14928 - Orbit of the Patroclus-Menoetius Binary, a Lucy Mission Target

Cycle: 24, 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?*
11	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:39.0	yes
01	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:41.0	yes
02	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:43.0	yes
03	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:44.0	yes
04	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:46.0	yes
05	(1) PATROCLUS	WFC3/UVIS	1	02-May-2017 21:03:48.0	yes

6 Total Orbits Used

ABSTRACT

We are proposing to observe Trojan binary asteroid (617) Patroclus-Menoetius, one of the targets of the Lucy mission. Lucy was selected as the next Discovery mission on January 4, 2017, for launch in October 2021. Observations this year are needed to establish the mutual orbit of the binary, which is of critical importance for mission planning. The mutual orbit phase is essentially undetermined from the accumulation of orbit period

uncertainty since last measured in 2010. Orbital phase is needed in order to be able to predict the timing of mutual events that will begin late in 2017. These mutual events are essential to planning for the Lucy mission, especially in establishing the precise orientation of the mutual orbit plane and ascending node that is critical to early planning for flyby encounter design and capabilities.

OBSERVING DESCRIPTION

Observations will consist of five one-orbit visits. Each visit will have a minimum component of 9 dithers in the F555W. For at least one visit we will supplement this with additional color filters as proposed.

We will use the phase option to tie visits to the 103 hour orbit of the binary in order to get sampling around the orbit. If possible, the observations should span multiple binary orbit periods consistent with the phasing (i.e. add n*P). All observations must be completed by June 24, 2017.

We have a preference for some of the visits to occur as soon as possible in order to maximize angular resolution.

Visit

Proposal 14928, Visit 11, implementation Wed May 03 01:03:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BEFORE 25-JUN-2017:00:00:00; ON HOLD

On Hold Comments: version of first visit with filters separated. less efficient but allows for orbit splitting if needed

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), (2-3)

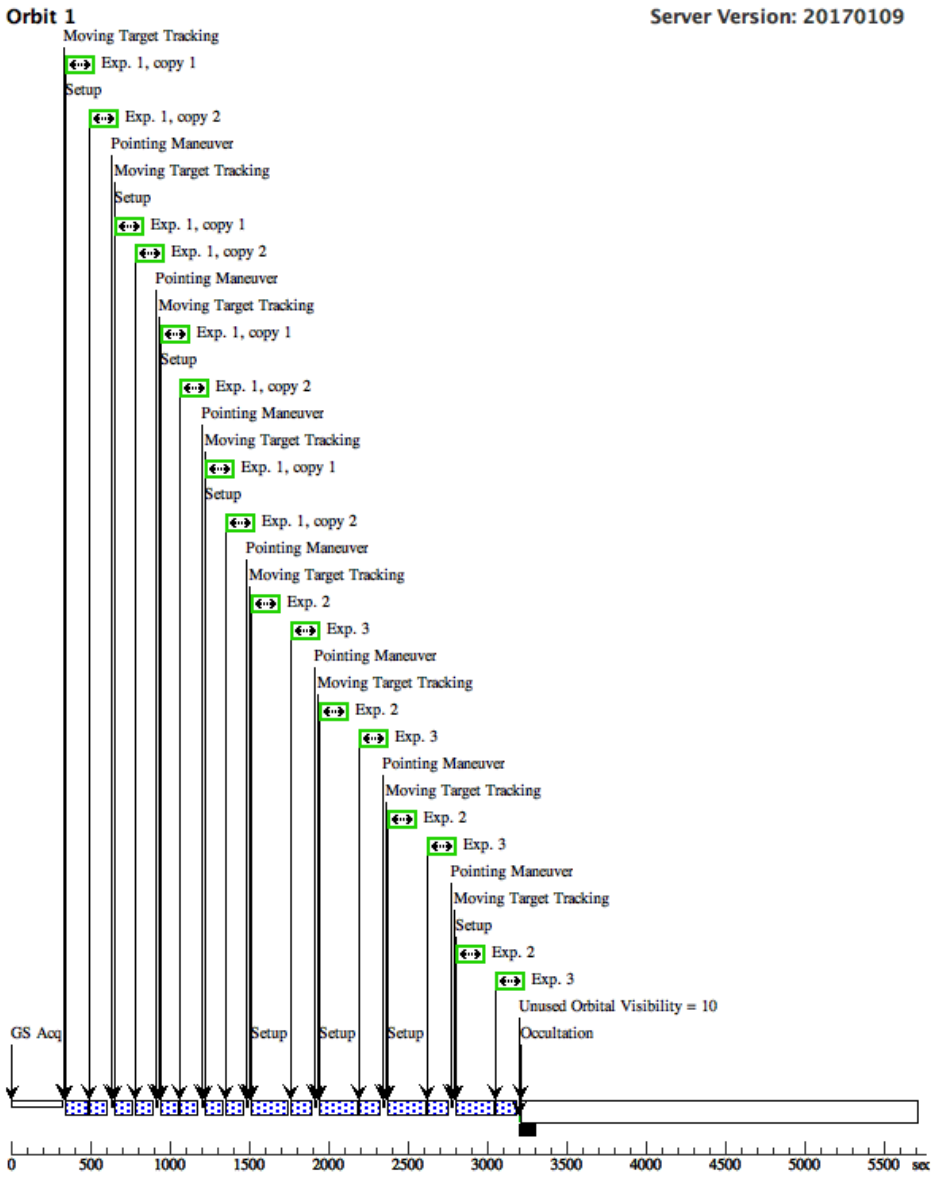
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-1 Non-Int in Visit 11 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 11 (1)	60 Secs X 2 (480 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F438W	FLASH=11		Sequence 2-3 Non-Int in Visit 11 Pattern 1, Exps 2-3 in Sequence 2-3 Non-Int in Visit 11 (1)	160 Secs (640 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
3		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 2-3 Non-Int in Visit 11 Pattern 1, Exps 2-3 in Sequence 2-3 Non-Int in Visit 11 (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14928, Visit 01, implementation Wed May 03 01:03:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

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		(1-3)

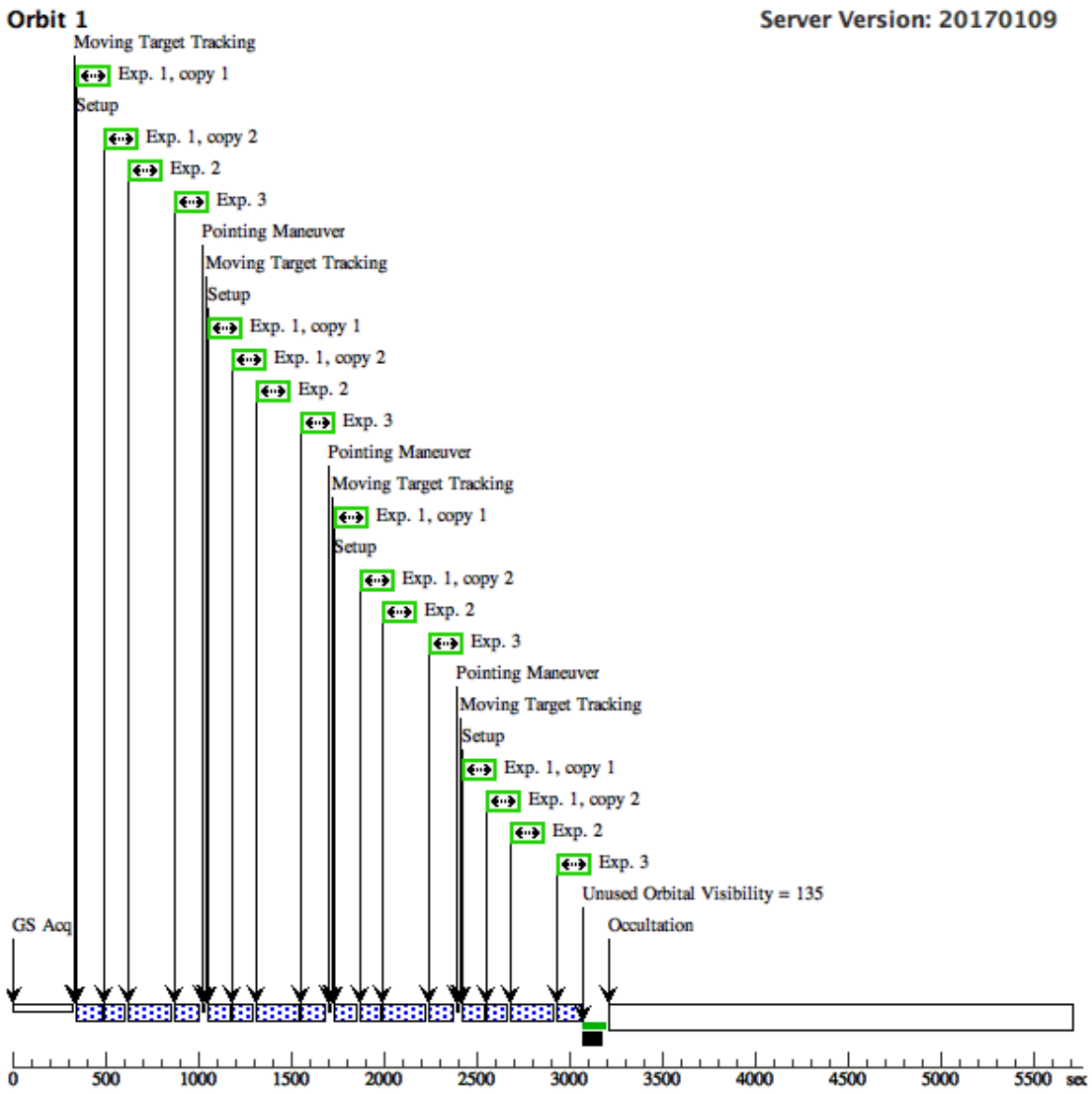
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-3 Non-Int in Visit 01 Pattern 1, Exps 1-3 in Sequence 1-3 Non-Int in Visit 01 (1)	60 Secs X 2 (480 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F438W	FLASH=11		Sequence 1-3 Non-Int in Visit 01 Pattern 1, Exps 1-3 in Sequence 1-3 Non-Int in Visit 01 (1)	160 Secs (640 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
3		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 1-3 Non-Int in Visit 01 Pattern 1, Exps 1-3 in Sequence 1-3 Non-Int in Visit 01 (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14928, Visit 02, implementation

Wed May 03 01:03:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 29-MAY-2017:21:50:00 AND 29-MAY-2017:22:40:00

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)

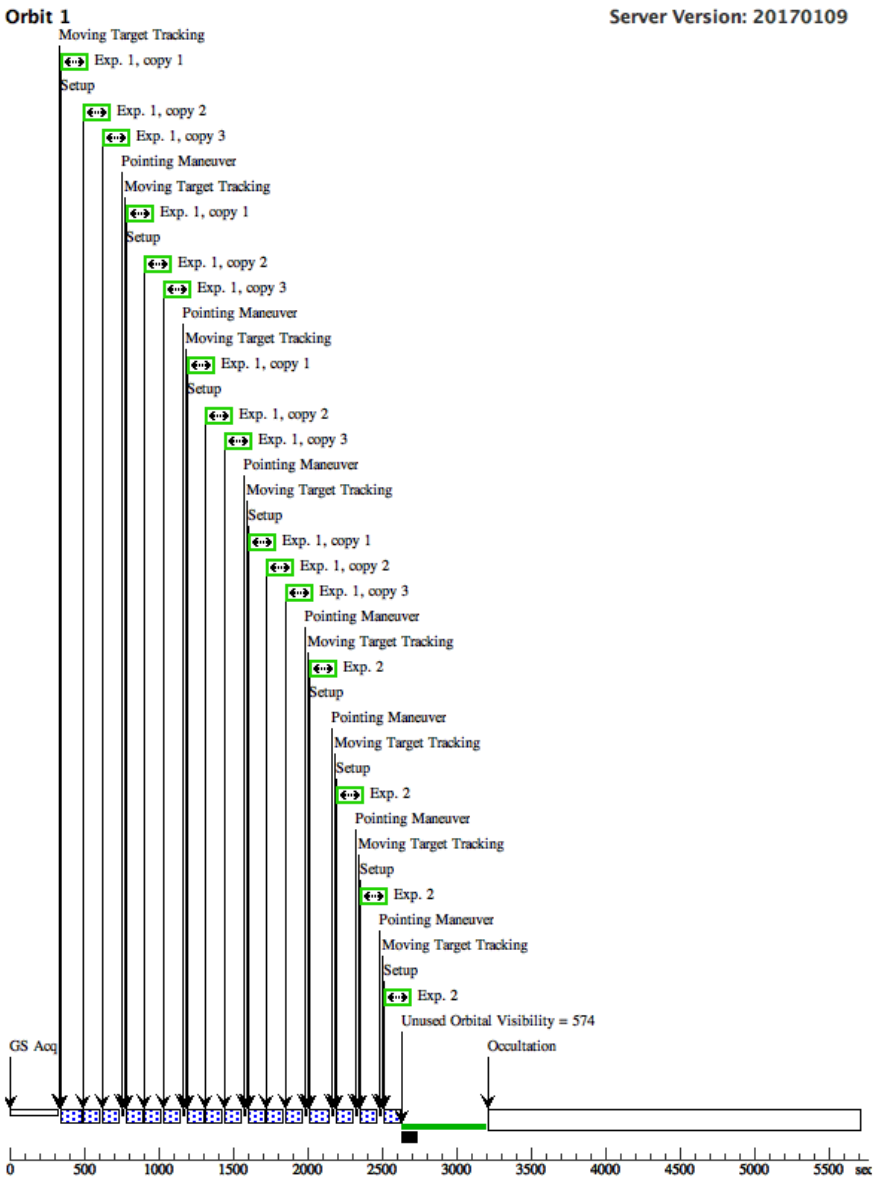
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-1 Non-Int in Visit 02 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 02 (1)	60 Secs X 3 (720 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 2-2 Non-Int in Visit 02 Pattern 1, Exps 2-2 in Sequence 2-2 Non-Int in Visit 02 (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14928, Visit 03, implementation

Wed May 03 01:03:49 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

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)

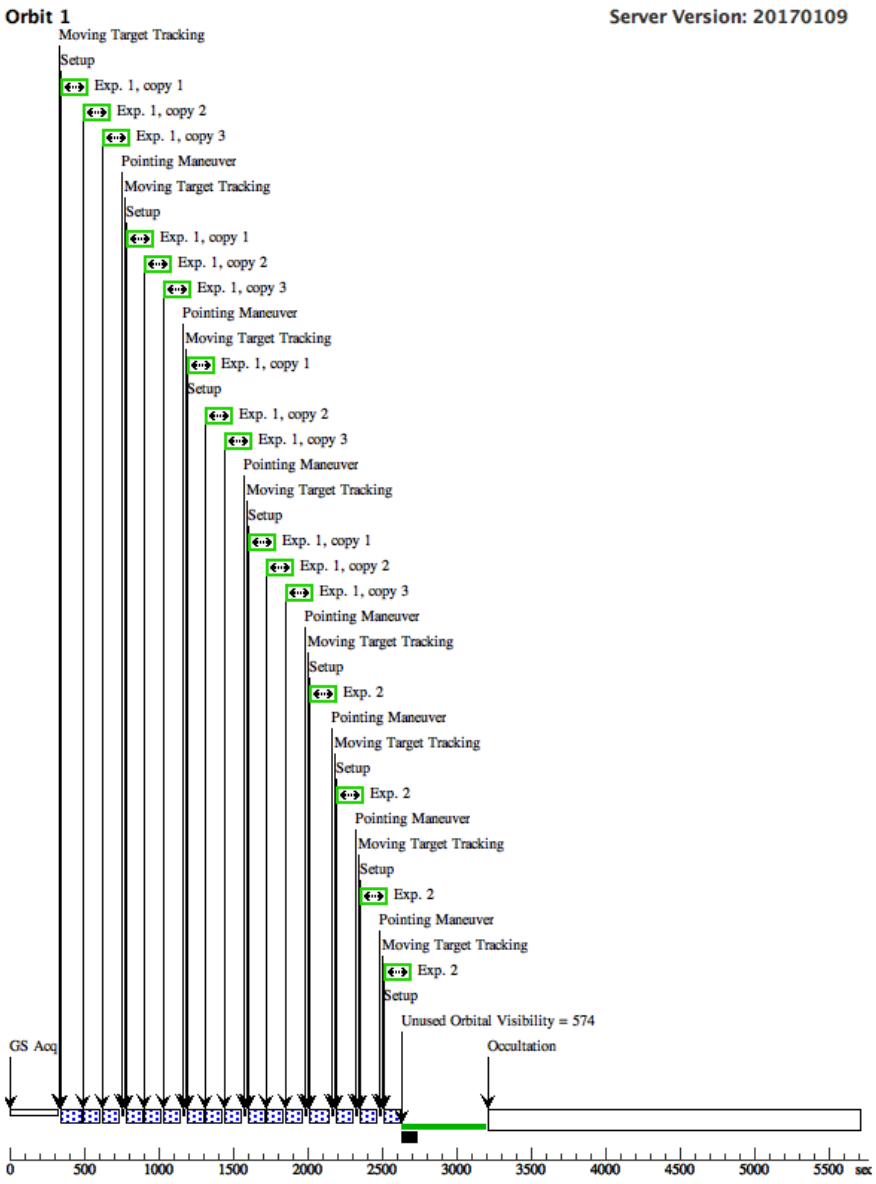
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-1 Non-Int in Visit 03 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 03 (1)	60 Secs X 3 (720 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 2-2 Non-Int in Visit 03 Pattern 1, Exps 2-2 in Sequence 2-2 Non-Int in Visit 03 (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14928, Visit 04, implementation Wed May 03 01:03:50 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

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)

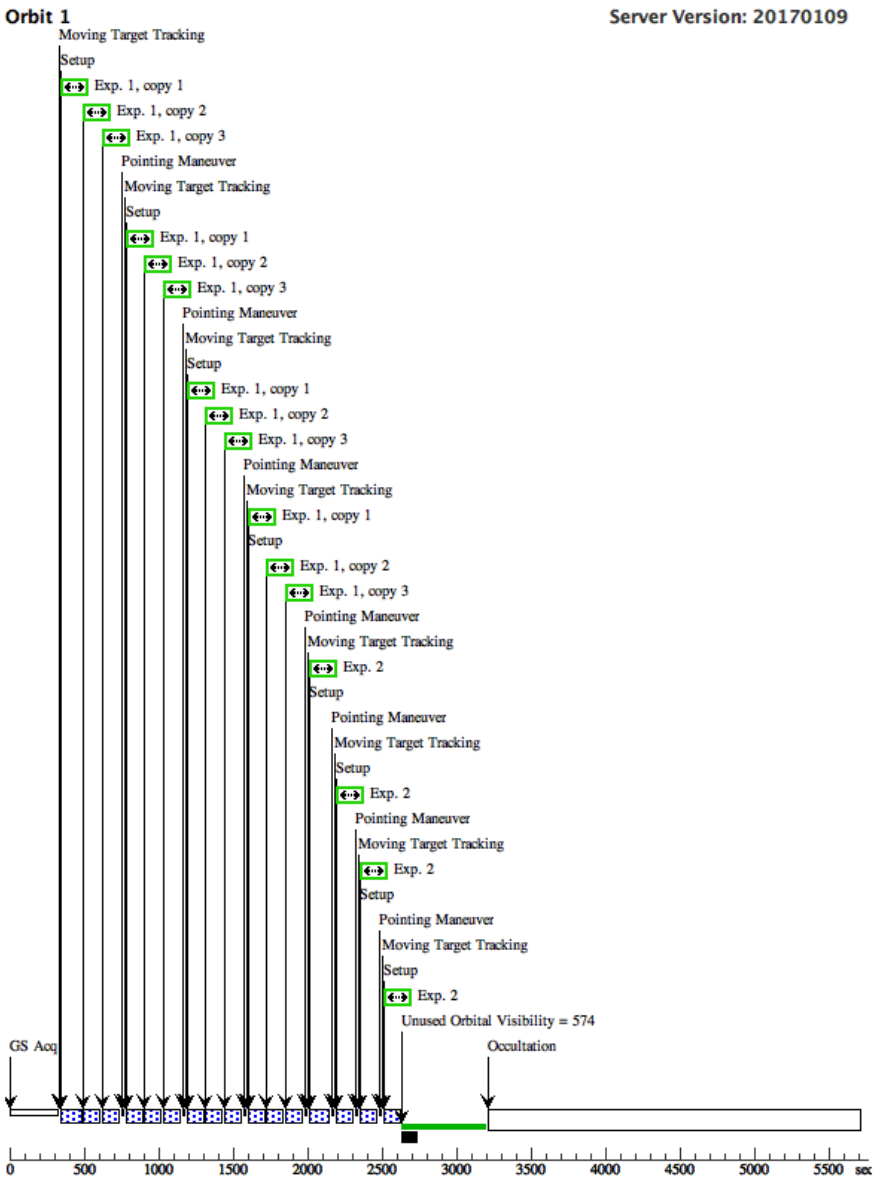
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-1 Non-Int in Visit 04 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 04 (1)	60 Secs X 3 (720 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 2-2 Non-Int in Visit 04 Pattern 1, Exps 2-2 in Sequence 2-2 Non-Int in Visit 04 (1)	60 Secs (240 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Proposal 14928 - Visit 05 - Orbit of the Patroclus-Menoetius Binary, a Lucy Mission Target

Visit

Proposal 14928, Visit 05, implementation

Wed May 03 01:03:50 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 14-JUN-2017:06:35:00 AND 14-JUN-2017:07:20:00

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)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	PATROCLUS	TYPE=ASTEROID,A=5.217346931413996 ,E=0.1382962811465384,I=22.04733136614898,O=44.3552188187178 ,W=308.3729072973491 ,M=137.0180464264951 ,EQUINOX=J2000,EPOCH=16-FEB-2017:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F555W	FLASH=11	GS ACQ SCENARIO BASE1B3	Sequence 1-1 Non-Int in Visit 05	60 Secs X 3 (720 Secs)	
							Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 05 (1)	*[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]*	***[1]***
2		(1) PATROCLUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F814W	FLASH=11		Sequence 2-2 Non-Int in Visit 05	60 Secs (240 Secs)	
							Pattern 1, Exps 2-2 in Sequence 2-2 Non-Int in Visit 05 (1)	*[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: Phasing requirements discussed in the phase 1 are required, but have not been included in the phase 2 because there is no way to do this easily without artificially overconstraining the problem.

For the Patroclus binary we will assume a binary orbital period of 103.11 hours for planning purposes. The goal is to get five visits at every 0.20+/-0.02 of this orbital phase. The uncertainty in the phasing of +/-0.02 corresponds to +/-2 hours so that multiple orbits should be usable on a given day. It is possible to relax this if needed with consultation.

There is no particular phase at which we need to start, but we do have preferred times for visit 1 which contains all three color filters. Those times, in JD, starting in mid-May from the time of the last estimated peak are shown below. We prefer as close to the start of this list as possible for angular resolution. Acceptable start times are +/-5 hours for this visit relative to the tabulated time below if this is used as the first visit. Subsequent visits would then follow the phasing as described above.

binary orbit	*JD 2457...*	*date*
10	*876.79*	*May 03, 6:58*
11	*881.09*	*May 07, 14:10*
12	*885.38*	*May 11, 21:07*
13	*889.68*	*May 16, 04:19*
14	*893.98*	*May 20, 11:31*
15	*898.27*	*May 24, 18:29*
16	*902.57*	*May 29, 01:41*
17	*906.86*	*Jun 02, 08:38*
18	*911.16*	*Jun 06, 15:50*
19	*915.46*	*Jun 10, 23:02*
20	*919.75*	*Jun 15, 06:00*
21	*924.04*	*Jun 19, 12:57*
22	*928.35*	*Jun 23, 20:24*

In addition to the above phasing, we have a preference for the visits to be spread over multiple binary orbital periods as described in the phase 1. Ideally the first and last visits would be separated by at least 4 binary orbit periods. However, implementation of this preference is flexible and should not override other scheduling considerations.

Orbit Structure