16789 - The ever-changing face of SN 1987A

Cycle: 29, 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-1987A	WFC3/UVIS	2	10-Sep-2021 09:01:41.0	yes
02	(1) SN-1987A	WFC3/UVIS	3	10-Sep-2021 09:01:43.0	yes
03	(1) SN-1987A	WFC3/UVIS	2	10-Sep-2021 09:01:44.0	yes
04	(1) SN-1987A	WFC3/UVIS	2	10-Sep-2021 09:01:44.0	yes

9 Total Orbits Used

ABSTRACT

SN 1987A is the great supernova (SN) of the HST era. An unbroken string of observations is the essential tool for detecting change and establishing a uniform legacy archive. Recent imaging has shown dramatic changes in the ejecta and the interaction with the circumstellar material. After a steady increase in flux, the inner circumstellar ring reached a maximum in 2009 and is now fading rapidly as it is destroyed by shocks. At the same time, diffuse emission and new spots outside the inner ring are becoming visible, gradually revealing previously unseen material that extends toward the outer rings. Monitoring this emission is required to understand the formation of the rings and the mass-loss history of the progenitor star. In addition, the expanding innermost ejecta reveal asymmetries and mixing in the explosion. As the ejecta expand, X-rays from the inner ring penetrate into the metal-rich core, which results in a brightening in the optical band. We request imaging in narrow and broad filters over the next three cycles to follow these developments. Annual observations are needed to monitor the rapid evolution of the shocks. Imaging in additional filters in one of the cycles will provide flux measurements crucial to estimating the energy budget of the ejecta, that, perhaps, will begin to reveal the elusive compact object. The HST observations have a unique blend of photometric fidelity and angular resolution that make them the indispensable partner to ongoing X-ray, sub-mm ALMA, and ground-based optical/NIR observations. They are also an important complement to the JWST GTO observations in 2022.

OBSERVING DESCRIPTION

We request imaging with WFC3/UVIS in Cycles 28, 29, and 30. The total time requested is 4 + 9 + 4 = 17 orbits.

Monitoring:

We request imaging with F438W, F625W, F502N, and F657N in all three cycles. With these observations, we will follow the light curve and morphology of the ejecta, the ER, and the new spots and diffuse gas outside the ER. To obtain a similar quality as the previous observations, we need half an orbit each for the broad filters, one orbit for F657N and two orbits for F502N. This amounts to 4 X 3 = 12 orbits over three years. Since 2003,

all ACS and WFC3 imaging has used a fixed dither strategy to improve the resolution of the HST PSF. Using the same dither strategy and the empirical PSFs by Anderson (2016), we will use PSF-matched difference imaging (Sugerman 2005) across the full ACS/WFC3 dataset and search for faint changes in the rings and outer structures.

Additional filters in Cycle 29:
We request imaging with F275W, F336W, F555W, F814W and F280N in Cycle 29 only, which is expected to be close in time to the planned JWST GTO observations. In the event of a significant delay in the JWST launch, we would request the STScI Director to move these observations to Cycle 30. The HST observations in this cycle will give complete coverage of the wavelength interval between 2300A-10000A. The primary science objectives for the broad filters are the energy budget for the ejecta and compact object, but the observations will also measure the other emission components in the system, which can verify our models for the shock interaction. The last time that SN 1987A was observed in all these filters was in 2009. We request a full orbit each in F275W and F336W, which is a significant improvement compared to the 400 s UV-band exposures in the 2009 epoch. The longer exposures are motivated by the relatively low transmission as well as the fact that these filters are important for estimating limits on the compact object. We will need one orbit to cover F555W and F814W.

The narrow F280N filter covering the Mg II lambda-2800 lines has not previously been used for SN 1987A, though it is known from STIS spectra that the ejecta are strong in Mg II (Larsson et al. 2013). As described above, these lines can also help refine the shock models for the new spots. The F280N filter will cover almost all ejecta emission inside 2500 km/s, while the highest velocities will be included in the F275W image. Given the filter throughput and the expected strength of the lines, we require two orbits for F280N.

Visit

Proposal 16789, Visit 01, implementation Fri Sep 10 13:01:45 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 78D TO 82 D; ORIENT 168D TO 172 D; ORIENT 258D TO 262 D; ORIENT 348D TO 352 D; BETWEEN 01-MAY-2022:00:00:00 AND 30-SEP-2022:00:00:00; SEQ 01,02,03,04 WITHIN 14 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX	Coordinate Frame=POS-TARG		(1-4)
	Purpose=DITHER	Pattern Orientation=23.884		
	Number Of Points=4	Angle Between Sides=81.785		
	Point Spacing=0.173	Center Pattern=false		
	Line Spacing=0.112			

Fixed Targets

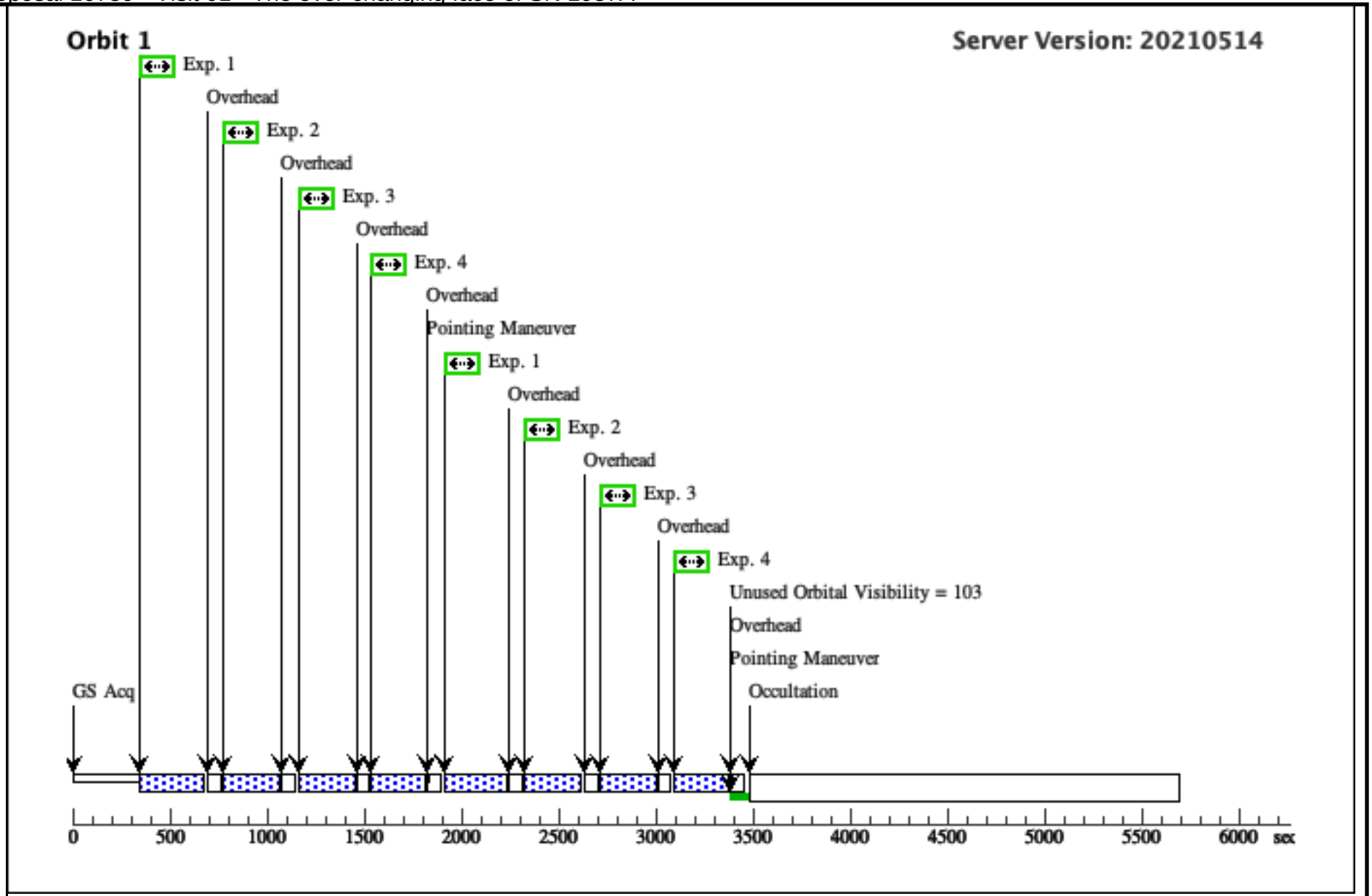
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-1987A	RA: 05 35 28.0200 (83.8667500d)	Epoch of Position: 2015.5	V=22	Reference Frame: SIMBAD
		Dec: -69 16 11.07 (-69.26974d)			
		Equinox: J2000			

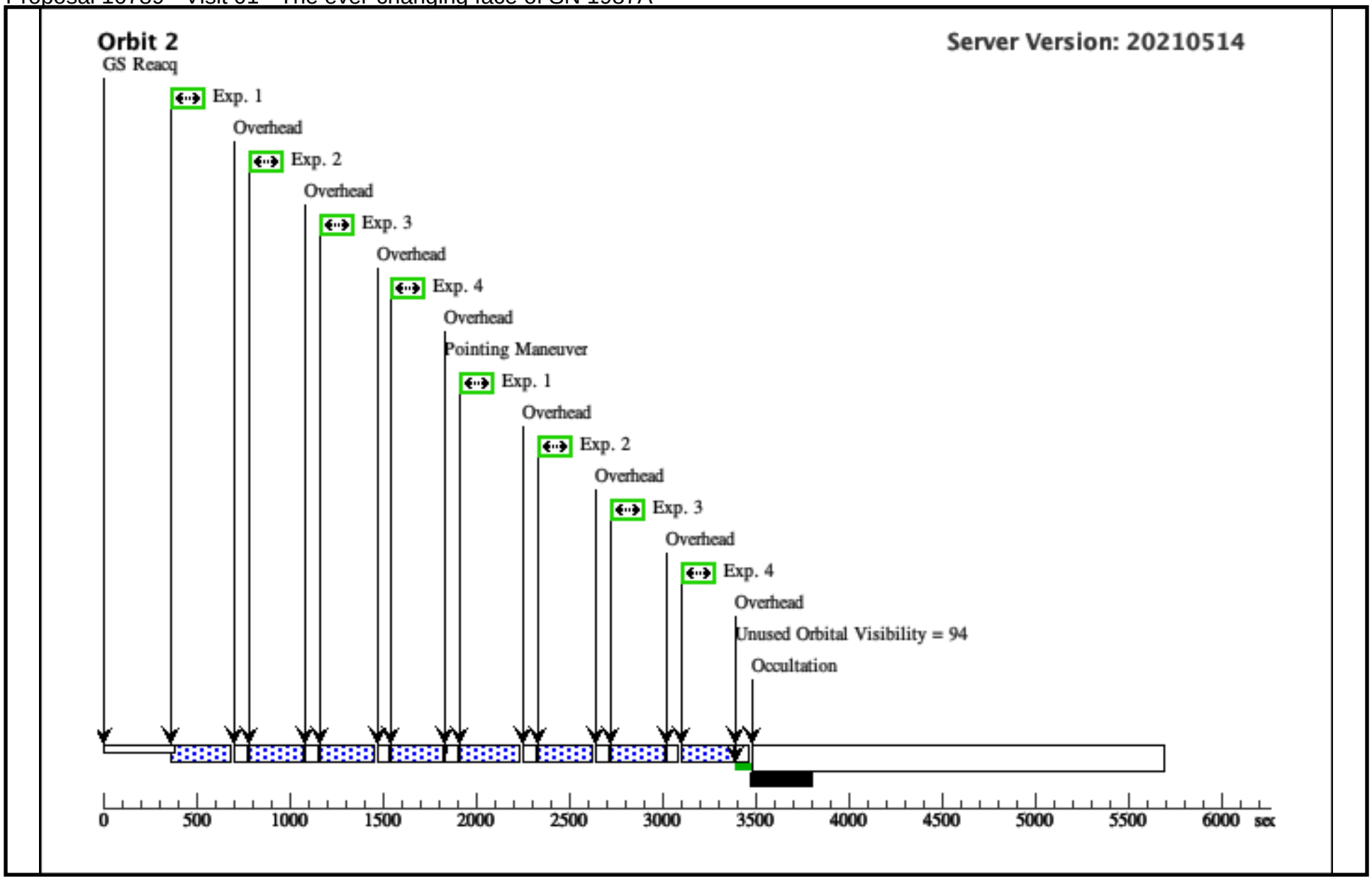
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F438W	FLASH=16		Pattern 1, Exps 1-4 in Visit 01 (1)	300 Secs (1200 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
2		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F625W	FLASH=10		Pattern 1, Exps 1-4 in Visit 01 (1)	270 Secs (1080 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
3		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=14		Pattern 1, Exps 1-4 in Visit 01 (1)	270 Secs (1080 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
4		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=10		Pattern 1, Exps 1-4 in Visit 01 (1)	270 Secs (1080 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	

Orbit Structure




Orbit 2
Server Version: 20210514
GS Reacq
Exp. 1
Overhead
Exp. 2
Overhead
Exp. 3
Overhead
Exp. 4
Overhead
Pointing Maneuver
Exp. 1
Overhead
Exp. 2
Overhead
Exp. 3
Overhead
Exp. 4
Overhead
Unused Orbital Visibility = 94
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 16789, Visit 02, implementation Fri Sep 10 13:01:45 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 78D TO 82 D; ORIENT 168D TO 172 D; ORIENT 258D TO 262 D; ORIENT 348D TO 352 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1-2)

Fixed Targets

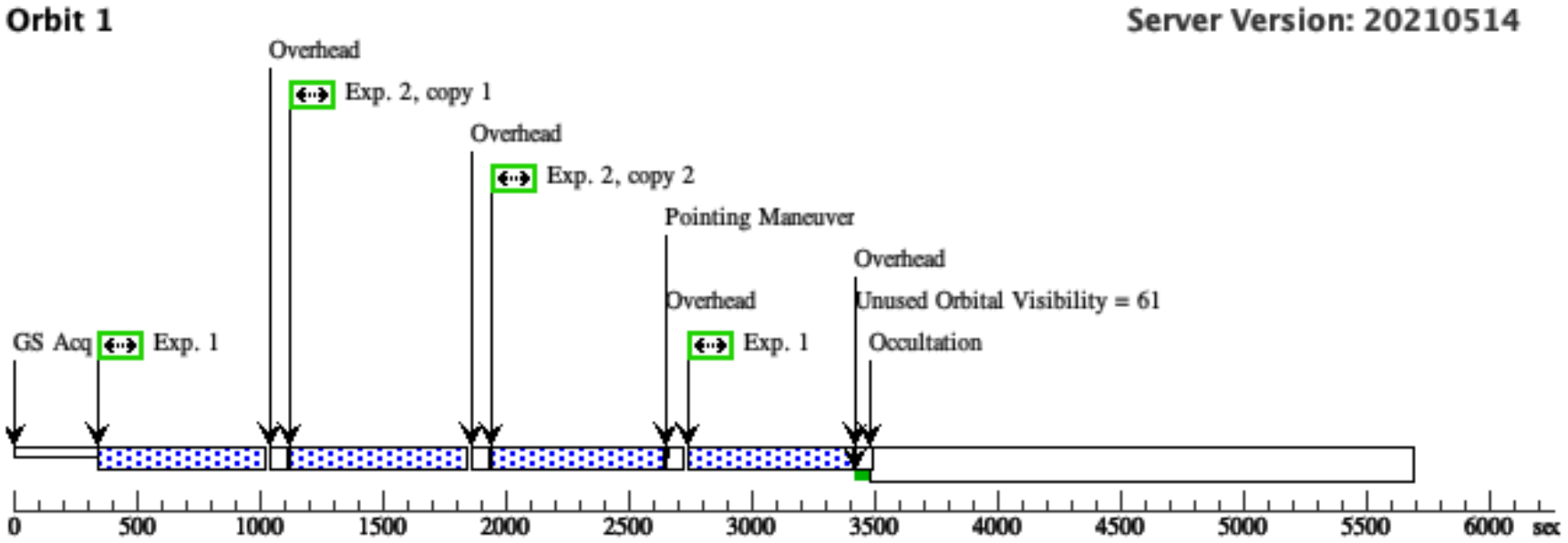
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-1987A	RA: 05 35 28.0200 (83.8667500d) Dec: -69 16 11.07 (-69.26974d) Equinox: J2000	Epoch of Position: 2015.5	V=22	Reference Frame: SIMBAD

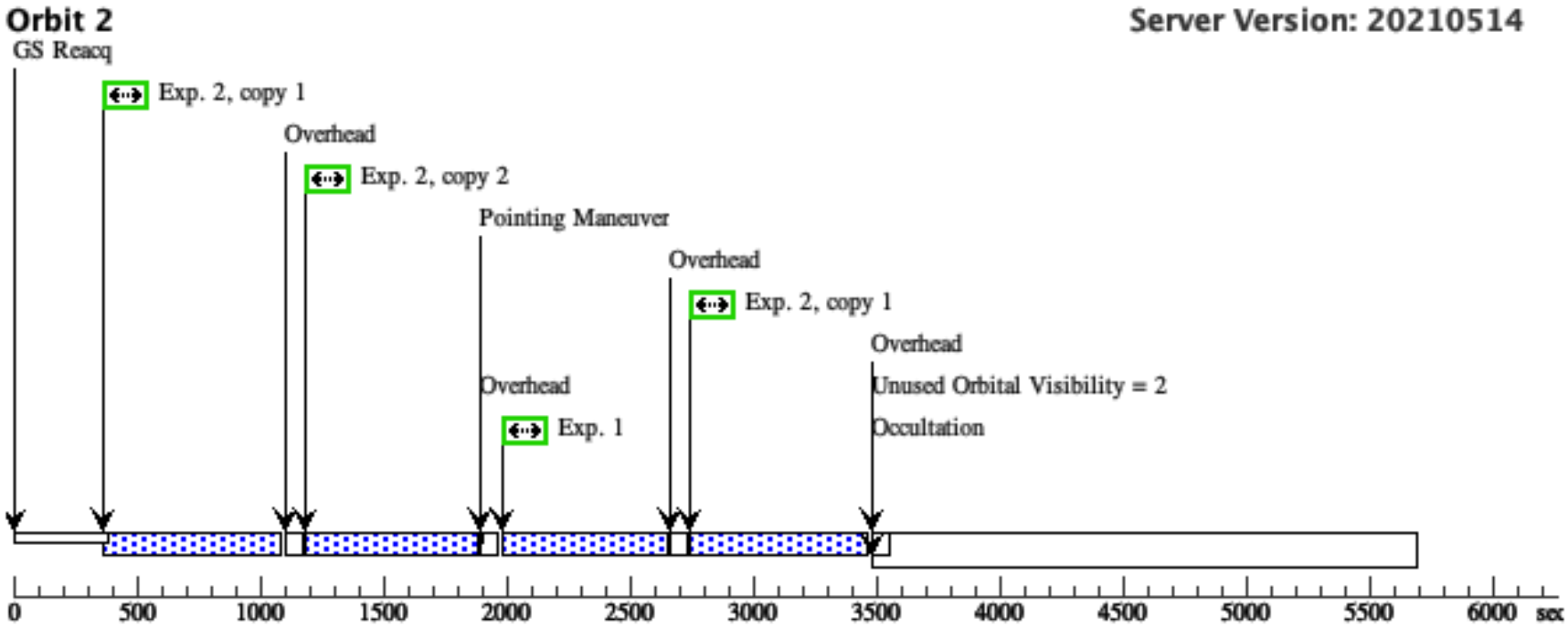
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[SUPERNOVA]

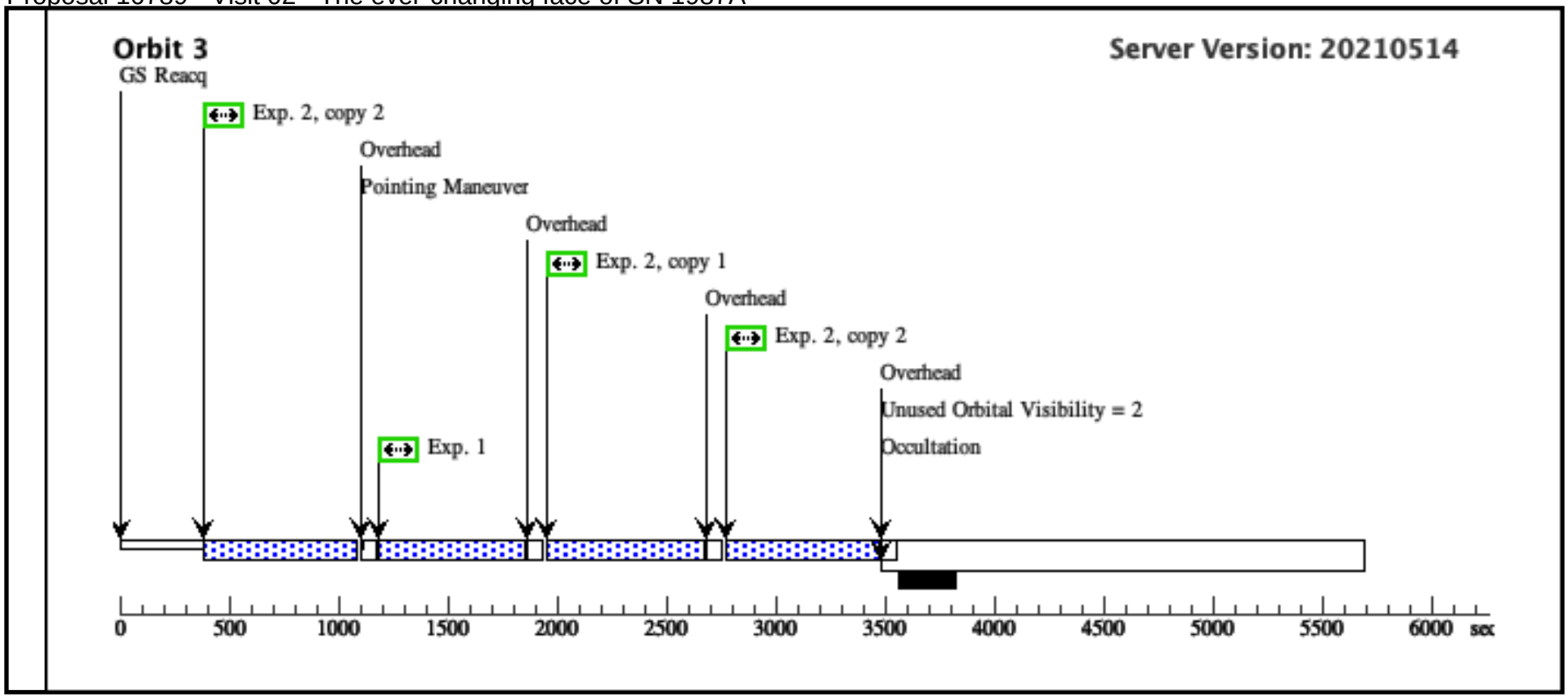
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F657N	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 02 (1)	650 Secs (2600 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	***[3]***
2		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 02 (1)	700 Secs X 2 (5600 Secs)	
								[==>(Pattern 1, Copy 1)]	***[1]***
								[==>(Pattern 1, Copy 2)]	
								[==>(Pattern 2, Copy 1)]	***[2]***
								[==>(Pattern 2, Copy 2)]	
								[==>(Pattern 3, Copy 1)]	
								[==>(Pattern 3, Copy 2)]	***[3]***
								[==>(Pattern 4, Copy 1)]	
								[==>(Pattern 4, Copy 2)]	

Orbit Structure




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


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

Visit

Proposal 16789, Visit 03, implementation Fri Sep 10 13:01:45 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 78D TO 82 D; ORIENT 168D TO 172 D; ORIENT 258D TO 262 D; ORIENT 348D TO 352 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1-2)

Fixed Targets

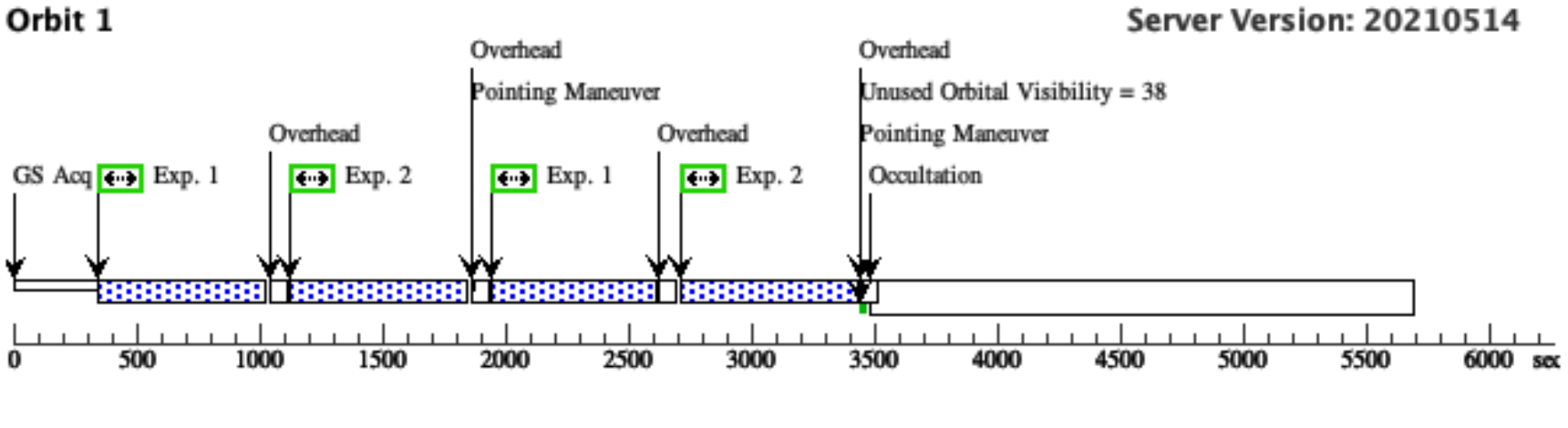
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-1987A	RA: 05 35 28.0200 (83.8667500d) Dec: -69 16 11.07 (-69.26974d) Equinox: J2000	Epoch of Position: 2015.5	V=22	Reference Frame: SIMBAD

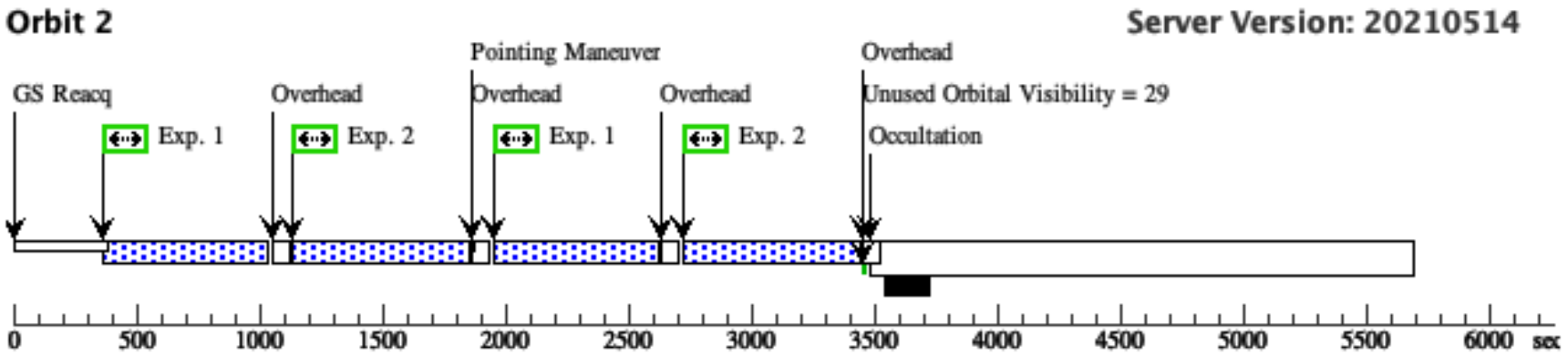
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 03 (1)	650 Secs (2600 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***
2		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F275W	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 03 (1)	700 Secs (2800 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 16789, Visit 04, implementation Fri Sep 10 13:01:45 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 78D TO 82 D; ORIENT 168D TO 172 D; ORIENT 258D TO 262 D; ORIENT 348D TO 352 D

Diagnostics

(Visit 04) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SN-1987A	RA: 05 35 28.0200 (83.8667500d) Dec: -69 16 11.07 (-69.26974d) Equinox: J2000	Epoch of Position: 2015.5	V=22	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 04 (1)	700 Secs (2800 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***
2		(1) SN-1987A	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	CR-SPLIT=NO; FLASH=18		Pattern 1, Exps 1-2 in Visit 04 (1)	700 Secs (2800 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure