15984 - Time-resolved UV spectroscopy of the accretion disk and wind in a super-Eddington black-hole X-ray transient

Cycle: 26, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

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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) SWIFTJ1858.6-0814	COS/FUV COS/NUV	2	24-Jul-2019 18:01:56.0	yes
02	(1) SWIFTJ1858.6-0814 (2) BLIND-OFFSET-STAR	STIS/CCD STIS/NUV-MAMA	1	24-Jul-2019 18:01:57.0	yes

3 Total Orbits Used

ABSTRACT

In October 2018, Swift announced the discovery of a new Galactic X-ray transient, Swift J1858. Just before Sun-angle constraints rendered the system unobservable, follow-up observations revealed extreme flaring activity, of a kind that has so far only been seen in the famous black hole X-ray binary (BHXRB) V404 Cyg during its 2015 eruption and in V4641 Sgr. The peculiar behaviour of these sources is thought to be a consequence of super-Eddington accretion regime.

After several months of unusual strong and rapid flaring in its high-luminosity state, Swift J1858 is currently exhibiting impressive optical P-Cygni profiles, suggesting the pres- ence of a dense and cool wind from the outer accretion disk. The dominant spectroscopic signatures of such winds are actually expected to lie in the far-ultraviolet region, but they are usually inaccessible in black-hole X-ray binaries, due to interstellar reddening. Given its low extinction, Swift J1858 provides us with a rare chance to study the accretion disk wind in the crucial ultraviolet band - an opportunity that was

missed in the other two systems.

Building on an ongoing multi-wavelength campaign (X-rays: NICER; optical: GTC; radio: VLA & AMI), we therefore request far- and near-UV time-resolved spectroscopic observations of this system with HST/STIS+COS in order to (a) study its extreme accretion disk wind; (b) test proposed wind driving mechanisms; (c) characterize its UV variability properties and determine the origin of these variations; (d) construct the broad-band SED of the outer accretion disk that dominates the UV flux; and (e) determine the extinction towards the system in order to constrain the mass accretion rate.

OBSERVING DESCRIPTION

This visit willl consist of 3 HST orbits spread over single 2 visits, 2 orbits using the COS and 1 orbit with STIS.

For the exposure calculations we used the known reddening towards the line of sight, E(B-V)=0.25 mag. From the most recent Swift/UVOT observation, performed on 2019 June 11 with the UVW2 filter (1928 A) we measure a NUV continuum flux of 1.7E-15 erg/s/cm2/A. Following based on the swift UVOT broad band photometry in the UV filters, we model our point source with a flat spectrum in F_lambda space normalized at 1928 Angstroms.

During one visit (2 orbits) we will perform the FUV spectroscopic observation with COS/140L instrument/grating combination, in TIME-TAG mode. The resolving power of the low-resolution grating is sufficient to resolve the expected ionized emission lines as these have typical widths of ~10 A in LMXBs. We will use the 1105 A setting that provides continuous coverage between 1121-2148 A segment A, while segment B is switched off. With this setup, a S/N~13 will be reached in the whole FUV observation (OS.sp.1366685). We will bee using different FP-POS positions to reduce fixed-pattern noise and to minimize long-term gain sag. The source position is accurately known (to within 0.06 arcsec from Pan-STARRS DR1; Chambers et al. 2016), so target aquisition can be performed using ACQ/IMAGE (a S/N of ~30 is expected with the exposure time we have adopted; COS.ta.1370120). We also checked the worst and best case scenarios for our source based on the long term UV light curve, there is no safety concerns for COS detectors in ACQ/IMAGE nor 140L (COS.ta.1370166, COS.sp.1370172 in the lower observed flux and COS.ta.1370169, COS.sp.1370175 for the maximoum observed flux). In the worst case scenario the S/N =17 is predicted for the ACQ/IMAGE.

During the other visit (1 orbit) we will carry out time-resolved NUV TIME-TAG spectroscopy with the STIS/NUV-MAMA/G230L instrument/grating combination. We will use the 2376 A setting for these observations, allowing us to achieve continuous wavelength coverage

between 1570 A and 3180 A, with the 52x0.2 slit. There are no safety concerns for the STIS detectors (STIS.ta.1370183 and STIS.sp.1370190). In the NUV, ongoing Swift/UVOT monitoring observations show that the system is nowhere near bright enough to threaten deetector damage (STIS.sp.1370049). We will use an imaging target aquisition with mirror B as the best compromise between efficency and instrument safety. With this set-up, a 0.9 ACQ/IMAGE target aquisition exposure with the CCD and the 50 CCD aperture yelds S/N~40 (STIS.ta.1369901). In the worst case scenario a S/N~23 will be reached by the ACQ/IMAGE (STIS.ta.1370177).

We note that our target (a black hole binary in super-Eddington regime) is currently in an active state, confirmed by NICER observation taken by July 21, long term monitoring UVOT monitoring of the current outburst (lasting for ~8 months) did never become observed brigther than ~ 8E-15 erg/s/cm2/A at 1928 A. Therefore, there is no risk that our target wll suddently become brighter.

Notes with regard to scheduling:

Our target has been active for ~8 months at the time of submitting this phase 2 proposal (ATel #12151). It is regularly monitored by Swift at UV/optical and also by NICER at X-ray wavelengths. The current state of the source as of July 21 is reported to be still flaring in X-Rays, consistent with its behaviour over the last few months (i.e. the behaviour when optical winds have being observed). However, the presence of these optical winds are thought to drain the material from the accretion disk in short time scales (weeks-months; Munoz-Darias et al. 2016). For this reason it would be highly desirable to schedule the observations as soon as can be accommodated within the HST constraints.

In order to maximise the scientific return, we will also carry out a multi-wavelength campaign of the source, from X-rays to radio, to accompany the HST ultraviolet data with (near-)simultaneous observations in other bands. In this campaign, we expect to use several 10 meter class optical telescopes and radio facilities (VLT, GEMINI, GTC, VLA, GMRT, ATCA, AMI and probably ALMA and MeerKAT). If the HST observations can start 24 UT time, that would be ideal for allowing strictly simultaneous continuous (spectroscopic) coverage from 1100 A down to 2.2 microns from the optical side and from mm down to 150MHz in the radio.

Concerning the scheduling of the 2 visits (2 orbits using the COS and 1 using STIS), as mentioned in phase I, it would be preferred to schedule the visits back to back. This is because black hole X-ray binaries can display significant intrinsic variability on a time scale of days-weeks.

Visit

Proposal 15984, COS_FUV (01), implementation Wed Jul 24 22:01:58 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SWIFTJ1858.6-0814	RA: 18 58 34.8932 (284.6453883d) Dec: -08 14 14.94 (-8.23748d) Equinox: J2000		V=16.85+/-0.18 1.922689 +/- 0.12 x 10^-15 erg s/s/cm^2/A at 1928A (Swift/UV OT UW2) on June 11th	Reference Frame: ICRS

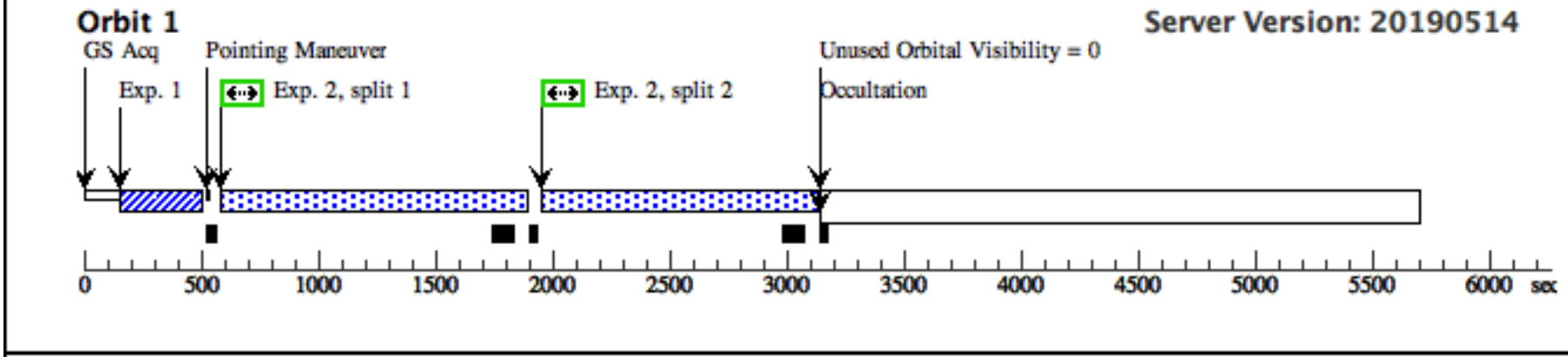
Comments: V mag is in AB system, taken on June 11th

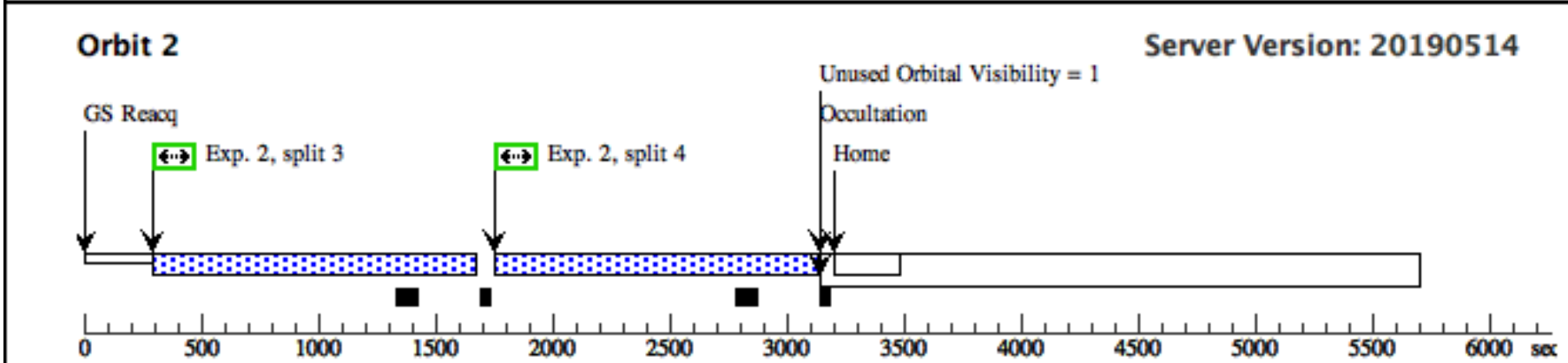
The position is from Pan-STARRS DR1
Category=STAR
Description=[ACCRETION DISK, JET, X-RAY NOVAE, X-RAY TRANSIENT]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1370120)	(1) SWIFTJ1858.6-0814	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				30 Secs (30 Secs) *[==>]*	*[1]*
Comments: No blind offset required, because the target is the brightest NUV target in the field (confirmed in recent Swift images)									
2	(COS.sp.1366685)	(1) SWIFTJ1858.6-0814	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=1000; FP-POS=ALL			1050 Secs (4908 Secs) *[==>1127.0 Secs (Split 1)]* *[==>1127.0 Secs (Split 2)]* *[==>1327.0 Secs (Split 3)]* *[==>1327.0 Secs (Split 4)]*	*[1]* *[2]*

Orbit Structure





Visit

Proposal 15984, STIS_NUV (02), implementation Wed Jul 24 22:01:58 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SWIFTJ1858.6-0814	RA: 18 58 34.8932 (284.6453883d) Dec: -08 14 14.94 (-8.23748d) Equinox: J2000		V=16.85+/-0.18 1.922689 +/- 0.12 x 10^-15 erg s/s/cm^2/A at 1928A (Swift/UV OT UW2) on June 11th	Reference Frame: ICRS

Comments: V mag is in AB system, taken on June 11th

The position is from Pan-STARRS DR1
Category=STAR
Description=[ACCRETION DISK, JET, X-RAY NOVAE, X-RAY TRANSIENT]
Extended=NO

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	BLIND-OFFSET-STAR	RA: 18 58 38.2868 (284.6595283d) Dec: -08 14 43.56 (-8.24543d) Equinox: J2000	Proper Motion RA: 0.98 mas/yr Proper Motion Dec: 0.60 mas/yr Parallax: 0.0007" Epoch of Position: 2015	V=15.5+/-0.5	Reference Frame: ICRS

Comments:
Category=STAR
Description=[G V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ_NUV (STIS.ta.1371234)	(2) BLIND-OFFSET-STAR	STIS/CCD, ACQ, 50CCD	MIRROR				0.3 Secs (0.3 Secs) *[==>]*	 ***[1]***
Comments: Acqusition of the offset star from which we will slew to the target.									
2	(STIS.sp.1366688)	(1) SWIFTJ1858.6-0814	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=580			1000 Secs (2208 Secs) *[==>2208.0 Secs]*	 ***[1]***

Orbit Structure