



16178 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

Cycle: 28, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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	(2) SN2021YJA CCDFLAT	STIS/CCD	6	10-Sep-2021 21:00:21.0	yes
02	(2) SN2021YJA CCDFLAT	STIS/CCD	5	10-Sep-2021 21:00:24.0	yes
03	(2) SN2021YJA CCDFLAT	STIS/CCD	6	10-Sep-2021 21:00:28.0	yes

17 Total Orbits Used

ABSTRACT

We propose to obtain a series of three early-time UV spectra of one stripped-envelope core-collapse supernova (either a normal SN Ib or a normal SN Ic), starting well before 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 high-redshift SNe are being found in deep transient surveys, but the ability to distinguish between thermonuclear Type Ia SNe and stripped-envelope core-collapse SNe requires thorough knowledge of the latter at UV wavelengths with a low- z object. 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 mechanism and the degree of mixing during the explosion. Moreover, we should be able to determine the metal content of the progenitor's outer layers with our spectral models and compare with the measured metallicity of the environment. The heterogeneity seen in stripped-envelope SNe compels us to choose a normal SN Ib or SN Ic, objects with DIFFERENT characteristics than the ones that HST has observed in previous Cycles (SNe Ic-pec, Iib, Ibn), thereby gaining further insights into this unique class of cosmic explosion. We need to seize this opportunity now, while we have access to the space UV, and indeed the UV is an HST Cycle 28 priority.

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 $t < -7$ d, relative to maximum brightness), with subsequent spectra taken at intervals of 5 days, for a total of 3 epochs ($6 + 5 + 6 = 17$ orbits total). The cadence of the spectral observations is determined from the timescale over which significant changes are observed in ground-based optical/near-UV spectra.

----- Realtime Justification -----

Proposal 16178 (STScI Edit Number: 0, Created: Friday, September 10, 2021 at 8:00:29 PM Eastern Standard Time) - Overview

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 we trigger 13-14 days before maximum brightness, and we have a turnaround time of 4-7 days, the first observation will commence about 10-5 days before maximum light.

We will use both the STIS/CCD and MAMA detectors to provide full wavelength coverage. The CCD observations can be done during the final MAMA orbit of each epoch. The spectra of SNe change on a timescale of 1-2 days at these early phases, so we prefer that the whole spectrum be obtained in a single visit. Although visits of 6 orbits using STIS/MAMA are discouraged owing to the interfering effects of the SAA, we hope that it will be possible, as it has been in previous cycles for this program. However, if this request cannot be accommodated in Cycle 28, we request visits not more than about 1 day from each other.

We understand that in Cycle 28, we are strongly encouraged to structure our observations into visits of only 1-3 orbits duration each. As noted above, we prefer durations of up to 6 orbits (6, 5, and 6 for Visits 1, 2, and 3, respectively -- separated by about 5 days) because of the temporal variability of the supernova spectrum. However, we will be fine with restructuring our program to give a combination of 2-orbit or 3-orbit visits ($3+3 = 6$ and $3+2 = 5$; $2+2+2 = 6$ would be less desirable but still doable), if those shorter "subvisits" are within 1 day of each other. There will be a loss of S/N at a given epoch, but we could still average the UV MAMA data from two reasonably closely spaced epochs. The optical CCD spectra take just 1 orbit (or a fraction of an orbit), so we would be able to use the optical spectra directly with the corresponding UV spectra, with no mixing of dates.

We have considered the impact of reduced gyro operations on our program. They will not significantly impact this program. We will need to choose a target that has a suitable observing window in the immediate future (since this is a disruptive ToO). The orientation of the field is not relevant, nor is the spatial scan speed.

----- 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. In order to make sure there are no

Proposal 16178 (STScI Edit Number: 0, Created: Friday, September 10, 2021 at 8:00:29 PM Eastern Standard Time) - Overview

bright objects in the target vicinity and to estimate the target UV flux, we will obtain rapid-response Swift/UVOT observations, as we have done in the past for this program.

Proposal 16178 - Visit 01 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

Visit	Proposal 16178, Visit 01, implementation Sat Sep 11 01:00:29 GMT 2021 Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD Special Requirements: ON HOLD <i>On Hold Comments: Target of Opportunity</i>					
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
(2)		SN2021YJA	RA: 03 24 21.1740 (51.0882250d) Dec: -21 33 56.23 (-21.56562d) Equinox: J2000		V=14.7	Reference Frame: ICRS
	<i>Comments:</i> Category=EXT-STAR Description=[SUPERNOVA] Extended=NO					

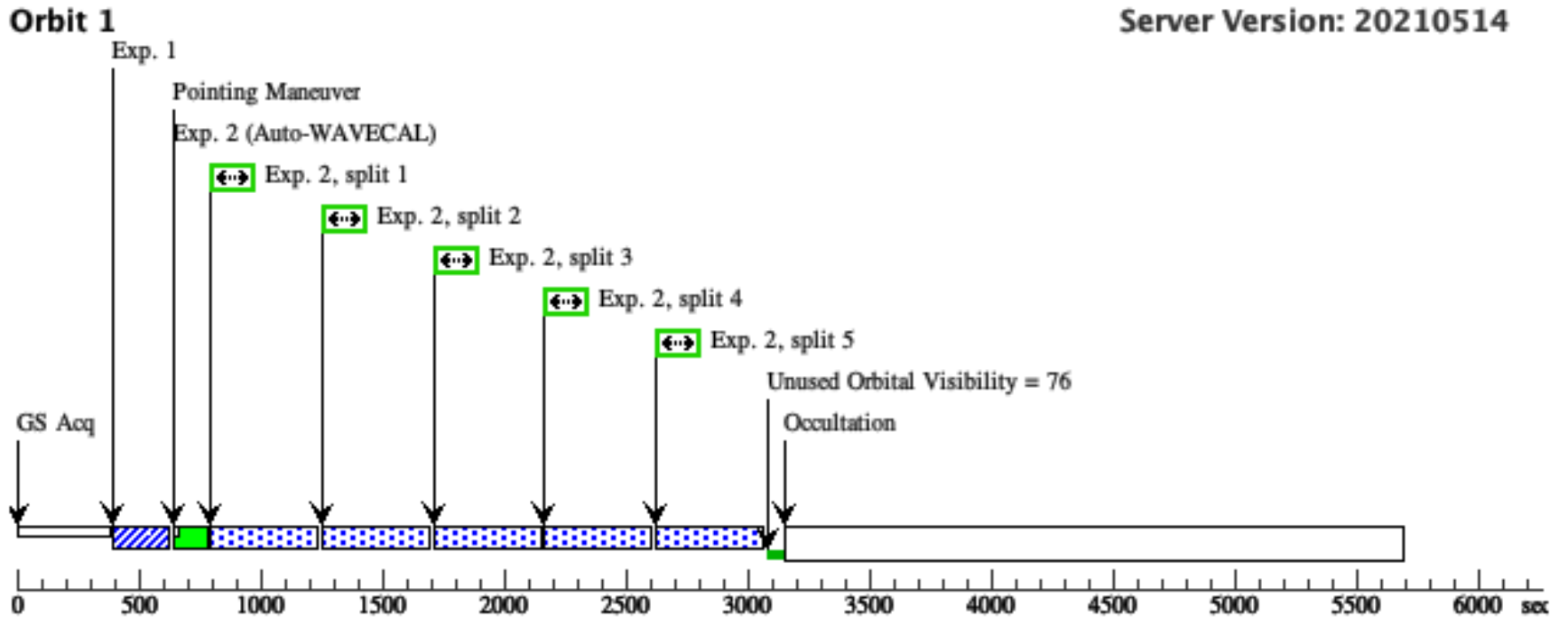
Proposal 16178 - Visit 01 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	Target Acquisition (STIS.ta.623 545)	(2) SN2021YJA	STIS/CCD, ACQ, F28X50LP	MIRROR			2 Secs (2 Secs) [==>]	[1]
	<i>Comments: Our SN, though UV-faint, will be optically bright. Using the STIS Acquisition ETC and the spectrum of PTF12gzk obtained in Cycle 20, we find that a 2s exposure yields a S/N > 100.</i>								
	2	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5		2060 Secs (2060 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
	3	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6		2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[2]
	4	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6		2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[3]
	5	Peakup (STIS.ta.651 490)	(2) SN2021YJA	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR			1.2 Secs (1.2 Secs) [==>]	[4]
	6	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5		2000 Secs (2000 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[4]
7	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6		2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[5]	

Proposal 16178 - Visit 01 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

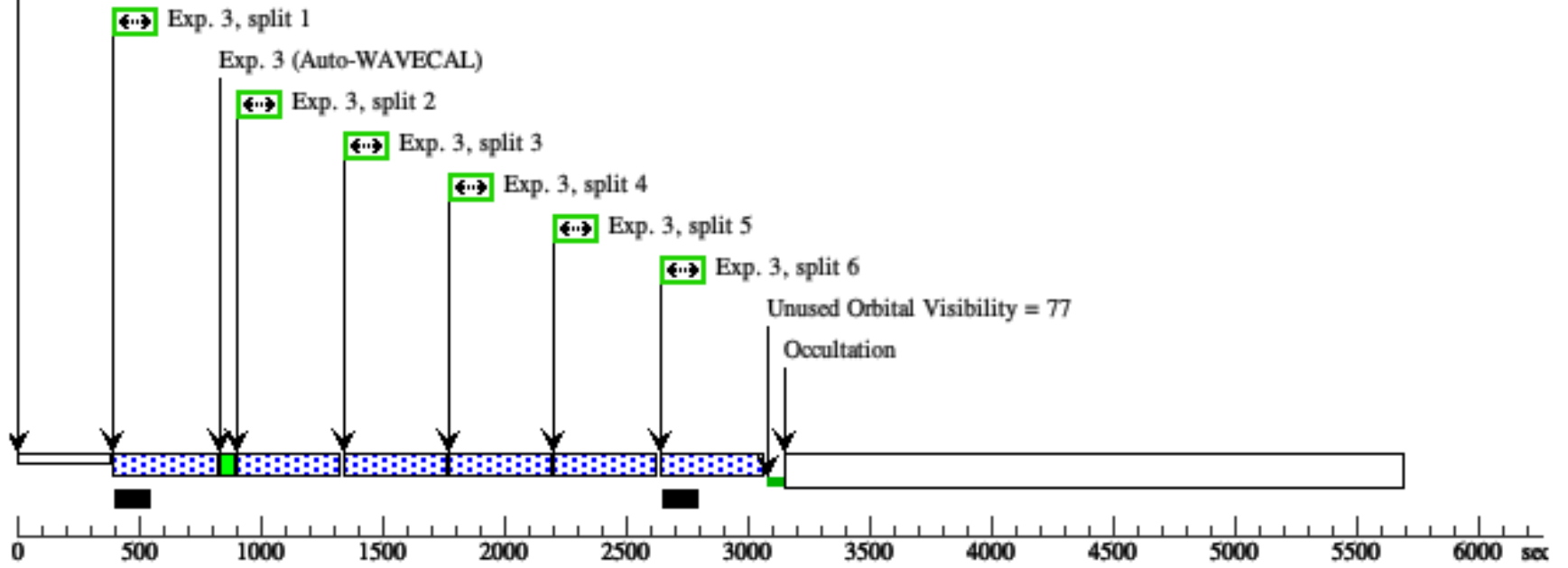
8	Spectroscopy yNUV (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=4	1544 Secs (1544 Secs)	
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						[==>(Split 2)]	
						[==>(Split 3)]	
[==>(Split 4)]							
9	Spectroscopy yG430L (STIS.sp.62 1403)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A		200 Secs (200 Secs)	
						[==>(Split 1)]	[6]
10	Spectroscopy yG750L (STIS.sp.62 1405)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A		100 Secs (100 Secs)	
						[==>(Split 1)]	[6]
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						[==>(Copy 2)]	

Orbit Structure



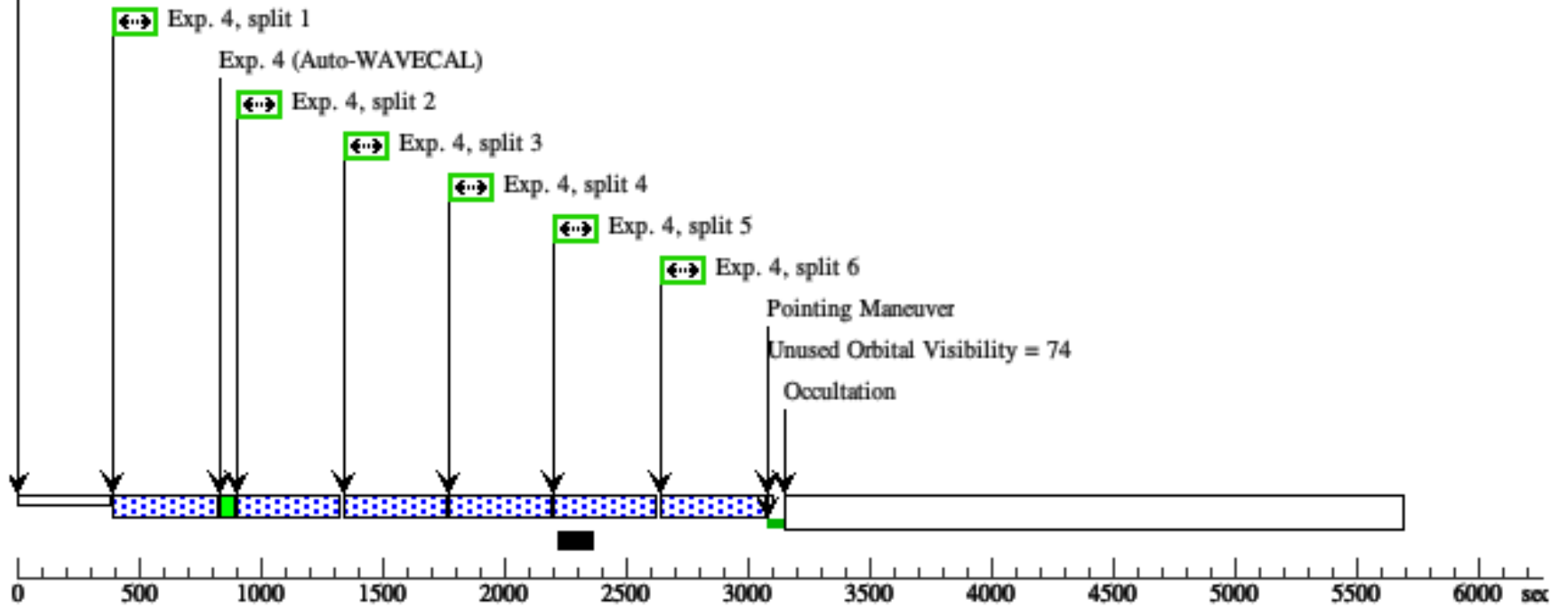
Orbit 2

GS Reacq



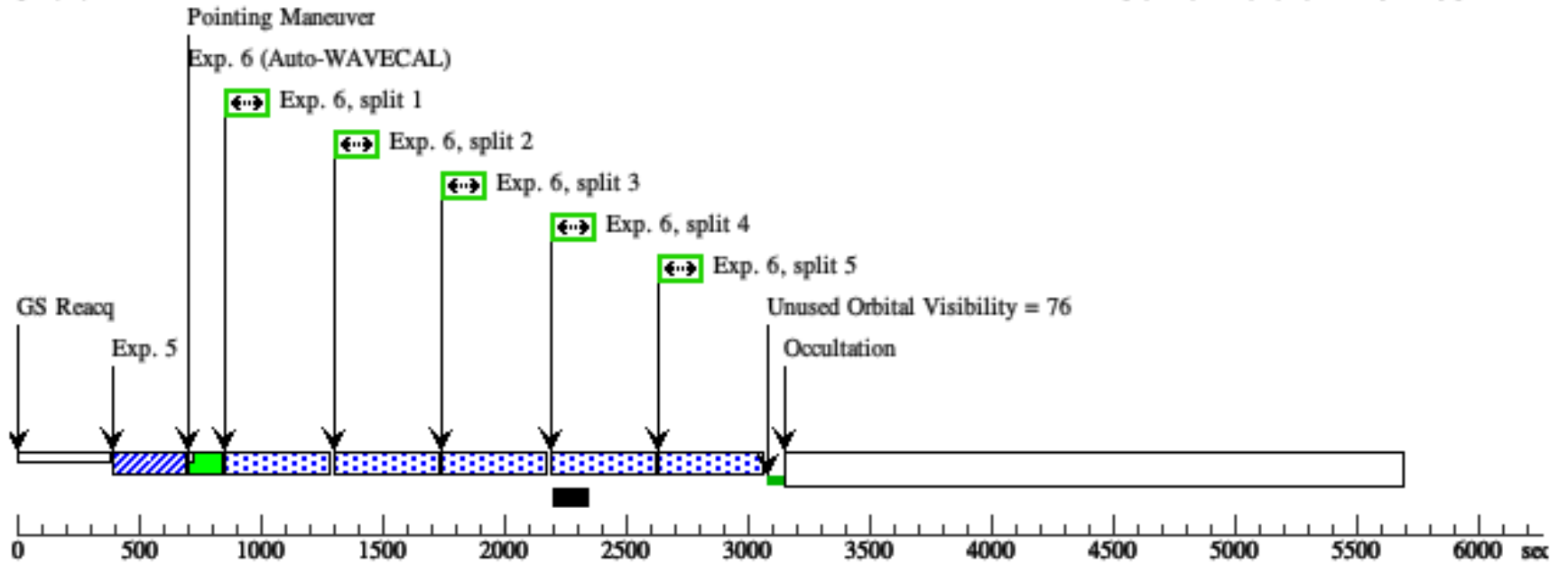
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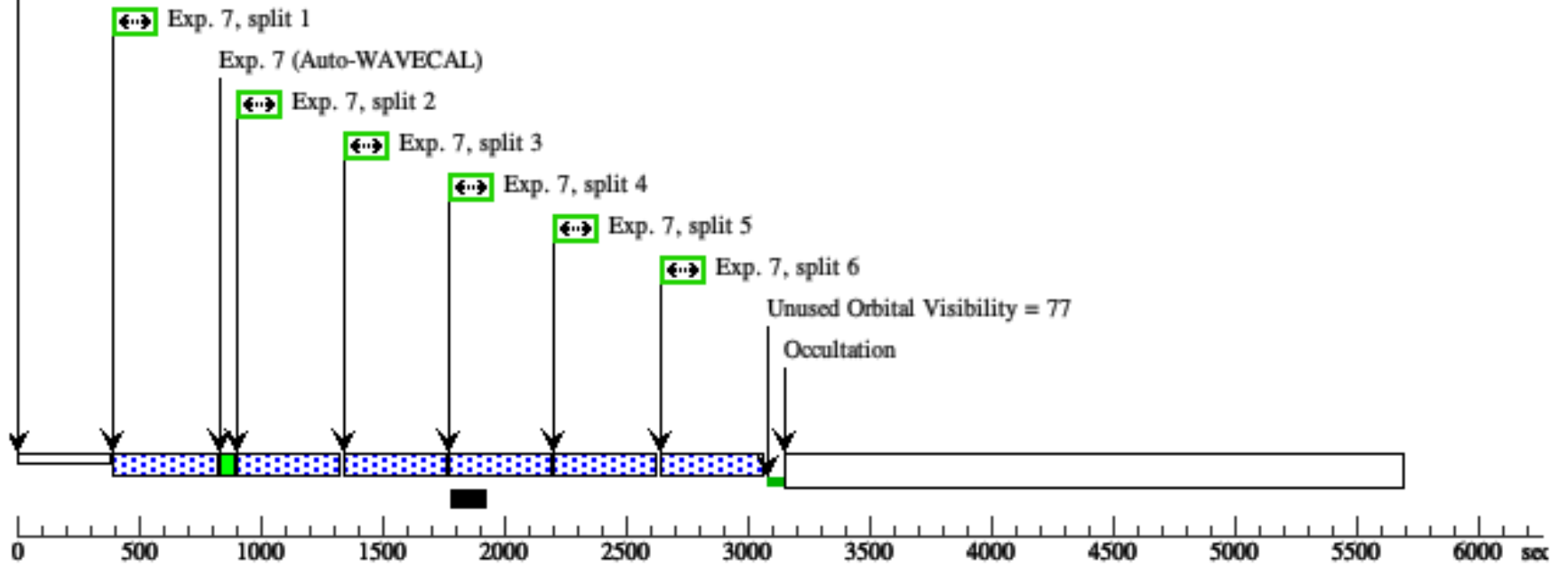
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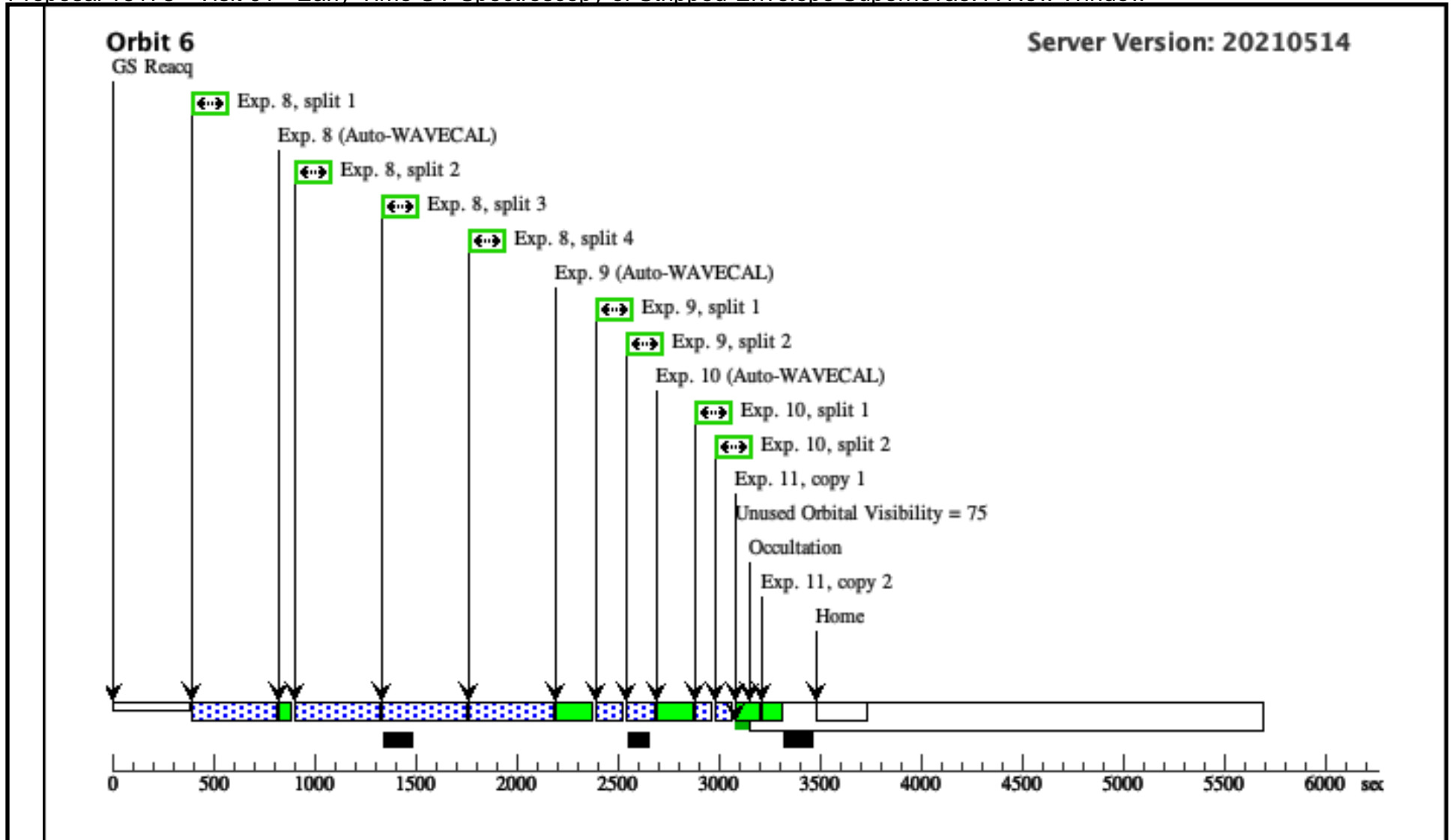
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Orbit 5

GS Reacq





Proposal 16178 - Visit 02 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

Sat Sep 11 01:00:29 GMT 2021

Visit	Proposal 16178, Visit 02 Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD Special Requirements: ON HOLD <i>On Hold Comments: Target of Opportunity</i>				
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections
(2)		SN2021YJA	RA: 03 24 21.1740 (51.0882250d) Dec: -21 33 56.23 (-21.56562d) Equinox: J2000		V=14.7
	Miscellaneous Reference Frame: ICRS				
	<i>Comments:</i> Category=EXT-STAR Description=[SUPERNOVA] Extended=NO				

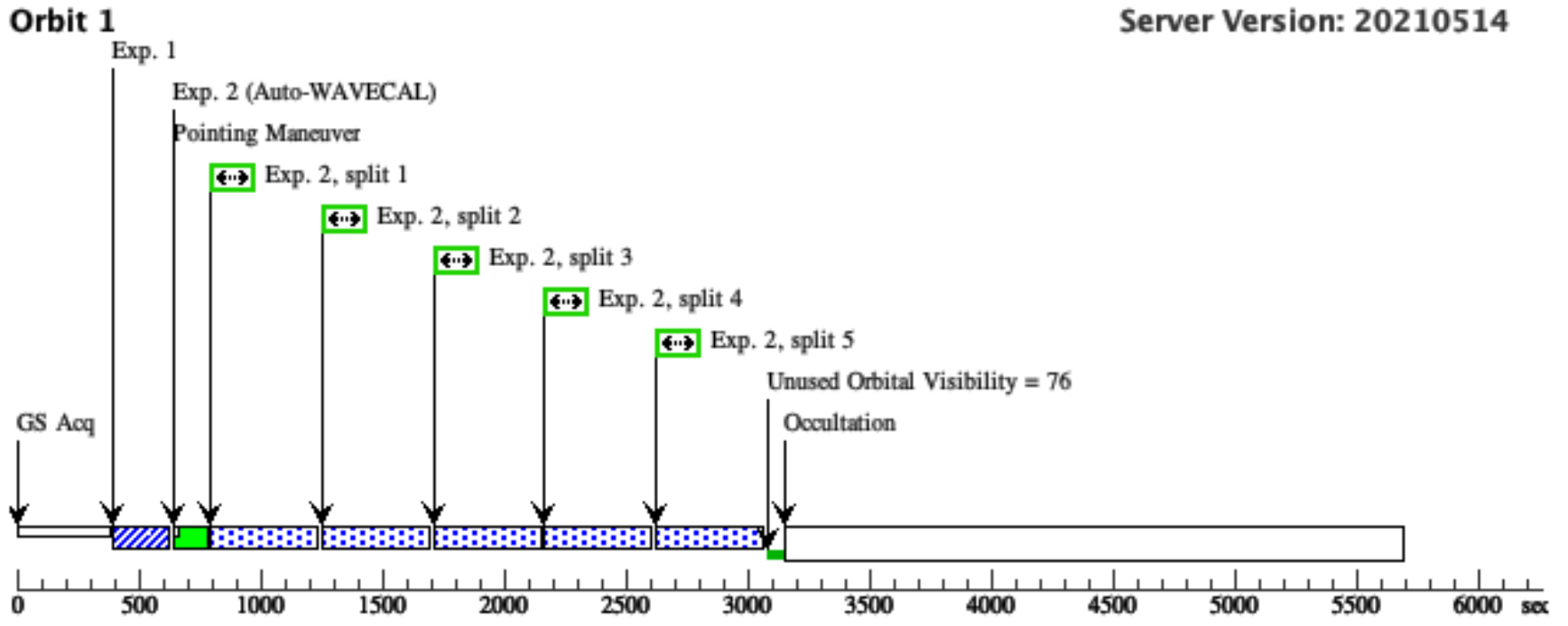
Proposal 16178 - Visit 02 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	Target Acquisition (2) SN2021YJA (STIS.ta.623 545)	STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs) [==>]	[1]
	<i>Comments: Our SN, though UV-faint, will be optically bright. Using the STIS Acquisition ETC and the spectrum of PTF12gzk obtained in Cycle 20, we find that a 2s exposure yields a S/N > 100.</i>								
	2	Spectroscopy (2) SN2021YJA (STIS.sp.62 4498)	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5			2060 Secs (2060 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
	3	Spectroscopy (2) SN2021YJA (STIS.sp.62 4498)	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6			2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[2]
	4	Spectroscopy (2) SN2021YJA (STIS.sp.62 4498)	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6			2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[3]
	5	Peakup (2) SN2021YJA (STIS.ta.651 490)	STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				1.2 Secs (1.2 Secs) [==>]	[4]
	6	Spectroscopy (2) SN2021YJA (STIS.sp.62 4498)	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5			2000 Secs (2000 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[4]
	7	Spectroscopy (2) SN2021YJA (STIS.sp.62 4498)	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=4			1544 Secs (1544 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[5]
	8	Spectroscopy (2) SN2021YJA (STIS.sp.62 1403)	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A				200 Secs (200 Secs) [==>(Split 1)] [==>(Split 2)]	[5]
	9	Spectroscopy (2) SN2021YJA (STIS.sp.62 1405)	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A				100 Secs (100 Secs) [==>(Split 1)] [==>(Split 2)]	[5]

Proposal 16178 - Visit 02 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

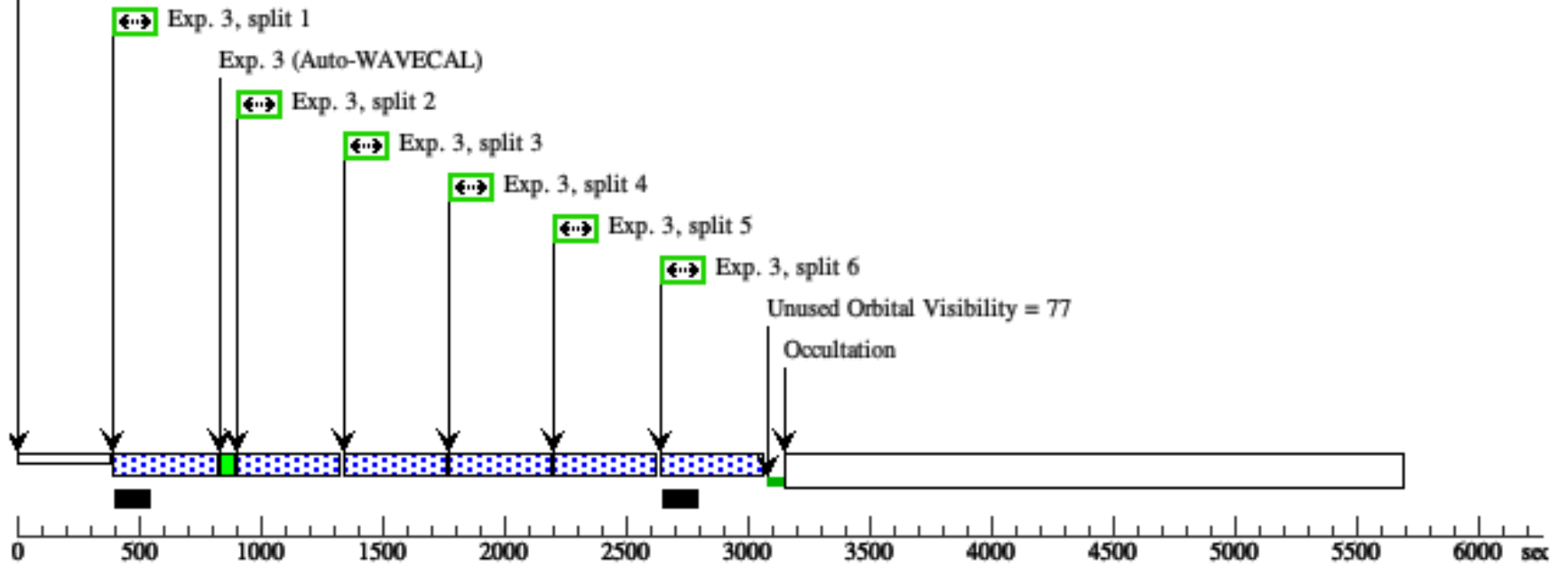
10	Fringe Flat G750L	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A	[==>(Copy 1)] [==>(Copy 2)]	[5]
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Orbit Structure



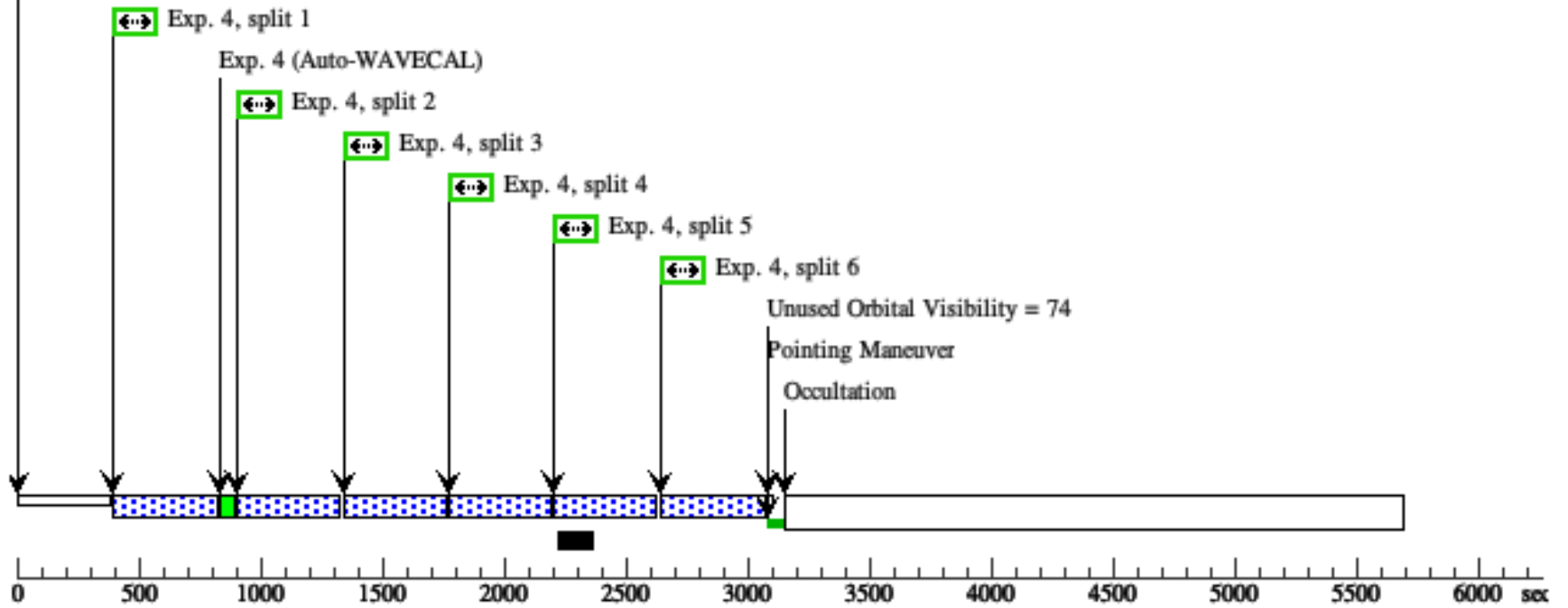
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GS Reacq



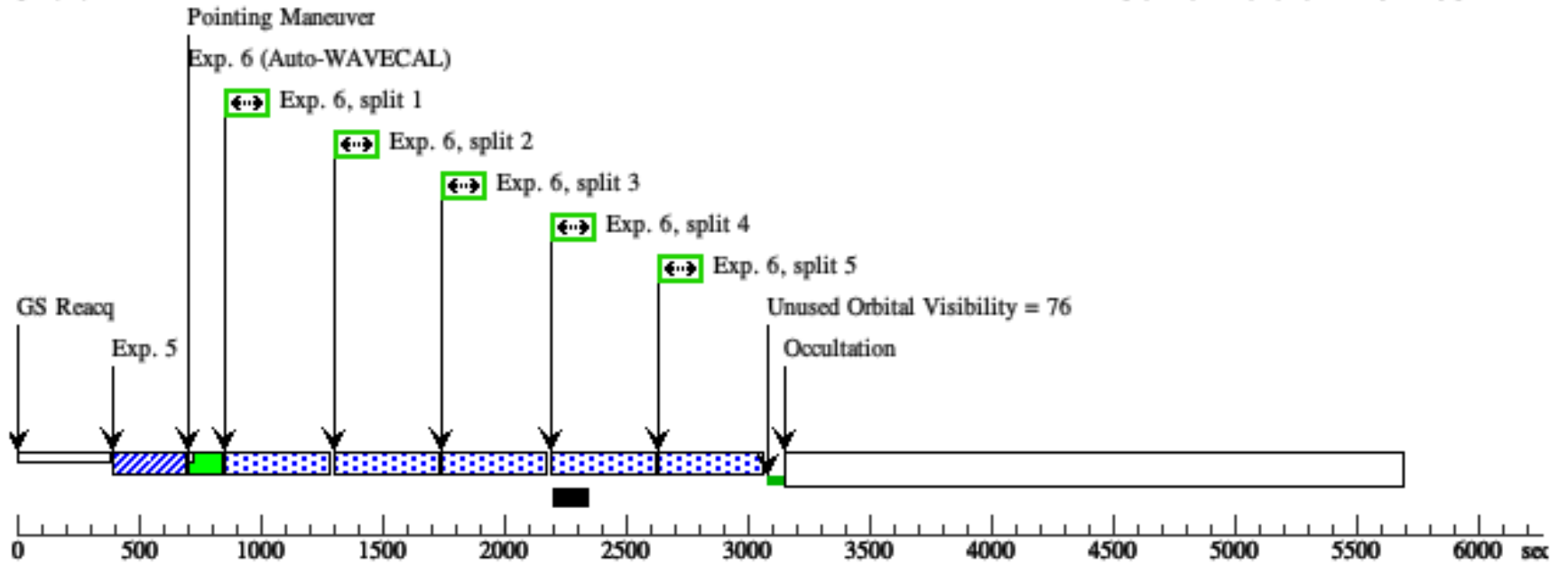
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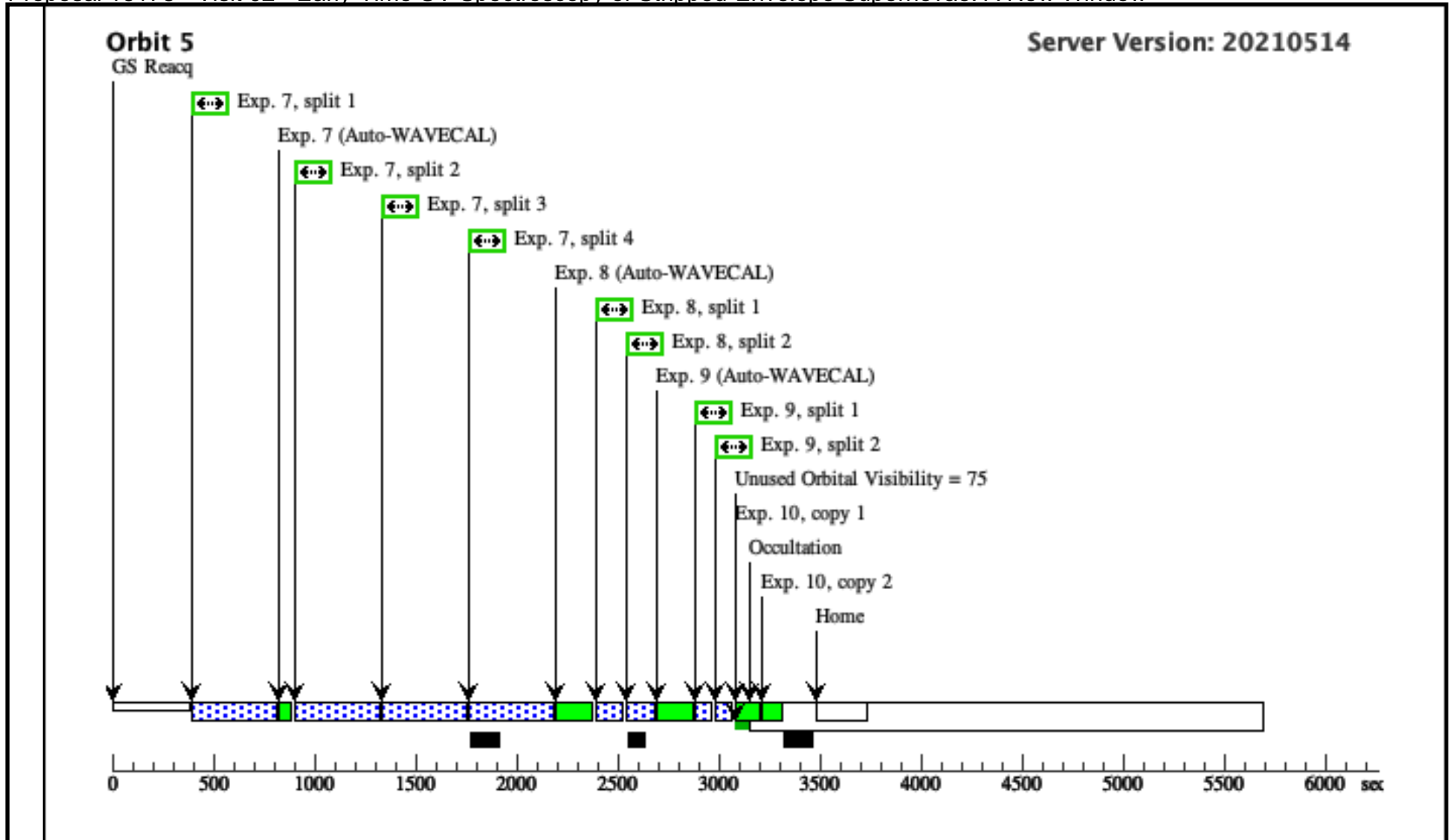
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Orbit 4

Server Version: 20210514





Proposal 16178 - Visit 03 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

Sat Sep 11 01:00:30 GMT 2021

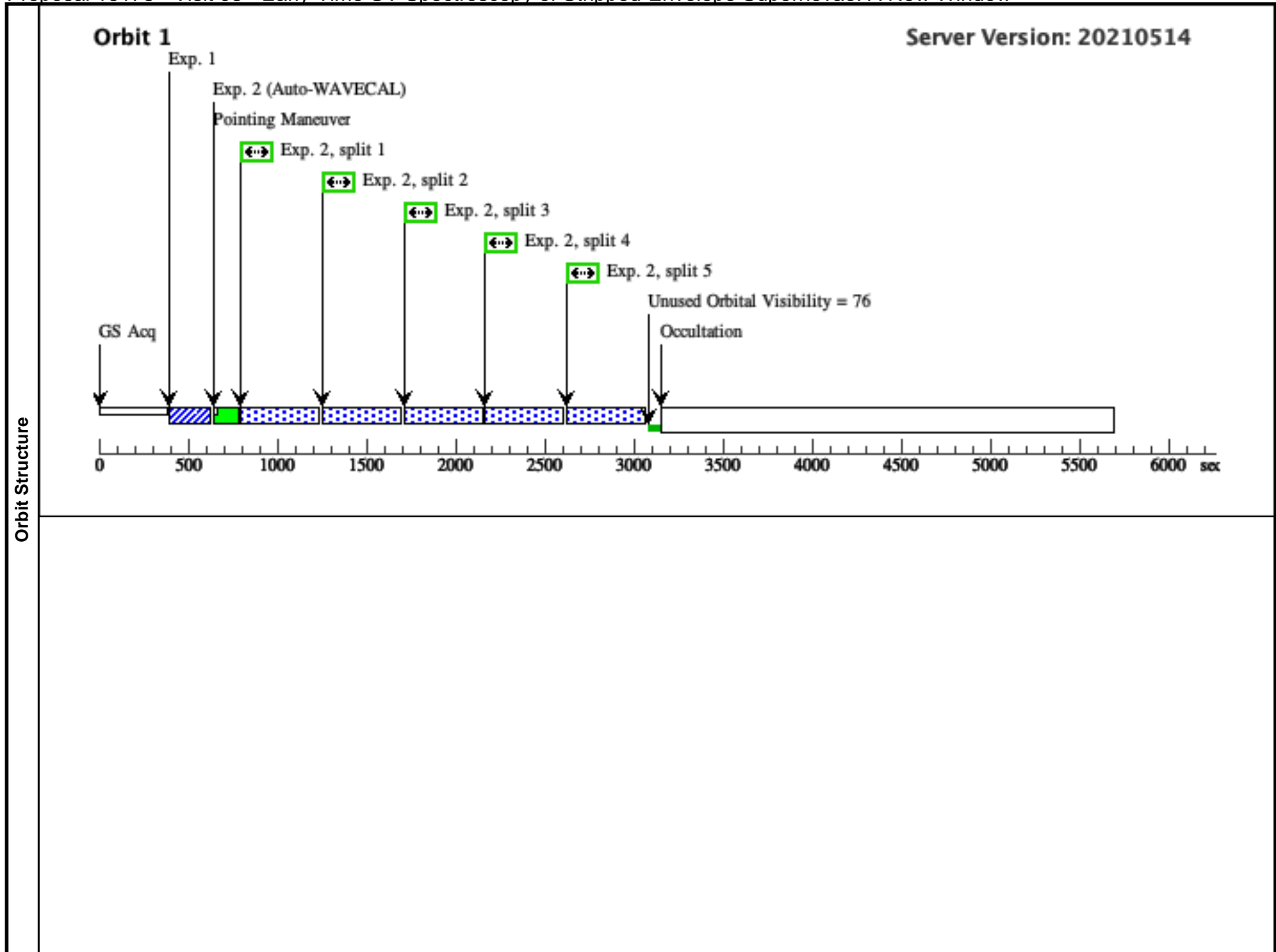
Visit	Proposal 16178, Visit 03 Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD Special Requirements: ON HOLD <i>On Hold Comments: Target of Opportunity</i>					
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
(2)		SN2021YJA	RA: 03 24 21.1740 (51.0882250d) Dec: -21 33 56.23 (-21.56562d) Equinox: J2000		V=14.7	Reference Frame: ICRS
<i>Comments:</i> Category=EXT-STAR Description=[SUPERNOVA] Extended=NO						

Proposal 16178 - Visit 03 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	Target Acquisition (STIS.ta.623 545)	(2) SN2021YJA STIS/CCD, ACQ, F28X50LP	MIRROR				2 Secs (2 Secs) [==>]	[1]
	<i>Comments: Our SN, though UV-faint, will be optically bright. Using the STIS Acquisition ETC and the spectrum of PTF12gzk obtained in Cycle 20, we find that a 2s exposure yields a S/N > 100.</i>								
	2	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5			2060 Secs (2060 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[1]
	3	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6			2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[2]
	4	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6			2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[3]
	5	Peakup (STIS.ta.651 490)	(2) SN2021YJA STIS/CCD, ACQ/PEAK, 52X0.1	MIRROR				1.2 Secs (1.2 Secs) [==>]	[4]
	6	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=5			2000 Secs (2000 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)]	[4]
7	Spectroscopy (STIS.sp.62 4498)	(2) SN2021YJA STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=6			2340 Secs (2340 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)] [==>(Split 5)] [==>(Split 6)]	[5]	

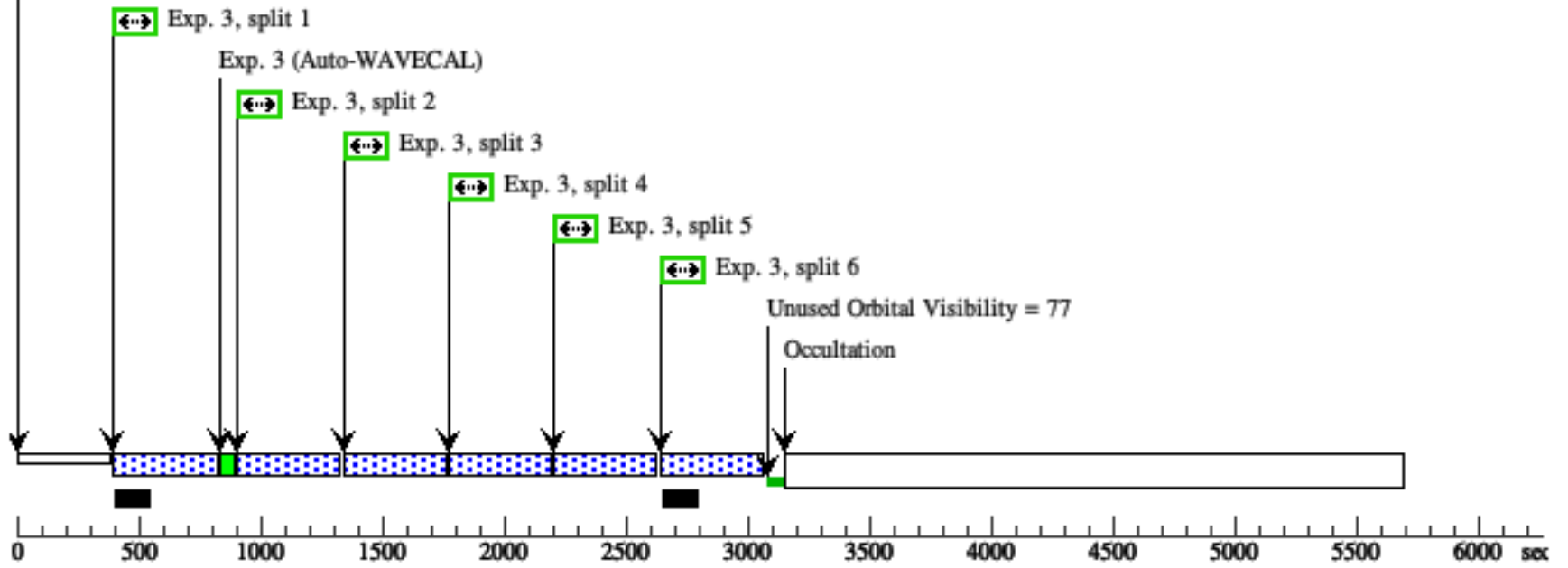
Proposal 16178 - Visit 03 - Early-Time UV Spectroscopy of Stripped-Envelope Supernovae: A New Window

8	Spectroscopy yNUV (STIS.sp.62 4498)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G230LB 2375 A	CR-SPLIT=4	1544 Secs (1544 Secs)	
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[==>(Split 4)]							
9	Spectroscopy yG430L (STIS.sp.62 1403)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G430L 4300 A		200 Secs (200 Secs)	
						[==>(Split 1)]	[6]
10	Spectroscopy yG750L (STIS.sp.62 1405)	(2) SN2021YJA	STIS/CCD, ACCUM, 52X0.2E1	G750L 7751 A		100 Secs (100 Secs)	
						[==>(Split 1)]	[6]
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						[==>(Copy 2)]	



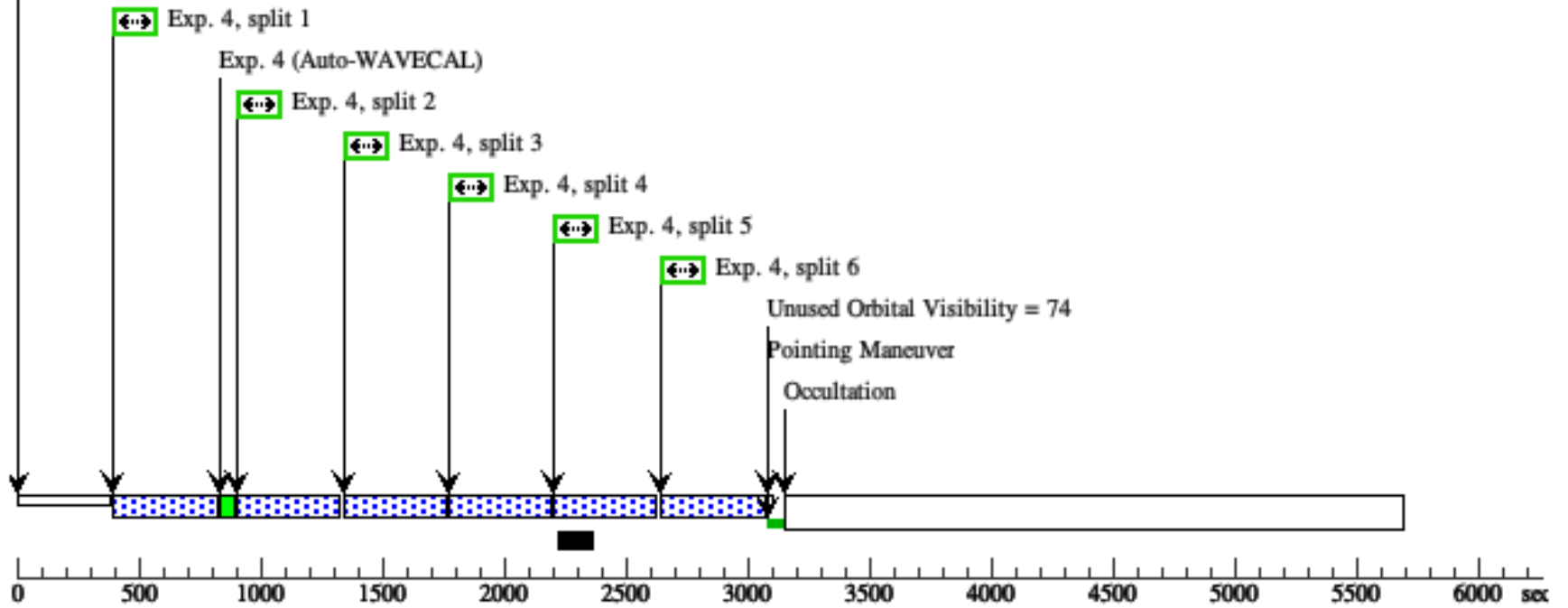
Orbit 2

GS Reacq



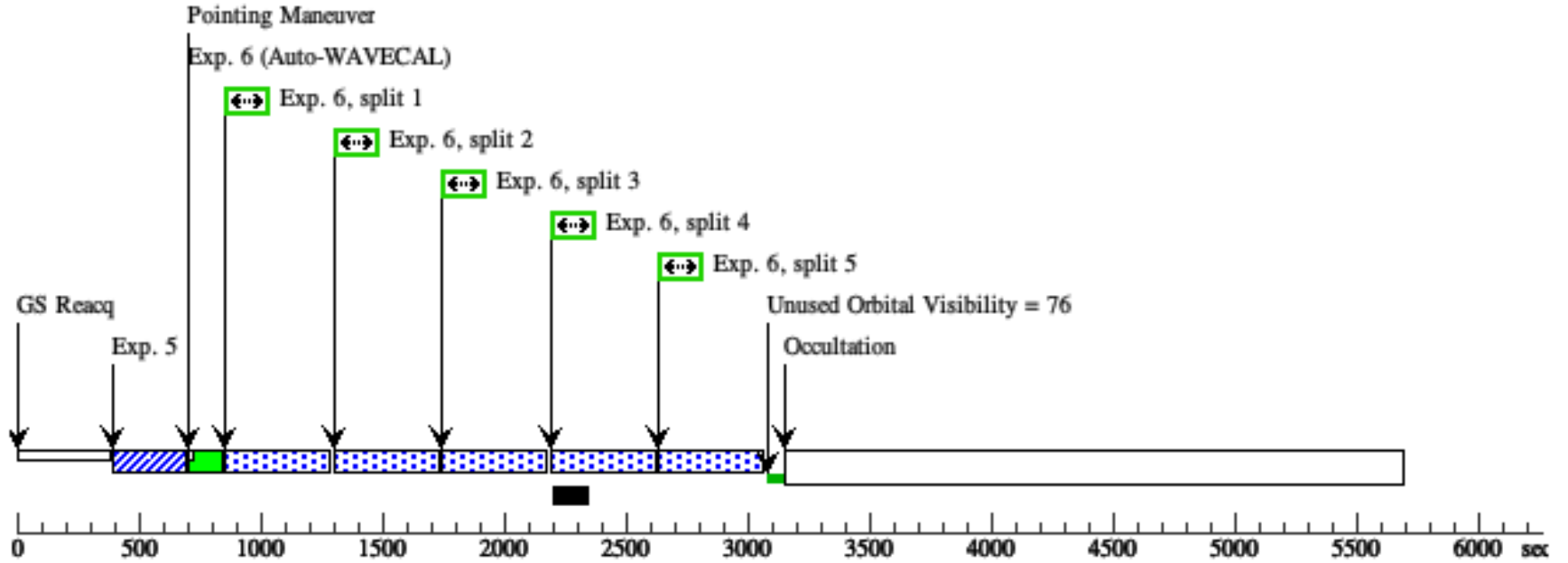
Orbit 3

GS Reacq



Orbit 4

Server Version: 20210514



Orbit 5

GS Reacq

