COO

CALIFORNIA INSTITUTE OF TECHNOLOGY

The NGPS Graphical User Interface

Rev. 2.1.2
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YELLOW = NEEDS EDITING

GREEN = MISSING FEATURE / UNVERIFIED / BUG

Useful links:

- NGPS Homepage
- NGPS Software Issue Reporting

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1 Getting Started

1.1 Accessing the NGPS Computer – VNC

Both the planning tool (**ngps-plan**) and the observing tool (**ngps-observe**) must be run on the ngps computer located at Palomar Observatory. Access to the ngps computer requires a Caltech IP address, so you must either log in from campus or use the Caltech VPN.

You will run the programs through VNC so you will need an SSH and a VNC client. Prior to connecting for the first time you will need to generate an SSH key pair and provide us with your public key.

1.1.1 SSH Key Pair Generation

Your SSH client may vary; the command line version is shown. On your computer type:

```
ssh-keygen -t ed25519
```

You'll be prompted for a file in which to save your key, and a passphrase. The passphrase is optional and is known only by you. It provides protection in the event that someone were to gain access to your computer and obtain a copy of your private key; it's not strictly necessary. If you enter one here then you will need to enter it every time you use your key to access ngps.
Whatever you chose for a filename, this will generate two keys, "`yourkey`" and "`yourkey.pub`". You will need to send the `.pub` file to an ngps computer administrator for installation on the ngps computer. It is completely safe to send your *public* key over insecure connections (such as email) -- send *only* the public key!

1.1.2 Secure VNC Tunneling

To access the ngps VNC session you will first create a secure SSH tunnel using your SSH client. SSH clients may vary; the command line version is shown.

```
ssh -L 5901:localhost:5941 -i /path/to/yourkey observer@ngps.caltech.edu
```

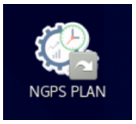
Where `/path/to/yourkey` is the location of the ssh key you generated. NOTE: While NGPS is located on campus, use the local campus address, ngps.caltech.edu. Once ngps is deployed to Palomar, this hostname will be updated. This will create a secure SSH tunnel from your computer to ngps. You must leave this connection open while using VNC.

Finally, connect your VNC client to the ngps computer via this secure tunnel. VNC clients may vary; the command line version is shown.

```
vncviewer -shared localhost:1
```

Note that any number of people may connect to this VNC session so you may find that someone else is already using it. **HOW DO WE HANDLE THIS? OR DO WE?**

Once logged in, use one of the desktop icons to launch a GUI:



The two GUI versions look very similar, but only the OBSERVE version connects to the instrument and telescope. Use the PLAN version to import, edit, and organize your list of target observations without disturbing the hardware. The two versions share a common database, so all your target data is accessible from either GUI.

Only one OBSERVE can run at a time; the software will prevent multiple simultaneous instances of the Observing window. Multiple copies of PLAN can be run by users simultaneously; **however, at this time running multiple copies can lead to race conditions, including with OBSERVE.**

1.2 Accessing the NGPS Computer – SSH

The ngps computer can also be accessed via SSH.

When using SSH any number of users may simultaneously access the ngps computer and run the planning software without affecting any other users. **NOT TRUE**

Image data from the spectrograph is located in `/data/yyyymmdd` with the date matching the observations in UTC time.

Accessing via SSH requires no password but you must supply us (an ngps administrator, or dhale@caltech.edu) with your public key. It is strongly advised that you generate an ssh key specifically for connecting to the ngps computer rather than re-using an existing ssh key. To generate a public/private key pair, from Mac, Windows or Linux, navigate to your computer's command line prompt and type the following:

```
ssh-keygen -t ed25519
```

You will be prompted for a file in which to save the key – use any filename you like. Then, you will be prompted for a passphrase. This is your own personal passphrase to protect and access your private key. Never share this password with us or anyone else. It is optional, and you can press enter for no passphrase. With no passphrase, anyone with physical access to your computer will have access to that private key. With a passphrase enabled, you will have to enter it each time you use your private key.

You will have now generated two files with the *keyname* you selected above, a private key (*keyname*) and a public key (*keyname*.pub). The private key must be stored in

```
your_home_directory/.ssh/keyname
```

and must remain private; never share this file.

The public key can be stored anywhere and is safe to share; it should be emailed to dhale@caltech.edu. After your public key has been received and installed you will be able to access the ngps computer from off-site using ssh as follows:

```
ssh -Y observer@hale.palomar.caltech.edu -p 58031
```

If you are prompted for a password, then you might have multiple keypairs and ssh is not selecting the correct one for ngps. In that case, specify exactly the name of the keypair as follows:

```
ssh -Y observer@hale.palomar.caltech.edu -p 58031 -i keyname
```

where `keyname` is the full path and filename of your key.

To access the ngps computer from on-site (from within the Palomar network) use the following:

```
ssh -Y observer@10.200.129.162
```

1.3 Overview of the NGPS GUI

While logged into the VNC, start ngps-observe. The main window of the GUI appears:

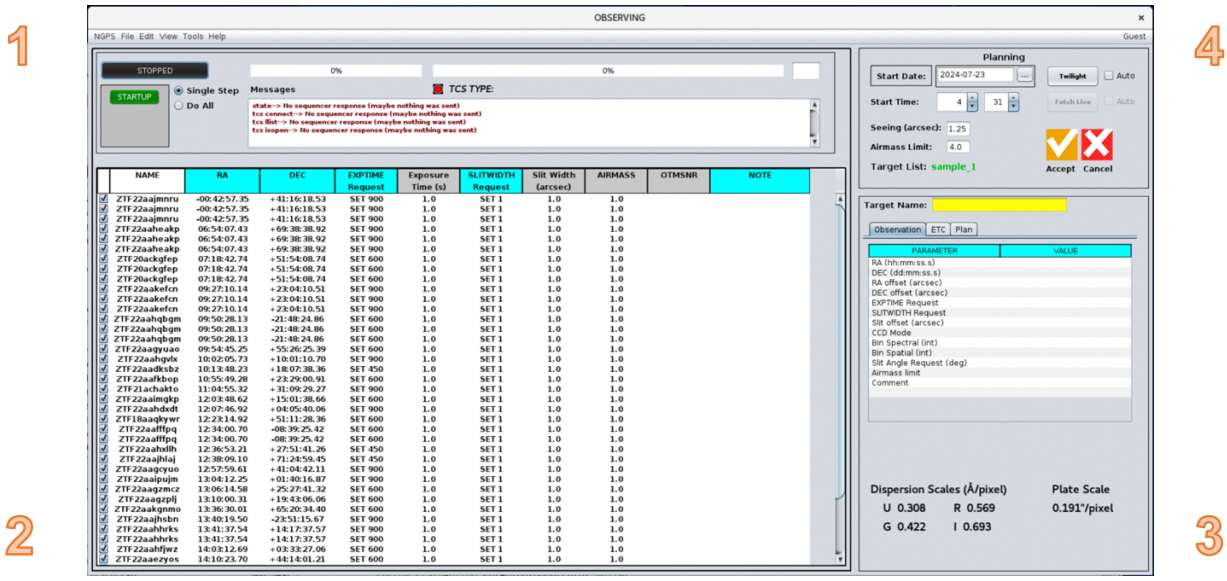


Figure 1: GUI main window

1) In the upper left is the control panel for the **Observation Sequencer** (or Sequencer). The Sequencer orchestrates instrument operations – it controls all subsystems, talks to the telescope, and executes observations. It includes progress bars for observations and control buttons on the left which change according to the instrument's state. **This panel does *not* appear on the ngps-plan GUI.**

2) The large, **Main Table** in the lower left contains the user's **Target List**. You can load and edit the targets you want to observe in this table while also monitoring their progress as observations are executed by the Sequencer. On startup, this list will be blank.

3) To the lower right is the **Detail Pane** which contains additional optional parameters for observations. Some helpful information is printed below it for quick reference.

4) To the upper right is the **Planning Pane** which is used to run the Observation Timeline Modeler (OTM). The OTM is a tool to help the user optimize and visualize the evening's timeline of observations. It generates predictions of when each target will be observed, but does **not** control that timing, i.e. ***it is not a scheduler***.

1.4 Entering your targets manually

All NGPS observations are controlled by creating and then executing target lists. There is no way for users to manually set up an observation outside of entering or importing parameters into the Main Table.

Select **File > New Target List.** A single line is added to the main table. Fill out all the required parameters (cyan headers) by directly editing the cells in the table. Fields with grey column headers cannot be edited.

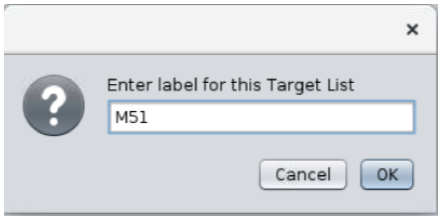
	NAME	RA	DEC	Requested EXPTIME	Calculated EXPTIME	Requested SLIT width	Calculated SLIT width	AIRMASS	OTMSNR	NOTE
☑				SET 1	1.0	SET 1	1.0	1.0		

Additional parameters can be modified in the Observation tab in the Detail Pane. To access the additional parameters for a target that target must be selected in the main table.

The following entries set up an observation of M51 for 900 seconds with a slit width of 1". The SET keyword is **required** to set the exposure time (in seconds) and slit width (in arcsec) to fixed values (more on this in section 5.4).

	NAME	RA	DEC	Requested EXPTIME	Calculated EXPTIME	Requested SLIT width	Calculated SLIT width	AIRMASS	OTMSNR	NOTE
☑	M51	13:29:52.7	47:11:43	SET 900	900.0	SET 1	1.0	1.2	28.5	

Once satisfied with the parameters, save the Target List to the database so that it can be accessed by the Sequencer. To save, click the "Accept" button in the Planning Pane to the upper right of the GUI. Some values in the table will now auto-populate. Since you have not previously saved this Target List to the database, it will prompt you to enter a name:



Each time the Target List is saved, the Observation Timeline Modeler (OTM) will be run. The OTM checks the target list for valid entries, updates computed fields in the table (grey headers), and then displays a prediction for the timeline of planned observations.

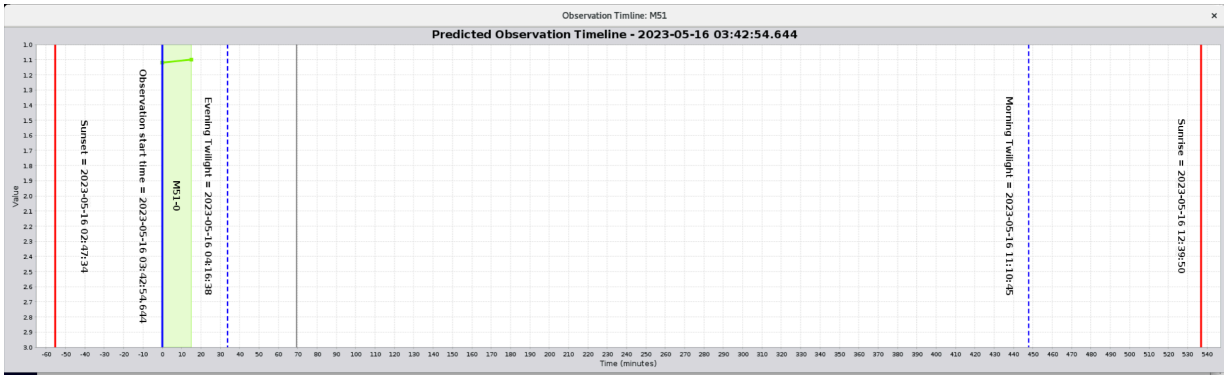


Figure 2: OTM result for the new target list M51

In the above plot, a single observation (M51) is planned at the beginning of the night for 900 seconds. The target happens to be near zenith at the start of the night so the observation can be carried as soon as the evening twilight begins. A line plot in the shaded region for the target shows the expected airmass.

You can add more targets – see details in 3.1.

1.5 Entering targets using a CSV file

Rather than manually entering parameters for each target into the main table, you can create a Comma Separated Value (CSV) file on your own computer (or the NGPS computer) and import it. CSV files can be conveniently edited in common spreadsheet apps like Excel or Pages (or any text editor). CSV templates are available from a folder on the Desktop. See section 3.2 of the OTM-ETC manual for details on constructing the CSV file.

Create your CSV file on the NGPS computer or upload it via e.g. `scp`.

Select **File > Import** and a file selection dialog will pop up. Browse the file system and select a CSV file. The "Import CSV" dialog pops up and displays the file contents. The first tab in the dialog displays how the CSV file has been interpreted. Each column in the CSV file has been mapped to a column in the table. Some parameters needed by the Exposure Time Calculator (ETC) will be set to defaults if missing from the CSV file – you may ignore these if not using the ETC.

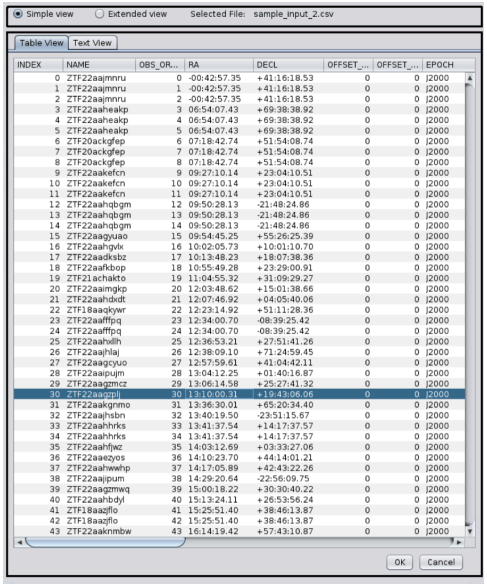


Figure 3: Importing the CSV file

If you run into a problem with the format of your CSV file, e.g. it has not been parsed correctly, you can edit the raw text in the "Text View" panel. Once you have modified the text, you must parse the input file again to update the table with any changes. If there are lots of problems, you should edit your CSV file directly in the file system and try importing again.

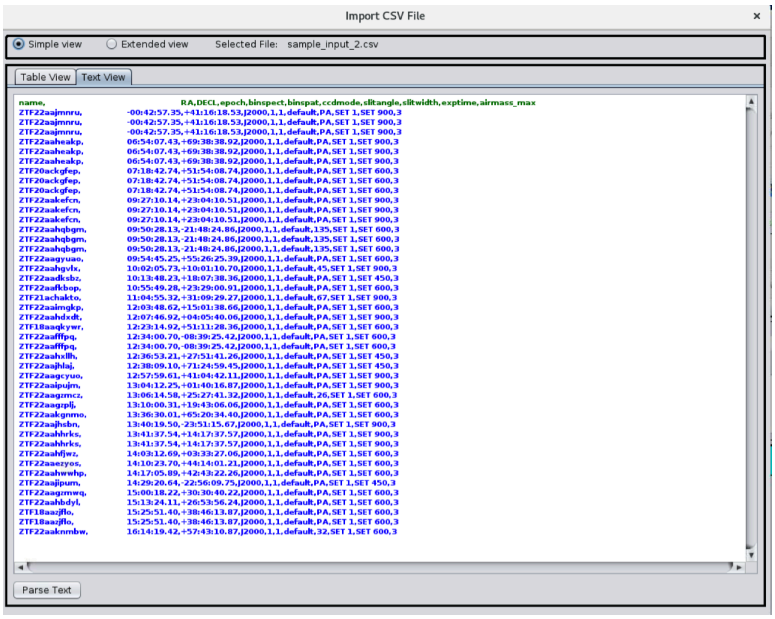


Figure 4 Editing the CSV file text

Once you are satisfied with the parsing of your CSV file, click “OK” to import the target set into the database. A dialog will open asking for a target set name. Enter a name and then click “OK.”

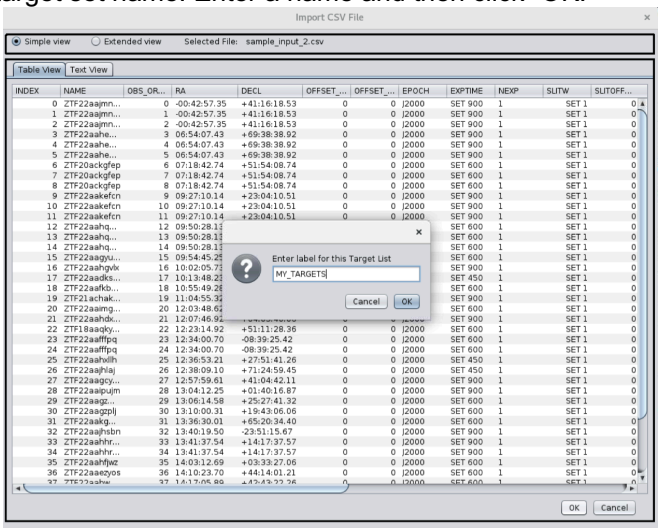


Figure 5 Importing and saving the target list

The target list has now been imported into the active database and can be edited in the Target List pane or in the Details Pane. Press the Accept button to run the OTM on the target list and save the latest data to the NGPS database. This will display a plot of the predicted timeline for the list including the airmass of each target.

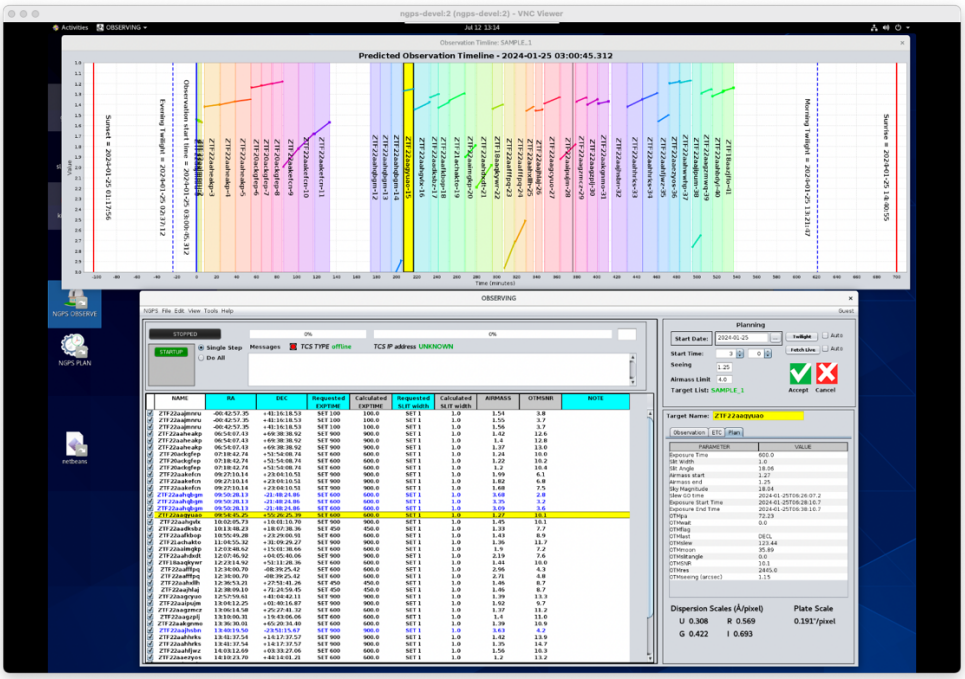


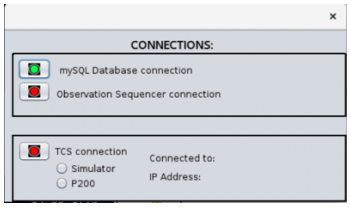
Figure 6: Target List and timeline display after CSV import and clicking "Accept".

1.6 Observing your targets

1.6.1 Connecting to the Instrument

Before we can observe, the GUI must connect to the Telescope Control System (TCS) and the Observation Sequencer, which controls NGPS. These manual steps were implemented to prevent accidentally commanding NGPS and the telescope during testing and planning. You may load and edit targets before this step, but if you do not intend to use the instrument, you should use ngps-plan not ngps-observe.

Select **NGPS > Connections** to display the connections window:



Select the **P200** radio button and click any buttons to connect and turn them green. You can now close this window. The **Simulator** option will connect the GUI to a simulated TCS interface for testing purposes and is not for typical users.

1.6.2 Starting observing

STARTUP
PRESS GO. – what happens
Confirming with TCS operator
Exposure – what happens

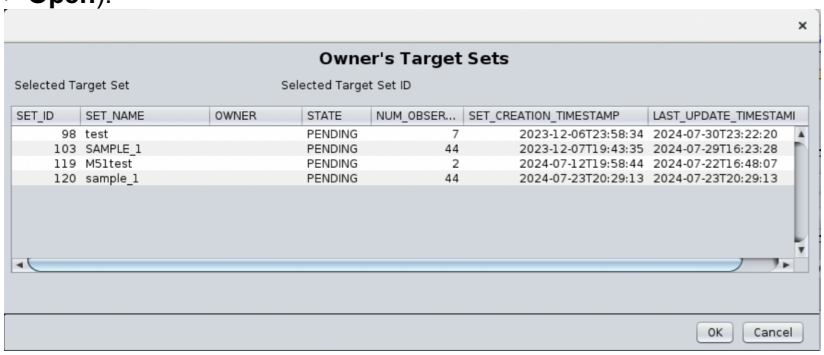
2 Logging in as a particular user

The GUI allows users to save target lists under a username to aid organization and keep sensitive data private. In the following example, we create an account and then log into it. On the top menu bar, on the right side of the window, click the name of the currently signed in user. Choose “Create User”.

Provide a unique username and password and an email address for the account point of contact, then click “Create Owner”. Now you can sign in under this new account. Choose “Sign In” from the user menu and enter the same credentials.

If already signed in as another user, select “Sign Out” from the user menu to sign out, which allows you to continue as the GUEST user. The GUEST user has all the same functionality as other users but saved data will not be private.

Once logged in, you will have access to any Target Lists saved to the NGPS database under your username (**File > Open**).



Note that files saved to the local file system (accessible via File > Import) are never private. If you have imported a list via CSV file and want to keep it private, save the list to the database under your user account and delete the CSV file.

3 Working with your Target List

Both the PLAN and OBSERVE GUIs allow you to create, edit, and save target lists to the NGPS database. If you are not observing soon, you should use the PLAN version, which does not connect to the instrument.

3.1 Target List Main Table

This list represents the set of observations to be executed by the sequencer. Each row specifies the parameters for a single observation of a single target. When the software is first started, this table is empty except for column names. Users may open previously saved tables, import target lists from a CSV file, or start a new list (File menu).

After loading a target list, the name of the list is displayed in the Planning pane to the upper right. The GUI reads and writes the target list using a database which the Sequencer reads to execute the observations. Every target list and any changes must therefore be saved in the database to take effect. The user will be prompted to commit changes as necessary.

3.1.1 Editing Targets

To edit the list, the user may click individual fields in the table, use the Edit menu, or right-click a target to show an abbreviated Edit menu. Targets can also be moved in the list by dragging and dropping them into place. Multiple rows can be selected (for copy/cut/drag) by holding down the SHIFT key while selecting the rows. **NOT SUPOPRTED YET.** Fields are also editable in the Detail Pane. Non-editable fields are identified by grey headers, including all items in the "Plan" tab of the Detail Pane. If the user edits a field, the ACCEPT button changes from green to orange:

The ACCEPT button must be clicked to save the changes and refresh the predicted (non-editable) fields. Changing any value in the target list table while the sequencer is running will automatically switch the Sequencer mode to **Single Step**. This prevents the sequencer from reaching rows that the user has changed but has not saved to the database. Click the CANCEL button to undo any changes to the table since the last Accept/Save.

Cyan Columns (editable):

- **RA** – Target right ascension in sexagesimal hours
- **DEC** – Target declination in sexagesimal degrees
- **EXPTIME Request** – A string specifying the exposure time request. Use "SET <exptime> " to choose a fixed duration in seconds, e.g. "SET 60". Other keywords will invoke the ETC.
- **SLITWIDTH Request –** A string specifying the slit width request. Use "SET <width> " to choose a fixed width in arcsec, e.g. "SET 1.5". Other keywords will invoke the ETC.
- **Note** – A place to write brief notes (max 128 characters) e.g. **target priority**. *These do not affect observations*.

Additional editable fields are found in the Detail Pane to the right.

At this time the checkboxes to the left do nothing. This is a planned feature to allow skipping targets without deleting them.

Grey Columns (non-editable):

- Exposure Time (s) – The exposure time that will be used for the observation (all spectrograph channels)
- Slit Width (arcsec) – The slit width that will be used for the observation (all spectrograph channels)
- Airmass – Airmass of the target at the predicted observation time
- OTMSNR – Predicted SNR of the target at the predicted observation time. This depends on details provided in the ETC tab of the Details Pane. If not using the ETC, ignore this field (it will be meaningless).

3.1.2 Target State

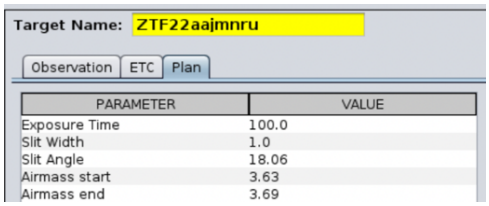
Rows in the Main Table will have changing colors according to the state of each observation:

- **Pending**: The default state. The target will be observed once the Sequencer reaches it in the list.

- **Selected**: Yellow Highlight. The row can be copied, pasted, etc., and viewed in the Detail Pane. The row color may override other colors below.
- **Active**: Green Highlight. The Sequencer is currently commanding the telescope and instrument to execute the observation.
- **Completed**: Grey Text. The observation has been completed.
- **OTM Warning**: **Blue Text.** The OTM predicts some problem with the observation, e.g. a delay. Check the OTMflag value in the Plan tab of the Detail Pane for more info.
- **OTM Error**: **Red Text.** The OTM predicts the observation cannot be executed. Check the OTMflag value in the Plan tab of the Detail Pane for more info.

3.2 Detail Pane

When a target is selected in the main table, the detail pane shows all the information for that selected target, organized by three tabs:



1. **Observation** – Fields defining the observation, some of which are duplicated from the cyan header columns in the main table.
2. **ETC** – Optional inputs for the NGPS Exposure Time Calculator.
3. **Plan** – Predictions from the Observation Timeline Modeler (OTM)

Observation tab fields: (not including copies from main table)

- **CCD Mode** – String specifying the CCD readout mode
- **Bin Spectral** (int) – On-chip binning factor for the CCD in the spectral direction.
- **Bin Spatial** (int) – On-chip binning factor for the CCD in the spatial direction.
- **Slit Angle Request** (deg) – Position angle of the long slit axis (E over N) in decimal degrees. Since the slit has 180 deg symmetry, the system will choose the equivalent angle that minimizes slew time. Enter "PA" to use the target's parallactic angle at the predicted time of observation (make sure this was refreshed recently).
- **Airmass Limit** – Maximum airmass target must have before starting observation. Overrides the global airmass parameter in the Planning Pane. NOT IMPLEMENTED IN OS
- **Point Mode** – The default is "SLIT" (or blank) which places the target on the spectrograph slit. Use "ACAM" to instead view the target with the Acquisition and Guide Camera. Images can be manually acquired with a ds9-based GUI for the ACAM.
- **Not Before** (timestamp string) – The observation is not to be started before the specified time. If the Sequencer reaches this observation in the list before this time, it will enforce a delay. NOT IMPLEMENTED IN OS
- **Comment** – A place to put additional text (max 1024 characters)

The Plan and ETC tabs are discussed in section 5.

4 Carrying Out Observations

The ngps-observe GUI interacts with the Observation Sequencer to carry out each observation from the target list quasi-automatically. When an observation is initiated ("GO"), the Sequencer will load that target's information, slew to the next target, acquire and position the target on the slit, set the slit width and angle, set the needed camera settings, and then expose and write the images from all channels to a FITS file. Observations can be executed one at a time, or a full list can be executed sequentially. **At this time, Palomar policy requires an operator to manually approve slews and report when the slew is complete, so the process is not 100% automatic.**

The state of the Observation Sequencer can be viewed and controlled using the pane at the top left of the OBSERVE GUI.

4.1 Observation Sequencer Pane

This top panel of the GUI is the visible difference between ngps-plan and ngps-observe, with the latter adding this panel which is used to operate the instrument. The features of this panel are described in the following sections.

4.1.1 System Status Indicator

A colored box at upper left displays the current system status. This status will be one of those shown in the leftmost column of Table 7 ("Indicator"). In general, black and grey indicate dead time; amber and yellow indicate that the system needs attention.

4.1.2 System Control

One or more colored and labeled pushbuttons are displayed at lower left under an area labeled "Available Actions". Only the button(s) for the currently allowable action(s) are displayed (e.g., when "stop" is not an option, given the current state of the instrument, then the stop button is not displayed). The possible control buttons displayed for each state are shown with their accompanying states in Table 7.

System Status Indicator	Action Control Button(s) Displayed	Remarks
Stopped	Startup	The system is offline (power off, dust covers closed, etc.) and needs to be started.
No Targets	Go	The system is ready to observe but the "Go" button is greyed-out because no targets have been loaded.
Idle	Go	Target list is loaded, and the sequencer is ready to be started; the system is idle, waiting for the user to click "Go".
TCS Operator?	Abort	The sequencer was started but is waiting for the TCS Operator to initiate the slew.
Slewing	Abort	The TCS slew has been initiated. The user can abort now; this may or may not abort the slew, but it will abort the pending observation.

Table 7.

Figure Table 7

Acquiring	Abort	The ACAM is acquiring the target. The user can abort now; this will abort the acquisition sequence and the pending observation.
Airmass?	Abort	The sequencer is waiting for the airmass of the current target to cross the limit set in the GUI before starting the exposure. The user can change the airmass limit or abort the observation.
Exposing	Pause Stop Abort	The shutter is open, and exposure is underway. The user can pause, stop, or abort the exposure.
Paused	Resume Stop Abort	An exposure is paused. The user can resume, stop, or abort the exposure.
Stopping...	n/a	The sequencer is in the process of stopping; there are no actions to take.
Aborting...	n/a	The sequencer is in the process of aborting; there are no actions to take.
Starting...	n/a	The instrument is starting up, powering on equipment, establishing communication with subsystems, homing motors, if necessary, etc.

System Status Indicators and Control Buttons

A pair of radio buttons on the left determine whether the sequencer is in a manual or automated mode. When "Single Step" is selected, clicking "GO" will observe the first pending target in the list and then return to an "idle" state; no further observations will occur. The state indicator/selector button will return to "*GO*" after the observation has completed, requiring the user to manually click "*GO*" again to observe the next pending target in the list, and so on. When "DO ALL" is selected then clicking "*GO*" will observe each target in the list in succession, until all targets are observed or interrupted by the user.

The Single Step / DO ALL button can be selected at any time. While in the do all mode, selecting Single Step during an exposure will mean the system returns to idle after that exposure, requiring a manual start of any subsequent exposure. Similarly, the user can enable do all after starting a single step exposure to continue the list processing.

If "abort" is selected, the system will automatically switch to "Single Step" mode. The default is "DO ALL".

4.1.3 Progress indicators

At the top of the Sequencer Pane is a pair of progress bars which indicate the total and elapsed times of the current target observation. The left bar indicates the progress of overhead operations including slew, settling, acquisition, etc. The right bar indicates the progress of the CCD exposure. In both cases, the elapsed time of the task (underway or pending) is displayed within the bar along with the total duration.

4.1.4 Message Display

This large text box displays messages describing the status of the system, including what the system is waiting on. For example, "exposing", "reading out", or "waiting on slew", as well as any critical errors, calibration lamps, filters, etc.

When the wait is for a human (e.g., TCS Operator) then there should be an additional indicator, such as a blinking indicator and/or beeping, to call attention to the fact that the system is waiting for human input.

4.1.5 Target Status

While the sequencer is running, the current active target is highlighted in green. This will always be at the top of the remaining planned targets since targets are always observed in the order they appear in the table. The active target cannot be edited in the table; however you can stop or abort the exposure depending on the Sequencer status.

Completed targets will be greyed-out and remain un-editable. They can be copied and pasted as new targets lower down in the list, which can then be edited. How to access completed targets once the list is cleared?

4.2 Quick Start Guide

When the software is first started it is in the ***OFFLINE*** state, at which point the only possible action "**STARTUP**" so only that button is displayed.

Click STARTUP – this willAfter starting up, the system is ready to observe so the status reads *Idle* if there are any targets listed or *No Targets* if there are no targets in the table. Clicking *Go* will immediately start observing, either a single target at a time or the complete list, depending on the state of the "Single Step / DO ALL" radio button located immediately above.

Clicking *Go* will start the observing.

The indicators *Stopping* and *Aborting* are used when a stop or abort is selected, since these may take some time to complete.

4.2.1.1 STOP

When the user selects Stop..., a floating dialog window appears, not attached to anything. The dialog will contain the text, "Stop: Are you sure?" along with three buttons, as follows:

1. "No"
2. “Yes, stop and idle”
3. “Yes, stop and go to next target”

Clicking "No" will close the dialog and no further action occurs.
Clicking "Yes stop and idle" will set the sequencer option to "Single Step" (by sending the "`do one`" command to the sequencer) and then send the "`stop`" command to the sequencer.
Clicking the "Yes stop and go to next target" will set the sequencer option to "Do All" (by sending the "`do all`" command to the sequencer) and then send the "next" command to the sequencer.

4.2.1.2 ABORT

When the user selects Abort..., a floating dialog window appears, not attached to anything. The dialog will contain the text, "Abort: Are you sure?" along with two buttons, as follows:

1. "No"
2. "Yes, abort and idle"

Clicking "No" will close the dialog and no further action occurs.
Clicking "Yes abort and idle" will set the sequencer option to "Single Step" (by sending the "`do one`" command to the sequencer) and then send the "`abort`" command to the sequencer.

5 The Observation Timeline Modeler (OTM)

The OTM is a tool to help users plan and visualize their observation schedule, which is particularly useful for large target lists. Each time the user clicks the Accept button or attempts to save a target list, the OTM will be run on the

target list in the main table. A graph will pop up, displaying a *predicted timeline* of when each target will be observed and predicted conditions such as airmass. Other predicted parameters will populate (non-editable) fields in the main table and Plan tab on the Detail Pane.

The OTM is not a scheduler and does not control the timing of observations – it only provides feedback about the user's plan. Since we cannot predict exactly what any given user is going to do during their observing run, some assumptions are made in generating the timeline. A single OTM run assumes:

- Observing conditions such as seeing are constant throughout the night.
- Targets will be observed in the order that they appear in the main table with no skips.
- The telescope will slew to each target as soon as the previous exposure completes, provided the target is available (within pointing range).
- If a target is predicted to be unavailable when the previous target completes (e.g. hasn't risen yet), the user will wait on that target until it is available.

The final assumption may result in wasted time, recognizable as an unacceptably large gap in the predicted timeline or targets missing because the night ends before they will be observed. It is up to the user to edit or rearrange the target list to use time efficiently.

The OTM cannot predict changing conditions like seeing, so it should be periodically rerun to update predictions with the latest conditions.

We chose not to have the OTM "smartly" make changes to the target order since 1) we cannot predict what observing rules a given user considers "smart," and 2) we want to avoid changing the list without the user noticing, perhaps missing a high-priority target. Optimizing target order while accounting for time-dependent parameters is a non-trivial computational problem. Nevertheless, we have been experimenting with a tool to optimize target order in terms of maximizing the number of completed observations and reducing dead time. This may be a future feature.

The OTM can use the NGPS Exposure Time Calculator to optimize the exposure time and/or the slit width for individual targets. For the advanced and curious reader, the OTM-ETC manual contains details about the modeling behind these modules and how to use them as standalone Python scripts (which is not at all necessary to use NGPS).

5.1 Planning Pane

The upper right area of the GUI displays the Planning Pane, which has controls for informing the predictions of the OTM. There are text boxes for OTM-required inputs: start time, seeing, and Airmass Limit. When the GUI is started, these fields are initially auto populated with default values.

