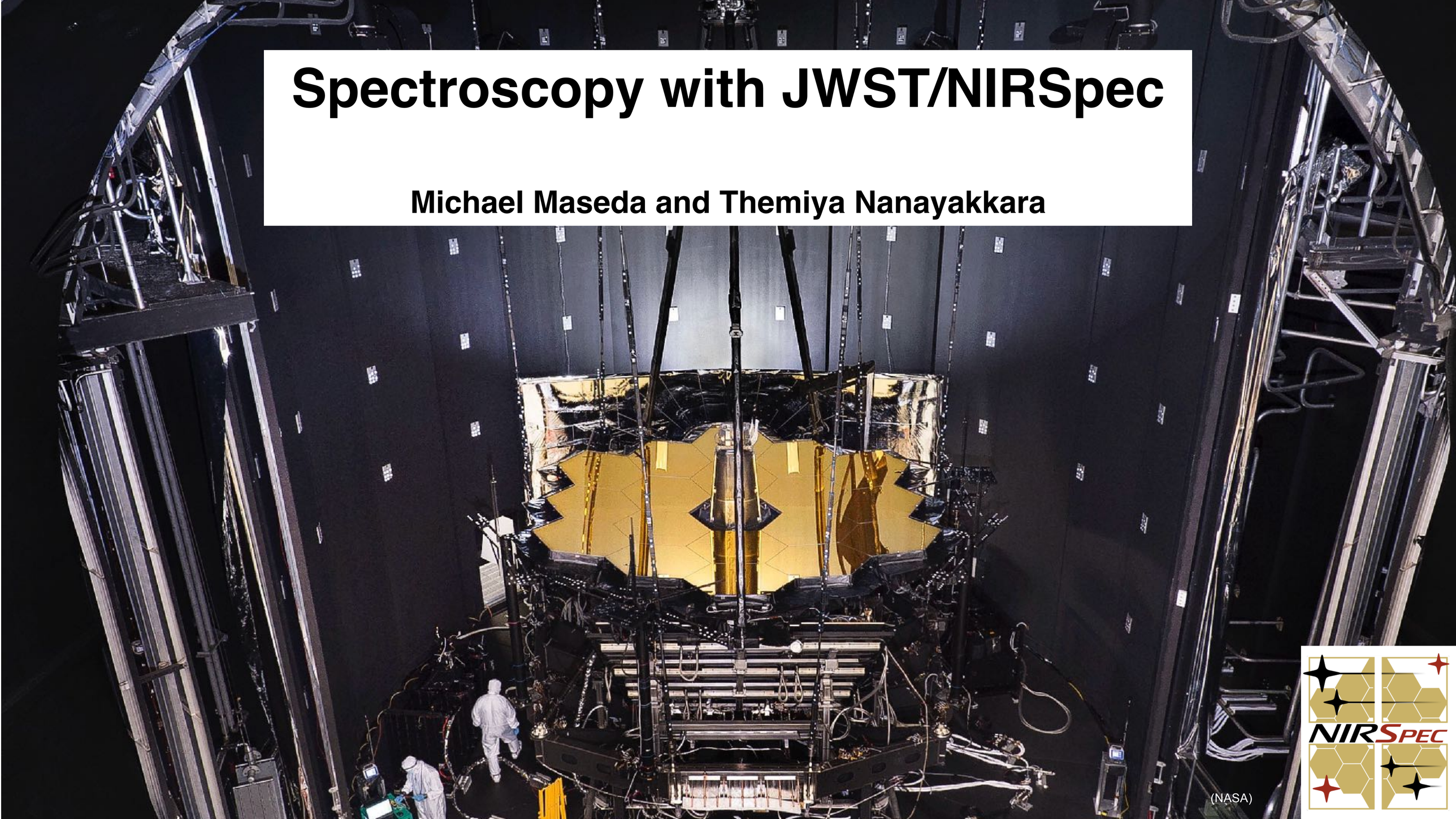
Spectroscopy with JWST/NIRSpec

Michael Maseda and Themiya Nanayakkara



(NASA)

SPECTROSCOPIC CAPABILITIES

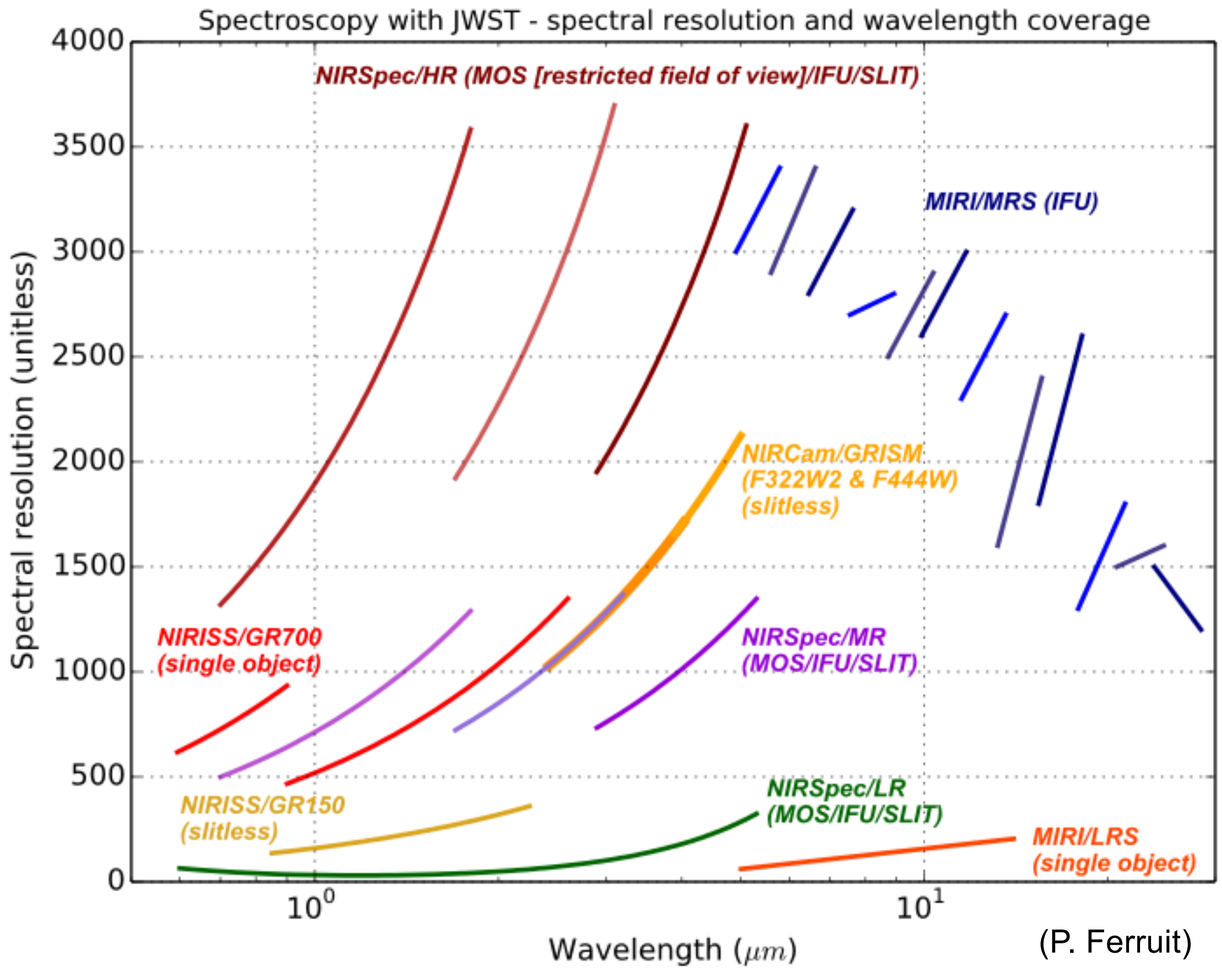
Take-home message: JWST spectroscopy comes in many different flavors…

- Can address many different scientific needs.
- Unique combination of sensitivity & spatial resolution.

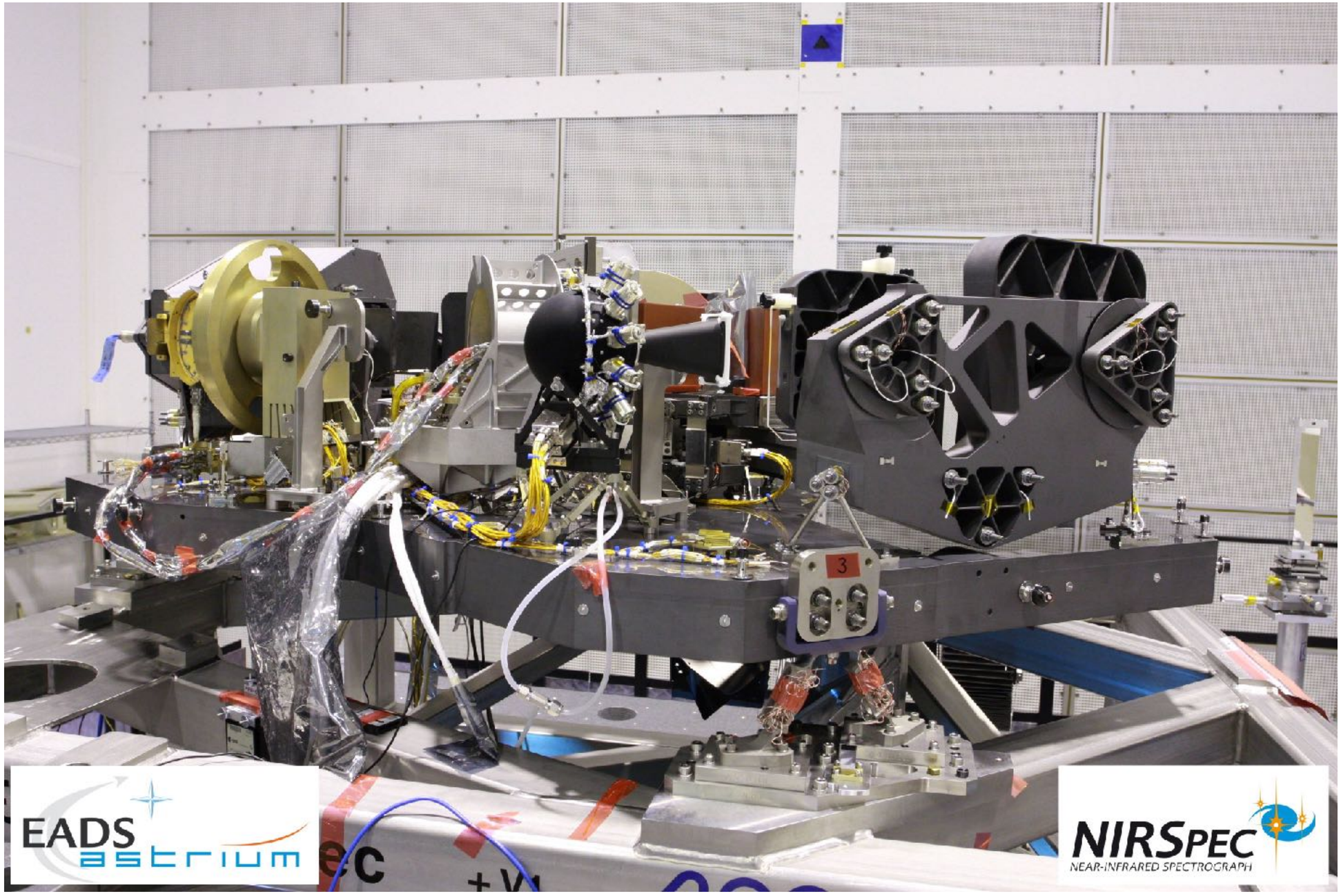
Instrument	Type	Wavelength (microns)	Spectral resolution	Field of view
NIRISS	slitless	1.0-2.5	~150	2.2’ x 2.2’
NIRCam	slitless	2.4-5.0	~2000	2.2’ x 2.2’
NIRSpec	MOS	0.6-5.3	100/1000/[2700]	9 square arcmin.
NIRSpec	IFU	0.6-5.3	100/1000/2700	3” x 3”
MIRI	IFU	5.0-28.8	2000-3500	>3” x >3.9”
NIRSpec	SLIT	0.6-5.0	100/1000/2700	Single object
MIRI	SLIT	5.0-10.0	60-140	Single object
NIRSpec	Aperture	0.6-5.3	100/1000/2700	Single object
NIRISS	Aperture	0.6-2.5	700	Single object

SPECTROSCOPIC CAPABILITIES

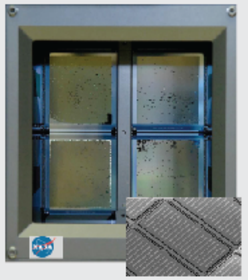
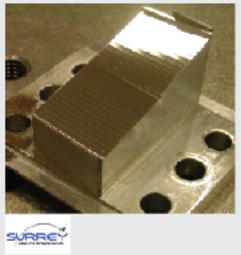
Take-home message: JWST spectroscopy comes in many different flavors…



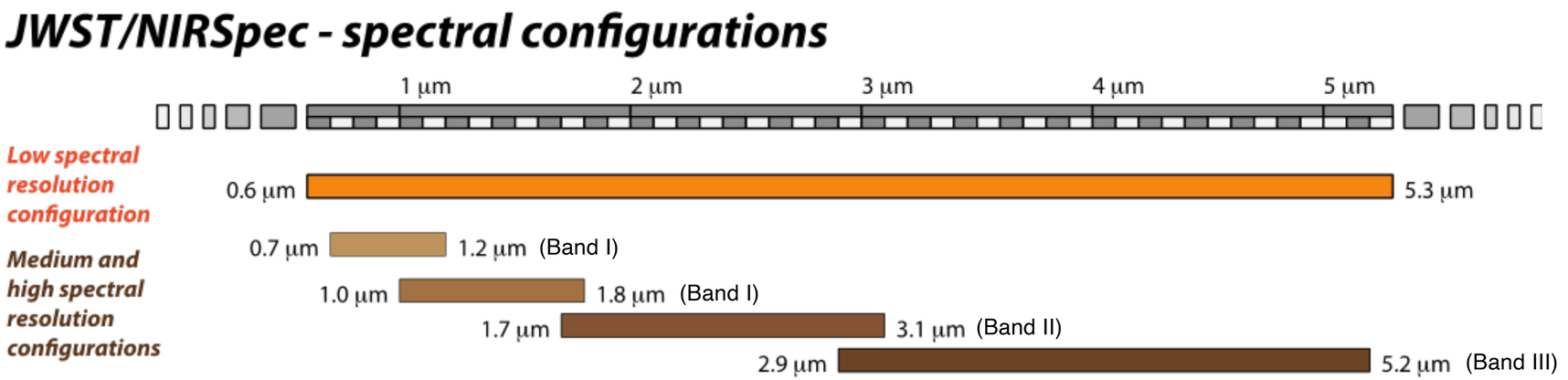
(P. Ferruit)


EADS
astrium
NIRSPEC
NEAR-INFRARED SPECTROGRAPH

NIRSPEC: THE INSTRUMENT

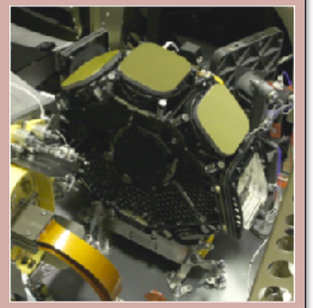
JWST/NIRSpec			
MOS		**Multi-object spectroscopy with 0.2″-wide mini-slits.**	- 9 square arcmin. field of view - Low spectral resolution (30 to 300), prism-based mode covering the 0.6-5.0 micron range in one exposure. - Medium spectral resolution (500 to 1300), grating-based mode covering the 0.7-5.0 range
IFU		**IFU spectroscopy with a 0.1″ sampling.** (IFU made of 30 slices for a total of 900 "spaxels")	- 3″x3″ field of view - Low spectral resolution (30 to 300), prism-based mode covering the 0.6-5.0 micron range in one exposure. - Medium (500 to 1300) and high (1400-3600) spectral resolution modes, covering the 0.7-5.0 range in 4 exposures. - IFU and MOS cannot be used at the same time.
SLIT		**High-contrast slit spectroscopy.** (including with a 1.6″x1.6″ square aperture for extra-solar planet transit observation)	- 5 slits available All spectral resolution modes available. - SLIT can be used simultaneously to IFU or MOS.

NIRSPEC: THE INSTRUMENT



- At low spectral resolution, full coverage of the 0.6-5.3 micron range in one shot.
  - R ~ 100 (low)
- At medium and high spectral resolution, several exposures are necessary to cover the full wavelength range of NIRSpec.
  - R ~ 1000 and ~ 2700
  - R2700 has incomplete wavelength coverage in some parts of MSA

Configurations that can be obtained thanks to a combination of filters and dispersers installed on two wheels (FWA and GWA)

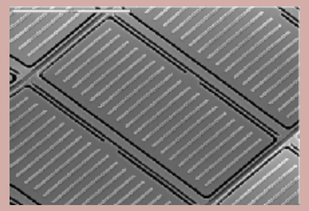


NIRSPEC: MOS

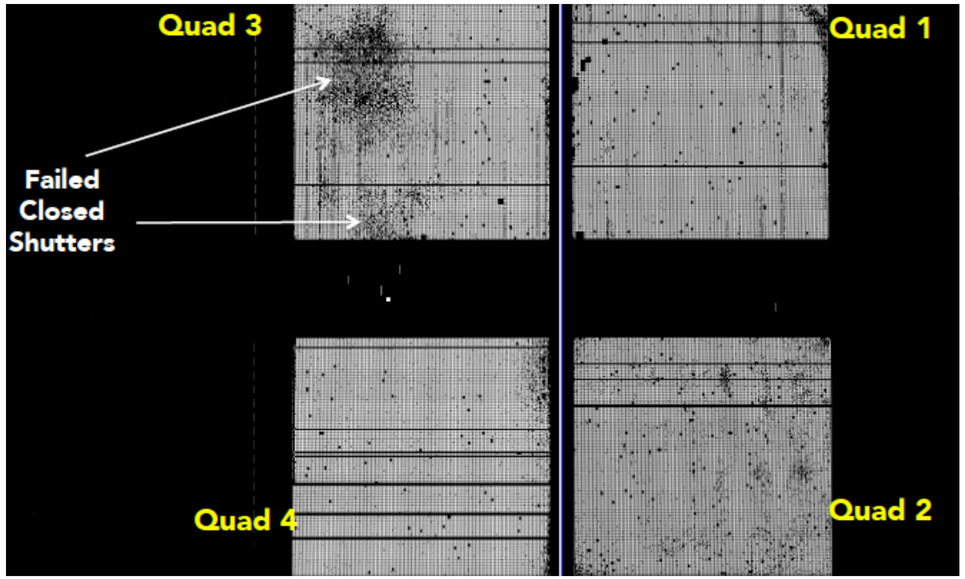
- The challenge of multi-object spectroscopy
  - Letting the light from selected objects go through while blocking the light from all the other objects.
  - A configurable mask was needed.

Using 4 arrays of 365x171 micro-shutters each, provided by NASA GSFC.

This gives us a total of almost **250 000** small apertures that can be individually opened/closed



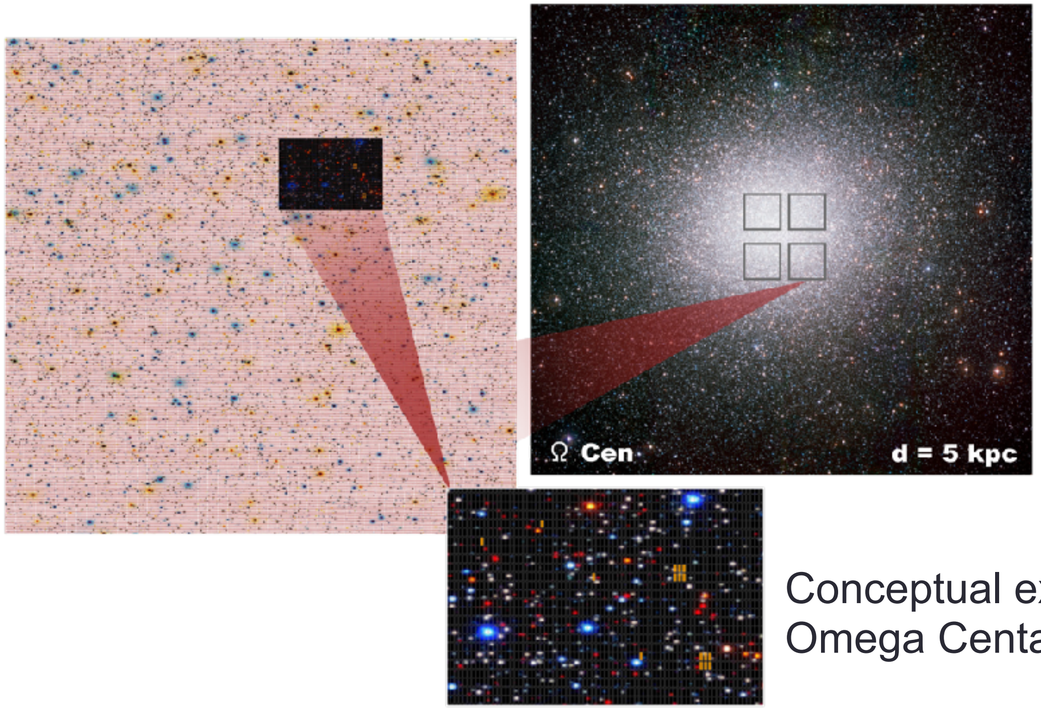
MEMS device – 105x204 micron shutters



We have > 85-90 % of the shutters operable.

NIRSPEC: MICROSHUTTER ARRAY (MSA)

- An unusual MOS: a regular grid of apertures.
  - Finding the best combination of pointing parameters (RA, DEC, PA) AND the best list of targets.
  - A dedicated tool has been developed for the preparation of the observations.



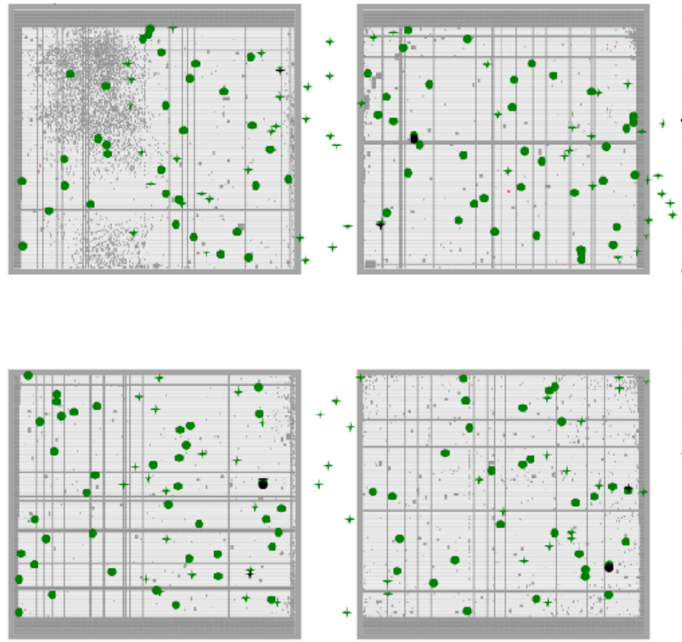
Conceptual example on a very crowded field! Omega Centauri.

http://www.stsci.edu/jwst/science/sodrm/highlightSpecDenseStellarFields.pdf

NIRSPEC: MICROSHUTTER ARRAY (MSA)

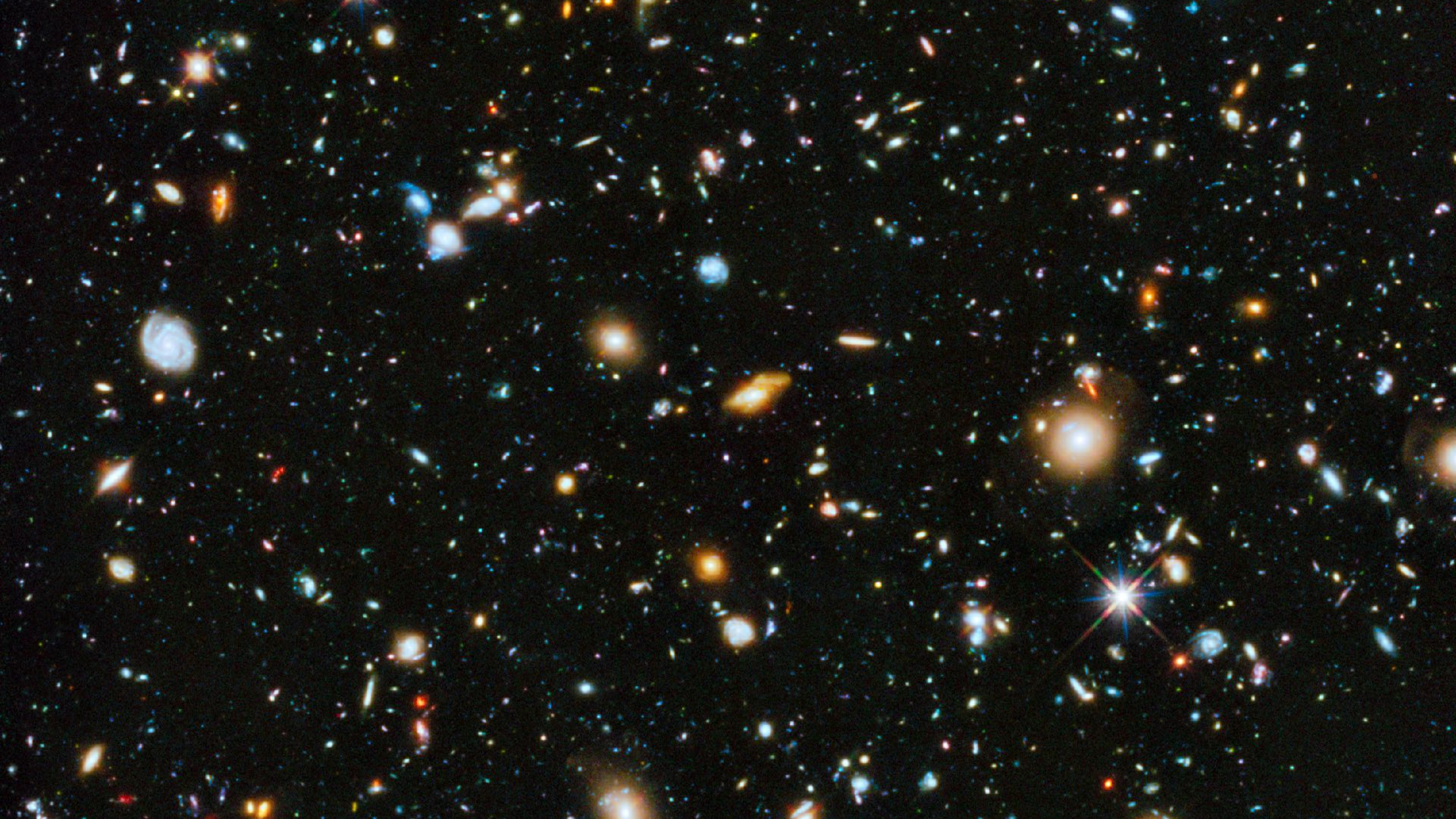
- Conceptual example on deep-field type of observation (tiled-version of a XDF drop-out catalog)
  -

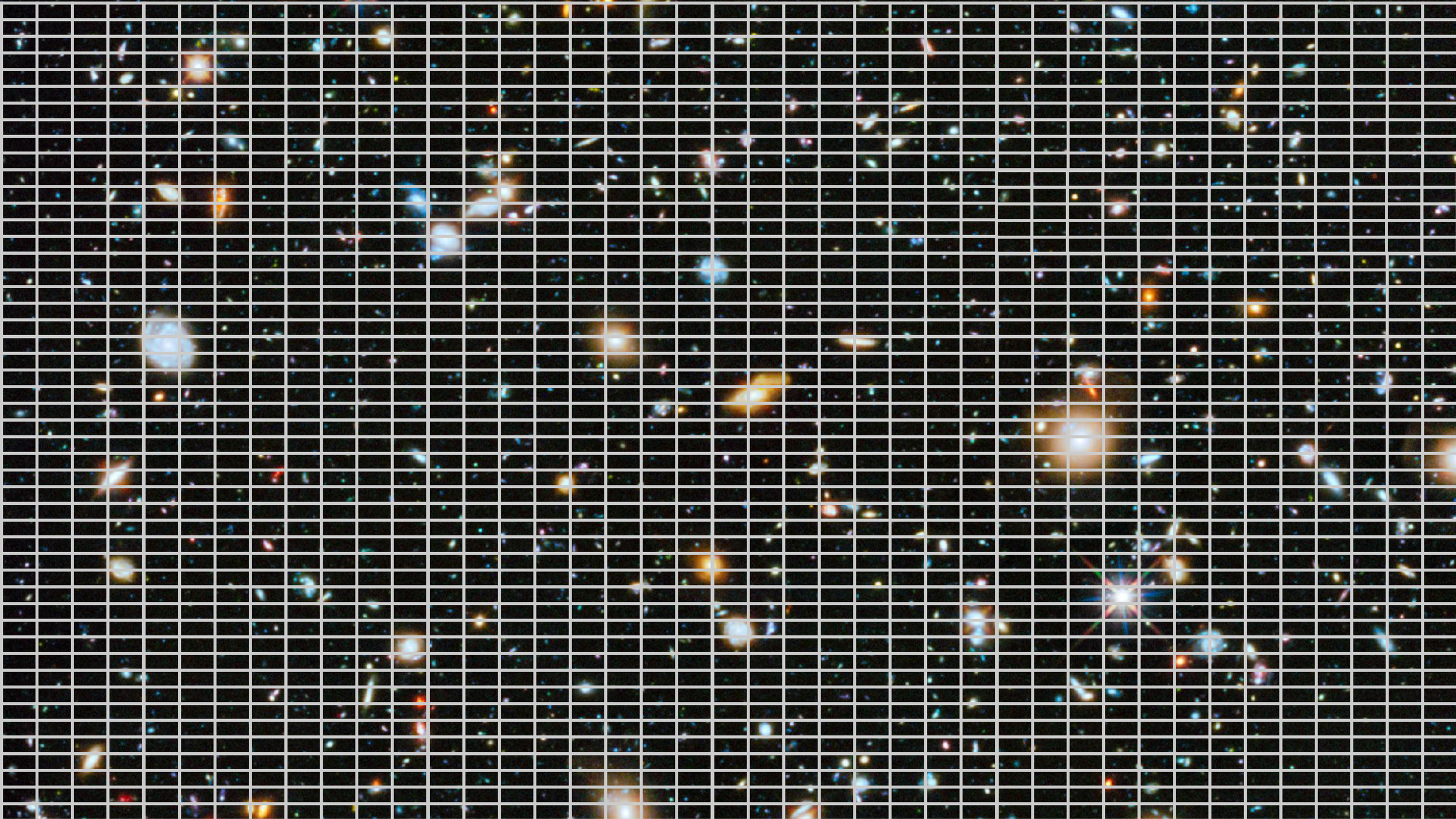
Objects assigned to a microslit
Objects not assigned

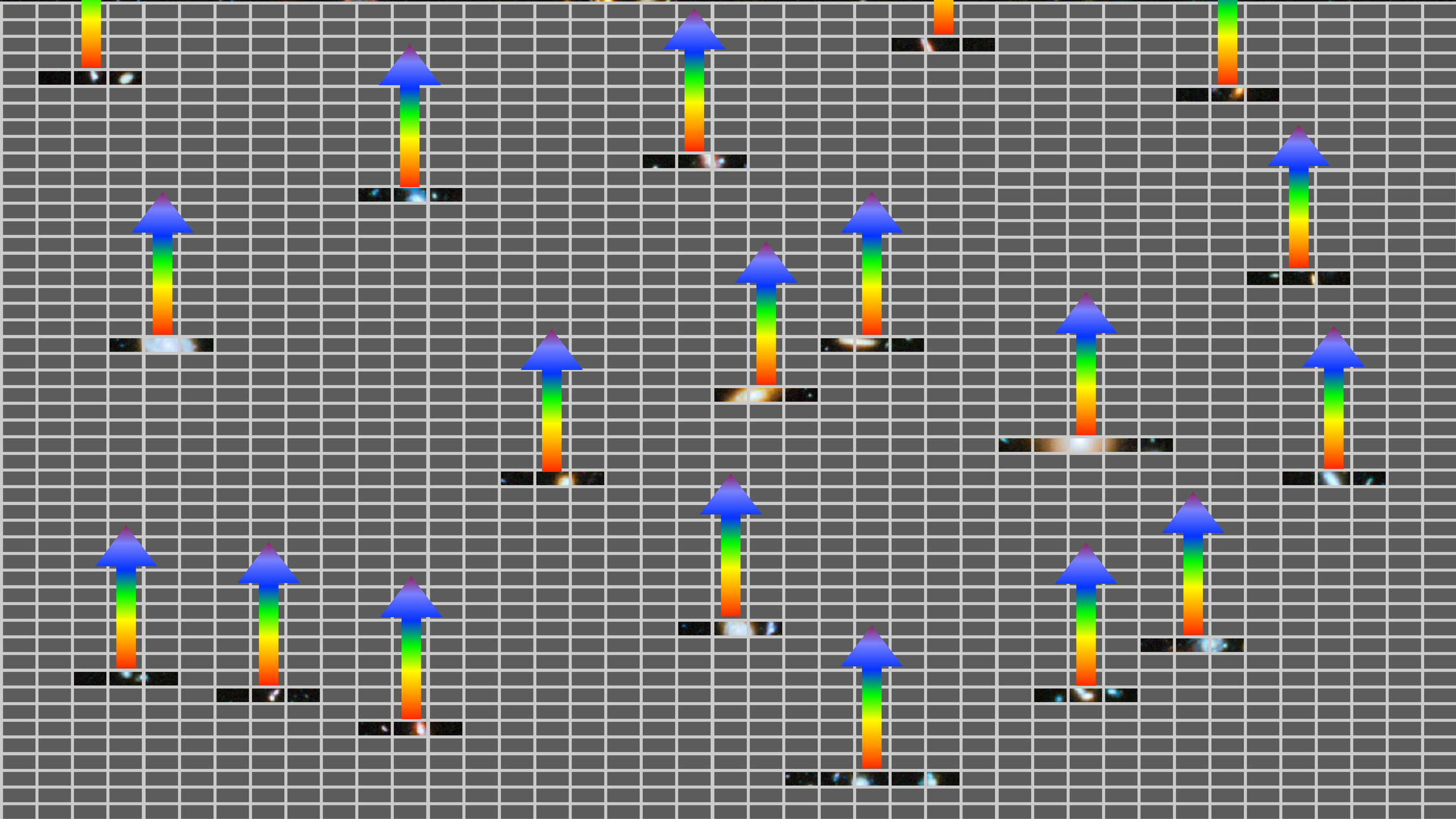


Fake observation prepared using the MOS preparation tool (**MPT**) available as part of the HST/JWST proposal preparation suite.

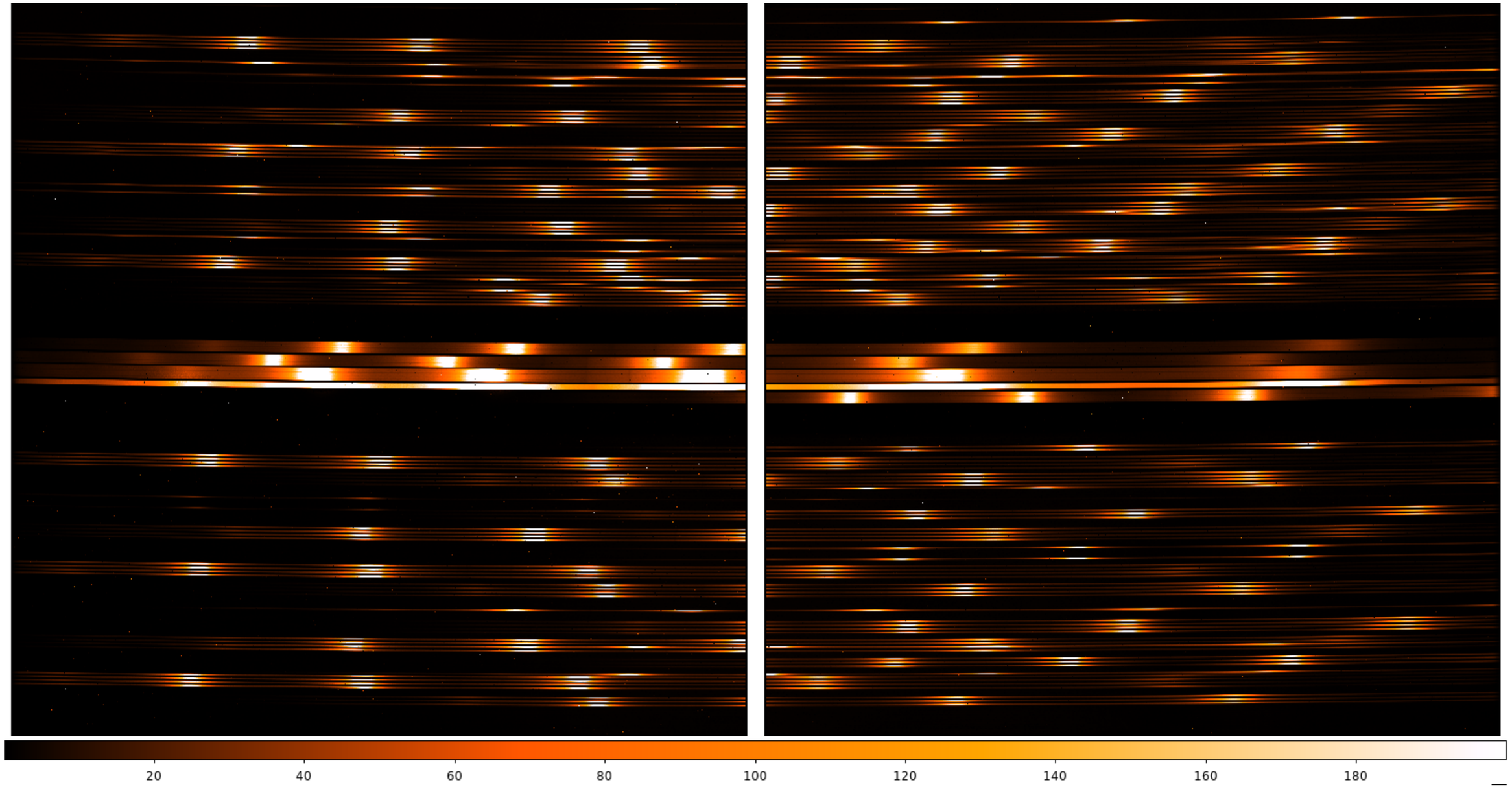
PAs will not be known far in advance of observations!



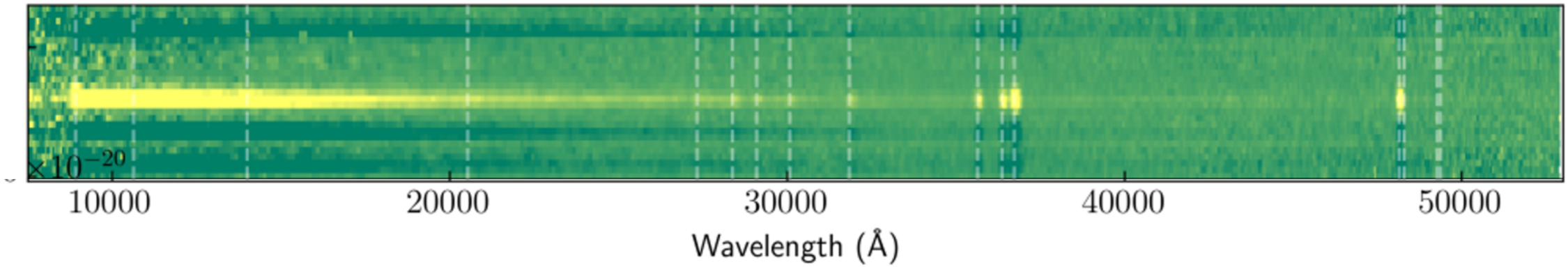




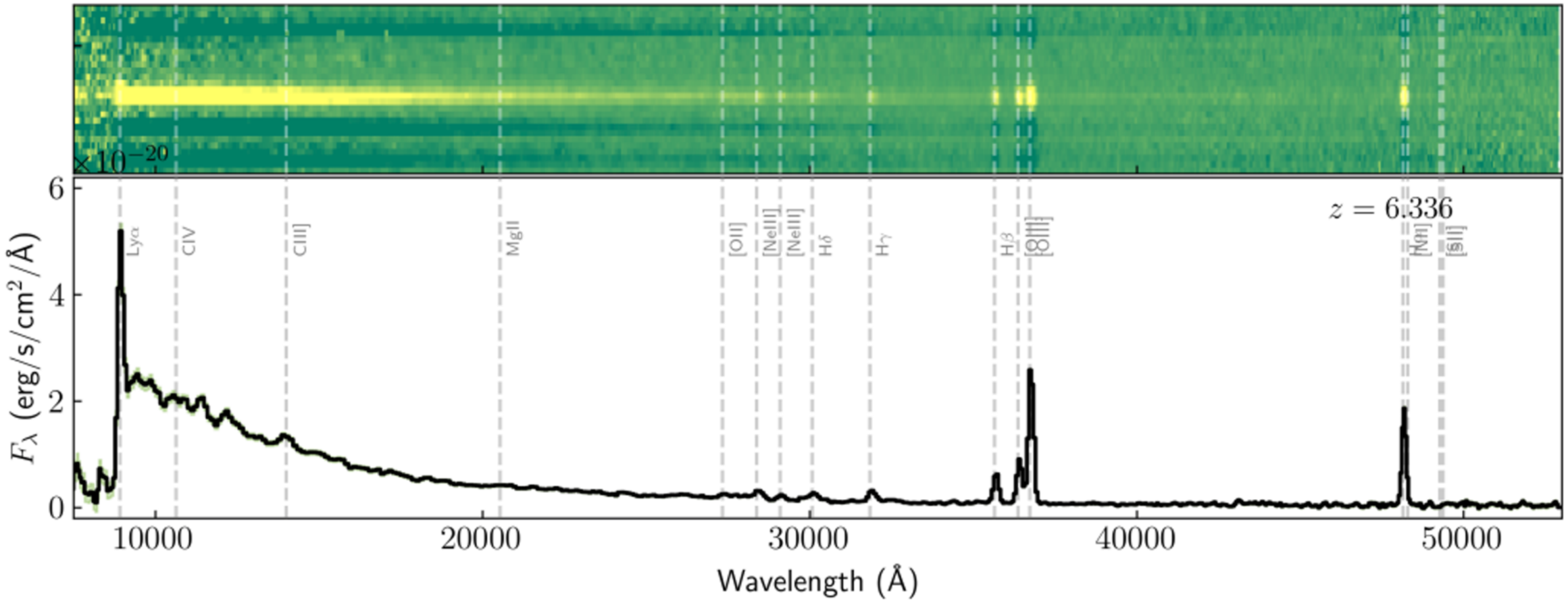
Spectra as they appear on the detector



Spectra after they have been processed

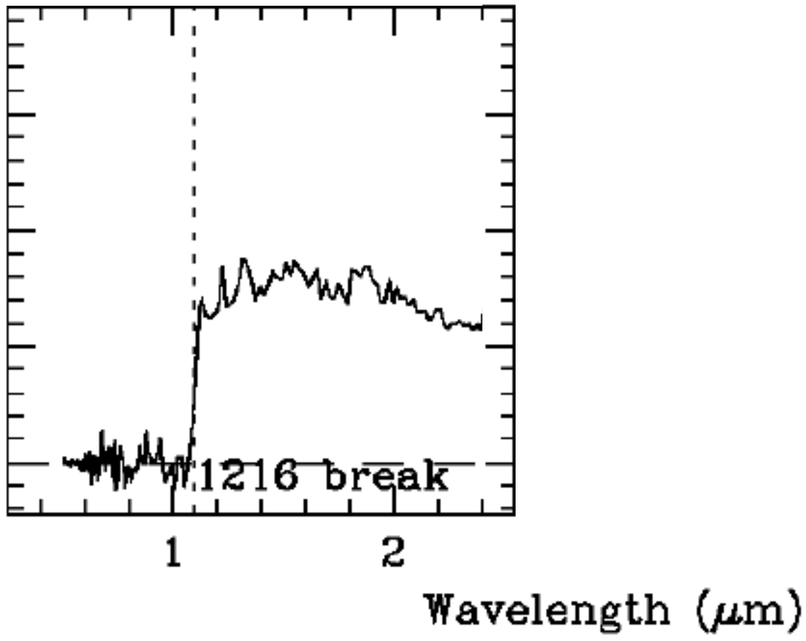


Spectra after they have been processed

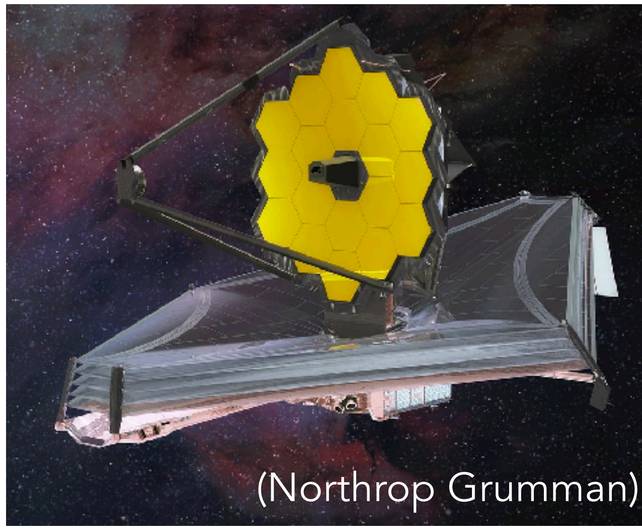


Before JWST, we could not get restframe-optical emission lines


(ESO)

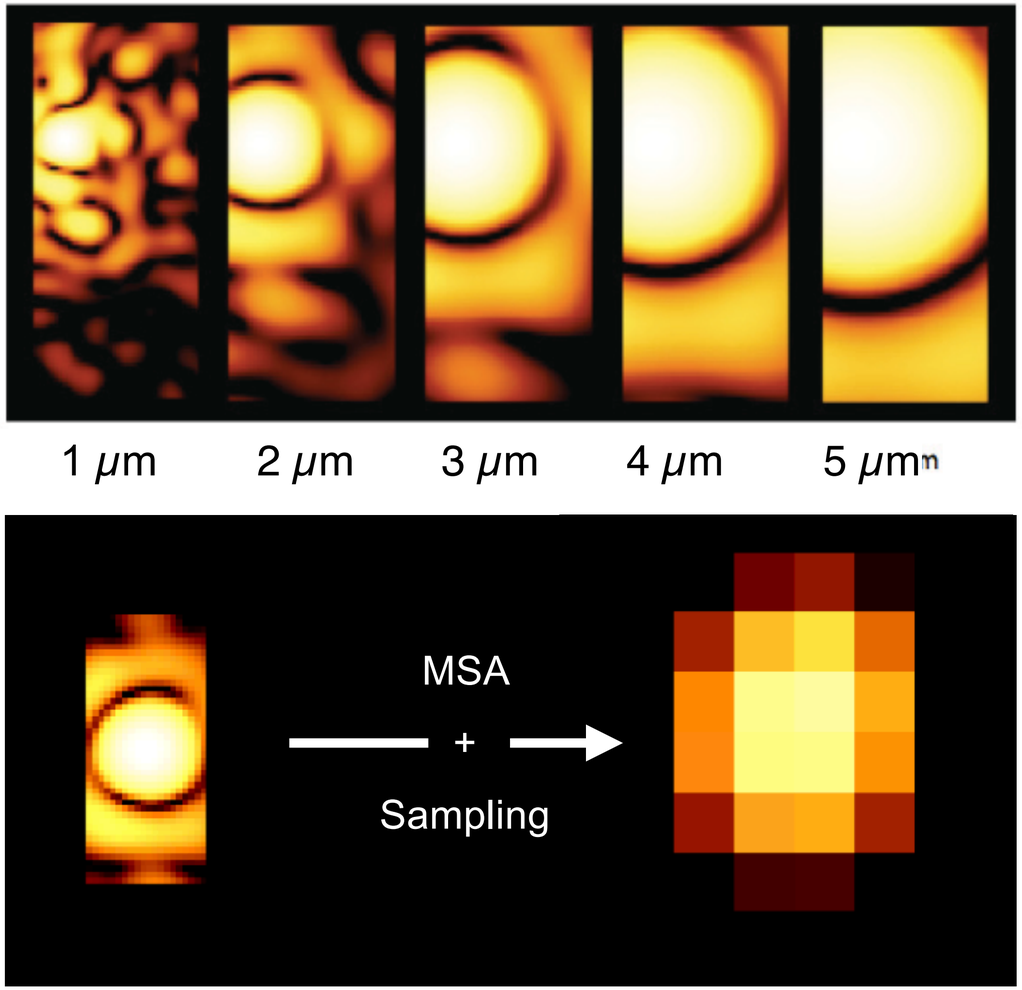


z = 8 galaxy


(Northrop Grumman)

NIRSPEC: MICROSHUTTER ARRAY (MSA)

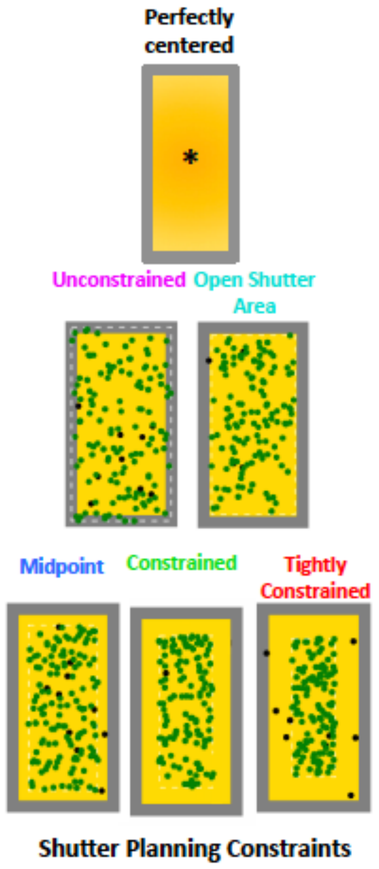
- The PSF varies strongly as a function of wavelength, but the shutters are fixed in size

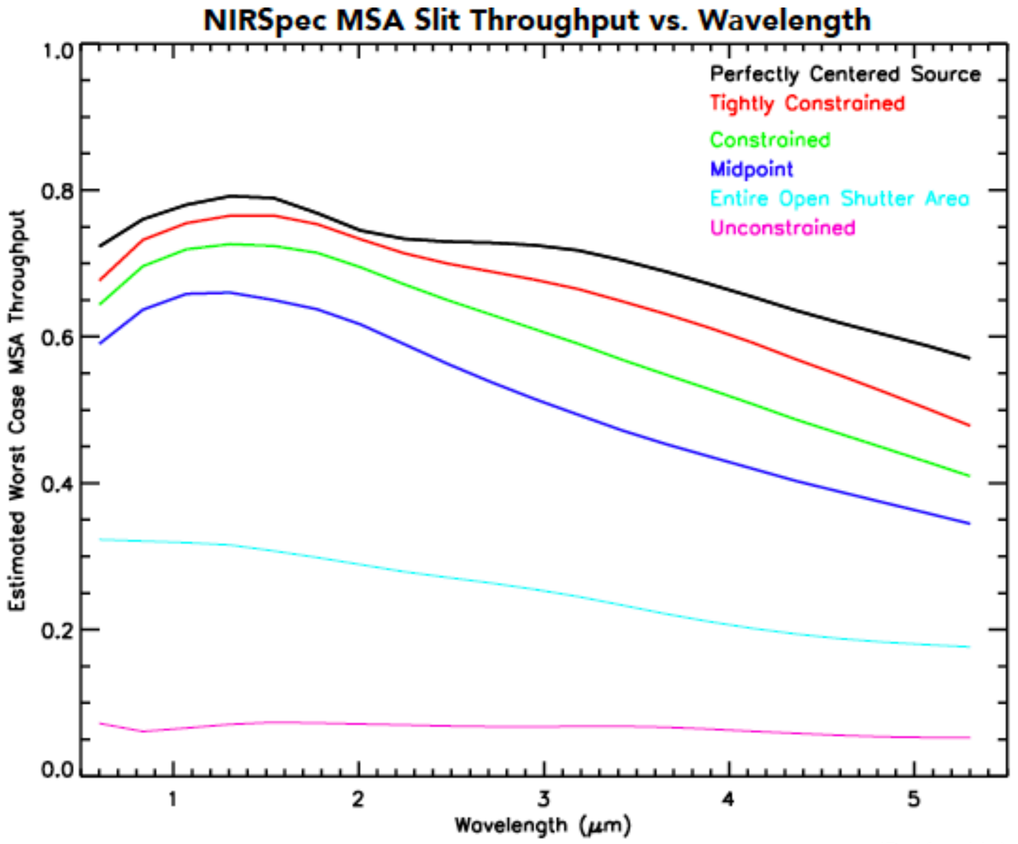


(P. Jakobsen)

NIRSPEC: MICROSHUTTER ARRAY (MSA)

- Point source throughputs
- Strongly constrained position within shutter makes slit assignment harder





(D. Karakla)