17902 - The Variable Optical-X-ray SED of M87

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Joseph Neilsen (PI) (Contact)	**Villanova University**
Prof. Daryl Haggard (CoI) (CSA Member)	McGill University
Dr. Venkatessh Ramakrishnan (CoI) (ESA Member)	University of Turku
Dr. Mislav Balokovic (CoI)	Yale University
Dr. Kazuhiro Hada (CoI)	National Astronomical Observatory of Japan (NAOJ)
Dr. Michael Johnson (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Stefanie Komossa (CoI) (ESA Member)	Max Planck Institut fur Radioastronomie
Dr. Thomas Krichbaum (CoI) (ESA Member)	Max Planck Institut fur Radioastronomie
Dr. Geoffrey Bower (CoI)	Academia Sinica, Institute of Astronomy and Astrophysics
Dr. Jaeyeong Kim (CoI)	Korea Astronomy and Space Science Institute (KASI)
Prof. Sera Markoff (CoI) (ESA Member)	Universiteit van Amsterdam
Dr. Michael Nowak (CoI)	Washington University in St. Louis
Mr. George Wong (CoI)	University of Illinois at Urbana - Champaign
Monika Moscibrodzka (CoI) (ESA Member)	Radboud University Nijmegen
Dr. Marcos Santander (CoI)	University of Alabama
Dr. Svetlana G. Jorstad (CoI)	Boston University
Dr. Alan P. Marscher (CoI)	Boston University
Dr. Mark Reynolds (CoI)	The Ohio State University
Mr. Chris Sheridan (CoI)	Villanova University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) M-87	WFC3/UVIS	2	03-Nov-2025 15:00:14.0	yes
02	(1) M-87	WFC3/UVIS	2	03-Nov-2025 15:00:15.0	yes

4 Total Orbits Used

ABSTRACT

On behalf of the EHT's Multiwavelength (MWL) Working Group, we propose a joint campaign on M87* coordinated in part with EHT: 50 ks XMM-Newton, 4 orbits Hubble, & 50 ks NuSTAR. These observations will improve constraints on (1) the SED of M87* and its particle acceleration processes, as well as (2) the variability of the famous jet across the electromagnetic spectrum.

OBSERVING DESCRIPTION

The goal of our HST program is to study the optical and UV variability of M87 in conjunction with NuSTAR and XMM-Newton observations. We are particularly interested in tracking the relative flux and SED changes of the core and the knot HST-1 over time. Our observations will occur in two pieces separated by roughly six months and consisting of two orbits each. The first piece should be coordinated with XMM and NuSTAR in June/July 2025; the second will be coordinated with XMM and NuSTAR in December 25/Jan 26. We adopt a modified version of the WFC3/UVIS observing strategy used for historical Hubble M87 monitoring (e.g. PI:Shara). In our analysis, comparable exposures produced to 3-10% uncertainties on the core and HST-1 fluxes after subtracting the host galaxy contribution.

Generally each visit consists of two orbits to acquire observations in F275W and F814W (orbit 1) and F390W and F606W (orbit 2) in ACCUM mode. For the summer visit ~contemporaneous with XMM-Newton/NuSTAR, the first orbit consists of three dithered 462 s exposures in F275W and two dithered 348 s exposures in F814W in ACCUM mode, for a total of 2084 s on source; the second orbit has 2x509 s in F390W and 3x348 s in F606W. ETC calculations are given for the nucleus and are approximate as they neglect the host galaxy. The remaining ~1 ks per orbit is covered by overhead (setup, readouts, filter changes, and dithering). We mitigate CTE with a flash to increase the background; sub-exposures reduce cosmic rays.

The winter visit ismuch the same, though roll angle constraints make it possible to arrange simultaneous observations with XMM/NuSTAR.

Visit

Proposal 17902, Summer (01), withdrawn Mon Nov 03 20:00:15 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: PCS MODE FINE; BETWEEN 01-MAY-2025:00:00:00 AND 31-MAY-2025:00:00:00

Comments: This observation should be scheduled to overlap with XMM-Newton observations; the "between" requirement represents the window where XMM observations can occur.

Diagnostics

(Summer (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Summer (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(F390W (01.003)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(F606W (01.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-GAP-LINE Purpose=DITHER Number Of Points=3 Point Spacing=2.414 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.759 Angle Between Sides= Center Pattern=true		(1), (4)
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2), (3)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M-87	RA: 12 30 49.4234 (187.7059308d) Dec: +12 23 28.04 (12.39112d) Equinox: J2000	Proper Motion RA: -8.029 mas/yr Proper Motion Dec: 10.734 mas/yr Epoch of Position: 2000	V=8.63	Reference Frame: ICRS

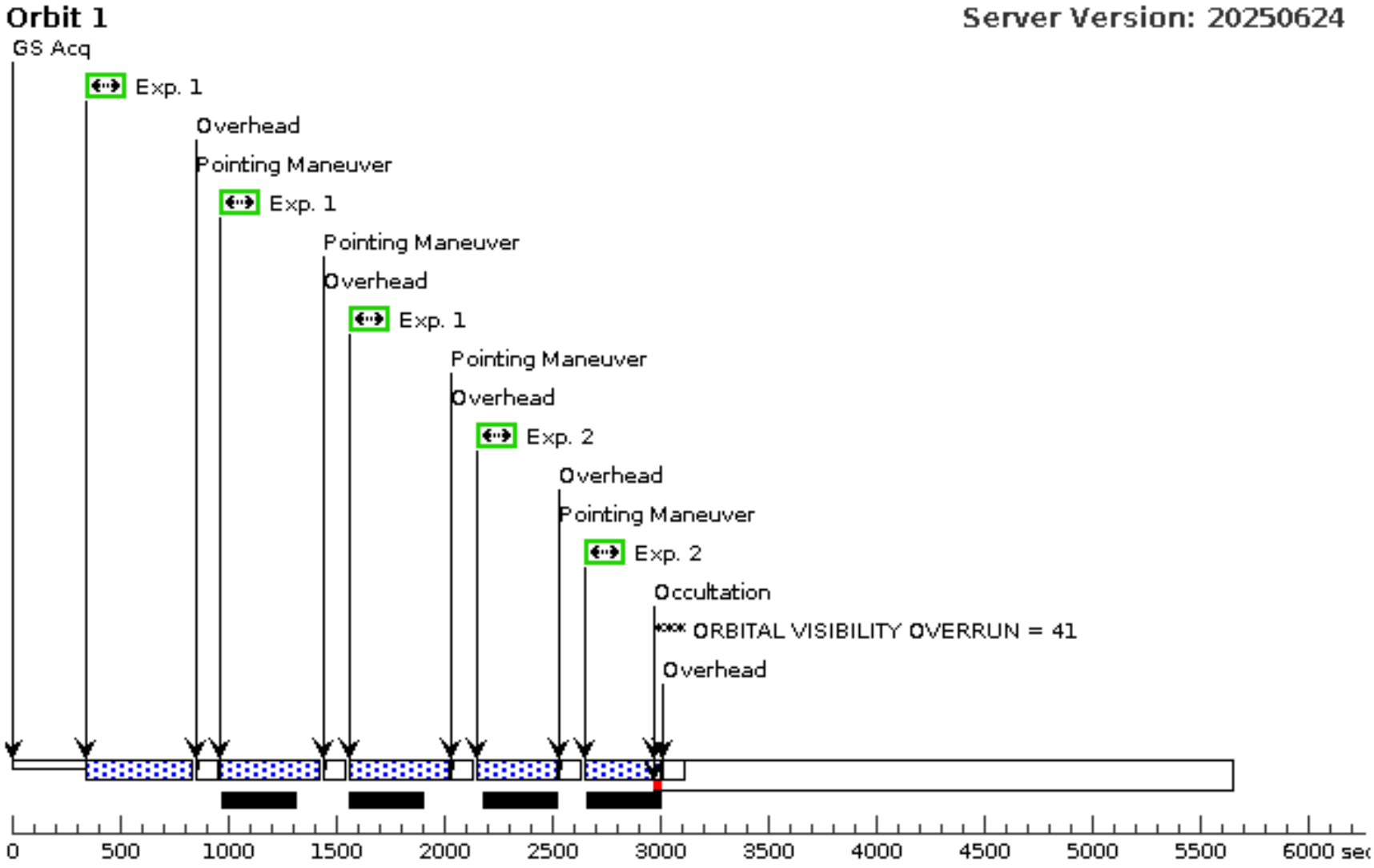
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

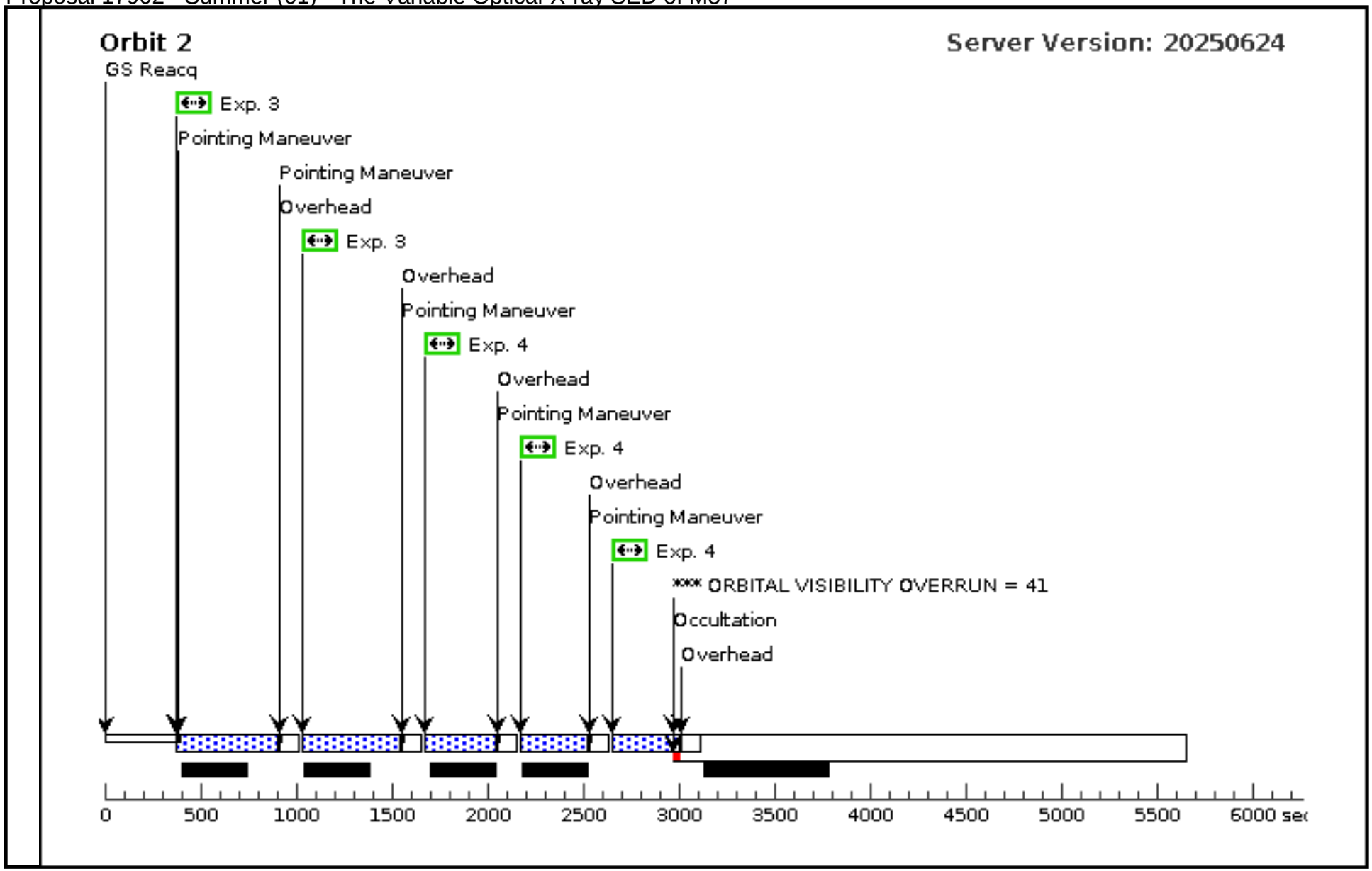
SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.
Category=GALAXY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

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F275W (WFC3UVIS.im.1948599)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F275W	FLASH=21		Pattern 1, Exps 1-1 in Summer (01) (1)	462 Secs (1387 Secs) *[==>(Pattern 1)]* *[==>463.0 Secs (Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2	F814W (WFC3UVIS.im.1948600)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=14		Pattern 2, Exps 2-2 in Summer (01) (2)	348 Secs (696 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	F390W (WFC3UVIS.im.1948601)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=21		Pattern 2, Exps 3-3 in Summer (01) (2)	509 Secs (1019 Secs) *[==>(Pattern 1)]* *[==>510.0 Secs (Pattern 2)]*	***[2]***
4	F606W (WFC3UVIS.im.1948602)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=14		Pattern 1, Exps 4-4 in Summer (01) (1)	348 Secs (1044 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 3
Pointing Maneuver
Pointing Maneuver
Overhead
Exp. 3
Overhead
Pointing Maneuver
Exp. 4
Overhead
Pointing Maneuver
Exp. 4
Overhead
Pointing Maneuver
Exp. 4
**** ORBITAL VISIBILITY OVERRUN = 41
Occultation
Overhead
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17902, Winter (02), implementation Mon Nov 03 20:00:15 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: PCS MODE FINE; BETWEEN 05-DEC-2025:16:54:00 AND 12-JAN-2026:01:28:00

Comments: This observation should be scheduled to overlap with XMM-Newton observations; the "between" requirement represents the window where XMM observations can occur.

Diagnostics

(F390W (02.003)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

(F606W (02.004)) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2), (3), (4)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M-87	RA: 12 30 49.4234 (187.7059308d) Dec: +12 23 28.04 (12.39112d) Equinox: J2000	Proper Motion RA: -8.029 mas/yr Proper Motion Dec: 10.734 mas/yr Epoch of Position: 2000	V=8.63	Reference Frame: ICRS

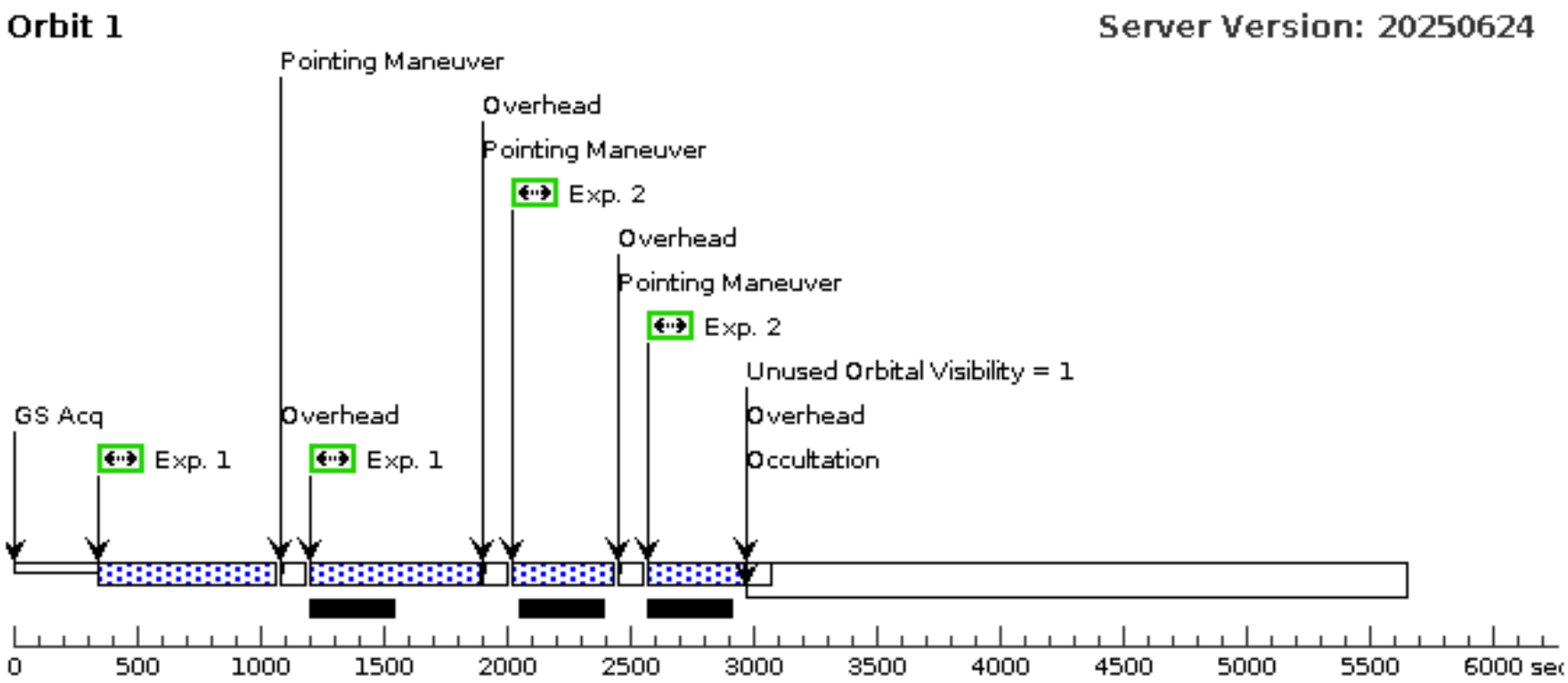
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

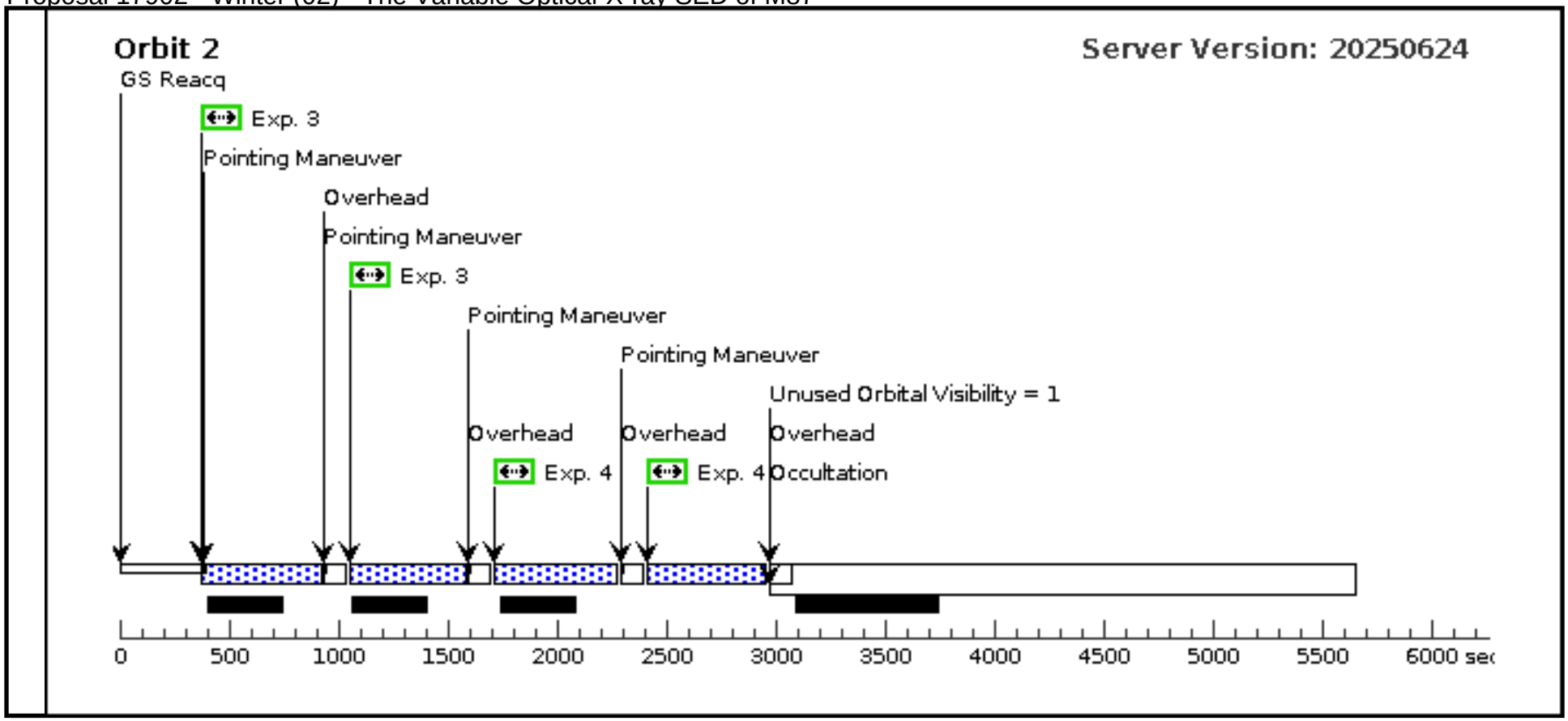
SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.
Category=GALAXY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

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F275W (WFC3UVIS.im.1948599)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F275W	FLASH=21		Pattern 2, Exps 1-1 in Winter (02) (2)	695 Secs (1390 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	F814W (WFC3UVIS.im.1948600)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=14		Pattern 2, Exps 2-2 in Winter (02) (2)	391 Secs (782 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	F390W (WFC3UVIS.im.1948601)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=21		Pattern 2, Exps 3-3 in Winter (02) (2)	529 Secs (1058 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[2]***
4	F606W (WFC3UVIS.im.1948602)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=14		Pattern 2, Exps 4-4 in Winter (02) (2)	547 Secs (1094 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20250624
GS Reacq
Exp. 3
Pointing Maneuver
Overhead
Pointing Maneuver
Exp. 3
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 1
Overhead
Overhead
Overhead
Exp. 4
Exp. 4
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec