

NIRSpec FS and IFU Mosaic APT Guide

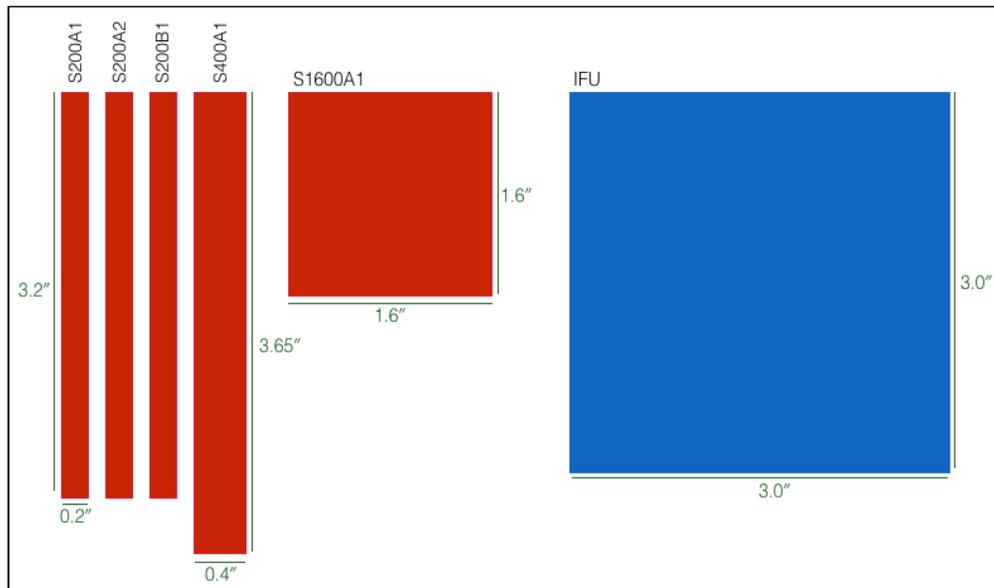
Two of the JWST NIRSpec observing modes (Integral Field Unit and Fixed Slits) may be used to create mosaic patterns. This capability allows the user to obtain data for a region larger than the original aperture size. This article explains how to create IFU and FS mosaic patterns in APT templates.

Introduction

NIRSpec has 5 [fixed slits](#) (FSs) cut into the metal plate that holds the four quadrants of the [micro-shutter assembly](#) (MSA). The individual sizes of these slits and their names are presented in Figure 1. NIRSpec also has an [integral field unit](#) (IFU) that can obtain spatially resolved imaging spectroscopy of a contiguous 3" × 3" area on the sky. An aperture the size of the IFU is also presented in Figure 1 for comparison. The [NIRSpec Integral Field Unit](#) article includes diagrams that describe in detail the location of the fixed apertures with respect to the MSA quadrants.

In order to obtain data for a region larger than the original aperture sizes, NIRSpec [FS](#) and [IFU](#) modes support the creation of mosaic patterns.

Figure 1. NIRSpec fixed slits and IFU size comparison



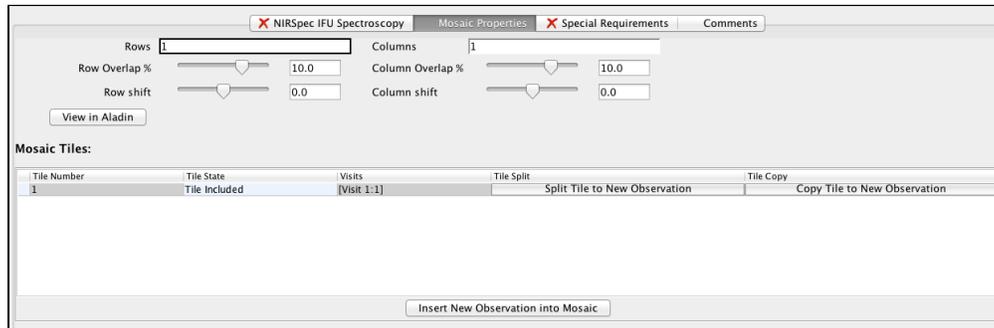
A comparison of aperture sizes as projected onto the sky. NIRSpec's five fixed slits and the NIRSpec IFU are presented with their corresponding sizes in arcseconds. All apertures are on the same scale.

