



13015 - WPVS 007: Acceleration or Evolution in a Broad Absorption Line Outflow

Cycle: 20, 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) QSO-003916-511701	COS/FUV COS/NUV	2	11-Jul-2012 01:17:06.0	yes
02	(1) QSO-003916-511701	COS/FUV COS/NUV	2	11-Jul-2012 01:17:16.0	yes

4 Total Orbits Used

ABSTRACT

Outflowing gas, recognised through broad absorption lines, is an important component of AGN and quasars. Outflows remove angular momentum, enrich the intergalactic medium, and possibly play a key role in the evolution of galaxies. Yet outflow astrophysics remains poorly understood. Absorption line variability is a potentially valuable too, offering constraints on distance from the continuum emission region, density, and homogeneity and stability of the outflow.

Dramatic absorption-line variability has been observed in the Seyfert-luminosity AGN WPVS 007 ($M_V = -19.7$, $z = 0.02882$). Observed to have a miniBAL with maximum velocity $v_{\text{max}} \sim 1000$ km/s in an 1996 HST observation, it was discovered to have developed an additional BAL flow by the time of the FUSE observation in 2003. The BAL flow had a maximum velocity of 6,000 km/s, and the unambiguous presence of PV indicated that it is very optically thick. A third observation by HST COS in 2010 shows further dramatic variability, a shift of the BAL to higher velocities of $\sim 8,000$ km/s. Yet the absorption profile is similar to that observed in 2003, suggesting acceleration.

We propose two COS observations designed to reveal the origin of the dramatic variability in WPVS 007. WPVS 007 is an extreme object, but it may be key to understanding outflows, since its low luminosity for such a high-velocity outflow challenges acceleration mechanisms, and its small size means that we may be able to see, on human time scales, phenomena important in all quasars.

OBSERVING DESCRIPTION

We were awarded two observations of WPVS 007 using COS in the FUV channel with the G140L grating that should be separated by an interval of 6 to 10 months. We observed this object in 2010 as part of a Cycle 17 proposal, and we have been monitoring it with Swift UVOT since 2005. We base the exposure time estimates on these data.

PROPERTIES OF WPVS 007:

The reddening of our Galaxy in the direction of WPVS 007 is 0.012 mag. The redshift is $z = 0.02882$. The GSC II states that the best optical magnitude is 13.6. This, however, is the integrated magnitude for the galaxy which is resolved at this redshift. A better estimate for the AGN is $V = 15.3$, based on Swift UVOT monitoring. We estimate an uncertainty in this value of 0.5 due to AGN variability. A more relevant flux would be the continuum flux observed at 1500 Angstroms

of $F(\lambda)=1.0e-14 \text{ erg/s/cm}^2/\text{\AA}$ from our 2010 COS observation. But we also have a large amount of Swift monitoring data. Our 2010 HST COS observation was made when the objects was near a maximum; the magnitude in the UVW2 filter (central wavelength=1928 Angstroms) was 14.3. The historical maximum and minimum from our monitoring data (beginning in 2005 and continuum through March 2012) are 14.16 and 14.88. Recently, it has been fainter (UVW2=14.77). So we will investigate flux densities in the range $3.0e-15$ to $1.0e-14 \text{ erg/s/cm}^2/\text{\AA}$.

The brightest line in the FUV is Lyalpha, and it will be present in the spectrum for CENWAVE=1105. Using an approximate spectral model based on the FOS spectrum of WPVS 007, but renormalizing it to the flux observed during the 2010 COS observation, we find that the brightest pixel (at Lyalpha) attains a count rate of only 0.09 counts/s (COS.sp.416496).

OBSERVATION DETAILS:

Two observations of the object were awarded. There are no coordinated observations so the first observation can be done at any time. We request that the second observation be done between 6 and 10 months after the first. WPVS 007 has an RA of 00:40, so it is in a restricted RA region of the sky. However, because of its large declination (-51), it has very good visibility. In addition, the exposures that we request are short (two orbits per visit), so we expect that it will not be extremely difficult to schedule.

The principal lines of interest are PV, SiIV, and CIV. For this object, with $z=0.02882$ and maximum blueshift velocity of the line of approximately 11,000 km/s, these lines span 1111-1153, 1387-1440, and 1536-1594 Angstroms respectively. All settings described below will partially or completely cover these wavelength ranges.

We conduct the observations differently than we did in 2010 in order to obtain better wavelength coverage and to account for different central wavelength availability (the 2010 observation was done using CENWAVE=1230). After acquisition, we will devote the remainder of the first orbit in each visit to CENWAVE=1280. We do not expect to attain extremely high signal to noise ratios for this object, so we will use two FP-POS only. We will use FP-POS=2 and FP-POS=3. Segment B will be left on as it will cover PV.

The second orbit in each visit will use CENWAVE=1105. This time we will use FP-POS=3 and FP-POS=4. These FP-POS are chosen to provide short wavelength coverage, and FP-POS=4 should cover PV completely.

