NIRISS Wide Field Slitless Spectroscopy Template APT Guide

This article provides instructions for filling out the JWST NIRISS wide field slitless spectroscopy APT template.

Introduction

> *Main article: NIRISS Wide Field Slitless Spectroscopy*
> *See also: NIRISS WFSS Recommended Strategies, NIRISS WFSS Science Use Case, NIRISS GR150 Grisms*

Wide field slitless spectroscopy (WFSS) is one of 4 observing modes available with the Near Infrared Imager and Slitless Spectrograph (NIRISS). The WFSS mode is used for low-resolution (R ≈ 150) multi-object spectroscopy of sources over the full 2.2' × 2.2' NIRISS field of view. This mode uses a pair of identical grisms (GR150R, GR150C) that are mounted orthogonally to each other in the filter wheel and cover the wavelength range from 0.8 to 2.2 μm. The relative dispersion directions are perpendicular to each other, allowing blended spectra to be disentangled in crowded fields. Individual WFSS grism exposures are performed with a filter in the pupil wheel (PW) to (1) select the wavelength range of interest, and (2) reduce blending spectra in different wavelength regions from objects throughout the field. Obtaining spectral coverage across the full 0.8–2.2 μm bandpass requires separate exposures in the adjacent filters.

Each WFSS observation will consist of one or more **Exposures** in APT that include: 1) direct imaging and 2) dithered grism exposures using the same PW filter as the direct image. The direct imaging enables identification of objects in the grism image and calibration of the absolute wavelength zeropoint for grism spectra of each object in the field. One direct image will be taken at the first dither position and a final one at the last dither position. Since the NIRISS point spread function (PSF) is under-sampled over the WFSS wavelength range, dithering will be required for WFSS observations.

The observer will have control over 3 primary parameters for NIRISS WFSS: 1) filter for direct and grism images, 2) dithering pattern, and 3) detector readout mode and exposure time (via the number of groups and integrations). Allowed values are documented in the NIRISS WFSS Template parameters article.

Step-by-step APT instructions

Generic

The following parameters are generic to all templates, and are not discussed in this article: Observation Number, Observation Label, Observations Comments, Target Name, ETC Workbook Calculation ID, Mosaic Properties, and Special Requirements.

Science observation

Dither

> *Main article: NIRISS WFSS Dithers*
> *See also: NIRISS Dithers*

Choose the NIRISS WFSS dither pattern. The dither offsets are large enough to ensure that a compact source does not fall on the same pixel twice, but not so large as to be affected by distortion across the detector.

Specify:

- ***IMAGE DITHERS:*** number of steps, where the first step corresponds to initial pointing; allowed values are ***2, 3, 4, 6, 8, 12, 16***
- ***PATTERN SIZE:*** amplitude of dither step; allowed values are ***SMALL*** (≈0.3")***, MEDIUM*** (≈0.6")***,*** and ***LARGE*** (≈1.2")

Sequences

> *Main Article: NIRISS Wide Field Slitless Spectroscopy*
> *See Also: NIRISS GR150 Grisms, NIRISS Filters, NIRISS Detector Readout Patterns*

Specify:

- ***GRISM*****: *GR150R*, *GR150C*, *BOTH***
- ***FILTER*****: *F090W*, *F115W*, *F140M*, *F150W*, *F158M*, *F200W***
- ***READOUT PATTERN***
  - ***NISRAPID:*** all frames are read and stored. Generally this can be used if the number of frames per integration is small and the data volume is not an issue. There is a limit of 30 on the number of groups per ramp in ***NISRAPID*** read out.
  - ***NIS:*** four frames are averaged per group. Used for producing a lower data rate for longer integrations of faint targets.
- ***NO. OF GROUPS:*** the number of groups during an integration, equal to the number of frames read per integration (for ***NISRAPID***), or the number of frames read out divided by 4 (for ***NIS***).
- ***NO. OF INTEGRATIONS*****:** the number of integrations during an exposure, where an integration is the time between detector resets.

The Exposure Time Calculator (ETC) should be used to determine the combination of ***NO. OF GROUPS*** and ***NO. OF INTEGRATIONS*** necessary to achieve the required signal-to-noise. Individual integrations longer than 1000 seconds are discouraged because of the effect of cosmic ray hits on the detector. For long exposures, a suitable number of integrations and a number of groups less than or equal to 25 is suggested.

To take observations in different filters, **Add** additional observations and specify the appropriate filter. This option will by default add a corresponding direct image for the new grism observation in the **Direct Image Exposure Parameters** dialog box.

Direct image exposure parameters

A direct image will be taken before and after each set of dithered grism observations. In the case where both grisms are used with the same filter, two direct images are taken when switching between grisms, one at the dither position of the last exposure from the first set and another at the dither position of the first exposure from the second set.

Direct images

> *Main article: NIRISS Imaging*
> *See also: NIRISS Detector Readout Patterns*

Specify choice of the following parameters, whose meanings are identical to the descriptions above:

- ***READOUT PATTERN: NIS, NISRAPID***
- ***NO. OF GROUPS***
- ***NO. OF INTEGRATIONS***

The ***FILTER*** of the direct image will by default match the ***FILTER*** specified for the corresponding grism image in **Science Observation**.

Note: the Exposure Time Calculator mode for WFSS does not include calculations for direct imaging. To run calculations for direct imaging to determine ***NO. OF GROUPS*** and ***NO. OF INTEGRATIONS***, use the NIRISS imaging mode in ETC.

All exposures display

Exposures

The **All Exposures Display** dialog box will show the sequence of observations for each science observation specified in the **Science Observation** dialog box. If ***BOTH*** grisms are selected in the **Science Observation** dialog box, the exposure sequence for that observation will be DIRECT → N × GRISM → 2 × DIRECT → N × GRISM → DIRECT, where all exposures in this sequence will have the same exposure number and N refers to the number

of dithered grism exposures as specified in the ***IMAGE DITHERS*** parameter. Note: fields can not be edited in the **All Exposures Display** dialog box, but must be edited in the **Science Observation** and **Direct Image Exposure Parameters** dialog boxes. Changes to these parameters will be propagated to **All Exposures Display**.

Other tabs

Mosaic properties

The NIRISS WFSS mode can be used to obtain data for a region larger than the field-of-view by creating a mosaic pattern. Mosaics are required to ensure that complete spectra are obtained over the full 2.2' x 2.2' NIRISS FOV, as specified on the NIRISS Mosaics article. Visit the Mosaic Parameters article for information on setting up a mosaic.

Special requirements

A variety of observatory level special requirements may be chosen.