14740 - Exploring a Massive Starburst in the Epoch of Reionization

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Daniel Marrone (PI) (Contact)	**University of Arizona**	**dmarrone@email.arizona.edu**
Prof. Joaquin Daniel Vieira (CoI)	University of Illinois at Urbana - Champaign	jvieira@illinois.edu
Dr. Manuel A Aravena (CoI)	Diego Portales University	manuel.aravenaa@mail.udp.cl
Prof. Scott C. Chapman (CoI) (CSA Member)	Dalhousie University	scott.chapman@dal.ca
Dr. Carlos Albert De Breuck (CoI) (ESA Member)	European Southern Observatory - Germany	cdebreuc@eso.org
Prof. Anthony Hernan Gonzalez (CoI)	University of Florida	anthonyhg@ufl.edu
Dr. Yashar Hezaveh (CoI)	Stanford University	hezaveh@stanford.edu
Ms. Katrina Litke (CoI)	University of Arizona	kclitke@email.arizona.edu
Ms. Jingzhe Ma (CoI)	University of Florida	jingzhema@ufl.edu
Prof. Matthew A. Malkan (CoI)	University of California - Los Angeles	malkan@astro.ucla.edu
Mr. Justin Scott Spilker (CoI)	University of Arizona	jspilker@email.arizona.edu
Dr. Brian Stalder (CoI)	University of Hawaii	stalder@ifa.hawaii.edu
Prof. Daniel P. Stark (CoI)	University of Arizona	dpstark@email.arizona.edu
Ms. Maria Strandet (CoI) (ESA Member)	Max-Planck-Institut fur Radioastronomie	strandet@mpifr-bonn.mpg.de
Mr. Mengtao Tang (CoI)	University of Arizona	tangmtasua@email.arizona.edu
Dr. Axel Weiss (CoI) (ESA Member)	Max-Planck-Institut fur Radioastronomie	aweiss@mpifr-bonn.mpg.de
Dr. Niraj Welikala (CoI) (ESA Member)	University of Oxford	niraj.welikala@astro.ox.ac.uk

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) SPT0311-58	ACS/WFC WFC3/IR	5	07-Feb-2017 21:01:51.0	yes

5 Total Orbits Used

ABSTRACT

We request deep multi-band imaging of a unique dusty galaxy in the Epoch of Reionization (EoR), selected via its millimeter-wavelength dust emission in the 2500-square-degree South Pole Telescope survey. Spectroscopically confirmed to lie at z=6.900, this galaxy has a large dust mass and is likely one of the most rapidly star-forming objects in the EoR. Using Gemini-S, we have identified z-band emission from this object that could be UV continuum emission at z=6.9 or from a foreground lens. Interpretation of this object, and a complete understanding of its meaning for the census of star formation in the EoR, requires that we establish the presence or absence of gravitational lensing. The dust mass observed in this source is also unexpectedly large for its era, and measurements of the assembled stellar population, through the UV-continuum slope and rest-frame optical color, will help characterize the stellar mass and dust properties in this very early galaxy, the most spectacular galaxy yet discovered by the SPT.

OBSERVING DESCRIPTION

We propose five-band imaging with HST /ACS, HST /WFC3, and Spitzer /IRAC of a unique dusty galaxy at z = 6.9. These observations are designed to confirm or refute the lensing hypothesis, provide a photometric redshift estimate for the putative lens galaxy, and to search for rest-UV and rest-optical emission from the background galaxy. Our target depths are informed by our deep Gemini imaging, as well as a handful of lower redshift analogues with HST imaging (HFLS3: Cooray et al. 2014; SPT DSFGs: Ma et al. 2015), and are outlined in Table 1. Five orbits are required.

Why HST? - SPT0311-58 is a very dusty, very distant object, that is likely lensed by a 24th magnitude galaxy. The most comparable object, a dusty maximum starburst galaxy at z = 6.34 (HFLS3; Riechers et al. 2013), was only separable from two nearby 24/25th magnitude galaxies with HST and only after subtraction of the foreground objects. No sufficiently bright guide stars for adaptive optics lie near the source. If the source is lensed, the unmatched depth and sharpness of HST imaging will be required to distinguish any rest-frame UV emission from the target galaxy, and to deconvolve source/lens in the Spitzer imaging. High-resolution ALMA submillimeter continuum observations are also scheduled for April/May as part of a survey of our targets that was approved for ALMA Cycle 3 (our redshift identification came from this program), which will greatly aid in the interpretation of the HST and Spitzer imaging.

