15704 - A First Opportunity to Test Models of Atmospheric Escape for a Terrestrial Exoplanet

Cycle: 26, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) L-119-213	COS/FUV COS/NUV	3	16-Apr-2019 17:00:48.0	yes
02	(1) L-119-213	COS/FUV COS/NUV	3	16-Apr-2019 17:00:49.0	yes
03	(1) L-119-213	COS/FUV COS/NUV	4	16-Apr-2019 17:00:50.0	yes

10 Total Orbits Used

ABSTRACT

The recently discovered strongly irradiated terrestrial exoplanet LHS3844b presents a first opportunity to understand the impact of the UV environment produced by an M dwarf star on planetary atmospheric escape processes. Astronomers were recently awarded 100 hours with Spitzer to measure the infrared phase curve of LHS 3844b and determine if this planet has retained an atmosphere. Whether we learn that the planet has retained or lost its atmosphere, we argue that it essential to constrain the UV spectrum of its host star, LHS 3844, which in turn will allow us to test models of UV-driven hydrodynamic escape. Due to the faintness of LHS 3844, it would be prohibitive to directly observe the UV spectrum to high precision over the full wavelength range. Instead, we propose to leverage the results of the MUSCLES treasury program and use line-to-line emission correlations in order to obtain a robust estimate of the UV spectrum of LHS 3844 from only 10 spacecraft orbits.

OBSERVING DESCRIPTION

We will use HST/COS to observe the full UV spectrum, from 1150-3200A, of LHS 3844, an M4.5 star at a distance of 14.9 pc (M = 0.151 Solar masses, R = 0.189 Solar radii). All data will be obtained in TIME-TAG mode so that we monitor the star's activity during the exposures, which we can compare to previous flare frequency distributions for M dwarfs derived from other HST/COS spectra (Loyd et al., 2018). We will use the FLASH=YES setting to maximize exposure time on target. We vary FP-POS as much as possible for the gratings we use.

We base our COS observing strategy on the successful MUSCLES (GO Program 13650) and Mega-MUSCLES (GO Program 15071) surveys. We scaled the MUSCLES HST/COS data of the mid-M dwarf GJ 1214 to the distance and stellar radius of LHS 3844, and used this scaled data as an input to the Space Telescope Science Institute exposure time calculator (ETC) for COS. Given that LHS 3844 has H-alpha emission consistent with 0A EW, a 128-day rotation period, and showed no flares during 28 days of 2-minute cadence TESS observations (Vanderspek et al., 2018), we do not expect this star (V = 15.3, estimated U = 18.53; Pecaut & Mamajek, 2013) to pose a threat to the COS detectors. The Bright Object Tool finds all stars in the aperture field to be safe for target acquisition with the NUV imager as well as for our science observations of FUV and NUV spectra.

To measure the prominent emission lines in the FUV we will use COS G130M (Si III, N V, C II, Si IV) and COS G160M (C IV, He II). We will expose for a combined total of 17802s with COS G130M. These observations will provide S/N > 4 for prominent lines in this range. We break up these obesrvations into 2 visits of 3 orbits each for ease of scheduling. This set-up will still allow us to monitor LHS 3844 for flares, which occur on the timescales of minutes to hours, but will be less constraining than if we could observe for 6 contiguous orbits. We get this flare monitoring "for free" since we need these exposures to build up S/N in UV lines of interest. We will expose for a combined total of 8854s with COS G160M which will provide S/N > 4 for C IV and S/N > 2 for He II. The Si IV, C IV, and He II lines are particularly important for estimating the EUV flux. For the

NUV we will expose for a total of 2864s with COS G230L and detect the Mg II doublet at S/N > 5.

There is a transiting planet in the system, but the expected signal from the planet is small compared to our photon-noise limited uncertainties. Given the size and temperature of this planet (R = 1.36 Earth radii, Teq = 805 K) we do not expect it to have an evaporating exosphere that would contribute UV line emission. In the interest of efficient scheduling, it is not necessary to put a phase constraint on these observations due to the planet transits.

In the APT we provide COS ETCs corresponding to the exposure time in each orbit. Here are the ETCs for the combined exposure times for each set up: COS G130M: COS.sp.1349239; COS G160M COS.sp.1349243; COS G230L: COS.sp.1349244.

Visit

Proposal 15704, FUV (01) Tue Apr 16 21:00:51 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(FUV (01)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

Fixed Targets

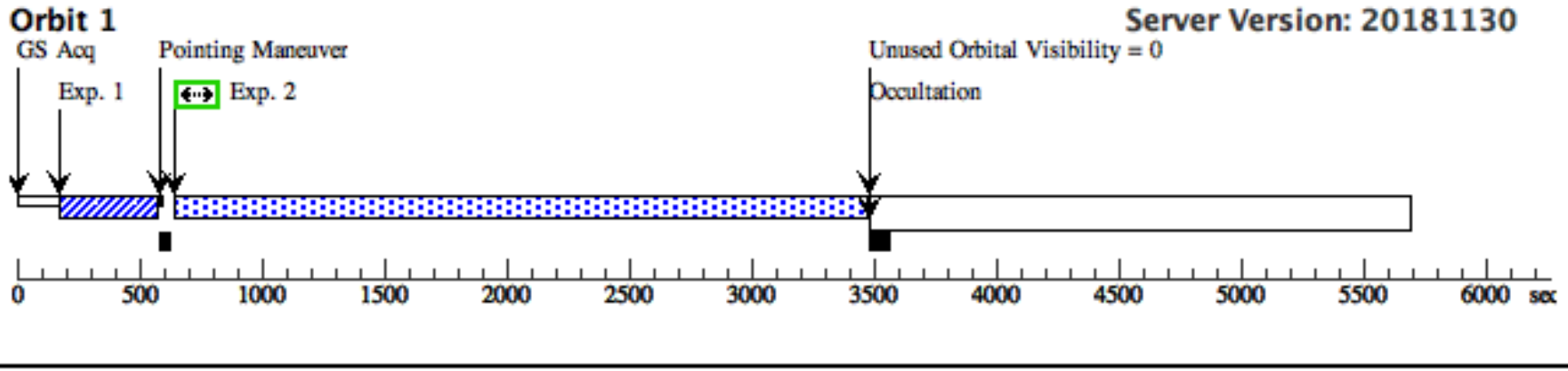
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	L-119-213 Alt Name1: LHS3844	RA: 22 41 58.1173 (340.4921554d) Dec: -69 10 8.32 (-69.16898d) Equinox: J2000	Proper Motion RA: 334.3569979205936 mas/yr Proper Motion Dec: -726.9742938259122 mas/yr Epoch of Position: 2000	V=15.26+/-0.03	Reference Frame: ICRS

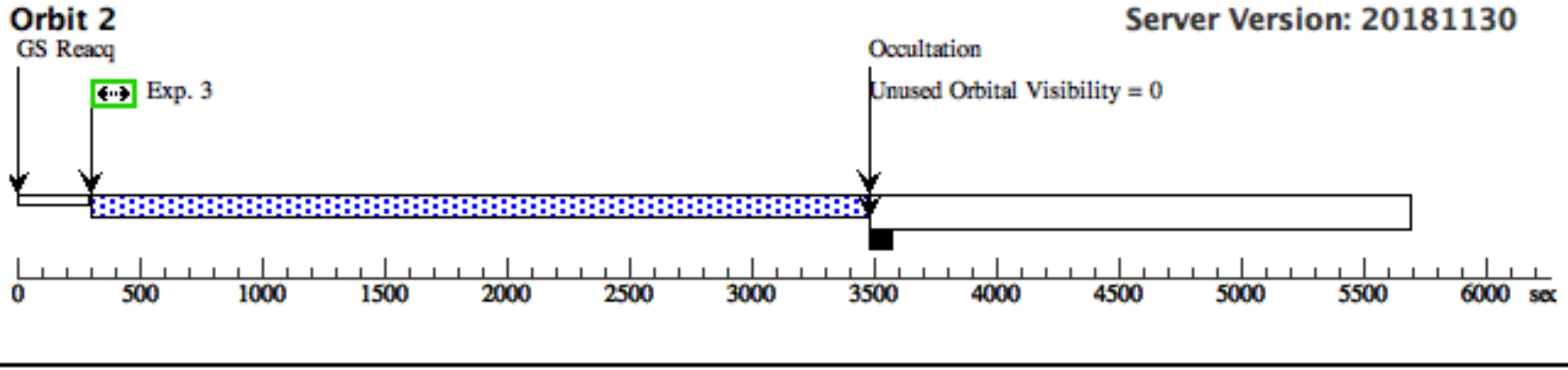
Comments:
Category=STAR
Description=[EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

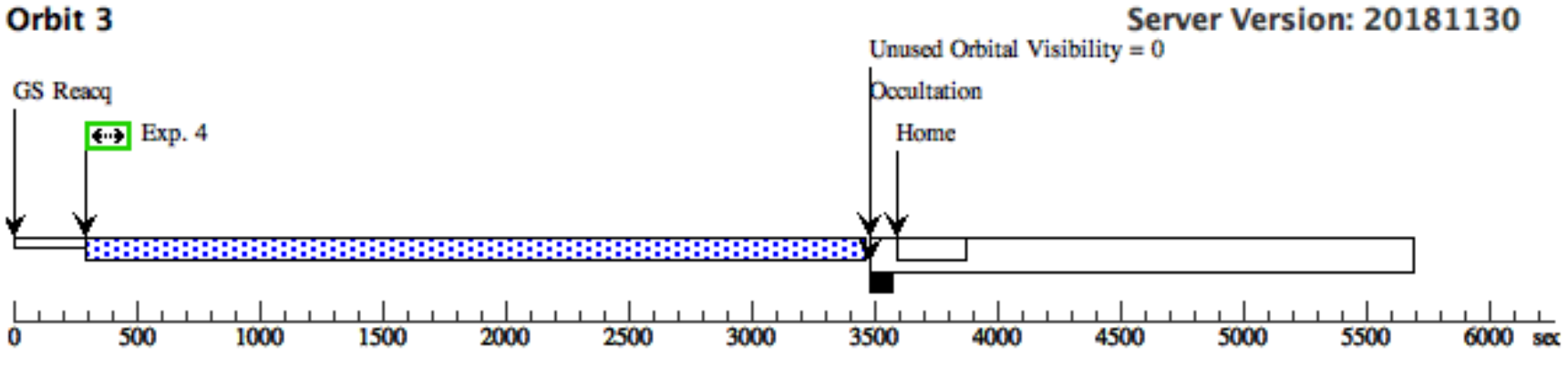
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquiring (COS.ta.1349242)	(1) L-119-213	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				90 Secs (90 Secs) *[==>]*	***[1]***
2	(COS.sp.1349090)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=3748; SEGMENT=BOTH; FLASH=YES			2661 Secs (2661 Secs) *[==>]*	***[1]***
3	(COS.sp.1349092)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3748; FP-POS=3; SEGMENT=BOTH; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[2]***
4	(COS.sp.1349092)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3748; FP-POS=4; SEGMENT=BOTH; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[3]***

Orbit Structure







Visit

Proposal 15704, FUV (02)

Tue Apr 16 21:00:51 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(FUV (02)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

Fixed Targets

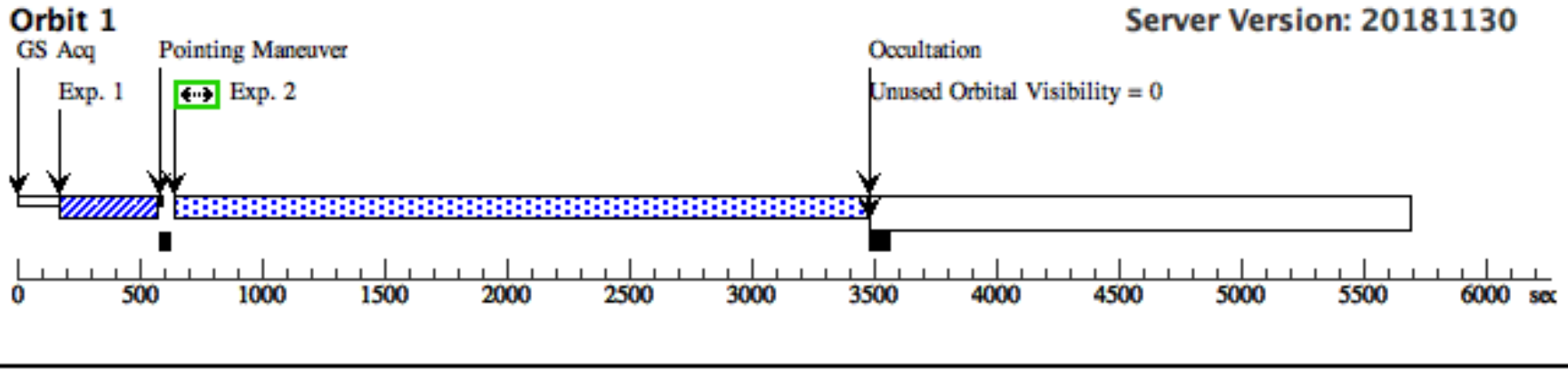
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	L-119-213 Alt Name1: LHS3844	RA: 22 41 58.1173 (340.4921554d) Dec: -69 10 8.32 (-69.16898d) Equinox: J2000	Proper Motion RA: 334.3569979205936 mas/yr Proper Motion Dec: -726.9742938259122 mas/yr Epoch of Position: 2000	V=15.26+/-0.03	Reference Frame: ICRS

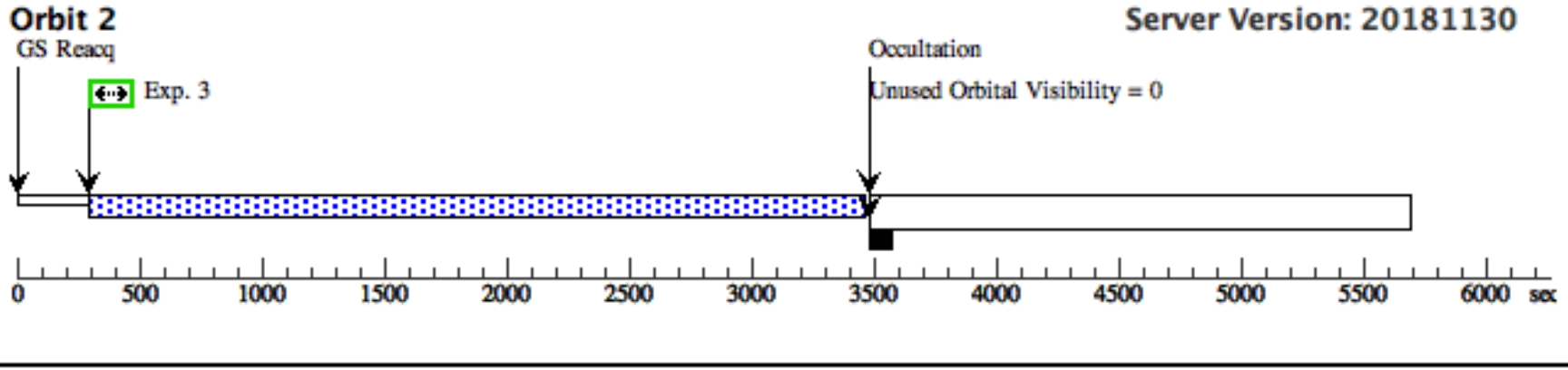
Comments:
Category=STAR
Description=[EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

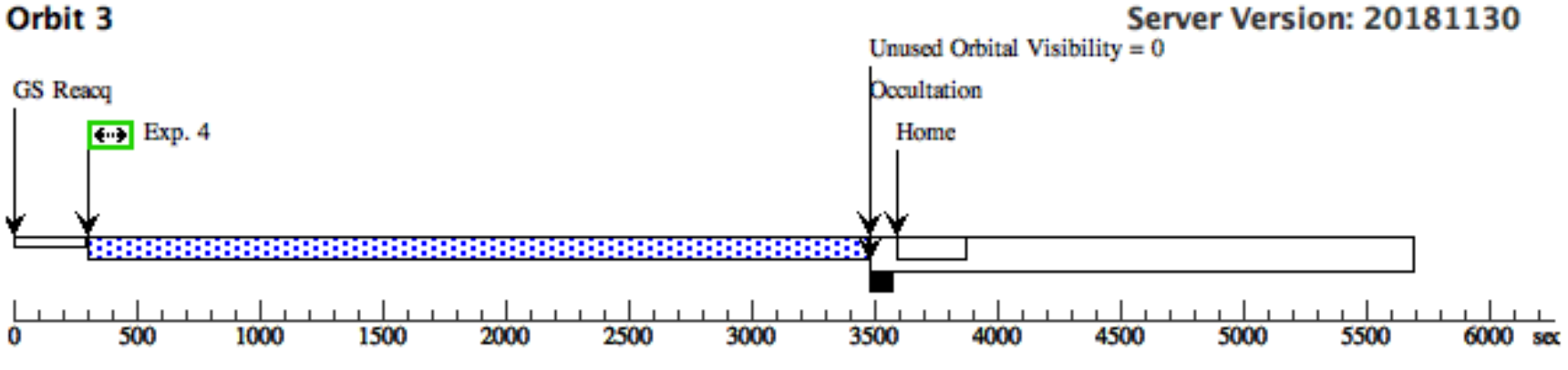
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquiring (COS.ta.1349242)	(1) L-119-213	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				90 Secs (90 Secs) *[==>]*	***[1]***
2	(COS.sp.1349090)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=3748; SEGMENT=BOTH; FLASH=YES			2661 Secs (2661 Secs) *[==>]*	***[1]***
3	(COS.sp.1349092)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3748; FP-POS=4; SEGMENT=BOTH; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[2]***
4	(COS.sp.1349092)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3748; FP-POS=4; SEGMENT=BOTH; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[3]***

Orbit Structure







Visit

Proposal 15704, FUV & NUV (03) Tue Apr 16 21:00:51 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(FUV & NUV (03)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

Fixed Targets

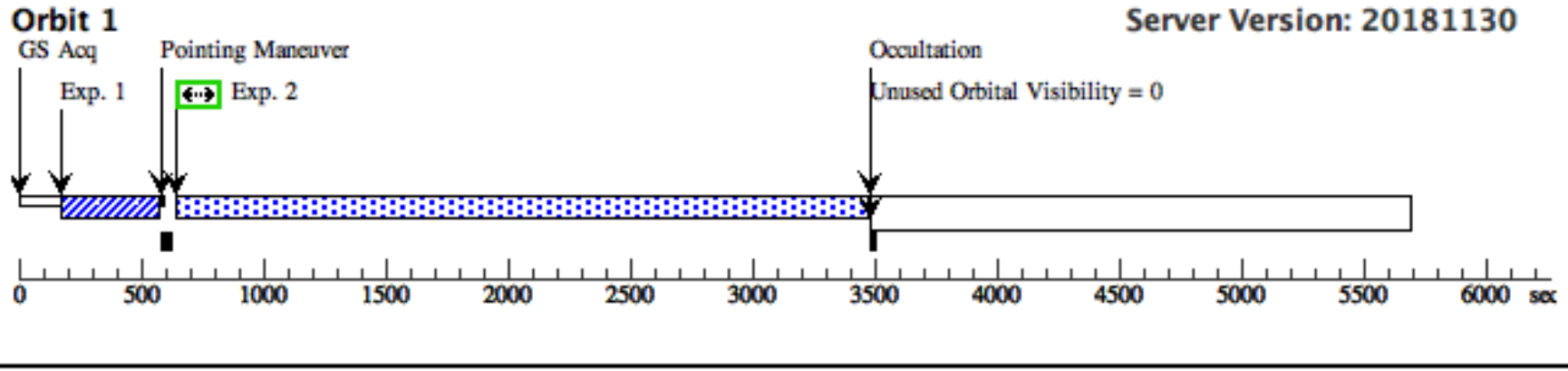
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	L-119-213 Alt Name1: LHS3844	RA: 22 41 58.1173 (340.4921554d) Dec: -69 10 8.32 (-69.16898d) Equinox: J2000	Proper Motion RA: 334.3569979205936 mas/yr Proper Motion Dec: -726.9742938259122 mas/yr Epoch of Position: 2000	V=15.26+/-0.03	Reference Frame: ICRS

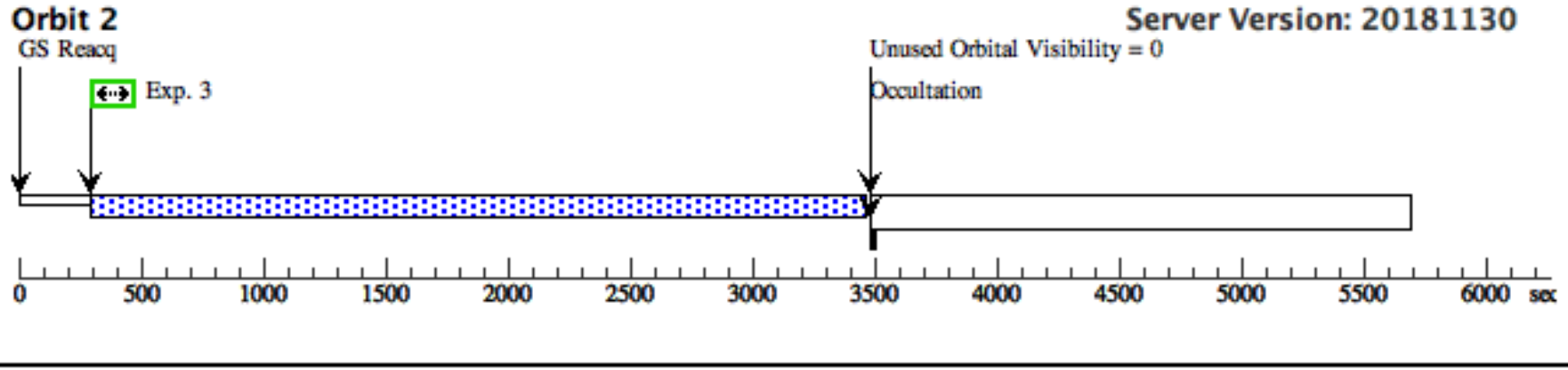
Comments:
Category=STAR
Description=[EXTRA-SOLAR PLANETARY SYSTEM, M V-IV]
Extended=NO

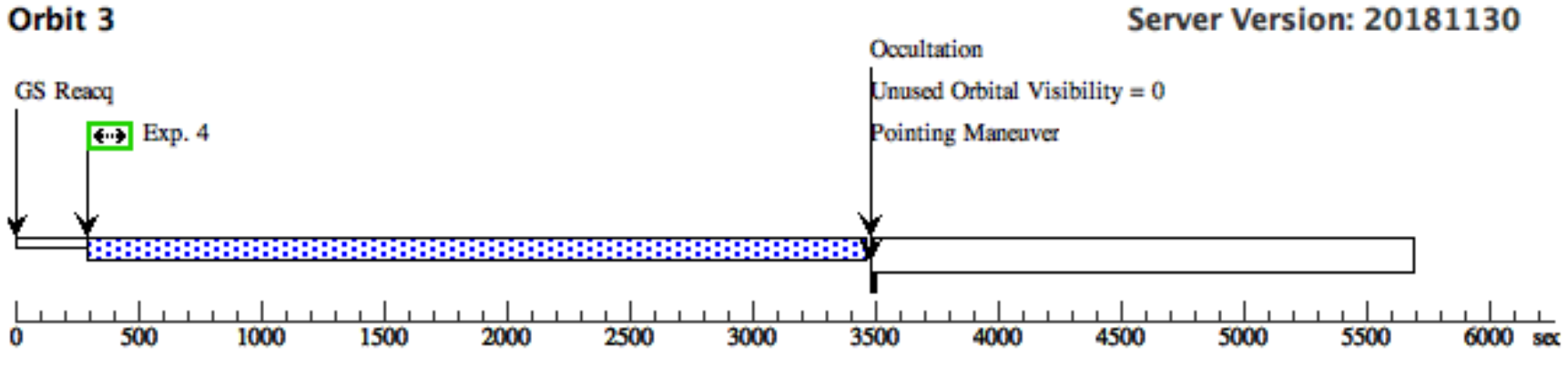
Exposures

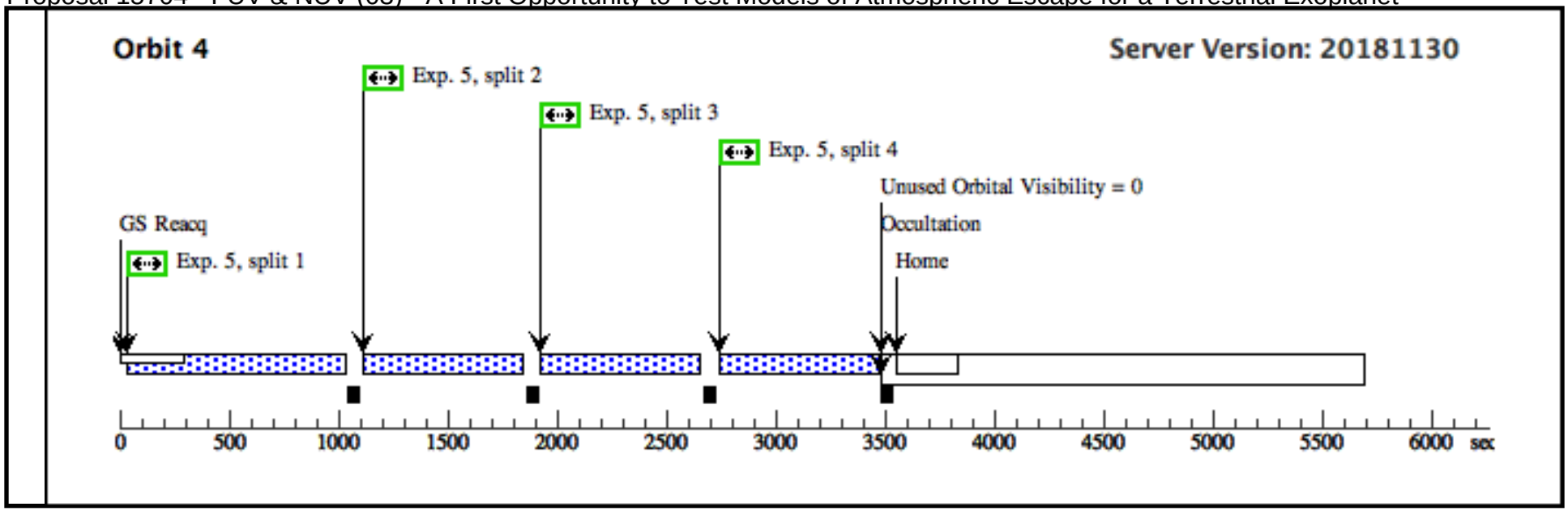
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquiring (COS.ta.1349242)	(1) L-119-213	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				90 Secs (90 Secs) *[==>]*	***[1]***
2	(COS.sp.1349102)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=28390; SEGMENT=BOTH; FP-POS=2; FLASH=YES			2614 Secs (2614 Secs) *[==>]*	***[1]***
3	(COS.sp.1349104)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=28390; SEGMENT=BOTH; FP-POS=3; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[2]***
4	(COS.sp.1349104)	(1) L-119-213	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=28390; SEGMENT=BOTH; FP-POS=4; FLASH=YES			3120 Secs (3120 Secs) *[==>]*	***[3]***
5	(COS.sp.1349114)	(1) L-119-213	COS/NUV, TIME-TAG, PSA	G230L 2950 A	FP-POS=ALL; FLASH=YES; BUFFER-TIME=1705			716 Secs (2864 Secs) *[==>(Split 1)]* *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[4]***

Orbit Structure





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