



14924 - Increasing Diversity in Galaxies with Black Hole Mass Measurements

Cycle: 24, 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>
01	(1) NGC1589	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:42.0	yes
02	(3) NGC772	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:43.0	yes
03	(4) PGC12557	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:45.0	yes
04	(5) NGC7242	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:46.0	yes
05	(6) UGC11537	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:47.0	yes
06	(7) NGC1022	WFC3/IR WFC3/UVIS	1	03-Apr-2017 21:08:48.0	yes

6 Total Orbits Used

ABSTRACT

Supermassive black holes (BHs) are fundamental components of galaxies, as demonstrated by the correlations between BH mass and large-scale galaxy properties. However, these scaling relations are based on BH mass measurements in a galaxy sample that is significantly biased relative to the overall galaxy population. We propose to enhance the diversity of galaxies with BH mass measurements using a combination of adaptive optics kinematics and HST imaging. Our proposal focuses on the first six galaxies observed as part of a recently approved Gemini Large Program to

measure BH masses in 31 galaxies. HST imaging is required for (1) the creation of high-resolution stellar mass models, and (2) the determination of the adaptive optics point spread function; both are essential for measuring accurate BH masses. Immediate observations are needed to guide our approved future Gemini observations and to develop and refine our BH mass estimation pipeline. The six galaxies in the present proposal have a wide range of galaxy sizes and luminosities, significantly expanding the types of galaxies with known BH masses. This data is crucial for understanding the underlying physics driving the BH -- galaxy scaling relations and their scatter.

OBSERVING DESCRIPTION

Targets:

All target positions were taken from NED, with the exception of NGC7242 (where the NED position is the centroid of a double galaxy), for this object we located the center of the galaxy in our Gemini images. Given our FOV, offsets of up to a few arcseconds in these central positions are not a problem, therefore we have not spent a lot of maximizing their accuracy. We expect the positions to be accurate to $\sim 1''$.

Filters, Subarrays & Exposure Times:

We are scheduling observations in 3 filters as detailed below. We are most concerned about achieving reasonable S/N in each pixel for our targets out to a radius of $\sim 10''$. Our exposure times in F475W are ~ 850 s (in 4 exposures), in F814W are ~ 750 s (in 2 exposures), and in F160W are 37s (in 2 exposures). These exposure times will achieve $S/N > 50$ per pixel near the center of our galaxies (overlapping with our kinematic data), and $S/N > 10$ per pixel at a radius of $10''$, the radius out to which we need to accurately model the mass distribution of the galaxies. In order to get the required number of exposures (see dithering below), we use the UVIS-2K2C-SUB subarray, otherwise buffer dumps prevent us from taking the needed number of exposures. The F160W images are taken with WFC3 IR without subarrays, and will be used to constrain the larger scale structure of the galaxies; the S/N levels achieved in these observations are similar/higher than the S/N achieved per pixel than in the UVIS bands.

Dithering:

Resolution of the inner parts of the galaxies are of critical importance. Therefore, we have used four exposures in F475W and two exposures in F814W to enable the construction of Nyquist sampled images. These use the existing defined box/line dither patterns which include half-integer + a few pixel dithers. This achieves removal of hot pixels and recovery of the undersampled PSF.

Saturation:

Based on model fits to 2MASS data, our brightest targets have expected central SBs of $\mu_{F475W} \sim 15$ mag/arcsec² and $\mu_{F814W} \sim 14$

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mag/arcsec²; the saturation time for an individual exposures are ~2000s in both filters, while our individual exposures will be 5-10x shorter than this. Therefore even if our estimates are off a bit, we do not expect any of the galaxies to saturate.

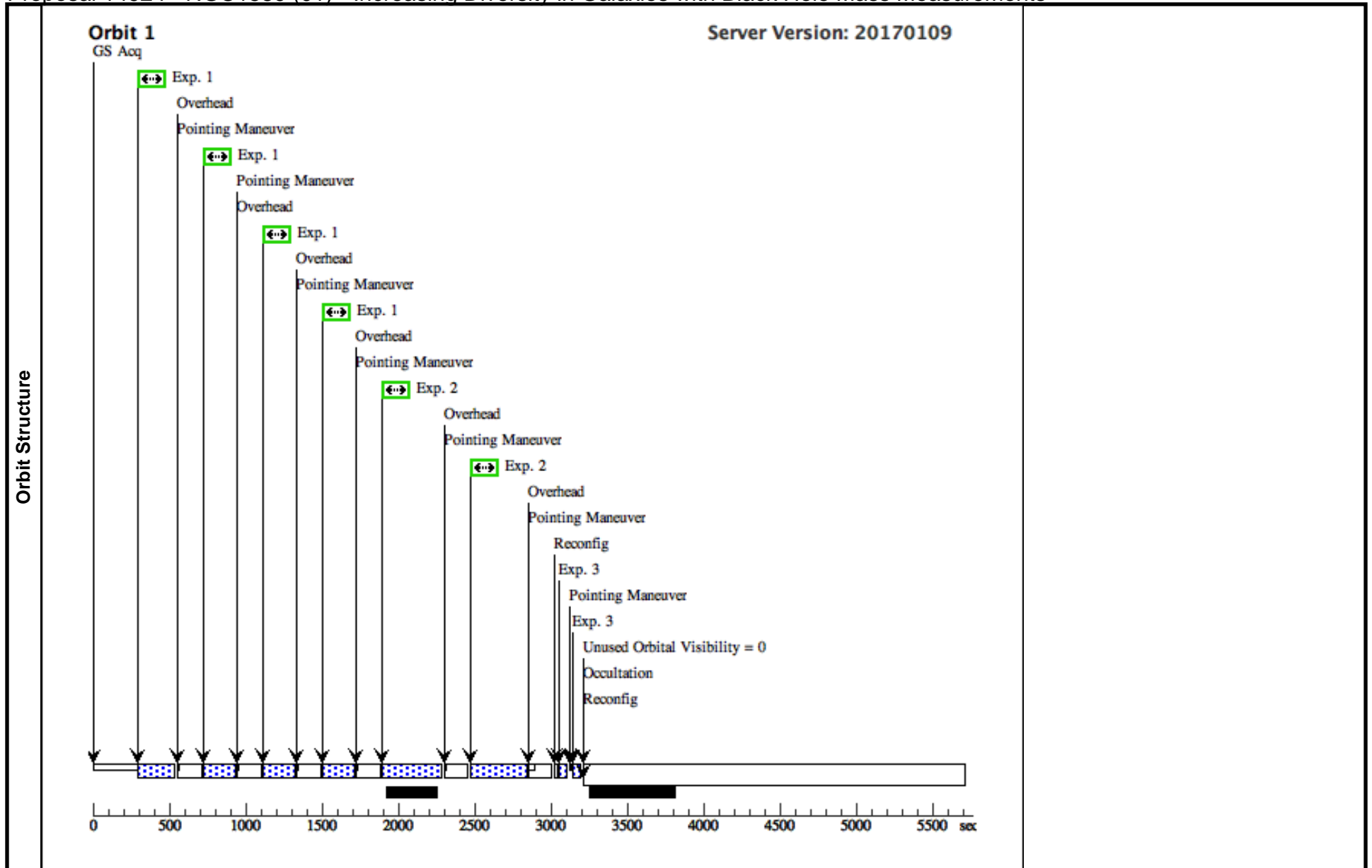
ORIENT restrictions for UGC11537:

The nucleus of UGC11537 has a $g=12.8$ star just to the NW of the nucleus: it is at a radius of 6.75" and PA=-66 E of N. To avoid diffraction spikes from this star crossing the nucleus, we request that the star be placed so the diffraction spikes will be at least 10 degrees away from the line connecting the nucleus to the star. On the UVIS chip the optimal positions are therefore when the Y-axis of the chip is oriented at 24, 114, 204, and 294 degrees E of N. Because this axis is offset by 45 degrees from the U3 axis in which the ORIENT is defined, we have specified ORIENTs of +/- 20 degrees around 69, 159, 249, and 339 degrees. In addition, we've removed ORIENTS around 69 and 249, where bleeding of the star saturated star could overlap the nucleus.

Proposal 14924 - NGC1589 (01) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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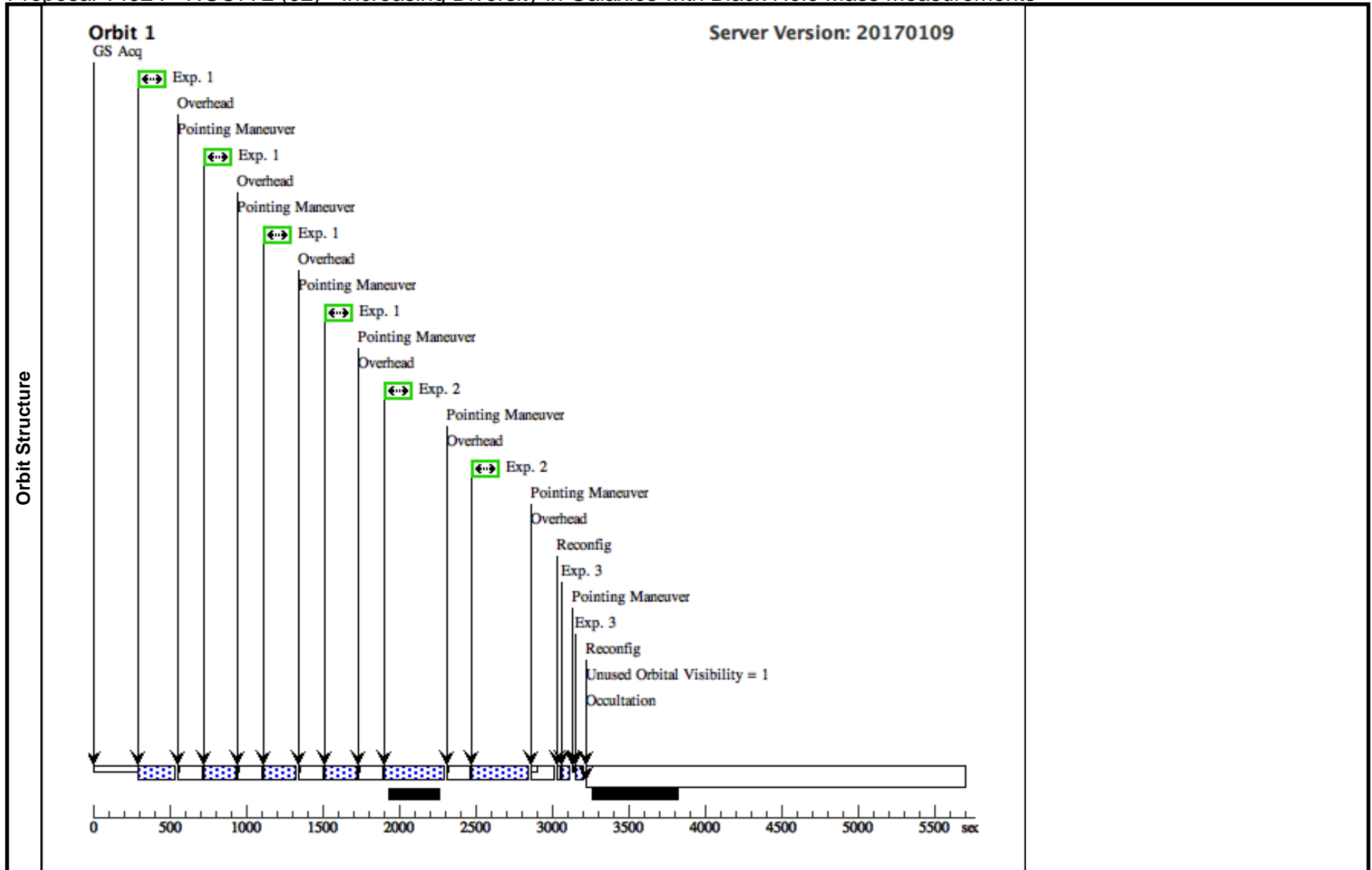
Visit	Proposal 14924, NGC1589 (01), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	NGC1589	RA: 04 30 45.4400 (67.6893333d) Dec: +00 51 49.16 (.86366d) Equinox: J2000 Comments: Extended=YES		V=11.76	Reference Frame: NED				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) NGC1589	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in NGC1589 (01) (1)	209 Secs (836 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(1) NGC1589	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in NGC1589 (01) (3)	372 Secs (744 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
3		(1) NGC1589	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=RAPID			Pattern 2, Exps 3-3 in NGC1589 (01) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]



Proposal 14924 - NGC772 (02) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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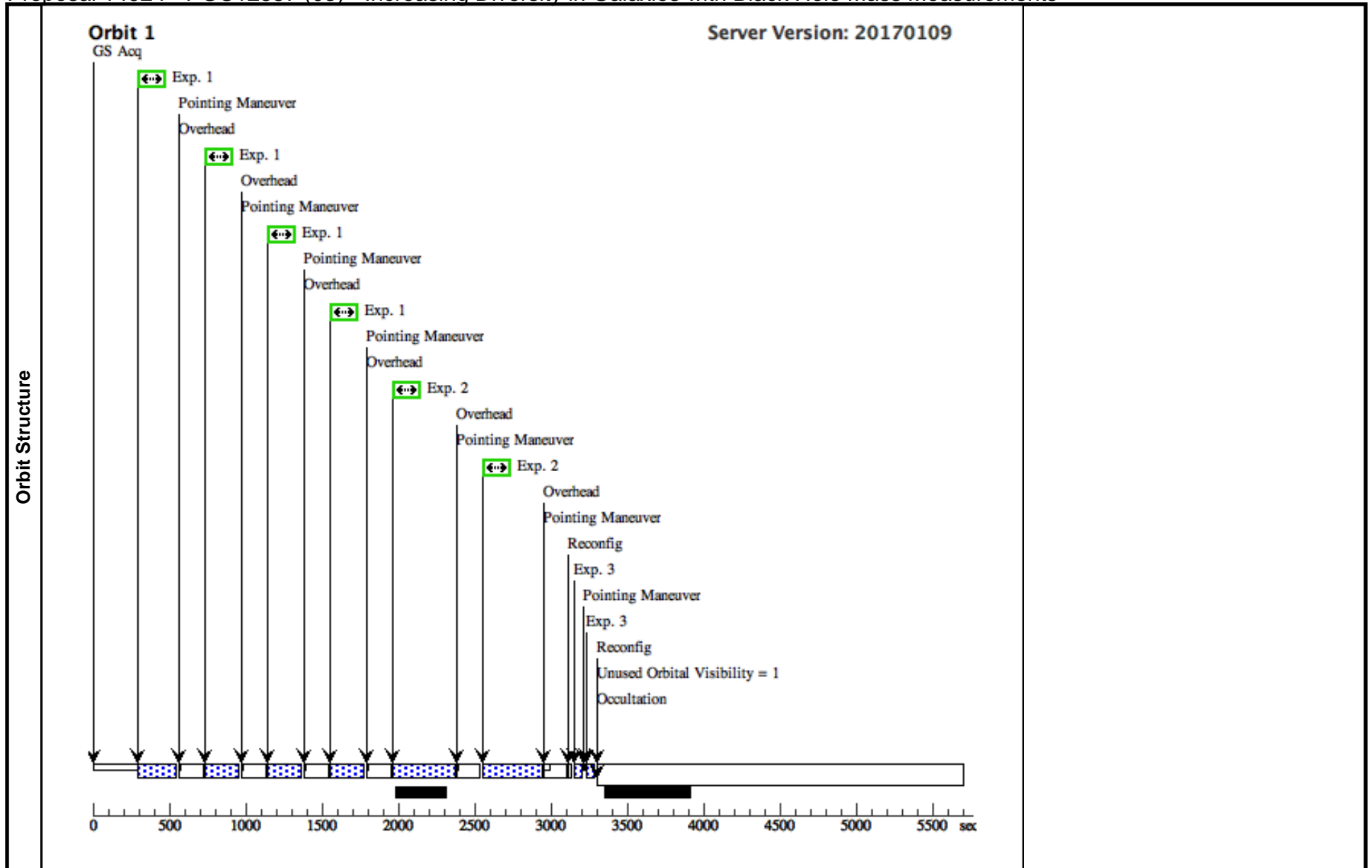
Visit	Proposal 14924, NGC772 (02), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	NGC772	RA: 01 59 19.5800 (29.8315833d) Dec: +19 00 27.10 (19.00753d) Equinox: J2000 Comments: Extended=YES		V=10.31	Reference Frame: NED				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(3) NGC772	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in NGC772 (02) (1)	211 Secs (844 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(3) NGC772	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in NGC772 (02) (3)	373 Secs (746 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
3		(3) NGC772	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=RAPID			Pattern 2, Exps 3-3 in NGC772 (02) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]



Proposal 14924 - PGC12557 (03) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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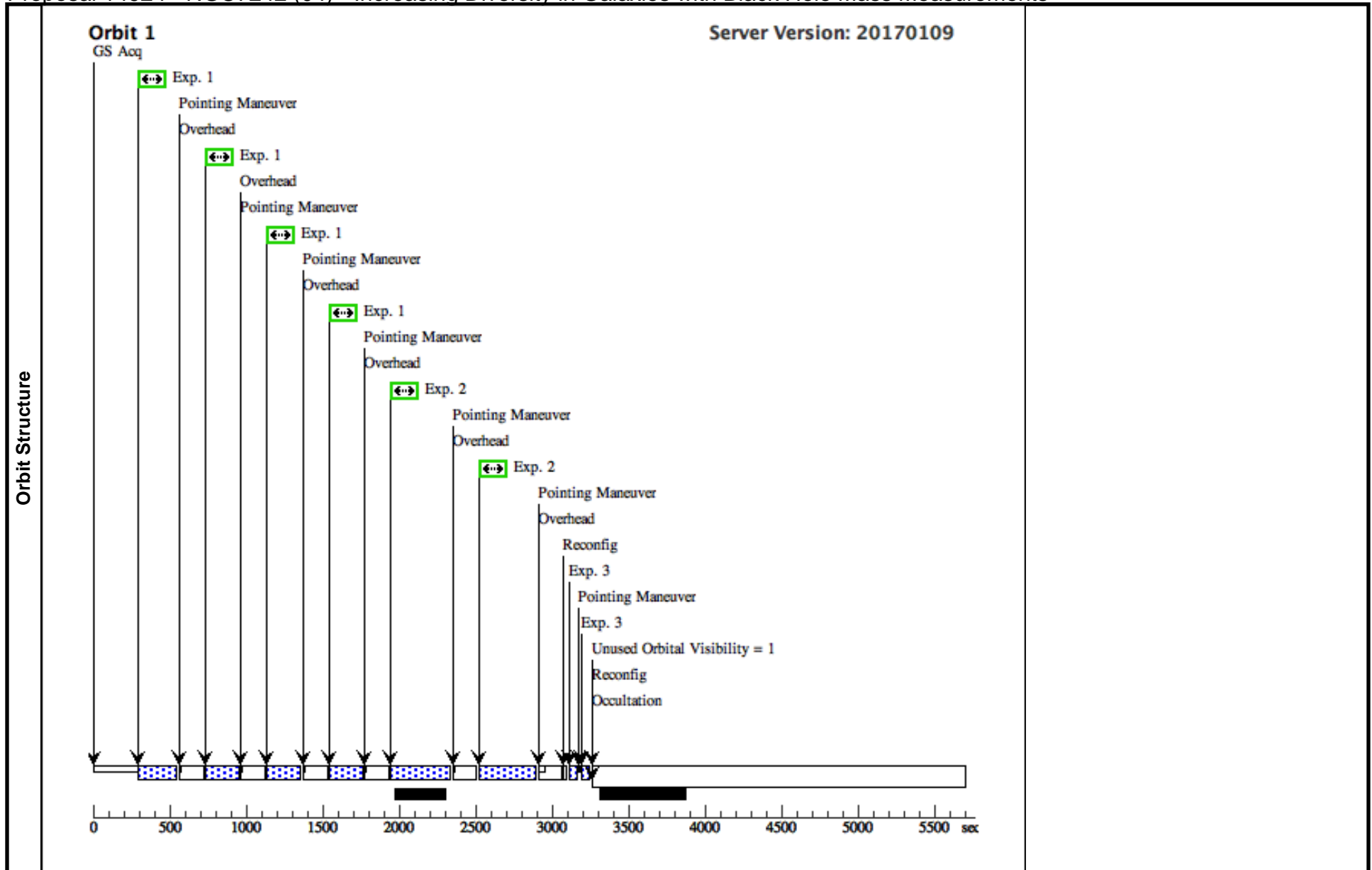
Visit	Proposal 14924, PGC12557 (03), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(4)	PGC12557	RA: 03 20 57.7960 (50.2408167d) Dec: +41 30 22.97 (41.50638d) Equinox: J2000		V=13.9	Reference Frame: NED				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(4) PGC12557	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in PGC12557 (03) (1)	225 Secs (900 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(4) PGC12557	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in PGC12557 (03) (3)	388 Secs (776 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
3		(4) PGC12557	WFC3/IR, MULTIACCUM, IR	F160W		NSAMP=9; SAMP-SEQ=RAPID		Pattern 2, Exps 3-3 in PGC12557 (03) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]



Proposal 14924 - NGC7242 (04) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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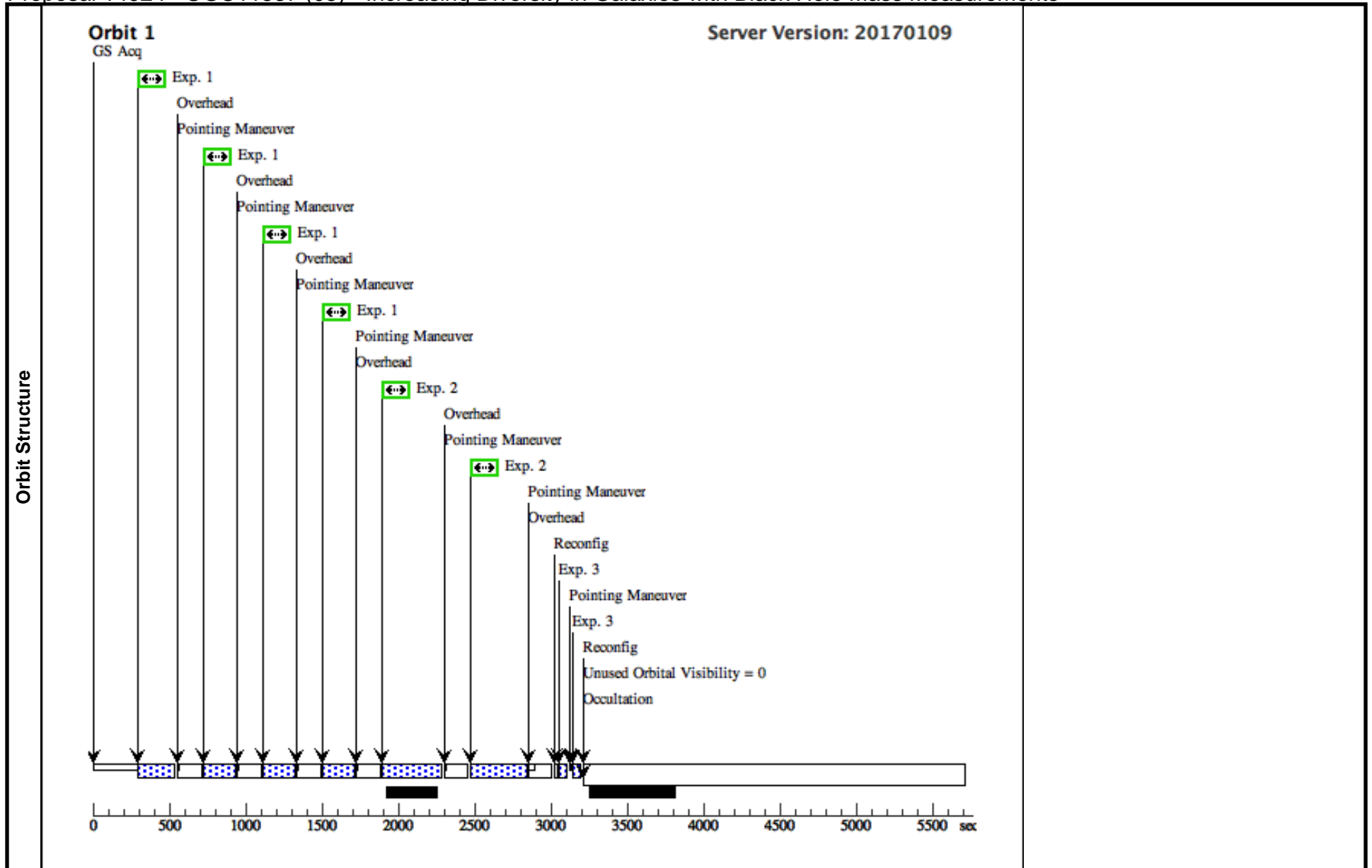
Visit	Proposal 14924, NGC7242 (04), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: (none)									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(5)	NGC7242	RA: 22 15 39.4700 (333.9144583d) Dec: +37 17 55.47 (37.29874d) Equinox: J2000		V=12.97	Reference Frame: Gemini				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(5) NGC7242	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in NGC7242 (04) (1)	222 Secs (888 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(5) NGC7242	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in NGC7242 (04) (3)	374 Secs (748 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
3		(5) NGC7242	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=RAPID			Pattern 2, Exps 3-3 in NGC7242 (04) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]



Proposal 14924 - UGC11537 (05) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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Visit	Proposal 14924, UGC11537 (05), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: ORIENT 34D TO 59 D; ORIENT 79D TO 104 D; ORIENT 124D TO 194 D; ORIENT 214D TO 239 D; ORIENT 259D TO 284 D; ORIENT 304D TO 14 D									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(6)	UGC11537	RA: 20 18 38.0900 (304.6587083d) Dec: -00 09 1.80 (-.15050d) Equinox: J2000		V=12.5	Reference Frame: 2MASS/NED				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(6) UGC11537	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in UGC11537 (05) (1)	209 Secs (836 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(6) UGC11537	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in UGC11537 (05) (3)	372 Secs (744 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
3		(6) UGC11537	WFC3/IR, MULTIACCUM, IR	F160W		NSAMP=9; SAMP-SEQ=RAPID		Pattern 2, Exps 3-3 in UGC11537 (05) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]



Proposal 14924 - NGC1022 (06) - Increasing Diversity in Galaxies with Black Hole Mass Measurements

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Visit	Proposal 14924, NGC1022 (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-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false	(1)						
	(2)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.636 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false	(3)						
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	(2)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(7)	NGC1022	RA: 02 38 32.7050 (39.6362708d) Dec: -06 40 38.74 (-6.67743d) Equinox: J2000		V=11.34	Reference Frame: NED/2MASS				
<i>Comments: Extended=YES</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(7) NGC1022	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F475W	FLASH=8		Pattern 1, Exps 1-1 in NGC1022 (06) (1)	210 Secs (840 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2		(7) NGC1022	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=4		Pattern 3, Exps 2-2 in NGC1022 (06) (3)	371 Secs (742 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]
	3		(7) NGC1022	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=9; SAMP-SEQ=RAPID		Pattern 2, Exps 3-3 in NGC1022 (06) (2)	26.390619 Secs (52.781 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[1]

