



## 15897 - ZTF J1539+5027: the Shortest Period Eclipsing White Dwarf Binary

Cycle: 27, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

### INVESTIGATORS

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### 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) ZTFJ153932.16+502738.8	COS/FUV COS/NUV	5	04-Dec-2019 16:00:53.0	yes
02	(1) ZTFJ153932.16+502738.8	COS/FUV COS/NUV	5	04-Dec-2019 16:00:55.0	yes

10 Total Orbits Used

## **ABSTRACT**

Here, we propose to obtain high resolution ultraviolet spectroscopy using COS on the shortest eclipsing binary system known, the double white dwarf binary ZTF J1539+5027 (submitted to Nature). This deeply eclipsing binary system has an orbital period of 6.91 minutes and exhibits a rapid orbital decay due to the emission of gravitational radiation. The binary emits gravitational waves near the peak of the Laser Interferometer Space Antenna's (LISA) sensitivity, making it one of the strongest LISA gravitational wave sources, with detection expected within the first week of operations. We are requesting Hubble's unique capability to obtain high resolution far-ultraviolet spectroscopy because the more compact white dwarf in this system is 50,000K despite its short cooling age, suggesting heating via accretion; however, no signs of accretion have been detected in the optical or X-ray. If we fail to detect metal lines visible uniquely in the UV, we will be able place an upper limit on the accretion rate to a level 8 orders of magnitude below what is currently possible in the X-ray or optical, ruling out the possibility that this white dwarf is currently heated by ongoing mass-transfer. If we detect metal lines, we will measure the accretion rate, obtain precise radial velocity semi-amplitudes of the components. Additionally, by using Lyman absorption lines as well as the ratio of metal lines (if present), we will be able to accurately measure the temperature of the primary, refining the distance estimate to the system. Finally, by obtaining a high SNR ultraviolet lightcurve, we will constrain the temperature ratio of the two components.

## **OBSERVING DESCRIPTION**

This program will obtain time-resolved intermediate resolution spectroscopy of the ultra-short-period eclipsing double-white dwarf binary to

- (1) determine an accurate effective temperature of the hotter white dwarf from its Ly alpha absorption profile
- (2) construct a far-ultraviolet eclipse light curve to model the stellar radii
- (3) probe for photospheric metal lines arising from accretion from the companion

The target acquisition is done via near-UV imaging. However, as the primary, which totally dominates the ultraviolet flux, is eclipsed every 7min, we need to implement an ephemeris timing constraint to avoid that the target acquisition occurs during primary eclipse.

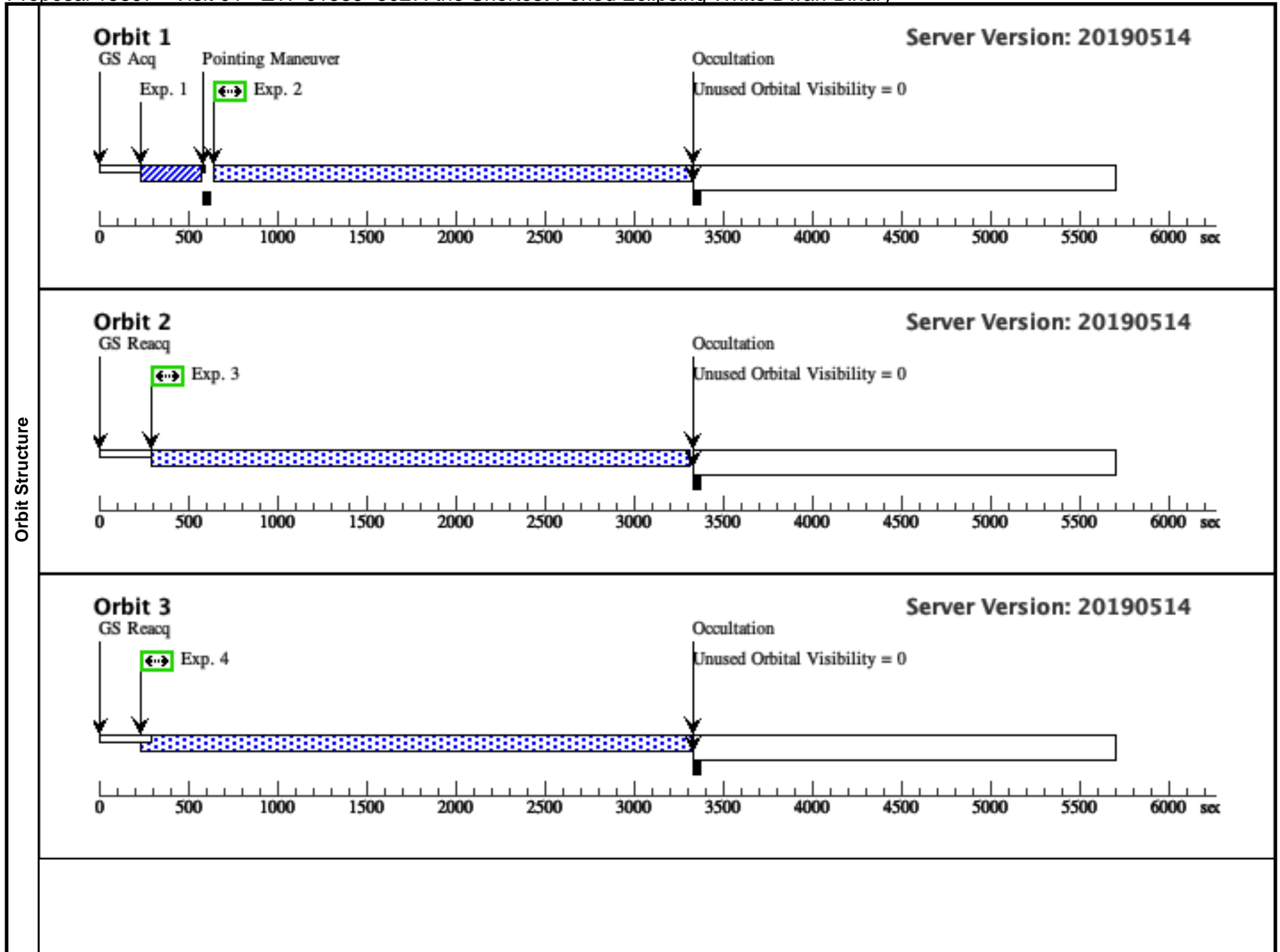
We split this ten-orbit program into two five-orbit visits, using the 1291A and 1222A central wavelengths to maximise the total wavelength range covered: extending the blue Ly alpha wing, and covering the Si IV 1393/1403A resonance lines. We will achieve a combined signal-to-noise ratio of ~20 in the overlapping region.

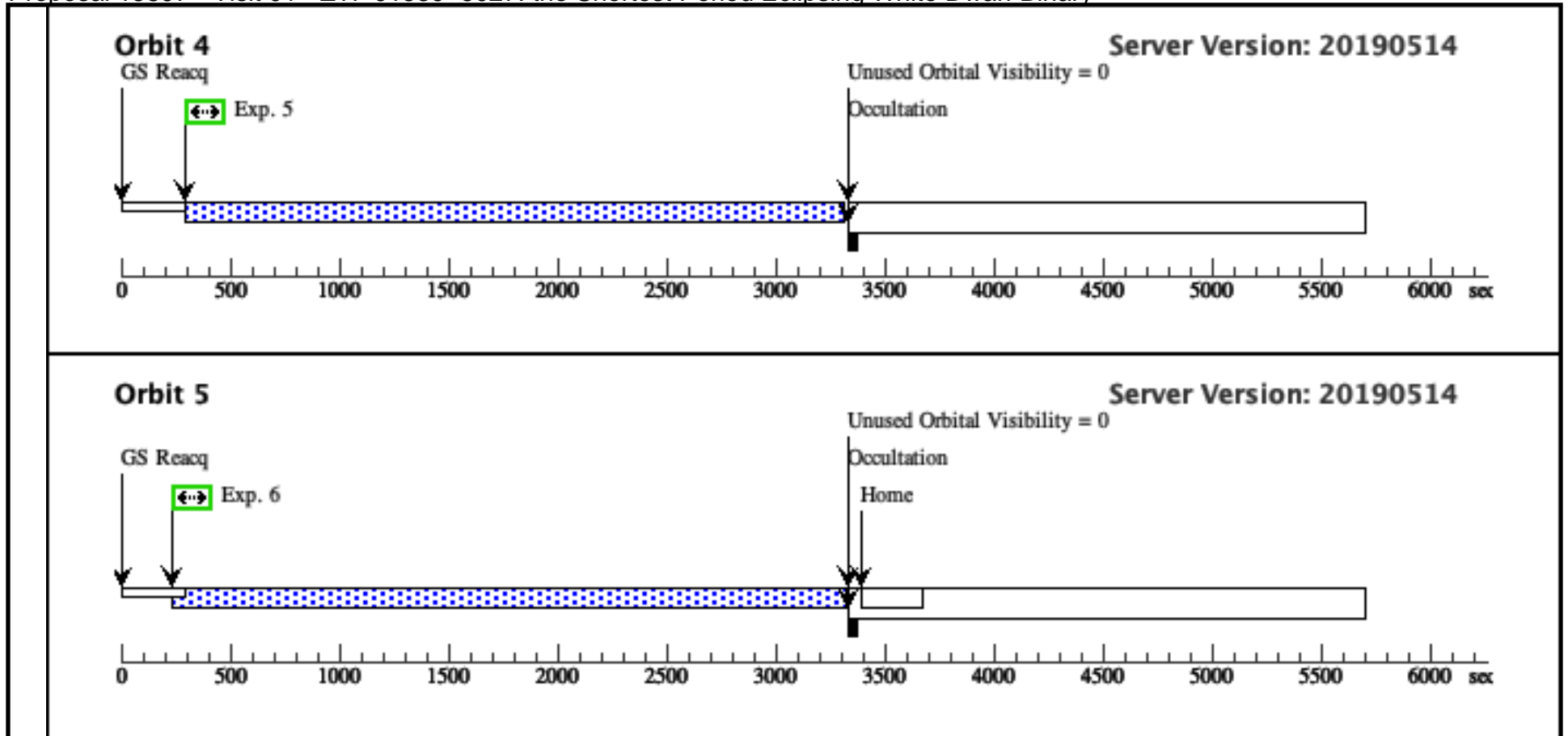
The time-tagged photon stream will be used to construct average spectra on the 7min orbital period of the system, and far-ultraviolet light curves in at least two wavelength bands .

Proposal 15897 - Visit 01 - ZTF J1539+5027: the Shortest Period Eclipsing White Dwarf Binary

Wed Dec 04 21:00:56 GMT 2019

<b>Visit</b>	<b>Proposal 15897, Visit 01, implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS (Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS									
<b>Diagnosics</b>										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>		<b>Fluxes</b>	<b>Miscellaneous</b>			
	(1)	ZTFJ153932.16+502738.8	RA: 15 39 32.1588 (234.8839950d) Dec: +50 27 38.78 (50.46077d) Equinox: J2000	Proper Motion RA: -3.413 mas/yr Proper Motion Dec: -3.823 mas/yr Epoch of Position: 2000		V=20.2+/-0.2 GALEX FUV=18.75 NUV=19.3 3	Reference Frame: ICRS			
Comments: Category=STAR Description=[DA] Extended=NO										
<b>Exposures</b>	<b>#</b>	<b>Label (ETC Run)</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	(COS.ta.136 8076)	(1) ZTFJ153932.16+502738.8	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				60 Secs (60 Secs) [==>]	[1]
	2	(COS.sp.136 8077)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=94 97; FP-POS=3			2508 Secs (2508 Secs) [==>]	[1]
	3	(COS.sp.136 8077)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=94 97; FP-POS=4			2967 Secs (2967 Secs) [==>]	[2]
	4	(COS.sp.136 8077)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=94 97; FP-POS=3			2967 Secs (2967 Secs) [==>]	[3]
	5	(COS.sp.136 8077)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=94 97; FP-POS=4			2967 Secs (2967 Secs) [==>]	[4]
	6	(COS.sp.136 8077)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=94 97; FP-POS=3			2967 Secs (2967 Secs) [==>]	[5]





Proposal 15897 - Visit 02 - ZTF J1539+5027: the Shortest Period Eclipsing White Dwarf Binary

Wed Dec 04 21:00:56 GMT 2019

<b>Visit</b>	<b>Proposal 15897, Visit 02, implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none)									
	(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS									
<b>Fixed Targets</b>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	ZTFJ153932.16+502738.8	RA: 15 39 32.1588 (234.8839950d) Dec: +50 27 38.78 (50.46077d) Equinox: J2000	Proper Motion RA: -3.413 mas/yr Proper Motion Dec: -3.823 mas/yr Epoch of Position: 2000	V=20.2+/-0.2 GALEX FUV=18.75 NUV=19.3 3	Reference Frame: ICRS				
Comments: Category=STAR Description=[DA] Extended=NO										
<b>Exposures</b>	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(COS.ta.136 8076)	(1) ZTFJ153932.16+502738.8	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				60 Secs (60 Secs) [==>]	[1]
	2	(COS.sp.136 8351)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=94 97; FP-POS=3			2493 Secs (2493 Secs) [==>]	[1]
	3	(COS.sp.136 8351)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=94 97; FP-POS=4			2967 Secs (2967 Secs) [==>]	[2]
	4	(COS.sp.136 8351)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=94 97; FP-POS=1			2967 Secs (2967 Secs) [==>]	[3]
	5	(COS.sp.136 8351)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=94 97; FP-POS=2			2967 Secs (2967 Secs) [==>]	[4]
	6	(COS.sp.136 8351)	(1) ZTFJ153932.16+502738.8	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=94 97; FP-POS=3			2967 Secs (2967 Secs) [==>]	[5]

