



14082 - Connecting white dwarf rotation and debris accretion

Cycle: 23, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Prof. Dan Maoz (PI) (Contact)	Tel Aviv University - Wise Observatory	dani@wise.tau.ac.il
Dr. Eric Agol (CoI)	University of Washington	agol@astro.washington.edu
Dr. Jay Farihi (CoI) (ESA Member)	University College London	j.farihi@ucl.ac.uk
Prof. Boris T. Gaensicke (CoI) (ESA Member)	The University of Warwick	boris.gaensicke@warwick.ac.uk
Ms. Na'ama Hallakoun (CoI)	Tel Aviv University - Wise Observatory	naama@wise.tau.ac.il
Dr. Mukremin Kilic (CoI) (AdminUSPI)	University of Oklahoma Norman Campus	kilic@ou.edu
Dr. Abraham Loeb (CoI)	Harvard University	aloeb@cfa.harvard.edu
Prof. Tsevi Mazeh (CoI)	Tel Aviv University - Wise Observatory	mazeh@astro.tau.ac.il
Dr. Fergal Mullally (CoI)	NASA Ames Research Center	fergal.mullally@nasa.gov

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) WD1949+4734	COS/FUV COS/NUV	2	22-Apr-2016 15:37:47.0	yes
02	(2) WD1909+4717	COS/FUV COS/NUV	1	22-Apr-2016 15:37:49.0	yes
03	(3) WD1927+4219	COS/FUV COS/NUV	1	22-Apr-2016 15:37:49.0	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>
04	(4) WD1855+4207	COS/FUV COS/NUV	1	22-Apr-2016 15:37:50.0	yes
05	(5) WD1857+4909	COS/FUV COS/NUV	1	22-Apr-2016 15:37:51.0	yes
06	(6) WD1919+3958	COS/FUV COS/NUV	2	22-Apr-2016 15:37:52.0	yes
07	(7) WD1940+4240	COS/FUV COS/NUV	2	22-Apr-2016 15:37:53.0	yes

10 Total Orbits Used

ABSTRACT

Recent Kepler photometry has revealed that half of white dwarfs have periodic, low-level ($\sim 10^{-3}$ - 10^{-4}), optical variations. HST UV spectroscopy has shown that half of white dwarfs are actively accreting rocky planetary debris. By obtaining UV spectra of 9 WDs monitored with Kepler, we will test the hypothesis that these two phenomena are causally connected, i.e. that the optical periodic modulation is caused by WD rotation coupled with an inhomogeneous surface distribution of accreted metals. If there is a match between the periodically variable WDs and the WDs with UV line opacity, this will confirm the hypothesis. The Kepler photometric modulation will then be established as the first method that can provide reliable rotation periods for hundreds of normal WDs. WD rotation is a critical observable for understanding stellar evolution, stellar mass loss, Type-Ia supernova progenitors and more, but rotation periods have been measured for only tens of WDs, mainly rare magnetic ones. Furthermore, confirmation of the connection between UV line opacity and optical modulation will provide an inexpensive photometric probe for identifying accretion of rocky debris in large samples of WDs, and mapping its dependence on WD (and progenitor system) properties. If the hypothesis is rejected (there is no match between UV line opacity and optical modulation), this will point to alternative and no-less-interesting explanations for the optical variability, e.g. the abundant presence of close-in companions to WDs, such as giant planets or secondary cool WDs.

OBSERVING DESCRIPTION

Sample Selection: To test the correspondence between the existence of periodic optical variability and the presence of UV metal absorption lines in WDs, we will observe 9 WDs that have been monitored for low-level variability with good S/N: four WDs that have clear periodic modulation, and five that do not, with upper limits on any periodic variability at amplitude levels below 100 ppm (i.e. 10^{-4}). Additional selection criteria for all 9

Proposal 14082 (STScI Edit Number: 0, Created: Friday, April 22, 2016 2:37:53 PM EST) - Overview

WDs are: visual magnitude < 18 mag, to ensure sufficient S/N; effective temperatures $T_{\text{eff}} < 32000\text{K}$, to avoid WDs in which radiative levitation plays a role in the presence of atmospheric metals; surface gravity $7.5 < \log g < 8.5$, to include only bona-fide normal WDs of the kind whose UV metal pollution has been studied.

The choice of 9 WDs will permit, in principle, to significantly reject the null hypothesis that optical modulations and UV metal pollution are unrelated. Assuming that in two of the nine WDs there could be a mismatch between the presence of optical modulation and UV metal lines, due to a different cause for the modulation (e.g. rotation plus magnetic dichroism, or beaming due to a close companion), this would still leave seven WDs with a match between the two effects. Since the probability of any WD to display each effect alone is $\sim 50\%$ (Koester et al., 2014; Maoz et al., 2015), the chance probability for seven matches would be $2^{-7} < 1\%$, and thus seven or more matches will firmly reject the null hypothesis.

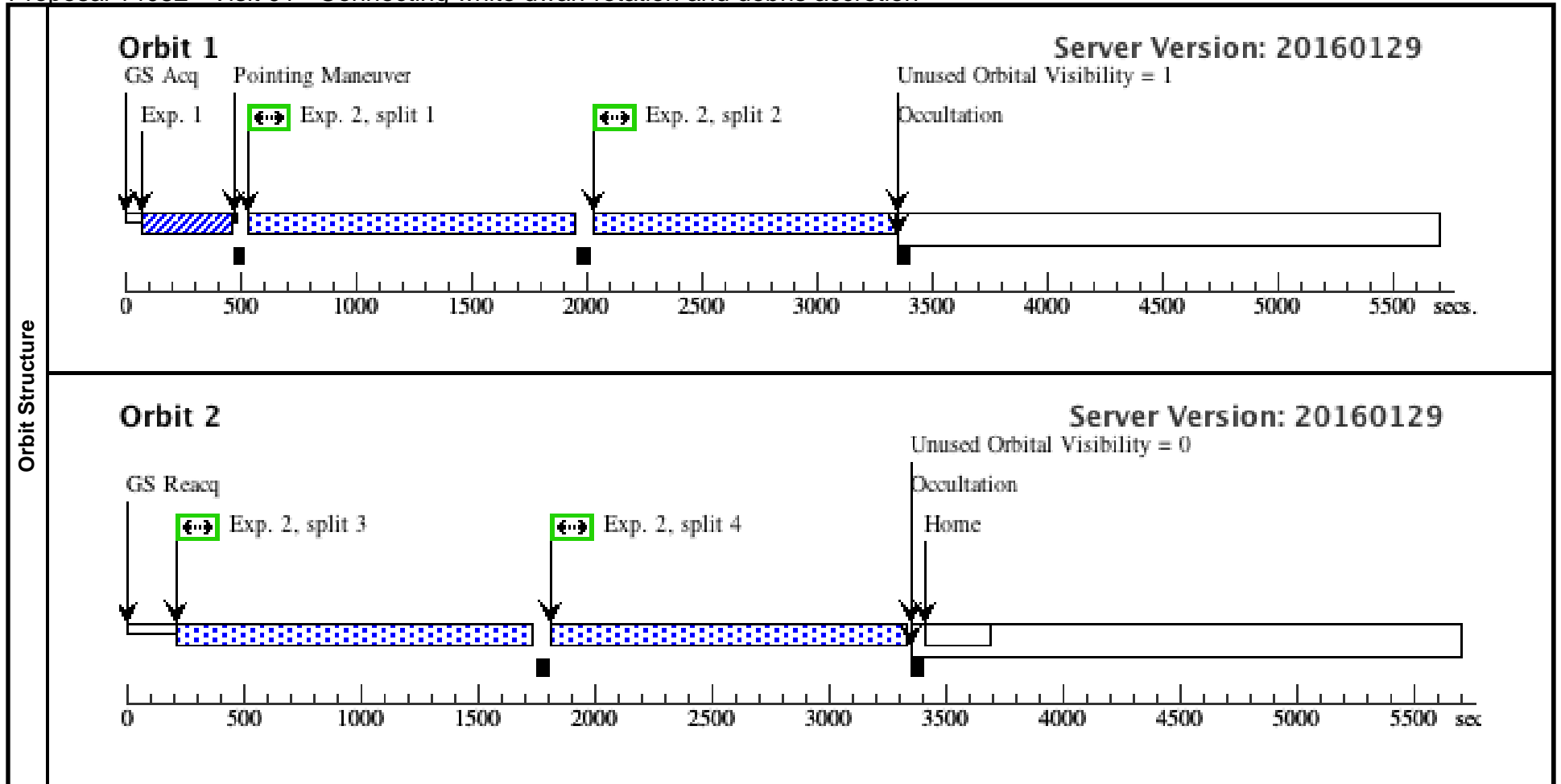
Observations:

Each WD will be observed for one orbit with COS/FUV, except for the three faint WDs with no FUV magnitude measurements, which will be observed for two orbits, in order to achieve higher S/N, as two WDs of our sample were already observed/scheduled for observation by COS. For acquisition we will generally use the COS/NUV ACQ/IMAGE mode with MirrorB. For two of the targets, which are too bright to be acquired with ACQ/IMAGE, we will use instead COS/FUV with ACQ/PEAKXD and ACQ/PEAKD modes. Science exposures will be taken using the TIME-TAG mode by the G130M grating of COS/FUV with a central wavelength of 1291Å, which will cover the wavelength range 1130-1435Å. We will dither the exposures over the four FP-POS settings in order to remove fixed pattern noise. We will fill each orbit with a net exposure time of ~ 35 min, to get a S/N ~ 10 per resolution element, more than adequate for detecting and measuring the UV metal lines.

Proposal 14082 - Visit 01 - Connecting white dwarf rotation and debris accretion

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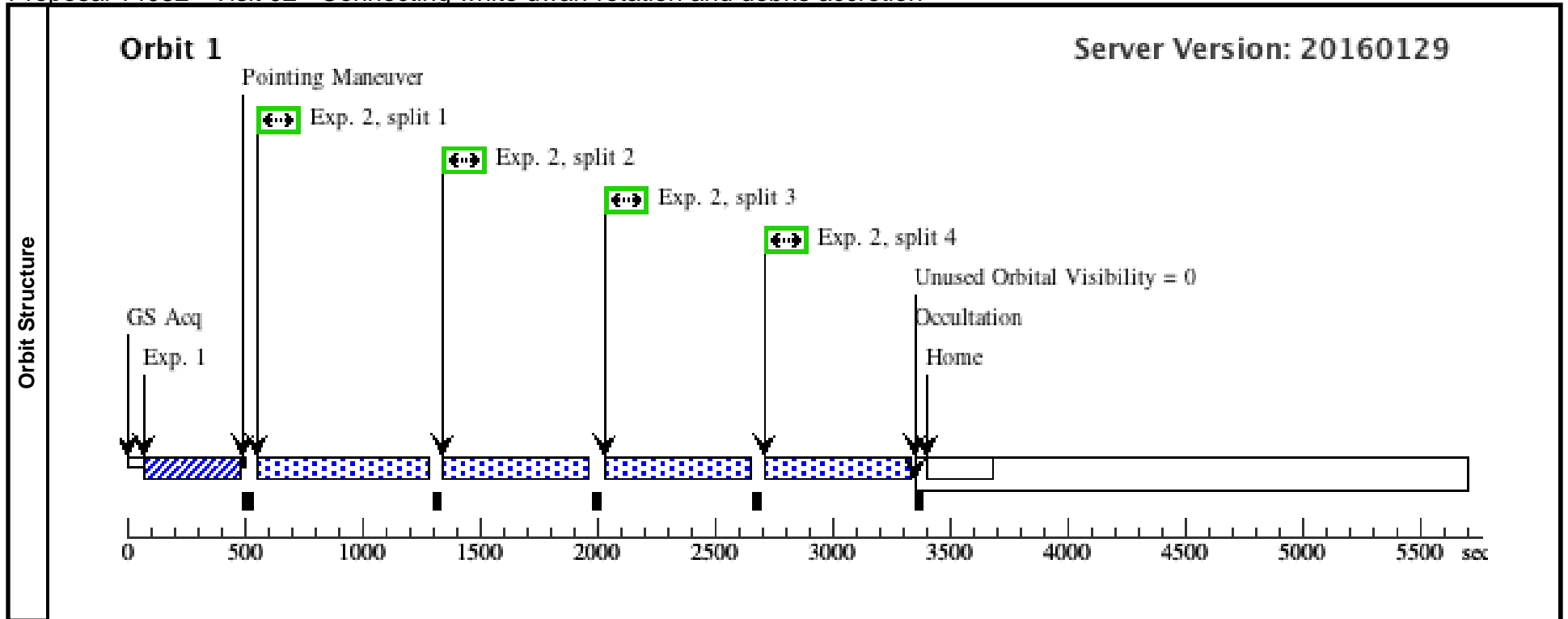
Visit	Proposal 14082, Visit 01 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 01) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	WD1949+4734	RA: 19 49 14.5790 (297.3107458d) Dec: +47 34 45.98 (47.57944d) Equinox: J2000	Proper Motion RA: -18.9 mas/yr Proper Motion Dec: -16.7 mas/yr Epoch of Position: 2000	V=16.2+/-0.1	Reference Frame: ICRS				
Comments: A<50 ppm, T=16kK, DA E(B-V)=0.111 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.732 810)	(1) WD1949+4734	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				34.2 Secs (34.2 Secs)	
									[==>]	[1]
	2	(COS.sp.796 323)	(1) WD1949+4734	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=35 19; FP-POS=ALL			3000 Secs (5437 Secs)	
									[==>1252.0 Secs (Split 1)] [==>1253.0 Secs (Split 2)] [==>1466.0 Secs (Split 3)] [==>1466.0 Secs (Split 4)]	[1] [2]
Comments: Exposure time (seconds) = 5,437.0000 at wavelength 1310.00A gives: SNR = 10.7515 (per resolution element)										



Proposal 14082 - Visit 02 - Connecting white dwarf rotation and debris accretion

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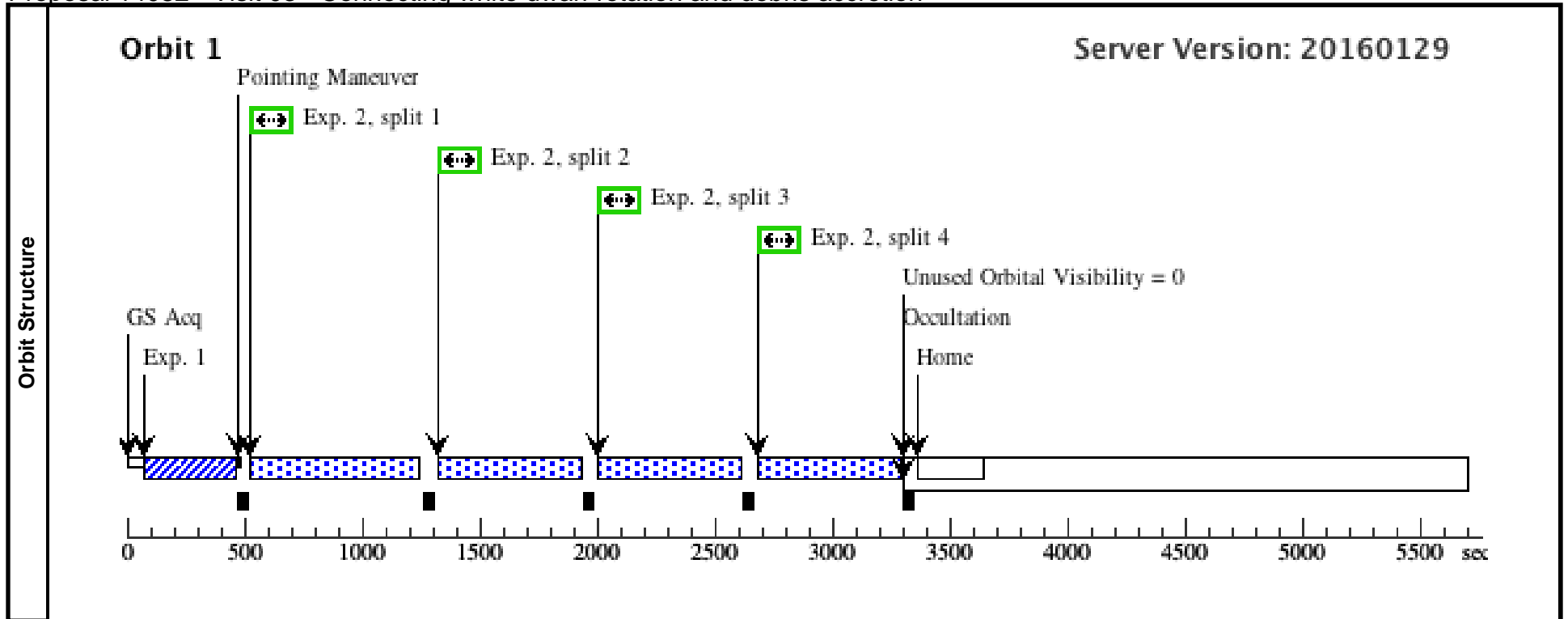
Visit	Proposal 14082, Visit 02 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 02) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(2)	WD1909+4717	RA: 19 09 59.3470 (287.4972792d) Dec: +47 17 10.00 (47.28611d) Equinox: J2000	Proper Motion RA: 14.2 mas/yr Proper Motion Dec: -54.8 mas/yr Epoch of Position: 2000	V=16.4+/-0.1 GALEX FUV=16.5AB	Reference Frame: ICRS				
Comments: A<70 ppm, T=14kK, DA E(B-V)=0.058 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.732 796)	(2) WD1909+4717	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				45 Secs (45 Secs)	
									[==>]	[1]
	2	(COS.sp.789 865)	(2) WD1909+4717	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=27 53; FP-POS=ALL			3000 Secs (2275 Secs)	
								[==>568.0 Secs (Split 1)] [==>568.0 Secs (Split 2)] [==>568.0 Secs (Split 3)] [==>571.0 Secs (Split 4)]	[1]	
Comments: Exposure time (seconds) = 2,275.0000 at wavelength 1310.00A gives: SNR = 10.4222 (per resolution element)										



Proposal 14082 - Visit 03 - Connecting white dwarf rotation and debris accretion

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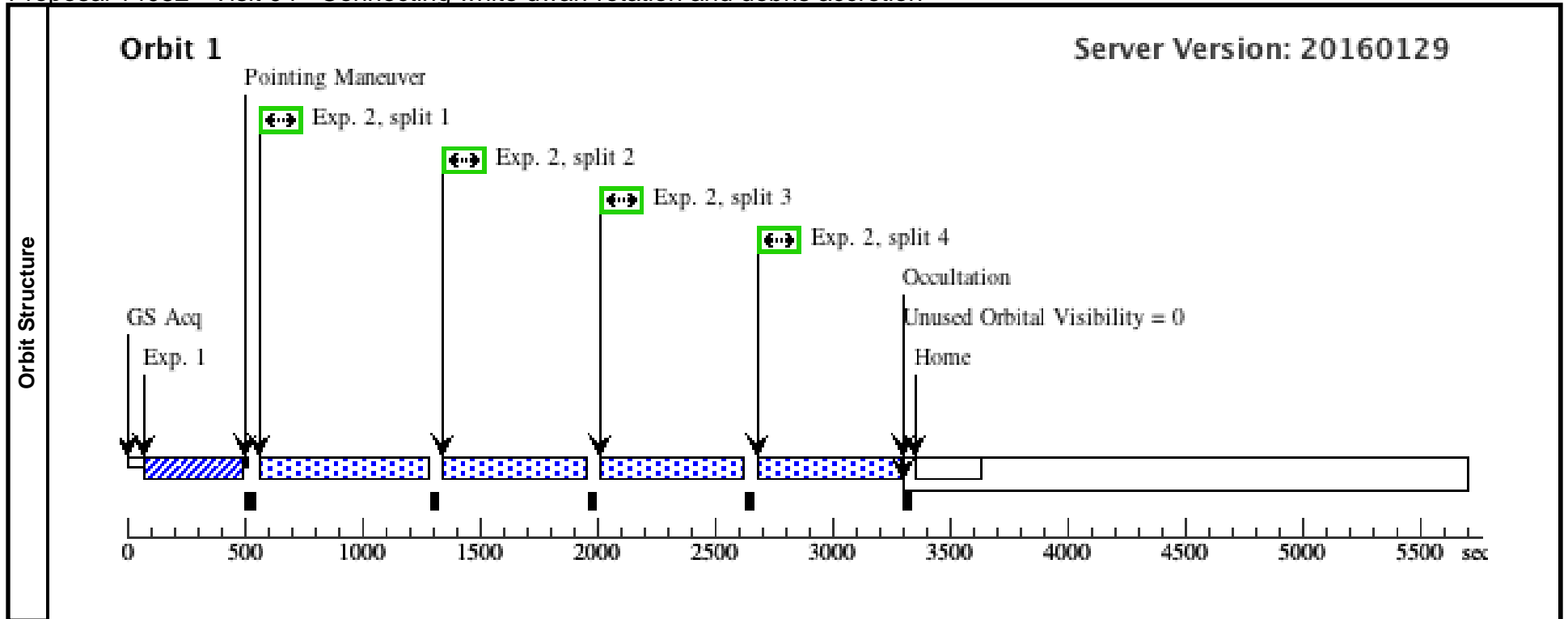
Visit	Proposal 14082, Visit 03 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 03) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections		Fluxes	Miscellaneous			
	(3)	WD1927+4219	RA: 19 26 46.0110 (291.6917125d) Dec: +42 19 35.32 (42.32648d) Equinox: J2000	Proper Motion RA: -5.1 mas/yr Proper Motion Dec: -2.7 mas/yr Epoch of Position: 2000		V=18.2+/-0.1 GALEX FUV=16.7AB, GALEX NUV=16.8AB	Reference Frame: ICRS			
Comments: P=0.6 d, A=500 ppm, T~34kK, DB E(B-V)=0.112 Temperature according to SED 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.766 877)	(3) WD1927+4219	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				32.2 Secs (32.2 Secs)	
									[==>]	[1]
2	(COS.sp.766 887)	(3) WD1927+4219	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=22 07; FP-POS=ALL				3000 Secs (2227 Secs)	
									[==>556.0 Secs (Split 1)] [==>556.0 Secs (Split 2)] [==>557.0 Secs (Split 3)] [==>558.0 Secs (Split 4)]	[1]
Comments: Exposure time (seconds) = 2,227.0000 at wavelength 1310.00A gives: SNR = 12.6901 (per resolution element)										



Proposal 14082 - Visit 04 - Connecting white dwarf rotation and debris accretion

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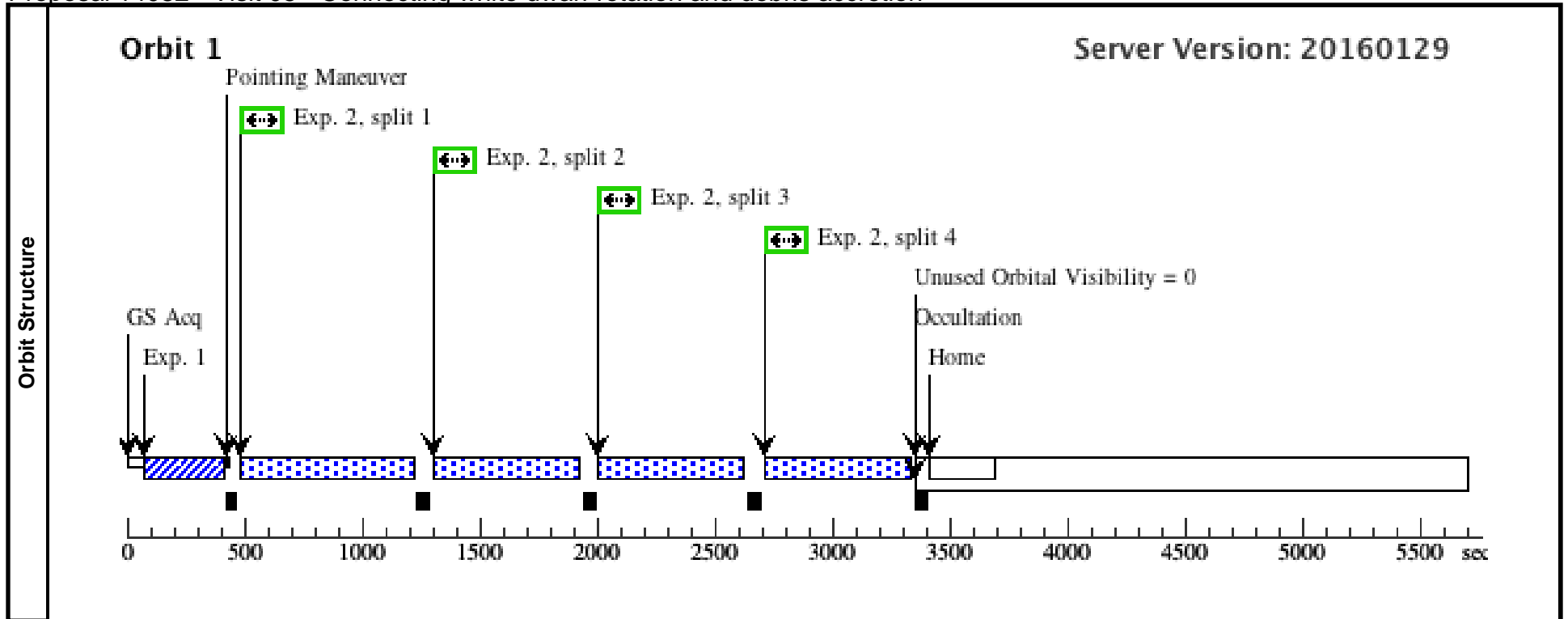
Visit	Proposal 14082, Visit 04 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 04) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(4)	WD1855+4207	RA: 18 55 46.0330 (283.9418042d) Dec: +42 07 4.43 (42.11790d) Equinox: J2000	Proper Motion RA: -0.1 mas/yr Proper Motion Dec: -4.6 mas/yr Epoch of Position: 2000	V=17.9+/-0.1 GALEX FUV=16.2AB	Reference Frame: ICRS				
Comments: P=0.37d,A=800 ppm,T=30.5kK DA E(B-V)=0.081 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.732 789)	(4) WD1855+4207	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				50.3 Secs (50.3 Secs)	
	2	(COS.sp.789 861)	(4) WD1855+4207	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=26 04; FP-POS=ALL			3000 Secs (2218 Secs)	[1]
Comments: Exposure time (seconds) = 2,218.0000 at wavelength 1310.00A gives: SNR = 15.9079 (per resolution element)										



Proposal 14082 - Visit 05 - Connecting white dwarf rotation and debris accretion

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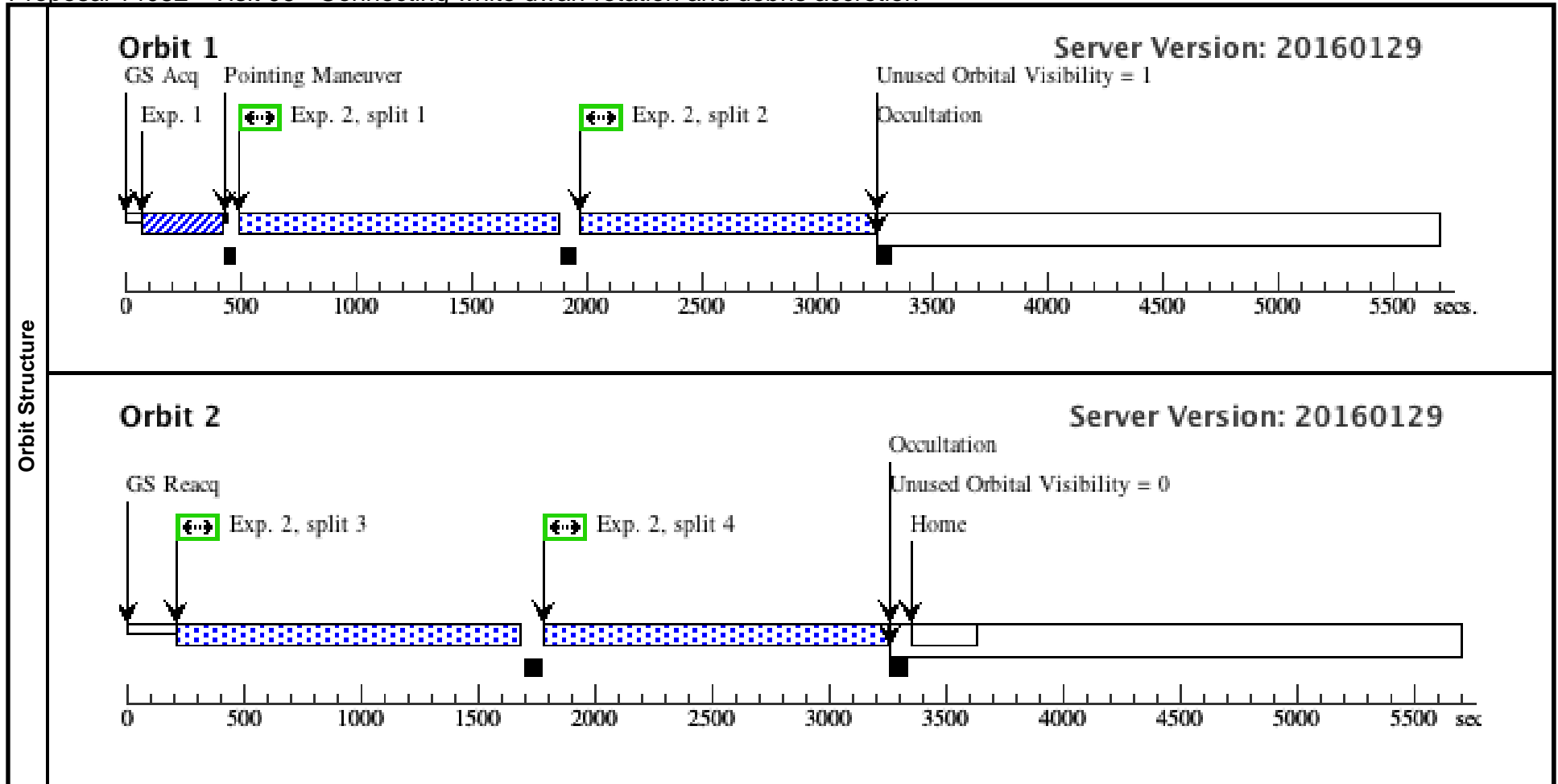
Visit	Proposal 14082, Visit 05 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 05) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections		Fluxes	Miscellaneous			
	(5)	WD1857+4909	RA: 18 57 47.1310 (284.4463792d) Dec: +49 09 39.25 (49.16090d) Equinox: J2000	Proper Motion RA: -10.8 mas/yr Proper Motion Dec: 68.9 mas/yr Epoch of Position: 2000		V=16.1+/-0.1 GALEX FUV=15.2AB	Reference Frame: ICRS			
Comments: P=0.09 d, A=300 ppm, T=23kK, DA E(B-V)=0.043 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.732 790)	(5) WD1857+4909	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				11.8 Secs (11.8 Secs)	
	2	(COS.sp.789 863)	(5) WD1857+4909	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=14 20; FP-POS=ALL			3000 Secs (2284 Secs)	[1]
Comments: Exposure time (seconds) = 2,284.0000 at wavelength 1310.00A gives: SNR = 24.2557 (per resolution element)										



Proposal 14082 - Visit 06 - Connecting white dwarf rotation and debris accretion

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Visit	Proposal 14082, Visit 06 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 06) 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				
	(6)	WD1919+3958	RA: 19 19 27.6850 (289.8653542d) Dec: +39 58 39.71 (39.97770d) Equinox: J2000	Proper Motion RA: 12.2 mas/yr Proper Motion Dec: 44.9 mas/yr Epoch of Position: 2000	V=15.8+/-0.1	Reference Frame: ICRS				
Comments: A<50 ppm. T=19kK, DA E(B-V)=0.1118 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.732 792)	(6) WD1919+3958	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				16.8 Secs (16.8 Secs)	
									[==>]	[1]
	2	(COS.sp.796 272)	(6) WD1919+3958	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=23 82; FP-POS=ALL			3000 Secs (5275 Secs)	
									[==>1223.0 Secs (Split 1)] [==>1224.0 Secs (Split 2)] [==>1414.0 Secs (Split 3)] [==>1414.0 Secs (Split 4)]	[1] [2]
Comments: Exposure time (seconds) = 5,275.0000 at wavelength 1310.00A gives: SNR = 18.7255 (per resolution element)										



Proposal 14082 - Visit 07 - Connecting white dwarf rotation and debris accretion

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Visit	Proposal 14082, Visit 07 Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 07) 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				
	(7)	WD1940+4240	RA: 19 40 59.3670 (295.2473625d) Dec: +42 40 31.30 (42.67536d) Equinox: J2000	Proper Motion RA: -40.6 mas/yr Proper Motion Dec: -57.5 mas/yr Epoch of Position: 2000	V=16.6+/-0.1	Reference Frame: ICRS				
Comments: A<80 ppm, T=24kK, DA+DA E(B-V) = 0.1513 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.732 795)	(7) WD1940+4240	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				28.3 Secs (28.3 Secs)	
									[==>]	[1]
	2	(COS.sp.796 279)	(7) WD1940+4240	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=25 69; FP-POS=ALL			3000 Secs (5332 Secs)	
									[==>1232.0 Secs (Split 1)] [==>1232.0 Secs (Split 2)] [==>1434.0 Secs (Split 3)] [==>1434.0 Secs (Split 4)]	[1] [2]
Comments: Exposure time (seconds) = 5,332.0000 at wavelength 1310.00A gives: SNR = 17.2929 (per resolution element)										

