14778 - Hiding in Plain Sight: The Low Mass Helium Star Companion of EL CVn

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Douglas Russell Gies (PI) (Contact)	**Georgia State University Research Foundation**	**gies@chara.gsu.edu**
Ms. Rachel Matson (CoI)	Georgia State University Research Foundation	rmatson@chara.gsu.edu
Mr. Zhao Guo (CoI)	Georgia State University Research Foundation	guo@chara.gsu.edu
Ms. Luqian Wang (CoI)	Georgia State University Research Foundation	lwang@chara.gsu.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) V-EL-CVN	COS/FUV COS/NUV	1	29-Jul-2016 15:37:52.0	yes
02	(1) V-EL-CVN	COS/FUV COS/NUV	1	29-Jul-2016 15:37:54.0	yes
03	(1) V-EL-CVN	COS/FUV COS/NUV	1	29-Jul-2016 15:37:55.0	yes
04	(1) V-EL-CVN	COS/FUV COS/NUV	1	29-Jul-2016 15:37:57.0	yes

4 Total Orbits Used

ABSTRACT

Binary stars with orbital periods of a decade or less are destined to interact during their evolution. The mass donor star among intermediate

binaries may be stripped of its envelope by mass transfer to reveal its helium core. In cases that avoid merger, the low mass helium star will remain in a binary orbit but be lost in the glare of the mass gainer star. Thanks to photometric time series from Kepler and WASP, we now know of 27 such systems that are oriented to produce mutual eclipses. Although the helium star companions are too small and faint in the optical band for spectroscopic detection, they contribute a larger fraction of the total flux in the ultraviolet. HST/COS measurements of one long period system, KOI-81, successfully detected the helium star's spectrum in the far-ultraviolet, leading to estimates of its mass and temperature.
Here we propose to obtain new HST/COS FUV spectra of the prototype of this class of evolved binaries, EL CVn, and to determine the mass and physical properties of a star that barely escaped a merger.

OBSERVING DESCRIPTION

We propose to obtain COS spectra of the FUV spectrum of EL CVn using the G160M grating to cover most of the spectrum from 1386 to 1774 Angstroms with a resolving power of 22,000.
In order to meet our radial velocity measurement criteria, we need to obtain a S/N per resolution element of 25 or better.
This S/N level can be achieved with multiple exposures.
We created model spectra from the UVBLUE grid for both component stars using temperatures from Maxted et al. (2014).
We scaled the flux of the hot component by (R2/R1)^2, and then formed the sum of the two spectra. The summed spectrum was reduced for interstellar extinction using E(B-V)=0.065 and then normalized to the observed GALEX FUV flux in the vicinity of 1528 Angstroms.

We used the COS ETC with the summed model spectrum
to estimate that a single S/N = 12.3 spectrum can be
obtained with an exposure time of 153 s. Following the example
in the Instrument Handbook, we would obtain one exposure at
each of four FP-POS spectral offsets and two CENWAVE postions
to increase the net S/N to 35. By making four visits at different orbital
phases, the final S/N in the reconstructed spectra will be about 69.
Note that we expect to observe radial velocity semiamplitudes of
29 and 267 km/s for the orbits of the primary and white dwarf,
respectively (Maxted et al. 2014), which should be readily measured.
All these exposures will be made in TIME-TAG mode. There are no
bright limit problems associated with this target.

We estimate that there are 55 minutes of visibility per orbit
for the position of EL CVn. In one orbit, we require 8 minutes for
acquisition and a COS ACQ/IMAGE centering on the aperture
(ICRS astrometry is good enough for this direct acquisition).
This leaves time for eight science exposures of 153 sec each
(with preparation and readout times included).
Thus, we will need only one orbit for each visit to obtain
a combined spectrum with the requisite S/N.
Note that the binary orbital period (19 hours) is much longer
than the HST orbit, so any orbital related changes over
the duration of the exposures is small.

In order to determine the orbital elements for each star from
the Doppler shifts, we will require four visits, with two each
around the times of highest and lowest radial velocity excursions.
Because the orbital period is so short, there are many

opportunities during Cycle 24 to obtain the spectra during the
orbital phases required.

Visit

Proposal 14778, Visit 01 Fri Jul 29 19:37:57 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 0.7956269 D AND ZERO-PHASE HJD2454230.5558

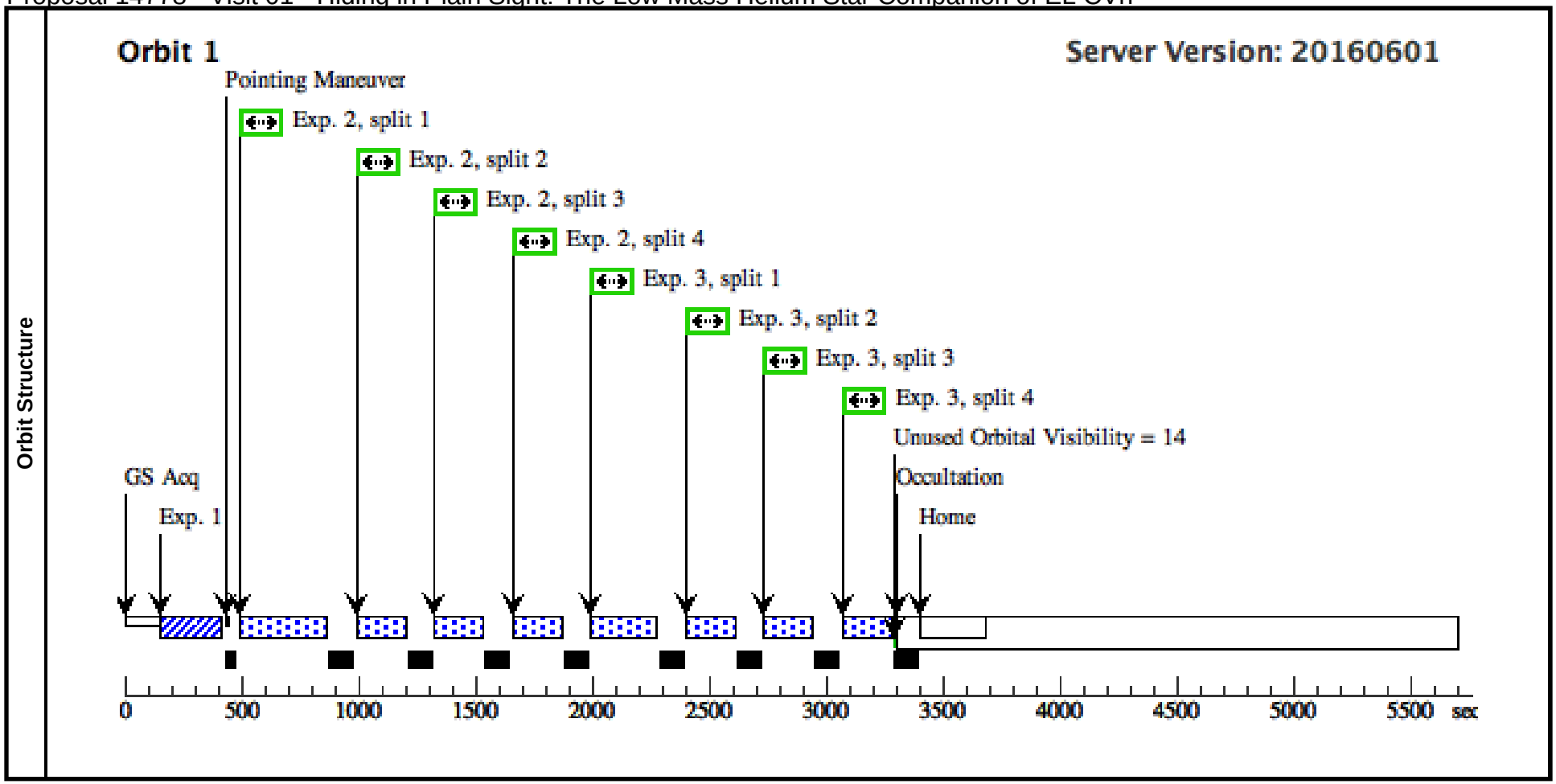
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EL-CVN Alt Name1: HD116608 Alt Name2: HIP65380	RA: 13 23 57.0187 (200.9875779d) Dec: +43 35 55.44 (43.59873d) Equinox: J2000	Proper Motion RA: 19.34 mas/yr Proper Motion Dec: -18.47 mas/yr Parallax: 0.00384" Epoch of Position: 2000.	V=9.42+/-0.02 F(1528 Angstroms) = 1.9e-13 erg/s/cm^2/Angstrom (GALEX FUV)	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
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.820593)	(1) V-EL-CVN	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.11 TO 0.26		15 Secs (15 Secs)	
								[==>]	***[1]***
2	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***


Orbit Structure
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Server Version: 20160601
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Exp. 3, split 4
Unused Orbital Visibility = 14
Occultation
Home
GS Acq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14778, Visit 02 Fri Jul 29 19:37:58 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 0.7956269 D AND ZERO-PHASE HJD2454230.5558

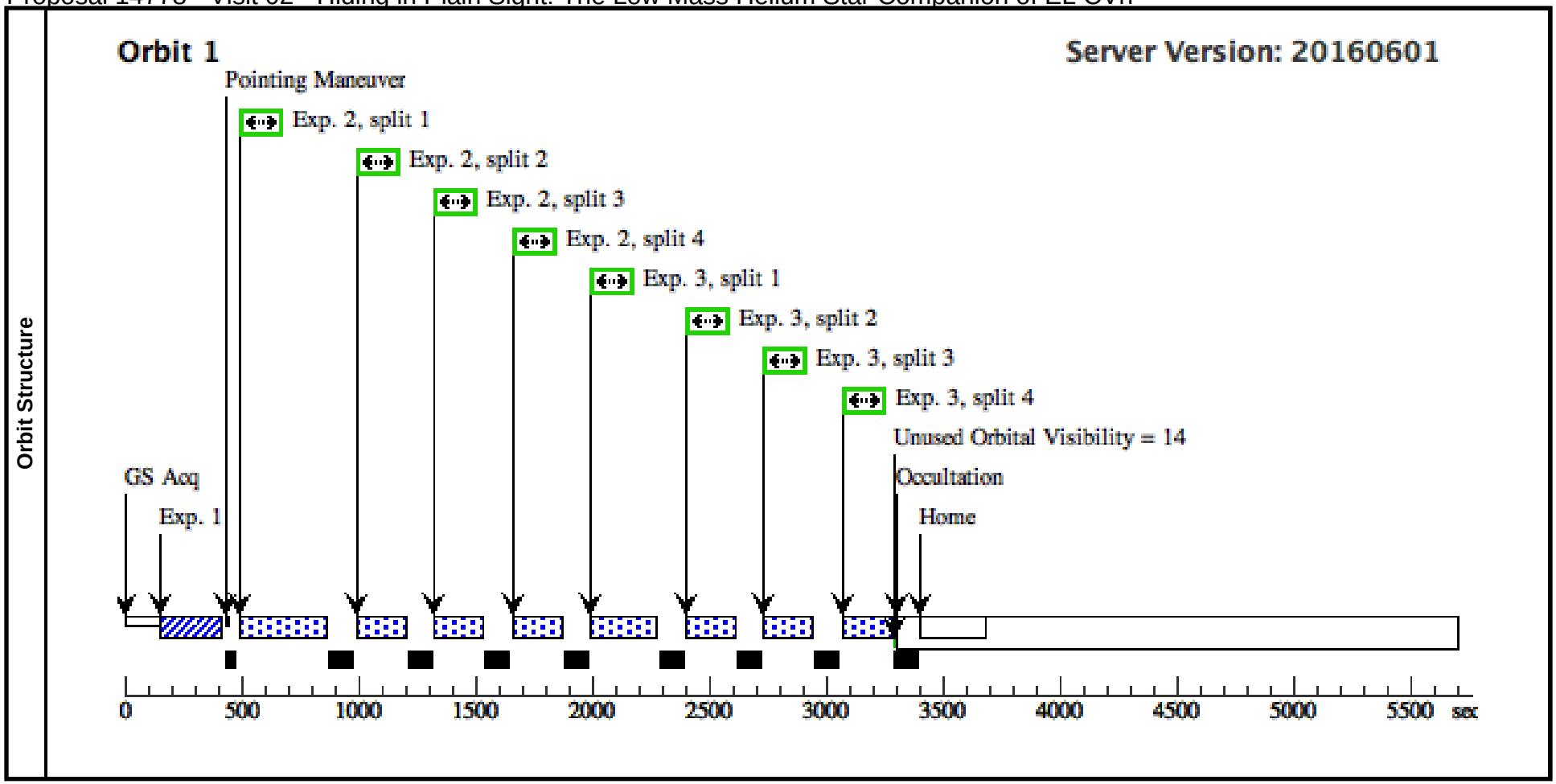
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EL-CVN Alt Name1: HD116608 Alt Name2: HIP65380	RA: 13 23 57.0187 (200.9875779d) Dec: +43 35 55.44 (43.59873d) Equinox: J2000	Proper Motion RA: 19.34 mas/yr Proper Motion Dec: -18.47 mas/yr Parallax: 0.00384" Epoch of Position: 2000.	V=9.42+/-0.02 F(1528 Angstroms) = 1.9e-13 erg/s/cm^2/Angstrom (GALEX FUV)	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
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.820593)	(1) V-EL-CVN	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.24 TO 0.39		15 Secs (15 Secs)	
								[==>]	***[1]***
2	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20160601
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Exp. 3, split 4
Unused Orbital Visibility = 14
Occultation
Home
GS Acq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14778, Visit 03 Fri Jul 29 19:37:58 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 0.7956269 D AND ZERO-PHASE HJD2454230.5558

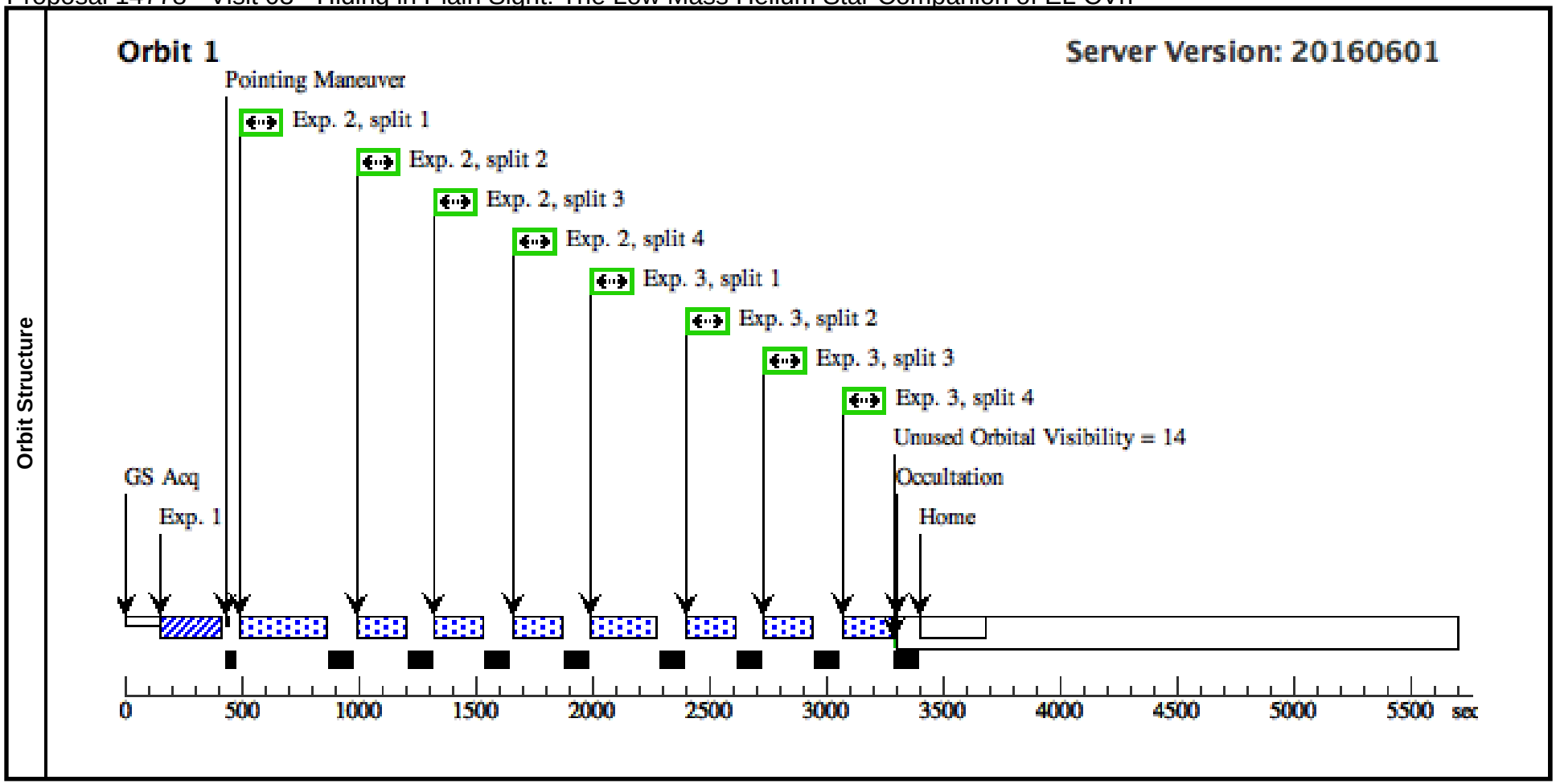
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EL-CVN Alt Name1: HD116608 Alt Name2: HIP65380	RA: 13 23 57.0187 (200.9875779d) Dec: +43 35 55.44 (43.59873d) Equinox: J2000	Proper Motion RA: 19.34 mas/yr Proper Motion Dec: -18.47 mas/yr Parallax: 0.00384" Epoch of Position: 2000.	V=9.42+/-0.02 F(1528 Angstroms) = 1.9e-13 erg/s/cm^2/Angstrom (GALEX FUV)	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
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.820593)	(1) V-EL-CVN	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.61 TO 0.76		15 Secs (15 Secs)	
								[==>]	***[1]***
2	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20160601
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Exp. 3, split 4
Unused Orbital Visibility = 14
Occultation
Home
GS Acq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14778, Visit 04 Fri Jul 29 19:37:58 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: Period 0.7956269 D AND ZERO-PHASE HJD2454230.5558

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EL-CVN Alt Name1: HD116608 Alt Name2: HIP65380	RA: 13 23 57.0187 (200.9875779d) Dec: +43 35 55.44 (43.59873d) Equinox: J2000	Proper Motion RA: 19.34 mas/yr Proper Motion Dec: -18.47 mas/yr Parallax: 0.00384" Epoch of Position: 2000.	V=9.42+/-0.02 F(1528 Angstroms) = 1.9e-13 erg/s/cm^2/Angstrom (GALEX FUV)	Reference Frame: ICRS

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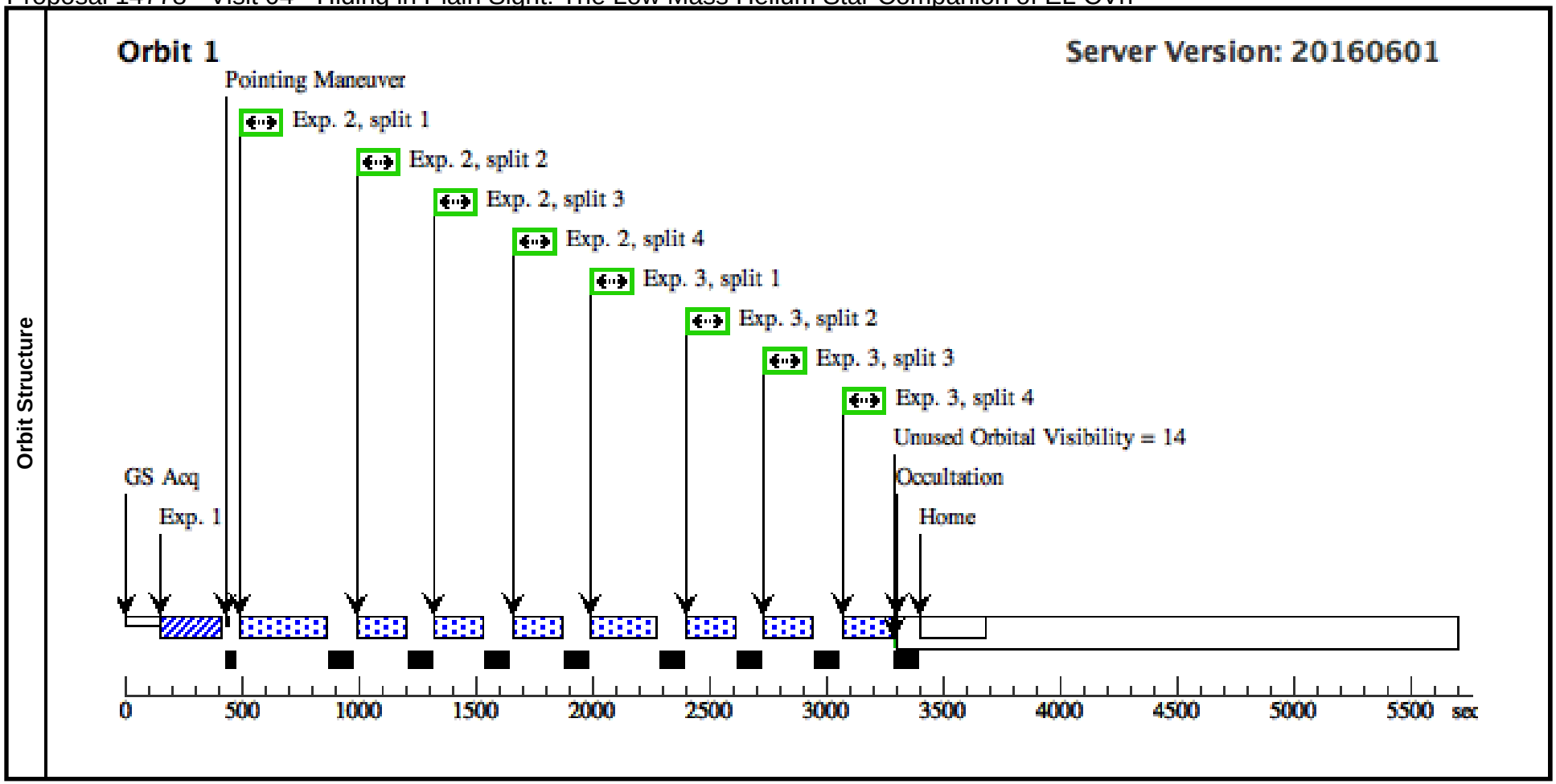
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.820593)	(1) V-EL-CVN	COS/NUV, ACQ/IMAGE, BOA	MIRRORA		PHASE 0.74 TO 0.89		15 Secs (15 Secs)	
								[==>]	***[1]***
2	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***
3	(COS.sp.820633)	(1) V-EL-CVN	COS/FUV, TIME-TAG, PSA	G160M 1600 A	BUFFER-TIME=153; FP-POS=ALL			153 Secs (612 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]*	***[1]***


Orbit 1
Server Version: 20160601
Orbit Structure
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Exp. 3, split 4
Unused Orbital Visibility = 14
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