17124 - High Resolution Spectroscopic Mapping of Mass Loss in Luminous Blue Variables

Cycle: 30, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

INVESTIGATORS

Name	*Institution*
Dr. Frederick C. Bruhweiler (PI) (Contact)	**American University**
Mr. Bruce McCollum (CoI)	American University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) MR-35	STIS/CCD STIS/NUV-MAMA	1	20-Nov-2023 09:00:31.0	yes
02	(1) V-AG-CAR WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Nov-2023 09:00:32.0	yes
03	(1) V-AG-CAR	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	3	20-Nov-2023 09:00:34.0	yes
04	(3) HD-90177	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	3	20-Nov-2023 09:00:36.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
05	(1) V-AG-CAR	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	4	20-Nov-2023 09:00:38.0	yes

13 Total Orbits Used

ABSTRACT

High-resolution (R~110,000) HST UV spectra of the very massive LBV, eta Car, reveal interstellar-like extremely narrow, discrete absorption components with line widths ~5 km/s arising from transitions from ground configurations and metastable levels up to 40,000 cm-1 of Fe-group ions.These features, seen at high negative velocities, arise in dense gas in the near circumstellar environment of eta Car. The implied densities, at least 10^7-8 cm-3, are highly uncharacteristic of the normal ISM. They appear to have originated from clumping in mass outflow of eta Car. IUE spectra show clumping in wind features of other LBVs and has been confirmed by optical observations of Ca II and Fe II. High-resolution UV STIS spectra coupled with proper photoionization modeling offers the only means to detect these extremely narrow absoptions and determine the physical conditions, and line-of-sight distribution (distance from the star) of the ejecta producing the extremelly narrow absoptions. Knowledge of ejecta velocities and distances will permit us to construct a time history for the ejection events. We will obtain and analyze the first high-resolution HST UV spectra of three LBVs having typical masses, and perform the same analysis on archival Eta Car spectra. This information will have many implications for aspects of LBV mass loss, evolution, and wind mechanisms that are not yet understood.

OBSERVING DESCRIPTION

We have three LBV targets with a total of 13 orbits:

MR35(Visit 1 -1 0rbit & Visit 5- 4 Orbit)
AG Car (Visit 2 - 2 orbits & Visit 3 - 3 orbits)
HD90177(Visit 4 - 3 orbits)

In our calculations, we present exposure times for the maximum fluxes seen in archival IUE spectra at each reference wavelength, where there are many spectra for AG Car & HR Car. We will use STIS E140H, E230H, and the E140M echelles.

MR35:
We request Visit 1, which is only 1 orbit, be executed well before Visit 5, our repeat visit for MR35. We may want to adjust exposures in Visit 5, based upon the fluxes in Visit 1. We expect the fluxes of MR 35 to be lower than the IUE fluxes used. The AAVSO shows MR35 in a flux decline.

HST MAMA Detector Safety: AG Car is the UV-brightest of our targets, and as the AAVSO light-curve shows it is currently at V~5.5. We approach the buffer warning limit in a few cases, The maximum global counts we obtain is for AG Car, which is ~13,000 counts globally for source plus background.

Only overexposed IUE spectra exist for Hen 3-591=MR35 (SWP39269 & LWP18410). But IUE/SWP spectra are adequate to estimate flux levels, based upon expected flux distributions of other similar stars. Strong N V 1240 and C IV 1550 in the SWP clearly indicate an O supergiant. The AAVSO light curve shows a flux decline.

In most exposures, we try to achieve S/N = 20 or better at the quoted wavelength and flux level. Because of the brightness of our targets in some bandpasses, we often must use the small 0.2"x0.09" and 0.1"x0.03"apertures. Otherwise, we use the 0.2"x0.2" aperture. The declinations of or three targets indicate that we have 57, 57, and 56 min visibility for AG Car, Hen 3-591=MR35, and HR Car=HD 90177. All exposures were calculated using the STIS ETC.
We describe our exposures and time overhead for all three targets. These targets have pronounced extinction which is notable by extreme decreased flux near 2200A and shorter wavelengthd. Exposure times vary dramatically across the UV spectrum.

Visit

Proposal 17124, Visit 01, completed Mon Nov 20 14:00:40 GMT 2023

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

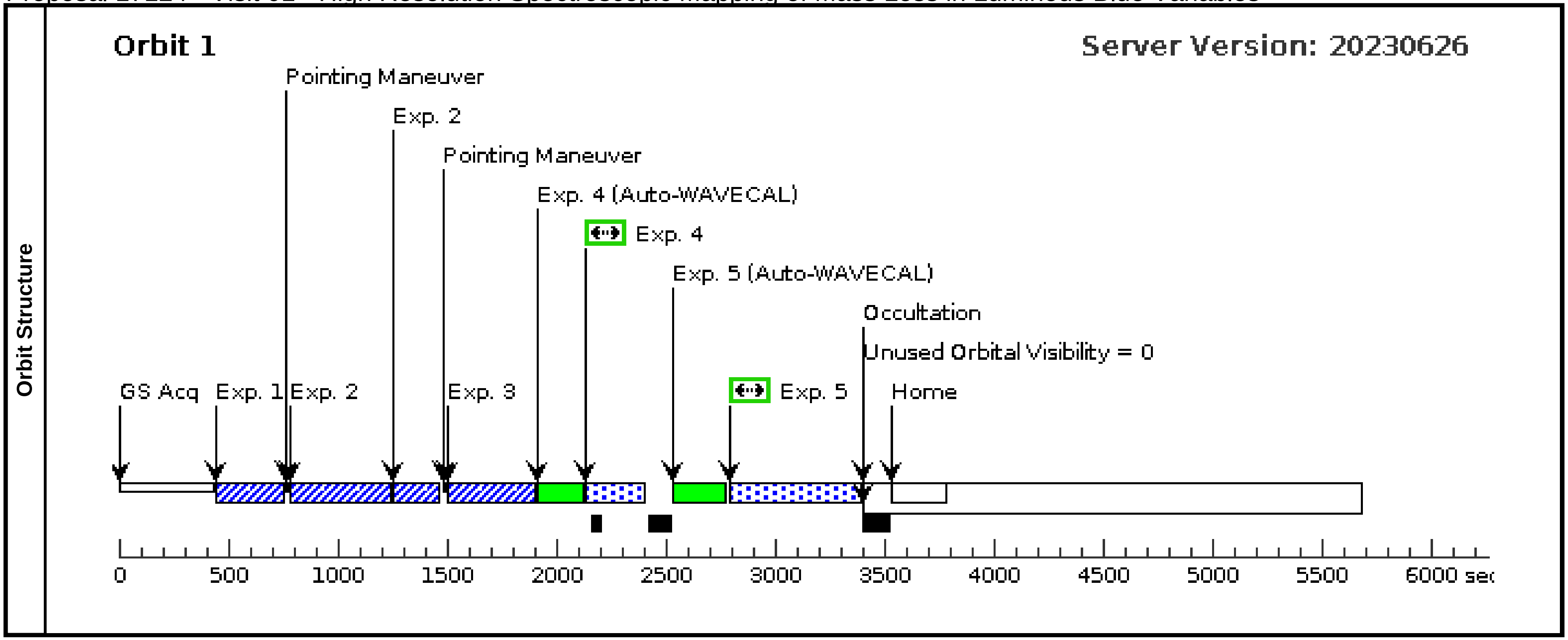
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	MR-35	RA: 11 08 40.0512 (167.1668800d) Dec: -60 42 51.69 (-60.71436d) Equinox: J2000	Proper Motion RA: -7.90328136479356E-4 sec of time/yr Proper Motion Dec: 0.002212 arcsec/yr Epoch of Position: 2015.5	V=10.2 7E-12 @ 1300A; 6.5E-12 @ 1700A; 3.8E-12 @ 2000A; 3.8E-12 @ 2600A; 3.8E-12 @ 3000A : LBV- IUE fluxes	Reference Frame: ICRS

Comments: Coordinates are from Gaia.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1892561)	(2) MR-35	STIS/CCD, ACQ, F25ND3	MIRROR				5.4 Secs (5.4 Secs) *[==>]*	***[1]***
	Comments: We request Visit 1, which is only 1 orbit, be executed well before Visit 5, our repeat visit for MR35. We may want to adjuxt exposures in Visit 5, based upon the fluxes in Visit 1. We expect the fluxes of MR 35 to be lower than the IUE fluxes used. The AAVSO shows MR35 in a flux decline. on 24 Sep 23, the V-mag=12.5								
2	(1892563)	(2) MR-35	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				10.0 Secs (10 Secs) *[==>]*	***[1]***
	Comments: A 02x0.05ND is required becasue of the small aperture that we are using for the spectral exposures.								
3	(1892565)	(2) MR-35	STIS/CCD, ACQ/PEAK, 0.1X0.03	MIRROR				0.2 Secs (0.2 Secs) *[==>]*	***[1]***
4	(1813341)	(2) MR-35	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230H 2513 A				500 Secs (256 Secs) *[==>256.0 Secs]*	***[1]***
	Comments: Buffer-Time is 4/5 of the calculated Buffer-Time.								
5	(1811991)	(2) MR-35	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230H 2762 A				600 Secs (586 Secs) *[==>586.0 Secs]*	***[1]***
	Comments: Buffer-Time is 4/5 of that given in the ETC. NOTE: THE ADJUSTED BUFFER-TIME IS EXACTLY THE LIMIT.								



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Server Version: 20230626
Pointing Maneuver
Exp. 2
Pointing Maneuver
Exp. 4 (Auto-WAVECAL)
Exp. 4
Exp. 5 (Auto-WAVECAL)
Occultation
Unused Orbital Visibility = 0
GS Acq
Exp. 1
Exp. 2
Exp. 3
Exp. 5
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Proposal 17124 - Visit 02 - High Resolution Spectroscopic Mapping of Mass Loss in Luminous Blue Variables

Visit

Proposal 17124, Visit 02, completed Mon Nov 20 14:00:40 GMT 2023

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

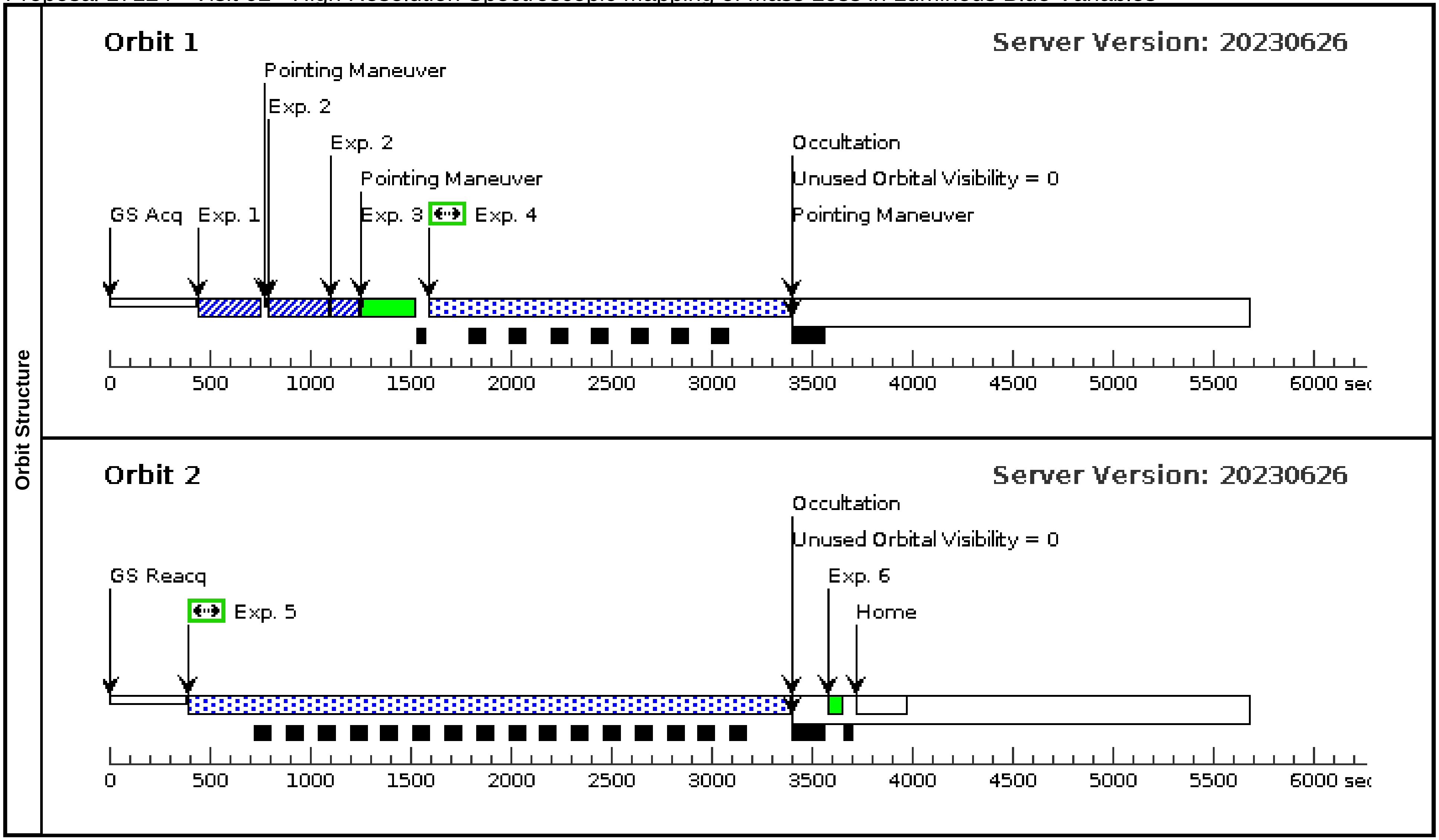
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-AG-CAR	RA: 10 56 11.5681 (164.0482004d) Dec: -60 27 12.78 (-60.45355d) Equinox: J2000	Proper Motion RA: -6.499989539337533E-4 sec of time/yr Proper Motion Dec: 0.001955 arcsec/yr Epoch of Position: 2000.0	V=6.96 5E-12 @ 1400A; 5.5E-12 @ 1650A; 2E-12 @ 2000A; 4E-12 @ 2400A; 1E-11 @ 2900A : LBV	Reference Frame: ICRS

Comments: Coordinates are from Gaia.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1812288)	(1) V-AG-CAR	STIS/CCD, ACQ, F25ND5	MIRROR				6 Secs (6 Secs) *[==>]*	*[1]*
2	(1812933)	(1) V-AG-CAR	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs (0.1 Secs) *[==>]*	*[1]*
3		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1234 A				70 Secs (70 Secs) *[==>]*	*[1]*
4	(1893127)	(1) V-AG-CAR	STIS/FUV-MAMA, TIME-TAG, 0.2X0.09	E140H 1234 A	BUFFER-TIME=202; WAVECAL=NO			982 Secs (1784 Secs) *[==>1784.0 Secs]*	*[1]*
5	(1812152)	(1) V-AG-CAR	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230H 2013 A	BUFFER-TIME=158; WAVECAL=NO			1420 Secs (2810 Secs) *[==>2810.0 Secs]*	*[2]*
6		WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 2013 A				*[==>]*	*[2]*


Orbit Structure
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Pointing Maneuver
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Exp. 2
Occultation
Pointing Maneuver
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GS Acq
Exp. 1
Exp. 3
Exp. 4
Pointing Maneuver
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Orbit 2
Server Version: 20230626
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 6
Exp. 5
Home
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 sec

Visit

Proposal 17124, Visit 03, completed Mon Nov 20 14:00:40 GMT 2023

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

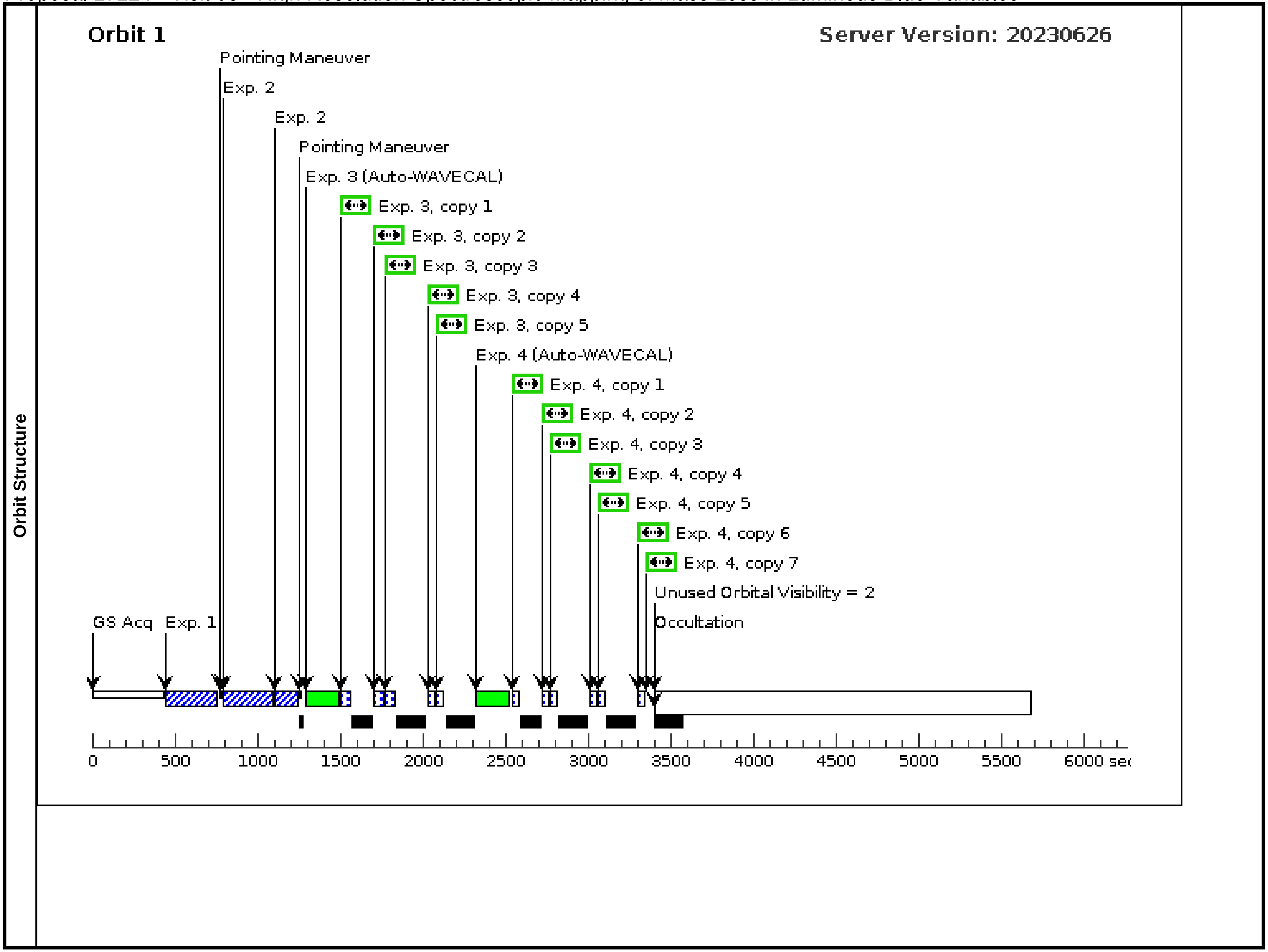
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-AG-CAR	RA: 10 56 11.5681 (164.0482004d) Dec: -60 27 12.78 (-60.45355d) Equinox: J2000	Proper Motion RA: -6.499989539337533E-4 sec of time/yr Proper Motion Dec: 0.001955 arcsec/yr Epoch of Position: 2000.0	V=6.96 5E-12 @ 1400A; 5.5E-12 @ 1650A; 2E-12 @ 2000A; 4E-12 @ 2400A; 1E-11 @ 2900A : LBV	Reference Frame: ICRS

Comments: Coordinates are from Gaia.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1812288)	(1) V-AG-CAR	STIS/CCD, ACQ, F25ND5	MIRROR				6 Secs (6 Secs)	
								[==>]	***[1]***
2	(1812933)	(1) V-AG-CAR	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs (0.1 Secs)	
								[==>]	***[1]***
3	(1893131)	(1) V-AG-CAR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2513 A				60 Secs X 5 (190 Secs)	
								[==>46.0 Secs (Copy 1)] *[==>46.0 Secs (Copy 2)]* *[==>46.0 Secs (Copy 3)]* *[==>26.0 Secs (Copy 4)]* *[==>26.0 Secs (Copy 5)]*	***[1]***
Comments: 4/5 of ETC Buffer-time is 62 sec, which is below the 99s minimum. Thus, I have split exposuure times into smll 45s segments in an attempt to get around this.									
4	(1893141)	(1) V-AG-CAR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 3012 A				40 Secs X 8 (225.1 Secs)	
								[==>26.0 Secs (Copy 1)] *[==>26.0 Secs (Copy 2)]* *[==>26.0 Secs (Copy 3)]* *[==>26.0 Secs (Copy 4)]* *[==>26.0 Secs (Copy 5)]* *[==>26.0 Secs (Copy 6)]* *[==>26.0 Secs (Copy 7)]*	***[1]***
								[==>43.1 Secs (Copy 8)]	***[2]***
Comments: Adjusted Buffer-Time=48s, which is 4/5 of that given by the ETC. i've adopted short, repeated ACCUM exposures									
5	(1812933)	(1) V-AG-CAR	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs (0.1 Secs)	
								[==>]	***[2]***
6	(1811971)	(1) V-AG-CAR	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1416 A				1190 Secs (1978 Secs)	
								[==>1978.0 Secs]	***[2]***
7	(1811918)	(1) V-AG-CAR	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1598 A	BUFFER-TIME=206			1620 Secs (2984 Secs)	
								[==>2984.0 Secs]	***[3]***



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Exp. 2
Pointing Maneuver
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Exp. 3, copy 4
Exp. 3, copy 5
Exp. 4 (Auto-WAVECAL)
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Exp. 4, copy 2
Exp. 4, copy 3
Exp. 4, copy 4
Exp. 4, copy 5
Exp. 4, copy 6
Exp. 4, copy 7
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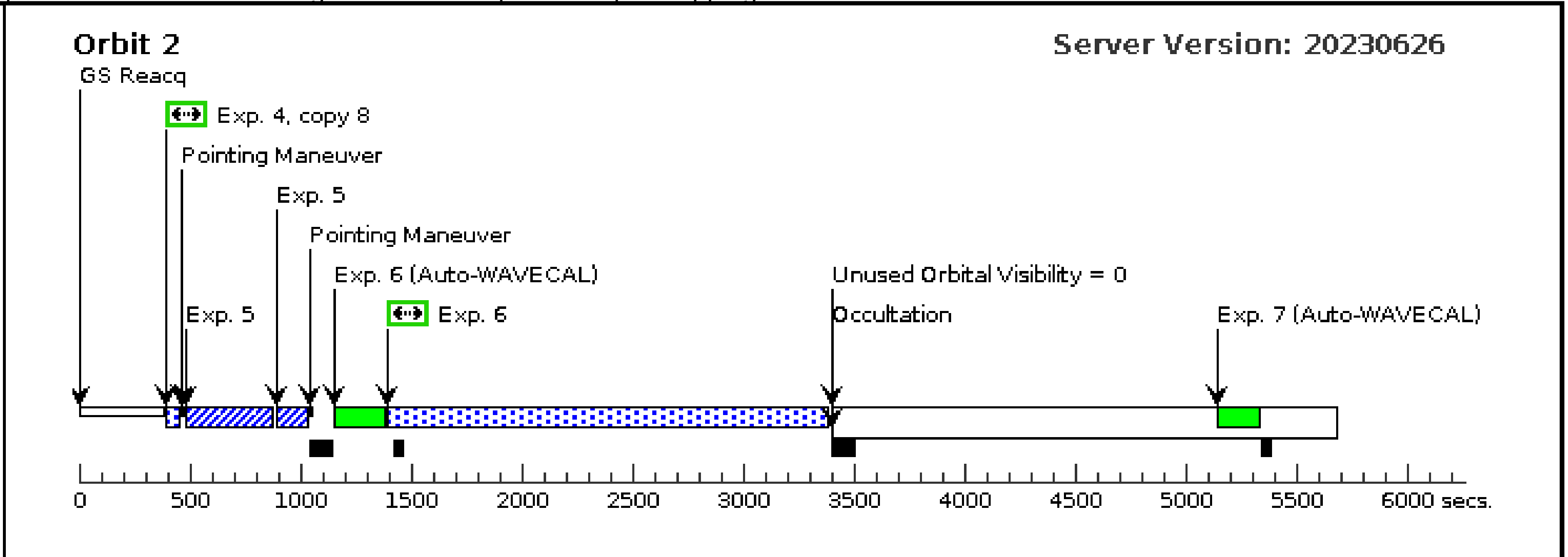
6000 sec


Orbit 2
Server Version: 20230626
GS Reacq
Exp. 4, copy 8
Pointing Maneuver
Exp. 5
Pointing Maneuver
Exp. 6 (Auto-WAVECAL)
Unused Orbital Visibility = 0
Exp. 5
Exp. 6
Occultation
Exp. 7 (Auto-WAVECAL)
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1000
1500
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2500
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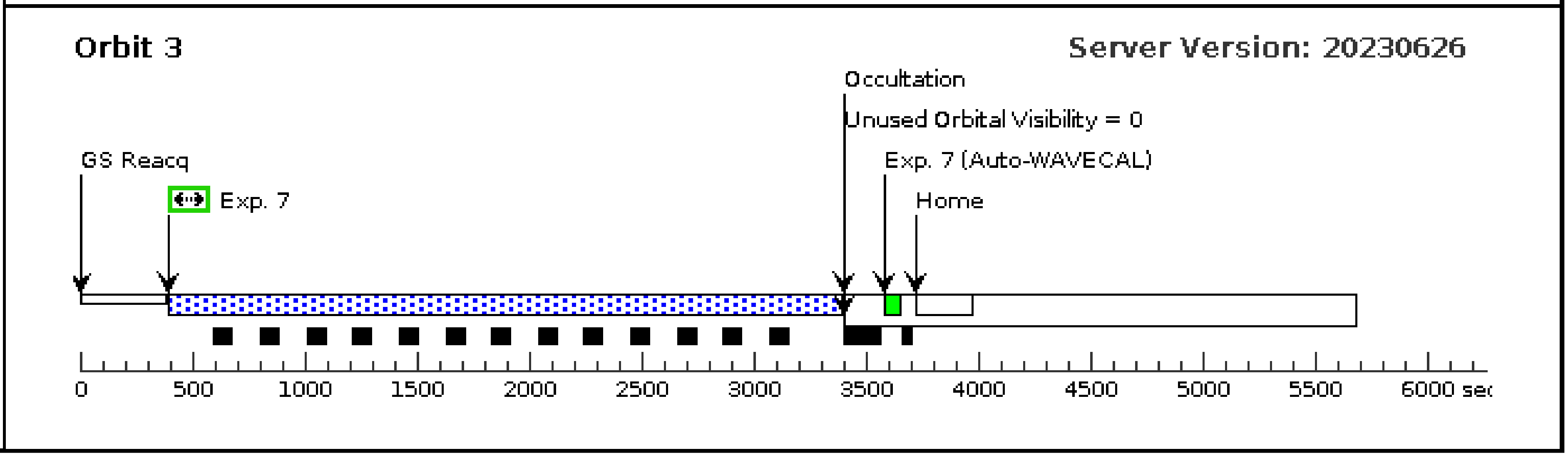
3500
4000
4500
5000
5500
6000 secs.


Orbit 3
Server Version: 20230626
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 7 (Auto-WAVECAL)
Exp. 7
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17124, Visit 04, completed

Mon Nov 20 14:00:40 GMT 2023

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

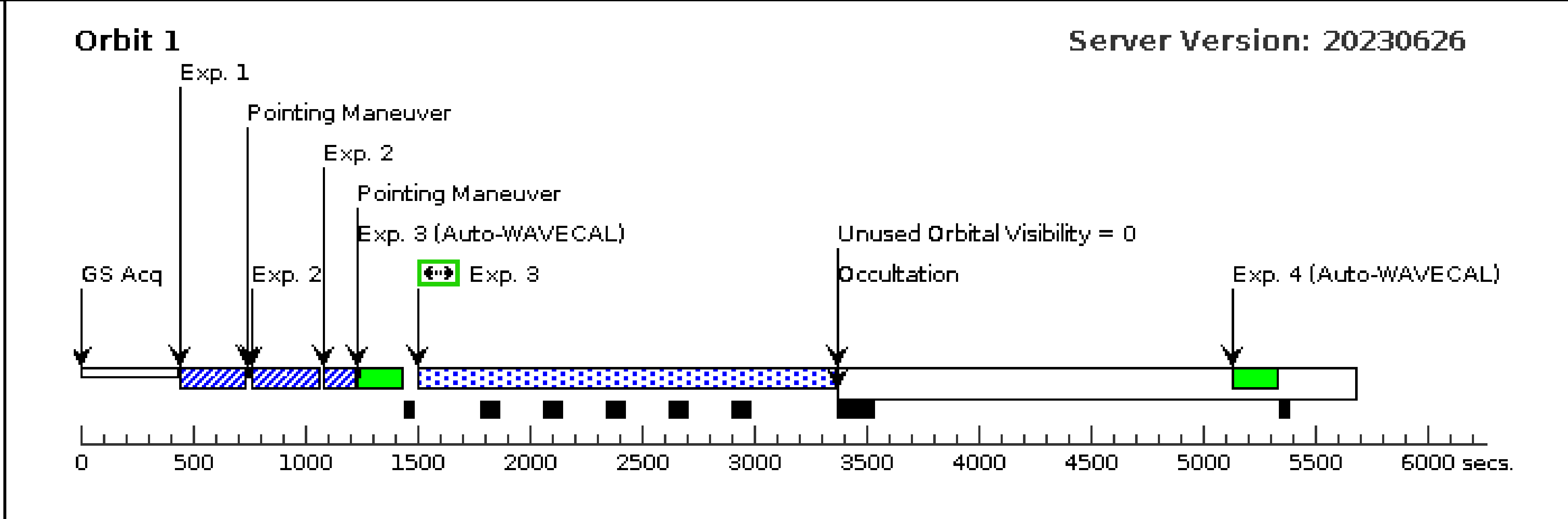
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD-90177	RA: 10 22 53.8301 (155.7242921d) Dec: -59 37 28.33 (-59.62454d) Equinox: J2000	Proper Motion RA: -8.330954137036184E-4 sec of time/yr Proper Motion Dec: 0.002332 arcsec/yr Epoch of Position: 2015.5	V=8.0 4E-14@1305A; 7E-14@1400A; 1.5E-13@1600A; 2E-13@2400: 4E-13@2600A; 7E-13@2800A; 1E-12@3000A	Reference Frame: ICRS

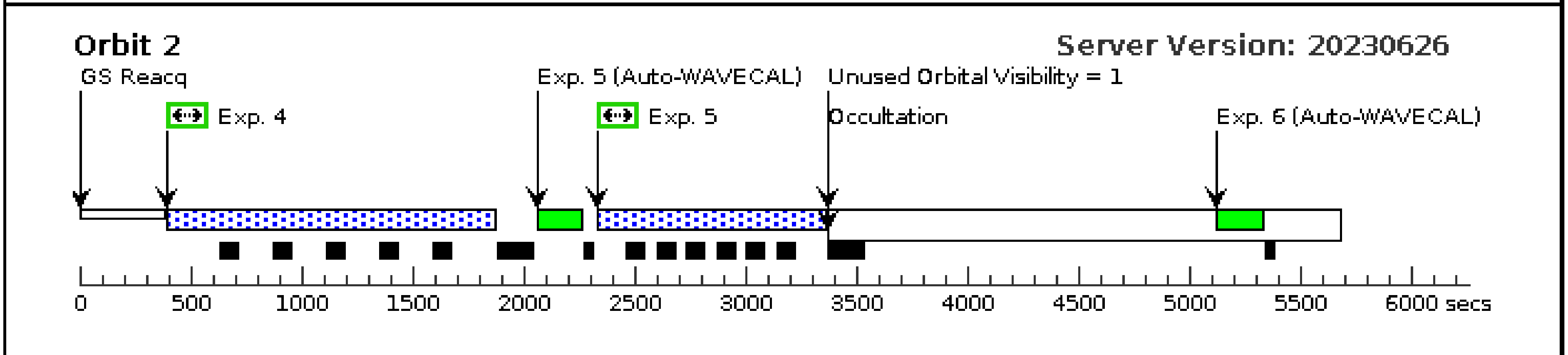
Comments: Coordinates are from Gaia.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE]
Extended=NO

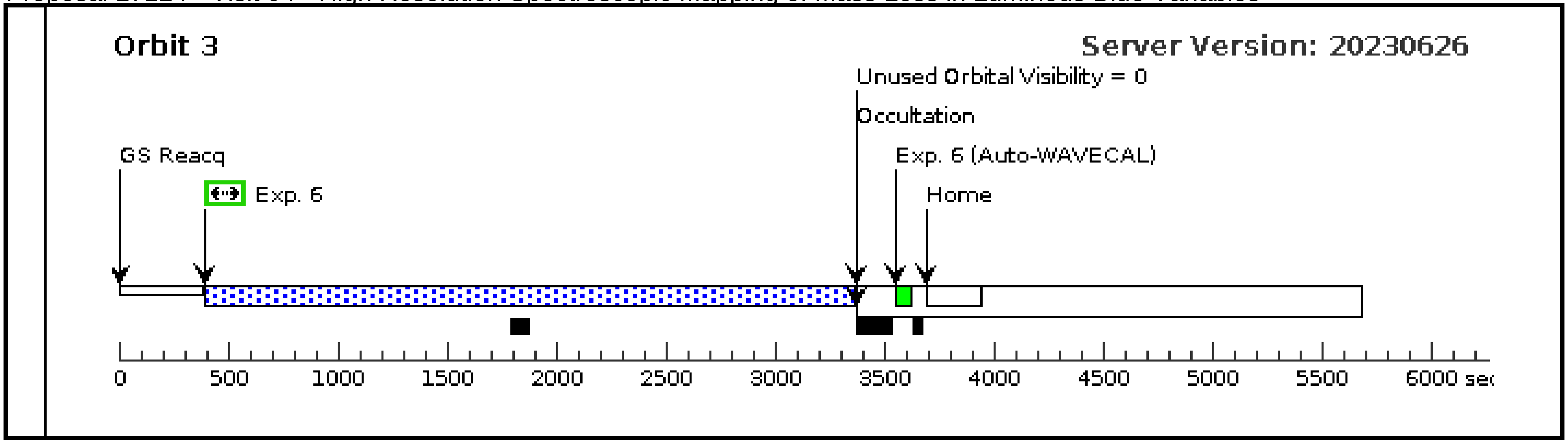
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1813465)	(3) HD-90177	STIS/CCD, ACQ, F25ND3	MIRROR				0.2 Secs (0.2 Secs) *[==>]*	***[1]***
2	(1813466)	(3) HD-90177	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.3 Secs (0.3 Secs) *[==>]*	***[1]***
3	(1812001)	(3) HD-90177	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230H 3012 A	BUFFER-TIME=279			1960 Secs (1845 Secs) *[==>1845.0 Secs]*	***[1]***
	Comments: Buffer-Time is 4/5 of that given in the ETC.								
4	(1811997)	(3) HD-90177	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230H 2762 A	BUFFER-TIME=239			1450 Secs (1464 Secs) *[==>1464.0 Secs]*	***[2]***
	Comments: Buffer-Time given above is 4/5 that given in ETC								
5	(1813164)	(3) HD-90177	STIS/NUV-MAMA, TIME-TAG, 0.2X0.2	E230H 2513 A	BUFFER-TIME=134			680 Secs (1014 Secs) *[==>1014.0 Secs]*	***[2]***
	Comments: Buffer-Time is 4/5 of tht given in ETC.								
6	(1811993)	(3) HD-90177	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=1403			2610 Secs (2956 Secs) *[==>2956.0 Secs]*	***[3]***
	Comments: The buffer-time given bove is 4/5 tht given by the ETC.								

Orbit Structure



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Occultation
GS Reacq
Exp. 6
Exp. 6 (Auto-WAVECAL)
Home
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1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17124, Visit 05, implementation Mon Nov 20 14:00:41 GMT 2023

Diagnostic Status: No Diagnostics

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

Special Requirements: AFTER 01 BY 30.0 D TO 365.0 D; ON HOLD FOR 01

On Hold Comments: on hold for data analysis in visit 01

Fixed Targets

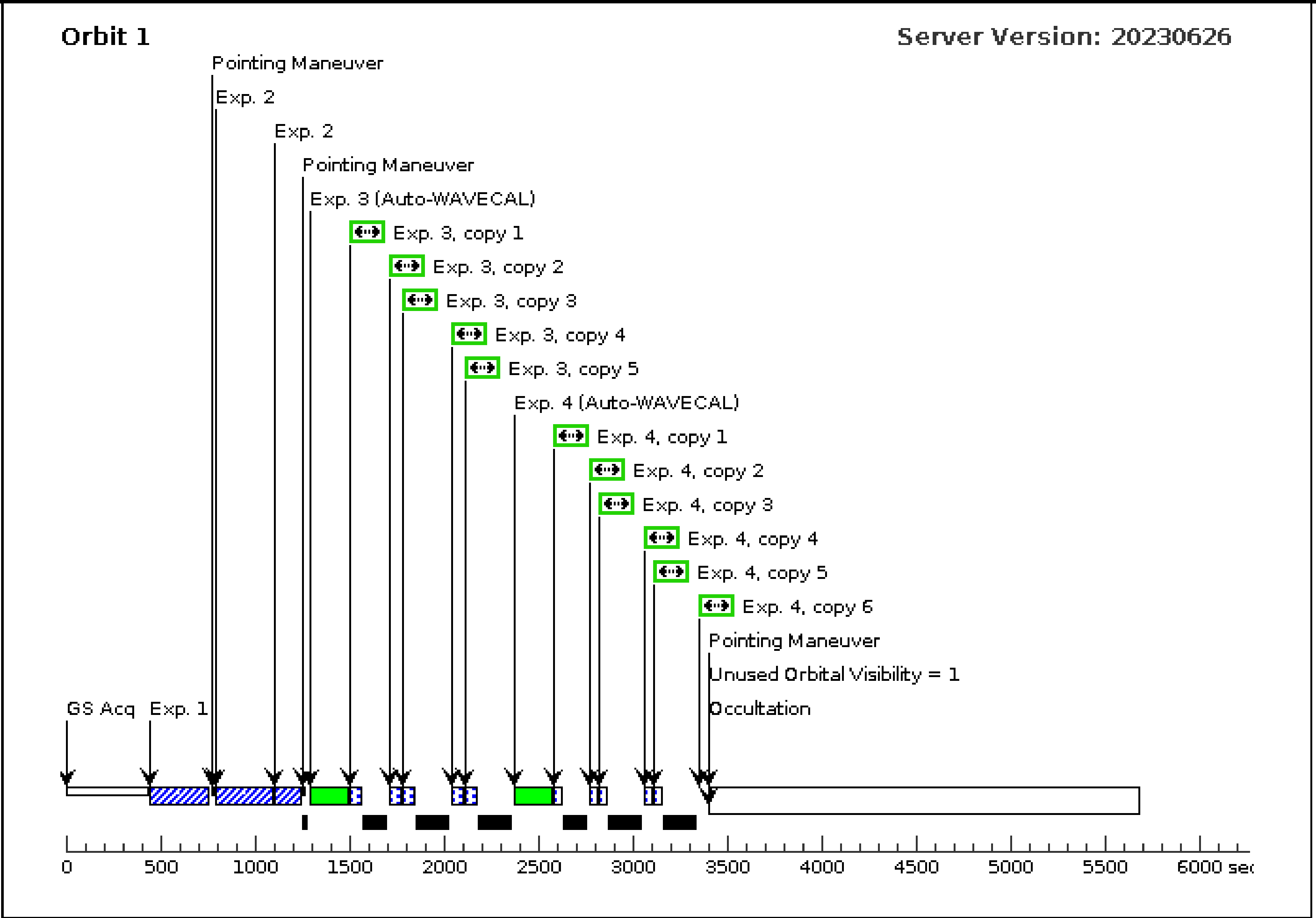
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-AG-CAR	RA: 10 56 11.5681 (164.0482004d) Dec: -60 27 12.78 (-60.45355d) Equinox: J2000	Proper Motion RA: -6.499989539337533E-4 sec of time/yr Proper Motion Dec: 0.001955 arcsec/yr Epoch of Position: 2000.0	V=6.96 5E-12 @ 1400A; 5.5E-12 @ 1650A; 2E-12 @ 2000A; 4E-12 @ 2400A; 1E-11 @ 2900A : LBV	Reference Frame: ICRS

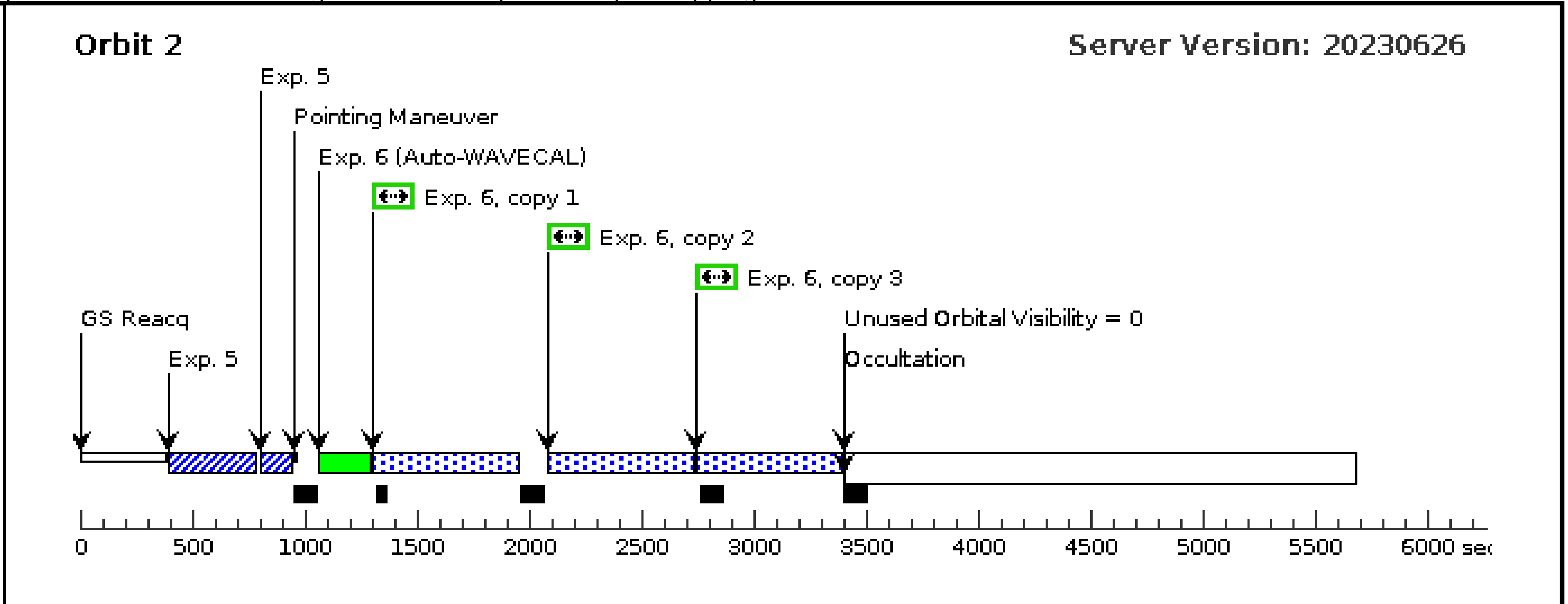
Comments: Coordinates are from Gaia.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1812288)	(1) V-AG-CAR	STIS/CCD, ACQ, F25ND5	MIRROR				6.0 Secs (6 Secs) *[==>]*	*[1]*
2	(1812933)	(1) V-AG-CAR	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs (0.1 Secs) *[==>]*	*[1]*
3	(1893131)	(1) V-AG-CAR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2513 A				60 Secs X 5 (235 Secs) *[==>47.0 Secs (Copy 1)]* *[==>47.0 Secs (Copy 2)]* *[==>47.0 Secs (Copy 3)]* *[==>47.0 Secs (Copy 4)]* *[==>47.0 Secs (Copy 5)]*	*[1]*
	Comments: 4/5 the ETC buffer-time=115ss								
4	(1893141)	(1) V-AG-CAR	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 3012 A				40 Secs X 6 (162 Secs) *[==>27.0 Secs (Copy 1)]* *[==>27.0 Secs (Copy 2)]* *[==>27.0 Secs (Copy 3)]* *[==>27.0 Secs (Copy 4)]* *[==>27.0 Secs (Copy 5)]* *[==>27.0 Secs (Copy 6)]*	*[1]*
5	(1812933)	(1) V-AG-CAR	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.1 Secs (0.1 Secs) *[==>]*	*[2]*
6	(1811971)	(1) V-AG-CAR	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1416 A				500 Secs X 3 (1911 Secs) *[==>637.0 Secs (Copy 1)]* *[==>637.0 Secs (Copy 2)]* *[==>637.0 Secs (Copy 3)]*	*[2]*
7	(1811918)	(1) V-AG-CAR	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1598 A				2900 Secs (2984 Secs) *[==>2984.0 Secs]*	*[3]*
8	(1812152)	(1) V-AG-CAR	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 2013 A				500 Secs X 3 (2823 Secs) *[==>941.0 Secs (Copy 1)]* *[==>941.0 Secs (Copy 2)]* *[==>941.0 Secs (Copy 3)]*	*[4]*

Orbit Structure




Orbit 2
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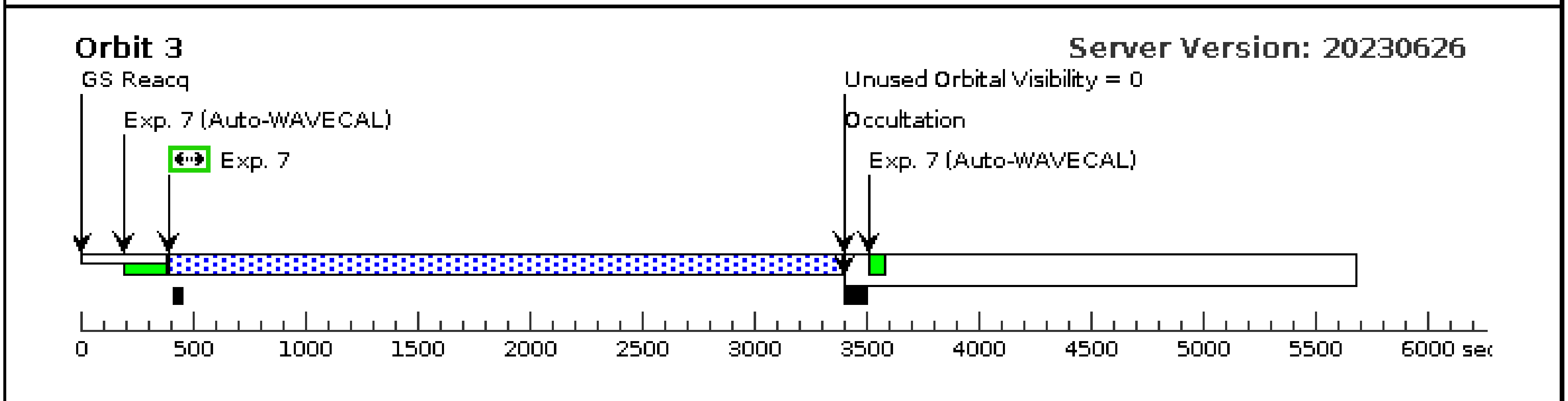
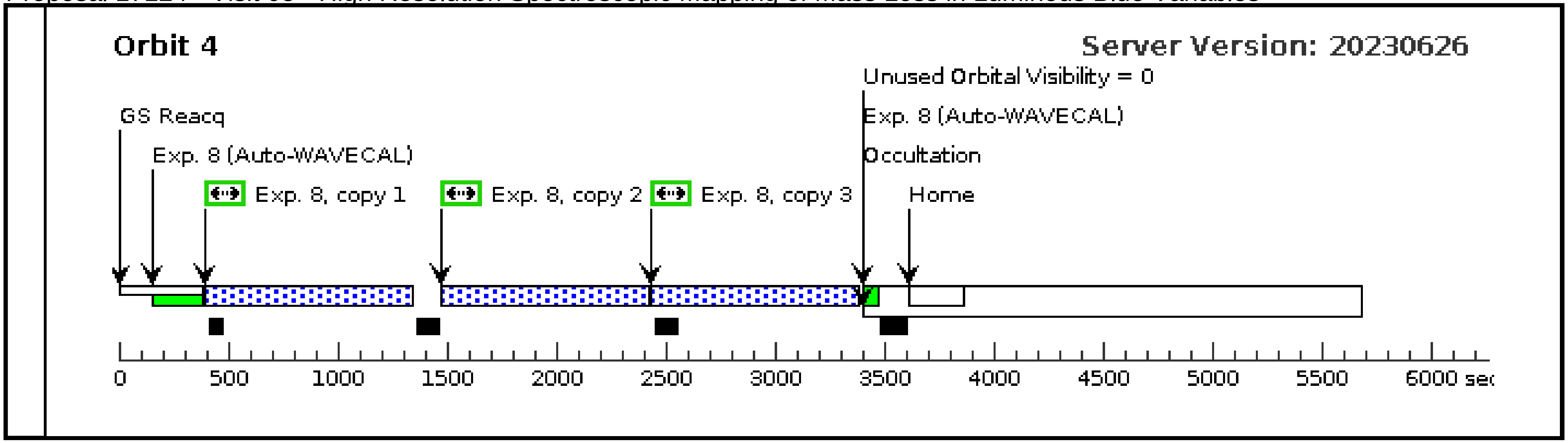
Exp. 5
Pointing Maneuver
Exp. 6 (Auto-WAVECAL)
Exp. 6, copy 1
Exp. 6, copy 2
Exp. 6, copy 3
GS Reacq
Exp. 5
Unused Orbital Visibility = 0
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec


Orbit 3
Server Version: 20230626
GS Reacq
Exp. 7 (Auto-WAVECAL)
Exp. 7
Unused Orbital Visibility = 0
Occultation
Exp. 7 (Auto-WAVECAL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec


Orbit 4
Server Version: 20230626
Unused Orbital Visibility = 0
GS Reacq
Exp. 8 (Auto-WAVECAL)
Exp. 8 (Auto-WAVECAL)
Occultation
Exp. 8, copy 1
Exp. 8, copy 2
Exp. 8, copy 3
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec