12895 - The Massive Black Hole in the MS0735 Brightest Cluster Galaxy

Cycle: 20, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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) ZWCL-0735+7421 (2) N76K001232 CCDFLAT	STIS/CCD	4	06-Jul-2012 21:37:20.0	yes
02	(1) ZWCL-0735+7421 (2) N76K001232 CCDFLAT	STIS/CCD	4	06-Jul-2012 21:38:07.0	yes

8 Total Orbits Used

ABSTRACT

We propose to obtain STIS spectroscopy of the brightest cluster galaxy (BCG) in the MS0735.6+7421 cluster to measure the mass of its nuclear black hole. Recent studies have shown that nuclear black holes in BCGs may be more massive than expected based on the stellar velocity dispersion of the host galaxy. With the largest stellar core radius (3.8 kpc) and the most energetic (1E62 erg) AGN outburst known, the BCG in MS0735 is a strong candidate for harboring nuclear black hole mass exceeding 10 billion solar masses. The proposed spectra will be sensitive to black hole masses above ~7E9 solar masses, which is only 40% larger than scaling relations between black hole mass and bulge luminosity predict for MS0735. Our mass measurement will be sensitive to any significant upward departure from the mean scaling relations, and thus will place, at minimum, a significant constraint on the upper mass limit of black holes. Our program will likely yield the first dynamical evidence for an ultramassive black hole.

OBSERVING DESCRIPTION

Our observations will search for an unusually massive black hole in the MS0735 BCG, which is experiencing the most energetic AGN outburst known (1E62 erg, McNamara et al. 2009). Our mass measurement, to be obtained using MS0735's bright central nebular emission, will place, at minimum, a significant constraint on the upper mass limit of black holes. Our program will likely yield the first dynamical evidence for an ultramassive black hole.

Since the BCG in MS0735 is an extended source, acquisition and peak-up will be performed on a nearby star (HST ID N76K001232) and a fixed offset will be applied to locate the galaxy center. The central coordinates for the star were determined using an HST R-band image taken in 2006. These coordinates are consistent, within uncertainties, with the coordinates listed in the STScI GSC2 database, which were determined from an observation in 1992. With such insignificant motion over the span of 15 years, the proper motion of the star can be neglected. The offset distance to the BCG, determined using brightest pixels in the R-band image, is -9.661 sec and 3.38" in RA and DEC, respectively.

The STIS/CCD configuration will be used to obtain a spectrum of the H + [N II] line centroids and shapes as a function of position along the slit. With a redshift of 0.216, the H line in MS0735 lies at 7980A. We will use the G750M grating in first order centered at 7795A. The 52x0.1 arcsec slit will be used to resolve the gas inside the black hole's radius of influence.

A total of 8 orbits were granted for this observation, which will be divided into two visits. Four of these orbits will be performed with the slit oriented along the semi-major axis of the galaxy -- which lies roughly along the jet axis -- and the other four will use a perpendicular slit orientation. Using these two slit orientations will allow us to correct for any non-gravitational motion caused by the jet.

The STIS Exposure Time Calculator estimates that the acquisition of the star will take ~4 seconds and the peak-up will take ~9 seconds. The ACQ and ACQ/PEAK exposures will be applied on each orbit. Data will be accumulated following the short pointing maneuver to focus on the BCG. The exposure is dithered into 3 sub-exposures, each with a CR-SPLIT of 2, for a total of 6 sub-exposures. The dithering will shift the slit along its length by 5 pixels (0.25"). This shift will aid in the removal of cosmic rays and hot pixels. The data accumulation accounts for the remainder of each orbit's visibility window. A total exposure time of ~8450 seconds will be obtained for each visit. A fringe flat calibration will be performed during occultation in each orbit.

Visit

Proposal 12895, Semi-major Obs (01), implementation Sat Jul 07 01:38:25 GMT 2012

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 110D TO 130 D; ORIENT 290D TO 310 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3), (7), (11), (15)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=3	Angle Between Sides=		
	Point Spacing=0.25	Center Pattern=false		
	Line Spacing=			

Fixed Targets

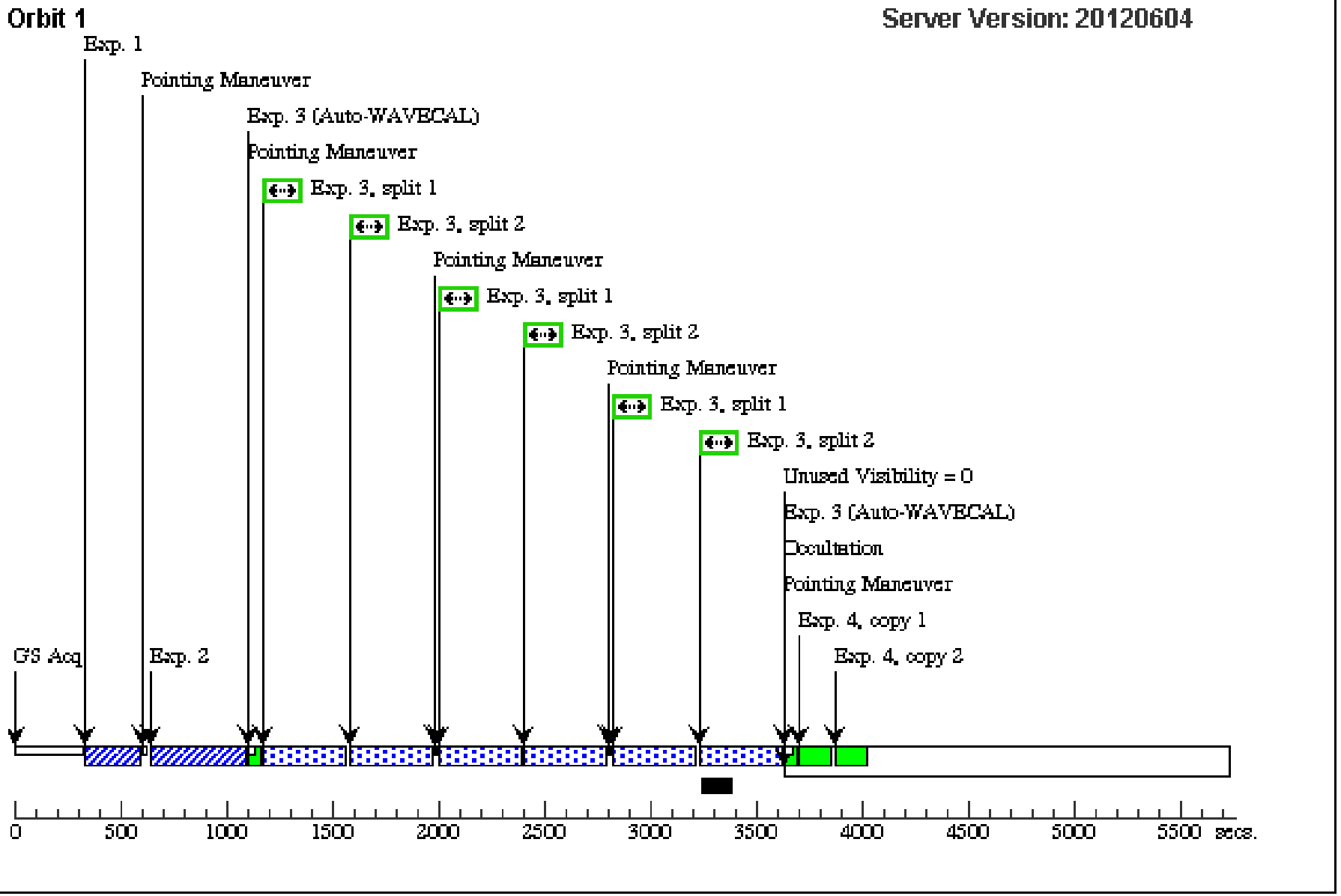
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	ZWCL-0735+7421	Offset from N76K001232 by		V=19.8	Offset Position (ZWCL-0735+7421)
		RA Offset: -9.661 Secs			Reference Frame: ICRS
		Dec Offset: 3.38 Arcsec			
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	N76K001232	RA: 07 41 54.1810 (115.4757542d)		V=17.8728+/-0.388143	Reference Frame: ICRS
		Dec: +74 14 35.70 (74.24325d)			
		Equinox: J2000			

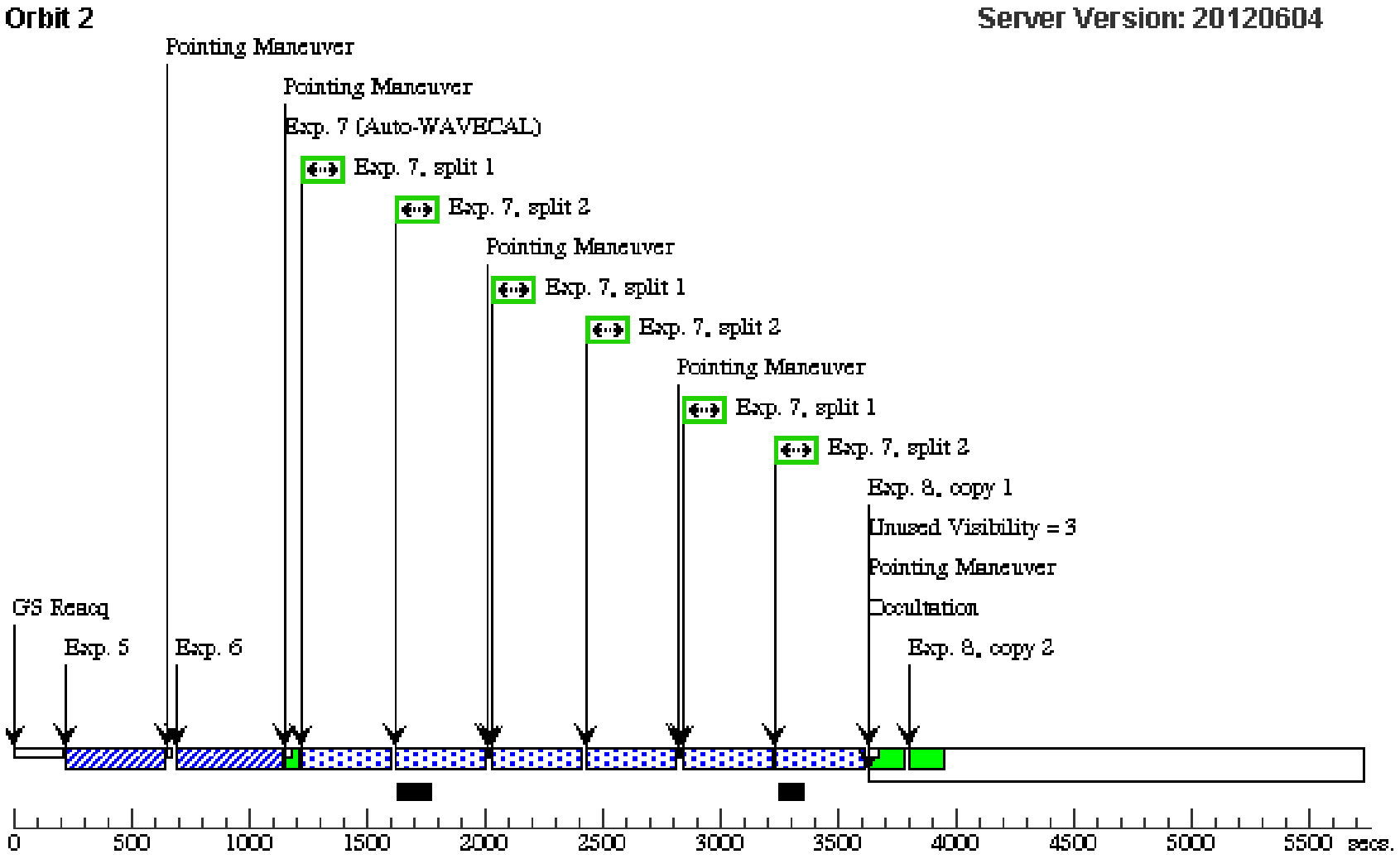
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Orbit1 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	 ***[1]***
2	Orbit1 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	 ***[1]***
3	Orbit1 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 3-3 in Semi-major Obs (01) (1)	1000 Secs *[==>356.0 Secs (Pattern 1, Split 1)]* *[==>356.0 Secs (Pattern 1, Split 2)]* *[==>356.0 Secs (Pattern 2, Split 1)]* *[==>356.0 Secs (Pattern 2, Split 2)]* *[==>356.0 Secs (Pattern 3, Split 1)]* *[==>356.0 Secs (Pattern 3, Split 2)]*	 ***[1]***
4	Orbit1 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[1]***
5	Orbit2 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	 ***[2]***
6	Orbit2 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	 ***[2]***
7	Orbit2 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 7-7 in Semi-major Obs (01) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	 ***[2]***
8	Orbit2 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[2]***
9	Orbit3 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	 ***[3]***
10	Orbit3 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	 ***[3]***
11	Orbit3 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 11-11 in Semi-major Obs (01) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	 ***[3]***
12	Orbit3 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[3]***
13	Orbit4 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	 ***[4]***

	14	Orbit4 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A			9 Secs *[==>]*	 ***[4]***
	15	Orbit4 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2	Pattern 1, Exps 15-15 in Semi-major Obs (01) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	 ***[4]***
	16	Orbit4 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A			*[==>(Copy 1)]* *[==>(Copy 2)]*	***[4]***

Orbit Structure

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Pointing Maneuver
Pointing Maneuver
Exp. 7 (Auto-WAVECAL)
Exp. 7, split 1
Exp. 7, split 2
Pointing Maneuver
Exp. 7, split 1
Exp. 7, split 2
Pointing Maneuver
Exp. 7, split 1
Exp. 7, split 2
Exp. 8, copy 1
Unused Visibility = 3
Pointing Maneuver
Occultation
Exp. 8, copy 2
GS Reacq
Exp. 5
Exp. 6
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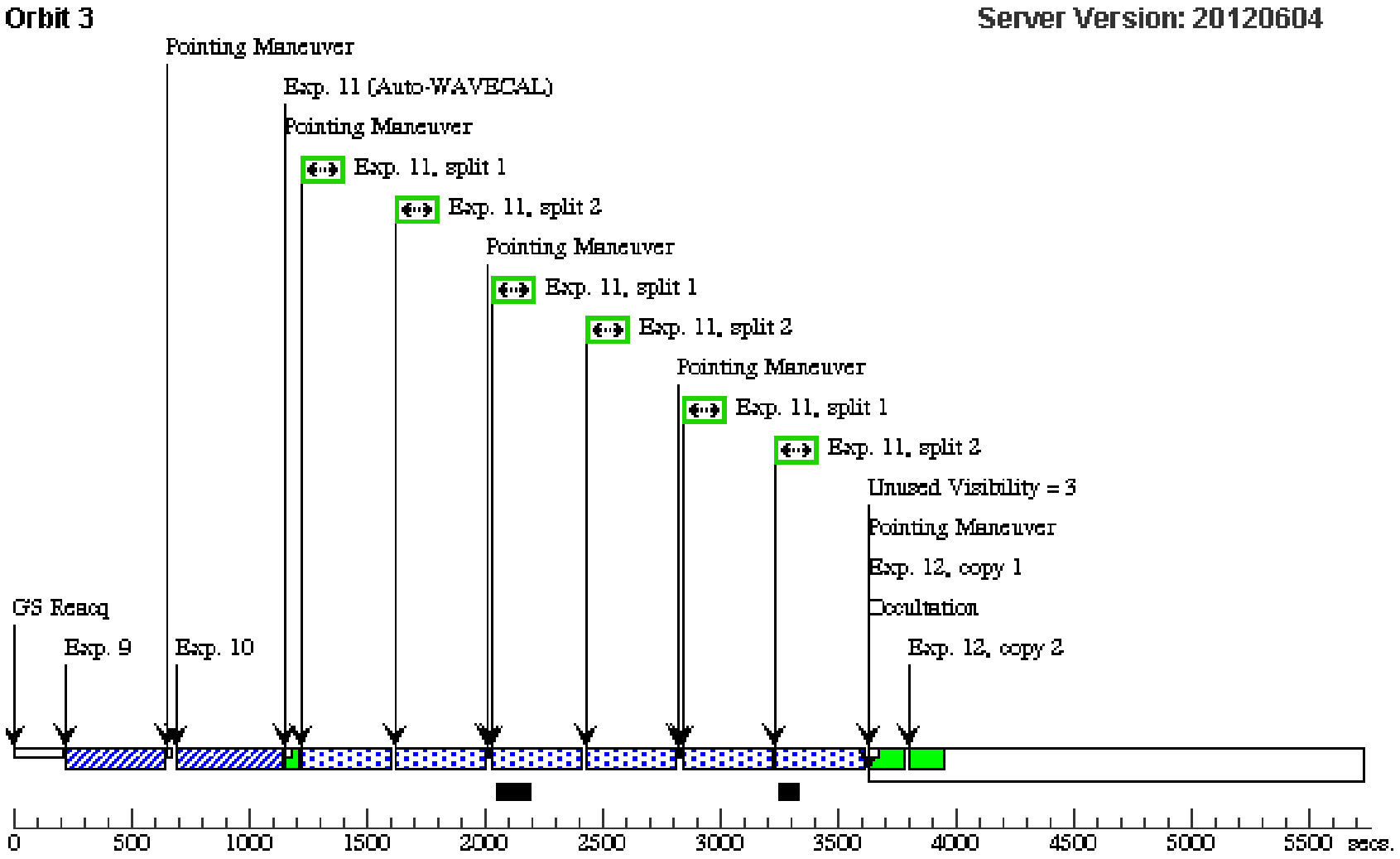
4500
5000
5500
secs.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Server Version: 20120604
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Exp. 11, split 2
Pointing Maneuver
Exp. 11, split 1
Exp. 11, split 2
Pointing Maneuver
Exp. 11, split 1
Exp. 11, split 2
Unused Visibility = 3
Pointing Maneuver
Exp. 12, copy 1
Occultation
Exp. 12, copy 2
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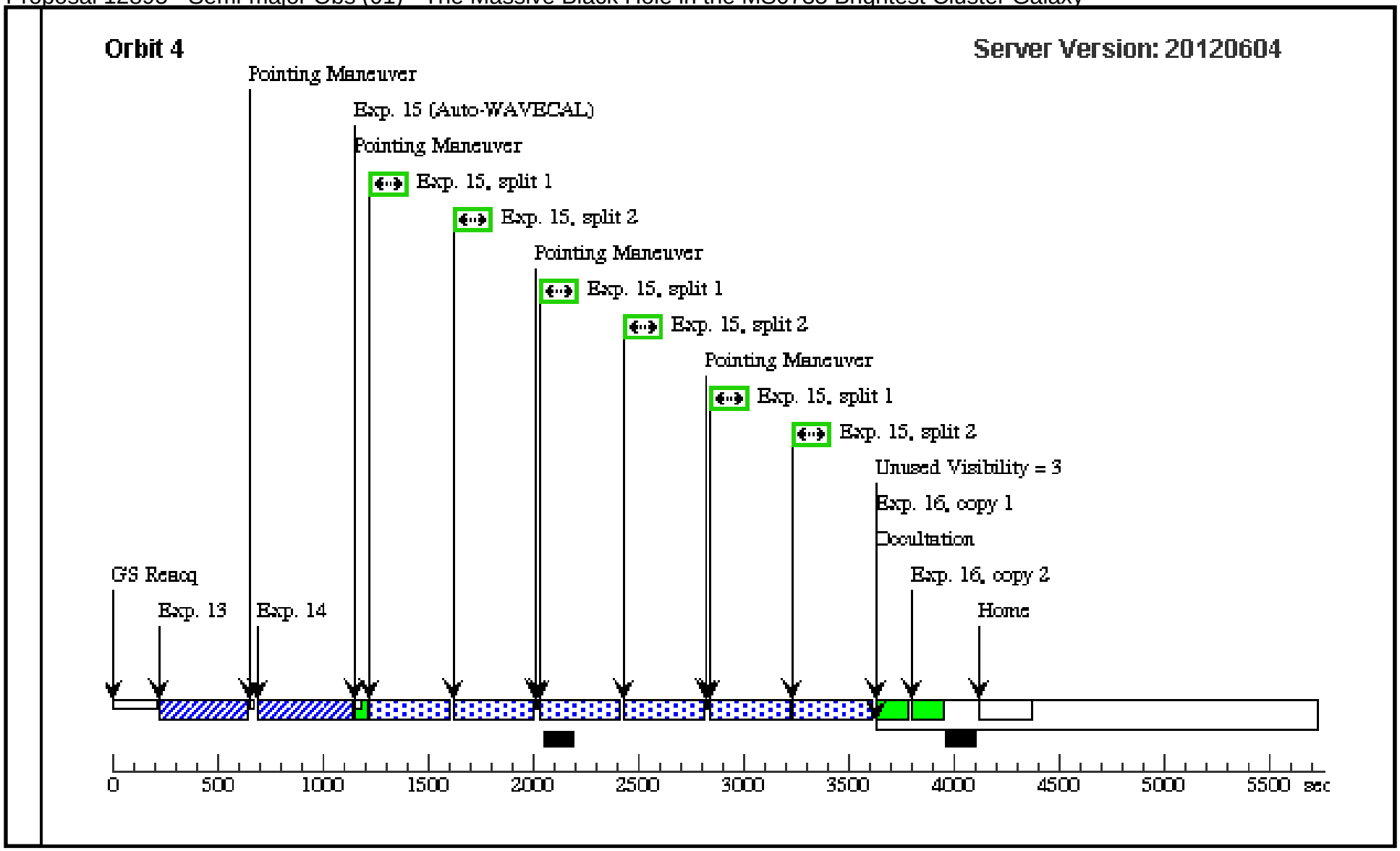
secs.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Server Version: 20120604
Pointing Maneuver
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Exp. 15, split 2
Pointing Maneuver
Exp. 15, split 1
Exp. 15, split 2
Pointing Maneuver
Exp. 15, split 1
Exp. 15, split 2
Unused Visibility = 3
Exp. 16, copy 1
Occultation
Exp. 16, copy 2
GS Reacq
Exp. 13
Exp. 14
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 12895, Semi-minor Obs (02), implementation Sat Jul 07 01:38:33 GMT 2012

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 20D TO 40 D; ORIENT 200D TO 220 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3), (7), (11), (15)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=3	Angle Between Sides=		
	Point Spacing=0.25	Center Pattern=false		
	Line Spacing=			

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		RA Offset: -9.661 Secs			Reference Frame: ICRS
		Dec Offset: 3.38 Arcsec			
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	N76K001232	RA: 07 41 54.1810 (115.4757542d)		V=17.8728+/-0.388143	Reference Frame: ICRS
		Dec: +74 14 35.70 (74.24325d)			
		Equinox: J2000			

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
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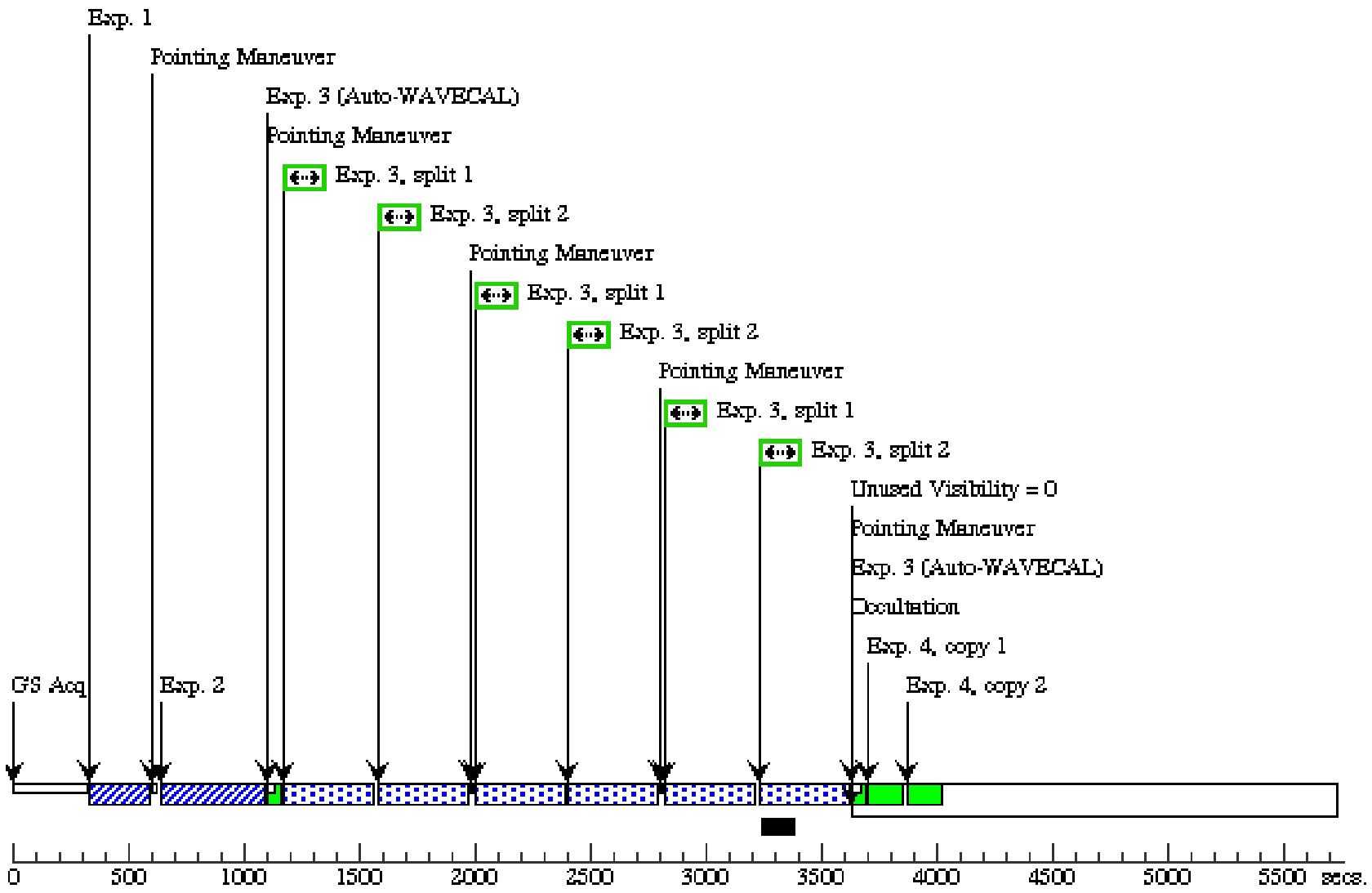
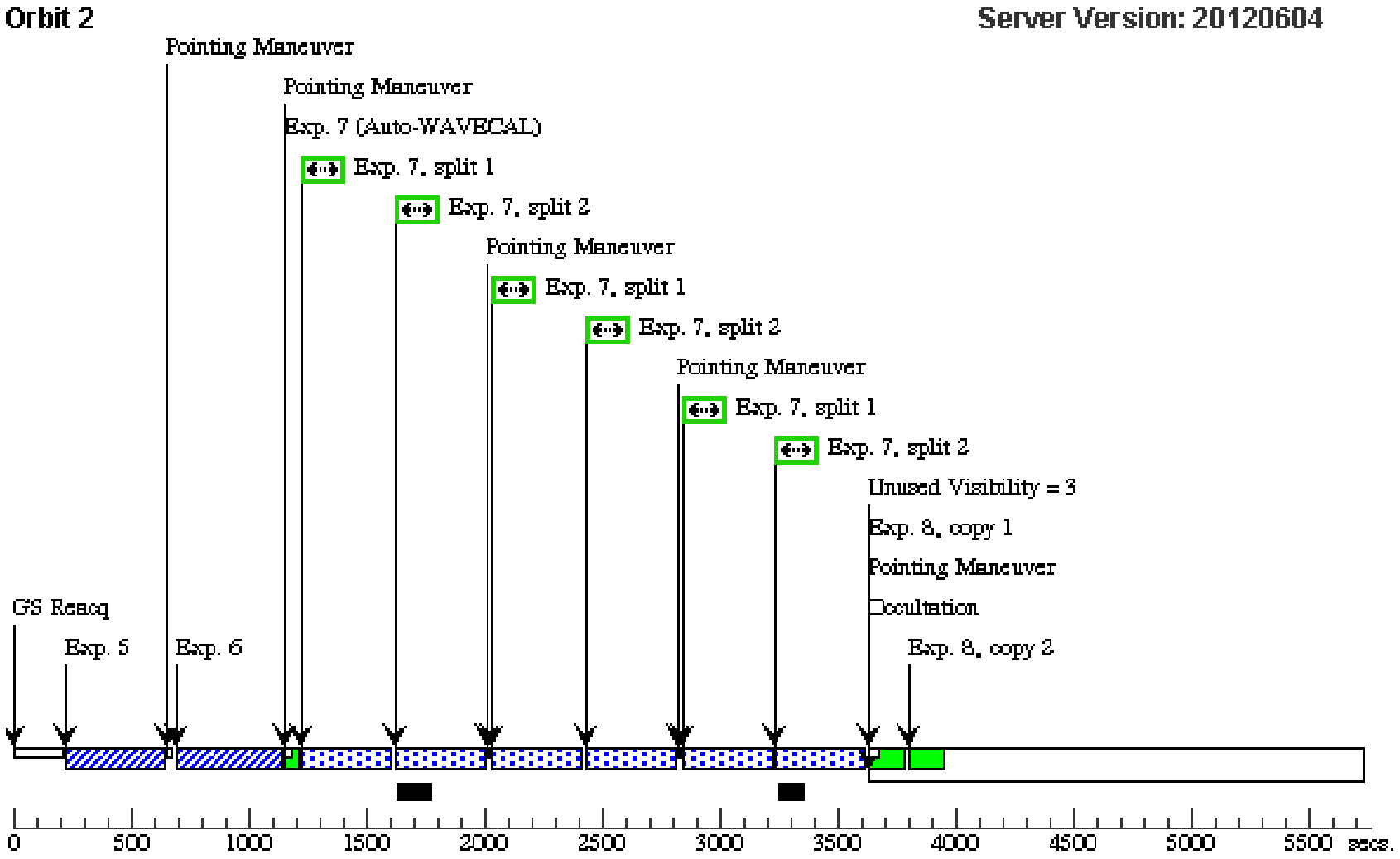
2	Orbit1 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	***[1]***
3	Orbit1 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 3-3 in Semi-minor Obs (02) (1)	1000 Secs *[==>356.0 Secs (Pattern 1, Split 1)]* *[==>356.0 Secs (Pattern 1, Split 2)]* *[==>356.0 Secs (Pattern 2, Split 1)]* *[==>356.0 Secs (Pattern 2, Split 2)]* *[==>356.0 Secs (Pattern 3, Split 1)]* *[==>356.0 Secs (Pattern 3, Split 2)]*	***[1]***
4	Orbit1 Flat Calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[1]***
5	Orbit2 ACQ	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	***[2]***
6	Orbit2 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	***[2]***
7	Orbit2 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 7-7 in Semi-minor Obs (02) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	***[2]***
8	Orbit2 Flat Calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[2]***
9	Orbit3 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	***[3]***
10	Orbit3 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A				9 Secs *[==>]*	***[3]***
11	Orbit3 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2		Pattern 1, Exps 11-11 in Semi-minor Obs (02) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	***[3]***
12	Orbit3 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[3]***
13	Orbit4 ACQ (1234)	(2) N76K001232	STIS/CCD, ACQ, 50CCD	MIRROR				4 Secs *[==>]*	***[4]***

	14	Orbit4 PEAK	(2) N76K001232	STIS/CCD, ACQ/PEAK, 52X0.1E1	G750M 7795 A			9 Secs *[==>]*	 ***[4]***
	15	Orbit4 ACCUM	(1) ZWCL-0735+7421	STIS/CCD, ACCUM, 52X0.1E1	G750M 7795 A	CR-SPLIT=2	Pattern 1, Exps 15-15 in Semi-minor Obs (02) (1)	1000 Secs *[==>347.0 Secs (Pattern 1, Split 1)]* *[==>347.0 Secs (Pattern 1, Split 2)]* *[==>347.0 Secs (Pattern 2, Split 1)]* *[==>347.0 Secs (Pattern 2, Split 2)]* *[==>347.0 Secs (Pattern 3, Split 1)]* *[==>347.0 Secs (Pattern 3, Split 2)]*	 ***[4]***
	16	Orbit4 Flat calibration	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750M 7795 A			*[==>(Copy 1)]* *[==>(Copy 2)]*	***[4]***

Orbit Structure

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Pointing Maneuver
Pointing Maneuver
Exp. 7 (Auto-WAVECAL)
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Exp. 7, split 2
Pointing Maneuver
Exp. 7, split 1
Exp. 7, split 2
Pointing Maneuver
Exp. 7, split 1
Exp. 7, split 2
Unused Visibility = 3
Exp. 8, copy 1
Pointing Maneuver
Occultation
Exp. 8, copy 2
GS Reacq
Exp. 5
Exp. 6
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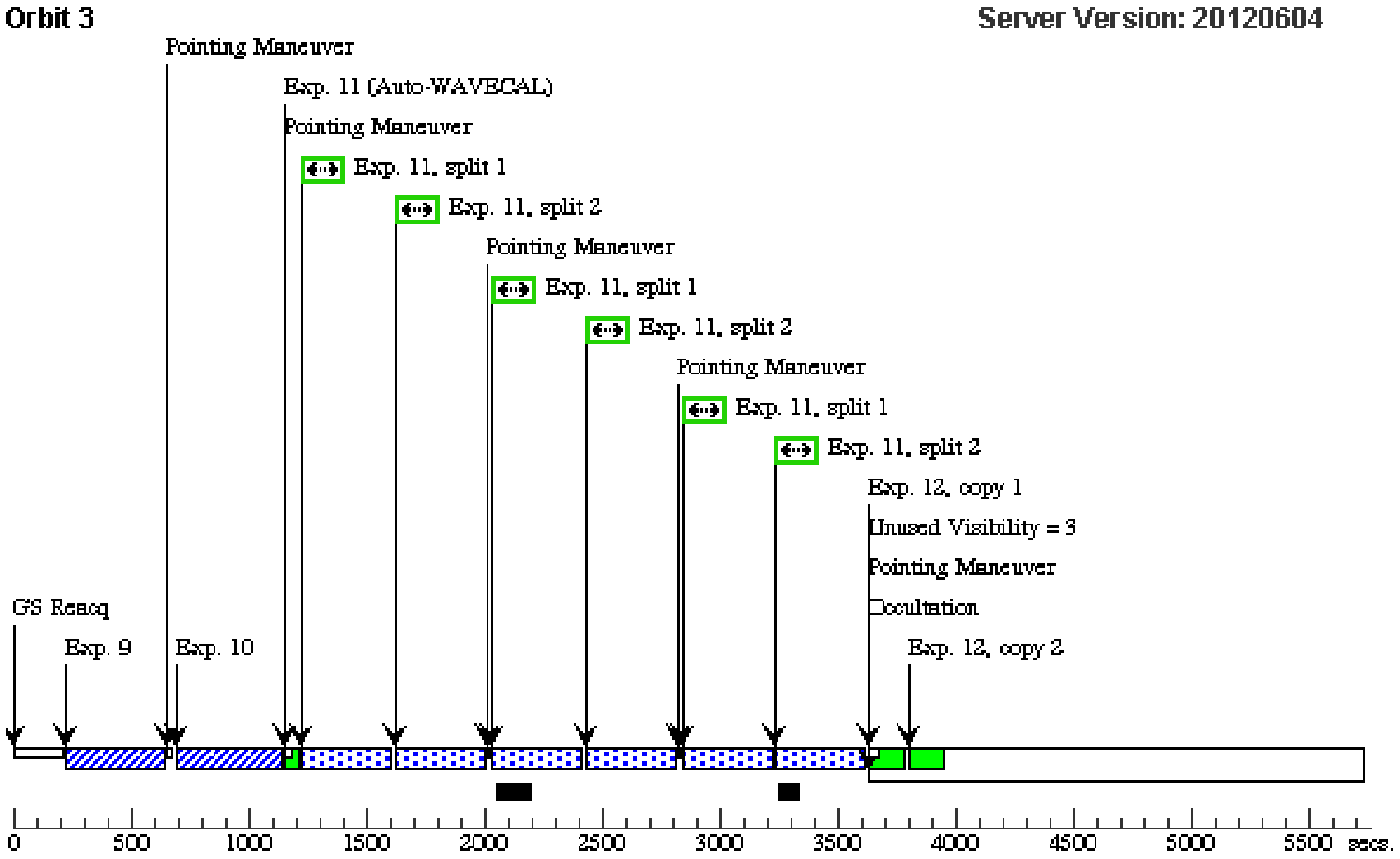
secs.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Exp. 11, split 1
Exp. 11, split 2
Pointing Maneuver
Exp. 11, split 1
Exp. 11, split 2
Exp. 12, copy 1
Unused Visibility = 3
Pointing Maneuver
Occultation
Exp. 12, copy 2
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Exp. 9
Exp. 10
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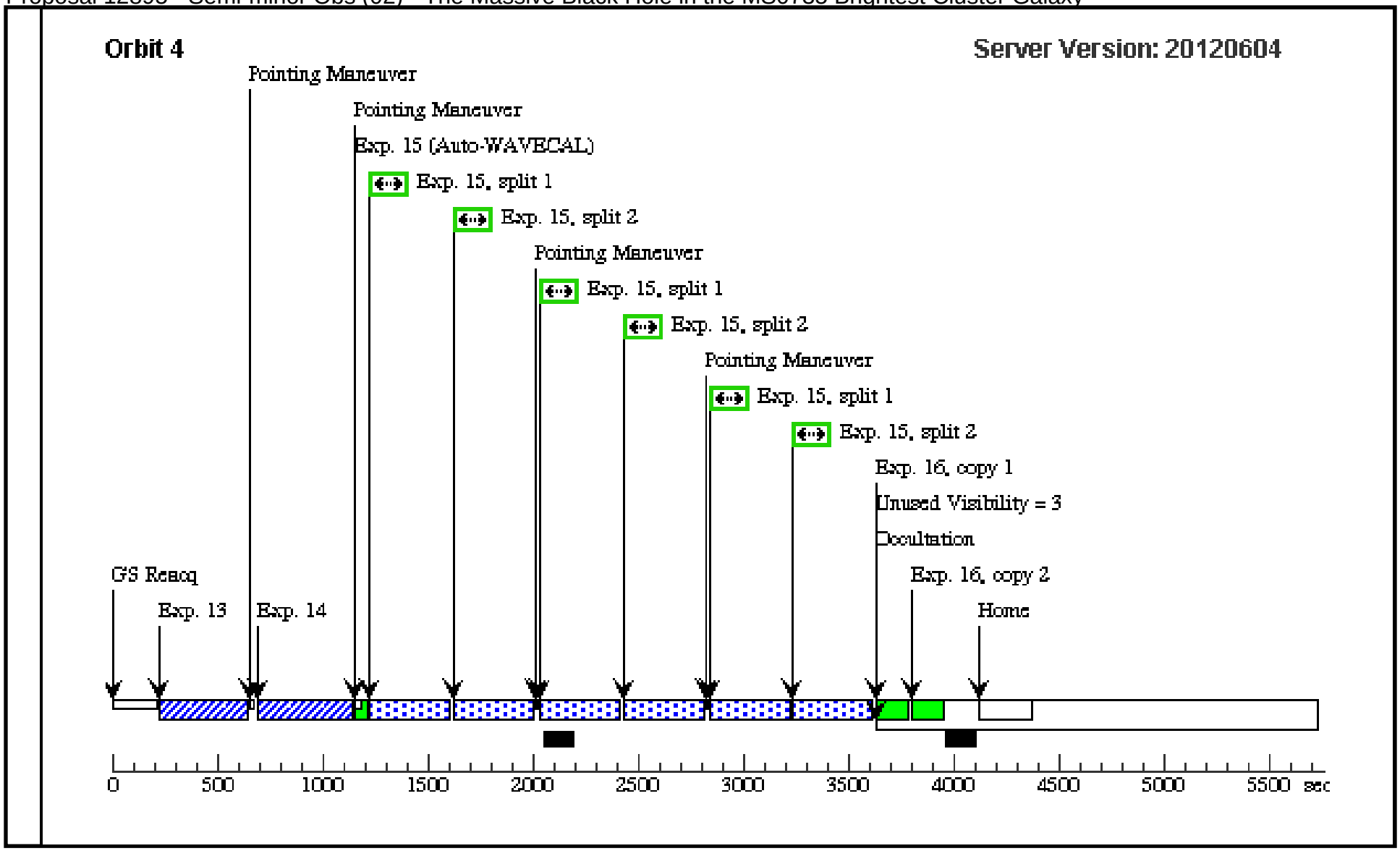
Orbit 4
Server Version: 20120604
Pointing Maneuver
Pointing Maneuver
Exp. 15 (Auto-WAVECAL)
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Exp. 15, split 2
Pointing Maneuver
Exp. 15, split 1
Exp. 15, split 2
Pointing Maneuver
Exp. 15, split 1
Exp. 15, split 2
Exp. 16, copy 1
Unused Visibility = 3
Occultation
Exp. 16, copy 2
GS Reacq
Exp. 13
Exp. 14
Home
0
500
1000
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2500
3000
3500
4000
4500
5000
5500
sec