



15618 - Stellar X-ray Cycles: the Shape of Things to Come

Cycle: 26, Proposal Category: GO

(Availability Mode: AVAILABLE)

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>
10	(1) HD128620 (2) HD128621 WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	05-Dec-2018 14:00:47.0	yes
11	(3) HD61421 WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	05-Dec-2018 14:00:49.0	yes

4 Total Orbits Used

ABSTRACT

Somewhat erratic, unpredictable long-term starspot cycles of late-type stars are followed with highest sensitivity in coronal X-rays. Sun's high-energy modulations are crucial to Earth-impacting "Space Weather," as stellar counterparts are for their exoplanets. The decadal oscillations are symptomatic of a deep-seated magnetic pump -- the Dynamo -- whose internal workings remain elusive. Key question: is solar 11-year cycle normal, or instead a transition state? 3-year continuation of previous CXO/HST program is proposed for Alpha Cen AB (G2V+K1V) and Procyon (F5IV). Alpha Cen cycles bracket solar behavior, although true period of sunlike A is uncertain. So far, Procyon is a flat-liner. Shape of rise and fall of cycle is a key diagnostic, most clearly traced at high energies.

HST part of the program will measure FUV subcoronal ($T \sim 100,000$ K) emission lines, like Si IV 140 nm and C IV 155 nm, as well as the important NUV chromospheric ($T \sim 10,000$ K) emission doublet of Mg II at 280 nm, in all three stars, with one visit of STIS echelle spectroscopy per system each year. Non-standard wavecalcs are used to provide better wavelength calibrations, so that subtle Doppler shifts of the high-excitation transitions can be assessed. Dynamical information also is encoded in distortions of the emission lineshapes, which are captured using a combination of FUV medium- and high-resolution echelle settings. This program builds on previous long-term Chandra/HST time series on both systems.

OBSERVING DESCRIPTION

The high-declination Alpha Cen system falls in the HST Continuous Viewing Zone numerous times during the year, allowing the two stars to be captured in a single visit of just two orbits. One such visit is planned for Cycle 26, compatible with the semiannual pointings by Chandra. There is no need to strictly coordinate the FUV and X-ray pointings, because the FUV Fe XII 124 nm coronal forbidden line can tie the STIS observation into the X-ray timeline.

In the single HST/STIS visit, the binary companions are observed sequentially, beginning with Alp Cen A, brighter of the two. The target is acquired with the CCD and F25ND5, followed by an exposure with the E140M-1425 medium-res echelle through the photometric slot (0.2x0.2), which delivers $R=40,000$ and good sensitivity (peak $S/N=40$ per resol at the tops of the important Si IV 140 nm and C IV 155 nm resonance doublets). A peak-up is not needed because the CCD ACQ is accurate enough for centering in the photometric slot. The exposure depth is sufficient to capture the key Fe XII 124 nm coronal forbidden line, which as mentioned earlier is used to tie the STIS FUV measurements into the X-ray time series. The combination of resolution, spectral coverage, and sensitivity of E140M for A has proven successful in previous incarnations of this program. Following the E140M exposure, a peak-up is performed with the 31x0.05NDC slit in dispersed visible light with the CCD and G430M; then an E230H-2713 exposure is taken through that (long) slit. This setting captures the key chromospheric Mg II 280 nm resonance doublet.

After the Alp Cen A exposures, a $\sim 5''$ offset maneuver to B is performed, followed by a CCD ACQ through F25ND5. The time-dependent separation of the binary companions is accurately known (to $\sim 0.1''$), based on orbital reconstructions of ten years of positional measurements by Chandra. Similarly, the coordinates and (an effective) proper motion of Alp Cen A were updated for Cycle 26 based on combining the orbital and proper motion solutions derived from the Chandra positions to trace out A's trajectory across the sky.

After the CCD-ACQ of B, an E140H-1307 exposure is taken through the photometric aperture, followed by an E140H-1486. The previous STIS

Proposal 15618 (STScI Edit Number: 1, Created: Wednesday, December 5, 2018 at 2:00:50 PM Eastern Standard Time) - Overview observations of B have shown that its FUV "hot lines" (like Si IV and C IV) are narrower than those of A, and display smaller Doppler shifts. Thus, B benefits from the higher resolution, with more precise wavelength scales, of E140H. The pair of E140Hs is the minimum needed to span the key region from Si III 120 nm up to beyond the C IV 155 nm doublet, with overlapping exposure at 140 nm, which covers Si IV as well as a density-sensitive multiplet of semi-permitted O IV. By using the 0.2x0.2 photometric aperture, sensitivity is maximized without significantly sacrificing resolution, as well as minimizing telescope "breathing" effects. The ~2x higher exposure depth for B in the key 1307/1489 overlap region is needed because, despite being chromospherically more active than A, B is fainter in apparent flux due to its smaller size. After the E140H exposures, an E230H-2713 is taken, again to cover the important Mg II region. The 0.2x0.09 spectroscopic aperture can be used, because the predicted Global Count Rate is below the bright limit (based on previous observations of the target with the same setup), and B is only minimally variable in the continuum light that dominates that setting (the Mg II lines can be more variable, but do not contribute significantly to the total flux in that region; and do not approach the local bright limit). A peak-up ensures maximum throughput. The whole FUV+NUV sequence for both stars requires two CVZ orbits.

Also, because a tall slit is used for A, an ORIENT constraint is specified to avoid having both targets fall on the slit simultaneously, and consequently corrupt the echellegram with overlapping spectra (and possibly also violate the global limits). The constraint is not severe, however, because the NDC slit is only 0.05" wide and the separation of the stars will be >5" in 2019. A +/- 10 degree avoidance zone (+/- 0.9" pivot from B) should be sufficient to exclude B and any possible scattered light. The ORIENT avoidance zones for 2019 are listed in the Visit-level specifications. There are numerous CVZ windows throughout the year that satisfy the ORIENT constraints.

The proposed STIS observations of Procyon are similar. There is one visit of two orbits, non-CVZ because of the low-declination target. The optically bright star is acquired by direct imaging with the CCD and F25ND5 filter. The ACQ is followed by a high-res FUV echelle exposure with setting E140H-1307 through the 0.2x0.2 photometric aperture, to fill out the first orbit. Second orbit begins with another high-res FUV echelle exposure, now with H-1489, again through the 0.2x0.2 slot. Together, these two settings cover the range from below Lyman Alpha (121 nm) out to beyond the C IV doublet at 155 nm, where the rising F-type photospheric continuum begins to overwhelm the faint subcoronal emission line spectrum. At the end of the second orbit, a brief NUV high-res echelle exposure is taken with setting E230H-2713 to capture the important chromospheric emission doublet of Mg II at 280 nm. Owing to the brightness of Procyon at these wavelengths, the observation must be taken through the ND2 slit, which requires a prior peak-up (in dispersed light with G430M).

Non-standard lamp exposures are used for all the FUV and NUV settings of all three stars to provide accurate zero-point wavelength shifts for the respective echellegrams, given that the lamp output has faded over the years, and the default wavecals no longer are able to provide the desired

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accuracy. The deeper-than-normal wavecalcs ensure that the dispersion properties of the spectrometer are accurately monitored, to take full advantage of STIS's ability to measure small differential velocity shifts between emission lines formed in different environments in the stellar outer atmosphere, a major scientific goal of the project. The non-standard wavecalcs are forced to be adjacent to the respective science exposures by a "SEQ NON-INT" pairing. Because the GO-specified wavelength calibrations can substitute for the normal brief AUTO-WAVECALs, the latter are turned off in the respective science exposures.

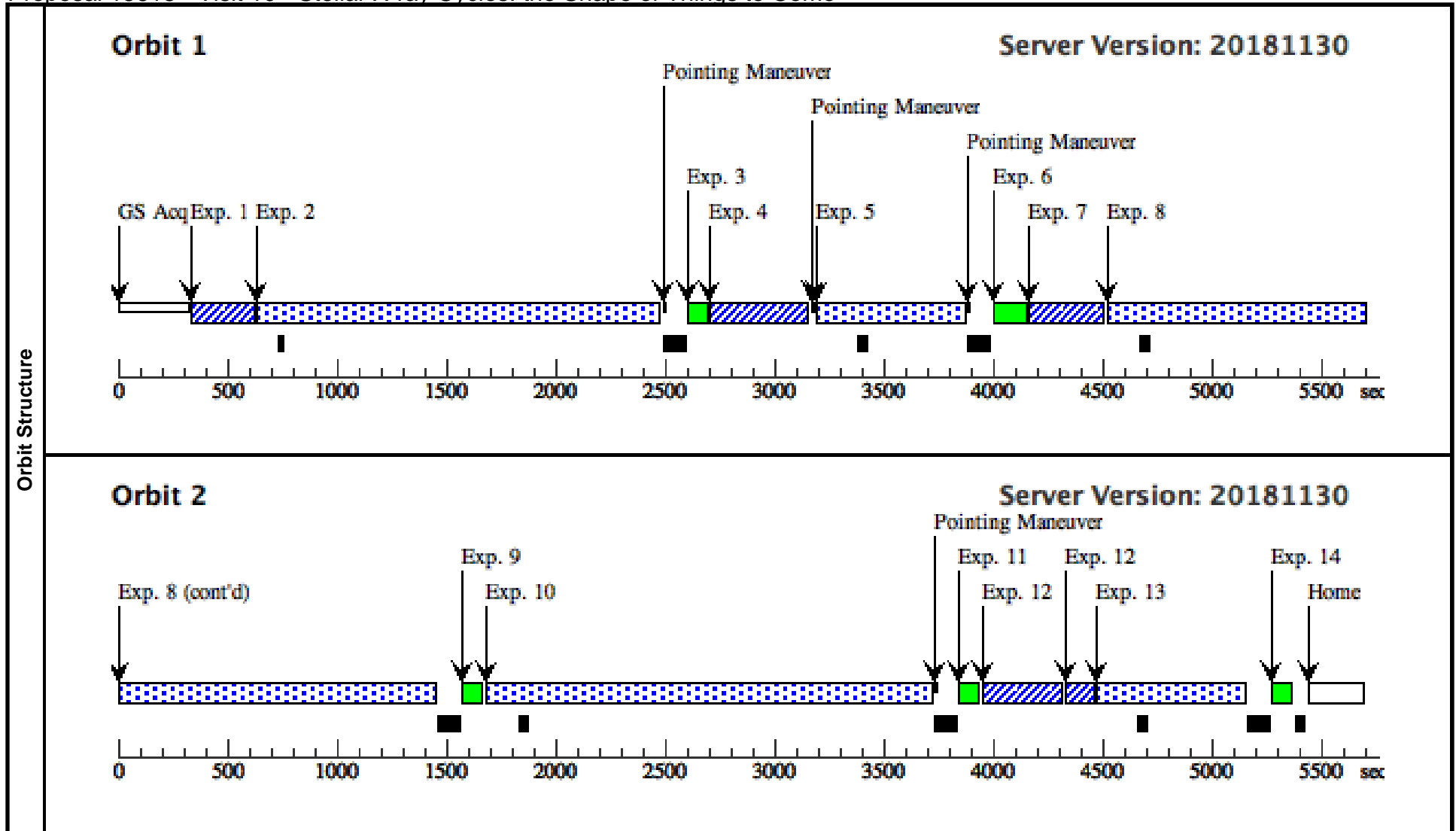
Proposal 15618 - Visit 10 - Stellar X-ray Cycles: the Shape of Things to Come

Wed Dec 05 19:00:50 GMT 2018

Visit	Proposal 15618, Visit 10, implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: CVZ; ORIENT 35D TO 195 D; ORIENT 215D TO 359.99 D; ORIENT 0D TO 15 D					
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
(1) Alt Name1: ALP-CEN-A <i>Comments: Target coords for epoch 2018.38 were based on a global orbital + proper-motion + parallax fit to ten years of Chandra X-ray positions. Alpha Cen AB are moving past their close approach (on the sky), which occurred in 2016, consequently the relative orbital motion of A has a significant influence on its apparent proper motion.</i> Category=STAR Description=[CORONA, G V-IV] Extended=NO		HD128620 RA: 14 39 26.8500 (219.8618750d) Dec: -60 49 56.90 (-60.83247d) Equinox: J2000	Proper Motion RA: -3.84 arcsec/yr Proper Motion Dec: +0.33 arcsec/yr Parallax: 0.747" Epoch of Position: 2018.38 Radial Velocity: -24 km/sec	V=+0.01+/-0.1	Reference Frame: ICRS	
	(2) Alt Name1: ALP-CEN-B	Offset from HD128620 RA Offset: -0.23 Secs Dec Offset: 4.9 Arcsec	V=1.33+/-0.1	Offset Position (HD128621)	<i>Comments: Offset of B relative to A, for 2019.5, was determined from the empirical ephemeris, designed to closely match the relative orbit as recorded by Chandra's High Resoultion Camera in recent years.</i> Category=STAR Description=[CORONA, K V-IV] Extended=NO	

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#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
Exposures	1	(STIS.im.11 1) HD128620 84308)	STIS/CCD, ACQ, F25ND5	MIRROR		GS ACQ SCENARI O BASE1B3		0.1 Secs (0.1 Secs) [==>]	[1]	
	<i>Comments: Castelli-Kurucz Models G2V 5750 4.5, renormalized to vegamag = 0.01 in filter Johnson/V: SNR~140 in 0.1 s; time to saturation 0.6 s.</i>									
	2	(STIS.sp.11 1) HD128620 84381)	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A	WAVECAL=NO		Sequence 2-3 Non-Int in Visit 10	1750 Secs (1750 Secs) [==>]	[1]	
	<i>Comments: Input=special ETC file for ALP-CEN-A from previous STIS echelle spectra; exposure time= 1.5 ks at Si IV 139 nm gives peak SNR~40 (per resol) with 0.2x0.2 aperture. No LCR or GCR issues.</i>									
	3		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		Sequence 2-3 Non-Int in Visit 10	45 Secs (45 Secs) [==>]	[1]	
	<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>									
	4	(STIS.sp.11 1) HD128620 84256)	STIS/CCD, ACQ/PEAK, 31X0.05NDC	G430M 4451 A				0.1 Secs (0.1 Secs) [==>]	[1]	
	<i>Comments: Dispersed light peak-up; Castelli-Kurucz Model G2V 5750 4.5, renormalized to vegamag = 0.01 in filter Johnson/V: in 0.1 s with NDA, GCR= 2780k e-.</i>									
	5	(STIS.sp.11 1) HD128620 84194)	STIS/NUV-MAMA, ACCUM, 31X0.05NDC	E230H 2713 A	WAVECAL=NO		Sequence 5-6 Non-Int in Visit 10	500 Secs (500 Secs) [==>]	[1]	
	<i>Comments: ETC GCR~135k for Castelli-Kurucz Model G2V 5750 4.5, renormalized to vegamag = 0.01 in filter Johnson/V. Measured GCR~110k for several exposures in similar setting H-2812 with NDC; H-2713 GCR should be less because NUV continuum is falling toward shorter wavelengths.</i>									
	6		WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A		Sequence 5-6 Non-Int in Visit 10	45 Secs (45 Secs) [==>]	[1]	
	<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>									
	7	(STIS.im.11 2) HD128621 84300)	STIS/CCD, ACQ, F25ND5	MIRROR				0.1 Secs (0.1 Secs) [==>]	[1]	
	<i>Comments: Castelli-Kurucz Models K2V 4750 4.5, renormalized to vegamag = 1.33 in filter Johnson/V: SNR~74 in 0.1 s; time to saturation 1.7 s.</i>									
8	(STIS.sp.11 2) HD128621 84375)	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A	WAVECAL=NO		Sequence 8-9 Non-Int in Visit 10	2500 Secs (2500 Secs) [==>]	[1]		
<i>Comments: Based on new FUV spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>										
9		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A		Sequence 8-9 Non-Int in Visit 10	45 Secs (45 Secs) [==>]	[2]		
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										
10	(STIS.sp.11 2) HD128621 84376)	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A	WAVECAL=NO		Sequence 10-11 Non-Int in Visit 10	1900 Secs (1900 Secs) [==>]	[2]		
<i>Comments: Based on new FUV spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>										
11		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A		Sequence 10-11 Non-Int in Visit 10	45 Secs (45 Secs) [==>]	[2]		
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										
12	(STIS.sp.11 2) HD128621 84373)	STIS/CCD, ACQ/PEAK, 0.2X0.09	G430M 3936 A				0.1 Secs (0.1 Secs) [==>]	[2]		
<i>Comments: Dispersed light peak-up; Castelli-Kurucz Models K2V 4750 4.5, renormalized to vegamag = 1.33 in filter Johnson/V: 5470k e- in 0.1 s; time to saturation 0.9 s.</i>										
13	(STIS.sp.11 2) HD128621 84211)	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A	WAVECAL=NO		Sequence 13-14 Non-Int in Visit 10	500 Secs (500 Secs) [==>]	[2]		
<i>Comments: GCR= 73k from ETC run for Castelli-Kurucz Model K2V 4750 4.5, renormalized to vegamag = 1.33 in filter Johnson/V. Variability expected to be very low in the K-dwarf continuum, which dominates the H-2713 setting. Measured GCRs from ocre10050, ocre11050, octr10050, and od5c10050 (same setting and slit) are 126k+/-13k.</i>										
14		WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A		Sequence 13-14 Non-Int in Visit 10	45 Secs (45 Secs) [==>]	[2]		
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										



Proposal 15618 - Visit 11 - Stellar X-ray Cycles: the Shape of Things to Come

Wed Dec 05 19:00:50 GMT 2018

Visit	Proposal 15618, Visit 11, implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)									
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
Fixed Targets	(3)	HD61421	RA: 07 39 17.1867 (114.8216113d) Dec: +05 13 9.74 (5.21937d)	Proper Motion RA: -0.7146 arcsec/yr Proper Motion Dec: -1.0368 arcsec/yr Parallax: 0.285" Epoch of Position: 2019.50 Radial Velocity: -3.2 km/sec	V=0.37+/-0.1	Reference Frame: ICRS				
	<i>Comments: Target coords for epoch 2019.5 were taken from SIMBAD, in ICRS frame.</i> Category=STAR Description=[CORONA, F3-F9] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(STIS.im.11 84316)	(3) HD61421	STIS/CCD, ACQ, F25ND5	MIRROR			GS ACQ SCENARI O BASE1B3	0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: Castelli-Kurucz Model F5V 6500 4.0, renormalized to vegamag = 0.37 in filter Johnson/V: SNR~110 in 0.1 s; time to saturation 0.9 s.</i>										
2	(STIS.sp.11 84382)	(3) HD61421	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A		WAVECAL=NO		Sequence 2-3 Non-Int in Visit 11	2355 Secs (2355 Secs) [==>]	[1]
<i>Comments: Input=special ETC file for ALP-CMI from previous STIS echelle spectra; exposure time= 2 ks at Si IV 139 nm gives peak SNR~30 (per resol) with 0.2x0.2 aperture. No LCR or GCR issues</i>										
3			WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A			Sequence 2-3 Non-Int in Visit 11	45 Secs (45 Secs) [==>]	[1]
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										
4			WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A			Sequence 4-5 Non-Int in Visit 11	45 Secs (45 Secs) [==>]	[1]
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										
5	(STIS.sp.11 84383)	(3) HD61421	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A		WAVECAL=NO		Sequence 4-5 Non-Int in Visit 11	1386 Secs (1386 Secs) [==>]	[2]
<i>Comments: Input=special ETC file for ALP-CMI from previous STIS echelle spectra; exposure time= 2 ks at Si IV 139 nm gives peak SNR~40 (per resol) with 0.2x0.2 aperture. No LCR or GCR issues.</i>										
6	(STIS.sp.11 84260)	(3) HD61421	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	G430M 4451 A					0.1 Secs (0.1 Secs) [==>]	[2]
<i>Comments: Dispersed light peak-up for Castelli-Kurucz Model F5V 6500 4.0, renormalized to vegamag = 0.37 in filter Johnson/V: in 0.1 s, 477k e- with ND2 slit.</i>										
7	(STIS.sp.11 84232)	(3) HD61421	STIS/NUV-MAMA, ACCUM, 0.2X0.05ND	E230H 2713 A		WAVECAL=NO		Sequence 7-8 Non-Int in Visit 11	500 Secs (500 Secs) [==>]	[2]
<i>Comments: Input=special ETC file for ALP-CMI from previous STIS echelle spectra; exposure time= 500 s at Mg II 279 nm gives peak SNR~30 (per resol) with ND2 aperture. No LCR or GCR issues. (ETC GCR ~60 k; but, ~40k as measured from raw images in similar settings, also with ND2).</i>										
8			WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A			Sequence 7-8 Non-Int in Visit 11	45 Secs (45 Secs) [==>]	[2]
<i>Comments: Deeper than normal wavecal to determine accurate zero-point shift.</i>										

