12951 - Do Lyman-alpha photons escape from star-forming galaxies through dust-holes?

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) KISSR218	ACS/SBC WFC3/UVIS	5	24-Sep-2012 21:38:15.0	yes
02	(2) KISSR298	ACS/SBC WFC3/UVIS	6	24-Sep-2012 21:38:39.0	yes
03	(3) KISSR1084	ACS/SBC WFC3/UVIS	4	24-Sep-2012 21:38:59.0	yes

15 Total Orbits Used

ABSTRACT

The hydrogen Lyman-alpha line is arguably the most important signature of galaxies undergoing their first violent burst of star formation. Although Lya photons are easily destroyed by dust, candidate Lya emitters have been detected at z>5. Thus the line can potentially be used to probe galaxy formation and evolution, as long as the astrophysical processes that regulate the escape of Lya photons from star-forming galaxies are well understood.

We request 15 orbits for imaging in Lya and the FUV continuum with ACS/SBC, and in the H-beta/H-alpha ratio (proxy for dust extinction) with WFC3/UVIS, a sample of isolated non-AGN face-on spirals for which our team previously obtained and analyzed COS FUV spectroscopy of the central regions. Each target shows a different Lya profile, i.e., pure absorption, P-Cygni like, and multiple-emission. From the COS data, we already know the starburst phase and H I gas velocity. The images would greatly increase the impact of our spectroscopic study by enabling us to 1) conclusively determine if Lya photons escape through dust-holes, 2) assess the relative importance of dust extinction, ISM kinematics, and starburst phase in regulating the Lya escape, 3) clarify what we can really learn from the Lya equivalent width, and 4) provide constraints on the dust extinction to Lya 3D radiative transfer models. Ultimately this program will inform our understanding of the Lya escape at high redshift by providing spatially resolved views of the local conditions within star-forming galaxies that favor escape.

OBSERVING DESCRIPTION

FUV Observations. We require nine orbits to observe three galaxies with ACS/SBC in the three filters F125LP, F140LP, and F150LP (one orbit per filter). Since the total FUV continuum fluxes of our galaxies are within a factor of a few, using equal exposures for each object in all filters is a reasonable observing strategy. Our objects have redshifts high enough to move Ly into the F125LP filter bandpass, the use of which will eliminate contamination by the geocoronal Ly emission produced by the Earth's exosphere, however, this filter does not block the weaker O I 1304 and 1356 lines, so we will require observations with F125LP to be made during shadow time, which the on-line exposure time calculator (ETC) shows effectively eliminates the O I background. The duration of shadow time is half of the visibility window. The ETC shows that the other two filters are unaffected by geocoronal light, so they have no orbital restrictions. We will synthesize bandpass filters by forming subtracted images, F125 - F140 and F140 - F150, which we refer to as S132 and S141 respectively (since they have central wavelengths of 1320 Å and 1410 Å, respectively). The S141 and F150 images will contain mostly continuum, while the S131 image will contain continuum and any Ly emission that might be present. We require two continuum band images (S141 and F150) to provide an estimate of the continuum present in the S131 image. The use of two continuum bands provides a means to estimate both amplitude and slope differences in the spectral energy distributions (SEDs), which improves the accuracy of the continuum flux estimation in the S131 bandpass over that provided by a single continuum image, with which we could only account for amplitude. The observations in each filter will be divided into three sub-exposures for small-scale dithering, which will enable artifact rejection and

provide a better sampling of the point spread function (PSF). We intend to split the observation of F125LP and one of the other filters into two orbits to accommodate the shadow only observations. Our calculations for the number of orbits take into consideration the exposure and overhead times. The unrestricted visibility times corresponding to the declinations of our targets are 54 to 55 minutes. In the 54 minute case, allowing for 6 minutes of target acquisition, 3 minutes for filter changes, and 0.6 minutes for the pointing pattern, we arrive at a total on target orbital integration time of 44.4 min = 2664 s. We used our COS spectra to derive the expected sensitivity for detecting Ly emission using these filters. We find that a Ly emission line with an EW of 20 Å will produce approximately 10% of the flux in the S132 bandpass. We also find that none of our targets will exceed the MAMA local or global countrate limits of 50 counts s-1 pixel-1 and 2 x 105 counts s-1, respectively. The left panels in Fig. 1 show the COS/G130M spectra of the central regions of our spirals, and the transmission curves of the proposed SBC filters. The right legend of the left panels provides the KISSR ID, redshift, oxygen abundance relative to solar (12+log[O/H]=8.69, Asplund et al. 2009), extinction in the V band (Av), and flux and equivalent width of the Ly line (the EW is uncorrected for the stellar Ly; this correction is expected to be <5 Å for ages of <107 Myr, see Fig. 3 of Valls-Gabaud 1993).

Optical Observations. We require six orbits to image the above three galaxies with WFC3/UVIS in three filters (one for H, one for the continuum, and one for H). The specific filters for each target are specified in the right panels of Fig. 1, where we also show the SDSSS spectra of our targets, which corresponds to the COS pointings, and were taken with a 3” aperture, well matched to the COS aperture of 2.5” in diameter. The H images will be contaminated with the adjacent [N II] lines, and in the case of KISSR 298, with the [S II] doublet. The central regions of the images can be corrected using the H/[ ] and H/[S II] ratios given by the SDSS spectra. For the rest of the galaxy, we will apply a statistical correction as in Ly et al. (2011). We note the absence of strong emission lines within the bandpass of the off-line filter F621M, to be used for the continuum subtraction. The scaling of the off-line image will be determined by the offset of its bandpass with respect to the relevant emission line. The reduced field of view of the quad filters is a non-issue, since unvignetted (66”x66”), it is still larger than the FOV of SBC (35”x30”), which we propose to use for the Ly imaging. We will use four dithered exposures in each filter in order to reject cosmic rays, mask detector artifacts, and resample the PSF. In order to reduce the overhead time, we plan to only use a UVIS subarray of ¼ of the area of a full-frame image. We used the SDSS spectra to derive the expected sensitivity for detecting the H and H emission lines with the filters of Fig. 1. We find that H and H, with EWs derived from the spectra, will produce approximately the following fluxes in their bandpasses. H: 32%, 34%, and 11%; H 9%, 20% and 7 %, for KISSR 218, KISSR 1084, and KISSR 298, respectively.

Allowing for 6 minutes for the guide-star acquisition, ~10.4 minutes of overhead time per filter (2.6 min for filter change, camera set-up, and readout of the 1st exposure; 3 x 2.1 min = 6.3 min for readout of the 2nd, 3rd, and, 4th exposures; and 3 x 0.5 min = 1.5 min to offset between dither points), and adopting and unrestricted visibility time of 54 minutes, the total on target orbital integration time per filter is 5.6 min = 336 s = (54 min – 6 min – 3 x 10.4 min) / 3, which is shorter than the buffering time of 348 s and qualifies as a short exposure, therefore, in one orbit, we are dominated by

the overhead. The quad filters require an additional minute of overhead time, in order to place them in the correct quadrant, reducing the integration time to 4.6 minutes = 276 seconds. One orbit per target is insufficient to achieve S/N>5 in H and H in the central regions of our targets, for an extraction aperture of 0.5”, therefore, we request two orbits per target for the optical.

Visit

Proposal 12951, KISSR 218 (01), implementation Tue Sep 25 01:39:09 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS, ACS/SBC

Special Requirements: SCHED 100%

Diagnostics

(FQ492N (01.010)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(10), (11), (12)

Fixed Targets

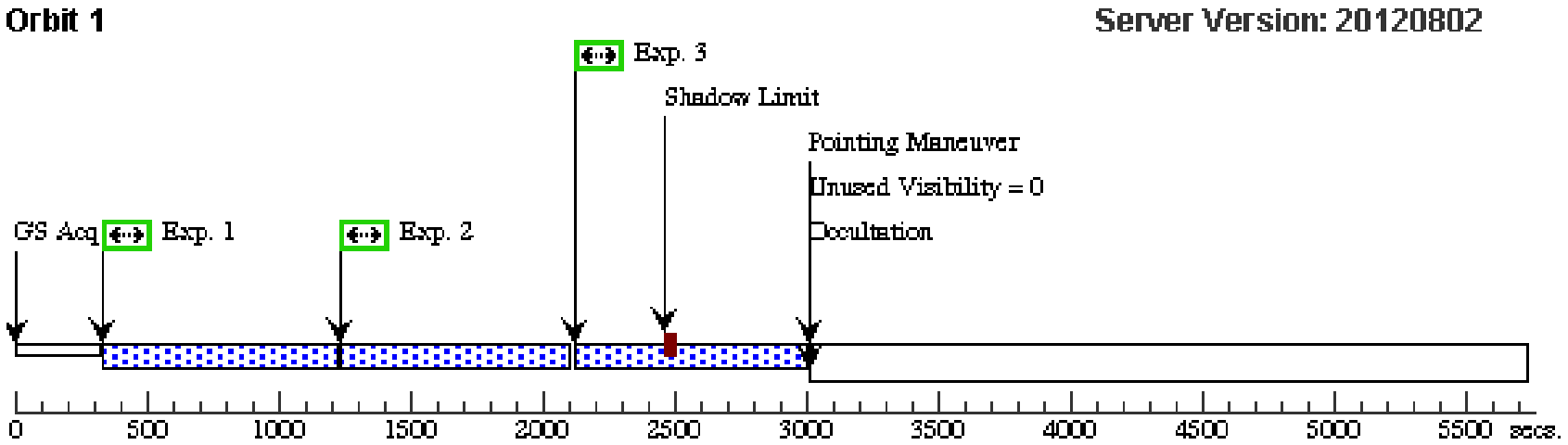
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	KISSR218 Alt Name1: IRAS-13068+2937	RA: 13 09 16.1390 (197.3172458d) Dec: +29 22 2.61 (29.36739d) Equinox: J2000	Redshift: 0.02093	V=15.2 FUV_1500 [cgs]=8.3e-16 (COS)	Reference Frame: ICRS

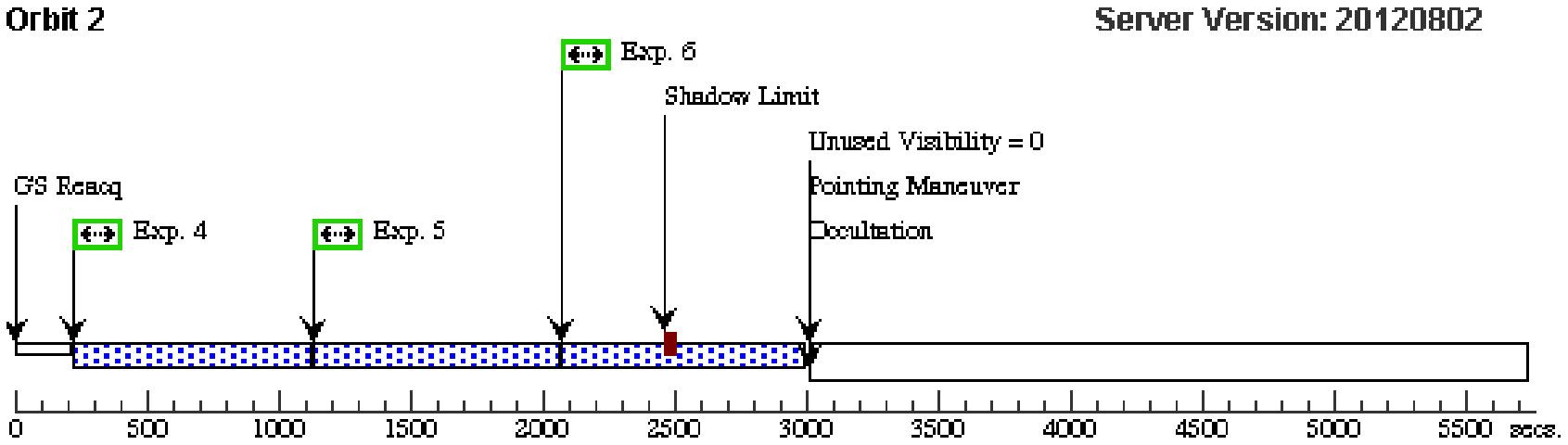
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

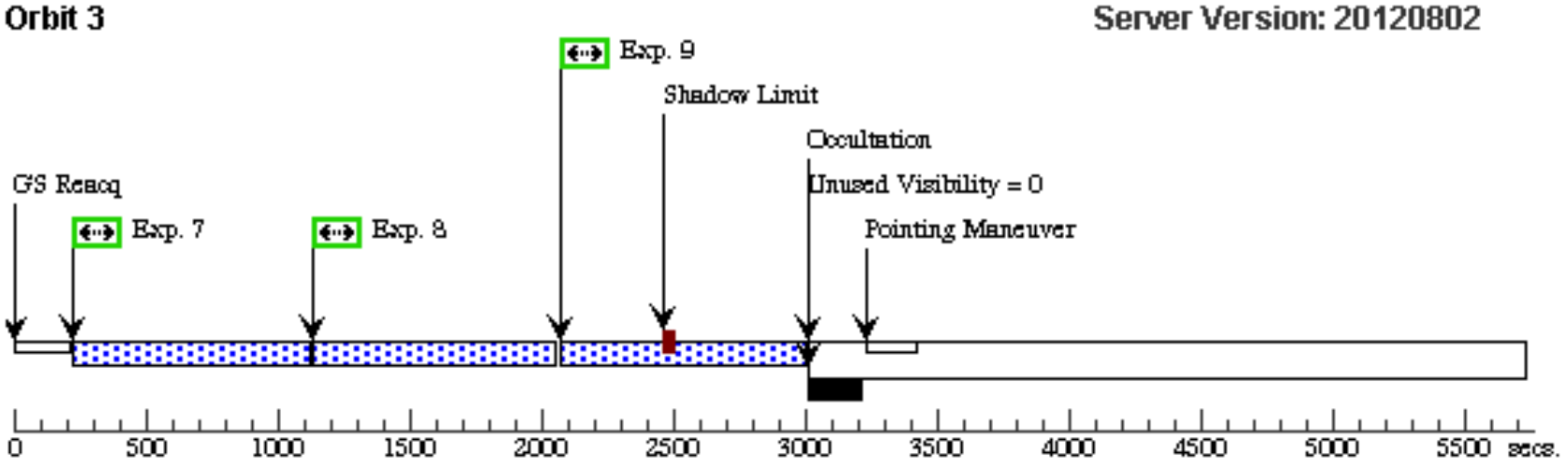
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	F140LP (415950)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F140LP		GS ACQ SCENARIO BASE1B3		823 Secs *[==>]*	 ***[1]***
2	F125LP (415951)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 1; SHADOW		823 Secs *[==>]*	 ***[1]***
3	F150LP (415952)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 1		823 Secs *[==>]*	 ***[1]***
4	F150LP (415952)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F150LP		POS TARG 0.5,0.5		874 Secs *[==>]*	 ***[2]***
5	F125LP (415951)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 4; SHADOW		874 Secs *[==>]*	 ***[2]***
6	F140LP (415950)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F140LP		SAME POS AS 4		873 Secs *[==>]*	 ***[2]***
7	F140LP (415950)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F140LP		POS TARG 1,0.25		874 Secs *[==>]*	 ***[3]***
8	F125LP (415951)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 7; SHADOW		874 Secs *[==>]*	 ***[3]***
9	F150LP (415952)	(1) KISSR218	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 7		873 Secs *[==>]*	 ***[3]***
10	FQ492N (416770)	(1) KISSR218	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ492N	FLASH=9.0	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 10-10 in KISSR 218 (01) (1)	768 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[4]***
11	F621M (416773)	(1) KISSR218	WFC3/UVIS, ACCUM, UVIS1-2K2B-SUB	F621M	FLASH=9.0		Pattern 1, Exps 11-11 in KISSR 218 (01) (1)	184 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[5]***
12	F665N (416772)	(1) KISSR218	WFC3/UVIS, ACCUM, UVIS1-2K2B-SUB	F665N	FLASH=10.		Pattern 1, Exps 12-12 in KISSR 218 (01) (1)	426 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[5]***

Orbit Structure



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Occultation
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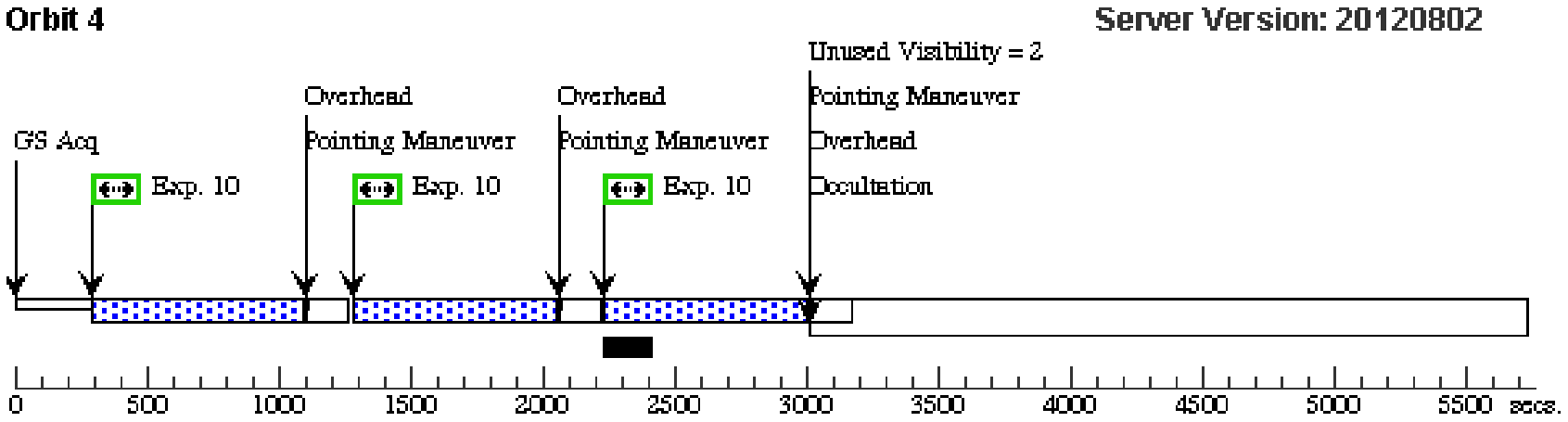
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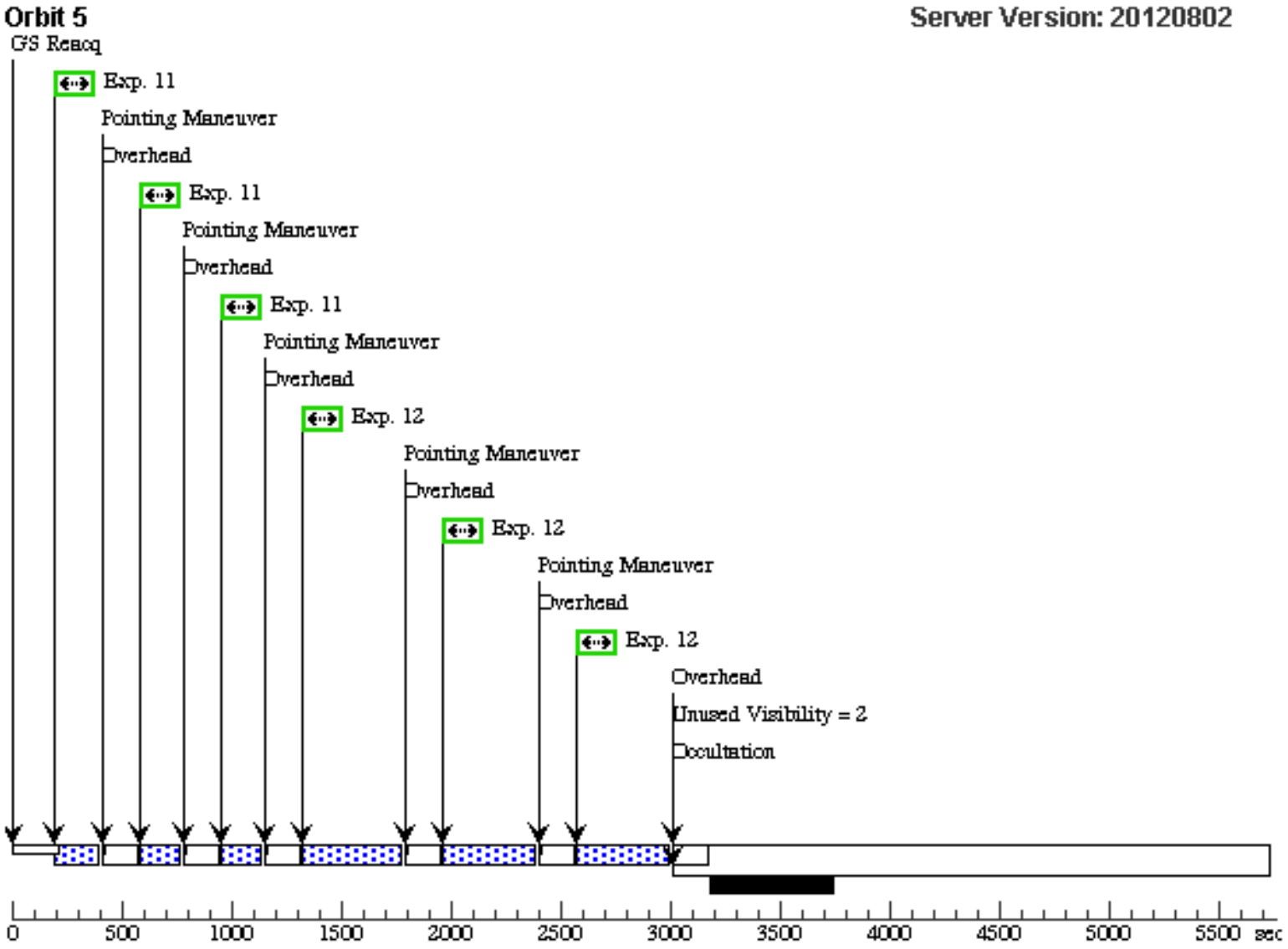
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Overhead
Exp. 12
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Unused Visibility = 2
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Visit

Proposal 12951, KISSR 298 (02), implementation Tue Sep 25 01:39:18 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS, ACS/SBC

Special Requirements: SCHED 100%

Diagnostics

(FQ508N (02.011)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(10), (11), (12)

Fixed Targets

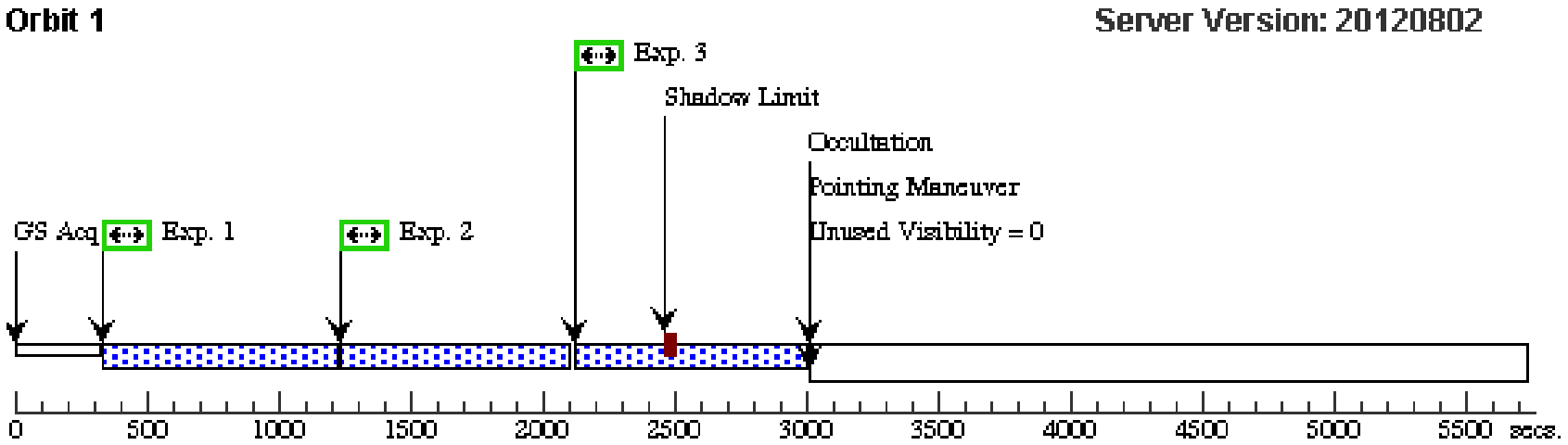
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	KISSR298	RA: 13 29 49.7900 (202.4574583d) Dec: +29 34 47.00 (29.57972d) Equinox: J2000	Redshift: 0.04901	V=16.5 FUV_1500 [cgs]=3.3E-16 (COS)	Reference Frame: ICRS

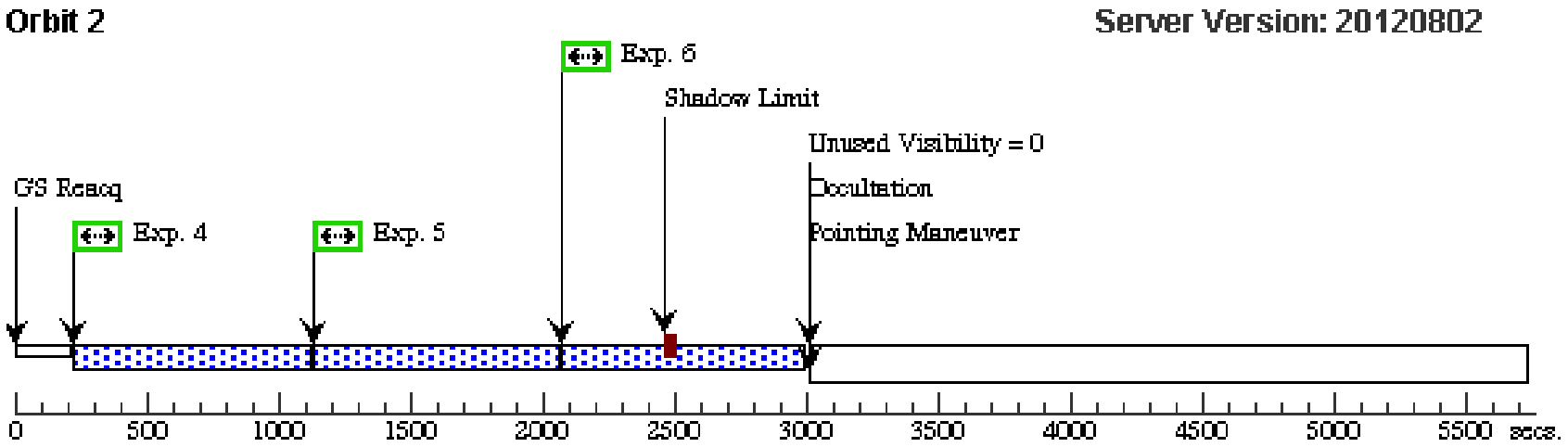
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

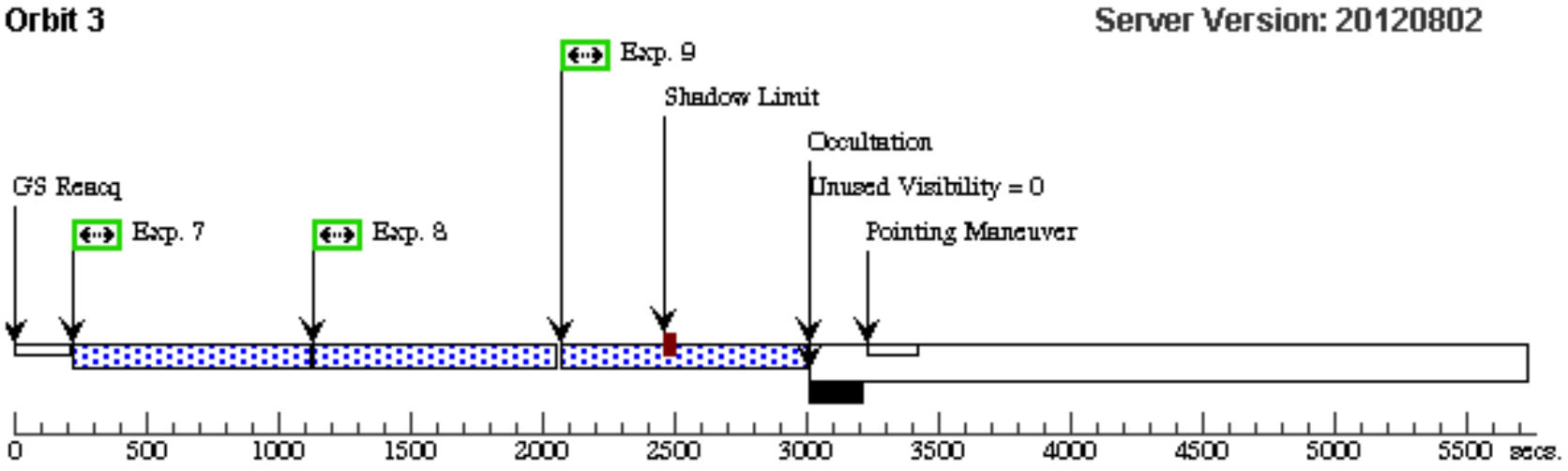
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	F140LP (415940)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F140LP				823 Secs	
								[==>]	***[1]***
2	F125LP (415943)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 1; SHADOW		823 Secs	
								[==>]	***[1]***
3	F150LP (415947)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 1		823 Secs	
								[==>]	***[1]***
4	F150LP (415947)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F150LP		POS TARG 0.5,0.5		873 Secs	
								[==>]	***[2]***
5	F125LP (415943)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 4; SHADOW		874 Secs	
								[==>]	***[2]***
6	F140LP (415940)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F140LP		SAME POS AS 4		874 Secs	
								[==>]	***[2]***
7	F140LP (415940)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F140LP		POS TARG 1,0.25		874 Secs	
								[==>]	***[3]***
8	F125LP (415943)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 7; SHADOW		874 Secs	
								[==>]	***[3]***
9	F150LP (415947)	(2) KISSR298	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 7		873 Secs	
								[==>]	***[3]***
10	F621M (427463)	(2) KISSR298	WFC3/UVIS, ACCUM, UVIS1-2K2A-SUB	F621M	FLASH=7.0		Pattern 1, Exps 10-10 in KISSR 298 (02) (1)	268 Secs	
								[==>(Pattern 1)]	***[4]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
11	FQ508N (416784)	(2) KISSR298	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ508N	FLASH=7.0		Pattern 1, Exps 11-11 in KISSR 298 (02) (1)	1300 Secs	
								[==>(Pattern 1)]	***[4]***
								[==>(Pattern 2)]	***[5]***
								[==>(Pattern 3)]	
12	F680N (416786)	(2) KISSR298	WFC3/UVIS, ACCUM, UVIS1-2K2A-SUB	F680N	FLASH=4.0		Pattern 1, Exps 12-12 in KISSR 298 (02) (1)	807 Secs	
								[==>(Pattern 1)]	***[6]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	

Orbit Structure



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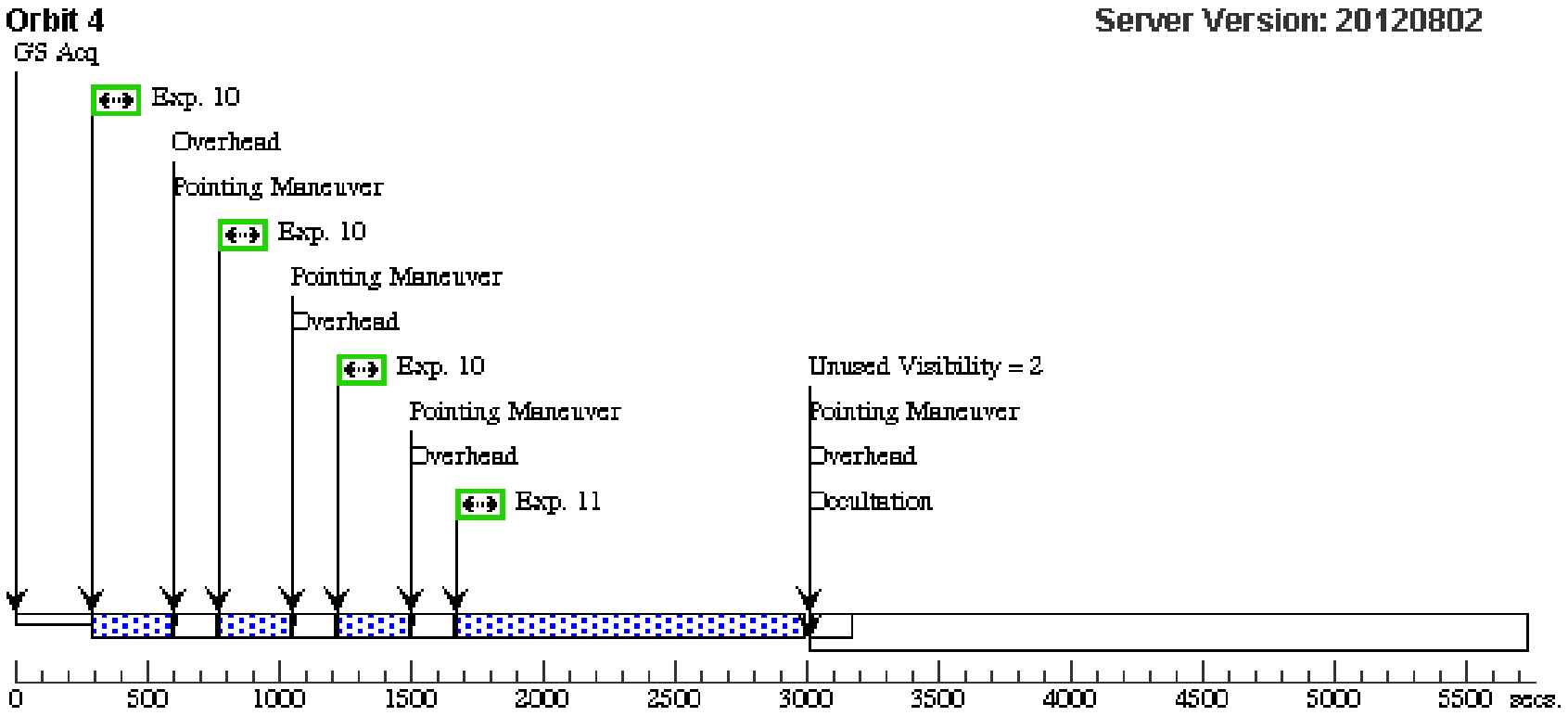
secs.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Overhead
Exp. 11
Unused Visibility = 2
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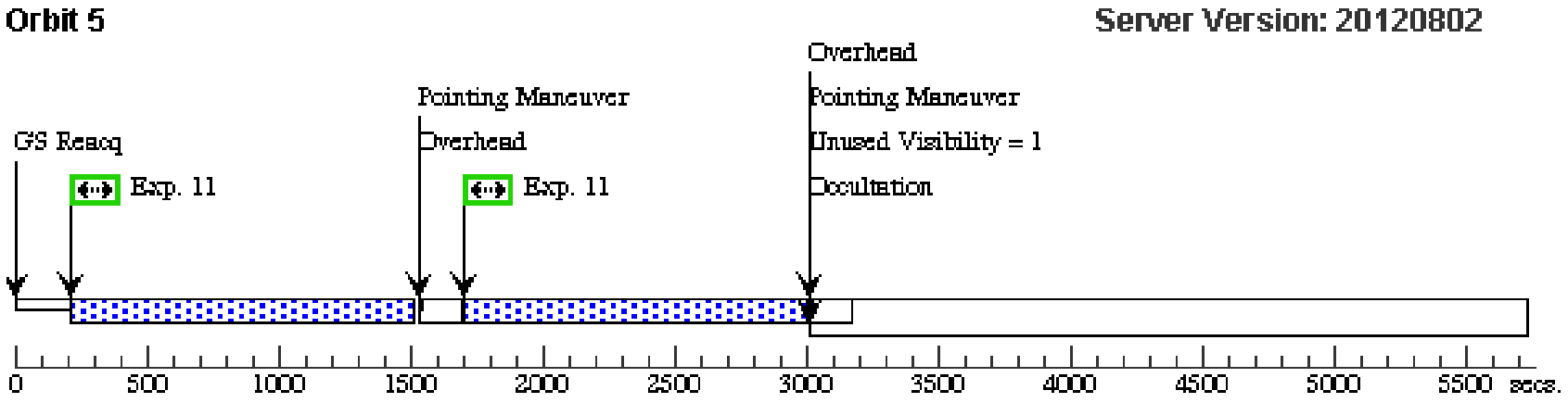
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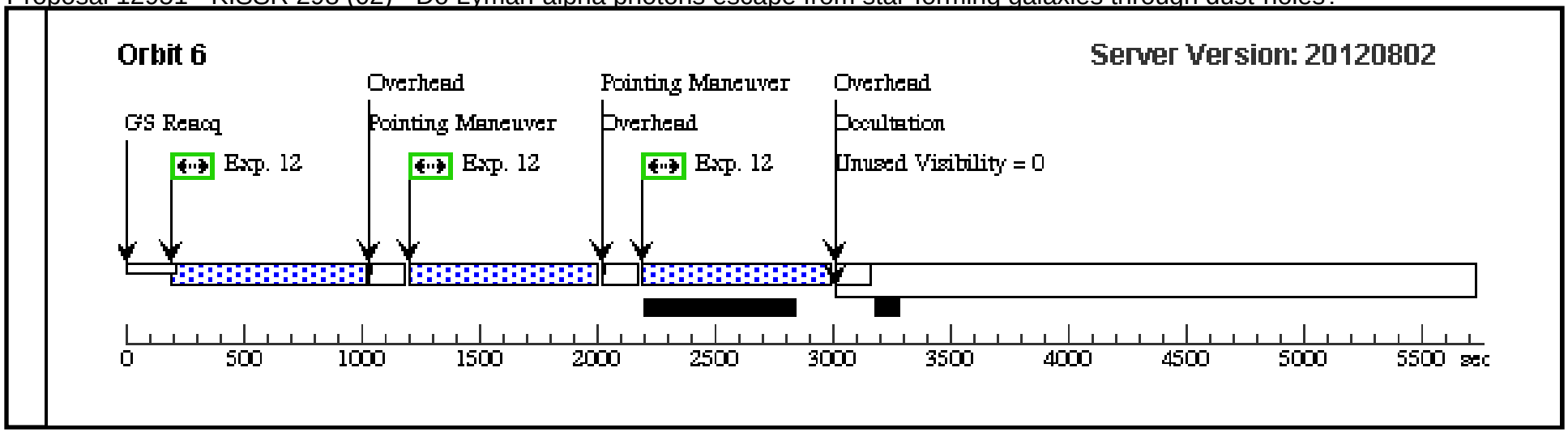
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Occultation
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Visit

Proposal 12951, KISSR 1084 (03), implementation Tue Sep 25 01:39:23 GMT 2012

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS, ACS/SBC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(10), (11), (12)

Fixed Targets

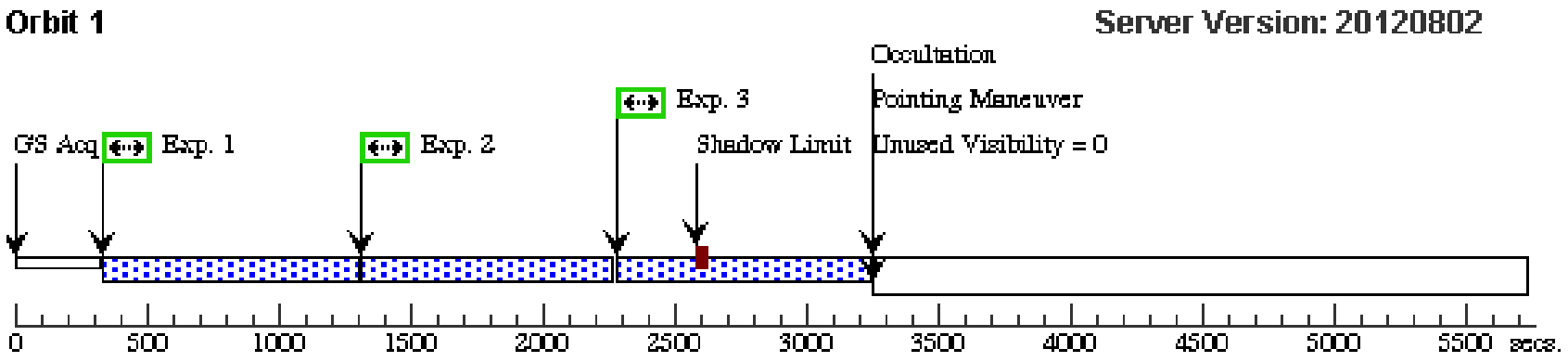
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	KISSR1084 Alt Name1: IRAS-16471+2950	RA: 16 49 5.2656 (252.2719400d) Dec: +29 45 31.61 (29.75878d) Equinox: J2000	Redshift: 0.03208	V=15.1 FUV_1500 [cgs]=4.4E-16 (COS)	Reference Frame: ICRS

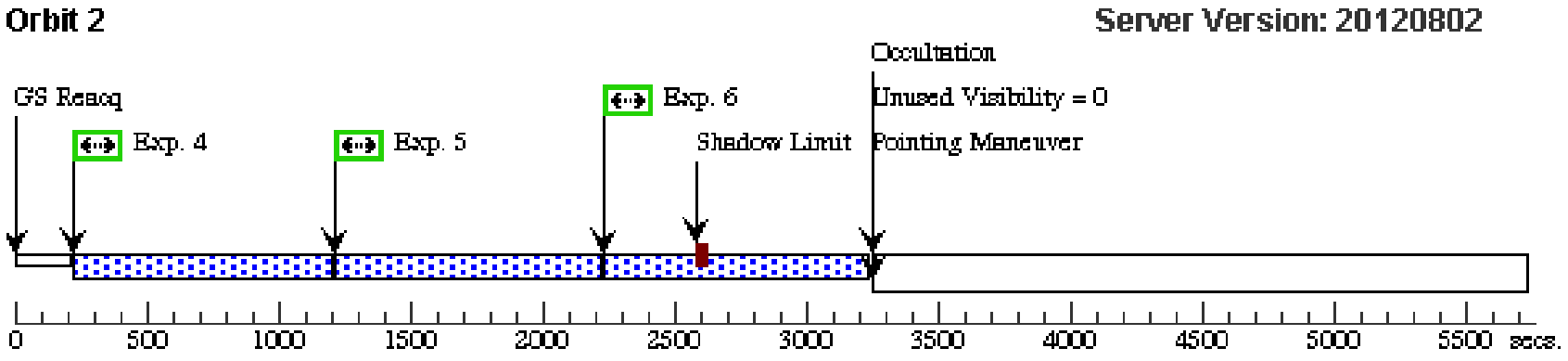
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

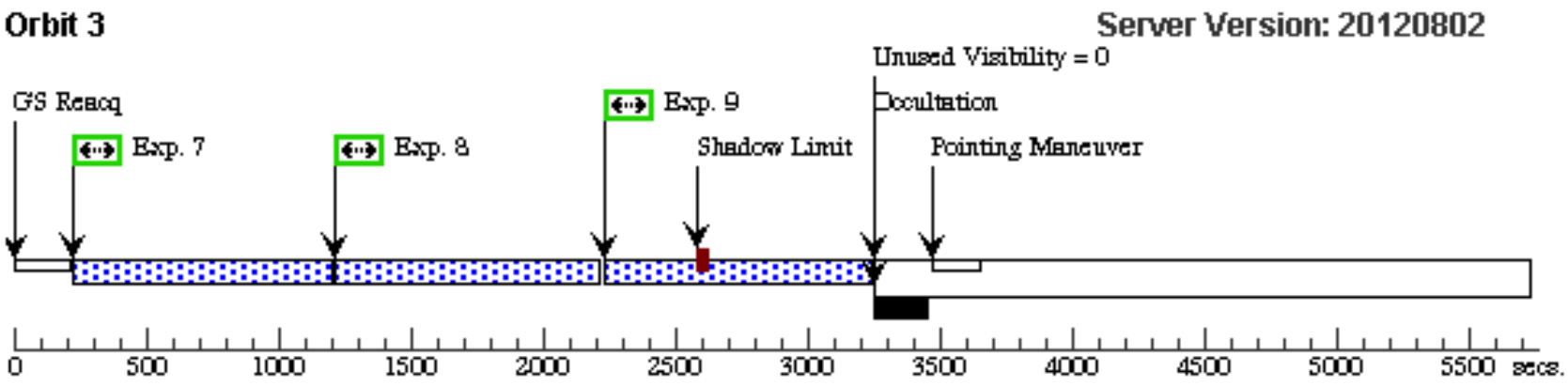
Exposures

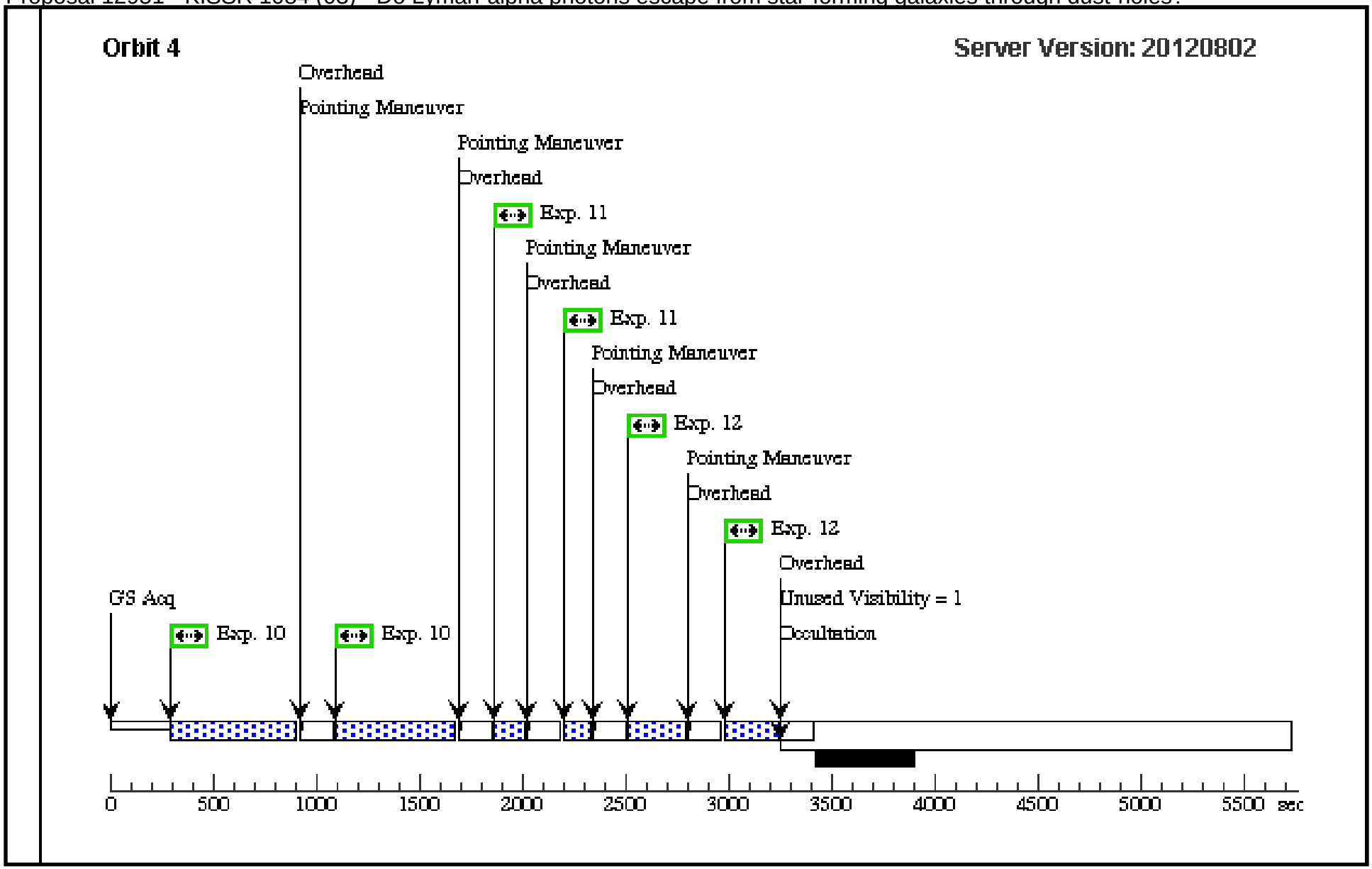
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	F140LP (416028)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F140LP				903 Secs *[==>]*	***[1]***
2	F125LP (416030)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 1; SHADOW		903 Secs *[==>]*	***[1]***
3	F150LP (416033)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 1		903 Secs *[==>]*	***[1]***
4	F150LP (416033)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F150LP		POS TARG 0.5,0.5		953 Secs *[==>]*	***[2]***
5	F125LP (416030)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 4; SHADOW		955 Secs *[==>]*	***[2]***
6	F140LP (416028)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F140LP		SAME POS AS 4		953 Secs *[==>]*	***[2]***
7	F140LP (416028)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F140LP		POS TARG 1,0.25		953 Secs *[==>]*	***[3]***
8	F125LP (416030)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F125LP		SAME POS AS 7; SHADOW		955 Secs *[==>]*	***[3]***
9	F150LP (416033)	(3) KISSR1084	ACS/SBC, ACCUM, SBC	F150LP		SAME POS AS 7		953 Secs *[==>]*	***[3]***
10	F502N (416788)	(3) KISSR1084	WFC3/UVIS, ACCUM, UVIS1-2K2A-SUB	F502N	FLASH=10.0		Pattern 2, Exps 10-10 in KISSR 1084 (03) (2)	585 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[4]***
11	F621M (427465)	(3) KISSR1084	WFC3/UVIS, ACCUM, UVIS1-2K2A-SUB	F621M	FLASH=10.0		Pattern 2, Exps 11-11 in KISSR 1084 (03) (2)	128 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[4]***
12	F673N (416789)	(3) KISSR1084	WFC3/UVIS, ACCUM, UVIS1-2K2A-SUB	F673N	FLASH=11.0		Pattern 2, Exps 12-12 in KISSR 1084 (03) (2)	259 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[4]***

Orbit Structure






Orbit 3
Server Version: 20120802
Unused Visibility = 0
GS Reacq
Exp. 7
Exp. 8
Exp. 9
Shadow Limit
Occultation
Pointing Maneuver
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20120802
Overhead
Pointing Maneuver
Pointing Maneuver
Overhead
Exp. 11
Pointing Maneuver
Overhead
Exp. 11
Pointing Maneuver
Overhead
Exp. 12
Pointing Maneuver
Overhead
Exp. 12
Overhead
Unused Visibility = 1
Occultation
GS Acq
Exp. 10
Exp. 10
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec