Telescopio Nazionale Galileo

GIANO-B

Observer's Manual

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Change record

Version	Date	Section/Page	Remarks
1.0	20/11/2017	All	First version
1.1	12/03/2018	2.2.1, 2.2.3, 6, 7, 8, 10	Updated figures and text, new chapter on the Online Data Reduction Software
1.5	17/09/2020	2, 3, 5, 7, 9	2, 3, 7 and 9 text rewritten, images updated. Some text modification in 5 introduction, 5.2 and 5.3.

Table of Contents

1 Introduction

1.1 Scope

This manual is intended as a guide for potential GIANO-B observers. The contents of this manual will be continuously modified with the most up-to-date information on the instrument and the best practices of its use.

1.2 GIANO-B Web Page

GIANO-B Web Page is available at: **http://www.tng.iac.es/instruments/giano-b/** .
Please refer to the web page for general information and a short instrument description. Also, additional resources for observation preparation as exposure time calculator, catalog file example, etc., are provided through the web page.

1.3 Contact information

The users of GIANO-B are encouraged to send a feedback on this manual. Also, any kind of instrument related problem or error reporting is welcome. Please email to Avet Harutyunyan (avet at tng.iac.es).

2 Instrument start-up guide

In this section, the steps required for the afternoon instrument start-up are described. The instrument start-up is designed to be a quick and straightforward process.

The components of the instrument control software reside on Support Astronomer (SA) and Telescope Operator (TO) workstations. The presence of both SA and TO is desirable for the instrument start-up but in principle either of them can carry out the start-up alone by accessing the two workstations.

The main components of the GIANO-B observing control software are Sequencer, New Short Time Scheduler (NSTS) and the Auto-Guider (AG). These are installed and have to be used on ***brunello*** and ***wsoper*** machines of the Telescope Control Room.

In particular, Sequencer and NSTS will run on ***brunello*** while AG on ***wsoper***. The shortcut launchers to run the software can be found on the desktops of the machines (Figure 1).

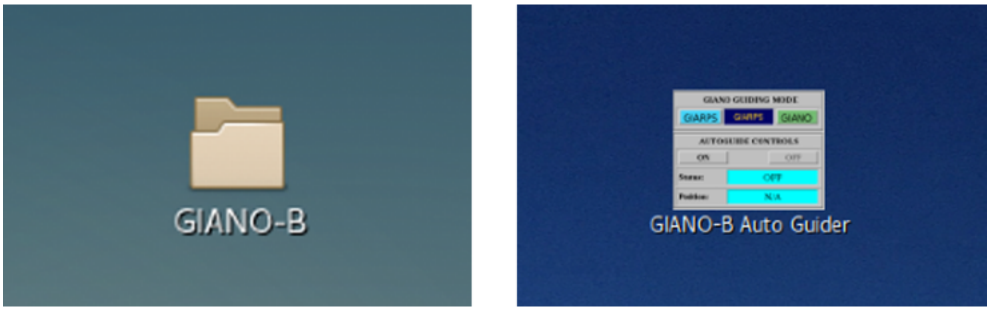


Figure 1. GIANO-B launcher folder on brunello (left) and AG launcher on wsoper (right) desktops.

For ease of reference, a small checklist of the instrument startup is as follows:

- start Sequencer on brunello (2.1),
- start NSTS on brunello (2.1),
- start AG on wsoper (2.2),
- initialize Sequencer (2.3).

2.1 Sequencer and NSTS start-up

The shortcut launchers of the software used to operate GIANO-B are placed in a folder called “GIANO-B” on the Desktop of brunello (Figure 1, left).

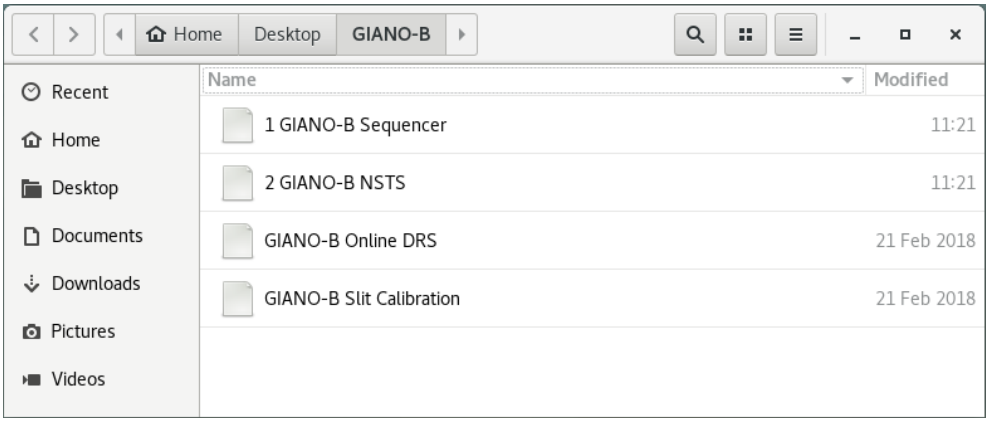


Figure 2. GIANO-B folder and its contents on brunello.

In this folder (Figure 2), among the others, the following two launchers can be found:

- 1 GIANO-B Sequencer
- 2 GIANO-B NSTS

As the naming suggests, the launchers have to be clicked in their numbering order for the software start-up.

1 GIANO-B Sequencer

Sequencer has to be launched double clicking on “2 GIANO-B Sequencer” icon. This will open a console terminal and the Sequencer start-up dialog window (Figure 3).

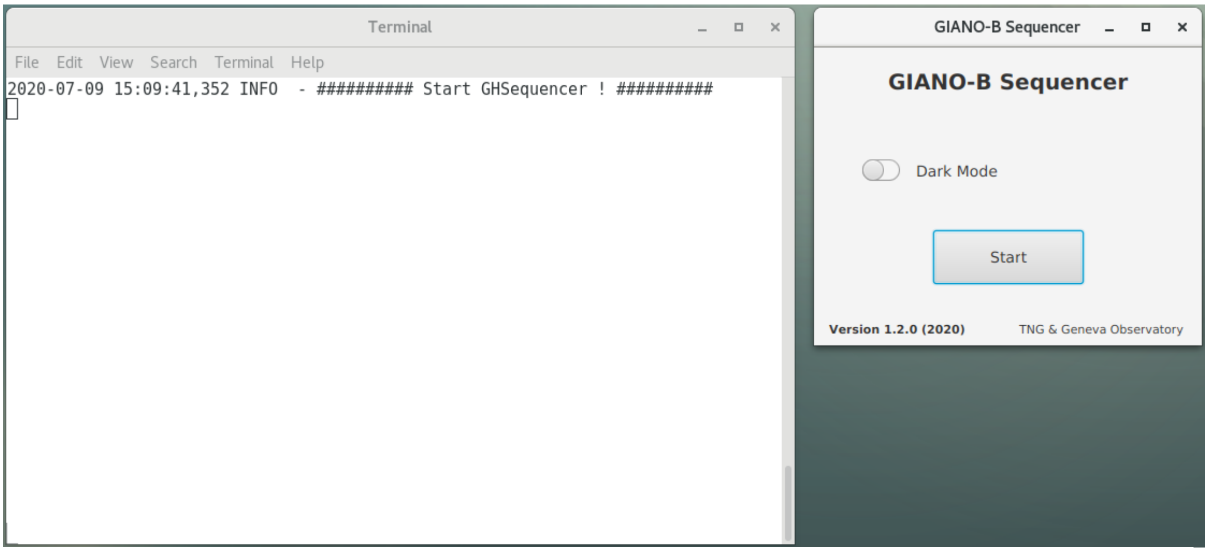


Figure 3. GIANO-B Sequencer console and start-up dialogue window on brunello.

The dark colored version of the Sequencer Graphical User Interface (GUI) can be started toggling the dialog window “Dark Mode” switch, otherwise the default (“Light”) mode will start. Once the “Start” button is clicked, the Sequencer main GUI and a SAOImage ds9 window will open (Figure 4).

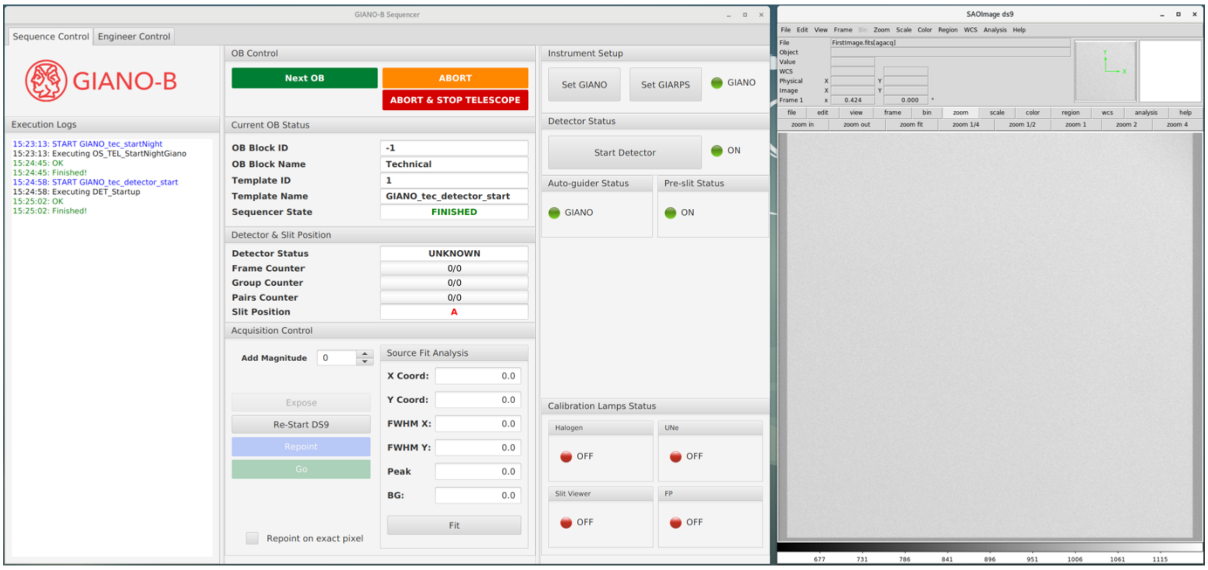


Figure 4. GIANO-B Sequencer main GUI with SAOImage ds9 window on brunello.

2 GIANO-B NSTS

Double clicking “2 GIANO-B NSTS” launcher, the corresponding terminal and the NSTS start-up window will appear (Figure 6).

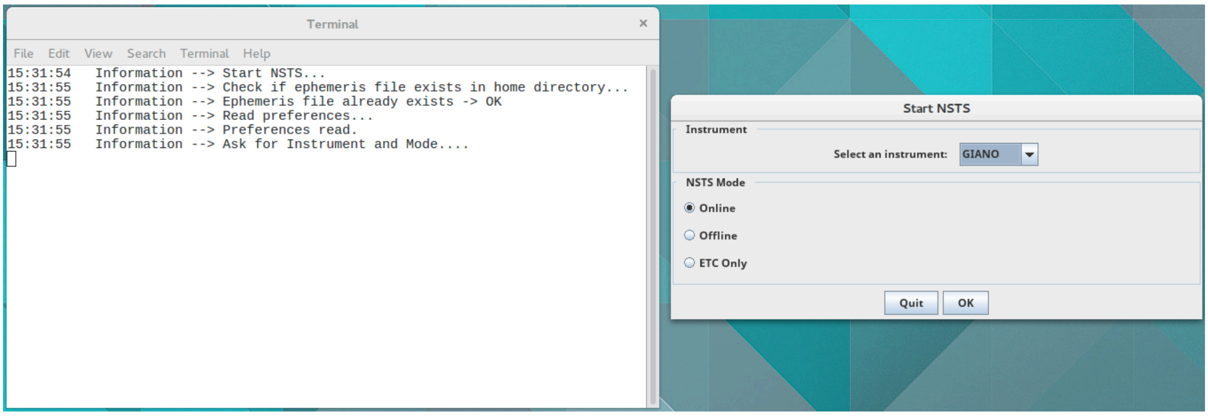


Figure 6. GIANO-B NSTS console with instrument and mode selection window on brunello.

Pick the "GIANO" option in the instrument selection box and check the "Online" mode radio button (Figure 6). Hit "OK" and the NSTS GUI will open (Figure 5).

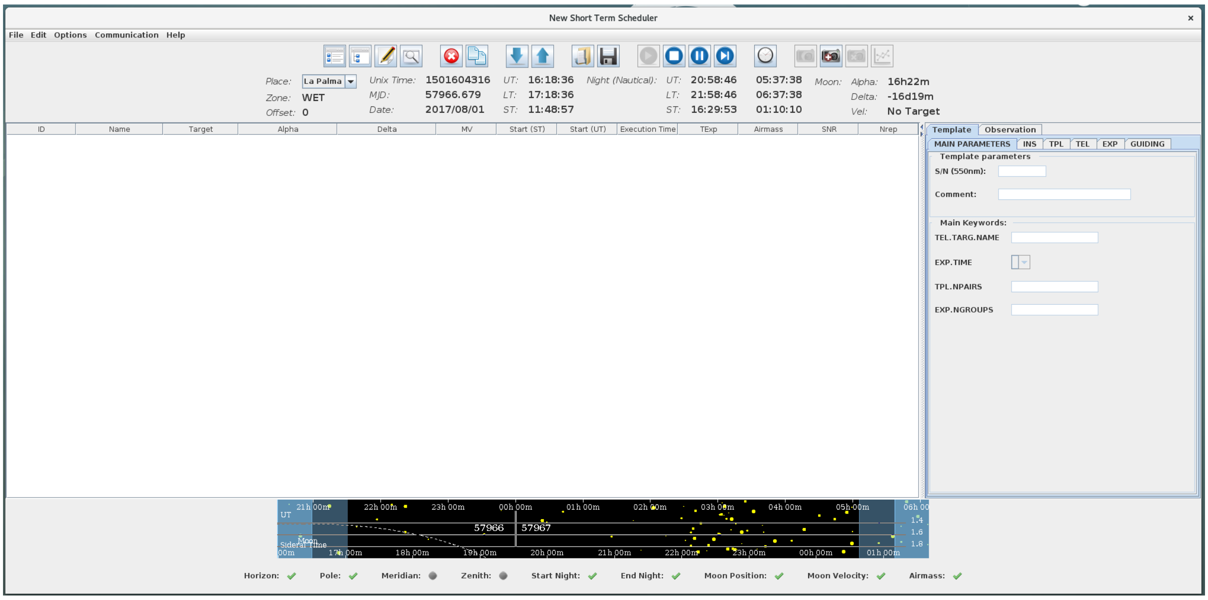


Figure 5. GIANO-B NSTS main GUI on brunello.

In order to use NSTS in "Online" mode, the Sequencer has to be already running.

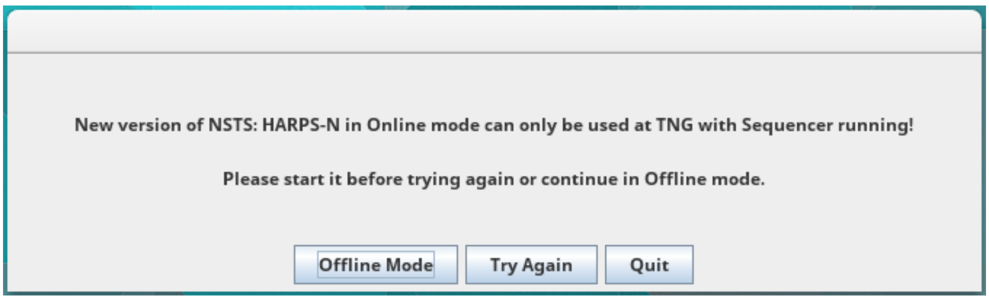


Figure 7. The warning window of NSTS launched in online mode without Sequencer running.

If NSTS is started in online mode before starting Sequencer, a warning window will appear informing that Sequencer is not running (Figure 7).

2.2 AG start-up

The AG software is started double clicking on the “GIANO-B Auto Guider” launcher on the wsoper Desktop (Figure 1, right). The AG IDL terminal/console and the GUI will appear (Figure 8). No commands have to be typed in the console, neither its window has to be closed.

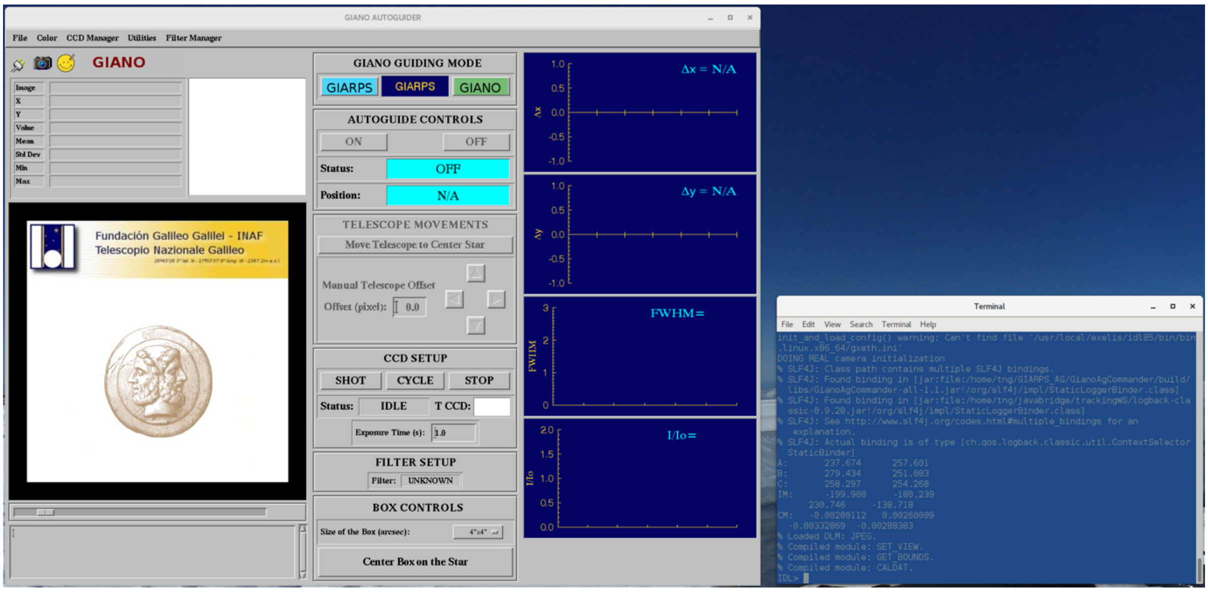


Figure 8. GIANO-B AG GUI and IDL console terminal on the wsoper.

On startup, the AG will be in its default “GIARPS” guiding mode. For GIANO-B observations it has to be set to “GIANO” operation mode using the corresponding button of the “GIANO GUIDING MODE” panel of the GUI.

2.3 Sequencer initialization

To conclude the instrument and its control software start-up procedure, Sequencer will have to be initialized. This consists in GIANO-B setup selection and its detector start-up.
Before performing these tasks, the state of the AG and the Pre-slit service has to be checked.

- The “led” light on “Auto-guider Status” panel of the Sequencer GUI has to be green indicating that the AG is running (Figure 9). Next to it, “GIANO” label has to be displayed, specifying that the AG operation mode is set for GIANO-B observations.
- The led on “Pre-slit Status” panel has to be green and the label “ON” confirming that the Pre-slit service is running (Figure 9).

At this point, “Set GIANO” and “Start Detector” Sequencer commands have to be issued using the corresponding buttons.

Set GIANO

This command is issued clicking “Set GIANO” button on the “Instrument Setup” panel of the GUI (see Figure 9). The TO has to be warned before the launch of this command. On the button click, a warning message will pop up stating that this operation may take up to 3 minutes. Until the end of the execution of this command no other Sequencer command has to be issued.
“Set GIANO” will place the LRS Entrance Slider and Frame to specific positions in order to allow the light from the telescope to reach GIANO-B. The led indicator will turn into green and its label to “GIANO” when the process will end successfully. Also, the Sequencer “success” sound will play and the corresponding messages in the “Execution Logs” panel will show “OK” and “Finished!”.
If on Sequencer start-up the Instrument Setup led is already green with “GIANO” label, there is no need to execute “Set GIANO” as the instrument is already set for GIANO-B observations.

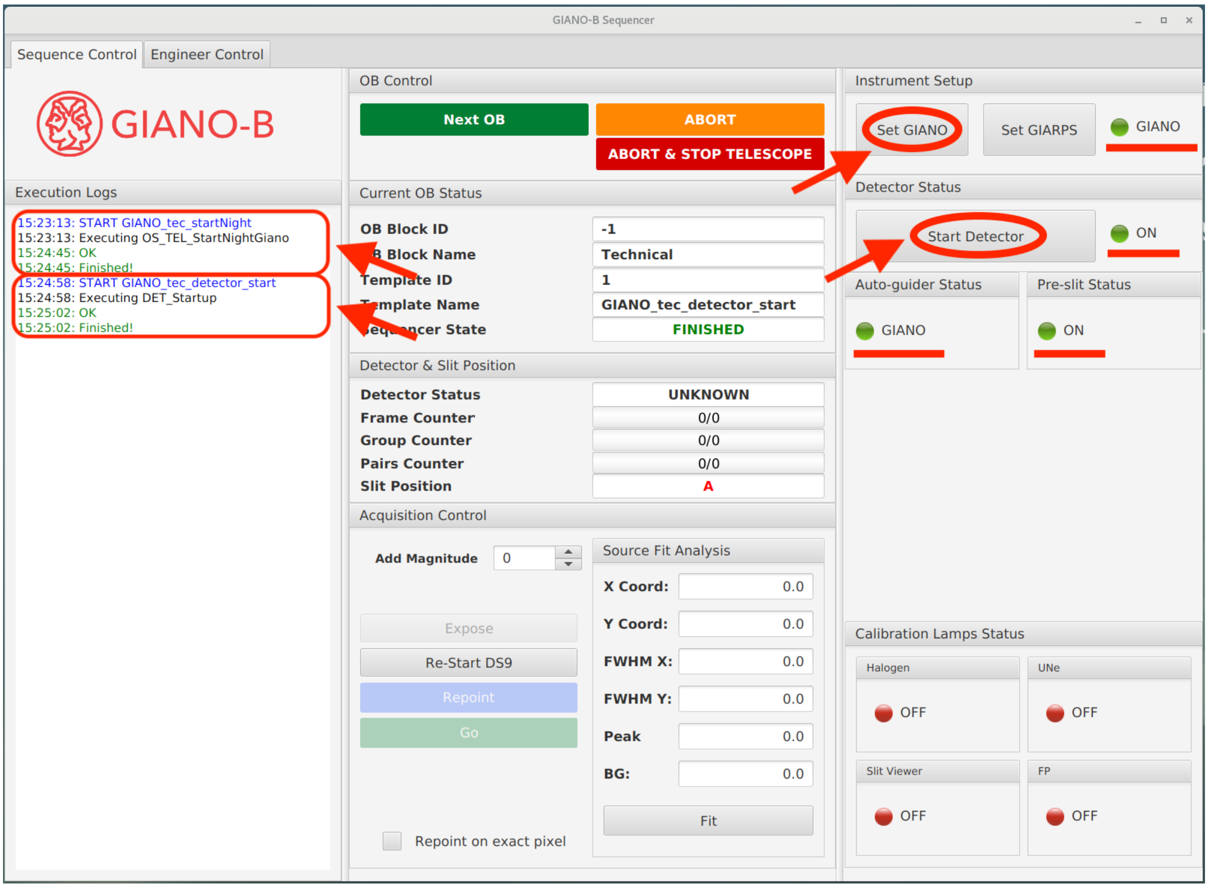


Figure 9. The Sequencer GUI with buttons used for initialization and corresponding status leds and log messages indicated in red.

Start Detector

This command is issued clicking “Start Detector” button on the “Detector Status” panel of the GUI (see Figure 9). When the operation is successfully finished, the led indicator will

turn into green and its label to “ON”. Also, the Sequencer “success” sound will play and the corresponding messages in the “Execution Logs” panel will show “OK” and “Finished!”.
If “Start Detector” command is already executed, there is no need to repeat it in case of a Sequencer restart. In fact, in such cases, after the Sequencer restart, the Detector Status led will be green with “ON” label indicating that the detector was already started.

3 Sequencer Operation Guide

The main function of GIANO-B Sequencer is to sequentially execute the observing blocks (OBs) scheduled by the NSTS and give a real-time feedback to the user on the progress of the data acquisition. In addition to this, Sequencer performs also the instrument initialization as described in 2.3.

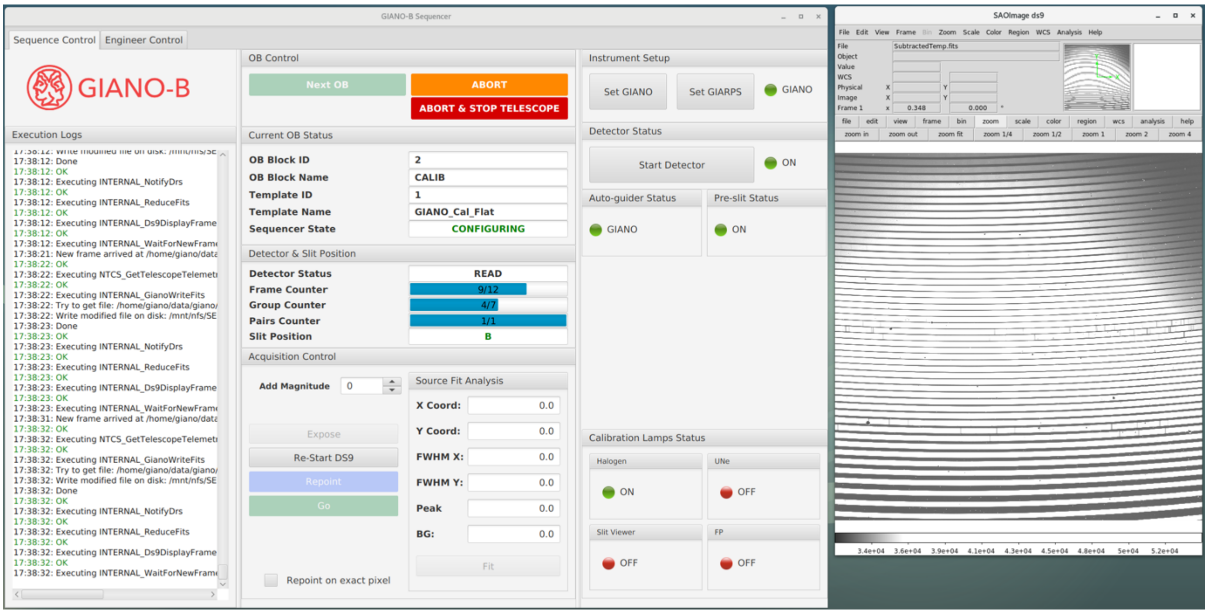


Figure 10. The Sequencer GUI (in Light Mode) with SAOImage ds9 window during Flat image exposures.

3.1 GUI structure and commands

The Sequencer main GUI has two color modes, Light (Figure 10) and Dark (Figure 11). The Dark Mode can be toggled on the Sequencer start-up dialog window (Figure 3), otherwise the default Light Mode will start. Beside the main GUI, Sequencer has an auxiliary SAOImage ds9 window (Figure 10) used as an image display for ongoing 2D spectra exposures and AG acquisition images. The Sequencer GUI is divided into a number of sections, panes, that are discussed more in detail in the following paragraphs.

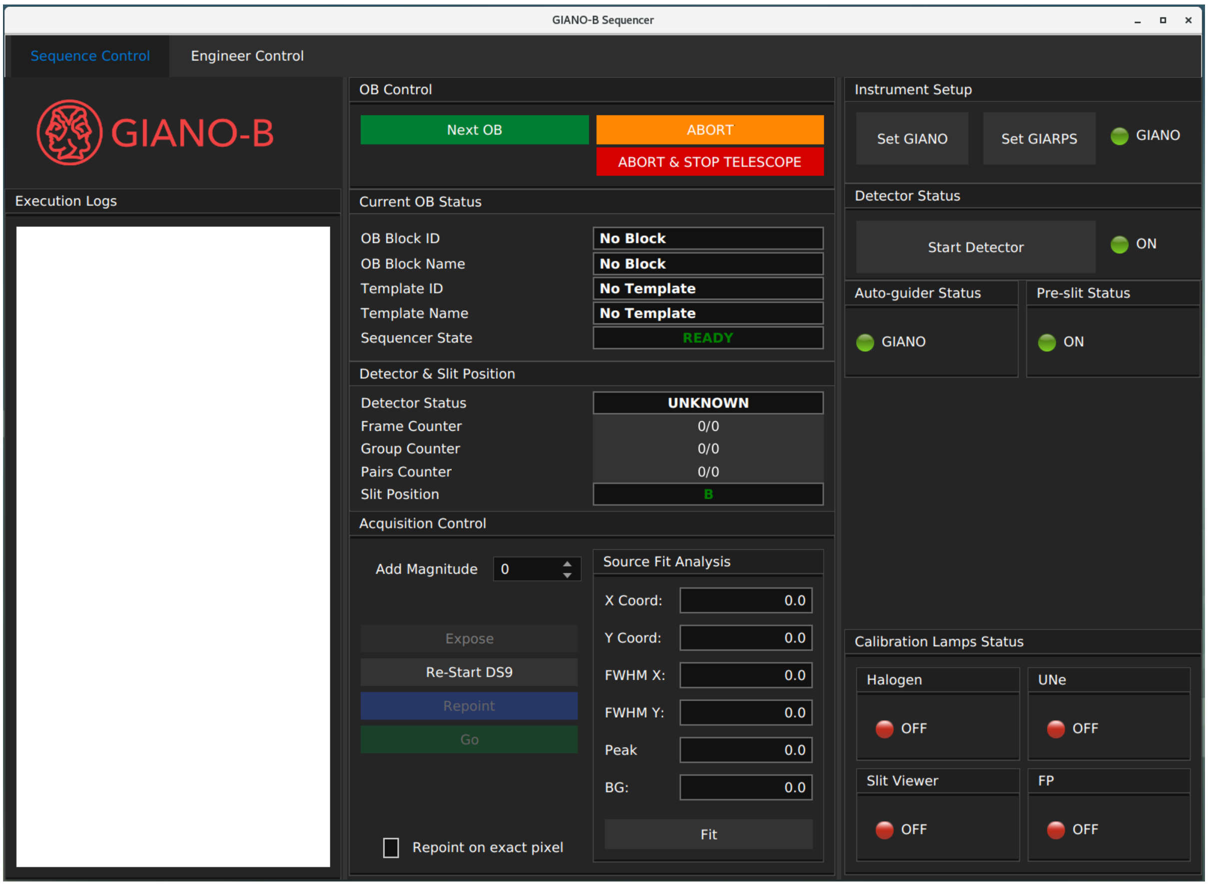


Figure 11. The Sequencer main GUI in Dark Mode.

Execution Logs

This is the leftmost pane of the GUI and displays the real-time time stamped log of the Sequencer operations. The error messages shown in the logs pane are of particular importance, as they will aid the correct recovery from the error or any further debugging.

OB control

The buttons of this pane are as follows:

- Next OB → loads the subsequent OB (subsequent to the last executed one) from the NSTS.
- ABORT → stops any ongoing Sequencer operation. During a science OB execution, this stops the auto-guider and the image acquisition.
- ABORT & STOP TELESCOPE → stops any ongoing Sequencer operation. During a science OB execution, this stops the telescope tracking, the auto-guider and the image acquisition.

Current OB Status | Detector & Slit Position

At any given moment, these two panes display the state of the ongoing operations, including the detector, AG, OB and Sequencer status.

Current OB status pane provides info on the NSTS OB being executed. See 4 for more information on the NSTS and OBs.

- OB Block ID → the ID of the OB in the NSTS.
- OB Block Name → the type of the OB, either SCI or CALIB.
- Template ID → the ID of the template inside the OB.
- Template Name → template name.
- Sequencer State → one of the Sequencer states, as FINISHED, ABORTED, CONFIGURING or WAITING_CLICK.

Detector & Slit Position pane informs on the detector status, frame, group and pair number progress, as well as (when applicable) current position on which the AG is guiding and spectra are obtained.

- Detector status → one of the detector states, like Unknown, INTEG, READ or DWNLD.
- Frame Counter → ramp segment counter (i-th of n frames) and progress bar.
- Group Counter → group number counter, similar to above. Disabled during nodding observations (see 4).
- Pairs Counter → pairs number counter, similar to above. Enabled only during nodding observations.
- Slit Position → slit position on which the AG is guiding, one of A, B or C values.

Acquisition Control

During a science OB execution, this pane (Figure 12) provides sky image acquisition, field re-centering and source analysis functions.

- Add Magnitude → adds the specified value to the target magnitude present in the OB. The resulting magnitude is used to set the exposure times of the AG image acquisitions.
- Expose → takes an acquisition image.
- Re-Start DS9 → restarts ds9 in case it is not already running.
- Repoint → moves the telescope to re-position the point on the sky indicated by the ds9 crosshair to the AG "C" position. After the telescope is moved, a new acquisition image is obtained. If a source is present close to the crosshair, the peak position of the source will be used, otherwise the exact pixel position of the crosshair.
- Go → re-points as above, but without obtaining a new acquisition image, then starts the auto-guiding and science spectra integration.
- Repoint on exact pixel → if checked, this forces the Repoint or Go commands to use the exact pixel position of the ds9 crosshair.

When an acquisition image with a target star source is present on the ds9 window, the "Source Fit Analysis" pane subsection will display the information on the Gaussian fit parameters of the source closest to the crosshair position. The parameters will be displayed when "Fit" button is pressed, as well as when "Repoint" or "Go" commands are issued.

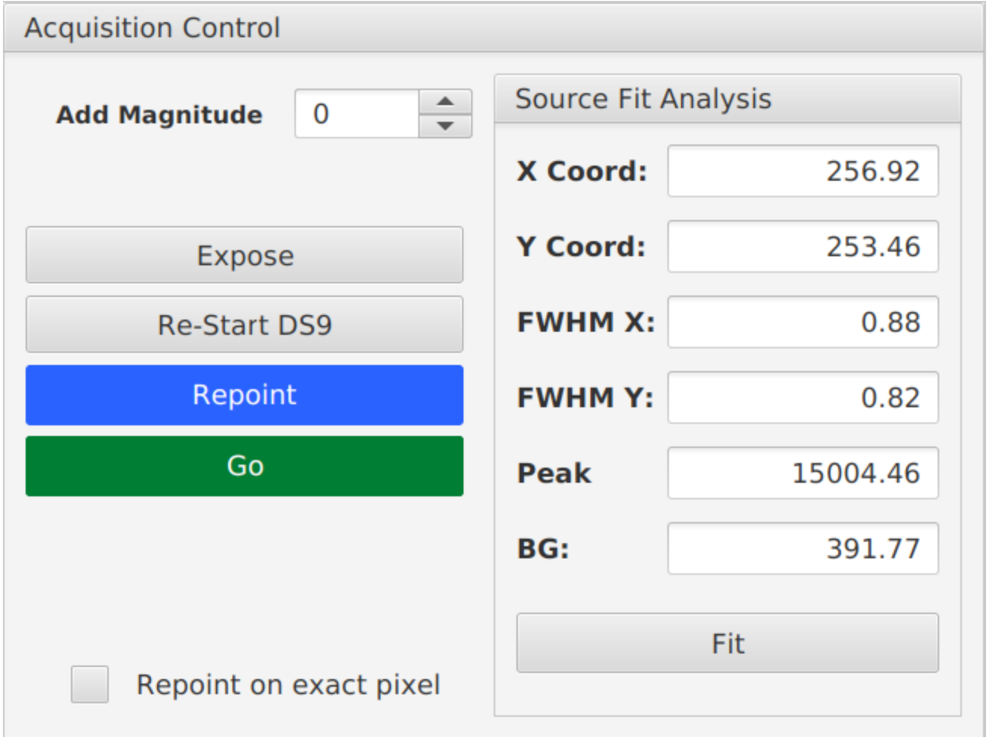


Figure 12. Acquisition Control pane of the Sequencer GUI.

- X Coord → X pixel coordinate of the source center obtained from the fit.
- Y Coord → Y pixel coordinate of the source center.
- FWHM X → the FWHM in arcseconds of the fit in image X direction.
- FWHM Y → the same as above, but in Y direction
- Peak → the peak value from the fit.
- BG → the background value from the fit.
- Fit → execute the fit procedure.

Instrument Setup | Detector Status

- Set GIANO / Set GIARPS → moves the LRS Entrance Slider and Frame to specific positions in order to allow the light from the telescope to reach GIANO-B (or to enable GIARPS mode, if "Set GIARPS" is used).
- Start Detector → establishes the communication with the detector control software.

Auto-guider Status | Pre-slit Status

These leds indicate whether AG software and Pre-slit service are running. Also, for the AG, the corresponding label indicates the AG operation mode.

Calibration Lamps Status

The indicators on this pane show the real-time status of the calibration lamps.

3.2 Execution of OBs

After a calibration or scientific observing blocks are prepared in NSTS (see 4), the OBs can be sequentially loaded into and executed by Sequencer.

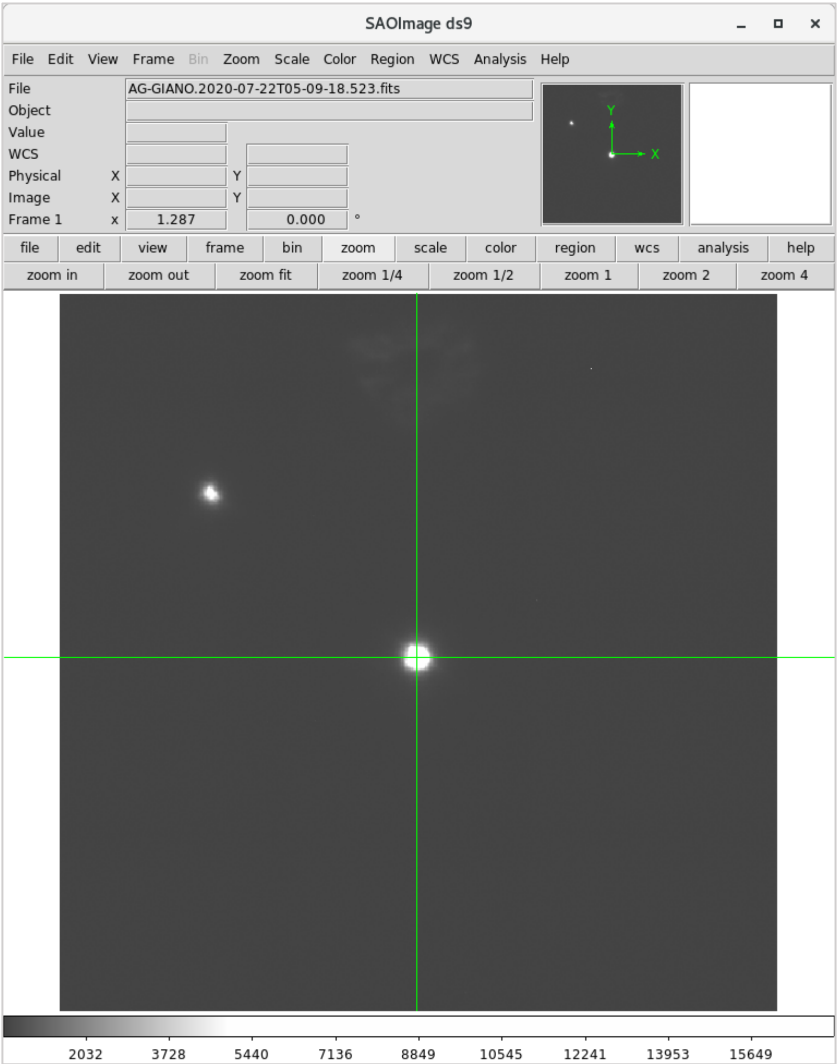


Figure 13. The Sequencer SAOImage ds9 window showing an AG acquisition image.

To obtain calibration frames, the corresponding OB has to be loaded into Sequencer by clicking Next OB button (see 3.1). After this, no other action is required from the observer as the sequence of the commands including corresponding pre-slit setup and detector acquisitions will be carried out by Sequencer. While the exposure ramp segments are obtained, the current last and the first ramp segments image subtraction will be instantaneously displayed in the ds9 window (Figure 10). As ramp segments are taken every 10 seconds, the ds9 image will be updated every 10 seconds during the entire ramp exposure. In parallel, the acquired frames are sent to the Online Data Reduction Software (DRS) for their processing (see 8).

In order to carry out on-sky observations of a scientific target, the typical actions by the observer and Sequencer are as follows:

observer		**Sequencer**
1. load the scientific OB using "Next OB" command (see 3.1)	→	slew the telescope and acquire an AG field image once on the target
2. identify target, re-point using the Acquisition Control pane commands and the AG image in ds9 window (Figure 12 and Figure 13)	→	telescope offset, start auto-guiding, detector integration, dispatching frames to the Online DRS
		end of execution

For target identification, the ds9 crosshair has to be placed on the target in the AG acquisition image (Figure 13). Then, either "Repoint" or "Go" commands (see 3.1 and Figure 12) can be issued. Also, a new AG acquisition image can be obtained using "Expose" command, if needed.

The "Expose" and "Repoint" command combination (see 3.1 and Figure 12) can be used as many times as necessary, in order to verify the target identification and on-slit centering. After that the "Go" button has to be clicked, and Sequencer will continue the operations, instructing AG to start guiding and then the spectrograph detector to start image acquisition.

4 NSTS Operation Guide

GIANO-B New Short Time Scheduler (NSTS) is used to prepare, modify and schedule the Observing Blocks (OB). These blocks are predefined groups of available instrument and telescope commands and procedures that can be executed by the Sequencer. Even if all of them are referred to as "Observing" Blocks (OBs), there are three types of OBs and not all of them are for actual on-sky observations:

- **Observing OBs.** These OBs, containing "Obs" in their name, are for scientific on-sky (usually night time) observations. There are three predefined Obs OBs: "OB_Obs_NoddingAB", "OB_Obs_StareObjSky" and "OB_Obs_Stare". Please see 4.1 for their description.
- **Calibration OBs.** These OBs contain "Cal" in their name and are used for calibrations. The following predefined Cal OBs are currently in use: "OB_Cal_Dark", "OB_Cal_Flat" and "OB_Cal_UNe". Please see the instructions in 6 on how to carry out the calibrations and the corresponding OBs to be used.
- **Technical OBs.** These OBs are used for technical tasks like instrument initialization (for instance, Start INS or AG Init commands in **Error! Reference source not found.** a re executed via Technical OBs), they also can be used for other engineering operations. Technical OBs are not supposed to be created and executed by the observers.

Once an OB-list is prepared and ready in NSTS, the OBs of the list are picked and executed by the Sequencer in the exact same sequence present in NSTS. The OBs can be prepared and modified using NSTS in the TNG Control Room immediately before or during the observations (online mode), they can also be prepared well in advance of the observations (offline mode) without a need to be at the Telescope. NSTS can be set and working in online mode only on brunello machine in the TNG Control Room and only when Sequencer is running. NSTS binary can be downloaded and used in offline mode on any other computer, without the need of communication with Sequencer.
To start-up NSTS, please follow the instructions of the corresponding section in 0.
The NSTS workflow consists of the following actions: create a new OB, modify it as needed, move it to the desired position within the sequence of other already loaded OBs.

4.1 Observation modes and corresponding OBs

Three observation modes are possible with GIANO-B. Each of them has its particularities and requires its own Obs OB type.

In-slit A-B nodding observations

During this type of observations, the object is placed on, observed on and switched between predefined A and B positions in the slit. This operation is repeated the desired number of times. The NSTS OB to carry out AB nodding observation is "**OB_Obs_NoddingAB**".

Object-sky stare observations
In such observations, the object is placed and observed (once or more consecutive times) in one of the predefined positions within the slit, then the telescope points to a different part of the sky and one or more observations (of sky) are taken. The number of exposure repetitions can be set as desired. The OB for this type of observation is "**OB_Obs_StareObjSky**".

Stare (standalone) observation
This standalone observations (exposures) of the object are not coupled with any subsequent sky ones. The target can be observed on any on the predefined slit positions and as many times as desired. The OB for standalone stare observation is "**OB_Obs_Stare**".

4.2 Creating a new OB

There are two ways of creating a new NSTS "Observing" (Obs) OB: through the direct commands on the GUI or through an NSTS Catalog. In the former case, "Insert OB" menu item and its sub-items are used to select and create a new Obs OB, while in the latter case an entry (or a number of them) is loaded from a Catalog creating thus a new OB. 4.4 explains how to prepare an NSTS Catalog. The Obs OBs created both ways are identical, however the use of a Catalog provides a more streamlined procedure to create multiple Obs OBs. The "Calibration" (Cal) OBs can only be created through NSTS GUI menu commands.

Create a new OB via GUI menu commands
To create a new OB directly through the GUI menu, go to File → Insert OB and select one of the Cal or Obs OBs. The OB will then load into the OB list. There is also a shortcut for the Insert OB command (Figure 14).

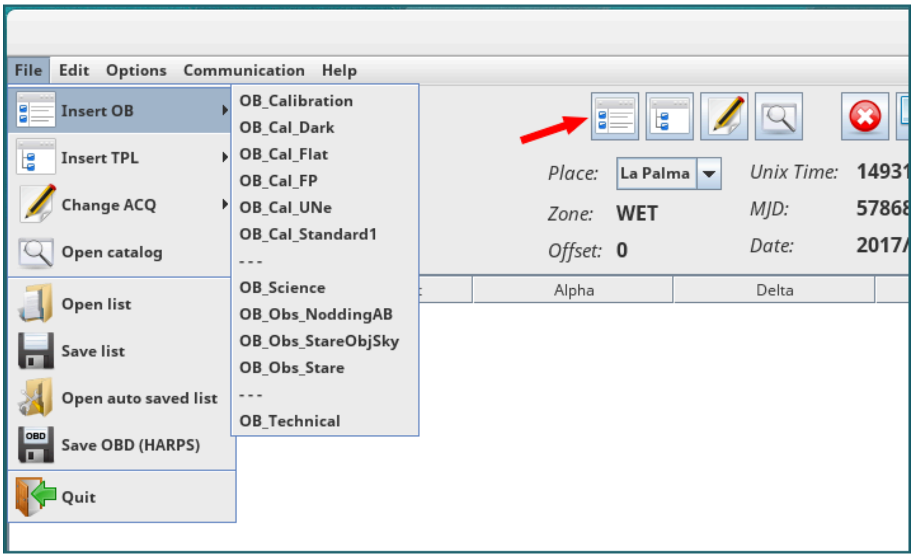


Figure 14. NSTS GUI part. Insert OB command of the menu with available OB selection, and with the red arrow indicating Insert OB shortcut.

Create a new OB via Catalog

In order to create one or more Obs OBs, click on File → Open Catalog (as can be seen on Figure 14) and look for the desired catalog on the file system. Once a catalog is open, its various entries will be shown in the NSTS catalog target selection tool window as a number of lines (rows) as shown in Figure 15. Select the necessary OB or multiple OBs and click on "SEND" button to send them to the NSTS. Also "SEND ALL" can be used, to load all catalog entries into NSTS.

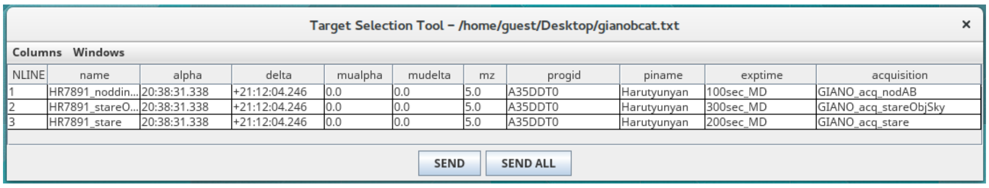


Figure 15. The NSTS catalog window with several catalog entries present.

4.3 Modifying an OB

Once the OBs are loaded into NSTS, their different parameters can be modified if needed. Some of the parameters are common to all three types of Obs OBs, while others can be set or modified only for one or two of them. The OB parameters are shown on the right-side pane of the NSTS GUI and are organized in different tabs. The parameters that can be modified by the user are those found in the following tabs:

- Template → MAIN PARAMETERS
- Template → TEL
- Template → GUIDING
- Observation → OB Keywords

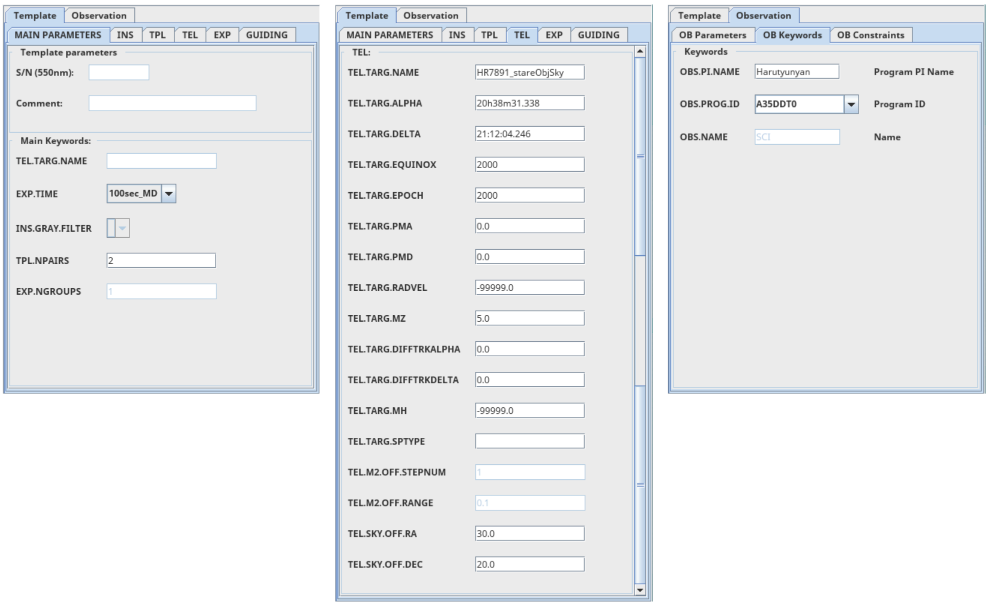


Figure 16. NSTS Template → MAIN PARAMETERS, TEL and Observation → OB Keywords parameter tabs.

A care has to be taken when editing the values of text input fields: the fields will be colored in red during the modification and the new values will be accepted only when Enter is issued on the field.

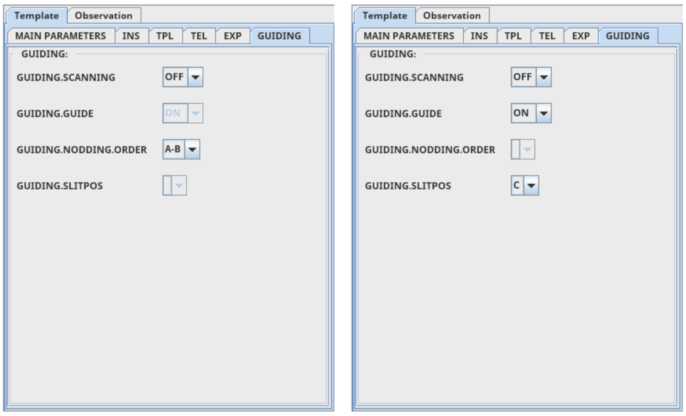


Figure 17. The NSTS Template → GUIDING parameter tabs for NoddingAB (left) and StareObjSky (right) OBs.

4.3.1 Common parameters for all Obs OBs

The list of parameters that can be modified in any Obs OB and their format and description are as follows:

Template → MAIN PARAMETERS tab (Figure 16)

- TEL.TARG.NAME – the object name

- EXP.TIME – exposure time of single exposure, had to be one of the predefined values and is expressed in seconds with trailing “sec_MD”.

Observation → OB Keywords tab (Figure 16)

- OBS.PI.NAME – the PI name of the observing program
- OBS.PROG.ID – the ID of the observing program

Template → TEL tab (Figure 16)

- TEL.TARG.NAME – the object name, found also in MAIN PARAMETERS
- TEL.TARG.ALPHA – the object RA
- TEL.TARG.DELTA – the object DEC
- TEL.TARG.EQUINOX – the coordinates equinox
- TEL.TARG.EPOCH – the coordinates epoch
- TEL.TARG.PMA - the object proper motion in RA (arcsec/year)
- TEL.TARG.PMD – the object proper motion in DEC (arcsec/year)
- TEL.TARG.RADVEL – the RV guess, -99999.0 if not known
- TEL.TARG.MZ – object z SDSS magnitude
- TEL.TARG.DIFFTRKALPHA – differential tracking RA (sky motion, in arcsec/hour)
- TEL.TARG.DIFFTRKDELTA – differential tracking in DEC (sky motion, in arcsec/hour)
- TEL.TARG.MH – object H magnitude, -99999.0 if not known
- TEL.TARG.SPTYPE – object spectral type, void if not known

Template → GUIDING tab (Figure 17)

- GUIDING.SCANNING – enable or disable (ON/OFF) the Tip-tilt slit scanning. The default is OFF. This guiding mode is not implemented yet.

4.3.2 OB type specific parameters

Based on the Obs OB type, the following additional parameters are available and can be modified:

OB_Obs_NoddingAB

- Template → MAIN PARAMETERS → TPL.NPAIRS (Figure 16) – the number of AB pairs to be observed. Not available for StareObjSky and Stare OBs.
- Template →GUIDING → GUIDING.NODDING.ORDER (Figure 17) – the order of AB slit positions in which the target is placed and observed. Can be A-B (default) or B-A. Not available for StareObjSky and Stare OBs.

OB_Obs_StareObjSky

- Template → MAIN PARAMETERS → EXP.NGROUPS (Figure 16) – the number of repetitions (groups) of the exposure in the given telescope/slit position, i.e. number of object or sky exposures in this case. Not available for NoddingAB OBs.
- Template → TEL → TEL.SKY.OFF.RA (Figure 16) – the telescope offset in RA in arcseconds, sent after object exposures in order to obtain sky ones. Not available for NoddingAB and Stare OBs.
- Template → TEL → TEL.SKY.OFF.DEC (Figure 16) – the telescope offset in DEC in arcseconds, sent after object exposures in order to obtain sky ones. Not available for NoddingAB and Stare OBs.
- Template → GUIDING → GUIDING.GUIDE (Figure 17) – enable or disable (ON/OFF) the guiding. Normally should be ON for object exposures and OFF for sky ones. Not available for NoddingAB OBs.
- Template → GUIDING → GUIDING.SLITPOS (Figure 17) – select one of the predefined A, B or C slit positions on which the object will be guided and the spectra will be obtained. Default is C. Not available for NoddingAB OBs.

OB_Obs_Stare

- Template → MAIN PARAMETERS → EXP.NGROUPS (Figure 16) – the number of repetitions (groups) of the exposure, supposedly the object ones in this case. Not available for NoddingAB OBs.
- Template → GUIDING → GUIDING.GUIDE (Figure 17) – enable or disable (ON/OFF) the guiding. Normally should be ON for object exposures and OFF for sky ones. Not available for NoddingAB OBs.
- Template → GUIDING → GUIDING.SLITPOS (Figure 17) – select one of the predefined A, B or C slit positions on which the object will be guided and the spectra will be obtained. Default is C. Not available for NoddingAB OBs.

4.3.3 OB parameters set through a catalog entry

An OB loaded through a catalog entry will set only a part of the available parameters. The rest of the parameters available for a given OB will be automatically set to their default values. After a catalog entry is loaded as a new OB, a good practice is to verify and, if needed, modify the parameters. The following parameters are set when a catalog entry is loaded:

TEL.TARG.NAME	TEL.TARG.MZ
TEL.TARG.ALPHA	EXP.TIME
TEL.TARG.DELTA	TPL.NPAIRS
TEL.TARG.PMA	EXP.NGROUPS
TEL.TARG.PMD	OBS.PROG.ID
TEL.TARG.EQUINOX	OBS.PI.NAME

4.4 NSTS Catalog

The NSTS catalog is a text file with a predefined format which can be parsed by NSTS. The catalog is a convenient way of loading multiple OBs into NSTS. Any text editor can be used to create a catalog, as far as its formatting requirements are met (Figure 18).

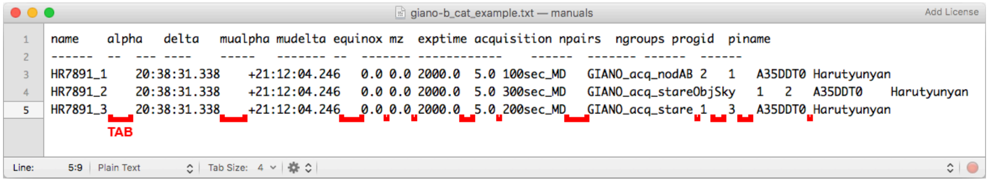


Figure 18. An example catalog in a text editor window with the tabs indicated in the last row.

All catalog fields are mandatory. Tab characters have to be used as separators between values of the catalog fields. The catalog fields, value formats and their descriptions are listed below.

name	The object name, e.g. “HR7891”
alpha	The object RA in hh:mm:ss.sss format, e.g. “20:38:31.338”
delta	The object DEC in dd:mm:ss.sss format with +/-, e.g. “+21:12:04.246”
mualpha	The object proper motion in RA in arcsec/year, e.g. “0.0723”
mudelta	The object proper motion in DEC in arcsec/year, e.g. “0.2145”
equinox	The coordinate system equinox, normally (J) “2000.0”
mz	The object z SDSS magnitude, e.g. “8.5”
exptime	The time of single exposure in seconds and in “<nsec>sec_MD” format, e.g. “300sec_MD”. The nsec has to be one of the predefined 10, 30, 60, 100, 200, 300 and 600 values.
acquisition	Acquisition template name. This string (selector) will identify the corresponding OB. The possible three values are GIANO_acq_nodAB, GIANO_acq_stareObjSky and GIANO_acq_stare.
npairs	Number of AB pairs to be observed, e.g. “3”. This field value is only applicable to nodding exposures, i.e. when the acquisition value is “GIANO_acq_nodAB”. In the rest of the cases this has to be set to “1” and any other value will be ignored.
ngroups	Number of exposure repetitions, e.g. “2”. This field value is only applicable to stare exposures, i.e. when the acquisition value is “GIANO_acq_stare” or “GIANO_acq_stareObjSky”. In the “GIANO_acq_nodAB” case this value has to be “1” and any other value will be ignored.
progid	The observing program ID.
piname	The observing program PI name.

Once the catalog file is ready, it can be opened and its entries loaded into NSTS following the steps described in 4.2.

5 AG Operation Guide

GIANO-B AG performs guiding on the same scientific target exposed by the spectrograph. During a scientific exposure, the AG maintains the target on one of the predefined “A”, “B” or “C” positions of the spectrograph slit. If required by the science OB, the position on which the AG keeps the target can be changed between the exposures (e.g. alternating between “A” and “B”).

Before a scientific exposure, acquisition images obtained by the AG are used for target identification and target positioning on the slit. The AG is also used in the afternoon during the slit auto-calibration procedure (see 7).

The predefined ABC positions are read from the telemetry every time AG software starts up. Also, these positions can be read from the telemetry through a dedicated command (see 5.3), if AG is already running.

The AG has a standalone software application with a GUI. During an OB execution the intended use of AG is via Sequencer remote commands, that include the main and most frequent AG operations. However, some operations like telescope focusing, guiding box selection, etc., have to be done directly through the GUI. Also, operation interruptions or software restarts in case of technical problems may sometimes require direct GUI use.

It is important to ensure that the AG is not operated simultaneously from Sequencer and from the GUI as the concurrent commands will conflict causing AG failure.

5.1 GUI structure and commands

The AG GUI consists of a number of sections, which are described below.

AG image section and corresponding controls and fields

This area itself consists of the following subsections: image statistics area, zoom window, main display area and scrollbar (Figure 19).

Once an AG image is obtained, it is displayed in the main display area and a 100x100 pixels box centered on the cursor position is displayed in the zoom window.

A compass can be overlaid on the image in the main display area, indicating current on-sky N-E directions, using Utilities → Display Compass menu item command. Also, Utilities → Display AZ/EL Axis menu command draws azimuth and elevation axes.

The statistics area provides basic image information under a mouse cursor position or within a 20x20 pixels box centered on the cursor position. A left mouse button click on the image is needed in order to set the cursor position. The information fields are as follows:

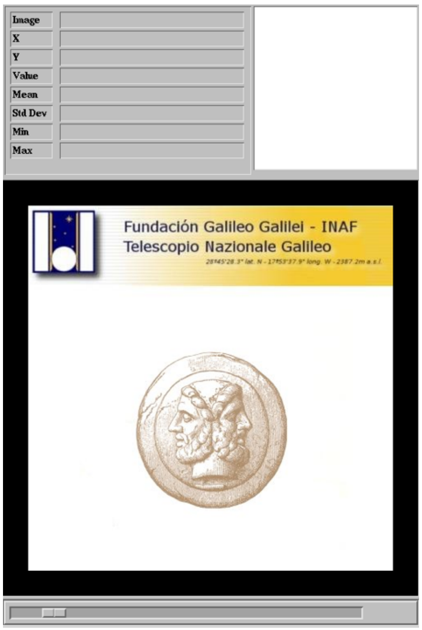


Figure 19.The AG GUI image display.

- Image → image FITS file name,
- X → cursor position X image pixel coordinate,
- Y → cursor position Y image pixel coordinate,
- Value → the image value on the cursor pixel position,
- Mean → mean image value within the box,
- Std Dev → standard deviation of image values within the box,
- Min → minimum image value within the box,
- Max → maximum image value within the box.

At bottom, below the main image window, there is a scrollbar allowing image display scale changes.

A number of basic image analysis tools are available for the image display. Once a left mouse click is done on the image, one of the following key commands can be invoked and the results of the command execution will be displayed in a separate window:

- c → plot image column at the cursor position,
- l → plot image line at the cursor position,
- e → make a contour plot of the box centered on the cursor position,
- s → make a surface plot of the box centered on the cursor position,
- k → make a Gaussian fit along the column at the cursor position,
- j → make a Gaussian fit along the line at the cursor position,
- g → make a two-dimensional Gaussian fit at the cursor position,
- q → close the plot window.

All the above functionalities are enabled both when single acquisition images are obtained and when the images are obtained in automated manner during auto-guiding. However, during auto-guiding these commands may not be very responsive.

Operation log section

The real-time operation log is displayed in this window (Figure 20), both when the guiding is active and not.

Figure 20. The AG GUI part with log section.

GIANO guiding mode section

In this section, the two "GIANO" and "GIARPS" buttons allow to select the AG operation mode. Obviously, GIANO-B observations require "GIANO" mode to be selected. This is accomplished by the Sequencer AG Init command, or, if needed, clicking the corresponding button here. The area in between the two buttons is an indicator of the currently selected AG operation mode.

Figure 21. AG GUI part with guiding mode selector.

Autoguide controls section

Autoguider controls allow to start and stop autoguiding via the two corresponding buttons. Also, the status of the autoguiding (ON or OFF) and the position on which the autoguiding is done (A, B, C or N/A when not guiding) are shown.

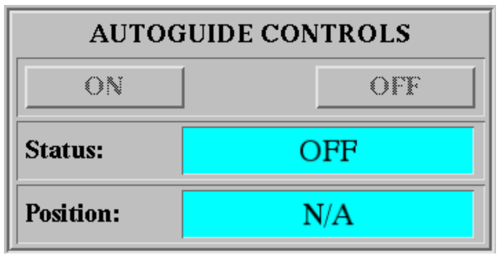


Figure 22. AG GUI part with autoguiding controls.

Telescope movements section

As the name indicates, "Move telescope to center the star" button in this area sends and offset to the telescope in order to bring the target to the center position. Also, manual telescope offsets can be sent, specifying the offset length in AG image pixels in the "Offset (pixels)" text field and then clicking one of the four directional buttons with arrow. Obviously, the requested pixel offset length and direction will be transformed in actual telescope movement length and direction that will yield the desired result on the AG image.

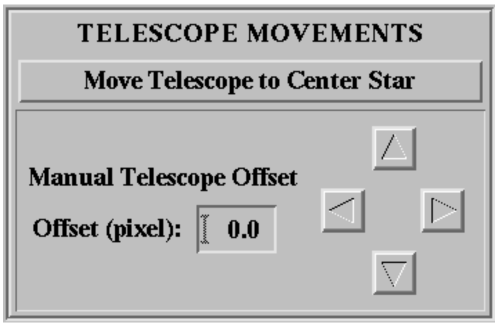


Figure 23. AG GUI part with telescope movements commands.

CCD setup section

"Shot", "Cycle" and "Stop" buttons in this section acquire a single AG image, start automated AG image consecutive acquisition cycle and stop an ongoing cycle, respectively. "Status" read-only field displays the current image acquisition status. An exposure time in seconds for image acquisition can be specified in the "Exposure time" field. Once the exposure time is set, any shot or cycle command will use that time to obtain AG images. If, however, the autoguiding command is received from Sequencer, the exposure time for the image acquisition will be the one requested by Sequencer command.

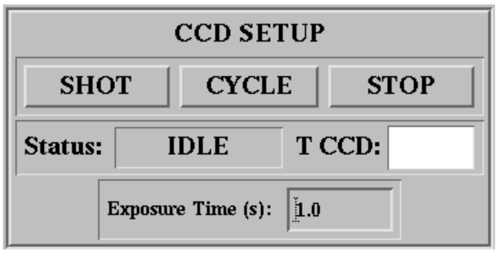


Figure 24. AG GUI part with ccd setup controls.

Filter setup section

The "Filter" field in this section indicates the current AG filter used. Filters can be inserted or removed through "Filter Manager" menu of the GUI. The possible choices are FILT002, FILT033, FILT450, CLOSED, OPEN, PUPIL LENS. After the filter is set (or removed), it will be used in the Shot or Cycle commands of the GUI. When the autoguiding request is received from Sequencer, the filter is set according to the request and the manual choice through the GUI can be overridden.

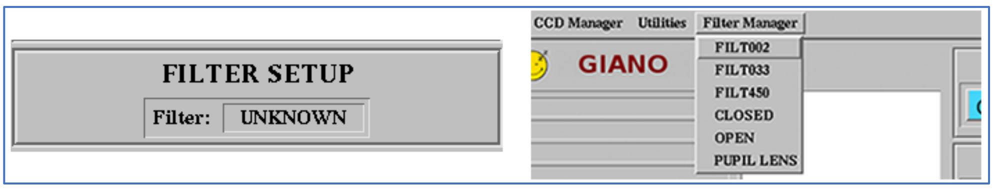


Figure 25. AG GUI with box controls area and Filter Manager menu items.

Box controls section

Guiding box dimension can be selected through the "Size of the box" pull down menu in this section. The box size is in arcseconds, and available sizes are 2x2 through 6x6 arcesconds. Once a new box size is selected, a mouse click on the AG image area is needed to effectively set the new box. On AG start-up, the smallest box size of 2x2 arcseconds is selected by default.

As the name indicates, "Center box on the star" button click will move the box through the image in order to position the target at its center.

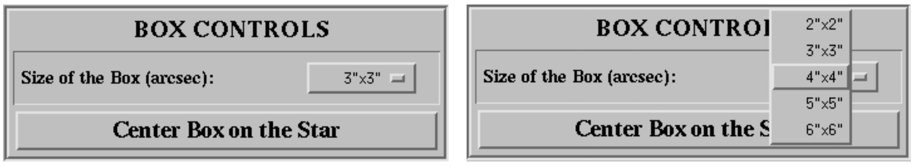


Figure 26. AG GUI part with box controls.

Autoguiding graphs section

The rightmost part of the GUI hosts four plots that refresh in real-time when the autoguiding is on, to show its performance. The plots, from top to bottom, show the evolution of:

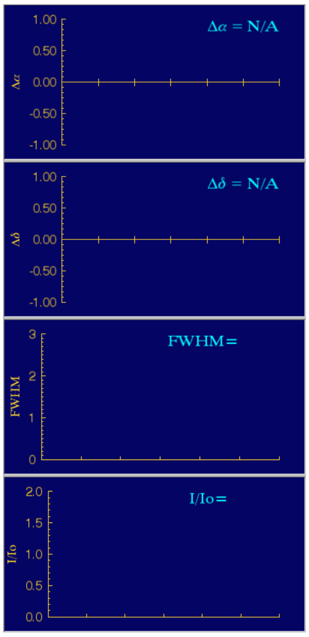


Figure 27. AG GUI part with plots area.

