JWST ETC Calculations Page Overview

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The JWST Exposure Time Calculator initializes a calculation once the user chooses an instrument and mode. Multiple calculations can be compared, copied and modified in the ETC workbook.

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Introduction

The "Calculations" page in the JWST ETC is where a user specifies an instrument and mode, the background, instrument and detector configuration, and observing setup and extraction strategy for a given calculation. This is typically done after scene(s) and source(s) of interest have been defined on the "Scene and Sources" page, although a default scene containing a central point source is always available. The "Calculations" page offers users the ability to do a comparative analysis of multiple sources or locations to determine which calculation offers the best signal-to-noise ratio (SNR).

Calculations page layout

Figure 1 shows the layout of the "Calculations" page, labeled in blue to identify its panes, tabs, and sub-tabs in the graphical user interface.

Figure 1. The "Calculations" page with labels on its various panes

JWST Exposure Time Calculator

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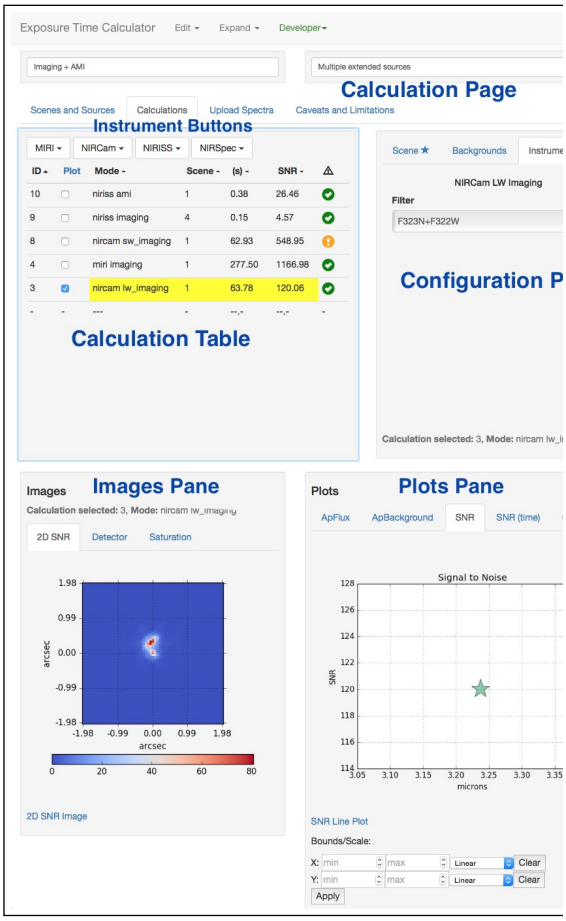

Click on the image for a larger view.

New calculations can be created using the instrument buttons above the calculation table. Selecting a row in the calculation table (upper left) by clicking anywhere on the row allows you to modify its parameters and recalculate using the configuration pane (upper right). Output information from the selected calculation is shown in the lower left and right panes. Selecting a calculation automatically checks its **Plot** checkbox, and plots its 1D results in the central lower pane. Multiple 1D and scalar products from calculations are compared by manually checking their **Plot** checkboxes. The selected calculation can be copied or deleted from the **Edit** menu (top left), and can be used as the basis for select parameter space expansions from the **Expand** menu (top left).

The calculation table consists of the following columns: **ID** (calculation identification number), **Plot** (checkbox to display plot), **Mode** (mode of instrument), **Scene** (Scene ID from library), **(s)** (total time required for integration, in seconds), **SNR** and **status** column. The **status** column will display the following indicators: success (green checkmark), warning (orange exclamation point), or error (red "x"). If the calculation results in a warning or error, the **Warnings** or **Errors** tab located in the "Reports"

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pane (lower right) will turn red, indicating a message should be reviewed.

Initialize a calculation

To begin a calculation, an instrument and mode must be initialized by selecting the mode from the instrument buttons in the calculation table. Selecting an instrument and mode initializes a calculation, which is run with default values and appears in the calculations table with the following columns: **ID**, **Plot**, **Mode**, **Scene**, **(s)**, **SNR** and **status** column. After the calculation is complete, selecting the row will highlight it in yellow and the ETC outputs for that calculation will be shown in the "Images" and "Reports" panes.

Edit a calculation

To edit or modify a calculation, the user may identify a scene from the **Scene** tab, in the configuration pane, and change default parameters listed under the following tabs: **Backgrounds**, **Instrument Setup**, **Detector Setup** and **Strategy**.

Scene and background

The **Scene** tab contains information for both source and scene choices that can be selected for a given calculation. Primarily the **Scene** tab should only be used for selecting the scene to use in the calculation. The **Sources in that Scene** and other subtabs are for modifying the source itself, and its location in the scene.

> **Warning**
> The **Scene** tab does not inform users about what other calculations will be affected by changing the parameters of the source and scene, while the Scene and Sources page does. Changing the parameters of a source on the configuration pane will cause all calculations using that source to be automatically updated with the modified source properties.

The JWST background model includes zodiacal light, interstellar medium, and cosmic infrared background, as well as telescope self-emission and scattered light (see JWST Backgrounds). In the **Backgrounds** tab, the user can specify the RA and DEC to be used to calculate the background. The user can specify a date to calculate the background on that date. Alternatively, the user can choose to assume a ***low***, ***medium***, or ***high*** background, from the ranges expected for that RA and DEC.

Instrument and detector setup

The **Instrument Setup** tab allows the user to specify parameters for the desired configuration of the selected instrument mode. A plot of the full system throughput for a given mode and chosen optical element is shown as a function of wavelength (in μm).

The **Detector Setup** tab allows the user to enter the desired exposure (photon-collecting) time by specifying the readout pattern and subarray to be used, and the number of groups, integrations, and exposures to simulate.

> **Helpful Info**
> - Groups = number of groups in a ramp (each group can have a number of reads, depending on readout pattern)
> - Integrations = number of ramps in a single exposure
> - Exposures = number of exposures
>
> **Total integration time is:** Frame time (depending on the subarray) × number of groups × number of integrations × number of exposures.

Extraction strategies for sources and background

The **Strategy** tab is where the extraction and observation parameters can be specified. Imaging and spectroscopic modes support aperture extraction, in which the user can choose to specify the extraction aperture centered on a source, or at an arbitrary offset in the scene. This allows for exploration of observation setup and extraction strategies. IFU, MSA, and coronagraphy modes have more complex strategies available. For spectroscopic modes, a wavelength of interest is chosen, which is the wavelength used to calculate various scalar values, including the SNR shown in the calculations list. A user is also allowed to determine whether a background subtraction should be performed. If the background subtraction is performed, a sky annulus for the inner and outer radius will need to be defined.

> **Note**
> If the user inputs are not valid, then the affected tab names will turn italicized red, and explanatory red text will appear near the incorrect field.

Performing the calculation

Lastly, the user can now click the **Calculate** button at the bottom right of the configuration pane. To abandon your changes and restore the last-applied values, click **reset**. The bottom of the configuration pane lists the **calculation id**, **instrument**, and **mode** that is presently selected. When calculations are deleted by selecting the row of the calculation then selecting **Delete Calculation** from the **Edit** menu at the top left of the "Calculations" page, other calculations will retain the original

identification number, resulting in non-sequential Calculation ID numbers.

> **Note**
> The **Calculate** button will change to ***What's wrong?*** if the calculation cannot be performed. Just click the button to see the problem and suggested solution.

Exploring parameter space

The 'copy and modify' workflow allows users to copy and modify their calculations by copying or requesting a batch expansion of a specific calculation. Selecting a single calculation and then selecting **Copy Calculation** from the **Edit** menu at the top left of the page enables the copy feature.

Batch expansions are performed based on varying filters and exposure specifications such as number of groups or integrations. Selecting a single calculation and then selecting **Expand Groups**, **Integrations or Filters** from the **Expand** menu at the top left of the page, will duplicate the selected calculation, varying only the expansion parameter, and the resulting set of calculations will appear in the calculations table. Batch expansions are for automating the copying calculations process and varying exposure specifications are described in the Edit a Calculation section above.

Analyze the results

The bottom panes of the "Calculations" page are where users can view the "Reports" pane that displays the scalar results, warnings, errors and a download link for the defined calculation, which allows a user to download all 2D and 1D products, the 3D data cube for IFU calculations and a FITS table of the calculated background spectrum. One may view the 2D images of per-pixel SNR, countrate at the detector and saturation. Furthermore, the SNR vs wavelength, SNR vs time, and contrast vs separation can be compared for multiple calculations. Visit the Outputs Overview page for more information on the ETC results.

Related links

JWST Exposure Time Calculator, ETC

JWST Exposure Time Calculator Overview

JWST ETC Creating a New Calculation

JWST ETC Scenes and Sources Page Overview

JWST ETC Outputs Overview

JWST ETC User Supplied Spectra

References

go to the on-line JWST Exposure Time Calculator Tool

Pontoppidan, K. M., Pickering, T. E., Laidler, V. G. et al., 2016, *Proc. SPIE* 9910, Observatory Operations: Strategies, Processes, and Systems VI, 991016 , "Pandeia: a multi-mission exposure time calculator for JWST and WFIRST"