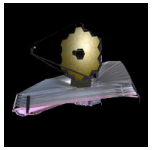

2420 - Probing the Terrestrial Planet TRAPPIST-1c for the Presence of an Atmosphere

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Annabella Meech (PI)	**Smithsonian Institution Astrophysical Observatory**
Prof. Lars A. Buchhave (CoI) (ESA Member)	Technical University of Denmark-DTU Space
Dr. Nestor Espinoza (CoI)	Space Telescope Science Institute
Dr. Mercedes Lopez-Morales (CoI)	Space Telescope Science Institute
Dr. Neale Gibson (CoI) (ESA Member)	Trinity College Dublin
Dr. Jens Hoeijmakers (CoI) (ESA Member)	Lund University
Dr. Joao Manuel Mendonca (CoI) (ESA Member)	University of Southampton
Dr. Aaron Bello-Arufe (CoI)	Jet Propulsion Laboratory
Andrea Guzman Mesa (CoI) (ESA Member)	University of Bern
Dr. Daniel Kitzmann (CoI) (ESA Member)	University of Bern
Chloe Fisher (CoI) (ESA Member)	University of Oxford
Prof. Kevin Heng (CoI) (ESA Member)	Ludwig Maximilian Universitat of Munich
Prof. Adam J. Burgasser (CoI)	University of California - San Diego
Thea Kozakis (CoI) (ESA Member)	Technical University of Denmark-DTU Space
Dr. Hannah Diamond-Lowe (CoI)	Space Telescope Science Institute
Dr. Brett M. Morris (CoI)	Space Telescope Science Institute
Dr. Matthew Hooton (CoI) (ESA Member)	University of Cambridge
Dr. Iouli Gordon (CoI) (US Admin CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Alexander Rathcke (CoI) (ESA Member)	

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Transit observations				
	1	Transit 1	NIRSpec Bright Object Time Series	(1) TRAPPIST-1
	2	Transit 2	NIRSpec Bright Object Time Series	(1) TRAPPIST-1
	5	Transit 2-WOPR COPY	NIRSpec Bright Object Time Series	(1) TRAPPIST-1
	3	Transit 3	NIRSpec Bright Object Time Series	(1) TRAPPIST-1
	4	Transit 4	NIRSpec Bright Object Time Series	(1) TRAPPIST-1

ABSTRACT

Since the discovery of the first exoplanets, a prime aspiration has been characterization of planets akin to our own Earth. JWST will, for the first time, enable observations of the atmospheres of terrestrial planets, allowing us to understand the nature and diversity and ultimately the habitability of Earth-like worlds. Facilitated by the broad spectral coverage of the NIRSpec Prism, we propose to characterize the atmosphere of the terrestrial-sized exoplanet TRAPPIST-1c, which is one of the most favorable such targets due to its significant transit depth and proximity to Earth. The seven terrestrial planets in the TRAPPIST-1 system receive between 0.1 to 4 times the irradiation of Earth and thus form a unique natural laboratory for testing and understanding planetary environments, their composition and their habitability. Planets b, d, e, and f are part of GTO programs and observations of planet c will thus allow comparative atmospheric characterization of all the inner planets in the TRAPPIST-1 system. Our program will enable the detection of the most probable types of clear atmospheres for TRAPPIST-1c, and its atmospheric constituents. Distinguishing between a cloudy/hazy atmosphere and no atmosphere is extremely challenging for any terrestrial planet, including planet c, and will require occupying JWST for close to 100 hours. We submit that the most fruitful use of JWST will be to reveal the clear-atmosphere Earth-like planets early, using short visits like this proposal, enabling ground-breaking exhaustive characterization of the most favorable Earth-like planets with clear atmospheres before the end of JWST’s lifetime.

OBSERVING DESCRIPTION

We will observe four primary transits of the terrestrial planet TRAPPIST-1c (R = 1.1 R_earth, M = 1.3 M_earth). We plan to carry out these observations with NIRSpec Prism, utilizing the S1600A1 slit, with the SUB512s subarray, and with the NRSRAPID readout pattern. As no enchanced readout patterns are enabled in cycle 1, we maximize our signal-to-noise by setting Exp/Dith = 1, Groups/Int = 3, and Integrations/Exp = 27459 during each of the four transit events. This leads to a total exposure time of 16369.957 per visit. As recommended, this total exposure time reflects 0.75hr of detector settling, 1hr timing window, 1hr of pre-transit baseline, 0.7hr transit duration and 1hr of post-transit baseline. The observations needs to be timed with the transit of TRAPPIST-1c (P = 2.4 days). The TRAPPIST-1 system resides near the ecliptic and are thus only

observable in two visibility windows per year, totalling approximately 100 days/year. This yields 45 opportunities to observe the planet during transit in cycle 1.

Proposal 2420 - Targets - Probing the Terrestrial Planet TRAPPIST-1c for the Presence of an Atmosphere

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Observation

Proposal 2420, Observation 1: Transit 1

Tue Aug 05 15:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Transit 1 (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)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	64203

Template

Subarray
SUB512S

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	3	27459	1	1	27459	16369.957	64190

Special Requirements

Phase 0.9466115358436333 to 0.9638164161750331 with period 2.42179346 Days and zero-phase 2457282.810578842 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 2420, Observation 2: Transit 2

Tue Aug 05 15:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Transit 2 (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)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	64203

Template

Subarray
SUB512S

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	6	15925	1	1	15925	16369.626	64190

Special Requirements

Phase 0.9466115358436333 to 0.9638164161750331 with period 2.42179346 Days and zero-phase 2457282.810578842 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 2420, Observation 5: Transit 2-WOPR COPY Tue Aug 05 15:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: WOPR copy of visit 2:!

Diagnostics

(Transit 2-WOPR COPY (Obs 5)) 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 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	64203

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	6	10208	1	1	10208	16369.549	64190

Special Requirements

Between Dates 09-JUL-2024:18:25:00 and 09-JUL-2024:19:25:01
Time Series Observation
No Parallel Attachments

Observation

Proposal 2420, Observation 3: Transit 3

Tue Aug 05 15:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Transit 3 (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)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	64203

Template

Subarray
SUB512S

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	6	15925	1	1	15925	16369.626	64190

Special Requirements

Phase 0.9466115358436333 to 0.9638164161750331 with period 2.42179346 Days and zero-phase 2457282.810578842 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 2420, Observation 4: Transit 4

Tue Aug 05 15:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Transit 4 (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)	TRAPPIST-1	RA: 23 06 30.3341 (346.6263921d) Dec: -05 02 36.46 (-5.04346d) Equinox: J2000	Proper Motion RA: 0.062299806210057845 sec of time/yr Proper Motion Dec: -0.479402999985723 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[M dwarfs]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	64203

Template

Subarray
SUB512S

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	6	15925	1	1	15925	16369.626	64190

Special Requirements

Phase 0.9466115358436333 to 0.9638164161750331 with period 2.42179346 Days and zero-phase 2457282.810578842 HJD
Time Series Observation
No Parallel Attachments