13853 - UV Spectroscopy of Newly Discovered Tidal Disruption Flares

Cycle: 22, Proposal Category: GO

(UV Initiative)

(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	(3) ASASSN-14LI	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	15-Sep-2015 21:26:48.0	yes
02	(5) ASASSN-15OI	WFC3/UVIS	1	15-Sep-2015 21:26:50.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(5) ASASSN-15OI	WFC3/IR WFC3/UVIS	2	15-Sep-2015 21:26:52.0	yes
04	(4) IPTF15AF	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	5	15-Sep-2015 21:26:55.0	yes
07	(5) ASASSN-15OI	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	5	15-Sep-2015 21:26:59.0	yes
05	(2) TDF-TOO2	WFC3/UVIS	1	15-Sep-2015 21:27:00.0	yes
06	(2) TDF-TOO2	WFC3/IR WFC3/UVIS	2	15-Sep-2015 21:27:02.0	yes

18 Total Orbits Used

ABSTRACT

When a star passes within the sphere of disruption of a massive black hole, tidal forces will overcome self-gravity and unbind the star. While approximately half of the stellar debris is ejected at high velocities, the remaining material remains bound to the black hole and accretes, resulting in a luminous, long-lived transient known as a tidal disruption flare (TDF). Aside from serving as a unique laboratory for accretion physics, TDFs offer the hope of measuring black hole masses in galaxies much too distant for resolved kinematic studies. In the simplest analytic models, the black hole mass should scale as dt^2, where dt is the time delay between the disruption and the start of the flare.

Two primary factors have so far limited precise black hole mass estimates from current TDF searches: 1) The difficulty of distinguishing a bona fide TDF from the many other transients that can occur in galactic nuclei; 2) Determing the nature of the disrupted star from the observed electromagnetic signal (in particular the presence or absence of H in optical spectra). Here we request non-disruptive ToO spectra of two nearby TDF candidates in the UV with STIS. Our objectives are to search for unique "smoking gun" signatures of the tidal disruption process, and to constrain the geometry and composition of the newly formed accretion disk (and hence the disrupted star). Much like type Ia supernovae, these observations will furthermore serve as a cornerstone for future high-redshift TDF discoveries by LSST, where the rest-frame UV emission is redshifted into the optical bandpass.

OBSERVING DESCRIPTION

We request non-disruptive ToO HST observations of two (2) nearby (z <~ 0.3) candidate tidal disruption flares (TDFs) in Cycle 22 or 23. In order to avoid triggering on false positives (i.e., supernovae, AGN outbursts), we require the following (strict) criteria be met in order to trigger our program:

- Detection of an optically variable source astrometrically consistent with the nucleus of a resolved galaxy.
- Evidence of an absence of previous AGN activity, either photometrically (i.e., through a constant light curve in the historical PTF database) and/or spectroscopically (i.e., a spectrum that is inconsistent with an AGN or LINER).
- High luminosity (M <~ -19 mag), with a blue, thermal spectrum, and a slow temporal evolution (weeks to months), to distinguish from core-collapse supernovae.
- Resides in a nearby (z <~ 0.3) galaxy (so that we are sampling rest-frame UV with our STIS spectra).
- UV detection with the Swift satellite (to ensure limited host extinction, and also for MAMA safety considerations).

Our principle objective is to obtain UV (1200-3000 A) spectra of our TDF candidates around maximum light, as this is a region inaccessible from the ground, and we expect unique signatures in this bandpass. We note that these observations are entirely unique to HST -- the Swift grism is neither sufficiently sensitive nor sufficiently high resolution to conduct such observations. As our primary objective (and the bulk of our time request) is dedicated to UV science, we consider
this proposal appropriate for the UV initiative.

While the exact details of our source cannot be known at the moment, we can use PS1-10jh and previous PTF discoveries as templates to plan our observation. We assume an r-band magnitude around peak of ~ 20 (note that PTF discoveries will be limited to sources approximately this magnitude or brighter, as the survey limit is r <~ 21 mag), a blackbody spectrum with T ~ 1e4 K, and little to no host extinction (the requirement of a Swift UV detection will limit us to at most lightly extincted sight lines).

Inputting this SED into the online exposure time calculator, we find we can achieve the largest SNR in the near-UV using STIS with the NUV-MAMA detector and the G230L (1570-3180 A) grating. We assume our targets are visible for 54 minutes each orbit. After including overheads for guide-star acquisition (6 min for the first orbit, 4 min for the second orbit), target acquisition (~ 8 min for an extended source, no peak-up required for 0.2" slit width), and wavelength calibration (4 min per orbit), we find that we can obtain 80 min of integration time (36 min in the first orbit, 44 in

the second) with a two-orbit visit. According to the exposure time calculator, we would expect a SNR per resolution element >= 10 for the range from 1650-3000 A for the continuum emission. This should allow us to easily detect strong (W >= 1 A) absorption lines. Simple CLOUDY models of an accretion disk of solar composition also suggest we should be able to detect at least emission lines of Mg II and C III at these wavelengths (depending on the exact redshift of the source).

In the far UV, we have compared the throughput possible with both COS (G140L grating) and STIS (G140L grating) and find that they are roughly comparable. To enable the possibility of executing our spectroscopic observations in a single visit, as well as enable some amount of subtraction of the surrounding host galaxy, we have chosen STIS with the FUV-MAMA detector. Using similar overheads as above, with three (3) orbits we can obtain ~ 125 min of exposure time with this setup. Using the exposure time calculator, this implies a SNR >= 10 over the range from 1200-1700 A for the continuum. Here we should be most sensitive to C IV, Si IV, and, most importantly, Ly-alpha (both in emission and absorption).

In addition to spectroscopy, we also request three (3) orbits of WFC3 imaging of each source. We have chosen WFC3 because of its finer pixel scale (for astrometry). The first epoch should be obtained near peak (though it need only coincide with the UV spectroscopy within ~ 2 weeks or so). Here we will obtain a strong detection of the transient emission in the F606W filter: we choose a redder (than UV) filter to ensure a sufficient number of sources for astrometric alignment. This can then be used for precise astrometry to ensure that the transient is indeed located in the host galaxy nucleus (following host subtraction). Assuming standard overheads and dither patterns,
a source with the characteristics described above (r = 20 mag, T = 5e4K) will be detected with SNR
> 100. Given the brightness of the source, we should also have time to image in a second filter even in just one orbit, in which case we will select a broadband UV option (e.g., F225W). Note that we may need to apply a post flash to avoid charge transfer issues in this case.

Finally, at late times (> 6 months post-peak), when the transient emission has significantly faded, we will obtain a single epoch of reference imaging of the host galaxy. 1 orbit will be detected
to WFC3-UVIS imaging in the same filters to use for template subtraction (and precise astrometry), while the other will be obtained with the NIR channel (F160W) to enable the most precise possible bulge-disk decomposition for the host. Our past experience with this technique implies we can achieve an astrometric precision of < 10 mas in the transient location, while any galaxy with M_BH >~ 1e5 Msun at z <~ 3 will be bright enough to measure the bulge luminosity in a single orbit of F160W imaging.

Our total HST request then comes to 16 orbits of HST observations (5 STIS + 3 WFC3 per target). We emphasize that due to the slowly evolving nature of these transients, we do not require disruptive ToO observations, but can instead obtain spectra at maximum light with a time delay of at

least three weeks.

Proposal 13853 - Visit 01 - UV Spectroscopy of Newly Discovered Tidal Disruption Flares

Visit

Proposal 13853, Visit 01, completed Wed Sep 16 01:27:04 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA, STIS/NUV-MAMA

Special Requirements: BETWEEN 05-JAN-2015:00:00:00 AND 18-JAN-2015:00:00:00; ON HOLD ; TOO RESPONSE TIME 21.0D

On Hold Comments: Triggering based on detection of tidal disruption candidate ASASSN-14li.

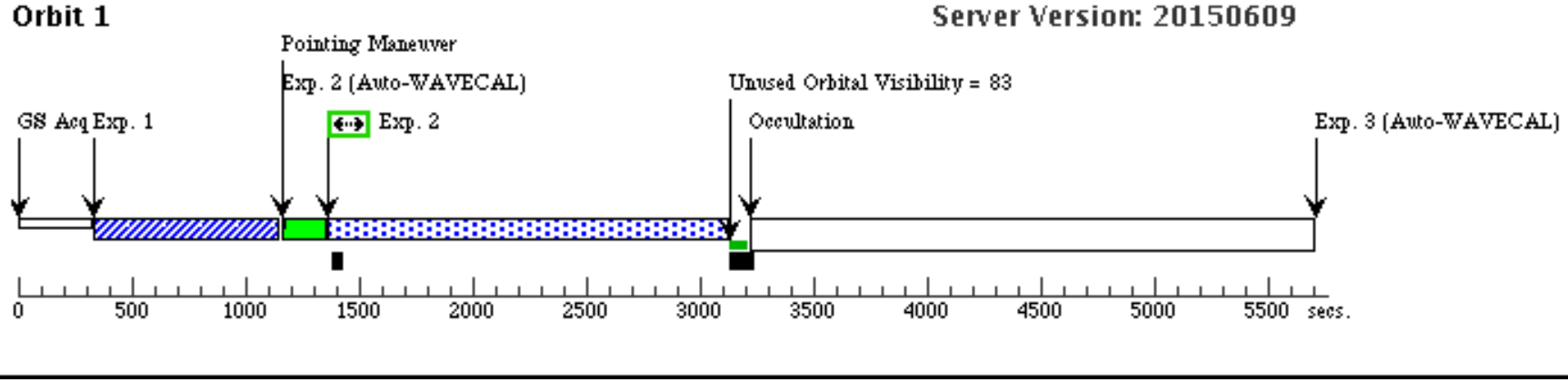
Fixed Targets

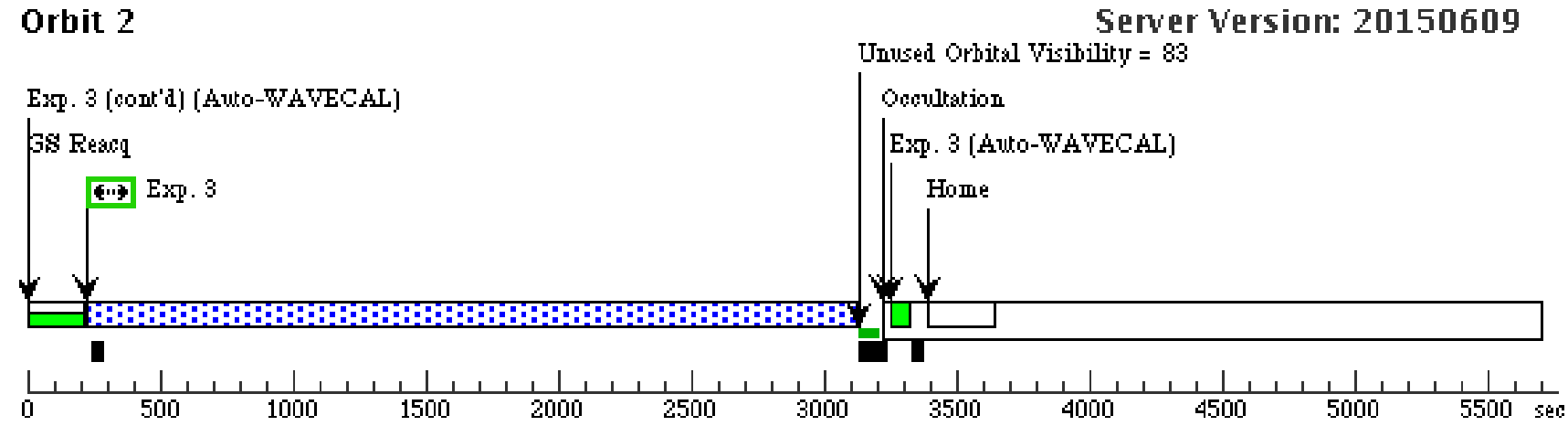
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	ASASSN-14LI	RA: 12 48 15.2300 (192.0634583d) Dec: +17 46 26.20 (17.77394d) Equinox: J2000	Redshift: 0.02	V=16.0+/-0.2	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) ASASSN-14LI	STIS/CCD, ACQ, F25ND3	MIRROR				130 Secs (130 Secs)	
								[==>]	***[1]***
2	(STIS.sp.65 1078)	(3) ASASSN-14LI	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				1750.0 Secs (1750 Secs)	
								[==>]	***[1]***
3	(STIS.sp.65 1079)	(3) ASASSN-14LI	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2888.0 Secs (2888 Secs)	
								[==>]	***[2]***

Orbit Structure





Visit

Proposal 13853, Visit 02, implementation Wed Sep 16 01:27:05 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 07-OCT-2015:00:00:00 AND 28-OCT-2015:00:00:00; ON HOLD ; TOO RESPONSE TIME 21.0D

On Hold Comments: Slow ToO TDF trigger

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

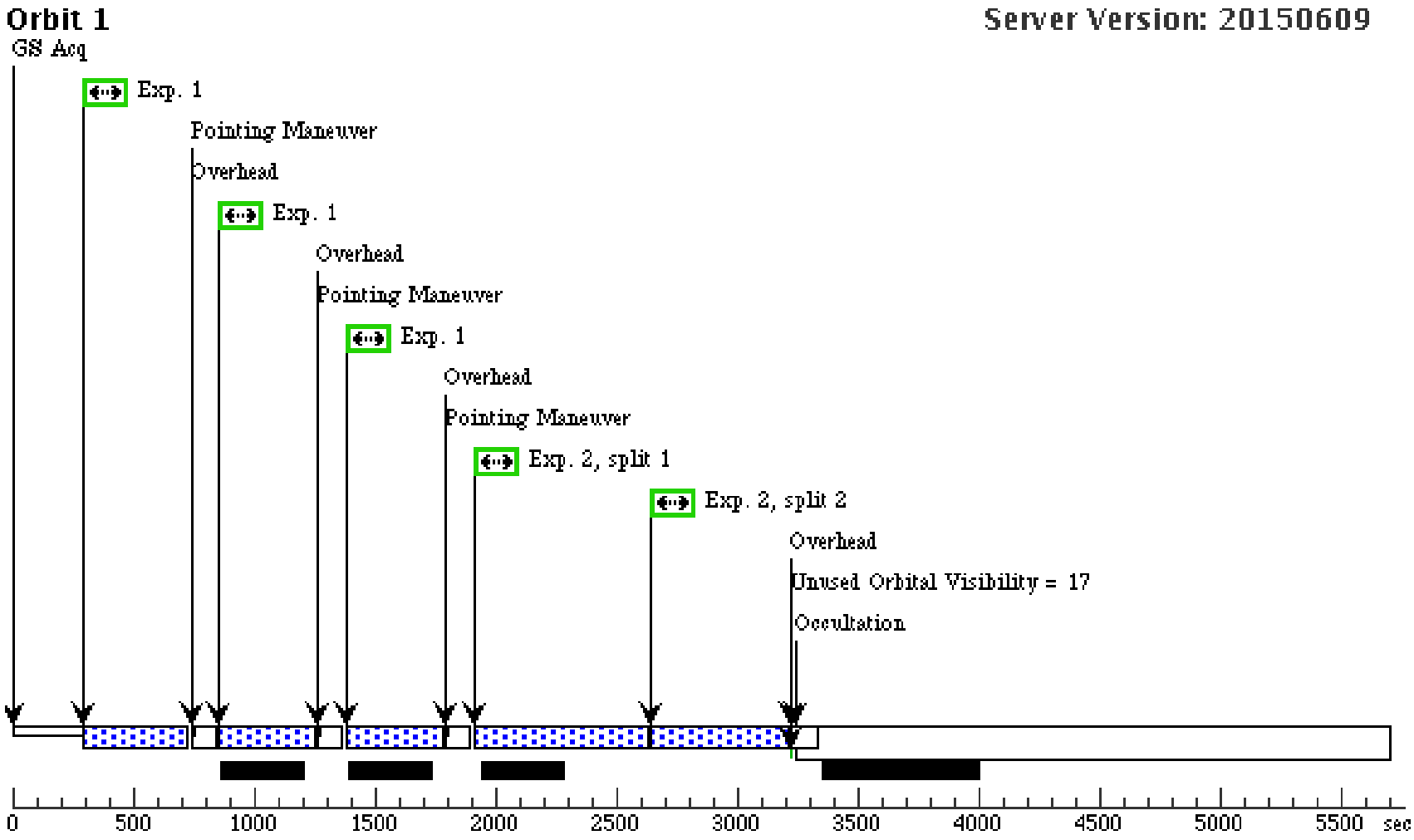
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	ASASSN-15OI	RA: 20 39 9.0960 (309.7879000d) Dec: -30 45 20.71 (-30.75575d) Equinox: J2000		V=17.0	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) ASASSN-15OI	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 1, Exps 1-1 in Visit 02 (1)	400.0 Secs (1200 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(5) ASASSN-15OI	WFC3/UVIS, ACCUM, UVIS	F225W	CR-SPLIT=2; FLASH=10.0			1146.0 Secs (1146 Secs)	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***

Orbit Structure



Visit

Proposal 13853, Visit 03, implementation Wed Sep 16 01:27:05 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: SAME ORIENT AS 02; AFTER 02 BY 180.0 D TO 365.0 D; ON HOLD ; ON HOLD FOR 02

On Hold Comments: Host galaxy observations for TDF candidate 1.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)
(2)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)

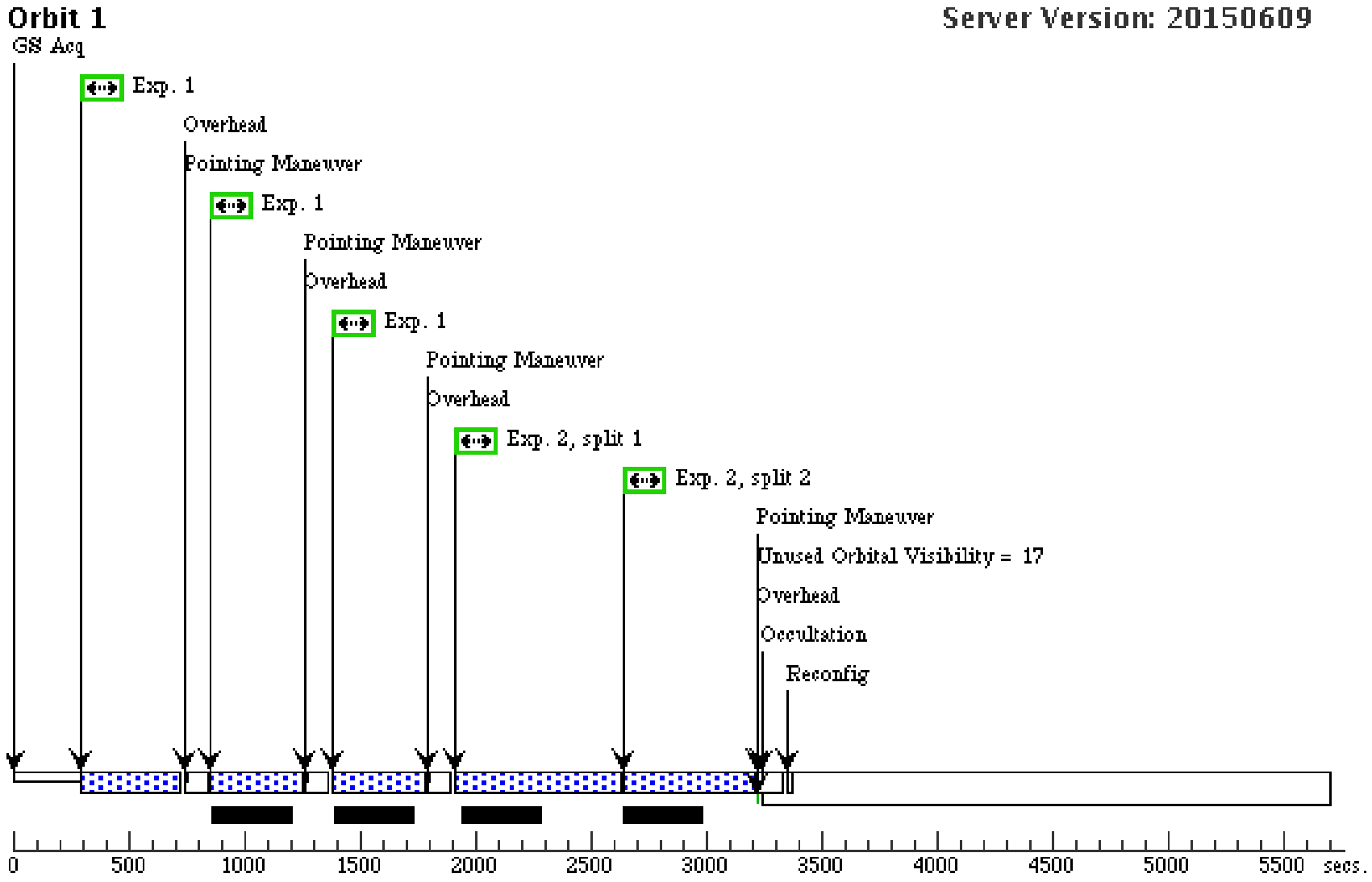
Fixed Targets

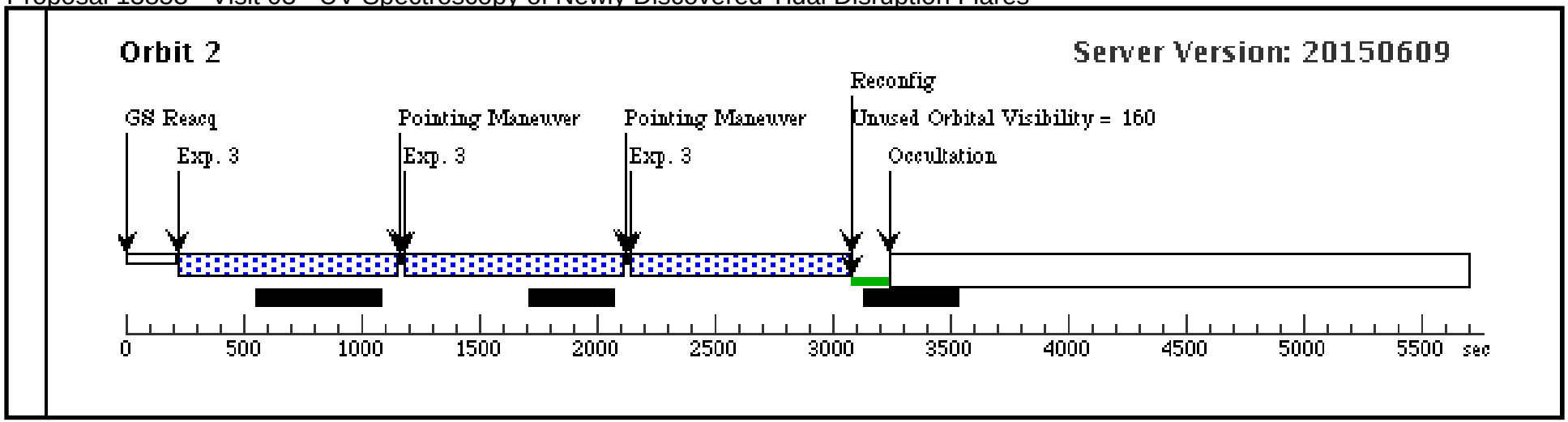
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	ASASSN-15OI	RA: 20 39 9.0960 (309.7879000d) Dec: -30 45 20.71 (-30.75575d) Equinox: J2000		V=17.0	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) ASASSN-15OI	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 1, Exps 1-1 in Visit 03 (1)	400.0 Secs (1200 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[1]***
2		(5) ASASSN-15OI	WFC3/UVIS, ACCUM, UVIS	F225W	CR-SPLIT=2; FLASH=10.0			1146.0 Secs (1146 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	 ***[1]***
3		(5) ASASSN-15OI	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=STEP100		Pattern 2, Exps 3-3 in Visit 03 (2)	899.233261 Secs (2697.7 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	 ***[2]***

Orbit Structure

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Reconfig
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Proposal 13853 - Visit 04 - UV Spectroscopy of Newly Discovered Tidal Disruption Flares

Visit

Proposal 13853, Visit 04, completed Wed Sep 16 01:27:05 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA, STIS/NUV-MAMA

Special Requirements: BETWEEN 23-FEB-2015:00:00:00 AND 09-MAR-2015:00:00:00; ON HOLD ; TOO RESPONSE TIME 21.0D

On Hold Comments: Slow ToO for TDF candidate 2.

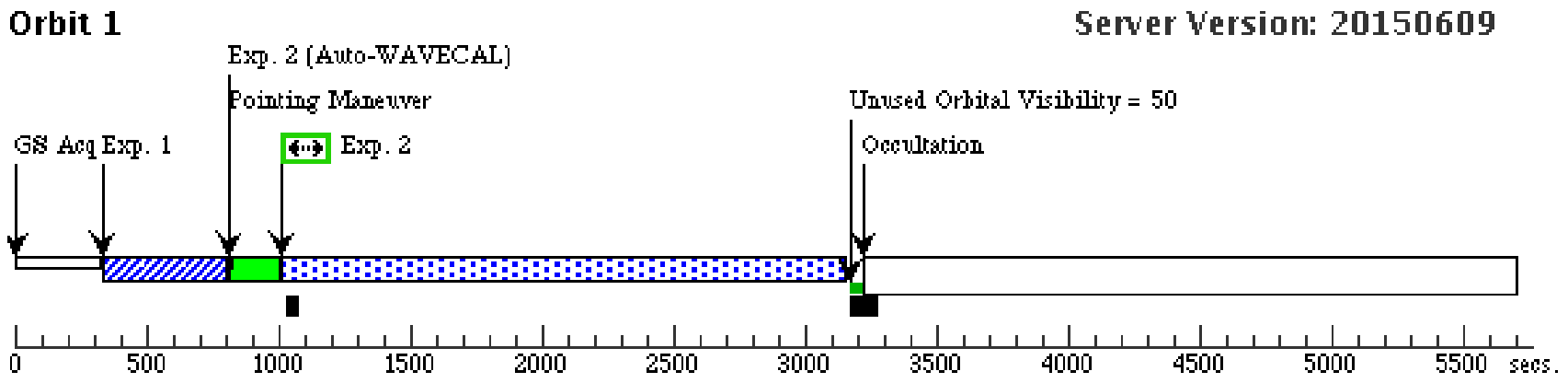
Fixed Targets

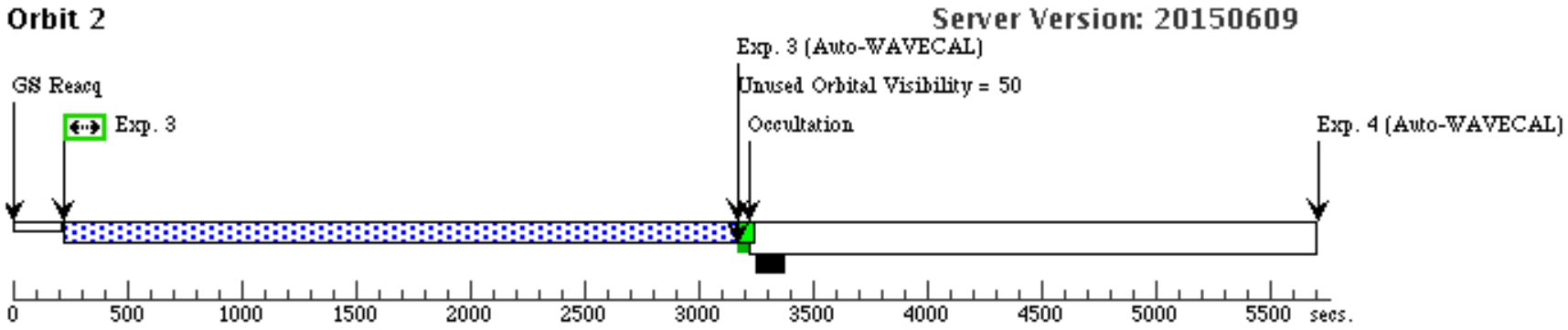
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	IPTF15AF	RA: 08 48 28.1300 (132.1172083d) Dec: +22 03 34.20 (22.05950d) Equinox: J2000		V=18.0+/-0.1	Reference Frame: ICRS

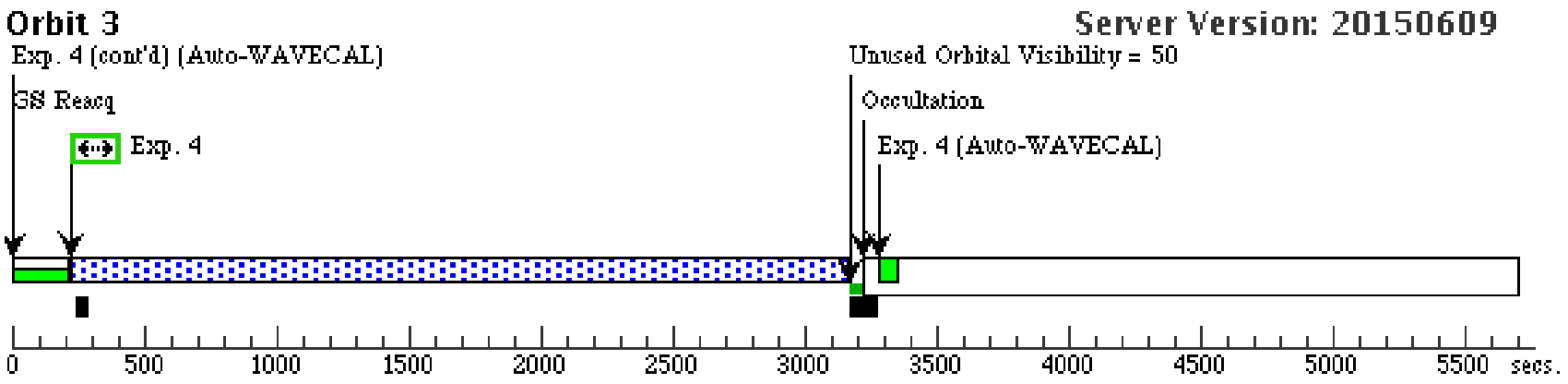
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.661119)	(4) IPTF15AF	STIS/CCD, ACQ, F28X50LP	MIRROR				60 Secs (60 Secs) *[==>]*	 ***[1]***
2	(STIS.sp.661126)	(4) IPTF15AF	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				2130 Secs (2130 Secs) *[==>]*	 ***[1]***
3	(STIS.sp.661126)	(4) IPTF15AF	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				2922 Secs (2922 Secs) *[==>]*	 ***[2]***
4	(STIS.sp.661128)	(4) IPTF15AF	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs) *[==>]*	 ***[3]***
5	(STIS.sp.661128)	(4) IPTF15AF	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs) *[==>]*	 ***[4]***
6	(STIS.sp.661128)	(4) IPTF15AF	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs) *[==>]*	 ***[5]***

Orbit Structure



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Exp. 4
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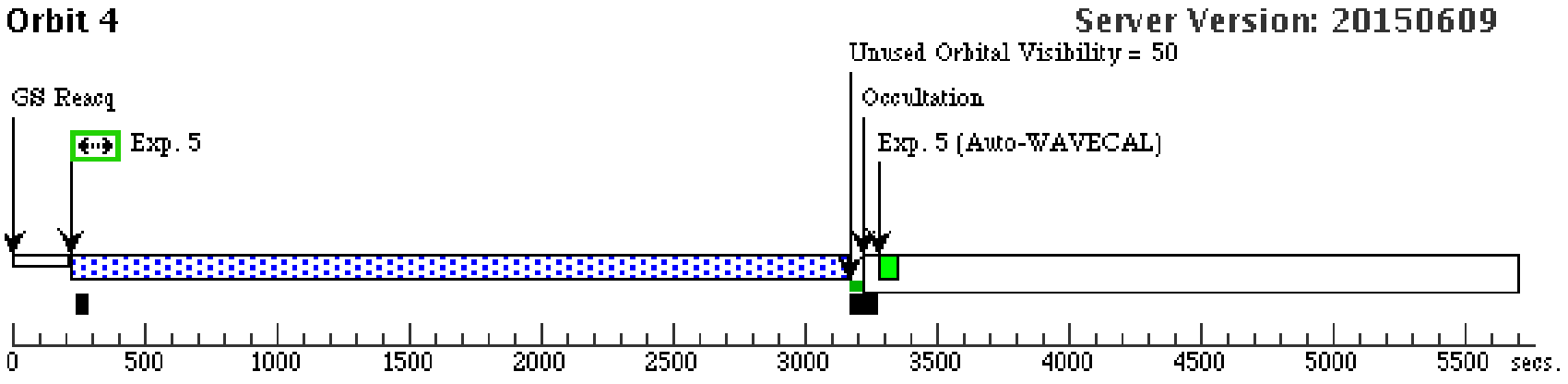
secs.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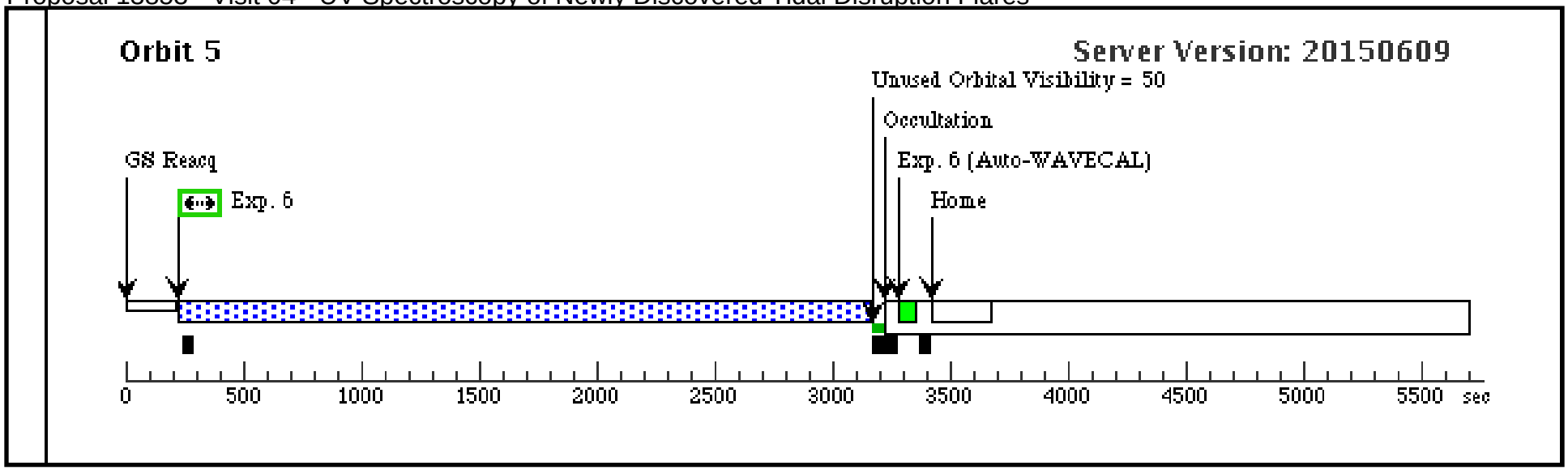
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Visit

Proposal 13853, Visit 07 Wed Sep 16 01:27:06 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA, STIS/NUV-MAMA

Special Requirements: BETWEEN 07-OCT-2015:00:00:00 AND 28-OCT-2015:00:00:00; ON HOLD ; TOO RESPONSE TIME 21.0D

On Hold Comments: Slow ToO for TDF candidate 2.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	ASASSN-15OI	RA: 20 39 9.0960 (309.7879000d) Dec: -30 45 20.71 (-30.75575d) Equinox: J2000		V=17.0	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.742572)	(5) ASASSN-15OI	STIS/CCD, ACQ, F28X50LP	MIRROR				60 Secs (60 Secs)	
								[==>]	***[1]***
2	(STIS.sp.742573)	(5) ASASSN-15OI	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				2130 Secs (2130 Secs)	
								[==>]	***[1]***
3	(STIS.sp.742573)	(5) ASASSN-15OI	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A				2922 Secs (2922 Secs)	
								[==>]	***[2]***
4	(STIS.sp.742574)	(5) ASASSN-15OI	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs)	
								[==>]	***[3]***
5	(STIS.sp.742574)	(5) ASASSN-15OI	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs)	
								[==>]	***[4]***
6	(STIS.sp.742574)	(5) ASASSN-15OI	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A				2922.0 Secs (2922 Secs)	
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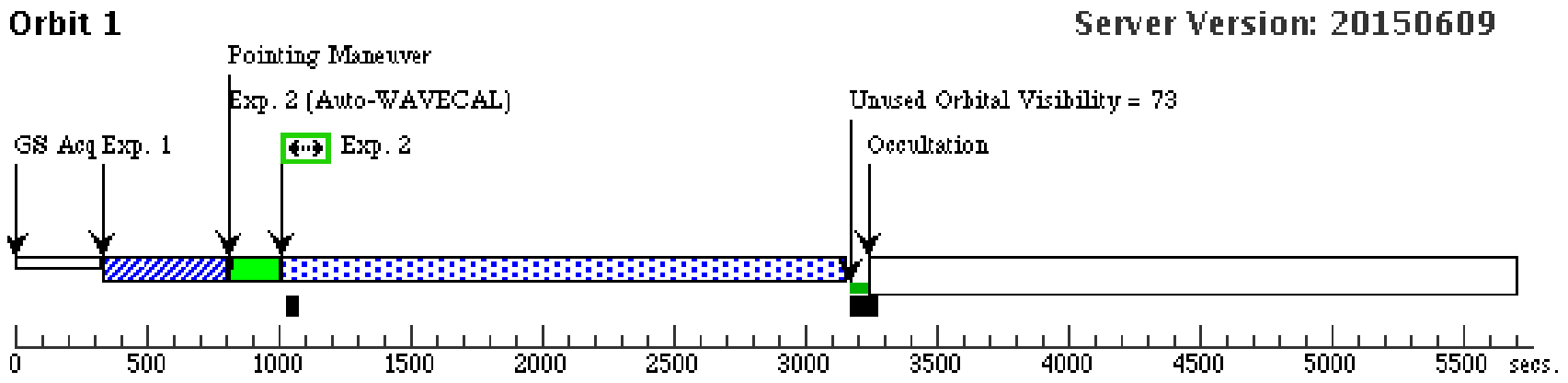
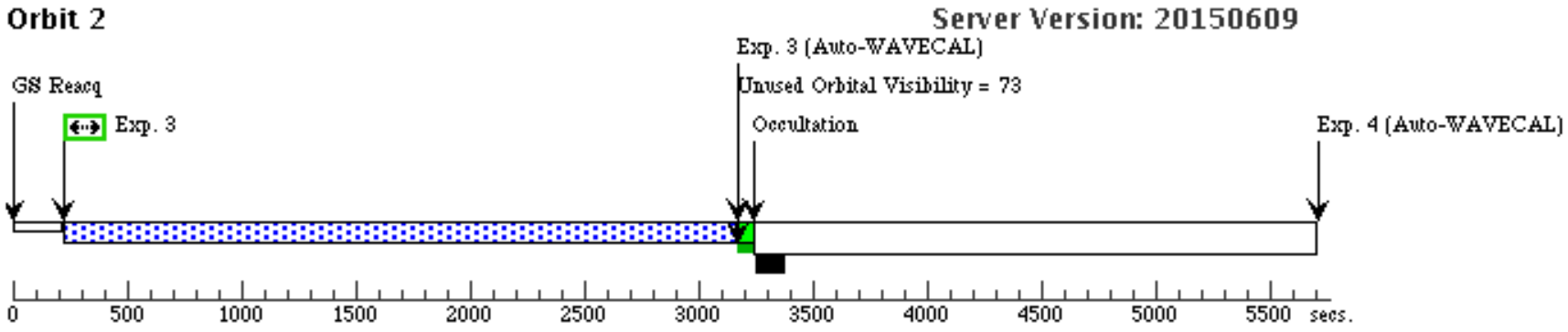
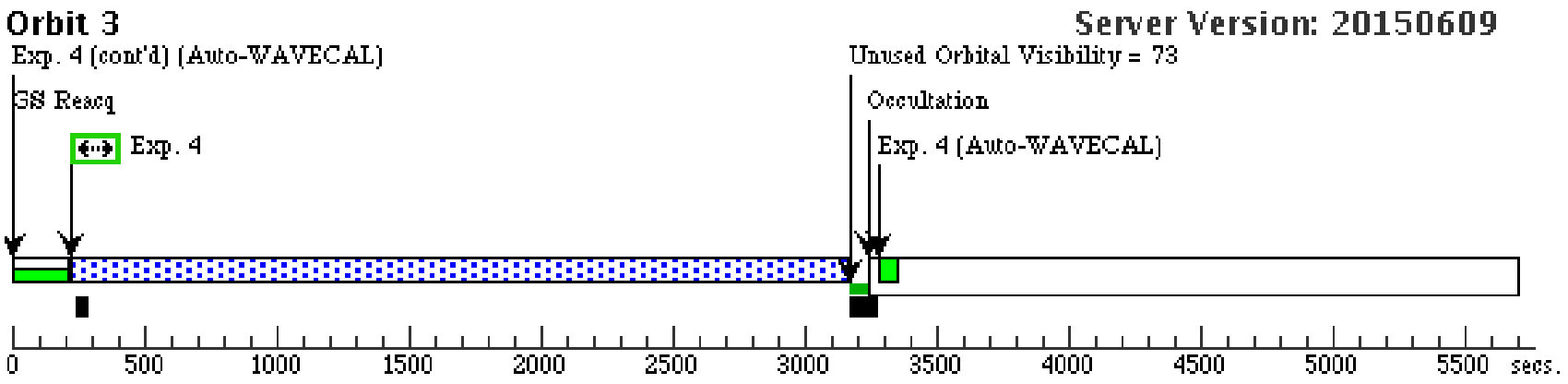
Orbit Structure






Orbit 3
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Exp. 4
Occultation
Exp. 4 (Auto-WAVECAL)
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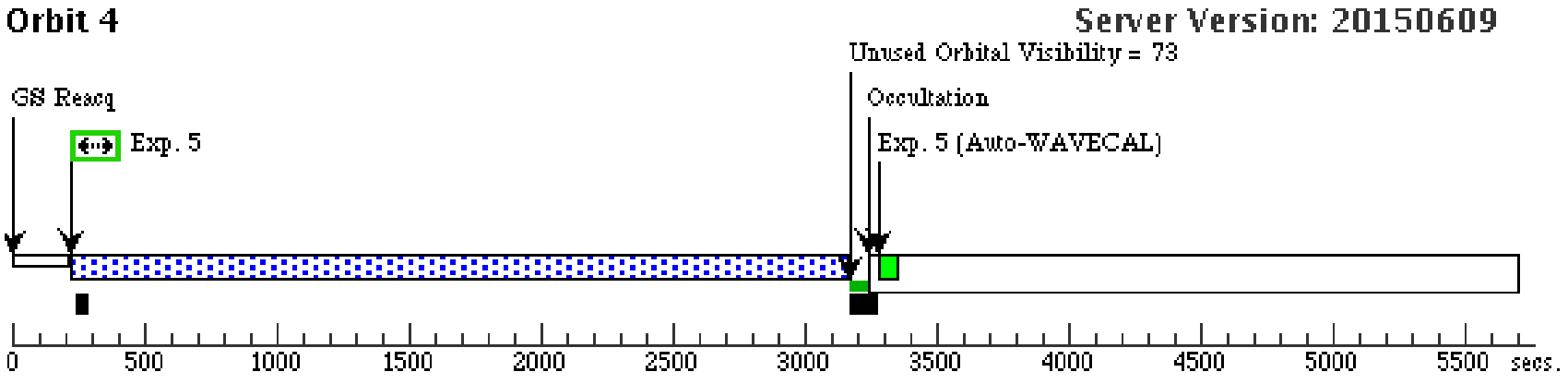
secs.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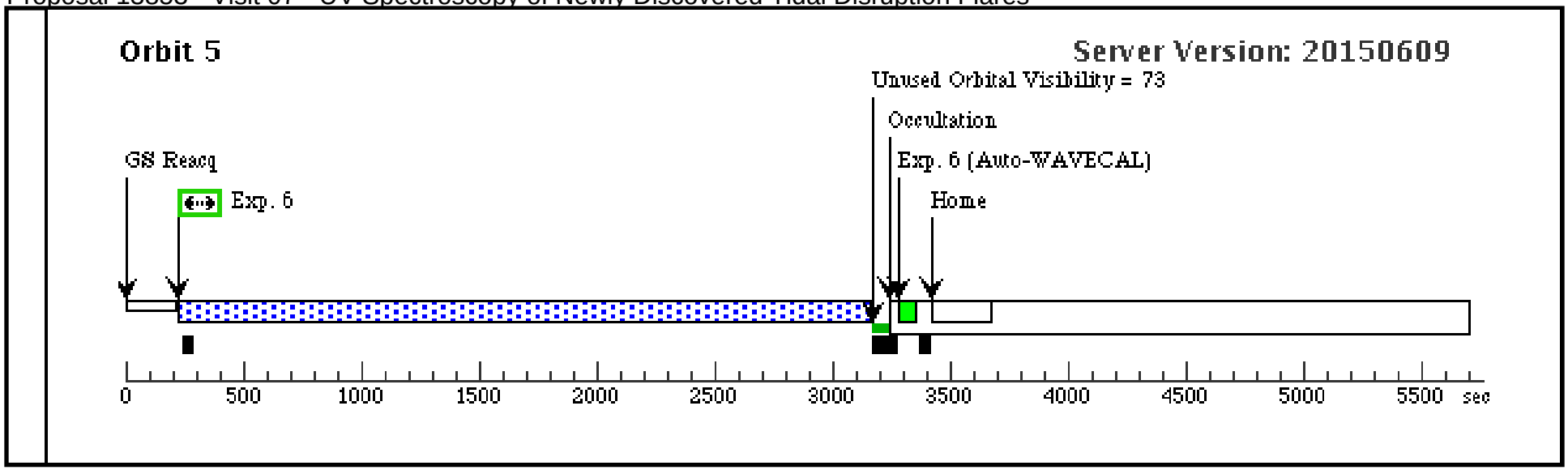
Server Version: 20150609
Unused Orbital Visibility = 73
GS Reacq
Exp. 5
Occultation
Exp. 5 (Auto-WAVECAL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 5
Server Version: 20150609
Unused Orbital Visibility = 73
Occultation
GS Reacq
Exp. 6 (Auto-WAVECAL)
Exp. 6
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13853, Visit 05, implementation Wed Sep 16 01:27:06 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ON HOLD ; TOO RESPONSE TIME 21.0D

On Hold Comments: Slow ToO for TDF candidate 2.

Diagnostics

(Visit 05) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Exposure 2 (Visit 05)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

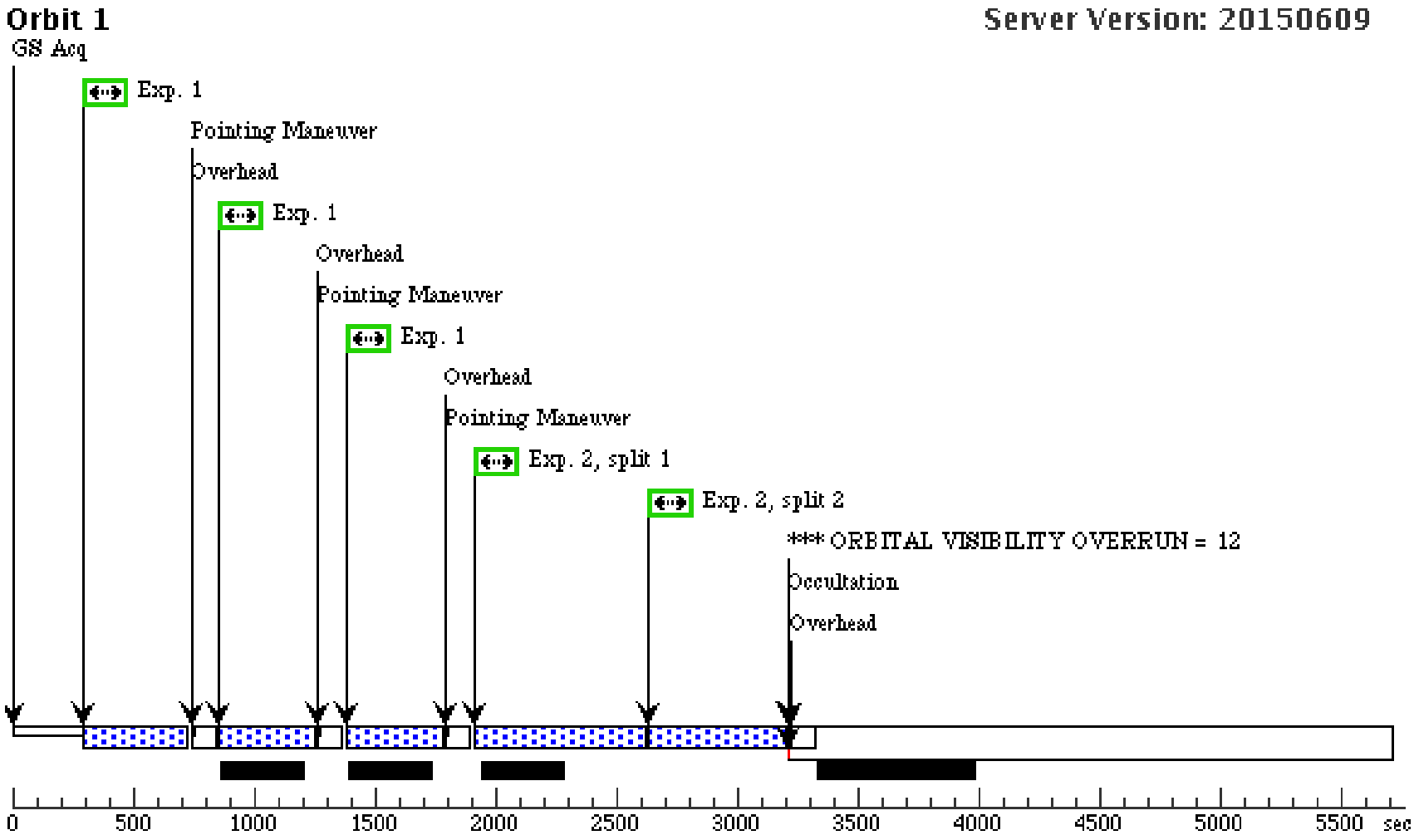
Generic Targets

#	Name	Criteria	Description
(2)	TDF-TOO2	Long-lived, thermal transient from nucleus of non-active galaxy	

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) TDF-TOO2	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 1, Exps 1-1 in Visit 05 (1)	400.0 Secs (1200 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(2) TDF-TOO2	WFC3/UVIS, ACCUM, UVIS	F225W	CR-SPLIT=2			1146.0 Secs (1146 Secs)	
								[==>(Split 1)] *[==>(Split 2)]*	***[1]***

Orbit Structure



Visit

Proposal 13853, Visit 06, implementation Wed Sep 16 01:27:06 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: AFTER 05 BY 180.0 D TO 365.0 D; ON HOLD ; ON HOLD FOR 05

On Hold Comments: Host galaxy observations for TDF candidate 2.

Diagnostics

(Visit 06) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Exposure 2 (Visit 06)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)
(2)	Pattern Type=WFC3-IR-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.605 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)

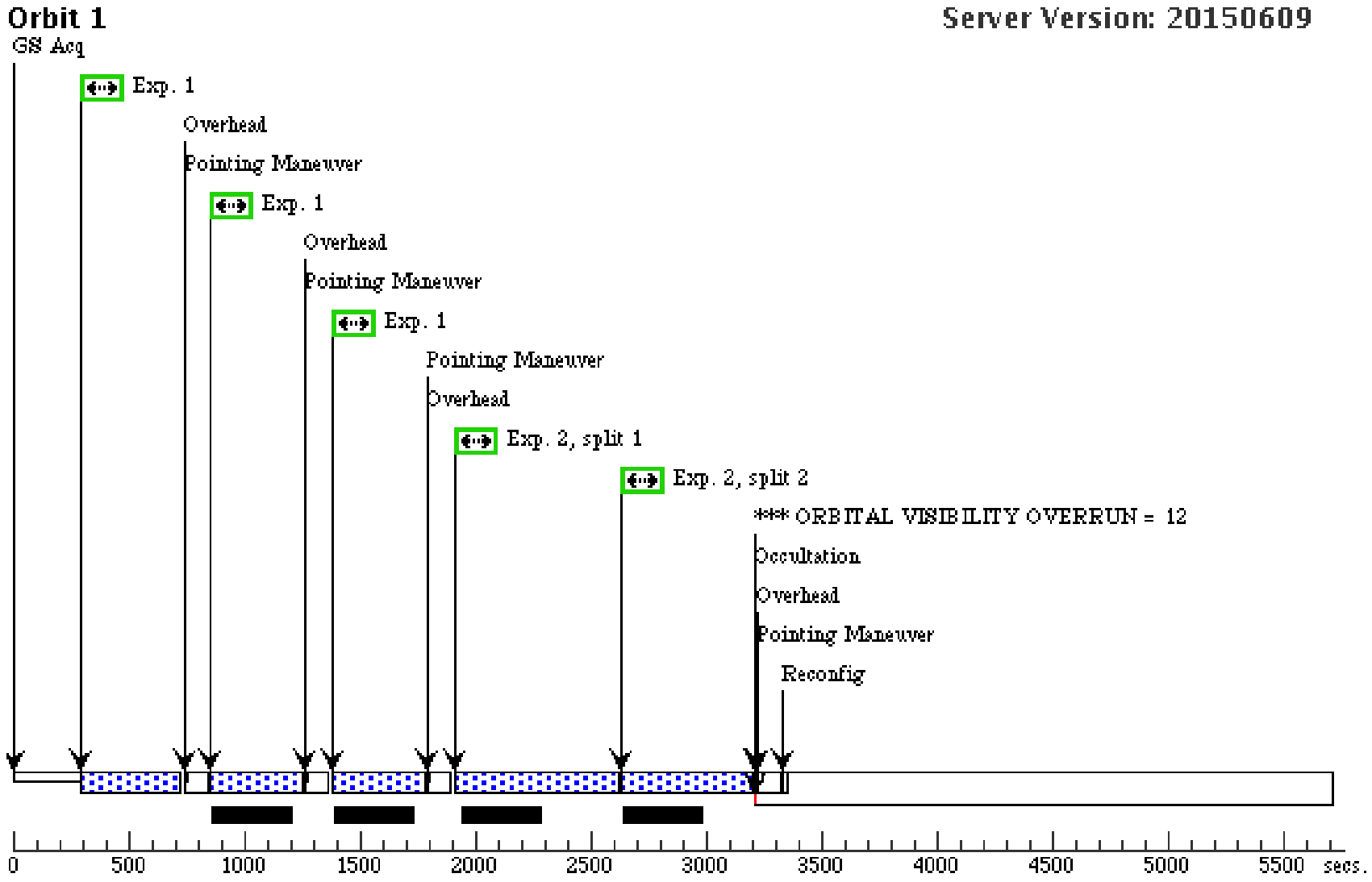
Generic Targets

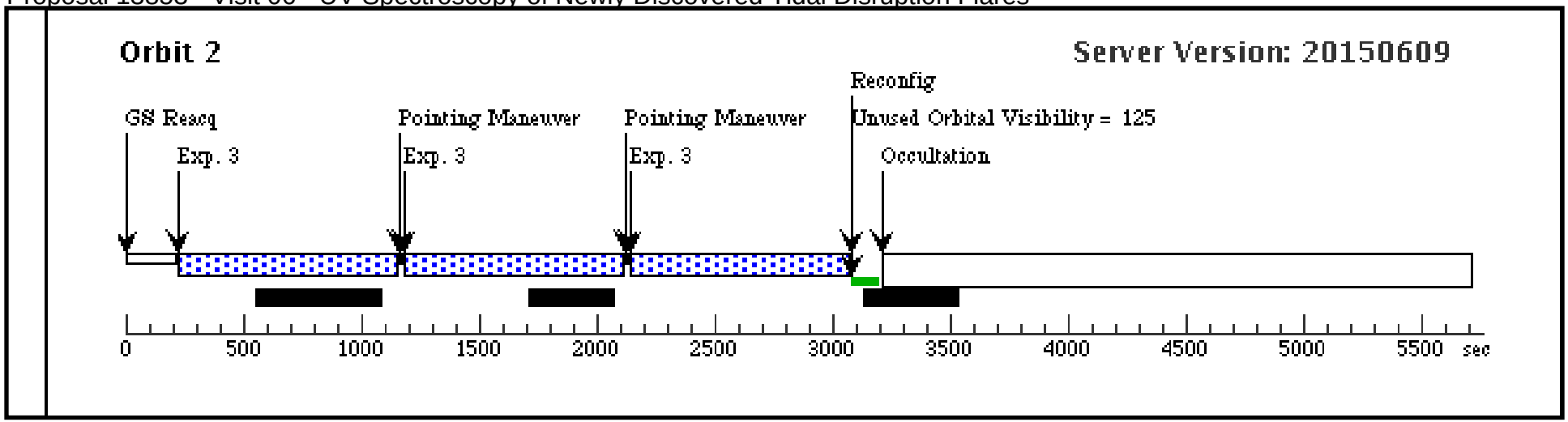
#	Name	Criteria	Description
(2)	TDF-TOO2	Long-lived, thermal transient from nucleus of non-active galaxy	

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) TDF-TOO2	WFC3/UVIS, ACCUM, UVIS	F606W			Pattern 1, Exps 1-1 in Visit 06 (1)	400.0 Secs (1200 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(2) TDF-TOO2	WFC3/UVIS, ACCUM, UVIS	F225W	CR-SPLIT=2			1146.0 Secs (1146 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	***[1]***
3		(2) TDF-TOO2	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=STEP100		Pattern 2, Exps 3-3 in Visit 06 (2)	899.233261 Secs (2697.7 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[2]***

Orbit Structure




Orbit 2
Server Version: 20150609
Reconfig
GS Reacq
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 125
Exp. 3
Exp. 3
Exp. 3
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec