15264 - The M Dwarf UV Spectra Irradiating Nearby Transiting Terrestrial Planets

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) LHS-1140	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	03-Mar-2020 15:00:16.0	yes
1C	(1) LHS-1140	COS/FUV	3	03-Mar-2020 15:00:17.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
02	(2) LHS-1140-GAIA	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	03-Mar-2020 15:00:19.0	yes
2C	(2) LHS-1140-GAIA	COS/FUV COS/NUV	3	03-Mar-2020 15:00:21.0	yes
03	(2) LHS-1140-GAIA	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	03-Mar-2020 15:00:22.0	yes
3C	(2) LHS-1140-GAIA	COS/FUV COS/NUV	3	03-Mar-2020 15:00:23.0	yes
04	(2) LHS-1140-GAIA	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	2	03-Mar-2020 15:00:25.0	yes
4C	(2) LHS-1140-GAIA	COS/FUV COS/NUV	3	03-Mar-2020 15:00:27.0	yes

20 Total Orbits Used

ABSTRACT

Of the 500 stars within 12 pc, we know of three very low-mass M dwarfs that host small transiting planets: LHS1140, TRAPPIST-1, and GJ1132. All of these planets appear to be rocky, and some orbit in their stars's habitable zones. Thanks to their stars' proximity and small sizes, the atmospheres of these planets are within reach of spectroscopic characterization by JWST and giant ground-based telescopes. Here, we propose to use Hubble to gather deep ultraviolet spectra of these important M dwarfs. These UV spectra are crucial for understanding the habitability of planets around these stars. Without knowledge of the high-energy radiation environment in which these planets reside, it is impossible to understand their evolution or to interpret observations of their atmospheres. UV light can promote obscuring hazes in a planetary atmosphere, or even produce biosignature false positives. The Hubble Space Telescope is the only facility that can observe the UV spectra of these systems. With no future UV capabilities planned to overlap with JWST, it is essential that we characterize these planet hosts with HST as soon as possible.

OBSERVING DESCRIPTION

Summary

This program focuses on the UV spectrum of LHS1140, a 0.15 solar mass star at 12.5 pc that hosts a transiting rocky planet in its habitable zone. Our Phase I proposal also requested observations of TRAPPIST-1 and GJ1132. However, these targets were grouped into the also-accepted Mega-MUSCLES Treasury Program (GO-15071). Our goals for LHS1140 are to gather measurements that will allow us to (1) determine the average intrinsic UV spectrum that is illuminating the planet and (2) constrain its variability over time. To meet these goals, we split our 20 orbits into four (hopefully) identical visits, each containing five orbits. (We say "hopefully", because we may wish to tweak the balance of exposure times across different instruments after the first visit gives us a better sense of the overall shape of the spectrum).

Templates for ETC Calculations:

To map the chromospheric emission lines we wish to detect and to check for bright limits in every mode, we need a good spectral template estimate for LHS1140. The default spectral templates in the ETC are not sufficient for estimating the expected flux in the FUV or NUV for this quient late M dwarf, LHS1140. Therefore, we constructed four representative models connecting the FUV, NUV, and optical -- for the sake of exposure time estimates, mode selection, acquisition strategies, and bright object checks. These models are:

1) The MUSCLES-constructed SED for GJ1214. The star GJ1214 is bolometrically 1.4X more luminous than LHS1140, but it is 1.2X farther away (14.5pc vs 12.5pc). Therefore, the bolometric flux we receive from both stars is nearly identical. However, the MUSCLES spectrum has low S/N (or non-detections) for most lines.

2) To estimate the weak line strengths more accurately, we construct an average of all the MUSCLES M dwarf spectra, after rescaling each by a factor that would give it the same bolometric flux as LHS1140. This does not account for the changing shape of the spectrum across subtypes of the M spectral class, but it doesn't account for the much lower intrinsic luminosity of LHS1140 than most of the MUSCLES stars.

3) So we can more clearly see the S/N per resolution element in the ETC (and provide a more extreme check for local bright limits), we construct a cartoon spectrum for LHS1140 that consists of a smooth 3000K thermal Planck spectrum superimposed by very narrow emission lines with strengths consistent with the measurements for GJ1214. With these narrow lines, we can more clearly see the tradeoffs in resolution between modes than in the

stacked MUSCLES SED (which lines were smeared by the stacking process).

4) For some ACQ tests, we also use a cartoon that is the same as (3) but with a PHOENIX stellar atmosphere instead of the Planck spectrum. This better accounts for the suppression of NUV flux due to line damping.

And for some ETC calculations that are less sensitive to the UV spectrum, we use a Pickles M4V 3111K star, normalized to V=14.18, as an approximation for LHS1140.

Visit Design

Here we outline the design of our standard visit. Details associated with each exposure are provided in its comments section.

The first orbit uses STIS/G140M/FUV-MAMA to measure the Lyman-alpha profile of the star, relying on the long-slit to subtract geocoronoal airglow. Despite the substantial absorption from the ISM, we reliably detected Lyman-alpha from GJ1132 (a 0.18 solar mass star at 12.1pc) in every single orbit of GO-14757, so expect slightly lower fluxes but similar detections for LHS1140. We use an unobscured LyA profile for our ETC calculations, to provide very cautious bright limits. LyA is the strongest M dwarf line in the FUV.

The second orbit uses STIS/G230L/NUV-MAMA to measure the MgII flux from the star. We opt for STIS over COS for the NUV because (a) it shows similar sensitivity at MgII and (b) it covers a much broader simultaneous wavelength span than COS. MgII is the strongest M dwarf line in the NUV. Having these first two exposures back to back will enable the most reliable instantaneous FUV-to-NUV ratios within each visit.

The third through fifth orbits use COS/G160M and COS/G130M to probe the forest of weaker lines across the rest of the FUV. These weaker lines are important for determining the overall shape of the UV spectrum and the thermal structure of the M dwarf's upper atmosphere. We opt for the supported science modes with this instruments that allow simultaneous use of both FUV detectors and still cover the lines of interest that were previously observed for other stars in the MUSCLES program. The expected S/N for these weaker lines is on the order of [a few] per visit. For the stronger among them we may be able to probe variability across multiple visit; for the weaker we will likely need to combine all four visits for a single robust detection. We do not expect to detect any FUV continuum with COS; therefore, although we do not use all FP-POS for every wavelength center, we do ensure most of the emission lines are measured at four different locations on the detectors.

Timing of Visits:

We specify scheduling constraints for the visits so that all visits are conducted at times when contemporaneous ground-based optical spectroscopy will be possible, either from New Mexico or from Chile. The first two visits would ideally schedule for the 2017 season, with the second visit following at least 25 days after the first, to provide time to make changes to the exposure times if deemed necessary. The other two visits would then happen in the 2018 season, after multiple 130 day rotational periods of the star have passed. We specified our ideal timing constraints, but could relax them if need be to fit these visits into the schedule.

Visit

Proposal 15264, STIS - 2017 (01), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

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

Special Requirements: BETWEEN 15-JUL-2017:00:00:00 AND 15-DEC-2017:00:00:00

Diagnostics

(STIS - 2017 (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(STIS - 2017 (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LHS-1140	RA: 00 44 59.3400 (11.2472500d) Dec: -15 16 17.50 (-15.27153d) Equinox: J2000	Proper Motion RA: 299.202 mas/yr Proper Motion Dec: -594.896 mas/yr Parallax: 0.0802" Epoch of Position: 2000.0	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13	Reference Frame: ICRS

Comments: We adopt RECONS astrometry for LHS1140, drawing values from Winters et al. (2017; 2017AJ....153...14W). These values are more accurate than those quoted on SIMBAD, which came from Salim and Gould (2003; 2003ApJ...582.1011S). An extra check, we note that the magnitude of the difference between the predicted Winters and S&G positions, when propagated to 2018.5, is 0.915 arcsecond -- this is smaller than the 2.5" aperture of through which the COS/NUV/ACQ is performed, providing encouragement that uncertainties in the proper motions will not prevent ACQ. We also confirm that the APT Target Confirmation chart correctly locates the cross hair on the star in the 1991.68 epoch image.
Category=STAR
Description=[M V-IV]
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-ACQ (STIS.ta.1010795)	(1) LHS-1140	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.3 Secs (0.3 Secs) *[==>]*	*[1]*

Comments: We use the F28X50LP filter for this ACQ image to maximize flux and to ensure the brightness is weighted most strongly toward red wavelengths. This ensures that unknown faint blue sources do not throw off the ACQ centroid. This star has high proper motion, and we checked that there are no noticeable stars in either the red or blue DSS plates that will fall within 5" of the predicted position of LHS1140 for the 2017-2020 time span.

We aim for a S/N of 130. If the flux is 10X lower than expected, we still reach the required S/N=40. If the flux is 10X higher, we would just barely saturate (S/N~400). We consider the following spectral templates for the ETC calculation.

STIS.ta.1012838: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.2388 seconds to reach S/N=130, and a time to saturation of 5.37 seconds.

STIS.ta.1012837: Using GJ1214's MUSCLE SED, the ACQ ETC lists a time of 0.2877 seconds to reach S/N=130, and a time to saturation of 6.73 seconds.

We adopt the mean of these two values, and round up.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	STIS-ACQ/PEAK-FUV (STIS.ta.1012844)	(1) LHS-1140	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[1]*

Comments: We ACQ/PEAK on the 0.05" slit, to ensure optimal centering when we switch to the 0.1" slit for the subsequent G140M/FUV exposure to measure the star's Lyman-alpha profile. We will be using the D1 pseudo-aperture in that exposure, so we use the same here.

As with the ACQ, we compare two assumptions about the stellar spectrum:

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

We adopt the mean of these two values.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	STIS-G140M (STIS.sp.1012846)	(1) LHS-1140	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=977			1900 Secs (1953 Secs) *[==>1953.0 Secs]*	*[1]*

Comments: We select the 0.1" slit as a compromise between two considerations: we want a narrow slit to minimize contamination from the geocoronal LyA to our faint M dwarf spectrum, but we also want a slit wide enough that the slit losses can be relatively well-characterized. We choose the D1 aperture to minimize dark current for our very faint M dwarf. For the ACQ/PEAK preceding this exposure, we used the smaller 52X0.05D1 aperture, in the hopes getting better and more reliable centering for this science exposure.

We checked three assumptions about the spectra:
STIS.sp.1012850: GJ1214 spectrum from MUSCLES
STIS.sp.1012846: scaled-averaged-MUSCLES spectrum as a template
STIS.sp.1012849: cartoon Planck spectrum + emission lines at GJ1214's strength but made artificially narrow
In all cases, the spectrum contains a profile for the stellar Lyman-alpha that has been reconstructed to correct for ISM absorption. In reality, the Lyman-alpha flux will be lower than represented here. However, with these unrealistically high fluxes, the ETC issues no warnings.

In GO-14757, we confidently detected Lyman-alpha in GJ1132 (another star of similar luminosity and distance to LHS1140) in a single orbit. Therefore, we expect a detection should be possible in a single orbit for LHS1140 (and we will adjust future visits based on the flux seen in the first).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	STIS-ACQ/PEAK-NUV (STIS.ta.1012833)	(1) LHS-1140	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[2]*

Comments: We perform this ACQ/PEAK with the 52X0.05 aperture, to ensure we are optimally centered in the 52X0.5 aperture will use for the G230L/NUV observation.

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

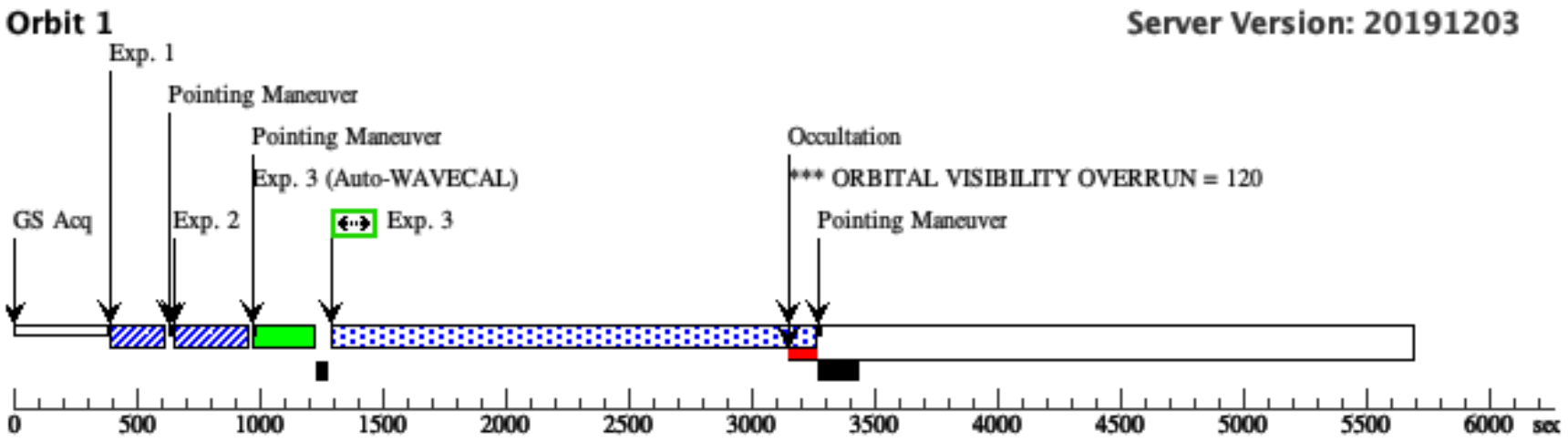
We adopt the mean of these two values.

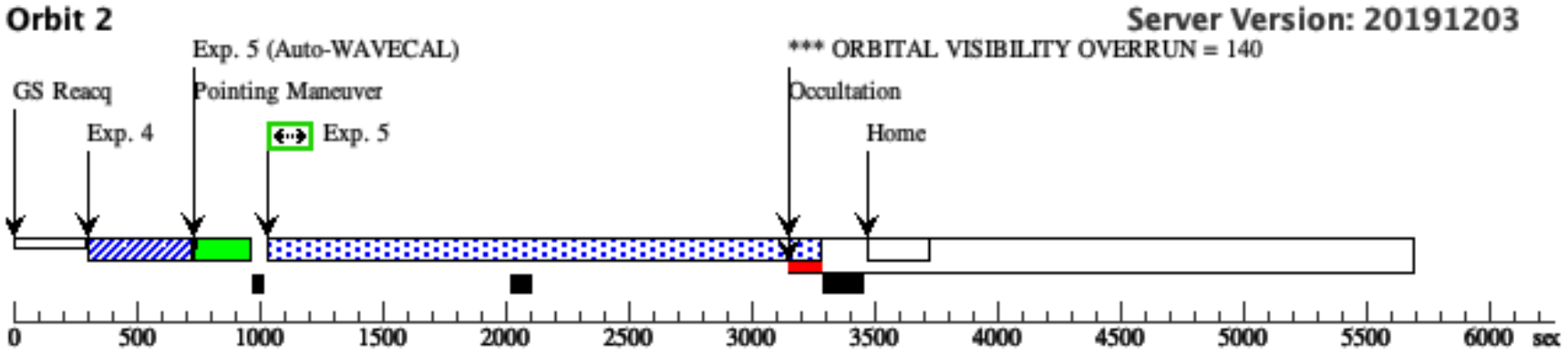
5	STIS-G230L (STIS.sp.1012858)	(1) LHS-1140	STIS/NUV-MAMA, TIME-TAG, 52X0.5	G230L 2376 A	BUFFER-TIME=977	2000 Secs (2214 Secs)	[==>2214.0 Secs]	[2]

Comments: We select the 0.5" slit because we want to minimize throughput and maximize spectrophotometric accuracy, at these longer wavelengths. We are less concerned about sky subtraction for MgII and the NUV than we were for the G140M, so we shift the balance toward the wider slit. ETC calculations show the addition sky background from the larger slit does not significantly degrade the S/N.

We checked four assumptions about the spectra:
STIS.sp.1012853: GJ1214 spectrum from MUSCLES (S/N=20 on MgII, maybe continuum)
STIS.sp.1012855: scaled-averaged-MUSCLES spectrum as a template (S/N=17 on MgII, definite continuum)
STIS.sp.1012858: cartoon Planck spectrum + emission lines (S/N=17 on MgII, definite continuum)
STIS.sp.1012859: PHOENIX spectrum + emission lines (S/N = 16 on MgII, maybe continuum)
No warnings were raised.

Orbit Structure





Visit

Proposal 15264, COS - 2017 (1C), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: AFTER_01 BY 0_Orbits TO 2.5_Orbits; BETWEEN 15-JUL-2017:00:00:00 AND 15-DEC-2017:00:00:00

Diagnostics

(COS - 2017 (1C)) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronography with STIS or COS.

(COS - 2017 (1C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (1C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (1C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LHS-1140	RA: 00 44 59.3400 (11.2472500d)	Proper Motion RA: 299.202 mas/yr	V=14.15+/-0.03	Reference Frame: ICRS
		Dec: -15 16 17.50 (-15.27153d)	Proper Motion Dec: -594.896 mas/yr	V=14.18,	
		Equinox: J2000	Parallax: 0.0802"	R=12.88,	
			Epoch of Position: 2000.0	Ic=11.19,	
				J=9.61,	
				H=9.09,	
				Ks=8.82,	
				W1=8.61,	
				W2=8.39,	
				W3=8.23,	
				W4=8.13	

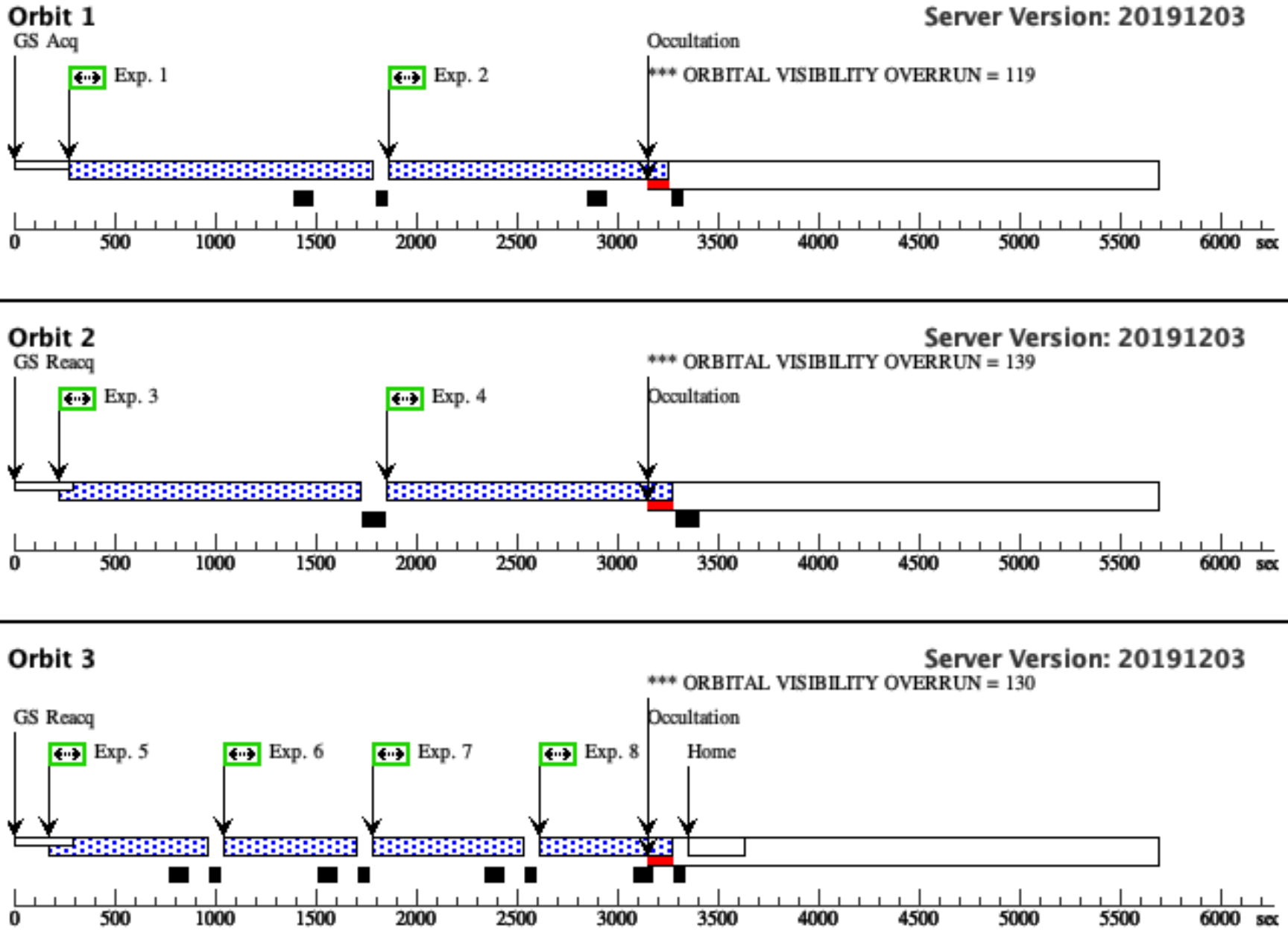
Comments: We adopt RECONS astrometry for LHS1140, drawing values from Winters et al. (2017; 2017AJ....153...14W). These values are more accurate than those quoted on SIMBAD, which came from Salim and Gould (2003; 2003ApJ...582.1011S). An extra check, we note that the magnitude of the difference between the predicted Winters and S&G positions, when propagated to 2018.5, is 0.915 arcsecond -- this is smaller than the 2.5" aperture of through which the COS/NUV/ACQ is performed, providing encouragement that uncertainties in the proper motions will not prevent ACQ. We also confirm that the APT Target Confirmation chart correctly locates the cross hair on the star in the 1991.68 epoch image.
Category=STAR
Description=[M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	COS/G160 M-1611FP3 (COS.sp.1013266)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=964			1000 Secs (1341 Secs) *[==>1341.0 Secs]*	***[1]***
	Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV. *COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013266: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
2	COS/G160 M-1611FP4 (COS.sp.1013266)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=954			1000 Secs (1341 Secs) *[==>1341.0 Secs]*	***[1]***
	Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV. *COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013266: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
3	COS/G160 M-1577FP1 (COS.sp.1013287)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=1; BUFFER-TIME=1297			1300 Secs (1369 Secs) *[==>1369.0 Secs]*	***[2]***
	Comments: These two FP-POS at 1577 cover CIV and HeII and SiIV. *COS.sp.1013293: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013287: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
4	COS/G160 M-1577FP2 (COS.sp.1013287)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=1297			1300 Secs (1369 Secs) *[==>1369.0 Secs]*	***[2]***
5	COS/G130 M-1223FP1 (COS.sp.1013299)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=1; BUFFER-TIME=440			550 Secs (607 Secs) *[==>607.0 Secs]*	***[3]***
	Comments: These two FP-POS at 1223 cover (maybe SiII), NV, SiII, and CII. We assume the wavelength coverage is very close to 1222, and we use 1222 for ETC calculations. *COS.sp.1013298: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013299: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
6	COS/G130 M-1223FP2 (COS.sp.1013299)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=2; BUFFER-TIME=440			550 Secs (607 Secs) *[==>607.0 Secs]*	***[3]***
7	COS/G130 M-1291FP3 (COS.sp.1013301)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=440			550 Secs (607 Secs) *[==>607.0 Secs]*	***[3]***
	Comments: These two FP-POS at 1291 cover SiII, LyA, NV, SiII, CII, SiIV. *COS.sp.1013302: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013301: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								

	8	COS/G130 M-1291FP4 (COS.sp.1013301)	(1) LHS-1140	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=440	550 Secs (607 Secs) *[==>607.0 Secs]*	***[3]***

Orbit Structure



Visit

Proposal 15264, STIS - 2017 (02), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

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

Special Requirements: AFTER_01 BY 25 D TO 10000 D

Diagnostics

(STIS - 2017 (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(STIS - 2017 (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
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-ACQ (STIS.ta.1010795)	(2) LHS-1140-GAIA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.3 Secs (0.3 Secs) *[==>]*	***[1]***

Comments: We use the F28X50LP filter for this ACQ image to maximize flux and to ensure the brightness is weighted most strongly toward red wavelengths. This ensures that unknown faint blue sources do not throw off the ACQ centroid. This star has high proper motion, and we checked that there are no noticeable stars in either the red or blue DSS plates that will fall within 5" of the predicted position of LHS1140 for the 2017-2020 time span.

We aim for a S/N of 130. If the flux is 10X lower than expected, we still reach the required S/N=40. If the flux is 10X higher, we would just barely saturate (S/N~400). We consider the following spectral templates for the ETC calculation.

STIS.ta.1012838: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.2388 seconds to reach S/N=130, and a time to saturation of 5.37 seconds.

STIS.ta.1012837: Using GJ1214's MUSCLE SED, the ACQ ETC lists a time of 0.2877 seconds to reach S/N=130, and a time to saturation of 6.73 seconds.

We adopt the mean of these two values, and round up.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	STIS-ACQ/PEAK-FUV (STIS.ta.1012844)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	***[1]***

Comments: We ACQ/PEAK on the 0.05" slit, to ensure optimal centering when we switch to the 0.1" slit for the subsequent G140M/FUV exposure to measure the star's Lyman-alpha profile. We will be using the D1 pseudo-aperture in that exposure, so we use the same here.

As with the ACQ, we compare two assumptions about the stellar spectrum:

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

We adopt the mean of these two values.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	STIS-G140M (STIS.sp.1012846)	(2) LHS-1140-GAIA	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=977			1900 Secs (1953 Secs) *[==>1953.0 Secs]*	***[1]***

Comments: We select the 0.1" slit as a compromise between two considerations: we want a narrow slit to minimize contamination from the geocoronal LyA to our faint M dwarf spectrum, but we also want a slit wide enough that the slit losses can be relatively well-characterized. We choose the D1 aperture to minimize dark current for our very faint M dwarf. For the ACQ/PEAK preceding this exposure, we used the smaller 52X0.05D1 aperture, in the hopes getting better and more reliable centering for this science exposure.

We checked three assumptions about the spectra:
STIS.sp.1012850: GJ1214 spectrum from MUSCLES
STIS.sp.1012846: scaled-averaged-MUSCLES spectrum as a template
STIS.sp.1012849: cartoon Planck spectrum + emission lines at GJ1214's strength but made artificially narrow
In all cases, the spectrum contains a profile for the stellar Lyman-alpha that has been reconstructed to correct for ISM absorption. In reality, the Lyman-alpha flux will be lower than represented here. However, with these unrealistically high fluxes, the ETC issues no warnings.

In GO-14757, we confidently detected Lyman-alpha in GJ1132 (another star of similar luminosity and distance to LHS1140) in a single orbit. Therefore, we expect a detection should be possible in a single orbit for LHS1140 (and we will adjust future visits based on the flux seen in the first).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	STIS-ACQ/PEAK-NUV (STIS.ta.1012833)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	***[2]***

Comments: We perform this ACQ/PEAK with the 52X0.05 aperture, to ensure we are optimally centered in the 52X0.5 aperture will use for the G230L/NUV observation.

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

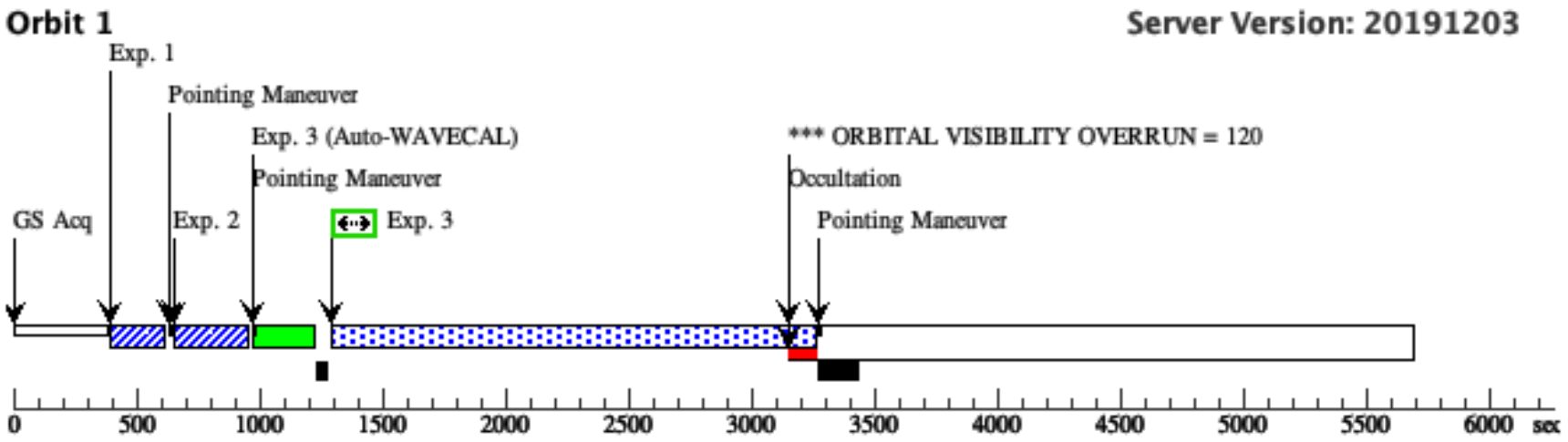
We adopt the mean of these two values.

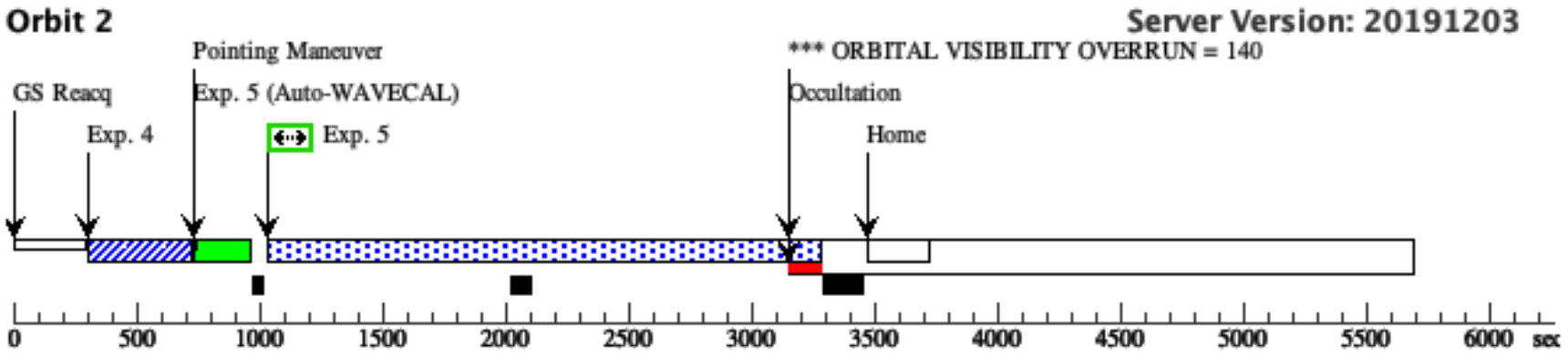
5	STIS-G230L (STIS.sp.1012858)	(2) LHS-1140-GAIA	STIS/NUV-MAMA, TIME-TAG, 52X0.5	G230L 2376 A	BUFFER-TIME=977	2000 Secs (2214 Secs)	[==>2214.0 Secs]	[2]

Comments: We select the 0.5" slit because we want to minimize throughput and maximize spectrophotometric accuracy, at these longer wavelengths. We are less concerned about sky subtraction for MgII and the NUV than we were for the G140M, so we shift the balance toward the wider slit. ETC calculations show the addition sky background from the larger slit does not significantly degrade the S/N.

We checked four assumptions about the spectra:
STIS.sp.1012853: GJ1214 spectrum from MUSCLES (S/N=20 on MgII, maybe continuum)
STIS.sp.1012855: scaled-averaged-MUSCLES spectrum as a template (S/N=17 on MgII, definite continuum)
STIS.sp.1012858: cartoon Planck spectrum + emission lines (S/N=17 on MgII, definite continuum)
STIS.sp.1012859: PHOENIX spectrum + emission lines (S/N = 16 on MgII, maybe continuum)
No warnings were raised.

Orbit Structure





Visit

Proposal 15264, COS - 2017 (2C), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: AFTER_02 BY 0.0_Orbits TO 2.5_Orbits

Diagnostics

(COS - 2017 (2C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (2C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (2C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ/IMAGE (COS.ta.1159404)	(2) LHS-1140-GAIA	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				958 Secs (958 Secs) *[==>]*	***[1]***

Comments: Thanks to Gaia astrometry, we can predict the location of the star to better than 0.4", so we do not conduct an ACQ/SEARCH.

If the star is flaring (9000K Planck spectrum normalized to U = 14.8 = quiescient U + 2.3 mag.):
I cannot ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159401), because I get "WARNING MESSAGE: Total count rate per pixel 112.175 exceeds bright limit 50."
I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159400) to S/N=20 in 11s without warnings.

If the star is its expected non-flaring brightness (GJ1214 from MUSCLES, scaled by luminosity + distance, 30X fainter than the flaring case):
I can ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159402) to S/N=20 in 14s.
I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159404) to S/N=20 in 958s.

I expose for the longest of these scenarios, using MIRRORB.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	COS/G160M-1611FP3 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=964			200 Secs (606 Secs) *[==>606.0 Secs]*	***[1]***

Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV.

COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013266: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	COS/G160M-1611FP4 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=954			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV.

COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013266: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	COS/G160M-1577FP1 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=1; BUFFER-TIME=1297			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

Comments: These two FP-POS at 1577 cover CIV and HeII and SiIV.

COS.sp.1013293: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013287: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
5	COS/G160M-1577FP2 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=1297			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
6	COS/G130M-1223FP1 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=1; BUFFER-TIME=440			550 Secs (627 Secs) *[==>627.0 Secs]*	***[2]***

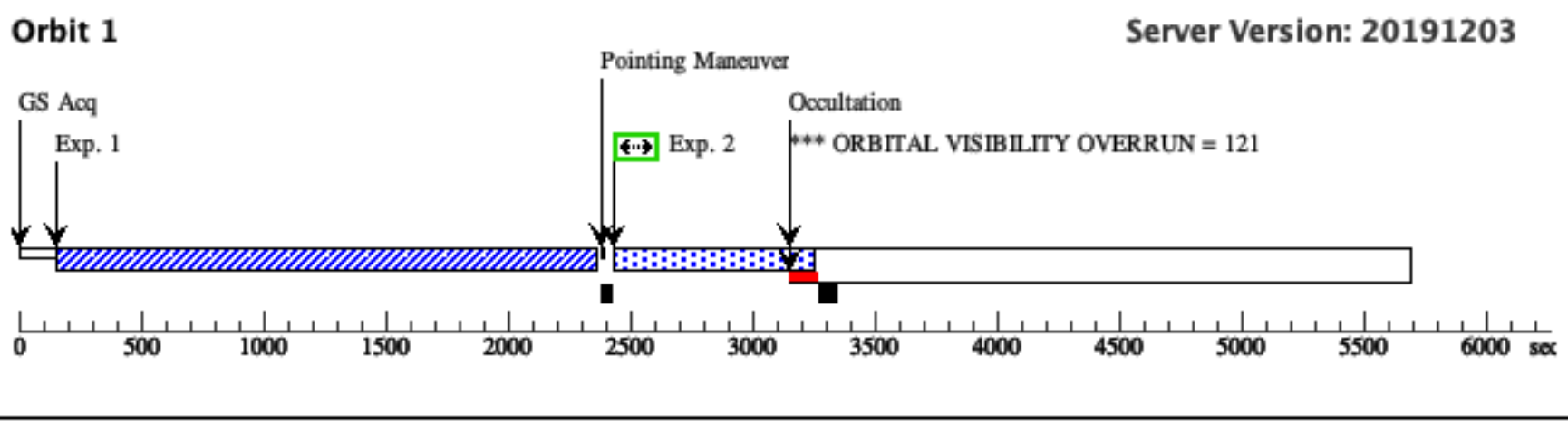
Comments: These two FP-POS at 1223 cover (maybe SiII), NV, SiII, and CII. We assume the wavelength coverage is very close to 1222, and we use 1222 for ETC calculations.

