



JWST

IVOA Focus Session on Multi-dimensional Data

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JWST is NASA's flagship mission

- Endorsed by the National Academy as a top priority for space-based astronomy in the 2000 Decadal Survey, science priorities reaffirmed in 2010 Decadal Survey
- Launch in 2018 out to L2, 5 year baseline mission with extension to 10 years
- Operates at cryogenic temperatures
- New generation of complex instrumentation to ensure diverse modes of operation without servicing:
 - >40 imaging filters
 - 7 coronagraphs for high-resolution imaging
 - 8 different types of spectroscopic modes

4 instruments for wide range of science all delivered to Goddard Space Flight Center



Near Infrared Camera

Near Infrared Spectrograph



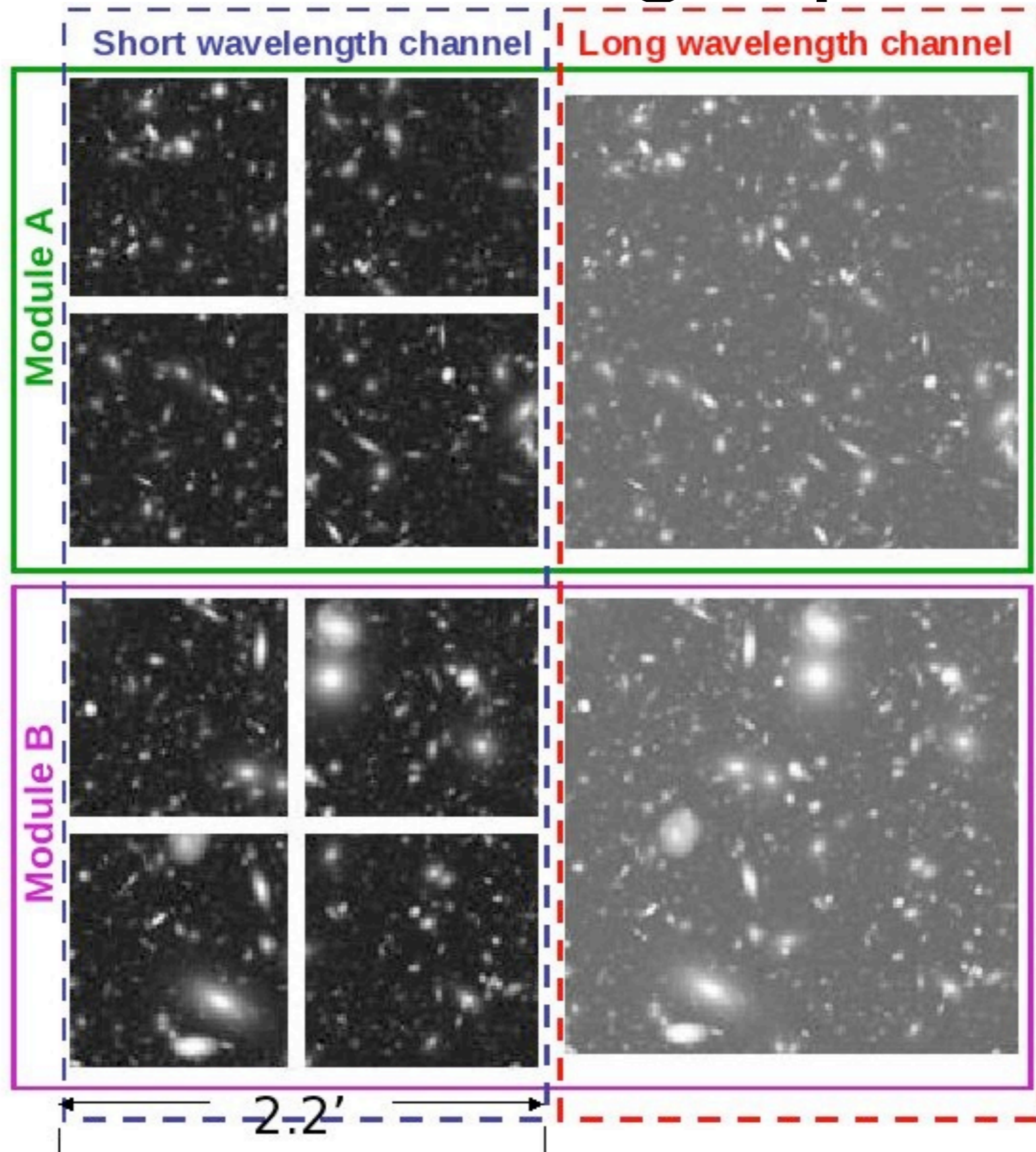
Mid Infrared Instrument

Near Infrared Imager & Slitless Spectrograph

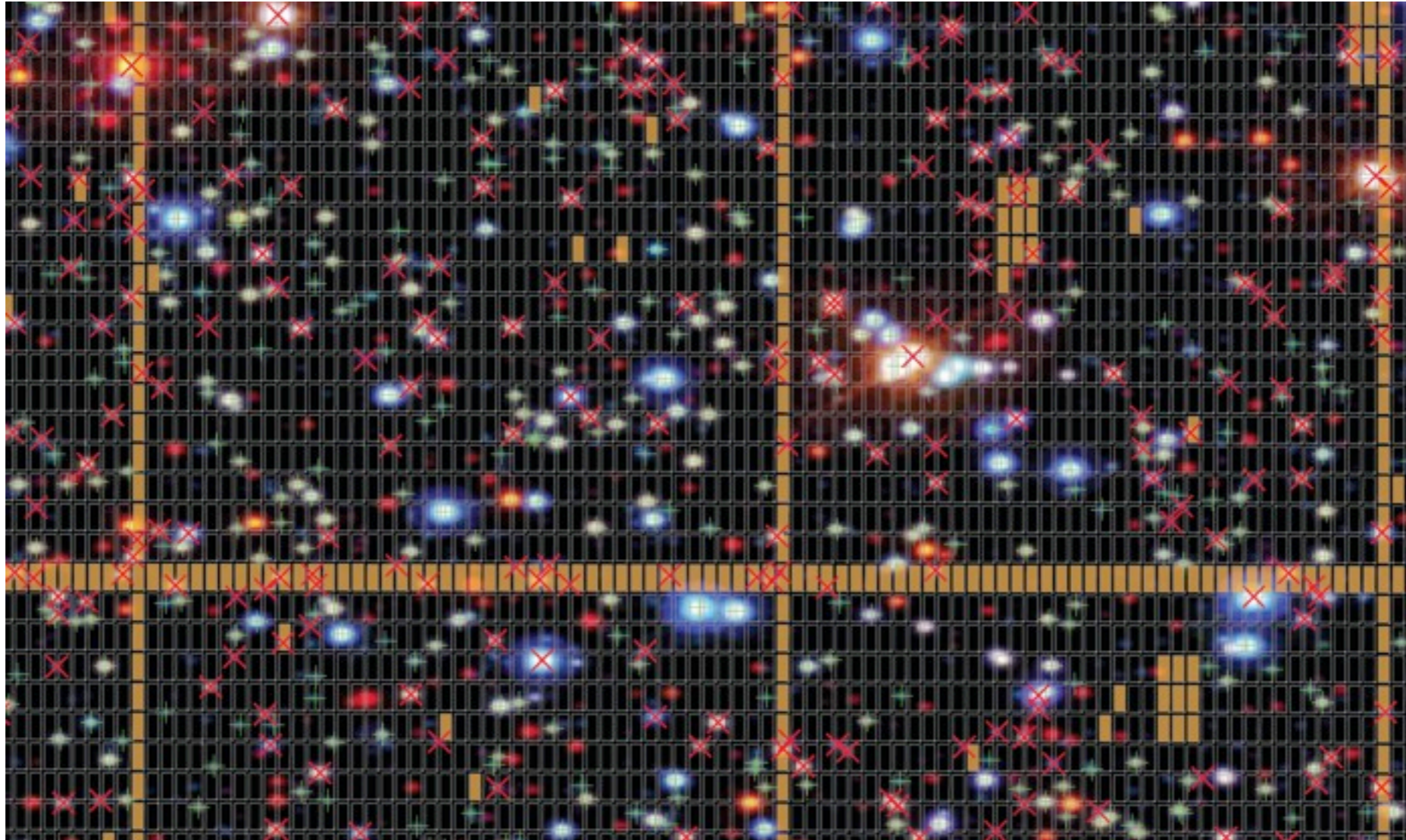


Diverse observing capabilities

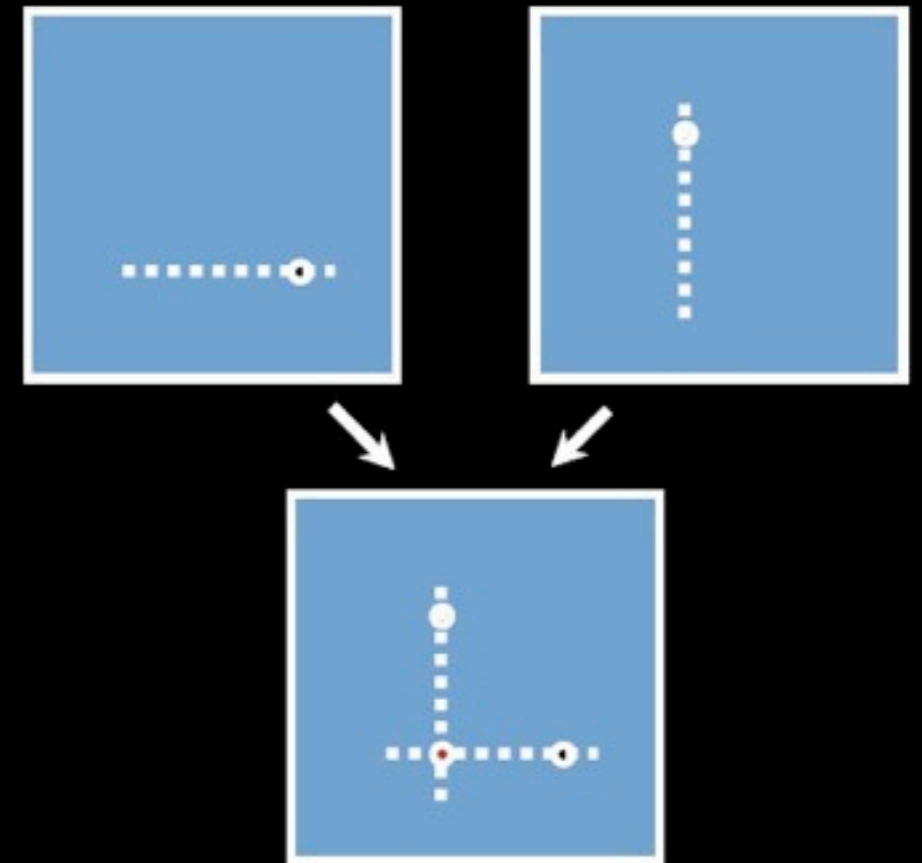
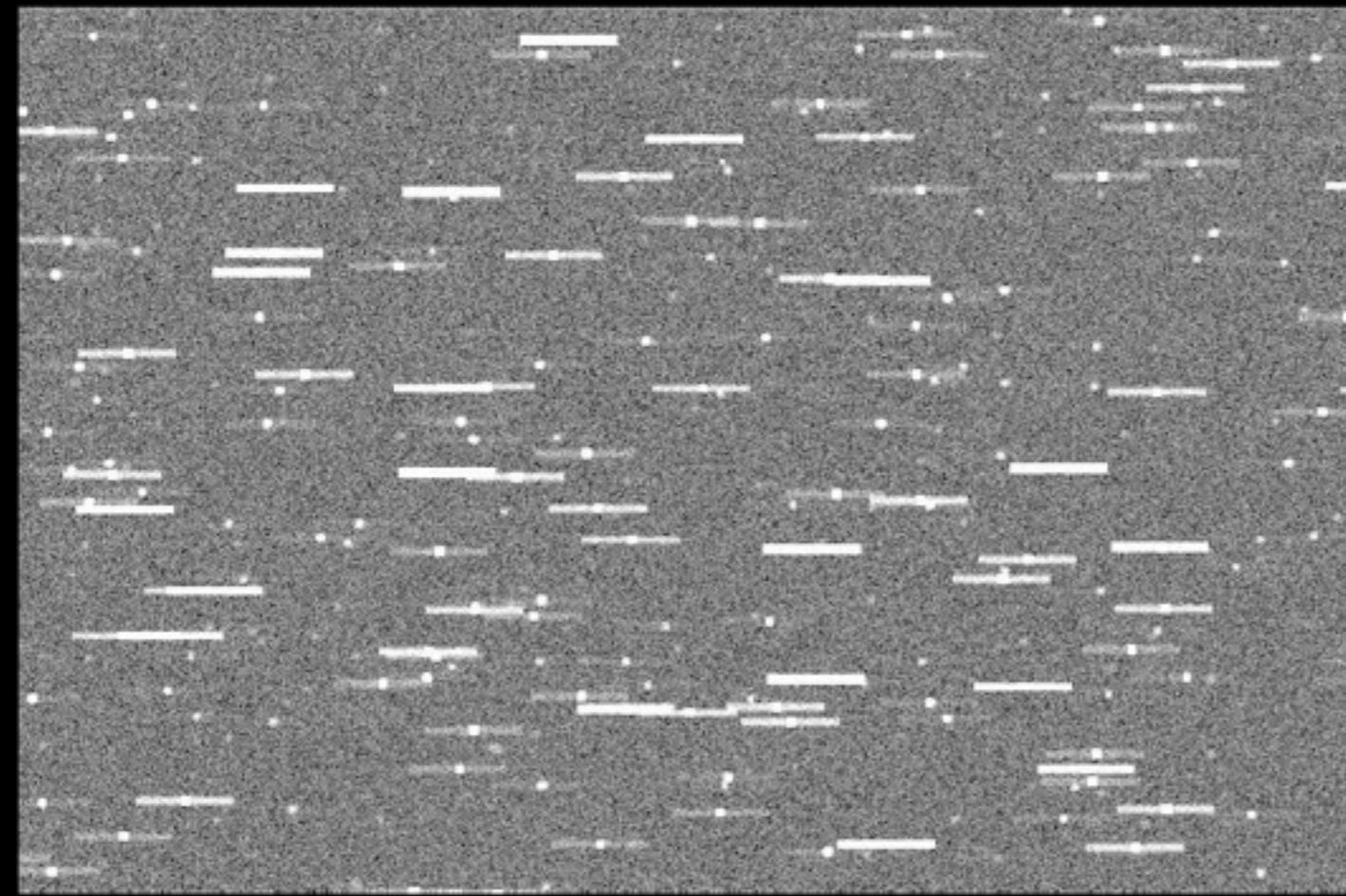
Diverse observing capabilities



Diverse observing capabilities

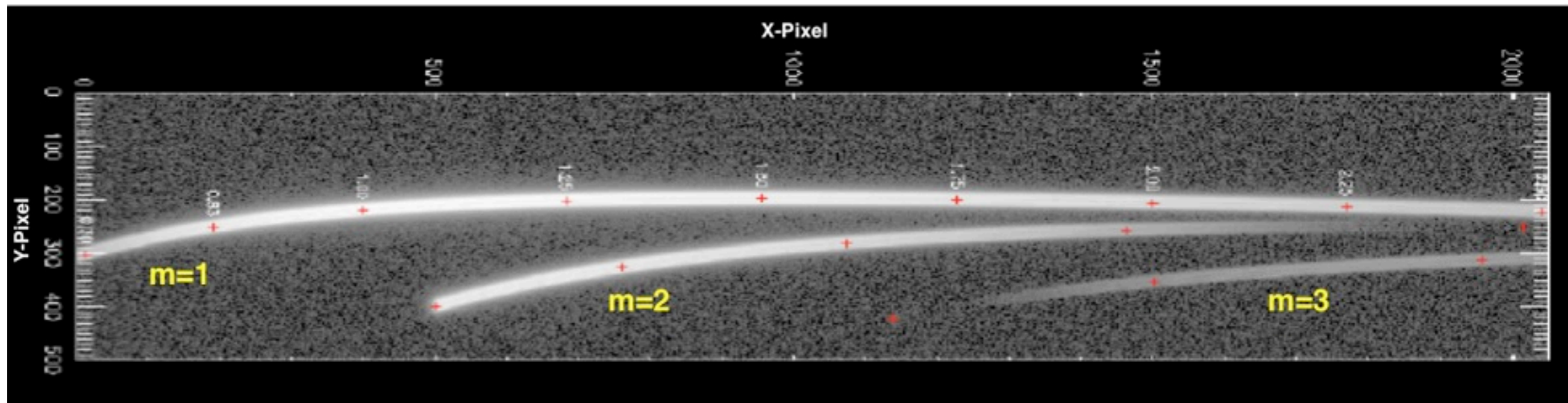


Diverse observing capabilities

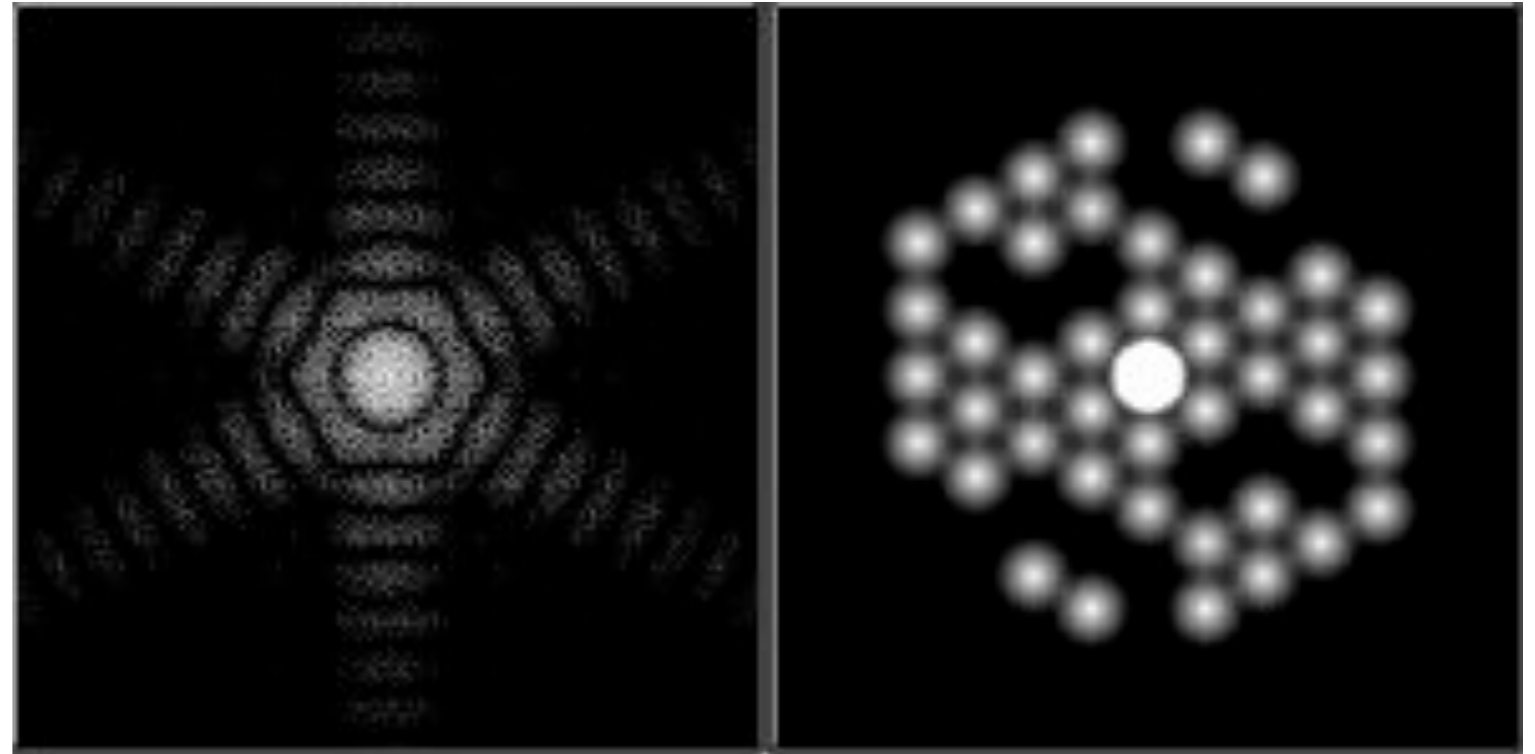


- A spectrum for every source in the field of view.
- Not restricted

Diverse observing capabilities



Diverse observing capabilities



Diverse observing capabilities



ND



Lyot diaph.
+
23 μm filter



4Q diaph.
+
15.5 μm filter

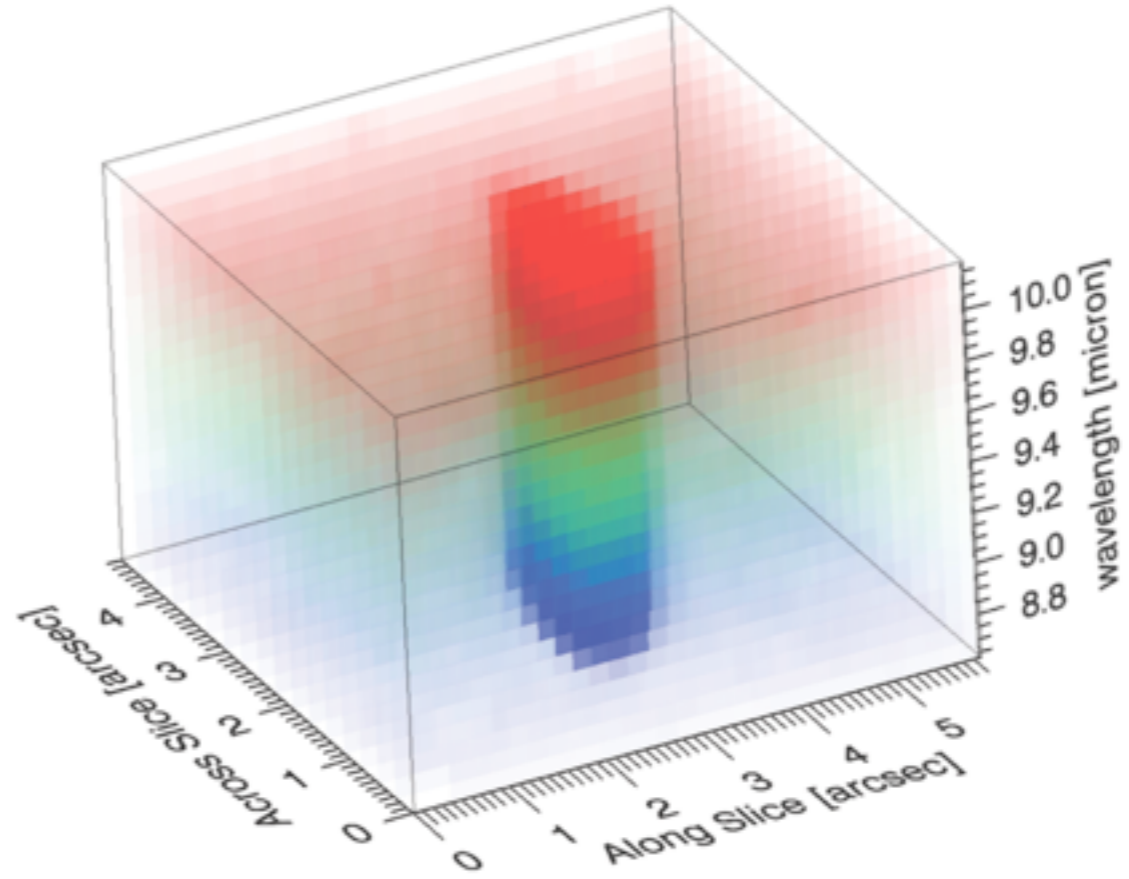


4Q diaph.
+
11.4 μm filter



4Q diaph.
+
10.65 μm filter

Diverse observing capabilities



JWST Imaging Modes

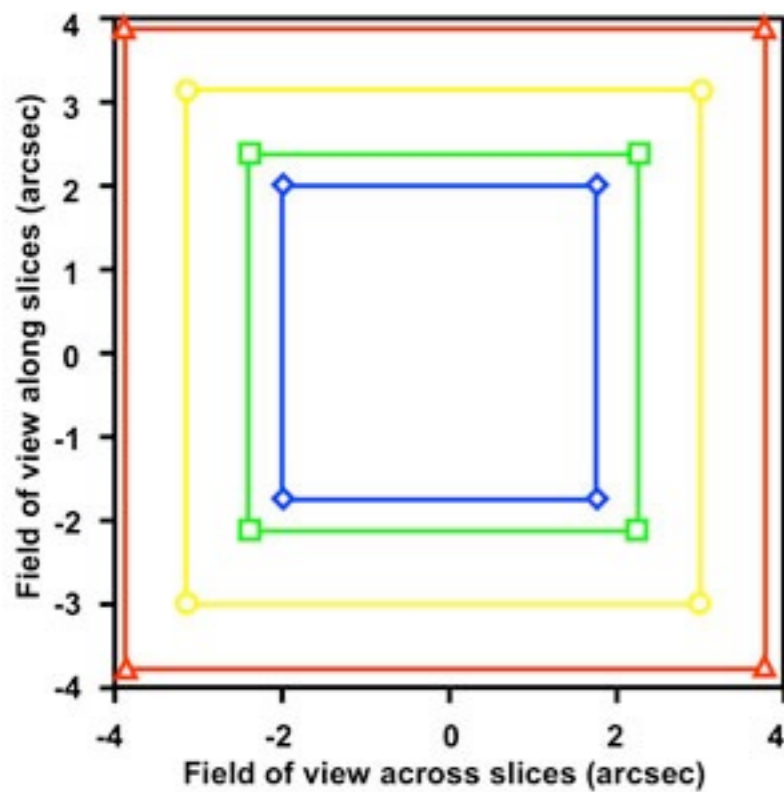
Mode	Instrument	Wavelength (micron)	Pixel Scale (arcsec)	Field of View
Imaging	NIRCam	0.6-2.3	0.032	2.2x4.4'
	NIRCam	2.4-5.0	0.065	2.2x4.4'
	NIRISS	0.9-5.0	0.065	2.2x2.2'
	MIRI	5.0-28	0.11	1.23x1.88'
Aperture Mask Interferometry	NIRISS	3.8-4.8	0.065	2.2x2.2'
Coronagraphy	NIRCam	0.6-2.3	0.032	20x20''
	NIRCam	2.4-5.0	0.065	20x20''
	MIRI	10.65	0.11	24x24''
	MIRI	11.4	0.11	24x24''
	MIRI	15.5	0.11	24x24''
	MIRI	23	0.11	30x30''

JWST Spectroscopic Modes

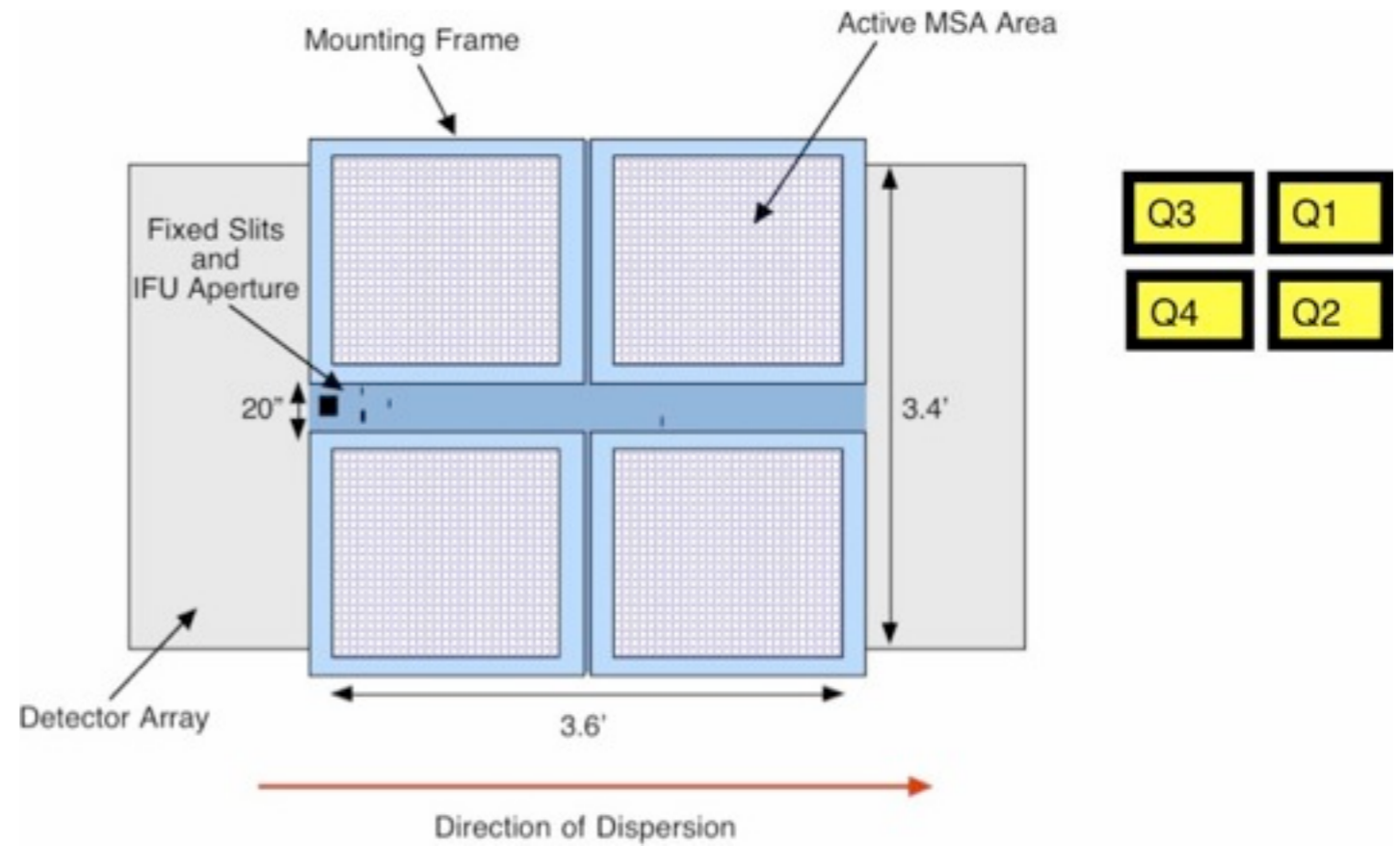
Mode	Instrument	Wavelength (micron)	Resolving Power ($R=\lambda/\Delta\lambda$)	Field of View
Slitless	NIRISS	1.0-2.5	150	2.2x2.2'
Spectroscopy	NIRISS	0.6-2.5	700	single object
	NIRCam	2.4-5.0	2000	2.2x2.2'
Multi-Object Spectroscopy	NIRSpec	0.6-5.0	100	3.4x3.4' with
			1000	250k 0.2x0.5''
			2700	microshutters
Single Slit Spectroscopy	NIRSpec	0.6-5.0	100	slits with
			1000	0.4x3.8''
			2700	0.2x3.3''
	MIRI	5.0- ~14.0	~100 at 7.5 microns	0.6x5.5'' slit
IFU Spectroscopy	NIRSpec	0.6-5.0	100	3.0x3.0''
			2700	
	MIRI	5.0-7.7	3500	3.0x3.9''
		7.7-11.9	2800	3.5x4.4''
		11.9-18.3	2700	5.2x6.2''
		18.3-28.8	2200	6.7x7.7''

IFUs have small fields of view, obtain low- and medium- resolution spectra

MIRI Channels 1-4 Fields of View



◆ Channel 1	5.00- 7.71 μm
■ Channel 2	7.71-11.89 μm
○ Channel 3	11.89-18.35 μm
▲ Channel 4	18.35-28.30 μm



NIRSpec IFU FOV is 3''x3''

Requirements on Data Management System (DMS) Tools I.

- utilize FITS data format
- utilize VO data access protocols
- provide a capability for users to run individual Calibration Pipeline steps on JWST data
- distribute Data Analysis Software to users on request
- provide a capability to display and analyze Archived Science Data and Science Data Products
- provide a capability for JWST users to perform data analysis functions on Science Data Products electronically from remote locations
- provide a capability for visualizing JWST data

Requirements on Data Management System (DMS) Tools II.

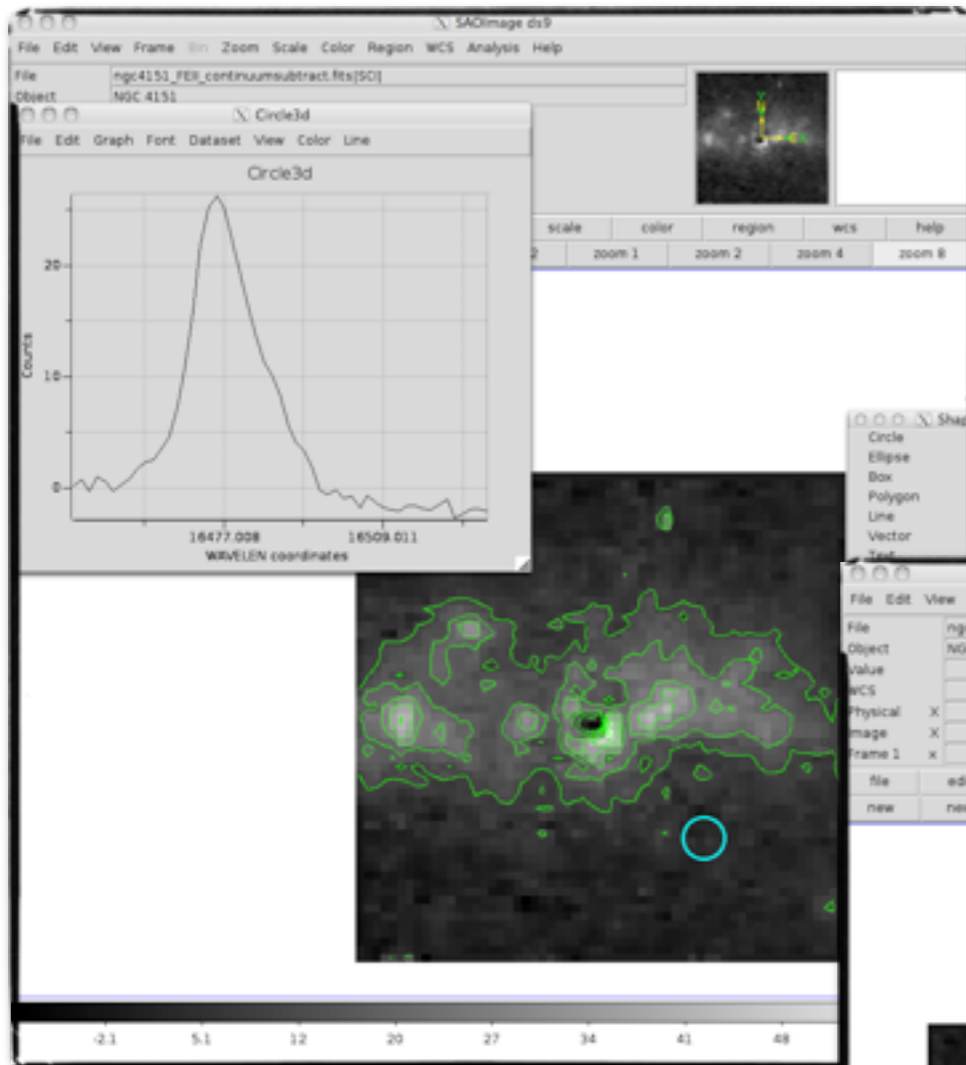
- provide a capability for arithmetic operations on collections of JWST datasets.
- provide the capability of comparing JWST Calibrated Science Data with models that can be cast into arrays with the same dimensionality as the Calibrated Science Data
- provide the capability to combine JWST datasets including tools to determine dataset registration and optimal combination of 1-d spectra, 2-d images and 3-d spectral data cubes.
- provide tools to support JWST coronagraphic science
- provide tools to enable analysis of JWST IFU data
- provide facilities for analyzing JWST spectral data
- provide tools for modeling JWST instrumental effects.

Current Data Analysis Efforts

- python based, modular
 - compatible with Python 2.x and 3.x
 - PEP8 coding style standard
 - use standard core libraries for
 - FITS IO
 - ASCII tables
 - VOTables
 - Physical Units/Quantities
 - WCS
 - Coordinates
 - Fitting/Models
 - Science Data Objects
 - use Travis/Shining Panda Continuous Integration tools
- designed to be generic, extensible: AstroPy collaboration

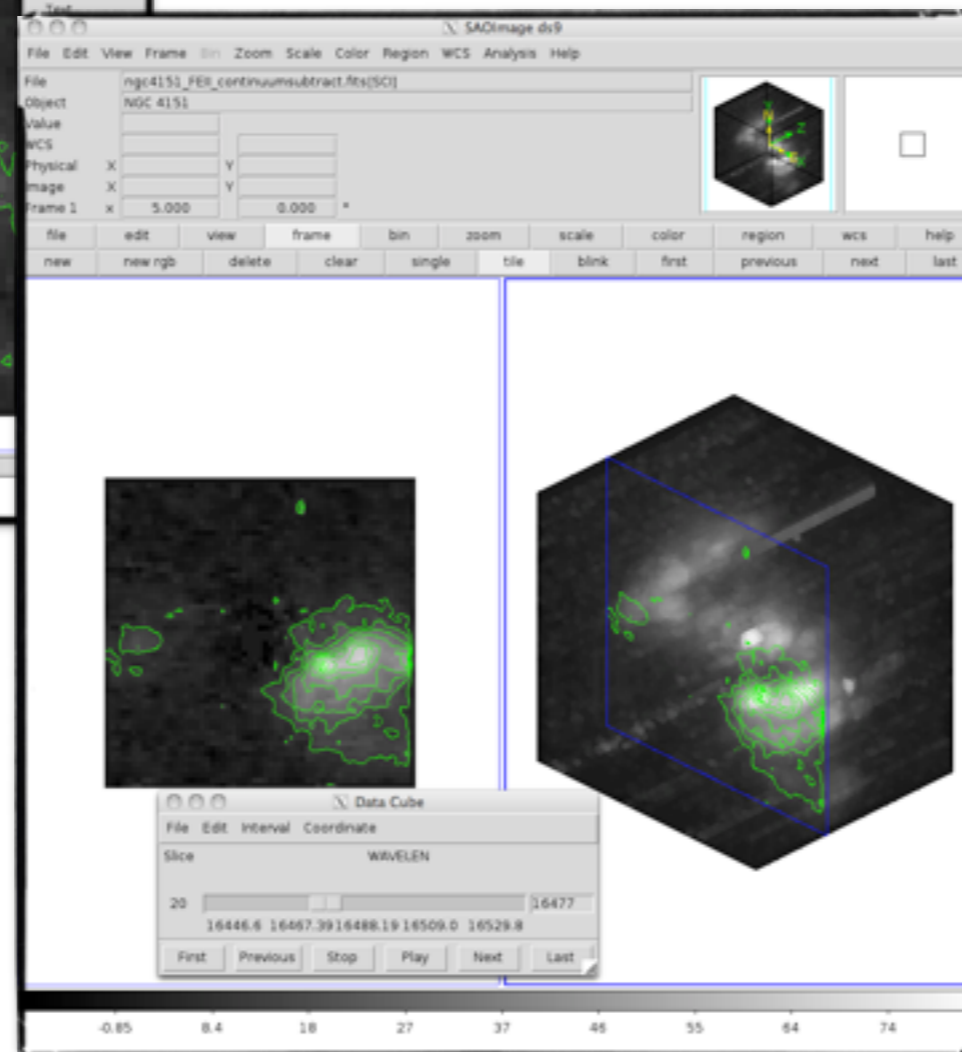
Work on next generation visualization tools
multiple dimensions: 1-D spectra, 2-D images/spectra, 3-D IFU datacubes

DS9 3D module



python replacement for IRAF imexamine task
interacts with DS9

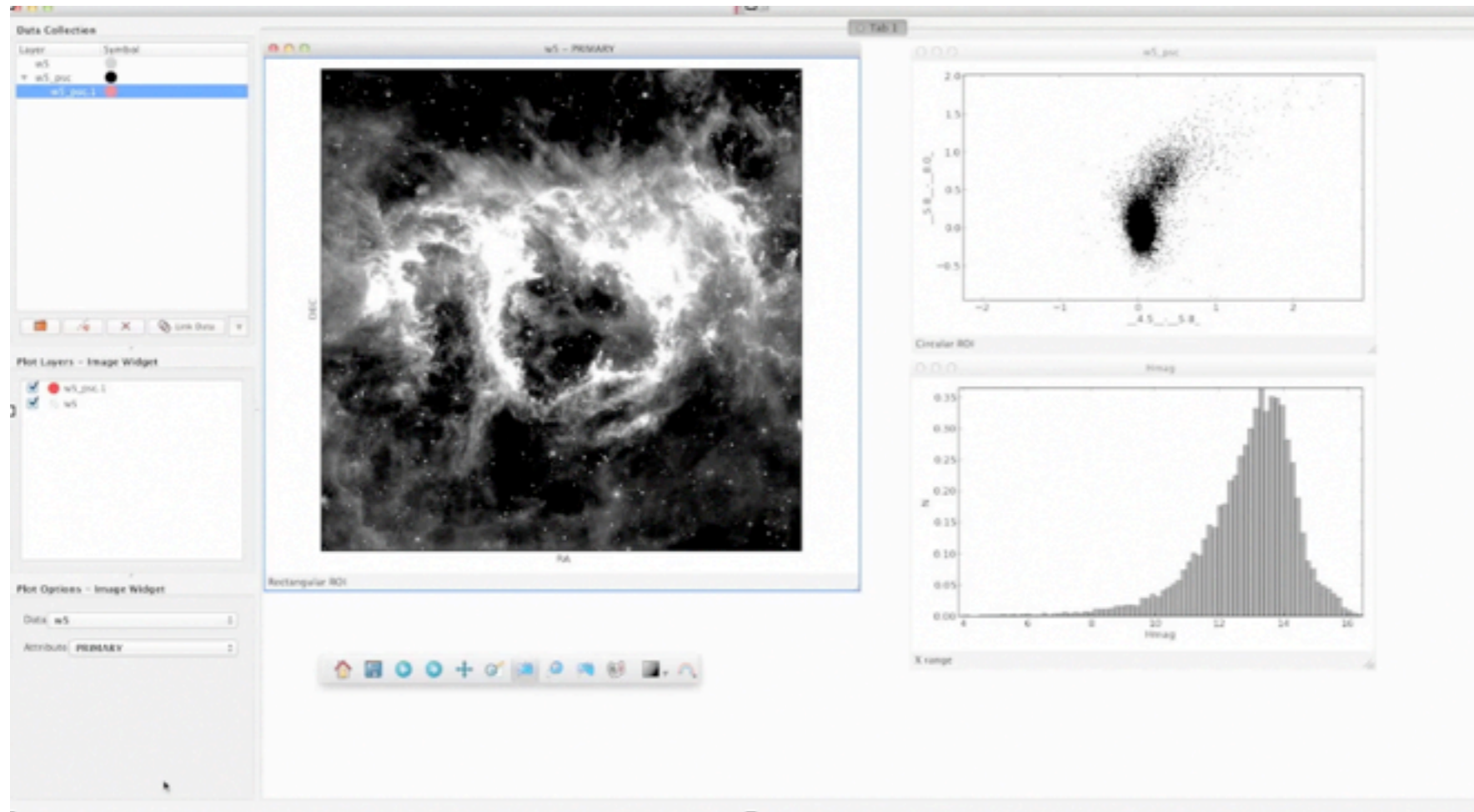
python scripts to interact with visualization tool



Work on next generation visualization tools

multiple dimensions: 1-D spectra, 2-D images/spectra, 3-D IFU datacubes

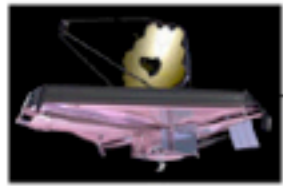
GLUE



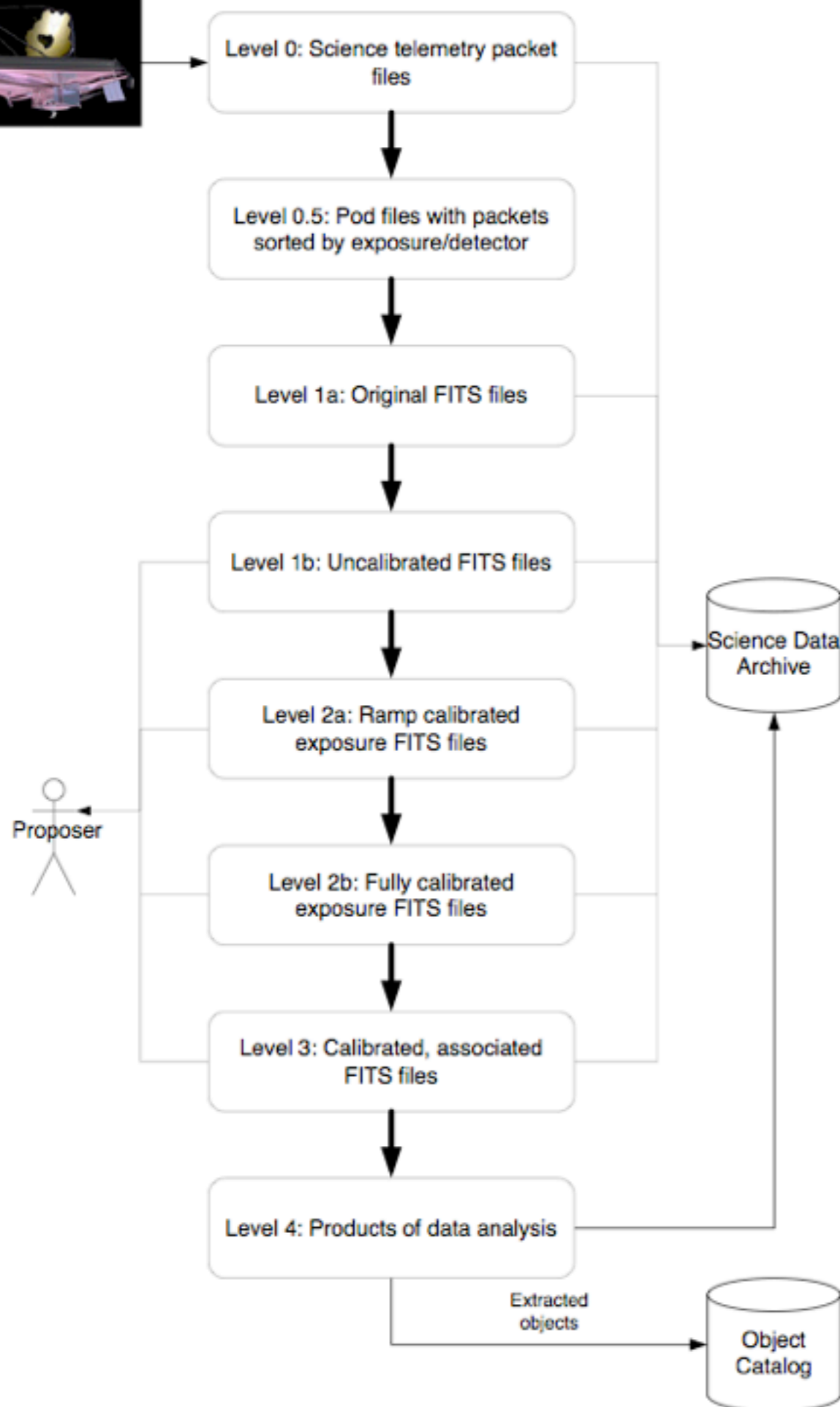
interactive layer on python matplotlib
offers linked view functionality
implementing cube visualization, scripting ability

Questions to consider

- What data products will be delivered?
- Is there a plan to do this in a VO-compatible manner?
- For data cubes, is there an intent to provide users with a capability to modify project-provided data before downloading it?



NIRCam Associations



Data products

- mosaic combined image (multiple detectors)
- dither combined image (if no detector)

Related files

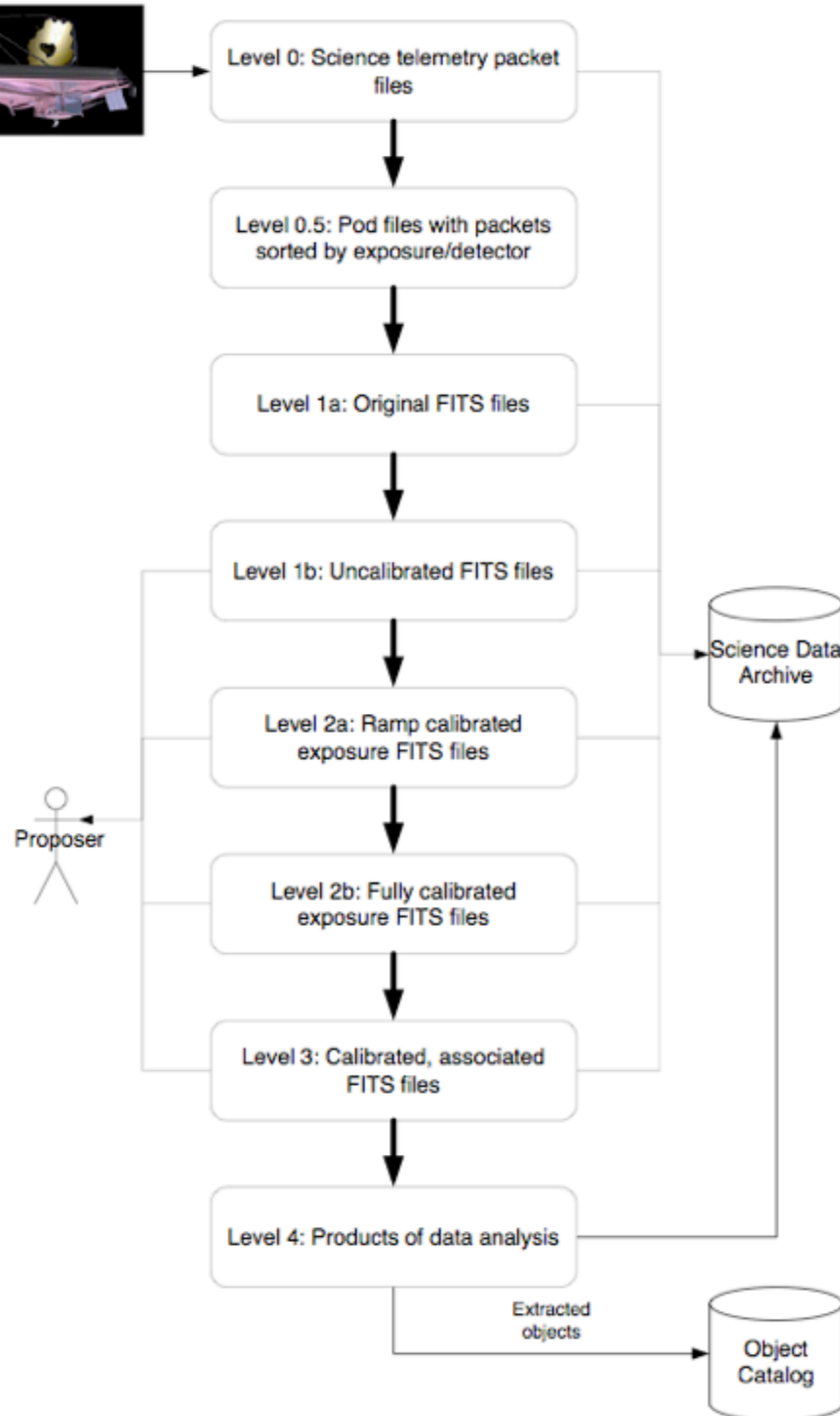
- individual exposures (single detector; levels 1a, 1b, 2a, 2b)
- coronagraphic target acquisition
- jitter data

Contemporaneous calibration files

- flats (taken with science exposure)
- persistence darks (in the distant future)



NIRSpec Associations



Data products

- extracted 1-d and 2-d spectra over both detectors
- MSA Source Catalog (level 4)

Related files

- individual exposures (single detector; levels 1a, 1b, 2a, 2b)
- target acquisition images
- confirmation images
- jitter data
- MSA Pre-image
- MSA Metadata file
- reference star file
- background exposures (may be shared among exposures)

Contemporaneous calibration files

- auto-flats
- wave-cals



MIRI Associations

Data products

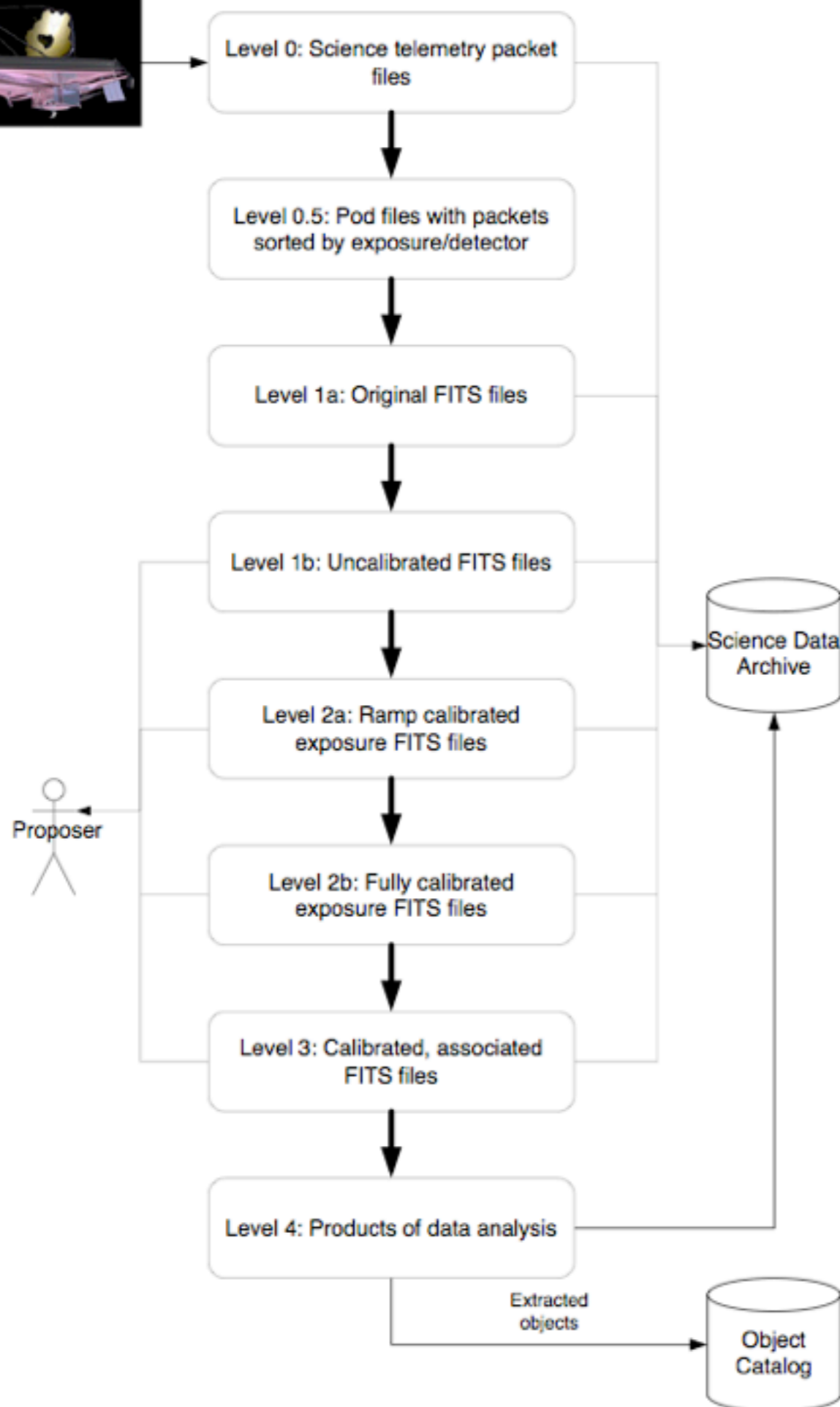
- mosaic combined image
- dither combined image (if no mosaic)
- extracted 1-d and 2-d spectra
- extracted 1-d and 2-d spectra over both IFU detectors

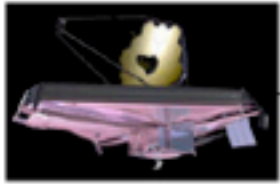
Related files

- individual exposures (single detector; levels 1a, 1b, 2a, 2b)
- coronagraphic target acquisition images
- spectroscopic target acquisition images
- jitter data

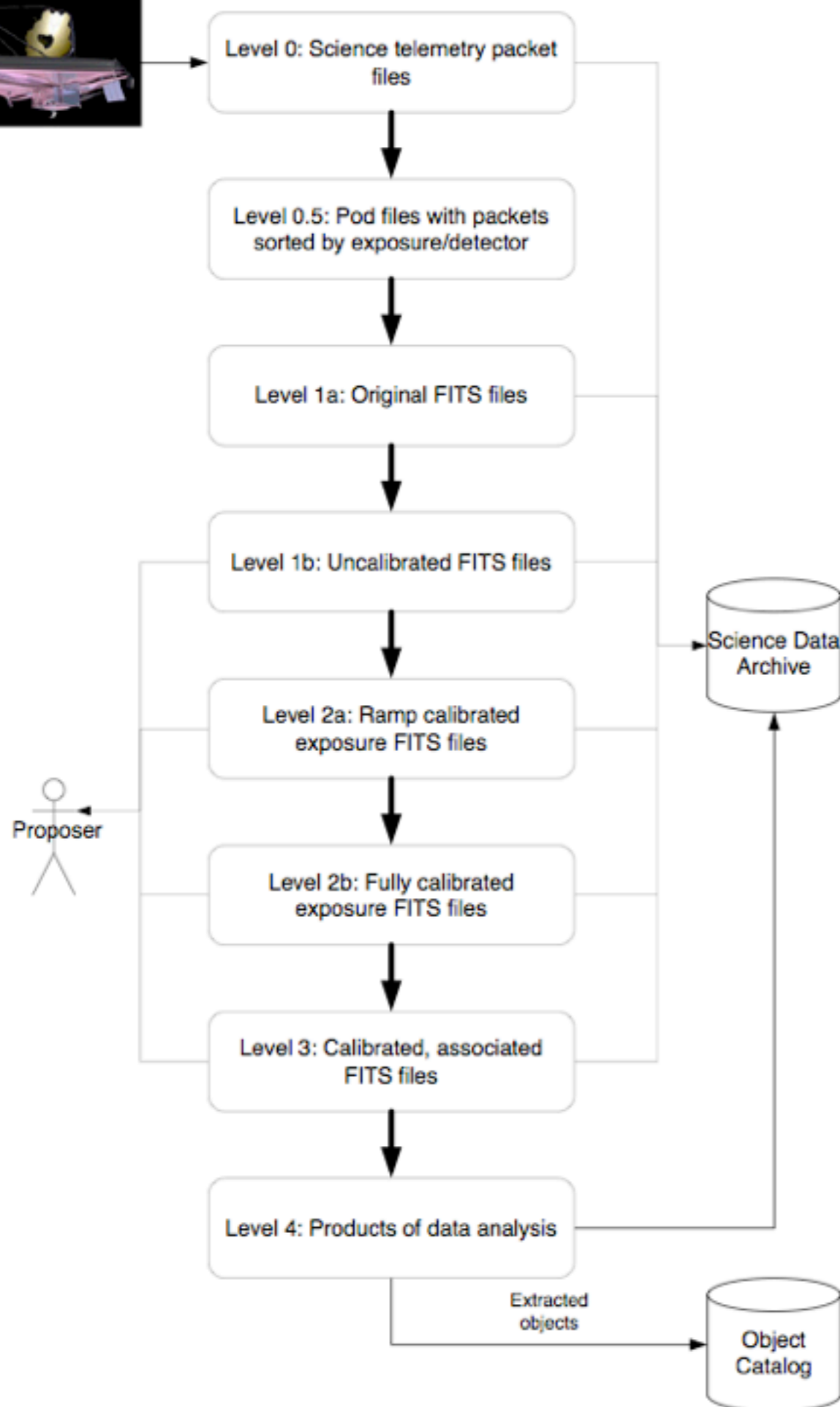
Contemporaneous calibration files

- imager internal flats
- MRS internal flats
- chopped background image
- persistence darks (in the distant future)





NIRISS Associations



Data products

- mosaic combined image
- dither combined image (if no mosaic)

Related files

- individual exposures (single detector; levels 1a, 1b, 2a, 2b)
- jitter data

Contemporaneous calibration files

- point source image for PSF characterization
- persistence darks (in the distant future)