18131 - Unveiling Wandering Black Holes: HST Imaging and UV Spectroscopy of Off-nuclear Tidal Disruption Events

Cycle: 33, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Yuhan Yao (PI) (Contact)	**University of California - Berkeley**
Prof. Ryan Chornock (CoI)	University of California - Berkeley
Dr. Charlotte Ward (CoI)	Princeton University
Dr. Raffaella Margutti (CoI)	University of California - Berkeley
Dr. Wenbin Lu (CoI)	University of California - Berkeley

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(5) TDE2025ABCR	WFC3/UVIS	1	14-Nov-2025 08:00:13.0	yes
02	(5) TDE2025ABCR (6) GAIA2452799545790172672	STIS/CCD STIS/FUV-MAMA	2	14-Nov-2025 08:00:13.0	yes
03	(5) TDE2025ABCR (6) GAIA2452799545790172672	STIS/CCD STIS/NUV-MAMA	2	14-Nov-2025 08:00:14.0	yes
04	(2) TDE2	WFC3/UVIS	1	14-Nov-2025 08:00:14.0	yes
05	(2) TDE2 (4) TDE2-OFFSET	STIS/CCD STIS/FUV-MAMA	2	14-Nov-2025 08:00:15.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
06	(2) TDE2 (4) TDE2-OFFSET	STIS/CCD STIS/NUV-MAMA	2	14-Nov-2025 08:00:15.0	yes

10 Total Orbits Used

ABSTRACT

The hierarchical assembly of galaxies and dynamical interactions in galactic nuclei naturally predict a population of off-nuclear massive black holes (MBHs), yet direct observational evidence remains limited. Off-nuclear tidal disruption events (TDEs) provide a unique avenue to probe these elusive wandering MBHs. We propose HST ToO observations of two offset TDE candidates selected with optical time-domain surveys. For each candidate, we request 1 orbit of WFC3 imaging and 4 orbits of SITS UV spectroscopy. The imaging will confirm the off-nuclear nature of the transient, precisely measure its offset from the host galaxy nucleus, and search for morphological signatures of recent mergers. The spectroscopic observations will constrain kick velocities and provide key diagnostics for this rare class of events. This program will increase the number of optically selected off-nuclear TDEs from one to three, enabling the first steps toward characterizing the demographics and physical origins of offset MBHs powering TDEs.

OBSERVING DESCRIPTION

This proposal consists of non-disruptive ToO observations (up to 25 days response time) of 2 off-nuclear tidal disruption events (TDEs), each for 5 orbits with HST.

Each TDE trigger will be for an off-nculear TDE candidate that has (1) a peak g-band magnitude of <19.5, (2) a significant offset (>3-sigma) from the nearest galaxy nucleus determined via forward modeling of science images, and (3) an optical spectrum that is consistent with one of the established TDE classes: TDE+H, TDE+H+He, TDE+He, TDE-featureless. The 1 orbit of WFC3 imaging observation will be triggered if these three criteria are met. The 4 orbits of STIS spectroscopic observations will be triggered if the expected g-band magnitude is <20 mag.

Due to the fact that the spectroscopic component will only be triggered if the predicted g<20, we have broken up each TDE trigger into 3 visits:

first visit: 1 orbit with WFC3 imaging

second visit: 2 orbits with STIS/FUV-MAMA using G140L with the 52x0.2 aperture

third visit: 2 orbits with STIS/NUV-MAMA using G230L with the 52x0.2 aperture

Each spectroscopic visit requires an ACQ in the first orbit. As these are triggered observations, we do not yet know the exact brightness of the TDE. We expect that the TDE will be a UV-bright point source that is offset from a (much redder) galaxy nucleus. Since the TDE is offset from the host, we have chosen nearby stars for aquisition observations, from which offsets will be applied to observe the TDEs. The exposure times may be adjusted depending on the actual properties of the target, so we have not provided ETC output until the actual fluxes are known.

A ToO activation on TDE1 should trigger Visit 01, and also Visits 02 and 03 if the predicted $g < 20$.
A ToO activation on TDE2 should trigger Visit 04, and also Visits 05 and 06 if the predicted $g < 20$.

Visit

Proposal 18131, Visit 01, implementation

Fri Nov 14 13:00:15 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: TOO RESPONSE TIME 25.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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

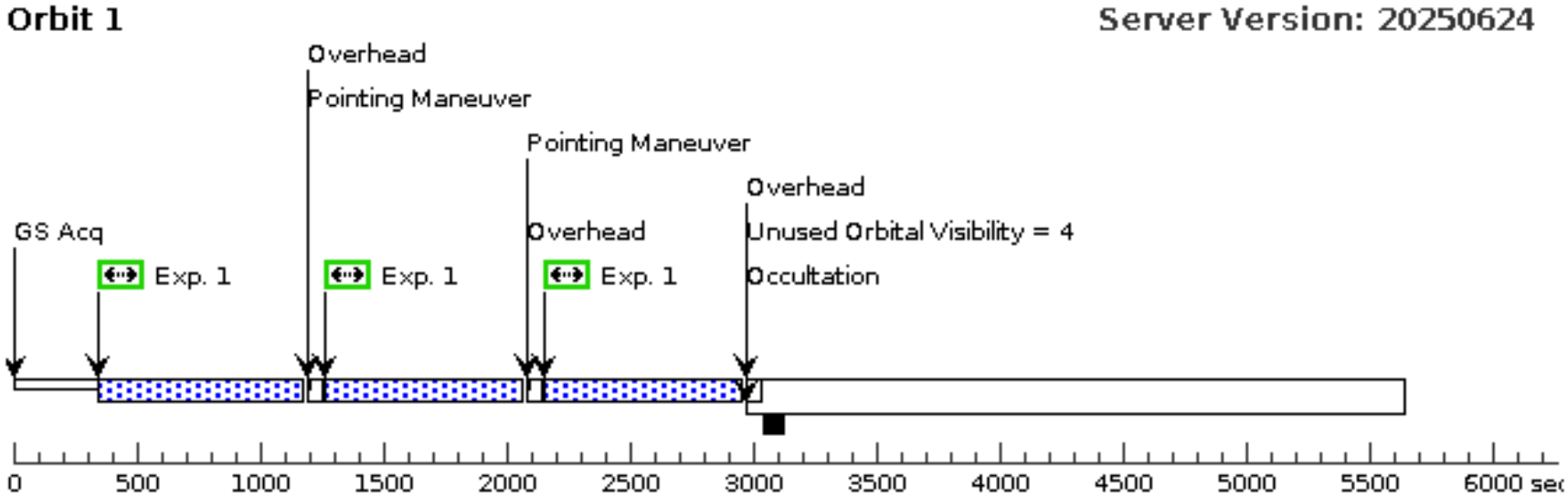
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	TDE2025ABCR	RA: 01 46 55.3877 (26.7307821d) Dec: -15 22 15.75 (-15.37104d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	V=19.5+/-0.3	Reference Frame: ICRS

Comments:
Category=UNIDENTIFIED
Description=[ULTRAVIOLET EMITTER]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.2230639)	(5) TDE2025ABCR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F625W	FLASH=1		Pattern 1, Exps 1-1 in Visit 01 (1)	802 Secs (2406 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***

Orbit Structure



Visit

Proposal 18131, Visit 02, implementation

Fri Nov 14 13:00:15 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: TOO RESPONSE TIME 25.0D

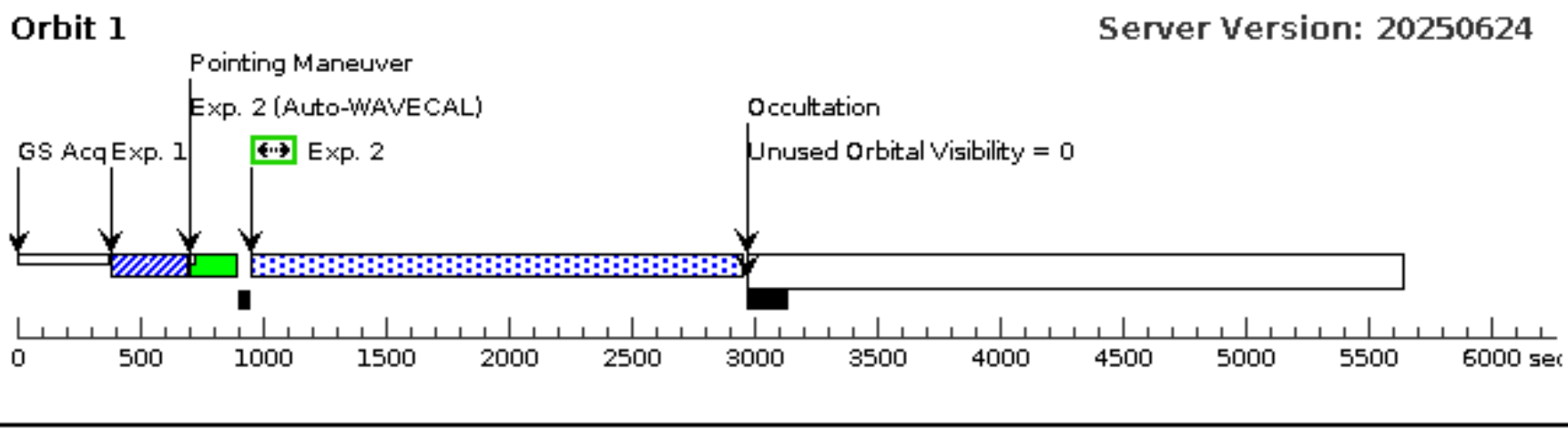
Fixed Targets

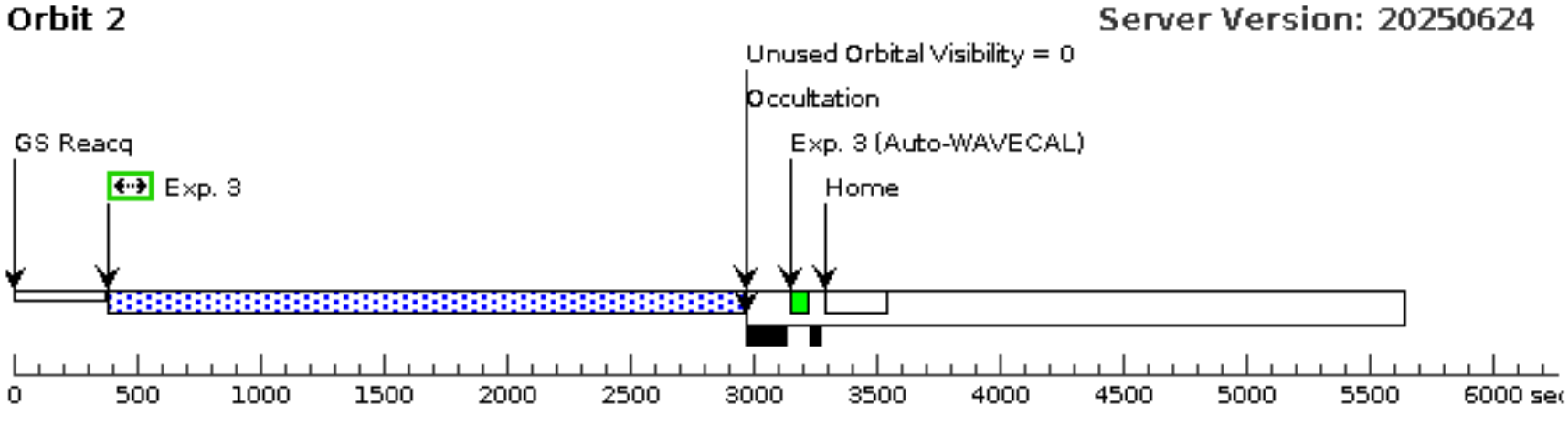
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	TDE2025ABCR	RA: 01 46 55.3877 (26.7307821d) Dec: -15 22 15.75 (-15.37104d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	V=19.5+/-0.3	Reference Frame: ICRS
Comments: *Category=UNIDENTIFIED* *Description=[ULTRAVIOLET EMITTER]*					
(6)	GAIA2452799545790172672	RA: 01 46 54.2745 (26.7261437d) Dec: -15 22 14.50 (-15.37069d) Equinox: J2000	Proper Motion RA: 2.732 mas/yr Proper Motion Dec: -75.069 mas/yr Parallax: 0.0033337" Epoch of Position: 2016	V=16.6+/-0.1	Reference Frame: ICRS
Comments: *Category=EXT-STAR* *Description=[M III-I]* *Extended=NO*					

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	aquisition FUV (STIS.ta.2230664)	(6) GAIA2452799545790172672	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			20 Secs (20 Secs) *[==>]*	 ***[1]***
2	science FUV (STIS.sp.2230671)	(5) TDE2025ABCR	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=7622			1989 Secs (1989 Secs) *[==>]*	 ***[1]***
3	science FUV (STIS.sp.2230671)	(5) TDE2025ABCR	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=7622			2568 Secs (2568 Secs) *[==>]*	 ***[2]***

Orbit Structure





Visit

Proposal 18131, Visit 03, implementation Fri Nov 14 13:00:15 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: TOO RESPONSE TIME 25.0D

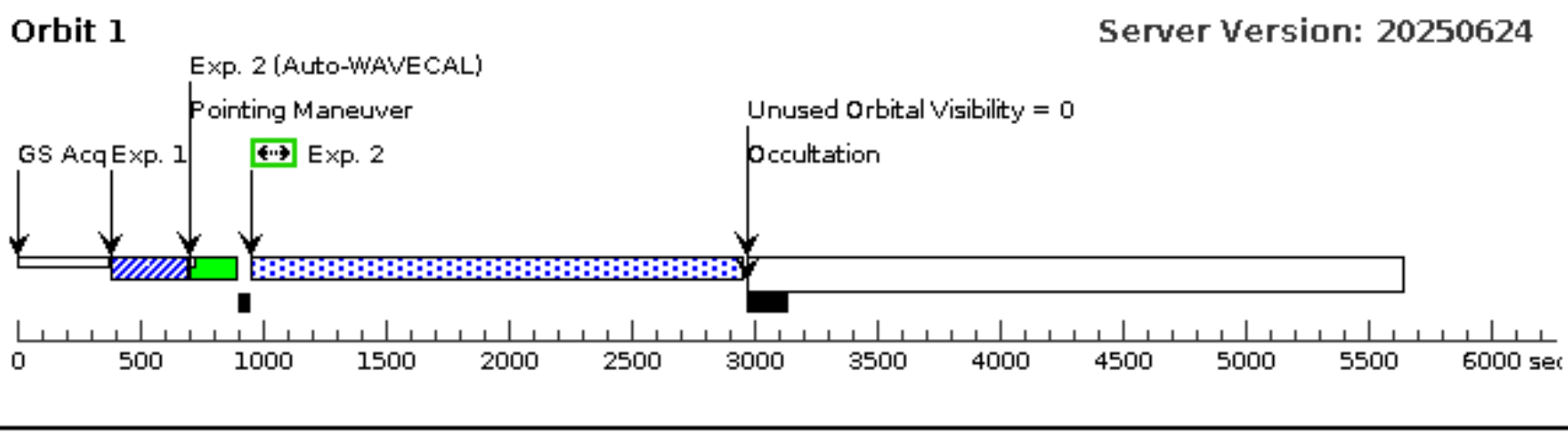
Fixed Targets

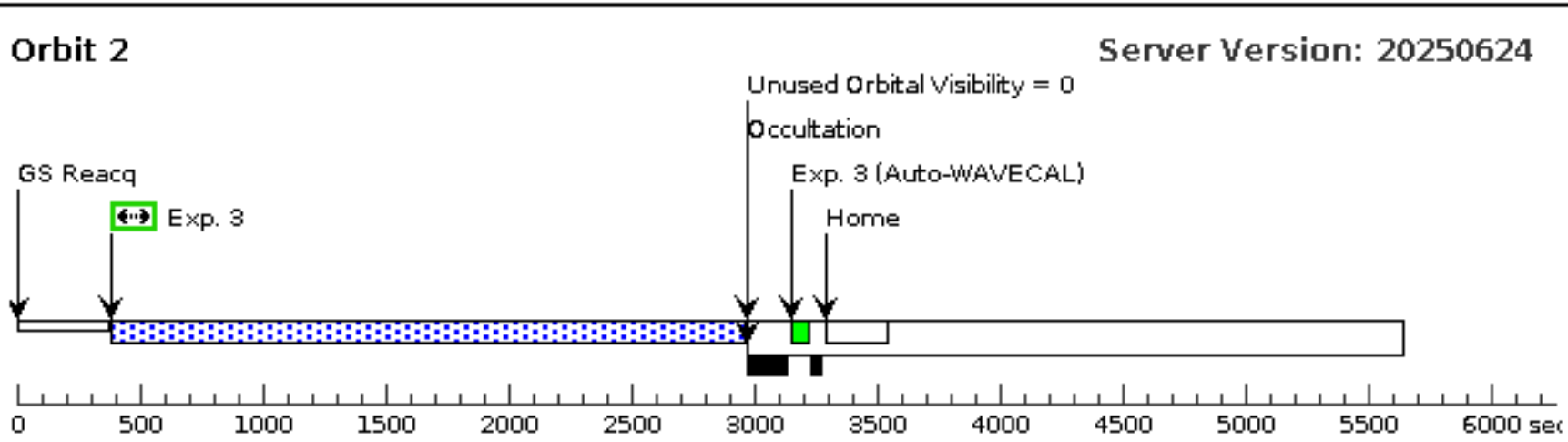
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	TDE2025ABCR	RA: 01 46 55.3877 (26.7307821d) Dec: -15 22 15.75 (-15.37104d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	V=19.5+/-0.3	Reference Frame: ICRS
Comments: *Category=UNIDENTIFIED* *Description=[ULTRAVIOLET EMITTER]*					
(6)	GAIA2452799545790172672	RA: 01 46 54.2745 (26.7261437d) Dec: -15 22 14.50 (-15.37069d) Equinox: J2000	Proper Motion RA: 2.732 mas/yr Proper Motion Dec: -75.069 mas/yr Parallax: 0.0033337" Epoch of Position: 2016	V=16.6+/-0.1	Reference Frame: ICRS
Comments: *Category=EXT-STAR* *Description=[M III-I]* *Extended=NO*					

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	aquisition NUV (STIS.ta.2230664)	(6) GAIA2452799545790172672	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			20 Secs (20 Secs) *[==>]*	 ***[1]***
2	science NUV (STIS.sp.2230672)	(5) TDE2025ABCR	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1558			1989 Secs (1989 Secs) *[==>]*	 ***[1]***
3	science NUV (STIS.sp.2230672)	(5) TDE2025ABCR	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1558			2568 Secs (2568 Secs) *[==>]*	 ***[2]***

Orbit Structure





Visit

Proposal 18131, Visit 04, implementation

Fri Nov 14 13:00:15 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: TOO RESPONSE TIME 25.0D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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)

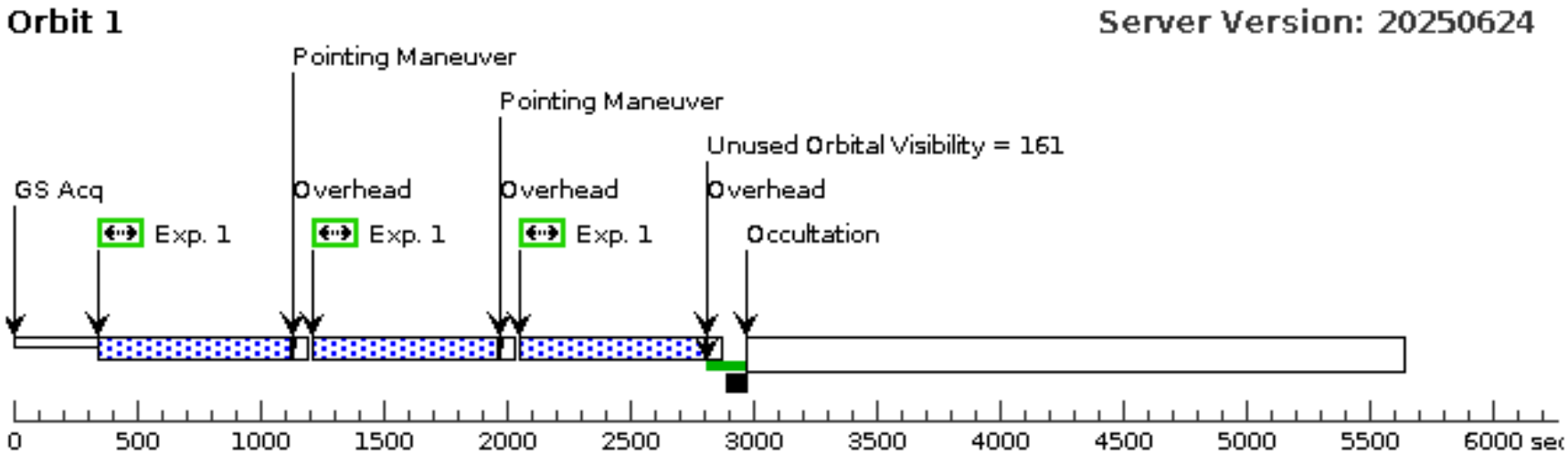
Generic Targets

#	Name	Criteria	Description
(2)	TDE2	(1) spectroscopic TDE (2) >3-sigma offset from host galaxy center (3) g<19.5	NUCLEUS ULTRAVIOLET EMITTER

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) TDE2	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F625W	FLASH=3		Pattern 1, Exps 1-1 in Visit 04 (1)	750 Secs (2250 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	*[1]*

Orbit Structure



Visit

Proposal 18131, Visit 05, implementation Fri Nov 14 13:00:15 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: TOO RESPONSE TIME 25.0D

Diagnostics

(science FUV (05.002)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(science FUV (05.003)) Warning (Form): Sensitive exposures should have an ETC run number provided.

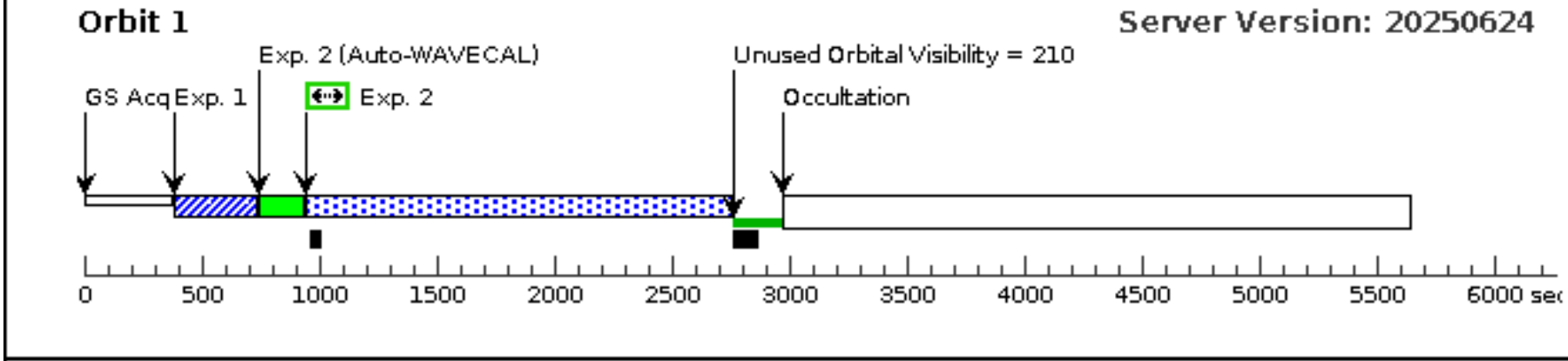
Generic Targets

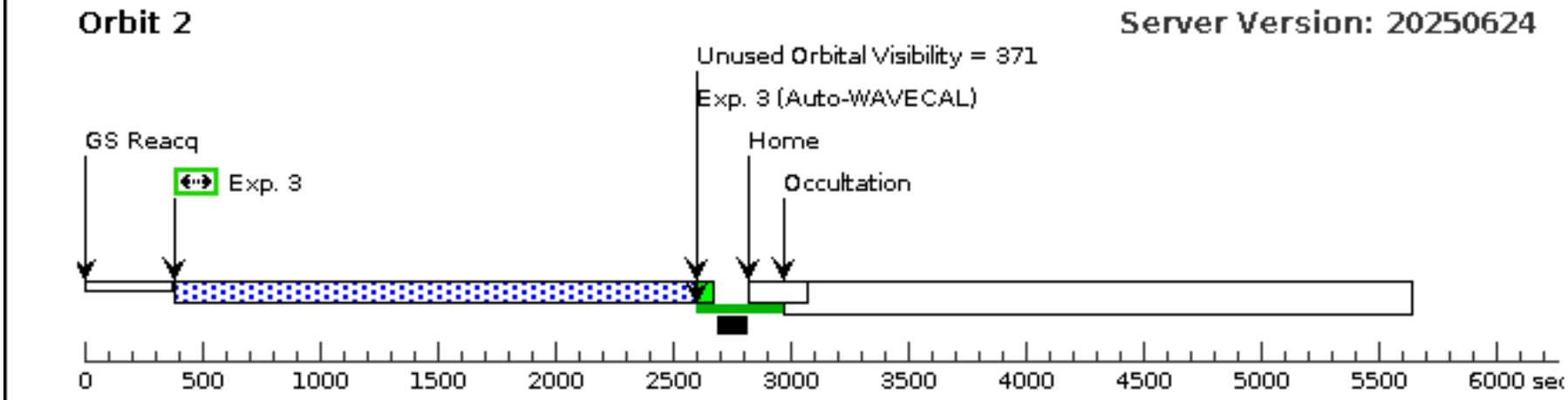
#	Name	Criteria	Description
(2)	TDE2	(1) spectroscopic TDE (2) >3-sigma offset from host galaxy center (3) g<19.5	NUCLEUS ULTRAVIOLET EMITTER
(4)	TDE2-OFFSET	A star that is nearby TDE2 for acquisition	UNDESIGNATED

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	aquisition F UV	(4) TDE2-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			30 Secs (30 Secs) *[==>]*	*[1]*
2	science FUV	(2) TDE2	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				1800 Secs (1800 Secs) *[==>]*	*[1]*
3	science FUV	(2) TDE2	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2200 Secs (2200 Secs) *[==>]*	*[2]*

Orbit Structure





Visit

Proposal 18131, Visit 06, implementation Fri Nov 14 13:00:16 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: TOO RESPONSE TIME 25.0D

Diagnostics

(science NUV (06.002)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(science NUV (06.003)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Generic Targets

#	Name	Criteria	Description
(2)	TDE2	(1) spectroscopic TDE (2) >3-sigma offset from host galaxy center (3) g<19.5	NUCLEUS ULTRAVIOLET EMITTER
(4)	TDE2-OFFSET	A star that is nearby TDE2 for acquisition	UNDESIGNATED

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	aquisition NUV	(4) TDE2-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			30 Secs (30 Secs) *[==>]*	*[1]*
2	science NUV	(2) TDE2	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				1800 Secs (1800 Secs) *[==>]*	*[1]*
3	science NUV	(2) TDE2	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				2200 Secs (2200 Secs) *[==>]*	*[2]*

Orbit Structure