Preparation of a NIRSpec MOS-observation

How to use the MSA-planning tool (MPT)

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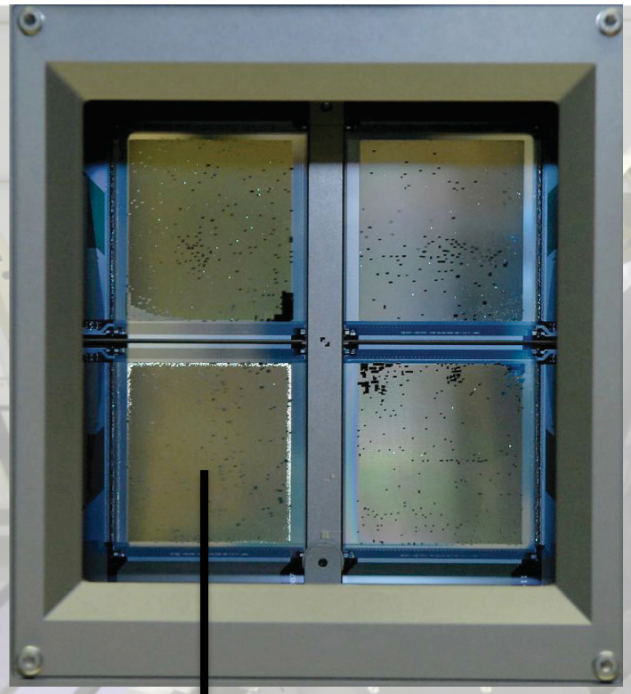
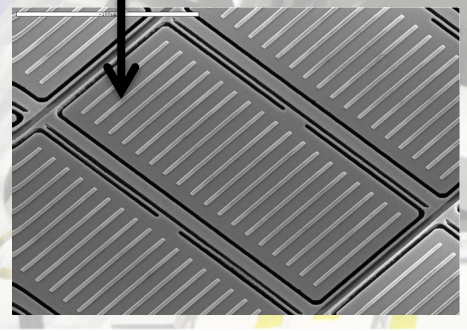
with major contributions from presentations by Diane Karakla (STScI)

NIRSpec “soul”





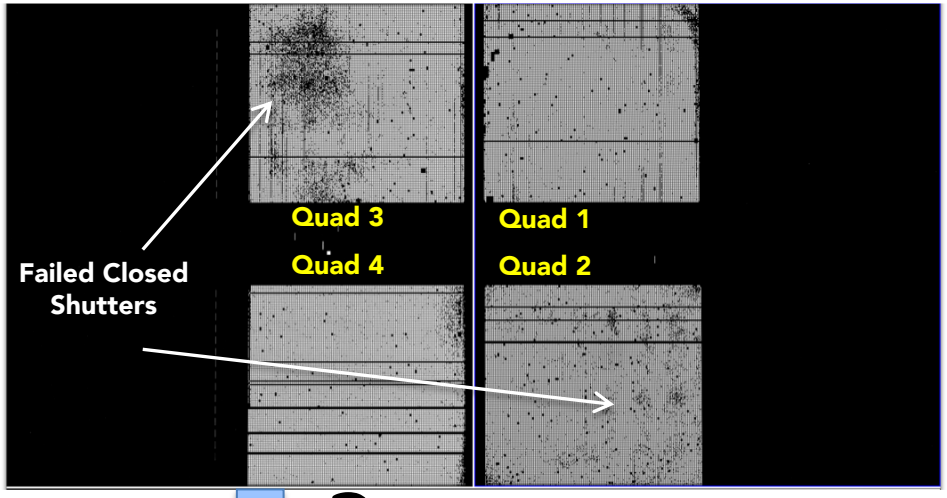
- The MSA:

4 arrays of 365x171 micro-shutters

➔ 250,000 individually addressable shutters

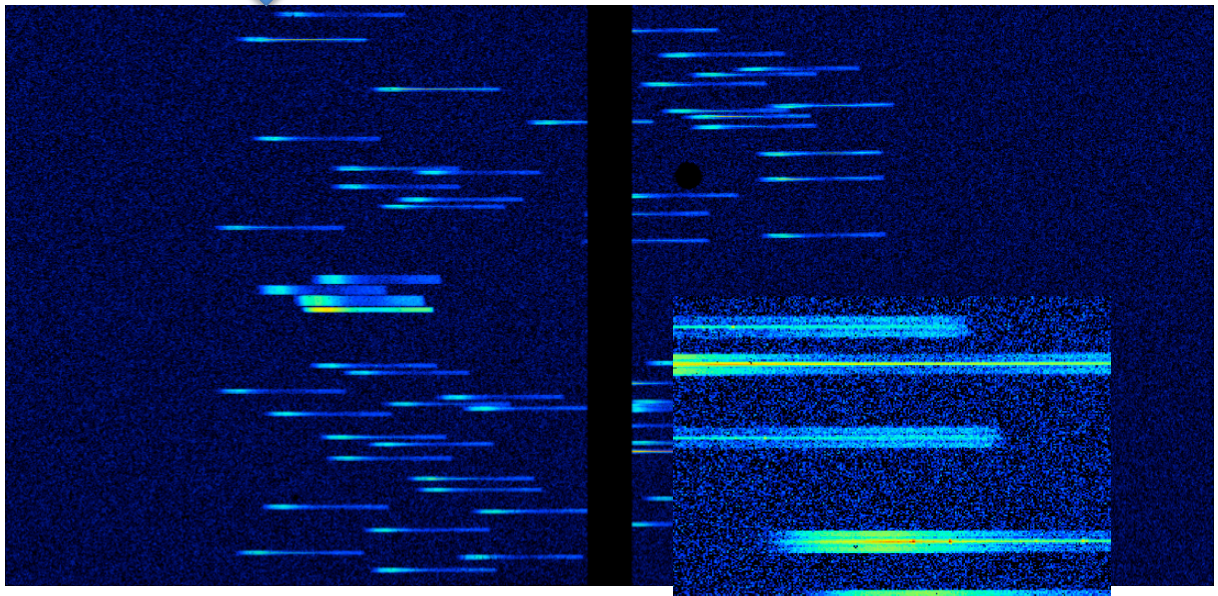
➔ 9 arcmin^2 FOV

The question



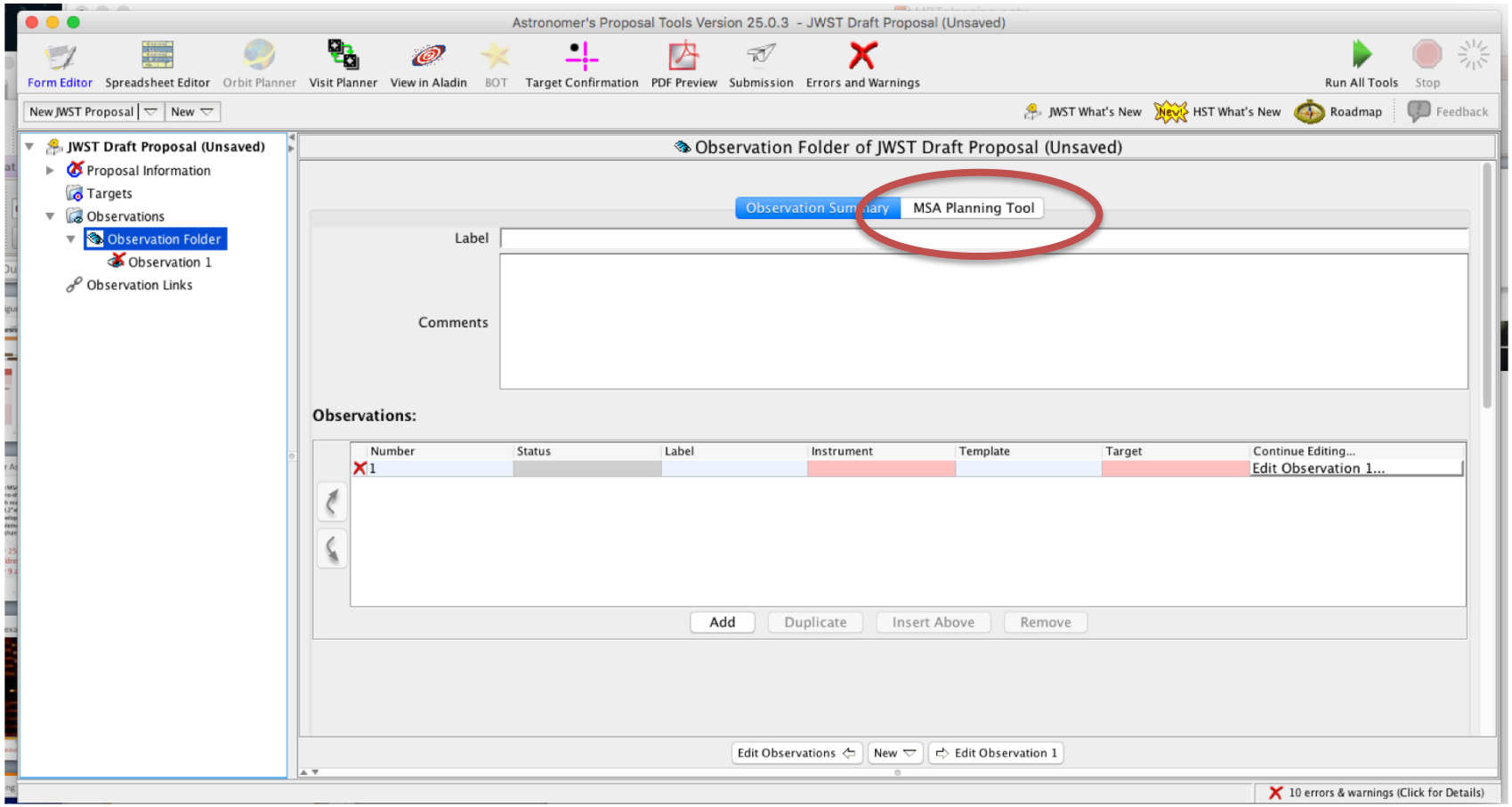
- The MSA is a **fixed grid** (with shutter bars that vignette light from sources)
- **Gap** between the 2 detectors → missing wavelengths.
- Positioning sources in MSA require knowledge of **optical distortions/ velocity aberrations**

?



- The MSA has **Failed shutters, shorted rows/columns**. Shutter status can evolve!
- **Dithers and Noddings** to subtract background, cover gap, mitigate detector artifacts, observe sources behind bars or mounting plate.

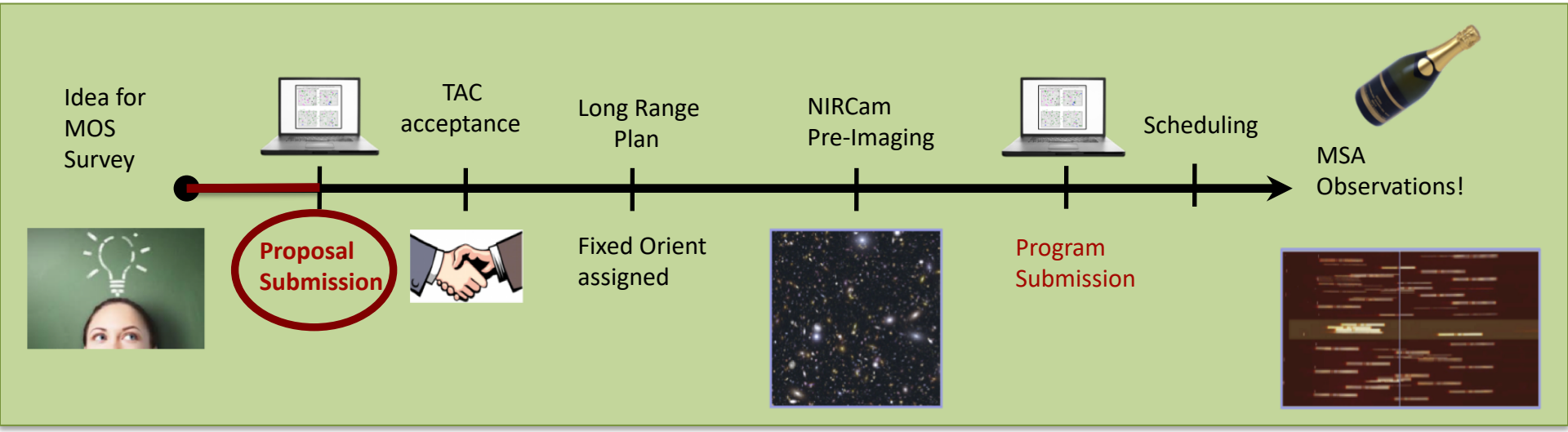
The answer: STScI MPT



- Download Astronomer's Proposal Tool (APT, including MPT) here
  http://apst.stsci.edu/apt/external/downloads/installers/install.html

Timeline for MOS Observations

MOS Spectroscopy will require a **2-phase approach**:



Proposal Submission: Users must request the **time needed (including overheads)** to observe an expected number of targets to desired exposure depths.

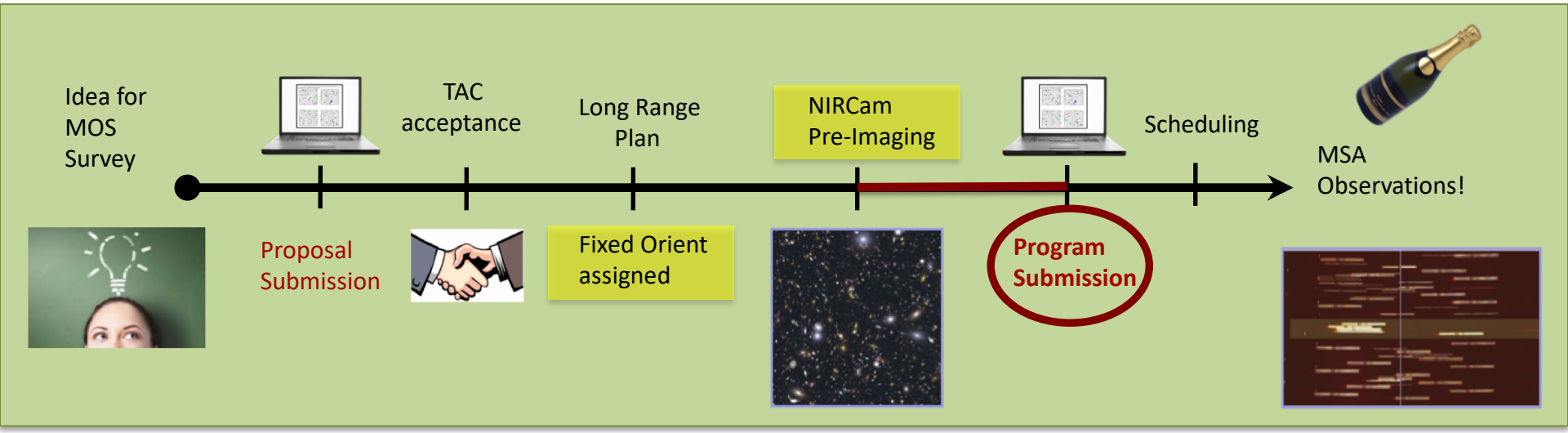
The MSA Planning tool (MPT) can be used with simulated or existing catalogs to explore the effects of planning choices (dithers, slit length, etc.) on

- the **number of observable targets**
- the **number of MSA configurations needed**
- **How many visits** will be needed to obtain those targets.

→ Use the tool to best estimate the time required.

Timeline for MSA Observations

MOS Spectroscopy will require a **2-phase approach**:

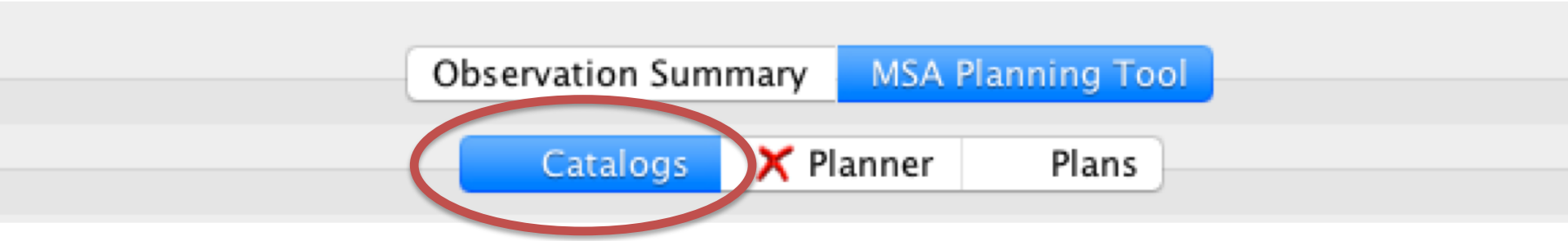


To allow some scheduling flexibility, most MOS observations will be assigned an orient after TAC acceptance.

Program Submission: After an **Orient is assigned**, and **pre-imaging** becomes available. Pre-Imaging may be needed to

- identify **actual targets**
- identify **suitable MSA reference stars** for target acquisition
- obtain **accurate positions** to be used in defining finalized **MPT-plan**

Step 1 - Input catalogue



A source **catalog** is the main input to the MPT.

Key Planning Parameters in MPT: Target Weights

- **Target weights** can be added in catalog to prioritize source
  Relative integer values. W(100) = 100 x W(1).
- **Order your input catalog by target weight** before ingest.

- Create a **Primary candidate set**, and an optional **Filler candidate set**

- Only the weights of the primaries are used during planning.

  - The **best pointing** is determined from the (weighted) Primaries.
  - Fillers help to **optimize the MSA configuration**.

Source ID	Weight
1	100
2	100
3	100
4	100
5	100
6	1
7	1
8	1
9	…

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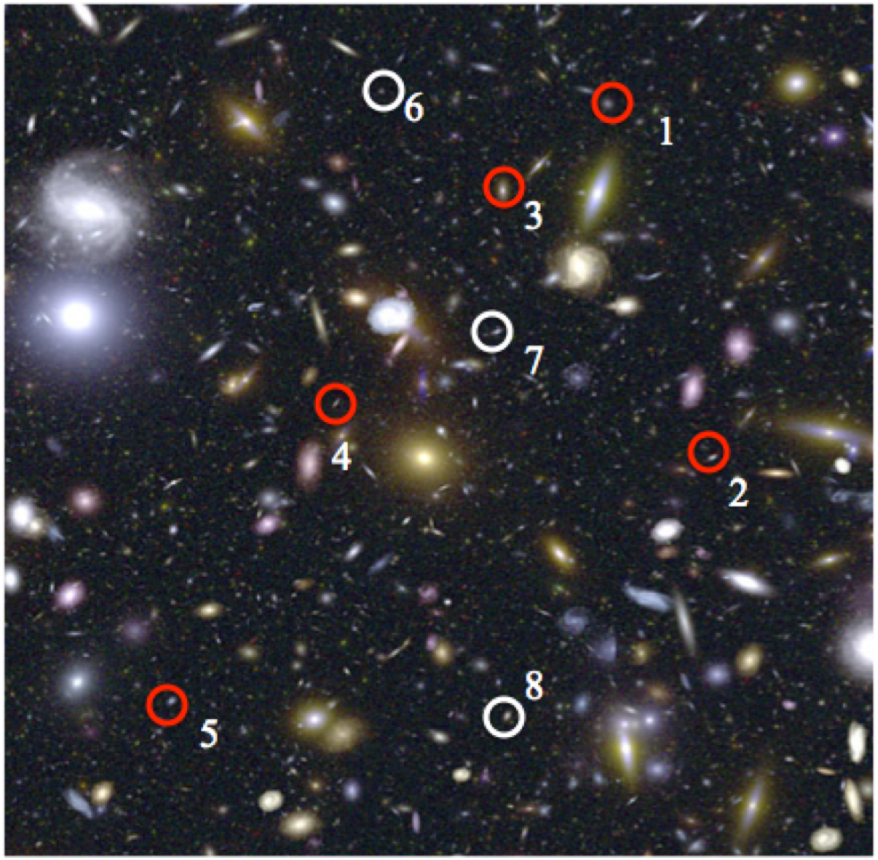
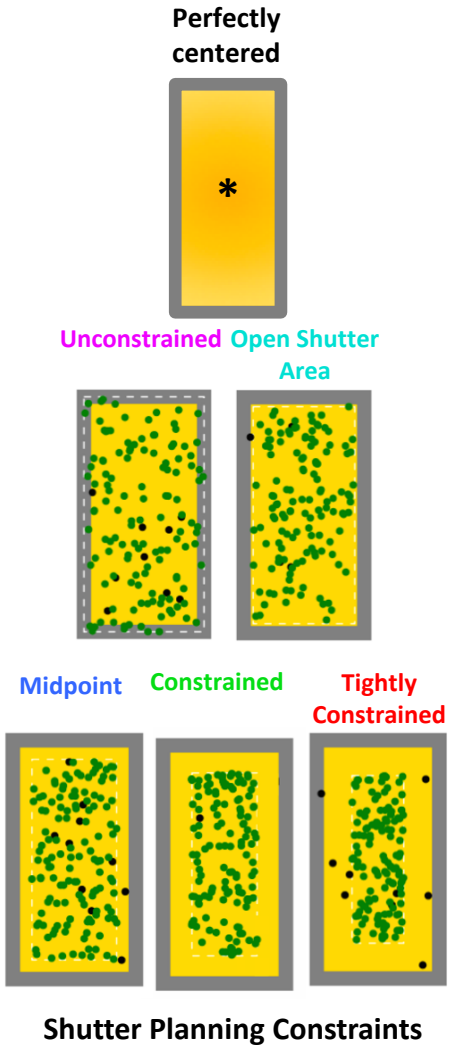


Step 2 - Set-up the plan

Key Planning Parameters: Slitlet Shape & Shutter Margin

- **Shutter margin** to limit slit losses (5 choices):



Shutter Planning Constraints

- **Slitlet shape** (can be 1, 2, 3, or 5 shutters)

NIRSpec MSA Slit Throughput vs. Wavelength

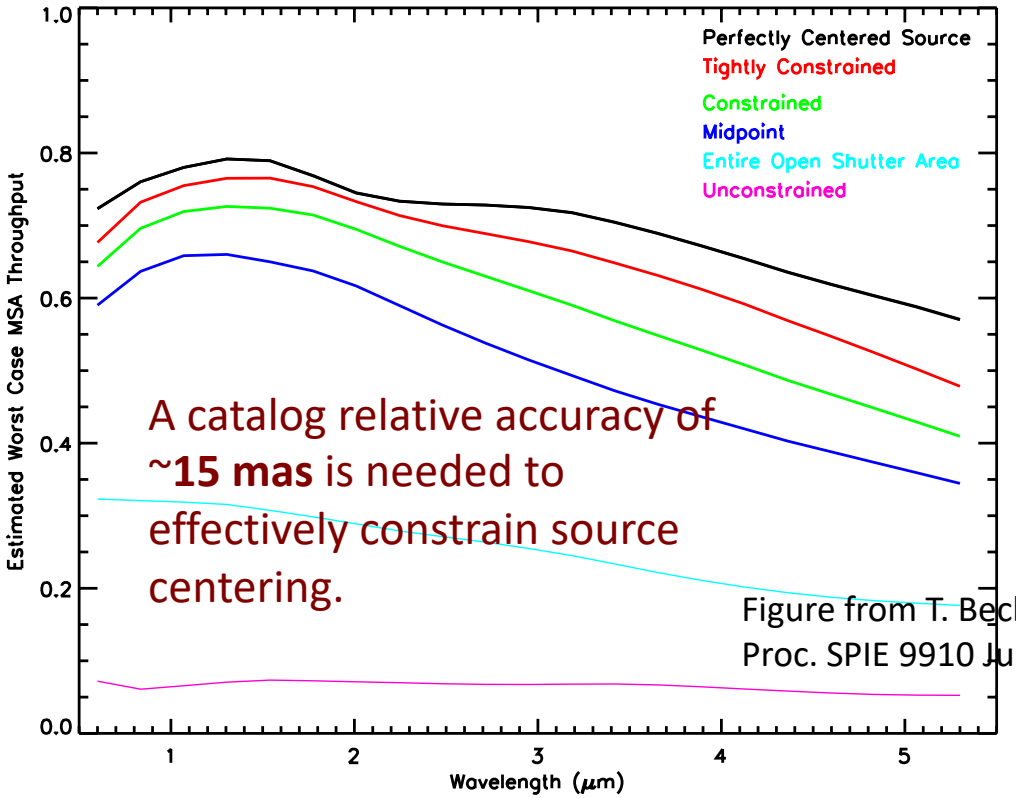
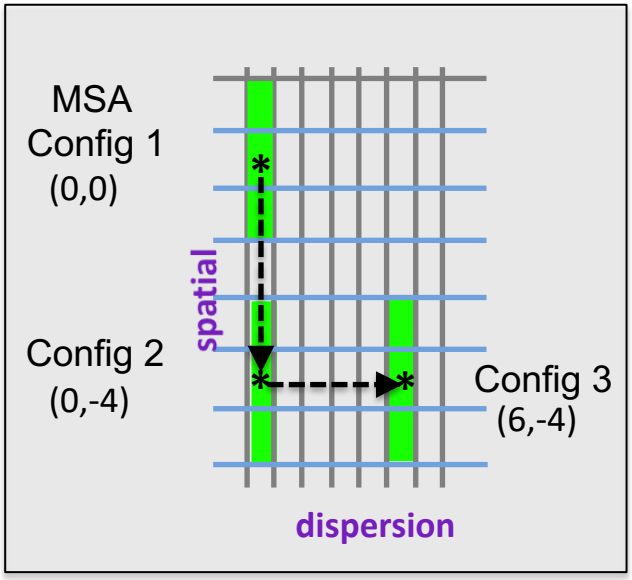


Figure from T. Beck
Proc. SPIE 9910 July 15 2016

Key Planning Parameters: Dithers and search area

Users can apply **Fixed dithers** or **Flexible dither constraints** – e.g. gap coverage

Fixed dithers: Translate MSA config pattern to new dither point.



SMALL dithers only! <~ 10 arcsec

Flexible Dithers: User specifies a min or max separation between dither points in spectral and/or spatial direction.

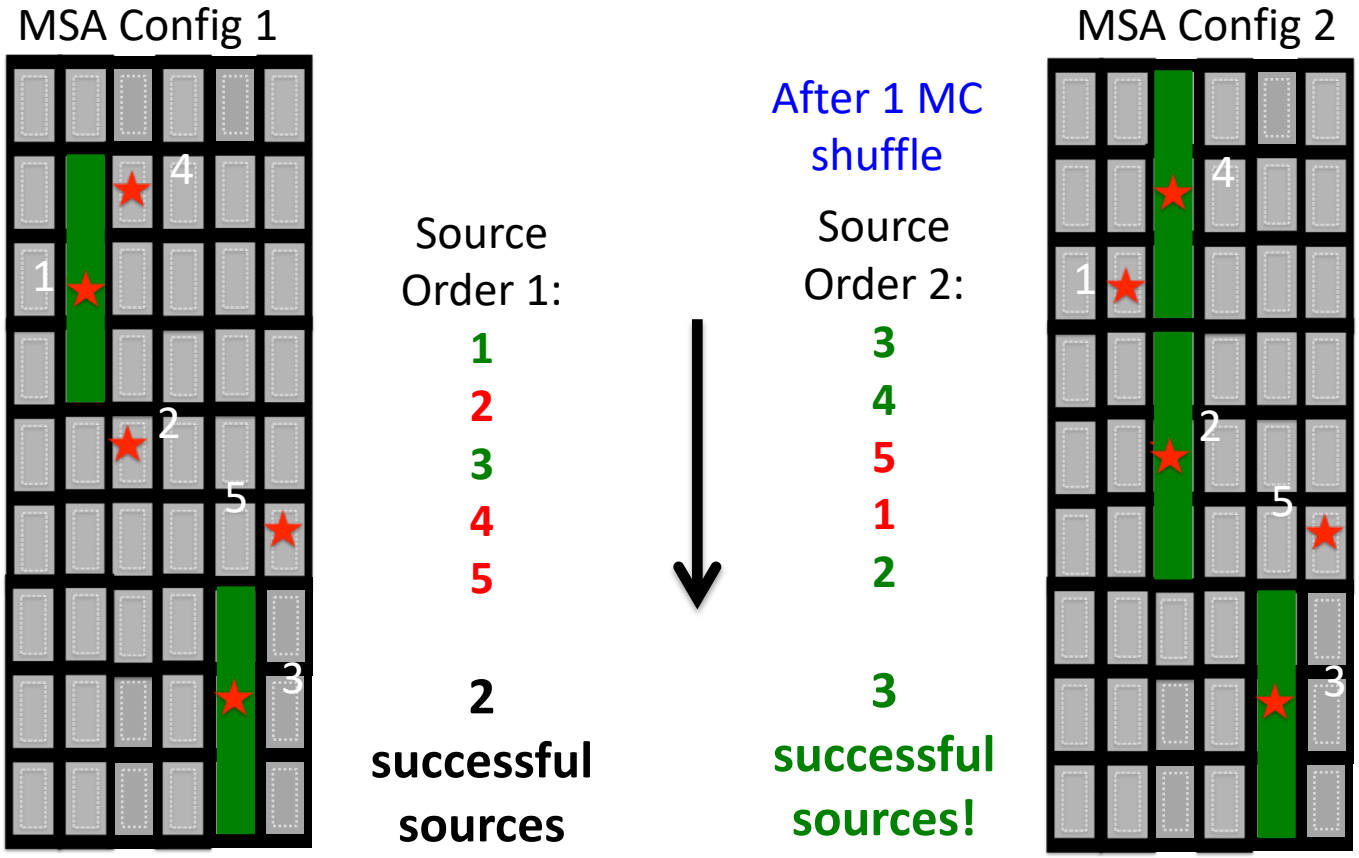
- This method handles **relative distortions** between dithers, so larger dithers are fine

MPT process:

- At each grid point, an MSA configuration is built, and sources are tallied. Can be optimized with MC shuffling.
- Multiple pointings are tested at each dither step, building **families of possible solutions**.
- The **best family** is chosen. (One that observes the **largest number of highly-weighted sources** over all dithers.)

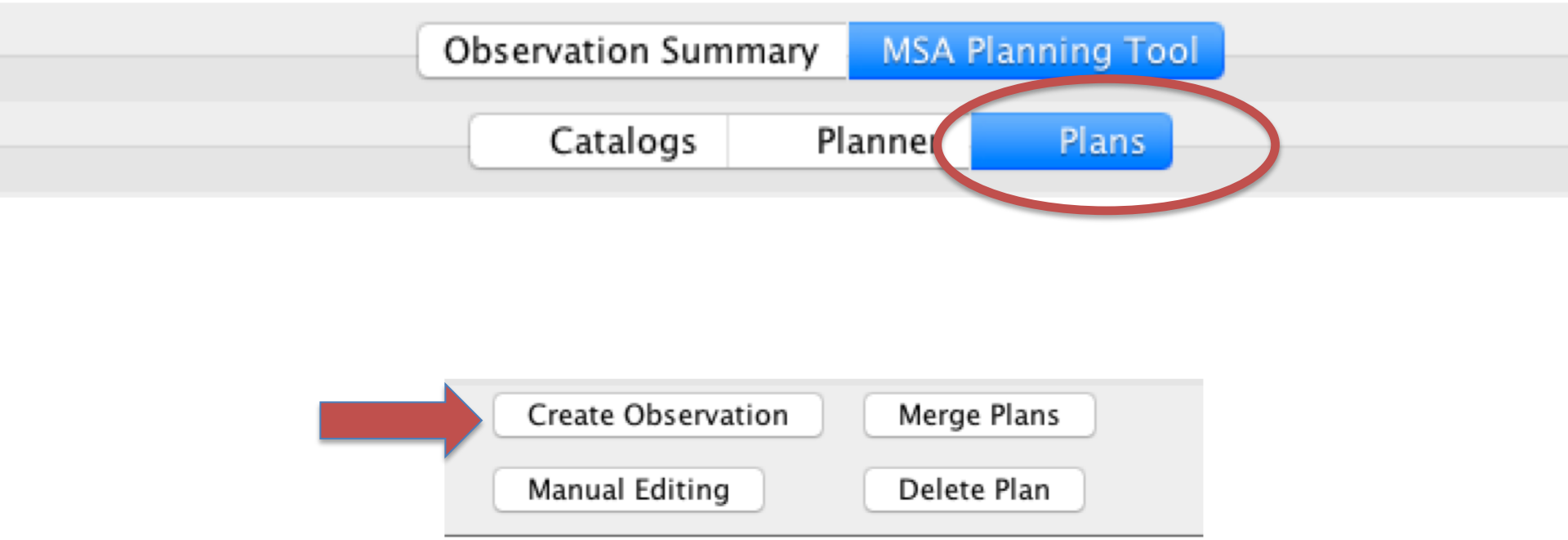
Key Planning Parameters: Monte Carlo optimization

- User can **choose whether to re-order the Primary candidate list** at each pointing. This can increase the number of targets observed at that pointing.

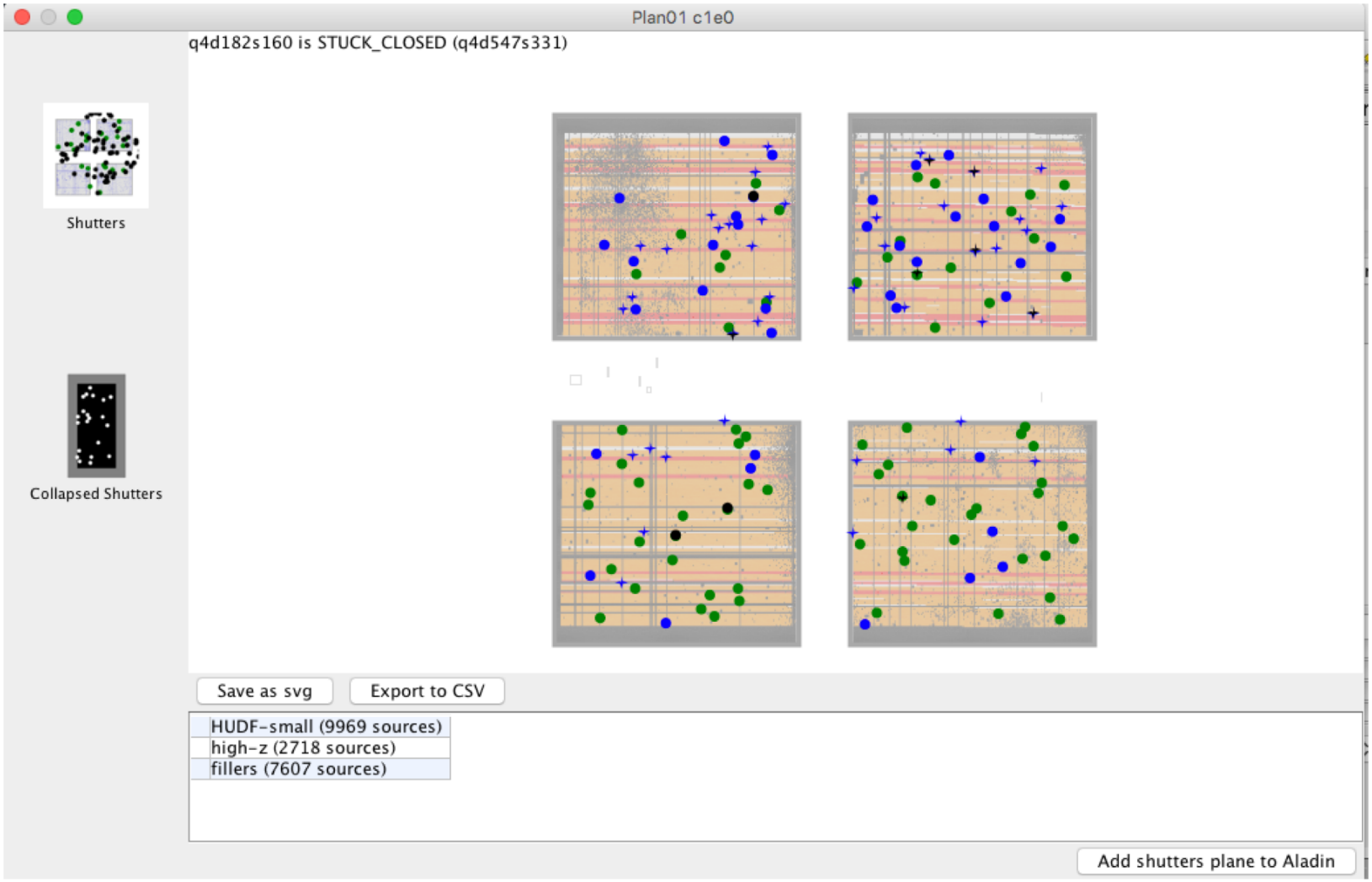


- Can also **customize** MSA configurations in the **manual planner**. Tedious!

Step 3: Asses the plan & generate observation



APT/MPT Visualization

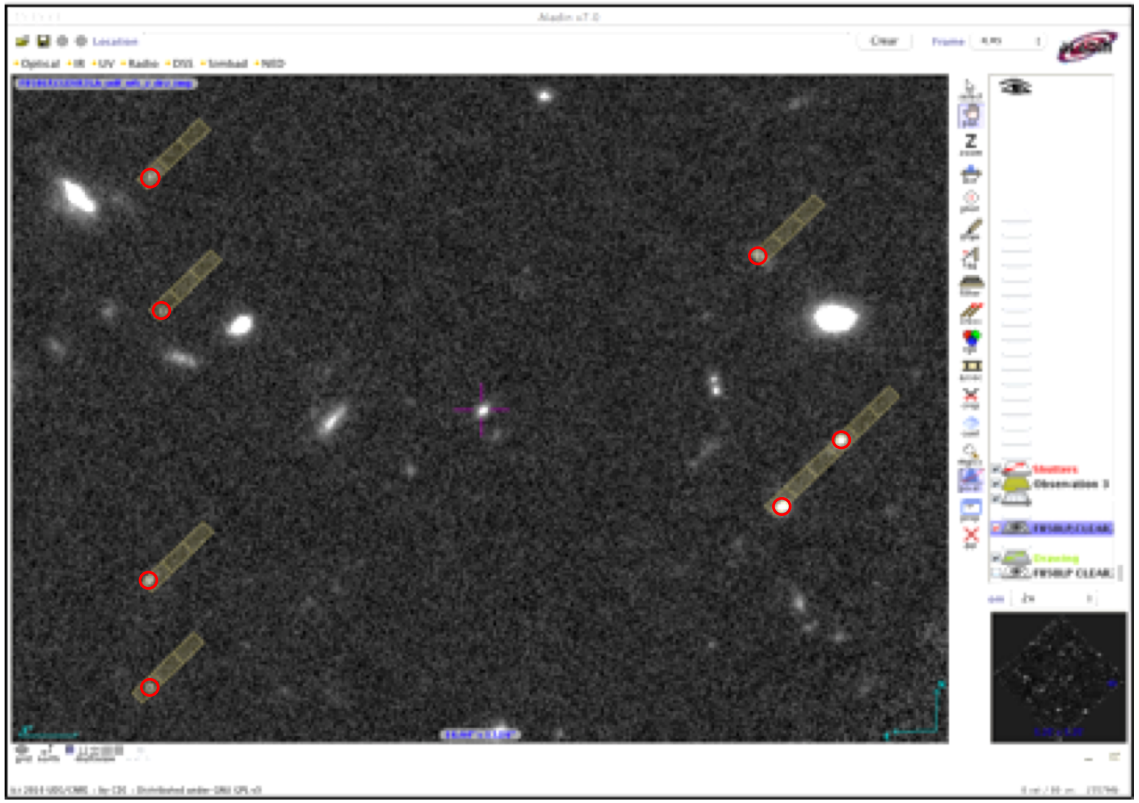


APT/MPT Visualization

- MSA slitlets from a single pointing can be displayed on an image of the field in Aladin.

Source positions from one of the following lists can be plotted in Aladin:

- the **catalog**,
- a **candidate list** made from the catalog, or
- the **target list** (observed MSA sources)



Demo based on MOS Science Case (Tim Rawle)

Overview

Goal: This program aims to study the evolution of galaxies

Methodology: An in-depth program of this type would likely combine deep imaging (NIRCam) and follow-up spectroscopy (NIRSpec MOS). A large mosaicked FoV could even allow for parallel NIRCam/NIRSpec.

However, in the following example, we concentrate on the NIRSpec MOS component, by imagining a deep single "pointing" of the MSA, using an input source catalogue derived from existing HST imaging.

Planned observations: single-pointing NIRSpec MOS at low and medium spectral resolution

Type of sources: galaxies over a wide range of redshifts, all assumed to be compact objects

Observations strategy: combination of 3-shutter "slitlet" nodding and dithering

Demo …

JDOX: NIRSpec MSA Planning Tool, MPT