17592 - The Variable Optical-X-ray SED of M87

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	***Institution***
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Dr. Venkatessh Ramakrishnan (CoI) (ESA Member)	University of Turku
Dr. Mislav Balokovic (CoI)	Yale University
Dr. Michael Johnson (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Sunil Chandra (CoI)	North-West University Potchefstroom Campus
Dr. Stefanie Komossa (CoI) (ESA Member)	Max-Planck-Institut fur Radioastronomie
Hope Boyce (CoI) (CSA Member)	McGill University
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
Dr. Marcos Santander (CoI)	University of Alabama
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	10-Jul-2024 16:00:39.0	yes
02	(1) M-87	WFC3/UVIS	2	10-Jul-2024 16:00:40.0	yes

4 Total Orbits Used

ABSTRACT

On behalf of the EHT's Multiwavelength (MWL) Working Group, we propose a joint campaign on M87: 100 ks XMM, 4 orbits Hubble, and 100 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 2024; the second will be coordinated with XMM and NuSTAR in December 24/Jan 25. 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.

The winter and summer observations are similar, with adjustments to compensate for varying orbital visibility of M87. Generally each 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 to be coordinated with NuSTAR and XMM-Newton, the first orbit consists of three dithered 496 s exposures in F275W and two dithered 352 s exposures in F814W in ACCUM mode, for a total of 2192 s on source; the second orbit has 2x 571 s in F390W and 3x 349 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.

Reduced visibility in March requires shorter exposures. The first orbit consists of three dithered 438 s exposures in F275W and two dithered 348 s exposures in F814W in ACCUM mode, for a total of 2046 s on source; the second orbit/visit has 2x 482 s in F390W and 3x348 s in F606W. Per our accepted XMM/HST/NuSTAR proposal, this visit should be scheduled within 1 day of a Chandra/EHT observation.

Visit

Proposal 17592, Summer (01), implementation Wed Jul 10 20:00:41 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: PCS MODE FINE

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 (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

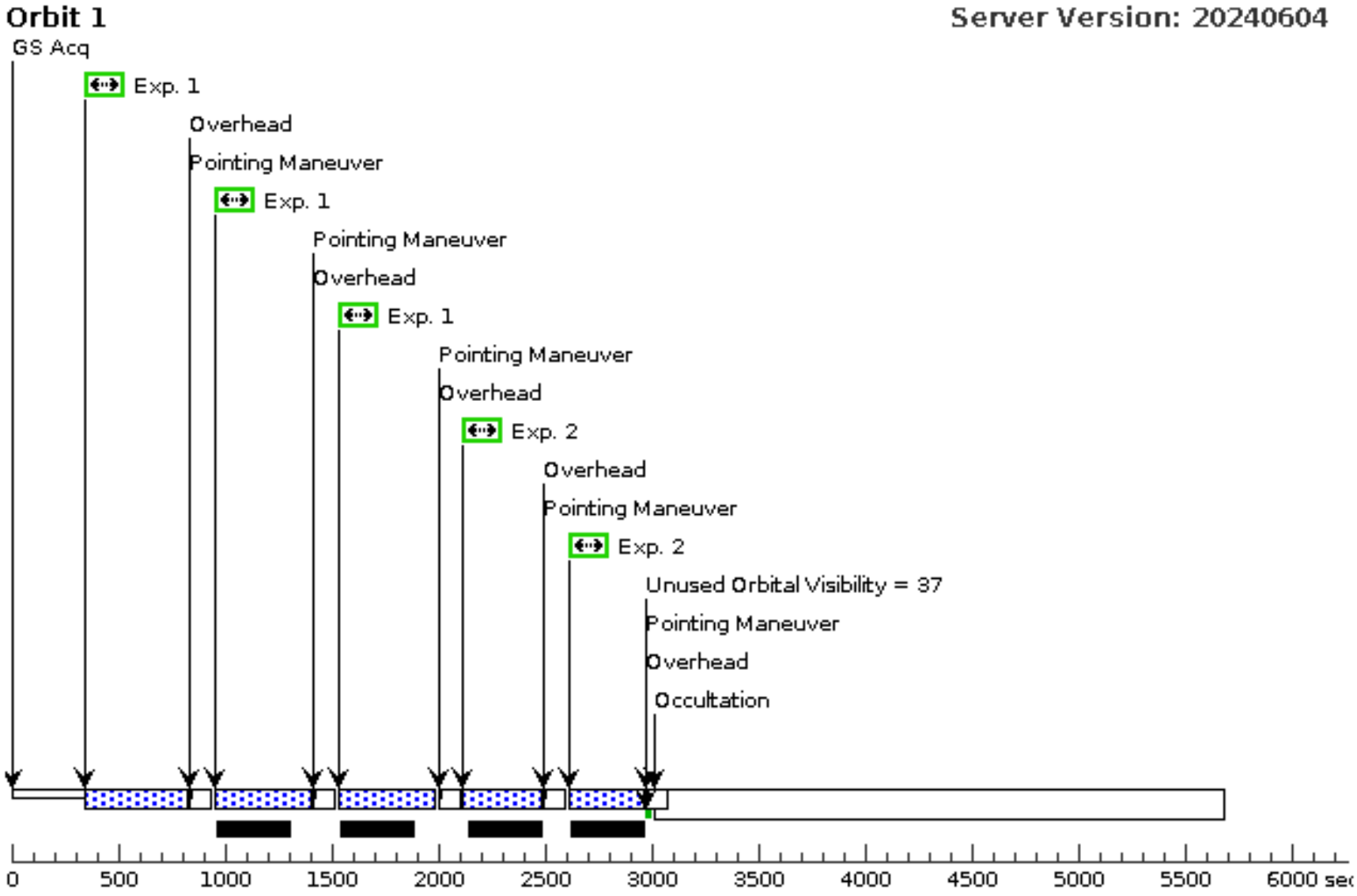
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M-87	RA: 12 30 49.4149 (187.7058954d) Dec: +12 23 28.21 (12.39117d) Equinox: J2000	Proper Motion RA: -5.480328945655651E-4 sec of time/yr Proper Motion Dec: 0.010734 arcsec/yr Epoch of Position: 2015.5	V=8.63	Reference Frame: SIMBAD

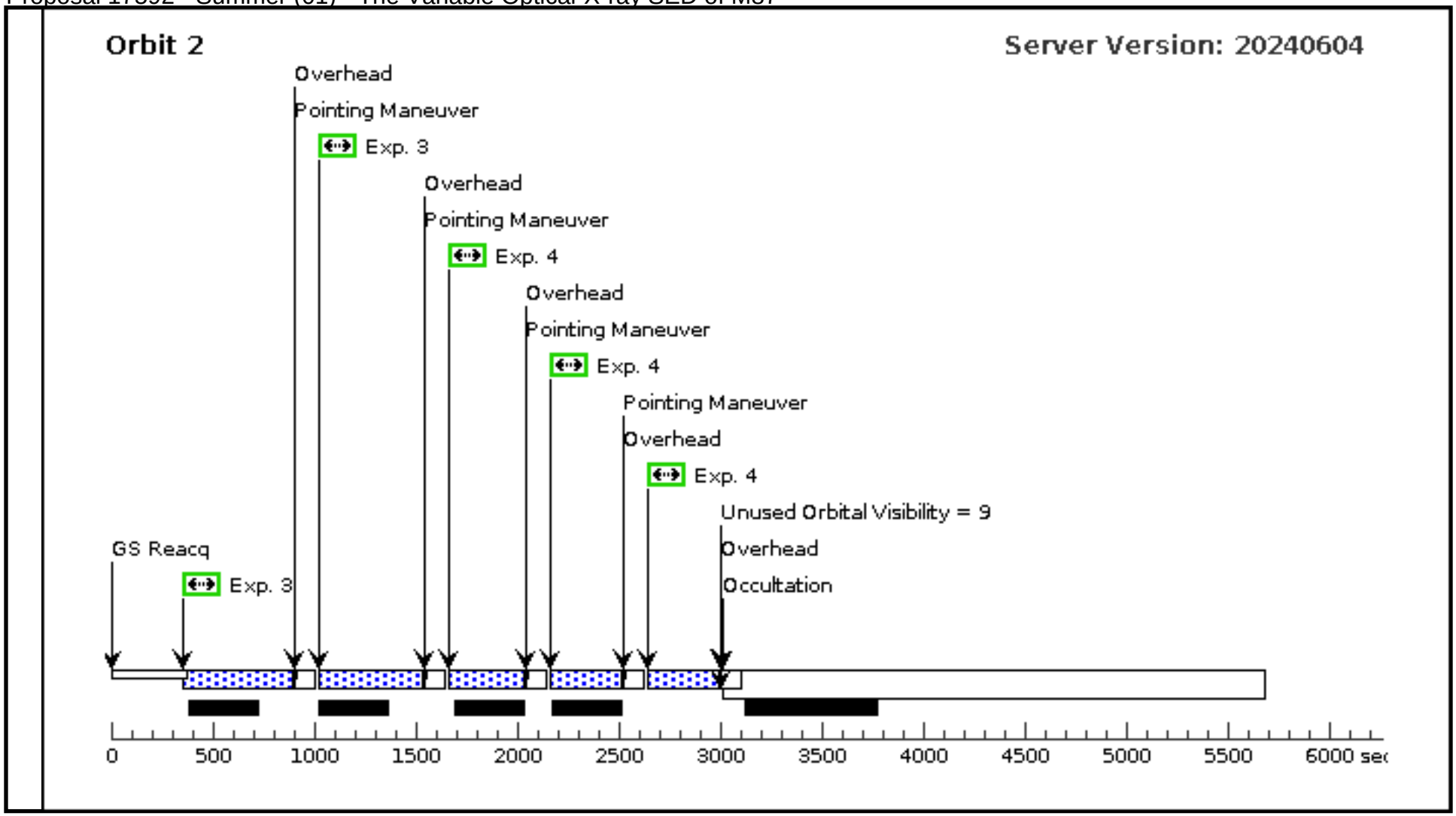
Comments:
Category=GALAXY
Description=[ELLIPTICAL, JET, KNOT, NUCLEUS]

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.1900101)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F275W	FLASH=21		Pattern 1, Exps 1-1 in Summer (01) (1)	450 Secs (1350 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2	F814W (WFC3UVIS.im.1900099)	(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.1900098)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=21		Pattern 2, Exps 3-3 in Summer (01) (2)	515 Secs (1030 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[2]***
4	F606W (WFC3UVIS.im.1900092)	(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: 20240604
Overhead
Pointing Maneuver
Exp. 3
Overhead
Pointing Maneuver
Exp. 4
Overhead
Pointing Maneuver
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
Unused Orbital Visibility = 9
Overhead
Occultation
GS Reacq
Exp. 3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17592, Winter (02), implementation Wed Jul 10 20:00:41 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: PCS MODE FINE; BETWEEN 05-DEC-2024:10:42:00 AND 12-JAN-2025:08:49:00

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

Diagnostics

(Winter (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Winter (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(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

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(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 49.4149 (187.7058954d) Dec: +12 23 28.21 (12.39117d) Equinox: J2000	Proper Motion RA: -5.480328945655651E-4 sec of time/yr Proper Motion Dec: 0.010734 arcsec/yr Epoch of Position: 2015.5	V=8.63	Reference Frame: SIMBAD

Comments:
Category=GALAXY
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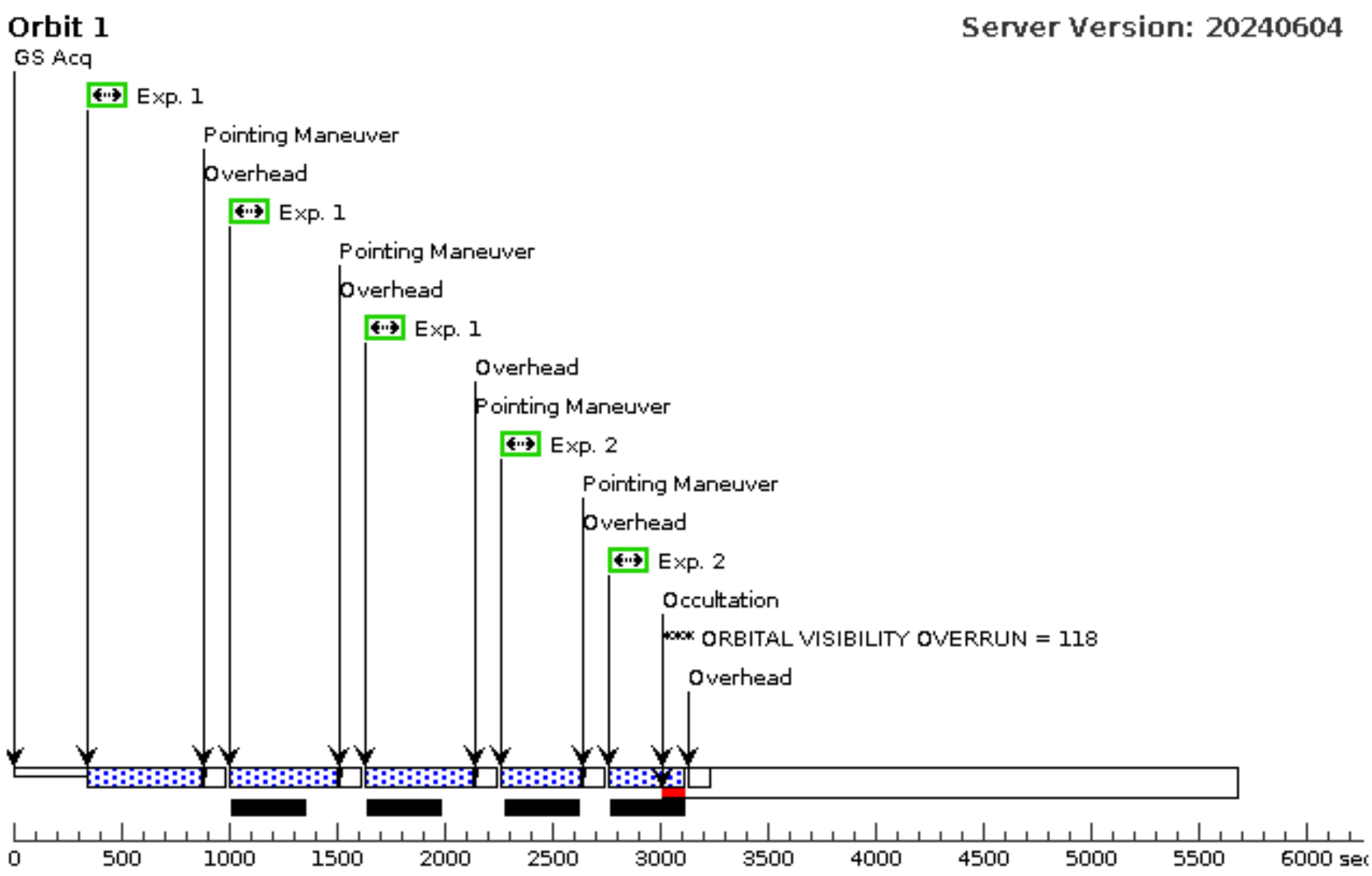
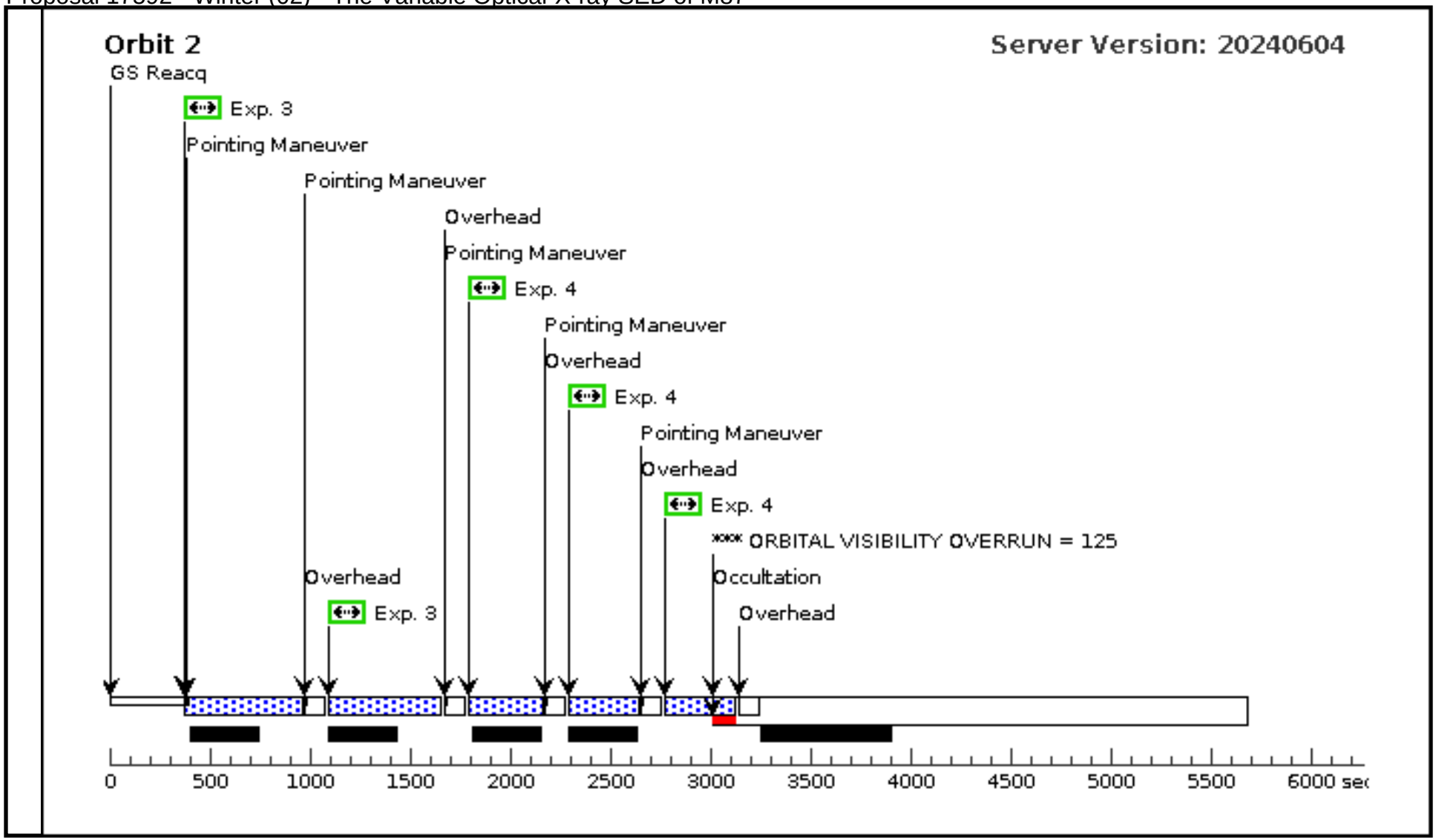
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F275W (WFC3UVIS.im.1900101)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F275W	FLASH=21		Pattern 1, Exps 1-1 in Winter (02) (1)	492 Secs (1494 Secs) *[==>498.0 Secs (Pattern 1)]* *[==>498.0 Secs (Pattern 2)]* *[==>498.0 Secs (Pattern 3)]*	***[1]***
2	F814W (WFC3UVIS.im.1900099)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F814W	FLASH=14		Pattern 2, Exps 2-2 in Winter (02) (2)	348 Secs (707 Secs) *[==>354.0 Secs (Pattern 1)]* *[==>353.0 Secs (Pattern 2)]*	***[1]***
3	F390W (WFC3UVIS.im.1900098)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=21		Pattern 2, Exps 3-3 in Winter (02) (2)	562 Secs (1132 Secs) *[==>566.0 Secs (Pattern 1)]* *[==>566.0 Secs (Pattern 2)]*	***[2]***
4	F606W (WFC3UVIS.im.1900092)	(1) M-87	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=14		Pattern 1, Exps 4-4 in Winter (02) (1)	348 Secs (1056 Secs) *[==>352.0 Secs (Pattern 1)]* *[==>352.0 Secs (Pattern 2)]* *[==>352.0 Secs (Pattern 3)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20240604
GS Reacq
Exp. 3
Pointing Maneuver
Pointing Maneuver
Overhead
Pointing Maneuver
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
Pointing Maneuver
Overhead
Exp. 4
**** ORBITAL VISIBILITY OVERRUN = 125
Occultation
Overhead
Overhead
Exp. 3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec