14242 - Deep Multiwavelength Campaign on an AGN Outflow: Absolute Abundances and the Warm Absorber Connection

Cycle: 23, 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) NGC-7469	COS/FUV	4	09-Jul-2015 21:09:20.0	yes
02	(1) NGC-7469	COS/FUV	5	09-Jul-2015 21:09:25.0	yes

9 Total Orbits Used

ABSTRACT

Our team was recently awarded a deep multiwavelength campaign on the AGN outflow seen in the Seyfert 1 galaxy NGC 7469: 560 ks on XMM, 140 ks NuSTAR observations, 80 ks Swift, 14 HST/COS orbits (covering 1135A - 1700A), and optical ground-based monitoring. The missing piece in our campaign is the ability to measure absolute abundances, which are crucial for determining the ionization equilibrium and kinetic luminosity of the outflow. Here we propose to obtain near-simultaneous HST/COS spectra of the 940A-1100A range covering the Lyman beta, gamma and delta lines, which are needed for abundance determination. This will reduce the uncertainties on the ionization equilibrium and kinetic luminosity by an order of magnitude. These observations also cover the O VI doublet that allows us to connect the X-ray warm absorber with the UV outflow.

AGN Outflows play a crucial role in feedback processes that control galaxy evolution, the growth of central black holes in galaxies, and the enrichment of the ICM and the IGM. Our research collaboration achieved unprecedented scientific results from two similarly large campaigns on Mrk 509 and NGC 5548. Besides the deep coverage of many spectral regions, we also cover the time domain, which is crucial for determining the distance of the bulk of the outflow from the central source.

OBSERVING DESCRIPTION

We will obtain medium-resolution far-UV spectra of NGC 7469 using COS. We will use grating G130M/1096 primarily to measure absorption in the high-ionization O VI 1032,1038 resonance doublet, and the Ly beta, Ly gamma, and Ly delta lines. The R~12,000 resolving power of the G130M/1096 grating setting fully resolves the 100 km/s widths of the UV absorption components in NGC 7469 (Scott et al. 2004). This resolution enables detailed measurements of trough profiles, optical depths, and covering factors in Lybeta, Ly gamma, Lydelta, and O VI. The far-UV flux of

NGC 7469 has historically ranged from a low of 1.5e-14 erg cm^{-2} s^{-1} A^{-1} at 1360 A to a high of 6.2e-14 erg cm^{-2} s^{-1} A^{-1} (based on data from the HST archive), with a mean flux of 3.2e-14 erg cm^{-2} s^{-1} A^{-1}. A S/N of 10 per resolution element in the continuum at 1040 A is necessary to measure the mildly saturated O VI troughs seen in the FUSE spectrum. Using the COS ETC (v23.2.1), a S/N of 10 per resolution element in the continuum at 1040 A requires 22,200 seconds of exposure time. This calculation is optimized for O VI, but we will achieve comparable S/N in Lybeta, Ly gamma and Lydelta. For the longer-wavelength lines S/N will exceed 50, in principle. With multiple exposures at different FP-POS positions, this is possible. We note that the high resolution afforded by COS makes our proposed observations robust to flux variations to fainter levels. The ~100 km/s troughs are spanned by 4 COS resolution elements. In the extreme case where NGC 7469 will be in the lowest historic observed flux state, we could bin our spectrum up by a factor of two and still oversample the absorption troughs at the same S/N.

These observations pose no bright object concerns. All historical flux levels for NGC 7469 lie below the bright object limits for COS. Since NGC 7469 has been observed successfully before (see HST PIDs 12212 and 14054), there are also no surrounding field objects that are too bright. Our ETC calculations use the ETC FOS quasar spectrum redshifted to z=0.016317 with foreground extinction of E(B-V)=0.061 and normalized to the historical minimum and maximum flux at 1360 A (flam_min=1.5e-14, flam_max=6.2e-14, Dunn et al. 2006) in order to get our limiting cases:

- ACQUISITION -

Configuration	Flux	EXP time	Max cts/s/pix	Total rate	Buffer Time	COS ETC ID
G130M/1291	1.5e-14	25 s	0.10	1059	2227	COS.sa.715054
G130M/1291	6.2e-14	25 s	0.11	2979	791	COS.sa.715055

- EXPOSURES -

Configuration	Flux	EXP time	Max cts/s/pix	Total rate	Buffer Time	COS ETC ID
G130M/1096	6.2e-14	1000	0.08	970	2431	COS.sp.715060

Coordination with XMM-Newton

Our HST observations will be coordinated with an on-going XMM-Newton program which is currently scheduled to observe NGC 7469 simultaneously with HST program 14054 in the following plan windows:

Visit 02 NGC-7469 Nov 24, 2015 - Nov 25, 2015
Visit 03 NGC-7469 Dec 14, 2015 - Dec 16, 2015
Visit 04 NGC-7469 Dec 22, 2015 - Dec 22, 2015

Visit 05 NGC-7469 Dec 24, 2015 - Dec 26, 2015

Visit 06 NGC-7469 Dec 26, 2015 - Dec 28, 2015

Visit 07 NGC-7469 Dec 28, 2015 - Dec 30, 2015

Each of the two visits from this program should be scheduled adjacent to one of the visits from program 14054 above, within 1 day.

Visit

Proposal 14242, Visit 01, implementation Fri Jul 10 01:09:27 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: SCHED 100%

Diagnostics

(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

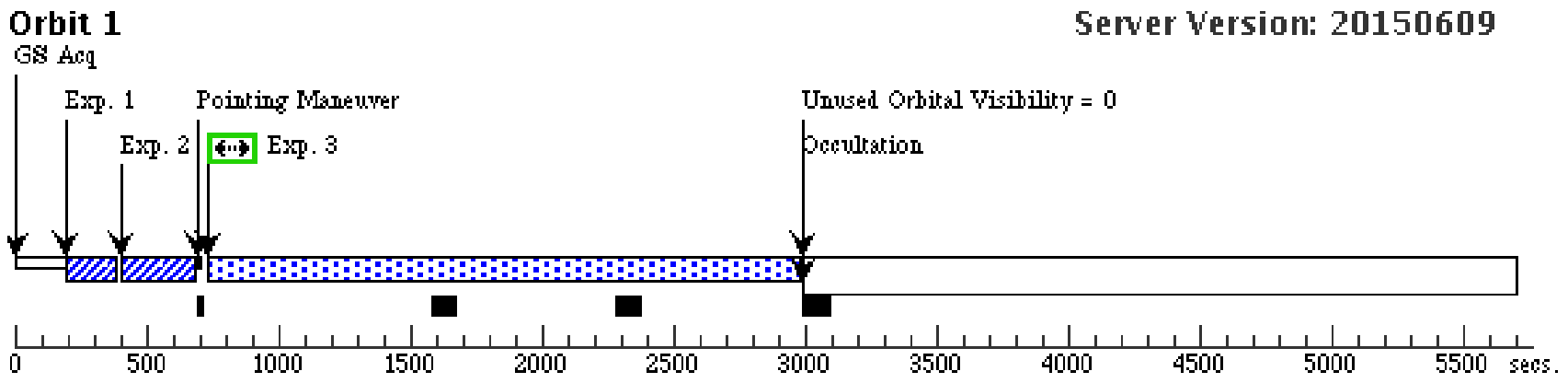
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-7469	RA: 23 03 15.6740 (345.8153083d) Dec: +08 52 25.28 (8.87369d) Equinox: J2000	Redshift: 0.016317	V=12.34+/-0.5 3.2e-14 at 1360 A	Reference Frame: ICRS

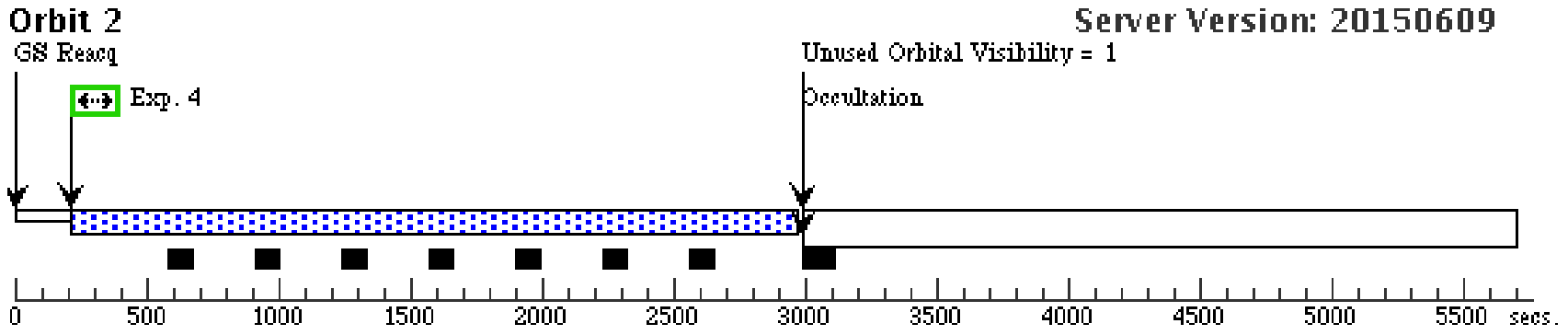
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

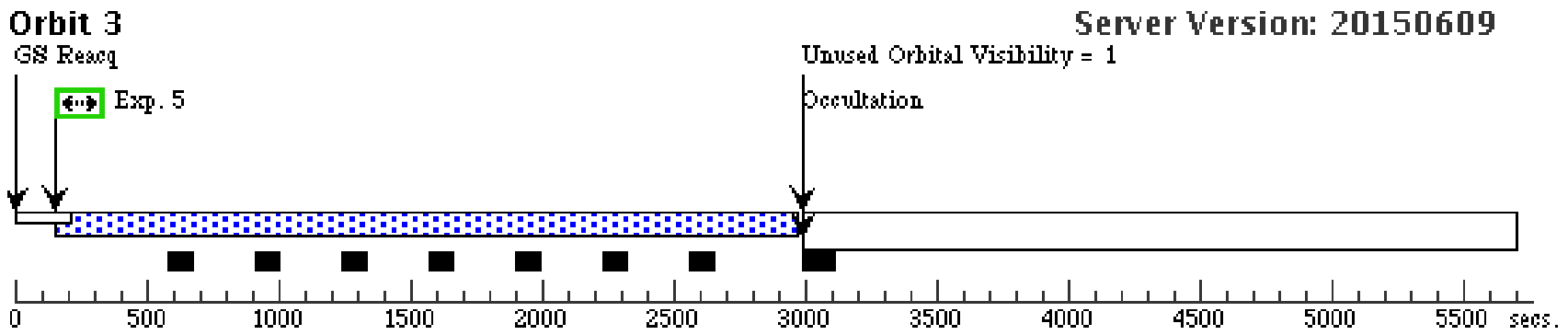
Exposures

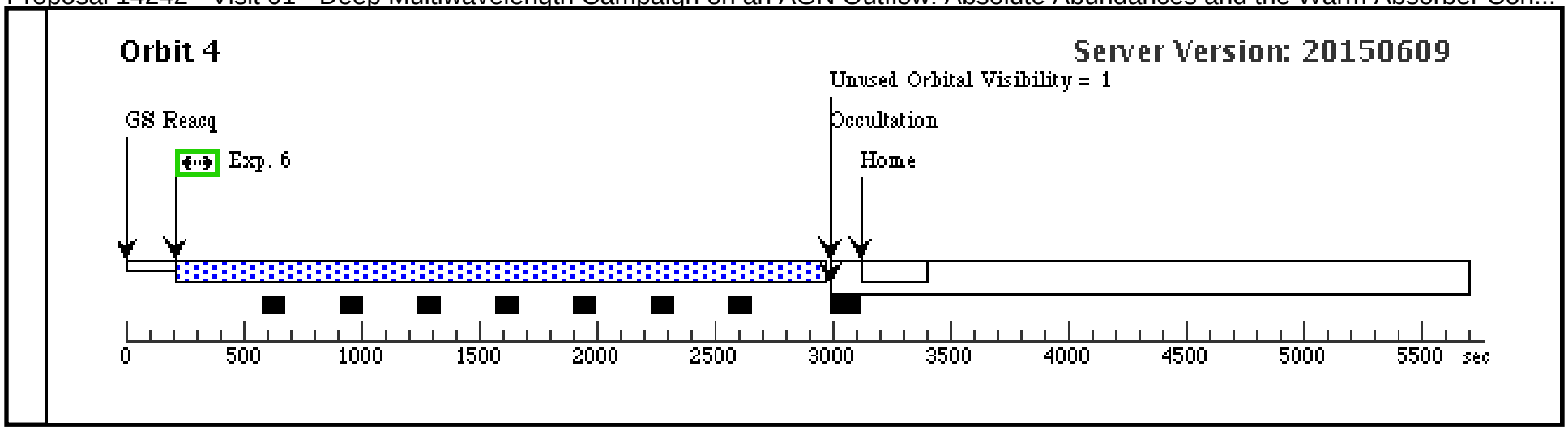
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.sa.715055)	(1) NGC-7469	COS/FUV, ACQ/PEAKXD, PSA	G130M 1291 A				25 Secs (25 Secs) *[==>]*	***[1]***
2	(COS.sa.715055)	(1) NGC-7469	COS/FUV, ACQ/PEAKD, PSA	G130M 1291 A	NUM-POS=5; STEP-SIZE=0.9; CENTER=FLUX-WT-FLR			25 Secs (25 Secs) *[==>]*	***[1]***
3	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=700; FP-POS=3			2075 Secs (2075 Secs) *[==>]*	***[1]***
4	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=4			2705 Secs (2705 Secs) *[==>]*	***[2]***
5	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=1			2705 Secs (2705 Secs) *[==>]*	***[3]***
6	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=2			2705 Secs (2705 Secs) *[==>]*	***[4]***

Orbit Structure





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Visit

Proposal 14242, Visit 02, implementation Fri Jul 10 01:09:27 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: SCHED 100%

Diagnostics

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-7469	RA: 23 03 15.6740 (345.8153083d) Dec: +08 52 25.28 (8.87369d) Equinox: J2000	Redshift: 0.016317	V=12.34+/-0.5 3.2e-14 at 1360 A	Reference Frame: ICRS

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Exposures

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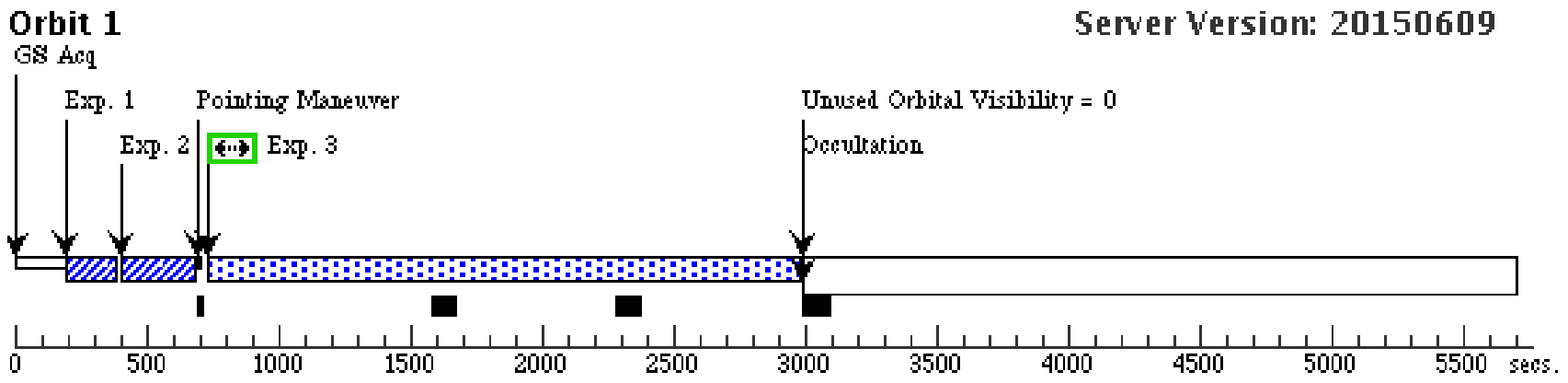
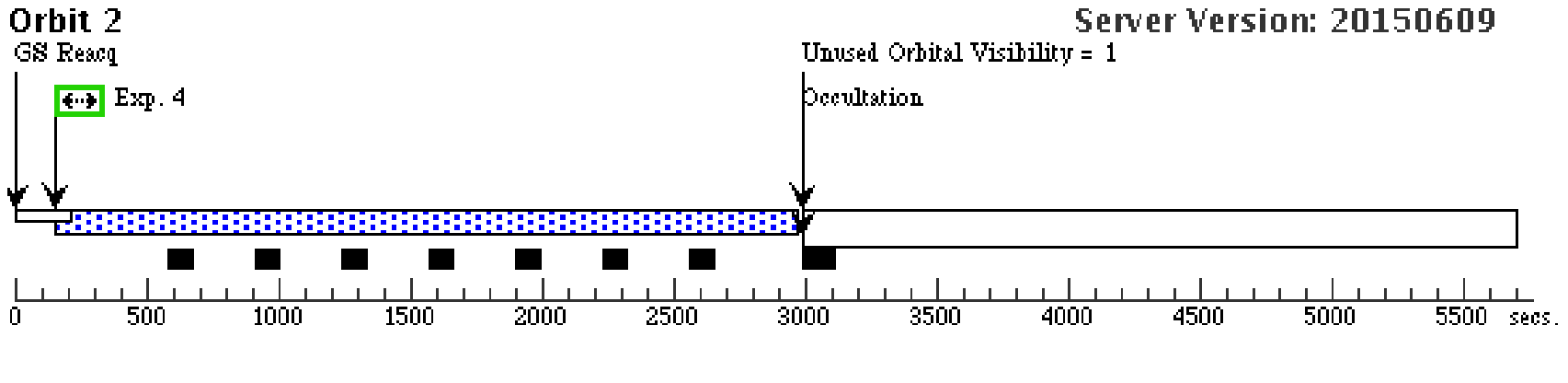
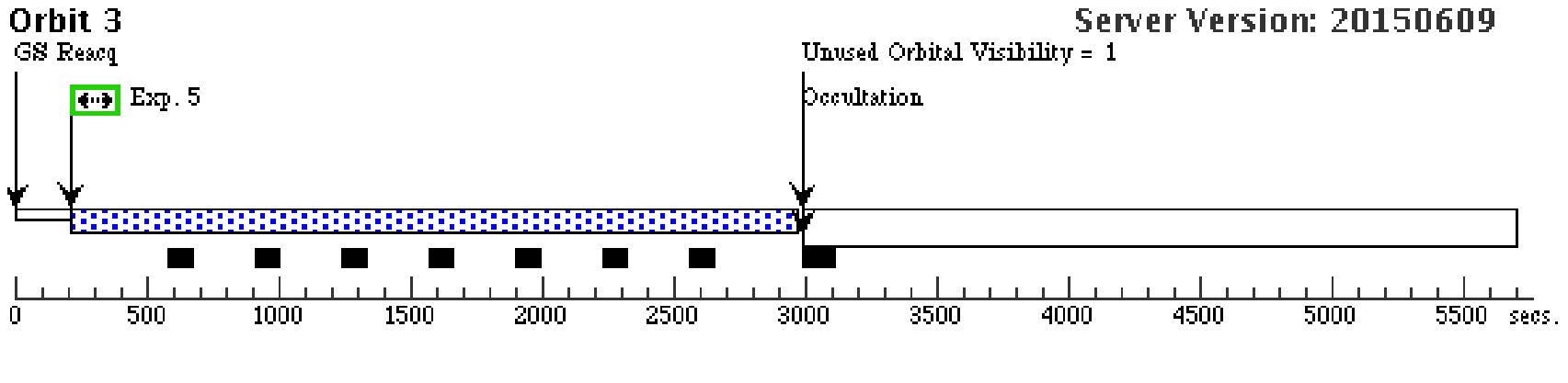
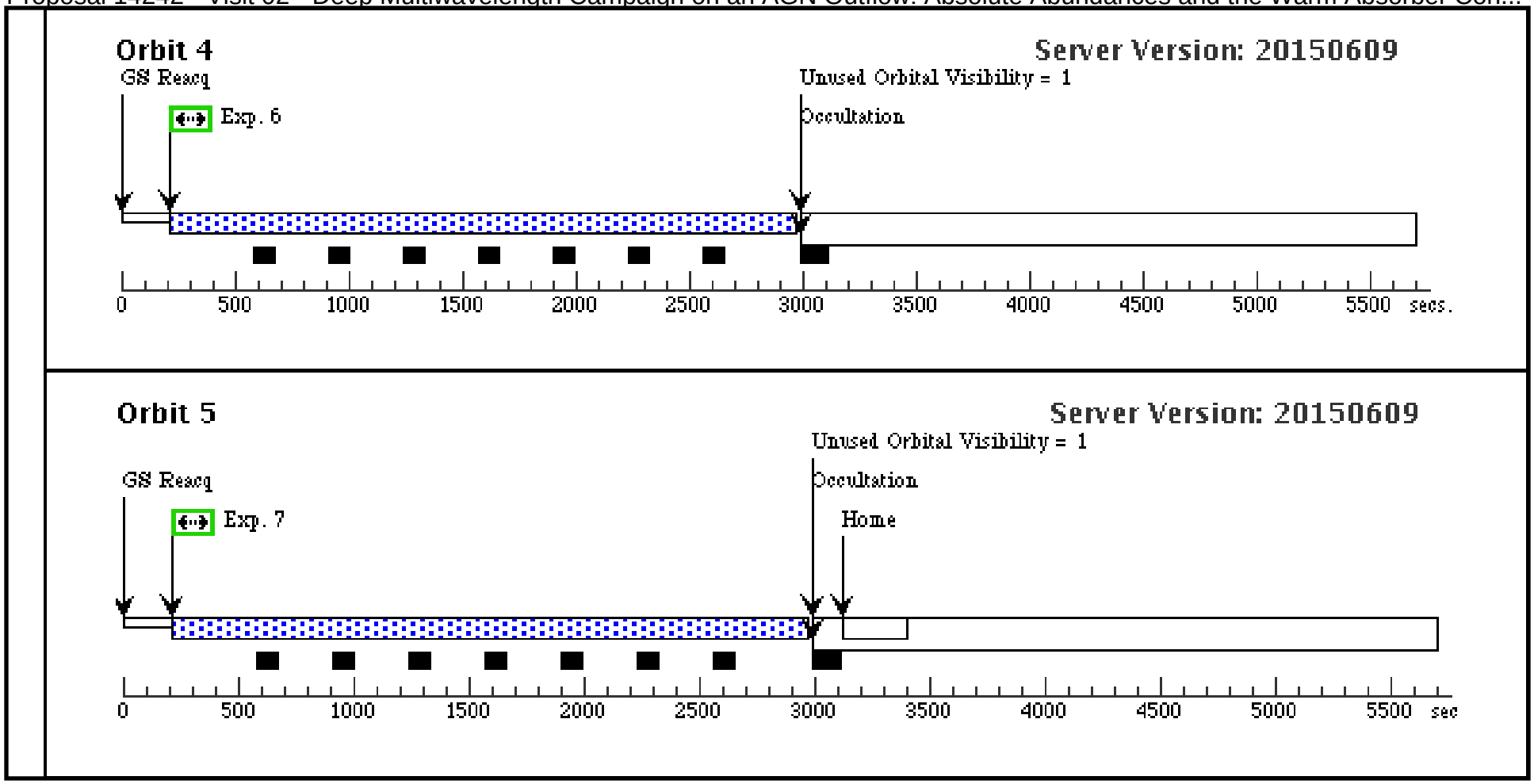
1	(COS.sa.715055)	(1) NGC-7469	COS/FUV, ACQ/PEAKXD, PSA	G130M 1291 A				25 Secs (25 Secs) *[==>]*	***[1]***
2	(COS.sa.715055)	(1) NGC-7469	COS/FUV, ACQ/PEAKD, PSA	G130M 1291 A	NUM-POS=5; STEP-SIZE=0.9; CENTER=FLUX-WT-FLR			25 Secs (25 Secs) *[==>]*	***[1]***
3	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=700; FP-POS=3			2075 Secs (2075 Secs) *[==>]*	***[1]***
4	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=1			2705 Secs (2705 Secs) *[==>]*	***[2]***
5	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=2			2705 Secs (2705 Secs) *[==>]*	***[3]***
6	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=3			2705 Secs (2705 Secs) *[==>]*	***[4]***
7	(COS.sp.715060)	(1) NGC-7469	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=330; FP-POS=4			2705 Secs (2705 Secs) *[==>]*	***[5]***

Orbit Structure





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GS Reacq
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Orbit 5
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