16671 - Unveiling the nature of interacting supernovae or supernova impostors

Cycle: 29, 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-2015BH	WFC3/IR WFC3/UVIS	2	26-Jul-2021 07:00:16.0	yes
02	(2) AT-2016JBU	WFC3/IR WFC3/UVIS	2	26-Jul-2021 07:00:18.0	yes
03	(3) SN-2013GC	WFC3/IR WFC3/UVIS	2	26-Jul-2021 07:00:20.0	yes
04	(4) SN-2009IP	WFC3/IR WFC3/UVIS	2	26-Jul-2021 07:00:21.0	yes

8 Total Orbits Used

ABSTRACT

Some apparent supernovae (SNe) with strong circumstellar interaction are likely the explosion of very massive stars. Surprisingly, a significant fraction of these explosions is preceded by outbursts from weeks to years before. When and why outbursts herald terminal SN explosions is still unknown. Moreover, in some cases, it is not even clear whether the star has undergone a terminal SN explosion or has rather experienced an extreme, but non-terminal, eruption as a "supernova impostor". To answer these questions, we must first obtain clear evidence that these stars have indeed undergone a core-collapse supernova explosion. We propose to use HST+WFC3 to visit the field of four of these transients after they have faded to obtain a deep, high-resolution image. This will allow us to search for (or place limits on) any surviving stellar progenitor and hence test whether these are terminal explosions or not.

OBSERVING DESCRIPTION

Our HST observations will focus on sampling the entire spectral energy distribution of four nearby (<30 Mpc) supernova (SN) impostors with deep imaging of their sites in the most similar filters to those used at the pre-discovery observations. We are looking to compare magnitude changes without an additional source of error from large color terms and set a robust limit on the bolometric luminosity of any source at the transient.

(1) We will observe the SN 2015bh site using WFC3/UVIS with F438W, F606W and F814W and a pattern of 3 dither positions to achieve a 5sigma detection at > 26 mag. Similarly, we estimate we can reach a 4.5sigma limiting magnitude at H ~25 using WFC3/IR with F160W. Allowing 6.5 min for target acquisition and ~13 min per intermittent overheads and pointing maneuvers, we calculate ~53 min for 2 exposures per each UVIS filter, which is within the visibility for an orbit. Similarly, we estimate the reminding WFC3/UVIS observations and F160W, accounting for readout, guide-star, (re)-acquisition and switching between UVIS and IR channels, will take approximately 53 minutes, again within a single orbit.

(2) We request F350LP, F555W and F814W images of the AT 2016jbu's site using WFC3/UVIS, reaching between 5 and 10sigma at > 26 mag. Additionally, we will obtain images in the IR using WFPC3/IR in the F160W filter. Considering target acquisition, overheads and pointing maneuvers, we need 2 orbits again.

(3) We will observe SN 2013gc in F438W, F606W and F814W, with the addition of F160W. We estimate observations in these four filters while aiming to achieve a 5sigma limiting magnitude at ~25 mag, accounting for readout, guide-star, (re)-acquisition and switching between UVIS and IR channels, will be obtainable within 2 orbits.

(4) SN 2009ip will also be observed with F438W, F606W, F814W using WFC3/UVIS, and F160W using WFC3/IR. Allowing for the necessary

overheads, this is achievable within 2 orbits.

We, therefore, use 8 orbits to obtain observations of our SN 2009ip-like transient sample. We use point dithering to correct for cosmic rays and hot pixels and to improve the sampling of the point spread function. We exploit the entire detector in each case, placing our targets in the optimal position on the chips according to their location in the host galaxy. For each case, we have sought a compromise between having the highest number of reference stars with a high enough S/N for accurate astrometric registration.

Visit

Proposal 16671, SN2015bh (01) Mon Jul 26 11:00:22 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(10)

Fixed Targets

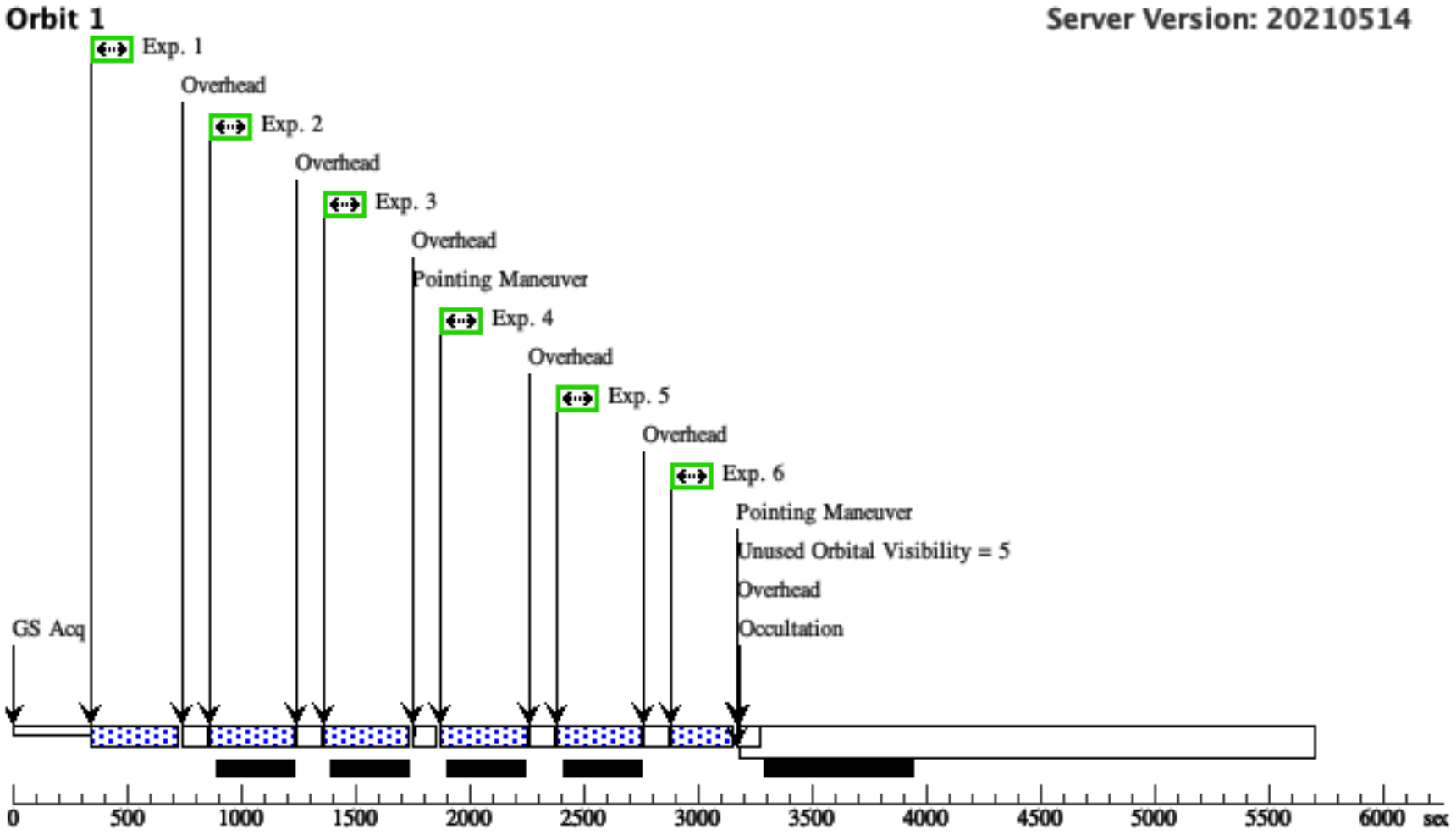
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-2015BH	RA: 09 09 35.3500 (137.3972917d) Dec: +33 06 57.60 (33.11600d) Equinox: J2000		V=26	Reference Frame: ICRS

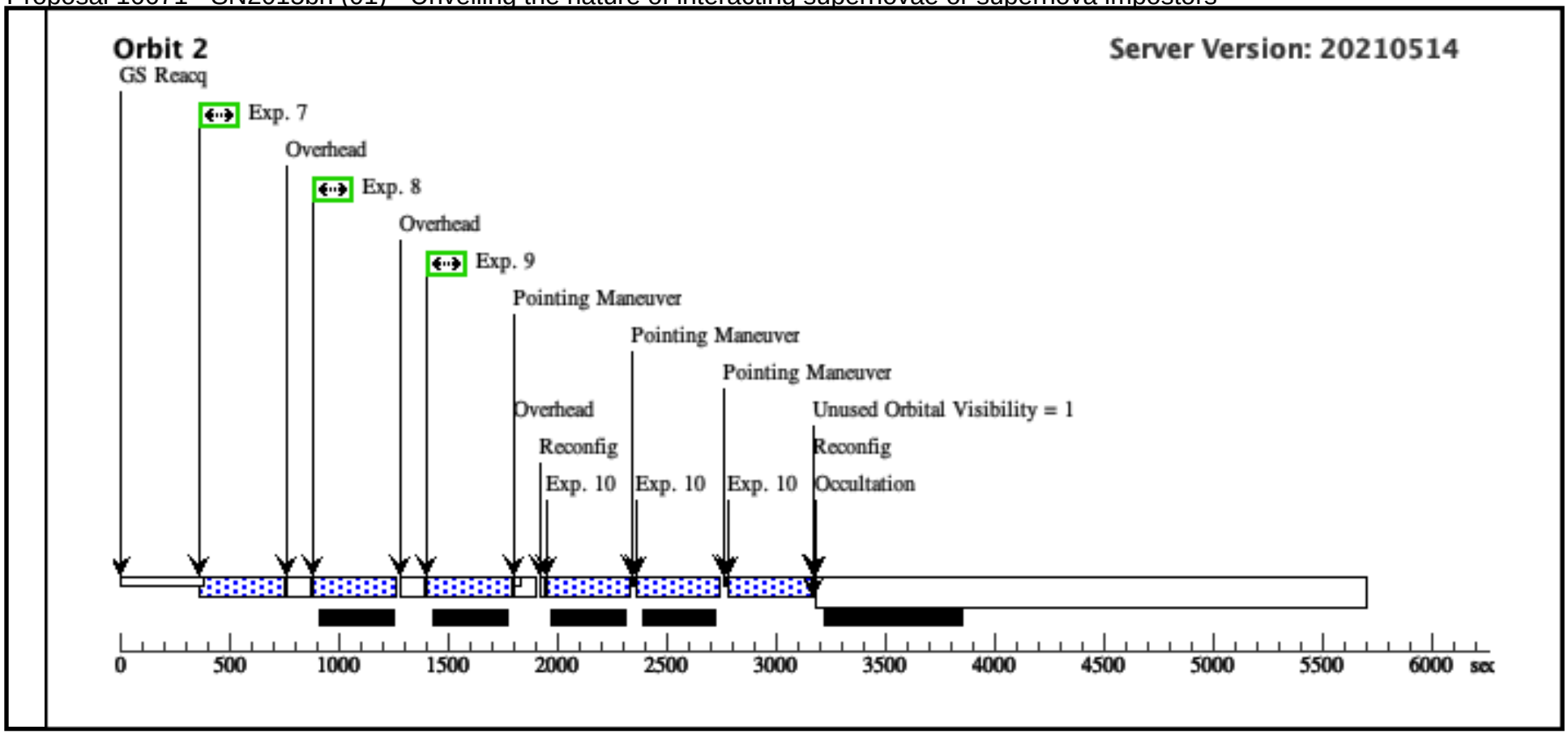
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0,0		350 Secs (352 Secs) *[==>352.0 Secs]*	 ***[1]***
2		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0,0		350 Secs (352 Secs) *[==>352.0 Secs]*	 ***[1]***
3		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,0		350 Secs (352 Secs) *[==>352.0 Secs]*	 ***[1]***
4		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.092,0.098		350 Secs (352 Secs) *[==>352.0 Secs]*	 ***[1]***
5		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.092,0.098		350 Secs (352 Secs) *[==>352.0 Secs]*	 ***[1]***
6		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=1	POS TARG 0.092,0.098		250 Secs (252 Secs) *[==>252.0 Secs]*	 ***[1]***
7		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.185,0.197		350 Secs (366 Secs) *[==>366.0 Secs]*	 ***[2]***
8		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.185,0.197		350 Secs (366 Secs) *[==>366.0 Secs]*	 ***[2]***
9		(1) SN-2015BH	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0.185,0.197		350 Secs (366 Secs) *[==>366.0 Secs]*	 ***[2]***
10		(1) SN-2015BH	WFC3/IR, MULTIACCUM, IR-UVIS	F160W	SAMP-SEQ=SPARS25; NSAMP=15		Pattern 4, Exps 10-10 in SN2015bh (01) (4)	352.939501 Secs (1058.819 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[2]***

Orbit Structure




Orbit 2
Server Version: 20210514
GS Reacq
Exp. 7
Overhead
Exp. 8
Overhead
Exp. 9
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Overhead
Unused Orbital Visibility = 1
Reconfig
Reconfig
Exp. 10
Exp. 10
Exp. 10
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16671, AT2016jbu (02) Mon Jul 26 11:00:22 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1-3)
(4)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(4)

Fixed Targets

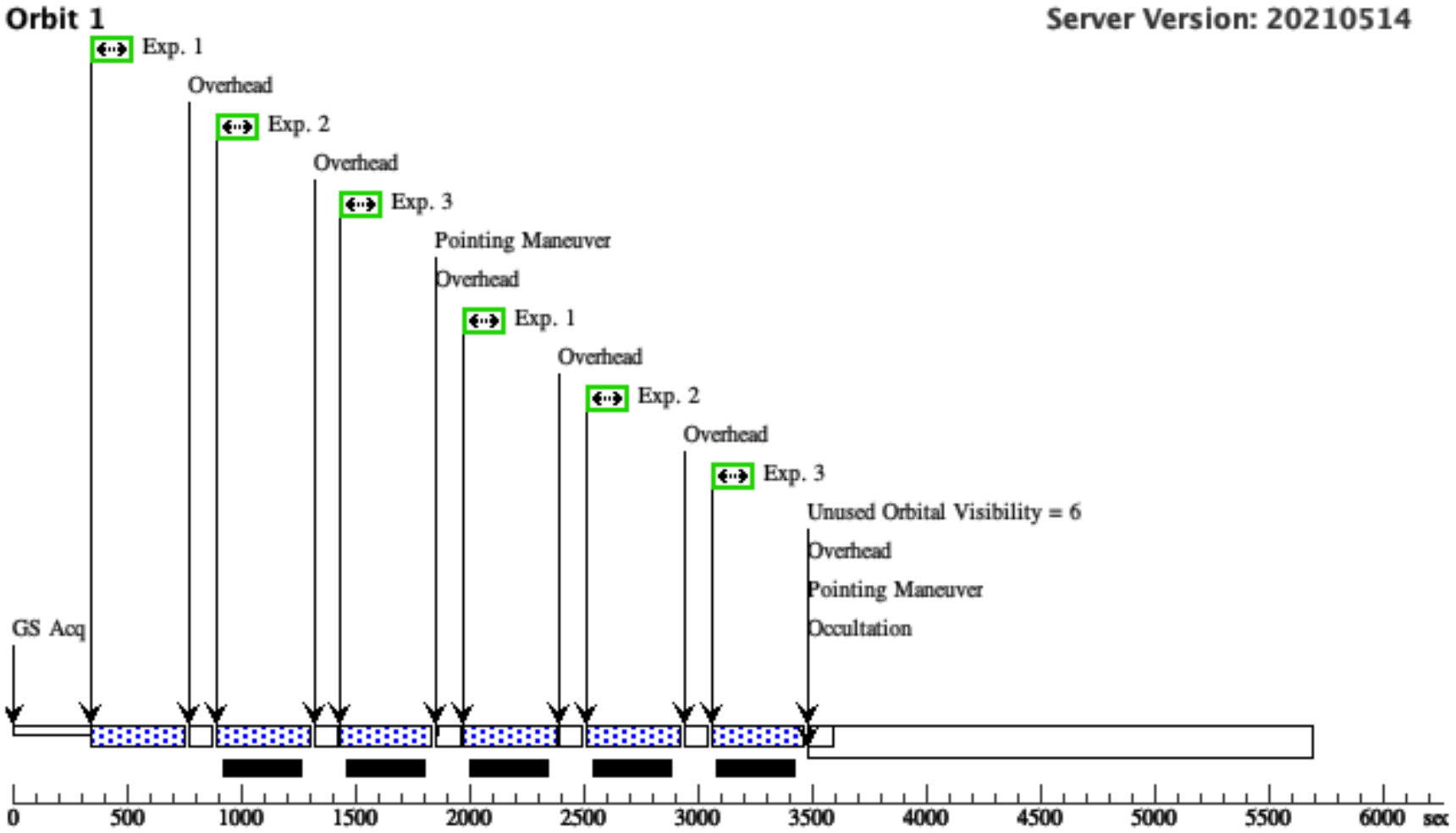
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	AT-2016JBU	RA: 07 36 25.9800 (114.1082500d) Dec: -69 32 55.40 (-69.54872d) Equinox: J2000		V=26	Reference Frame: ICRS

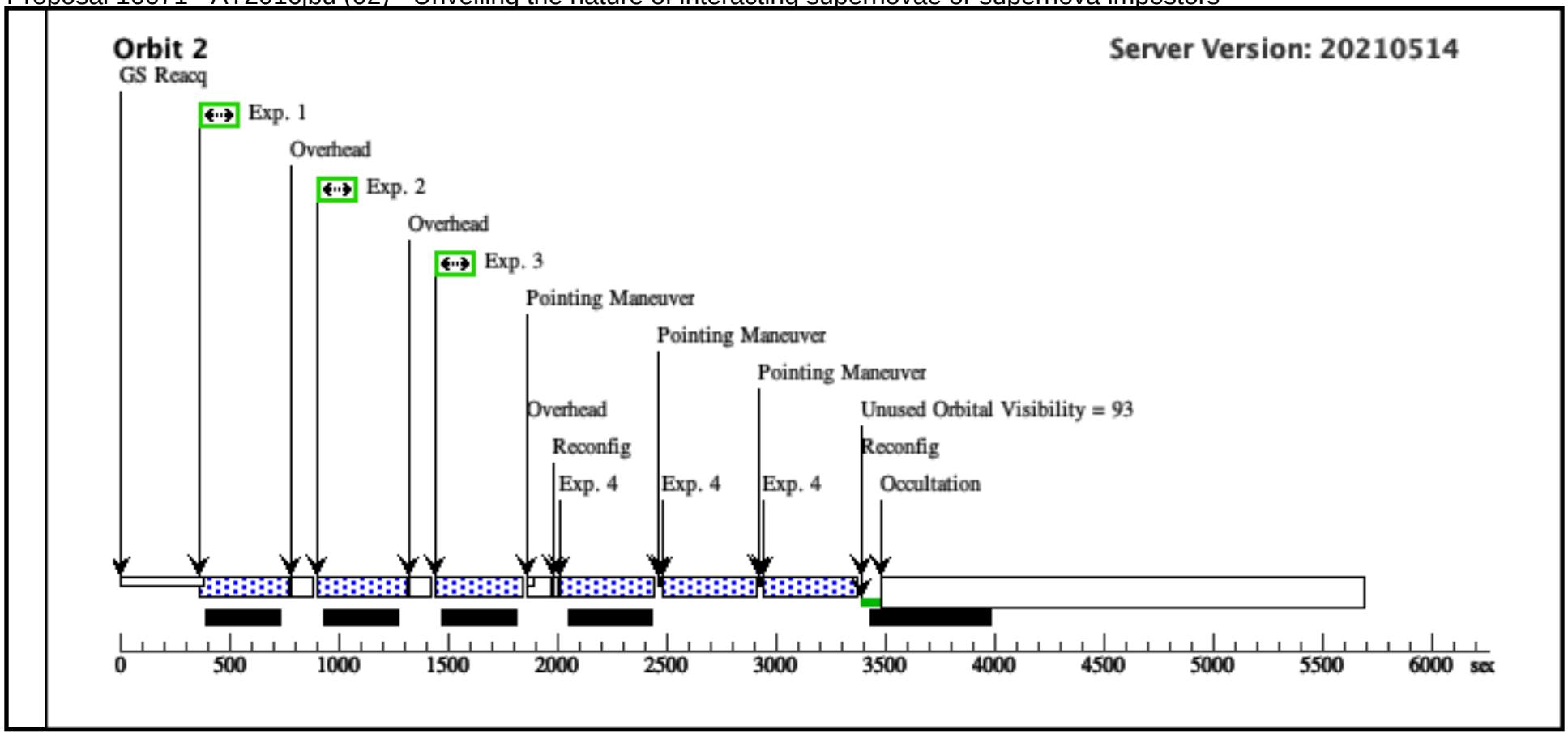
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F350LP	(2) AT-2016JBU	WFC3/UVIS, ACCUM, UVIS2	F350LP			Pattern 3, Exps 1-3 in AT2016jbu (02) (3)	385 Secs (1155 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)]	***[2]***
2	F555W	(2) AT-2016JBU	WFC3/UVIS, ACCUM, UVIS2	F555W	FLASH=1		Pattern 3, Exps 1-3 in AT2016jbu (02) (3)	390 Secs (1170 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)]	***[2]***
3	F814W	(2) AT-2016JBU	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=3		Pattern 3, Exps 1-3 in AT2016jbu (02) (3)	390 Secs (1170 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)]	***[2]***
4	F160W	(2) AT-2016JBU	WFC3/IR, MULTIACCUM, IR-UVIS	F160W	SAMP-SEQ=SPARS50; NSAMP=9		Pattern 4, Exps 4-4 in AT2016jbu (02) (4)	402.935899 Secs (1208.808 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[2]***
								[==>(Pattern 3)]	

Orbit Structure




Orbit 2
Server Version: 20210514
GS Reacq
Exp. 1
Overhead
Exp. 2
Overhead
Exp. 3
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Overhead
Reconfig
Exp. 4
Exp. 4
Exp. 4
Unused Orbital Visibility = 93
Reconfig
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16671, SN2013gc (03) Mon Jul 26 11:00:22 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(10)

Fixed Targets

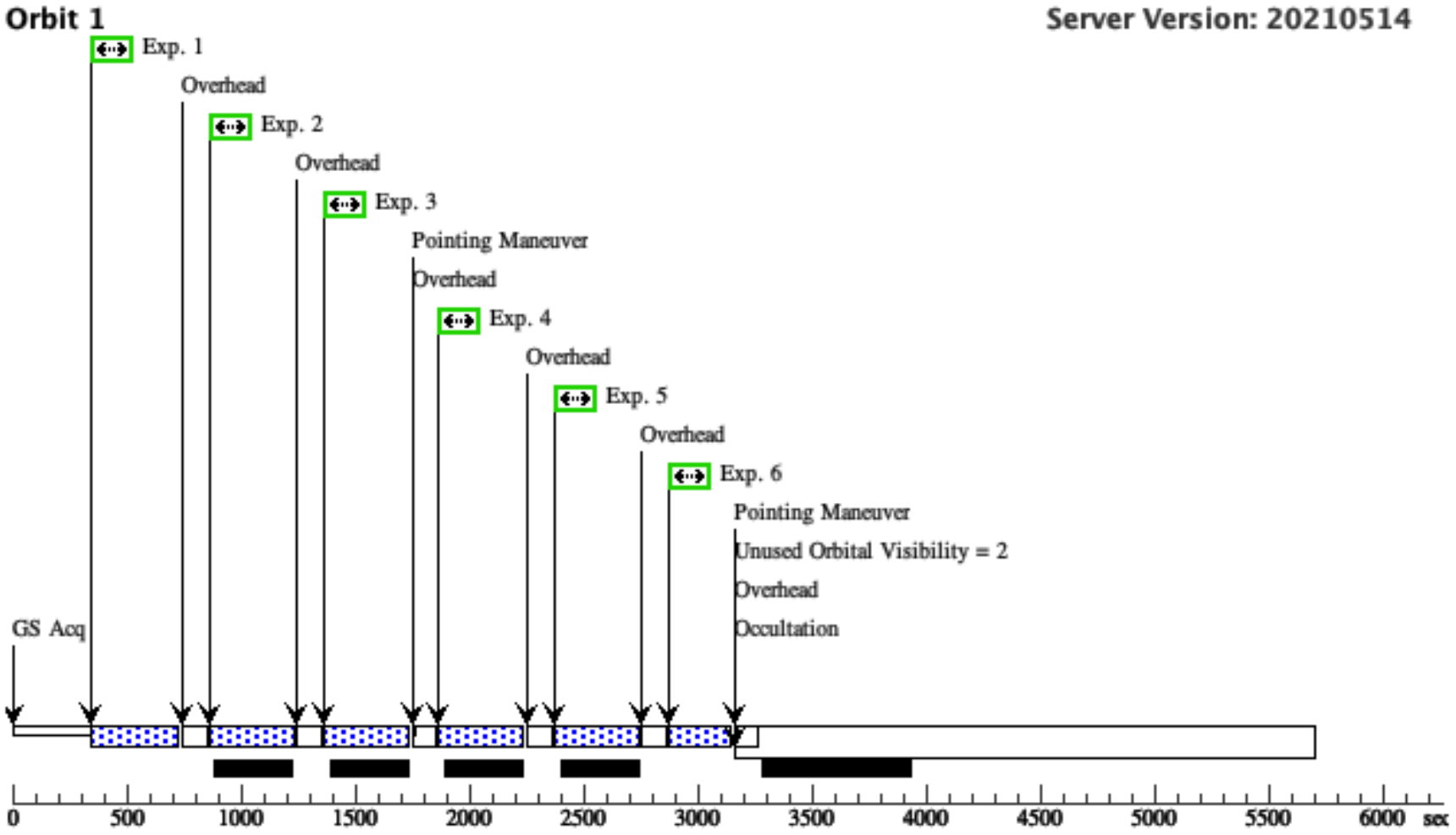
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SN-2013GC	RA: 08 07 11.8800 (121.7995000d) Dec: -28 03 26.30 (-28.05731d) Equinox: J2000		V=25	Reference Frame: ICRS

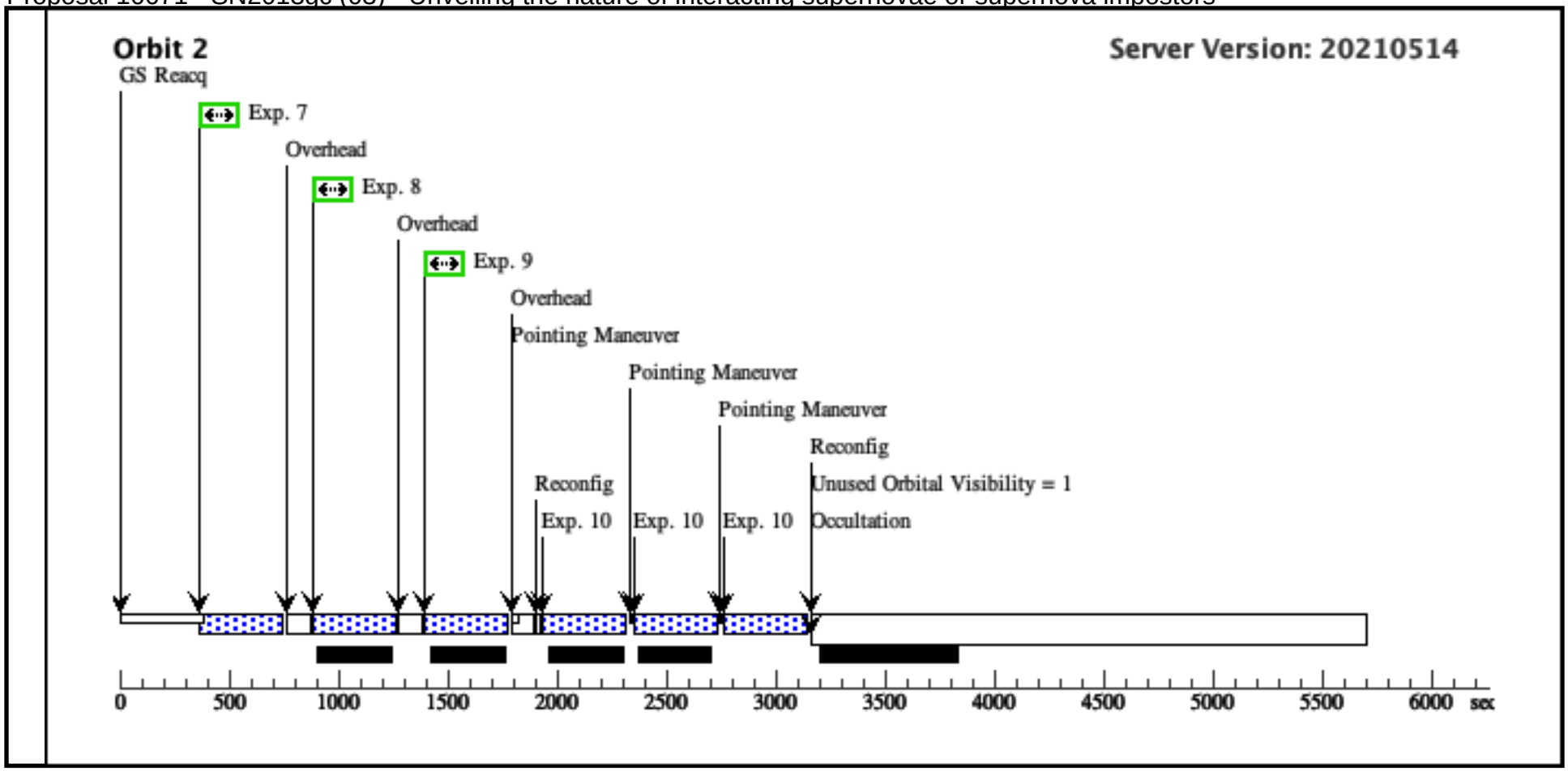
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0,0		350 Secs (350 Secs) *[==>]*	***[1]***
2		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0,0		350 Secs (350 Secs) *[==>]*	***[1]***
3		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,0		350 Secs (350 Secs) *[==>]*	***[1]***
4		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.092,0.098		350 Secs (350 Secs) *[==>]*	***[1]***
5		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.092,0.098		350 Secs (350 Secs) *[==>]*	***[1]***
6		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=2	POS TARG 0.092,0.098		250 Secs (250 Secs) *[==>]*	***[1]***
7		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	***[2]***
8		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	***[2]***
9		(3) SN-2013GC	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	***[2]***
10		(3) SN-2013GC	WFC3/IR, MULTIACCUM, IR-UVIS	F160W	SAMP-SEQ=SPARS25; NSAMP=15		Pattern 4, Exps 10-10 in SN2013gc (03) (4)	352.939501 Secs (1058.819 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20210514
GS Reacq
Exp. 7
Overhead
Exp. 8
Overhead
Exp. 9
Overhead
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Reconfig
Unused Orbital Visibility = 1
Reconfig
Exp. 10
Exp. 10
Exp. 10
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16671, SN2009ip (04) Mon Jul 26 11:00:22 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(10)

Fixed Targets

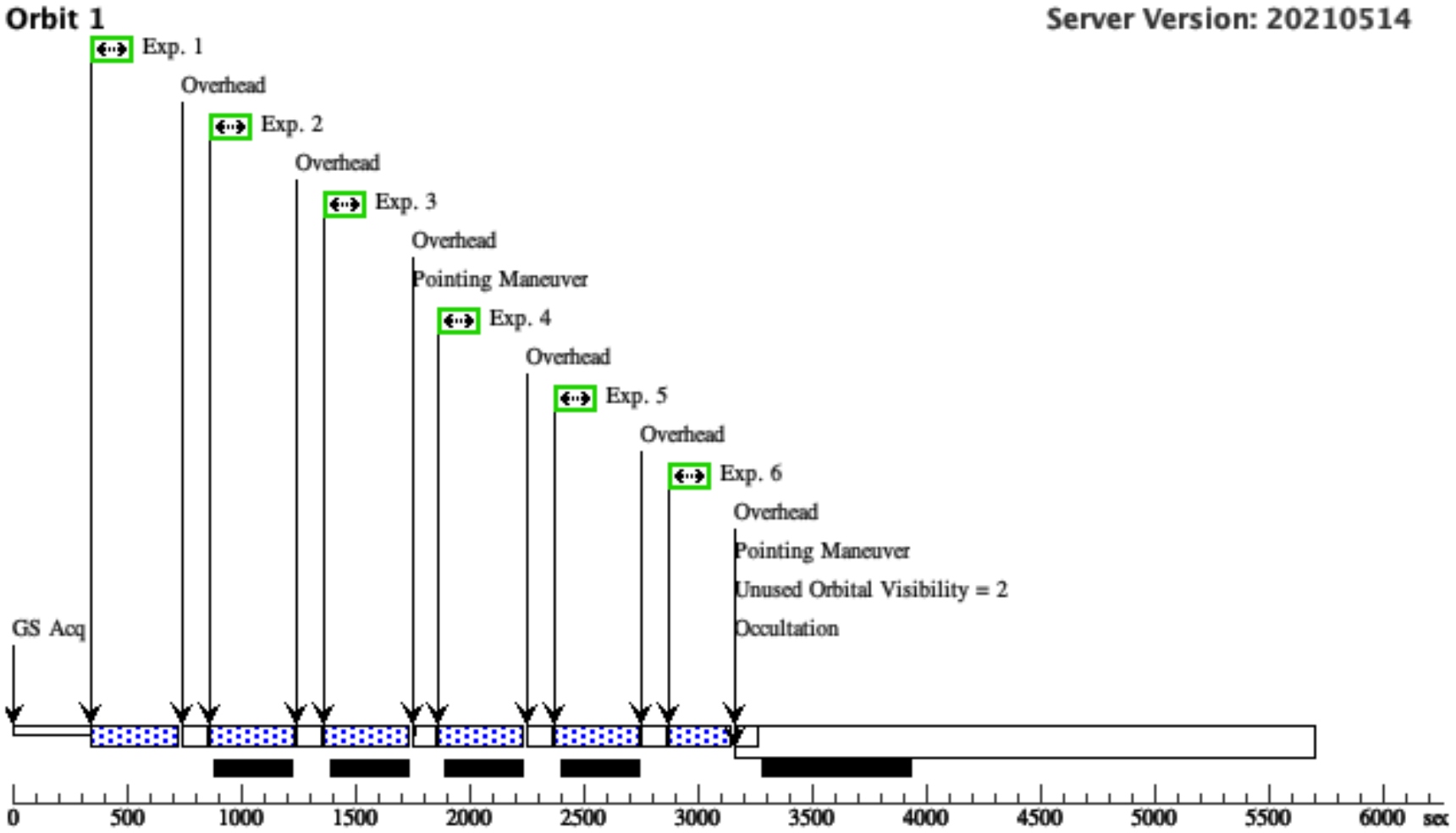
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	SN-2009IP	RA: 22 23 8.2600 (335.7844167d) Dec: -28 56 52.40 (-28.94789d) Equinox: J2000		V=26.5	Reference Frame: ICRS

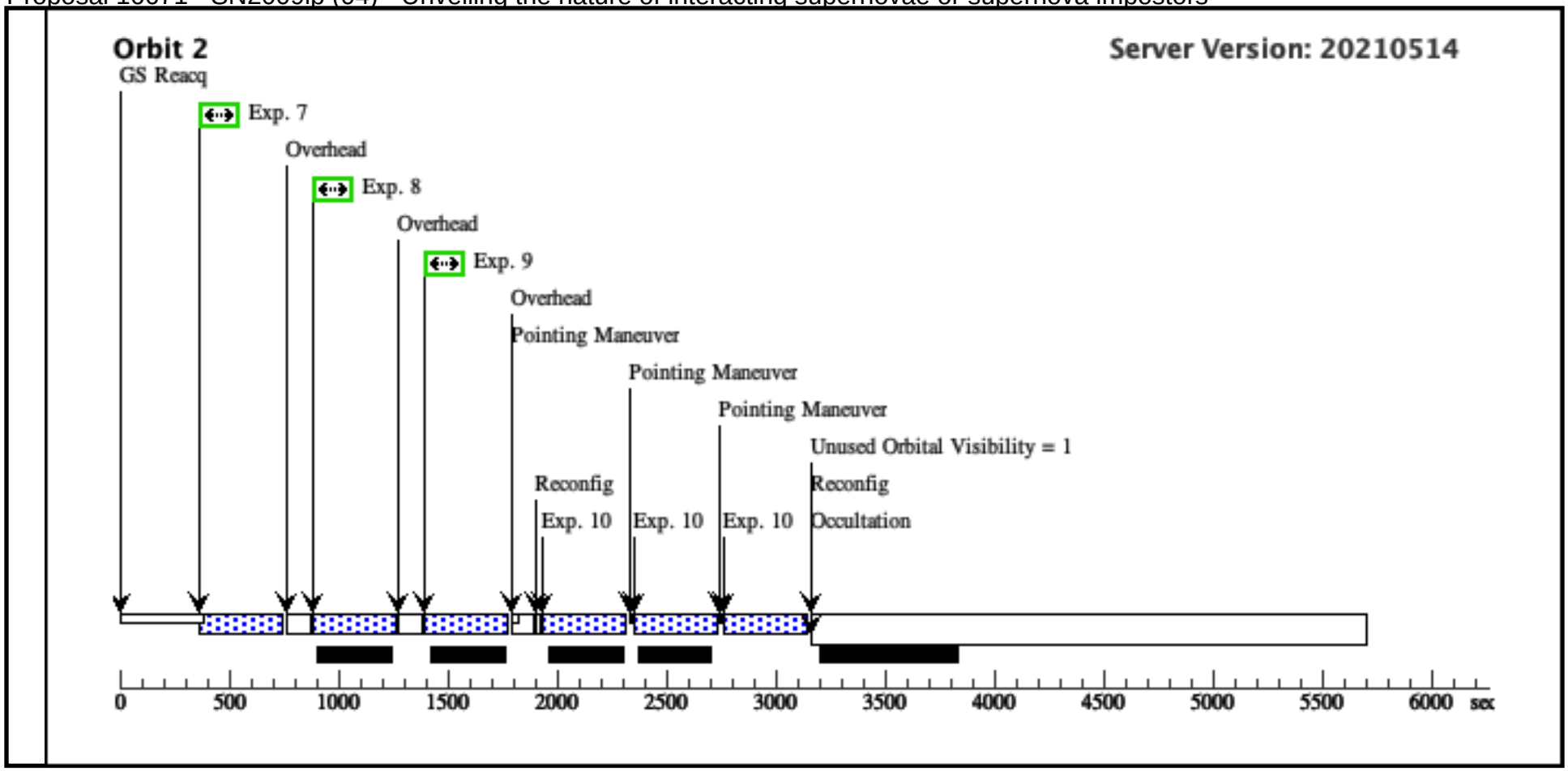
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[LUMINOUS BLUE VARIABLE, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0,0		350 Secs (350 Secs) *[==>]*	 ***[1]***
2		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0,0		350 Secs (350 Secs) *[==>]*	 ***[1]***
3		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,0		350 Secs (350 Secs) *[==>]*	 ***[1]***
4		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.092,0.098		350 Secs (350 Secs) *[==>]*	 ***[1]***
5		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.092,0.098		350 Secs (350 Secs) *[==>]*	 ***[1]***
6		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=2	POS TARG 0.092,0.098		250 Secs (250 Secs) *[==>]*	 ***[1]***
7		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F438W	FLASH=9	POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	 ***[2]***
8		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=4	POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	 ***[2]***
9		(4) SN-2009IP	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0.185,0.197		350 Secs (361 Secs) *[==>361.0 Secs]*	 ***[2]***
10		(4) SN-2009IP	WFC3/IR, MULTIACCUM, IR-UVIS	F160W	SAMP-SEQ=SPARS25; NSAMP=15		Pattern 4, Exps 10-10 in SN2009ip (04) (4)	352.939501 Secs (1058.819 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[2]***

Orbit Structure




Orbit 2
Server Version: 20210514
GS Reacq
Exp. 7
Overhead
Exp. 8
Overhead
Exp. 9
Overhead
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 1
Reconfig
Exp. 10
Exp. 10
Exp. 10
Reconfig
Occultation
0
500
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2000
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3000
3500
4000
4500
5000
5500
6000
sec