Start Date
The date (UTC) you expect to observe the first target in the list. When changed, the Start Time field will change to the end of astronomical twilight (sunset) for that day.

Start Time

The time (hh:mm, UTC) you expect to observe the first target in the list.

Twilight
Click this button to fill the start time field with the predicted twilight for the current day; the field remains editable.

Seeing
Expected seeing (arcsec) for the night. When seeing changes, you should update it and click ACCEPT to re-run OTM predictions. This seeing is specified at zenith; the OTM calculates seeing for targets at higher airmass.

Fetch Live – NOT IMPLEMENTED
Click this button to fill the seeing field with a value based on images from the Acquisition and Guide Camera (ACAM). The field remains editable.

Airmass Limit – NOT IMPLEMENTED IN OS
A default value for all targets, indicating that if a target is above this limit, you will wait until the threshold is passed before observing it. Limits for individual targets can be overridden using the same field in the Observation tab of the Detail Pane. Note that if the active target is waiting for the airmass limit to be met, no other targets can be observed until this condition is met. If a later target has a less conservative limit that is meant to override the global airmass limit, that override will not be read while waiting on the active target. In this case one must either change the airmass limit or abort the active target, in order to move to the next target.

AUTO Start Time
When AUTO start time is selected, the start time field is greyed-out. If the Sequencer is *not* running, the Start Time always displays the current time (hh:mm) so that pressing ACCEPT will run the OTM assuming the observations will start immediately. If the Sequencer is running, Start Time will be set to the actual start time of the current exposure – NOT IMPLEMENTED.

When "DO ALL" is selected and the Sequencer is running, the GUI automatically checks the AUTO Start Time checkbox.

AUTO Seeing/Background -- NOT IMPLEMENTED
When AUTO seeing/background is selected (one button is associated with both fields), the seeing and background fields are greyed out and are populated by retrieving these values from the ACAM.

Once changes are made to the Planning Pane, clicking the ACCEPT icon will perform the following functions:

1. Run the OTM
2. Refresh the target list table with updated OTM predictions.
3. Save the resulting table in the database.

Menu options **File > Save** and **File > Save as...** perform the same functions (except in the case of Save as..., the save-as dialog window is presented).

5.2 OTM Warnings and Errors

If the OTM predicts a problem with a particular observation, it will flag the corresponding row in the main table by changing the color and showing an **OTMflag** error code located in the Plan tab of the Detail Pane. Observations that cannot be completed at all will be colored red in the table. **They cannot be carried out by the Sequencer** and will not appear in the timeline prediction display. Observations that could cause a delay or other minor issues will be colored blue.

For example, if the OTM predicts that sunrise (twilight) will occur before a target is completed, that row will be colored red. If the OTM predicts that a target will be out of the telescope's pointing range, causing a delay while we wait for it to come into range, that target will be colored blue. Such a target would appear next to a noticeable time gap in the timeline prediction.

When you notice that a row has been flagged, you can check the OTMflag code in the Detail Pane. A guide to OTMflag codes is accessible from the Help menu. The only way to clear OTM flags is to rearrange or delete rows manually or to edit target list parameters. Users may choose to ignore blue flags.

When clicking Accept or saving a list, the OTM may display errors in a pop-up window, indicating some problem with the values or formats of the parameters in the table. You will also get a pop-up if no targets can be observed. A common cause for this is a bad Start Time or Date (e.g. are you trying to view summer constellations in the winter?)

5.3 OTM Predictions

The Plan tab in the Detail Pane displays various predictions about the user's observations based on the target parameters provided, the target list order, and the date/time of observing. Apart from Exposure Time and Slit Width, these are only predictions and do not control the Sequencer in any way. The values in this tab are for the target selected in the main table at its predicted time of observation.

- Exposure Time (s) – If not using the ETC, this simply matches the EXPTIME request.
- Slit Width (arcsec) – If not using the ETC, this simply matches the SLITWIDTH request.
- OTMSNR – Signal to noise ratio (if using the ETC, meaningless otherwise)

- Cassegrain Angle (deg) – Angle setting of the P200 Cassegrain ring
- Airmass start – Airmass at start of exposure
- Airmass end – Airmass at end of exposure
- Sky Magnitude – Sky background at the target coordinates (mag/arcsec^2 ; band?)
- Slew GO time – Clock time when the slew to target starts
- Exposure Start Time – Clock time when exposure starts
- Exposure End Time – Clock time when exposure ends
- OTMpa (deg) – The target's parallactic angle
- OTMwait (min) – Estimated wait time due to delays. If non-zero, check OTMflag to diagnose the cause.
- OTMflag – A string with codes describing warnings or errors.
- OTMlast – The last telescope or instrument component to wait for before an exposure can start
- OTMslew (s) – Slew duration
- OTMmoon (deg) – Angle between the moon and the target
- OTMslitangle (deg) -- Position angle of the long slit axis (E over N) in decimal degrees
- OTMres – Resolution "R" of the spectrograph (if using the ETC, meaningless otherwise)
- OTMseeing (arcsec) – Seeing at the target position (band?)

5.4 Exposure Time Calculator (ETC)

5.4.1 Understanding SNR

The ETC can used two ways – it can predict the signal-to-noise ratio (SNR) of an observation given a fixed exposure time and slit width, or it can optimize exposure time and/or slit width given a desired SNR. **Our working definition of "SNR" is crucial to understand so that the user knows what is being optimized and can compare it to their needs.** Since it is difficult to predict how users will analyze their data, we must adopt a definition that is generic and unambiguous to compute.

Our SNR is basically the expected signal-to-noise ratio of the target signal per wavelength bin, averaged over a given range of bins. To start, the user must choose a single spectrograph channel (U, G, R, I) and a wavelength range of interest. If the range endpoints do not correspond exactly to spectral bins (columns) on the CCD for that channel, they will be rounded to the nearest pixel. If the given range is not completely within the channel range,

the OTM will report an error when it runs. Given a spectrum model for the target (flat spectrum is often sufficient), the ETC computes the expected number of signal counts and the RMS noise (photon shot noise, detector noise, background) in each wavelength bin in each of the 3 image slices. By default, for a single bin, the ETC estimates the SNR of a profile fit in the spatial direction (rows), which provides higher SNR than a simple sum over pixels. It also assumes the user will optimally combine the signals from all slices. This produces an SNR for each wavelength bin in the range, and the final SNR is an average over all bins.

We recognize it may be useful to have other SNR definitions, including integrating over bins, combining channels, or extracting particular features. If NGPS users can agree on additional unambiguous SNR definitions, we might be able to incorporate them in the ETC.

There's an option to estimate the SNR from only the center image slice or only the bright central pixels of the spatial profile. See 5.4.3 for details.

5.4.2 Using the ETC

To use the ETC, the user must supply additional parameters about the observation in the ETC tab on the Detail Pane (or in an imported CSV file). You may use the ETC on any subset of your targets (including all or none). The ETC results depend on time-dependent parameters such as airmass and moon angle; thus, editing the target list can affect the ETC results for all targets after (below) your edit. Changing OTM inputs in the Planning Pane (e.g. start time or seeing) will also affect the ETC results, so it is important to periodically re-run the OTM when conditions change or as delays occur.

ETC parameters:

- Wavelength Min (nm) – Minimum wavelength used to compute SNR
- Wavelength Max (nm) -- Maximum wavelength used to compute SNR
- Spectrograph Channel – Channel (U, G, R, I) used to compute SNR
- Magnitude – Source magnitude observed at the top of the atmosphere
- Magnitude System – AB or Vega
- Magnitude Filter – Johnson filter (UBVRIJK) defining source magnitude. Use the default string "match" to define a band equivalent to the wavelength range set above. **See 5.4.3**
- SRCMODEL Parameters – Advanced modeling of the source and measurement. **See 5.4.3**

When the OTM runs with the above fields completed, the SNR computed in the OTMSNR field should be sensible. If these fields are left with their default values, the OTMSNR field will generally be meaningless to the user.

To have the ETC compute optimized values for exposure time and/or slit width, use a keyword other than "SET" in a Request field on the Main Table. Valid keywords are below:

EXPTIME Request:

- **SET** X ; set to a fixed value in seconds ($0.001 \le X \le 16{,}777.216$). Example: SET 600
- **SNR** X ; compute exposure time that will achieve SNR=X. Example: SNR 10

SLITWIDTH Request:

- **SET** X: sets slit width to a fixed value X in arcsec ($0 < X \le 10$). Example: SET 1.1
- **LOSS** X: yields an X% slit loss of the PSF for the slicer (3x slit width). Example: LOSS 3. The "SNR" keyword below improves on this mode.
- **RES** X: yields a resolution $R=\lambda/d\lambda=X$. Example: RES 2000. If X is less than the minimum resolution set by the PSF for a point source, the slit will be set to yield R=X for an extended source.
- **SNR** X: yields a signal-to-noise ratio that is X% of the maximum possible SNR (combining all slices). Sacrificing a small amount of SNR like "SNR 95" can significantly improve resolution.

- **AUTO**: Equivalent to “SNR 95” which we find to be a useful rule of thumb for achieving a balance between SNR and R.

When the OTM is next run, the Exposure Time and Slit Width fields will be populated with any ETC results (or the value specified by the SET keyword). Things to keep in mind:

- Using the ETC this way generally makes the OTM take a bit longer to run.
- The computed exposure time will affect all channels although it has only been optimized for the specified channel in the ETC tab.

5.4.3 Advanced ETC usage

The default value for Magnitude Filter is “match” which makes advanced modeling of the source unnecessary. When the filter is “match”, the band defining the source magnitude is the same as the wavelength range for which we compute the SNR. In this case, the SNR will be largely insensitive to the shape of the source spectrum. The SRCMODEL field can be left blank or it can use the default setting “-model constant”, both of which specify a constant magnitude across the band.

If the filter is significantly different from the wavelength range defining the SNR, then the ETC must predict the flux at the wavelengths of interest based on a function that is being normalized at other wavelengths. Then the shape of the source spectrum is important. As an extreme example, if you enter an I-band (~800nm) magnitude for the source and want the ETC to compute SNR for 380-385nm (U channel), then we need to know the spectrum shape to predict the flux at an entirely different part of the spectrum.

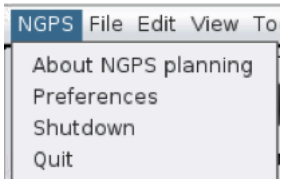
If needed, the SRCMODEL field can be used to model the spectrum using various templates, extinction curves, etc. Please see the OTM-ETC manual for details.

You can also use the SRCMODEL field to change the definition of SNR from the default (5.4.1):

- Add “-noslicer” to compute SNR from a spatial profile fit to the center image slice only.
- Add “-fastSNR” to compute SNR from only the 2 brightest pixels (rows) of the center image slice.

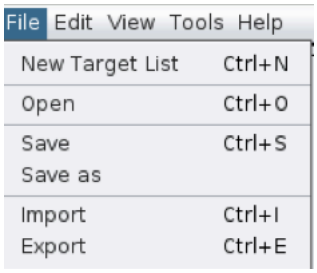
6 Main Menu Bar

6.1.1 NGPS menu



- **About**. Contains version info, compilation date, etc.
- **Shutdown**. Performs the shutdown procedure, which closes all dust covers and powers off all subsystems. This is considered an end-of-night procedure. The software continues to run, changing the state indicator/selector button to read *STOPPED*.
- **Quit**. Quits the GUI. Reminds the user to shutdown the instrument first if needed.
- **Preferences...** Changes made in this dialog apply only to the current session; NOT IMPLEMENTED
  - start time for calibrations
  - sun altitude for observing start (relative to horizon, positive for sunup)
  - sun altitude for observing end

6.1.2 File menu



- **New Target List.** Close the current Target List and start a new blank one. Greyed-out if the sequencer is currently running.
- **Open.** Open a Target List from the current user's saved lists and load into the main table. Greyed-out if the sequencer is currently running.
- **Save**. Save the current target list to the database using the current name. If no name has been saved yet, then prompt the user for a name. Prior to saving, the OTM will be invoked.
- **Save as...** Save the current target list to the database under a new name. Prior to saving, the OTM will be invoked.
- **Import.** Import a CSV file from the file system to create a target list in the main table. See description in Section 1.5. The main table cannot be updated if the sequencer is running.
- **Export.** Export the current target list to a CSV file in the file system. NOT IMPLEMENTED

Remember that the logged-in user can only see, Open, or Save target lists that they own in the database. CSV files saved to the file system are accessible by anyone.

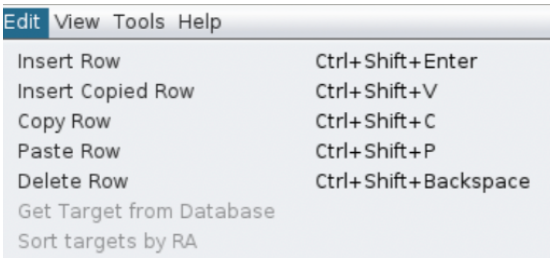
6.1.2.1 File > Import...

Does the NEXP keyword do anything?

More details about CSV file format, usage, defaults, etc.

6.1.3 Edit menu

The Edit menu is used to edit the target list in the main table. Edits can be undone by clicking the Cancel (red X) button in the Planning pane. If a target is active (sequencer is executing the observation), edits and insertions are only allows on rows below that target. The Edit menu items are also accessible by right-clicking a target in the main table.



- **Insert Row.** Insert a row into table below the selected row, filling in some default values.
- **Insert Copied Row.** Paste a row from the clipboard into the table below the selected row.
- **Copy Row.** Copy the selected row to the clipboard.
- **Paste Row.** Overwrite the selected row with data copied to the clipboard.
- **Delete Row.** Delete the selected row, shift remaining rows up.
- **Get Target from database...** NOT IMPLEMENTED
- **Sort Targets by RA.** NOT IMPLEMENTED

6.1.3.1 Getting a Target from Database...

NOT IMPLEMENTED BUT SOME CODE EXISTS

The "Edit > Get Target From Database..." option allows a user to retrieve a previously observed target by name (along with its associated settings) from the database. Selecting this option displays a popup dialog window as shown in Figure 23, titled "Get Target from Database" and in which there is a text entry box for the target name to search for, and Cancel and Search buttons. This is a case-sensitive search. Clicking ***Cancel*** will close the dialog window. Clicking Search will search all the target lists the current user can access.

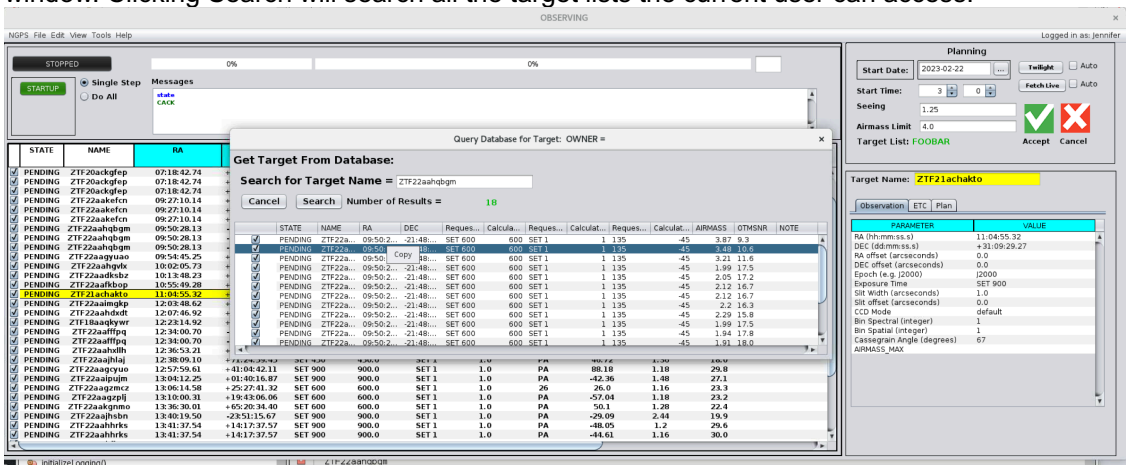
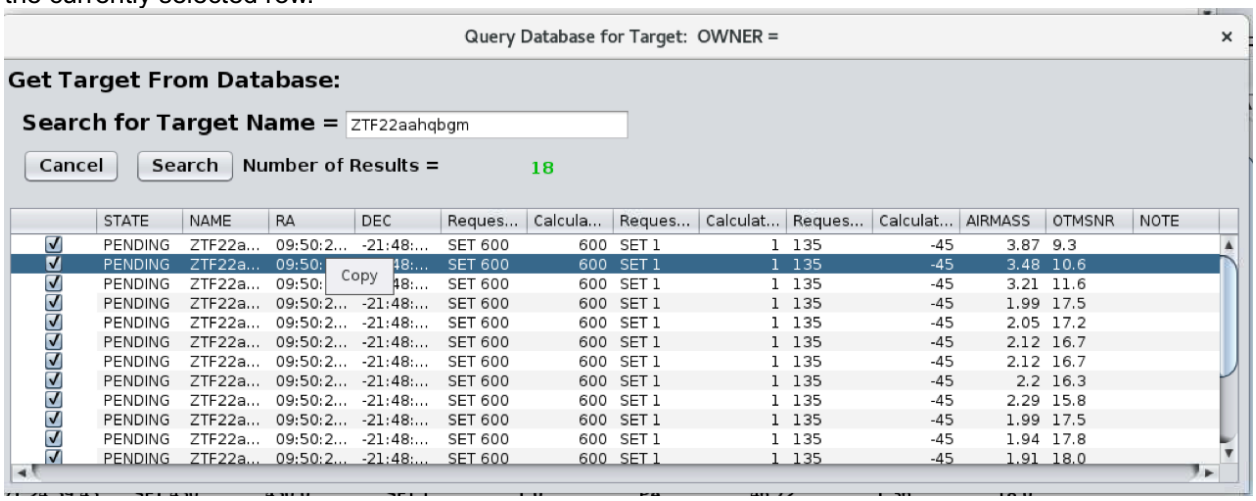


Figure 8 Edit > Get Target From Database

If no match is found then the text, "no match found" is displayed within the dialog window; the dialog box remains, and the user may choose new search criterion or click ***Cancel***.
Otherwise, the target name may match one or more targets across all the tables the logged-in user can access. If one or more matches are found then the search dialog window closes and a new floating dialog window opens,

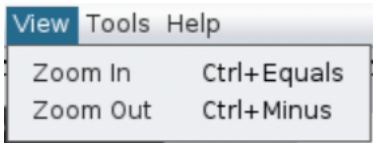
titled "Search Results: *target name*" as shown in Figure 24. The user selects which of the rows they want and clicks ***Insert***. This has the effective action of copying that target row and inserting it into the current targets table above the currently selected row.



	STATE	NAME	RA	DEC	Reques...	Calcula...	Reques...	Calculat...	Reques...	Calculat...	AIRMASS	OTMSNR	NOTE
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	3.87	9.3	
☑	PENDING	ZTF22a...	09:50:	48:...	SET 600	600	SET 1	1	135	-45	3.48	10.6	
☑	PENDING	ZTF22a...	09:50:	48:...	SET 600	600	SET 1	1	135	-45	3.21	11.6	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	1.99	17.5	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	2.05	17.2	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	2.12	16.7	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	2.12	16.7	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	2.2	16.3	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	2.29	15.8	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	1.99	17.5	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	1.94	17.8	
☑	PENDING	ZTF22a...	09:50:2...	-21:48:...	SET 600	600	SET 1	1	135	-45	1.91	18.0	

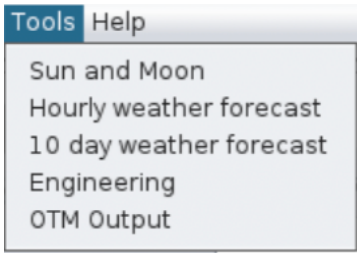
Figure 9 Get Target From Database Search Results

6.1.4 View menu



- **Zoom in**. Increase font size for target list and detail pane. DETAIL PANE NOT IMPLEMENTED
- **Zoom out.** Decrease font size for target list and detail pane.

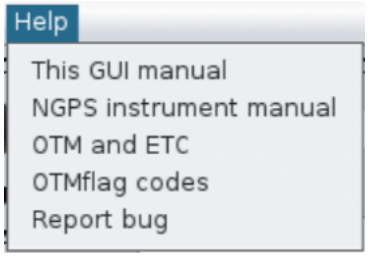
6.1.5 Tools menu



- **Sun and Moon**. Displays a window with information about Sun and Moon rise and set times.
- **Hourly Weather Forecast**. Opens a browser window with local weather information.
- **10 day Weather Forecast**. Opens a browser window with local weather information.
- **Engineering.** Displays a window with GUI backend info for debugging.
- **OTM output.** Displays a window with OTM backend info for debugging.

6.1.6 Help menu

Each of these items opens a browser window with helpful information. The **Report Bug** item directs you to the NGPS Github page – please feel free to use it to add a bug/issue (you may need to log in to Github).



6.1.7 User menu (Right side of main menu bar)

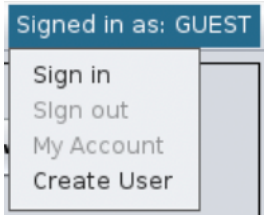


Figure 10 The User Menu

The User menu will change depending on the user signed in.

- **Sign In**. Enter your username and password to access your private target lists.
- **Sign out.** Sign out – main table will be cleared.
- **My Account**. Change account info like password or email.
- **Create User**. Create a new GUI account

7 FAQ, Troubleshooting, and other Resources

- Exposure Time Calculator
- Optimizing observation order
- Data reduction
- Calibration
- Example spectra
- NGPS instrument manual
- Errors and diagnostics