16717 - UV spectroscopy of a serendipitously-detected He star in Leo A: an unprecendented glimpse of binary mass transfer at extremely low metallicity

Cycle: 29, 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) J095921.90+304518.1	COS/FUV COS/NUV	2	16-May-2022 15:00:12.0	yes
51	(1) J095921.90+304518.1	COS/FUV COS/NUV	2	16-May-2022 15:00:13.0	yes
02	(1) J095921.90+304518.1	COS/FUV COS/NUV	2	16-May-2022 15:00:13.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(1) J095921.90+304518.1	COS/FUV COS/NUV	2	16-May-2022 15:00:14.0	yes
04	(1) J095921.90+304518.1	COS/FUV COS/NUV	2	16-May-2022 15:00:15.0	yes

10 Total Orbits Used

ABSTRACT

Binary mass transfer likely plays an outsized role in the evolution of massive stars, yet direct empirical constraints on these processes remain elusive. In particular, stars stripped by a binary companion are among the hottest sources of ionizing radiation expected at low metallicity. Such stripped stars plausibly dominate the flux of composite stellar populations at the hardest EUV energies, and may be required to explain the puzzling high-ionization nebular emission routinely encountered in low-metallicity star-forming galaxies. But despite substantial interest and modeling effort, only one star unambiguously stripped by binary interaction has yet been uncovered and studied in-detail. Exploratory optical spectroscopy in the extremely metal-poor (<10% solar) dwarf galaxy Leo A has recently uncovered a peculiar FUV-bright star with extremely prominent optical He II emission embedded in a small ionized nebula. Preliminary NLTE atmosphere modeling confirms that this source is broadly consistent with an intermediate mass metal-poor He star stripped by binary mass transfer; yet its fundamental properties remain uncertain without spectroscopy at the FUV wavelengths where it is brightest. Here we propose COS/G160M follow-up to confirm and characterize this unique target. These observations will enable confident measurement of the luminosity, temperature, and mass of this likely stripped star as well as strong constraints to be placed on its wind velocity structure and mass loss rate. The serendipitous discovery of this object represents an unexpected and extremely timely opportunity for HST to directly observe a product of binary evolution at unprecendentedly-low metallicity.

OBSERVING DESCRIPTION

This program will obtain a deep FUV spectrum for a peculiar star in Leo A identified as a potential stripped binary product in optical spectroscopy and NUV HST imaging. We leverage both in designing a safe observing program with COS.

Coordinates: To determine accurate ICRS coordinates for the target star, we compare the centroids of 14 nearby optically-bright stars in the F475W image to their GAIA ICRS coordinates to derive a (small and consistent to <0.1") correction to the F475W image astrometry. We use this offset to correct the F475W coordinates of the target star to the ICRS frame. Comparison to a calibrated SDSS u-band image in which the target is detected at

modest SNR and which was previously used successfully to derive ICRS coordinates for COS spectroscopy of two brighter Leo A targets suggests good agreement.

Acquisition: We have a calibrated HST WFC3/F275W image in-hand covering the target star (GO:15275), which is close to the COS NUV imaging bandpass. Since the shape of the target star SED is not yet constrained blueward of F275W, we assume conservatively a flat continum in Flambda and require a S/N of 30 to derive an acquisiton exposure time estimate.

Observing plan: In accordance with STScI recommendations to maximize the scheduling of observations in Cycle 29, we split our spectroscopic observations into 4 visits of 2 orbits each. After acqusition, each orbit is filled with a single spectroscopic exposure at fixed FP-POS, with full buffer dumps and grating shifts occurring during occultation. All four FP-POS positions are cycled through over the course of the four visits to minimize the impact of fixed-pattern noise on the final stacked spectra.

Safety: While the shape of the target SED is not yet constrained into the FUV, the faint F275W magnitude of 19.3 (Vega) provides a strong constraint. Even assuming an extraordinarily hot unextincted blackbody of Teff>~200 kK results in expected counts well below safety limits both for a Mirror A target acquisition and G160M spectroscopic observation (where it is not expected to approach filling the buffer).

Visit

Proposal 16717, Visit 01, failed Mon May 16 19:00:15 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

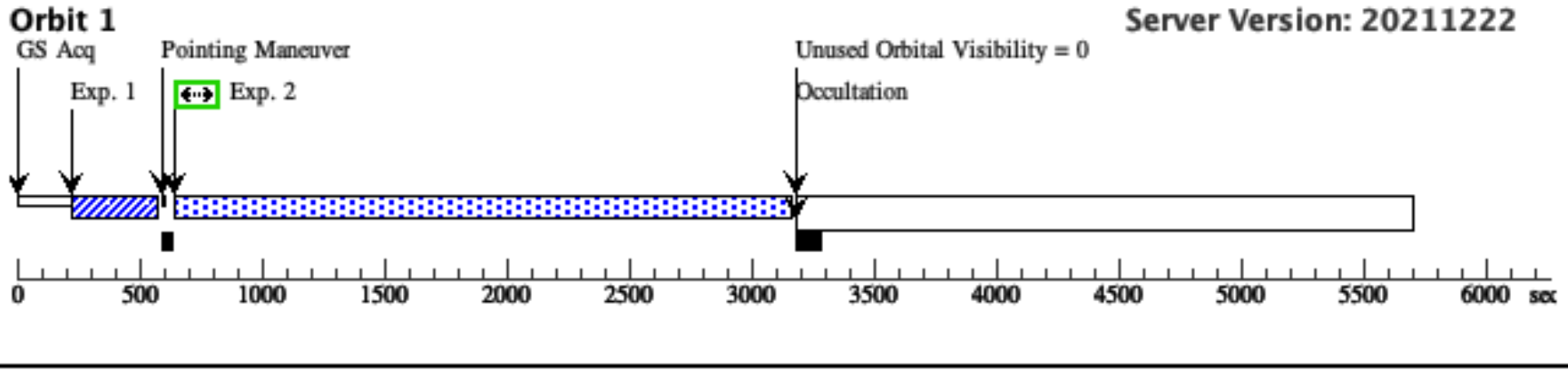
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J095921.90+304518.1	RA: 09 59 21.9000 (149.8412500d) Dec: +30 45 18.07 (30.75502d) Equinox: J2000		V=19.9	Reference Frame: ICRS

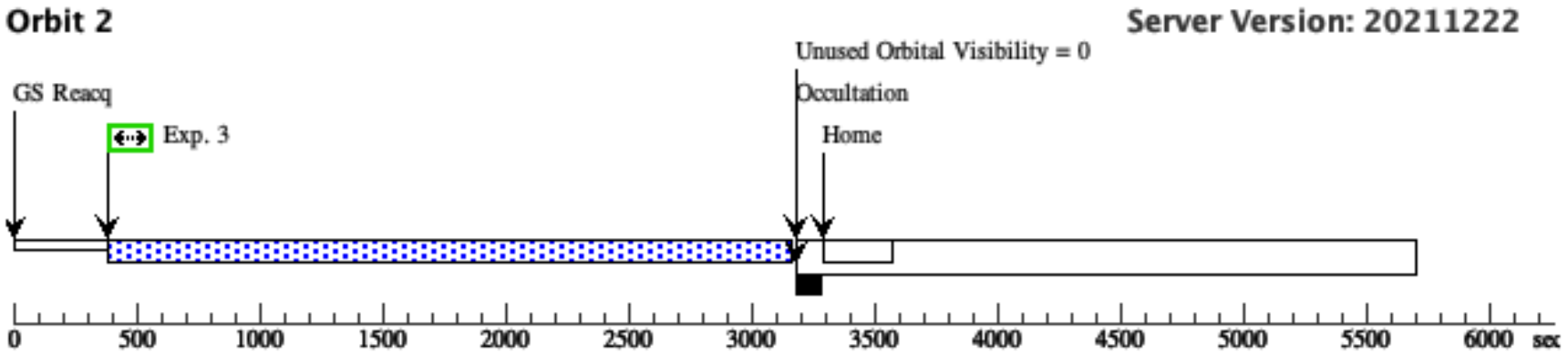
Comments:
Category=EXT-STAR
Description=[EMISSION LINE STAR, SDO, UNDESIGNATED, WIND]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1525794)	(1) J095921.90+304518.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				62 Secs (62 Secs) *[==>]*	*[1]*
2	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=1; FLASH=YES; BUFFER-TIME=2308			2200 Secs (2308 Secs) *[==>2308.0 Secs]*	*[1]*
3	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=2; FLASH=YES; BUFFER-TIME=2724			2200 Secs (2724 Secs) *[==>2724.0 Secs]*	*[2]*

Orbit Structure





Visit

Proposal 16717, Visit 51 Mon May 16 19:00:15 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

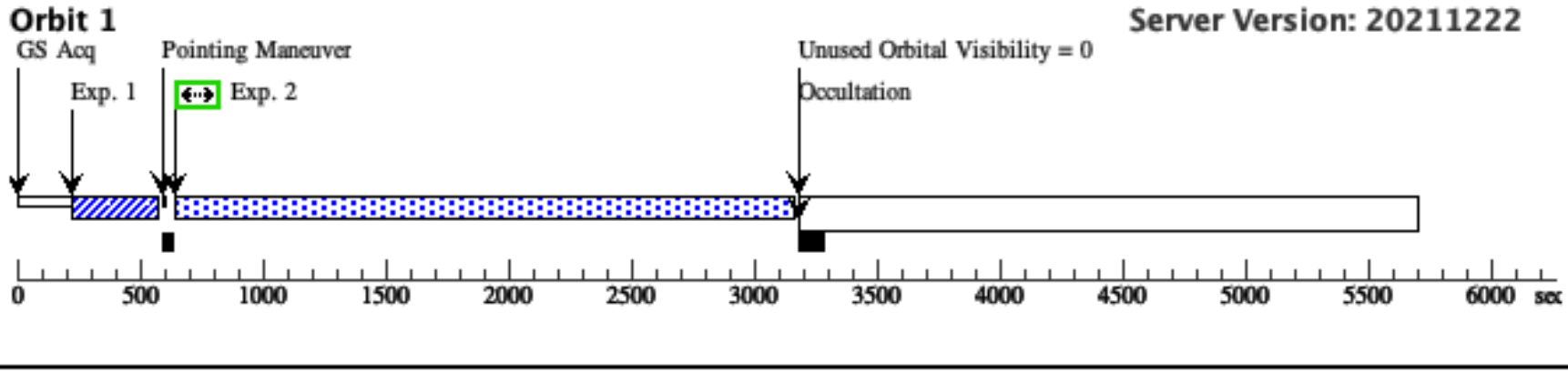
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J095921.90+304518.1	RA: 09 59 21.9000 (149.8412500d) Dec: +30 45 18.07 (30.75502d) Equinox: J2000		V=19.9	Reference Frame: ICRS

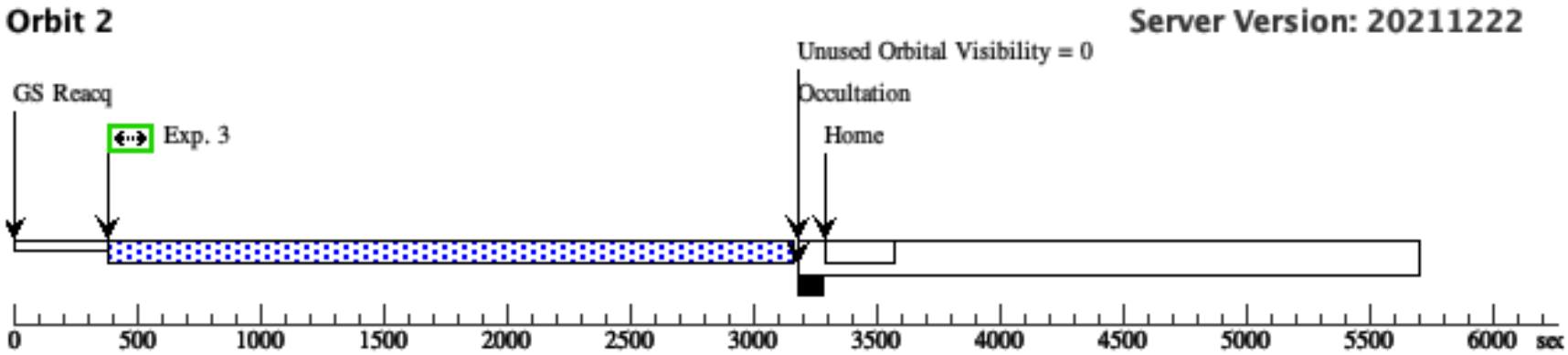
Comments:
Category=EXT-STAR
Description=[EMISSION LINE STAR, SDO, UNDESIGNATED, WIND]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1525794)	(1) J095921.90+304518.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				62 Secs (62 Secs) *[==>]*	 ***[1]***
2	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=1; FLASH=YES; BUFFER-TIME=2308			2200 Secs (2308 Secs) *[==>2308.0 Secs]*	 ***[1]***
3	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=2; FLASH=YES; BUFFER-TIME=2724			2200 Secs (2724 Secs) *[==>2724.0 Secs]*	 ***[2]***

Orbit Structure





Visit

Proposal 16717, Visit 02, completed Mon May 16 19:00:15 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

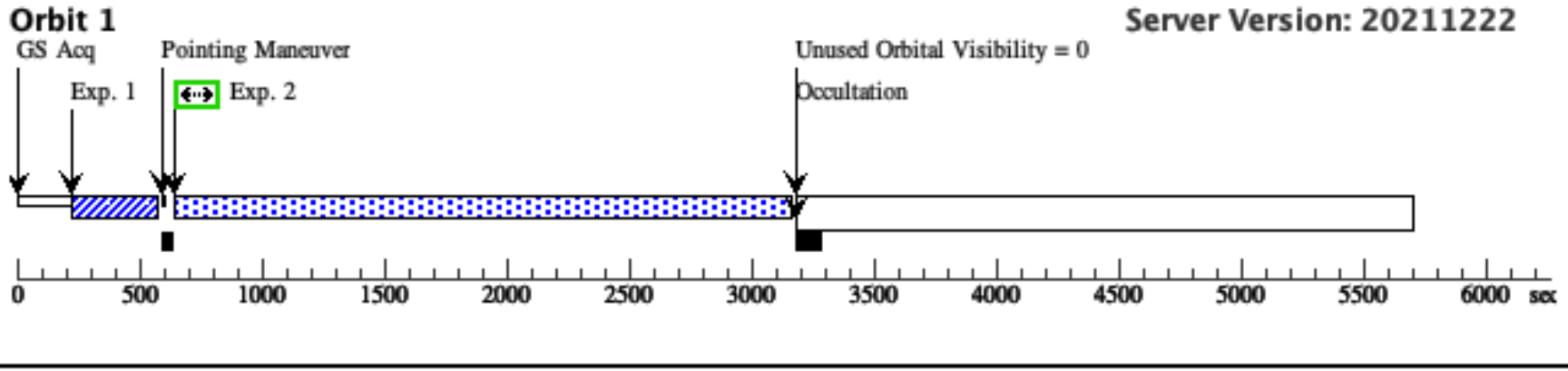
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J095921.90+304518.1	RA: 09 59 21.9000 (149.8412500d) Dec: +30 45 18.07 (30.75502d) Equinox: J2000		V=19.9	Reference Frame: ICRS

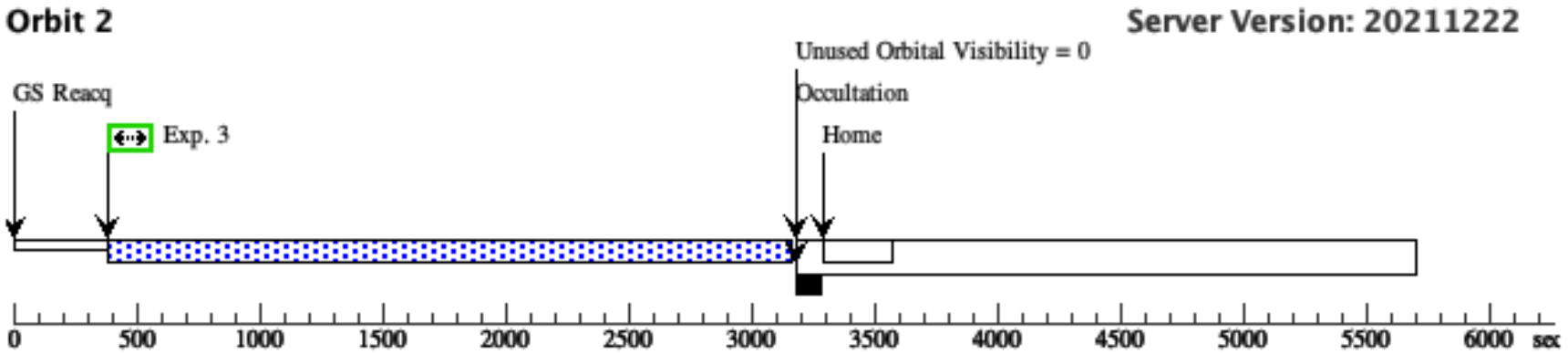
Comments:
Category=EXT-STAR
Description=[EMISSION LINE STAR, SDO, UNDESIGNATED, WIND]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1525794)	(1) J095921.90+304518.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				62 Secs (62 Secs) *[==>]*	*[1]*
2	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=2; FLASH=YES; BUFFER-TIME=2308			2200 Secs (2308 Secs) *[==>2308.0 Secs]*	*[1]*
3	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=3; FLASH=YES; BUFFER-TIME=2724			2200 Secs (2724 Secs) *[==>2724.0 Secs]*	*[2]*

Orbit Structure





Visit

Proposal 16717, Visit 03, completed Mon May 16 19:00:15 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

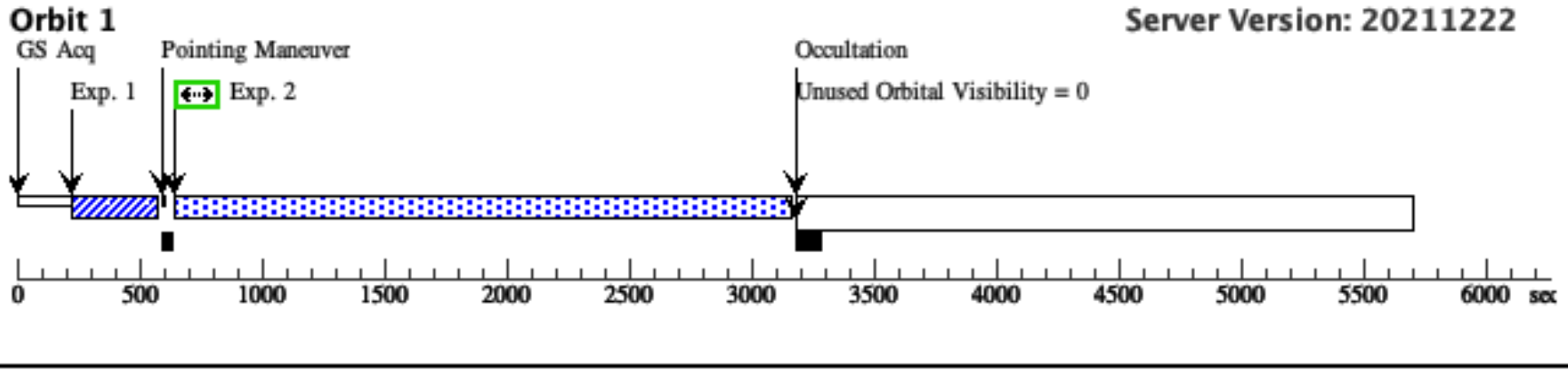
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J095921.90+304518.1	RA: 09 59 21.9000 (149.8412500d) Dec: +30 45 18.07 (30.75502d) Equinox: J2000		V=19.9	Reference Frame: ICRS

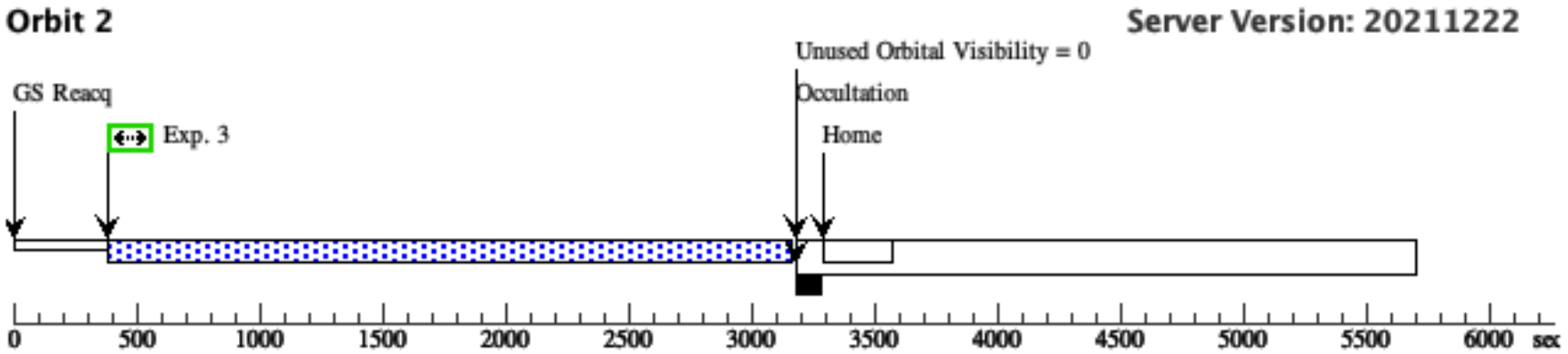
Comments:
Category=EXT-STAR
Description=[EMISSION LINE STAR, SDO, UNDESIGNATED, WIND]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1525794)	(1) J095921.90+304518.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				62 Secs (62 Secs) *[==>]*	 ***[1]***
2	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=3; FLASH=YES; BUFFER-TIME=2308			2200 Secs (2308 Secs) *[==>2308.0 Secs]*	 ***[1]***
3	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=4; FLASH=YES; BUFFER-TIME=2724			2200 Secs (2724 Secs) *[==>2724.0 Secs]*	 ***[2]***

Orbit Structure





Visit

Proposal 16717, Visit 04, completed Mon May 16 19:00:15 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J095921.90+304518.1	RA: 09 59 21.9000 (149.8412500d) Dec: +30 45 18.07 (30.75502d) Equinox: J2000		V=19.9	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[EMISSION LINE STAR, SDO, UNDESIGNATED, WIND]
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.ta.1525794)	(1) J095921.90+304518.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				62 Secs (62 Secs) *[==>]*	***[1]***
2	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=4; FLASH=YES; BUFFER-TIME=2308			2200 Secs (2308 Secs) *[==>2308.0 Secs]*	***[1]***
3	(COS.sp.1525795)	(1) J095921.90+304518.1	COS/FUV, TIME-TAG, PSA	G160M 1589 A	FP-POS=1; FLASH=YES; BUFFER-TIME=2724			2200 Secs (2724 Secs) *[==>2724.0 Secs]*	***[2]***

Orbit Structure