Filters and Depths - Assuming that the Gemini-detected object is in the foreground, its i-z>0.6 color is consistent with a z~1 early-type galaxy (Fukugita et al. 1995). For interpretation of the background object we must photometrically determine the redshift for this object and estimate its mass. In the event that the lensing geometry is not easily constrained from the ALMA data, the combination of a well-determined position and the mass/redshift of the lens will allow a probabilistic magnification estimate, similar to HFLS3 (Cooray et al. 2014). Our observations are designed to provide a reliable photometric redshift for a very wide range of possible lens redshifts. A single orbit divided between two ACS filters, F606W and F775W (i), will cover the Balmer break for 0.2 < z < 1.1. For higher redshifts there will be two filters on either side of the break out to z = 1.75, above which the break passes through WFC3/F125W. The zAB = 24.4 Gemini measurement shows that the half-orbit ACS depths of 27.2 and 26.5 (5sig, per ACS ETC) will be adequate.

To target the z = 6.9 dusty source, we use deep imaging with WFC3/IR and Spitzer. The two ACS filters correspond to the blue side of the Lyman break at this redshift, so we expect no emission. We request two IR filters to enable a measurement of the UV spectral slope, and to provide color information that may help separate foreground and background sources. We will be able to infer dust properties and column densities through the infrared- excess to UV-slope (IRX-beta) relation (Reddy et al. 2010; Casey et al. 2014b), which relates the amount of dust absorption measured in the UV to the amount of infrared re-emission. We select the longest-wavelength bands possible (F125W and F160W), spanning rest wavelengths of 140-210 nm. While pairing F160W with either F105W or F110W would provide a longer wavelength baseline to measure the UV slope, both of these filters would include any LyA (Lambda_obs = 960 nm) flux, complicating the interpretation of the rest-UV slope. Cooray et al. (2014) found that after subtracting out two foreground objects, residual emission from HFLS3 was visible in both F125W and F160W at mAB = 27.0. As this is the best example we presently have of a dusty galaxy near the EoR, we use these values to guide our integration times. Two-orbit integrations in both filters will achieve depths of mAB = 27.4 and 27.1 (5sig, per WFC3 ETC), which would be adequate to detect similar residual stellar continuum. The combination of both bands will allow us to push even deeper, though without color information. Spitzer/IRAC observations will probe the rest-frame optical (450, 570 nm) emission. These data will likely provide the best available handle on the stellar content of the galaxy before JWST. Depths are determined from SED models fit to the FIR and optical data, as well as from the Cooray et al. (2014) SED for HFLS3. Two IRAC channels will provide color information that will improve our SED modeling of the stellar mass and stellar population ages. We note also that Smit et al. (2015) suggested IRAC 3.6/4.5um color could be contaminated by extreme line emission at similar redshifts, but fortunately the OIII and OII lines fall between and outside the filters for this object. Although our current imaging provides no information about the degree to which the foreground and background objects overlap, in Bothwell et al. (2013) and Ma et al. (2015) we have disentangled lens and background source emission using HST imaging or jointly between HST and Spitzer.

It is possible that the observed z-band emission arises from the dusty source rather than a lens (see Figure 3 for a possible SED). This unlikely case will be readily identifiable by the lack of detections of a lens galaxy or any other emission in F606W and F775W, both of which are beyond the Lyman break.

Visit

Proposal 14740, Visit 01, implementation Wed Feb 08 02:01:52 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, ACS/WFC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.149 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=34.25 Angle Between Sides= Center Pattern=false		(1-2)
(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		(3), (4), (5), (6)

Fixed Targets

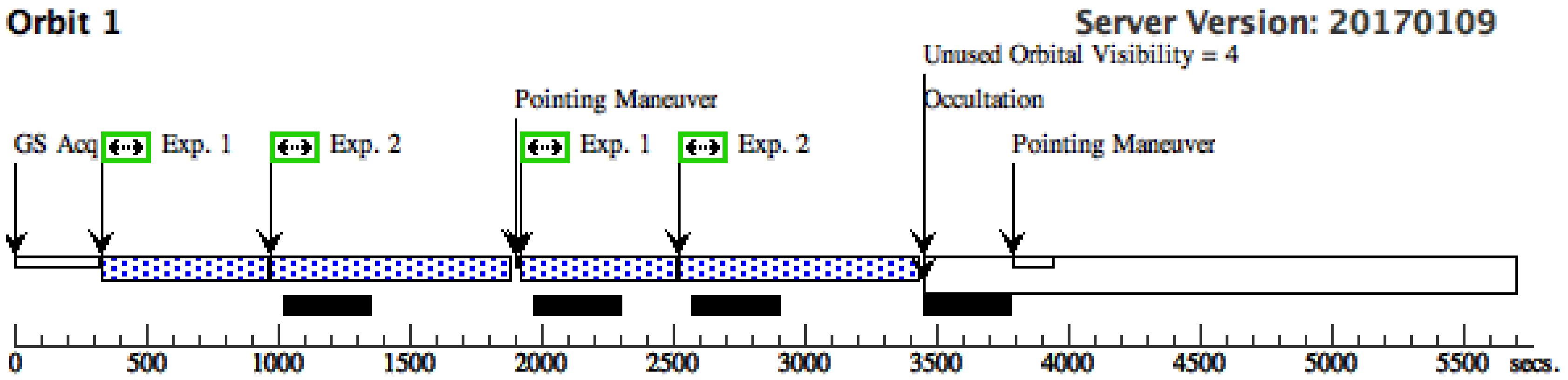
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SPT0311-58	RA: 03 11 33.1570 (47.8881542d) Dec: -58 23 33.61 (-58.39267d) Equinox: J2000		V=25.6+/-1	Reference Frame: ICRS

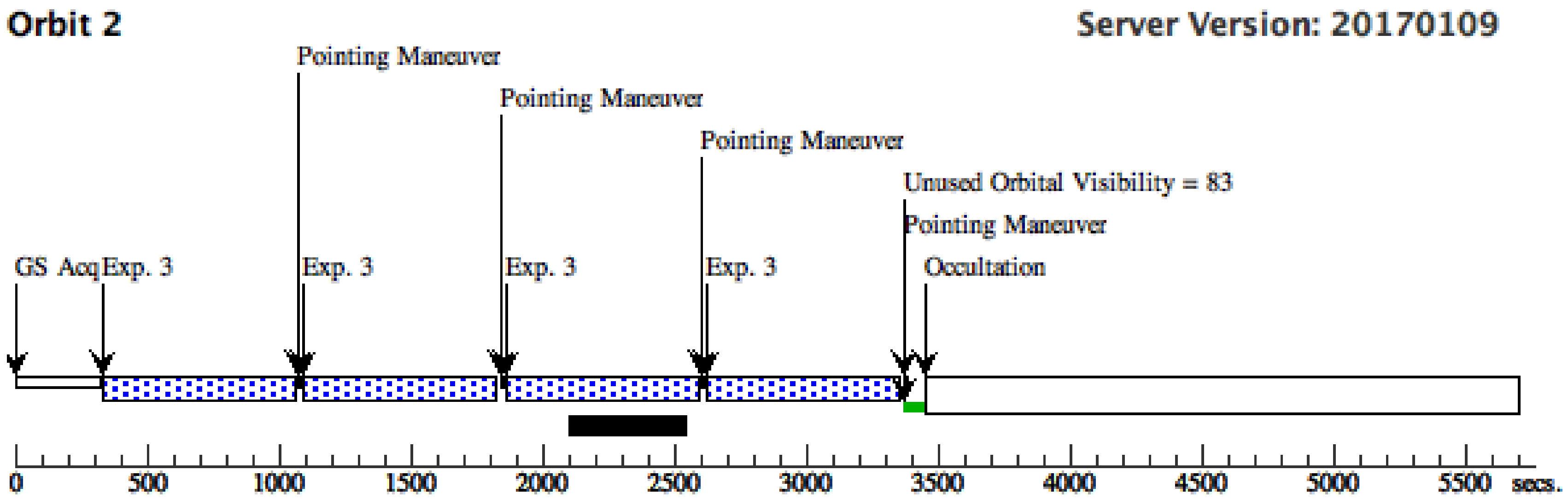
Proposal 14740 - Visit 01 - Exploring a Massive Starburst in the Epoch of Reionization

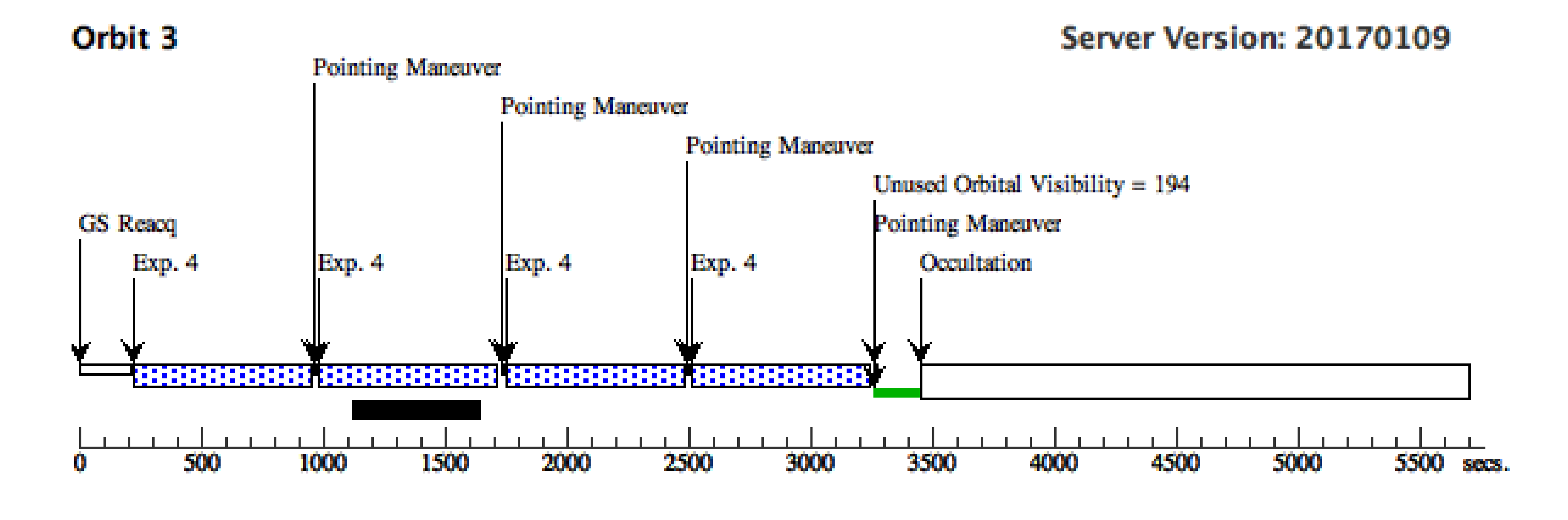
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SPT0311-58	ACS/WFC, ACCUM, WFC1	F606W		POS TARG 10,0	Pattern 1, Exps 1-2 in Visit 01 (1)	422 Secs (844 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) SPT0311-58	ACS/WFC, ACCUM, WFC1	F775W		POS TARG 10,0	Pattern 1, Exps 1-2 in Visit 01 (1)	750 Secs (1500 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3		(1) SPT0311-58	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=8; SAMP-SEQ=SPARS100		Pattern 2, Exps 3-3 in Visit 01 (2)	702.934552 Secs (2811.738 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
4		(1) SPT0311-58	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=8; SAMP-SEQ=SPARS100		Pattern 2, Exps 4-4 in Visit 01 (2)	702.934552 Secs (2811.738 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***
5		(1) SPT0311-58	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=8; SAMP-SEQ=SPARS100		Pattern 2, Exps 5-5 in Visit 01 (2)	702.934552 Secs (2811.738 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[4]***
6		(1) SPT0311-58	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=8; SAMP-SEQ=SPARS100		Pattern 2, Exps 6-6 in Visit 01 (2)	702.934552 Secs (2811.738 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[5]***

Orbit Structure



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Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 194
Pointing Maneuver
GS Reacq
Exp. 4
Exp. 4
Exp. 4
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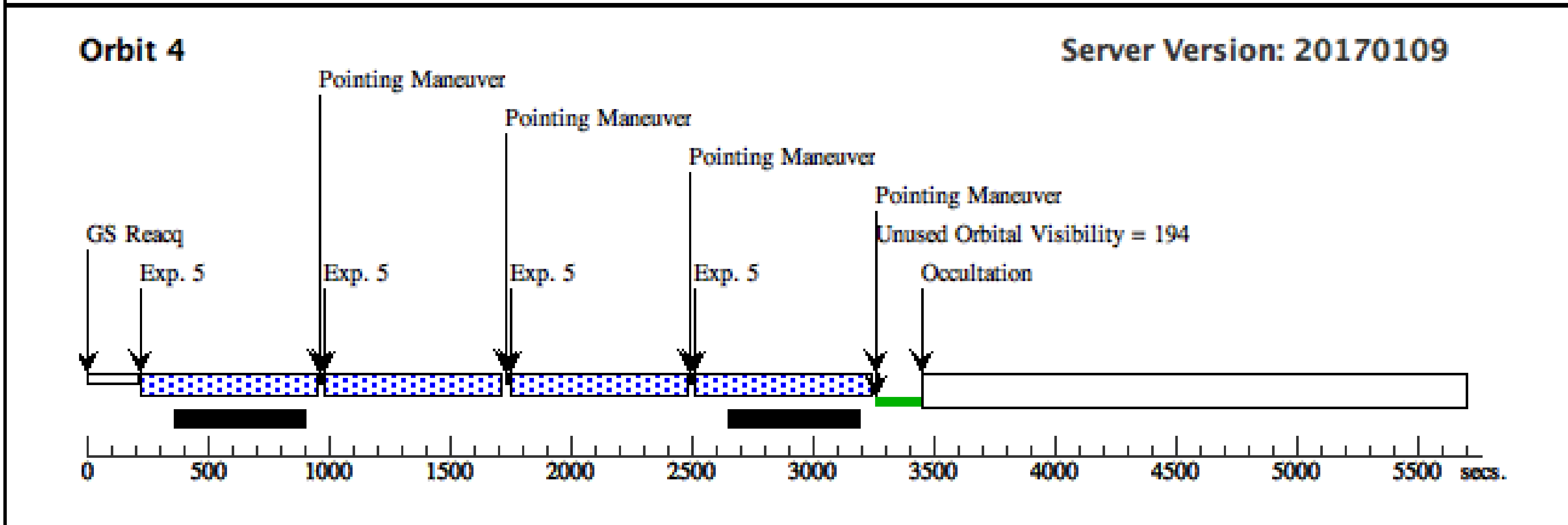
Orbit 4
Server Version: 20170109
Pointing Maneuver
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Unused Orbital Visibility = 194
GS Reacq
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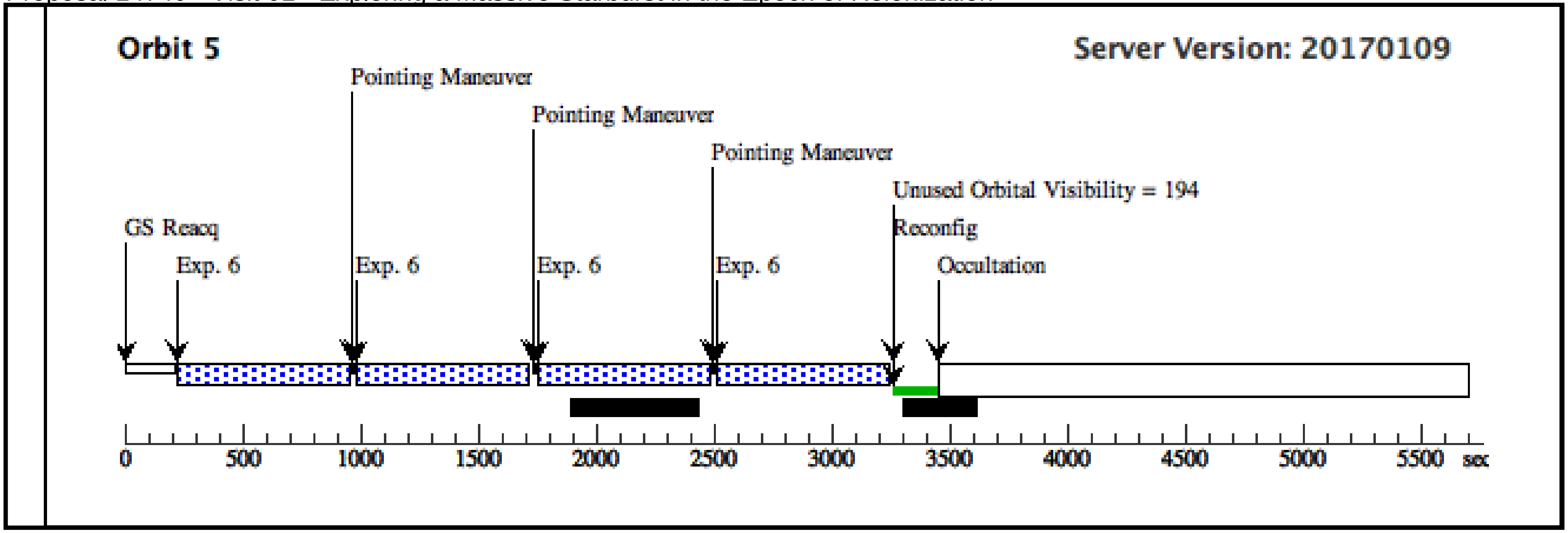
secs.



Orbit 5
Server Version: 20170109
Pointing Maneuver
Pointing Maneuver
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GS Reacq
Reconfig
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