The NIRSpec Multi-Object Spectroscopy (MOS) mode

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"On your mark" JWST Workshop
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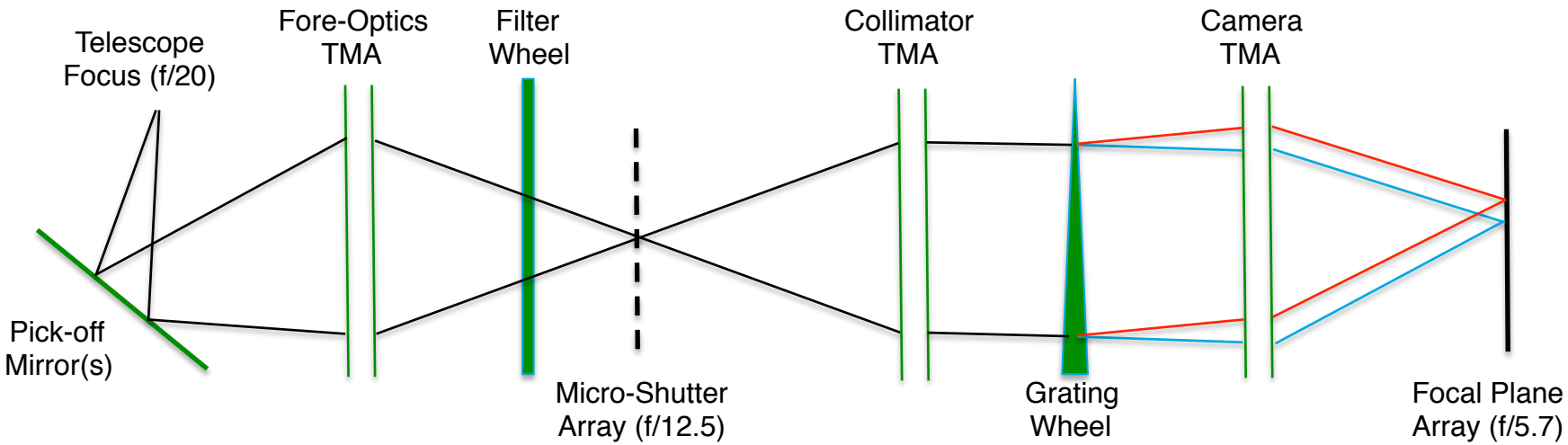
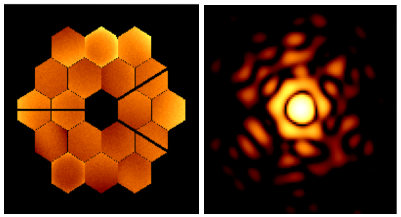
Outline…

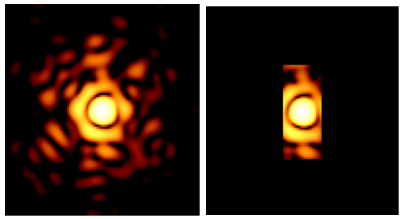
- NIRSpec optical and mechanical design overview
- The Microshutter Array – design and functionality
- Focal plane(s) layout
- Example: MOS observations of a deep galaxy field
- Wavelength coverage and instrument configurations
- Hardware Constraints: failed shutters
- Observing Strategy for MOS mode
- Data products
- Planning the target acquisition and MSA configuration(s)
- Sensitivity in MOS mode

NIRSpec Optical Design

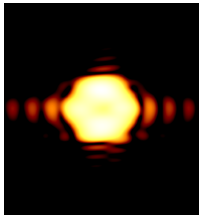




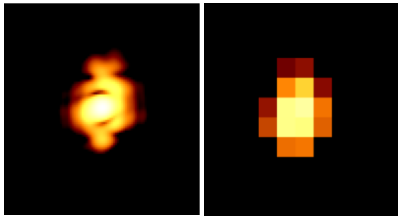
Telescope Focus



Slit Mask

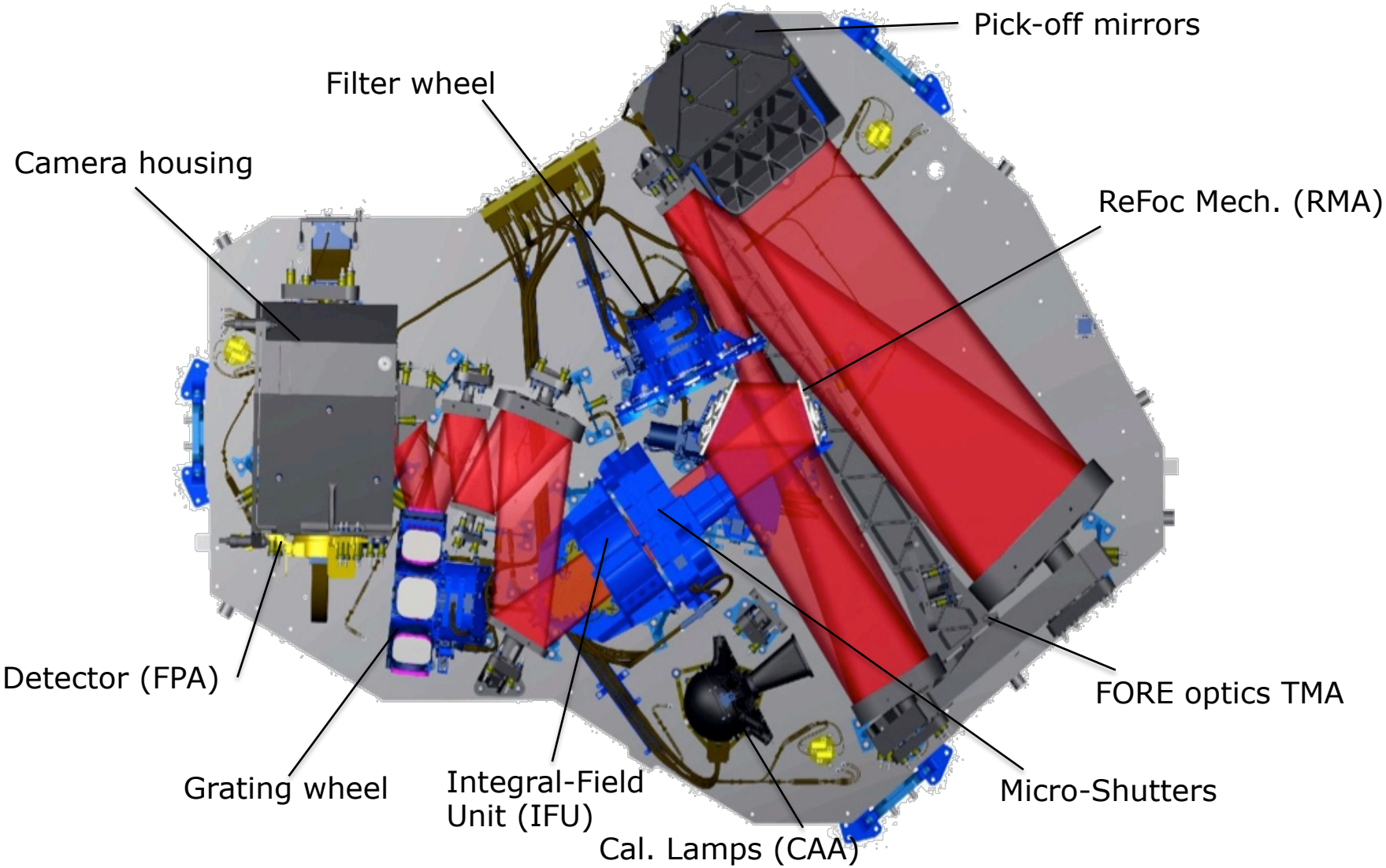


Pupil at Disperser



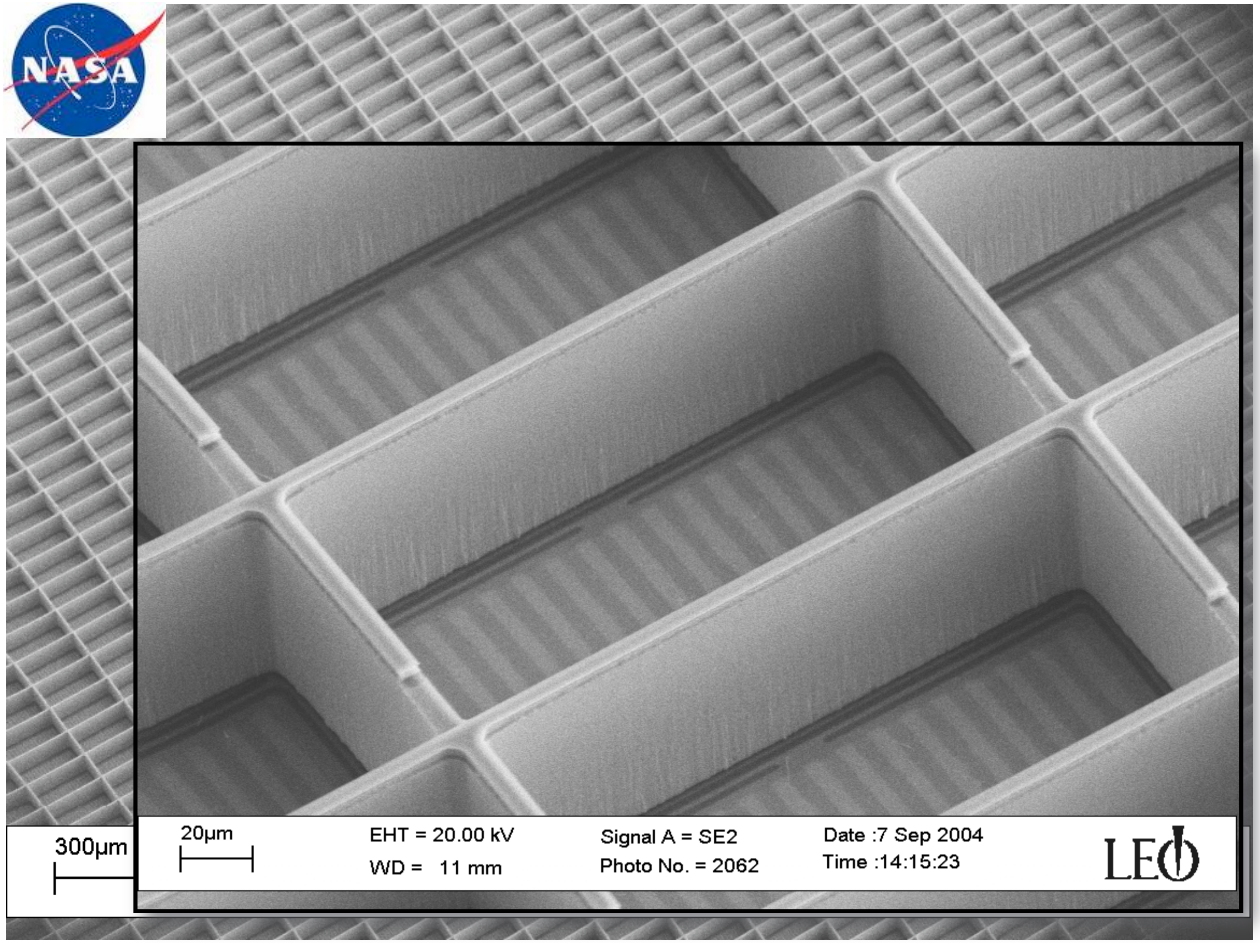
Detector Array

NIRSpec Mechanical Design

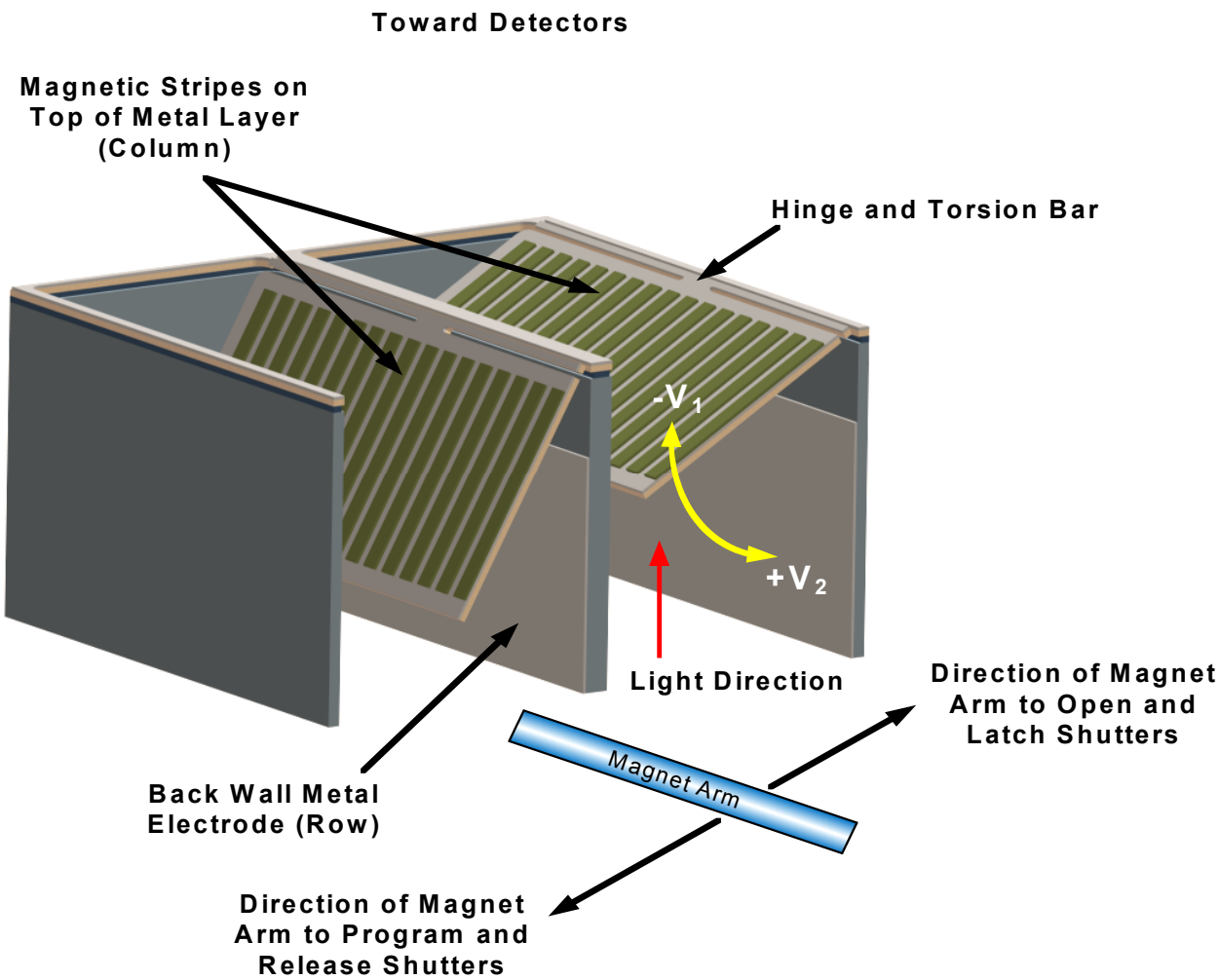


NIRSpec – the first MOS in space

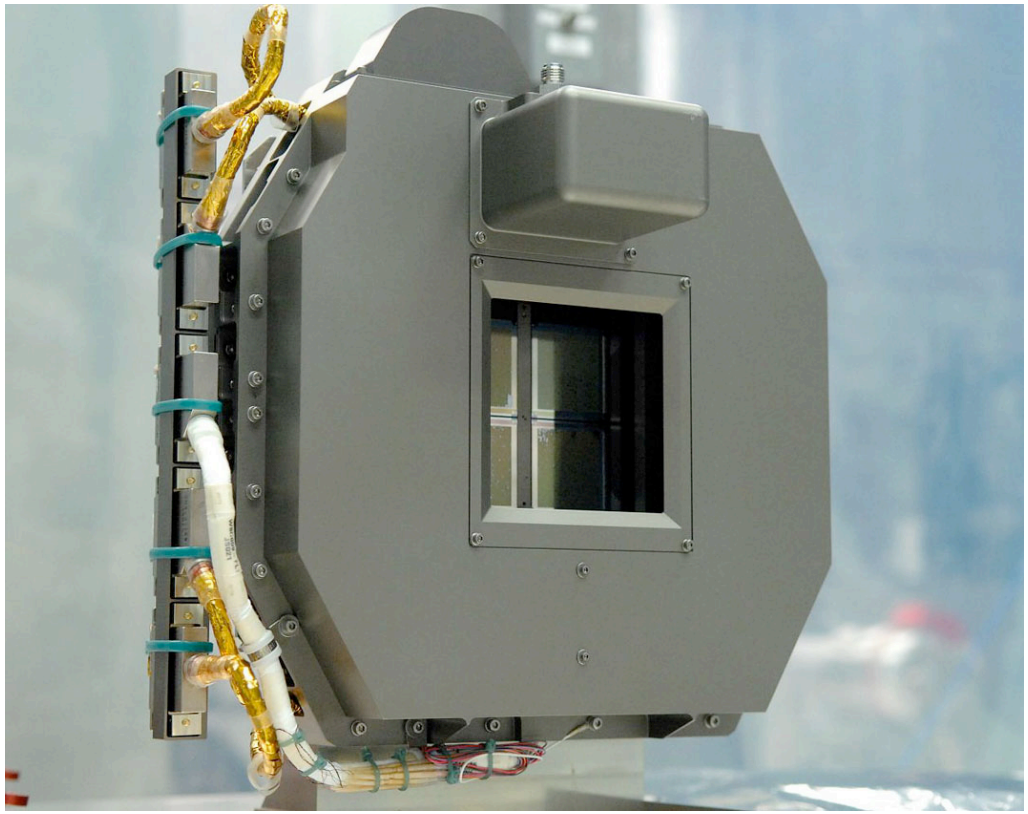
- "traditional" slit masks not an option at L2
- Instead, use MEMS technology to configure slit mask

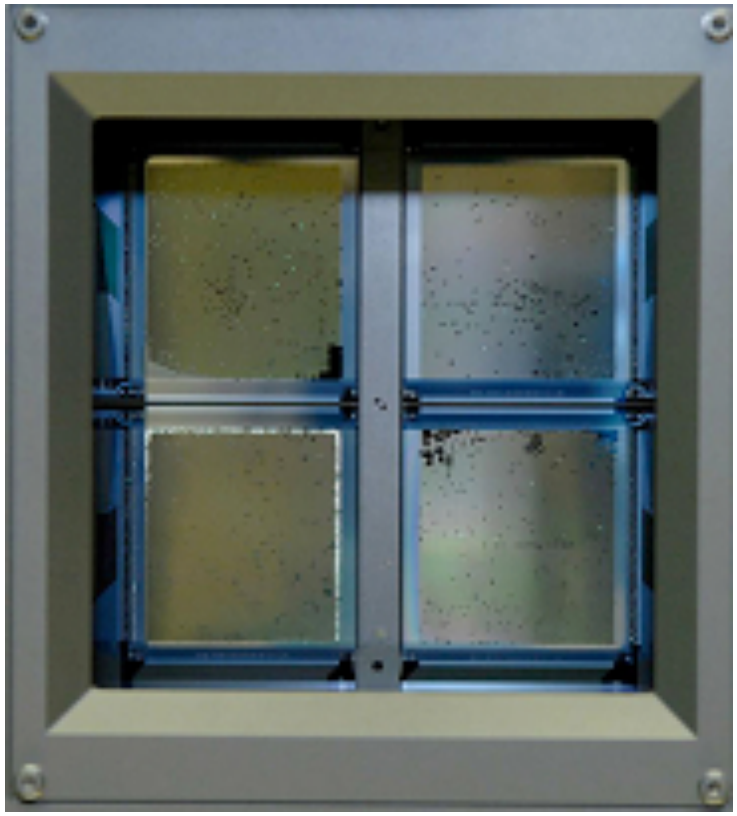


How the MSA works

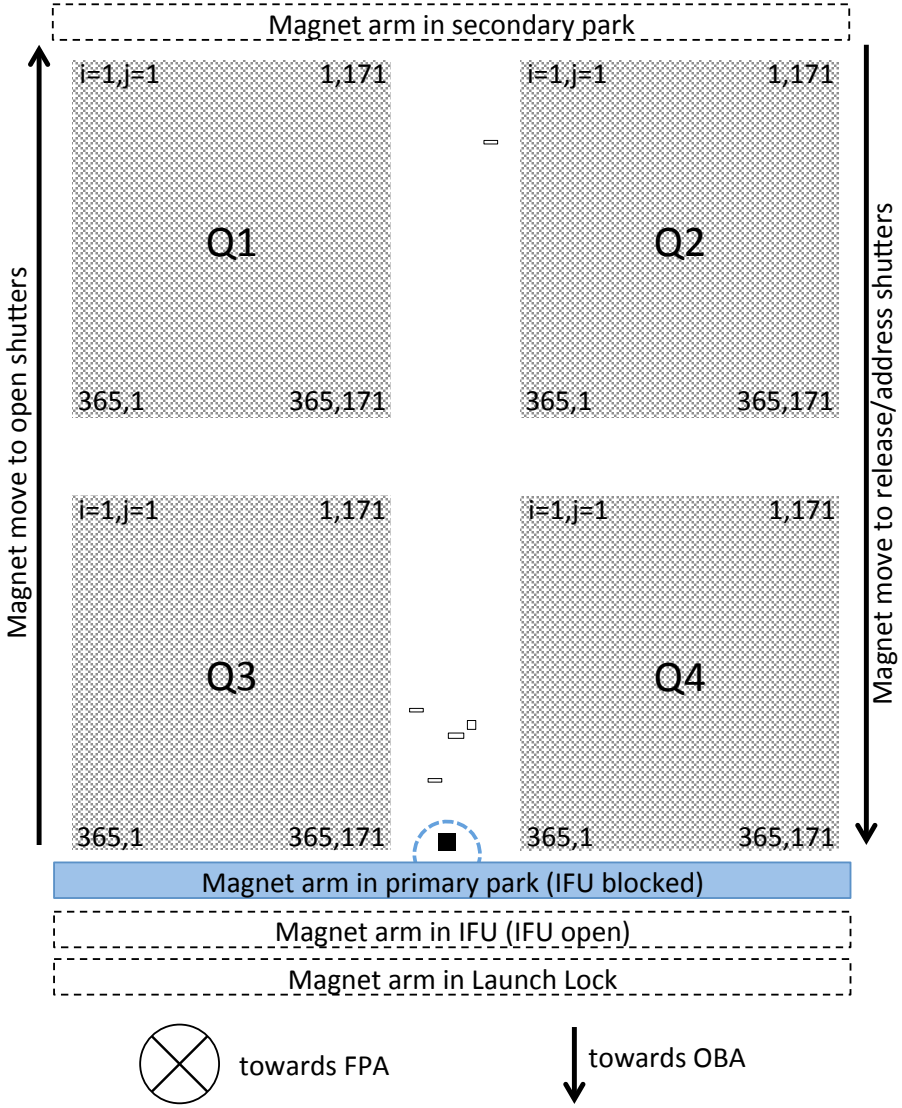


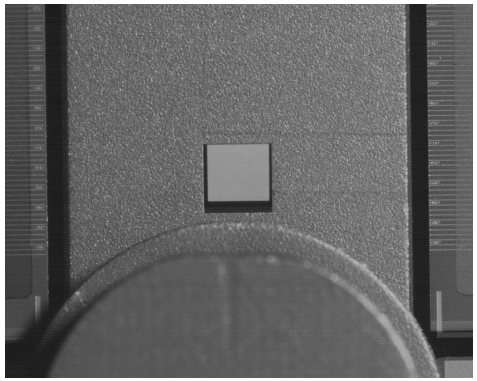
MSA hardware



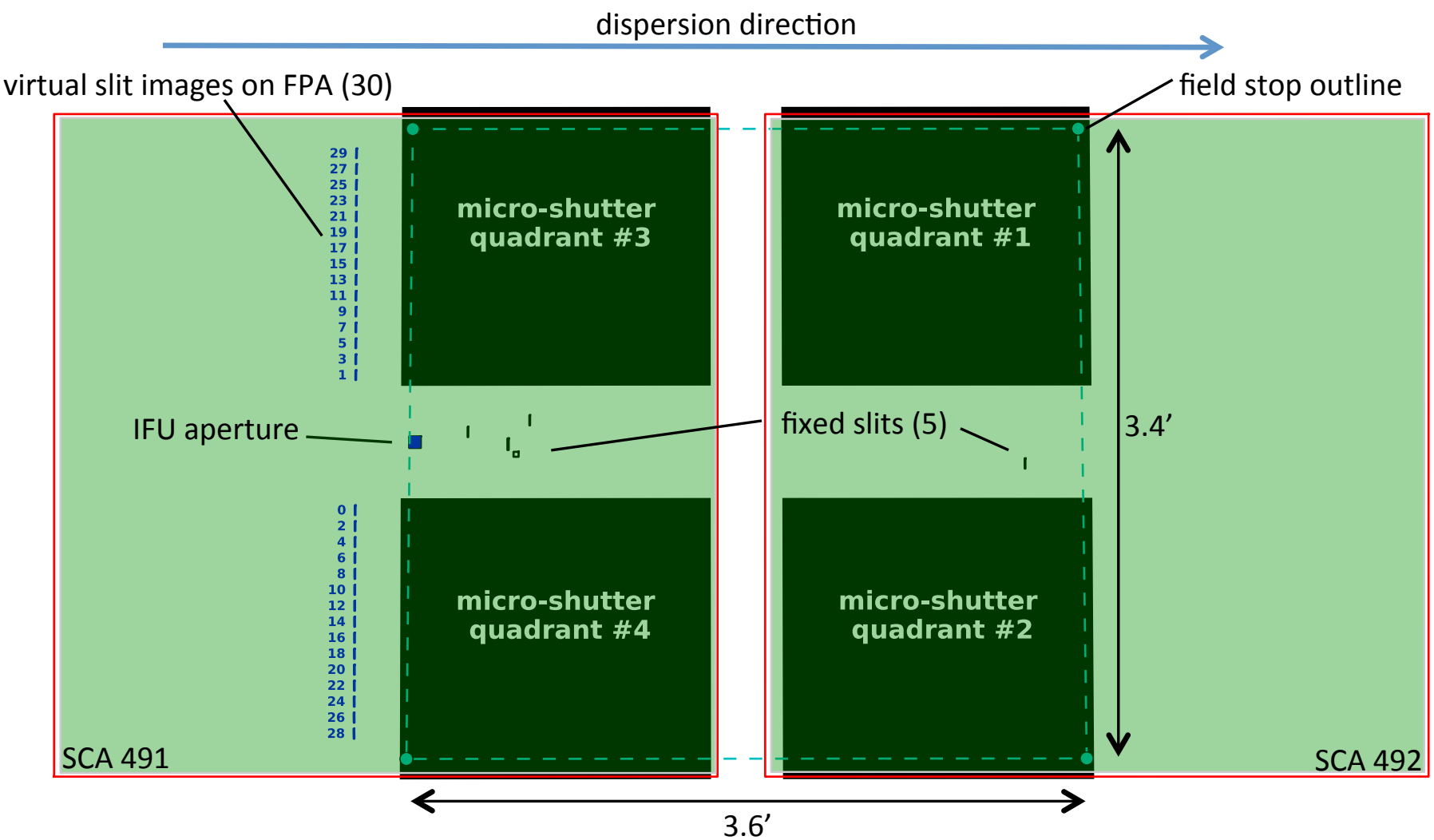


Apertures in the MSA Plane



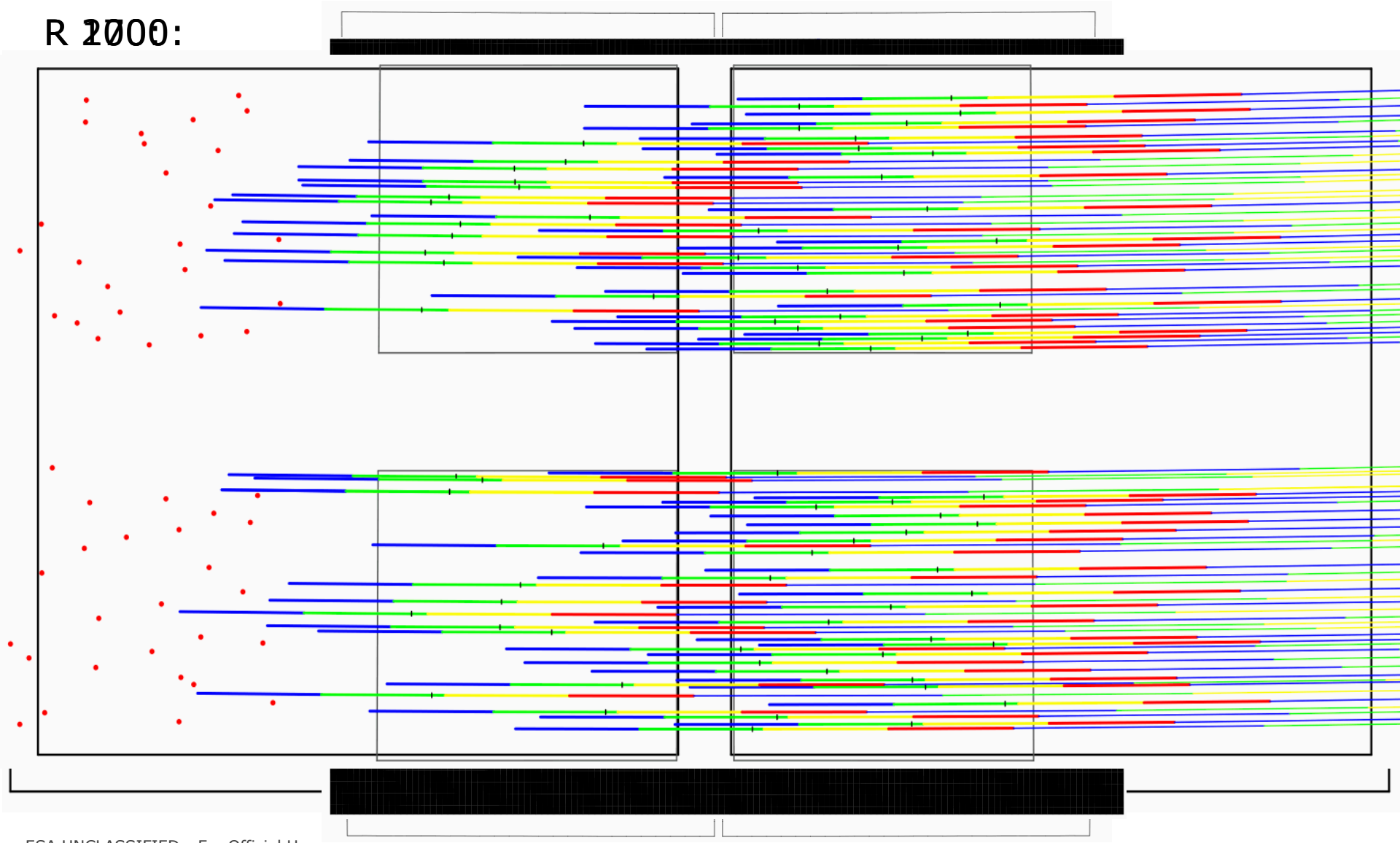


NIRSpec Focal Plane(s)



Example: a deep galaxy field

R 2000:



Available filter/grating combinations

- For R~100, CLEAR/PRISM delivers full spectral range (0.6-5.3 μm) in a single exposure

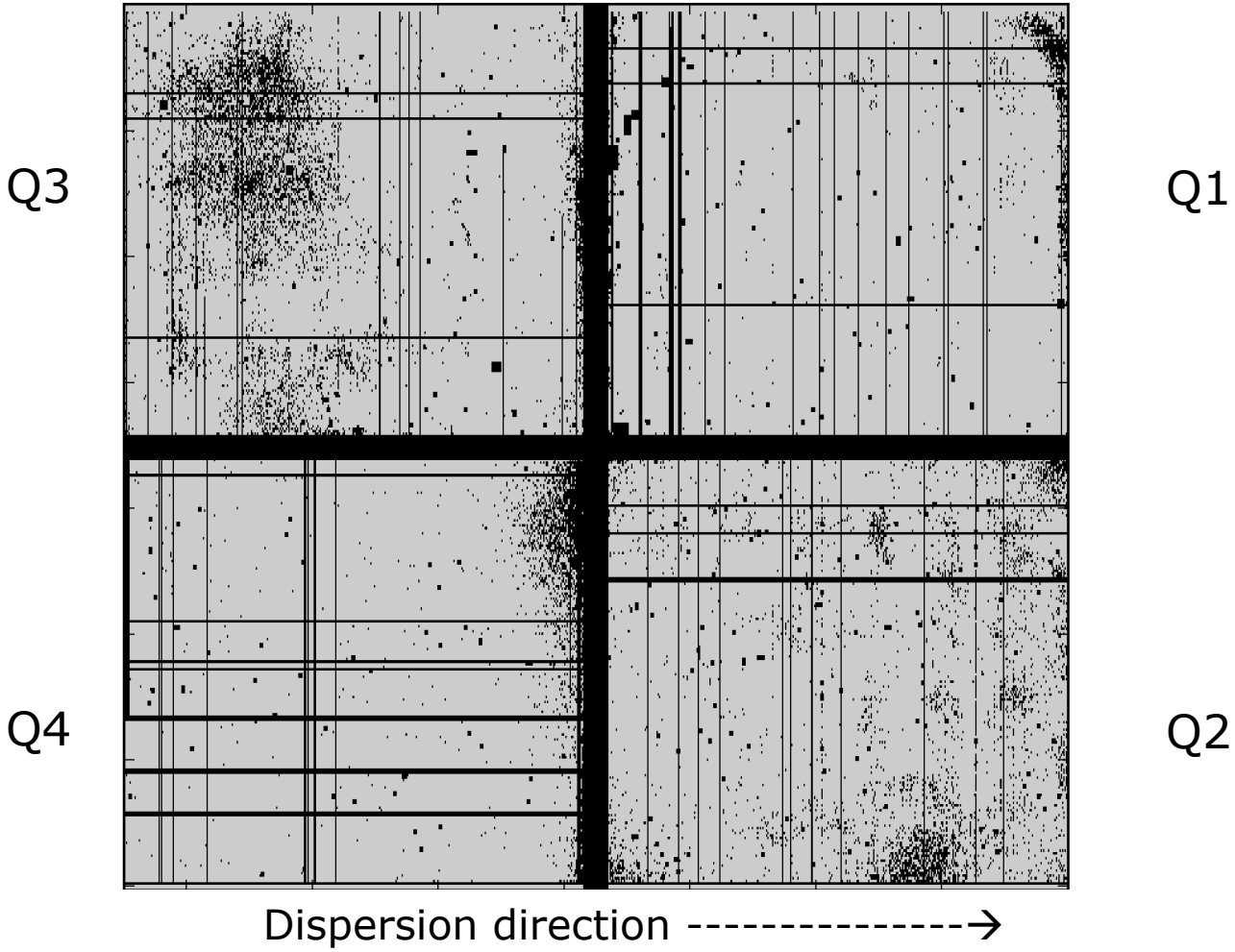
- For R~1000, require 3-4 exposures to cover full wavelength range:
  - F100LP/G140M: 0.97 – 1.89 μm
  - F170LP/G235M: 1.66 – 3.17 μm
  - F290LP/G395M: 2.87 – 5.27 μm
  - (F070LP/G140M: 0.70 – 1.27 μm)

- For R~2700, require 3-4 exposures to cover full wavelength range:
  - F100LP/G140H: 0.97 – 1.89 μm
  - F170LP/G235H: 1.66 – 3.17 μm
  - F290LP/G395H: 2.87 – 5.27 μm
  - (F070LP/G140H: 0.70 – 1.27 μm)

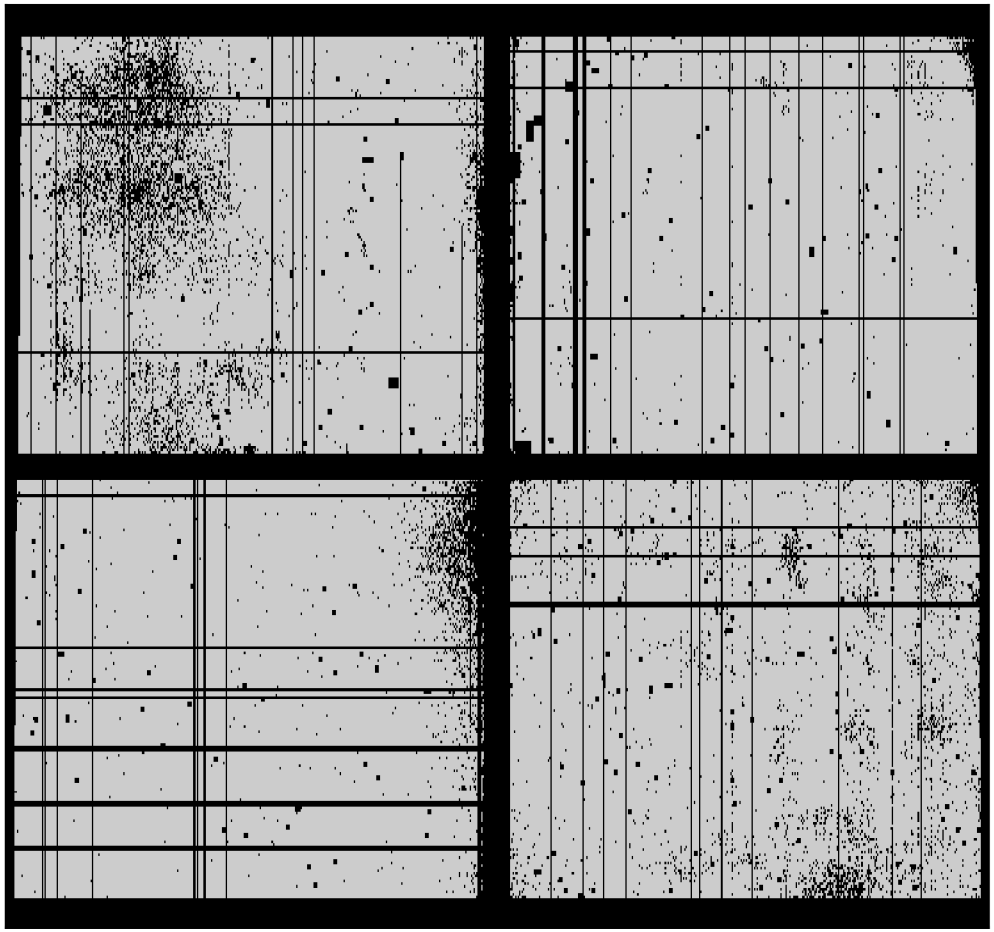
MSA cosmetics

.... welcome to reality ....

Failed closed shutters

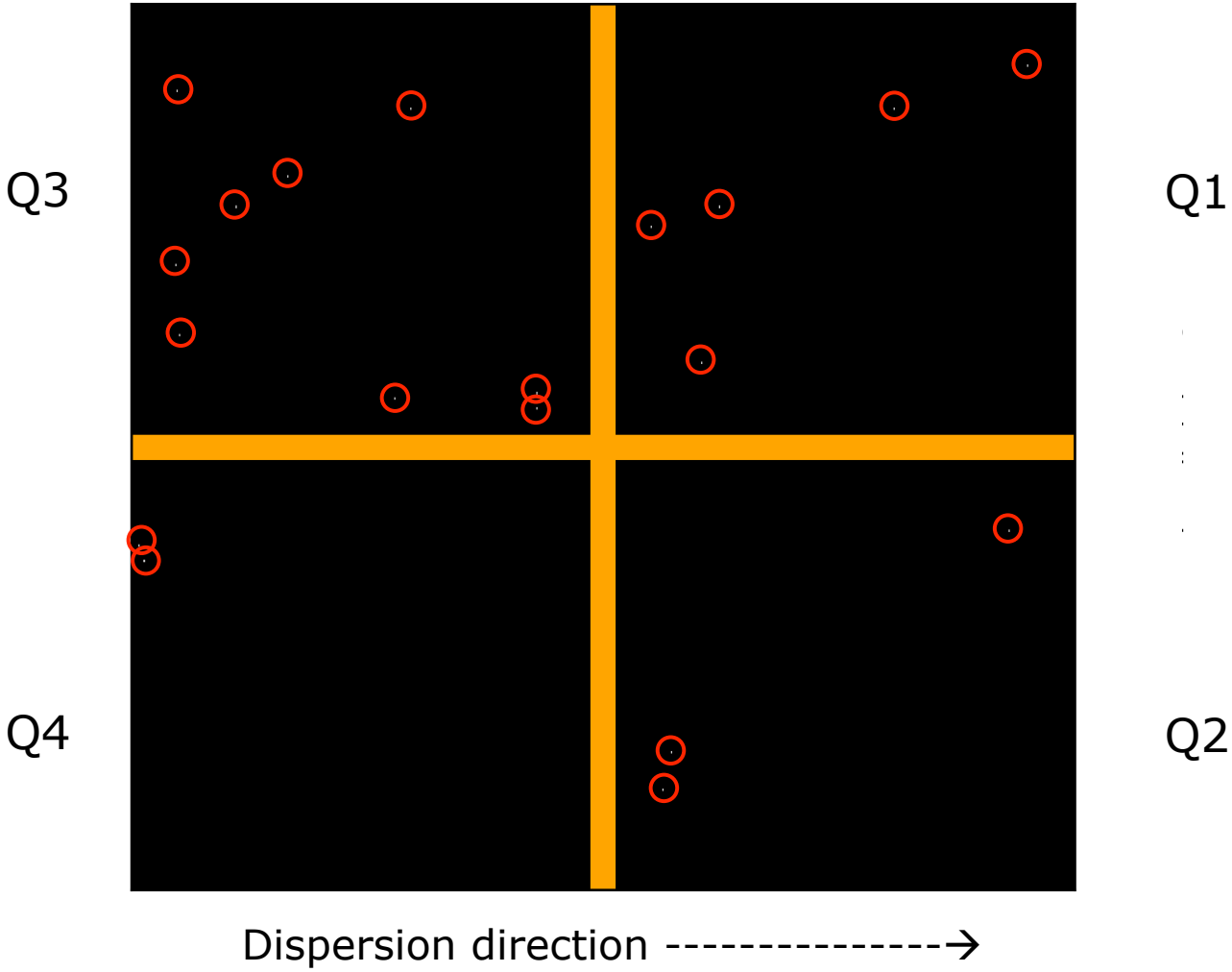


Failed closed shutters (with field stop shadow)

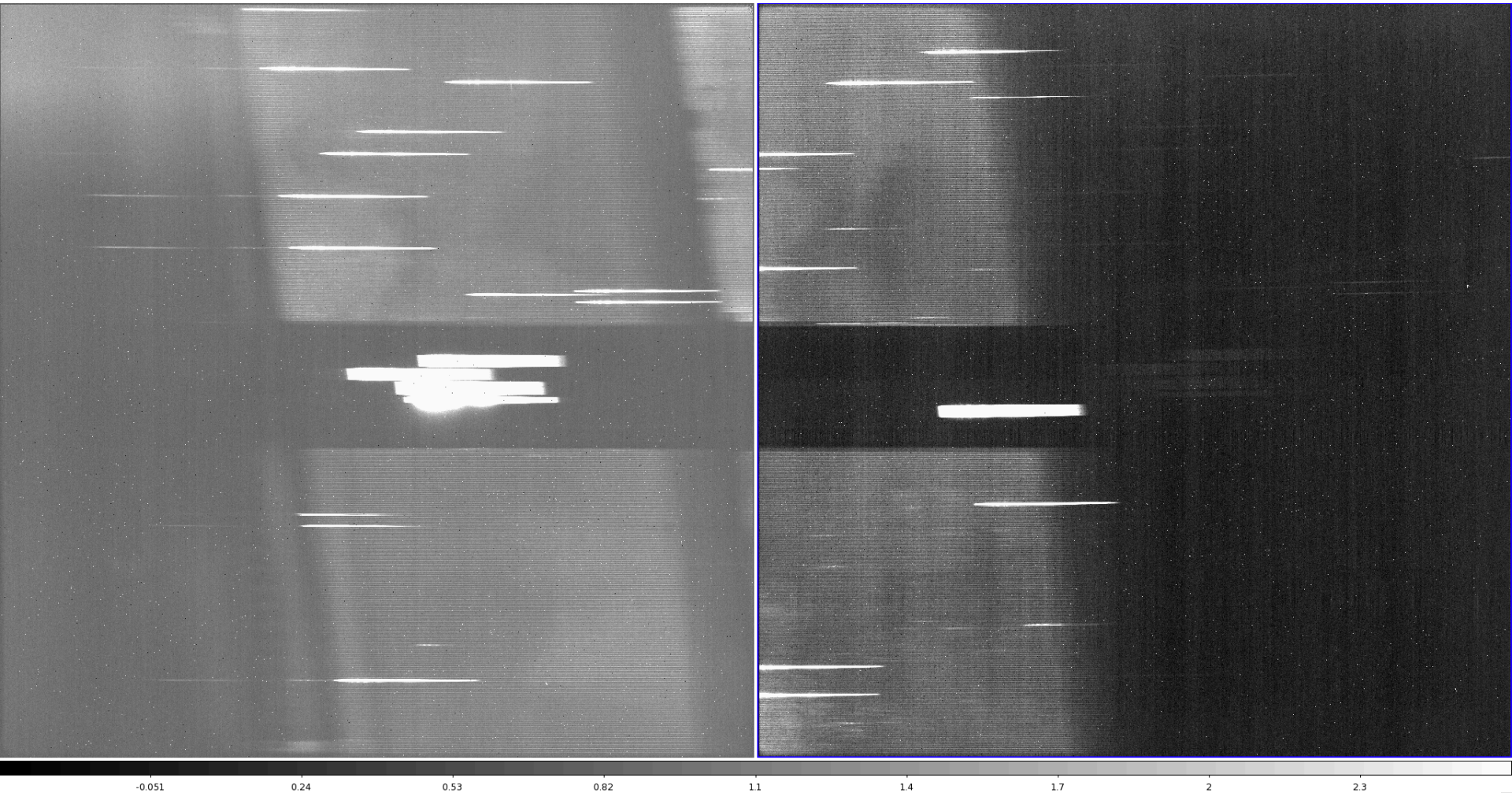


Dispersion direction ----------→

Failed open shutters (all 19 of them)

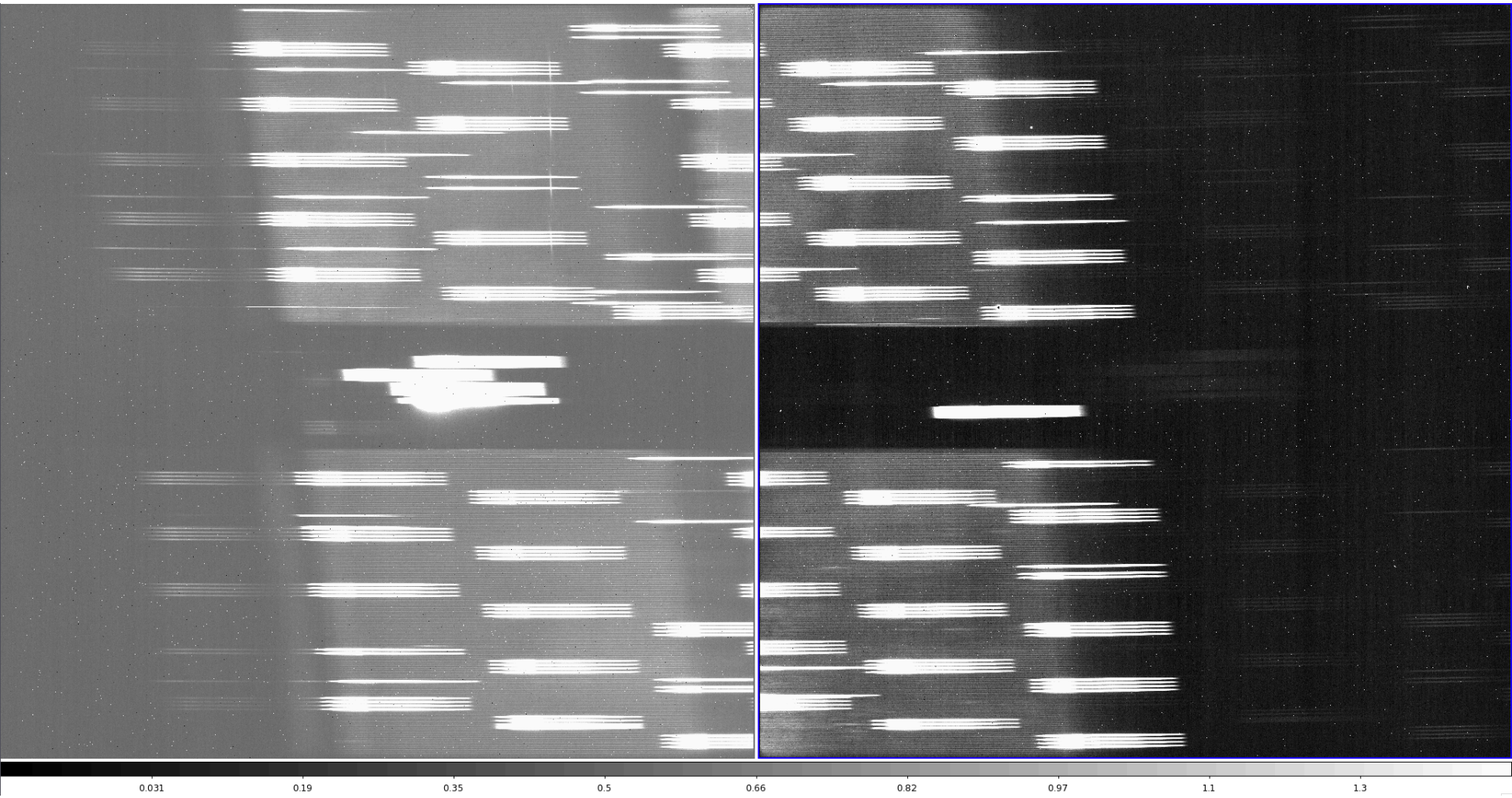


When the MSA is “all closed”…..

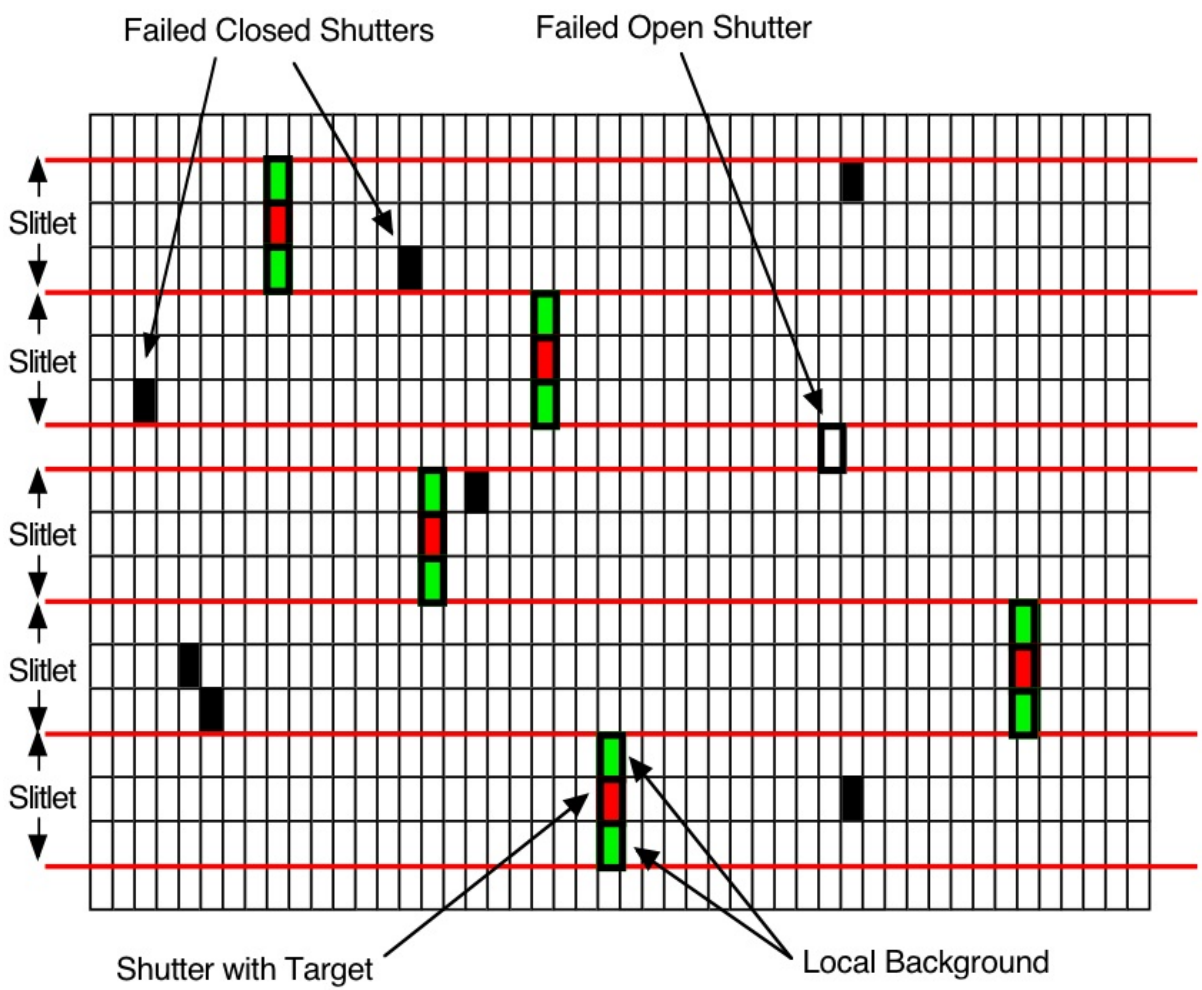


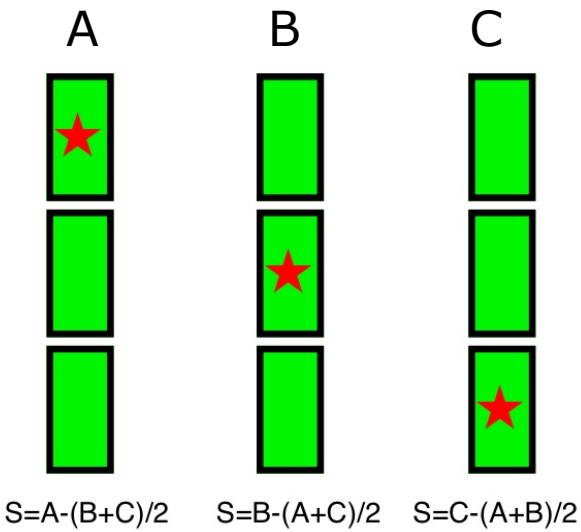
Note: effect is highly exaggerated in this figure!
(very bright lamp and narrow color scale)

Failed open shutters



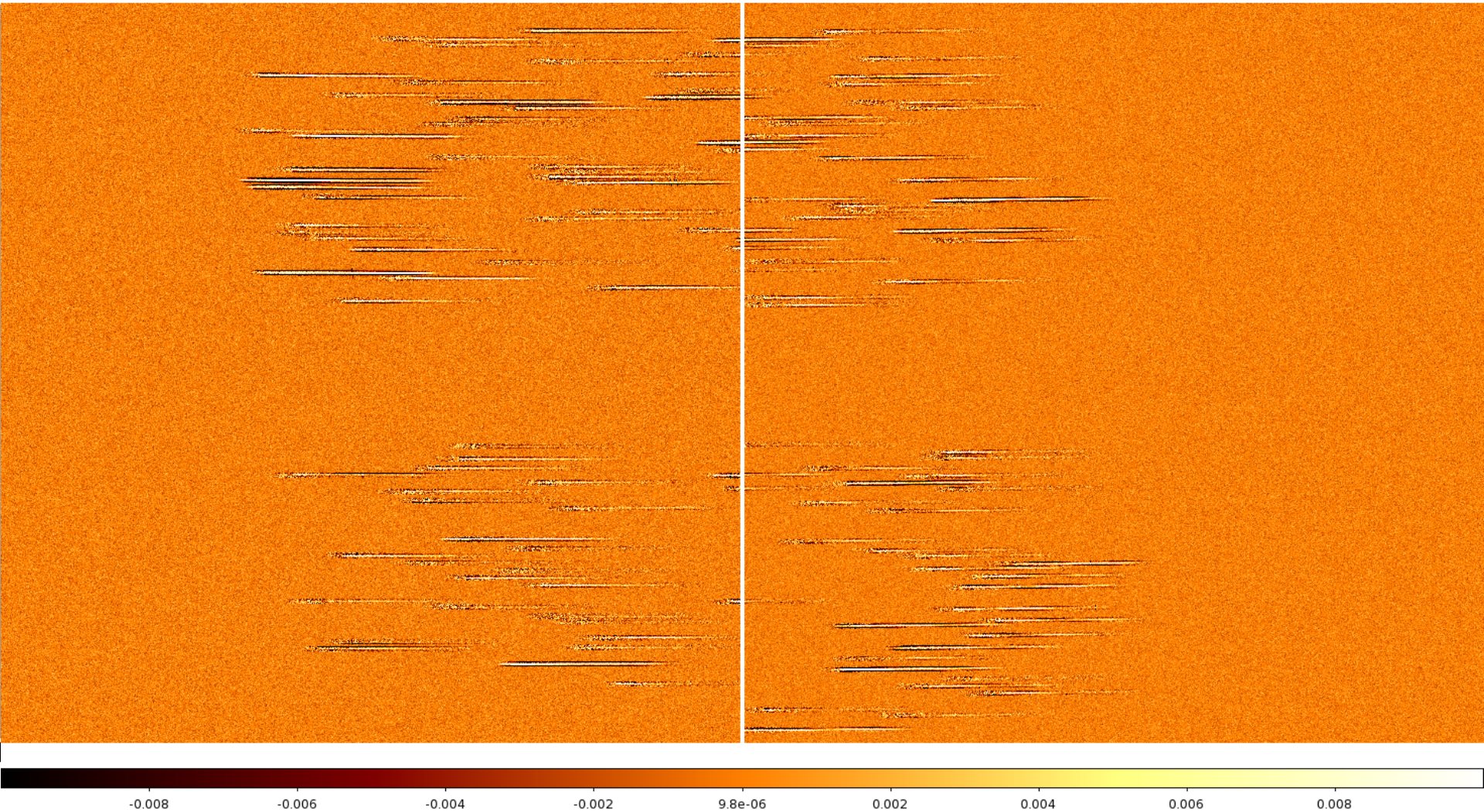
“Default” Observing Strategy





Example exposures

Simulated 100ks exposure:
(created by “nodding” three 33ks exposures)



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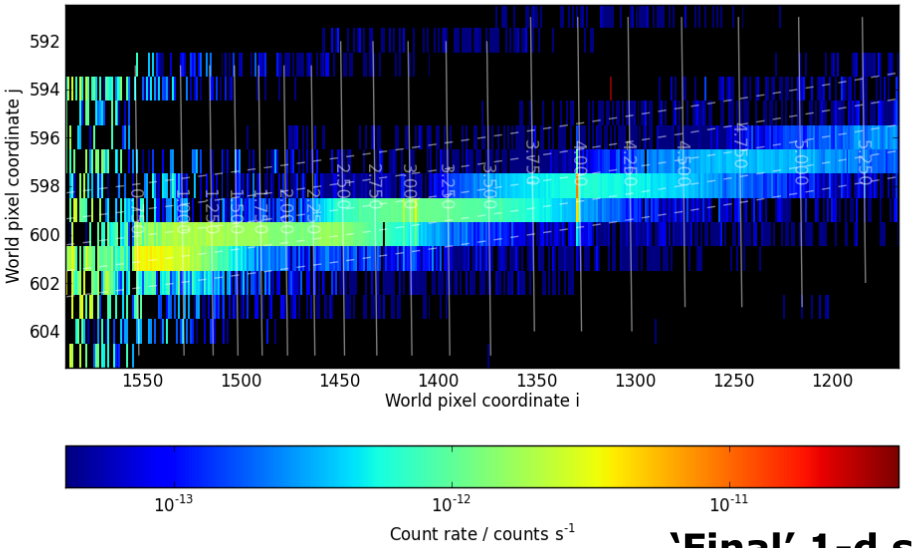
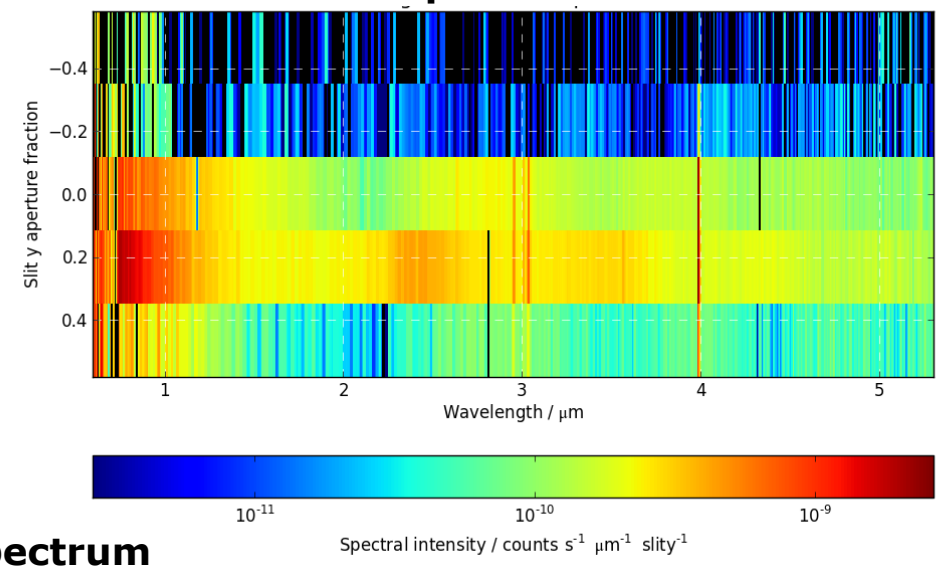
Data Products

Example: CLEAR/PRISM spectrum of XDFV-3953261056
(R.A. 03:32:39.532, Dec -27:46:10.56, m(F160W)=27.0, z=5.1)

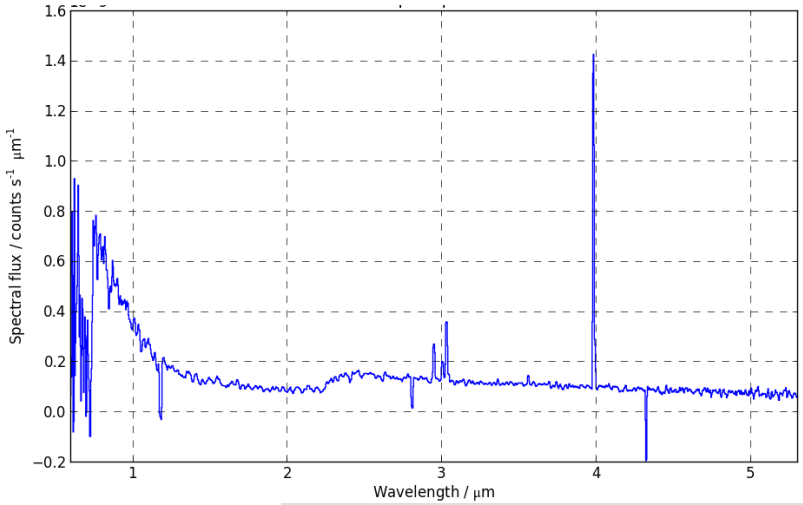
'Trace':



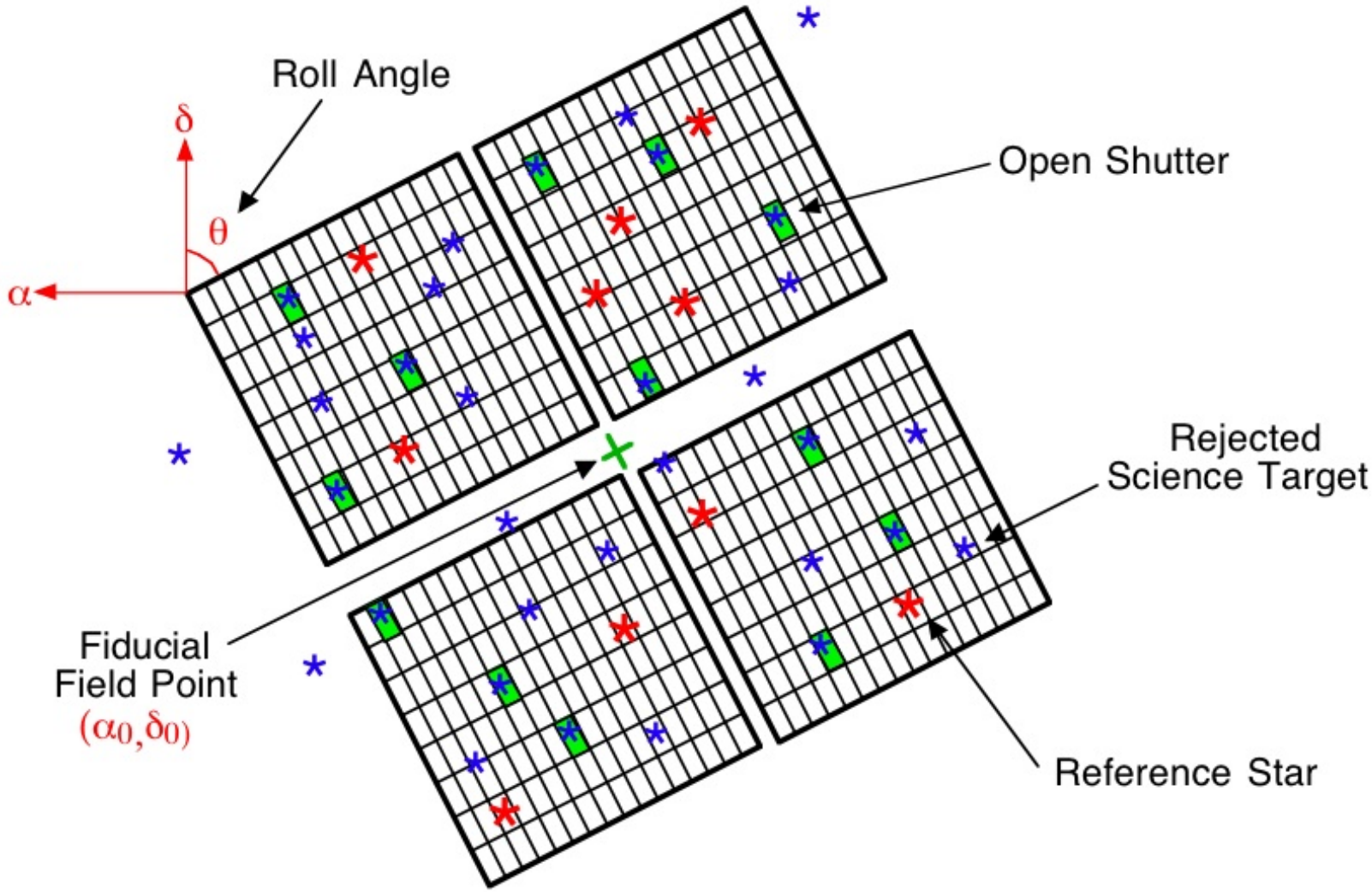
'Rectified' 2-d spectrum



'Final' 1-d spectrum



Target Acquisition



TA planning

- need source catalog (incl. both science targets and reference stars) with knowledge of relative source positions to within (ideally) 5 mas

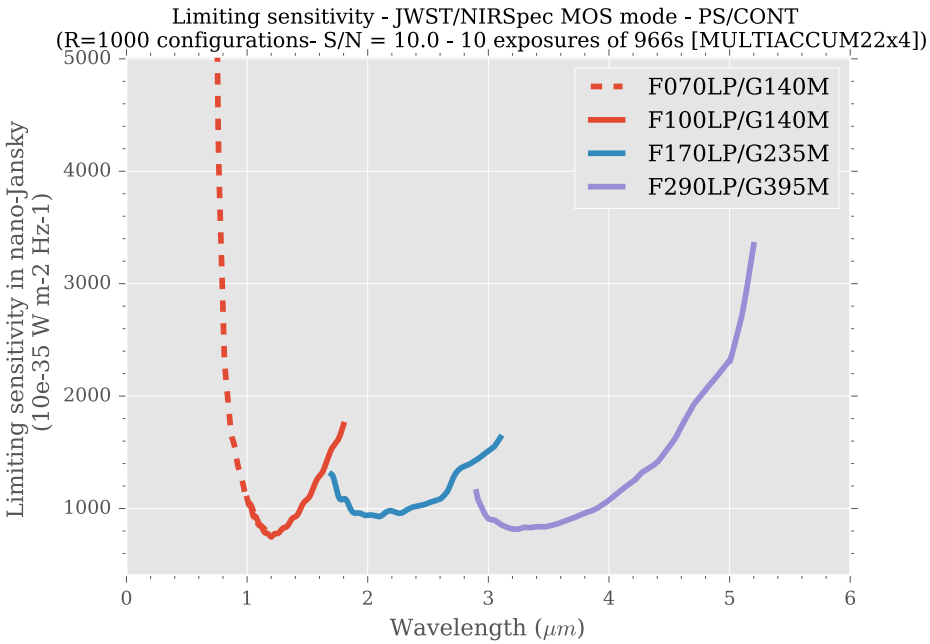
- Once observations have been scheduled, use the micro-shutter planning tool (MPT) to optimize the desired MSA position on the sky (i.e. roll angle and RA/Dec of MSA fiducial point) and to create the required MSA configuration files (see talk by D. Karakla).

- TA data and MSA configuration files will be attached to the visit files and uplinked for autonomous execution

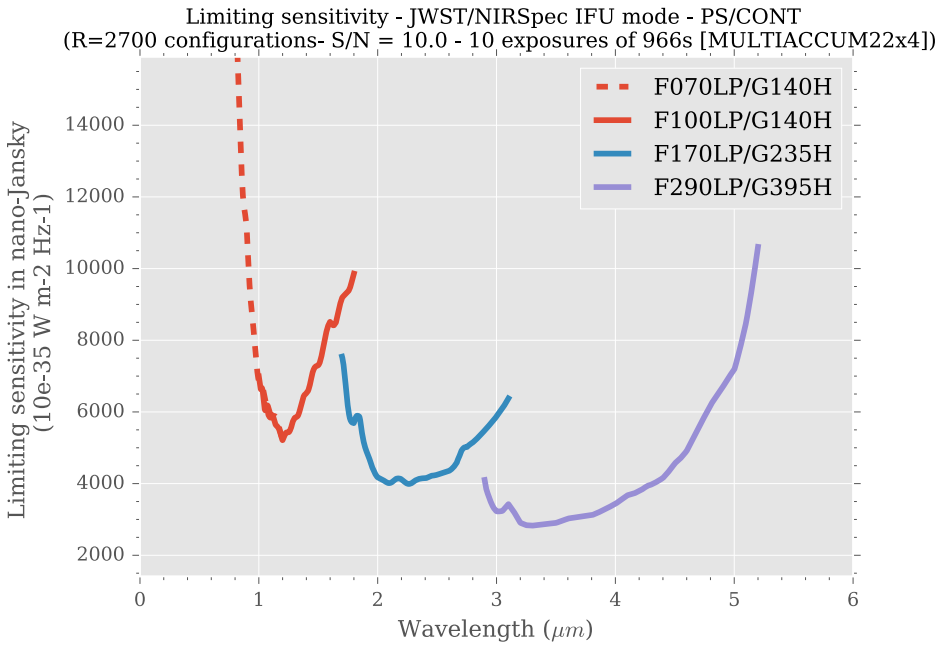
- note that roll angle constraints limit schedulability of observations

MOS Sensitivity – point source continuum flux

R=1000:



R=2700:

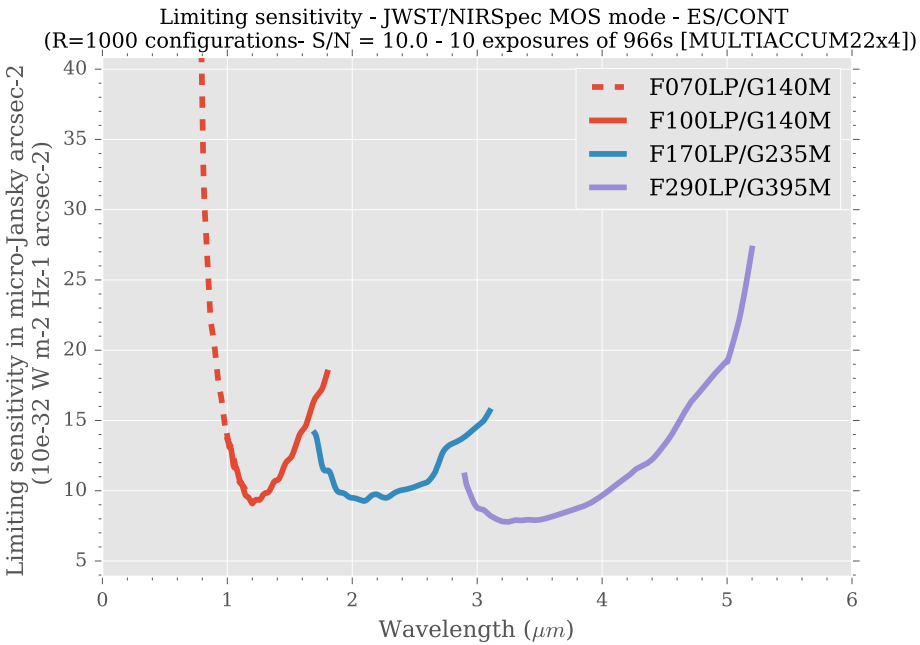


Disclaimer:

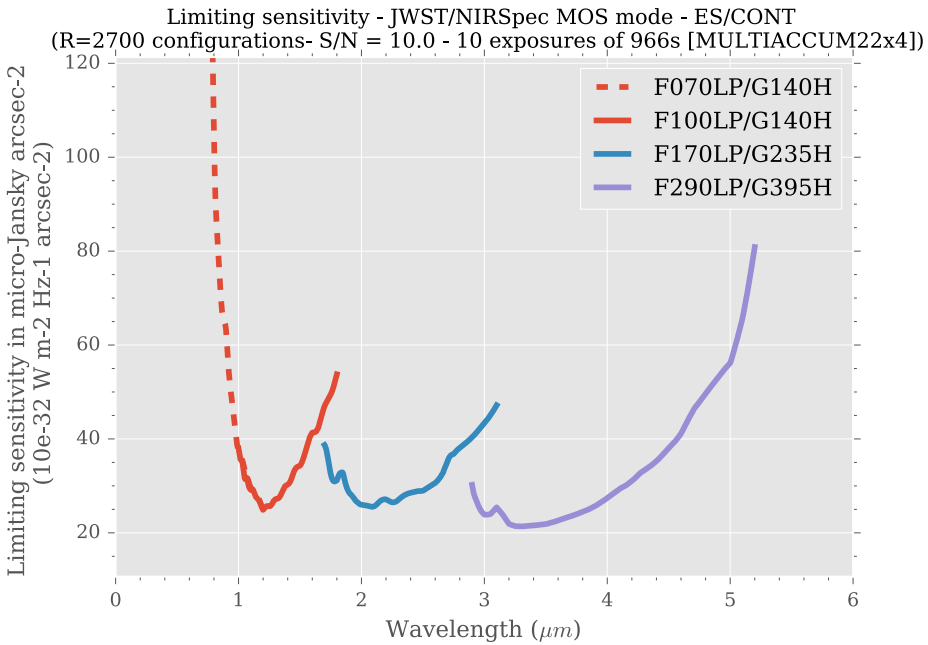
These estimates are conservative, and are expected to improve.
Always refer to the STScI ETC for up-to-date sensitivity estimates.

MOS Sensitivity – extended source surface brightness

R=1000:



R=2700:



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NIRSpec MOS sensitivity

- End-of-life (EOL) Sensitivity Requirements

ISIM-153 (JWST-RQMT-000835)	Requirement	Computed	Margin	Compliance
CLEAR/PRISM at 3 microns S/N=10 in 10,000 seconds Point-source, continuum spectrum	132 nJy	120 nJy	9%	**OK**
F170LP/G235M at 2 microns S/N=10 in 100,000 seconds Point source, emission-line spectrum	5.7×10^{-22} Wm^{-2}	4.76×10^{-22} Wm^{-2}	16%	**OK**