14475 - HST Investigation of a Candidate Ultra-Young Rotational Asteroid Family Harboring a Doubly-Synchronous Binary

Cycle: 23, Proposal Category: GO/DD

(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	(1) P2012F5	WFC3/UVIS	4	28-Jan-2016 21:02:19.0	yes

4 Total Orbits Used

ABSTRACT

We request 10 orbits of DD time to complete Hubble investigation of the fragmented asteroid P/2012 F5. Our GO-14192 program executed on 25 and 28 December 2015 UT, providing spectacular WFC3/UVIS images of the object and an unparalleled insight into its real nature. We have detected at least nine star-like fragments of the main nucleus, still cocooned in their birth dust trail, suggesting that P/2012 F5 is actively forming a new full-sized asteroid family before our eyes. Given that the main nucleus rotates at a critical rate, this ultra-young system is the best candidate for a family generated by rotational fission, as opposed to all the other asteroid families, which are of collisional origin. To our great surprise, the largest fragment of the main nucleus has all the characteristics of a small, doubly-synchronous binary. If confirmed, this object will challenge the established theory of formation of binary asteroids. The requested additional HST orbits are critically needed to verify this exciting possibility, confirm the stability of the P/2012 F5 family, and quantify the key dynamical parameters, such as fragment ejection times and separation speeds. Hubble is the

only facility with sufficient sensitivity and wide-field angular resolution to carry out this investigation, which is more than likely to have a profound impact on asteroid science, including our solar system and systems around other stars.

OBSERVING DESCRIPTION

Our target is a fragmented asteroid P/2012 F5, which has a bright nucleus and many fainter fragments embedded in a long dust trail. Currently, the nucleus is of 22.5 mag and the brightest fragment of about 27 mag (R-band magnitudes). The TARGETS component contains the orbital elements of the main nucleus. The nucleus and the fragments are dispersed along a straight line. At the time of the expected HST observations (see below), the sky PA of this line is 269 deg, coinciding almost exactly with the E-W direction. The expected angular distance between the easternmost component (the main nucleus) and the westernmost component (one of the faint fragments) is 30 arcsec. However, the associated dust trail extends further out, and can be several arcminutes long. The orbit of our target is very well known, with a standard uncertainty of the target's position at the epoch of the expected observations at the level of 2 arcsec (obtained from the JPL Horizons system). These observations are time-critical and should be executed as soon as possible. This is because the target is fading by 0.2 mag per week and soon will be too faint even for HST to investigate the fainter fragments and reach the goals of this proposal.

Each orbit has basically the same architecture. We consistently use WFC3/UVIS with the F350LP filter, which offers the best SNR on asteroid nuclei. We wish to take six full-frame images per orbit, which is small enough to ensure parallel buffer dumps and good overall observing efficiency, but large enough to adequately sample the object's light curve. Orbital visibility allows us to take all six images with 368 sec integration time when a GS is re-acquired, or five images with 368 sec integration time and one image with 228 sec integration time when a new GS is acquired.

We request that the ORIENT angle be 84 deg, i.e. the same as used in the earlier HST study of this target under GO-14192 program. This angle implies that the U3 axis be close to the E-W direction. Given that our target is also oriented along the E-W direction, the requested ORIENT angle ensures target orientation parallel to U3. Furthermore, we place the target's nucleus in the UVIS2-C1K1C-CTE aperture, resulting in all the fragments and dust being aligned along the WFC3's diagonal connecting quadrants C and B, which is also the instrument's tilt axis, minimizing geometric distortions. Conveniently, the nucleus and the known fragments will all be present in quadrant C, but thanks to full-frame readout, we will be able to detect new fragments at larger separations from the nucleus in quadrant B. To maximize observing efficiency dithering will be applied between consecutive orbits (i.e. all six exposures taken during a single orbit will not be dithered) through changing POS TARG offsets. Orbit to orbit dithering incurs no overheads, but naturally fills out the gap between the two UVIS detectors and mitigates the effect of bad pixels in a deep, visit-averaged image. To minimize the influence of geometric distortions, the POS TARG offsets move the target along the diagonal connecting quadrants C and B.

Visit

Proposal 14475, Visit 01 Fri Jan 29 02:02:21 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 84D TO 84 D

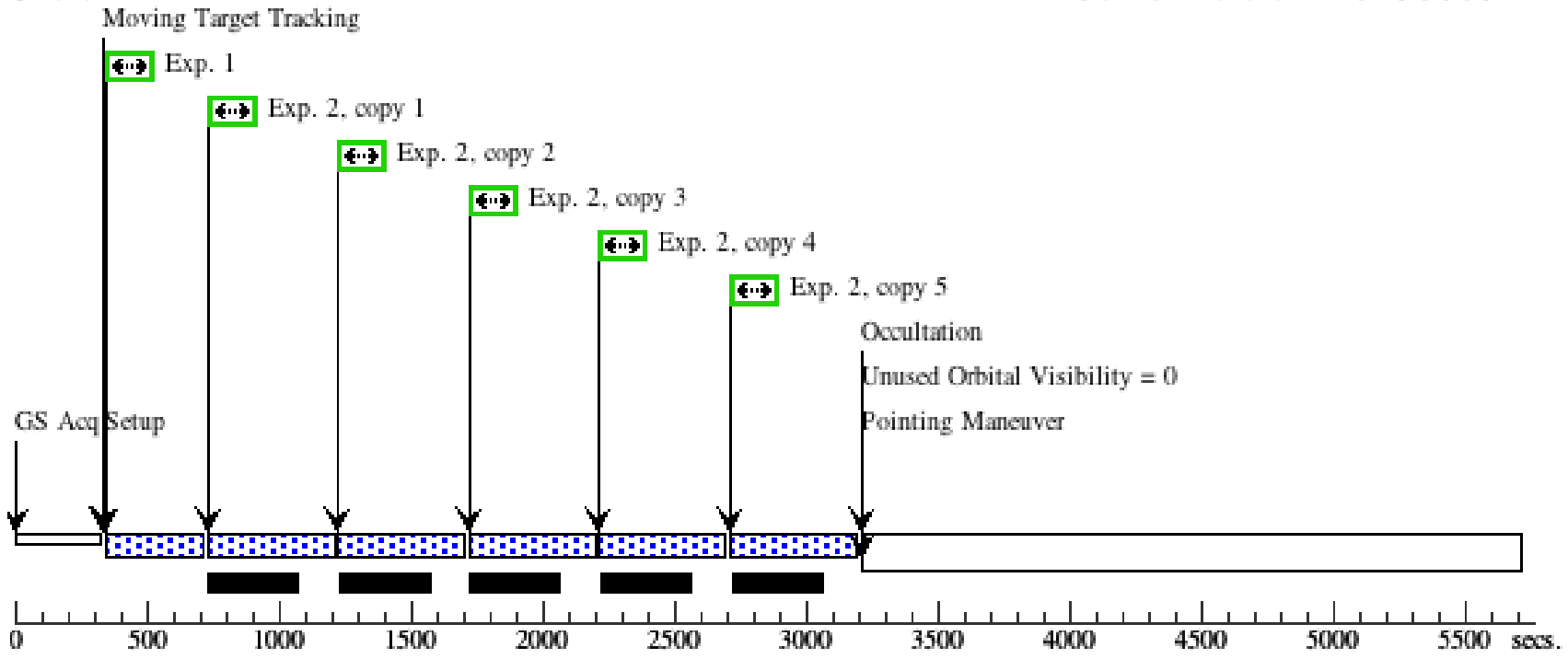
Solar System Targets

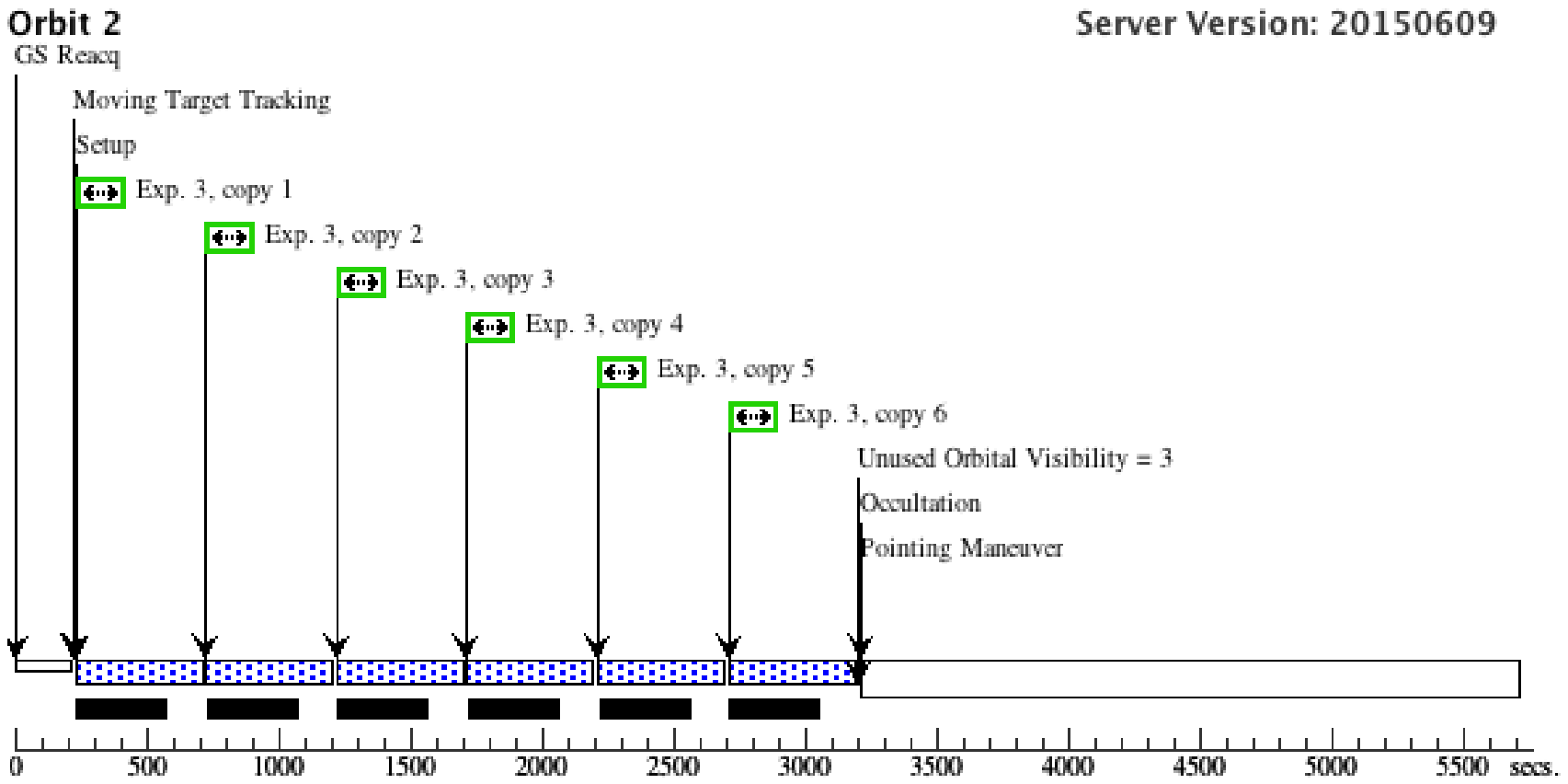
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	P2012F5	TYPE=ASTEROID,A=3.003793367671304,E=.04208657647659044,I=9.73968241169762,O=216.8596526258951,W=177.4017799217546,M=128.34402544313,EQUINOX=J2000,EPOCH=04-FEB-2012:00:00:00,EpochTimeScale=TDB				EARTH

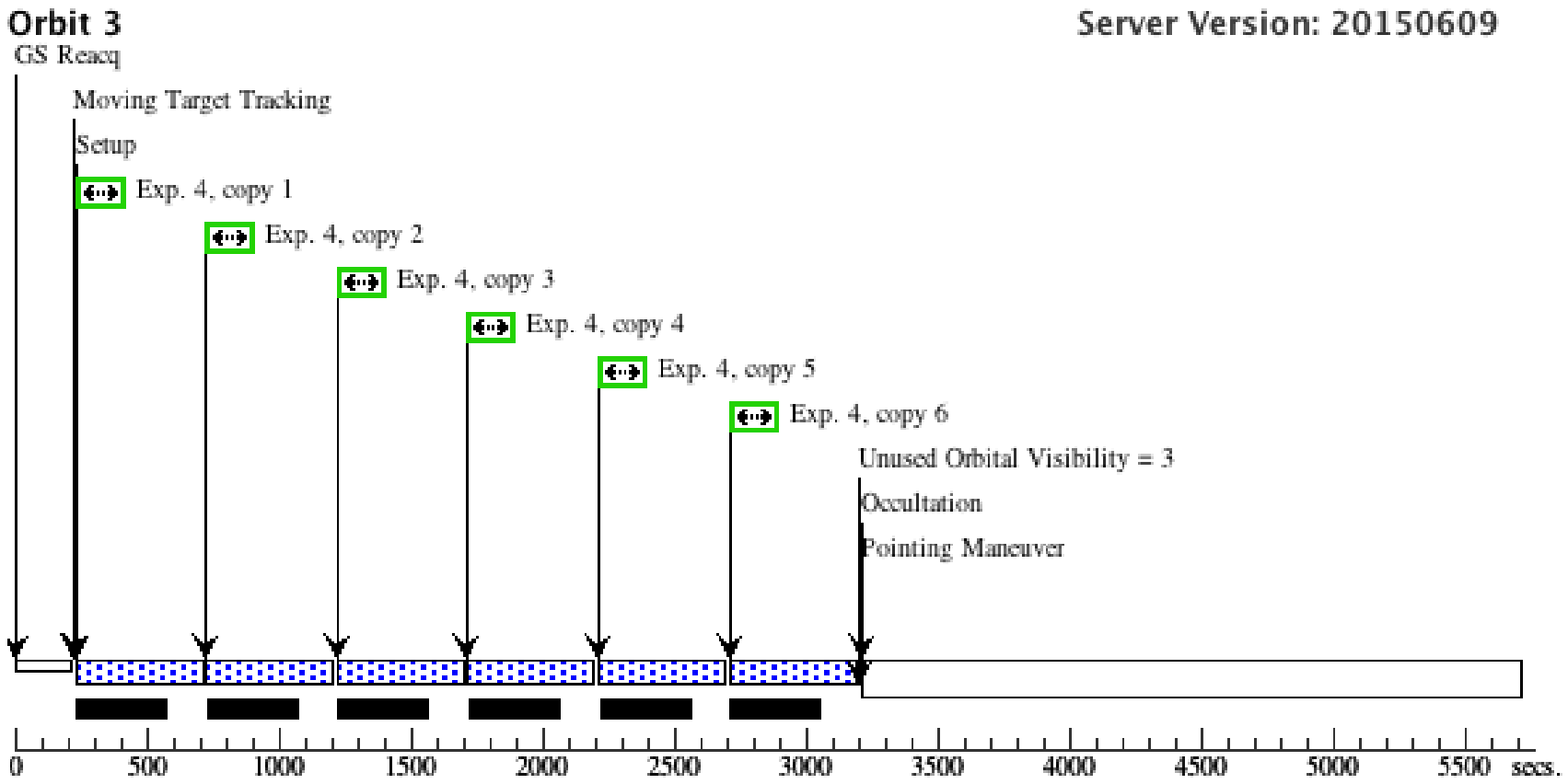
Exposures

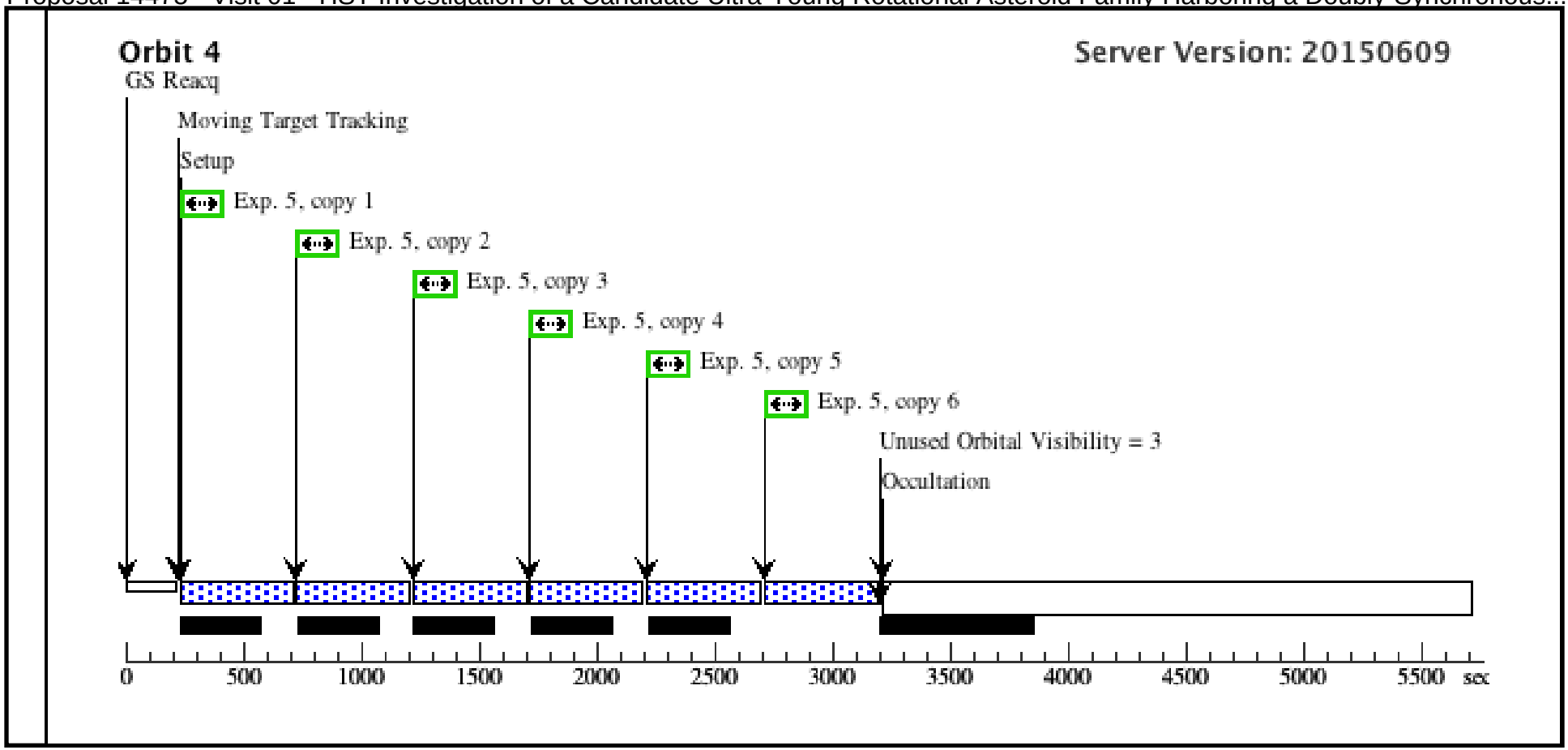
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) P2012F5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F350LP				228 Secs (228 Secs)	
								[==>]	***[1]***
2		(1) P2012F5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F350LP				368 Secs X 5 (1840 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]*	***[1]***
3		(1) P2012F5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F350LP		POS TARG 1.25,1.25		368 Secs X 6 (2208 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]*	***[2]***
4		(1) P2012F5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F350LP		POS TARG 2.50,2.50		368 Secs X 6 (2208 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]*	***[3]***
5		(1) P2012F5	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F350LP		POS TARG 3.75,3.75		368 Secs X 6 (2208 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]*	***[4]***

Orbit Structure




Orbit 2
Server Version: 20150609
GS Reacq
Moving Target Tracking
Setup
Exp. 3, copy 1
Exp. 3, copy 2
Exp. 3, copy 3
Exp. 3, copy 4
Exp. 3, copy 5
Exp. 3, copy 6
Unused Orbital Visibility = 3
Occultation
Pointing Maneuver
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 3
Server Version: 20150609
GS Reacq
Moving Target Tracking
Setup
Exp. 4, copy 1
Exp. 4, copy 2
Exp. 4, copy 3
Exp. 4, copy 4
Exp. 4, copy 5
Exp. 4, copy 6
Unused Orbital Visibility = 3
Occultation
Pointing Maneuver
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20150609
GS Reacq
Moving Target Tracking
Setup
Exp. 5, copy 1
Exp. 5, copy 2
Exp. 5, copy 3
Exp. 5, copy 4
Exp. 5, copy 5
Exp. 5, copy 6
Unused Orbital Visibility = 3
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec