



# 13030 - Early Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window

Cycle: 20, Proposal Category: GO  
(Availability Mode: SUPPORTED)

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Prof. Alex V. Filippenko (PI) (Contact)</b>	<b>University of California - Berkeley</b>	<b>alex@astro.berkeley.edu</b>
Dr. Avishay Gal-Yam (CoI)	Weizmann Institute of Science	avishay.gal-yam@weizmann.ac.il
Dr. Paolo Mazzali (CoI) (ESA Member)	Liverpool John Moores University	mazzali@ts.astro.it
Prof. Maryam Modjaz (CoI)	New York University	mmodjaz@nyu.edu
Dr. Thomas Matheson (CoI)	National Optical Astronomy Observatory, AURA	tmatheson@noao.edu
Dr. Daniel Sauer (CoI) (ESA Member)	Stockholm University	dsauer@astro.su.se
Dr. Jeffrey M. Silverman (CoI)	University of Texas at Austin	jsilverman@astro.as.utexas.edu
Mr. Sagi Ben-Ami (CoI) (Contact)	Weizmann Institute of Science	sagiba.ph@gmail.com
Dr. Ofer Yaron (CoI)	Weizmann Institute of Science	ofer.yaron@weizmann.ac.il
Dr. Nathan Smith (CoI)	University of Arizona	nathans@as.arizona.edu

## VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(3) SNNGC4414 CCDFLAT	STIS/CCD STIS/NUV-MAMA	4	13-Jun-2013 21:32:13.0	yes
02	(3) SNNGC4414 CCDFLAT	STIS/CCD STIS/NUV-MAMA	4	13-Jun-2013 21:32:41.0	yes
03	(3) SNNGC4414 CCDFLAT	STIS/CCD STIS/NUV-MAMA	4	13-Jun-2013 21:33:08.0	yes

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
04	(3) SNNGC4414 CCDFLAT	STIS/CCD STIS/NUV-MAMA	3	13-Jun-2013 21:33:33.0	yes

15 Total Orbits Used

## ABSTRACT

We propose to continue our Cycle 19 program and obtain 4 epochs of UV spectroscopy of a Target of Opportunity stripped-envelope core-collapse supernova during 2 weeks roughly centered on maximum brightness. The underlying nature of these objects, from the mass-loss process stripping the envelope to the details of the explosion mechanism, remain mysterious. Connections to gamma-ray bursts and X-ray flashes further motivate this study. Many supernovae (SNe) of all types will be found in future high-redshift transient surveys, but the ability to distinguish between thermonuclear Type Ia SNe and stripped-envelope core-collapse SNe will require thorough knowledge of the latter, especially at UV wavelengths. The spectra will lead to several new insights. By comparing the evolution of the spectra as the photosphere recedes to deeper layers of the ejecta with our time series of spectral models, we will gain a better understanding of the explosion, and possibly of the progenitor star. Specifically, we may be able to determine the metal content of the progenitor through comparisons with our spectral models, and we should be able to probe the degree of mixing during the explosion. With coordinated observations of the SN in the optical and near-IR using our ground-based programs, we will be able to comprehensively characterize the nature of the emission radiated by these SNe. The heterogeneity seen in stripped-envelope SNe will allow us to choose a transient with different characteristics than the one to be observed in Cycle 19, gaining further insights into this unique class of cosmic explosion.

## OBSERVING DESCRIPTION

Obtain STIS UV spectra of one bright ( $V_{\max} < 15.5$  mag), nearby, stripped-envelope SN as soon as possible after discovery (preferably at  $t < -6$  d, relative to maximum brightness), with subsequent spectra taken at predetermined intervals as follows, for a total of 5 epochs (15 orbits):

Epoch(days)	-6	-2	2	6
V(mag)	15.56	15.23	15.12	15.16
Orbits	4	4	4	3
S/N(2376Ang)	9	9	8.5	5
S/N(4300Ang)	47	54	56	52
S/N(7751Ang)	50	62	68	69

The cadence of the spectral observations is determined from the timescale over which significant changes are observed in ground-based optical/near-UV spectra.

### **REAL TIME JUSTIFICATION**

This is a disruptive ToO observation of a single bright SN. However, it is not an ultra-rapid ( $< 2$  day turnaround) ToO. We will work with STScI staff to expedite the observations, and we will try to choose an object that minimizes the time between ToO activation and observations. If our object is found 14 days before maximum brightness, and we have a turnaround time of 8 days (i.e., significantly longer than the 25 day minimum), the first observation will commence about 6 days before maximum light.

Our observations use both the STIS CCD and MAMA detectors in order to provide full wavelength coverage. The CCD observations do not need an entire orbit, and can be done during the final MAMA orbit of each epoch.

The requirement described in the STIS Instrument Handbook for Cycle 20 that such observations be split into separate visits presents a substantial problem for our program. The spectra of SNe change rapidly (on a time scale of 12 days) at these early phases; temporally separating pieces of the spectrum might seriously compromise our ability to model it. Our program would greatly benefit if the whole spectrum were obtained in a single visit. Therefore, we request an exception to the rule as outlined in Section 2.6 of the STIS Instrument Handbook (MAMA Scheduling Policies).

However, if this request cannot be accommodated, we request visits not more than 1 day from each other.

### **CALIBRATION JUSTIFICATION**

Our SN, which is optically bright, will have ground-based astrometry with respect to HST guide stars accurate to better than 0.2". Using the STIS Acquisition ETC we find acquisition times of less than 1 min for all epochs, for the 0.2" slit. Previously, we have successfully acquired SNe with STIS in this manner.

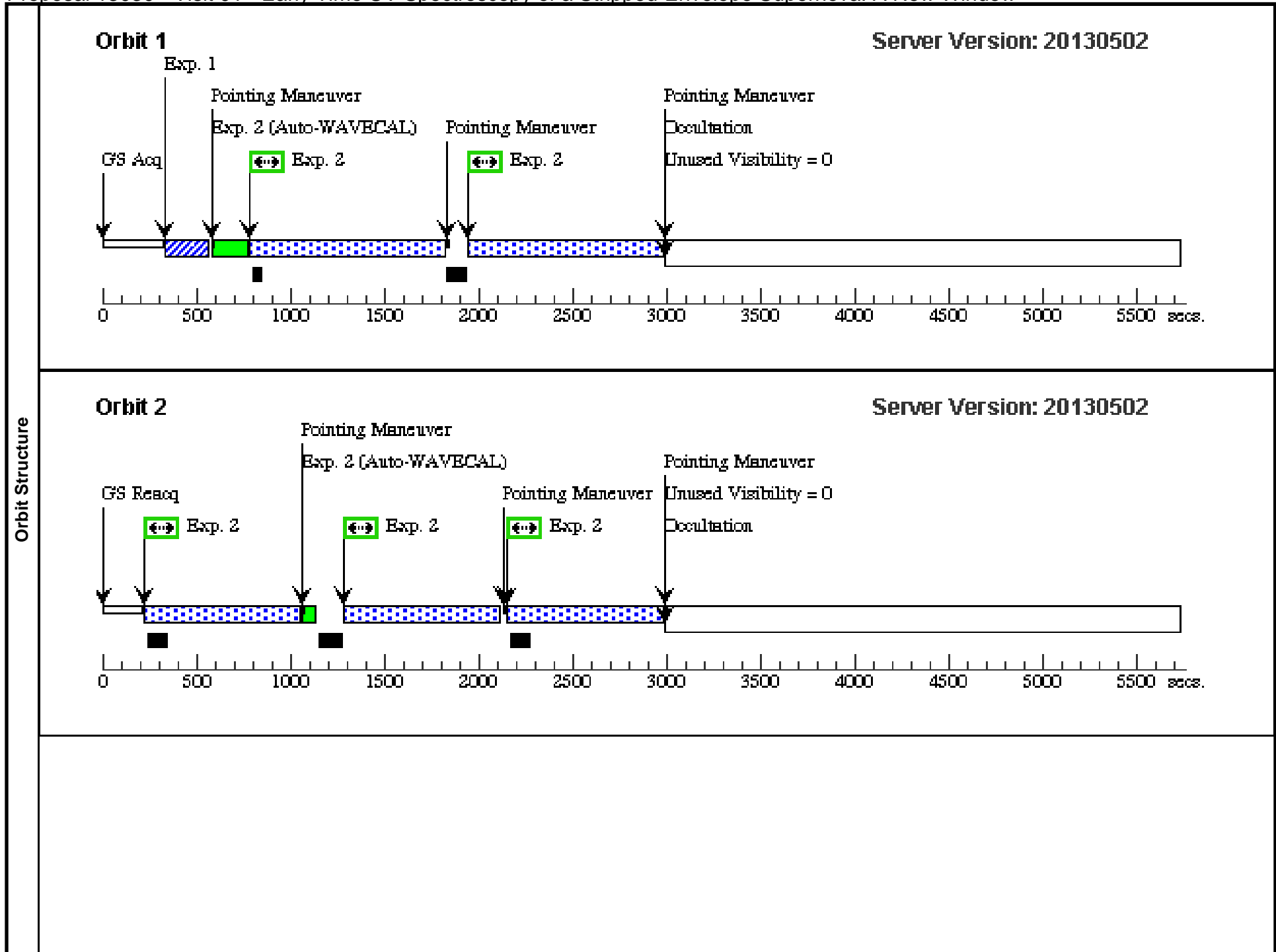
### **ADDITIONAL COMMENTS**

This is a ToO proposal. We will update our phase 2 with the supernova coordinates as they become available.

Proposal 13030 - Visit 01 - Early Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window

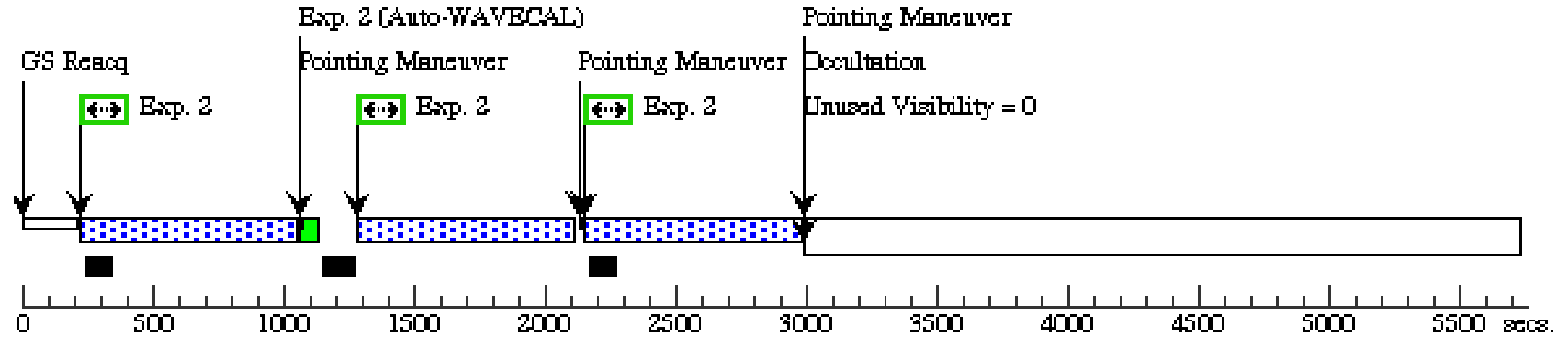
Fri Jun 14 01:33:43 GMT 2013

Visit	<b>Proposal 13030, Visit 01, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: SCHED 100%; BEFORE 24-JUN-2013:00:00:00; ON HOLD <i>On Hold Comments: Target of Opportunity</i>									
	Patterns	#	Primary Pattern			Secondary Pattern			Exposures	
		(1)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG						
		Purpose=DITHER	Pattern Orientation=90.0							
		Number Of Points=10	Angle Between Sides=							
		Point Spacing=1.1	Center Pattern=false							
		Line Spacing=								
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SNNGC4414	RA: 12 26 29.3300 (186.6222083d) Dec: +31 13 38.30 (31.22731d) Equinox: J2000	Redshift: 0.0024	V=14.5+/-0.1 U=15.09 UW1=16.14 UM2=16. 74 UW2=17.09	Reference Frame: ICRS				
	<i>Comments: Based on the UV magnitudes obtained with SWIFT on UT 20130613, the MAMA detectors can be safely used to observe this target. We ask the target to be observed as soon as possible, because of the rapid decline in UV flux in stripped envelope SNe.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	Target Acquisition	(3) SNNGC4414	STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs)	
									[==>]	[1]
	2	SpectroscopyNUV (STIS.sp.41 0696)	(3) SNNGC4414	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A			Pattern 1, Exps 2-2 in Visit 01 (1)	700 Secs (8476 Secs)	
									[==>1023.0 Secs (Pattern 1)]	[1]
									[==>1023.0 Secs (Pattern 2)]	
									[==>818.0 Secs (Pattern 3)]	
									[==>818.0 Secs (Pattern 4)]	[2]
									[==>818.0 Secs (Pattern 5)]	
									[==>818.0 Secs (Pattern 6)]	
								[==>818.0 Secs (Pattern 7)]	[3]	
								[==>818.0 Secs (Pattern 8)]		
								[==>761.0 Secs (Pattern 9)]	[4]	
								[==>761.0 Secs (Pattern 10)]		
3	SpectroscopyG430L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				100 Secs (222 Secs)		
								[==>111.0 Secs (Split 1)]	[4]	
								[==>111.0 Secs (Split 2)]		
4	SpectroscopyG750L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A				50 Secs (172 Secs)		
								[==>86.0 Secs (Split 1)]	[4]	
								[==>86.0 Secs (Split 2)]		
5	G750LFring eFlats	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				[==>(Copy 1)]	[4]	
								[==>(Copy 2)]		



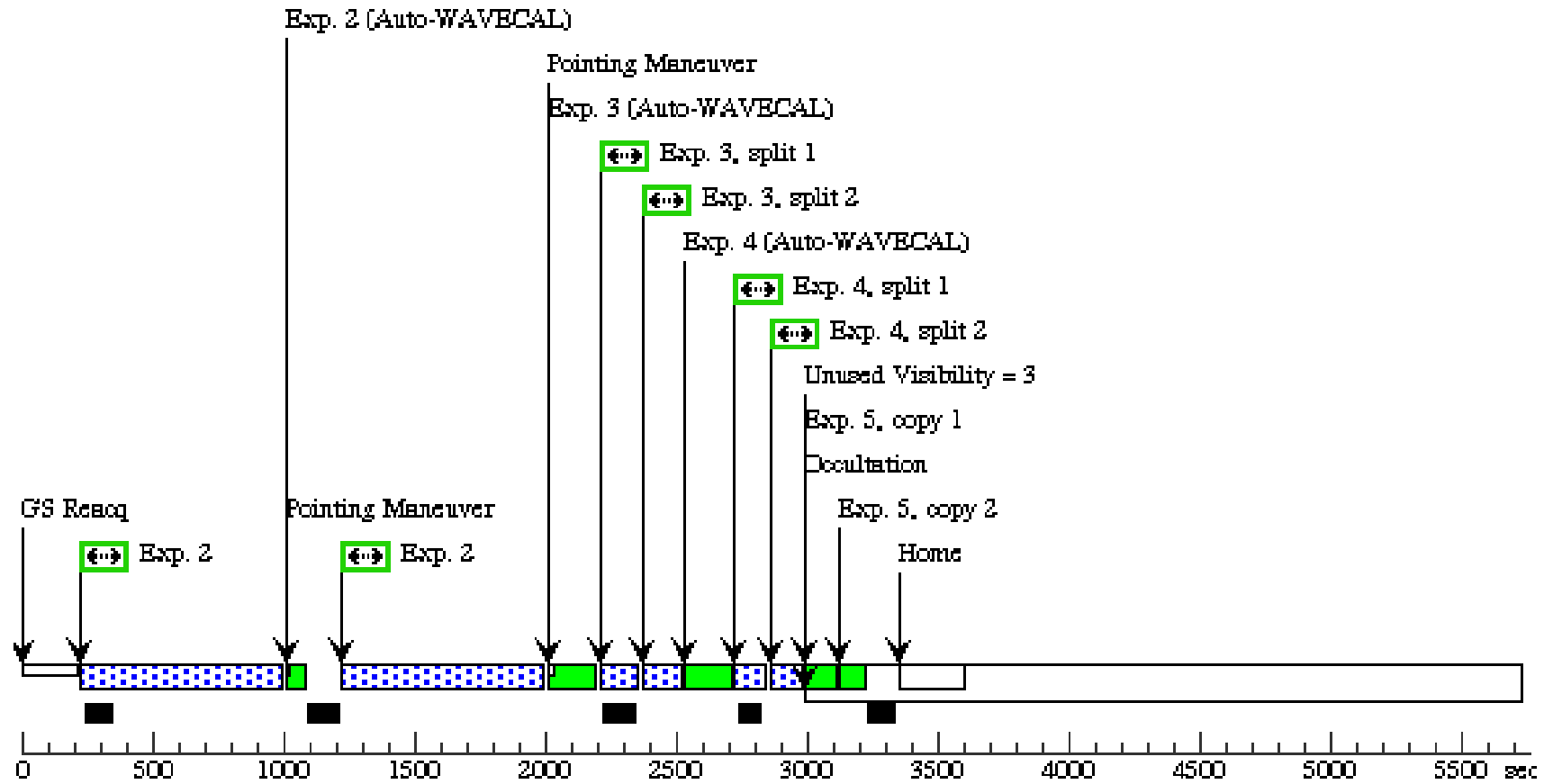
**Orbit 3**

**Server Version: 20130502**



Orbit 4

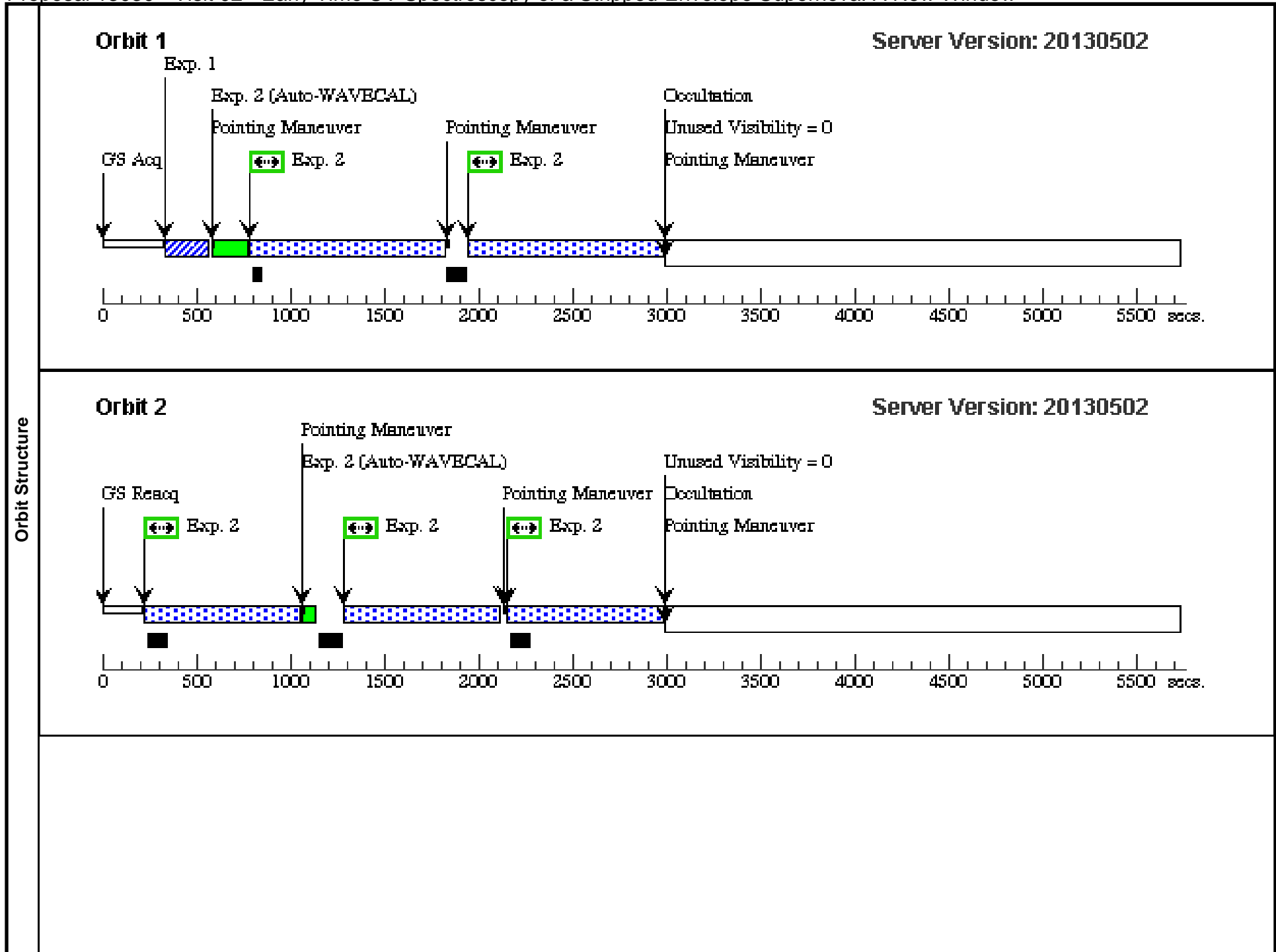
Server Version: 20130502



Proposal 13030 - Visit 02 - Early Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window

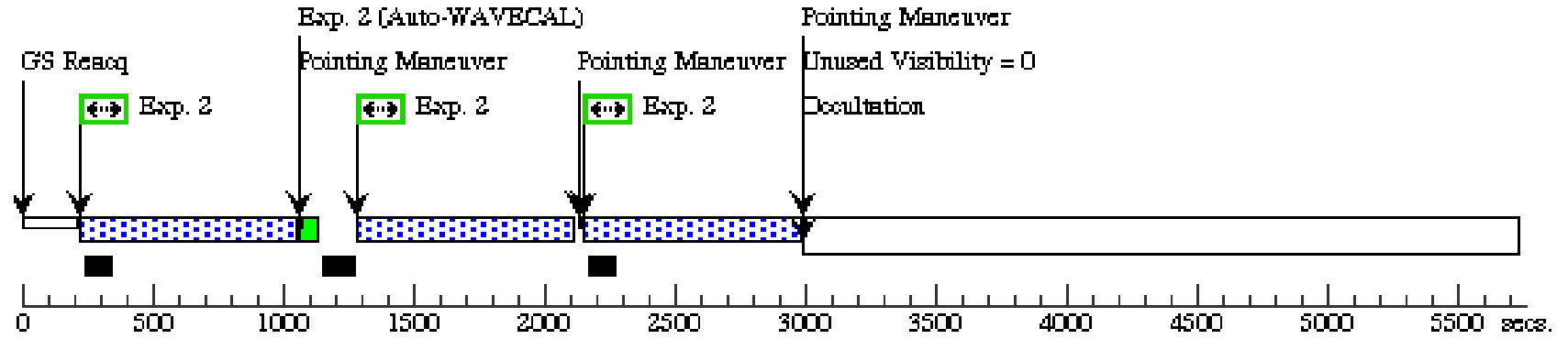
Fri Jun 14 01:33:48 GMT 2013

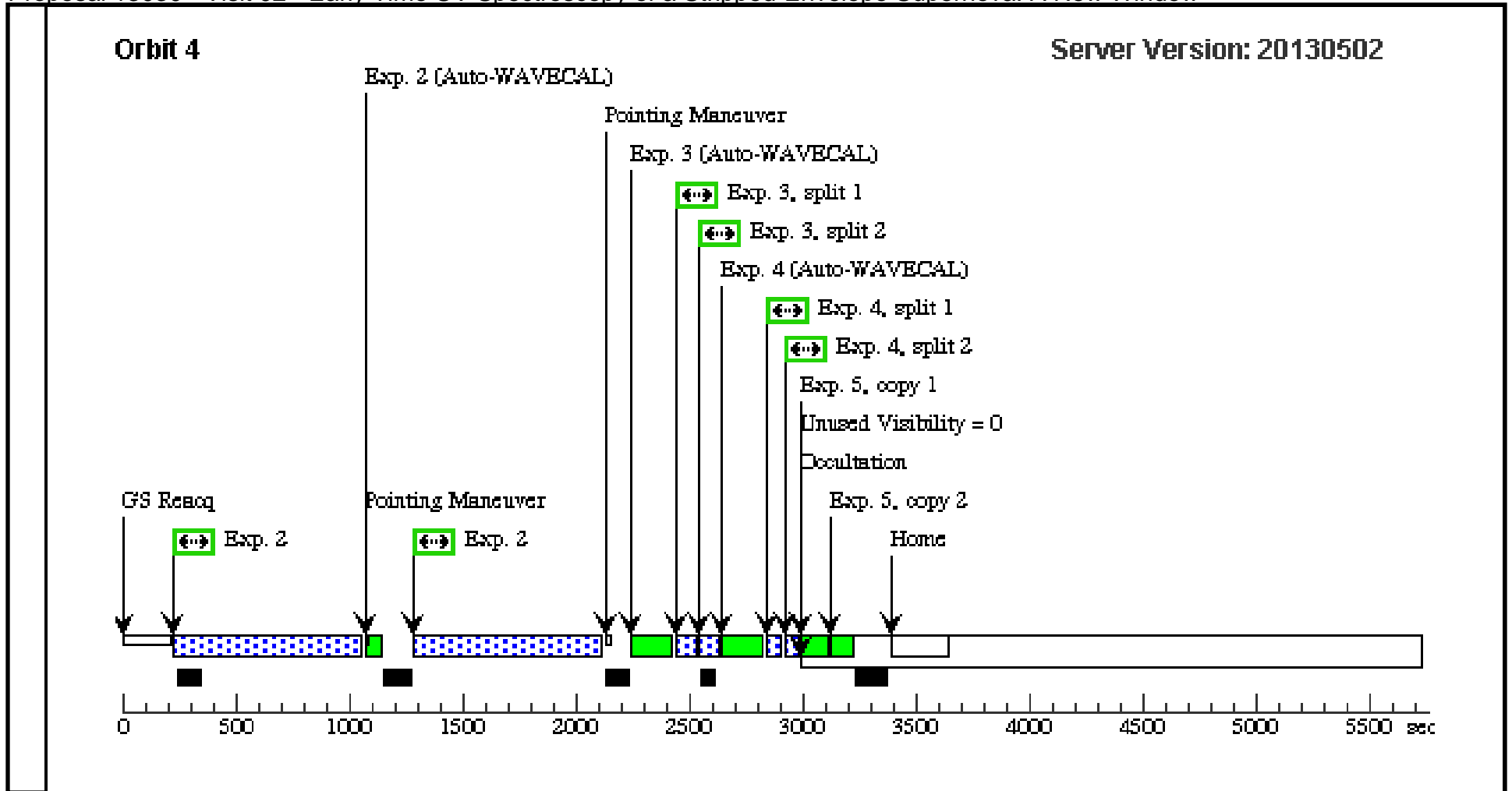
Visit	<b>Proposal 13030, Visit 02, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: SCHED 100%; AFTER 01 BY 3 D TO 7 D; ON HOLD <i>On Hold Comments: Target of Opportunity</i>									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=STIS-ALONG-SLIT Purpose=DITHER Number Of Points=10 Point Spacing=1.1 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=90.0 Angle Between Sides= Center Pattern=false		(2)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SNNGC4414	RA: 12 26 29.3300 (186.6222083d) Dec: +31 13 38.30 (31.22731d) Equinox: J2000	Redshift: 0.0024	V=14.5+/-0.1 U=15.09 UW1=16.14 UM2=16.74 UW2=17.09	Reference Frame: ICRS				
<i>Comments: Based on the UV magnitudes obtained with SWIFT on UT 20130613, the MAMA detectors can be safely used to observe this target. We ask the target to be observed as soon as possible, because of the rapid decline in UV flux in stripped envelope SNe.</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	TargetAquisition	(3) SNNGC4414	STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs)	
									[==>]	[1]
	2	SpectroscopyNUV (STIS.sp.410692)	(3) SNNGC4414	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A			Pattern 1, Exps 2-2 in Visit 02 (1)	816 Secs (8594 Secs)	
									[==>1023.0 Secs (Pattern 1)]	[1]
									[==>1023.0 Secs (Pattern 2)]	
									[==>818.0 Secs (Pattern 3)]	
									[==>818.0 Secs (Pattern 4)]	[2]
									[==>818.0 Secs (Pattern 5)]	
									[==>818.0 Secs (Pattern 6)]	
								[==>818.0 Secs (Pattern 7)]	[3]	
								[==>818.0 Secs (Pattern 8)]		
								[==>820.0 Secs (Pattern 9)]	[4]	
								[==>820.0 Secs (Pattern 10)]		
3	SpectroscopyG430L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				100 Secs (108 Secs)		
								[==>54.0 Secs (Split 1)]	[4]	
								[==>54.0 Secs (Split 2)]		
4	SpectroscopyG750L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A				50 Secs (58 Secs)		
								[==>29.0 Secs (Split 1)]	[4]	
								[==>29.0 Secs (Split 2)]		
5	G750LFringeFlats	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				[==>(Copy 1)]	[4]	
								[==>(Copy 2)]		



**Orbit 3**

**Server Version: 20130502**

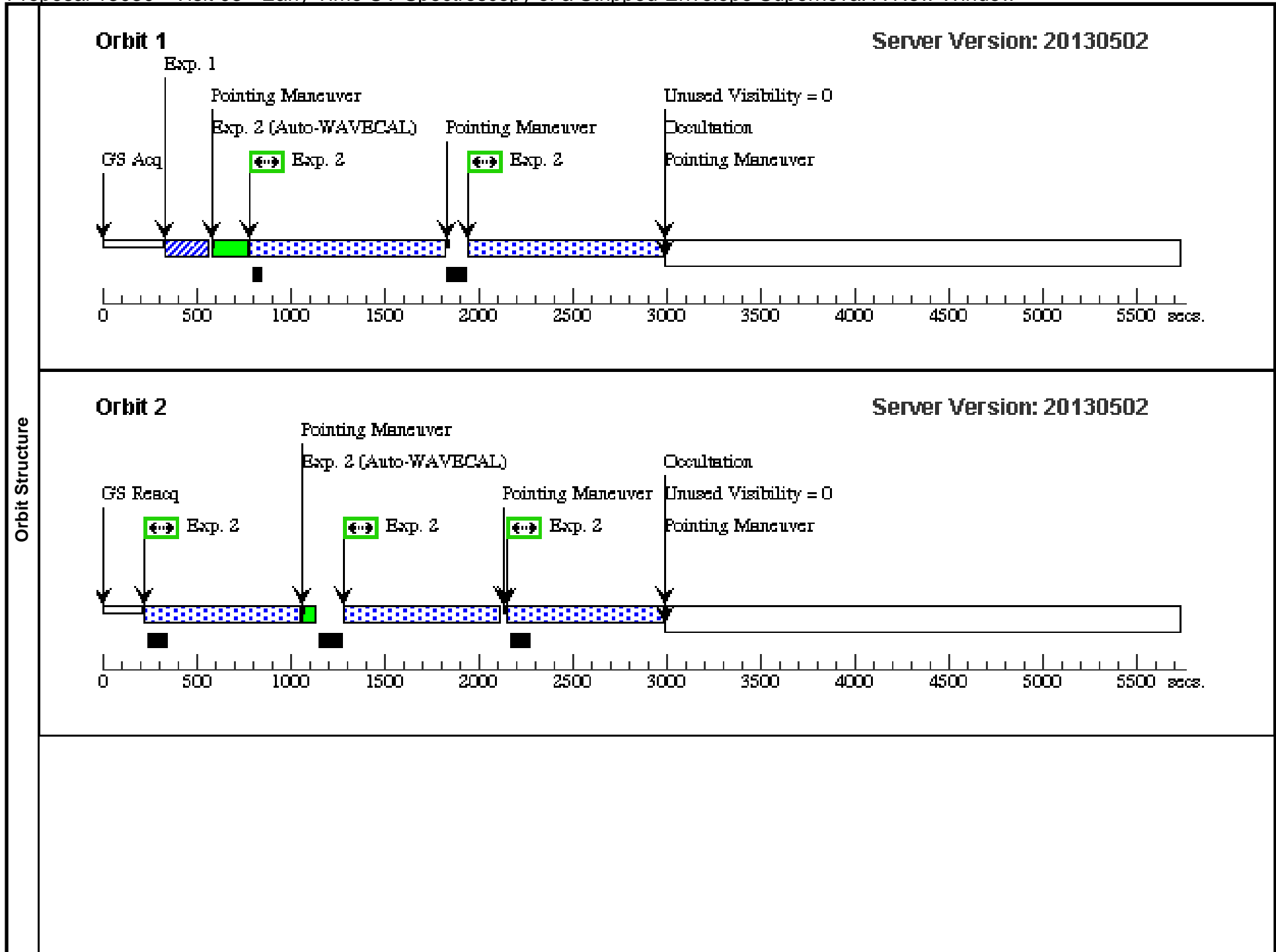




Proposal 13030 - Visit 03 - Early Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window

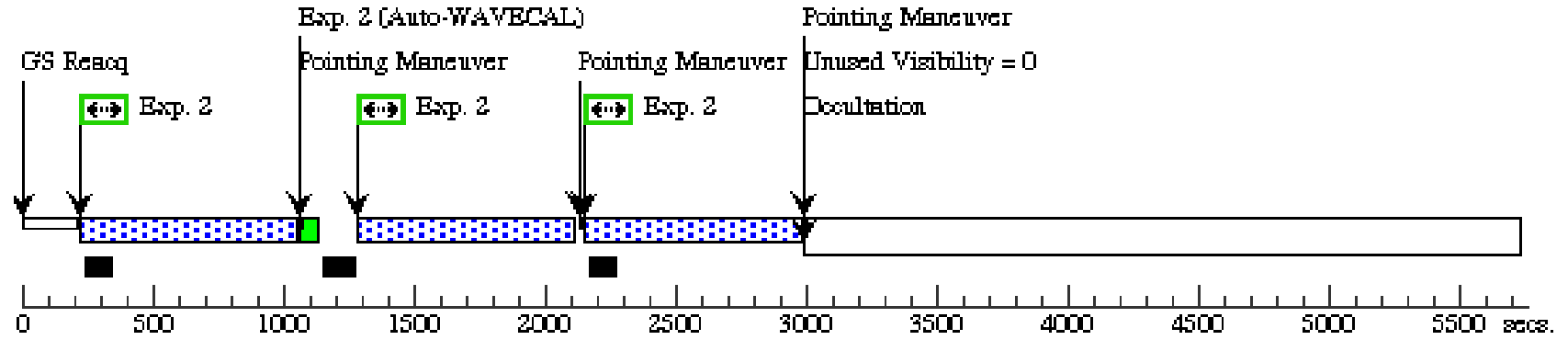
Fri Jun 14 01:33:54 GMT 2013

Visit	<b>Proposal 13030, Visit 03, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: SCHED 100%; AFTER 02 BY 3 D TO 7 D; ON HOLD <i>On Hold Comments: Target of Opportunity</i>									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=STIS-ALONG-SLIT Purpose=DITHER Number Of Points=10 Point Spacing=1.1 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=90.0 Angle Between Sides= Center Pattern=false		(2)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SNNGC4414	RA: 12 26 29.3300 (186.6222083d) Dec: +31 13 38.30 (31.22731d) Equinox: J2000	Redshift: 0.0024	V=14.5+/-0.1 U=15.09 UW1=16.14 UM2=16.74 UW2=17.09	Reference Frame: ICRS				
<i>Comments: Based on the UV magnitudes obtained with SWIFT on UT 20130613, the MAMA detectors can be safely used to observe this target. We ask the target to be observed as soon as possible, because of the rapid decline in UV flux in stripped envelope SNe.</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	TargetAquisition	(3) SNNGC4414	STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs)	
									[==>]	[1]
	2	SpectroscopyNUV (STIS.sp.410693)	(3) SNNGC4414	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A			Pattern 1, Exps 2-2 in Visit 03 (1)	816 Secs (8594 Secs)	
									[==>1023.0 Secs (Pattern 1)]	[1]
									[==>1023.0 Secs (Pattern 2)]	
									[==>818.0 Secs (Pattern 3)]	
									[==>818.0 Secs (Pattern 4)]	[2]
									[==>818.0 Secs (Pattern 5)]	
									[==>818.0 Secs (Pattern 6)]	
								[==>818.0 Secs (Pattern 7)]	[3]	
								[==>818.0 Secs (Pattern 8)]		
								[==>820.0 Secs (Pattern 9)]	[4]	
								[==>820.0 Secs (Pattern 10)]		
3	SpectroscopyG430L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				100 Secs (108 Secs)		
								[==>54.0 Secs (Split 1)]	[4]	
								[==>54.0 Secs (Split 2)]		
4	SpectroscopyG750L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A				50 Secs (58 Secs)		
								[==>29.0 Secs (Split 1)]	[4]	
								[==>29.0 Secs (Split 2)]		
5	G750LFringeFlats	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				[==>(Copy 1)]	[4]	
								[==>(Copy 2)]		



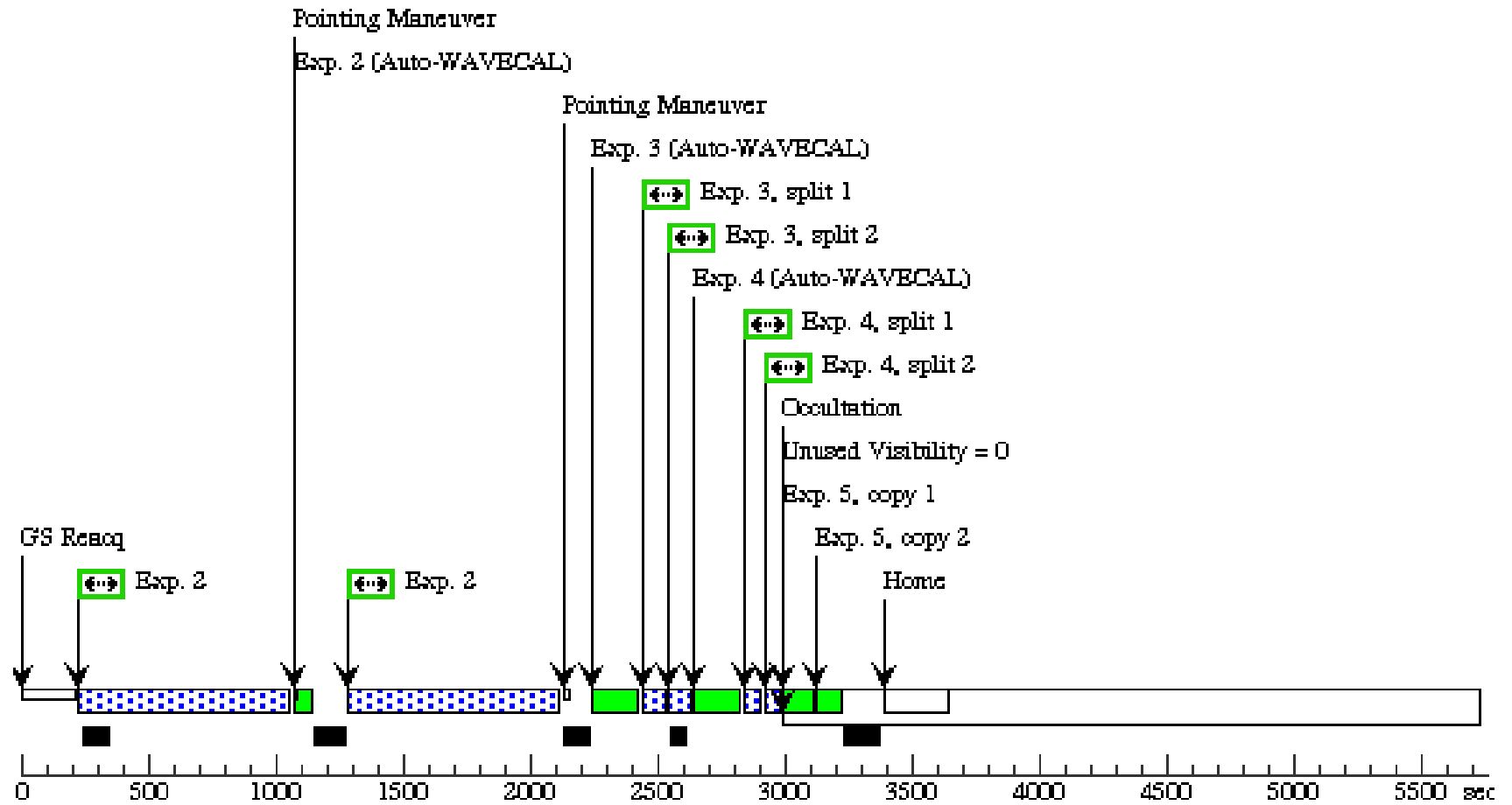
**Orbit 3**

**Server Version: 20130502**



Orbit 4

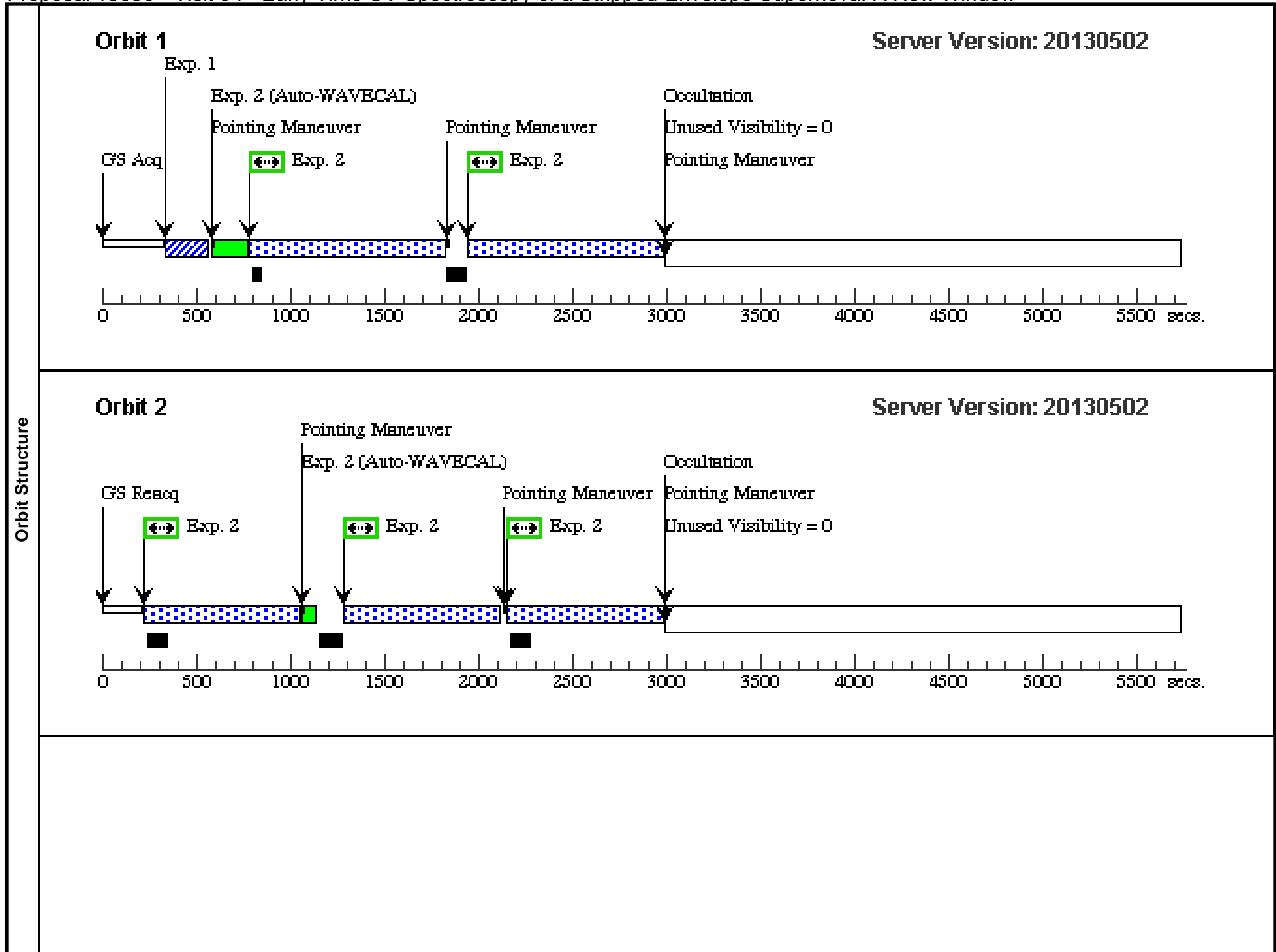
Server Version: 20130502



Proposal 13030 - Visit 04 - Early Time UV Spectroscopy of a Stripped-Envelope Supernova: A New Window

Fri Jun 14 01:33:58 GMT 2013

Visit	<b>Proposal 13030, Visit 04, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: SCHED 100%; AFTER 03 BY 3 D TO 7 D; ON HOLD <i>On Hold Comments: Target of Opportunity</i>									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(2)	Pattern Type=STIS-ALONG-SLIT      Coordinate Frame=POS-TARG Purpose=DITHER                      Pattern Orientation=90.0 Number Of Points=7                  Angle Between Sides= Point Spacing=1.14                  Center Pattern=false Line Spacing=		(2)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SNNGC4414	RA: 12 26 29.3300 (186.6222083d) Dec: +31 13 38.30 (31.22731d) Equinox: J2000	Redshift: 0.0024	V=14.5+/-0.1 U=15.09 UW1=16.14 UM2=16. 74 UW2=17.09	Reference Frame: ICRS				
<i>Comments: Based on the UV magnitudes obtained with SWIFT on UT 20130613, the MAMA detectors can be safely used to observe this target. We ask the target to be observed as soon as possible, because of the rapid decline in UV flux in stripped envelope SNe.</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	TargetAquisition	(3) SNNGC4414	STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs)	
									[==>]	[1]
	2	SpectroscopyNUV (STIS.sp.410694)	(3) SNNGC4414	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A			Pattern 2, Exps 2-2 in Visit 04 (2)	800 Secs (6118 Secs)	
									[==>1023.0 Secs (Pattern 1)]	[1]
									[==>1023.0 Secs (Pattern 2)]	
									[==>818.0 Secs (Pattern 3)]	[2]
								[==>818.0 Secs (Pattern 4)]	[2]	
								[==>818.0 Secs (Pattern 5)]		
								[==>809.0 Secs (Pattern 6)]	[3]	
								[==>809.0 Secs (Pattern 7)]		
3	SpectroscopyG430L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				100 Secs (118 Secs)		
								[==>59.0 Secs (Split 1)]	[3]	
								[==>59.0 Secs (Split 2)]		
4	SpectroscopyG750L	(3) SNNGC4414	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A				50 Secs (68 Secs)		
								[==>34.0 Secs (Split 1)]	[3]	
								[==>34.0 Secs (Split 2)]		
5	G750LFringeFlats	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				[==>(Copy 1)]	[3]	
								[==>(Copy 2)]		



Orbit 3

Server Version: 20130502

