



15999 - What is the Mass of the NGC 300 X-1 Black Hole?

Cycle: 27, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Breanna Binder (PI) (Contact)	California State Polytechnic University, Pomona	babinder@cpp.edu
Dr. Benjamin F. Williams (CoI)	University of Washington	ben@astro.washington.edu
Prof. Michael Eracleous (CoI)	The Pennsylvania State University	mxe17@psu.edu
Dr. Paul P. Plucinsky (CoI)	Smithsonian Institution Astrophysical Observatory	plucinsky@cfa.harvard.edu

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) NGC-300-X-1	COS/FUV COS/NUV	2	26-Feb-2020 14:00:15.0	yes
02	(1) NGC-300-X-1	COS/FUV COS/NUV	2	26-Feb-2020 14:00:17.0	yes
03	(1) NGC-300-X-1	COS/FUV COS/NUV	2	26-Feb-2020 14:00:18.0	yes
04	(1) NGC-300-X-1	COS/FUV COS/NUV	2	26-Feb-2020 14:00:19.0	yes

8 Total Orbits Used

ABSTRACT

NGC 300 X-1 is a high mass Wolf-Rayet + black hole X-ray binary located ~2 Mpc away in the spiral galaxy NGC 300. Radial velocity measurements of the He II 4686 line were used to derive a black hole mass $M_{\text{BH}} \sim 20 M_{\text{sun}}$, making X-1 one of the heaviest known X-ray-bright

Proposal 15999 (STScI Edit Number: 4, Created: Wednesday, February 26, 2020 at 2:00:19 PM Eastern Standard Time) - Overview solar-mass BHs. However, follow-up Chandra observations revealed a phase shift between the X-ray emission and the He II 4686 radial velocity, indicating that this emission line did not trace the motion of the WR donor; recent XMM-Newton observations have confirmed this discrepancy, thereby invalidating prior estimates of M_{BH} . With combined Chandra X-ray imaging/timing and HST/COS FUV spectroscopy that samples the binary orbital period, we will be able to reliably separate the spectral features of the WR donor and provide correct measurements of the system's component masses.

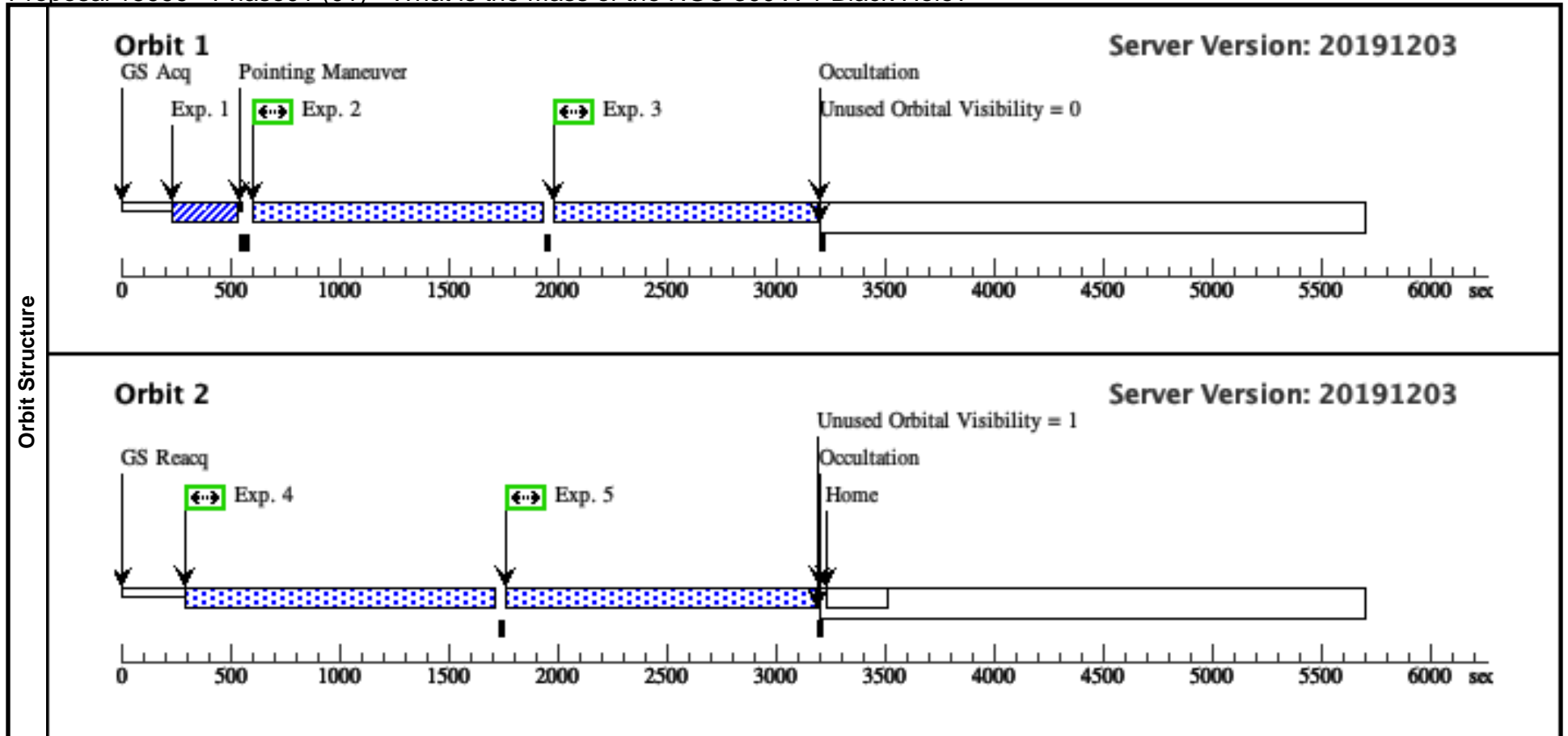
OBSERVING DESCRIPTION

We will collect COS spectra for the Wolf-Rayet + black hole binary NGC 300 X-1 at four different orbital phases (with 2 orbits per visit). The instrument settings for all four visits is identical: NGC 300 X-1 (4 x 2 orbits): COS/FUV G140L. The best measurement of the binary orbital period is 32.7932 ± 0.0029 hr, with a zero-point time corresponding to phase=0 (e.g., the deepest part of the X-ray dip) on MJD 57741.3642. The Hubble visits should roughly sample the entire binary orbital period, although they need not be taken during a single orbital cycle. However, to keep the orbital phase uncertainty to a minimum, all HST visits and the Chandra X-ray observations should be completed within roughly one month of one another.

Proposal 15999 - Phase01 (01) - What is the Mass of the NGC 300 X-1 Black Hole?

Wed Feb 26 19:00:19 GMT 2020

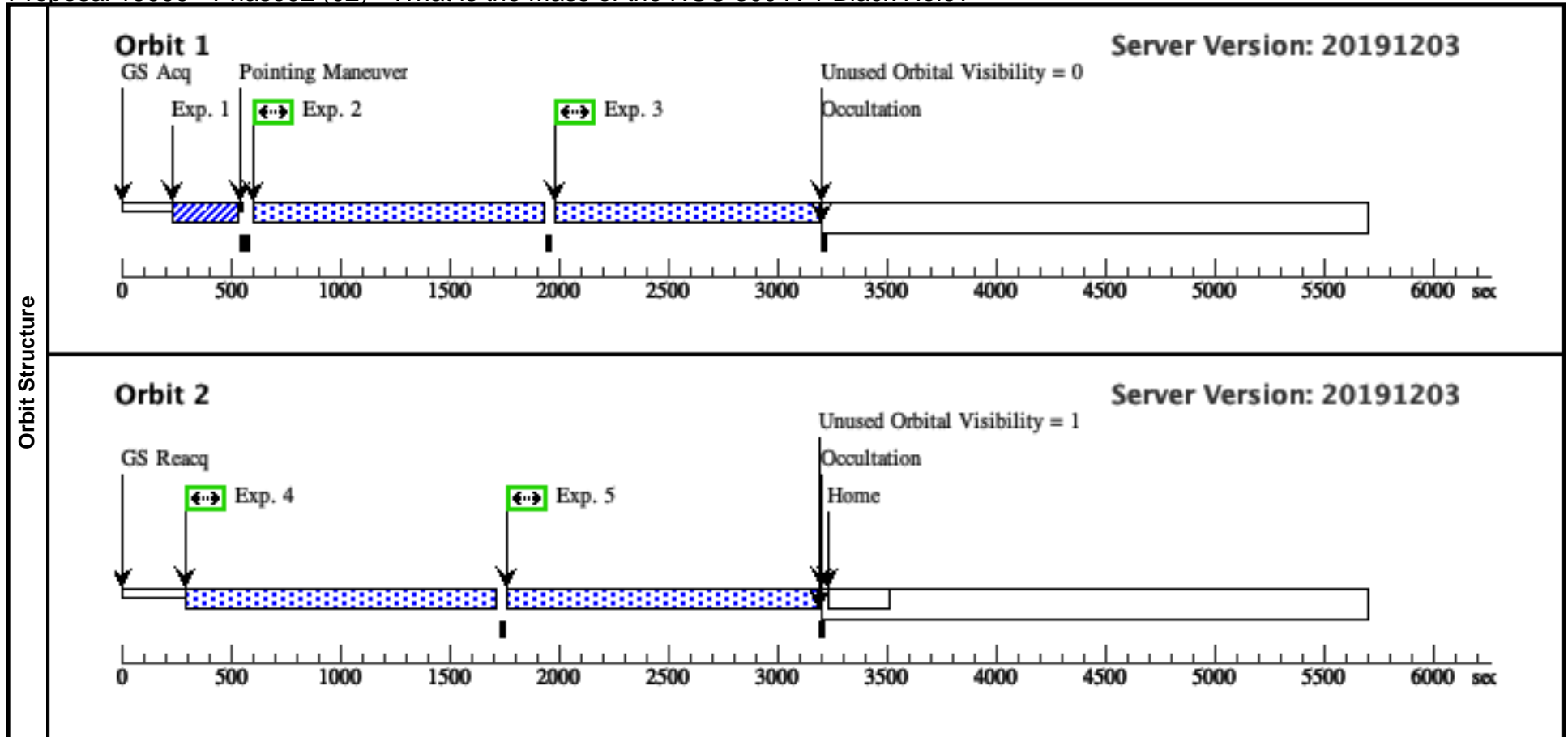
Visit	Proposal 15999, Phase01 (01), implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 32.8 H AND ZERO-PHASE HJD2457741.8642 <i>Comments: Must be taken within ~1 month of the coordinated Chandra observations</i>									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
		(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44	Reference Frame: ICRS			
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[WIND, WOLF RAYET, WOLF RAYET - WN] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	Visit01 (COS.ta.137 5984)	(1) NGC-300-X-1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA		PHASE 0.975 TO 0.025; GS ACQ SCENARI O BASE1BE	Sequence 1-3 Non-Int in Phase01 (01)	40 Secs (40 Secs) [==>]	[1]
	2	Visit01 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=1	Sequence 1-3 Non-Int in Phase01 (01)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]
	3	Visit01 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=2	Sequence 1-3 Non-Int in Phase01 (01)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]
	4	Visit01 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=3	Sequence 4-5 Non-Int in Phase01 (01)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]
	5	Visit01 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=4	Sequence 4-5 Non-Int in Phase01 (01)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]



Proposal 15999 - Phase02 (02) - What is the Mass of the NGC 300 X-1 Black Hole?

Wed Feb 26 19:00:19 GMT 2020

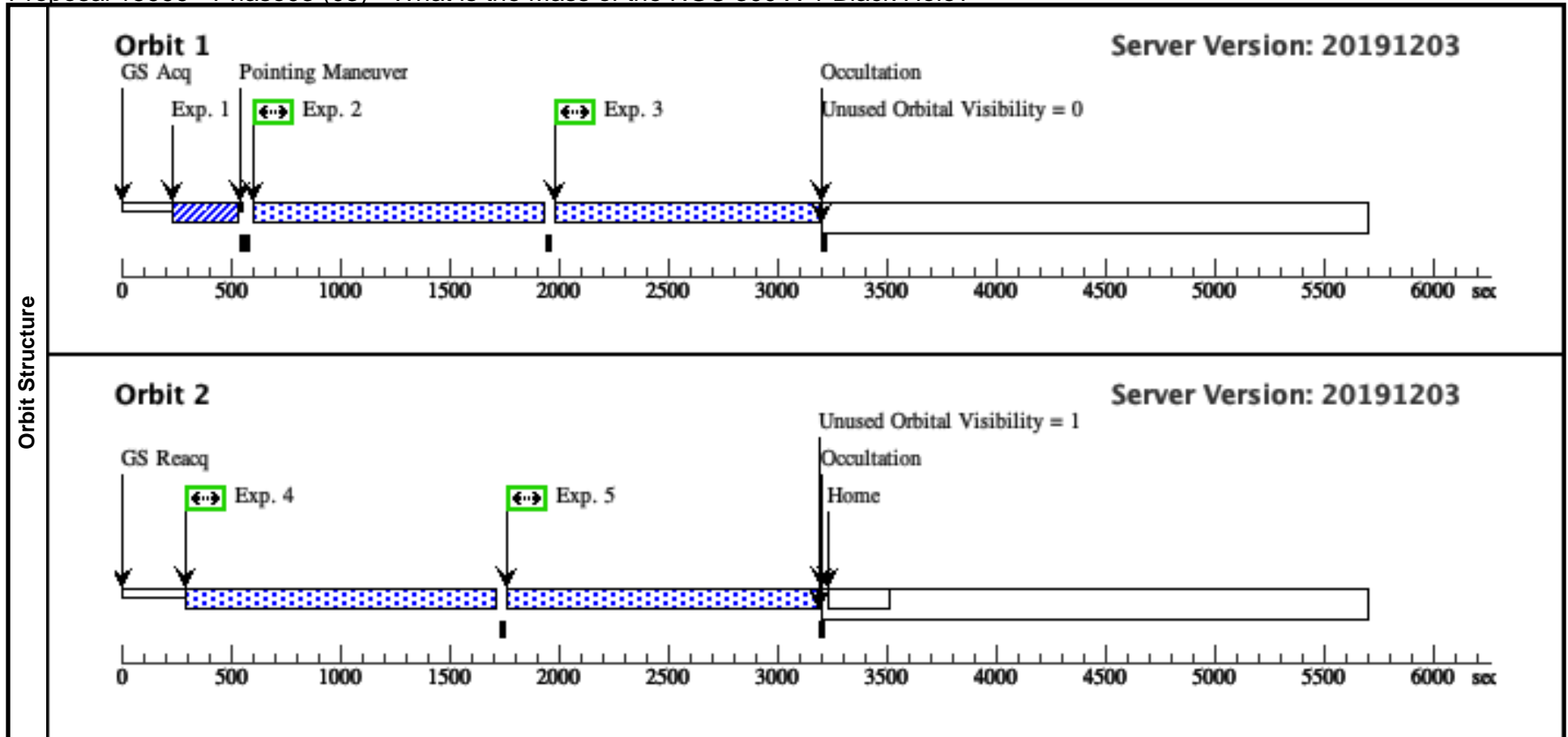
Visit	Proposal 15999, Phase02 (02), implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 32.8 H AND ZERO-PHASE HJD2457741.8642 <i>Comments: Must be taken within ~1 month of the coordinated Chandra observations</i>												
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>NGC-300-X-1</td> <td>RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000</td> <td>Epoch of Position: 2015.5 Radial Velocity: 144 km/sec</td> <td>V=22.44</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[WIND, WOLF RAYET, WOLF RAYET - WN] Extended=NO</p>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous								
(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44	Reference Frame: ICRS								
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit			
	1	Visit02 (COS.ta.137 5984)	(1) NGC-300-X-1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA		PHASE 0.225 TO 0.275; GS ACQ SCENARI O BASE1BE	Sequence 1-3 Non-Int in Phase02 (02)	40 Secs (40 Secs) [==>]	[1]			
	2	Visit02 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=1	Sequence 1-3 Non-Int in Phase02 (02)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]			
	3	Visit02 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=2	Sequence 1-3 Non-Int in Phase02 (02)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]			
	4	Visit02 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=3	Sequence 4-5 Non-Int in Phase02 (02)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]			
	5	Visit02 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=4	Sequence 4-5 Non-Int in Phase02 (02)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]			



Proposal 15999 - Phase03 (03) - What is the Mass of the NGC 300 X-1 Black Hole?

Wed Feb 26 19:00:19 GMT 2020

Visit	Proposal 15999, Phase03 (03), implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 32.8 H AND ZERO-PHASE HJD2457741.8642 <i>Comments: Must be taken within ~1 month of the coordinated Chandra observations</i>												
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>NGC-300-X-1</td> <td>RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000</td> <td>Epoch of Position: 2015.5 Radial Velocity: 144 km/sec</td> <td>V=22.44</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[WIND, WOLF RAYET, WOLF RAYET - WN] Extended=NO</p>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous								
(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44	Reference Frame: ICRS								
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit			
	1	Visit03 (COS.ta.137 5984)	(1) NGC-300-X-1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA		PHASE 0.475 TO 0.525; GS ACQ SCENARI O BASE1BE	Sequence 1-3 Non-Int in Phase03 (03)	40 Secs (40 Secs) [==>]	[1]			
	2	Visit03 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=1	Sequence 1-3 Non-Int in Phase03 (03)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]			
	3	Visit03 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=2	Sequence 1-3 Non-Int in Phase03 (03)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]			
	4	Visit03 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=3	Sequence 4-5 Non-Int in Phase03 (03)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]			
	5	Visit03 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=4	Sequence 4-5 Non-Int in Phase03 (03)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]			



Proposal 15999 - Phase04 (04) - What is the Mass of the NGC 300 X-1 Black Hole?

Wed Feb 26 19:00:20 GMT 2020

Visit	Proposal 15999, Phase04 (04), implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: Period 32.8 H AND ZERO-PHASE HJD2457741.8642 <i>Comments: Must be taken within ~1 month of the coordinated Chandra observations</i>																					
	Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>NGC-300-X-1</td> <td>RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000</td> <td>Epoch of Position: 2015.5 Radial Velocity: 144 km/sec</td> <td>V=22.44</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[WIND, WOLF RAYET, WOLF RAYET - WN] Extended=NO</p>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous																	
(1)	NGC-300-X-1	RA: 00 55 9.9900 (13.7916250d) Dec: -37 42 12.65 (-37.70351d) Equinox: J2000	Epoch of Position: 2015.5 Radial Velocity: 144 km/sec	V=22.44	Reference Frame: ICRS																	
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit												
	1	Visit04 (COS.ta.137 5984)	(1) NGC-300-X-1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA		PHASE 0.725 TO 0.775; GS ACQ SCENARI O BASE1BE	Sequence 1-3 Non-Int in Phase04 (04)	40 Secs (40 Secs) [==>]	[1]												
	2	Visit04 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=1	Sequence 1-3 Non-Int in Phase04 (04)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]												
	3	Visit04 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=2	Sequence 1-3 Non-Int in Phase04 (04)	1000 Secs (1153 Secs) [==>1153.0 Secs]	[1]												
	4	Visit04 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=3	Sequence 4-5 Non-Int in Phase04 (04)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]												
	5	Visit04 (COS.sp.137 6015)	(1) NGC-300-X-1	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=1.7 e4; FLASH=YES; SEGMENT=BOTH; FP-POS=4	Sequence 4-5 Non-Int in Phase04 (04)	1000 Secs (1364 Secs) [==>1364.0 Secs]	[2]												