This article provides a step-by-step guide on how to create mosaic patterns using either the NIRSpec Fixed Slit Spectroscopy APT Template or the IFU Spectroscopy APT Template.

Creating NIRSpec mosaic patterns with APT

The NIRSpec FS and IFU observing modes allow for the creation of mosaics. This feature is available under the **Mosaic Properties** tab shown in Figure 2. General information on the mosaic planning for JWST instruments is given in the article [JWST APT Mosaic Planning](#).

Figure 2. Mosaic properties tab



*When the Mosaic Properties tab is selected, the user can create a mosaic of tiles based on the number of **Rows¹** and **Columns¹** of each aperture. Overlaps and shifts are also allowed. The View in Aladin button creates a footprint of the mosaic on an Aladin window, outside of APT.*

Mosaics are defined by selecting a pattern with a given number of **Rows¹** and **Columns¹**. Mosaics are composed of tiles. For example, a mosaic with 3 **Rows** and 4 **Columns** contains 12 tiles. The parameters that can be defined by the user are listed in Table 1. A visual description of these parameters is in Table 2.

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

Table 1. Mosaic properties configurable by the user

Mosaic Property	Description
Rows	Number of rows of the mosaic
Columns	Number of columns of the mosaic
Row Overlap (%)	This slider gives the percentage of aperture overlap between two consecutive rows
Column Overlap (%)	This slider gives the percentage of aperture overlap between two consecutive columns
Row shift	This slider selects the displacement between consecutive rows, in angular units of degrees. A Row shift of 30 (degrees) applied to an IFU mosaic offsets the rows as shown in the figures in the fourth row of Table 2. Note that the number 30 actually refers to the angle between the same tile corner on two adjacent rows.
Column shift	This slider selects the displacement between consecutive columns, in angular units of degrees. Column shifts can be applied either separately or in conjunction with Row shifts .

In Table 2 we present several examples of simple mosaic configurations created using the mosaic properties listed in the last columns. An image of the corresponding mosaic as viewed in Aladin is listed in the first column for the IFU case. Each pattern should be suitable for different science programs. Click on each images to see a more detailed version of the figures.

Table 2. Example IFU mosaic configurations. The footprint plots are ~31" on each side.

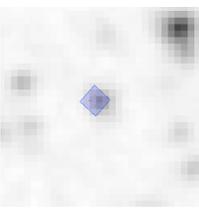
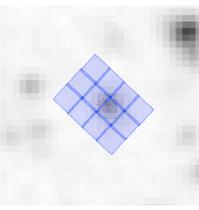
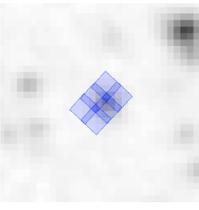
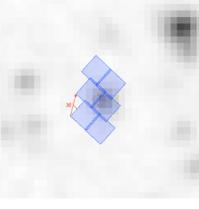
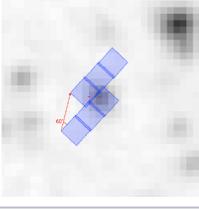
IFU mosaic footprint	Rows	Columns	Row	Column	Row	Column
			Overlap (%)		Shift (degrees)	
	1*	1*	10	10	0	0
	3	4	10	10	0	0
	3	2	30	10	0	0
	3	2	10	10	30	0
	3	2	10	10	0	60
	1	4	0	0	0	0

Table Note *: The default parameters are a 1 row, 1 column "mosaic" with 10% overlap in each dimension. This is the equivalent to a single pointing and no mosaic. Altering these parameters will add additional pointings to the mosaic to create a mapped shape.

