17119 - Completing the stellar census of Westerlund 1

Cycle: 30, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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Dr. Matthew Hosek Jr. (CoI)	University of California - Los Angeles	mwhosek@gmail.com

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) CL-WESTERLUND-1	WFC3/IR	3	15-Jul-2022 12:02:11.0	yes
02	(1) CL-WESTERLUND-1	WFC3/IR	4	15-Jul-2022 12:02:16.0	yes

7 Total Orbits Used

ABSTRACT

We propose to obtain a new epoch of precise astrometry covering a 4'x4' extent of the massive, young cluster Westerlund 1. Previous epochs of HST data have been used to determine cluster membership for the full cluster down to a mass limit of 1.4 Msun using proper motions derived from a combination of optical and near infrared data. By adding an additional epoch of astrometry from WFC3-IR, we will be able to confirm the full membership of the cluster down to 0.1 Msun. These observations will be used to map the full initial mass function (IMF) of the cluster, which we have tentatively found is bottom-light. Furthermore, the additional epoch of data will offer an improvement in proper motion precision by a factor of 3, enabling the measurement of velocities to ~1 km/s. Using this information, we will map the velocities as a function of mass to test star formation

models. These data will provide new insight into the origin and universality of the IMF.

OBSERVING DESCRIPTION

Our program to measure the internal kinematics of the massive young cluster, Westerlund 1, requires precise astrometric observations. Archival HST data sets of Wd 1 include three epochs multi-band WFC3-IR imaging of the full extent of the cluster, which we will use as our initial epochs. New observations in cycle 30 will provide a critical fourth near-infrared astrometric epochs, providing membership confirmation and precise velocities down to the substellar limit. A 2x2 (4'x4') mosaic is needed to cover the full cluster extent.

Our target goal is to identify and measure cluster members down to the limits of the existing WFC3-IR data at 0.1 solar masses, which corresponds to H=20.5. In order to effectively select the field stars, we require a 1 sigma proper motion precision of <0.3 mas/yr. We will use existing data from 2010, 2013, and 2015 with a total time baseline of 12 years to achieve our desired proper motion errors. We will measure the astrometry with WFC3's longest-wavelength filter (F160W) to minimize the impact of extinction. Therefore, we need a total SNR=160 on the stars of interest to achieve an astrometric precision of 1 mas and a final velocity precision of 0.1 mas/yr. Additionally, to minimize the impact of geometric distortions, we request that the astrometric observations have the SAME ORIENT with small POSTARG offsets as the 2013 and 2015 observations.

Our observations require a high dynamic range as we are interested in both the higher mass, brighter stars (typically H=0) and the lower mass, fainter stars (typically H=20.5) in the cluster. As a result we must limit our integration time per exposure so as to avoid saturating too many stars, such that the resulting persistence images would not impact the astrometric measurements. We also adopt a minimum integration time that still allows us to dump the WFC3 buffer in parallel (249 s for a STEP50 readout pattern with 10 MULTIACCUM reads). Integration times for observations of Wd 1 in the F160W filter were calculated with the WFC3 exposure time calculator to achieve SNR=160 for an H=20.5 star with a late M dwarf spectral type and an E(B-V) = 3.5. For each position in our proposed 2x2 mosaic of Wd 1, we require 13-14 exposures for a total of 3240-3490 s of integration time per pointing. We also require additional short exposures in sub-arrayed mode to capture the most massive stars that were saturated in the longer exposures. This amounts to 7 orbits to complete the entire mosaic in cycle 30.

--------- Additional Comments ----------

The archival observations have the PID 11708 from 2010 and PID 13809 from 2013/2015. We request that our new observations have the same orientation and detector position as the F160W images from the archived data set.

Visit

Proposal 17119, Visit 01 Fri Jul 15 16:02:18 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 265D TO 275 D

Diagnostics

(Visit 01) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE

(Visit 01) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

(Visit 01) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=SPIRAL	Coordinate Frame=POS-TARG		(5), (6)
	Purpose=DITHER	Pattern Orientation=14		
	Number Of Points=13	Angle Between Sides=		
	Point Spacing=3.26	Center Pattern=false		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	CL-WESTERLUND-1	RA: 16 47 4.0000 (251.7666667d) Dec: -45 50 42.00 (-45.84500d) Equinox: J2000	Proper Motion RA: -2.2253430573750216E-4 sec of time/yr Proper Motion Dec: -0.0036540000337481615 arcsec/yr Epoch of Position: 2015.5	V=12 H=9-20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STELLAR CLUSTER
Description=[OB ASSOCIATION, OPEN CLUSTER, STAR FORMING REGION, YOUNG ASSOCIATION]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 24.2,-21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
2		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 85.8,-21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
3		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 24.2,21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
4		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 85.8,21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
5		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG 55,-55	Pattern 2, Exps 5-5 in Visit 01 (2)	249.23203 Secs (3240.016 Secs)	
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								[==>(Pattern 7)]	
								[==>(Pattern 8)]	
								[==>(Pattern 9)]	***[2]***
								[==>(Pattern 10)]	
								[==>(Pattern 11)]	
								[==>(Pattern 12)]	
								[==>(Pattern 13)]	
6		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG 55,55	Pattern 2, Exps 6-6 in Visit 01 (2)	249.23203 Secs (3240.016 Secs)	
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								[==>(Pattern 4)]	
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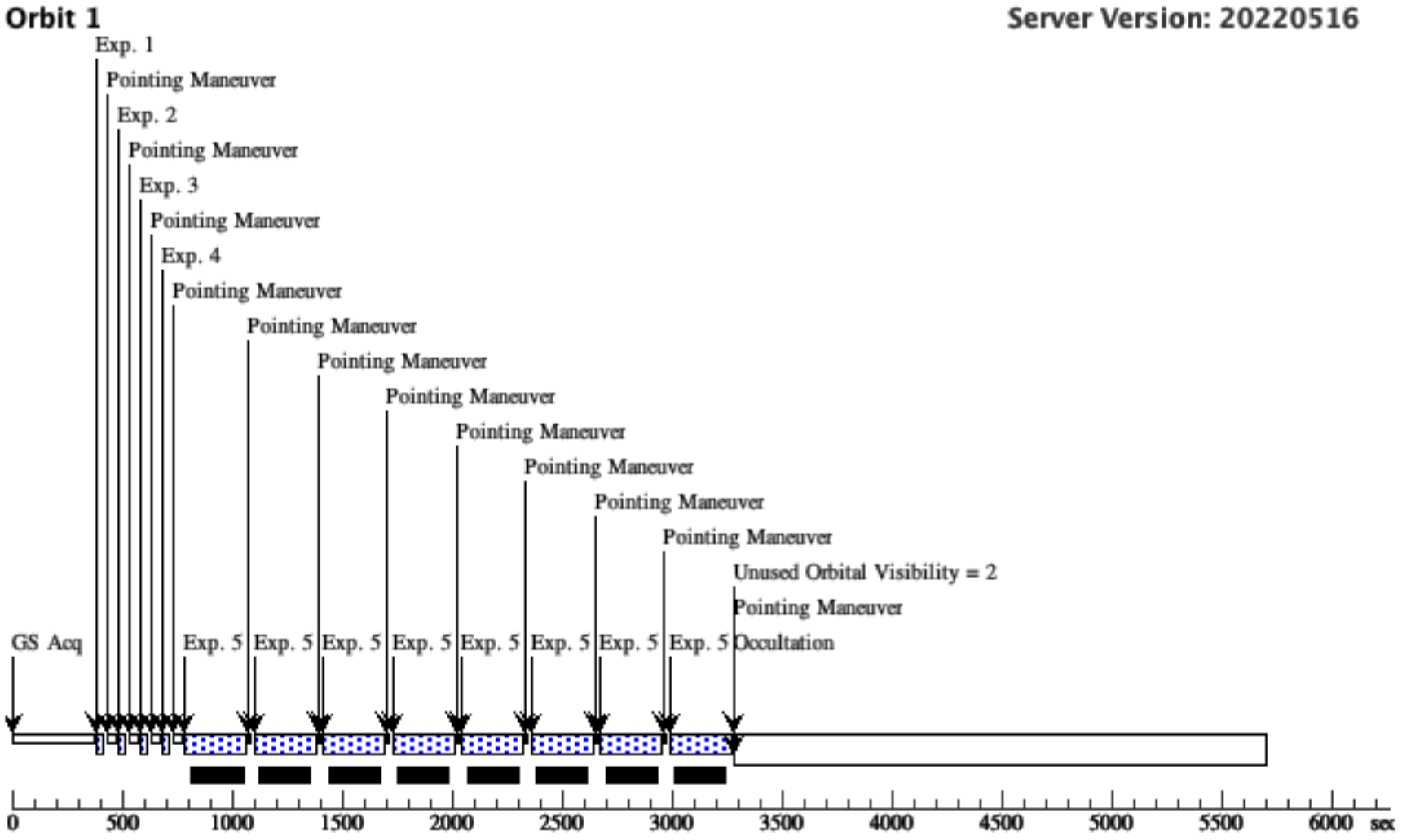
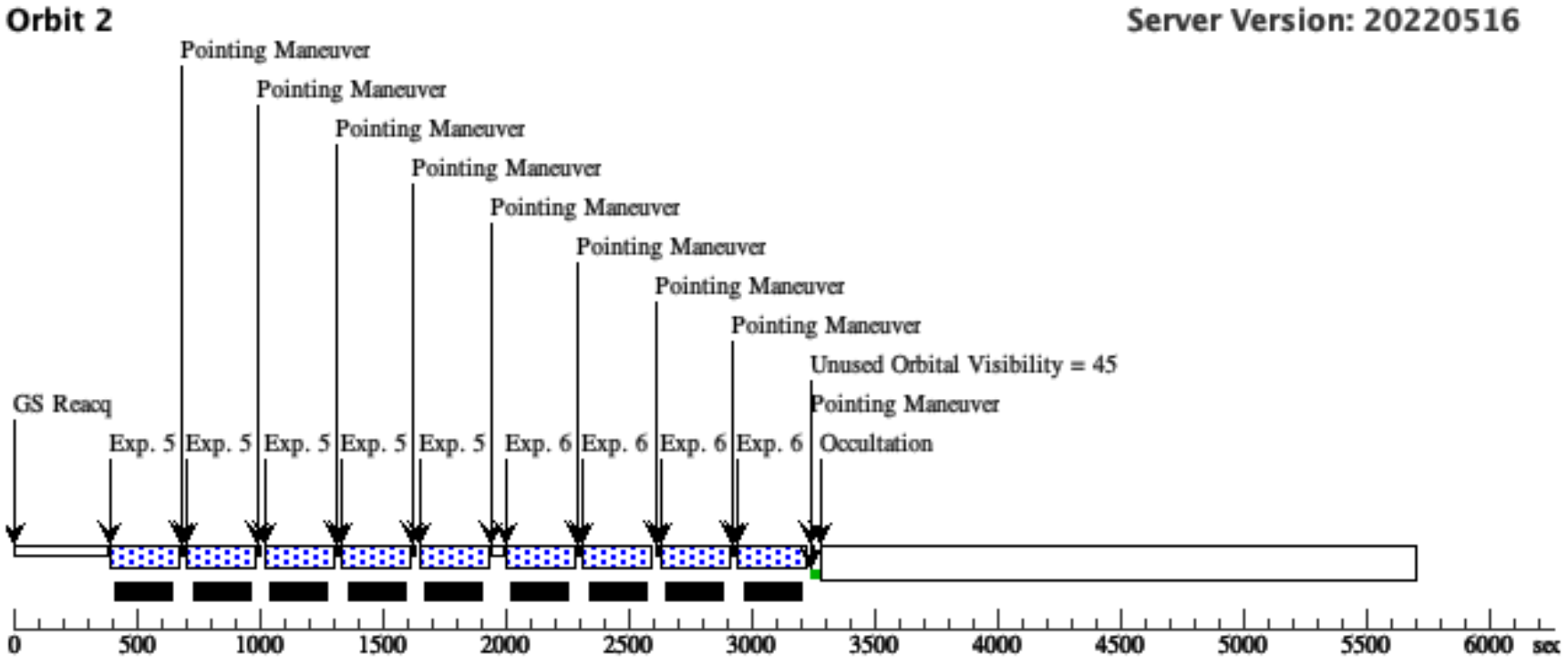
Orbit Structure

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Unused Orbital Visibility = 45
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GS Reacq
Exp. 5
Exp. 5
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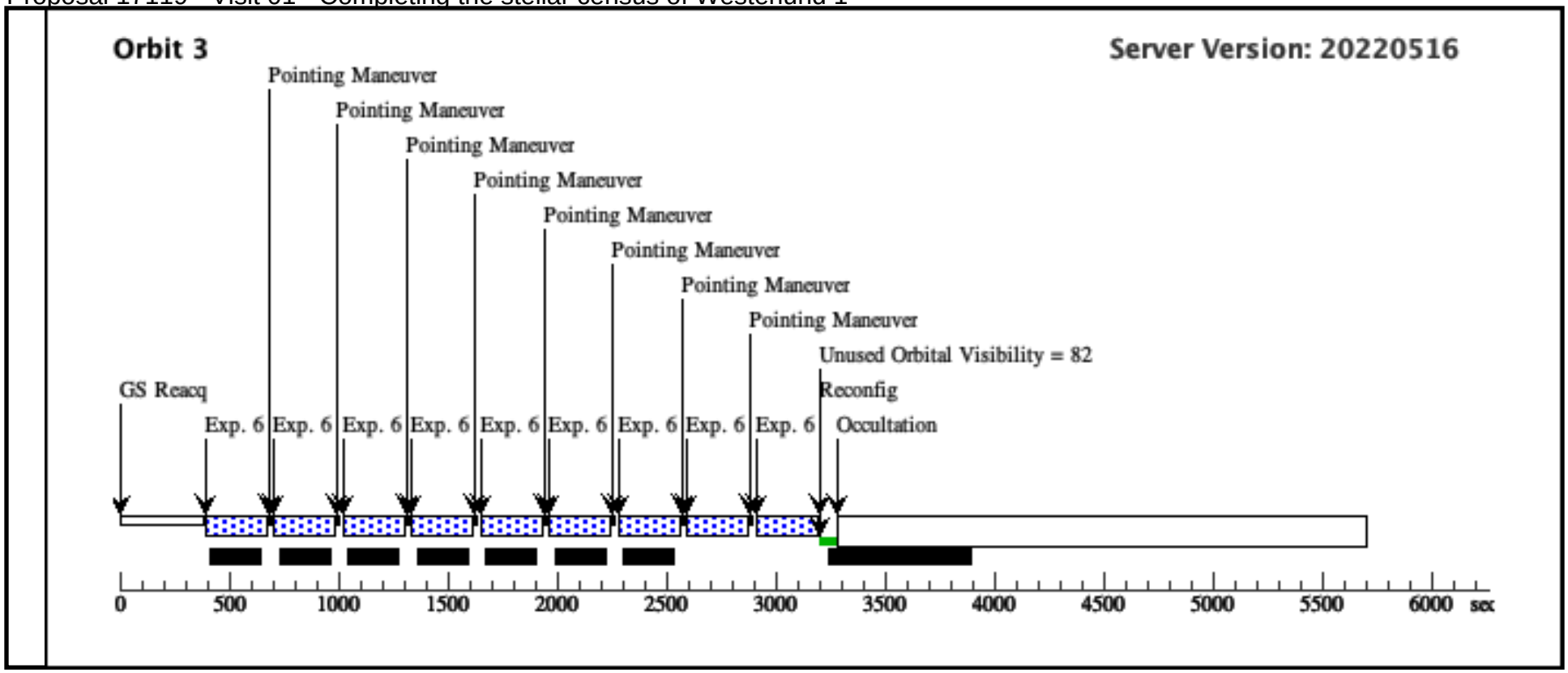
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Exp. 6
Occultation
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3000
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4000
4500
5000
5500
6000
sec

Visit

Proposal 17119, Visit 02

Fri Jul 15 16:02:18 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR

Special Requirements: SAME ORIENT AS 01; AFTER 01 BY 0 D TO 30 D

Diagnostics

(Visit 02) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE
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(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=SPIRAL Purpose=DITHER Number Of Points=14 Point Spacing=3.26 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=14 Angle Between Sides= Center Pattern=false		(6)
(2)	Pattern Type=SPIRAL Purpose=DITHER Number Of Points=13 Point Spacing=3.26 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=14 Angle Between Sides= Center Pattern=false		(5)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	CL-WESTERLUND-1	RA: 16 47 4.0000 (251.7666667d) Dec: -45 50 42.00 (-45.84500d) Equinox: J2000	Proper Motion RA: -2.2253430573750216E-4 sec of time/yr Proper Motion Dec: -0.0036540000337481615 arcsec/yr Epoch of Position: 2015.5	V=12 H=9-20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
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Description=[OB ASSOCIATION, OPEN CLUSTER, STAR FORMING REGION, YOUNG ASSOCIATION]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -85.8,21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
2		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -24.1,21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
3		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -85.8,-21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
4		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -24.2,-21		8.53027 Secs (8.53 Secs)	
								[==>]	***[1]***
5		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG -55,55	Pattern 2, Exps 5-5 in Visit 02 (2)	249.23203 Secs (3240.016 Secs)	
								[==>(Pattern 1)]	***[1]***
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								[==>(Pattern 8)]	
								[==>(Pattern 9)]	***[2]***
								[==>(Pattern 10)]	
								[==>(Pattern 11)]	
								[==>(Pattern 12)]	
								[==>(Pattern 13)]	
6		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG -55,-55	Pattern 1, Exps 6-6 in Visit 02 (1)	249.23203 Secs (3489.248 Secs)	
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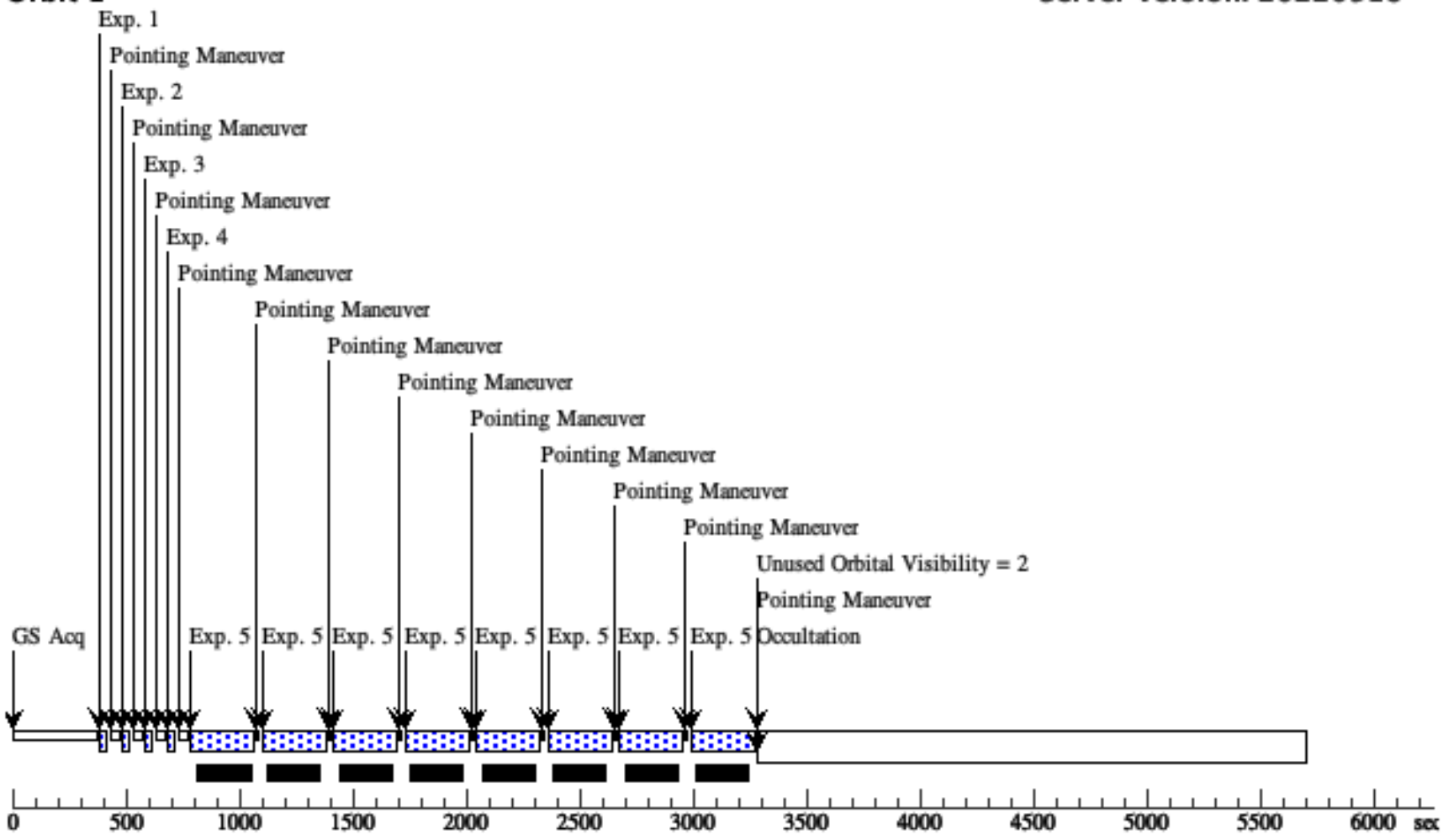
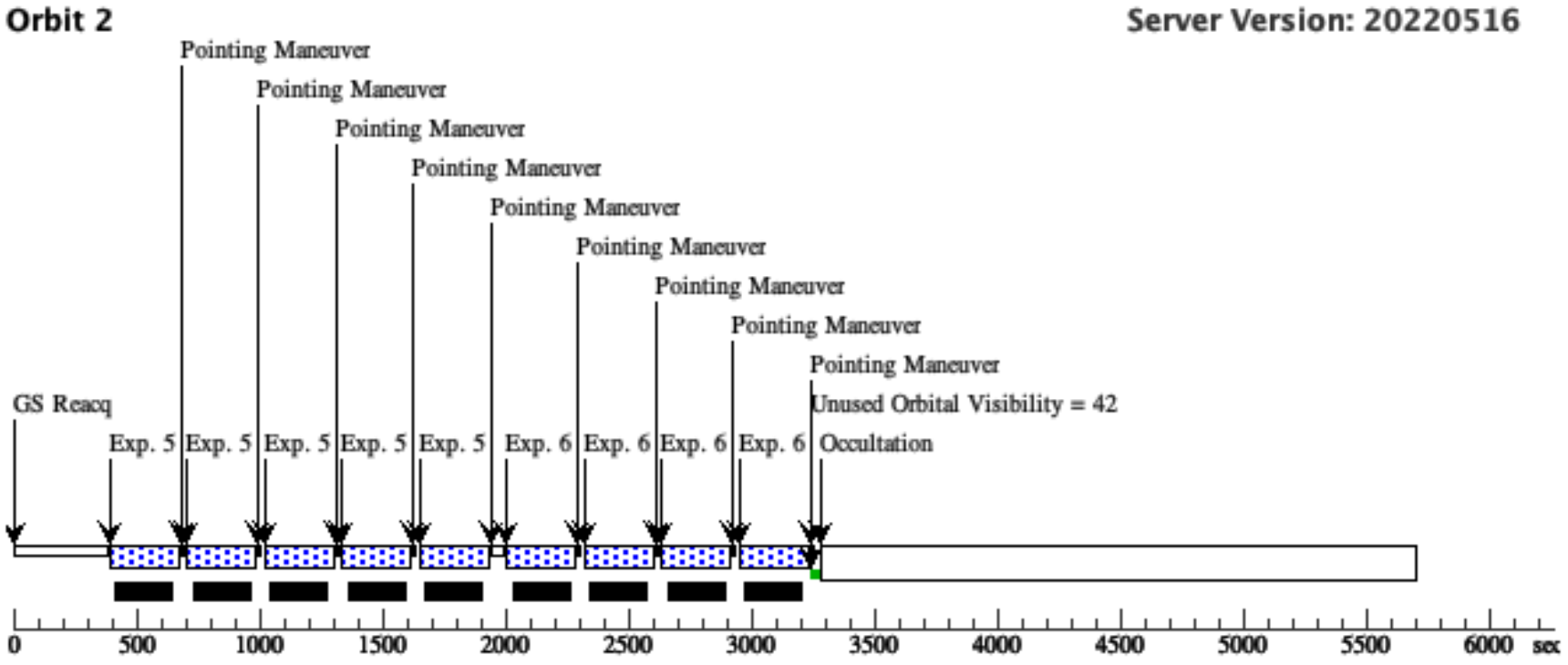
7		(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 24.2,89		8.53027 Secs (8.53 Secs)	
								[==>]	***[4]***

	8	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG -24.2,89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***
	9	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG -85.8,89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***
	10	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG -85.8,-89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***
	11	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG -24.2,-89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***
	12	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG 24.2,-89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***
	13	(1) CL-WESTERLUND-1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID ; NSAMP=10	POS TARG 85.8,-89	8.53027 Secs (8.53 Secs) *[==>]*	 ***[4]***

Orbit Structure

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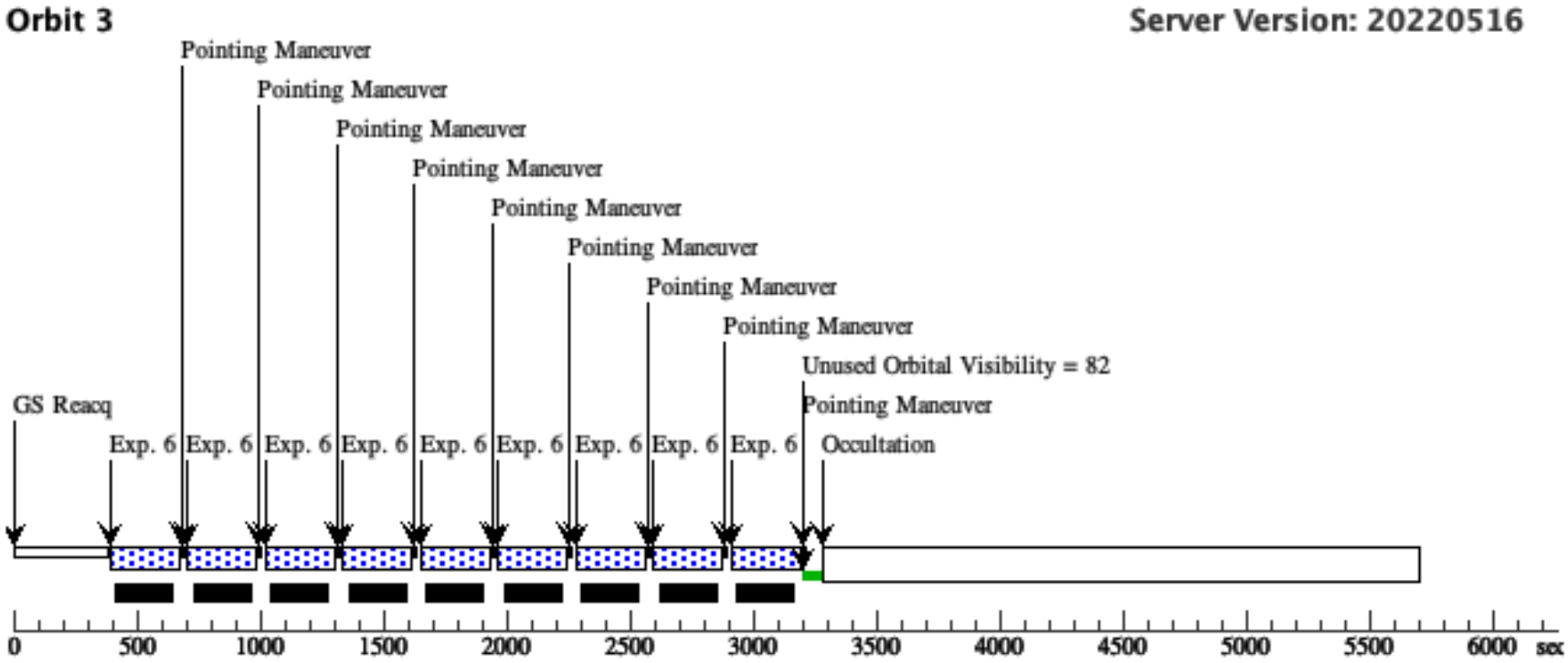
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Exp. 6
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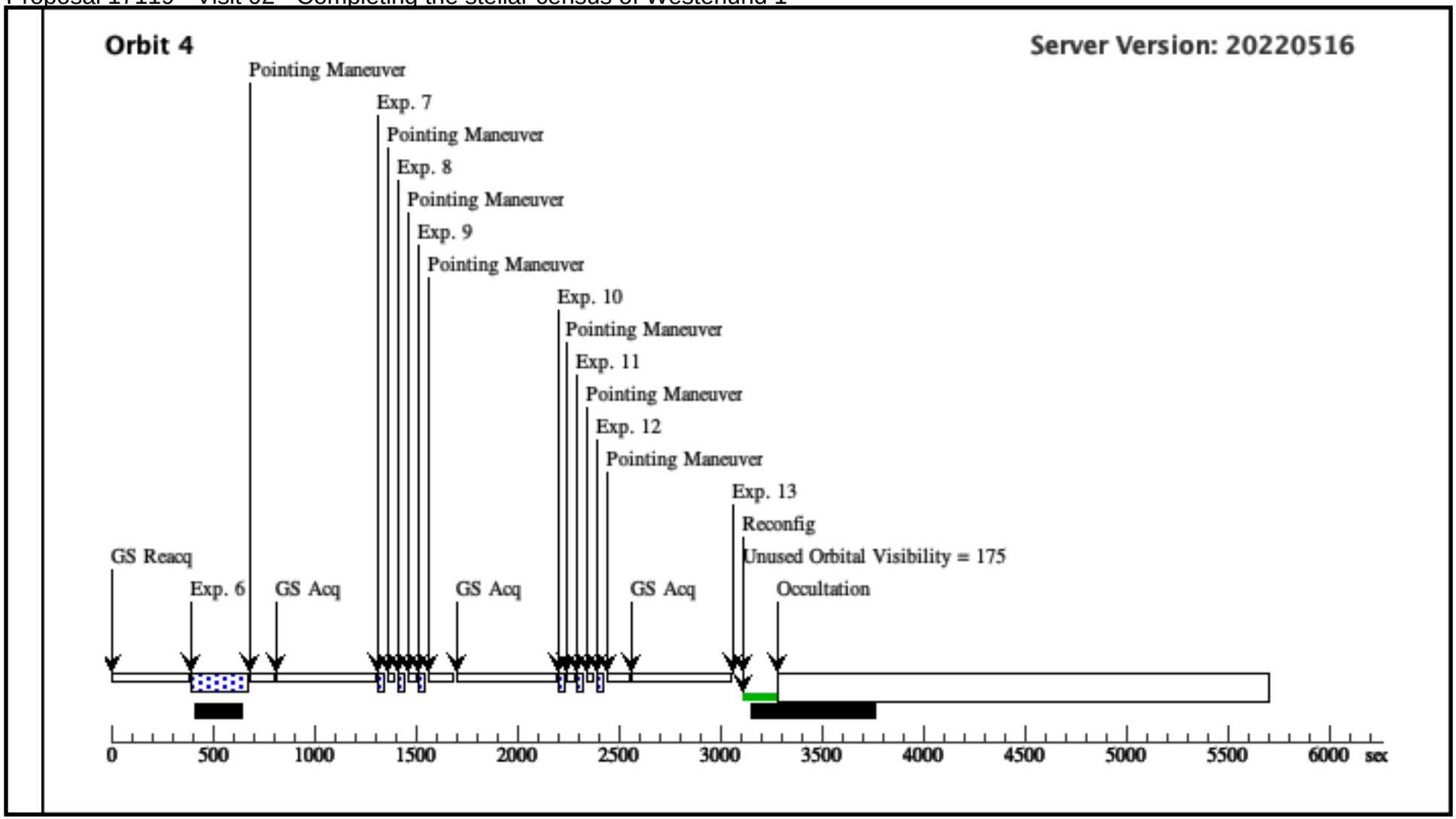
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Exp. 13
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GS Acq
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