14685 - Underlying Hosts or Highly-Kicked? Determining the Nature of Host-less Short Gamma-ray Bursts with HST

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Wen-fai Fong (PI) (Contact)	**University of Arizona**	**wfong@email.arizona.edu**
Prof. Edo Berger (CoI)	Harvard University	eberger@cfa.harvard.edu
Prof. Ryan Chornock (CoI)	Ohio University	chornock@ohio.edu
Dr. Derek B. Fox (CoI)	The Pennsylvania State University	dfox@astro.psu.edu
Dr. Chris Fryer (CoI)	Los Alamos National Laboratory	fryer@lanl.gov
Prof. Brian Metzger (CoI)	Columbia University in the City of New York	bmetzger@phys.columbia.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) GRB091109B	WFC3/IR	2	29-Jul-2016 14:50:41.0	yes
02	(2) GRB110112A	WFC3/IR	2	29-Jul-2016 14:50:42.0	yes
03	(3) GRB130912A	WFC3/IR	2	29-Jul-2016 14:50:43.0	yes
04	(4) GRB131004A	WFC3/IR	2	29-Jul-2016 14:50:44.0	yes
05	(5) GRB150423A	WFC3/IR	2	29-Jul-2016 14:50:44.0	yes
06	(6) GRB160303A	WFC3/IR	2	29-Jul-2016 14:50:45.0	yes

12 Total Orbits Used

ABSTRACT

Studies of the environments of short-duration gamma-ray bursts (GRBs) from sub-kpc to galactic scales have provided several lines of indirect observational evidence that short GRBs originate from the mergers of compact object binaries (neutron stars and/or black holes; NS-NS/NS-BH). A fundamental prediction of NS-NS/NS-BH mergers is natal kicks imparted to the systems; thus the locations of short GRBs with respect to their hosts have served as the most crucial diagnostic in solving the progenitor question. One key result that has emerged from these studies is the discovery of a subset of short GRBs which lack coincident galaxies to deep optical and near-IR limits (termed "host-less" bursts). These events either originate from faint underlying low-luminosity or high redshift hosts, or originate from galaxies at large separations of tens to hundreds of kpc (indicative of large kicks). Here, we propose to use HST to obtain deep imaging of six "host-less" short GRBs which have deep ground-based optical limits of >25-26 mag, necessitating the sensitivity of HST. These observations will uncover or place meaningful limits on coincident hosts, providing vital constraints on the true spatial distribution of short GRBs, the fraction of highly-kicked mergers which occur far from their hosts, and will directly inform population synthesis models of compact object mergers, which at present rely on poorly-constrained distributions of kick velocities and delay times. Our proposed WFC3/F110W observations will double the sample of host-less bursts, and are tailored to locate or rule out underlying hosts to a significantly greater depth and redshift than is possible from the ground.

OBSERVING DESCRIPTION

This program is designed to observe the locations of 6 short-duration gamma-ray bursts (GRBs) to search for a faint (>25 AB mag) host galaxy, or place deep limits on a spatially coincident host galaxy. We utilize the WFC3/IR camera and F110W filter to be sensitive to a wide redshift range of galaxies and provide significantly improved sensitivity upon the existing ground-based observations.

This program requires 6 visits, or 1 visit per GRB. For each visit, we utilize a 4-point dither pattern (WFC3-IR-DITHER-BOX-MIN) and read-out mode SAMP-SEQ=SPARS100. For Visit 01 (GRB 091109B), the number of samples is NSAMP=15. The remaining visits (Visit 02-06) have a number of samples NSAMP=14, as a higher number overruns the orbit visibility. Thus, Visit 01 has a total exposure time of 4x1403sec = 5612sec, while Visits 02-06 have total exposure times of 4x1303sec = 5212sec each. Including target acquisition and overheads, each visit is 2 orbits long. Thus, this program uses the allocated 12 orbits in total.

For some of our targets, there are one or more bright sources within 12 arcseconds of the GRB position that may create diffraction spikes which contaminate the target position. This applies to Visits 01, 04, and 06. Thus, we provide several ranges of allowed orientation angles for each target to

avoid diffraction spike contamination in the the visit orientation requirements.

Visit

Proposal 14685, Visit 01 Fri Jul 29 18:50:45 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 0D TO 34 D; ORIENT 64D TO 124 D; ORIENT 154D TO 214 D; ORIENT 244D TO 304 D; ORIENT 334D TO 359 D

Comments: The target of interest is 8" away from a bright 15th mag star. Thus we set the orientation to avoid bleeding from this star that affects the target position. The PA between the target and star is 319 deg. The selected axis is 45 deg from the Y-axis (since diffraction spikes are 45 deg offset from the X- and Y-axes for WFC3). Employing an offset angle of 135 deg, we calculate angles to avoid of ORIENT = 319(PA) + 135(offset angle for y-axis) + 45(offset from y-axis) - 360 = 139 deg. We also calculate angles 90, 180, and 270 deg offset from this angle to avoid all 4 diffraction spikes - 49 deg, 229 deg, 319 deg. We set ORIENT angles to avoid this, +/- 15 deg about each angle: ORIENT = 0-34, 64-124, 154-214, 244-304, 334-359 deg.

Note: We would greatly appreciate that this part is checked over since we are not sure if this is correct, particularly the addition of the 45 deg offset.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

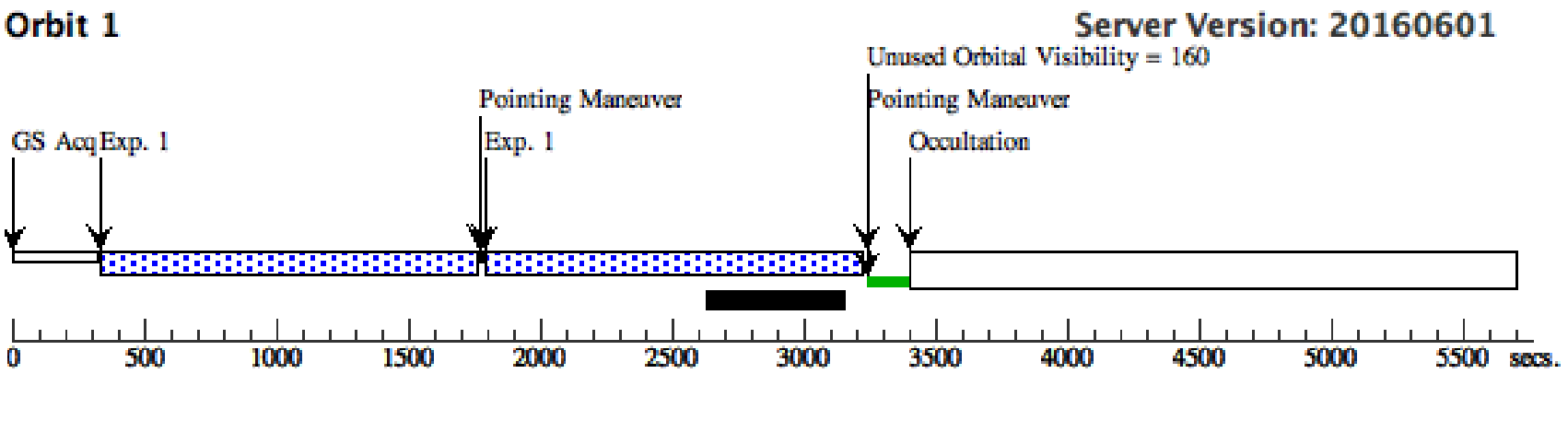
Fixed Targets

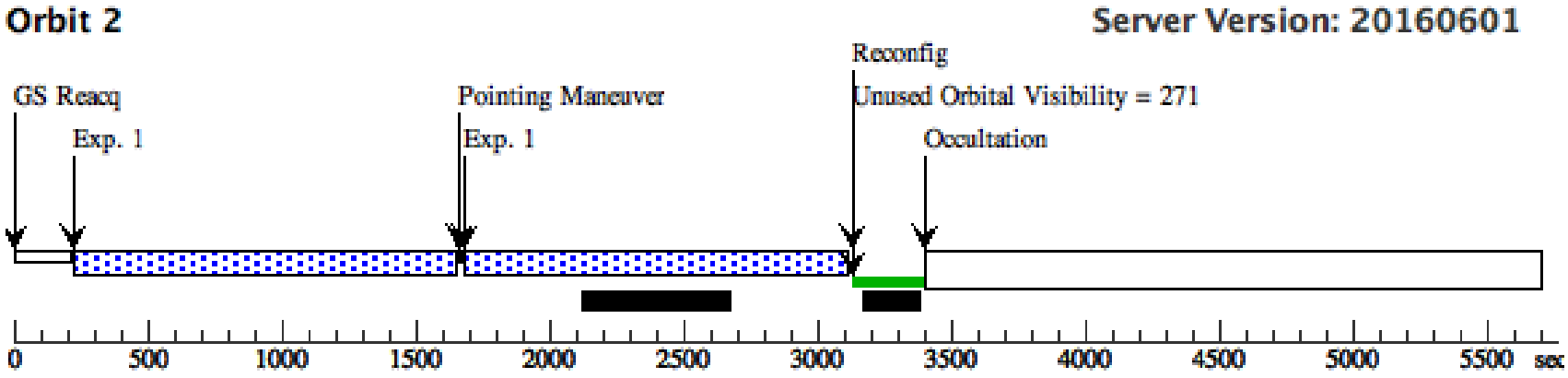
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	GRB091109B	RA: 07 30 56.6100 (112.7358750d) Dec: -54 05 22.85 (-54.08968d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) GRB091109B	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=15		Pattern 1, Exps 1-1 in Visit 01 (1)	1402.936813 Secs (5611.747 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 14685, Visit 02 Fri Jul 29 18:50:46 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

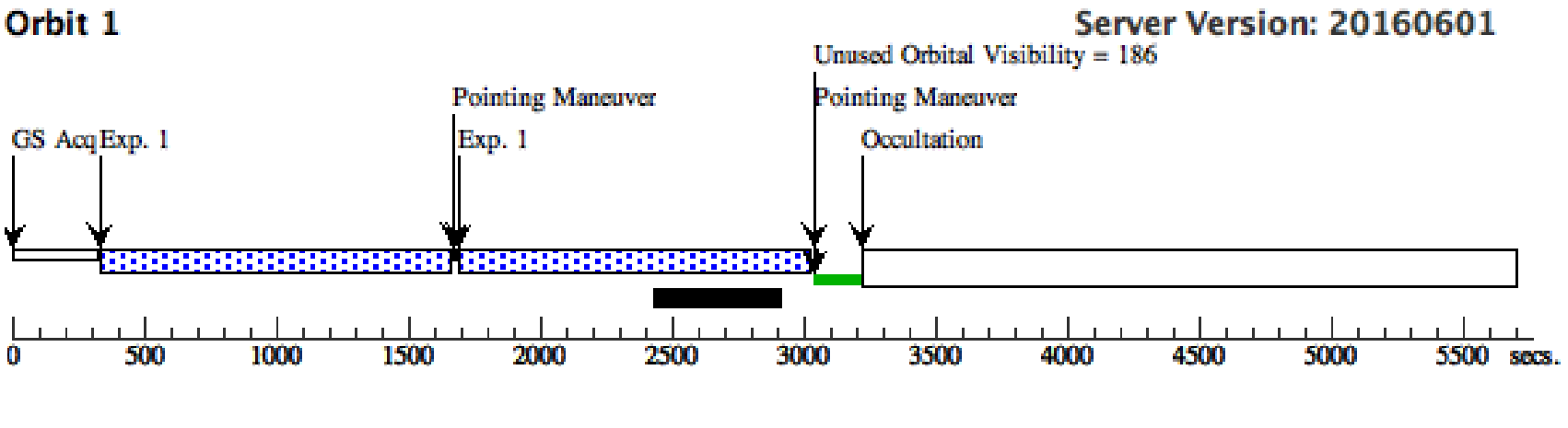
Fixed Targets

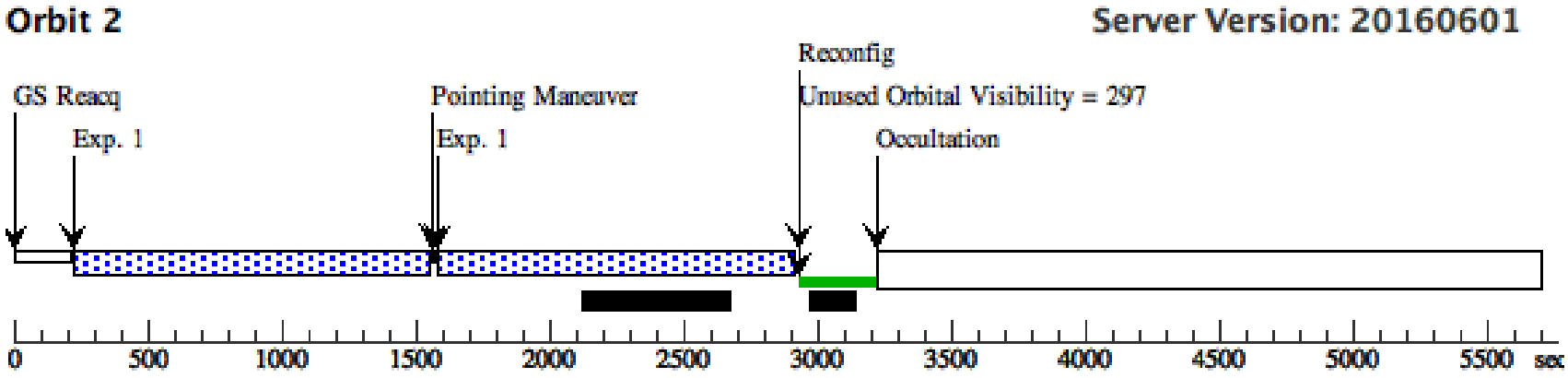
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	GRB110112A	RA: 21 59 43.8300 (329.9326250d) Dec: +26 27 24.07 (26.45669d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) GRB110112A	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=14		Pattern 1, Exps 1-1 in Visit 02 (1)	1302.93649 Secs (5211.746 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]*	*[2]*

Orbit Structure





Visit

Proposal 14685, Visit 03 Fri Jul 29 18:50:46 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

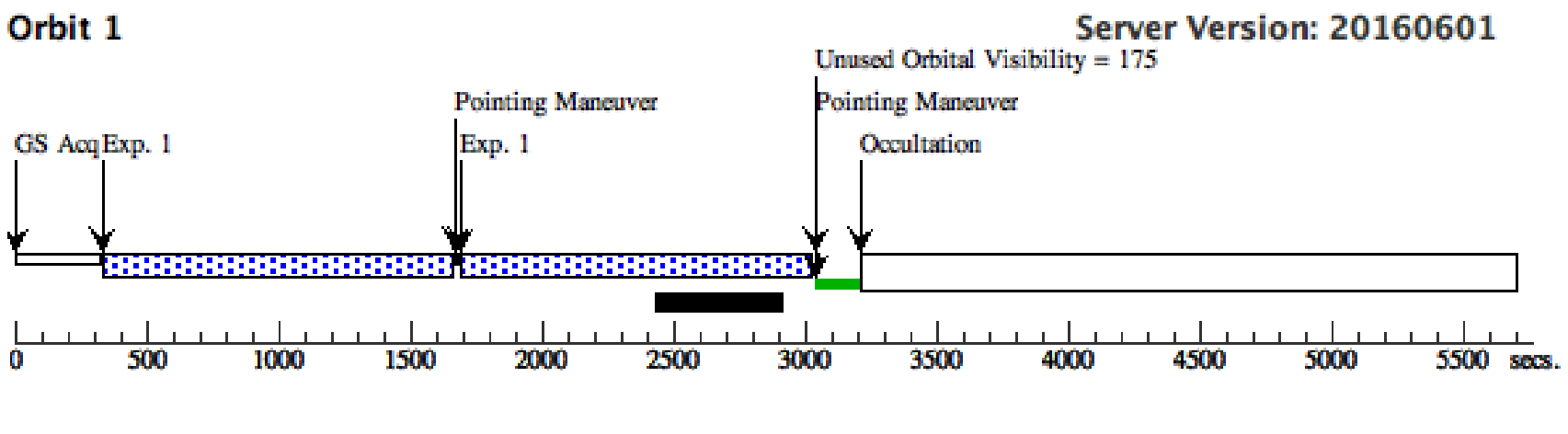
Fixed Targets

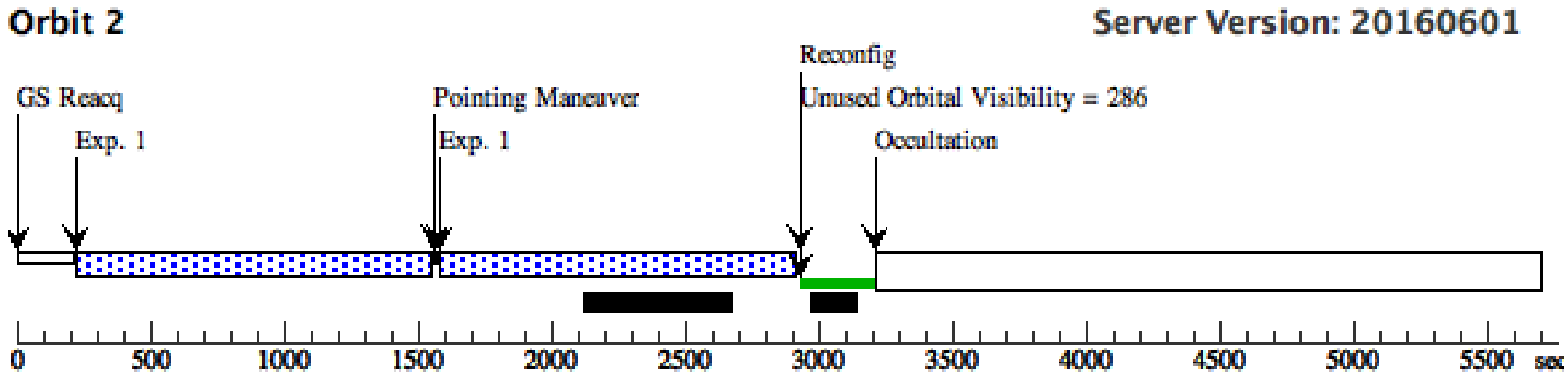
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	GRB130912A	RA: 03 10 22.2300 (47.5926250d) Dec: +13 59 48.70 (13.99686d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) GRB130912A	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=14		Pattern 1, Exps 1-1 in Visit 03 (1)	1302.93649 Secs (5211.746 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 14685, Visit 04 Fri Jul 29 18:50:46 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 5D TO 55 D; ORIENT 95D TO 145 D; ORIENT 185D TO 235 D; ORIENT 275D TO 325 D

Comments: We set the orientation to avoid bleeding from two nearby stars. The PA between the target and stars are 250 and 260 deg, respectively. The selected axis is 45 deg from the Y-axis (since diffraction spikes are 45 deg offset from the X- and Y-axes for WFC3). Employing an offset angle of 135 deg, we calculate angles to avoid of ORIENT = 250 to 260(PA) + 135(offset angle for y-axis) + 45(offset from y-axis) - 360 = 70-80 deg. We also calculate angles 90, 180, and 270 deg offset from this angle to avoid all 4 diffraction spikes: 160-170, 250-260, and 340-350 deg. We set ORIENT angles to avoid this, +/- 15 deg about each angle: ORIENT = 5-55, 95-145, 185-235, and 275-325 deg.

Note: We would greatly appreciate that this part is checked over since we are not sure if this is correct, particularly the addition of the 45 deg offset.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

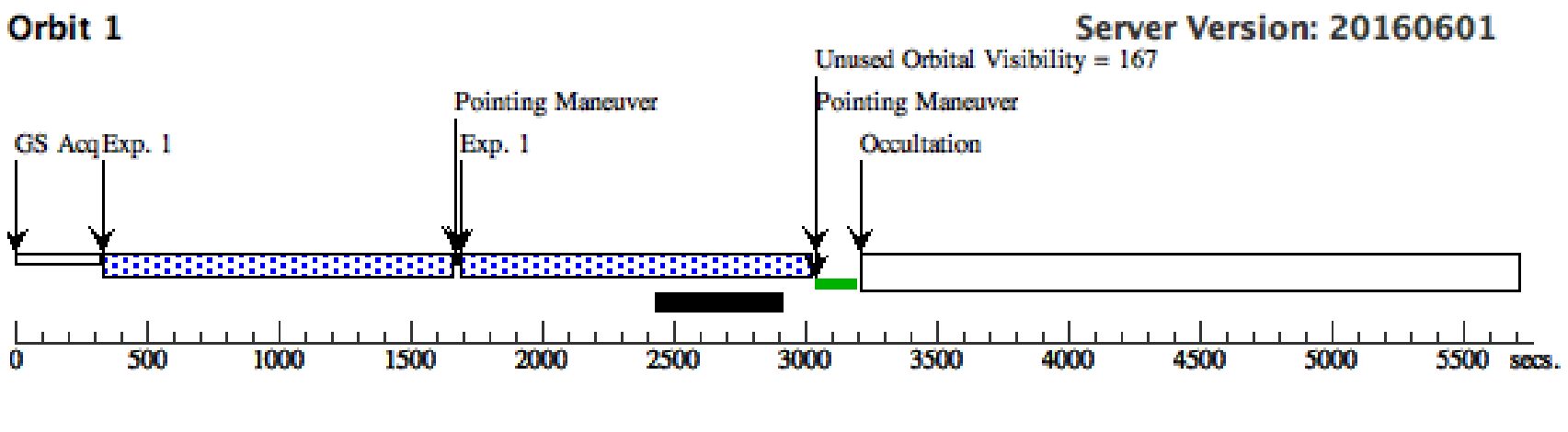
Fixed Targets

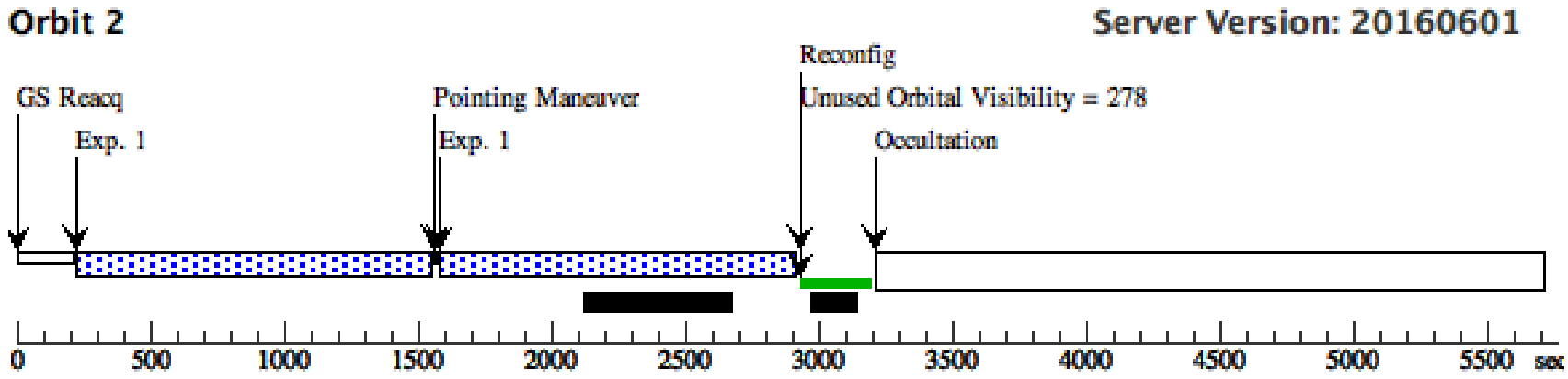
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	GRB131004A	RA: 19 44 27.0800 (296.1128333d) Dec: -02 57 30.20 (-2.95839d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(4) GRB131004A	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=14		Pattern 1, Exps 1-1 in Visit 04 (1)	1302.93649 Secs (5211.746 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 14685, Visit 05 Fri Jul 29 18:50:46 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

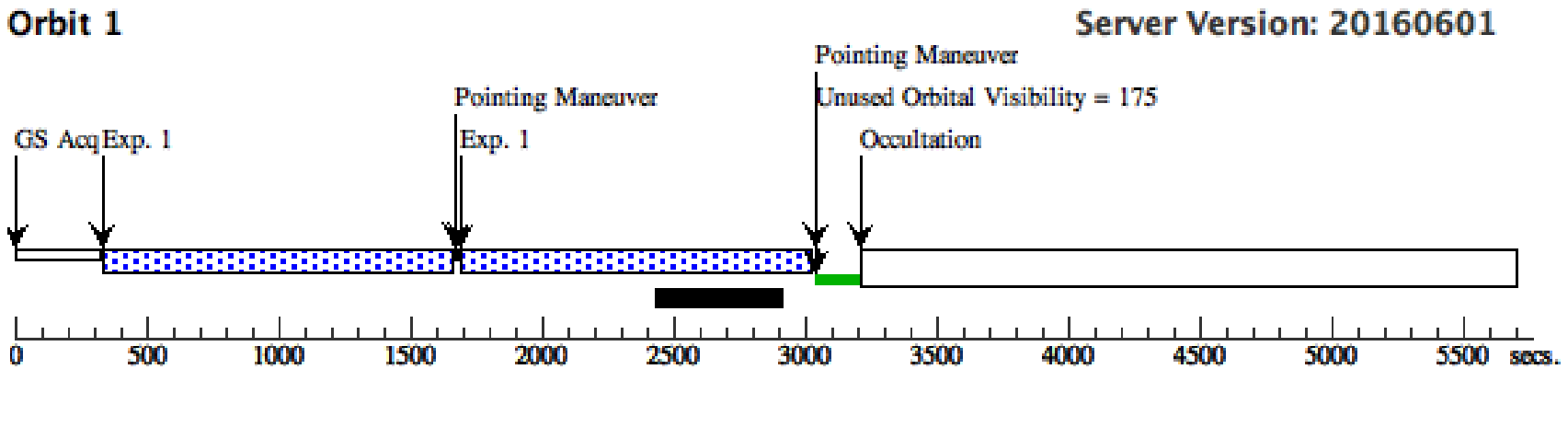
Fixed Targets

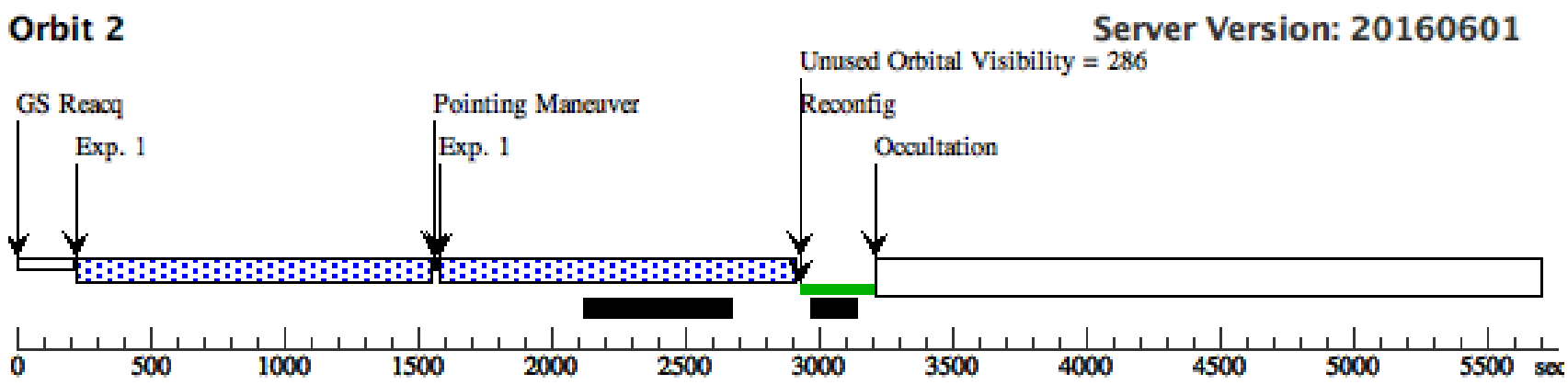
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	GRB150423A	RA: 14 46 18.8600 (221.5785833d) Dec: +12 17 0.70 (12.28353d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) GRB150423A	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=14		Pattern 1, Exps 1-1 in Visit 05 (1)	1302.93649 Secs (5211.746 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 14685, Visit 06 Fri Jul 29 18:50:46 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 30D TO 90 D; ORIENT 120D TO 180 D; ORIENT 210D TO 270 D; ORIENT 300D TO 360 D

Comments: There is a star with J=16.7 mag (from 2MASS) 11" from the target position. We set the orientation to avoid bleeding from this nearby star. The PA between the target and star is 15 deg. The selected axis is 45 deg from the Y-axis (since diffraction spikes are 45 deg offset from the X- and Y-axes for WFC3). Employing an offset angle of 135 deg, we calculate angles to avoid of ORIENT = 15(PA) + 135(offset angle for y-axis) + 45(offset from y-axis) = 195 deg. We also calculate angles 15, 105, and 285 deg to avoid all 4 diffraction spikes. We set ORIENT angles to avoid this, +/- 15 deg about each angle: ORIENT = 30-90, 120-180, 210-270, 300-360 deg.

Note: We would greatly appreciate that this part is checked over since we are not sure if this is correct, particularly the addition of the 45 deg offset.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	GRB160303A	RA: 11 14 48.0600 (168.7002500d) Dec: +22 44 32.20 (22.74228d) Equinox: J2000		V=27	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(6) GRB160303A	WFC3/IR, MULTIACCUM, IR	F110W	SAMP-SEQ=SPARS100; NSAMP=14		Pattern 1, Exps 1-1 in Visit 06 (1)	1302.93649 Secs (5211.746 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***

Orbit Structure