16700 - Transit Spectroscopy in the Lyman alpha Line Core with a High Velocity Star: A New Window into Atmospheric Escape

Cycle: 29, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Allison Youngblood (PI) (Contact)	**NASA Goddard Space Flight Center**
Dr. Eric David Lopez (CoI)	NASA Goddard Space Flight Center
Prof. Kevin France (CoI)	University of Colorado at Boulder
Dr. Jennifer Burt (CoI)	Jet Propulsion Laboratory
Ethan Kruse (CoI)	NASA Goddard Space Flight Center
Veselin Kostov (CoI)	NASA Goddard Space Flight Center
Dr. Antonio Garcia Munoz (CoI) (ESA Member)	CEA, Universite Paris-Saclay

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) L-248-27 WAVE	STIS/CCD STIS/FUV-MAMA	5	15-Nov-2023 14:00:17.0	yes
02	(1) L-248-27 WAVE	STIS/CCD STIS/FUV-MAMA	1	15-Nov-2023 14:00:18.0	yes
03	(1) L-248-27 WAVE	STIS/CCD STIS/FUV-MAMA	1	15-Nov-2023 14:00:18.0	yes

7 Total Orbits Used

ABSTRACT

H I Lyman alpha, the most sensitive probe of exoplanet upper atmospheres and escaping material, is generally unable to probe material bound to or weakly escaping from a planet because of severe attenuation from the interstellar medium in the line core. This attenuation hinders our understanding of atmospheric escape, a process likely responsible for shaping the demographics of close-in exoplanets that we observe today, as well as properties of individual exoplanets including habitability. The newly discovered warm Neptune TOI-1231b will allow us to probe the exosphere region where planetary winds are launched due to a unique property of its host star. The host star's radial velocity (+70.5 km/s) Doppler shifts the star's Lyman alpha emission and the planet's Lyman alpha absorbers out of the 100% ISM attenuation zone allowing us to see the stellar line core and use it as a backlight for transit observations. The proposed STIS transit observation of TOI-1231b will be a novel dataset on which to test the validity of hydrodynamic escape models, a set of assumptions at the underpinning of all interpretations of all Lyman alpha transit detections to date.

OBSERVING DESCRIPTION

We will observe a transit TOI-1231b with a single visit of five consecutive orbits. To capture Lyman alpha (1216 Ang), we will use STIS G140M with the 52"x0.1" slit and 1222 cenwave. Time-tag mode will be used to model and remove the STIS breathing effect and remove any flares from the data. We select wavecal=no to increase the duty cycle of the STIS observations, and we add a wavelength calibration exposure during the Earth occultation at the end of each orbit.

The transit duration of TOI-1231b is 3.3 +/- 0.04 hours (approx. 2 orbits), and we have setup the visit timing requirements to achieve a visit setup of 2 orbits pre-transit, 2 orbits in-transit, and 1 orbit post-transit. We have also limited the time of year to between Jan 31 and Dec 3 (any year) to prevent the airglow emission from coinciding with the spectral region of interest.

Visit

Proposal 16700, Visit 01, failed

Wed Nov 15 19:00:19 GMT 2023

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 29-JUL-2021:00:00:00 AND 03-DEC-2021:00:00:00; BETWEEN 31-JAN-2022:00:00:00 AND 03-DEC-2022:00:00:00; BETWEEN 31-JAN-2023:00:00:00 AND 03-DEC-2023:00:00:00; Period 24.245586 D AND ZERO-PHASE HJD2458563.88839

Diagnostics

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

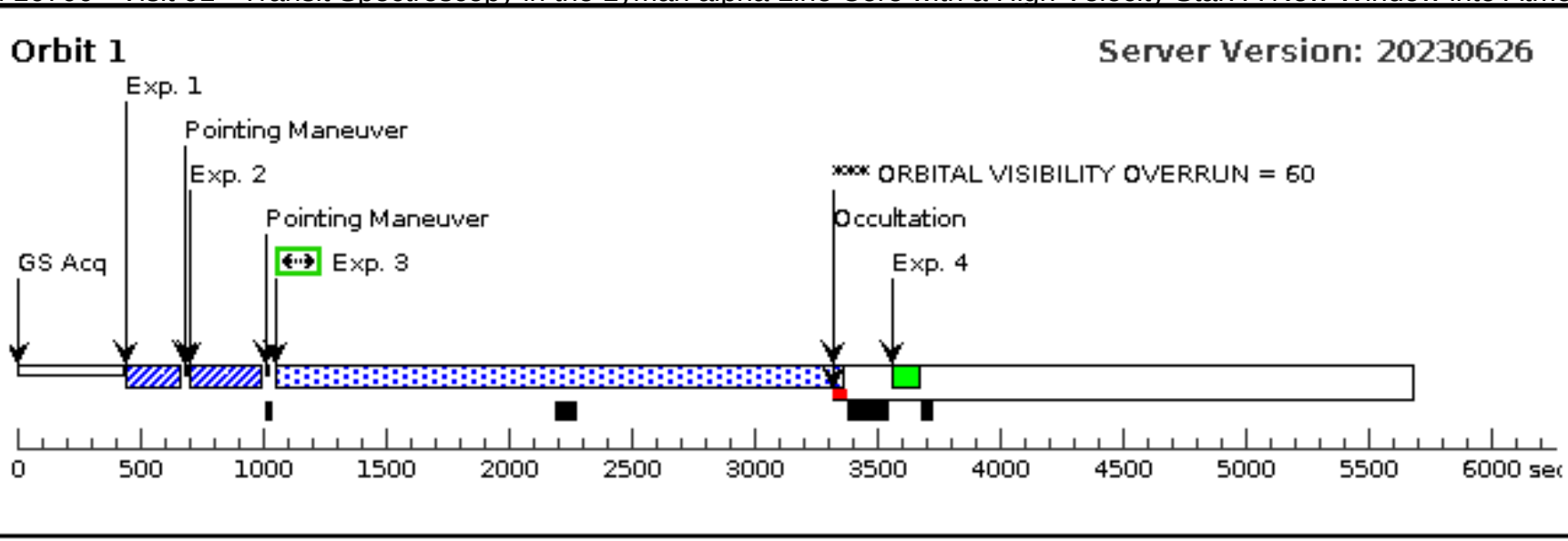
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	L-248-27 Alt Name1: TOI-1231	RA: 10 26 59.3375 (156.7472396d) Dec: -52 28 4.16 (-52.46782d) Equinox: J2000	Proper Motion RA: -89.39406558542368 mas/yr Proper Motion Dec: 361.546043558718 mas/yr Parallax: 0.03638958468" Epoch of Position: 2016	V=12.302	Reference Frame: ICRS

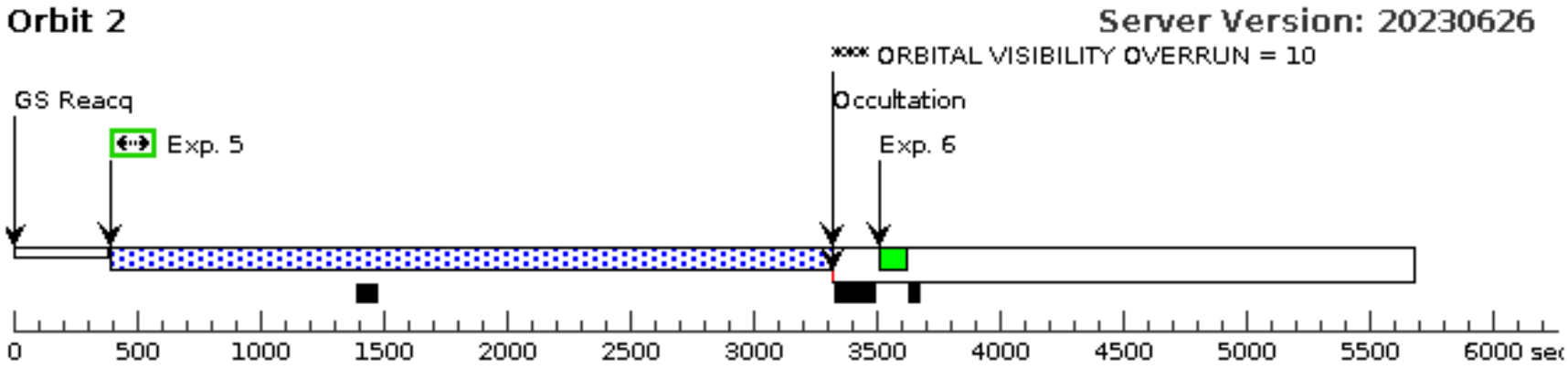
Comments: Coordinates from Gaia EDR3. In order to ensure that the airglow does not overlap with the spectral region of interest, Hubble must not observe this target between Dec 03 and Jan 30 (any year).
Category=STAR
Description=[EXTRA-SOLAR PLANET, EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

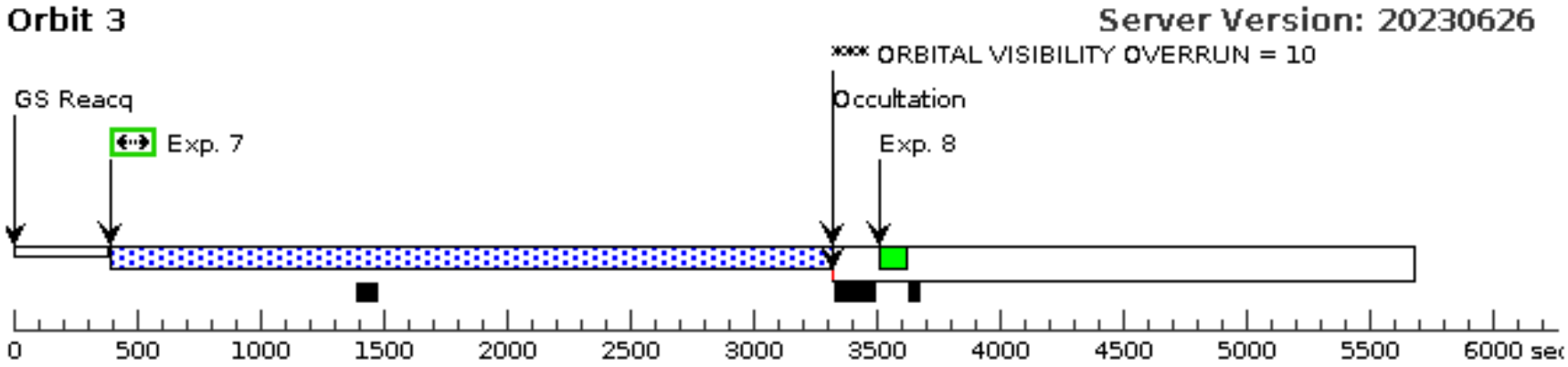
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1523734)	(1) L-248-27	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	PHASE 0.9923 TO 0.9958; GS ACQ SCENARIO BASE1BE	Sequence 1-4 Non-Int in Visit 01	0.1 Secs (0.1 Secs) *[==>]*	*[1]*
2	(STIS.ta.1524223)	(1) L-248-27	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR			Sequence 1-4 Non-Int in Visit 01	0.5 Secs (0.5 Secs) *[==>]*	*[1]*
3	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO		Sequence 1-4 Non-Int in Visit 01	2161 Secs (2161 Secs) *[==>]*	*[1]*
Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.									
4		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A			Sequence 1-4 Non-Int in Visit 01	*[==>]*	*[1]*
5	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO		Sequence 5-6 Non-Int in Visit 01	2911 Secs (2911 Secs) *[==>]*	*[2]*
Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.									
6		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A			Sequence 5-6 Non-Int in Visit 01	*[==>]*	*[2]*
7	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO		Sequence 7-8 Non-Int in Visit 01	2911 Secs (2911 Secs) *[==>]*	*[3]*
Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.									
8		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A			Sequence 7-8 Non-Int in Visit 01	*[==>]*	*[3]*
9	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO		Sequence 9-10 Non-Int in Visit 01	2911 Secs (2911 Secs) *[==>]*	*[4]*
Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.									
10		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A			Sequence 9-10 Non-Int in Visit 01	*[==>]*	*[4]*
11	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO		Sequence 11-12 Non-Int in Visit 01	2911 Secs (2911 Secs) *[==>]*	*[5]*
Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.									
12		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A			Sequence 11-12 Non-Int in Visit 01	*[==>]*	*[5]*

Orbit Structure



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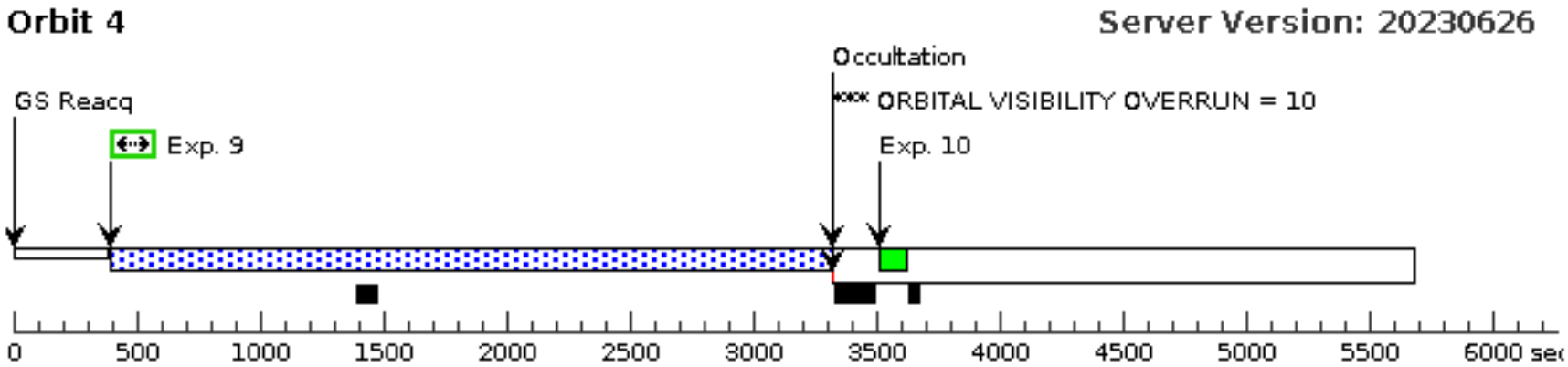
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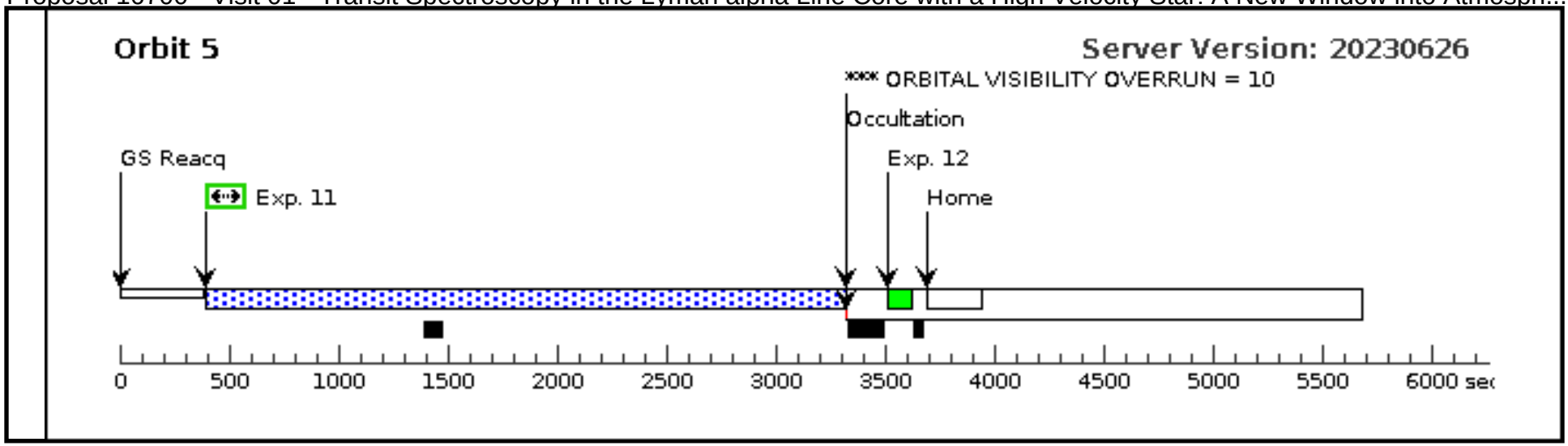
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Server Version: 20230626
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GS Reacq
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Exp. 12
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6000 sec

Visit

Proposal 16700, Visit 02, failed Wed Nov 15 19:00:19 GMT 2023

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 31-JAN-2023 AND 03-DEC-2023; BETWEEN 31-JAN-2024 AND 03-DEC-2024; BETWEEN 31-JAN-2025 AND 03-DEC-2025; Period 24.245586 D AND ZERO-PHASE HJD2458563.88839

Fixed Targets

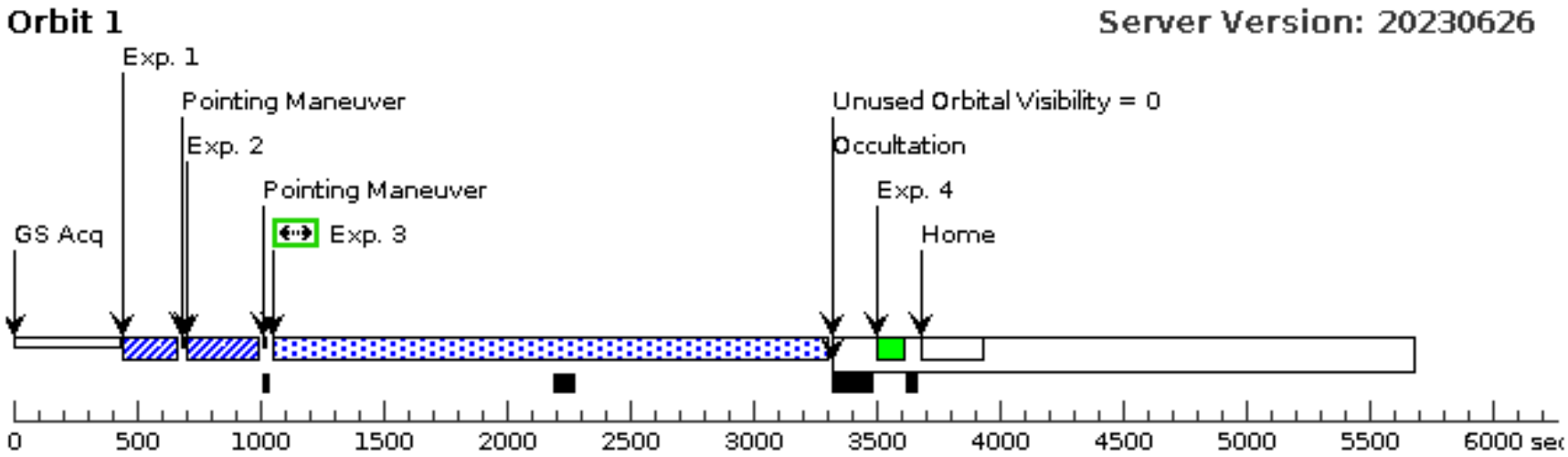
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	L-248-27 Alt Name1: TOI-1231	RA: 10 26 59.3375 (156.7472396d) Dec: -52 28 4.16 (-52.46782d) Equinox: J2000	Proper Motion RA: -89.39406558542368 mas/yr Proper Motion Dec: 361.546043558718 mas/yr Parallax: 0.03638958468" Epoch of Position: 2016	V=12.302	Reference Frame: ICRS

Comments: Coordinates from Gaia EDR3. In order to ensure that the airglow does not overlap with the spectral region of interest, Hubble must not observe this target between Dec 03 and Jan 30 (any year).
Category=STAR
Description=[EXTRA-SOLAR PLANET, EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1523734)	(1) L-248-27	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	PHASE 0.0086 TO 0.9914; GS ACQ SCENARIO BASE1BE		0.1 Secs (0.1 Secs) *[==>]*	*[1]*
2	(STIS.ta.1524223)	(1) L-248-27	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.5 Secs (0.5 Secs) *[==>]*	*[1]*
3	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO			2101 Secs (2101 Secs) *[==>]*	*[1]*
	Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.								
4		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A				*[==>]*	*[1]*

Orbit Structure



Visit

Proposal 16700, Visit 03 Wed Nov 15 19:00:19 GMT 2023

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: BETWEEN 31-JAN-2023 AND 03-DEC-2023; BETWEEN 31-JAN-2024 AND 03-DEC-2024; BETWEEN 31-JAN-2025 AND 03-DEC-2025; Period 24.245586 D AND ZERO-PHASE HJD2458563.88839

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
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Category=STAR
Description=[EXTRA-SOLAR PLANET, EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1523734)	(1) L-248-27	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	PHASE 0.0086 TO 0.9914; GS ACQ SCENARIO BASE1BE		0.1 Secs (0.1 Secs) *[==>]*	*[1]*
2	(STIS.ta.1524223)	(1) L-248-27	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.5 Secs (0.5 Secs) *[==>]*	*[1]*
3	(STIS.sp.1523742)	(1) L-248-27	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=1000; WAVECAL=NO			2101 Secs (2101 Secs) *[==>]*	*[1]*
	Comments: See STIS.sp.1479879, STIS.sp.1479877, and STIS.sp.1479876 for our ETCs with realistic estimates of the Lyman alpha emission in-transit and out-of-transit.								
4		WAVE	STIS/FUV-MAMA, ACCUM, 52X0.1	G140M 1222 A				*[==>]*	*[1]*

Orbit Structure