MIRI Detector Readout Overview

JWST MIRI detectors can be read out using several different modes, each with their own advantages. They're associated with specific parameters used to define an observation.

Introduction

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> *See also: Understanding Exposure Times*

The MIRI readout patterns fall within the framework of the general MULTIACCUM readout patterns adopted by the JWST mission so that all instruments will have similar exposure interfaces. MIRI offers two readout modes:

1. ***SLOW*** [1] ($N_{samples}$ = 9, t_1 = 23.890 s)
2. ***FAST*** ($N_{samples}$ = 1, t_1 = 2.775 s)

where $N_{samples}$ is the number of samples per pixel per frame and t_1 is the resulting frame time.

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

Timing

In MULTIACCUM mode, an exposure consists of one or more identical integrations that are grouped together. The number of integrations, N_{int}, determines the exposure time as follows:

$$t_{exp} = N_{int} \times t_{int}$$

For instance, if exposing for five integrations with a t_{int} = 27.75 s, then t_{exp} = 138.75 s and during this exposure time, there were five resets of the array.

Each integration is a ramp composed of a number of groups. Unlike the other instruments, each MIRI group is limited to only one frame. The value of $N_{samples}$ determines the time, $t_{1,}$ between each group (i.e., frame) up the ramp. The value of N_{groups} determines the integration time, t_{int}, as follows:

$$t_{int} = N_{group} \times t_1$$

For example, 10 frames of ***FAST*** mode yield a $t_{int} = 10 \times 2.775 = 27.75$ s

The optimal combination of groups and integrations depends on the specific science case. The MIRI Best Practices article explains how to optimize the number of samples, groups, integrations, and exposures.

Readout scheme

See also: MIRI Detector Readout Fast, MIRI Detector Readout Slow

The MIRI readout scheme for the sensor chip assembly (SCA) includes a “fast” direction (horizontal across the rows) and a “slow” direction (vertical along the columns). The detector has a total of 1024 × 1024 active pixels. There are four additional reference pixels at both the beginning and end of each row. All pixels are read out through four interleaved data outputs (i.e., 258 × 1024 pixels per output). The outputs are read simultaneously, resulting in a full frame readout in just under 3 s given the sampling rate of 10 µs per pixel.

In general, every exposure begins with a read-reset. The pixels are reset by row pairs (i.e., 2 rows, 2064 pixels, at a time). For example, row 1 will be read, then row 2 will be read, then they will be reset together, then row 3 will be read, etc. This approach enables a final read immediately before resetting the SCA, and thus captures the longest possible integration time.

References

Ressler, M. E. et al. 2015, PASP, 127, 675
The Mid-Infrared Instrument for the James Webb Space Telescope, VIII: The MIRI Focal Plane System