12958 - Large Scale Structure in Absorption up to z~0.4

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) SDSS-J141038.39+230447.1	COS/FUV COS/NUV	4	05-Jul-2012 21:31:17.0	yes
02	(1) SDSS-J141038.39+230447.1	COS/FUV COS/NUV	4	05-Jul-2012 21:31:28.0	yes
03	(1) SDSS-J141038.39+230447.1	COS/FUV COS/NUV	4	05-Jul-2012 21:31:37.0	yes

12 Total Orbits Used

ABSTRACT

We propose to observe and characterize IGM absorption systems associated with Large Scale Structure (LSS) in a statistical manner up to redshift ~0.4. For this purpose, we have used a recently published cluster catalog (GMBCG; Hao et al., 2010) to identify massive nodes in the 'cosmic web'. Then, we used cluster pairs with small separations (<20 Mpc) at similar redshifts to identify zones where filaments should reside with high probabilities. Combining the GMBCG cluster catalog with the SDSS DR7 QSO catalog, we selected a single QSO whose sightline passes through a total of 6 predicted filaments (3 of which are independent) and 3 clusters with spectroscopic redshifts at impact parameters <1.5 Mpc. This will considerably increase the sample of known LSS (especially filaments) at low redshift. We propose to observe the QSO with HST/COS using the G130M and G160M gratings to cover the full FUV spectral range at high resolution (R~20000). We require observations at S/N~10 to ensure a full characterization of HI and OVI lines at small column densities (N~10^13 cm^-2). These low column densities will allow us to detect broad and shallow HI lines with OVI, believed to be associated with portions of the warm-hot intergalactic medium (WHIM). Our results will also be suitable for testing an alternative hypothesis which states that the majority of OVI absorbers at low-z are confined within <300 kpc from galaxies and are not directly related to the WHIM (Prochaska et al., 2011; Tumlinson et al., 2011). Our findings will test our understanding of galaxy formation and the importance of AGN/supernova feedbacks by comparing them with state-of-the-art hydrodynamical simulations.

OBSERVING DESCRIPTION

Our unique target was selected in the following way:

We first searched in the GMBCG catalog for cluster-cluster pairs where at least one member has a spectroscopic redshift and where the redshift difference between them is less than 3 times the combined redshift uncertainty. Hao et al. show that a minimum richness value of 15 is enough to ensure a high completeness and reliability of the clusters, and so, we adopted this in our cluster-pair search (this value corresponds to roughly M>~ 10^{14} M_{sun}; e.g., Hansen et al., 2007, ApJ, 699, 1333). We then measured the transverse co-moving separation between clusters at the redshift of the cluster with spectroscopic identification (if both clusters had spectroscopic redshifts we used the average redshift), and kept the ones separated by X<20 c-Mpc (co-moving Mpc). For these cluster-pairs we drew an imaginary cylinder of radius Y=2 c-Mpc joining the pairs members. These parameters were chosen in order to have a high probability of finding real filaments (see `Scientific Justification'). We refer to these cylinders as `possible filaments' or simply as `filaments'. We then looked for QSOs with redshifts greater than the filament and located inside the sky-projected `filament' area. We imposed a magnitude limit of r<17.5 mag to select relatively bright QSOs. We then counted the number of independent `filaments' (those which were separated by more than 1000 km/s from another, and by more than 5000 km/s from the QSO in rest-frame velocity space) per QSO sightline and we kept the ones with at least 3. For these QSO sightlines we also searched for clusters at impact parameters of <2 Mpc. In order to maximize the scientific output of this proposal we gave more priority to QSOs z>0.3, ensuring large redshift path coverage. We then searched in the GALEX database and prioritized those QSOs with high FUV fluxes to ensure no higher-z Lyman Limit Systems were present and enable a S/N~10 spectra to be observed in a relatively short exposure time.

A minimum S/N~10 per resolution element is desirable as our experience with existing STIS echelle spectra suggests that for S/N <~ 5 it becomes difficult to independently constrain the column density (N) and Doppler parameter (b). We tested this limit by generating a set of mock Voigt profiles with known N and b, degraded them to the HST/COS resolution for a range of S/N, and then fitted them with the VPFIT (Voigt-profile fitting program written by R.F. Carswell and J. K. Webb; http://www.ast.cam.ac.uk/rfc/vpfit.html). The results confirmed that S/N~5 per resolution element is too low to reliably recover the input parameters, and that S/N = 10 is adequate for recovering them for a wide range of input values. With such a limit, we expect to have a rest-frame equivalent width limit of ~24 mA, small enough to trace N~10^{13} cm^{-2} for typical b values of 30 km/s in neutral hydrogen.

Finally, we selected the most promising QSO sightline (from a total of ~100000) that passes through 6 `filaments' (3 of which are independent) and 3 rich clusters with spectroscopic redshifts. Our target was selected to provide the maximum number of LSS at the minimum observing cost and is located in a safe region where no object is brighter than the target itself within the COS field-of-view (FUV=17.4 mag; note that we have successfully aquired a object of similar magnitude in a previous HST/COS observation). This object will significantly increase the number of known LSS (especially filaments) at low-z and it will also test the validity of our novel selection strategy.

We require full FUV coverage and high resolution for the spectrum. High resolution is essential to fully characterize systems. This is important for comparisons with simulations as well as for determining whether absorption may arise in the WHIM. Thus, we will use both G130M(1318A) and G160M(1611A) gratings. This choice will provide wavelength coverage between ~1160-1790 A, with substantial overlap from at least two settings at R~20000. To avoid the expected absorption systems falling in one of the four ~20 A gaps covered only by one setting, we will choose both the setting and the FP-POS accordingly in Phase-II.

Exposure times were calculated to obtain a S/N >~10 over the majority of the FUV spectral range using the current COS ETC (v20.1.1). Our target is at low declination giving orbital visibility of ~54 minutes. From our previous experience with Phase-II COS proposal, we estimated 2500 s of science exposure time for the first orbit of a visit, and 3000 s for the subsequent orbits. Then, a total of 12 orbits are required for this project, distributed as shown in the `Observing Summary'. Visits were restricted to be shorter than 5 orbits to ensure flexibility in scheduling the observations.

Visit

Proposal 12958, Visit 1 - G130M (01), implementation Fri Jul 06 01:31:44 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Comments: This visit corresponds to the visit 1/1 of the G130M grating exposure:
- 4 orbits in total.
- 1 science exposure per orbit.
- 4 FP-POS in total (1 per orbit), 1 central wavelenght (1318A)
- Buffer times are set to be equal than the exposure times themselves in order to help with the HST scheduling of parallel observations.

Diagnostics

(Visit 1 - G130M (01)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

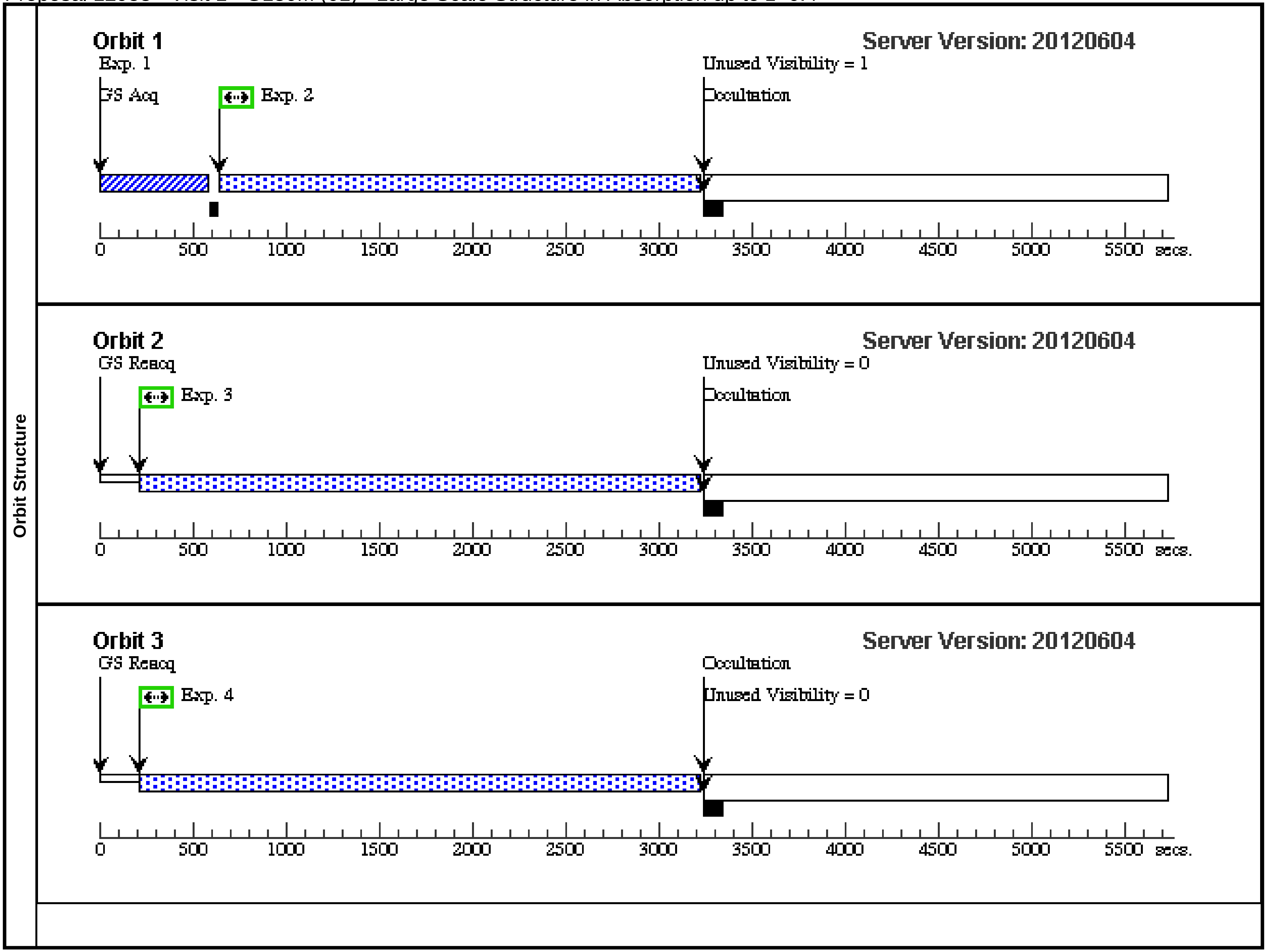
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSS-J141038.39+230447.1 Alt Name1: SDSS-J141038.39+230447.2	RA: 14 10 38.3960 (212.6599833d) Dec: +23 04 47.18 (23.07977d) Equinox: J2000	Redshift: 0.7958	V=16.9+/-0.02 r=17.0, g=16.9, NUV=17.4, FUV=18.7	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
The objects has not photometric information in the V band. The actual value corresponds to the SDSS g band which is close to the V filter.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	ACQ (COS.ta.408284)	(1) SDSS-J141038.39+230447.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				75 Secs *[==>]*	***[1]***
2	Science 1 (COS.sp.408289)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G130M 1318 A	FP-POS=1; BUFFER-TIME=2400; SEGMENT=BOTH			2500 Secs *[==>2400.0 Secs]*	***[1]***
	Comments: Note that the actual time is set to be 2400 s. The ETC calculation is set also with 2400 s.								
3	Science 2 (COS.sp.407875)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G130M 1318 A	FP-POS=2; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[2]***
4	Science 3 (COS.sp.407875)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G130M 1318 A	FP-POS=3; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[3]***
5	Science 4 (COS.sp.407875)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G130M 1318 A	FP-POS=4; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[4]***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Exp. 1
GS Acq
Exp. 2
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Orbit 2
Server Version: 20120604
GS Reacq
Exp. 3
Unused Visibility = 0
Occultation
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 secs.
Orbit 3
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Exp. 4
Occultation
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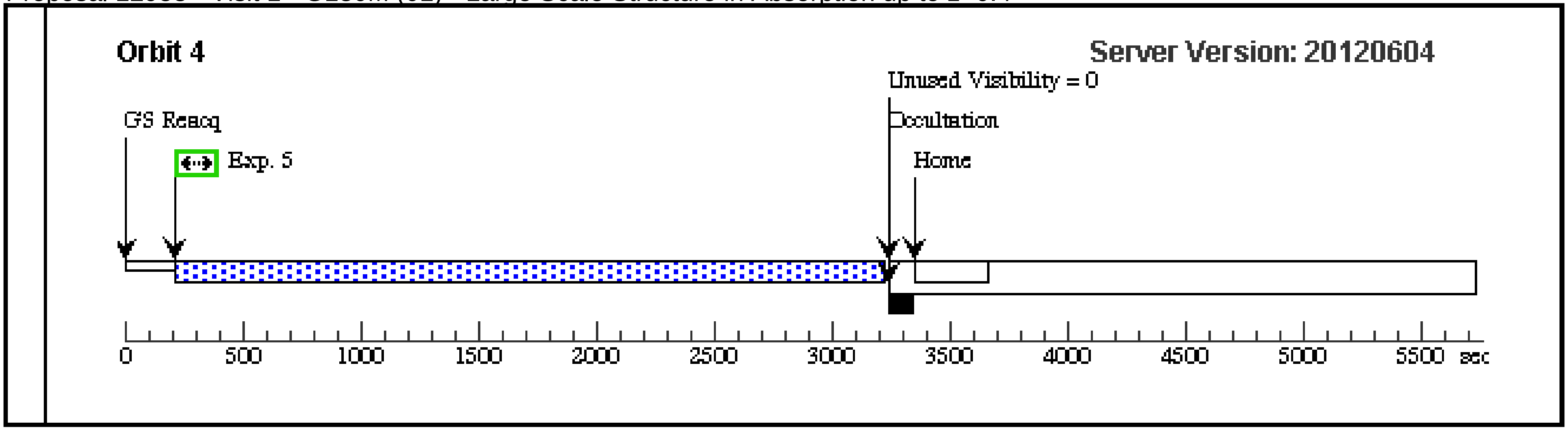
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Occultation
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sec

Visit

Proposal 12958, Visit 2 - G160M (02), implementation Fri Jul 06 01:31:49 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Comments: This visit corresponds to the visit 1/2 of the G160M grating exposure:
- 4 orbits in total.
- 1 science exposure per orbit.
- 4 FP-POS in total (1 per orbit), 1 central wavelenght (1611A)
- Buffer times are set to be equal than the exposure times themselves in order to help with the HST scheduling of parallel observations.

Diagnostics

(Visit 2 - G160M (02)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

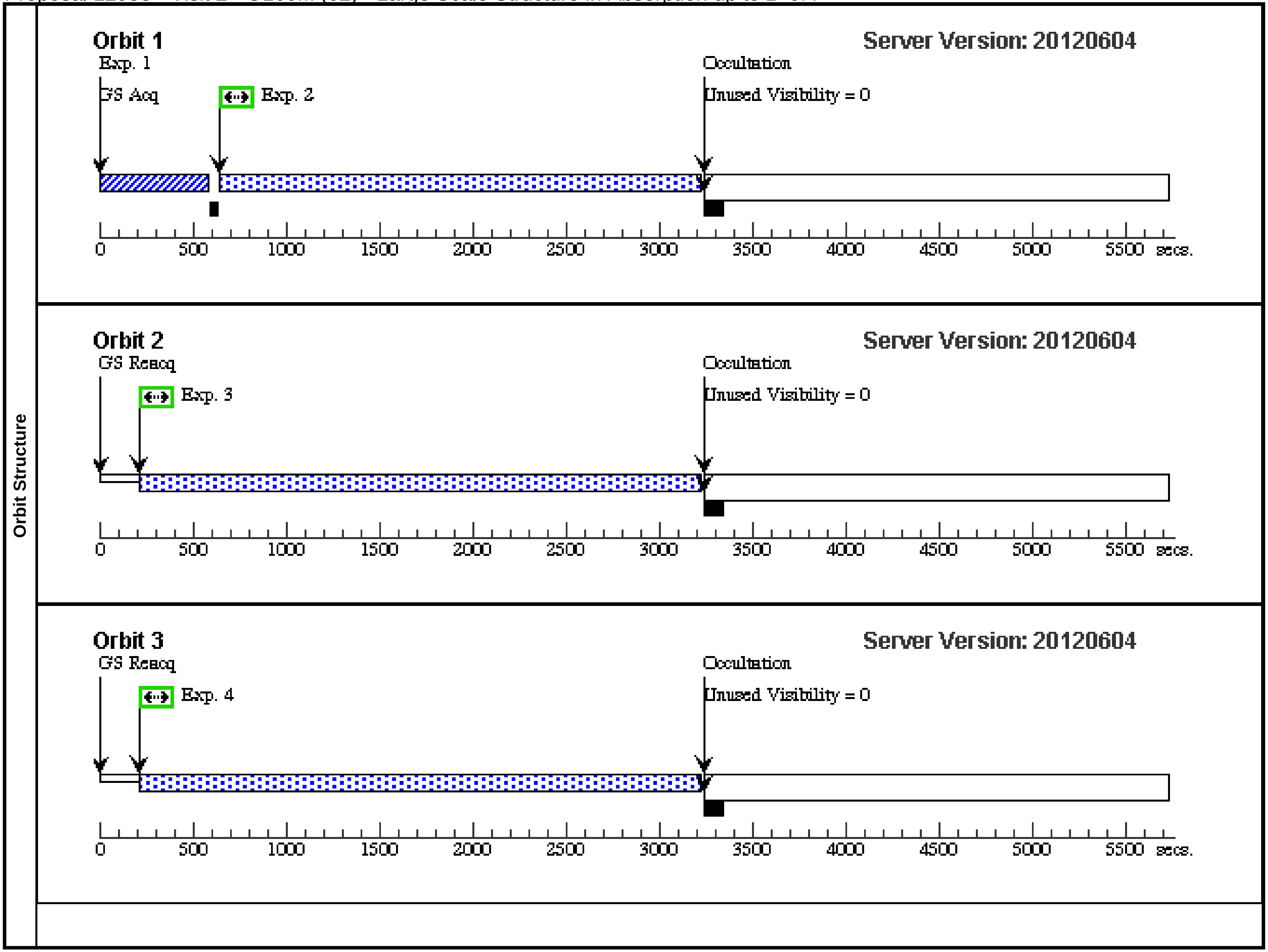
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSS-J141038.39+230447.1 Alt Name1: SDSS-J141038.39+230447.2	RA: 14 10 38.3960 (212.6599833d) Dec: +23 04 47.18 (23.07977d) Equinox: J2000	Redshift: 0.7958	V=16.9+/-0.02 r=17.0, g=16.9, NUV=17.4, FUV=18.7	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
The objects has not photometric information in the V band. The actual value corresponds to the SDSS g band which is close to the V filter.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	ACQ (COS.ta.408284)	(1) SDSS-J141038.39+230447.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				75 Secs *[==>]*	***[1]***
2	Science 1 (COS.sp.408287)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=1; BUFFER-TIME=2367; SEGMENT=BOTH			2400 Secs *[==>2367.0 Secs]*	***[1]***
3	Science 2 (COS.sp.408288)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=2; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[2]***
4	Science 3 (COS.sp.408288)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[3]***
5	Science 4 (COS.sp.408288)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[4]***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Exp. 1
GS Acq
Exp. 2
Occultation
Unused Visibility = 0
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Orbit 2
Server Version: 20120604
GS Reacq
Exp. 3
Occultation
Unused Visibility = 0
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 secs.
Orbit 3
Server Version: 20120604
GS Reacq
Exp. 4
Occultation
Unused Visibility = 0
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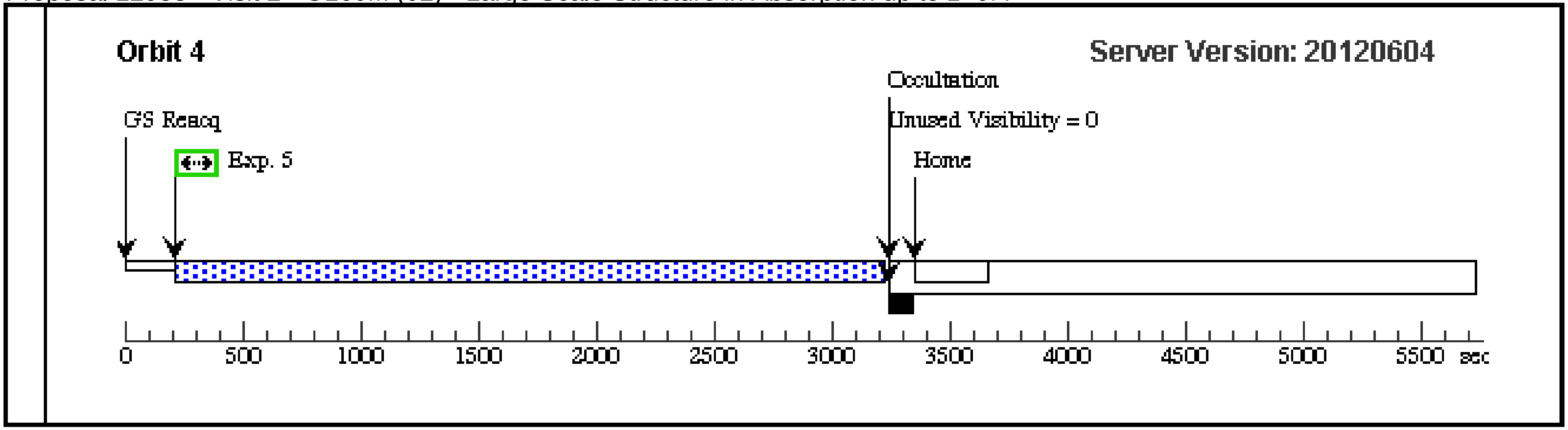
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Server Version: 20120604
Occultation
GS Reacq
Unused Visibility = 0
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sec

Visit

Proposal 12958, Visit 3 - G160M (03), implementation Fri Jul 06 01:31:52 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Comments: This visit corresponds to the visit 2/2 of the G160M grating exposure:
- 4 orbits in total.
- 1 science exposure per orbit.
- 4 FP-POS in total (1 per orbit), 1 central wavelenght (1611A)
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Diagnostics

(Visit 3 - G160M (03)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

Fixed Targets

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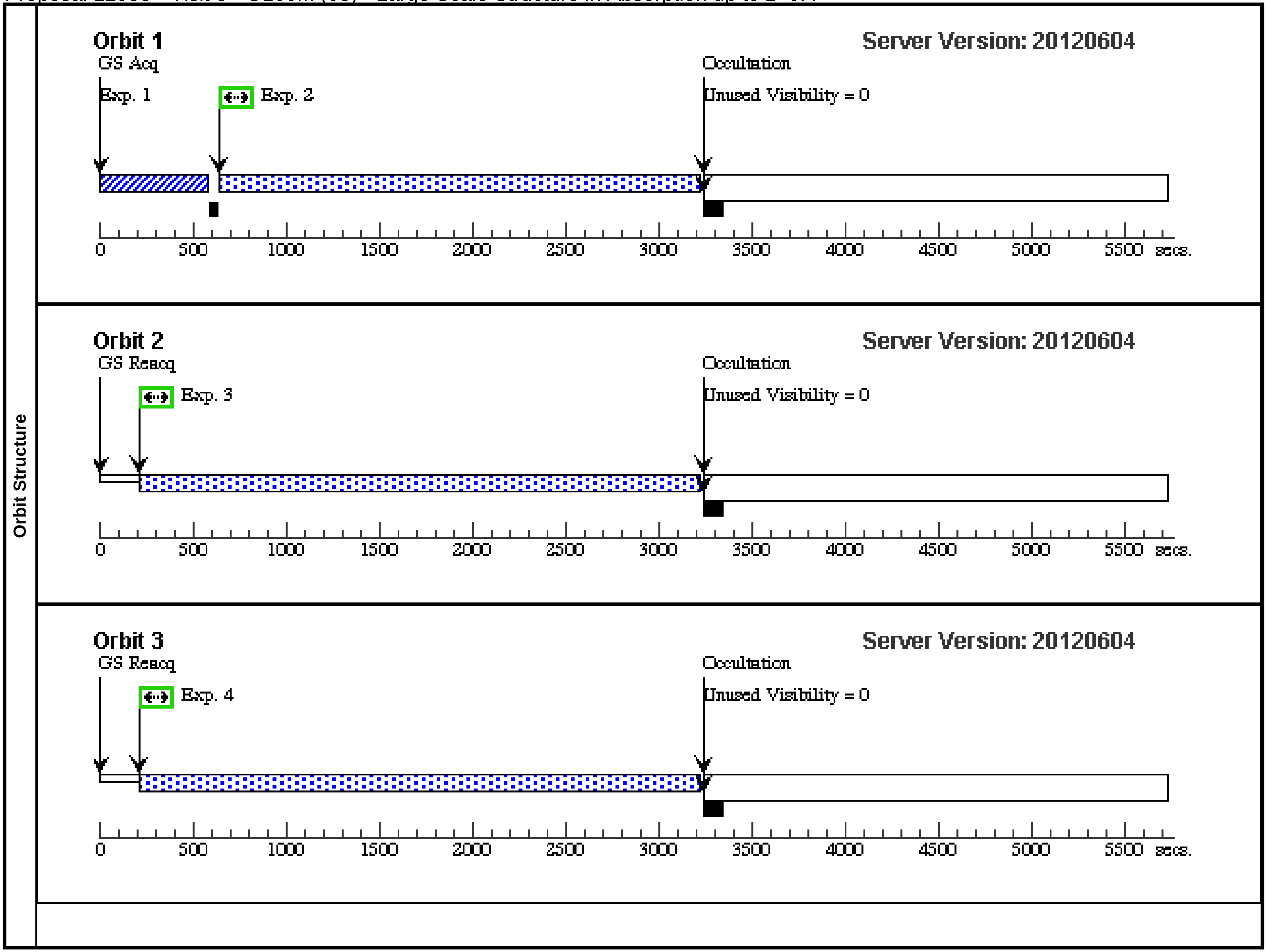
4	Science 3 (COS.sp.408288)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[3]***
5	Science 4 (COS.sp.408288)	(1) SDSS-J141038.39+230447.1	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=2958; SEGMENT=BOTH			3000 Secs *[==>2958.0 Secs]*	***[4]***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Exp. 1
Exp. 2
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Server Version: 20120604
GS Reacq
Exp. 3
Occultation
Unused Visibility = 0
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 secs.
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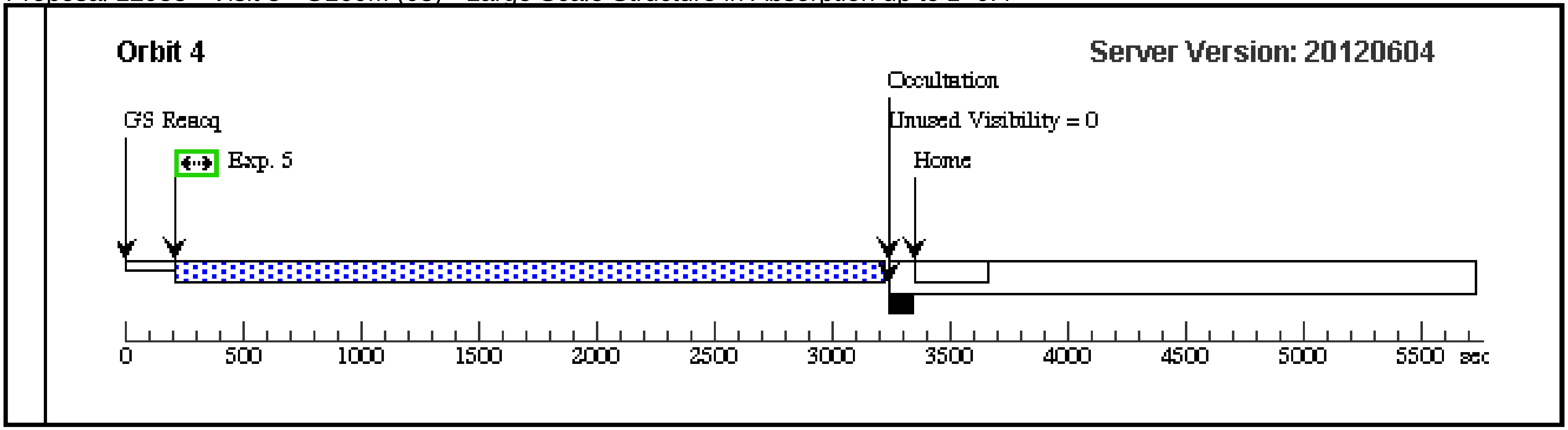
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Occultation
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