



## 15327 - Procyon: New Candidate for the Dynamo Clinical Trial

Cycle: 25, Proposal Category: GO

(Availability Mode: AVAILABLE)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Thomas R. Ayres (PI) (Contact)</b>	<b>University of Colorado at Boulder</b>	<b>thomas.ayres@colorado.edu</b>

### 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) HD61421 WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Sep-2018 11:08:19.0	yes
11	(1) HD61421 WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Sep-2018 11:08:21.0	yes
51	(1) HD61421 WAVE	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	20-Sep-2018 11:08:22.0	yes

6 Total Orbits Used

### ABSTRACT

This is the third year of a joint Chandra/HST program to follow the evolution of the high-energy (X-ray and UV) activity cycles of the nearby mid-F subgiant Procyon. This bright star has high-energy attributes that are similar to the Sun, yet it is a hotter star, at the edge of the region in the H-R diagram where surface convection occurs (the power source for stellar magnetic activity). The HST part is to record STIS UV spectra of the bright star on a semiannual basis at high echelle resolution and high S/N, especially to capture the FUV Fe XII 124,134 nm coronal forbidden lines, which

can tie together the non-simultaneous Chandra X-ray and HST pointings; as well as to record other key high-energy species like Si IV, C IV, and N V. The latter display Doppler-shifted, bimodal distorted emission profiles that signify high-powered dynamics in the interface regions of the stellar atmosphere between the super-hot corona ( $>1$  MK) and the cold photosphere ( $<6000$  K). The associated flows are a hot topic in contemporary solar physics, and one focus of a new space-based solar imaging spectrometer called IRIS. The solar and stellar FUV views are strongly complementary. The HST part of the program has two general objectives: (1) follow changes in the FUV spectra associated with any slowly evolving X-ray activity cycle of Procyon; and (2) combine the multiple epochs of echelle spectra to provide the highest possible S/N for identifying weak, but diagnostically important, emission lines (absorption, in some cases), and for decomposing the high-temperature line profiles (e.g., Si IV, C IV) into multiple dynamical components (which are thought to be symptomatic of coronal heating and cooling processes).

## **OBSERVING DESCRIPTION**

The proposed STIS observations of Procyon are straightforward. There are two identical visits of two orbits each, with a BETWEEN constraint specified to ensure scheduling at about a half-year separation, which is adequate timing to follow starpot cycle variations (which occur on timescales of roughly a decade, at least for the Sun).

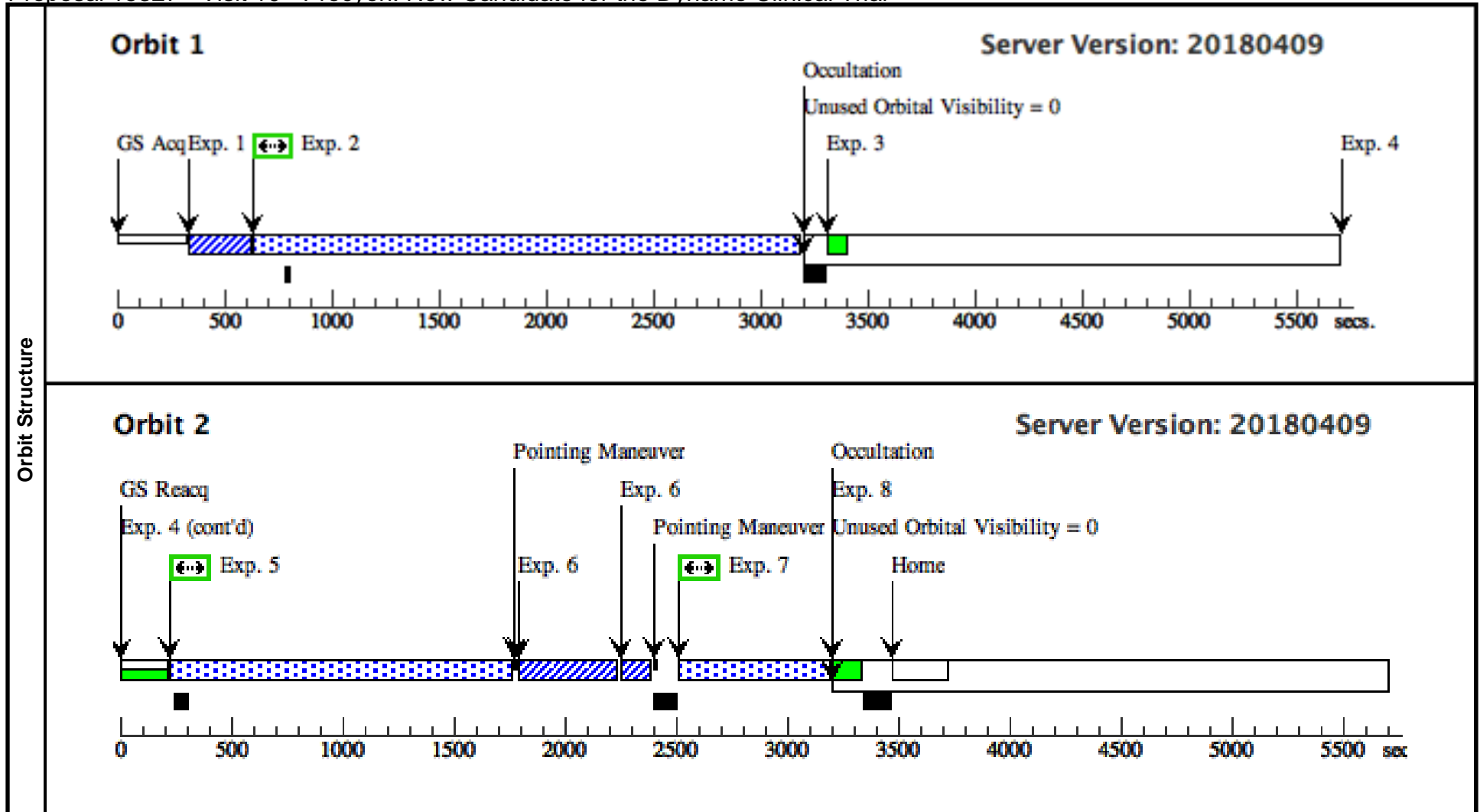
In each visit, the optically bright target is acquired by direct imaging with the CCD through the F25ND5 filter. The remainder of the first orbit is occupied by a high-res FUV echelle exposure with setting E140H-1307 through the 0.2x0.2 photometric aperture. A peak-up is not needed because the CCD ACQ is accurate enough for centering in the photometric slot. During the occultation period, a 100s wavecal is taken in H-1307, followed by a 100s wavecal in E140H-1486. These deeper-than-normal wavecals provide an accurate zero-point wavelength shift 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 accuracy. The second orbit begins with a second high-res FUV echelle exposure of the target, now with H-1489, but again through the 0.2x0.2 aperture. 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. The two settings overlap in the key 140 nm region which contains the prominent Si IV doublet, as well as a density-sensitive multiplet of semi-permitted O IV. At the end of the second orbit, a brief NUV high-res echelle exposure is taken with setting E230H-2762 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 this case in dispersed light with G430M-4451). In the occultation period following, a 50s wavecal is taken in H-2762. Again, the purpose of the deeper-than-normal wavecal is to ensure that the dispersion properties of the spectrometer are accurately recorded under the same conditions as the science exposures, to take full advantage of the STIS capabilities 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 nonstandard wavecals 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 three science exposures.

Proposal 15327 - Visit 10 - Procyon: New Candidate for the Dynamo Clinical Trial

Thu Sep 20 15:08:23 GMT 2018

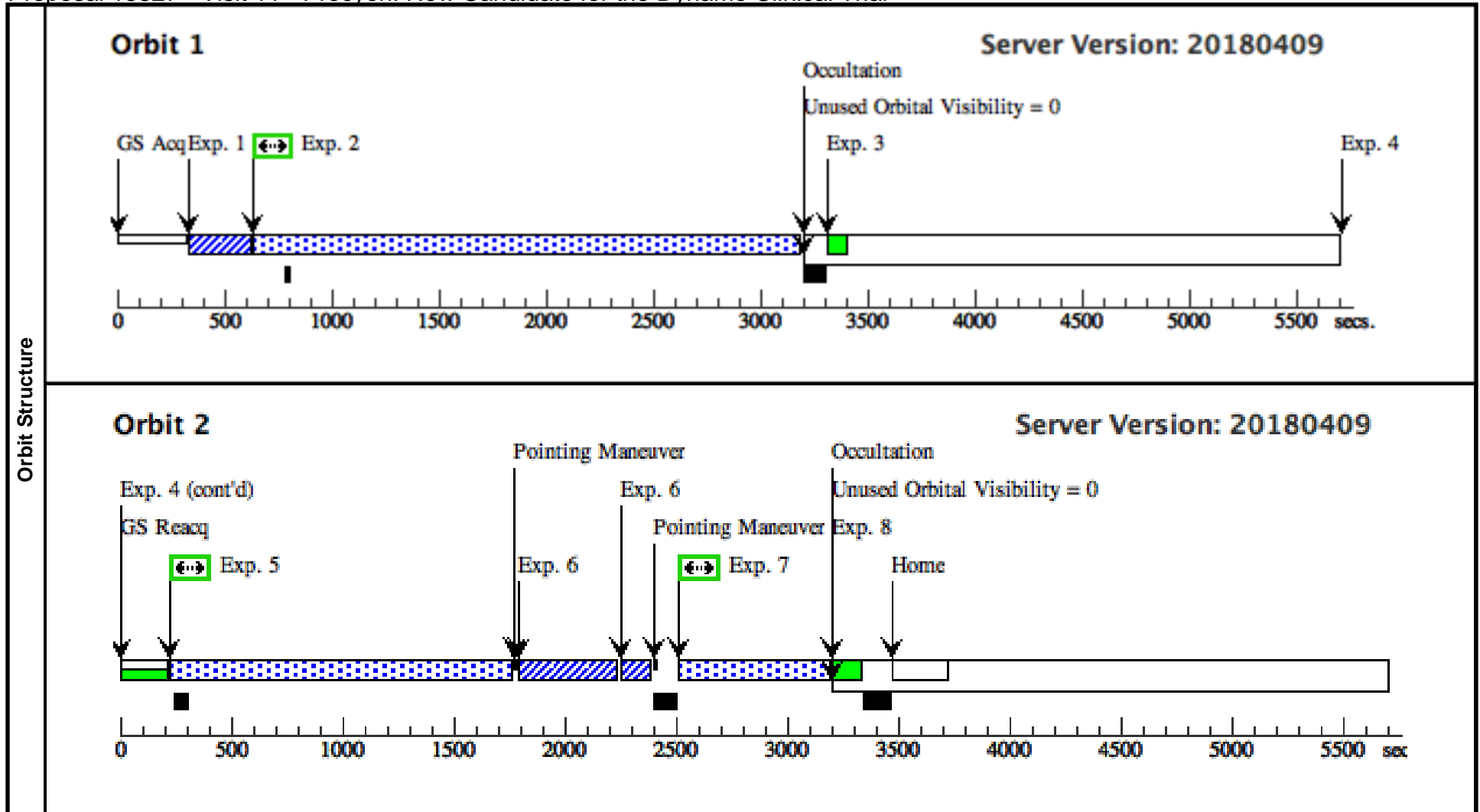
Visit	<b>Proposal 15327, Visit 10, completed</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: BETWEEN 05-MAR-2018 AND 05-APR-2018 Comments: The BETWEEN range given below is about 6 months prior to the narrower (~1 week) visibility window in SEP 2018. This is the best pair of six-month-separated visibilities in Cycle 25, consistent with the desired semiannual starspot cycle monitoring interval.																																																																																																																																																																																			
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# Proposal 15327 - Visit 11 - Procyon: New Candidate for the Dynamo Clinical Trial

Thu Sep 20 15:08:23 GMT 2018

Visit	<b>Proposal 15327, Visit 11, failed</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: BETWEEN 16-SEP-2018 AND 24-SEP-2018 Comments: The BETWEEN range given below is about 6 months after the broader (several month) visibility window in FEB-MAY 2018. This is the best pair of six-month-separated visibilities in Cycle 25, consistent with the desired semiannual starspot cycle monitoring interval.																
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	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]							
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Proposal 15327 - Visit 51 - Procyon: New Candidate for the Dynamo Clinical Trial

Thu Sep 20 15:08:23 GMT 2018

Visit	<b>Proposal 15327, Visit 51, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS/FUV-MAMA Special Requirements: AFTER 10 BY 180 D TO 220 D Comments: The BETWEEN range given below is about 6 months after the broader (several month) visibility window in FEB-MAY 2018. This is the best pair of six-month-separated visibilities in Cycle 25, consistent with the desired semiannual starspot cycle monitoring interval.																
	Fixed Targets	<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>HD61421</td> <td>RA: 07 39 17.2345 (114.8218104d) Dec: +05 13 10.77 (5.21966d) Equinox: J2000</td> <td>Proper Motion RA: -0.7146 arcsec/yr Proper Motion Dec: -1.0368 arcsec/yr Parallax: 0.285" Epoch of Position: 2018.50 Radial Velocity: -3.2 km/sec</td> <td>V=+0.37+/-0.1</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> Comments: The target coords for epoch 2018.5 were taken from SIMBAD, in the ICRS frame. Category=STAR Description=[F3-F9] Extended=NO					#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	HD61421	RA: 07 39 17.2345 (114.8218104d) Dec: +05 13 10.77 (5.21966d) Equinox: J2000	Proper Motion RA: -0.7146 arcsec/yr Proper Motion Dec: -1.0368 arcsec/yr Parallax: 0.285" Epoch of Position: 2018.50 Radial Velocity: -3.2 km/sec	V=+0.37+/-0.1
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Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit							
	1	(STIS.ta.743 495)	(1) HD61421	STIS/CCD, ACQ, F25ND5	MIRROR		GS ACQ SCENARIO BASE1B3		0.1 Secs (0.1 Secs) [==>]	[1]							
	Comments: Castelli-Kurucz Model:F5V; V=+0.37; Optimum SNR = 95; time to sat 3.2 s																
	2	(STIS.sp.74 3498)	(1) HD61421	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A		WAVECAL=NO	Sequence 2-3 Non-Int in Visit 51	2355 Secs (2355 Secs) [==>]	[1]							
	Comments: Input=special ETC file for ALP-CMI from ASTRAL catalog; exposure time= 2 ks at Si IV 139 nm gives peak SNR~25 (per resol) with 0.2x0.2 aperture; no LCR or GCR issues																
	3		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1307 A			Sequence 2-3 Non-Int in Visit 51	45 Secs (45 Secs) [==>]	[1]							
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	4		WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A			Sequence 4-5 Non-Int in Visit 51	45 Secs (45 Secs) [==>]	[1]							
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	5	(STIS.sp.74 3499)	(1) HD61421	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1489 A		WAVECAL=NO	Sequence 4-5 Non-Int in Visit 51	1466 Secs (1466 Secs) [==>]	[2]							
Comments: Input=special ETC file for ALP-CMI from ASTRAL catalog; exposure time= 2 ks at Si IV 139 nm gives peak SNR~35 (per resol) with 0.2x0.2 aperture; no LCR or GCR issues																	
6	(STIS.sp.74 3497)	(1) HD61421	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	G430M 4451 A				0.1 Secs (0.1 Secs) [==>]	[2]								
Comments: dispersed light peak-up assuming Castelli-Kurucz Model F5V, V=+0.37 mag: in 0.1 s, 479k e- with ND2 slit																	
7	(STIS.sp.74 3502)	(1) HD61421	STIS/NUV-MAMA, ACCUM, 0.2X0.05ND	E230H 2762 A		WAVECAL=NO	Sequence 7-8 Non-Int in Visit 51	500 Secs (500 Secs) [==>]	[2]								
Comments: Input=special ETC file for ALP-CMI from ASTRAL catalog; exposure time= 750 s at Mg II 279 nm gives peak SNR~32 (per resol) with ND2 aperture; no LCR or GCR issues																	
8		WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2762 A			Sequence 7-8 Non-Int in Visit 51	50 Secs (50 Secs) [==>]	[2]								
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