



18047 - Disentangling the True Nature of Three Broadline-Offset & VLBA/Gaia-Offset Quasars with HST

Cycle: 33, Proposal Category: GO
(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. Peter Breiding (PI) (Contact)	State University of New York Binghamton

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) 2MASS-J09503674+5128382	ACS/WFC	1	14-Aug-2025 08:00:14.0	yes
02	(2) 2MASS-J12111399+4647120	ACS/WFC	1	14-Aug-2025 08:00:15.0	yes
03	(3) 2MASS-J12281188+5146232	ACS/WFC	1	14-Aug-2025 08:00:16.0	yes

3 Total Orbits Used

ABSTRACT

In a sample of 15,900 SDSS quasars, Eracleous et al. (2012) found 88 objects exhibiting broad emission lines with >1000 km/s velocity offsets with respect to the host galaxy rest frame. One leading hypothesis for the origin of these velocity-offset broad lines is the dynamics of a binary supermassive black hole (SMBH), with competing hypotheses of recoiling SMBH and a broad line region (BLR) gas outflow due to entrainment by a relativistic jet. Three of these quasars were also shown to have significant VLBI/Gaia offsets in follow-up VLBA observations, where recoiling SMBHs, binary SMBHs, and optical synchrotron jets are all potential causes of these offsets. We propose HST observations to test the various competing physical models for both the observed spectroscopic and astrometric offsets, requiring a total of 3 ACS/WFC + F606W orbits to achieve our science goals.

OBSERVING DESCRIPTION

These observations are focused on three quasars (all $z \sim 0.2-0.3$), where we allocate one orbit per target with ACS/WFC + F606W. The F606W filter is required for our science goals as it matches the Gaia filter used to measure the quasar radio-optical astrometric offsets. These observations require long exposures in order to maximize sensitivity to low surface brightness indicators of a previous major galaxy merger in the host galaxy of our quasar targets (this is essential to our science goals). We will use 4x438s science exposures in order to achieve 1752s of total integration time on each target. According to the online ACS Exposure Time Calculator, this will allow for 5-sigma surface brightness sensitivity limits of ~ 26 AB magnitudes per square arcsec (which should be sufficient for faint host galaxy structural analysis).

The WFC1-FIX aperture and POS TARG offset of $X=40$ arcsec and $Y=5$ arcsec (moving towards the B amplifier of the WFC1 chip) was chosen to improve charge transfer efficiency performance and lower amplifier readnoise -- allowing us the best sensitivity to faint host galaxy components which are relevant to our science goals (e.g., imaging faint tidal structures or possible faint jet structures). This strategy will also keep our quasar position far away from the chip gap during the dithers. We will use the standard ACS/WFC 4-point box dither pattern (4x438s exposures) in order to allow for a good sampling of the PSF for PSF modeling and subtraction. These exposure times may lead to saturation of a few central core PSF pixels for our quasars (note that the AB V-band magnitudes for our quasars range from $\sim 18.3-19.2$). Therefore, we also employ a short 30s exposure at the start of each orbit, allowing us to obtain a good model of the central core and inner wings of the PSF. We can use the unsaturated core pixels from the short 30s exposures to reconstruct the saturated pixels in the PSF cores of the longer dithered exposures. The short 30s exposure and the longer dithered 4x438s exposures are in "non-interruptible sequences" with the same WFC1-FIX position offsets. This will ensure that the short exposures occur at the same chip position as the first dither point (and without much time separation), allowing us to construct a PSF model for the central pixels which is very close to the PSF core sampled by the subsequent dithered exposures.

Proposal 18047 - Visit 01 - Disentangling the True Nature of Three Broadline-Offset & VLBA/Gaia-Offset Quasars with HST

Thu Aug 14 12:00:16 GMT 2025

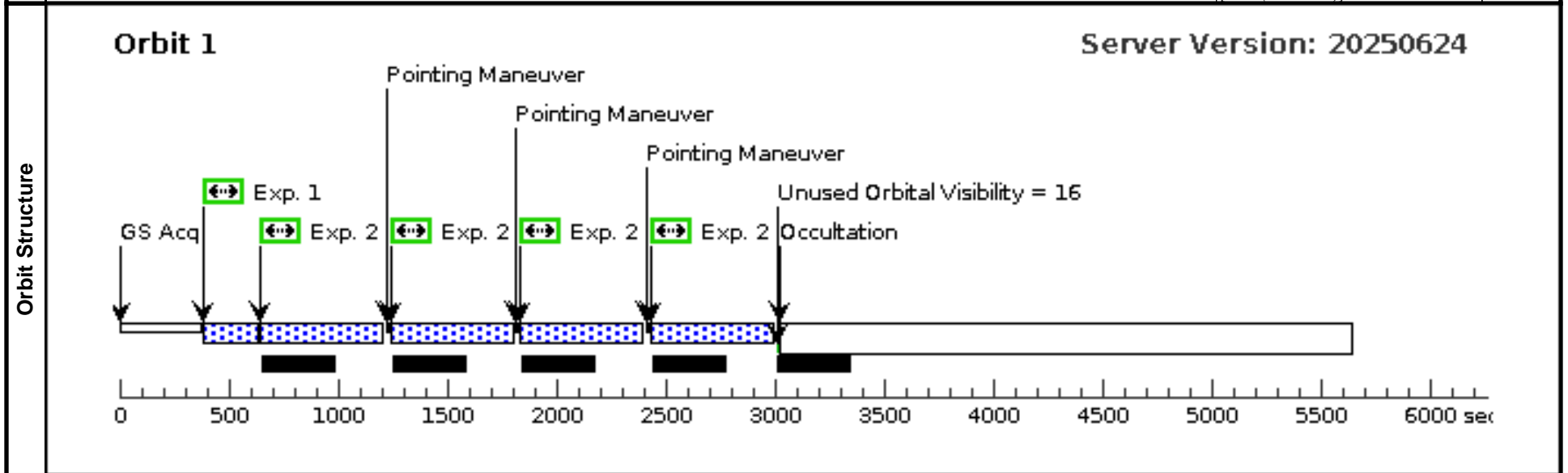
Visit	Proposal 18047, Visit 01		
	Diagnostic Status: No Diagnostics		
	Scientific Instruments: ACS/WFC		
	Special Requirements: (none)		

Patterns	#	Primary Pattern	Secondary Pattern	Exposures
	(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2637 Line Spacing=0.1856	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false	

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	2MASS-J09503674+5128382	RA: 09 50 36.7566 (147.6531525d) Dec: +51 28 38.07 (51.47724d) Equinox: J2000	Proper Motion RA: -4.388602477941542E-6 sec of time/yr Proper Motion Dec: 8.39E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.214	V=18.34	Reference Frame: SIMBAD

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

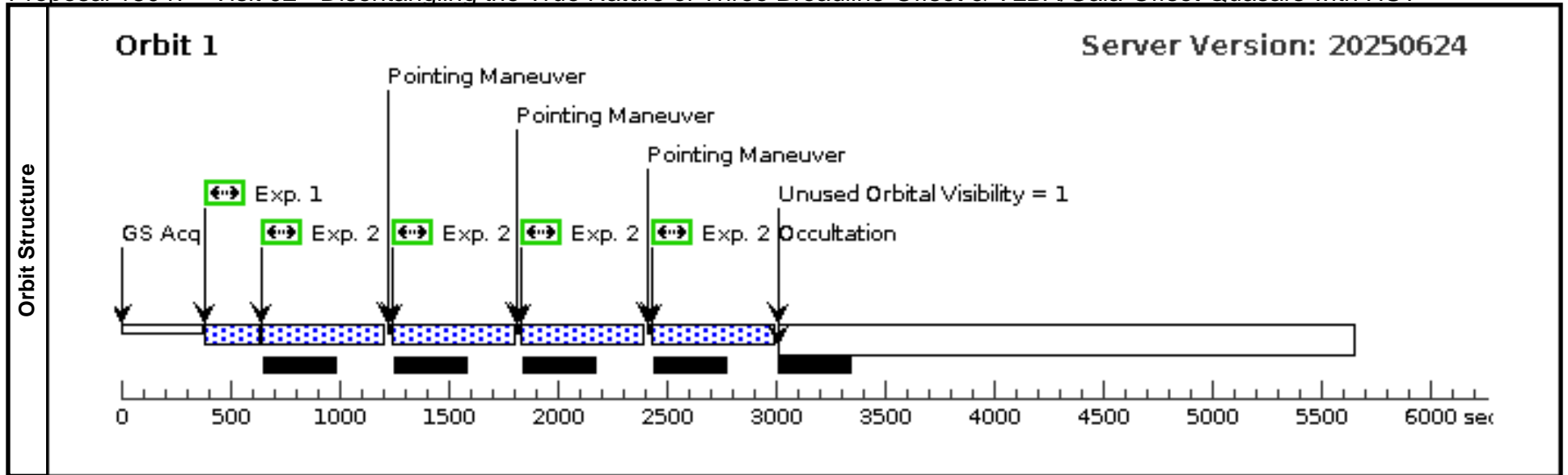
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) 2MASS-J09503674+5128382	ACS/WFC, ACCUM, WFC1-FIX	F606W			POS TARG 40,5	Sequence 1-2 Non-Int in Visit 01	30 Secs (30 Secs) [==>]
2		(1) 2MASS-J09503674+5128382	ACS/WFC, ACCUM, WFC1-FIX	F606W			POS TARG 40,5	Sequence 1-2 Non-Int in Visit 01 Pattern 1, Exps 2-2 in Sequence 1-2 Non-Int in Visit 01 (1)	438 Secs (1752 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]



Proposal 18047 - Visit 02 - Disentangling the True Nature of Three Broadline-Offset & VLBA/Gaia-Offset Quasars with HST

Thu Aug 14 12:00:16 GMT 2025

Visit	Proposal 18047, Visit 02 Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)										
	Patterns	#	Primary Pattern				Secondary Pattern				Exposures
(1)		Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2637 Line Spacing=0.1856		Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false						(2)	
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(2)	2MASS-J12111399+4647120	RA: 12 11 13.9824 (182.8082600d) Dec: +46 47 11.98 (46.78666d) Equinox: J2000		Proper Motion RA: -1.8499131969291317E-6 V=19.02 sec of time/yr Proper Motion Dec: 1.21E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.295				Reference Frame: SIMBAD		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=GALAXY Description=[QSO] Extended=YES											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	guard	(2) 2MASS-J12111399+4647120	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 40,5	Sequence 1-2 Non-Int in Visit 02	30 Secs (30 Secs)		
2		(2) 2MASS-J12111399+4647120	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 40,5	Sequence 1-2 Non-Int in Visit 02	438 Secs (1752 Secs)		[1]	
								Pattern 1, Exps 2-2 in Sequence 1-2 Non-Int in Visit 02 (1)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]		[1]



Proposal 18047 - Visit 03 - Disentangling the True Nature of Three Broadline-Offset & VLBA/Gaia-Offset Quasars with HST

Thu Aug 14 12:00:16 GMT 2025

Visit	Proposal 18047, Visit 03 Diagnostic Status: No Diagnostics Scientific Instruments: ACS/WFC Special Requirements: (none)									
	Patterns	#	Primary Pattern			Secondary Pattern			Exposures	
		(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.2637 Line Spacing=0.1856	Coordinate Frame=POS-TARG Pattern Orientation=20.7 Angle Between Sides=69.02 Center Pattern=false						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(3)	2MASS-J12281188+5146232	RA: 12 28 11.8876 (187.0495317d) Dec: +51 46 22.78 (51.77299d) Equinox: J2000	Proper Motion RA: -3.361460077475965E-5 sec of time/yr Proper Motion Dec: 6.850000000000001E-4 arcsec/yr Epoch of Position: 2015.5 Redshift: 0.321	V=19.15	Reference Frame: SIMBAD				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[QSO] Extended=YES									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	guard	(3) 2MASS-J12281188+5146232	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 40,5	Sequence 1-2 Non-Int in Visit 03	30 Secs (30 Secs) [==>]	[1]
	2		(3) 2MASS-J12281188+5146232	ACS/WFC, ACCUM, WFC1-FIX	F606W		POS TARG 40,5	Sequence 1-2 Non-Int in Visit 03 Pattern 1, Exps 2-2 in Sequence 1-2 Non-Int in Visit 03 (1)	438 Secs (1752 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]

