13823 - A complete census of galaxy activity in a massive z>1.5 cluster: probing the SF-density relation down to the low M* regime

Cycle: 22, Proposal Category: GO

(Availability Mode: SUPPORTED)

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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) XDCPJ0044.0-0233	WFC3/IR	1	23-Jul-2015 21:04:46.0	yes
02	(1) XDCPJ0044.0-0233	WFC3/IR	4	23-Jul-2015 21:04:49.0	yes

5 Total Orbits Used

ABSTRACT

We propose deep WFC3 spectroscopic observations of the z=1.58 X-ray luminous galaxy cluster XDCP J0044.3-2033. This is a remarkable structure, one of a handful of galaxy clusters secured at z>1.5 and one of the even fewer confirmed to be virialized thanks to high-quality X-ray data. Yet, despite its degree of structural maturity and high mass, optical and infrared observations indicate that its central galaxy population is undergoing significant morphological transformation and experiencing a high degree of star formation as well. This raises interesting questions on the actual degree of environmental forcing and the true diversity of galaxy populations in high mass, high redshift environments. This project thus aims at quantifying star-formation in cluster galaxies down to 5 Msun/yr. In a single HST visit, the proposed observations will allow us to probe the SF-density relation at z~1.6 down to the largely unexplored 5e9 Msun galaxy mass regime.

OBSERVING DESCRIPTION

We propose to use the G141 grism in order to assemble and characterize the most complete sample of star forming cluster members. Covering the wavelength range 1.08-1.7 micron, the G141 grism is well suited to detect the H-beta and [OIII]5007 emission lines (although, due the slitless nature of the instrument, the [OIII] doublet will be blended), as well as the H-alpha emission line for galaxies at z<1.59.
While H-alpha falls on the edge of the useful response range of the grism, and thus will suffer from higher noise, its intrinsic flux is similar to [OIII]5007 in normal star-forming galaxies (higher in the presence of dust extinction) and hence is expected to have a S/N ratio comparable to H-beta. H-alpha is a good star-formation tracer (e.g., Kennicutt 1998) and, in conjunction with Hβ, an important estimator of dust extinction. When only H-beta is present, the SFR can be derived assuming standard ratios (e.g., Osterbrock & Ferland 2006) and a reddening correction based on the UV-NIR photometry. The prominent [OIII]5007 emission line, on the other hand, is important to help identify and select AGN from the sample. Because of its high equivalent width (especially at high-redshift; e.g., Trump et al. 2011), it will be also useful in confirming members where H-beta is suppressed (due to, e.g., above-average extinction) and H-alpha not present (e.g., at z>1.6).

We set the integration time according to the expected flux of the weakest observable emission line, H-beta, with a requirement of S/N>3 for detection. We find the H-beta flux of the weakest Herschel-detected cluster member candidate to be ~1.5*10^-17 erg/s. Using the ETC, we estimate that S/N=3 can then be reached in 10000 seconds of G141 integration, allowing for sensitivity variations due to redshift scatter. Including overheads, this translates into about 4 orbits, which matches well our previous experience with a similar G141 study on a z=2 galaxy cluster (Gobat et al. 2013). This integration time also ensures that H-beta be observable down to galaxy masses of 6*10^9 Msun (or M*-1 dex; Ilbert et al. 2013) and 3*10^9 Msun unreddened (a plausible assumption for low-mass, high-redshift galaxies). We note that, even in the absence of emission lines, we will still reach a good enough continuum S/N to allow for easy redshift confirmation of M* galaxies. In this case, according to the ETC, we expect S/N$~10

on the continuum, with the
observable absorption features being H-beta and H-gamma+G-band.

The 4-orbit G141 observation will be taken at a single roll angle. Although the field is crowded, and thus some objects are expected to be contaminated in both orientations, previous experience on a similar dataset has led us to develop tools and techniques to efficiently deblend traces and recover usable spectra of even faint contaminated sources (see Gobat et al. 2013 for details). We are thus confident that we will be able to recover all member galaxies in the WFC3 field down to the predicted mass limit.
In addition, direct imaging is needed in a filter with similar coverage to the G141 grism (in this case F140W) to obtain accurate source positions and derive the wavelength calibrations. This will be a challenging observation in a very crowded field. To efficiently extract spectra, we will need the best possible information about all potential bright contaminants. We therefore will image on a slightly larger area than the field of view of the WFC3. We estimate that a padding of ~26" and ~60", respectively in and opposite to the direction of dispersion, will fulfill this requirement. This implies a minimum of 4 dither positions, each with enough depth to detect galaxies at the limit of the G141 spectroscopy (6*10^9 Msun). Using a composite stellar population model (Bruzual & Charlot 2003, assuming a constant star formation history) of the right mass and SFR as input to the ETC, we find that S/N$~40 can be reached in as little as 500 seconds. One orbit of direct imaging with the F140W filter is then more than sufficient. The F140W imaging will be done just before the G141 observations, for each orientation, as it is imperative that the astrometry be stable between the grism and direct images.

Visit

Proposal 13823, Visit 01, implementation Fri Jul 24 01:04:51 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 300D TO 300 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(1), (2), (3), (4)

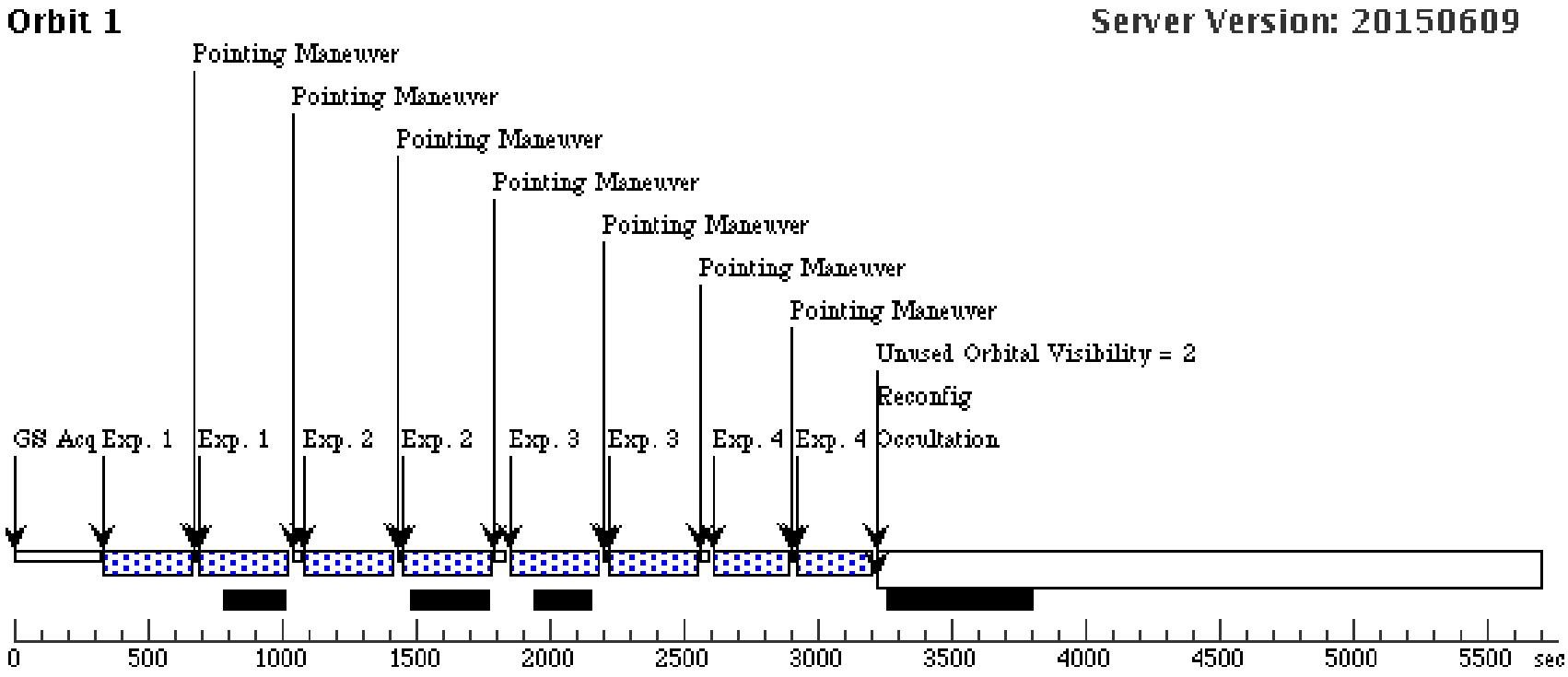
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	XDCPJ0044.0-0233	RA: 00 44 3.0770 (11.0128208d) Dec: -20 33 52.89 (-20.56469d) Equinox: J2000	Epoch of Position: 2000	V=25	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, IR-FIX	F140W	SAMP-SEQ=SPARS50; NSAMP=7	POS TARG -60,20	Pattern 1, Exps 1-1 in Visit 01 (1)	302.934997 Secs (605.87 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***
2		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, IR-FIX	F140W	SAMP-SEQ=SPARS50; NSAMP=7	POS TARG -60,-20	Pattern 1, Exps 2-2 in Visit 01 (1)	302.934997 Secs (605.87 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***
3		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, IR-FIX	F140W	SAMP-SEQ=SPARS50; NSAMP=7	POS TARG 26,20	Pattern 1, Exps 3-3 in Visit 01 (1)	302.934997 Secs (605.87 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***
4		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, IR-FIX	F140W	SAMP-SEQ=SPARS50; NSAMP=6	POS TARG 26,-20	Pattern 1, Exps 4-4 in Visit 01 (1)	252.934546 Secs (505.869 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***

Orbit Structure



Visit

Proposal 13823, Visit 02, implementation Fri Jul 24 01:04:51 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 300D TO 300 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1), (3), (5), (7)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	XDCPJ0044.0-0233	RA: 00 44 3.0770 (11.0128208d) Dec: -20 33 52.89 (-20.56469d) Equinox: J2000	Epoch of Position: 2000	V=25	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS50; NSAMP=14		Pattern 2, Exps 1-1 in Visit 02 (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	F140W	SAMP-SEQ=SPARS10; NSAMP=9			82.939995 Secs (82.94 Secs) *[==>]*	***[2]***
3		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS50; NSAMP=14		Pattern 2, Exps 3-3 in Visit 02 (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
4		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	F140W	SAMP-SEQ=SPARS10; NSAMP=9			82.939995 Secs (82.94 Secs) *[==>]*	***[3]***
5		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS50; NSAMP=14		Pattern 2, Exps 5-5 in Visit 02 (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***
6		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	F140W	SAMP-SEQ=SPARS10; NSAMP=9			82.939995 Secs (82.94 Secs) *[==>]*	***[4]***
7		(1) XDCPJ0044.0-0233	WFC3/IR, MULTIACCUM, GRISM1024	G141	SAMP-SEQ=SPARS50; NSAMP=14		Pattern 2, Exps 7-7 in Visit 02 (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[4]***

Orbit Structure

Orbit 1

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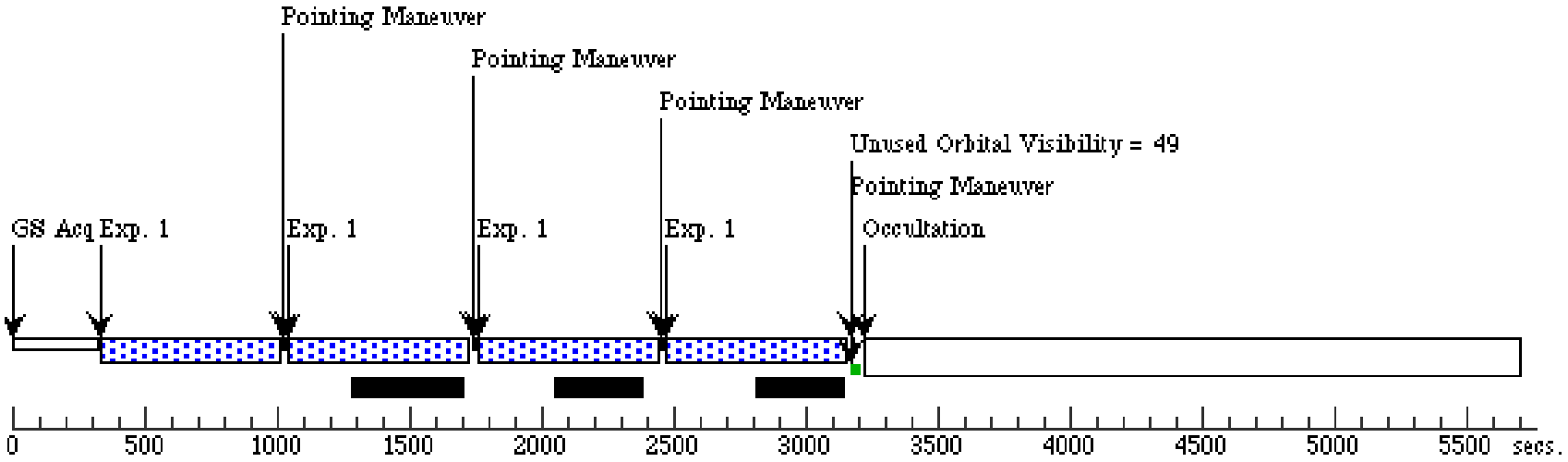
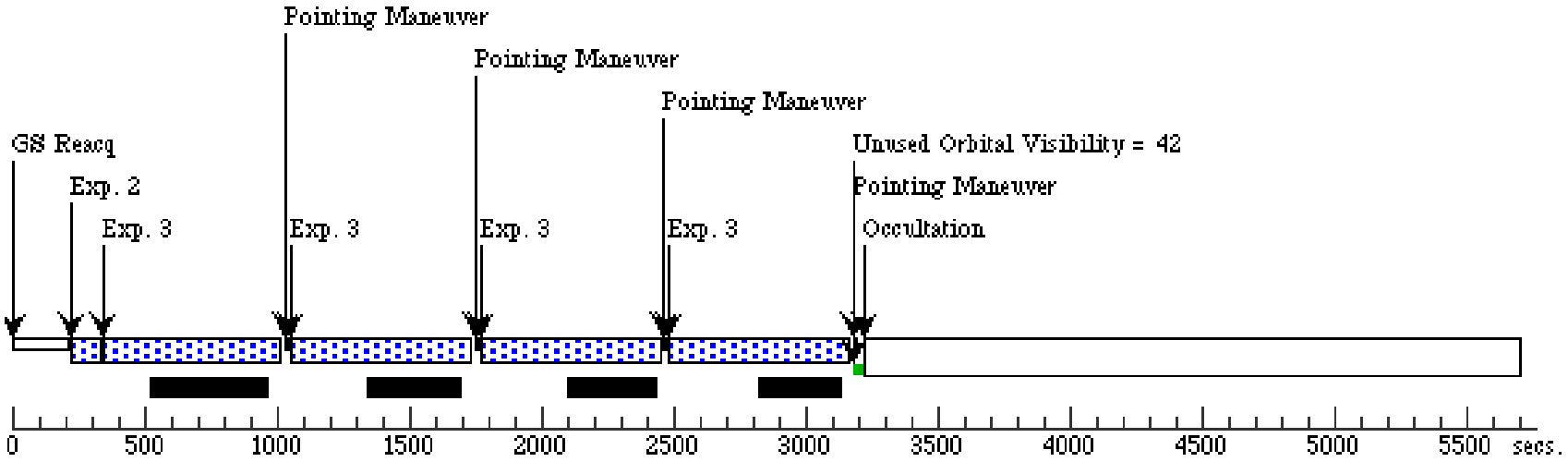
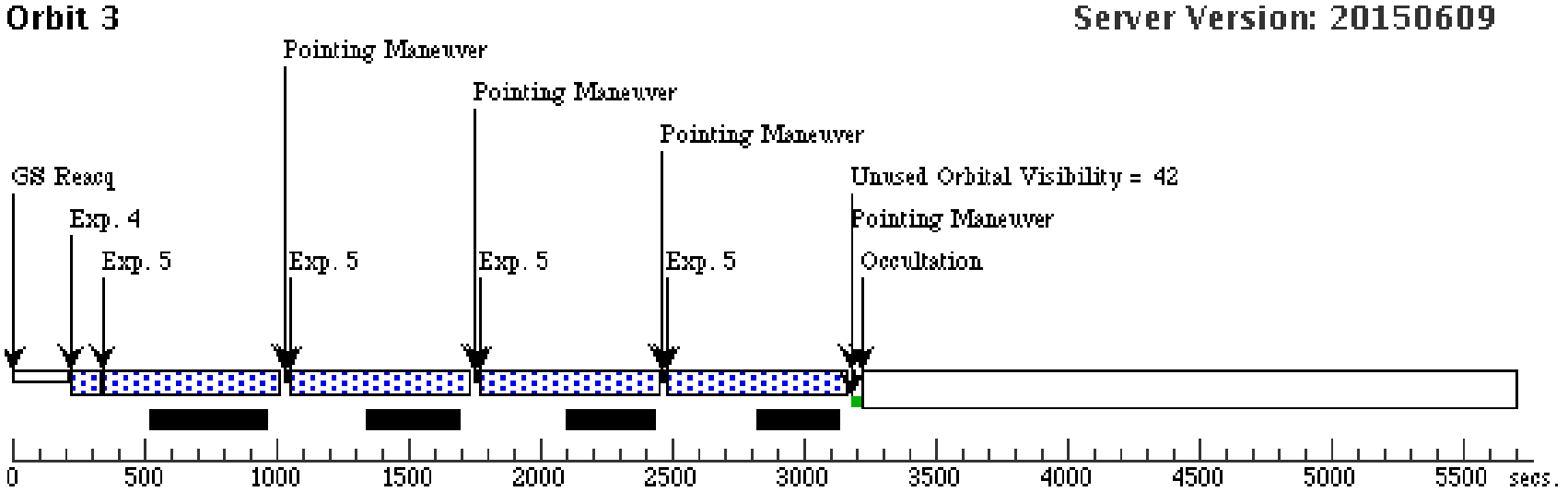
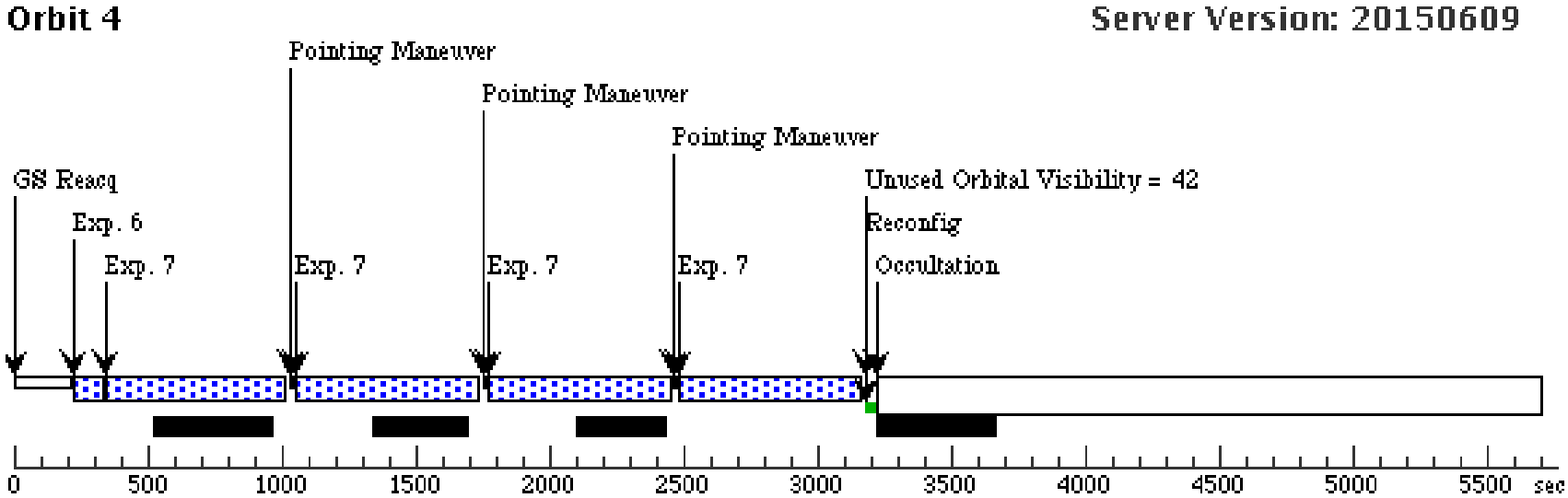


Orbit 2

Server Version: 20150609




Orbit 3
Server Version: 20150609
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
GS Reacq
Exp. 4
Exp. 5
Exp. 5
Exp. 5
Exp. 5
Unused Orbital Visibility = 42
Pointing Maneuver
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20150609
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
GS Reacq
Exp. 6
Exp. 7
Exp. 7
Exp. 7
Exp. 7
Unused Orbital Visibility = 42
Reconfig
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec