



14898 - The Ongoing Search for Supermassive Black Hole Binaries

Cycle: 24, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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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>
01	(1) SED1	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:17.0	yes
02	(2) SED2	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:19.0	yes
03	(3) SED3	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:21.0	yes
04	(4) SED4	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:23.0	yes
05	(5) SED5	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:24.0	yes
06	(6) SED6	WFC3/IR WFC3/UVIS	1	15-Jan-2017 21:00:26.0	yes

6 Total Orbits Used

ABSTRACT

Although we have entered the gravitational wave era of astronomy, to date there is no definitive electromagnetic evidence for sub-parsec supermassive binary black holes at cosmological distances. We propose to obtain three-band radio spectra of six promising SMBHB candidates. These six were selected from 80,000 quasars in the Sloan Digital Sky Survey to have anomalous spectral energy distributions best explained by a gap cleared in the accretion disk by the orbiting secondary black hole. Multi-frequency radio observations are required to remove contamination from synchrotron sources that peak in the far-to-mid-IR. We also request 6 orbits with HST to acquire simultaneous UV-NIR SEDs; only HST has the UV sensitivity required to remove potential ambiguity due to variability. Determining the fraction of binary black holes will help predict the level of the gravitational wave background that may soon be detected by Pulsar Timing Arrays.

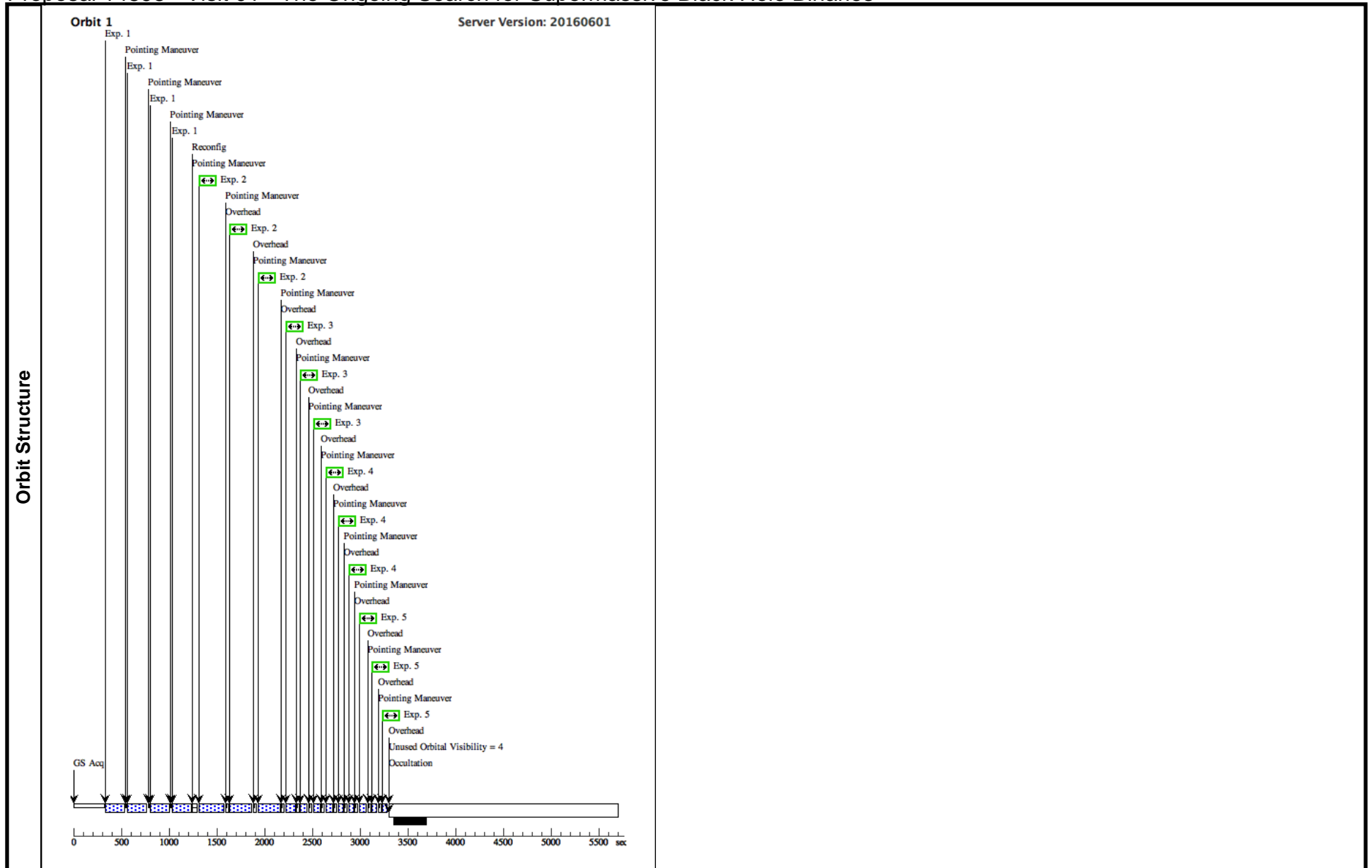
OBSERVING DESCRIPTION

Although we have entered the gravitational wave era of astronomy, to date there is no definitive electromagnetic evidence for sub-parsec supermassive binary black holes at cosmological distances. We will obtain three-band radio spectra of six promising SMBHB candidates. These six were selected from 80,000 quasars in the Sloan Digital Sky Survey to have anomalous spectral energy distributions best explained by a gap cleared in the accretion disk by the orbiting secondary black hole. Multi-frequency radio observations are required to remove contamination from synchrotron sources that peak in the far-to-mid-IR. We will use 6 orbits with HST to acquire simultaneous UV-NIR SEDs; only HST has the UV sensitivity required to remove potential ambiguity due to variability. With these observations, we will construct continuous SEDs observed at one time (removing ambiguity due to variability) and investigate whether the SEDs are in fact consistent with a gap in the accretion disk. Determining the fraction of binary black holes will help predict the level of the gravitational wave background that may soon be detected by Pulsar Timing Arrays.

Proposal 14898 - Visit 01 - The Ongoing Search for Supermassive Black Hole Binaries

Mon Jan 16 02:00:28 GMT 2017

Visit	Proposal 14898, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(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)						
	(2)	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		(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	SED1	RA: 09 11 3.5000 (137.7645833d) Dec: +44 46 30.30 (44.77508d) Equinox: J2000	Redshift: 1.302	V=20.1	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) SED1	(1) SED1	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5		Pattern 1, Exps 1-1 in Visit 01 (1)	174.282148 Secs (697.129 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]
	2	(1) SED1	(1) SED1	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 in Visit 01 (2)	235 Secs (705 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
	3	(1) SED1	(1) SED1	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 in Visit 01 (2)	70 Secs (210 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
	4	(1) SED1	(1) SED1	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 in Visit 01 (2)	50 Secs (150 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
	5	(1) SED1	(1) SED1	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 in Visit 01 (2)	50 Secs (150 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]



Proposal 14898 - Visit 02 - The Ongoing Search for Supermassive Black Hole Binaries

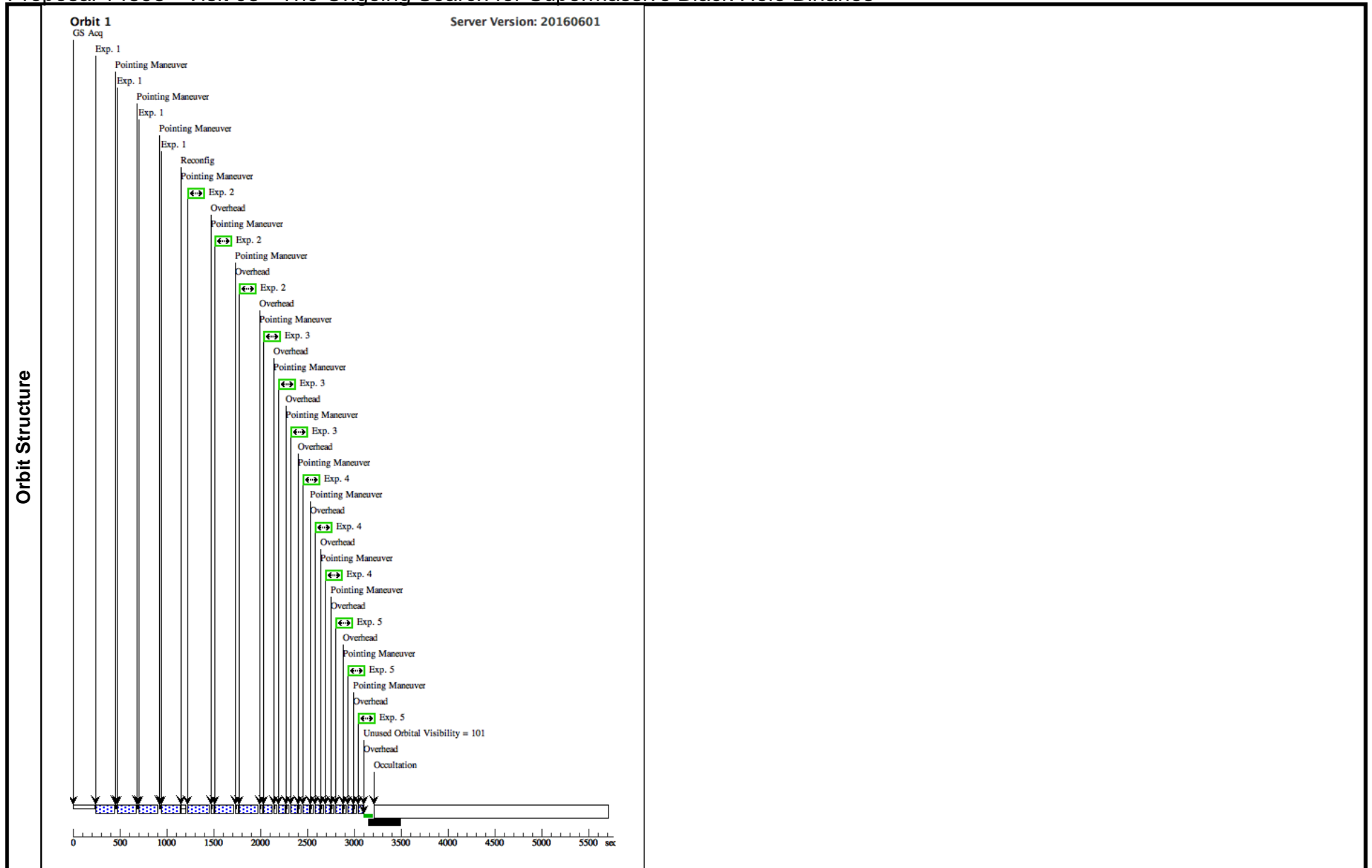
Mon Jan 16 02:00:28 GMT 2017

Visit	Proposal 14898, Visit 02, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(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)						
	(2)	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		(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(2)	SED2	RA: 11 10 4.7700 (167.5198750d) Dec: +37 52 36.80 (37.87689d) Equinox: J2000		V=19	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(2) SED2	(2) SED2	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5		Pattern 1, Exps 1-1 in Visit 02 (1)	174.282148 Secs (697.129 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(2) SED2	(2) SED2	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 in Visit 02 (2)	210 Secs (639 Secs) [==>213.0 Secs (Pattern 1)] [==>213.0 Secs (Pattern 2)] [==>213.0 Secs (Pattern 3)]	[1]
	3	(2) SED2	(2) SED2	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 in Visit 02 (2)	70 Secs (219 Secs) [==>73.0 Secs (Pattern 1)] [==>73.0 Secs (Pattern 2)] [==>73.0 Secs (Pattern 3)]	[1]
	4	(2) SED2	(2) SED2	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 in Visit 02 (2)	50 Secs (159 Secs) [==>53.0 Secs (Pattern 1)] [==>53.0 Secs (Pattern 2)] [==>53.0 Secs (Pattern 3)]	[1]
	5	(2) SED2	(2) SED2	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 in Visit 02 (2)	50 Secs (159 Secs) [==>53.0 Secs (Pattern 1)] [==>53.0 Secs (Pattern 2)] [==>53.0 Secs (Pattern 3)]	[1]

Proposal 14898 - Visit 03 - The Ongoing Search for Supermassive Black Hole Binaries

Mon Jan 16 02:00:28 GMT 2017

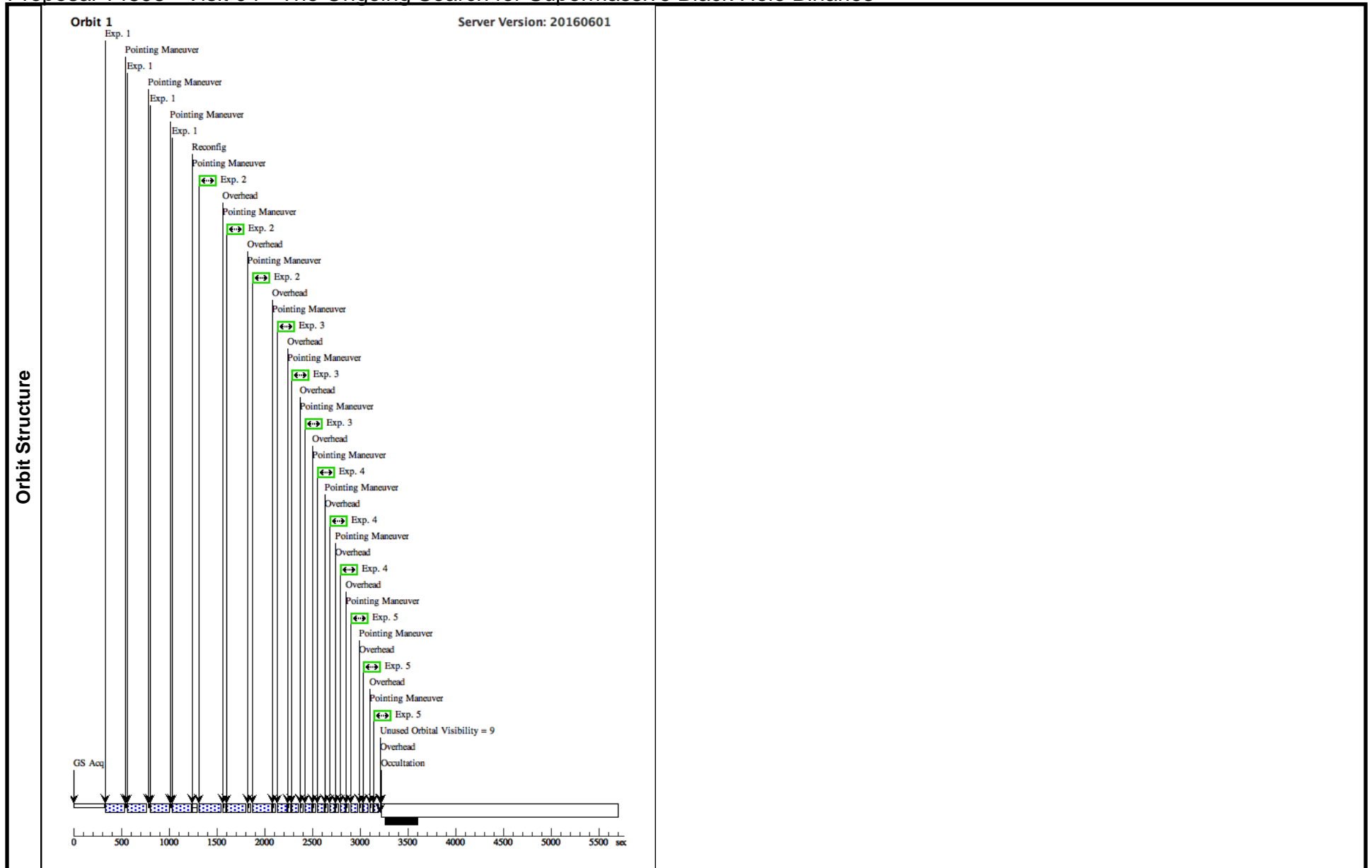
Visit	Proposal 14898, Visit 03, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365 Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)						
	(2)	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		(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	SED3	RA: 12 34 21.9300 (188.5913750d) Dec: +03 31 47.20 (3.52978d) Equinox: J2000		V=19.8	Reference Frame: ICRS				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(3) SED3	(3) SED3	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5	GS ACQ SCENARI O SINGLE	Pattern 1, Exps 1-1 i n Visit 03 (1)	174.282148 Secs (697.129 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]
	2	(3) SED3	(3) SED3	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 i n Visit 03 (2)	205 Secs (612 Secs) [=>204.0 Secs (Pattern 1)] [=>204.0 Secs (Pattern 2)] [=>204.0 Secs (Pattern 3)]	[1]
	3	(3) SED3	(3) SED3	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 i n Visit 03 (2)	70 Secs (207 Secs) [=>69.0 Secs (Pattern 1)] [=>69.0 Secs (Pattern 2)] [=>69.0 Secs (Pattern 3)]	[1]
	4	(3) SED3	(3) SED3	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 i n Visit 03 (2)	50 Secs (147 Secs) [=>49.0 Secs (Pattern 1)] [=>49.0 Secs (Pattern 2)] [=>49.0 Secs (Pattern 3)]	[1]
	5	(3) SED3	(3) SED3	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 i n Visit 03 (2)	50 Secs (147 Secs) [=>49.0 Secs (Pattern 1)] [=>49.0 Secs (Pattern 2)] [=>49.0 Secs (Pattern 3)]	[1]



Proposal 14898 - Visit 04 - The Ongoing Search for Supermassive Black Hole Binaries

Mon Jan 16 02:00:28 GMT 2017

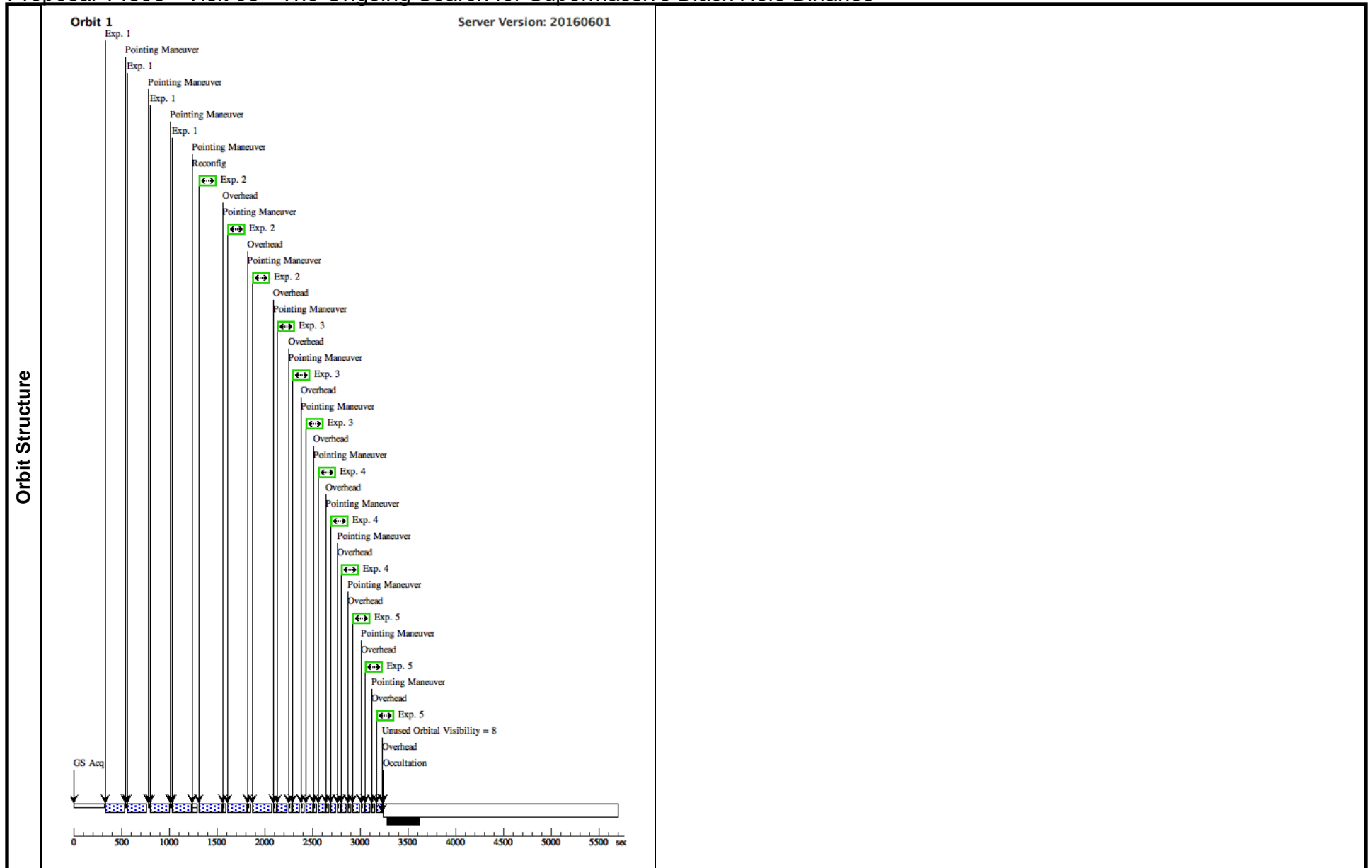
Visit	Proposal 14898, Visit 04, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365 Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(1)						
	(2)	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		(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(4)	SED4	RA: 09 15 1.7000 (138.7570833d) Dec: +24 18 12.20 (24.30339d) Equinox: J2000		V=20	Reference Frame: ICRS				
<i>Comments: Extended=NO</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(4) SED4	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5		Pattern 1, Exps 1-1 in Visit 04 (1)	174.282148 Secs (697.129 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(4) SED4	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 in Visit 04 (2)	205 Secs (615 Secs) [==>205.0 Secs (Pattern 1)] [==>205.0 Secs (Pattern 2)] [==>205.0 Secs (Pattern 3)]	[1]
	3		(4) SED4	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 in Visit 04 (2)	70 Secs (210 Secs) [==>70.0 Secs (Pattern 1)] [==>70.0 Secs (Pattern 2)] [==>70.0 Secs (Pattern 3)]	[1]
	4		(4) SED4	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 in Visit 04 (2)	50 Secs (150 Secs) [==>50.0 Secs (Pattern 1)] [==>50.0 Secs (Pattern 2)] [==>50.0 Secs (Pattern 3)]	[1]
	5		(4) SED4	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 in Visit 04 (2)	50 Secs (150 Secs) [==>50.0 Secs (Pattern 1)] [==>50.0 Secs (Pattern 2)] [==>50.0 Secs (Pattern 3)]	[1]



Proposal 14898 - Visit 05 - The Ongoing Search for Supermassive Black Hole Binaries

Mon Jan 16 02:00:28 GMT 2017

Visit	Proposal 14898, Visit 05, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(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)						
	(2)	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	(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(5)	SED5	RA: 10 02 8.9200 (150.5371667d) Dec: +31 10 51.50 (31.18097d) Equinox: J2000		V=19.5	Reference Frame: ICRS				
<i>Comments: Extended=NO</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(5) SED5	(5) SED5	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5		Pattern 1, Exps 1-1 in Visit 05 (1)	174.282148 Secs (697.129 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(5) SED5	(5) SED5	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 in Visit 05 (2)	205 Secs (621 Secs) [==>207.0 Secs (Pattern 1)] [==>207.0 Secs (Pattern 2)] [==>207.0 Secs (Pattern 3)]	[1]
	3	(5) SED5	(5) SED5	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 in Visit 05 (2)	70 Secs (216 Secs) [==>72.0 Secs (Pattern 1)] [==>72.0 Secs (Pattern 2)] [==>72.0 Secs (Pattern 3)]	[1]
	4	(5) SED5	(5) SED5	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 in Visit 05 (2)	50 Secs (156 Secs) [==>52.0 Secs (Pattern 1)] [==>52.0 Secs (Pattern 2)] [==>52.0 Secs (Pattern 3)]	[1]
	5	(5) SED5	(5) SED5	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 in Visit 05 (2)	50 Secs (156 Secs) [==>52.0 Secs (Pattern 1)] [==>52.0 Secs (Pattern 2)] [==>52.0 Secs (Pattern 3)]	[1]



Proposal 14898 - Visit 06 - The Ongoing Search for Supermassive Black Hole Binaries

Mon Jan 16 02:00:28 GMT 2017

Visit	Proposal 14898, Visit 06, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(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)						
	(2)	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		(2), (3), (4), (5)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(6)	SED6	RA: 00 06 59.2800 (1.7470000d) Dec: -00 17 40.90 (-.29469d) Equinox: J2000		V=19.4	Reference Frame: ICRS				
<i>Comments: Extended=NO</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(6) SED6	(6) SED6	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=12; SAMP-SEQ=STEP2 5		Pattern 1, Exps 1-1 in Visit 06 (1)	174.282148 Secs (697.129 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(6) SED6	(6) SED6	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F225W	FLASH=11		Pattern 2, Exps 2-2 in Visit 06 (2)	195 Secs (588 Secs) [==>196.0 Secs (Pattern 1)] [==>196.0 Secs (Pattern 2)] [==>196.0 Secs (Pattern 3)]	[1]
	3	(6) SED6	(6) SED6	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	FLASH=12		Pattern 2, Exps 3-3 in Visit 06 (2)	70 Secs (213 Secs) [==>71.0 Secs (Pattern 1)] [==>71.0 Secs (Pattern 2)] [==>71.0 Secs (Pattern 3)]	[1]
	4	(6) SED6	(6) SED6	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W	FLASH=12		Pattern 2, Exps 4-4 in Visit 06 (2)	50 Secs (153 Secs) [==>51.0 Secs (Pattern 1)] [==>51.0 Secs (Pattern 2)] [==>51.0 Secs (Pattern 3)]	[1]
	5	(6) SED6	(6) SED6	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=12		Pattern 2, Exps 5-5 in Visit 06 (2)	50 Secs (153 Secs) [==>51.0 Secs (Pattern 1)] [==>51.0 Secs (Pattern 2)] [==>51.0 Secs (Pattern 3)]	[1]

