17279 - Benchmarking the first bona fide extragalactic X-ray faint massive black-hole binary

Cycle: 30, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Tomer Shenar (PI) (ESA Member) (Contact)	**Universiteit van Amsterdam**
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Dr. Kareem El-Badry (CoI) (AdminUSPI)	California Institute of Technology
Dr. Laurent Mahy (CoI) (ESA Member)	Institute of Astronomy, KU Leuven
Pablo Ignacio Marchant Campos (CoI) (ESA Member)	Institute of Astronomy, KU Leuven
Dr. Norbert Langer (CoI) (ESA Member)	Universitat Bonn, Argelander Institute for Astronomy
Dr. Julia Bodensteiner (CoI) (ESA Member)	European Southern Observatory - Germany

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) 2MASS-J05380840-6909190	COS/FUV COS/NUV	1	20-Jul-2023 17:00:21.0	yes
02	(1) 2MASS-J05380840-6909190	COS/FUV COS/NUV	1	20-Jul-2023 17:00:23.0	yes
03	(1) 2MASS-J05380840-6909190	COS/FUV COS/NUV	1	20-Jul-2023 17:00:25.0	yes

3 Total Orbits Used

ABSTRACT

We propose to secure two phase-resolved HST/COS UV spectra of VFTS 243: the only known X-ray faint binary hosting a black hole outside our Milky Way. VFTS 243, a 10-d period binary residing in the Large Magellanic Cloud, was recently reported (July 2022, Nature Astronomy) to comprise a 25Msun O-type primary and a black hole that weighs at least 9Msun. Unlike all other extragalactic black holes known, the black hole in VFTS 243 is X-ray quiet. VFTS 243, which received wide media coverage, thus provides us with a laboratory to study black hole formation, supernova physics, and wind accretion in an uncharted parameter domain. With only two orbits of UV spectroscopy, we will: (1) establish the wind properties of the O-type primary, which is crucial for understanding the lack of X-rays in the system; (2) ensure that no hot companion is hidden in the spectrum; (3) investigate whether the atmosphere of the primary is polluted by material from a previous mass-transfer or explosion event, and (4) study the interaction between the black hole and the stellar wind in an X-ray faint black hole binary. These investigations will shed light on the formation process of black holes at sub-solar metallicity and on accretion physics, with implications on gravitational-wave astronomy and supernova physics.

OBSERVING DESCRIPTION

We aim to obtain UV spectra with the G130M (1222 & 1291) and G160M(1623) gratings of the O+black-hole binary VFTS 243 at two distinct orbital phases:

- Phase ~0.32 or ~0.82 (RV extreme)
- Phase ~0.07 (black hole in front of O star)

The spectra should cover the range ~1100-1800Ang, with an S/N of 5-10 in @ 1500Ang per resolution element.

Visit

Proposal 17279, Visit 01, completed Thu Jul 20 21:00:26 GMT 2023

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 10.4031 D AND ZERO-PHASE HJD2454870.6996801454

Comments: Visit at RV extreme, phases 0.32 or 0.82.
Current time requirement set for phase interval 0.72 - 0.92 (RV extreme is at ~0.82)
However, the interval 0.22 - 0.42 would work equally well.

Diagnostics

(Visit 01) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions when observing at a given COS cenwave. See the COS Instrument Handbook for exceptions that may apply to observations with G130M/1291 or G160M.

(Visit 01) Warning (Orbit Planner): COS EXPOSURE TIME ROUNDED DOWN TO NEAREST 0.1 SECONDS

Fixed Targets

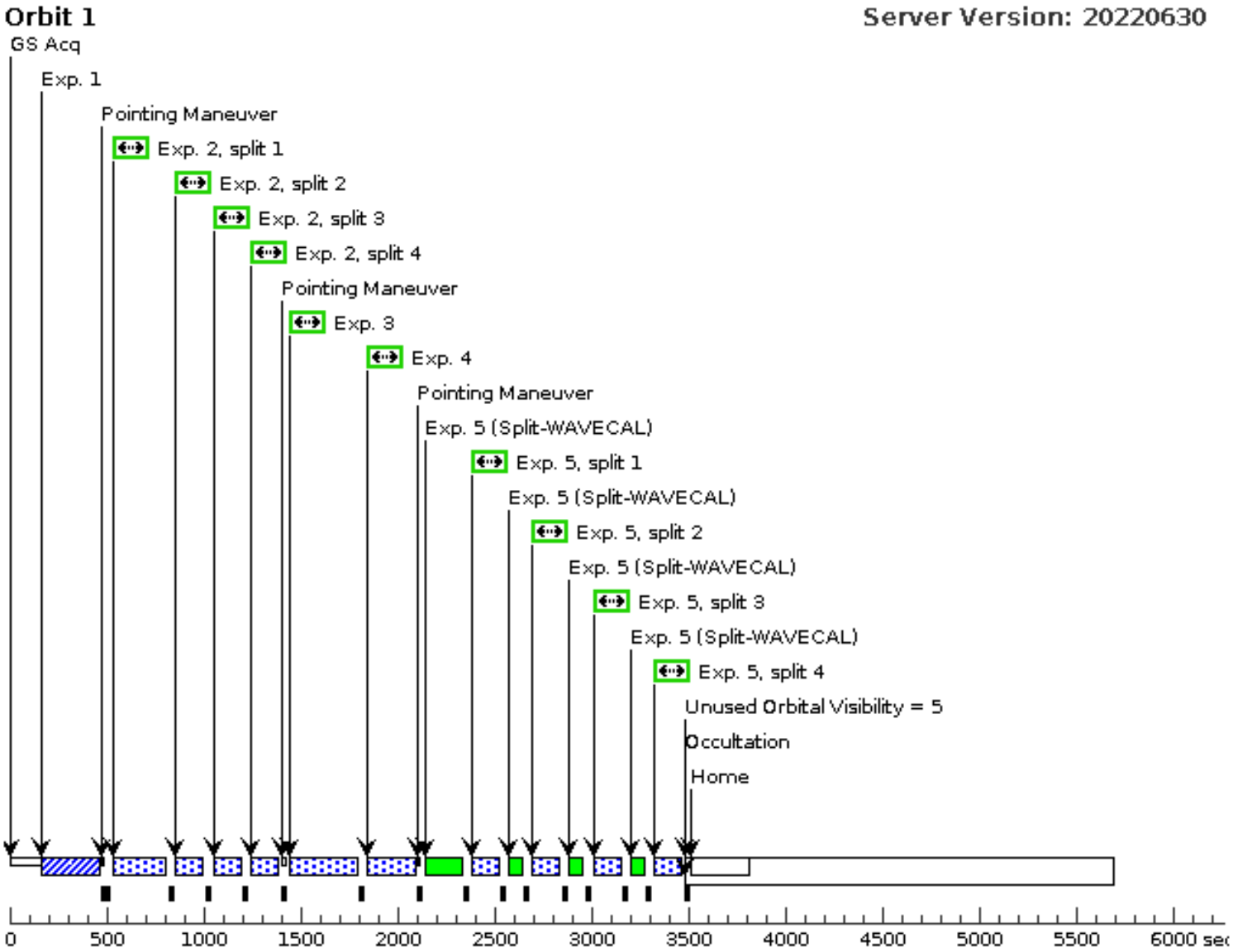
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J05380840-6909190	RA: 05 38 8.4067 (84.5350279d) Dec: -69 09 18.98 (-69.15527d) Equinox: J2000	Proper Motion RA: 3.226199123727453E-4 sec of time/yr Proper Motion Dec: 6.03E-4 arcsec/yr Epoch of Position: 2015.5	V=15.26 UIT_B1 flux [cgs/A]= 8.79E-15 @ lam =1521 Ang	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[MAIN SEQUENCE O]
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.1836414)	(1) 2MASS-J05380840-6909190	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		PHASE 0.72 TO 0.92		6.0884 Secs (6.088 Secs) *[==>]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run.								
2	(COS.sp.1836417)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=ALL; BUFFER-TIME=5938			300 Secs (356 Secs) *[==>89.0 Secs (Split 1)]* *[==>89.0 Secs (Split 2)]* *[==>89.0 Secs (Split 3)]* *[==>89.0 Secs (Split 4)]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run. *ExpTime ~ 370/4 ~ 90sec per subexposure for S/N ~5 at 1300Ang*								
3	(COS.sp.1836418)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=5959			600 Secs (199 Secs) *[==>199.0 Secs]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Adopted extinction: EBV = 0.54 (at RV=3.1) *ExpTime ~ 400/2 sec for S/N ~5 at 1350Ang* *Split into FP-POS 3 & 4 (exposures 3 & 4)*								
4	(COS.sp.1836418)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=5959			600 Secs (199 Secs) *[==>199.0 Secs]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Adopted extinction: EBV = 0.54 (at RV=3.1) *ExpTime ~ 400/2 sec for S/N ~5 at 1350Ang* *Split into FP-POS 3 & 4 (exposures 3 & 4)*								
5	(COS.sp.1836411)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=ALL; BUFFER-TIME=5938			300 Secs (356 Secs) *[==>89.0 Secs (Split 1)]* *[==>89.0 Secs (Split 2)]* *[==>89.0 Secs (Split 3)]* *[==>89.0 Secs (Split 4)]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run. *ExpTime ~ 370/4 ~ 90sec per subexposure for S/N ~5 at 1500Ang*								

Orbit Structure



Visit

Proposal 17279, Visit 02, failed

Thu Jul 20 21:00:26 GMT 2023

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 10.4031 D AND ZERO-PHASE HJD2454870.6996801454

Comments: Visit at conjunction, black hole in front of primary (phi = 0.0645)

Diagnostics

(Visit 02) Warning (Orbit Planner): COS EXPOSURE TIME ROUNDED DOWN TO NEAREST 0.1 SECONDS

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

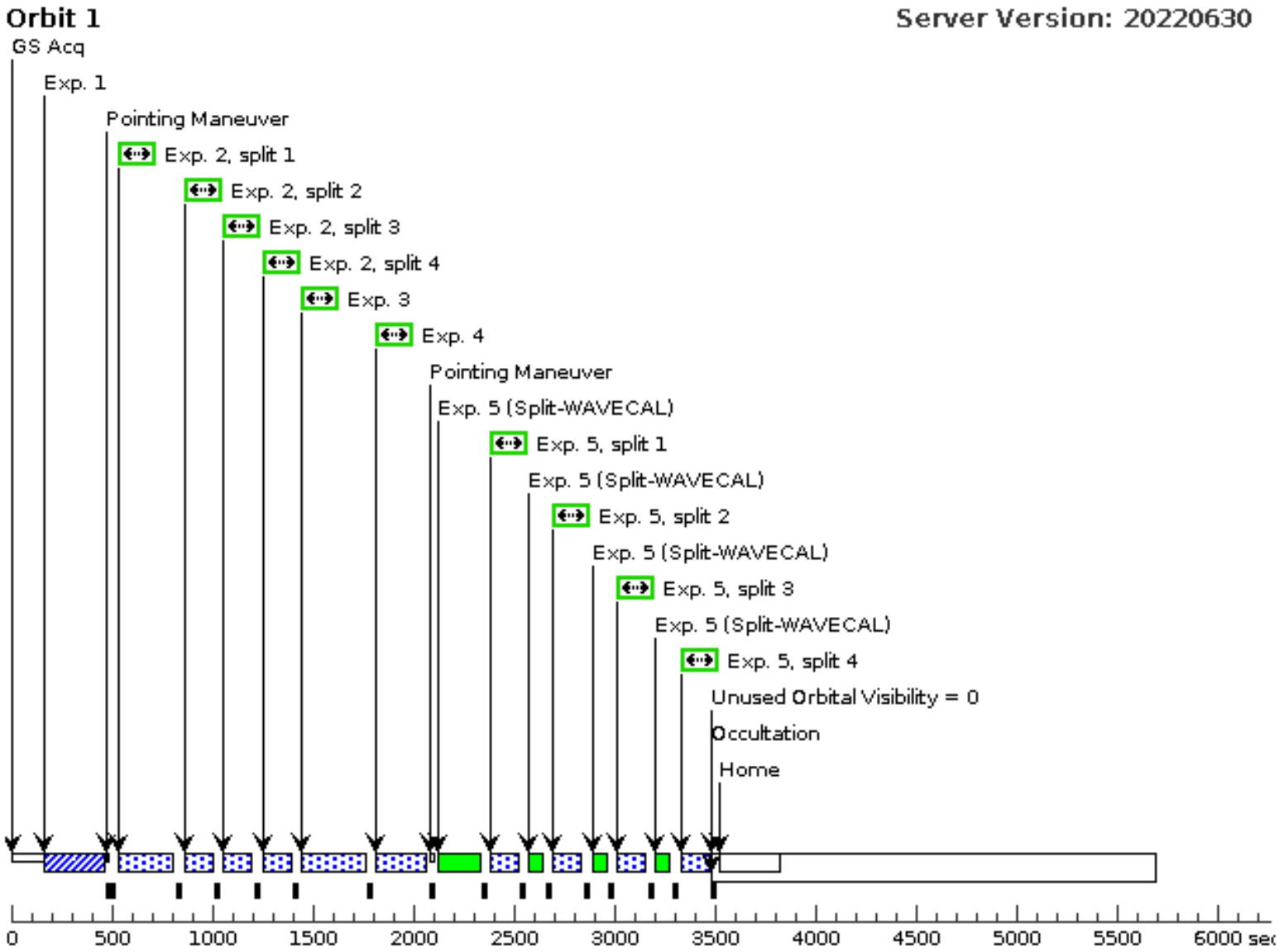
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2MASS-J05380840-6909190	RA: 05 38 8.4067 (84.5350279d) Dec: -69 09 18.98 (-69.15527d) Equinox: J2000	Proper Motion RA: 3.226199123727453E-4 sec of time/yr Proper Motion Dec: 6.03E-4 arcsec/yr Epoch of Position: 2015.5	V=15.26 UIT_B1 flux [cgs/A]= 8.79E-15 @ lam =1521 Ang	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[MAIN SEQUENCE O]
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.1836414)	(1) 2MASS-J05380840-6909190	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		PHASE 0.96 TO 0.16		6.0884 Secs (6.088 Secs) *[==>]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run.								
2	(COS.sp.1836417)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=ALL; BUFFER-TIME=5938			300 Secs (360 Secs) *[==>90.0 Secs (Split 1)]* *[==>90.0 Secs (Split 2)]* *[==>90.0 Secs (Split 3)]* *[==>90.0 Secs (Split 4)]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run. *ExpTime ~ 370/4 ~ 90sec per subexposure for S/N ~5 at 1300Ang*								
3	(COS.sp.1836418)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=3; BUFFER-TIME=3059			600 Secs (200 Secs) *[==>200.0 Secs]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Adopted extinction: EBV = 0.54 (at RV=3.1) *ExpTime ~ 400/2 sec for S/N ~5 at 1350Ang* *Split into FP-POS 3 & 4 (exposures 3 & 4)*								
4	(COS.sp.1836418)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=4; BUFFER-TIME=3059			600 Secs (200 Secs) *[==>200.0 Secs]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Adopted extinction: EBV = 0.54 (at RV=3.1) *ExpTime ~ 400/2 sec for S/N ~5 at 1350Ang* *Split into FP-POS 3 & 4 (exposures 3 & 4)*								
5	(COS.sp.1836411)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=ALL; BUFFER-TIME=5938			300 Secs (360 Secs) *[==>90.0 Secs (Split 1)]* *[==>90.0 Secs (Split 2)]* *[==>90.0 Secs (Split 3)]* *[==>90.0 Secs (Split 4)]*	*[1]*
	Comments: ETC input: tailored model atmosphere for VFTS 243 (from Shenar et al. 2022, Nat As, 2022, 6, 1085, calculated with PoWR code. Model already includes extinction (EBV = 0.55 for RV=3.1; AV=1.7; Shenar+22), hence EBV=0 in ETC run. *ExpTime ~ 370/4 ~ 90sec per subexposure for S/N ~5 at 1500Ang*								

Orbit Structure



Visit

Proposal 17279, Visit 03

Thu Jul 20 21:00:26 GMT 2023

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 10.4031 D AND ZERO-PHASE HJD2454870.6996801454

Comments: Visit at conjunction, black hole in front of primary (phi = 0.0645)

Diagnostics

(Visit 03) Warning (Orbit Planner): COS EXPOSURE TIME ROUNDED DOWN TO NEAREST 0.1 SECONDS

(Visit 03) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

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5	(COS.sp.1836411)	(1) 2MASS-J05380840-6909190	COS/FUV, TIME-TAG, PSA	G160M 1623 A	FP-POS=ALL; BUFFER-TIME=5938			300 Secs (360 Secs) *[==>90.0 Secs (Split 1)]* *[==>90.0 Secs (Split 2)]* *[==>90.0 Secs (Split 3)]* *[==>90.0 Secs (Split 4)]*	*[1]*
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Orbit Structure