



## 14788 - Alpha Centauri at a Crossroads

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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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) HD128621-1 (3) HD128621-2	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	09-Nov-2016 12:15:26.0	yes
11	(1) HD128620 (2) HD128621-1 (3) HD128621-2	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	09-Nov-2016 12:15:28.0	yes

4 Total Orbits Used

### ABSTRACT

Nearby Alpha Centauri AB (G2V+K1V) contains the two best characterized solar-like dwarf stars, which also have the best studied multi-MK coronal X-ray activity cycles, extending back to the 1970's. Objective is to continue tracking the evolving multi-decadal high-energy narrative of Alpha Cen with semiannual X-ray pointings in Chandra Cycles 16-18, as the system reaches a coronal crossroads: solar twin A rising toward starspot cycle maximum, K-type companion B sinking into a minimum. HST/STIS UV spectra will support and leverage the X-ray measurements by probing chromospheric and subcoronal dynamics, with connection to the corona through the FUV Fe XII 1242 forbidden line. Only Chandra can resolve the AB X-ray pair as the Alpha Cen orbit also reaches a crossroads in 2016 (only 4" separation), and only HST/STIS can measure the bright Alpha Cen

stars with sufficient UV spectral resolution and wavelength coherence. What's more, the recent validation of the STIS NDA,B,C long slits for echelle use now make feasible NUV E230H measurements (e.g., of key chromospheric tracers Mg II 2800 and Mg I 2852) which heretofore were not practical in a long-term program of this nature.

## **OBSERVING DESCRIPTION**

The STIS observations are straightforward. Alpha Cen 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. Two such visits (four orbits total), about six months apart, are contemplated for Cycle 24, compatible with the semiannual pointings by Chandra. There is no need to strictly coordinate the FUV and X-ray visits, because the FUV Fe XII 124 nm coronal forbidden line can tie the STIS observation into the X-ray framework.

In each 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 a 1500 s exposure with the E140M-1425 medium-res echelle through the photometric slot (0.2x0.2), which delivers  $R=40,000$  and good sensitivity (peak  $S/N=30$  per resol at the tops of the important Si IV 140 nm and C IV 155 nm resonance lines). 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 timeline. 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-4194, then an E230H exposure (setting 2812) is taken through that slit, for 500 s. Previously, this exposure would have to have been done with ND2 and 4x the exposure duration. The setting covers the key chromospheric Mg II 280 nm resonance lines (and Mg I 285 nm), a new focus of the joint program with Chandra.

After the Alp Cen A exposures are completed, a ~4" offset maneuver is performed to B, and a peak-up is performed in dispersed light (G430L-4300) with 0.3x0.05ND3 to precisely locate the target. This particular slit was chosen because the default peak-up sweeps out a sufficient area (0.3"x0.3") to capture the B component, given that the time-dependent separation of the binary companions is accurately known to ~0.1", based on orbital reconstructions to fit ten years of positional measurements by Chandra. Given that the AB orbital separation is changing relatively rapidly in the current epoch, Alp Cen B was specified as two separate targets, with different offsets, to reflect the orbital evolution over the six months between the two STIS visits. Similarly, although Alp Cen A is specified as a single target, the position and proper motion for Cycle 24 were updated based on combining the orbital and proper motion solutions derived from the Chandra positions. This strategy has worked well for the post-SM4 STIS visits to AB.

## Proposal 14788 (STScI Edit Number: 1, Created: Wednesday, November 9, 2016 12:15:29 PM EST) - Overview

After the peak-up on B, a 1500 s E140H-1307 exposure through the photometric aperture is taken, followed by an E140H-1486 exposure also for 1500 s. This is a departure from the previous exclusive use of E140M for B in the previous Alp Cen campaigns, but is dictated by recently published results from 4 years of STIS observations of B (Ayres 2015, AJ), which show that its FUV "hot lines" (like Si IV and C IV) are narrower than those of A, and display smaller Doppler shifts. Thus, B would benefit from the higher resolution measurements, with more precise wavelength scales, of E140H. The specified pair of exposures is the minimum required to cover the key region from Si III 120 nm up to beyond the C IV 155 nm doublet, with overlapping coverage in the important Si IV 140 nm region. By using the 0.2x0.2 photometric aperture, sensitivity is maximized without significantly sacrificing resolution. The 2x higher exposure depth for B in the key 1307/1489 overlap region reflects the fact that, despite being chromospherically more active than A, B is fainter in apparent flux due mainly to its smaller size; and further, B has been declining in activity the past several years as it falls to a starspot minimum (while A has been climbing to a peak of its own). After the E140H exposures, a pair of E230H's are taken (settings 2713 & 2862), for 745 s each. The 0.2x0.09 spectroscopic aperture can be used for 2713, 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). However, the continuum light picks up significantly in the 2862 setting and NDA must be used to keep the GCR below the limit. (Technically, the 0.1x0.03 "Jenkins" slit also would be an option to bring the GCR below the limit, but that aperture requires an expensive double peak-up, and previous experience has shown that even with the peak-up, the effective throughputs can be quite unreliable. NDA appears to be much more reproducible, even though its nominal throughput is lower.) Because of the use of NDA for the H-2862 exposure, a prior peak-up in that aperture must be performed. The pair of exposures allows for similar spectral coverage as the E230H-2812 for A (i.e., up to Mg I 285 nm), but also achieves enhanced S/N at the Mg II lines by the deeper effective exposure with H-2713 and H-2852, which overlap in the Mg II region. The E230H pair also improves mitigation of fixed pattern noise. The whole sequence requires two CVZ orbits per visit.

Also, because tall apertures are being exploited for both stars, an ORIENT constraint must be specified to avoid the situation where both targets fall on the slit simultaneously, and consequently corrupt the echellegram with overlapping spectra (and possibly also violate the bright limits). The constraint is not severe, however, since the slits are only 0.05" wide and the separation of the stars will be >4" in 2017. A +/- 11 degree avoidance zone (+/- 0.75" pivot away from other star) should be sufficient to exclude the other star and any possible scattered light. The ORIENT avoidance zones are 182+/-11 degrees and 2+/-11 degrees for visit 10 (early 2017), and 190+/-11 degrees and 10+/-11 degrees for Visit 11 (late 2017). There are CVZ windows for both visits, early-FEB and mid-SEP, respectively, following the most recent Cycle 23 Alp Cen observations (Visit 11 of program 14341, scheduled for Aug 2016) by the desired approximately half a year.

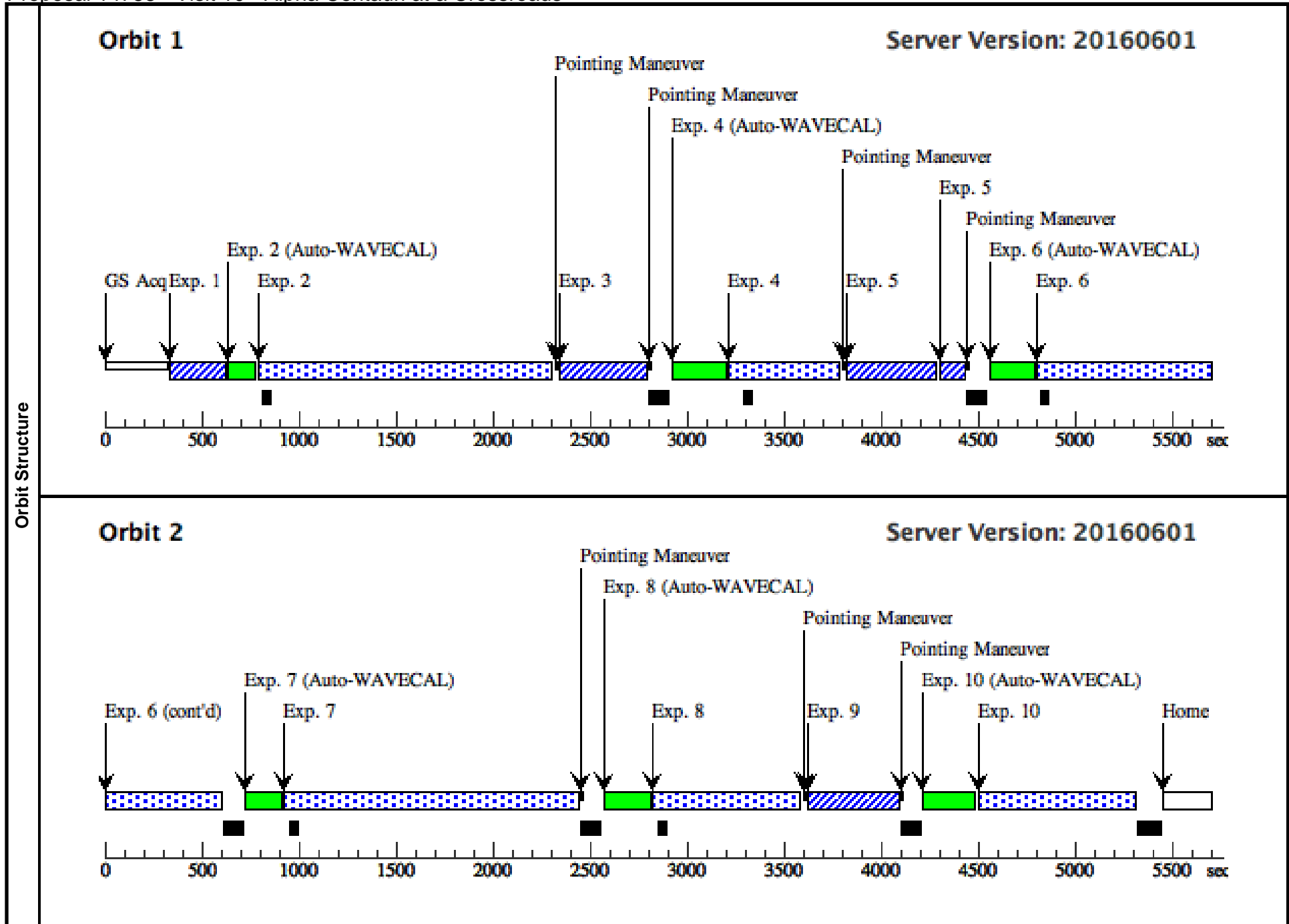
# Proposal 14788 - Visit 10 - Alpha Centauri at a Crossroads

Wed Nov 09 17:15:29 GMT 2016

Visit	<b>Proposal 14788, Visit 10, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: CVZ; ORIENT 13D TO 171 D; ORIENT 193D TO 351 D; BETWEEN 08-FEB-2017:00:00 AND 09-FEB-2017:23:59 Comments: This is first CVZ opportunity roughly 6 months after most recent Visit of program 14341 (of which this is continuation), consistent with ORIENT constraints					
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
Fixed Targets	(1)	HD128620 Alt Name1: ALP-CEN-A	RA: 14 39 28.6610 (219.8694208d) Dec: -60 49 57.70 (-60.83269d) Equinox: J2000	Proper Motion RA: -3.826 arcsec/yr Proper Motion Dec: +0.323 arcsec/yr Parallax: 0.747" Epoch of Position: 2015.0 Radial Velocity: -24 km/sec	V=+0.01+/-0.1 FUV peak fluxes are 5E-12 per Angstrom (excluding Lyman-alpha, which is ~ 8E-11)	Reference Frame: ICRS
	Comments: The target coords for epoch 2015.0 were based on a global orbital + proper-motion fit to ten years of Chandra HRC positions, accounting for parallax in each epoch. Alpha Cen AB are moving past a close approach (on the sky) in 2016, consequently the orbital motion of A has a significant influence on its apparent proper motion. These are "parallax-free" coordinates. Extended=NO					
	(2)	HD128621-1 Alt Name1: ALP-CEN-B	Offset from HD128620 RA Offset: -0.385 Secs Dec Offset: 3.045 Arcsec		V=1.33+/-0.1	Offset Position (HD128621-1)
Comments: Offset of B relative to A determined from the slightly modified ephemeris, which closely matches the relative orbit as recorded by Chandra HRC in recent years. Extended=NO						
(3)	HD128621-2 Alt Name1: ALP-CEN-B	Offset from HD128620 RA Offset: -0.342 Secs Dec Offset: 3.53 Arcsec		V=1.33+/-0.1	Offset Position (HD128621-2)	
Comments: Offset of B relative to A determined from the slightly modified ephemeris, which closely matches the relative orbit as recorded by Chandra HRC in recent years. Extended=NO						

# Proposal 14788 - Visit 10 - Alpha Centauri at a Crossroads

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.640 577)	(1) HD128620	STIS/CCD, ACQ, F25ND5	MIRROR		GS ACQ SCENARI O BASE1B3		0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: Castelli-Kurucz Model:G2V; V=+0.01; Optimum SNR = 169; time to sat 0.6 s</i>									
2	(STIS.sp.64 0578)	(1) HD128620	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				1499 Secs (1499 Secs) [==>]	[1]
<i>Comments: Input=special file for ALP-CEN-A based on 4 years of STIS E140M observations; Exposure time= 1.5 ks at Si IV 139 nm gives SNR = 30 (per resol); no LCR or GCR issues</i>									
3	(STIS.sp.83 5734)	(1) HD128620	STIS/CCD, ACQ/PEAK, 31X0.05NDC	G430M 4194 A				0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model G2V, V=+0.01 mag: in 0.1 s with NDA, GCR= 2534k e-.</i>									
4	(STIS.sp.83 5737)	(1) HD128620	STIS/NUV-MAMA, ACCUM, 31X0.05NDC	E230H 2812 A				500 Secs (500 Secs) [==>]	[1]
<i>Comments: ASTRAL ETC input file for ALP-CEN-A; 500s with NDC aper gives GCR=157k; source not significantly variable in continuum at these long NUV wavelengths</i>									
5	(STIS.sp.64 0591)	(3) HD128621-2	STIS/CCD, ACQ/PEAK, 0.3X0.05ND	G430L 4300 A				0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model K0V, V=1.33 mag: in 0.1 s, 96k e-</i>									
6	(STIS.sp.64 0596)	(2) HD128621-1	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A				1500 Secs (1500 Secs) [==>]	[1]
<i>Comments: based on new E140M spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>									
7	(STIS.sp.64 0597)	(2) HD128621-1	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A				1500 Secs (1500 Secs) [==>]	[2]
<i>Comments: based on new E140M spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>									
8	(STIS.sp.64 0598)	(2) HD128621-1	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2713 A				745 Secs (745 Secs) [==>]	[2]
<i>Comments: Based on post-SM4 NUV high-res spectrum of ALP-CEN-B, supplemented with average of selected IUE LW spectra for wavelengths &gt; 285 nm. GCR= 185k from ETC run; variability expected to be very low in the K-dwarf continuum, which dominates the H-2713 setting. Measured GCRs from ocre10050, ocre11050, and octr10050 (same setting and slit) are 124k+/-18k.</i>									
9	(STIS.sp.83 5732)	(3) HD128621-2	STIS/CCD, ACQ/PEAK, 31X0.05NDA	G430M 4194 A				0.1 Secs (0.1 Secs) [==>]	[2]
<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model K0V, V=1.33 mag: in 0.1 s, with NDA slit, 2822k e-.</i>									
10	(STIS.sp.83 5733)	(2) HD128621-1	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2862 A				745 Secs (745 Secs) [==>]	[2]
<i>Comments: based on new NUV high-res spectrum of ALP-CEN-B: with NDA slit, GCR= 84k. No LCR or GCR issues.</i>									



# Proposal 14788 - Visit 11 - Alpha Centauri at a Crossroads

Wed Nov 09 17:15:30 GMT 2016

Visit	<b>Proposal 14788, Visit 11, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: CVZ; ORIENT 21D TO 179 D; ORIENT 201D TO 359 D; BETWEEN 14-SEP-2017:00:00 AND 15-SEP-2017:23:59 <i>Comments: This is first CVZ opportunity roughly 6 months after Visit 10, consistent with ORIENT constraints</i>					
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	HD128620 Alt Name1: ALP-CEN-A	RA: 14 39 28.6610 (219.8694208d) Dec: -60 49 57.70 (-60.83269d) Equinox: J2000	Proper Motion RA: -3.826 arcsec/yr Proper Motion Dec: +0.323 arcsec/yr Parallax: 0.747" Epoch of Position: 2015.0 Radial Velocity: -24 km/sec	V=+0.01+/-0.1 FUV peak fluxes are 5E-12 per Angstrom (excluding Lyman-alpha, which is ~ 8E-11)	Reference Frame: ICRS
	<i>Comments: The target coords for epoch 2015.0 were based on a global orbital + proper-motion fit to ten years of Chandra HRC positions, accounting for parallax in each epoch. Alpha Cen AB are moving past a close approach (on the sky) in 2016, consequently the orbital motion of A has a significant influence on its apparent proper motion. These are "parallax-free" coordinates.</i> Extended=NO					
	(2)	HD128621-1 Alt Name1: ALP-CEN-B	Offset from HD128620 RA Offset: -0.385 Secs Dec Offset: 3.045 Arcsec		V=1.33+/-0.1	Offset Position (HD128621-1)
	<i>Comments: Offset of B relative to A determined from the slightly modified ephemeris, which closely matches the relative orbit as recorded by Chandra HRC in recent years.</i> Extended=NO					
	(3)	HD128621-2 Alt Name1: ALP-CEN-B	Offset from HD128620 RA Offset: -0.342 Secs Dec Offset: 3.53 Arcsec		V=1.33+/-0.1	Offset Position (HD128621-2)
	<i>Comments: Offset of B relative to A determined from the slightly modified ephemeris, which closely matches the relative orbit as recorded by Chandra HRC in recent years.</i> Extended=NO					

Proposal 14788 - Visit 11 - Alpha Centauri at a Crossroads

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.640 577)	(1) HD128620	STIS/CCD, ACQ, F25ND5	MIRROR		GS ACQ SCENARI O BASE1B3		0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: Castelli-Kurucz Model:G2V; V=+0.01; Optimum SNR = 169; time to sat 0.6 s</i>									
2	(STIS.sp.64 0578)	(1) HD128620	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				1499 Secs (1499 Secs) [==>]	[1]
<i>Comments: Input=special file for ALP-CEN-A based on 4 years of STIS E140M observations; Exposure time= 1.5 ks at Si IV 139 nm gives SNR = 30 (per resol); no LCR or GCR issues. Is shaved off this exposure to fit 2 orbits in Orbit Planner.</i>									
3	(STIS.sp.83 5734)	(1) HD128620	STIS/CCD, ACQ/PEAK, 31X0.05NDC	G430M 4194 A				0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model G2V, V=+0.01 mag: in 0.1 s with NDA, GCR= 2534k e-.</i>									
4	(STIS.sp.83 5737)	(1) HD128620	STIS/NUV-MAMA, ACCUM, 31X0.05NDC	E230H 2812 A				500 Secs (500 Secs) [==>]	[1]
<i>Comments: ASTRAL ETC input file for ALP-CEN-A; 500s with NDC aper gives GCR=157k; source not significantly variable in continuum at these long NUV wavelengths</i>									
5	(STIS.sp.64 0591)	(3) HD128621-2	STIS/CCD, ACQ/PEAK, 0.3X0.05ND	G430L 4300 A				0.1 Secs (0.1 Secs) [==>]	[1]
<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model K0V, V=1.33 mag: in 0.1 s, 96k e-</i>									
6	(STIS.sp.64 0596)	(3) HD128621-2	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A				1500 Secs (1500 Secs) [==>]	[1]
<i>Comments: based on new E140M spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>									
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<i>Comments: based on new E140M spectrum of ALP-CEN-B from 4 years of STIS measurements. No LCR or GCR issues.</i>									
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<i>Comments: Based on post-SM4 NUV high-res spectrum of ALP-CEN-B, supplemented with average of selected IUE LW spectra for wavelengths &gt; 285 nm. GCR= 185k from ETC run; variability expected to be very low in the K-dwarf continuum, which dominates the H-2713 setting. Measured GCRs from ocre10050, ocre11050, and octr10050 (same setting and slit) are 124k+/-18k.</i>									
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<i>Comments: dispersed light peak-up assuming Castelli-Kurucz Model K0V, V=1.33 mag: in 0.1 s, with NDA slit, 2822k e-.</i>									
10	(STIS.sp.83 5733)	(2) HD128621-1	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2862 A				745 Secs (745 Secs) [==>]	[2]
<i>Comments: based on new NUV high-res spectrum of ALP-CEN-B: with NDA slit, GCR= 84k. No LCR or GCR issues.</i>									

Exposures

