MIRI Detector Subarrays

MIRI imaging, coronagraphic imaging, and low-resolution spectroscopy utilize a pre-defined set of nine subarrays for different observing strategies, each with its own advantages and recommended uses.

Introduction

Parent page: MIRI Instrumentation → MIRI Detector Overview
See Also: Understanding Exposure Times

MIRI's detector arrays have the ability to read out partial frames through the manipulation of clocking patterns. Subarray readouts reduce the frame time to less than the nominal ~2.7 s per full frame. The portion of the full array that forms the subarray is read out and stored while the remaining parts of the array are reset.

Nine different subarrays are available for imaging, coronagraphic imaging, and low-resolution spectroscopy (LRS): four separate subarrays for coronagraphs, one for high background, three for bright objects, and one slitless LRS spectrum. No subarrays are available for the medium-resolution spectrometer (MRS).

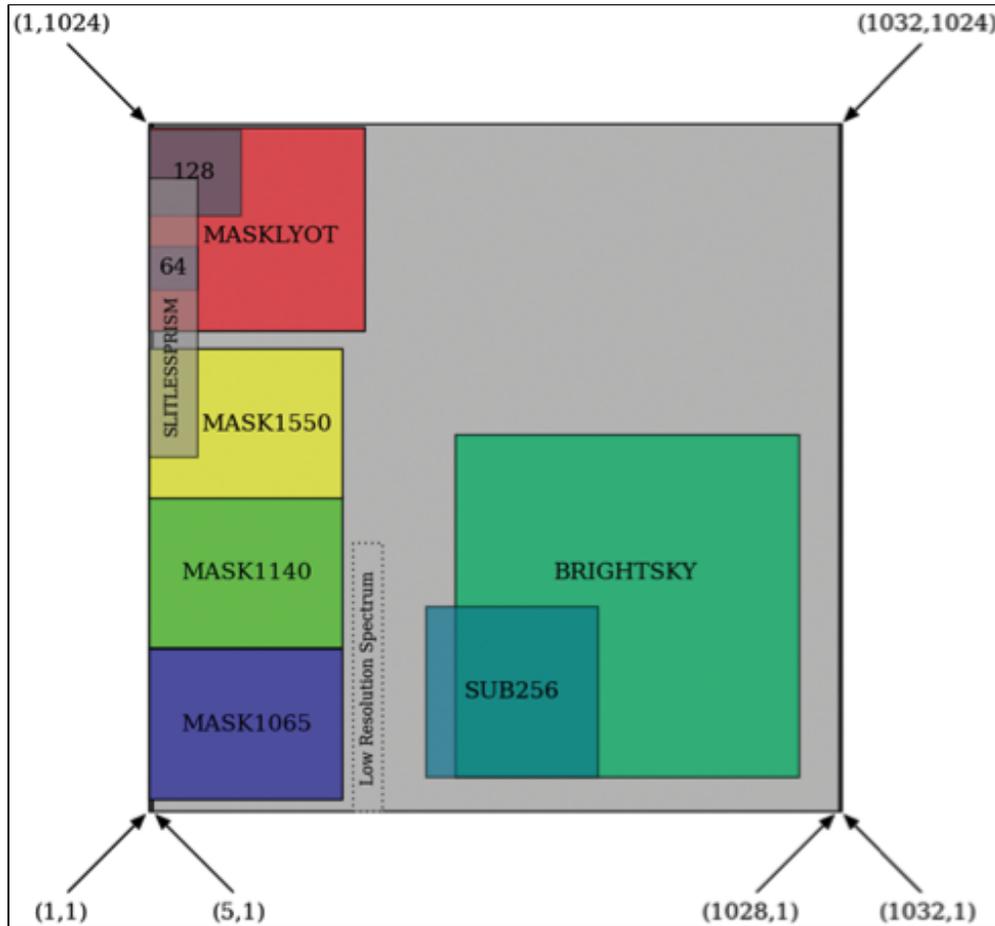**Figure 1. Subarray locations for the MIRI imager as viewed from the telescope looking down onto the detector**

Subarray readout

Main article: MIRI Detector Readout Overview
See also: MIRI Detector Readout Fast, MIRI Detector Readout Slow

Subarray coordinates cannot be randomly accessed so the row and column shift registers must step from the origin (1,1) to the starting subarray corner before proceeding. In other words, at the beginning of each frame read, the first two rows of the full array are accessed briefly and reset, then the 2nd pair, etc., until the subarray is reached.

In the first row of the subarray, pixels on the left that are not part of the subarray are clocked through (and not digitized), then the pixels that are part of the subarray are read. Pixels to the right of the subarray are ignored by resetting the column shift register to 0 immediately after the last subarray pixel. This pattern is repeated through all the rows contained within the subarray. The rows after the subarray are stepped through quickly and reset as were the rows before the subarray. It follows that subarrays are slower the farther they are from the left hand edge of the array.

This readout scheme drove the orientation of the imager array, since it is advantageous to have the fastest subarrays located within the coronagraph. It also means that it takes exactly the same amount of time to read a 256 × 256 subarray starting at (257,257) as it does to read a 512 × 256 subarray starting at (1,257); the only difference is the amount of data passed to the solid state recorders and the ground. Other issues that determined the subarray location included: the ability to utilize reference pixels, minimizing dead time from the clocking to access the first pixel, bad pixels on the array, and the best imaging location for the optics.

For more efficient subarray operation, a "burst mode" clocks through the left-hand columns at five times the normal speed. In the first row of the region of interest (ROI), pixels on the left that are not part of the ROI are clocked through (and not digitized), after which the pixels that are part of the ROI are read. Pixels to the right of the ROI are ignored by resetting the column shift register to zero (recall the special shift register definition) immediately after the last ROI pixel. This pattern is repeated through all the rows contained within the ROI. The rows after the ROI are stepped through quickly and reset as are the rows before the ROI.

Imaging

Main article: *MIRI Imaging*
See also: *MIRI Imaging Template Parameters*

Imaging subarrays are generally used to image bright sources or bright backgrounds without saturating the detector. The size for the high background subarray is determined by the readout time governing the dynamic range needed to image faint sources in the background glow of the Orion Nebula region. Sizes for bright object subarrays are determined by the saturation limits needed to observe known radial velocity planet host stars.

Table 1. MIRI imaging subarray characteristics

Subarray	Size in pixels (rows × columns)	First row corner	First column corner	Usable size	Frame time[†]
FULL [1]	1024 × 1032	1	1	74" × 113"	2.775 s
BRIGHTSKY	512 × 512	51	457	56.3" × 56.3"	0.865 s
SUB256	256 × 256	51	413	28.2" × 28.2"	0.300 s
SUB128	128 × 136	889	1	14.1" × 14.1"	0.119 s
SUB64	64 × 72	779	1	7" × 7"	0.085 s

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

[†] Frame times are calculated for *FAST* mode only. *SLOW* mode readout will only be available for the *FULL* array.

Coronagraphic imaging

Main article: MIRI Coronagraphic Imaging
See also: MIRI Coronagraphic Imaging Template Parameters

In coronagraphic imaging, each subarray is tied to a specific filter. The subarray choice is therefore hidden from the user in the JWST Astronomer's Proposal Tool (APT).

Table 2. MIRI coronagraphic imaging subarray characteristics

Subarray	Filter	Size in pixels (rows × columns)	First row corner	First column corner	Size	Frame time[†]
MASK1065	F1065C	224 × 288	19	1	24" × 24"	0.240 s
MASK1140	F1140C	224 × 288	245	1	24" × 24"	0.240 s
MASK1550	F1550C	224 × 288	467	1	24" × 24"	0.240 s
MASKLYOT	F2300C	304 × 320	717	1	30" × 30"	0.324 s

[†] Frame times are calculated for *FAST* mode only. *SLOW* mode readout will only be available for the *FULL* array.

Low-resolution spectroscopy

Main article: *MIRI Low-Resolution Spectroscopy*
See also: *MIRI Low Resolution Spectroscopy Template Parameters*

The size of the slitless prism subarray is determined by the number of pixels needed to cover the 5–14 µm low-resolution spectrometer spectrum in the dispersion direction and provide adequate sky observations for background subtraction in the spatial direction.

Table 3. MIRI low-resolution spectroscopy imaging subarray characteristics

Subarray	Size in pixels (rows × columns)	First row corner	First column corner	Frame time †	Notes
FULL	1024 × 1032	1	1	2.775 s	Slit spectrum
SLITLESSPRISM	416 × 72	529	1	0.159 s	Slitless spectrum

† Frame times are calculated for *FAST* mode only. *SLOW* mode readout will only be available for the *FULL* array.