11590 - Observing the IR Catastrophe in a Deflagration Type Ia Supernova

Cycle: 17, 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) SN-2008A	WFPC2	2	23-Jun-2009 21:05:19.0	yes
02	(1) SN-2008A	ACS/WFC	4	23-Jun-2009 21:05:30.0	yes
03	(1) SN-2008A	WFPC2	1	23-Jun-2009 21:05:36.0	yes
04	(1) SN-2008A	WFC3/IR	3	23-Jun-2009 21:05:45.0	yes

10 Total Orbits Used

ABSTRACT

Our lack of understanding of Type Ia supernova (SN Ia) explosions limits our confidence in their use for cosmology. While there is broad agreement that these objects represent the explosions of white dwarfs, the details of the explosion mechanism are not well-understood. Recently, we have identified an internally homogeneous subclass of SNe Ia whose photometric and spectroscopic peculiarities make them quite distinct from normal SNe Ia. Models suggest we may be seeing the result of an explosion with a subsonic burning front, called a deflagration. We propose to test SN Ia models by obtaining late-time photometry for SN 2008A, a recent, nearby example of this subclass, using ACS and WFC3 on HST. We will accurately measure the late-time photometric decline rate and spectral energy distribution (SED). These observations will allow us to test whether the ejecta contain the large amount of oxygen predicted by certain models. We also aim to detect major evolution of the SED expected due to the "IR catastrophe," a change in the dominant cooling mechanism in the ejecta, as generically predicted by models but only hinted at by current observations.

OBSERVING DESCRIPTION

We aim to constrain the SED of SN 2008A with HST observations at two epochs as the supernova fades: February-March 2009 (400 days after SN maximum light), and June-August 2009 (550 days after maximum). Using optical and near-infrared data, we will measure the SN decline rate and look for color signatures of the "infrared catastrophe" predicted by models. The timing of the two epochs corresponds to the available observability windows for SN 2008A in cycle 17.

REVISED (current version June 23, 2009)

Because of the time-sensitive nature of these observations and the delay in SM4, we have revised the proposal so that our first epoch observations use WFPC2 instead of ACS and WFC3/IR. Thus they can still be scheduled in early 2009; we have opened the observing window from 2009-Jan-15 to 2009-Mar-31 to facilitate two-gryo mode visibility. Because NICMOS will not be available for the first epoch data, we have switched visit03 to WFPC2.

Our second-epoch observations (August 2009) have been revised based on the first-epoch data in which we found the SN to be about 1 magnitude fainter than the nominal prediction. We have updated visits 02 and 04 using the new information. We have structured the observations in 4 visits:

In the first optical epoch we will observe with WFPC2 in four filters: F555W, F622W, F791W, and F850LP; corresponding to ground-based Vriz. Based on extrapolations of the current data and inferences from other SN 2002cx-like SNe Ia (including our recent cycle 16 experience with SN 2005hk), we anticipate SN 2008A will have V = 23.5, r = 22.5, i = 22.0, and z = 22.0 mag in the first epoch, with an uncertainty of about 1 mag. To meaningfully constrain models, we must achieve S/N >= 10 in all bands, even in the pessimistic case (1 mag below the prediction). The WFPC2 exposure time calculator indicates this can be done comfortably in two orbits, and we can fill the orbits with exposures of 1000, 800, 900, and 1200 seconds in F555W, F622W, F791W, and F850LP, respectively. We will employ the recommended two-point dither to remove cosmic rays and hot pixels; these have been input using POS TARG offsets to minimize telescope motions. We will put the SN on the PC chip, offset towards the readout amplifier to minimize CTE effects. [COMPLETED]

In the first epoch (but a separate visit, visit 03 which was formerly NICMOS) we will also add 350 seconds of F850LP exposure to increase the sensitivity, as well as 1500 seconds of dithered F439W exposure to increase the wavelength range of the SED. [COMPLETED]

In the second optical epoch (VISIT 02), we will observe with ACS/WFC in three filters: F555W, F625W, and F775W, and we anticipate SN 2008A will have V = 26.5, r = 26.4, and i = 25.3 at that time, with an uncertainty of 0.5 mag. We will fill four orbits, with total exposures of 3750, 3530, and 2484 seconds in F555W, F625W, and F775W, respectively, with box-dithered observations. In this epoch, the ORIENT restrictions (which overlap entirely the available roll ranges) lead us to use the WFC1 aperture to avoid a nearby bright star (HD 9983, V=7.6, about 2 arcmin to the southwest).

