18335 - The size, density, shape, and interior of mid-sized TNO Uni

Cycle: 34, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) UNI	WFC3/UVIS	1	04-Aug-2026 14:01:21.0	yes
02	(1) UNI	WFC3/UVIS	1	04-Aug-2026 14:01:21.0	yes
03	(1) UNI	WFC3/UVIS	1	04-Aug-2026 14:01:22.0	yes
04	(1) UNI	WFC3/UVIS	1	04-Aug-2026 14:01:22.0	yes
05	(1) UNI	WFC3/UVIS	1	04-Aug-2026 14:01:23.0	yes

5 Total Orbits Used

ABSTRACT

The densities of trans-Neptunian objects (TNOs) provide insight into the formation of planetary building blocks in the earliest epochs of the solar system. The largest TNOs have high densities, implying a large rock fraction and a history of melting/differentiation, while the smallest TNOs have low densities, implying porous interiors. Surprisingly, the transition between those extremes happens at diameters of 600-800 km, allowing for

relatively large bodies to maintain high porosity. The mid-sized TNO Uni is in this group, with a diameter estimated from thermal measurements of ~650 km and a density of 0.82 g/cm^3, requiring Uni to maintain a ~50% porosity. Recent evidence, however, has shown that Uni's satellite, named Tinia, is smaller than expected, calling into question the thermally-derived diameter for Uni. Thankfully, two upcoming stellar occultations provide a rare opportunity to measure both Uni and Tinia's sizes and shapes. To support observations of these occultations, and to significantly enhance the scientific return from this rare opportunity, we propose a 5 orbit program to observe Uni and Tinia using WFC3/UVIS. In addition to improving planning of the occultation campaigns, our observations will measure the mass ratio of Uni and Tinia and detect non-Keplerian precession of Tinia's orbit. These investigations will provide deep insight into the shape, orientation, and interior of Uni, allowing us to better understand the important mid-sized TNO population.

OBSERVING DESCRIPTION

Our observations call for 5 single-orbit visits to image the Uni-Tinia system using the WFC3/UVIS instrument. All imaging will use the F350LP filter to maximize throughput and astrometric precision. The 5 visits are divided into two groups. The first three visits will be carefully timed to provide updates for stellar occultations occuring in Dec 2026. The last two visits will be scheduled in Jul-Oct 2027 to provide a maximal baseline for understanding the precession of the satellite's orbit.

Occultation prep. observations:

These visits will consist of 5 dithered images using the full UVIS aperture. The large aperture is used to capture as many Gaia reference stars in the images as possible for astrometric calibration. Exposure times are 350 seconds to allow for memory buffer dumps to occur during subsequent exposures. Scheduling of these observations is important. The timing windows (encoded in betweens) are to take place an integer number of satellite orbits before the occultations on Dec 05 and 15. The windows for Visits 1 and 2 are not flexible (although the selection between the available windows is flexible), but Visit 3 can have additional flexibility (above that included in the betweens) if needed.

Long baseline observations:

These visits will consist of 12 dithered images, 10 with the UVIS2-C512C-SUB aperture and 2 with the UVIS aperture. Exposures times are ~100 seconds to achieve SNR>50 on the satellite. The 2 full UVIS images will be taken at the end of the orbit with the memory buffer dump pushed into occultation. To maximize the return from these visits, we will initially place them on hold pending analysis of visits 1-3 (and the archival dataset of astrometric data). The visits will be scheduled in Uni's next HST visibility window (Jul-Oct 2027). Observing windows will last ~1 day and repeat once per orbit period (8.3095 days). As such, there should be ~10 scheduling opportunities for both these visits.

Visit

Proposal 18335, Occ. prep. 1 (01) Tue Aug 04 18:01:24 GMT 2026

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-NOV-2026:20:00:00 AND 02-NOV-2026:14:00:00; BETWEEN 10-NOV-2026:03:30:00 AND 10-NOV-2026:21:30:00; BETWEEN 18-NOV-2026:11:00:00 AND 19-NOV-2026:05:00:00

Comments: Scheduled to take place an integer number of orbit periods (8.3095 days) before the occultation that will take place on 2026-12-05 19:50. There are three scheduling opportunities before Uni leaves HST's FOR.

Diagnostics

(Occ. prep. 1 (01)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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		(2)

Solar System Targets

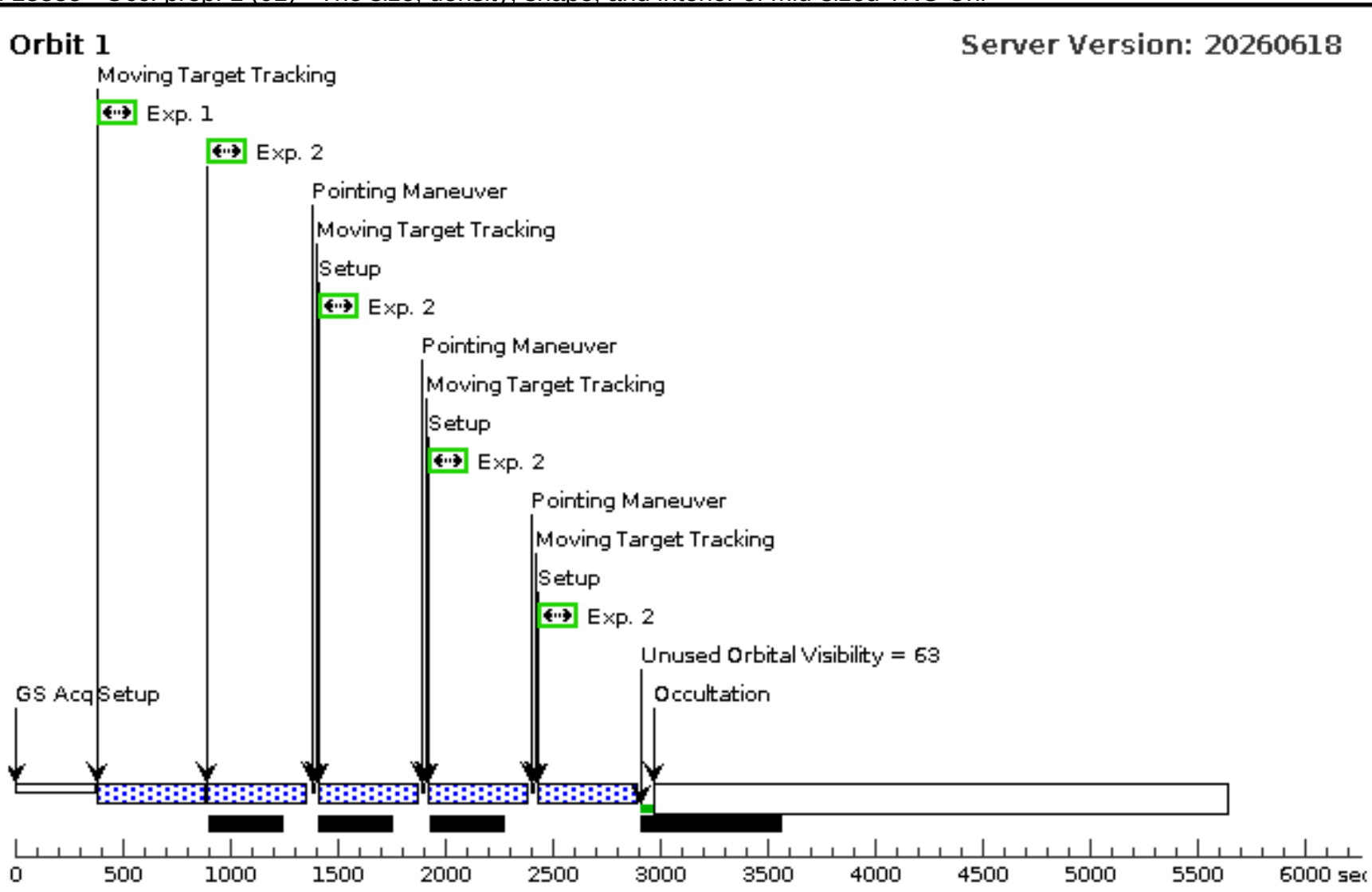
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	UNI	TYPE=ASTEROID,A=42.924569473864417,E=0.1462441869199175,I=19.42327844654774,O=204.6157936874821,W=276.0993480674751,M=310.1542385365317,EQUINOX=J2000,EPOCH=09-JUN-2026:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=uni

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP				350 Secs (350 Secs)	
								[==>]	***[1]***
2		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP			Pattern 1, Exps 2-2 in Occ. prep. 1 (01) (1)	350 Secs (1400 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 18335, Occ. prep. 2 (02) Tue Aug 04 18:01:24 GMT 2026

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 03-NOV-2026:20:30:00 AND 04-NOV-2026:20:30:00; BETWEEN 12-NOV-2026:04:00:00 AND 13-NOV-2026:04:00:00; BETWEEN 20-NOV-2026:11:00:00 AND 21-NOV-2026:11:00:00

Comments: Scheduled to take place an integer number of orbit periods (8.3095 days) before the occultation that will take place on 2026-12-15 21:28. There are three scheduling opportunities before Uni leaves HST's FOR.

Diagnostics

(Occ. prep. 2 (02)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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		(2)

Solar System Targets

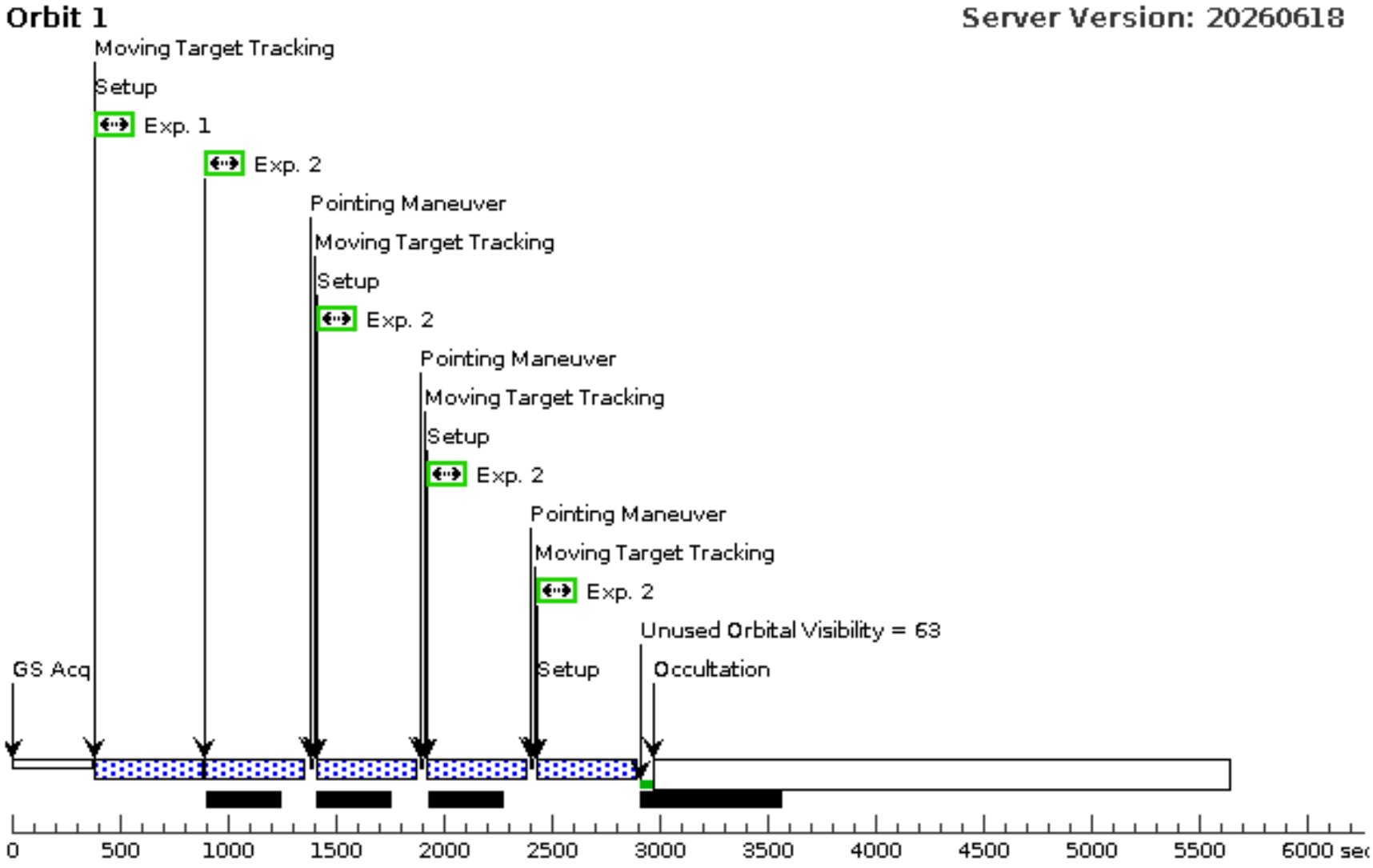
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	UNI	TYPE=ASTEROID,A=42.924569473864417,E=0.1462441869199175,I=19.42327844654774,O=204.6157936874821,W=276.0993480674751,M=310.1542385365317,EQUINOX=J2000,EPOCH=09-JUN-2026:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=uni

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP				350 Secs (350 Secs)	
								[==>]	***[1]***
2		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP			Pattern 1, Exps 2-2 in Occ. prep. 2 (02) (1)	350 Secs (1400 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 18335, Occ. prep. 3 (03) Tue Aug 04 18:01:24 GMT 2026

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-NOV-2026:00:00:00 AND 01-NOV-2026:10:00:00; BETWEEN 08-NOV-2026:17:30:00 AND 09-NOV-2026:17:30:00; BETWEEN 17-NOV-2026:01:00:00 AND 18-NOV-2026:01:00:00

Comments: Scheduled to take place at an orbit phase maximally separated from visits 1 and 2. As with those visits, there are three scheduling opportunities, each an orbit period (8.3095 days) apart. If needed, a slightly different orbit phase can be targeted to provide more scheduling flexibility with only a minimal loss in scientific return.

Diagnostics

(Occ. prep. 3 (03)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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		(2)

Solar System Targets

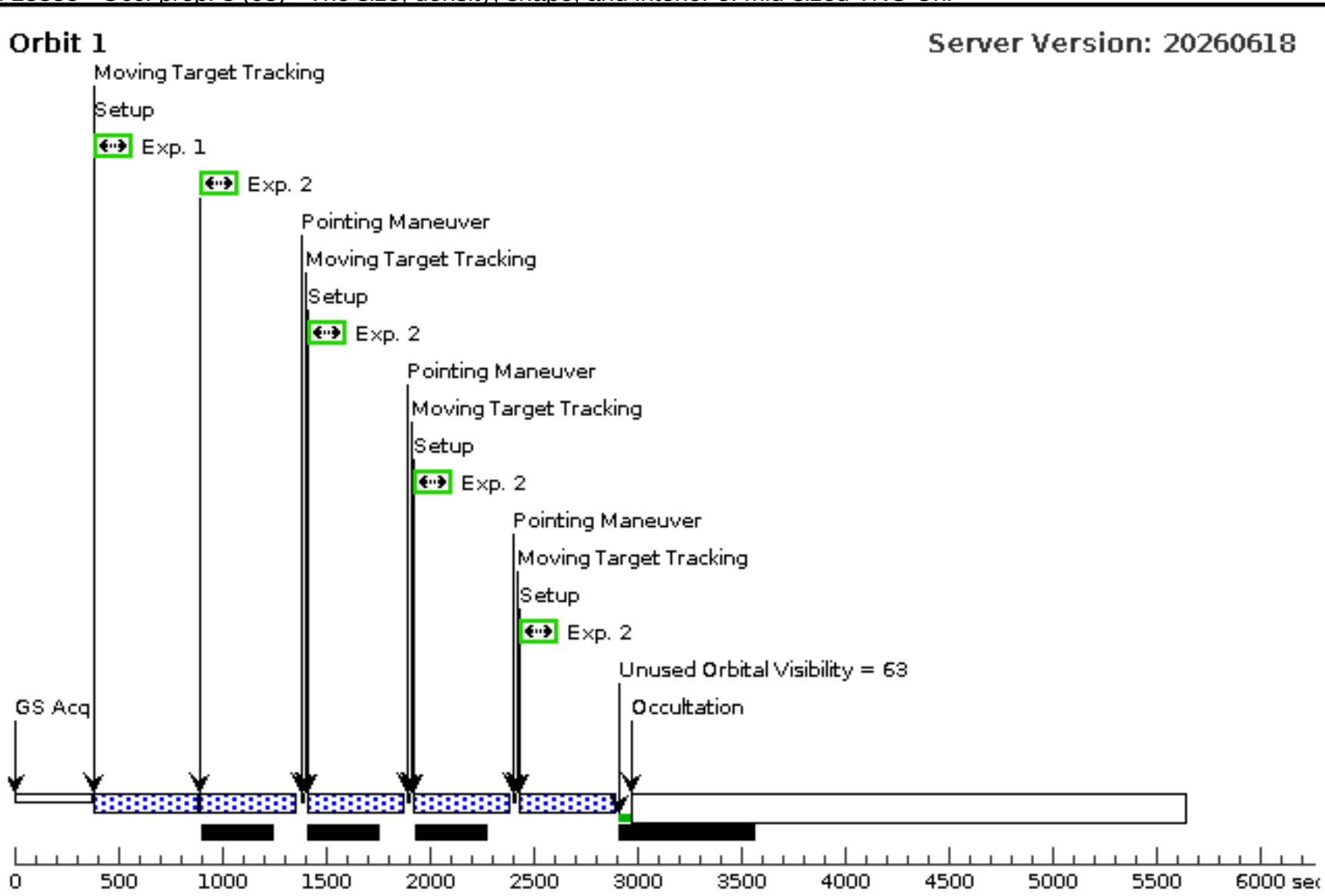
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	UNI	TYPE=ASTEROID,A=42.924569473866417,E=0.1462441869199175,I=19.42327844654774,O=204.6157936874821,W=276.0993480674751,M=310.1542385365317,EQUINOX=J2000,EPOCH=09-JUN-2026:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=uni

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP				350 Secs (350 Secs)	
								[==>]	***[1]***
2		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP			Pattern 1, Exps 2-2 in Occ. prep. 3 (03) (1)	350 Secs (1400 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 18335, Precession baseline 1 (04) Tue Aug 04 18:01:24 GMT 2026

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: ON HOLD

Comments: Initially on hold pending analysis of visits 1-3. Scheduling windows are expected to last ~1 day and recur every orbit period (8.3095 days).

On Hold Comments: On hold for Visits 1-3 to be analyzed. Will be scheduled when the target is visible with HST in July-Oct 2027. Scheduling windows should be similar to visits 1-3, although there will be more opportunities.

Diagnostics

(Precession baseline 1 (04)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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), (2)
(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		(3), (4)

Solar System Targets

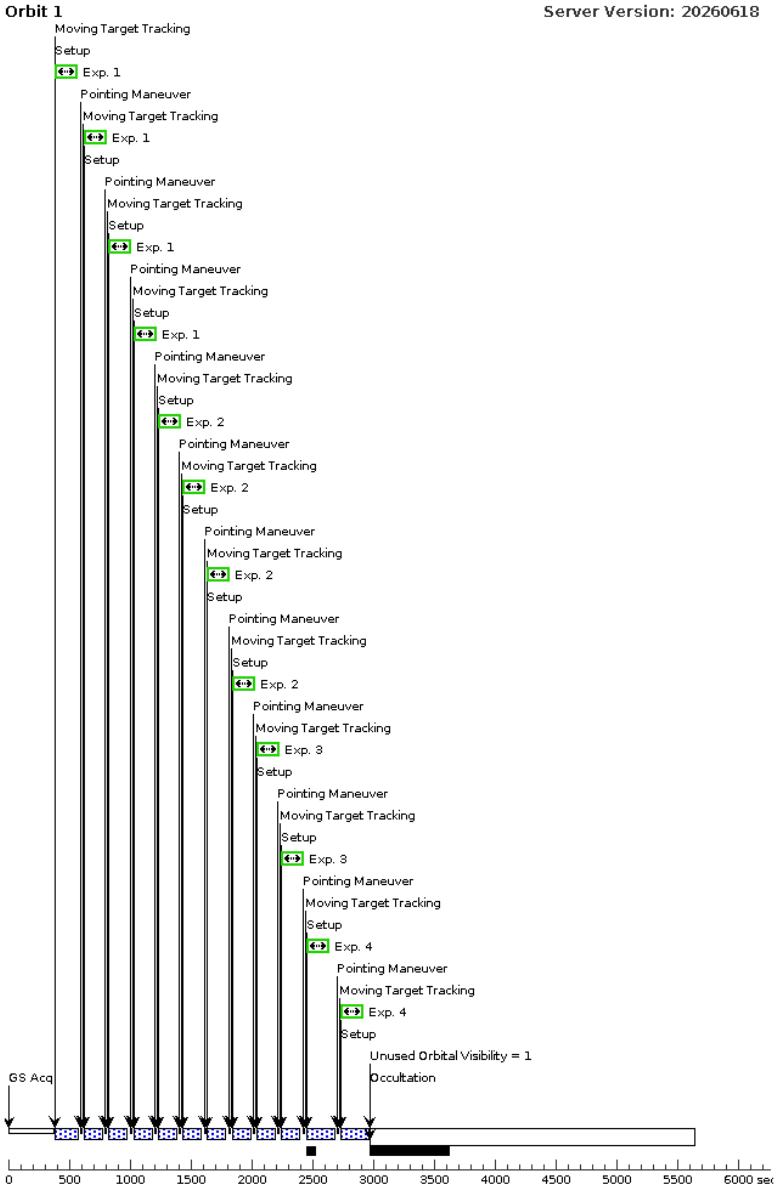
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	UNI	TYPE=ASTEROID,A=42.924569473864417,E=0.1462441869199175,I=19.42327844654774,O=204.6157936874821,W=276.0993480674751,M=310.1542385365317,EQUINOX=J2000,EPOCH=09-JUN-2026:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=uni

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 1, Exps 1-1 in Precession baseline 1 (04) (1)	100 Secs (428 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]* *[==>107.0 Secs (Pattern 3)]* *[==>107.0 Secs (Pattern 4)]*	***[1]***
2		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 1, Exps 2-2 in Precession baseline 1 (04) (1)	100 Secs (428 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]* *[==>107.0 Secs (Pattern 3)]* *[==>107.0 Secs (Pattern 4)]*	***[1]***
3		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 2, Exps 3-3 in Precession baseline 1 (04) (2)	100 Secs (214 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]*	***[1]***
4		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP	FLASH=10		Pattern 2, Exps 4-4 in Precession baseline 1 (04) (2)	100 Secs (214 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]*	***[1]***

Orbit Structure



Visit

Proposal 18335, Precession baseline 2 (05) Tue Aug 04 18:01:24 GMT 2026

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: ON HOLD

Comments: Initially on hold pending analysis of visits 1-3. Scheduling windows are expected to last ~1 day and recur every orbit period (8.3095 days).

On Hold Comments: On hold for Visits 1-3 to be analyzed. Will be scheduled when the target is visible with HST in July-Oct 2027. Scheduling windows should be similar to visits 1-3, although there will be more opportunities.

Diagnostics

(Precession baseline 2 (05)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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), (2)
(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		(3), (4)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	UNI	TYPE=ASTEROID,A=42.924569473864417,E=0.1462441869199175,I=19.42327844654774,O=204.6157936874821,W=276.0993480674751,M=310.1542385365317,EQUINOX=J2000,EPOCH=09-JUN-2026:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=uni

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 1, Exps 1-1 in Precession baseline 2 (05) (1)	100 Secs (428 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]* *[==>107.0 Secs (Pattern 3)]* *[==>107.0 Secs (Pattern 4)]*	***[1]***
2		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 1, Exps 2-2 in Precession baseline 2 (05) (1)	100 Secs (428 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]* *[==>107.0 Secs (Pattern 3)]* *[==>107.0 Secs (Pattern 4)]*	***[1]***
3		(1) UNI	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	FLASH=10		Pattern 2, Exps 3-3 in Precession baseline 2 (05) (2)	100 Secs (214 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]*	***[1]***
4		(1) UNI	WFC3/UVIS, ACCUM, UVIS	F350LP	FLASH=10		Pattern 2, Exps 4-4 in Precession baseline 2 (05) (2)	100 Secs (214 Secs) *[==>107.0 Secs (Pattern 1)]* *[==>107.0 Secs (Pattern 2)]*	***[1]***

Orbit Structure