17490 - A Local Lyman Continuum Leaker: Direct and Indirect Detections with KISSB 85

Cycle: 31, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Alec S. Hirschauer (PI) (Contact)	**Space Telescope Science Institute**
Samantha Wallis Brunker (CoI)	Indiana University System
Prof. John J. Salzer (CoI)	Indiana University System
Dr. Svea S Hernandez (CoI) (ESA Member)	Space Telescope Science Institute - ESA - JWST
Dr. Bethan Lesley James (CoI) (ESA Member)	Space Telescope Science Institute - ESA - JWST
Dr. Alessandra Aloisi (CoI)	Space Telescope Science Institute
Dr. Matilde Mingozzi (CoI) (ESA Member)	Space Telescope Science Institute - ESA - JWST
Dr. Logan H Jones (CoI)	Space Telescope Science Institute
Dr. Claus Leitherer (CoI)	Space Telescope Science Institute
Dr. Swara Ravindranath (CoI)	Catholic University of America

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) KISS-F1205-5985	COS/FUV COS/NUV	5	02-Jul-2024 14:02:51.0	yes
02	(1) KISS-F1205-5985	COS/FUV COS/NUV	3	02-Jul-2024 14:02:52.0	yes

8 Total Orbits Used

ABSTRACT

The specific mechanisms responsible for the reionization of the Universe remain poorly understood. While it is generally accepted that this period of transformation was primarily a consequence of highly-ionizing Lyman continuum (LyC) radiation leaking from high-redshift star-forming galaxies (SFGs), their direct detection is observationally precluded due to the high opacities of the ubiquitous intergalactic medium. Local analogs to these systems, with attributes which mirror the environments of the early Universe such as high ionization and low metal abundances, represent our best accessible means to obtain detailed measurements of LyC photons. We propose for COS far-ultraviolet (FUV) observations of the candidate LyC leaker KISSB 85, a nearby (z = 0.046; D = 206 Mpc), metal-poor (12+log(O/H) = 7.42; ~5% Z_solar), high-ionization (O32 = 17.3) SFG. This dwarf system possesses similar charateristics to early-Universe LyC leakers, but is nearby enough to allow for meticulous examination of its radiation profile. In addition, we will utilize these direct detections to examine an indirect means for estimating LyC with the saturated C II 1334.5 A absorption feature, which will allow for a broader understanding of the mechanisms which enable LyC leakage. With measurement of the Lyman-alpha line profile, we will study the neutral gas properties of this high-z analog system, and through efforts fitting the spectral profile with two different theoretical models, we will characterize the metallicity, age, and dust attenuation of the observed young, massive stellar population which produces the ionizing radiation, supporting current efforts being undertaken with JWST.

OBSERVING DESCRIPTION

We are observing the Lyman continuum (LyC) leaker candidate KISSB 85. This is a nearby (z = 0.046; D = 206 Mpc), metal-poor (12+log(O/H) = 7.42; ~5% Z_solar), high-ionization (O32 = 17.3) star-forming galaxy. Observations will be undertaken utilizing HST/COS far-ultraviolet (far-UV) spectroscopy with the G140L grating and cenwave 800, which will recover LyC photons (lambda_observed < 954.3 A) directly. Additionally, we will observe with HST/COS grating G130M and cenwave 1291, which will detect Lyman-alpha (Lya) photons (lambda_observed = 1272.0 A), as well as the C II 1334.5 A spectral feature (lambda_observed = 1396.4 A), which has proven a reliable proxy for measuring the LyC escape fraction when direct observations are precluded. This will enable us to better understand the mechanism(s) facilitating the escape of ionizing photons which are capable of ionizing the early Universe in the nearby, high-redshift star-forning galaxy analog KISSB 85. In addition, we will characterize Lya itself and, employing the near-UV target acquisition images, we will study the morphology of this compact system as well.

The exposure time necessary to acquire an ACQ/IMAGE with S/N = 20 was preliminarily calculated by the exposure time calculator (ETC) to be 219.25 seconds, which is much less than one orbit. G140L/800 spectroscopy of LyC photons with S/N = 2-3 was computed with the ETC to take

21,353.86 seconds, or approximately 6.7 orbits. G130M/1291 spectroscopy of Lya emission (S/N = 20) and the indirect C II feature (S/N >5) was computed with the ETC to take 3,429.93 seconds, or approximately 1.0 orbits. The total exposure time is estimated to require eight orbits.

Our observing strategy will be to split our eight orbits into two separate visits, as scheduling is limited to five orbits at a time, avoiding visits of four orbits, whenever possible. We therefore will conduct a first visit of five orbits, which will begin with an imaging acquisition. The remainder of this first orbit will then be taken up entirely with an exposure of G140L/800 at FP-POS = 1. The subsequent three orbits (orbits 2, 3, and 4 of visit 1) will each be entirely comprised of G140L/800 exposures, at FP-POS = 2, 3, and 4, respectively. Finally, the last orbit of this visit (orbit 5) will be split between the two allowed G130M/1291 FP-POS settings (3 and 4).

The second visit will then be three orbits, which will again begin with an imaging acquisition. Once again, the remainder of this first orbit will be entirely taken up with an exposure of G140L/800 at FP-POS = 1. Orbit 2 will be split evenly between G140L/800 FP-POS = 2 and 3. Finally, the last orbit of the visit (orbit 3) will be entirely dedicated to G140L/800 FP-POS = 4.

This strategy results in uneven exposure times for the four FP-POS settings of G140L/800, with emphasis on FP-POS = 4. This is because, of the four FP-POS possible, FP-POS = 4 goes to the shortest wavelength, which will give us the best possible chance at recovering LyC photons. The total exposure time for each of the four G140L/800 FP-POS settings are as follows:

FP-POS	First Integration	Second Integration	Total Exposure Time
1	1909 seconds	1909 seconds	3818 seconds
2	2688 seconds	1286 seconds	3974 seconds
3	2688 seconds	1286 seconds	3974 seconds
4	2688 seconds	2688 seconds	5376 seconds

We note that, comparing the ETC computations made for this APT Phase II file with those made for the initial Phase I submission in May 2023, there had been a version update of pyETC (v31.1 to v31.2) within which the dark rates (as reported via monitoring by the HST/COS Instrument Team) were elevated significantly. This has the effect of requiring a longer science integration time to achieve the same S/N. Due to the necessities of the strategy outlined here, including time lost to overheads, the number of orbits which will be dedicated to G140L/800 (~6.5) is a bit less than proposed

for (~6.7). This has the consequence of potentially lowering the S/N expected for LyC photons, however as we expect to bin heavily below the Lyman Break in effort to recover said photons, this should not be a problem.

Here now is a summary of the observing program strategy:

Visit	Orbit	Mode	FP-POS	Exp. Time	ETC#
1	1	IMAGE/ACQ	N/A	221 sec	COS.ta.1888782
1	1	G140L/800	1	1909 sec	COS.sp.1888785
1	2	G140L/800	2	2686 sec	COS.sp.1888786
1	3	G140L/800	3	2686 sec	COS.sp.1888786
1	4	G140L/800	4	2686 sec	COS.sp.1888786
1	5	G130M/1291	3	1285 sec	COS.sp.1888783
1	5	G130M/1291	4	1285 sec	COS.sp.1888783
2	1	IMAGE/ACQ	N/A	221 sec	COS.ta.1888782
2	1	G140L/800	1	1909 sec	COS.sp.1888785
2	2	G140L/800	2	1286 sec	COS.sp.1888784
2	2	G140L/800	3	1286 sec	COS.sp.1888784
2	3	G140L/800	4	2686 sec	COS.sp.1888786

BUFFER-TIME values for science exposures were set to be 2/3 * Buffer Fill Time reported in the ETC calculations. For the G140L/800 observations, 10,101 sec * 2/3 = 6,734 sec. For the G130M/1291 observations, 5,883 sec * 2/3 = 3,922 sec.

UPDATE (1 July 2024): Due to HST now operating under reduced gyro mode (RGM), the usable exposure duration per orbit has been reduced further. In addition, at this point in time the ETC version has been updated to 32.2. Here are updated records for the ETC runs, where the BUFFER-TIME has been revised to reflect the constraints of the exposure times.

(G140L/800)

FP-POS	First Integration	Second Integration	Total Exposure Time
1	1860 seconds	1860 seconds	3720 seconds
2	2588 seconds	1236 seconds	3824 seconds
3	2588 seconds	1237 seconds	3825 seconds
4	2588 seconds	2588 seconds	5176 seconds

(observing program summary)

Visit	Orbit	Mode	FP-POS	Exp. Time	ETC#
1	1	IMAGE/ACQ	N/A	221 sec	COS.ta.1888782
1	1	G140L/800	1	1860 sec	COS.sp.1926681
1	2	G140L/800	2	2588 sec	COS.sp.1926380
1	3	G140L/800	3	2588 sec	COS.sp.1926380
1	4	G140L/800	4	2588 sec	COS.sp.1926380
1	5	G130M/1291	3	1216 sec	COS.sp.1926381
1	5	G130M/1291	4	1217 sec	COS.sp.1926381
2	1	IMAGE/ACQ	N/A	221 sec	COS.ta.1888782
2	1	G140L/800	1	1860 sec	COS.sp.1926681
2	2	G140L/800	2	1236 sec	COS.sp.1926678
2	2	G140L/800	3	1237 sec	COS.sp.1926678
2	3	G140L/800	4	2588 sec	COS.sp.1926380

Visit

Proposal 17490, Visit 01, implementation Tue Jul 02 18:02:52 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Exposure 2 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 3 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 5 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 6 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 7 (Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	KISS-F1205-5985	RA: 12 06 47.5459 (181.6981079d) Dec: +29 20 33.26 (29.34257d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.046	V=19.27 m_B = 19.85, FUV (GALEX) AB = 20.1377 +/- 0.1793, g (SDSS model) AB = 19.016 +/- 0.013	Reference Frame: ICRS

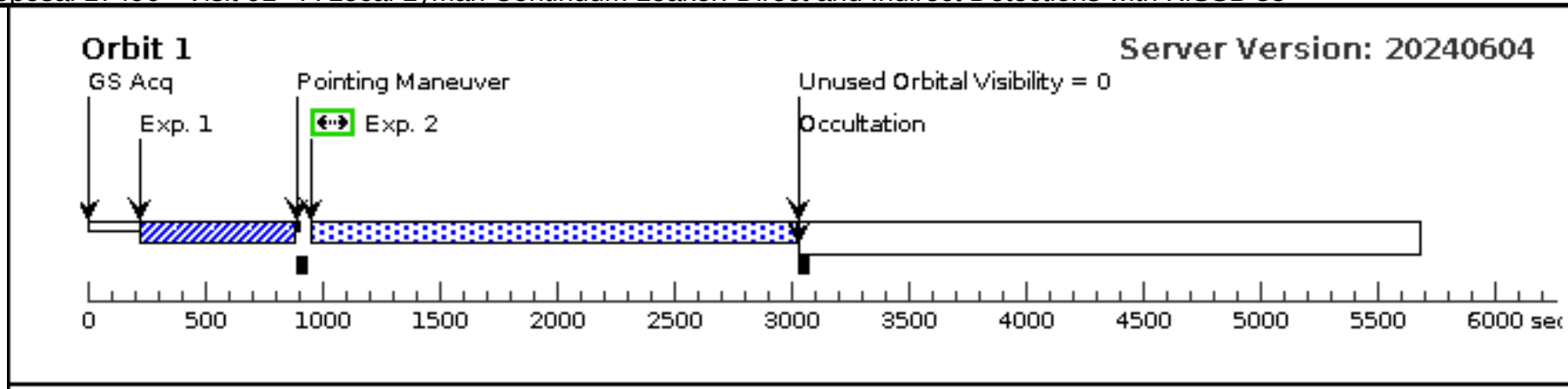
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

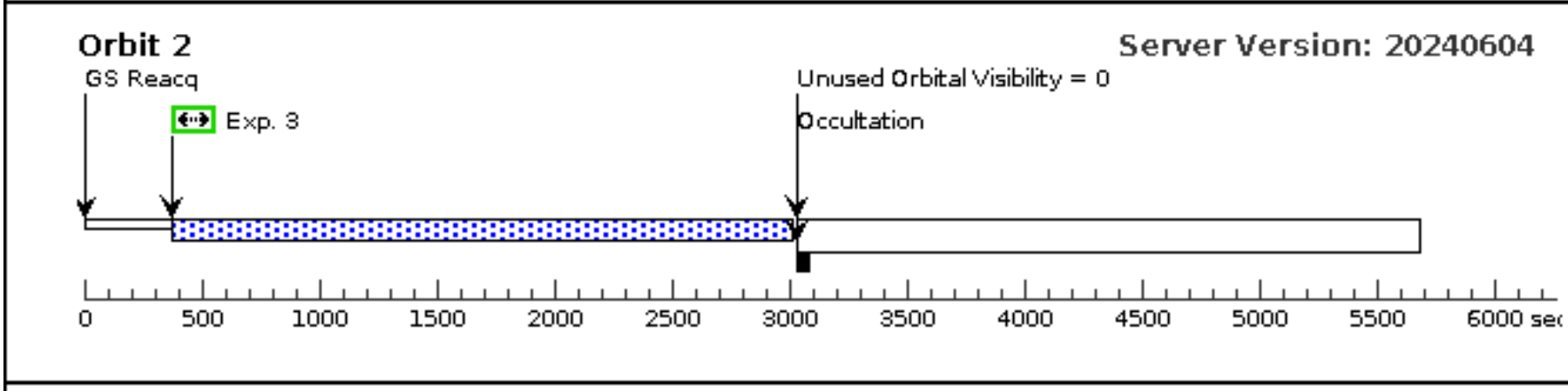
See http://ned.ipac.caltech.edu/byname?objname=KISSB+85&hconst=67.8&omegam=0.308&omegav=0.692&wmap=4&corr_z=1 for more "Other Fluxes".
Category=GALAXY
Description=[DWARF COMPACT, EMISSION LINE NEBULA, STARBURST]
Extended=YES

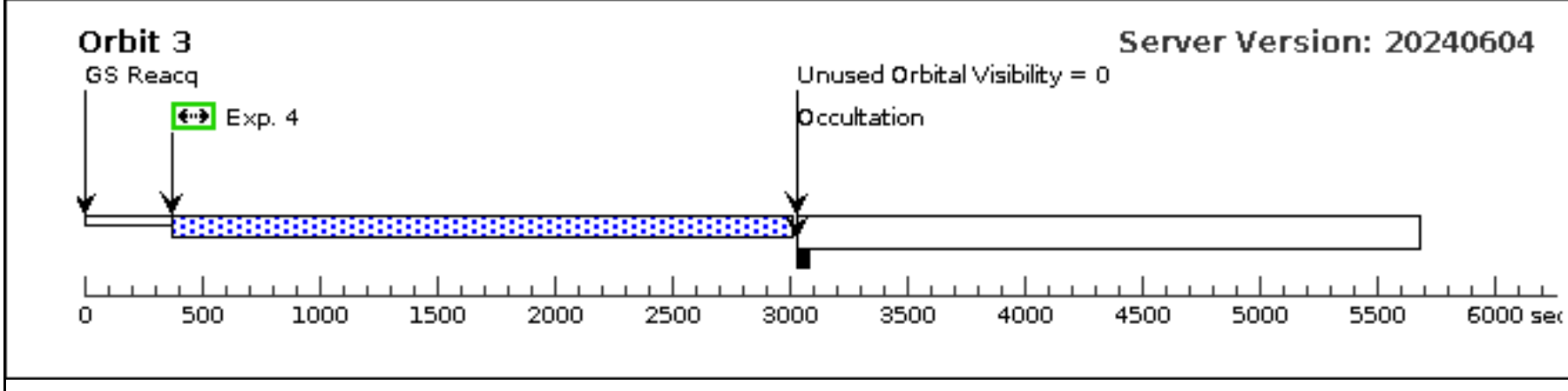
Exposures

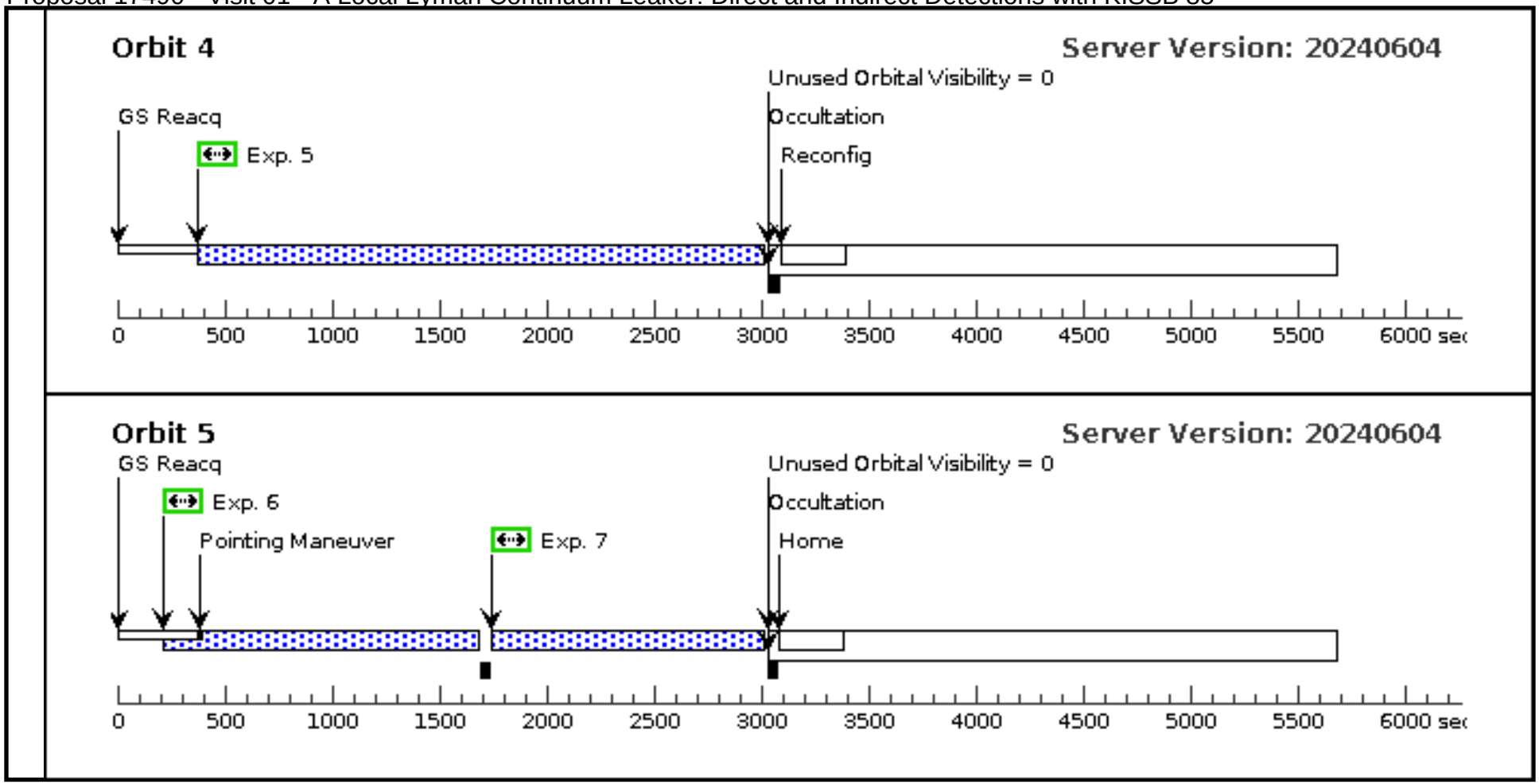
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1888782)	(1) KISS-F1205-5985	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				221 Secs (221 Secs) *[==>]*	***[1]***
2	(COS.sp.1926681)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=1; BUFFER-TIME=7806			1860 Secs (1860 Secs) *[==>]*	***[1]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 11709 seconds (from ETC's Buffer Fill Time) * 2/3 = 7806 seconds*								
3	(COS.sp.1926380)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=2; BUFFER-TIME=7293			2588 Secs (2588 Secs) *[==>]*	***[2]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 10939 seconds (from ETC's Buffer Fill Time) * 2/3 = 7293 seconds*								
4	(COS.sp.1926380)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=3; BUFFER-TIME=7293			2588 Secs (2588 Secs) *[==>]*	***[3]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 10939 seconds (from ETC's Buffer Fill Time) * 2/3 = 7293 seconds*								
5	(COS.sp.1926380)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=4; BUFFER-TIME=7293			2588 Secs (2588 Secs) *[==>]*	***[4]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 10939 seconds (from ETC's Buffer Fill Time) * 2/3 = 7293 seconds*								
6	(COS.sp.1926381)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=4279			1216 Secs (1216 Secs) *[==>]*	***[5]***
	*Comments: Original BUFFER-TIME = 5883 seconds (from ETC's Buffer Fill Time) * 2/3 = 3922 seconds* *New BUFFER-TIME = 6418 seconds (from ETC's Buffer Fill Time) * 2/3 = 4279 seconds*								
7	(COS.sp.1926381)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=4279			1217 Secs (1217 Secs) *[==>]*	***[5]***
	*Comments: Original BUFFER-TIME = 5883 seconds (from ETC's Buffer Fill Time) * 2/3 = 3922 seconds* *New BUFFER-TIME = 6418 seconds (from ETC's Buffer Fill Time) * 2/3 = 4279 seconds*								

Orbit Structure








Orbit 4
Server Version: 20240604
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 5
Reconfig
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec
Orbit 5
Server Version: 20240604
GS Reacq
Unused Orbital Visibility = 0
Exp. 6
Occultation
Pointing Maneuver
Exp. 7
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17490, Visit 02, implementation Tue Jul 02 18:02:53 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(Exposure 2 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 3 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 5 (Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	KISS-F1205-5985	RA: 12 06 47.5459 (181.6981079d) Dec: +29 20 33.26 (29.34257d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.046	V=19.27 m_B = 19.85, FUV (GALEX) AB = 20.1377 +/- 0.1793, g (SDSS model) AB = 19.016 +/- 0.013	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

See http://ned.ipac.caltech.edu/byname?objname=KISSB+85&hconst=67.8&omegam=0.308&omegav=0.692&wmap=4&corr_z=1 for more "Other Fluxes".
Category=GALAXY
Description=[DWARF COMPACT, EMISSION LINE NEBULA, STARBURST]
Extended=YES

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1888782)	(1) KISS-F1205-5985	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				221 Secs (221 Secs) *[==>]*	***[1]***
2	(COS.sp.1926681)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=1; BUFFER-TIME=7806			1860 Secs (1860 Secs) *[==>]*	***[1]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 11709 seconds (from ETC's Buffer Fill Time) * 2/3 = 7806 seconds*								
3	(COS.sp.1926678)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=2; BUFFER-TIME=7806			1236 Secs (1236 Secs) *[==>]*	***[2]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 11709 seconds (from ETC's Buffer Fill Time) * 2/3 = 7806 seconds*								
4	(COS.sp.1926678)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=3; BUFFER-TIME=7806			1237 Secs (1237 Secs) *[==>]*	***[2]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 11709 seconds (from ETC's Buffer Fill Time) * 2/3 = 7806 seconds*								
5	(COS.sp.1926380)	(1) KISS-F1205-5985	COS/FUV, TIME-TAG, PSA	G140L 800 A	FP-POS=4; BUFFER-TIME=7293			2588 Secs (2588 Secs) *[==>]*	***[3]***
	*Comments: Original BUFFER-TIME = 10101 seconds (from ETC's Buffer Fill Time) * 2/3 = 6734 seconds* *New BUFFER-TIME = 10939 seconds (from ETC's Buffer Fill Time) * 2/3 = 7293 seconds*								

Orbit Structure