



13866 - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Cycle: 22, Proposal Category: GO
(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
10	(1) MBC-2013P5-EPOCH-A	WFC3/UVIS	1	03-Mar-2015 21:07:31.0	yes
20	(1) MBC-2013P5-EPOCH-A	WFC3/UVIS	1	03-Mar-2015 21:07:32.0	yes
30	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:33.0	yes
40	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:34.0	yes
50	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:35.0	yes
60	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:36.0	yes
70	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:37.0	yes
3A	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:38.0	yes

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
3B	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:39.0	yes
3C	(2) MBC-2013P5-JPL19	WFC3/UVIS	1	03-Mar-2015 21:07:40.0	yes

10 Total Orbits Used

ABSTRACT

We propose a program of WFC3 images of active asteroid P/2013 P5 in order to determine the nature and origin of mass loss from this object. P5 ejects dust episodically, creating a multi-tailed appearance unlike that of any other known asteroid or comet. The ejection is thought to result from surface rotational instabilities (a process called "mass-shedding" by modelers). We will test the role of rotation by measuring the lightcurve of the nucleus and we will study the evolution of continued mass loss through Cycle 22. Rotational breakup and rotational mass-shedding are suspected to be the main mechanisms of destruction for sub-kilometer asteroids. Neither has been observed before but, between P/2013 P5 and P/2013 R3 (subject of another proposal) we have the first, potentially ground-breaking opportunities to observe both.

OBSERVING DESCRIPTION

We request a total of 10 orbits devoted to the temporal evolution of this MBC. P/2013 P5 lies outside the HST's 50 degree Sun exclusion zone from 2014 Oct 15 and 2015 Aug 26. It reaches opposition on 2015 Mar 19, while the Earth crosses its orbit plane on 2014 Dec 31 and 2015 Jul 01. The variation of apparent magnitude in Cycle 22 (scaled from Cycle 21 data) is shown in Figure 4. Single-orbit visits using the WFC3 F350LP filter provide us with sufficient sensitivity to image faint structures and enough images for adequate cosmic ray and artifact rejection, as established by our ToO work. We possess only a limit to the size (and brightness) of the nucleus of P5 derived from dust-contaminated Cycle 21 WFC3 observations. Accepting the brightest possible nucleus, and the complete absence of background dust, the WFC3 ETC gives integrations from 54 to 513 s for photometry at SNR 100 in a standard 0.4 arcsec aperture, using the F350LP filter. Longer integrations will be needed if the nucleus is substantially fainter, or if there is non-zero coma contamination. Regardless, WFC3 offers sufficient sensitivity to study the lightcurve of P5 with good time resolution. We will combine the images from each visit to increase sensitivity to extend tails. The science objectives cannot be met using other facilities. We need Hubble's high angular resolution and stable point-spread function (PSF) to photometrically isolate the nucleus from surrounding dust. For example, we routinely employ a 0.2 arcsec radius aperture on HST whereas on Keck we are forced by seeing to use apertures 5 to 10 times larger to obtain photometric stability. These larger apertures capture a larger proportion of light scattered from near-nucleus dust, corrupting the photometry. Adaptive-optics observations are wholly unsuitable, owing to the PSF (and resulting photometric) instabilities that are an inevitable feature of this technique. P5 is also far too faint to be observed using self-tracking AO techniques and its motion relative to wavefront reference stars

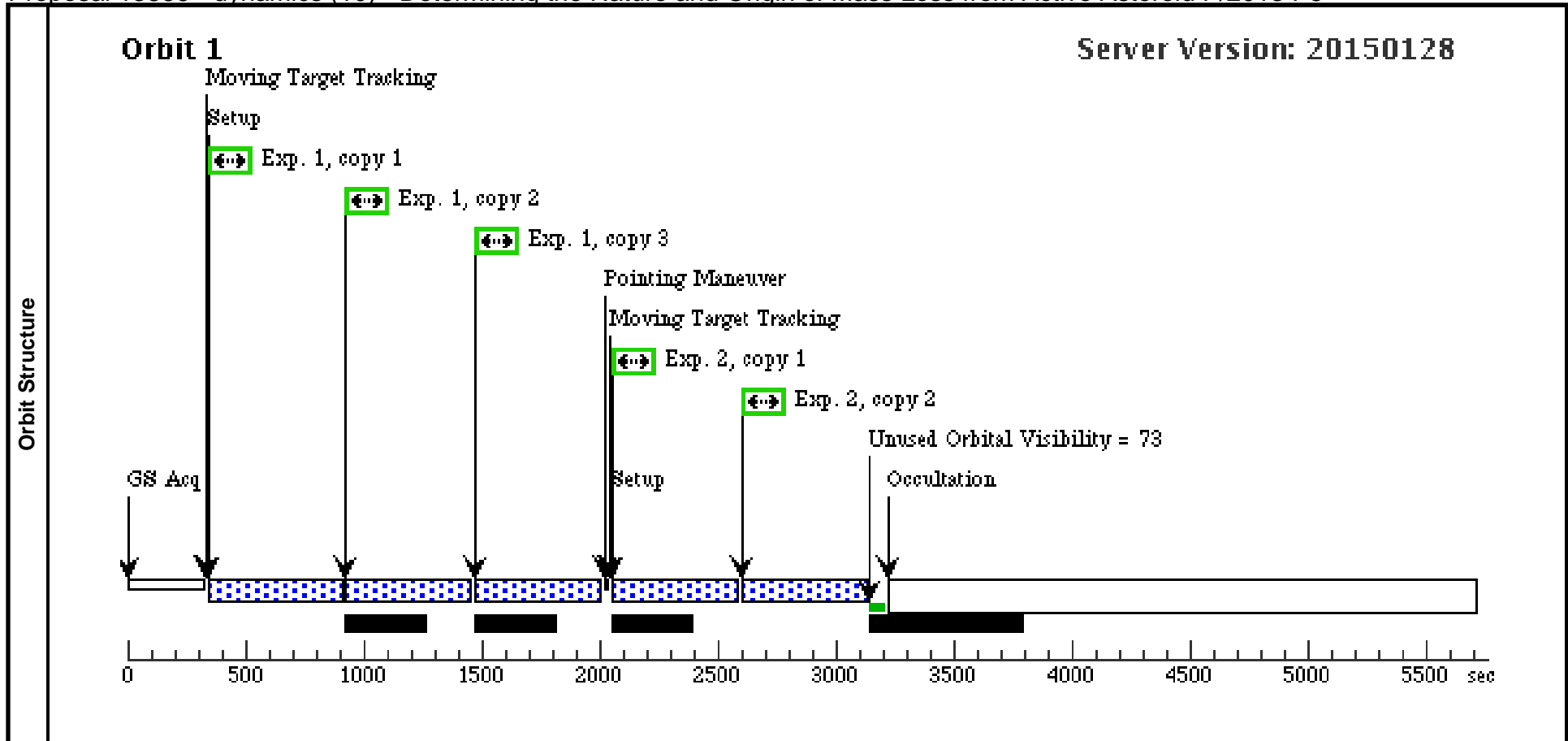
Proposal 13866 (STScI Edit Number: 0, Created: Tuesday, March 3, 2015 9:07:41 PM EST) - Overview

is additionally problematic. There is a roughly 2 magnitude variation through Cycle 22 (Figure 4), with peak brightness expected on UT 2015 Mar 19. Figure 5 shows synchro predictions for the dust tail position angles. It reveals that before Mar 11 projection effects cause all synchroes to project to approximately the same p.a. Dust observations are preferred after Mar 11, when the tail p.a. swings wildly with time, providing maximum diagnostics from the data. We request 1 orbit in 2014 Nov to assess the morphology and dust quantity, then visits on 4 occasions in the Mar 11 - Jun 10 period when the tail p.a. is most sensitive to the ejection epoch. For nucleus rotation determination we request 4 consecutive orbits near opposition (2015 Mar 19), so as to maximize the brightness. Four consecutive orbits will provide a 4 hour baseline of coverage enough to show two periods of the expected 2 hr rotation. Observations over two periods are the minimum needed to be sure that rotation is responsible, as opposed to activity-related, non-periodic brightness fluctuations. A possible set of observing dates is Tail dynamics orbits: 2014 Nov 10, 2015 Mar 11, Apr 10, May 08, Jul 01, Aug 01 (6 x 1 orbits) Nucleus rotation: Mar 19 (4 orbits), for a total of $6 + 4 = 10$ orbits with WFC3. The observations all have flexible observing windows (e.g. 1 week) except that 1) we request the first visit to occur as soon as possible in order to establish the starting morphology in Cycle 22 and 2) we request a visit on 2015 Jul 01 to coincide with Earth's passage through the P5 orbital plane. The latter configuration removes all ambiguity about projection effects on material above and below the plane. From our synchro interpretation, we predict negligible vertical extent of the dust because radiation pressure has no out-of-plane component. The measured thickness will give us the ejection speed, an important parameter for disruption models.

Proposal 13866 - dynamics (10) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:41 GMT 2015

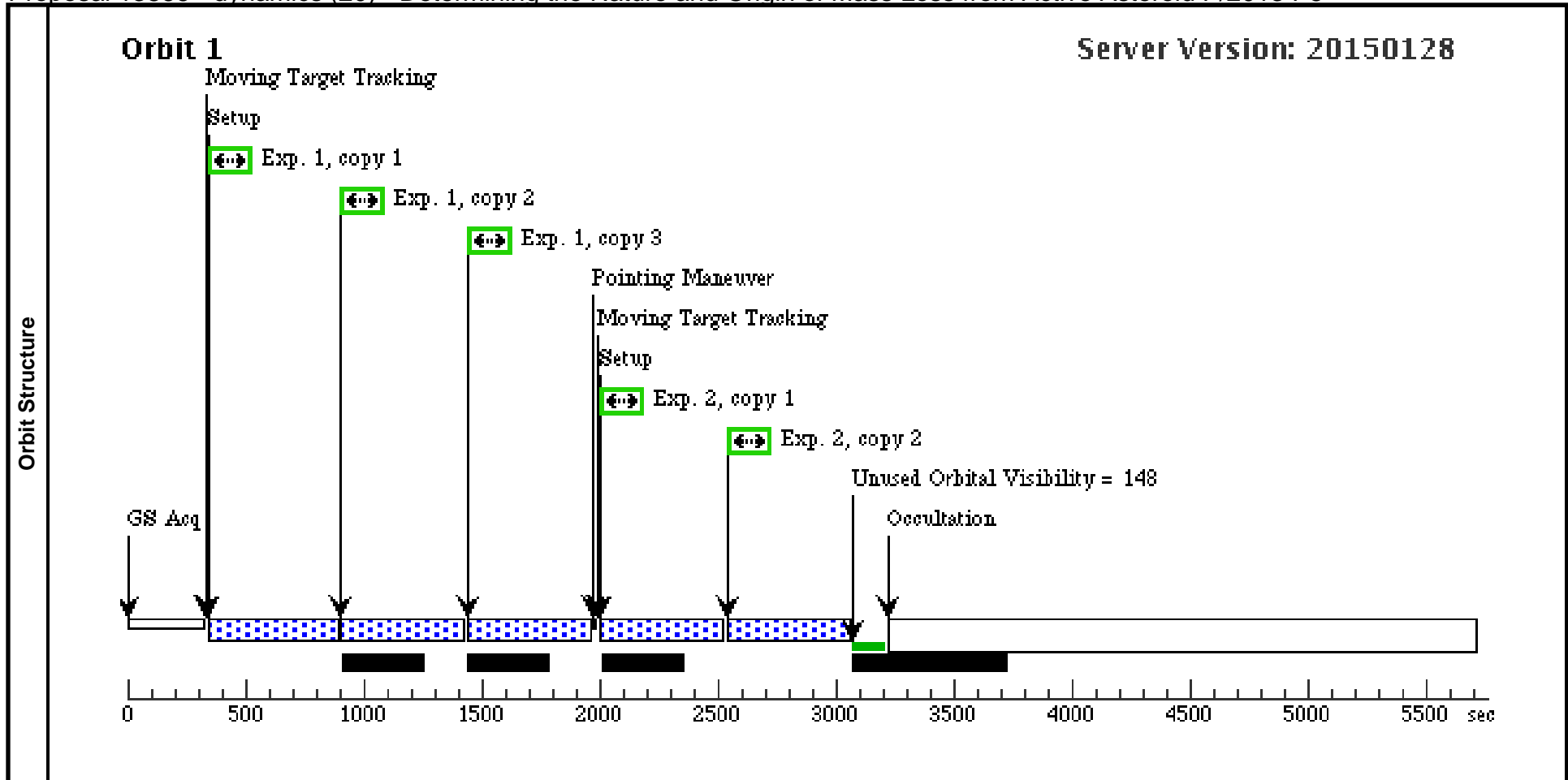
Visit	Proposal 13866, dynamics (10), completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 03-NOV-2014:00:00:00 AND 18-NOV-2014:00:00:00										
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	MBC-2013P5-EPOCH-A	TYPE=COMET,Q=1.9363894526099 25,E=0.1152839802288967 .I=4.968466064328145,O=279.289473 2263348,W=144.209729874557,T=15-APR-2014:18:07:56,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=14-JUN-2013,EpochTimeScale=TDB <i>Comments: JPL #17 orbital elements</i>					EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(1) MBC-2013P5-EP OCH-A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			420 Secs X 3 (1260 Secs)		
									[==>(Copy 1)]		[1]
									[==>(Copy 2)]		
								[==>(Copy 3)]			
2		(1) MBC-2013P5-EP OCH-A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0			420 Secs X 2 (840 Secs)		
									[==>(Copy 1)]		[1]
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Proposal 13866 - dynamics (20) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:41 GMT 2015

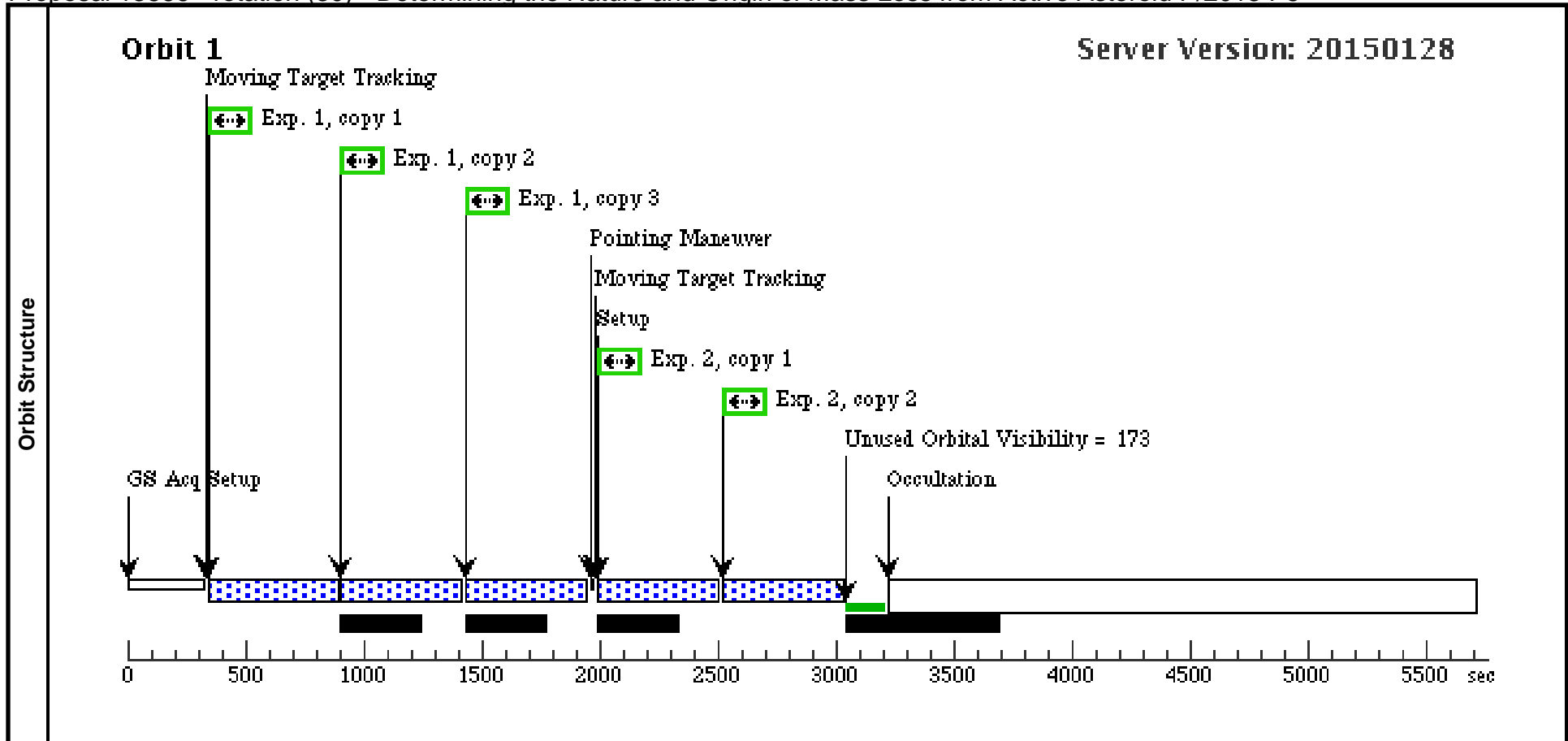
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	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	MBC-2013P5-EPOCH-A	TYPE=COMET,Q=1.9363894526099 25,E=0.1152839802288967 .I=4.968466064328145,O=279.289473 2263348,W=144.209729874557,T=15- APR- 2014:18:07:56,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=14-JUN- 2013,EpochTimeScale=TDB <i>Comments: JPL #17 orbital elements</i>					EARTH		
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) MBC-2013P5-EP OCH-A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			405 Secs X 3 (1215 Secs)	
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	2		(1) MBC-2013P5-EP OCH-A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0		405 Secs X 2 (810 Secs)	
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Proposal 13866 - rotation (30) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:41 GMT 2015

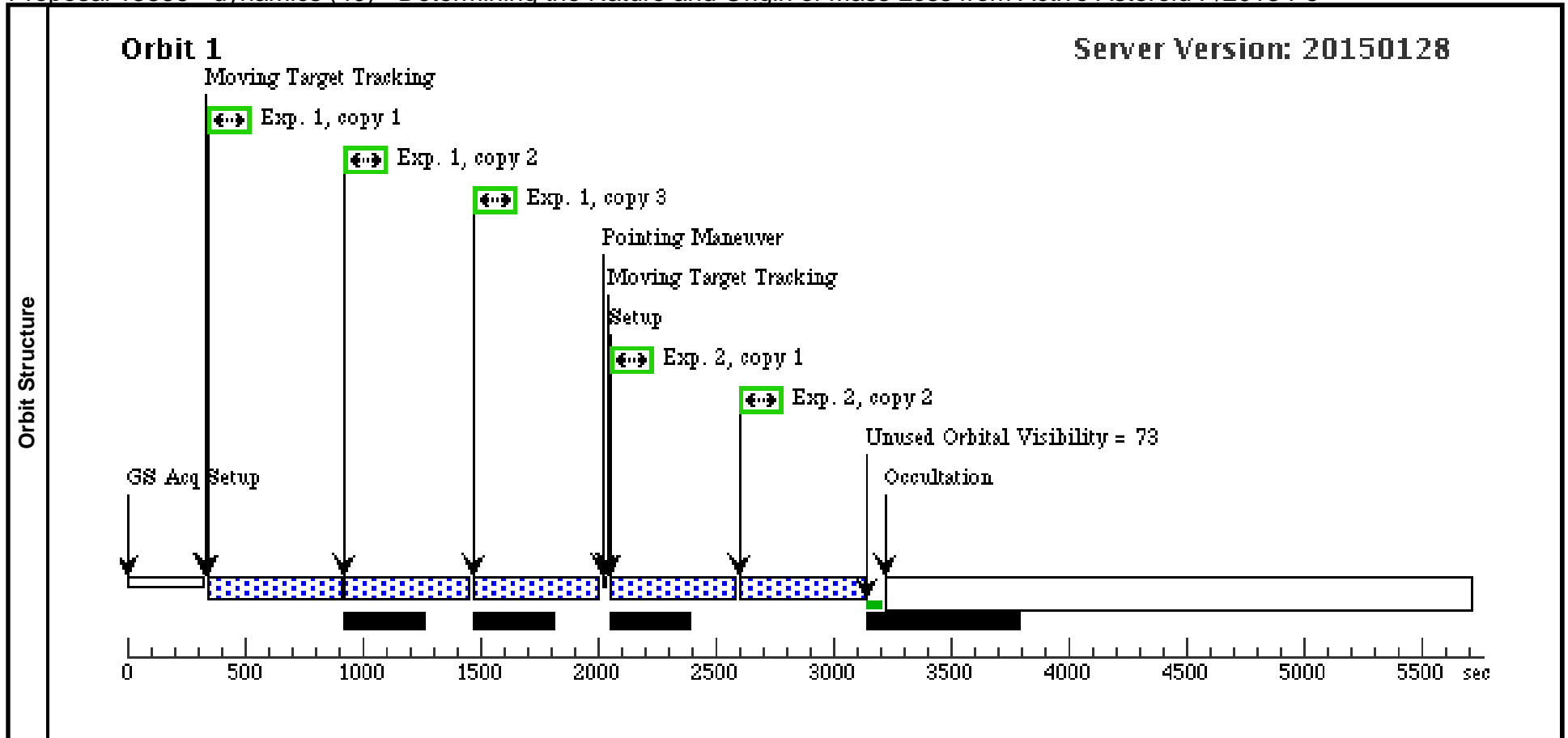
Visit	Proposal 13866, rotation (30), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 18-MAR-2015:18:00:00 AND 20-MAR-2015:06:00:00; SEQ 30,3A,3B,3C WITHIN 3.5 Orbits										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 I1,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH			
<i>Comments: JPL #19 orbital elements</i>											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			400 Secs X 3 (1200 Secs)		
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2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2			400 Secs X 2 (800 Secs)		
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Proposal 13866 - dynamics (40) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

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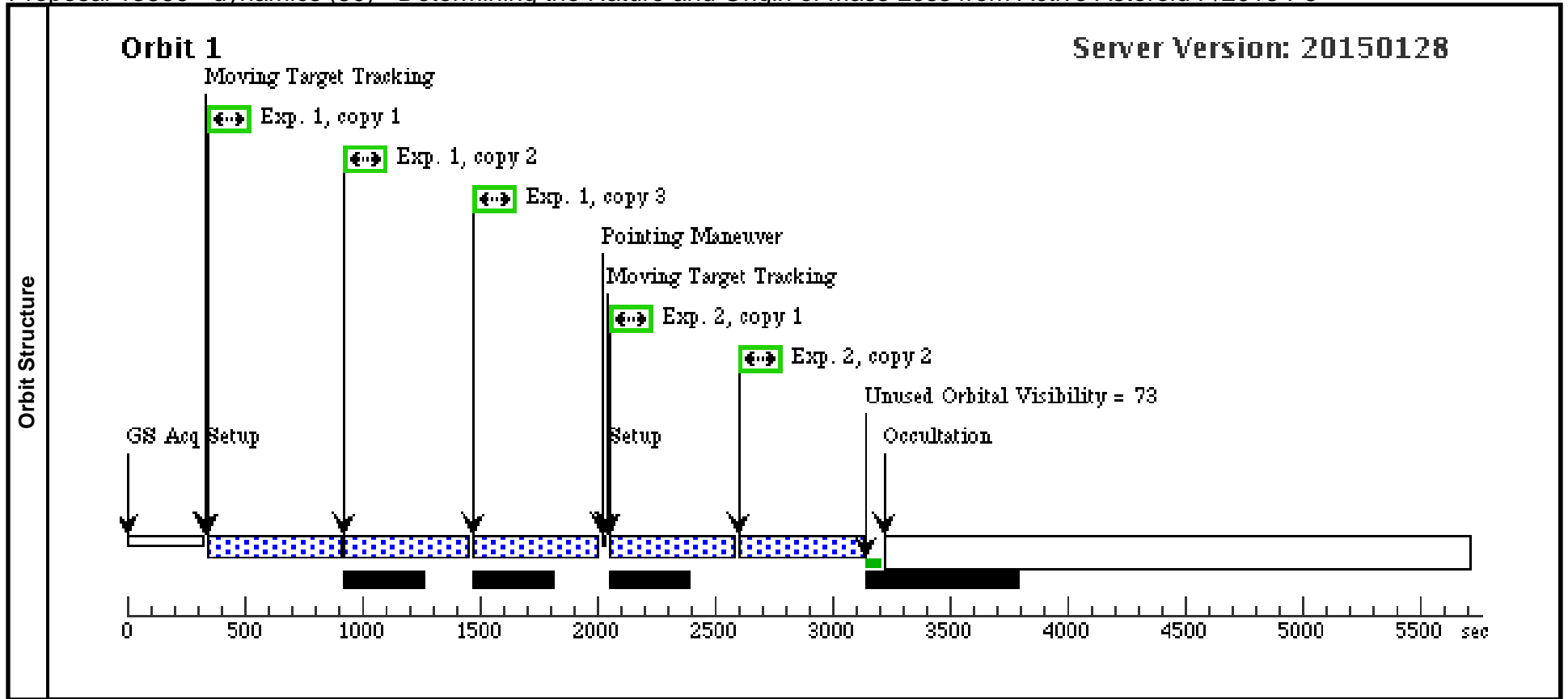
Visit	Proposal 13866, dynamics (40), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 06-APR-2015:00:00:00 AND 13-APR-2015:00:00:00										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH			
<i>Comments: JPL #19 orbital elements</i>											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			420 Secs X 3 (1260 Secs)		
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2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0			420 Secs X 2 (840 Secs)		
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Proposal 13866 - dynamics (50) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

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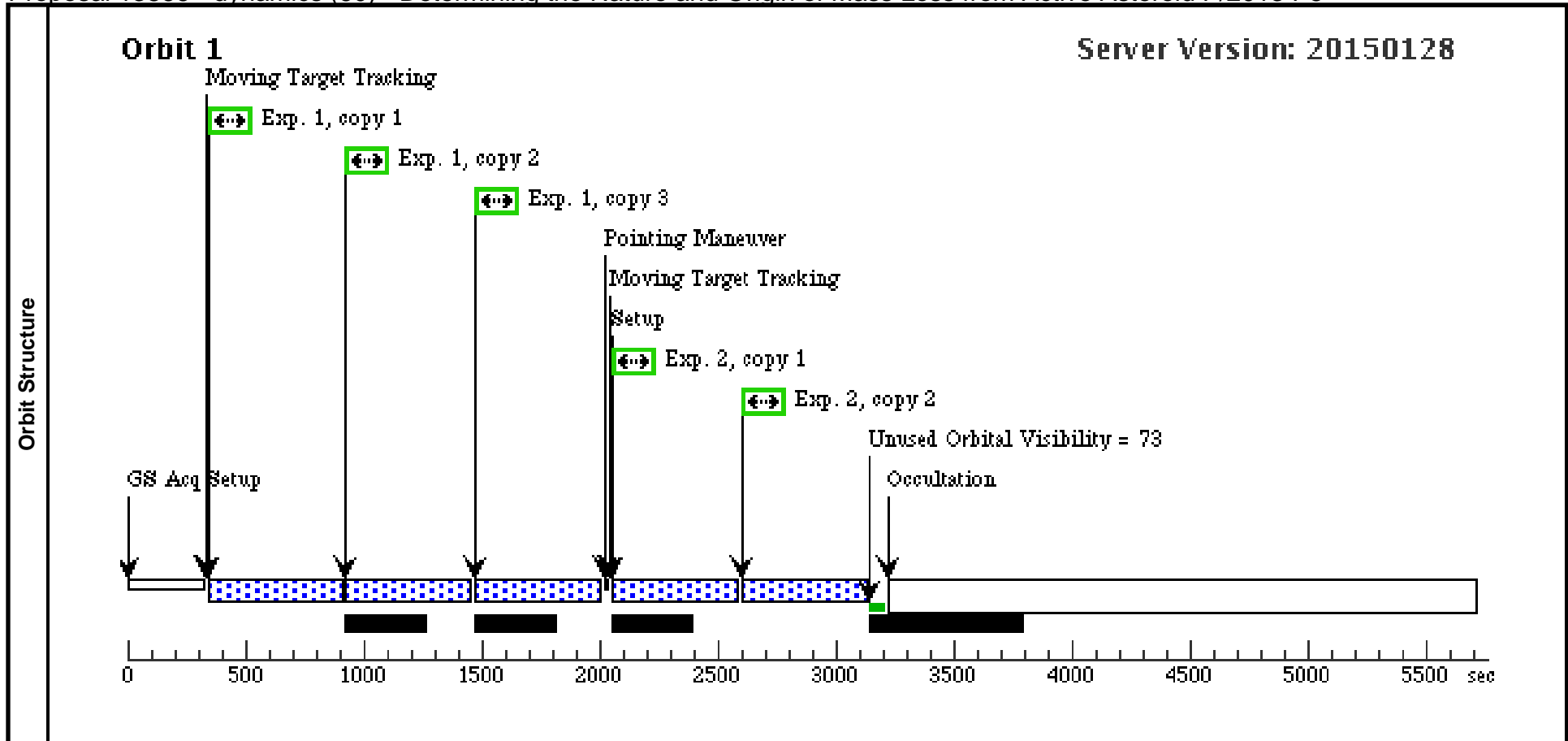
Visit	Proposal 13866, dynamics (50), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 04-MAY-2015:00:00:00 AND 11-MAY-2015:00:00:00										
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB <i>Comments: JPL #19 orbital elements</i>					EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			420 Secs X 3 (1260 Secs)		
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2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0			420 Secs X 2 (840 Secs)		
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Proposal 13866 - dynamics (60) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

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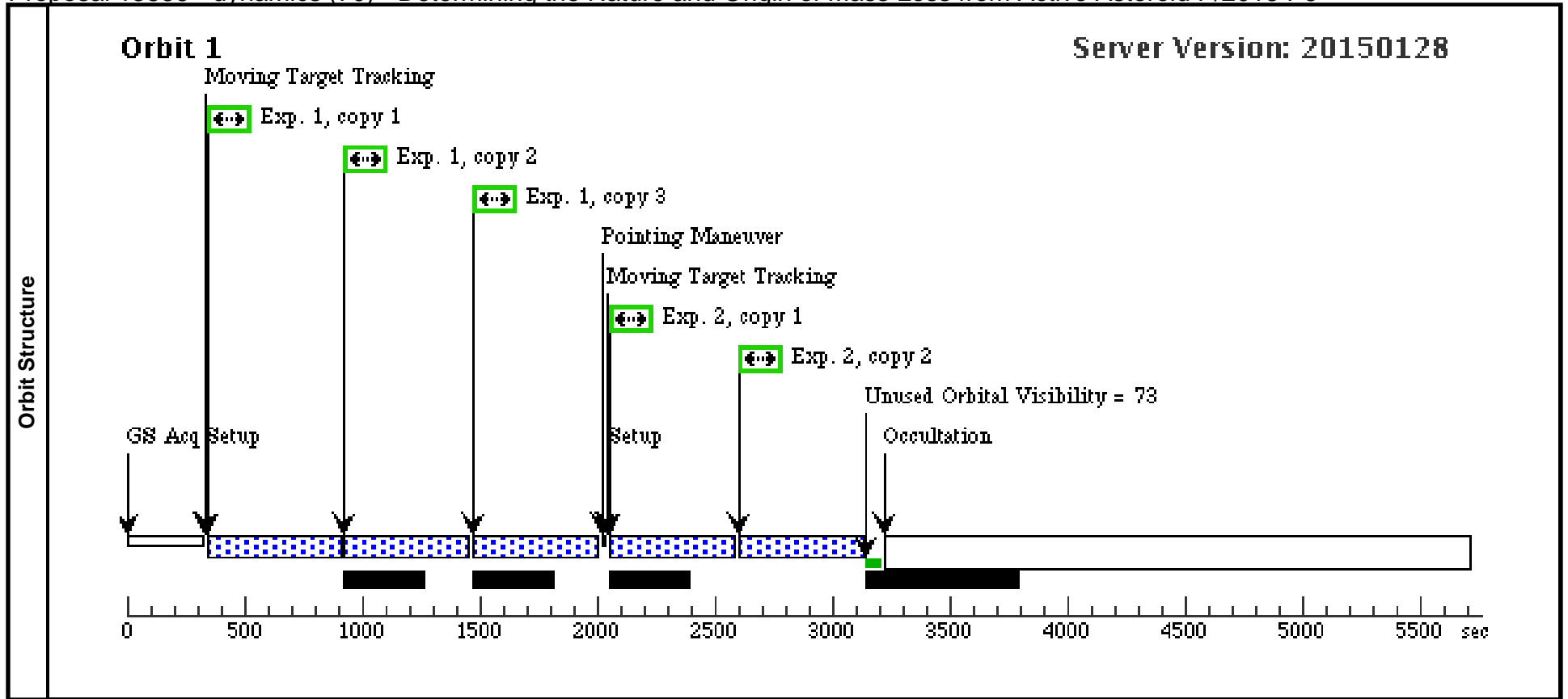
Visit	Proposal 13866, dynamics (60), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 29-JUN-2015:00:00:00 AND 06-JUL-2015:00:00:00										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH			
<i>Comments: JPL #19 orbital elements</i>											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			420 Secs X 3 (1260 Secs)		
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2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0			420 Secs X 2 (840 Secs)		
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Proposal 13866 - dynamics (70) - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

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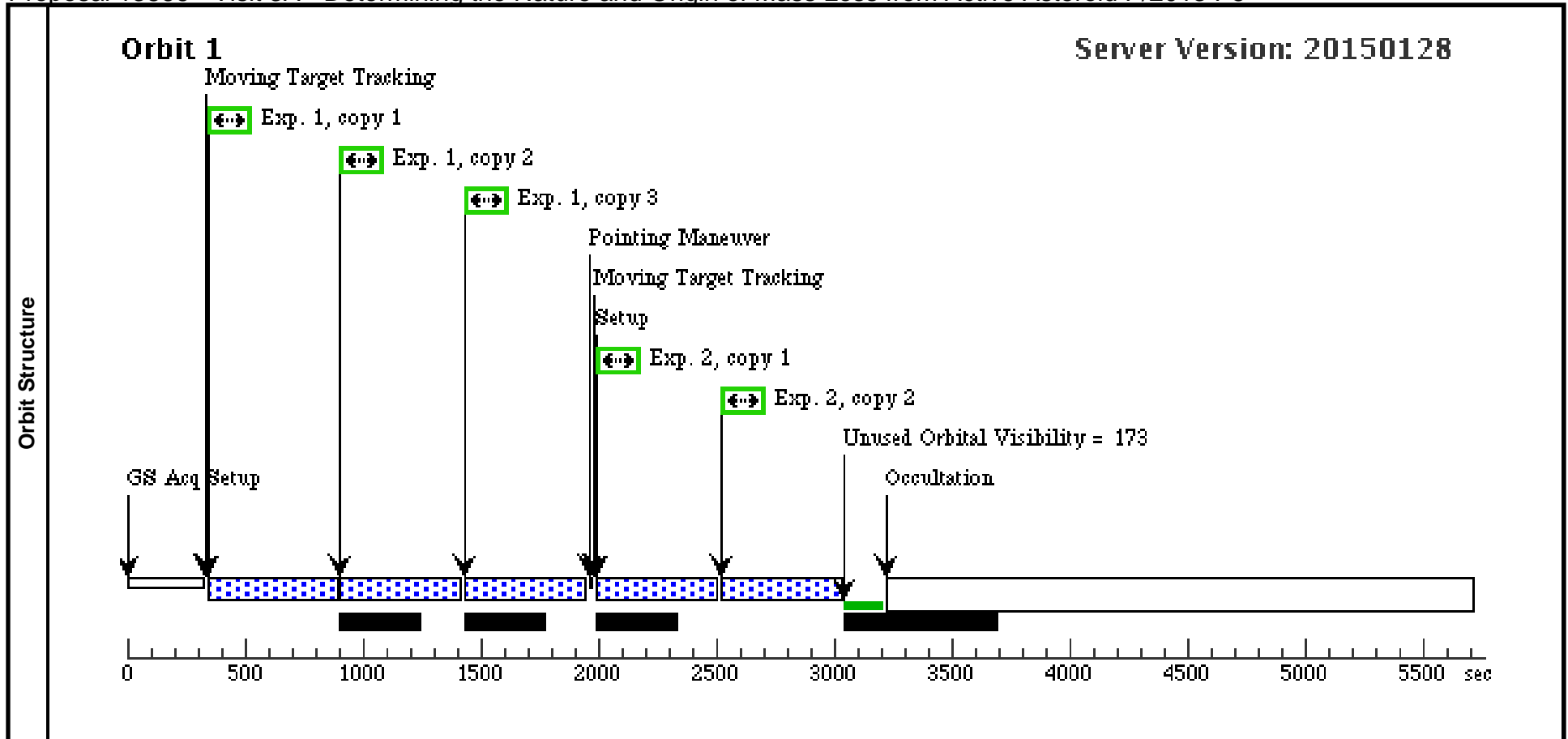
Visit	Proposal 13866, dynamics (70), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 27-JUL-2015:00:00:00 AND 03-AUG-2015:00:00:00										
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB <i>Comments: JPL #19 orbital elements</i>					EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			420 Secs X 3 (1260 Secs)		
									[==>(Copy 1)]		[1]
									[==>(Copy 2)]		
								[==>(Copy 3)]			
2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0			420 Secs X 2 (840 Secs)		
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Proposal 13866 - Visit 3A - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:42 GMT 2015

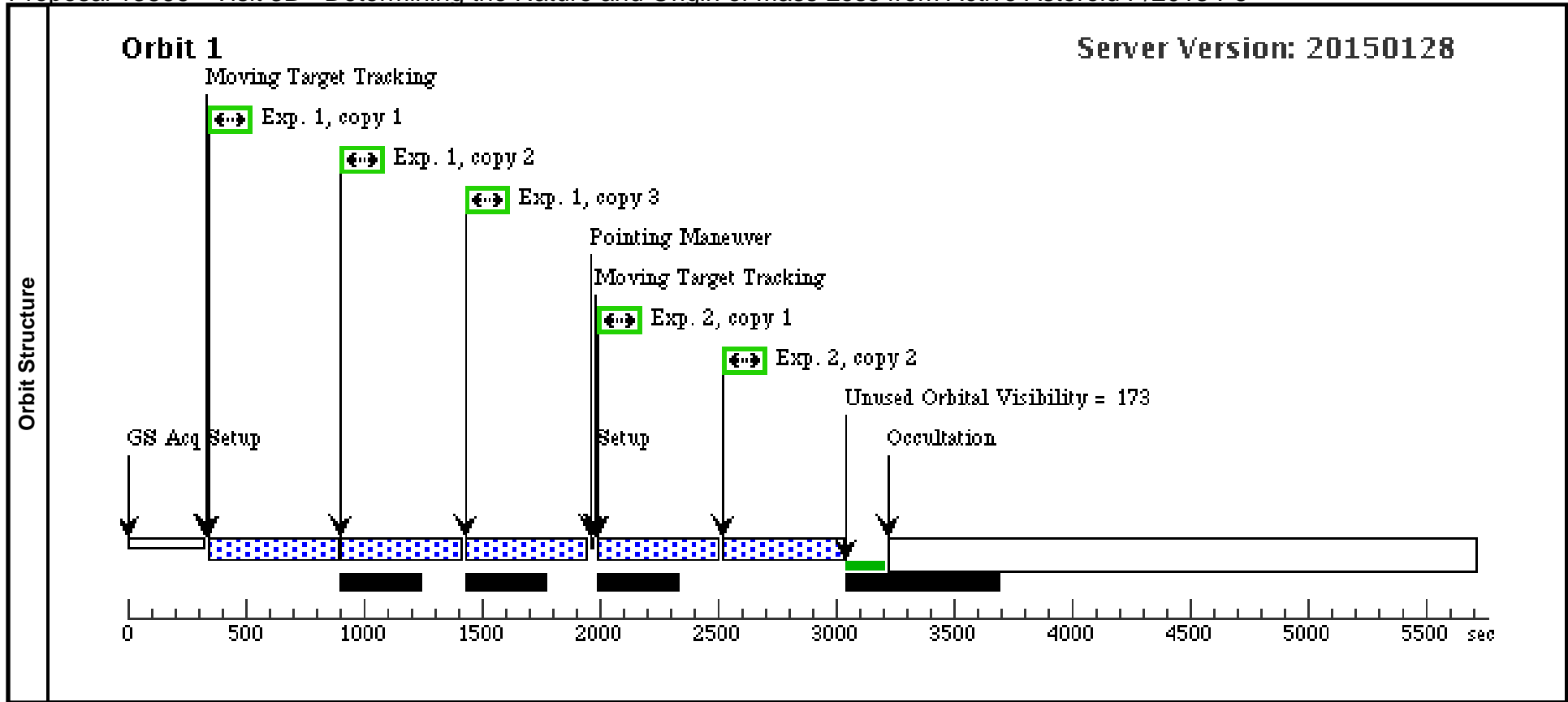
Visit	Proposal 13866, Visit 3A, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none) <i>Comments: exp. 2 of original visit 30</i>									
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	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH		
	<i>Comments: JPL #19 orbital elements</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			400 Secs X 3 (1200 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)]	[1]
	2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2		400 Secs X 2 (800 Secs)	
								[==>(Copy 1)] [==>(Copy 2)]	[1]	



Proposal 13866 - Visit 3B - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:42 GMT 2015

Visit	Proposal 13866, Visit 3B, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none) <i>Comments: exp. 3 of original visit 30</i>									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH		
	<i>Comments: JPL #19 orbital elements</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			400 Secs X 3 (1200 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)]	[1]
	2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2		400 Secs X 2 (800 Secs)	
								[==>(Copy 1)] [==>(Copy 2)]	[1]	



Proposal 13866 - Visit 3C - Determining the Nature and Origin of Mass Loss from Active Asteroid P/2013 P5

Wed Mar 04 02:07:42 GMT 2015

Visit	Proposal 13866, Visit 3C, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none) <i>Comments: exp. 4 of original visit 30</i>									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(2)	MBC-2013P5-JPL19	TYPE=COMET,Q=1.9363787596092 11,E=0.1152834645135037 .I=4.968458674964833,O=279.289428 0674857,W=144.2127841838233,T=1 5-APR- 2014:18:19:05,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUN- 2013,EpochTimeScale=TDB					EARTH		
	<i>Comments: JPL #19 orbital elements</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			400 Secs X 3 (1200 Secs) [==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)]	[1]
2		(2) MBC-2013P5-JP L19	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2		400 Secs X 2 (800 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]	