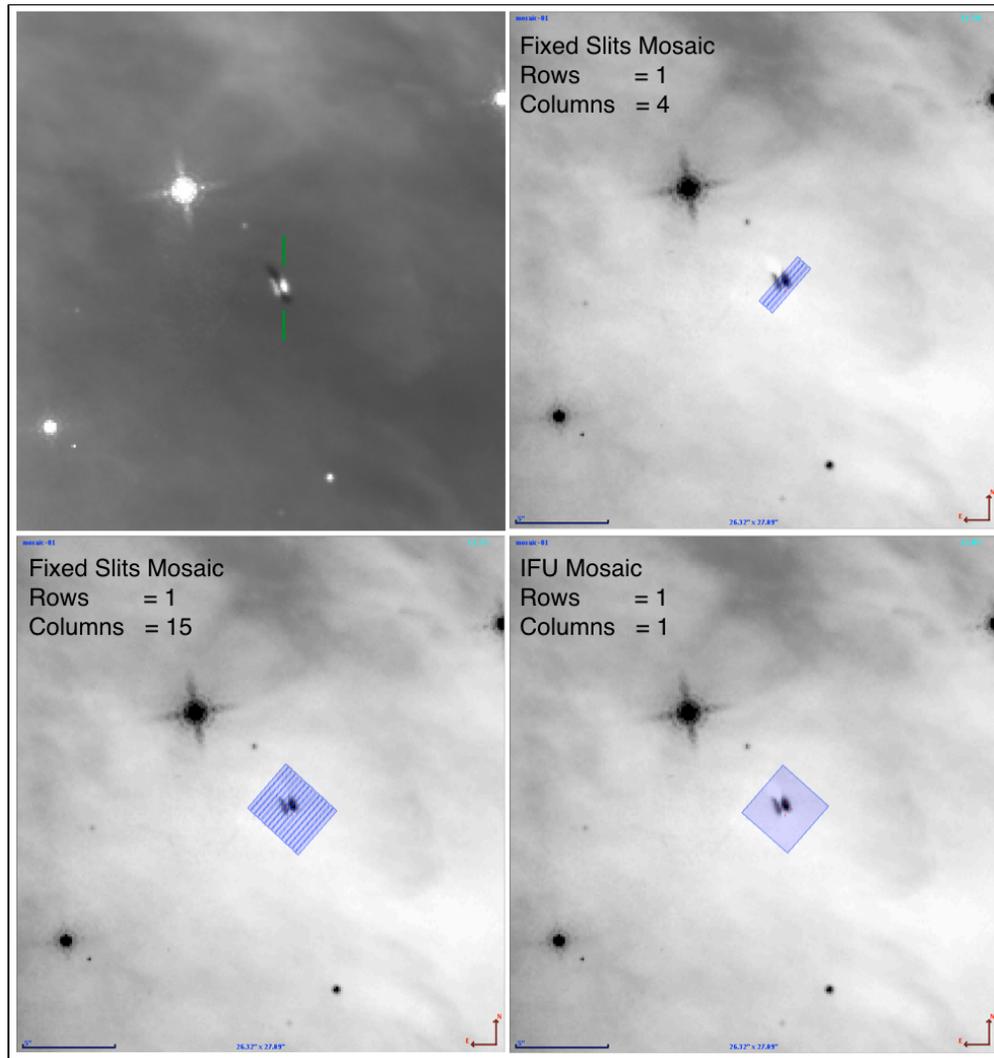
Figure 3 shows two mosaics created using the Fixed Slit Mosaic pattern to cover a proto planetary disk in the Orion Nebula shown in the upper left panel.

Users can select the number of '*Rows*' and '*Columns*' in the **Mosaic Properties** pane.

Once the number of rows and columns have been selected, the user can display the mosaic as an Aladin plane by clicking on the '*View in Aladin*' button. It is usually useful to display an image of the target as well. As an example, Figure 3 shows two mosaics, one with four columns and the other with fifteen columns. For comparison, the lower right panel in Figure 3 shows the same field of view superimposed with the NIRSpec IFU footprint.

- ✔ Note that one IFU observation can achieve the same coverage in a single exposure/pointing compared to a fixed slit mosaic with 15 position offsets in the cross dispersion direction. The IFU observing mode should always be used to map out such a spectral field whenever possible. Keep in mind that some targets may be too bright for the IFU and can saturate the detectors. In order to avoid saturation, the FS mosaics may be needed to map out spectra on bright targets with [subarray readouts](#).

Figure 3. FS Mosaic tiles

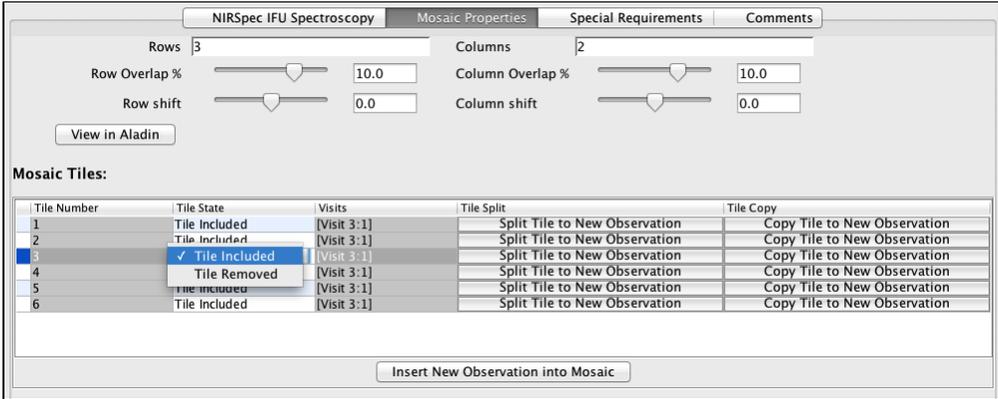


Four Aladin views of a $\sim 20' \times 20'$ region in Orion centered on a proto-planetary disk highlighted in green in the upper left panel. The upper right image represents a fixed slit mosaic using one row and four columns. The lower left image presents the same field covered with a mosaic generated using one row and 15 columns. For comparison, the lower right image shows what the NIRSpec IFU single tile mosaic footprint looks like using the same target.

Once the mosaic properties are defined, APT automatically creates a table of mosaic tiles (Figure 4) with a tile number, a tile state, the visit in which the tile will be observed, a column to split the tile to a new observation, and a column to copy the tile to a new observation. The tile number and the visit value are not editable. The tile state provides two options: included or removed. Users can include or remove tiles depending on their need. Tile splitting is discussed in detail in the articles [JWST APT Mosaic Planning](#) and [JWST APT Mosaic Tile Splitting Activity](#). For NIRSpec IFU and FS mosaics, the mosaic patterns that are smaller in spatial extent than the [visit splitting distance](#) ($< 40''$) can all be within one visit per spectral configuration.

 In the current version of APT (APT 27.1), NIRSpec IFU and FS mosaics that are acquired in different spectral configurations are placed into different visits.

Figure 4. Mosaic tiles



Mosaic Tiles:

Tile Number	Tile State	Visits	Tile Split	Tile Copy
1	Tile Included	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation
2	Tile Included	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation
3	✓ Tile Included	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation
4	Tile Removed	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation
5	Tile Included	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation
6	Tile Included	[Visit 3:1]	Split Tile to New Observation	Copy Tile to New Observation

APT creates a table with information on each generated tile. This table allows users to remove tiles and split them to new observations as needed.