17793 - Stellar Rotation and Winds for Old Sun-like Stars

Cycle: 32, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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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) HD10700	STIS/CCD STIS/FUV-MAMA	1	20-Jun-2025 13:00:42.0	yes
02	(2) HD2151	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Jun-2025 13:00:43.0	yes
03	(3) HD185144	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Jun-2025 13:00:43.0	yes
53	(3) HD185144	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Jun-2025 13:00:44.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(4) HD166620	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Jun-2025 13:00:45.0	yes

9 Total Orbits Used

ABSTRACT

We propose to use STIS to study the H I Lyman-alpha spectra of four nearby old Sun-like coronal GK stars, to search for signs of astrospheric absorption. The Lyman-alpha astrospheric absorption signature is currently the only means of detecting the coronal winds of cool main sequence stars, and HST is the only observatory that has ever been capable of observing it. The project will allow us to explore the future of our own Sun's wind. In addition, one of our targets, HD 166620, appears to have an interrupted activity cycle, possibly analogous to the "Maunder minimum" state that the Sun went through in the 1600s. Thus, the HD 166620 data could tell us what the solar wind was like then. A particular area of scientific interest is the phenomenon of "weakened magnetic braking", recently discovered from analyses of Kepler data, indicating a significant change in stellar rotation evolution at late stellar ages. All of our chosen targets have existing or expected ground-based spectropolarimetric constraints, which when combined with HST mass loss measurements will allow us to determine if the weakened magnetic braking is due to dramatically weaker winds or fundamental changes in stellar magnetic morphology.

OBSERVING DESCRIPTION

Table 1 in the proposal lists the 4 GK dwarfs that we plan to observe with STIS for 1-2 orbits each. Note that COS cannot be used for Lyman-alpha studies due to obscuration by geocoronal Lyman-alpha caused by the large COS aperture, so STIS is our only option. Our project is focused on detecting and measuring astrospheric absorption in the H I Ly-alpha line, but confidence in this analysis is significantly improved with information provided by observations of the MgII h & k lines near 2800 A, so we will be obtaining an E230H spectrum of the 2574-2851A wavelength range for each of our targets, through the 0.2"x0.09" aperture. Such an observation already exists for Tau Ceti, so we will not make the E230H exposure for this star.

The Mg II lines provide two benefits. The first is that the ISM Mg II absorption lines are much narrower than the ISM H I and D I lines, allowing us to discern multiple velocity components in the ISM towards our stars, which we can then account for in our analysis of the Lyman-alpha line. The second benefit is that the Mg II emission lines are highly opaque chromospheric lines like Lyman-alpha, and so provide useful guidance for what the intrinsic stellar Lyman-alpha lines should look like. This is useful considering that the stellar Lyman-alpha profile is always greatly obscured by the

broad ISM absorption (see Figure 2).

After the E230H exposure (if done), the rest of the observing time will be used for an E140M spectrum of the 1150-1700 A wavelength range through the 0.2"x0.2" aperture, which will contain the primary line of interest: H I Ly-alpha at 1216 A. All but one of our targets are comfortably in compliance with STIS/MAMA bright object limits, as verified using both Table 13.45 in the STIS Instrument Handbook and the online STIS exposure time calculator. The exception is Beta Hyi. The E230H exposure for this star exceeds the total image count rate limit unless we replace the 0.2"X0.09" aperture with the tiny 0.1"x0.03" slit.

The E230H observation will provide the highest resolution (R= \lambda/\Delta\lambda = 110,000) spectrum of the Mg II lines. After target acquisition we will perform an ACQ/PEAK peakup observation to accurately center the target in the narrow 0.2"x 0.09" slit (or the smaller slit for Beta Hyi), thereby maximizing the accuracy of our wavelength calibration, important for both this spectrum and the following E140M spectrum. The E140M grating does not have quite the resolution of E230H, but its R=45,800 resolution is good enough to study the H I Ly-alpha line profile in the detail that we require.

Previous studies provide many examples of Mg II and Ly-alpha spectra of inactive GK dwarfs (Wood et al. 2021). The chromospheric Mg II and H I Ly-alpha lines are very bright even for inactive GK dwarfs, so we have high confidence that we can acquire high-quality Mg II and Ly-alpha spectra in only 2 orbits, or just 1 in the case of Tau Ceti where we do not need Mg II.

Visit

Proposal 17793, Visit 01, completed Fri Jun 20 17:00:45 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 02-MAR-2025:00:00:00 AND 15-NOV-2025:00:00:00; BETWEEN 02-MAR-2026:00:00:00 AND 15-NOV-2026:00:00:00; BETWEEN 02-MAR-2027:00:00:00 AND 15-NOV-2027:00:00:00

Fixed Targets

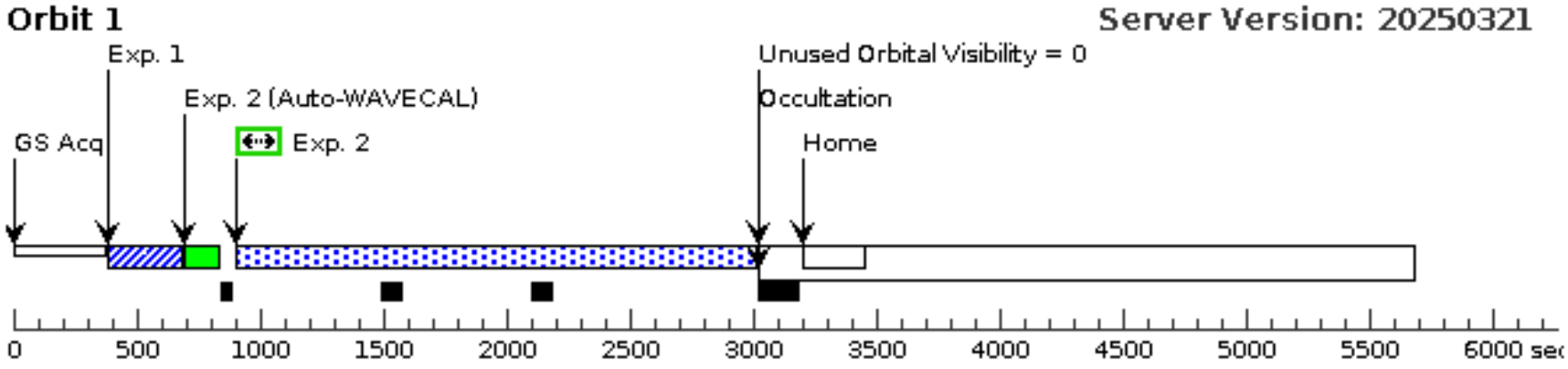
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD10700	RA: 01 44 4.0831 (26.0170129d)	Proper Motion RA: -1721.728 mas/yr	V=3.50+/-0.01	Reference Frame: ICRS
	Alt Name1: GJ71	Dec: -15 56 14.93 (-15.93748d)	Proper Motion Dec: 854.963 mas/yr	G8-V,	
	Alt Name2: TAU-CETI	Equinox: J2000	Parallax: 0.2738097"	B-V=0.72	
			Epoch of Position: 2000		
			Radial Velocity: -16.6 km/sec		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[G V-IV]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1929623)	(1) HD10700	STIS/CCD, ACQ, F25ND5	MIRROR				1.0 Secs (1 Secs)	
								[==>]	***[1]***
2	(STIS.sp.1929633)	(1) HD10700	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=600			2000 Secs (2093 Secs)	
								[==>2093.0 Secs]	***[1]***

Orbit Structure



Visit

Proposal 17793, Visit 02, completed Fri Jun 20 17:00:45 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

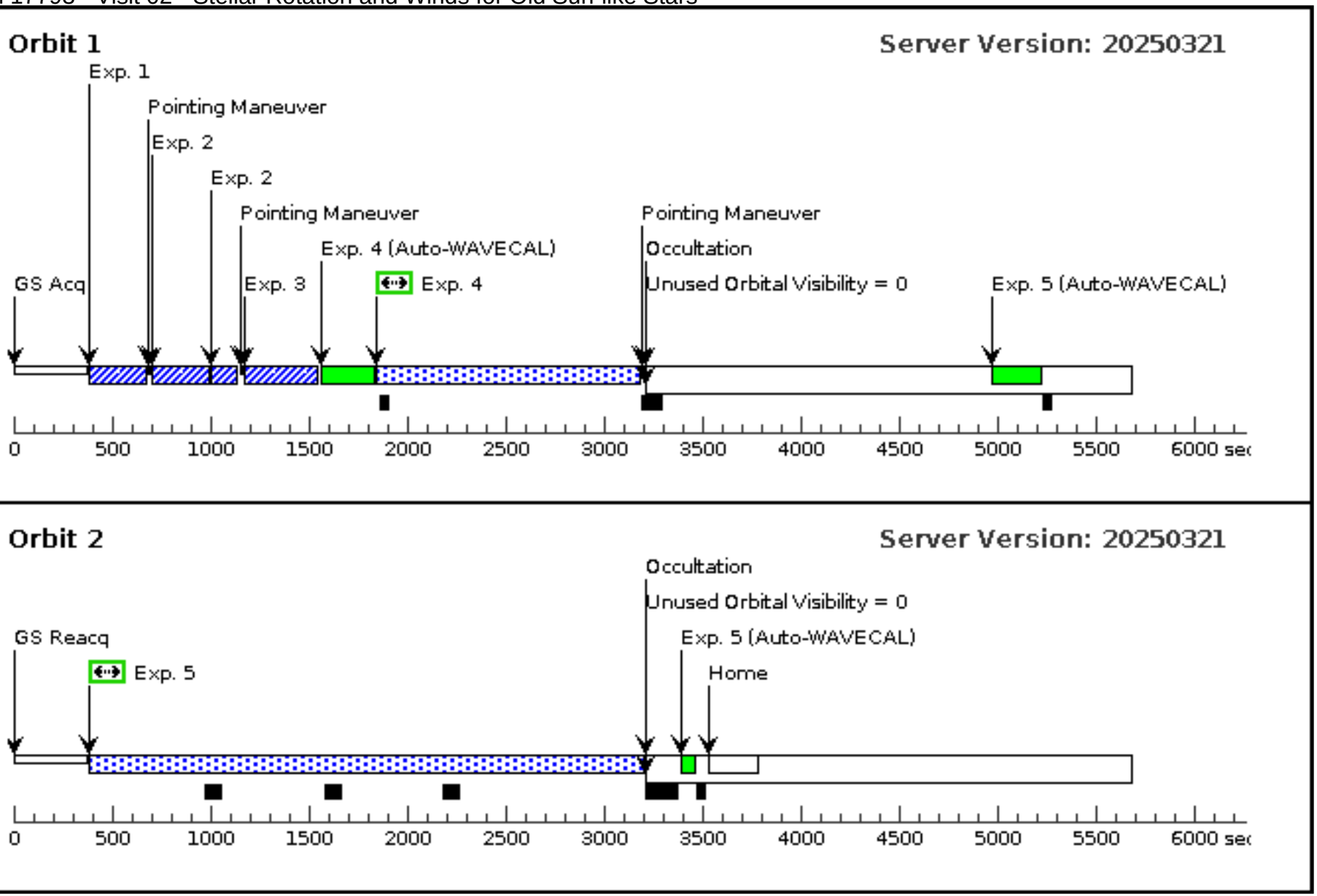
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HD2151	RA: 00 25 45.0704 (6.4377933d)	Proper Motion RA: 2219.54 mas/yr	V=2.79+/-0.01	Reference Frame: ICRS
	Alt Name1: GJ19	Dec: -77 15 15.29 (-77.25425d)	Proper Motion Dec: 324.09 mas/yr	G0-V,	
	Alt Name2: BETA-HYI	Equinox: J2000	Parallax: 0.13407"	B-V=0.62	
			Epoch of Position: 2000		
			Radial Velocity: 23.1 km/sec		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[G V-IV]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1929643)	(2) HD2151	STIS/CCD, ACQ, F25ND5	MIRROR				0.5 Secs (0.5 Secs)	
								[==>]	***[1]***
2	(STIS.sp.1929657)	(2) HD2151	STIS/CCD, ACQ/PEAK, 0.2X0.09	G430M 4451 A				0.5 Secs (0.5 Secs)	
								[==>]	***[1]***
3	(STIS.sp.1929661)	(2) HD2151	STIS/CCD, ACQ/PEAK, 0.1X0.03	G430M 4451 A				0.5 Secs (0.5 Secs)	
								[==>]	***[1]***
4	(STIS.sp.1929676)	(2) HD2151	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230H 2713 A				600 Secs (1325 Secs)	
								[==>1325.0 Secs]	***[1]***
5	(STIS.sp.1929677)	(2) HD2151	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=600			2000 Secs (2808 Secs)	
								[==>2808.0 Secs]	***[2]***

Orbit Structure



Visit

Proposal 17793, Visit 03, failed

Fri Jun 20 17:00:46 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

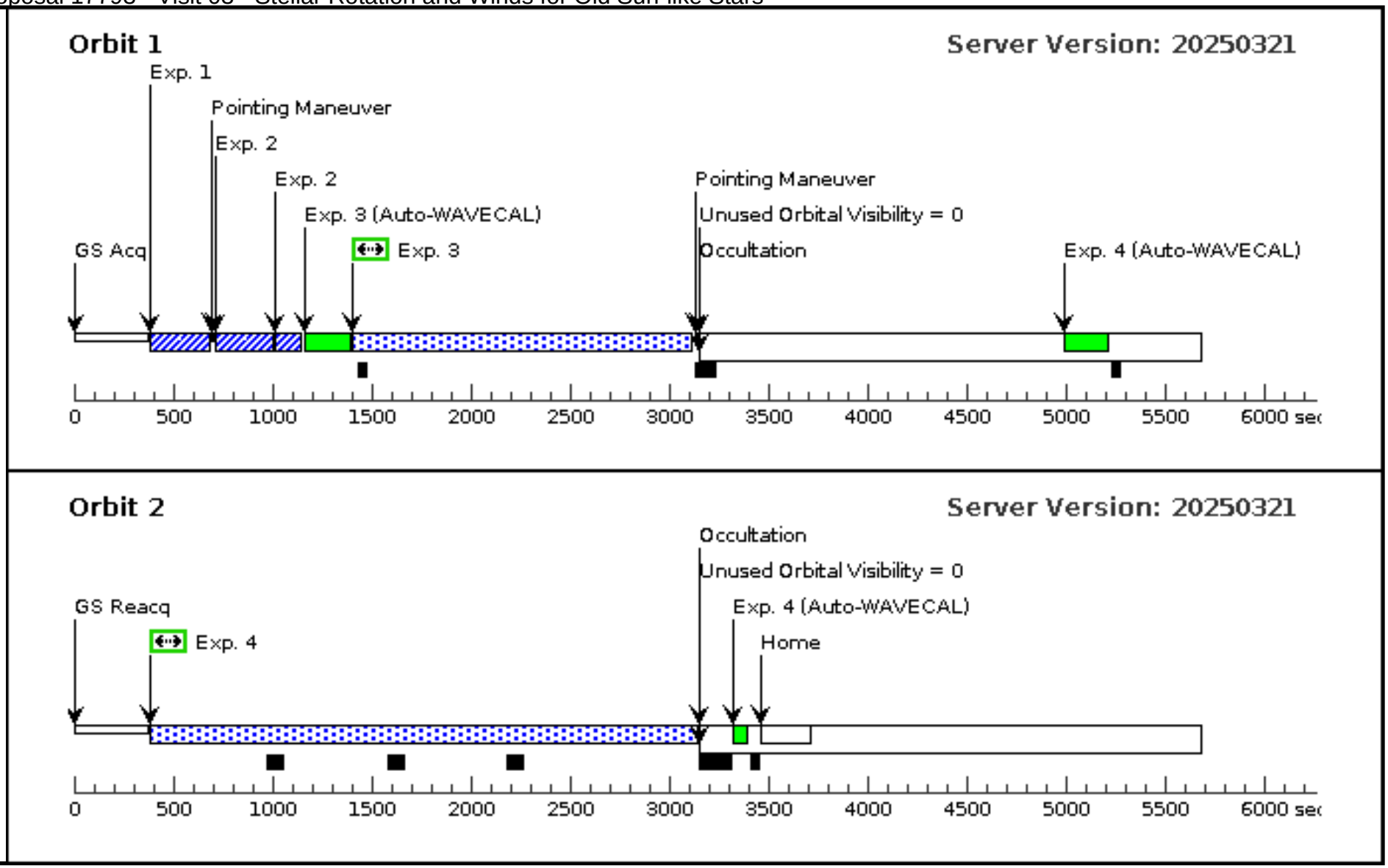
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD185144 Alt Name1: GJ764 Alt Name2: SIGMA-DRA	RA: 19 32 21.5902 (293.0899592d) Dec: +69 39 40.24 (69.66118d) Equinox: J2000	Proper Motion RA: 597.384 mas/yr Proper Motion Dec: -1738.286 mas/yr Parallax: 0.1734939" Epoch of Position: 2000 Radial Velocity: 26.7 km/sec	V=4.68+/-0.01 K0-V, B-V=0.78	Reference Frame: ICRS

Comments:
Category=STAR
Description=[K V-IV]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1929680)	(3) HD185144	STIS/CCD, ACQ, F25ND5	MIRROR				3.0 Secs (3 Secs) *[==>]*	 ***[1]***
2	(STIS.sp.1929682)	(3) HD185144	STIS/CCD, ACQ/PEAK, 0.2X0.09	G430M 4451 A				0.5 Secs (0.5 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.1929692)	(3) HD185144	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A				600 Secs (1693 Secs) *[==>1693.0 Secs]*	 ***[1]***
4	(STIS.sp.1929686)	(3) HD185144	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=600			2000 Secs (2741 Secs) *[==>2741.0 Secs]*	 ***[2]***

Orbit Structure



Visit

Proposal 17793, Visit 53 Fri Jun 20 17:00:46 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

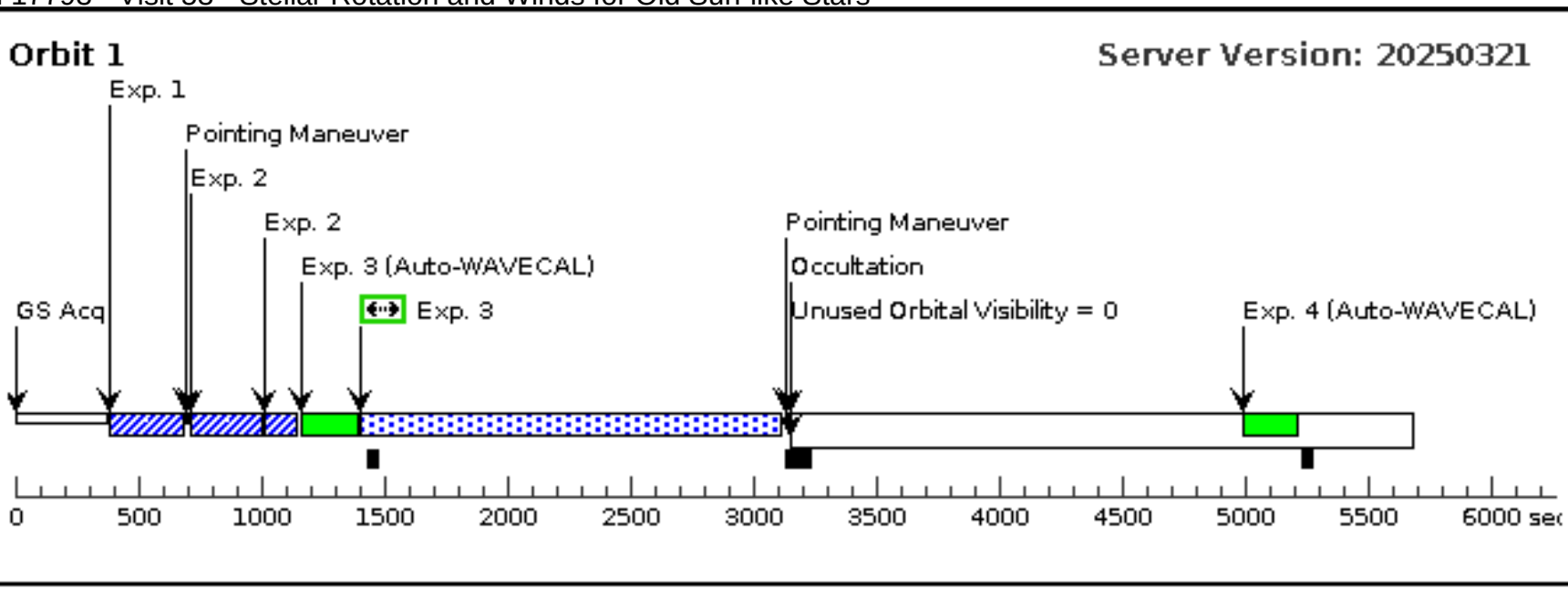
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD185144 Alt Name1: GJ764 Alt Name2: SIGMA-DRA	RA: 19 32 21.5902 (293.0899592d) Dec: +69 39 40.24 (69.66118d) Equinox: J2000	Proper Motion RA: 597.384 mas/yr Proper Motion Dec: -1738.286 mas/yr Parallax: 0.1734939" Epoch of Position: 2000 Radial Velocity: 26.7 km/sec	V=4.68+/-0.01 K0-V, B-V=0.78	Reference Frame: ICRS

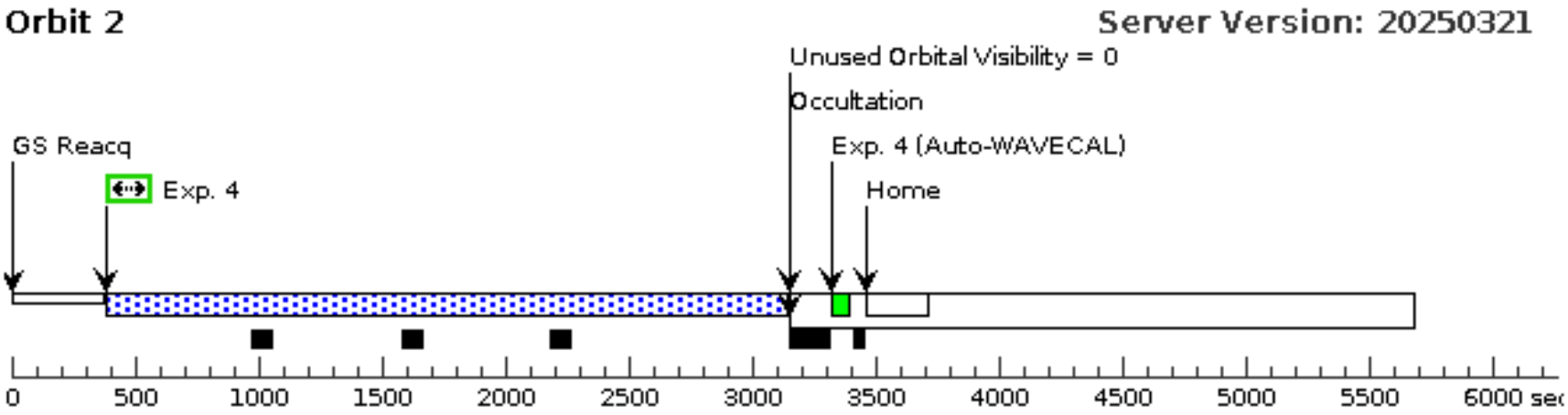
Comments:
Category=STAR
Description=[K V-IV]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1929680)	(3) HD185144	STIS/CCD, ACQ, F25ND5	MIRROR				3.0 Secs (3 Secs) *[==>]*	 ***[1]***
2	(STIS.sp.1929682)	(3) HD185144	STIS/CCD, ACQ/PEAK, 0.2X0.09	G430M 4451 A				0.5 Secs (0.5 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.1929692)	(3) HD185144	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A				600 Secs (1693 Secs) *[==>1693.0 Secs]*	 ***[1]***
4	(STIS.sp.1929686)	(3) HD185144	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=600			2000 Secs (2741 Secs) *[==>2741.0 Secs]*	 ***[2]***

Orbit Structure





Visit

Proposal 17793, Visit 04, completed Fri Jun 20 17:00:46 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	HD166620	RA: 18 09 37.4162 (272.4059008d)	Proper Motion RA: -316.454 mas/yr	V=6.40+/-0.01	Reference Frame: ICRS
	Alt Name1: GJ706	Dec: +38 27 28.00 (38.45778d)	Proper Motion Dec: -468.348 mas/yr	K2-V,	
		Equinox: J2000	Parallax: 0.0901234"	B-V=0.87	
			Epoch of Position: 2000		
			Radial Velocity: -19.3 km/sec		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[K V-IV]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.1929693)	(4) HD166620	STIS/CCD, ACQ, F25ND5	MIRROR				5.0 Secs (5 Secs)	
								[==>]	***[1]***
2	(STIS.sp.1929695)	(4) HD166620	STIS/CCD, ACQ/PEAK, 0.2X0.09	G430M 4451 A				2.0 Secs (2 Secs)	
								[==>]	***[1]***
3	(STIS.sp.1929698)	(4) HD166620	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A				600 Secs (1543 Secs)	
								[==>1543.0 Secs]	***[1]***
4	(STIS.sp.1929700)	(4) HD166620	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=600			2000 Secs (2629 Secs)	
								[==>2629.0 Secs]	***[2]***

Orbit Structure