

NIRCam Wide Field Slitless Spectroscopy APT Template

Instructions for designing JWST [NIRCam wide field slitless spectroscopy](#) observations using [APT, the Astronomer's Proposal Tool](#).

Introduction

[Wide field slitless spectroscopy](#) (WFSS) is one of five observing modes available for the [Near-Infrared Camera \(NIRCam\)](#). The WFSS mode uses [grisms](#) to obtain multi-object spectroscopy from 2.4–5.0 μm with $R \sim 1500$. WFSS can be obtained in one [module](#) (2.2' \times 2.2'), or with both modules (note the module **B** grism throughputs are 25% lower than module **A**). There are two grisms available on the pupil wheels that disperse in orthogonal directions, along detector rows (**GRISMR**) and columns (**GRISMC**). Use of both grisms mitigates confusion from overlapping spectra.

WFSS observations include simultaneous short-wavelength (SW; 0.6–2.3 μm) imaging over roughly the same [field of view](#) via a dichroic. These SW images aid in wavelength calibration by precisely tracking the position of each dither. Direct imaging in the long-wavelength (LW) channel is also supported, including coverage of [out-of-field sources](#), which disperse light onto the detector despite being outside the imaging field of view. LW direct images and out-of-field dithers occur at the final dither position in a dither sequence.

The observer will have control over five primary parameters for NIRCam WFSS:

1. [NIRCam module\(s\)](#)
2. [Dither pattern](#)
3. [Grism choice](#)
4. [Filter choice for direct and grism images](#)
5. Exposure parameters ([detector readout pattern](#), number of groups, and integrations).

Allowed values are documented and maintained in the [NIRCam Wide Field Slitless Spectroscopy Template parameters](#) and described below.

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](#).

Module

Observers can select **A** or **ALL**. **Module A** covers one 2.2' × 2.2' field of view, while **ALL** includes both modules **A** and **B** to double the [field of view](#). The **Module B grism throughputs** are 25% lower than those on **Module A**.

Subarray

The only available option is **FULL**. [Subarrays](#) are not currently available for NIRCcam WFSS mode, but are available in [NIRCcam Grism Time Series](#) mode.

Grism (long wavelength)

Main article: [NIRCcam Grisms](#)

Specify **GRISMR**, **GRISMC**, or **BOTH** (for the long-wavelength observations). **GRISMR** disperses along the detector rows, and **GRISMC** disperses along the detector columns. Use **BOTH** to help disentangle overlapping spectra in the data. When using both grisms, a **FULL** dither sequence is executed for **GRISMR**, then executed again for **GRISMC**.

Science (GRISM) exposures

Dither parameters

Main article: [NIRCcam Wide Field Slitless Spectroscopy Dithers](#)

See also: [NIRCcam Dithers and Mosaics](#)

Choose a NIRCcam WFSS dither pattern. Larger primary dithers cover the 4"–5" gaps between the short-wavelength detectors. Smaller subpixel dithers improve the spatial resolution of the final combined image, which is especially important at wavelengths shorter than the Nyquist wavelengths: 2 μm in the SW channel, and 4 μm in the LW channel.

Specify:

- **PRIMARY DITHER TYPE:** choose whether to use one of the [INTRAMODULE](#) dithers or **NONE**.
- **PRIMARY DITHERS:** number of primary dither positions; allowed values are different for **INTRAMODULE**, **INTRAMODULEBOX**, and **INTRAMODULEX**.

- **SUBPIXEL POSITIONS:** number of subpixel dithers; allowed values are [4-POINT](#) and [9-POINT](#).

Science

See also: [NIRCam Filters](#), [NIRCam Wide Field Slitless Spectroscopy](#), [NIRCam Detector Readout Patterns](#)

Specify the grism exposure sequences. Multiple exposures may be defined here. For each, specify:

- **DIRECT IMAGE:** check the box to obtain "direct" LW and SW images after each LW grism + SW image exposure (required for the final exposure).
- **LONG FILTER:** choose the long-wavelength medium or wide [filter](#) to be used with the grism.
- **SHORT FILTER:** choose the short-wavelength [filter](#) used for simultaneous imaging.
- **READOUT PATTERN:** The NIRCam detectors are read out continuously, 10.7 s per frame. Groups of frames are averaged according to [readout patterns](#) to reduce data volume for long exposures. Of the 9 [readout patterns](#), **RAPID**, **BRIGHT2**, **SHALLOW4**, **MEDIUM8**, and **DEEP8** are currently recommended as yielding higher signal-to-noise for faint sources (Robberto 2009, [2010](#); and more recent tests with the [ETC](#)).
- **GROUPS/INT:** The number of groups to save per integration. Multiple groups are desirable to enable "up-the-ramp" fitting to observed count rates. The resulting integration time is relevant for saturation. Each integration is preceded and followed by detector resets.
- **INTEGRATIONS/EXP:** The number of integrations per exposure. Multiple dithers are preferred over multiple integrations to improve data quality, though dithers will increase overheads somewhat.
- **ETC Wkbk.Calc ID:** The ETC workbook and calculation ID used to determine the exposure setup can be entered here.

Users should consult the [Exposure Time Calculator, ETC](#), to achieve sufficient signal-to-noise for their science without saturating during each integration. Approximate sensitivity curves for 10,000-second exposures are available at [NIRCam Wide Field Slitless Spectroscopy](#).

Direct image exposures

Direct images

Main article: [NIRCam Wide Field Slitless Spectroscopy](#)

See also: [NIRCam Detector Readout Patterns](#), [NIRCam Filters](#)

For each requested [direct imaging](#), specify:

- **LONG FILTER:** choose the long-wavelength filter to be used for direct imaging.
- **SHORT FILTER:** choose the short-wavelength filter used for simultaneous imaging. This can be a different filter than what was used simultaneously with the grism observations.
- **READOUT PATTERN**
- **GROUPS/INT**
- **INTEGRATIONS/EXP**

- *ETC Wkbk.Calc ID*

The available options for all of these parameters are the same as those above in Science (Grism) Exposures.

Exposure sequence display

Exposures

The Exposure Sequence Display dialog box shows the sequence of observations. The exposure sequence is:

- (GRISM LW + IMAGE SW)₁
- (DIRECT LW + DIRECT SW)₁ (optional)
- (GRISM LW + IMAGE SW)₂
- (DIRECT LW + DIRECT SW)₂ (optional)
-
- ...
- (GRISM LW + IMAGE SW)_n
- (DIRECT LW + DIRECT SW)_n
- OUT-OF-FIELD DITHERS

Parameters cannot be edited in this display box, but they can be changed by editing parameters in the boxes above: Science (Grism) Exposures and Direct Image Exposures.