- RA offsets in arcseconds,
- DEC offsets in arcseconds,
- target's FWHM in arcseconds,
- target's relative intensity.

5.2 Telescope focusing using AG

Besides their main use for guiding, the AG images can also be used for telescope focusing. The M2 focus model should in principle set the telescope focus automatically at every telescope pointing, based on the temperature and telescope elevation. However, the model performance has to be monitored and when the automatic focusing is not satisfactory, a "manual" focus refinement procedure should be carried out using the AG images.
The procedure consists of taking a series of AG images with a target star, changing M2 position for each image. The M2 is finally set to the position in which the target star's FWHM is the smallest.
To do this, first a target star is pointed, then the AG images are obtained using the "Shot" command described in 5.1. If needed, the exposure time in seconds is adjusted in the Exposure time box in CCD setup section. Also, a filter can be inserted through the Filter manager menu. On the image, a mouse click has to be done on the target and then "g" key command for two-dimensional Gaussian fit is used to evaluate the FWHM, as described in 5.1. These steps are repeated several times, slightly changing the M2 position in between the images, until the best M2 focus position is identified. The M2 is then set to this position.
During prolonged observations of the same target (e.g. exoplanet transit observations) the telescope can sometimes gradually go out of focus due to elevation or more rarely temperature changes. In those cases, too, the focusing has to be corrected manually.

5.3 Updating "ABC" slit positions

As written above, the auto-guiding is performed on 3 predefined "A", "B" and "C" positions on the slit of the spectrograph. The pre-slit tip-tilt mirror is used to switch the target between these positions. The AG software fetches these positions from the telemetry at the moment of the start-up. In case a new slit auto-calibration (7) is carried out and new ABC positions are defined while AG is running, then the new positions will not be available to the AG software until they are explicitly reloaded.
In order to read new values, File → Reload Configuration command from the GUI menu has to be executed.

6 Standard calibrations

The standard calibrations consist of sets of Dark, Flat and U-Ne exposures with predefined exposure times. Dark and Flat images have to be obtained in the afternoon before night-time observations. U-Ne images however shall not be carried out before scientific observations, as this lamp exposures have considerably higher detector persistence charge especially in highly exposed or saturated regions. Taking into account these persistency issues, the U-Ne images have to be taken immediately after the end of the scientific observations when there is a time window of at least 6-8 hours after the next ones start.

Calibrations in the afternoon

The standard calibration session in the afternoon consists in obtaining a set of 7 Dark and 7 Flat images. The exposure times for both Dark and Flat images are of 100 seconds. With this configuration, the total time necessary to carry out the afternoon calibrations is around 35 minutes.

In order to execute the calibration exposures, the corresponding calibration OBs have to be loaded in NSTS and executed by the Sequencer.

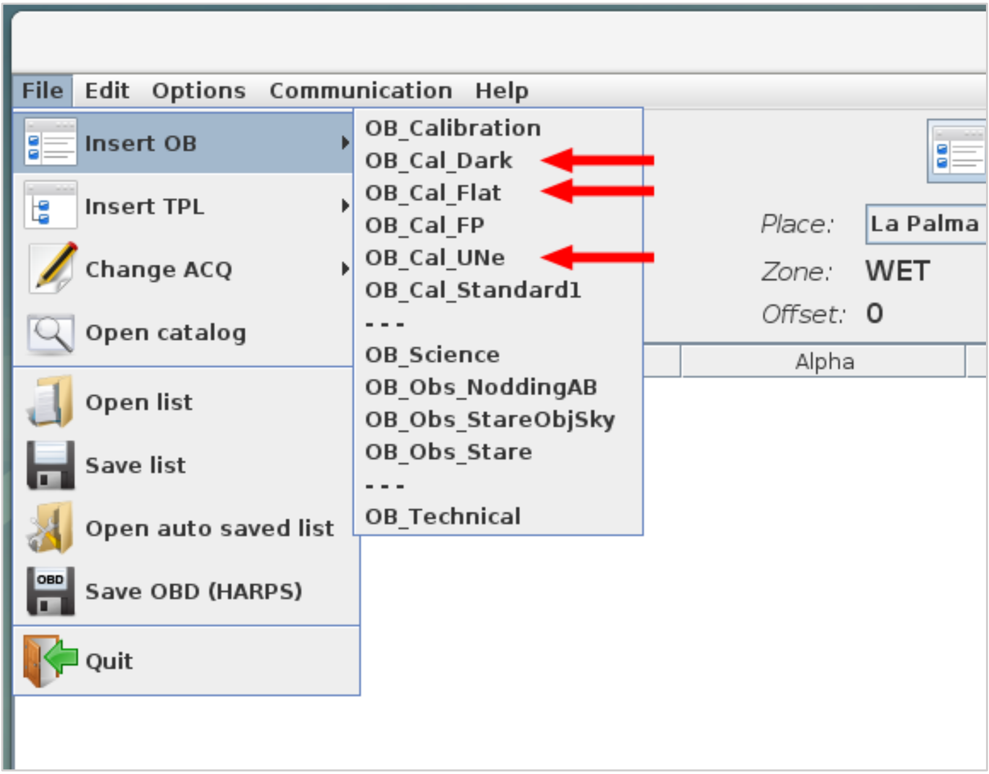


Figure 28. NSTS GUI part. The menu items with Calibration OBs are shown with the arrows.

OB_Cal_Dark and OB_Cal_Flat OBs have to be chosen in the File → Insert OB menu section of NSTS, as shown in Figure 28. The Dark and Flat OBs will be loaded into NSTS with default exposure times of 100 seconds and default number of exposure repetitions of 7 (Figure 29). Check these values in NSTS and modify them if needed.

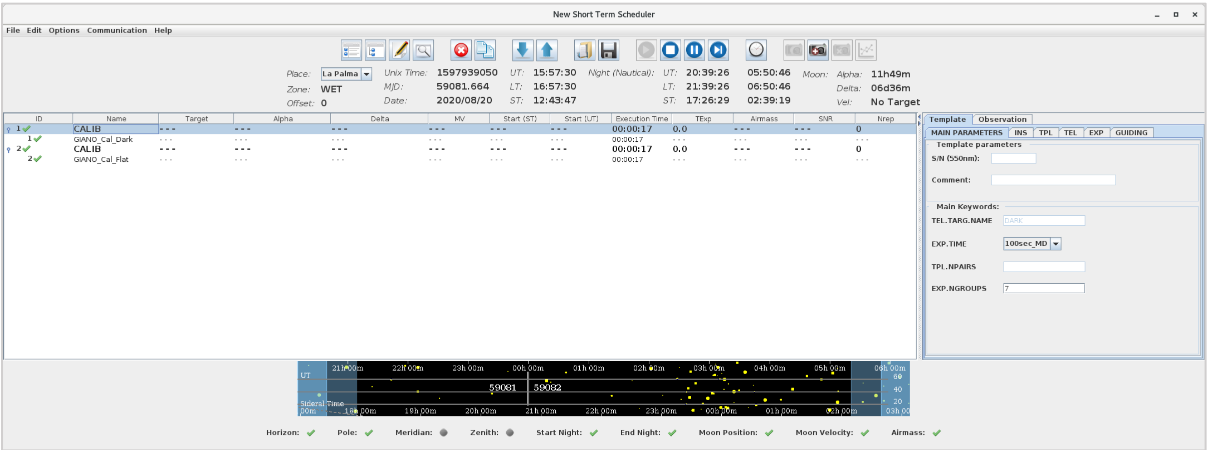


Figure 29. NSTS window with Dark and Flat calibration OBs loaded.

Once the OBs are ready in NSTS, they can be executed by the Sequencer "Next OB" command. While the calibration images are obtained, the operations progress can be seen on Sequencer, with the corresponding frames displayed in real-time in the SAOImage ds9 window (Figure 30).

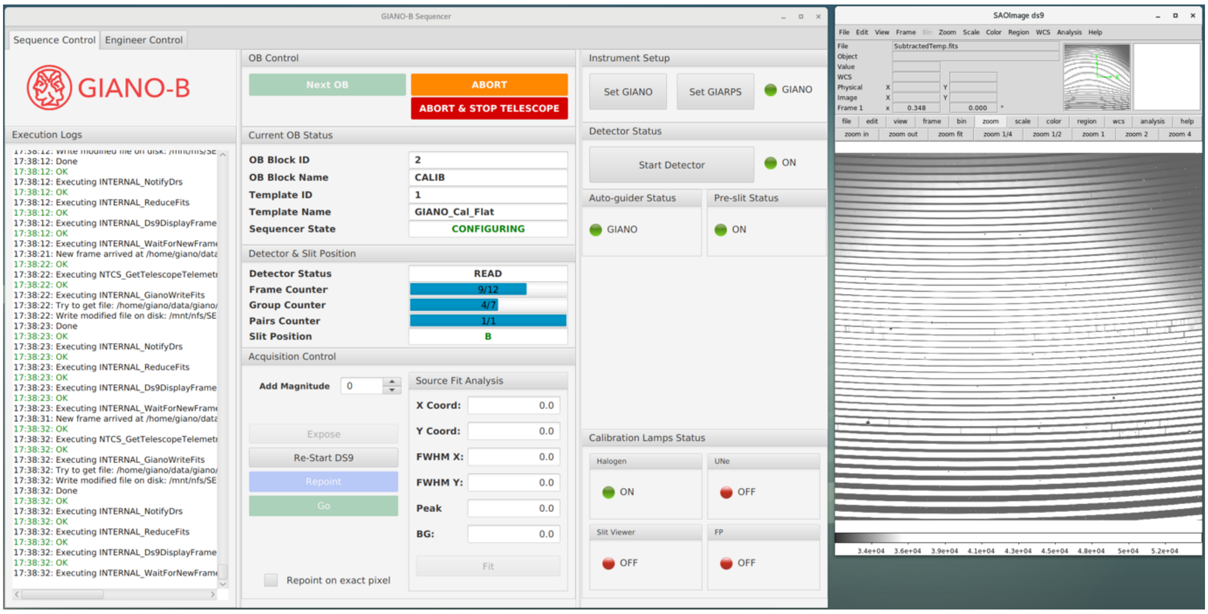


Figure 30. Sequencer GUI during Flat calibration exposures.

Shortly after each (Dark or Flat) OB execution the outcome of corresponding calibration data processing can be verified through the Online DRS Web User Interface (see 8). On the Web Interface, each calibration OB processing will create an entry in the "Calibrations" section (Figure 37). If the processing has no issues and data passes the quality checks, the status column shows "OK", otherwise "NOT OK".

Calibrations immediately after the scientific observations

A single U-Ne exposure has to be obtained as soon as the scientific observations are finished. The exposure time for U-Ne image is 100 seconds. Corresponding predefined calibration OB called OB_Cal_UNe (Figure 28) has to be loaded into NSTS and executed by Sequencer. As with the calibration OBs above, also the processing status of the U-Ne one is shown and can be verified in the Calibrations section on the Online DRS Web User Interface.

7 Slit auto-calibration

Point source targets are observed with GIANO-B on one of the 3 possible predefined positions on the spectrograph slit. These positions, conventionally called "A", "B" and "C", are located at around the ¼, ¾ and ½ of the slit length along spatial axis, respectively ("C" loosely standing for "center").

The ABC positions are mapped to the AG sensor pixel positions through the slit auto-calibration procedure. Once these three points are defined on the AG frame, the auto-guiding of the scientific targets can be performed on these positions.

Figure 31. Slit-AG auto-calibration web interface start page with default automatic mode active.

The slit auto-calibration can be performed during both day and night time. When the auto-calibration is ongoing, no observations or any other calibrations can be done with the spectrograph. Since the slit to AG relative position can slightly change during the time due to instrumental drift, at least one auto-calibration procedure has to be done every afternoon preceding observations. If necessary, the auto-calibration can be repeated during the night for even higher precision of slit positioning.

The slit auto-calibration has to be carried out through a specially designed web-based interface. The interface can be accessed using "**GIANO-B Slit Calibration**" shortcut launcher located in the "GIANO-B" folder on brunello Desktop (Figure 2). The interface can also be accessed opening **http://giano-preslit.tng.iac.es/calibrations/** URL in a web browser.
The web interface can perform the auto-calibration as either an automatic all-in-one or interactive step-by-step procedure. The automatic mode is currently recommended.

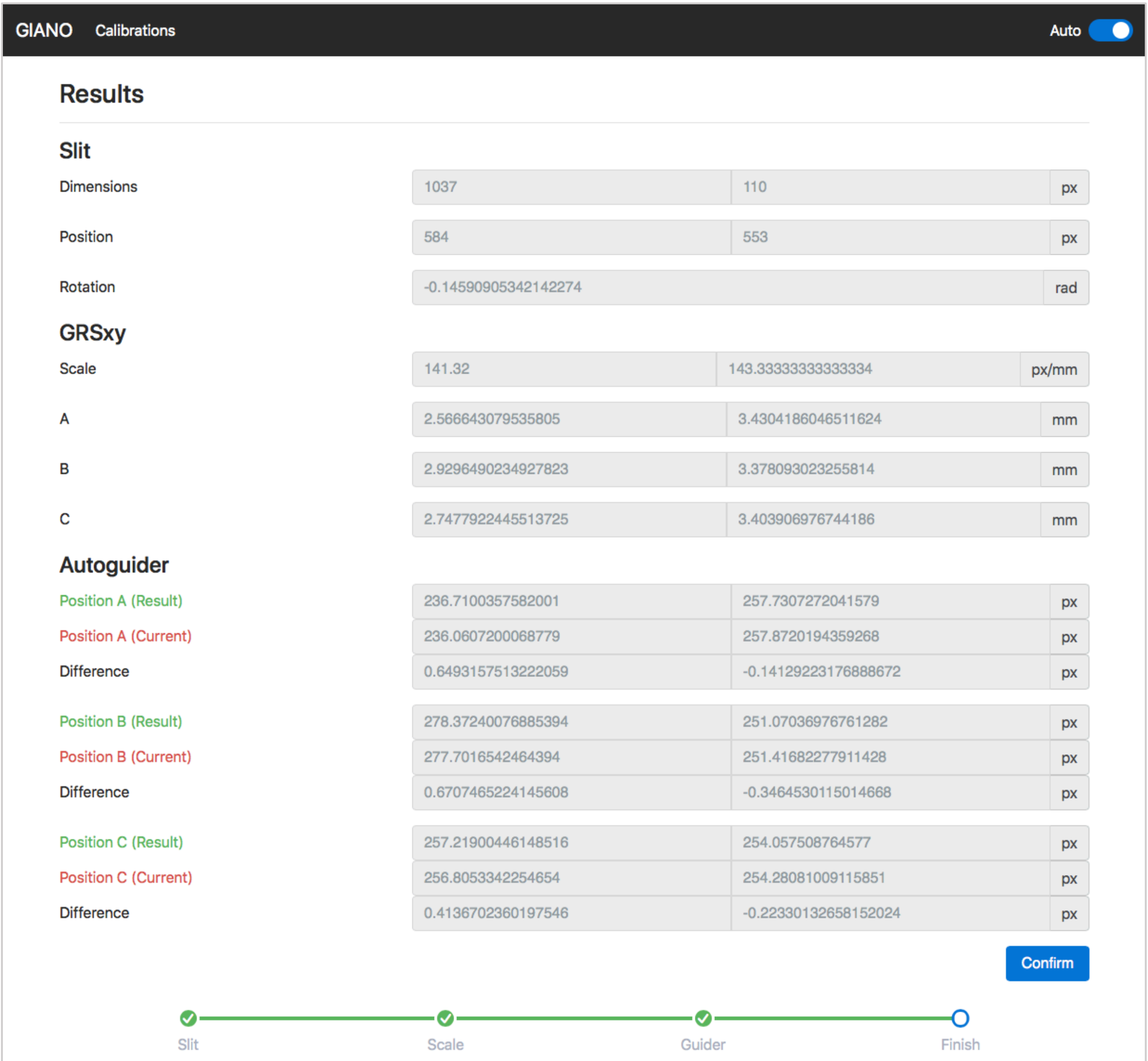


Figure 32. Slit-autocalibration results confirmation page.

Before starting the slit auto-calibration, it is important to ensure that the GIANO-B AG is running, otherwise the procedure will fail.

Once the interface is loaded (see Figure 31), by default the automatic mode of the procedure will be active as indicated by the "Auto" mode switch. The slit auto-calibration is started clicking the "Start" button on the interface.
All the different steps of the procedure will be performed in a sequence and the final page with the outcome of the calibration results will be displayed as in Figure 32. In order to write these results into the telemetry from where the AG can fetch and use them, the "Confirm" button has to be clicked and a feedback message will indicate that the operation is successful.
If the results of the slit auto-calibration are not reliable due to a problem during the procedure, a warning message will appear above the "Confirm" button (Figure 33). As also urged in the warning message, the auto-calibration has to be repeated. If the second attempt does not yield valid results either, the instrument scientist has to be contacted.
It is important to ensure that after any new slit auto-calibration, the updated results are reloaded into the AG, as described in 5.3.

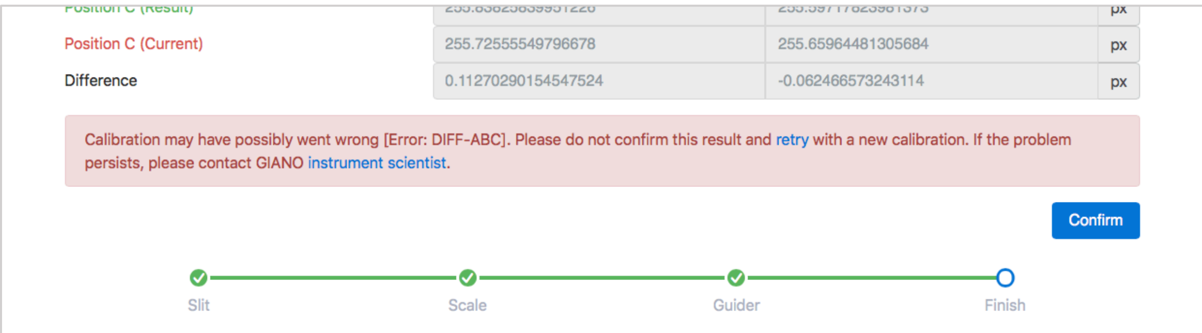


Figure 33. Slit auto-calibration results page part with a warning message.

8 Online Data Reduction Software (DRS)

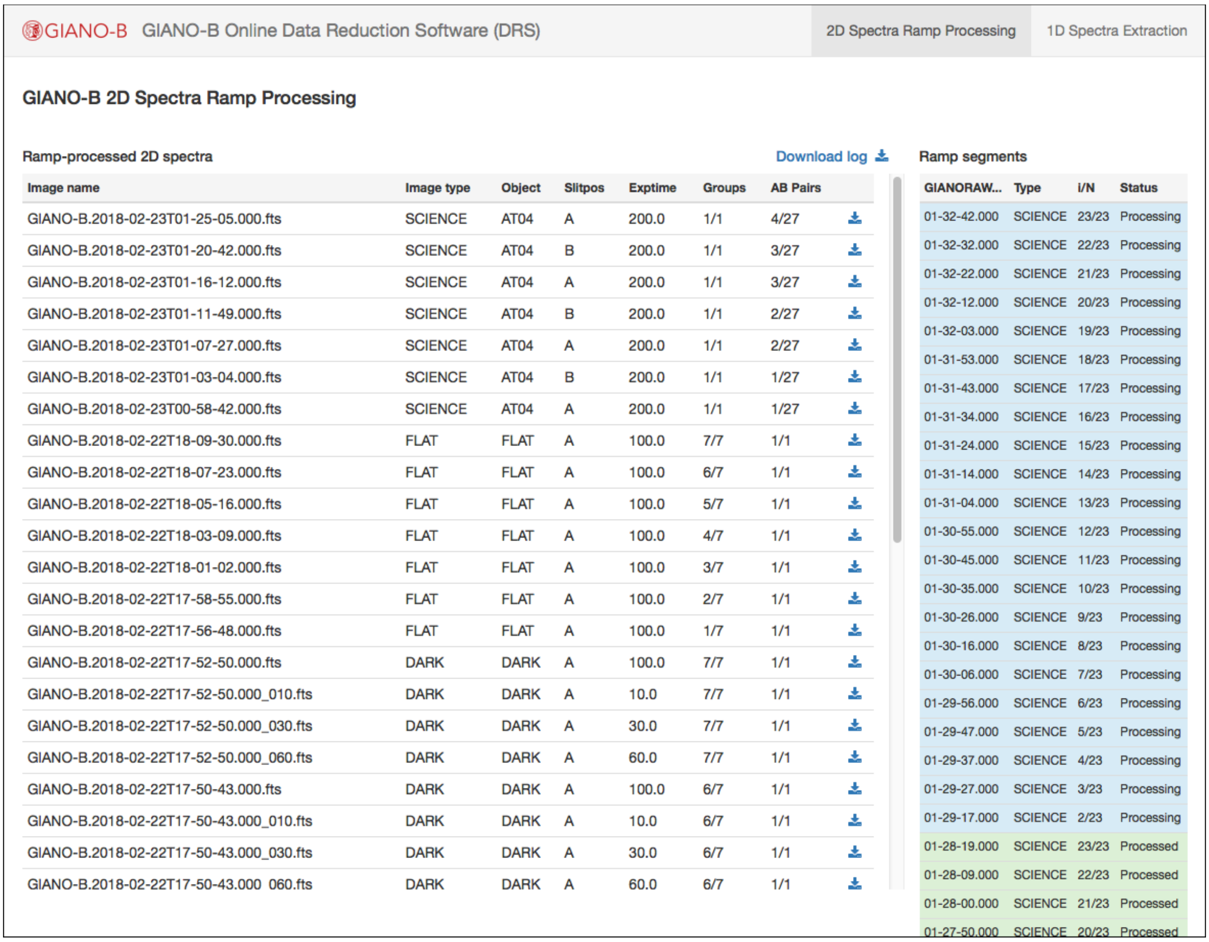
Online DRS provides real time data processing and archival of GIANO-B 2D and 1D spectra, as well as a web-based user interface (UI). **GIANO-B Online DRS** shortcut launcher from the "GIANO-B" folder on brunello Desktop (Figure 2) has to be used in order to access the DRS user feedback and control interface. The interface can also be accessed typing **http://gianodrs.tng.iac.es/drs/** URL in a web browser. Figure 34 shows the Online DRS Web UI default screen, once it is loaded as described above. Parts of the Online DRS such as exposure ramp-processing or data archival are always running, while the others have to be turned on (see below).

Figure 34. The Online DRS Web UI.

It is important to note, that, given the definition of the Online DRS, the Web UI will only display the information relative to the data processing being carried out in real-time on the current date, for any given day or night.

2D Spectra Ramp Processing Tab

When the Online DRS Web UI is opened, this is the tab that is loaded by default. This tab shows the 2D spectra creation through real-time exposure ramp processing.



GIANO-B GIANO-B Online Data Reduction Software (DRS) — 2D Spectra Ramp Processing — 1D Spectra Extraction

GIANO-B 2D Spectra Ramp Processing

Ramp-processed 2D spectra — Download log

Image name	Image type	Object	Slitpos	Exptime	Groups	AB Pairs
GIANO-B.2018-02-23T01-25-05.000.fts	SCIENCE	AT04	A	200.0	1/1	4/27
GIANO-B.2018-02-23T01-20-42.000.fts	SCIENCE	AT04	B	200.0	1/1	3/27
GIANO-B.2018-02-23T01-16-12.000.fts	SCIENCE	AT04	A	200.0	1/1	3/27
GIANO-B.2018-02-23T01-11-49.000.fts	SCIENCE	AT04	B	200.0	1/1	2/27
GIANO-B.2018-02-23T01-07-27.000.fts	SCIENCE	AT04	A	200.0	1/1	2/27
GIANO-B.2018-02-23T01-03-04.000.fts	SCIENCE	AT04	B	200.0	1/1	1/27
GIANO-B.2018-02-23T00-58-42.000.fts	SCIENCE	AT04	A	200.0	1/1	1/27
GIANO-B.2018-02-22T18-09-30.000.fts	FLAT	FLAT	A	100.0	7/7	1/1
GIANO-B.2018-02-22T18-07-23.000.fts	FLAT	FLAT	A	100.0	6/7	1/1
GIANO-B.2018-02-22T18-05-16.000.fts	FLAT	FLAT	A	100.0	5/7	1/1
GIANO-B.2018-02-22T18-03-09.000.fts	FLAT	FLAT	A	100.0	4/7	1/1
GIANO-B.2018-02-22T18-01-02.000.fts	FLAT	FLAT	A	100.0	3/7	1/1
GIANO-B.2018-02-22T17-58-55.000.fts	FLAT	FLAT	A	100.0	2/7	1/1
GIANO-B.2018-02-22T17-56-48.000.fts	FLAT	FLAT	A	100.0	1/7	1/1
GIANO-B.2018-02-22T17-52-50.000.fts	DARK	DARK	A	100.0	7/7	1/1
GIANO-B.2018-02-22T17-52-50.000_010.fts	DARK	DARK	A	10.0	7/7	1/1
GIANO-B.2018-02-22T17-52-50.000_030.fts	DARK	DARK	A	30.0	7/7	1/1
GIANO-B.2018-02-22T17-52-50.000_060.fts	DARK	DARK	A	60.0	7/7	1/1
GIANO-B.2018-02-22T17-50-43.000.fts	DARK	DARK	A	100.0	6/7	1/1
GIANO-B.2018-02-22T17-50-43.000_010.fts	DARK	DARK	A	10.0	6/7	1/1
GIANO-B.2018-02-22T17-50-43.000_030.fts	DARK	DARK	A	30.0	6/7	1/1
GIANO-B.2018-02-22T17-50-43.000_060.fts	DARK	DARK	A	60.0	6/7	1/1

Ramp segments

GIANORAW...	Type	I/N	Status
01-32-42.000	SCIENCE	23/23	Processing
01-32-32.000	SCIENCE	22/23	Processing
01-32-22.000	SCIENCE	21/23	Processing
01-32-12.000	SCIENCE	20/23	Processing
01-32-03.000	SCIENCE	19/23	Processing
01-31-53.000	SCIENCE	18/23	Processing
01-31-43.000	SCIENCE	17/23	Processing
01-31-34.000	SCIENCE	16/23	Processing
01-31-24.000	SCIENCE	15/23	Processing
01-31-14.000	SCIENCE	14/23	Processing
01-31-04.000	SCIENCE	13/23	Processing
01-30-55.000	SCIENCE	12/23	Processing
01-30-45.000	SCIENCE	11/23	Processing
01-30-35.000	SCIENCE	10/23	Processing
01-30-26.000	SCIENCE	9/23	Processing
01-30-16.000	SCIENCE	8/23	Processing
01-30-06.000	SCIENCE	7/23	Processing
01-29-56.000	SCIENCE	6/23	Processing
01-29-47.000	SCIENCE	5/23	Processing
01-29-37.000	SCIENCE	4/23	Processing
01-29-27.000	SCIENCE	3/23	Processing
01-29-17.000	SCIENCE	2/23	Processing
01-28-19.000	SCIENCE	23/23	Processed
01-28-09.000	SCIENCE	22/23	Processed
01-28-00.000	SCIENCE	21/23	Processed
01-27-50.000	SCIENCE	20/23	Processed

Figure 35. The 2D Spectra Ramp Processing Tab of the Online DRS Web UI.

No action has to be carried out by the user in order turn on the ramp processing, this process is always active watching for new ramp segments obtained on a given date. If no ramp segment images are available for the current date, this Web UI tab is as shown in Figure 34. When ramp segments are acquired, they will almost immediately show up on this tab in the corresponding table. Once a complete exposure ramp is available, it is automatically processed into a ramp-reduced 2D spectrum image. A screenshot of this Web UI tab during a typical observing night and corresponding ramp processing is shown in Figure 35.
If GIANO-B images are obtained but no exposure segments appear in the “Ramp segments” table, the instrument scientist has to be informed about, as this may be due to general data flow problem.
If necessary (i.e. for inspection), the ramp-processed spectra files can be individually downloaded using the download links located in the rightmost column of the “Ramp-processed 2D spectra” table.
“Download log” link at the top of the “Ramp-processed 2D spectra” table can be used to download the contents of this table as a text file. When done at the end of the observations, this is a convenient way to generate a night log.

1D Spectra Extraction Tab

To access this tab, the corresponding link has to be clicked on the upper right part of the Web UI. As the name says, this tab will show the real-time 1D spectra extraction. Unlike the ramp processing, the spectra extraction has to be explicitly turned on. When the process is turned off, the tab is as shown in Figure 36.

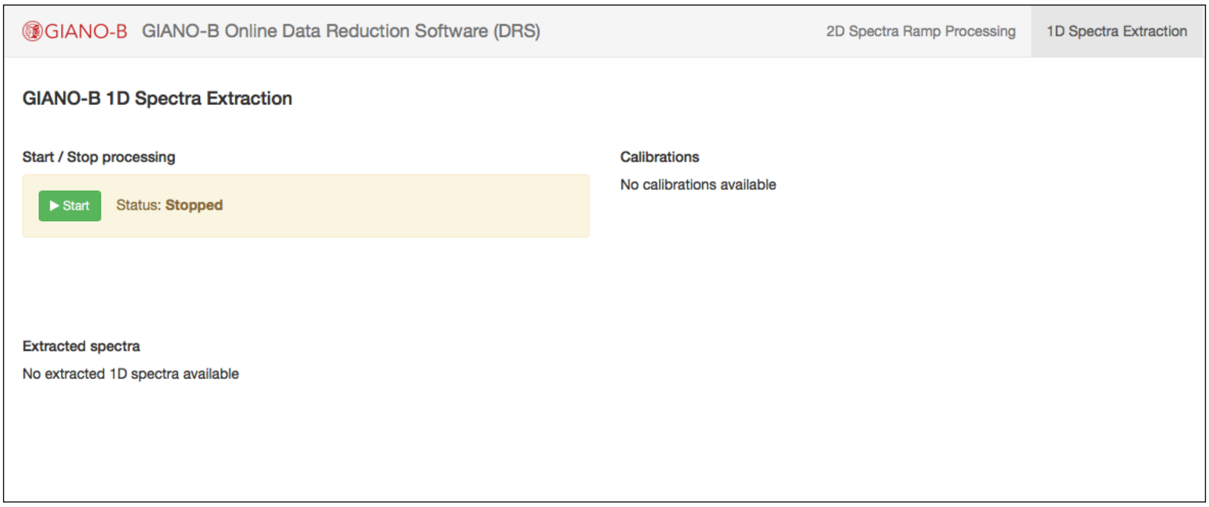


Figure 36. The 1D Spectra Extraction Tab of the Online DRS Web UI.

To turn on the 1D spectra extraction, the “Start” button of the “Start/Stop processing” section of the page has to be clicked. It has to be taken into account that if no 2D spectra were obtained on a given date (i.e. 2D Spectra Ramp Processing tab tables are empty), the spectra extraction process will stop 7-10 seconds after it was turned on. Thus, the best practice is turning on the spectra extraction after the first (calibration or scientific) image of the day is obtained.

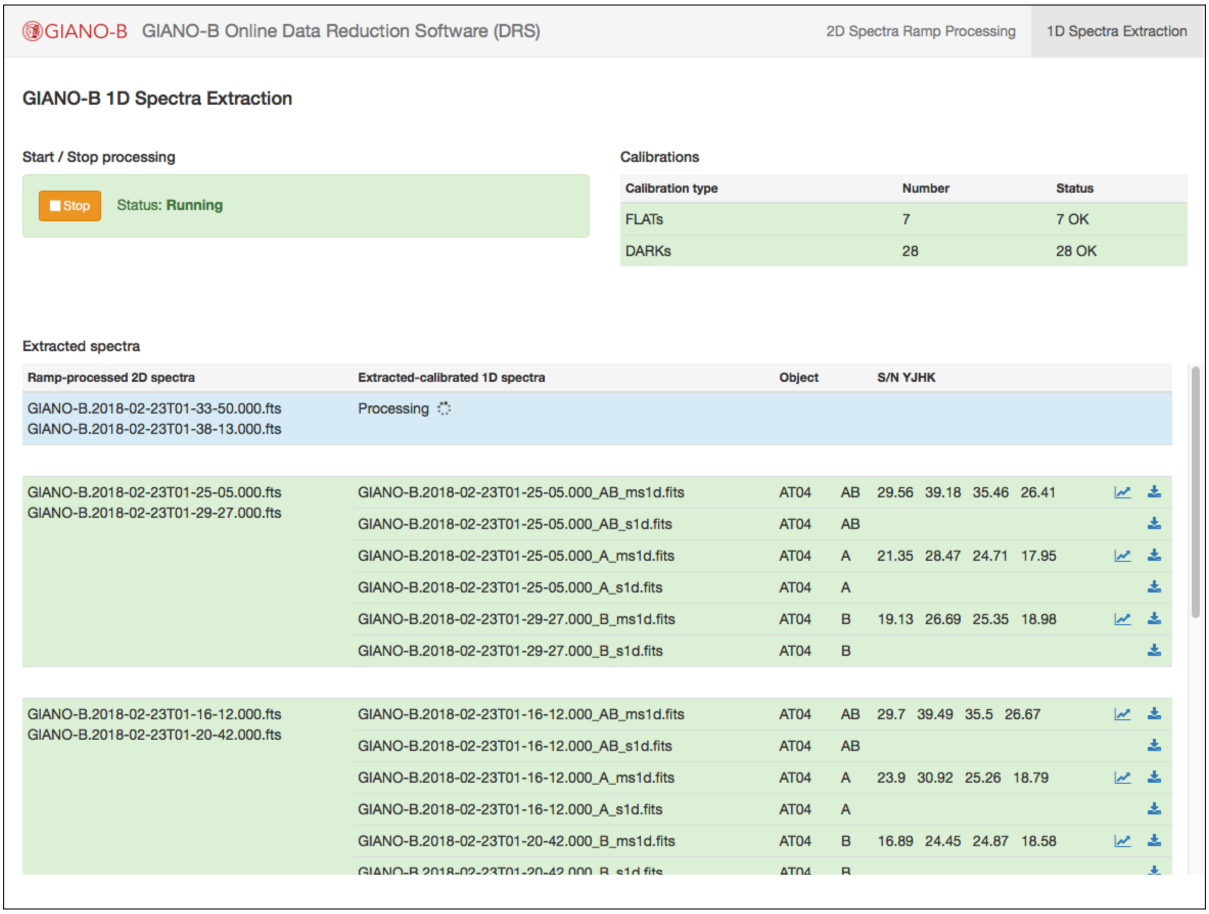


Figure 37. The 1D Spectra Extraction Tab showing spectra processing running during a typical observing night.

A screenshot of this tab of the Web UI during a typical observing night is shown in Figure 37. When a group of calibration 2D spectra is obtained, the corresponding processing is done and the outcome is shown in “Calibrations” table. Once scientific data, i.e. a complete nodding pair or stare sequence of 2D spectra is available, their processing is done in real-time and the results appear in the “Extracted spectra” table of the tab.

All extracted 1D spectra (both in ms1d and s1d format) can be individually downloaded clicking the corresponding download links located in the rightmost column of the “Extracted spectra” table.

The extracted spectra in ms1d format can be plotted using the corresponding links in the right part of each table entry for ms1d spectra. When clicked, the plot dialog will appear in the corresponding overlay window (Figure 38).

The pulldown menu with spectral orders and corresponding wavelength ranges and the “Re-plot” button can be used to plot any order of the extracted “multispec” ms1d spectrum. Also, the S/N throughout the same spectral order will be shown.

If needed, the 1D spectra extraction can be stopped and restarted at any time during the processing, e.g. when the extraction process sometimes stalls.

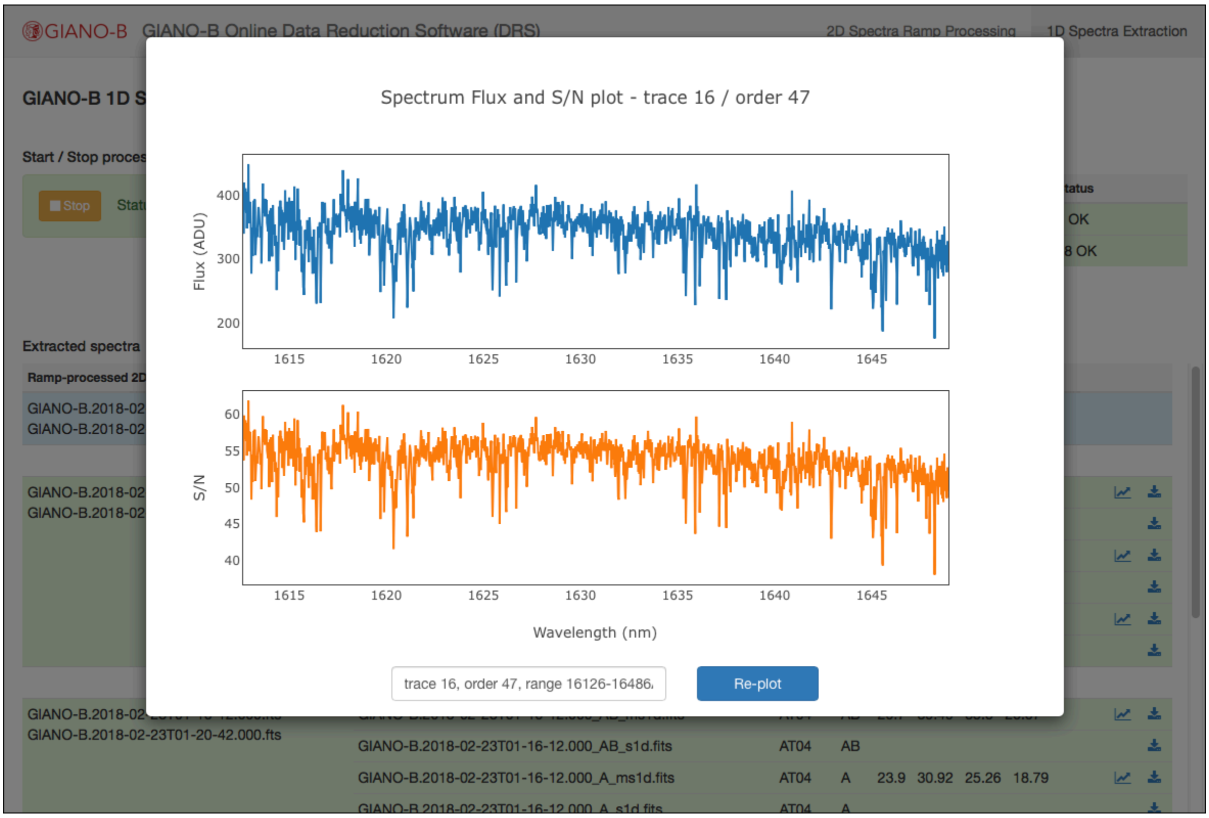


Figure 38. The plot overlay window of the Online DRS Web UI.

It is important to bear in mind that the 1D spectra extraction process is completely independent from the observations and a stopped reduction process does not affect or harm anyhow the observations. The observations have not to be stopped for any reason related to the 1D spectra extraction.
When the observations are over, the 1D spectra extraction process has to be turned off clicking on “Stop” button in the “Start/Stop processing” section of the page.

Processed data archiving and download

All GIANO-B ramp-processed and extracted spectra FITS files are automatically archived to the TNG data archive. The 2D spectra are archived as soon as the corresponding ramp processing is finished, while the extracted 1D spectra archival is done in the morning after the observations.
The download links both on ramp-processed 2D spectra and extracted 1D spectra tabs are not intended for bulk downloads of groups of files. The TNG data archive has to be used for downloads of bigger sets of available data, e.g. those of an observing night or entire observing run.

9 Instrument shut-down

Instrument shut-down is a quick and straightforward process, consisting in the actions described below.

- **NSTS shut-down.** Shut-down NSTS closing its GUI window. A dialog will pop-up asking to confirm the action.
- **Sequencer shut-down.** Simply close the Sequencer GUI window to shut it down. Also, close the SAOImage ds9 window.
- **AG shut-down.** Close AG GUI through “File” → “Close GIANO-B AutoGuider” menu command. Then, in the remaining IDL console type “exit”.

10 GIANO-B observations summary

For sake of clearness, a brief observer action list of typical GIANO-B observations is reported below. More detailed instructions are available for each operation of the list in the corresponding chapters of the manual.

Afternoon

- Instrument start-up and initialization (chapter 2).
- Standard calibrations (chapter 6).
- Online DRS (1D spectra extraction) start-up (chapter 8).
- Slit auto-calibration (chapter 7).
- NSTS OB preparation (chapter 4).

Nautical dusk

- Telescope focusing, if required (chapter 5.2)

Night

- On-sky observations (chapters 3, 4, 5)

Nautical dawn (or in any case immediately after the end of on-sky observations)

- Wavelength U-Ne calibration (chapter 6).
- Instrument shut-down (chapter 9).
- Online DRS (1D spectra extraction) shut-down (chapter 8).