

NGPS Quicklook Data Reduction

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last update: 2025-07-02

1. Startup

Normally the Quicklook GUI will already be running and open on Workspace 1 (make sure you are on workspace 1 using the workspace buttons on the top right of the screen on the Quicklook computer)

If the Quicklook GUI is not already open, double click the 'NGPS Quicklook' icon on the left side of the desktop.

2. Usage

Update the path on the top right of the GUI, by changing the date string to the UT date of your observing night. Make sure the path ends with /spec2d

Click the 'List files' button on the top right of the GUI to update the working directory contents table on the right side of the GUI.

Turn on 'listen for new files' on the left side of the GUI. This will automatically display new data as it reads out from the NGPS instrument. If you want to keep inspecting an existing frame, you can turn this off to make sure you are not interrupted by new data coming in. If it is off, you need to click the 'List files' button to update the working directory contents to display new data that has been taken.

To display a specific object or .fits file, click the object name in the working directory contents table. This extracts the 1d spectrum from all .fits files associated with that object. If the 'Stack' button is clicked and highlighted (green) on the left side of the GUI, all 2d images associated with that object are summed.

If you have multiple exposures of an object, you can click the arrow next to the object name. This shows all .fits files associated with that object (based on the NAME keyword in your .fits files). To display the 1d spectrum extracted from a specific file, simply click that file. Usually you want to click both R and I channel files for the same image number (specified in the filenames as *_R.fits, *_I.fits). If the 'Stack' button is enabled, all files that are clicked for the same object are summed, until you click the 'Clear plots' button, or move to another object. **[If you want to inspect a single .fits file, make sure you are not in the stacking mode, and/or have cleared the current stack].**

2.1 Trace extraction settings:

The width of the extraction can be adjusted using the 'Trace width' box at the center of the GUI. Click a new file, or click 'Extract/Save' (left side of the GUI) for changes to be applied and re-extract.

The spatial locations of the extraction on each spectrograph channel can be changed by clicking on the 2d images displayed on the top left of the GUI. The signal is typically expected to be at the center of the central slice. To confirm the rough location of the signal, you can display a bright object, such as a

standard star where the signal will be clear and unambiguous. It can be helpful to zoom in onto the center slice only using the buttons that appear above the 2d images when you hover over them with the cursor. The 'Lock zoom' checkbox allows you to keep the same zoom for subsequently displayed images. **[Make sure you de-select the zoom function once you are done zooming in. Otherwise, the images will not recognize clicks to change the spatial location of the extraction].**

The 'Lock trace shape' checkbox under the 2d images can be enabled to lock down the fitted curvature of the traces using e.g., a standard star if the shape cannot be determined on your science data (e.g., very faint signal or only a few emission features present).

The software keeps the spatial extraction locations at the same spatial pixels until they are changed by the user. The 'Place aperture' button at the center of the GUI can be used to move the extraction in all the channels together by the same amount, by clicking the button and then clicking anywhere on the Spatial profiles display (top center of the GUI).

2.2 Local Background subtraction

The NGPS data reduction pipeline automatically performs a 2d background subtraction to remove emission from the sky. An additional 'local' background subtraction can be enabled by clicking the 'Background sub' button on the left side of the GUI. If the button is green, local background subtraction is enabled. The subtraction width and location can be adjusted with the buttons and fields that appear under the Spatial profiles display when background subtraction is enabled. **[Note that performing an additional local background subtraction will add some extra noise to your final 1d spectrum. This can be mitigated by trying to keep the width of the background regions as large as possible.]**

2.3 Sensitivity function calibration

The DRP automatically chooses the sensitivity function derived from the standard star exposure that was observed closest in time to your selected science frame. **The NGPS Quicklook software contains reference spectra of stars included in the list of HST Spectrophotometric standards: https://archive.stsci.edu/hlsp/reference-atlases/cdb/current_calspec/ ; other stars will not generate sensitivity functions automatically.**

If you do not observe a standard star, a sensitivity function from a previous night will be used automatically. If you want to manually inspect or change the sensitivity function, click the 'Calibration info' button on the bottom left of the GUI.

Using the panel that pops up, you can inspect all available sensitivity functions. Usually the latest ones are at the bottom of the list. To use a specific sensitivity function on your data, highlight it by clicking on both the R and I channel tables, and check the 'Use selected' checkbox under the tables at the center of the window. To re-enable automatic selection, de-select the 'Use selected' checkbox.

To plot multiple sensitivity functions on top of each other, check the 'Hold plots' checkbox and then select the sensitivity functions you want to compare.

If your standard star data does not generate a new sensitivity function, it could be because of a few typical reasons: The star is not included in HST Calspec. Your data are saturated (check that your counts do not exceed ~50,000 anywhere, including in the sky lines). Too low SNR to generate a

reliable sensitivity function. Check that your signal reaches at least $\sim 1,000$ counts (preferably closer to 10,000). You can see the raw counts in the Spatial profiles panel.

2.4 Cosmic Ray Rejection

Cosmic Ray Rejection is by default enabled in the Quicklook GUI (bottom checkbox on the left side panel of the GUI). The default parameters work well for 2x spatial binning and 3x spectral binning. For 2x and 1x spectral binnings, you may experiment with reducing the 'Fth' parameter, which sets the threshold for how sharp cosmic rays are expected to be relative to the 'real' signal.

'Nsig' sets the sigma threshold for detection of cosmics, and 'Grow' expands or grows all detections with the chosen number of pixels. For twilight observations or very bright sources (such as standard stars), it may be necessary to increase 'Nsig' significantly, and/or reduce 'Grow', to avoid clipping a high percentage of the data/signal. A clear signature of over-clipping is if the 2d images appear blurred/garbled. This is likely a result of excessive interpolation over a large amount of masked pixels.

2.5 Signal To Noise Estimation

The Quicklook software can estimate the SNR per pixel by computing a moving standard deviation and comparing it to the signal level. This feature can be enabled by clicking the 'Compute SNR' checkbox at the bottom left of the GUI. Note that this calculation is not perfect and may be affected by sharp spectral features or cosmic rays. A signature of this can be sudden jumps in the SNR curve. However, generally the calculation gives a usable estimate of the SNR per pixel of your extracted signal.

2.6 Basic Troubleshooting Tips

If the Quicklook GUI appears to be missing, first check that it is not on a different workspace (check the top right on the ngps computer's menu bar). If it is really not running, start it with the 'NGPS Quicklook' icon on the left side of the desktop.

The view of the 1d spectrum can be zoomed and panned using the icons that appear at the top right when you hover over the main panel. If the home icon does not restore the zoom to a reasonable state, the display can be reset using the 'Clear plots' button on the left panel of the GUI, and clicking the .fits images again in the working directory contents to display them.

Errors may appear in the logging terminal if 'lock zoom' or 'lock trace shape' is enabled and the user goes to display an image with a different binning setting compared to the previous one where the zoom or trace was locked. To fix this, disable the check-boxes for lock zoom and trace shape.

If multiple binnings are used on the same night, the user should make sure to manually set the sensitivity function (Section 2.3) to use a standard star taken at the same binning for optimal results. This is currently not automated.

If the extracted 1d spectrum looks completely unreasonable, it is possible that a bad sensitivity function is being used. This can be checked with the 'Calibration info' button on the left side of the GUI (see also Section 2.3)

APPENDIX 1 (for SAs/Operators)

If new data does not turn up in the quicklook GUI. Check that IMGTYPE=SCI in the fits headers (gethead ngps*.fits IMGTYPE). If not, change the keyword on the ngps machine. Existing data headers can be modified with sethead -x 0 ngps_XXXX.fits IMGTYPE=SCI on the Quicklook machine in */media/data_archive/UTDATE*. Once the header is updated, the DRP should automatically pick up the data and it should show up in the Quicklook GUI.

If IMGTYPE=SCI is correct in the headers but new data still does not turn up, check that the 'listen for new files' is enabled (left hand side of the GUI). If yes, and it is still not updating after ~30 seconds, **restart the DRP with the icon on the bottom right of the desktop**. Wait ~1 minute, then start and try the Quicklook GUI again.

Clicking the restart icon opens a terminal showing the low level DRP logging. If you do not want to keep this terminal up, it is safe to close the terminal. This will exit the screen session while leaving the DRP running in the background.

General tips: Check that only one Quicklook GUI is running (check all workspaces). The GUI is easily restarted by closing any existing ones and then double clicking the 'NGPS Quicklook' icon on the left side of the desktop.

APPENDIX 2, reduced data

The reduced data from the Quicklook DRP will be located in */media/data_archive/UTDATE_reduced/*

The observers may transfer their directory off the Quicklook machine to their own server using

```
scp -r /media/data_archive/UTDATE_reduced their_username@their_machine.address:/their_directory/
```

The UTDATE_reduced/ directory should have the following contents:

sensitivity functions in .fits format

spec1d/ - 1d spectra saved by the Quicklook GUI 'Extract/save' button. wavelength, flux CSV format.

spec2d/ - reduced 2d spectra in multi-extension .fits format

The extensions for the sensitivity function .fits files are as follows:

- [1] Wavelength solution for sensitivity function
- [2] Raw sensitivity function per wavelength (cgs/counts)
- [3] Smoothed sensitivity function per wavelength (cgs/counts)
- [4] Smoothed sensitivity function per wavelength (AB mag)
- [5] Raw sensitivity function per wavelength (AB mag)

The reduced 2d spectra .fits files have the following extensions:

- [1] Bias subtracted and flat fielded data
- [2] 2d sky model
- [3] 2d wavelength solution (currently this contains the solution derived from the central part of each slice, so it does not at the moment change spatially within an individual slice, but does vary between

slices)

[4] Bad pixel map (currently blank)

[5] Illumination flat (can be used to correct side slices relative to center slice. But unsuitable for actual flat fielding since the dome light intensity is wavelength dependent)