15171 - The rotation period, orbit, and mass of Eris' satellite Dysnomia

Cycle: 25, Proposal Category: GO

(JWST Initative)

(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	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:03:59.0	yes
02	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:00.0	yes
03	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:01.0	yes
53	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:02.0	yes
04	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:03.0	yes
05	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:04.0	yes
06	(2) ERIS-OFFSET	WFC3/UVIS	1	05-Jan-2018 20:04:05.0	yes

7 Total Orbits Used

ABSTRACT

Almost 80 satellite systems have been identified in the trans-Neptunian region in the outer Solar System. These systems fall into two classes: equal mass, wide separation binaries and large primaries with relatively small satellites. The existence of these two distinct classes suggests different formation mechanisms of capture and giant impact, respectively, but there is no way to confirm this without more in-depth observations of a given system. Little is known about the majority of these satellite systems besides the orbital period and the relative brightness of the components. The orbital period provides the total system mass but does nothing to constrain the masses of the individual components. The mass and rotation period of the satellite can provide valuable information about the tidal state and thus the formation mechanism of the second class of binary systems. Previous observations of large trans-Neptunian objects (TNOs) with multiple satellites point to formation by giant impact, but never before has this kind of investigation been performed for a large TNO with only one satellite. In this work, we propose to observe Eris and its satellite Dysnomia with the WFC3 instrument to provide useful constraints on the mass Dysnomia, calculate Dysnomia's rotation period, and compute an improved orbit solution for Dysnomia, with the ultimate goal of understanding the origin of this and other large TNO binary systems.

OBSERVING DESCRIPTION

These observations of Eris and its satellite, Dysnomia, are designed to provide data for two separate investigations: constructing a rotation light curve of Dysnomia and measuring the wobble of Eris. Data for a third investigation, a new calculation of Dysnomia's orbit, come from the the observations that satisfy the other two investigations. To measure the wobble of Eris, the motion of Eris around the system barycenter due to the gravitational influence of Dysnomia, a majority of the orbits are timed to coincide with the maximum elongation of Dysnomia; the times of maximum elongation were extrapolated from Brown and Schaller (2007). Al six orbits are planned to occur within one orbital period of Dysnomia (15.774 days) to avoid the effects of changing phase angle. Two of the six orbits in this program are timed to coincide with one maximum elongation, while two more are timed to coincide with the opposite maximum elongation. We place 3-7 HST orbits between the two orbits at each maximum elongation. The two maximum elongation sets are separated by ~7.9 days (about half of a rotation period). The remaining two orbits are set up to be made at some point in a large range between the maximum elongations (one on either side of Dysnomia's orbit). The large ranges for these two orbits satisfy two goals: enable more flexible scheduling and mitigate aliasing in the determination of Dysnomia's rotation period. Photometry will be performed on all the images to extract the flux from Dysnomia and construct a rotational light curve. Additionally, the short time between the two orbits at each maximum elongation serve the purpose of testing for short (~5-12 hour) periods. Relative astrometry between Eris and Dysnomia in each image will be used to compute an orbital solution for Dysnomia. In order to obtain enough stars for the absolute astrometry required to measure Eris' wobble, a full readout of the WFC3/UVIS detector is required. This means the minimum time for each image is 348 seconds to prevent a loss of time for a buffer dump. Four of these images are planned using the WFC-UVIS-DITHER-BOX, a four-point box dither used for sub-sampling the PSF. Each box dither is

followed by one 585-second image to fill out the orbit; some leeway is left so as not to fill the entire orbit and therefore open up the scheduling options. Eris saturates in the 585-second images, but is not saturated in the 348-second images, allowing for the possibility of obtaining photometric measurements of Eris for construction of a rotational light curve. Large orientation ranges are provided to prevent Dysnomia from falling in the same columns as Eris, especially for the 585-second images where Eris saturates and may bleed into nearby pixels in the columns. The orientation ranges are not meant to avoid the diffraction spikes, although this was the original plan; such constraints, combined with the timing constraints, placed significant constraints on the observations as a whole and rendered them unschedulable.

Visit

Proposal 15171, Maximum elongation 1-1 (01), completed Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; Period 7.887 D AND ZERO-PHASE HJD2458032.92355; SEQ 01,02,03,04,05,06 WITHIN 15.774 D

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=true		(1)

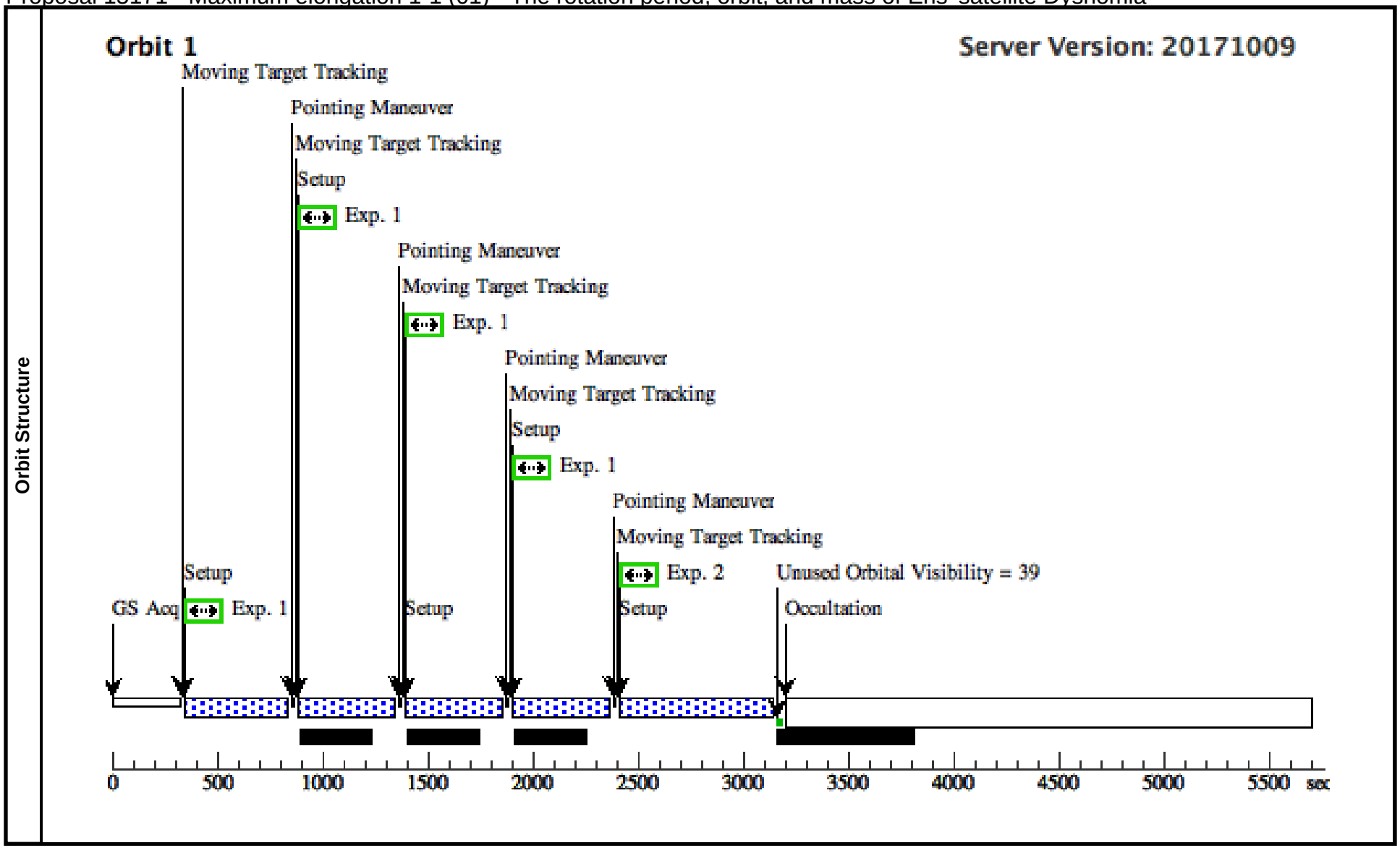
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W		PHASE 0 TO 0.05	Pattern 1, Exps 1-1 in Maximum elongation 1-1 (01) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W		PHASE 0 TO 0.05		585 Secs (585 Secs)	
								[==>]	***[1]***


Orbit 1
Server Version: 20171009
Orbit Structure
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 2
Unused Orbital Visibility = 39
Setup
GS Acq
Exp. 1
Setup
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15171, Maximum elongation 1-2 (02), completed Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; AFTER 01 BY 3 Orbits TO 7 Orbits

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=true		(1)

