NIRCam Grism Time-Series APT Template

Instructions for designing JWST NIRCam grism time-series observations using APT, the Astronomer's Proposal Tool.

Introduction

Grism time series is one of the five NIRCam observing modes and one of two NIRCam time-series observing modes. Each mode has a corresponding template in APT for users to design their observing programs.

This mode uses the NIRCam grisms for long-wavelength observations (2.4–5.0 μm) and weak lenses for short-wavelength observations (0.6–2.3 μm) obtained simultaneously.

No telescope moves (dithering nor mosaics) are allowed during NIRCam time series observations.

Lists of allowed values for each input parameter are documented and maintained in the NIRCam Grism Time Series Imaging 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.

Note: mosaics are not available for NIRCam grism time-series.

Target acquisition parameters

Target ACQ

Users can opt to do target acquisition on any nearby object, including the science target. Target acquisition occurs with a 32 × 32 pixel subarray on the long-wavelength channel of Module *A* located near the grism field positions, and uses the *F335M* filter. Target acquisition objects other than the science target can be defined in Targets. Choose *SAME TARGET AS OBSERVATION* to use the science target.

Figure 1. Target acquisition location
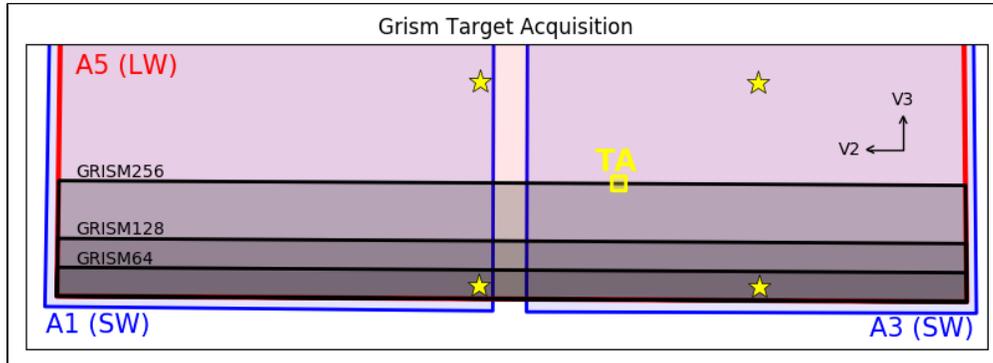
Target acquisition is performed with a 32 × 32 pixel subarray (yellow square) near the bottom of the long-wavelength detector A5. The grism subarrays are shown in black for long-wavelength channel. The corresponding short-wavelength subarrays are not shown; they span the short-wavelength detectors horizontally and are centered vertically within the long-wavelength subarrays. The target acquisition pointing is centered on the TA subarray. If any of the three grism subarrays is chosen, a slew places the target on one of the lower two yellow stars, depending on the science filter. If FULL array exposures are selected, the target is positioned at one of the upper two yellow stars, depending on the selected filter.

Acq exposure time

> ⓘ Please consult the Exposure Time Calculator (ETC). We recommend a signal-to-noise ratio of 30 or higher to obtain a centroid accuracy of 0.1 pixel for the TA source. We also recommend not saturating any pixels.

ACQ READOUT PATTERN: The NIRCam detectors are read out continuously using *readout patterns*. Patterns with longer exposure times typically average more frames to reduce data volume (less of a concern for subarrays).

ACQ GROUPS/INT: The number of groups to include during an integration. Each group results in a saved image, which may be averaged from multiple frames (reads), depending on the *readout pattern*.

Only one integration per exposure is permitted.

Thus the exposure time and integration time are equal.

Time-series parameters

Note: Module *A* is used for this observing mode.

Subarray

Users may opt to either read out three detectors completely or more quickly read out three smaller detector subarrays. Smaller subarrays allow for brighter saturation limits in each integration.

