



16176 - ``Last Call!'' Eta Carinae's Spectroscopic Event in 2020

Cycle: 28, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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Dr. Kazunori Ishibashi (CoI)	Nagoya University	bish@nagoya-u.jp

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) ETA-CAR-A WAVE	STIS/CCD	1	18-Dec-2020 15:00:20.0	yes
02	(1) ETA-CAR-A	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	1	18-Dec-2020 15:00:21.0	yes

2 Total Orbits Used

ABSTRACT

Eta Car, the only giant eruption survivor that can be studied well, has been unsteady in recovering from the 1830-1870 explosion. About 20 years ago its spectroscopic and photometric trends dramatically accelerated -- signaling a rapid decrease in the primary mass loss rate. This is a novel clue to the stellar interior's thermal and rotational disequilibrium following the eruption.

Meanwhile, "spectroscopic events" occur at 5.54-year intervals marking the companion star's periastron. HST showed that the basic nature of these events changed between 2003 and 2014 --but we do not know whether this change was temporary, or permanent, or the precursor to something more extreme. Hence the next spectroscopic event, in early 2020, is crucial.

For reasons noted in the proposal, ground-based instruments have inadequate spatial resolution for this purpose, and can't observe the UV. 2020 will be our last opportunity for HST spectroscopy, and the star will be irreversibly changed when suitable instruments become available sometime in the future. Therefore we propose an adequate set of STIS/CCD and STIS/MAMA observations. They will be valuable for a wide range of topics including stellar instabilities, colliding-wind physics, and abnormal emission-line processes as well as eta Car's recovery from a giant eruption.

OBSERVING DESCRIPTION

Eta Car's periastron spectroscopic event occurred in January-April 2020, and was observed in HST program 15812. This program, 16176, consists of 2 visits to sample the spectrum well after the event. We followed a similar procedure for the preceding event in 2014-2015. ** These are expected to be the last HST observations of eta Carinae, 30 years after the first ones. **

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---- (((Original description for program 15812, written in 2019, follows below.))) ----

Eta Car's periastron spectroscopic event will occur mainly in January-April 2020. This program samples it with STIS-CCD in 7 one-orbit visits, plus a single orbit for STIS-MAMA near the middle of the event. Much later, 2 more orbits in Cycle 28 will show the post-event state of the object.

Each CCD visit includes several critical wavelength intervals. Approximately in decreasing order of spectroscopic priority, these are --

(1) Interval 4570-4840 Å using grating G430M. This includes the exotic HeII 4687 flash, the EUV-excited N II 4600 multiplet, a significant He I feature, and useful low-excitation features.

(2) 6490-7040 Å using G750M. The H-alpha line profile changes dramatically during an event, and so does He I 6680. This also provides photometry of the red continuum.

(3) 2760-2910 Å using G230MB. This includes the bright Mg II emission feature, plus necessary UV continuum photometry.

(4) 3800-4070 Å using G430M. This range includes a variety of diagnostics including high-order Balmer lines, Ca H & K, and He I.

In addition, we also use low-dispersion gratings G230LB and G430L for photometry across the broad wavelength range 1700-5500 Å. A secondary purpose of the low-dispersion spectrum is to detect any major unexpected changes outside the main wavelength ranges listed above.

Incidentally, these slit spectra also provide useful information about ejecta located 0.2 to 4 arcsec from the star. (But the star is far more important for our goals.)

The STIS-CCD exposure times range from 0.2 to 150 seconds (totals of CR-SPLITS). For practical reasons they are not done in order of scientific priority. In order to obtain sufficient schedulability throughout the January-April time interval, the usable time in each orbit is reduced by several minutes.

In the MAMA visit, echelles E140M and E230M cover the entire attainable UV range 1300-3100 Å, using the FUV and NUV detectors respectively. Exposures of several hundred seconds give high S/N, so the combination fits well into one orbit. Regarding detector brightness limits, we apply a double test: specific count rates were found in earlier observations of the same type, and CCD visits 1 and 2 will give information about the current UV brightness level. See comments in Visit 4.

Concerning HST's gyro issue: 1-gyro operation would most likely cause a shortage of visibility windows during the 4-month event. In that case we would need to heavily revise the plan -- for instance, reducing the number of observations per visit might allow more time-windows, and/or we might need to accept sparser temporal sampling.. Meanwhile, depending on gyro performance and jitter amounts, we might need to use the 52x0.2 slit instead of 52x0.1. This would be acceptable for the main science goals.

Proposal 16176 - STIS-CCD-8 (01) - ``Last Call!'' Eta Carinae's Spectroscopic Event in 2020

Fri Dec 18 20:00:22 GMT 2020

Visit	<p>Proposal 16176, STIS-CCD-8 (01), scheduling</p> <p>Diagnostic Status: No Diagnostics</p> <p>Scientific Instruments: STIS/CCD</p> <p>Special Requirements: BETWEEN 26-DEC-2020:00:00:00 AND 30-MAR-2021:00:00:00</p> <p><i>Comments: This visit was preceded by 7 CCD visits in program 15812, covering eta car's periastron event in 2020. Unlike them, this visit does not have severe timing requirements.</i></p> <p>--</p> <p><i>Historical note: . Program 16176 will most likely be the last HST coverage of eta Car. For almost 30 years, in several respects this object was repeatedly the most successful stellar HST target -- mainly because it is bright enough, complex enough, and variable enough to demonstrate HST's capabilities for spatial resolution plus UV coverage.</i></p>															
	<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-A</td> <td>RA: 10 45 3.5910 (161.2649625d) Dec: -59 41 4.26 (-59.68452d) Equinox: J2000 Plate Id: ZZZQ</td> <td>Proper Motion RA: 0 sec of time/yr Proper Motion Dec: 0 arcsec/yr Parallax: 0.0004"</td> <td>V=5+/-0.5</td> <td>Reference Frame: GSC1</td> </tr> </tbody> </table> <p><i>Comments: Special catalog ZZZQ was prepared in 1989 because the original HST GSC was very poor in this crowded nebular region. Later GSC, and especially GAIA, would _probably_ be OK for Eta Car acquisition. However, ZZZQ was used for nearly every successful Eta Car HST observation 1991--2018, and it never failed. Absolute position of Eta Car is still uncertain at the 0.2 arcsec level, even with GAIA, because this object has asymmetric structure at every size scale. The RA and dec listed here were used for successful programs in 2014 and 2018.</i></p> <p>Category=STAR Description=[ETA CARINAE STAR]</p>					#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	ETA-CAR-A	RA: 10 45 3.5910 (161.2649625d) Dec: -59 41 4.26 (-59.68452d) Equinox: J2000 Plate Id: ZZZQ	Proper Motion RA: 0 sec of time/yr Proper Motion Dec: 0 arcsec/yr Parallax: 0.0004"	V=5+/-0.5
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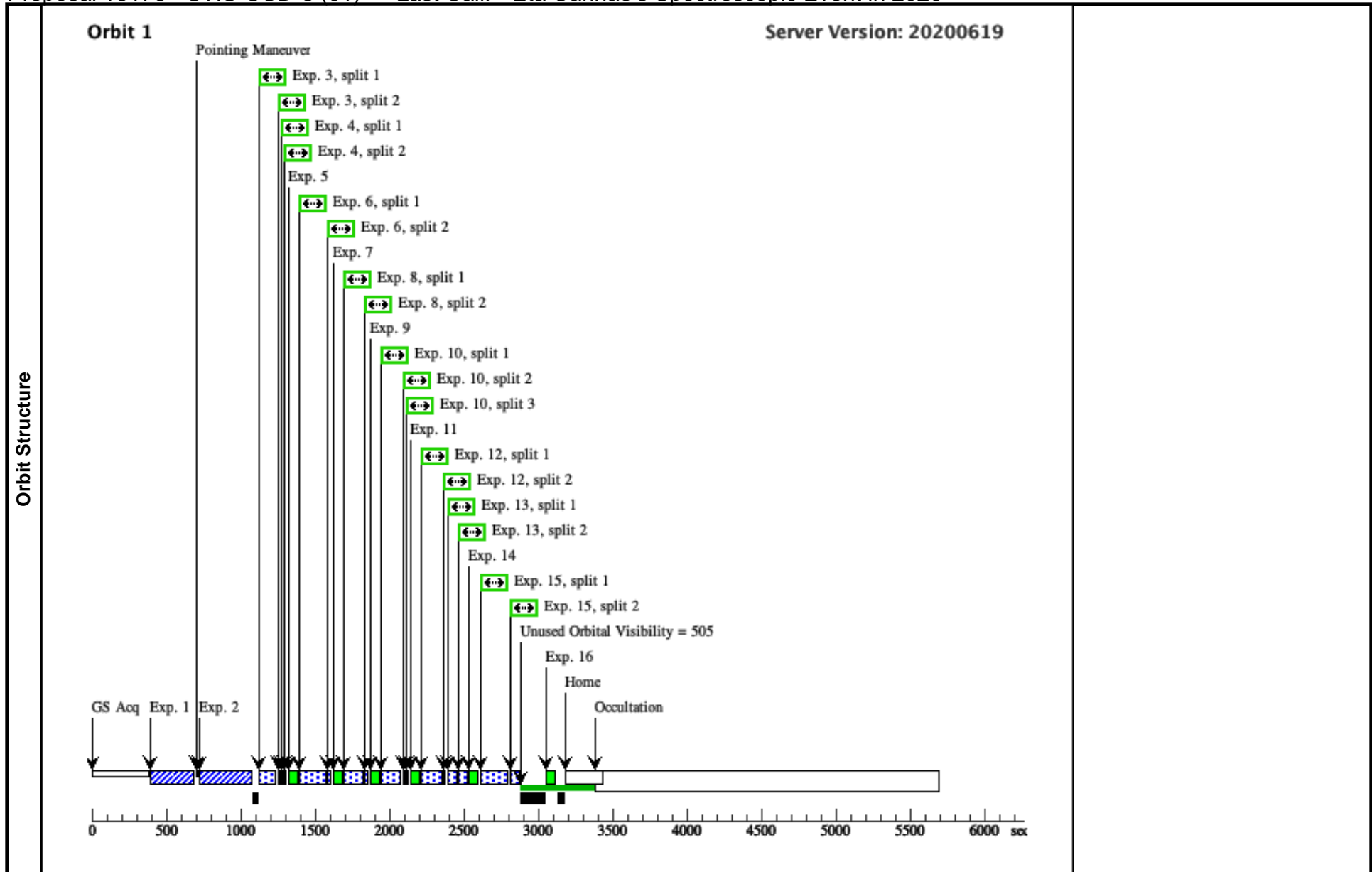
Proposal 16176 - STIS-CCD-8 (01) - ``Last Call!'' Eta Carinae's Spectroscopic Event in 2020

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ1	(1) ETA-CAR-A	STIS/CCD, ACQ, F25ND3	MIRROR				0.3 Secs (0.3 Secs) [==>]	[1]
<i>Comments: Because of the crowded field, special catalog ZZZQ has been used for almost every successful HST acquisition of eta Car since 1991.</i>									
2	ACQ2	(1) ETA-CAR-A	STIS/CCD, ACQ/PEAK, 52X0.1	G750M 7795 A				0.4 Secs (0.4 Secs) [==>]	[1]
<i>Comments: We use wavelength interval 7795 because it is relatively free of narrow emission lines produced in blobs at r = 0.2 arcsec. Shorter wavelengths would be better in other respects, but they can be perturbed by the extraneous off-center emission lines.</i>									
3	A6768a	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G750M 6768 A	CR-SPLIT=2; GAIN=4; SIZEAXIS2=80; WAVECAL=NO			0.2 Secs (0.2 Secs) [==>(Split 1)] [==>(Split 2)]	[1]
<i>Comments: Ultra-short exposure for bright H-alpha emission profile. WAVECAL=NO because we are explicitly managing the WCALs. Throughout this program we restrict SIZEAXIS2 to avoid buffer dump.</i>									
4	A6768b	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G750M 6768 A	CR-SPLIT=2; GAIN=4; WAVECAL=NO; SIZEAXIS2=160			2 Secs (2 Secs) [==>(Split 1)] [==>(Split 2)]	[1]
<i>Comments: Some H-alpha pixels will be saturated in this exposure. WAVECAL=NO because we are explicitly managing the WCALs.</i>									
5	WCAL6768	WAVE	STIS/CCD, ACCUM, 52X0.1	G750M 6768 A				[==>]	[1]
<i>Comments: We use explicit WCALs for two reasons: (1) Some may be omitted if not needed for program goals, and (2) this may help to force a WCAL into the occultation period after last science exposure.</i>									
6	A4706	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G430M 4706 A	CR-SPLIT=2; GAIN=4; SIZEAXIS2=120; WAVECAL=NO			24 Secs (24 Secs) [==>(Split 1)] [==>(Split 2)]	[1]
<i>Comments: Extremely important wvl interval for He II 4687 and rad-exc N II features. WAVECAL=NO because we manage the WCALs explicitly.</i>									
7	WCAL4706	WAVE	STIS/CCD, ACCUM, 52X0.1	G430M 4706 A				[==>]	[1]
8	A3936	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G430M 3936 A	CR-SPLIT=2; GAIN=4; SIZEAXIS2=120; WAVECAL=NO			24 Secs (24 Secs) [==>(Split 1)] [==>(Split 2)]	[1]
9	WCAL3936	WAVE	STIS/CCD, ACCUM, 52X0.1	G430M 3936 A				[==>]	[1]
10	LODISP4300	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G430L 4300 A	CR-SPLIT=3; GAIN=4; SIZEAXIS2=80; WAVECAL=NO			2.4 Secs (2.4 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)]	[1]
11	WCAL-LO DISP4300	WAVE	STIS/CCD, ACCUM, 52X0.1	G430L 4300 A				[==>]	[1]
<i>Comments: WAVECAL=L after orbit visibility time.</i>									
12	LODISP2375a	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G230LB 2375 A	CR-SPLIT=2; SIZEAXIS2=80; GAIN=4; WAVECAL=NO			12 Secs (12 Secs) [==>(Split 1)] [==>(Split 2)]	[1]

Exposures

Proposal 16176 - STIS-CCD-8 (01) - ``Last Call!'' Eta Carinae's Spectroscopic Event in 2020

13	LODISP237 5b	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G230LB 2375 A	CR-SPLIT=2; GAIN=4; SIZEAXIS2=120; WAVECAL=NO	100 Secs (100 Secs)	
						[==>(Split 1)] [==>(Split 2)]	[1]
14	WCAL2375	WAVE	STIS/CCD, ACCUM, 52X0.1	G230LB 2375 A		[==>]	[1]
15	A2836	(1) ETA-CAR-A	STIS/CCD, ACCUM, 52X0.1	G230MB 2836 A	GAIN=4; SIZEAXIS2=80; WAVECAL=NO; CR-SPLIT=2	100 Secs (100 Secs)	
						[==>(Split 1)] [==>(Split 2)]	[1]
16	WCAL2836	WAVE	STIS/CCD, ACCUM, 52X0.1	G230MB 2836 A		[==>]	[1]



Proposal 16176 - STIS-MAMA-2 (02) - ``Last Call!'' Eta Carinae's Spectroscopic Event in 2020

Fri Dec 18 20:00:22 GMT 2020

Visit	<p>Proposal 16176, STIS-MAMA-2 (02), implementation</p> <p>Diagnostic Status: No Diagnostics</p> <p>Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA</p> <p>Special Requirements: AFTER 01 BY 20 D TO 30 D</p> <p><i>Comments: Re. MAMA brightness limits: In March 2020, visit 04 of program 15812 also used MAMA on this target. See notes and correspondence about that case. As we did in past MAMA observations of this star, we'll use the preceding CCD visit (STIS-CCD-8) to confirm that the UV has not brightened by a dangerous amount.</i></p> <p>-- <i>Note that eta Car's progressive brightening has a timescale of years -- i.e., this is not an irregular variable in the context of MAMA safety limits.</i></p> <p>-- <i>Additional detail: If the UV brightness approaches the safety limits, we can reduce the overall count rates by using a smaller MAMA aperture.</i></p> <p>--</p>																																																																																																			
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Absorption lines have caused rapid UV decreases in previous spectroscopic events, but there have been no strong rapid increases in UV emission.</p> <p>-- ((Later remarks, June 2020:)) Program 15812 followed the above plan and was successful. Its MAMA visit was done in March 2020. In the same way, program 16176 uses a fresh CCD visit to verify that the UV brightness is still safe for MAMA. If the brightness has become uncomfortably bright by late 2020 or early 2021, we can reduce the count rates by using a smaller MAMA aperture.</p> <p>--</p> </td> </tr> <tr> <td>4</td> <td>FUV1425A (1369096)</td> <td>(1) ETA-CAR-A</td> <td>STIS/FUV-MAMA, ACCUM, 0.2X0.2</td> <td>E140M 1425 A</td> <td></td> <td></td> <td></td> <td>600 Secs (600 Secs) [==>]</td> <td>[1]</td> </tr> <tr> <td colspan="10"> <p><i>Comments: ((Remarks written in 2019 for program 15812:)) Re. 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<p><i>Comments: ((Remarks written in 2019 for program 15812:)) Re. BRIGHTNESS LIMITS: ETC is only a rough guide for this object, because the spectrum is extremely complex and changes during the spectroscopic event. Real observed count rates are better. On 21 April 2018, E140M produced 0.5 cts/s in the maximum pixel, and 75,000 cts/s in the entire detector. On average, Eta Car is brightening about 12 percent per year in the UV -- EXCEPT that it has always become temporarily fainter during each spectroscopic event.</i></p> <p>--- In order to verify that Eta Car has not brightened by a dangerous amount, we will examine CCD-G230LB and CCD-G230MB data from visits 1 and 2.</p> <p>--- Note that this object is not a strong irregular variable in the sense used for brightness limits. Absorption lines have caused rapid UV decreases in previous spectroscopic events, but there have been no strong rapid increases in UV emission.</p> <p>-- ((Remarks in June 2020, for program 16176:)) The above approach was successful, see comments for the NUV1978 observation.</p> <p>--</p>																																																																																																				

