MIRI TSO updates

TrEx WG meeting, 22 March 2018

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Topics covered

I. MIRI exposure setup recommendations for bright source observations

II. MIRI Imaging TSO photometry for lightcurves

III. MIRI saturation advice

I. Exposure setup recommendations

- MIRI nominal detector bias = 2.2 V (Rieke et al, 2015)
- Non-linearity has been well studied & calibration data products in place for Imaging & MRS detectors
  - Non-linearity has a wavelength dependence; separate corrections filters > 20 µm
  - Small pixel to pixel variatons in non-linearity but this is not currently quantified

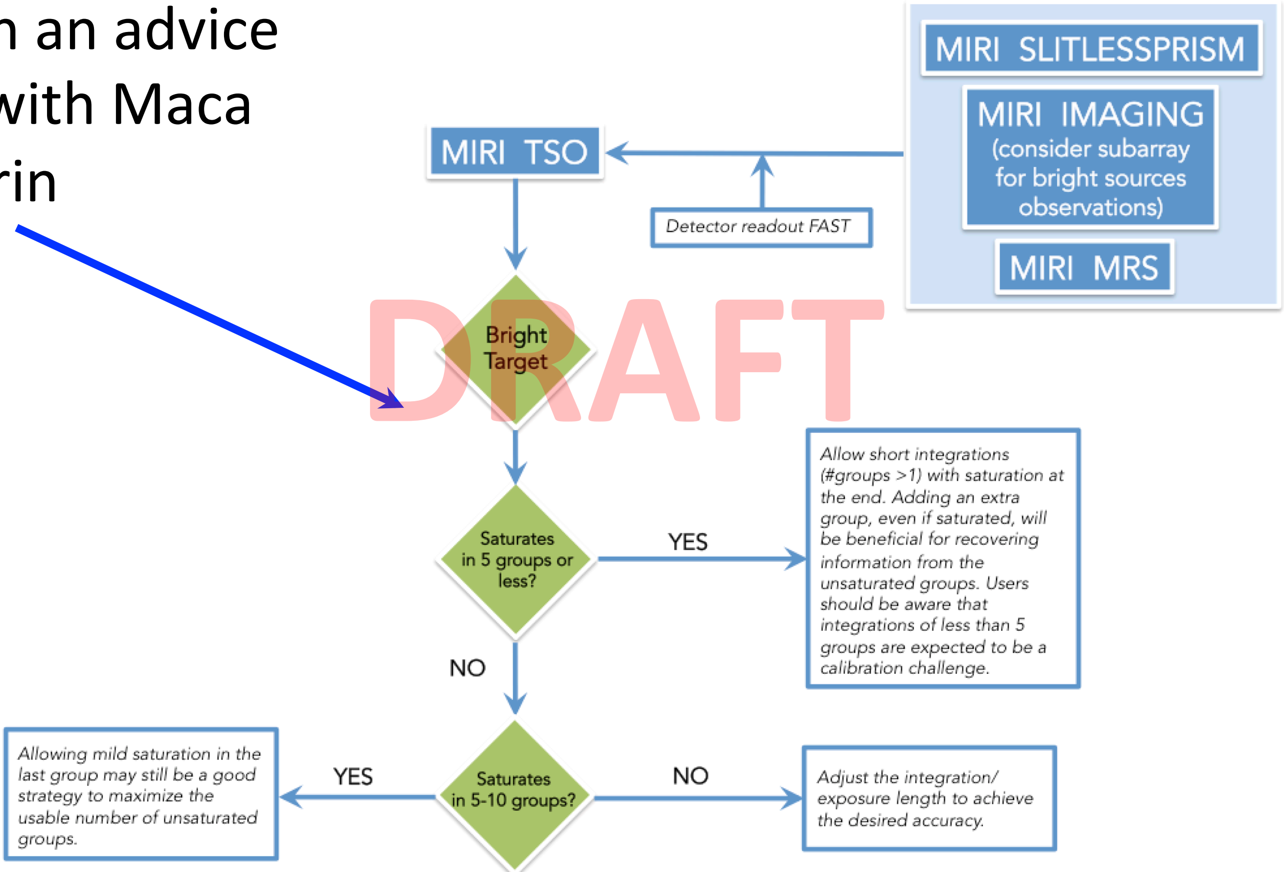
Non-linearity correction

- Method uses a 4th order polynomial, coefficients defined in the calibration data products (CDPs)
  - Correction is “fixed” at 20,000 e-
  - First CALDETECTOR1 correction after bad pixel & saturation masking

- Reverse-calculating these corrections, find the 1% non-linearity limit at:
  - 43,500 e- for imager < 20 µm, F2300W, F2550W, MRS Ch 1 & 2
  - 44,000 e- for F2100W
  - 40,000 e- for MRS Ch 3, 4 SHORT
  - 36,000 e- for MRS Ch 3, 4 MEDIUM & LONG

Recommendations for bright source exposures

Working on an advice flowchart with Maca Garcia-Marin



Similar to the graphic on:
https://jwst-docs.stsci.edu/display/JPP/MIRI+Generic+Recommended+Strategies

MIRI advice re exposure setup

- There is no one-size-fits-all "ideal count level"
- Bright sources will always have some artifacts & sometimes it might be better to saturate in the final groups (see notes at the end re. saturation)

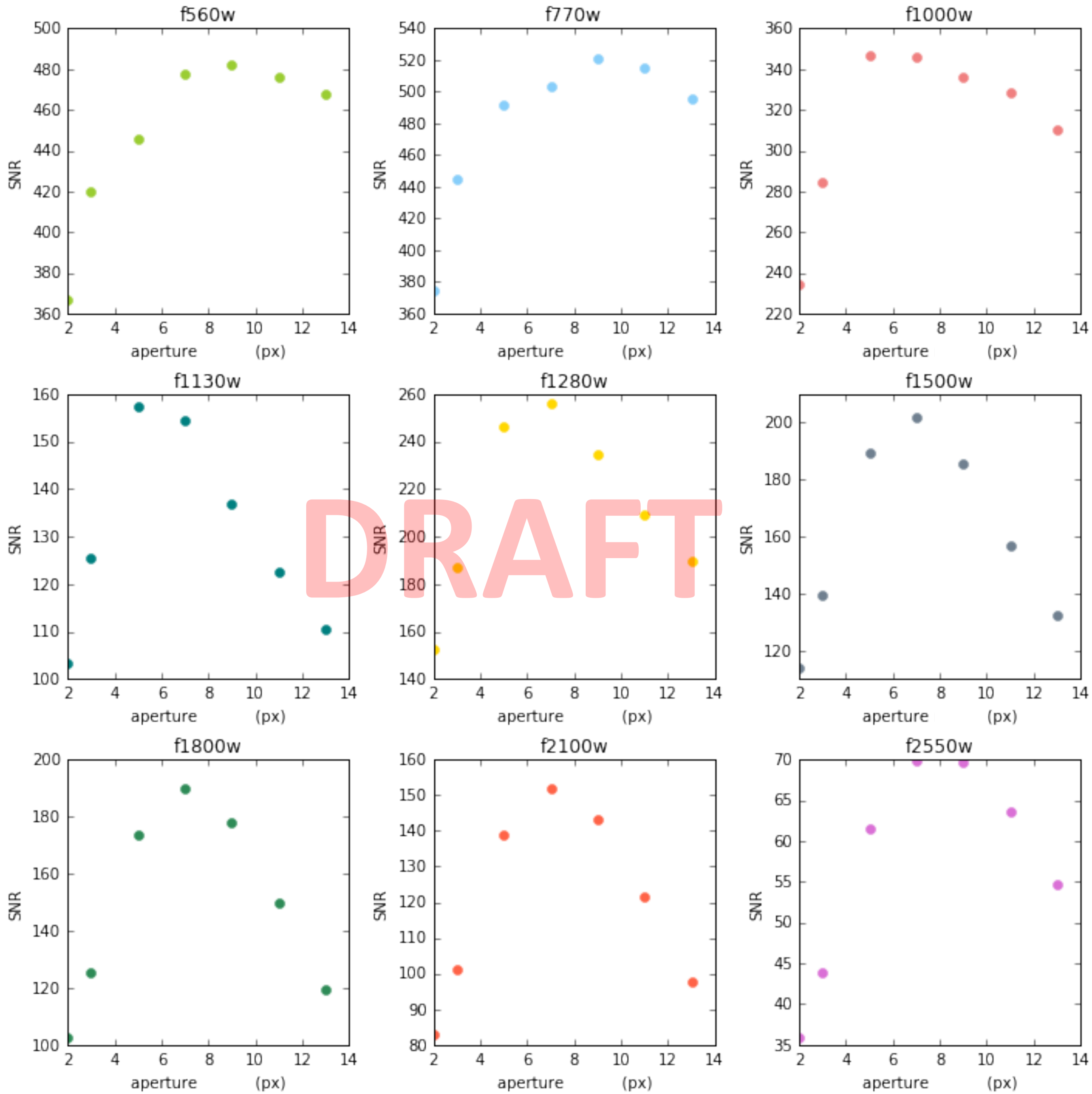
II. MIRI TSO Photometry

- Pipeline returns a lightcurve by performing aperture photometry
- What is the optimal aperture for MIRI Imaging that will work for a baseline pipeline?
- Performed Pandeia calculations to look at SNR as a function of aperture size and filter
  - Input source: star with V ~ 10.6
  - High background
  - ETC calculations such that SNR >300 for most filters (> 100 for $\lambda > 20$ μm)
  - Background annulus set to 1-1.2” size

MIRI FWHM sizes & pixel scale

Filter name	λ_0 (μm)	Δλ (μm)	FWHM (arcsec)
F560W[1]	5.6	1.2	0.22
F770W	7.7	2.2	0.25
F1000W	10.0	2.0	0.32
F1130W	11.3	0.7	0.36
F1280W	12.8	2.4	0.41
F1500W	15.0	3.0	0.48
F1800W	18.0	3.0	0.58
F2100W	21.0	5.0	0.67
F2550W	25.5	4.0	0.82

- Pixel scale is 0.11”/px
- FWHM sampled by 2.0 to 7.45 px
- Undersampling limited to F560W


f560w
SNR
aperture (px)
500 480 460 440 420 400 380 360
2 4 6 8 10 12 14
f770w
SNR
aperture (px)
540 520 500 480 460 440 420 400 380 360
2 4 6 8 10 12 14
f1000w
SNR
aperture (px)
360 340 320 300 280 260 240 220
2 4 6 8 10 12 14
f1130w
SNR
aperture (px)
160 150 140 130 120 110 100
2 4 6 8 10 12 14
f1280w
SNR
aperture (px)
260 240 220 200 180 160 140
2 4 6 8 10 12 14
f1500w
SNR
aperture (px)
200 180 160 140 120
2 4 6 8 10 12 14
f1800w
SNR
aperture (px)
200 180 160 140 120 100
2 4 6 8 10 12 14
f2100w
SNR
aperture (px)
160 150 140 130 120 110 100 90 80
2 4 6 8 10 12 14
f2550w
SNR
aperture (px)
70 65 60 55 50 45 40 35
2 4 6 8 10 12 14

Notes on these results

- Seem to show quite consistent SNR vs aperture relationships across filters

- Code is in jupyter notebook hosted in STScI-MIRI Github space – happy to provide access

- Any considerations I have not included?

III. MIRI saturation advice

- We've changed the wording regarding saturation in the Jdox pages on MIRI TSO recommendations, and the MIRI LRS main page

- Saturation causes detector artefacts (i.e. an additional source of systematics) but sometimes this can be preferable over reducing the number of groups (more groups -> better ramp sampling -> better stability)

- The pipeline masks saturated groups, and is able to process data with only the unsaturated portion of the ramp

- Note that row/column artefacts appear for very bright sources, even if pixels are not saturated.

- Saturation produces stronger latents BUT non-saturated bright source data are not free of latents. Decay behaviour seems similar whether pixels were saturated or not
.

- So, Q: "Is my LRS spectrum still scientifically useful if saturated at 5-6 µm but not at longer wavelengths?"
  ~~A: "No, avoid this"~~
  A: "Possibly yes, but you'll likely have some additional systematics to deal with"