The grism time series subarrays span all detector columns and either some or all rows. The same numbers of pixels are read out from all subarrays, so each short-wavelength subarray covers a quarter the area on the sky as the long-wavelength subarray. When a subset of rows are selected, subarrays are defined in two short-wavelength detectors to overlap and be centered vertically within the long-wavelength subarray's footprint on the sky.

Note the weak lenses WLP4 and WLP8 produce defocused images roughly 66 and 132 pixels across, respectively. Therefore, WLP8 images would be significantly truncated by the smallest subarray *SUBGRISM64*.

Grism subarray	Size in pixels $N_{rows} \times N_{columns}$	Short-wavelength FOV	Long-wavelength FOV	Frame time (s)	No. of output channels
FULL	2048 × 2048	132" (with 4"–5" gaps) × 132" (with 4"–5" gaps)	129" × 129"	42.20940 10.73677	1 4
SUBGRISM256	256 × 2048	8.1" × 132" (with gaps)	16.6" × 129"	5.29420 1.34669	1 4
SUBGRISM128	128 × 2048	4.1" × 132" (with gaps)	8.3" × 129"	2.65740 0.67597	1 4
SUBGRISM64	64 × 2048	2.0" × 132" (with gaps)	4.2" × 129"	1.33900 0.34061	1 4

Number of output channels

The detectors may be read out through a single output channel or more quickly through four output channels simultaneously. The latter produces roughly four times as much data for a given exposure time. (Put another way, for a given set of exposure parameters which produces a given data volume, the exposure time is roughly four times higher when using a single output channel instead of four.) Data rates and data volumes are limited somewhat by APT; tighter limitations may be required to facilitate scheduling (see Data Volume Limitations).

Number of exposures

Multiple exposures may be performed in sequence to increase the total exposure time. Each exposure is executed as defined in the remaining sections below.

> ⓘ In APT, this section is named "Exposures/Dith" (Exposures per Dither) for consistency with other observing modes, even though no dithering is allowed in this mode.

Short pupil + filter

Two weak lenses are available in this mode for short-wavelength observations, and one or the other must be used:

- WLP8 (8 waves of defocus at 2.12 μm)
- WLP4 + *F212N2* (4 waves of defocus at 2.12 μm; coupled to a 2.12 μm *narrowband* filter with a 2.3% bandpass)

The weak lenses defocus incoming light, mitigating uncertainties (jitter and flat fields) and allowing for observations of brighter objects before saturation in a given integration time.

WLP8 is located in the pupil wheel and must be used in combination with a medium or *narrowband* filter. WLP4 + *F212N2* is located in the filter wheel and is used in combination with the *CLEAR* filter.

Short-wavelength pupil wheel	Short-wavelength filter wheel
WLP8	*F182M, F187N, F210M, or F212N*
CLEAR	*WLP4 + F212N2*

Long pupil + filter

The row dispersion grism *GRISMR* (in the pupil wheel) is used in combination with a wide long-wavelength filter (in the filter wheel): *F277W*, *F322W2*, *F356W*, or *F444W*. See NIRCam Grism Time Series for more details.

Exposure time

Each exposure is defined as a *readout pattern*, *number of groups*, and *number of integrations*. The resulting Total Exposure Time is reported. This readout configuration applies to both wavelength channels (short and long); the observations are obtained simultaneously using a *dichroic*.

Users should consult the Exposure Time Calculator, ETC, to achieve sufficient signal-to-noise for their science without saturating during each integration. Approximate saturation limits may be found at NIRCam Grism Time Series.

Each group yields saved data. Each integration accumulates charge for its duration, preceded and followed by detector resets. Shorter integrations may prevent saturation. Saturated sources may be recovered (unsaturated) in earlier groups during the integration.

Each exposure is performed without moving the telescope nor any mechanisms, with one exception. Exposures of more than 10,000 s are permitted in this observing mode, but users are warned that the High Gain Antenna may need to move during a longer exposure. That movement may introduce jitter and affect data quality.