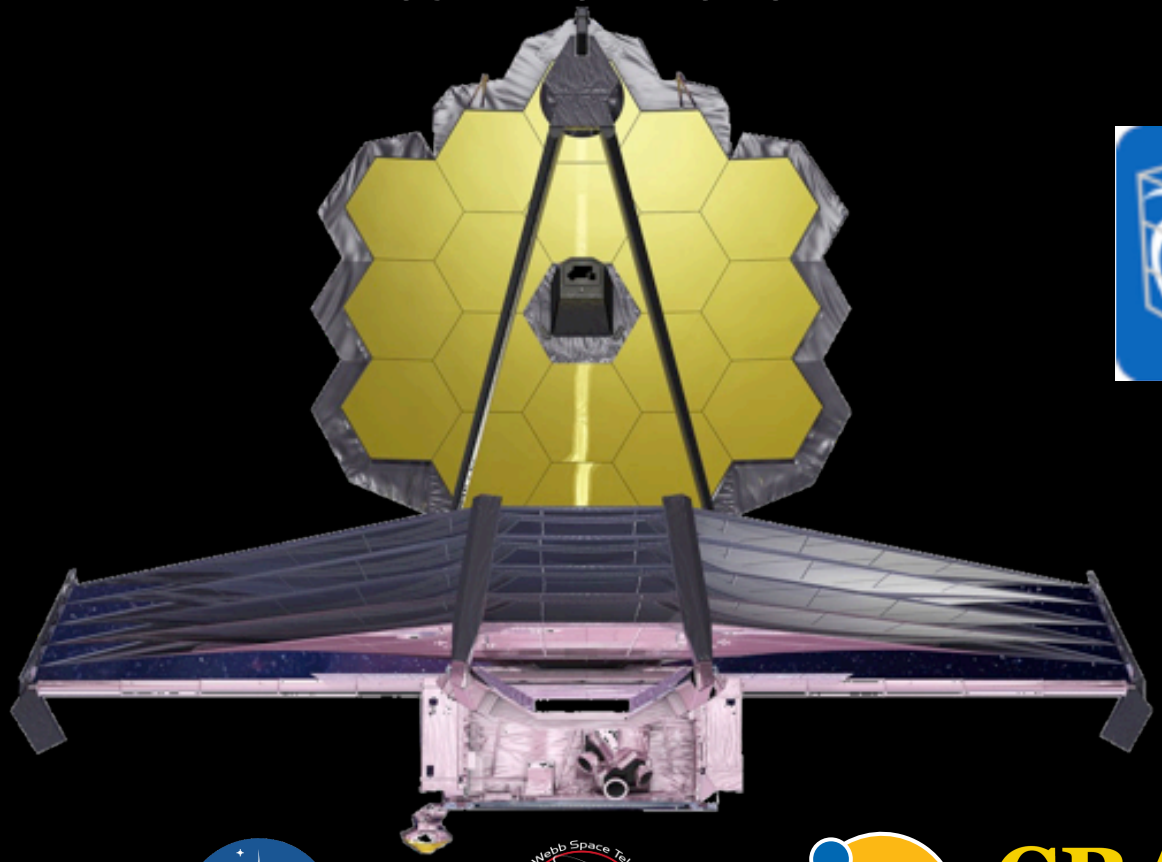
Integral Field Spectroscopy with JWST

CSA webinar #5

Jan. 10th 2018



Université de Montréal

Outline

Recap of JWST IFS modes

Demo with a science case

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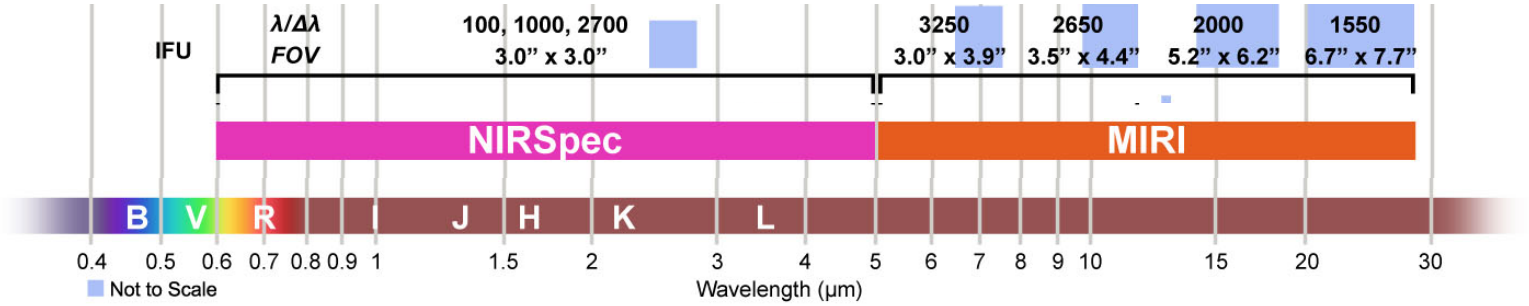
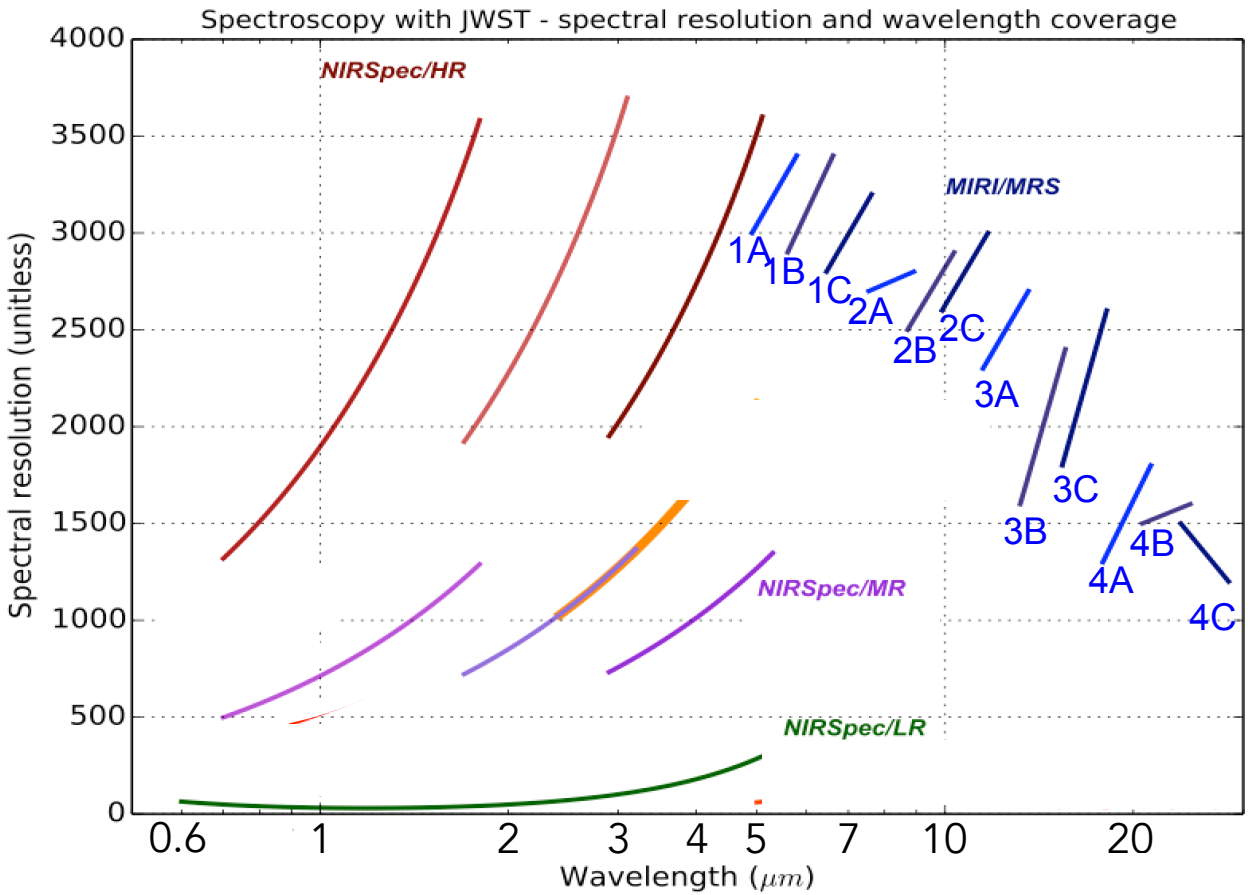
Demo with a science case

Wavelength coverage from 0.6 to 29.8 μm via 16 configurations



	NIRSpec IFU	MIRI MRS
Wavelength	0.6-5 μm	4.88-28.55 μm
Resolution	30-3600	3250-1550
FoV	3"x3"	3.7"x3.7"/7.7"x7.95"
Sampling	0.11"	0.196"-0.273"

Modes and Resolutions



7 configurations
0.7-28.5 μm
R~1600-3600

3 configurations
0.7-5 μm
R~500-1300

1 configuration
0.6-5 μm
R~30-300

©P. Ferruit

MIRI MRS complex design

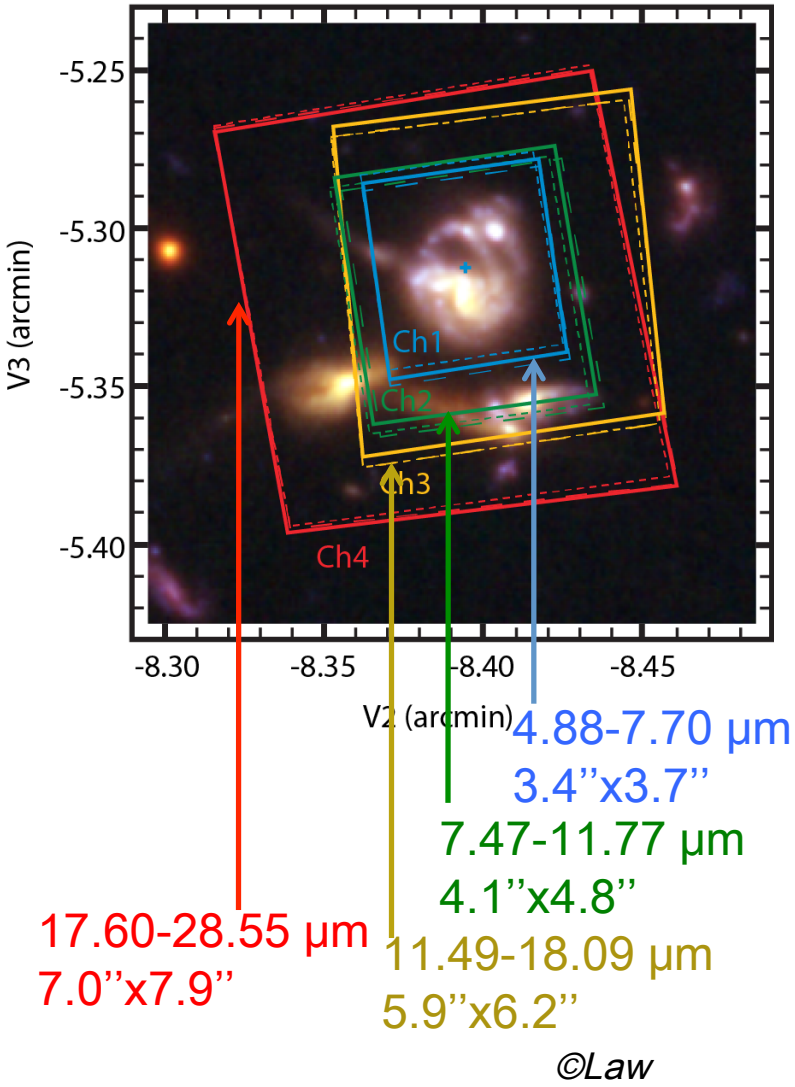
4 IFUs (channel 1, 2, 3, 4)

Simultaneous coverage in all channels

(=>same exposure length)

All channels have concentric fields of view

Choose a channel or all to drive the dither and mosaic edges



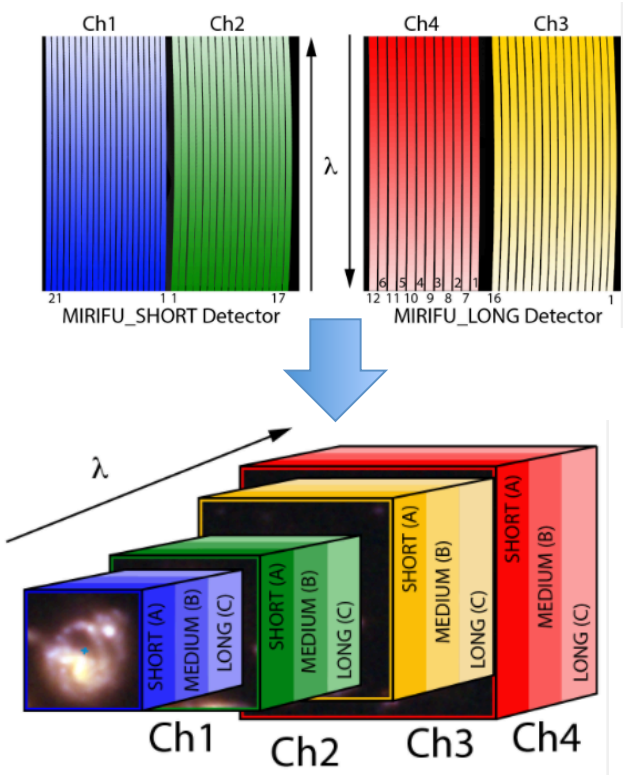
MIRI MRS complex design

2 detectors (MRS_Short, MRS_Long)=> same readout param. on ch1+2 & 3+4

3 sub-bands (A,B,C) provide full 5-29 μm coverage

(can have ≠ settings at cost of higher overheads)

Channel	Band	Nr. slices	Wavelength Range [μm]	Spectral Resolution	FoV [arcsec]
1	1A	21	4.88 - 5.77	~3500	3.46 x 3.72
	1B		5.64 - 6.67		3.46 x 3.72
	1C		6.50 - 7.70		3.41 x 3.72
2	2A	17	7.47 - 8.83	~3000	4.16 x 4.76
	2B		8.63 - 10.19		4.16 x 4.76
	2C		9.96 - 11.77		4.12 x 4.76
3	3A	16	11.49 - 13.55	~2600	6.00 x 6.24
	3B		13.28 - 15.66		5.96 x 6.24
	3C		15.34 - 18.09		5.91 x 6.24
4	4A	12	17.60 - 21.00	~1600	7.14 x 7.87
	4B		20.51 - 24.48		7.06 x 7.87
	4C		23.92 - 28.55		6.99 x 7.87

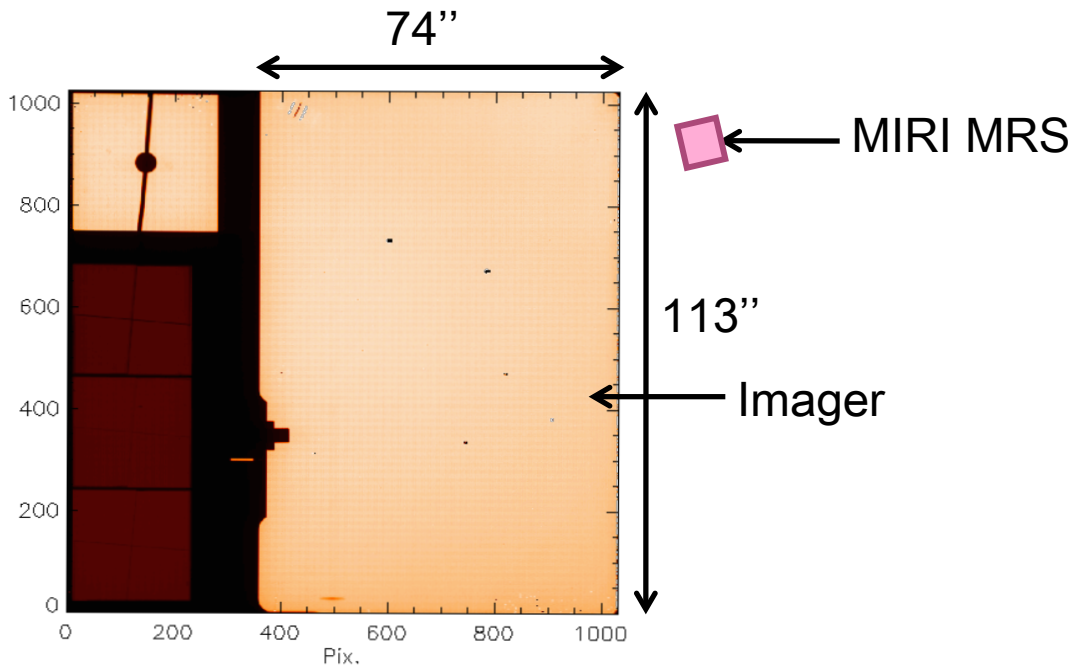


©JDox

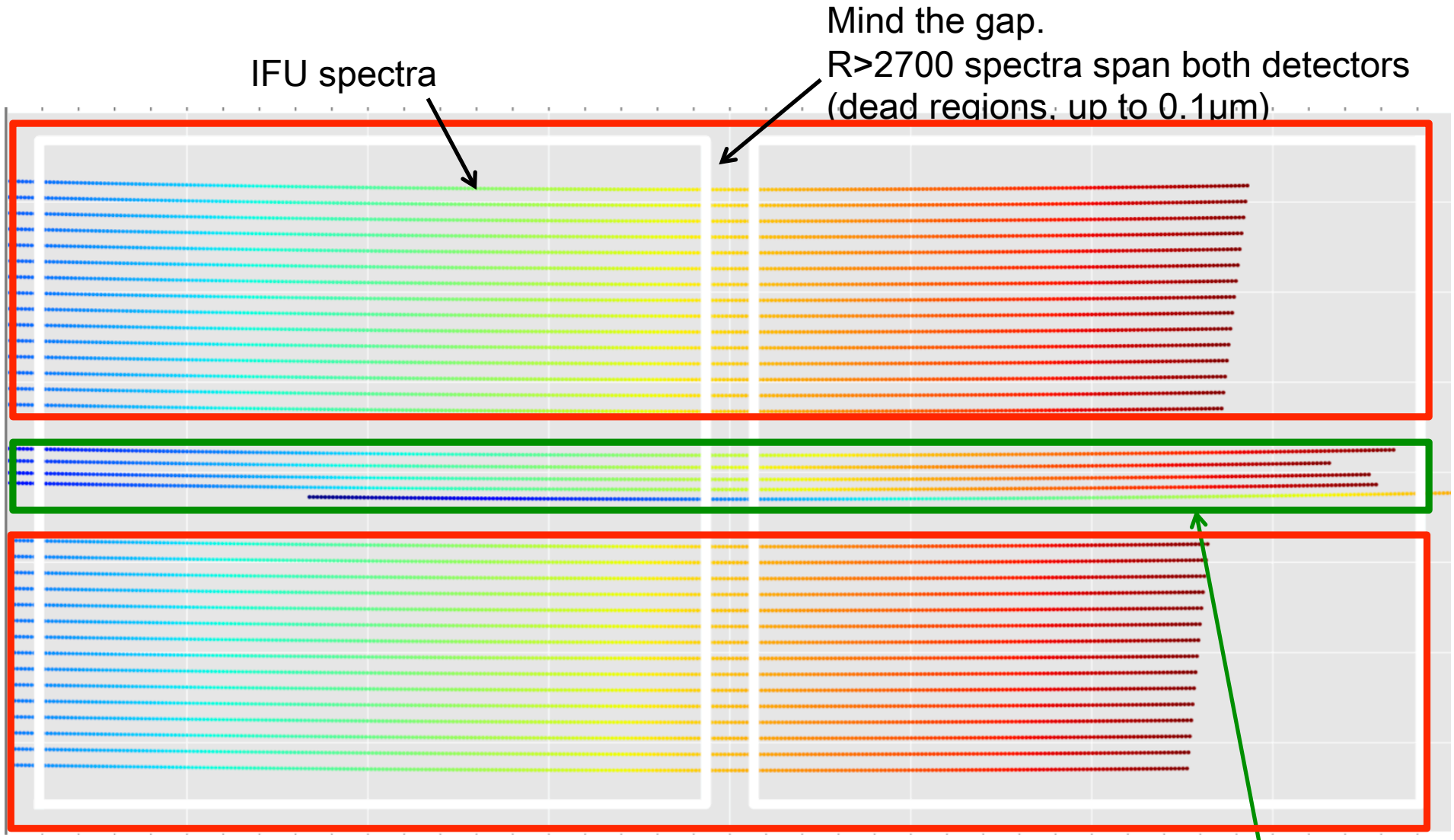
MIRI MRS+Imaging simultaneously

Imaging will have to follow the dither pattern of the MRS

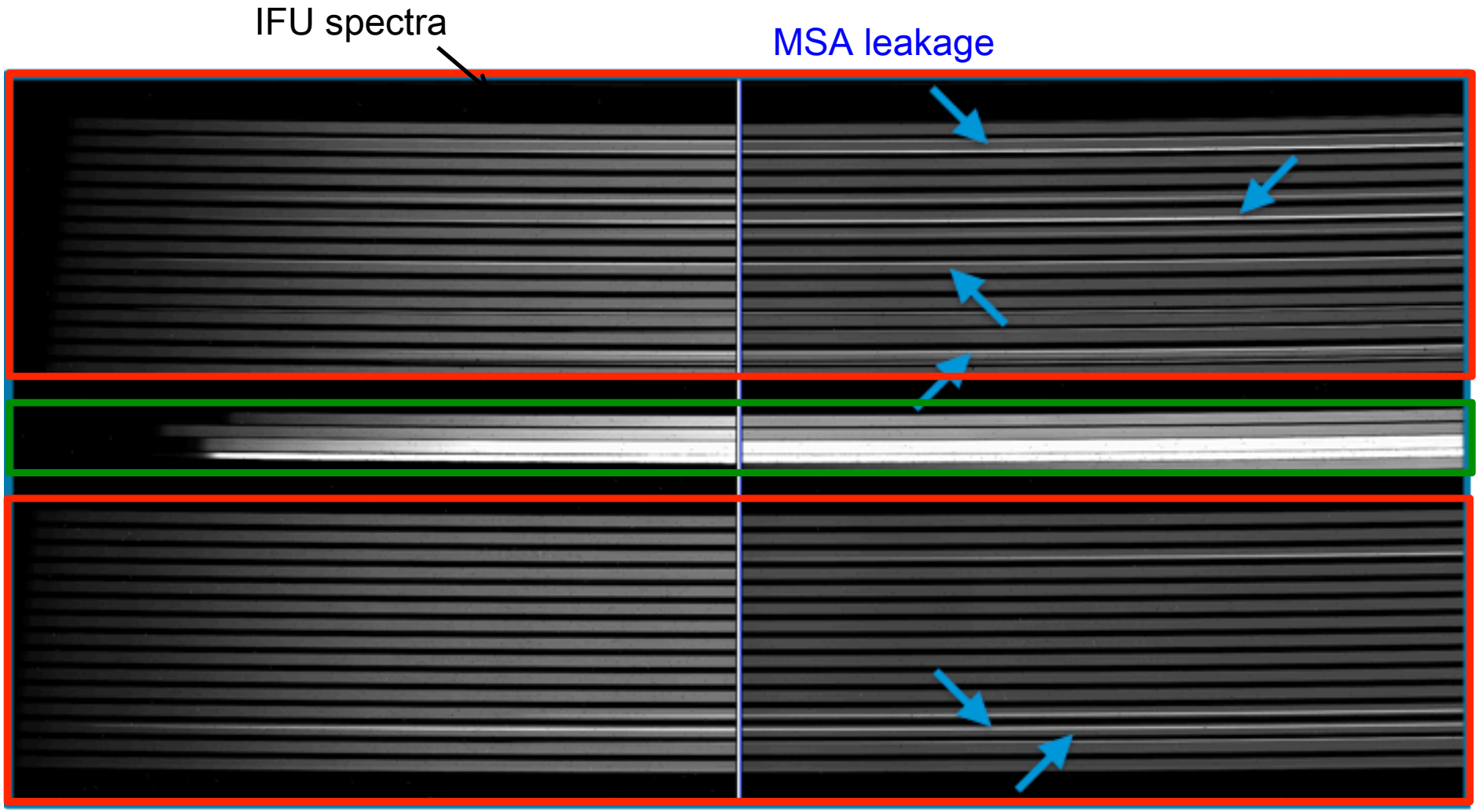
An Imaging exposure cannot be longer than the MRS exposure



NIRSpec IFU shares MOS detectors



NIRSpec IFU shares MOS detectors: MSA leakage from failed open shutters



©Ferruit et al. (2012)

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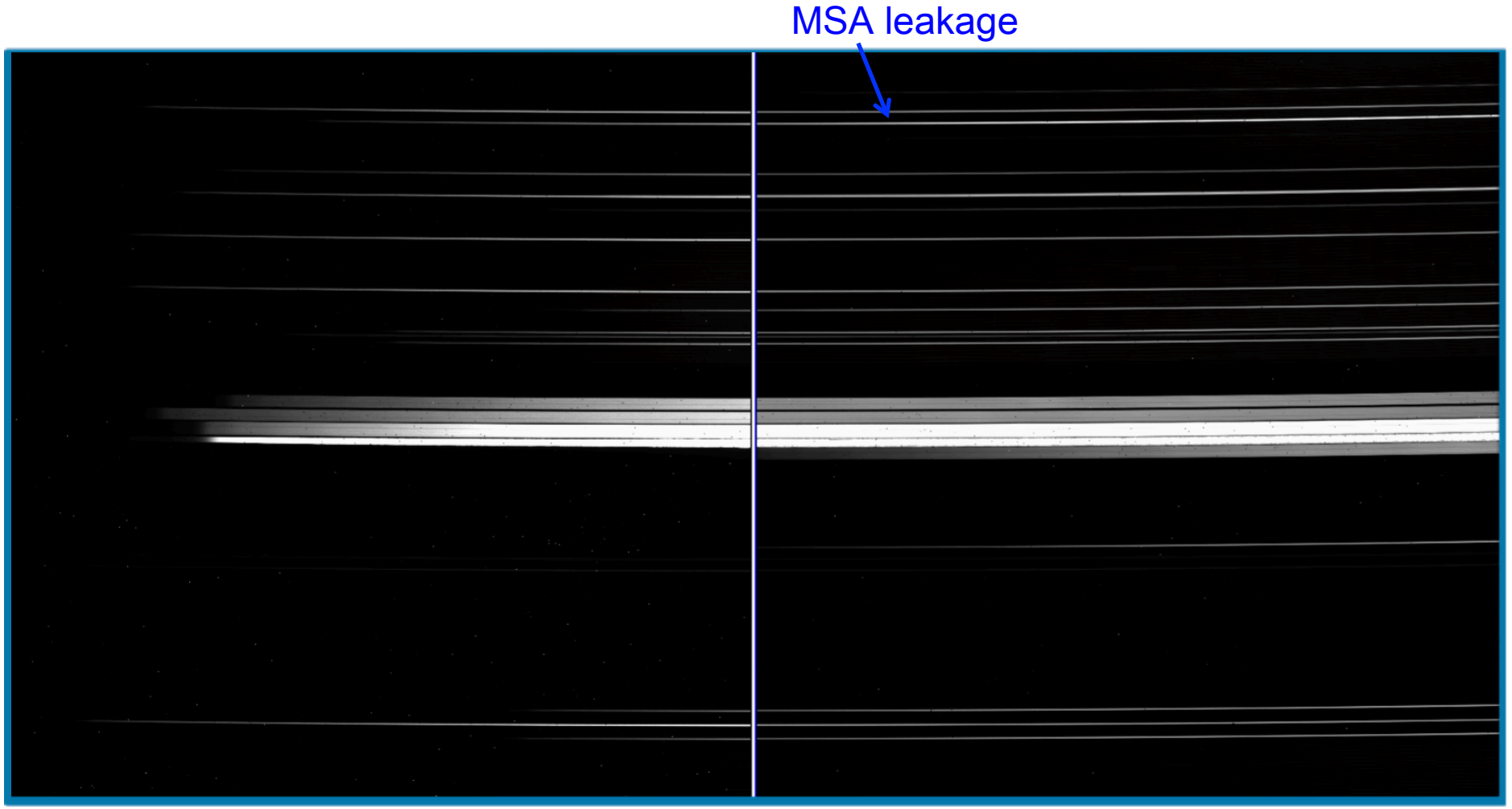


©Ferruit et al. (2012)

Nodding/Dithering for pixel sampling, cosmetics and background estimates

Nodding (especially for MIRI) for background:

- at least one pointing away (>3'' if extended, dithering not mandatory at the nodding point)

Dithering:

- MIRI MRS and NIRSpec IFU undersampled (or at the limit) over the entire wavelength coverage
- Large steps for background obs. with small/pt sources

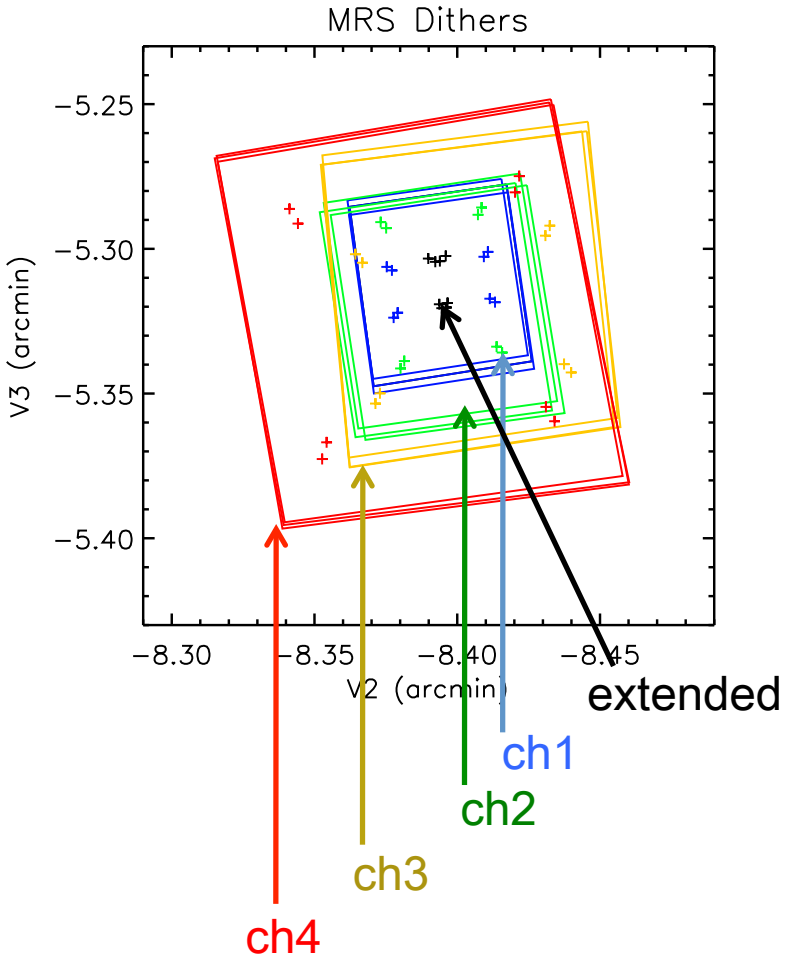
MIRI MRS pre-defined dithering patterns

Optimized for **ALL**, Ch1, Ch2, Ch3, or Ch4

2-pt :
- Large offsets (<5”) for pt source separation > 1”
- ½ integer sampling in all channels (but not optimal)

4-pt (**default** for pt/compact source):
- Small additional offsets mitigate sampling issues due to optical distortion

4-pt ‘Extended’
- Small offsets for use with extended sources and mosaics.
- ½ integer sampling in all channels



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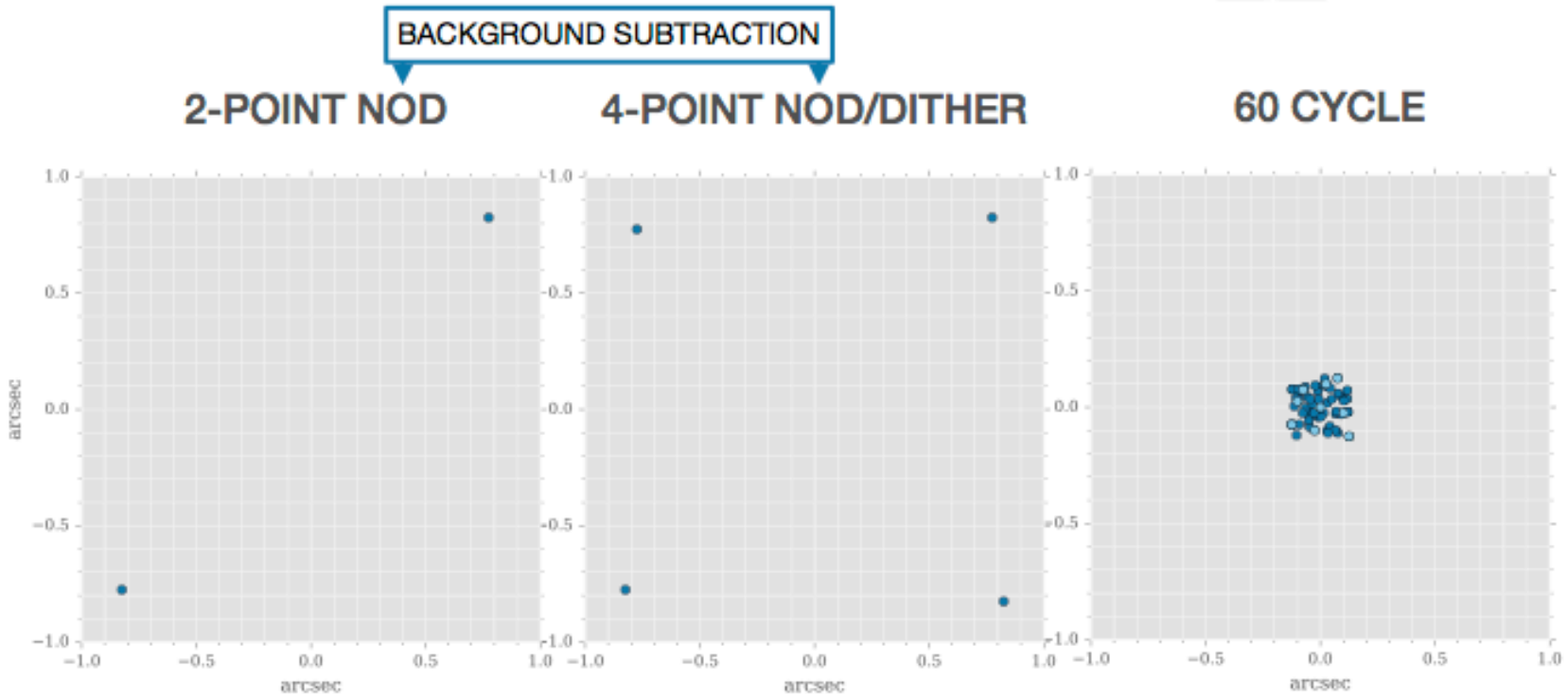
NIRSpec IFU pre- and user-defined dithering patterns



-1.6” away
-Pt/compact source (<0.3”)

-1.6”/0.4” on a side
-Improved sampling (dither)
-Bkg subtraction for pt/compact source (nods)

-Drawn from gauss distr.
-Up to 60 points
-Small (0.25”)
-Medium (0.5”)
-Large (1.0”)

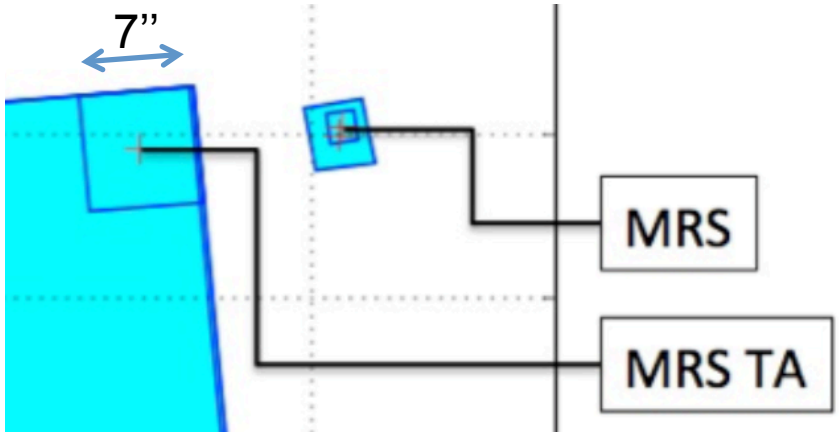
©N. Luzgendorf

Target acquisition possible

Point and shoot allowed (not for MIRI MRS on APT 25.4.1) at the absolute precision of FGS (~0.45’’)

MIRI MRS (90mas required accuracy):

- with the imager with a choice of 3 filters and a neutral density
- on target or suitable off-axis point source <50’’



Target acquisition possible

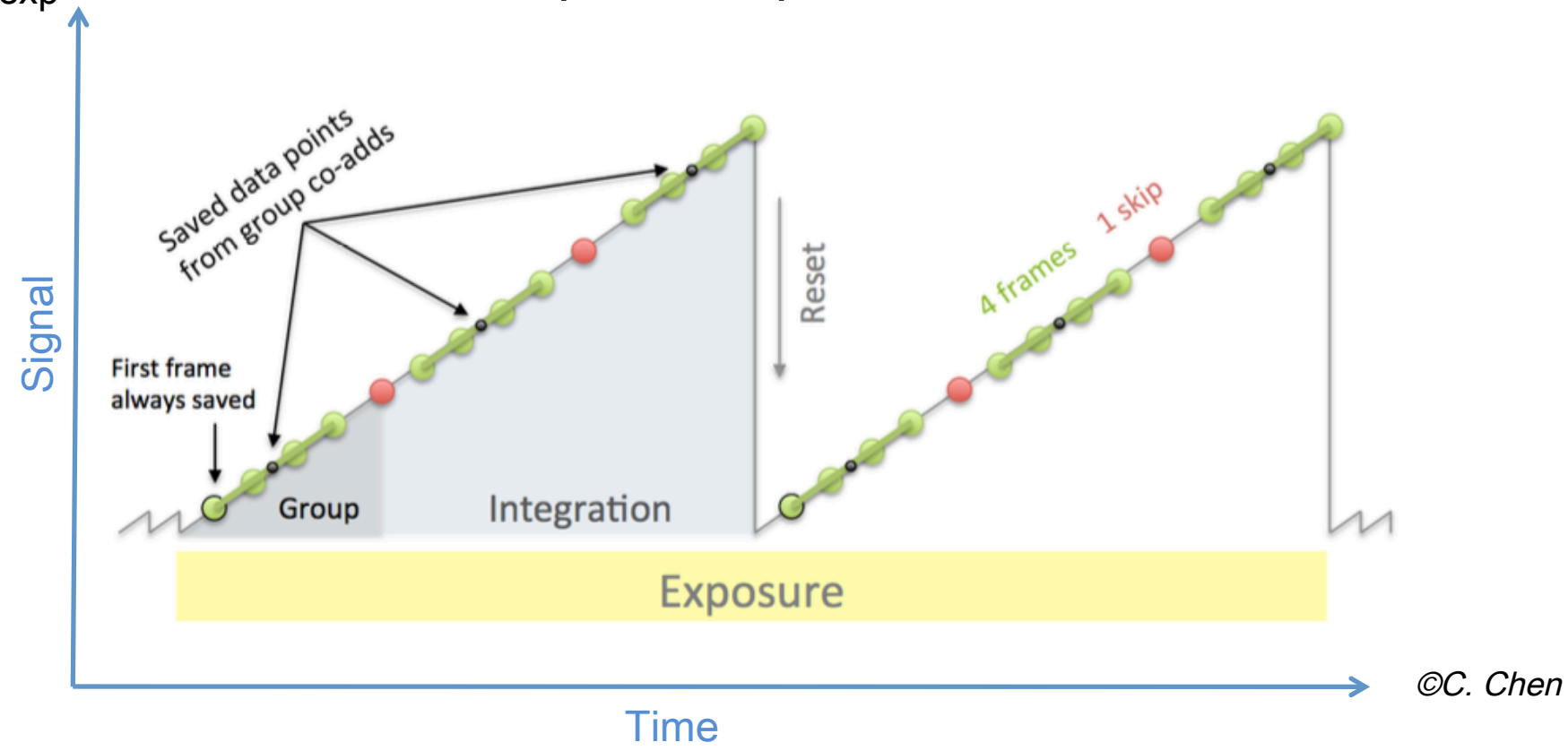
Point and shoot allowed (not for MIRI MRS on APT 25.4.2) at the absolute precision of FGS (~0.45'')

NIRSpec IFU (on target):

- NONE
- **VERIFY_ONLY** (take a post visit image for analysis, no correction done)
- MSTA via MSA on reference stars with 5-50mas accuracy (standard but not for very extended objects)
- WATA via the wide-aperture slit (standard for bright pt source)

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 (for bright target): N_f=1, N_s=0, t_f=2.775s
- SLOW (default): N_f=1, N_s=0, t_f=23.88s

NIRSpec:

- NRS (default) : N_f=4, N_s=0, t_f=42.9s
- NRSRAPID: N_f=1, N_s=0, t_f=10.7s
- both with IRS^2 (improved sensitivity) (t_f=14.5/72.9s)

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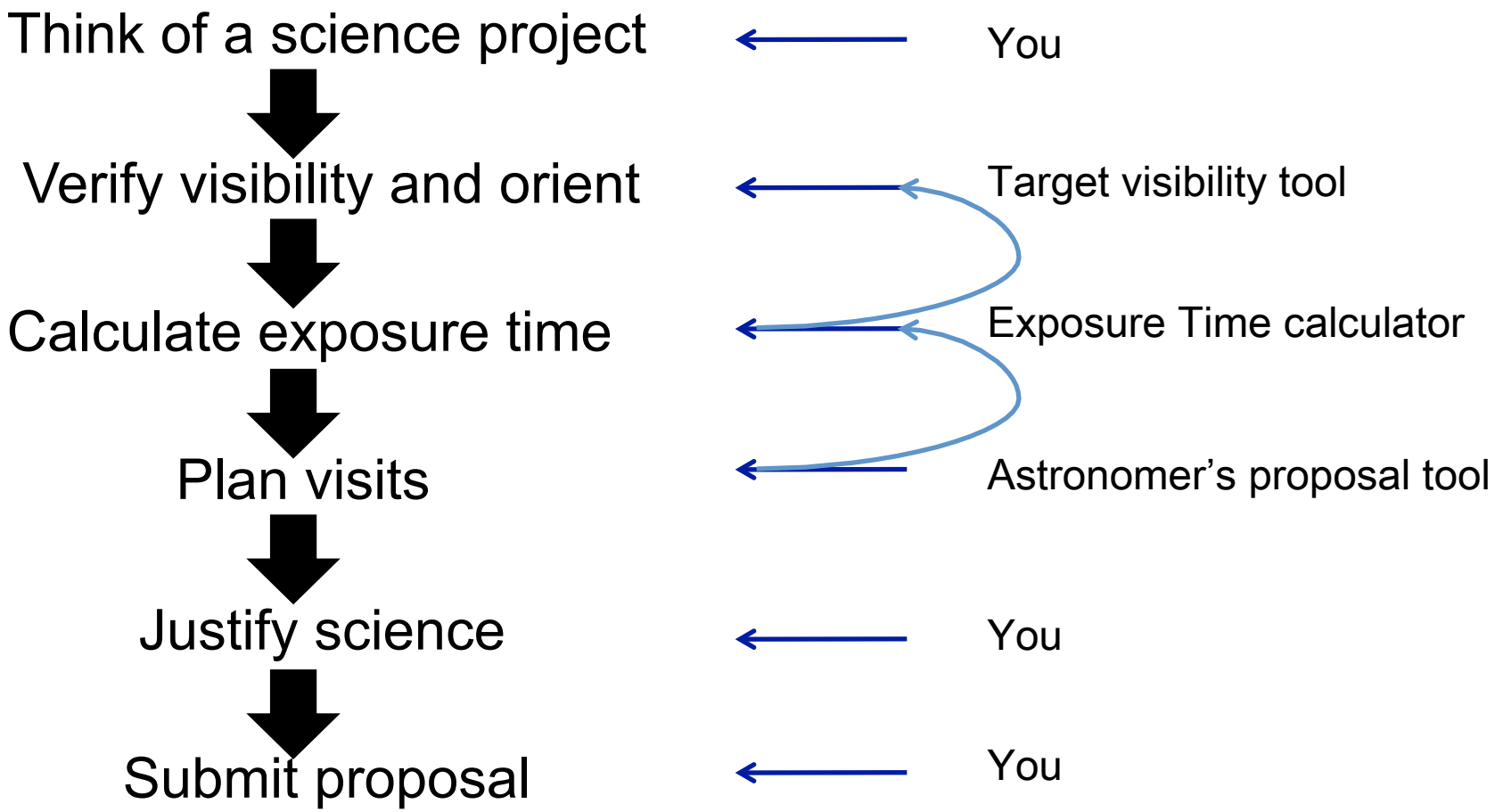
JWST Cycle 1 proposals are due by Apr 6, 2018, in a single phase.



Demo: NIRSpec+MIRI IFS

Resolved gas kinematics of the NGC4151 AGN

© ESAC Workshop (S. Hoenig)

Goal: Determining the physical conditions of the inflowing and outflowing gas on the AGN.

Method: IFU spectroscopy with NIRSpec and MIRI with high resolution and full wavelength coverage at SNR ~100 on the central engine.

Source: Extended (mapping the central 200pc)

Z=0.003319, r=0.069kpc/arcsec

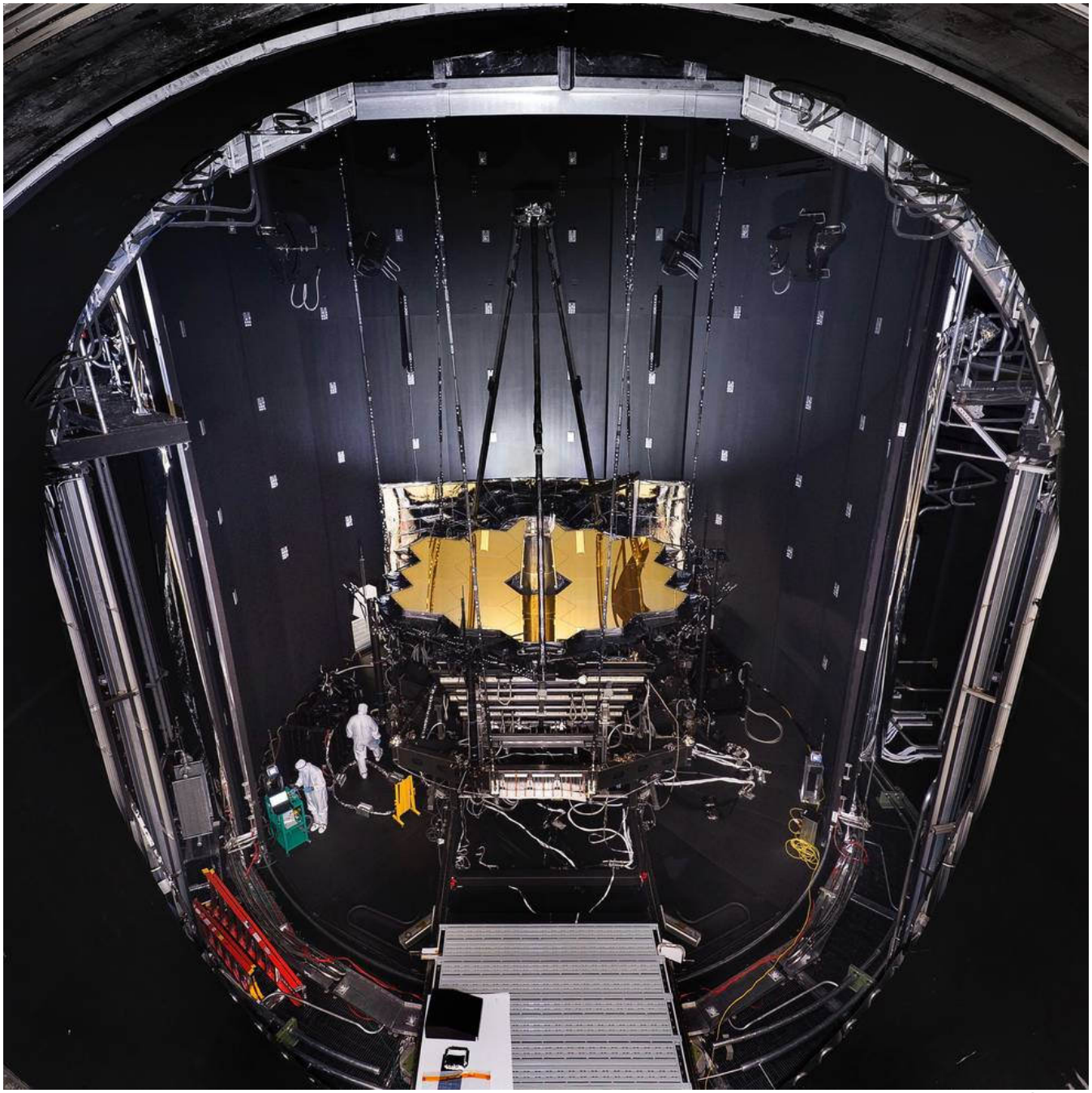
Other useful informations

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



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