

NIRSpec IFU Spectroscopy Template APT Guide

Detailed step-by-step instructions are available for filling out the JWST NIRSpec IFU Spectroscopy APT template.

Introduction

The [NIRSpec integral field unit \(IFU\)](#) can obtain spatially resolved imaging spectroscopy of a contiguous, extended 3" × 3" area on the sky. To achieve this, the IFU uses specialized optics to reformat the spatial region and direct light to the spectrograph optics, which it shares with the [multi-object spectroscopy \(MOS\)](#) and [fixed slit \(FS\)](#) observing modes. Additional information is available on the [IFU hardware](#) and the [IFU observing mode](#) pages.

This article presents preparation of a NIRSpec IFU observation using the [Astronomer's Proposal Tool NIRSpec IFU template](#).

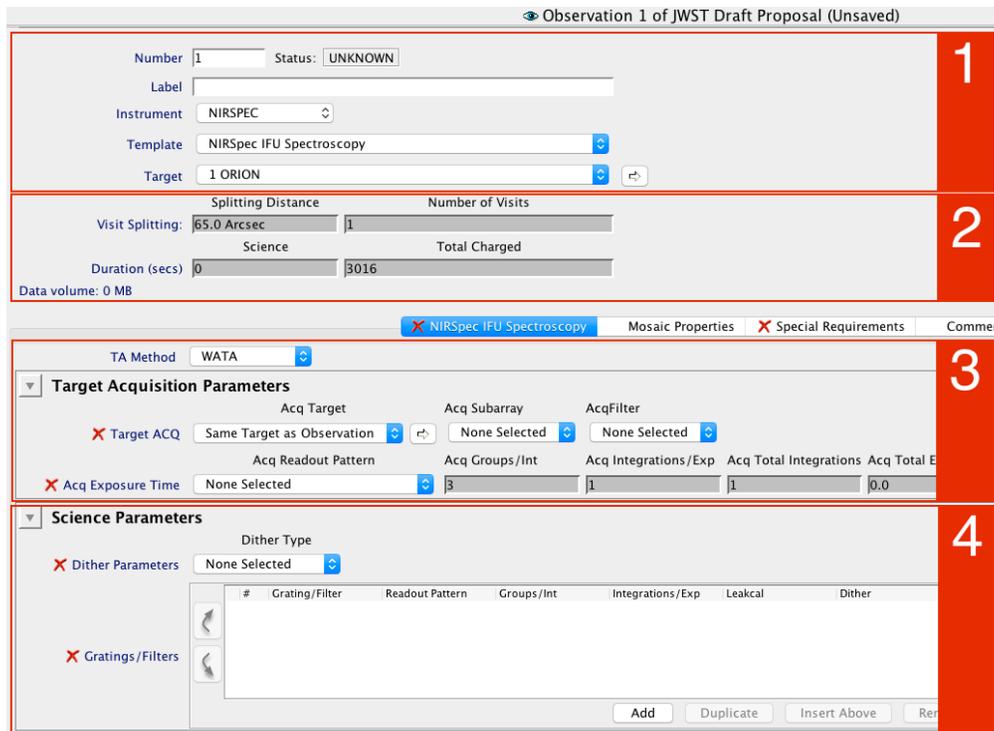
Step-by-step APT instructions

We assume the observer has already defined target(s) to be observed, created an observation folder, and loaded the NIRSpec IFU template. Instructions for doing this are presented in the [JWST Astronomers Proposal Tool](#).

The [IFU template](#) can be divided into four sections, as shown in Figure 1.

- [Section 1](#): This section shows that the NIRSpec IFU spectroscopy template has been selected, along with a target that was previously defined by the user.
- [Section 2](#): The area contains parameters that are for the proposer's information. The observer cannot edit this section.
- [Section 3](#): In this section the observer enters the target acquisition parameters.
- [Section 4](#): In this section the user defines the science parameters that determine the specifics of the observation.

Section 3 and 4 are part of the 'NIRSpec IFU Spectroscopy' tab. There are three additional tabs: "**Mosaic Properties**", "**Special Requirements**", and "**Comments**", which are discussed at the [end of this article](#).



IFU template section 1: Generic

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](#).

IFU template section 2: observation information

The following is included for information only and is generic to all templates. The article [APT Observations](#) contains more detailed information on the topics Visit Splitting, Duration, and Data volume.

IFU template section 3: Target Acquisition Parameters

Section 3 in [Figure 1](#) corresponds to the target acquisition (TA) parameters.

For NIRSpec IFU observations there are four options for **TA Method 1**, MSA target acquisition (called **MSATA**), the Wide Aperture Target Acquisition (**WATA**), **VERIFY_ONLY**, and **NONE**. The default option for this template is **WATA**.

Two of the options, **MSATA** and **WATA**, perform a target acquisition sequence of imaging and centroiding to make pointing corrections which will result in the science source centered in the science aperture. **WATA** centers the TA target in the wide aperture to determine a pointing correction to place the science target in the science aperture. **MSATA** uses reference stars in the MSA to determine the pointing correction. The remaining two **TA Method** options, **NONE** and **VERIFY_ONLY**, forego target acquisition altogether and rely on the pointing accuracy delivered by the guide star acquisition.

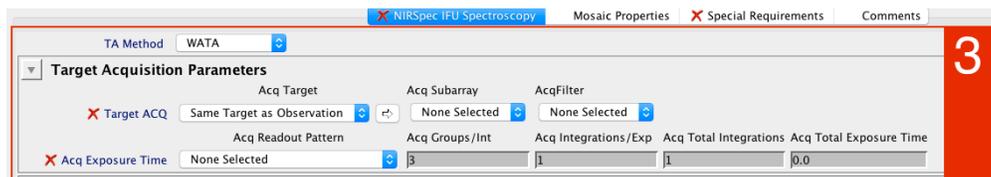
A complete description of the target acquisition procedures used to point the telescope with different JWST NIRSpec observing modes are addressed in the [NIRSpec Target Acquisition](#) article.

WATA

When selecting **WATA** as the **TA Method**, Section 3 looks like [Figure 2](#). A detailed description of this TA method is found in the [NIRSpec Target Acquisition - WATA](#) article.

Basically, the current implemented TA procedure starts with placing the science target in the **S1600A1** aperture, centering it with onboard software. This method requires less planning effort on the part of the observer but is appropriate only for targets that are point sources or close to point sources. Typical suggested coordinate accuracies for the target are in the order of 100 milli-arcsec. Observers can define four **TA** parameters in the IFU APT template: the **Acquisition Target**, **Subarray** type, the **Filter**, and the **Readout Pattern**. The options for **Subarray** are **SUB32**, **SUB2048**, and **FULL**. The options for **TA** filter are **F110W**, **F140X**, and **CLEAR**. Detailed information on these filters can be found in the article [NIRSpec Dispersers and Filters](#). The available readout patterns are **NRS**, and **NRSRAPID** which define the TA exposure time. Further information on these options can be found in the article [NIRSpec Detector Readout Patterns](#).

Figure 2. Adjusting the Target Acquisition Parameters using the WATA method



Detail of the NIRSpec IFU spectroscopy template showing the Target Acquisition Parameters under the WATA method.

MSATA

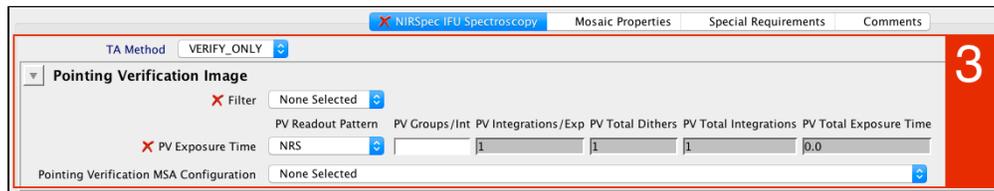
When selecting the **MSATA** option, the target acquisition parameters will be specified at the visit level. **MSATA** uses reference stars to accurately correct the pointing.

i Observers do not need to define reference stars in order to propose for NIRSpec IFU science. That can be deferred until the final program update. The planning parameters will be specified for accepted programs after the MSA-based Target Acquisition is assigned an aperture position angle by the long range planning system. A detailed description of this TA mode is available in the [NIRSpec Target Acquisition - MSATA](#) article.

VERIFY_ONLY

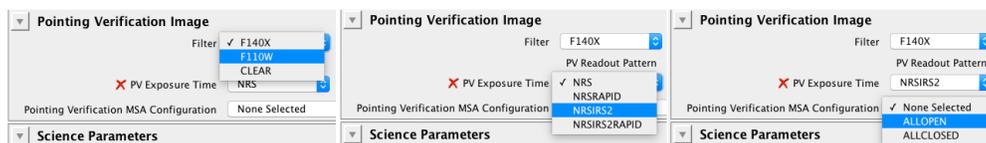
The NIRSpec **VERIFY_ONLY** method relies only on [guide star acquisition](#) performed by the [Fine Guidance Sensor \(FGS\)](#) to derive a telescope pointing. This method is suitable for placing extended objects in the field for IFU observations or for very extended targets with the NIRSpec MOS spectroscopy mode. The precision of this method is limited by the [JWST observatory pointing accuracy](#).

When selecting **VERIFY_ONLY** as the **TA Method**, Section 3 looks like Figure 3.



VERIFY_ONLY will obtain an image to verify the pointing during post-analysis. The image, obtained with NIRSpec's imaging mirror, will provide knowledge of the exact pointing so that it can be aligned with other images and/or data of the field. Under the **TA Method VERIFY_ONLY**, the proposer needs to define a Filter for the **Pointing Verification Image**. The options are NIRSpec filters **F140X**, **F110W**, and **CLEAR**, as shown in Figure 4. The **Readout Pattern** options for this verification image are **NRS**, **NRSRAPID**, **NRSIRS2**, and **NRSIRS2RAPID**, which are described in further detail in the [NIRSpec Detector Readout Modes and Patterns](#) article. When selected, the pointing verification image is taken at the end of the visit, after all science spectroscopy exposures are completed.

Figure 4. Pointing Verification Image options



Filter options (left) and Readout Pattern (center) for the pointing verification image . MSA configuration used to obtain the verification image (right).

By default the **Verification Image** is taken through an **ALLOPEN MSA** configuration and the GWA set to **MIRROR**. The [MSA Planning Tool \(MPT\)](#) can be used to make protected MSA configurations to block shutters on bright targets. The **ALLCLOSED MSA** shutter configuration option is included. This might not be commonly used, but can be suitable for targets that would saturate in open shutters.

The number of groups for the **Pointing Verification Image** should be determined using the [NIRSpec ETC](#) in single object target acquisition mode with estimates of the brightnesses of sources within the field.

NONE

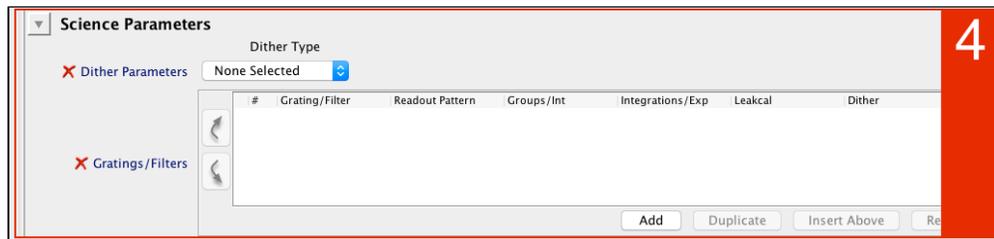
Like **VERIFY_ONLY**, selecting **NONE** as the **TA Method** relies only on guide star acquisition performed by the **Fine Guidance Sensor (FGS)** to derive a telescope pointing. Unlike **VERIFY_ONLY** though, no pointing verification images are taken.

¹ ***Bold italics*** font style is used to indicate parameters, parameter values, and/or special requirements that are set in the APT GUI.

IFU template section 4: Science Parameters

The Science Parameters are defined in section 4 of the IFU Template, as shown in Figure 5. The Science Parameters include the **IFU dithering options**, and the science exposure specification(s): the **spectral configuration used for science**, and the **detector and exposure configuration options** to specify the exposure time.

Figure 5. The Science Parameters section

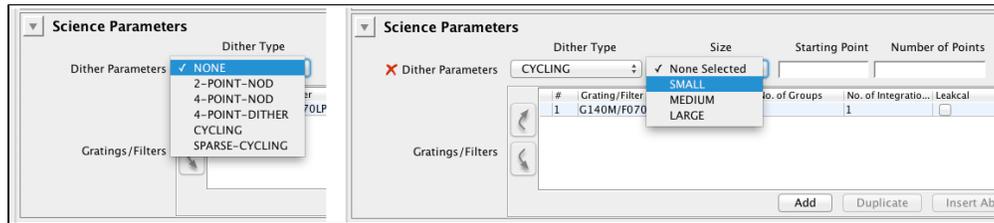


Detail of the NIRSpec IFU Spectroscopy Template showing the Science Parameters section.

Dither Parameters and Dither Type

The user needs to define the Dither Type for the IFU observation. Dithering is always recommended for JWST observations. The **dither patterns** are pre-determined and the available options in the IFU Spectroscopy Template are: **NONE**, **2-POINT-NOD**, **4-POINT-NOD**, **2-POINT-DITHER**, **CYCLING**, and **SPARSE-CYCLING**. These options are in a pull down menu under Dither Type as shown in Figure 6 (Left).

Figure 6. Dither options



Detail of the IFU Template where we show the options for Dither Types (left) and the special menu when selecting the *CYCLING* Dither Type (right).

Note that additional information is required for dither types *CYCLING*, and *SPARSE-CYCLING*. Figure 6 (Right) shows the case of the *CYCLING dither* type, where a Size parameter is required with options **SMALL**, **MEDIUM**, and **LARGE**, as well as the Starting Point and the Number of Points. The complete description of each offset pattern is presented in detail in the article [NIRSpec IFU Dither and Nod Patterns](#).

Gratings/Filters and Exposure Configuration

The [Exposure Time Calculator](#) (ETC) should be used to determine the best exposure configuration to optimize the SNR of your observation. An exposure is configured by setting the *Grating/Filter* combination, *Readout Pattern*, *Groups per Integration*, and *Integrations per exposure*.

i Users should ultimately use the [Exposure Time Calculator Old](#) for all sensitivity calculations.

✓ Recommendations about exposure parameter selection are given in [NIRSpec Detector Recommended Strategies](#).

An exposure specification is created by using the "Add" button located at the bottom of section 4 of the IFU Template as shown in Figure 5. Each line in this field represents a set of exposures acquired with the defined dither option (e.g., a dither option of **NONE** will result in one exposure, a **4-POINT** dither will result in four exposures). The required exposure parameters are listed in Table 1.

Table 1. Description of Science Parameters for a given exposure specification.

Exposure Parameter	Description
Grating /Filter	Select a Grating/Filter combination from the pull down menu. The article NIRSpec Dispersers and Filters describes all the available combinations for NIRSpec.
Readout Pattern	The default value is <i>NRS</i> , but the available values are <i>NRS</i> , <i>NRSRAPID</i> , <i>NRSIRS2</i> , and <i>NRSIRS2RAPID</i> . These patterns are described in full detail in NIRSpec Detector Readout Patterns . Select the pattern that best suits your observation.
Groups/Int	The number of groups during an integration, where a group is the product of reading the detectors with a specific readout pattern.
Integrations /Exp	This represents the number of Integrations during an exposure, where integration is defined as the time between resets.
Leakcal	These IFU leakage calibrations can be acquired to mitigate the effects of excess MSA flux from open shutters or leakage.
Autocal	This option is available to automatically add calibration exposures to a science exposure. For the IFU template the only options are <i>NONE</i> or <i>WAVECAL</i> . <i>NONE</i> is the default and is recommended because Autocal can add significant overhead to an observation.

Other Tabs

Mosaics

NIRSpec's IFU may be used to obtain data for a region larger than its 3 × 3 arcsec size by creating a mosaic pattern. The use of APT's mosaic tool is described in the article [NIRSpec FS and IFU Mosaic APT Guide](#).

Special Requirements

A variety of observatory level [special requirements](#) may be chosen.

Comments

The [comments](#) field should be used only to record observing notes. They will become part of the APT file and therefore of the submitted proposal.

