



17738 - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supernovae

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
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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	(1) SN2021AHPL	WFC3/UVIS	1	11-Feb-2025 17:00:20.0	yes
02	(2) SN2022AAWB	WFC3/UVIS	1	11-Feb-2025 17:00:20.0	yes
03	(3) SN2022LXD	WFC3/UVIS	1	11-Feb-2025 17:00:21.0	yes
04	(4) SN2022NPQ	WFC3/UVIS	1	11-Feb-2025 17:00:21.0	yes
05	(5) SN2022XGC	WFC3/UVIS	1	11-Feb-2025 17:00:22.0	yes
06	(6) SN2023AAFk	WFC3/UVIS	1	11-Feb-2025 17:00:22.0	yes
07	(7) SN2023CMX	WFC3/UVIS	1	11-Feb-2025 17:00:22.0	yes
08	(8) SN2023OUS	WFC3/UVIS	1	11-Feb-2025 17:00:23.0	yes
09	(9) SN2016EAY	ACS/WFC	1	11-Feb-2025 17:00:23.0	yes

9 Total Orbits Used

ABSTRACT

Since the discovery of hydrogen-poor superluminous supernovae (SLSNe) over a decade ago, research has focused on identifying the source of their enormous luminosities that can reach up to a hundred times brighter than normal supernovae. Early on, it was realized that the standard radioactive decay model that powers normal supernovae is unable to explain these events. Since then, light curve modeling of large samples, spectral modeling of both early and late-time nebular spectra, and analyses of their dwarf host galaxies have pointed towards a scenario in which the spin-down of a newly-formed magnetar central engine provides energy that is thermalized in the SN ejecta and radiated in the UV/optical. Perhaps the best evidence in favor of this model are the recent HST observations of two events at 400-1100 days after peak that match the power-law decline predicted by magnetar energy input. These observations strongly motivate new observations of a large and diverse sample to measure the distribution of power-law slopes and assess whether the diversity evident in the early light curves of SLSNe correlates with diversity at late times. We therefore propose to observe 8 new SLSNe each at three epochs spread across Cycles 32, 33, and 34 (plus one template observation of an old event). As the late-time optical light curve is highly sensitive to the thermalization of the magnetar's energy, a key goal is to compare our observations with recent radiative transfer simulations to infer properties of the magnetar wind nebulae, the region where the magnetar's energy is transferred to the ejecta. This will be the most comprehensive test to date of the magnetar model for SLSNe.

OBSERVING DESCRIPTION

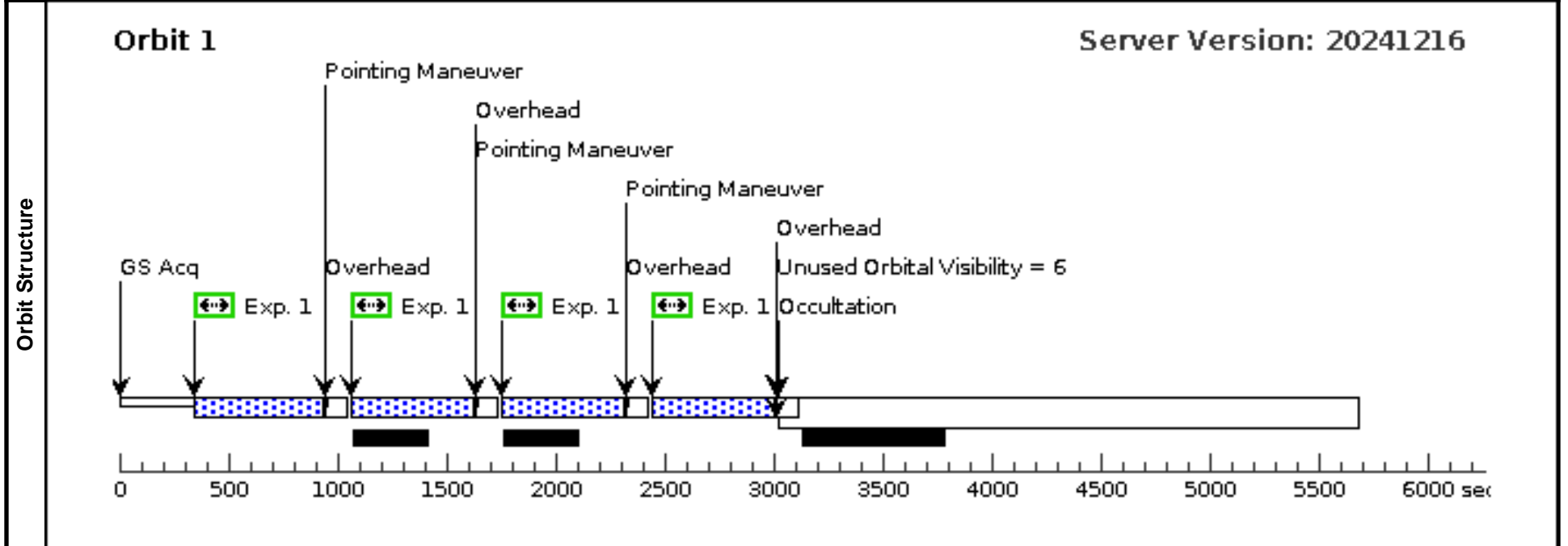
In Cycle 32 we will observe 9 superluminous supernovae one time each in a single filter, 8 with WFC3/UVIS and one with ACS/WFC. Each visit will consist of a dithered observation (standard ACS or WFC3 dither pattern) in one filter lasting one orbit. We will observe 8 of these supernovae two additional times, once in Cycle 33 and a final epoch in Cycle 34.

Visit	Proposal 17738, SN2021ahpl Epoch 1 (01), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)		

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(2)	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)

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	SN2021AHPL	RA: 15 15 57.9400 (228.9914167d) Dec: -19 17 31.96 (-19.29221d) Equinox: J2000		V=26.0	Reference Frame: ICRS
	<i>Comments:</i> 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) SN2021AHPL	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F625W	FLASH=2.0		Pattern 2, Exps 1-1 in SN2021ahpl Epoch 1 (01) (2)	559 Secs (2236 Secs)	
									[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]



Proposal 17738 - SN2022aawb Epoch 1 (02) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Sup...

Tue Feb 11 22:00:23 GMT 2025

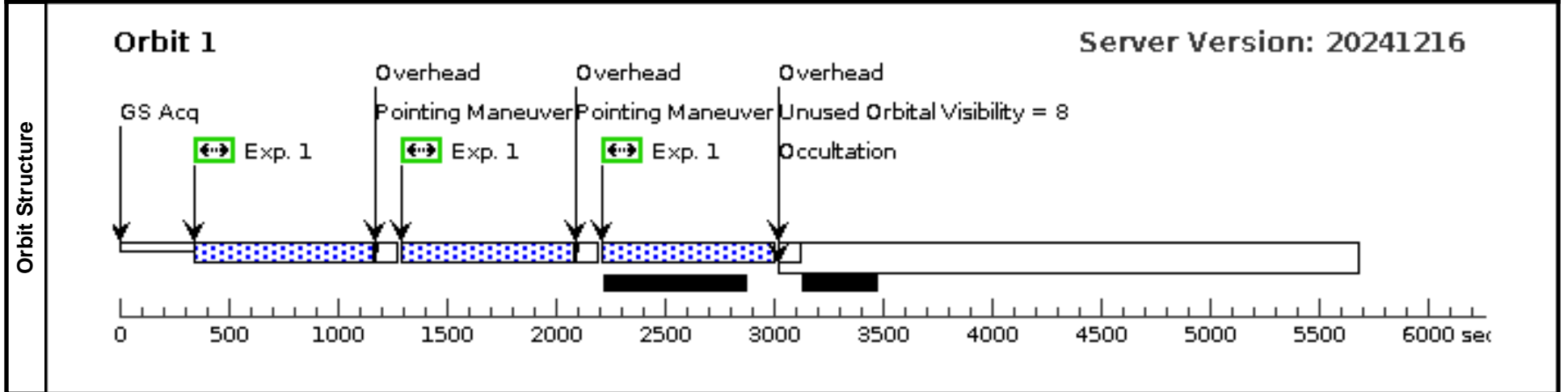
Visit	Proposal 17738, SN2022aawb Epoch 1 (02), implementation		
	Diagnostic Status: No Diagnostics		
	Scientific Instruments: WFC3/UVIS		
	Special Requirements: (none)		

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	

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(2)	SN2022AAWB	RA: 01 44 52.3800 (26.2182500d) Dec: +23 00 43.85 (23.01218d) Equinox: J2000		V=26.0	Reference Frame: ICRS

Comments:
 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	(2) SN2022AAWB	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0			Pattern 3, Exps 1-1 in SN2022aawb Epoch 1 (02) (3)	790 Secs (2370 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[1]



Proposal 17738 - SN2022lxd Epoch 1 (03) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Tue Feb 11 22:00:24 GMT 2025

Visit	Proposal 17738, SN2022lxd Epoch 1 (03), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Patterns	# (3)	Primary Pattern Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Secondary Pattern Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	Exposures (1)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SN2022LXD	RA: 17 36 38.6830 (264.1611792d) Dec: +61 33 18.66 (61.55518d) Equinox: J2000		V=26.0	Reference Frame: ICRS				
	Comments: 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	(3) SN2022LXD		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F850LP	FLASH=10.0		Pattern 3, Exps 1-1 i n SN2022lxd Epoch 1 (03) (3)	820 Secs (2460 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
Orbit Structure	<div style="display: flex; justify-content: space-between;"> Orbit 1 Server Version: 20241216 </div> <p>The diagram shows a timeline for Orbit 1 from 0 to 6000 seconds. Key events include: GS Acq at ~200s, three exposures (Exp. 1) at ~400s, ~1300s, and ~2200s, each preceded by an Overhead period and a Pointing Maneuver. An Occultation period occurs between ~3100s and ~3500s. A blue checkered bar at the bottom indicates orbital visibility from ~400s to ~5700s. The text 'Unused Orbital Visibility = 1' is present near the occultation.</p>									

Proposal 17738 - SN2022npq Epoch 1 (04) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Tue Feb 11 22:00:24 GMT 2025

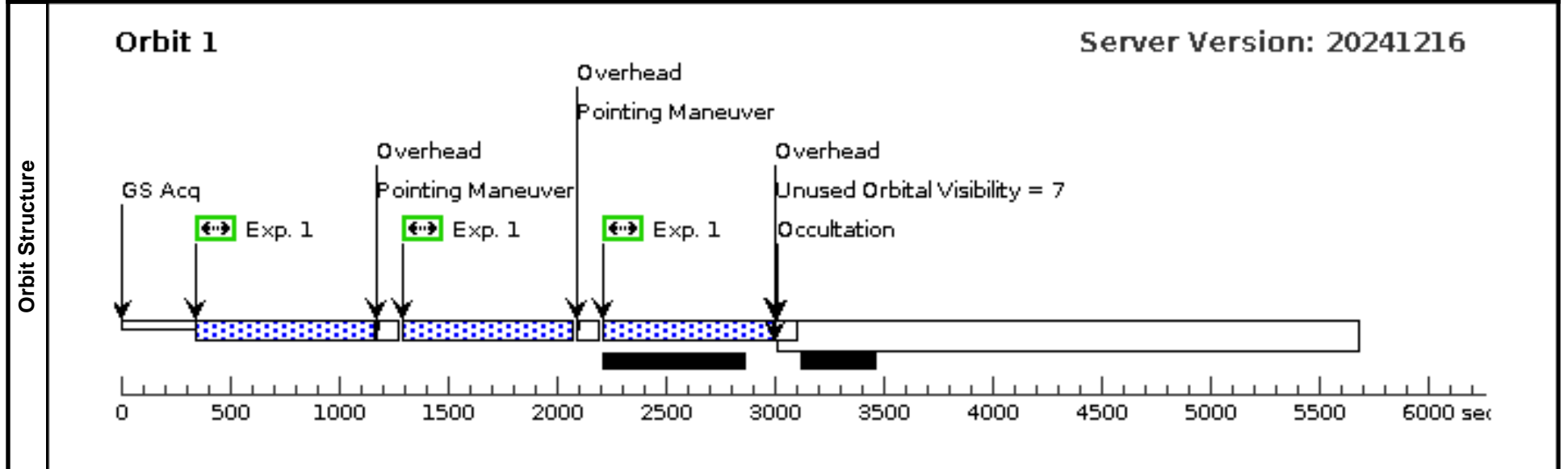
Visit	Proposal 17738, SN2022npq Epoch 1 (04), implementation		
	Diagnostic Status: No Diagnostics		
	Scientific Instruments: WFC3/UVIS		
	Special Requirements: (none)		

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	

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(4)	SN2022NPQ	RA: 16 21 3.7320 (245.2655500d) Dec: +14 50 54.75 (14.84854d) Equinox: J2000		V=26.0	Reference Frame: ICRS

Comments:
 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		(4) SN2022NPQ	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0		Pattern 3, Exps 1-1 i n SN2022npq Epoch 1 (04) (3)	786 Secs (2358 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]



Proposal 17738 - SN2022xgc Epoch 1 (05) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Tue Feb 11 22:00:24 GMT 2025

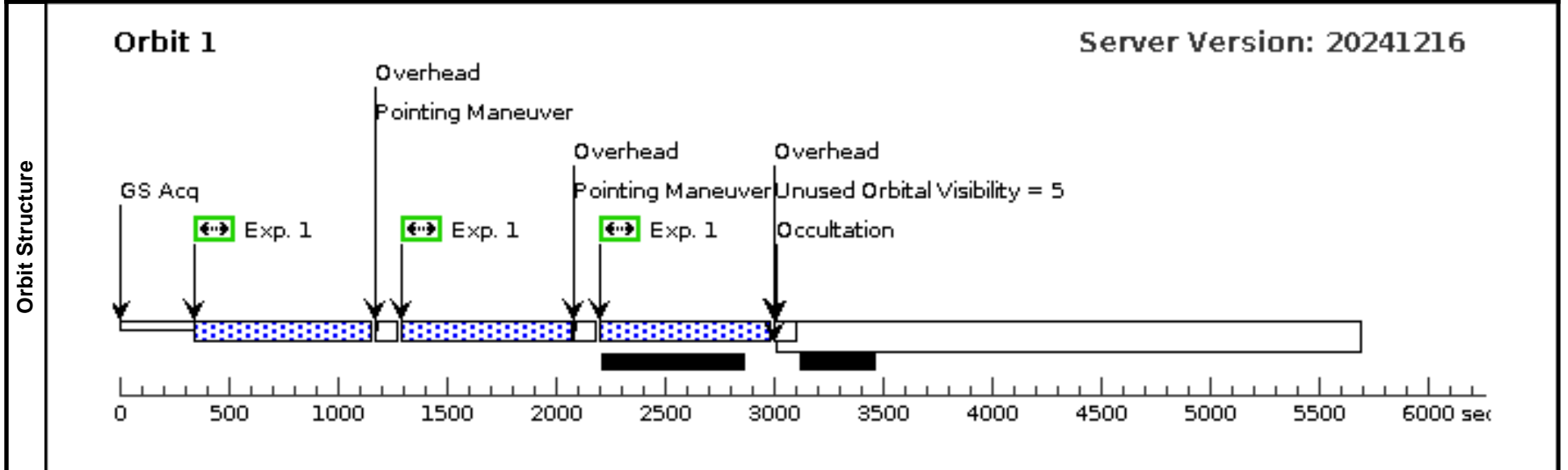
Visit	Proposal 17738, SN2022xgc Epoch 1 (05), implementation		
	Diagnostic Status: No Diagnostics		
	Scientific Instruments: WFC3/UVIS		
	Special Requirements: (none)		

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	

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(5)	SN2022XGC	RA: 07 12 41.8100 (108.1742083d) Dec: +07 18 59.95 (7.31665d) Equinox: J2000		V=26.0	Reference Frame: ICRS

Comments:
 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	(5) SN2022XGC	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0			Pattern 3, Exps 1-1 i n SN2022xgc Epoch 1 (05) (3)	785 Secs (2355 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]



Proposal 17738 - SN2023aafk Epoch 1 (06) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supe...

Tue Feb 11 22:00:24 GMT 2025

Visit	Proposal 17738, SN2023aafk Epoch 1 (06), implementation Diagnostic Status: No Diagnostics Scientific Instruments: 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)					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(6)	SN2023AAFK	RA: 04 30 41.6710 (67.6736292d) Dec: +02 56 42.89 (2.94525d) Equinox: J2000		V=26.0	Reference Frame: ICRS				
	Comments: 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	(6) SN2023AAFK		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0		Pattern 3, Exps 1-1 i n SN2023aafk Epoch 1 (06) (3)	784 Secs (2352 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[1]
Orbit Structure	Orbit 1 Server Version: 20241216									
	<p>The diagram illustrates the orbital structure for Orbit 1, spanning from 0 to 6000 seconds. Key events and intervals are marked:</p> <ul style="list-style-type: none"> GS Acq: Occurs at approximately 300 seconds. Exp. 1: Three exposures are shown as green boxes with double-headed arrows, occurring at approximately 400, 1300, and 2100 seconds. Overhead: Intervals between exposures and before/after the final exposure. Pointing Maneuver: Intervals between exposures. Unused Orbital Visibility = 3: A shaded region from approximately 3000 to 5700 seconds, labeled as 'Occultation'. 									

Proposal 17738 - SN2023cmx Epoch 1 (07) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supe...

Tue Feb 11 22:00:24 GMT 2025

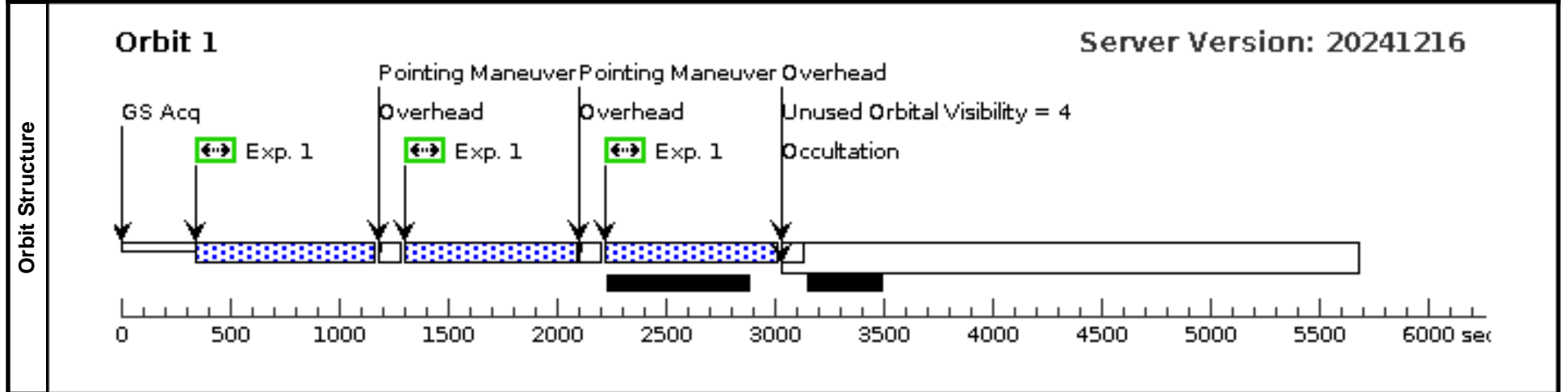
Visit	Proposal 17738, SN2023cmx Epoch 1 (07), implementation		
	Diagnostic Status: No Diagnostics		
	Scientific Instruments: WFC3/UVIS		
	Special Requirements: (none)		

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	

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(7)	SN2023CMX	RA: 07 06 54.6500 (106.7277083d) Dec: +37 58 35.54 (37.97654d) Equinox: J2000		V=26.0	Reference Frame: ICRS

Comments:
 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		(7) SN2023CMX	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0		Pattern 3, Exps 1-1 i n SN2023cmx Epoch 1 (07) (3)	795 Secs (2385 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]



Proposal 17738 - SN2023ous Epoch 1 (08) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Tue Feb 11 22:00:24 GMT 2025

Visit	Proposal 17738, SN2023ous Epoch 1 (08), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)						
	Patterns	# (3) Primary Pattern 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	Secondary Pattern	Exposures (1)		
Fixed Targets	# (8)	Name SN2023OUS	Target Coordinates RA: 04 25 50.1000 (66.4587500d) Dec: -09 09 28.08 (-9.15780d) Equinox: J2000	Targ. Coord. Corrections Fluxes V=26.0	Miscellaneous Reference Frame: ICRS		
Exposures	# 1	Label (8) SN2023OUS	Config,Mode,Aperture WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	Spectral Els. F775W Opt. Params. FLASH=2.0	Special Reqs. Groups Pattern 3, Exps 1-1 i n SN2023ous Epoch 1 (08) (3)	Exp. Time (Total)/[Actual Dur.] 785 Secs (2355 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	Orbit [1]
Orbit Structure	<div style="display: flex; justify-content: space-between;"> Orbit 1 Server Version: 20241216 </div> <p>The diagram illustrates the orbit structure over a 6000-second period. It shows the sequence of operations: GS Acq, followed by three exposure cycles (each with overhead and pointing maneuver), and finally an occultation. A significant portion of the orbit (from ~300s to ~5700s) is marked as 'Unused Orbital Visibility = 5'.</p>						

Visit	Proposal 17738, SN2016eay template (09), scheduled Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)		
	#	Primary Pattern	Secondary Pattern
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2637 Line Spacing=0.1856	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false
			Exposures

Patterns	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(9)	SN2016EAY	RA: 12 02 51.7000 (180.7154167d) Dec: +44 15 27.40 (44.25761d) Equinox: J2000		V=26.0	Reference Frame: ICRS

Comments:
 Category=EXT-STAR
 Description=[SUPERNOVA]

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(9) SN2016EAY	ACS/WFC, ACCUM, WFC1	F625W				Pattern 1, Exps 1-1 in SN2016eay template (09) (1)	470 Secs (1972 Secs) [==>493.0 Secs (Pattern 1)] [==>493.0 Secs (Pattern 2)] [==>493.0 Secs (Pattern 3)] [==>493.0 Secs (Pattern 4)]	[1]

