14799 - Why the Different Looks of Changing-Look Quasars?

Cycle: 24, 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	(1) 2MASS-J10115298+5442063	COS/FUV COS/NUV	5	04-Jan-2017 21:03:17.0	yes
02	(2) 2MASS-J10215235+4645158	COS/FUV COS/NUV	3	04-Jan-2017 21:03:18.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(3) GALEX-J233603.04+0017	COS/FUV COS/NUV	5	04-Jan-2017 21:03:20.0	yes

13 Total Orbits Used

ABSTRACT

We propose to take UV spectra of three representative changing-look quasars that we recently discovered. The parent sample of 12 changing-look quasars comprises the first luminous examples of a newly-appreciated phenomenon and represents the tip of the iceberg. Their defining characteristic is a sharp decline in the broad emission lines and non-stellar continuum by an order of magnitude or more over a time-scale of a decade or less. They may represent the obscuration of the central engine or an abrupt dimming of the accretion-powered light of the quasar. We thus aim to definitively discriminate between these two possibilities with a straightforward UV spectroscopic test. Determining the cause of the "off" state can point to thermal or other instabilities in the black hole accretion flow and will also have implications for the ionization structure that quasars impart on the intergalactic medium. We also wish to exploit this unique opportunity to isolate the narrow UV emission lines, use their response to the decaying continuum to probe the structure of the interface between the broad- and narrow-line region, and find how their profiles introduce uncertainties in empirical schemes for determining black home masses.

OBSERVING DESCRIPTION

1. TARGET PROPERTIES

Our three targets have redshifts in a fairly narrow range, between 0.204 and 0.246. Their galactic E(B-V) values are between 0.009--0.026 and the resulting attenuation at Lya is a few percent.

We obtained the target coordinates from the SDSS DR9 SkyServer. These coordinates are in the ICRS coordinate system. We computed astrometric errors for each target following the prescription described in the SDSS DR9 web pages. In summary we combined in quadrature the uncertainties in the astrometric solution of each plate with the uncertainties in the centroid of each object. The final uncertainties are listed in the target forms; they are 0.06 arcsec or less for all of our targets.

The proposed targets are the declining changing-look quasars with the highest [O III] 5007 line luminosities and their broad Ha lines in their dim states are bright enough that the implied strengths of the broad UV lines are unambiguously detectable with the proposed exposure times. It is also important to note that these three quasars are representative of changing look quasars as a class. Their Eddington ratios span a factor of 30, 0.005-0.2, while their Ha decay factors, as measured by the ratio of the line fluxes between the bright and dim states, range from 2 to 36. This is the smallest set of objects we can observe and still sample the full range of properties of known changing-look quasars.

We note that all our targets have been observed by GALEX and we give the GALEX magnitudes in the target forms (they range between 18.8 and 21.9). However, the GALEX observations were made when the objects were in the bright state, therefore we expect the UV magnitudes to be considerably fainter now. As we note below, we use the UV spectrum of the Seyfret 2 galaxy NGC1068, available in the ETC, as a template for our target spectra in all exposure time calculations.

2. CHOICE OF INSTRUMENT, EXPOSURE TIME ESTIMATES, AND VISIT STRICTURE

To achieve our goals, we wish to observe the strong UV lines, Lya 1216, N V 1240, C IV 1550, He II 1640, and C III] 1909 in the spectra of our targets. To cover the Lya and N V lines, we choose COS+G140L since this instrument setting is far more sensitive than STIS+G140L. All the other lines of interest fall at wavelengths longer than 1860 Angstrom so, we chose COS+G230L (with two central wavelength settings per object), which will save us one orbit per object compared to STIS+G230L in the end. Of course, we will have to bin the COS+G230L spectra into bins of width 450 km/s.

Our primary goals are to measure the relative strengths of the narrow UV emission lines and to search for broad components on these emission lines, especially Lya. In order to estimate the required exposure times we adopted the relative strengths of narrow UV emission lines measured for type 2 Seyfert galaxies and quasars and related them to the narrow optical emission lines that we have measured from our own spectra. Typical narrow UV line ratios are C III] / C IV ~ 0.4-0.7, Lya / C IV ~ 3.0-3.5, and He II / C IV ~ 0.4-0.6 (e.g., Nagao et al. 2006 A&A, 447, 863; Hainline et al. 2011, ApJ, 733, 31). These can be related to the optical narrow lines through C IV / [O III] ~ 1.2 (e.g., Greene et al. 2014, ApJ, 788, 91). In practice, the spectrum of the Seyfert 2 galaxy NGC 1068, available in the spectroscopic ETCs, has line ratios on the lower (conservative) end of the above ranges, therefore we adopted it as a template, normalized it according to the [O III] flux we measure from our spectra, and added broad lines of varying strengths. This way we got a conservative estimate of the expected line strengths.

We estimated the COS+G230L exposure times in order to detect the C IV, He II, and C III] lines at a high enough significance to determine the ratio of the C IV line to the other two lines. We find that we can detect these three lines at a significance of at least 8-sigma, 4.4-sigma, and 4.8-sigma, respectively (after binning to 450 km/s bins) in 2700-5000 seconds. This amounts to 1--2 orbits per object per wavelength setting considering the orbital visibility (56-58 minutes) as well as acquisition and other overheads.

Similarly, we estimated the COS+G140L exposure times so that we could detect the broad Lya lines in the pessimistic scenario where Lya/Ha=3 (typically this ratio is greater than 3 and close to 5; Kuraszkiewicz et al. 2002, ApJS, 143, 257; Tang et al. 2012, ApJS, 201, 38). We find that for our object with the faintest broad Ha line, we can detect a broad Lya line at 3.4-sigma (after binning to 160 km/s bins) in an exposure time of 2400 seconds. In the same exposure, the narrow Lya line is detected at 17-sigma after binning. Thus, we can obtain the required exposure time in one orbit even for our faintest object.

Since our targets have precise coordinates, we can reduce the acquisition overhead by using the ACQ/IMAGE procedure with MIRRORA. To calculate the acquisition exposure times we, again, use the spectrum of NGC 1068 and normalize it according to the observed strength of the [O III] 5007 emission line. Thus most of the flux in the UV that determines the exposure times comes from the emission lines. The resulting acquisition exposure times are 1075, 120, and 617 seconds, respectively, for the targets in order of increasing R.A. As a consequence of the long acquisition exposure time for the first target, J1011, the acquisition takes approximately 60% of the time in the initial orbit.

Of course, there are uncertainties in our estimate arising from two factors: (a) we do not know in practice if the lines will decay and by how much, and (b) there is some spread in the relative strengths of narrow lines in type 2 quasars, which was the basis for our UV line strength estimates but we tried to err on the side of caution and assumed conservative values of the line strengths.

Our final request is for 13 orbits: five orbits for J1011, three orbits for J1021, and five orbits for J2336. orbits. The program is structured so that each of our targets is observed in a single visit. For all targets the first orbit begins with acquisition using the NUV detector and MIRRORA, followed by exposures with NUV+G230L, which minimizes the overhead of switching detectors and spectral elements. Since the S/N we expect is not so hight that fixed-pattern noise is an issue, we use only FP_POS=1 for the NUV+G230L exposures to reduce the overheads somewhat. The last orbit for all targets is used for an exposure with FUV+G140L with FP_POS=ALL, as advised in the COS instrument handbook.

We realize that the two targets with 5-orbit visits may be scheduled late in the cycle. This does not create any scientific problems with our program. Should it become impossible to schedule the 5-orbit visits, these can be broken up into 2+3 orbit visits by splitting off the NUV+G230L(3000) exposures (first 2 orbits) into a separate visit. We are prepared to do that, if it becomes necessary. However, we prefer the 5-orbit visits since these reduce the target acquisition overheads, especially for the first target, J1011, which is also the faintest.

Visit

Proposal 14799, J1011 (01), implementation Thu Jan 05 02:03:21 GMT 2017

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(J1011 (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

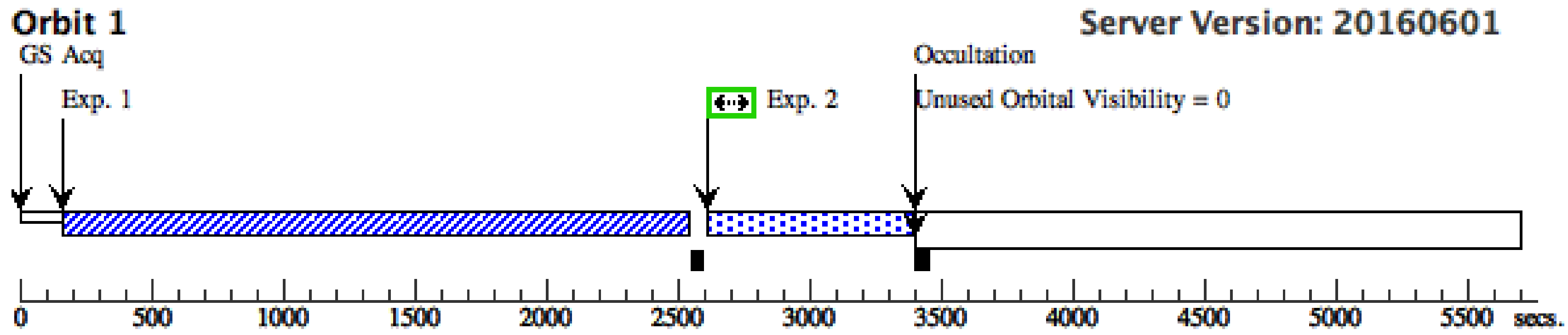
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J10115298+5442063 Alt Name1: SDSS-J101152.97+544206.4	RA: 10 11 52.9800 (152.9707500d) Dec: +54 42 6.42 (54.70178d) Equinox: J2000	Redshift: 0.246	V=18.31 GALEX FUV_mag=18.91 +/- 0.11, NUV_mag=18.98 +/- 0.08	Reference Frame: ICRS

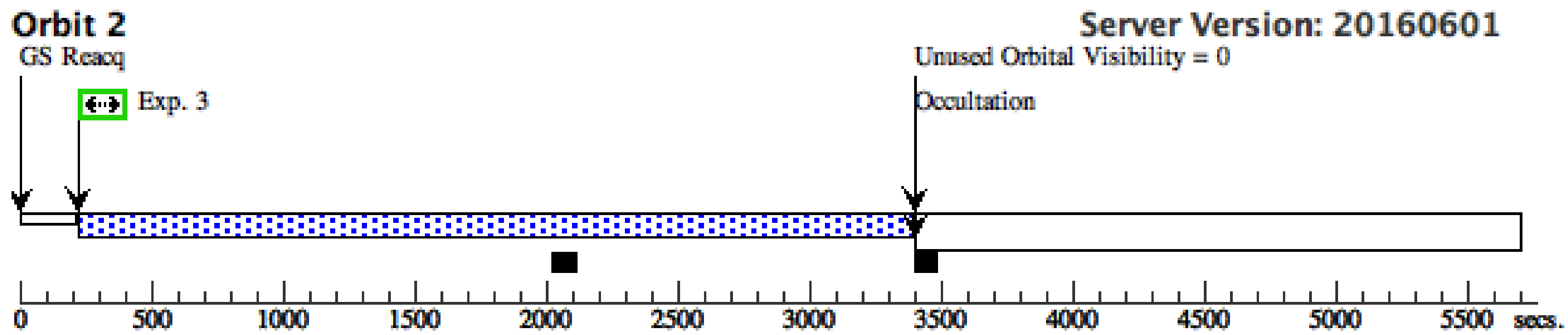
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. The coordinates were updated in phase 2 to those of the SDSS DR9 (ICRS), with uncertainties as given above. The GALEX observations were made when the object was in a bright state, therefore we expect the UV magnitudes to be fainter now.
Extended=NO

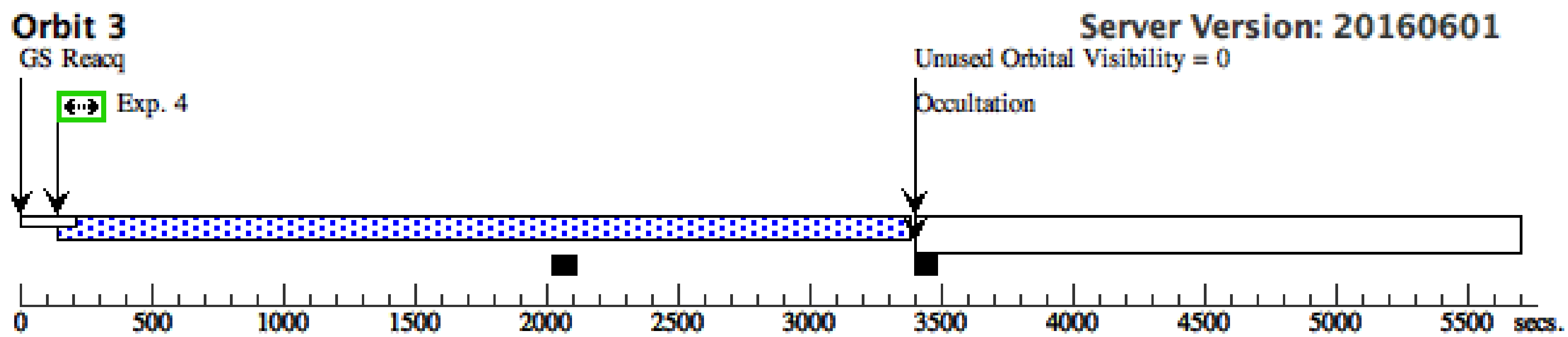
Exposures

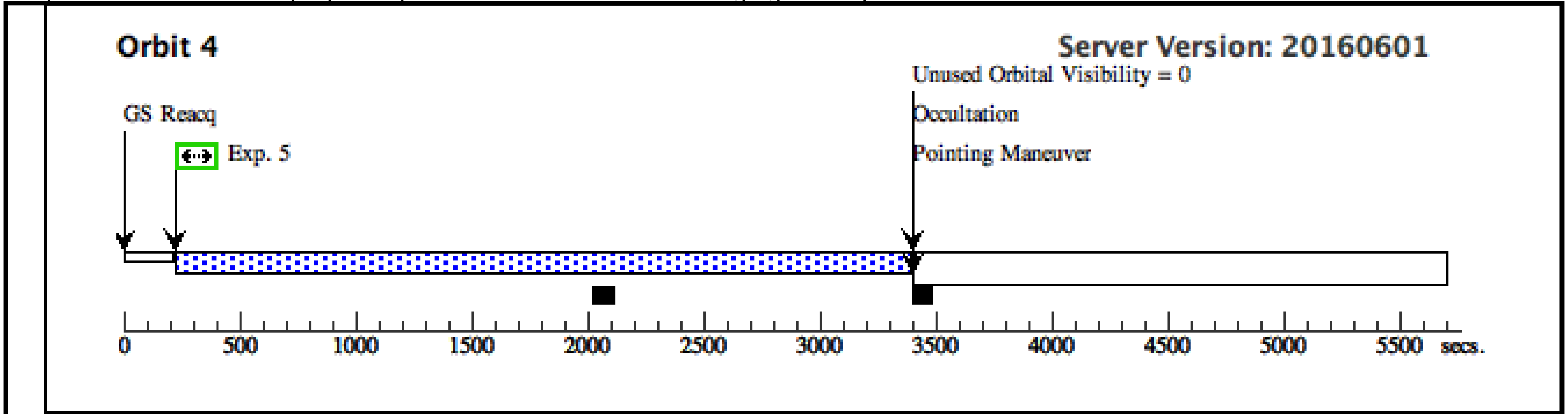
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq (COS.ta.825980)	(1) 2MASS-J10115298+5442063	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				1075 Secs (1075 Secs) *[==>]*	*[1]*
2	G230L-3000-1 (COS.sp.826603)	(1) 2MASS-J10115298+5442063	COS/NUV, TIME-TAG, PSA	G230L 3000 A	BUFFER-TIME=1806; FLASH=YES; FP-POS=1			200 Secs (663 Secs) *[==>663.0 Secs]*	*[1]*
3	G230L-3000-2 (COS.sp.826603)	(1) 2MASS-J10115298+5442063	COS/NUV, TIME-TAG, PSA	G230L 3000 A	BUFFER-TIME=1806; FLASH=YES; FP-POS=1			2500 Secs (3154 Secs) *[==>3154.0 Secs]*	*[2]*
4	G230L-3360-1 (COS.sp.826605)	(1) 2MASS-J10115298+5442063	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=1806; FLASH=YES; FP-POS=1			2500 Secs (3154 Secs) *[==>3154.0 Secs]*	*[3]*
5	G230L-3360-2 (COS.sp.826605)	(1) 2MASS-J10115298+5442063	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=1806; FLASH=YES; FP-POS=1			2500 Secs (3154 Secs) *[==>3154.0 Secs]*	*[4]*
6	G140L-1280 (COS.sp.826601)	(1) 2MASS-J10115298+5442063	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=15509; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			600 Secs (2768 Secs) *[==>692.0 Secs (Split 1)]* *[==>692.0 Secs (Split 2)]* *[==>692.0 Secs (Split 3)]* *[==>692.0 Secs (Split 4)]*	*[5]*

Orbit Structure





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Occultation
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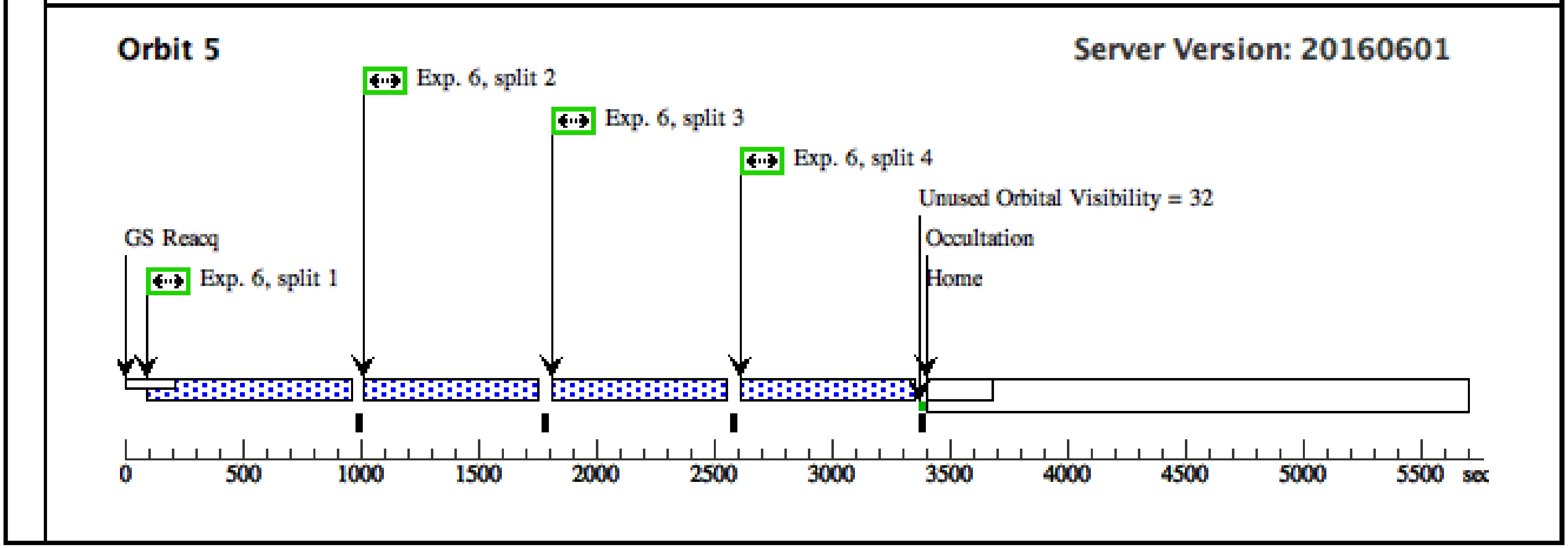
secs.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Exp. 6, split 3
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Occultation
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Home
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500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14799, J1021 (02), implementation Thu Jan 05 02:03:21 GMT 2017

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(J1021 (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

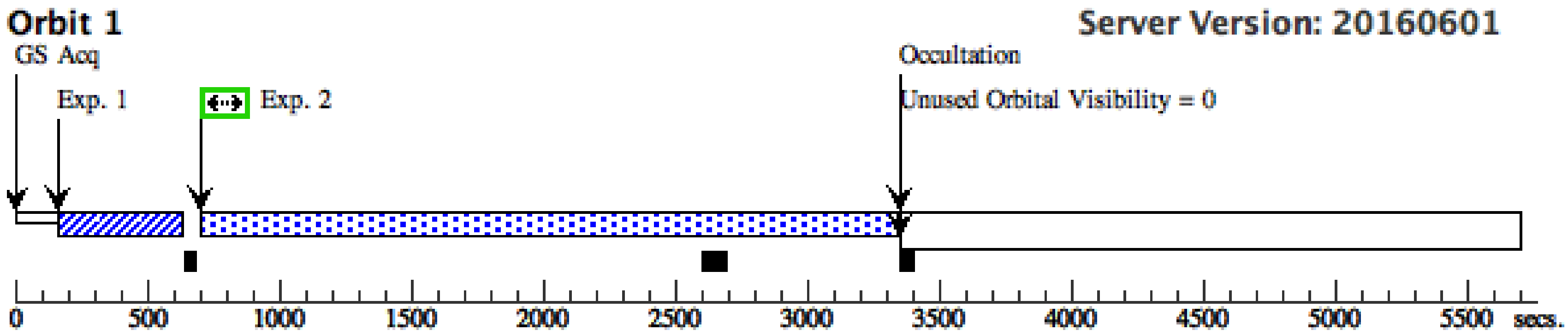
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	2MASS-J10215235+4645158 Alt Name1: SDSS-J102152.33+464515.6	RA: 10 21 52.3300 (155.4680417d) Dec: +46 45 15.65 (46.75435d) Equinox: J2000	Redshift: 0.204	V=18.03 GALEX FUV_mag=18.87 +/- 0.11, NUV_mag=19.04 +/- 0.04	Reference Frame: ICRS

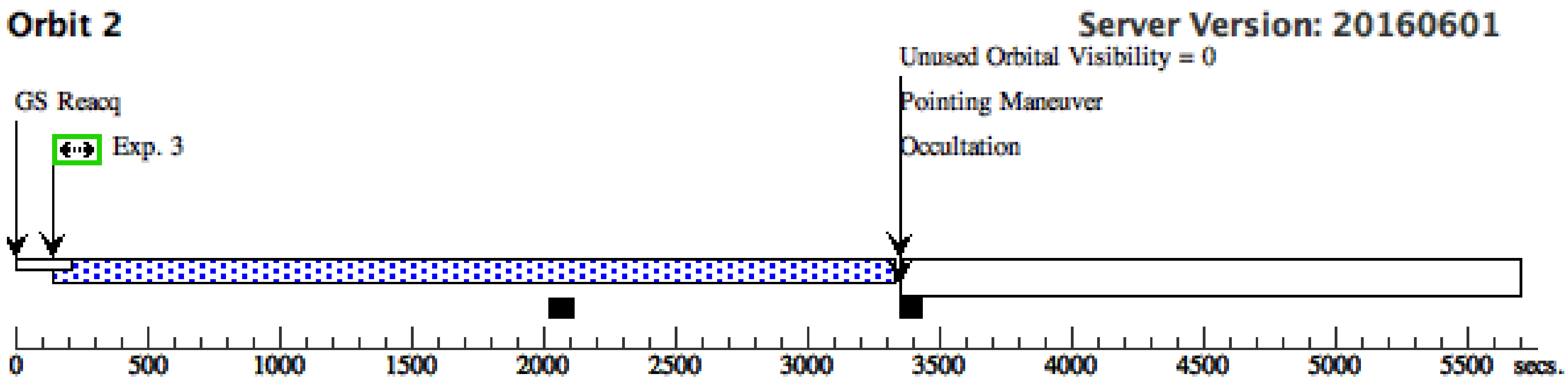
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. The coordinates were updated in phase 2 to those of the SDSS DR9 (ICRS), with uncertainties as given above. The GALEX observations were made when the object was in a bright state, therefore we expect the UV magnitudes to be fainter now.
Extended=NO

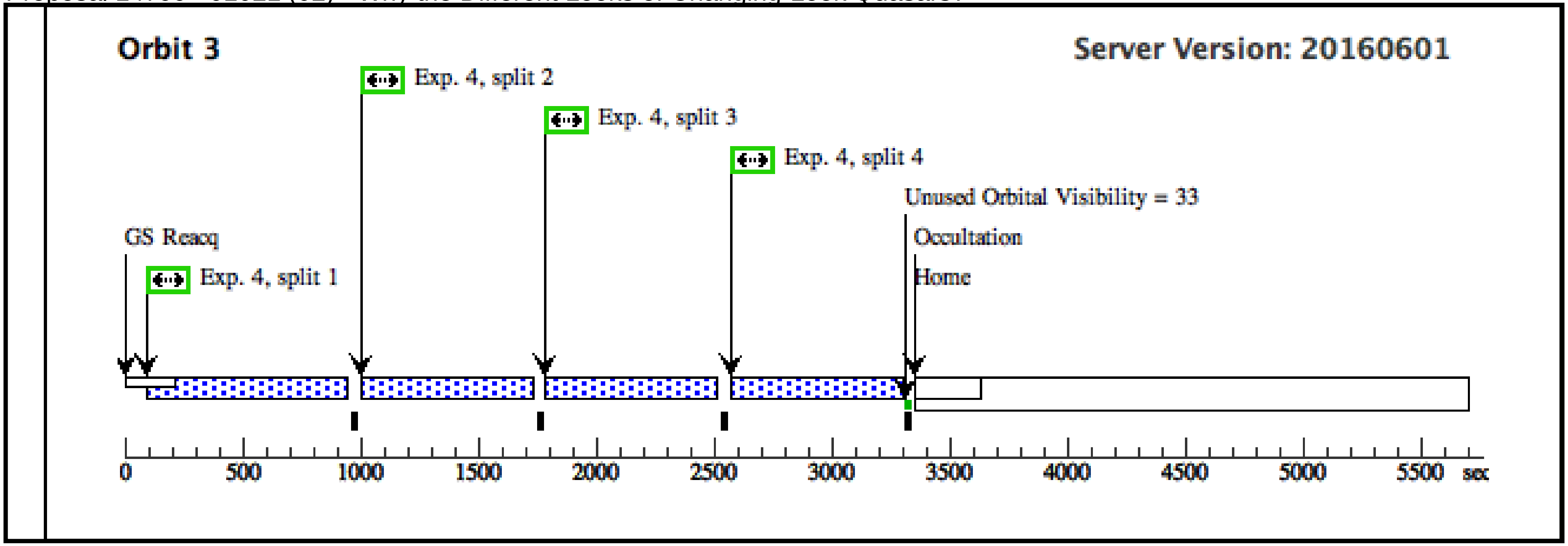
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq (COS.ta.825548)	(2) 2MASS-J10215235+4645158	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				120 Secs (120 Secs) *[==>]*	***[1]***
2	G230L-2950 (COS.sp.826608)	(2) 2MASS-J10215235+4645158	COS/NUV, TIME-TAG, PSA	G230L 2950 A	BUFFER-TIME=1801; FLASH=YES; FP-POS=1			1000 Secs (2522 Secs) *[==>2522.0 Secs]*	***[1]***
3	G230L-3360 (COS.sp.826606)	(2) 2MASS-J10215235+4645158	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=1801; FLASH=YES; FP-POS=1			2400 Secs (3103 Secs) *[==>3103.0 Secs]*	***[2]***
4	G140L-1280 (COS.sp.826609)	(2) 2MASS-J10215235+4645158	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=15447; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			600 Secs (2716 Secs) *[==>679.0 Secs (Split 1)]* *[==>679.0 Secs (Split 2)]* *[==>679.0 Secs (Split 3)]* *[==>679.0 Secs (Split 4)]*	***[3]***

Orbit Structure



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Occultation
Exp. 4, split 1
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0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14799, J2335 (03), implementation — Thu Jan 05 02:03:22 GMT 2017

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(J2335 (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.

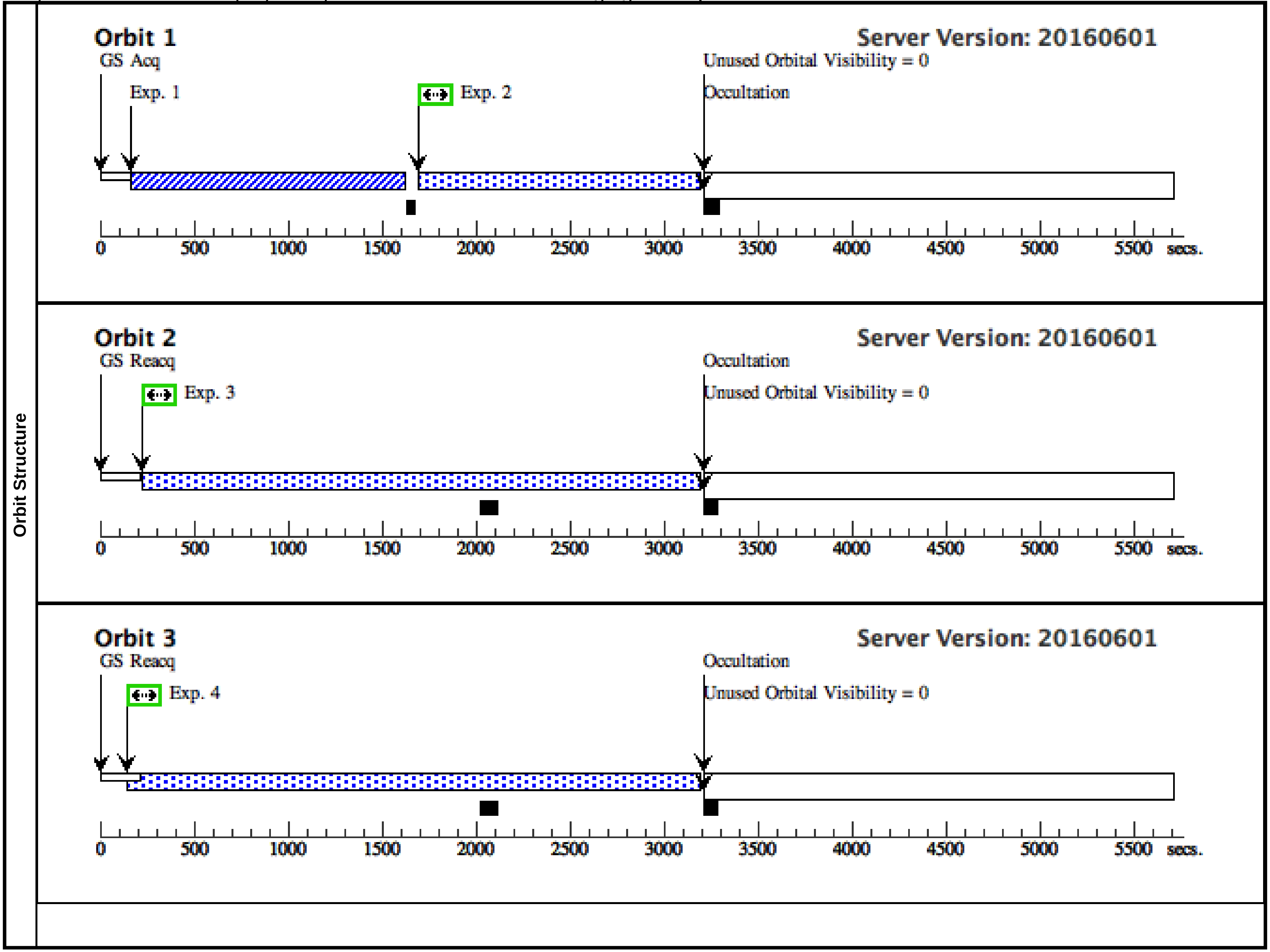
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	GALEX-J233603.04+0017 Alt Name1: SDSS-J233602.98+001728.7	RA: 23 36 2.9800 (354.0124167d) Dec: +00 17 28.77 (.29133d) Equinox: J2000	Redshift: 0.243	V=19.66 GALEX FUV_mag=21.45 +/- 0.27, NUV_mag=21.95 +/- 0.29	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. The coordinates were updated in phase 2 to those of the SDSS DR9 (ICRS), with uncertainties as given above. The GALEX observations were made when the object was in a bright state, therefore we expect the UV magnitudes to be fainter now.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq (COS.ta.825952)	(3) GALEX-J233603.04+0017	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				617 Secs (617 Secs) *[==>]*	*[1]*
2	G230L-3000-1 (COS.sp.826620)	(3) GALEX-J233603.04+0017	COS/NUV, TIME-TAG, PSA	G230L 3000 A	BUFFER-TIME=1805; FLASH=YES; FP-POS=1			200 Secs (1386 Secs) *[==>1386.0 Secs]*	*[1]*
3	G230L-3000-2 (COS.sp.826620)	(3) GALEX-J233603.04+0017	COS/NUV, TIME-TAG, PSA	G230L 3000 A	BUFFER-TIME=1805; FLASH=YES; FP-POS=1			2500 Secs (2961 Secs) *[==>2961.0 Secs]*	*[2]*
4	G230L-3360-1 (COS.sp.826622)	(3) GALEX-J233603.04+0017	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=1805; FLASH=YES; FP-POS=1			2500 Secs (2961 Secs) *[==>2961.0 Secs]*	*[3]*
5	G230L-3360-2 (COS.sp.826622)	(3) GALEX-J233603.04+0017	COS/NUV, TIME-TAG, PSA	G230L 3360 A	BUFFER-TIME=1805; FLASH=YES; FP-POS=1			2500 Secs (2961 Secs) *[==>2961.0 Secs]*	*[4]*
6	G140L-1280 (COS.sp.826616)	(3) GALEX-J233603.04+0017	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=15447; FLASH=YES; FP-POS=ALL; SEGMENT=BOTH			600 Secs (2576 Secs) *[==>644.0 Secs (Split 1)]* *[==>644.0 Secs (Split 2)]* *[==>644.0 Secs (Split 3)]* *[==>644.0 Secs (Split 4)]*	*[5]*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GS Reacq
Occultation
Exp. 3
Unused Orbital Visibility = 0
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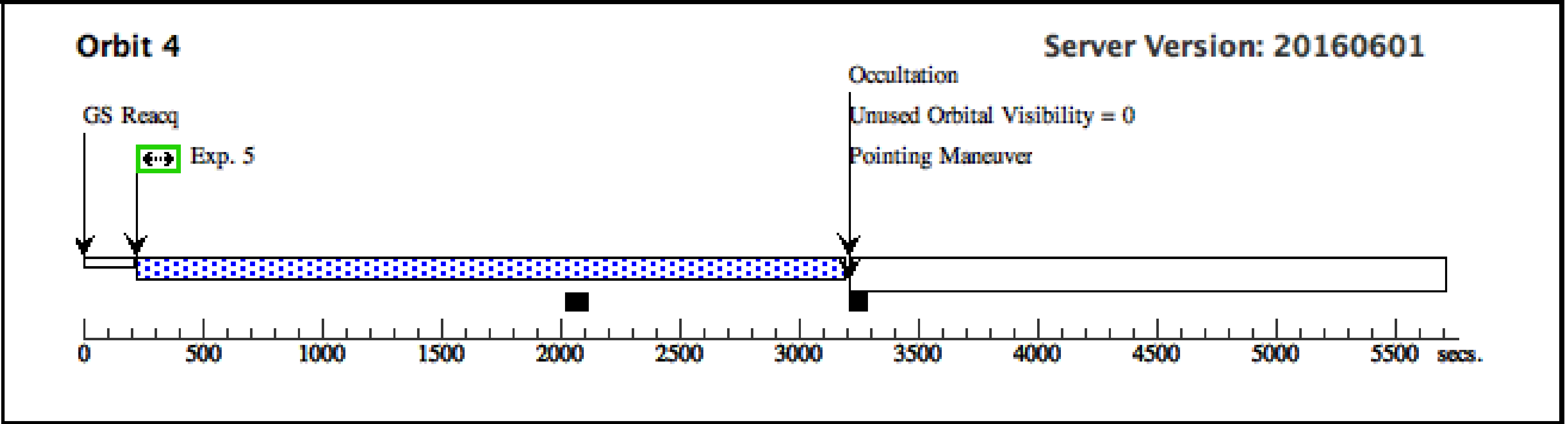
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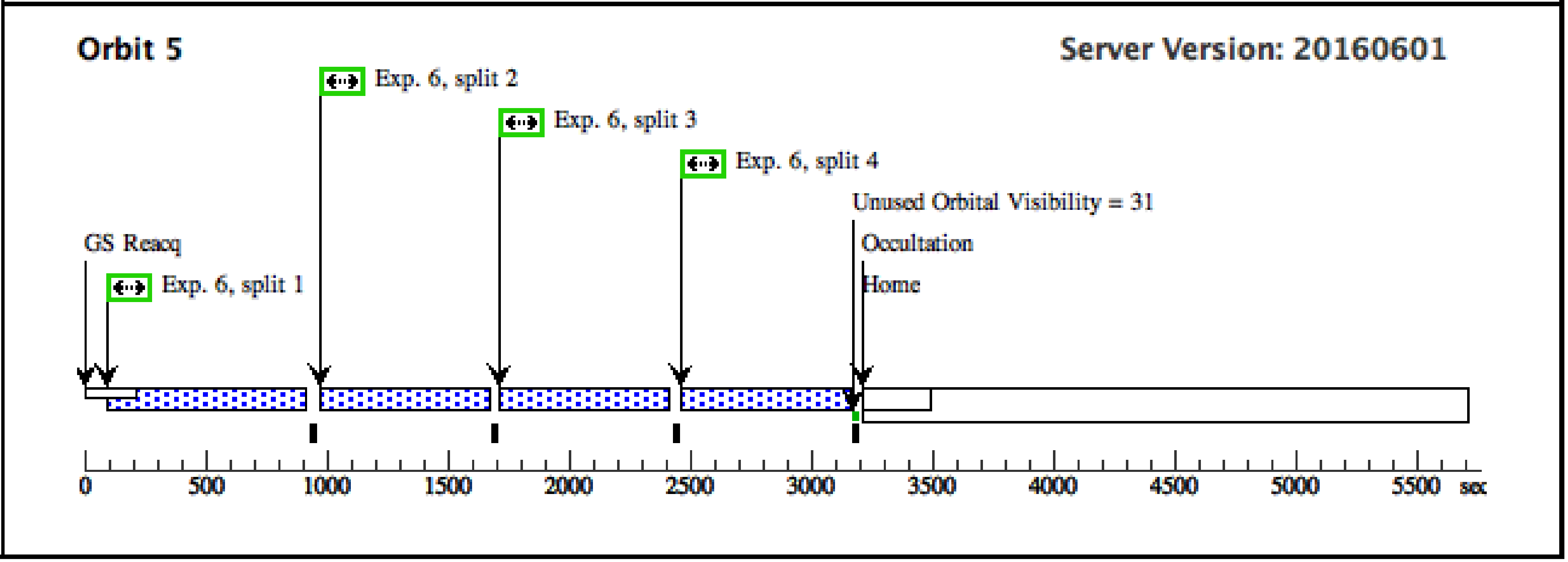
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Exp. 6, split 3
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Occultation
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