13044 - The IMF and Internal Kinematics of the Massive Young Star Cluster, Westerlund 1

Cycle: 20, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Jessica R. Lu (PI) (Contact)	**University of Hawaii**	**jlu@ifa.hawaii.edu**
Dr. Nate McCrady (CoI)	University of Montana - Missoula	nate.mccrady@umontana.edu
Dr. Mark R. Morris (CoI)	University of California - Los Angeles	morris@astro.ucla.edu
Dr. Andrea M. Ghez (CoI)	University of California - Los Angeles	ghez@astro.ucla.edu
Dr. William I. Clarkson (CoI)	Indiana University System	wiclarks@indiana.edu
Dr. Jay Anderson (CoI)	Space Telescope Science Institute	jayander@stsci.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) WESTERLUND1	WFC3/IR	3	11-Jul-2012 01:48:35.0	yes
02	(1) WESTERLUND1	WFC3/IR	4	11-Jul-2012 01:49:36.0	yes

7 Total Orbits Used

ABSTRACT

The most massive young star cluster known in the Milky Way, Westerlund 1, represents a far more extreme environment for star formation than nearby, well-studied, and lower-mass star forming regions such as Taurus and Orion. We propose to construct a complete photometric and kinematic census of Westerlund 1 in order to identify cluster members down to 0.1 solar masses, precisely determine the initial mass function (IMF), and measure the internal kinematic structure of the cluster. With these measurements, we will test whether the IMF is universal, as may be the case for

nearby lower-mass star forming regions, or favors high-mass star formation, as has been suggested theoretically and from some observational results. We will observe Wd 1 with WFC3-IR, which is the only instrument capable of delivering high spatial resolution, a well-characterized and stable PSF, and a wide field of view at infrared wavelengths. We exploit WFC3's capabilities to cover the full extent of the cluster with photometry, to correct for variable extinction and derive stellar masses, and with proper motions, to distinguish between cluster members and contaminating field stars. Our proposed observations of Westerlund 1 will help determine whether the star formation process, and the emergent stellar mass distribution, varies with initial cloud conditions.

OBSERVING DESCRIPTION

Our program to measure the IMF and internal kinematics of the massive young cluster, Westerlund 1, requires both astrometric and near-infrared photometric observations. Archival HST data sets of Wd 1 include multi-band WFC3-IR imaging of the full extent of the cluster, which we will use as our first epoch of observation when establishing membership probabilities down to the lowest stellar masses. New observations in cycle 20 and cycle 22 would be obtained with WFC3 in the near infrared to provide additional astrometric epochs. A 2x2 (4'x4') mosaic is needed to cover the full cluster extent.

We will obtain 2 additional observations using WFC3-IR in cycle 20 and cycle 22 specifically optimized for astrometry. Our target goal is to identify 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 and new observations in cycles 20 (2013) and 22 (2015) with a total time baseline of 5 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 0.3 mas/yr. Additionally, to minimize the impact of geometric distortions, we request that the astrometric observations have the SAME ORIENT with small POSTARG osets as the 2010 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 and photometric 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 14 exposures for a total of 3486

s of integration time. 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 20. The observations will be repeated in cycle 22 with an additional 7 orbits.

ADDITIONAL COMMENTS

The archival observations have the PID 11708. We request that our new observations have the same orientation and position as the F160W images from the archived data set. The relevant data set numbers are ib5w02, ib5w03, ib5w04, and ib5w05.

Visit

Proposal 13044, Visit 01 Wed Jul 11 05:49:52 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 269D TO 270 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

(Visit 01) Warning (Orbit Planner): VISIBILITY OVERRUN

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=SPIRAL	Coordinate Frame=POS-TARG		(3), (4)
	Purpose=DITHER	Pattern Orientation=14		
	Number Of Points=14	Angle Between Sides=		
	Point Spacing=3.26	Center Pattern=false		
	Line Spacing=			

Fixed Targets

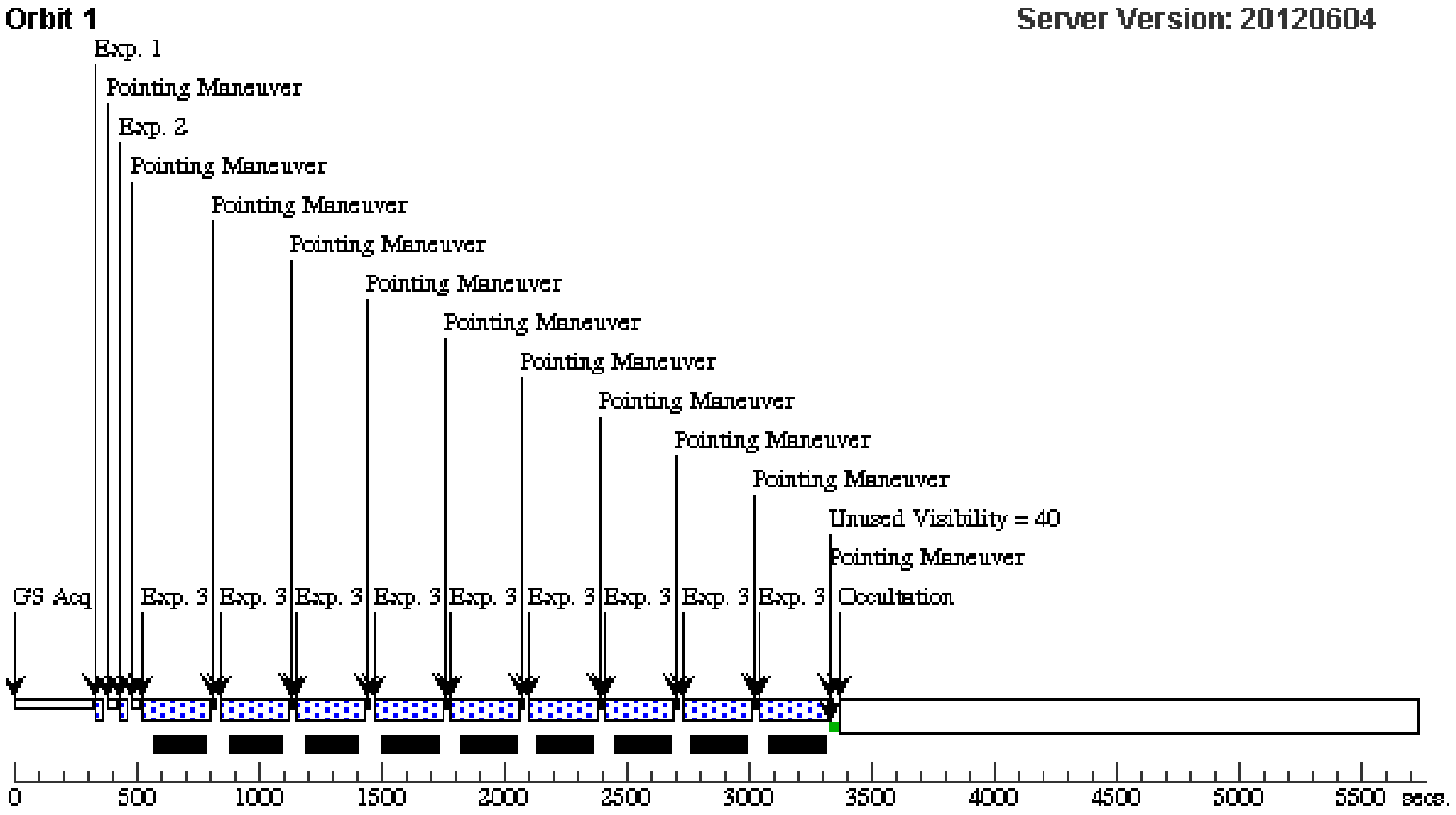
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	WESTERLUND1	RA: 16 47 4.0000 (251.7666667d)		V=12+/-1	Reference Frame: ICRS
		Dec: -45 50 42.00 (-45.84500d)		H=9-20	
		Equinox: J2000			

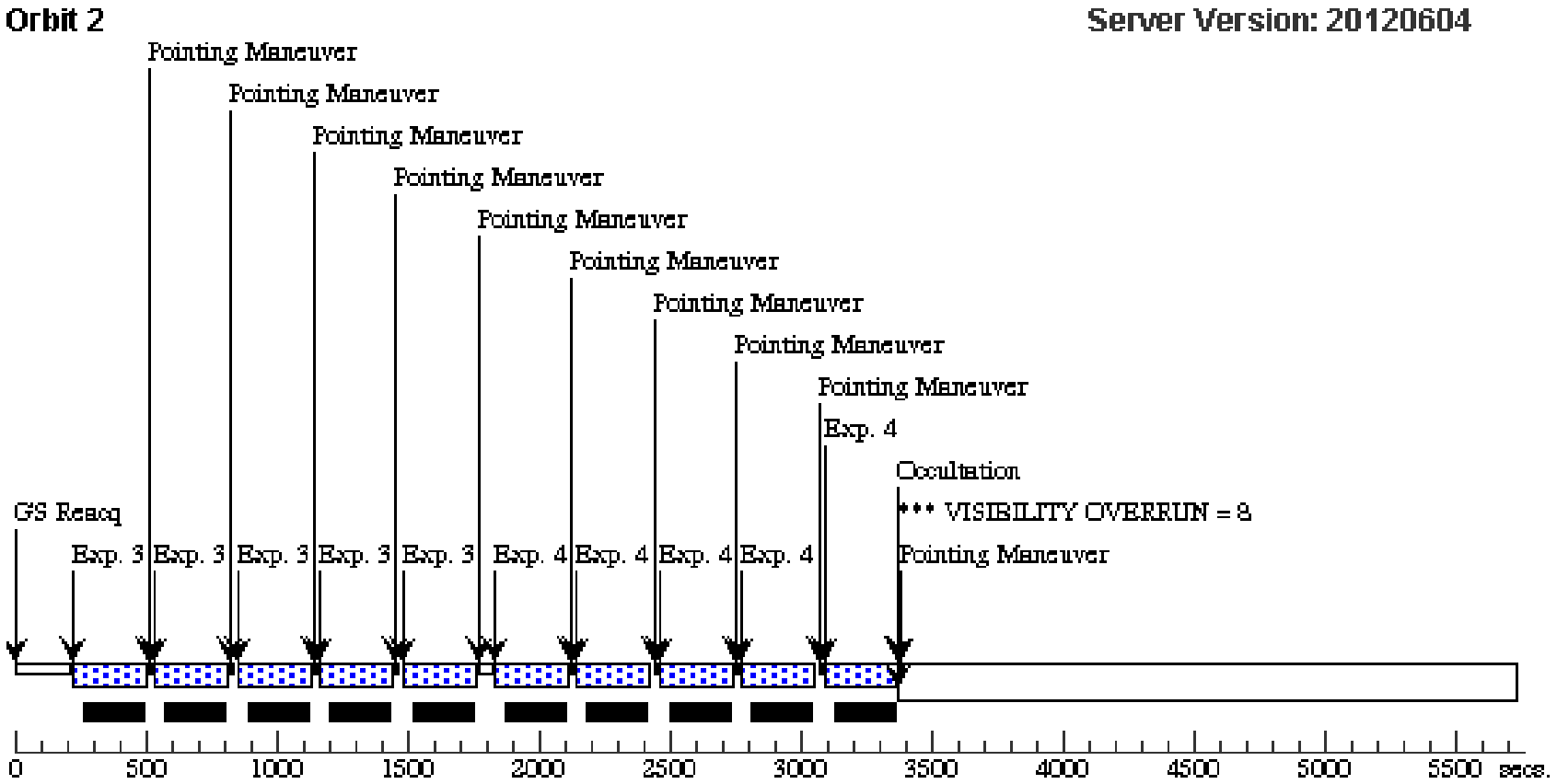
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 24.2,-21		*[==>]*	***[1]***
2		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 85.8,-21		*[==>]*	***[1]***
3		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG 55,-55	Pattern 1, Exps 3-3 in Visit 01 (1)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]*	***[1]***
								[==>(Pattern 10)] *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]*	***[2]***
4		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=10; SAMP-SEQ=STEP50	POS TARG 55,55	Pattern 1, Exps 4-4 in Visit 01 (1)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]*	***[2]***
								[==>(Pattern 6)] *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]* *[==>(Pattern 10)]* *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]*	***[3]***
5		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 24.2,21		*[==>]*	***[3]***
6		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG 85.8,21		*[==>]*	***[3]***

Orbit Structure

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Pointing Maneuver
Exp. 4
Occultation
*** VISIBILITY OVERRUN = 8
GS Reacq
Exp. 3
Exp. 3
Exp. 3
Exp. 3
Exp. 3
Exp. 4
Exp. 4
Exp. 4
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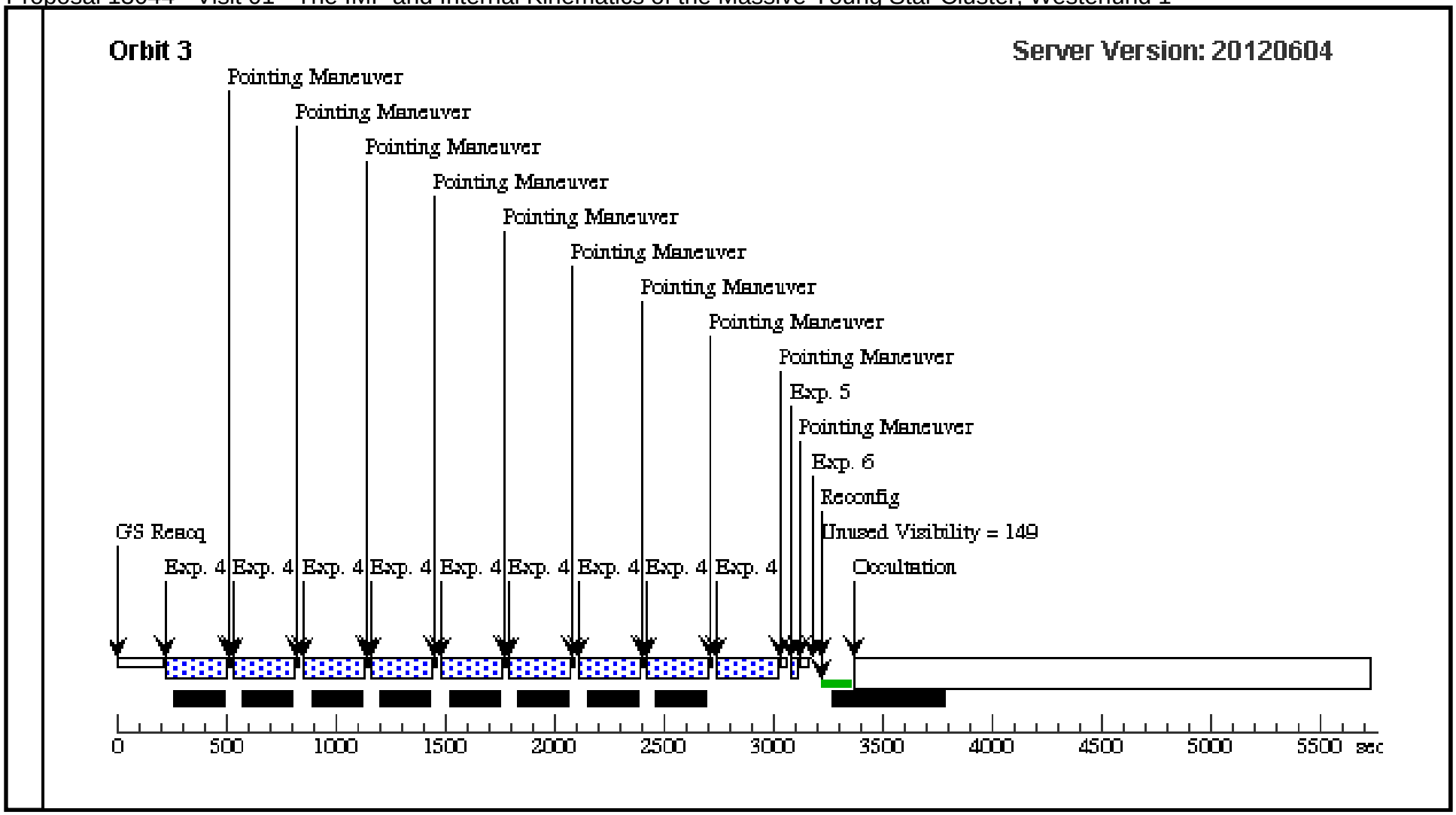
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Exp. 5
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Exp. 6
Reconfig
Unused Visibility = 149
GS Reacq
Exp. 4
Exp. 4
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Occultation
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sec

Visit

Proposal 13044, Visit 02 Wed Jul 11 05:49:59 GMT 2012

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
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF 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): VISIBILITY OVERRUN
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE
(Visit 02) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=SPIRAL	Coordinate Frame=POS-TARG		(3), (4)
	Purpose=DITHER	Pattern Orientation=14		
	Number Of Points=14	Angle Between Sides=		
	Point Spacing=3.26	Center Pattern=false		
	Line Spacing=			

Fixed Targets

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(1)	WESTERLUND1	RA: 16 47 4.0000 (251.7666667d)		V=12+/-1	Reference Frame: ICRS
		Dec: -45 50 42.00 (-45.84500d)		H=9-20	
		Equinox: J2000			

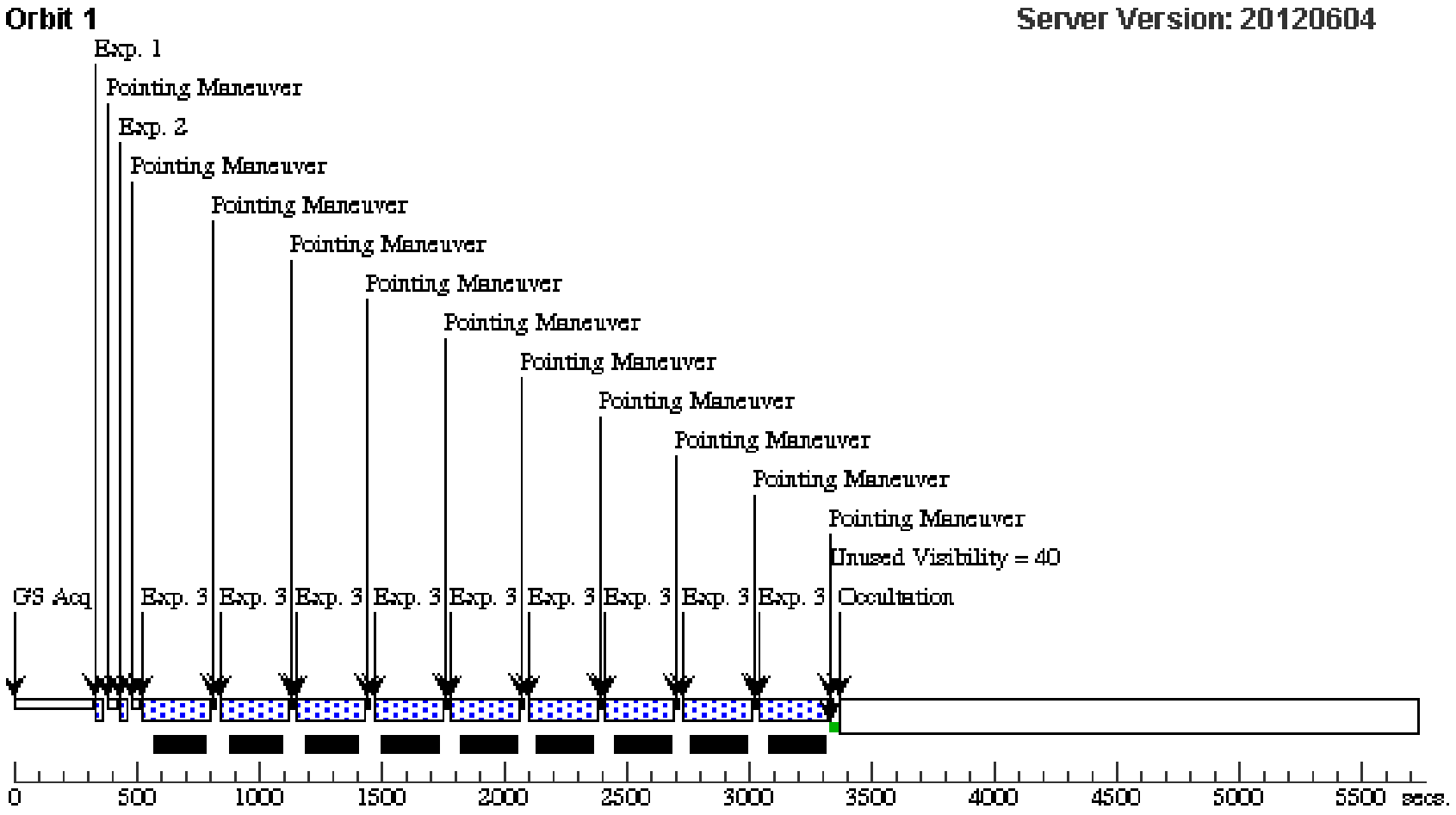
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

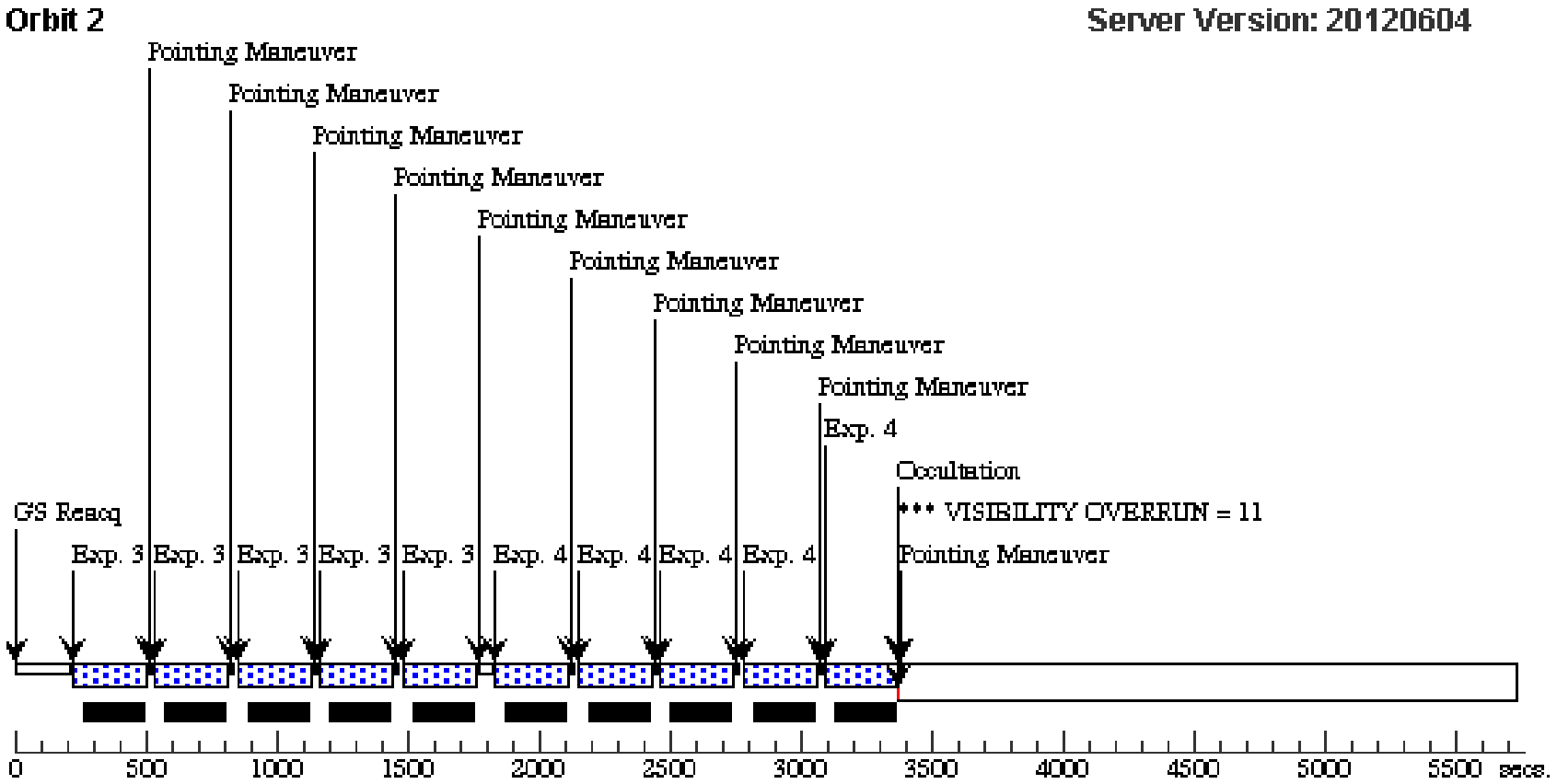
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -85.8,21		*[==>]*	***[1]***
2		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -24.1,21		*[==>]*	***[1]***
3		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG -55,55	Pattern 1, Exps 3-3 in Visit 02 (1)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]*	***[1]***
								[==>(Pattern 10)] *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]*	***[2]***
4		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IR-FIX	F160W	SAMP-SEQ=STEP50; NSAMP=10	POS TARG -55,-55	Pattern 1, Exps 4-4 in Visit 02 (1)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]*	***[2]***
								[==>(Pattern 6)] *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]* *[==>(Pattern 10)]* *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]*	***[3]***
5		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -85.8,-21.0		*[==>]*	***[3]***
6		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -24.2,-21		*[==>]*	***[3]***
7		(1) WESTERLUND 1	WFC3/IR, MULTIACCUM, IRSUB512-FIX	F160W	SAMP-SEQ=RAPID; NSAMP=10	POS TARG -85.8,89		*[==>]*	***[4]***

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

Orbit Structure

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Occultation
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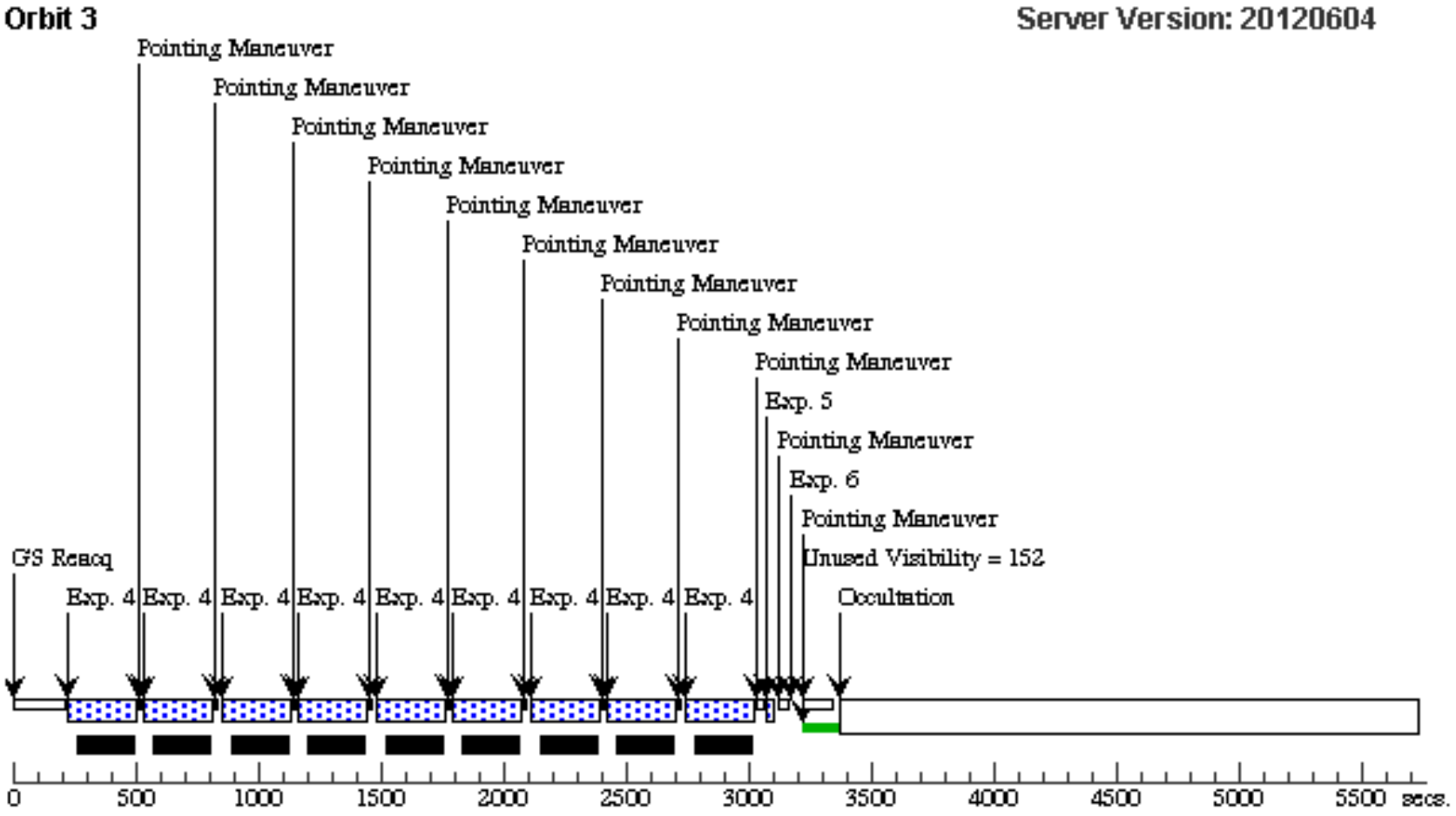
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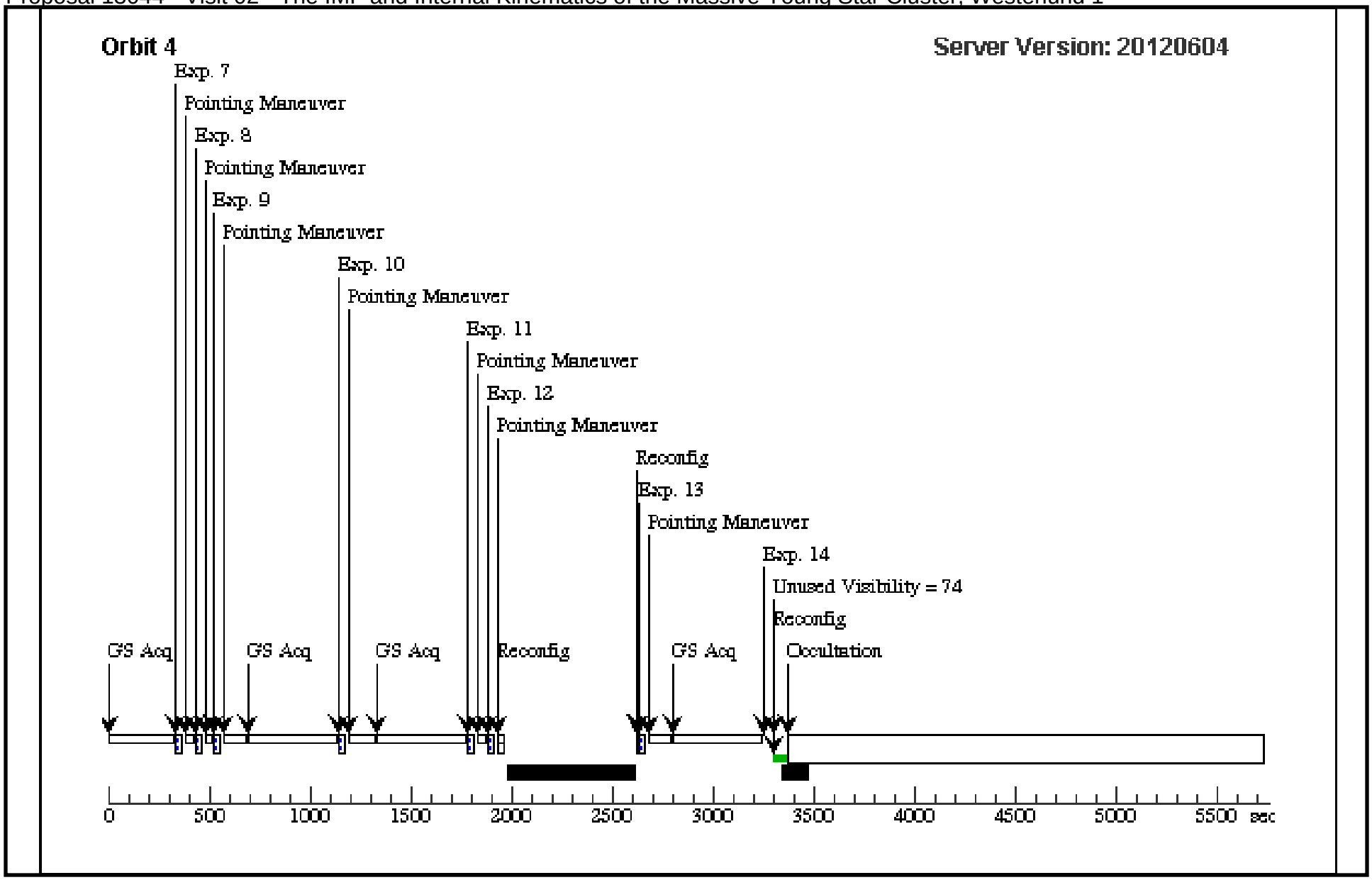
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Exp. 12
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Exp. 14
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GS Acq
GS Acq
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GS Acq
Occultation
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sec