



14739 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

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) SDSSJ031856.61-060037.67	ACS/WFC	4	29-Jul-2016 15:09:40.0	yes
02	(2) 3C191	ACS/WFC	4	29-Jul-2016 15:09:44.0	yes
03	(3) STAR-GRW+70D5824	ACS/WFC	1	29-Jul-2016 15:09:46.0	yes

9 Total Orbits Used

ABSTRACT

Quasar outflows are increasingly invoked as a major contributor to the formation and evolution of supermassive black holes, their host galaxies, the surrounding IGM, and cluster cooling flows. Using spectral data, our group has determined the distance of the outflows from the central source in a sample of objects. Some of these outflows are found to be at ~ 10 kpc from the nucleus and thus can be imaged directly using ACS at redshifts 1-3. We therefore propose to obtain the first ever imaging of BALQSO outflows at high redshifts. This project will uncover the spatial geometry of the outflows, which is the final piece needed to derive their kinetic luminosities, and therefore a direct measurement of their importance to AGN feedback processes. We will image each object with filters corresponding to deep absorption troughs. Such configuration will detect light scattered

from the same ionic transitions that cause the trough, which are outflowing in directions other than our line of sight. The natural coronagraph supplied by the absorption trough will greatly reduce the flux of the quasar in that narrow spectral region, facilitating the detection of the outflow. To distinguish between the outflow features and the underlying galaxy we will use two narrow band filters at wavelengths of deep troughs as well as a broader band filter that does not cover significant troughs and therefore should show only the underlying galaxy and not the outflowing material.

OBSERVING DESCRIPTION

Imaging outflows. For the narrow band imaging at the wavelength of the chosen troughs, we will use the Linear Ramp Filter (LRF) on ACS/WFC, which has a continuous tunable central wavelength ranging from about 3700 Ang to 11000 Ang. The full width at half maximum of the filter is dependent upon the location of the center of the bandpass via $\Delta\lambda/\lambda = 0.02$. For SDSS J0318-0600, Fig. 2 shows the SDSS spectrum and the coverage of the LRF for the Civ (observed at about 4500 Ang) and Al iii trough (observed at about 5450 Ang). As explained on page 2, we assume that the outflow will scatter $\sim 10\%$ of the light from the quasar continuum level adjacent to the Civ and Al iii troughs into our line of sight (11 and $16 \times 10^{17} \text{ ergs s}^{-1} \text{ cm}^{-2} \text{ Ang}^{-1}$, respectively). With residual flux of 1.4 and $4 \times 10^{17} \text{ ergs s}^{-1} \text{ cm}^{-2} \text{ Ang}^{-1}$, respectively, these absorption troughs provide a "natural coronagraph" for imaging the outflows by suppressing the quasar glare by a factor of 4 - 8.

We estimate the surface brightness of the wind by assuming uniform emission over 1 arcsec^2 for the scattered fluxes. In the LRF images, read noise is comparable to (or larger than) the source noise and sky background noise. We will take two exposures per orbit with position offsets to create a 4-point dither over the course of the total exposure. This will allow us to remove cosmic rays and CCD imperfections. We require an average $S/N=5$ per 2×2 pixels (a resolution downgraded to this level remains sufficient for our science goal) in both the Civ and the Al iii features in order to deal with expected image complexity, due to e.g., non-uniformity in the outflow surface brightness, wind sizes larger than 1 arcsec^2 , confusion by features in the host galaxy and nuclear PSF residuals. Using the on-line ACS ETC we calculate the exposure time required to achieve a $S/N=5$ per 2×2 pixels in the Al iii and Civ lines.

Imaging host galaxies. We will use the wide-band filter F625W to image the host galaxies in a trough-free continuum region redward of the Al iii trough (Fig. 3). The feasibility of such imaging and PSF subtraction involved has been demonstrated for $z=2$ galaxies hosting quasars (Floyd et al. 2013). Taking SDSS J0318-0600 as an example, the quasar continuum flux in this region is $\sim 21 \times 10^{-17} \text{ ergs s}^{-1} \text{ cm}^{-2} \text{ \AA}^{-1}$, and we expect the host galaxy to be ~ 50 times fainter. Requiring a $S/N=5$ per 2×2 pixels, this flux level necessitates an exposure time of 2.2 kilo-seconds (ks) for a source extended over 4 arcsec^2 . Thus, the total exposure time for the two narrow band filters and the wide bandpass filter is 8.7 ks. A typical HST orbit includes 6 minutes for guide star acquisition (5 for re-acquisition), 4 min overhead (2.5 min for subsequent exposures), which leaves about 40 minutes observing time. Therefore, the total observing time of 8.7 ks translates to 4 HST orbits for SDSS J0318-0600. Table 1 shows our second target, with a similar observing method of 2 absorption troughs observed with the LRFs and the continuum observed through a wide filter. We will calibrate the ACS/LRFs using flat fields interpolated from non-LRF filters close in wavelength as described by Tremblay et al. (2009).

PSF observation. Past experience has demonstrated that the success of modeling the QSO/host combination hinges on obtaining an accurate empirical PSF (e.g., McLure et al. 1999, Floyd et al. 2004, 2013). As in those programs, we need to obtain both unsaturated and very deep images of a star using the same filter and positioned on the same part of the detector as our target QSOs. We will observe the HST standard star GRW+70D5824 which has colors similar to those of a typical QSO over the wavelength intervals of interest. We will perform the a 2-point dither pattern to attain a clean and well-sampled PSF. These PSF observations will be carried out for the bluers of the LRFs for each target and the broad band filter. the obtained PSF will be at the same location on the chip as our targets. Because of the large number of short exposures, overhead is significant including buffer dumps and additional GS acqqs.

