14742 - Improving Central Black Hole Mass Measurements in Low Mass Early Type Galaxies

Cycle: 24, Proposal Category: GO

(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	(2) NGC5102	WFC3/UVIS	1	29-Jul-2016 15:10:28.0	yes
02	(1) NGC205	STIS/CCD	2	29-Jul-2016 15:10:30.0	yes
03	(2) NGC5102	STIS/CCD	4	29-Jul-2016 15:10:32.0	yes
04	(3) NGC5206	STIS/CCD	5	29-Jul-2016 15:10:34.0	yes

12 Total Orbits Used

ABSTRACT

Measurements of black hole masses in massive early type galaxies have revealed that they tightly correlate with the properties of their host galaxies. At lower galaxy masses, almost no black hole mass measurements exist in early type galaxies, while existing measurements in later type galaxies

show significant scatter. By finding and measuring the mass of black holes in low mass early type galaxies we can (1) constrain the fraction of low mass galaxies with black holes, an important measurement for understanding the formation of the first seed black holes, and (2) anchor the black hole mass scaling relations and quantify the scatter in these relations.

We propose to make a robust dynamical estimation of the central black hole masses in three nearby, low mass early type galaxies. We request HST/STIS spectroscopy to constrain the variation in the stellar populations and mass-to-light ratio at high spatial resolution. We will combine this information with new and archival HST imaging to create accurate stellar mass maps of each galaxy. These will be combined with existing stellar kinematic maps from adaptive optics Gemini/NIFS and VLT/SINFONI data. The resulting analysis will enable us to dynamically measure black hole masses below the mass of any known central black holes.

OBSERVING DESCRIPTION

1/ Purpose:

Our observation includes of STIS spectroscopy of all three galaxies NGC 205 (2 orbits), NGC 5102 (4 orbits), and NGC 5206 (5 orbits) and WFC3 imaging (1 orbit) only for NGC 5102 to measure the spatial mass-to-light ratio
variations within the NGC 205, NGC 5102, and NGC 5206 nuclei and enable a more robust masses determination of their black holes. We require that the total time for the imaging and spectroscopy will be observed within ~19 hours.

2/ Coordinates of the nucleus:

For all images we have checked both the NED coordinates and those from 2MASS or the 2MASS large galaxy atlas. Some discrepancies exist at the <1" level for the centers of these galaxies, but given the size of the acquisition image (~5") we don't anticipate this lack of precision will cause any problems.

3/ STIS Spectroscopy:

We propose to obtain high spatial resolution observations of the stellar populations by obtaining STIS observations with the G430L gratings and the 52"x0.1" slit. we have chosen the 50CCD aperture to reduce CTE and used exposure times ~1000 sec to ensure good cosmic ray rejections. In total, we will obtain 5, 11, and 14 science exposures without any splits over 2, 4, and 5 orbits for NGC 205 (Visit 2), NGC 5102 (Visit 3), and NGC 5206 (iVisit 4), respectively.

3.1/ ACQ details:

We have used existing HST WFPC2 & ACS/RHRC data of these galaxies on HLA to estimate the ACQ exposure times; specifically, F555W band for NGC 205 and NGC 5206, and the F547M band for NGC 5102. We calculate the magnitude in a 5x5 box to estimate the S/N in the STIS ETC, and to calculate saturation assuming this magnitude as a point source with a K0V Kurucz spectrum. For NGC205, NGC5206 & NGC5102 we get a ~V magnitude of 16.8, 17.1 & 14.7 respectively. This leads to minimum exposure times of 1s, 2s & 0.2s for each source, and saturation limits of 202s, 266s, and 29s. We choose 10s exposures for both ACQ and ACQ/PEAK exposures for NGC205 (increasing the ACQ/PEAK exposure time resulted in overfilling the first orbit), 10s ACQ exposures and 20s ACQ-PEAK in NGC5206, and 3s for ACQ and 6s for ACQ/PEAK in NGC5102. These exposure times should give us plenty of S/N and be <20% saturation in all cases.

3.2/ Exposure Times:

Given the orbits available, we have tried to pack the visits with maximal efficiency. We find that packing three ~930s exposures per orbit, with the first orbit having the two acquisition exposures + 2 science exposures provides the maximal efficiency. In total we have 5 science frames in NGC205, 11 frames in NGC5102 and 14 science frames in NGC5206. These are designed to provide sufficient S/N out to radii of ~0.8".

3.3/ Dithers & CR-SPLIT:

For NGC205 and NGC5102, no CR-SPLITs are used and integer pixel dithers are requested to ease combination of exposures without using multidrizzle. Larger dithers are used in NGC205 (since there are just 5 separate exposures). For NGC5206, we CR-SPLIT our exposures to get 7x2

science frames, each at a separate dither. This strategy is identical to our successful NGC404 STIS observations, but with larger dithers to ensure better subtraction using a median frame to mitigate detector artifcats..

3.4/ Orientation:

The position angles (E of N) desired for our observations are described below and are selected to roughly correspond to the major axis of the nuclear star clusters. We have added 45 degrees to these to determined the requested ORIENTs and included the 180 degree rotation of these to maximize schedulability, we note that NGC205 has minimal schedulability even with a relatively wide range of ORIENTs.

NGC205 PA=135+-20

NGC 5102 PA=50+-10

NGC5206 PA=40+-20

4/ WFC3 Imaging for NGC 5102

For NGC5102, good archival imaging data is not available, so we requested 1 orbit of additional imaging. This will be used to measure the spatial stellar M/L ratio variability beyond the boundaries of the slit. We will obtain images in three filters (F336W, F547M, F814W), and four dithered exposures in each filter to ensure the highest possible spatial resolution for our observations. To manage so many exposures, we use the C512C subarray, which will give us information within the central 20" of the galaxy, sufficient for our mass-modeling purposes.

The exposure times were simulated via ETC to make sure the S/N are still high enough (~10) out to the edge of the subarray field of (r ~ 10") and to ensure obtained images unsaturated. We used a variety of existing HST data and our adaptive optics data to estimate the colors in each band, and our requirements are met using 4x297s exposures in F336W, 4x120s exposures in F547M, 4x105s exposures in F814W.

Visit

Proposal 14742, Visit 01 Fri Jul 29 19:10:35 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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), (3)

Fixed Targets

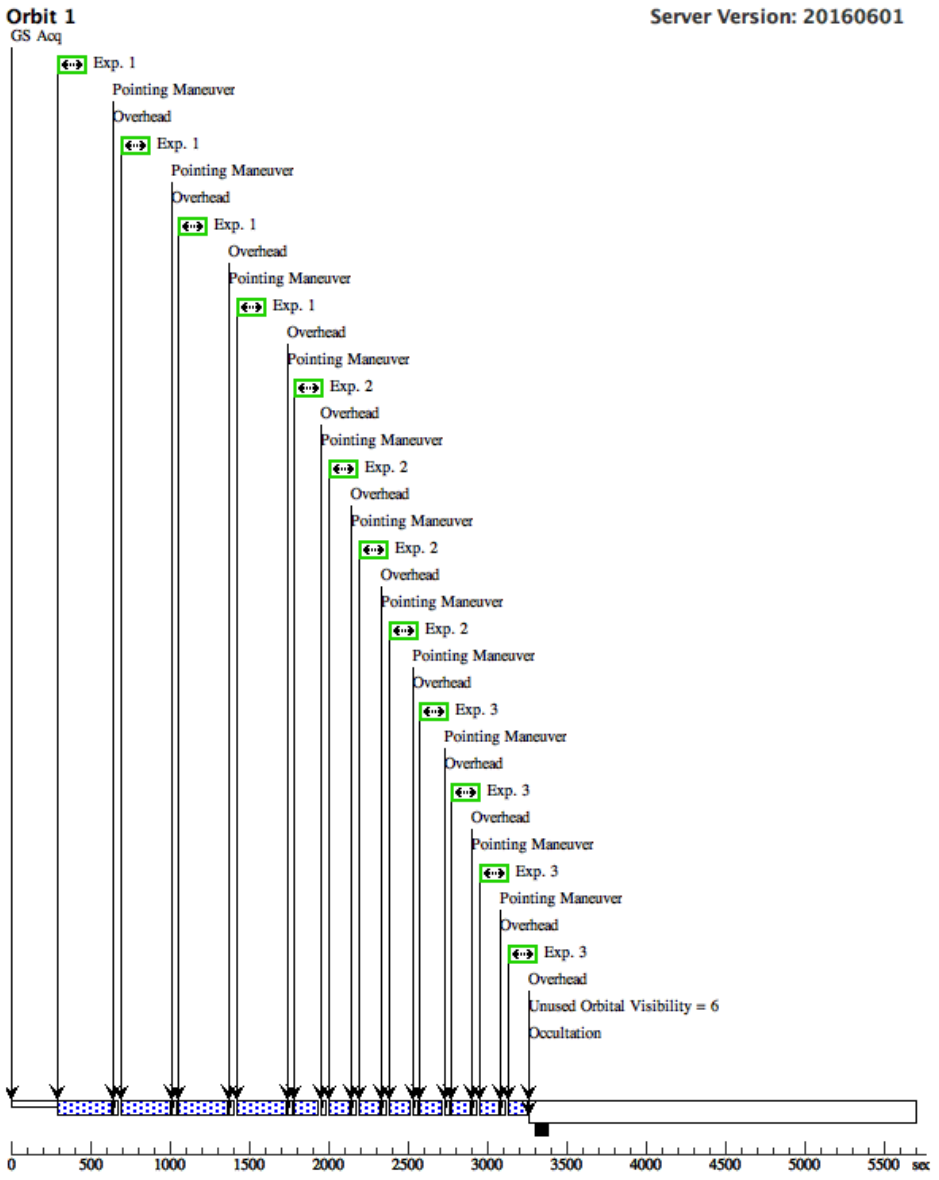
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC5102	RA: 13 21 57.6120 (200.4900500d) Dec: -36 37 48.52 (-36.63014d) Equinox: J2000	Radial Velocity: 468 km/sec	V=9.65	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC5102	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F336W	CR-SPLIT=NO; FLASH=12		Pattern 1, Exps 1-1 in Visit 01 (1)	297 Secs (1232 Secs) *[==>308.0 Secs (Pattern 1)]* *[==>308.0 Secs (Pattern 2)]* *[==>308.0 Secs (Pattern 3)]* *[==>308.0 Secs (Pattern 4)]*	***[1]***
2		(2) NGC5102	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F547M	CR-SPLIT=NO; FLASH=12		Pattern 1, Exps 2-2 in Visit 01 (1)	120 Secs (524 Secs) *[==>131.0 Secs (Pattern 1)]* *[==>131.0 Secs (Pattern 2)]* *[==>131.0 Secs (Pattern 3)]* *[==>131.0 Secs (Pattern 4)]*	***[1]***
3		(2) NGC5102	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	CR-SPLIT=NO; FLASH=12		Pattern 1, Exps 3-3 in Visit 01 (1)	105 Secs (464 Secs) *[==>116.0 Secs (Pattern 1)]* *[==>116.0 Secs (Pattern 2)]* *[==>116.0 Secs (Pattern 3)]* *[==>116.0 Secs (Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14742, Visit 02 Fri Jul 29 19:10:35 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 340D TO 20 D; ORIENT 160D TO 200 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=5	Angle Between Sides=		
	Point Spacing=1.523	Center Pattern=false		
	Line Spacing=			

Fixed Targets

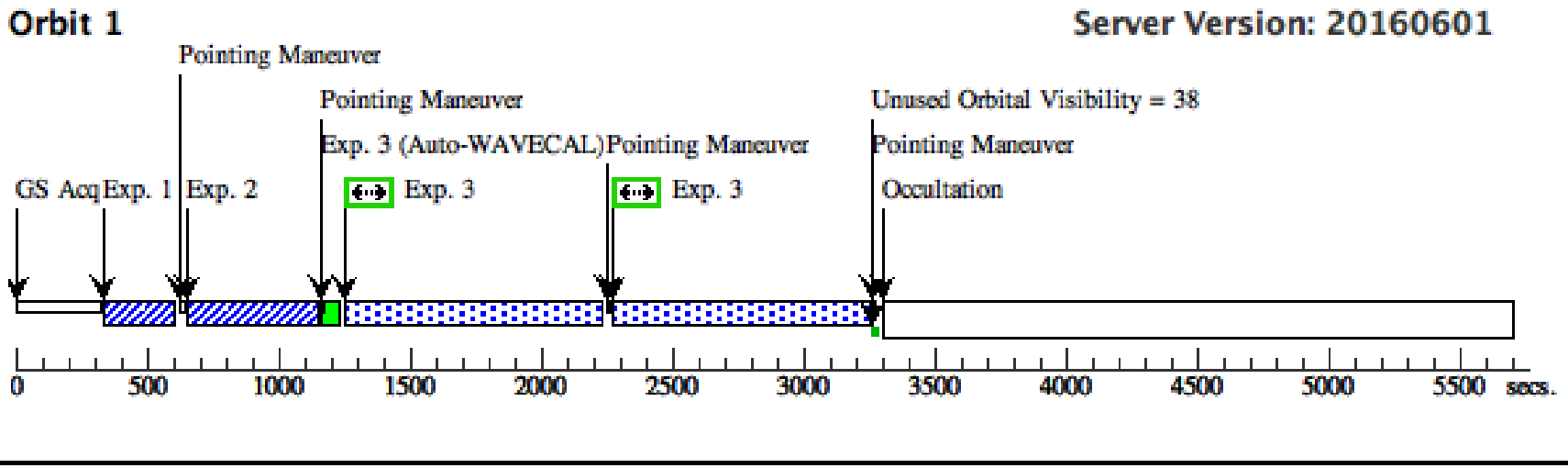
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC205	RA: 00 40 22.0750 (10.0919792d) Dec: +41 41 7.08 (41.68530d) Equinox: J2000	Radial Velocity: -241 km/sec	V=8.07	Reference Frame: ICRS

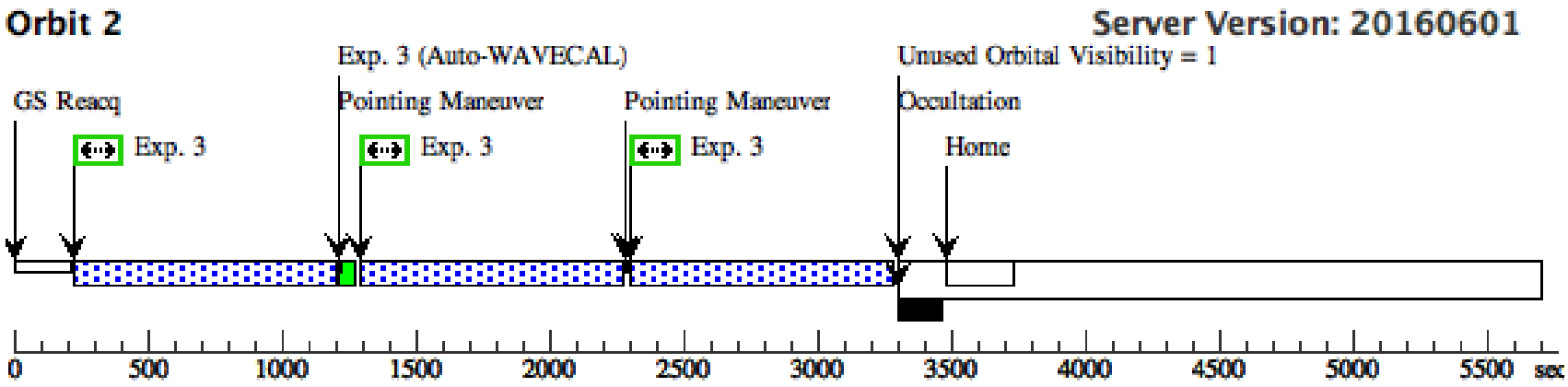
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC205	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5; DIFFUSE-CENTER=FLUX-CENTROID			10 Secs (10 Secs) *[==>]*	***[1]***
2		(1) NGC205	STIS/CCD, ACQ/PEAK, 52X0.05E1	G430L 4300 A				10 Secs (10 Secs) *[==>]*	***[1]***
3		(1) NGC205	STIS/CCD, ACCUM, 52X0.1E1	G430L 4300 A	CR-SPLIT=NO; GAIN=1		Pattern 2, Exps 3-3 in Visit 02 (2)	946 Secs (4730 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]*	***[1]*** ***[2]***

Orbit Structure





Visit

Proposal 14742, Visit 03 Fri Jul 29 19:10:35 GMT 2016

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 85D TO 105 D; ORIENT 265D TO 285 D

Diagnostics

(Visit 03) Warning (Orbit Planner): PATTERN POSITION OUTSIDE APERTURE

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(3)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=11	Angle Between Sides=		
	Point Spacing=0.711	Center Pattern=false		
	Line Spacing=			

Fixed Targets

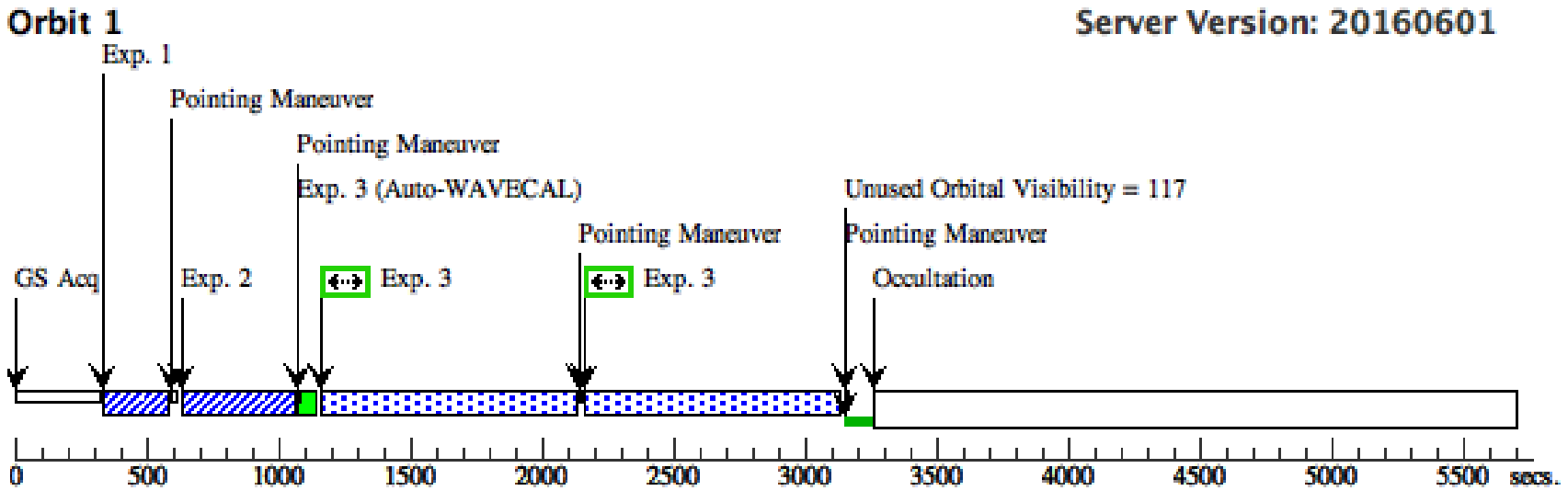
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	NGC5102	RA: 13 21 57.6120 (200.4900500d) Dec: -36 37 48.52 (-36.63014d) Equinox: J2000	Radial Velocity: 468 km/sec	V=9.65	Reference Frame: ICRS

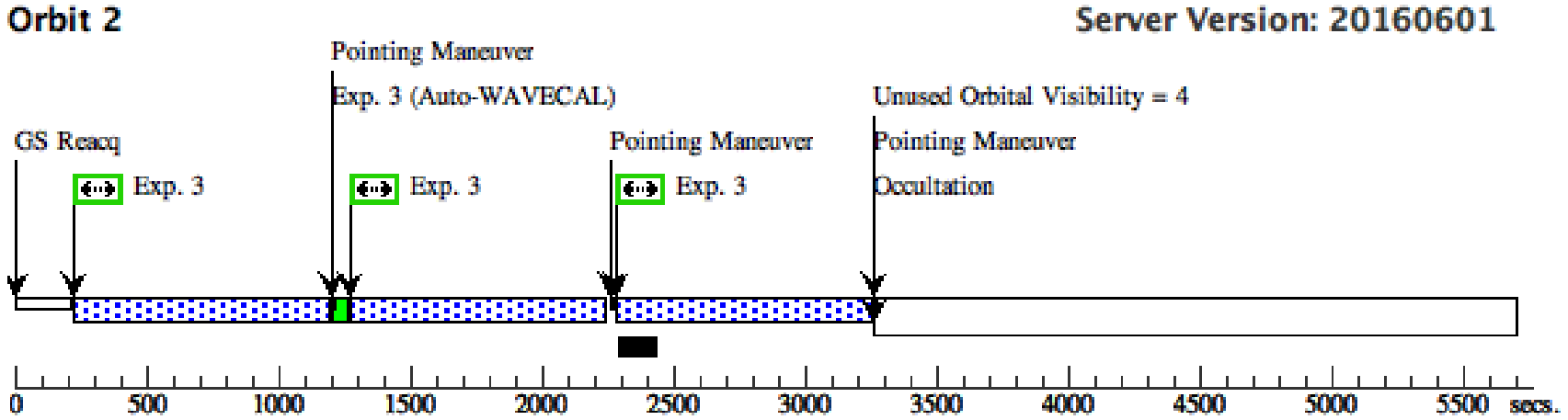
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

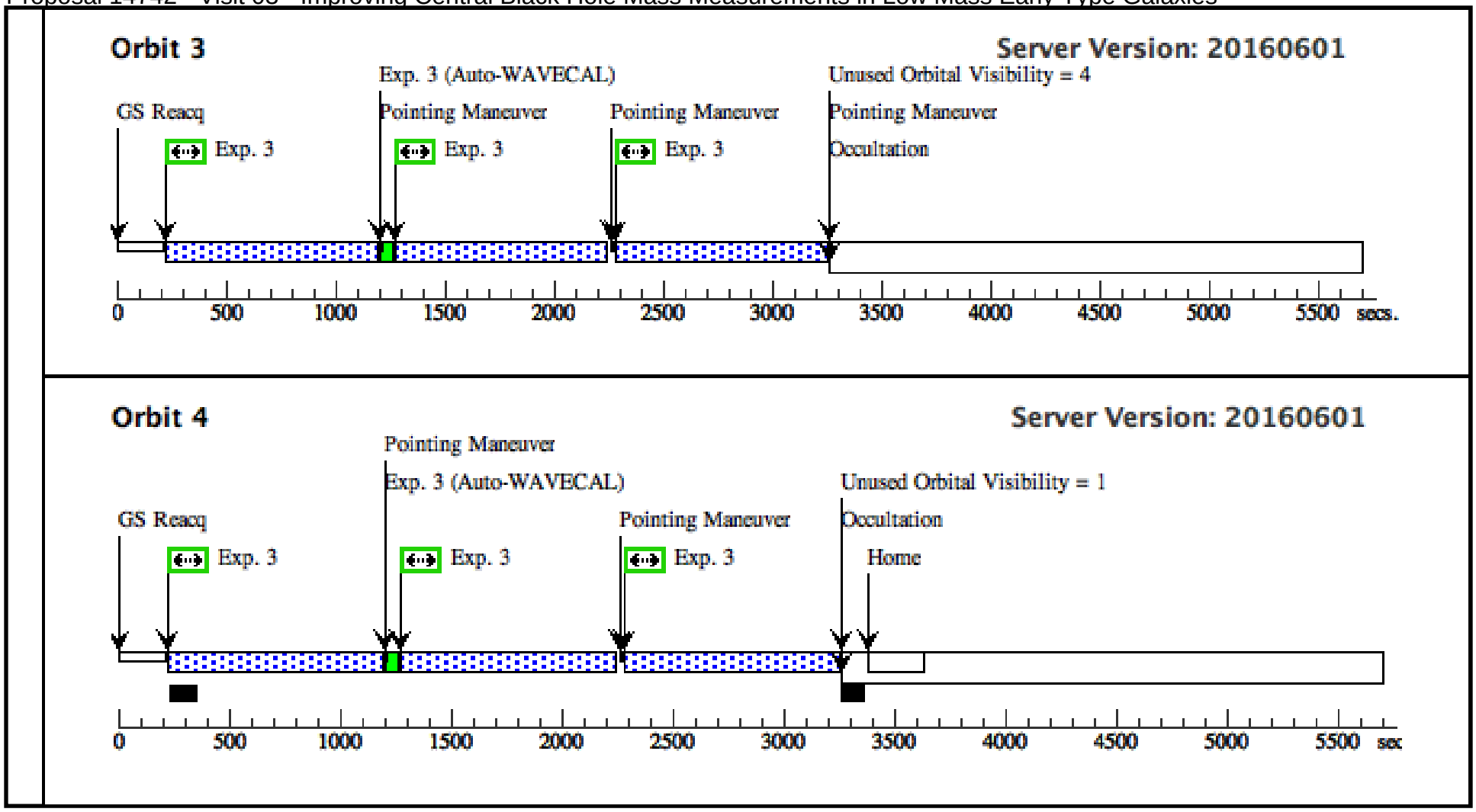
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) NGC5102	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5; DIFFUSE-CENTER=FLUX-CENTROID			3 Secs (3 Secs) *[==>]*	*[1]*
2		(2) NGC5102	STIS/CCD, ACQ/PEAK, 52X0.05E1	G430L 4300 A				6 Secs (6 Secs) *[==>]*	*[1]*
3		(2) NGC5102	STIS/CCD, ACCUM, 52X0.1E1	G430L 4300 A	CR-SPLIT=NO; GAIN=1		Pattern 3, Exps 3-3 in Visit 03 (3)	933 Secs (10263 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]* *[==>(Pattern 5)]*	*[2]*
								[==>(Pattern 6)] *[==>(Pattern 7)]* *[==>(Pattern 8)]*	*[3]*
								[==>(Pattern 9)] *[==>(Pattern 10)]* *[==>(Pattern 11)]*	*[4]*

Orbit Structure






Orbit 3
Server Version: 20160601
GS Reacq
Exp. 3
Exp. 3 (Auto-WAVECAL)
Pointing Maneuver
Exp. 3
Pointing Maneuver
Exp. 3
Unused Orbital Visibility = 4
Pointing Maneuver
Occultation
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 secs.
Orbit 4
Server Version: 20160601
Pointing Maneuver
Exp. 3 (Auto-WAVECAL)
GS Reacq
Exp. 3
Exp. 3
Pointing Maneuver
Exp. 3
Unused Orbital Visibility = 1
Occultation
Home
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 sec

Visit

Proposal 14742, Visit 04 Fri Jul 29 19:10:35 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 65D TO 105 D; ORIENT 245D TO 285 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(4)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(3)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=7	Angle Between Sides=		
	Point Spacing=1.016	Center Pattern=false		
	Line Spacing=			

Fixed Targets

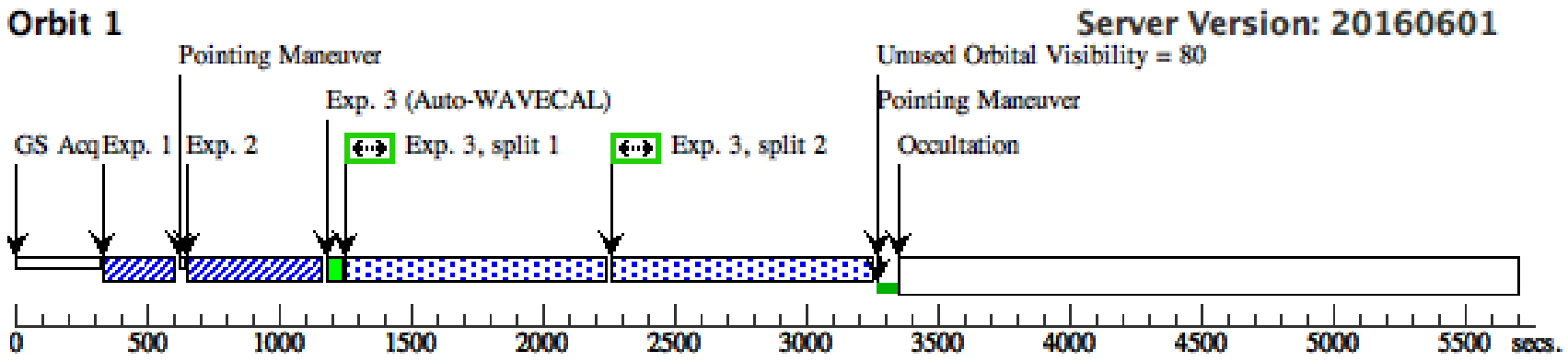
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	NGC5206	RA: 13 33 43.9710 (203.4332125d) Dec: -48 09 4.11 (-48.15114d) Equinox: J2000	Radial Velocity: 571 km/sec	V=9.05	Reference Frame: ICRS

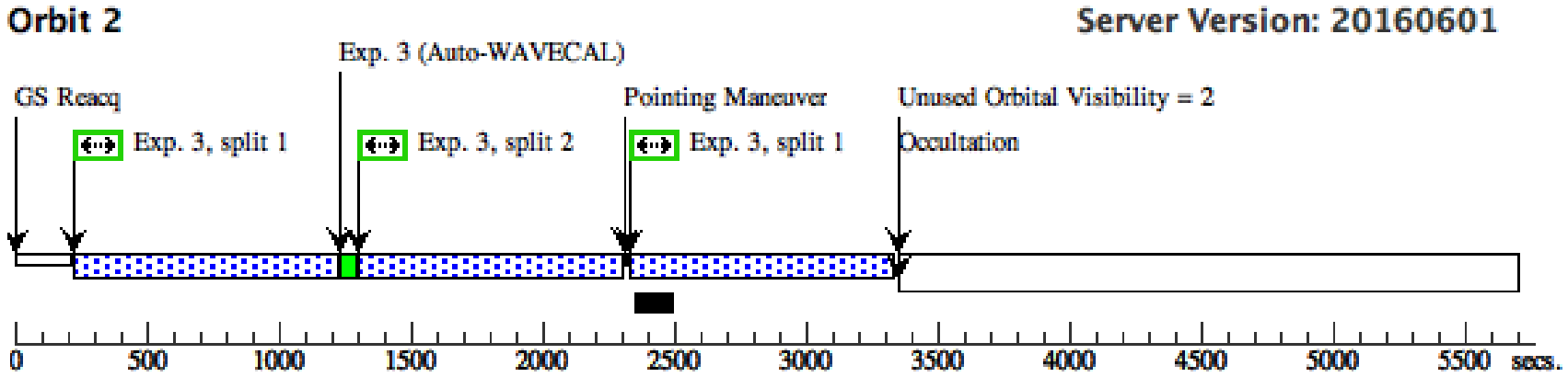
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

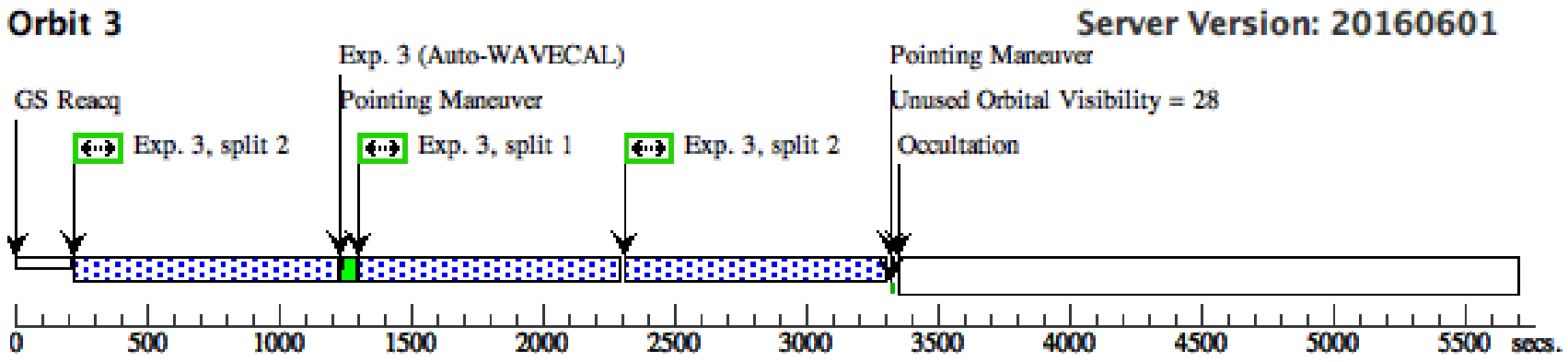
Exposures

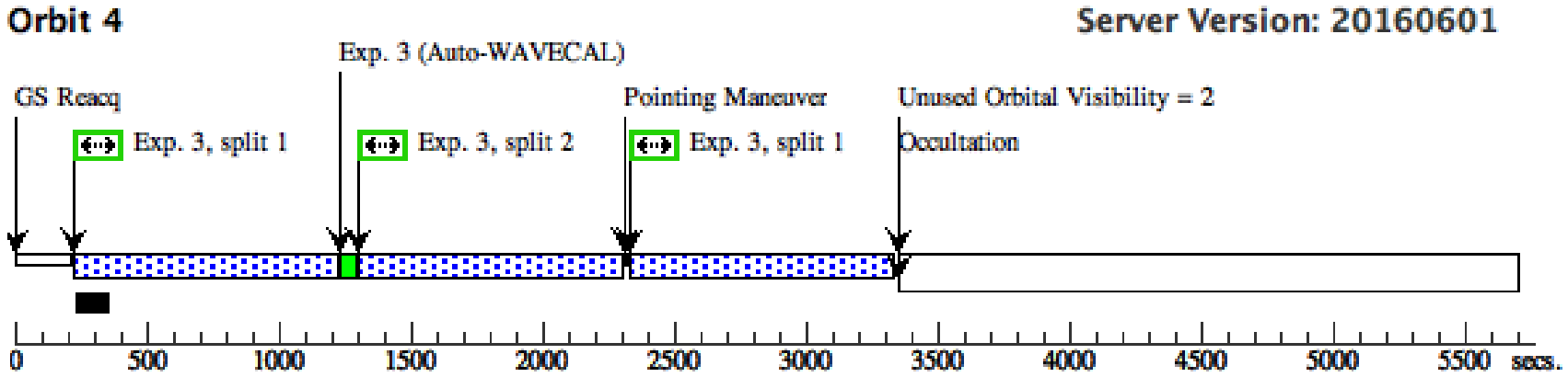
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) NGC5206	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5; DIFFUSE-CENTER=FLUX-CENTROID			10 Secs (10 Secs) *[==>]*	***[1]***
2		(3) NGC5206	STIS/CCD, ACQ/PEAK, 52X0.1E1	G430L 4300 A				20 Secs (20 Secs) *[==>]*	***[1]***
3		(3) NGC5206	STIS/CCD, ACCUM, 52X0.1E1	G430L 4300 A	CR-SPLIT=2; GAIN=1		Pattern 4, Exps 3-3 in Visit 04 (4)	1924 Secs (13468 Secs) *[==>(Pattern 1, Split 1)]* *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]* *[==>(Pattern 4, Split 1)]* *[==>(Pattern 4, Split 2)]* *[==>(Pattern 5, Split 1)]* *[==>(Pattern 5, Split 2)]* *[==>(Pattern 6, Split 1)]* *[==>(Pattern 6, Split 2)]* *[==>(Pattern 7, Split 1)]* *[==>(Pattern 7, Split 2)]*	***[1]*** ***[2]*** ***[3]*** ***[4]*** ***[5]***

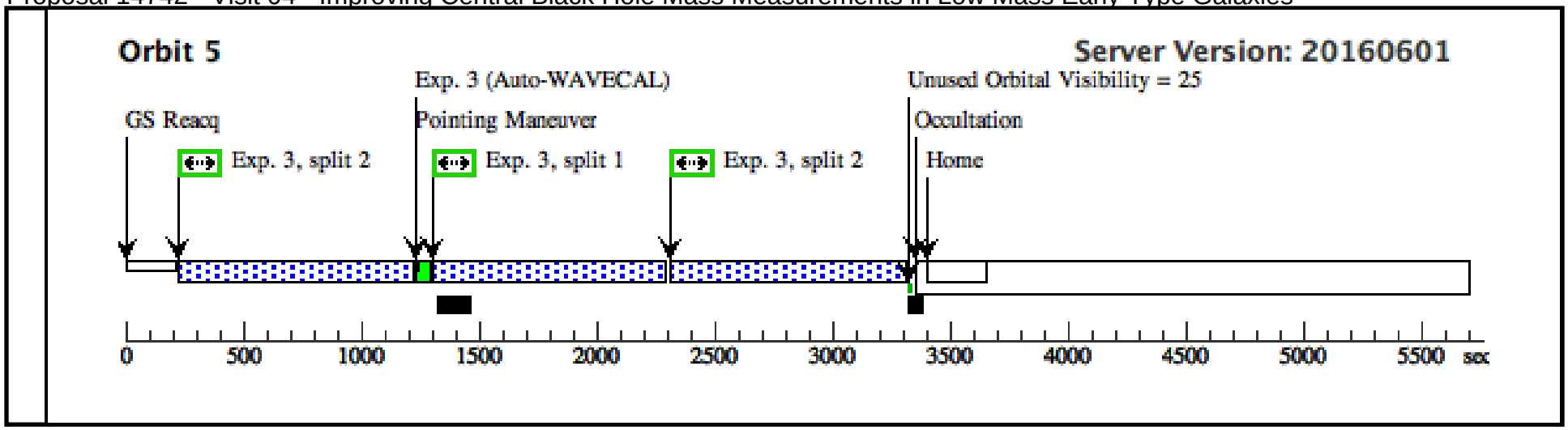
Orbit Structure






Orbit 3
Server Version: 20160601
Exp. 3 (Auto-WAVECAL)
Pointing Maneuver
GS Reacq
Pointing Maneuver
Unused Orbital Visibility = 28
Exp. 3, split 2
Exp. 3, split 1
Exp. 3, split 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20160601
Exp. 3 (Auto-WAVECAL)
GS Reacq
Pointing Maneuver
Unused Orbital Visibility = 2
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 5
Server Version: 20160601
Exp. 3 (Auto-WAVECAL)
Unused Orbital Visibility = 25
GS Reacq
Pointing Maneuver
Occultation
Exp. 3, split 2
Exp. 3, split 1
Exp. 3, split 2
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec