



**STScI** | SPACE TELESCOPE  
SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

# Planning MOS Observations

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JWST Master Class November 18-22, 2019

Diane Karakla, NIRSpec Instrument Team

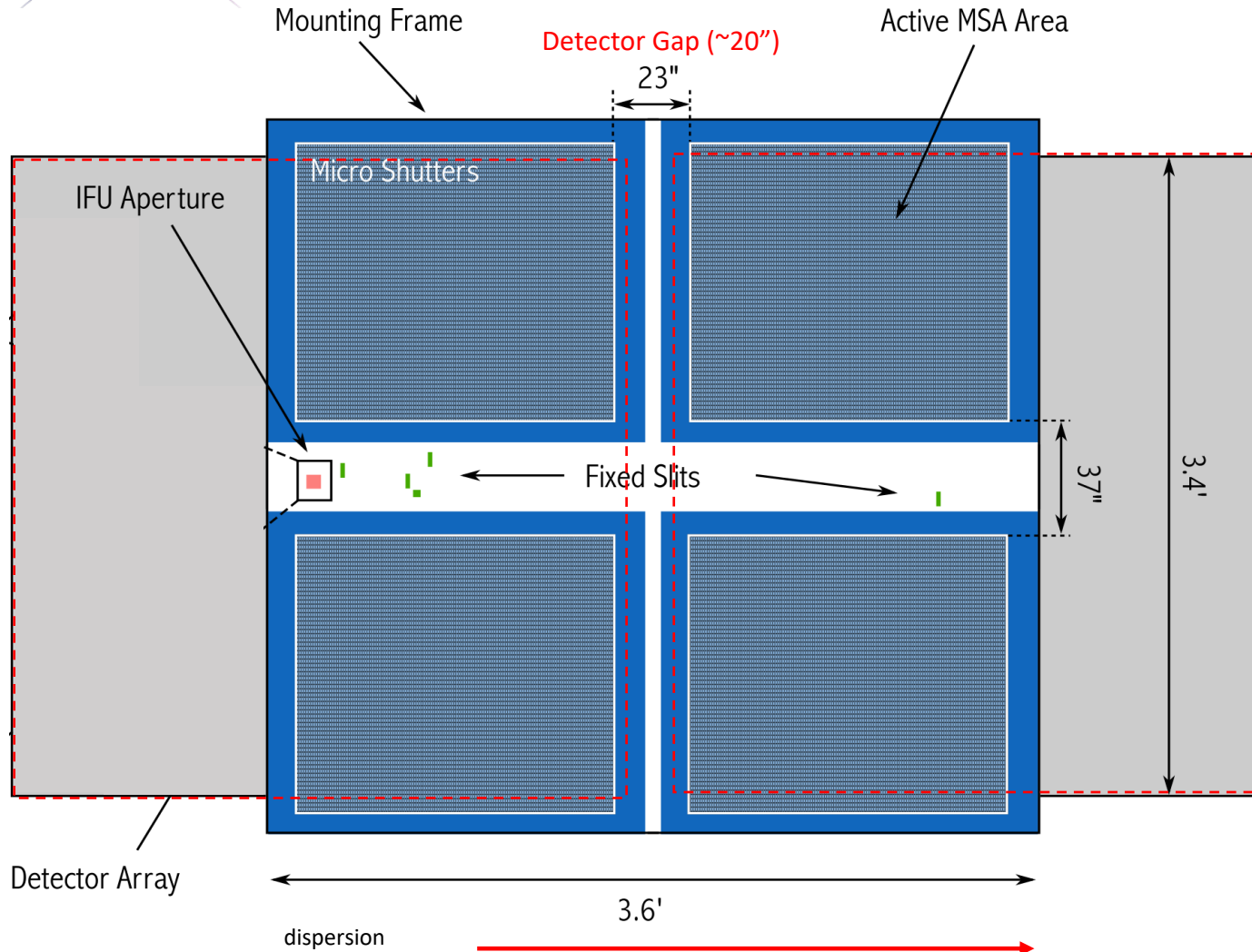
# The NIRSpec Micro-shutter Assembly

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# NIRSpec MSA for multi-object spectroscopy (MOS)



- The Micro-Shutter Assembly (**MSA**) is a 4 quadrant array of tiny configurable shutters. The entire array has nearly 250,000 shutters.
  - Each shutter is just 200 x 450 mas
- The MSA Field of View is ~3.6' x 3.4'
- NIRSpec has 2 detectors. There is gap between them (~20").
- Spectra are dispersed from left to right, and in many cases, will fall across the gap.



# The MOS Observing Process

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## Multi-step process

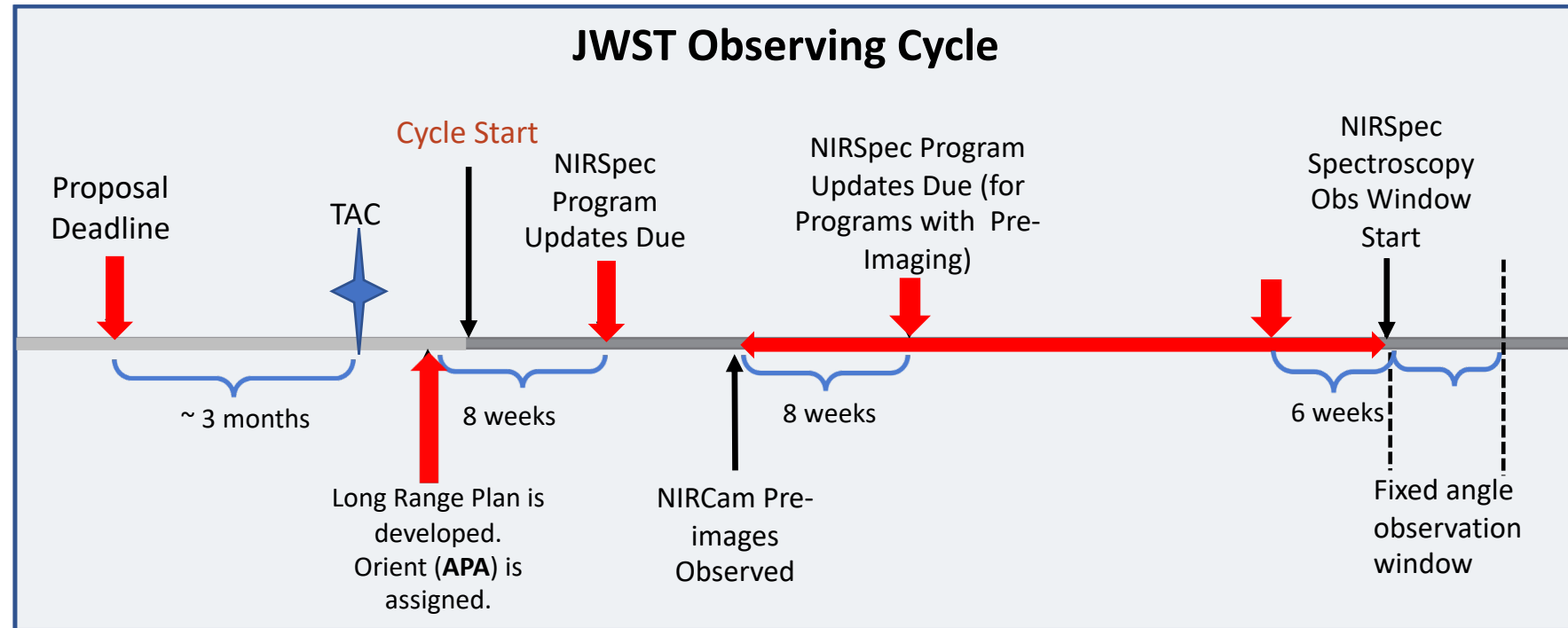
To accurately align science sources within the small MSA shutters, NIRSpec MOS mode observations must be **planned and executed at a fixed instrument Aperture Position Angle (APA), assigned by STScI**. Hence, a multi-step planning process.

For the **Proposal deadline**, use **MPT** to create placeholder visits to accurately estimate the overheads.

After the TAC, an **APA will be assigned** by STScI.

Flight ready programs are due **8 weeks after the APA is assigned** (no NIRCам pre-imaging)

Or, **8 weeks after the NIRCам pre-imaging** is observed.

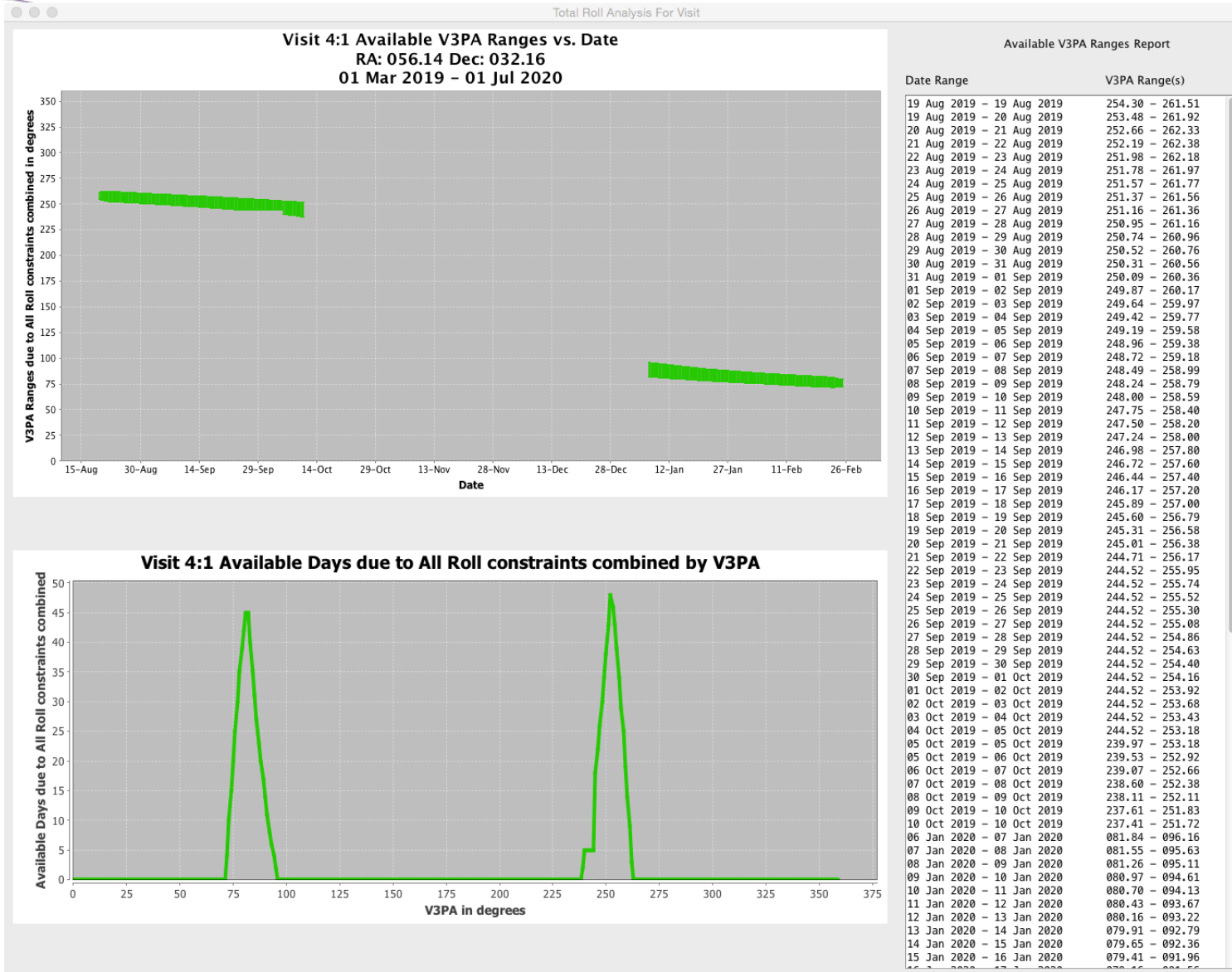


For best success, users should place their NIRCам pre-imaging and NIRSpec observations **in different visibility windows** to have time to reduce and analyze the NIRCам astrometry.

When that's not possible, program updates will be due **a min of 6 weeks in advance of the NIRSpec observing window.**



# Target visibility



For most targets, there will be two visibility windows, separated by about 180 degrees

Can assess the target visibility using the TVT or in APT using the Visit Planner



# Positional Accuracies, Target Acq, and Pre-imaging

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## Pointing accuracies

Most MOS science will require the pointing accuracy delivered by MSATA (using reference stars). The delivered TA pointing accuracy depends on the input **Catalog relative astrometric accuracy**.

TA Type	Catalog Relative Accuracy	Delivered Pointing Accuracy	Science Goal
Optimal (MSATA)	<b>5 - 15 mas</b> (HST: ~ 10 mas is possible. NIRCam: 5 mas is the goal)	20 - 25 mas (20 mas = 1/10 <sup>th</sup> shutter)	Best possible photometric accuracy
Relaxed (MSATA)	<b>&lt; 40 mas</b>	< 50 mas	Extended sources, or reduced flux accuracy w/ MSA
VERIFY_ONLY	No ref stars required	~ 100 mas (TBD)	Special cases – extended source

If accurate astrometry is required for the science, and if **HST imaging** does not exist – request **NIRCam pre-imaging**. Pre-imaging needs to be **fully executable** at Proposal submission.





## Target acquisition considerations

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- **Moving targets must use Wide Aperture TA.** WATA does not require pre-imaging or reference stars, only a good ephemeris.
- **For their Program Update submissions – observers will use MPT to select reference stars at the assigned APA** that will not be behind MSA bars or in failed shutters. This vetting is done at the Visit level, at the first pointing in the Visit.
- **MSATA for Cycle 1 requires 5-8 reference stars.**
  - MPT will impose a limit of 8 maximum.
  - Programs using MSATA will be charged a **fixed overhead** equivalent to an average charge for 8 reference stars.
- **8 reference stars have been determined to be optimal.**
  - This means that **more than 8 suitable candidates** should be defined in the Catalog.
  - There are tradeoffs between increased accuracy and overheads.
  - The number will be adjusted if needed.



# Pre-imaging with NIRCam

Is imaging available that is :

- Deep enough and wide enough to identify sources and reference stars.
  - The brightest reference stars must be no brighter than 18-19<sup>th</sup> mag.
- accurate enough to plan MOS obs?

If not → request **NIRCam pre-imaging** in your Proposal:

- Area should be large enough to **allow for any APA** for the NIRSpec obs:
  - Ideally 5 x 5 arcmin:
  - typically a 2x1 mosaic + dithers to cover the gaps.
- **NIRCam observations must be fully executable at proposal submission.**

## NIRSpec Observation Visualization Tool, NOVT (L. Ubeda)

The screenshot shows the NIRSpec Observation Visualization Tool (NOVT) interface. The left panel is titled "JAMES WEBB Space Telescope NIRSpec Observation Visualization Tool" and contains several configuration sections:

- Input FITS background image:** Select File, /Users/lubeda/Desktop/mosaic\_ngc5194\_acs\_f814w\_sci.fits
- Output directory:** /Users/lubeda/Desktop
- Input catalogue:** No, Catalog on? Select File
- DS9 parameters:** Colour Map: grey, Scale: log, Low: 0.0, High: 100.0
- NIRSpec Micro Shutter Array and IFU:** Yes, Red, MSA footprint on? 202.47, RA center of MSA, 47.21, DEC center of MSA, 38.0, MSA aperture PA
- NIRCam Long and Short Wavelength Channels:** No, Green, Short channel on? Yes, Yellow, Long channel on? 202.47, RA center of NIRC, 47.21, DEC center of NIRC, 75.0, NIRC aperture PA
- NIRCam dither pattern:** FULL3TL
- NIRCam mosaic:** Yes, Offset 60.0, Offset 110.0

The right panel shows a visualization of the observation field with overlaid yellow and red rectangles representing the observation areas. The background is a star field image. The x-axis at the bottom ranges from 0.099 to 50.



# The MSA Planning Tool in APT

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# The MPT Cast

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Tracy Beck

Gary Curtis

Tom Donaldson

Karrie Gilbert

Josh Goldberg

Rob Hawkins

Alaina Henry

Diane Karakla

Susan Kassin

Ernie Morse

Andrew Myers

Daniel Nemergut

Karla Peterson

Klaus Pontoppidan Christine Ritchie

Sasha Shyrovkov

David Soderblom

Andrew Spina

Jeff Valenti

Emily Wislowski



# MSA Planning Tool (MPT) in APT



- NIRSpec MOS observing mode is able to obtain spectra of **tens to hundreds objects** within the 3.6' x 3.4' FoV at the same time.
- The **MPT** was designed to align science sources with the very small MSA shutters (0.2" x 0.46" )

Astronomer's Proposal Tools Version 27.3 mpt-demo (Thu Jul 25 2019) JWST PRD: PRDOPSSOC-L-023

Form Editor Spreadsheet Editor **MSA Planning Tool** Orbit Planner Visit Planner Timeline View in Aladin BOT Target Confirmation PDF Preview Submission Errors and Warnings

New Document | ▾

NEW What's New Roadmap Feedback

## Astronomer's Proposal Tools

Version 27.3 mpt-demo (Thu Jul 25 2019) JWST PRD: PRDOPSSOC-L-023

- Copyright 2002 – 2007 United States Government as represented by the Administrator of the National Aeronautics and Space Administration. All Rights Reserved.
- This software has made use of the Aladin Sky Atlas (<http://aladin.u-strasbg.fr/>) developed at the *Centre de Données astronomiques de Strasbourg* (CDS - <http://cdsweb.u-strasbg.fr/>)
- This software has made use of the SIMBAD database, operated at CDS, Strasbourg, France.
- This software has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.
- This software uses portions of the JSky library which is maintained by the European Southern Observatory.

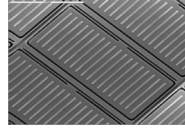
Show: ▾

✓ No errors & warnings (Click for Details)

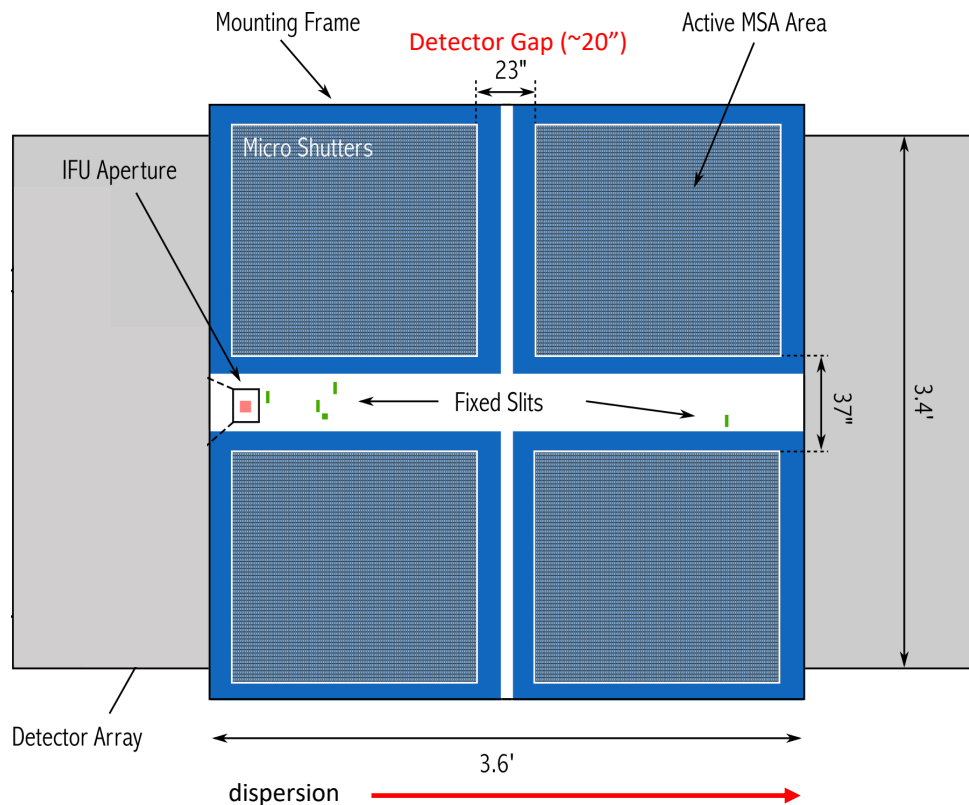


## Why use MPT?

- The MSA is a **fixed grid** (with bars that vignette light from sources behind them)

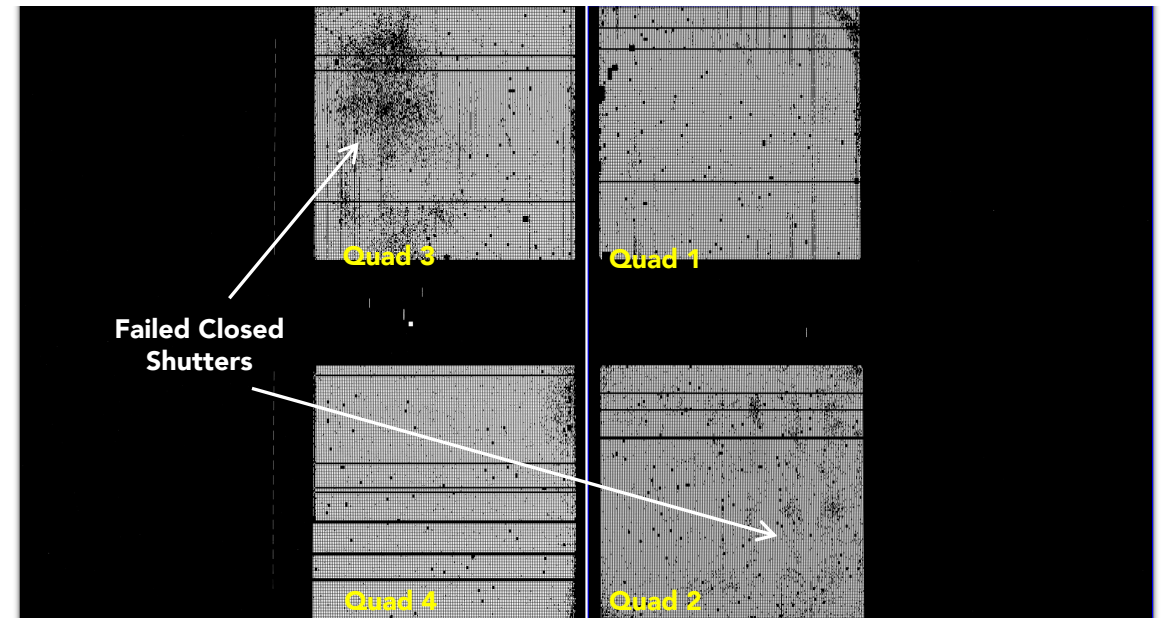


- There is a **gap** between the 2 detectors → missing wavelengths.



- The MSA has **Failed shutters, shorted rows/columns**. Shutter status evolves! MPT plans using the most up-to-date operability.
- Source positions in MSA require knowledge of **optical distortions and velocity aberrations** at a planned Aperture Position Angle.

### Shutter Operability





## What's needed to run the MSA Planning Tool?

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- An internet connection:
  - to access the most up-to-date **MSA shutter operability**
  - To check for **guide stars** during planning
- A complete astrometric Catalog
  - With accurate source positions (< 15 mas relative accuracy for optimal TA) – may require NIRCam pre-imaging.
  - “Complete” to indicate when planned sources are impacted by nearby sources.

**MPT produces:** “Plans” with Pointings, MSA configurations, Target Sets

**One or multiple plans** can be selected and made into an **Observation**

A deep blue and black starry night sky. In the center, there is a large, glowing nebula with wispy, ethereal structures in shades of blue, purple, and white. The sky is filled with numerous stars of varying sizes and colors, including bright blue, white, and yellow. A thin, horizontal orange line runs across the middle of the image, positioned just below the text.

# The Source Catalog





## Source Catalog requirements

The first step - create a complete **catalog of sources**. The catalog should include **all known sources in the field**.

- The source catalog is an **ASCII file**
- It must contain J2000 **RA and Dec** expressed in degrees or hexadecimal units.
- It **cannot** have **duplicate IDs nor NULL entries**.
- A header is optional. The header is marked with "#".

ID	RA	DEC	Size	Redshift	Reference	Stellarity	MAG_F160W	NRS_F110W	NRS_F140X	NRS_CLEAR	W
23796	03 32 39.0842	-27 46 1.79	0	1.415	Yes	0.92	20.122	20.674	20.366	20.122	
54454	03 32 35.5075	-27 46 26.13	0	1.268	Yes	0.03	20.384	20.845	20.474	20.384	
22410	03 32 39.8827	-27 47 15.06	0	1.107	Yes	0.03	20.711	21.199	20.786	20.711	
24439	03 32 37.1930	-27 46 8.08	0	1.101	Yes	0.03	19.494	20.254	19.672	19.494	
23546	03 32 38.4836	-27 47 2.42	0	0.919	Yes	0.03	20.088	20.785	20.261	20.088	
21268	03 32 42.4216	-27 47 58.80	0	0.779	Yes	0.94	17.811	18.026	-99	17.811	
22990	03 32 38.7749	-27 47 32.14	0	0.767	Yes	0.03	20.286	20.695	20.415	20.286	
21840	03 32 37.3079	-27 47 29.36	0	0.708	Yes	0.03	18.793	19.473	18.966	18.793	
22951	03 32 40.6729	-27 47 30.99	0	0.692	Yes	0.03	20.163	20.839	20.34	20.163	
24350	03 32 38.4386	-27 46 31.90	0	0.69	Yes	0.03	20.68	21.324	20.855	20.68	
24353	03 32 38.5957	-27 46 31.36	0	0.663	Yes	0.03	20.768	21.177	20.893	20.768	
21298	03 32 39.2188	-27 47 58.36	0	0.662	Yes	0.03	19.618	20.265	19.785	19.618	
21281	03 32 35.7539	-27 47 58.82	0	0.66	Yes	0.03	19.35	19.991	19.507	19.35	
23847	03 32 38.7915	-27 46 48.90	0	0.657	Yes	0.03	20.287	20.927	20.451	20.287	
22428	03 32 41.4054	-27 47 17.17	0	0.612	Yes	0.03	19.596	20.241	19.767	19.596	
24587	03 32 40.7814	-27 46 15.69	0	0.571	Yes	0.03	19.482	19.901	19.615	19.482	
24348	03 32 38.9675	-27 46 30.23	0	0.447	Yes	0.03	20.152	20.541	20.258	20.152	
24685	03 32 41.7599	-27 46 19.40	0	0.383	Yes	0.04	20.047	20.635	20.189	20.047	
21671	03 32 38.0057	-27 47 41.71	0	0.253	Yes	1	18.276	18.562	18.369	18.276	

Because of the small size of the shutters (just 200 mas in width) the relative positional accuracy of the planning catalog must be **between 5 and 40 mas**.



## Source Catalog at program update

- For (later) program update submission MPT needs magnitudes in TA filters to properly define the reference stars.
- There will be a tool for creating this data by converting HST magnitudes. (The tool will be made available in time for updates.)

Candidate Sets Comments

Astrometric Accuracy (mas) 10.0

Reference Position RA: 03 32 38.9682 Dec: -27 47 26.86

Pre-Image Availability Not required

ID	RA	DEC	Size	Redshift	Reference	Stellarity	MAG_F160W	NRS_F110W	NRS_F140X	NRS_CLEAR
23796	03 32 39.0842	-27 46 1.79	0	1.415	Yes	0.92	20.122	20.674	20.366	20.122
54454	03 32 35.5075	-27 46 26.13	0	1.268	Yes	0.03	20.384	20.845	20.474	20.384
22410	03 32 39.8827	-27 47 15.06	0	1.107	Yes	0.03	20.711	21.199	20.786	20.711
24439	03 32 37.1930	-27 46 8.08	0	1.101	Yes	0.03	19.494	20.254	19.672	19.494
23546	03 32 38.4836	-27 47 2.42	0	0.919	Yes	0.03	20.088	20.785	20.261	20.088
21268	03 32 42.4216	-27 47 58.80	0	0.779	Yes	0.94	17.811	18.026	-99	17.811
22990	03 32 38.7749	-27 47 32.14	0	0.767	Yes	0.03	20.286	20.695	20.415	20.286
21840	03 32 37.3079	-27 47 29.36	0	0.708	Yes	0.03	18.793	19.473	18.966	18.793
22951	03 32 40.6729	-27 47 30.99	0	0.692	Yes	0.03	20.163	20.839	20.34	20.163
24350	03 32 38.4386	-27 46 31.90	0	0.69	Yes	0.03	20.68	21.324	20.855	20.68
24353	03 32 38.5957	-27 46 31.36	0	0.663	Yes	0.03	20.768	21.177	20.893	20.768
21298	03 32 39.2188	-27 47 58.36	0	0.662	Yes	0.03	19.618	20.265	19.785	19.618
21281	03 32 35.7539	-27 47 58.82	0	0.66	Yes	0.03	19.35	19.991	19.507	19.35
23847	03 32 38.7915	-27 46 48.90	0	0.657	Yes	0.03	20.287	20.927	20.451	20.287
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21671	03 32 38.0057	-27 47 41.71	0	0.253	Yes	1	18.276	18.562	18.369	18.276

Edit MSA Catalogs ← New ▾ → Edit Observations

12 errors & warnings (Click for Details)

The background of the slide is a deep blue and purple starry sky. A large, diffuse nebula with wispy, ethereal structures is visible, primarily on the left and bottom-left sides. The sky is filled with numerous stars of varying brightness and colors, including many bright blue stars. A thin, horizontal orange line spans the width of the slide, positioned just below the main text.

# The MPT Planner

## Making a plan for an observation

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# The MPT Planner

In the **MSA Planning Tool** -

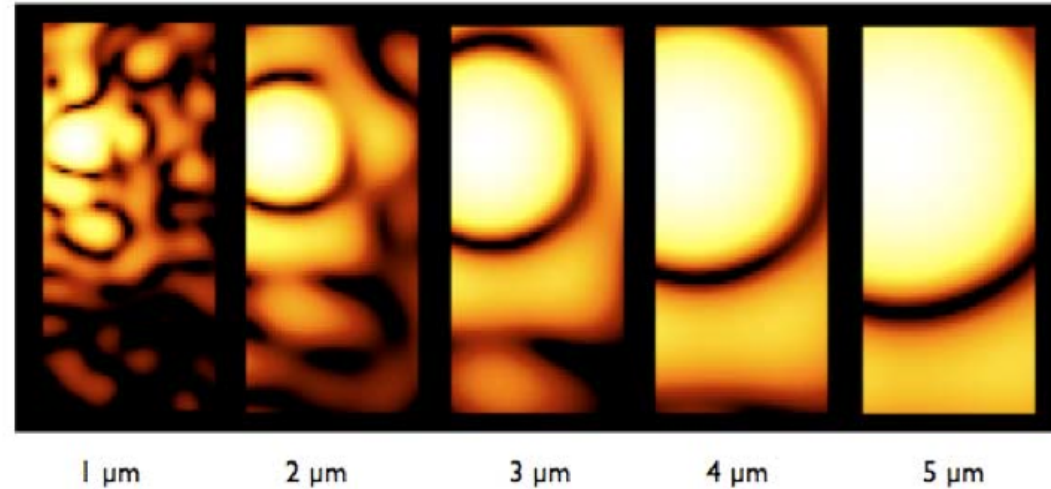
Select the **Planner** tab.

The Planner is where you design plans for your MOS observation.

- Choose the **Primary Candidates** (and Filler Candidates)
- Choose an **APA** (place holder or assigned from STScI)
- Choose the **slitlet configuration**
- Choose the **source centering constraints**



## Source centering and slit losses



Slit throughput or slit loss is a function of wavelength and the relative placement of the science source in the MSA shutter



## Source centering constraint

A tighter constraint on the source shutter yields more accurate photometry and higher flux, but may reduce the number of observable targets. Important for point sources.

Source Centering Constraint	Figure†	Minimum Relative Flux Transmission at 2.95 $\mu\text{m}^{\dagger\dagger}$	Margin (milli-arcsec)
<i>Unconstrained</i> (sources can be behind the MSA bars)		12%	0
<i>Entire Open Shutter Area</i> (default)		30%	38
<i>Midpoint</i>		62%	59
<i>Constrained</i>		75%	72
<i>Tightly Constrained</i>		85%	91

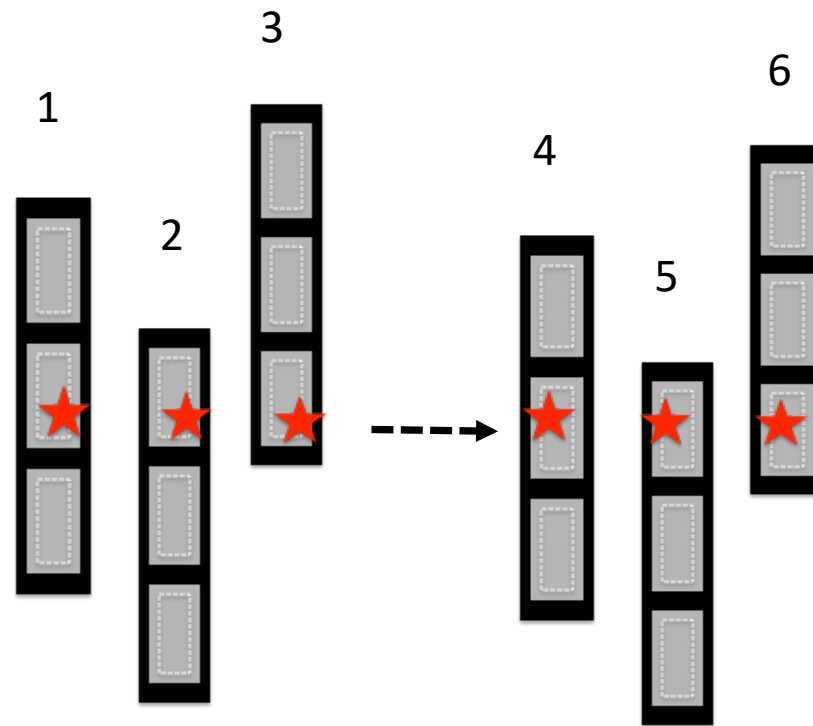


## The benefits of dithering

In addition to improving the sampling of the PSF and correcting for hot/bad pixels, dithering helps with:

- Improve background subtraction (**Nodding**)
- Recover important wavelengths that could fall in the detector gap (**Fixed dither**)
- Mitigate the effects of **light leakage** through the MSA
- Observe additional sources behind bars or mounting plate.

Nod in 3-  
shutter  
slitlet:  
3 exposures



**Fixed dithers:**  
MSA is  
reconfigured at  
the new dither  
point.

**MPT takes dithers into account and will attempt to observe as many sources as possible through a set of dithers.**



# Specifying dithers and nods in the MPT Planner

The **Planner** is where you decide how to dither:

**Nodding** moves the sources within the slitlet – no MSA reconfiguration.

**Fixed Dither** moves the sources by a finite number of shutters specified by the user along the dispersion and/or the cross-dispersion direction.

Nodding and dithering can be used together or independently.

Astronomer's Proposal Tools Version 2020.1 mpt-demo (Thu Oct 24 2019) - JWST Draft Proposal (RAFEL-2015.aptx)

Form Editor Spreadsheet Editor MSA Planning Tool Orbit Planner Visit Planner Timeline View in Aladin BOT Target Confirmation PDF Preview Submission Errors and Warnings

New JWST Proposal Import MSA Source Catalog...

JWST Draft Proposal (RAFEL-2015) Proposal Information Targets MSA Catalogs Observations Observation Folder G140M-step10-cat (Obs) PRISM-step10-z5-fillers Observation Links JWST Draft Proposal (Unsaved)

Planner Plans

Candidate Lists  
Primary Candidate List Z>5 (344 sources)  
Filler Candidate List RAFEL-2015 (9969 sources)

Plan Angle  
Planned  
Aperture PA 135.0 Degrees

Slit Setup  
Slitlet 3 Shutter Slitlet Entire Open Shutter Area Source Centering Constraint

Pointing Setup  
Nod in slitlet  3 exposures per configuration.  
Dither Type None

Exposure  
Grating/Filter  
 G140H/F070LP  
 G140H/F100LP  
 G140M/F070LP  
 G140M/F100LP  
 G235H/F170LP  
 G235M/F170LP  
 G395H/F290LP  
 G395M/F290LP  
 PRISM/CLEAR

Search Grid  
Search Area Dimensions:  
Center RA: 03 32 39.6524 Dec: -27 47 26.91

RAFEL\_2015\_HUDF\_SMALL\_ALLREF\_RANDOM (9969 sources) Name Astrometric Accuracy (mas) Reference Position  
RAFEL\_2015\_RANDOM (9969 sources) 10 03 32 39.6524 -27 47 26.91  
Show: RAFEL\_2015\_HUDF\_SMALL\_ALLREF\_RANDOM (9969 sources)

22 errors & warnings (Click for Details)





# A few more options, and then create a Plan in MPT

Grating and Filter combination must be selected in the Planner (each has different masking to prevent spectral overlaps).

Can select “Use Weights” and “Enable Monte Carlo” to test randomly shuffled ordering of sources.



**Grating/Filter**

- G140H/F070LP
- G140H/F100LP
- G140M/F070LP
- G140M/F100LP
- G140M/F290LP
- G235H/F170LP
- G235M/F170LP
- G395H/F290LP
- G395M/F290LP
- PRISM/CLEAR

Search Area Dimensions:  
Center RA: 03 32 39.6524 Dec: -27 47 26.91

Name	Astrometric Accuracy (mas)	Reference Position
RAFEL_2015_HUDF_SMALL_ALLREF_RANDOM (996...)	10	03 32 39.6524 -27 47 26.91
RAFEL_2015_RANDOM (9969 sources)		

Show: RAFEL\_2015\_HUDF\_SMALL\_ALLREF\_RANDOM (9969 sources)

22 errors & warnings (Click for Details)



## MSA Operability: Failed shutters and shorts

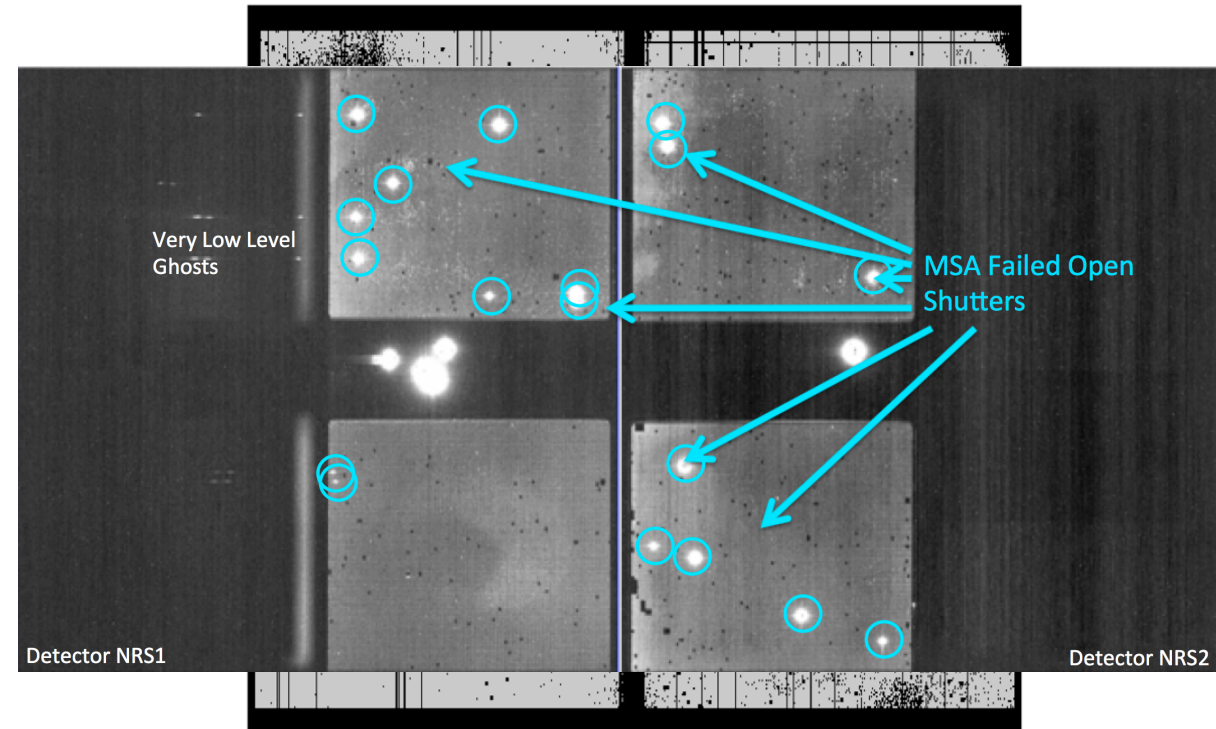
Some of the MSA shutters are not operable...

**Failed Closed** shutters affect sources that may happen to fall into them.

**Shorts** between columns and rows can occur, but are expected to be fairly stable.

**Failed Open** shutters have the most severe impact on the observations, and can prohibit observing sources over a sizeable area. Unintended spoilers can contaminate spectra of planned sources.

At each test pointing, MPT plans around failed shutters and shorts and searches for an optimal MSA configuration. The latest operability information is used.

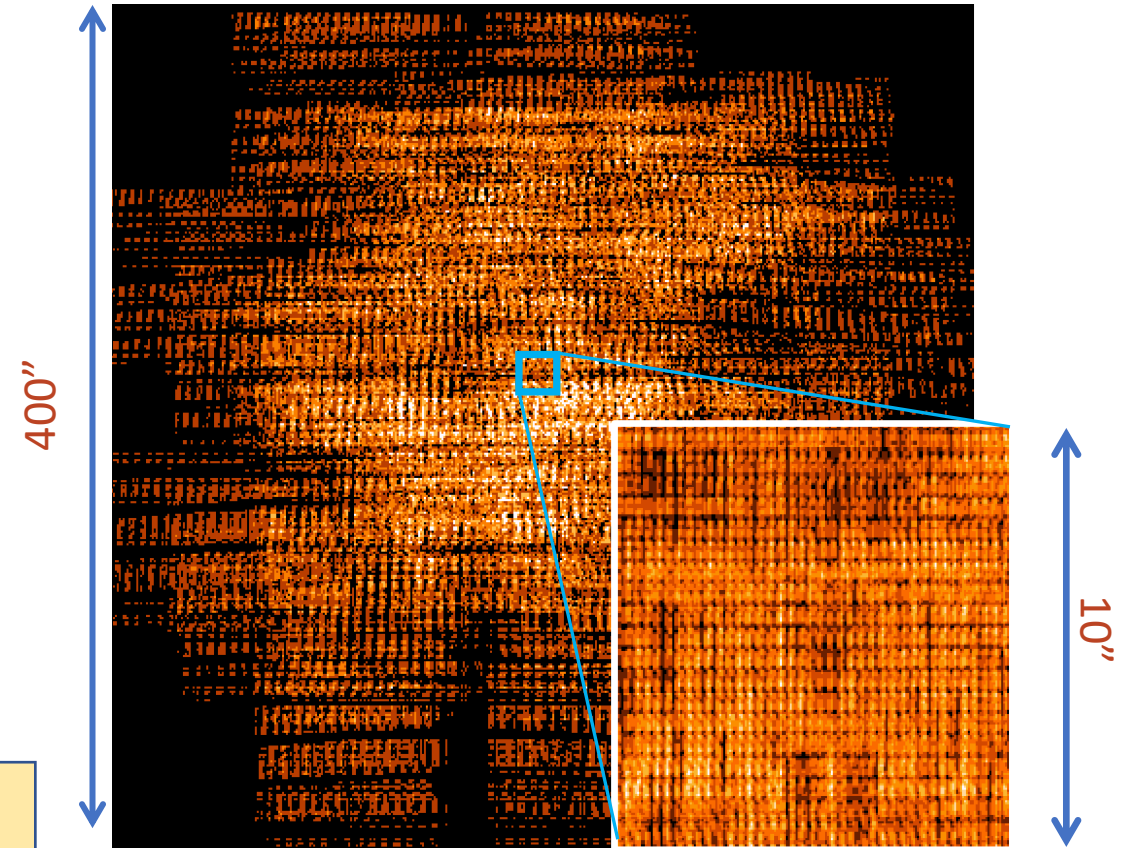




## How MPT works

- The Catalog sources are mapped to the MSA plane.
  - **MPT creates a grid of test pointings** over the area of the Primary candidate list using the **user-specified search grid parameters**.
  - At each test pointing, MPT checks each source in the **Primary list** (in the order given) to find those that are in operable shutters and within constraints set in the Planner, and that present no conflict to other selected sources. These checks are done at all of the points in the **user-specified dither** pattern before accepting a source.
- At each test pointing, the **weights of all observable primary sources in an MSA configuration are summed**. These steps are repeated at each test pointing. The result is a **Heatmap**.

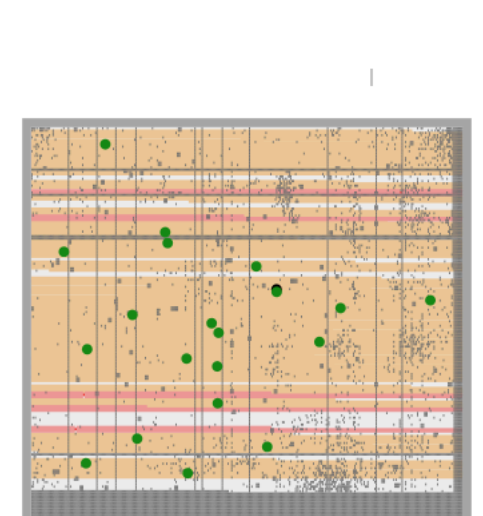
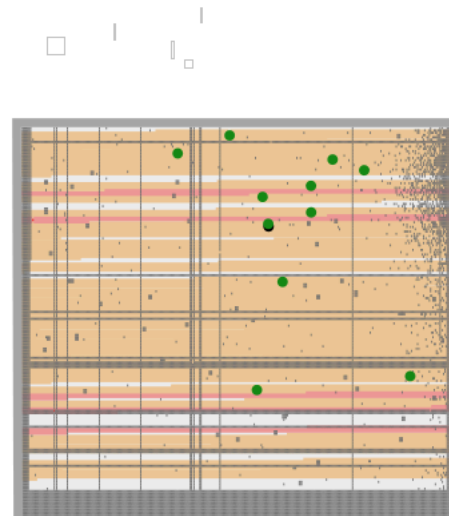
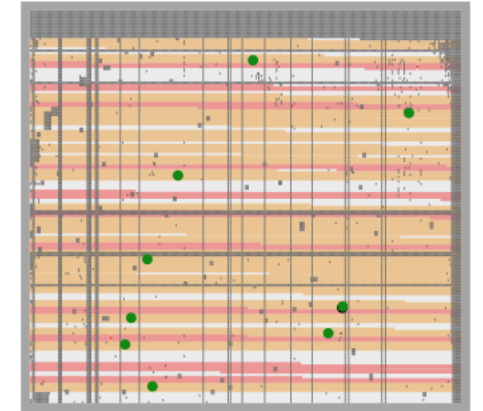
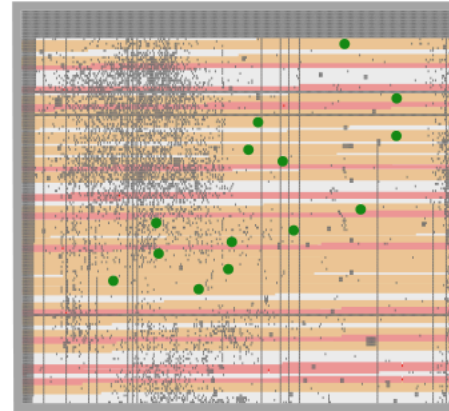
Heatmap:  
Every point is the sum of source weights





## How MPT works

- The “best” pointing is selected. (Or, a **set of pointings**, if dithers were specified.) These are solely based on the Primary candidates.
- The MSA configs for the selected pointings are built, and Filler sources are added.
- A **Plan** is created in MPT.
  - Plans have **Pointings**, a **set of sources that will be observed**, and associated **MSA configurations**.
- One or more Plans are selected by the user and made into an **Observation**.





The MPT Plans  
Evaluating and selecting plans for an observation

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# Examine and visualize Plan results

Examine plan results in the Plans pane of MPT

- MSA shutter view
- Collapsed shutter view

The screenshot shows the Astronomer's Proposal Tools (APT) interface for a JWST Draft Proposal (RAFEL-2015). The 'Planner' tab is active, and the 'Plans' pane is highlighted. The 'Plan Selection' table shows three plans: G140M-step10-cat, G140M-step10-z5-fillers, and PRISM-step10-z5-fillers. The 'Pointings' table shows three pointing configurations for the PRISM plan, with 'Show' and 'Send' buttons highlighted for each. The 'Targets' section shows a list of 56 targets with columns for Id, Weight, Exposures, and three pointing configurations (c1e1n1, c1e1n2, c1e1n3).

#	Plan	# Configs	# Exposures	# Primary Sources	# Secondary Sources	Export
1	G140M-step10-cat	1	3	63	0	Export
2	G140M-step10-z5-fillers	1	3	35	27	Export
3	PRISM-step10-z5-fillers	1	3	56	55	Export

#	Plan number	Name	RA	Dec	RA (HMS)	Dec (DMS)	APA	Grating...	Target set size	Total weight	Send to	Export Config	
1	3	c1e1n1	53.1696588	-27.7888441	03 32 40.71...	-27 47 19.8...	134.996614...	PRISM/...	123	14187	Show	Send	Export
2	3	c1e1n2	53.1695414	-27.7887403	03 32 40.68...	-27 47 19.4...	134.996668...	PRISM/...	117	14106	Show	Send	Export
3	3	c1e1n3	53.1697762	-27.7889480	03 32 40.74...	-27 47 20.2...	134.996559...	PRISM/...	119	14148	Show	Send	Export

Id	Weight	Exposures	c1e1n1	c1e1n2	c1e1n3
8030	300	3x	x	x	x
4449	30	3x	x	x	x
9768	300	3x	x	x	x
9098	300	3x	x	x	x
9104	300	3x	x	x	x
8950	300	3x	x	x	x
10492	30	3x	x	x	x
7878	300	3x	x	x	x
8346	30	3x	x	x	x
2784	300	3x	x	x	x
6542	300	3x	x	x	x
1416	300	3x	x	x	x



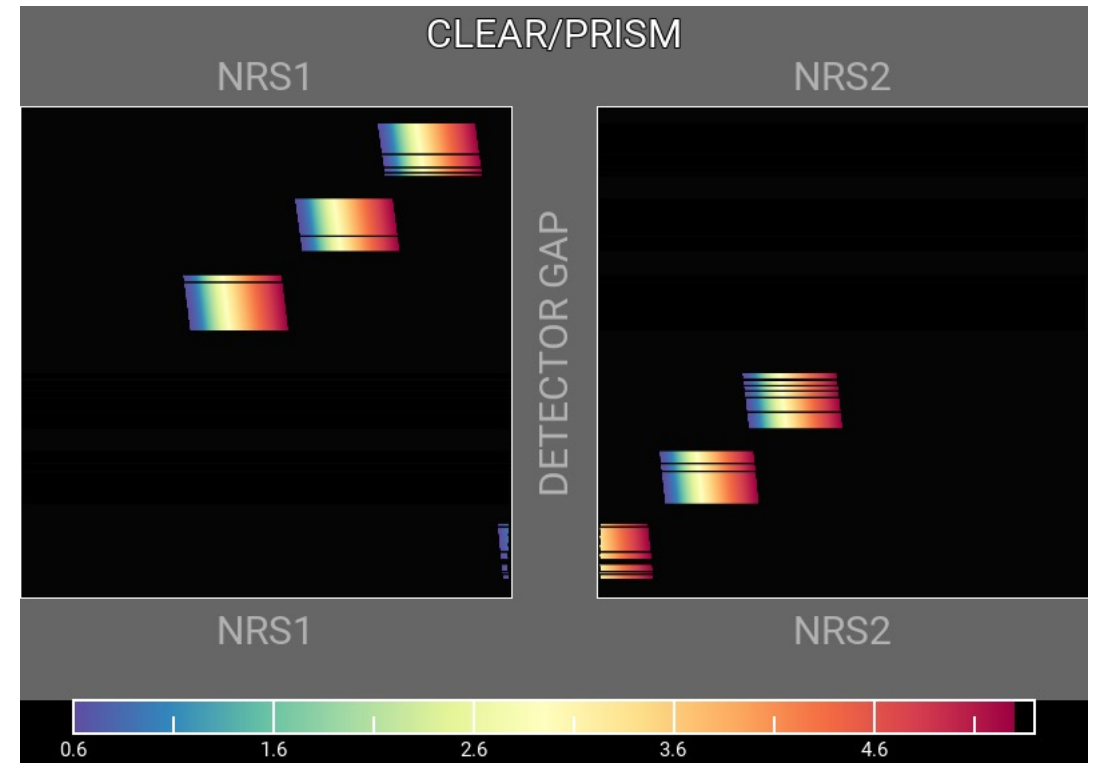
## MSA Spectral Visualization Tool

**MSAVis** is a standalone tool that can be downloaded from GitHub.

It takes the export file “MSA Target Info” output from MPT and projects the spectra of the observed targets on the 2 NIRSpec detectors for both visual inspection and a report indicating wavelength cutoffs.

Instructions to download, install and run MSAVis can be found in the **NIRSpec JDox**:

<https://jwst-docs.stsci.edu/near-infrared-spectrograph/>



G. Kanarek

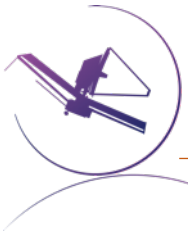


## Take Away

---

- New version of MPT will be available for the Cycle 1 call for proposal – easier to use, more intuitive and discoverable, lighter.
- Need high precision relative astrometry – 5-15 mas for point sources – up to 40 mas for extended objects.
- MOS is one of the very few observing modes of JWST that will follow a **multi-step planning process**.
- MOS **requires an aperture position angle** – it is **assigned by STScI** (although it may be requested at the time of call for proposals, but have to be strongly justified).
- NIRSpec **overheads** for MSA are considerable – USE MPT to have a good estimate.
- You can use **MSAVis** to verify that wavelengths are properly sampled.
- You can use **Nirspec Obs Visualization Tool (NOVT)** to visualize NIRCам pre-imaging relative to MSA observations.
- **Dither! Dither!! Dither!!!** It improves background subtraction, wavelength coverage, etc.





## Helpful Hints

---

- Order the input Catalog by target weights prior to ingest into MPT. When building an MSA configuration, MPT tries adding sources in the order they appear in the Catalog.
- Include Primary candidates in the Filler list if you want to obtain observe more of them.
- Only the weights of the Primaries matter (not the Fillers), so to help ensure observations of certain sources, include them in the Primary candidate list, **with appropriate weighting**.
- Add Fillers to maximize efficiency/multiplexing.
- If feasibility windows are large, **test several APAs** to see if it makes a statistical difference. If so, set conservative limits on requested exposure time. **Add an Orient SR only if needed, with a min range of 20 - 30 deg.**
- If using the **high-res gratings (G140H, G235H, G395H)**, try to get your sources onto the leftmost quadrants to avoid red-end detector cutoffs.
- Use **Aladin FoV** to show the position of NIRCcam parallaxes with respect to the NIRSspec MSA.
- Your **catalog should be complete** to be able to **check for contaminants** getting into failed open shutters, or into planned target shutters/slitlets.
- The **MSA Config Editor** can be used to make changes to your MSA configurations designed automatically with MPT. It's found at the **observation level** in APT.



END



# Starting from scratch in APT

Astronomer's Proposal Tools Version 27.3 mpt-demo (Thu Jul 25 2019) JWST PRD: PRDOPSSOC-L-023

Form Editor Spreadsheet Editor MSA Planning Tool Orbit Planner Visit Planner Timeline View in Aladin BOT Target Confirmation PDF Preview Submission Errors and Warnings

New Document  
New HST Proposal  
New JWST Proposal

## Astronomer's Proposal Tools

Version 27.3 mpt-demo (Thu Jul 25 2019) JWST PRD: PRDOPSSOC-L-023

- Copyright 2002 – 2007 United States Government as represented by the Administrator of the National Aeronautics and Space Administration. All Rights Reserved.
- This software has made use of the Aladin Sky Atlas (<http://aladin.u-strasbg.fr/>) developed at the *Centre de Données astronomiques de Strasbourg* (CDS – <http://cdsweb.u-strasbg.fr/>)
- This software has made use of the SIMBAD database, operated at CDS, Strasbourg, France.
- This software has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.
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Show:

✓ No errors & warnings (Click for Details)



# Load the Catalog as an MSA Catalog Target

Notice that we are in the Form Editor

Astronomer's Proposal Tools Version 27.3 mpt-demo (Thu Jul 25 2019) JWST PRD: PRDOPSSOC-L-023 - JWST Draft Proposal (Unsaved)

Form Editor | Spreadsheet Editor | MSA Planning Tool | Orbit Planner | Visit Planner | Timeline | View in Aladin | BOT | Target Confirmation | PDF Preview | Submission | Run All Tools | Stop

New JWST Proposal | New

What's New | Roadmap | Feedback

JWST Draft Proposal (Unsaved)

- Proposal Information
  - Proposal Description
  - Team Expertise
  - Unnamed PI
  - Unnamed Col
  - Targets**
  - Observations
  - Observation Links

Targets of JWST Draft Proposal (Unsaved)

### Targets

- Fixed Target Resolver | Resolve a target name or position
- New Fixed Target | Create a new Fixed Target
- New Target Group | Create a new Target Group
- New Solar System Target | Create a new Solar System Target
- New Generic Target | Create a new Generic Target
- Import MSA Source Catalog...** | Import a source catalog to use in MSA Planning
- Import Targets... | Import Fixed Targets from whitespace, CSV, TSV, or VOTable

Edit Unnamed Col | New | Edit Observations

9 errors & warnings (Click for Details)



## Load the Catalog as an MSA Catalog Target

A window will pop up...

- Browse and select the Catalog file.
- Choose a name and file format

MPT tries to identify the type of data in each column

ZMAX_BPZ	ODDS_BPZ	CHISQ2_BPZ	STAR	WEIGHT
1.52	0.996	1.241	0	3
1.36	0.995	0.096	0	3
1.2	0.995	0.1	0	2
1.10	0.994	0.07	0	2

Weights can be used to prioritize the targets. Higher weights are for more interesting targets.

Click



# Catalog declarations and making candidate sets

MPT complains because:

- 1) The target is not used in the proposal (yet! – It's just a warning)
  - 2) We must specify the astrometric accuracy
  - 3) We must tell MPT if we need pre-imaging or not:
- If NIRCam pre-imaging will be done in this program, it is linked here for archival purposes.

Astronomer's Proposal Tools Version 2020.1 mpt-demo (Thu Oct 24 2019) - JWST Draft Proposal (Unsaved)

Form Editor | Spreadsheet Editor | MSA Planning Tool | Orbit Planner | Visit Planner | Timeline | View in Aladin | BOT | Target Confirmation | PDF Preview | Submission | Errors and Warnings

New JWST Proposal | Import MSA Source Catalog...

1 RAFELSKI-2015-RANDOM of JWST Draft Proposal (Unsaved)

Number: 1  
Name in the Proposal: RAFELSKI-2015-RANDOM (unique within proposal)  
Name for the Archive: RAFELSKI-2015 (standard resolvable name)

Candidate Sets | Comments

Astrometric Accuracy (mas)

Reference Position RA: 03 32 38.9682 Dec: -27 47 26.86

Pre-Image Availability: Not required

ID	RA	DEC	Size	Redshift	Reference	Stellerity	MAG_F160W	NRS_F110W	NRS_F140X	NRSst	
23796	03 32 39.0842	-27 46 1.79		0	1.415	Yes	0.92	20.122	20.674	20.366	3
54454	03 32 35.5075	-27 46 26.13		0	1.268	Yes	0.03	20.384	20.845	20.474	3
22410	03 32 39.8827	-27 47 15.06		0	1.107	Yes	0.03	20.711	21.199	20.786	2
24439	03 32 37.1930	-27 46 8.08		0	1.101	Yes	0.03	19.494	20.254	19.672	2
23546	03 32 38.4836	-27 47 2.42		0	0.919	Yes	0.03	20.088	20.785	20.261	2
21268	03 32 42.4216	-27 47 58.80		0	0.779	Yes	0.94	17.811	18.026	-99	2
22990	03 32 38.7749	-27 47 32.14		0	0.767	Yes	0.03	20.286	20.695	20.415	2
21840	03 32 37.3079	-27 47 29.36		0	0.708	Yes	0.03	18.793	19.473	18.966	2
22951	03 32 40.6729	-27 47 30.99		0	0.692	Yes	0.03	20.163	20.839	20.34	1
24350	03 32 38.4386	-27 46 31.90		0	0.69	Yes	0.03	20.68	21.324	20.855	1
24353	03 32 38.5957	-27 46 31.36		0	0.663	Yes	0.03	20.768	21.177	20.893	1
21298	03 32 39.2188	-27 47 58.36		0	0.662	Yes	0.03	19.618	20.265	19.785	1
21281	03 32 35.7539	-27 47 58.82		0	0.66	Yes	0.03	19.35	19.991	19.507	1
23847	03 32 38.7915	-27 46 48.90		0	0.657	Yes	0.03	20.287	20.927	20.451	1
22428	03 32 41.4054	-27 47 17.17		0	0.612	Yes	0.03	19.596	20.241	19.767	1
24587	03 32 40.7814	-27 46 15.69		0	0.571	Yes	0.03	19.482	19.901	19.615	1
24348	03 32 38.9675	-27 46 30.23		0	0.447	Yes	0.03	20.152	20.541	20.258	1
24685	03 32 41.7599	-27 46 19.40		0	0.383	Yes	0.04	20.047	20.635	20.189	1
21671	03 32 38.0057	-27 47 41.71		0	0.253	Yes	1	18.276	18.562	18.369	1

New Candidate Set... | Delete | Send to Aladin

Edit MSA Catalogs | New | Edit Observations

23 errors & warnings (Click for Details)

Notice that we are in the Form Editor



# Catalog sources can be displayed in Aladin

Aladin v8.1

Location  Frame ICRS

★DSS ★SDSS ★2MASS ★WISE ★GALEX ★AKARI ★Simbad ★NED ★IRIS ★Spitzer +

h\_udf\_wfc\_b\_dr2\_img

5"

37.26" x 18.57"

MSA Source6991: 53.16492, -27.78385; Mags: [29.596 MAG\_F160W, 29.509 NRS\_F110W, 29.023 NRS\_F140X, 29.596 NRS\_CLEAR] - Click on it to get Search

0 sel / 12632 src 168Mb



# MSA Catalog Target

The MSA Catalog Target is now in the Targets Folder

Highlight/select the Catalog to see its data

The screenshot displays the Astronomer's Proposal Tools (APT) interface for a JWST Draft Proposal (RAFEL-2015). The left sidebar shows a tree view with 'Targets' > 'MSA Catalogs' > '1 RAFEL-2015' selected. The main panel shows the configuration for this target, including its name, astrometric accuracy, and reference position. Below the configuration is a table of source data.

ID	RA	DEC	Size	Redshift	Reference	Stellarity	MAG_F160W	NRS_F110W	NRS_F140X	NRS_CLEAR	W
23796	03 32 39.0842	-27 46 1.79	0	1.415	Yes	0.92	20.122	20.674	20.366	20.122	
54454	03 32 35.5075	-27 46 26.13	0	1.268	Yes	0.03	20.384	20.845	20.474	20.384	
22410	03 32 39.8827	-27 47 15.06	0	1.107	Yes	0.03	20.711	21.199	20.786	20.711	
24439	03 32 37.1930	-27 46 8.08	0	1.101	Yes	0.03	19.494	20.254	19.672	19.494	
23546	03 32 38.4836	-27 47 2.42	0	0.919	Yes	0.03	20.088	20.785	20.261	20.088	
21268	03 32 42.4216	-27 47 58.80	0	0.779	Yes	0.94	17.811	18.026	-99	17.811	
22990	03 32 38.7749	-27 47 32.14	0	0.767	Yes	0.03	20.286	20.695	20.415	20.286	
21840	03 32 37.3079	-27 47 29.36	0	0.708	Yes	0.03	18.793	19.473	18.966	18.793	
22951	03 32 40.6729	-27 47 30.99	0	0.692	Yes	0.03	20.163	20.839	20.34	20.163	
24350	03 32 38.4386	-27 46 31.90	0	0.69	Yes	0.03	20.68	21.324	20.855	20.68	
24353	03 32 38.5957	-27 46 31.36	0	0.663	Yes	0.03	20.768	21.177	20.893	20.768	
21298	03 32 39.2188	-27 47 58.36	0	0.662	Yes	0.03	19.618	20.265	19.785	19.618	
21281	03 32 35.7539	-27 47 58.82	0	0.66	Yes	0.03	19.35	19.991	19.507	19.35	
23847	03 32 38.7915	-27 46 48.90	0	0.657	Yes	0.03	20.287	20.927	20.451	20.287	
22428	03 32 41.4054	-27 47 17.17	0	0.612	Yes	0.03	19.596	20.241	19.767	19.596	
24587	03 32 40.7814	-27 46 15.69	0	0.571	Yes	0.03	19.482	19.901	19.615	19.482	
24348	03 32 38.9675	-27 46 30.23	0	0.447	Yes	0.03	20.152	20.541	20.258	20.152	
24685	03 32 41.7599	-27 46 19.40	0	0.383	Yes	0.04	20.047	20.635	20.189	20.047	
21671	03 32 38.0057	-27 47 41.71	0	0.253	Yes	1	18.276	18.562	18.369	18.276	

12 errors & warnings (Click for Details)





# The MPT Planner

In the **MSA Planning Tool** -

Select the **Planner** tab.

The Planner is where you design plans for your MOS observation.

- Choose the **Primary Candidates** (and Filler Candidates)
- Choose an **APA** (place holder or assigned from STScI)
- Choose the **slitlet configuration**
- Choose the **source centering constraints**





**EXPANDING THE FRONTIERS OF SPACE ASTRONOMY**