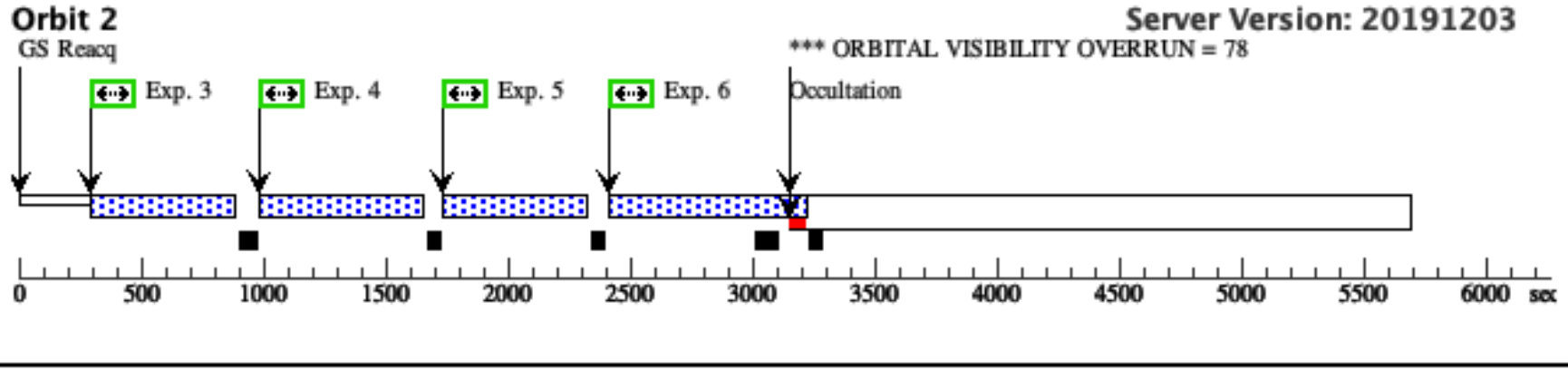
COS.sp.1013298: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299
COS.sp.1013299: cartoon Planck spectrum + emission lines

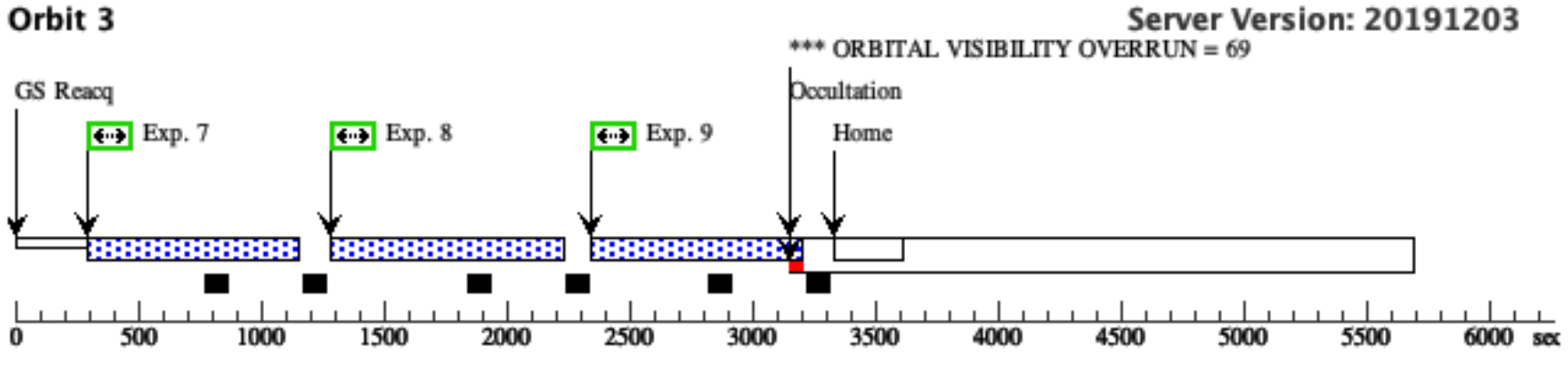
We tested both these scenarios. Neither exceeded the bright limit.

	7	COS/G130 M-1223FP2 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=2; BUFFER-TIME=440	550 Secs (809 Secs) *[==>809.0 Secs]*	***[3]***
	8	COS/G130 M-1291FP3 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=440	550 Secs (809 Secs) *[==>809.0 Secs]*	***[3]***
	Comments: These two FP-POS at 1291 cover SiII, LyA, NV, SiII, CII, SiIV. *COS.sp.1013302: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013301: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*							
	9	COS/G130 M-1291FP4 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=440	550 Secs (809 Secs) *[==>809.0 Secs]*	***[3]***

Orbit Structure







Visit

Proposal 15264, STIS - 2018 (03), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

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

Special Requirements: (none)

Diagnostics

(STIS - 2018 (03)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(STIS - 2018 (03)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
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-ACQ (STIS.ta.1010795)	(2) LHS-1140-GAIA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.3 Secs (0.3 Secs) *[==>]*	*[1]*

Comments: We use the F28X50LP filter for this ACQ image to maximize flux and to ensure the brightness is weighted most strongly toward red wavelengths. This ensures that unknown faint blue sources do not throw off the ACQ centroid. This star has high proper motion, and we checked that there are no noticeable stars in either the red or blue DSS plates that will fall within 5" of the predicted position of LHS1140 for the 2017-2020 time span.

We aim for a S/N of 130. If the flux is 10X lower than expected, we still reach the required S/N=40. If the flux is 10X higher, we would just barely saturate (S/N~400). We consider the following spectral templates for the ETC calculation.

STIS.ta.1012838: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.2388 seconds to reach S/N=130, and a time to saturation of 5.37 seconds.

STIS.ta.1012837: Using GJ1214's MUSCLE SED, the ACQ ETC lists a time of 0.2877 seconds to reach S/N=130, and a time to saturation of 6.73 seconds.

We adopt the mean of these two values, and round up.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	STIS-ACQ/PEAK-FUV (STIS.ta.1012844)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[1]*

Comments: We ACQ/PEAK on the 0.05" slit, to ensure optimal centering when we switch to the 0.1" slit for the subsequent G140M/FUV exposure to measure the star's Lyman-alpha profile. We will be using the D1 pseudo-aperture in that exposure, so we use the same here.

As with the ACQ, we compare two assumptions about the stellar spectrum:

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

We adopt the mean of these two values.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	STIS-G140M (STIS.sp.1012846)	(2) LHS-1140-GAIA	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=977			1900 Secs (1953 Secs) *[==>1953.0 Secs]*	*[1]*

Comments: We select the 0.1" slit as a compromise between two considerations: we want a narrow slit to minimize contamination from the geocoronal LyA to our faint M dwarf spectrum, but we also want a slit wide enough that the slit losses can be relatively well-characterized. We choose the D1 aperture to minimize dark current for our very faint M dwarf. For the ACQ/PEAK preceding this exposure, we used the smaller 52X0.05D1 aperture, in the hopes getting better and more reliable centering for this science exposure.

We checked three assumptions about the spectra:
STIS.sp.1012850: GJ1214 spectrum from MUSCLES
STIS.sp.1012846: scaled-averaged-MUSCLES spectrum as a template
STIS.sp.1012849: cartoon Planck spectrum + emission lines at GJ1214's strength but made artificially narrow
In all cases, the spectrum contains a profile for the stellar Lyman-alpha that has been reconstructed to correct for ISM absorption. In reality, the Lyman-alpha flux will be lower than represented here. However, with these unrealistically high fluxes, the ETC issues no warnings.

In GO-14757, we confidently detected Lyman-alpha in GJ1132 (another star of similar luminosity and distance to LHS1140) in a single orbit. Therefore, we expect a detection should be possible in a single orbit for LHS1140 (and we will adjust future visits based on the flux seen in the first).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	STIS-ACQ/PEAK-NUV (STIS.ta.1012833)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[2]*

Comments: We perform this ACQ/PEAK with the 52X0.05 aperture, to ensure we are optimally centered in the 52X0.5 aperture will use for the G230L/NUV observation.

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

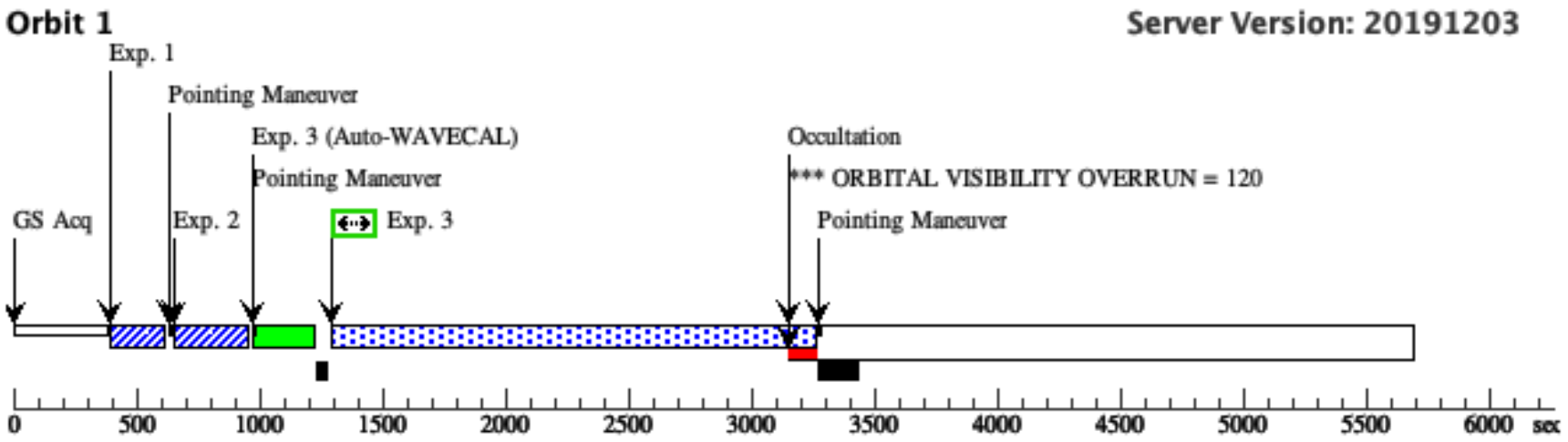
We adopt the mean of these two values.

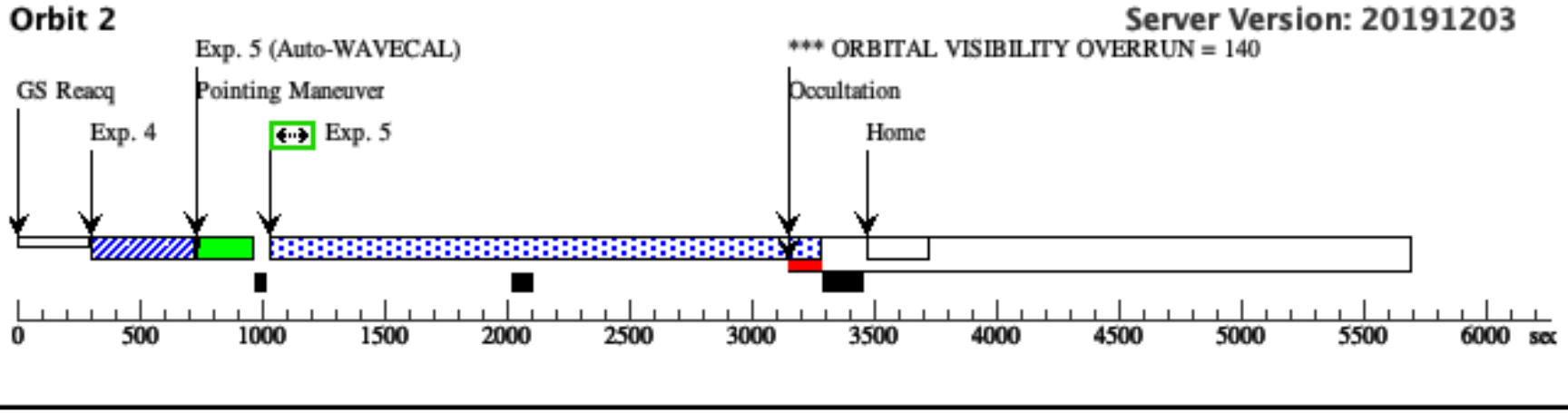
5	STIS-G230L (STIS.sp.1012858)	(2) LHS-1140-GAIA	STIS/NUV-MAMA, TIME-TAG, 52X0.5	G230L 2376 A	BUFFER-TIME=977	2000 Secs (2214 Secs)	[==>2214.0 Secs]	[2]

Comments: We select the 0.5" slit because we want to minimize throughput and maximize spectrophotometric accuracy, at these longer wavelengths. We are less concerned about sky subtraction for MgII and the NUV than we were for the G140M, so we shift the balance toward the wider slit. ETC calculations show the addition sky background from the larger slit does not significantly degrade the S/N.

We checked four assumptions about the spectra:
STIS.sp.1012853: GJ1214 spectrum from MUSCLES (S/N=20 on MgII, maybe continuum)
STIS.sp.1012855: scaled-averaged-MUSCLES spectrum as a template (S/N=17 on MgII, definite continuum)
STIS.sp.1012858: cartoon Planck spectrum + emission lines (S/N=17 on MgII, definite continuum)
STIS.sp.1012859: PHOENIX spectrum + emission lines (S/N = 16 on MgII, maybe continuum)
No warnings were raised.

Orbit Structure





Visit

Proposal 15264, COS - 2017 (3C), completed Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: AFTER_03 BY 0.0_Orbits TO 2.5_Orbits

Diagnostics

(COS - 2017 (3C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (3C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(COS - 2017 (3C)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ/IMAGE (COS.ta.1159404)	(2) LHS-1140-GAIA	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				958 Secs (958 Secs) *[==>]*	***[1]***

Comments: Thanks to Gaia astrometry, we can predict the location of the star to better than 0.4", so we do not conduct an ACQ/SEARCH.

If the star is flaring (9000K Planck spectrum normalized to U = 14.8 = quiescient U + 2.3 mag.):
I cannot ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159401), because I get "WARNING MESSAGE: Total count rate per pixel 112.175 exceeds bright limit 50."
I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159400) to S/N=20 in 11s without warnings.

If the star is its expected non-flaring brightness (GJ1214 from MUSCLES, scaled by luminosity + distance, 30X fainter than the flaring case):
I can ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159402) to S/N=20 in 14s.
I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159404) to S/N=20 in 958s.

I expose for the longest of these scenarios, using MIRRORB.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	COS/G160M-1611FP3 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=964			200 Secs (606 Secs) *[==>606.0 Secs]*	***[1]***

Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV.

COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013266: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	COS/G160M-1611FP4 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=954			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV.

COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013266: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	COS/G160M-1577FP1 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=1; BUFFER-TIME=1297			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

Comments: These two FP-POS at 1577 cover CIV and HeII and SiIV.

COS.sp.1013293: scaled-averaged-MUSCLES spectrum as a template
COS.sp.1013287: cartoon Planck spectrum + emission lines

We tested both these scenarios. Neither exceeded the bright limit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
5	COS/G160M-1577FP2 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=1297			400 Secs (537 Secs) *[==>537.0 Secs]*	***[2]***

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
6	COS/G130M-1223FP1 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=1; BUFFER-TIME=440			550 Secs (687 Secs) *[==>687.0 Secs]*	***[2]***

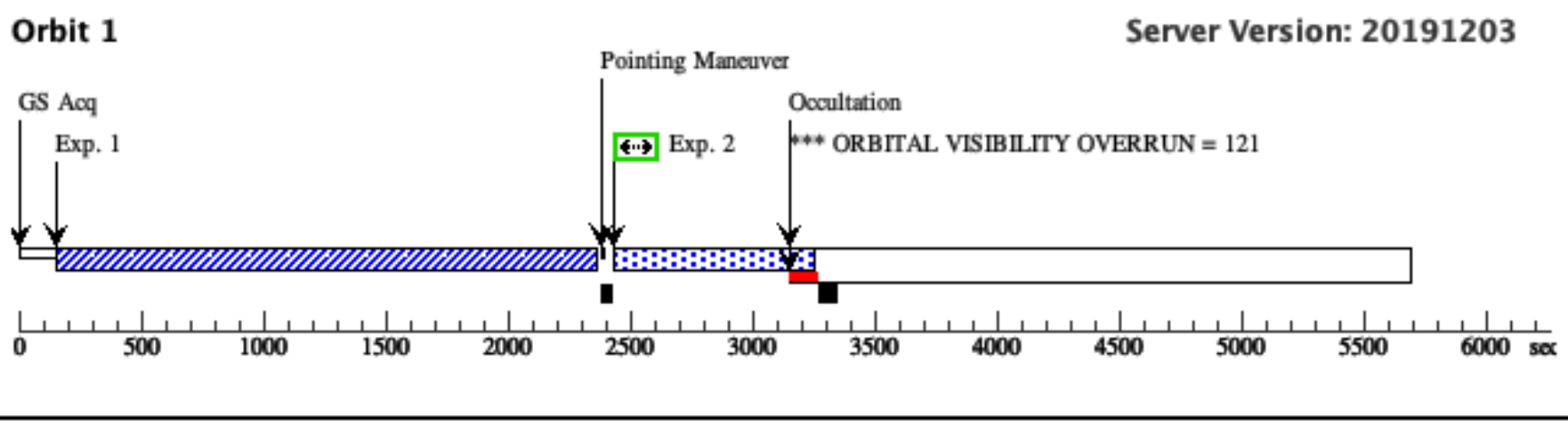
Comments: These two FP-POS at 1223 cover (maybe SiII), NV, SiII, and CII. We assume the wavelength coverage is very close to 1222, and we use 1222 for ETC calculations.

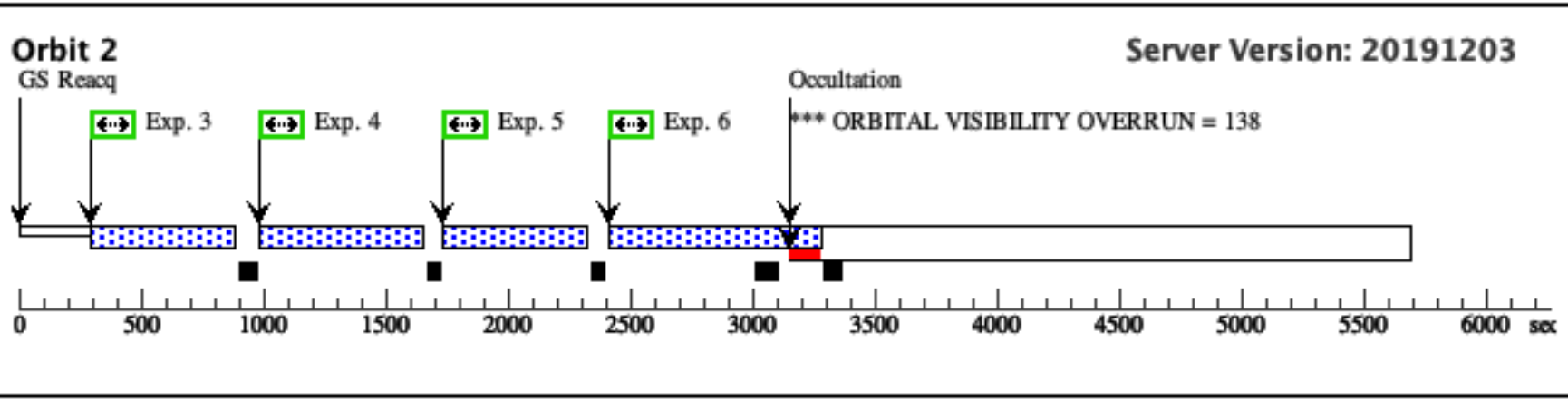
COS.sp.1013298: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299
COS.sp.1013299: cartoon Planck spectrum + emission lines

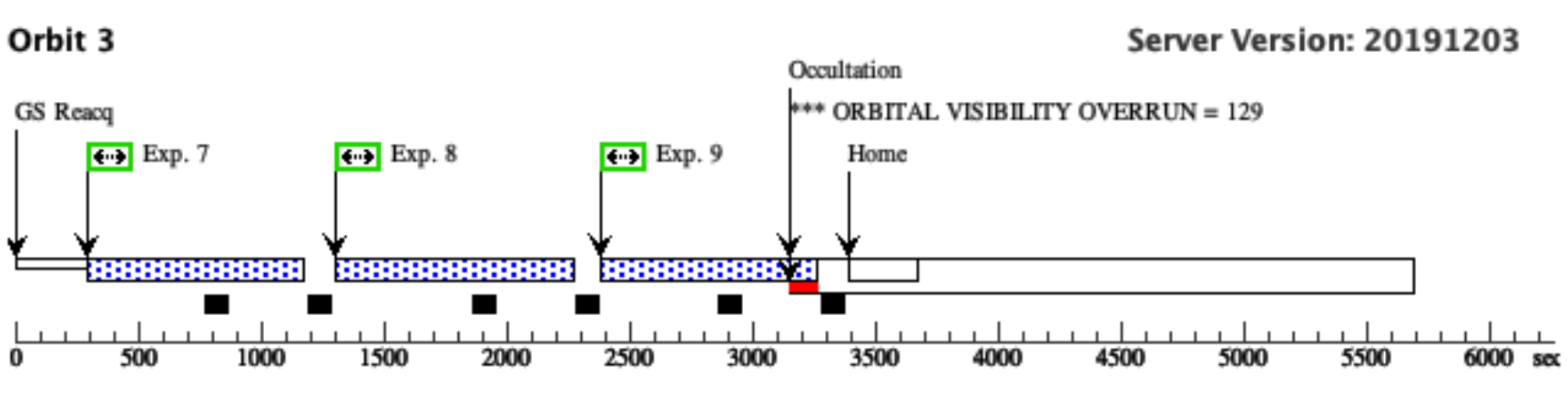
We tested both these scenarios. Neither exceeded the bright limit.

	7	COS/G130 M-1223FP2 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=2; BUFFER-TIME=440	550 Secs (829 Secs) *[==>829.0 Secs]*	***[3]***
	8	COS/G130 M-1291FP3 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=440	550 Secs (829 Secs) *[==>829.0 Secs]*	***[3]***
	Comments: These two FP-POS at 1291 cover SiII, LyA, NV, SiII, CII, SiIV. *COS.sp.1013302: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013301: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*							
	9	COS/G130 M-1291FP4 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=440	550 Secs (829 Secs) *[==>829.0 Secs]*	***[3]***

Orbit Structure







Visit

Proposal 15264, STIS - 2018 (04), implementation Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
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-ACQ (STIS.ta.1010795)	(2) LHS-1140-GAIA	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.3 Secs (0.3 Secs) *[==>]*	*[1]*

Comments: We use the F28X50LP filter for this ACQ image to maximize flux and to ensure the brightness is weighted most strongly toward red wavelengths. This ensures that unknown faint blue sources do not throw off the ACQ centroid. This star has high proper motion, and we checked that there are no noticeable stars in either the red or blue DSS plates that will fall within 5" of the predicted position of LHS1140 for the 2017-2020 time span.

We aim for a S/N of 130. If the flux is 10X lower than expected, we still reach the required S/N=40. If the flux is 10X higher, we would just barely saturate (S/N~400). We consider the following spectral templates for the ETC calculation.

STIS.ta.1012838: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.2388 seconds to reach S/N=130, and a time to saturation of 5.37 seconds.

STIS.ta.1012837: Using GJ1214's MUSCLE SED, the ACQ ETC lists a time of 0.2877 seconds to reach S/N=130, and a time to saturation of 6.73 seconds.

We adopt the mean of these two values, and round up.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	STIS-ACQ/PEAK-FUV (STIS.ta.1012844)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05D1	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[1]*

Comments: We ACQ/PEAK on the 0.05" slit, to ensure optimal centering when we switch to the 0.1" slit for the subsequent G140M/FUV exposure to measure the star's Lyman-alpha profile. We will be using the D1 pseudo-aperture in that exposure, so we use the same here.

As with the ACQ, we compare two assumptions about the stellar spectrum:

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

We adopt the mean of these two values.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
3	STIS-G140M (STIS.sp.1012846)	(2) LHS-1140-GAIA	STIS/FUV-MAMA, TIME-TAG, 52X0.1D1	G140M 1222 A	BUFFER-TIME=977			1900 Secs (1833 Secs) *[==>1833.0 Secs]*	*[1]*

Comments: We select the 0.1" slit as a compromise between two considerations: we want a narrow slit to minimize contamination from the geocoronal LyA to our faint M dwarf spectrum, but we also want a slit wide enough that the slit losses can be relatively well-characterized. We choose the D1 aperture to minimize dark current for our very faint M dwarf. For the ACQ/PEAK preceding this exposure, we used the smaller 52X0.05D1 aperture, in the hopes getting better and more reliable centering for this science exposure.

We checked three assumptions about the spectra:
STIS.sp.1012850: GJ1214 spectrum from MUSCLES
STIS.sp.1012846: scaled-averaged-MUSCLES spectrum as a template
STIS.sp.1012849: cartoon Planck spectrum + emission lines at GJ1214's strength but made artificially narrow
In all cases, the spectrum contains a profile for the stellar Lyman-alpha that has been reconstructed to correct for ISM absorption. In reality, the Lyman-alpha flux will be lower than represented here. However, with these unrealistically high fluxes, the ETC issues no warnings.

In GO-14757, we confidently detected Lyman-alpha in GJ1132 (another star of similar luminosity and distance to LHS1140) in a single orbit. Therefore, we expect a detection should be possible in a single orbit for LHS1140 (and we will adjust future visits based on the flux seen in the first).

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
4	STIS-ACQ/PEAK-NUV (STIS.ta.1012833)	(2) LHS-1140-GAIA	STIS/CCD, ACQ/PEAK, 52X0.05	MIRROR				0.9 Secs (0.9 Secs) *[==>]*	*[2]*

Comments: We perform this ACQ/PEAK with the 52X0.05 aperture, to ensure we are optimally centered in the 52X0.5 aperture will use for the G230L/NUV observation.

STIS.ta.1012844: Using the V=14.18 Pickles M4V, the ACQ/PEAK ETC lists a time of 0.818 seconds to reach S/N=130, and a time to saturation of 11.96 seconds.

STIS.ta.1012841: Using GJ1214's MUSCLE SED, the ACQ/PEAK ETC lists a time of 1.033 seconds to reach S/N=130, and a time to saturation of 15.60 seconds.

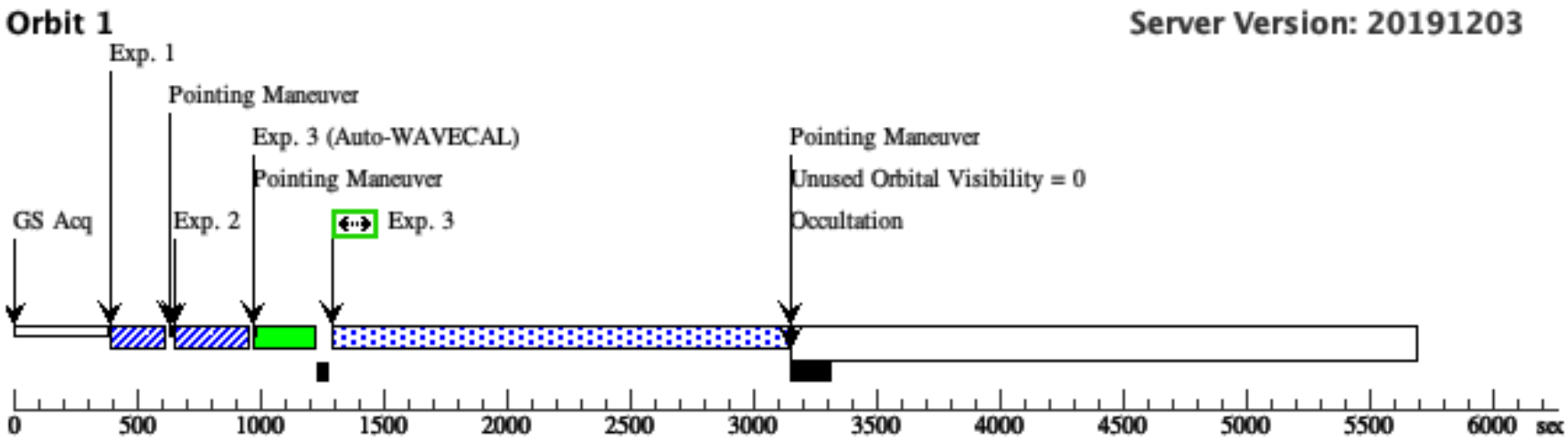
We adopt the mean of these two values.

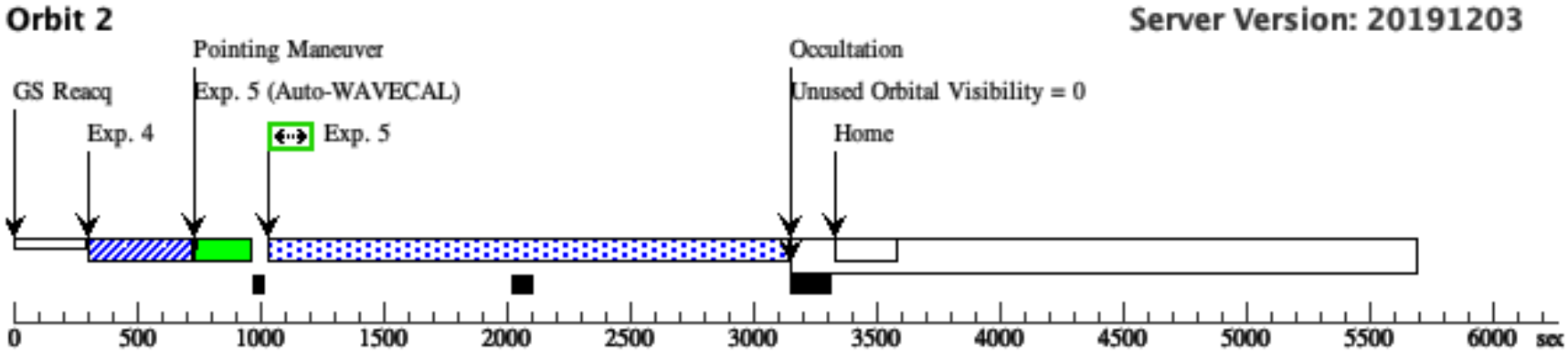
5	STIS-G230L (STIS.sp.1012858)	(2) LHS-1140-GAIA	STIS/NUV-MAMA, TIME-TAG, 52X0.5	G230L 2376 A	BUFFER-TIME=977	2000 Secs (2074 Secs)	[==>2074.0 Secs]	[2]

Comments: We select the 0.5" slit because we want to minimize throughput and maximize spectrophotometric accuracy, at these longer wavelengths. We are less concerned about sky subtraction for MgII and the NUV than we were for the G140M, so we shift the balance toward the wider slit. ETC calculations show the addition sky background from the larger slit does not significantly degrade the S/N.

We checked four assumptions about the spectra:
STIS.sp.1012853: GJ1214 spectrum from MUSCLES (S/N=20 on MgII, maybe continuum)
STIS.sp.1012855: scaled-averaged-MUSCLES spectrum as a template (S/N=17 on MgII, definite continuum)
STIS.sp.1012858: cartoon Planck spectrum + emission lines (S/N=17 on MgII, definite continuum)
STIS.sp.1012859: PHOENIX spectrum + emission lines (S/N = 16 on MgII, maybe continuum)
No warnings were raised.

Orbit Structure





Visit

Proposal 15264, COS - 2017 (4C), implementation Tue Mar 03 20:00:28 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: AFTER_04 BY 0.0_Orbits TO 2.5_Orbits

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	LHS-1140-GAIA Alt Name1: GAIA-DR2-2371032916186181760	RA: 00 44 59.6717 (11.2486321d) Dec: -15 16 26.79 (-15.27411d) Equinox: J2000	Proper Motion RA: 317.58479536673076 mas/yr Proper Motion Dec: -596.6172189050758 mas/yr Parallax: 0.06669961637554519 " Epoch of Position: 2015.5	V=14.15+/-0.03 V=14.18, R=12.88, Ic=11.19, J=9.61, H=9.09, Ks=8.82, W1=8.61, W2=8.39, W3=8.23, W4=8.13, G=12.67	Reference Frame: ICRS

Comments: We update the positions and proper motions of LHS-1140 based on Gaia DR2. These are significant more precise than the previous RECONS astrometry we were using, and referenced to a more recent 2015.5 epoch.
Category=STAR
Description=[M V-IV]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ/IMAGE (COS.ta.1159404)	(2) LHS-1140-GAIA	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				958 Secs (958 Secs) *[==>]*	***[1]***
	Comments: Thanks to Gaia astrometry, we can predict the location of the star to better than 0.4", so we do not conduct an ACQ/SEARCH. *If the star is flaring (9000K Planck spectrum normalized to U = 14.8 = quiescient U + 2.3 mag.):* *I cannot ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159401), because I get "WARNING MESSAGE: Total count rate per pixel 112.175 exceeds bright limit 50."* *I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159400) to S/N=20 in 11s without warnings.* *If the star is its expected non-flaring brightness (GJ1214 from MUSCLES, scaled by luminosity + distance, 30X fainter than the flaring case):* *I can ACQ/IMAGE/NUV/PSA/MIRRORA (COS.ta.1159402) to S/N=20 in 14s.* *I can ACQ/IMAGE/NUV/PSA/MIRRORB (COS.ta.1159404) to S/N=20 in 958s.* *I expose for the longest of these scenarios, using MIRRORB.*								
2	COS/G160M-1611FP3 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=3; BUFFER-TIME=964			200 Secs (485 Secs) *[==>485.0 Secs]*	***[1]***
	Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV. *COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013266: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
3	COS/G160M-1611FP4 (COS.sp.1013266)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1611 A	FP-POS=4; BUFFER-TIME=954			400 Secs (505 Secs) *[==>505.0 Secs]*	***[2]***
	Comments: These two FP-POS at 1611 cover CIV and HeII, but not SiIV. *COS.sp.1013261: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013266: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
4	COS/G160M-1577FP1 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=1; BUFFER-TIME=1297			400 Secs (505 Secs) *[==>505.0 Secs]*	***[2]***
	Comments: These two FP-POS at 1577 cover CIV and HeII and SiIV. *COS.sp.1013293: scaled-averaged-MUSCLES spectrum as a template* *COS.sp.1013287: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								
5	COS/G160M-1577FP2 (COS.sp.1013287)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G160M 1577 A	FP-POS=2; BUFFER-TIME=1297			400 Secs (505 Secs) *[==>505.0 Secs]*	***[2]***
6	COS/G130M-1223FP1 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=1; BUFFER-TIME=440			550 Secs (655 Secs) *[==>655.0 Secs]*	***[2]***
	Comments: These two FP-POS at 1223 cover (maybe SiII), NV, SiII, and CII. We assume the wavelength coverage is very close to 1222, and we use 1222 for ETC calculations. *COS.sp.1013298: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013299: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*								

	7	COS/G130 M-1223FP2 (COS.sp.1013299)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1222 A	FP-POS=2; BUFFER-TIME=440	550 Secs (786 Secs) *[==>786.0 Secs]*	***[3]***
	8	COS/G130 M-1291FP3 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=440	550 Secs (786 Secs) *[==>786.0 Secs]*	***[3]***
	Comments: These two FP-POS at 1291 cover SiII, LyA, NV, SiII, CII, SiIV. *COS.sp.1013302: scaled-averaged-MUSCLES spectrum as a template COS.sp.1013299* *COS.sp.1013301: cartoon Planck spectrum + emission lines* *We tested both these scenarios. Neither exceeded the bright limit.*							
	9	COS/G130 M-1291FP4 (COS.sp.1013301)	(2) LHS-1140-GAIA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=440	550 Secs (786 Secs) *[==>786.0 Secs]*	***[3]***

Orbit Structure