17533 - Identifying a New Source of r-Process Nucleosynthesis with HST

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Jillian Rastinejad (PI) (Contact)	**University of Maryland**
Dr. Wen-fai Fong (CoI)	Northwestern University
Prof. Andrew James Levan (CoI) (ESA Member)	Radboud University Nijmegen
Prof. Nial Rahil Tanvir (CoI) (ESA Member)	University of Leicester
Dr. Peter Blanchard (CoI)	Harvard University
Prof. Ashley Villar (CoI)	Harvard University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
05	(3) 250108A	WFC3/UVIS	2	08-Sep-2025 10:00:14.0	yes
06	(3) 250108A	WFC3/IR	2	08-Sep-2025 10:00:15.0	yes
07	(3) 250108A	WFC3/UVIS	2	08-Sep-2025 10:00:15.0	yes
08	(3) 250108A	WFC3/IR	2	08-Sep-2025 10:00:16.0	yes

8 Total Orbits Used

ABSTRACT

The origin of the Universe's heavy r-process elements is a fundamental issue which affects chemical enrichment across cosmic time and the development of complex life. It is now confirmed that neutron star mergers are responsible for at least some of the r-process budget, but there is gaining observational and theoretical support for an additional and faster production channel: the core-collapse of rapidly-rotating, massive stars. In

particular, energetic supernovae with associated long-duration gamma-ray bursts (GRB-SNe) are the strongest candidates for a fast channel. Here, their massive neutronized accretion disks mix with the outer, Ni-dominated ejecta producing dramatic reddening at late times (~50-200 days). Even for the most nearby events, HST is necessary to detect the SN at these epochs when the color of an r-process enriched SN will be distinguishable from an event with no r-process, especially against the background light of a star-forming host galaxy. Yet, as these GRB-SNe r-process models gain traction, no tailored observations with the relevant sensitivity or wavelength coverage exist. We propose a first-of-its-kind study to monitor the late-time evolution of one nearby ($z<0.3$) GRB-SN as a crucial test of current models. We will obtain 12 HST orbits over 5 epochs in F606W and F160W. The detection of r-process nucleosynthesis in a GRB-SN would be transformative for our understanding of when and where heavy elements enter galaxies like our Milky Way. Given both the long time baseline and rarity of neary LGRBs, we request long-term and carry-over status.

OBSERVING DESCRIPTION

This is a non-disruptive target-of-opportunity proposal with long-term and carry-over status. This proposal is for 12 orbits (8 orbits awarded in Cycle 31, 4 in Cycle 32) of HST imaging of a nearby GRB supernova (SN), a promising but untested site to observe the formation of elements via rapid neutron capture (r-process) nucleosynthesis. These observations will observe the SN's color evolution by observing contemporaneously in one optical (F606W) filter and one near-IR (F160W) filter over ~50 - 600 days following the GRB, when ground-based telescopes are no longer sensitive to the SN's expected brightness. Observations will be obtained across 5 visits, with the first 4 visits consisting of one orbit each of WFC3/UVIS F606W and WFC3/IR F160W imaging. The final visit will be 2 orbits in each filter in order to provide a deep template for image subtraction with earlier epochs, intended to remove host galaxy light contamination.

Visit

Proposal 17533, F606W visit 05 (05), implementation Mon Sep 08 14:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-NOV-2025:00:00:00 AND 25-NOV-2025:00:00:00; TOO RESPONSE TIME 15.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	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

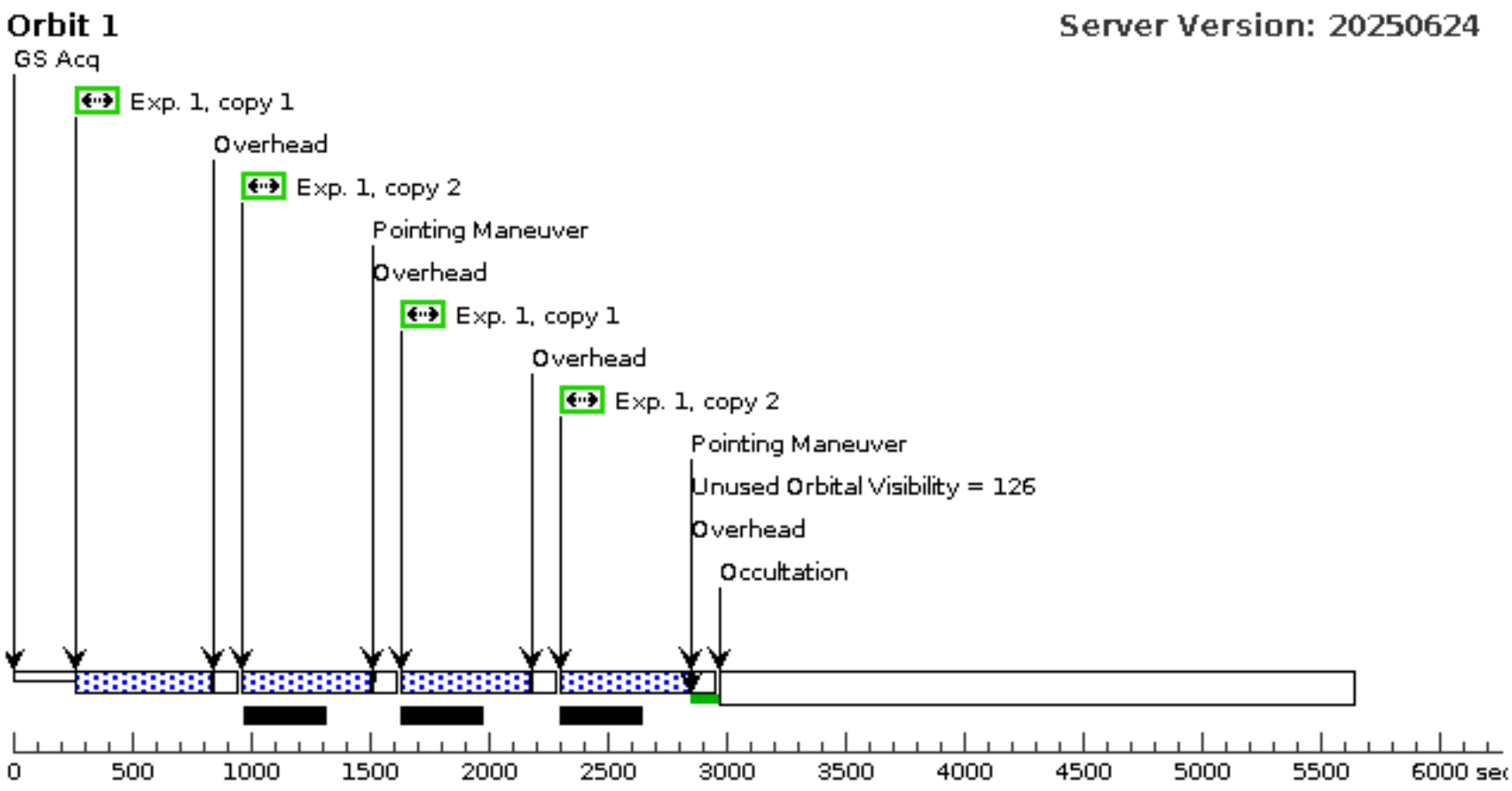
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	250108A	RA: 03 42 28.3900 (55.6182917d) Dec: -22 30 21.20 (-22.50589d) Equinox: J2000		V=27+/-0.5	Reference Frame: ICRS

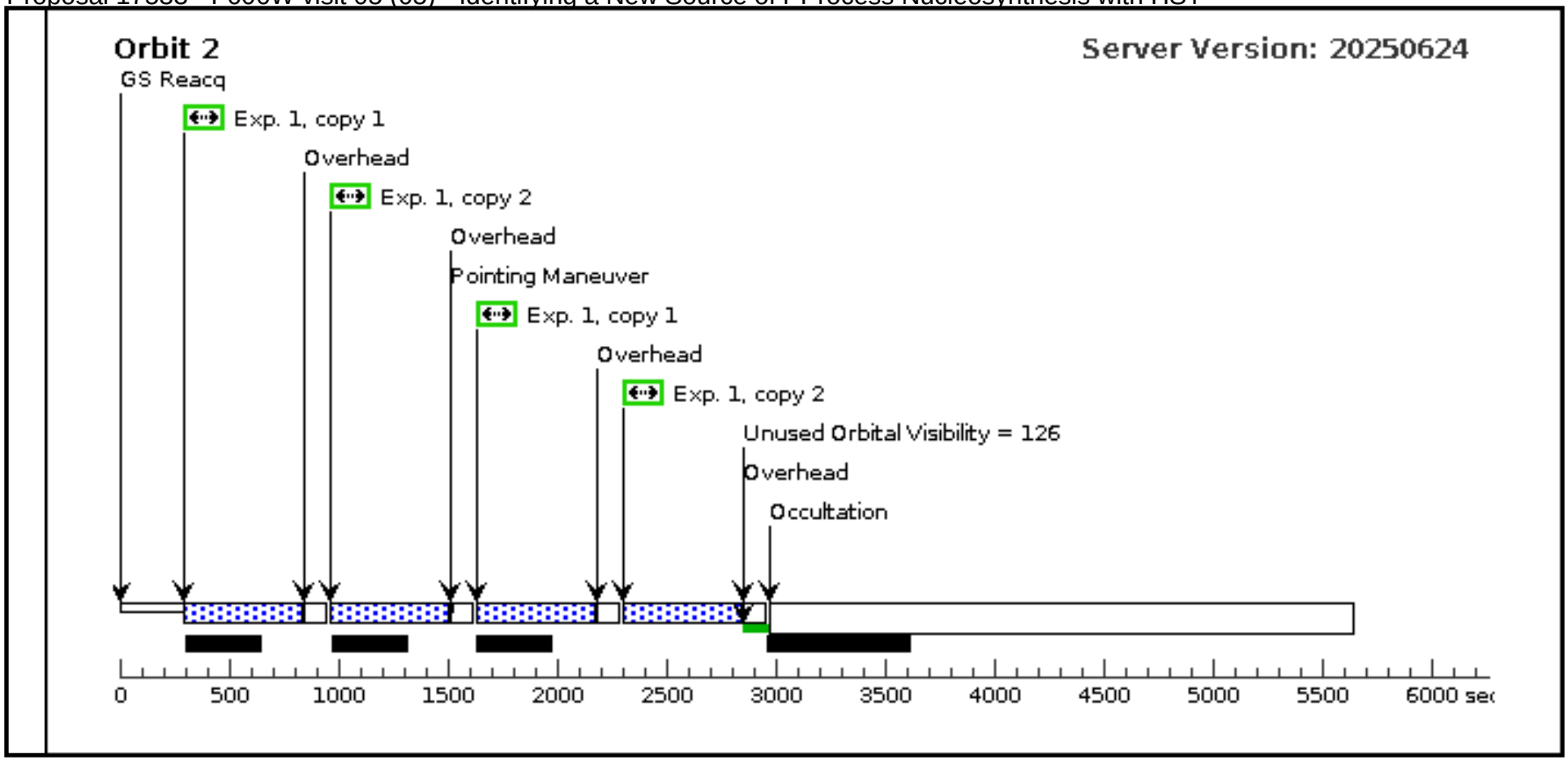
Comments: Expected magnitude based on supernova modeling. We have not been able to get ground-based imaging since March due to Sun constraint.
Category=STAR
Description=[GAMMA RAY BURSTER, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) 250108A	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG -65,-65; GS ACQ SCENARIO ONEB1O3	Pattern 3, Exps 1-1 in F606W visit 05 (05) (3)	540 Secs X 2 (4320 Secs)	
								[==>(Pattern 1, Copy 1)]	***[1]***
								[==>(Pattern 1, Copy 2)]	
								[==>(Pattern 2, Copy 1)]	
								[==>(Pattern 2, Copy 2)]	
								[==>(Pattern 3, Copy 1)]	***[2]***
								[==>(Pattern 3, Copy 2)]	
								[==>(Pattern 4, Copy 1)]	
								[==>(Pattern 4, Copy 2)]	

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 1, copy 1
Overhead
Exp. 1, copy 2
Overhead
Pointing Maneuver
Exp. 1, copy 1
Overhead
Exp. 1, copy 2
Unused Orbital Visibility = 126
Overhead
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17533, F160W visit 06 (06), implementation Mon Sep 08 14:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: AFTER 05 BY 0 D TO 3 D; TOO RESPONSE TIME 15.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

Fixed Targets

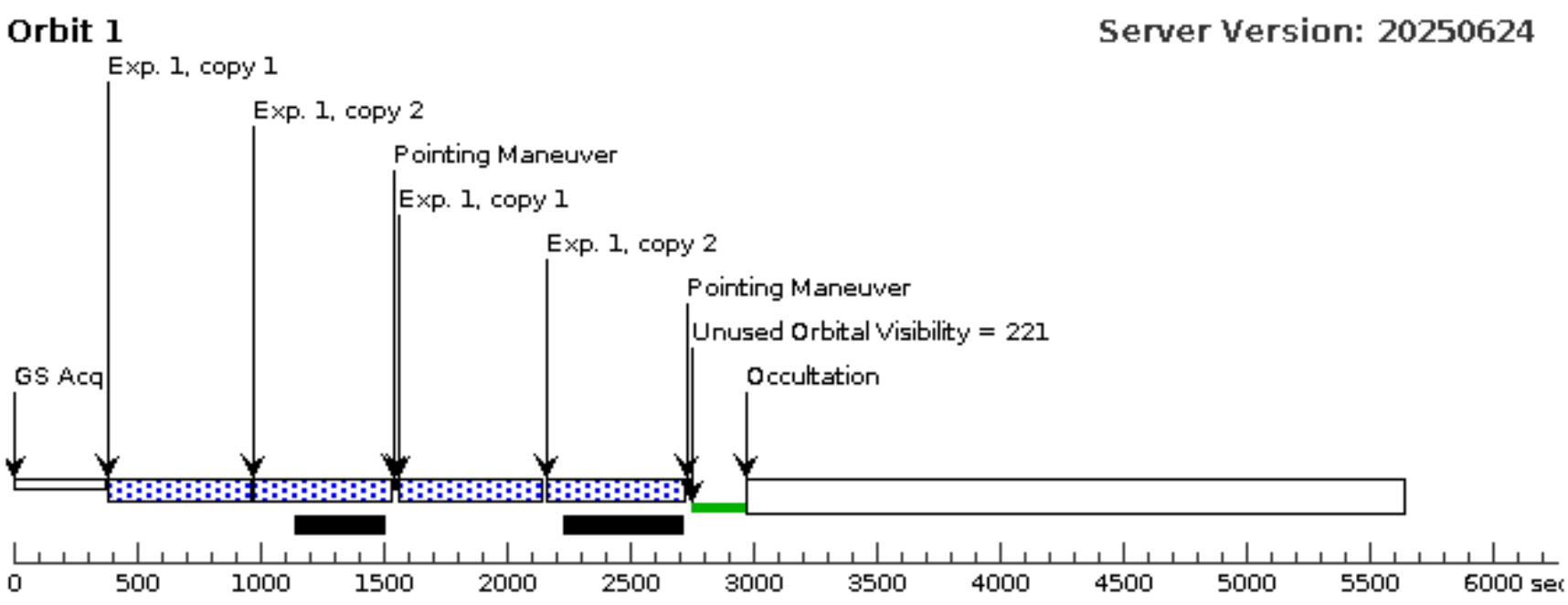
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	250108A	RA: 03 42 28.3900 (55.6182917d) Dec: -22 30 21.20 (-22.50589d) Equinox: J2000		V=27+/-0.5	Reference Frame: ICRS

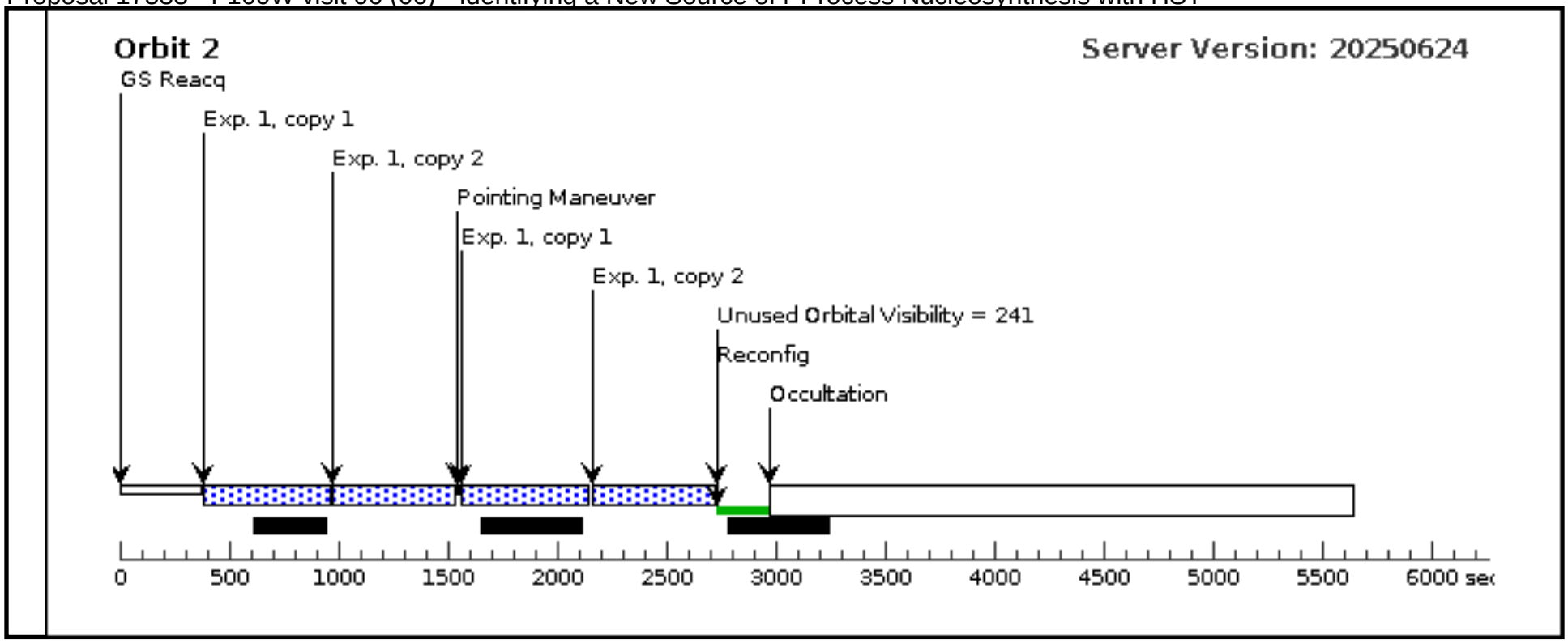
Comments: Expected magnitude based on supernova modeling. We have not been able to get ground-based imaging since March due to Sun constraint.
Category=STAR
Description=[GAMMA RAY BURSTER, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) 250108A	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=12; SAMP-SEQ=SPARS50	POS TARG 40,35	Pattern 1, Exps 1-1 in F160W visit 06 (06) (1)	552.937252 Secs X 2 (4423.498 Secs)	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[1]***
								[==>(Pattern 3, Copy 1)] *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 1, copy 1
Exp. 1, copy 2
Pointing Maneuver
Exp. 1, copy 1
Exp. 1, copy 2
Unused Orbital Visibility = 241
Reconfig
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17533, F606W visit 07 (07), implementation Mon Sep 08 14:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-APR-2026:00:00:00 AND 31-AUG-2026:00:00:00; TOO RESPONSE TIME 15.0D

Comments: Deep template observations for image subtraction

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	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

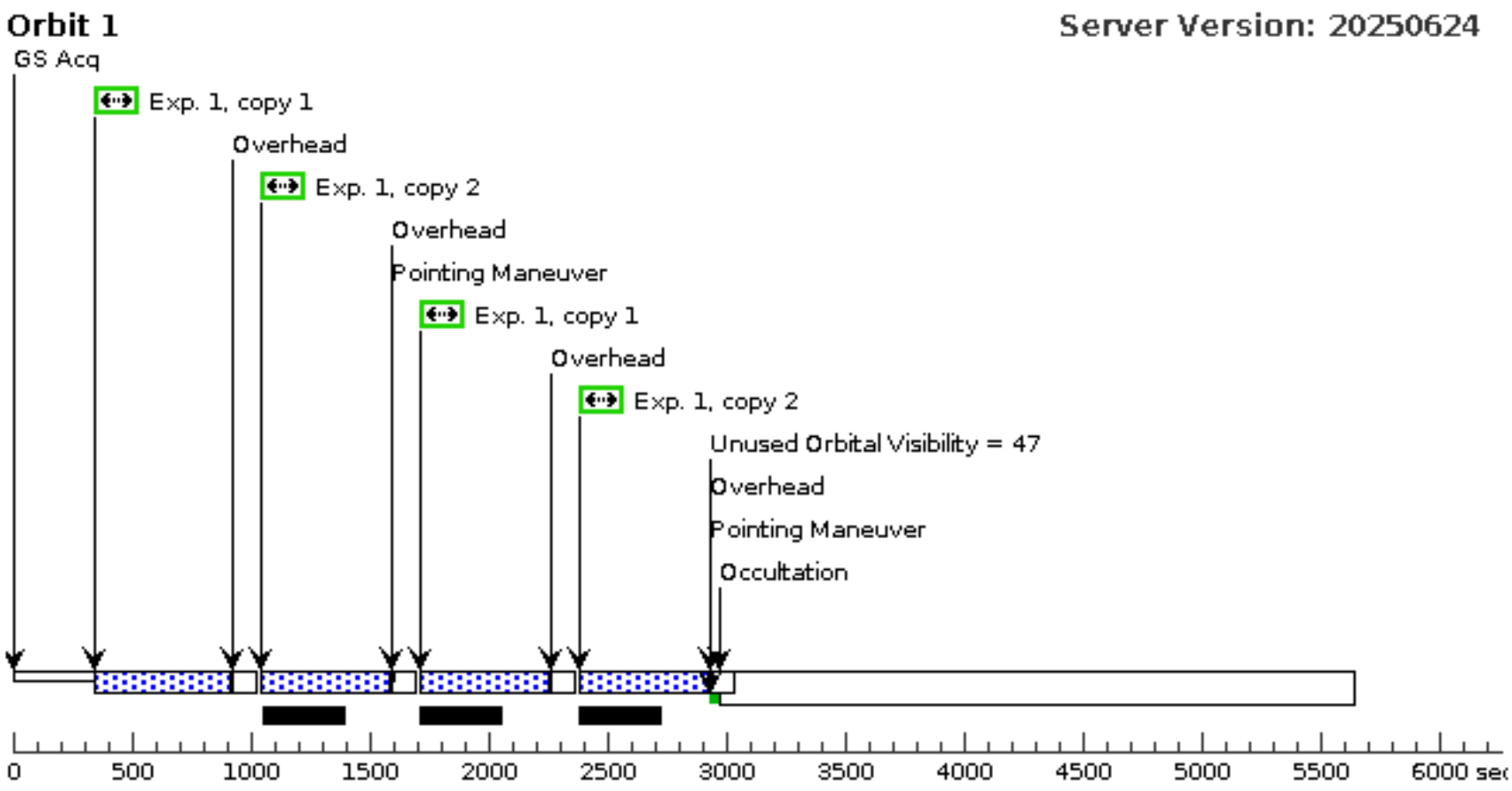
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	250108A	RA: 03 42 28.3900 (55.6182917d) Dec: -22 30 21.20 (-22.50589d) Equinox: J2000		V=27+/-0.5	Reference Frame: ICRS

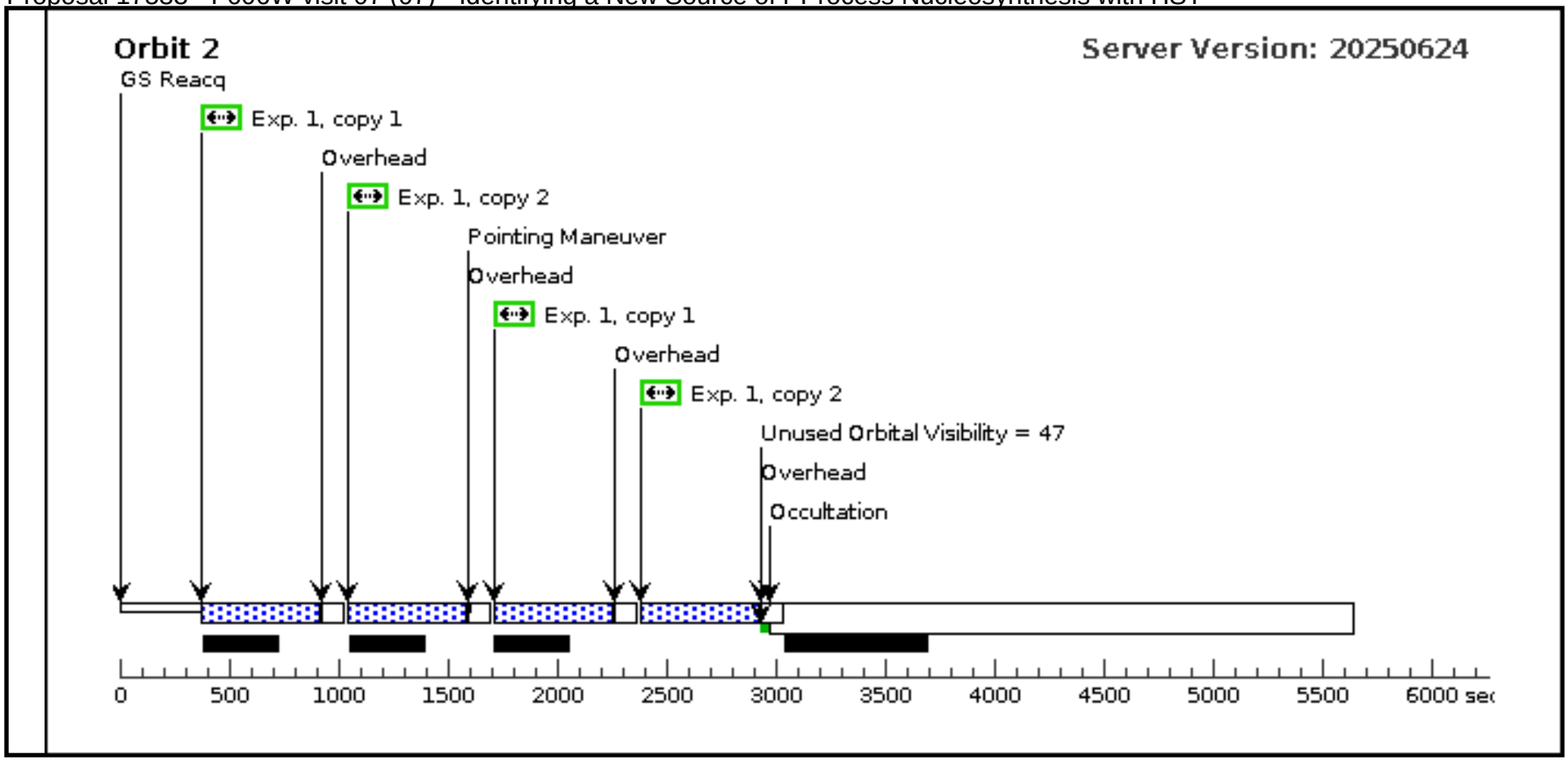
Comments: Expected magnitude based on supernova modeling. We have not been able to get ground-based imaging since March due to Sun constraint.
Category=STAR
Description=[GAMMA RAY BURSTER, SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) 250108A	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W		POS TARG -65,-65	Pattern 3, Exps 1-1 in F606W visit 07 (07) (3)	540 Secs X 2 (4320 Secs)	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[1]***
								[==>(Pattern 3, Copy 1)] *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 1, copy 1
Overhead
Exp. 1, copy 2
Pointing Maneuver
Overhead
Exp. 1, copy 1
Overhead
Exp. 1, copy 2
Unused Orbital Visibility = 47
Overhead
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17533, F160W visit 08 (08), implementation Mon Sep 08 14:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: AFTER_07 BY 0 D TO 31 D; TOO RESPONSE TIME 15.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

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Exposures

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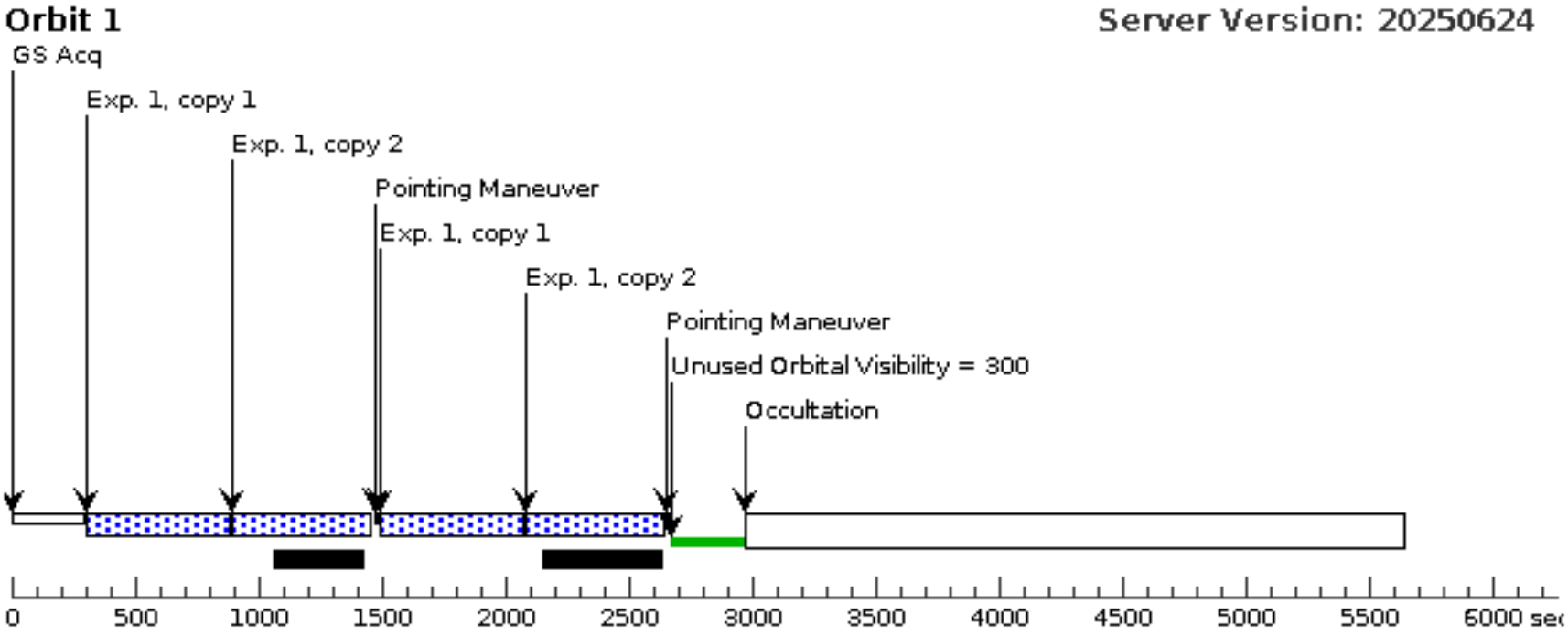
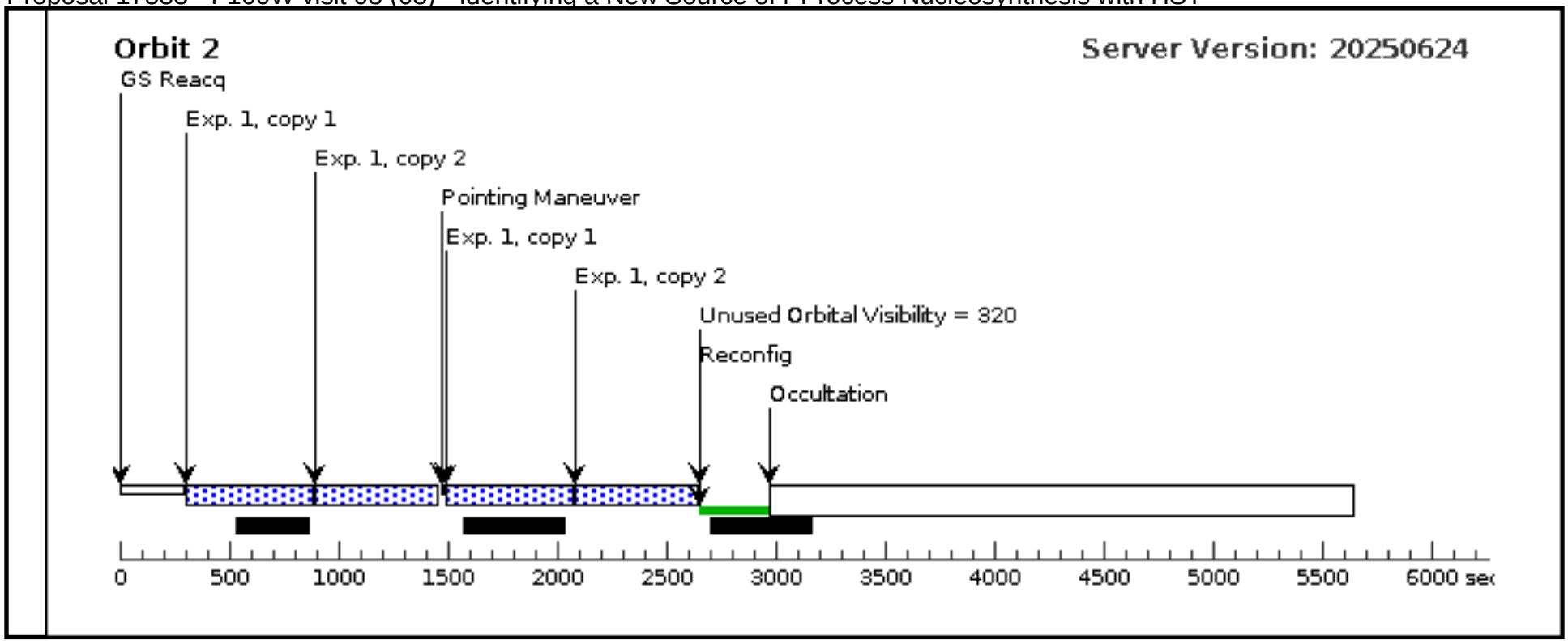
1		(3) 250108A	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=12; SAMP-SEQ=SPARS50	POS TARG 40,35; GS ACQ SCENARIO ONEB1O3	Pattern 1, Exps 1-1 in F160W visit 08 (08) (1)	552.937252 Secs X 2 (4423.498 Secs)	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[1]***
								[==>(Pattern 3, Copy 1)] *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 1, copy 1
Exp. 1, copy 2
Pointing Maneuver
Exp. 1, copy 1
Exp. 1, copy 2
Unused Orbital Visibility = 320
Reconfig
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec