ESA Science Research Fellowship

What?

- ➤ independent postdoctoral fellowship for ESA State nationals ➤ research project covering any topic in space science
- ➤ 2 + 1 years (proposal for 3rd year extension)

Where?

- ➤ ESTEC (Netherlands), ESAC (Spain) or STScI (USA)

Why?

- ➤ 100% research time (optionally <20% functional work, e.g. archive/data science, citizen science, operations, calibration, communication)
- ➤ insights into ESA environment & activities
- ➤ mentoring from senior ESA Science Faculty members
- ➤ training available (e.g. spacecraft design, soft skills, management)
- ➤ 3500-4800€ net monthly salary (depending on location & experience)
- ➤ comprehensive health coverage

Deadline: September 18, 2023

Website: https://www.cosmos.esa.int/web/space-science-faculty/opportunities/research-fellowships

Contact: yannis.zouganelis@esa.int

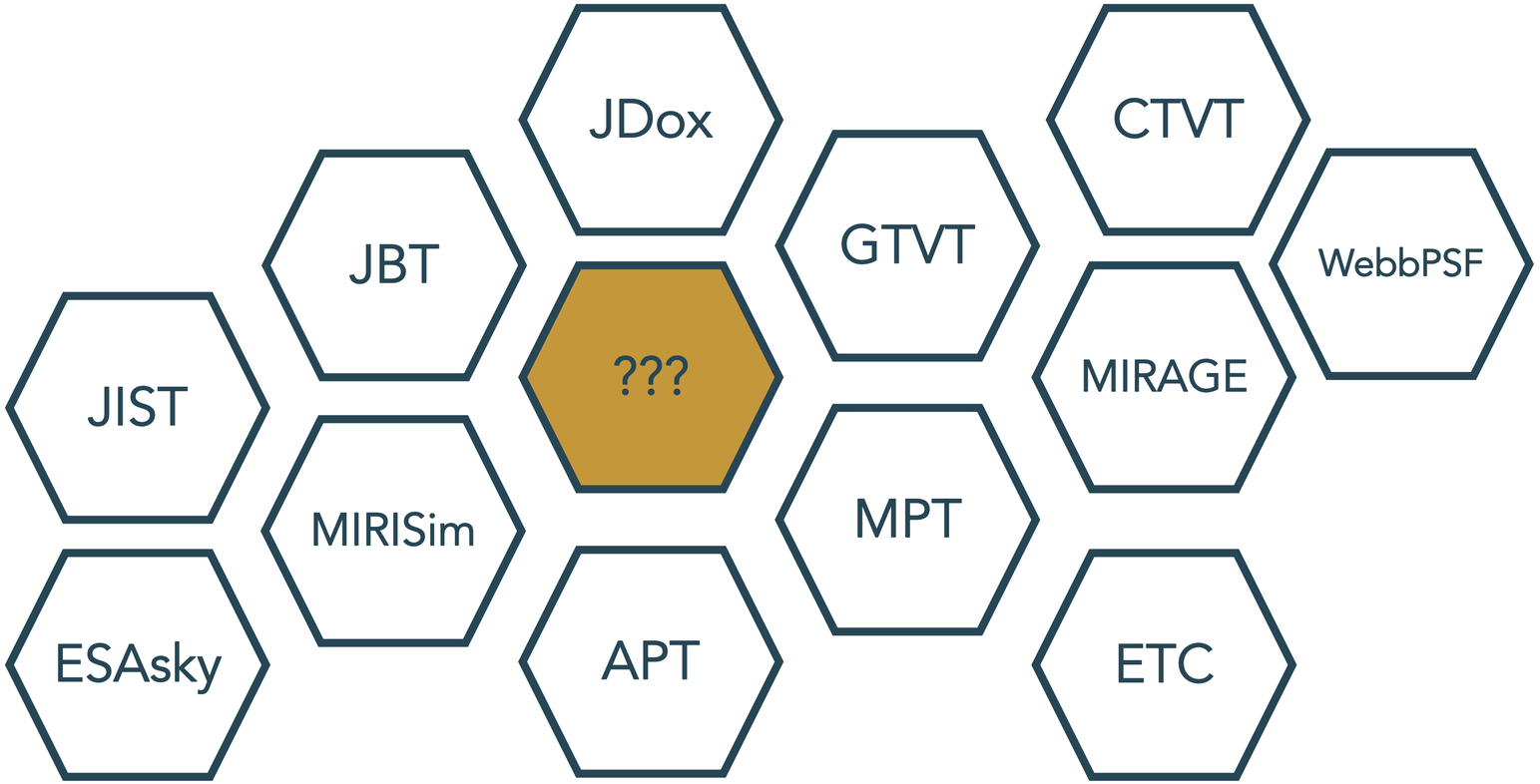
JWST Proposal Preparation

Nora Lützgendorf, ESA

IMPRS Summer School, 04-08.09.2023, Heidelberg

Preparing a JWST proposal: where do I start?!

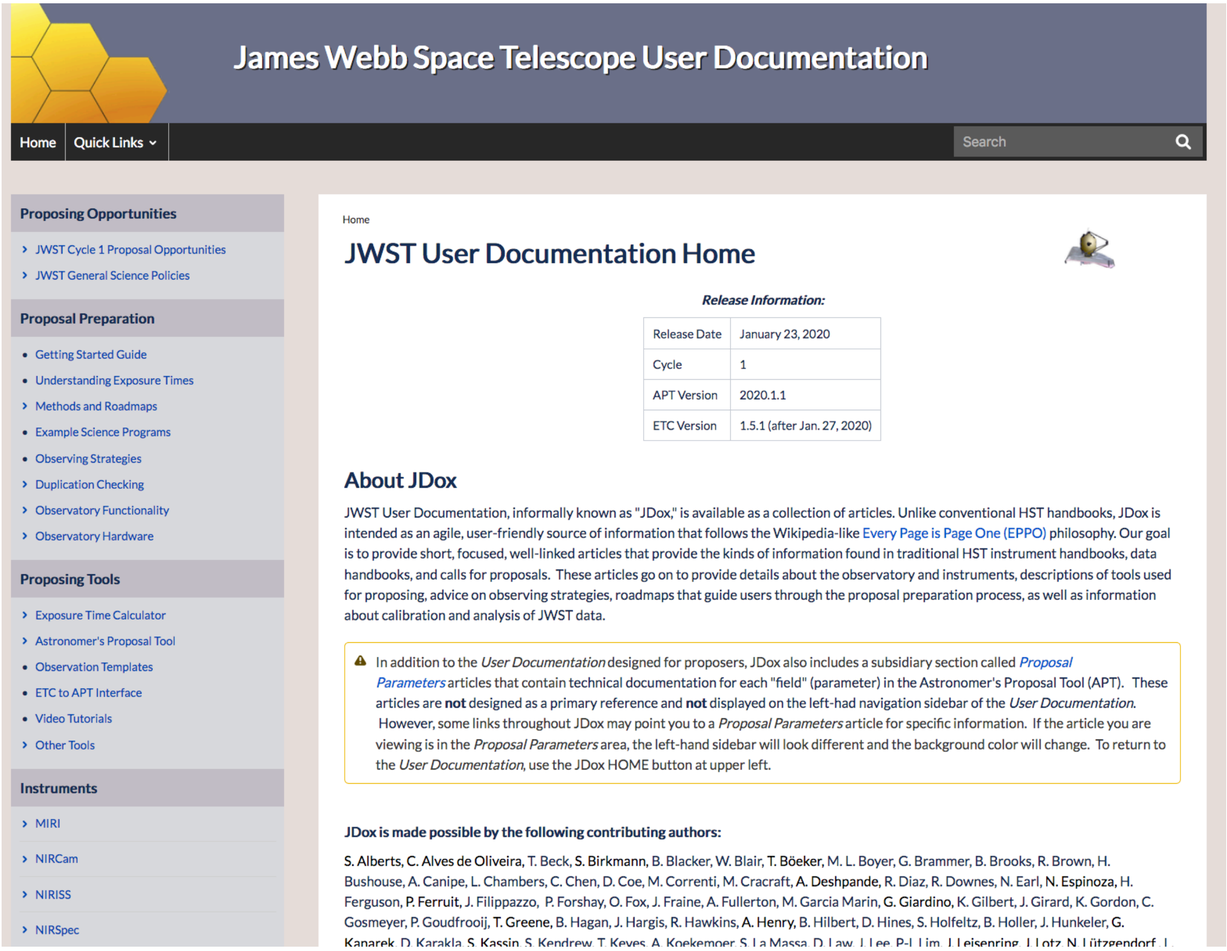
- The JWST proposal toolbox has a large number of resources, some of them specific to certain observing modes or science cases
- This presentation provides suggestions on how to navigate it



Suggestions for a roadmap

First impressions: what can JWST do?

- Become familiar with JDox, the JWST documentation:
  - https://jwst-docs.stsci.edu/
  - The menu on the left points to useful pages to start with:
    - Starting guide
    - Observatory and instruments capabilities
    - Examples of roadmaps for science programs
    - Available tools



Downselect: pick the instrument(s)/mode(s)

- Identify the instruments and observing modes you need to address your science goals

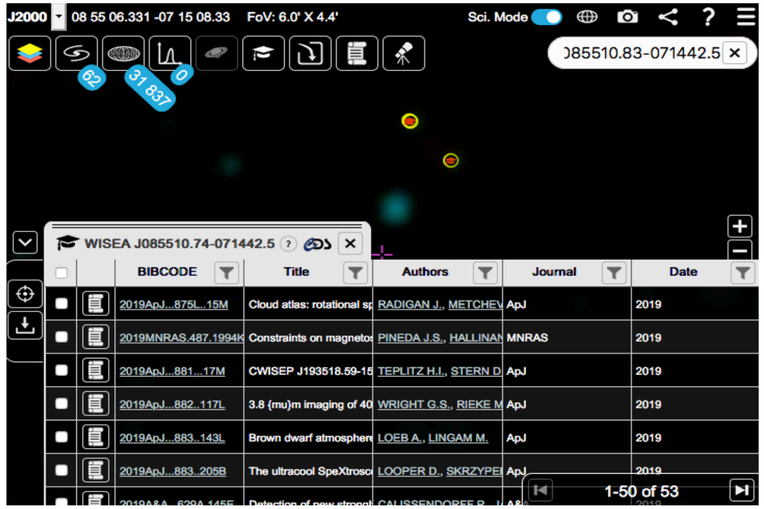
- Use JDox to get familiar with the documentation for that instrument:
  - Do operations involve dithering? Target acquisition? Mosaicking?
  - What are the detector readouts? Wavelength ranges? Sampling?

- Browse some example science programs and recommended observing strategies for that instrument/mode:
  - https://jwst-docs.stsci.edu/methods-and-roadmaps

Feasibility: did I select the right target? (1)

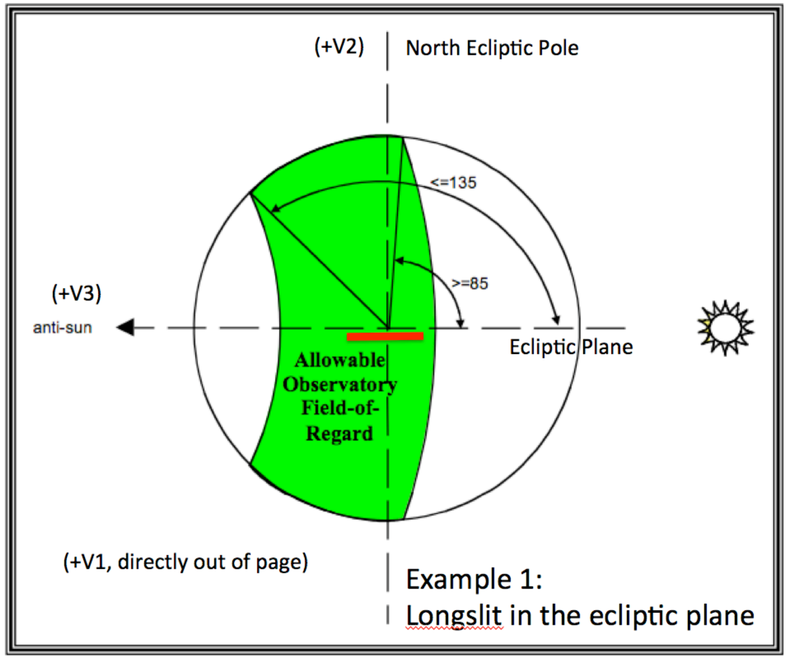
Availability

- MAST: check for duplications in JWST ERS/GTO
  - https://mast.stsci.edu/
- ESASky: check existing observations/ publications with other space missions
  - https://sky.esa.int



Visibility

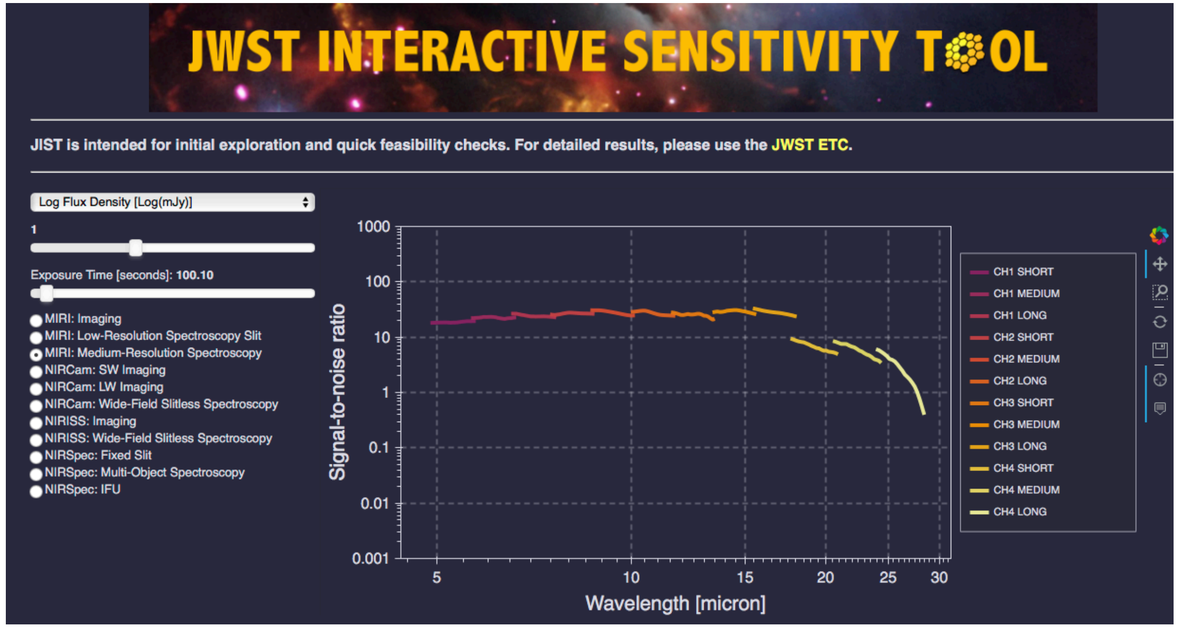
- Use the Target visibility tools (TVT) to check the targets visibility
  - General target (GTVT)
  - Coronagraphic (CVT)



Feasibility: did I select the right target? (2)

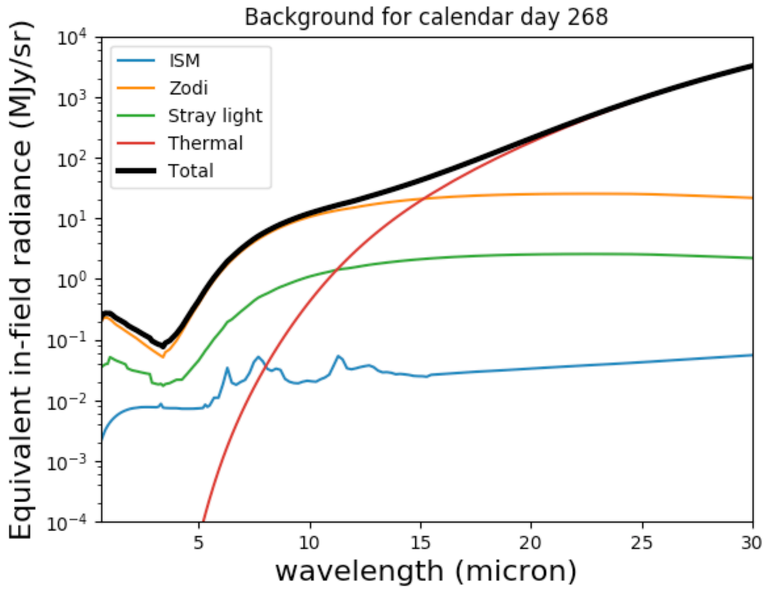
Sensitivity

- JIST: JWST Interactive Sensitivity Tool works as a quick-look tool to explore the feasibility of observations for any mode
  - https://jist.stsci.edu/



Background

- JBT: JWST Backgrounds Tool can be used to estimate the impact of the background on the schedulability of observations
  - Available through pip or github



Just do it: which tools do I need to propose?

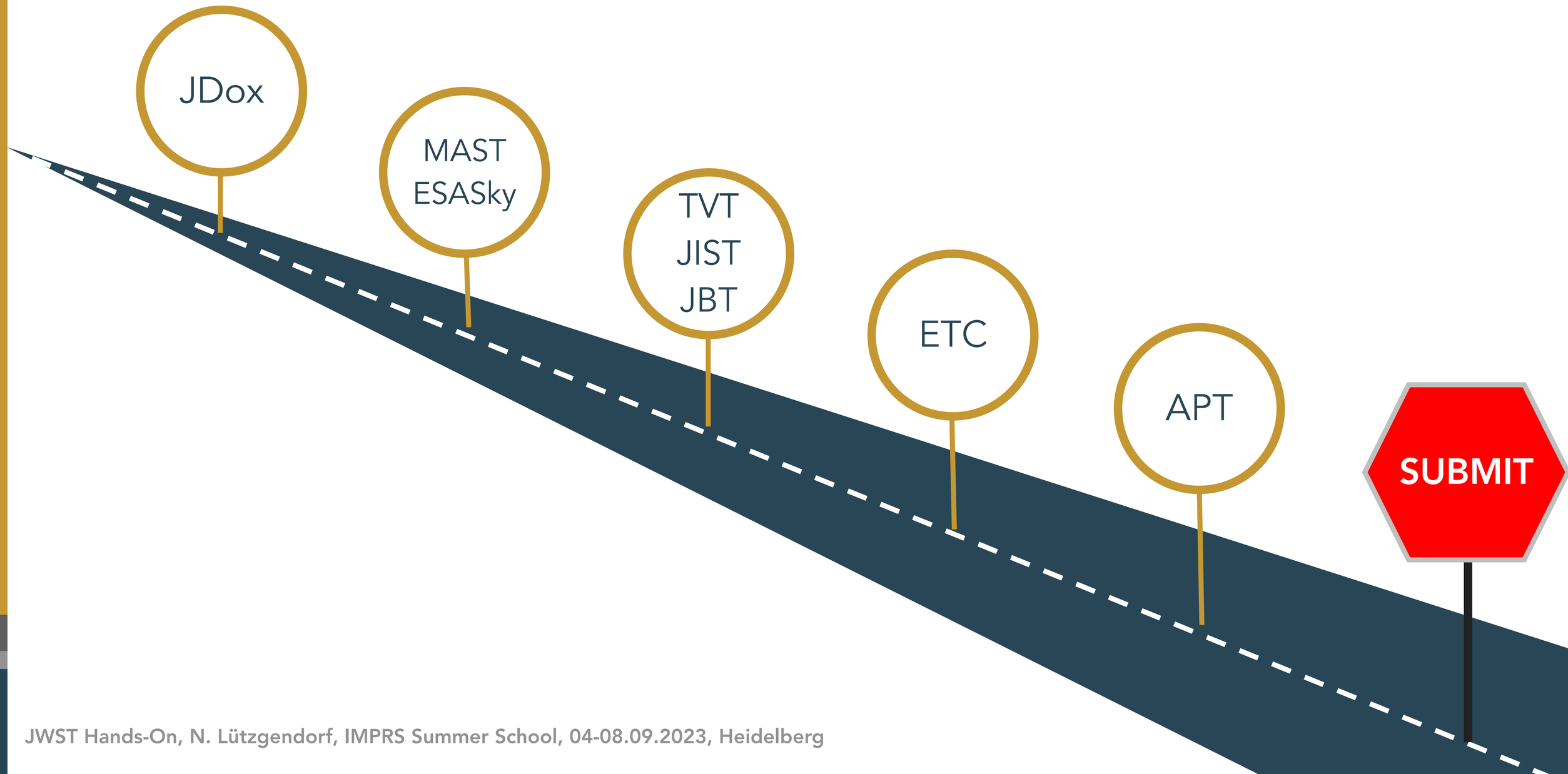
- Exposure Time Calculator (ETC)
  - https://jwst.etc.stsci.edu/
  - The ETC should be used to determine the exposure parameters needed to achieve the signal-to-noise for the science target

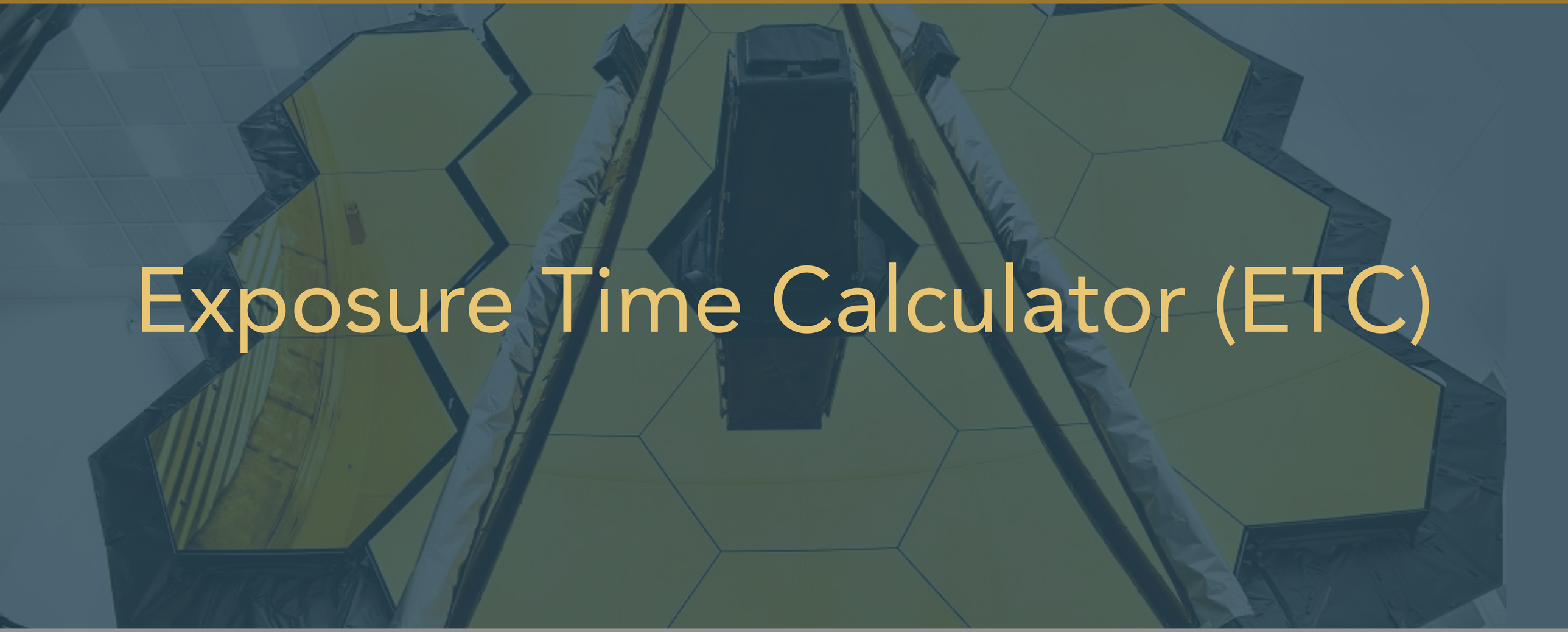
- Astronomer's Proposal Tool (APT)
  - The APT is where you will set up your program and submit your proposal
  - http://www.stsci.edu/scientific-community/software/astronomers-proposal-tool-apt/

A step further: what else is available?

- You may want to use other available tools to better understand JWST capabilities, improve your proposal, or get ready for the data
  - Simulated data:
    - http://www.stsci.edu/jwst/science-planning/proposal-planning-toolbox/simulated-data
  - Simulators: WebbPSF, Mirage, Awesimsoss, MIRISIM, ExoCTK, Pandexo
    - https://jwst-docs.stsci.edu/jwst-other-tools
- Run into an issue? Remember, there is help!
  - https://stsci.service-now.com/jwst

Suggestion of a roadmap to submission

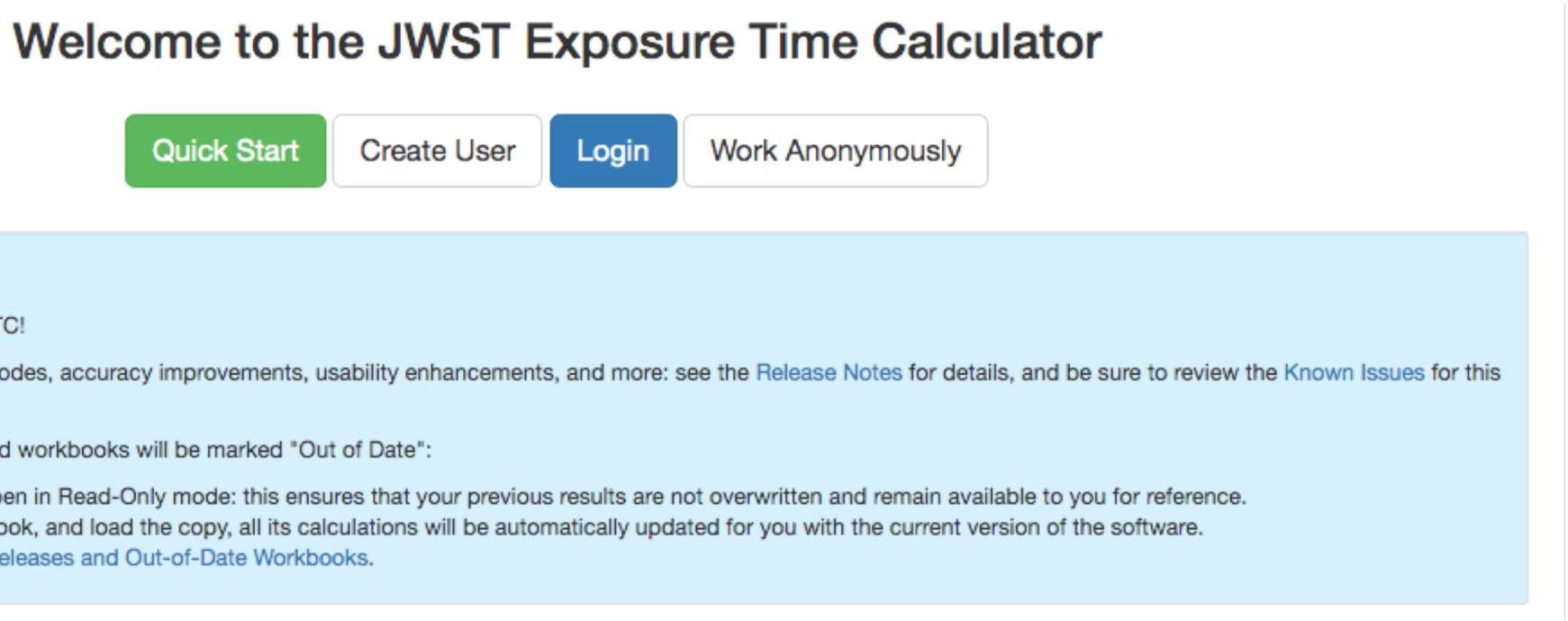




Exposure Time Calculator (ETC)

Where is ETC?

jwst.etc.stsci.edu



- Pontoppidan et al., Proc. SPIE. 9910, Observatory Operations: Strategies, Processes, and Systems VI, 991016. July 15, 2016 (https://arxiv.org/abs/1707.02202)

The “Pandeia” project

3D ETC engine
Python library

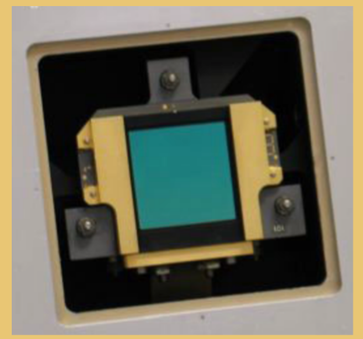
Reference database
Throughputs, detector noise, PSFs, …

Web application
(jwst.etc.stsci.edu)
User interface, collaborative function

JWST background model
Integrated into web application or as a standalone tool

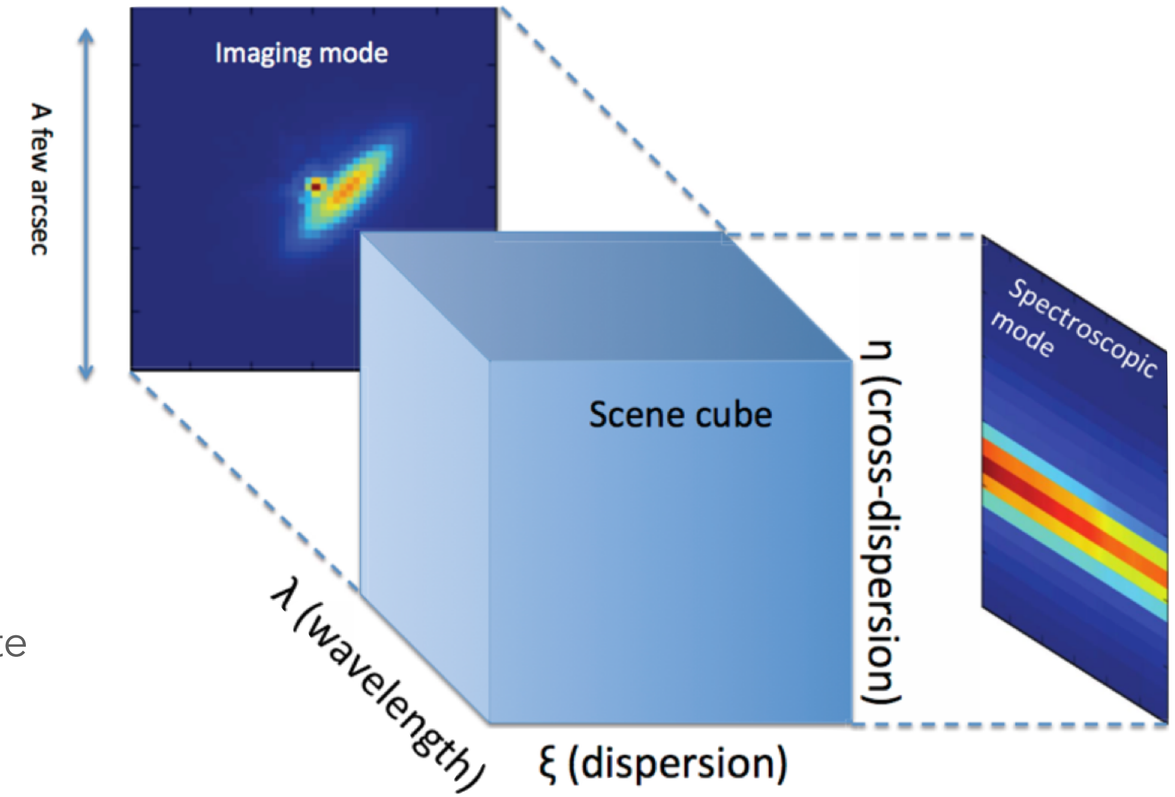
The engine algorithm

Space → Telescope → Instrument → Detector



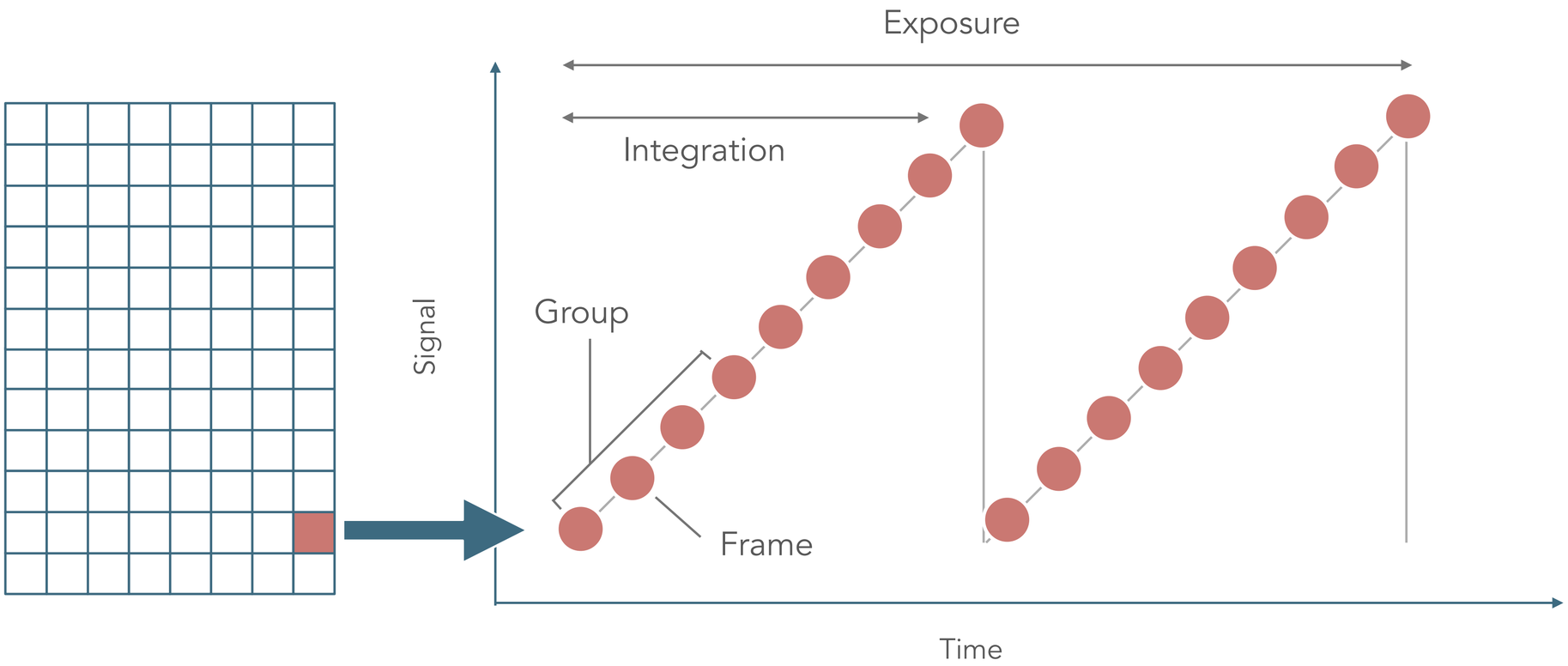
JWST ETC concept

- **Modern design**
  - Signal (source + background) modelled in 3D
    - conserves flux
    - resolve lines
    - oversample JWST resolution
  - Pixel based:
    - Models the detector (e.g. correlated noise)
    - Final S/N calculation includes data analysis and post-processing steps ("strategy")
    - Allows the modelling of complex scenes (e.g. estimate contamination from bright sources)
- **Supports all JWST modes**



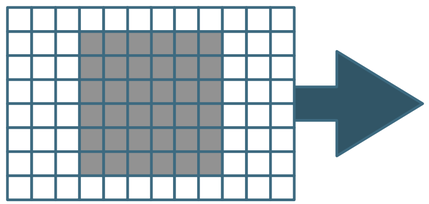
Excursion: JWST Detectors

- All JWST detectors use the up-the-ramp (MULTIACCUM) readout method
  - reads and records the signal of individual pixels multiple times as it is accumulated during an exposure

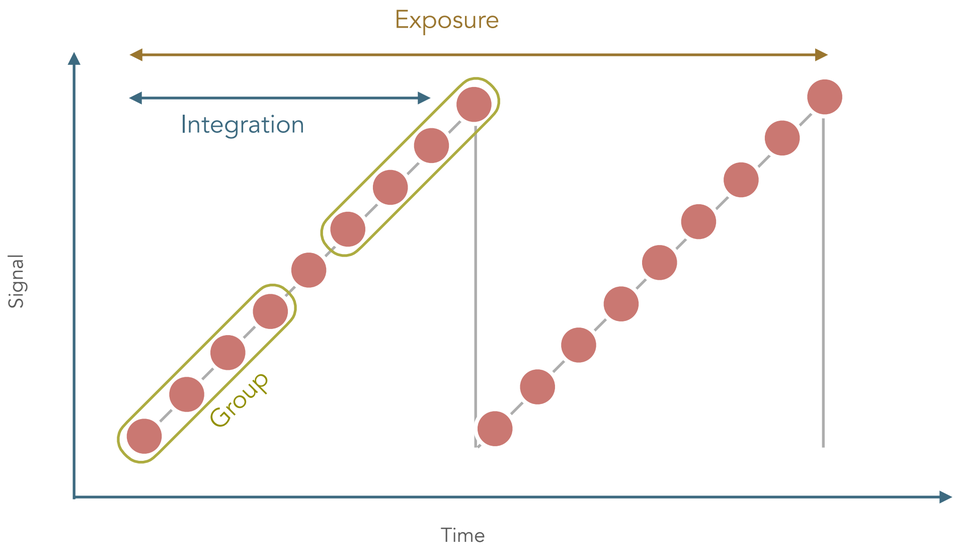


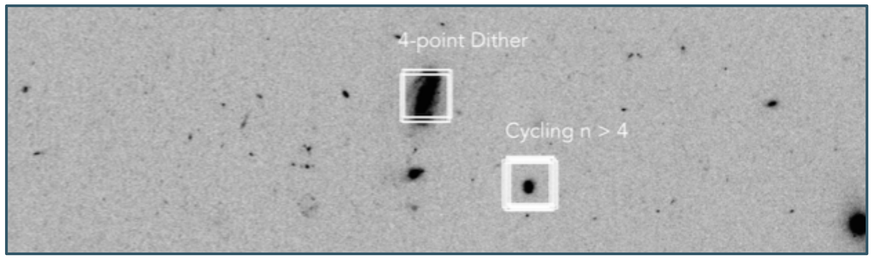
Readout terminology

- **subarray**: the window on the detector being read out
- **frame**: one complete read of the detector or subarray
- **group**: a set of consecutive frames averaged onboard (some frames may be skipped)
- **integration**: one non-destructive ramp
- **exposure**: a set of consecutive integrations at the same pointing
- **dither**: an exposure at a new pointing



You want to use subarrays if your target is very bright and saturates quickly (because your readout can be faster)

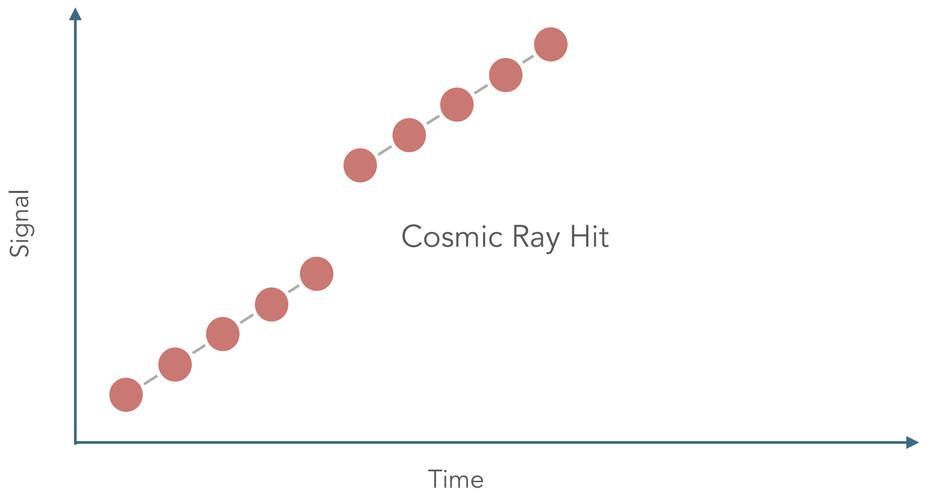


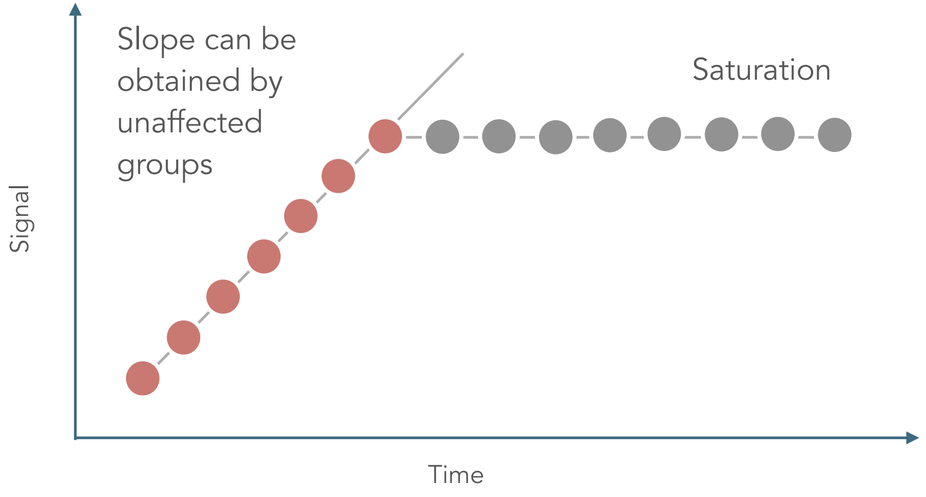


Soooo… how many groups??

It depends…

- **"Ideal" number of groups:** as many groups as possible without saturation.
  - Reason: Reduced noise, Easier to mitigate Cosmic Rays
- **Maximum number of groups:** < 1,500s (group number varies per setup)
  - Reason: Cosmic Ray Impact
- **Minimum number of groups:** 2
  - Reason: Increased noise, Lower duty cycle





JWST ETC features

- **Workbooks**
  - Organise several ETC calculations into a workbook
  - A workbook can contain multiple sources, scenes and calculations
  - Workbooks remain in your MyST account, and are shareable

- **Reusability**
  - Calculations in a workbook start with reasonable defaults
  - Simply copy a calculation, modify the inputs as desired and recalculate

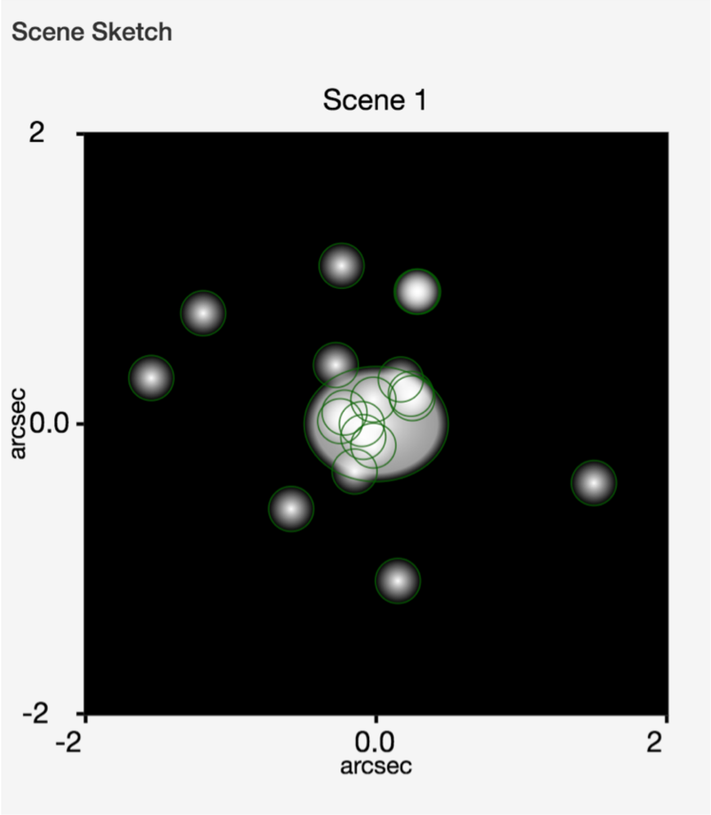
- **Batch expansion**
  - Efficiently run a batch of many calculations
  - Calculation is duplicated N times varying only the selected parameter
  - Expansion over e.g. Ngroups offers a way to show the behaviour of SNR as a function of “exposure” time

- **Auto-update**
  - Changes made to the input, flow through to associated forms and calculations

Scenes and sources

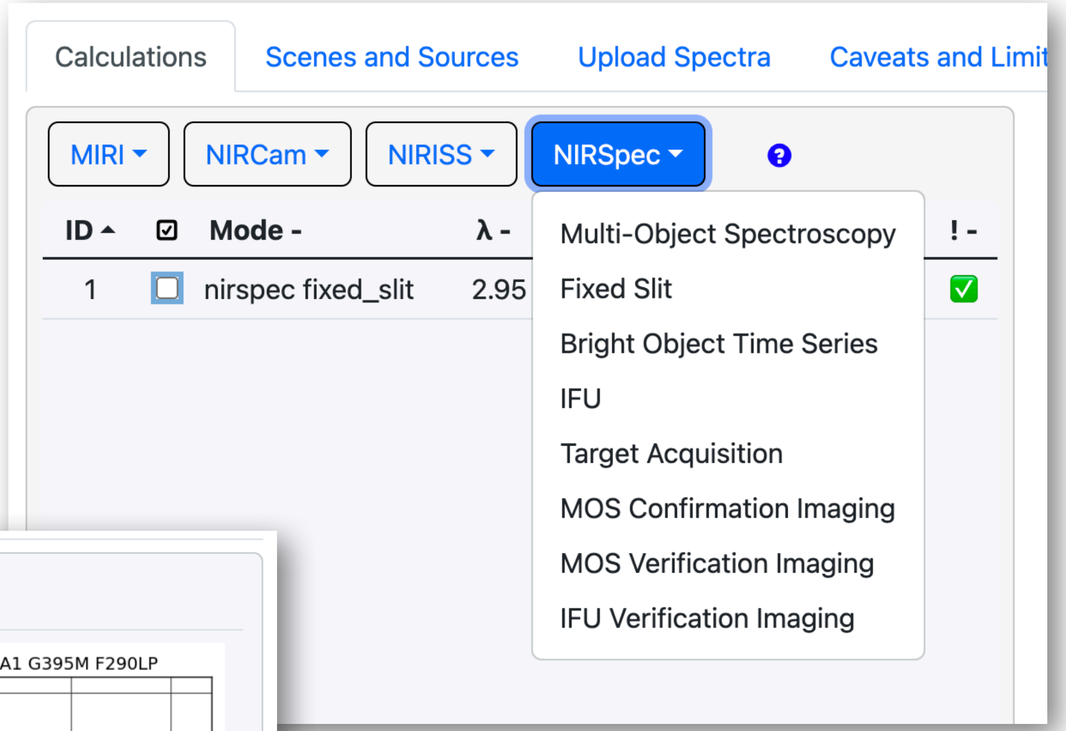
- **Scene**: small postage-stamp of the sky (a few arcsec on a side)
  - A scene can have no source (just background) or multiple sources
  - Scenes can be reused in multiple calculations

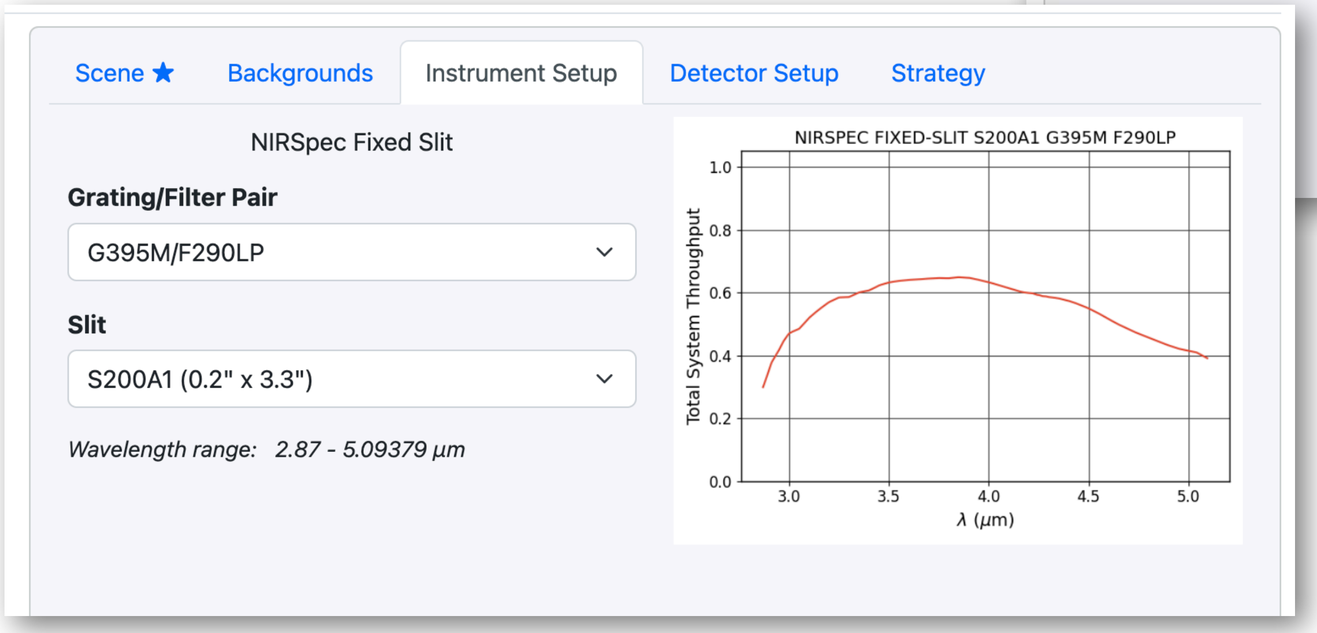
- **Source**: specify SED, normalisation, extinction, emission lines and shape
  - Each sources can be reused in multiple scenes
  - Location: x,y offset (with orientation) within the postage stamp scene
  - Shape: point source or extended (flat, Gaussian, Sersic, power law…)
  - Spectrum:
    - Continuum: flat, black body, power law, templates
    - Lines: centre, width, flux
    - Normalise to magnitude/flux in JWST or HST bandpass, or at a λ
    - Upload a spectrum (ASCII or FITS format)



Calculations

- Select an Instrument and start setting up your calculations
- You will have to select background, gratings, filters, apertures, detector setup, and **Strategy**

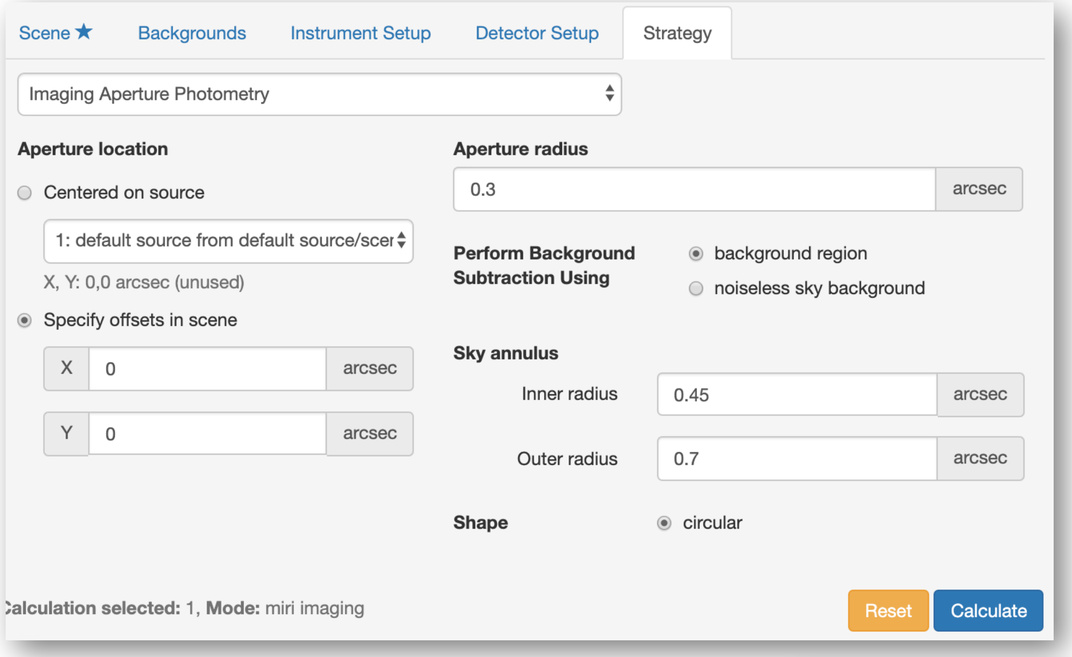


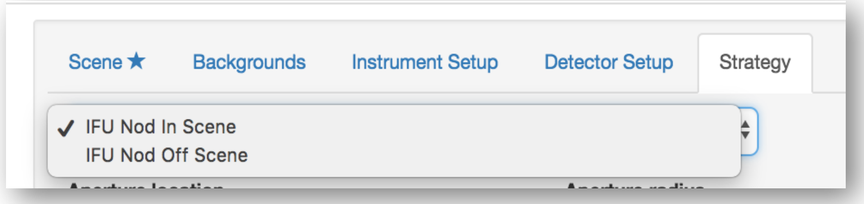


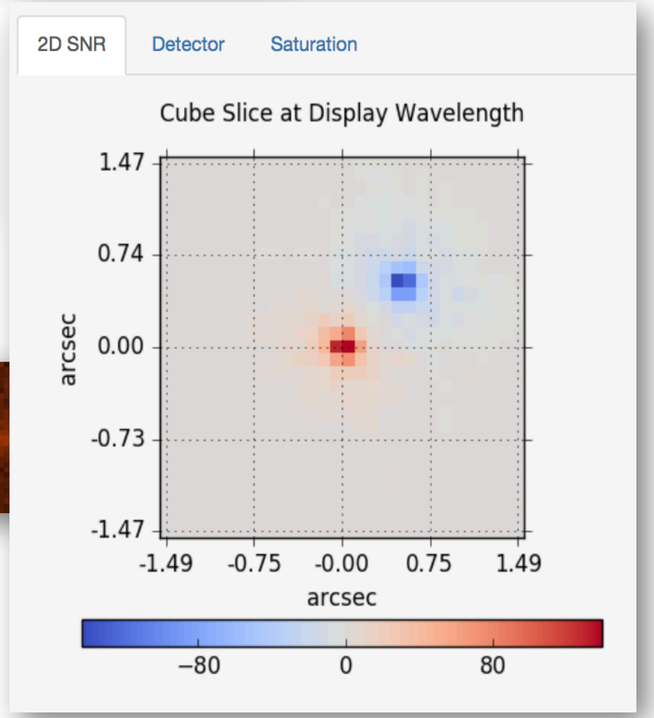
ETC Strategies

- "Strategies" are prescriptions for how to go from a detector image to an extracted product

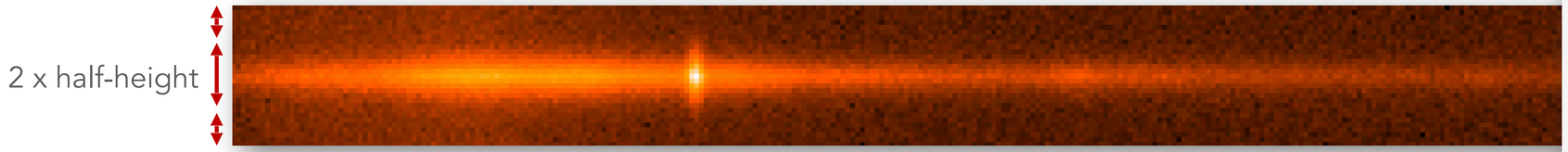
- Examples of available strategies:
  - Imaging aperture photometry
  - Spectroscopic aperture extraction
  - IFU extraction with a background
  - Coronagraphic contrast







Aperture extraction / fixed slit



Target Acquisition calculations

- The ETC has dedicated calculations to help plan Target Acquisition (TA) observations, which are recommended or required for many modes.

- Models the GENTALOCATE algorithm that is executed on board
  - Uses the first – middle – last (or last-but-one) groups in an integration
  - Mitigates cosmic rays by taking minimum of two difference frames
  - Uses a fixed square aperture for centroiding (e.g. 3x3, 5x5 px)

- Each instrument/mode has different range of options, settings & recommendatiojns for TA -> refer to mode-specific documentation to learn about the options.

Useful links

- **JWST ETC**
  - https://jwst.etc.stsci.edu/

- **Documentation:**
  - ETC introduction
  - Links to all pages, video tutorials and more
  - https://jwst-docs.stsci.edu/jwst-exposure-time-calculator-overview

- **ETC release notes, known issues and FAQ (@ JWST Help Desk)**
  - JWST Help Desk ETC FAQ
  - JWST Help Desk ETC known issues

- **JWST Community Lecture Webcasts**
  - "The JWST Exposure Time Calculator" - Klaus Pontoppidan (Nov 2019)
  - "JWST ETC Demo" (interface demonstration) - Swara Ravindranath (Feb 2017)

Demo

Final checklist

- There are many parameters affecting the predicted ETC sensitivities.
- That's the point of having a versatile tool, but comes with some responsibility.

✓Think about your **background subtraction strategy**.

✓Think about what **extraction aperture** is optimal (point or extended sources).

✓Is your background correct for your target – enter the actual RA, DEC. Investigate time dependency.

✓Check that your extraction aperture does not contain contaminating flux from other sources.

✓Is your selected readout pattern giving you the best SNR?