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JWST ETC Creating a New Calculation

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In the JWST Exposure Time Calculator (ETC) a new calculation can be initiated by choosing an instrument and mode, or copying and modifying an existing calculation. The calculation requires an existing library of scenes and sources.
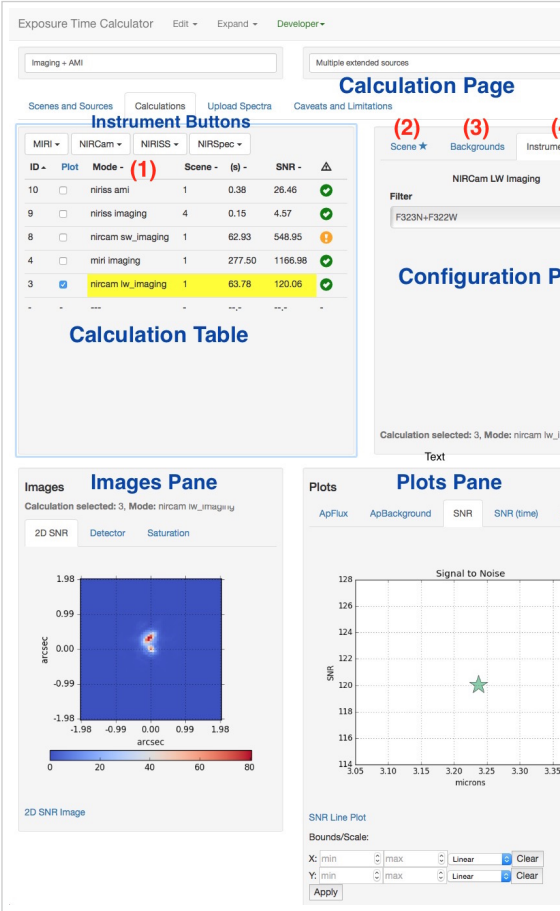
Introduction

The JWST Exposure Time Calculator (ETC) calculation is performed from the calculation page where the user chooses the input parameters which include: (1) instrument and mode, (2) a scene containing one or more sources, (3) background model parameters, (4) instrument configuration, (5) detector setup, and (6) the strategy for calculation of the signal-to-noise. The location of the tabs where the input parameters can be provided on the calculations page is shown in Figure 1 by the numbers in red.

Figure 1. Calculation Page Layout

Create a new ETC calculation

A new calculation may be created by two methods: by selecting an instrument and mode, or by copying and modifying an existing calculation. The calculation page has instrument buttons for the JWST instruments, and each instrument button has a drop-down menu with all the modes offered for that instrument. Selecting an instrument and the mode immediately initiates a calculation using the default scene with default source. The new calculation can then be edited for the desired input parameters as described in the following sections. If the user wants to copy and modify an existing calculation that is provided in a sample workbook, this is accomplished by using the "Copy Calculation" option from the drop-down menu under "Edit" button at the topmost left corner. This creates an exact copy of the calculation and the user can modify the calculation by changing the input parameters as described below.

Editing an ETC calculation

To edit a calculation, select it by clicking on the row corresponding to that calculation so it is highlighted. The configuration pane is activated and the input parameters can now be modified to change the scene, backgrounds, instrument setup, detector setup, and strategy.

Scene

On the configuration pane, click on the scene tab. This offers a dropdown menu of all the scenes available in the scene library, which you can use to specify which scene should be used for the existing calculation. Often, this is the only thing users need to manipulate on the scene tab.

 Choosing a scene automatically populates the source tab with all the sources present in that scene. The configuration pane provides all the same input parameters offered under the source editor of the Scenes and Sources page and can be directly modified on this pane in the calculation page.

- *Remember that when a change is made to the source properties from the configuration pane, it modifies the source in the source library on the Scenes and Sources page and affects all the calculations that use that particular source.*

- *If you are not sure you want to change the property of a given source and affect all the calculations involving that source, then go to the scenes and sources page, copy and modify the source and use it in the desired scene before performing the calculation.*

Backgrounds

The ETC calculations can include the expected in-field zodiacal light (within the FOV) and stray light (scattered from the outside into the FOV) which is the total input sky background for a given set of celestial coordinates and optionally a specified date. The thermal self-emission of JWST will be characterized on-orbit, and currently the ETC assumes that the thermal self-emission is constant with time and pointing. The ETC can use and report a dated sky background or a non-dated sky background. When a date is specified, the ETC will use the background model generator to generate the background for the specified sky position (RA, Dec) for that date. The non-dated background offers a choice of low, medium, or high which corresponds to the 10th, 50th, or 90th percentile of the sky background over the period of visibility for that sky position.

Instrument Setup

The instrument setup offers the choice of filters, grism, dispersers, and slits for the different JWST instruments. For imaging modes, the instrument setup has a drop-down menu with the choice of filters that can be used for the imaging calculation. For wide-field slitless spectroscopy mode available with NIRISS and NIRCam there are two drop-down menus, one for the grisms and the other for the blocking filters that are used in combination with the grism. The MIRI MRS mode has options for choosing the channel and disperser. The NIRSpec IFU calculations require the grating/filter pair to be selected. The NIRSpec MSA setup is specified by choosing the grating/filter pair, slitlest shape, and MSA location. The NIRSpec fixed slit requires the grating/filter pair and slit to be selected. For spectroscopy modes that do not require a blocking filter, only a menu for the disperser is provided (eg; NIRISS SOSS, MIRI LRS).

Detector Setup

The detector setup allows the user to enter the desired exposure time (photon-collecting duration) by specifying the subarray configuration, readout pattern, groups, integrations, and number of exposures.

ⓘ **Helpful Tips**
- 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) x number of groups x number of integrations x number of exposures.

The number of groups and number of integrations vary by instrument, and users are advised to consult the documentation on JWST Astronomer's Proposal Tool (APT) and JWST instruments for more information on

the allowed range of values for these detector parameters. The ETC will alert the user with red color for the parameter entry boxes if the values provided for the detector parameters are invalid and will prevent the ETC calculation to be completed. The detector parameters available for the different instruments and modes are set to be consistent with that offered by the APT.

Strategy

The strategy tab is where the user defines the extraction parameters for the source flux and for the background to be used for background subtraction. There are different strategies implemented depending on the mode, for example, imaging, spectroscopy, coronagraphy, etc.

In general terms, the strategy defines the location of the aperture for extracting the source flux, and the size of the aperture. There is also an option to define a region for extracting the background flux if background subtraction is required. The background in the region defined for background flux extraction will include the sky background as well as any other flux from nearby overlapping sources that contribute to the defined background region. For the IFU modes the background is estimated by using the IFU Nod off scene option.

If a background region is not specified, then a noiseless sky background is subtracted from the source aperture. The total sky background includes the contribution to the FOV from the in-field zodiacal light and the stray light from outside that is scattered into the FOV.

Running the edited new ETC calculation

After all the above mentioned parameters have been set, the calculation is performed by clicking on the "Calculate" button. If the sources used in the newly created calculation are included in other existing calculations, then all of those calculations will be run simultaneously. If the user wants to delete a calculation, there is a "Delete Calculation" option available in the drop-down menu under "Edit" button at the topmost left corner. Once the calculation is completed the results may be viewed in the Images pane, Plots pane, and the Reports pane.

Related links

JWST Backgrounds

JWST ETC Outputs Overview

JWST Exposure Time Calculator, ETC

JWST ETC Scenes and Sources Overview

JWST ETC Strategies

JWST Observatory and Instrumentation Documentation

MIRI Low Resolution Spectroscopy

MIRI Medium Resolution Spectroscopy

MIRI Overview

NIRCam Overview

NIRISS Overview

NIRSpec Integral Field Unit

NIRSpec Overview

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"