12285 - Mapping the core and lobes of the extraordinary FRII microquasar in NGC 7793

Cycle: 18, 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) NGC7793-S26	WFC3/UVIS	5	10-Aug-2010 13:14:10.0	yes

5 Total Orbits Used

ABSTRACT

We have discovered an extraordinary microquasar in NGC 7793, with all the textbook physical structures of an FRII radio galaxy: an X-ray/optical core, X-ray and radio hot spots, radio lobes, and a large cocoon with radio, X-ray and optical line emission. It reveals a new class of accreting black holes dominated by mechanical power even at high accretion rates; it is the missing link between ordinary microquasars and ultraluminous X-ray sources.

After studying the system with radio, X-ray and ground-based optical telescopes, we propose a WFC3/UVIS study. We will:
a) resolve and constrain the nature of the black hole counterpart;

b) map density structures in the nebula (knots, filaments), measure their UV and optical line flux, and model the shock excitation process;
c) resolve the forward and reverse shock, and map the outer edge of the expanding shell;
d) study the age and metallicity of the surrounding stellar population.

Our goals are to determine the mass and total radiative and mechanical power of the black hole, model how the power is transferred to the ambient medium, and how the accretion/ejection properties scale between non-nuclear stellar-mass black holes and supermassive black holes in radio galaxies.

OBSERVING DESCRIPTION

We propose to observe the jet-powered S26 nebula in NGC 7793 with WFC3/UVIS. One of our main objectives is to study the UV emission from the BH counterpart and the nebula: thus, we choose WFC3/UVIS because it has the highest throughput over the near-UV range. WFC3 is also slightly more sensitive than ACS in the V and R bands, and the WFC3 field of view is more than adequate for our target (size of 15 arcsec x 10 arcsec).

We propose to use the following filters:
F225W (which will cover nebular lines such as C II] 2325 Ang, [Ne IV] 2425 Ang, [O II] 2470 Ang, in addition to the continuum emission from the BH counterpart);
F275W (which will include Mg II 2798 Ang);
F336W (similar to U);
F555W (similar to V);
F814W (similar to I);
F502N (covering [O III] 5007 Ang);
F656N (covering H-ALPHA);
F673N (covering [S II] 6716,6731 Ang).

The systemic velocity of S26 is approximately the same as the systemic velocity of its host galaxy NGC 7793, namely about 230 km/s (from NED). Therefore, the emission lines are well centred in the passbands of the respective rest-wavelength filters.

We used the WFC3 Exposure Time Calculator to estimate the requested time. The optical counterpart to the X-ray core is quite bright (B = 23 mag),

but we are also interested in mapping filaments and knots to a spatial resolution better than 0.4 arcsec, down to brightnesses of about 24 mag/square-arcsec, and to determine the brightness and colour of nearby stars of spectral type B4 or earlier (B <~ 25 mag), which give us a characteristic evolutionary timescale for the BH and its donor star. We used the H-ALPHA and He II 4686 line fluxes observed from our ground-based narrow-band observations as a guideline for the exposure time in the narrow-band WFC3 filters; they reach values of a few 10^{-15} erg/s/cm2/square-arcsec in the southern lobe and rim. We also compared those observations with what we expect for ionized gas with a temperature of 25,000-30,000 K and density ~ 1/cm3, at a distance of 3.9 Mpc. We estimate that about 1500 s in each filter, and about 2000 s in H-ALPHA will suffice to achieve our objectives and will at the same time suit the observational constraints and dithering strategy. The longer exposure time for H-ALPHA reflects the higher importance of a possible detection of Balmer line emission from the optical core.

We propose to use the WFC3-UVIS-MOS-DITH-LINE pattern---a three-point dithering pattern to cover the chip gap as well as remove cosmic rays and bad pixels. Thus, every observation in each filter has to be split into three subexposures, which have to be longer than 340 s for a more efficient use of the observing time. Taking into account the overheads, we can fit the five broad-band observations into three orbits, and the three narrow-band observations into two more orbits. For example, in orbit 1: all three dithered exposures of filter 1 (exposure time of about 500 s each), plus the first two dithered exposures of filter 2; in orbit 2: the last dithered exposures of filter 2 plus all three dithered exposures of filter 3, plus the first dithered exposures of filter 4; etc. In total, we will use 5 HST orbits.

