17993 - It Takes Two Planets to Tango: Constraining the Orbit of a Planetary-Mass Binary

Cycle: 33, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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Dr. Clemence Fontanive (CoI) (CSA Member)	Universite de Montreal
Dr. Chih-Chun Hsu (CoI)	Northwestern University
Dr. Johanna Vos (CoI) (ESA Member)	Trinity College Dublin

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
07	(1) 2MASS-J13550323-8258375	WFC3/UVIS	1	08-Aug-2025 17:00:15.0	yes
08	(1) 2MASS-J13550323-8258375	WFC3/UVIS	1	08-Aug-2025 17:00:16.0	yes
09	(1) 2MASS-J13550323-8258375	WFC3/UVIS	1	08-Aug-2025 17:00:17.0	yes
10	(1) 2MASS-J13550323-8258375	WFC3/UVIS	1	08-Aug-2025 17:00:18.0	yes

4 Total Orbits Used

ABSTRACT

We aim to measure the orbit of the plantary-mass (M < 13 M_Jup) binary WISE J135501.90-825838.9, the second-lowest mass (unresolved) binary currently known. This binary was first identified as a "spectral binary," a composite object of two unresolved near-infrared spectra which have the features of two ultracool (T < 1300 K) objects combined into one spectrum. A preliminary RV and parallax solution place WISE 1355-8258 within the AB Doardus kinematic association (150-200 Myr). The WISE parallax + proper motion solution also shows a periodic astrometric signal in the residuals, which is likely due to the orbital motion of the binary. However, higher precision astrometry is needed to constrain the orbital parameters, which has an estimated period of P ~ 1116 days. Using HST/WFC3-UVIS we will obtain a precise astrometric solution for the parallax and proper motion, and constrain the orbital solution in the periodic motion of the astrometric residuals using 10 orbits over the next 2 cycles (6+4 orbits). These measurements will provide the first ever direct mass measurement of a planetary-mass binary. This system will be a touchstone benchmark system for models of planet formation and evolution.

OBSERVING DESCRIPTION

Each orbit is spaced at least 2 months apart and is set to cover the longest time baseline possible within Cycle 32 while also offering higher coverage during the estimated maximum orbital separation of the two binary components. We are unable to cover the entire estimated orbital period of 1116 days, but we are able to cover approximately a third of the orbit which will allow us to put preliminary constraints on the orbital motion of the binary. We have 4 additional epochs in Cycle 33, which will allow us to constrain the orbital parameters to better than 1%.

We have grouped epochs into 3 groups of 2 orbits, where each group of 2 orbits is taken within 1 month of each other, and each group is separated by 3 months, maximizing the time baseline of Cycle 32 (6 orbits total in Cycle 32). We will utilize an additional 4 orbits over the maximum time baseline of Cycle 33 to sample the majority of the estimated period. This strategy will also allow us to detect shorter and longer periods of orbital movement, between ~60--2000 days.

The first epoch should be taken as early as possible (approximately November 28th, 2024), and the last epoch as late as possible (approximately October 31, 2025). We have created windows for each orgit that span ~20 days, offering flexibility in scheduling while also covering the requested time baseline for each epoch (orbit) and grouping of orbits.

Each drift-scan image is taken along a principal axis of the detector. After each drift-scan image, we perform a large dither along the same axis and direction as the previous image before the next drift-scan image is taken along another principal axis. This effectively makes a box pattern which will help us reduce systematics.

Each epoch contains two images in point source imaging mode, and four in spatial-scanning mode with WFC3/UVIS.

In addition to the images taken in spatial scan mode using F775W which will be used for absolute astrometry, we will take two short exposure (100s) point-source images at the beginning and at the end of the single orbit visits in F775W and F606W. These snapshots will provide information about calibrator source color, which is paramount to discriminate object type and distance of the reference sources in the field.

Visit

Proposal 17993, Epoch 7 (Cycle 33) (07) Fri Aug 08 21:00:18 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 16-JAN-2026:00:00:00 AND 24-JAN-2026:23:59:00

Fixed Targets

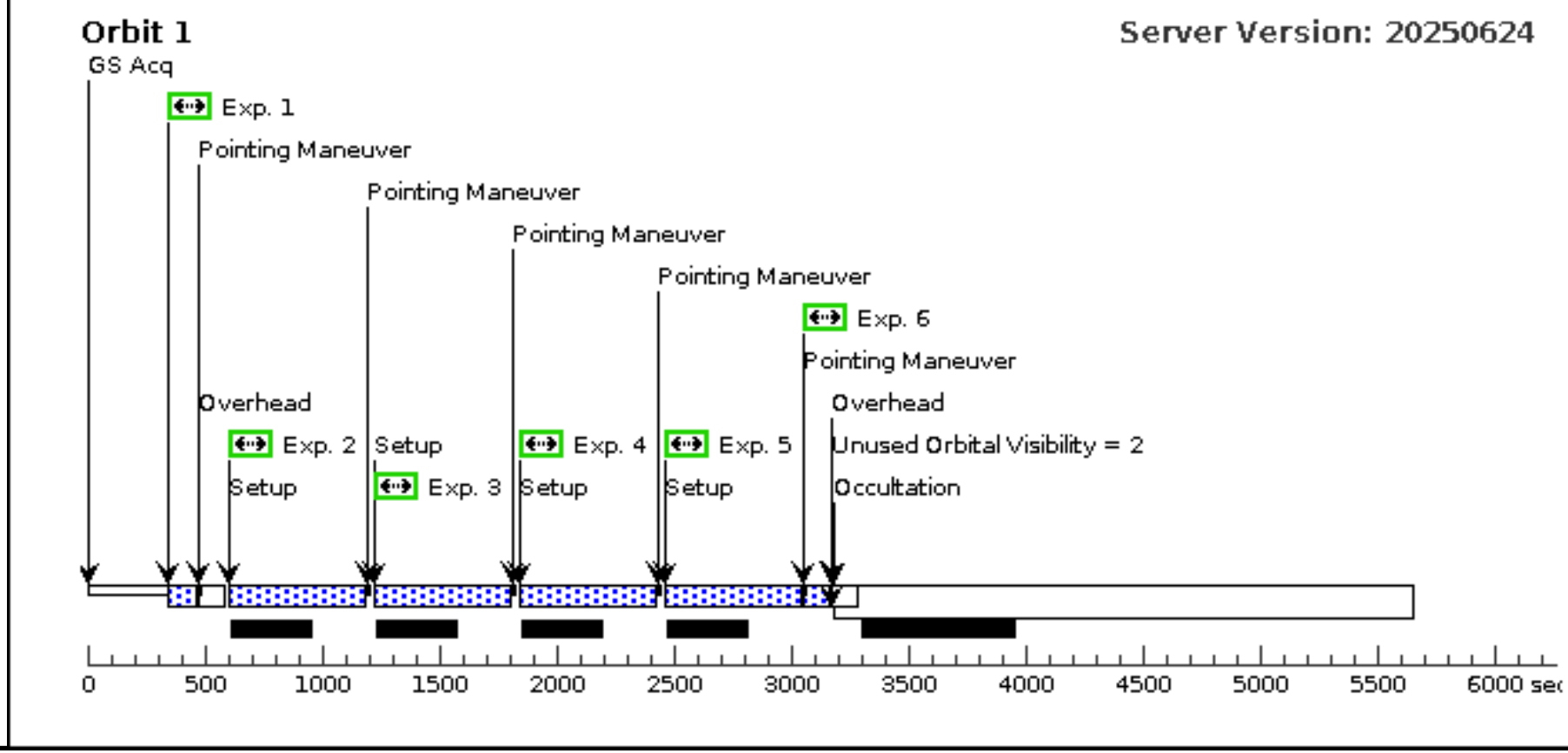
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J13550323-8258375	RA: 13 55 1.9050 (208.7579375d) Dec: -82 58 38.96 (-82.97749d) Equinox: J2000	Proper Motion RA: -248.0 mas/yr Proper Motion Dec: -161.0 mas/yr Parallax: 0.062" Epoch of Position: 2010	V=18.2+/-1 J=16.135+-0.128; H=15.310+-0.132; K=14.721+-0.137	Reference Frame: ICRS

Comments:
Category=STAR
Description=[BROWN DWARF, EXTRA-SOLAR PLANET]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F775W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***
2	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,4; SPATIAL SCAN 0.0013,270.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
3	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,-4; SPATIAL SCAN 0.0013,0.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
4	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,-4; SPATIAL SCAN 0.0013,90.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
5	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,4; SPATIAL SCAN 0.0013,180.0 Degrees,Forward		400 Secs (451 Secs) *[==>451.0 Secs]*	 ***[1]***
6	F606W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F606W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***

Orbit Structure



Visit

Proposal 17993, Epoch 8 (Cycle 33) (08) Fri Aug 08 21:00:19 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 03-MAR-2026:00:00:00 AND 15-MAR-2026:23:59:00

Fixed Targets

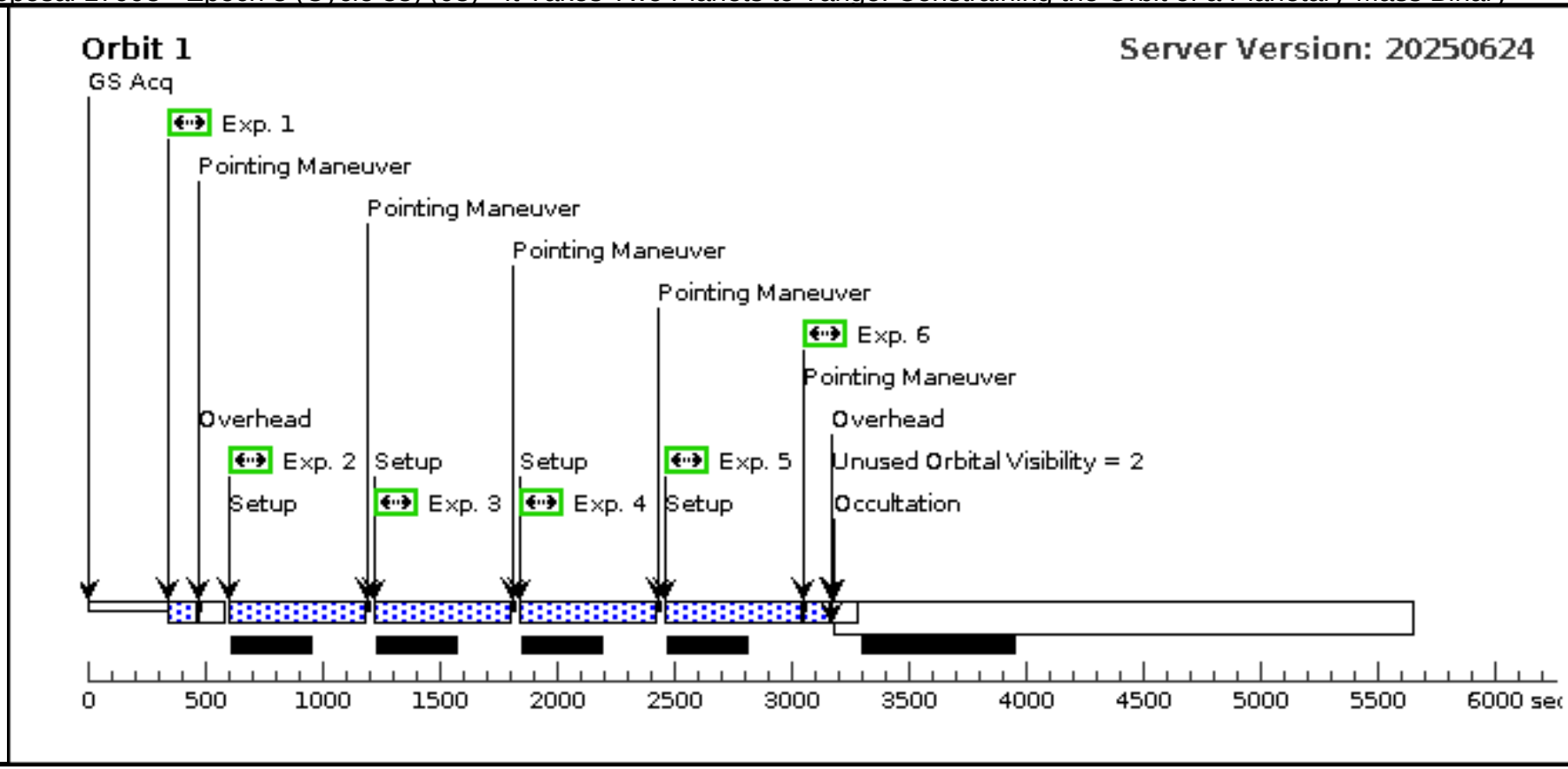
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J13550323-8258375	RA: 13 55 1.9050 (208.7579375d) Dec: -82 58 38.96 (-82.97749d) Equinox: J2000	Proper Motion RA: -248.0 mas/yr Proper Motion Dec: -161.0 mas/yr Parallax: 0.062" Epoch of Position: 2010	V=18.2+/-1 J=16.135+-0.128; H=15.310+-0.132; K=14.721+-0.137	Reference Frame: ICRS

Comments:
Category=STAR
Description=[BROWN DWARF, EXTRA-SOLAR PLANET]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F775W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***
2	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,4; SPATIAL SCAN 0.0013,270.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
3	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,-4; SPATIAL SCAN 0.0013,0.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
4	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,-4; SPATIAL SCAN 0.0013,90.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
5	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,4; SPATIAL SCAN 0.0013,180.0 Degrees,Forward		400 Secs (451 Secs) *[==>451.0 Secs]*	 ***[1]***
6	F606W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F606W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***

Orbit Structure



Visit

Proposal 17993, Epoch 9 (Cycle 33) (09) Fri Aug 08 21:00:19 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 01-JUN-2026:00:00:00 AND 16-JUN-2026:23:59:00

Fixed Targets

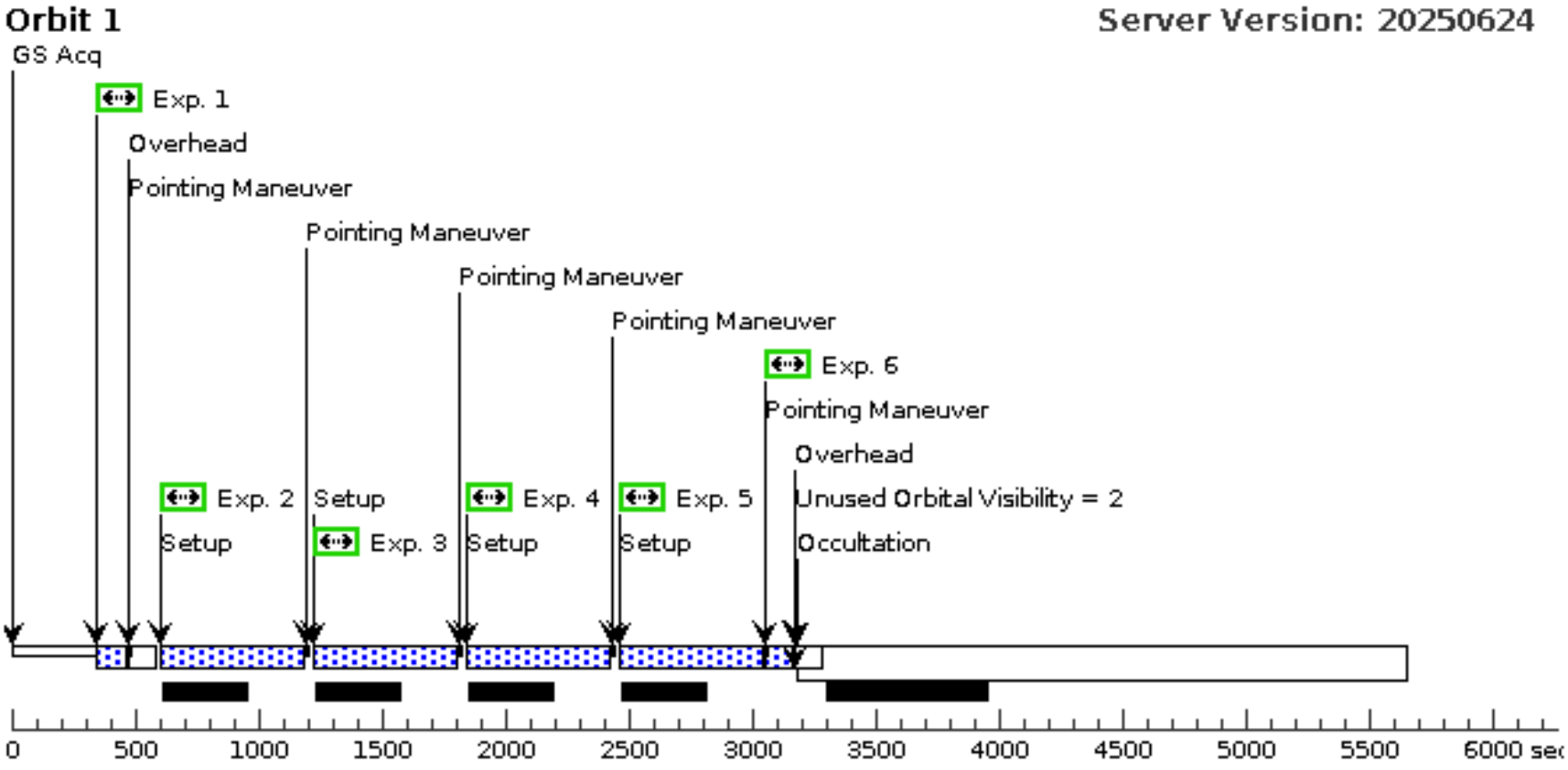
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J13550323-8258375	RA: 13 55 1.9050 (208.7579375d) Dec: -82 58 38.96 (-82.97749d) Equinox: J2000	Proper Motion RA: -248.0 mas/yr Proper Motion Dec: -161.0 mas/yr Parallax: 0.062" Epoch of Position: 2010	V=18.2+/-1 J=16.135+-0.128; H=15.310+-0.132; K=14.721+-0.137	Reference Frame: ICRS

Comments:
Category=STAR
Description=[BROWN DWARF, EXTRA-SOLAR PLANET]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F775W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***
2	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,4; SPATIAL SCAN 0.0013,270.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
3	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,-4; SPATIAL SCAN 0.0013,0.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
4	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,-4; SPATIAL SCAN 0.0013,90.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
5	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,4; SPATIAL SCAN 0.0013,180.0 Degrees,Forward		400 Secs (451 Secs) *[==>451.0 Secs]*	 ***[1]***
6	F606W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F606W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***

Orbit Structure



Visit

Proposal 17993, Epoch 10 (Cycle 33) (10) Fri Aug 08 21:00:19 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 07-SEP-2026:00:00:00 AND 18-SEP-2026:23:59:00

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J13550323-8258375	RA: 13 55 1.9050 (208.7579375d) Dec: -82 58 38.96 (-82.97749d) Equinox: J2000	Proper Motion RA: -248.0 mas/yr Proper Motion Dec: -161.0 mas/yr Parallax: 0.062" Epoch of Position: 2010	V=18.2+/-1 J=16.135+-0.128; H=15.310+-0.132; K=14.721+-0.137	Reference Frame: ICRS

Comments:
Category=STAR
Description=[BROWN DWARF, EXTRA-SOLAR PLANET]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F775W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***
2	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,4; SPATIAL SCAN 0.0013,270.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
3	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG -4,-4; SPATIAL SCAN 0.0013,0.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
4	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,-4; SPATIAL SCAN 0.0013,90.0 Degrees,Forward		400 Secs (452 Secs) *[==>452.0 Secs]*	 ***[1]***
5	F775W exposure (WFC3UVIS.si.1930980)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F775W	FLASH=10	POS TARG 4,4; SPATIAL SCAN 0.0013,180.0 Degrees,Forward		400 Secs (451 Secs) *[==>451.0 Secs]*	 ***[1]***
6	F606W Snapshot (WFC3UVIS.im.1930440)	(1) 2MASS-J13550323-8258375	WFC3/UVIS, ACCUM, UVIS1	F606W	FLASH=18	POS TARG -4,4		100 Secs (88 Secs) *[==>88.0 Secs]*	 ***[1]***

Orbit Structure