Gemini South PV Observer's Guide

Welcome!

Welcome to Gemini Observatory! This guide will give you an introduction to observing with the Gemini South telescope, provide a 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 when at Gemini.

Prior to your run:

The priority visitors are encouraged to spend one day before their observing run at the Gemini La Serena base facility, where they will be given preliminary training, an introduction to observation techniques and software, and the health and safety briefing.

Observatory roles

At Gemini observatory the queue observations are performed by either a **staff astronomer** or a **Science Operations Specialist (SOS)**. Another SOS is acting as **telescope operator** (and safety officer), so that at any time of the night at least two people are present at the telescope.

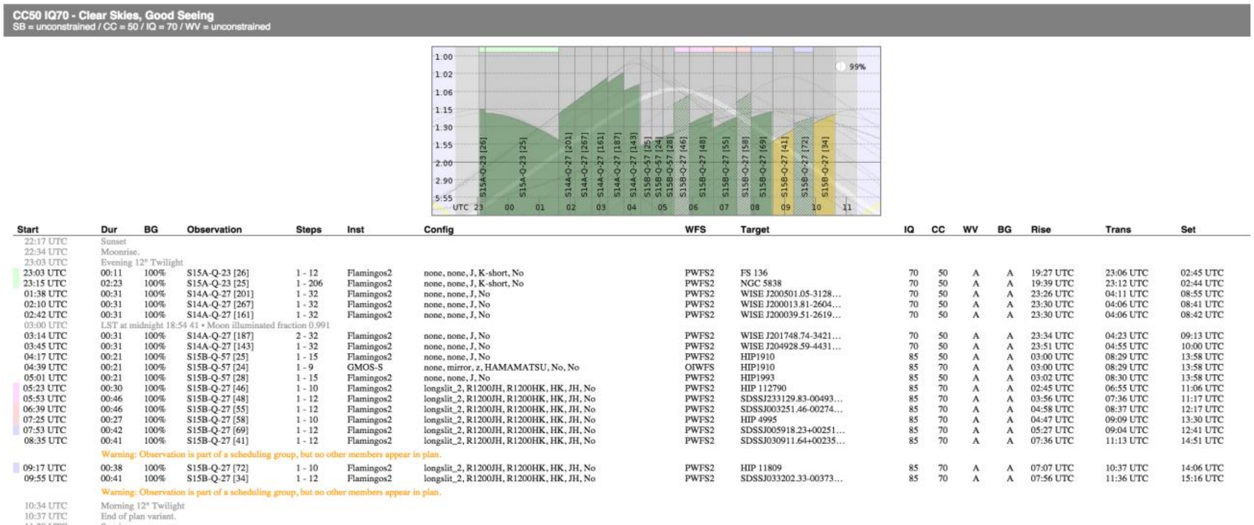
When priority observers are visiting during the first nights of their run a scheduled queue observer introduces them to observing with the Gemini telescope and provides full assistance. However, over the rest of the PV run, only an SOS operating the telescope is present at the observatory; thus the PVs should be able to perform both their own observations and the queue observations independently, although with all the necessary help of the telescope operator.

The **queue coordinator (QC)** is the person responsible for generating the daily observing plan that queue observers follow each night. They are on-call at night until 23.00 and may 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. If it's before 23.00, call the queue coordinator (the phone number can be found in the Queue Plan).
3. If you are still in doubt, move on to another observation

Queue Plan



CC50 IQ70 - Clear Skies, Good Seeing
SB = unconstrained / CC = 50 / IQ = 70 / WV = unconstrained

Start	Dur	BG	Observation	Steps	Inst	Config	WFS	Target	IQ	CC	WV	BG	Rise	Trans	Set
22:17 UTC	Sunset														
22:34 UTC	Moonrise.														
23:03 UTC	Evening 12° Twilight														
23:03 UTC	00:11	100%	S15A-Q-23 [26]	1 - 12	Flamingos2	none, none, J, K-short, No	PWFS2	FS 136	70	50	A	A	19:27 UTC	23:06 UTC	02:45 UTC
23:15 UTC	02:23	100%	S15A-Q-23 [25]	1 - 206	Flamingos2	none, none, J, K-short, No	PWFS2	NGC 5838	70	50	A	A	19:39 UTC	23:12 UTC	02:44 UTC
01:38 UTC	00:31	100%	S14A-Q-27 [201]	1 - 32	Flamingos2	none, none, J, No	PWFS2	WISE J200501.05-3128…	70	50	A	A	23:26 UTC	04:11 UTC	08:55 UTC
02:10 UTC	00:31	100%	S14A-Q-27 [267]	1 - 32	Flamingos2	none, none, J, No	PWFS2	WISE J200013.81-2604…	70	50	A	A	23:30 UTC	04:06 UTC	08:41 UTC
02:42 UTC	00:31	100%	S14A-Q-27 [161]	1 - 32	Flamingos2	none, none, J, No	PWFS2	WISE J200039.51-2619…	70	50	A	A	23:30 UTC	04:06 UTC	08:42 UTC
03:00 UTC	LST at midnight 18:54 41 • Moon illuminated fraction 0.991														
03:14 UTC	00:31	100%	S14A-Q-27 [187]	2 - 32	Flamingos2	none, none, J, No	PWFS2	WISE J201748.74-3421…	70	50	A	A	23:34 UTC	04:23 UTC	09:13 UTC
03:45 UTC	00:31	100%	S14A-Q-27 [143]	1 - 32	Flamingos2	none, none, J, No	PWFS2	WISE J204928.59-4431…	70	50	A	A	23:51 UTC	04:55 UTC	10:00 UTC
04:17 UTC	00:21	100%	S15B-Q-57 [25]	1 - 15	Flamingos2	none, none, J, No	PWFS2	HIP1910	85	50	A	A	03:00 UTC	08:29 UTC	13:58 UTC
04:39 UTC	00:21	100%	S15B-Q-57 [24]	1 - 9	GMOS-S	none, mirror, z, HAMAMATSU, No, No	OIWFS	HIP1910	85	70	A	A	03:00 UTC	08:29 UTC	13:58 UTC
05:01 UTC	00:21	100%	S15B-Q-57 [28]	1 - 15	Flamingos2	none, none, J, No	PWFS2	HIP1993	85	50	A	A	03:02 UTC	08:30 UTC	13:58 UTC
05:23 UTC	00:30	100%	S15B-Q-27 [46]	1 - 10	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	HIP 112790	85	70	A	A	02:45 UTC	06:55 UTC	11:06 UTC
05:53 UTC	00:46	100%	S15B-Q-27 [48]	1 - 12	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	SDSSJ233129.83-00493…	85	70	A	A	03:56 UTC	07:36 UTC	11:17 UTC
06:39 UTC	00:46	100%	S15B-Q-27 [55]	1 - 12	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	SDSSJ003251.46-00274…	85	70	A	A	04:58 UTC	08:37 UTC	12:17 UTC
07:25 UTC	00:27	100%	S15B-Q-27 [58]	1 - 10	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	HIP 4995	85	70	A	A	04:47 UTC	09:09 UTC	13:30 UTC
07:53 UTC	00:42	100%	S15B-Q-27 [69]	1 - 12	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	SDSSJ005918.23+00251…	85	70	A	A	05:27 UTC	09:04 UTC	12:41 UTC
08:35 UTC	00:41	100%	S15B-Q-27 [41]	1 - 12	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	SDSSJ030911.64+00235…	85	70	A	A	07:36 UTC	11:13 UTC	14:51 UTC
	Warning: Observation is part of a scheduling group, but no other members appear in plan.														
09:17 UTC	00:38	100%	S15B-Q-27 [72]	1 - 10	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	HIP 11809	85	70	A	A	07:07 UTC	10:37 UTC	14:06 UTC
09:55 UTC	00:41	100%	S15B-Q-27 [34]	1 - 12	Flamingos2	longslit_2, R1200JH, R1200HK, HK, JH, No	PWFS2	SDSSJ033202.33-00373…	85	70	A	A	07:56 UTC	11:36 UTC	15:16 UTC
	Warning: Observation is part of a scheduling group, but no other members appear in plan.														
10:34 UTC	Morning 12° Twilight														
10:37 UTC	End of plan variant.														

Fig. 1. *An example of a queue plan variant, prepared for the case of good seeing and photometric*

conditions. The observations' timeline with QC's notes is shown under the plan.

Every day a scheduled QC prepares several variants (Fig. 1) of the GS Nightly Queue Plan for different sets of observing conditions, e.g. photometric & good seeing (CC=50% IQ=70%), cirrus, poor seeing (CC=70% IQ=85%), etc. Thus, the night is pre-planned not only for the most likely conditions but also changing conditions, should they happen. In the event of changing conditions, the observer will switch plan variant as needed to avoid taking data in poorer conditions than required and to minimize the 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. Look through this to be familiar with the information provided. 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 (spec-phots & fringe frames) that might prove useful to fill holes in the plan or to observe during poor weather conditions. Useful information on twilight (end of night) observations and closed dome suggestions are listed at the very beginning 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 at the top of the plan for the night. Relevant information from the daytime telescope crew and day-SOS to the night crew can be found in the Plan for the Week. Make sure to read these at 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 SOSs, 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 the ephemeris information from the plan for the night (sunset/sunrise and 12-deg twilight times). Fill out the rest of the nightlog around these important events.
- Accurate timing is nice, but just do your best. Having the time off by a few minutes is not a big deal. We use Chilean Local Time (CLT) in the nightlog.

Events:

- Arrival and departure times from the summit.
- 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, missed the beep, 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 lost to weather).
- End time when a problem has been resolved (and the time lost).
- Phone calls to or from observatory staff, along with the time the call was received.

Additional Information:

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

Please avoid the following:

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

Examples of the nightlog:

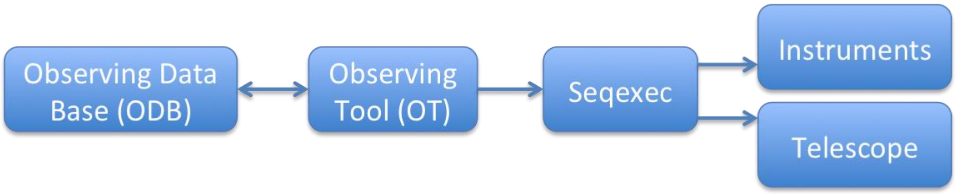
- GS Nightlog 2012 sep12-sep13
- GS Nightlog 2012 aug26-aug27
- GS Nightlog 2012 apr07-apr08

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 software, either type its name at a command prompt on the observer’s workstation terminal, or find it in the appropriate Gemini menu from the Applications button in the bottom left of any monitor.

Observation sequences of science programs are set up and managed using a graphical user interface - the Observing Tool. To execute the observation sequences we use another tool: the 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 South.

Observing Software Overview

At 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 the four instruments at Gemini South. As only three instruments are ever on the telescope at the same time, the unused ISDs can be closed. ISDs can be re-opened from the Applications -> Gemini -> Instruments tab.
- **Telescope Status Display (TSD)**. Displays almost all of the feedback you will need to know at 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 the seeing estimate and much more.
- **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.
- **Seqexec.** This is the sequence executor and is used by the observer to run 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.
- **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 target.
- **StripTools.** An application that acquires data from guiders and weather stations and plots it in real time on a number of charts. For a chosen wavefront sensor (WFS) it will display tip/tilt and astigmatism corrections, guide counts, the focus value and the seeing estimate. The seeing estimate is good for showing how the seeing is trending, but is not entirely reliable as an absolute seeing value. Select "GWS" and "Wind" to display the weather trends as well.
- IQTool. This is a useful tool for quickly calculating the seeing and airmass-corrected seeing given the instrument/filter/camera setup, airmass, and full-width half-maximum (FWHM) measurement.

Other useful tools

QAP. This is the image quality assessment pipeline. It automatically measures image quality for GMOS imaging and outputs the data to this page. To launch the automated reduction of incoming images open Applications -> Gemini -> QA Pipeline and leave this running.

Quick Look Tool. The quick look tool (QLT3) can be used to display images as they are read out. It is launched from Applications -> Gemini -> Iraf -> QLT.

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 Flamingos-2. 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*

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.

Gemini Observing Tool

The Gemini **Observing Tool (OT)** is the software used for defining and pre-planning observations from approved proposals during the Phase II process. The OT is also the high-level interface for on-site observers. It supports observations with all facility instruments. This section will provide you with an overview of the OT elements and operations. For a complete guide please see the OT manual pages.

Bringing up the OT:

- Type "ot" in your terminal window;
- **Or** select the OT option from Applications -> Gemini -> OCS -> OT.

Opening science programs:

- On the startup screen click the "Open" button (or, if you already have a program open, select open from the main toolbar of the Science program editor).

- Select the semester using the selection menu in the bottom right corner.
- Use the Program type menu checkboxes (e.g. Queue or Classical) to limit the programs being displayed.
- 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 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 databases are stored in a local database on your hard disk. Whenever you make changes to your local copy of a science program (e.g. edit an observation, add a comment), or someone else uploads this program's modified version to the Gemini database, you need to synchronize your version of the program with the Gemini Observing Database. This is done using the Sync button on the top right corner of the OT window (see Fig. 2). Every time syncing is required a yellow message box will be displayed in the bottom of OT window, notifying you about the sync state (Fig. 2).

Queuing 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" and the observing status is set to “New” or “Ongoing” (the icon to the left of the program would be set to green or pink, respectively). To view all the queued observations, click File -> Display Session Queue.

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. a 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: 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** (GMOS/Flamingos-2/GPI/GSAOI): summarizes the instrument configuration for a particular observation. This window is frequently used by the observer for setting up the mean Parallactic Angle and for adjusting the exposure time for an observation when 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 is 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,

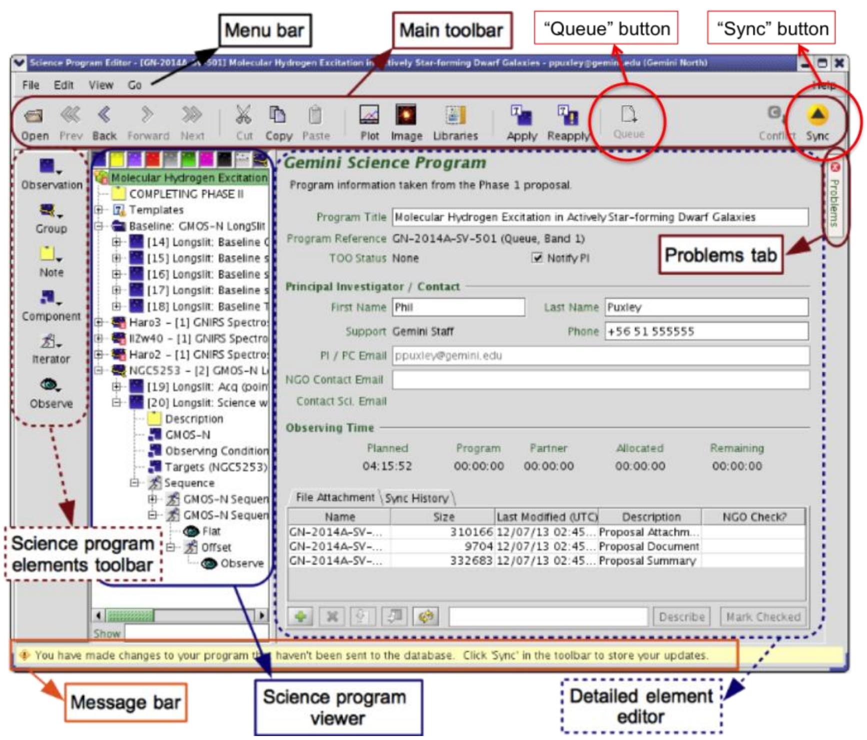


***Fig. 2.** Overview of the Science Program Editor.*

like the class of the observation, the offsets, exposure times etc. (see Fig. 3).

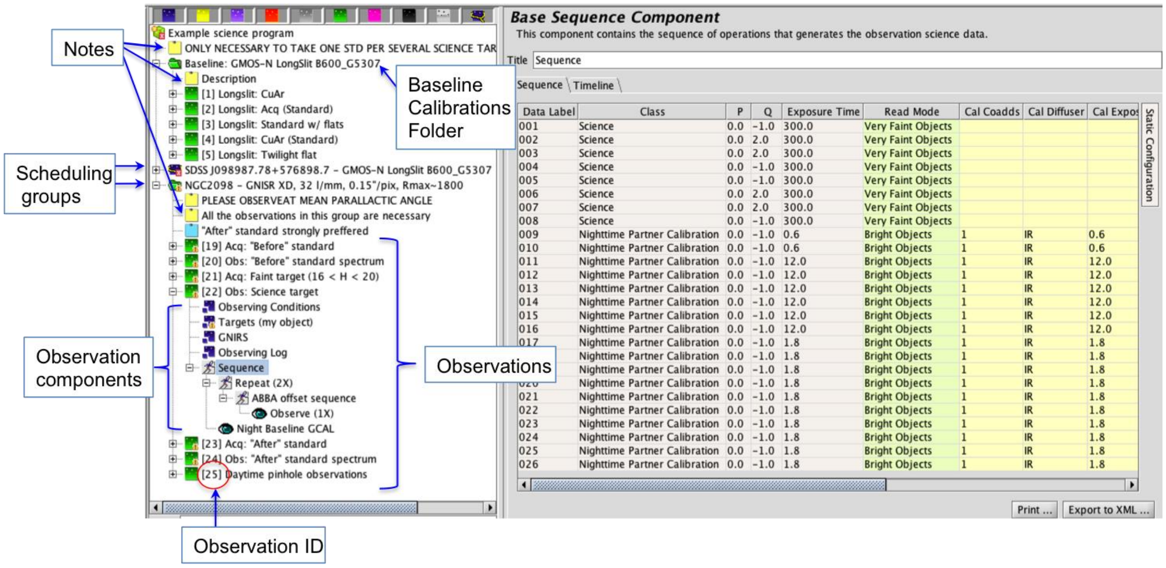


Fig. 3. *Main elements of the Science program viewer.*

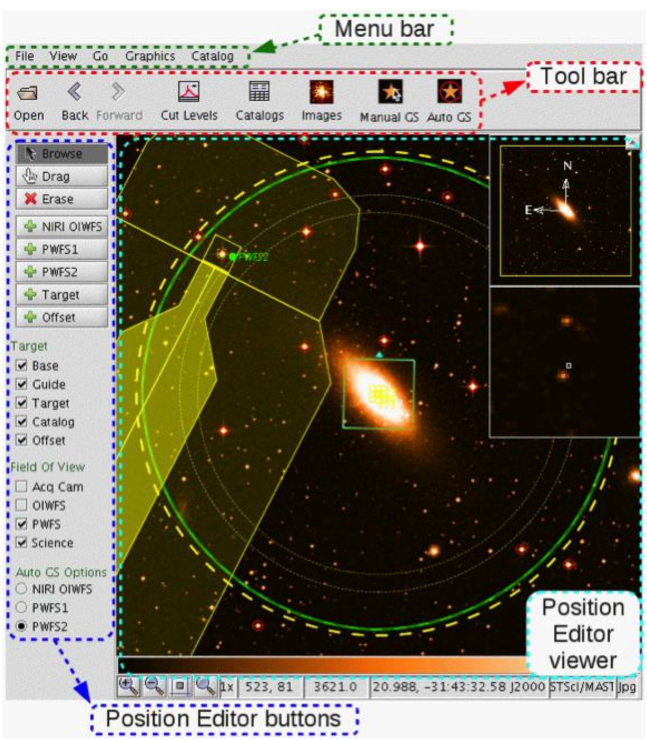


Fig. 4. *Position editor window.*
The **Position editor** provides a graphical view of the observation and can interactively modify elements of it. During observations it's used to display the instrument and WFS fields of view, display positions of the science targets and guide stars, display on-line catalogue sources, download images and search for new guide stars. To launch it, select an observation and then click the *Image* button on the main toolbar. More information on the Position editor usage can be found here.

Seqexec

The current **seqexec** (Sequence Executor) is shown in Fig 5. This tool is used by the observer in order to execute an observation, or a sequence of observations, throughout the night. It controls 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, or read one out early.

Seqexec window main elements

Header information: The top four header information fields are filled in automatically once the sequence is loaded into the seqexec. The "Observer" and "Operator" fields are filled in by the observer at the beginning of the night. "Raw Image Quality", "Raw Cloud Cover" and "Raw Background" you should update throughout the night as the conditions change. "Raw Water Vapour" can be left set to "Unknown", since this is not measured at Gemini South.

Immediately under the Header information section, there is a dithering pattern visualization window.

The Active subsystems box allows you to enable/disable the systems to be configured prior to the start of the observation. *All systems - TCS, GCAL, Instrument, and DHS - must be ticked during an observation.* During night-time observations "Operation" mode must be set to "Queue". It should be set to "DayCal" mode only when running the daytime calibrations in the morning.

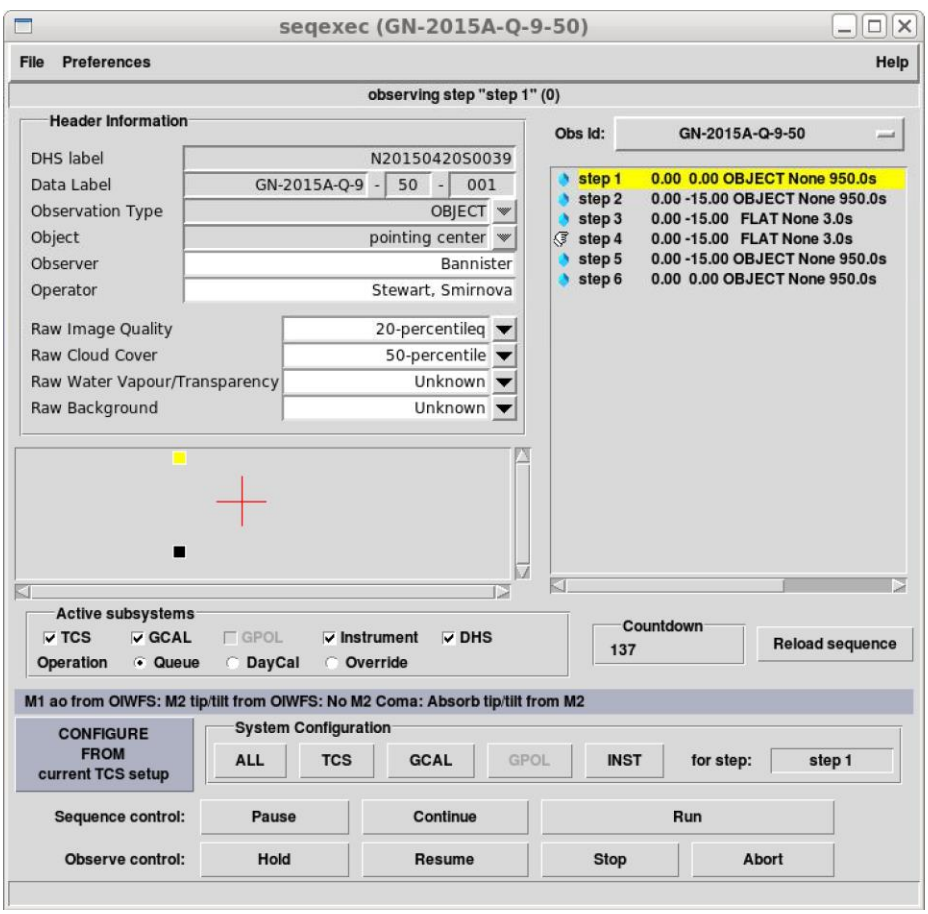


Fig. 5. *A snapshot of the Seqexec window as it appeared during a GMOS sequence of observations. The first step of the sequence (highlighted in yellow) is being executed, and the breakpoint ("Pause") has been put on step 4.*

Right under the "Active subsystems" box, the information on the current guiding configuration is displayed. NOTE: when changing from one WFS to another, information on guiding configuration is not updated automatically from the TCS. Press the "CONFIGURE FROM current TCS setup" button every time before running a new observation to have it updated.

The System Configuration box contains buttons for configuring different subsystems for a particular step in a sequence (the number of the step is shown to the right). It is a good habit to configure the instrument (INST) while still slewing to an object, as sometimes this may entail a significant overhead.

The Sequence control and Observe control button usage is explained below. These are used for controlling the run of the sequence.

Loading a sequence into Seqexec

To load a sequence into the seqexec, queue the observation in the OT first, then select "File" -> "Load sequence from OCS..." from the seqexec menu toolbar. You can also load multiple sequences by selecting "Load multiple sequences from OCS" (this is usually used to run the Morning Calibrations).

Once the sequence is loaded, its steps will be listed on the right side of the seqexec window. Next to the step number are the P and Q offsets (except for calibration observations), the class of observation (OBJECT, ARC etc.), filter and exposure time. The currently executing step appears in yellow.

Running Seqexec

For most science observations, in order to run the sequence the user only needs to click "CONFIGURE FROM CURRENT TCS SETUP", check that the seqexec guide status is correct, and then hit "Run".

Pausing and skipping steps

If one wishes to only take the first N number of steps, then a pause can be placed on step N+1 by middle-clicking on that step. This will display a hand icon on step N+1 step (please note that middle-clicking the diamond symbol to the left of the word "step" will not work).
To skip steps: select the step you want to observe, then click "Configure All". After configuring is done, click "Continue" (NOT "Run"). NOTE: you cannot return to the steps in the sequence once they have been skipped.

Stopping Observations Early

- Sequence control (applies to all instruments)
    - **"Pause"** will cause the sequence to pause on the next step (equivalent to middle-clicking the next step).

    - **"Continue"** is sometimes used instead of "Run", and specifically if the observer is skipping steps.
- Observing control
    - **"Hold"** is used to pause the observation immediately without reading it out, e.g. in the case of clouds passing by (GMOS only).
    - **"Resume"** will resume the observation after the "Hold" button has been pressed (GMOS only).
    - **"Stop"** will stop the observation, reading it out early (all instruments).
    - **"Abort"** will also stop the observation, but the frame will be lost (all instruments).

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 look for relevant sky and slit images, automatically perform sky subtraction (for Flamingos-2, if needed), measure the 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** *filenumber* (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 longslit 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)

- Take the first 2 images in the acquisition sequence (an image of the target field and an image of the slit).
- gacq the image of the target field, which will be the first image:
    - **gacq** *image1*
- Next put your cursor on the object to be centered, press **'r'**, **'a'** or **'x'**
    - 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
- You will need to confirm the slit center automatically measured by gacq.
- 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'**.
- Confirm the offsets calculated by gacq make sense, and if so send them to the TCC by typing **'y'.**

- Copy and paste the offsets sent to the TCC into the OT observing log for the related image.
- Take an image with the slit in the beam.
- 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.
- Gacq will display the image of the target through the slit. With wider slits you can tweak the offsets as follows: **'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).
- If this time gacq advises you to ignore offsets you are ready to start science; otherwise take another through-slit image.

The 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 the gacq acquisition yourself on real data, using the available tutorial pages for GMOS, and Flamingos-2.

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" at the terminal:
    - ISDs, TSD, OT, Quicklook Tools, Pyraf & DS9, Seqexec, IQtool, StripTools.
- Launch the QLT3 and QAP.
- In Firefox open the following pages:
    - Queue plan
    - Nightlog
    - Finder chart page
    - The Gemini weather page, which includes links to the satellite images, all-sky camera and the forecast.
    - QAP

Start of Night (before sunset)

- Grab a radio
- Read the Plan for the Week.
- Familiarize yourself with the queue plan

- Update the [nightlog]() with CC / ephemeris (found in the queue plan) / environmental data
- Seqexec:
  - Make sure seqexec is set to "Queue" mode
  - Put in initial guess of current CC and IQ observing conditions
  - Fill out observer / operator fields

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 PWFS1) by the telescope operator. This settles out the higher-order aberration terms (zernikes) that may be present at the beginning of the night (i.e., coma and trefoil - 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 and CC from the PWFS1 and PWFS2 striptools.
- Update the seqexec observing conditions.

Acquiring and Observing with Gemini Instruments

Before Slew:

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

During Slew / While Establishing Guiding:

- Configure the instrument
- Inform the operator of unusual modes (blind offsets, non-sidereal)
- Help operator identify guide stars / targets if there are problems
- Non-sidereal: check RA/Dec/track rates on TSD

Acquisition:

- After guiding is established, check that the target name on the TSD is correct
- Configure from current TCS setup and run the acquisition
- Use finder / OT image to verify telescope position
- Run gacq, put offsets into the OT obslog
- If unable to definitively identify the target abandon and ask for PI input.

- Before starting science check that:
    - The astigmatism has converged.
    - The baffles and periscope are in the correct positions. For GMOS, the baffle should be in the visible position with the periscope closed. F2 requires the baffles to be fully retracted with the periscope open.

Immediately After Science Start

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

Regularly During Science

- Add comments to nightlog & OT obslog needed by daytime staff / PI
- After taking a flat, check count level (use QLT3 or pyraf)
- Using the science data, monitor: science IQ, spectral counts (re-centre if needed)
- Using the striptools, monitor: guide counts, guider seeing (update seqexec conditions)
- Check environmental webpages often
- If clouds start coming in make sure all photometric standards are taken

10 minutes before the end of science

- Do "Before Slew" checklist

Observing at the Parallactic Angle

- Some GMOS and F2 spectroscopic observations will request the observations be taken at the 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/F2) of the science observation. Under Position Angle choose “Average parallactic” and set the approximate time of the beginning of the science observation.
    - Copy the derived angle value and paste it into the Instrument component (GMOS/F2) component of the acquisition observation, this time leaving the Position Angle as “Fixed”.

- 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.

Observing Non-Sidereal Targets

Prior to slewing to a non-sidereal target, the observer needs to pick a suitable guide star for the time of observation. For that, the coordinates of the target in the OT need to be updated as for the time of slew. This is done in two ways, depending on the program type.

- If the observation uses the **Orbital elements method**, the type of the object in the Target component will be set to either "Solar system object", "Comet", or "Asteroid". To find the guide star:
    - In the "General" section of Target component, update the UTC time with the time of slew.
    - Click "Plot" button. This will open the Position Editor, with six calculated object positions, one per hour.
    - Choose a guide star (click "Auto GS" button).
    - Sync the OT.

- If the observation uses the **Ephemeris method**, the ephemeris file will be attached as a note to the observation. The type of the object in the Target component will be set to "Sidereal Target". To find the guide star:
    - From the note with ephemeris, find the correct coordinates for the expected time of slew (for the UT date, not local date!).
    - Copy the coordinates to the "General" section of Target component.
    - Choose a guide star (click "Auto GS" button).
    - Sync the OT.

Note that the telescope will not use the OT coordinates when slewing, they are updated only to pick the guide star.

For those observations using the Orbital elements method, the OT coordinates need to be updated also in order to recognize the so-called "**non-sidereal bug**". This bug manifests as large errors in the calculated position for objects with rapidly changing orbital parameters (e.g. near-Earth objects). In this case there is a significant difference between the TSD coordinates and OT coordinates (in the order of 1-2 arcmin). The observer can issue an offset to correct it. To do that, calculate the difference between the OT and TSD coordinates and ask the telescope operator to apply the corresponding offsets.

More information on observing the non-sidereal targets can be found here.

Data Quality Assessment

The PV observers are asked to set the Quality Assessment (QA) states for queue programs observed during the night, particularly for Band-1 targets. 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.

If in doubt, observers should leave the QA State as "Undefined".
Sync the program to save comments and QA states in the ODB and update the headers.

Tools and directions for assessing weather conditions and observing constraints

Image Quality (IQ)

- Gemini IQ constraints (at zenith).
- For estimation of airmass-corrected IQ: use these plots.
- For GMOS: use the QAP seeing measurements.
- If measuring the FWHM directly from images use the IQTool (from the Gemini menu) to convert the FWHM into airmass-corrected IQ.
- 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.
- DIMM seeing.

Sky transparency: cloud cover (CC)

- Gemini CC constraints.
- The SASCA All-Sky camera.
- Latest Satellite image.
- Watch guide counts monitors for drops. Note that, besides clouds, another common reason for drops in counts can be seeing deterioration.

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 the time left before the 2AM limit will be reached for a particular target.

Observing with GMOS

Overview

The Gemini Multi-Object Spectrograph (GMOS) provides 0.36-0.94-micron spectroscopy and imaging over a 5.5’x5.5’ 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

- The GMOS **detector** is an array of 3 2k x 4k CCDs, 3 amplifiers per detector;
- Full imaging **field-of-view**: 5.5’ x 5.5’;
- The **pixel scale** is 0.080"/pixel (0.160"/pixel if binning 2x2);
- **Orientation of GMOS images (PA=0):** North down, and East left. In order to change the orientation of GMOS-S 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-S **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 the "Hold" button on the seqexec. To resume the observation, press the "Resume" button. Due to cosmic rays’ impact, the charge shouldn’t be held for more than 30 min;

- **Guiding options** are the On-Instrument Wavefront Sensor (OIWFS) and the telescope's Peripheral Wavefront Sensors (PWFSs)**:**
    - OIWFS: recommended for all but non-sidereal objects.
    - PWFS2: has a large patrol field and should be used for fast-moving non-sidereal objects or when an OIWFS guide star is not available.
    - PWFS1: is not used with GMOS-S.

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

- Follow the Acquiring section guidelines.
- Wait until focus and astigmatism has converged, then run observations.
- Use QAP measurements for image quality assessment.

GMOS Long-Slit Spectroscopy

Long slit spectroscopy can be obtained in either normal or Nod and Shuffle modes using GMOS standard slits or custom slits.

Acquiring

For most objects the long slit acquisition consists of the following steps:

- *Field image* (offsets: P=0, Q=0);
- Off-object *Slit image* for measuring the slit centre (typical offsets P=10", Q=0);
- Several *Through-slit images* of an object for fine centering on the slit (offsets P=0, Q=0)

On-axis long-slit acquisition

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

- Follow the Acquiring section guidelines (don't forget to set the Parallactic Angle if needed);
- Take the first two images of the acquisition sequence (the field and the slit image).
- Once the images have been read out, run gacq on them as following:
    - **gacq** *filenumber* slit=*filenumber* (e.g. gacq 300 slit=301)
- 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 that could affect the slit measurement. If there are, say "no" and manually measure the slit. For point sources the centering error should be

< 10% of the slit width. The placement along a slit is not critical but in general the error should be < 0.5".

- Send offsets to the TCC and copy the offset values to the OT (Observing Log -> Comments).
- Observe step 3 of the acquisition sequence.
- 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;
- If you are doing an acquisition with a *BLIND OFFSET* ask the telescope operator *to swap to the 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 *filenumber* slit=*filenumber* *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 we recommend taking another field image (without the slit).

Acquisition with Blind offset

In the 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 acquisition is done and prior to running the science observation, *ask the telescope operator to swap to the science target*, i.e. to apply the blind offset.

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 those objects the astronomer is interested in. 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 straight with the MOS mask already in the beam or, in some cases, the full frame field image needs to be taken prior obtaining the through-mask images. When the mask is in the beam, the observations are set up to use the Custom ROI (Region of Interest), 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)

- Follow the Acquiring section guidelines.
- Take the first image of the acquisition sequence (MOS mask out of the beam).
- Once the image has been read out, click “Configure Inst” to configure the instrument for the next step (inserting the mask into the beam has quite a large overhead);
- Run gacq on the first image and follow gacq’s instructions. During this step of the acquisition you will be centering the acquisition stars on the expected position of the acquisition boxes (each mask has 2 or more of them).
- At some point in the acquisition you will be asked to provide the “MOS Mask Number or Custom Mask MDF” - this you can find in the OT: click the GMOS-S component of the observation and look for the “Custom Mask MDF” name.
- Send offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
- Take step 2 of the acquisition sequence (this time with the MOS mask in the beam).
- Run gacq on the image you have just taken. During this part of the acquisition you will be centering the stars in the acquisition boxes, which might require several iterations.
- Send offsets to the TCC, copy offset values to the OT.
- Observe step 3 of the acquisition sequence and run gacq on it. This step is to confirm the centering of the acquisition stars.
- If **gacq** advises you to ignore the offsets – you are ready to start science; otherwise – take another acquisition image.

MOS acquisition starting with mask IN the beam

Follow the instructions above, skipping the steps 2-6.

Integral Field Spectroscopy

GMOS IFU can be used in either two-slit (IFU-2) or one-slit (IFU-R) mode. IFU-2 provides full coverage of the IFU field-of-view but limited spectral coverage, whereas with IFU-R 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 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 being in the beam. The reconstructed 2-dimensional IFU field image is displayed**,** and the object's centering is adjusted in several iterations from the 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)

- Follow the Acquiring section guidelines.
- Take the first image in the acquisition sequence (IFU out of the beam).
- Once the image has been read out, click "Configure Inst" to configure the instrument for the next step (inserting the IFU into the beam has large overhead).
- Run gacq on the first image and follow gacq's instructions.
- You will be asked 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-S 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.
- 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 the IFU field.
- Send the offsets to the TCC, copy offset values to the OT (Observing Log -> Comments).
- Observe step 2 (this time with the IFU unit in the beam).
- Run gacq on the next image and follow the instructions. In this step you will first need to indicate the top fiber of the bottom bundle (for image reconstruction purposes). Next, the reconstructed science IFU field will be displayed, on which you will be centering your object.
- Send offsets to the TCC and observe step 3 of acquisition sequence.
- Repeat steps 8-9 until gacq advises you to ignore offsets and start science.
- 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!

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.

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** to any other observing mode.

The easiest way to pause an N&S sequence is to put the pause on the next STEP (not a sub-exposure!) of the N&S sequence.

Below we provide the preferred way (due to simplicity and the minimal number of steps) of stopping a N&S **sub-exposure** early (Fig. 7.) For more information on pausing and aborting the N&S observations, please see this detailed instruction page.

Stop N&S observation immediately

NOTE that the following sequence will not work if you are trying to execute a stop while still in the very FIRST step of the N&S sequence. For practicality, never try to stop a sequence in the first step; either let it continue to the second step or simply abort.
NEVER use the seqexec's "Pause" button in N&S mode. Instead use the middle mouse button!
To stop and read out:

- Use a break point on the next sub-exposure in the seqexec sequence (using the middle mouse button) in order to pause the sequence.
- When the sequence is paused, click on the last sub-exposure of the N&S sequence (NSLAST).
- Press the **System Configuration "ALL"** button (to set up GMOS for a NSLAST observe which will allow the data to be read out).
- Click "**Continue**".

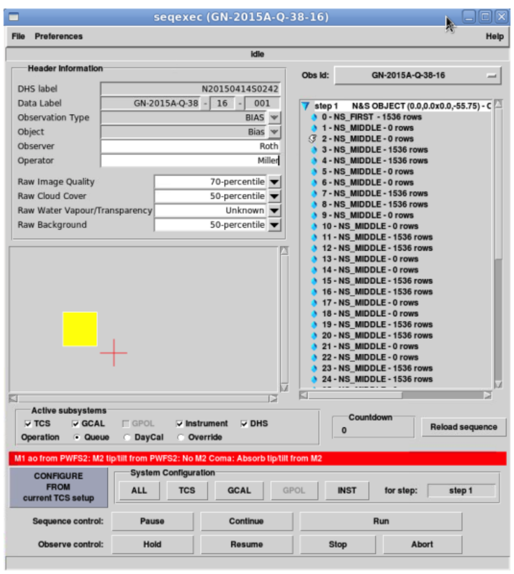


Fig. 7. *Seqexec with pause on a sub-exposure after an A-B pair.*

To abort (stop and not readout):

- Press the seqexec "**Abort**" button. Note however that GMOS must be exposing for this to work, and must have at least 3 seconds left in the countdown.

GMOS Imaging 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 (only if photometric and imaging was taken that night);
- 10 minutes after twilight: slew to a 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 *GS-CAL-GMOSCAL* 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, e.g., 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 GS-CAL-GMOSCAL program. Under "Photometric Standards", chose an observation with an RA close to the sidereal time for when you will run the observation. Copy and paste the observation to the daily calibration program and run from there.
- 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 and evening twilight at Gemini South. We take bluer bands in the evening, and redder bands in the morning. 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 "GS-LIB-GMOSCAL" program. Under "Twilight Flats Morning" or “Twilight Flats Evening” as appropriate, copy the desired band for which twilight flats are needed and paste it into the Daily calibrations 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.
- 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 QLT3, and use this value to determine the exposure time for the next frame. Note that the bias level is about 800ADU.

- Select the step with the appropriate exposure time then in Seqecex 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.

GMOS 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:** If defined within the science observation group, should be taken together with science.

Morning calibrations:

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

- The spectrophotometric standard sequences are located in each science program in Baseline Calibrations folder;
- Spectrophotometric standards are to be obtained ONCE during a semester per program configuration (unless they are defined WITHIN the science observation group);
- Select an appropriate target from the “GS-LIB-GMOSCAL” OT program. These are found in the folder entitled "Spectroscopic Flux Standards";
- 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, we'll live with 1500 counts above bias in the peak;
- IFU: At least 1000 counts above bias in the peak. If conditions are very poor, we'll live with 500 counts above bias in the peak.

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 QLT3 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 on the same evening, one should start with the narrower masks/slits, finer gratings, and redder setups and move to the setups that can use fainter sky conditions to avoid saturation;
- IFU spectral twilights can be done before sunset.

Recommended Counts:

- For IFU flats, the mean counts need to be about 3,000 but not saturated;
- For MOS flats, the mean counts should be at least 5,000 (but it's best to have counts above 10,000).

GMOS 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 always be obtained as part of daytime calibrations;
- Copy the "GMOS-S biases slow/low/12 amps" observation from the “GS-LIB-GMOSCAL” program in the OT to 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** *filenumber framenumber* (*framenumber* specifies the ds9 frame).
- Use QAP data for quality control of imaging data.
- ***QLT3*** makes it easy to check for saturation in all data - the saturated pixels are shown in red.

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 Flamingos-2

Overview

Flamingos-2 (F2) is a Near-Infrared wide-field imager and spectrometer for Gemini South. As a NIR (0.95-2.4 micron) imager, it has a 6'.1 diameter circular field, with a uniform PSF of 0’’.36 both on- and off-axis, excluding the effect of seeing. As a spectrometer, F2 delivers resolutions up to R = 1200-3000 for objects within a 2'x6' quasi-rectangular field. JH and HK grisms provide an average resolution of 950 across 75% of the spectral range and the R3k grism provides an average resolution of 2600 across 75% of the J, H or Ks spectral ranges. Multi-object spectroscopy is planned for commissioning in the next year, but at the moment only longslit mode is available for spectroscopy.

Useful Information:

- The F2 detector is a Hawaii-II (HgCdTe) array, with 2048x2048 18μm pixels.
- For imaging there is a circular field of view with diameter 6’.1.
- For spectroscopy there is a quasi-rectangular field of view of 2’x6’.
- The pixel scale is 0.18’/pixel.
- When using F2 the baffle should be in the fully retracted position, and the periscope should be open. This should happen automatically when you slew, but you can check with the telescope operator if you are unsure.
- The orientation of the images (PA=0) is north right, west down. To orient them such that north is up and east to the left go to *Pan Zoom Rotate to* and set to 90 degrees. If you are observing at a non-zero position angle then change the orientation to IPA + 90 degrees.
- Guiding options: PWFS2 is currently used for both imaging and spectroscopy modes for F2. There is an OIWFS which may be used in the future with F2, but it is not yet fully commissioned.

F2 Imaging

Acquiring

Acquisitions are normally not necessary for F2 imaging. Please check the Queue Plan and the program notes in case acquiring is necessary.

Taking Science

- Follow the Acquiring section guidelines.
- Wait until focus and astigmatism has converged, then run observations.
- Use pyraf or QLT3 and the IQTool for image quality assessment.

F2 Long-Slit Spectroscopy

The high sky background present in the NIR means that for fainter targets it is necessary to take sky frames during an acquisition in order to be able to see the target one wishes to acquire. This is done by offsetting the telescope by 10", taking an image, and subtracting that from the acquisition image. Acquisitions done in this mode will be referred to as 'Faint-mode acquisitions'. When the target is bright enough not to require the sky frames we will call them 'Bright-mode acquisitions'.

Acquiring

Longslit acquisitions with F2 work very similarly to longslit acquisitions with GMOS, but with a few differences. The first is that in the near infrared the sky background is much higher than in the optical. Therefore there are many targets which aren't visible in the acquisition without performing a sky subtraction. This adds another step to the acquisition for faint objects – the telescope is offset by 10", and another image of equal duration to the acquisition image is taken. It can then be subtracted from the acquisition image, allowing fainter objects to be seen.

Also of note is that the slit in acquisitions appears horizontal, and is offset from the centre of the image. Also, because the optical centre of F2 does not coincide with the slit centre, you should not expect the target to show up in the slit centre.

For bright objects (H<12) the long slit acquisition consists of the following steps:

- *Field image* (offsets: P=0, Q=0);
- Off-object *Slit image* for measuring the slit centre (typical offsets P=10", Q=0);
- Several *Through-slit images* of an object for fine centering on the slit (offsets P=0, Q=0)

For faint objects (H>14) the long slit acquisition consists of the following steps:

- *Sky image* (offsets: P=0, Q=10");
- *Field image* (offsets: P=0, Q=0);
- Off-object *Slit image* for measuring the slit centre (offsets P=10", Q=0);
- *Sky image* through slit (P=0, Q=10");
- *Target image* through slit (P=0, Q=0);
- Additional exposures of the source through the slit as necessary.

On-axis long-slit acquisition

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

- Follow the Acquiring section guidelines (don't forget to set the Parallactic Angle if needed);
- Take the sky image (for faint objects only), the field image and the slit image.
- Once the images have been read out, run gacq on the *field image* as following:
    - **gacq** *filenumber* slit=*filenumber* (e.g. gacq 300 slit=301)
- 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 that could affect the slit measurement. If there are, say "no" and manually measure the slit. For point sources the centering error should be < 10% of the slit width. The placement along a slit is not critical but in general the error should be < 0.5".

- Send offsets to the TCC and copy the offset values to the OT (Observing Log -> Comments).
- Observe the sky image through the slit (for faint objects only) and the through-slit image of the object.
- 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.
- In case you are doing an acquisition with a *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 *filenumber* slit=*filenumber* *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 the 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 acquisition is done and prior to running the science observation, *ask the telescope operator to swap to the science target*, i.e. to apply the blind offset.

F2 Calibrations

Flats and arcs

Some programs have flats and/or arcs included in the science observation, others have them set up separately in a second observation. If in a separate observation, assume it can be run with the telescope at zenith at the end of the night unless there is a note in the program stating otherwise.

For F2 the normal CuAr lamp is used for the arcs, and the IR lamp is used for the flats. The IR lamp is located in a light-safe container, with a shutter that can be opened when it is being used. It should be turned on at least a couple of minutes before you take the first flat as it takes a few minutes to heat up, and may be left on the whole night. Be sure to check the flats carefully as they are taken – they should have between 10K-20K counts.

Tellurics

A telluric standard is required for every longslit observation with F2. It should be taken at similar airmass (<0.3 airmass difference if possible) and either directly before or directly after the observation. Generally speaking we try to provide a telluric for every 1.5 hours of data. However, there are some programs which only request one telluric per night – read all the program notes to see if this is the case.

Each F2 longslit observation should have a before and after telluric observation in the same folder. As long as the science observation is less than 1,5 hours in length you need only take one of them. You can select the science and telluric observations and use the 'plot' function in the OT to see which of them is closer in airmass to the observation. That is the one you should use.

Using the QLT3 you can check the telluric observation as it comes out to make sure the counts are <20K and >3K. Adjust the exposure times as needed to achieve this.

Darks

F2 does have some dark current, but it is consistent over the time period of a few weeks. Therefore, we only take darks once a week, on a Saturday morning. On Friday, all the necessary darks are prepared and put into the calibration program for that night. It is then the observer's responsibility to leave them running on Saturday morning after the observations finish for the night. There will be a reminder of this put into the night plan for this.

F2 Image Quality

F2 data can be displayed using the *ndisplay* task in pyraf.

ndisplay [filenumber]

The task will assume that the previous image taken in a sky image and automatically subtract it from the image you're displaying. If you wish to use a different image for sky subtraction you can specify it using the 'sky' keyword:

ndisplay [filenumber] sky=[filenumber of sky]

If you don't wish to use any form of sky subtraction you can use the 'sub-' keyword.

ndisplay [filenumber] sub-

The IQ of the images can be checked by displaying images (or the acquisition image in the case of spectroscopy) using ndisplay, using 'r' to find the FWHM of point sources, and feeding that number into the IQTool to convert that into an IQ.

Useful F2 links

External:

- F2 Public Page

Internal:

- Internal F2 Instrument Information
- Troubleshooting with F2
- Gacq Tutorial for F2

Wrapping Up

1 hour before End of Night

- Look for GMOS imaging (fits/summary/today/science/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
    - Make sure the OIWFS is parked
    - Wait for the baffles
      Broadband imaging flats
    - Narrow band imaging flats
    - MOS spectral flats for any masks taken during the night
    - IFU spectral flats
- Queue daytime calibrations (queue GMOS biases last)
- When the 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 the number of science hours used
  - Verify any additional problems with SOS
  - Verify personnel involved
  - Complete the plan for the night and the nightly summary
  - No specific target names
  - Arrival / departure times
  - Save the nightlog
  - Send the nightlog
- Turn off radios and place in charger
- Check the kitchen is clean
- Make sure fire doors are closed, lights off

Suggestions on the Efficient Use of the Nightly Queue Plan

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 cloud cover, the weather forecast, 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 that 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 it 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.