



15239 - Searching for the UV counterpart of the extraordinary X-ray UFO in the NLSy1 IRAS17020+4544

Cycle: 25, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Yair Krongold (PI) (Contact)	Universidad Nacional Autonoma de Mexico (UNAM)	yair@astro.unam.mx
Dr. Anna Lia Longinotti (CoI)	Instituto Nacional de Astrofisica, Optica y Electronica	annalia@inaoep.mx
Dr. Maria Santos-Lleo (CoI) (ESA Member)	European Space Agency - ESTEC	msantos@sciops.esa.int
Dr. Francesca Panessa (CoI) (ESA Member)	INAF-Istituto di Astrofisica e Planetologia Spaziali	francesca.panessa@iaps.inaf.it
Dr. Smita Mathur (CoI) (AdminUSPI)	The Ohio State University	smita@astronomy.ohio-state.edu
Dr. Marcello Giroletti (CoI) (ESA Member)	INAF Istituto di Radioastronomia	giroletti@ira.inaf.it
Dr. Fabrizio Nicastro (CoI)	Smithsonian Institution Astrophysical Observatory	fnicastro@cfa.harvard.edu
Dr. Elisa Costantini (CoI) (ESA Member)	Space Research Organization Netherlands	e.costantini@sron.nl
Dr. Anjali Gupta (CoI)	Columbus State Community College	agupta1@csc.edu
Dr. Gerard A. Kriss (CoI)	Space Telescope Science Institute	gak@stsci.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) IRAS17020+4544	COS/FUV COS/NUV	3	10-Aug-2018 17:00:17.0	yes
02	(1) IRAS17020+4544	COS/FUV COS/NUV	3	10-Aug-2018 17:00:19.0	yes

<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>
03	(1) IRAS17020+4544	COS/FUV COS/NUV	3	10-Aug-2018 17:00:20.0	yes

9 Total Orbits Used

ABSTRACT

We recently reported the first unambiguous discovery in high resolution X-ray data of an ultra fast outflow (UFO) with velocity $\sim 0.1c$. This wind, in Narrow Line Seyfert 1 galaxy IRAS17020+4544, represents so far the most compelling detection of an UFO, with many different absorption lines that give rise to very high significance detections. The charge states that form the wind clearly indicate a large range of ionization states in the gas, and significant absorption by Ly alpha, C IV, Si IV and N V (among other ions) is expected in the UV band. The goal of our proposed program is to observe and characterize the best X-ray detected UFO in the UV. These observations are crucial to study in great detail the UFO phenomenon, and understand its nature and its relation to the narrow absorption line low velocity systems. Only through detection of Ly alpha absorption in the UV data, measurements of the metallicity of these winds will be possible. The proposed program will help guide new theoretical models of UFOs origins, beyond the simple actual picture that predicts only very high ionization Fe absorption. UV data are required to understand the wind nature and launching mechanism (whether due to radiation pressure via line or continuum opacity, or magnetic forces). Fully characterizing the wind properties will put stronger constraints in the mass outflow and kinetic outflow rates of these systems, as well as in their geometry. Such estimates will give a much clearer picture of UFOs feedback potential, and will provide clues on the feedback mode in action (e.g. energy conserving vs. momentum conserving).

OBSERVING DESCRIPTION

We will use a total of 9 orbits of HST to observe IRAS17 with COS G140L/1105 in order to detect and measure the strength of UV absorption lines expected to be associated with its known ultra-fast X-ray outflow. IRAS17 has been detected in both GALEX UV photometric bands, and our XMM-OM observations show comparable ultraviolet photometric fluxes. We note that IRAS17 is in many ways comparable to another dusty warm absorber, IRAS13349+2438 (Lee et al. 2013). Based on the similar spectral shapes of these two objects, we scaled the STIS spectrum of IRAS13349+2438 down to the fainter GALEX flux for IRAS17 ($m_{\text{nuv}} = 19.1$), and adjusted it to the $z=0.06$ redshift of IRAS17 for our feasibility calculations. Since IRAS17 is relatively faint, and we wish to cover a wide wavelength range from shortward of Ly alpha to redshifted C IV all at once, we choose grating G140L/1105. This gives a resolution of 125 km/s per 6-pixel resolution element. Considering that the UV ultra-fast outflow (UFO) absorption lines are expected to be blue-shifted by an average velocity of $-25,000$ km/s, the expected position of the

Proposal 15239 (STScI Edit Number: 3, Created: Friday, August 10, 2018 4:00:20 PM EST) - Overview

two strongest UFO lines in the COS spectrum will be at 1187 Å for Ly alpha and 1512 Å for CIV. The 125 km/s resolution of G140L is sufficient to resolve individual standard warm absorber components, which typically have widths of 100 km/s (Kriss et al. 2011), and would easily resolve the broad features (several hundred km/s) expected to be associated with a UFO.

Using the COS ETC v25.1.1 (ETC ID COS.sp.936381), in 18,000 s (9 orbits), we obtain a S/N of 11 per resolution element in the continuum at 1160 Å (near the expected location of blue-shifted Ly alpha absorption from the UFO), 10 in the continuum at 1360 Å, and 7 in the continuum at 1520 Å, near C IV. We therefore expect to be able to detect Ly alpha absorption at a limiting 5-sigma equivalent width of 0.24 Å, which for an optically thin absorption line of Doppler width $b=100$ km/s corresponds to a limiting detectable column density of $N_{\text{HI}} > 5 \times 10^{13}/\text{cm}^2$. Similarly, for C IV, we expect a limiting 5-sigma equivalent width of 0.34 Å, and minimum detectable column density of $N_{\text{CIV}} > 10^{14}/\text{cm}^2$. This is sufficient to easily detect UFO lines with expected column densities in the range of 10^{15} to $10^{16}/\text{cm}^2$, as predicted by our X-ray photoionization modeling of the absorbers in IRAS17.

Our experience with low-velocity NAL systems has shown that our requirements are also sufficient to characterize the intrinsic AGN absorption lines (e.g. Mathur et al. 1998; Fields et al. 2005). Indeed, lines similar to those expected for IRAS17 are visible in the lower-resolution STIS G140L spectrum of IRAS13349+2438 (Lee et al. 2013). We note that there is no evidence for a transient behavior of the X-ray UFO over the last 10 years. Our new Chandra data beautifully show the presence of the UFO. In addition, the X-ray flux of IRAS17 has been strikingly constant over the last 20 yrs in four prior observations with ASCA, XMM, and Swift; and in the new Chandra observation. Thus simultaneous observations in both bands are not needed. Given that our 9 orbits must be split into 3 separate visits, the relative timing of these visits is also not an issue, although completing the program in a timely fashion (e.g., all observations within 1 month) would be desirable for expediting our joint analysis of the X-ray data in hand and the new UV spectrum.

Our target is sufficiently faint that an ACQ/IMAGE target acquisition is acceptable, and our target coordinates are known to better than 0.4 arc sec, as recommended in the COS instrument handbook. Our target and its surrounding field pose no bright-object safety concerns for COS, as verified in APT. Here we summarize our ETC calculations that back our exposure-time estimates and demonstrate the safety of our observations.

1. We use the HST STIS spectrum of IRAS13349+2438 as a template.
2. We place this at the redshift of IRAS17020 ($z=0.06$).
3. Since the foreground Galactic extinction is similar for IRAS17020 and IRAS13349+2438, we do not include any additional extinction.
4. We normalize the flux to the GALEX NUV magnitude $m_{\text{nuv}}=19.1$.

Our spectroscopic ETC calculation using v25.2 is identified by COS.sp.914455. In 16,000 s we achieve a S/N=6.4 per resolution element at 1575 Å with a total count rate of 179 counts/s and a brightest pixel count rate of 0.053 counts/s, both well below safety limits. The buffer time is 13,195,

much longer than any exposure time. We therefore adjust the buffer time in each exposure to minimize the overhead of buffer dumps.

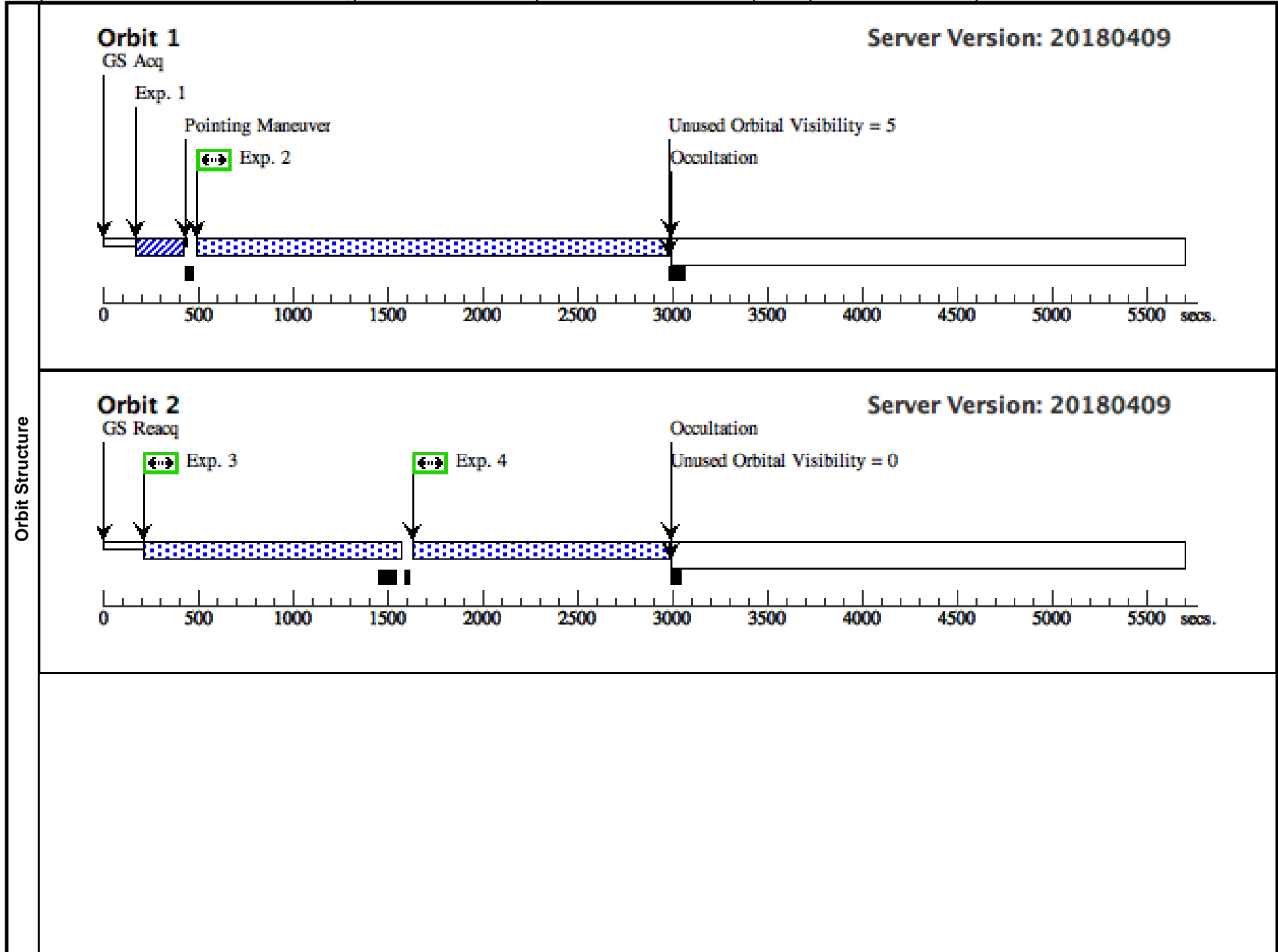
For target acquisition, our ETC calculation in COS.ta.1007130 uses MIRROR A and iras1334_hstall_rest.dat to obtain an exposure time of 16.48 s. As a check, we also used a heavily reddened ($E(B-V)=1.0$) SDSS-based spectrum at $z=0.06$ also normalized to GALEX $m_{\text{nuv}}=19.1$ and get an exposure time of 9.5 s. (COS.ta.1007134) We choose the more conservative time estimate based on the IRAS13349+2438, which had maximum count rates of 961 counts/s over the detector, and 13.2 per pixel, again, well below safety limits.

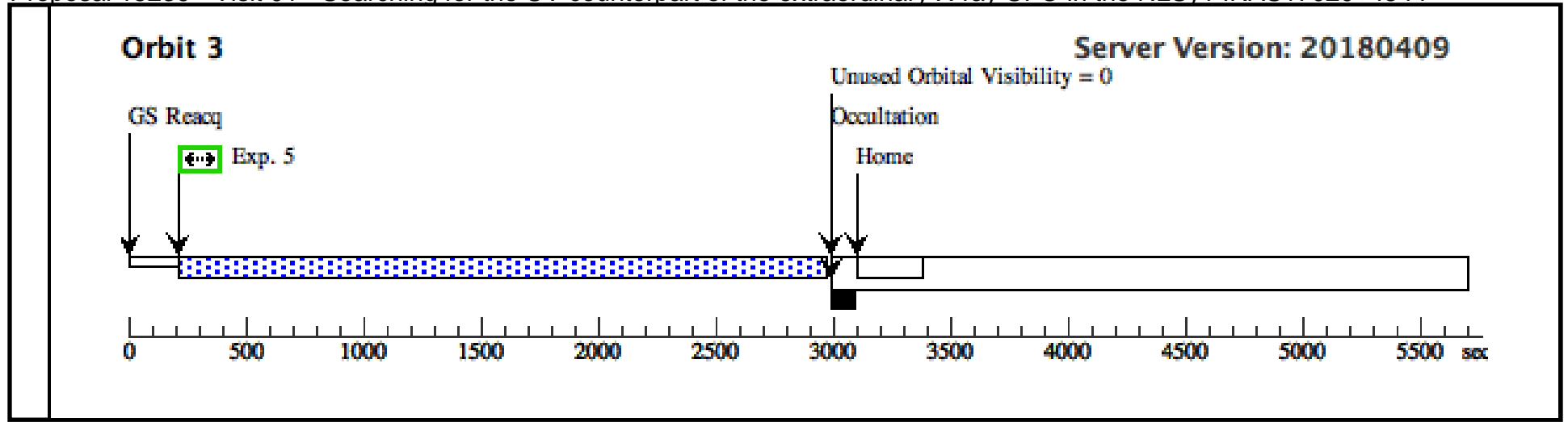
For flexibility in scheduling, we set the schedulability on each of the three visits to 100%. Since the sum total spectrum after all three visits is required, please schedule all visits within 1 month.

Proposal 15239 - Visit 01 - Searching for the UV counterpart of the extraordinary X-ray UFO in the NLSy1 IRAS17020+4544

Fri Aug 10 21:00:20 GMT 2018

Visit	Proposal 15239, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: SCHED 100% <i>Comments: Please group Visits 1, 2, and 3 together within 1 month. The sum total spectrum is required to carry out the science of this proposal.</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>IRAS17020+4544</td> <td>RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000</td> <td></td> <td>V=16.07+/-1 GALEX m_NUV=19.1</td> <td>Reference Frame: ICRS</td> </tr> <tr> <td colspan="6"> <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO </td> </tr> </tbody> </table>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO				
#		Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous																						
(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS																							
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] 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.100 7130)	(1) IRAS17020+4544 4	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				17 Secs (17 Secs) [==>]	[1]																		
	2	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=1; BUFFER-TIME=3000			2299 Secs (2299 Secs) [==>]	[1]																		
	3	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=2; BUFFER-TIME=1199			1309 Secs (1309 Secs) [==>]	[2]																		
	4	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=3; BUFFER-TIME=3000			1293 Secs (1293 Secs) [==>]	[2]																		
	5	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=4; BUFFER-TIME=3000			2707 Secs (2707 Secs) [==>]	[3]																		

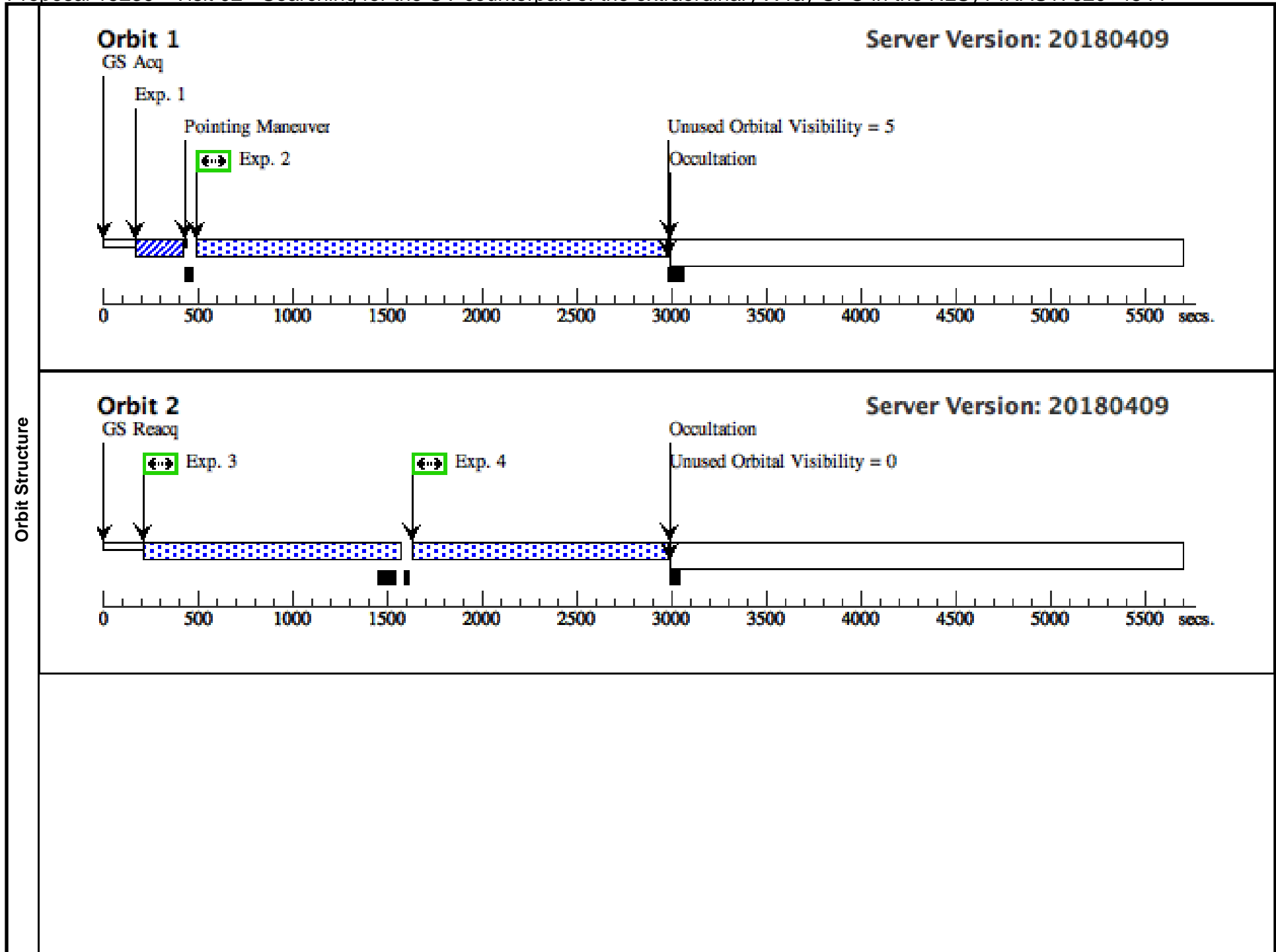


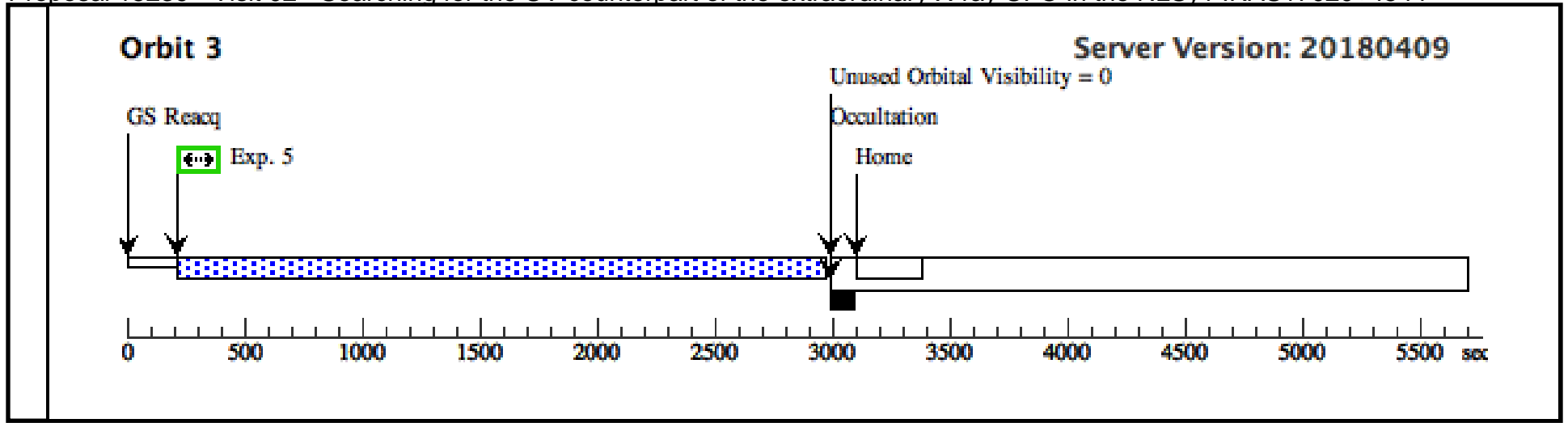


Proposal 15239 - Visit 02 - Searching for the UV counterpart of the extraordinary X-ray UFO in the NLSy1 IRAS17020+4544

Fri Aug 10 21:00:21 GMT 2018

Visit	Proposal 15239, Visit 02, implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: SCHED 100% <i>Comments: Please group Visits 1, 2, and 3 together within 1 month. The sum total spectrum is required to carry out the science of this proposal.</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>IRAS17020+4544</td> <td>RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000</td> <td></td> <td>V=16.07+/-1 GALEX m_NUV=19.1</td> <td>Reference Frame: ICRS</td> </tr> <tr> <td colspan="6"> <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO </td> </tr> </tbody> </table>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO				
#		Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous																						
(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS																							
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] 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.100 7130)	(1) IRAS17020+4544 4	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				17 Secs (17 Secs) [==>]	[1]																		
	2	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=1; BUFFER-TIME=3000			2299 Secs (2299 Secs) [==>]	[1]																		
	3	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=2; BUFFER-TIME=1199			1309 Secs (1309 Secs) [==>]	[2]																		
	4	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=3; BUFFER-TIME=3000			1293 Secs (1293 Secs) [==>]	[2]																		
	5	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=4; BUFFER-TIME=3000			2707 Secs (2707 Secs) [==>]	[3]																		





Proposal 15239 - Visit 03 - Searching for the UV counterpart of the extraordinary X-ray UFO in the NLSy1 IRAS17020+4544

Fri Aug 10 21:00:21 GMT 2018

Visit	Proposal 15239, Visit 03, implementation Diagnostic Status: No Diagnostics Scientific Instruments: COS/FUV, COS/NUV Special Requirements: SCHED 100% <i>Comments: Please group Visits 1, 2, and 3 together within 1 month. The sum total spectrum is required to carry out the science of this proposal.</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>IRAS17020+4544</td> <td>RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000</td> <td></td> <td>V=16.07+/-1 GALEX m_NUV=19.1</td> <td>Reference Frame: ICRS</td> </tr> <tr> <td colspan="6"> <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO </td> </tr> </tbody> </table>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] Extended=NO				
#		Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous																						
(1)	IRAS17020+4544	RA: 17 03 30.4100 (255.8767083d) Dec: +45 40 47.08 (45.67974d) Equinox: J2000		V=16.07+/-1 GALEX m_NUV=19.1	Reference Frame: ICRS																							
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=GALAXY Description=[NUCLEUS, QSO, QUASAR, SEYFERT, WIND] 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.100 7130)	(1) IRAS17020+4544 4	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				17 Secs (17 Secs) [==>]	[1]																		
	2	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=1; BUFFER-TIME=3000			2299 Secs (2299 Secs) [==>]	[1]																		
	3	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=2; BUFFER-TIME=1199			1309 Secs (1309 Secs) [==>]	[2]																		
	4	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=3; BUFFER-TIME=3000			1293 Secs (1293 Secs) [==>]	[2]																		
	5	(COS.sp.936 381)	(1) IRAS17020+4544 4	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=4; BUFFER-TIME=3000			2707 Secs (2707 Secs) [==>]	[3]																		

