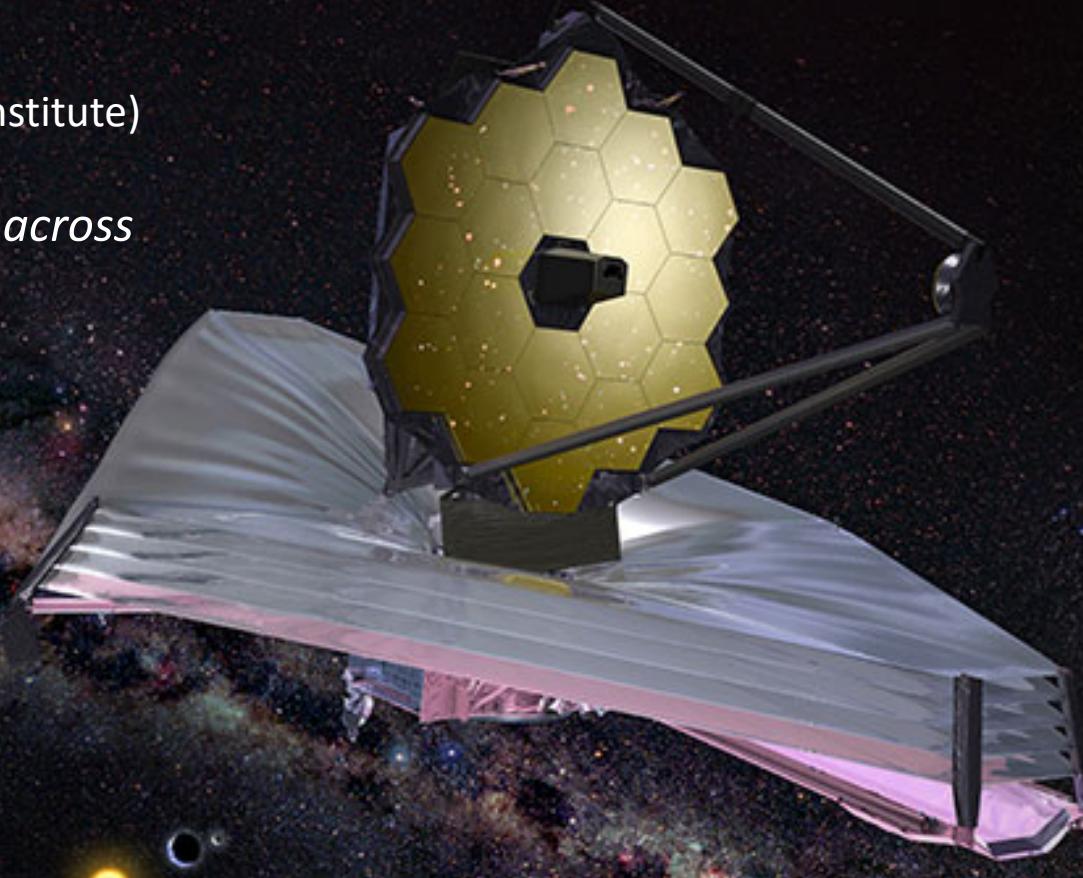


JWST Instrument Capabilities

Tea Temim

(Space Telescope Science Institute)

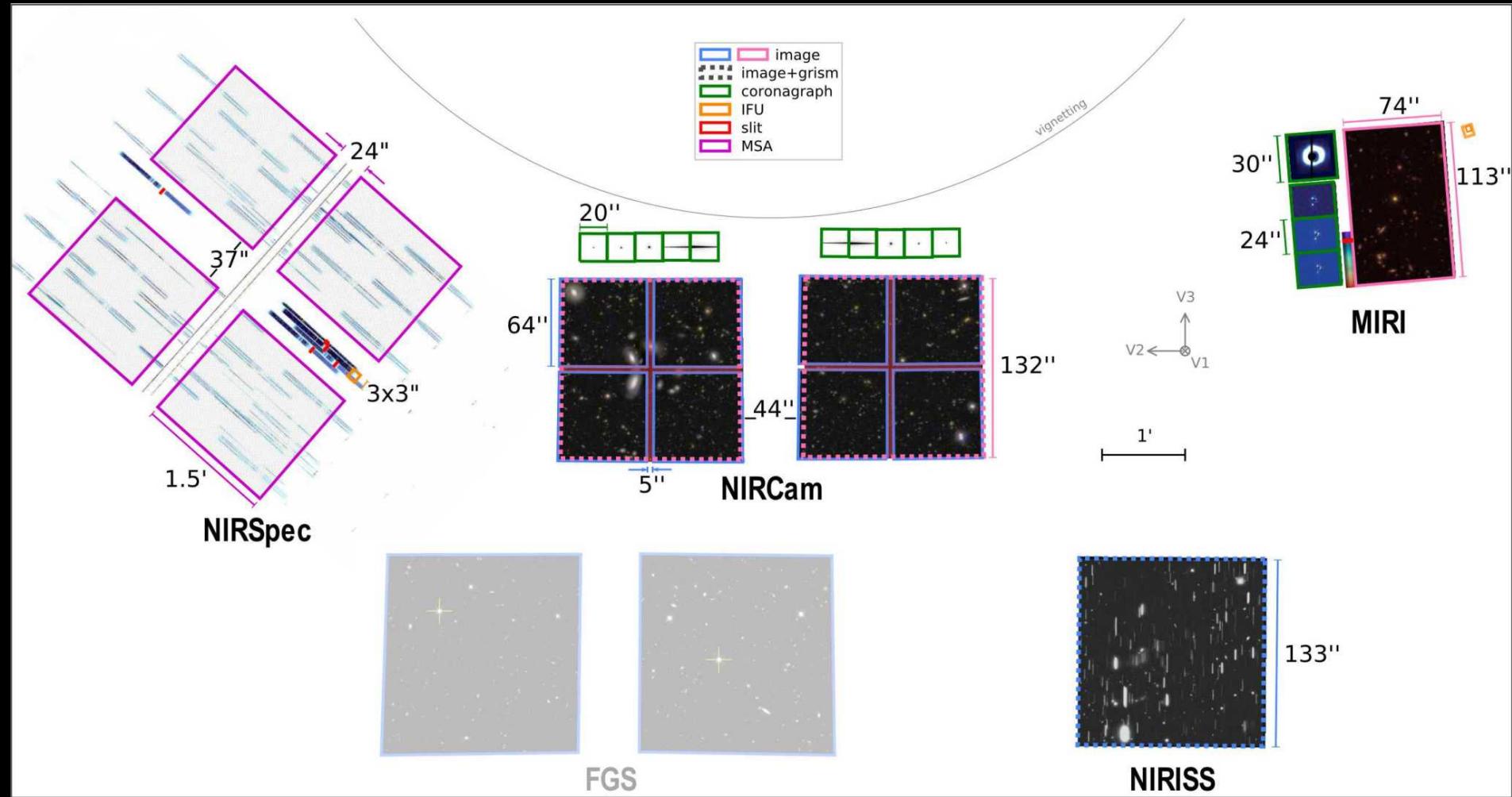
*Based on work by many across
the JWST project*



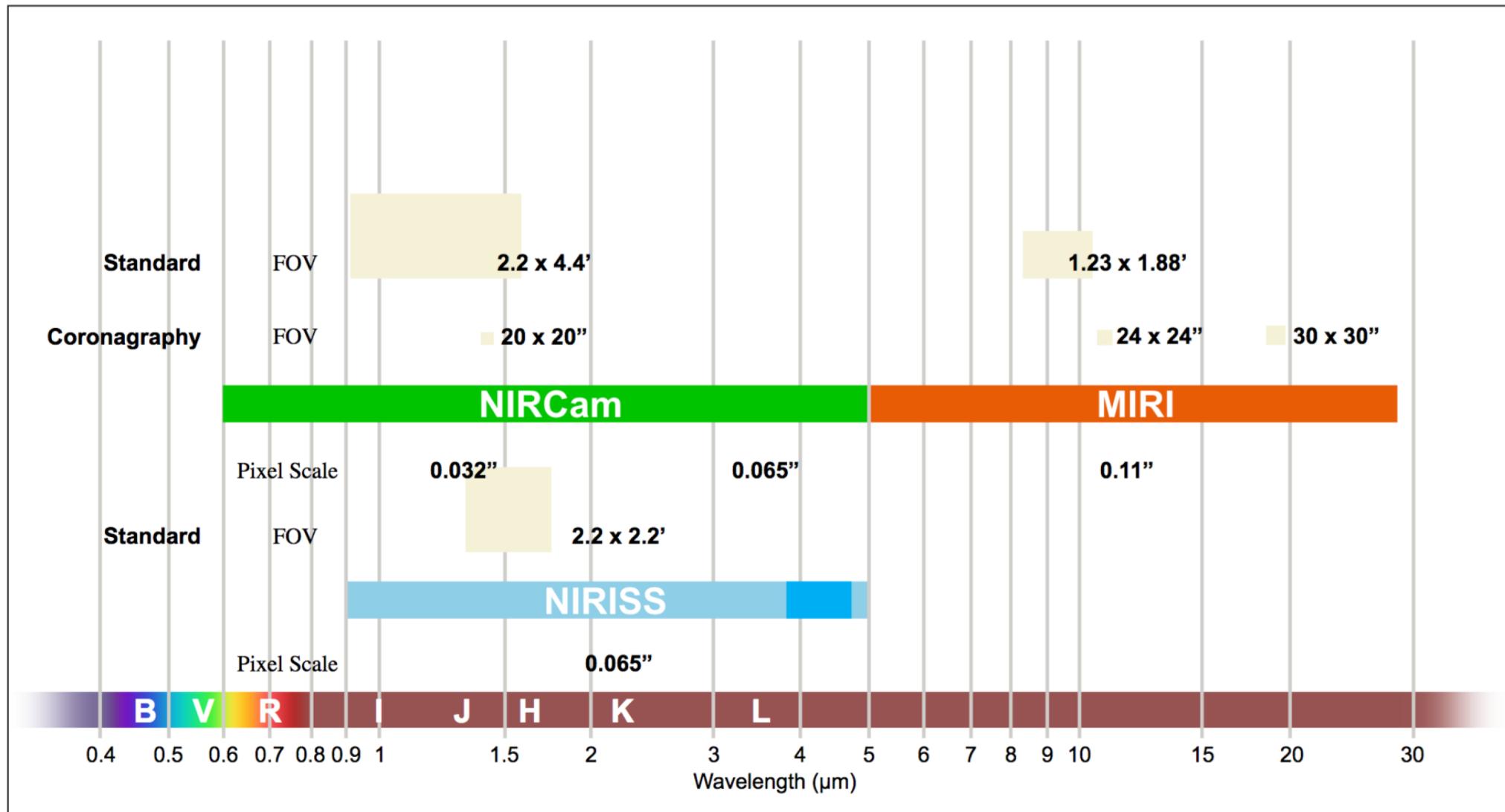
March 27 2018: Based on recommendations made by the JWST Standing Review Board, NASA is re-scheduling JWST's launch window for 2020. Given those circumstances, **STScI will delay the Cycle 1 GO/AR proposal deadline until no earlier than February 1 2019.**

A revised proposal schedule will be developed in consultation with the JWST Users Committee, the JWST Project and representatives from the European and Canadian Space Agencies. Proposals already submitted in response to the Cycle 1 Call will not be carried over and will need to be resubmitted.

Instruments in the JWST Focal Plane



Wavelength Coverage: Imaging

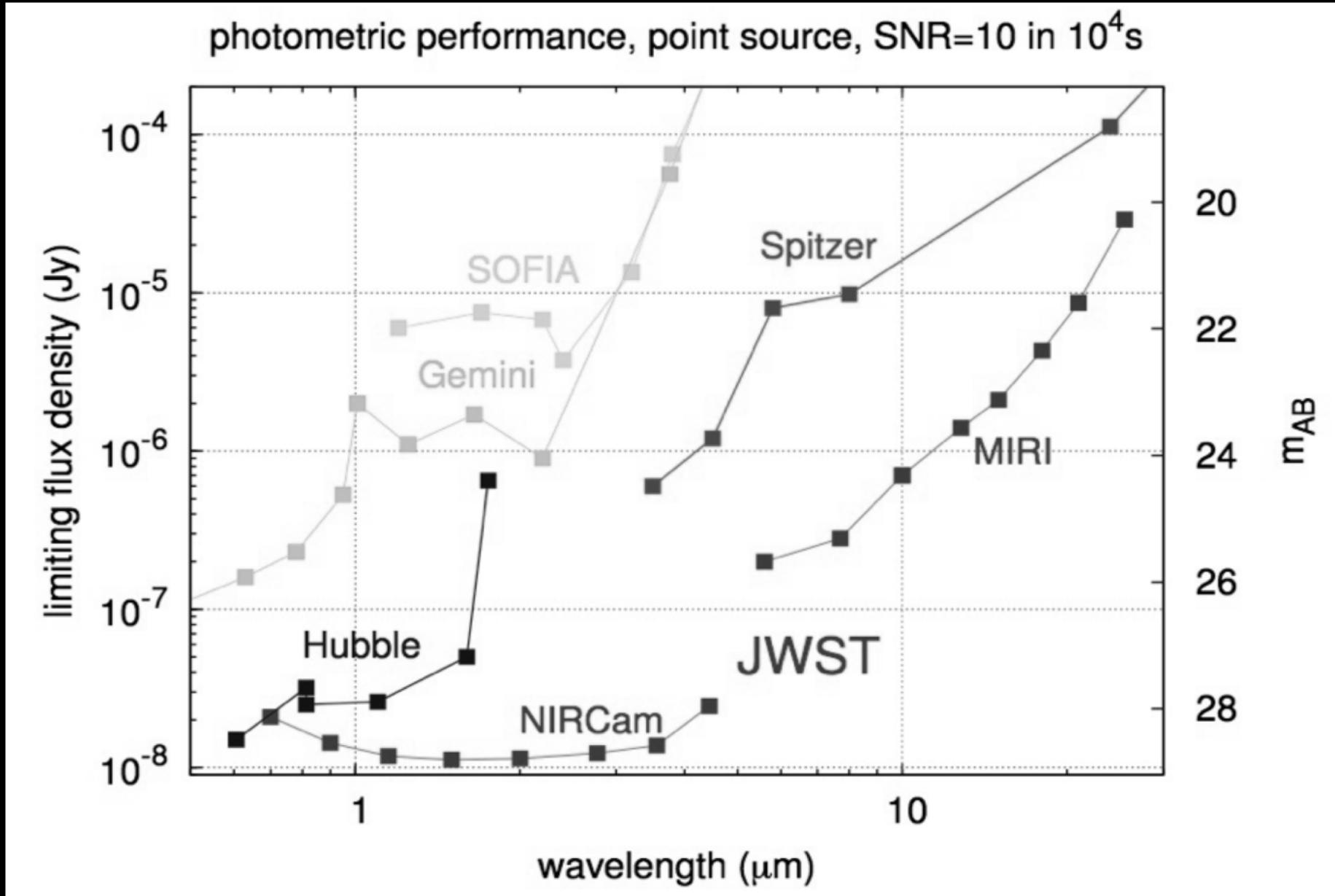


From G. Kriss

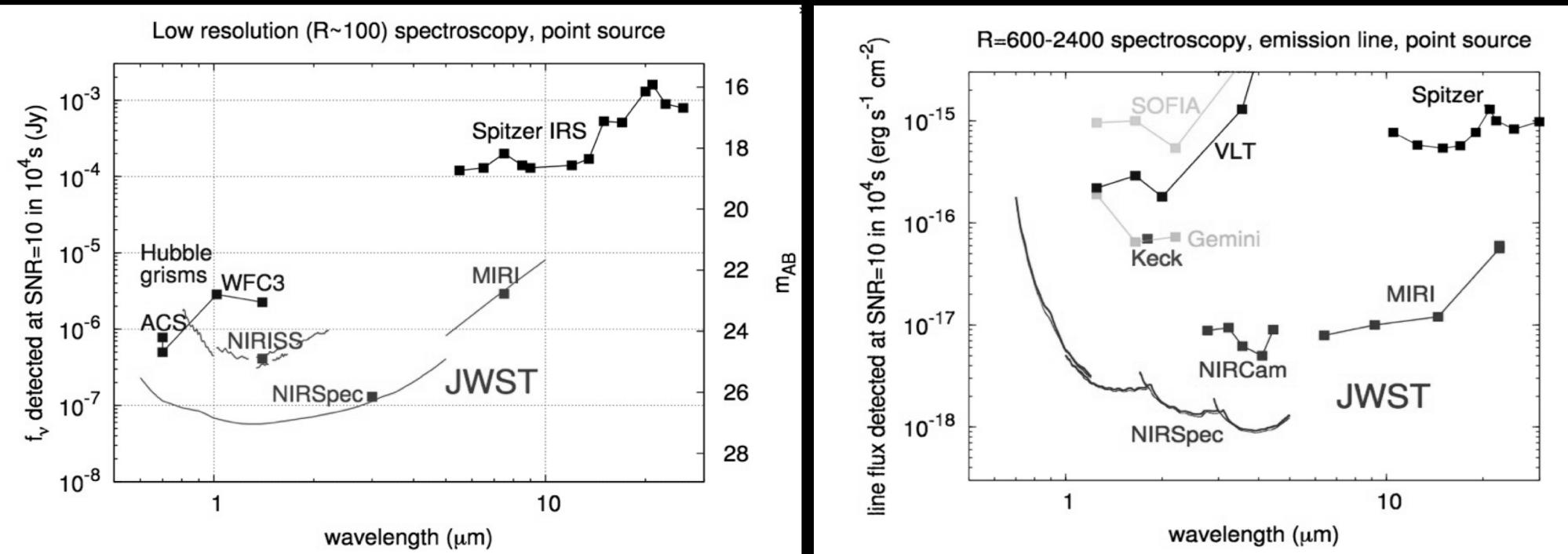
JWST Spectroscopy Modes

Instrument	Single Object Fixed Slit	Single Object Slitless	Integral Field Unit	Wide Field Slitless	Multi Object
NIRCam		R~2000 λ : 2.4–5 μ m		R~2000 λ : 2.4–5 μ m	
NIRISS		R~700 λ : 0.6–2.5 μ m		R~150 λ : 1–2.5 μ m	
NIRSpec	R~100, 1000, 2700 λ : 0.6–5 μ m		IFU R~100, 1000, 2700 λ : 0.6–5 μ m FOV: 3.0" x 3.0"		MSA R~100, 1000, 2700 λ : 0.6–5 μ m
MIRI	LRS R~100 λ : 5–12 μ m	LRS-Slitless R~100 λ : 5–12 μ m	MRS R~3000 λ : 5–28 μ m FOV: 3.0" x 3.9" - 6.7" x 7.7"		

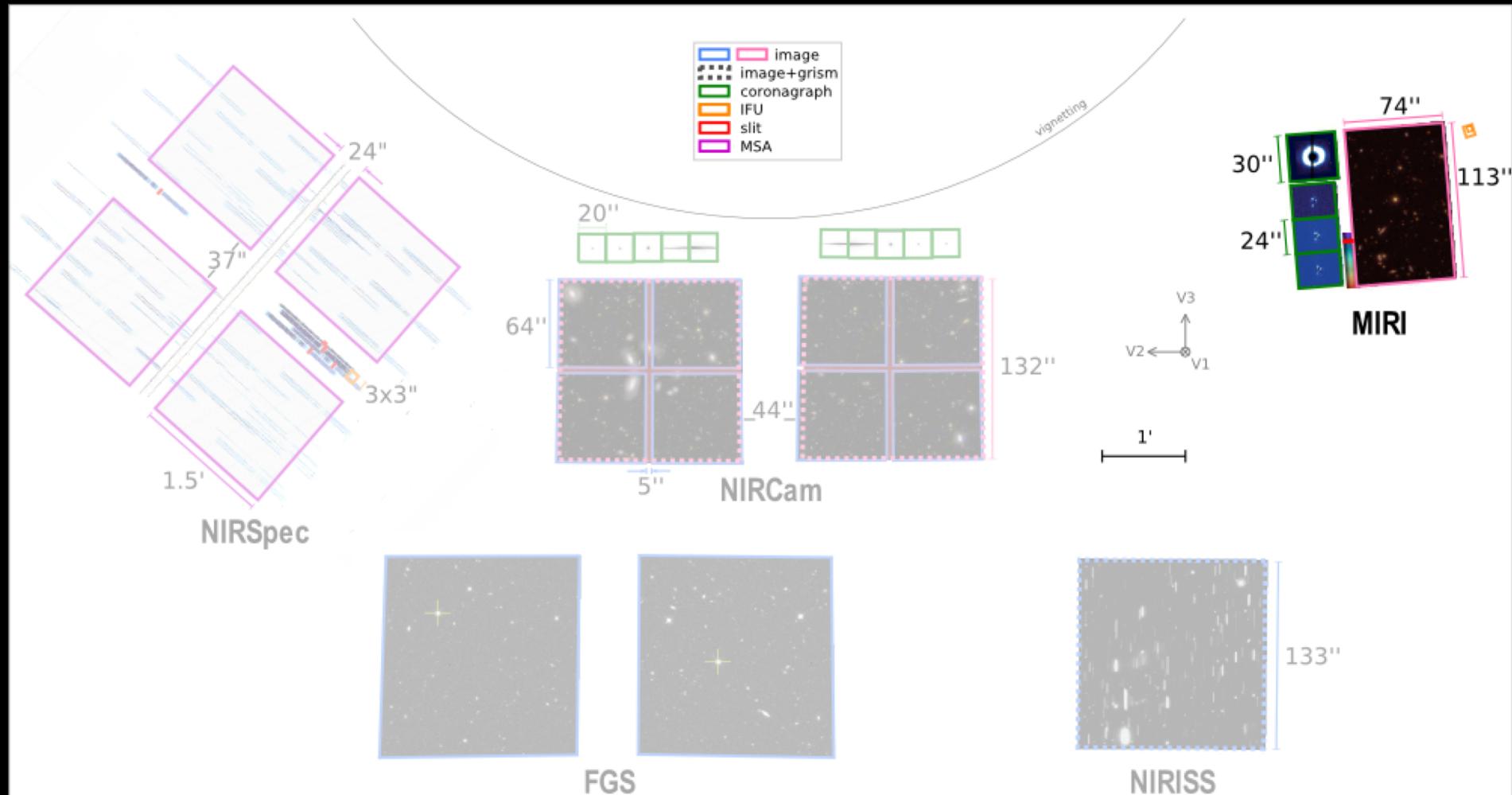
Sensitivity



Sensitivity



Mid-Infrared Instrument (MIRI)



Wavelength range: 5 - 28 μm

50 times more sensitive than *Spitzer*

Sub-arcsec resolution

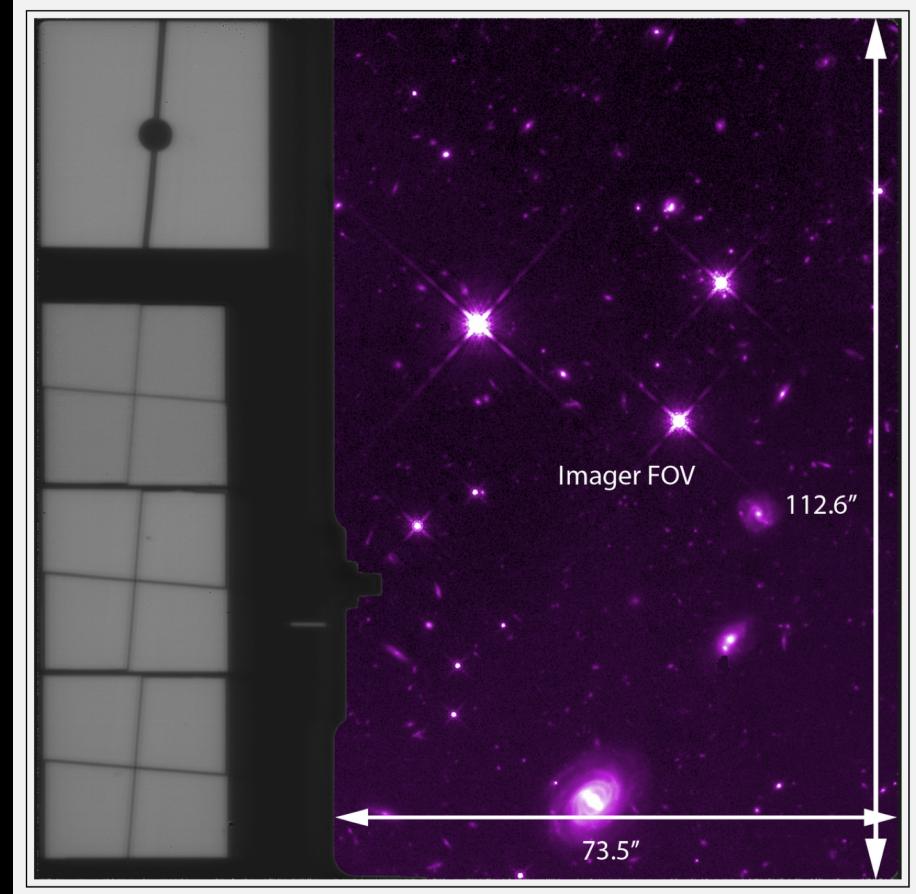
Observing modes:

- Imaging
- Coronagraphs
- Low Resolution Spectrometer
- Medium Resolution Spectrometer

MIRI Imager

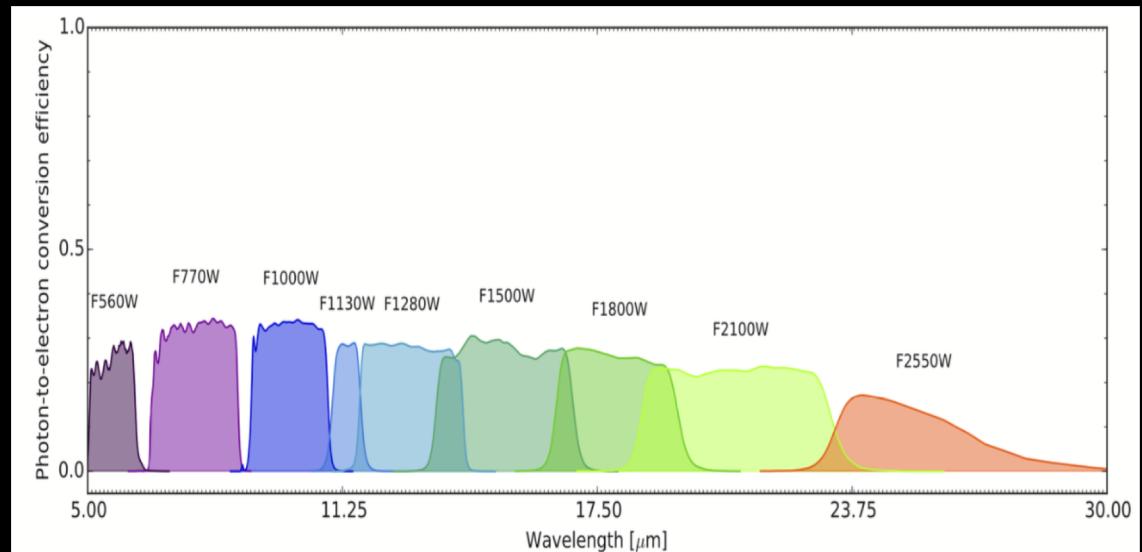
Imaging

- FOV: $74'' \times 113''$
- Plate scale: $0.11''/\text{pix}$
- 9 broad filters from 5.6 to $25.5 \mu\text{m}$
- PSF: $0.22''$ - $0.82''$
- Subarrays
 - BRIGHTSKY
 - SUB256
 - SUB128
 - SUB64



Coronagraphy

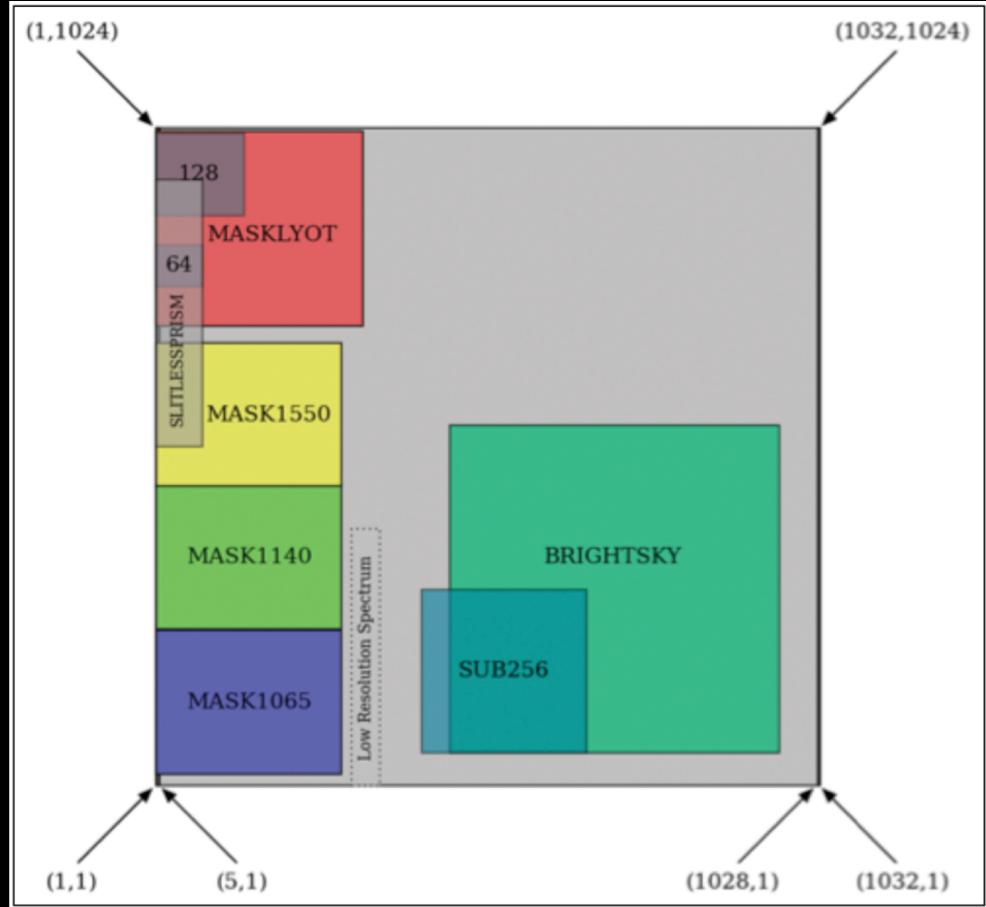
- 3 4QPM (no central spot)
 10.65 , 11.4 , & $15.5 \mu\text{m}$
- 1 Lyot (central spot) $23 \mu\text{m}$



MIRI Imager

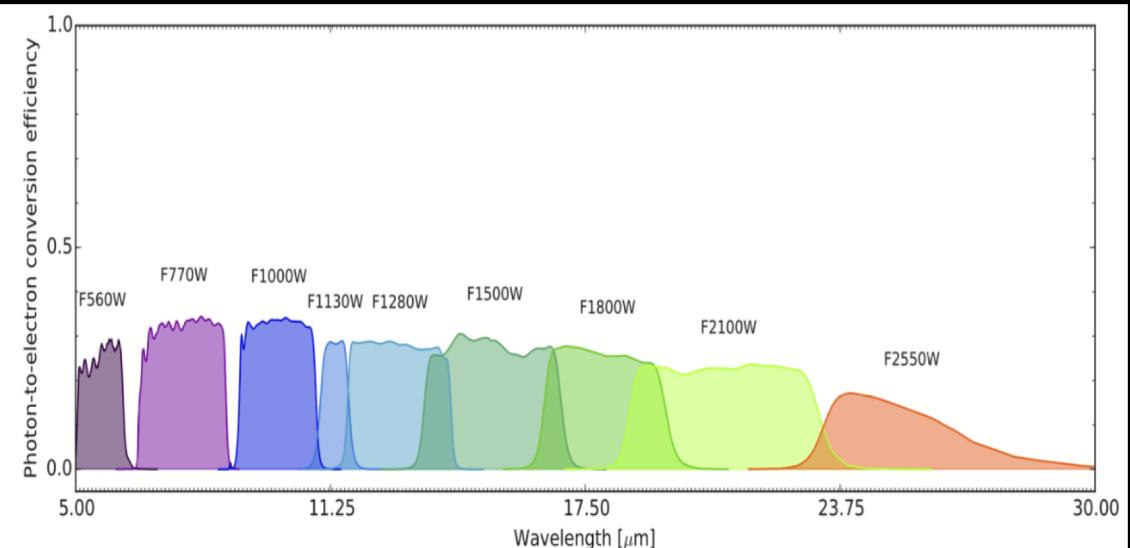
Imaging

- FOV: $74'' \times 113''$
- Plate scale: $0.11''/\text{pix}$
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- PSF: $0.22''$ - $0.82''$
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 - BRIGHTSKY
 - SUB256
 - SUB128
 - SUB64



Coronagraphy

- 3 4QPM (no central spot)
 10.65 , 11.4 , & $15.5 \mu\text{m}$
- 1 Lyot (central spot) $23 \mu\text{m}$



MIRI Low Resolution Spectrometer (LRS)

Spectroscopy of compact sources from 5-12 μm

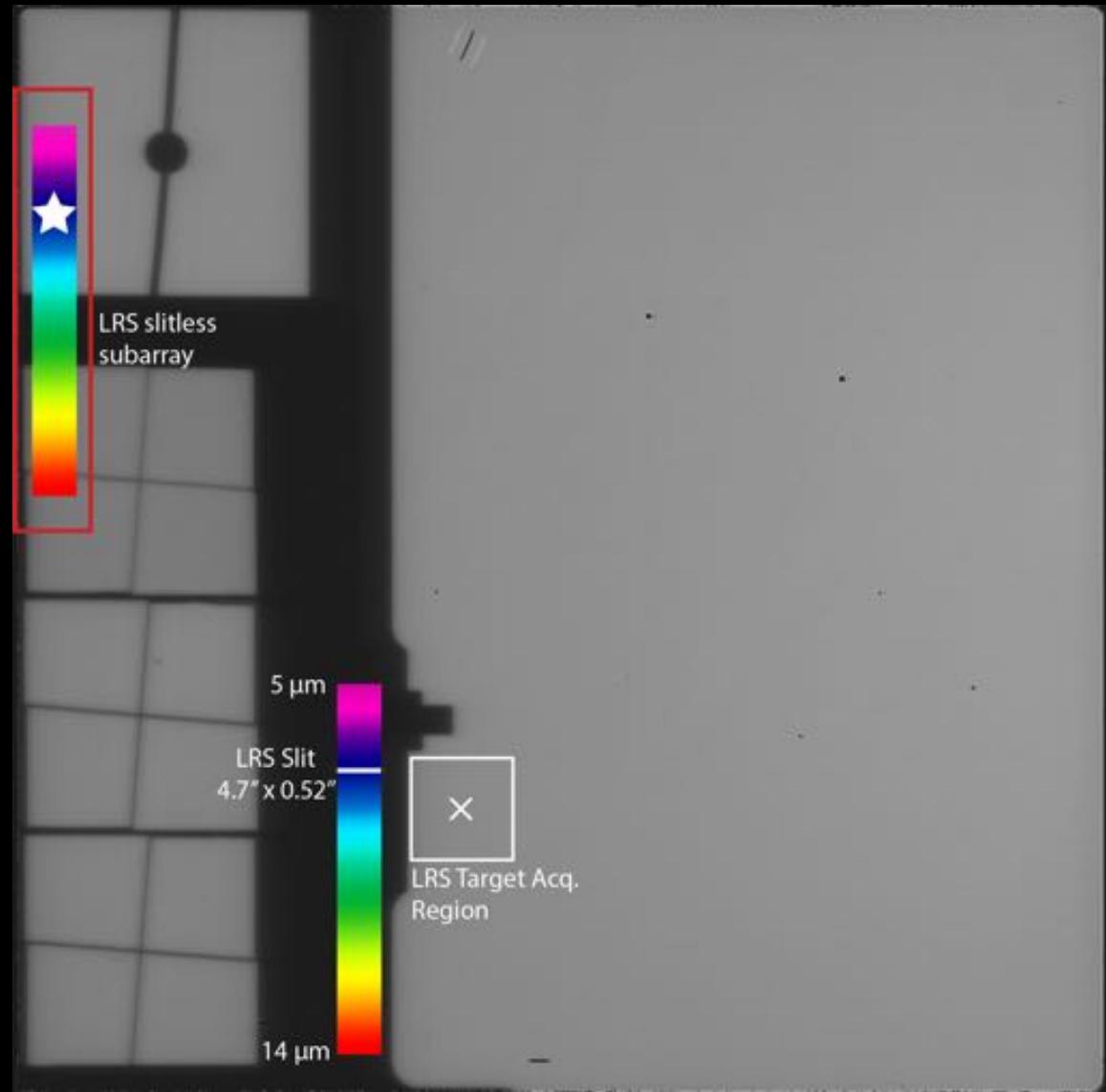
$R = 40 - 160$

Operated with $4.7'' \times 0.51''$ slit

Dispersion via double prism in filter wheel

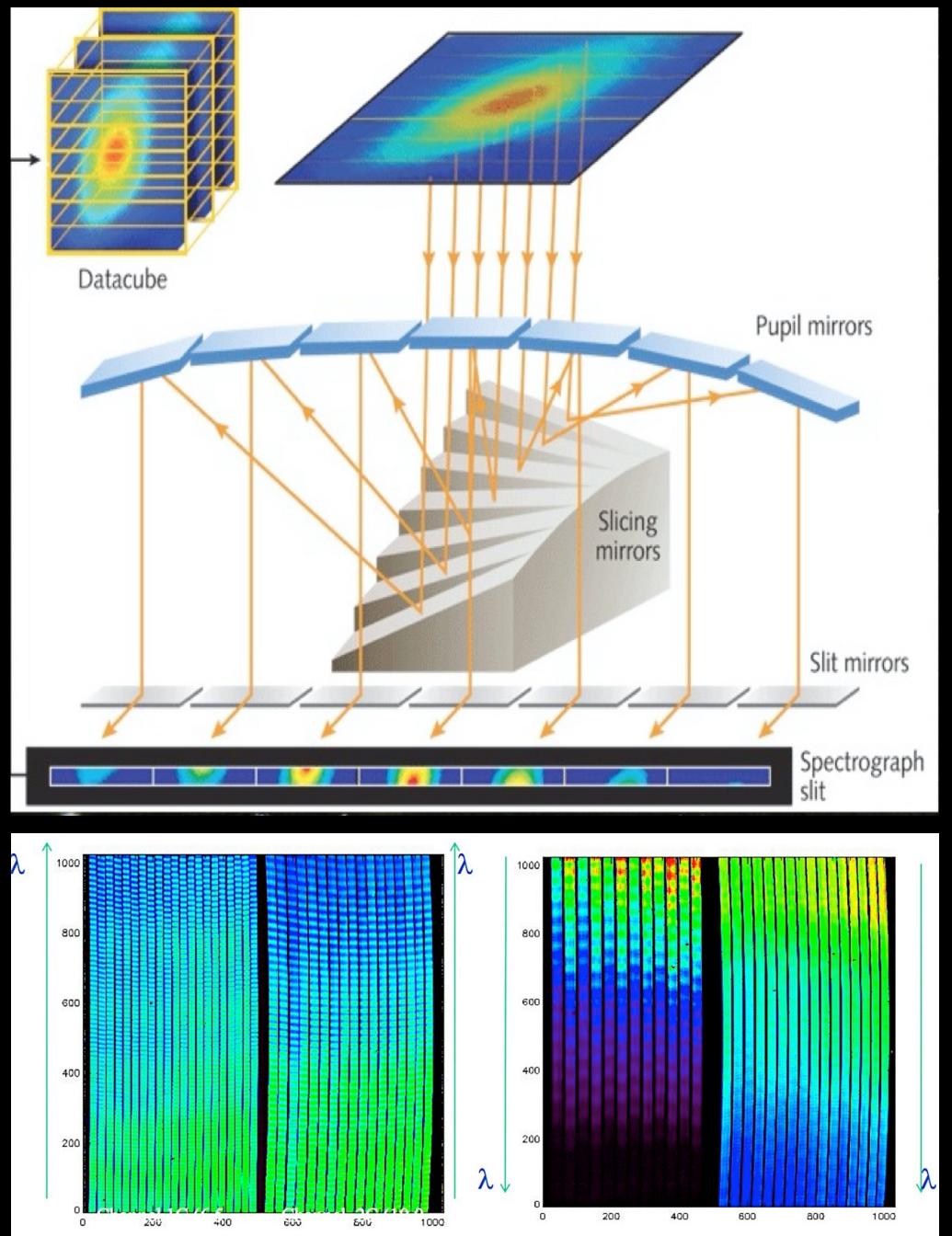
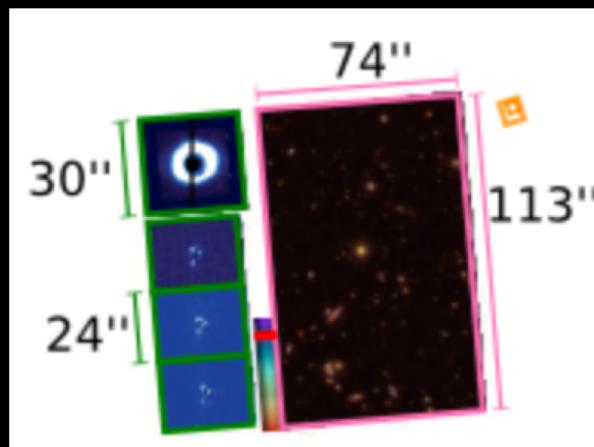
Slitless mode

- Non-dithered high precision variable source observations (e.g. transiting exoplanets)



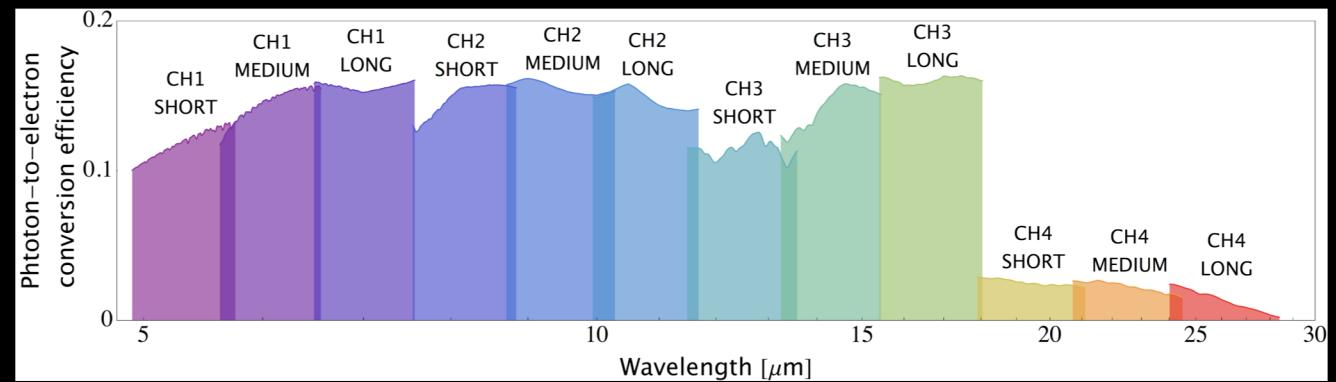
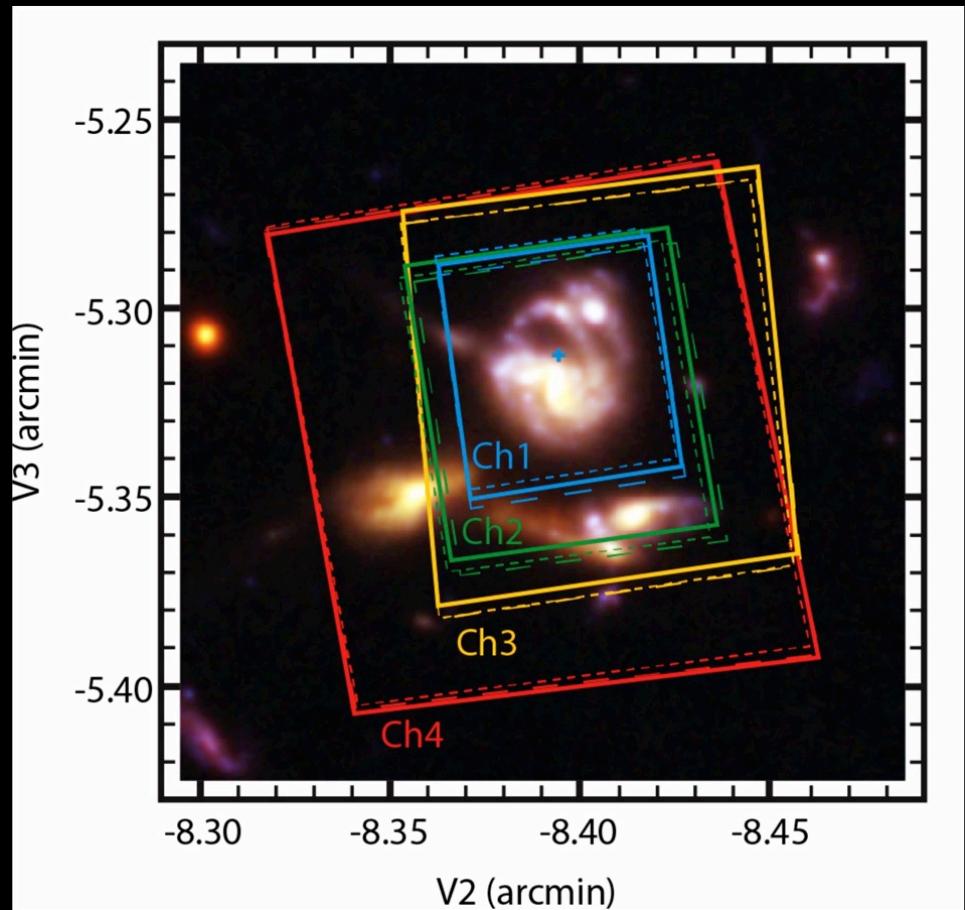
MIRI Medium Resolution Spectrometer (MRS)

- $R \sim 3000$, 4 nested IFUs (4 channels)
- $3.44'' \times 3.64''$ to $7.7'' \times 8.0''$ FOVs
- 2 detectors
- 3 grating settings to get full 5-28 μm spectra

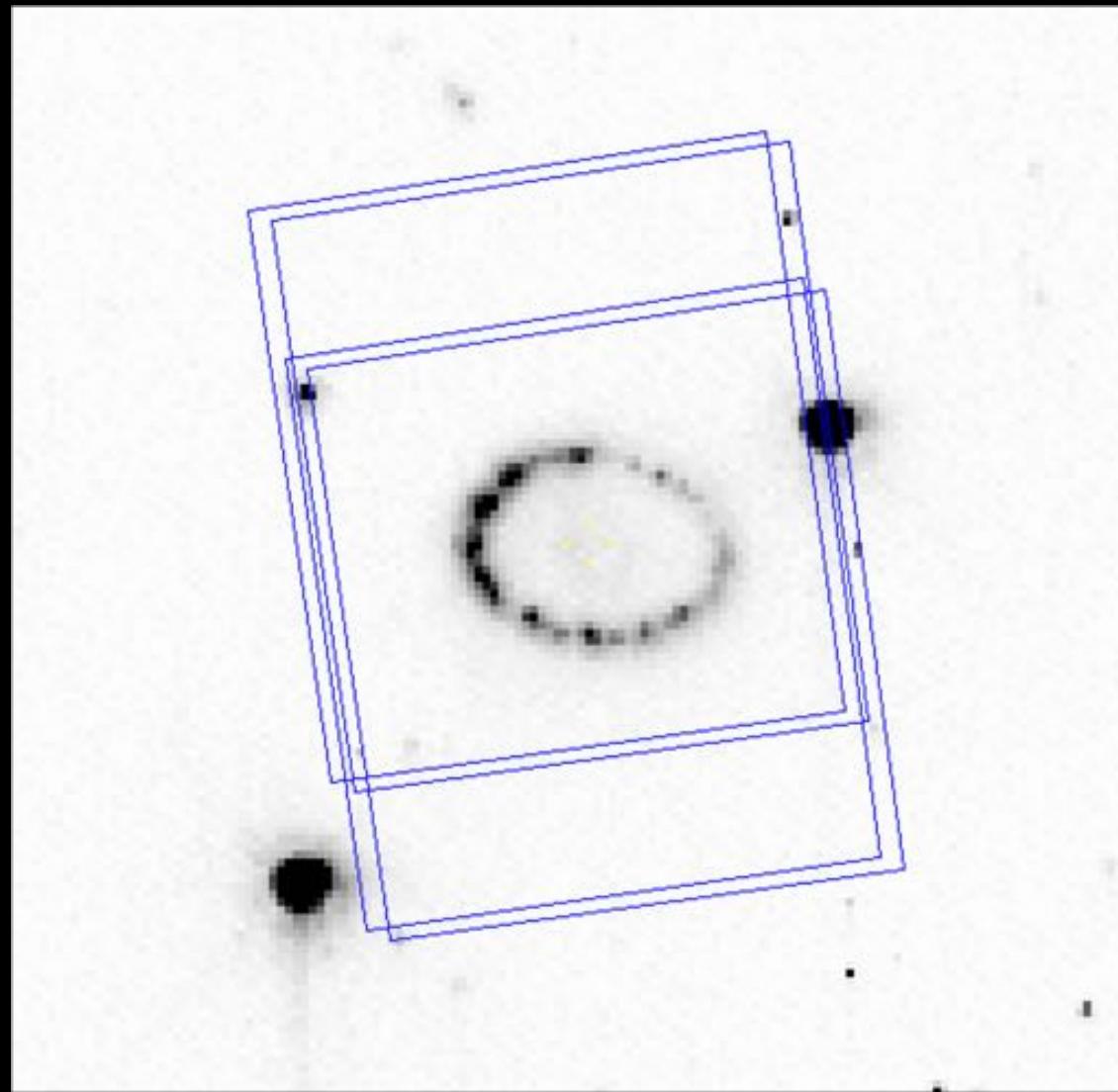


MIRI Medium Resolution Spectrometer (MRS)

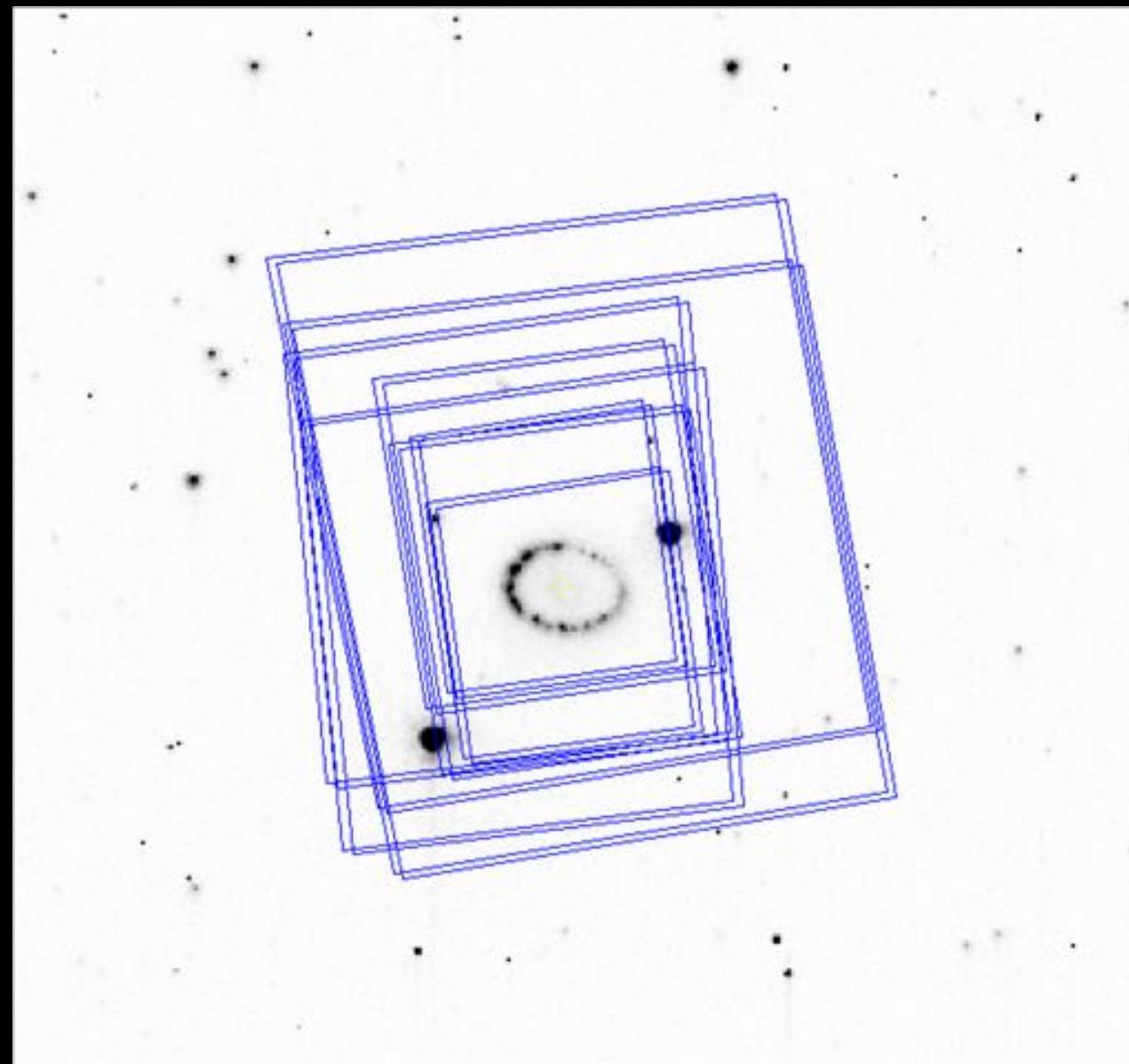
- $R \sim 3000$, 4 nested IFUs (4 channels)
- $3.44'' \times 3.64''$ to $7.7'' \times 8.0''$ FOVs
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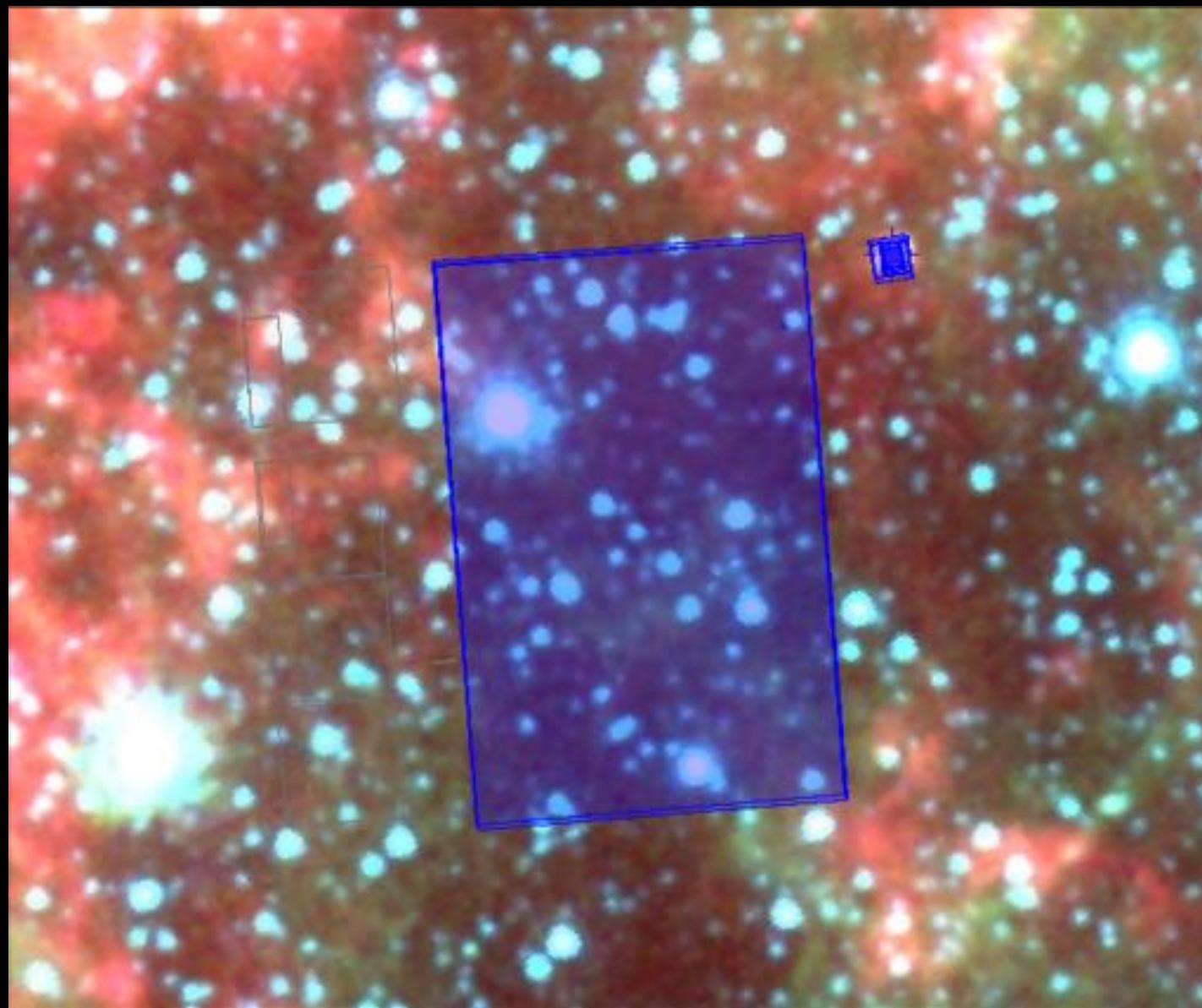
MIRI MRS Footprint



MIRI MRS Footprint



MIRI MRS: Simultaneous imaging

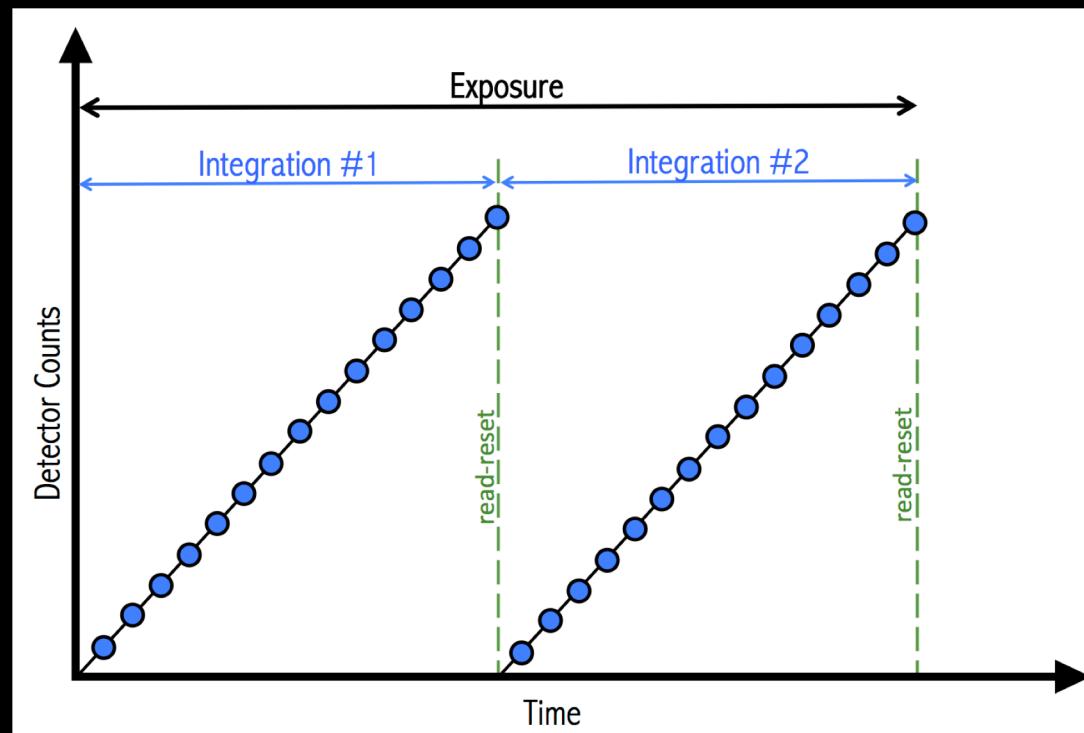


MIRI Readout Modes

Group (frame) = single downlinked detector readout of all pixels

Integration = time between detector resets, defined by the number

Exposure = time spent in a single dither position, defined by the number of groups and integrations



FAST mode

- Frame time = 2.775 s in FULL array (shorter with subarrays)
- Finer time sampling

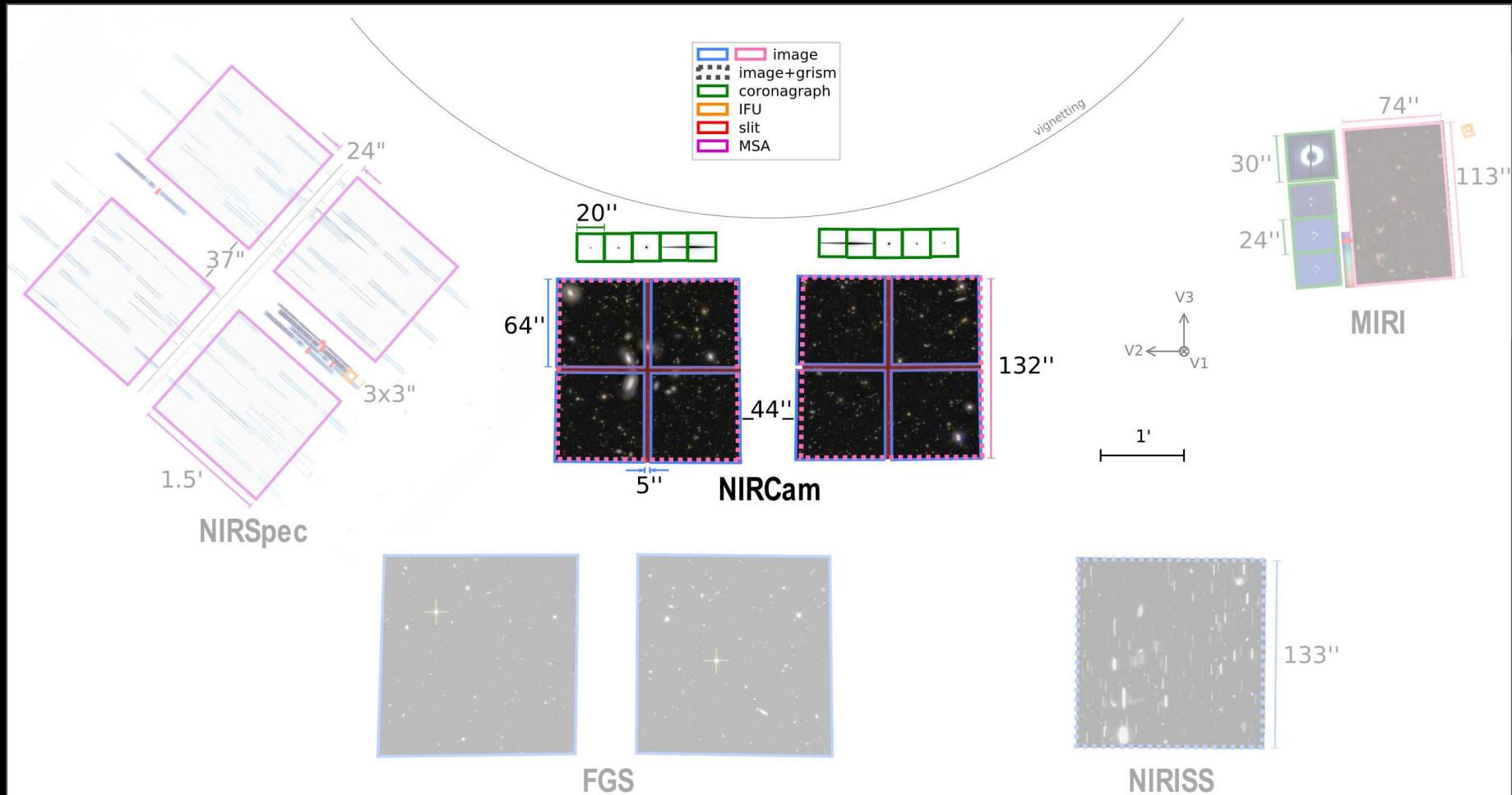
SLOW mode

- Frame time = 23.889 s
- 9 times less data volume

Considerations:

- Source/background brightness (if <10 grps in SLOW mode are needed, use FAST)
- Cosmic rays (for a 1000 s integration, 60% pixels affected)
- Data volume

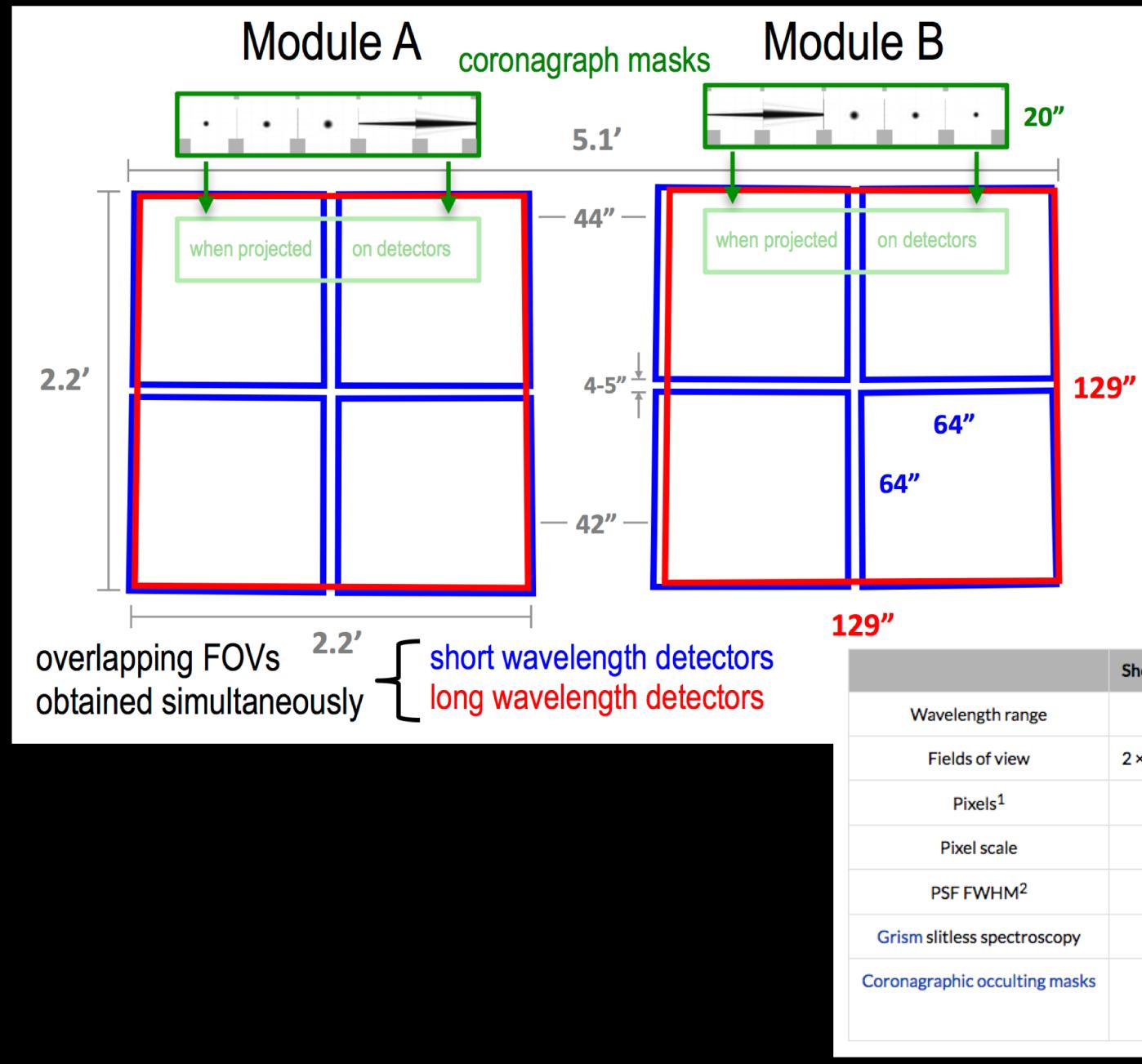
Near Infrared Camera (NIRCam)



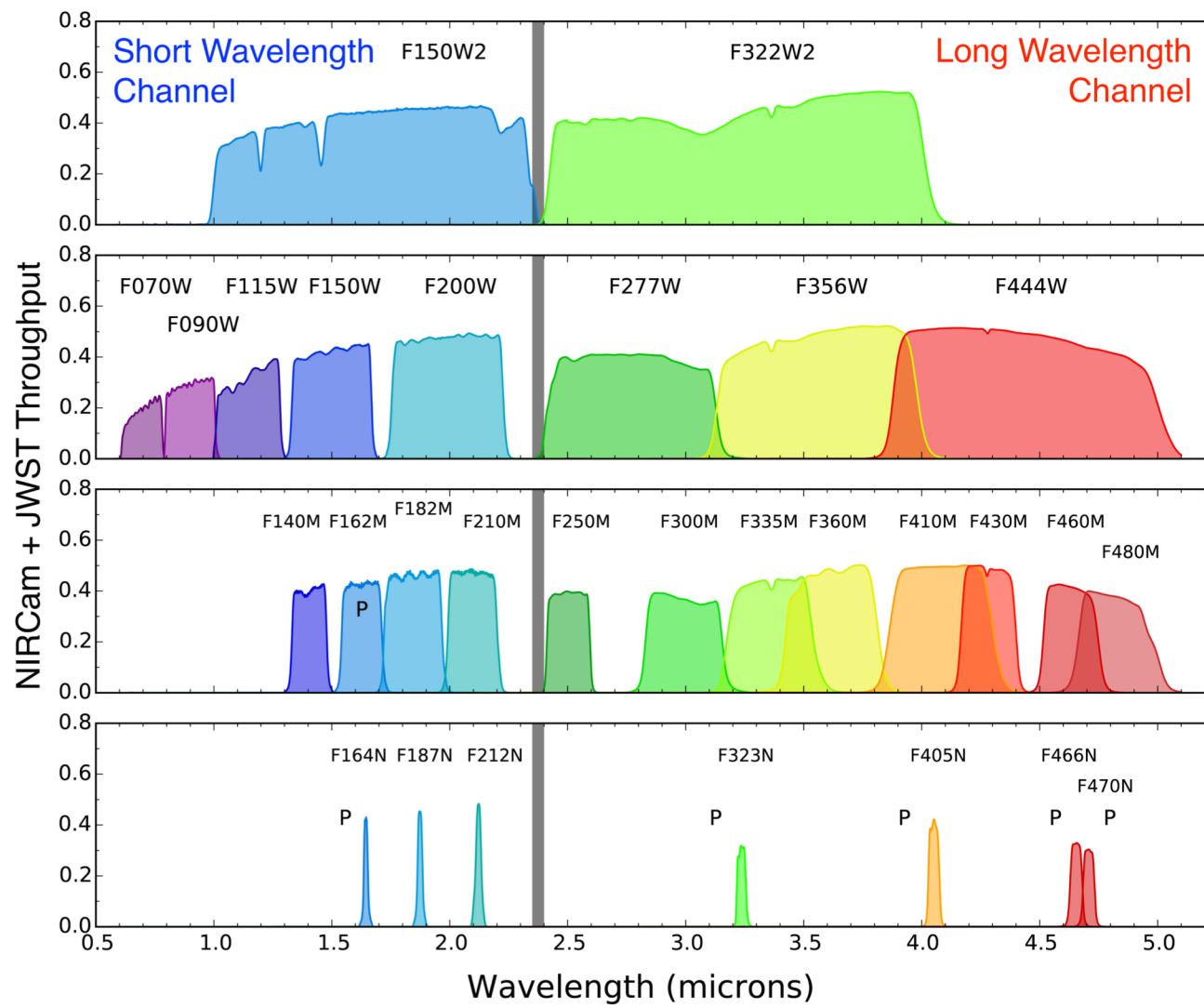
Observing modes:

- Imaging
- Coronapgrahy
- Wide Field Slitless Spectroscopy
- Time Series Imaging
- Grism Time Series

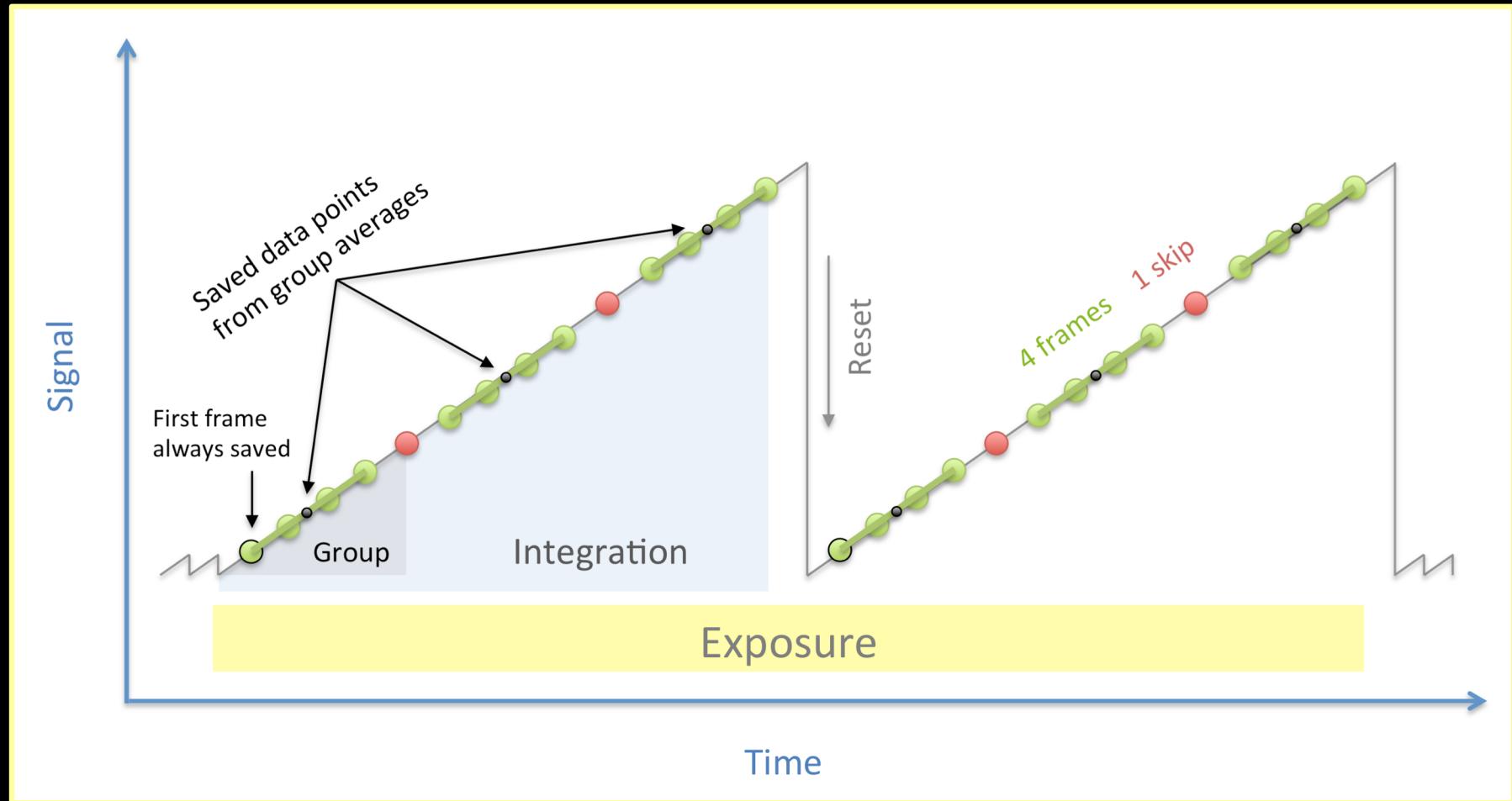
NIRCam FOV



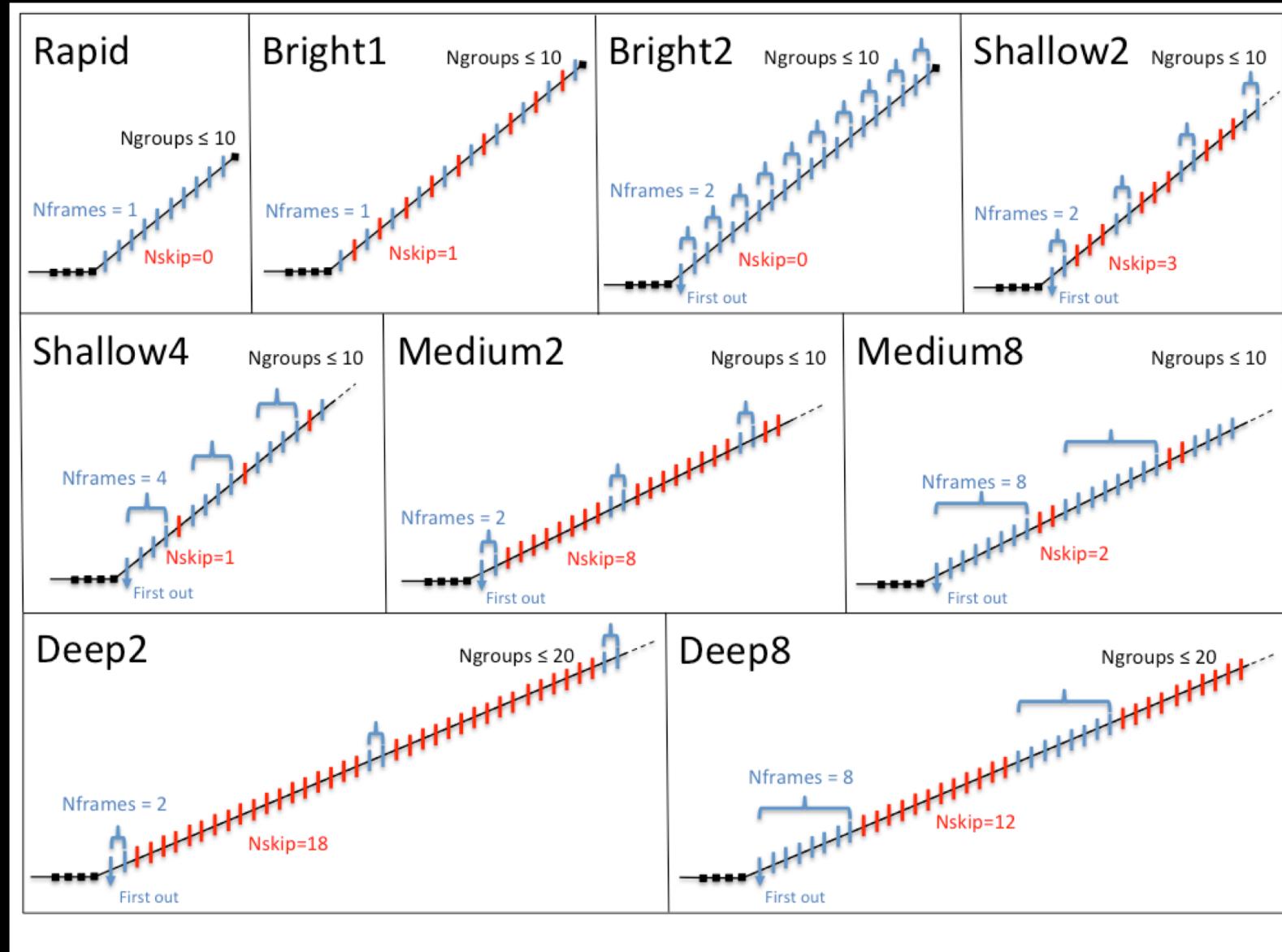
NIRCam Filters



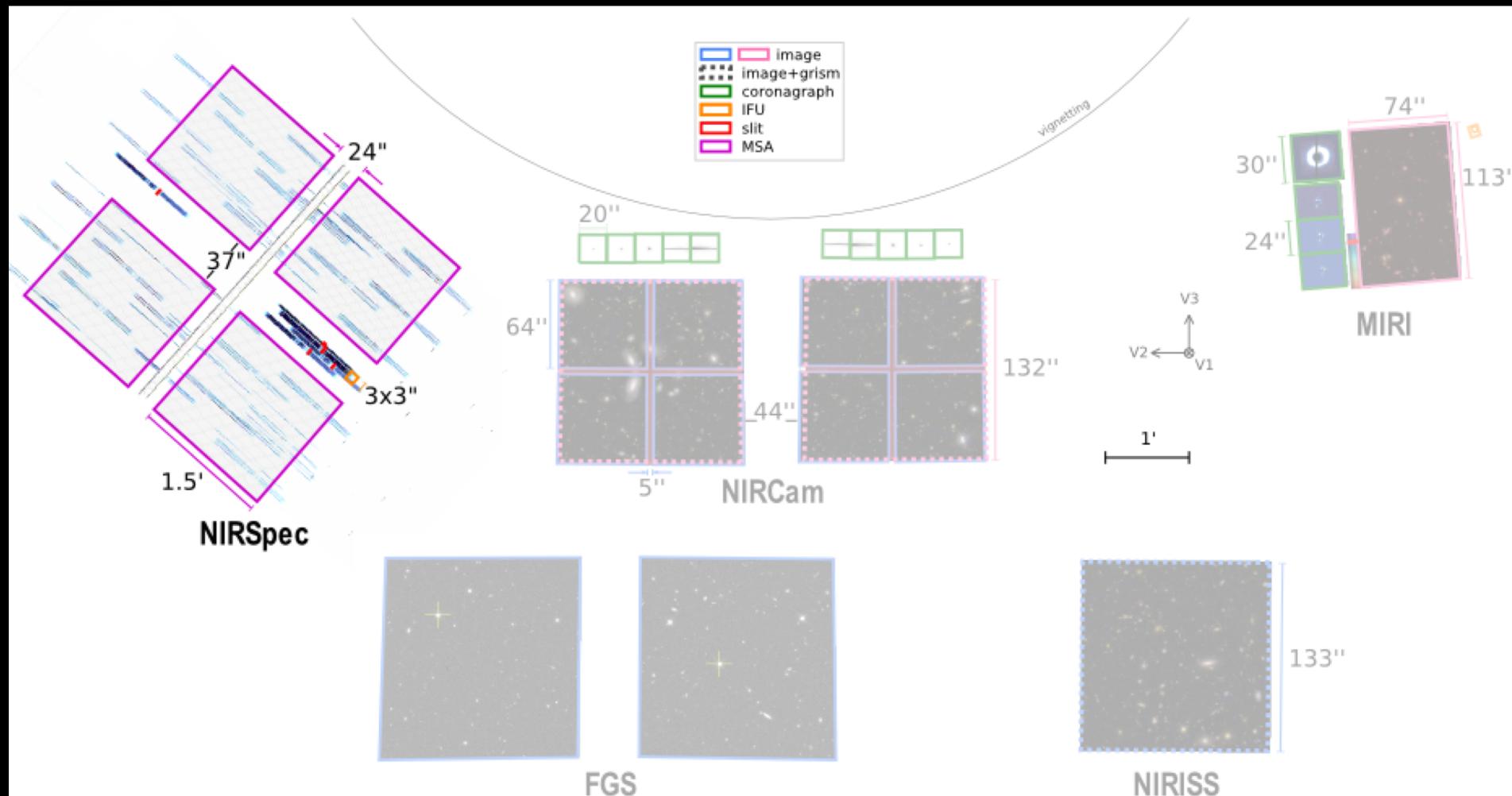
Charge accumulation within a pixel in a NIRCam exposure



NIRCam Readout Patterns



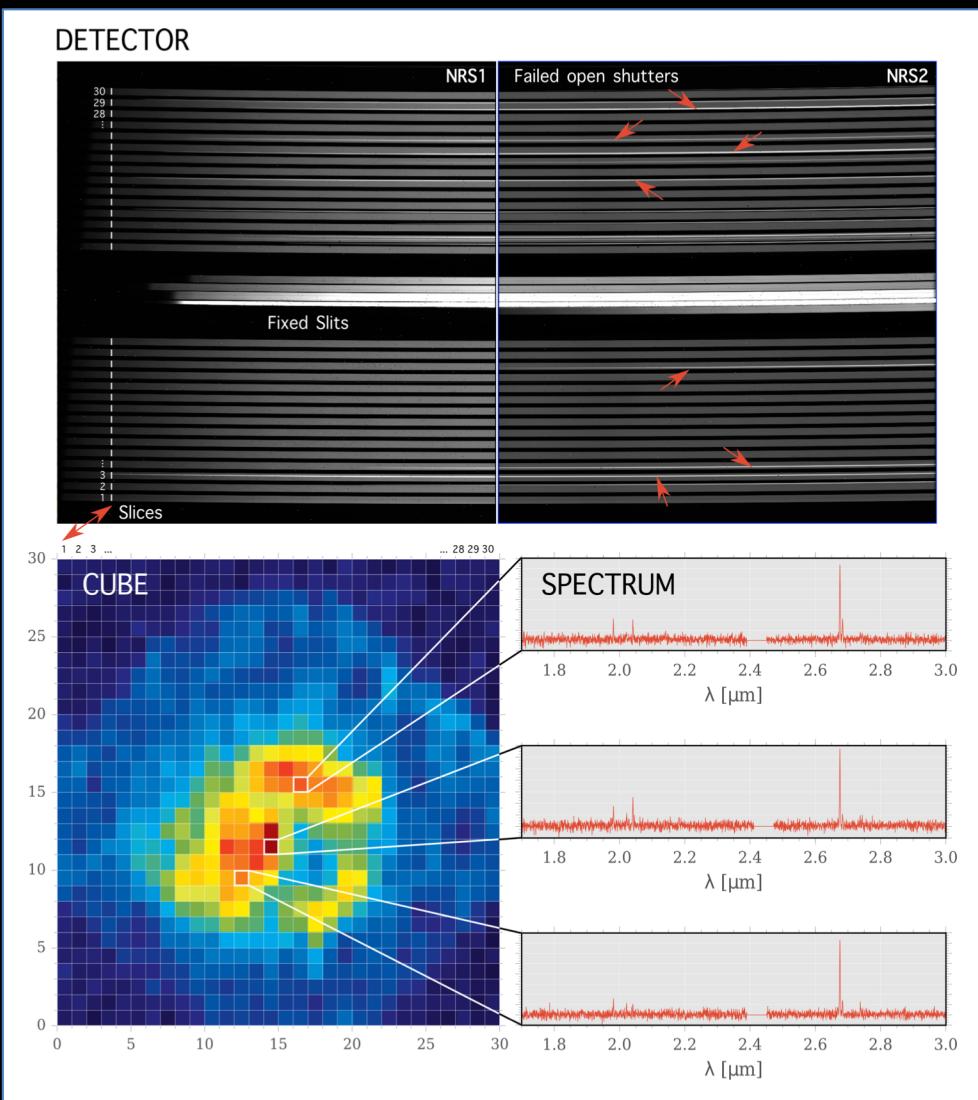
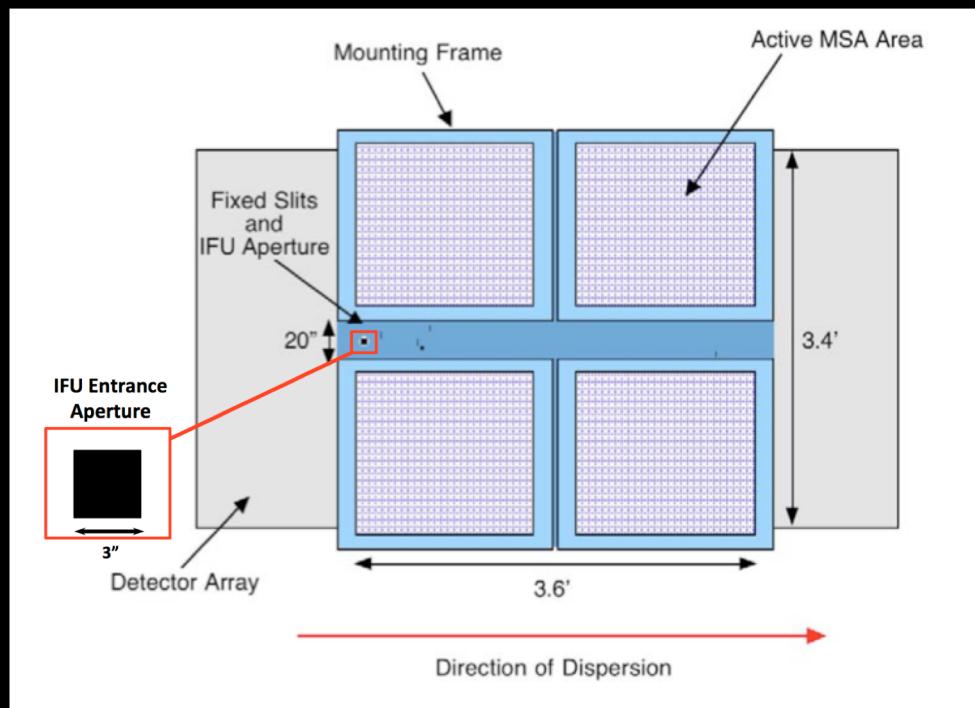
Near Infrared Spectrograph (NIRSpec)



Observing modes:

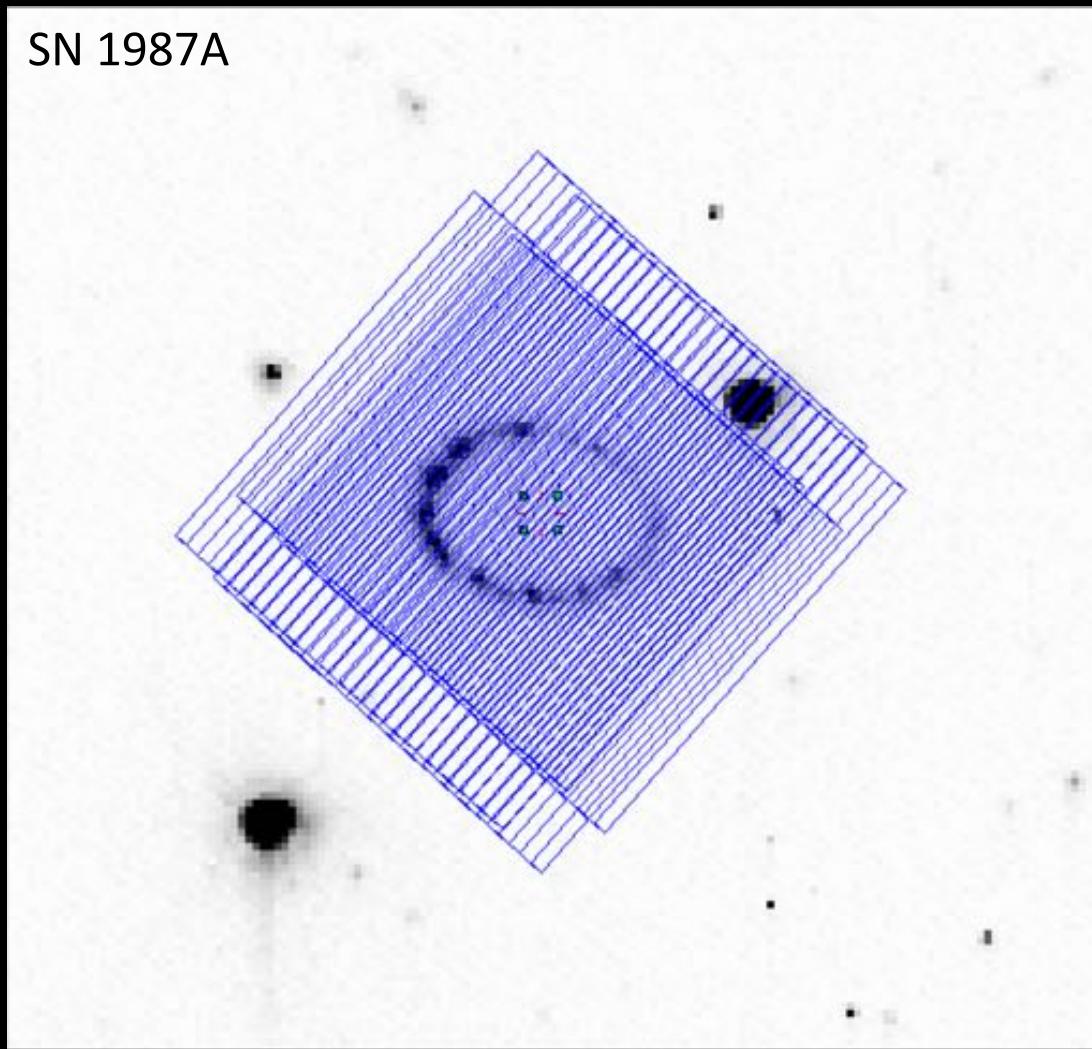
- Multi-object Spectroscopy (MOS): 0.6–5.3 μm , ~ 250,000 shutters, 0.2" x 0.46" in size each
- IFU Spectroscopy: 0.7 – 5.27 μm , 3" x 3" fov
- Fixed Slit Spectroscopy: five slits
- Bright Object Time Series: 1.6" x 1.6" fov

NIRSpec IFU Spectroscopy

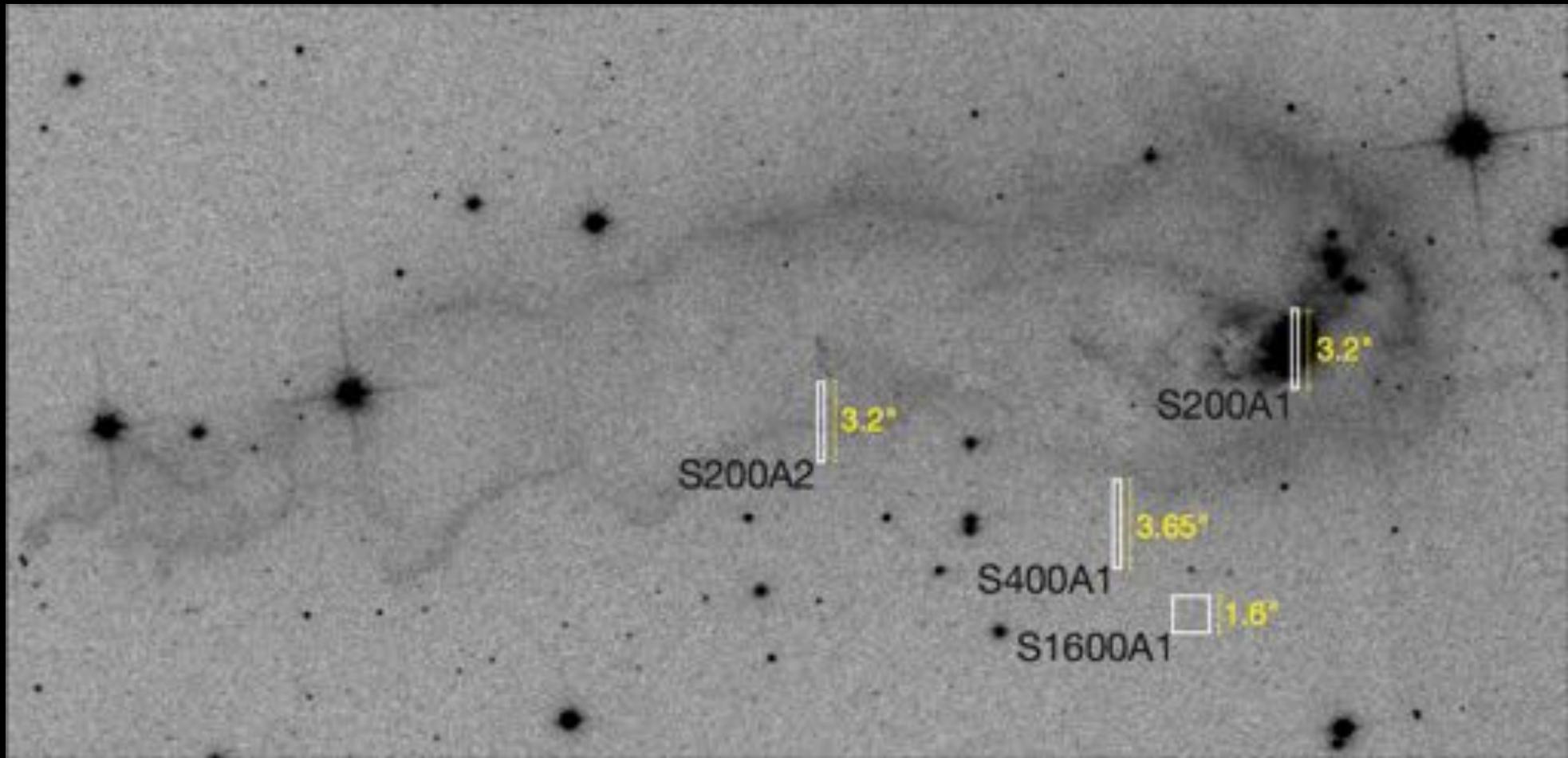


- Provides spatially resolved imaging spectroscopy in a $3'' \times 3''$ square region
- Dissected into 30 slices and mapped onto 900 spatial elements ($0.1'' \times 0.1''$ each)

NIRSpec IFU Footprint



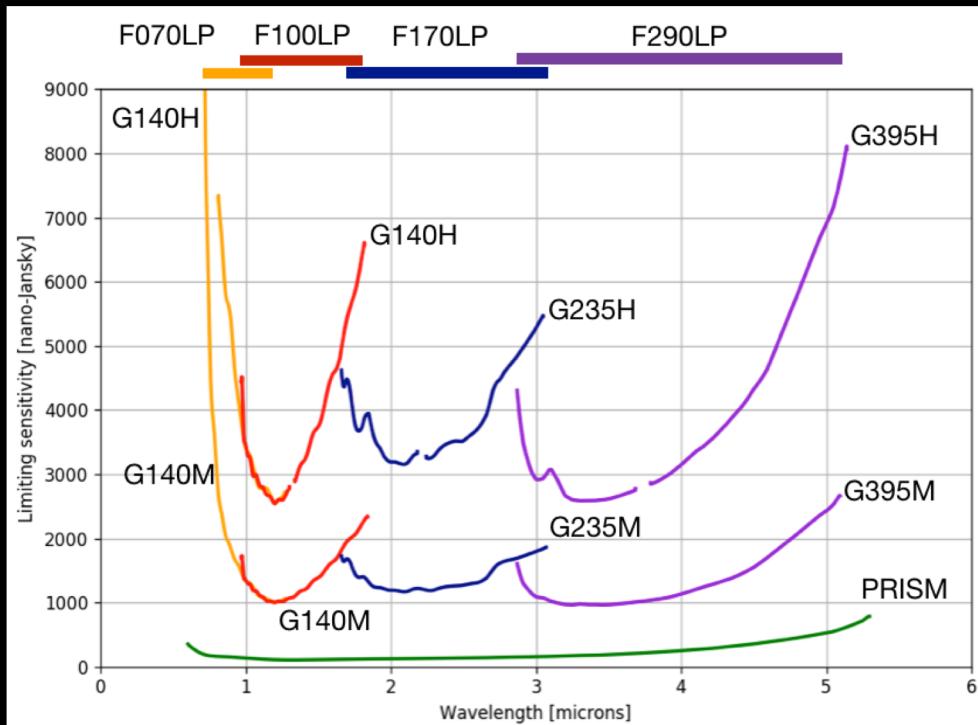
NIRSpec Fixed Slit Spectroscopy



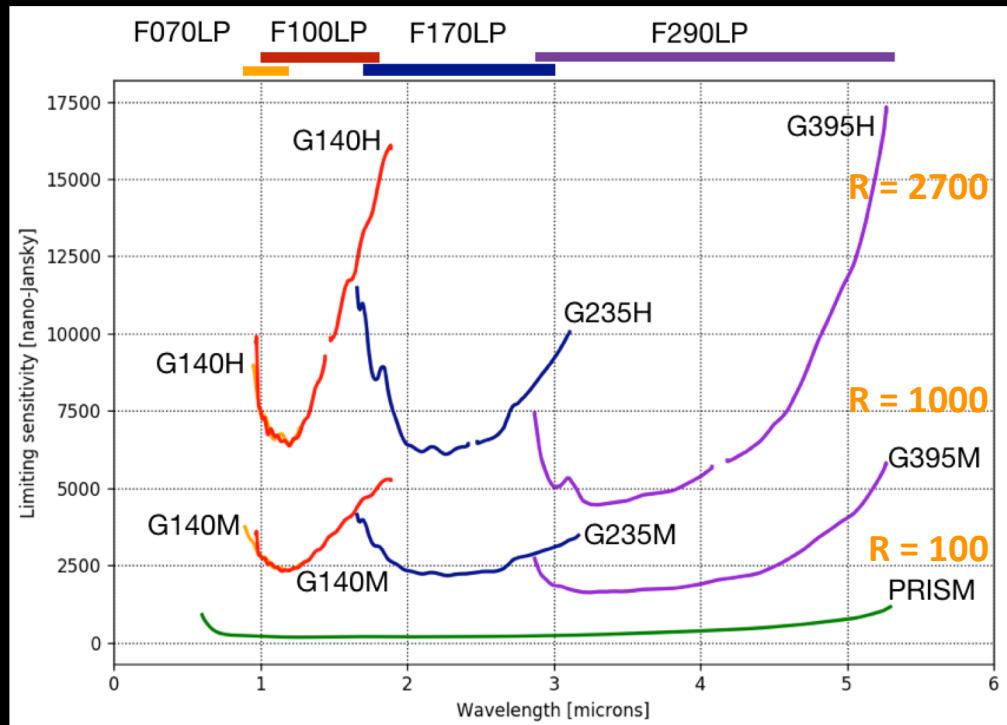
- High sensitivity single object spectroscopy over the full 0.6–5.3 μm wavelength region
- Highest contrast, highest sensitivity spectra possible with NIRSpec

NIRSpec Fixed Slit vs. IFU

Fixed Slit



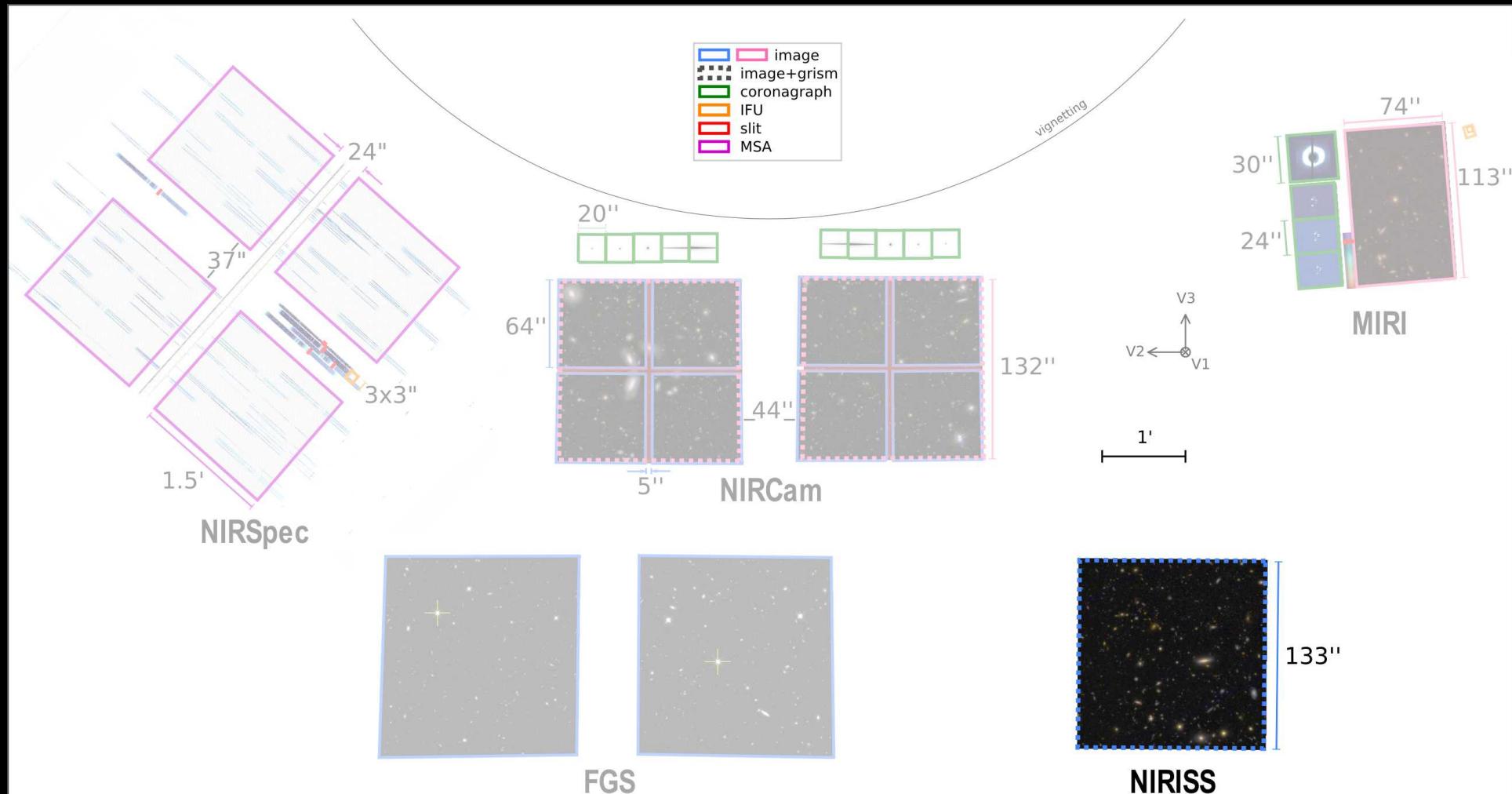
IFU



- Higher sensitivity
- Lower background
- Not affected by contamination through failed MSA shutters

- Larger field of view
- Simultaneously obtains spectra for 900 spatial elements ($0.1'' \times 0.1''$ each)

Near-Infrared Imager and Slitless Spectrograph (NIRISS)



Observing modes:

- Wide Field Slitless Spectroscopy: 0.8–2.2 μm , 2.2' x 2.2' fov, $R = 150$
- Single Object Slitless Spectroscopy: : 0.6 – 2.8 μm , $R = 700$
- Aperture Masking Interferometry: 2.8 – 4.8 μm , 5.2" x 5.2" fov (70–400 mas)
- Imaging: 2.8 – 4.8 μm , 2.2' x 2.2', in parallel with NIRCam

Parallel Observation Supported in Cycle 1

First (Primary) template	Second (Parallel) template	Comments
NIRCam imaging ¹	MIRI imaging ¹	Either template can be selected as primary, with the other as parallel.
NIRCam imaging ¹	NIRISS WFSS	Either template can be selected as primary, with the other as parallel.
MIRI imaging	NIRISS WFSS	Either template can be selected as primary, with the other as parallel.
NIRCam imaging ¹	NIRISS imaging	NIRCam must be primary. Use to increase areal coverage, but note NIRISS differences in pixel size and available filters.
NIRSpec MOS	NIRCam imaging	NIRSpec MOS must be primary.

Example Overheads for a MIRI IFU Observation

Operation	Overhead (s)	
Slew	1800	
Guide Star Acquisition	282	
MRS Target Acquisition	300	
Imager filter wheel change	50.0	
Select 1st of 3 gratings	50.0	
Exposure 1 Overhead	63.0	
SAM to Dither position 2	48.0	
Exposure 2 Overhead	63.0	
SAM to Dither position 3	48.0	
Exposure 3 Overhead	63.0	
SAM to Dither position 4	48.0	
Exposure 4 Overhead	63.0	
SAM back to starting position	48.0	
Select 2nd of 3 gratings	50.0	
Exposure 5 Overhead	63.0	
SAM to Dither position 2	48.0	
Exposure 6 Overhead	63.0	
SAM to Dither position 3	48.0	
Exposure 7 Overhead	63.0	
SAM to Dither position 4	48.0	
Exposure 8 Overhead	63.0	
SAM back to starting position	48.0	
Select 3rd of 3 gratings	50.0	
Exposure 9 Overhead	63.0	
SAM to Dither position 2	48.0	
Exposure 10 Overhead	63.0	
SAM to Dither position 3	48.0	
Exposure 11 Overhead	63.0	
SAM to Dither position 4	48.0	
Exposure 12 Overhead	63.0	
OSS overhead	75	
Visit overhead	50	
TOTAL	3991	

*Plus an additional 16% observatory overhead on the total time

Cycle 1 Proposal Categories

GO proposal categories

- Small (≤ 25 hours) ~ 3500 hours available
- Medium (25 to 75 hours) ~ 1500 hours available
- Large (>75 hours) ~ 1000 hours available
- Treasury (datasets of lasting value to the JWST)
- Calibration (must contact instrument team)
- Long-Term (multi-cycle, time = total for all cycles)
- Survey (short *filler* observations) ~ 200 hours available

Archival Research (AR) Proposal

- Regular
- Calibration
- Legacy (provide product to scientific community)
- Theory
- Community Data Science Software

Important Dates:

- Cycle 1 GO/AR proposal deadline until no earlier than **February 1 2019**
- JWST launch is scheduled for **Spring 2020**.
- Science observations will commence after a 6 month commissioning phase

Useful Links:

JWST Documentation (especially Recommended Strategies pages):

<https://jwst-docs.stsci.edu/>

JWST Helpdesk:

<https://stsci.service-now.com/jwst>

JWST Exposure Time Calculator:

<https://jwst/etc.stsci.edu/>