



ESAC 2017 JWST Workshop



TSO observations with NIRISS, NIRSpec and
MIRI

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Science Case #2.3



Overview



Goal: Obtain the transmission spectrum of the atmosphere of WASP-107b from 0.6 to 12 μm . WASP-107b is a bloated “Super-Neptune” with twice the mass of Neptune, but almost the radius of Jupiter. Desired spectral resolution of at least 300 for wavelengths $< 5 \mu\text{m}$ and at least 30 for $> 5 \mu\text{m}$.

Methodology: Perform time series observations of a transit of WASP-107b with NIRISS, NIRSpec and MIRI.





Target: WASP-107b



Target Info:

Host star:

T_{eff} : 4400 K

Metallicity: 0.0

Log g: 4.5

Apparent K mag: 8.6

Planet:

T_0 : 2457584.329897

Period: 5.7214742 days

Transit duration: 2.75 h

System Parameters of WASP-107

Parameter		References
Stellar Parameters		
T_{eff} (K)	4430 ± 120	A
log g (dex)	4.5 ± 0.1	A
[Fe/H] (dex)	$+0.02 \pm 0.10$	A
$v \sin i_*$ (km s ⁻¹)	2.5 ± 0.8	A
M_* (M_{\odot})	0.69 ± 0.05	A
R_* (R_{\odot})	0.66 ± 0.02	A
Apparent V mag	11.6	A
P_{rot} (days)	17.1 ± 1.0	A
u_1	0.6666 ± 0.0062	B
u_2	0.015 ± 0.011	B
Planetary Parameters		
P (days)	5.7214742 ± 0.0000043	B
T_c (BJD)	$2457584.329897 \pm 0.000032$	B
a/R_*	18.164 ± 0.037	B
a (au)	0.0558 ± 0.0018	B
R_p/R_*	0.14434 ± 0.00018	B
R_p (R_{Jup})	0.948 ± 0.030	B
M_p (M_{Jup})	0.12 ± 0.01	B
i ($^{\circ}$)	89.8 ± 0.2	B
$b \equiv a \cos i/R_*$	0.07 ± 0.07	B
e (assumed)	0	A

Anderson et al., 2017; Dai & Winn, 2017





Instrument Configurations



NIRISS: Single Object Slitless Spectroscopy (SOSS); 0.6 to 2.8 μm , $R \sim 700$

NIRSpec: Bright Object Time Series (BOTS) Spectroscopy with the wide aperture; 0.6 to 5.3 μm (PRISM, $R \sim 100$) or 0.7 to 5.2 μm in four bands (gratings, $R \sim 1000$ or 2700)

MIRI: Single Object Slitless Low Resolution Spectroscopy (LRS) with the PRISM; 5 – 12 μm , $R \sim 100$





Instrument Configurations



Setup: How to cover the full wavelength range most efficiently? What disperser/filter settings should be used? What readout modes/subarrays?

Look through the JDOx pages to find the wavelength ranges of the different instruments/modes available for TSO. Keep in mind source brightness limits.

Also, look at the different readout patterns available for JWST's instruments. For TSO, what readout patterns should be selected?

The number of groups/integration and integration/exposure will be decided when running the exposure time calculator(s).





Exposure Time Calculator



Requirements: Observe transits of WASP-107b to obtain the transmission spectrum of its atmosphere in the wavelength range from 0.6 to 12 μm .

Implementation: Depends on the chosen tool: The official ETC (Pandeia) or PandExo.

The ETC (<https://jwst.etc.stsci.edu>) is recommended for all “standard” JWST observations, especially for faint targets. All spectroscopic modes for all instruments supported. Has to specify all exposure parameters, gets SNR.

PandExo (<http://pandexo.science.psu.edu:1111>) offers an “automatic” mode to determine the suitable number of groups per integration without saturation. Specifically designed for simulating transit observations.

We will not use PandExo in this exercise, but it can be educational to try both.





Exposure Time Calculator



ETC (Pandeia) Implementation:

Set up a scene with a K6V star. Add observations with NIRISS, NIRSpec and MIRI. Select the chosen disperser/filter combinations for each instrument to cover the desired wavelength range.

With the selected subarray/readout mode, how many groups per integration can/should you use? Is some saturation at the end of the ramp at some wavelengths acceptable? What would be the potential benefit of that?

For the chosen number of groups/subarray/readout mode, how many integrations does one need to cover the event? This will be different for each instrument. What baseline (out of transit observation time) would you use?





Astronomer's Proposal Tool



Target Coordinates:

RA: 12:33:32.8480 DEC: -10 08 46.14 (can also use APT's look up feature)

Templates: NIRSpec BOTS, NIRISS SOSS, MIRI LRS TSO

For each instrument/mode:

- Pick a configuration (filter/disperser) configuration for this instrument that matches the goals.
- Select adequate subarray and readout mode and number of groups/integration and integrations/exposure based on the ETC/PandExo runs. Make sure to have enough “baseline” before and after the transits.





Astronomer's Proposal Tool



Target Acquisition:

Do you need to perform a target acquisition?

Special Requirements:

Do you need to impose some (scientifically justified) time constraints? In other words, does timing matter when scheduling the observations?

Visit planner:

Can the observations be scheduled? If so, when? How do you check?

Warnings or Errors:

Are there any warnings or errors in APT? Are these acceptable?

