



Integral Field Spectrographs

NIRSpec IFS & MRS

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CENTRO DE ASTROBIOLOGÍA
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Instituto Nacional de
Técnica Aeroespacial

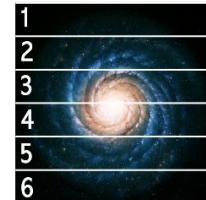


- 1. What is an integral field spectrograph?**
- 2. The IFSs of JWST**
 - a. NIRSpec IFS
 - b. MRS
- 3. Summary of NIRSpec IFS and MRS**



What is an Integral Field Spectrograph (IFS)?

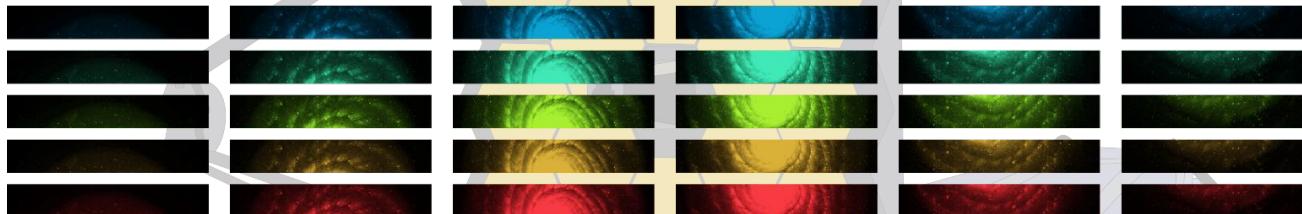
Original on-sky field of view



Optical slicing (mirrors) of the on-sky image

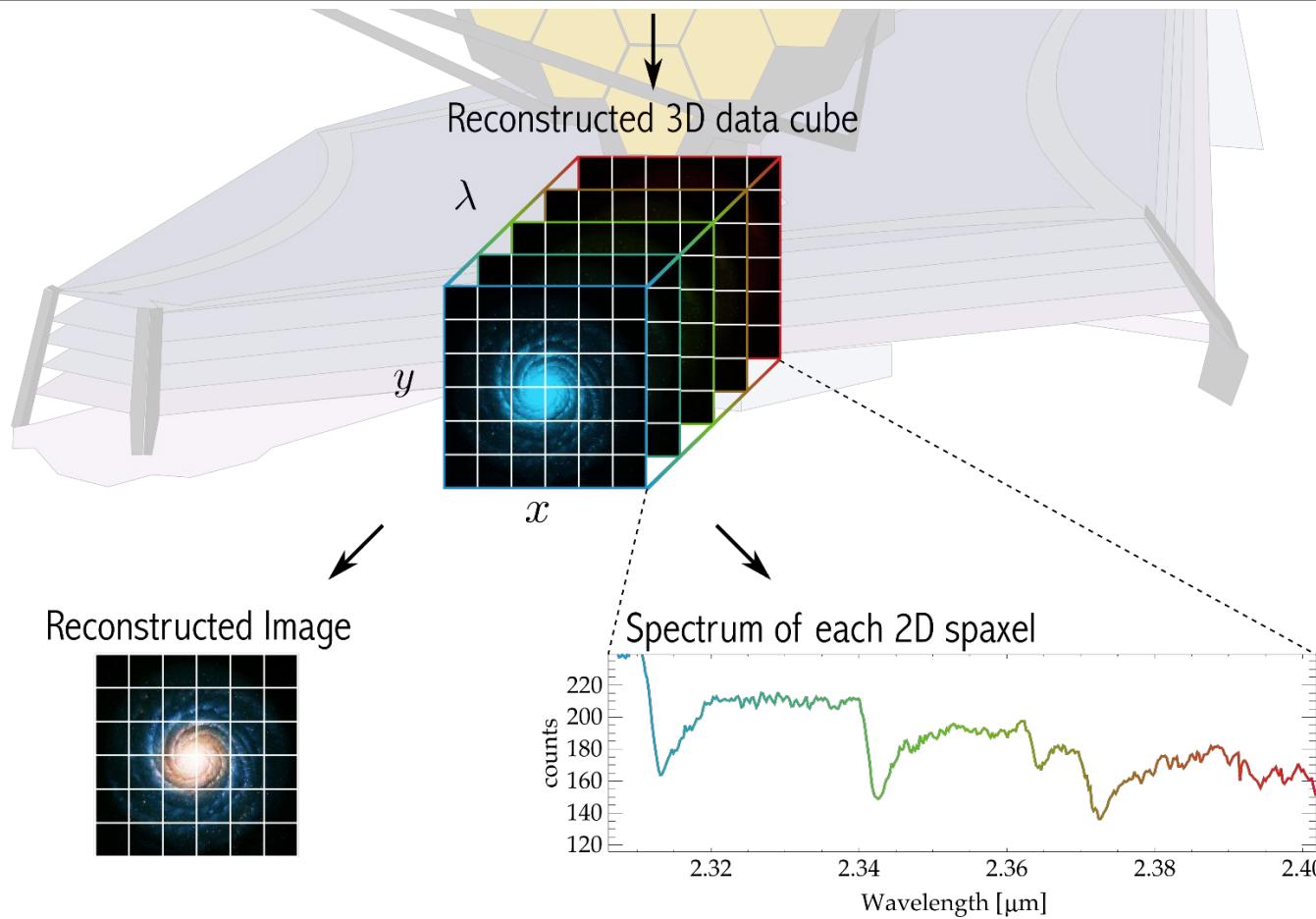


Spectral dispersion of the sliced image



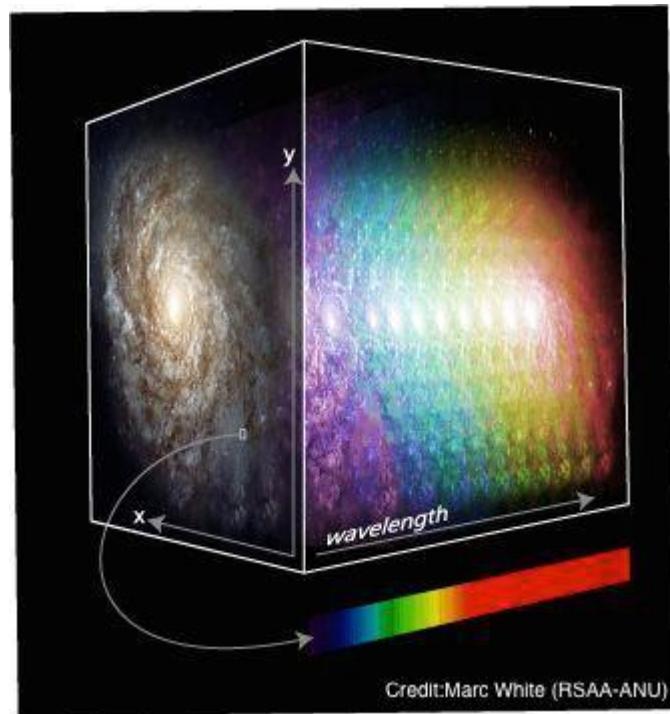


What is an Integral Field Spectrograph (IFS)?





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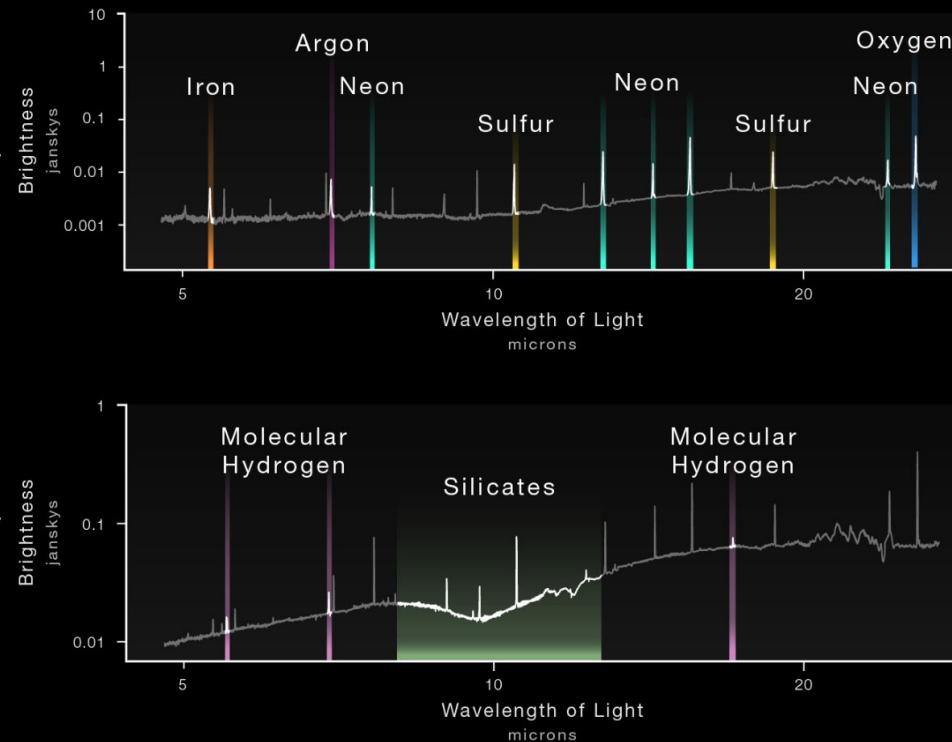


What is an Integral Field Spectrograph (IFS)?

NIRCam and MIRI Imaging



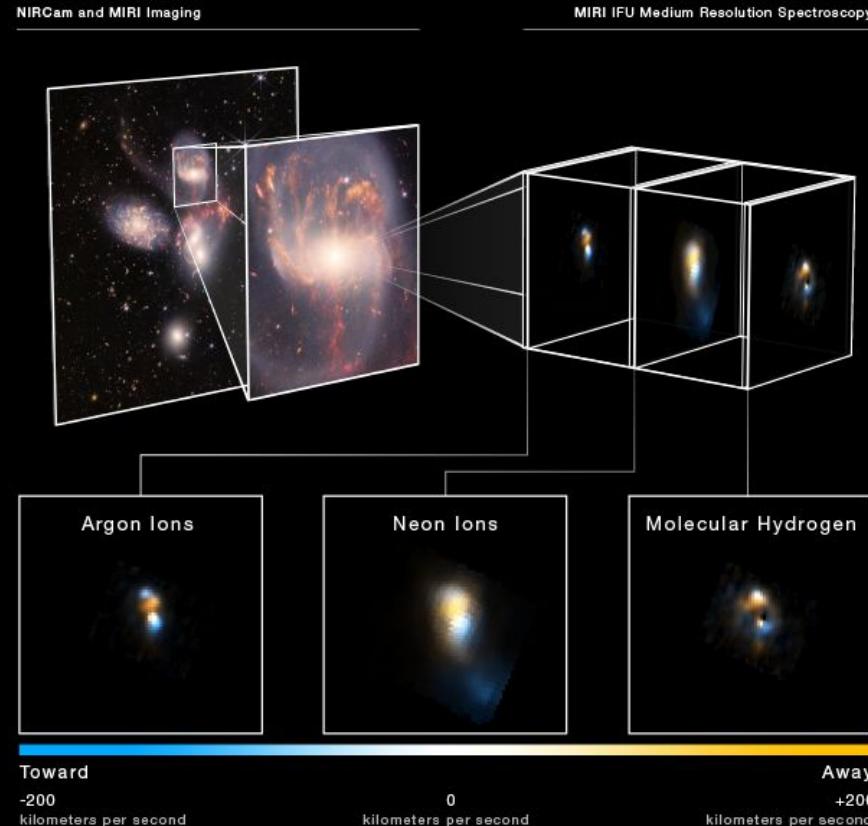
MIRI IFU Medium Resolution Spectroscopy



WEBB
SPACE TELESCOPE



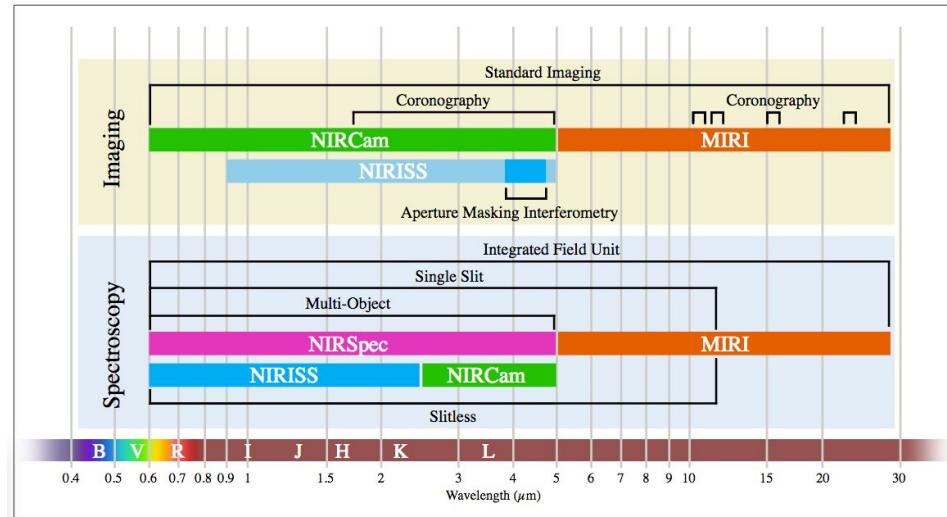
What is an Integral Field Spectrograph (IFS)?



WEBB
SPACE TELESCOPE



The Mid-Infrared Instrument (MIRI): overview

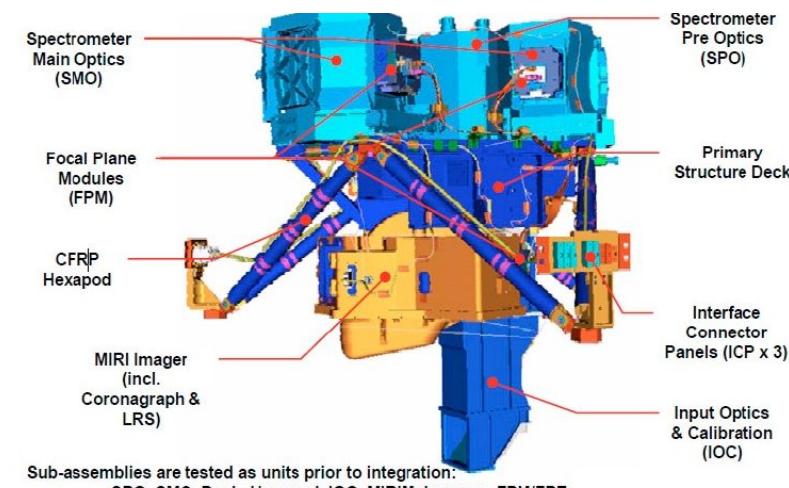


Mid-Infrared Instrument (MIRI)

Wavelength coverage: from 4.9 to $28.8 \mu\text{m}$

Observing modes:

- **MIRIM:** Imaging (Stacey's talk)
- **MRS:** Integral field unit (IFU) spectroscopy
- **LRS:** Slitted & slitless spectroscopy
- **Coronography** (Isa's talk)



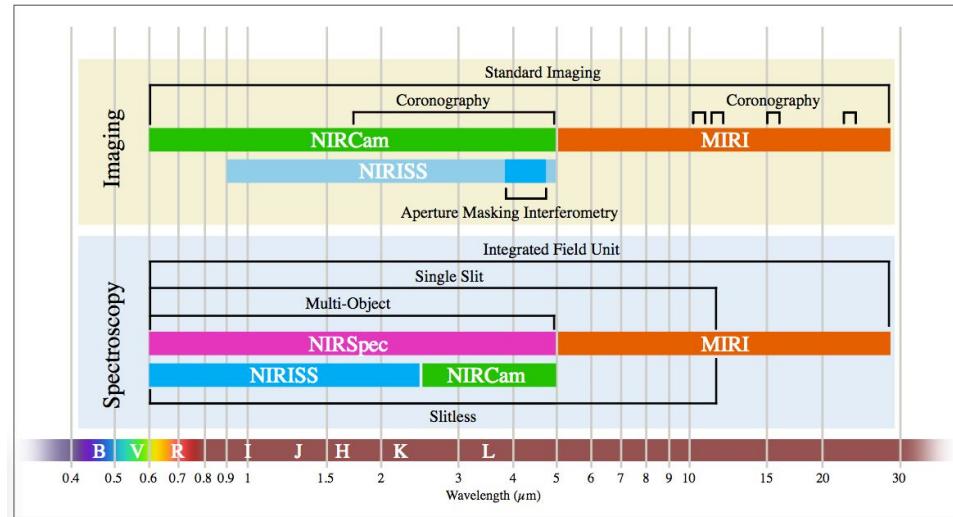


The Mid-Infrared Instrument (MIRI): commissioning team





Near Infrared Spectrograph (NIRSpec): overview

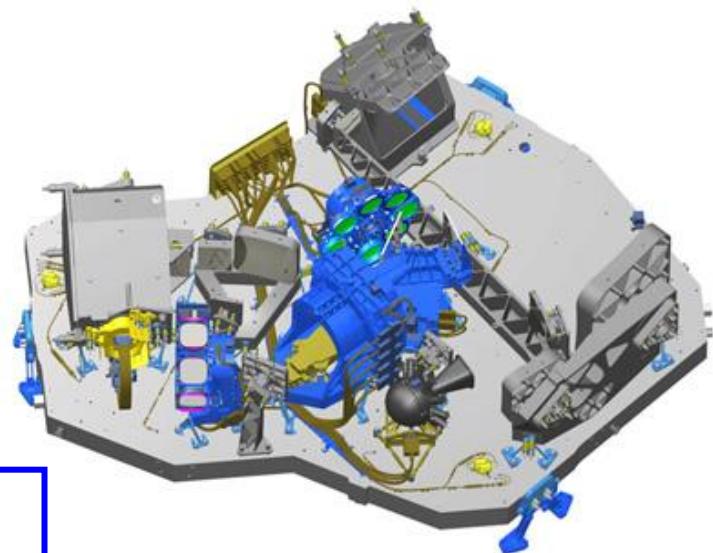


Near Infrared Spectrograph (NIRSpec)

Wavelength coverage: from 0.6 to 5.3 μm

Observing modes:

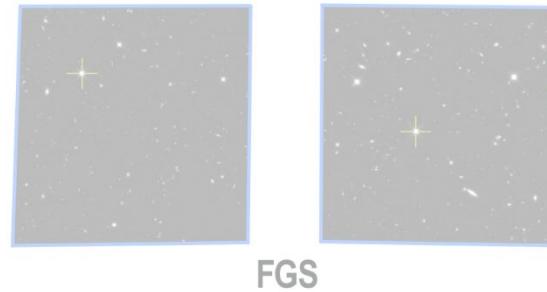
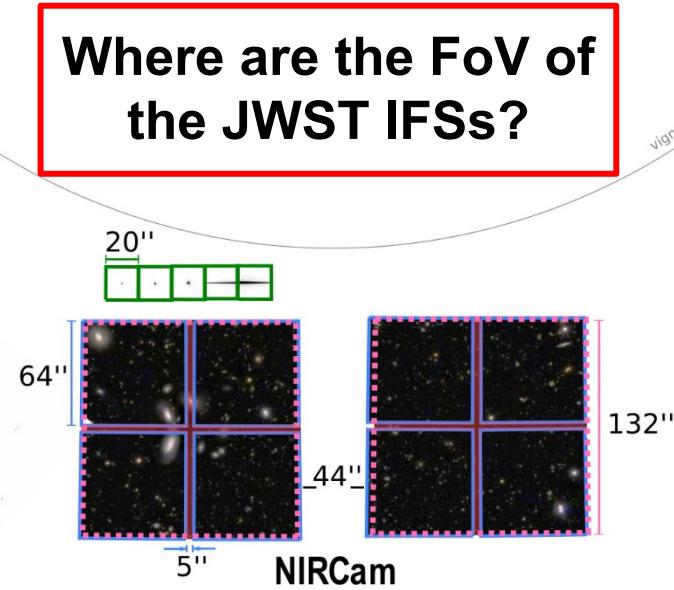
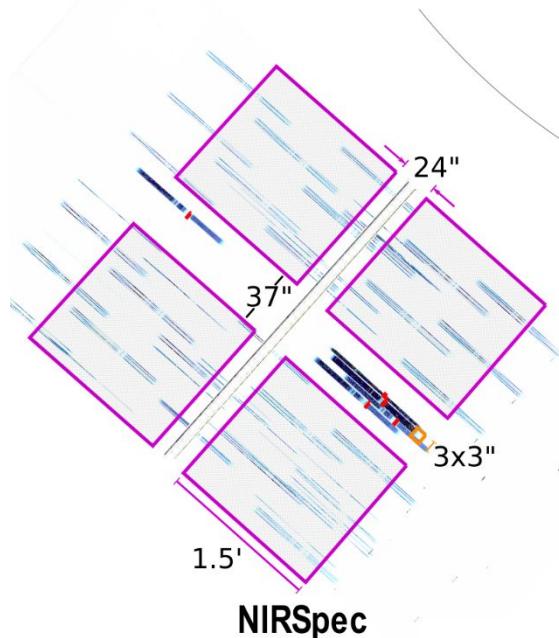
- Multi-Object Spectroscopy (MOS; Nimisha's talk)
- Fixed slit spectroscopy
- Integral-field spectroscopy (IFS)



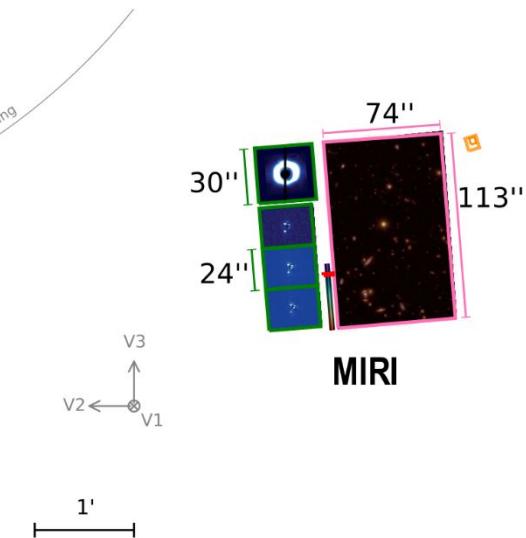


Field of View of the JWST: NIRSpec & MRS IFSs

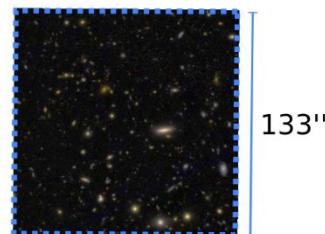
Where are the FoV of
the JWST IFSs?



FGS



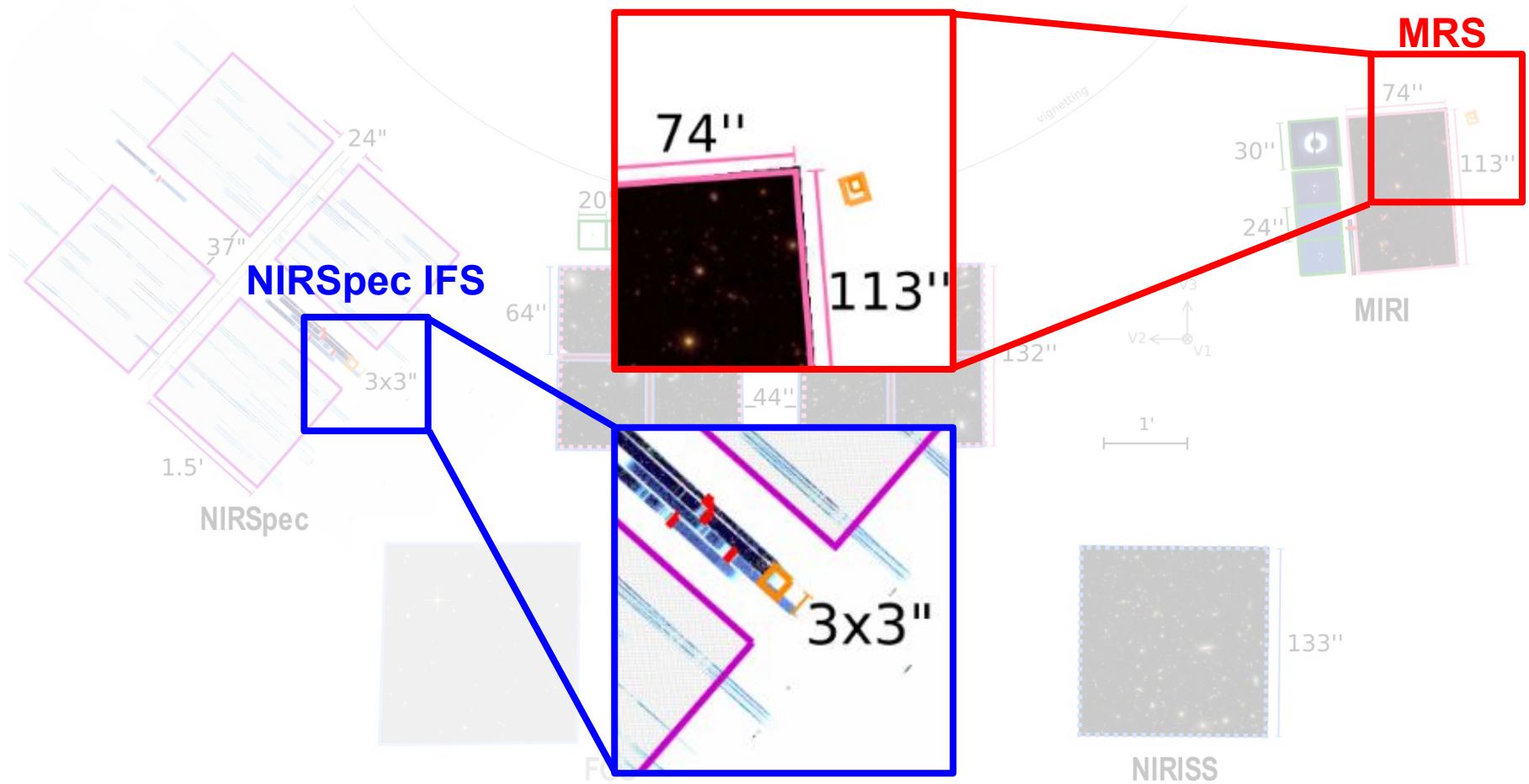
MIRI



NIRISS



Field of View of the JWST: NIRSpec & MRS IFSs





NIRSpec IFS: Overview

NIRSpec IFS covers the 0.6 to 5.3 micron spectral range

FoV: 3"x 3"

Number of slices: 30

Slice width: 0.1"

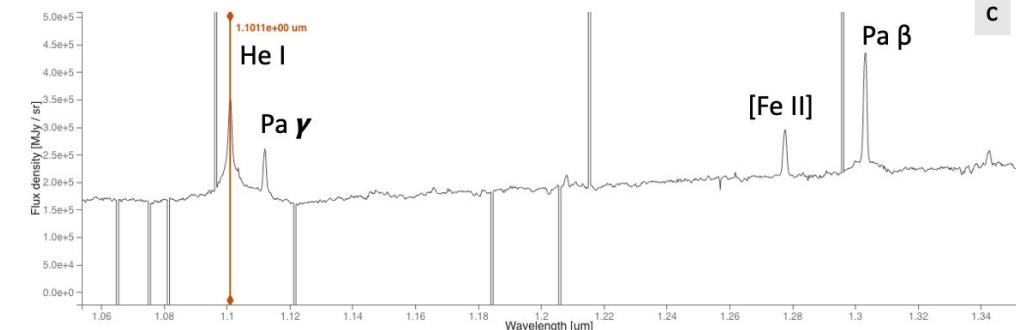
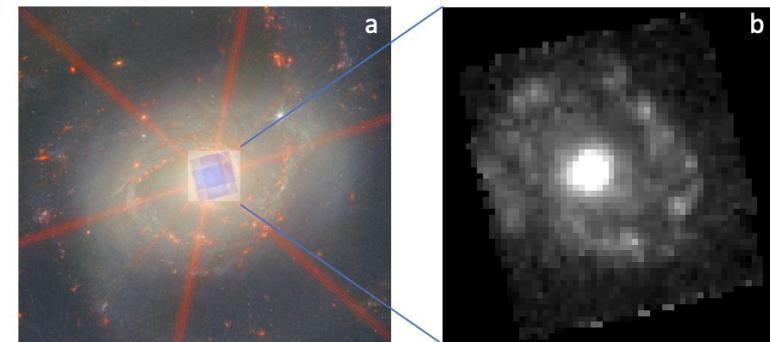
Two array detectors of 2048x2048 pixels

- Traditionals and IRS2 readout modes

Spectral resolution: 100 / 1000 / 2700

PSF FWHM: sub-arcsec in all channels

Seyfert galaxy NGC 7469





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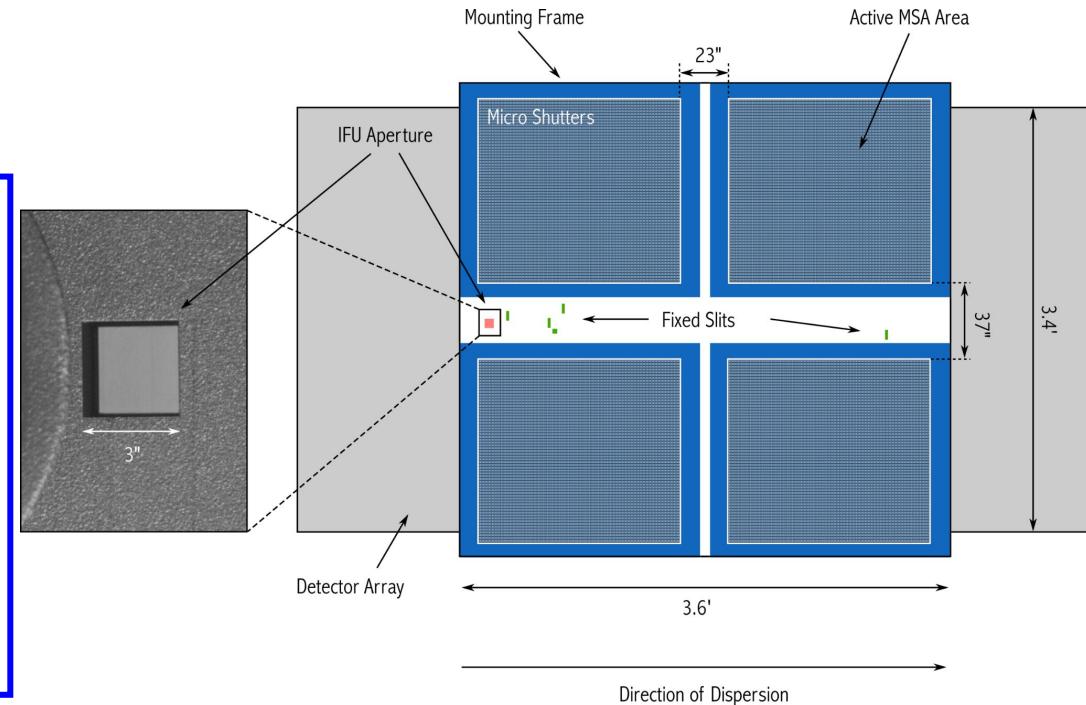
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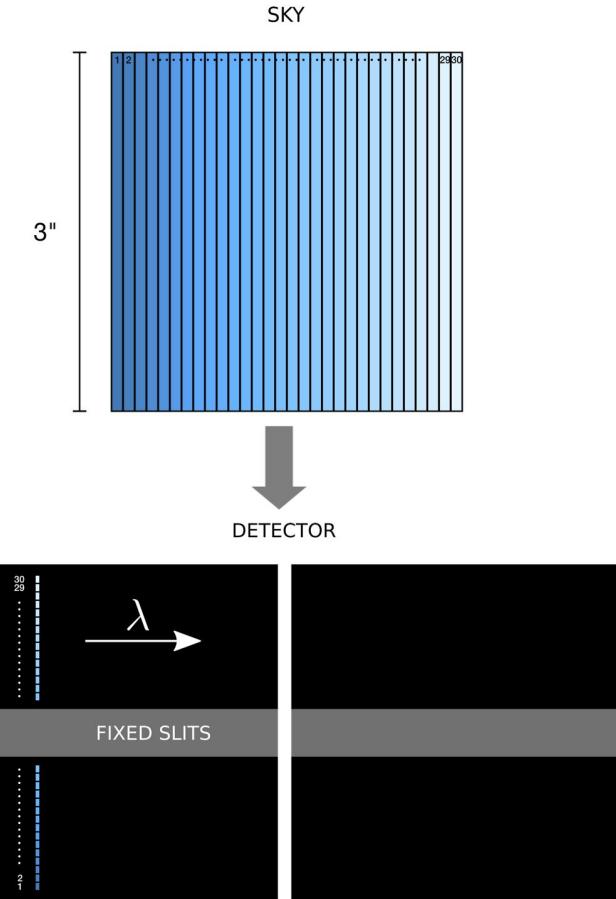
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NIRSpec IFS: detector and readouts

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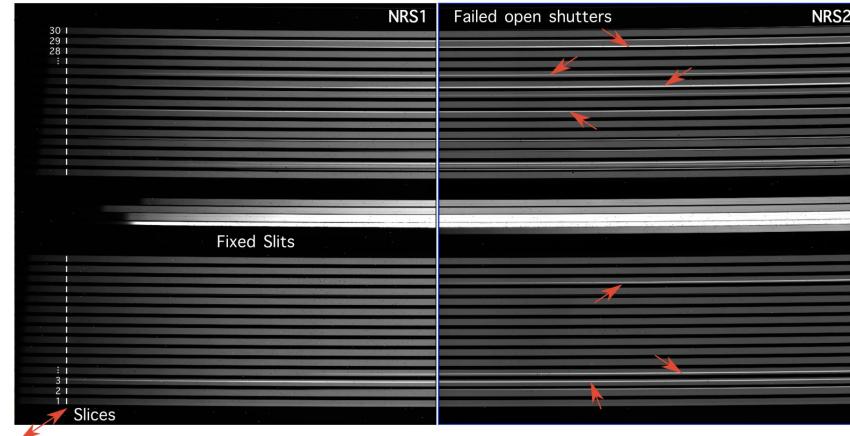
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Spectral resolution: 100 / 1000 / 2500

PSF FWHM: sub-arcsec in all channels

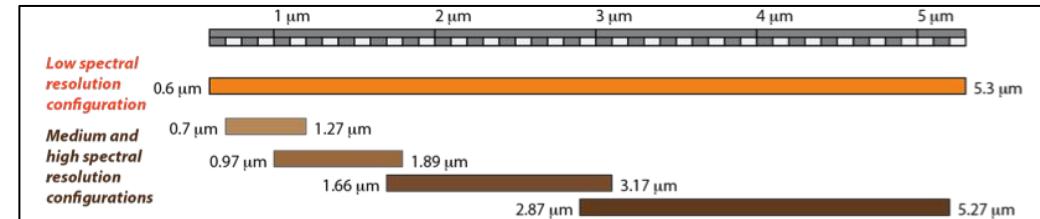
DETECTOR



Detector readout mode	NIRSpec readout pattern name	N _{frames} per group	Group time (s)	Unprocessed data size (one integration)
Traditional	NRSRAPID	1	10.737	2048 pixels × 2048 pixels × N _{groups}
	NRSRAPIDD1 ^{†,‡}	1	21.474	
	NRSRAPIDD2 ^{†,*}	1	32.210	
	NRSRAPIDD6 ^{§,¶}	1	75.159	
	NRS	4	42.947	
IRS2	NRSIRS2RAPID	1	14.589	3200 pixels × 2048 pixels × N _{groups}
	NRSIRS2	5	72.944	

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Disperser-filter combination	Nominal resolving power	Wavelength range (μm)
G140M/F070LP	~1,000	0.90–1.27
G140M/F100LP		0.97–1.89
G235M/F170LP		1.66–3.17
G395M/F290LP		2.87–5.27
G140H/F070LP	~2,700	0.95–1.27
G140H/F100LP		0.97–1.89
G235H/F170LP		1.66–3.17
G395H/F290LP		2.87–5.27
PRISM/CLEAR	~100	0.6–5.3

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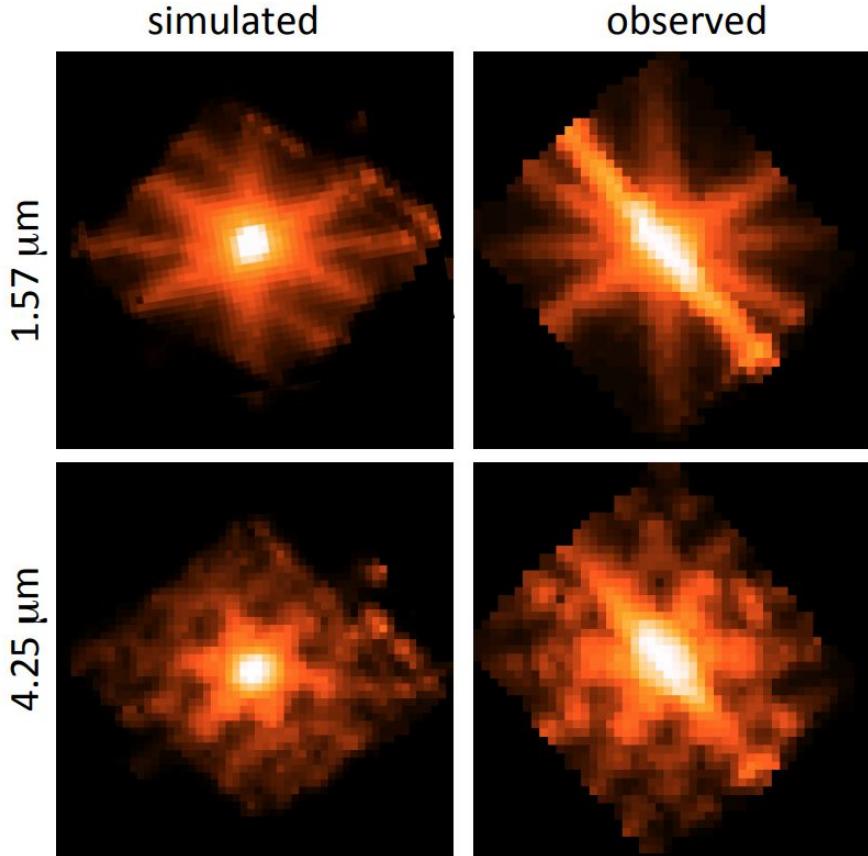
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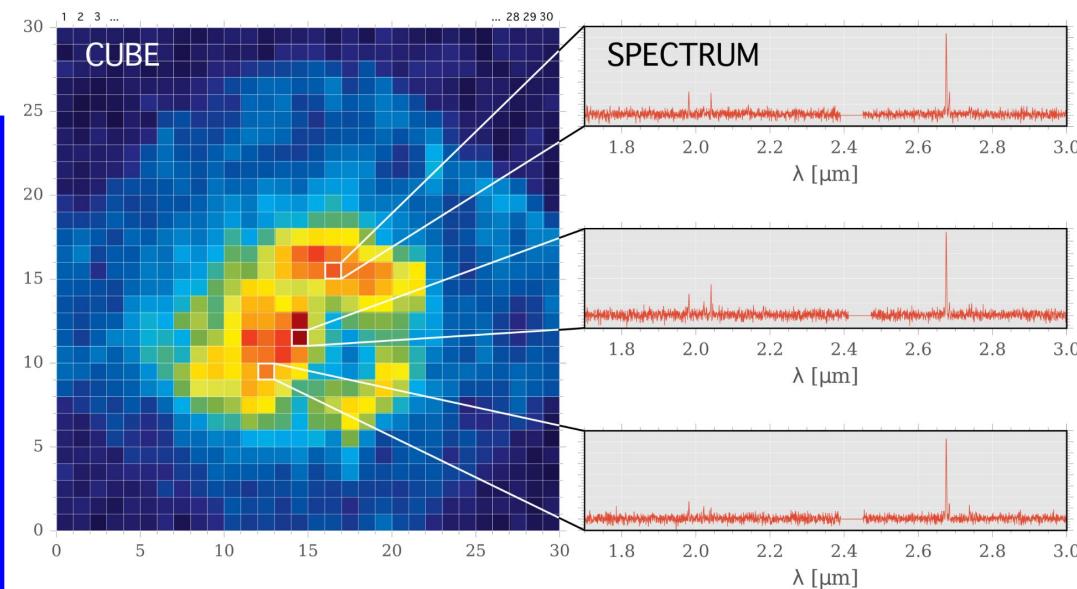
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MRS: overview

MRS is the only JWST spectrograph covering the 5-28 micron spectral range

Total number of Channels and Bands:

- **Channels:** 1, 2, 3, 4
- **Bands:** SHORT, MEDIUM, LONG

Two array detectors of 1024x1024 pixels

- FASTR1 & SLOWR1 readouts mode

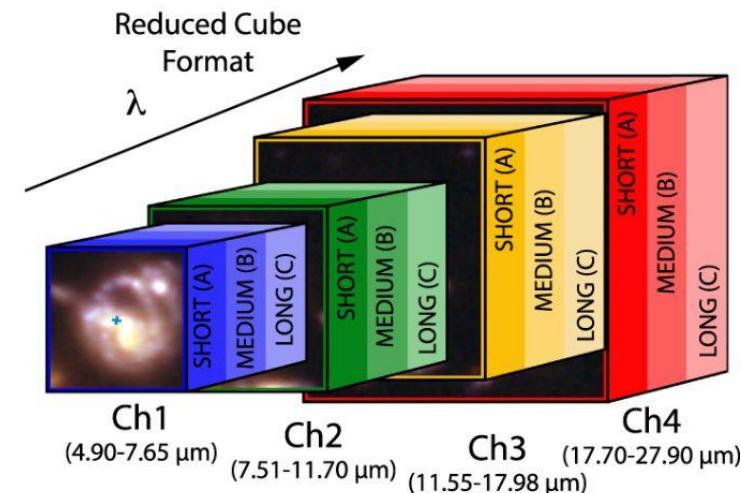
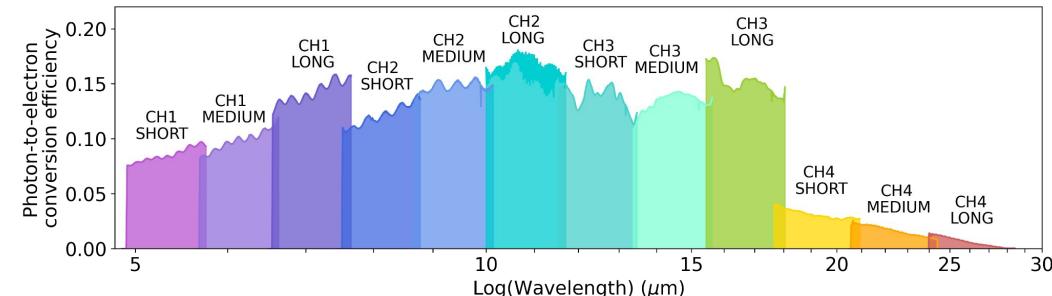
FoV: 3.7" x 3.7" (Ch1) – 7.4" x 7.9" (Ch4)

Slice width: 0.18" (Ch-1) - 0.64" (Ch-4)

Spectral resolution: R~1500-3500

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Simultaneous coverage of a third of the entire spectral range





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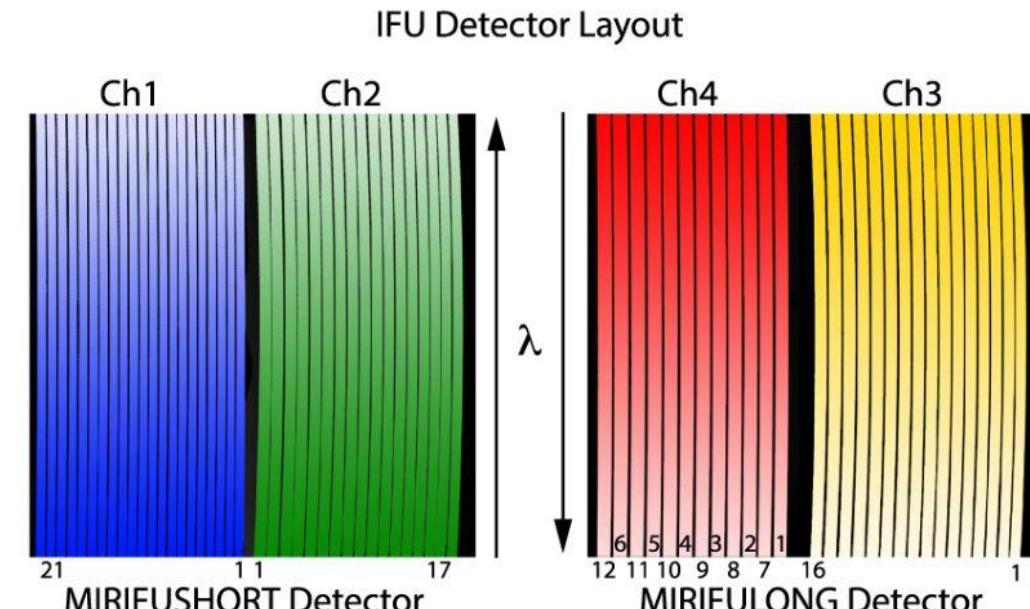
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1. **SLOWR1** ($N_{\text{samples}} = 9, t_1 = 23.890 \text{ s}$)
2. **FASTR1** ($N_{\text{samples}} = 1, t_1 = 2.775 \text{ s}$)



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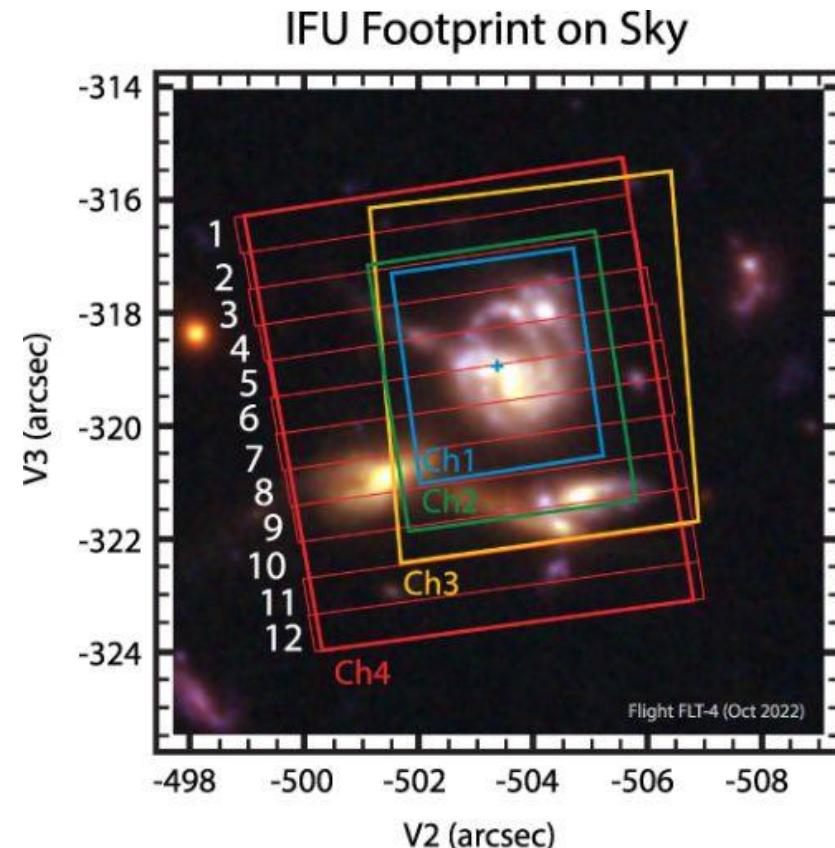
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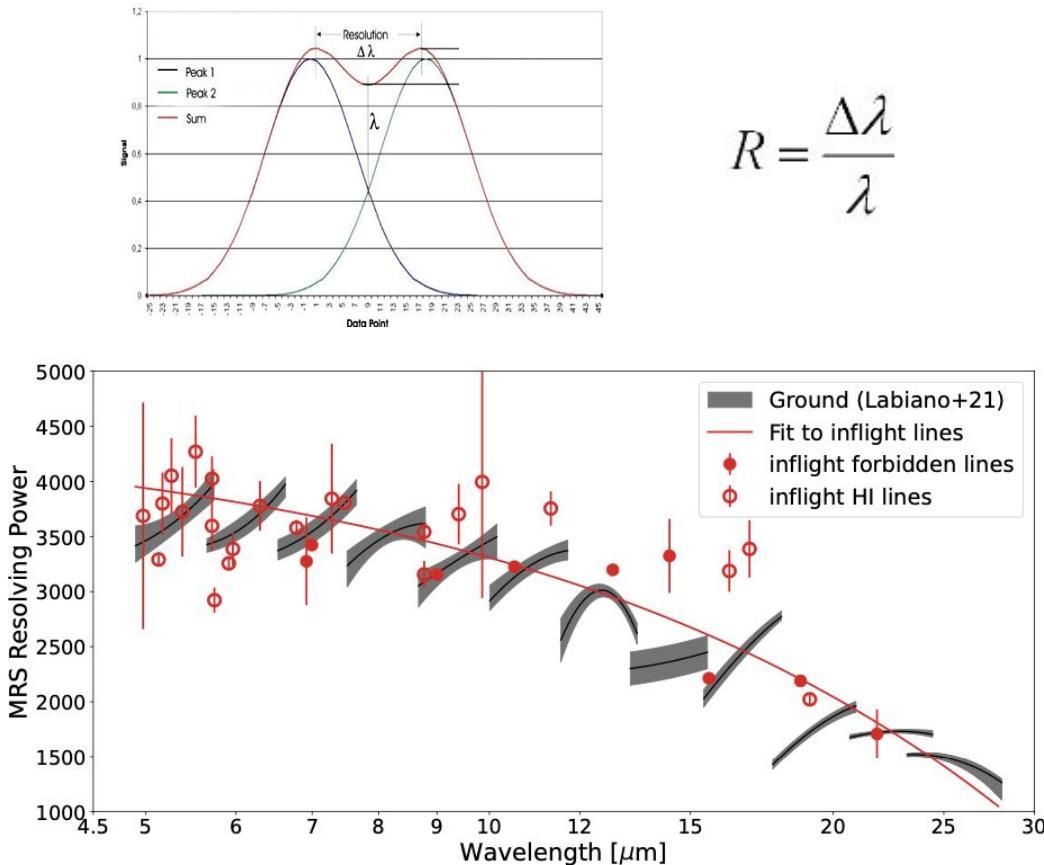
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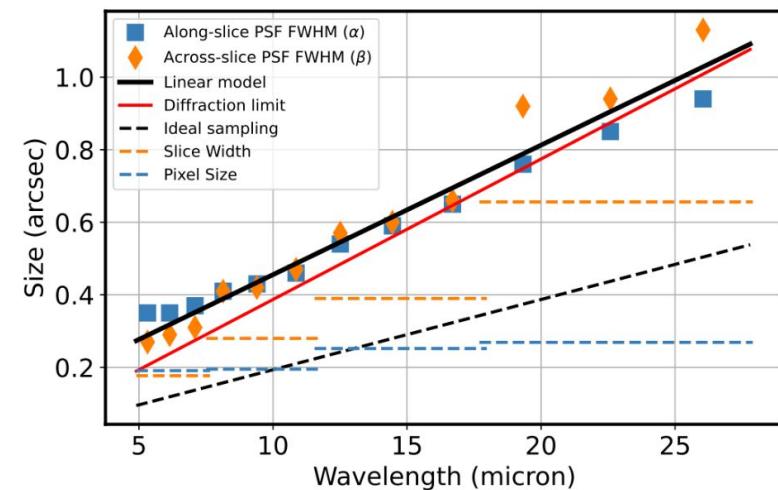
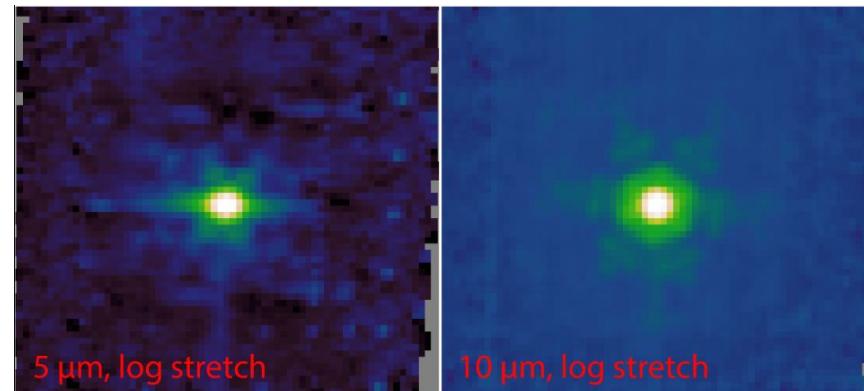
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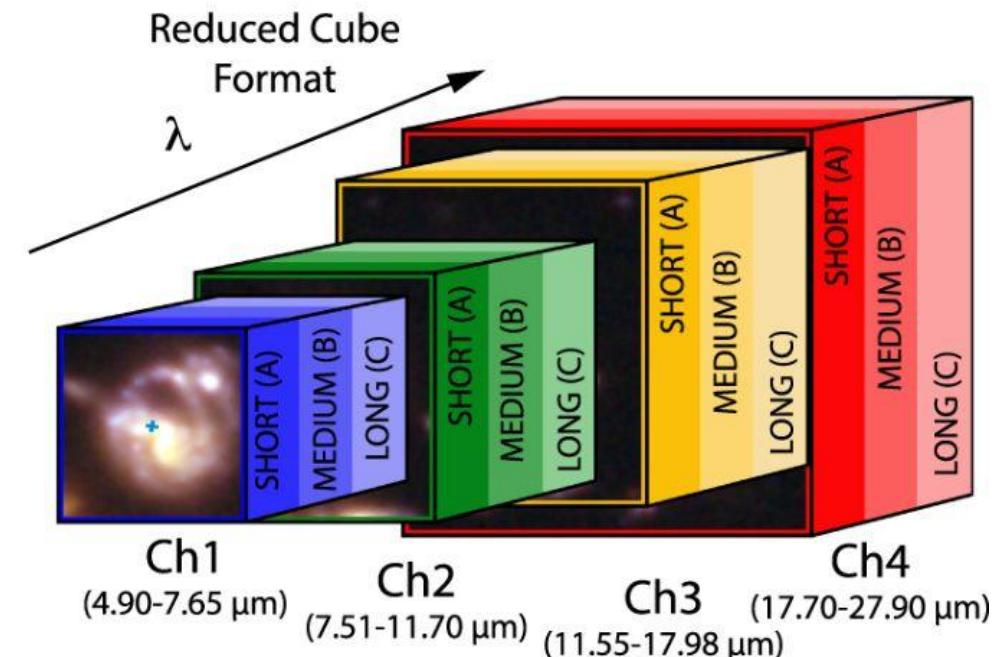
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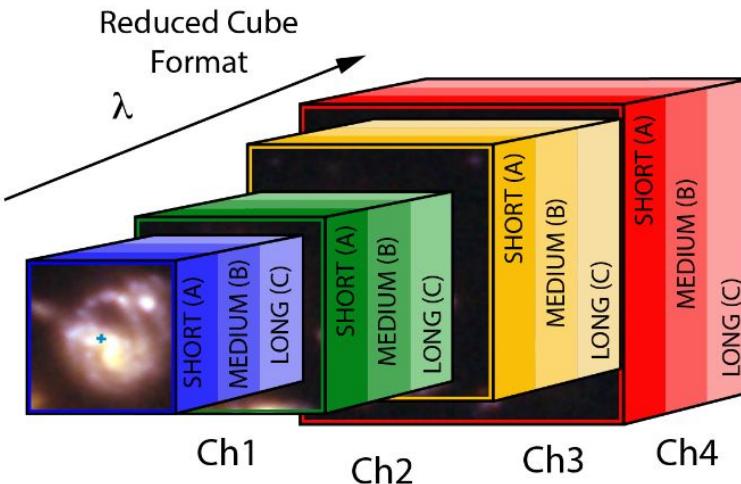




Summary of MRS and NIRSpec IFS

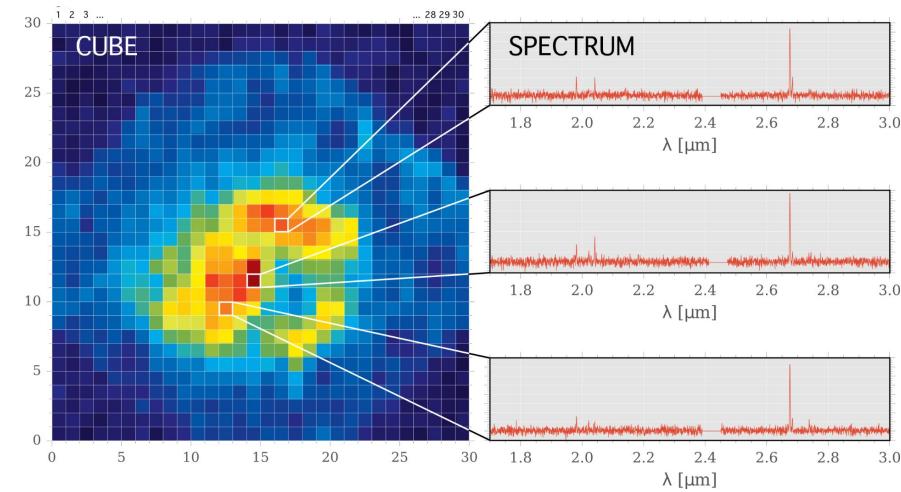
Medium Resolution Spectrograph (MRS)

- MIRI observing mode
- Wavelength coverage: $5\text{-}28\mu\text{m}$
- FoV: $3.7''\times 3.7''$ (Ch1) – $7.4''\times 7.9''$ (Ch4)
- Spectral resolution (R): 2000-4000
- Spatial resolution (PSF FWHM): sub-arcsec
- Slice size: $0.18''$ (Ch1) to $0.64''$ (Ch4)



NIRSpec IFS

- NIRSpec observing mode
- Wavelength coverage: $0.6\text{ - }5.3\mu\text{m}$
- FoV: $3''\times 3''$
- Spectral resolution (R): 100 / 1000 / 2700
- Spatial resolution (PSF FWHM): sub-arcsec
- Slice size: $0.1''$





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