Visit

Proposal 12285, Visit 01 Tue Aug 10 17:14:12 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

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		(1), (2), (3), (4), (5), (6), (7), (8)

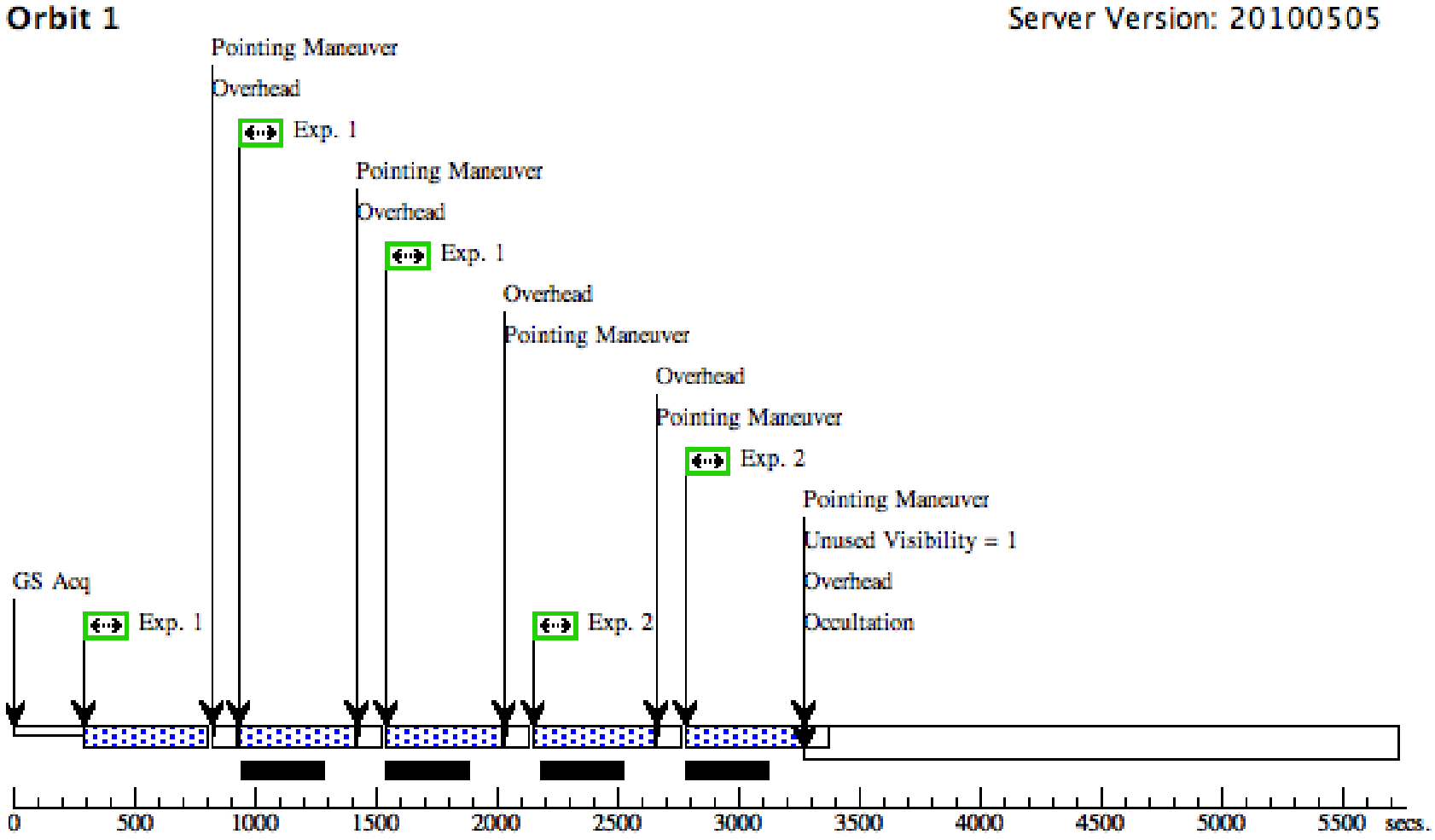
Fixed Targets

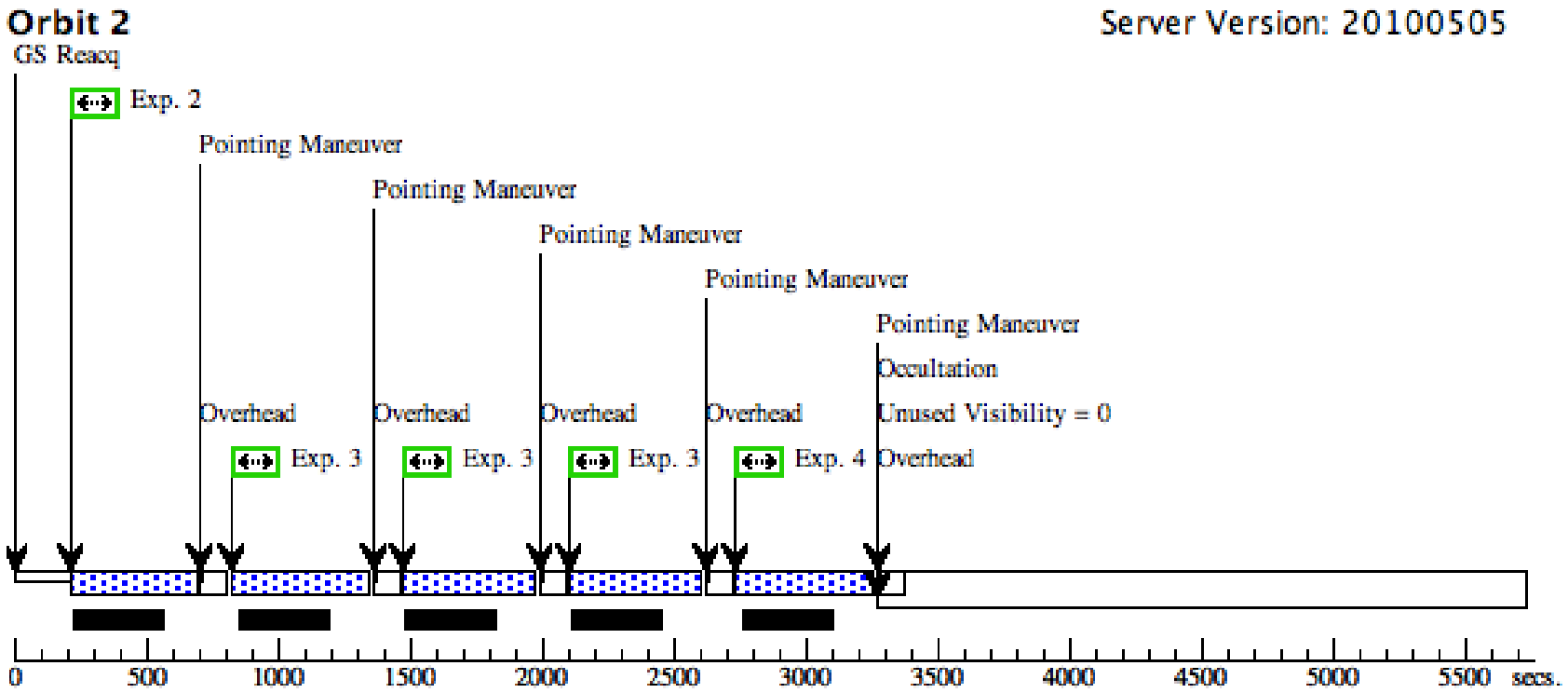
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC7793-S26	RA: 23 57 59.9400 (359.4997500d) Dec: -32 33 20.90 (-32.55581d) Equinox: J2000		V=23+/-0.5 Extended nebula. V~23 refers to the point-like core.	Reference Frame: from radio & X-ray positions

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	S26-F225W	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F225W			Pattern 1, Exps 1-1 (1)	479 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	***[1]***
								[==>(Pattern 3)]	
2	S26-F275W	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F275W			Pattern 1, Exps 2-2 (1)	479 Secs	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
3	S26-F336W	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F336W			Pattern 1, Exps 3-3 (1)	502 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	***[2]***
								[==>(Pattern 3)]	
4	S26-F555W	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F555W			Pattern 1, Exps 4-4 (1)	502 Secs	
								[==>(Pattern 1)]	***[2]***
								[==>(Pattern 2)]	***[3]***
								[==>(Pattern 3)]	
5	S26-F814W	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F814W			Pattern 1, Exps 5-5 (1)	504 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	***[3]***
								[==>(Pattern 3)]	
6	S26-F502N	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F502N			Pattern 1, Exps 6-6 (1)	502 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	***[4]***
								[==>(Pattern 3)]	
7	S26-F673N	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F673N			Pattern 1, Exps 7-7 (1)	503 Secs	
								[==>(Pattern 1)]	***[4]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[5]***
8	S26-F656N	(1) NGC7793-S26	WFC3/UVIS, ACCUM, UVIS1	F656N			Pattern 1, Exps 8-8 (1)	712 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	***[5]***
								[==>(Pattern 3)]	

Orbit Structure

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Pointing Maneuver
Pointing Maneuver
Occultation
Overhead
Overhead
Overhead
Overhead
Unused Visibility = 0
Exp. 3
Exp. 3
Exp. 3
Exp. 4
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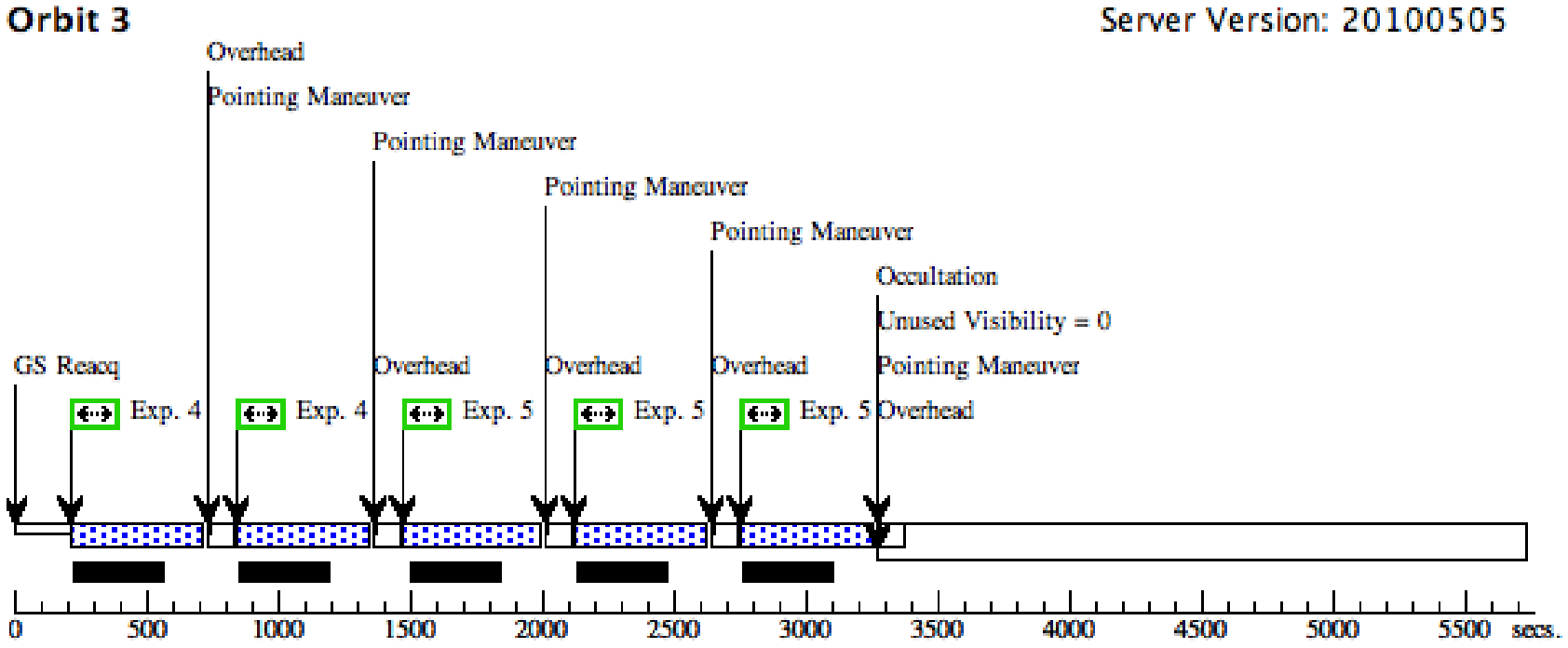
secs.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Occultation
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GS Reacq
Exp. 4
Exp. 4
Overhead
Exp. 5
Overhead
Exp. 5
Overhead
Exp. 5
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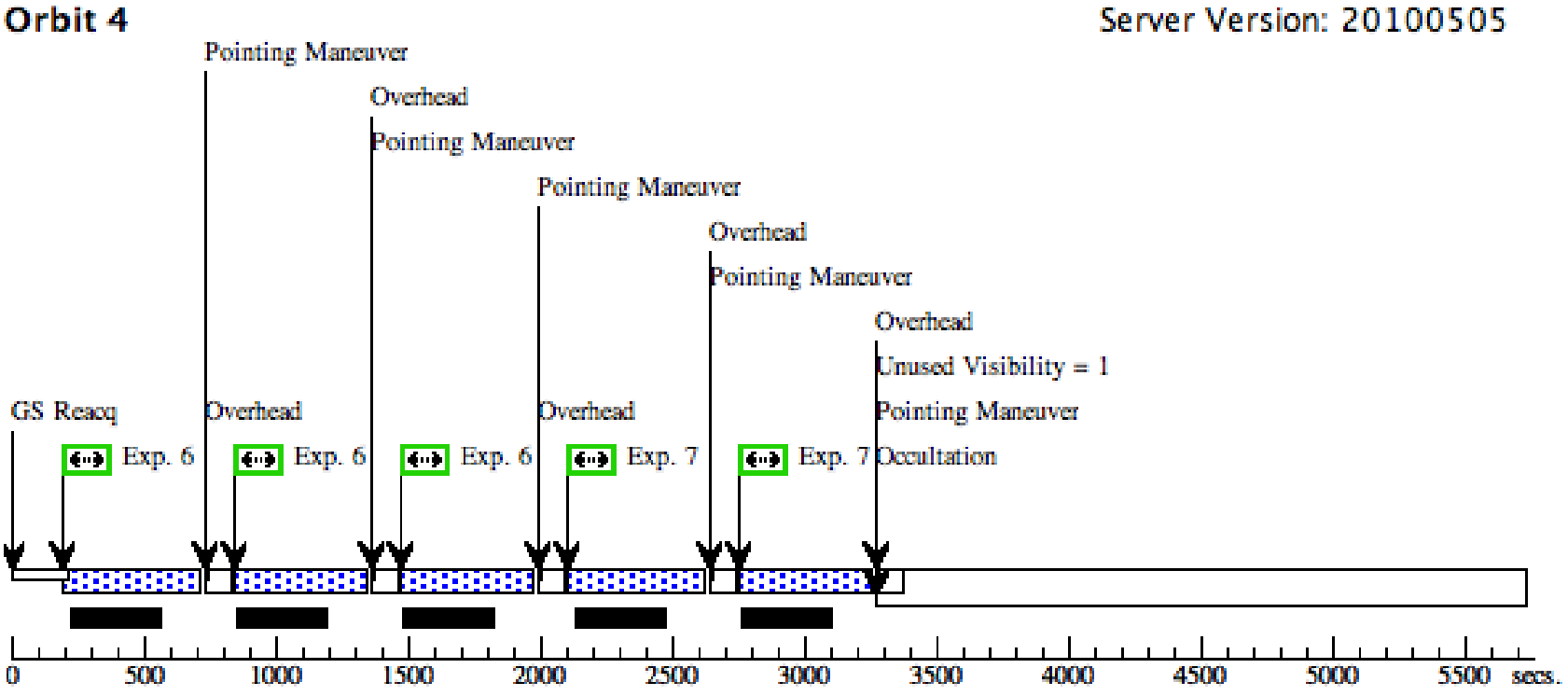
secs.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Pointing Maneuver
GS Reacq
Overhead
Overhead
Occultation
Exp. 6
Exp. 6
Exp. 6
Exp. 7
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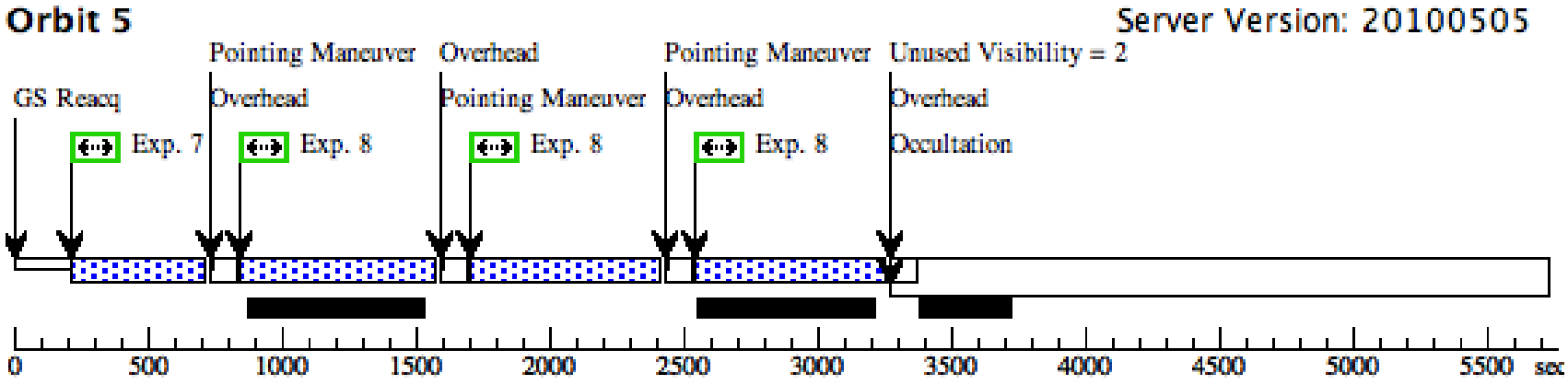
secs.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Occultation
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