Enabling JWST High-Efficiency Modes for TSOs

Date

30 Apr 2021

Attendees

- Nestor Espinoza
- Michael Regan
- Sarah Kendrew
- Eddie Bergeron
- Unknown User (birkmann)
- Nikolay Nikolov
- Loic Albert
- Brian Brooks

Meeting agenda:

Discussion of the technical potential for high-efficiency read modes with the JWST detectors, and path forward to making a case for their implementation.

Slides presented

Nestor

Mike Regan

Notes

Basic summary of the current situation (Nestor):

- We know there is demand from the community for higher efficiency operational modes for times series. The motivation is well documented in Batalha et al 2018, who quantify the improvement in spectral precision with 100% efficiency read modes as a function of magnitude across the IR wavelengths covered by JWST.
- But questions remain:
    - What would be the gain for different types of transiting exoplanet observations, e.g. transit vs eclipse vs phase curves?
    - What is the overall science gain for JWST?
    - Do the changes needed for the high-efficiency operations risk introducing new or increased systematic noise sources

Michael Reganpresented very good slides showing work that was previously presented at TIPS, showing the current readout schemes for the NIR and MIR detectors and the potential for increasing the efficiency.

Some summary points:

- a 100% duty cycle option is already possible for the NIR detectors with *some* work, but no major software changes required. This is achieved by performing the pixel reset within the 10 µs frame read time. The settling time is 8 µs, then read & reset within the last 2 µs. This gives a duty cycle of 50% if a bias read is required, or 100% without the bias read if a superbias is available. The superbias method would allow ngroups = 1, btu there's no reason we cannot use it for longer integrations.
- implementing such a mode requires editing the "personality file" in the ASIC (at Goddard)
- This read mode has no negative impact on non-TSO data.
- for MIRI the situation is more complex: the high-efficiency mode (the current FAST mode, without extra reset between integrations) is good for TSOs, but has very clear downsides for any observations that require absolute calibration (i.e. everything else). This is why the FASTR1 mode is being implemented.
- A superbias is much harder with MIRI as the zero point of the integration is much more flexible than in the NIR. The new extra reset mode improves a lot of systematics, especially the odd-even flux-dependent gain variations in the flat.
- It is also harder to switch back for MIRI, as Mike Ressler has optimised the bias voltages for the new readout mode and it is not trivial to switch back and forth.

Way forward:

- the case for the NIR high efficiency mode seems very compelling from a *technical* standpoint
- probably best to focus our attention & energy there for a scientific impact study, and wait for MIRI.
- we will report back to the TSO WG on this on Weds May 5th.