13392 - Six in One Blow: Reconstructing the Circumstellar Environments of Supernovae in NGC 6946 with Light Echoes

Cycle: 21, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Ben E. K. Sugerman (PI) (Contact)	**Goucher College**	**ben.sugerman@goucher.edu**
Dr. Jennifer Andrews (CoI)	University of Massachusetts - Amherst	jandrews@astro.umass.edu
Prof. Michael J. Barlow (CoI) (ESA Member)	University College London	mjb@star.ucl.ac.uk
Dr. Geoffrey C. Clayton (CoI)	Louisiana State University and A & M College	gclayton@fenway.phys.lsu.edu
Prof. Barbara Ercolano (CoI) (ESA Member)	Universitats-Sternwarte Munchen	ercolano@usm.uni-muenchen.de
Dr. Joseph S. Gallagher (CoI)	University of Cincinnati-Raymond Walters College	jgallagher@uc.edu
Dr. Mikako Matsuura (CoI) (ESA Member)	University College London	mikako@star.ucl.ac.uk
Dr. Margaret Meixner (CoI)	The Johns Hopkins University	meixner@stsci.edu
Dr. Masaaki Otsuka (CoI)	Academia Sinica, Institute of Astronomy and Astrophysics	otsuka@asiaa.sinica.edu.tw
Prof. Nino Panagia (CoI)	Space Telescope Science Institute	panagia@stsci.edu
Dr. Roger Wesson (CoI) (ESA Member)	European Southern Observatory (ESO)	rwesson@eso.org

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) SN-2002HH-FIELD (2) SN-2004ET-FIELD	WFC3/UVIS	5	11-Jul-2013 18:39:13.0	yes

5 Total Orbits Used

ABSTRACT

Reconstructing the circumstellar (CS) environment around a supernova (SN) is critical to studying the evolution and mass-loss mechanisms of massive stars, and in establishing the extent to which SNe and their progenitors contribute to the dust found in the early universe. Over the last decade, we have been performing all of these studies through imaging analyses and radiative-transfer modeling of HST optical and Spitzer mid-IR observations of the three SNe 1980K, 2002hh, and 2004et (all within "The Fireworks Galaxy" NGC 6946). These SNe all show evidence of optical and thermal echoes (see below) off of CS material. For each object, a variety of actual CS geometries fit the data equally well, since we have no recent optical images to disentangle important ambiguities in our analyses. Using 5 orbits of HST WFC3/UVIS and 1.6 hours of Spitzer, we propose to image these 3 SNe, which will provide crucial late-time data needed to complete our light-echo modeling. We will also attempt to recover the historic SNe 1917A and 1969P, and will continue our studies of the SN-imposter 2008S, all of which are in the same fields of view.

Light echoes are one of the most powerful and efficient means to directly probe of the structure and composition of dust in CS environments, since echoes provide exact three-dimensional positions of dust while constraining its density, grain-size and chemical make-up. However, echoes pass through a given point only once, and since potential data are permanently lost for each epoch that echoes are not observed, most of the science we propose cannot be achieved if these observations are not taken this cycle.

OBSERVING DESCRIPTION

This Phase 2 sequence is intended to image SNe 1980K and 2004et in one pointing, and SNe 1917A, 1969P, 2002hh, and 2008S in another pointing. The first pointing can image both targets using the UVIS1 chip and therefore has no restrictions on roll angle, however the second pointing requires that the full array be used, which eliminates roll angles 25-45 and 205-225 degrees. These restrictions have been coded into the visit roll-angle requirements. Also, please note that these HST observations must occur within 1 month of approved Spitzer observations of the same field. Given the restrictions on roll angle, and the fact that this field will be viewed by another Spitzer proposal in mid-to-late 2013, the best window for HST observations is 17 Feb 2014 to 7 Mar 2014.

Each target needs to be imaged in a four-point sub-pixel dither pattern so that higher spatial resolution can be gained using drizzling. Each target requires exposure times of at least 1600 sec in F606W and F814W, and 2400 sec in F438W. We have allowed APT to resize the exposures to fill each of the 5 allotted orbits, giving slightly-higher observing times for each filter. Note that although these exposure times are much longer than strictly needed to reach S/N = 10 for a V = 25 point-source (roughly the level of our faintest targets), our previous programs have clearly

demonstrated that these longer exposures dramatically reduce background noise, which is crucial when probing for very faint echoes or marginally-resolved sources.

Visit

Proposal 13392, HST Visit (01), implementation Thu Jul 11 22:39:28 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 45D TO 205 D; ORIENT 225D TO 25 D; BETWEEN 17-FEB-2014:00:00:00 AND 07-MAR-2014:00:00:00

Comments: This proposal included 1.6 hours of Spitzer time to image the same fields with IRAC bands 1-2 (PID 10002). The Spitzer observation needs to happen within 1 month of the HST observation, and preferably as close as possible. The Spitzer visibility window is 02 Aug 2013 to 04 Apr 2014. Given the restrictions on roll angle, and the fact that this field will be viewed by another Spitzer proposal in mid-to-late 2013, the best window for HST observations is 17 Feb 2014 to 7 Mar 2014. We have put this in as a timing constraint in this proposal and the coordinated Spitzer AORs.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1), (2), (3), (4), (5), (6)

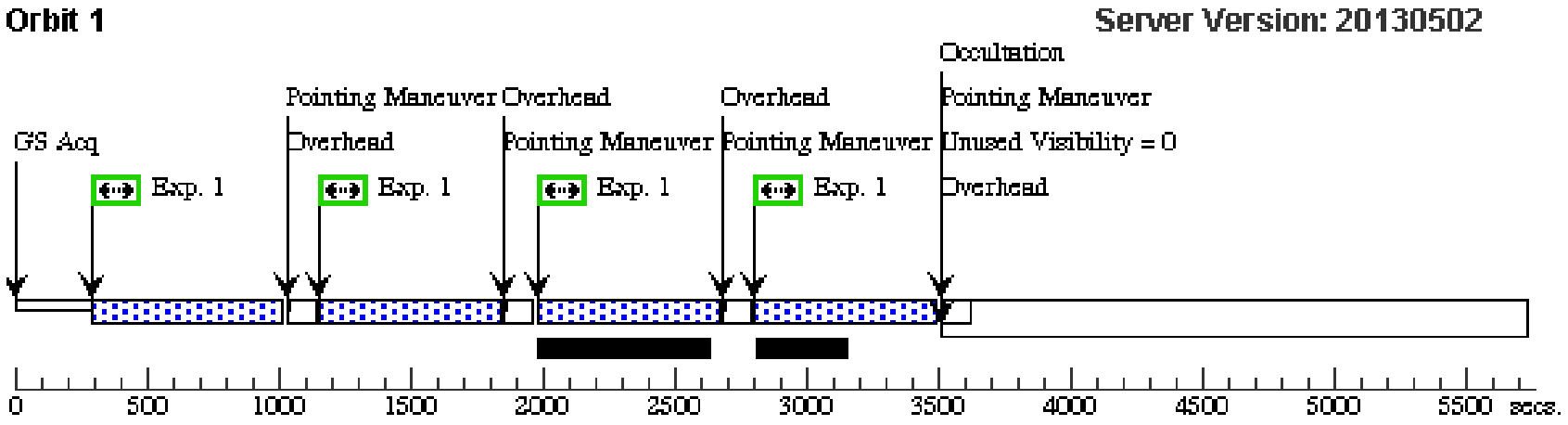
Fixed Targets

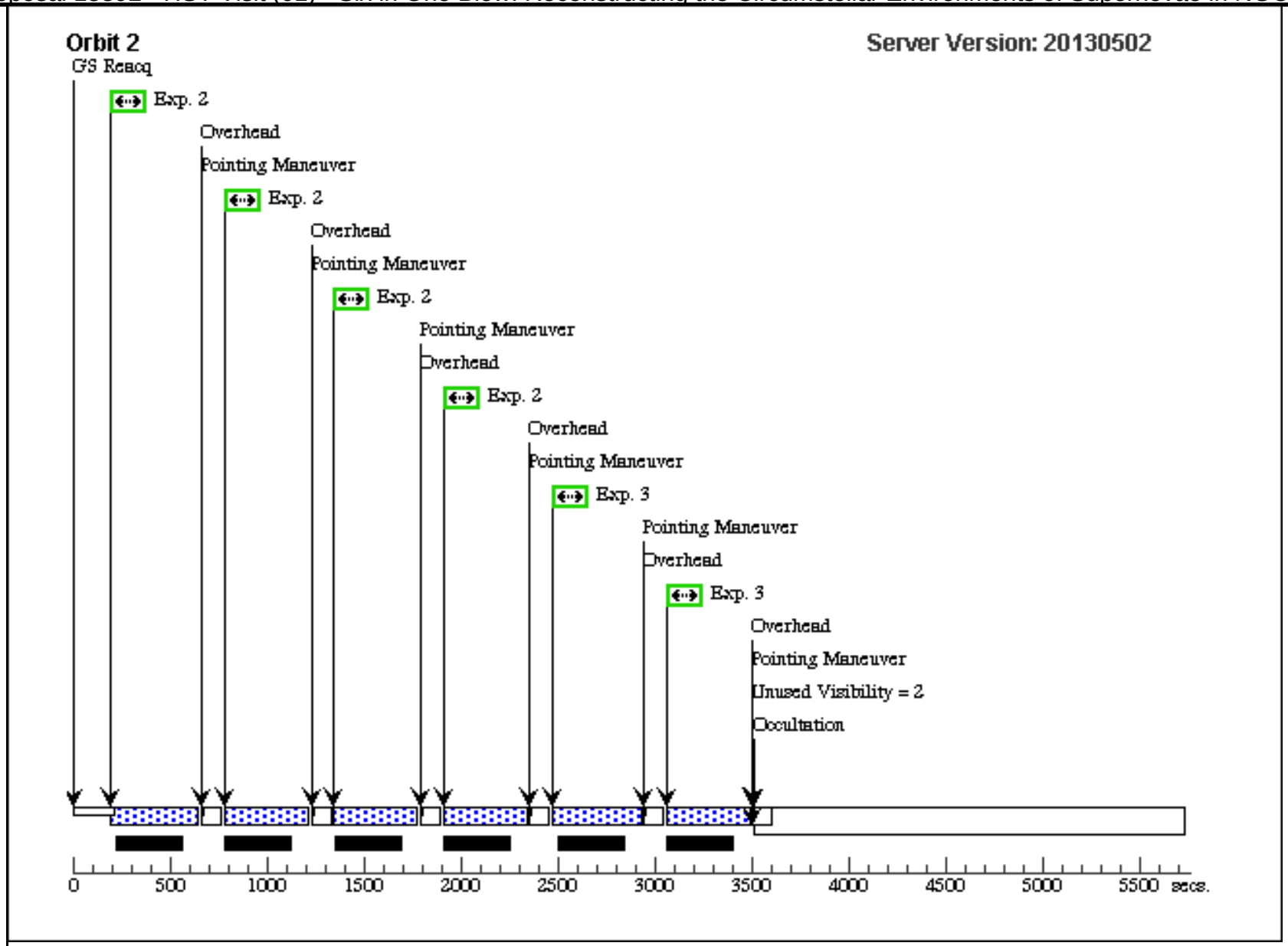
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2002HH-FIELD	RA: 20 34 44.8078 (308.6866992d) Dec: +60 06 38.34 (60.11065d) Equinox: J2000		V=20	Reference Frame: ICRS
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	SN-2004ET-FIELD	RA: 20 35 27.8827 (308.8661779d) Dec: +60 06 50.97 (60.11416d) Equinox: J2000		V=20	Reference Frame: ICRS
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					

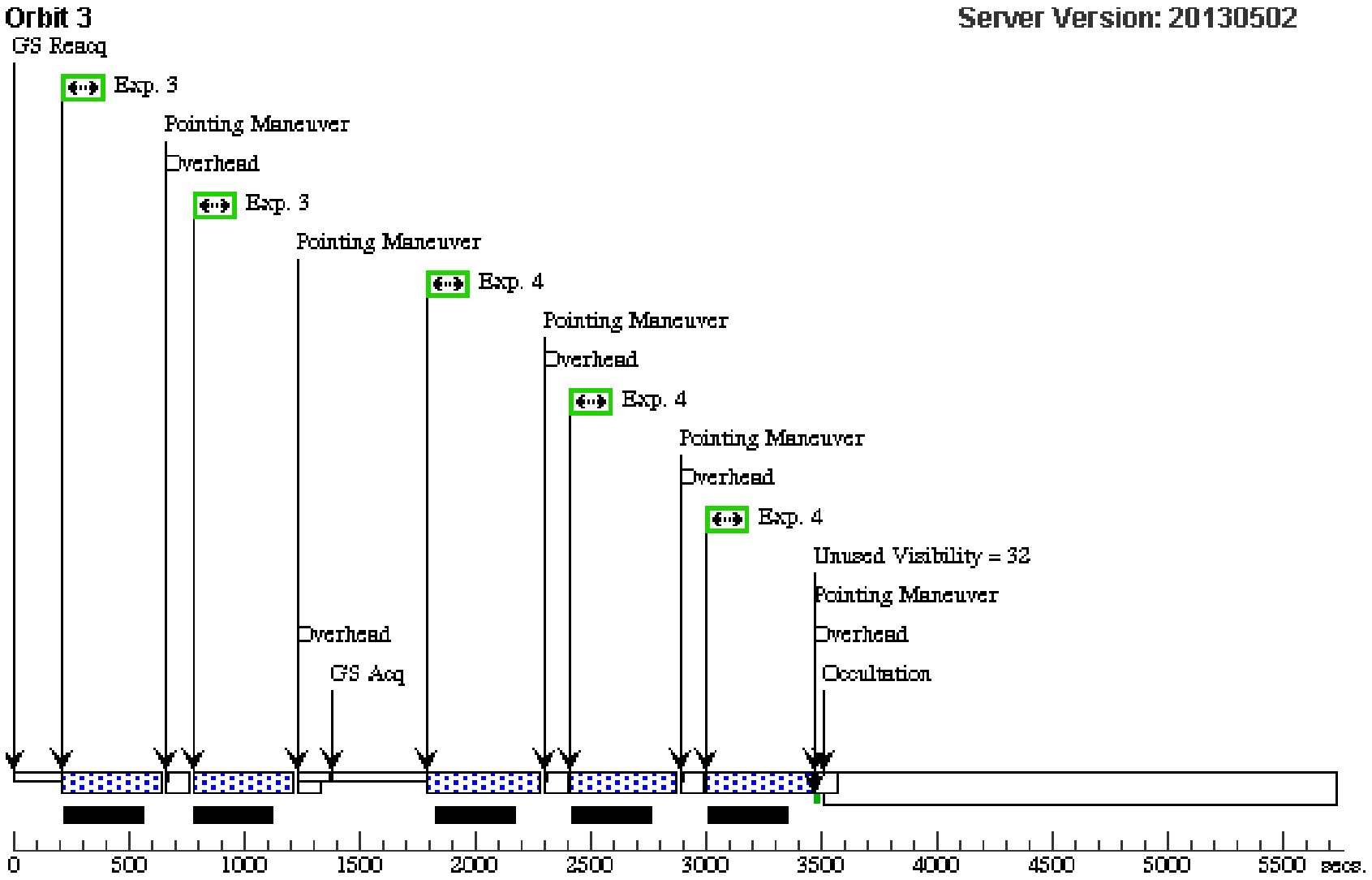
Exposures

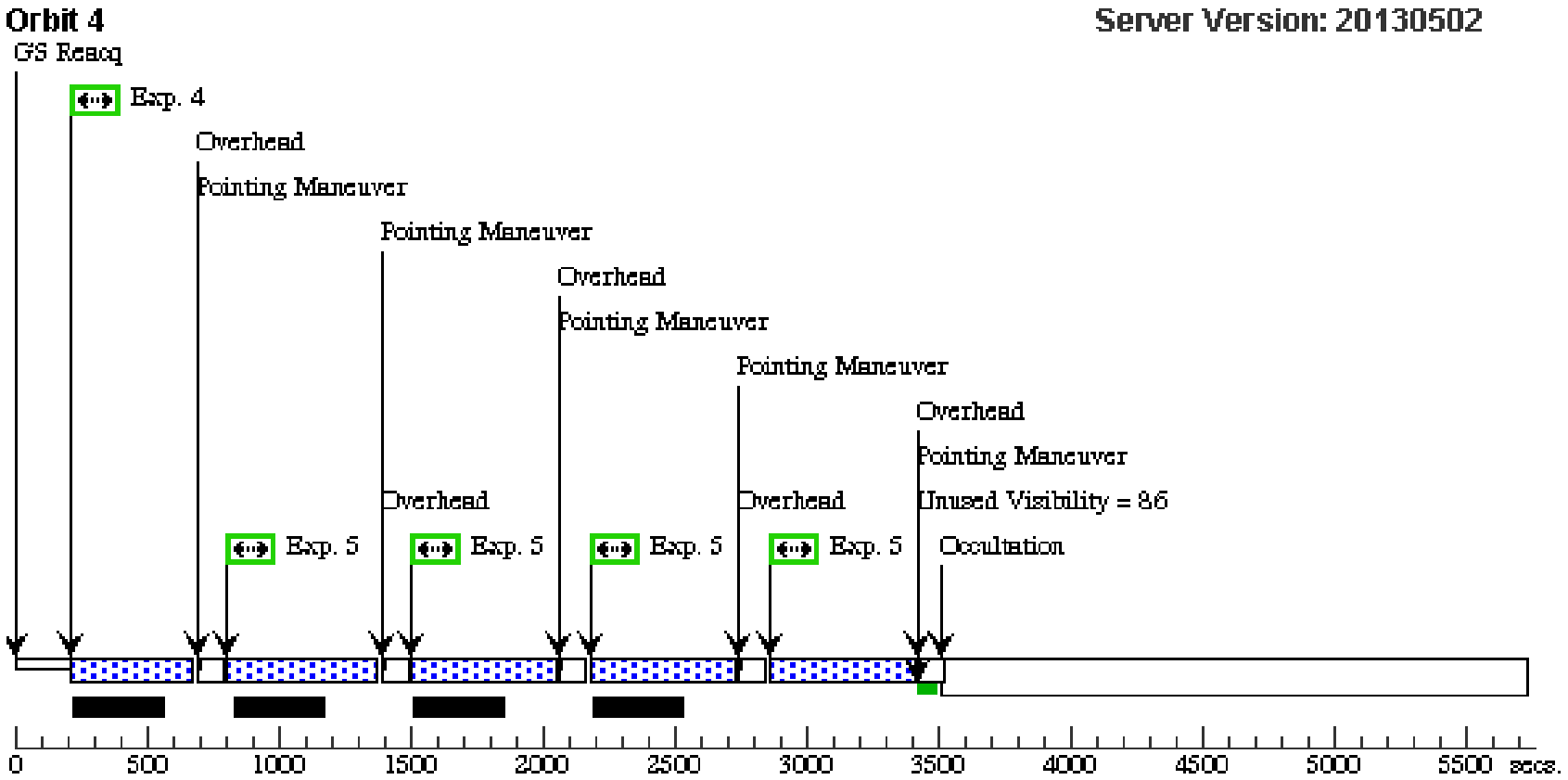
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	04et-B	(2) SN-2004ET-FIELD	WFC3/UVIS, ACCUM, UVIS1	F438W	FLASH=8		Pattern 1, Exps 1-1 in HST Visit (01) (1)	692 Secs (2768 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
2	04et-R	(2) SN-2004ET-FIELD	WFC3/UVIS, ACCUM, UVIS1	F606W			Pattern 1, Exps 2-2 in HST Visit (01) (1)	436 Secs (1744 Secs)	
								[==>(Pattern 1)]	***[2]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
3	04et-I	(2) SN-2004ET-FIELD	WFC3/UVIS, ACCUM, UVIS1	F814W			Pattern 1, Exps 3-3 in HST Visit (01) (1)	436 Secs (1744 Secs)	
								[==>(Pattern 1)]	***[2]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[3]***
								[==>(Pattern 4)]	
4	02hh-I	(1) SN-2002HH-FIELD	WFC3/UVIS, ACCUM, UVIS-CENTER	F814W			Pattern 1, Exps 4-4 in HST Visit (01) (1)	460 Secs (1840 Secs)	
								[==>(Pattern 1)]	***[3]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	***[4]***
5	02hh-R	(1) SN-2002HH-FIELD	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W			Pattern 1, Exps 5-5 in HST Visit (01) (1)	550 Secs (2200 Secs)	
								[==>(Pattern 1)]	***[4]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
6	02hh-B	(1) SN-2002HH-FIELD	WFC3/UVIS, ACCUM, UVIS-CENTER	F438W	FLASH=8		Pattern 1, Exps 6-6 in HST Visit (01) (1)	719 Secs (2876 Secs)	
								[==>(Pattern 1)]	***[5]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	

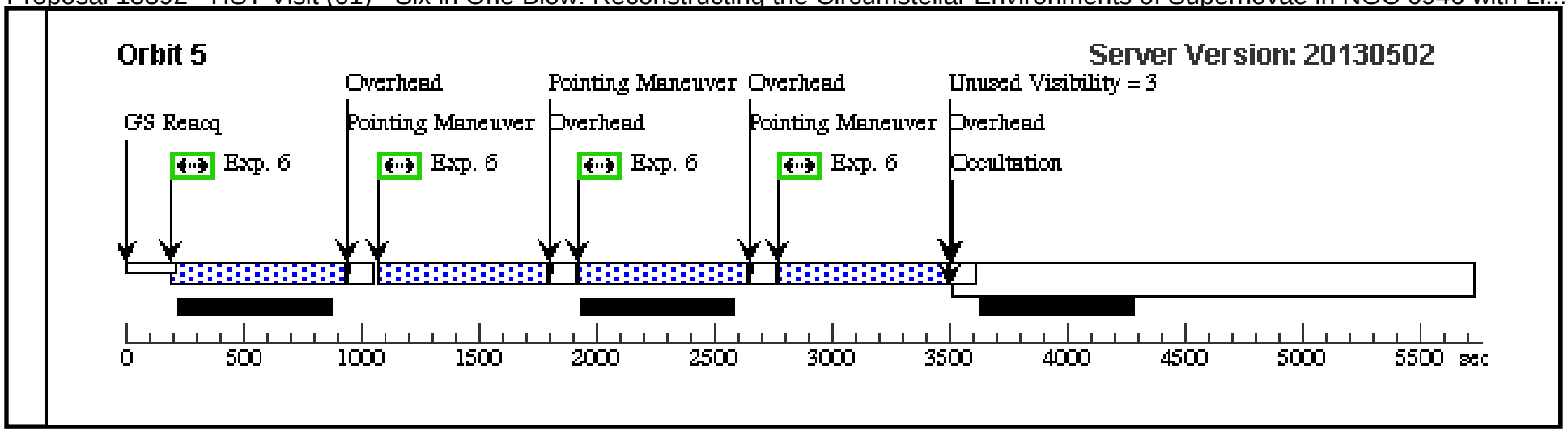
Orbit Structure




Orbit 2
Server Version: 20130502
GS Reacq
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Overhead
Pointing Maneuver
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Overhead
Pointing Maneuver
Unused Visibility = 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 3
Server Version: 20130502
GS Reacq
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Pointing Maneuver
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
Unused Visibility = 32
Pointing Maneuver
Overhead
Occultation
Overhead
GS Acq
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20130502
GS Reacq
Exp. 4
Overhead
Pointing Maneuver
Pointing Maneuver
Overhead
Pointing Maneuver
Pointing Maneuver
Overhead
Pointing Maneuver
Unused Visibility = 86
Occultation
Overhead
Overhead
Exp. 5
Exp. 5
Exp. 5
Exp. 5
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 5
Server Version: 20130502
GS Reacq
Exp. 6
Overhead
Pointing Maneuver
Exp. 6
Pointing Maneuver
Overhead
Exp. 6
Overhead
Pointing Maneuver
Exp. 6
Unused Visibility = 3
Overhead
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec