13013 - How Extended was Helium II Reionization? A Statistical Census Probing Deep into the Reionization Era

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) QSO-215743+233037	COS/FUV COS/NUV	3	31-Oct-2012 21:15:02.0	yes
02	(2) QSO-232154+155834	COS/FUV COS/NUV	3	31-Oct-2012 21:15:11.0	yes
03	(3) QSO-170621+590406	COS/FUV COS/NUV	3	31-Oct-2012 21:15:19.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(4) QSO-214927-085903	COS/FUV COS/NUV	3	31-Oct-2012 21:15:27.0	yes
05	(5) QSO-023306-014950	COS/FUV COS/NUV	3	31-Oct-2012 21:15:35.0	yes
06	(6) QSO-091620+240804	COS/FUV COS/NUV	3	31-Oct-2012 21:15:41.0	yes
07	(7) QSO-163056+043559	COS/FUV COS/NUV	3	31-Oct-2012 21:15:48.0	yes

21 Total Orbits Used

ABSTRACT

The advent of GALEX and HST/COS have revolutionized studies of HeII reionization. In Cycle 17 we pioneered an effective strategy that combines highly efficient GALEX/FUV selection with HST/COS spectroscopy. Our proven approach now accounts for more than half of the science-grade HeII Ly-alpha transmission spectra in the HST archive. The clear picture emerging from these data is that z~2.7-3 marks the end of HeII reionization. However, comparison to our state-of-the-art radiative transfer simulations indicates that the duration of HeII reionization and its stochasticity remain virtually unconstrained because of the sparseness of current data at z>3. It is thus unequivocal that the path forward is COS spectra of higher redshift (z>3) QSOs deep into the reionization era. Further, a statistical census is crucial given the large sightline-to-sightline variance implied by limited existing data and verified by our numerical models. We request 21 orbits to obtain science-grade COS far-UV spectra of 7 UV-bright QSOs (newly discovered by our dedicated survey), which will double the HeII pathlength at z>3. Comparison of the distribution of HeII optical depths to our simulations will constrain the duration and stochasticity of reionization. Additional leverage will be obtained by observing the anticipated spectral hardening of the UV radiation field as reionization progresses, achieved by combining HeII transmission with ancillary coeval HI Ly-alpha forest spectra. Our survey also enables statistical investigations of the sources of HeII reionization from the HeIII QSO proximity zones, and by identifying foreground QSOs via a dedicated ground-based imaging and spectroscopic survey.

OBSERVING DESCRIPTION

We will obtain COS FUV G140L spectra of 7 z>3.1 quasars to search for intergalactic HeII absorption. The targets are spectroscopically confirmed FUV-bright quasars discovered by our team in a dedicated survey. Given the ~80% success rate of previous HeII surveys using GALEX-selected

high-redshift quasars, we will directly obtain science-grade HeII absorption spectra.

Our targets have accurate GALEX FUV magnitudes covering the quasar continuum redward of the HeII break at z<3.5 and accurate GALEX NUV magnitudes for reliable acquisition via ACQ/IMAGE. All targets are safe to observe with COS and have precise SDSS coordinates. With the COS ETC we estimated NUV imaging acquisition exposure times of 40-300s to reach the recommended S/N=40 for our sometimes NUV-faint targets.

The G140L grating provides the wavelength coverage to define the quasar continuum and the necessary resolution to measure the patchy HeII absorption at the end of HeII reionization (z~2.7). For each target we plan a single 3-orbit visit, yielding a S/N~3 per resolution element at 1400A, in agreement with our previous experience (note that the ETC overestimates the S/N in the low-count regime). For one target we request CVZ observations.

Continuous wavelength coverage at good sensitivity (lambda>1100A) is required to give maximum coverage of the HeII absorption, only provided by the G140L 1105A setup in the bluest grating setting (FP-POS=4, lambda>1110A corresponding to z>2.66). To correct for the COS grid wires (any further fixed-pattern noise is unimportant at our S/N) we request G140L 1105A observations at FP-POS=3 and 4, in accordance with our Phase I proposal. One-orbit exposures per setup will ensure proper background assessment of COS and the contaminating geocoronal emission. All 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 we will issue a buffer dump slightly before the end of each exposure to minimize readout overhead. To correct z>3.25 HeII Gunn-Peterson troughs for geocoronal OI emission, we will take only one exposure in FP-POS=4 in which geocoronal OI falls on a COS grid wire. For z<3.25 targets in which OI falls on the quasar continuum, two exposures in FP-POS=4 maximize depth at the shortest wavelengths.

REAL TIME JUSTIFICATION

In accordance with our Phase I proposal we request CVZ observations for QSO-170621+590406.

Visit

Proposal 13013, Visit 01, implementation Thu Nov 01 01:15:56 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 30%

Diagnostics

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

(Visit 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.

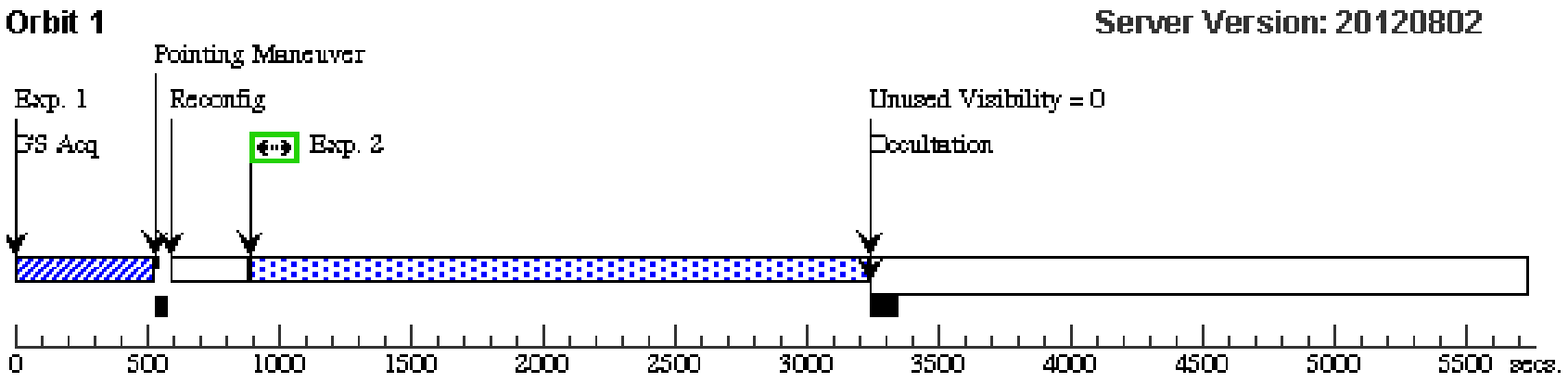
Fixed Targets

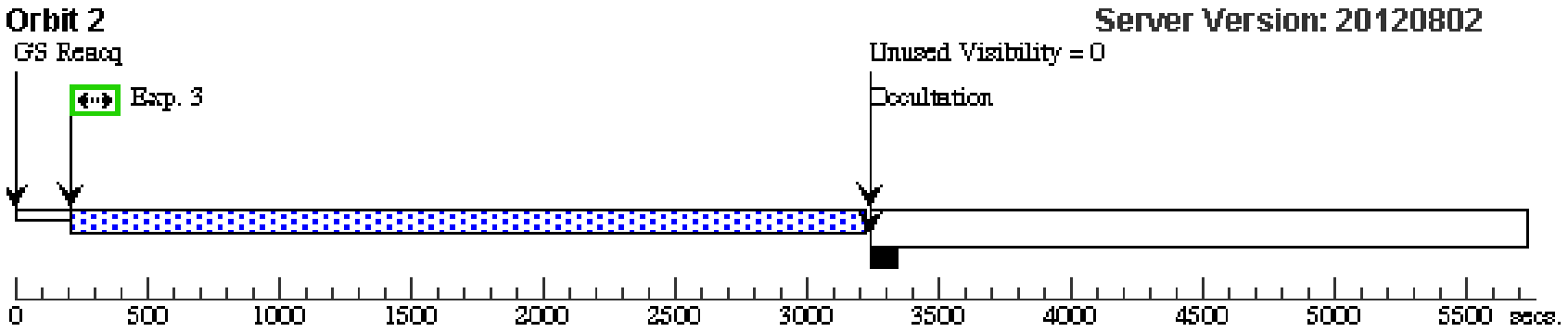
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	QSO-215743+233037	RA: 21 57 43.6300 (329.4317917d) Dec: +23 30 37.34 (23.51037d) Equinox: J2000	Redshift: 3.143	V=17.90+/-0.1 F(1539)=1.36+/-0.23 E-16, F(2316)=1.40+/-0.09 E-16	Reference Frame: ICRS

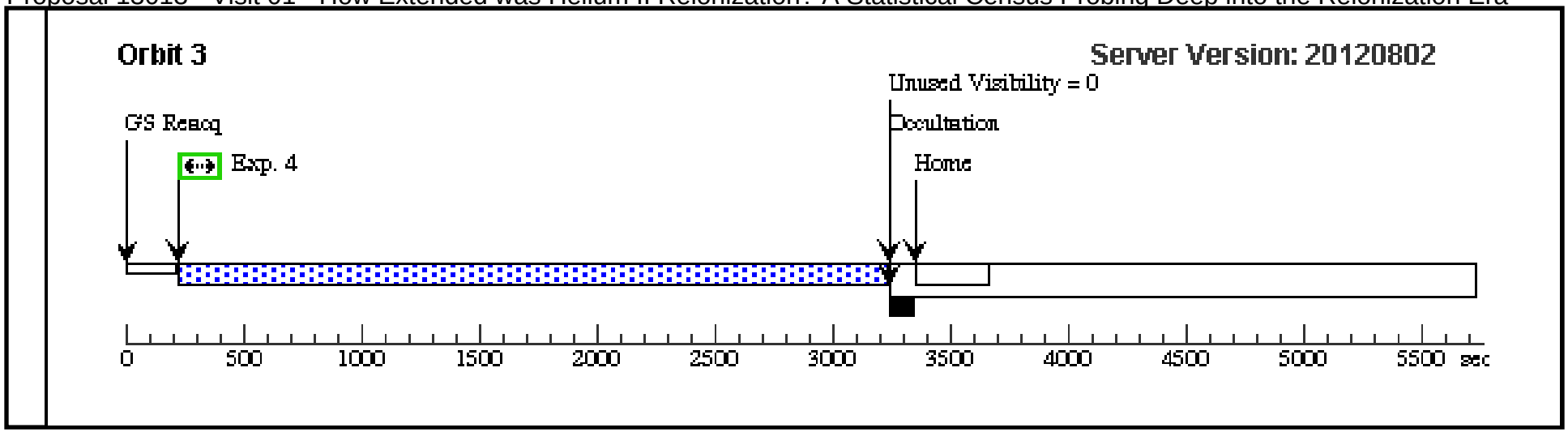
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409132)	(1) QSO-215743+233037	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 01	60 Secs *[==>]*	*[1]*
2	(409194)	(1) QSO-215743+233037	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2400; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 01	2700 Secs *[==>2158.0 Secs]*	*[1]*
3	(409194)	(1) QSO-215743+233037	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2958.0 Secs]*	*[2]*
4	(409194)	(1) QSO-215743+233037	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2958.0 Secs]*	*[3]*

Orbit Structure



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5500
sec

Visit

Proposal 13013, Visit 02, implementation Thu Nov 01 01:15:59 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 100%

Diagnostics

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

(Visit 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.

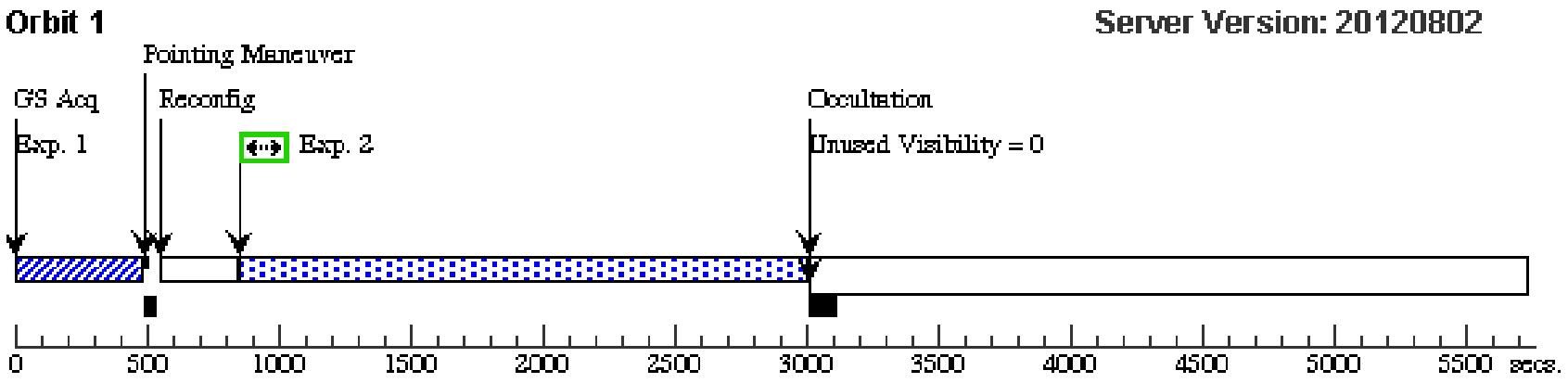
Fixed Targets

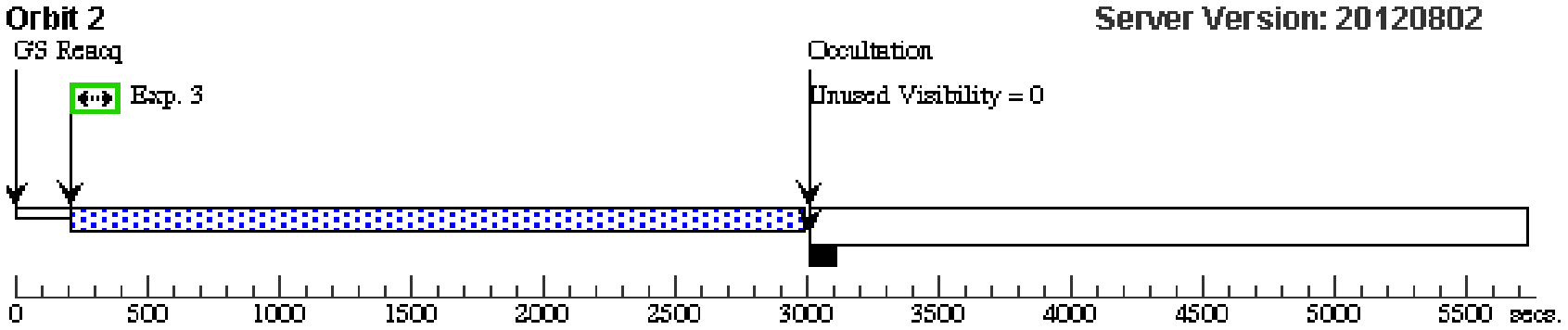
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	QSO-232154+155834	RA: 23 21 54.9900 (350.4791250d) Dec: +15 58 34.24 (15.97618d) Equinox: J2000	Redshift: 3.212	V=18.0+/-0.1 F(1539)=2.72+/-0.10 E-16, F(2316)=2.22+/-0.04 E-16	Reference Frame: ICRS

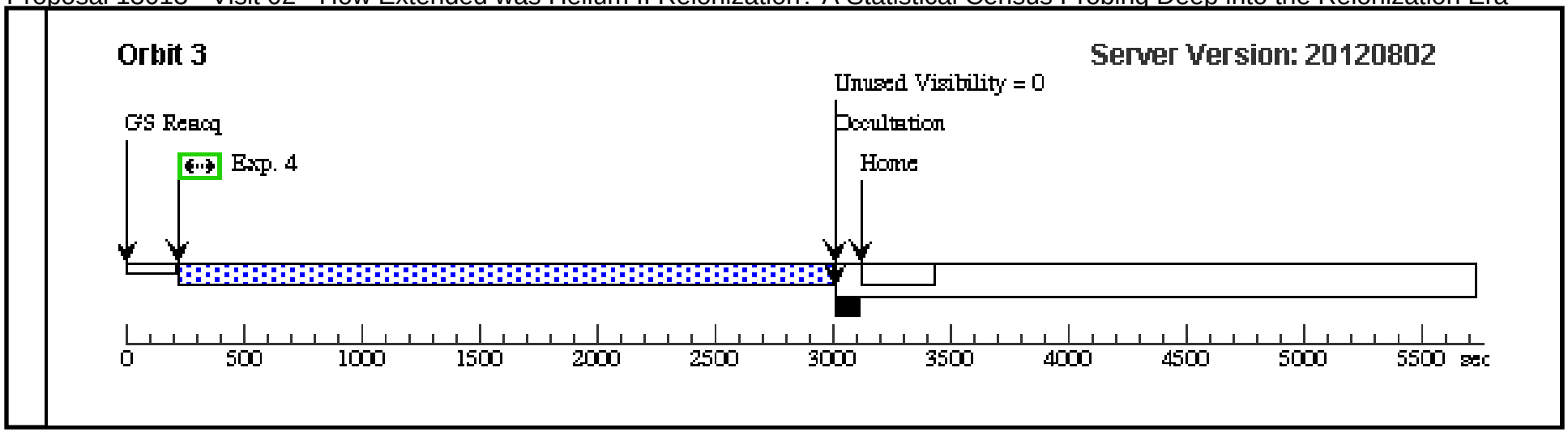
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409133)	(2) QSO-232154+155834	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 02	40 Secs *[==>]*	*[1]*
2	(409195)	(2) QSO-232154+155834	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2200; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 02	2700 Secs *[==>1969.0 Secs]*	*[1]*
3	(409195)	(2) QSO-232154+155834	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3000; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2729.0 Secs]*	*[2]*
4	(409195)	(2) QSO-232154+155834	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3000; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2729.0 Secs]*	*[3]*

Orbit Structure



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Occultation
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Visit

Proposal 13013, Visit 03, implementation Thu Nov 01 01:16:04 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ

Diagnostics

(Visit 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.

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

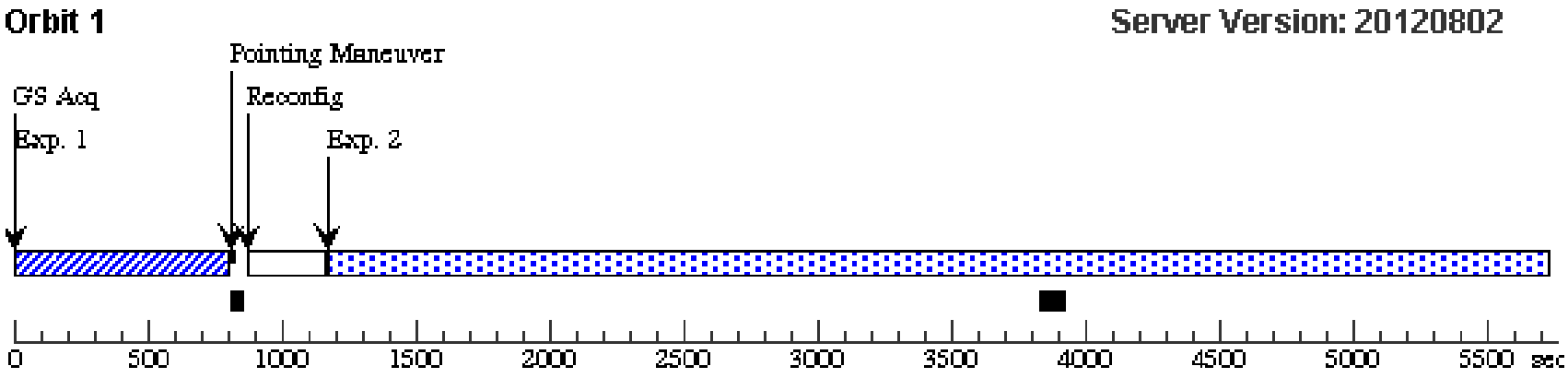
Fixed Targets

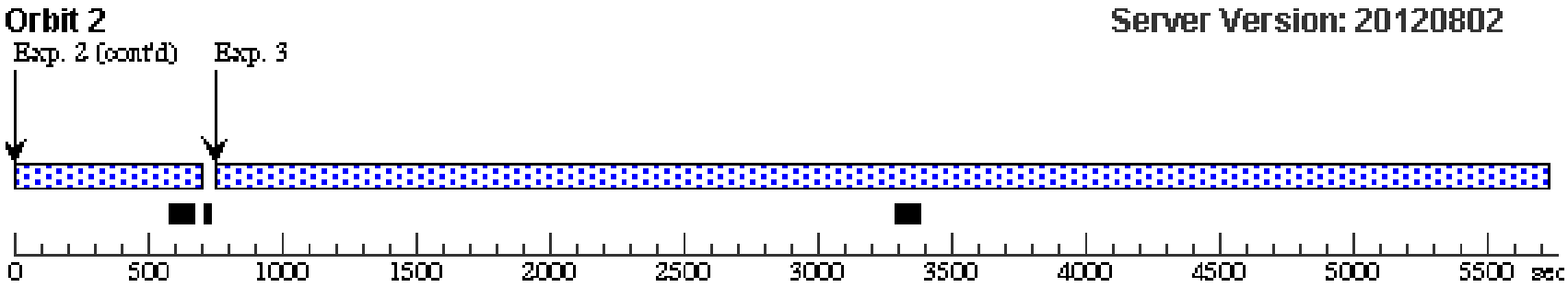
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	QSO-170621+590406	RA: 17 06 21.7500 (256.5906250d) Dec: +59 04 6.41 (59.06845d) Equinox: J2000	Redshift: 3.248	V=19.1+/-0.1 F(1539)=0.92+/-0.12 E-16, F(2316)=0.42+/-0.04 E-16	Reference Frame: ICRS

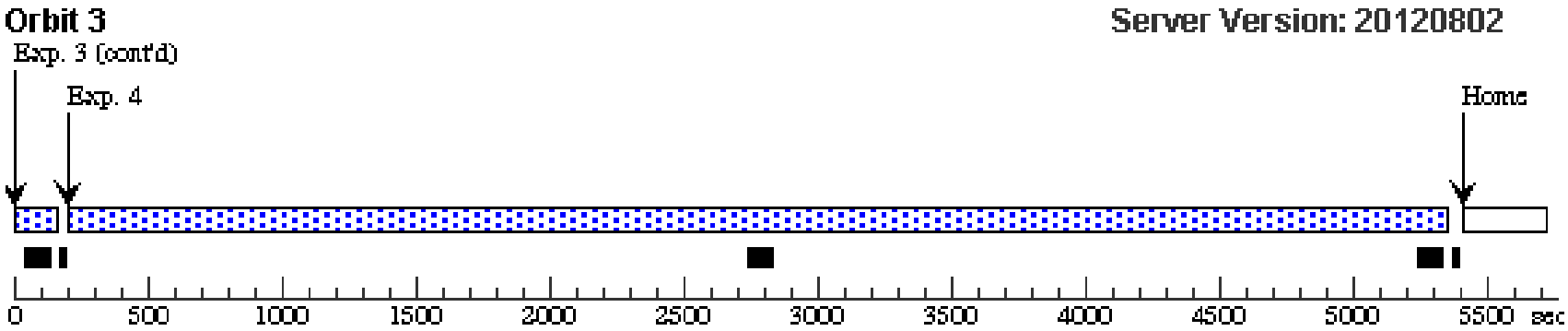
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409134)	(3) QSO-170621+590406	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-4 Non-Int in Visit 03	200 Secs *[==>]*	*[1]*
2	(409193)	(3) QSO-170621+590406	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2500; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-4 Non-Int in Visit 03	5100 Secs *[==>]*	*[1]*
3	(409193)	(3) QSO-170621+590406	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2500; EXTENDED=NO; FLASH=YES; FP-POS=4		Sequence 1-4 Non-Int in Visit 03	5100 Secs *[==>]*	*[2]*
4	(409193)	(3) QSO-170621+590406	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2500; EXTENDED=NO; FLASH=YES; FP-POS=4		Sequence 1-4 Non-Int in Visit 03	5100 Secs *[==>]*	*[3]*

Orbit Structure







Visit

Proposal 13013, Visit 04, implementation Thu Nov 01 01:16:06 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 30%

Diagnostics

(Visit 04) 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.

(Visit 04) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

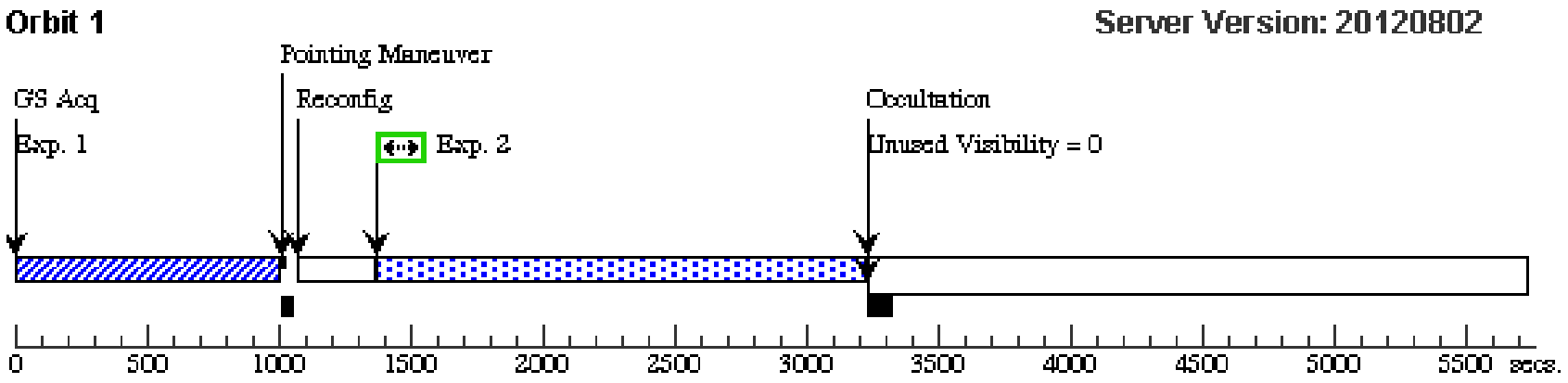
Fixed Targets

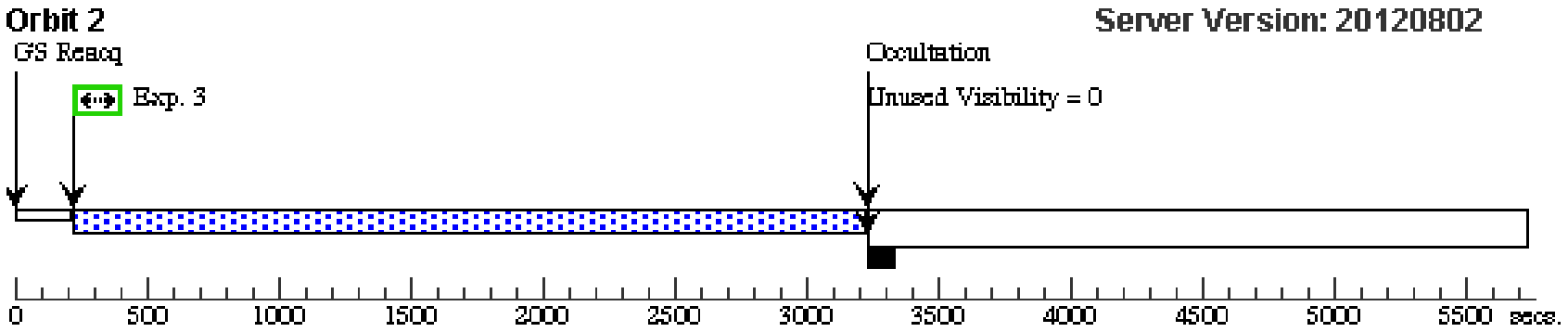
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	QSO-214927-085903	RA: 21 49 27.7700 (327.3657083d) Dec: -08 59 3.61 (-8.98434d) Equinox: J2000	Redshift: 3.259	V=18.8+/-0.1 F(1539)=1.34+/-0.47 E-16, F(2316)=0.26+/-0.09 E-16	Reference Frame: ICRS

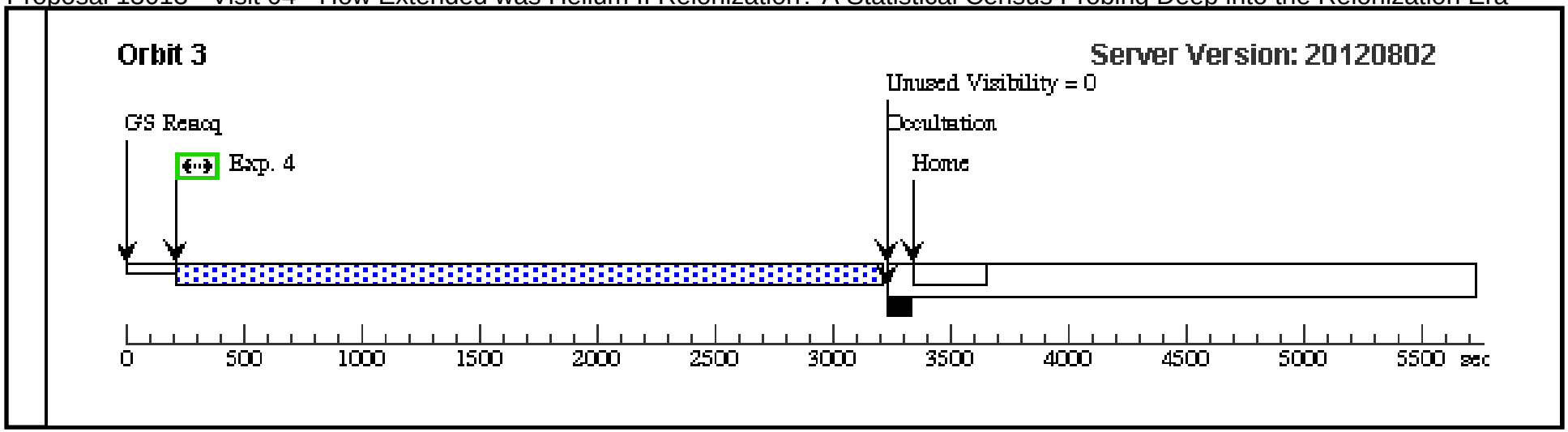
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409135)	(4) QSO-214927-085903	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 04	300 Secs *[==>]*	 ***[1]***
2	(409198)	(4) QSO-214927-085903	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=1900; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 04	2700 Secs *[==>1667.0 Secs]*	 ***[1]***
3	(409198)	(4) QSO-214927-085903	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=3			2700 Secs *[==>2947.0 Secs]*	 ***[2]***
4	(409198)	(4) QSO-214927-085903	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2947.0 Secs]*	 ***[3]***

Orbit Structure



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Visit

Proposal 13013, Visit 05, implementation Thu Nov 01 01:16:09 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 100%

Diagnostics

(Visit 05) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

(Visit 05) 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.

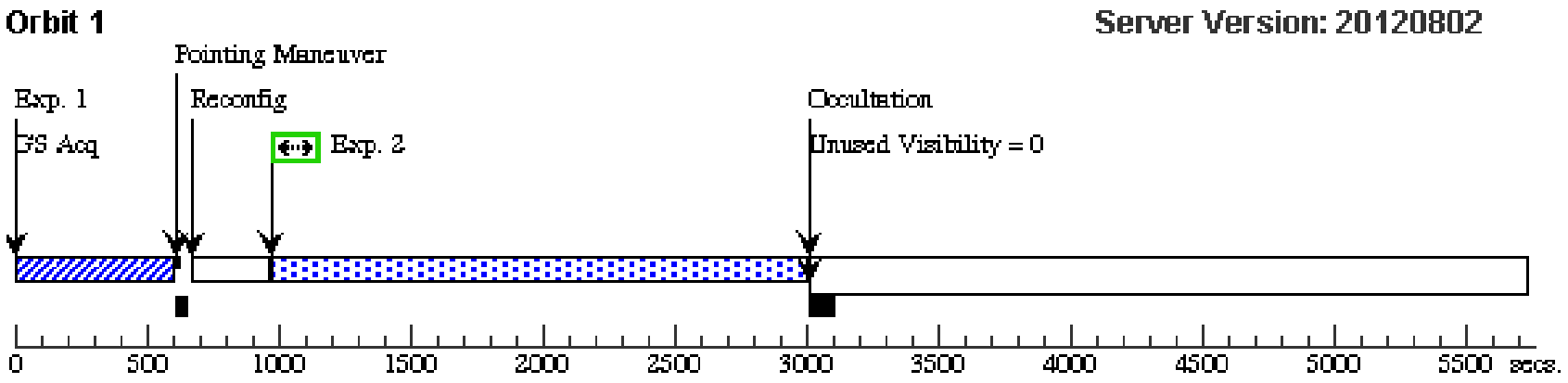
Fixed Targets

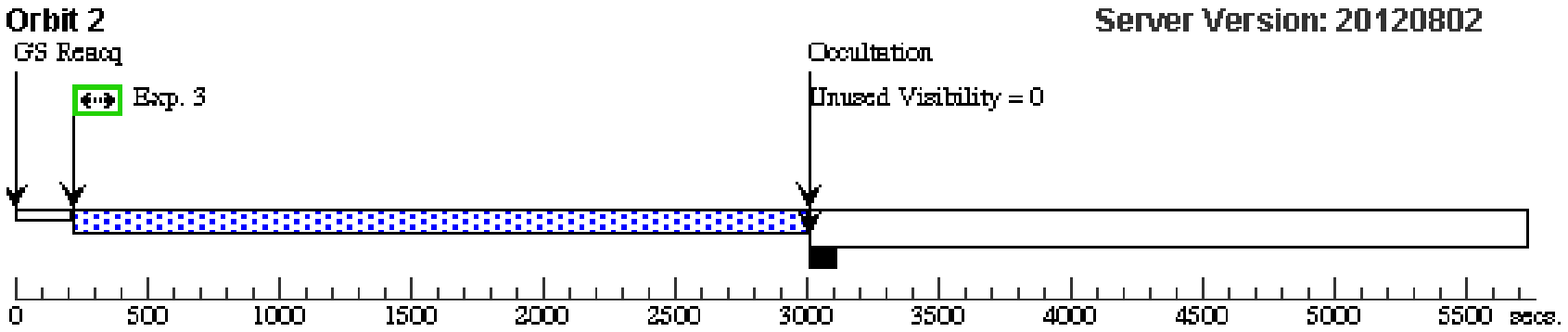
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	QSO-023306-014950	RA: 02 33 6.0100 (38.2750417d) Dec: -01 49 50.58 (-1.83072d) Equinox: J2000	Redshift: 3.314	V=18.5+/-0.1 F(1539)=1.56+/-0.29 E-16, F(2316)=0.81+/-0.13 E-16	Reference Frame: ICRS

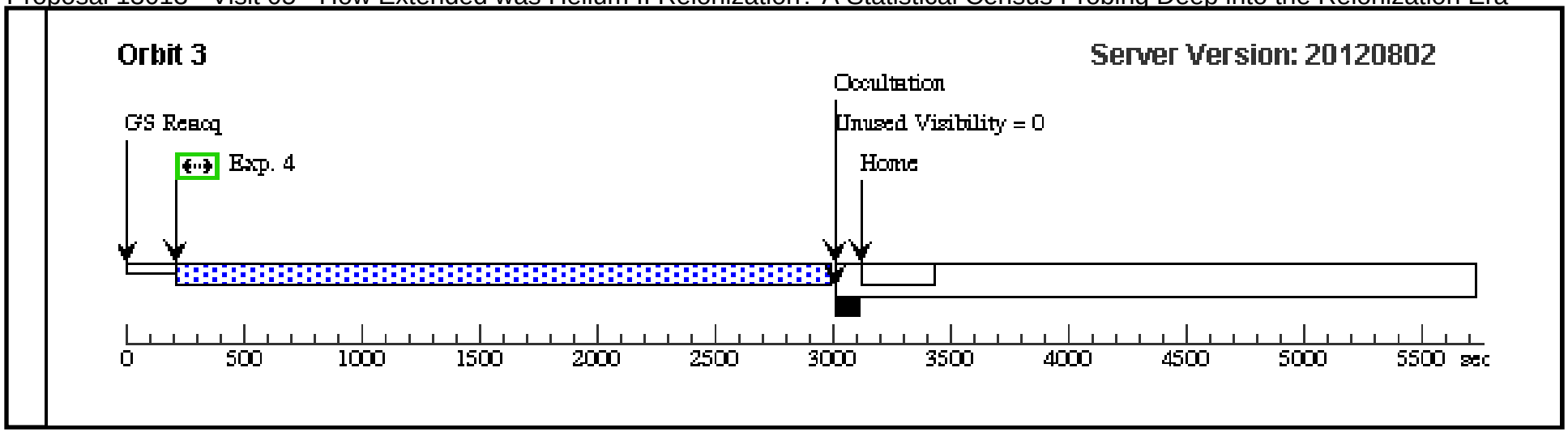
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409136)	(5) QSO-023306-014950	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 05	100 Secs *[==>]*	*[1]*
2	(409200)	(5) QSO-023306-014950	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2100; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 05	2700 Secs *[==>1849.0 Secs]*	*[1]*
3	(409200)	(5) QSO-023306-014950	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3000; EXTENDED=NO; FLASH=YES; FP-POS=3			2700 Secs *[==>2729.0 Secs]*	*[2]*
4	(409200)	(5) QSO-023306-014950	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3000; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2729.0 Secs]*	*[3]*

Orbit Structure



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Visit

Proposal 13013, Visit 06, implementation Thu Nov 01 01:16:12 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 30%

Diagnostics

(Visit 06) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

(Visit 06) 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.

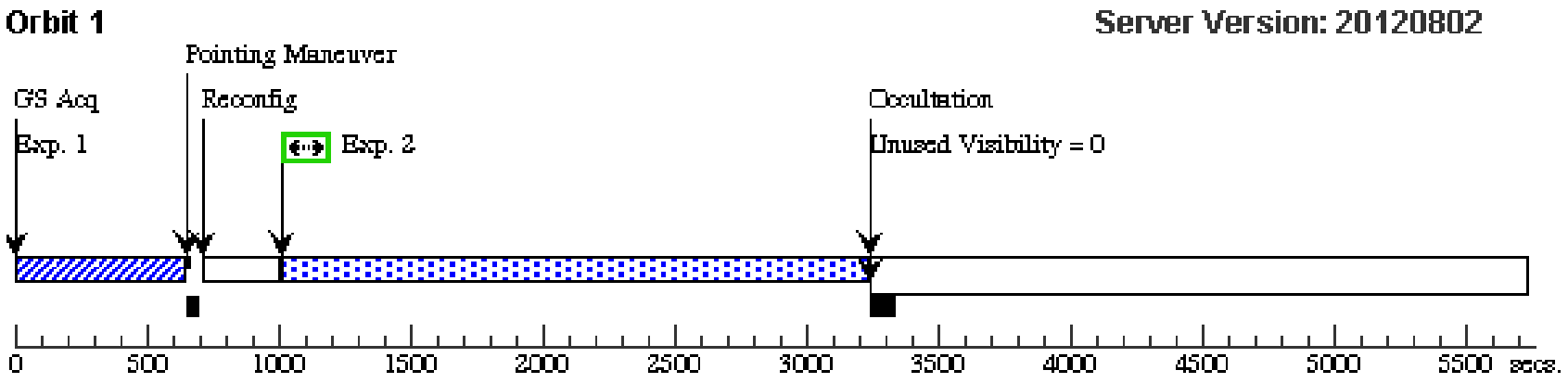
Fixed Targets

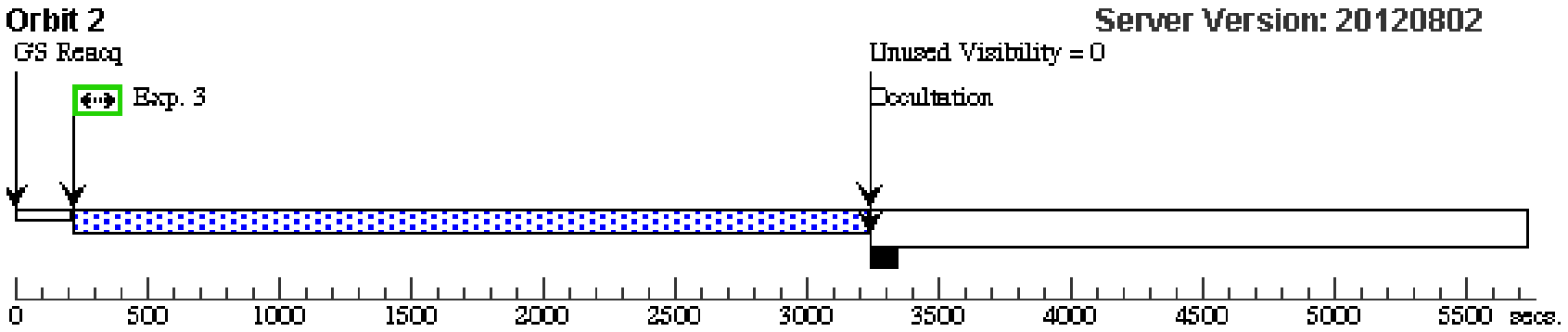
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	QSO-091620+240804	RA: 09 16 20.8500 (139.0868750d) Dec: +24 08 4.69 (24.13464d) Equinox: J2000	Redshift: 3.440	V=18.8+/-0.1 F(1539)=1.27+/-0.22 E-16, F(2316)=0.67+/-0.06 E-16	Reference Frame: ICRS

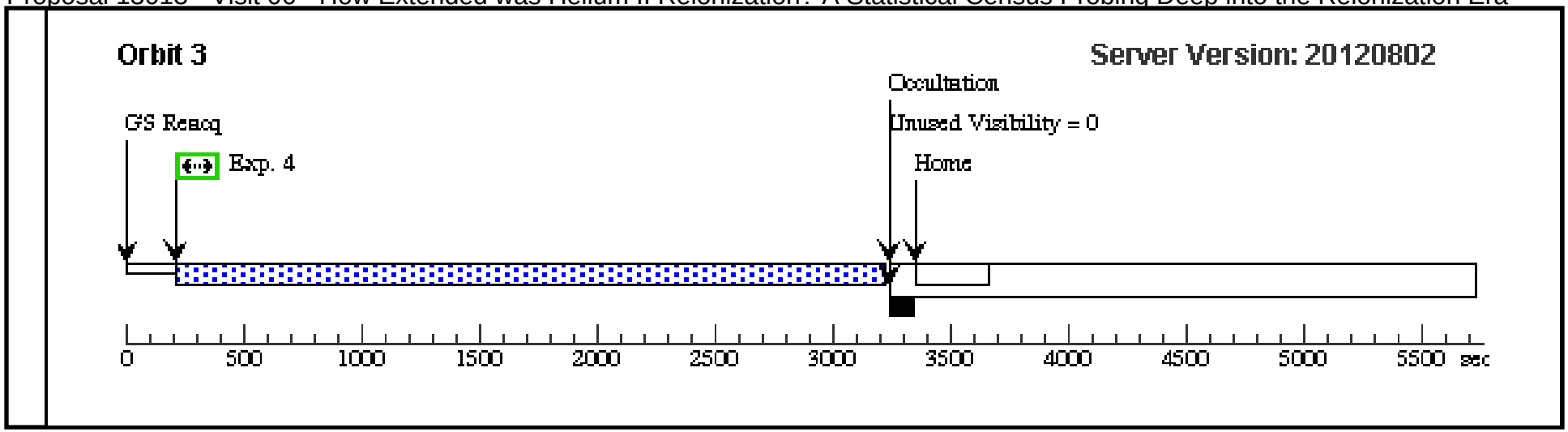
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409137)	(6) QSO-091620+240804	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 06	120 Secs *[==>]*	*[1]*
2	(409201)	(6) QSO-091620+240804	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2300; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 06	2700 Secs *[==>2038.0 Secs]*	*[1]*
3	(409201)	(6) QSO-091620+240804	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=3			2700 Secs *[==>2958.0 Secs]*	*[2]*
4	(409201)	(6) QSO-091620+240804	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2958.0 Secs]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20120802
Occultation
GS Reacq
Unused Visibility = 0
Exp. 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13013, Visit 07, implementation Thu Nov 01 01:16:14 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: SCHED 30%

Diagnostics

(Visit 07) 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.

(Visit 07) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

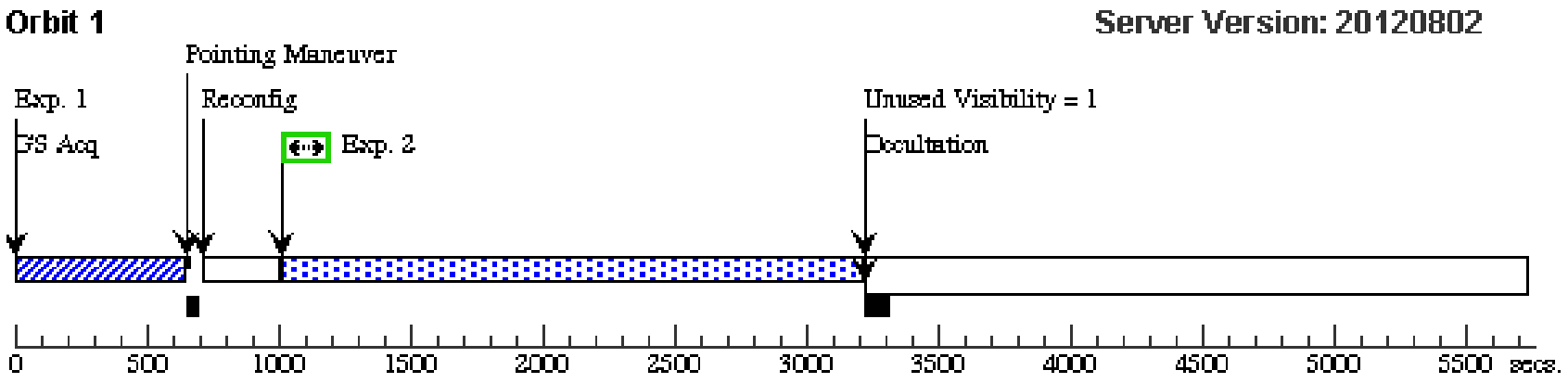
Fixed Targets

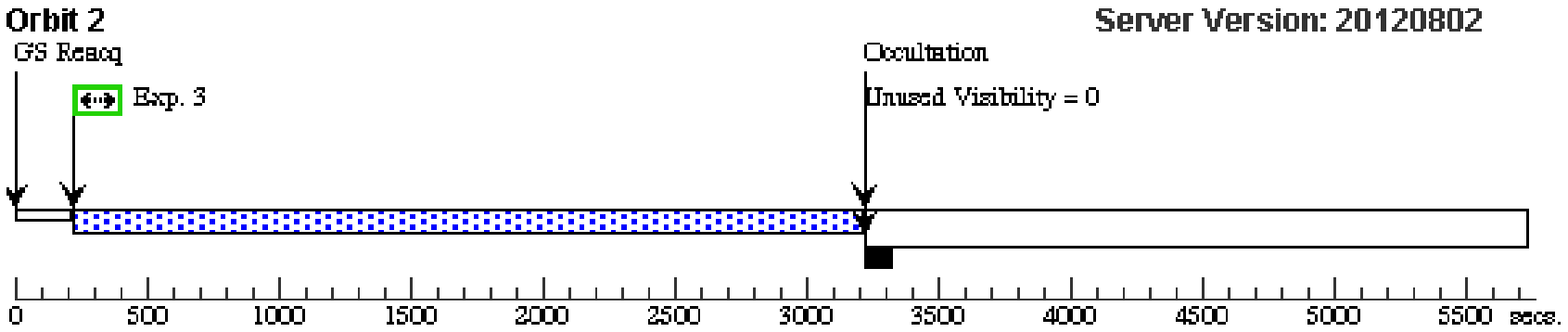
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(7)	QSO-163056+043559	RA: 16 30 56.3400 (247.7347500d) Dec: +04 35 59.42 (4.59984d) Equinox: J2000	Redshift: 3.788	V=17.6+/-0.1 F(1539)=1.55+/-0.21 E-16, F(2316)=0.72+/-0.14 E-16	Reference Frame: ICRS

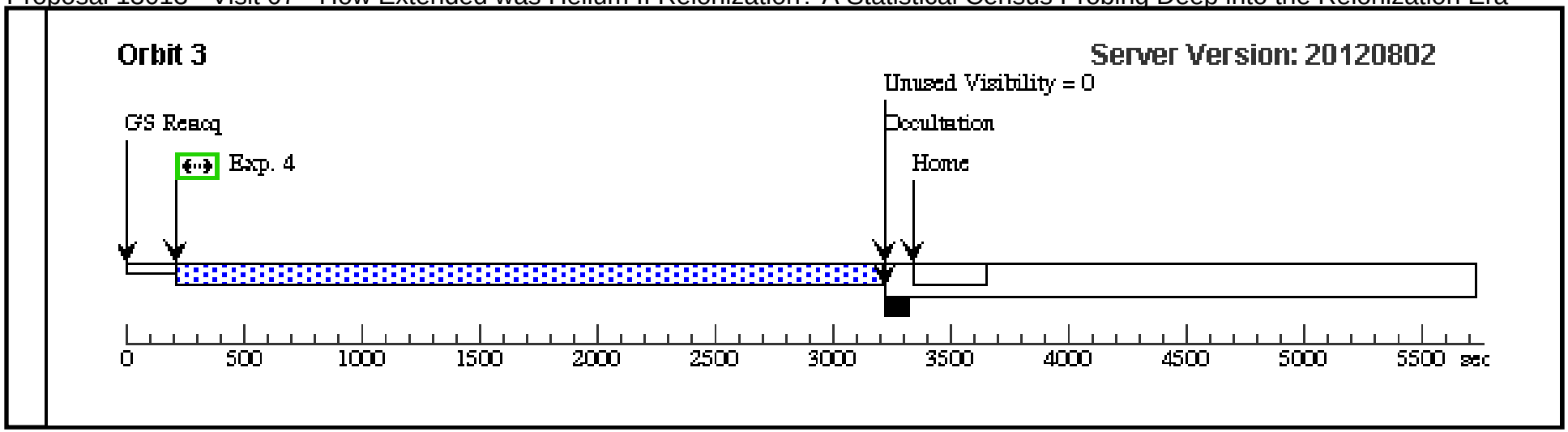
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(409138)	(7) QSO-163056+043559	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-2 Non-Int in Visit 07	120 Secs *[==>]*	*[1]*
2	(409202)	(7) QSO-163056+043559	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2300; EXTENDED=NO; FLASH=YES; FP-POS=3		Sequence 1-2 Non-Int in Visit 07	2700 Secs *[==>2022.0 Secs]*	*[1]*
3	(409202)	(7) QSO-163056+043559	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=3			2700 Secs *[==>2943.0 Secs]*	*[2]*
4	(409202)	(7) QSO-163056+043559	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=3200; EXTENDED=NO; FLASH=YES; FP-POS=4			2700 Secs *[==>2943.0 Secs]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20120802
Unused Visibility = 0
GS Reacq
Occultation
Exp. 4
Home
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500
1000
1500
2000
2500
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4000
4500
5000
5500
sec