13875 - A Potential Paradigm Shift in our Understanding of Helium Reionization

Cycle: 22, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Gabor Worseck (PI) (ESA Member) (Contact)	**Max-Planck-Institut fur Astronomie, Heidelberg**	**gabor@mpia-hd.mpg.de**
Prof. Joseph Hennawi (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	joe@mpia.de
Dr. Jason X. Prochaska (CoI) (AdminUSPI)	University of California - Santa Cruz	xavier@ucolick.org
Prof. Matthew McQuinn (CoI)	University of Washington	mcquinn@uw.edu
Dr. Sebastiano Cantalupo (CoI)	University of California - Santa Cruz	cantal@ucolick.org
Ilya Khrykin (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	khrykin@mpia-hd.mpg.de
Tobias Schmidt (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	tschmidt@mpia-hd.mpg.de

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) SDSSJ1137+6237	COS/FUV COS/NUV	5	23-Jul-2014 21:51:43.0	yes
02	(1) SDSSJ1137+6237	COS/FUV COS/NUV	5	23-Jul-2014 21:51:44.0	yes
03	(2) SDSSJ1614+4859	COS/FUV COS/NUV	5	23-Jul-2014 21:51:46.0	yes
04	(2) SDSSJ1614+4859	COS/FUV COS/NUV	5	23-Jul-2014 21:51:47.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
05	(3) QSO-231145-141752	COS/FUV COS/NUV	4	23-Jul-2014 21:51:48.0	yes

24 Total Orbits Used

ABSTRACT

The advent of GALEX and COS have revolutionized studies of HeII reionization. Observations of the FUV-brightest QSOs have resulted in a order-of-magnitude increase in science-grade HeII Lya absorption spectra in the HST archive. The clear picture emerging is that COS has successfully pinpointed the end of HeII reionization at z~2.7. Based on this, and our team's state-of-the-art radiative transfer simulations, one expects complete Gunn-Peterson absorption at higher redshifts. However, surprisingly, our analysis of the three existing sightlines at z>3.5 reveals high-transmission regions consistent with expectations for a reionized IGM, in striking conflict with the models. Explaining these measurements may require invoking other exotic sources of hard photons at high-z, which would amount to a paradigm shift in our understanding of HeII reionization, with concomitant implications for HI reionization. The unequivocal path forward is COS spectra of more QSOs at z>3.5, deep into the reionization era, to put this tentative result on firm statistical footing. We request 24 orbits to obtain science-grade COS far-UV spectra of the 3 brightest HeII QSOs at z>3.5, which will double the HeII pathlength at high-z and test tantalizing indications that HeII reionization began at z>4 and lasted over 1 Gyr. These spectra are complemented by ancillary data from 8m telescopes, including echelle spectra of the coeval HI Lya forest, and our dedicated survey for QSOs in the foreground of each HeII sightline. Our targets are the only viable sources probing z>3.5 in a reasonable orbit request, and it is critical to HST's legacy to solve this riddle before the mission ends.

OBSERVING DESCRIPTION

We will obtain COS FUV G140L spectra of 3 z~3.8 quasars to characterize intergalactic HeII Lyman alpha absorption along their sightlines. Two targets have been confirmed as HeII-transparent in previous cycles, but lack science-grade HST/COS follow-up spectroscopy. Our third target is the 2nd UV-brightest quasar at z>3.5, discovered by our team in a dedicated survey.

Our targets have accurate magnitudes covering the quasar continuum just redward of the HeII break (GALEX FUV, HST/ACS F150LP), and sufficiently accurate GALEX NUV magnitudes for reliable acquisition via ACQ/IMAGE. All targets are safe to observe with COS and have precise coordinates from SDSS or Pan-STARRS. Our targets are quite faint in the NUV, resulting in long NUV acquisition exposure times of 150-900sec. For the faintest target (SDSSJ1137+6237, NUV=24.0) we limit the acquisition exposure time to 900sec yielding S/N=30 instead of the recommended S/N=40, in order to limit the impact of dark current on the target centering. In accordance with our Phase I proposal we request CVZ observations for

SDSSJ1137+6237.

The G140L grating provides the wavelength coverage to define the quasar continuum and the necessary resolution to measure the onset of patchy HeII absorption. We require a S/N~3 per resolution element at 1500A, which results in a total request of 24 orbits for our three targets.

Continuous wavelength coverage at good sensitivity (lambda>1150A) is required to maximize the coverage of the HeII Lyman alpha absorption, only provided by the G140L 1105A setup. We will use all FP-POS offsets in consecutive orbits of a visit. Spectra will be recorded in TIME-TAG mode with concurrent wavelength calibration (TAGFLASH). Time intervals spent in the Earth's shadow will be used to correct for geocoronal OI and NI emission. Given our faint sources, airglow will dominate the COS count rates. However, even at the high airglow conditions conservatively assumed in our ETC calculations, buffer times are longer than the exposure times, except for the CVZ target. All exposure times have been adjusted to use the full visibility period in each orbit. For the CVZ target the buffer time has been adjusted to maximize the exposure time according to Section 5.4.2 of the COS Instrument Handbook.

Due to the time-dependent sensitivity of COS and COS detector gain sag, we request that visits of the same target (SDSSJ1137+6237: Visit 1 and 2; SDSSJ1614+4859: Visit 3 and 4) are scheduled within 60 days of another. The time gap should be minimized, depending on the observing schedule. Coaddition of data taken in the Poisson limit of COS over several visits requires the sensitivity and detector characteristics to be at least approximately equal. This also requires that all observations of a given target are performed at the same lifetime position of COS. Gain sag limits the accuracy of the COS background subtraction, which is critical to reach our science goals. Therefore, we strongly prefer all observations to be performed at COS lifetime position 3, and preferably as soon as possible after the move, in order to minimize gain sag.

Visit

Proposal 13875, Visit 01 Thu Jul 24 01:51:50 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; SEQ 01,02 WITHIN 60 D

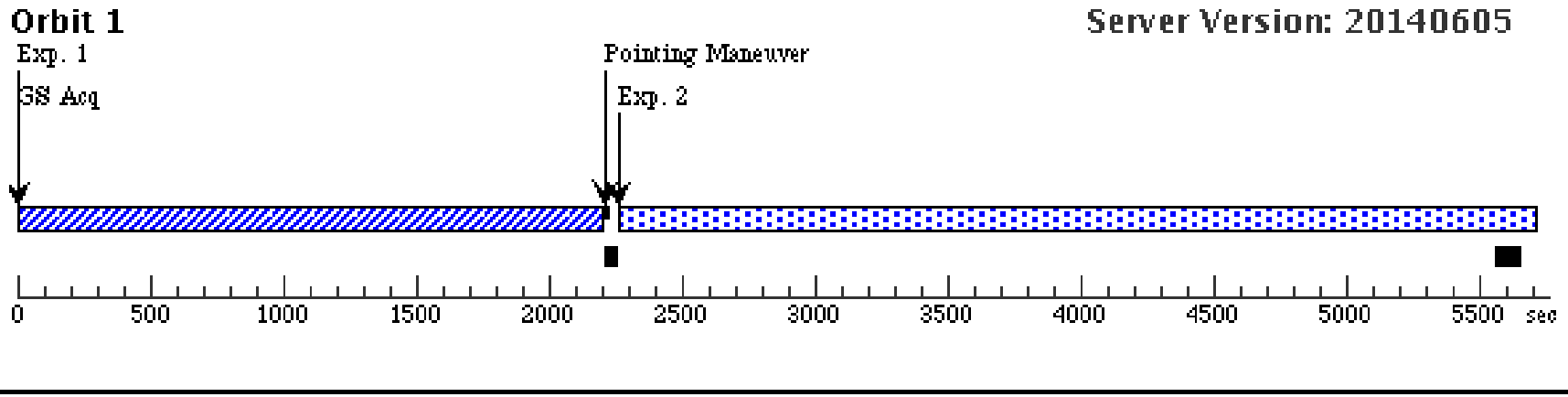
Fixed Targets

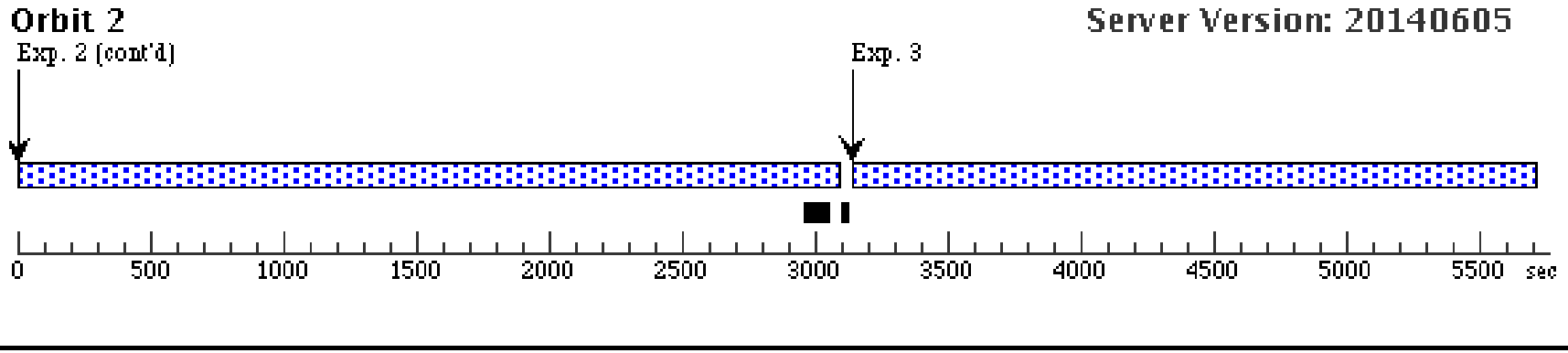
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ1137+6237 Alt Name1: SDSSJ113721.72+623707.2	RA: 11 37 21.7200 (174.3405000d) Dec: +62 37 7.28 (62.61869d) Equinox: J2000	Redshift: 3.77	V=19.27+/-0.10 ACS F150LP=22.83+-0.10, GALEX NUV=24.10+-0.34	Reference Frame: ICRS

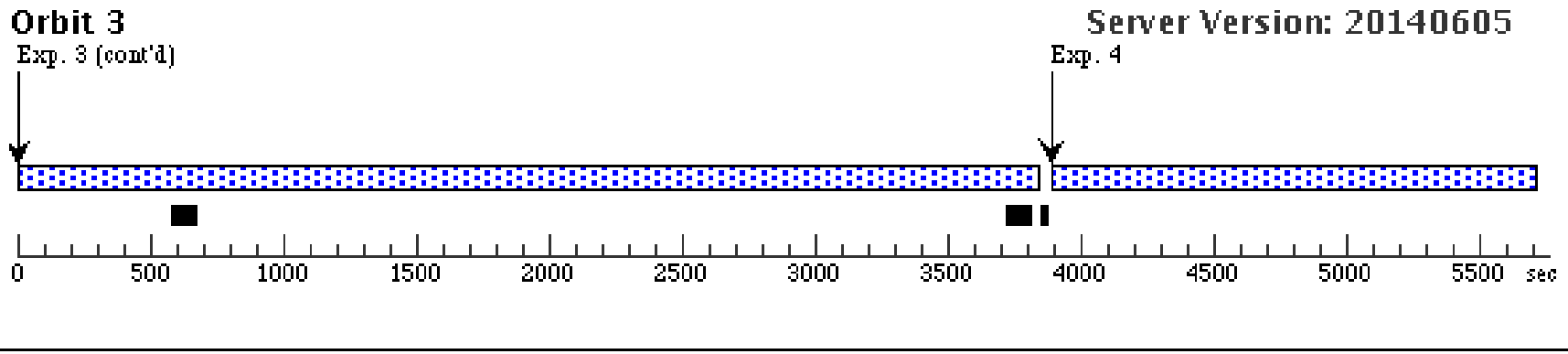
Exposures

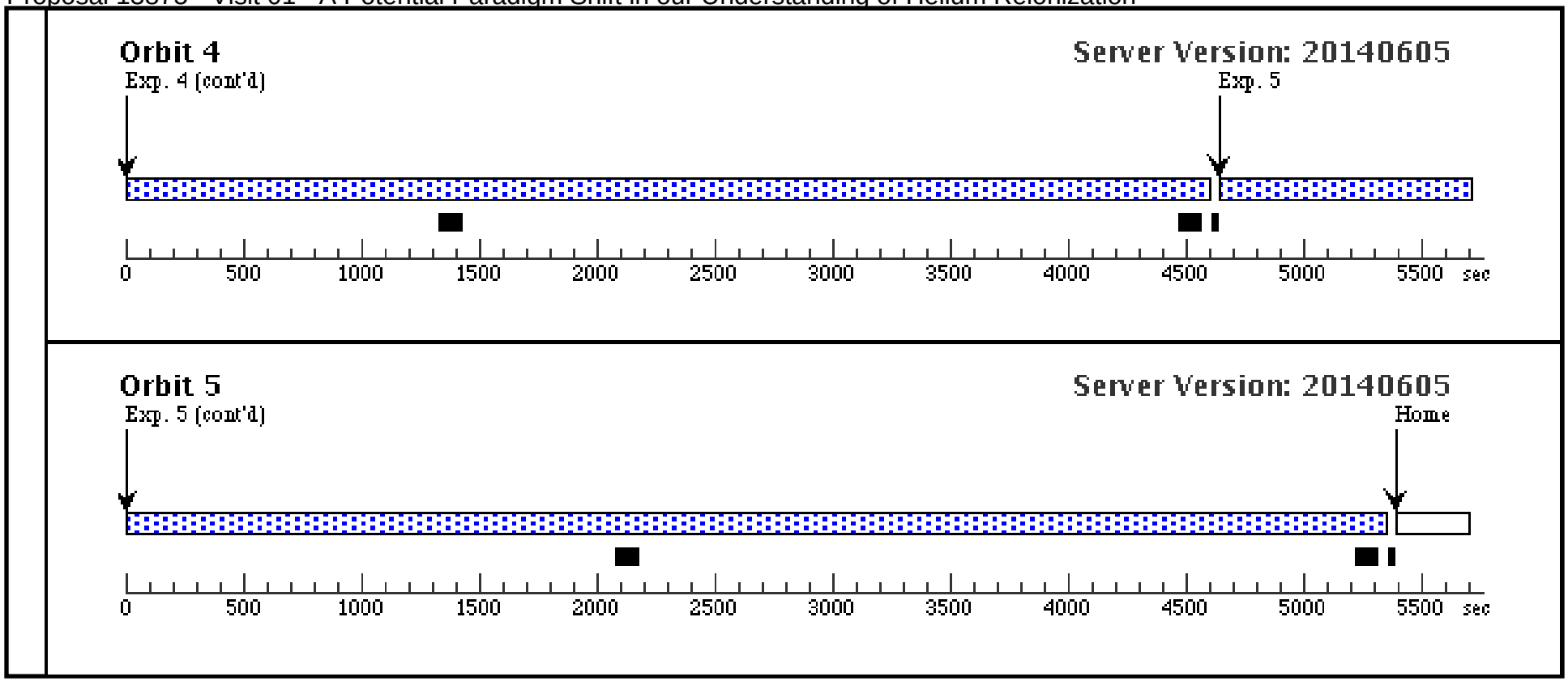
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.616387)	(1) SDSSJ1137+6237	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-5 Non-Int in Visit 01	900 Secs (900 Secs) *[==>]*	***[1]***
	Comments: The target is faint in the NUV, but has reasonably accurate photometry available. The spectral energy distribution likely rises steeply towards the FUV, but the more accurate flux from HST/ACS F150LP might indicate that the target is somewhat brighter in the NUV than the GALEX measurement. An acquisition exposure of 900sec calibrated to NUV=24.0 yields S/N=30 (see ETC result), enough to center the source in the COS PSA. For the recommended S/N=40, one would need 1600sec (COS.ta.616389), which is doable for a CVZ target, but might cause problems in the target centering due to dark current.								
2	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=1; SEGMENT=A		Sequence 1-5 Non-Int in Visit 01	6374 Secs (6374 Secs) *[==>]*	***[1]***
	Comments: The ETC run uses high airglow conditions for a conservative estimate of the buffer time, given the long exposure time and the generally high background conditions in the CVZ. The buffer time has been adjusted to maximize the exposure time according to Section 5.4.2 of the COS Instrument Handbook.								
3	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=2; SEGMENT=A		Sequence 1-5 Non-Int in Visit 01	6374 Secs (6374 Secs) *[==>]*	***[2]***
4	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A		Sequence 1-5 Non-Int in Visit 01	6374 Secs (6374 Secs) *[==>]*	***[3]***
5	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=4; SEGMENT=A		Sequence 1-5 Non-Int in Visit 01	6374 Secs (6374 Secs) *[==>]*	***[4]***

Orbit Structure








Orbit 4
Server Version: 20140605
Exp. 4 (cont'd)
Exp. 5
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Orbit 5
Server Version: 20140605
Exp. 5 (cont'd)
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13875, Visit 02 Thu Jul 24 01:51:50 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; SEQ 01,02 WITHIN 60 D

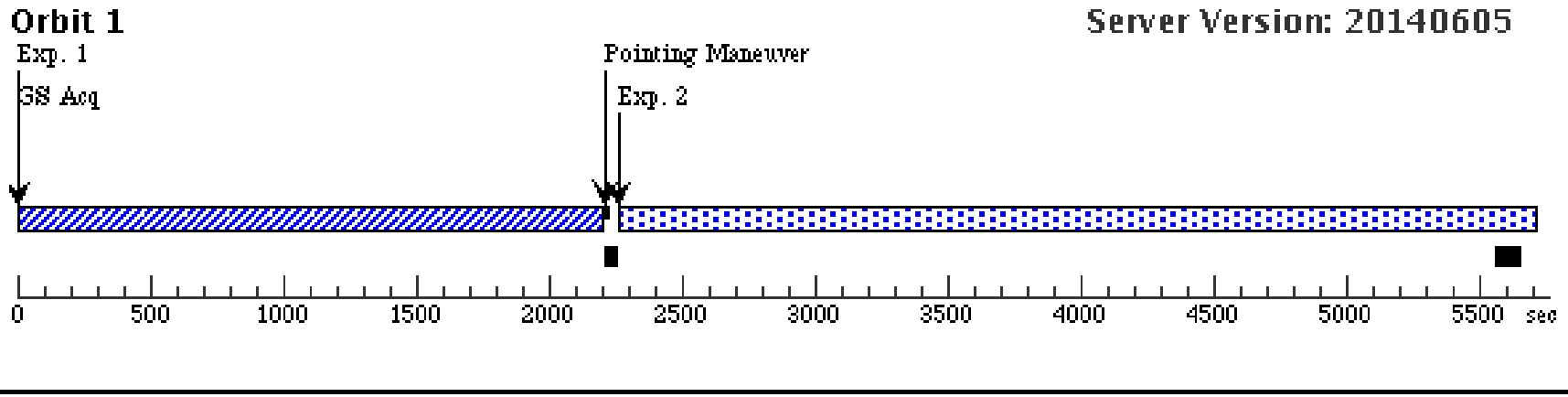
Fixed Targets

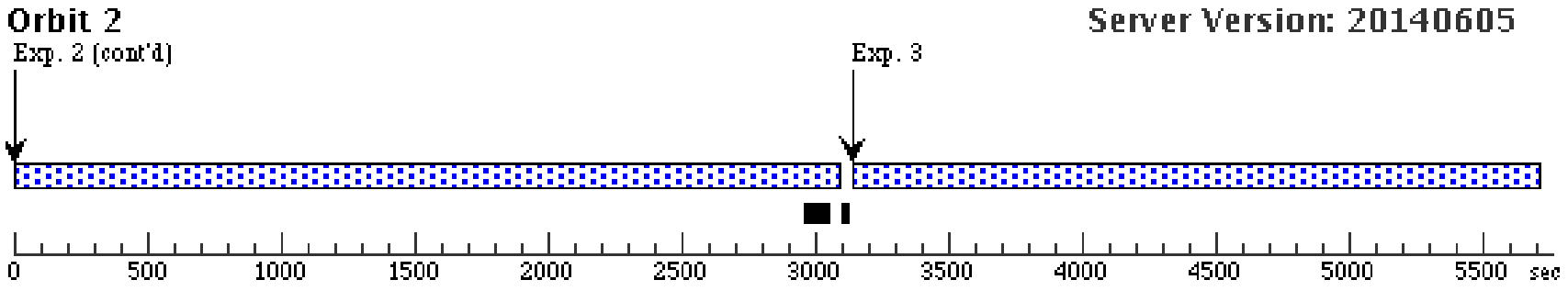
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ1137+6237 Alt Name1: SDSSJ113721.72+623707.2	RA: 11 37 21.7200 (174.3405000d) Dec: +62 37 7.28 (62.61869d) Equinox: J2000	Redshift: 3.77	V=19.27+/-0.10 ACS F150LP=22.83+-0.10, GALEX NUV=24.10+-0.34	Reference Frame: ICRS

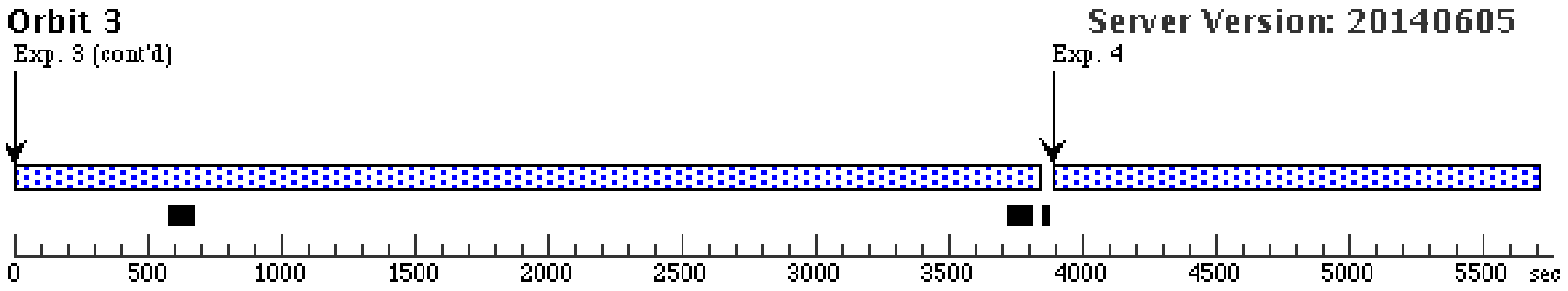
Exposures

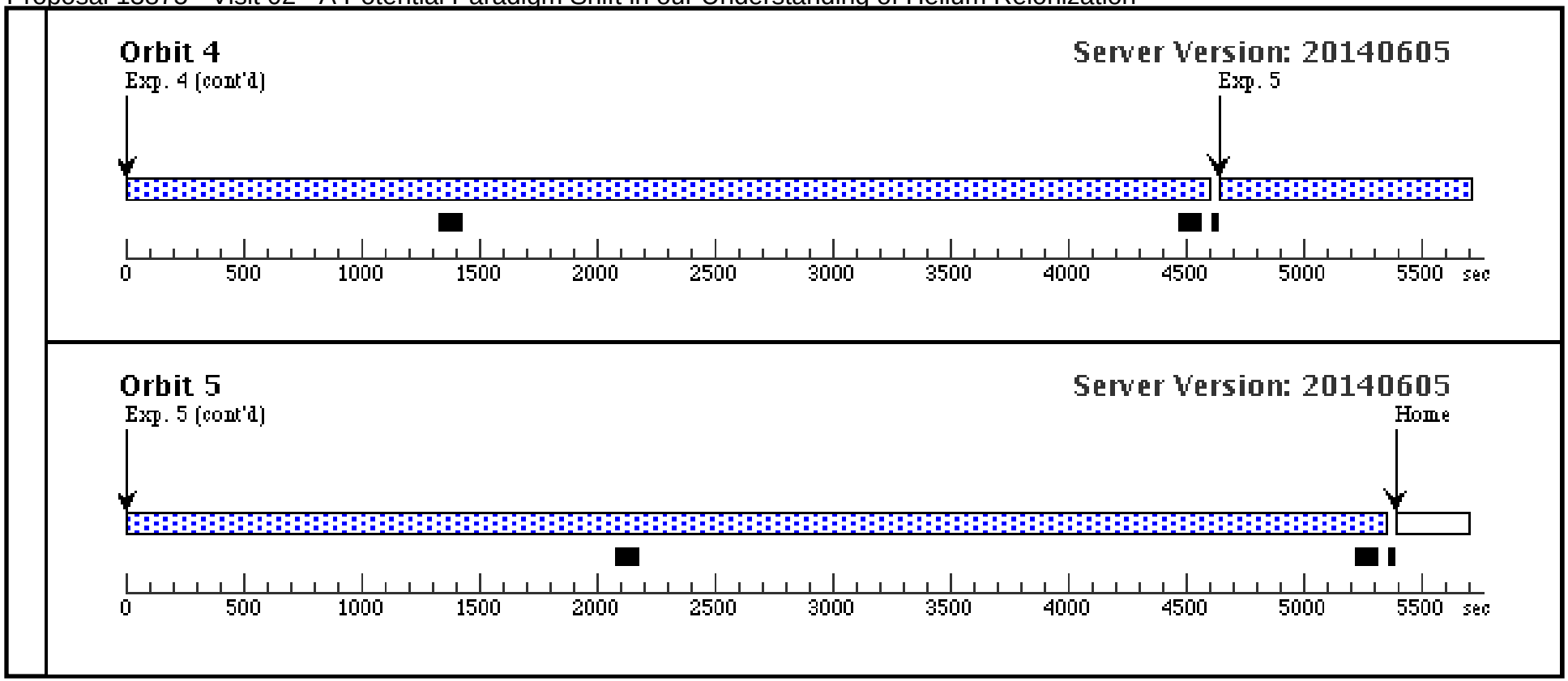
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.616387)	(1) SDSSJ1137+6237	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-5 Non-Int in Visit 02	900 Secs (900 Secs) *[==>]*	***[1]***
	Comments: The target is faint in the NUV, but has reasonably accurate photometry available. The spectral energy distribution likely rises steeply towards the FUV, but the more accurate flux from HST/ACS F150LP might indicate that the target is somewhat brighter in the NUV than the GALEX measurement. An acquisition exposure of 900sec calibrated to NUV=24.0 yields S/N=30 (see ETC result), enough to center the source in the COS PSA. For the recommended S/N=40, one would need 1600sec (COS.ta.616389), which is doable for a CVZ target, but might cause problems in the target centering due to dark current.								
2	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=1; SEGMENT=A		Sequence 1-5 Non-Int in Visit 02	6374 Secs (6374 Secs) *[==>]*	***[1]***
	Comments: The ETC run uses high airglow conditions for a conservative estimate of the buffer time, given the long exposure time and the generally high background conditions in the CVZ. The buffer time has been adjusted to maximize the exposure time according to Section 5.4.2 of the COS Instrument Handbook.								
3	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=2; SEGMENT=A		Sequence 1-5 Non-Int in Visit 02	6374 Secs (6374 Secs) *[==>]*	***[2]***
4	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A		Sequence 1-5 Non-Int in Visit 02	6374 Secs (6374 Secs) *[==>]*	***[3]***
5	(COS.sp.616399)	(1) SDSSJ1137+6237	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3132; EXTENDED=NO; FLASH=YES; FP-POS=4; SEGMENT=A		Sequence 1-5 Non-Int in Visit 02	6374 Secs (6374 Secs) *[==>]*	***[4]***

Orbit Structure








Orbit 4
Server Version: 20140605
Exp. 4 (cont'd)
Exp. 5
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Orbit 5
Server Version: 20140605
Exp. 5 (cont'd)
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13875, Visit 03 Thu Jul 24 01:51:50 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SEQ 03,04 WITHIN 60 D

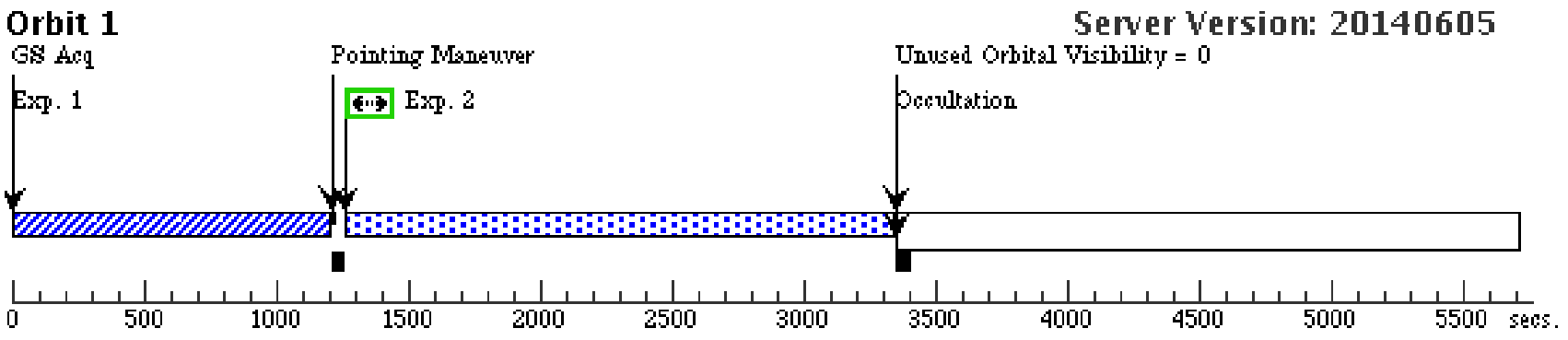
Fixed Targets

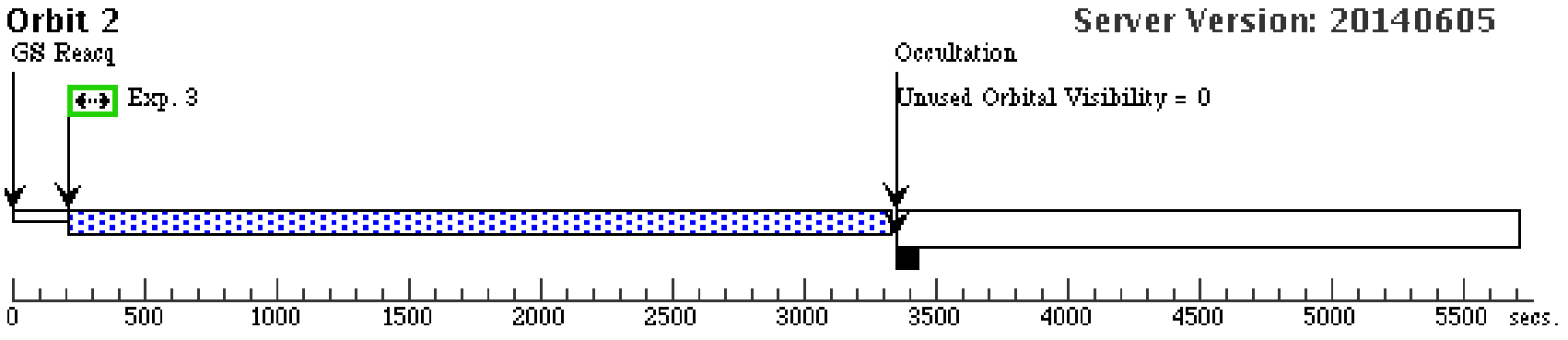
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ1614+4859 Alt Name1: SDSSJ161426.81+485958.8	RA: 16 14 26.8100 (243.6117083d) Dec: +48 59 58.81 (48.99967d) Equinox: J2000	Redshift: 3.82	V=19.56+/-0.10 ACS F150LP=21.83+-0.10, GALEX NUV=22.55+-0.39	Reference Frame: ICRS

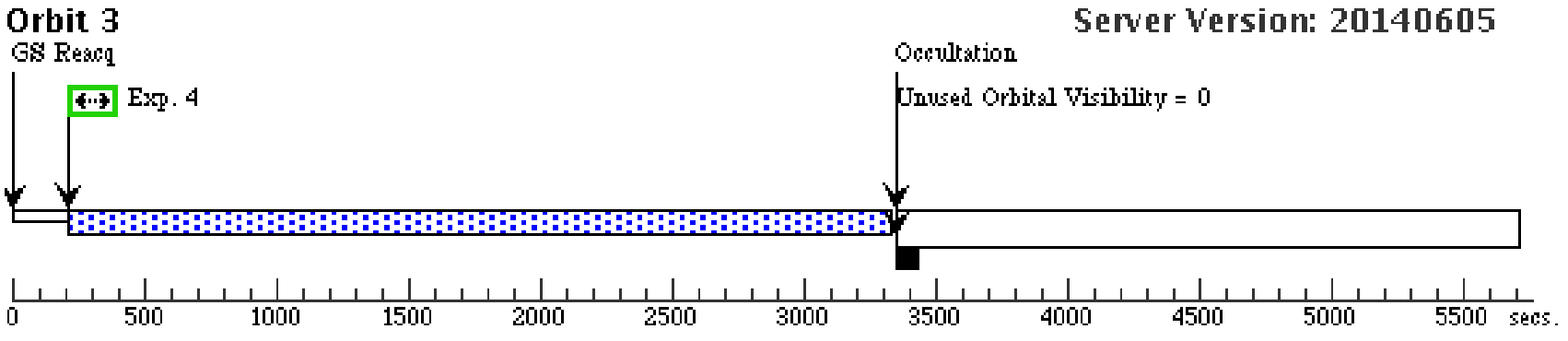
Exposures

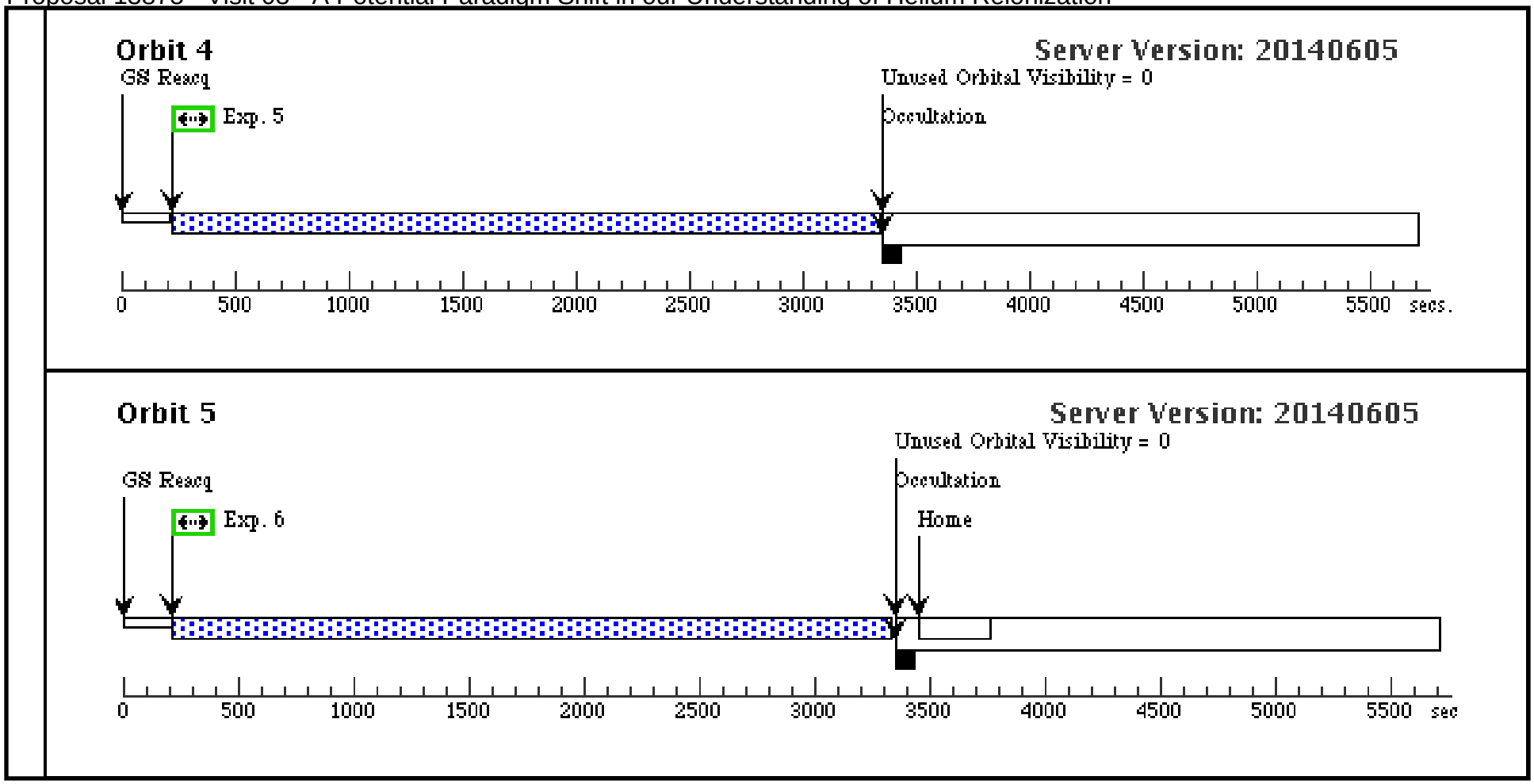
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.616464)	(2) SDSSJ1614+4859	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				400 Secs (400 Secs) *[==>]*	*[1]*
2	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=1; SEGMENT=A			1800 Secs (1896 Secs) *[==>1896.0 Secs]*	*[1]*
Comments: The ETC run conservatively assumes high background conditions, but given the faint target, the buffer time is still considerably longer than the exposure time.									
3	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=2; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[2]*
4	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[3]*
5	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[4]*
6	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=4; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[5]*

Orbit Structure








Orbit 4
Server Version: 20140605
GS Reacq
Exp. 5
Unused Orbital Visibility = 0
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.
Orbit 5
Server Version: 20140605
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 6
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13875, Visit 04 Thu Jul 24 01:51:51 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SEQ 03,04 WITHIN 60 D

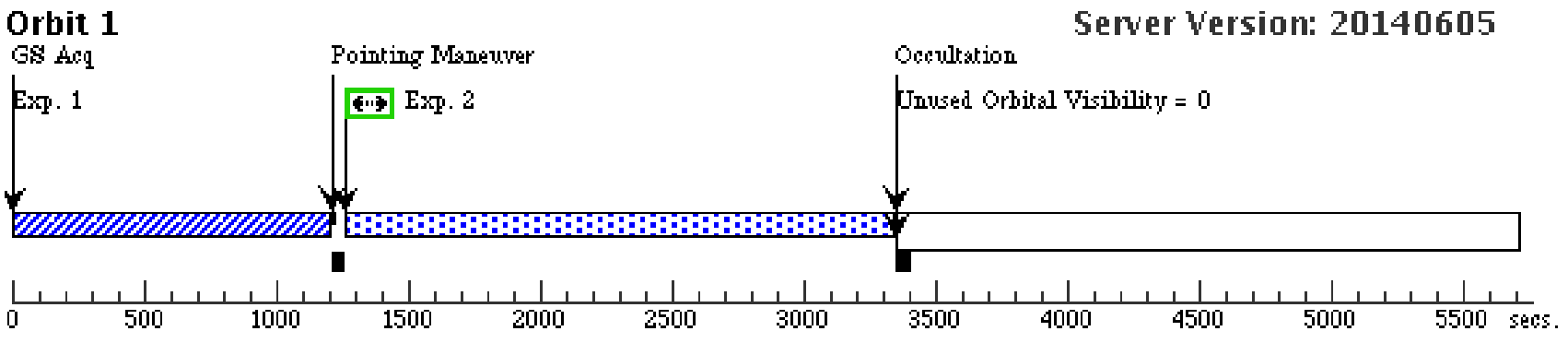
Fixed Targets

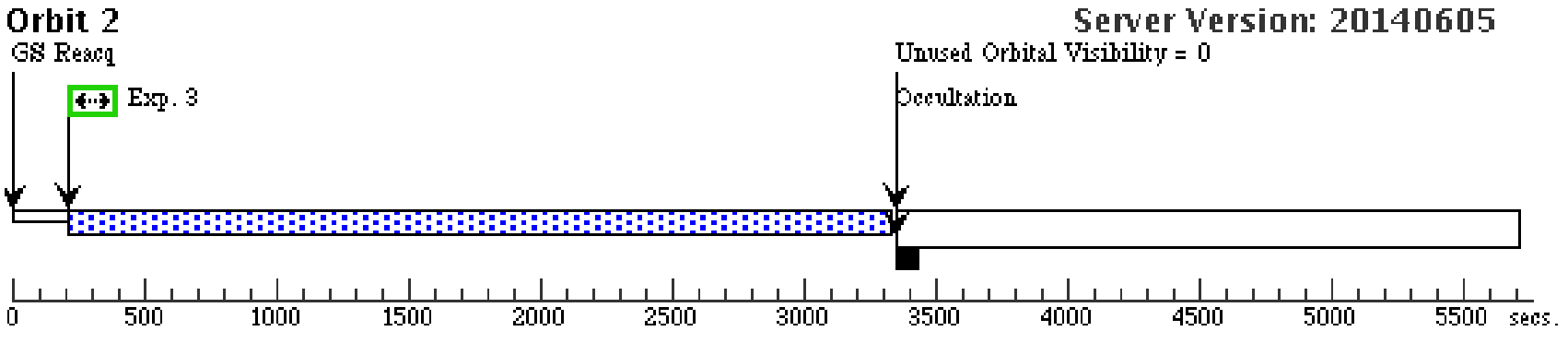
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ1614+4859 Alt Name1: SDSSJ161426.81+485958.8	RA: 16 14 26.8100 (243.6117083d) Dec: +48 59 58.81 (48.99967d) Equinox: J2000	Redshift: 3.82	V=19.56+/-0.10 ACS F150LP=21.83+-0.10, GALEX NUV=22.55+-0.39	Reference Frame: ICRS

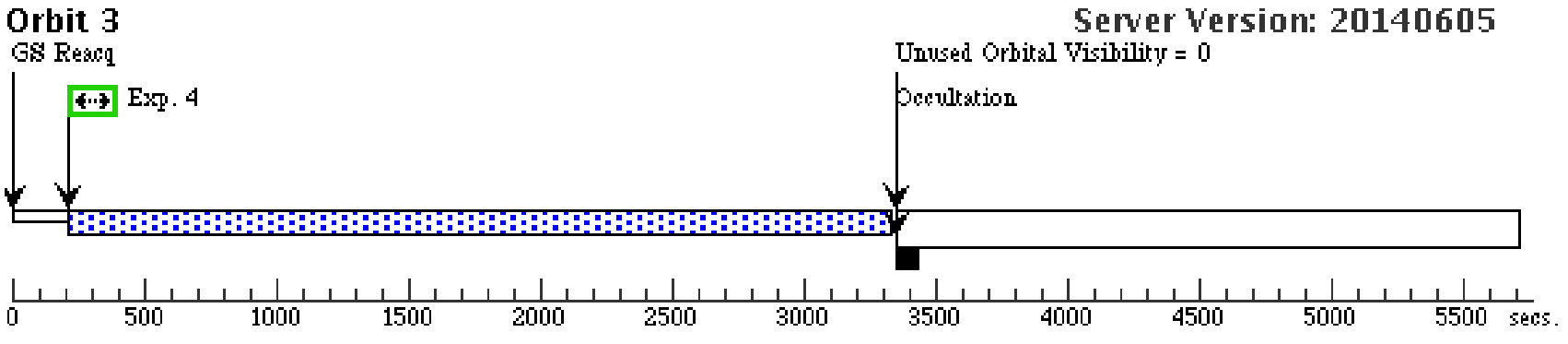
Exposures

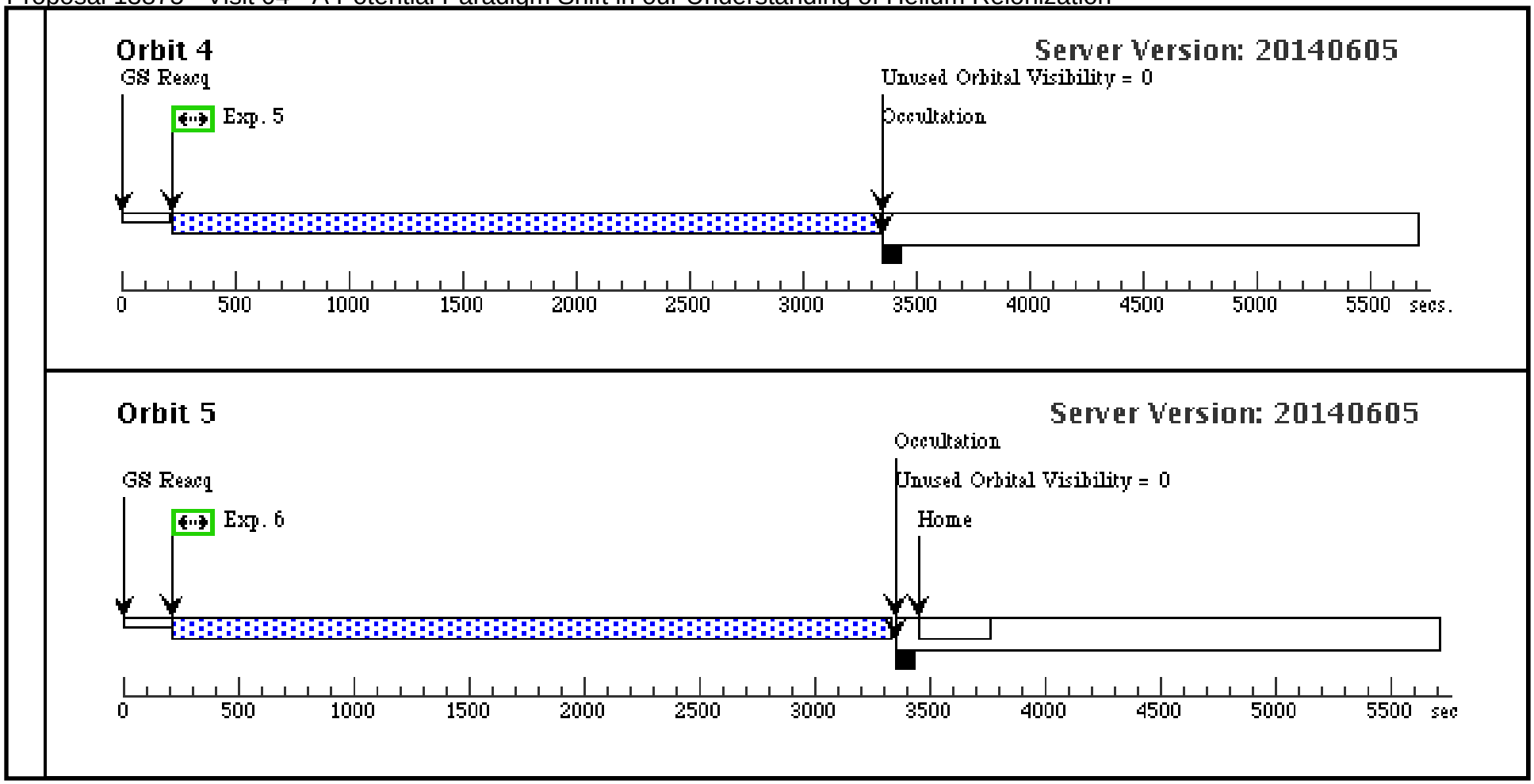
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.616464)	(2) SDSSJ1614+4859	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				400 Secs (400 Secs) *[==>]*	*[1]*
2	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=1; SEGMENT=A			1800 Secs (1896 Secs) *[==>1896.0 Secs]*	*[1]*
Comments: The ETC run conservatively assumes high background conditions, but given the faint target, the buffer time is still considerably longer than the exposure time.									
3	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=2; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[2]*
4	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[3]*
5	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[4]*
6	(COS.sp.616681)	(2) SDSSJ1614+4859	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=4; SEGMENT=A			3000 Secs (3072 Secs) *[==>3072.0 Secs]*	*[5]*

Orbit Structure








Orbit 4
Server Version: 20140605
GS Reacq
Exp. 5
Unused Orbital Visibility = 0
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.
Orbit 5
Server Version: 20140605
Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 6
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13875, Visit 05 Thu Jul 24 01:51:51 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

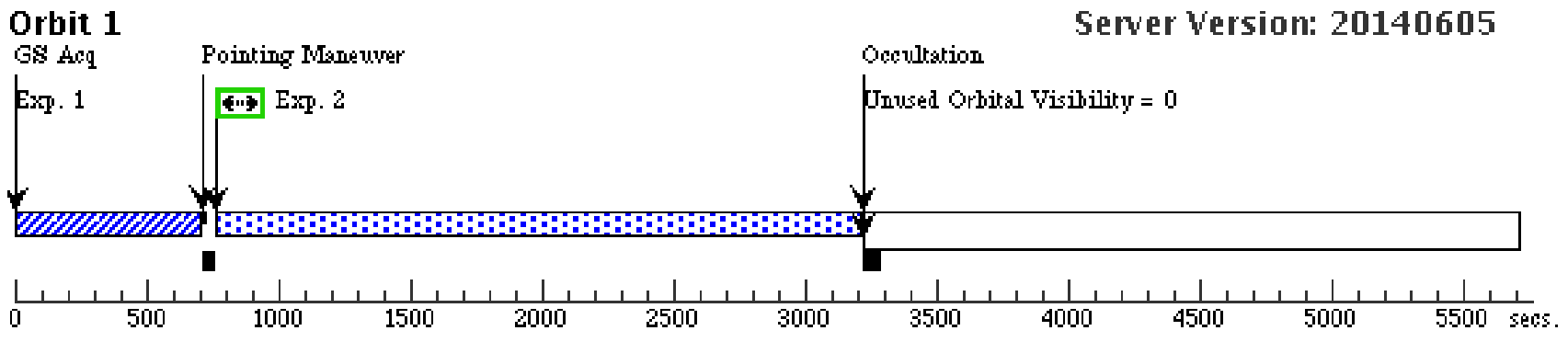
Fixed Targets

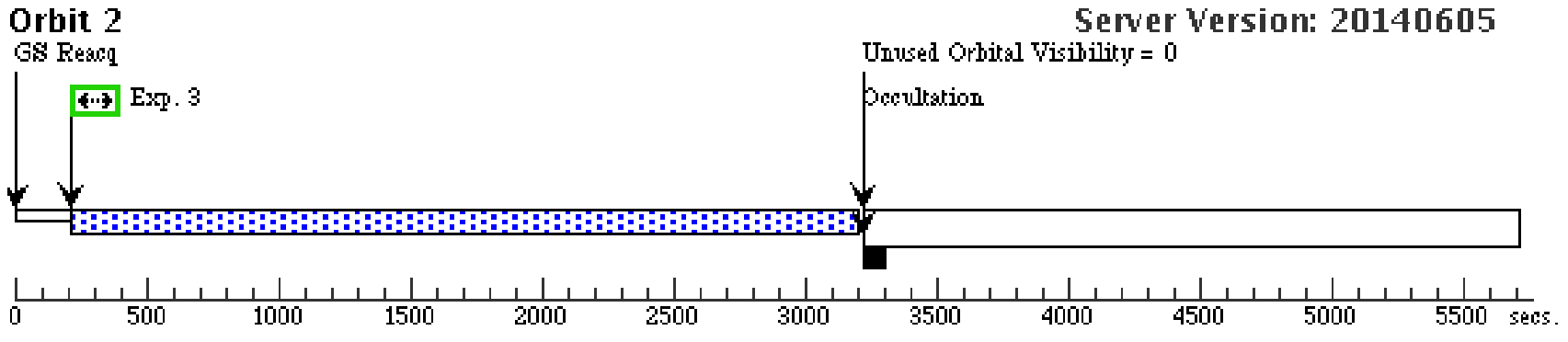
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	QSO-231145-141752	RA: 23 11 45.4600 (347.9394167d) Dec: -14 17 52.10 (-14.29781d) Equinox: J2000	Redshift: 3.70	V=18.09+/-0.10 GALEX FUV=21.60+-0.34, NUV=21.55+-0.29	Reference Frame: ICRS

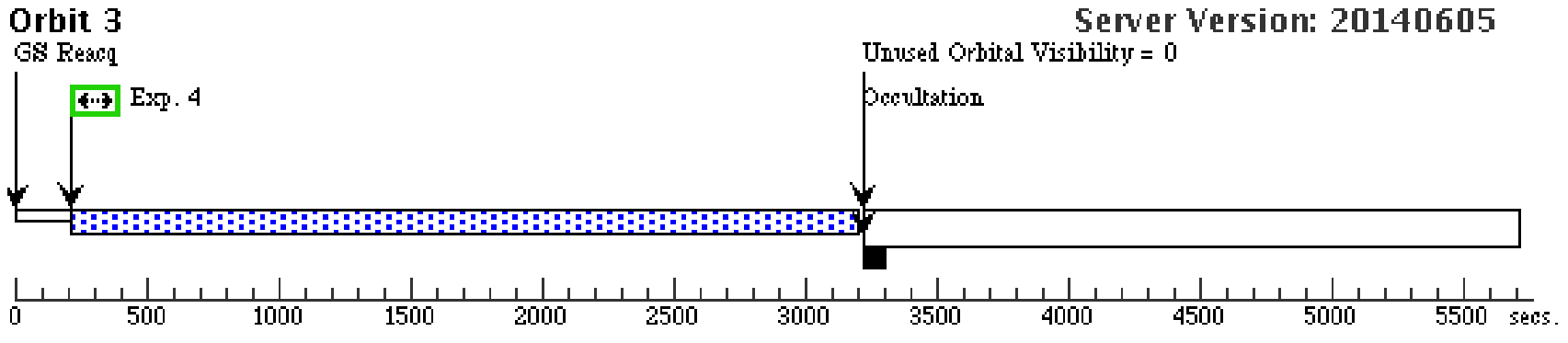
Exposures

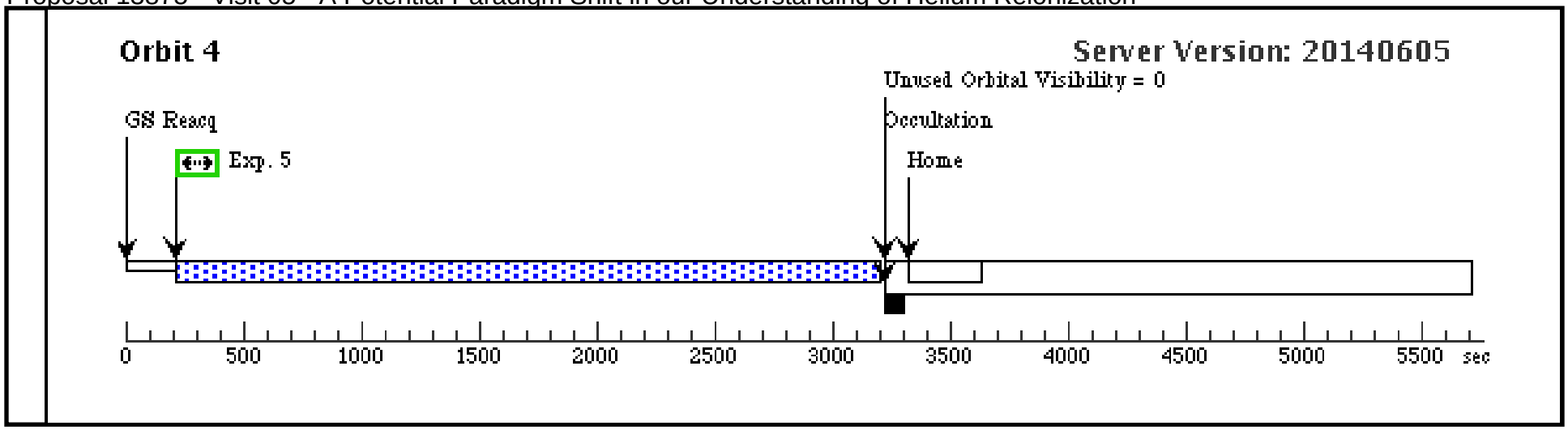
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.616482)	(3) QSO-231145-141752	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				150 Secs (150 Secs) *[==>]*	*[1]*
2	(COS.sp.616683)	(3) QSO-231145-141752	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=1; SEGMENT=A			3000 Secs (2264 Secs) *[==>2264.0 Secs]*	*[1]*
Comments: The ETC run conservatively assumes high background conditions, but given the faint target, the buffer time is still considerably longer than the exposure time.									
3	(COS.sp.616683)	(3) QSO-231145-141752	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=2; SEGMENT=A			3000 Secs (2940 Secs) *[==>2940.0 Secs]*	*[2]*
4	(COS.sp.616683)	(3) QSO-231145-141752	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=3; SEGMENT=A			3000 Secs (2940 Secs) *[==>2940.0 Secs]*	*[3]*
5	(COS.sp.616683)	(3) QSO-231145-141752	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=4300; EXTENDED=NO; FLASH=YES; FP-POS=4; SEGMENT=A			3000 Secs (2940 Secs) *[==>2940.0 Secs]*	*[4]*

Orbit Structure








Orbit 4
Server Version: 20140605
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 5
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec