MIRI Coronagraphic Imaging Template APT Guide

The JWST APT MIRI coronagraphic imaging template is used to specify parameter settings for the 4 coronagraphic modes in JWST's Mid-Infrared Instrument (MIRI).

Coronagraphic imaging is one of four observing modes available with the Mid-Infrared Instrument (MIRI) ; the 4 coronagraphs in the imaging channel provide high-contrast imaging capabilities covering photometric bands from 10 to 23 μm. In addition to a classical Lyot coronagraph (which provides an inner working angle (IWA) of ~3λ/D), MIRI incorporates three 4-quadrant phase masks (4QPM) to provide the smallest possible IWA of ~1λ/D at 10–16 μm. The design offers a very small IWA in a stable environment.

An observer will have control over three primary parameters for MIRI imaging:

1. coronagraphic mask/filter combination
2. dithering type
3. detector read out mode and exposure time (via the number of frames and integrations).

Allowed values are documented and maintained in the MIRI Coronagraphic Imaging Template Parameters page, but also described below.

Step-by-step APT instructions

> Page not found for multiexcerpt macro.

The page: **JWST MIRI Imaging APT Template Guide** was not found. Please check/update the page name used in the 'multiexcerpt-include macro.

Target acquisition parameters

Target acquisition is required for coronagraphic imaging. This field specifies the ***ACQ TARGET***, ***ACQ FILTER***, ***ACQ EXPOSURE TIME***, and ***ACQ QUADRANT***.

Target ACQ

For coronagraphic imaging the ***ACQ TARGET*** is the same as the target the user is observing. Filters available include: ***F560W***, ***F1000W***, ***F1500W***, and ***FND***.

ACQ exposure time

A Target ACQ must be completed by selecting a MULTIACCUM exposure configuration. Each exposure is configured by setting the readout pattern and characteristics parameters: ***READOUT PATTERN*** and ***NUMBER OF GROUPS***.

> Users should use the Exposure Time Calculator (ETC) to *determine the best exposure configuration to optimize the signal-to-noise.*

ACQ READOUT PATTERN

1. ***FAST*** (default)
2. ***FASTGRPAVG*** (required for TA exposures longer than 70 second)

NUMBER OF GROUPS AND INTEGRATIONS

The MIRI readout timing pattern in the ACQ exposure is defined by only one of the MULTIACCUM parameters:

1. ***ACQ NUMBER OF GROUPS***: the number of groups during an integration, where a group is the product of cycling through all the pixels

ACQ NUMBER OF INTEGRATIONS and ***ACQ PHOTON COLLECTION DURATION*** are not user changeable.

ACQ quadrant

Quadrants available are: ***1***, ***2***, ***3***, and ***4***. On the detector, the first quadrant starts at the top right and then increases going counterclockwise (note that these are displayed and labeled in the Coronagraphic Target Visibility Tool GUI). The TA can be achieved in any of four locations concentrically distributed about the center of each coronagraphic subarray. As target acquisition on bright targets can produce temporary latent images on the array, the user has the option to repeat the observation with the target acquisition performed in the diagonally-opposite quadrant (see Repeat Observation).

Coron parameters

The ***CORON PARAMETERS*** dialog box is used to create the entire imaging sequence for a single observation. Each MIRI coronagraphic imaging observation can consist of only a single set of images that all use the same filter, dither pattern, and exposure configuration.

CORON FILTER

Choose a ***CORON MASK/FILTER*** combination.

EXPOSURE TIME

> **Users should use the Exposure Time Calculator (ETC) to *determine the best exposure configuration to optimize the signal-to-noise.***

A coronagraphic imaging sequence must be completed by selecting a MULTIACCUM exposure configuration (in the ***CORON PARAMETERS*** dialog box). Each exposure is configured by setting the readout pattern and characteristics parameters: ***READOUT PATTERN***, ***NUMBER OF GROUPS***, and ***NUMBER OF INTEGRATIONS***. The number of exposures is set by ***NO. OF EXPOSURES.***

READOUT PATTERN

The MIRI coronagraphic imaging template offers only one readout mode:

1. Fast (only option)

NUMBER OF GROUPS AND INTEGRATIONS

The MIRI timing pattern per exposure is defined by only two MULTIACCUM parameters:

1. ***NUMBER OF GROUPS*****:** the number of groups during an integration, where a group is the product of cycling through all the pixels
2. ***NUMBER OF INTEGRATIONS*****:** the number of integrations during an exposure, where integration is defined as the time between resets.

DITHER TYPE

MIRI coronagraphic imaging supports the following types of small-grid dither patterns:

Dither type	Number of dithers
NONE	0
5-POINT-SMALL-GRID	5
9-POINT-SMALL-GRID	9

Small-grid dithers are very small, fast, and precise pointing offsets of a target image. Note that small-grid dithers do not provide the same functionality as the dither patterns for MIRI Imaging, MIRI LRS, or MIRI MRS. Small-grid dithers are used to obtain multiple images of a reference star to optimize the PSF subtraction with the science target, whereas the other dither patterns can provide optimal sampling, bad pixel mitigation, and background subtraction. Depending on the desired contrast, the user may wish to use small-grid dithers. With appropriate PSF subtraction post-processing techniques, highest contrast is achieved with the ***9-POINT-SMALL-GRID***, while ***5-POINT-SMALL-GRID*** will yield a higher contrast than ***NONE***.

REPEAT OBSERVATION

If ***YES*** is selected, the target acquisition (followed by a science exposure) will be repeated starting in the quadrant diagonally across the central spot from the initial ***TARGET ACQUISITION QUADRANT***, as follows:

First Quadrant	Second Quadrant
1	3
2	4
3	1
4	2

PSF Reference Observations

Here the user specifies visits to be used for PSF Reference observations. PSF Reference Observations allow the user to build a PSF reference library to be used for PSF subtraction. Ideally, PSF reference stars are similar to the user's science target and are known to be "good references" i.e. stars without additional astrophysical signal from a debris disk or companion. The observation for a PSF reference star should mirror the observation for the user's science target. Note reference stars have a 0 month proprietary period.

This is a PSF reference observation

Checking this box designates the observation as a PSF reference star used for PSF subtraction (a detailed discussion on the choice of a good PSF reference star can be found in the High Contrast Imaging pages). The observation for a PSF reference star should mirror the observation for the user's science target. Note reference star observations have no proprietary period.

PSF reference observations

If this observation is of a science target, then use this field to associate it with an appropriate PSF reference observation (based on those that have been defined elsewhere in the observing proposal).

Additional justification

For a survey of many targets, they may serve as PSF references for one another. In that case, the user may check this box and explain with additional text in the science justification section of a submitted proposal. The user must still select the science targets as PSF Reference Observations in the list above.

Other Tabs

Mosaic properties

Mosaics are not available for MIRI coronagraphic imaging.

Special requirements

A variety of observatory level special requirements may be chosen. As is often the case with coronagraphic observations, the user may specify in the the ***EXPLICIT REQUIREMENTS*** section that the observations be in sequence and non-interruptible. To achieve this, one would select "Add.." in the ***EXPLICIT REQUIREMENTS*** section, then ***Timing***, and then select "Group/Sequence Observations Link". Here the user can select observations from the "Observation List" and check the boxes that they be in "Sequence" and "Non-interruptible".

Additionally, the Special Requirements section is where the user would specify a roll dither for their science target. To achieve this, one would select "Add.." in the ***EXPLICIT REQUIREMENTS*** section, then ***Position Angle*** , and then select "PA Offset Link". From there, the user selects the two observations to offset in position angle, and they select the Min and Max PA offset (in degrees).

Comments

The comments field should be used only to record observing notes.

References

Lajoie, C-P et al., 2016, SPIE, 99045K
Small-grid dithers for the JWST coronagraphs