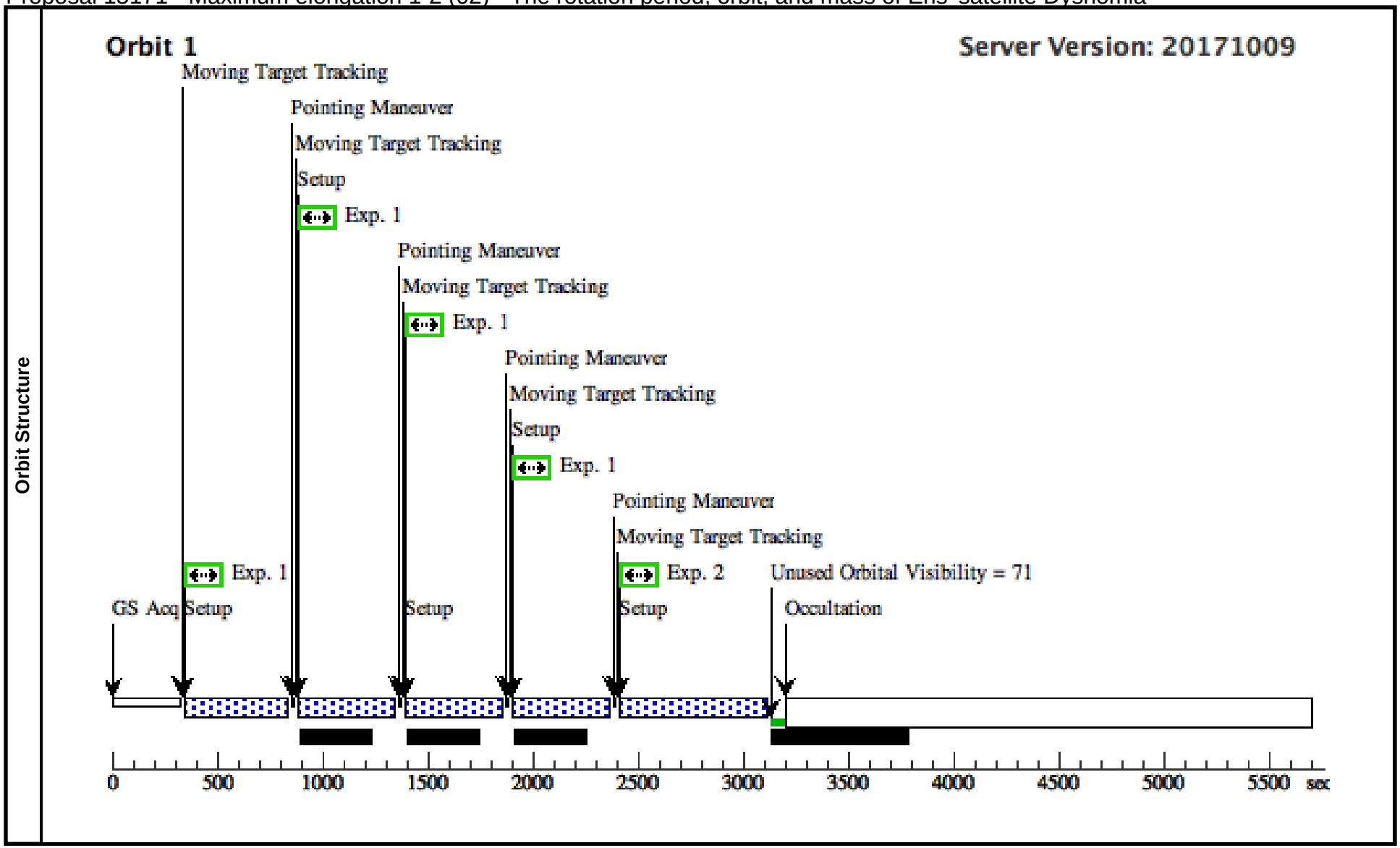
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Maximum elongation 1-2 (02) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs)	
								[==>]	***[1]***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Server Version: 20171009
Orbit Structure
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 2
Unused Orbital Visibility = 71
GS Acq
Setup
Setup
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15171, Floater 1 (03), failed Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; AFTER 01 BY 26 Orbits TO 95 Orbits

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=true		(1)

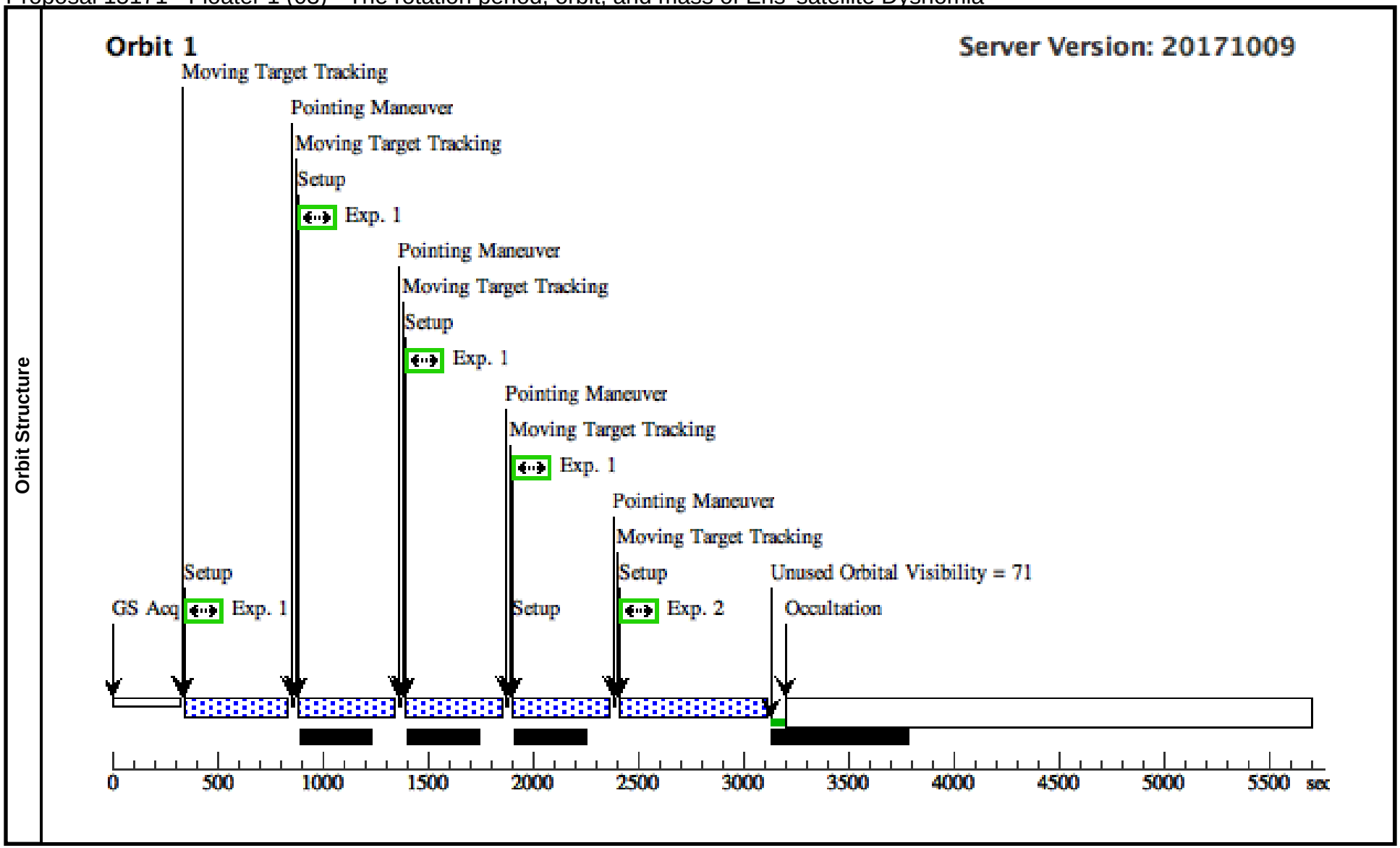
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Floater 1 (03) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs)	
								[==>]	***[1]***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Orbit Structure
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 2
Unused Orbital Visibility = 71
Occultation
Setup
GS Acq
Exp. 1
Setup
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15171, Floater 1 (53) Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; BETWEEN 18-JAN-2018:00:00:00 AND 24-JAN-2018:00:00:00; BETWEEN 03-FEB-2018:00:00:00 AND 09-FEB-2018:00:00:00; BETWEEN 18-FEB-2018:00:00:00 AND 24-FEB-2018:00:00:00

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=true		(1)

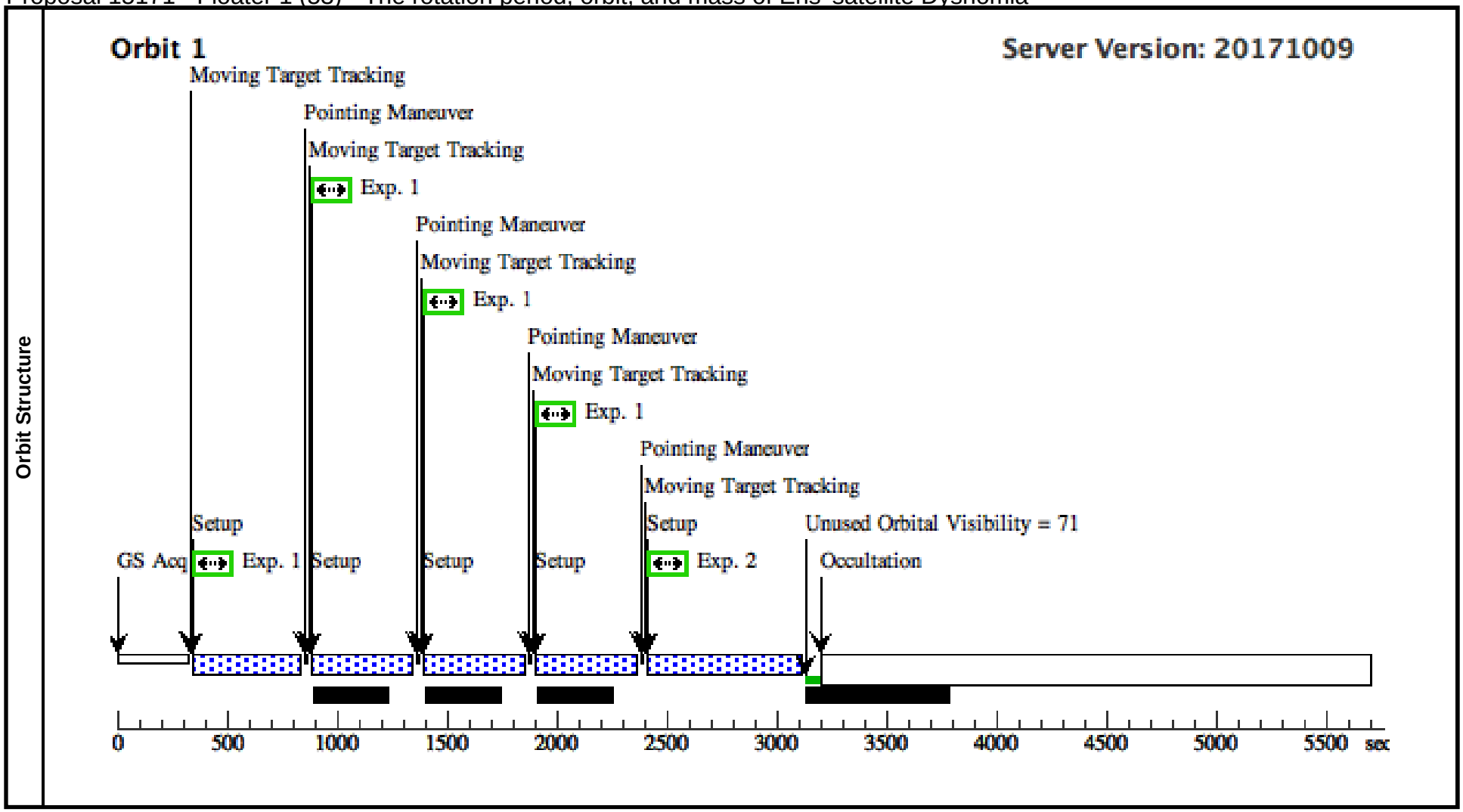
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Floater 1 (53) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs)	
								[==>]	***[1]***


Orbit Structure
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Server Version: 20171009
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Unused Orbital Visibility = 71
GS Acq
Exp. 1
Setup
Setup
Setup
Setup
Exp. 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
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4500
5000
5500
sec

Visit

Proposal 15171, Maximum elongation 2-1 (04), scheduled Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; AFTER 01 BY 115 Orbits TO 121 Orbits

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=true		(1)

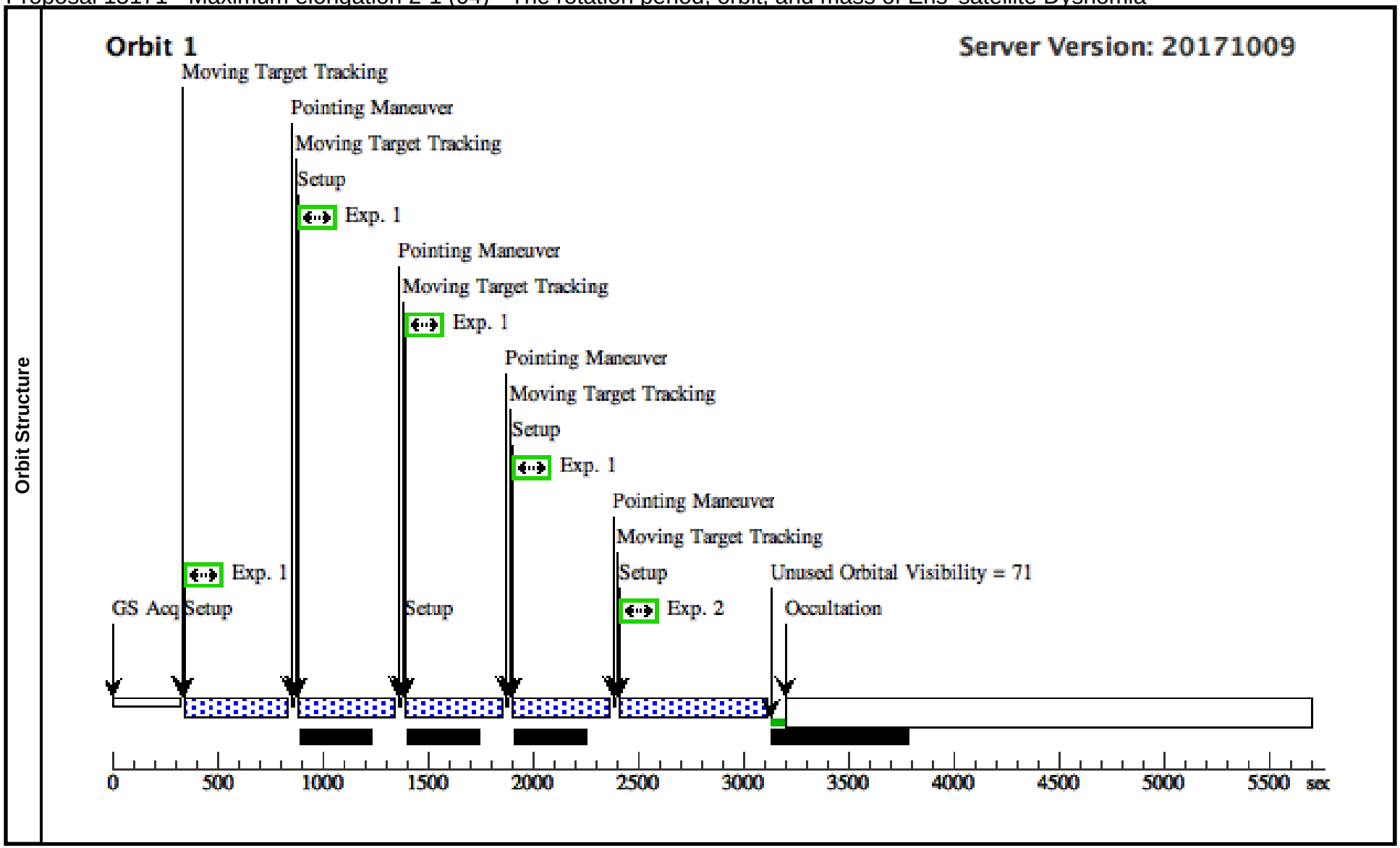
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Maximum elongation 2-1 (04) (1)	348 Secs (1392 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs) *[==>]*	***[1]***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Server Version: 20171009
Orbit Structure
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 2
Exp. 1
GS Acq Setup
Setup
Unused Orbital Visibility = 71
Occultation
0
500
1000
1500
2000
2500
3000
3500
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5500
sec

Visit

Proposal 15171, Maximum elongation 2-2 (05), scheduled Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; AFTER 01 BY 138 Orbits TO 142 Orbits

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=true		(1)

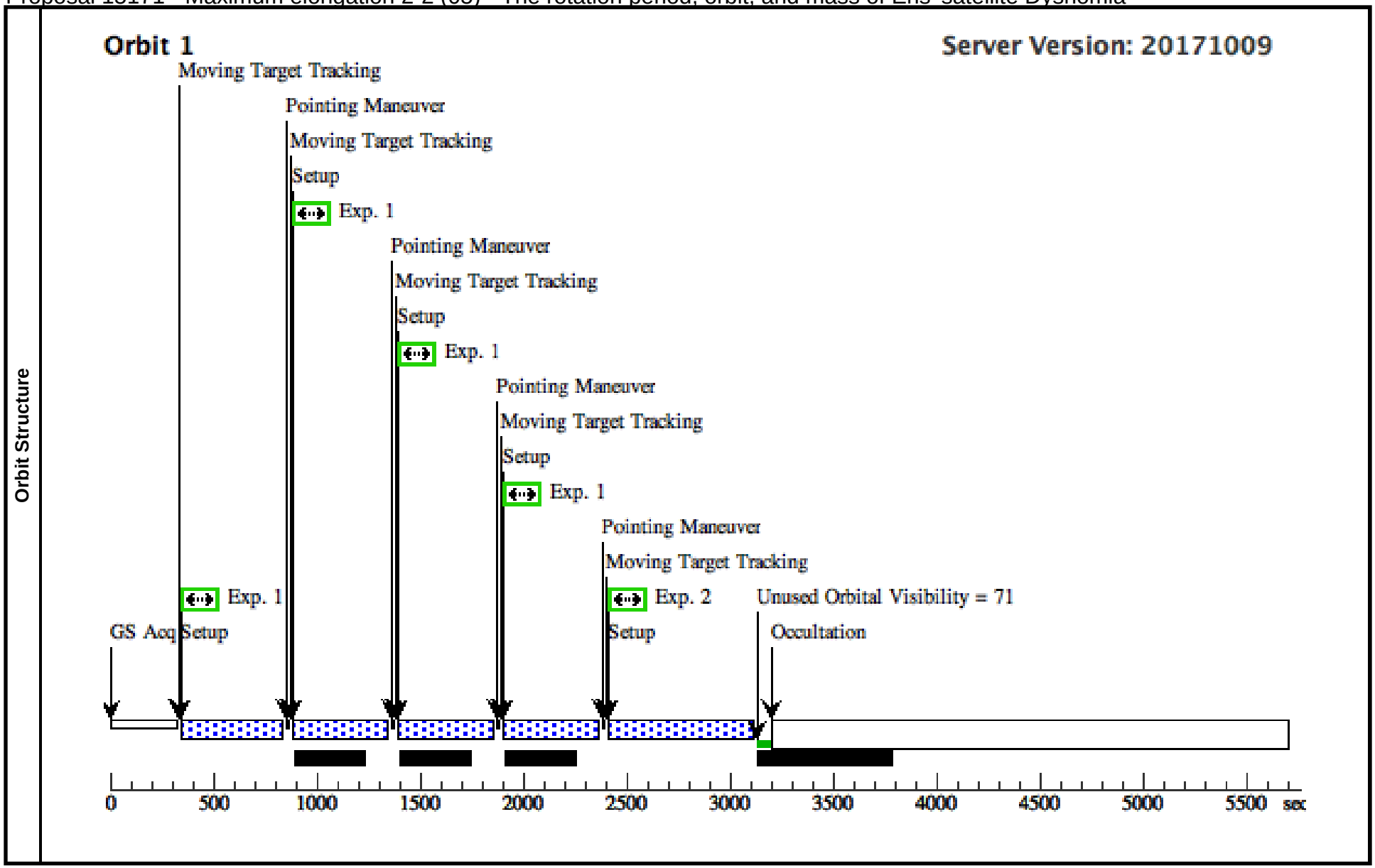
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Maximum elongation 2-2 (05) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs)	
								[==>]	***[1]***


Orbit 1
Server Version: 20171009
Orbit Structure
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Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 2
Setup
Unused Orbital Visibility = 71
Occultation
Exp. 1
GS Acq Setup
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5500
sec

Visit

Proposal 15171, Floater 2 (06), scheduled Sat Jan 06 01:04:06 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 61D TO 90 D; AFTER 01 BY 161 Orbits TO 213 Orbits

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=true		(1)

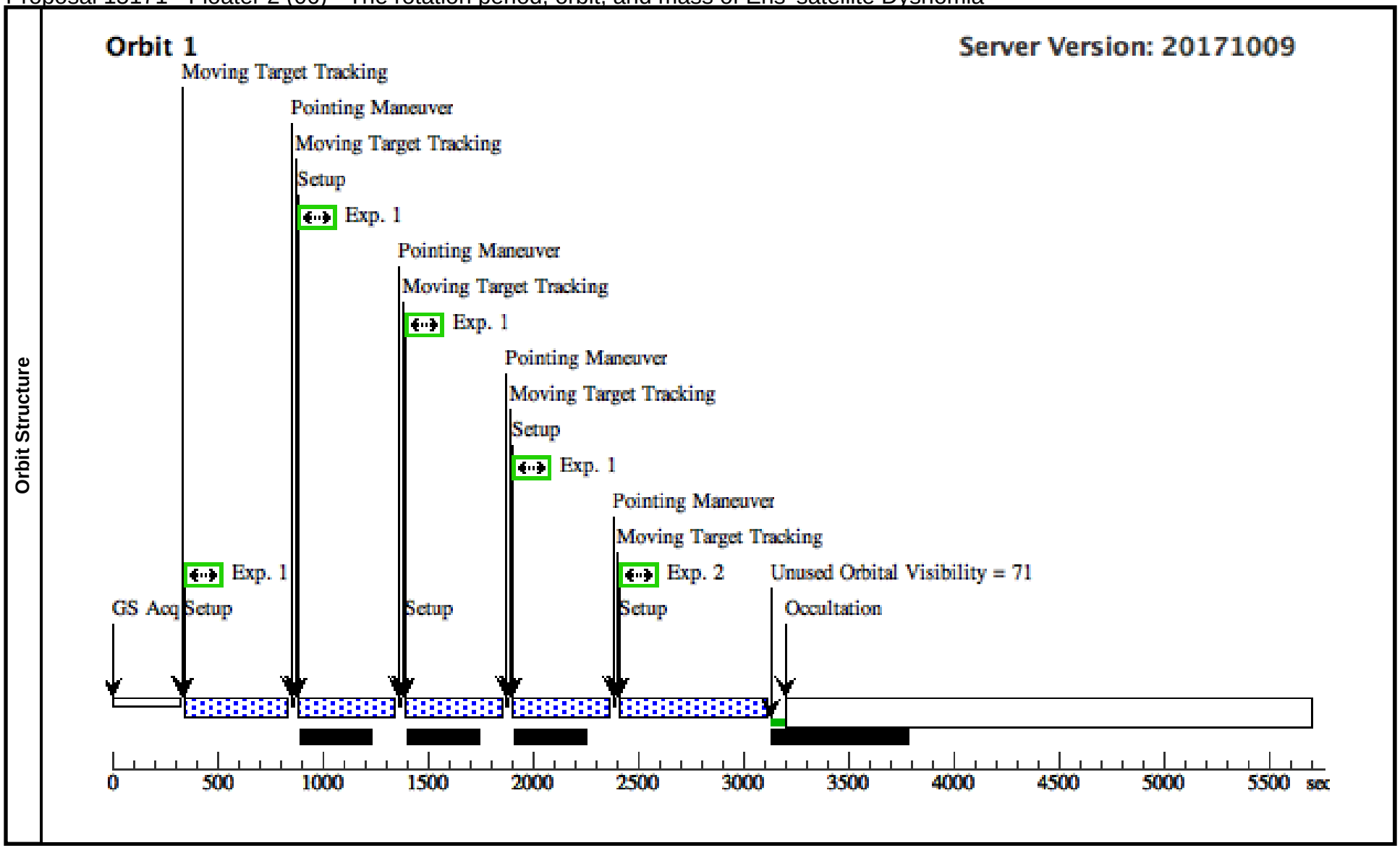
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	ERIS-OFFSET	STD=ERIS	TYPE=POS_ANGLE,RAD=20,ANG=225,REF=NORTH			EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W			Pattern 1, Exps 1-1 in Floater 2 (06) (1)	348 Secs (1392 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(2) ERIS-OFFSET	WFC3/UVIS, ACCUM, UVIS2	F606W				585 Secs (585 Secs)	
								[==>]	***[1]***


Orbit Structure
Orbit 1
Server Version: 20171009
Moving Target Tracking
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 1
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1
Pointing Maneuver
Moving Target Tracking
Exp. 2
Unused Orbital Visibility = 71
GS Acq
Setup
Setup
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec