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Summary of Enabling Programs for COS Lifetime Positions 7 and 10

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ABSTRACT

The enabling of new Lifetime Positions 7 and 10 for the Cosmic Origins Spectrograph (COS) Far-Ultraviolet (FUV) detector began in the fourth quarter of 2024. At the beginning of Cycle 33, COS G130M/1055 and 1096 modes move from Lifetime Position 2 (LP2) to Lifetime Position 7 (LP7), G130M/1222, and 1291 modes move from Lifetime Position 5 (LP5) to Lifetime Position 7 (LP7), and G160M/1533, 1577, 1589, 1600, 1611, and 1623 modes move from Lifetime Position 6 (LP6) to Lifetime Position 10 (LP10). The work involved in the enabling phase includes four observing programs to determine the optimal target placement and focus positions, verify target acquisitions at each new LP, and check whether the onboard deuterium lamps can illuminate the LP7 region for gain-map monitoring, reducing reliance on external targets.

Contents

1. Introduction

The COS far-ultraviolet (FUV) detector exhibits gain sag over time due to charge depletion from prolonged exposure to ultraviolet light. To prevent spurious absorption features from appearing in the spectra, periodic shifts to a new lifetime position (LP), which move the projected science spectra and calibration lamps to relatively fresh regions of the detector, are performed. Plesha et al. (2022) summarize the activities involved in commissioning a new LP. The primary purpose of the enabling phase for a new lifetime position is to establish the operational parameters required for routine science observations, including identifying the optimal focus values, determining precise spacecraft pointing and aperture offsets to accurately center targets in the new apertures, and enabling and verifying FUV spectroscopic target acquisition (TA) performance. Lifetime Positions 7 and 10 (LP7; LP10) are displaced by +8.3" and -3.7", respectively, in the cross-dispersion direction relative to LP1. Science observations at these new LPs began at the start of HST Cycle 33, in November 2025, with G130M 1055, 1096, 1222, and 1291 central wavelength (cenwave) observations occurring at LP7 and G160M observations with all cenwaves occurring at LP10. During Cycle 33, G140L observations continued to be executed at LP3 to allow completion of ongoing programs. Moving to a new LP requires slight shifts in telescope pointing and COS aperture position. As such, work toward enabling these new LPs began in the fourth quarter of 2024, and supporting observations were obtained at the beginning of 2025. This report provides an overview of the LP7 and LP10 enabling programs, along with their respective deliverables, which are detailed in separate Instrument Science Reports (ISRs). Johnson et al. (2025) summarize the exploratory phase for LP7 and LP10.

2. Overview of the LP7/LP10 Enabling Programs

Four programs, totaling 29 external orbits and 7 internal orbits, were executed from December 2024 to December 2025 to enable the use of LP7 and LP10; they were modeled on programs from previous LP moves. Table 1 provides a list of the executed programs. All data were manually set to bypass calibration in the Barbara A. Mikulski Archive for Space Telescopes (MAST) archive, since reference files for the new LPs were not available in the Calibration Reference Data System (CRDS) at the time. Due to the light leak through the Flat-field Calibration Aperture (FCA) at >5.5" above LP1, TAGFLASH wavecals were disabled (FLASH=NO, WAVECAL=NO) in APT for the LP7 observations. None of the data in the enabling programs required wavelength-calibrated data, so SPLIT-wavecals—separate calibration observations in which the aperture block is moved to a different position so the lamp can be flashed and the

Table 1. Overview of the LP7/LP10 enabling programs.

Prog. ID	Title	Orbits	Target
17884	Verification of Target Placement for COS at LP7 and LP10	4	WD0947+857
17885	FUV Focus Sweep Enabling Program at LP7/LP10	17	Feige 48, AG+81-266
17886	COS LP7/10 FUV Target Acquisition Enabling and Verification	8	WDG-1
17887	LP7 Exploratory Deuterium Exposures	7	deuterium lamp

wavelength zero point can be correctly accounted for (Rowlands et al. 2024, Dos Santos et al. 2025)—were not performed to minimize overhead.

Program 17884 (Verification of Target Placement for COS at LP7 and LP10; PI D. Som) observed the white dwarf AG+81 266 and the hot subdwarf Feige 48 with the aim of determining the optimal centering of targets in the COS aperture at LP7 and LP10, respectively. The observations were obtained using the G130M/1291 setting at LP7 and the G160M/1600 setting at LP10. The goal was to measure any required updates to the spacecraft pointing offsets in the Science Instrument Aperture File (SIAF), which contains COS aperture locations for each LP. These observations also served as a check of the target-acquisition centering algorithm. Final results from this program informed updates to the SIAF, supported the readiness of COS for operations at LP7 and LP10, and were required to complete the Target Acquisition Enabling and Verification program described below. Further details on the analysis of this program are available in Som et al. (in prep.).

Program 17885 (FUV Focus Sweep for COS: LP7 and LP10 Enabling; PI L. Miller) observed the subdwarf stars Feige 48 and AG+81 266 with the goal of determining the optimal focus values for G130M and G160M modes at LP7 and LP10, respectively. The program executed a detailed set of focus sweeps across multiple central wavelengths, including G130M/1055, 1096, 1222, and 1291 at LP7 (+8.3), and G160M/1600 at LP10 (-3.7). The strategy was informed by earlier enabling focus programs (e.g., PIDs 13635, 14527, 15451, 16431, 16491, 16850), using a combination of fine (100 step) and broad (200 step) focus increments to measure spectral sharpness as a function of focus. The resulting focus values were included in the HST Flight Software (FSW), ensuring optimal spectral resolution at both LPs. Further details on the analysis of this program are available in Miller et al. (2025).

Program 17886 (COS LP7/10 FUV Target Acquisition Enabling and Verification; PI A. Payne) verified COS spectroscopic acquisition performance at LP7 and LP10

using observations of the white dwarf WDG-1. The program uses fictitious offset pointings to simulate miscentered targets and test reacquisition performance, while also providing diagnostic coverage of detector regions used during target acquisitions but not normally downlinked. Observations use G130M/1291 for LP7 and G160M/1577 for LP10, with ORIENT constraints to ensure that offsets are aligned with the detector axes. The program is modeled on prior enabling efforts at earlier LPs (e.g., Programs 16432, 16851, 17246). The analysis determined that all spectroscopic acquisition modes worked as expected at LP7 for G130M and LP10 for G160M during eight visits spread over a period of several months, concluding with final visits for each LP at the start of Cycle 33. None of the described enabling calibration programs used spectroscopic acquisitions, and COS science exposures did not use spectroscopic acquisitions at LP7 or LP10 until the results from the final test were verified. Further details of this analysis are available in Payne et al. (in prep.)

Following the successful updates to the SIAF and flight software derived from these enabling programs, calibration activities for LP7 and LP10 began in 2025, and COS science operations at LP7 and LP10 successfully commenced at the start of Cycle 33.

Program 17887 (Exploration of Deuterium Lamp Illumination for LP7 Gain Maps; PI D. Sahnow) was executed as part of LP7 enabling to assess the feasibility of using the onboard deuterium lamps to generate gain maps at LP7 without relying on external targets. This investigation was motivated by the relatively large cross-dispersion offset of LP7 from LP1, which places the science region near the limits of the aperture mechanism's travel and raises concerns about whether the deuterium lamp illumination footprint adequately overlaps the LP7 detector region. The program obtained spectra from both deuterium lamps (D1 and D2) at multiple lamp currents and central-wavelength settings, with the goal of identifying configurations that could illuminate the LP7 region of the FUV detector while remaining within the aperture mechanism's soft stops.

Analysis of these data demonstrated that, while the deuterium lamps cannot be used to reliably obtain gain maps at LP7 and external targets will therefore be required, the program provided valuable characterization of the lamp illumination footprint on the detector as a function of central wavelength. These results may enable more efficient gain map acquisition strategies at lower lifetime positions (LP1–LP6) by informing optimal lamp and cenwave combinations, and they provide useful context for future lamp usage planning.

3. Program summaries

Details of the programs can be found in Tables 2, 3, 4, and 5, and the results of the enabling programs can be found in their respective ISRs.

Table 2. Overview of PID 17884: Verification of Target Placement for COS at LP7 and LP10.

Topic	Details
Purpose	For gain and optical performance reasons, the aperture block will be set to approximately +8.3″ from LP1 for LP7 (G130M/1055, 1096, 1222, 1291 will move here), and to approximately −3.7″ from LP1 for LP10 (G160M/ALL will move here). The data from this program were used to make minor adjustments to the Science Instrument Aperture File (SIAF) in order to center the target in the fixed LP7 and LP10 apertures.
Description	One visit each with G130M/1291 (for LP7) and G160M/1600 (for LP10) to take a series of FP-POS=3 observations scanning the target over the aperture in the dispersion and cross-dispersion directions using POSTARG offsets.
Observations	4 external orbits were required using target WD0947+857 (G130M; 2 orbits) and WD1337+705 (G160M; 2 orbits). The Optional Parameters LIFETIME-POS=LP7 and LIFETIME-POS=LP8 (as a placeholder for LP10) were used to apply the pointing, aperture position, and detector high-voltage values for LP7 and LP10 determined from exploratory data.
Deliverables	Minor updates to the HST pointing (V2, V3) values in the SIAF file to accurately center the target in the LP7 and LP10 apertures. These updates are needed before executing other calibration programs.
Accuracy Goals	Target centering to an accuracy of ∼0.05 arcsec.
Scheduling Requirements	Plan windows: The program was required to execute before Visit 01 of the Verification and Update of TA Parameters at LP7 & LP10 (PI: Payne). Implementation prerequisites included SIAF updates reflecting the initial pointing at LP7 and LP10 and patching of the FSW to indicate LP7 & LP10 aperture and focus positions.
Documentation	COS ISR in preparation (Som et al. in prep)

Table 3. Overview of PID 17885: FUV Focus Sweep for COS: LP7 and LP10 Enabling.

Topic	Details
Purpose	To determine the optimal focus of the FUV channel for the G130M/1055, 1096, 1222, and 1291 central wavelengths at Lifetime Position 7 (LP7) and for all G160M central wavelengths at Lifetime Position 10 (LP10) to maximize spectral resolution.
Description	Visit 01 – G130M/1222 FUVA and FUVB scan with target Feige 48 at LP7. Visit 02 – G130M/1291 FUVA and FUVB scan with target Feige 48 at LP7. Visit 03 – G130M/1096 FUVA and FUVB scan with target Feige 48 at LP7. Visit 04 – G160M/1600 FUVA scan with target AG+81-266 at LP10. Visit 05 – G160M/1600 FUVB scan with target Feige 48 at LP10.
Observations	The time required to achieve an optimal signal-to-noise ratio for analysis is 4 external orbits for the G130M/1222 scan, 4 external orbits for the G130M/1291 scan, 2 external orbits for the G130M/1096 scan, and 7 external orbits for the G160M/1600 scan. This results in a total of 17 external orbits.
Deliverables	Final focus value for LP7 is updated in the onboard FSW table for LP7. The LP10 value is updated in Commanding as part of the LP-Infinity methodology, ensuring accurate focusing for all observations at LP7 and LP10.
Accuracy Goals	Calculate the best focus positions to within $\pm$100 focus steps.
Scheduling Requirements	Updated numbers in the SIAF, modified values for high voltage and subarrays, and FSW patching for the aperture and focus positions for LP7 and LP10 were required prior to executing. Observations executed successfully between 2024 December 23 and 2025 January 5.
Documentation	Miller et al. 2025; COS ISR 2025-17

Table 4. Overview of PID 17886: COS LP7/10 FUV Target Acquisition Enabling and Verification.

Topic	Details
Purpose	Verify FUV spectroscopic target acquisition (TA) parameters, and verify TA modes at LP7 and LP10. Provide diagnostic data regarding positioning of acquisition within the subarray in case problems are encountered.
Description	Program verifies the operations of the three acquisition modes used in FUV: ACQ/SEARCH, ACQ/PEAKD, and ACQ/PEAKXD. In each case, a target is acquired using an NUV imaging acquisition, the telescope is offset, and the target is re-acquired in FUV to test the respective modes. Tests are conducted with cenwaves G130M/1291 and G160M/1577, which are the widest cross-dispersion profiles used for acquisition at LP7 and LP10, respectively. Because dispersed-light acquisition spectra are not downlinked, POSTARG displacements are used to replicate these observations and downlink them for verification of spectral placement within the acquisition apertures.
Observations	Four visits of one external orbit each, per LP: Visit 1: ACQ/SEARCH, Visit 2: ACQ/PEAKD, Visit 3: ACQ/PEAKXD, Visit 4: Integration test using default parameters at the start of Cycle 33.
Deliverables	Verification of TA subarray placements, verification of TA flight software functionality, derivation of offsets needed if there are array placement problems, mapping/detection of any significant detector features in the TA area.
Accuracy Goals	0.11 arcsec to 0.18 arcsec accuracy in the dispersion direction, $0.3''$ accuracy in the cross-dispersion direction.
Scheduling Requirements	Should execute only after: (1) All subarrays are defined in the flight software, (2) aperture placement has been verified by the LP7/LP10 Target Placement enabling program, and (3) focus values have been verified by the LP7/LP10 focus sweep program. To allow for analysis before SMS builds, TA values must be known at least three weeks before Visit 1, and there must be at least three weeks between visits. The target WDG-1 is visible during the required time windows, and ORIENT angle restrictions ($\pm$0.5 arcsec) result in narrow visit windows.
Documentation	COS ISR in preparation (Payne et al. in prep)

Table 5. Overview of PID 17887: LP7 Deuterium Lamp Investigation.

Topic	Details
Purpose	Explore the feasibility of using the deuterium lamps to take gain maps at the LP7 position on the COS FUV detector.
Description	This program obtains spectra of both deuterium lamps at multiple lamp currents using multiple central wavelengths to determine the viability of using the lamps to illuminate the LP7 region on the detector without moving past the soft stop.
Observations	7 internal orbits.
Deliverables	Two-dimensional spectra of the deuterium lamps.
Accuracy Goals	N/A
Scheduling Requirements	The program was intended to execute as early as possible in the LP7 planning process. Special commanding was required to select the non-default lamp and current settings and to return the aperture block to the HOME position at the end of each visit.
Documentation	COS ISR in preparation (Sahnow et al. in prep)

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References

Dos Santos, L., et al. 2025, COS Instrument Science Report 2025-13
Johnson, M., et al. in prep, COS Instrument Science Report 2026-XX
Miller, L., et al. 2025, COS Instrument Science Report 2025-17
Payne, A., et al. in prep, COS Instrument Science Report 2026-XX
Plesha, R., et al. 2022, COS Technical Instrument Report 2022-03
Rowlands, K., et al. 2024, COS Instrument Science Report 2024-08
Sahnow, D., et al. in prep, COS Instrument Science Report 2026-XX
Som, D., et al. in prep, COS Instrument Science Report 2026-XX