18128 - Search for an Intermediate-Mass Black Hole in Globular Cluster 47 Tuc

Cycle: 33, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Dana Ioana Casetti (PI) (Contact)	**Southern Connecticut State University**
Dr. Terrence M. Girard (CoI)	Southern Connecticut State University
Dr. Roberto Baena-Galle (CoI) (ESA Member)	International University of La Rioja
Dr. Holger Baumgardt (CoI)	University of Queensland
Ms. Arshia Anjum (CoI)	University of Queensland

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC-104	WFC3/UVIS	3	13-Nov-2025 08:00:14.0	yes
02	(1) NGC-104	WFC3/UVIS	3	13-Nov-2025 08:00:15.0	yes

6 Total Orbits Used

ABSTRACT

Intermediate-Mass Black Holes (IMBHs), with masses between ~100 and 100,000 solar masses, are expected to exist at the cores of Globular Clusters (GCs), but their existence has yet to be decisively confirmed observationally. Predictions suggest the influence of an IMBH would be limited to the central few arcsec of the GC core, an observationally challenging environment. It is here proposed to obtain highly precise proper motions at the core of 47 Tuc (NGC 104) in an effort to detect an IMBH. Existing archival WFPC2 observations for this cluster provide ideal first-epoch material that, when combined with the proposed new WFC3 observations, will provide an unprecedented 26-yr baseline for space-based, stellar proper motions. The expected relative proper-motion uncertainties will be on the order of 4 to 10 microarcsec/yr. The presence of an IMBH

will be made via the detection of fast-moving stars at the GC center, i.e., orbital motion that would otherwise exceed the GC's escape velocity in the absence of an IMBH, along with detailed fitting of the observed velocity-dispersion profile with a theoretical mass-distribution model.

OBSERVING DESCRIPTION

Second-epoch WFC3-UVIS images of the core of 47 Tuc (NGC 104) for relative proper-motion analysis.

Observations consist of F555W and F814W paired exposures, dithered as:
15 UVIS 2K-subarray pointings (8pt dither + 0.2" Y-offset 7pt dither, as recommended in ISR WFC3 2020-07), and
6 UVIS full-frame pointings (6-pt dither, as recommended in ISR WFC3 2020-07).

All exposures are 220-sec duration, with 12-electron FLASH.

Cluster center is roughly positioned (via POSTARGs) at geometric center of UVIS 2K-subarray C, in all exposures.

These exposures are split between two 3-orbit visits with a SAME-ORI-AS linkage.

Visit

Proposal 18128, Visit 01, implementation

Thu Nov 13 13:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-104	RA: 00 24 5.3590 (6.0223292d) Dec: -72 04 53.20 (-72.08144d) Equinox: J2000	Proper Motion RA: 5.25 mas/yr Proper Motion Dec: -2.529999915168446 mas/yr Parallax: 2.32E-4" Epoch of Position: 2000	V=4.09	Reference Frame: ICRS

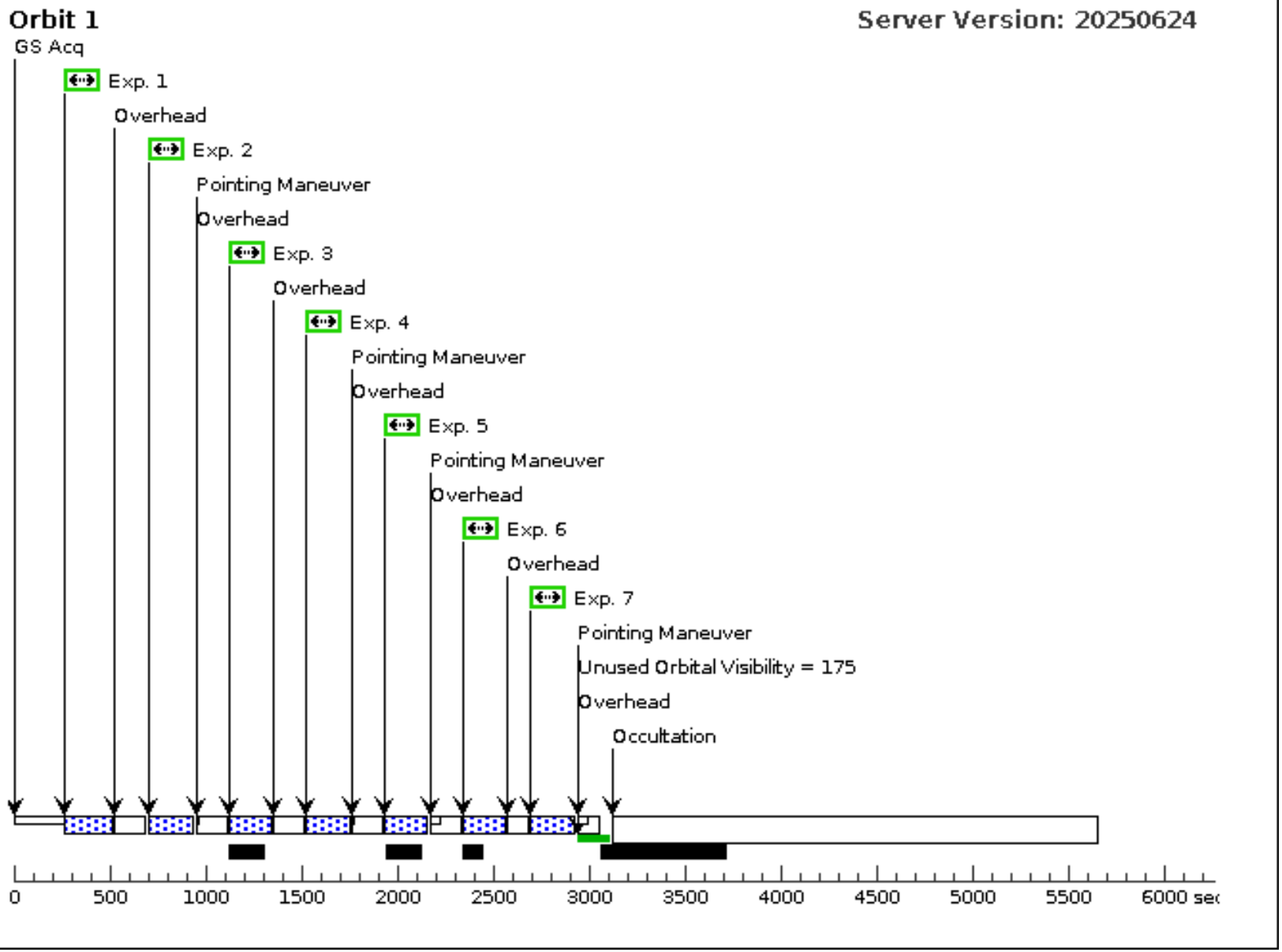
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

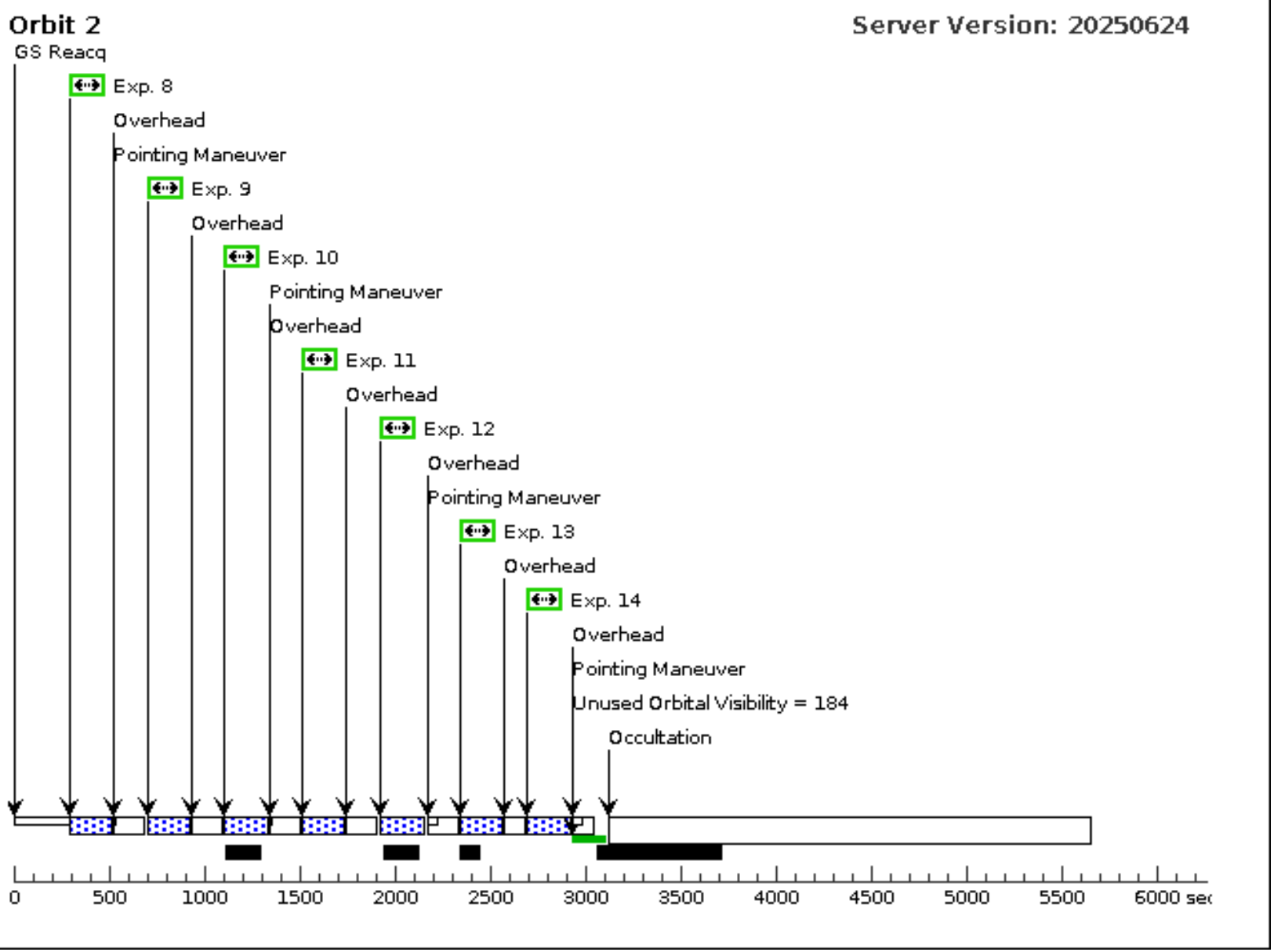
SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.
Category=STELLAR CLUSTER
Description=[GLOBULAR CLUSTER]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.4,8.7; GS ACQ SCENARIO ONEB1O3		220 Secs (220 Secs) *[==>]*	*[1]*
2		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.4,8.7		220 Secs (220 Secs) *[==>]*	*[1]*
3		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.4894,9.0341		220 Secs (220 Secs) *[==>]*	*[1]*
4		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.4894,9.0341		220 Secs (220 Secs) *[==>]*	*[1]*
5		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.5785,8.8908		220 Secs (220 Secs) *[==>]*	*[1]*
6		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 39.9,33.1		220 Secs (220 Secs) *[==>]*	*[1]*
7		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 39.9,33.1		220 Secs (220 Secs) *[==>]*	*[1]*
8		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.5785,8.8908		220 Secs (220 Secs) *[==>]*	*[2]*
9		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.6679,9.2249		220 Secs (220 Secs) *[==>]*	*[2]*
10		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.6679,9.2249		220 Secs (220 Secs) *[==>]*	*[2]*
11		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.7173,9.0591		220 Secs (220 Secs) *[==>]*	*[2]*
12		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.7173,9.0591		220 Secs (220 Secs) *[==>]*	*[2]*
13		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 39.9927, 33.4376		220 Secs (220 Secs) *[==>]*	*[2]*
14		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 39.9927, 33.4376		220 Secs (220 Secs) *[==>]*	*[2]*
15		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.8067,9.3932		220 Secs (220 Secs) *[==>]*	*[3]*
16		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.8067,9.3932		220 Secs (220 Secs) *[==>]*	*[3]*
17		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.8958,9.2101		220 Secs (220 Secs) *[==>]*	*[3]*
18		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.8958,9.2101		220 Secs (220 Secs) *[==>]*	*[3]*
19		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 10.0644, 9.3902		220 Secs (220 Secs) *[==>]*	*[3]*
20		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 40.0851, 33.2978		220 Secs (220 Secs) *[==>]*	*[3]*
21		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 40.0851, 33.2978		220 Secs (220 Secs) *[==>]*	*[3]*

Orbit Structure

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GS Reacq
Exp. 8
Overhead
Pointing Maneuver
Exp. 9
Overhead
Exp. 10
Pointing Maneuver
Overhead
Exp. 11
Overhead
Exp. 12
Overhead
Pointing Maneuver
Exp. 13
Overhead
Exp. 14
Overhead
Pointing Maneuver
Unused Orbital Visibility = 184
Occultation
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1500
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4500
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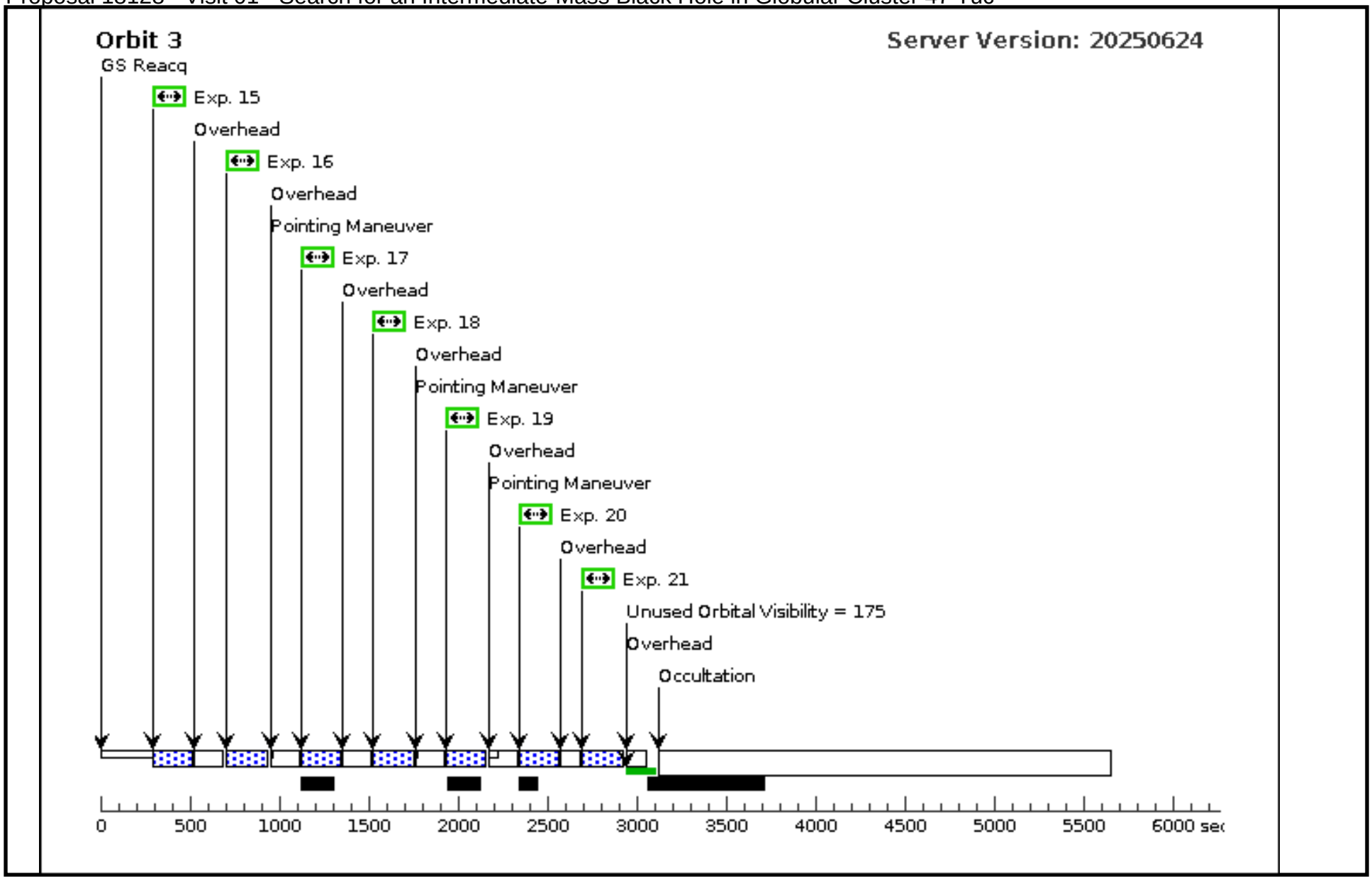
5500
6000 sec


Orbit 3
Server Version: 20250624
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Exp. 15
Overhead
Exp. 16
Overhead
Pointing Maneuver
Exp. 17
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Exp. 18
Overhead
Pointing Maneuver
Exp. 19
Overhead
Pointing Maneuver
Exp. 20
Overhead
Exp. 21
Unused Orbital Visibility = 175
Overhead
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 18128, Visit 02, implementation

Thu Nov 13 13:00:16 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: SAME ORIENT AS 01

Fixed Targets

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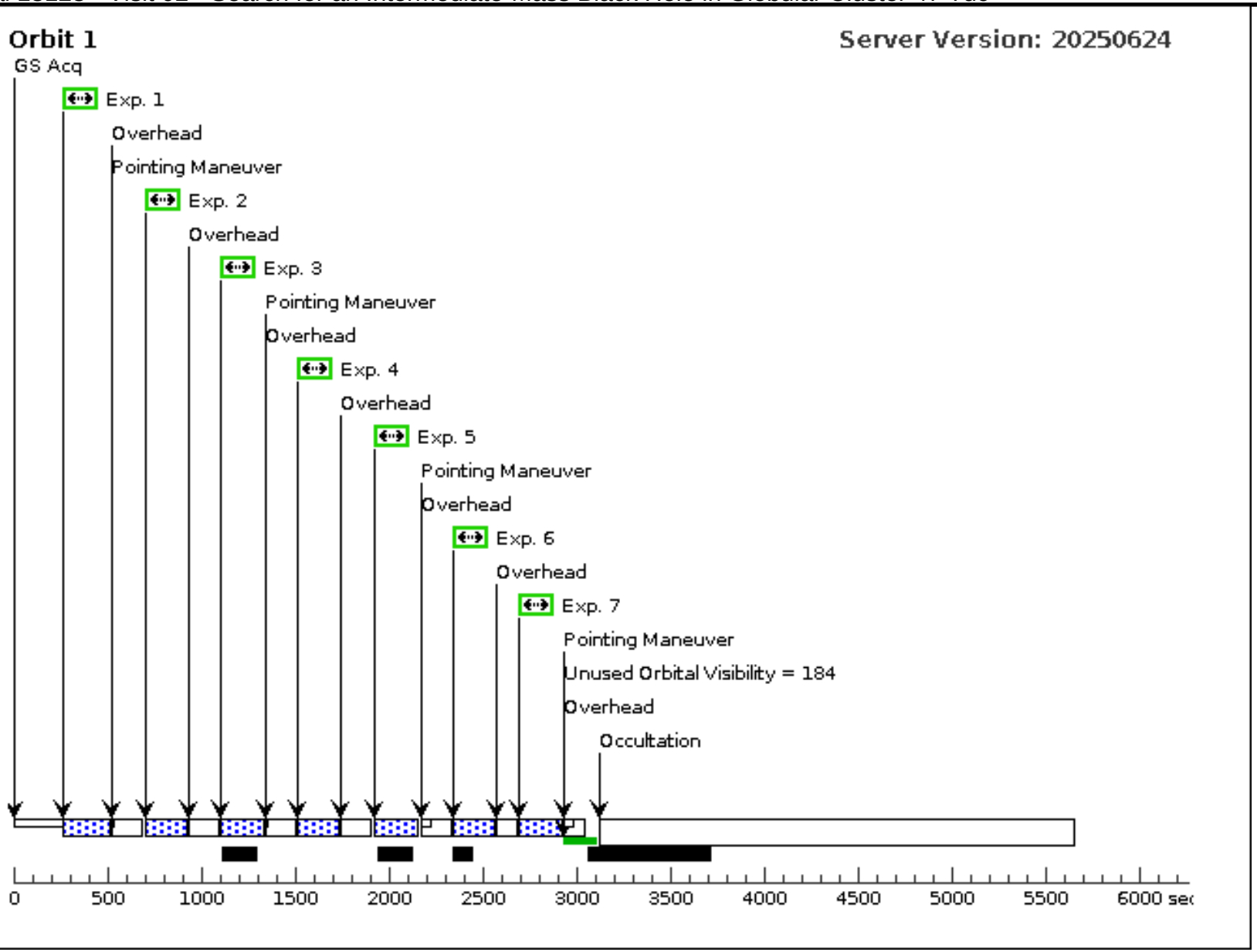
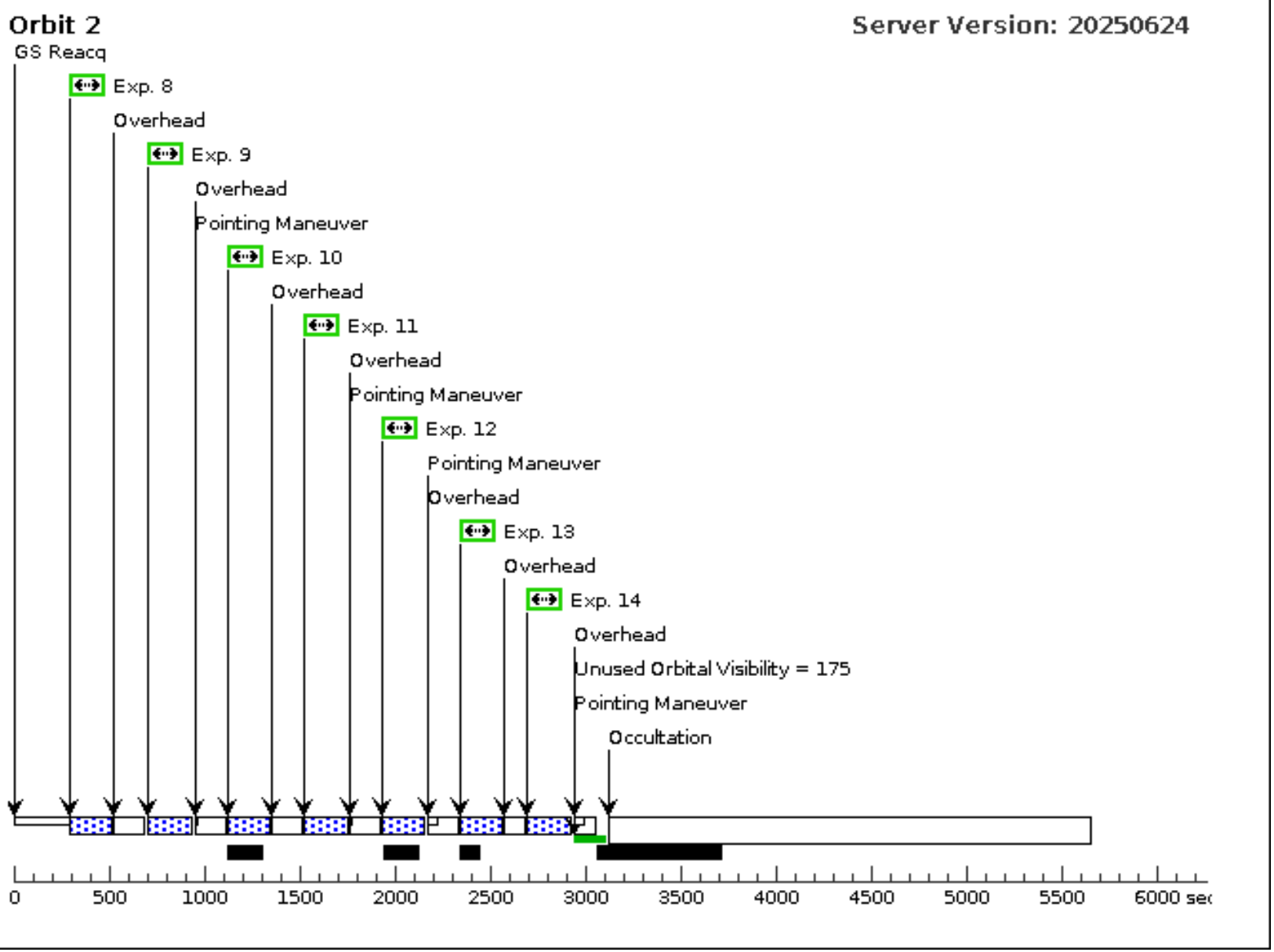
1		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 10.0644, 9.3902; GS ACQ SCENARI O ONEB1O3		220 Secs (220 Secs) *[==>]*	*[1]*
2		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.4,8.9		220 Secs (220 Secs) *[==>]*	*[1]*
3		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.4,8.9		220 Secs (220 Secs) *[==>]*	*[1]*
4		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.4894,9 .2341		220 Secs (220 Secs) *[==>]*	*[1]*
5		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.4894,9 .2341		220 Secs (220 Secs) *[==>]*	*[1]*
6		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 40.1382, 33.6130		220 Secs (220 Secs) *[==>]*	*[1]*
7		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 40.1382, 33.6130		220 Secs (220 Secs) *[==>]*	*[1]*
8		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.5785,9 .0908		220 Secs (220 Secs) *[==>]*	*[2]*
9		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.5785,9 .0908		220 Secs (220 Secs) *[==>]*	*[2]*
10		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.6679,9 .4249		220 Secs (220 Secs) *[==>]*	*[2]*
11		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.6679,9 .4249		220 Secs (220 Secs) *[==>]*	*[2]*
12		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.7173,9 .2591		220 Secs (220 Secs) *[==>]*	*[2]*
13		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 40.2305, 33.4732		220 Secs (220 Secs) *[==>]*	*[2]*
14		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 40.2305, 33.4732		220 Secs (220 Secs) *[==>]*	*[2]*
15		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.7173,9 .2591		220 Secs (220 Secs) *[==>]*	*[3]*
16		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.8100,9 .5967		220 Secs (220 Secs) *[==>]*	*[3]*
17		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.8100,9 .5967		220 Secs (220 Secs) *[==>]*	*[3]*
18		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F555W	FLASH=12	POS TARG 9.9024,9 .4158		220 Secs (220 Secs) *[==>]*	*[3]*
19		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=12	POS TARG 9.9024,9 .4158		220 Secs (220 Secs) *[==>]*	*[3]*
20		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F814W	FLASH=12	POS TARG 40.4024, 33.6171		220 Secs (220 Secs) *[==>]*	*[3]*
21		(1) NGC-104	WFC3/UVIS, ACCUM, UVIS-FIX	F555W	FLASH=12	POS TARG 40.4024, 33.6171		220 Secs (220 Secs) *[==>]*	*[3]*

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 8
Overhead
Exp. 9
Overhead
Pointing Maneuver
Exp. 10
Overhead
Exp. 11
Overhead
Pointing Maneuver
Exp. 12
Pointing Maneuver
Overhead
Exp. 13
Overhead
Exp. 14
Overhead
Unused Orbital Visibility = 175
Pointing Maneuver
Occultation
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500
1000
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3000
3500
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4500
5000
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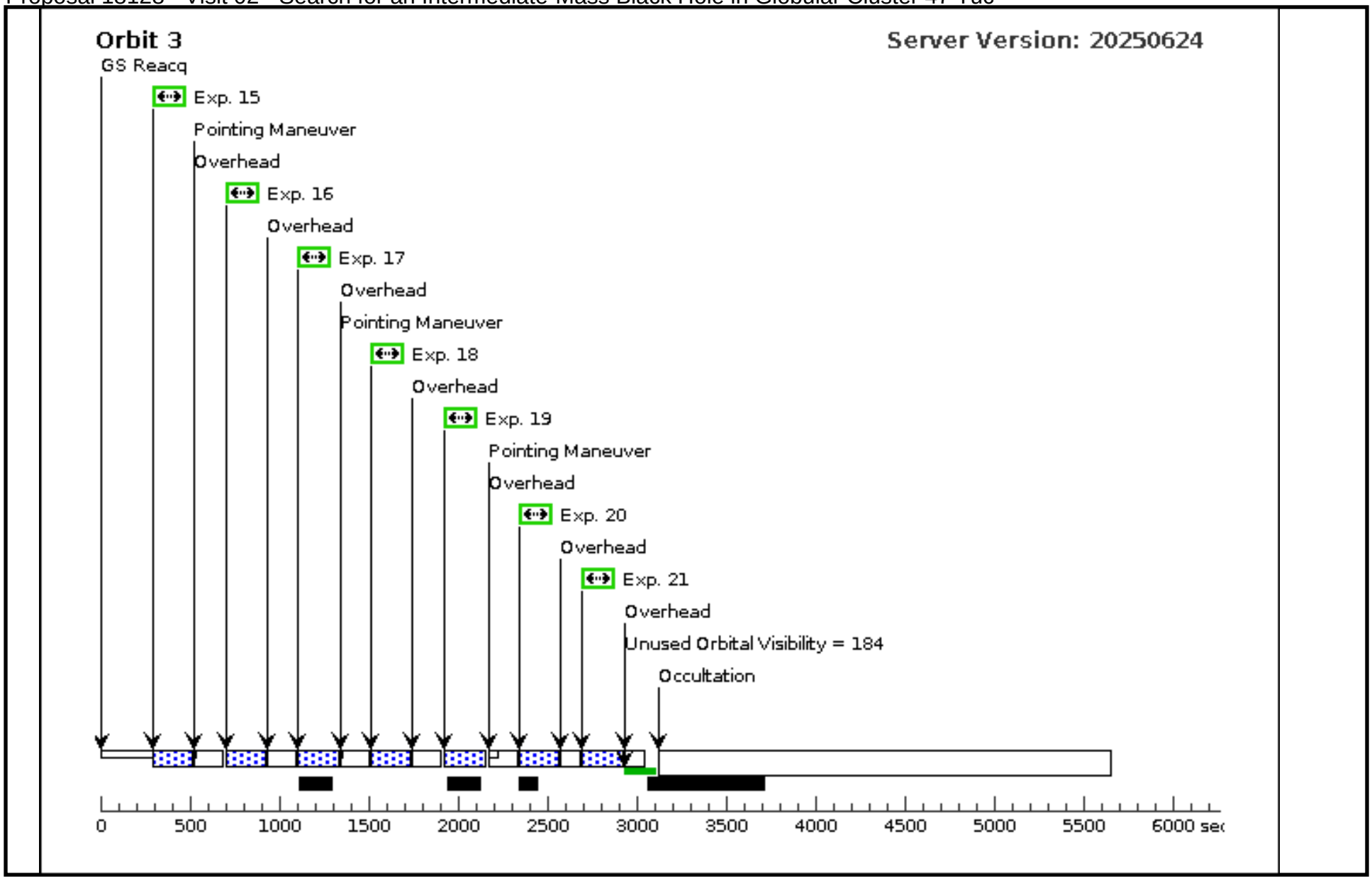
6000 sec


Orbit 3
Server Version: 20250624
GS Reacq
Exp. 15
Pointing Maneuver
Overhead
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Overhead
Exp. 17
Overhead
Pointing Maneuver
Exp. 18
Overhead
Exp. 19
Pointing Maneuver
Overhead
Exp. 20
Overhead
Exp. 21
Overhead
Unused Orbital Visibility = 184
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec