13720 - Testing Models of the Black-Hole X-ray Source in the NGC4472 Globular Cluster RZ2109 with COS UV Spectroscopy

Cycle: 22, Proposal Category: GO

(UV Initiative)

(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	(4) NGC4472BHGC-OFFSET	COS/FUV COS/NUV	5	24-Oct-2014 21:00:45.0	yes
02	(4) NGC4472BHGC-OFFSET	COS/FUV COS/NUV	5	24-Oct-2014 21:00:47.0	yes
03	(4) NGC4472BHGC-OFFSET	COS/FUV COS/NUV	5	24-Oct-2014 21:00:49.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(4) NGC4472BHGC-OFFSET	COS/FUV COS/NUV	3	24-Oct-2014 21:00:51.0	yes

18 Total Orbits Used

ABSTRACT

We propose to obtain COS ultraviolet spectroscopy of the black-hole X-ray source in the NGC 4472 globular cluster RZ2109. This object was the first unambiguous black hole X-ray source in a globular cluster. It is clearly identified as a black hole through its high X-ray luminosity and short-term variability. The optical spectrum of RZ2109 shows strong and extraordinarily broad [OIII]4959, 5007 emission, and our recent STIS spectrum demonstrates that this comes from an outflow extended across most of the globular cluster. The optical spectrum also remarkably shows no emission lines other than [OIII] to sensitive limits, indicating that the material is very hydrogen-poor. One way to account for these observations is if RZ2109 hosts a CO white dwarf accreting onto a stellar mass black hole. In this case, CIV 1549 emission is expected and no nitrogren lines will be seen. However, if nitrogen lines such as NIV 1486 and NV 1239, 1243 are observed, then a different source for the accreting material such as a nova shell or a horizontal branch star would be required, and a re-evaluation of all aspects of our understanding of the dynamics and accretion in RZ2109 would be needed. Determining which of these is the case is a major step for understanding how accreting black holes form and grow in dense stellar systems, whether they make intermediate mass black holes, and what accretion and feedback processes lead to strong outflows rich in elements such as oxygen.

OBSERVING DESCRIPTION

The aim of the program is to obtain an ultraviolet spectrum of the black hole X-ray source in the extragalactic globular cluster RZ2109. Specific goals include finding or setting an upper limit on CIV 1549, NIV 1486, and possibly CIII] 1908 emission. We also would like to detect or constrain the faint continuum emission from the globular cluster itself. If the donor star is a CO white dwarf, based on the observed [OIII]5007 emission, the CIV 1549 line will be present with a flux of about 3 x 10^-16 ergs/s/cm^2 with a velocity range extending over 2,000 km/s with a central peak with a width of 300 km/s. To detect such a line, we calculated that 18 orbits of COS spectriscopy with the G140L grating were required. We also note that the continuum from the globular cluster at 3200 Angstroms is observed to be about 5 x 10^-18 ergs/s/cm^2. Based on most extrapolations from this to farther into the ultraviolet, an image of 600 seconds or so will detect the cluster, but not at very high signal to noise. Therefore, we chose not to obtain an acquisition image, but to rely on our well measured position from WFPC2, confirmed by our STIS acquisition procedure. We do however want to obtain an image, so that we can bring any offset from the center into our total flux calculations. This is placed at the beginning of the first

visit, of two orbits. The remaining visits are of four orbits each, with each orbit being one FP-POS step. This was more efficient in maximizing total exposure time than doing four FP-POS steps in each orbit, even though a little bit of time is not used at the end each of the last three orbits per visit.

Visit

Proposal 13720, Visit 01, implementation Sat Oct 25 01:00:53 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: ORIENT 100D TO 100 D

Diagnostics

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

(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(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): POS TARG OUTSIDE OF APERTURE

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	NGC4472BHGC-OFFSET	RA: 12 29 40.6265 (187.4192771d) Dec: +07 54 40.41 (7.91122d) Equinox: J2000		V=13	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(639428)	(4) NGC4472BHGC-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				300 Secs (300 Secs)	
								[==>]	***[1]***
2	(623622)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=355	POS TARG -50.161, 47.184		355 Secs (1420 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(632622)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=2935	SAME POS AS 2		2935 Secs (11740 Secs)	
								[==>(Split 1)]	***[2]***
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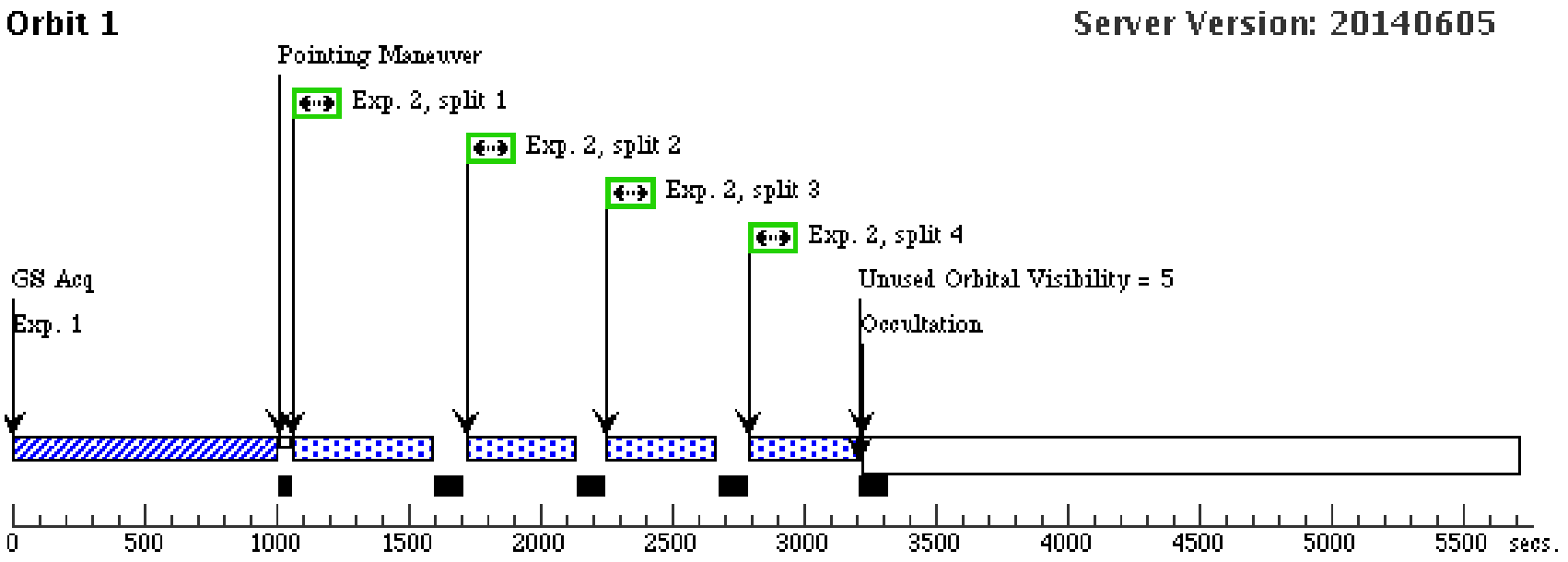

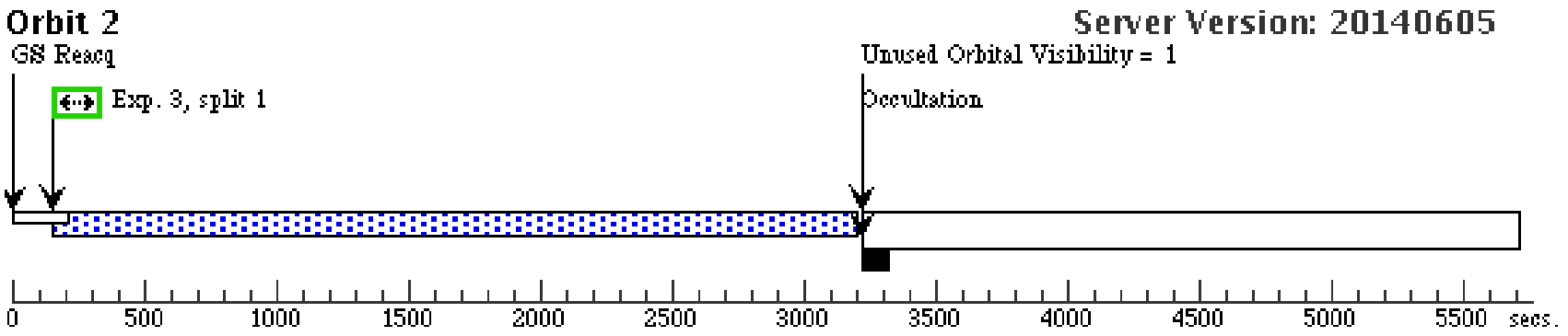

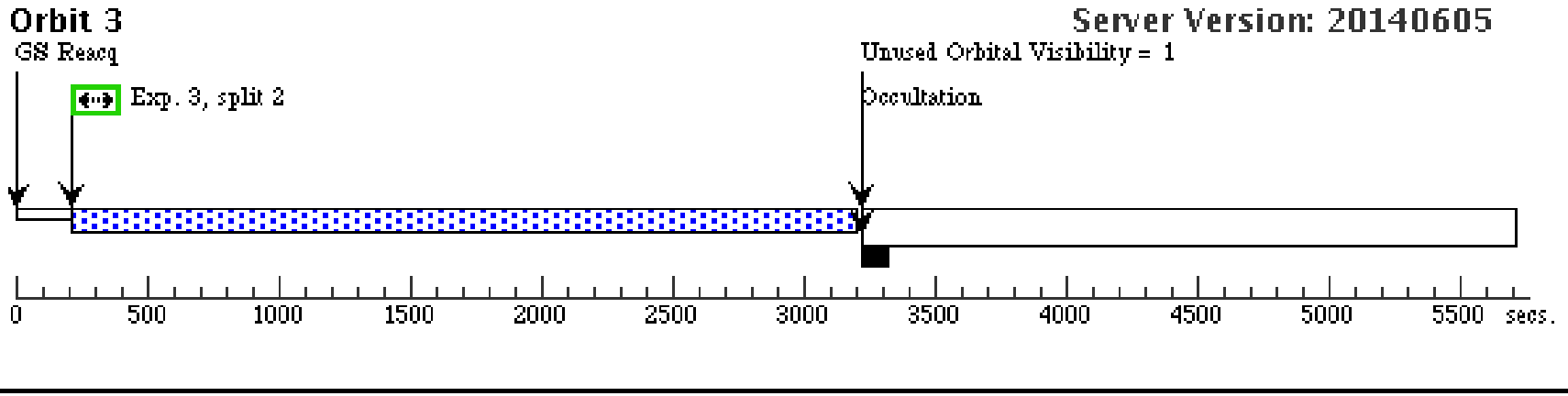
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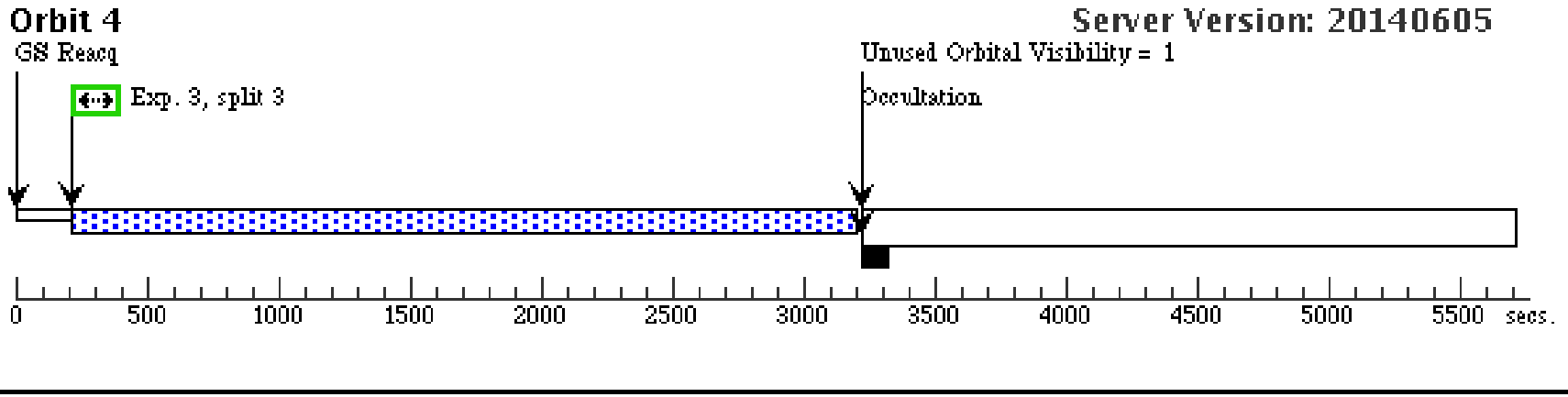
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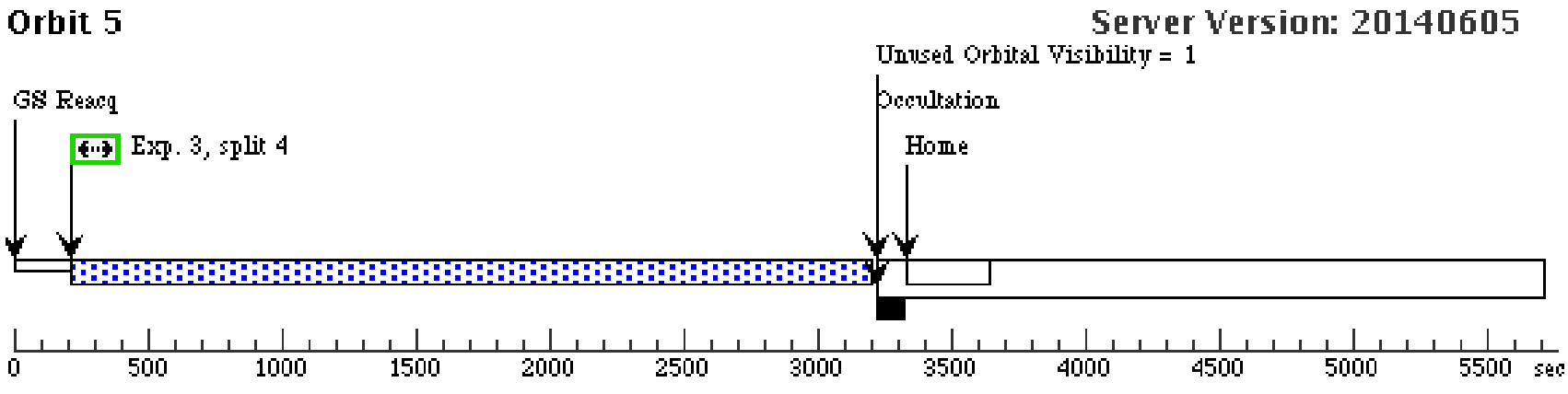
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Visit

Proposal 13720, Visit 02, implementation Sat Oct 25 01:00:54 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: ORIENT 100D TO 100 D

Diagnostics

(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): INEFFICIENT ORDERING OF FP-POS POSITIONS

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	NGC4472BHGC-OFFSET	RA: 12 29 40.6265 (187.4192771d) Dec: +07 54 40.41 (7.91122d) Equinox: J2000		V=13	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(639428)	(4) NGC4472BHGC-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				300 Secs (300 Secs)	
								[==>]	***[1]***
2	(623637)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=355	POS TARG -50.161, 47.184		355 Secs (1420 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(623637)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=2935	SAME POS AS 2		2935 Secs (11740 Secs)	
								[==>(Split 1)]	***[2]***
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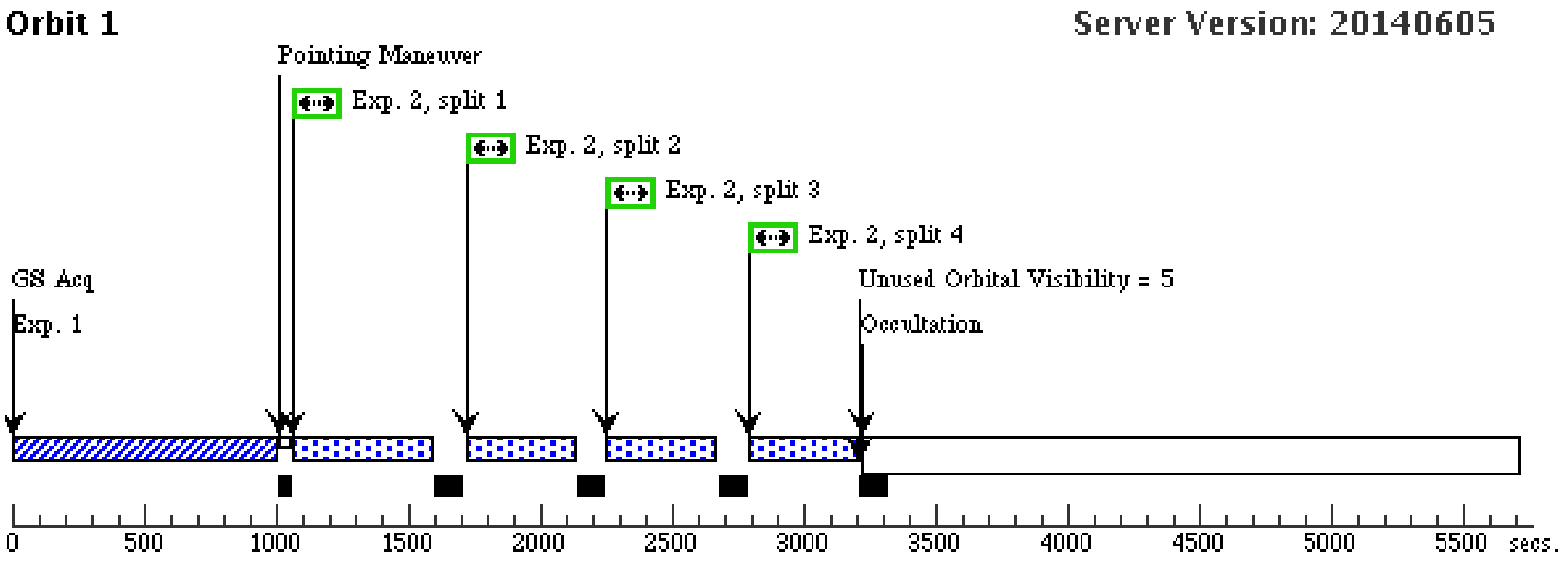
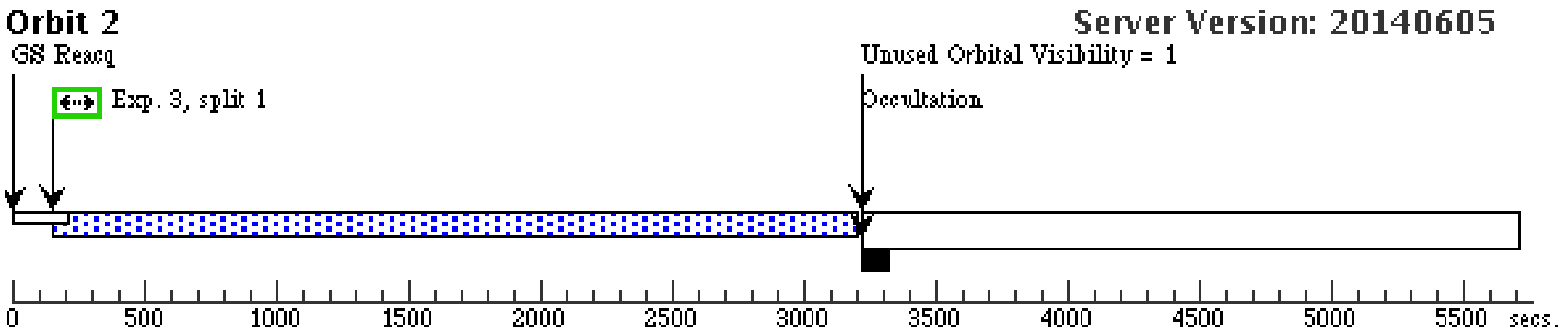
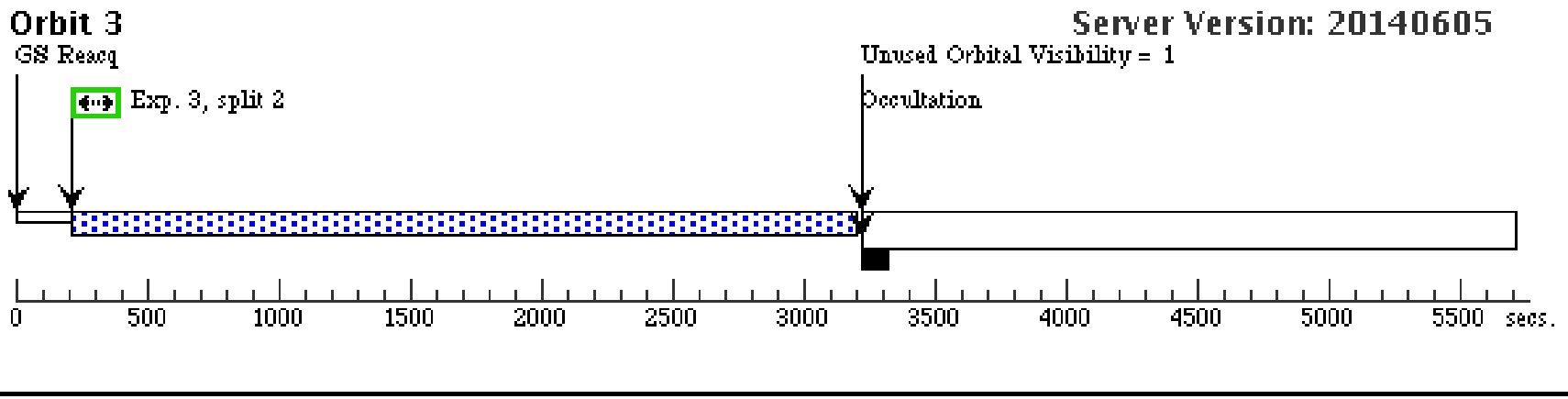
Orbit Structure



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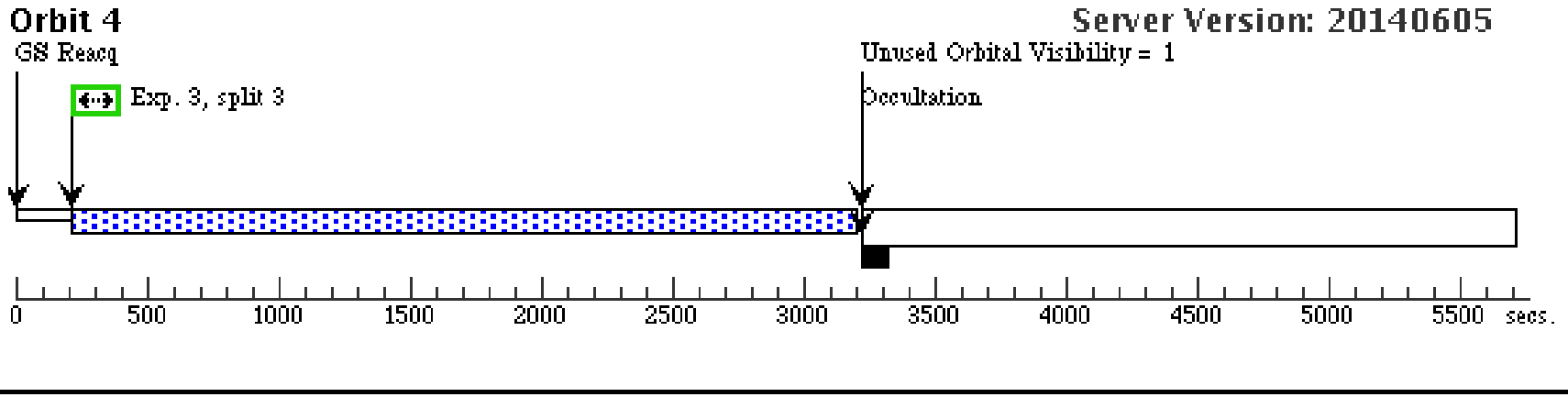
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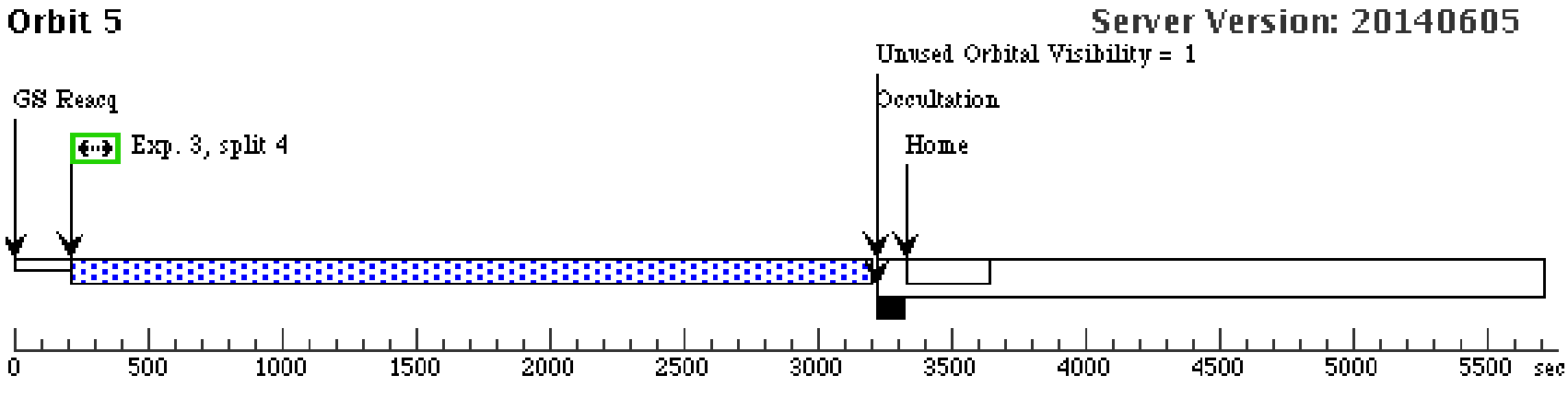
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Visit

Proposal 13720, Visit 03, implementation Sat Oct 25 01:00:54 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: ORIENT 100D TO 100 D

Diagnostics

(Visit 03) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 03) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

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(Visit 03) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	NGC4472BHGC-OFFSET	RA: 12 29 40.6265 (187.4192771d) Dec: +07 54 40.41 (7.91122d) Equinox: J2000		V=13	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(639428)	(4) NGC4472BHGC-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				300 Secs (300 Secs)	
								[==>]	***[1]***
2	(623622)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=355	POS TARG -50.161, 47.184		355 Secs (1420 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(623637)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=2935	SAME POS AS 2		2935 Secs (11740 Secs)	
								[==>(Split 1)]	***[2]***
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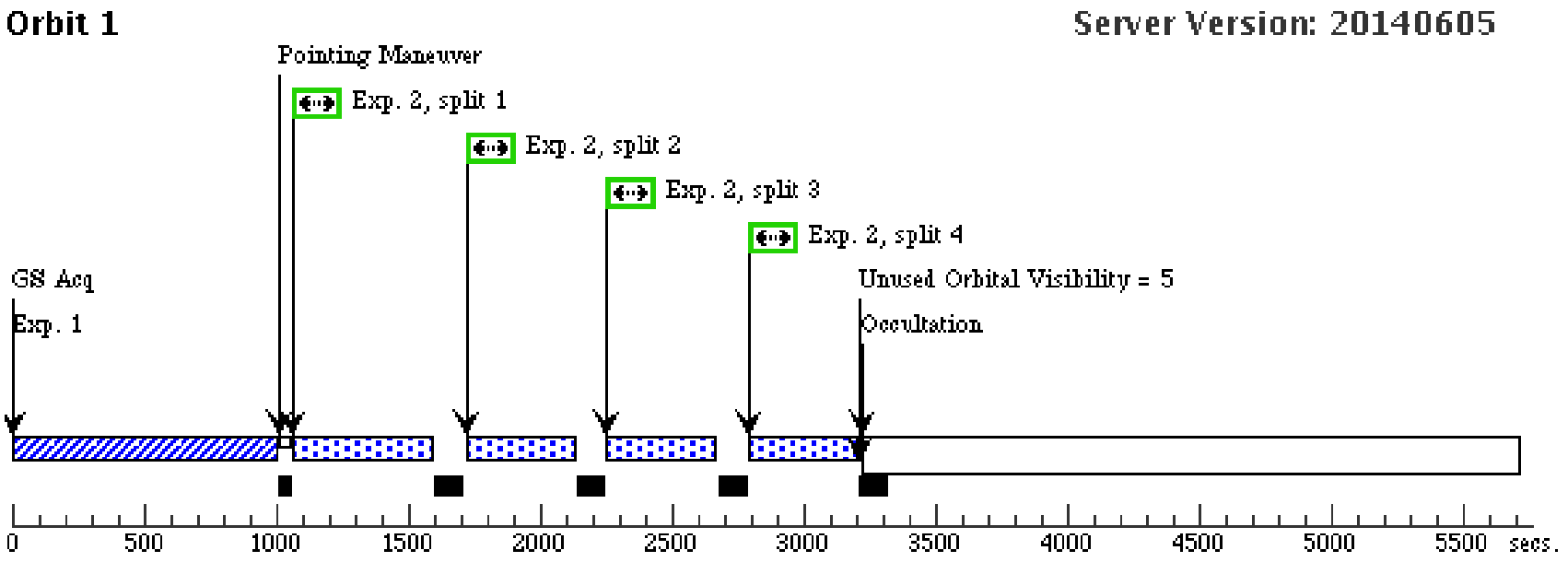
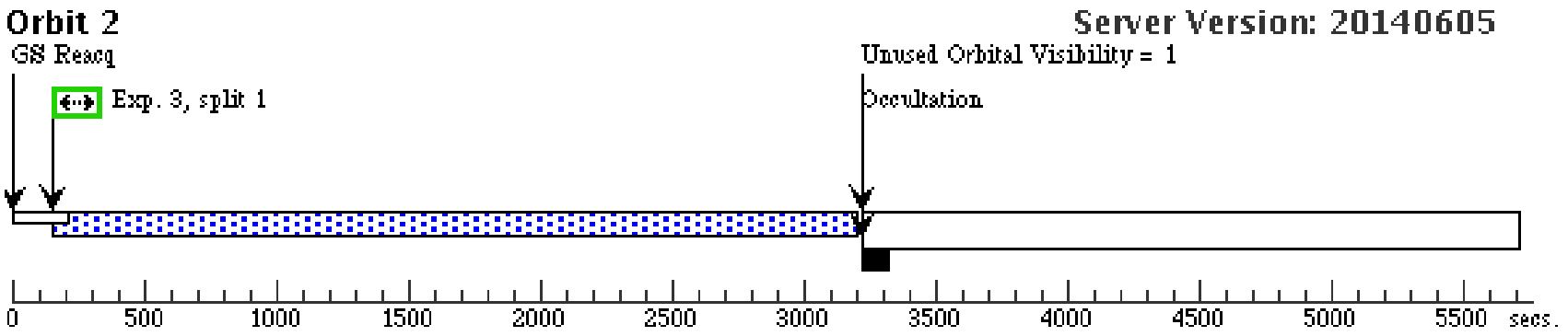
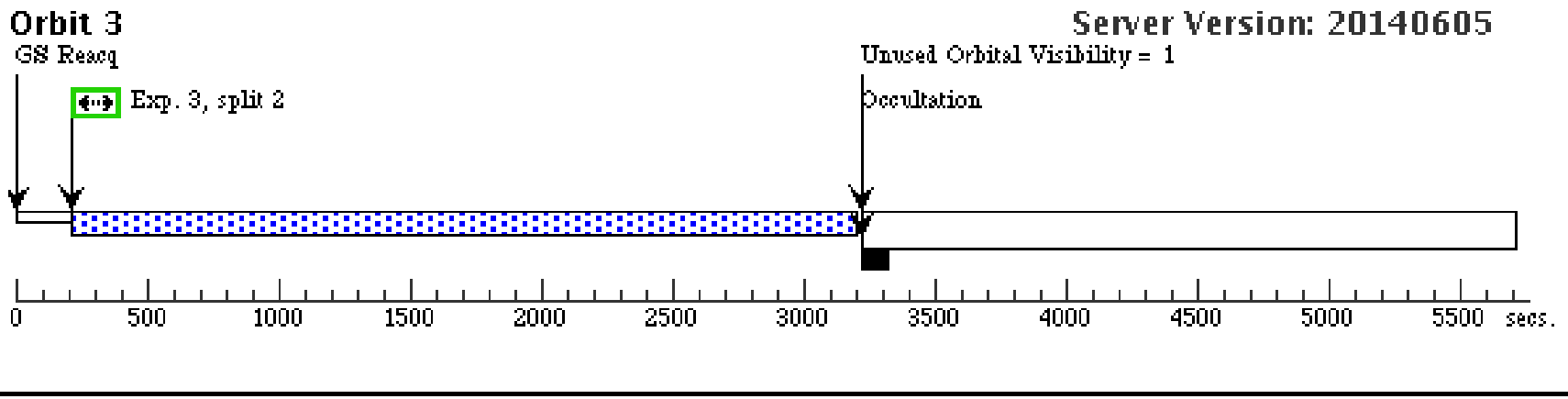
Orbit Structure



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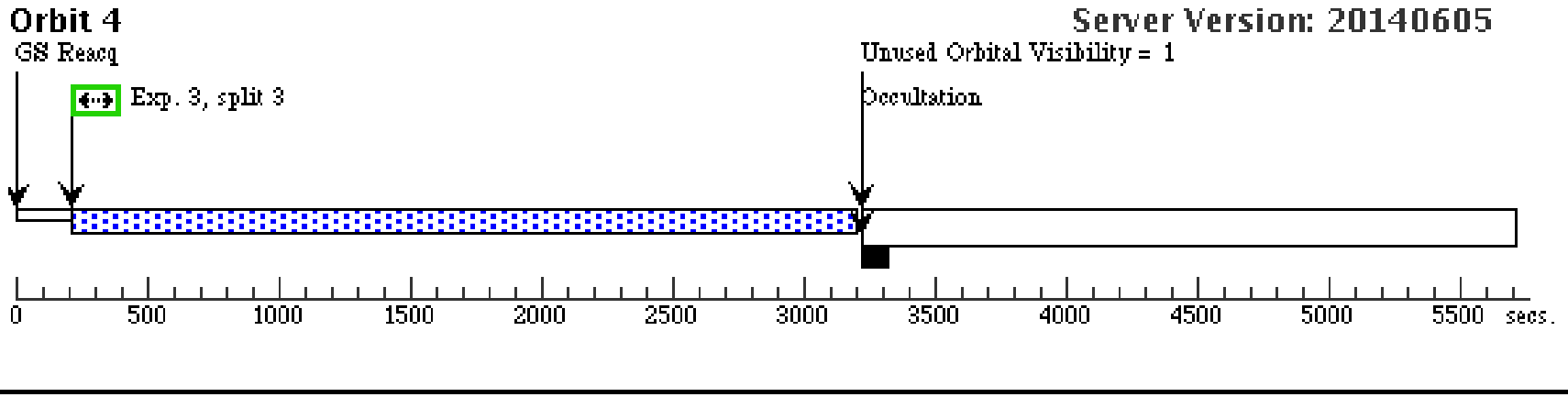
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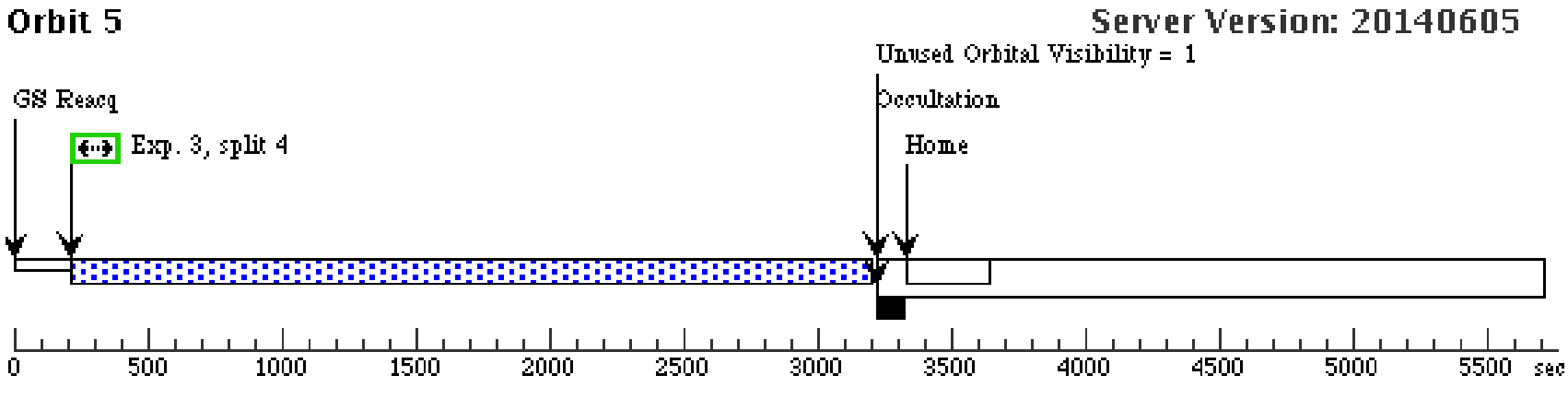
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Visit

Proposal 13720, Visit 04, implementation Sat Oct 25 01:00:54 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: ORIENT 100D TO 100 D

Diagnostics

(Visit 04) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 04) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

(Visit 04) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

(Visit 04) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE

(Exposure 3 (Visit 04)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	NGC4472BHGC-OFFSET	RA: 12 29 40.6265 (187.4192771d) Dec: +07 54 40.41 (7.91122d) Equinox: J2000		V=13	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(623637)	(4) NGC4472BHGC-OFFSET	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				300 Secs (300 Secs)	
								[==>]	***[1]***
2	(623622)	(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=355	POS TARG -50.171, 47.184		355 Secs (1420 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3		(4) NGC4472BHGC-OFFSET	COS/FUV, TIME-TAG, PSA	G140L 1280 A	FP-POS=ALL; BUFFER-TIME=1370	SAME POS AS 2		1370 Secs (5480 Secs)	
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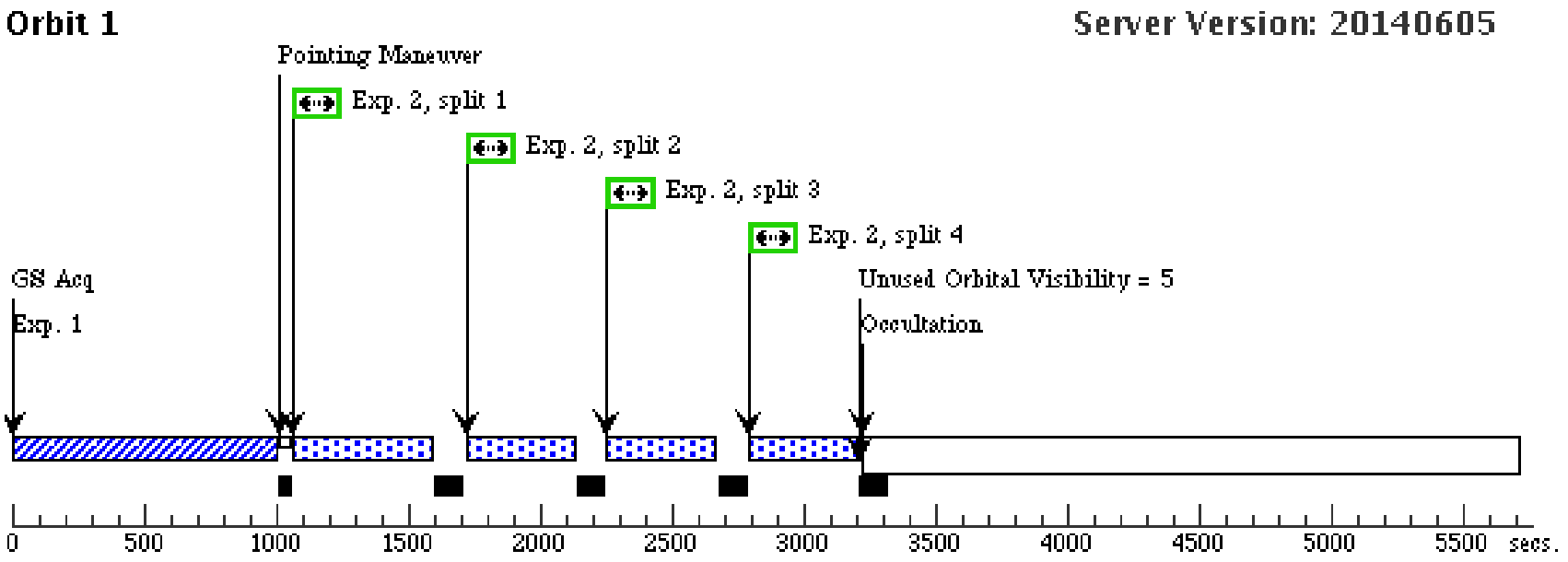
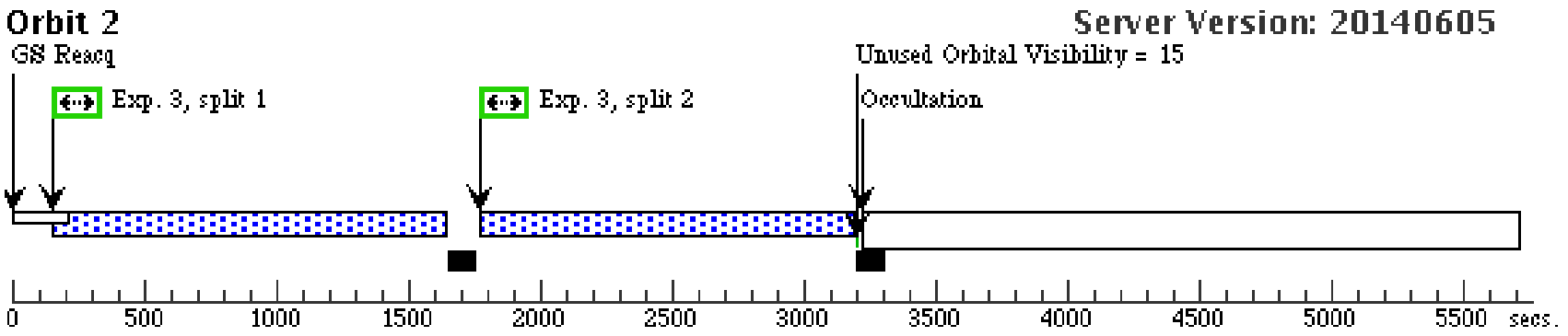
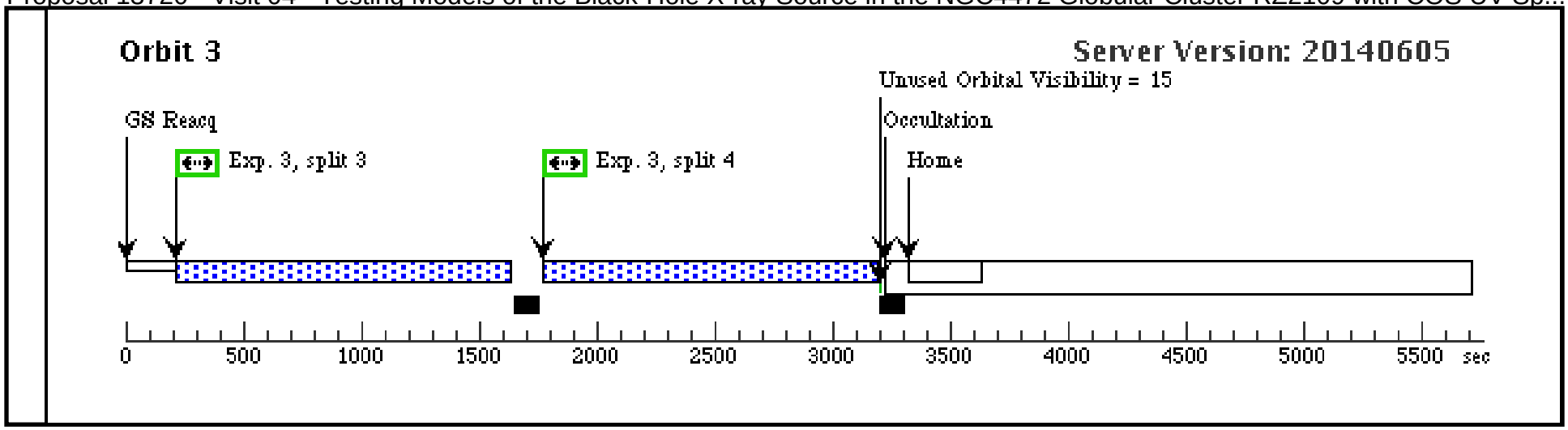
Orbit Structure



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