



13016 - The Nature of Partial Covering in Broad Absorption Line Quasars

Cycle: 20, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) SDSS-J085053.12+445122.5	COS/NUV	5	11-Jul-2012 01:18:33.0	yes
02	(2) SDSS-J142927.28+523849.5	COS/NUV	5	11-Jul-2012 01:18:50.0	yes
03	(2) SDSS-J142927.28+523849.5	COS/NUV	5	11-Jul-2012 01:19:05.0	yes

15 Total Orbits Used

ABSTRACT

Ejected gas is seen as broad absorption lines in ~20% of quasars. It has been known for ~15 years that prominent lines such as CIV are usually saturated but not black because the absorbing gas only partially covers the continuum emission region. Therefore, column densities estimated from these lines are only lower limits. Accurate column densities can be obtained from rare ions that have two or more transitions from the same lower level, so that the optical depth and covering fraction can be solved for simultaneously. Suitable lines are hard to find, so such measurements are rare. We have found that metastable helium is particularly useful for these measurements. Yet despite these advances, partial covering remains a just a

parameter and its physical nature is not understood.

We propose a unique experiment to constrain the physical nature of partial covering. We will compare the covering fraction measured from PV (a doublet in the far UV) with that measured from metastable HeI (optical and IR). The ions creating these lines are relatively rare, and they present similar opacity over a wide range of gas parameters. But due to their wide wavelength separation, these lines probe dramatically different regions of the continuum source, the temperature-dependent accretion disk. So we expect different covering fraction behavior for different partial covering scenarios. This experiment is relevant for understanding the geometry and clumpiness of the outflow, and the results may impact our understanding of the global covering fraction, a parameter critical for determining the outflow kinetic luminosity, and thereby estimating feedback efficiency for broad absorption line outflows.

OBSERVING DESCRIPTION

We were awarded observations of two HeI* BALQSOs using HST COS with the G230 grating. Two central wavelengths (2950 and 3360) will be used for each object. The properties and plan for each object will be described sequentially below.

We note that we will be applying for LBT observations of both objects starting with the 2012B opportunity. The ground-based observations are intended to be contemporaneous rather than simultaneous; nevertheless, we will keep STScI informed on our progress in obtaining the time and executing the observations.

SCIENCE SUMMARY AND STRATEGY

The UV and FUV rest-wavelength spectra of BALQSOs are full of absorption lines. Our science involves a comparison of the HeI* broad absorption lines (BALs) observed in the optical and IR with the BALs from other lines in the UV. The absorption line that we are

principally interested in its PV, which falls at ~ 1121 Angstroms rest frame, but approximately at 1760 Angstroms for these $z \sim 0.57$ objects. The maximum velocity of the outflow may be up to ~ 7000 km/s, thus stretching the feature down to ~ 1720 Angstroms. This is best observed in Segment A with CENWAVE=2950. So we allocate the larger fraction of our time to observations using that central wavelength. These observations are long enough that we are able to cover all four FP-POS. We are also interested in other absorption lines including CIV and SIV, which fall in Segment A with CENWAVE=3360. The shorter observations don't permit efficient use of all 4 FP-POS, and in the case of our higher redshift object SDSS-J142927.28+523849.5, CIV is not visible for FP-POS=3 or 4.

The objects are faint enough to be observed in TIME-TAG mode, and we will use FLASH=YES as recommended in the COS IHB section 5.2.1.

SDSS J085053.12+445122.5

Properties:

This HeI* BALQSO has a redshift of 0.5422. Based on the SDSS photometry, we estimate that $V=17.4$ and $B=17.7$. We estimate ~ 0.5 mag uncertainty due to quasar variability. SDSS 0850+4451 was observed four times by GALEX. The flux density inferred from the GALEX UV results ranged from $9.1e-16$ to $1.06e-15$ erg/s/cm²/Å. We use the mean $9.8e-16$ erg/s/cm²/Å for simulations. We plan to observe this object using 5 of our 15 orbits.

Acquisition:

The target is in the GSC2 and therefore it has ICRS coordinates. The positional uncertainties are 0.387 and 0.369 arc seconds. Those values are less than the limit of 0.4 arc seconds, so we can do a simple imaging acquisition.

The mean GALEX NUV flux density among four observations is 9.8×10^{-16} erg/s/cm²/Å. The GALEX NUV filter response is fairly similar to the COS NUV+Mirror A filter response. In principle, a target of this flux density should be able to be acquired using PSA+Mirror A. However, quasars vary, and so it is conceivable that the flux density may be half this value (5×10^{-16}) or twice this value (2×10^{-15}). If twice the observed flux, the object would be too bright to acquire using PSA+Mirror A. So, to be conservative, we choose COS NUV PSA+Mirror B and assume a low flux density of 5.0×10^{-16} erg/s/cm²/Å. In that case, we obtain, for SNR=40, an exposure time of 320s (COS.ta.415851).

Science Exposures:

We allocate the remainder of the first orbit and 3 more orbits (of 5 total for this target) for the observation with CENWAVE=2950. We use FP-POS=1 through 4 sequentially. All lines of interest should be visible in all four FP-POS. The first orbit allows 2071s of science exposure, and subsequent orbits allow 3084s. According to the ETC, the buffer time for these exposure times, assuming a flat spectrum and mean flux density, is 2439s (COS.sp.414030, COS.sp.414032). To account for variability, we multiply this value by 0.5, and again by

2/3 (as recommended), yielding a buffer time of 813s. The final orbit is allocated to observing the object using CENWAVE=3360. This setting has a nearly flat response curve, so in principle we could observe at any FP-POS. However, depending on the maximum velocity of the outflow, SiIV may not be completely observed for FP-POS=1. So we observe at FP-POS=2 and FP-POS=3, and split the orbit between these two FP-POS. The exposures are 1474s. The COS ETC gives a buffer time of 2,428s (COS.sp.414258) and so we again used $0.5 \times (2/3)$ of that value, which is 809 seconds for these final two exposures.

SDSS J142927.28+523849.5

Properties:

This HeI* BALQSO has a redshift of 0.5839. Based on the SDSS photometry, we estimate that $V=17.5$ and $B=17.7$. We estimate ~ 0.5 mag uncertainty due to quasar variability. SDSS 1429+5238 was observed twice by GALEX. The flux density inferred from the GALEX NUV results ranged from $4.6e-16$ to $5.0e-15$ erg/s/cm²/Å. We use the mean $4.8e-16$ erg/s/cm²/Å for simulations.

Acquisition:

The target is in the GSC2 and therefore it has ICRS coordinates. The positional uncertainties are 0.375 and 0.406 arc seconds. The DEC uncertainty exceeds the limit of 0.4 arc seconds, so we must do an ACQ/SEARCH with SCAN-SIZE=2, and CENTER=FLUX-WT (COS IHB Table 8.2).

Because the positional uncertainty is on the lower edge of the range given in Table 8.2, we use a STEP-SIZE=1.5.

The mean GALEX NUV flux among two observations is $4.8e-16$ erg/s/cm²/Å. So it is safely faint enough to use the COS NUV+Mirror A. The GALEX NUV filter response is fairly similar to the COS NUV+Mirror A filter response. We assume a flat spectrum, and to account for variability, assume a flux of $2.4e-16$ erg/s/cm²/Å (i.e., 50% decrease in flux). That yields an exposure of 32.7 seconds required to obtain a S/N=40 (COS.ta.414268). We increase that to 50 seconds. We then perform an ACQ/IMAGE with the same exposure time.

Science Exposures:

We have 10 orbits total on this target using CENWAVE=2950 and CENWAVE=3360. This will require two visits of 5 orbits each. All FP-POS will cover the PV line for CENWAVE=2950. In addition, we will be able to observe SIV in this higher redshift object at FP-POS=3 and 4. For CENWAVE=3360, we only cover CIV for FP-POS 1 and 2. So, for the first visit, we allocate the remainder of the first orbit to CENWAVE=2950 FP-POS=1. Orbits 2,3,4 are devoted to the other three FP-POS. For the final orbit, we move to CENWAVE=3360 and observe in FP-POS=1. The second visit is identical to the first except that we will observe CENWAVE=3360 in FP-POS=2.

For CENWAVE=2950, the exposure times of 2343s (first orbit) and 3181s, and for the estimated flux density of $4.8e-16$ erg/s/cm²/Å and a flat spectrum, the required buffer time is 2483s (COS.sp.414587). To accommodate variability, we multiply this value by $0.5^{(2/3)} * 2483 = 828s$.

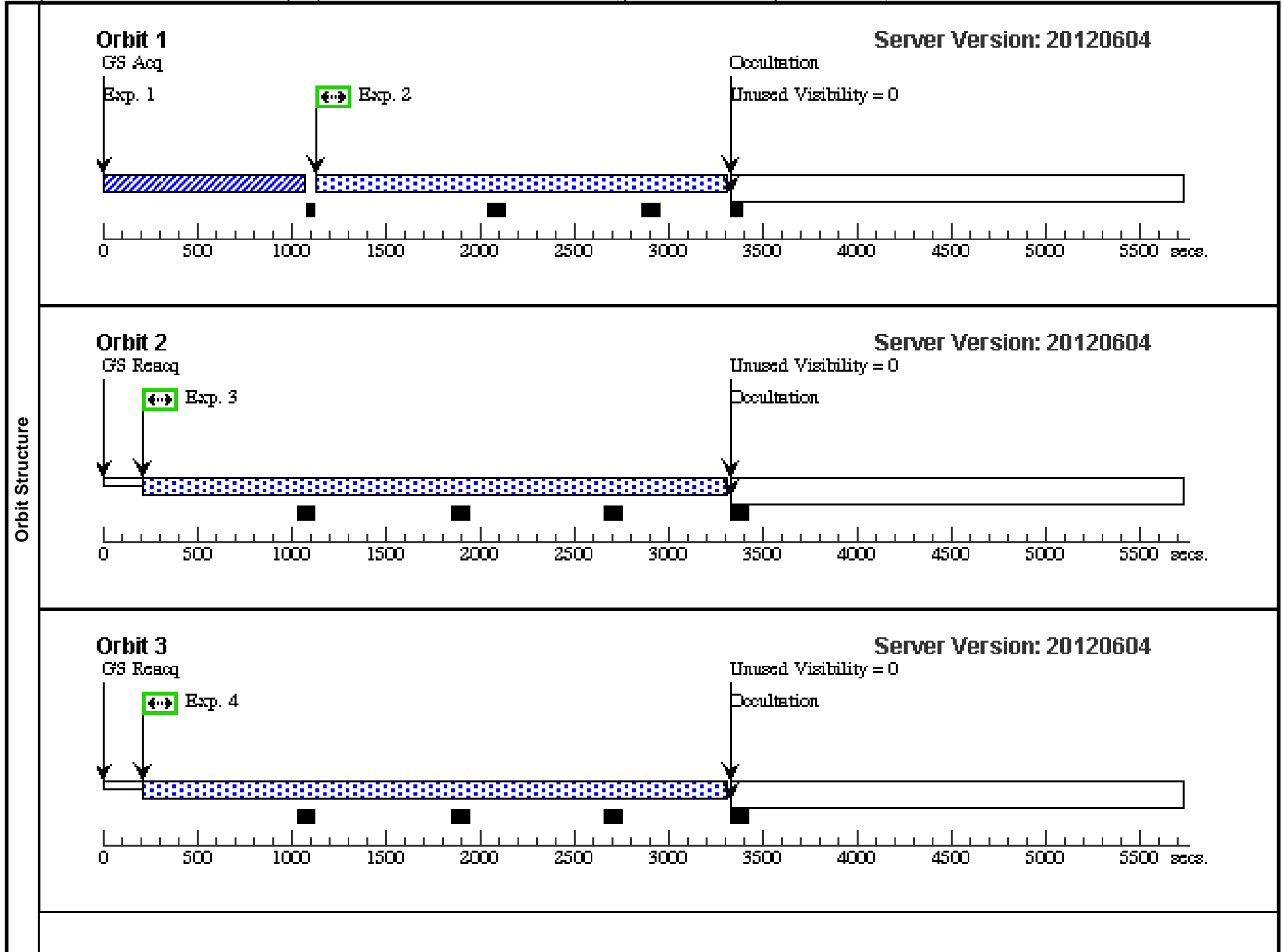
Proposal 13016 (STScI Edit Number: 0, Created: Wednesday, July 11, 2012 12:19:13 AM EST) - Overview

For CENWAVE=3360, the exposure times of 2343 and 3181s, and estimated flux density of $4e-16$ erg/s/cm²/Å and a flat spectrum, the required buffer time is 2477s (COS.sp.414589). As before, to accommodate variability, we multiply that value by $0.5^{2/3}$ yielding 826s.

Proposal 13016 - SDSS0850 (01) - The Nature of Partial Covering in Broad Absorption Line Quasars

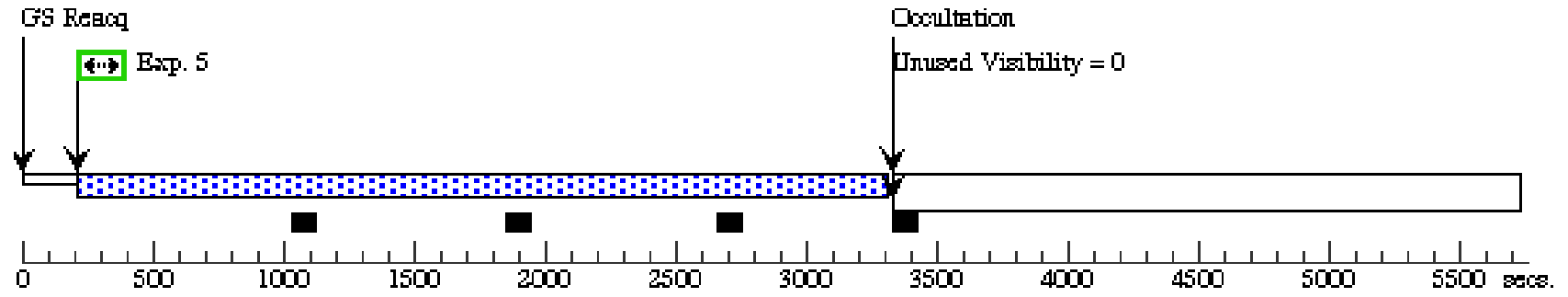
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Visit	Proposal 13016, SDSS0850 (01) Diagnostic Status: Warning Scientific Instruments: COS/NUV Special Requirements: (none)									
	Diagnostics	(SDSS0850 (01)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE. (SDSS0850 (01)) Warning (Form): For the best data quality, it is strongly recommended that all four FP-POS positions be used when observing at a given COS CENWAVE setting.								
Fixed Targets		#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	SDSS-J085053.12+445122.5	RA: 08 50 53.1079 (132.7212829d) Dec: +44 51 22.39 (44.85622d) Equinox: J2000	Redshift: 0.541441	V=17.4+/-0.5 B=17.7, Flambda(2267 Angstroms)=9.8e-16 erg/s/cm^2/A	Reference Frame: ICRS				
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	SDSS 0850 acquisition (COS.ta.415 851)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				320.0 Secs [==>]	[1]
	2	SDSS0850 2 950 FP-POS =1 (COS.sp.414 030)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=81 3; FLASH=YES; FP-POS=1			2071 Secs [==>]	[1]
	3	SDSS0850 2 950 FP-POS =2 (COS.sp.414 032)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=81 3; FLASH=YES; FP-POS=2			3084 Secs [==>]	[2]
	4	SDSS0850 2 950 FP-POS =3 (COS.sp.414 032)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=81 3; FLASH=YES; FP-POS=3			3084 Secs [==>]	[3]
	5	SDSS0850 2 950 FP-POS =4 (COS.sp.414 032)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=81 3; FLASH=YES; FP-POS=4			3084 Secs [==>]	[4]
	6	SDSS0850 3 360 FP-POS =2 (COS.sp.414 258)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=80 9; FLASH=YES; FP-POS=2			1475 Secs [==>]	[5]
	7	SDSS0850 3 360 FP-POS =3 (COS.sp.414 258)	(1) SDSS-J085053.1 2+445122.5	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=80 9; FLASH=YES; FP-POS=3			1474 Secs [==>]	[5]



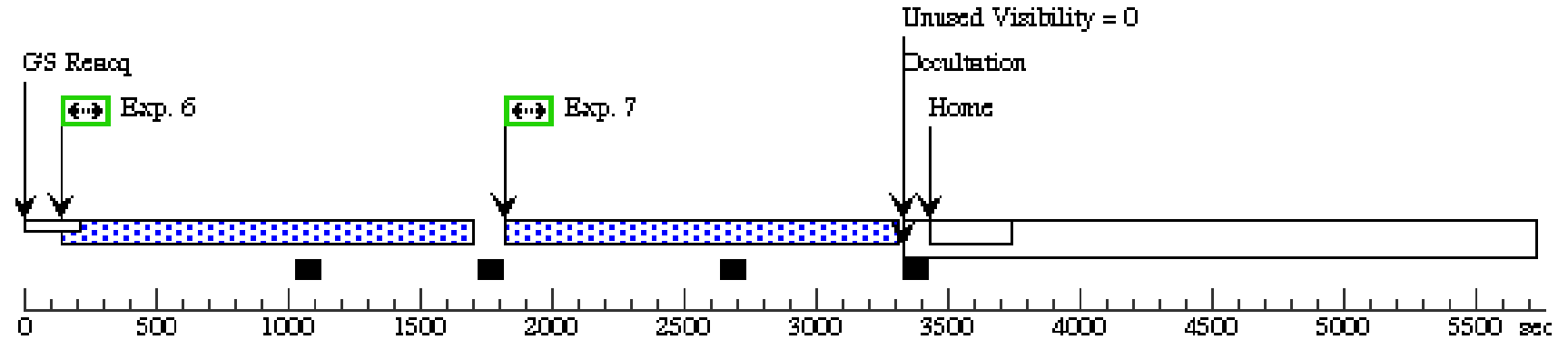
Orbit 4

Server Version: 20120604



Orbit 5

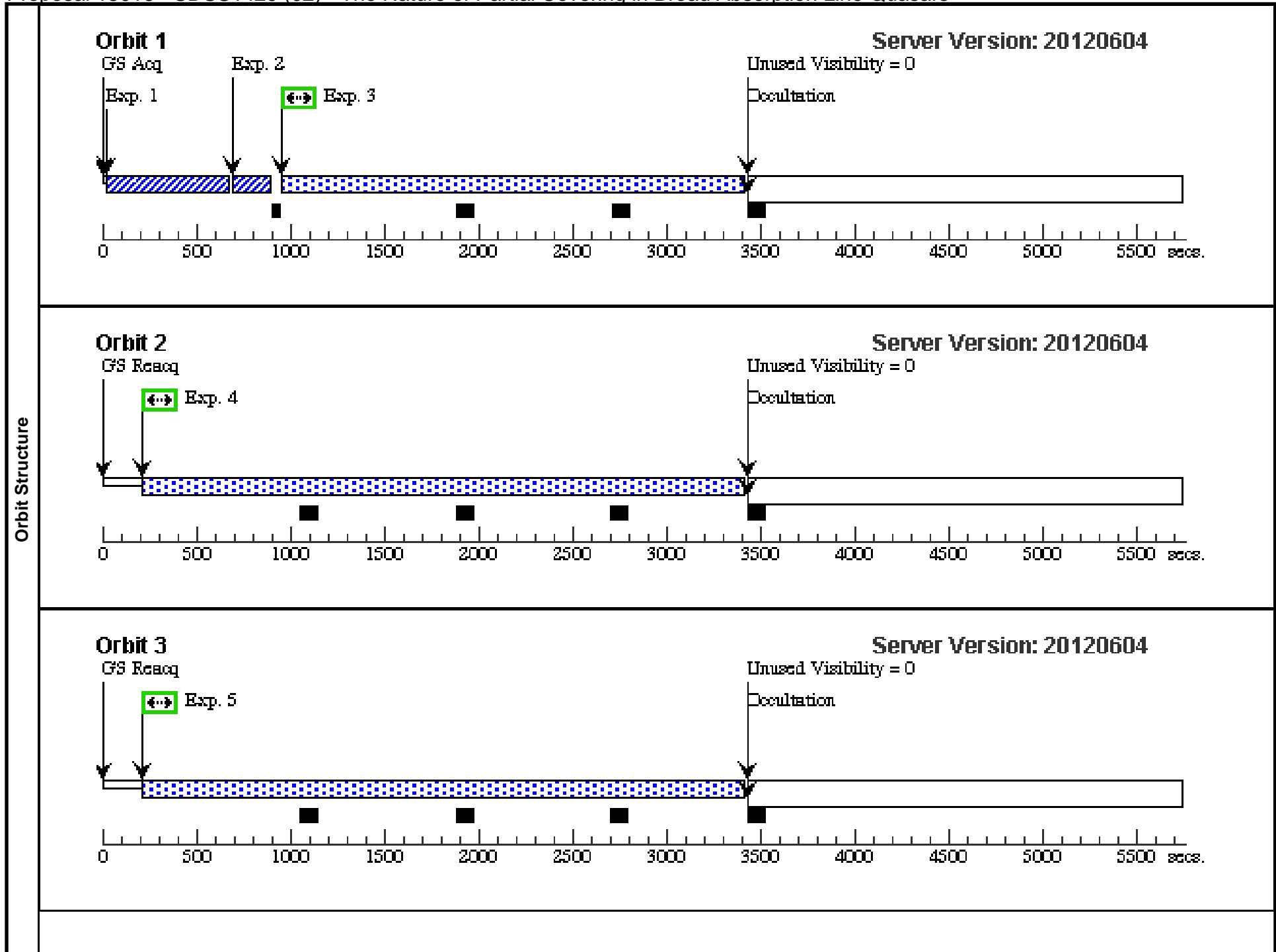
Server Version: 20120604

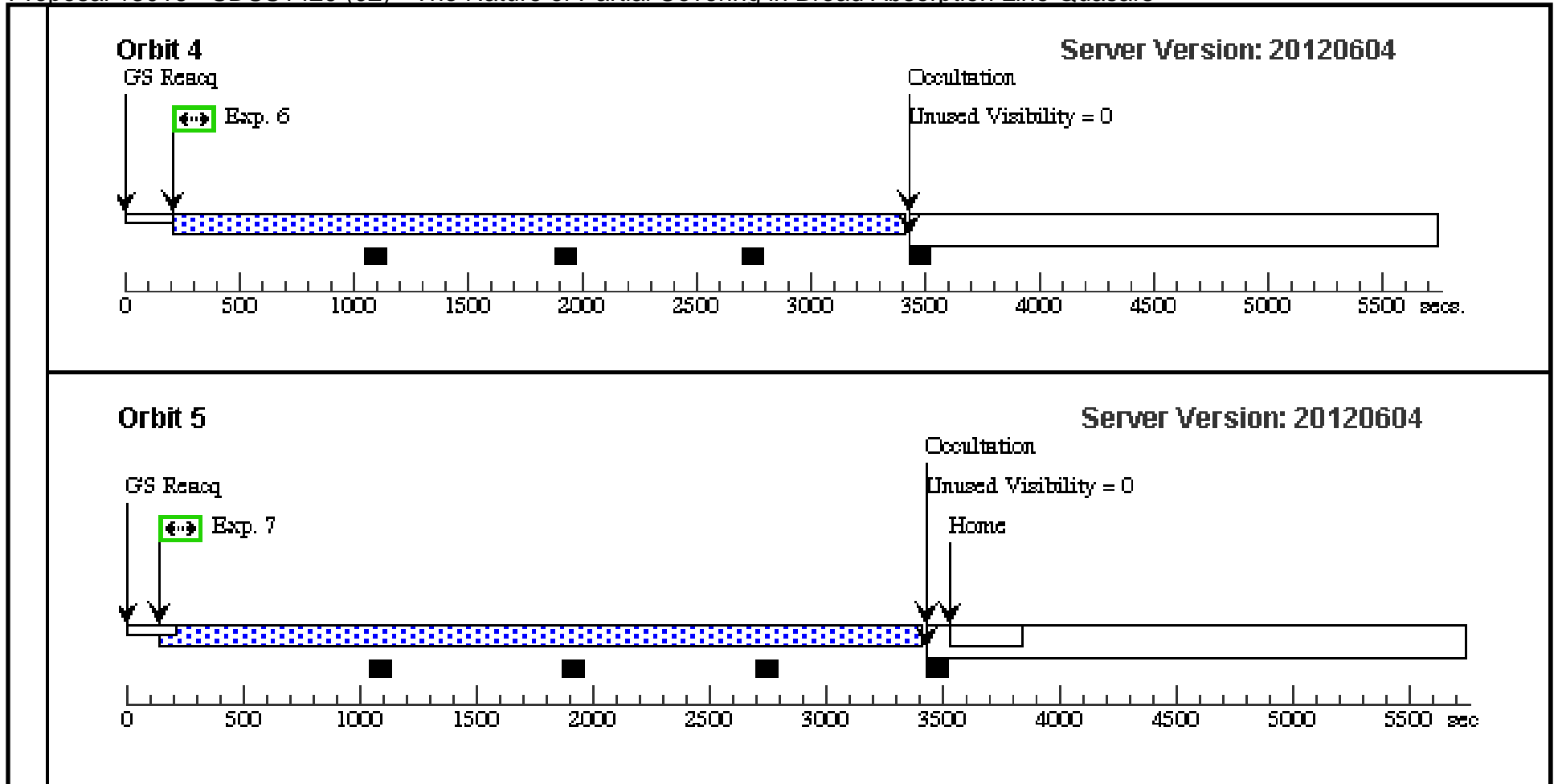


Proposal 13016 - SDSS1429 (02) - The Nature of Partial Covering in Broad Absorption Line Quasars

Wed Jul 11 05:19:21 GMT 2012

Visit	Proposal 13016, SDSS1429 (02) Diagnostic Status: Warning Scientific Instruments: COS/NUV Special Requirements: (none)									
	(SDSS1429 (02)) Warning (Form): For the best data quality, it is strongly recommended that all four FP-POS positions be used when observing at a given COS CENWAVE setting.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(2)	SDSS-J142927.28+523849.5	RA: 14 29 27.2974 (217.3637392d) Dec: +52 38 49.40 (52.64706d) Equinox: J2000	Redshift: 0.593691	V=17.5+/-0.5 B=17.7, F_lambda(2267 Angstroms)=4.8 e-16 erg/s/cm^2/A	Reference Frame: ICRS				
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	SDSS1429 ACQ/SEAR CH (COS.ta.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, ACQ/SEARCH, PSA	MIRRORA	SCAN-SIZE=2; STEP-SIZE=1.5; CENTER=FLUX-W T			50 Secs [==>]	[1]
	2	SDSS1429 ACQ/IMAG E (COS.ta.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				50 Secs [==>]	[1]
	3	SDSS1429 950 FP-POS =1 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8;	FLASH=YES; FP-POS=1		2343 Secs [==>]	[1]
	4	SDSS1429 950 FP-POS =2 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8;	FLASH=YES; FP-POS=2		3181 Secs [==>]	[2]
	5	SDSS1429 950 FP-POS =3 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8;	FLASH=YES; FP-POS=3		3181 Secs [==>]	[3]
	6	SDSS1429 950 FP-POS =4 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8;	FLASH=YES; FP-POS=4		3181 Secs [==>]	[4]
	7	SDSS1429 360 FP-POS =1 (COS.ta.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=82 6;	FLASH=YES; FP-POS=1		3181 Secs [==>]	[5]

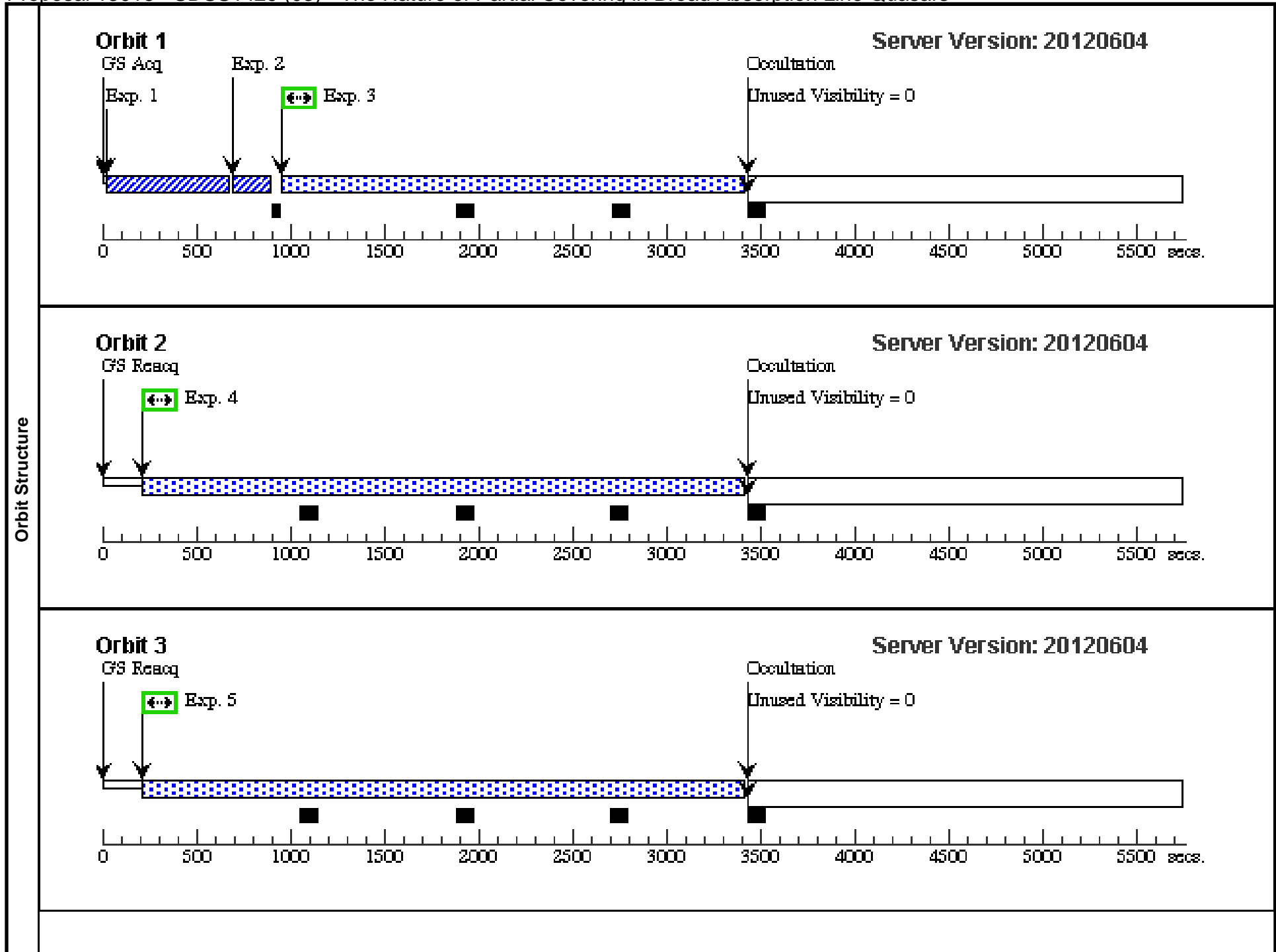




Proposal 13016 - SDSS1429 (03) - The Nature of Partial Covering in Broad Absorption Line Quasars

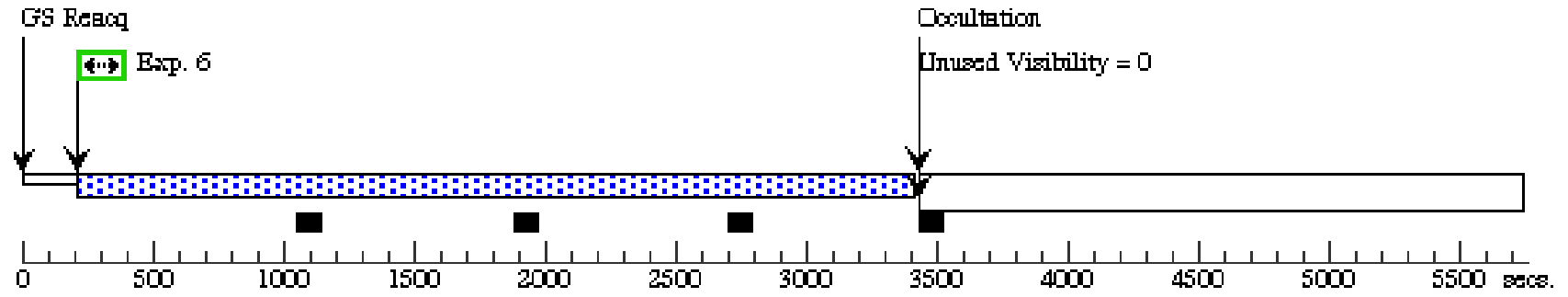
Wed Jul 11 05:19:25 GMT 2012

Visit	Proposal 13016, SDSS1429 (03) Diagnostic Status: Warning Scientific Instruments: COS/NUV Special Requirements: (none)									
	(SDSS1429 (03)) Warning (Form): For the best data quality, it is strongly recommended that all four FP-POS positions be used when observing at a given COS CENWAVE setting.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(2)	SDSS-J142927.28+523849.5	RA: 14 29 27.2974 (217.3637392d) Dec: +52 38 49.40 (52.64706d) Equinox: J2000	Redshift: 0.593691	V=17.5+/-0.5 B=17.7, F_lambda(2267 Angstroms)=4.8 e-16 erg/s/cm^2/A	Reference Frame: ICRS				
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	SDSS1429 ACQ/SEAR CH (COS.ta.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, ACQ/SEARCH, PSA	MIRRORA	CENTER=FLUX-W T; SCAN-SIZE=2; STEP-SIZE=1.5			50 Secs [==>]	[1]
	2	SDSS1429 ACQ/IMAG E (COS.ta.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				50 Secs [==>]	[1]
	3	SDSS1429 950 FP-POS =1 (COS.sp.414 590)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8; FLASH=YES; FP-POS=1			2343 Secs [==>]	[1]
	4	SDSS1429 950 FP-POS =2 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8; FLASH=YES; FP-POS=2			3181 Secs [==>]	[2]
	5	SDSS1429 950 FP-POS =3 (COS.sp.414 589)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8; FLASH=YES; FP-POS=3			3181 Secs [==>]	[3]
	6	SDSS1429 950 FP-POS =4 (COS.sp.414 587)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=82 8; FLASH=YES; FP-POS=4			3181 Secs [==>]	[4]
	7	SDSS1429 360 FP-POS =2 (COS.sp.414 268)	(2) SDSS-J142927.2 8+523849.5	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=82 6; FLASH=YES; FP-POS=2			3181 Secs [==>]	[5]



Orbit 4

Server Version: 20120604



Orbit 5

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