not need to be taken with telluric standards.
- All arcs should be checked with [seqplot](#) (use the “C” key), to reveal possible NIFS grating positioning errors.

Telluric standards

- All NIFS observations should be accompanied by a telluric calibrator unless specifically stated otherwise by the PI.
- Telluric standards must be taken for every 1.5h of science observations.
- Please check telluric spectra for saturation immediately and re-take with reduced exposure time, if necessary.

Daytime Calibrations

- Queue all the daytime calibrations (flats, and sometimes darks) in the current Observing Group and execute in the morning.

Taking Data

- Non-linearity begins at 35,000 ADU. Please keep counts below this level. Complete saturation occurs at 47,000 ADU.
- When using PWFS1 as a guider, the target centering should be checked frequently. For this, use the frames with zero offsets and re-center the target as needed.
- When observing with LGS, make sure to wait until the SFO focus converges before starting science.
- During LGS observations, in order to avoid losing the laser loop after a long (>5min) sky frame, please follow [these instructions](#).

NIFS Image Quality

- Always check image quality in the reconstructed IFU image (using gacq). For Altair observations, the FWHM should be ~0."11 to 0."15 (5.5-7.5 pix) in general, unless the

seeing is really poor, or your star is faint and you have correspondingly worse AO correction.

Displaying NIFS raw images

- To display the raw images in Pyraf use: `ndisplay image1 sky=image2` (if no sky subtraction needed, use **sub-**)
- For a fast preview of reconstructed images you can use `seqplot`: while displaying the dispersed IFU image, hit the “r” key to view the reconstructed (and sky-subtracted) image.
- Use `gacq` to monitor counts and FWHM, it will display the reconstructed image in your ds9 window and start an `imexamine` session (you might want to use sky subtraction for fainter objects).

Useful NIFS Links

External:

- [NIFS Public Page](#)

Internal:

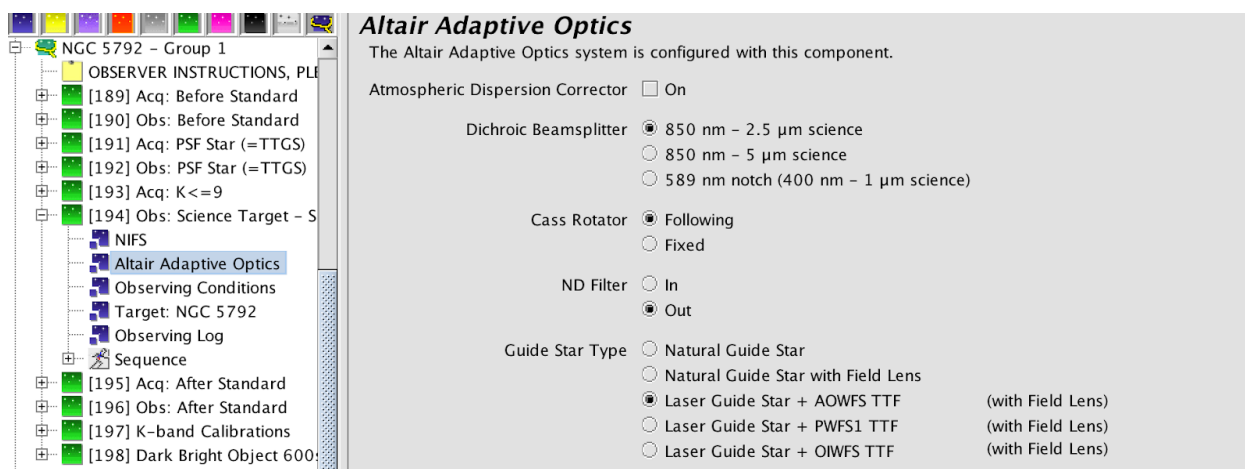
- [Internal NIFS Instrument Information](#)
- [GNIRS Good Data Library](#)
- [NIFS Bad Data Library](#)
- [Troubleshooting NIFS](#)
- [Instrument Checklist: GNIRS](#)
- [Gacq Tutorial for NIFS](#)

LGS Observing

Overview

In general observing with LGS is the mostly same as non-LGS on the observer side. One thing to be aware of is that the setup time on the operator's side is significantly longer than non-lgs acquisitions due to the complexity of closing multiple guide loops rather than just one, so be a bit patient and plan for some extra overhead. Also due to the complexity of the guide loops, sometimes the guiding can be a bit less stable: keep an eye on the queue and how much time is being lost if your operator is struggling, and be prepared to abandon for a non-lgs plan if need be. Currently GNIRS, NIFS, and NIRI can be used behind ALTAIR in LGS mode. Propagating the laser and shuttering are handled by the telescope operator and our automated control software.

You can tell if an observation uses LGS by looking the Altair component in the OT.

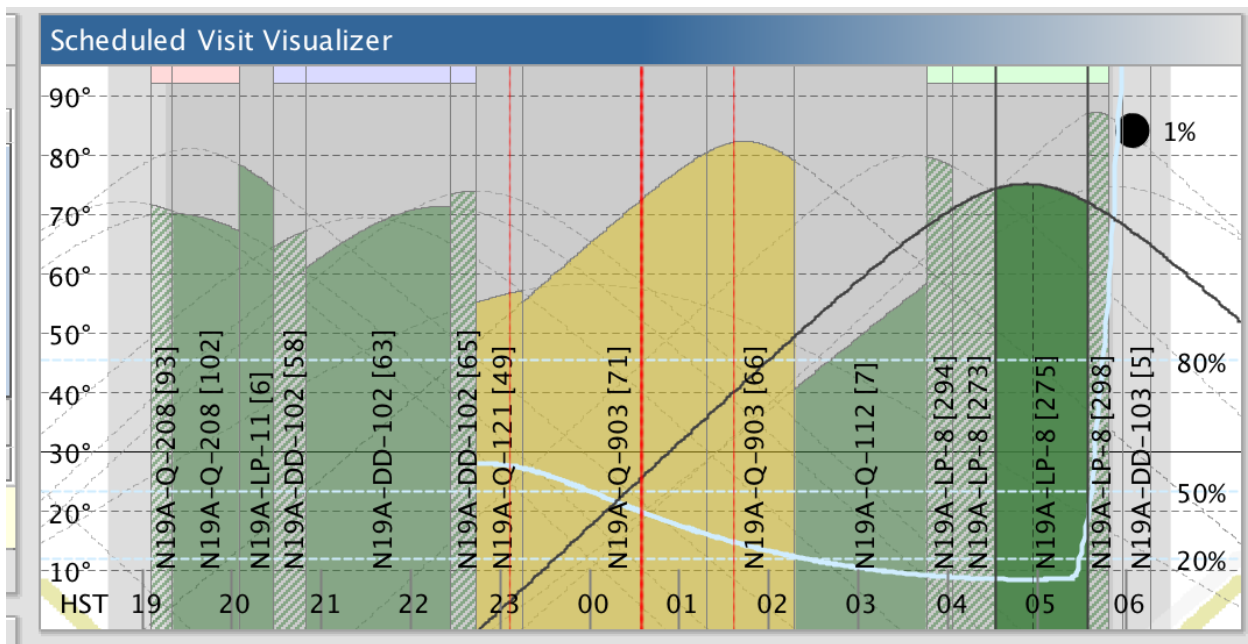


Shuttering Windows, LTTS, and QPT

QPT and Shuttering Windows

The QPT will automatically include the shuttering windows into the total observing time for the program. When you click on an observation in the QPT, all potential shuttering windows for that target will show in a red line. The QPT also keeps track of the elevation limit. The OT will automatically read in the shuttering windows and incorporate them into the expected time a program will take to be observed. In QPT, do "refresh" to retrieve the latest target info from the

Laser Target Tracking System (LTTS) (in the similar manner to retrieve the latest info from ODB for observing sequences etc.)



We can use the laser during evening and morning twilight. Our limit with the FAA is sunrise to sunset for laser propagation, but QPT will not let you schedule laser observations before 6 degrees twilight in the evening and after 6 degrees twilight in the morning. The QPT limit is our operating limit.

Gemini Laser Target Tracking System

The Gemini LTTS (Laser Target Tracking System) Alarms page will be running in the control room. This gives you audio and visual feedback on shuttering windows and when it safe to propagate the laser. You can bring up the Laser Target Tracking System Alarms (LTTS) by going to the following web page: Gemini North: <http://gnltts.hi.gemini.edu:8080/lts/app> . Across the very top there is a black bar, on the left side you will see "Nights PRM Window and Help". Click on Window and select Alarms.

Mostly you can follow the audio prompts from the LTTS Alarms window, but you can also use the 6 boxes across the top of the LTTS Alarms window to see immediate feedback on the status of the propagation and shuttering windows. They should be all that is needed during the night. Each of the 6 status boxes is described below:

1. Laser Status- Possible states:

NONE- Laser is off
LASER - laser is on sky (green)
BDM - laser is shuttered (red)
SHUTTERED- when shuttered at the bench.

2. Auto Shutter –

OFF - when laser is off
CLEAR- when you are allowed to propagate (green).
SHUTTERING – when the countdown reaches zero.
SHUTTERED – when the laser is shuttered (propagation is not allowed).

3. Propagation Window - Counts down to the shuttering window.

GREEN - when clear of shuttering window and laser is on they sky.
YELLOW - when approaching the shuttering window. This happens when there's 5 minutes to shuttering.
RED - Blinks red the last 30 seconds before shuttering and when shuttered.

The box will turn yellow when there are 5 minutes to shuttering, at 30 seconds to shuttering the box will go red, and the laser will start the shuttering procedure when it reaches 0. (As a safety precaution there are 2 seconds wait time for the operator to check that the laser loop opened, if the guide loops fail to open automatically the operator can open them manually. This leaves an additional 8-second buffer before the actual shuttering window occurs.) Button is solid red when shuttered and will say, "clear to propagate" once the window is cleared and turn green. There is no extra wait time to propagate again.

4. Beam collision (LTCS) –

GREEN - when there is no predicted collision.
YELLOW - when approaching a collision. Turns yellow when less than 5 minutes from the predicted collision.
RED - Blinks red the last 30 seconds before collision and turns solid red when collision has been reached.

5. LGS Elevation Limit –

GREEN - when the telescope pointing is above 40 degrees.
YELLOW - when it approaches the 40 degrees elevation limit. Note that the LTTS will never shutter the laser due to an elevation limit.

6. Cone Error Limit- given in percentage, 0-100 percent.

GREEN - when within the LCH cone error limit.

YELLOW - when within 5 minutes of approaching the limit.

RED - Blinks red the last 30 seconds before shuttering and when 100% is reached, the laser will shutter.

Below the large feedback button there are several secondary bits of information.

Time - You have a choice of displaying UTC or Local time.

Current Az/EI - Az/EI position mostly used for engineering

Current Ra/Dec - The position the telescope is currently pointing to, this includes any offsetting that was done.

Demand Ra/Dec - The position the telescope was slewed to.

Nearest Approved Position – This gives the nearest coordinates approved by LCH. For most targets this will be the coordinates of the base position in the OT. In cases where the target has an off axis guide star within 2 arc minutes, the approved position will be the midpoint between the target and off axis guide star.

Distances - Approved Position gives you the distance in arcminutes and arcseconds before the Cone Angle Limit is reached from your current ra/dec. Maximum distance allowed – is given from the approved position.

Timeline - shows a graphic display of the current laser target. It defaults to 2 hours but you can change this with the zoom +/- buttons or you can look at the whole night. When the 40-degree limit is reached that part of the time lines turns orange.

Propagation Windows - shows when you are clear to propagate the laser in UTC or Local time.

Shuttering Windows - shows when the laser has to be shuttered in UTC or Local time.

Information - This area gives you warnings and error messages of the LTCS and LTTS.

Observations in Range - displays all LCH-approved coordinates within the allowed propagation distance (cone error).

Elevation Limit

The lower (soft) limit for holding focus on the laser guide star is about 40 degrees elevation. This is set by the LGS Roof running into a hard limit at 99 mm. Since the LGS Roof compensates for the altitude of the sodium layer, the elevation limit can vary by a few degrees from night to night but generally the limit should not move above 40 degrees. In general practice this means that we observe laser targets when they are 40 degrees or higher in elevation. Please make sure the target you're slewing to is above this elevation limit if it is an LGS program.

Weather

LGS operations can be slightly more susceptible to high winds and variable seeing. If winds inside the dome, especially on the secondary mirror, are higher than 2 m/s then you may run into TT guiding problems with STRAP. Likewise, if seeing is highly variable then the LGS loop gains can become problematic. In general, if you are having trouble establishing and maintaining guide loops and are in either high wind or variable seeing, then it may be best to move to a non-LGS target while waiting for conditions to change or stabilize.

Acquisitions and LGS Observing

❖ Acquisition with Bright Stars ($10 < R < 16.5$)

This is the easiest type of acquisition. A bright star is one that you generally don't have to worry about at all, and will be somewhere in the range of $10 < R < 16.5$. The magnitude is usually correct since it will probably be in the UCAC-2 catalog. In this scenario, the setup usually should proceed normally without problems.

❖ Acquisition with Extended Sources

Extended sources are tricky because each one is different. Our advertised requirement is that an extended source must have an apparent FWHM of about 1 arcsec and a brightness $R < 16.5$. This has worked out fairly well for us in general, but there are always exceptions and some target profiles are not well known. In addition, we have seen some cores that work in good conditions but fail in poor conditions. So if conditions are poor and you are having trouble, it could be best to skip the target and put a note in the program so that the next observer can try in better conditions. If you do have to abandon, put a note in the program saying what conditions were like and also inform the Queue coordinator with adding a note in the nightlog.

❖ Acquisition with a Faint Star ($16.5 < R < 18.5$)

For these targets, magnitudes are typically not very well known, so you should be aware that they could be 0.5 magnitudes off. Our advertised faintness limit is $R = 18.0(18.5)$ for bright(grey) time, so you should be very careful if the target is fainter than 17.5 according to the science program. So if conditions are poor and you are having trouble, it could be best to skip the target and put a note in the program so that the next observer can try in better conditions. If you do have to abandon, put a note in the program saying what conditions were like and also inform the Queue coordinator with adding a note in the nightlog.

❖ **Slow Focus Adjustments**

The SFO guide loops are closed to keep the LGS spot on the WFS in focus (since it's at $\sim 90 \text{ km} \neq \infty$, the focus is different between natural stars and the LGS). In some cases (discussed below) it is better to "tune" this focus on a nearby bright star and leave it observing in an open loop mode on the science target (note: the longer the science, the worse this correction gets, so if it's particularly long, there might be notes about re-tuning half way through). The exp. times for SFO can vary between 1s and 50s, but there are a couple things to keep in mind:

1. The SFO exp. time should not be any more than half the length of a science exposure. This typically comes into play with very short NIRI exposures and many dithers. If the SFO is trying to correct on a moving target, it will fail to converge. In this case, it is better to run open loop after tuning on a nearby bright star. The program should have this set up and your operator will know how to do this.
2. On extended sources, the SFO focus algorithm may have trouble centroiding, and therefore correcting. In cases where you can't get a good centroid due to the extended object's PSF, you should have your operator tune out the focus on a nearby star (again, there should be one defined in the program).
3. In general, you should wait for the SFO focus to converge before taking science data. You can see the focus converging to its nominal value on the LGSST striptool. The red line is the target, and the green trace shows where the focus is presently. During stable SFO guiding, you'll see the trace oscillate a bit around the red line.

❖ **The Nightlog**

If you are able to guide on a tricky program because conditions are good, or if you fail because conditions are bad, please put these into notes in the program so that the next observer can know whether guiding on a target is possible. In general, this is only needed for targets on the edge of our faintness / extended source profile limits.

Additional Information

More detailed information about Gemini North LGS observing can be found on our [LGS guidelines page](#)

Wrapping Up

1 hour before End of Night

- Look for [GMOS imaging](#)
- If you took GMOS imaging, prepare standard in the same filters as science
- Prepare GMOS twilight flats, if needed

End of Night

- GMOS imaging standard
- GMOS twilight flats
 - randomize Blank field coordinates
 - make sure OIWFS is parked
 - wait for baffles
 - broadband imaging flats
 - narrow band imaging flats
 - MOS spectral flats for all masks taken during the night
 - IFU spectral flats
- queue daytime calibrations (queue GMOS biases last)
- when operator is ready, run calibrations (Seqexec in Daycal mode)
- nightlog
 - copy [fits/programsobserved/today](#) to nightlog
 - verify that fault tally / time loss / weather loss is correct
 - verify number of science hours used
 - verify any additional problems with SOS
 - verify personnel involved
 - complete plan for the night and nightly summary
 - no specific target names
 - save nightlog
 - send the nightlog
- check kitchen is clean
- make sure the lights off, front door locked

Suggestions on the Efficient Use of the Nightly Queue Plan (by K. Chiboucas)

❖ Be Prepared

Make sure to look through the full plan before the night begins and call the QC if you have any questions about specific observations, priorities, anything. Be sure to read any messages in the plan about specific program notes to read, non-standard acquisitions to watch out for, parallactic angles, or crucial timing windows. For any observations with the notes in the plan warning of complicated procedures, open the observation in the OT ahead of time and make sure you understand how the observation/acquisition is expected to run.

For non-sidereal observations, you will need to update the coordinates ahead of time, before slewing to the object. For observations which must be observed at the mean parallactic angle, you will need to set the position angle in the instrument component to that of the parallactic angle for the time (or expected time) of the observations, and possibly set up an appropriate guide star. All this should be done before slewing to that observation and should therefore be performed before the previous observation is completed.

❖ Stay a Couple Steps Ahead in the Plan

The most efficient way to use the plan is to be a couple of steps ahead in the plan. You should always have a good idea of which observation you will be running next, or in variable conditions, which observations in multiple variants you should be considering for upcoming observations.

❖ Under Variable Conditions, Consider Your Options in Multiple Variants

When conditions are variable, you will need to look at observations in multiple variants. To choose the best observation for the conditions, you should take into account the latest seeing and extinction measures, the weather forecast when clouds are present, if it is possible to split an observation over multiple nights, the wind speed and direction, and whether there are any time-critical or otherwise high priority observations that are expected to be observed that night. The seeing might be reasonable pointing in one part of the sky, but significantly worse in another. Be prepared to slew to another target. Often the wind will affect the seeing and guiding, and this will be dependent on the telescope pointing direction. In high winds, you will have to choose targets which will point the telescope out of the wind. If conditions are variable or only marginally good, and you are about to start a long observation that cannot be split, consider dropping to a poorer condition variant.

❖ When Choosing a Variant to Follow, Be Conservative

In most cases, it is wise to be conservative. Observe programs in better conditions than required rather than take a chance on obtaining data in worse conditions than allowed. However, if there is a very high priority observation, consider whether it is worth attempting in marginal conditions, or keep it in mind to observe at a later time if conditions improve. If you have started an observation and conditions become worse than the observing condition limits

for that observation, you should immediately abandon the observation and move on to something else that can tolerate the particular conditions. Even if the observation cannot be split, it is better to have lost only part of the time to weather.

❖ **Don't Forget the Calibrations!**

If an observation is abandoned, some part of the data may be usable as long as critical calibrations are also taken. Thus, if the observation has a series of calibrations at the end of the sequence, you should skip ahead to these and complete the sequence before moving on. If the observation requires a telluric standard, make sure to take one before moving to another observation. If you have taken any imaging data requiring photometric conditions, and clouds have been forecast, consider taking a photometric standard before any clouds do make an appearance.

❖ **Skip Observations When Getting Behind in the Plan**

If you get out of step with the plan and fall behind for any reason, it is usually best to skip an observation and pick an appropriate observation starting close to the current time. Of course, do not skip any high priority observations. When choosing to do a high priority observation at a much different time than scheduled in the plan, be sure to consider the AM of the observation, the sky brightness conditions, and any other timing constraints.