12566 - EK Draconis: Warm Coronal Rain?

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Thomas R. Ayres (PI)	**University of Colorado at Boulder**	**thomas.ayres@colorado.edu**

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HD129333	STIS/CCD STIS/FUV-MAMA	2	07-Feb-2012 21:01:14.0	yes
02	(1) HD129333	COS/FUV COS/NUV	1	07-Feb-2012 21:01:25.0	yes
03	(1) HD129333	COS/FUV COS/NUV	1	07-Feb-2012 21:01:36.0	yes
04	(1) HD129333	COS/FUV COS/NUV	1	07-Feb-2012 21:01:45.0	yes
05	(1) HD129333	COS/FUV COS/NUV	1	07-Feb-2012 21:01:55.0	yes

6 Total Orbits Used

ABSTRACT

A remarkable FUV spectrum of young solar analog EK Draconis (G1.5V) was taken by COS in Cycle 17. The mere 20-min SNAPshot captured two distinct Si IV flares (T~60,000 K); very broad profiles of Si IV and C II (T~30,000 K); and prominent Fe XXI coronal forbidden line emission (T~10

MK). Curiously, the bright Si IV features were significantly redshifted, suggesting that warm gas must be continually accreting onto the lower atmosphere. This possibly meshes with a new understanding of the solar "coronal heating paradox," whereby the lacy loop-like magnetic structures that define the Sun's "quiet" corona (away from active regions) are very close to potential, and thus cannot carry enough magnetic free energy to heat themselves: the heating must come from elsewhere. That elsewhere possibly has been discovered recently: needle-like jets of hot gas, called Type II Spicules, have been observed blasting from deep in the chromosphere out into the corona, where the ambient magnetic loops trap the upward streaming hot gas, which then cools and eventually falls back to the surface. Ironically, then, the corona was the wrong place to seek the roots of coronal heating: the chromosphere is where the action really is. The EK Dra redshifts perhaps are a glimpse of a super-sized version of the cooling phase of the solar process. The purpose of this proposal is to utilize STIS and COS to solidify the observational basis for the apparent coronal downdrafts on EK Dra. If the "coronal rain" hypothesis is borne out, it will be an important step toward resolving the long-standing mystery of coronal heating in the Sun and stars.

OBSERVING DESCRIPTION

Specic objectives of the program:

(1) Obtain high S/N COS FUV spectra at multiple rotational phases (four altogether) to measure emission line widths and centroids. Test whether the Doppler shifts might be phase-dependent, perhaps the result of a hot spot rotating across the advancing or retreating limb; or instead are an intrinsic phenomenon, like a persistent downward mass flux. (The “Doppler Imaging” interpretation was not favored for the original SNAP observation because coronal Fe XXI and chromospheric C II and O I were not shifted.) Extending the existing COS spectral coverage from G130M side-A, only, to the C IV 1549 doublet and He II 1640 at longer wavelengths (G160M), would contribute additional, supporting velocity information compared to the more restricted wavelengths of the Cycle 17 SNAPshot.

(2) Take a STIS medium-resolution echelle spectrum (E140M-1425) close in time to the initial COS G130M + G160M pointing to verify the COS wavelength scales. The single STIS exposure would match the two COS settings in wavelength grasp, and capture the key H I Lyman-alpha profile, which is too close to the FUV bright limits to activate side B for the G130M exposures. Because COS was expressly designed for raw sensitivity, rather than high precision spectroscopy, it is prudent to test the surprising EK Dra Doppler shifts with STIS. Although COS exposures have an internal wavelength reference (“lamp flash”), the lamp spectrum falls well above the stellar stripe, on a part of the detector where uncompensated geometrical distortions are different than they are where the stellar spectrum is located. The specific y-position of the stellar spectrum, and thus the local geometrical distortions it experiences, depends on the acquisition technique. However, since the same strategy will be used for all the COS

visits, spaced over less than two days, we can be confident that any wavelength issues identified in the comparison of the initial COS visit with STIS will apply to the subsequent COS pointings as well. At the same time, while STIS has exquisite velocity precision, and sufficient sensitivity to capture good profiles of the brightest lines, it lacks the sensitivity to time-resolve shapes of the bright lines, or dig down to fainter Fe XXI, and thus is not as suited for the other objectives of the program.

(3) Within each COS epoch, carry out a time-domain study of the hot lines, especially Si IV, analogous to the GHRS work of Saar & Bookbinder — but now with higher sensitivity, the key added dimension of spectral resolution, and access to coronal proxy Fe XXI — to better characterize the hot-line transients and their possible connection to episodes of catastrophic cooling.

One can acquire the target (STIS CCD, F25ND3), peak-up on a narrow aperture (again CCD, but now in dispersed light: G430M), and take four 2290 s E140M-1425 exposures (total: 9.2 ks), all in two orbits in the CVZ. The first E140M exposure, closest to the peak-up, serves as a velocity reference to mitigate spectral drifts due to thermal flexing and/or target motions. The observation is broken into pieces to avoid spectral smearing from these same sources. The 0.2"×0.2" aperture is used to maximize throughput. ETC runs using the COS flux densities predict that each 2.3 ks STIS segment will achieve S/N~ 10 per resol at Si IV 1393, which is adequate to measure the emission centroid velocity at the 1 km/s level, 20x smaller than the apparent COS redshifts. The four E140M segments combined will reach S/N~ 20 at Si IV.

The STIS observation is followed as soon as practical (no more than 1-orbit gap) by the first of the four 1-orbit COS visits. The initial COS pointing must be done in a separate visit, because COS utilizes different FGS “pickles” than STIS, and thus a different set of guide stars. The four COS sequences are identical; each leading off with an NUV imaging target acquisition, followed by a second NUV ACQ (to ensure best possible centering), then four G160M-1577 exposures, one at each of the four FP-POS positions, with exposures of 250 s (1.0 ks total); and finally a similar set of G130M-1291 integrations of 450 s each (1.8 ks total). Unfortunately, the stellar H I Lyman-alpha emission is predicted to be close to the local CR threshold, so only detector segment A can be activated for the G130M exposures.

For the purpose of estimating the Lyman-alpha flux, the StarCAT STIS spectrum of Chi1 Orionis, an active G dwarf with V=4.41, was scaled down in flux density by a factor of 4 to match the FUV line peaks of the Si IV features at 1400 A, recorded in the COS spectrum of EK Dra. (Based just on the V-mag difference, the factor would have been nearly 20, but EK Dra is more active than Chi1 Ori in terms of f/f_bol.) On the one hand, the scaling will slightly overestimate the H I flux, because the normalizing "hot" Si IV features increase in f/f_bol faster than chromospheric lines like Lyman-alpha; but, on the other hand, Chi1 Ori is much closer than EK Dra, so the ISM hydrogen absorption probably is less; perhaps the two effects compensate. In any event, the predicted peak Lyman-alpha count rate was close enough to the bright limit that the guardians of detector safety would

strenuously object to having side B activated for the G130M exposures.

The Chi1 Ori calculation was checked by considering the COS G130M spectrum of the Pleiades star Hii 314 (G0V: V=10.4), which is a better match to that of EK Dra, but the star is much further away so that the Lyman-alpha emission will be more attenuated by ISM absorption than for Chi1 Ori (which, as mentioned earlier, is much closer than EK Dra). The Hii 314 FUV fluxes were scaled upward by 19x to match those of EK Dra (close to the factor expected just from the V-mag difference). Even with the larger ISM attenuation, the outer peaks of Lyman-alpha still exceeded the bright limits by ~2X. Pity that.

The important Si IV 1400 A doublet is captured by both the G130M and G160M settings, so there will be near continuous coverage of that species. Although coronal proxy Fe XXI only appears in the G130M exposures, they account for nearly two-thirds of the observing time.

The subsequent COS pointings (Visits 3-5) would follow the first (#2) by half-day intervals, thereby accessing all four quadrants of the 2 day stellar rotation period. The intervals were specified using the "After Visit #" option in the visit-level Timing Requirements.

Visit

Proposal 12566, Visit 01, implementation Wed Feb 08 02:02:01 GMT 2012

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: CVZ

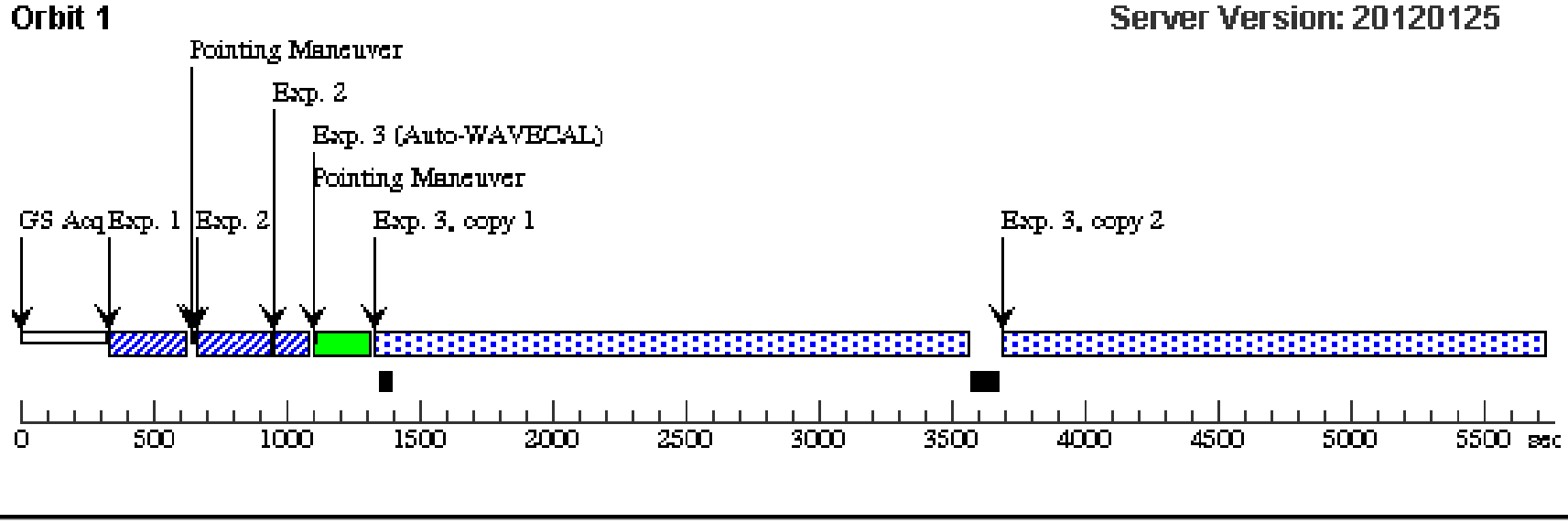
Fixed Targets

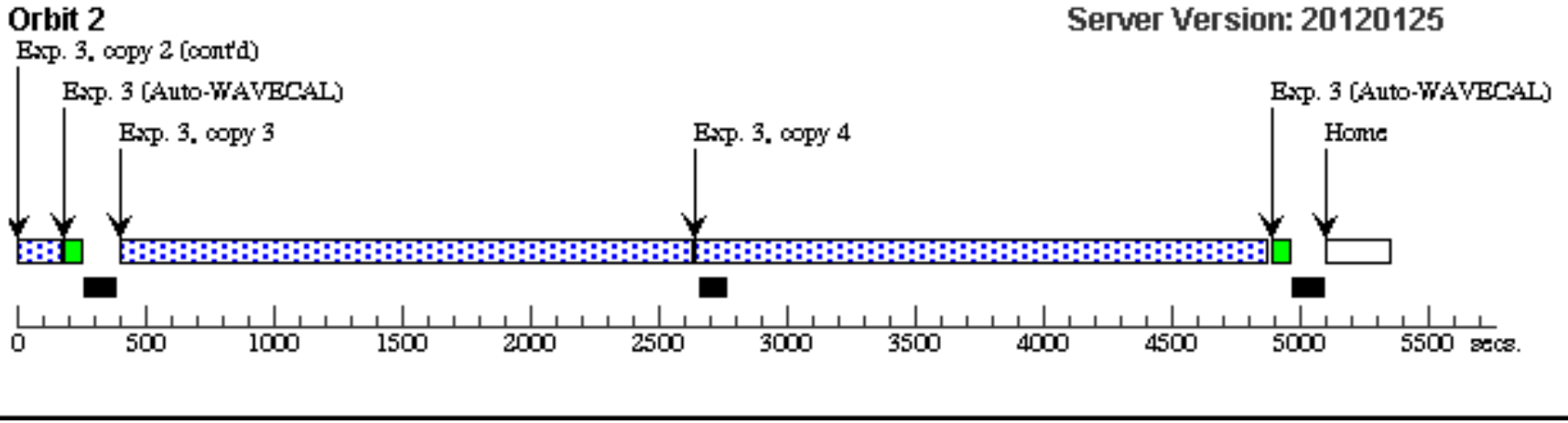
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD129333	RA: 14 39 0.1835 (219.7507646d)	Proper Motion RA: -0.13954 arcsec/yr	V=+7.61+/-0.5	Reference Frame: ICRS
	Alt Name1: EK-DRA	Dec: +64 17 29.94 (64.29165d)	Proper Motion Dec: -0.01259 arcsec/yr		
		Equinox: J2000	Parallax: 0.0293"		
			Epoch of Position: 2010		
			Radial Velocity: -30.5 km/sec		

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(STIS.ta.131784)	(1) HD129333	STIS/CCD, ACQ, F25ND3	MIRROR				0.1 Secs	
								[==>]	***[1]***
Comments: STIS.ta.131784: opt exp time 0.084s to yield S/N=53									
2	(STIS.sp.131791)	(1) HD129333	STIS/CCD, ACQ/PEAK, 0.2X0.06	G430M 3936 A				0.1 Secs	
								[==>]	***[1]***
Comments: STIS.sp.131791: yields S/N=10 per resol in 0.3s at 4000 A; should be >>40 over full spectrum in 0.1s									
3	(STIS.sp.179204)	(1) HD129333	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				2220 Secs X 4	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[1]***
								[==>(Copy 3)] *[==>(Copy 4)]*	***[2]***

Orbit Structure





Visit

Proposal 12566, Visit 02, implementation Wed Feb 08 02:02:02 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; AFTER_01 BY 0.0 D TO 0.2 D

Diagnostics

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 02) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

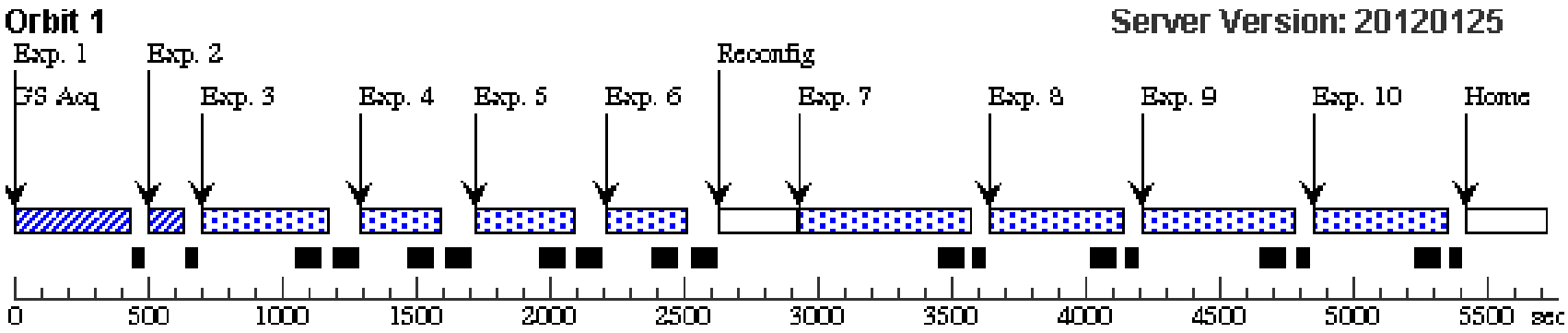
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD129333	RA: 14 39 0.1835 (219.7507646d)	Proper Motion RA: -0.13954 arcsec/yr	V=+7.61+/-0.5	Reference Frame: ICRS
	Alt Name1: EK-DRA	Dec: +64 17 29.94 (64.29165d)	Proper Motion Dec: -0.01259 arcsec/yr		
		Equinox: J2000	Parallax: 0.0293"		
			Epoch of Position: 2010		
			Radial Velocity: -30.5 km/sec		

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
2	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
3	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=3			250 Secs *[==>]*	 ***[1]***
4	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=4			250 Secs *[==>]*	 ***[1]***
5	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=1			250 Secs *[==>]*	 ***[1]***
6	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=2			250 Secs *[==>]*	 ***[1]***
7	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=3; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
8	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=4; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
9	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=1; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
10	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=2; SEGMENT=A			445 Secs *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 12566, Visit 03, implementation Wed Feb 08 02:02:03 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; AFTER_02 BY 0.4 D TO 0.8 D

Diagnostics

(Visit 03) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

(Visit 03) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 03) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

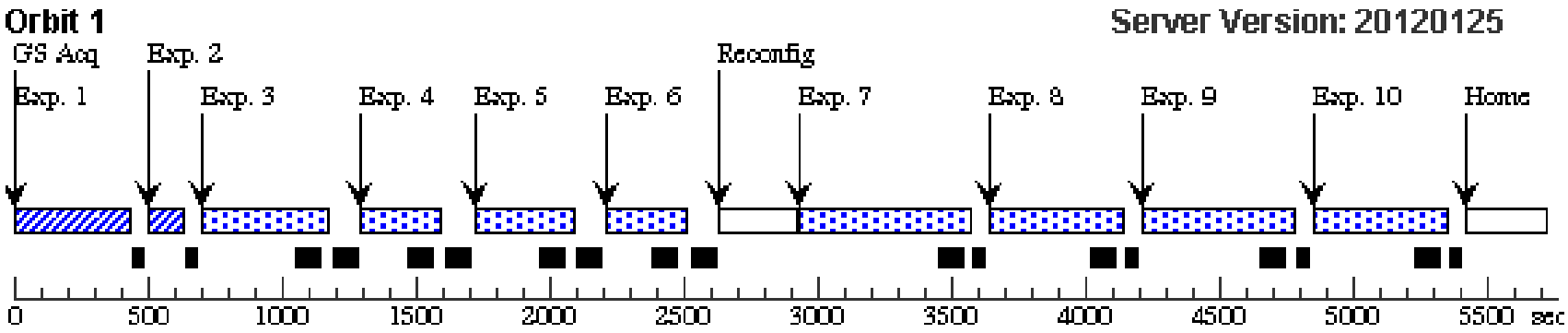
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD129333	RA: 14 39 0.1835 (219.7507646d)	Proper Motion RA: -0.13954 arcsec/yr	V=+7.61+/-0.5	Reference Frame: ICRS
	Alt Name1: EK-DRA	Dec: +64 17 29.94 (64.29165d)	Proper Motion Dec: -0.01259 arcsec/yr		
		Equinox: J2000	Parallax: 0.0293"		
			Epoch of Position: 2010		
			Radial Velocity: -30.5 km/sec		

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
2	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
3	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=3			250 Secs *[==>]*	***[1]***
4	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=4			250 Secs *[==>]*	***[1]***
5	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=1			250 Secs *[==>]*	***[1]***
6	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=2			250 Secs *[==>]*	***[1]***
7	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=3; SEGMENT=A			445 Secs *[==>]*	***[1]***
8	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=4; SEGMENT=A			445 Secs *[==>]*	***[1]***
9	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=1; SEGMENT=A			445 Secs *[==>]*	***[1]***
10	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=2; SEGMENT=A			445 Secs *[==>]*	***[1]***

Orbit Structure



Visit

Proposal 12566, Visit 04, implementation Wed Feb 08 02:02:04 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; AFTER_02 BY 0.9 D TO 1.3 D

Diagnostics

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 04) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

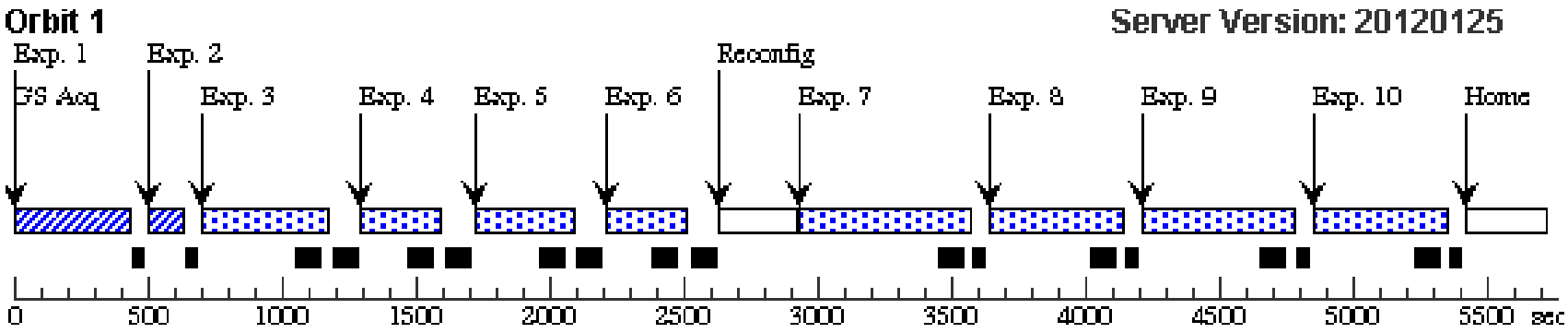
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD129333	RA: 14 39 0.1835 (219.7507646d)	Proper Motion RA: -0.13954 arcsec/yr	V=+7.61+/-0.5	Reference Frame: ICRS
	Alt Name1: EK-DRA	Dec: +64 17 29.94 (64.29165d)	Proper Motion Dec: -0.01259 arcsec/yr		
		Equinox: J2000	Parallax: 0.0293"		
			Epoch of Position: 2010		
			Radial Velocity: -30.5 km/sec		

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
2	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
3	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=3			250 Secs *[==>]*	 ***[1]***
4	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=4			250 Secs *[==>]*	 ***[1]***
5	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=1			250 Secs *[==>]*	 ***[1]***
6	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=2			250 Secs *[==>]*	 ***[1]***
7	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=3; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
8	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=4; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
9	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=1; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
10	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=2; SEGMENT=A			445 Secs *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 12566, Visit 05, implementation Wed Feb 08 02:02:04 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: CVZ; AFTER 02 BY 1.4 D TO 1.7 D

Diagnostics

(Visit 05) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 05) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 05) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

Fixed Targets

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		Equinox: J2000	Parallax: 0.0293"		
			Epoch of Position: 2010		
			Radial Velocity: -30.5 km/sec		

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
2	(COS.ta.131795)	(1) HD129333	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				13 Secs *[==>]*	 ***[1]***
Comments: COS.ta.131795: 13s MirrorA+BOA to yield S/N~60 for Kurucz G2V									
3	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=3			250 Secs *[==>]*	 ***[1]***
4	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=4			250 Secs *[==>]*	 ***[1]***
5	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=1			250 Secs *[==>]*	 ***[1]***
6	(COS.sp.179203)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G160M 1577 A	BUFFER-TIME=1400; FP-POS=2			250 Secs *[==>]*	 ***[1]***
7	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=3; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
8	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=4; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
9	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=1; SEGMENT=A			445 Secs *[==>]*	 ***[1]***
10	(COS.sp.179202)	(1) HD129333	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=3400; FP-POS=2; SEGMENT=A			445 Secs *[==>]*	 ***[1]***

Orbit Structure