



## ESAC 2017 JWST Workshop

---



Feeding and feedback of supermassive black holes. Resolved gas kinematics within 100pc of the NGC4151 AGN.

Sebastian Hoenig, Sarah Kendrew, Nora Luetzgendorf, Macarena Garcia Marin

Science Case #2.2



## Overview



**Science case:** Active accretion of gas onto supermassive black holes constitutes a significant phase in galaxy evolution. Feedback of the accretion process impacts star formation in the host galaxy, while starbursts in the central region of galaxies regulate the gas flow toward the black hole.

**Goal:** To determine the physical conditions of the inflowing and outflowing gas. Using NIRSpec and MIRI IFU observations will allow us to quantify mass accretion and mass outflows, and test how much mass will end up being available to fuel the

**Methodology:** Use rot-vib transition H<sub>2</sub> emission lines to trace the mass, temperature, and kinematics of the molecular gas within 100-200pc of a sample of nearby Seyfert AGN at different accretion efficiencies (Eddington ratios).





## Overview



Planned Observations: MIRI IFU Mosaic, NIRSpec IFU Mosaic.

Source Type: Extended Object

Object: NGC4151 ( $z=0.003319$ , 0.069 kpc/arcsec)

Technique: Integral Field Spectroscopy





# Instrument Configuration



## Spectral Configuration:

**NIRSpec:** Use an adequate combination of filters and dispersers to cover the full spectral range with a resolution of R2700.

**MIRI:** Cover the FULL spectral range.

## Pointings:

- Enough IFU pointings to cover the central  $\sim 200$ pc.
- Use the source distance to ensure you are mapping that area.





# Exposure Time Calculator



## MIRI

**Requirements:** We want high-quality spectra; aim for SNR of 40 or more in the entire MIRI wavelength range.

## **Implementation:**

- Upload in the ETC the provided file (S. Hoenig priv. comm.). First column is wavelength in microns, second is flux in mJy. The spectra represents the nucleus within FWHM of  $\sim 3.5''$  at 10 microns (i.e. define an extended source accordingly).
- Choose “do not renormalize” and low background level.
- Strategy should be IFU-nod-off scene (we will take a separate background observation for MIRI).
  - Derive exposure times for the MIRI imager in a filter of your choice, as it will be simultaneously used with the MRS.
  - Use the ETC to derive TA detector parameters using the same source. Choose an adequate imager filter that will prevent saturation. TA is currently mandatory in APT for the MIRI MRS. It will be optional in an upcoming version.





# Exposure Time Calculator



## MIRI

**Hints:** The  $N_{exp}$  defined in the ETC can be translated later as Number of dithers/ exposures to be implemented later in APT. The SNR given by the ETC assumes full redundancy in the dithers per pixel.

**JDocs:** Check the MIRI Best Practices Pages in JDocs for recommendations on how to best optimize the detector performance.





# Exposure Time Calculator



## NIRSpec

**Requirements:** We want high-quality spectra; aim for SNR of about 100 at the centre of the field.

**Implementation:** Select the ETC template for NGC4138, another Seyfert 1 galaxy, and normalize it to 60 mJy at 1 micron (Riffel et al. 2016). Note that this is just an approximation, as at longer wavelengths (about 5 microns) the galaxies SEDs are not exactly the same. For the source shape use an extended source with 1.486 arcsec semi-minor and -major axes.

In the calculations use a combination of filters and gratings that will cover the NIRSpec wavelength range with R2700. Use the “Nod-off scene” strategy in an aperture of 0.1” radius. Although we are not taking an associated background with NIRSpec, this does not have an impact in the final result as it assumes zodiacal emission low. Feel free to experiment with this. The “Nod-in scene” option is not feasible in this case, as the source occupies the entire FOV.

**Hints:** The Nexp. defined in the ETC can be translated later as Number of dithers/exposures to be implemented in APT. The SNR given by the ETC assumes full redundancy in the dithers per pixel.

For NIRSpec in general do not use integrations longer than ~1500 seconds, to avoid issues due to cosmic rays impacts.

In this case use the blind pointing option (VERIFY ONLY, i.e. no TA).







# Astronomer's Proposal Tool



## MIRI MRS Observations:

**Target:** Use the APT fixed target resolver to load the coordinates of NGC4151. Choose between point and extended source; that should drive your choice of dither pattern as well.

**Hint:** Copy the target and give them a different ID. One for NIRSpec and one for MIRI. This is because the MIRI one will have to have an associate background target, and the NIRSpec will not.

Define a background target for MIRI, and remember to associate the observations with the science ones. The background should be an (reasonably) empty region of the sky. Think whether you need to replicate the dither in your background. In this case we chose to do it, so the imager data could be combined and potential starts can be removed from the background image.

## Template:

- MIRI Medium Resolution Spectroscopy.
- Define TA following your ETC estimations.
- Define dither pattern.
- Make use of Simultaneous Imaging in an adequate filter.
  - Obtain FULL spectral coverage with the MRS.
  - Define a mosaic that will cover the central  $\sim 200$  pc.
  - Design background observations consistent with the science ones, and impose a special requirement so they are linked.
  - Is it possible to perform TA in the background target? Do you need that?







# Astronomer's Proposal Tool



## NIRSpec IFU Observations:

**Target:** Use NIRSpec science target (i.e. no associated background).

For NIRSpec we will not take a separate background, as the zodiacal light should not have a significant impact in this bright source.

## Template:

- NIRSpec IFU Spectroscopy.
- For TA use the pointing verification image option. Use MSA ALLCLOSED configuration, F110W, readout NRSIRS2RAPID, 5 groups 1 int.
- Define a dither pattern for the science observations and use an adequate combination of filters and dispersers to cover the full spectral range with a resolution of R2700.
  - Take LEAKCAL exposures.
- Define a mosaic that will cover the central  $\sim 200$  pc.





## Astronomer's Proposal Tool



**Data volume considerations:** Are you running into data volume issues?

**Special Requirements:**

Do you need to impose some (scientifically justified) time constraint? For this case we don't require PA constraints.

**Aladdin Visualization:** Use Aladdin to visualize instruments footprints/coverage/dithers. You can also play with the orientation.

**Visit Planner:** Verify when the program can be scheduled.



Are you satisfied with the overall program? Do you have errors or warnings? If yes, are they expected/can you fix them?