ESAC 2017 JWST Workshop

Deep Field Survey with NIRCam and MIRI.

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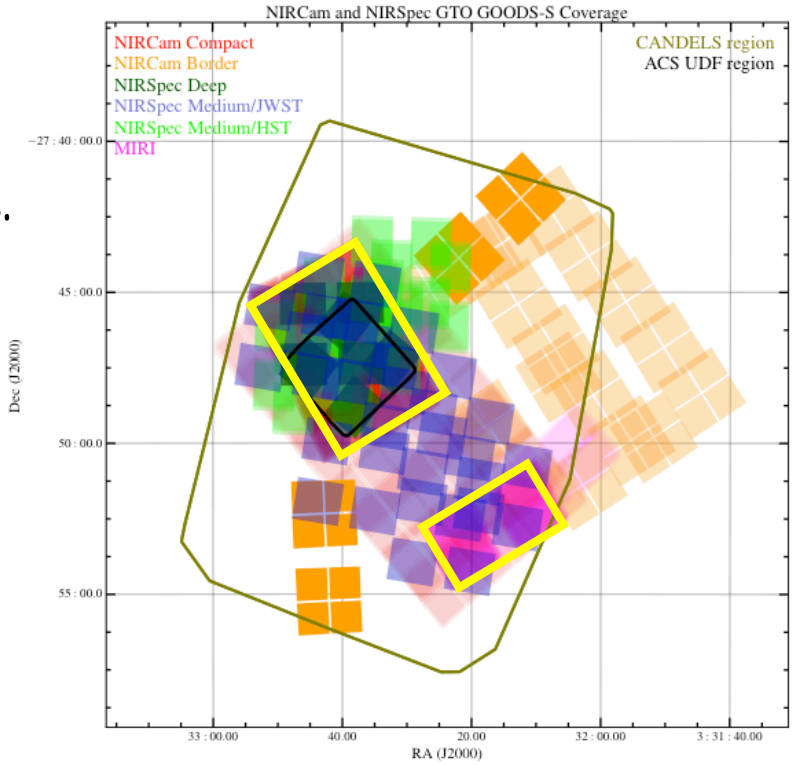
Science Case #3

Overview

Goal: This program will image the GOODS-S field to study galaxy evolution from the first steps ($z > 10$) through the end of the dark ages ($7 < z < 9$) and the epoch of galaxy assembly ($2 < z < 6$). This survey will construct luminosity functions at the highest redshifts to test galaxy formation models as well as measure the galaxy characteristics (metallicity, star formation, morphology).

Methodology: Image portions of the GOODS-S field with NIRCam and MIRI in parallel with several filters. The survey will cover about 25 sq. arcmin at 30 – 50 ksec depth.



IMAGING

Instrument Configuration

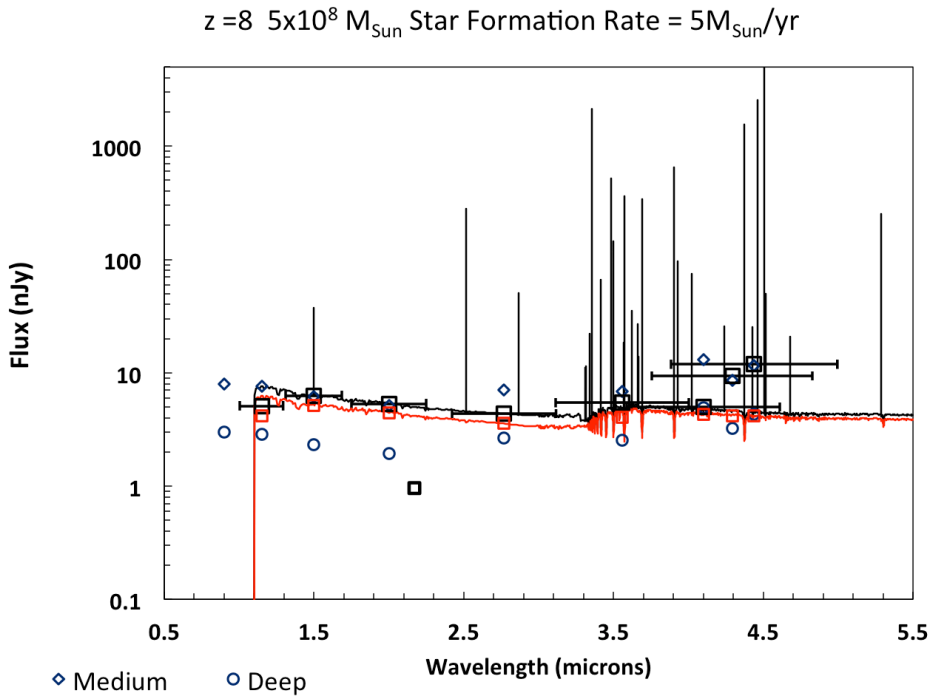
NIRCam: We want large spatial coverage, so we will image using both modules, with the FULL array. We will also implement dithers and a mosaic.

MIRI: Imaging in parallel, also using its FULL array.

Detector readout patterns will be decided when running the ETC. Find readout pattern details in Jdox.

IMAGING

Instrument Configuration: Filters Selection



- Include all wide NIRCam filters to sample the full wavelength range & provide maximum redshift discrimination.
  - Except F070W, which has a low transmission.

- Two additional NIRCam medium-band filters: F335M and F410M.
  - These overlap with the wide filters and guard against emission lines, providing additional redshift discrimination.
- MIRI is not as sensitive as NIRCam, so only one wide filter is included: F770W. This single filter will be run in parallel with all NIRCam filters.

IMAGING

ESA Sky

Use ESA Sky to find the source of interest, and display the JWST instruments footprint on it.

Identify the science aperture (NIRCam/MIRI imaging). Are there any gaps in the coverage? Dithers can be used to obtain full spatial coverage, slightly enlarge the field of view, mitigate detector artifacts, etc. Note that, in general, dithers are mandatory in the APT templates.

ESA Sky can also be used to download already reduced files of the target from all ESA missions.

IMAGING

Exposure Time Calculator

Requirements: Detect a wide range of galaxies at various redshifts with a S/N >3 in enough filters to estimate a redshift.

Implementation: Set up a scene with 2 galaxies:

1. The UGCA 219 template (blue compact dwarf) at z=8. Normalize the flux to10 nJy at 2 μm. Set the shape to an extended, 2D Gaussian flux distribution with semi-major axis 0.1" and semi-minor axis = 0.05".
2. The NGC 4552 template (E w/ UV upturn) at z=1.5. Normalize the flux to 250 nJy at 2 μm. Set the shape to an extended, Sersic flux distribution with semi-major axis = 0.5 ", semi-minor axis=0.2 ", and Sersic index=1.3.

Choose an adequate detector setup using about 30 ks in F200W, F277W, F335M, and F356W and about 50 ks in F090W, F115W, F150W, F410M, and F444W. The F770W MIRI filter will be observed in parallel with all observations for a total of about 200 ks, including readout pattern and the number of groups, integrations, and exposures.

Hints: The number of exposures in ETC can be translated later as the number of dithers *or* exposures in APT. This assumes the coverage achieved through dithers is even, though not all NIRCam dither patterns give uniform coverage.

- Avoid very long integrations (longer than ~1500 s) with NIRCam to mitigate problems with cosmic rays.
- NIRCam is prime, so the MIRI exposures cannot exceed NIRCam's. NIRCam also drives the dither slews, so MIRI will have the same number of dithers (exposures in ETC).

IMAGING

Astronomer's Proposal Tool

Target Coordinates: RA = 03:32:42.7, Dec = -27:47:59.7

Template:

- NIRCam imaging with MIRI imaging as the coordinated parallel.
- Select both NIRCam modules in FULL array mode (and the FULL array for MIRI).
- Choose a dither pattern that will cover the short-wavelength detector gaps (the primary pattern) and a subpixel dither pattern (which will provide good PSF sampling).
- For both MIRI and NIRCam, select the readout pattern and the number of groups, integrations, and exposures that were chosen using the ETC.

Mosaic: the goal is to cover an area about ~25 sq. arcmin in size with NIRCam. Select a mosaic setup that achieves this while also covering the gap between the NIRCam modules (hint: column overlap of 78%).

Astronomer's Proposal Tool

Data Volume Considerations: Are the individual visits running into data volume issues? If so, what are the possible solutions?

Filter Wheel Considerations: Filter wheel moves must be minimized. For this reason, dithers (which require fewer filter moves) are preferred over mosaics to cover detector gaps. How can this program avoid superfluous filter wheel moves?

Special Requirements: Do you need to impose some (scientifically justified) time or position angle (PA) constraint? Keep in mind that this program should fit within the GOODS-S field.

Aladin Visualization: Use Aladin to visualize instrument footprints/coverage/dithers. You can play with the orientation there.

Visit Planner: Verify that the program is schedulable.

Find more details about this science case at:

https://jwst-docs.stsci.edu/display/JPP/NIRCam+Deep+Field+Imaging#NIRCamDeepFieldImaging-APT