In the infrared (VISIT 04), we expect J = 25.0 +/- 1 mag for SN 2008A, and require three orbits using WFC3/IR. We use a four-point box dither in each orbit, with the boxes offset slightly from orbit to orbit, near the standard IR aperture. In orbits 2 and 3 we use a standard dither pattern with SPARS50, NSAMP=15 readout. In the first orbit we use specific POS TARG offsets so that we can have two NSAMP=14 and two NSAMP=15 exposures to optimally fill the shorter available exposure time. This yields a total exposure of 8336 seconds. The supernova will be too faint for our originally planned F160W observations.

Visit

Proposal 11590, Visit 01, completed Wed Jun 24 01:05:50 GMT 2009

Diagnostic Status: Warning

Scientific Instruments: WFPC2

Special Requirements: GYRO MODE 2G; BETWEEN 15-JAN-2009:00:00:01 AND 31-MAR-2009:23:59:59

Diagnostics

(Visit 01) Warning (Form): Gyro Mode overrides default value of 3GOBAD.

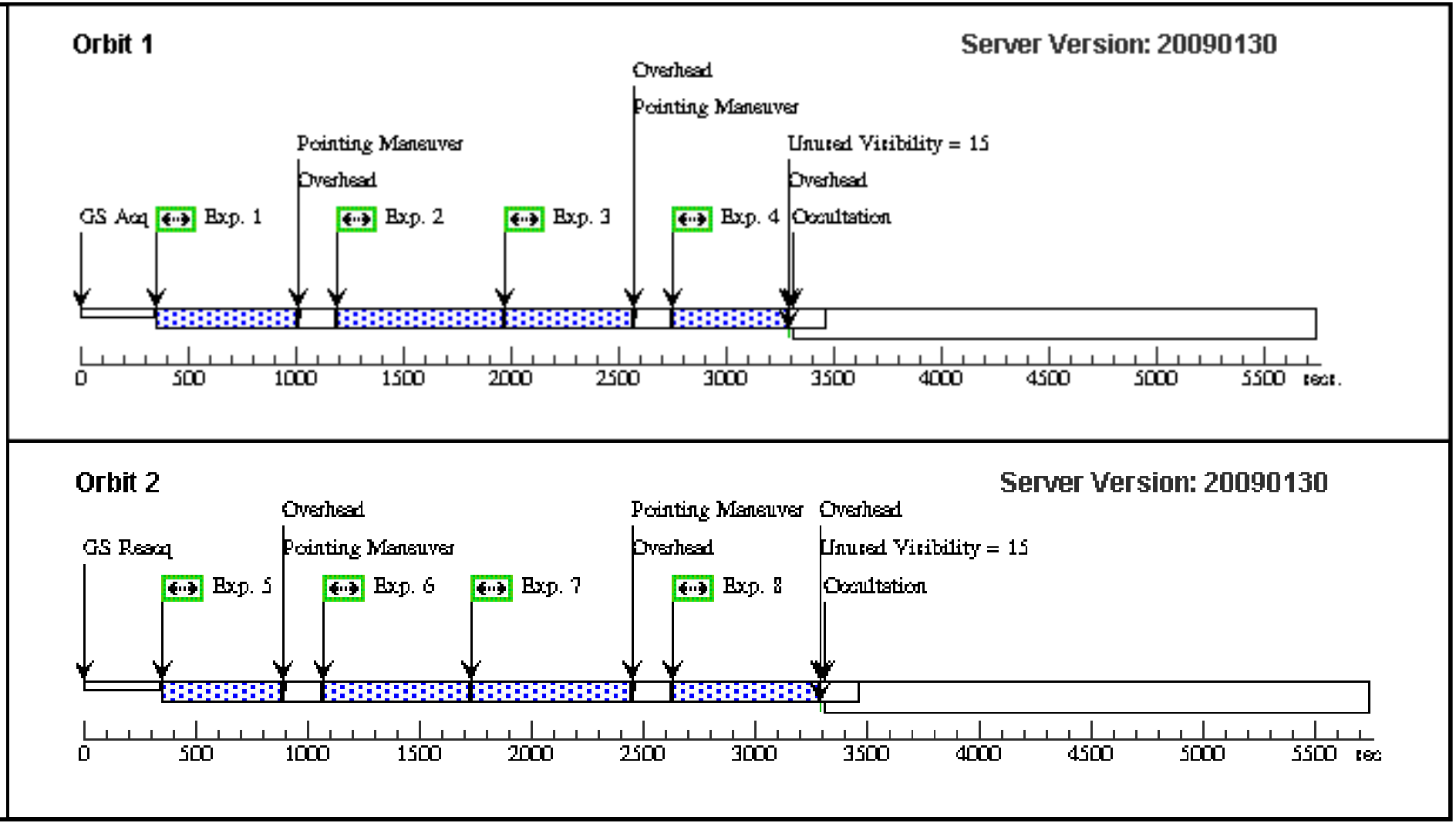
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2008A	RA: 01 38 17.3800 (24.5724167d) Dec: +35 22 13.70 (35.37047d) Equinox: J2000		V=23.5+/-1.0 fading	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) SN-2008A	WFPC2, IMAGE, PC1	F555W		POS TARG -7,-8		500 Secs	
								[==>]	***[1]***
2		(1) SN-2008A	WFPC2, IMAGE, PC1	F555W		POS TARG -6.751,-7.751		500 Secs	
								[==>]	***[1]***
3		(1) SN-2008A	WFPC2, IMAGE, PC1	F791W		POS TARG -6.751,-7.751		500 Secs	
								[==>]	***[1]***
4		(1) SN-2008A	WFPC2, IMAGE, PC1	F791W		POS TARG -7,-8		400 Secs	
								[==>]	***[1]***
5		(1) SN-2008A	WFPC2, IMAGE, PC1	F622W		POS TARG -7,-8		400 Secs	
								[==>]	***[2]***
6		(1) SN-2008A	WFPC2, IMAGE, PC1	F622W		POS TARG -6.751,-7.751		400 Secs	
								[==>]	***[2]***
7		(1) SN-2008A	WFPC2, IMAGE, PC1	F850LP		POS TARG -6.751,-7.751		600 Secs	
								[==>]	***[2]***
8		(1) SN-2008A	WFPC2, IMAGE, PC1	F850LP		POS TARG -7,-8		500 Secs	
								[==>]	***[2]***

Orbit Structure



Visit

Proposal 11590, Visit 02, implementation Wed Jun 24 01:05:51 GMT 2009

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: ORIENT 205D TO 295 D; BETWEEN 01-JUN-2009:00:00:01 AND 31-AUG-2009:23:59:59

Comments: ORIENT range avoids bright star to the southwest

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.265 Line Spacing=0.187	Coordinate Frame=POS-TARG Pattern Orientation=20.67 Angle Between Sides=69.05 Center Pattern=false		(1), (6), (7)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2008A	RA: 01 38 17.3800 (24.5724167d) Dec: +35 22 13.70 (35.37047d) Equinox: J2000		V=23.5+/-1.0 fading	Reference Frame: ICRS

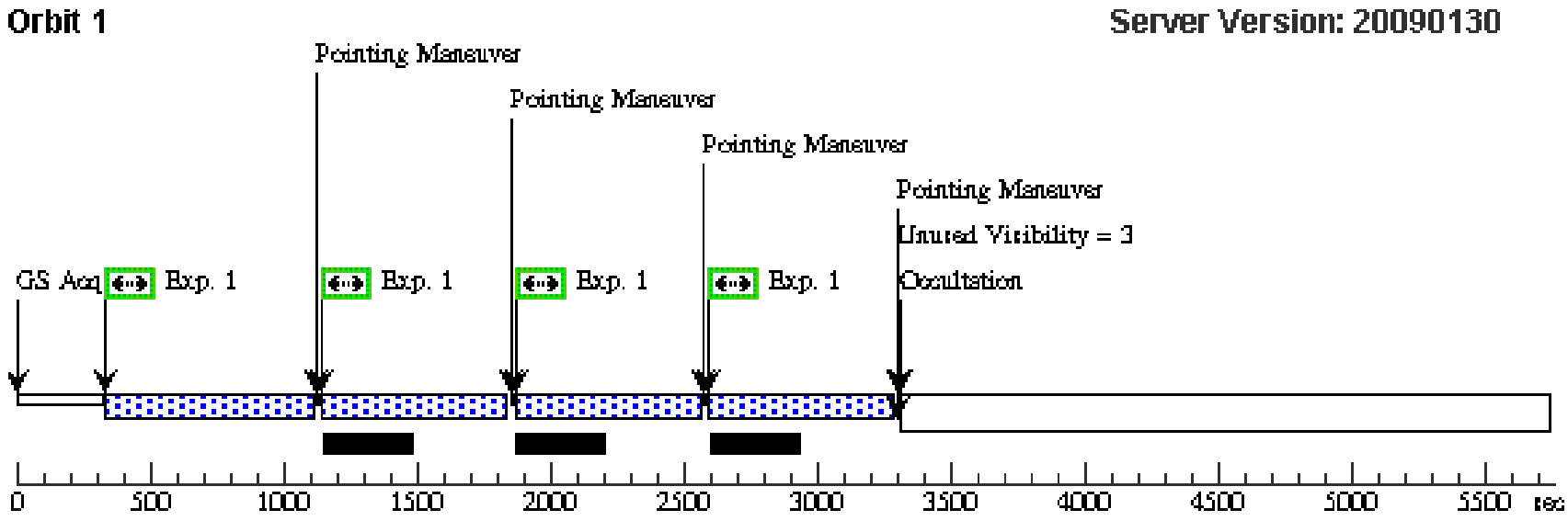
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F625W			Pattern 1, Exps 1-1 (1)	570 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F625W		POS TARG 0.198,0.214		625 Secs	
								[==>]	***[2]***
3		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F625W		POS TARG 0.099,0.107		625 Secs	
								[==>]	***[2]***
4		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F555W		POS TARG 0.099,0.107		625 Secs	
								[==>]	***[2]***
5		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F555W		POS TARG 0.198,0.214		625 Secs	
								[==>]	***[2]***
6		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F555W			Pattern 1, Exps 6-6 (1)	625 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***

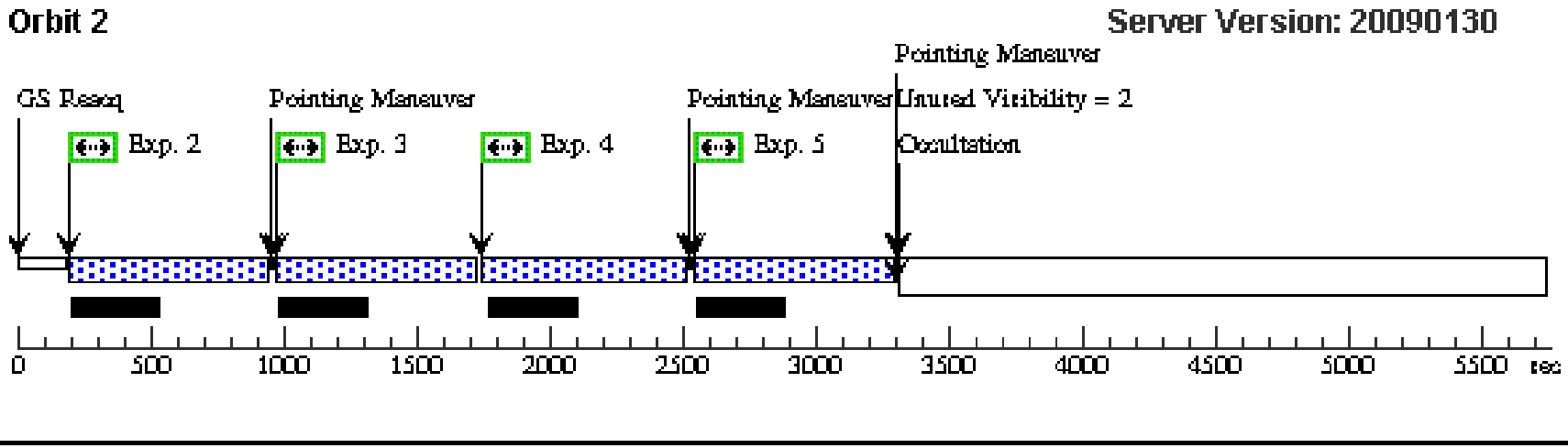
Exposures (continued)

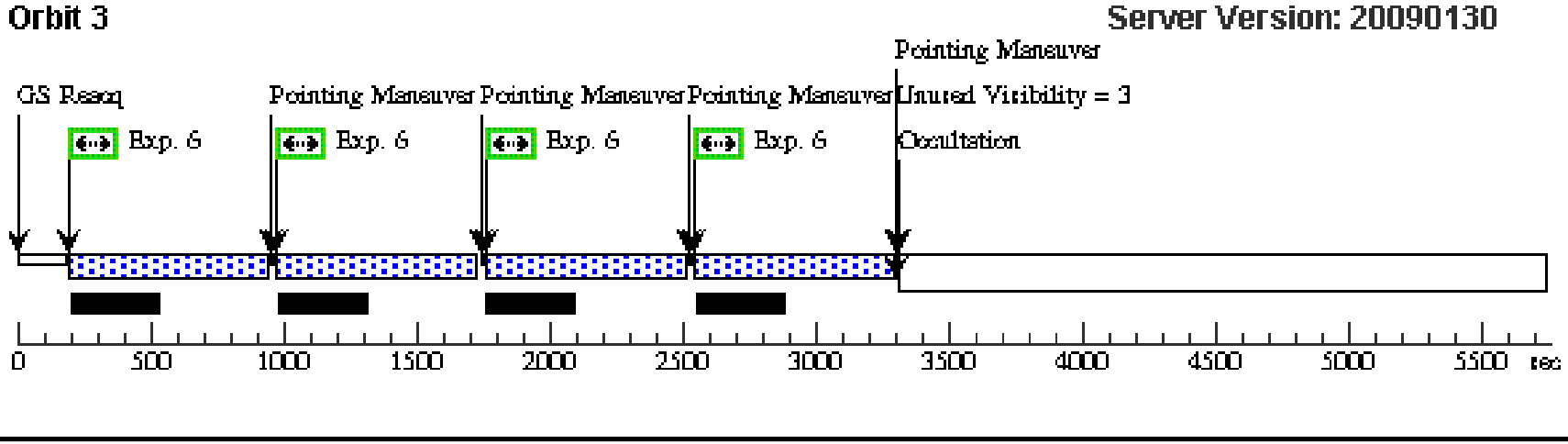
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
7		(1) SN-2008A	ACS/WFC, ACCUM, WFC1	F775W			Pattern 1, Exps 7-7 (1)	621 Secs	
								[==>(Pattern 1)]	
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	***[4]***

Orbit Structure

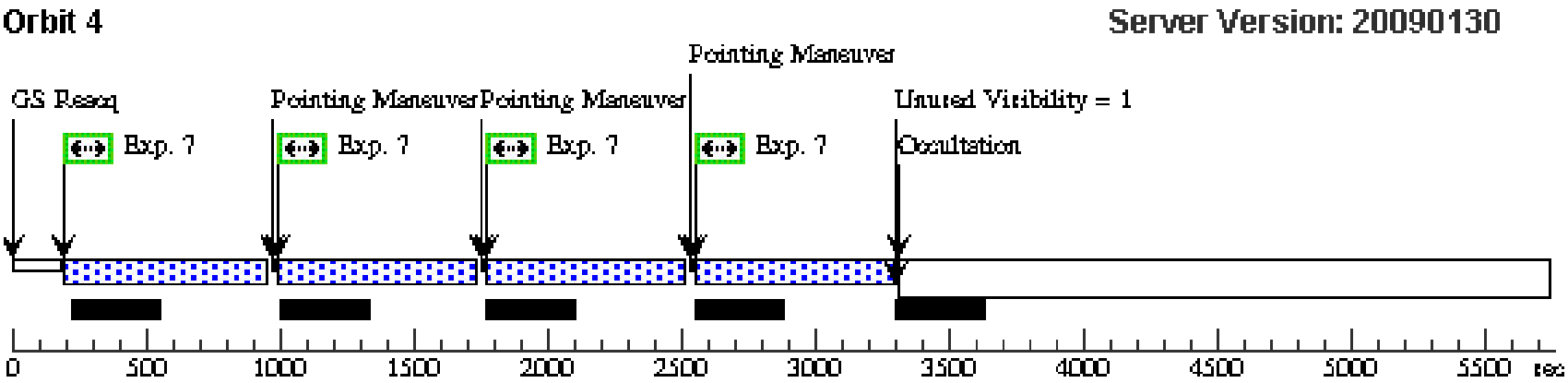


Orbit Structure (continued)





Orbit Structure (continued)



Visit

Proposal 11590, Visit 03, completed Wed Jun 24 01:05:52 GMT 2009

Diagnostic Status: Warning

Scientific Instruments: WFPC2

Special Requirements: GYRO MODE 2G; BETWEEN 15-JAN-2009:00:00:01 AND 31-MAR-2009:23:59:59

Diagnostics

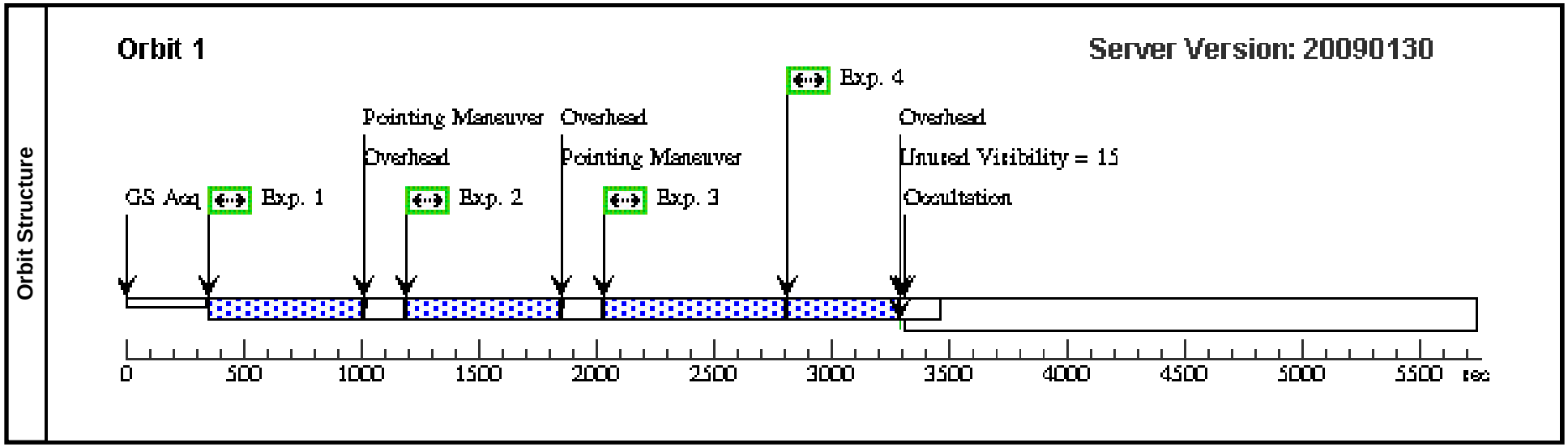
(Visit 03) Warning (Form): Gyro Mode overrides default value of 3GOBAD.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2008A	RA: 01 38 17.3800 (24.5724167d) Dec: +35 22 13.70 (35.37047d) Equinox: J2000		V=23.5+/-1.0 fading	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) SN-2008A	WFPC2, IMAGE, PC1	F439W		POS TARG -7,-8		500 Secs	
								[==>]	***[1]***
2		(1) SN-2008A	WFPC2, IMAGE, PC1	F439W		POS TARG -6.751,-7.751		500 Secs	
								[==>]	***[1]***
3		(1) SN-2008A	WFPC2, IMAGE, PC1	F439W		POS TARG -6.502,-7.502		500 Secs	
								[==>]	***[1]***
4		(1) SN-2008A	WFPC2, IMAGE, PC1	F850LP		POS TARG -6.502,-7.502		350 Secs	
								[==>]	***[1]***


Orbit Structure
Orbit 1
Server Version: 20090130
GS Acq
Exp. 1
Pointing Maneuver
Overhead
Exp. 2
Overhead
Pointing Maneuver
Exp. 3
Exp. 4
Overhead
Unused Visibility = 15
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 11590, Visit 04, implementation Wed Jun 24 01:05:52 GMT 2009

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: BETWEEN 01-JUN-2009:00:00:01 AND 31-AUG-2009:23:59:59

Patterns

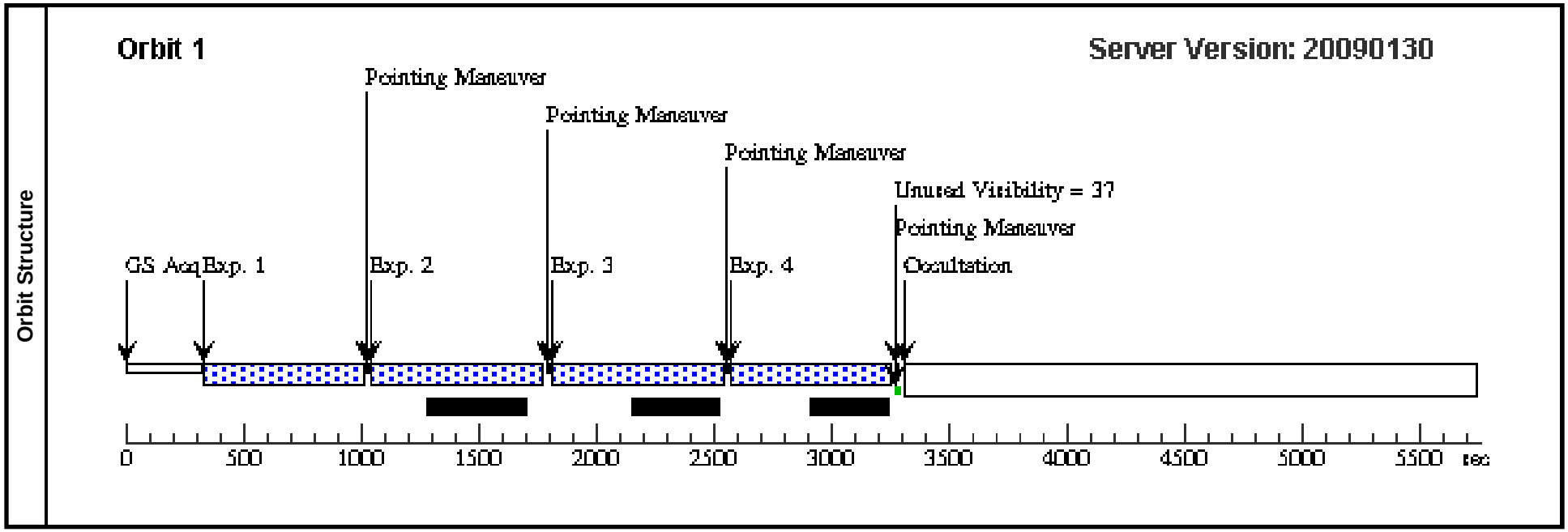
#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(5), (6)

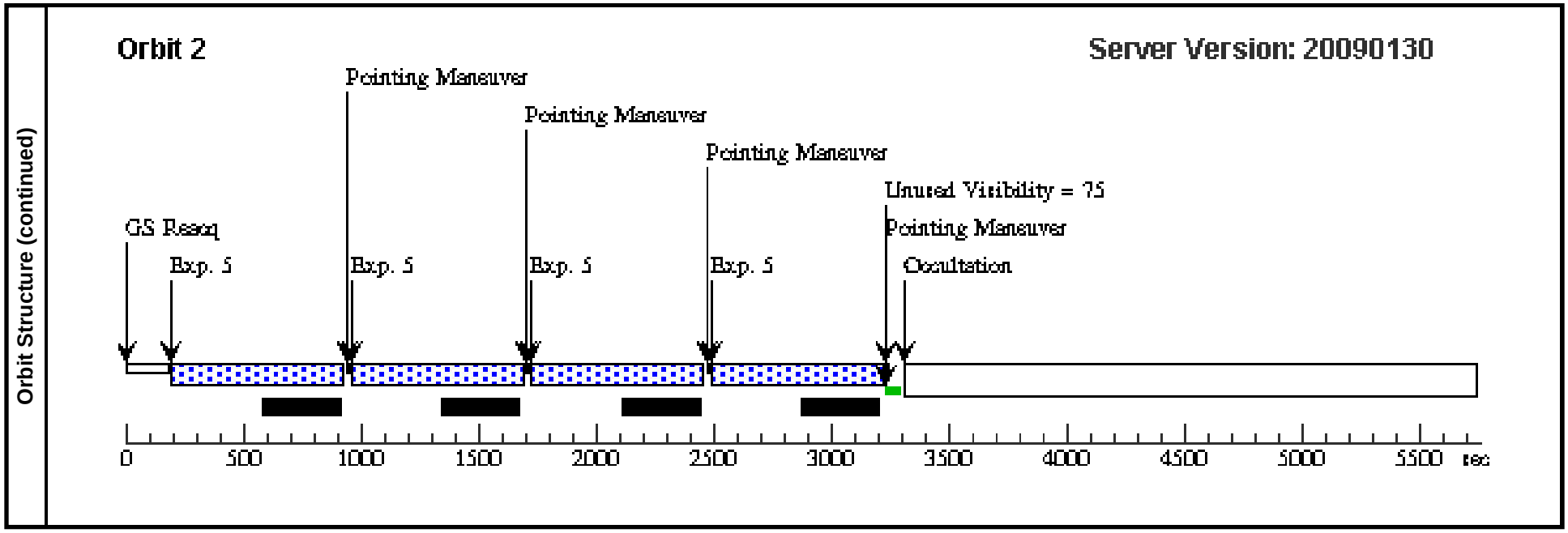
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2008A	RA: 01 38 17.3800 (24.5724167d) Dec: +35 22 13.70 (35.37047d) Equinox: J2000		V=23.5+/-1.0 fading	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=14; SAMP-SEQ=SPARS50	POS TARG -0.835,-0.835		*[==>]*	***[1]***
2		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=15; SAMP-SEQ=SPARS50	POS TARG -0.321,-0.643		*[==>]*	***[1]***
3		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=15; SAMP-SEQ=SPARS50	POS TARG -0.514,-0.321		*[==>]*	***[1]***
4		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=14; SAMP-SEQ=SPARS50	POS TARG -1.028,-0.514		*[==>]*	***[1]***
5		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=15; SAMP-SEQ=SPARS50		Pattern 2, Exps 5-5 (2)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***
6		(1) SN-2008A	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=15; SAMP-SEQ=SPARS50	POS TARG 0.835,-0.835	Pattern 2, Exps 6-6 (2)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***


Orbit Structure
Orbit 1
Server Version: 20090130
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Visibility = 37
Pointing Maneuver
GS Acq
Exp. 1
Exp. 2
Exp. 3
Exp. 4
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec


Orbit Structure (continued)
Orbit 2
Server Version: 20090130
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Visibility = 75
Pointing Maneuver
GS Reacq
Occultation
Exp. 5
Exp. 5
Exp. 5
Exp. 5
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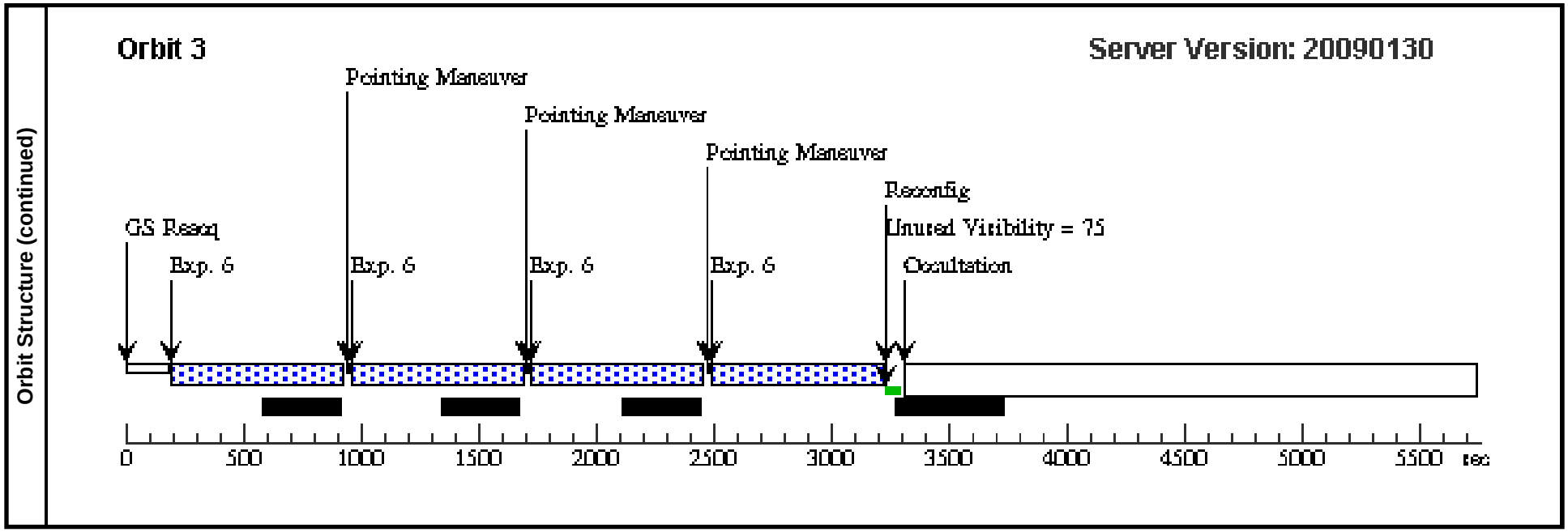
2000
2500
3000
3500
4000
4500
5000
5500
sec


Orbit Structure (continued)
Orbit 3
Server Version: 20090130
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Reconfig
GS Reacq
Unused Visibility = 75
Exp. 6
Exp. 6
Exp. 6
Exp. 6
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec