

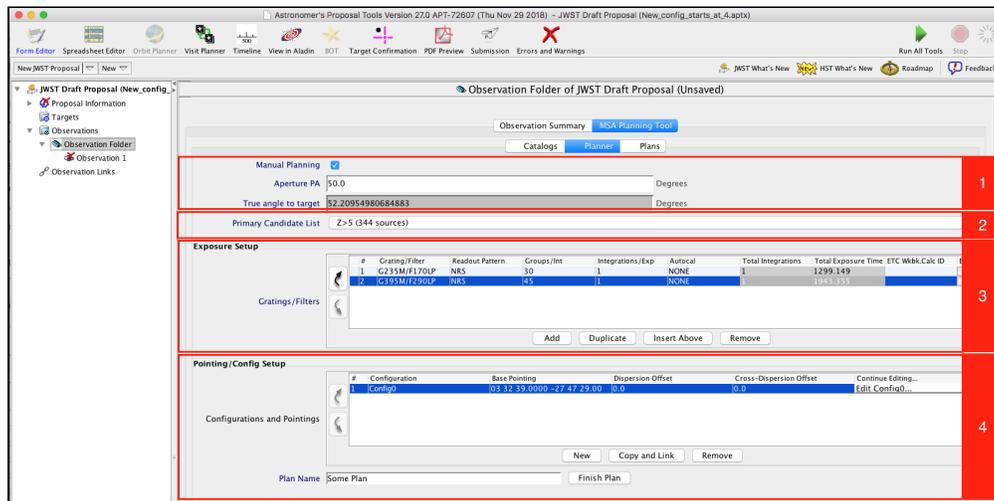
# NIRSpec MPT - Manual Planner

The JWST NIRSpec MSA Planning Tool (MPT) Manual Planner is designed to help the user manually create new plans and modify existing plans.

## Introduction

The [MSA Planning Tool \(MPT\) Planner](#) is designed to automatically create optimal [plans](#), but it is also possible for the user to create plans manually. Checking the ***Manual Planning***<sup>1</sup> box at the top of the **Planner** tab of [MPT](#) results in the view shown in Figure 1.

Figure 1. MPT *Manual Planner*



The ***Manual Planning*** template has four sections that are described in detail below.

- [Section 1](#): Planning Angles
- [Section 2](#): Primary Candidate List
- [Section 3](#): Exposure Setup
- [Section 4](#): Pointing/Config Setup

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

# MPT Section 1. Planning angles

## Aperture PA (APA)

A given NIRSpec MSA observation must be executed at a specific telescope orientation angle so that the selected sources will fall into the open shutters as planned. Because of the telescope's orbital position and sunshield constraints, a given orientation may only be possible for limited periods during the year or not available at all.

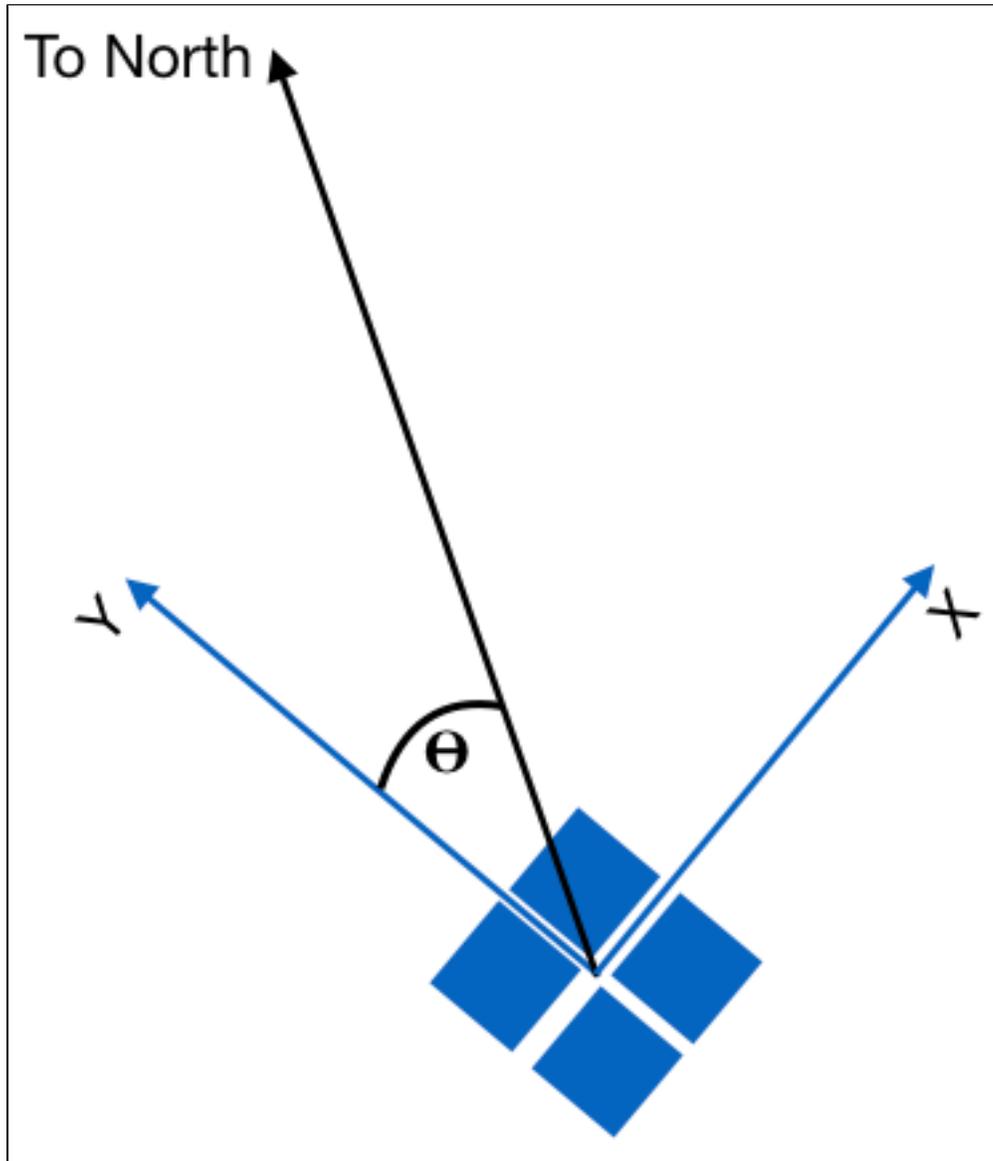
The [Target Visibility Tools](#) can be used to determine the range of feasible orientation angles for a target throughout the telescope's orbital cycle.

- ✔ For most NIRSpec MOS observations, it is recommended to experiment with several different feasible **Aperture Position Angles** prior to initial proposal submission. The submitted **APA** is used to create placeholder or "planning visits" with MPT. Once a proposal is accepted, it will be assigned a fixed orientation and a corresponding window of time when observations will be made.

For proposal submission, use any feasible **APA** from the orientation angles provided by the [JWST Target Visibility Tool](#) for the time of observation. For final program submission, use the fixed orientation **APA** that has been assigned to your observation by the schedulers at STScI. This assigned angle will correspond to one or more plan windows for execution in the scheduling timeline.

The **APA** (an angle between 0 and 360 degrees) specifies the orientation of the cross-dispersion axis of the MSA aperture measured from North in the counterclockwise direction. Figure 2 shows how this angle is measured on the sky. The "Y" axis represents the cross-dispersion direction of the MSA.

Figure 2. Aperture position angle



*The black arrow represents the North direction. The blue arrows represent the direction of the Ideal X and Y axes. Dispersion is along the "X" axis. The Aperture Position Angle ( $\theta$ ) is shown as measured in the sky.*

Programs that have an orientation or timing [special requirement](#) added to the observation can restrict scheduling opportunities. Most NIRSpec MOS programs should be submitted without added orientation restrictions, in order to allow the schedulers to find suitable windows for them. Also, when the proposal is submitted, the observer should explicitly add an "**ON HOLD for aperture position angle assignment**" [special requirement](#) to their NIRSpec spectroscopy observations.

## True angle to target

The *True angle to target* field appears in the **Planner**, but is greyed out and cannot be changed by the user. This is the angle between the telescope's velocity vector at the center of the planning window and the telescope pointing. It is used to make small corrections to source positions at the MSA resulting from the velocity of the spacecraft.

The *True angle to target* offers a quick way to check target visibility: its value will not update if the selected **APA** is not feasible.

## MPT Section 2. Primary Candidate List

The *Primary Candidate List* is a candidate set that should be defined in the [NIRSpec MPT - Catalogs](#) pane. In manual planning mode, select the appropriate list from the pull down menu.

## MPT Section 3. Exposure setup

In section 3 of the **Manual Planner** the observer defines the exposure specification. Click the **ADD** button to add a new exposure specification. Each new exposure specification results in one or more new exposures. The number of new exposures resulting from an exposure specification is determined by the dither pattern specified.

The [JWST Exposure Time Calculator](#) (ETC) should be used to determine the best exposure parameters to optimize the signal-to-noise of your observation. An exposure is configured by setting the *Grating/Filter* combination, *Readout Pattern*, *Number of Groups*, and *Number of Integrations*.

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

The exposure parameters that the observer needs to define are listed in Table 1.

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

Exposure Parameter	Description
<b>Grating /Filter</b>	Select a grating/filter combination from the pull down menu. The article <a href="#">NIRSpec Dispersers and Filters</a> describes all the available combinations for NIRSpec observing modes.
<b>Readout Pattern</b>	<p>Each exposure consists of a set of one or more integrations. Integrations consists of a set of nondestructive reads of the detector.</p> <p>The detectors can be read in different ways. The available patterns are <b>NRS</b>, <b>NRSRAPID</b>, <b>NRSIRS2</b>, and <b>NRSIRS2RAPID</b>. These patterns are described in full detail in the article <a href="#">NIRSpec Detector Readout Modes and Patterns</a>. The default pattern is NRS, which will average 4 frames on board (i.e. there are 4 frames in one Group).</p> <p>Select the pattern that best suits your observation.</p>
<b>Groups/Int</b>	The number of groups in an integration. The number of groups, together with the <a href="#">Readout Pattern</a> (i.e. the number of frames in a group) will determine the length or duration of an integration, using the specified options for averaging or not averaging frames.
<b>Integrations /Exp</b>	The number of integrations comprising an exposure, where an integration is defined as a set of non-destructive reads.
<b>Autocal</b>	This option is available to automatically add calibration exposures to a science exposure. For the MOS, the options are <b>NONE</b> , <b>WAVECAL</b> , <b>FLAT</b> , and <b>BOTH</b> . <b>NONE</b> is the default and is recommended.
<b>ETC Wkbk. Calc ID</b>	The user should enter the ETC calculation ID from the associated ETC Workbook. See note below.

Exposure specifications may be reorganized or removed as needed, using the **New**, **Copy and Link**, and **Remove** buttons, and the arrows at the left of the 'Exposure Setup' box. Each exposure specification will be used for each of the Pointing and Configurations specified below.

## MPT Section 4. Pointing/Config setup

### Configurations and Pointings

NIRSpec **MSA configurations** are described by a configuration file. Those configurations can be created with the **Manual Planner** as described below, or ingested to the **Manual Planner** from the automatic **MPT Planner**. It is possible to save a configuration off-line by exporting it from APT. A configuration file may also be imported into APT using the **MPT Manual Planner**. The only format supported for importing or exporting an MSA configuration file is comma-separated values (.csv).

Click **New**, **Copy and Link**, and/or **Remove** (as shown in Section 4 of Figure 1) to create or delete the configurations you want. **New** will create a new MSA configuration entry in the next row of the table. Table rows can be rearranged using the up and down arrows to the left of the table. **Copy and Link** can be used to make a copy of an existing configuration (first select the entry you want to copy).

 **Caution!** Any changes made to the configuration (including renaming it) will apply to all table entries using that configuration.

**Copy and Link** is provided for users who wish to create a set of offset exposures from a **Base Pointing**, and to save overheads by linking them as a set of dithers applied to the base pointing. The **Base Pointing**, **Dispersion Offset**, and **Cross-Dispersion Offset** columns can be edited directly in this table. Offsets are in units of shutters.

 By clicking on **Edit config** in the right column of a table entry, a window will pop open displaying the MSA shutter view for the selected MSA configuration. This window is the **Manual Editor**.

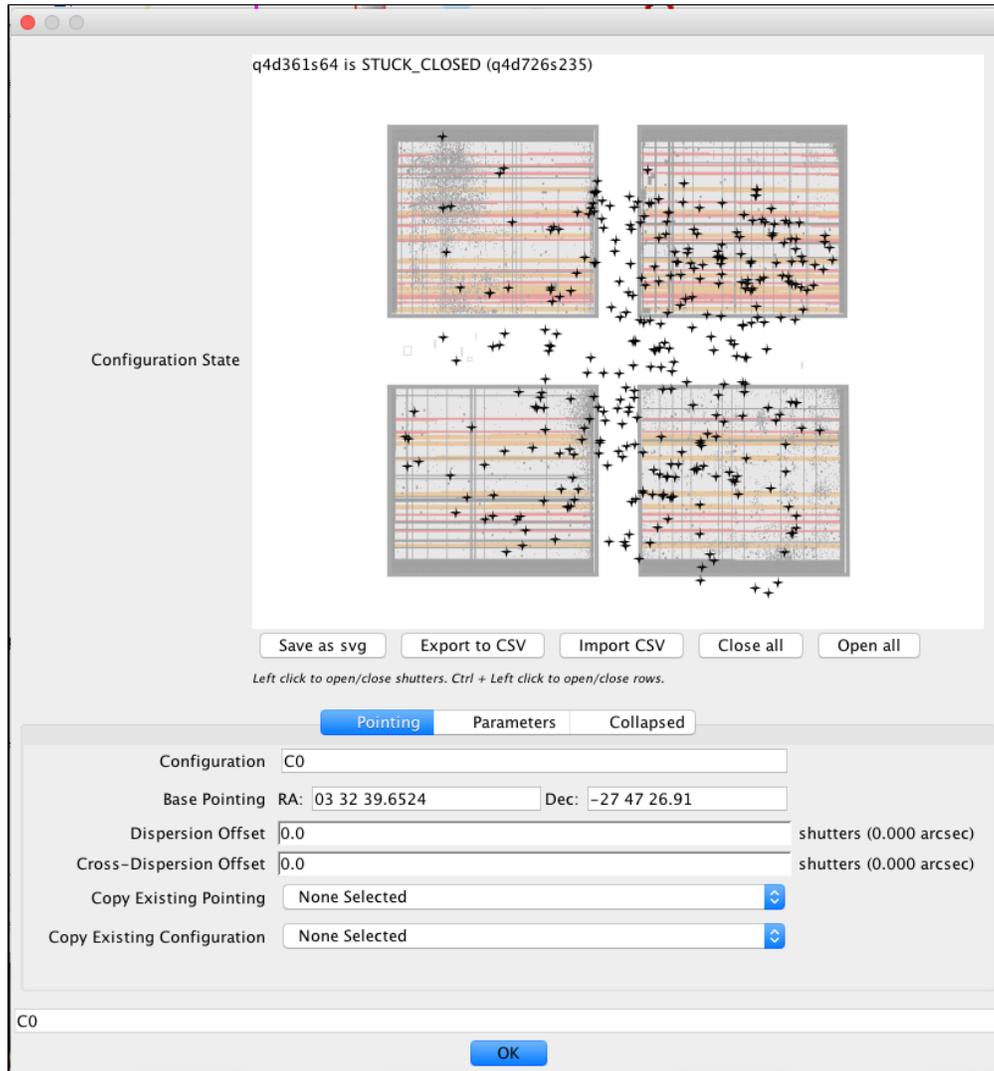
 As an example, to create a set of noded exposures that use the same MSA configuration in the **Manual Planner** -

1. Click **New** to generate a new MSA configuration.
2. Type in the base pointing.
3. Type in "0.0" for the dispersion and cross-dispersion offsets.
4. Click **Copy and Link** twice to create two new entries in the table. These will use the same MSA configuration as the first entry.
5. Edit the second entry cross-dispersion offset to have a value of 1.0 (exactly 1 shutter up from the base pointing).
6. Edit the third entry cross-dispersion offset to have a value of -1.0 (exactly 1 shutter down from the base pointing).
7. Click **Edit config** in the right column of the first table entry (at the base pointing). Wait for the **Manual Editor** window to appear.
8. Create the configuration you want by opening or closing shutters in the **Manual Editor**.
9. When finished, click **OK**.
10. To save this new Plan, give the plan a unique name, and click **Finish Plan** at the bottom of the main **Planner** window.

## Manually editing a configuration

When the **Manual Editor** is open, the shutter view is presented with the sources of the candidate list used to generate the configuration, as shown in Figure 3. Other lists may be displayed by selecting them from the [Parameters tab](#) of this window. Note that all sources appear as black plus symbols in the **Manual Editor**, whether they are in configured slitlets or not.

**Figure 3. Manual editor**



*The configuration of shutters in the four MSA quadrants is shown, using the color convention introduced in [NIRSpec MPT - Plans](#). Sources in the Manual Planner are always colored black.*

It is possible to zoom in to view individual shutters in the **Manual Editor**. Zooming in or out is accomplished by depressing the right mouse button while dragging up or down. This is usually enabled on a trackpad by depressing two fingers at once and dragging in an upward or downward motion. Hovering the mouse over a single micro-shutter provides its position in the MSA and its state (commanded open or closed, stuck open or closed, etc.)

Individual operable shutters may be commanded opened or closed with a "Left Click" on the mouse. Also available are the **Open all** and **Close all** buttons. The metadata for each open shutter is tracked during load, so opening all shutters in the **Manual Editor** will be *slow* and is not recommended for casual use. The **Manual Editor** should be used to open shutters that correspond to sources of interest, as shown in Figure 4. There is a shortcut to make a long slit configuration: point the mouse at a column of shutters, and use "Ctrl+Left Click" to open (or close) the column of shutters.

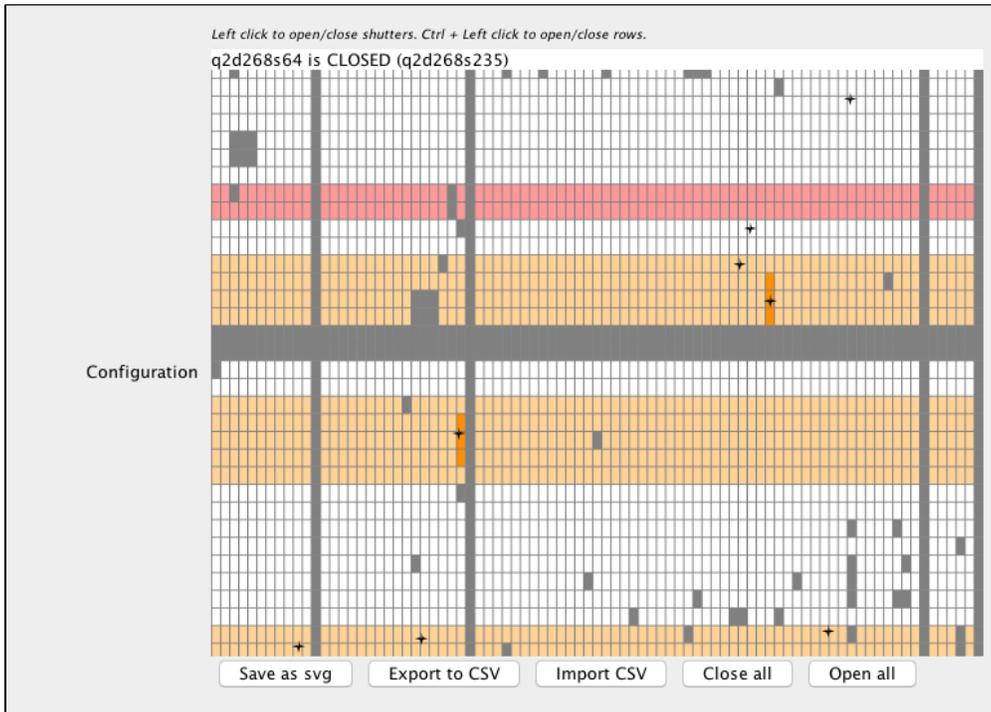
✔ For users who wish to observe moving targets with a long slit configuration at one of the Quadrant 4 Field Points in the MOS Spectroscopy template using WATA, columns can be opened in the following locations:

- **Q4 Field Point 1** corresponds to shutter q4d615s196
- **Q4 Field Point 2** corresponds to shutter q4d533s244

The [MOS Custom Configuration Process](#) article describes the process for extended sources.

⚠ Note that shutters open on sources will be designated as source shutters, and others are interpreted as background shutters (for Data Management System (DMS) pipeline calibration). There is currently no mechanism in APT for a user to specify a shutter without a source as a source shutter for DMS purposes (for extended sources, e.g.). Custom MSA configurations planned without the use of a Catalog will currently fail to be processed correctly. A fix is expected in APT 27.2.

**Figure 4. Manually editing the configuration file**



*Detail of the editing process using the Manual Editor. In this example, six shutters have been opened manually (shown in dark orange) creating slitlets around two sources. Note that the rows corresponding to those shutters will change from white to light orange to signify that they should be avoided for adding any other sources. See the note below about PRISM masking.*

⚠ Options exist to export and import MSA configurations. These options, however, are intended for expert users who wish to manipulate MSA configurations outside of APT. The MSA can only be configured after applying corrections to source positions at the MSA affected by instrument and telescope geometric distortions. A completed MSA configuration can be exported using the **Export to CSV** button. One can be imported with the **Import CSV** button. **Export to CSV** produces an ASCII file of comma-separated values that can be shared and imported into the **Manual Planner** with **Import CSV**. The exported CSV file has values of '0', '1', 's', or 'x' for each commanded open, commanded closed, **failed open**, or failed closed shutter, respectively. Additionally, an image of the configuration can be saved in SVG format.

✅ APT files themselves can be shared; this is the best way to share plans and configuration details. [At the bottom of this article](#) is a tip for saving the target info from a plan to a table that can be exported and examined outside of APT. This format is more accessible and useful for tracking observed target information.

There are a few known problems with the **Manual Editor**.

 The **Manual Planner** does not differentiate between primary or secondary (**Filler**) targets because that concept does not apply here. Sources are currently shown as '**Contaminants**' in the **Manual Planner**. This should be kept in mind when reviewing Plan results in the **Plans** pane of MPT. This problem does not affect observations, however. It is expected to be fixed in later versions of APT (in APT 27.2 or later).

 For *PRISM exposures*, the masking shown in light orange in the **Manual Editor** is incorrect in the dispersion direction. Masking is intended to indicate areas to avoid when adding new targets to prevent spectral overlaps on the detector. We expect this will be fixed in APT 27.2 or later. The user is not prohibited, however, from creating slitlets for new targets in the masked area. For *PRISM exposures*, the slitlets should be separated by at least 156 shutters in dispersion to prevent spectral contamination. The equivalent distance to factor in for the MSA gap is 86 shutters. This separation will allow up to 4 sources per row (depending on the source density and spatial distribution).

 It is easily possible to unintentionally click open a shutter in the **Manual Editor**. This can cause contamination of target spectra if the unintended shutter was opened within the masked region of another intended target. A warning will be added in later versions of APT (APT 27.2 or later) when this happens, but for now the user is advised to review the MSA configuration before finishing the Plan to avoid contaminating the spectra of an intended target.

Continuing with the **Manual Editor** window features - three tabs are located at the bottom of the window: **Pointing**, **Parameters**, and **Collapsed**.

Under the **Pointing** tab (Figure 5) it is possible to give a name to the configuration, and specify appropriate pointing equatorial coordinates. **Base Pointing RA** and **Dec** values are required before the MSA configuration can be saved. If other MSA configurations have already been designed, their **Pointing** and **Configuration** will be available from the pull-down menus **Copy Existing Pointing** and **Copy Existing Configuration**. If the **Base Pointing** coordinates are within the **Catalog** area, the source positions from the **Catalog** will appear in the shutter view.

**Figure 5. Pointing tab**

The screenshot shows the 'Pointing' tab of a software interface. At the top, there are three tabs: 'Pointing' (selected), 'Parameters', and 'Collapsed'. Below the tabs, there are several input fields and buttons:

- Configuration:** A text box containing 'C0'.
- Base Pointing:** Two text boxes. The first is labeled 'RA:' and contains '03 32 39.6524'. The second is labeled 'Dec:' and contains '-27 47 26.91'.
- Dispersion Offset:** A text box containing '0.0' with the unit 'shutters (0.000 arcsec)' to its right.
- Cross-Dispersion Offset:** A text box containing '0.0' with the unit 'shutters (0.000 arcsec)' to its right.
- Copy Existing Pointing:** A dropdown menu showing 'None Selected'.
- Copy Existing Configuration:** A dropdown menu showing 'None Selected'.

At the bottom of the window, there is a text box containing 'C0' and a blue 'OK' button.

*Detail of the Manual Editor. The Pointing tab allows the user to view the base pointing and offsets specified in the main window of the Manual Planner, or to specify or change the equatorial coordinates (RA, Dec) and assign a unique name to the MSA configuration. Offsets can be specified or altered here, and it is possible to select an existing pointing or MSA configuration from already existing ones.*

Under the **Parameters** tab, a Candidate set must be selected, even for plans generated with the **Manual Planner**. This implies that a **Catalog** is required as well. To further ensure that the standard calibration pipeline will not fail, there must be targets in planned slits. Figure 6 shows a detail of the Parameters tab design.

**Figure 6. Parameters tab**

The screenshot shows the 'Parameters' tab of a software interface. At the top, there are three tabs: 'Pointing', 'Parameters' (selected), and 'Collapsed'. Below the tabs, there are several controls:

- Candidates:** A pull-down menu showing 'Z>5 (344 sources)'.
- Master Background:** A checkbox that is currently unchecked.
- Add shutters plane to Aladin:** A button.

At the bottom of the window, there is a text box containing 'C0' and a blue 'OK' button.

*Detail of the Manual Editor. In the Parameters tab is shown the list of sources selected in the Manual Planner as described in Section 2. It is possible to click the Master Background button to indicate the users intent to specify multiple scattered shutters that are to be used for background measurements for all sources observed in the MSA configuration. Typically, background measurements are taken from the adjacent shutters in the same slit as a source.*

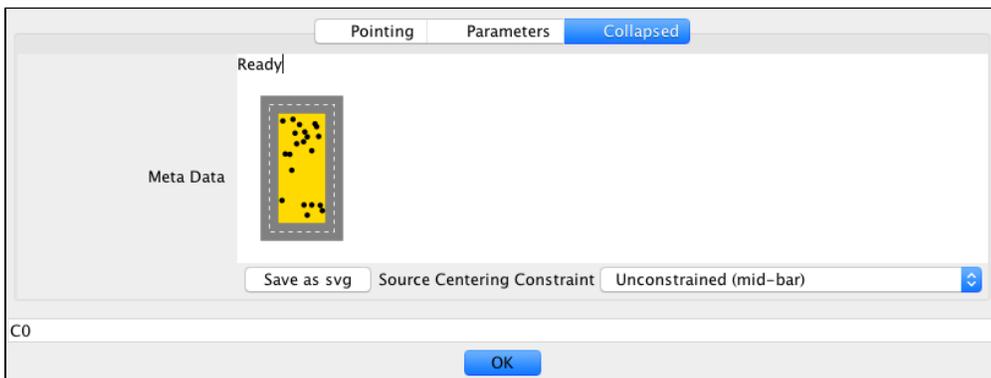
From the **Parameters** tab:

- The candidate set can be changed by selecting from the **Candidates** pull-down menu to show the positions of other sources near the sources of interest.
- The **Master Background** button, when selected, makes it possible to open scattered shutters in the MSA on areas of the sky that will be used for background measurement and subtraction from target spectra.

- The **Add shutters plane to Aladin** button will display the slitlets of each target in the Aladin viewer. When returning from Aladin to the main APT window, remember to click **'Form Editor'** in APT to see the normal **Manual Planner** view.

The **Collapsed** tab view (Figure 7) shows each target's position in its own shutter, all plotted together in a single virtual shutter. The **Source Centering Constraint** is selectable, and though it has no effect by itself, it can be used to identify which planned sources fall outside the margin of interest. These shutter constraints are described in the [NIRSpec MPT - Planner](#).

Figure 7. Collapsed tab



*Detail of the Manual Editor. The Collapsed tab shows the distribution of planned sources in a single virtual shutter (i.e. only those targets in shutters which the user clicked open in the Manual Editor window). This view is currently not working but we expect it to be fixed in APT 27.2.*

Finally, to confirm and accept this new configuration, click the **OK** button at the bottom of the **Manual Editor** window. This will return you to the **Manual Planner** view in APT, shown in Figure 1.

## Generating a plan

Under **Plan Name** in the main window of the **Manual Planner**, assign a name to this manual plan and click **Finish Plan**. This will process and generate the plan and direct the user to the **Plans** pane of MPT, where it is possible to review and assess the quality of the plan.

- ✓ After the Plan is saved, and an Observation is created from it, there is also a mechanism for saving the planned target info from exposures made with the **Manual Planner** or those automatically-generated using the MPT. The target positions, pointing, and shutter information can be saved to a .csv file. To do so, click on the **"File"** item from the main menu at the very top of the computer screen. From the pull-down menu, select **Export → MSA Target Info**. This mechanism makes it possible to track target coverage through all exposures of an Observation outside of APT. These files are ASCII and readable by Excel, for example.

# References

[Karakla, D. et al. 2014, Proc. SPIE 9149](#)

The NIRSpec MSA Planning Tool for multi-object spectroscopy with JWST