16033 - UV Spectroscopy of LTT1445A: Evaluating the Energetic Irradiance on a Nearby Terrestrial Exoplanet

Cycle: 27, Proposal Category: GO

(UV Initiative, JWST Initative)

(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) BD-17-588B	COS/FUV COS/NUV	5	09-Dec-2019 13:00:30.0	yes
02	(1) BD-17-588B	COS/FUV COS/NUV	3	09-Dec-2019 13:00:31.0	yes
03	(1) BD-17-588B	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	09-Dec-2019 13:00:33.0	yes

10 Total Orbits Used

ABSTRACT

JWST will be able to observe the atmospheres of rocky planets transiting nearby M dwarfs. A few such planets are already known and TESS has begun to find more. To interpret observations of the exoplanets' atmospheres, we must understand the high-energy SED of their host stars: EUV irradiation can erode a planet's gaseous envelope, FUV/NUV-driven photochemistry shapes an atmosphere's molecular abundances, and flares can affect long term stability. A number of recent surveys have used HST's UV capabilities to characterize the energetic irradiance spectra of M stars across a range of stellar masses, ages, and activity levels. While the surveys have proven invaluable for predicting the evolution of an exoplanet's atmosphere and its potential to support life, they have also shown scatter in behavior and irradiance properties for stars of similar type. As a result, direct UV observations remain the gold standard for understanding the effects of the stellar irradiance on its exoplanet compansions in the most promising targets for JWST observations. We propose here to obtain UV (1150-3200 A) spectroscopy and time-series monitoring of the new terrestrial planet host system, LTT1445Ab. Recently discovered by TESS, this system is the closest transiting system with an exoplanet around a low mass (0.25 Msun) star and has immediately risen to prominence as a potential target for characterization of its atmosphere. Our proposed observations will provide the UV context necessary to determine the likelihood of atmospheric formation and retention, the identification of potential (false positive) biomarkers, and the impacts of stellar activity on the exoplanet atmospheric stability.

OBSERVING DESCRIPTION

Observing Modes: For a full census of the UV emission incident on the habitable zone (HZ) around LTT1445A, we require spectral coverage from 1150-3100 A: the G130M, G160M, and G230L modes of COS and the G140M and G230L modes of STIS. In the FUV (excepting Lya) we will use COS G130M and COS G160M. Emission from Lya, Si IV, C IV, and He II is particularly interesting because these lines provide constraints on the Lyman continuum/EUV (100 - 900 A) irradiance in these systems. COS is essential for a moderate spectral resolution line census as the lower effective area and higher detector background of STIS make observations of all but the very brightest lines prohibitively time consuming. We will use the medium resolution COS modes to resolve chromospheric lines and maximize contrast from narrow features. At NUV wavelengths, we will use STIS G230L to observe the (> 2200 A) NUV continuum, Fe II 2400 and 2600, and Mg II 2800, but we will take advantage of the superior sensitivity of the COS G230L mode to observe the 1750-2100 A region that is important to the photodissociation of O2 and the production of O3. In order to calibrate the UV data to visible/IR photospheric models, we will also acquire short optical observations with the STIS G430L. We will use the G140M mode of STIS with the 52"x0.1" slit to measure the Lya profile for our target. STIS is needed over COS for Lya to minimize geocoronal contamination with a narrow slit. Lya experiences absorption from the intervening local ISM and the line must be reconstructed to provide a reliable

measure of the local Lya field in these systems.

Short duration (minutes to hours) flares are most common on M dwarfs and we will use the most sensitive UV photon-counting mode on HST (COS G130M) to perform 8-hour variability studies (5 contiguous spacecraft orbits) of characteristic chromospheric and transition region lines (C II, Si III, C IV, Si IV, He II, and N V) for our target. This observation strategy naturally splits the target campaign into 3 HST visits: 1) COS G130M (5 orbits), 2) COS G160M+G230L (3 orbits), and 3) STIS G140M+G230L+G430L (2 orbits). Employing this strategy in APT, we find that LTT1445A has three months of visibility during midcycle observing window (11/1/2019-3/31/2020). A key science goal for the program is to estimate the EUV emission from the star
and its effects on heating the planet's atmosphere. Using the FUV data alone, we will estimate the EUV flux using empirical scaling relations from Linsky et al. 2014. A more detailed calculation using DEM calculations is desirable but requires X-ray observations in combination with the FUV. We will apply for these under a separate proposal; this approach has proven successful for previous programs of this nature.

Exposure Time Calculations: We estimated the expected flux from LTT1445A using the observed quiescent spectrum of GJ 436 (from MAST), scaled to the distance of LTT1445A. The 5 orbit COS G130M variability observations will produce deep spectral observations in the 1150-1420 A range. For the remaining UV wavelengths, we estimated exposure times based on the amount of time required to achieve S/N>=10 per resolution element in the characteristic emission lines: Ly (STIS G140M), C IV (COS G160M), and Mg II (STIS G230L). We estimate SNR>=5 in the NUV continuum (1900 A, COS G230L and 2850 A, STIS G230L) and S/N>20 in the optical (STIS G430L). Using the STScI on-line ETCs, we have estimated the total exposure time per target resulting in a total observing time allocation request of 10 orbits.

Safety: We reviewed LTT1445A against the bright object screening limits for M stars and it meets the specications for the COS and STIS FUV detectors. The COS BOP would fail if Lya was observed. To avoid this (and because we are using STIS to get the Lya emission), we are using the G130M/1222 grating settting. We veried that we will not have to request a specic range of roll angles to keep LTT1445BC out of the COS Bright Object Aperture: the PSA and BOA are separated by 13 arcsec vs. 7 arcsec between
LTT1445A and LTT1445BC.

Visit

Proposal 16033, COS FUV (01), implementation Mon Dec 09 18:00:34 GMT 2019

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Comments: Five orbit monitoring visit in G130M for flare statistics.

Diagnostics

(COS FUV (01)) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

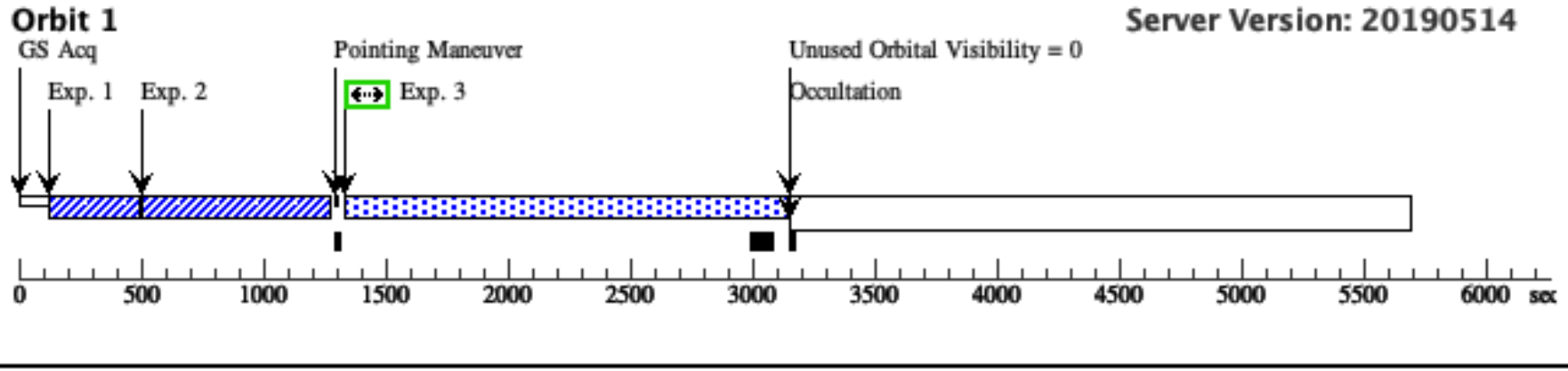
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BD-17-588B Alt Name1: LTT1445A	RA: 03 01 51.3900 (45.4641250d) Dec: -16 35 36.10 (-16.59336d) Equinox: J2000	Proper Motion RA: -369.2 mas/yr Proper Motion Dec: -268.3 mas/yr Parallax: 0.1455" Epoch of Position: 2015.5 Radial Velocity: -5.4 km/sec	V=10.4+/-0.013 Star is part of a triple system. Target is the brightest component, LTT1445A.	Reference Frame: ICRS

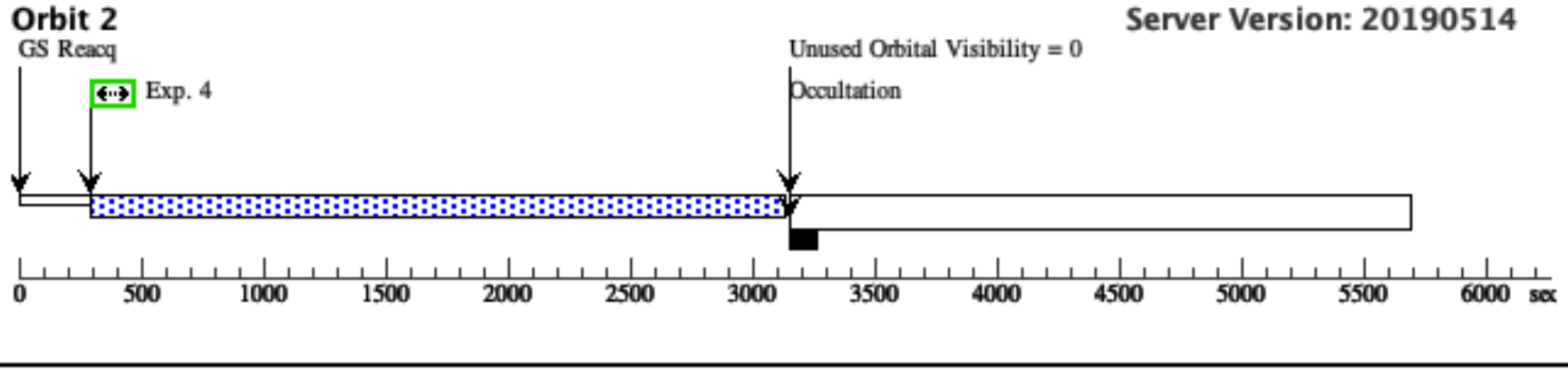
Comments: Coordinates from Henry et al. 2018, AJ, 155, 265. Proper motions from GAIA.
Category=STAR
Description=[M III-I, M V-IV]
Extended=NO

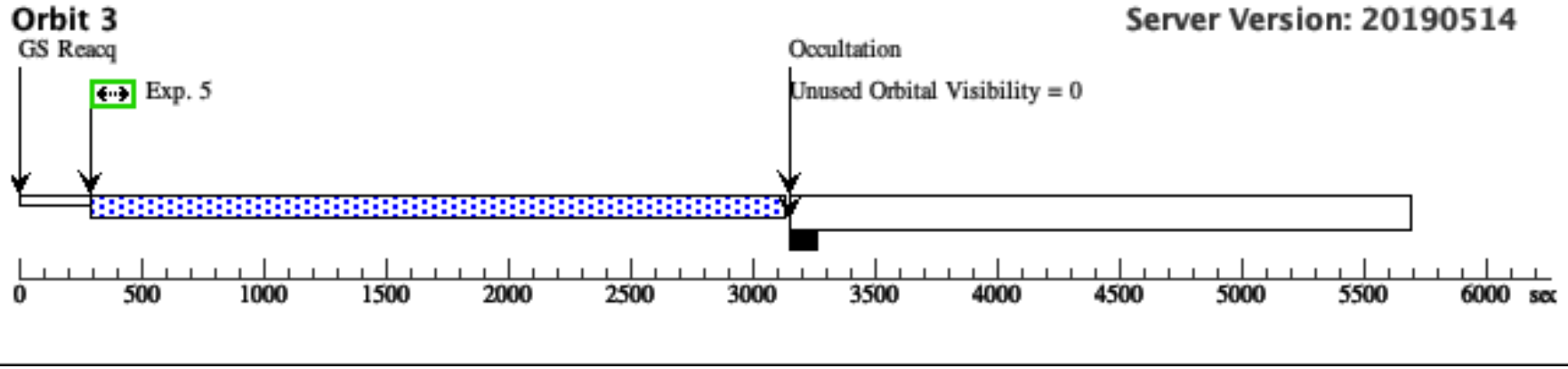
Exposures

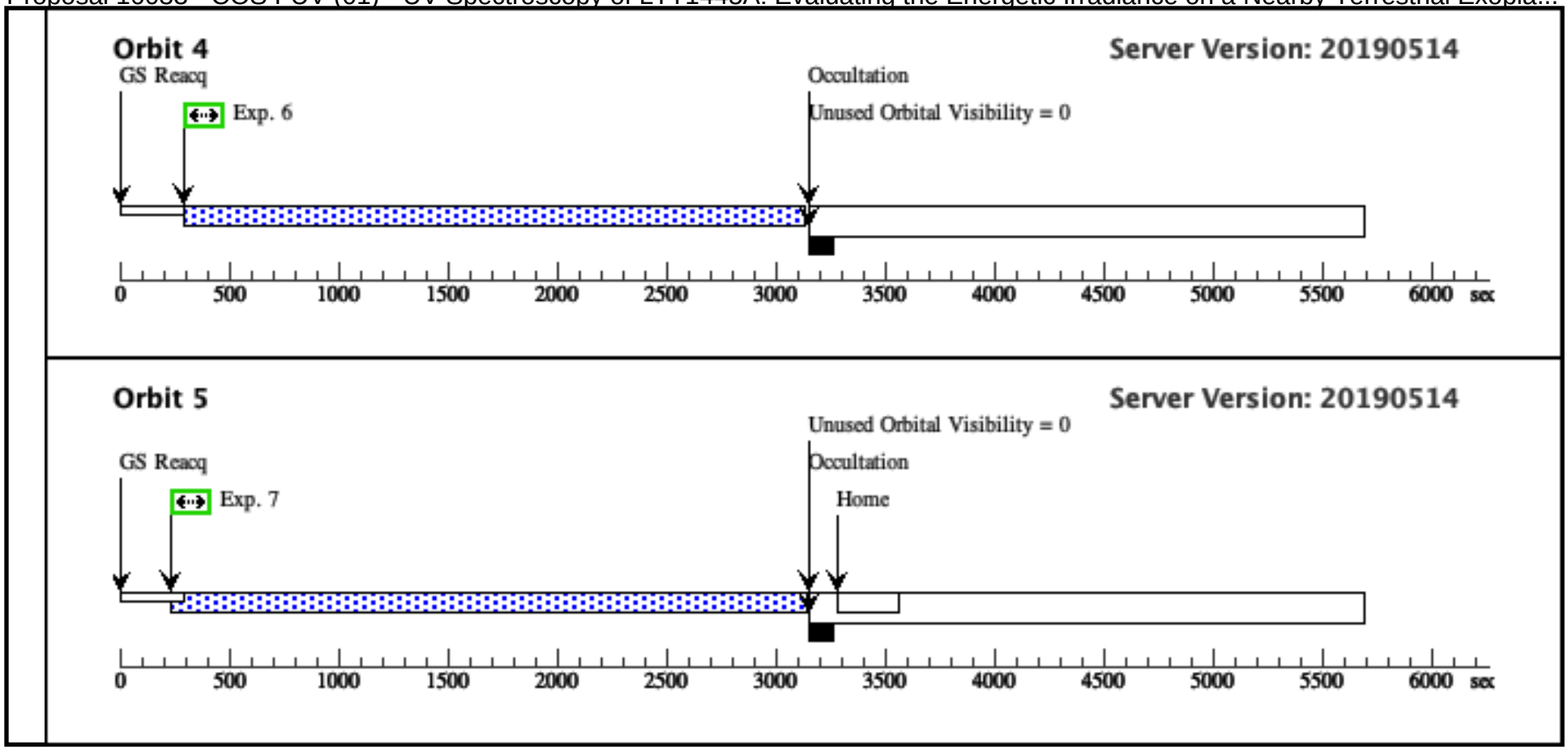
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.sa.1392918)	(1) BD-17-588B	COS/NUV, ACQ/PEAKXD, PSA	G230L 2950 A	STRIPE=MEDIUM			80 Secs (80 Secs) *[==>]*	*[1]*
2	(COS.sa.1392919)	(1) BD-17-588B	COS/NUV, ACQ/PEAKD, PSA	G230L 2950 A	NUM-POS=5; CENTER=FLUX-WT-FLR; STEP-SIZE=0.9			125 Secs (125 Secs) *[==>]*	*[1]*
3	(COS.sp.1392915)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=1500.0; FP-POS=1			1627 Secs (1627 Secs) *[==>]*	*[1]*
4	(COS.sp.1392915)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2700.0; FP-POS=2			2790 Secs (2790 Secs) *[==>]*	*[2]*
5	(COS.sp.1392915)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2700.0; FP-POS=3			2790 Secs (2790 Secs) *[==>]*	*[3]*
6	(COS.sp.1392915)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2700.0; FP-POS=4			2790 Secs (2790 Secs) *[==>]*	*[4]*
7	(COS.sp.1392915)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2700.0; FP-POS=1			2790 Secs (2790 Secs) *[==>]*	*[5]*

Orbit Structure





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Visit

Proposal 16033, COS NUV (02), implementation Mon Dec 09 18:00:34 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Comments: COS FUV (G160M) and NUV (G230L) spectra.

Fixed Targets

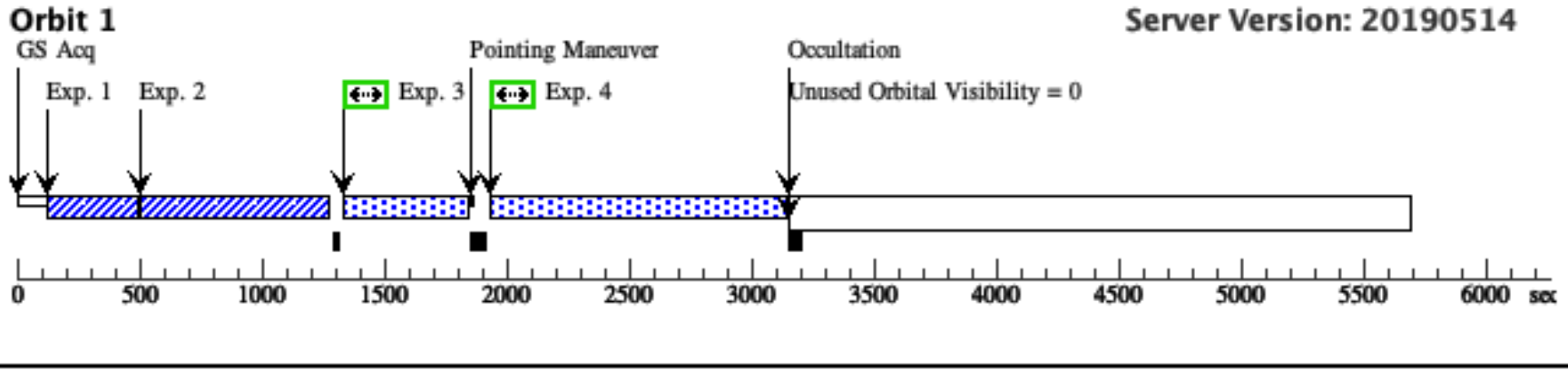
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BD-17-588B Alt Name1: LTT1445A	RA: 03 01 51.3900 (45.4641250d) Dec: -16 35 36.10 (-16.59336d) Equinox: J2000	Proper Motion RA: -369.2 mas/yr Proper Motion Dec: -268.3 mas/yr Parallax: 0.1455" Epoch of Position: 2015.5 Radial Velocity: -5.4 km/sec	V=10.4+/-0.013 Star is part of a triple system. Target is the brightest component, LTT1445A.	Reference Frame: ICRS

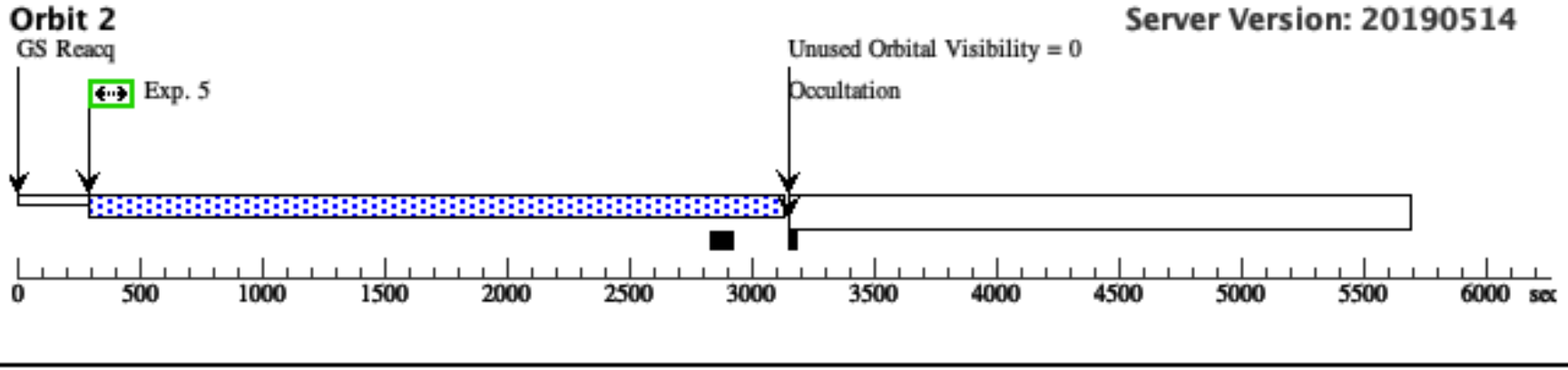
Comments: Coordinates from Henry et al. 2018, AJ, 155, 265. Proper motions from GAIA.
Category=STAR
Description=[M III-I, M V-IV]
Extended=NO

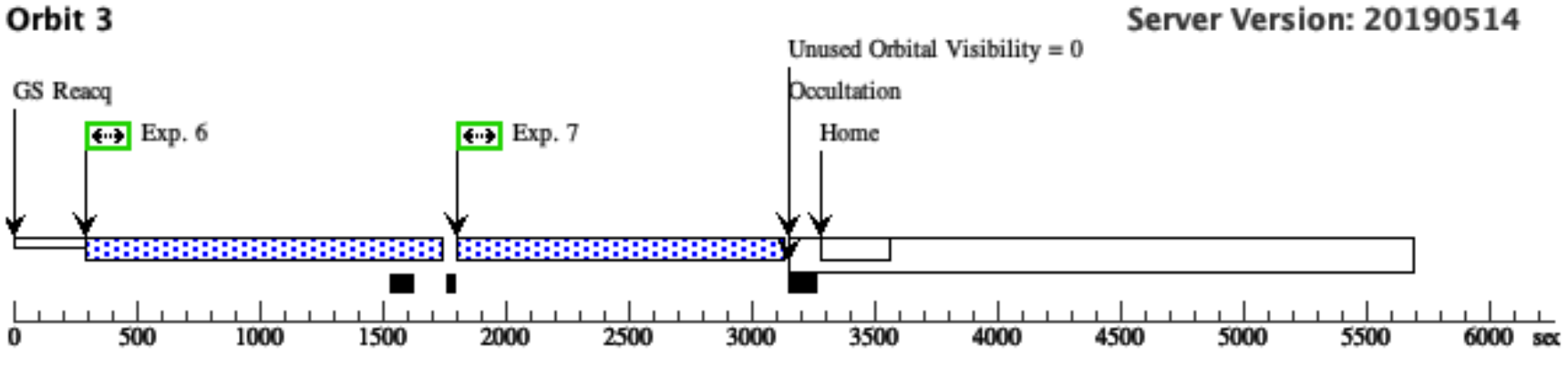
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.sa.1392918)	(1) BD-17-588B	COS/NUV, ACQ/PEAKXD, PSA	G230L 2950 A	STRIPE=MEDIUM			80 Secs (80 Secs) *[==>]*	*[1]*
2	(COS.sa.1392919)	(1) BD-17-588B	COS/NUV, ACQ/PEAKD, PSA	G230L 2950 A	CENTER=FLUX-WT-FLR; NUM-POS=5; STEP-SIZE=0.9			125 Secs (125 Secs) *[==>]*	*[1]*
3	(COS.sp.1392924)	(1) BD-17-588B	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=1000.0; FP-POS=3			500. Secs (500 Secs) *[==>]*	*[1]*
4	(COS.sp.1392917)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=2500.0; FP-POS=1			992 Secs (992 Secs) *[==>]*	*[1]*
5	(COS.sp.1392917)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=2500.0; FP-POS=2			2790 Secs (2790 Secs) *[==>]*	*[2]*
6	(COS.sp.1392917)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=1200.0; FP-POS=3			1395 Secs (1395 Secs) *[==>]*	*[3]*
7	(COS.sp.1392917)	(1) BD-17-588B	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=1200.0; FP-POS=4			1280 Secs (1280 Secs) *[==>]*	*[3]*

Orbit Structure







Visit

Proposal 16033, STIS Visit (03), implementation Mon Dec 09 18:00:34 GMT 2019

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Comments: G430L/G230L/G140M exposures.

Fixed Targets

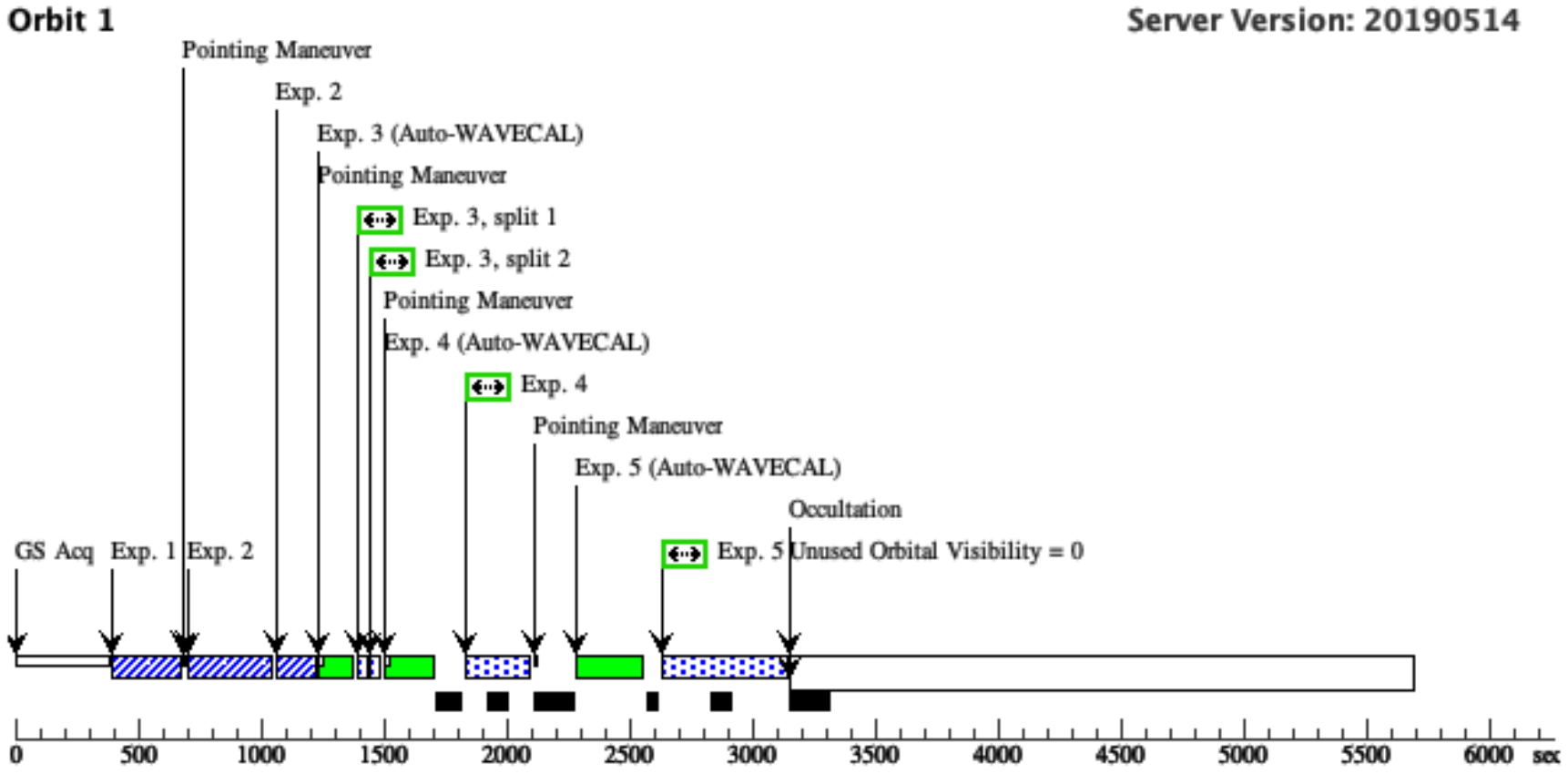
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BD-17-588B Alt Name1: LTT1445A	RA: 03 01 51.3900 (45.4641250d) Dec: -16 35 36.10 (-16.59336d) Equinox: J2000	Proper Motion RA: -369.2 mas/yr Proper Motion Dec: -268.3 mas/yr Parallax: 0.1455" Epoch of Position: 2015.5 Radial Velocity: -5.4 km/sec	V=10.4+/-0.013 Star is part of a triple system. Target is the brightest component, LTT1445A.	Reference Frame: ICRS

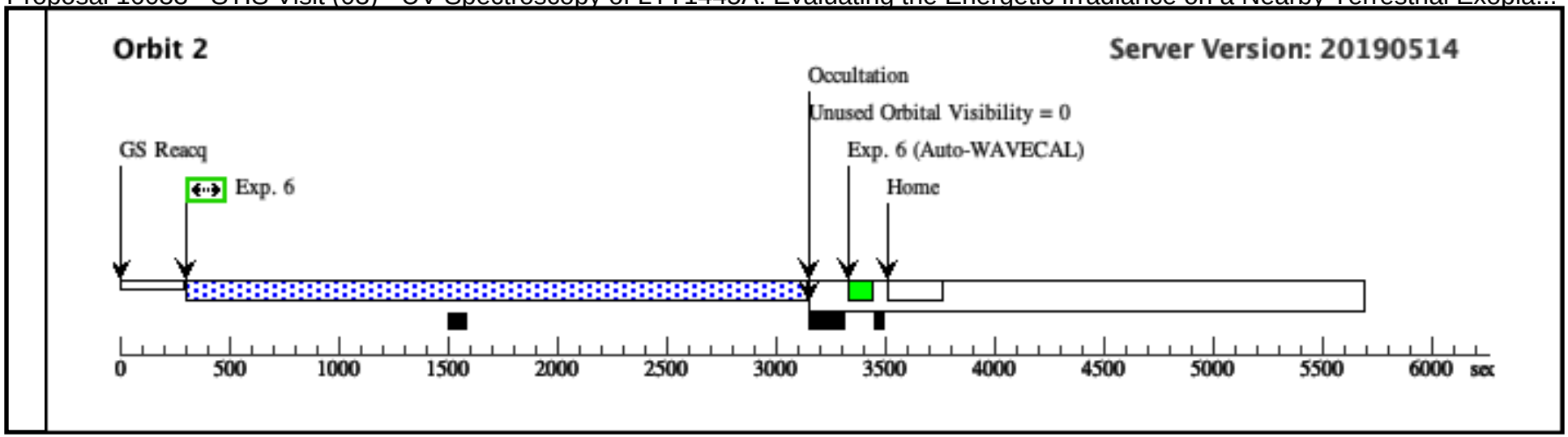
Comments: Coordinates from Henry et al. 2018, AJ, 155, 265. Proper motions from GAIA.
Category=STAR
Description=[M III-I, M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1392945)	(1) BD-17-588B	STIS/CCD, ACQ, F28X50OIII	MIRROR				2 Secs (2 Secs) *[==>]*	 ***[1]***
2	(STIS.ta.1392946)	(1) BD-17-588B	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				3 Secs (3 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.1392947)	(1) BD-17-588B	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				10 Secs (10 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	 ***[1]***
4	(STIS.sp.1392949)	(1) BD-17-588B	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=99.0			250 Secs (250 Secs) *[==>]*	 ***[1]***
5	(STIS.sp.1392950)	(1) BD-17-588B	STIS/FUV-MAMA, TIME-TAG, 52X0.1	G140M 1222 A	BUFFER-TIME=200.0			492 Secs (492 Secs) *[==>]*	 ***[1]***
6	(STIS.sp.1392950)	(1) BD-17-588B	STIS/FUV-MAMA, TIME-TAG, 52X0.1	G140M 1222 A	BUFFER-TIME=1200.0			2824 Secs (2824 Secs) *[==>]*	 ***[2]***

Orbit Structure

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