AQUISITION:

WPVS007 is in the GSC2 and therefore it has ICRS coordinates with positional uncertainties of 0.3 arc seconds in RA and 0.33 arcseconds in dec. These uncertainties are less than the nominal value of 0.4, and therefore we do not have to do a ACQ/SEARCH. Rather, we will start with an ACQ/IMAGE to acquire the object.

The flux density of the object was $\sim 1.0e-14$ erg/s/cm²/A during the

2010 COS observation, and the spectrum was approximately flat.

However, our long-term Swift lightcurve shows that it was in a relatively bright state during that observation, and 6 months later it was a factor of ~ 3 fainter. So we will assume a flux density range of $0.3\text{--}1.0\text{e-}14$ erg/s/cm²/Å account for variability. The COS Instrument handbook Figure 8.3 indicates that we can use the PSA aperture and MIRRORB for this flux, and Table 8.3 indicates that we need a S/N of 40. Assuming a flat spectrum and a flux density of $3.0\text{e-}15$ erg/s/cm²/Å, we use the COS ETC to determine the exposure time, finding that 52 seconds will be adequate to produce the required S/N=40 (Table 8.3; COS.ta.416441). We increase that value to 100 seconds.

The APT BOT estimates that the object should be too bright for this acquisition. This is because the conservative assumptions made by the BOT are not appropriate for this target. First, it uses the magnitude given in the GSC2 of 13.6. That is the magnitude for the galaxy, which is resolved at this redshift, rather than the target, which has a magnitude closer to 15.3. Second, it assumes a OV star spectrum, whereas the object is a modestly reddened AGN, nearly flat in Flambda between 1000 and 6626 Angstroms. The continuum flux level is about $0.3\text{--}1.0\text{e-}14$ erg/s/cm²/Å at 1500 Angstroms.

SCIENCE EXPOSURES:

All exposures are chosen to be TIME-TAG and FLASH is set to Yes.

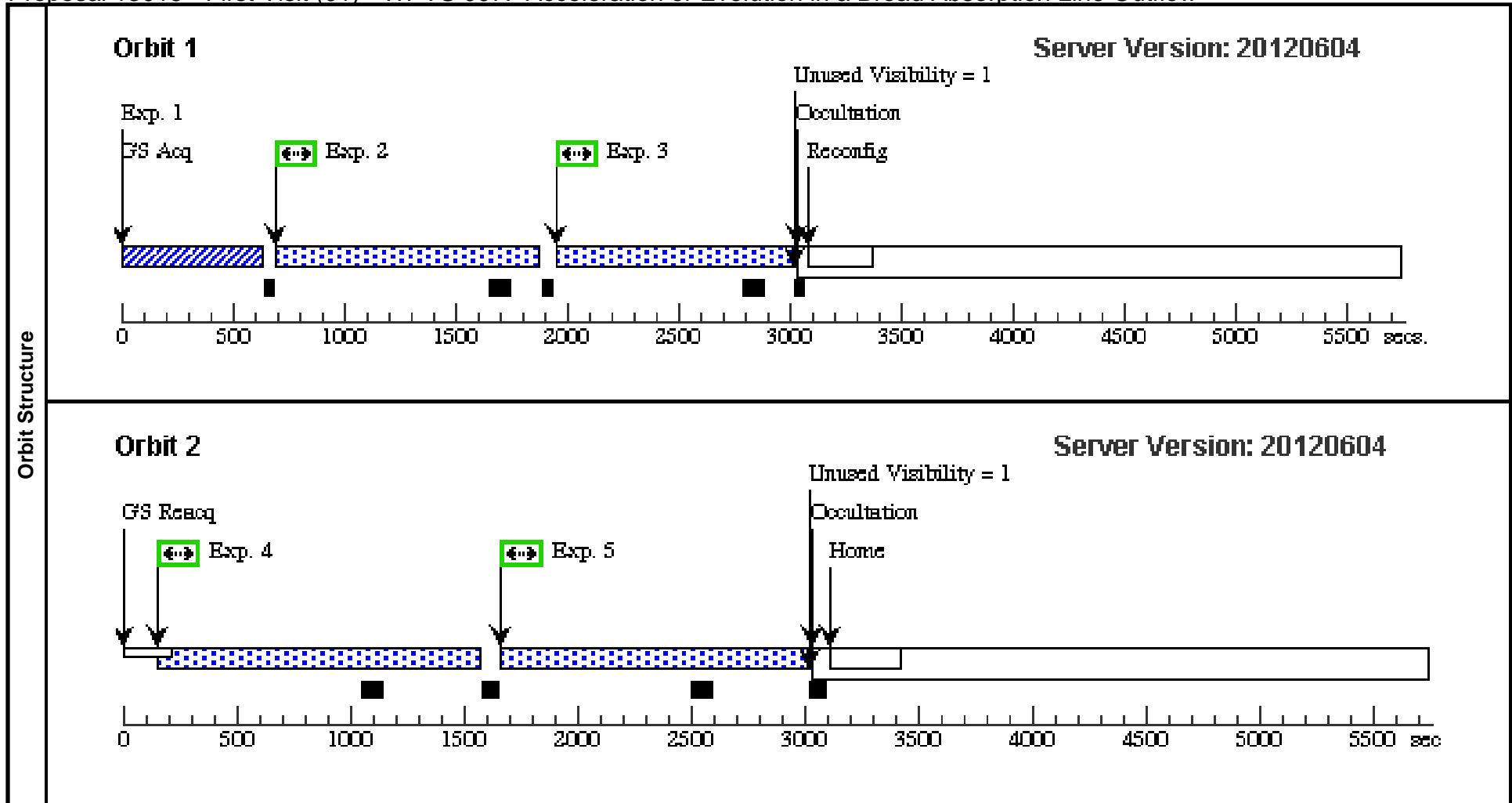
For each visit, the remainder of the first orbit will be divided into two exposures using CENWAVE=1280 using FP-POS=2 and FP-POS=3. The

exposure time for each of these exposures is 1008s. For a flux density of 1.0×10^{-14} erg/s/cm²/Å, the COS ETC gives a buffer time of 5245s. We conservatively set the buffer time to 800 seconds for each. The second orbit is divided into two exposures using CENWAVE=1105 using FP-POS=3 and FP-POS=4. The buffer time is the same for this setting, and so we use again a buffer time of 800s.

Proposal 13015 - First Visit (01) - WPVS 007: Acceleration or Evolution in a Broad Absorption Line Outflow

Wed Jul 11 05:17:24 GMT 2012

Visit	Proposal 13015, First Visit (01) Diagnostic Status: Warning Scientific Instruments: COS/NUV, COS/FUV Special Requirements: SCHED 100%									
	Diagnostics	(First Visit (01)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE. (First Visit (01)) Warning (Form): For the best data quality, it is strongly recommended that all four FP-POS positions be used when observing at a given COS CENWAVE setting.								
Fixed Targets		#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	QSO-003916-511701 Alt Name1: WPVS007 Alt Name2: GSC1ID0803000885	RA: 00 39 15.8290 (9.8159542d) Dec: -51 17 1.41 (-51.28373d) Equinox: J2000	Redshift: 0.02882	V=15.3+/-0.5	Reference Frame: ICRS F(lambda)=0.3-1.0e-14 at 1500 Angstroms (> 7 years of Swift monitoring and 2010 HST COS spectrum)				
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	WPVS007 ACQ/IMAG E (416441)	(1) QSO-003916-511 701	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				100 Secs [==>]	[1]
	2	WPVS007 1 280 FP-POS =2 (416450)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=2; SEGMENT=BOTH			1008 Secs [==>]	[1]
	3	WPVS007 1 280 FP-POS =3 (416450)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=3; SEGMENT=BOTH			1008 Secs [==>]	[1]
	4	WPVS007 1 105 FP-POS =3 (416471)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=3			1295 Secs [==>]	[2]
	5	WPVS007 1 105 FP-POS =4 (416471)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=4			1295 Secs [==>]	[2]



Proposal 13015 - Second Visit (02) - WPVS 007: Acceleration or Evolution in a Broad Absorption Line Outflow

Wed Jul 11 05:17:27 GMT 2012

Visit	Proposal 13015, Second Visit (02) Diagnostic Status: Warning Scientific Instruments: COS/NUV, COS/FUV Special Requirements: SCHED 100%; AFTER_01 BY 180 D TO 300 D									
	(Second Visit (02)) Warning (Form): For the best data quality, it is strongly recommended that all four FP-POS positions be used when observing at a given COS CENWAVE setting. (Second Visit (02)) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	QSO-003916-511701 Alt Name1: WPVS007 Alt Name2: GSC1ID0803000885	RA: 00 39 15.8290 (9.8159542d) Dec: -51 17 1.41 (-51.28373d) Equinox: J2000	Redshift: 0.02882	V=15.3+/-0.5 F(lambda)=0.3-1.0e-14 at 1500 Angstroms (> 7 years of Swift monitoring and 2010 HST COS spectrum)	Reference Frame: ICRS				
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	WPVS007 ACQ/IMAG E (416441)	(1) QSO-003916-511 701	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				100 Secs [==>]	[1]
	2	WPVS007 1 280 FP-POS =2 (416450)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=2; SEGMENT=BOTH			1008 Secs [==>]	[1]
	3	WPVS007 1 280 FP-POS =3 (416450)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=3; SEGMENT=BOTH			1008 Secs [==>]	[1]
	4	WPVS007 1 105 FP-POS =3 (416471)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=3			1295 Secs [==>]	[2]
	5	WPVS007 1 105 FP-POS =4 (416471)	(1) QSO-003916-511 701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=80 0; FLASH=YES; FP-POS=4			1295 Secs [==>]	[2]

