13662 - Measuring the Black Hole Mass in the Brightest Cluster Galaxy NGC 1275

Cycle: 22, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Aaron J. Barth (PI) (Contact)	**University of California - Irvine**	**barth@uci.edu**
Dr. Jonelle L. Walsh (CoI)	University of Texas at Austin	jlwalsh@astro.as.utexas.edu
Benjamin Boizelle (CoI)	University of California - Irvine	bboizell@uci.edu
Dr. Hai Fu (CoI)	University of Iowa	hai-fu@uiowa.edu
Dr. Remco van den Bosch (CoI) (ESA Member)	Max-Planck-Institut fur Astronomie, Heidelberg	bosch@mpia.de

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC-1275	STIS/CCD	5	25-Jul-2014 21:09:52.0	yes
02	(1) NGC-1275	WFC3/IR	1	25-Jul-2014 21:09:56.0	yes

6 Total Orbits Used

ABSTRACT

NGC 1275 is the brightest and most massive galaxy in the Perseus Cluster, and is an excellent laboratory in which to examine the processes of black hole fueling and feedback in a cluster core environment. Our goal is to carry out a direct measurement of the black hole mass in NGC 1275 using ionized gas dynamics, by resolving the H-alpha and [N II] kinematics within the black hole's dynamical sphere of influence. We request five orbits to carry out STIS G750M spectroscopy at five parallel positions of the 0.1 arcsec-wide slit, in order to map the ionized gas kinematics and measure the central mass using the same methods successfully used for other giant ellipticals such as M84 and M87. We will compare the ionized gas kinematics with our observations of the H_2 molecular kinematics recently measured at 0.02-arcsecond sampling with Keck adaptive optics data in order to

better understand the interplay between the different components of the ISM in this complex environment. We also request one orbit for WFC3/IR imaging of NGC 1275 in order to measure its near-IR surface brightness profile with unprecedented depth and resolution and model the galaxy's stellar mass profile. The results of this work will provide the first accurate measurement of the black hole mass in this highly unusual brightest cluster galaxy. Together with new and planned Keck AO observations, these HST observations will provide a critical new test of black hole mass measurement techniques by direct comparison of ionized gas dynamics, molecular gas dynamics, and stellar dynamics, and NGC 1275 is a nearly unique example of a galaxy in which all three methods are feasible.

OBSERVING DESCRIPTION

Our goal is to map the kinematic structure of the nuclear ionized gas disk in the brightest cluster galaxy NGC 1275 using 5 parallel slit positions with STIS. We will use the 52X0.1E1 aperture in order to minimize charge-transfer losses. The G750M grating with central wavelength 6581 A will be used to cover the [OI], H-alpha, [NII], and [SII] lines. The major axis PA of the disk is approximately 68 degrees and we will request a STIS slit aligned to within +-15 degrees of this in order to best sample the disk kinematics. The AGN in the core of NGC 1275 is bright (V approx. 15.5 mag) and pointlike. We will use a point source acquisition followed by a peakup in the 0.1"-wide slit to center the slit on the nucleus.

Following the peakup, we will obtain 3 observations with the slit centered on the nucleus, dithered by 3 pixels along the slit between exposures using a STIS-ALONG-SLIT pattern. Subsequently in each of the next four orbits we will offset the slit in the direction perpendicular to the slit length and then obtain 4 dithered exposures at each offset slit position. These perpendicular offsets will be done using POS-TARG moves at the start of each subsequent orbit to positions offset by +-0.1 and +-0.2 arcsec from the central position. This will produce a densely filled map of the ionized gas kinematics in the circumnuclear disk. Individual STIS exposures will be 600-700 sec in order to keep the number of cosmic-ray hits to a level that is suitable for cleaning. Each orbit will include the standard auto-wavecal. Our STIS exposure times are tuned to fill each orbit completely.

Using WFC3/IR and the F160W filter, we will use 1 orbit to obtain a wide-field mosaic of NGC 1275 to measure the galaxy's surface brightness profile. We will mosaic the galaxy in a 2x2 pattern using POS-TARG moves. This will cover a total field of view of about 3.5 x 3.5 arcmin^2 which is sufficient to cover the main body of the galaxy, with the galaxy's central region contained within the overlap region (approx. 30x30 arcsec^2) between the four mosaic positions. At each of the four mosaic positions, we will carry out two dithered exposures using the WFC3-IR-DITHER-LINE pattern. Exposures will be done using the STEP100 sampling pattern and NSAMP=8 which will provide a high dynamic range and a total exposure time of 400 sec at each mosaic position, with no time lost to buffer dump overheads. In order to ensure that we have an unsaturated image of the bright nucleus, we will then obtain a series of RAPID-mode exposures using the IRSUB128 subarray. Using a 4-point WFC3-IR-DITHER-

BOX-MIN pattern, we will obtain 4 RAPID exposures at each dither position. This will provide a total exposure time of 28.8 seconds in RAPID mode with 16 individual exposures of 1.8 sec each. There are no orientation constraints for the WFC3/IR visit.

Visit

Proposal 13662, Visit 01 Sat Jul 26 01:09:57 GMT 2014

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 98D TO 128 D; ORIENT 278D TO 308 D

Diagnostics

(Visit 01) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE
(Visit 01) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE
(Visit 01) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE
(Visit 01) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=3	Angle Between Sides=		
	Point Spacing=0.15	Center Pattern=false		
	Line Spacing=			
(2)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(4), (5), (6), (7)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=4	Angle Between Sides=		
	Point Spacing=0.15	Center Pattern=false		
	Line Spacing=			

Fixed Targets

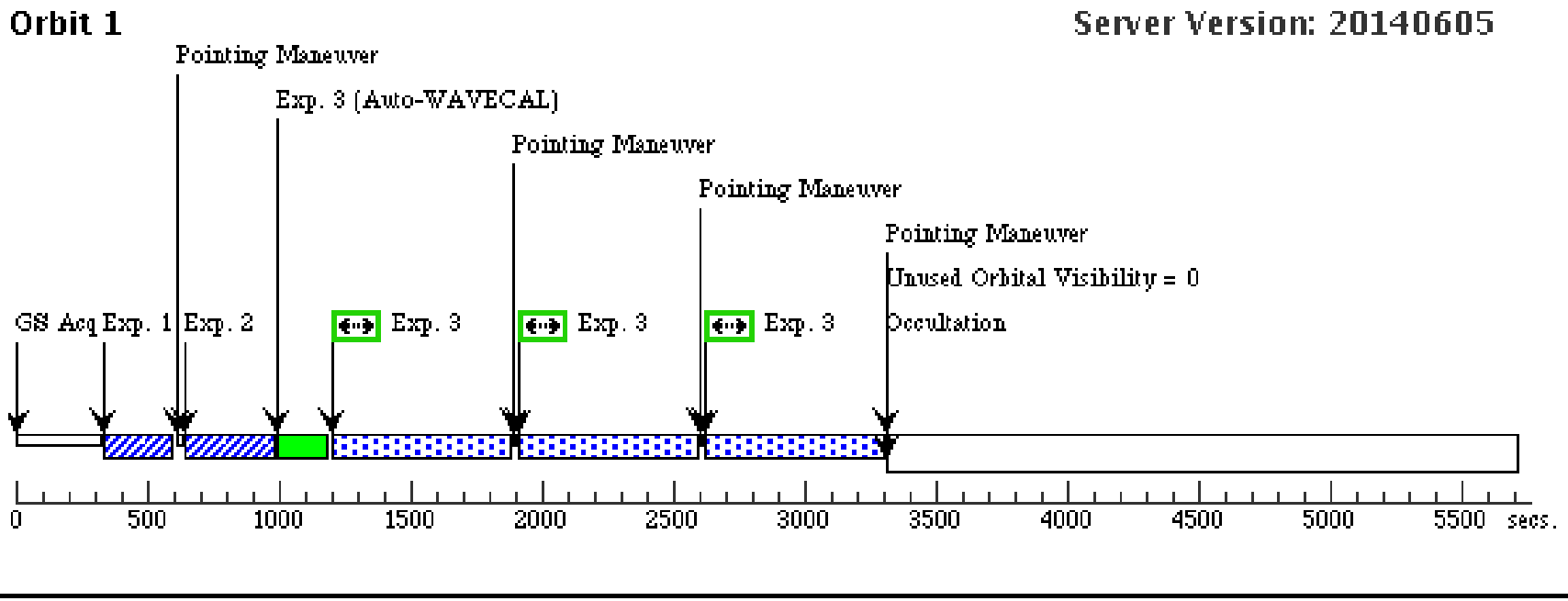
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-1275	RA: 03 19 48.1601 (49.9506671d)	Radial Velocity: 5264 km/sec	V=12.48	Reference Frame: ICRS
	Alt Name1: PERSEUS-A	Dec: +41 30 42.10 (41.51169d)			
	Alt Name2: 3C-084	Equinox: J2000			

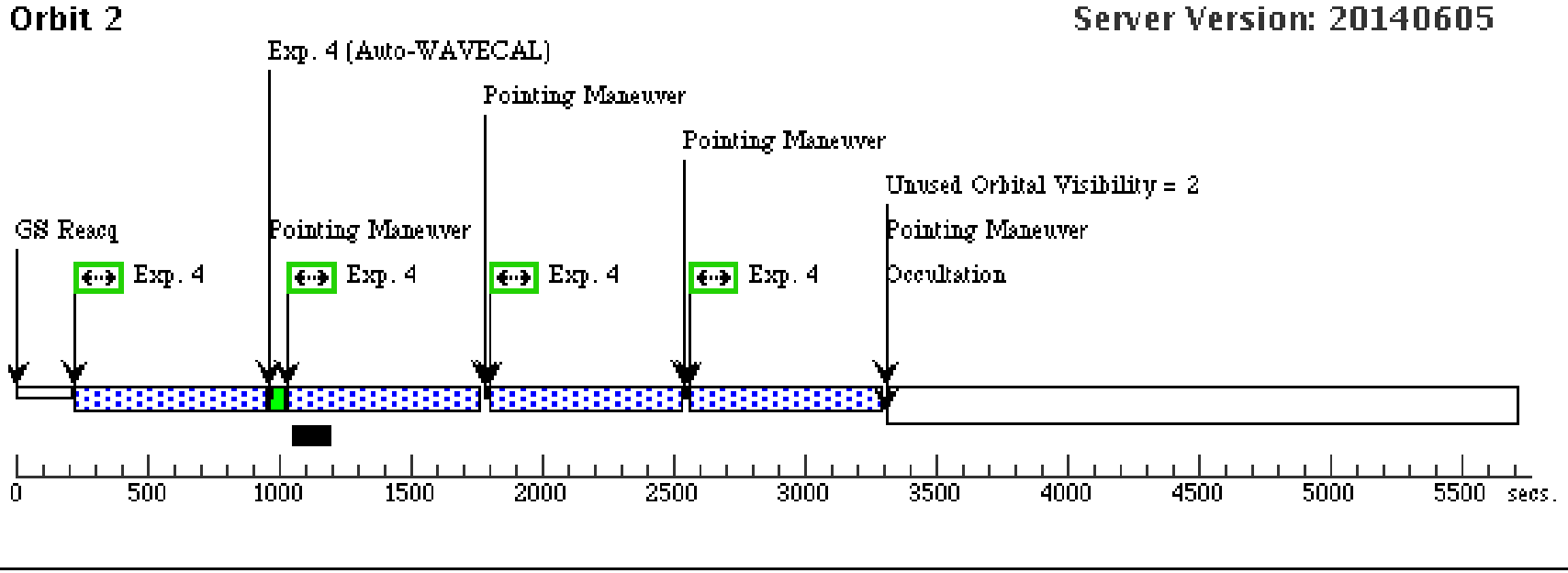
Comments: ICRS coordinates for this source are from Ma et al. 1998 (AJ 116, 516) and are measured via VLBI. This target is listed as an "other" source in the ICRF reference frame by Ma et al. with a positional uncertainty of approximately 3 mas. Coordinates of the nucleus in archival WFPC2/PC and ACS images agree with these VLBI coordinates to within 0.1 arcsec.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC-1275	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			10 Secs (10 Secs)	
								[==>]	***[1]***
2		(1) NGC-1275	STIS/CCD, ACQ/PEAK, 52X0.1E1	MIRROR				10 Secs (10 Secs)	
								[==>]	***[1]***
3		(1) NGC-1275	STIS/CCD, ACCUM, 52X0.1E1	G750M 6581 A	CR-SPLIT=NO	POS TARG 0,0	Pattern 1, Exps 3-3 in Visit 01 (1)	641 Secs (1923 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
4		(1) NGC-1275	STIS/CCD, ACCUM, 52X0.1E1	G750M 6581 A	CR-SPLIT=NO	POS TARG 0.2,0	Pattern 2, Exps 4-4 in Visit 01 (2)	695 Secs (2780 Secs)	
								[==>(Pattern 1)]	***[2]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
5		(1) NGC-1275	STIS/CCD, ACCUM, 52X0.1E1	G750M 6581 A	CR-SPLIT=NO	POS TARG 0.1,0	Pattern 2, Exps 5-5 in Visit 01 (2)	695 Secs (2780 Secs)	
								[==>(Pattern 1)]	***[3]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
6		(1) NGC-1275	STIS/CCD, ACCUM, 52X0.1E1	G750M 6581 A	CR-SPLIT=NO	POS TARG -0.1,0	Pattern 2, Exps 6-6 in Visit 01 (2)	695 Secs (2780 Secs)	
								[==>(Pattern 1)]	***[4]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	
7		(1) NGC-1275	STIS/CCD, ACCUM, 52X0.1E1	G750M 6581 A	CR-SPLIT=NO	POS TARG -0.2,0	Pattern 2, Exps 7-7 in Visit 01 (2)	694 Secs (2776 Secs)	
								[==>(Pattern 1)]	***[5]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	
								[==>(Pattern 4)]	

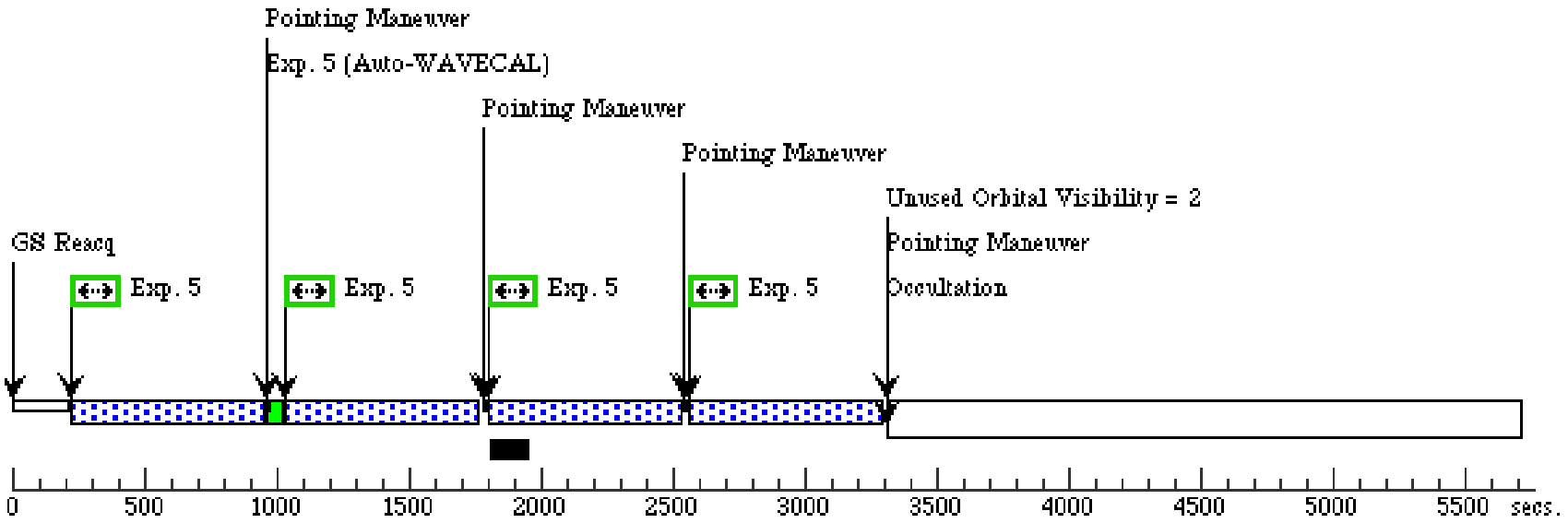
Orbit Structure





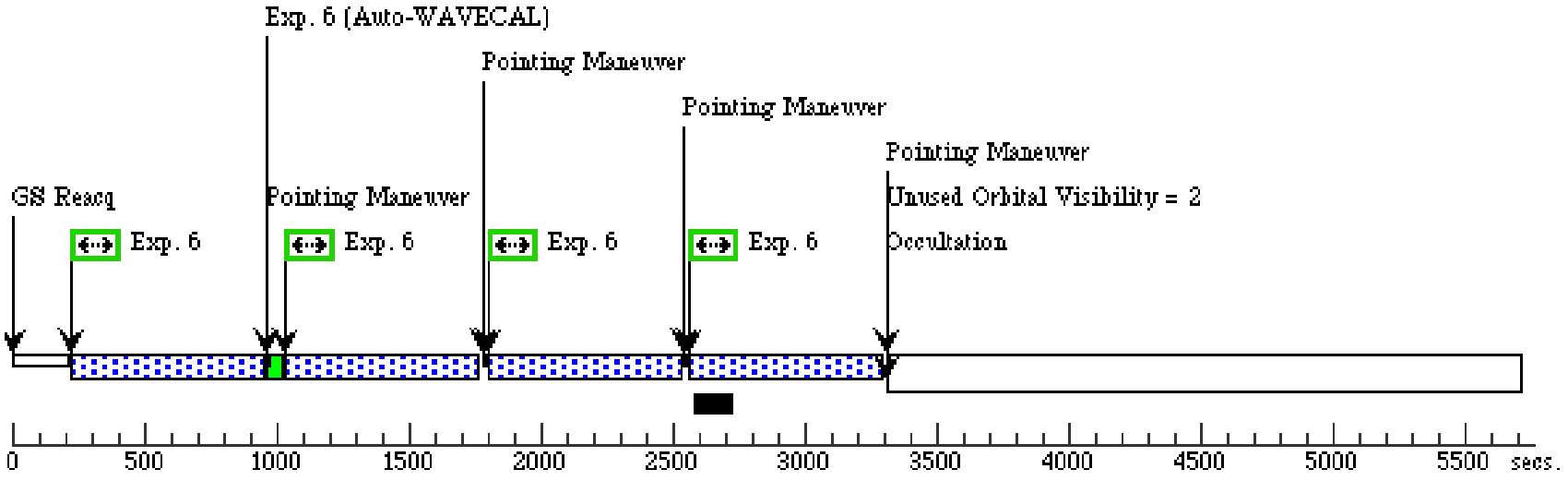
Orbit 3

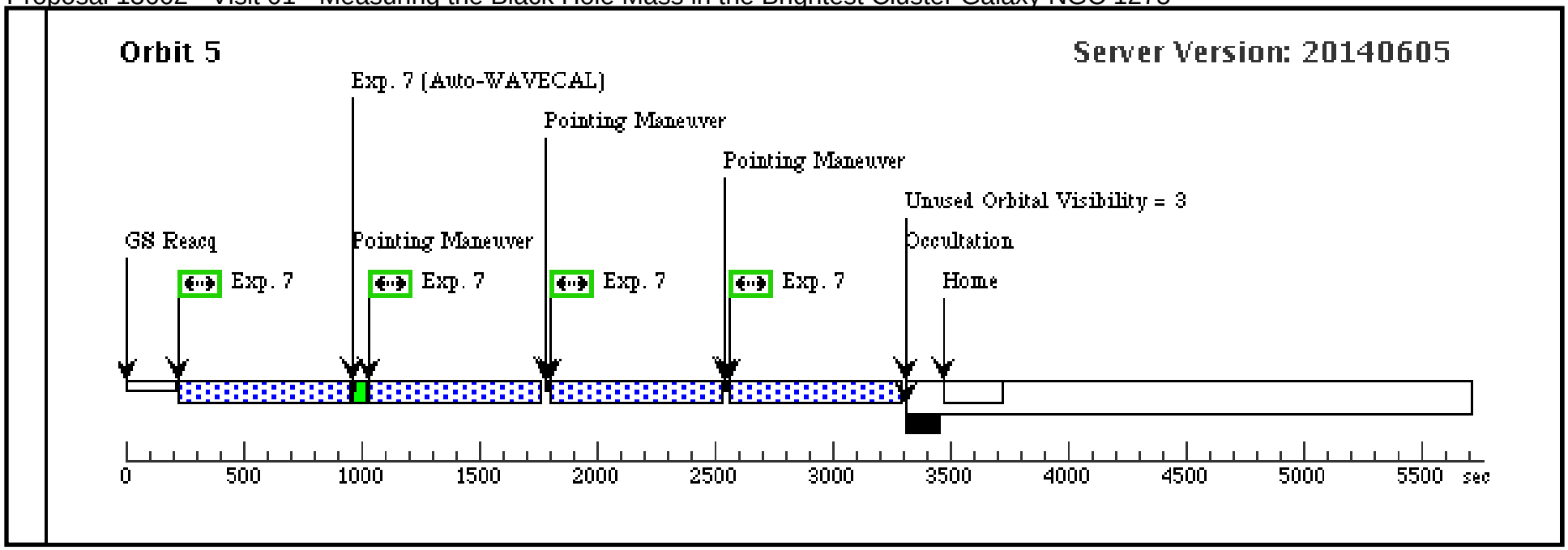
Server Version: 20140605



Orbit 4

Server Version: 20140605




Orbit 5
Server Version: 20140605
Exp. 7 (Auto-WAVECAL)
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 3
GS Reacq
Pointing Maneuver
Occultation
Exp. 7
Exp. 7
Exp. 7
Exp. 7
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13662, Visit 02 Sat Jul 26 01:09:58 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	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		(1), (2), (3), (4)
(5)	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		(5-8)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-1275 Alt Name1: PERSEUS-A Alt Name2: 3C-084	RA: 03 19 48.1601 (49.9506671d) Dec: +41 30 42.10 (41.51169d) Equinox: J2000	Radial Velocity: 5264 km/sec	V=12.48	Reference Frame: ICRS

Comments: ICRS coordinates for this source are from Ma et al. 1998 (AJ 116, 516) and are measured via VLBI. This target is listed as an "other" source in the ICRF reference frame by Ma et al. with a positional uncertainty of approximately 3 mas. Coordinates of the nucleus in archival WFPC2/PC and ACS images agree with these VLBI coordinates to within 0.1 arcsec.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC-1275	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=8; SAMP-SEQ=STEP100	POS TARG -47.46,-42.42	Pattern 4, Exps 1-1 in Visit 02 (4)	199.231 Secs (398.462 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) NGC-1275	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=8; SAMP-SEQ=STEP100	POS TARG 47.46,-42.42	Pattern 4, Exps 2-2 in Visit 02 (4)	199.231 Secs (398.462 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3		(1) NGC-1275	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=8; SAMP-SEQ=STEP100	POS TARG -47.46,42.42	Pattern 4, Exps 3-3 in Visit 02 (4)	199.231 Secs (398.462 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
4		(1) NGC-1275	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=8; SAMP-SEQ=STEP100	POS TARG 47.46,42.42	Pattern 4, Exps 4-4 in Visit 02 (4)	199.231 Secs (398.462 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
5		(1) NGC-1275	WFC3/IR, MULTIACCUM, IRSUB128-FIX	F160W	NSAMP=15; SAMP-SEQ=RAPID		Pattern 5, Exps 5-8 in Visit 02 (5)	1.690575 Secs (6.762 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
6		(1) NGC-1275	WFC3/IR, MULTIACCUM, IRSUB128-FIX	F160W	NSAMP=15; SAMP-SEQ=RAPID		Pattern 5, Exps 5-8 in Visit 02 (5)	1.690575 Secs (6.762 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
7		(1) NGC-1275	WFC3/IR, MULTIACCUM, IRSUB128-FIX	F160W	NSAMP=15; SAMP-SEQ=RAPID		Pattern 5, Exps 5-8 in Visit 02 (5)	1.690575 Secs (6.762 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
8		(1) NGC-1275	WFC3/IR, MULTIACCUM, IRSUB128-FIX	F160W	NSAMP=15; SAMP-SEQ=RAPID		Pattern 5, Exps 5-8 in Visit 02 (5)	1.690575 Secs (6.762 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure