17835 - Improving the masses of the Pluto Small Satellites

Cycle: 32, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Simon Bernard Porter (PI) (Contact)	**Southwest Research Institute**

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) PLUTO	WFC3/UVIS	1	30-May-2025 13:00:18.0	yes
02	(1) PLUTO	WFC3/UVIS	1	30-May-2025 13:00:18.0	yes
03	(1) PLUTO	WFC3/UVIS	1	30-May-2025 13:00:19.0	yes

3 Total Orbits Used

ABSTRACT

This program would measure astrometry for the small satellites of Pluto to update and improve their dynamical mass estimates. All four small satellites of Pluto were discovered by HST, and WFC3 has been the primary source of astrometry for them both before and after the New Horizons flyby in 2015. Styx and Keberos have only ever been observed with WFC3 due their extreme faintness (V~26-27). The proposed observations, which would be no earlier than Spring 2025, six years after the last HST observations of Pluto, would enable significant improvement in the orbits of Styx and Kerberos. Recently published dynamical studies of the Pluto small satellites (Kenyon & Bromley, 2022, Porter & Canup 2023) show that the much smaller Styx and Kerberos are sufficiently perturbed by Nix and Hydra that Styx and Kerberos can be used to constrain the mases of Nix and Hydra. This improvement in the orbits of Styx and Keberos would then directly help to better constrain the masses of Nix and Hydra, while also enabling the long-term monitoring of Styx and Kerberos that is critical to determine their masses. The masses of the small satellites of Pluto provide important constraints on the formation of the Pluto system. This in turn helps to constrain the moon-forming process after a giant impact, critical to

understanding planet formation in general. The proposed observations would use proven published techniques to measure the absolute astrometry of the small satellites relative to the background Gaia DR3 stars, eliminating the problem of historical anaylses that Pluto and Charon are barely resolved in WFC3 and make poor astrometric references.

OBSERVING DESCRIPTION

These are observations of the Pluto system to measure the positions of the satellites relative to background stars in order to improve their mass estimation (see Porter & Canup 2023 for desciption of the analysis to be performed). Some amount of background stars are expected and useful, and that's also why the observations are full frame, both chips.

However, as noted in the proposal, we will need to check each visit to make sure there isn't a direct star collision with any of the satellites. Pluto is in a dense star field, so there is a chance of that happening.

The timing requirements for the three visits are that they are sufficiently far apart to see significant motion of the satellites. The orbital period of Hydra is 38 days, so a separation between the orbits of at least 14 days (~1/3 of a Hydra orbit) is preferable, but any amount larger is fine, and the exact timing of the observations is not constrained. If needed, smaller timing separation are possible, but check with the PI.

All observations are 4 images in a box dither, with the F350LP filter, to maximize their throughput and efficiency.

Visit

Proposal 17835, Visit 01, completed Fri May 30 17:00:19 GMT 2025

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-MAY-2025:00:00 AND 07-MAY-2025:04:05; BETWEEN 14-MAY-2025:06:30 AND 18-MAY-2025:11:25; BETWEEN 18-MAY-2025:14:10 AND 30-MAY-2025:19:50; BETWEEN 30-MAY-2025:21:00 AND 31-MAY-2025:12:30; BETWEEN 31-MAY-2025:14:15 AND 04-JUN-2025:10:40; BETWEEN 04-JUN-2025:11:50 AND 04-JUN-2025:23:10; BETWEEN 05-JUN-2025:00:30 AND 05-JUN-2025:01:05; BETWEEN 05-JUN-2025:02:20 AND 05-JUN-2025:20:30; BETWEEN 05-JUN-2025:21:35 AND 10-JUN-2025:23:45; BETWEEN 11-JUN-2025:01:05 AND 22-JUN-2025:00:45; BETWEEN 22-JUN-2025:01:50 AND 24-JUN-2025:00:00

Diagnostics

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

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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)

Solar System Targets

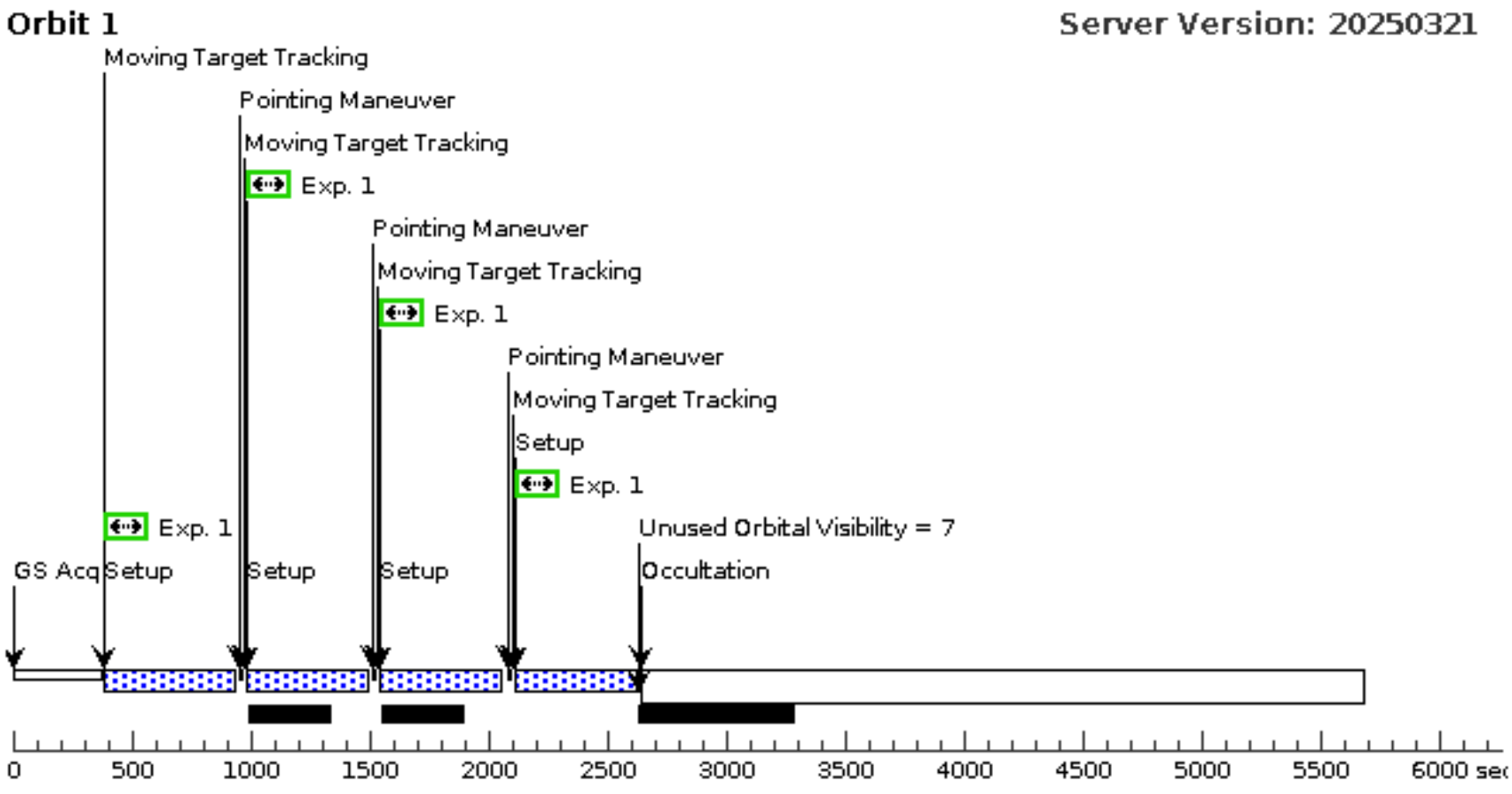
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PLUTO	STD=PLUTO				EARTH

Comments: Description=Pluto system

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PLUTO	WFC3/UVIS, ACCUM, UVIS2	F350LP			Sequence 1-1 Non-Int in Visit 01 Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 01 (2)	400 Secs (1600 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 17835, Visit 02, completed Fri May 30 17:00:19 GMT 2025

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER 01 BY 14 D TO 1000 D; BETWEEN 01-MAY-2025:00:00 AND 07-MAY-2025:04:05; BETWEEN 14-MAY-2025:06:30 AND 18-MAY-2025:11:25; BETWEEN 18-MAY-2025:14:10 AND 30-MAY-2025:19:50; BETWEEN 30-MAY-2025:21:00 AND 31-MAY-2025:12:30; BETWEEN 31-MAY-2025:14:15 AND 04-JUN-2025:10:40; BETWEEN 04-JUN-2025:11:50 AND 04-JUN-2025:23:10; BETWEEN 05-JUN-2025:00:30 AND 05-JUN-2025:01:05; BETWEEN 05-JUN-2025:02:20 AND 05-JUN-2025:20:30; BETWEEN 05-JUN-2025:21:35 AND 10-JUN-2025:23:45; BETWEEN 11-JUN-2025:01:05 AND 22-JUN-2025:00:45; BETWEEN 22-JUN-2025:01:50 AND 23-JUN-2025:03:35

Diagnostics

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

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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)

Solar System Targets

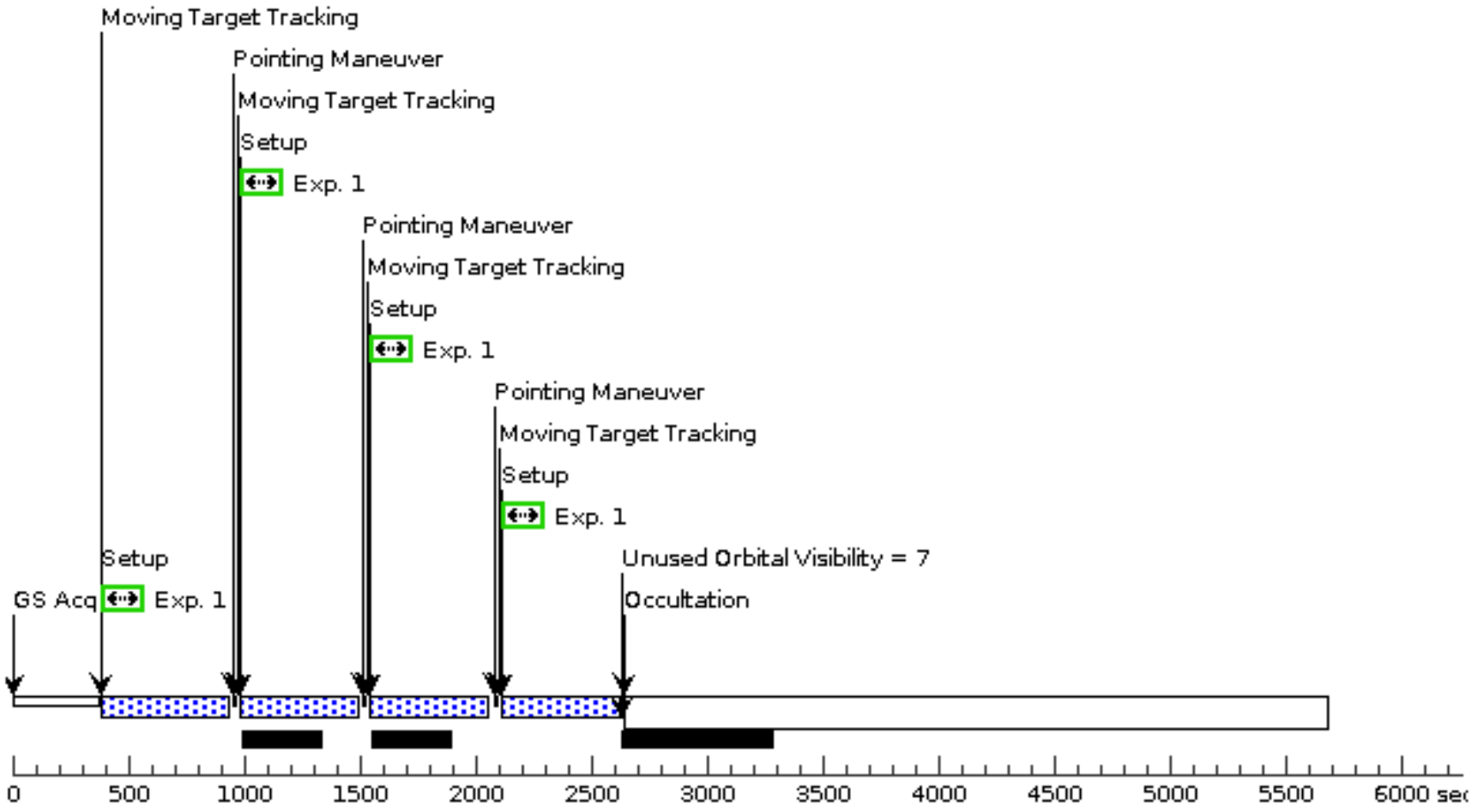
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PLUTO	STD=PLUTO				EARTH

Comments: Description=Pluto system

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PLUTO	WFC3/UVIS, ACCUM, UVIS2	F350LP			Sequence 1-1 Non-Int in Visit 02 Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 02 (2)	400 Secs (1600 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 17835, Visit 03, scheduling Fri May 30 17:00:19 GMT 2025

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER 02 BY 14 D TO 1000 D; BETWEEN 23-JUN-2025 AND 23-JUN-2025:02:30; BETWEEN 23-JUN-2025:04:00 AND 26-JUN-2025:00:10; BETWEEN 26-JUN-2025:02:05 AND 26-JUN-2025:15:45; BETWEEN 26-JUN-2025:16:55 AND 27-JUN-2025:07:25; BETWEEN 27-JUN-2025:08:25 AND 29-JUN-2025:19:40; BETWEEN 29-JUN-2025:21:00 AND 30-JUN-2025

Diagnostics

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

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	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)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PLUTO	STD=PLUTO				EARTH

Comments: Description=Pluto system

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PLUTO	WFC3/UVIS, ACCUM, UVIS2	F350LP			Sequence 1-1 Non-Int in Visit 03	400 Secs (1600 Secs)	
							Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 03 (2)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure