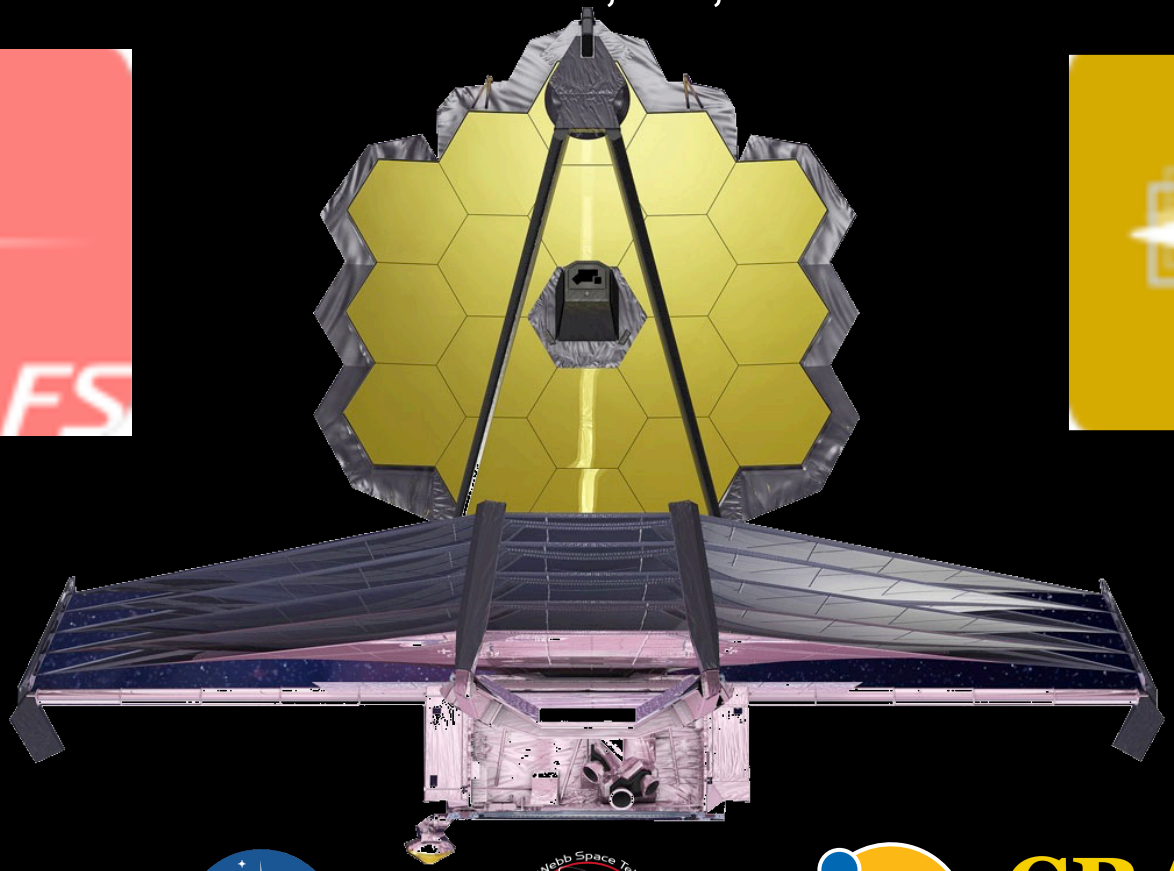
Single Object Spectroscopy with JWST

CSA webinar #4

December, 20, 2017

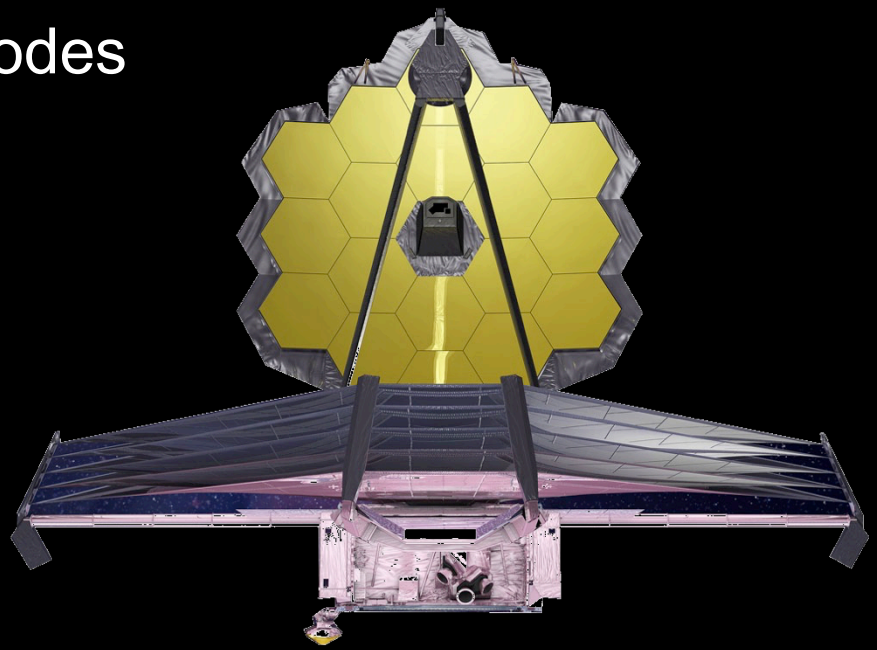


Université de Montréal

Outline

Recap of JWST spectroscopy modes

Demo with a science case



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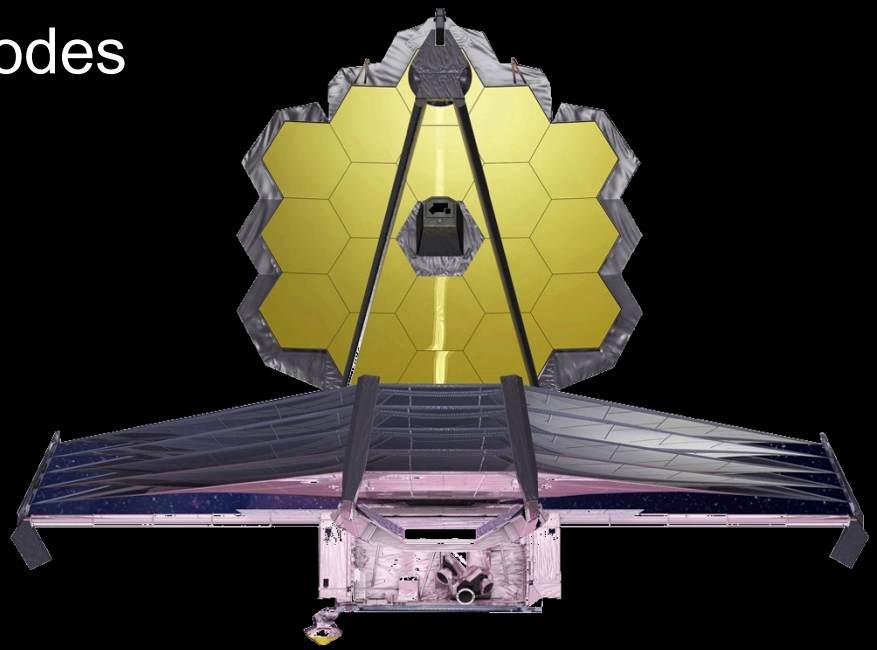
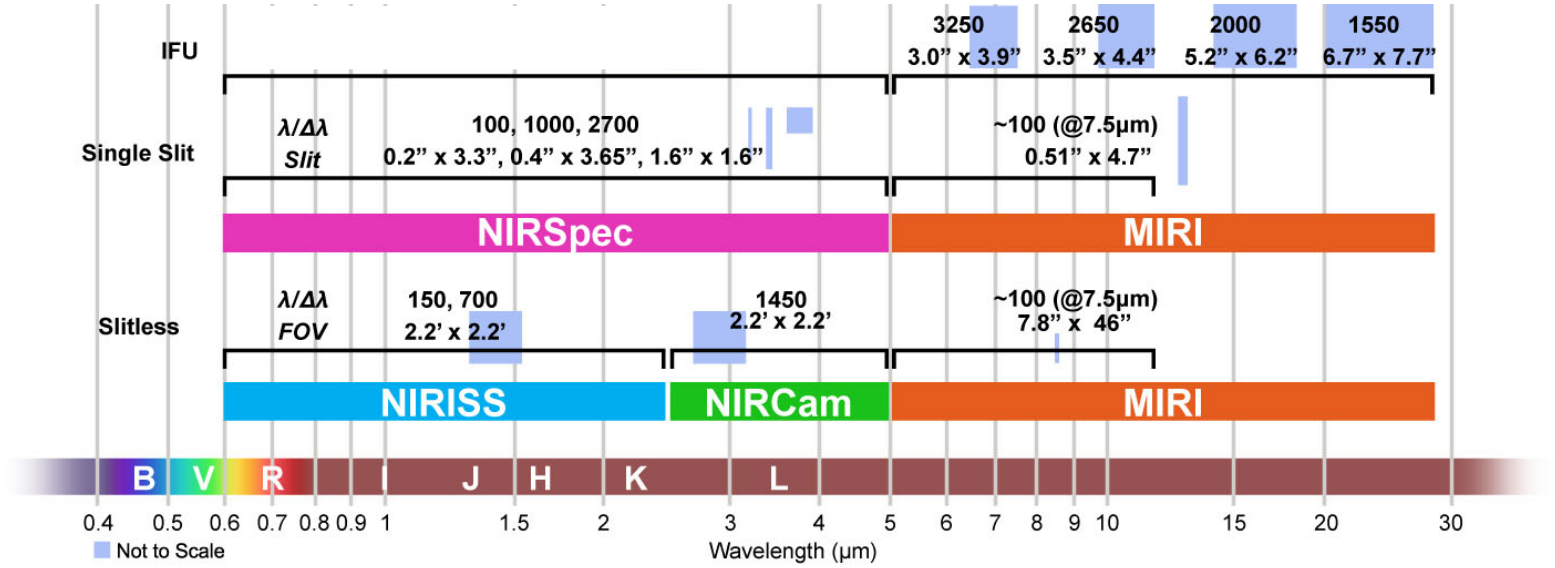
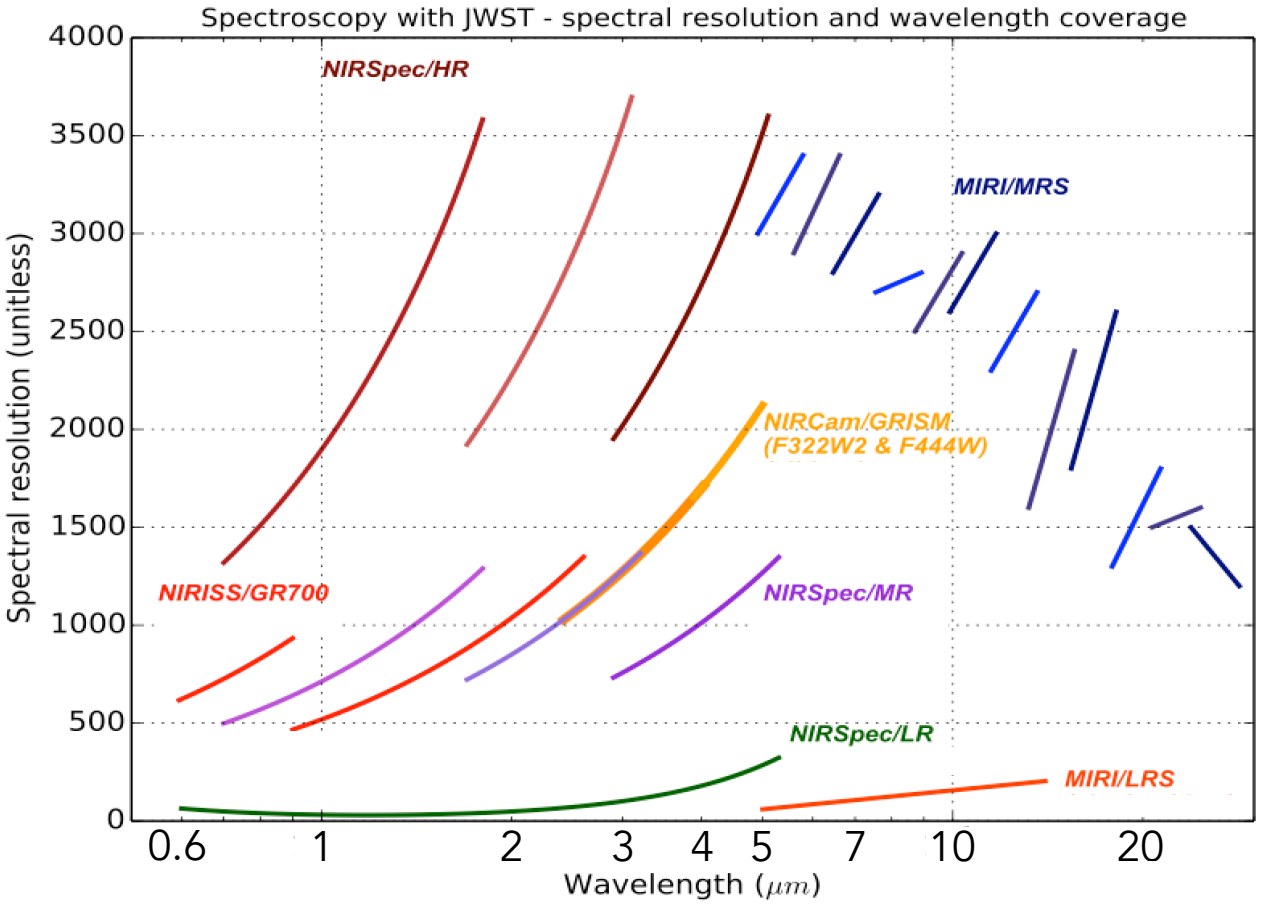


Wavelength coverage from 0.6 to 29.8 μm with the four instruments



©G. Kriss

Modes and Resolutions



7 configurations
0.7-28 μm
R~2700

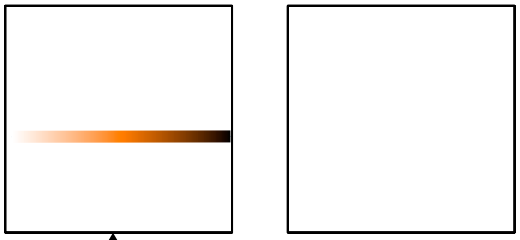
5 configurations
0.6-5 μm
R~100

2 configurations
0.6-12 μm
R~100

©P. Ferruit

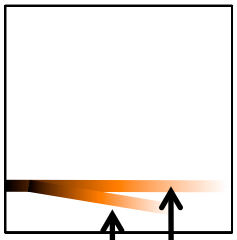
Spectra dispersed on the detectors

NIRCAM



GrismR spectrum
on module A

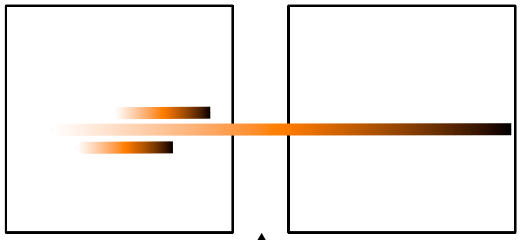
NIRISS



Order 2

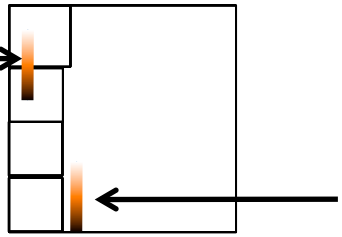
Order 1

NIRSpec



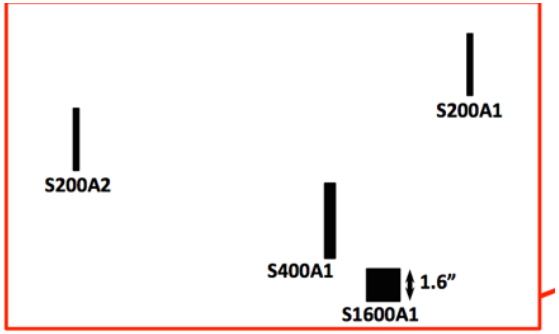
Gap at high R

MIRI



Slitless
spectrum

Slitted
spectrum



View of the NIRSpec slits
in the focal plane

Saturation limit at any λ for a G2V star

Inst	Disperser	Filter	λ	Limit	Ng	Amp
NRS	PRISM	CLEAR	0.6–5.3	J>9.8	1	1
	G140H	F100LP	1.0–1.9	J>6.6		
	G235H	F170LP	1.7-3.1	J>5.9		
	G395H	F290LP	2.9–5.2	J>5.1		
NIS	GR700XD		0.6–2.8	J>7.2	1	1
			1.0–2.8	J>6.0		
NRC	GRISMR	F322W2	2.4–4.0	K>4.6	2	4
	GRISMR	F444W	3.9–5.0	K>3.7		
MIR	LRS		5.0–12	*K>5.4*	2	

Partial saturation is allowed
The ETC has the final word on saturation limit

Use slits for a faint target

NIRSpec and MIRI slits:

- Wavelength coverage is 0.6-12 μm (2-5 settings);
- NIRCam and NIRISS do not have slits.

A slit reduces dispersed background:

- Line and continuum sensitivities are better;
- NIRSpec is ~2-5x more sensitive than NIRCam;
- MIRI slit is ~10x more sensitive than MIRI slitless;
- Slitless spec. might be contaminated by neighbors.

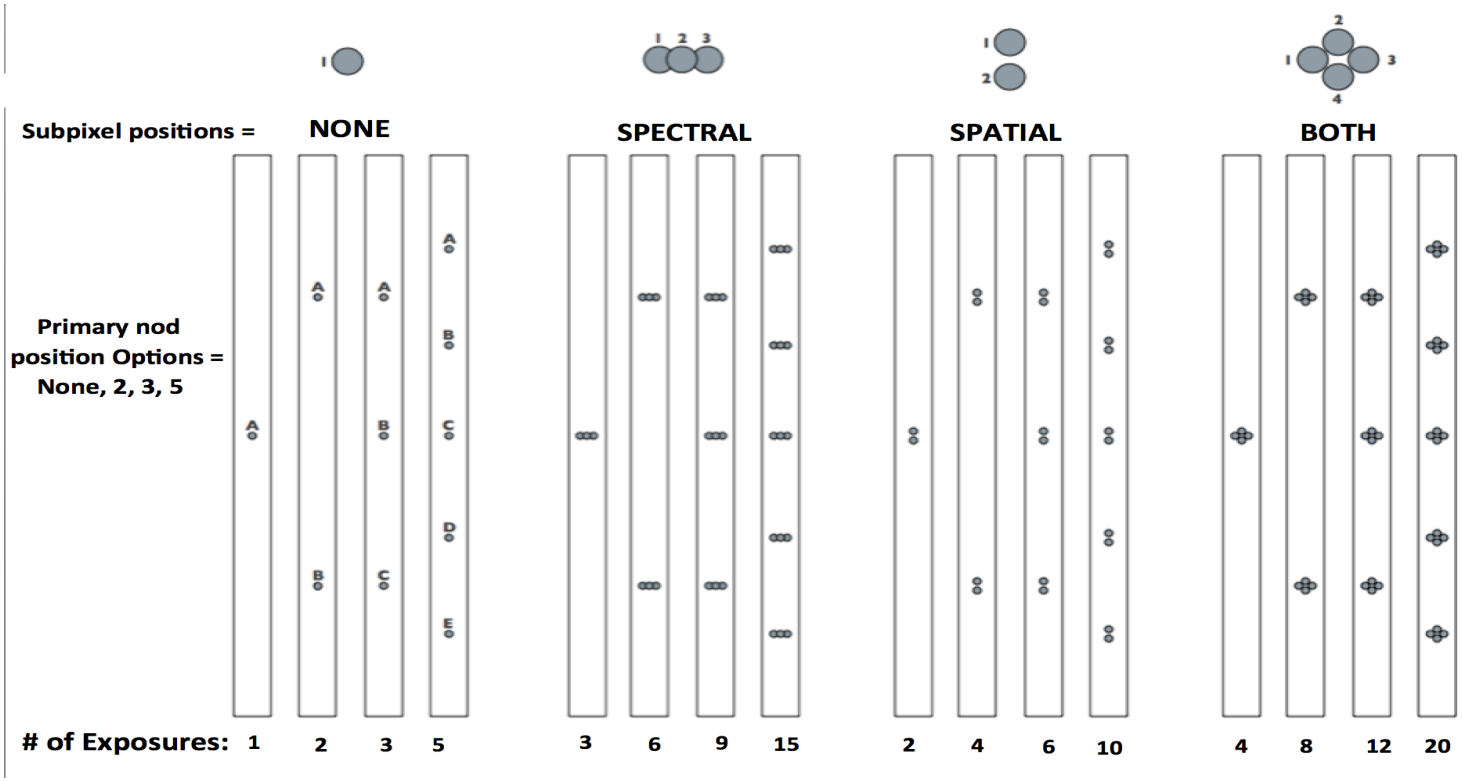
(Slit is sensitive to flux loss)

Nodding/Dithering for pixel sampling, cosmetics and background estimates

NIRSPEC:

- primary nods along the slits
- secondary dithering (spectral, spatial or both)

+ special mode in case of high R and full λ coverage (A1&A2)



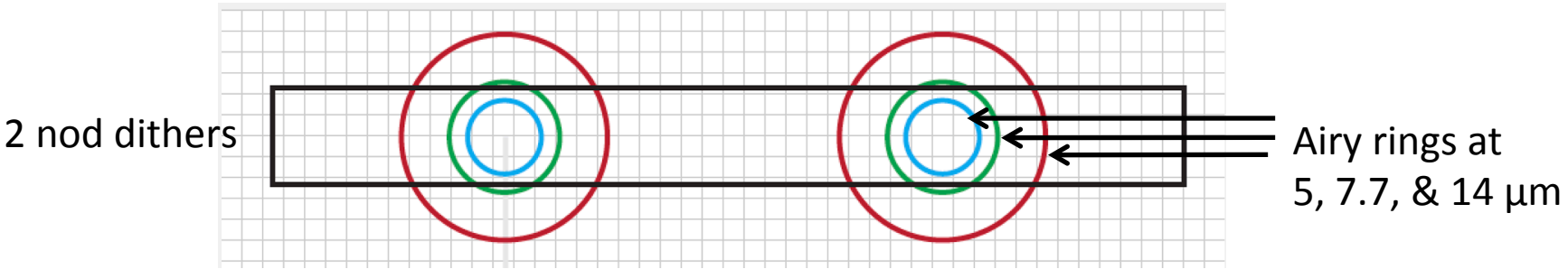
©JDox

Nodding/Dithering for pixel sampling, cosmetics and background estimates

MIRI with slit only:

- 2 nods along slit
- user-free (spatial and spectral) dithers

for extended source mapping



NIRISS & NIRCAM: none

Times Series Observations

NIRSpec BOTS:

- use the 1.6’’x1.6’’ square aperture (S1600A1, R~100-2700)

NIRISS SOSS (R~700)

MIRI Slitless LRS (<12 μm, R~100)

NIRCAM Grism time series (R~1500) & imaging time series

Very long exposures (>10000s)

No nodding/dithering for stability

Subarrays

Fast readout modes

Target acquisition is required (SNR>30)

Mandatory for all SOS modes
Specific modes in ETC

NIRSpec (20mas centroid accuracy):
- WATA via the S1600A1 aperture (recommended without PA constraint)
- MSATA via MSA but not available for BOTS

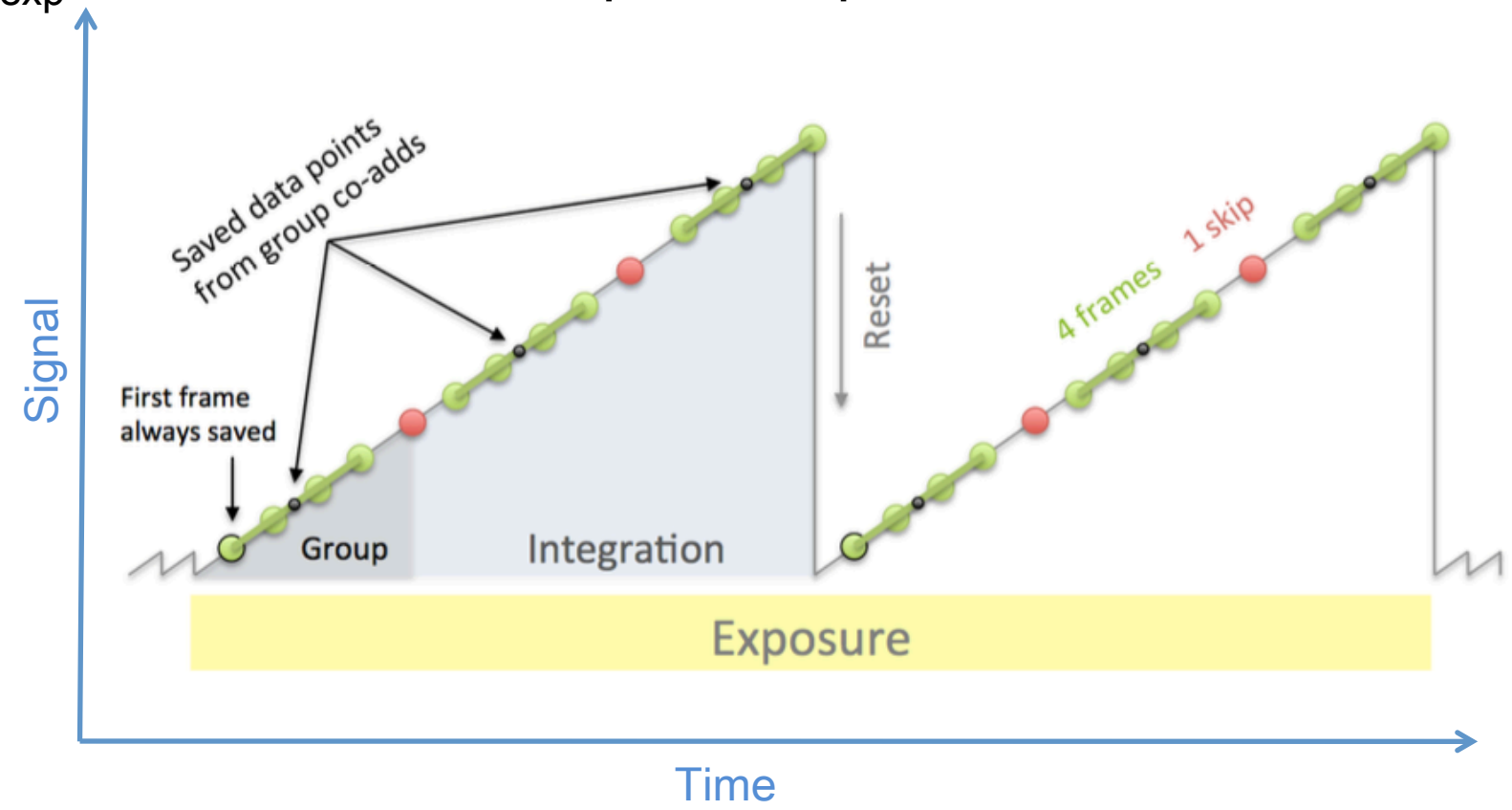
NIRISS:
- SOSSBRIGHT for objects with M<6.1mag
- SOSSFAINT otherwise

NIRCAM: 1 option with any filter

MIRI: 1 option with 3 filters + 1 ND

Review your IR vocabulary

N_f is the number of frames averaged in a group
N_g is the number of groups in an integration (ramp)
N_{int} is the number of integrations (ramps)
N_{exp} is the number of exposures per visit



©C. Chen

Readout patterns

MIRI:

- FAST (default): N_f=1, N_s=0, t_f=2.775s
- SLOW (not available for slitless): N_f=1, N_s=0, t_f=23.88s

NIRISS:

- NISRAPID: N_f=1, N_s=0
- NIS (faint source): N_f=4, N_s=0

NIRSpec:

- NRS: N_f=4, N_s=0
- NRSRAPID: N_f=1, N_s=0

+ IRS^2 (with full array only)

NIRCAM:

- Full suit of modes depending on brightness and int. time

Subarrays

NIRCAM:

- 2048x64/128/256 (only for TSO), & FULL

MIRI:

- SLITLESSPRISM & FULL (when slitted)

NIRISS:

- SUBSTRIP96, SUBSTRIP256 (x2048)

NIRSpec:

- one/slit, ALLSLIT (mandatory for the highest resolution and wavelength coverage using S200A1&2) and FULL (for IRS^2)

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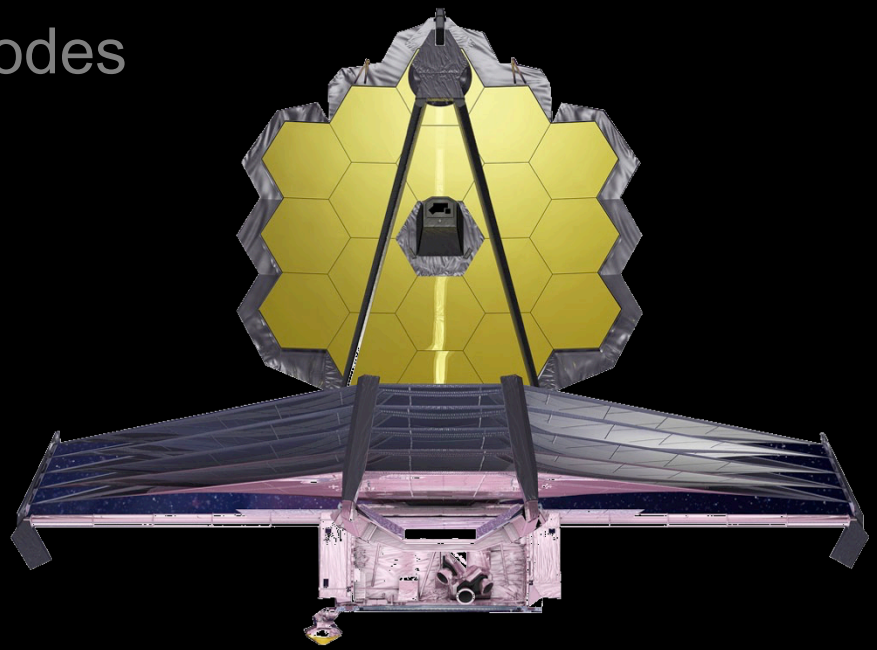
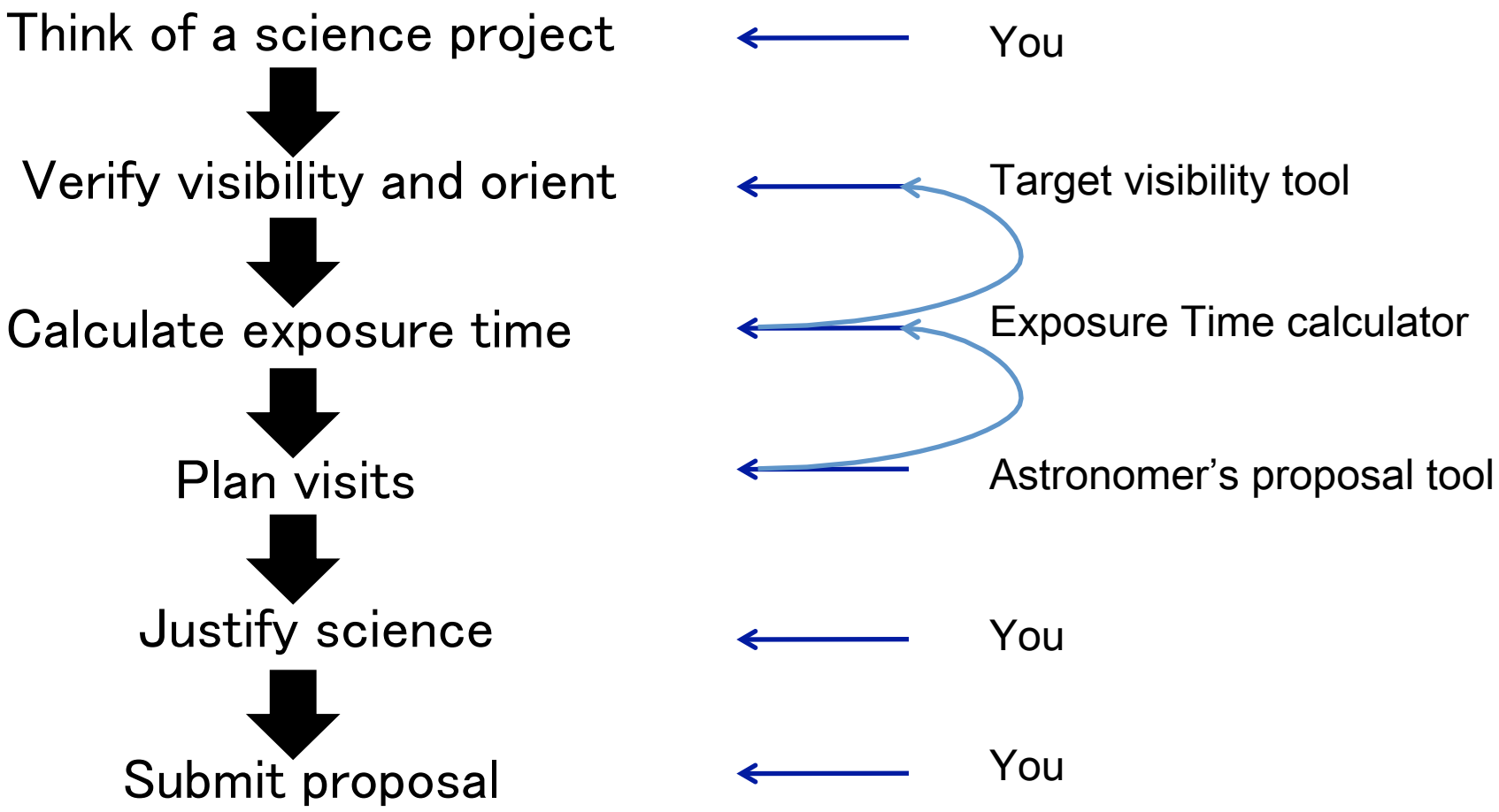


JWST Cycle 1 proposals are due by Apr 6, 2018, in a single phase.



Demo: NIRSpec+MIRI spectroscopy

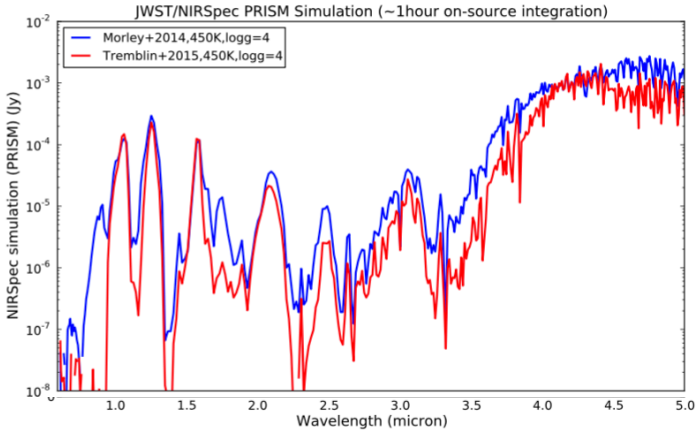
IR spectroscopy of a faint Y brown dwarf

© ESAC Workshop (De Olivera)

Goal: Atmospheric characterization of a cool brown-dwarf in the infrared to understand the origin of the chemistry disequilibrium (water clouds or vertical mixing) and constraints its gravity (mass)

Method: Low and medium resolution 0.6-12 micron slit spectroscopy to be compared with forward models at SNR>25 (~1 μm) and >100 (~4.7 μm)

Source: Point



Other useful informations

All JWST data will be reduced by the STScI pipeline (python)
Additional sets of tools are available for analysis
http://ssb.stsci.edu/doc/jwst/jwst/introduction.html

Simulated datasets are available for training
http://archive.stsci.edu/jwst/simulations/index.html

Everything you need to know
(observatory, planning, policies, data): JDox
jwst-docs.stsci.edu

Thank you