



# 15823 - Proper Motions and UV Spectroscopy of the MgII nebula around Eta Carinae

Cycle: 27, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Nathan Smith (PI) (Contact)</b>	<b>University of Arizona</b>	<b>nathans@as.arizona.edu</b>
Dr. Jon A. Morse (CoI)	BoldlyGo Institute	jamorse@boldlygo.org

## 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>
04	(1) ETA-CAR	WFC3/UVIS	3	11-Feb-2021 12:00:13.0	yes
02	(1) ETA-CAR WAVE	STIS/CCD	2	11-Feb-2021 12:00:15.0	yes
03	(1) ETA-CAR	STIS/CCD	2	11-Feb-2021 12:00:16.0	yes

7 Total Orbits Used

## ABSTRACT

In Cycle 25, a UV image of Mg II 2800 emission in the nebula around the massive star Eta Carinae was obtained using the F280N filter with WFC3. This was the first WFC3 imaging of Eta Car, the first image of Mg II around a massive star, and the first deep UV image of its nebulosity. That image revealed strong Mg II emission, but with unexpected morphology. Mg II is anticorrelated with any other line emission features seen previously in typical tracers like H $\alpha$ , [N II], or [Fe II] emission. Mg II emission provides an entirely new view of Eta Car, revealing a significant reservoir of additional ejecta mass and kinetic energy outside the main bipolar nebula, which has been invisible in all other imaging filters used so far. The

MgII emission is probably resonance scattering of near-UV starlight, tracing dense warm neutral gas that is unshocked. Since it is outside the main bipolar nebula, it may hold critical clues about the acceleration of the ejecta and the mass loss and instability of the star in the decades leading up to the eruption that cannot be ascertained any other way. We therefore propose to obtain a second epoch of imaging for proper motions, and deep STIS spectroscopy of the extended MgII emission in order to measure its expansion speed and its 3D structure. The measured ratio of the MgII doublet will trace the optical depth of the line and test our hypothesis that it is resonance scattering, allowing a rough mass estimate of this material. Combined with velocities from proper motions and spectra, these observations will therefore constrain the kinetic energy that this material adds to the total energy budget of Eta Carinae's eruption.

### **OBSERVING DESCRIPTION**

This program has two observational goals. One is to obtain a second epoch of imaging in the WFC3/UVIS F280N, F336W, and F658N filters in order to measure proper motions of Mg II 2800 AA emission, near-UV continuum, and [N II] emission as compared to previous epochs. Toward this goal, we duplicate as closely as possible our previous observation. The second observational goal is to obtain long-slit STIS spectra of Mg II 2800 AA line from ejecta immediately outside the bipolar Homunculus nebula in order to measure radial velocities along the slit, and hence, 3D kinematics in combination with proper motions. The WFC3 imaging uses two CVZ orbits (one for a deep F280N image, and one for both F336W and F658N). The STIS spectra use 4 CVZ orbits, with two different slit positions (2 orbits each).

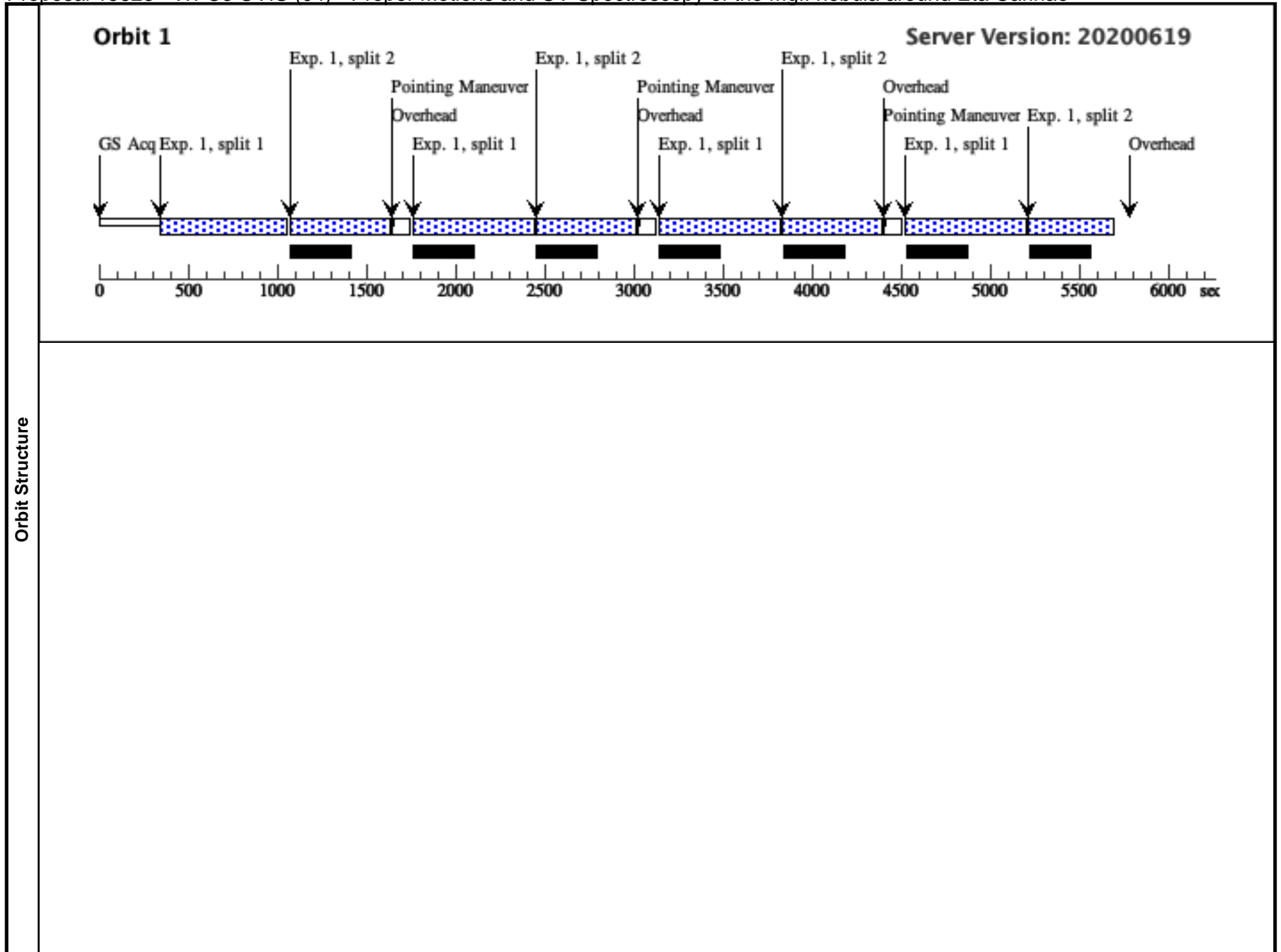
Proposal 15823 - WFC3 UVIS (04) - Proper Motions and UV Spectroscopy of the MgII nebula around Eta Carinae

Thu Feb 11 17:00:16 GMT 2021

<b>Visit</b>	<b>Proposal 15823, WFC3 UVIS (04), completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: WFC3/UVIS Special Requirements: CVZ; ORIENT 345D TO 355 D <i>Comments: Any ORIENT could suffice for these observations, however duplicating the orientation of program 15289 UVIS F280N observations would be helpful for data analysis and directs the diffraction spikes and CCD saturation bleeding away from important outer emission. The image header states that PA_V3 = 169.08 degrees for the March 2018 F280N images. Please duplicate this orientation (or use 349.08 degrees) if possible.</i>					
	<b>Diagnosics</b> (MgII-L (04.001)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (MgII-S (04.002)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (MgII-M1 (04.003)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (MgII-M2 (04.004)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (F336W-S (04.005)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (F336W-M1 (04.006)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (F336W-M2 (04.007)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (NII-S (04.008)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (NII-M1 (04.009)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (NII-M2 (04.010)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (F336W-L (04.011)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser (NII-L (04.012)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser					
<b>Patterns</b>	<b>#</b>	<b>Primary Pattern</b>	<b>Secondary Pattern</b>	<b>Exposures</b>		
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<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)	ETA-CAR	RA: 10 45 3.5460 (161.2647750d) Dec: -59 41 3.95 (-59.68443d) Equinox: J2000		V=6.21	Reference Frame: ICRS
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=STAR Description=[CIRCUMSTELLAR MATTER, ETA CARINAE STAR] Extended=YES						

Proposal 15823 - WFC3 UVIS (04) - Proper Motions and UV Spectroscopy of the MgII nebula around Eta Carinae

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
Exposures	1	MgII-L	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS-CENTER	F280N	CR-SPLIT=2; FLASH=2.0	GS ACQ SCENARIO BASE1B3	Pattern 4, Exps 1-1 in WFC3 UVIS (04) (4)	1120 Secs (4480 Secs) [==>(Pattern 1, Split 1)] [==>(Pattern 1, Split 2)] [==>(Pattern 2, Split 1)] [==>(Pattern 2, Split 2)] [==>(Pattern 3, Split 1)] [==>(Pattern 3, Split 2)] [==>(Pattern 4, Split 1)] [==>(Pattern 4, Split 2)]	[1]
	2	MgII-S	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	1.8 Secs (3.6 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	3	MgII-M1	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	20 Secs (40 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	4	MgII-M2	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	400 Secs (800 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	5	F336W-S	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	0.5 Secs (1 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	6	F336W-M1	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	8 Secs (16 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	7	F336W-M2	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	36 Secs (72 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	8	NII-S	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F658N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	0.5 Secs (1 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	9	NII-M1	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F658N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	8 Secs (16 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	10	NII-M2	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F658N	FLASH=2.0		Pattern 2, Exps 2-10 in WFC3 UVIS (04) (2)	36 Secs (72 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	11	F336W-L	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS-CENTER	F336W	FLASH=2.0		Pattern 2, Exps 11-12 in WFC3 UVIS (04) (2)	400 Secs (800 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]
	12	NII-L	(1) ETA-CAR	WFC3/UVIS, ACCUM, UVIS-CENTER	F658N	FLASH=2.0		Pattern 2, Exps 11-12 in WFC3 UVIS (04) (2)	360 Secs (720 Secs) [==>(Pattern 1)] [==>(Pattern 2)]	[2]



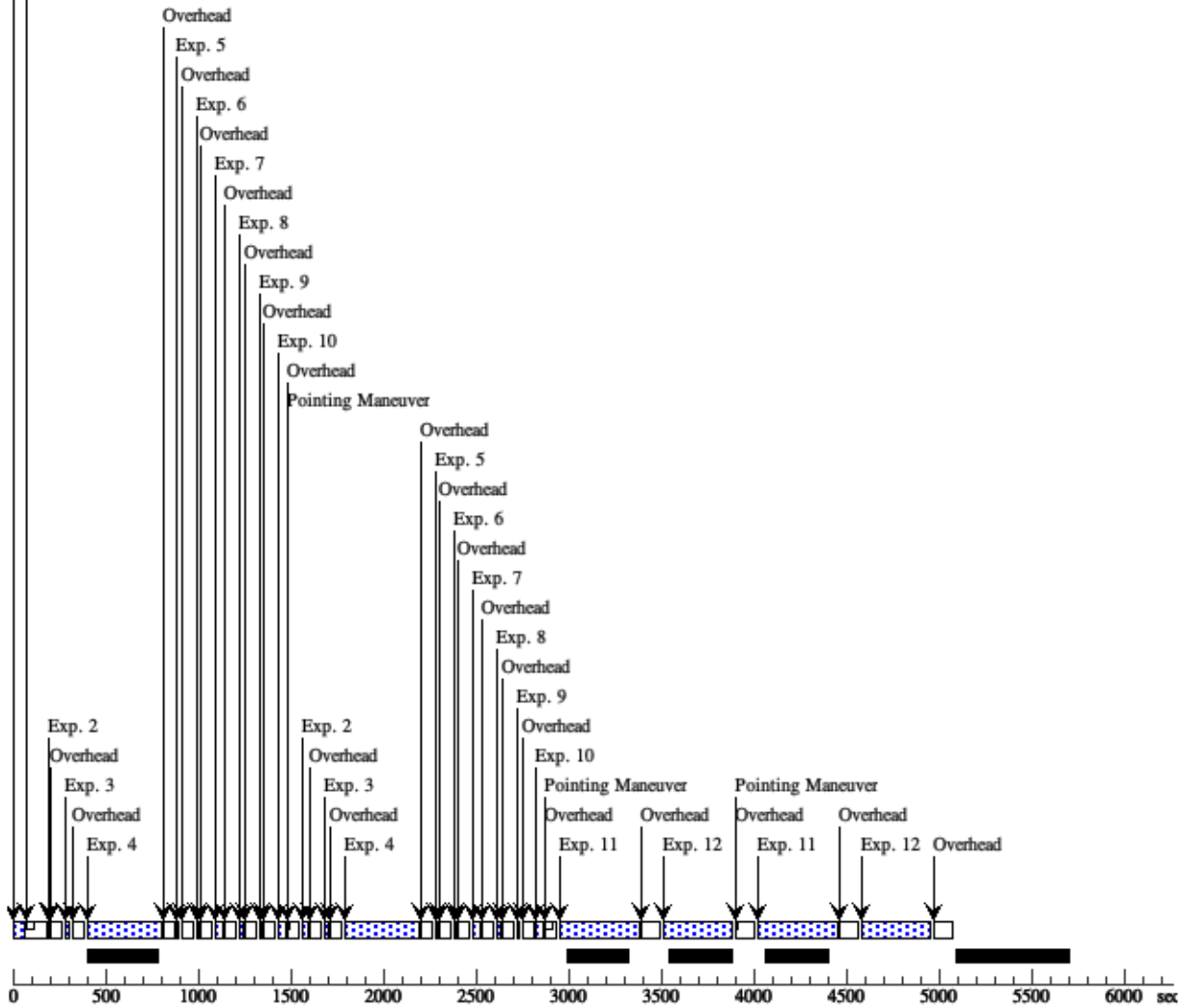
**Orbit 2**

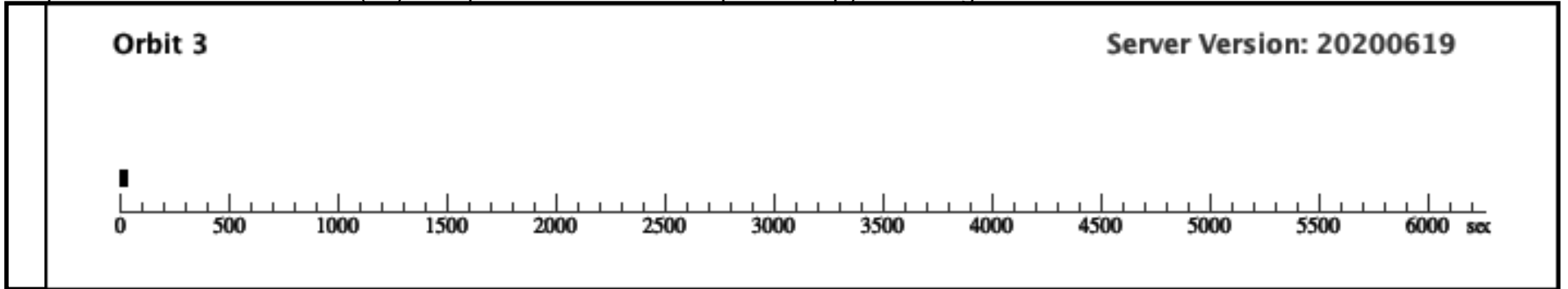
Server Version: 20200619

Overhead (cont'd)

Exp. 1, split 2 (cont'd)

Pointing Maneuver

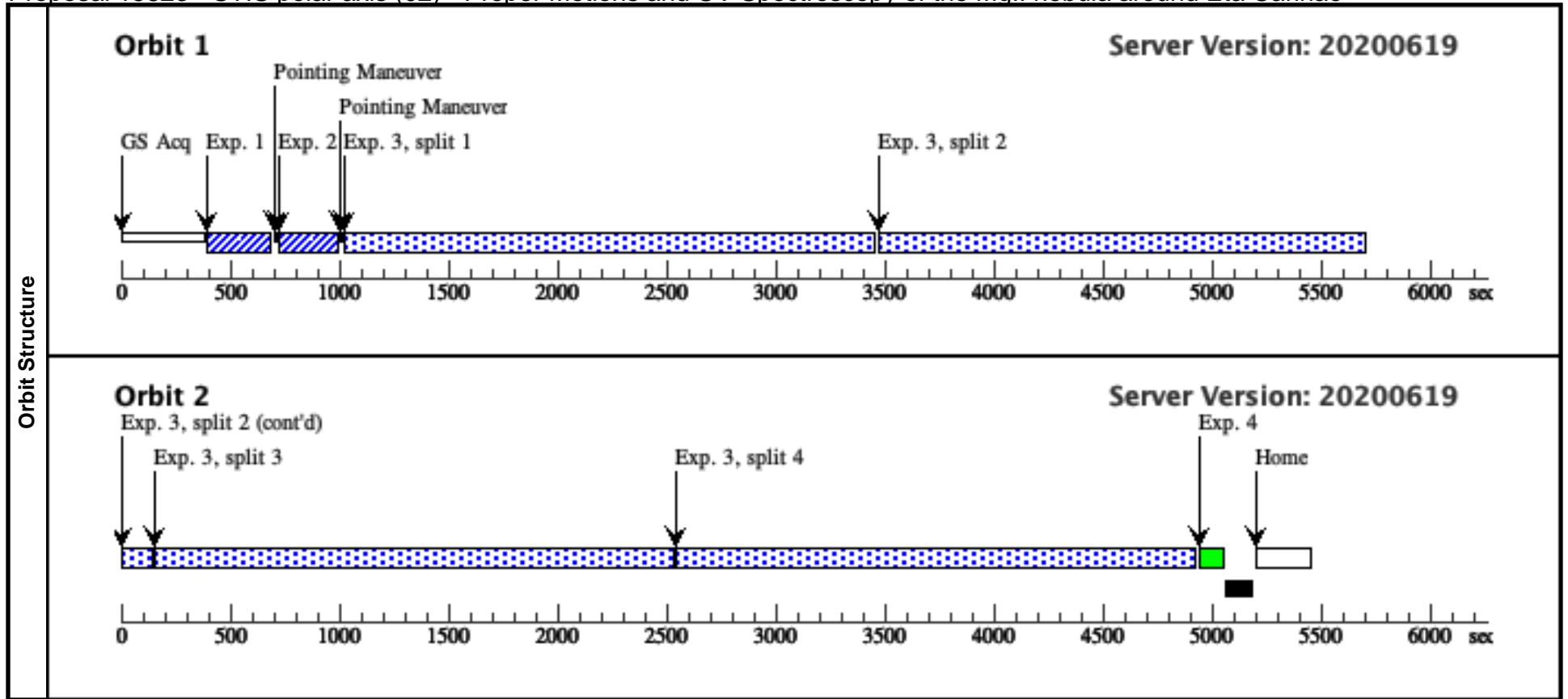




Proposal 15823 - STIS polar axis (02) - Proper Motions and UV Spectroscopy of the Mqll nebula around Eta Carinae

Thu Feb 11 17:00:17 GMT 2021

<b>Visit</b>	<b>Proposal 15823, STIS polar axis (02), implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD Special Requirements: CVZ; ORIENT 350D TO 360 D; ORIENT 170D TO 180 D <i>Comments: STIS spectrum with slit oriented roughly along polar axis</i>																																																										
	<b>Diagnosics</b> (STIS polar axis (02)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS polar axis (02)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS polar axis (02)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS polar axis (02)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS polar axis (02)) Warning (Orbit Planner): STIS SCIENCE TOO FAR FROM WAVECAL (STIS polar axis (02)) Warning (Orbit Planner): STIS SCIENCE TOO FAR FROM WAVECAL																																																										
<b>Fixed Targets</b>	<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>ETA-CAR</td> <td>RA: 10 45 3.5460 (161.2647750d) Dec: -59 41 3.95 (-59.68443d) Equinox: J2000</td> <td></td> <td>V=6.21</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=[CIRCUMSTELLAR MATTER, ETA CARINAE STAR]                  Extended=YES</p>										#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	ETA-CAR	RA: 10 45 3.5460 (161.2647750d) Dec: -59 41 3.95 (-59.68443d) Equinox: J2000		V=6.21	Reference Frame: ICRS																																					
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3		(1) ETA-CAR	STIS/CCD, ACCUM, 52X0.5	G230MB 2794 A	CR-SPLIT=4; WAVECAL=NO	POS TARG -1.5,0.0		9400 Secs (9400 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[1] [2]																																																		
4		WAVE	STIS/CCD, ACCUM, 52X0.05	G230MB 2794 A				[==>]	[2]																																																		
<b>Exposures</b>																																																											



Proposal 15823 - STIS minor axis (03) - Proper Motions and UV Spectroscopy of the Mqll nebula around Eta Carinae

Thu Feb 11 17:00:17 GMT 2021

<b>Visit</b>	<b>Proposal 15823, STIS minor axis (03), completed</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD Special Requirements: CVZ; ORIENT 255D TO 275 D; ORIENT 75D TO 95 D <i>Comments: STIS spectrum with slit oriented roughly perpendicular to the polar axis</i>																																																
	<b>Diagnosics</b> (STIS minor axis (03)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS minor axis (03)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS minor axis (03)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE (STIS minor axis (03)) Warning (Orbit Planner): POS TARG OUTSIDE OF APERTURE																																																
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