Proposal 14739 - Visit 01 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

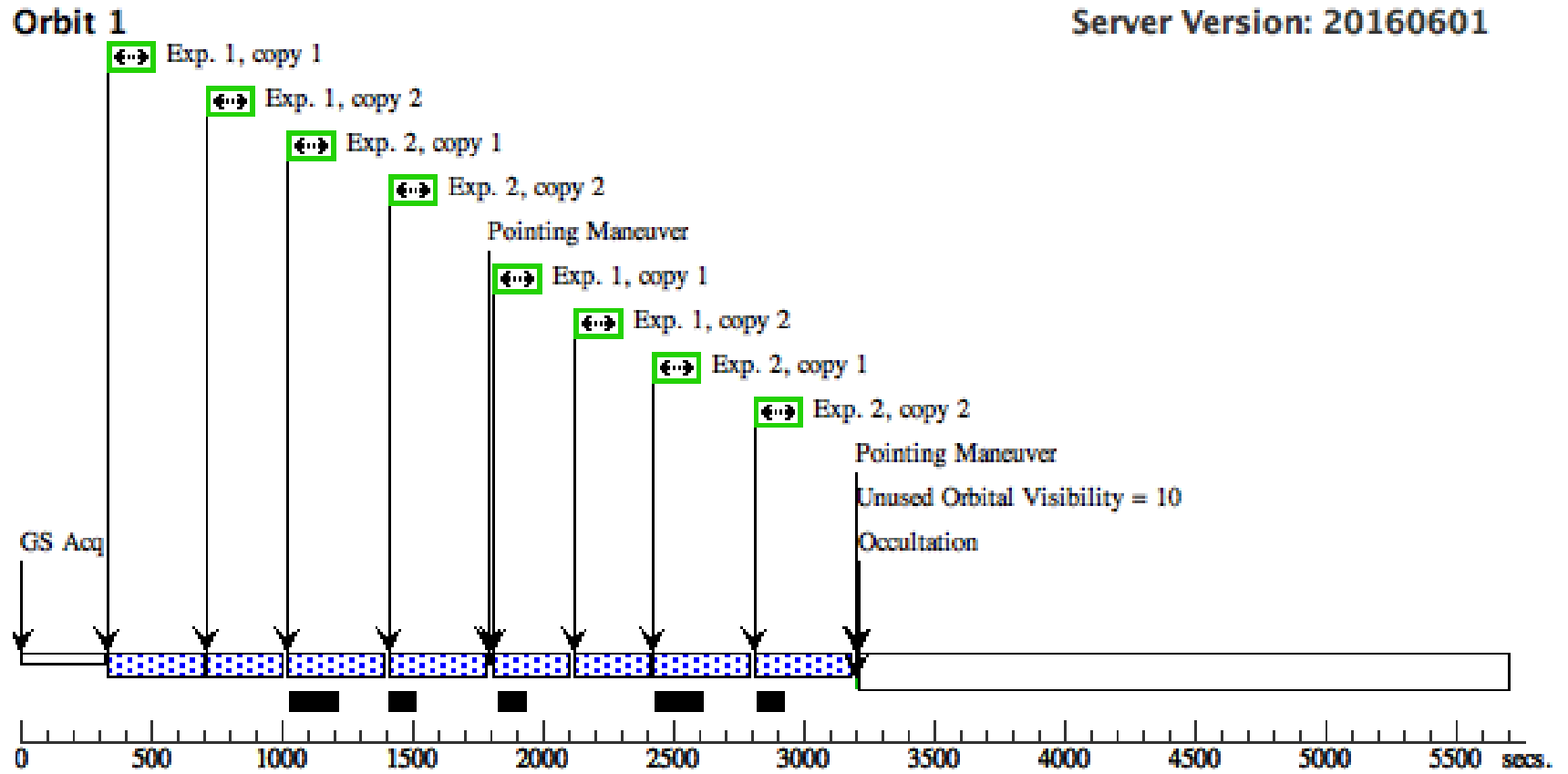
Fri Jul 29 19:09:47 GMT 2016

Visit	Proposal 14739, Visit 01 Diagnostic Status: Warning Scientific Instruments: ACS/WFC Special Requirements: (none)				
	(Exposure 1 (Pattern 1, Exps 1-2 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp filters as central wavelengths & transmission efficiencies vary within the apertures. (Exposure 2 (Pattern 1, Exps 1-2 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp filters as central wavelengths & transmission efficiencies vary within the apertures. (Exposure 3 (Pattern 1, Exps 3-3 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp filters as central wavelengths & transmission efficiencies vary within the apertures.				
Diagnosics					
Patterns	#	Primary Pattern	Secondary Pattern	Exposures	
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	(1)	SDSSJ031856.61-060037.67	RA: 03 18 56.6319 (49.7359662d) Dec: -06 00 37.74 (-6.01048d) Equinox: J2000		V=18.62 r = 17.6
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					

Proposal 14739 - Visit 01 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

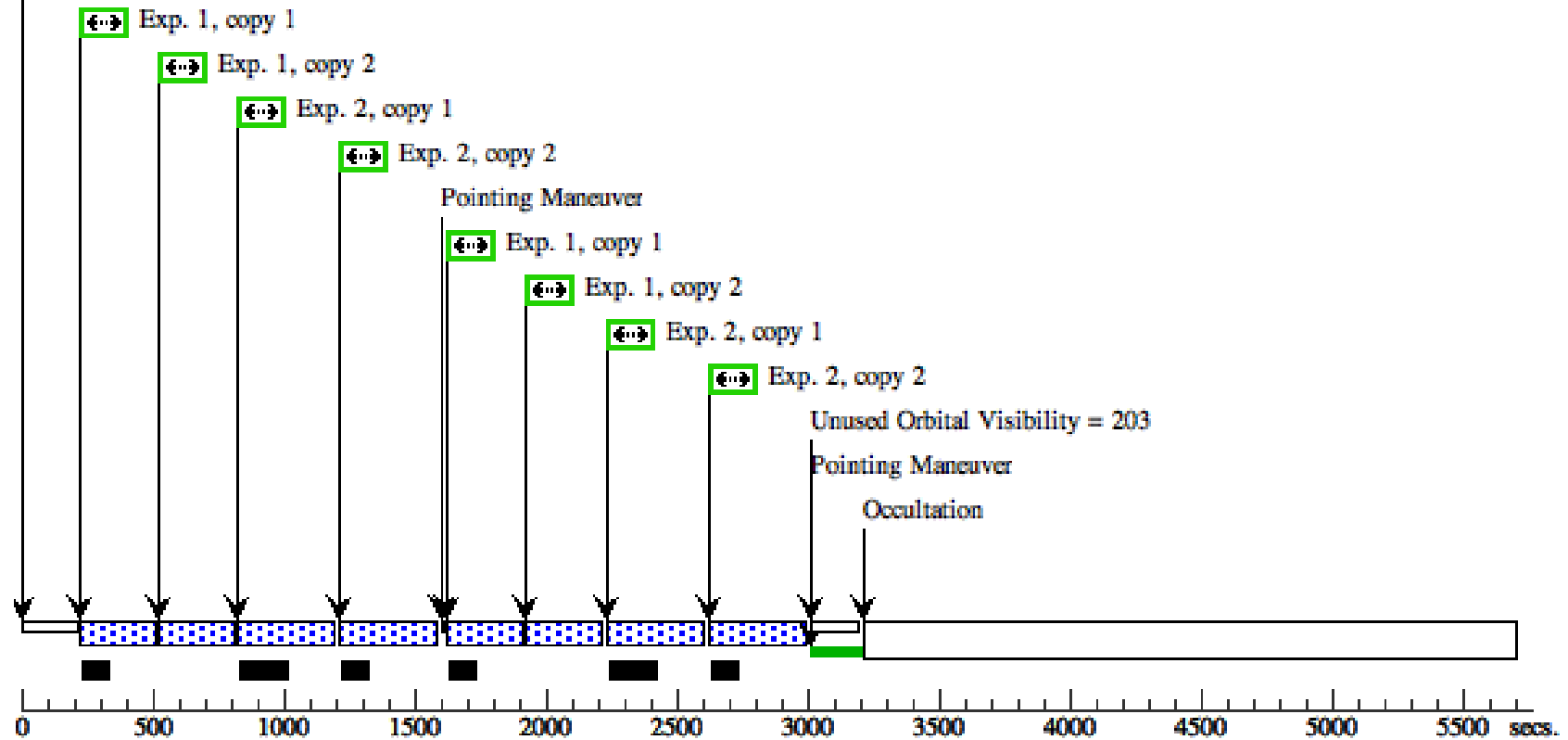
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Exposures	1	(1) SDSSJ031856.61-060037.67	ACS/WFC, ACCUM, WFC2-ORAMPQ	FR462N 4495.0 A			Pattern 1, Exps 1-2 in Visit 01 (1)	160.0 Secs X 2 (1280 Secs)		
								[==>(Pattern 1, Copy 1)]	[1]	
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								[==>(Pattern 2, Copy 1)]		
	[==>(Pattern 2, Copy 2)]									
	[==>(Pattern 3, Copy 1)]	[2]								
	[==>(Pattern 3, Copy 2)]									
	[==>(Pattern 4, Copy 1)]									
	[==>(Pattern 4, Copy 2)]									
	2	(1) SDSSJ031856.61-060037.67	ACS/WFC, ACCUM, WFC2-ORAMPQ	FR462N 4495.0 A				Pattern 1, Exps 1-2 in Visit 01 (1)	250.0 Secs X 2 (2000 Secs)	
									[==>(Pattern 1, Copy 1)]	[1]
									[==>(Pattern 1, Copy 2)]	
									[==>(Pattern 2, Copy 1)]	
	[==>(Pattern 2, Copy 2)]									
	[==>(Pattern 3, Copy 1)]	[2]								
	[==>(Pattern 3, Copy 2)]									
[==>(Pattern 4, Copy 1)]										
[==>(Pattern 4, Copy 2)]										
3	(1) SDSSJ031856.61-060037.67	ACS/WFC, ACCUM, WFC1-IRAMPQ	FR551N 5410.0 A				Pattern 1, Exps 3-3 in Visit 01 (1)	160.0 Secs X 2 (1280 Secs)		
								[==>(Pattern 1, Copy 1)]	[3]	
								[==>(Pattern 1, Copy 2)]		
								[==>(Pattern 2, Copy 1)]		
[==>(Pattern 2, Copy 2)]										
[==>(Pattern 3, Copy 1)]										
[==>(Pattern 3, Copy 2)]										
[==>(Pattern 4, Copy 1)]										
[==>(Pattern 4, Copy 2)]										
4	(1) SDSSJ031856.61-060037.67	ACS/WFC, ACCUM, WFC1A-2K	F625W				Pattern 1, Exps 4-4 in Visit 01 (1)	200.0 Secs X 2 (1600 Secs)		
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[==>(Pattern 2, Copy 2)]										
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Orbit Structure

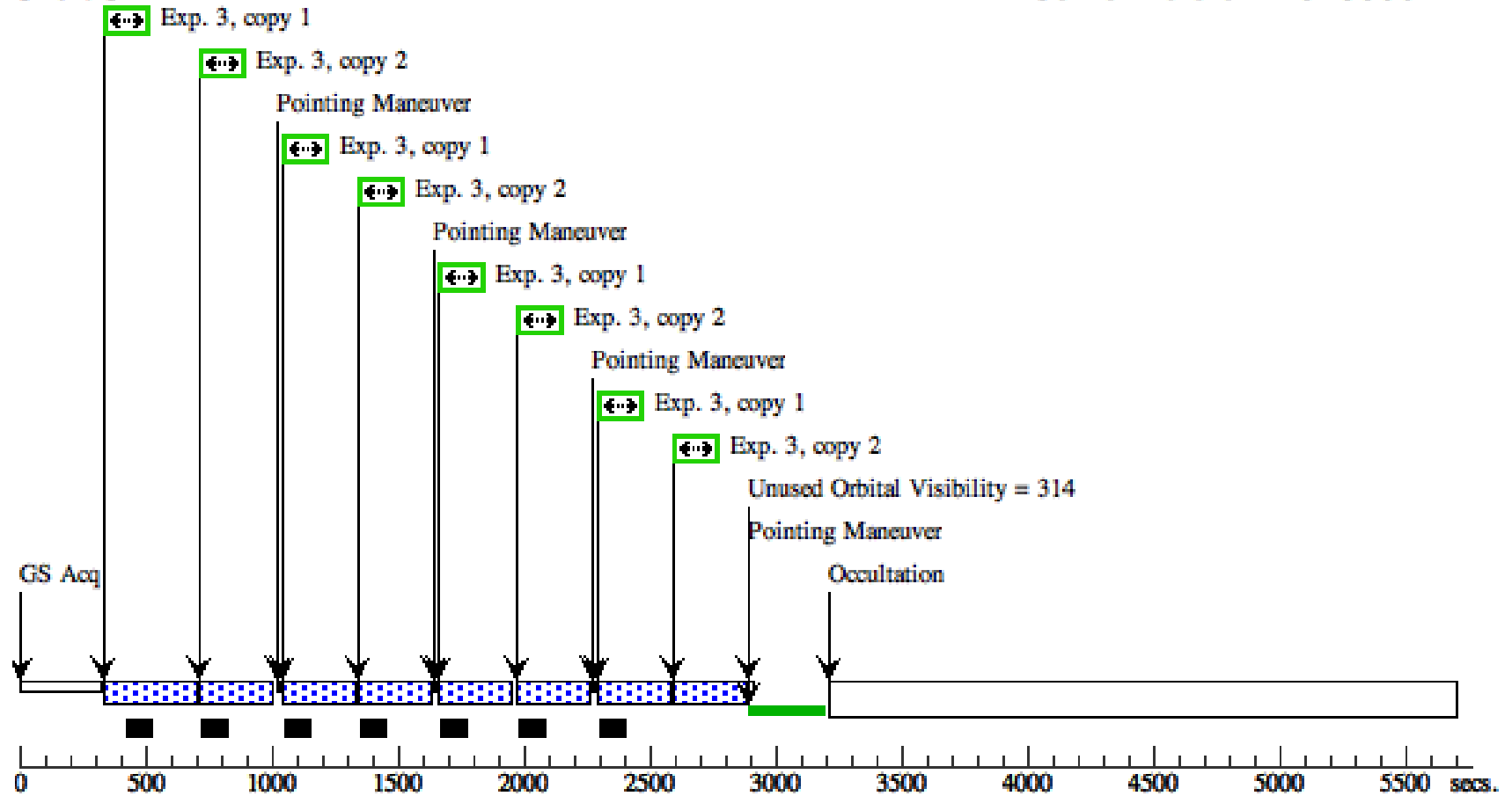


Orbit 2

GS Reacq

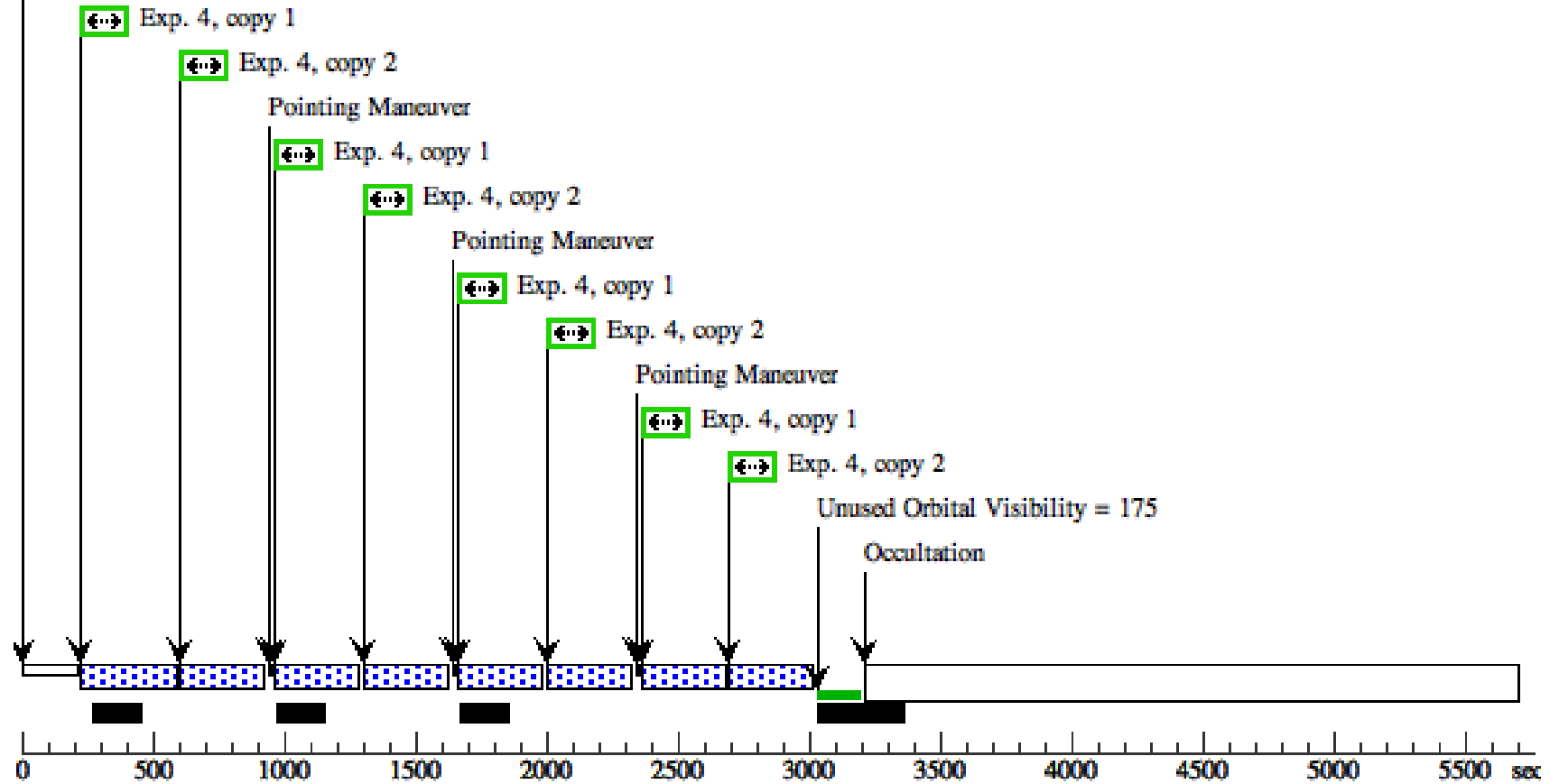


Orbit 3



Orbit 4

GS Reacq



Proposal 14739 - Visit 02 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

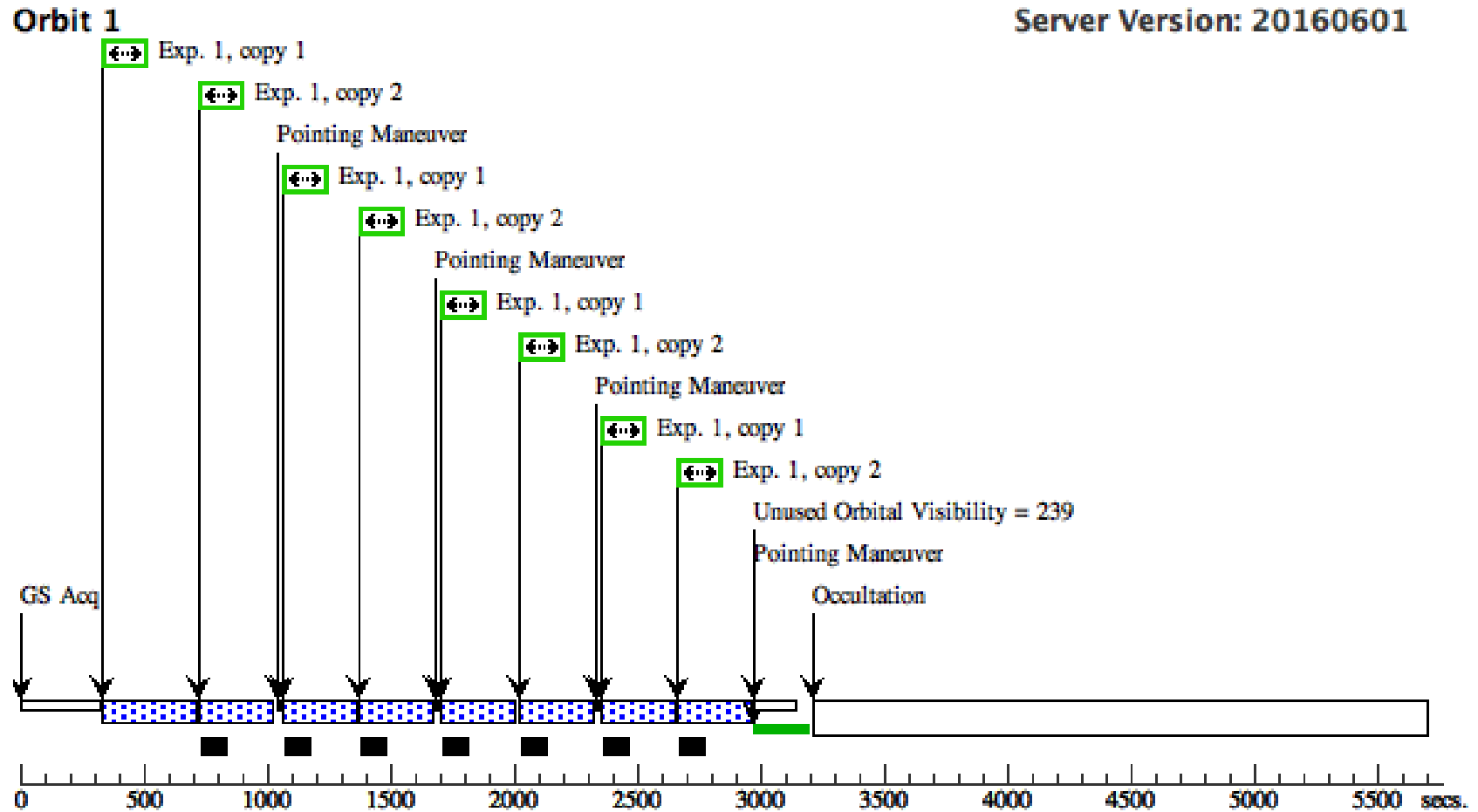
Fri Jul 29 19:09:47 GMT 2016

Visit	Proposal 14739, Visit 02 Diagnostic Status: Warning Scientific Instruments: ACS/WFC Special Requirements: (none)				
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Patterns	#	Primary Pattern	Secondary Pattern	Exposures	
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Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(2)	3C191	RA: 08 04 47.9625 (121.1998437d) Dec: +10 15 23.78 (10.25661d) Equinox: J2000		V=18.4 r = 17.7
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					

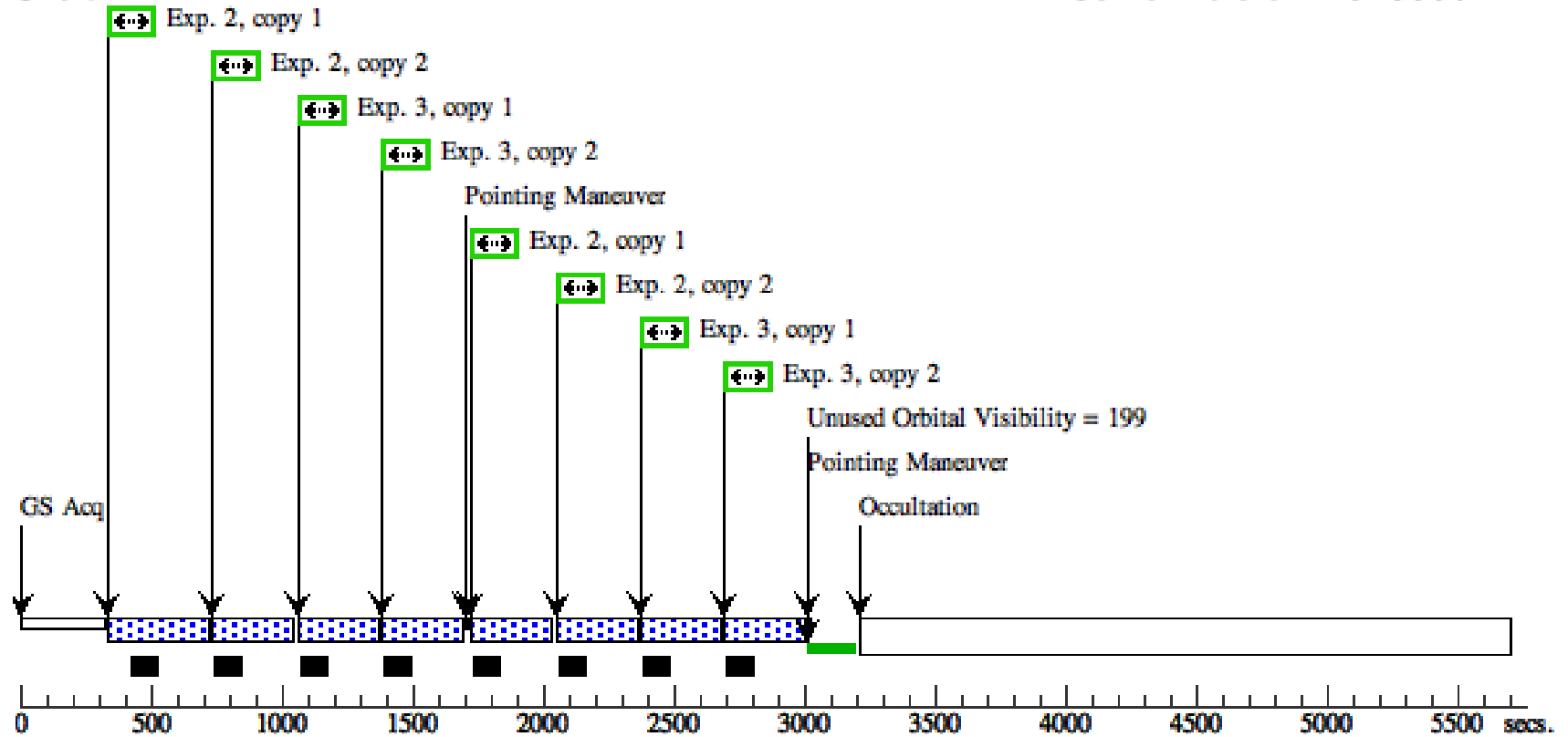
Proposal 14739 - Visit 02 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	(2) 3C191	ACS/WFC, ACCUM, WFC1-IRAMPQ	FR423N 4120.00 A			Pattern 1, Exps 1-1 i n Visit 02 (1)	170 Secs X 2 (1360 Secs) [=>(Pattern 1, Copy 1)] [=>(Pattern 1, Copy 2)] [=>(Pattern 2, Copy 1)] [=>(Pattern 2, Copy 2)] [=>(Pattern 3, Copy 1)] [=>(Pattern 3, Copy 2)] [=>(Pattern 4, Copy 1)] [=>(Pattern 4, Copy 2)]	[1]
	2	(2) 3C191	ACS/WFC, ACCUM, WFC2-ORAMPQ	FR462N 4531.0 A			Pattern 1, Exps 2-3 i n Visit 02 (1)	180 Secs X 2 (1440 Secs) [=>(Pattern 1, Copy 1)] [=>(Pattern 1, Copy 2)] [=>(Pattern 2, Copy 1)] [=>(Pattern 2, Copy 2)]	[2]
								[=>(Pattern 3, Copy 1)] [=>(Pattern 3, Copy 2)] [=>(Pattern 4, Copy 1)] [=>(Pattern 4, Copy 2)]	[3]
	3	(2) 3C191	ACS/WFC, ACCUM, WFC2-ORAMPQ	FR462N 4531.0 A			Pattern 1, Exps 2-3 i n Visit 02 (1)	180 Secs X 2 (1440 Secs) [=>(Pattern 1, Copy 1)] [=>(Pattern 1, Copy 2)] [=>(Pattern 2, Copy 1)] [=>(Pattern 2, Copy 2)]	[2]
								[=>(Pattern 3, Copy 1)] [=>(Pattern 3, Copy 2)] [=>(Pattern 4, Copy 1)] [=>(Pattern 4, Copy 2)]	[3]
	4	(2) 3C191	ACS/WFC, ACCUM, WFC1A-2K	F625W			Pattern 1, Exps 4-4 i n Visit 02 (1)	180.0 Secs X 2 (1440 Secs) [=>(Pattern 1, Copy 1)] [=>(Pattern 1, Copy 2)] [=>(Pattern 2, Copy 1)] [=>(Pattern 2, Copy 2)] [=>(Pattern 3, Copy 1)] [=>(Pattern 3, Copy 2)] [=>(Pattern 4, Copy 1)] [=>(Pattern 4, Copy 2)]	[4]

Orbit Structure

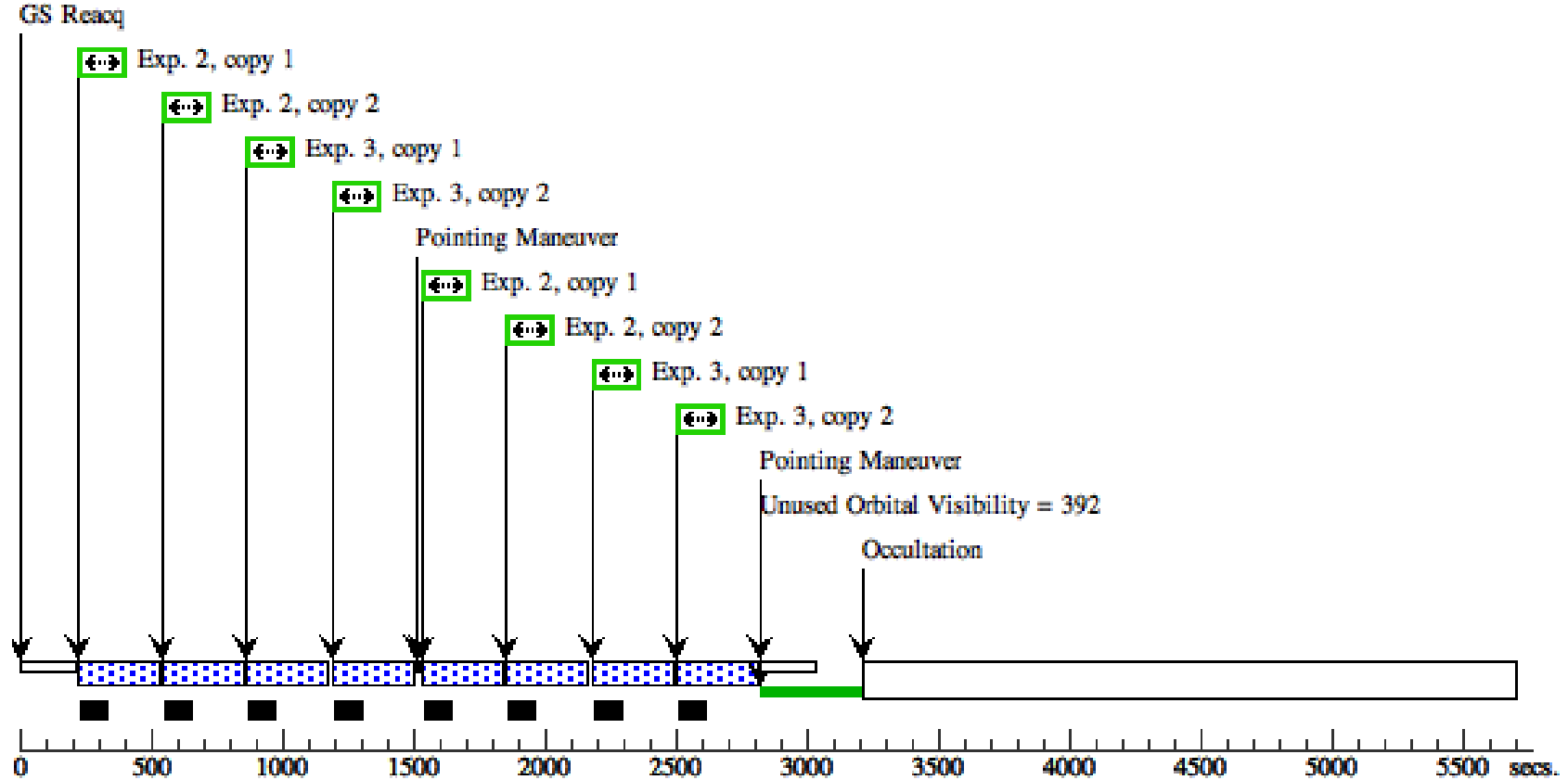


Orbit 2

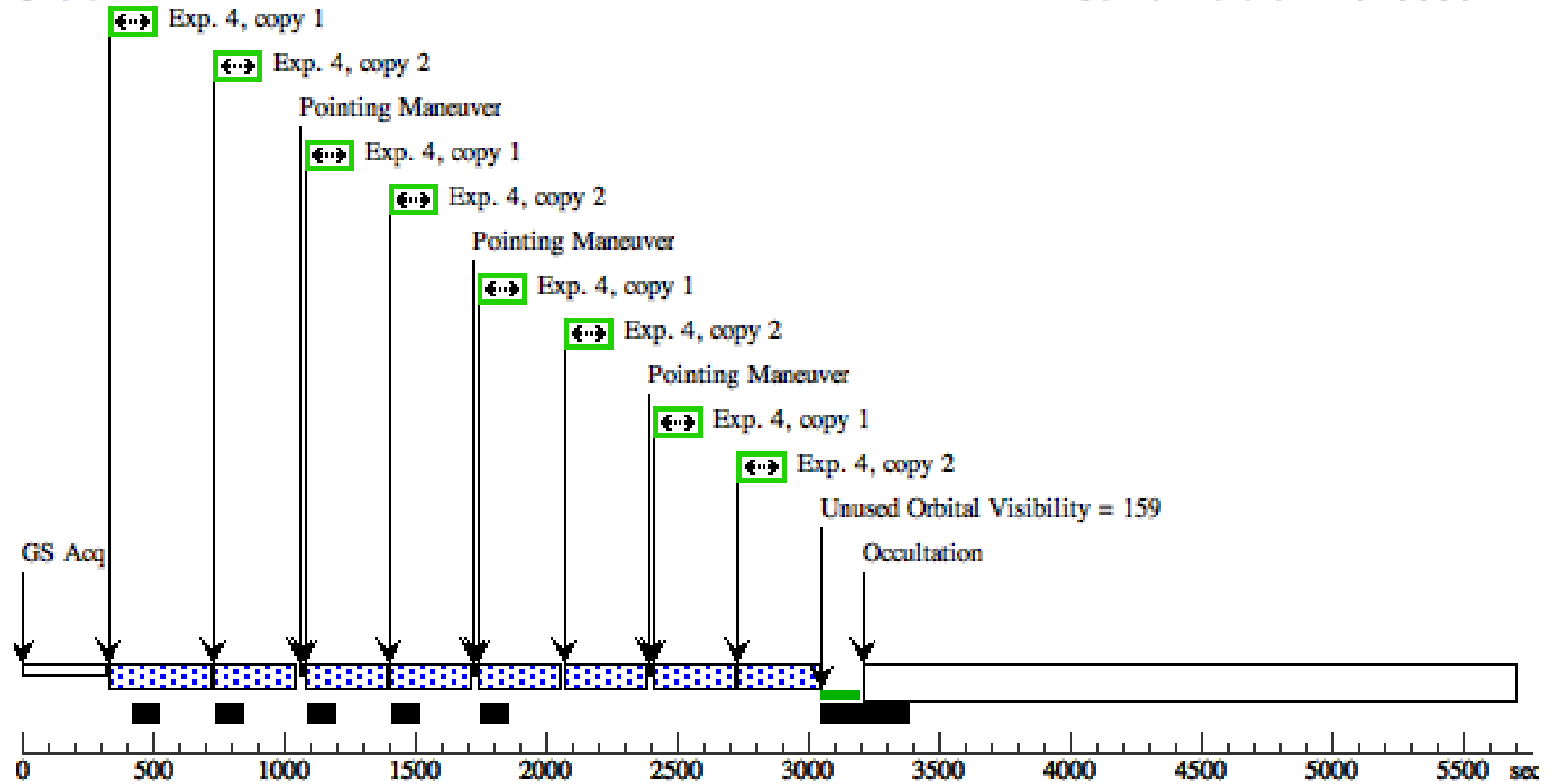


Orbit 3

Server Version: 20160601



Orbit 4



Proposal 14739 - Visit 03 - Imaging BALQSO outflows: a critical step in assessing AGN feedback

Fri Jul 29 19:09:48 GMT 2016

Visit	Proposal 14739, Visit 03 Diagnostic Status: Warning Scientific Instruments: ACS/WFC Special Requirements: (none)										
	(Exposure 1 (Pattern 2, Exps 1-1 in Visit 03)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp filters as central wavelengths & transmission efficiencies vary within the apertures. (Exposure 2 (Pattern 2, Exps 2-2 in Visit 03)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp filters as central wavelengths & transmission efficiencies vary within the apertures.										
Diagnos											
Patterns	#	Primary Pattern				Secondary Pattern				Exposures	
	(2)	Pattern Type=ACS-WFC-DITHER- LINE Purpose=DITHER Number Of Points=2 Point Spacing=3.034 Line Spacing=				Coordinate Frame=POS-TARG Pattern Orientation=85.29 Angle Between Sides= Center Pattern=false				(1), (2), (3-4)	
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(3)	STAR-GRW+70D5824	RA: 13 38 51.0095 (204.7125396d) Dec: +70 17 7.77 (70.28549d) Equinox: J2000				V=12.77		Reference Frame: ICRS		
<i>Comments: This object was generated by the targetselector and retrieved from the GSC 2.3 database.This object was generated by the targetselector and retrieved from the GSC 2.3 database.</i>											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	(3) STAR-GRW+70 D5824	(3) STAR-GRW+70 D5824	ACS/WFC, ACCUM, WFC1-IRAMPQ	FR423N 4120.0 A			Pattern 2, Exps 1-1 in Visit 03 (2)	20 Secs (40 Secs) [=>(Pattern 1)] [=>(Pattern 2)]		[1]
	2	(3) STAR-GRW+70 D5824	(3) STAR-GRW+70 D5824	ACS/WFC, ACCUM, WFC2-ORAMPQ	FR462N 4495.0 A			Pattern 2, Exps 2-2 in Visit 03 (2)	15 Secs (30 Secs) [=>(Pattern 1)] [=>(Pattern 2)]		[1]
	3	(3) STAR-GRW+70 D5824	(3) STAR-GRW+70 D5824	ACS/WFC, ACCUM, WFC1A-2K	F625W			Pattern 2, Exps 3-4 in Visit 03 (2)	6 Secs (12 Secs) [=>(Pattern 1)] [=>(Pattern 2)]		[1]
	4	(3) STAR-GRW+70 D5824	(3) STAR-GRW+70 D5824	ACS/WFC, ACCUM, WFC1A-2K	F625W			Pattern 2, Exps 3-4 in Visit 03 (2)	20 Secs (40 Secs) [=>(Pattern 1)] [=>(Pattern 2)]		[1]

