17536 - Probing the Cool, Warm, and Hot Gas at the Center of the Perseus Cluster with Deep Far-Ultraviolet Spectroscopy

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Prof. Sylvain Veilleux (PI) (Contact)	**University of Maryland**
Prof. Andrew C. Fabian (CoI) (ESA Member)	University of Cambridge
Dr. Richard Mushotzky (CoI)	University of Maryland
Dr. Christopher S. Reynolds (CoI)	University of Maryland

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC1275-CENTER	COS/FUV COS/NUV	4	07-Jun-2024 17:03:20.0	yes
02	(1) NGC1275-CENTER	COS/FUV COS/NUV	4	07-Jun-2024 17:03:21.0	yes

8 Total Orbits Used

ABSTRACT

The Perseus Cluster is an ideal laboratory to study the physics of radio-mode AGN feedback which prevents large-scale cooling flows and prodigious star formation at the centers of galaxy clusters. Remarkably, the engine at the heart of the Perseus Cluster, the jetted AGN NGC 1275, has never been spectroscopically observed below 1500 A with the high-resolution grating of COS. This is truly a missed opportunity. This spectral region is rich in spectroscopic diagnostics of the neutral, low-ionization, and high-ionization gas that sample a temperature range (10^4-10^7 K) largely inaccessible

to the optical and X-rays. COS is an order of magnitude more sensitive than the previously used FOS and STIS. We propose to obtain a deep COS G130M spectrum of this object covering 1140-1430 A to study the central AGN, its outflow, and the multi-phase circumgalactic and intracluster media along the light of sight to the core of the Perseus Cluster. The new data will allow us to derive the ionization, total column densities, metal abundances, and locations of metal-line absorbers from the wind and circumgalactic medium. The strengths and widths of the emission lines from the cooling intracluster medium, including [Fe XXI] 1354, will be measured with unprecedented precision and compared with the Hitomi X-ray measurements as well as predictions of the ionization state and turbulent pressure support in simulations of AGN feedback in clusters. Finally, the new data will be compared with a contemporaneous (<1 week) optical spectrum and on-going monitoring in the gamma-rays, high-frequency radio, hard X-rays, and optical to test recent claims that SMBH fueling regulates jet power in this system.

OBSERVING DESCRIPTION

We requested and were allocated 8 orbits to observe NGC 1275, the central galaxy in the Perseus cluster with COS G130M. The RA and DEC coordinates of NGC 1275 are in the ICRS reference frame and taken from PID 12260 (PI Johnstone); they have been verified using the finding chart generated by the Target Confirmation tool of APT. These coordinates are those of the VLBA radio centroid and are therefore accurate to << 0.1".

For each visit, we first use ACQ/IMAGE to obtain a NUV image of the field and center the aperture on the intensity peak. For this procedure, we follow the same method as in HST PID 12260, making use of MIRRORB since NGC 1275 is too bright for MIRRORA: it has a flux of 3.2E-15 erg/cm/cm/s/A at 2300 A and 3.0E-15 erg/cm/cm/s/A at 1380 A within the COS aperture (listed under "Other fluxes" in the target description). The exposure time of 60 seconds for ACQ/IMAGE is generous and results in S/N of 44 assuming NGC 1275 is approximately a point source in the NUV (S/N = 11 in the most pessimistic / unrealistic case where the source entirely fills the 1.25" aperture).

For the spectroscopic observations, we request the cenwave = 1291 A setting with both segments A and B to capture redshifted Si II 1190/1193, Si III 1206, Ly-alpha, Si II 1260, O I 1302, Si II 1304, C II 1334, Si IV 1393/1402, and [Fe XXI] 1354 from the AGN and ISM/CGM/ICM of NGC 1275 / Perseus Cluster (z = 0.0176). Following the COS2025 policies, we only use FP-POS = 3 and 4 to get equal exposures for segments A and B. The observations are split into two visits of 4 orbits with a single long exposure per orbit changing the FP-POS value for each orbit to reduce the fixed pattern noise. This observing strategy minimizes the overhead and maximize the on-target exposure time, and thus S/N. All of the observations are done in TIME-TAG mode. This temporal sampling will allow us to exclude poor quality data and get improved thermal correction and background removal. For simplicity and to guard against the (unlikely) possibility that our targets are more than ~50% brighter than expected, we set buffer-time = exposure-time.

According to the Bright Object Tool (BOT), there are no bright sources near our targets that could cause a problem for COS.

Visit

Proposal 17536, Visit 01, implementation

Fri Jun 07 21:03:21 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

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

Fixed Targets

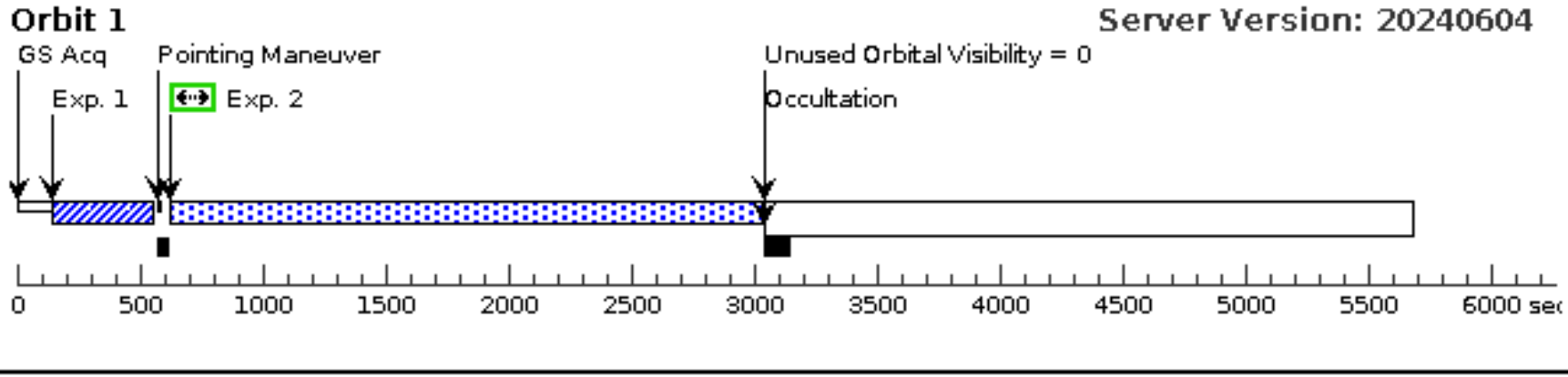
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1275-CENTER	RA: 03 19 48.1601 (49.9506671d) Dec: +41 30 42.11 (41.51170d) Equinox: J2000	Proper Motion RA: 9.971237766405197E-6 sec of time/yr Proper Motion Dec: -1.9799995243374724E-4 arcsec/yr Epoch of Position: 2015.5	V=16.7 3.2E-15 erg/cm/cm/s/A at 2300 A and 3.0E-15 erg/cm/cm/s/A at 1380 A within COS aperture.	Reference Frame: ICRS

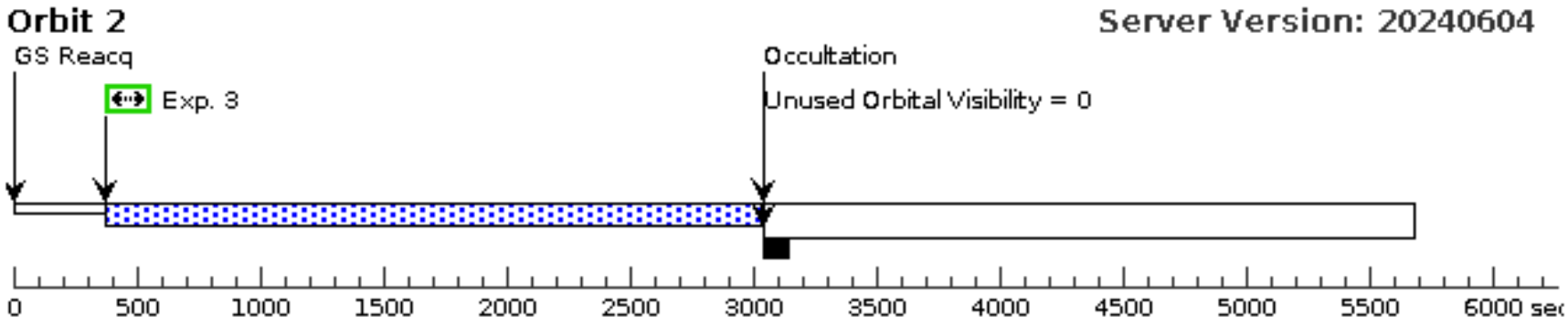
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[COOLING FLOW, NUCLEUS, QSO, RADIO GALAXY]
Extended=NO

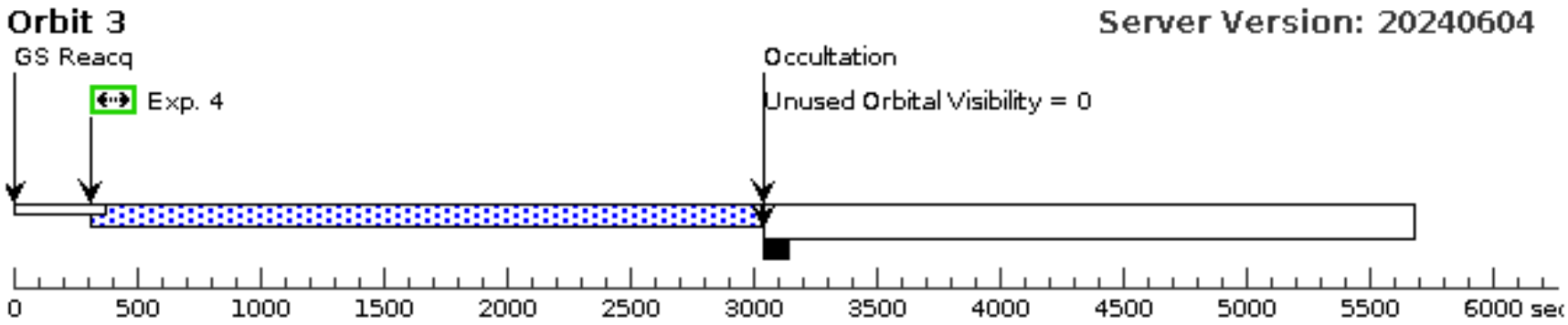
Exposures

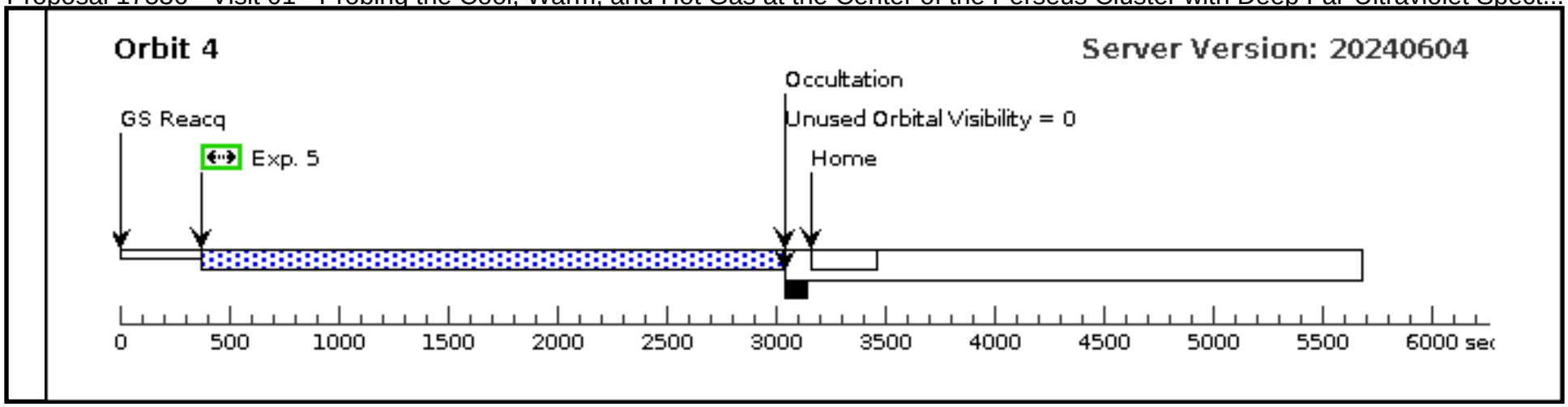
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1887636)	(1) NGC1275-CENTER	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				60 Secs (60 Secs) *[==>]*	*[1]*
2	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2340; FLASH=YES; FP-POS=3; SEGMENT=BOTH			2340 Secs (2236 Secs) *[==>2236.0 Secs]*	*[1]*
3	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[2]*
4	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=3; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[3]*
5	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[4]*

Orbit Structure





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Visit

Proposal 17536, Visit 02, implementation

Fri Jun 07 21:03:21 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1275-CENTER	RA: 03 19 48.1601 (49.9506671d) Dec: +41 30 42.11 (41.51170d) Equinox: J2000	Proper Motion RA: 9.971237766405197E-6 sec of time/yr Proper Motion Dec: -1.9799995243374724E-4 arcsec/yr Epoch of Position: 2015.5	V=16.7 3.2E-15 erg/cm/cm/s/A at 2300 A and 3.0E-15 erg/cm/cm/s/A at 1380 A within COS aperture.	Reference Frame: ICRS

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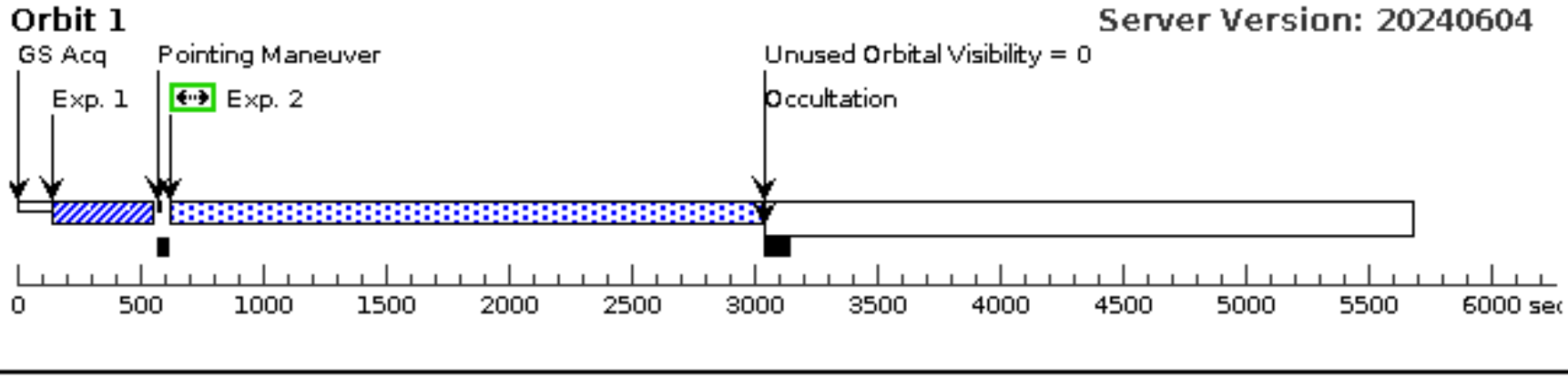
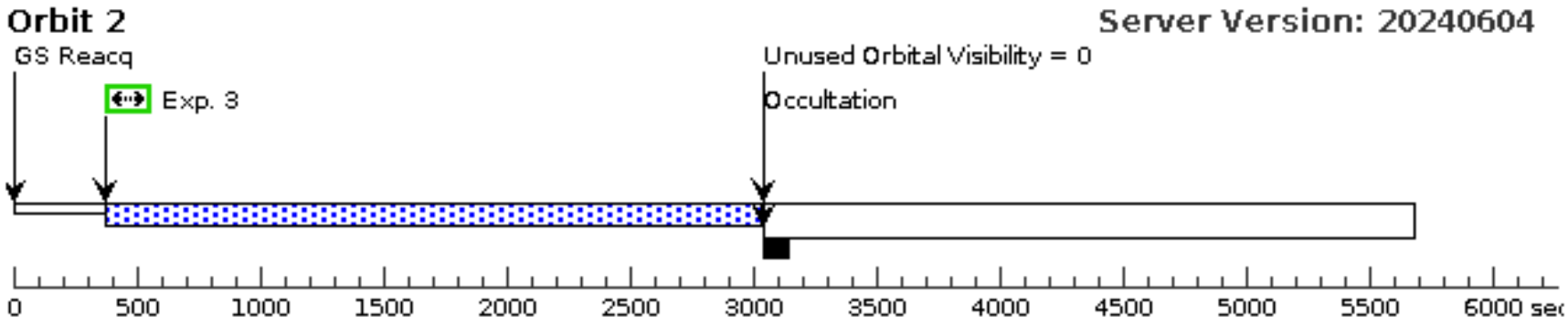
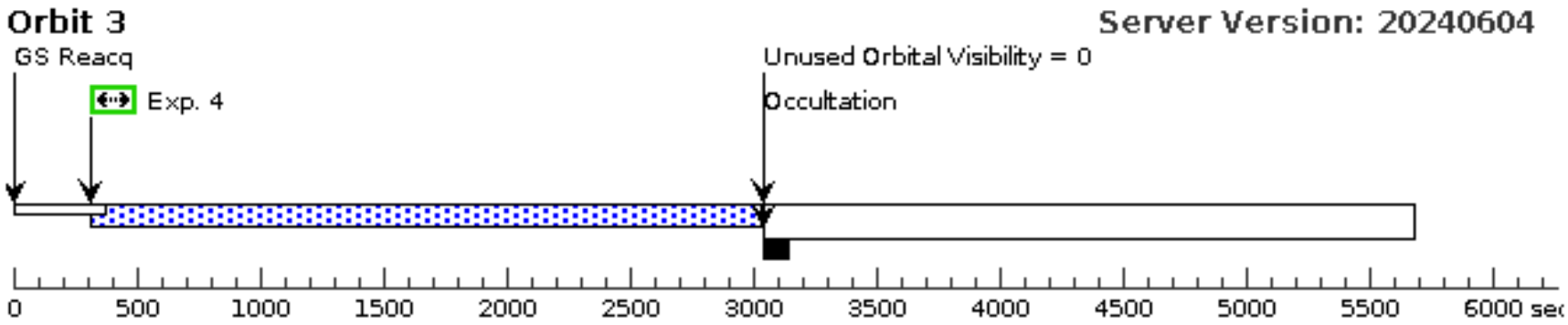
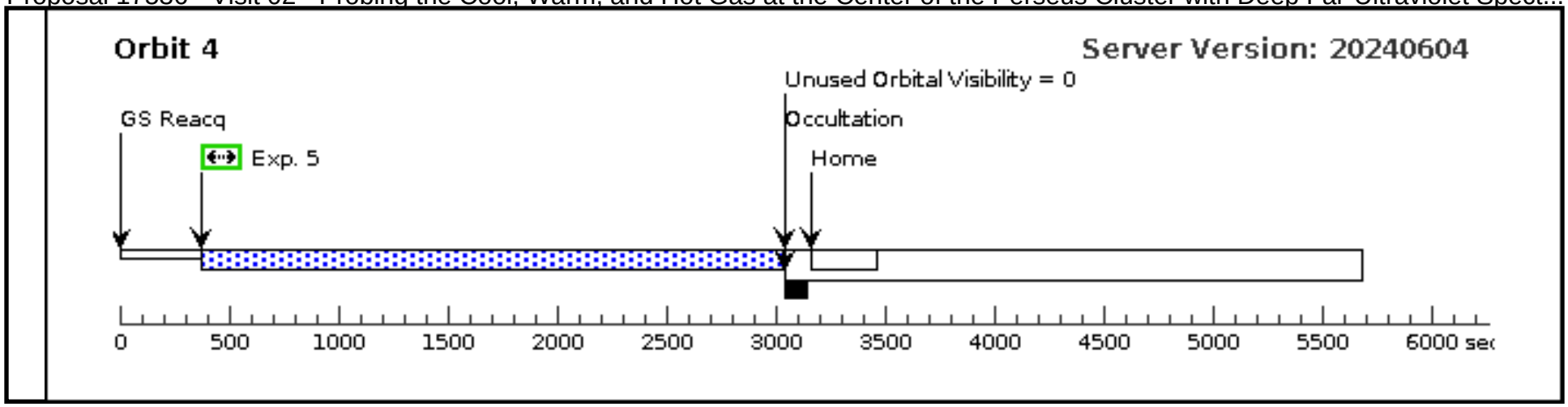
2	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2340; FLASH=YES; FP-POS=3; SEGMENT=BOTH			2340 Secs (2236 Secs) *[==>2236.0 Secs]*	*[1]*
3	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[2]*
4	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=3; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[3]*
5	(COS.sp.1853693)	(1) NGC1275-CENTER	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2760; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2760 Secs (2605 Secs) *[==>2605.0 Secs]*	*[4]*

Orbit Structure





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