16483 - A Hunt for Binary Supermassive Black Holes with the VLBA and HST

Cycle: 28, 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	(1) SDSSJ095036.75+512838.1	WFC3/IR	1	25-Jun-2021 07:00:13.0	yes
02	(2) SDSSJ102106.04+452331.8	WFC3/IR	1	25-Jun-2021 07:00:13.0	yes
52	(2) SDSSJ102106.04+452331.8	WFC3/IR	1	25-Jun-2021 07:00:14.0	yes
03	(3) SDSSJ105203.17+240505.0	WFC3/IR	1	25-Jun-2021 07:00:14.0	yes
53	(3) SDSSJ105203.17+240505.0	WFC3/IR	1	25-Jun-2021 07:00:15.0	yes
04	(4) SDSSJ151443.07+365050.4	WFC3/IR	1	25-Jun-2021 07:00:15.0	yes
05	(5) LAWD-52	WFC3/IR	1	25-Jun-2021 07:00:16.0	yes

7 Total Orbits Used

ABSTRACT

We propose 162.2 hours (including overheads) of Q-band observations with the VLBA in order to explore the underlying nature of eight peculiar active galactic nuclei (AGN). These eight objects originate from a sample of 88 SDSS quasars identified as having broad emission lines that are

velocity-offset (>1000~km/s) from the host galaxy (Eracleous et al., 2012), potentially indicating a binary supermassive black hole (SMBH). However, there are two other leading models for such shifts: a recoiling post-merger SMBH, or a broad line region (BLR) gas outflow caused by a jet or accretion disk wind. We have previously followed up all 88 objects from Eracleous et al. (2012) with VLA X-band observations. We then followed up the brightest VLA-detected objects with VLBA X-band observations. Our proposed Q-band observations of the eight brightest objects will provide a critical 5-fold increase in angular resolution over the previous VLBA X-band observations, and test the binary hypothesis down to sub-pc separations in all cases. In addition, we request 9 orbits with the HST in order to determine the SMBH masses, assess the host galaxies for any evidence of recent major galaxy mergers, and measure the photometric centers that will allow more precise determination of radio/optical offsets.

OBSERVING DESCRIPTION

The overall scientific goals of this proposal are two-fold: image the faint morphological structures of the quasar host galaxies for any indications of a recent merger (such as tidal tails); and photometricly model the bulge of the host galaxy in order to precisely determine its light center, along with measuring the bulge luminosity for determining a black hole mass. The precise measuement of the bulge's photocenter is necessary for comparison with the VLBI radio core position to determine if there are any offset AGN which may be indicative of a recoiling black hole. Given these requirements, we need a good description of the PSF in the F125W filter, for the optical quasar subtraction and photometric analysis of the host. Hence, we are observing the white dwarf star to get a picture of the PSF with same instrument configuration, and we are using a 4-point (box) dithering pattern to better sample the PSF. Since the expected host galaxies are faint, we chose the WFC3 IR camera in order to readout exposures in a STEP sequence (recommended for high dynamic range imaging), alllowing us to build up sensitivity to low surface brightness features. Our estimated necessary exposure times are all within the time allowed during a single orbit. However, since our stratgey is to observe one target per orbit, we intend to use all of the possible time during the orbit towards the target exposure to maximize our sensitivity. To this end, we adjust the number of readout samples to be within the constraints allowed for a single orbit.

Visit

Proposal 16483, Visit 01, completed Fri Jun 25 11:00:16 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

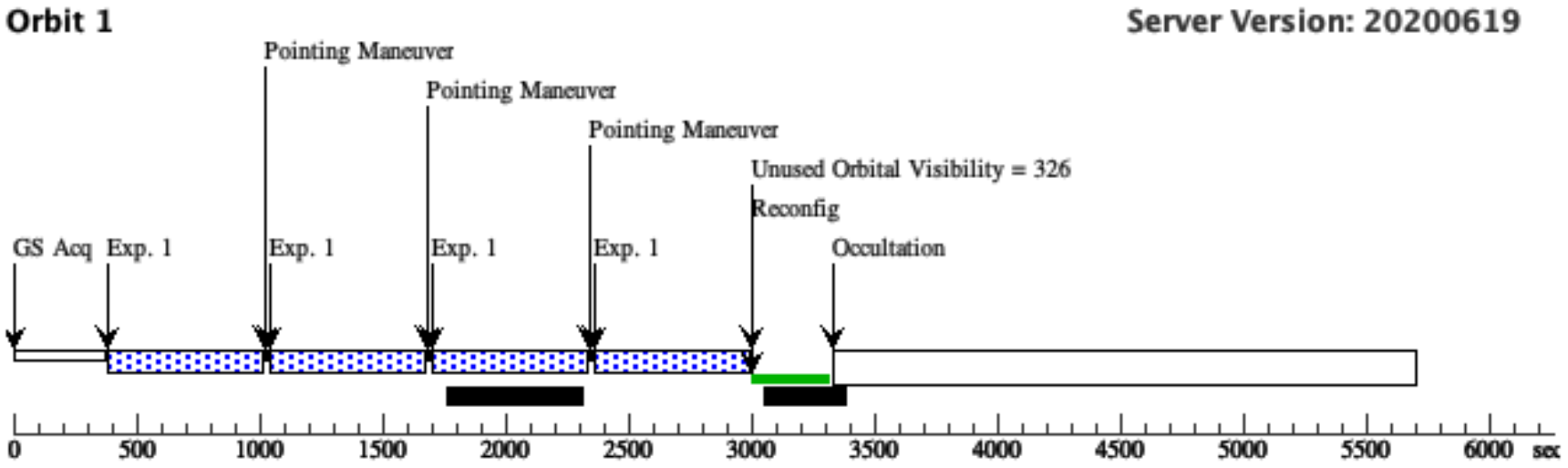
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ095036.75+512838.1 Alt Name1: 2MASS-J09503674+5128382	RA: 09 50 36.7565 (147.6531521d) Dec: +51 28 38.07 (51.47724d) Equinox: J2000	Proper Motion RA: -2.333452049979895E-5 sec of time/yr Proper Motion Dec: 0.001368 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.2144	V=18.34+/-0.1 B=18.74	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) SDSSJ095036.75+512838.1	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200		Pattern 1, Exps 1-1 in Visit 01 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	*[1]*

Orbit Structure



Visit

Proposal 16483, Visit 02, failed

Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

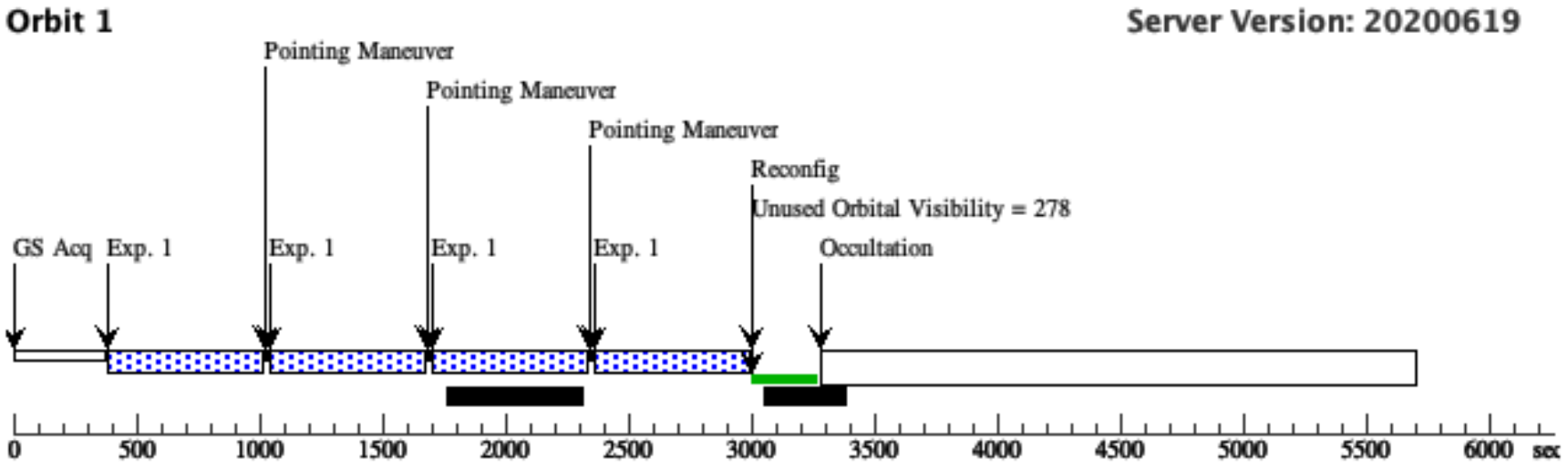
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ102106.04+452331.8 Alt Name1: 7C-101803.39+453837.00	RA: 10 21 6.0464 (155.2751933d) Dec: +45 23 31.82 (45.39217d) Equinox: J2000	Proper Motion RA: 2.5536952889654054E-5 sec of time/yr Proper Motion Dec: 2.98E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.3637	V=18.38+/-0.1 B=18.34	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) SDSSJ102106.04+452331.8	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200		Pattern 1, Exps 1-1 in Visit 02 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16483, Visit 52, implementation Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Comments: HOPR repeat of visit 02

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

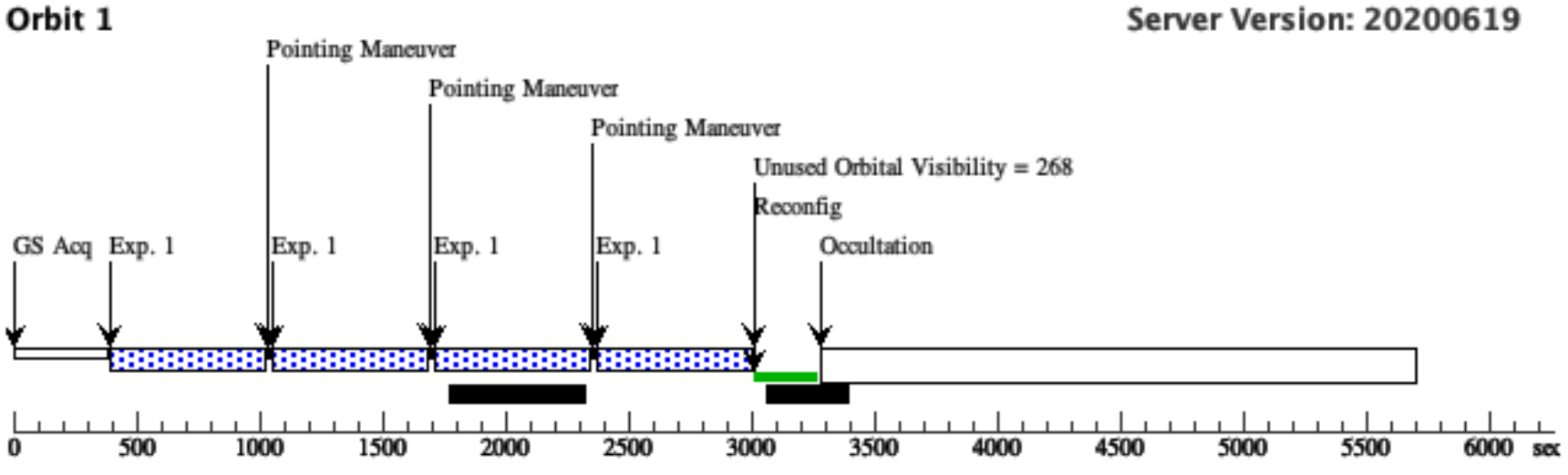
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	SDSSJ102106.04+452331.8 Alt Name1: 7C-101803.39+453837.00	RA: 10 21 6.0464 (155.2751933d) Dec: +45 23 31.82 (45.39217d) Equinox: J2000	Proper Motion RA: 2.5536952889654054E-5 sec of time/yr Proper Motion Dec: 2.98E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.3637	V=18.38+/-0.1 B=18.34	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) SDSSJ102106.04+452331.8	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200	GS ACQ SCENARIO BASE1BE	Pattern 1, Exps 1-1 in Visit 52 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16483, Visit 03, failed Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

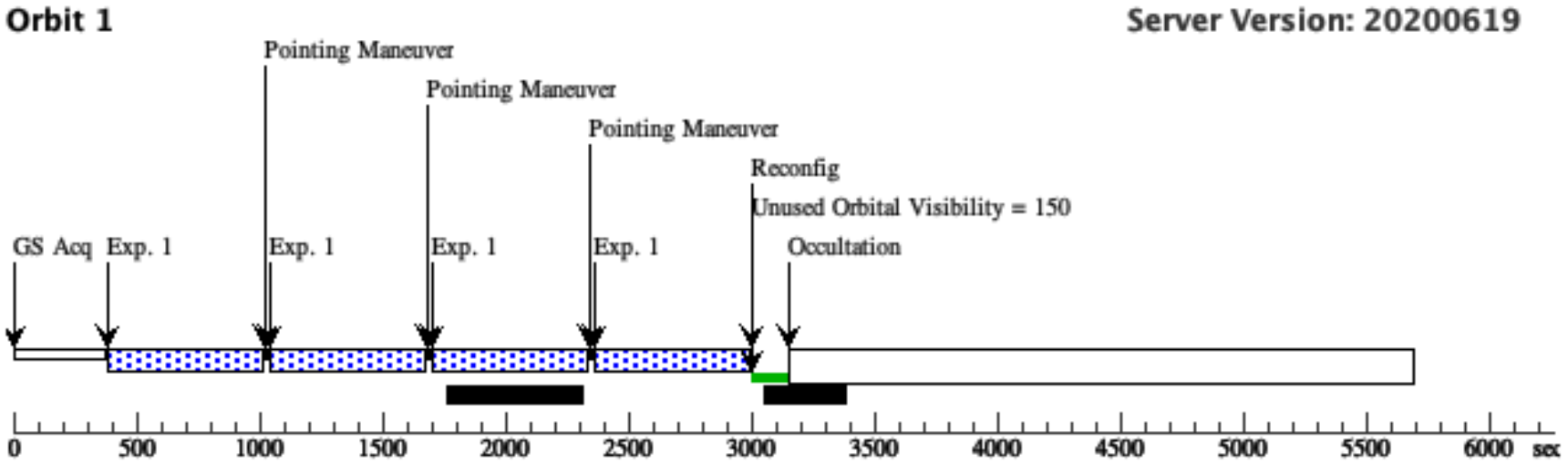
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SDSSJ105203.17+240505.0 Alt Name1: 2MASSI-J1052031+240505	RA: 10 52 3.1720 (163.0132167d) Dec: +24 05 4.98 (24.08472d) Equinox: J2000	Proper Motion RA: -3.870266875026689E-6 sec of time/yr Proper Motion Dec: -1.489999931436614E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.4002	V=18.6+/-0.1 B=18.5	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) SDSSJ105203.17+240505.0	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200		Pattern 1, Exps 1-1 in Visit 03 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16483, Visit 53, implementation Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Comments: HOPR repeat of visit 03

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

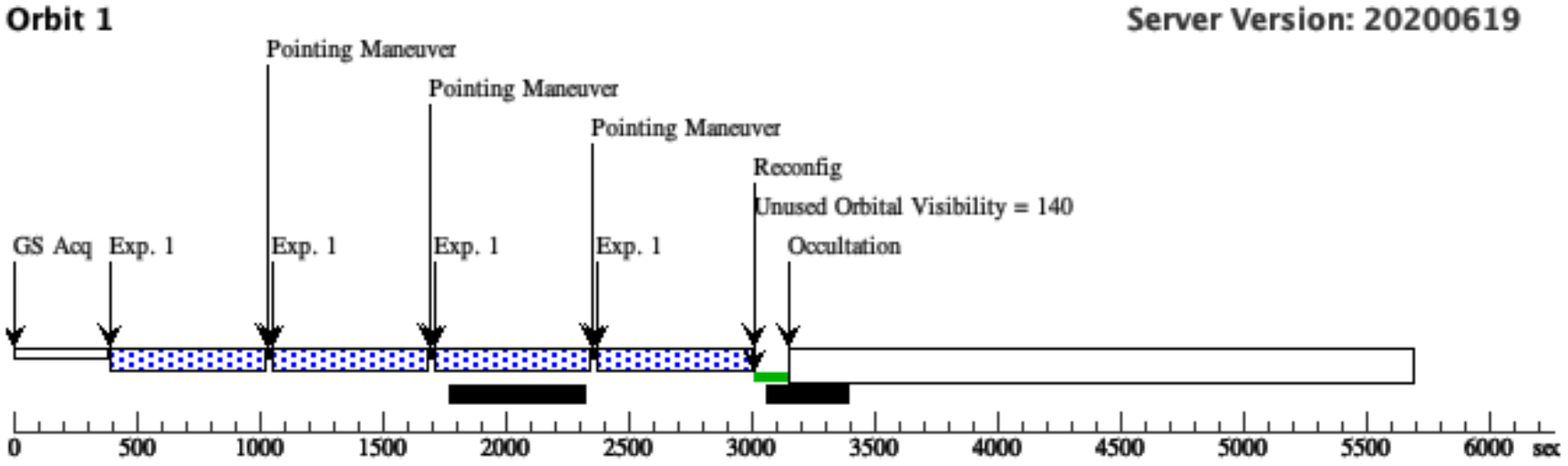
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	SDSSJ105203.17+240505.0 Alt Name1: 2MASSI-J1052031+240505	RA: 10 52 3.1720 (163.0132167d) Dec: +24 05 4.98 (24.08472d) Equinox: J2000	Proper Motion RA: -3.870266875026689E-6 sec of time/yr Proper Motion Dec: -1.489999931436614E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.4002	V=18.6+/-0.1 B=18.5	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) SDSSJ105203.17+240505.0	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200	GS ACQ SCENARIO BASE1BE	Pattern 1, Exps 1-1 in Visit 53 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16483, Visit 04, completed Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

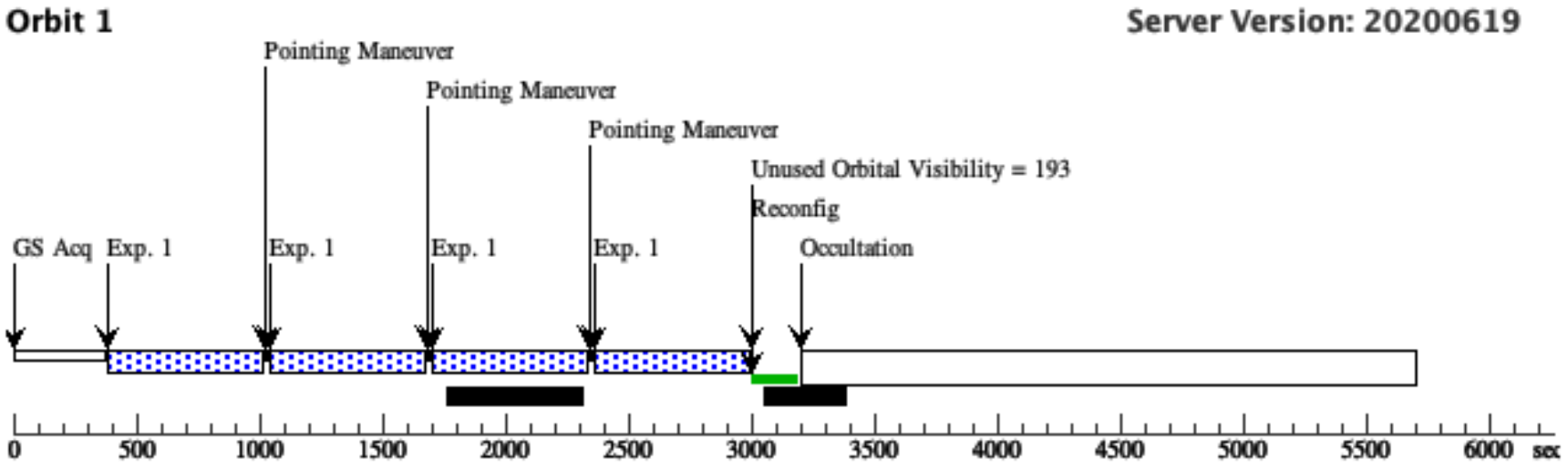
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	SDSSJ151443.07+365050.4 Alt Name1: 7C-151247.00+370154.00	RA: 15 14 43.0683 (228.6794512d) Dec: +36 50 50.36 (36.84732d) Equinox: J2000	Proper Motion RA: -4.998523195449508E-7 sec of time/yr Proper Motion Dec: 4.7E-5 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.3711	V=17.01+/-0.1 B=16.79	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=GALAXY
Description=[QUASAR]
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(4) SDSSJ151443.07+365050.4	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200		Pattern 1, Exps 1-1 in Visit 04 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure



Visit

Proposal 16483, Visit 05, completed Fri Jun 25 11:00:17 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(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)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	LAWD-52 Alt Name1: GRW+70D5824	RA: 13 38 49.2464 (204.7051933d) Dec: +70 17 7.26 (70.28535d) Equinox: J2000	Proper Motion RA: -0.07946439774064423 sec of time/yr Proper Motion Dec: -0.02460799998971197 arcsec/yr Epoch of Position: 2015.5 Radial Velocity: 26 km/sec	V=12.6+/-0.1	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=CALIBRATION
Description=[POINT SPREAD FUNCTION]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(5) LAWD-52	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=10; SAMP-SEQ=STEP200		Pattern 1, Exps 1-1 in Visit 05 (1)	599.231134 Secs (2396.925 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	*[1]*

Orbit Structure