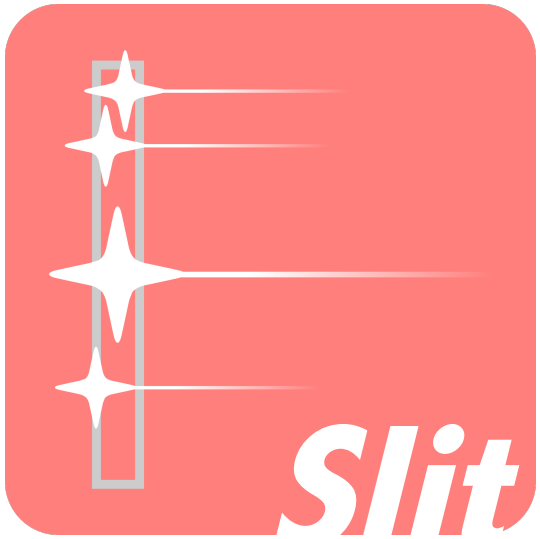
ESAC 2017 JWST Workshop



Near-IR spectroscopy of Y dwarfs

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Science Case #4

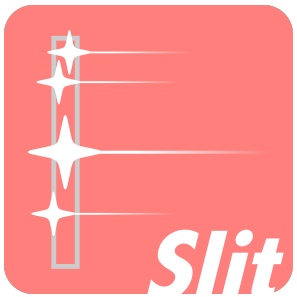
Overview

Goal: To obtain spectroscopic observations of a Y dwarf across the entire JWST NIRSpec wavelength range to understand whether these atmospheres are shaped by chemical disequilibrium driven by vertical transport or the formation of water clouds, and constrain the object's gravity, hence mass.

Methodology: Compare high-quality NIRSpec spectra in low (from 0.6 to 5.3 micron) and medium (from 2.87 to 5.27 micron) resolution, to models of cool atmospheres at different temperatures, gravity, degrees of turbulence, chemical equilibrium or disequilibrium driven by vertical transport, and clouds.

Planned observations: NIRSpec fixed slit spectroscopy

Source Type: Point source



Instruments Configuration

NIRSpec:

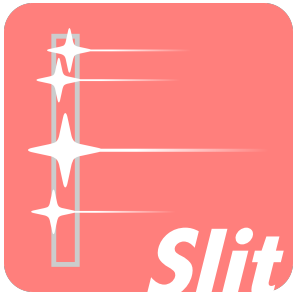
fixed slit spectroscopy

low and medium resolution: PRISM and G395M

subarray detector configuration

wide-aperture target acquisition

Detector readout pattern of choice should be decided when running the ETC. Find readout patterns details in JDox.

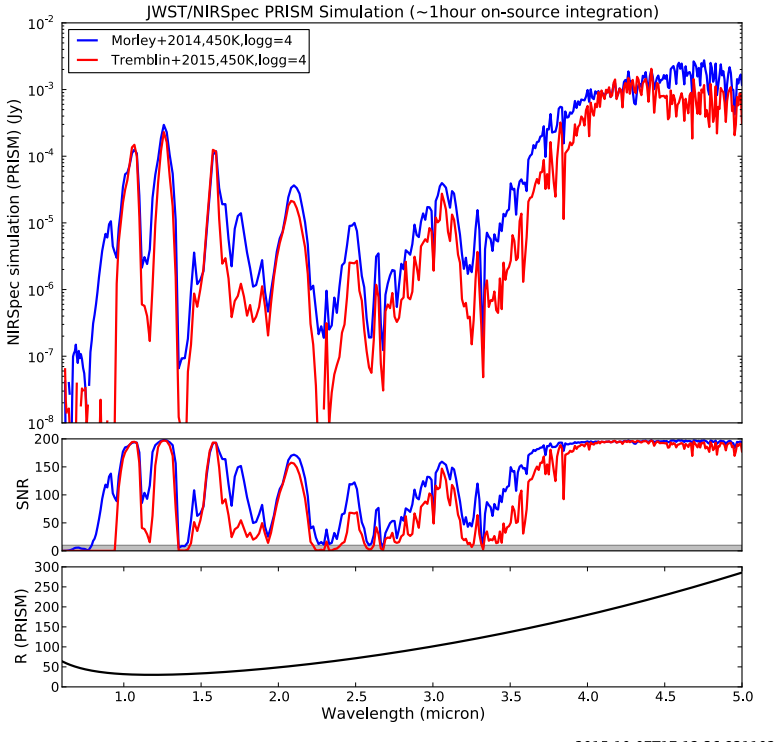


Instruments Configuration: Dispersers Selection

NIRSpec/**PRISM (0.6 to 5.3μm) data** gives access to several diagnostics that can constrain models that probe different:

- temperatures
- gravity
- degrees of turbulence
- in chemical equilibrium or with disequilibrium driven by vertical transport
- water clouds coverage

NIRSpec/**G395M (**2.87 to 5.27μm**) data** provides additional information in a region of the spectrum where the effect of water clouds is very pronounced and which contains the ammonia feature at 4.2μm which is sensitive to temperature



Slit

Target: WISE J035000.32-565830.2

Name: **WISE J035000.32-565830.2**

Coordinates: RA=03 50 00.328 Dec=-56 58 30.23

Magnitudes *(e.g.)*:

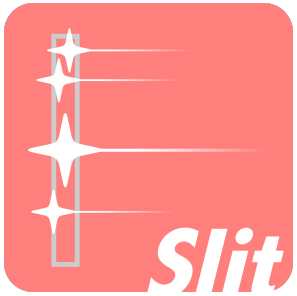
F140W= 22.30±0.20 mag (HST/WFC3)

W2=14.75±0.04 mag (WISE)

W3=12.33±0.28 mag (WISE)

Spectral type: Y1

Example model spectrum: exampleSpectrum_Morley+2014.txt



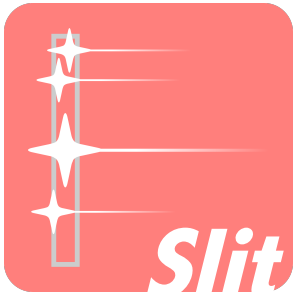
References: Kirkpatrick et al. 2012 (discovery), Leggett et al. 2015, Leggett et al. 2017, Morley et al 2014 (models: https://www.carolinemorley.com/models)

ESA Sky

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

Identify the science aperture (NIRSpec).

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



Visibility Tool

Target's visibility: Run the target visibility tool to find out when this target is visible and which orients will be available.

Use that information to check in ESA sky, or in Aladin/APT, that there are no other bright objects in the slit that could affect the observations.

Exposure Time Calculator

Requirements: S/N>25 at ~1micron using PRISM data

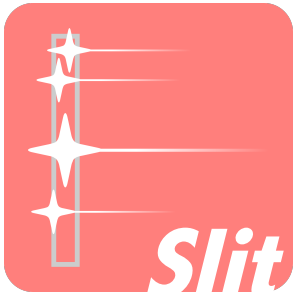
S/N>100 at ~4.7micron using G395M

Implementation: Set up a scene with the model provided as source,and normalize it using the magnitudes provided in this handout.

Setup a representative background by using the target's coordinates and an example date for the observations that you have previously derived from using the target visibility tool.

Derive Ngroups, Nints and Nexp necessary to achieve the above S/N. Choose an adequate detector readout mode. Consider which dither pattern will be used.

See next slide for some hints.



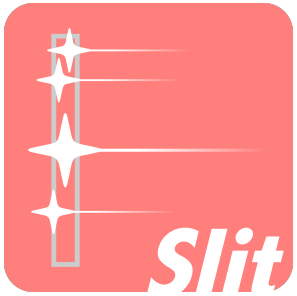
Exposure Time Calculator

Requirements: S/N>25 at ~1micron using PRISM data

S/N>100 at ~4.7micron using G395M

Hints:

- The Nexp. 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 exposures per pixel.
- For NIRSpec in general do not use integrations longer than ~1500 seconds, to avoid cosmic rays issues.
- Note that when setting up the detector with subarrays, the only readout patterns available are NRS and NRSRAPID.
  - In order to have both PRISM and G395M done in the same observation (only one target acquisition needed) the dither pattern in APT needs to be the same for PRISM and G395M.



Astronomer's Proposal Tool

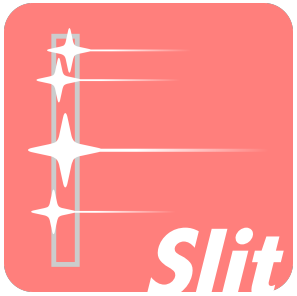
Target name: WISE J035000.32-565830.2

Target coordinates: RA=03 50 00.328 Dec=-56 58 30.23

Template:

NIRSpec fixed slit spectroscopy

Use NIRSpec in subarray mode and implement the ETC exposure time with the dither patterns available. Use both PRISM and G395M.



Astronomer's Proposal Tool

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

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 instrument footprints/ coverage/dithers. You can also play with the orientation.

Visit planner: Verify when the program can be scheduled.

Add-on: Try adding mid-IR spectroscopy (e.g., MIRI LRS) of the same target.