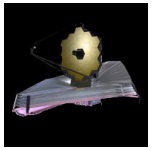

1366 - The Transiting Exoplanet Community Early Release Science Program

Cycle: 1, Proposal Category: ERS

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
Transmission - WASP-39b				
	1	NIRISS SOSS	NIRISS Single-Object Slitless Spectroscopy	(1) WASP-39
	2	NIRCam F322W2	NIRCam Grism Time Series	(1) WASP-39
	3	NIRSpec G395H	NIRSpec Bright Object Time Series	(1) WASP-39
	4	NIRSpec PRISM	NIRSpec Bright Object Time Series	(1) WASP-39
Phase Curve - WASP-43b				
	11	MIRI LRS Phase Curve	MIRI Low Resolution Spectroscopy	(2) WASP-43
Bright Object - WASP-18b				
	21	NIRISS SOSS Eclipse	NIRISS Single-Object Slitless Spectroscopy	(3) WASP-18

ABSTRACT

JWST presents the opportunity to transform our understanding of planets and the origins of life by revealing the atmospheric compositions, structures, and dynamics of transiting exoplanets in unprecedented detail. However, the high-precision, time-series observations required for such investigations have unique technical challenges, and our prior experience with HST, Spitzer, and Kepler indicates that there will be a steep learning curve when JWST becomes operational.

We propose an ERS program to accelerate the acquisition and diffusion of technical expertise for transiting exoplanet observations with JWST. This program will also provide a compelling set of representative datasets, which will enable immediate scientific breakthroughs. We will exercise the time-series modes of all four instruments that have been identified as the consensus highest priority by the community, observe the full suite of transiting planet characterization geometries (transits, eclipses, and phase curves), and target planets with host stars that span an illustrative range of

brightnesses. The proposed observations were defined through an inclusive and transparent process that had participation from JWST instrument experts and international leaders in transiting exoplanet studies. The targets have been vetted with previous measurements, will be observable early in the mission, and have exceptional scientific merit. We will engage the community with a two-phase Data Challenge that culminates with the delivery of planetary spectra, time-series instrument performance reports, and open-source data analysis toolkits.

Co-PIs: Natalie Batalha, Jacob Bean, & Kevin Stevenson
NOI reference number: 179

OBSERVING DESCRIPTION

As laid out more fully in the following sections, observations of the atmospheres of transiting exoplanets should be a major component of the JWST mission. However, as high-contrast targets, they pose one of the greatest observational challenges in modern astronomy. We will perform time-series observations of three exoplanets to address the most pressing technical issues in this area: characterization of instrument systematics on the variety of timescales relevant for transiting planet observations, cross-checking and validation of instrument performance at overlapping wavelengths, and identification of instrumental noise floors. To achieve this, the proposed program uses three modes of exoplanet characterization, including:

1) Transit observations of WASP-39b using all three NIR instruments and four unique modes that yield overlapping wavelength coverage,
2) A single phase curve observation of WASP-43b using MIRI/LRS, and
3) A secondary eclipse observation using NIRISS/SOSS of WASP-18b, whose host star is bright.

The fundamental parameter that determines the length of our time-series observations is the transit duration. Additionally, for each visit, we will require a few hours of baseline both before and after the transit to identify and effectively model any instrument systematics. Such systematics typically introduce red noise, which can occur on varying timescales and requires longer observational baselines to identify, characterize, and remove. We compute the exposure times and signal-to-noise ratio (SNR) for each observation based on the JWST ETC and PandExo estimates. We require a total of 80.4 hours (including overheads) for the given primary targets, but request some flexibility (either more or less time) should a delay in the launch schedule require that alternative targets be selected. Below we describe the technical details of each observation. We have vetted all primary and alternative targets with the available target overlap tools to minimize contamination from nearby stars.

1) Four primary transit observations of WASP-39b using NIRISS/SOSS, NIRCam/F322W2, NIRSpec/G395H, and NIRSpec/PRISM:

The NIRISS/SOSS observations use the GR700XD grism (in combination with a clear filter) to obtain spectroscopy from 0.6-2.8 microns. Since our primary target has a Kmag of 10.2, we will use the “nominal” SUBSTRIP256 subarray, which is 256x2048 pixels, to acquire both 1st and 2nd

orders simultaneously. With 9 groups per integration (49.5 sec) and 538 integrations per exposure, we will achieve a total exposure time of 8.25 hours at ~80% of saturation. The total science time is 7.4 hours, marking a 90% observation efficiency. Target acquisition (TA) for SOSS is performed using the 64x64 subarray centered on the “sweet spot” using the F480M filter. Using 13 groups and the SOSS Faint TA mode, we will achieve a SNR of >100 on our target (minimum SNR of 20 is required for all TA). We will also acquire 3 integrations using the F277W filter to isolate the 1st spectral order in the wavelength interval 2.4–2.8 m, where the 1st and 2nd orders overlap in the standard GR700XD/CLEAR exposure.

The NIRCam observations will use the grism time-series observing mode with the F322W2 filter (2.4-4.0 microns). In this mode, the Module A Grism R is used to disperse the target spectrum across 2048 pixel columns. We will use the SUBGRISM256 subarray mode with 4 output amplifiers and the BRIGHT2 readout pattern. With 30 groups per integration (82 sec), we require 361 integrations for a 8.25 hour exposure. The observation efficiency is 98%. We will position the target at one of the defined field points on the detector to obtain the full wavelength coverage within the subarray. We will use 17 groups in the SUB32 subarray to perform target acquisition and achieve a SNR of >100 on our target.

The NIRSpec observations are conducted in BOTS (Bright Object Time Series) mode, which requires the S1600A1 aperture with a fixed 1.6"x1.6" field of view (FoV). The first exposure will use the PRISM mode (0.6–5.0 microns) and SUB512 subarray with 5 groups per integration (1.4 sec) and 21530 integrations total. Although this number of groups will saturate 64 pixels (28 of which saturate at the end of the first group), we can still achieve our program goals. The second exposure will use the G395H+F290LP combination (2.87-5.27 microns) and SUB2048 subarray with 87 groups per integration (79.4 sec) and 374 integrations total. Each 8.25-hour observation is designed to stay below 80% of saturation. For target acquisition, we will utilize the Wide Aperture Target Acquisition (WATA) mode on WASP-39 with the F110W filter. The center pixel saturates, but precise centroiding should still be feasible.

Our primary target, WASP-39b, transits its host star in 2.8 hours. We require ~2 hours of baseline both before and after the transit to identify and correct the systematics plus 60 minutes to account for the JWST observation start window. Including overheads, we require 10.5 hours of telescope time per visit, or 42 hours for all four visits. Alternative targets for this program include WASP-43b and WASP-62b.

2) A single phase curve observation of WASP-43b using MIRI/LRS:

It is imperative that the phase curve observation be completed in a single visit to understand the long-term stability of the instrument. We must cover the full phase curve, commencing shortly before secondary eclipse and ending shortly after the following secondary eclipse, in order to mitigate degeneracies between the planetary signal, multi-timescale instrument systematics, and long-timescale (~1 day) stellar brightness variations.

Implementing multiple visits is inefficient due to significant overhead for time series observations, and would compromise the removal of expected systematics.

MIRI spectroscopic time-series observations use the LRS SLITLESSPRISM mode without dithers. This yields 5-12 micron spectra with resolving power of R=40-160. This slitless mode is recommended for time-series observations since minor pointing instabilities would otherwise result in a time-dependent systematic in the measured flux that would be degenerate with our astrophysical signal. We will obtain three 8.2-hour exposures so as to not exceed the maximum number of frames per exposure. Each exposure consists of 2865 integrations and each 10.3-sec integration consists of 65 groups, leaving us well below the saturation limit of the detector (~60%). The long duration of this visit will provide an excellent opportunity to test persistence and detector stability over day-long timescales, understand the repeatability of high gain antenna moves (which occur every 10,000 seconds), and mitigate their impact on time-series observations. We select the F1500W for target acquisition. This filter is adjacent to the LRS prism in the filter wheel; therefore, the star will not irradiate the detector through intermediate filters as the wheel rotates into position. Using 6 groups yields sufficient SNR (~537) to perform successful TA without causing a bright persistent image.

The period of WASP-43b is 19.52 hours. To this we add 1.16 hours to cover the duration of the second secondary eclipse and four hours of baseline (2.25+/-0.5 hours before the first eclipse and 1.75+/-0.5 hours after the second) to adequately measure the anticipated systematics while accounting for the 1 hour observation start window. This results in a total of 24.7 hours of science/exposure time (>99% efficient), or 29.5 hours when including overheads. Alternative targets for this program include WASP-103b and KELT-16b.

3) A secondary eclipse observation of WASP-18b using NIRISS/SOSS:

This NIRISS/SOSS observation is similar to that described above for WASP-39b, with the following exceptions. We will use the SUBSTRIP96 mode (96x2048 pixels) to avoid saturating our K=8.1 primary target. This slightly reduces our wavelength coverage to 0.85-2.8 microns. With 4 groups per integration (11.1 sec) and 2172 integrations per exposure, we will achieve a total exposure time of 6.68 hours at ~80% of saturation (5% non-linearity) for the most illuminated pixels. For target acquisition, we will achieve a SNR of ~77 using 19 groups in the SOSS Bright mode. Alternative targets for this program include WASP-38b and KELT-7b.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-39	RA: 14 29 18.3955 (217.3266479d) Dec: -03 26 40.20 (-3.44450d) Equinox: J2000	Proper Motion RA: -0.0012724988124342739 sec of time/yr Proper Motion Dec: 3.45E-4 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanet Systems]*				
(2)	WASP-43	RA: 10 19 37.9649 (154.9081871d) Dec: -09 48 23.19 (-9.80644d) Equinox: J2000	Proper Motion RA: -0.002840976884844842 sec of time/yr Proper Motion Dec: -0.038003999998181826 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanet Systems]*				
(3)	WASP-18	RA: 01 37 25.0708 (24.3544617d) Dec: -45 40 40.06 (-45.67779d) Equinox: J2000	Proper Motion RA: 0.002408593746637531 sec of time/yr Proper Motion Dec: 0.020597 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanet Systems]*				

Observation

Proposal 1366, Observation 1: NIRISS SOSS

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS SOSS (Obs 1)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-39	RA: 14 29 18.3955 (217.3266479d) Dec: -03 26 40.20 (-3.44450d) Equinox: J2000	Proper Motion RA: -0.0012724988124342739 sec of time/yr Proper Motion Dec: 3.45E-4 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SOSSFAINT	F480M	NISRAPID	13	1	1	0.657	114814

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	9	537	1	537	29513.778	114814
2	NISRAPID	9	10	1	10	549.605	

Special Requirements

Phase 0.95248 to 0.96275 with period 4.05527999 Days and zero-phase 2457792.356338 HJD
Aperture PA Range 95 to 106 Degrees (V3 94.43873283 to 105.43873283)
Aperture PA Range 123 to 130 Degrees (V3 122.43873283 to 129.43873283)
Time Series Observation
No Parallel Attachments

Observation

Proposal 1366, Observation 2: NIRCam F322W2

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRCam Grism Time Series

Diagnostics

(NIRCam F322W2 (Obs 2)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-39	RA: 14 29 18.3955 (217.3266479d) Dec: -03 26 40.20 (-3.44450d) Equinox: J2000	Proper Motion RA: -0.0012724988124342739 sec of time/yr Proper Motion Dec: 3.45E-4 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SUB32TATSGRISM	F335M	RAPID	17	1	1	0.272	114814

Template

Subarray	No. of Output Channels	SW Channel Mode
SUBGRISM256	4	IMAGING

Spectral Elements

#	Short Pupil+Filter	Long Pupil+Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	WLP8+F210M	GRISMR+F322W2	SHALLOW4	12	366	1	366	29580.808	114814

Special Requirements

Phase 0.95248 to 0.96275 with period 4.05527999 Days and zero-phase 2457792.356338 HJD
Aperture PA Range 100 to 109 Degrees (V3 99.75663934 to 108.75663934)
Aperture PA Range 117 to 130 Degrees (V3 116.75663934 to 129.75663934)
Time Series Observation
No Parallel Attachments

Observation

Proposal 1366, Observation 3: NIRSpec G395H

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(NIRSpec G395H (Obs 3)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-39	RA: 14 29 18.3955 (217.3266479d) Dec: -03 26 40.20 (-3.44450d) Equinox: J2000	Proper Motion RA: -0.0012724988124342739 sec of time/yr Proper Motion Dec: 3.45E-4 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 WASP-39	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	114814

Template

Subarray
SUB2048

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSRAPID	70	465	1	1	465	29789.053	114814

Special Requirements

Phase 0.95248 to 0.96275 with period 4.05527999 Days and zero-phase 2457792.356338 HJD
Aperture PA Range 200 to 300 Degrees (V3 61.14704895 to 161.14704895)
Time Series Observation
No Parallel Attachments

Observation

Proposal 1366, Observation 4: NIRSpec PRISM

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(NIRSpec PRISM (Obs 4)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WASP-39	RA: 14 29 18.3955 (217.3266479d) Dec: -03 26 40.20 (-3.44450d) Equinox: J2000	Proper Motion RA: -0.0012724988124342739 sec of time/yr Proper Motion Dec: 3.45E-4 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 WASP-39	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	114814

Template

Subarray
SUB512

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	PRISM/CLEAR	NRSRAPID	5	21500	1	1	21500	29614.96	114814

Special Requirements

Phase 0.95248 to 0.96275 with period 4.05527999 Days and zero-phase 2457792.356338 HJD
Aperture PA Range 200 to 300 Degrees (V3 61.14704895 to 161.14704895)
Time Series Observation
No Parallel Attachments

Observation

Proposal 1366, Observation 11: MIRI LRS Phase Curve

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: Doubled WASP-43b's period, halved its phase range in the MIRI Special Requirements

Diagnostics

(MIRI LRS Phase Curve (Obs 11)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 11:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(MIRI LRS Phase Curve (Obs 11)) Informational (Form): Permission has not been granted for this program to use Special Requirement 'No Parallel Attachments'.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WASP-43	RA: 10 19 37.9649 (154.9081871d) Dec: -09 48 23.19 (-9.80644d) Equinox: J2000	Proper Motion RA: -0.002840976884844842 sec of time/yr Proper Motion Dec: -0.038003999998181826 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 WASP-43	F1500W	FAST	6	1	1	0.954	25034

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset
1	NONE				

Pointing Verification

#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
1	FASTR1	6	1	1	1	1	0.954		F1500W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	64	3072	9216	3	1	95270.844	25034

Special Requirements

Before Date 11-DEC-2022:00:00:00
Phase 0.13912 to 0.16473 with period 1.62694828 Days and zero-phase 2456047.051715 HJD
Aperture PA Range 75 to 125 Degrees (V3 70.16455103 to 120.16455103)
Aperture PA Range 275 to 325 Degrees (V3 270.16455103 to 320.16455103)
Time Series Observation
No Parallel Attachments
No Parallel Attachments

Observation

Proposal 1366, Observation 21: NIRISS SOSS Eclipse

Tue Aug 05 22:00:14 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS SOSS Eclipse (Obs 21)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 21:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	WASP-18	RA: 01 37 25.0708 (24.3544617d) Dec: -45 40 40.06 (-45.67779d) Equinox: J2000	Proper Motion RA: 0.002408593746637531 sec of time/yr Proper Motion Dec: 0.020597 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems]

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SOSSBRIGHT	F480M	NISRAPID	19	1	1	0.93	103439

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP96	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	3	2720	1	2720	24144.026	103439
2	NISRAPID	3	15	1	15	133.147	103439

Special Requirements

Phase 0.32450 to 0.36875 with period 0.941452540 Days and zero-phase 2455562.110070 HJD
Aperture PA Range 40 to 62 Degrees (V3 39.43873283 to 61.43873283)
Aperture PA Range 270 to 320 Degrees (V3 269.43873283 to 319.43873283)
Aperture PA Range 340 to 5 Degrees (V3 339.43873283 to 4.43873283)
Time Series Observation
No Parallel Attachments