14099 - Measuring the L-T transition for a warm Saturn exoplanet

Cycle: 23, Proposal Category: GO

(Availability Mode: AVAILABLE)

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) HAT-P-18 WAVE	STIS/CCD	5	04-Nov-2015 21:23:37.0	yes
02	(1) HAT-P-18 CCDFLAT NONE WAVE	STIS/CCD	5	04-Nov-2015 21:23:45.0	yes
04	(1) HAT-P-18	WFC3/IR	5	04-Nov-2015 21:24:13.0	yes

15 Total Orbits Used

ABSTRACT

The transition between the L and T spectral types in brown dwarf atmospheres is characterized by a reduction in high-altitude clouds and the appearance of strong methane absorption features. Models predict a similar transition for gas giant atmospheres across the 1000-1200K temperature range. To test this theory, we propose to measure a detailed transmission spectrum for HAT-P-18b, a Saturn-mass gas giant with an equilibrium temperature of 850K. Our observations will span the 0.3-1.7 micron wavelength range, with the near-infrared wavelengths allowing us to constrain methane and water absorption, and the optical wavelengths probing alkali metal absorption and high-altitude Rayleigh scattering processes. The latter will allow us to determine whether or not aerosols are present in the atmosphere, addressing a key aspect of atmospheric chemistry. Our measurement for HAT-P-18b will be the first transmission spectrum for a gas giant exoplanet that is predicted to have a high methane abundance, providing unique constraints for atmosphere models.

OBSERVING DESCRIPTION

Our observations will provide a near-UV to near-IR transmission spectrum for the transiting exoplanet HAT-P-18b. This broad wavelength coverage will allow us to distinguish between fundamental atmosphere classes: the optical provides leverage for distinguishing between a clear or hazy atmosphere, while the near-IR contains strong CH4 absorption features, providing leverage for distinguishing between an L-type or T-type atmosphere.

**Observing strategy:

To construct the transmission spectrum, we require three separate transits of HAT-P-18b to be observed: one with STIS+G430L, one with STIS+G750L, and one with WFC3+G141. All observations will be made in spectroscopic mode. The STIS observations will be made with the 52x2 arcsec slit to avoid slit losses.

At the start of each visit, a standard phase-constrained acquisition image will be taken. The subsequent observing strategy consists of taking repeated exposures for the duration of the transit, plus time before and after the transit to establish the out-of-transit baseline flux.

For the STIS observations, we will use stare mode with individual exposure times of 278 sec. We will read out a subarray size of 128 pixels to reduce

overheads (SIZEAXIS2=128). As in our previous Programs 12473 and 11740, we will override the default wavelength calibrations at the end of each exposure (WAVECAL=NO). This is done to improve the duty cycle and to allow the thermal breathing trends to be removed, which is only possible with an un-interrupted photometric time series. A separate wavelength calibration image will be taken at the end of each visit. For the G750L visit, we will also take fringe flat images to correct for fringing longward of ~720 nm.

For the WFC3 observations, we will use the forward spatial scanning mode with a scan rate of 0.03 arcsec/sec and individual exposure times of 90 sec (i.e. resulting in a scan across 2.7 arcsec = 20 pixels per exposure). This will leave plenty of room on the detector to estimate the background flux. We will read out a subarray size of 256 pixels to reduce overheads.

Each transit of HAT-P-18b lasts for 163 minutes. We therefore require 5 consecutive HST orbits per visit. The first orbit serves to allow the telescope to thermally relax into its new pointing position, which is a standard procedure adopted by all HST exoplanet observations. The remaining orbits will provide good phase coverage during transit, and allow for sufficient time (2 HST orbits - one before transit, one after transit) to establish the baseline stellar flux necessary to accurately measure the transit depth. For both STIS and WFC3, we will obtain 10 exposures per HST orbit, coming to a total of 20 in-transit and 20 out-of-transit exposures for each instrument.
**Signal-to-noise estimates:

HAT-P-18b is a bright target in the conventional sense (V=12.8mag, J=10.8mag). The challenge with exoplanet transmission spectroscopy is to measure subtle changes in the system brightness across different wavelength channels, via variations in the transit depth. We used the HST Exposure Time Calculator with the observational setup described above to calculate the following SNRs per resolution element per exposure: 112 for G430L, 246 for G750L, and 1059 for G141. Note that the G141 flux will be spread over ~20 pixel columns due to the spatial scan (see above), so there is no risk of saturation.

Visit

Proposal 14099, HAT-P-18 G430L (01), scheduled Thu Nov 05 02:24:19 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: Period 5.50802888 D AND ZERO-PHASE HJD2456461.06765758

Comments: HAT-P-18. G430L. STIS visit. It is essential that the five orbits be scheduled in a coninuous block, free of the SAA.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HAT-P-18	RA: 17 05 23.1510 (256.3464625d)	Proper Motion RA: -21.3 mas/yr	V=12.8	Reference Frame: ICRS
	Alt Name1: GSC-02594-00646	Dec: +33 00 44.97 (33.01249d)	Proper Motion Dec: -44.2 mas/yr		
		Equinox: J2000	Epoch of Position: 2000		

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

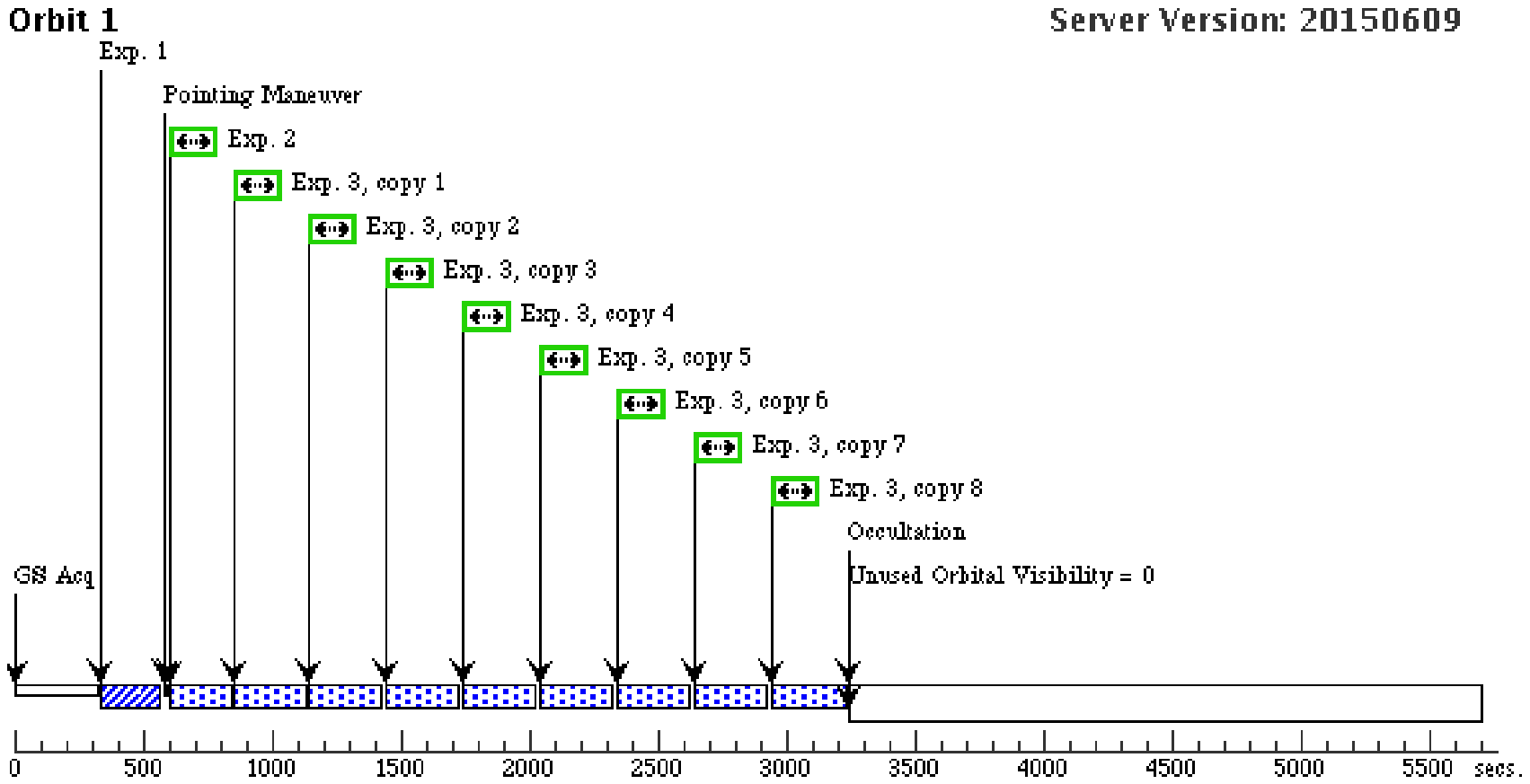
Exposures

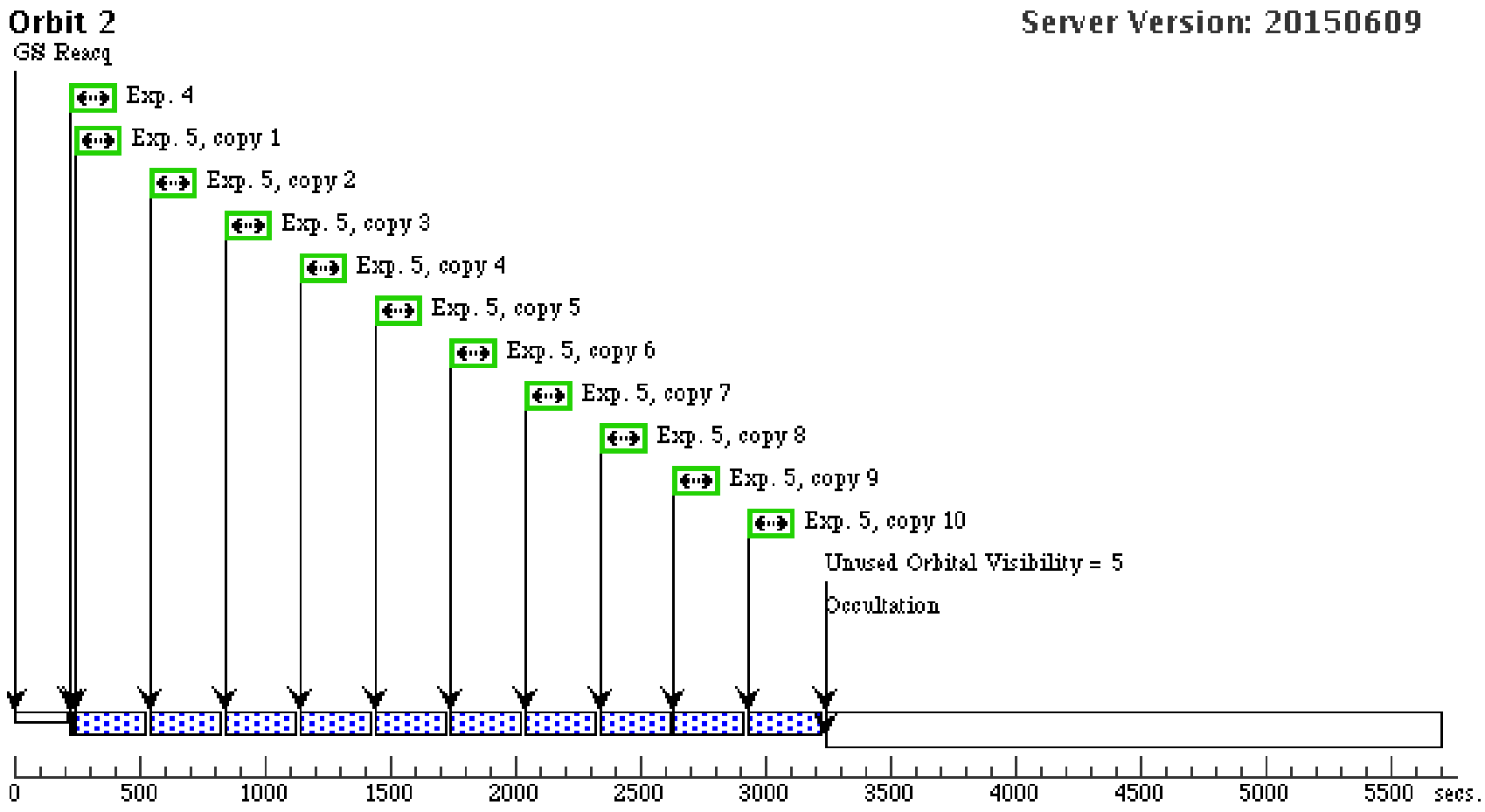
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ, phase constrained (STIS.ta.733341)	(1) HAT-P-18	STIS/CCD, ACQ, F28X50LP	MIRROR	GAIN=4	PHASE 0.9655 TO 0.9680		1.5 Secs (1.5 Secs) *[==>]*	*[1]*
2	HAT-P-18 G430L Orbit 1 (STIS.sp.733350)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO			120 Secs (120 Secs) *[==>]*	*[1]*
Comments: Short exposure to minimize instrument systematic of first exposure of orbit. Note that it is longer than first exposures in subsequent orbits, due to acquisition overhead and to ensure all time is used.									
3	HAT-P-18 G430L Orbit 1 (STIS.sp.733928)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO			278 Secs X 8 (2224 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	*[1]*
4	HAT-P-18 G430L Orbit 2 (STIS.sp.733352)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO			1 Secs (1 Secs) *[==>]*	*[2]*
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.									
5	HAT-P-18 G430L Orbit 2 (STIS.sp.733928)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO			278 Secs X 10 (2780 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	*[2]*
6	HAT-P-18 G430L Orbit 3 (STIS.sp.733352)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO			1 Secs (1 Secs) *[==>]*	*[3]*
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.									

7	HAT-P-18 G430L Orbit 3 (STIS.sp.73 3928)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	278 Secs X 10 (2780 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[3]***
8	HAT-P-18 G430L Orbit 4 (STIS.sp.73 3352)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	1 Secs (1 Secs) *[==>]*	***[4]***
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.							
9	HAT-P-18 G430L Orbit 4 (STIS.sp.73 3928)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	278 Secs X 10 (2780 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[4]***
10	HAT-P-18 G430L Orbit 5 (STIS.sp.73 3352)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	1 Secs (1 Secs) *[==>]*	***[5]***
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.							
11	HAT-P-18 G430L Orbit 5 (STIS.sp.73 3928)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G430L 4300 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	278 Secs X 10 (2780 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[5]***

	12	WAVE	WAVE	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	*[==>]*	***[5]***
	Comments: Explicit WAVECAL, auto-waves disabled						

Orbit Structure

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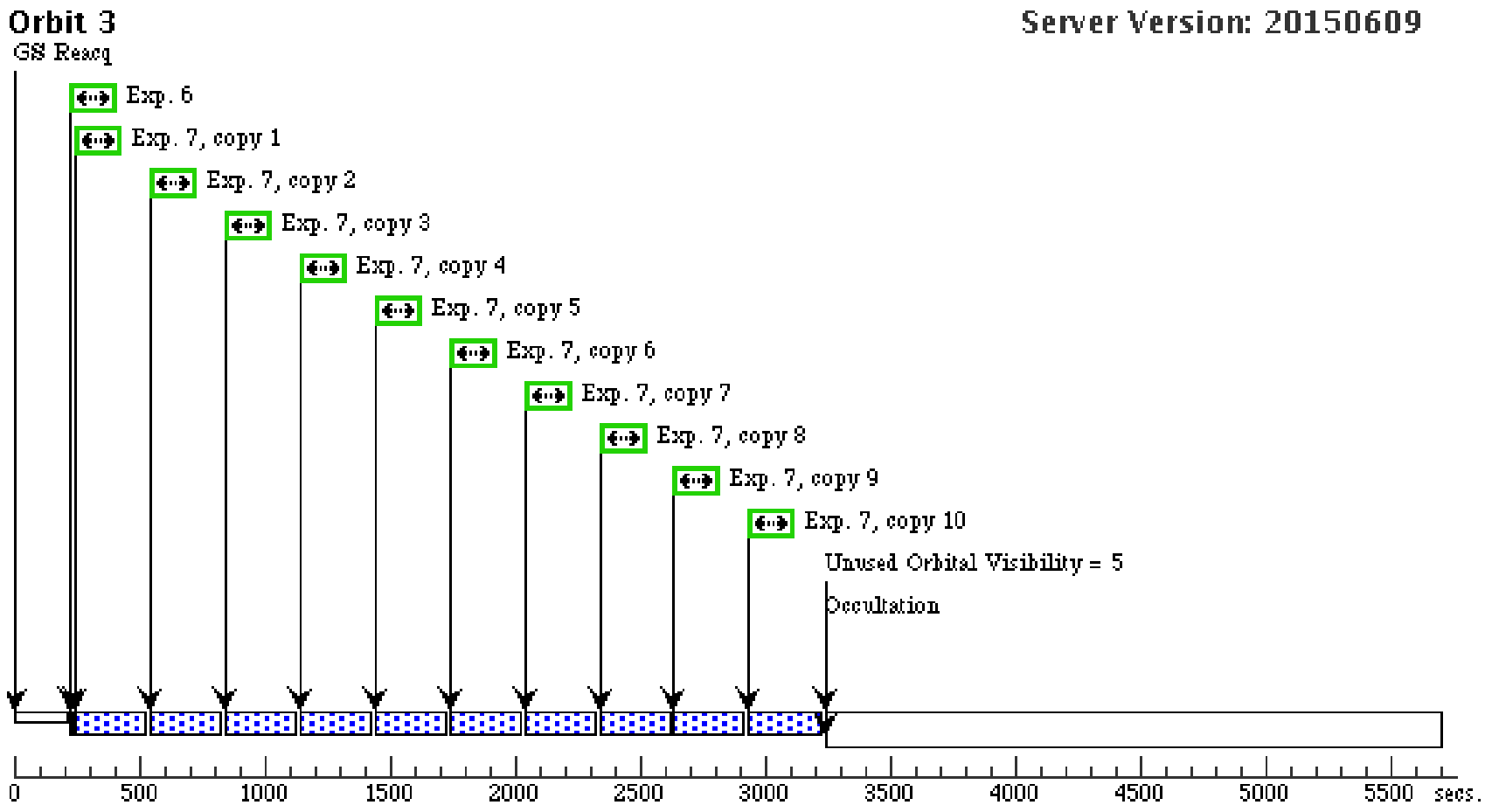
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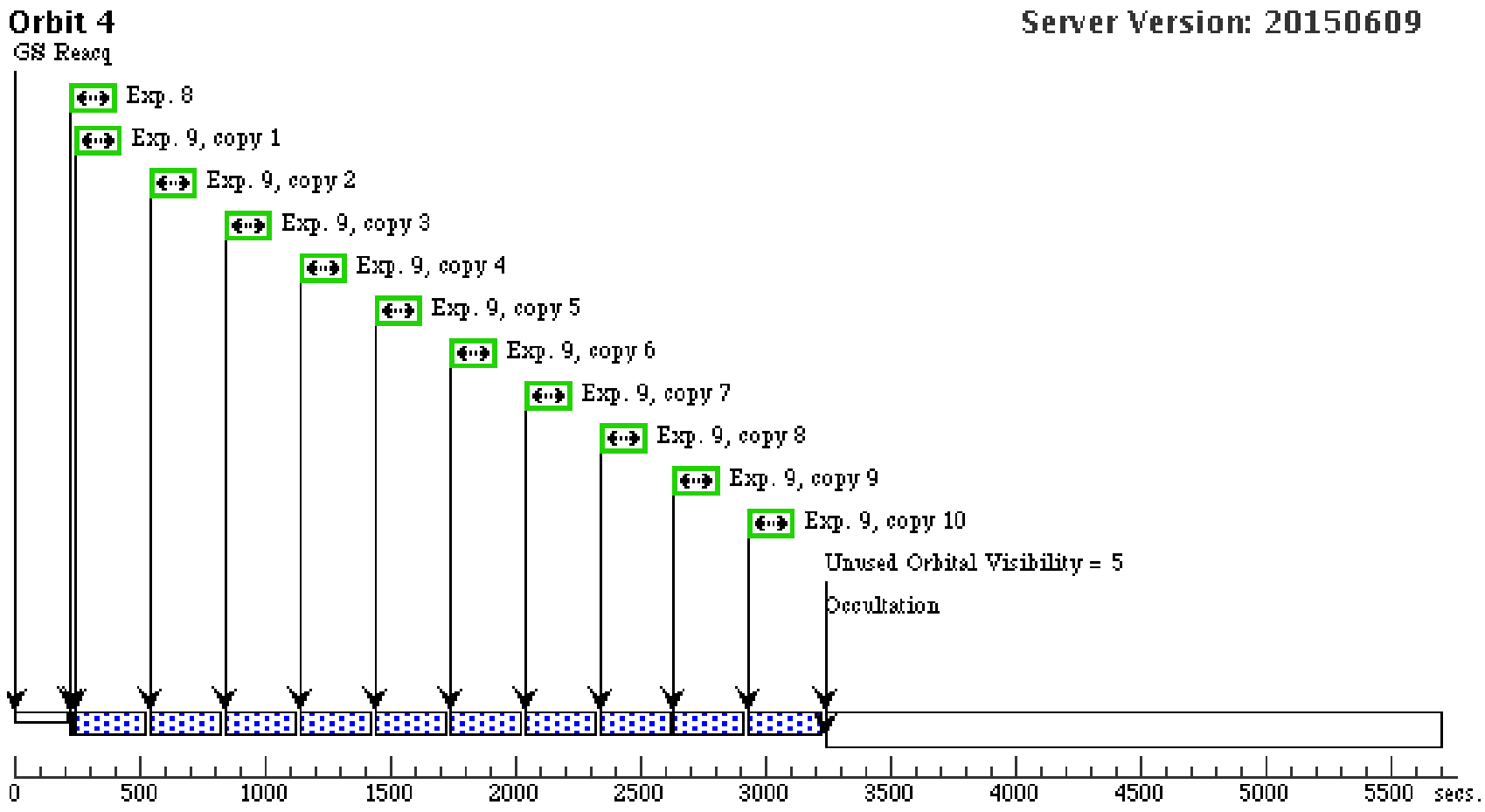
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Unused Orbital Visibility = 5
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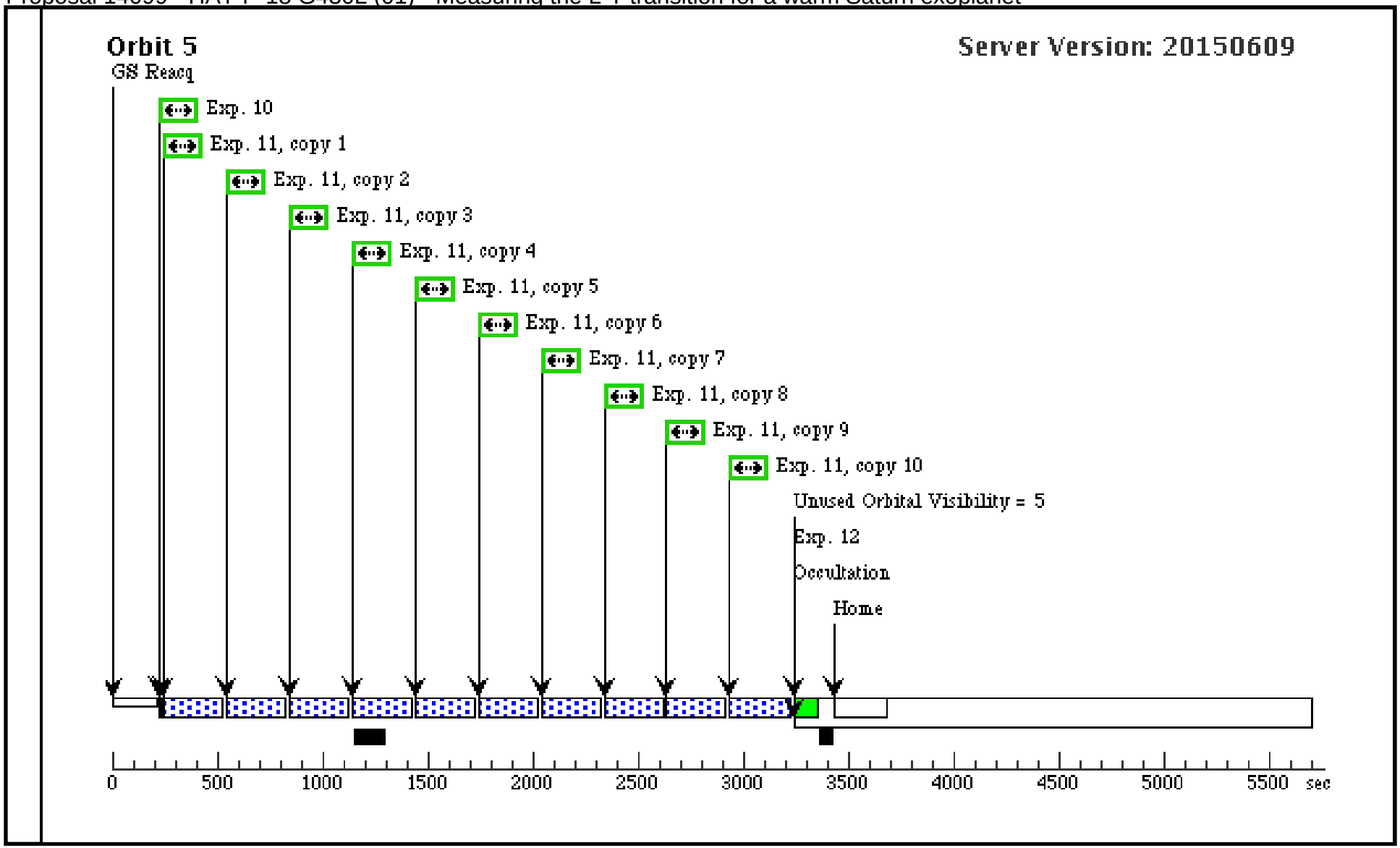
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Exp. 12
Occultation
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sec

Visit

Proposal 14099, HAT-P-18 G750L (02), implementation Thu Nov 05 02:24:20 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: SCHED 80%; Period 5.50802888 D AND ZERO-PHASE HJD2456461.06765758

Comments: HAT-P-18. G750L. STIS visit. It is essential that the five orbits be scheduled in a coninuous block, free of the SAA.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HAT-P-18	RA: 17 05 23.1510 (256.3464625d)	Proper Motion RA: -21.3 mas/yr	V=12.8	Reference Frame: ICRS
	Alt Name1: GSC-02594-00646	Dec: +33 00 44.97 (33.01249d)	Proper Motion Dec: -44.2 mas/yr		
		Equinox: J2000	Epoch of Position: 2000		

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

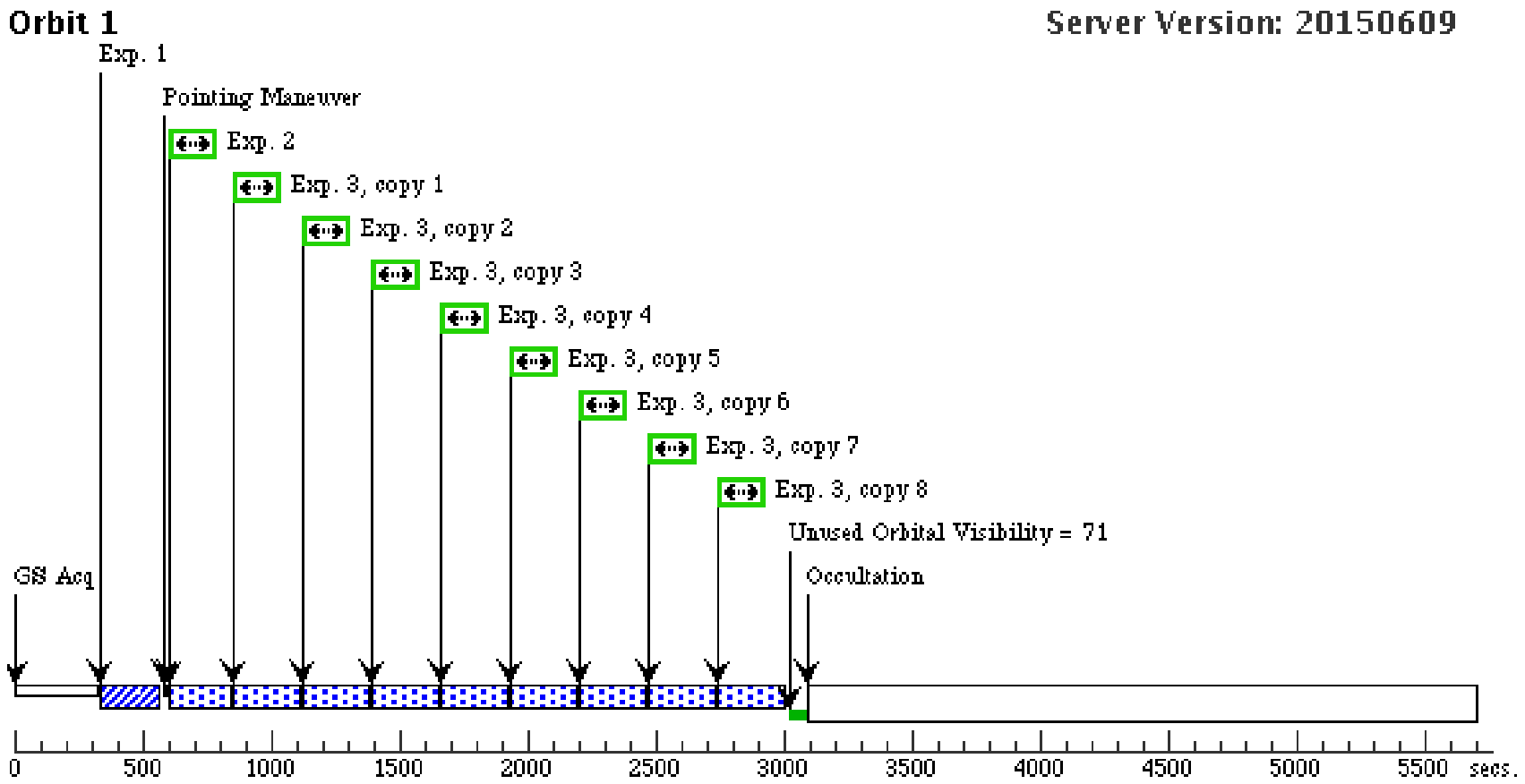
Exposures

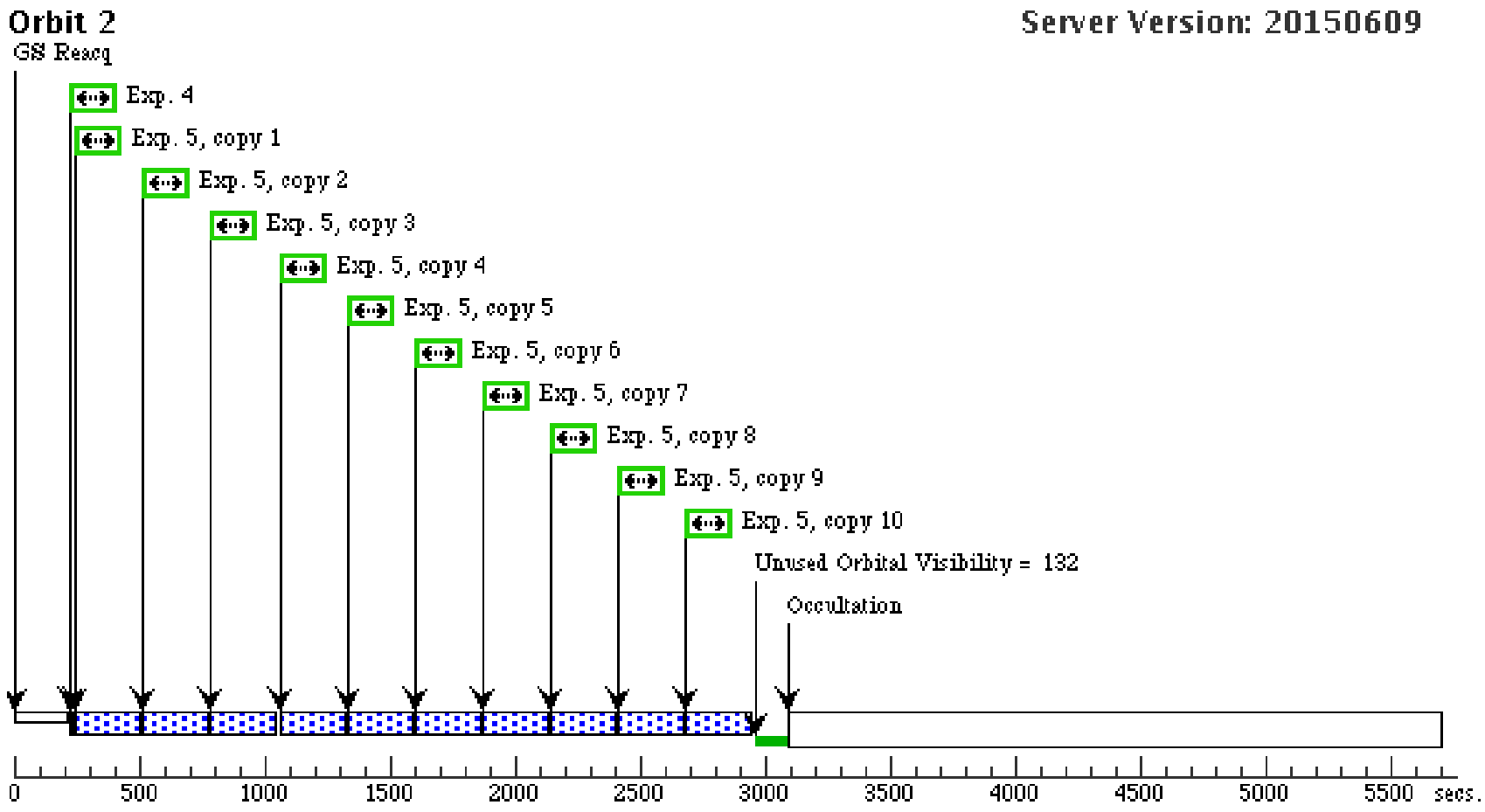
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ, phase constrained (STIS.ta.733341)	(1) HAT-P-18	STIS/CCD, ACQ, F28X50LP	MIRROR	GAIN=4	PHASE 0.9655 TO 0.9680	Sequence 1-3 Non-Int in HAT-P-18 G750L (02)	1.5 Secs (1.5 Secs) *[==>]*	***[1]***
2	HAT-P-18 G750L Orbit 1	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO		Sequence 1-3 Non-Int in HAT-P-18 G750L (02)	100 Secs (100 Secs) *[==>]*	***[1]***
	Comments: Short exposure to minimize instrument systematic of first exposure of orbit. Note that it is longer than first exposures in subsequent orbits, due to acquisition overhead and to ensure all time is used.								
3	HAT-P-18 G750L Orbit 1 (STIS.sp.733930)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO		Sequence 1-3 Non-Int in HAT-P-18 G750L (02)	250 Secs X 8 (2000 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***
4	HAT-P-18 G750L Orbit 2	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO		Sequence 4-5 Non-Int in HAT-P-18 G750L (02)	1 Secs (1 Secs) *[==>]*	***[2]***
	Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.								
5	HAT-P-18 G750L Orbit 2 (STIS.sp.733930)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO		Sequence 4-5 Non-Int in HAT-P-18 G750L (02)	250 Secs X 10 (2500 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[2]***
6	HAT-P-18 G750L Orbit 3	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO		Sequence 6-7 Non-Int in HAT-P-18 G750L (02)	1 Secs (1 Secs) *[==>]*	***[3]***
	Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.								

7	HAT-P-18 G750L Orbit 3 (STIS.sp.73 3930)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	Sequence 6-7 Non-Int in HAT-P-18 G750L (02)	250 Secs X 10 (2500 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[3]***
8	HAT-P-18 G750L Orbit 4	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	Sequence 8-9 Non-Int in HAT-P-18 G750L (02)	1 Secs (1 Secs) *[==>]*	***[4]***
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.								
9	HAT-P-18 G750L Orbit 4 (STIS.sp.73 3930)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	Sequence 8-9 Non-Int in HAT-P-18 G750L (02)	250 Secs X 10 (2500 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[4]***
10	HAT-P-18 G750L Orbit 5	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	Sequence 10-11 Non-Int in HAT-P-18 G750L (02)	1 Secs (1 Secs) *[==>]*	***[5]***
Comments: Short exposure to minimize instrument systematic of first exposure in each orbit.								
11	HAT-P-18 G750L Orbit 5 (STIS.sp.73 3930)	(1) HAT-P-18	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0; WAVECAL=NO	Sequence 10-11 Non-Int in HAT-P-18 G750L (02)	250 Secs X 10 (2500 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]*	***[5]***

	12	WAVE	WAVE	STIS/CCD, ACCUM, 52X0.2	G750L 7751 A		*[==>]*	***[5]***
	Comments: Explicit WAVECAL, auto-waves disabled							
	13	Flat	CCDFLAT	STIS/CCD, ACCUM, 0.3X0.09	G750L 7751 A		*[==>(Copy 1)]* *[==>(Copy 2)]*	***[5]***
	14	Tungsten Lamp	NONE	STIS/CCD, ACCUM, 0.3X0.09	G750L 7751 A	LAMP=TUNGSTEN; CR-SPLIT=NO; GAIN=4; SIZEAXIS2=128.0	240 Secs X 4 (960 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[5]***

Orbit Structure

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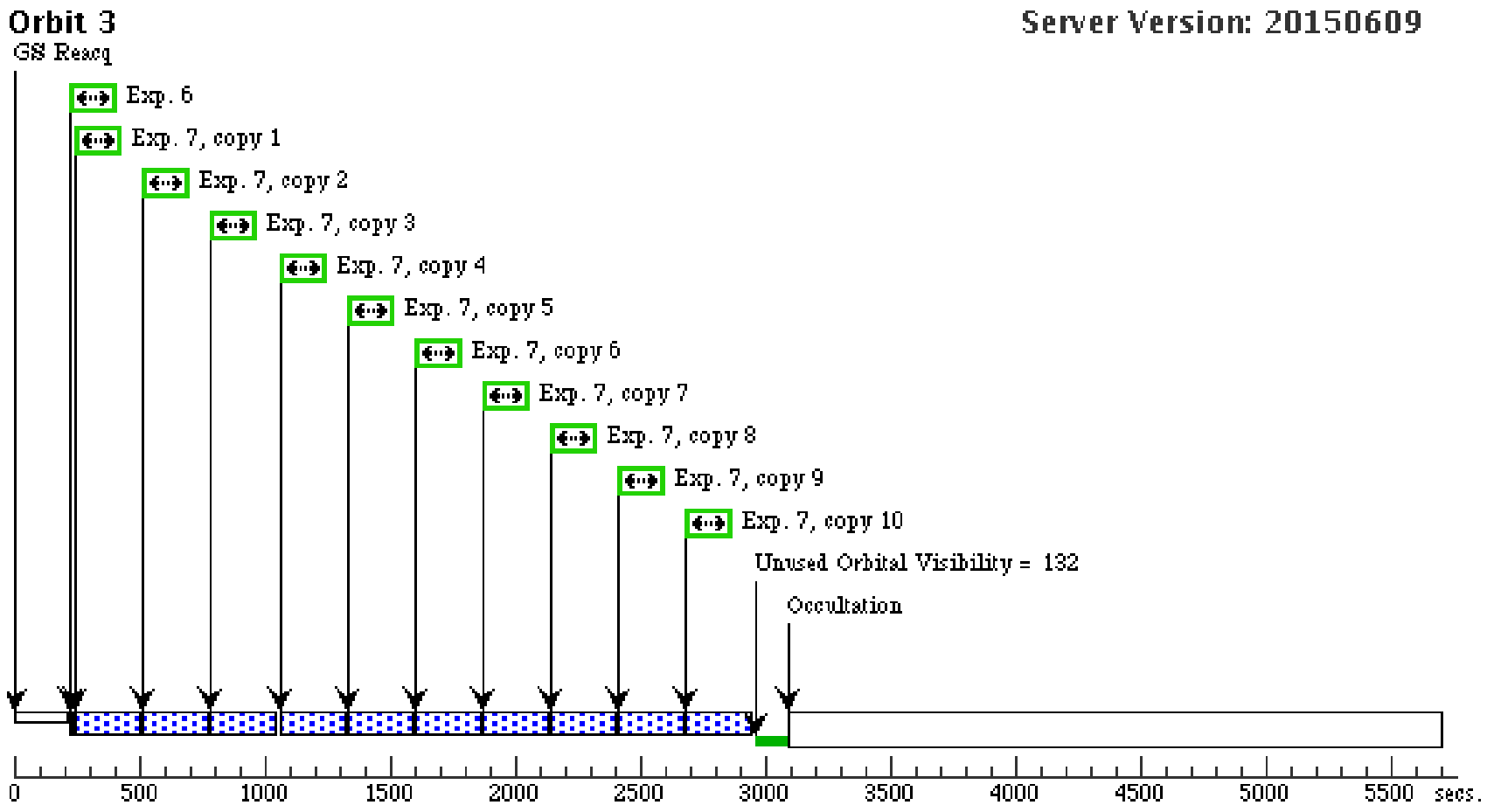
secs.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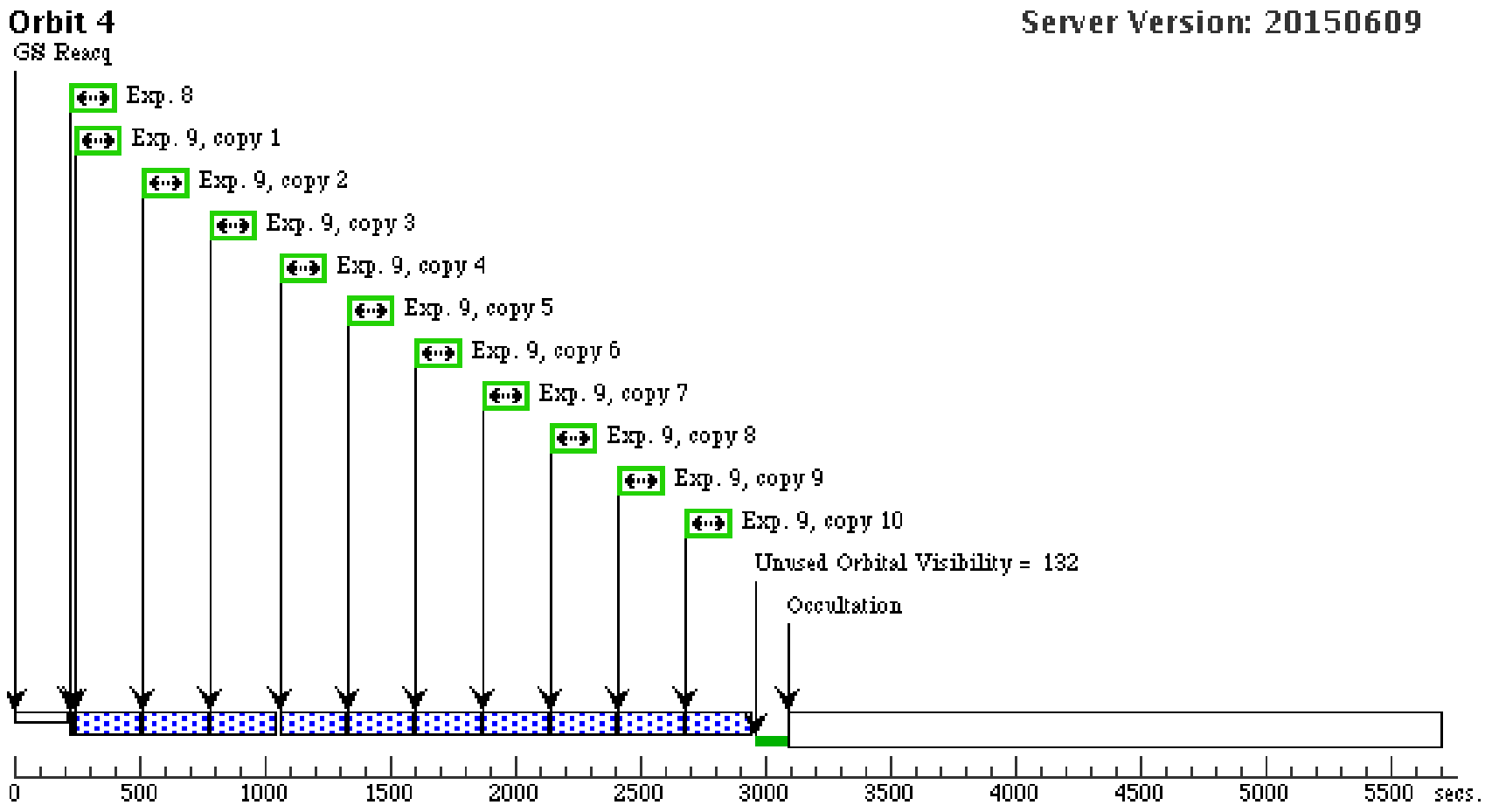
5500
secs.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Unused Orbital Visibility = 132
Occultation
0
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1000
1500
2000
2500
3000
3500
4000
4500
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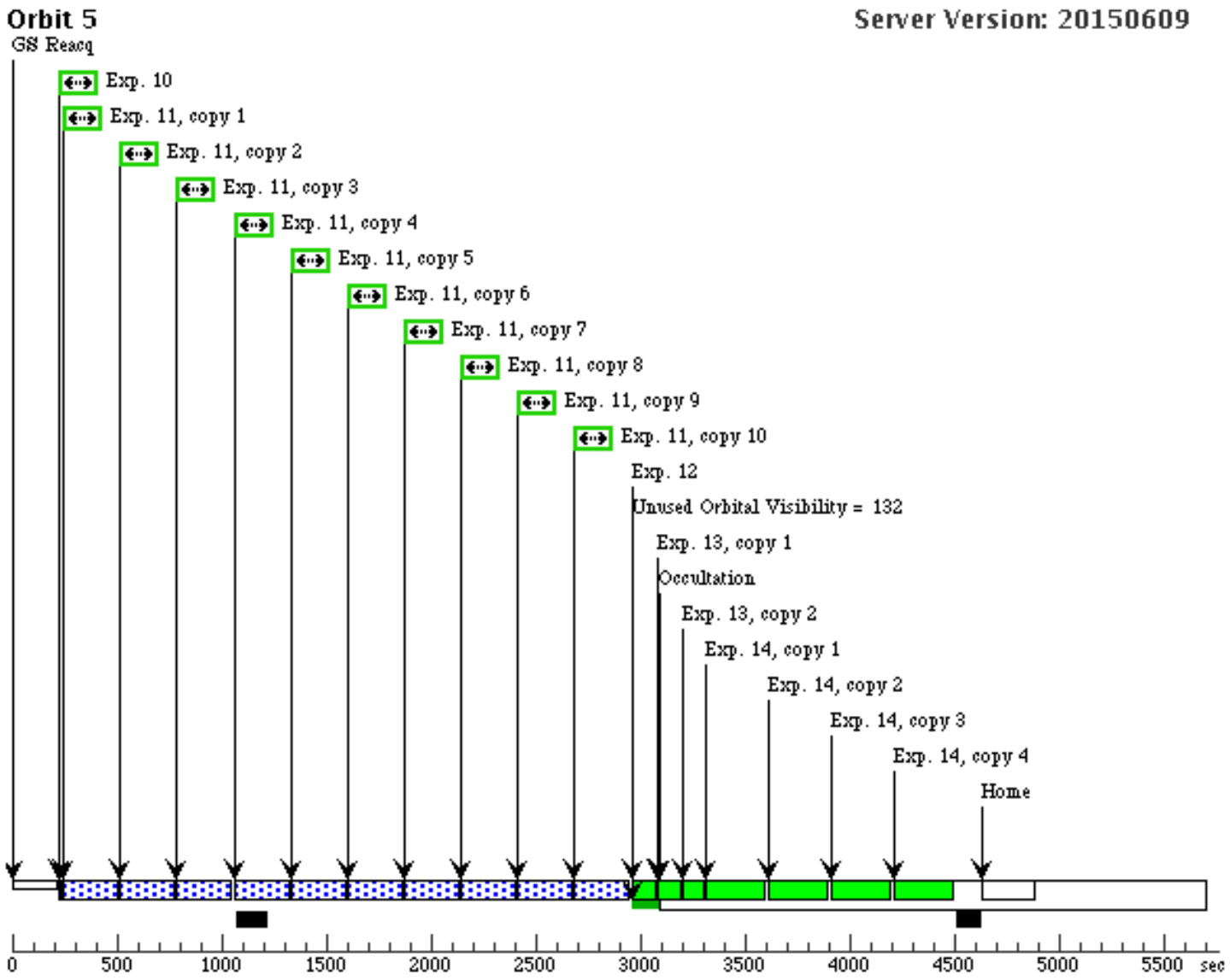
5500
secs.


Orbit 5
Server Version: 20150609
GS Reacq
Exp. 10
Exp. 11, copy 1
Exp. 11, copy 2
Exp. 11, copy 3
Exp. 11, copy 4
Exp. 11, copy 5
Exp. 11, copy 6
Exp. 11, copy 7
Exp. 11, copy 8
Exp. 11, copy 9
Exp. 11, copy 10
Exp. 12
Unused Orbital Visibility = 132
Exp. 13, copy 1
Occultation
Exp. 13, copy 2
Exp. 14, copy 1
Exp. 14, copy 2
Exp. 14, copy 3
Exp. 14, copy 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14099, HAT-P-18 WFC3 (04), completed Thu Nov 05 02:24:20 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: Period 5.50802888 D AND ZERO-PHASE HJD2456461.06765758

Comments: HAT-P-18. G141. WFC3 visit. It is essential that the five orbits be scheduled in a coninuous block, free of the SAA.

We will use the spatial scanning mode to lengthen the spectrum along the slit during the exposures, to avoid saturation on relatively long exposures. This mode greatly increases the efficiency.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HAT-P-18	RA: 17 05 23.1510 (256.3464625d)	Proper Motion RA: -21.3 mas/yr	V=12.8	Reference Frame: ICRS
	Alt Name1: GSC-02594-00646	Dec: +33 00 44.97 (33.01249d)	Proper Motion Dec: -44.2 mas/yr		
		Equinox: J2000	Epoch of Position: 2000		

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

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HAT-P-18 WFC3, phase constrained (WFC3IR.im.733974)	(1) HAT-P-18	WFC3/IR, MULTIACCUM, GRISM256	F130N	SAMP-SEQ=RAPID; NSAMP=7	PHASE 0.9655 TO 0.9680; GS ACQ SCENARIO BASE1B3		1.944705 Secs (1.945 Secs) *[==>]*	*[1]*

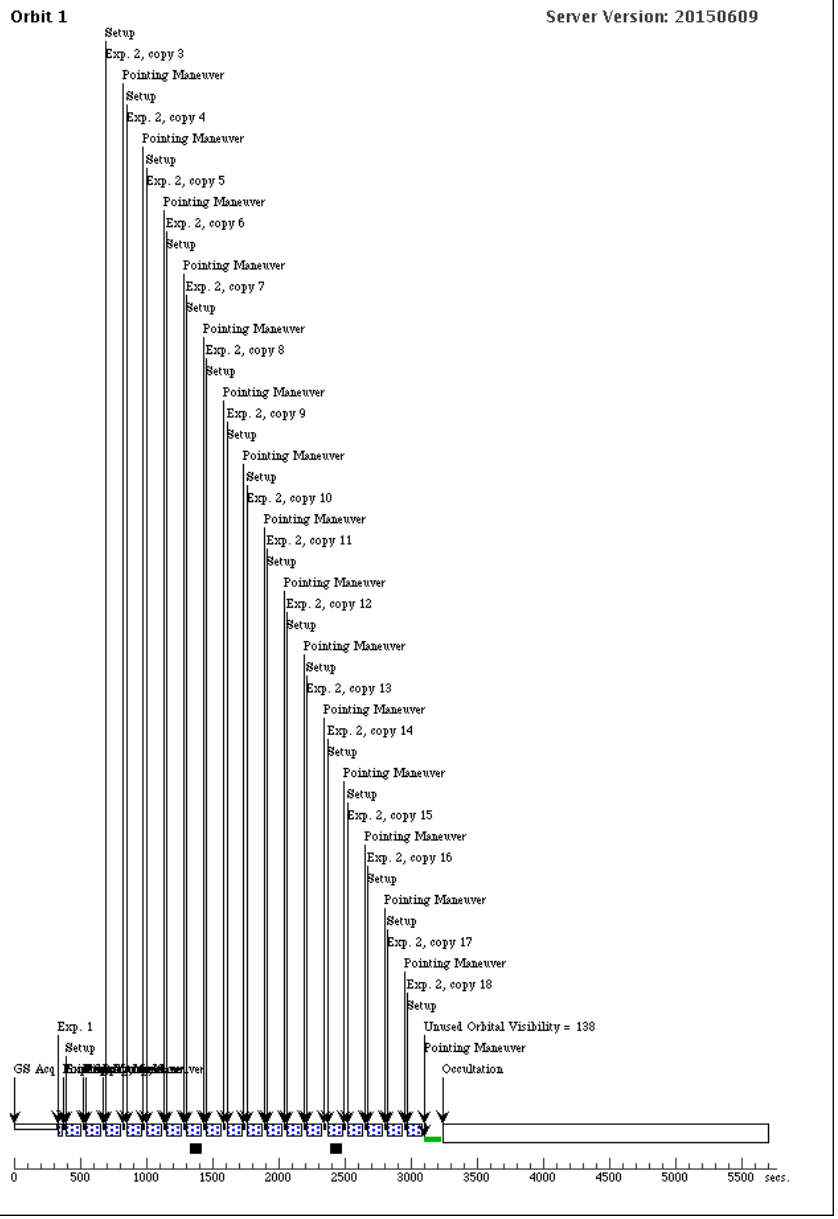
Comments: Direct image for wavelength calibration. Phase constrained.

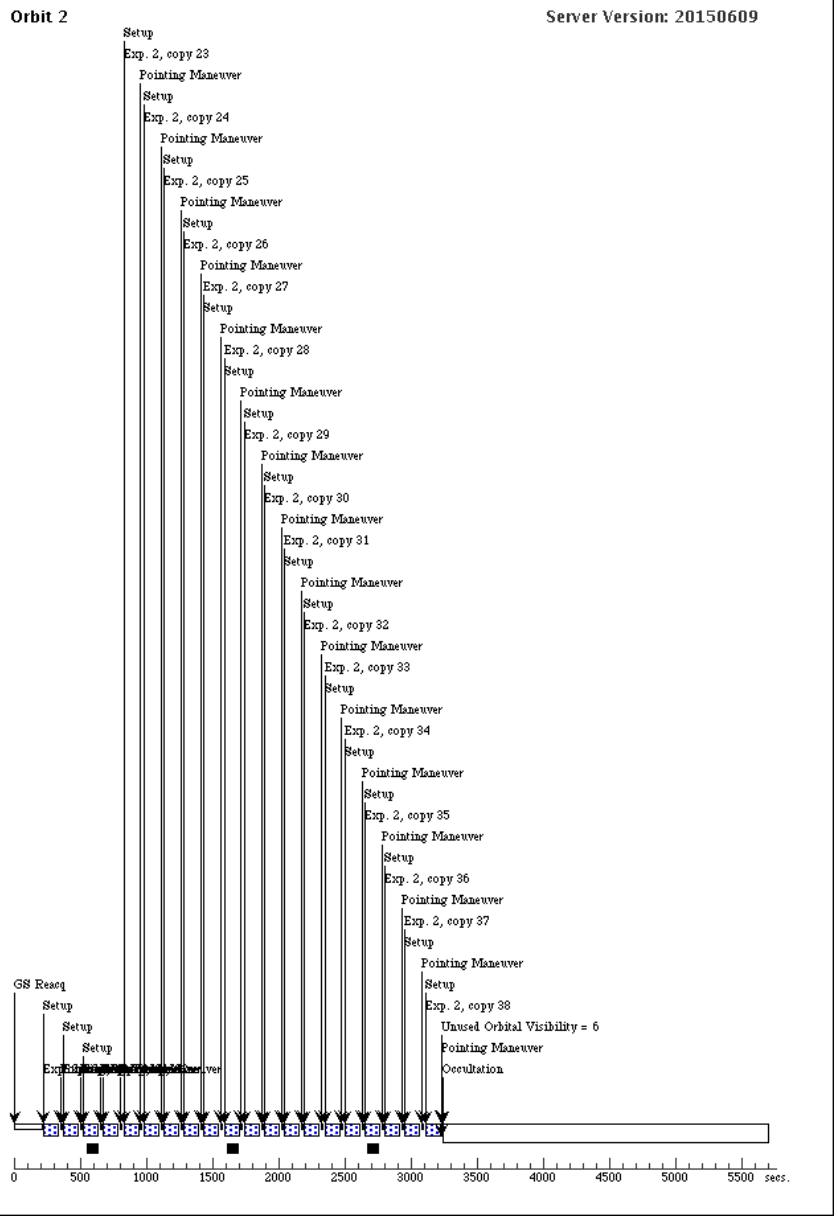
	2	HAT-P-18 WFC3 (WFC3IR.sp.734000)	(1) HAT-P-18	WFC3/IR, MULTIACCUM, GRISM256	G141	SAMP-SEQ=SPARS25; NSAMP=5	POS TARG 0.0,0.0; SPATIAL SCAN 0.0 22,90.0 Degrees,Forward	89.661971 Secs X 98 (8786.873 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]* *[==>(Copy 9)]* *[==>(Copy 10)]* *[==>(Copy 11)]* *[==>(Copy 12)]* *[==>(Copy 13)]* *[==>(Copy 14)]* *[==>(Copy 15)]* *[==>(Copy 16)]* *[==>(Copy 17)]* *[==>(Copy 18)]*	***[1]***
								[==>(Copy 19)] *[==>(Copy 20)]* *[==>(Copy 21)]* *[==>(Copy 22)]* *[==>(Copy 23)]* *[==>(Copy 24)]* *[==>(Copy 25)]* *[==>(Copy 26)]* *[==>(Copy 27)]* *[==>(Copy 28)]* *[==>(Copy 29)]* *[==>(Copy 30)]* *[==>(Copy 31)]* *[==>(Copy 32)]* *[==>(Copy 33)]* *[==>(Copy 34)]* *[==>(Copy 35)]* *[==>(Copy 36)]* *[==>(Copy 37)]* *[==>(Copy 38)]*	***[2]***

		[==>(Copy 39)] *[==>(Copy 40)]* *[==>(Copy 41)]* *[==>(Copy 42)]* *[==>(Copy 43)]* *[==>(Copy 44)]* *[==>(Copy 45)]* *[==>(Copy 46)]* *[==>(Copy 47)]* *[==>(Copy 48)]* *[==>(Copy 49)]* *[==>(Copy 50)]* *[==>(Copy 51)]* *[==>(Copy 52)]* *[==>(Copy 53)]* *[==>(Copy 54)]* *[==>(Copy 55)]* *[==>(Copy 56)]* *[==>(Copy 57)]* *[==>(Copy 58)]*	***[3]***
		[==>(Copy 59)] *[==>(Copy 60)]* *[==>(Copy 61)]* *[==>(Copy 62)]* *[==>(Copy 63)]* *[==>(Copy 64)]* *[==>(Copy 65)]* *[==>(Copy 66)]* *[==>(Copy 67)]* *[==>(Copy 68)]* *[==>(Copy 69)]* *[==>(Copy 70)]* *[==>(Copy 71)]* *[==>(Copy 72)]* *[==>(Copy 73)]* *[==>(Copy 74)]* *[==>(Copy 75)]* *[==>(Copy 76)]* *[==>(Copy 77)]* *[==>(Copy 78)]*	***[4]***

		[==>(Copy 79)] *[==>(Copy 80)]* *[==>(Copy 81)]* *[==>(Copy 82)]* *[==>(Copy 83)]* *[==>(Copy 84)]* *[==>(Copy 85)]* *[==>(Copy 86)]* *[==>(Copy 87)]* *[==>(Copy 88)]* *[==>(Copy 89)]* *[==>(Copy 90)]* *[==>(Copy 91)]* *[==>(Copy 92)]* *[==>(Copy 93)]* *[==>(Copy 94)]* *[==>(Copy 95)]* *[==>(Copy 96)]* *[==>(Copy 97)]* *[==>(Copy 98)]*	***[5]***
	Comments: Spatial scan.		

Orbit Structure




Orbit 2
Server Version: 20150609
Setup
Exp. 2, copy 23
Pointing Maneuver
Setup
Exp. 2, copy 24
Pointing Maneuver
Setup
Exp. 2, copy 25
Pointing Maneuver
Setup
Exp. 2, copy 26
Pointing Maneuver
Exp. 2, copy 27
Setup
Pointing Maneuver
Exp. 2, copy 28
Setup
Pointing Maneuver
Setup
Exp. 2, copy 29
Pointing Maneuver
Setup
Exp. 2, copy 30
Pointing Maneuver
Exp. 2, copy 31
Setup
Pointing Maneuver
Setup
Exp. 2, copy 32
Pointing Maneuver
Exp. 2, copy 33
Setup
Pointing Maneuver
Exp. 2, copy 34
Setup
Pointing Maneuver
Setup
Exp. 2, copy 35
Pointing Maneuver
Setup
Exp. 2, copy 36
Pointing Maneuver
Exp. 2, copy 37
Setup
Pointing Maneuver
Setup
Exp. 2, copy 38
Unused Orbital Visibility = 6
Pointing Maneuver
Occultation
GS Reacq
Setup
Setup
Setup
0
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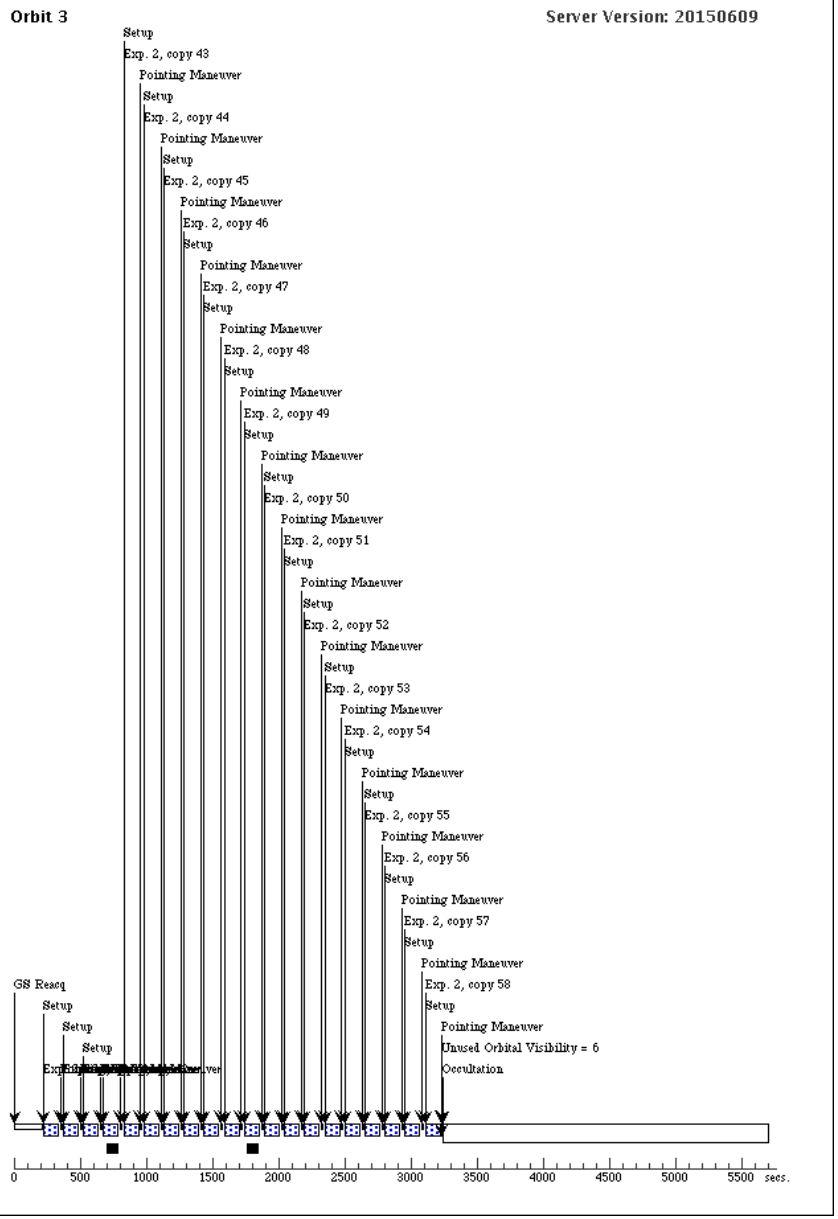
secs.


Orbit 3
Server Version: 20150609
Setup
Exp. 2, copy 43
Pointing Maneuver
Setup
Exp. 2, copy 44
Pointing Maneuver
Setup
Exp. 2, copy 45
Pointing Maneuver
Exp. 2, copy 46
Setup
Pointing Maneuver
Exp. 2, copy 47
Setup
Pointing Maneuver
Exp. 2, copy 48
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Pointing Maneuver
Exp. 2, copy 49
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Pointing Maneuver
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Exp. 2, copy 50
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Exp. 2, copy 51
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Pointing Maneuver
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Exp. 2, copy 52
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Exp. 2, copy 53
Pointing Maneuver
Exp. 2, copy 54
Setup
Pointing Maneuver
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Exp. 2, copy 55
Pointing Maneuver
Exp. 2, copy 56
Setup
Pointing Maneuver
Exp. 2, copy 57
Setup
Pointing Maneuver
Exp. 2, copy 58
Setup
Pointing Maneuver
Unused Orbital Visibility = 6
Occultation
GS Reacq
Setup
Setup
Setup
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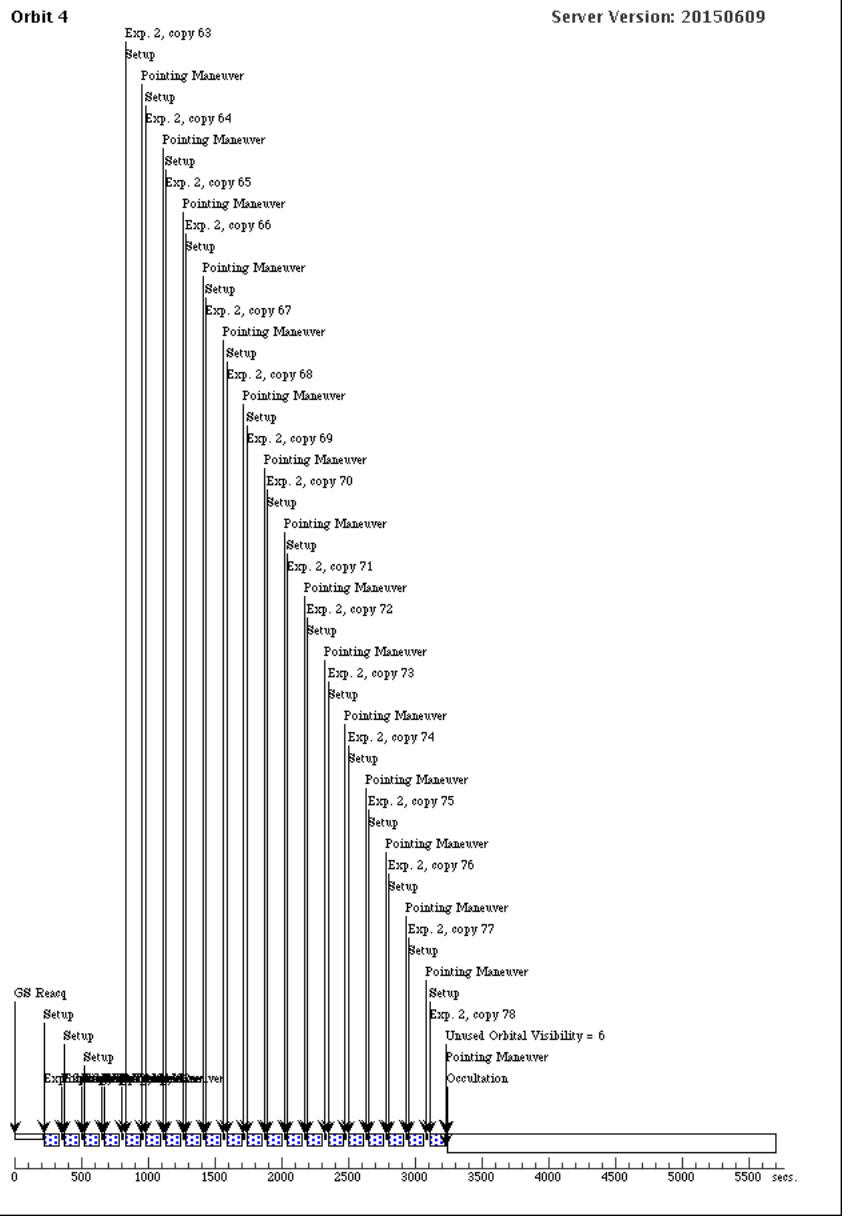
secs.


Orbit 4
Server Version: 20150609
Exp. 2, copy 63
Setup
Pointing Maneuver
Setup
Exp. 2, copy 64
Pointing Maneuver
Setup
Exp. 2, copy 65
Pointing Maneuver
Exp. 2, copy 66
Setup
Pointing Maneuver
Setup
Exp. 2, copy 67
Pointing Maneuver
Setup
Exp. 2, copy 68
Pointing Maneuver
Setup
Exp. 2, copy 69
Pointing Maneuver
Exp. 2, copy 70
Setup
Pointing Maneuver
Setup
Exp. 2, copy 71
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Exp. 2, copy 72
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Exp. 2, copy 73
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Pointing Maneuver
Exp. 2, copy 74
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Pointing Maneuver
Exp. 2, copy 75
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Pointing Maneuver
Exp. 2, copy 76
Setup
Pointing Maneuver
Exp. 2, copy 77
Setup
Pointing Maneuver
Setup
Exp. 2, copy 78
Unused Orbital Visibility = 6
Pointing Maneuver
Occultation
GS Reacq
Setup
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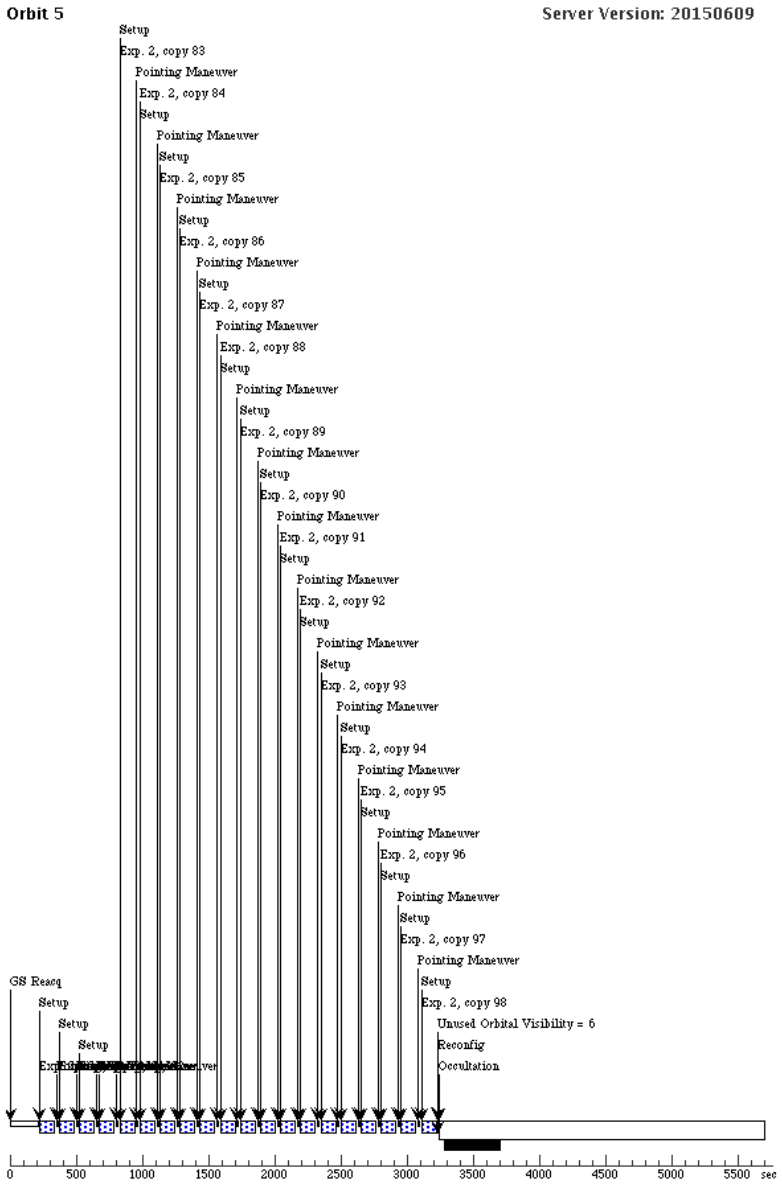
Orbit 5
Server Version: 20150609
Setup
Exp. 2, copy 83
Pointing Maneuver
Exp. 2, copy 84
Setup
Pointing Maneuver
Setup
Exp. 2, copy 85
Pointing Maneuver
Setup
Exp. 2, copy 86
Pointing Maneuver
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Exp. 2, copy 87
Pointing Maneuver
Exp. 2, copy 88
Setup
Pointing Maneuver
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Exp. 2, copy 89
Pointing Maneuver
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Exp. 2, copy 90
Pointing Maneuver
Exp. 2, copy 91
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Pointing Maneuver
Exp. 2, copy 92
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Pointing Maneuver
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Exp. 2, copy 93
Pointing Maneuver
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Exp. 2, copy 94
Pointing Maneuver
Exp. 2, copy 95
Setup
Pointing Maneuver
Exp. 2, copy 96
Setup
Pointing Maneuver
Setup
Exp. 2, copy 97
Pointing Maneuver
Setup
Exp. 2, copy 98
Unused Orbital Visibility = 6
Reconfig
Occultation
GS Reacq
Setup
Setup
Setup
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3000
3500
4000
4500
5000
5500
sec