13433 - Stellar Forensics V: A post-explosion view of the progenitor of SN 2011dh

Cycle: 21, Proposal Category: GO

(UV Initiative)

(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-2011DH	WFC3/UVIS	2	14-Jul-2014 21:00:26.0	yes
02	(1) SN-2011DH	ACS/WFC	2	14-Jul-2014 21:00:28.0	yes
A1	BIAS	ACS/WFC	1	14-Jul-2014 21:00:29.0	yes
A2	BIAS	ACS/WFC	1	14-Jul-2014 21:00:30.0	yes

6 Total Orbits Used

ABSTRACT

Recent studies have used high spatial resolution HST observations of supernova (SN) sites to directly identify the progenitors of core-collapse SNe on pre-explosion images. These studies have set constraints about the nature of massive stars and their evolution just prior to their explosion as SNe. Now, at late-times when the SNe have faded sufficiently, it is possible to return to the sites of these core-collapse supernovae to search for clues about the nature of their progenitors.

We request time to conduct deep, late-time, high-resolution imaging with WFC3 UVIS and ACS WFC of the site of the Type IIb supernova 2011dh. The nature of the observed yellow supergiant progenitor conflicts with the predictions of stellar evolution models and our understanding of the optical and radio light curves of the subsequent supernova.

We aim to: 1) Confirm our original identification, made in pre-explosion images, by confirming that the yellow supergiant is now missing; 2) Apply image subtraction techniques for the pre-explosion images with this late-time imaging to determine accurate photometry of the progenitor to constrain its temperature and luminosity; 3) conduct a deep search for the hypothesised hot binary companion; and 4) use the stellar population in the immediate vicinity of the SN to determine the reddening and extinction that affected the progenitor. HST provides the unique combination of high-resolution UV/optical imaging at very faint magnitudes that will facilitate this study.

OBSERVING DESCRIPTION

We require deep 5 colour imaging of the site of the Type IIb SN 2011dh at late-times. A progenitor object was identified in deep pre-explosion WFPC2 and ACS imaging; we wish to see if the object that was identified in the pre-explosion WFPC2 F336W and ACS F435W, F555W and F814W images has disappeared. In addition, we wish to ascertain the presence of a possible binary companion (either hot or cool) that may have been blended with the pre-explosion source, such that we also request an observation with the F225W filter (to probe a hot companion).

This late-time imaging consists of a series of deep observations at the site of SN 2011dh, using WFC3 UVIS and the 1kx1k subarray and ACS and the 1kx1k subarry (to reduce readout times, since only a small area around the SN is actually required). The WFC3 UVIS observations are to be conducted in the F225W and F336W filters, while the ACS/WFC observations will use the F435W, F555W and F814W filters. We use these filter combinations to accurately match the corresponding pre-explosion HST observations. A standard 4-point box dither pattern is employed to aid the rejection of cosmic rays and hotpixels, as well as improve the sampling of the PSF. The observations are designed to go down to levels of m_F225W~25.5, m_F336W~26., m_F435W~27, m_F555W~27, m_F814W~27 (to a S/N of 3) to probe the nature of the faint background. Given the duration of the four individual exposures that make up the dither pattern, any nearby bright sources should not saturate (which we have confirmed with our previous photometry of the position of this SN and the BOT).

The F225W and F336W observations use a larger box dither pattern to overcome the effects of local droplets in the UVIS field. The pattern A4 (from ISR WFC3-2010-09, Dahlen et al.) has been adopted, and I have calculated the values of the point spacing, line spacing, pattern orientation and angles between sides using their prescription - the resulting positions for the fovs for the individual pointings in this dither pattern (checked using Aladin) seem consistent with what I would expect for this pattern, but a check of my calculations would be useful.

The F225W, F336W and F438W observations have been updated to include a postflash - which has been set to 12e- per pixel, in accordance with Anderson et al. 2012, for the WFC3 observation and 40e- following Smith et al. 2013. Post-flash is not required for the F555W and F814W observations.

The 2 orbits per instrument have been broken into separate visits; however it will be useful to have them conducted at approximately similar times. This will enable us to evaluate any residual SN flux at UV and optical wavelength, using colour terms to derive the likely SN parameters and, hence, calculate the relative contamination at different wavelengths. In order to enable this science we require the SN to be as faint as possible, and loosely constrain the time window for the two visits to be in the second half of Cycle 21 (and loosely constrain Visit 2 to be conducted within 28 days of Visit 1).

------ Calibration Justification -------

A series of 26 ACS bias frames in the WFC1-1K subarray mode have been inserted directly into this program for the purpose of calibration of the ACS subarray images in visit 02. This subarray mode is fully supported, so the two internal orbits required to obtain these 26 frames should be charged to the Cycle 21 ACS Calibration Program. Contact David Golimowski (x4808) for more information.

--------- Additional Comments ----------

We note that there are previous observations of the site of SN 2011dh in the HST archive. These observations were either taken before the SN exploded (i.e. with the progenitor still present) or post-explosion (i.e. with the SN still bright). We aim to make the authoritative study of this progenitor system by probing the disappearance of the putative YSG progenitor and probe any hot/cool companion star remaining at the SN position (with minimal contribution from SN).

Visit

Proposal 13433, Visit 01, implementation Tue Jul 15 01:00:32 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER 15-MAR-2014:00:00:00

Comments: 2 orbits to acquire WFC3/UVIS F225W and F336W imaging of the site of SN 2011dh

Patterns

#	Primary Pattern		Secondary Pattern		Exposures
(3)	Pattern Type=LINE Purpose=DITHER Number Of Points=2 Point Spacing=4.26 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=47.616 Angle Between Sides= Center Pattern=false	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	(1), (2)

Fixed Targets

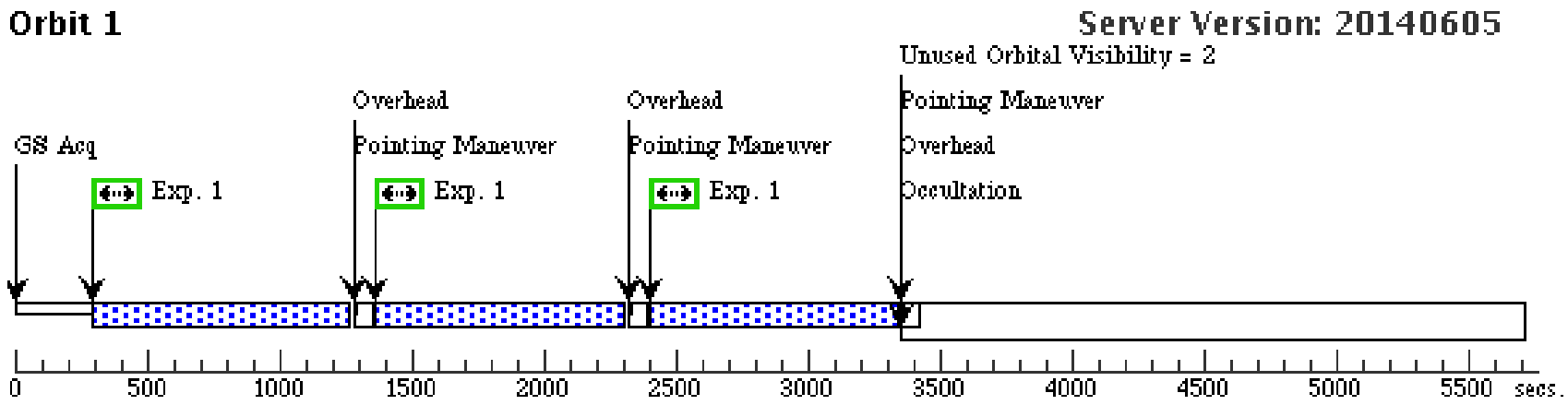
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2011DH	RA: 13 30 5.1200 (202.5213333d) Dec: +47 10 11.00 (47.16972d) Equinox: J2000		V=27+/-0.2	Reference Frame: SIMBAD

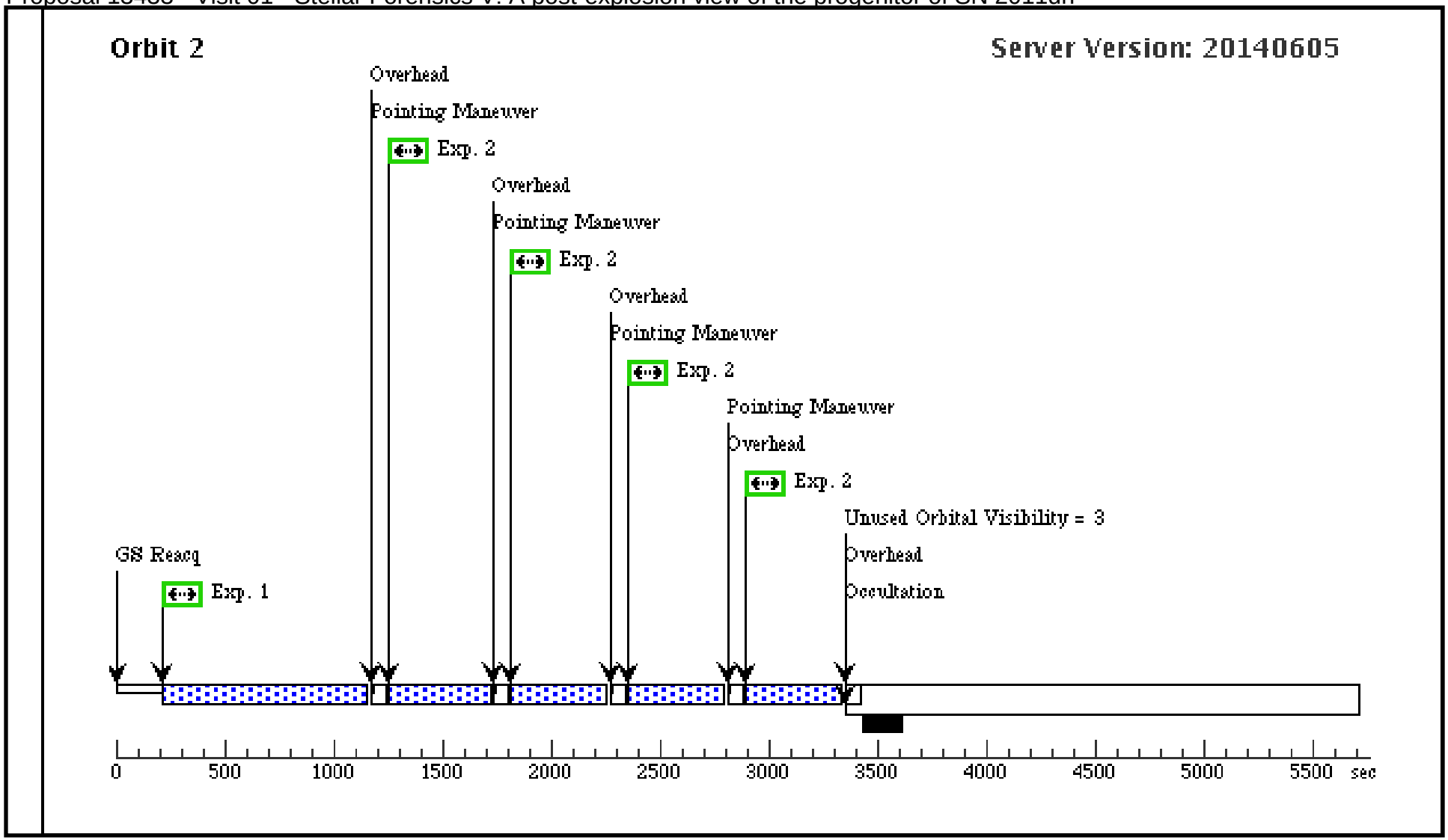
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-2011DH	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F225W	FLASH=12		Pattern 3, Exps 1-1 in Visit 01 (3)	943 Secs (3772 Secs)	
								[==>(Pattern 1,1)]	
								[==>(Pattern 1,2)]	***[1]***
								[==>(Pattern 2,1)]	
								[==>(Pattern 2,2)]	***[2]***
2		(1) SN-2011DH	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	FLASH=12		Pattern 3, Exps 2-2 in Visit 01 (3)	446 Secs (1784 Secs)	
								[==>(Pattern 1,1)]	
								[==>(Pattern 1,2)]	***[2]***
								[==>(Pattern 2,1)]	
								[==>(Pattern 2,2)]	

Orbit Structure




Orbit 2
Server Version: 20140605
Overhead
Pointing Maneuver
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Unused Orbital Visibility = 3
Overhead
Occultation
GS Reacq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13433, Visit 02, implementation Tue Jul 15 01:00:32 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: AFTER 01 BY 0 D TO 28 D

Comments: 2 orbits to acquire ACS/WFC F435W, F555W and F814W imaging of the site of SN 2011dh

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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), (2), (3)

Fixed Targets

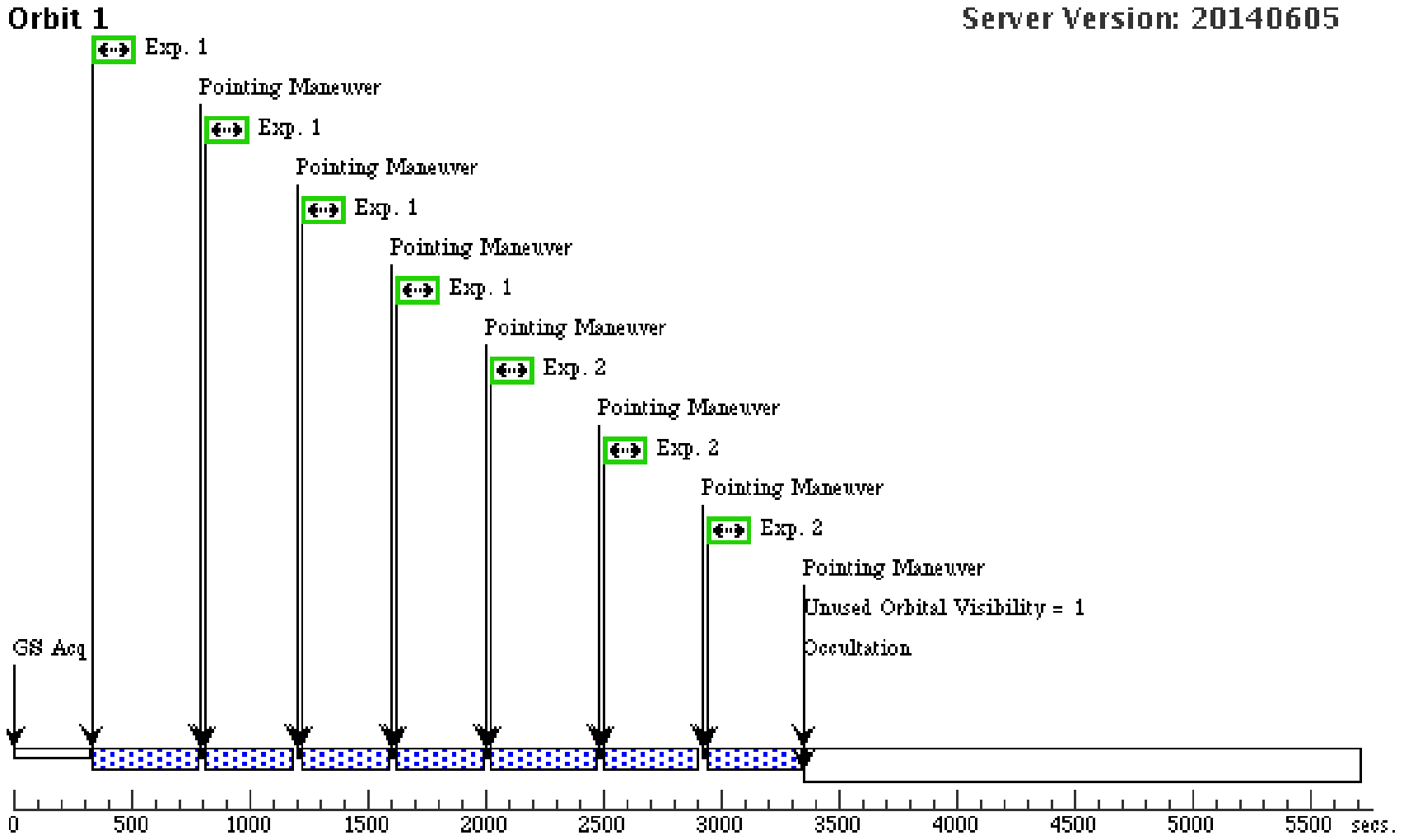
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2011DH	RA: 13 30 5.1200 (202.5213333d) Dec: +47 10 11.00 (47.16972d) Equinox: J2000		V=27+/-0.2	Reference Frame: SIMBAD

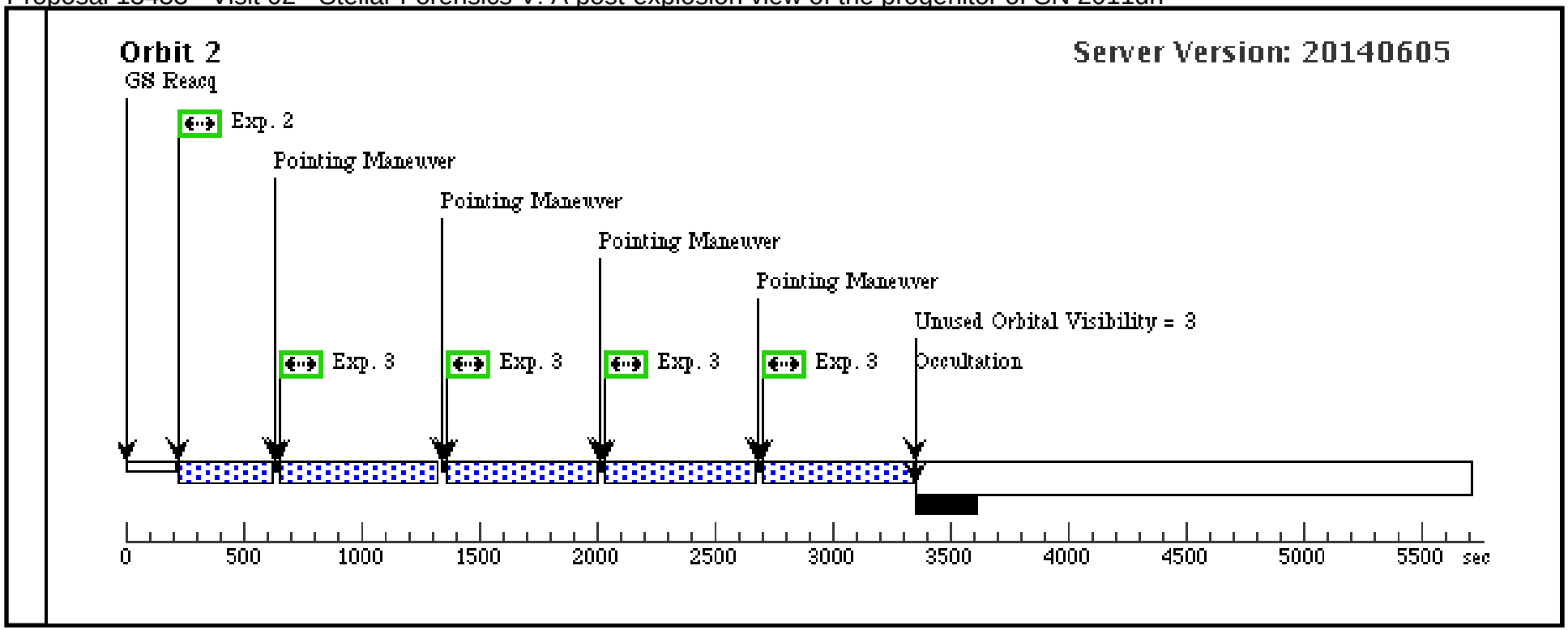
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-2011DH	ACS/WFC, ACCUM, WFC1-1K	F435W	FLASH=60		Pattern 2, Exps 1-1 in Visit 02 (2)	268 Secs (1072 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
2		(1) SN-2011DH	ACS/WFC, ACCUM, WFC1-1K	F555W			Pattern 2, Exps 2-2 in Visit 02 (2)	308 Secs (1232 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	***[2]***
3		(1) SN-2011DH	ACS/WFC, ACCUM, WFC1-1K	F814W			Pattern 2, Exps 3-3 in Visit 02 (2)	544 Secs (2176 Secs)	
								[==>(Pattern 1)]	***[2]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	

Orbit Structure




Orbit 2
Server Version: 20140605
GS Reacq
Exp. 2
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 3
Exp. 3
Exp. 3
Exp. 3
Exp. 3
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13433, Subarray Bias Calibration (A1) Tue Jul 15 01:00:32 GMT 2014

Diagnostic Status: Error

Scientific Instruments: ACS/WFC

Special Requirements: SEQ A1,A2 WITHIN 1 D

Comments: This orbit is charged to the Cycle 21 ACS Subarray Bias Calibration Program.

Diagnostics

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): Target BIAS is no longer a valid selection

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): This attribute is not allowed to have this value: Calibration_Target = BIAS
It is an Available option and cannot normally be used in a GO proposal.

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): Illegal selection: DEF.

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): This attribute cannot have this value due to other choices: Spectral_Element=DEF
This value is by default illegal.

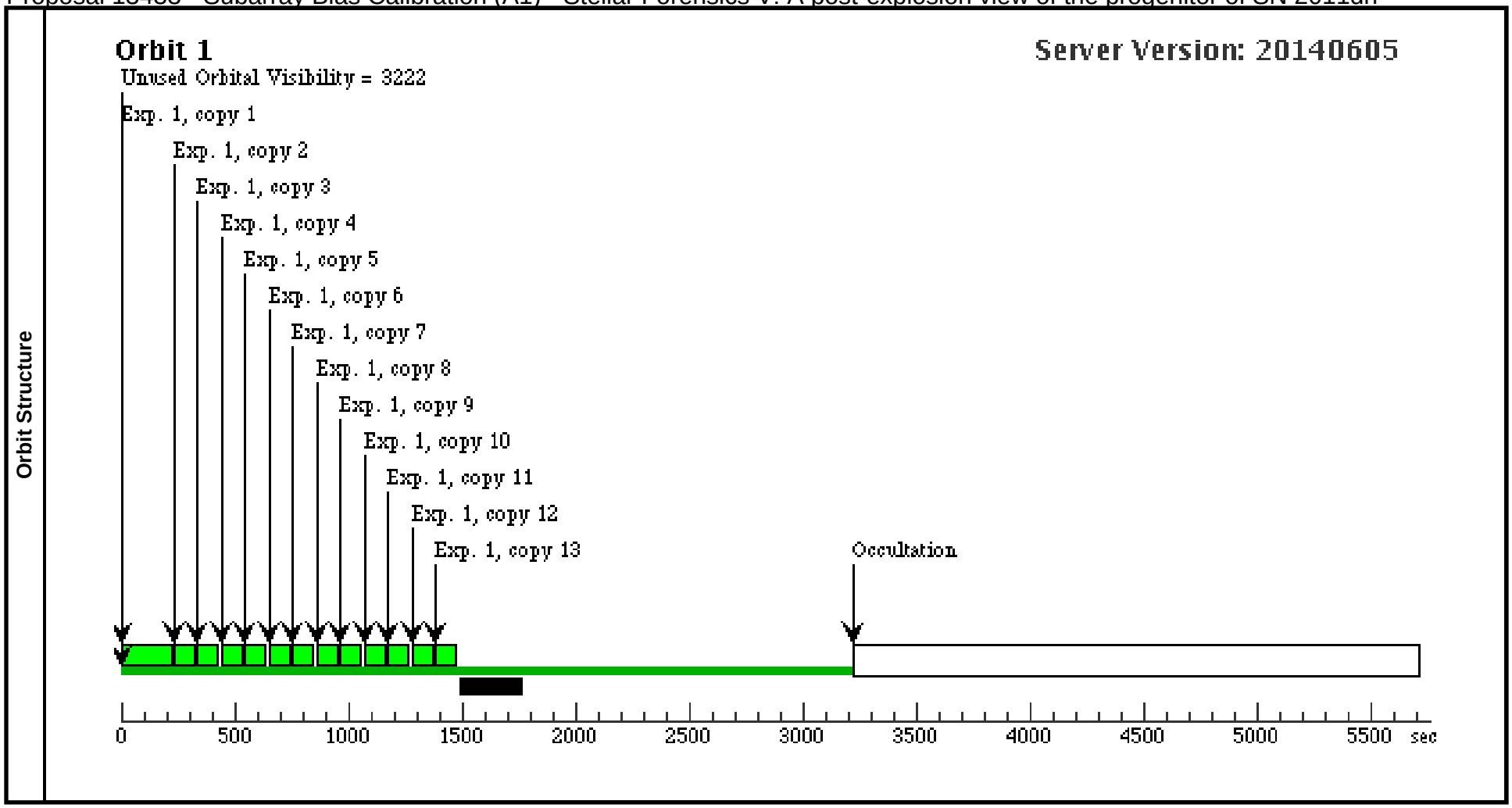
(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): COMPRESSION is not a valid selection

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): This attribute cannot have this value due to other choices: Optional_Parameter=COMPRESSION=NONE
The combination of attributes chosen is illegal.

(Exposure 1 (Subarray Bias Calibration (A1))) Error (Form): This attribute cannot have this value due to other choices: Optional_Parameter=COMPRESSION
The combination of attributes chosen is illegal.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		BIAS	ACS/WFC, ACCUM, WFC1-1K	DEF	GAIN=2.0; COMPRESSION=NONE			0 Secs X 13 (0 Secs)	
								[==>(Copy 1)]	
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	***[1]***
								[==>(Copy 8)]	
								[==>(Copy 9)]	
								[==>(Copy 10)]	
								[==>(Copy 11)]	
								[==>(Copy 12)]	
								[==>(Copy 13)]	


Orbit Structure
Orbit 1
Server Version: 20140605
Unused Orbital Visibility = 3222
Exp. 1, copy 1
Exp. 1, copy 2
Exp. 1, copy 3
Exp. 1, copy 4
Exp. 1, copy 5
Exp. 1, copy 6
Exp. 1, copy 7
Exp. 1, copy 8
Exp. 1, copy 9
Exp. 1, copy 10
Exp. 1, copy 11
Exp. 1, copy 12
Exp. 1, copy 13
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13433, Subarray Bias Calibration (A2) Tue Jul 15 01:00:32 GMT 2014

Diagnostic Status: Error

Scientific Instruments: ACS/WFC

Special Requirements: GROUP A2,02 WITHIN 14D

Comments: This orbit is charged to the Cycle 21 ACS Subarray Bias Calibration Program.

Diagnostics

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): Target BIAS is no longer a valid selection

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): COMPRESSION is not a valid selection

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): This attribute is not allowed to have this value: Calibration_Target = BIAS
It is an Available option and cannot normally be used in a GO proposal.

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): This attribute cannot have this value due to other choices: Spectral_Element=DEF
This value is by default illegal.

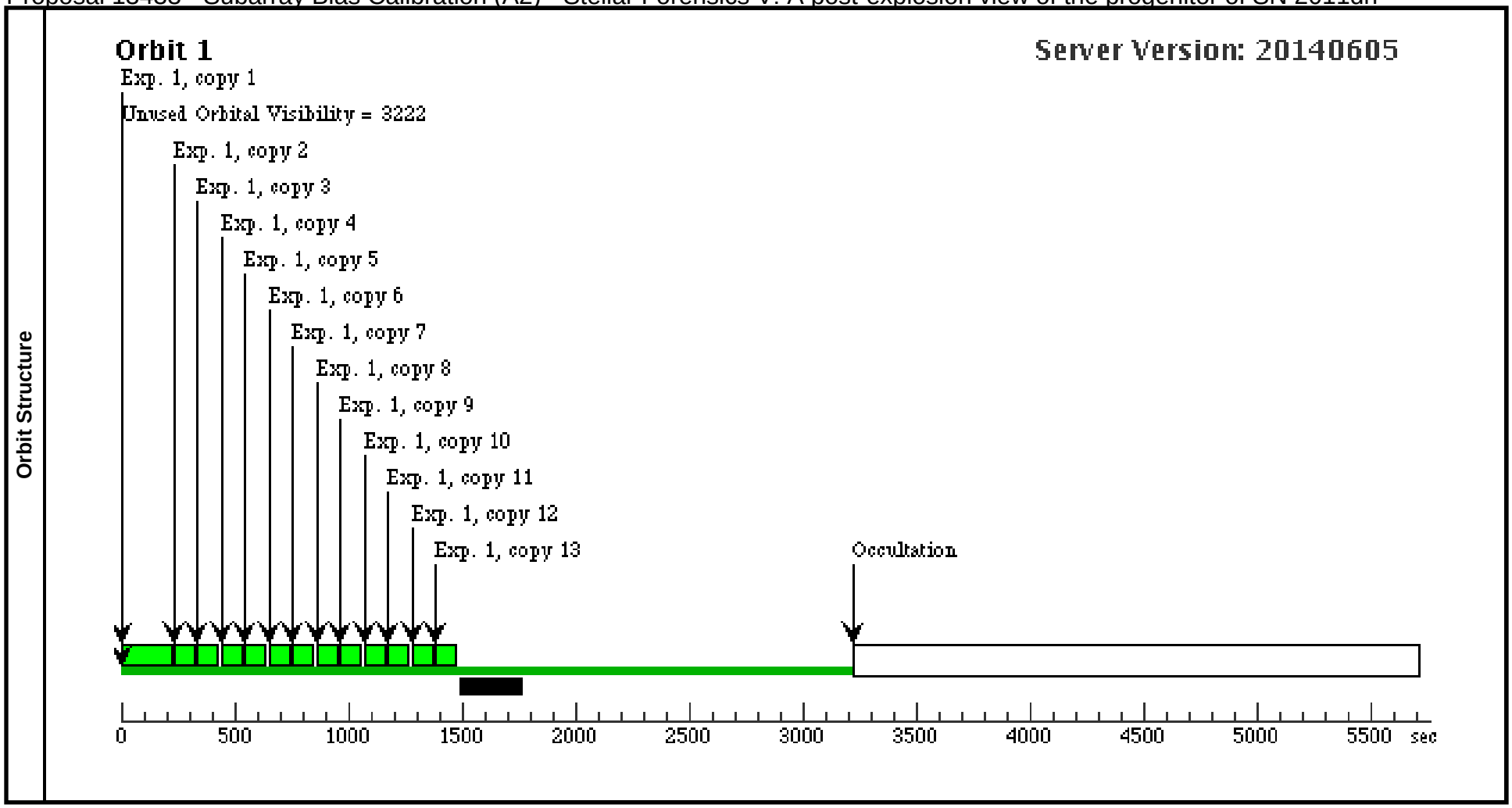
(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): This attribute cannot have this value due to other choices: Optional_Parameter=COMPRESSION
The combination of attributes chosen is illegal.

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): Illegal selection: DEF.

(Exposure 1 (Subarray Bias Calibration (A2))) Error (Form): This attribute cannot have this value due to other choices: Optional_Parameter=COMPRESSION=NONE
The combination of attributes chosen is illegal.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		BIAS	ACS/WFC, ACCUM, WFC1-1K	DEF	GAIN=2.0; COMPRESSION=NONE			0 Secs X 13 (0 Secs)	
								[==>(Copy 1)]	
								[==>(Copy 2)]	
								[==>(Copy 3)]	
								[==>(Copy 4)]	
								[==>(Copy 5)]	
								[==>(Copy 6)]	
								[==>(Copy 7)]	***[1]***
								[==>(Copy 8)]	
								[==>(Copy 9)]	
								[==>(Copy 10)]	
								[==>(Copy 11)]	
								[==>(Copy 12)]	
								[==>(Copy 13)]	


Orbit Structure
Orbit 1
Server Version: 20140605
Exp. 1, copy 1
Unused Orbital Visibility = 3222
Exp. 1, copy 2
Exp. 1, copy 3
Exp. 1, copy 4
Exp. 1, copy 5
Exp. 1, copy 6
Exp. 1, copy 7
Exp. 1, copy 8
Exp. 1, copy 9
Exp. 1, copy 10
Exp. 1, copy 11
Exp. 1, copy 12
Exp. 1, copy 13
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec