17122 - Testing Planetary Formation Mechanisms through the First FUV - Optical Spectrum of a Young, Accreting Planet

Cycle: 30, 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	(2) GAIA-DR3-4914632262501979520 (3) SCR-J0103-5515C-OFFSET	STIS/CCD STIS/NUV-MAMA	2	17-Dec-2024 16:00:12.0	yes
02	(2) GAIA-DR3-4914632262501979520 (3) SCR-J0103-5515C-OFFSET	STIS/CCD	2	17-Dec-2024 16:00:13.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(2) GAIA-DR3-4914632262501979520 (3) SCR-J0103-5515C-OFFSET	COS/FUV COS/NUV	5	17-Dec-2024 16:00:16.0	yes
51	(2) GAIA-DR3-4914632262501979520 (4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD STIS/NUV-MAMA	2	17-Dec-2024 16:00:18.0	yes
52	(2) GAIA-DR3-4914632262501979520 (4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD	2	17-Dec-2024 16:00:18.0	yes
53	(2) GAIA-DR3-4914632262501979520 (4) SCR-J0103-5515C-OFFSET-CORR	COS/FUV COS/NUV	5	17-Dec-2024 16:00:22.0	yes

18 Total Orbits Used

ABSTRACT

A new method of studying the formation history of exoplanets has recently become available through observations of accretion signatures in young substellar systems. We propose to obtain the first spectrum of a young, accreting planetary mass companion spanning FUV to optical wavelengths. This unprecedented measurement will enable us to calibrate substellar accretion diagnostics by directly measuring the NUV accretion continuum excess and probing the structure of the planetary accretion shock through FUV emission lines. The ideal target for these measurements is Delorme AB(b), a nearby, widely separated, young planetary-mass companion with a moderate accretion rate. Growing evidence of deviation at low masses above the empirical mass-mass accretion rate relationship established for stars suggests that substellar companions may form through disk fragmentation rather than core collapse. However, models of substellar accretion shocks differ in several fundamental ways from those designed for the stellar magnetospheric accretion paradigm. This suggests that the current stellar-derived, ground-based (e.g., optical/IR emission lines and the Balmer jump) accretion diagnostics may not be suitable for planets and brown dwarfs. Our proposed observations are critical to test these scenarios and improve our understanding of the substellar accretion process and the formation mechanisms of planets and brown dwarfs.

OBSERVING DESCRIPTION

********** Overview of Observations **********

We propose to obtain a gapless FUV - optical spectrum using COS and STIS of the young planet Delorme 1 (AB)b. We can complete our scientific goals with a total of 9 orbits.

For our COS measurements, we will use the G160M grating and for our STIS measurements, we plan to use the G230L and G430L gratings with the 0.2" slit. This slit was selected to maximize SNR while eliminating the possibility of contamination from the nearby (1.77") Delorme AB binary pair.

********** The Need for Contemporaneous Observations: **********

While optical spectra can be obtained from the ground for some substellar accreting objects, variability in measured accretion rates for planetary-mass objects can be significant. Accretion for substellar objects has been observed to vary on timescales of hours to weeks. Variability in non-contemporaneous observations may introduce systematic effects that would significantly weaken our key scientific objective of calibrating accretion diagnostics for existing/future space- and ground-based observations. Interpreting the FUV line profiles also relies heavily on detailed modeling of the NUV continuum. As such, we require that our FUV, NUV, and optical observations be obtained within adjacent orbits. Details for each requested observation are as follows.

********** FUV COS Observation Summary **********

We require moderate-resolution spectra to resolve the broad and narrow components of FUV emission lines which are unique probes of the accretion shock. Previous successful observations of the similar accreting substellar object 2M1207 used the COS 160M to successfully resolve the line profiles the C IV doublet (1548 and 1550 angstroms), which is necessary to complete our science objectives. This, along with the increased FUV sensitivity of COS over STIS, motivated our choice to use the COS detector with the G160M grating. We have chosen to use the 1533 and 1611 angstrom cenwave settings, because this allows for complete wavelength coverage between 1342 and 1784 angstroms while ensuring that neither lines in the C IV doublet are near detector edges in both modes. Furthermore, the wavelength coverage of this observing strategy includes all but one of the H2 lines (which probe the circumplanetary disk) that were identified by France et al. 2010 in both modes. Note that the requested cenwave setting has been corrected from the 1600 setting to the 1533 setting to increase the requested wavelength coverage.

We computed exposure times using the COS ETC and a COS spectrum of the accreting brown dwarf 2M1207 scaled to the equivalent estimated flux in the FUV and NUV for an object with the average inferred accretion rate of Delorme 1 (AB)b from multiple accretion line diagnostics (Mdot \approx 10^-11 Msun).

********** COS Acquisition Details **********

Given the faint nature of the planetary companion (V~23) and the relative faintness of its primary M-dwarf hosts in the UV (as well as to avoid safety limit issues due to potential primary flares), the COS G160M observations will require an initial target acquisition on a nearby (d = 1.5 arcmin) V=16.53 Gaia source (Gaia DR3 4914632262501979520) with a 20 s exposure before offsetting to the planet to ensure proper placement in the 2.5 arcsec COS science aperture. To center the COS FOV on the low-mass companion, we apply an RA offset of +3.6 sec and a Dec offset of +85.9461 arcsec. Within the APT, we have defined the coordinates of the low-mass companion in terms of these offsets from the GAIA source that we will use for our COS observations. This process follows along Section 8.10.3 in the COS instrument manual for Offset target acquisitions, which notes that this may be limited by guide stars remaining within the FOV of their respective FGS fields.

We note that the coordinates generated by the APT for the companion do not match those on Simbad. The coordinates from Simbad appear to be correct based on our comparison of the astrometry provided by Delorme et al. (2012) to that of the APT. Following this, the offset between the GAIA offset star and the companion reflects the position calculated using the J2000 IRCS Simbad coordinates of the companion, and the FK5 coordinates from Gaia converted into ICRS coordinates of the companion star.

********** FUV COS Observation Details **********

An observing sequence of 5 orbits with the G160M grating provides SNR of ~5 in the C IV line and a SNR of 2-3 in various $\rm{H_2}$, Si, C, N, O, lines. This is sufficient to accomplish our science objectives. After accounting for the offset star acquistion, pointing maneuver, and other overheads, we will expose twice for 1066 s and 1065 s during orbit 1 in the 1533 wavecen mode. Using the same mode, we will complete 2 x 1299 s exposures in orbit 2, and a 1299 s and 1296 s exposure in orbit 3. We then switch to the 1611 wavecen mode, and complete a 1299 s and 1296 s exposures during orbit 4 and 5. We choose to prioritize time in the 1533 position because the 1600 "H2 bump" (which is a potentially interesting feature that has been observed for TTS) falls into the gap in the 1611 wavecen position.

Following Table 2.0 in the COS instrument manual for the G160M mode, we will be using LP6 for our COS observations, and using all four FP-POS for both CENWAVE settings. This is slightly different than the original proposal which requested 2 FP-POS, as the overheads incurred when switching betwen FP-POS were very minimal (3 s per orbit).

Because of the wide angular separation between Delorme 1 (AB)b and the system barycenter (1.77 arcsec), flaring from the central pair of M-dwarf binary stars should not be a concern for STIS/COS flaring safety limits. Based on the relative transmission of the COS detectors as a function of

offset from the center of the detector (Figure 8.5 in the COS handbook), when Delorme 1 (AB)b is centered, the AB pair lie off the detector itself in a region where only 5% of the flux would be transmitted.

********** NUV STIS G230L MAMA Summary **********

STIS 230L observations of Delorme 1 AB(b) with the MAMA detector using the 52 x 0.2 arcsec slit will be used to recover the NUV continuum arising from accretion. We chose the STIS NUV MAMA detector for its increased sensitivity compared the STIS CCD, and because of the unbroken wide wavelength grasp (compared to COS NUV). Obtaining a wavelength-complete spectrum of the NUV with COS would add a significant number of orbits to our request and the low-resolution STIS G230L observations are sufficient to accomplish our science objectives as we do not require resolved NUV line profiles. We chose the 0.2 arcsec slit as a compromise between sensitivity and avoiding any possible contamination from the AB pair (which could be an issue for larger slits that maximize throughput, e.g., 2.0 arcsec). Similar to our COS observations, flaring from the AB pair is not a safety concern for our STIS MAMA observations. Based on Figure 7.16 of the STIS IHB, the PSF of the MAMA detector drops to less than 10^(-5) times the peak normalized intensity at a distance of 40 pixels, and the AB pair is even further away (~77 pixels).

********** STIS NUV G230L details **********

Similar to our FUV observations, we used a scaled COS NUV spectrum of 2M1207 as a template for the STIS ETC and find that we are able to recover the continuum at a SNR of ~2 near 2600 angstroms with 2 orbits. While we expect that our SNR will be lower at the blue end of the spectrum because of the detector throughput and spectral slope of our object, we find that our requested observations will be sufficient to accomplish our science objectives, especially if binning is used to increase the SNR in select line-free regions. During orbit 1 of the STIS observations, we will exposure for 2060 s in the G230L mode, and during orbit 2, we will exposure for 2969 s in the same mode. Both observations will be made using the STIS/NUV-MAMA detector in the TIME-TAG mode, with a BUFFER-TIME of 700 s (derived from our ETC calculations).

********** STIS 430L CCD Details **********

To recover the Balmer jump and several of the lines in the Balmer series (H beta, H gamma, H delta, etc.,) we require contemporaneous STIS 430L observations of our object. Using MUSE observations of Delorme 1 AB(b), as a template for the STIS ETC, we find that we are able to recover these lines at a SNR of >5 within only two orbits. These observations will also be sensitive to the anticipated continuum of the planet at an SNR of 2-10 between 4500-5700 angstroms, which is not possible from ground-based observations with the VLT . To accomplish these goals, we will expose for 2098 s during orbit 1 for 2822 s during orbit 2 using the 52 x 0.2 slit and the ACCUM mode with the STIS CCD. We include a CR-SPLIT 2 to help mitigate the effect of cosmics rays.

********** STIS CCD + MAMA Acquisition details **********

Similar to our COS acquisition, we require a target acquisition on the same nearby (d = 1.5 arcmin) V=16.53 Gaia source (Gaia DR3 4914632262501979520) with a 1.3 s exposure using the default acquisition aperture (F28X50LP). This is sufficient to reach a SNR of 50. After acquiring the Gaia source, we apply an RA offset of +3.6 sec and a Dec offset of +85.9461 arcsec to center the low-mass companion on the 0.2" slit. This acquisition strategy will be used for both Visits 1 and 2 (the STIS-MAMA and STIS-CCD observations, respectively).

We also include a PEAKUP during both STIS visits because of the offset manuever and the high-proper motion of the system. This acquisition will be completed using the 52x0.1 slit and the CCD detector. Note that this slit differs from the slit used to do our observations as PEAKUPs are typically not recommended for the 52x0.2 aperture. Based on ETC calculations using an appropriate BT Settl photosphere scaled to the brightness of the companion, we expect to reach 7300 e- from the source during a 10s exposure, which is ~50% higher than the minimum required 5000 e-.

********** ORIENT requirements **********

In order to obtain STIS spectra of the companion that are not contaminated by stellar flux from the nearby host binary pair, we require specific ORIENT constraints to place the host stars perpendicular to STIS' spectroscopic slit axis, as illustrated in Figure 3 of our Phase 1 proposal. Given the position angle of the barycenter of the AB system at 336.1 degrees E of N, we request an ORIENT range of either 106-116 degrees or 286-296 degrees for the STIS G230L and G430L observations. These offsets include the instrument offset from Table 6.2 to place the spatial axis perpendicular to that of the PA between the AB system and the companion. Because the COS observations must be obtained in series with our STIS observations, we request the same orientation.

Visit

Proposal 17122, STIS-MAMA (01), failed Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: SCHED 100%; ORIENT 60D TO 160 D; ORIENT 240D TO 340 D; GROUP 01,02,03 WITHIN 9.5 Orbits

Comments: The spatial axis of the slit should be perpendicular to the line between the M-dwarf binary pair and the companion (to avoid placing the M-dwarfs on the slit). Because of variability, these observations must be taken sequentially with the STIS-CCD and COS observations (although the order does not matter).

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.60 seconds of time and a Dec offset of +85.9461 arcsec.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SCR-J0103-5515C-OFFSET	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.6 Secs Dec Offset: 85.9461 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET)

Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has been calculated to take into the consideration the sizeable proper motion of the companion from its original J2000 measurement in 2012.
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.1864970)	(2) GAIA-DR3-4914632262501979520	STIS/CCD, ACQ, F28X50LP	MIRROR				1.3 Secs (1.3 Secs) *[==>]*	 ***[1]***

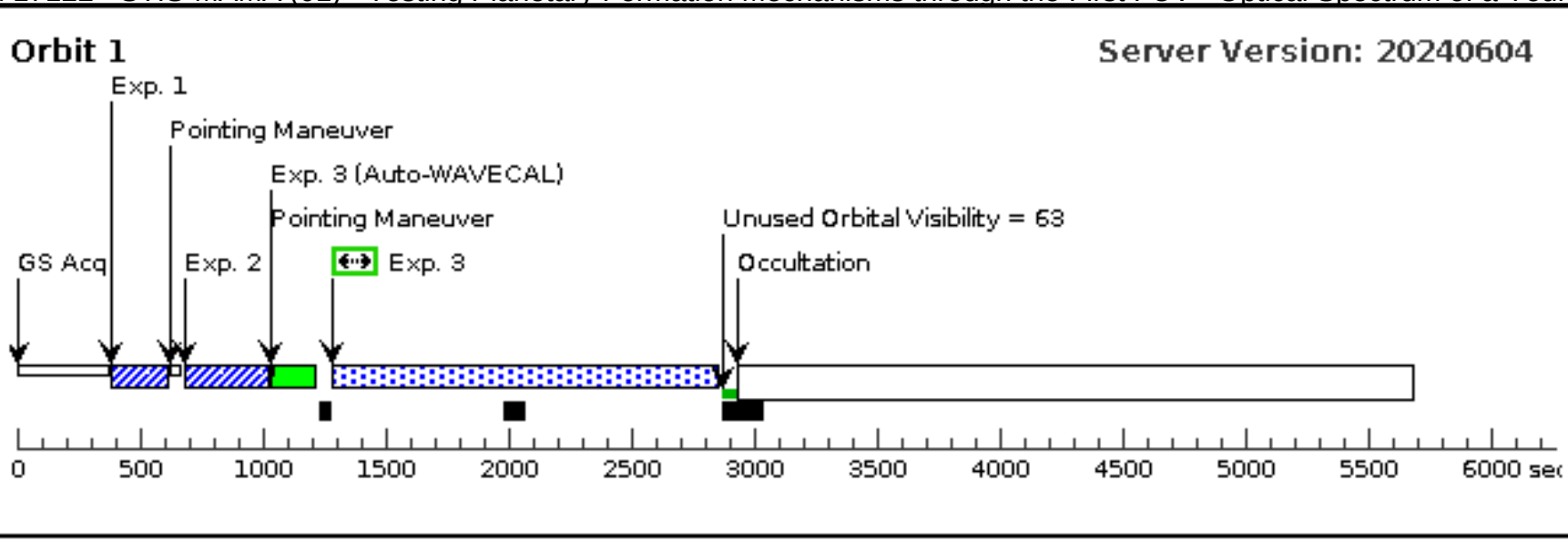
Comments: Target acquisition performed on this reference star before offsetting to planet companion for peakup and the actual observations w/G230L MAMA. ETC calculation assumes Bruzual K3V spectrum normalized to Gaia DR3 photometry.

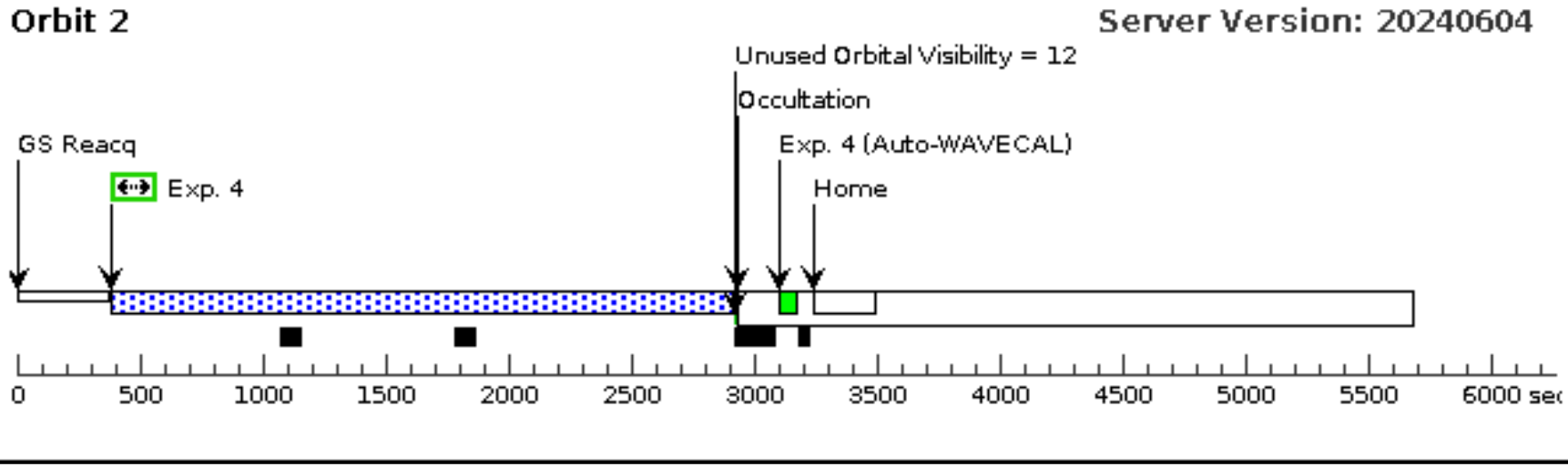
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	PEAKUP (1865065)	(3) SCR-J0103-5515C-OFFSET	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				10 Secs (10 Secs) *[==>]*	 ***[1]***

Comments: A PEAKUP on the low-mass companion is requested because of the offset acquisition strategy and the high proper motion of the source. Note that the chosen aperture for the PEAKUP is smaller than our science aperture (52x0.2). An exposure time of 10s is estimated to yield 7300 e- (~50% more than the required 5000 e- following the STIS handbook).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	G230L (STIS.sp.1865090)	(3) SCR-J0103-5515C-OFFSET	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=700			1555 Secs (1555 Secs) *[==>]*	 ***[1]***
4	G230L (STIS.sp.1865090)	(3) SCR-J0103-5515C-OFFSET	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=700			2514 Secs (2514 Secs) *[==>]*	 ***[2]***

Orbit Structure





Visit

Proposal 17122, STIS-CCD (02), failed Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: SCHED 100%; ORIENT 60D TO 160 D; ORIENT 240D TO 340 D

Comments: The spatial axis of the slit should be perpendicular to the line between the M-dwarf binary pair and the companion (to avoid placing the M-dwarfs on the slit). Because of variability, these observations must be taken sequentially with the STIS-MAMA and COS observations (although the order does not matter).

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.60 seconds of time and a Dec offset of +85.9461 arcsec.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

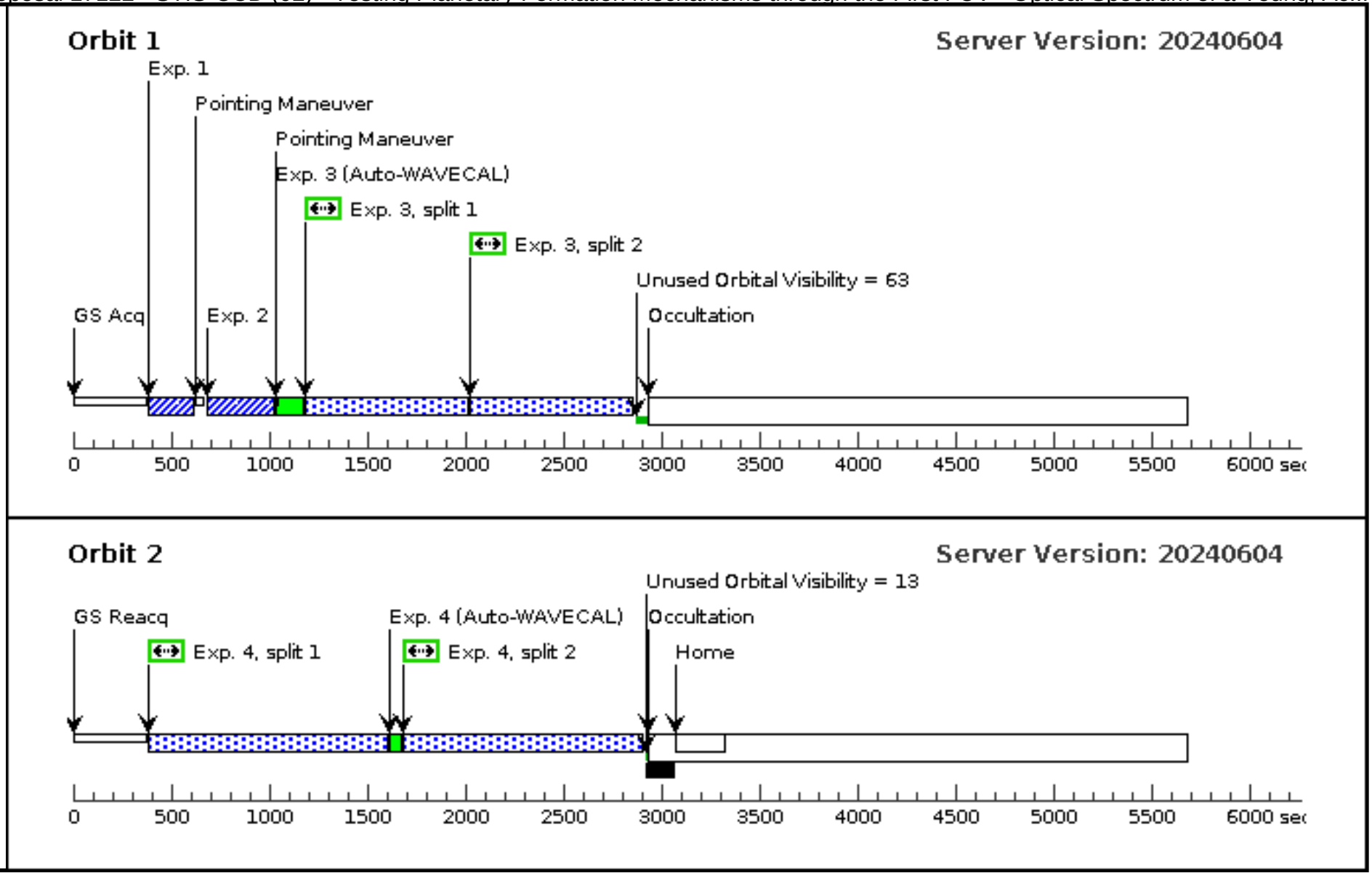
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SCR-J0103-5515C-OFFSET	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.6 Secs Dec Offset: 85.9461 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET)

Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has been calculated to take into the consideration the sizeable proper motion of the companion from its original J2000 measurement in 2012.
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.1864970)	(2) GAIA-DR3-4914632262501979520	STIS/CCD, ACQ, F28X50LP	MIRROR				1.3 Secs (1.3 Secs) *[==>]*	 ***[1]***
	Comments: Target acquisition performed on this reference star before offsetting to planet companion for peakup and the actual observations w/ G430L grating + CCD. ETC calculation assumes Bruzual K3V spectrum normalized to Gaia DR3 photometry.								
2	PEAKUP (1865065)	(3) SCR-J0103-5515C-OFFSET	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				10 Secs (10 Secs) *[==>]*	 ***[1]***
	Comments: A PEAKUP on the low-mass companion is requested because of the offset acquisition strategy and the high proper motion of the source. Note that the chosen aperture for the PEAKUP is smaller than our science aperture (52x0.2). An exposure time of 10s is estimated to yield 7300 e- (~50% more than the required 5000 e- following the STIS handbook).								
3	CCD (STIS.sp.1736421)	(3) SCR-J0103-5515C-OFFSET	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	CR-SPLIT=2			1594 Secs (1594 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	 ***[1]***
4	CCD (STIS.sp.1736421)	(3) SCR-J0103-5515C-OFFSET	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	CR-SPLIT=2			2366 Secs (2366 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	 ***[2]***

Orbit Structure



Visit

Proposal 17122, COS G160M (03), failed Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%

Comments: Because of variability, these observations must be taken sequentially with the STIS-MAMA and STIS-CCD observations (although the order does not matter).
All of the science exposures should be taken in LP6. We are using all 4 FP-POS since the overheads incurred by switching mid-orbit are minimal (~3 s)

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.60 seconds of time and a Dec offset of +85.9461 arcsec.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

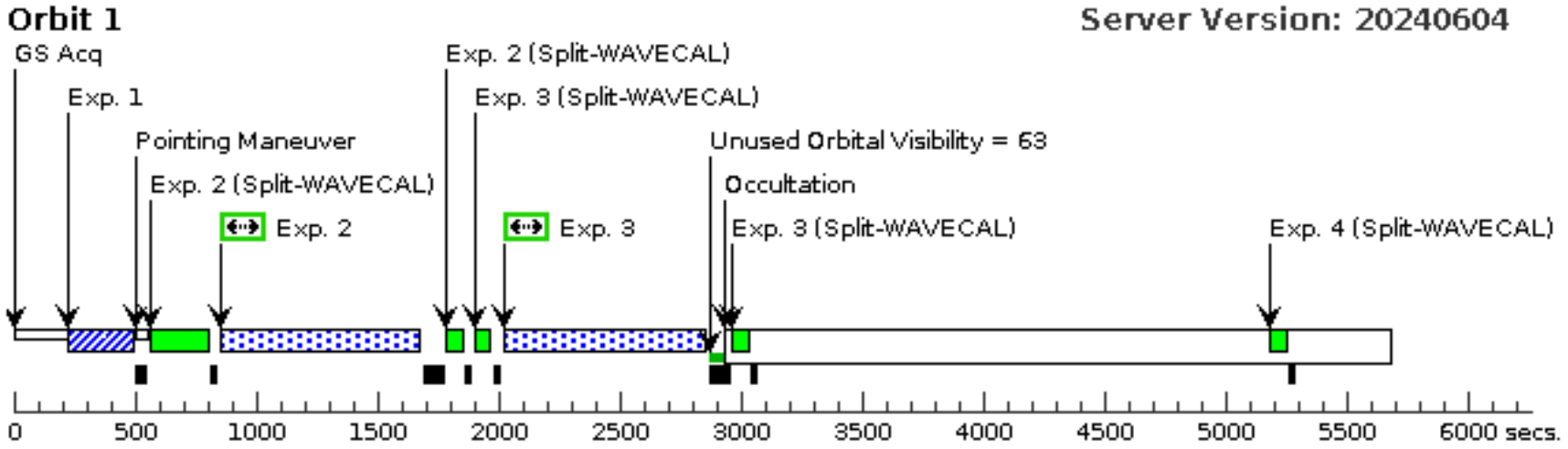
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SCR-J0103-5515C-OFFSET	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.6 Secs Dec Offset: 85.9461 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET)

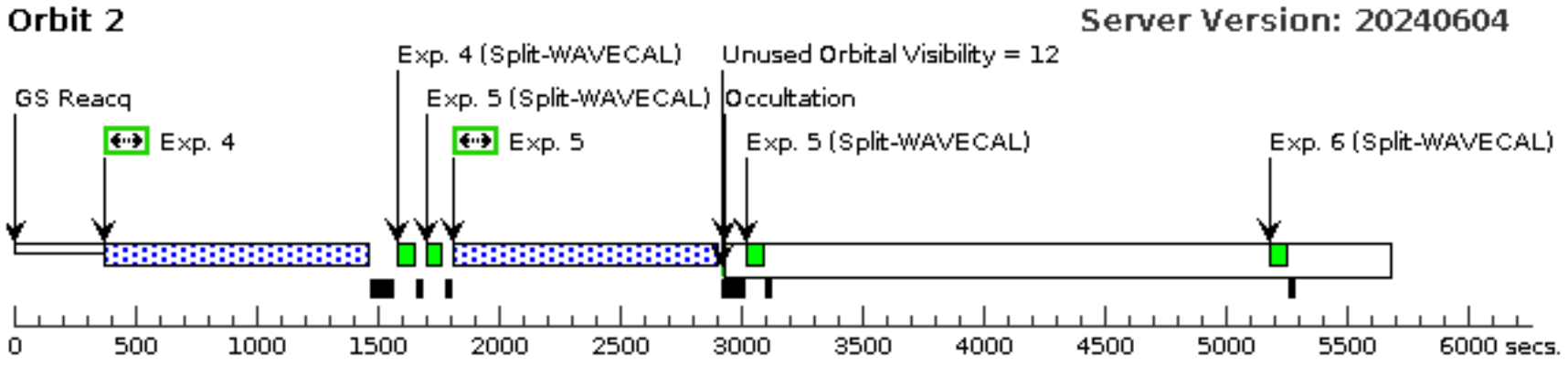
Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has been calculated to take into the consideration the sizeable proper motion of the companion from its original J2000 measurement in 2012.
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

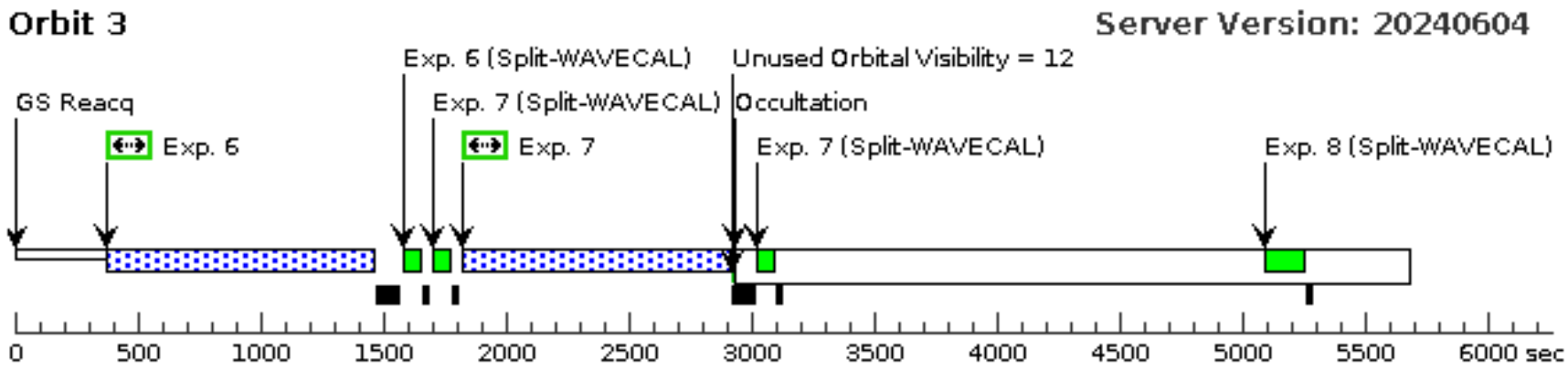
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquisition (COS.ta.1865108)	(2) GAIA-DR3-4914632262501979520	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				28 Secs (28 Secs) *[==>]*	***[1]***
	Comments: Following instrument science report COS 2010-14(v1), we will use the NUV COS mode using MIRRORA and the PSA to acquire our GAIA offset star. The requested exposure time will reach a SNR of 20 (following the advice on the ETC), based upon the GALEX NUV AB magnitude of 22.5. The science target for these observations is defined as an offset from the coordinates of this GAIA star (Target Number 3).								
2	Science - 1533 Orbit 1 - EXP 1 (COS.sp.1814645)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1012; FP-POS=1			770 Secs (770 Secs) *[==>]*	***[1]***
	Comments: These observations will require an offset from the acquistion source to the target.								
3	Science - 1533 Orbit 1 - EXP 2 (COS.sp.1814645)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1027; FP-POS=1	SAME POS AS 2		783 Secs (783 Secs) *[==>]*	***[1]***
	Comments: These observations will require an offset from the acquistion source to the target. Buffer time chosen to be 1/4th of								
4	Science - 1533 Orbit 2 - EXP 1 (COS.sp.1814657)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1261; FP-POS=2	SAME POS AS 2		1038 Secs (1038 Secs) *[==>]*	***[2]***
5	Science - 1533 Orbit 2 - EXP 2 (COS.sp.1814657)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1261; FP-POS=2	SAME POS AS 2		1038 Secs (1038 Secs) *[==>]*	***[2]***
6	Science - 1533 Orbit 3 - EXP 1 (COS.sp.1814657)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1260; FP-POS=3	SAME POS AS 2		1037 Secs (1037 Secs) *[==>]*	***[3]***
7	Science - 1533 Orbit 3 - EXP 2 (COS.sp.1814657)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1259; FP-POS=4	SAME POS AS 2		1036 Secs (1036 Secs) *[==>]*	***[3]***
8	Science - 1611 Orbit 4 - EXP 1 (COS.sp.1814658)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1260; FP-POS=1	SAME POS AS 2		1037 Secs (1037 Secs) *[==>]*	***[4]***
9	Science - 1611 Orbit 4 - EXP 2 (COS.sp.1814658)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1259; FP-POS=2	SAME POS AS 2		1036 Secs (1036 Secs) *[==>]*	***[4]***
10	Science - 1611 Orbit 5 - EXP 1 (COS.sp.1814658)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1260; FP-POS=3	SAME POS AS 2		1037 Secs (1037 Secs) *[==>]*	***[5]***
11	Science - 1611 Orbit 5 - EXP 2 (COS.sp.1814658)	(3) SCR-J0103-5515 C-OFFSET	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1259; FP-POS=4	SAME POS AS 2		1036 Secs (1036 Secs) *[==>]*	***[5]***

Orbit Structure



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Server Version: 20240604
GS Reacq
Exp. 6
Exp. 6 (Split-WAVECAL)
Exp. 7 (Split-WAVECAL)
Exp. 7
Unused Orbital Visibility = 12
Occultation
Exp. 7 (Split-WAVECAL)
Exp. 8 (Split-WAVECAL)
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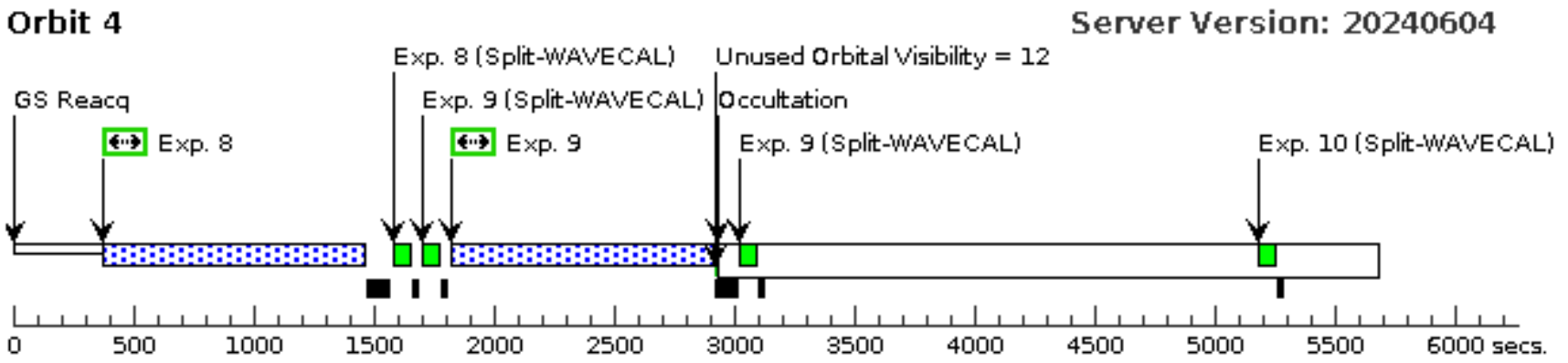
Orbit 4
Server Version: 20240604
GS Reacq
Exp. 8
Exp. 8 (Split-WAVECAL)
Exp. 9 (Split-WAVECAL)
Exp. 9
Unused Orbital Visibility = 12
Occultation
Exp. 9 (Split-WAVECAL)
Exp. 10 (Split-WAVECAL)
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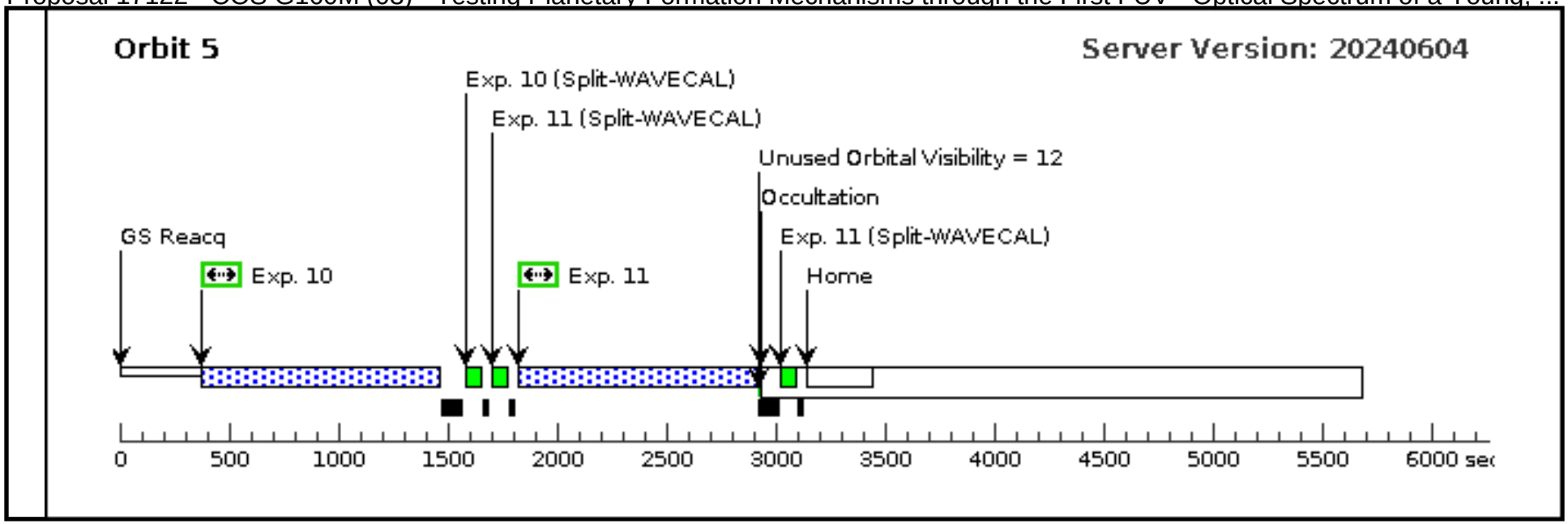

Orbit 5
Server Version: 20240604
Exp. 10 (Split-WAVECAL)
Exp. 11 (Split-WAVECAL)
Unused Orbital Visibility = 12
Occultation
GS Reacq
Exp. 10
Exp. 11
Exp. 11 (Split-WAVECAL)
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17122, STIS-MAMA (51) Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: SCHED 100%; ORIENT 60D TO 160 D; ORIENT 240D TO 340 D; GROUP 51,52,53 WITHIN 9.5 Orbits

Comments: The spatial axis of the slit should be perpendicular to the line between the M-dwarf binary pair and the companion (to avoid placing the M-dwarfs on the slit). Because of variability, these observations must be taken sequentially with the STIS-CCD and COS observations (although the order does not matter).

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.76401928 seconds of time and a Dec offset of +85.2877 arcsec.

HOPR repeat of visit 01

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	SCR-J0103-5515C-OFFSET-CORR	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.76401928 Secs Dec Offset: 85.2877 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET-CORR)

Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has been calculated to take into the consideration the sizeable proper motion of the companion from its considerable proper motion from its discovery in J2012.

The offsets have be corrected from the original observing request to reflect that the reported coordinates in the orginal discovery paper were in the J2000 epoch, not J2012 as part of the HOPR repeat request. The requested offset is in epoch J2025.5 (the middle of the large available observing window).

IMPORTANT: If the actual observing window is signficantly different than J2025.5, then a new offset will need to be calculated to reflect this change due to the high proper motion of the source! (~0.1 arcsec/yr)
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.1864970)	(2) GAIA-DR3-4914632262501979520	STIS/CCD, ACQ, F28X50LP	MIRROR				1.3 Secs (1.3 Secs) *[==>]*	 ***[1]***

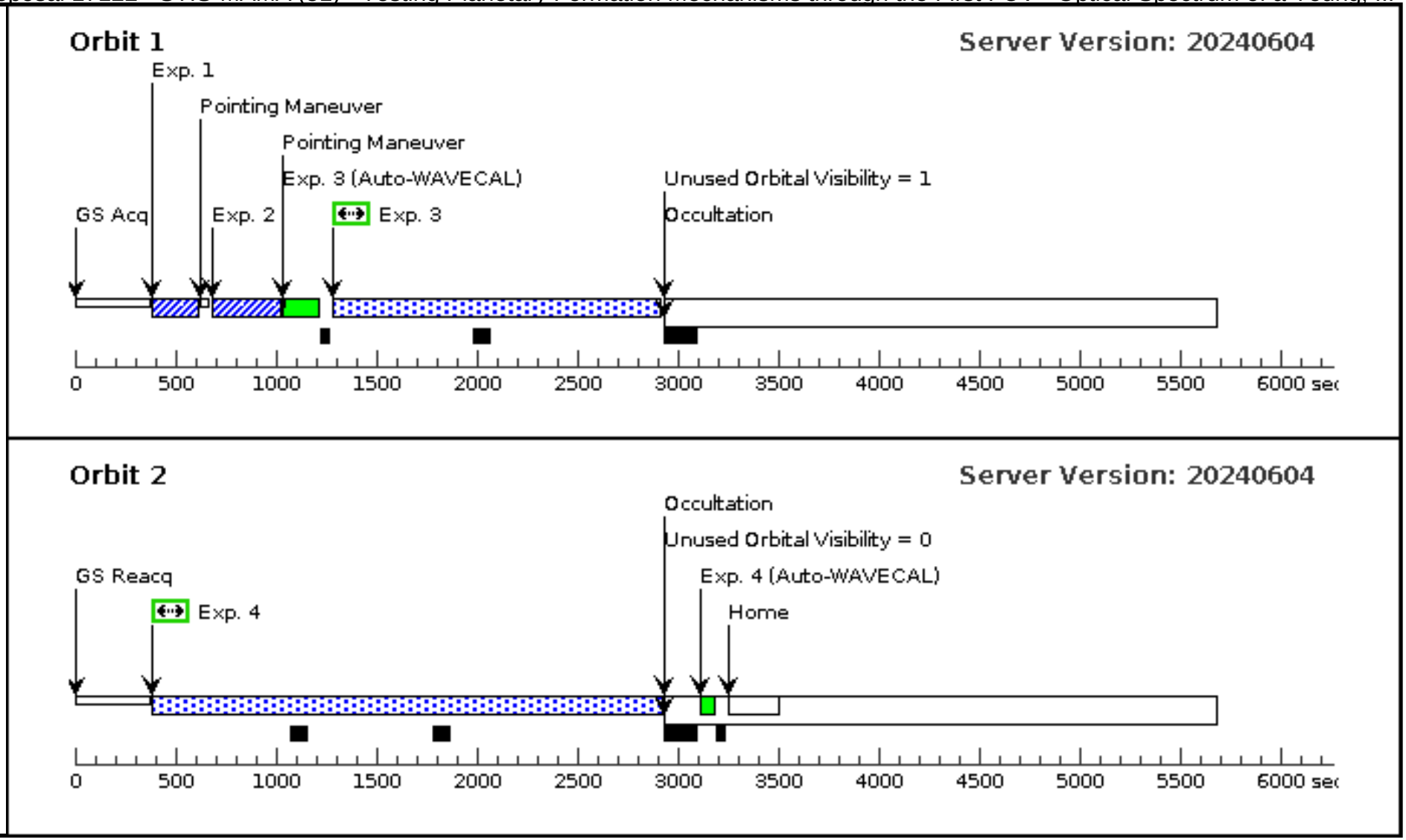
Comments: Target acquisition performed on this reference star before offsetting to planet companion for peakup and the actual observations w/G230L MAMA. ETC calculation assumes Bruzual K3V spectrum normalized to Gaia DR3 photometry.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	PEAKUP (1865065)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				10 Secs (10 Secs) *[==>]*	 ***[1]***

Comments: A PEAKUP on the low-mass companion is requested because of the offset acquisition strategy and the high proper motion of the source. Note that the chosen aperture for the PEAKUP is smaller than our science aperture (52x0.2). An exposure time of 10s is estimated to yield 7300 e- (~50% more than the required 5000 e- following the STIS handbook).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	G230L (STIS.sp.1865090)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=700			1555 Secs (1618 Secs) *[==>1618.0 Secs]*	 ***[1]***
4	G230L (STIS.sp.1865090)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=700			2514 Secs (2526 Secs) *[==>2526.0 Secs]*	 ***[2]***

Orbit Structure



Visit

Proposal 17122, STIS-CCD (52) Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: SCHED 100%; ORIENT 60D TO 160 D; ORIENT 240D TO 340 D

Comments: The spatial axis of the slit should be perpendicular to the line between the M-dwarf binary pair and the companion (to avoid placing the M-dwarfs on the slit). Because of variability, these observations must be taken sequentially with the STIS-MAMA and COS observations (although the order does not matter).

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.76401928 seconds of time and a Dec offset of +85.2877 arcsec.

HOPR repeat of visit 02

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	SCR-J0103-5515C-OFFSET-CORR	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.76401928 Secs Dec Offset: 85.2877 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET-CORR)

Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has been calculated to take into the consideration the sizeable proper motion of the companion from its considerable proper motion from its discovery in J2012.

The offsets have be corrected from the original observing request to reflect that the reported coordinates in the orginal discovery paper were in the J2000 epoch, not J2012 as part of the HOPR repeat request. The requested offset is in epoch J2025.5 (the middle of the large available observing window).

IMPORTANT: If the actual observing window is signficantly different than J2025.5, then a new offset will need to be calculated to reflect this change due to the high proper motion of the source! (~0.1 arcsec/yr)
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.1864970)	(2) GAIA-DR3-4914632262501979520	STIS/CCD, ACQ, F28X50LP	MIRROR				1.3 Secs (1.3 Secs) *[==>]*	 ***[1]***

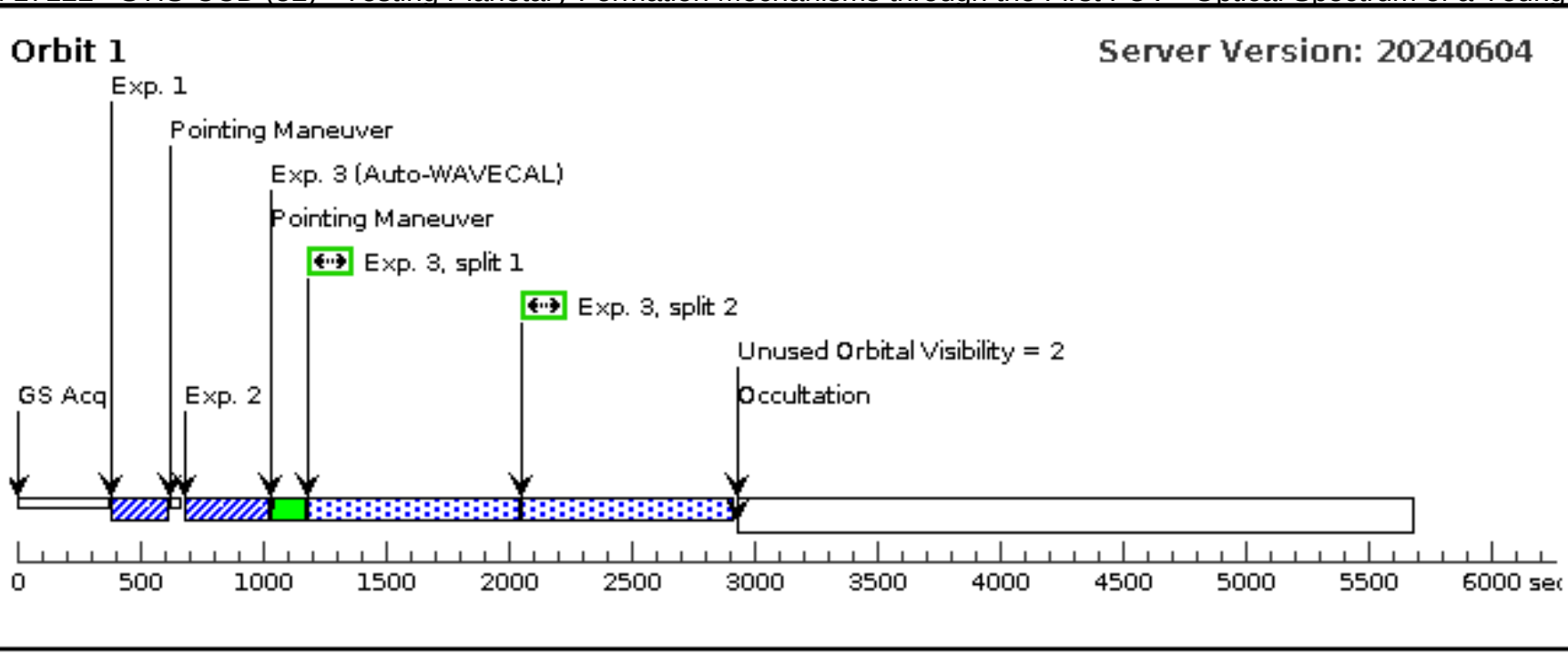
Comments: Target acquisition performed on this reference star before offsetting to planet companion for peakup and the actual observations w/ G430L grating + CCD. ETC calculation assumes Bruzual K3V spectrum normalized to Gaia DR3 photometry.

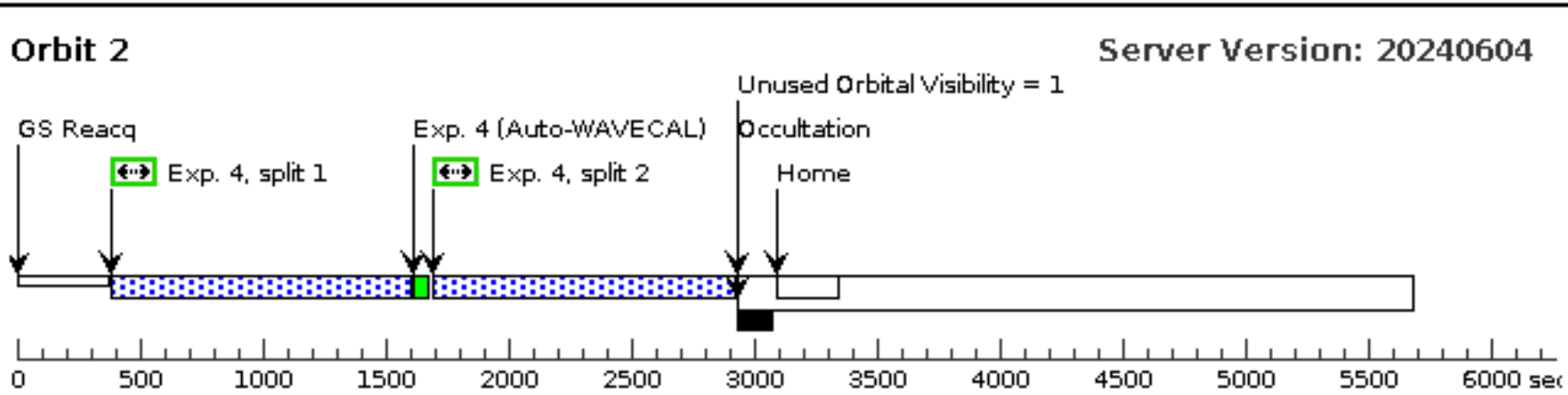
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	PEAKUP (1865065)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				10 Secs (10 Secs) *[==>]*	 ***[1]***

Comments: A PEAKUP on the low-mass companion is requested because of the offset acquisition strategy and the high proper motion of the source. Note that the chosen aperture for the PEAKUP is smaller than our science aperture (52x0.2). An exposure time of 10s is estimated to yield 7300 e- (~50% more than the required 5000 e- following the STIS handbook).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	CCD (STIS.sp.1736421)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	CR-SPLIT=2			1594 Secs (1656 Secs) *[==>828.0 Secs (Split 1)]* *[==>828.0 Secs (Split 2)]*	 ***[1]***
4	CCD (STIS.sp.1736421)	(4) SCR-J0103-5515C-OFFSET-CORR	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	CR-SPLIT=2			2366 Secs (2378 Secs) *[==>1189.0 Secs (Split 1)]* *[==>1189.0 Secs (Split 2)]*	 ***[2]***

Orbit Structure





Visit

Proposal 17122, COS G160M (53) Tue Dec 17 21:00:23 GMT 2024

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%

Comments: Because of variability, these observations must be taken sequentially with the STIS-MAMA and STIS-CCD observations (although the order does not matter).
All of the science exposures should be taken in LP6. We are using all 4 FP-POS since the overheads incurred by switching mid-orbit are minimal (~3 s)

Because of the faint nature of our target, we will do an acquisition of Gaia DR3 4914632262501979520, which is has a Gmag of 16.26 and is 1.5 arcmin away. It has a temperature of 4859K, and by applying the tables of Pecaut & Mamajek 2022 results in a Vmag of ~16.6. To center on the low-mass companion, we apply an RA offset of +3.76401928 seconds of time and a Dec offset of +85.2877 arcsec.

HOPR repeat of visit 03

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GAIA-DR3-4914632262501979520 Alt Name1: COS-OFFSET-STAR	RA: 01 03 32.0876 (15.8836983d) Dec: -55 17 20.76 (-55.28910d) Equinox: J2000	Proper Motion RA: 5.814 mas/yr Proper Motion Dec: -13.863 mas/yr Parallax: 0.0009354" Epoch of Position: 2000	V=16.58	Reference Frame: ICRS

Comments: These coordinates are from GAIA DR3 and have been converted into the ICRS frame from FK5. This source will be used for the COS acquistion, and as a reference for the offset for the companion for our COS observations (Target number 3).
Category=STAR
Description=[K V-IV]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	SCR-J0103-5515C-OFFSET-CORR	Offset from GAIA-DR3-4914632262501979520 RA Offset: 3.76401928 Secs Dec Offset: 85.2877 Arcsec		V=23.8	Offset Position (SCR-J0103-5515C-OFFSET-CORR)

Comments: This is the companion instead measured as an offset from Target number 2. The COS and STIS-CCD and STIS-MAMA observations will use Target 2 as the acquisition source and then center this companion. The offset has be calculated to take into the consideration the sizeable proper motion of the companion from its considerable proper motion from its discovery in J2012.

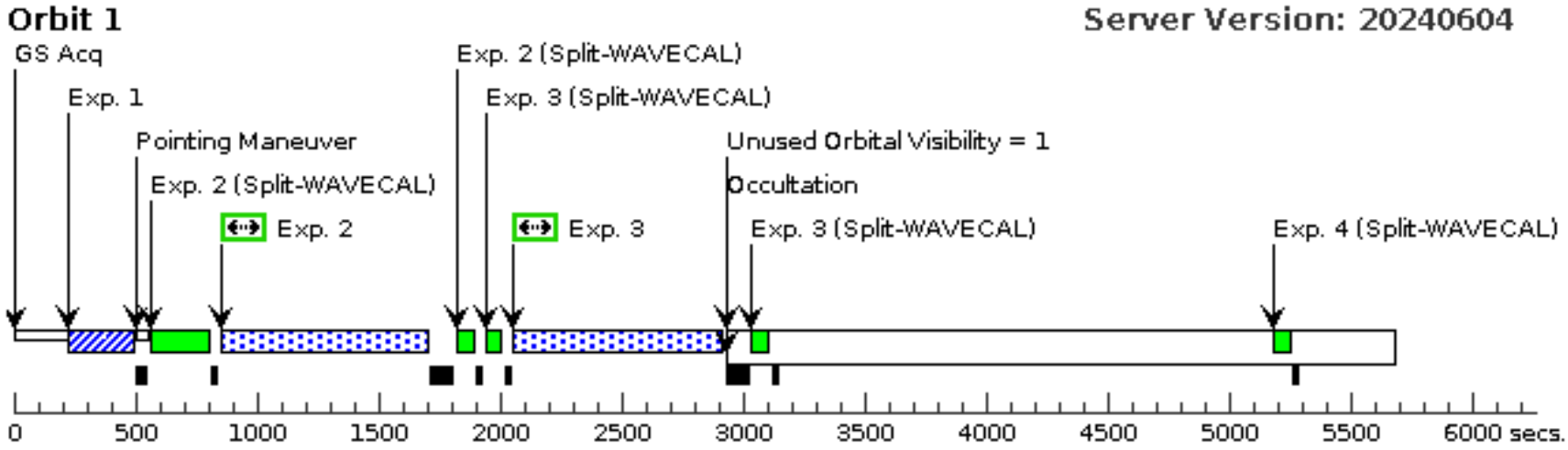
The offsets have be corrected from the original observing request to reflect that the reported coordinates in the orginal discovery paper were in the J2000 epoch, not J2012 as part of the HOPR repeat request. The requested offset is in epoch J2025.5 (the middle of the large available observing window).

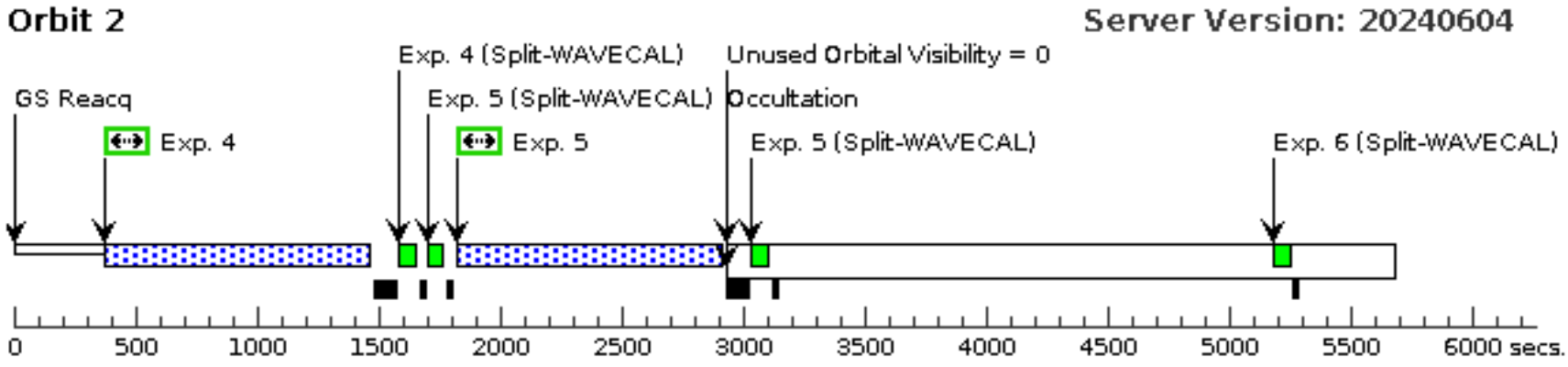
IMPORTANT: If the actual observing window is signficantly different than J2025.5, then a new offset will need to be calculated to reflect this change due to the high proper motion of the source! (~0.1 arcsec/yr)
Category=STAR
Description=[LOW MASS COMPANION]
Extended=NO

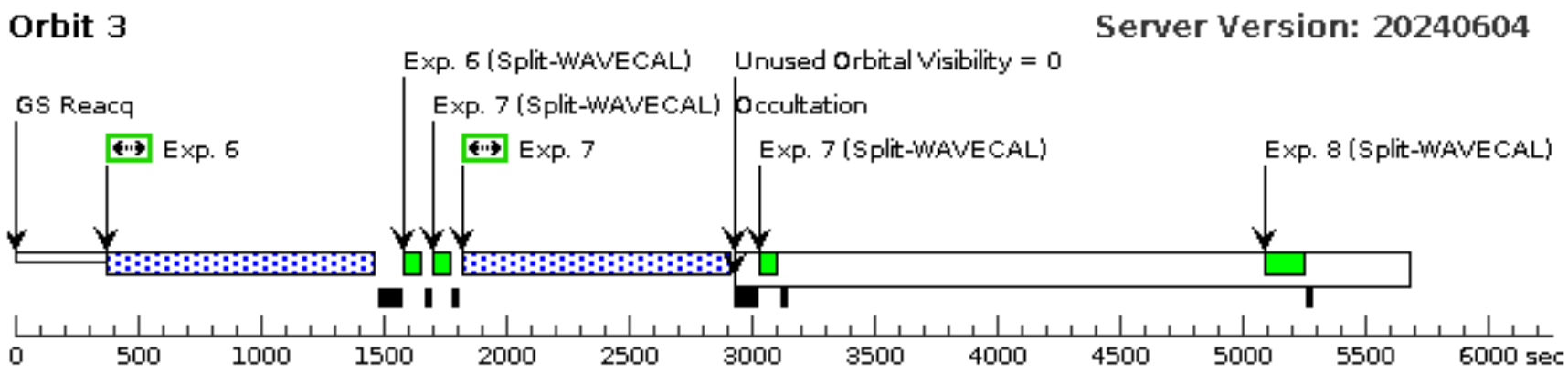
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acquisition (COS.ta.1865108)	(2) GAIA-DR3-4914632262501979520	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				28 Secs (28 Secs) *[==>]*	***[1]***
Comments: Following instrument science report COS 2010-14(v1), we will use the NUV COS mode using MIRRORA and the PSA to acquire our GAIA offset star. The requested exposure time will reach a SNR of 20 (following the advice on the ETC), based upon the GALEX NUV AB magnitude of 22.5. The science target for these observations is defined as an offset from the coordinates of this GAIA star (Target Number 3).									
2	Science - 1533 Orbit 1 - EXP 1 (COS.sp.1814645)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1012; FP-POS=1			770 Secs (796 Secs) *[==>796.0 Secs]*	***[1]***
Comments: These observations will require an offset from the acquistion source to the target.									
3	Science - 1533 Orbit 1 - EXP 2 (COS.sp.1814645)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1027; FP-POS=1	SAME POS AS 2		783 Secs (809 Secs) *[==>809.0 Secs]*	***[1]***
Comments: These observations will require an offset from the acquistion source to the target. Buffer time chosen to be 1/4th of									
4	Science - 1533 Orbit 2 - EXP 1 (COS.sp.1814657)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1261; FP-POS=2	SAME POS AS 2		1038 Secs (1044 Secs) *[==>1044.0 Secs]*	***[2]***
5	Science - 1533 Orbit 2 - EXP 2 (COS.sp.1814657)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1261; FP-POS=2	SAME POS AS 2		1038 Secs (1044 Secs) *[==>1044.0 Secs]*	***[2]***
6	Science - 1533 Orbit 3 - EXP 1 (COS.sp.1814657)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1260; FP-POS=3	SAME POS AS 2		1037 Secs (1043 Secs) *[==>1043.0 Secs]*	***[3]***
7	Science - 1533 Orbit 3 - EXP 2 (COS.sp.1814657)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1533 A	BUFFER-TIME=1259; FP-POS=4	SAME POS AS 2		1036 Secs (1042 Secs) *[==>1042.0 Secs]*	***[3]***
8	Science - 1611 Orbit 4 - EXP 1 (COS.sp.1814658)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1260; FP-POS=1	SAME POS AS 2		1037 Secs (1043 Secs) *[==>1043.0 Secs]*	***[4]***
9	Science - 1611 Orbit 4 - EXP 2 (COS.sp.1814658)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1259; FP-POS=2	SAME POS AS 2		1036 Secs (1042 Secs) *[==>1042.0 Secs]*	***[4]***
10	Science - 1611 Orbit 5 - EXP 1 (COS.sp.1814658)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1260; FP-POS=3	SAME POS AS 2		1037 Secs (1043 Secs) *[==>1043.0 Secs]*	***[5]***
11	Science - 1611 Orbit 5 - EXP 2 (COS.sp.1814658)	(4) SCR-J0103-5515 C-OFFSET-CORR	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=1259; FP-POS=4	SAME POS AS 2		1036 Secs (1042 Secs) *[==>1042.0 Secs]*	***[5]***

Orbit Structure



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Exp. 6 (Split-WAVECAL)
Exp. 7 (Split-WAVECAL)
Exp. 7
Unused Orbital Visibility = 0
Occultation
Exp. 7 (Split-WAVECAL)
Exp. 8 (Split-WAVECAL)
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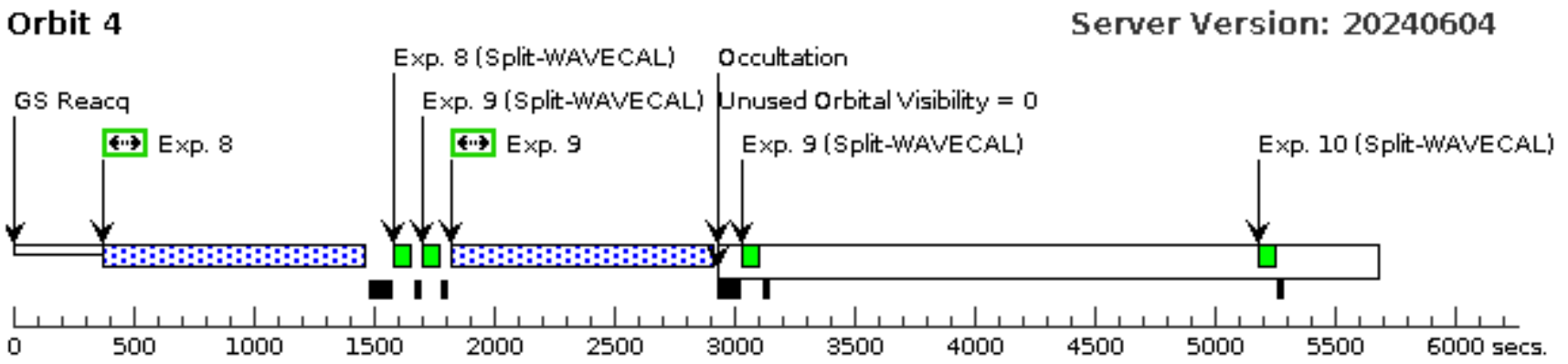
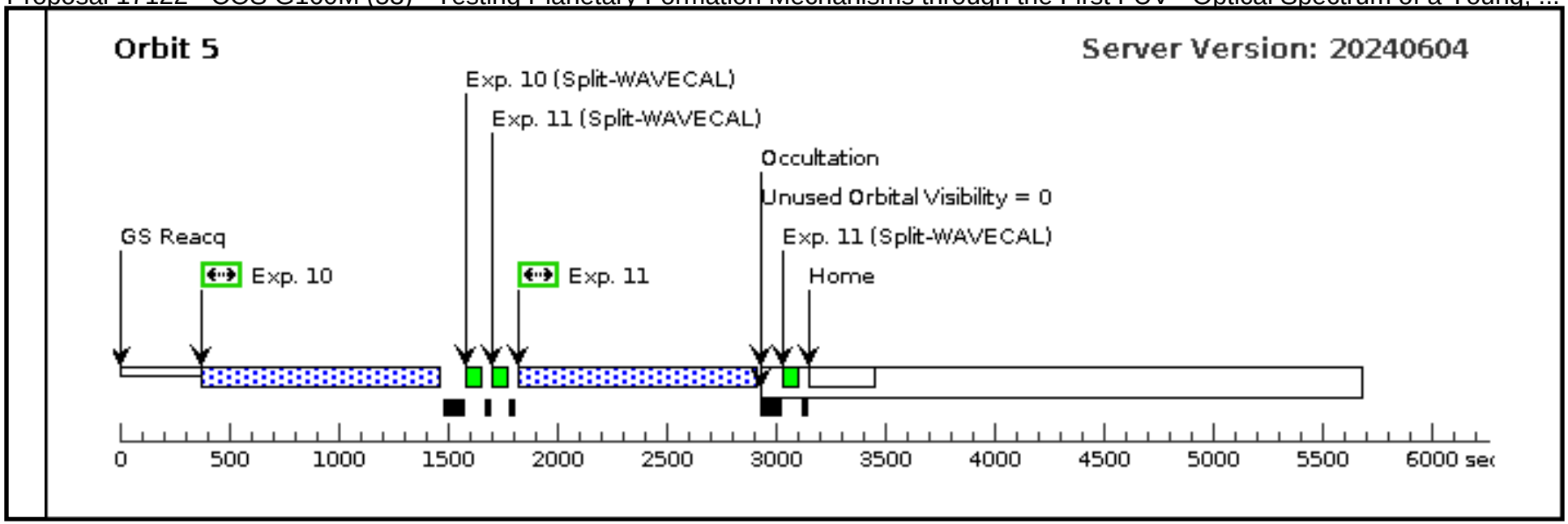
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec


Orbit 4
Server Version: 20240604
GS Reacq
Exp. 8
Exp. 8 (Split-WAVECAL)
Exp. 9 (Split-WAVECAL)
Exp. 9
Occultation
Unused Orbital Visibility = 0
Exp. 9 (Split-WAVECAL)
Exp. 10 (Split-WAVECAL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 secs.


Orbit 5
Server Version: 20240604
Exp. 10 (Split-WAVECAL)
Exp. 11 (Split-WAVECAL)
Occultation
Unused Orbital Visibility = 0
Exp. 11 (Split-WAVECAL)
GS Reacq
Exp. 10
Exp. 11
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec