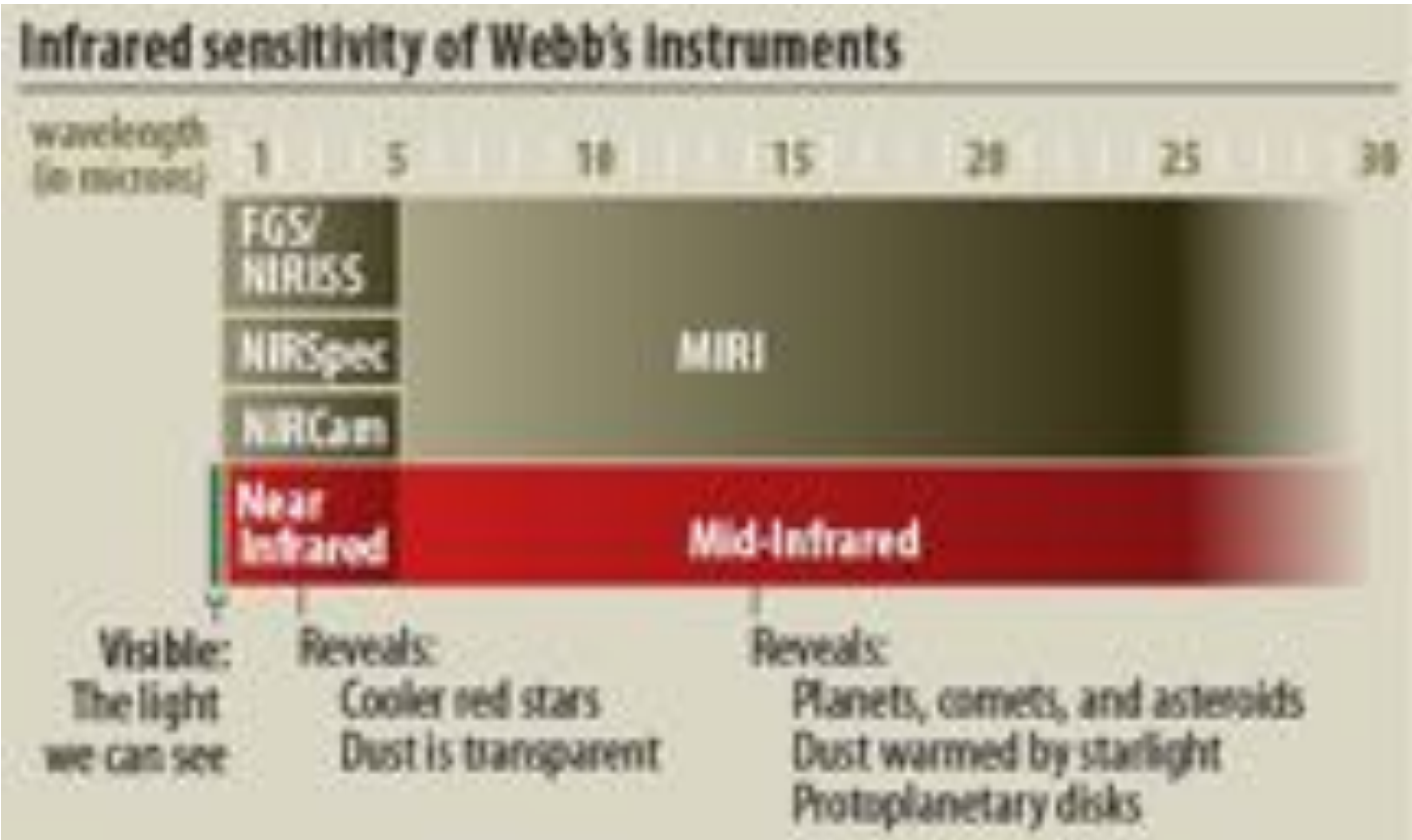
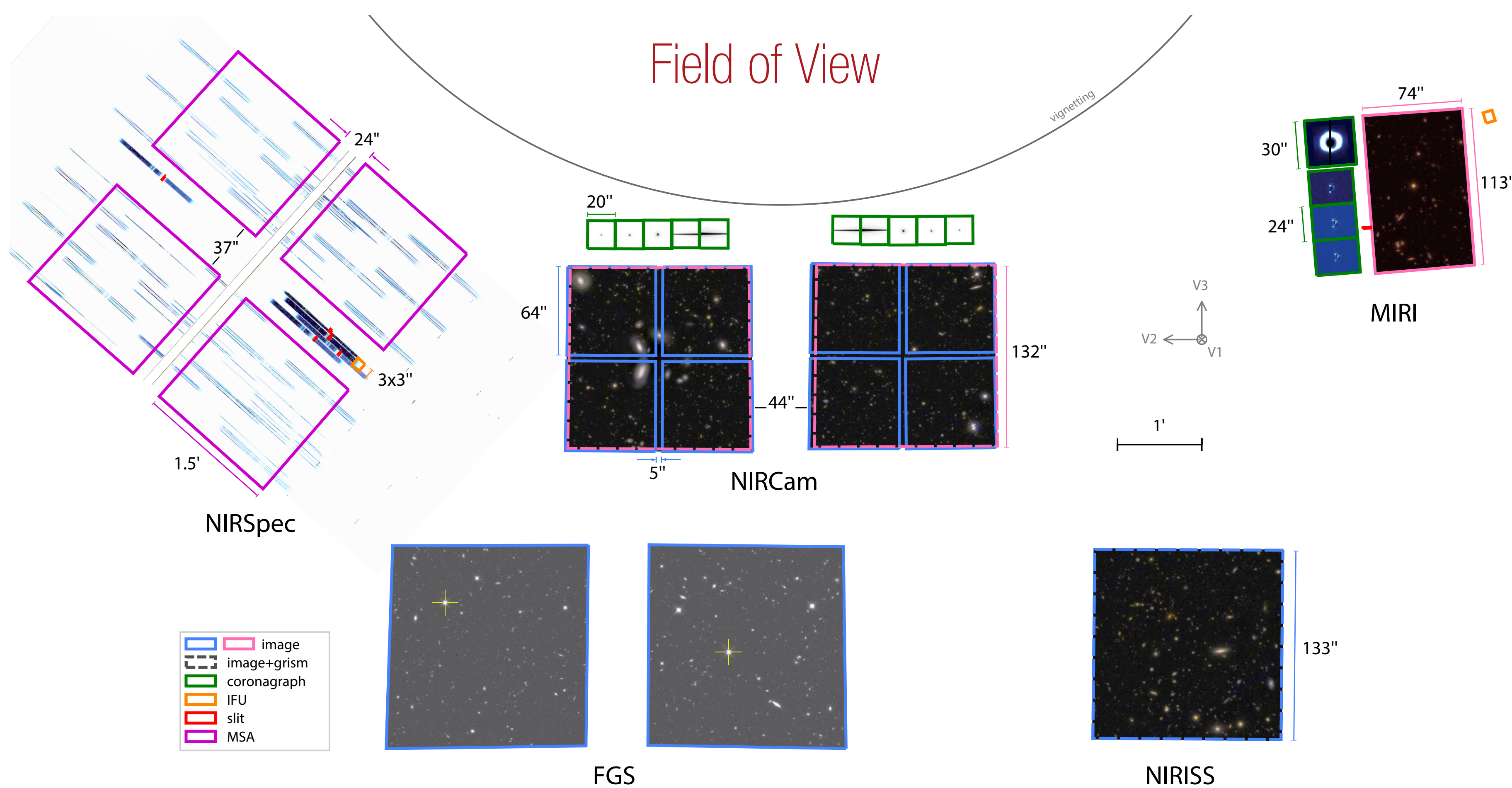
“Lessons learned” from JWST proposal preparation

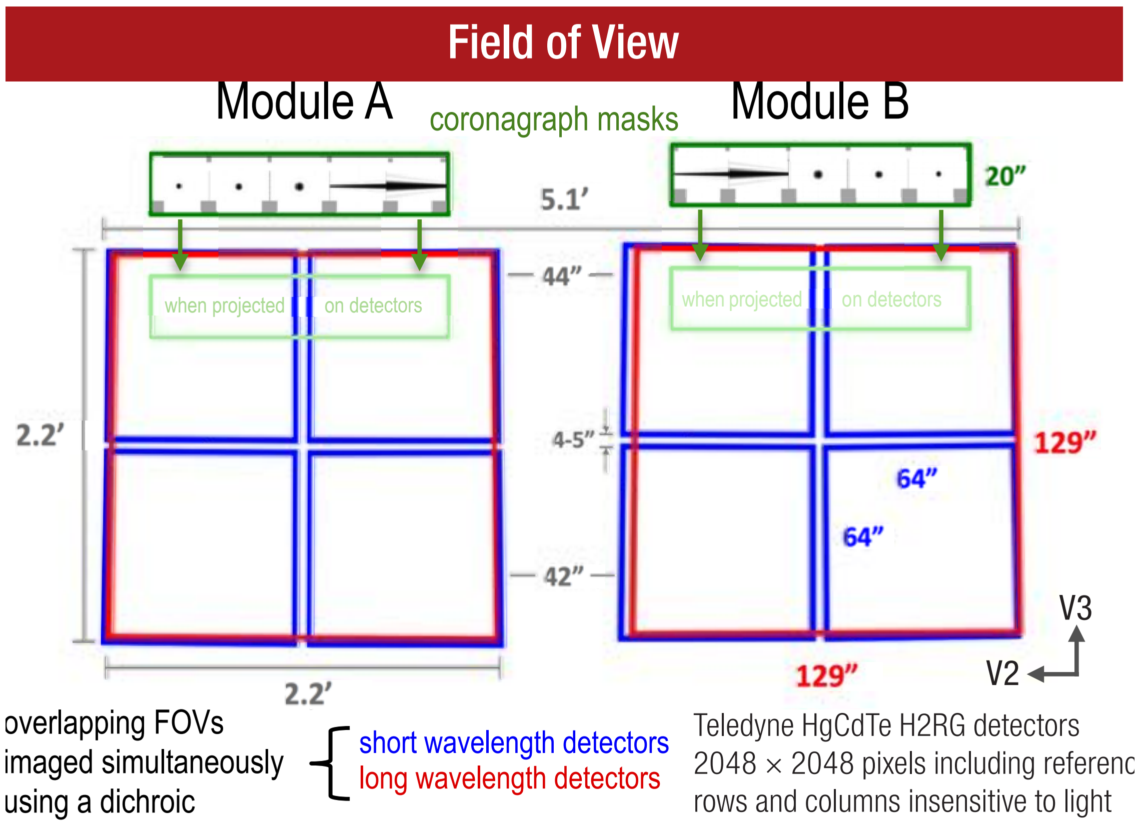
Steve Finkelstein

- **Overview of instruments**
- **Deadlines**
- **ERS program**
- **“Surprises”**

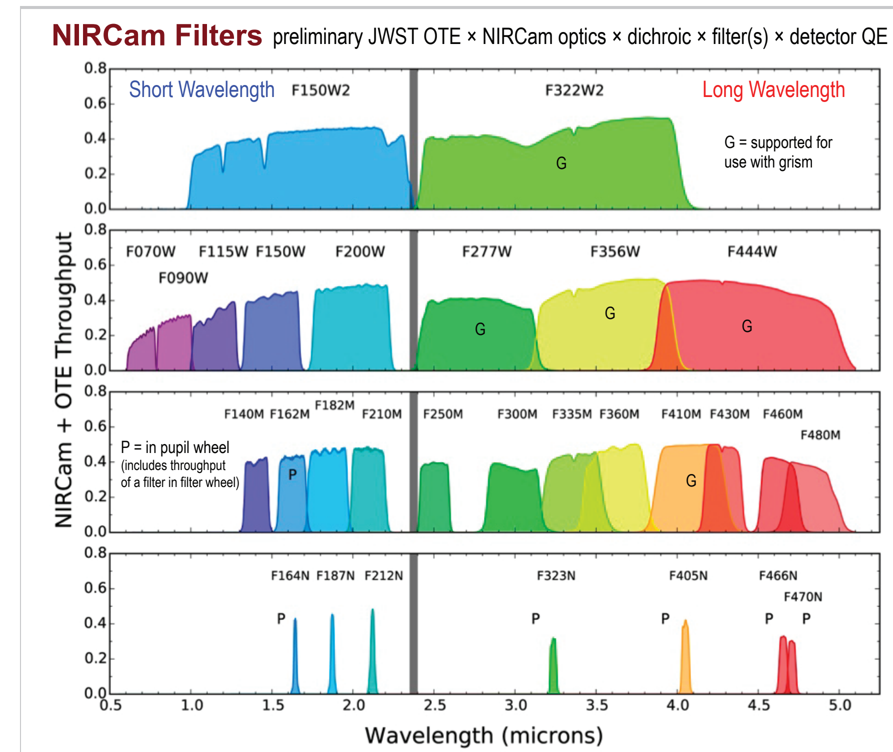

Infrared sensitivity of Webb's Instruments
wavelength (in microns)
1
5
10
15
20
25
30
FGS/ NIRISS
NIRSpec
NIRCam
MIRI
Near Infrared
Mid-Infrared
Visible: The light we can see
Reveals: Cooler red stars Dust is transparent
Reveals: Planets, comets, and asteroids Dust warmed by starlight Protoplanetary disks


Field of View
vignetting
24"
37"
3x3"
1.5'
NIRSpec
20"
64"
44"
5"
132"
NIRCam
74"
30"
113"
24"
MIRI
V3
V2
V1
1'
image
image+grism
coronagraph
IFU
slit
MSA
FGS
133"
NIRISS

NIRCam



Field of View
Module A
coronagraph masks
Module B
20″
5.1′
when projected
on detectors
44″
2.2′
4-5″
129″
64″
64″
42″
V3
V2
2.2′
129″
overlapping FOVs imaged simultaneously using a dichroic
short wavelength detectors
long wavelength detectors
Teledyne HgCdTe H2RG detectors
2048 × 2048 pixels including referenc
rows and columns insensitive to light



NIRCam Filters preliminary JWST OTE × NIRCam optics × dichroic × filter(s) × detector QE
Short Wavelength
F150W2
F322W2
Long Wavelength
G = supported for use with grism
F070W F115W F150W F200W
F090W
F277W F356W F444W
F140M F162M F182M F210M
F250M F300M F335M F360M F410M F430M F460M
F480M
P = in pupil wheel (includes throughput of a filter in filter wheel)
F164N F187N F212N
F323N F405N F466N
F470N
NIRCam + OTE Throughput
Wavelength (microns)

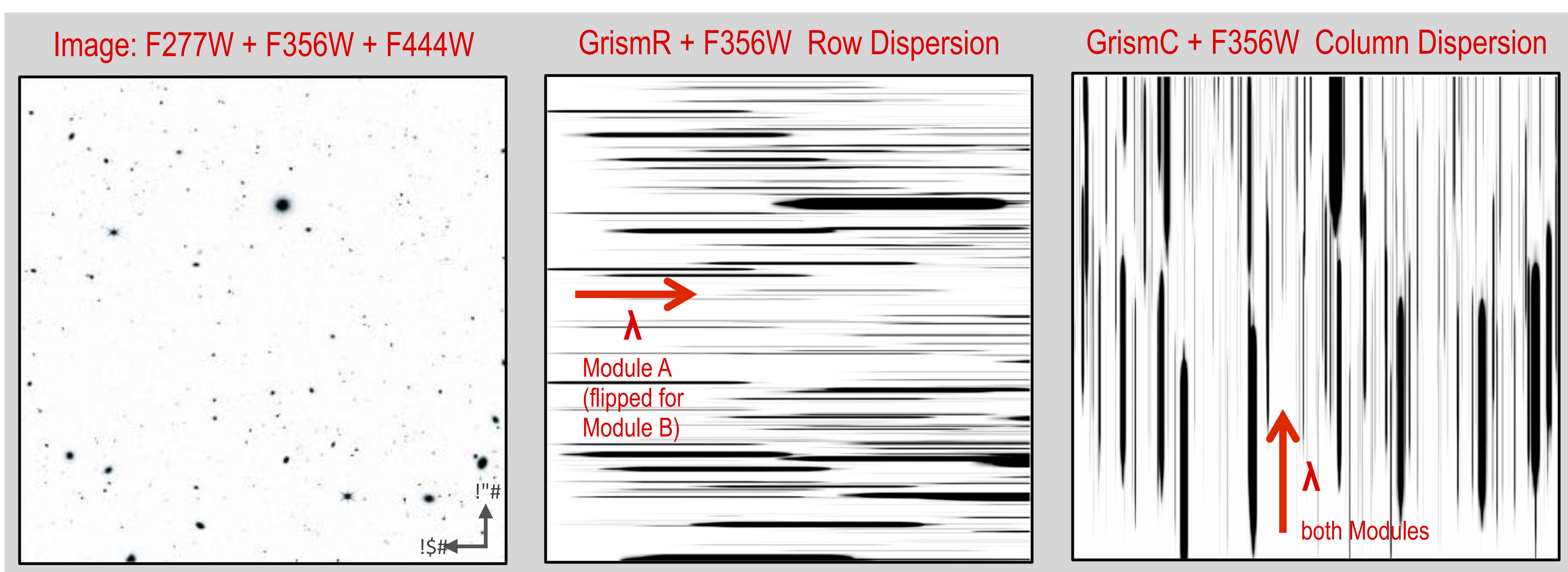
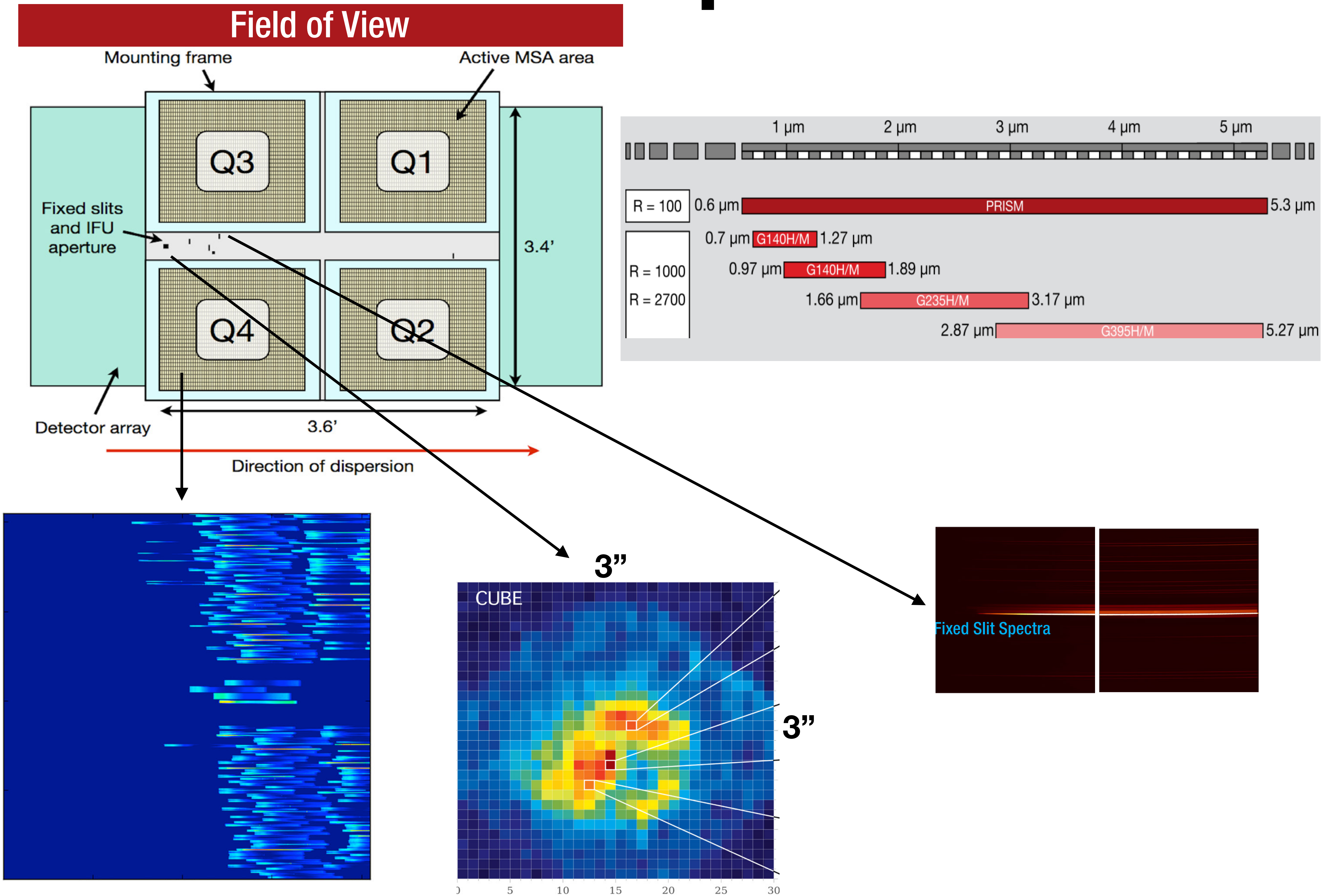


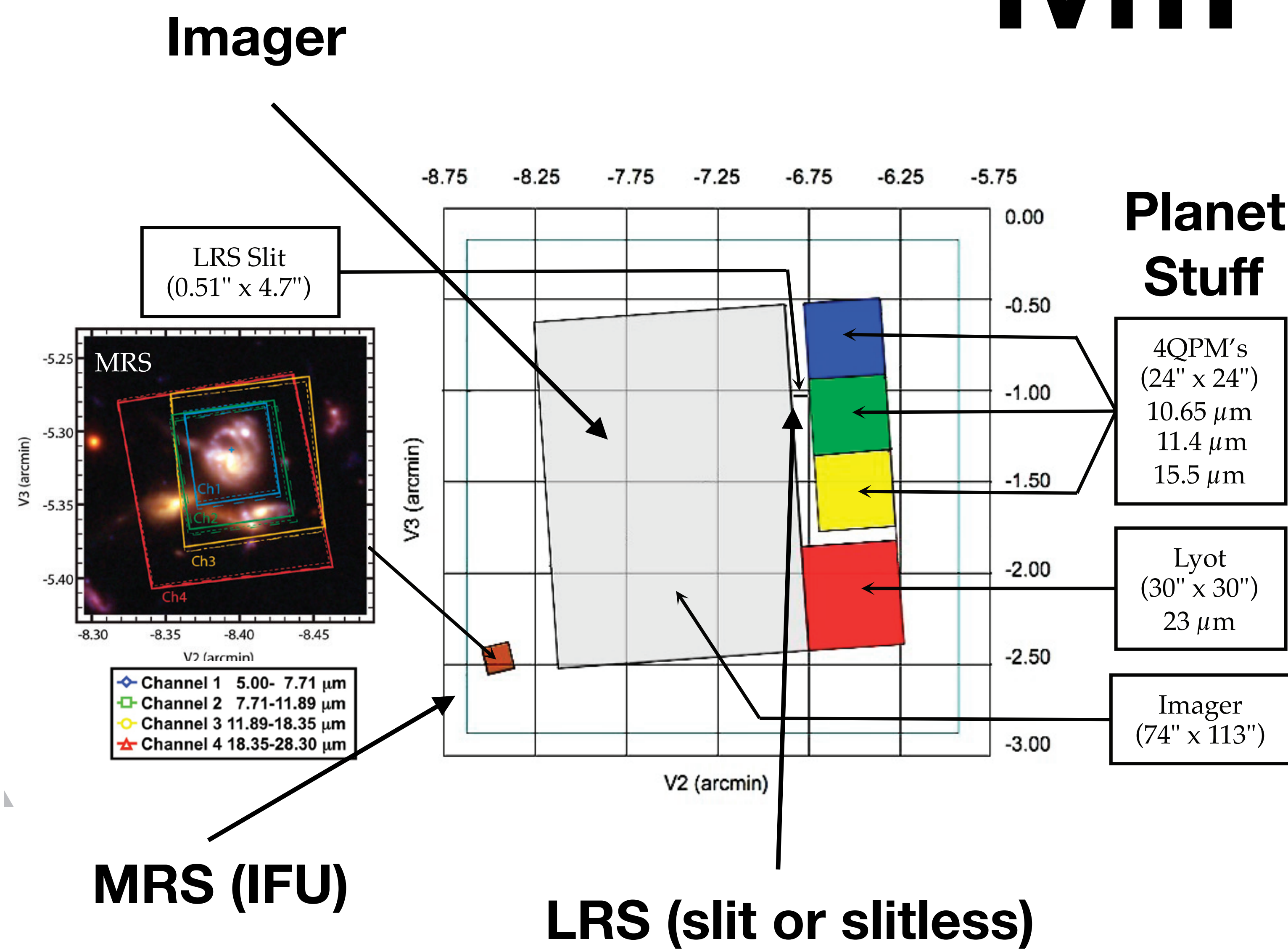
Image: F277W + F356W + F444W
GrismR + F356W Row Dispersion
GrismC + F356W Column Dispersion
λ
Module A (flipped for Module B)
λ
both Modules

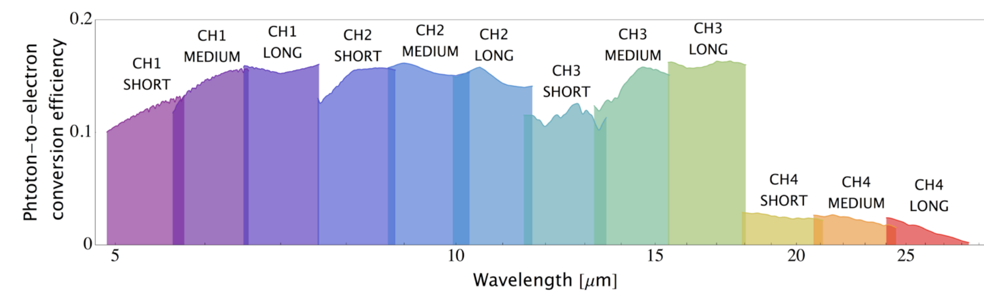
NIRSpec

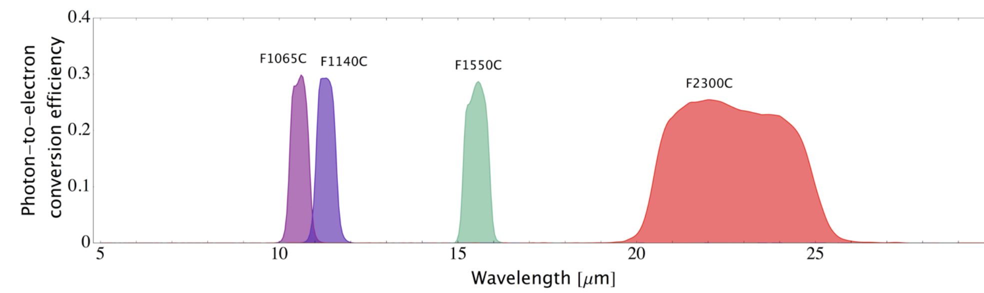


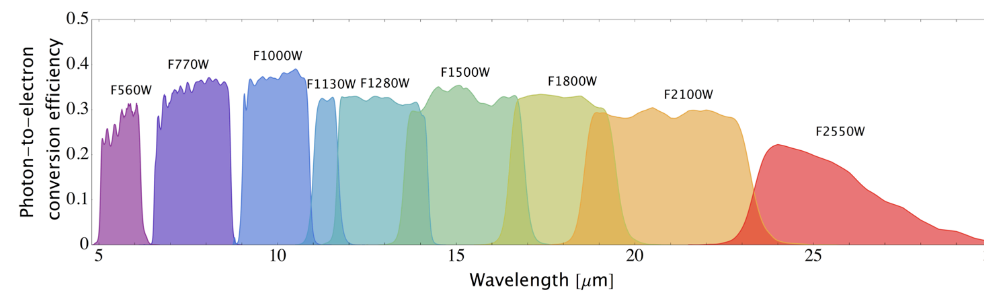
Field of View
Mounting frame
Active MSA area
Q3
Q1
Q4
Q2
Fixed slits and IFU aperture
3.4’
3.6’
Detector array
Direction of dispersion
1 µm
2 µm
3 µm
4 µm
5 µm
R = 100
0.6 µm
PRISM
5.3 µm
R = 1000
R = 2700
0.7 µm
G140H/M
1.27 µm
0.97 µm
G140H/M
1.89 µm
1.66 µm
G235H/M
3.17 µm
2.87 µm
G395H/M
5.27 µm
3”
CUBE
3”
5
10
15
20
25
30
Fixed Slit Spectra

MIRI









Name	λ (µm)	λ/Δλ	Point-Source Detection Limit[1]	Extended Source Detection Limit[1]	Point-Source Saturation Limit[2]
F560W	5.6	5.0	0.2 µJy	0.22 µJy arcsec $^{-2}$	7 mJy
F770W	7.7	3.5	0.28 µJy	0.26 µJy arcsec $^{-2}$	3 mJy
F1000W	10.0	5.0	0.7 µJy	0.53 µJy arcsec $^{-2}$	8 mJy
F1130W	11.3	16.0	1.7 µJy	1.2 µJy arcsec $^{-2}$	35 mJy
F1280W	12.8	5.0	1.4 µJy	0.83 µJy arcsec $^{-2}$	15 mJy
F1500W	15.0	5.0	1.8 µJy	0.93 µJy arcsec $^{-2}$	18 mJy
F1800W	18.0	6.0	4.3 µJy	1.9 µJy arcsec $^{-2}$	34 mJy
F2100W	21.0	4.0	8.6 µJy	3.3 µJy arcsec $^{-2}$	50 mJy
F2550W	25.5	6.0	28 µJy	9.1 µJy arcsec $^{-2}$	105 mJy

NIRISS

Wide-Field Slitless Spectroscopy with NIRISS: Simulations of MACS J0416.1-2403

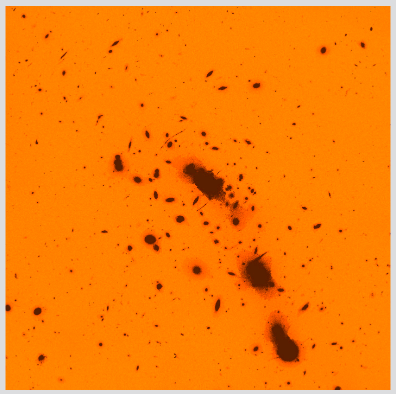
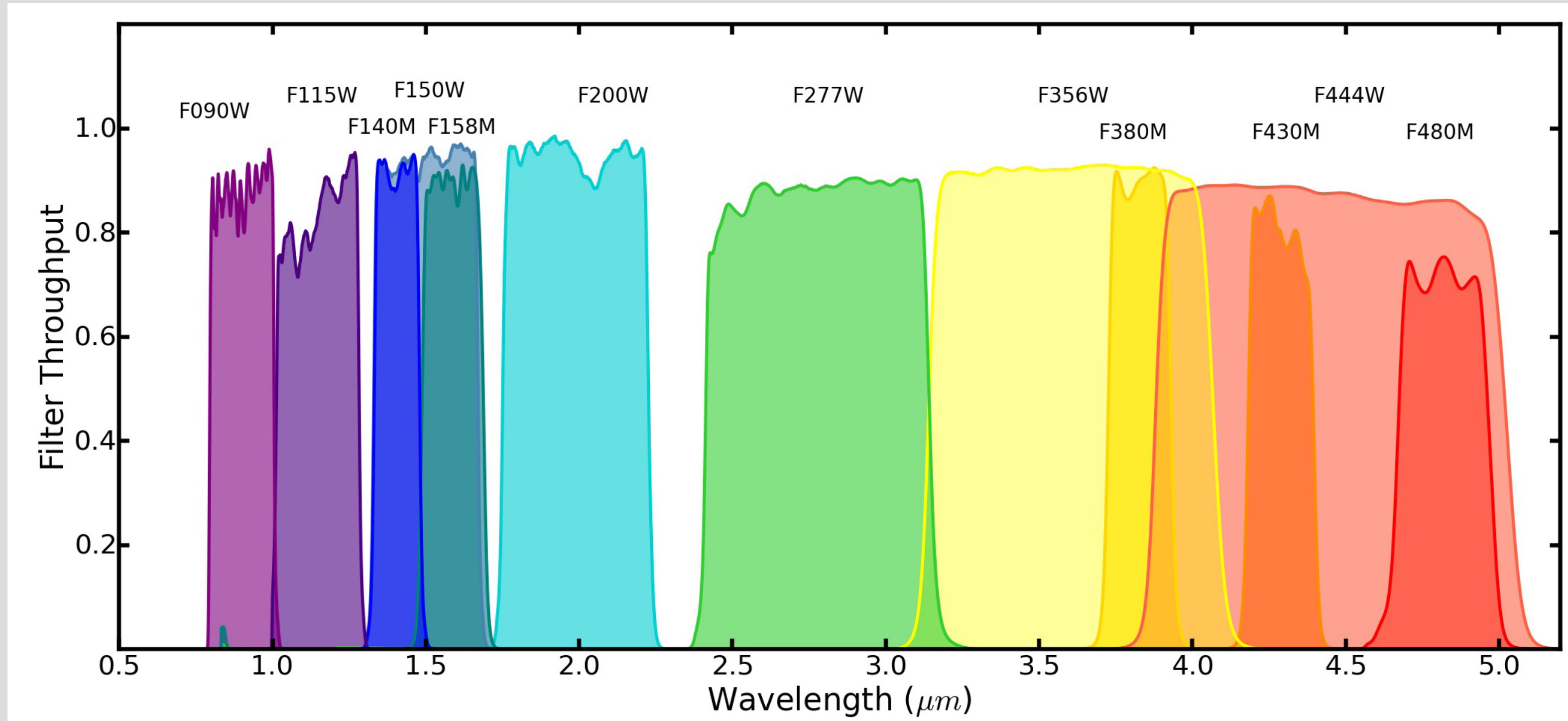


Image: F115W

Spectra: GR150C, F115W

Spectra: GR150R, F115W

Filter Transmission Profiles



Aperture Masking Interferometry

Non-Redundant Mask (NRM)

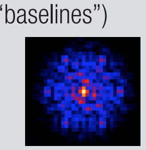
+ Medium-Band "Red" Filters

7-hole aperture mask with 21 distinct ("non-redundant") separations ("baselines")

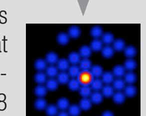
Mask

Michelson:

$\delta\theta = 0.5\ \lambda / D$



NRM PSF (Interferogram)



Fourier Transform

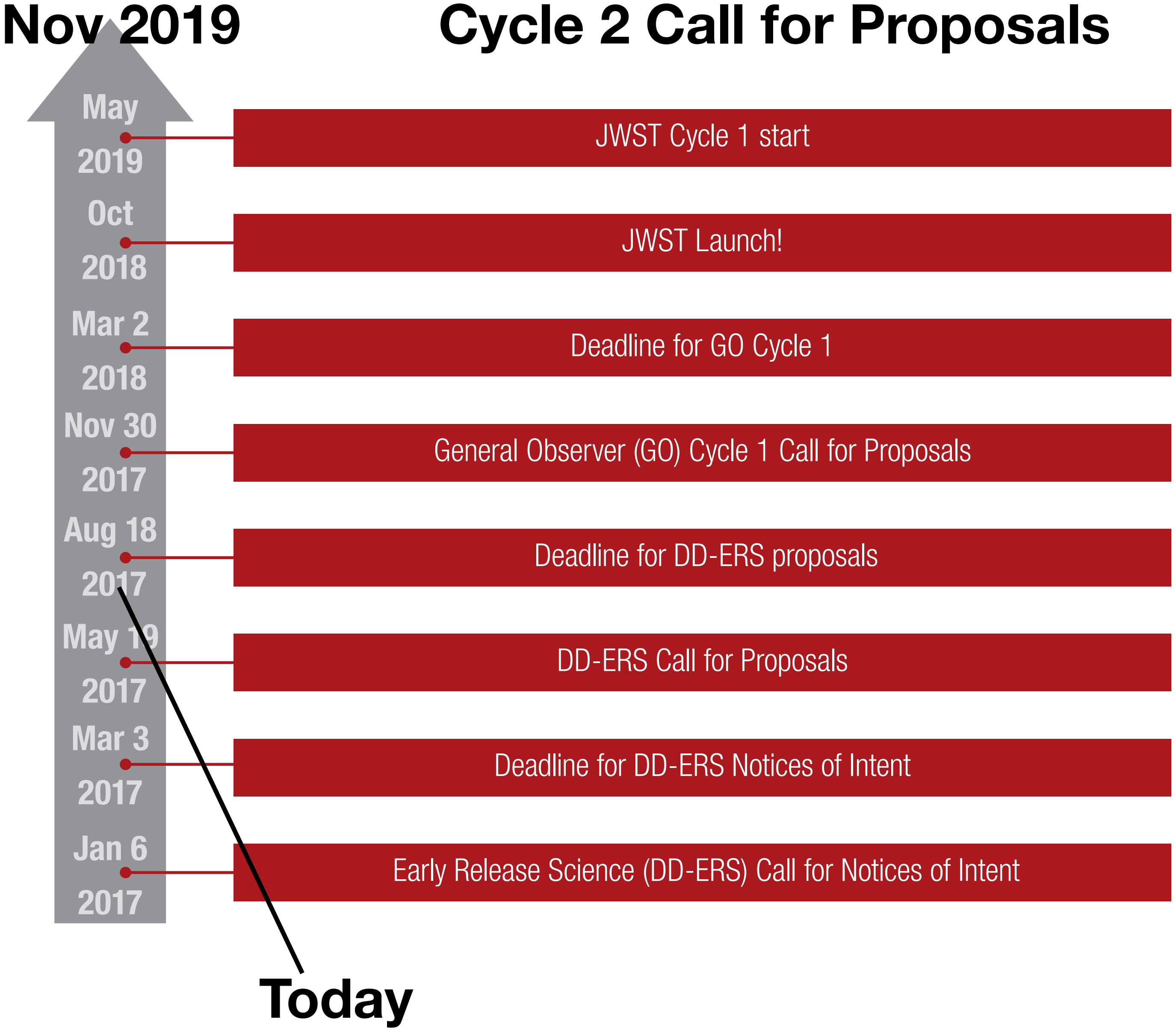
NIRISS AMI enables exoplanet detection at 3.8, 4.3, and 4.8 μm around stars as bright as M'~4, reaching 10^{-4} contrast at separations of 70–400 milli-arcseconds. It provides lower contrast at 2.8 μm with the F277W filter.

Image reconstruction is also enabled.

JWST Calendar

Dec 2020 **Cycle 2 Proposal Deadline**

Nov 2019 **Cycle 2 Call for Proposals**



JWST Calendar

Dec 2020 — **Cycle 2 Proposal Deadline**

Nov 2019 — **Cycle 2 Call for Proposals**

- May 2019 — JWST Cycle 1 start
- Oct 2018 — JWST Launch!
- Mar 2 2018 — Deadline for GO Cycle 1
- Nov 30 2017 — General Observer (GO) Cycle 1 Call for Proposals
- Aug 18 2017 — Deadline for DD-ERS proposals
- May 19 2017 — DD-ERS Call for Proposals
- Mar 3 2017 — Deadline for DD-ERS Notices of Intent
- Jan 6 2017 — Early Release Science (DD-ERS) Call for Notices of Intent

Today

Major Caveat

Early Release Science

- Up to 500 hr will be awarded to up to 15 programs.

- The DD-ERS program was designed to provide data over a wide range of observing modes *rapidly* to the community, to prepare for Cycle 2 proposals.

    - ***This*** is the major factor to be evaluated by the TAC. The science has to be good, but enabling Cycle 2 science and proposals is the most important thing.

DD ERS Proposal Deadline	August 18, 2017, 8pm ET
GTO APT Technical Reviews and Revisions End	September 15, 2017
APT version 25.4 Released (further updates for Cycle 1 GO Call)	November 1, 2017
DD ERS Results Released	November 2017
Release of the Cycle 1 Call for GO Proposals	November 30, 2017
Formal DD ERS Budget Proposals	Early December 2017
GTO APT Files Published (public)	December 15, 2017

Early Release Science

- Up to 500 hr will be awarded to up to 15 programs.

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ra
Cy

A subset of CANDELS people plus others in the community are collaborating on the Cosmic Evolution Early Release Science (CEERS) Survey.

Briefly, our goal is to demonstrate efficient survey operations with JWST, providing imaging and spectroscopic data sufficient for any science goal at 3 < z < 12.

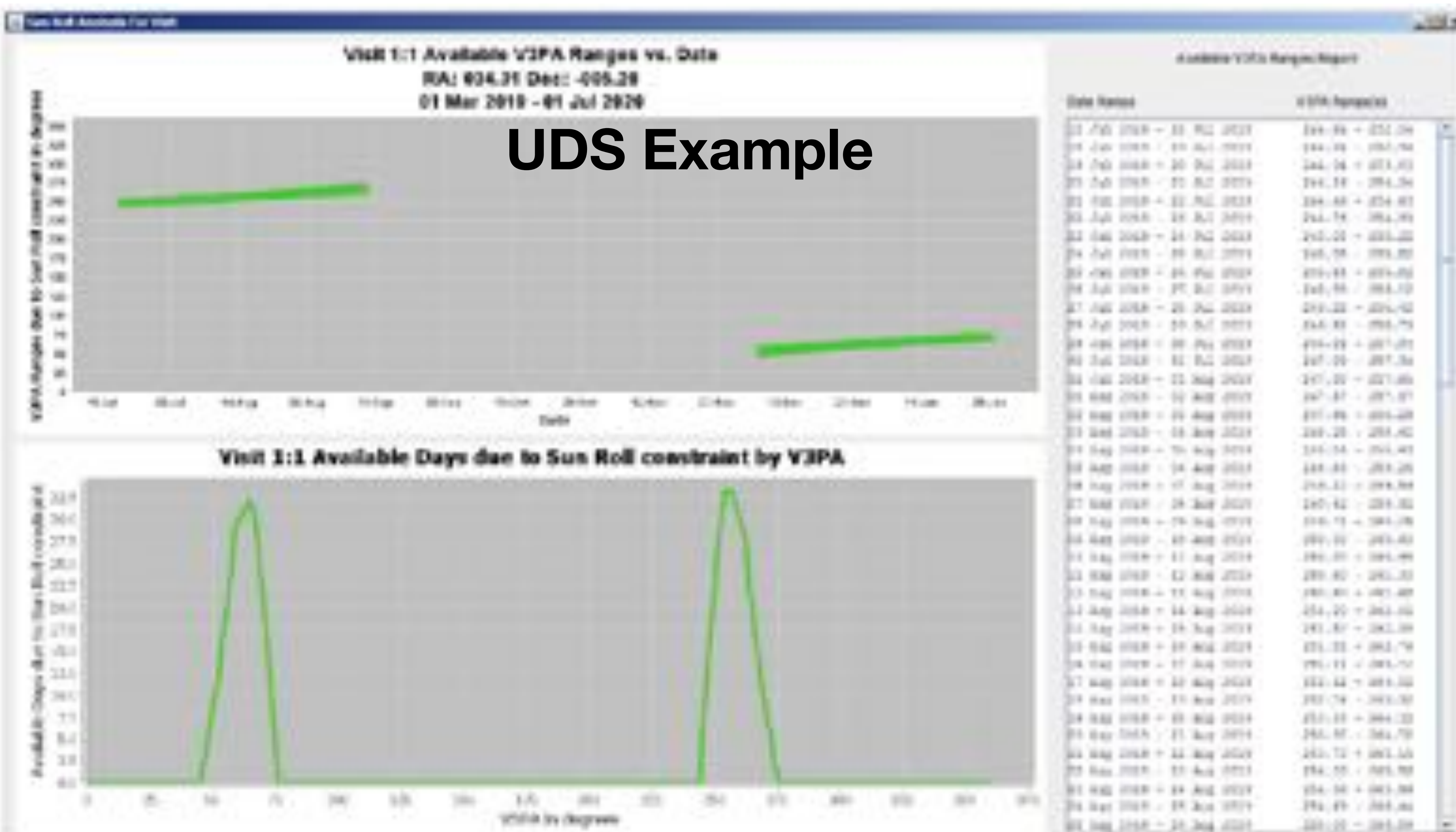
C	
C	
APT version 25.4 Released (further updates for Cycle 1 GO Call)	November 1, 2017
DD ERS Results Released	November 2017
Release of the Cycle 1 Call for GO Proposals	November 30, 2017
Formal DD ERS Budget Proposals	Early December 2017
GTO APT Files Published (public)	December 15, 2017

Overhead

- JWST overheads are surprisingly high. A maximally efficient program typically has only ~70% science. Some examples:
    - All programs pay a ~16% tax to account for slews from object to object.
    - Minimizing filter changes: If you are mosaicing, you need to do all pointings in one filter prior to swapping filters

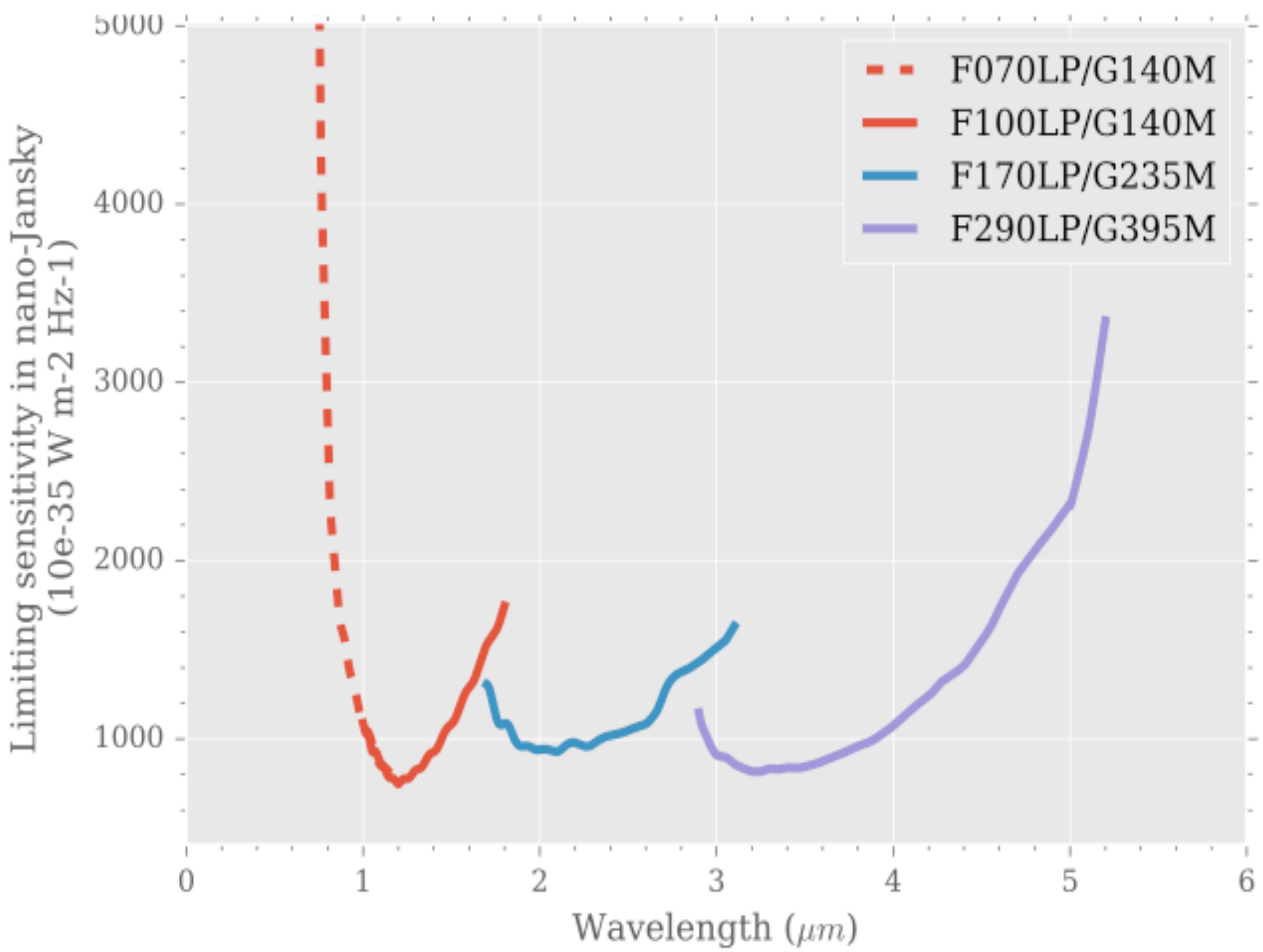
Observability

- JWST can only observe ~half of the sky at once, and depending on the ecliptic latitude, the observability can be even more restricted. The exception is the North and South ecliptic poles, which are always observable.
    - NEP is good, and is being targeted by GTOs. SEP not so great as its near the SMC.
- If you're restricted to a particular roll angle, you only have a few week period.
- Lesson - don't assume you can observe at the right PA - it may be that the PA you need doesn't fall during the window of observability.



Sensitivity & Background

R=1000



NIRSpec

Filter	Sensitivity Point source S/N=10 in 10 ks	Saturation G2V star 80% full well 2 reads of 64x64 subarray
F090W	13.1 nJy	K ~ 9.5 Vega
F115W	11.8 nJy	K ~ 9.6 Vega
F150W	9.6 nJy	K ~ 9.8 Vega
F200W	7.9 nJy	K ~ 9.3 Vega
F277W	11.5 nJy	K ~ 9.6 Vega
F356W	11.0 nJy	K ~ 8.9 Vega
F410M	20.6 nJy	K ~ 7.4 Vega
F444W	17.6 nJy	K ~ 8.0 Vega

NIRCam

Lesson - The sensitivity can drop off quite rapidly at the blue and red end of instruments.

Quantized Exposure Times

Table 1. Available NIRCam MULTIACCUM readout patterns

Readout pattern	Samples per group (NSAMPLES = NFRAMES + NSKIP)	Frames averaged in each group (NFRAMES)
RAPID	1	1
BRIGHT1	2	1
BRIGHT2	2	2
SHALLOW2	5	2
SHALLOW4	5	4
MEDIUM2	10	2
MEDIUM8	10	8
DEEP2	20	2
DEEP8	20	8

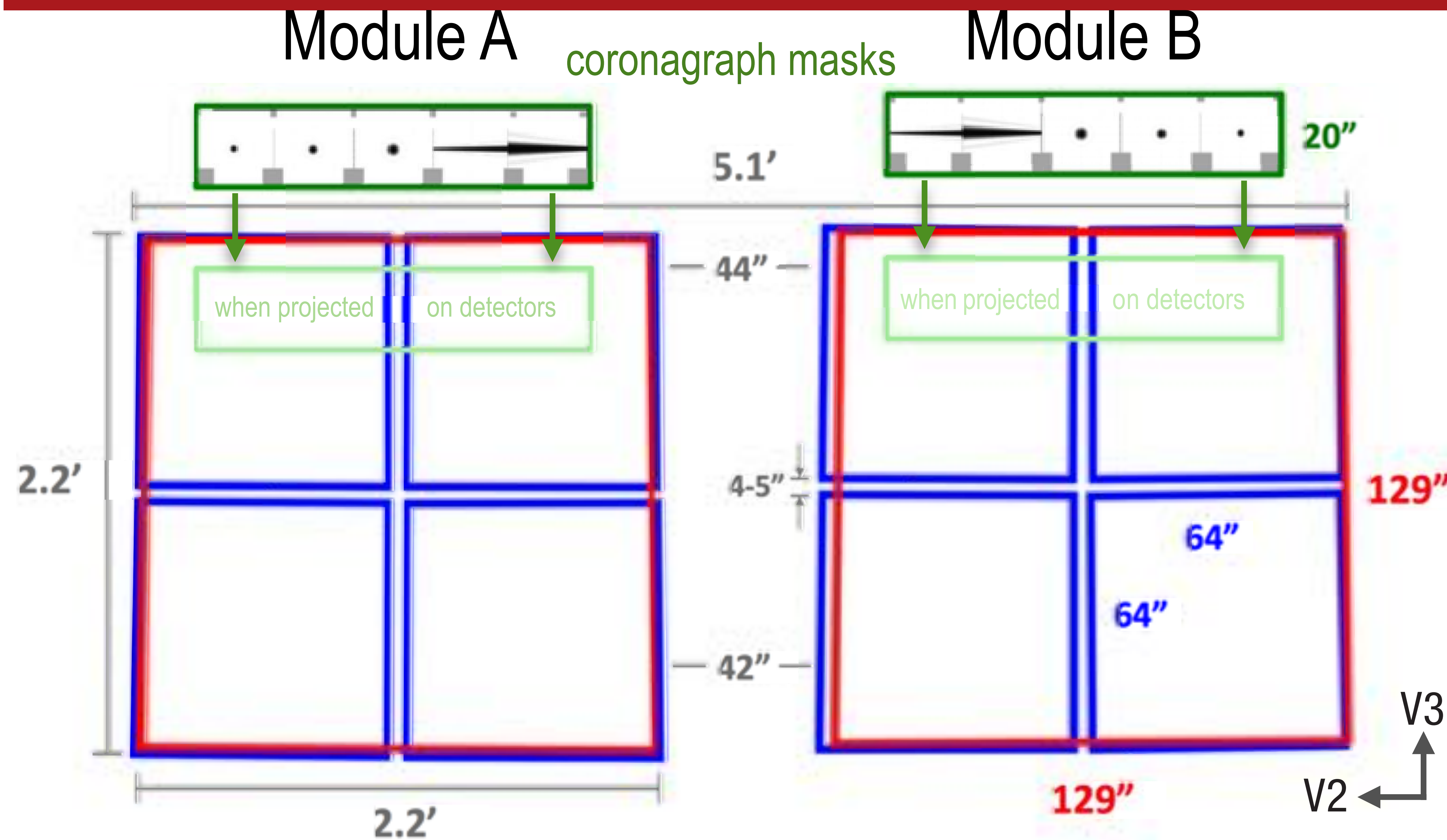
NIRCam team recommends 4-7 groups per exposure: ~700-1400 sec exptimes

Then you will dither, so you'll end up with 3+ of these exposures.

This quantization of exptime makes for less program flexibility

Module and Chip Gaps

Field of View



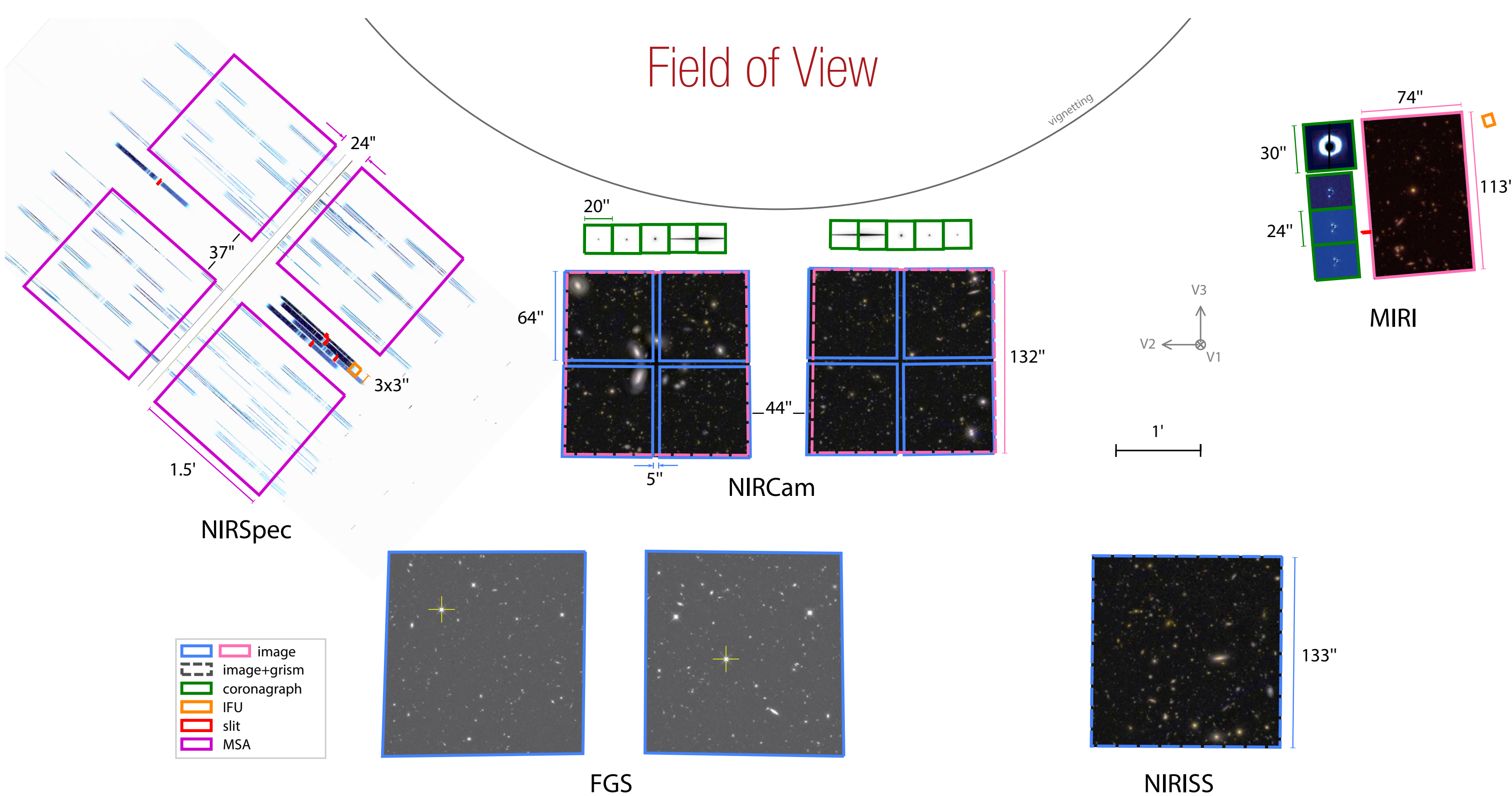
overlapping FOVs imaged simultaneously using a dichroic { short wavelength detectors / long wavelength detectors

Teledyne HgCdTe H2RG detectors
2048 × 2048 pixels including referenc
rows and columns insensitive to light

Coordinated Parallels

Allowed for Cycle 1:

1. NIRCam Imaging and MIRI Imaging,
2. NIRCam imaging and NIRISS Wide-Field Slitless Spectroscopy (WFSS),
3. NIRCam imaging and NIRISS imaging (NIRCam must be the prime instrument),
4. NIRCam imaging and NIRSpec MOS (NIRSpec must be the prime instrument),
5. MIRI imaging and NIRISS WFSS.



Coordinated Parallels

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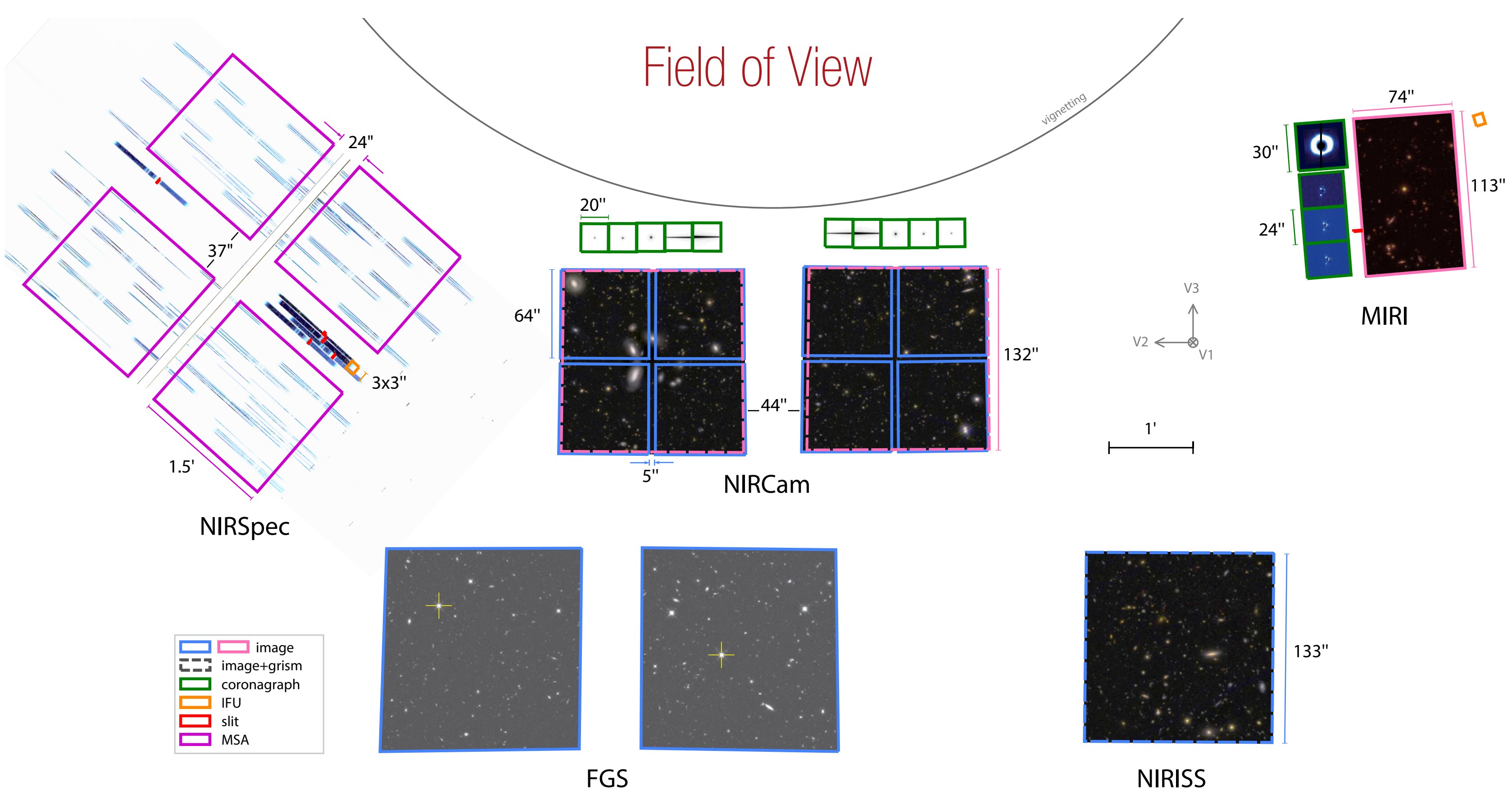
1. NIRCam Imaging and MIRI Imaging,
2. NIRCam imaging and NIRISS Wide-Field Slitless Spectroscopy (WFSS),
3. NIRCam imaging and NIRISS imaging (NIRCam must be the prime instrument),
4. NIRCam imaging and NIRSpec MOS (NIRSpec must be the prime instrument),
5. MIRI imaging and NIRISS WFSS.

When doing parallels, cannot do things like dither or change filters on only one instrument. Means that exposure times are linked.



Notice: No grism! The exception is that one can do NIRCam grism on the long-WL side, and imaging on the short-WL side.

NIRSpec MSA

- While there is an enormous number of microshutters, the FoV is small (~3.6’x3.6’ w/ gaps), and the spectra can take a decent amount of detector space.
  - Typical numbers NIRSpec GTO team says:
    - ~55 objects per config w/ R~1000 or 2700 grating.
    - ~190 objects per config w/ R~100 prism.
  - High source density is a must!
  - Multi-science proposals are also a good idea.

Questions?