17074 - Smoking guns in massive binary evolution: The hunt for Black Holes and Stripped Stars

Cycle: 30, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Varsha Ramachandran (PI) (ESA Member) (Contact)	**Universitat Heidelberg**	**vramachandran@uni-heidelberg.de**
Dr. Andreas Sander (CoI) (ESA Member)	Astronomisches Rechen-Institut Heidelberg	andreas.sander@uni-heidelberg.de
Prof. Lidia Oskinova (CoI) (ESA Member)	Universitat Potsdam	lida@astro.physik.uni-potsdam.de
Dr. Helge Todt (CoI) (ESA Member)	Universitat Potsdam	htodt@astro.physik.uni-potsdam.de
Daniel Pauli (CoI) (ESA Member)	Universitat Potsdam	dpauli@astro.physik.uni-potsdam.de
Matheus Bernini Peron (CoI) (ESA Member)	Astronomisches Rechen-Institut Heidelberg	matheus.bernini@uni-heidelberg.de
Roel Lefever (CoI) (ESA Member)	Astronomisches Rechen-Institut Heidelberg	roel.lefever@uni-heidelberg.de

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HD-215227	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	1	04-Oct-2022 11:00:16.0	yes
03	(1) HD-215227 WAVE	COS/FUV	1	04-Oct-2022 11:00:17.0	yes
02	(2) MLD95-LMC-1-546	COS/FUV	2	04-Oct-2022 11:00:19.0	yes

4 Total Orbits Used

ABSTRACT

With the detection of gravitational waves from merging compact objects, a new observational window onto the fates of massive stars has been opened. To explain the observed mergers of compact objects, we need accurate knowledge about the evolution of massive binary stars. Yet, current population synthesis calculations often yield puzzling results, as they predict certain types of stellar systems in large numbers, which are rarely observed. Whether this is due to observational challenges or due to errors in the underlying evolutionary models, is one of the major open questions in massive star research.

In this proposal, we tackle two crucial stages of massive binary evolution that are predicted in large numbers, but so far rarely observed: Systems containing an OB-star accompanied by an X-ray-quiet black hole (BH) and systems where a hot, envelope-stripped star is outshined by its OB-type companion. In both cases, the (compact) companion hardly leaves any trace in the optical beyond a suspicious, small He II disk-like emission. To identify the nature of the companion and distinguish between a BH and a stripped-star companion, UV spectroscopy is the only viable tool. With the unique capabilities of the HST, we will perform a pilot study for two prototypical systems in the Galaxy and the LMC that harbor either a BH or a stripped star companion. By determining the presence of tracing ions and the wind parameters of the stars, our study will confirm or deny the existence of the presently only known dormant BH in the Milky Way, marking an anchor point for our understanding of massive binary evolution and defining a framework for future observations of stripped stars.

OBSERVING DESCRIPTION

We are observing a bright Galactic B star MWC656 with Vmag~8.8 using STIS and COS. For STIS E140M and E230M settings, ETC only gives a warning about lower buffer time. In COS 130M /1096 setting, it gives a count rate warning in segment A.

But we are planning to observe only in segment B. Our main aim is to look at O IV line at 1032-38 A, which is important for our science case. Since the wavecal lines are too faint for Segment B, and only show up on Segment A, we added additional wavecal exposure before and after the science exposure.

When I run BOT for this object, it gives a warning in all exposures. However, the details of this warning consider an O5 spectral type for this star whereas the actual spectral type is B1-2. I hope this is not a problem.

The second target is an LMC O star, which will be observed using COS/FUV. In the COS130M/ 1291 setting (both segments), all FP-POS setting is

not available. So I opted for two different exposures with FP-POS=3 and 4. However, it still gives a warning in APT. In COS 160M/1611 we chose both segments and all FP-POS.

Each target has two consecutive orbits planned to reduce the overheads. In all spectral settings, we aim for S/N ~30 except COS 130M /1096 segment B.

Visit

Proposal 17074, Visit 01, implementation

Tue Oct 04 15:00:19 GMT 2022

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

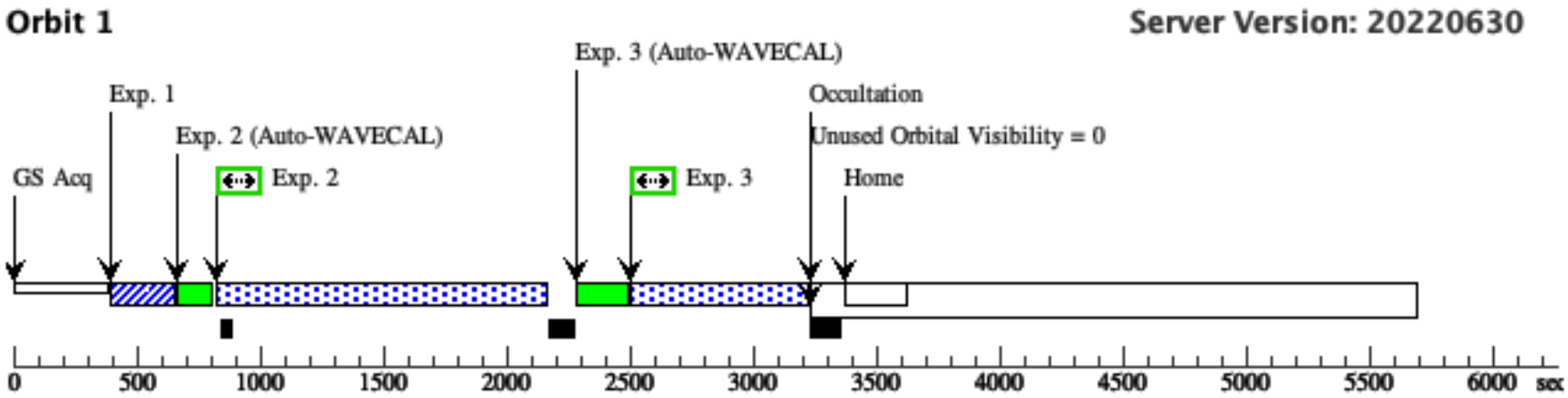
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-215227	RA: 22 42 57.3032 (340.7387633d)	Proper Motion RA: -3.478 mas/yr	V=8.81	Reference Frame: ICRS
		Dec: +44 43 18.26 (44.72174d)	Proper Motion Dec: -3.159 mas/yr	Gmag=8.7	
		Equinox: J2000	Epoch of Position: 2016		

Comments: Coordinates and proper motions are taken from Gaia DR3
Category=STAR
Description=[B0-B2 III-I]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1810745)	(1) HD-215227	STIS/CCD, ACQ, F28X50OII	MIRROR	ACQTYPE=POINT			1 Secs (1 Secs)	
								[==>]	***[1]***
2	(1821220)	(1) HD-215227	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				1320 Secs (1320 Secs)	
								[==>]	***[1]***
3	(1821222)	(1) HD-215227	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230M 2124 A				702 Secs (702 Secs)	
								[==>]	***[1]***

Orbit Structure



Visit

Proposal 17074, Visit 03, implementation Tue Oct 04 15:00:20 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: (none)

Diagnostics

(Visit 03) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions when observing at a given COS cenwave. See the COS Instrument Handbook for exceptions that may apply to observations with G130M/1291 or G160M.

(Exposure 4 (Visit 03)) Warning (Form): An FUV exposure with Wavelength 1055 or 1096 has been specified with SEGMENT=B.

(Exposure 5 (Visit 03)) Warning (Form): An FUV exposure with Wavelength 1055 or 1096 has been specified with SEGMENT=B.

Fixed Targets

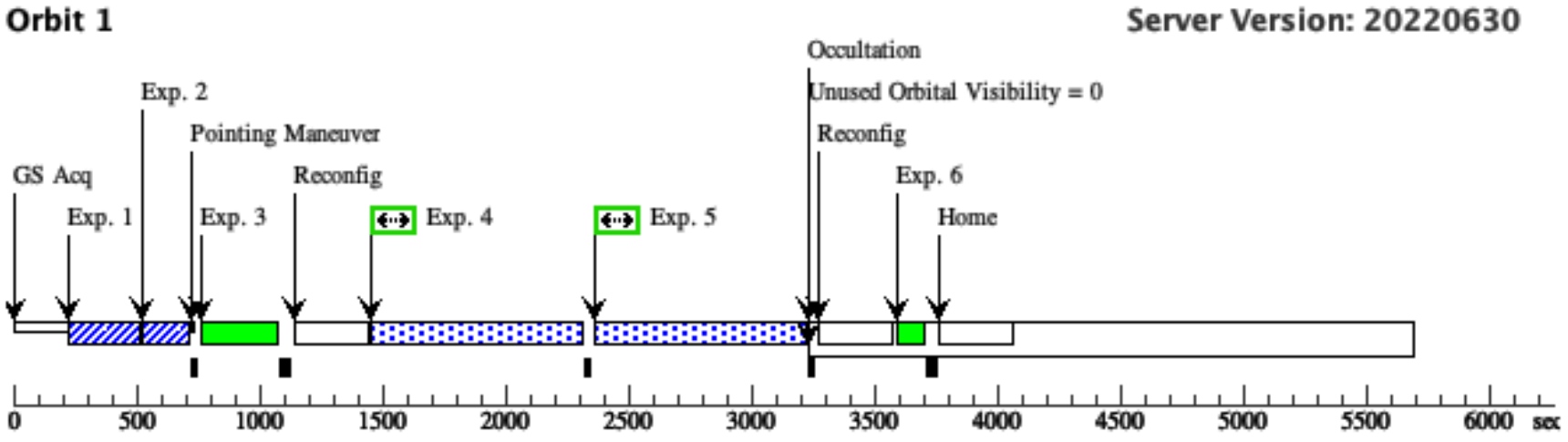
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-215227	RA: 22 42 57.3032 (340.7387633d) Dec: +44 43 18.26 (44.72174d) Equinox: J2000	Proper Motion RA: -3.478 mas/yr Proper Motion Dec: -3.159 mas/yr Epoch of Position: 2016	V=8.81 Gmag=8.7	Reference Frame: ICRS

Comments: Coordinates and proper motions are taken from Gaia DR3
Category=STAR
Description=[B0-B2 III-I]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1823561)	(1) HD-215227	COS/FUV, ACQ/PEAKXD, BOA	G140L 1280 A	LIFETIME-POS=LP 4			8.5 Secs (8.5 Secs) *[==>]*	 ***[1]***
2	(1823561)	(1) HD-215227	COS/FUV, ACQ/PEAKD, BOA	G140L 1280 A	CENTER=DEF; NUM-POS=5; STEP-SIZE=0.9; SEGMENT=BOTH; LIFETIME-POS=LP4			8.5 Secs (8.5 Secs) *[==>]*	 ***[1]***
3		WAVE	COS/FUV, TIME-TAG, WCA	G130M 1096 A	SEGMENT=BOTH; FP-POS=1; LIFETIME-POS=LP2			*[==>]*	***[1]***
4	(1823562)	(1) HD-215227	COS/FUV, TIME-TAG, PSA	G130M 1096 A	SEGMENT=B; FP-POS=1; LIFETIME-POS=LP2; BUFFER-TIME=11888			808 Secs (808 Secs) *[==>]*	 ***[1]***
5	(1823562)	(1) HD-215227	COS/FUV, TIME-TAG, PSA	G130M 1096 A	SEGMENT=B; FP-POS=3; LIFETIME-POS=LP2; BUFFER-TIME=11888			808 Secs (808 Secs) *[==>]*	 ***[1]***
6		WAVE	COS/FUV, TIME-TAG, WCA	G130M 1096 A	SEGMENT=BOTH; FP-POS=3; LIFETIME-POS=LP2			*[==>]*	***[1]***

Orbit Structure



Visit

Proposal 17074, Visit 02, implementation Tue Oct 04 15:00:20 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: (none)

Diagnostics

(Visit 02) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions when observing at a given COS cenwave. See the COS Instrument Handbook for exceptions that may apply to observations with G130M/1291 or G160M.

Fixed Targets

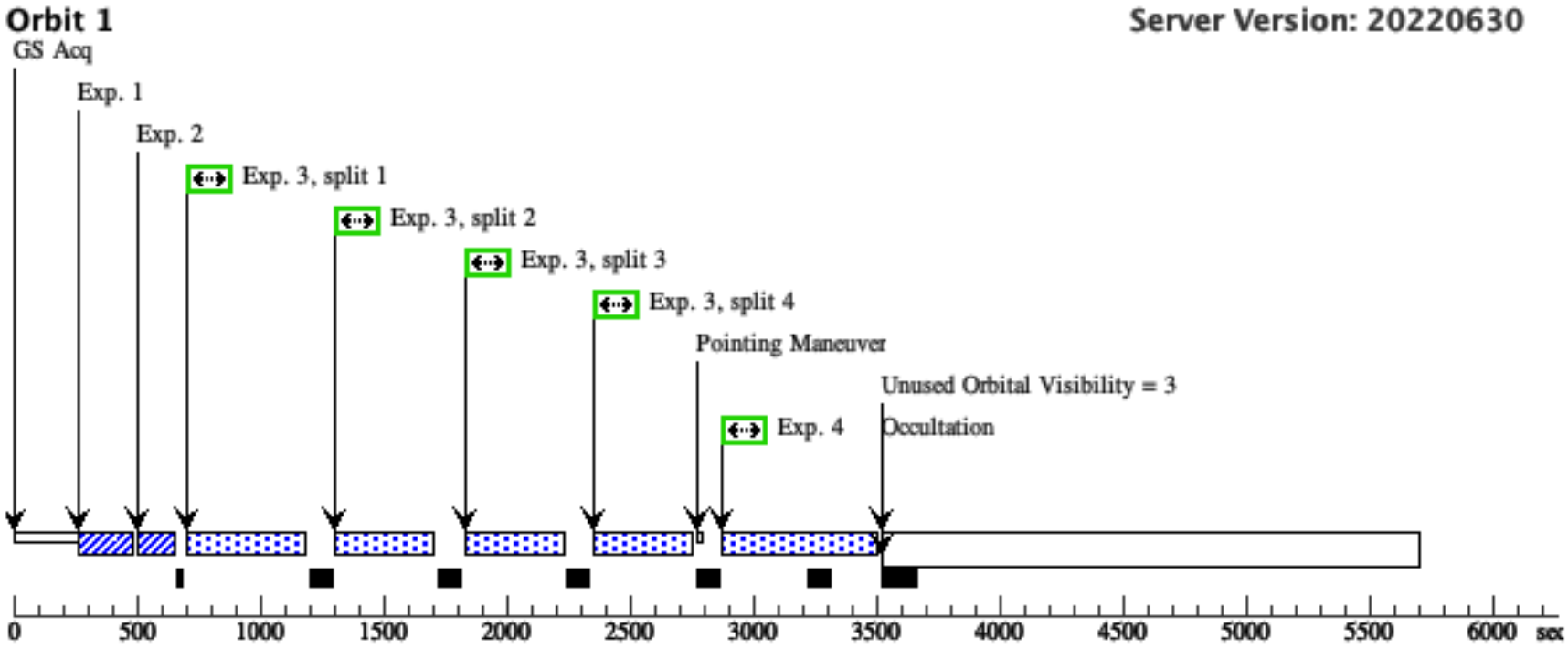
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	MLD95-LMC-1-546	RA: 05 31 23.7850 (82.8491042d)	Proper Motion RA: 1.866 mas/yr	V=13.88	Reference Frame: ICRS
		Dec: -71 04 12.66 (-71.07018d)	Proper Motion Dec: 0.484 mas/yr	Gmag=14.87	
		Equinox: J2000	Epoch of Position: 2016		

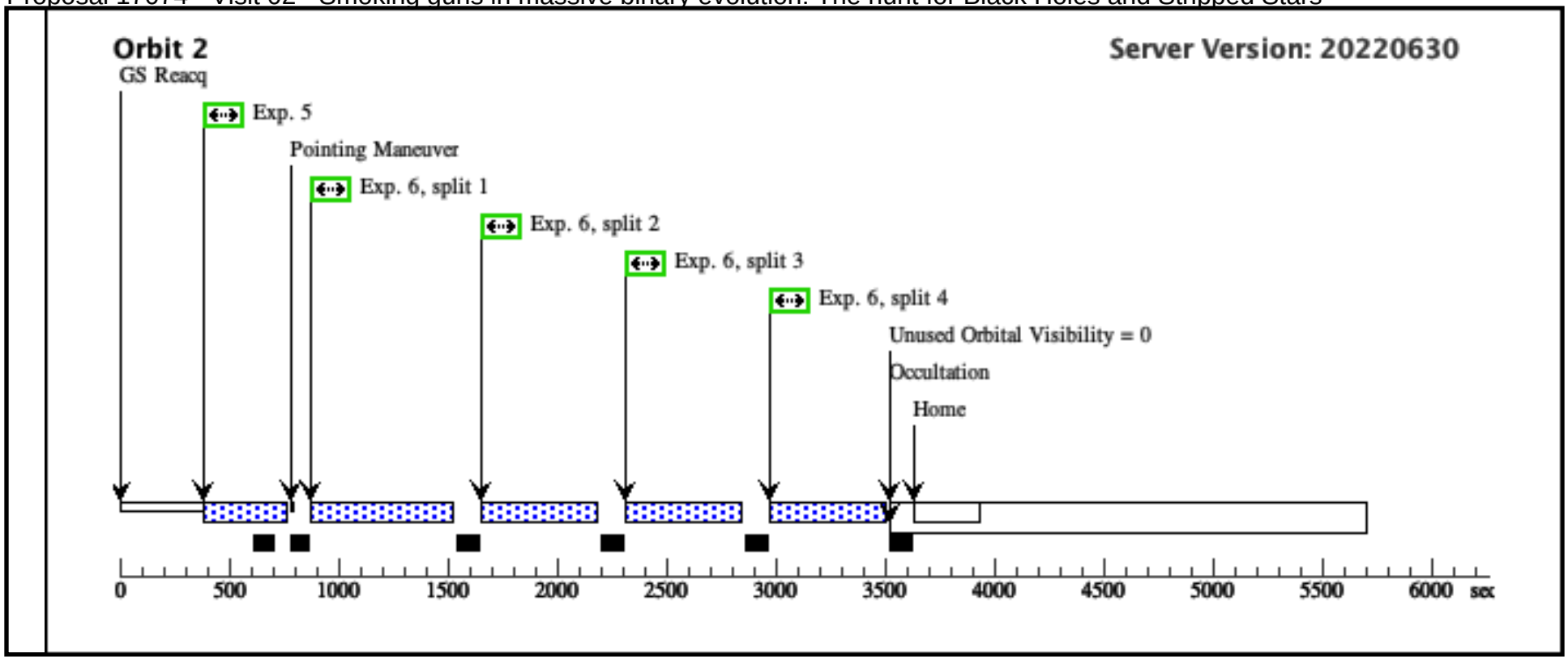
Comments: Coordinates and proper motions are taken from Gaia DR3
Category=EXT-STAR
Description=[MAIN SEQUENCE O]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1811362)	(2) MLD95-LMC-1-546	COS/FUV, ACQ/PEAKXD, PSA	G160M 1577 A	LIFETIME-POS=LP4			1 Secs (1 Secs) *[==>]*	 ***[1]***
2	(1811362)	(2) MLD95-LMC-1-546	COS/FUV, ACQ/PEAKD, PSA	G160M 1577 A	CENTER=DEF; NUM-POS=5; STEP-SIZE=0.9; LIFETIME-POS=LP4			1 Secs (1 Secs) *[==>]*	 ***[1]***
3	(1811367)	(2) MLD95-LMC-1-546	COS/FUV, TIME-TAG, PSA	G160M 1611 A	BUFFER-TIME=395; FP-POS=ALL; SEGMENT=BOTH; LIFETIME-POS=LP4			351 Secs (1404 Secs) *[==>(Split 1)]* *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	 ***[1]***
4	(1812080)	(2) MLD95-LMC-1-546	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=187; SEGMENT=BOTH; FP-POS=3; LIFETIME-POS=LP5			450 Secs (450 Secs) *[==>]*	 ***[1]***
5	(1812080)	(2) MLD95-LMC-1-546	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=187; SEGMENT=BOTH; FP-POS=4; LIFETIME-POS=LP5			328 Secs (328 Secs) *[==>]*	 ***[2]***
6	(1811381)	(2) MLD95-LMC-1-546	COS/FUV, TIME-TAG, PSA	G130M 1096 A	FP-POS=ALL; SEGMENT=BOTH; BUFFER-TIME=523; LIFETIME-POS=LP2			480 Secs (1920 Secs) *[==>(Split 1)]* *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	 ***[2]***

Orbit Structure




Orbit 2
Server Version: 20220630
GS Reacq
Exp. 5
Pointing Maneuver
Exp. 6, split 1
Exp. 6, split 2
Exp. 6, split 3
Exp. 6, split 4
Unused Orbital Visibility = 0
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec