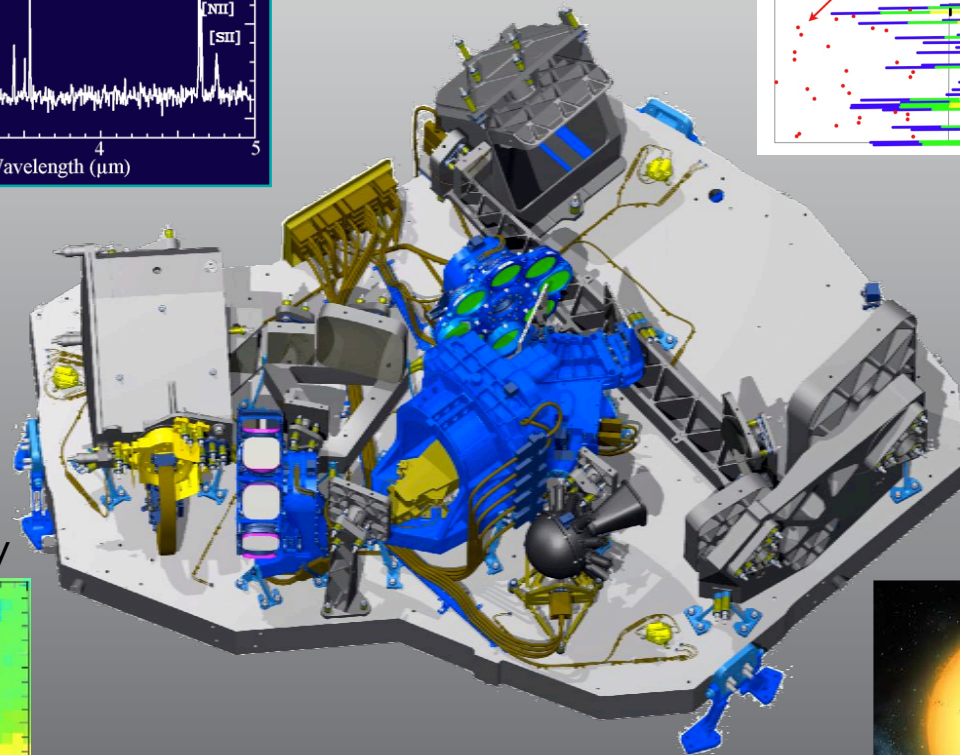
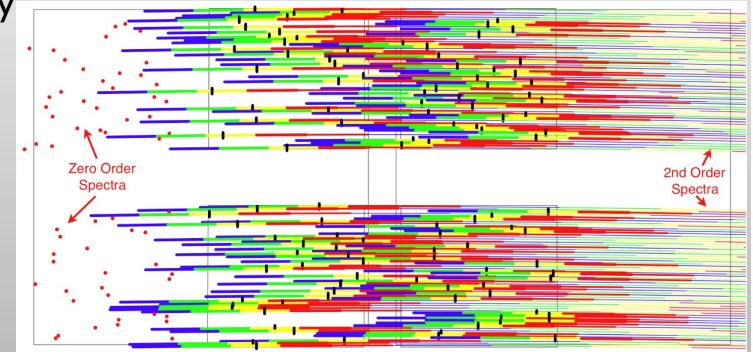
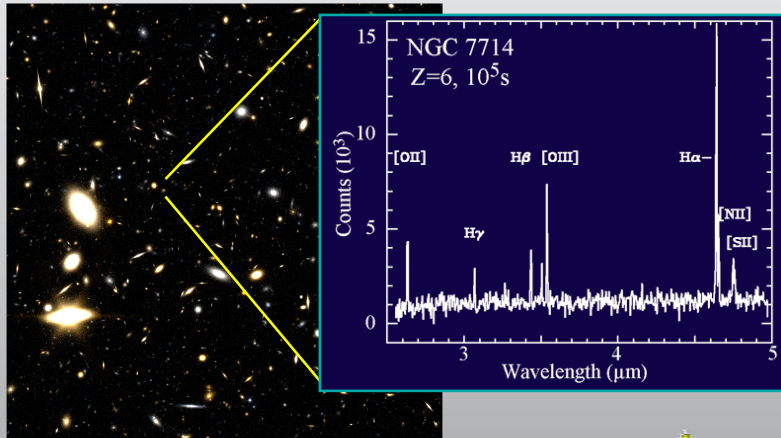


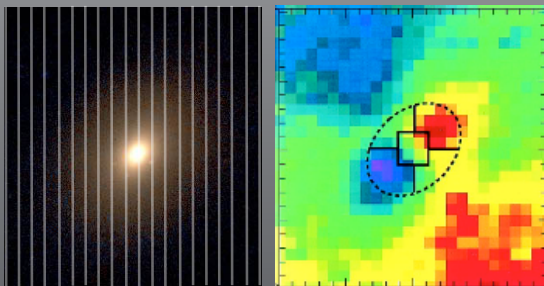
Observing with JWST and NIRSpec



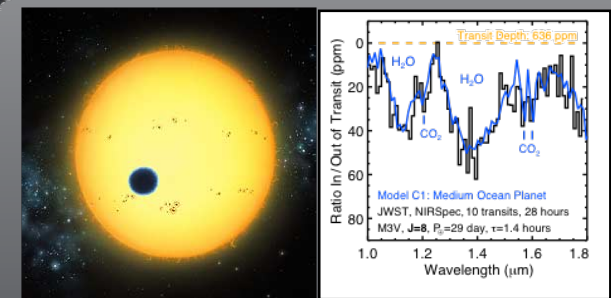
Multi-Object Spectroscopy



Integral-Field Spectroscopy



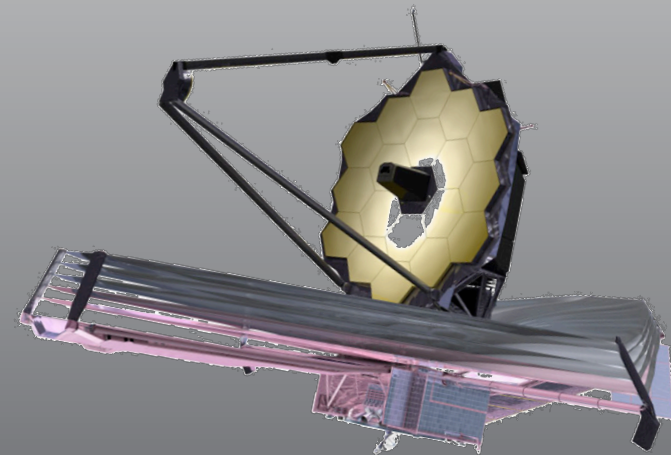
Fixed-Slit Spectroscopy



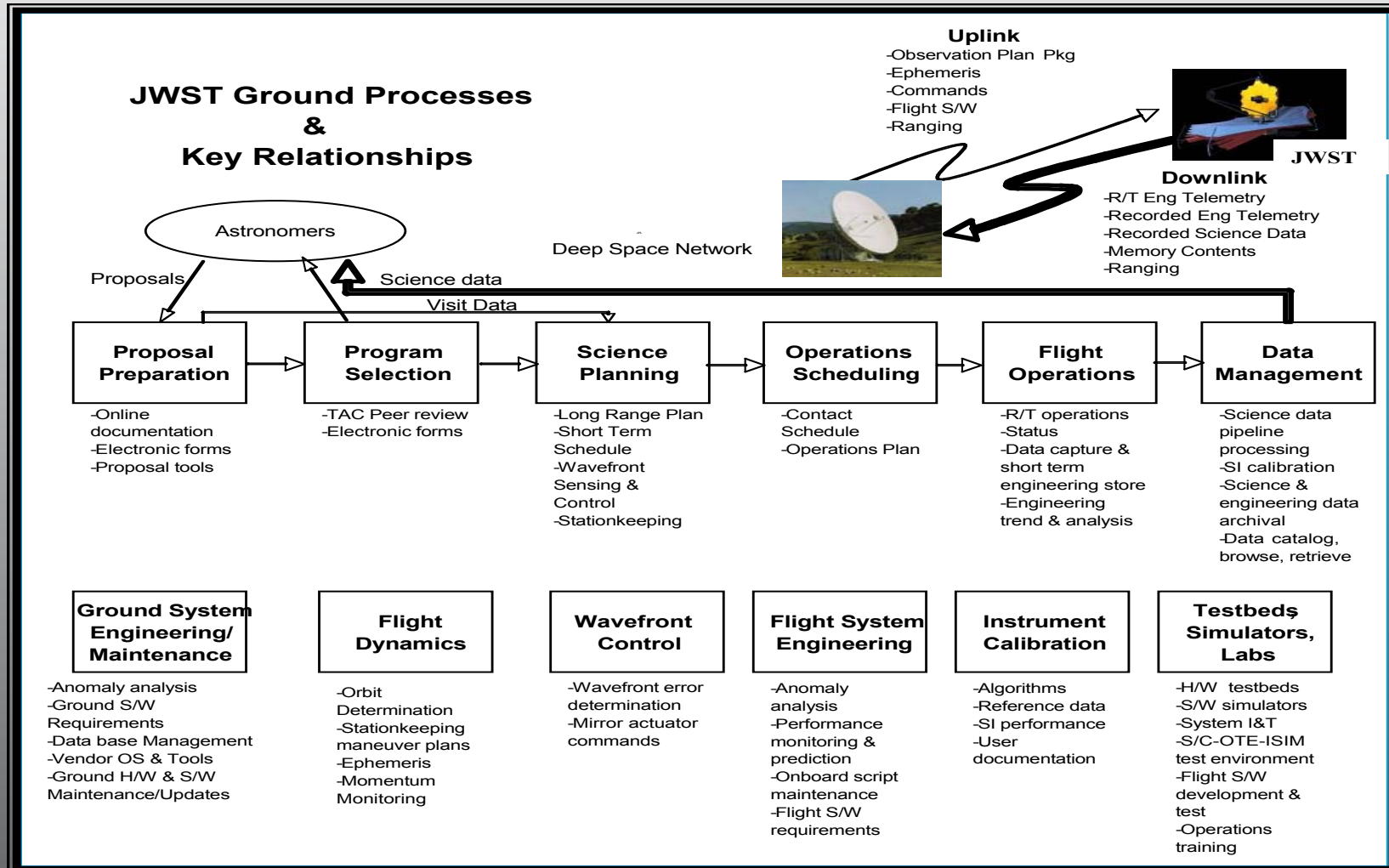
Agenda



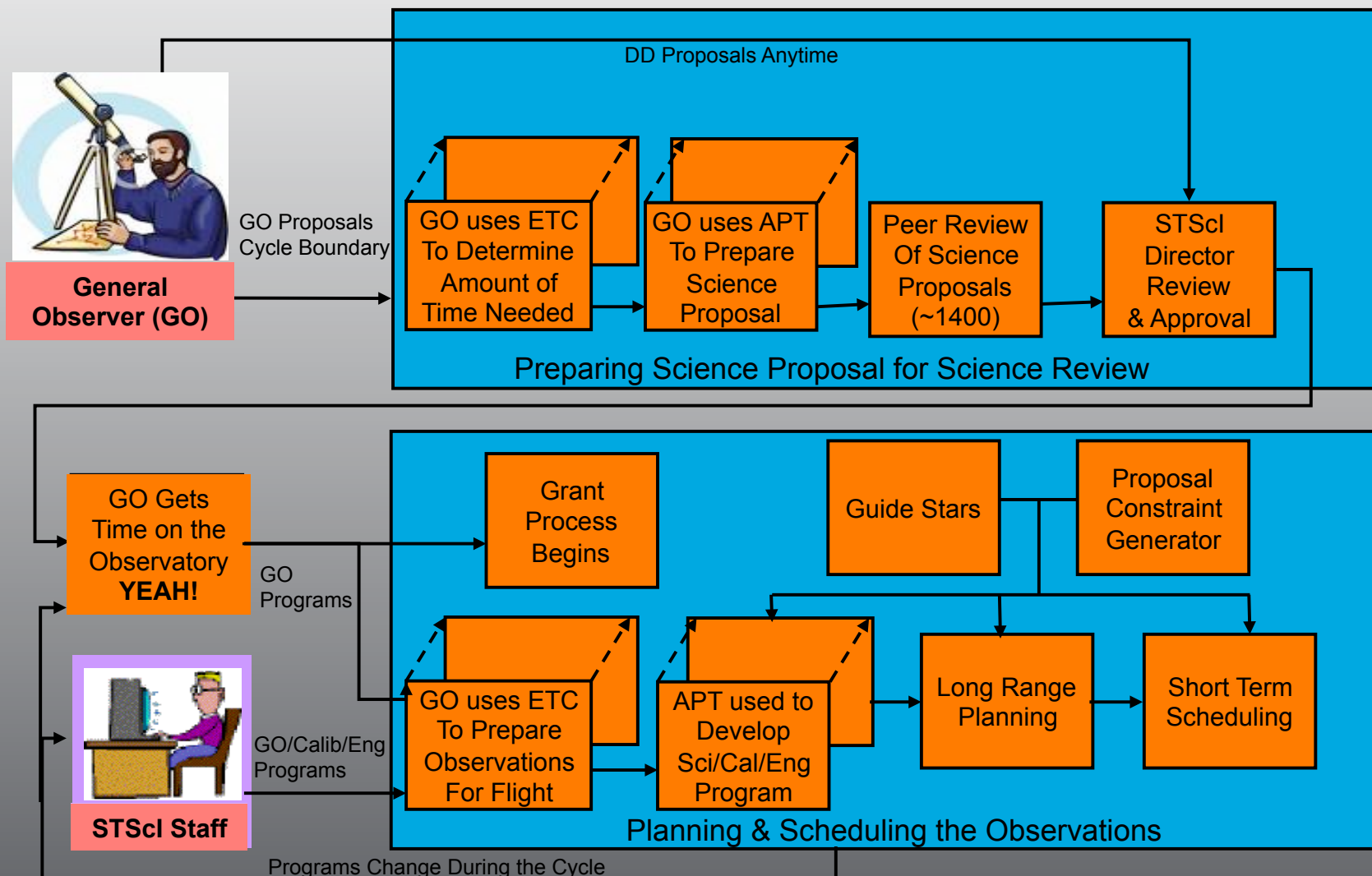
- 1) the big picture: mission operations
- 2) NIRSpec target acquisition
- 3) planning MOS observations



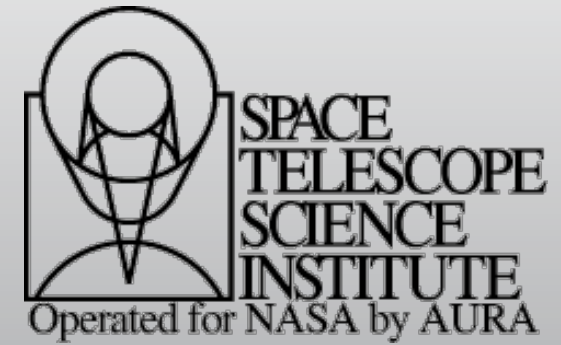
The Observer's view



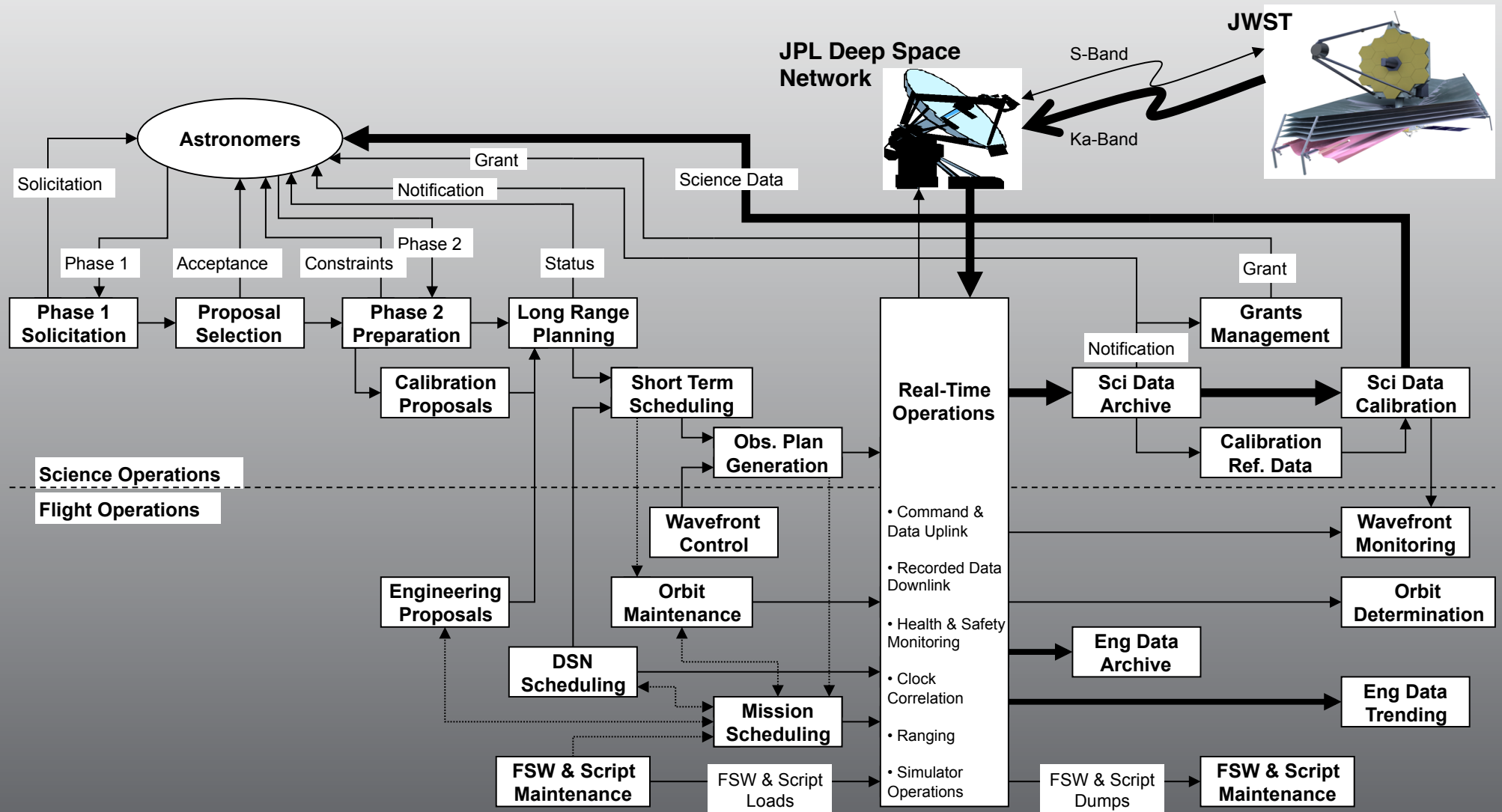
Proposals and Observation Planning



Science Operations Center



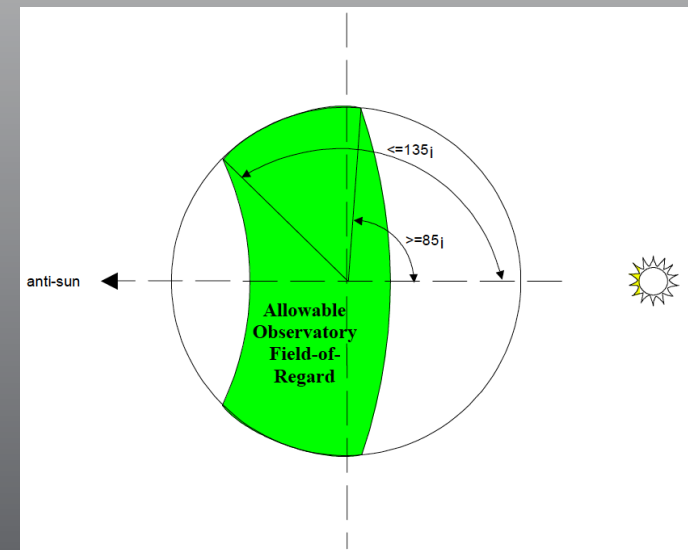
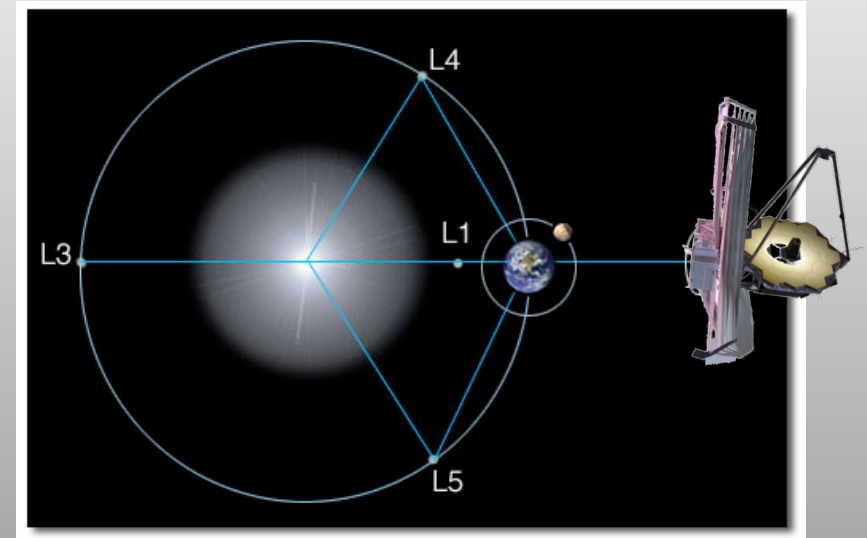
The full picture....



Observatory Issues



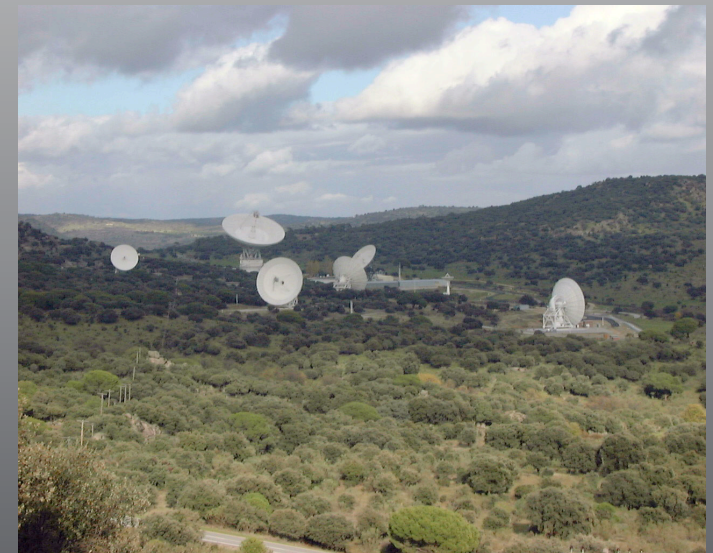
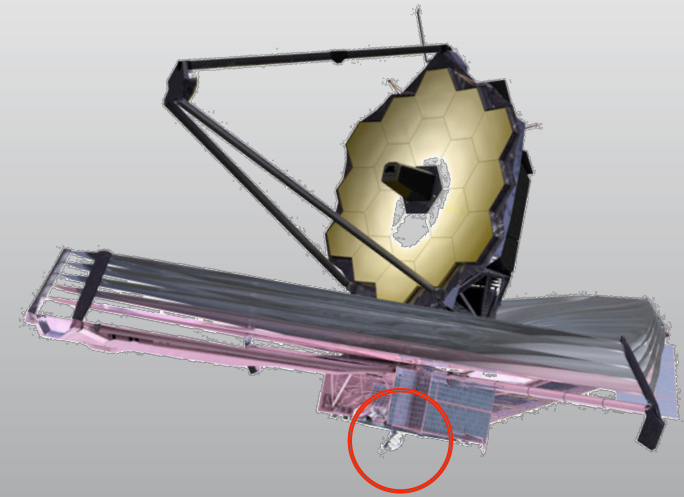
- Autonomous Operations
 - requires sophisticated on-board software
- Orbital constraints, target visibility
 - requires long-range planning
- Roll constraints
- Slew speed and accuracy
 - target sequence should be optimized



Observatory Issues (2/3)



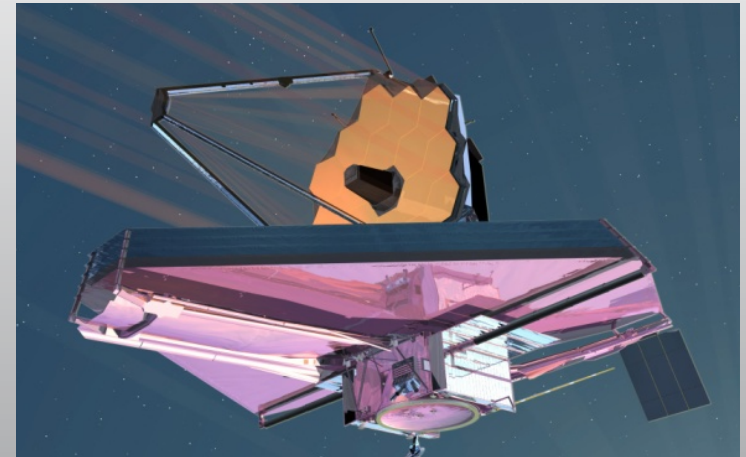
- Autonomous Operations
- Orbital constraints, target visibility
- Roll constraints
- Slew speed and accuracy
- Data volume and downlink
 - can't overfill solid-state recorders
 - high-gain antenna must be re-pointed towards ground station at least every 10,000s → stop observations
 - Deep Space Network antennas in California, Spain, and Australia
 - downlink contact 4h every 12h



Observatory Issues (3/3)



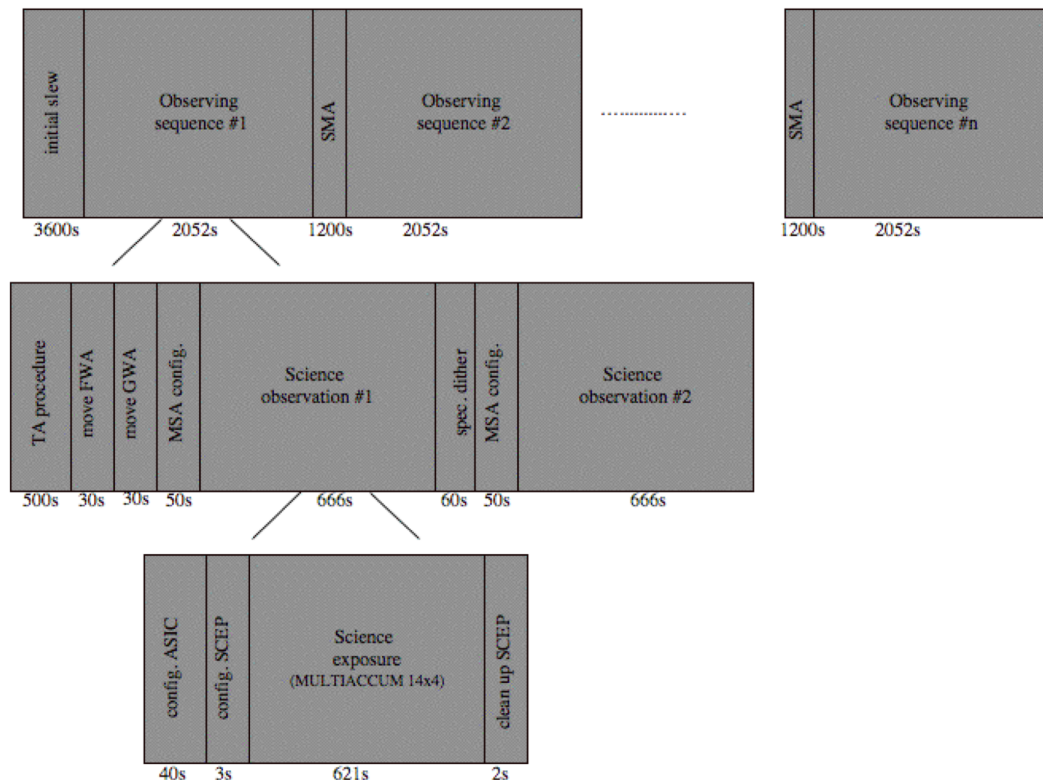
- Autonomous Operations
- Orbital constraints, target visibility
- Roll constraints
- Slew speed and accuracy
- Data volume and downlink
- Momentum management
 - radiation pressure on sunshield and trim flap
 - must be compensated by reaction wheels spin-up
 - eventually, reaction wheels must be slowed via thruster firing → orbit change
- Orbit maintenance
 - L2 is saddle point → unstable orbit
 - increases risk of straylight and downlink problems
 - “station keeping” through periodic thruster firings
- Wavefront maintenance...



Event-driven Operations



- wait for each command to execute successfully before issuing next command
- if confirmation is not received, react in optimal way
- efficient, because failed activities can be skipped
- inefficient, because it implies strictly sequential operations → large overheads



Operations Concept Document (OCD)



JWST-OPS-002018
Revision C
Effective Date: April 10, 2009
Expiration Date: April 10, 2014

James Webb Space Telescope Project

JWST Mission Operations Concept Document

April 10, 2009

JWST GSFC CMO

April 10, 2009

RELEASED

Prepared by: Space Telescope Science Institute (STScI)
DRD #: S&OC-OP-02
Under Contract/Agreement: NAS5-03092



National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

CHECK THE JWST DATA BASE AT:
<https://ngin.jwst.nasa.gov/>
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

ESA CM
26 March 2010
RELEASED

DOCUMENT

NIRSPEC OPERATIONS CONCEPT DOCUMENT

DRD OPS-02



JAMES WEBB SPACE TELESCOPE

prepared by

original signed by
T. Böker - ESA JWST Deputy Project Scientist
Date 25 March 2010

approved by

electronically signed by
J. Tumlinson - STScI NIRSpec Instrument Scientist
Date 25 March 2010

original signed by
P. Jakobsen - ESA JWST Project Scientist
Date 25 March 2010

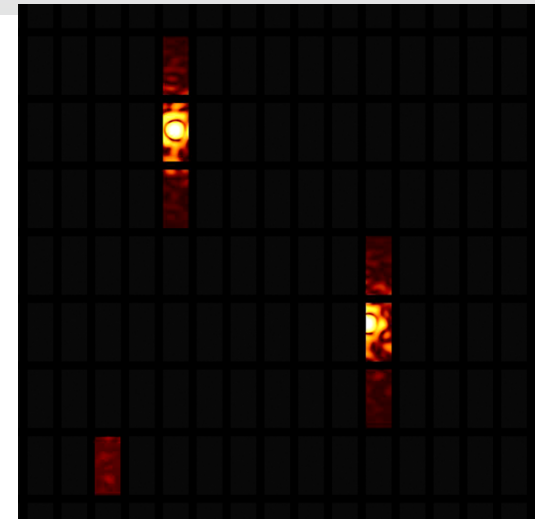
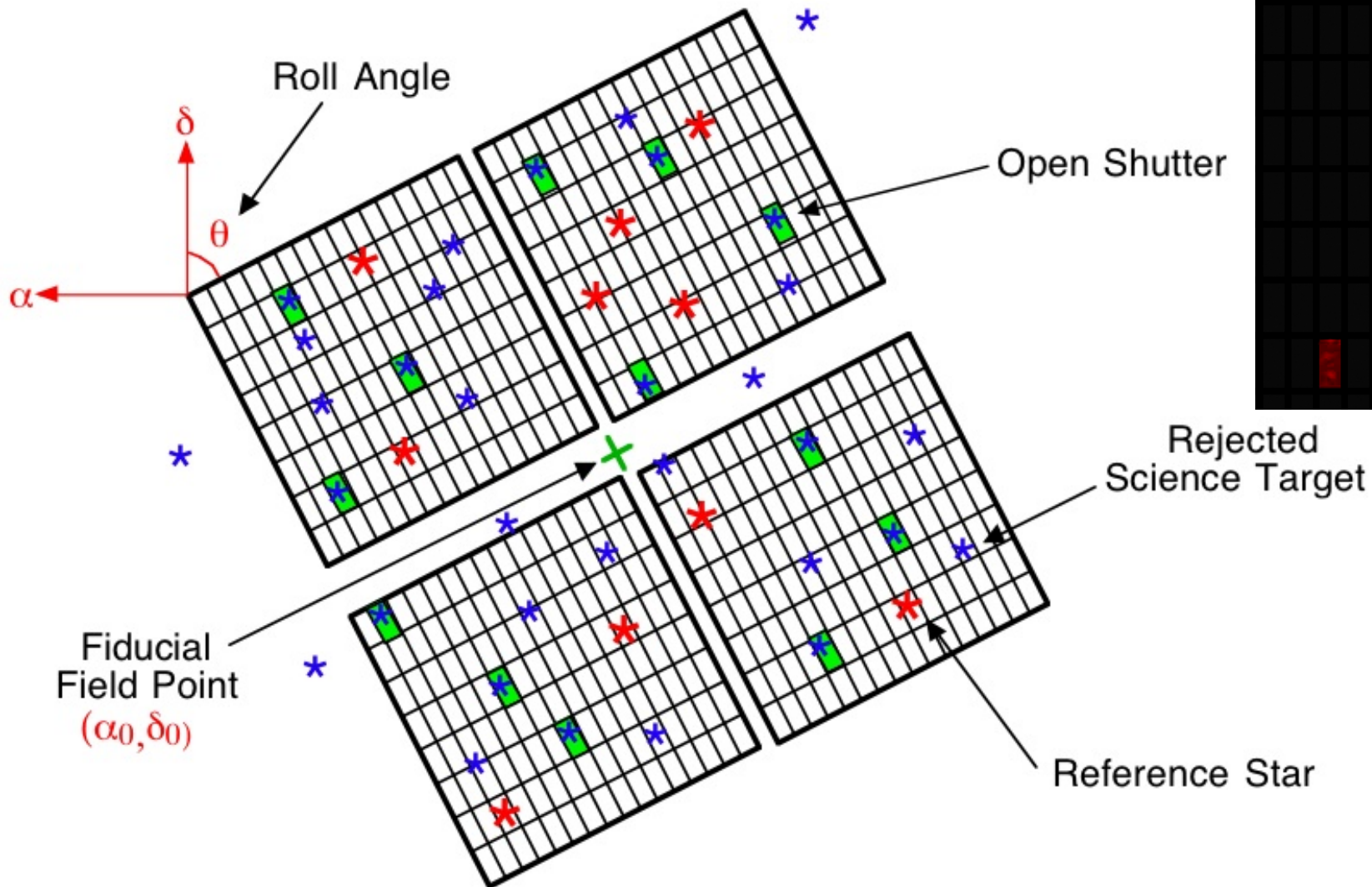
original signed by
P. Jensen - ESA JWST Project Manager
Date 25 March 2010

reference
issue
revision
date of issue

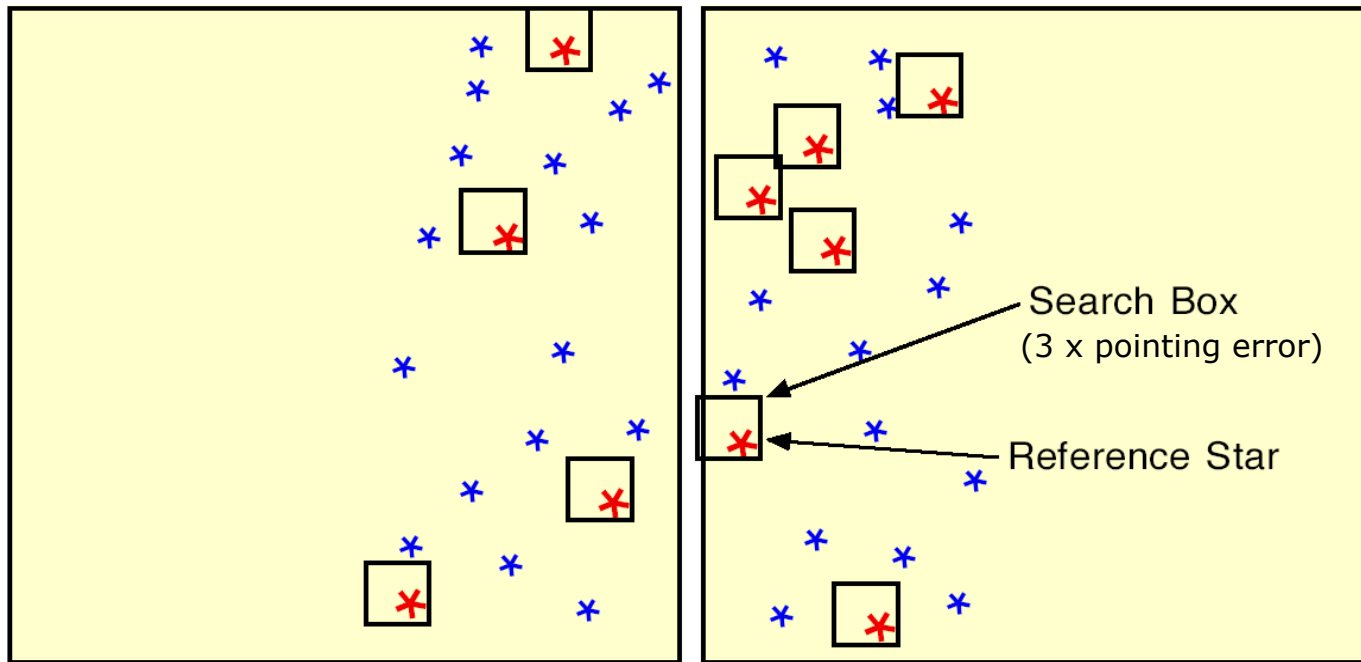
ESA-JWST-TN-0297 (JWST-OPS-003212)
6
0
26 March 2010

ESTEC
Keplerlaan 1 - 2201 AZ Noordwijk - The Netherlands
Tel. (31) 71 5656565 - Fax (31) 71 5656040

The Problem:

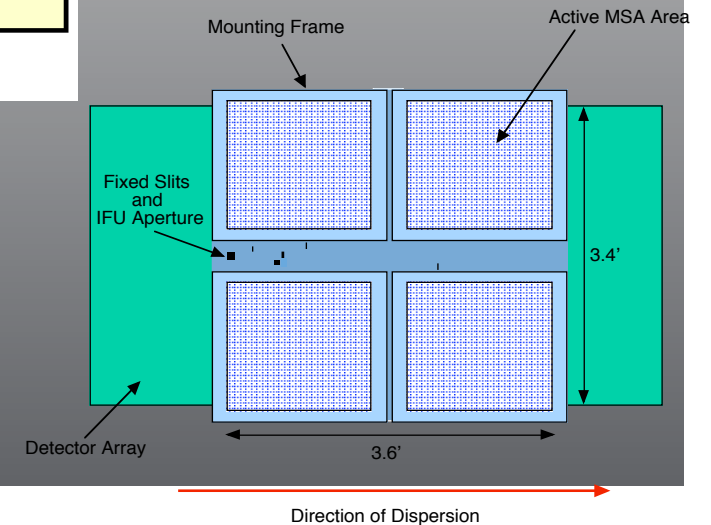


Target Acquisition and Slew Accuracy



SCA A

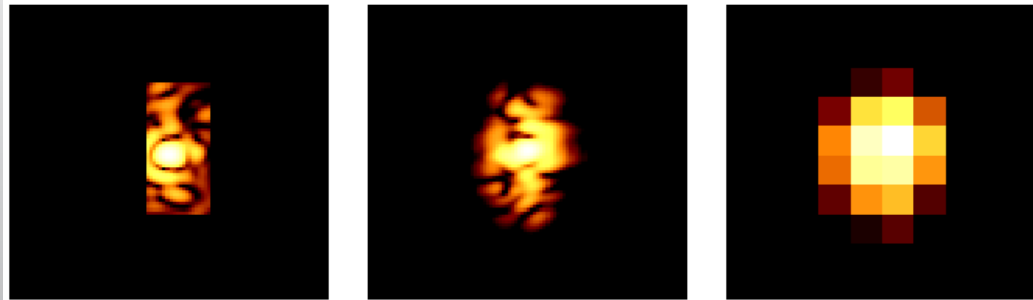
SCA B



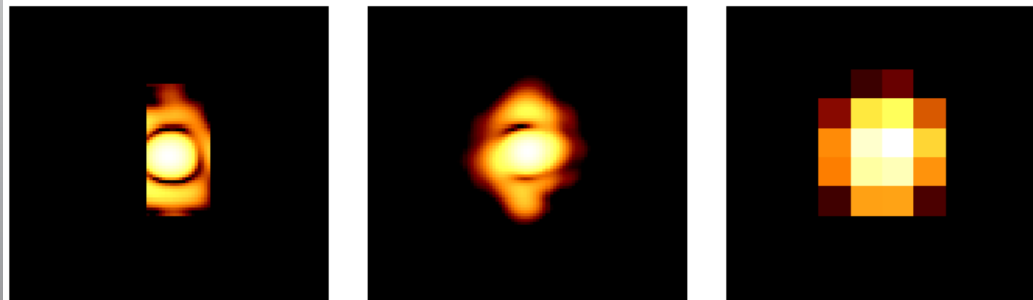
PSF Size



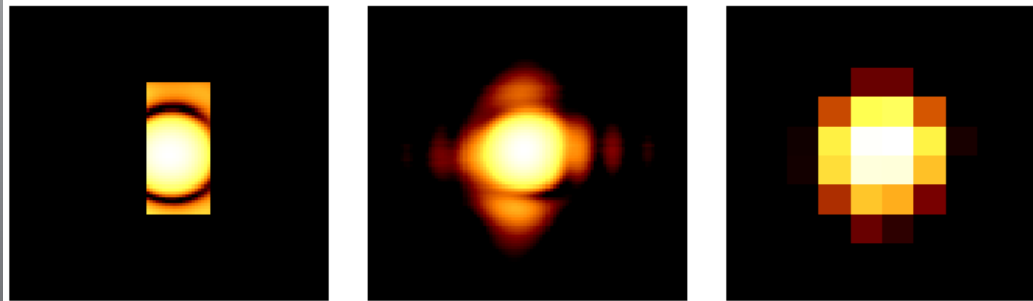
1.4 μm



2.4 μm



4.0 μm

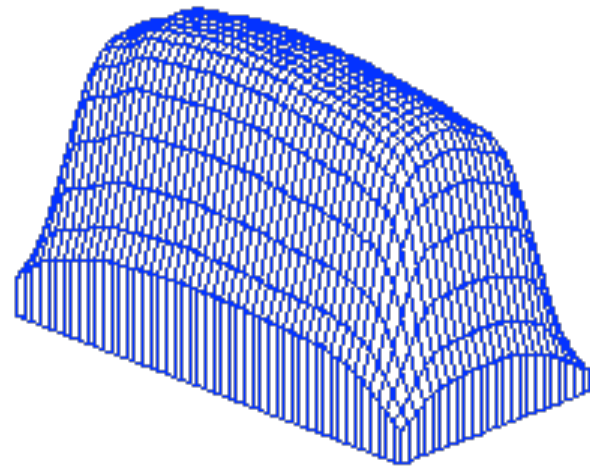


@ MSA

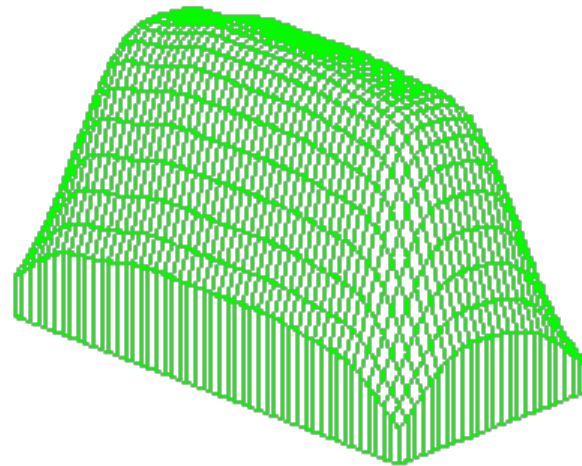
@ Detector

Pixels

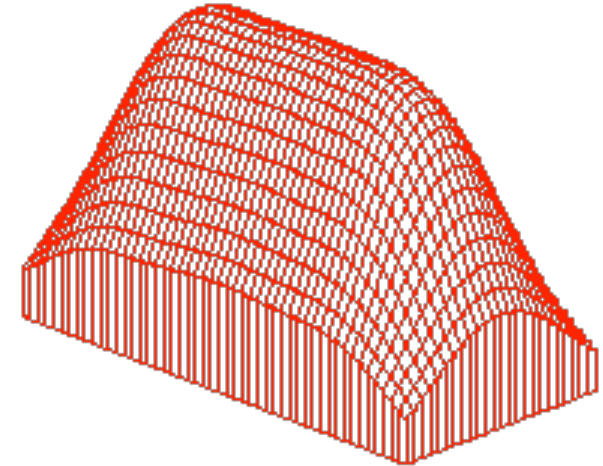
Slit Throughput



1.4 μm



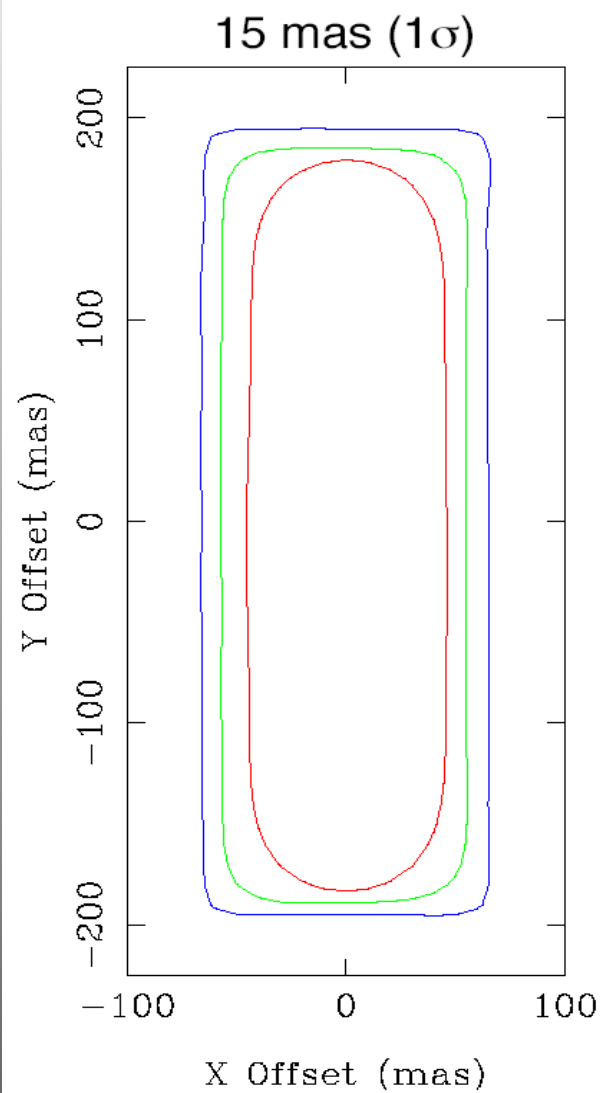
2.4 μm



4.0 μm

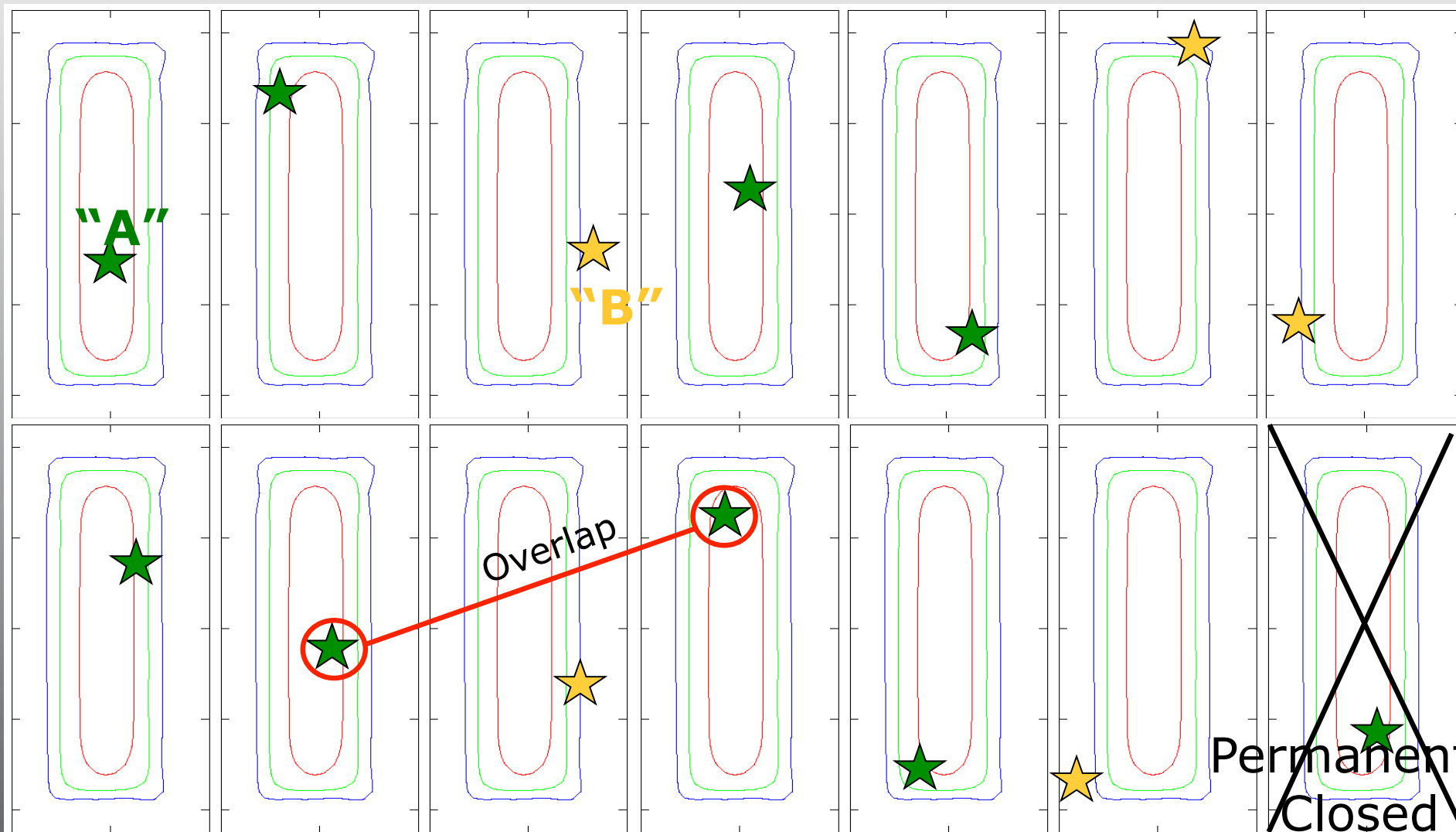
Throughput varies strongly across the slit.

Acceptance Zone (a.k.a "Sweet Spot")



1.4 μm
2.4 μm
4.0 μm

(Conceptual) MSA Planning

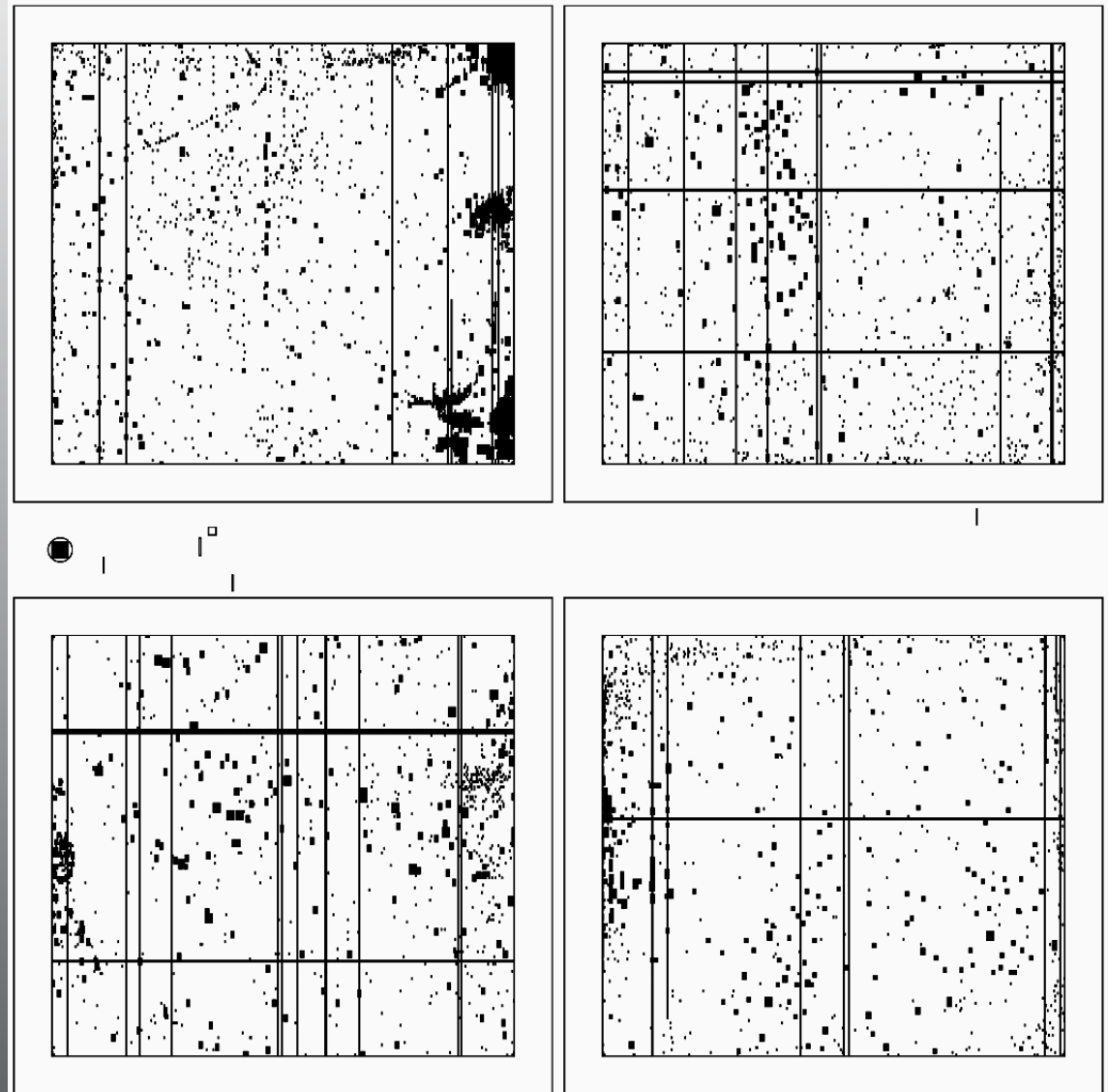
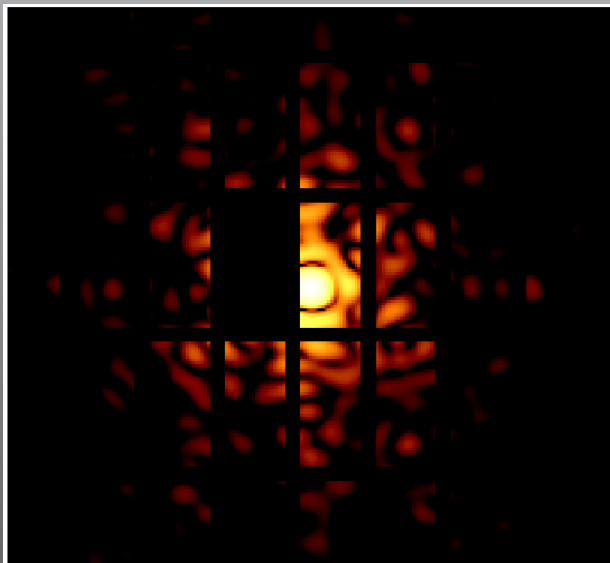


MSA performance: Closed Shutters



shutters that do not open
("failed closed"):

- cannot be used, but do not cause further harm
- electrical shorts cause entire columns/rows to fail in closed state

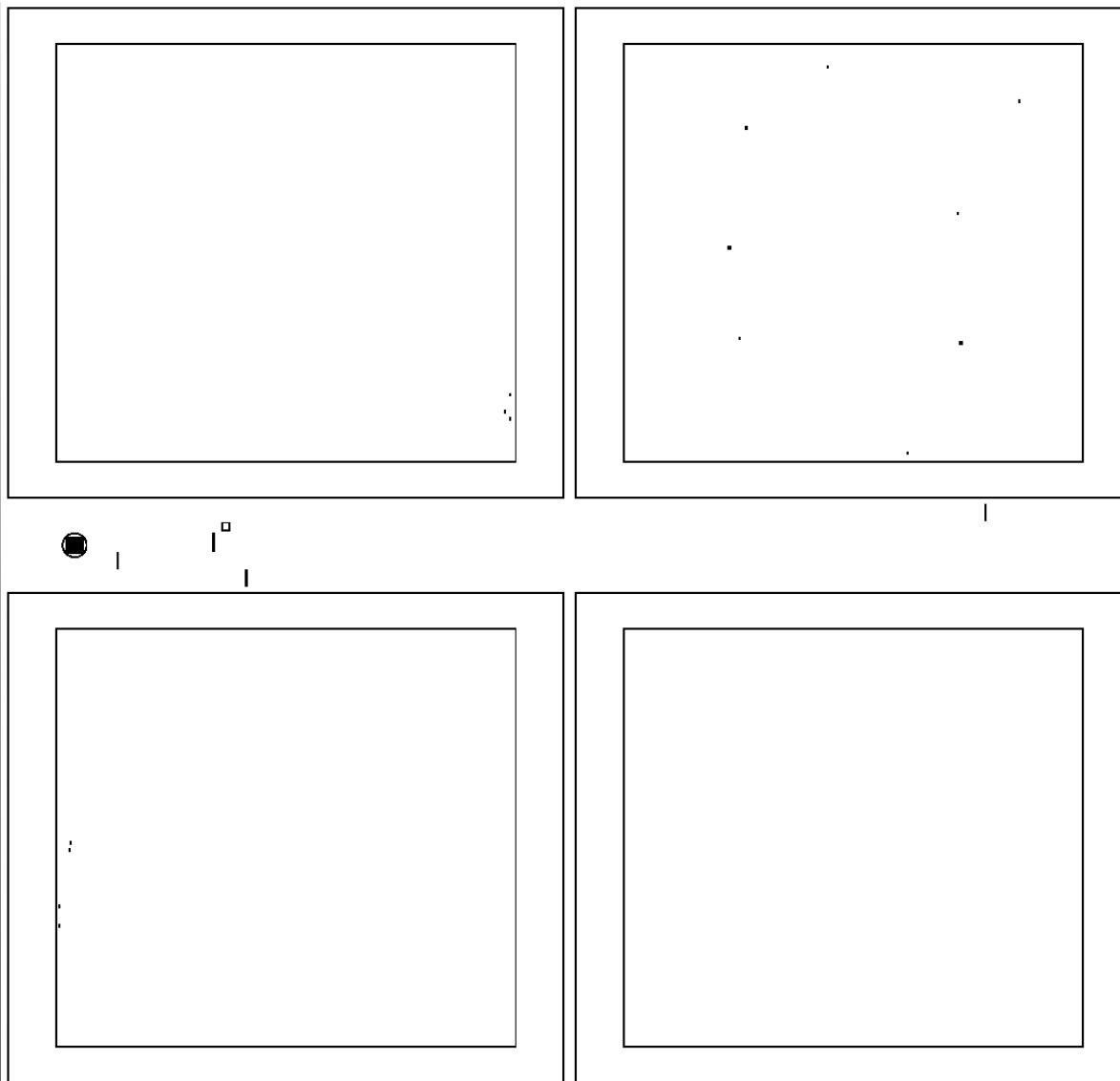


MSA Performance: Open Shutters



shutters that do not close ("failed open"):

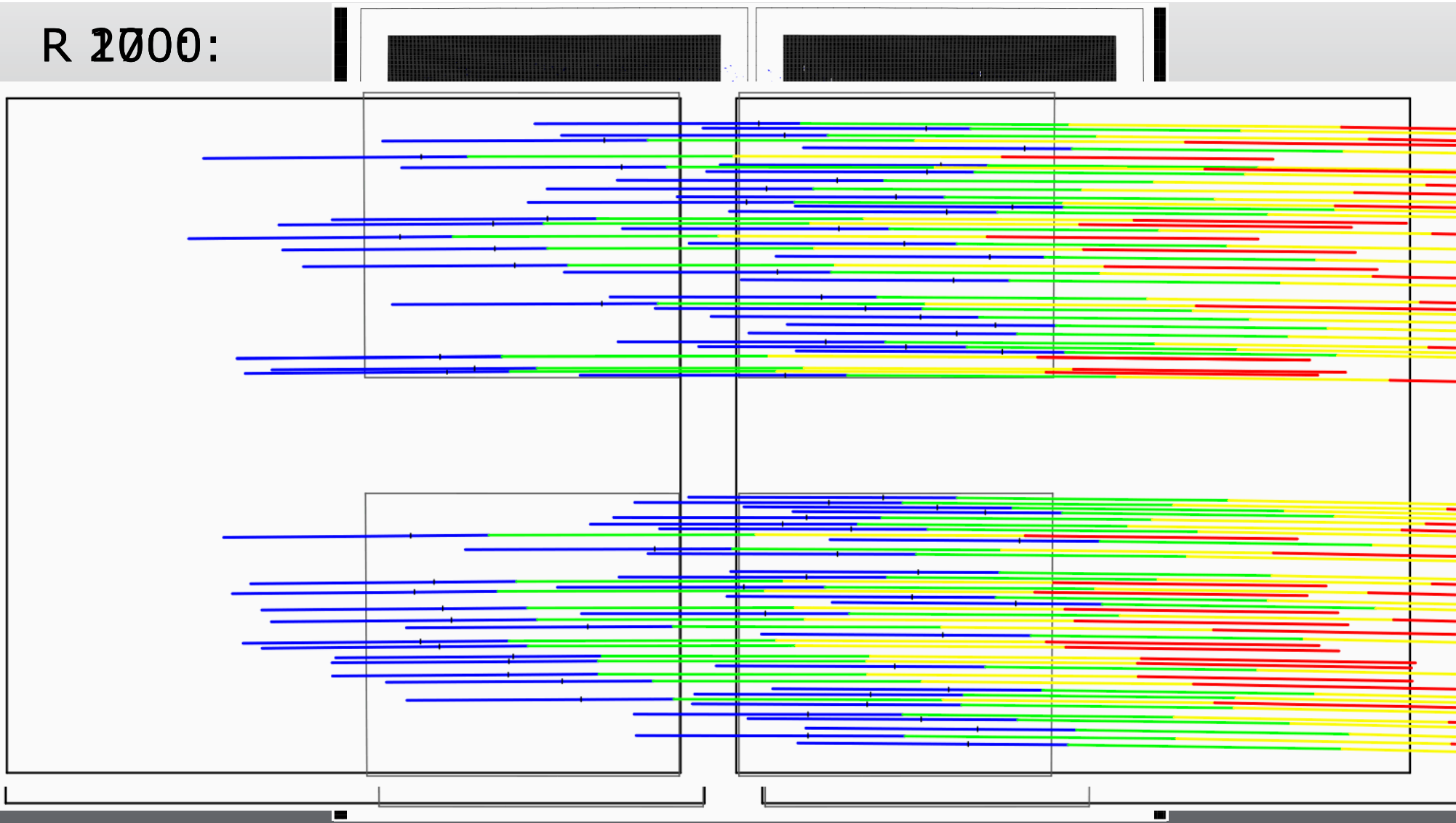
- are critical because they contaminate science spectra
- can mostly be plugged, turning them into "failed closed"



An Example: the HUDF



R 2000:



The MSA Planning Tool



Astronomer's Proposal Tools Version 17.0.3 - Phase II Proposal 15001 (Unsaved)

Form Editor | Spreadsheet Editor | Orbit Planner | Visit Planner | View in Aladin | BOT | MSA | PDF Preview | Submission | Errors and Warnings | Run All Tools | Stop

New HST Proposal | Phase II->I | New Visit | New Exposure | New Sequence | New Pattern | New Parallel | What's New? | Roadmap

MSA Planning Tool

MSA Exposure Summary:

Status	Visit #	Exp. #	Config	Exp. Label	In Shutter	In Aperture	Outside Apertures	Unknown	Total
completed	01	1	NIRSPEC/MSA	1.1 (01.001)	448	303	248	0	999

Shutter Open Percentages: (X) 70.0 (Y) 89.0

Analyze Sources | Print... | Save To File... | Show Details...

Exposure	Number	Label	Config	Target	Mode	Spectral Ele...	Polarizer	Crossed Filter	Aperture	Wavelength
1.1 (01.0...	1	1.1	NIRSPEC/...	1 CENTER...	ACCUM	MSA-FILT...			MSA	

Show: Exposure

998 errors & warnings (Click for Details)

The MSA Planning Tool



Aladin v3.7 multiview

ALADIN Position J2000 03:32:45.19 -27:50:15.1 Pixel full -2.9402822838164866

h_ufc_wfc_b_drz_img.fits

7.03' x 6.29'

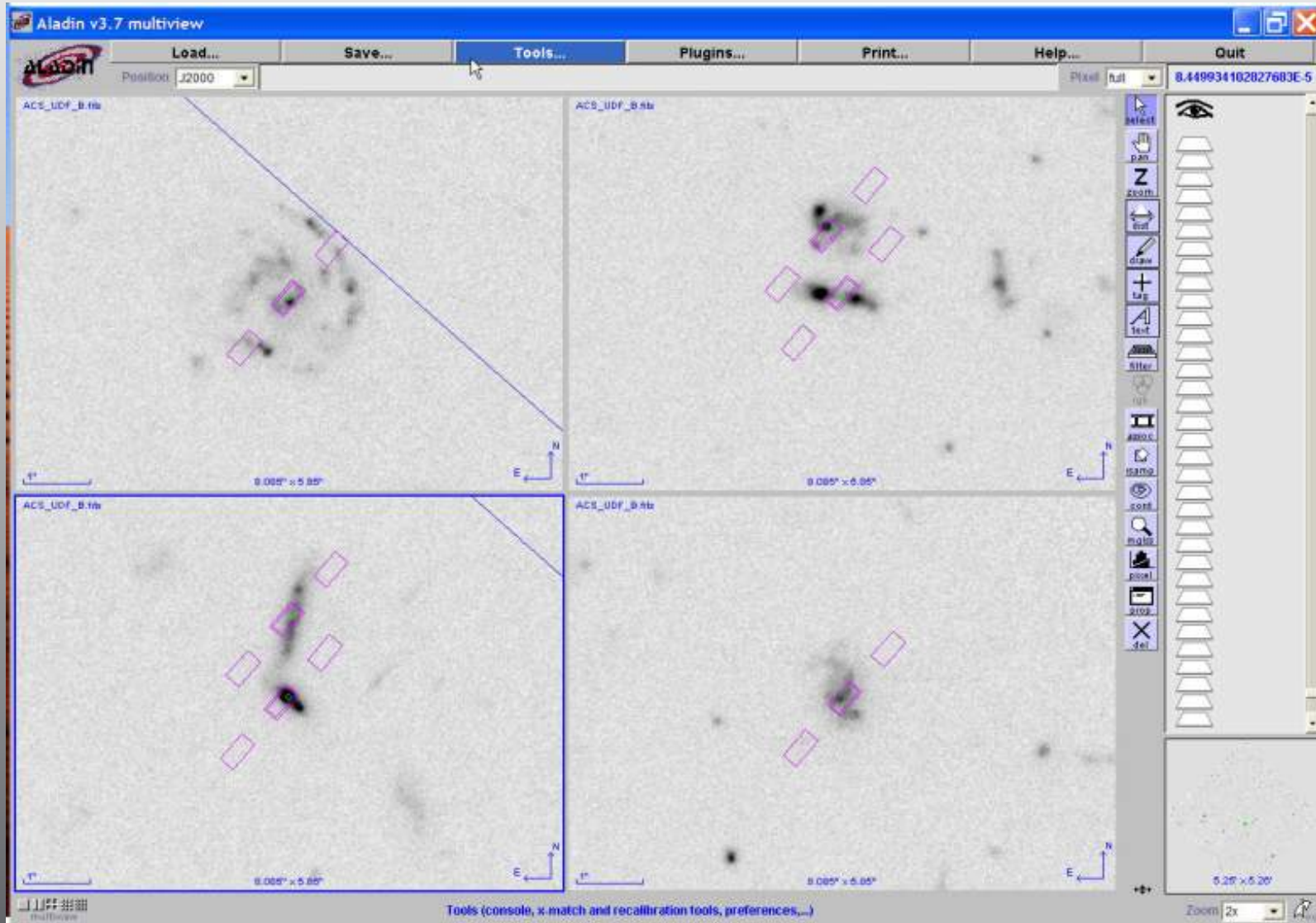
5.25' x 5.26'

Zoom 1/16x

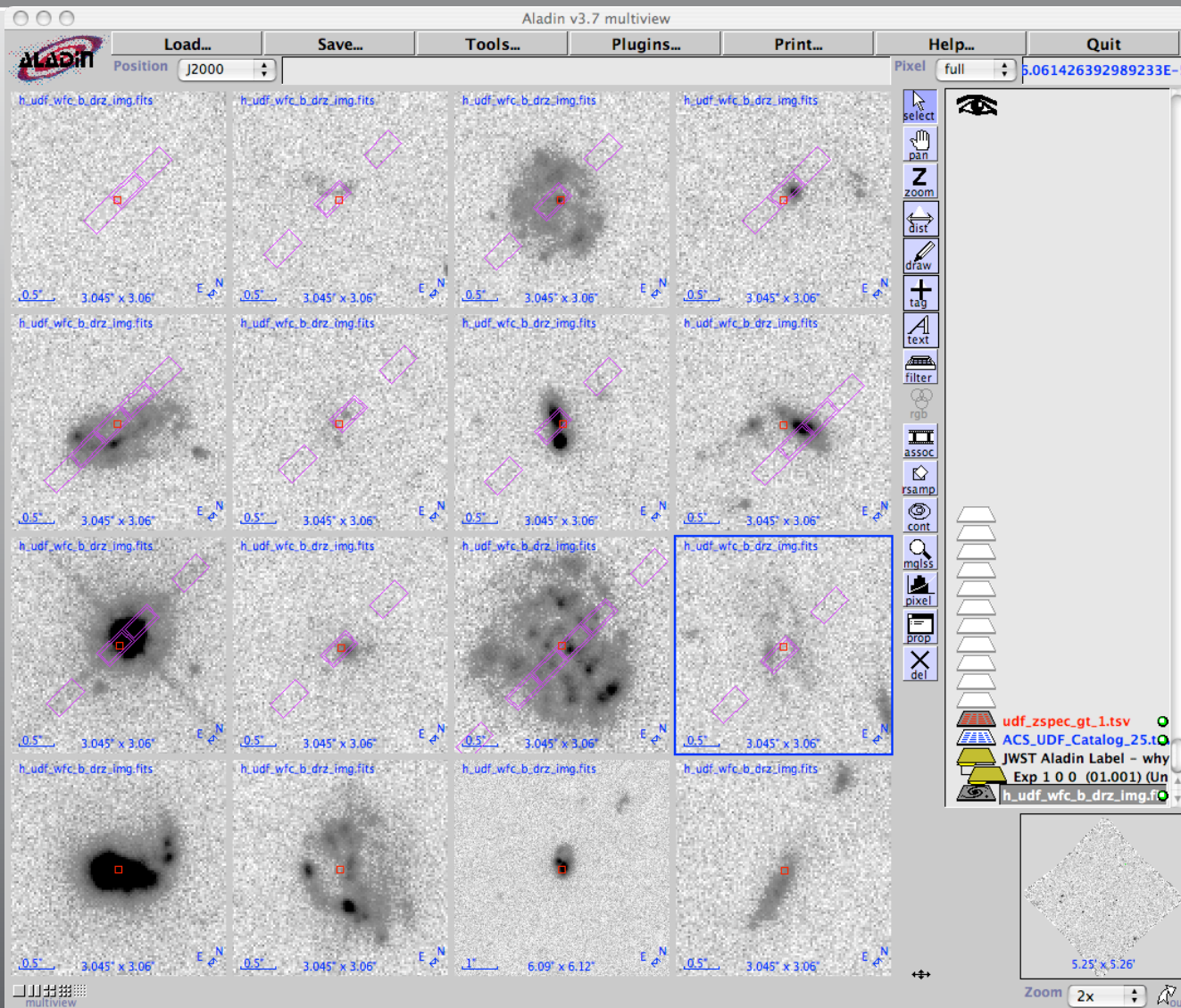
Tools: select, pan, zoom, dist, draw, tag, text, filter, rgb, assoc, rsamp, cont, mqlss, pixel, prop, del

- JWST Aladin Label - why are yo
- msa-pos4 0 0 (01.001) (Unsu
- Bright Objects msa-pos4 0
- msa-pos4 0 0 (01.001) (Un
- UDF_z6_zm283.tsv
- msa_missed_pos3.tsv
- h_ufc_wfc_b_drz_img.fits

The MSA Planning Tool



The MSA Planning Tool



The MSA Planning Tool



MSA Source Details: NIRSPEC/MSA - Exp 1

MSA Source Details

Status Filter

	Objects
<input checked="" type="checkbox"/> ★ Inside Shutter	12
<input checked="" type="checkbox"/> ★ Inside Aperture	3
<input checked="" type="checkbox"/> ★ Outside Apertures	4
<input checked="" type="checkbox"/> ★ Unknown	0

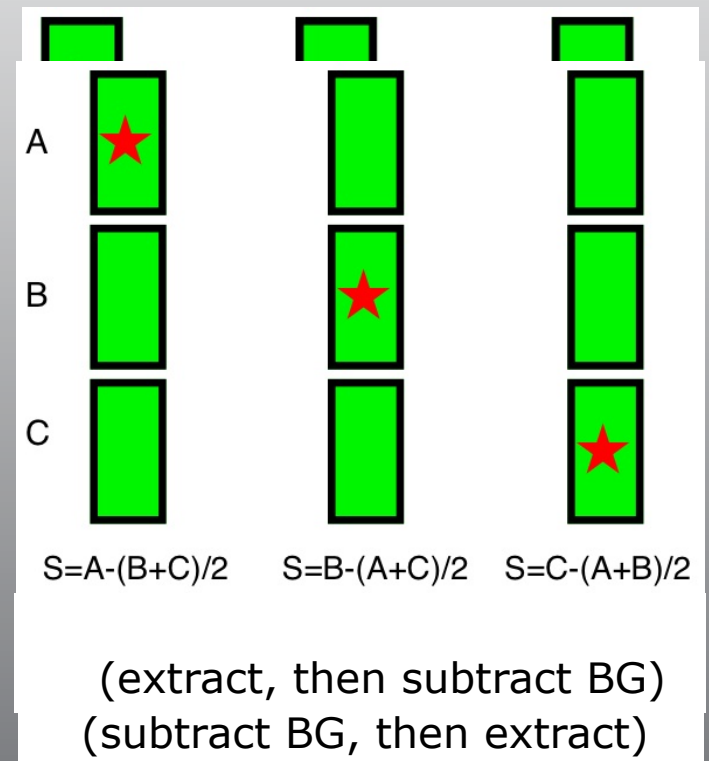
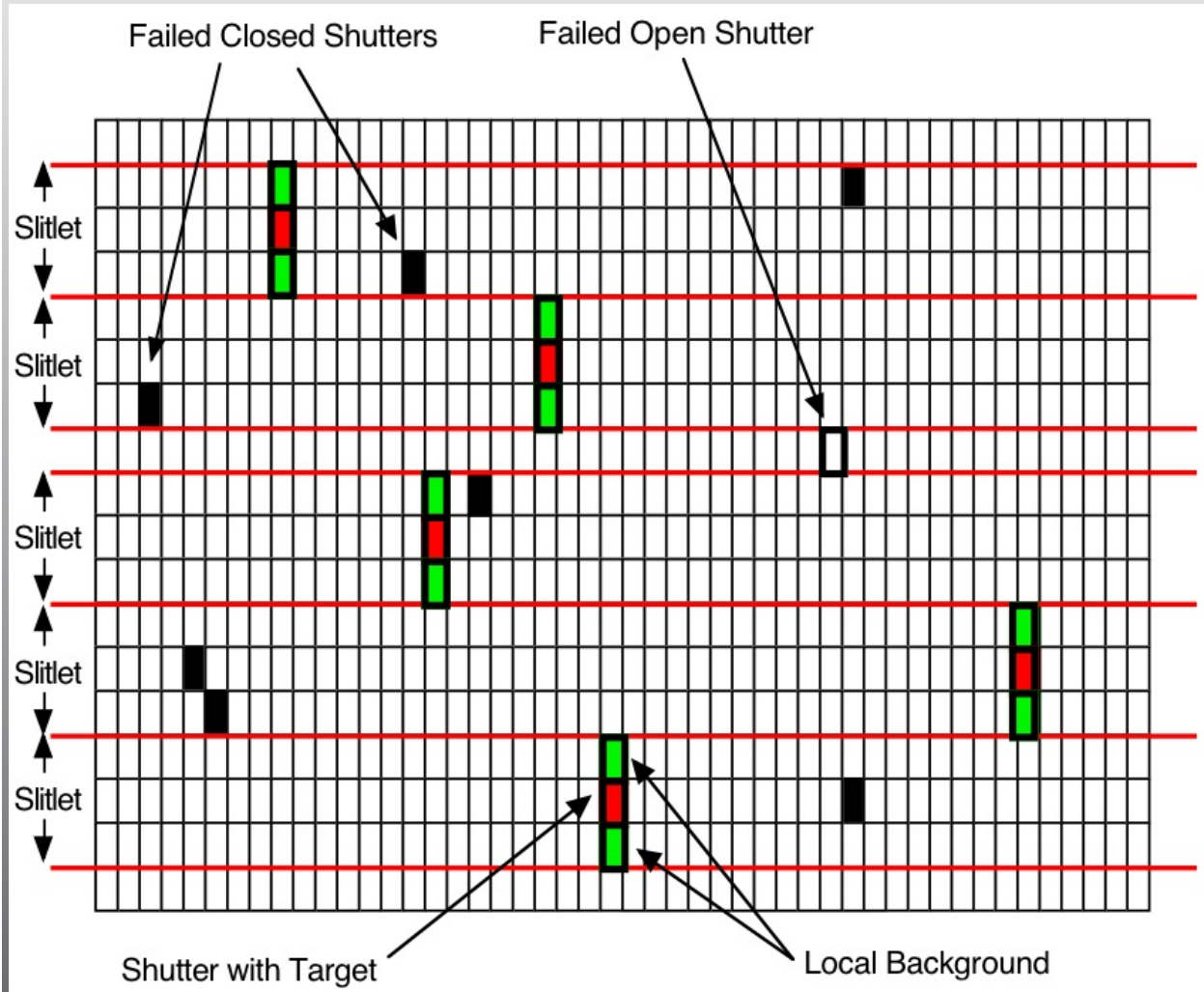
Exposure Parameters

Visit #: 01
 Exposure #: 1
 Exposure Name: Exp 1
 Instrument: NIRSPEC
 Detector: MSA
 Spectral Element: MSA-FILTER1
 Aperture: MSA
 Exposure Time: 100.0

Zoom	Shutter Pattern	Status Δ	OBJECT ID	Aperture	Shutter X	Shutter Y	RA	Dec	Offset X	Offset Y
<input checked="" type="checkbox"/>	Default	★ In Shutter	033240.0080-27481...	4	362 (1%)	121 (82%)	03 32 40.0...	-27 48 15.12	-16.721	76.733
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033239.6720-27485...	4	248 (61%)	167 (20%)	03 32 39.6...	-27 48 50.76	-45.122	98.721
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033244.6160-27463...	3	354 (53%)	61 (41%)	03 32 44.6...	-27 46 32.16	99.386	47.426
<input checked="" type="checkbox"/>	Default	★ In Shutter	033239.6480-27479...	3	61 (55%)	18 (51%)	03 32 39.6...	-27 47 9.24	26.592	26.864
<input checked="" type="checkbox"/>	Extended Source	★ In Shutter	033235.0880-27461...	2	42 (36%)	100 (23%)	03 32 35.0...	-27 46 15.60	21.896	-53.867
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033242.3840-27477...	3	168 (10%)	69 (75%)	03 32 42.3...	-27 47 7.80	53.230	51.578
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033240.9200-27482...	4	372 (54%)	152 (47%)	03 32 40.9...	-27 48 23.76	-14.306	91.404
<input checked="" type="checkbox"/>	Custom...	★ In Shutter	033244.1840-27472...	3	174 (31%)	136 (16%)	03 32 44.1...	-27 47 29.40	54.774	83.745
<input checked="" type="checkbox"/>	Custom...	★ In Shutter	033239.0960-27461...	2	232 (13%)	158 (22%)	03 32 39.0...	-27 46 1.92	69.127	-25.828
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033237.2000-27468...	2	143 (0%)	130 (13%)	03 32 37.2...	-27 46 8.04	47.033	-39.341
<input checked="" type="checkbox"/>	Custom...	★ In Shutter	033239.8880-27471...	3	53 (67%)	31 (66%)	03 32 39.8...	-27 47 15.00	24.758	33.185
<input checked="" type="checkbox"/>	Detached Backgro...	★ In Shutter	033235.7840-27462...	2	34 (35%)	131 (47%)	03 32 35.7...	-27 46 27.48	19.997	-38.939
<input type="checkbox"/>	Default	★ Not In Shutter	033235.9760-27485...	4	109 (88%)	95 (99%)	03 32 35.9...	-27 48 50.40	-79.468	63.722
<input type="checkbox"/>	Default	★ Not In Shutter	033242.2640-27462...	3	285 (80%)	5 (9%)	03 32 42.2...	-27 46 25.32	82.211	20.478
<input type="checkbox"/>	Default	★ Not In Shutter	033234.8240-27483...	4	108 (24%)	51 (89%)	03 32 34.8...	-27 48 35.64	-79.796	42.477
<input type="checkbox"/>	Default	★ Outside Apertures	REF				03 32 38.5...	-27 47 30.00	1.132	30.717
<input type="checkbox"/>	Default	★ Outside Apertures	033237.5600-27464...				03 32 37.5...	-27 46 46.56	23.111	-8.774
<input type="checkbox"/>	Default	★ Outside Apertures	033235.7840-27473...				03 32 35.7...	-27 47 34.80	-27.701	8.568
<input type="checkbox"/>	Detached Backgro...	★ Outside Apertures	033234.8480-27464...				03 32 34.8...	-27 46 40.44	2.049	-38.594

Print...
Save To File...
Done

Removing the Sky Background

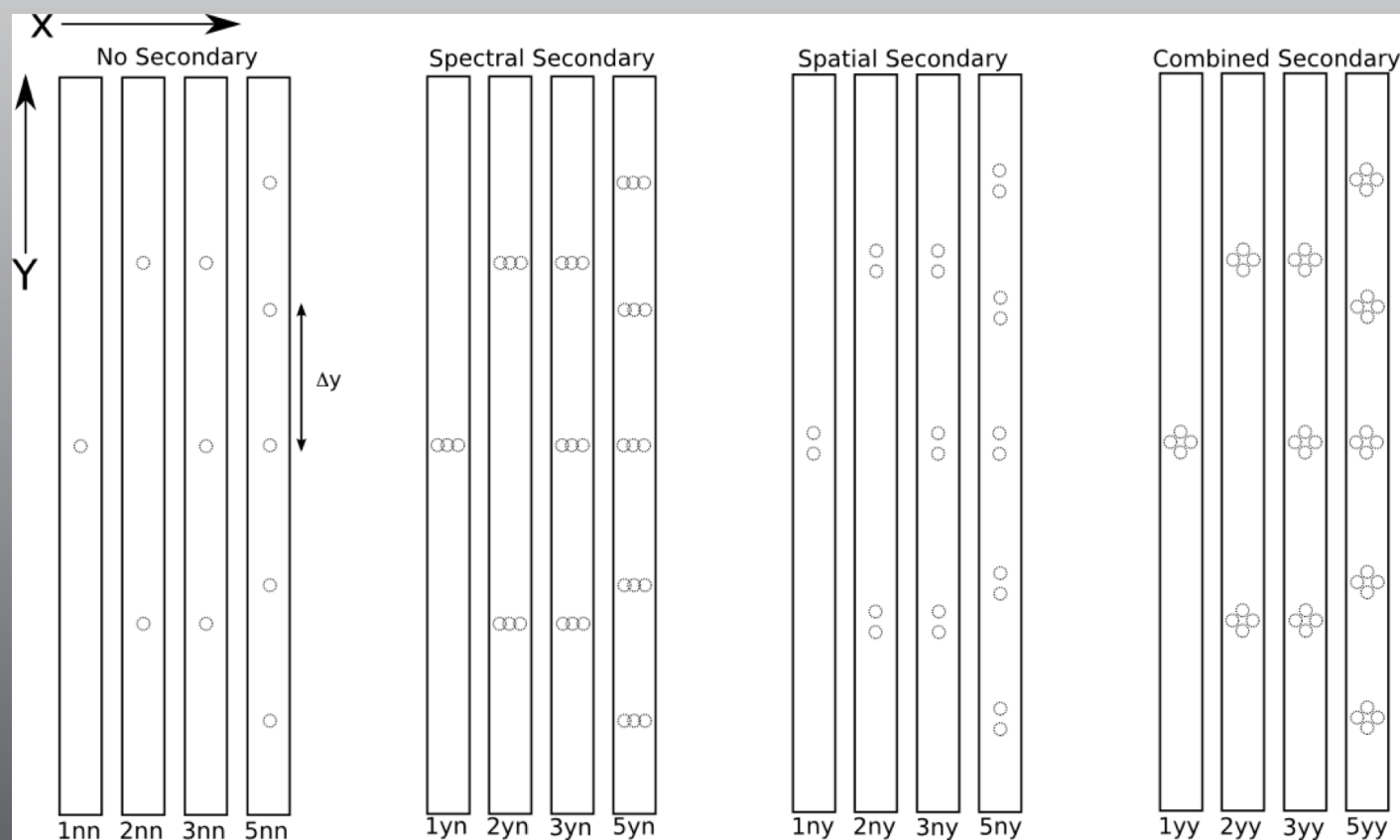


Dithering Schemes



- corrects bad detector pixels
- improves sampling (spatial and spectral)
- allows background subtraction
- covers the detector gap

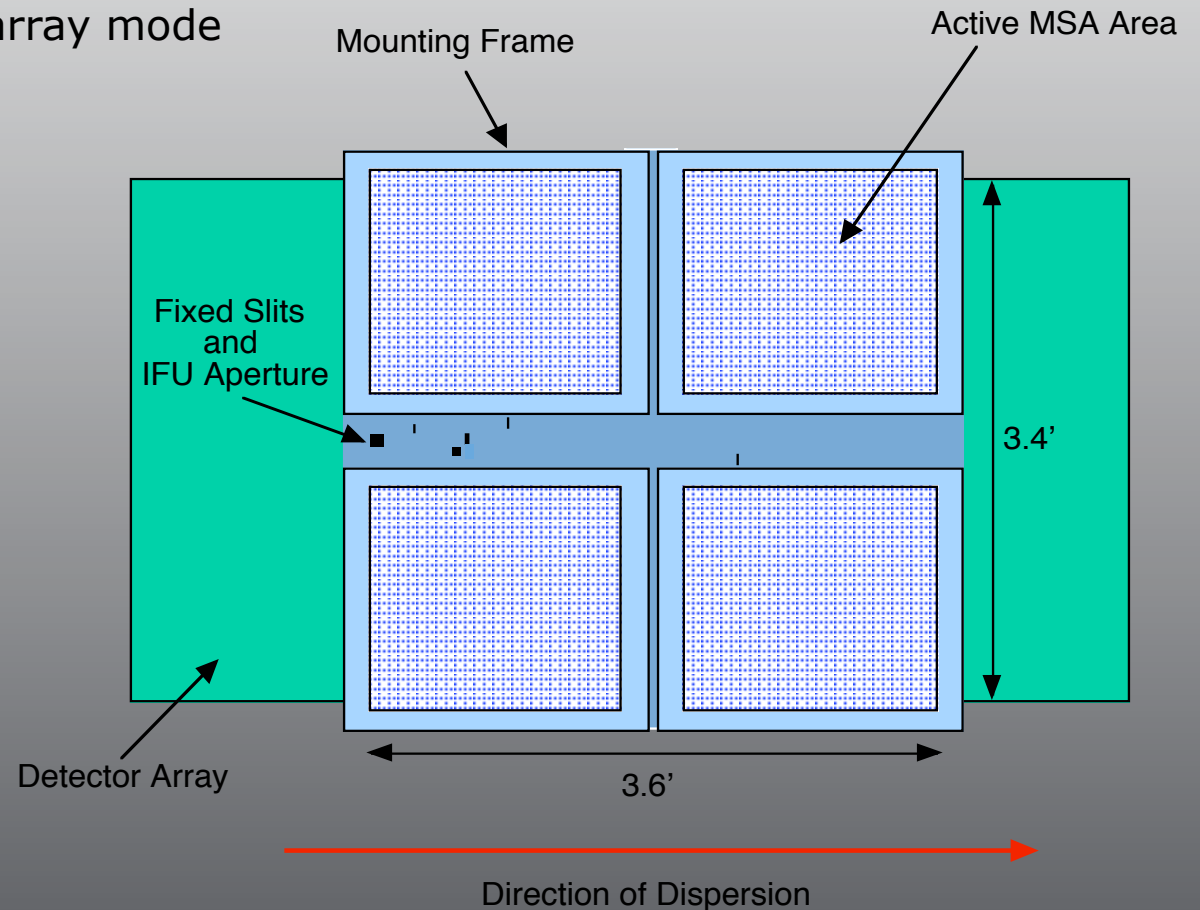
e.g. for the fixed slits:



What about IFU and Fixed Slits?



- Conceptually much simpler
- still requires target acquisition, but may rely on "peak up" method if target is bright enough
- for bright targets in FS, use subarray mode



IFU Dithers and Mosaics



The screenshot displays the Astronomer's Proposal Tools (APT) software interface, version 17.4, running on a Mac OS. The main window is titled "Observation 1 of JWST Proposal (v838-jwst.apt)".

Mosaic Configuration Panel:

- Pattern Size:** Rows: 2, Cols: 5
- Pattern Controls:**
 - Row Overlap (%): 0.0
 - Col Overlap (%): 23.4
 - Skew X (Deg): 12.9
 - Skew Y (Deg): 0.0
 - Orient: 67.8
- Mosaic:** A small thumbnail visualization of the mosaic pattern.

Table of Observations:

Observation	Number	Instrument	Instrument...	Coming So...	Object Type	Subarray	Filters	Total Time	Dither Pat...	Dither Point
Observati...	1	MIRI	MIRI Imagi...	Gyro,	BRIGHT	FULL	IF560W 2...	2001.12	Dither Pat...	[edu.stsci...

Star Field Visualization: The main window shows a star field with a grid of observation fields overlaid. The fields are arranged in a 2x5 grid, tilted at an angle. The grid is labeled "ICRS" and "Pixel 4570.0".

Bottom Panel (Multimission Archive at STScI (MAST)):

- Target:** 07:04:05.21 - 03:50:48.5
- Radius:** 2.5'
- Mission/Instrument:** ALL - Search all missions

Image Servers: Aladin images, SkyView, Sloan, MAST, CADC, DSS..., VLA..., Others...

Catalog Servers: All VizieR, Surveys, Missions, SIMBAD, NED, SkyBot, Others...

System Information: Tue 10:05 AM, Aladin v5.0, 0 sel / 0 src, Aladin.app

Summary



goal for JWST operations is to minimize the amount of time “wasted”

this means minimizing overheads and risk of “failed” observations

there are many non-scientific constraints on JWST activity flow

NIRSpec is particularly challenging to operate efficiently

many aspects have been streamlined, but process is ongoing