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Summary of COS Cycle 25 Calibration Plan

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ABSTRACT

We summarize the calibration activities for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope during Cycle 25, which ran from 2017 October through 2018 September. We give an overview of the COS calibration plan and COS usage statistics, and we briefly describe major changes with respect to the previous cycle. High-level executive summaries for each calibration program comprising Cycle 25 are also given here. Results of the analysis attached to each program are published in separate ISRs.

Contents

1. Introduction

The Cosmic Origins Spectrograph (COS) was installed on the Hubble Space Telescope (HST) in May 2009. Cycle 25 was thus the ninth cycle of on-orbit operations for COS, running from 2017 October through 2018 September. Each cycle, the COS team monitors the performance of the COS instrument through routine calibration programs that are designed to monitor instrument throughput, dispersion solutions, dark rates, and overall performance of the FUV and NUV channels. Updates to the COS reference files are made, when necessary, based on the results of the data analyses performed by the COS team. The Cycle 25 calibration plan is composed of ten regular calibration programs, two contingency programs, and seven special calibration programs (i.e., Cycle 25 only) that were designed to commission two new central wavelength settings for COS: G140L/800 and G160M/1533. There are also several carryover programs, consisting of five engineering programs and four science verification programs, that remain unchanged each year with regard to their structure and orbit request numbers.

In this document we give an overview of the overall COS usage with respect to other HST instruments, and we summarize the distribution of COS FUV and NUV usage per mode and cenwave (Section 2). In Section 3, we give an overview of the 12 individual programs that comprise the COS Cycle 25 calibration plan, and we summarize the changes applied to some of the regular Cycle 25 calibration programs compared to Cycle 24 (Sahnow et al. 2019). Section 4 contains the high-level executive summaries for the all calibration programs comprising the Cycle 25 COS plan.

2. Overview of COS Usage in Cycle 25

2.1 Prime Orbit Usage Statistics by HST Instrument

The HST orbit usage in terms of science time allocation is published yearly, shortly after the Phase II submission deadline, and can be found in `/grp/hst/cos/user_support/Cycle25/stats`. Table 1 summarizes the distribution of GO prime orbits and SNAP orbits among the HST instruments currently active. Based on Phase II submission statistics for Cycle 25, the COS usage comprises ~ 25% (~ 1259 orbits) of all approved GO prime orbits, making COS the second most-used instrument this cycle. COS SNAP orbits represent ~ 16% of the total SNAP orbit allocation this cycle. Compared to Cycle 24, the COS GO prime usage has increased slightly by 5.3%, whereas SNAP usage has remained approximately the same.

Table 1. Cycle 25 Allocation of Science Time among HST Instruments

Instrument	GO Prime Orbit Usage	GO SNAP Orbit Usage
ACS	12.7%	14.7%
COS	24.8%	16.0%
STIS	16.2%	5.2%
WFC3	46.3%	64.1%
FGS	0.0%	0.0%

2.2 COS Prime Orbit Usage Statistics by Mode

Based on Cycle 25 Phase II submissions, 98.7% of the total COS prime observing time consists of *science* exposures, and the remaining 1.3% of the total COS prime observing time consists of target acquisition exposures. Of the 98.7% of COS *science* observing time, ~ 89.7% is used for COS FUV spectroscopic exposures, and ~ 10.3% is used for NUV spectroscopic exposures. Of the 1.3% target acquisition exposures, 95% are NUV imaging acquisition exposures and 5% are FUV spectroscopic acquisition exposures. The breakdown among observing modes is summarized in Table 2. This distribution is very similar to that obtained in Cycle 24 and reflects the continued high demand for FUV spectroscopic capabilities from the HST user community.

Table 2. COS Usage Statistics by Mode for Cycle 25 (Percentage by Time)

Configuration / Mode	Prime Usage (Science Exposures)	SNAP Usage (Science Exposures)
FUV / Spectroscopy	89.7%	84.9%
NUV / Imaging	0.0%	0.0%
NUV / Spectroscopy	10.3%	15.1%

Table 3. COS Science Usage Statistics by Mode and Grating in Cycles 24 and 25

Configuration	Grating	COS Prime Science Exposure Time (%)		COS SNAP Science Exposure Time (%)	
		C24	C25	C24	C25
COS / FUV (C25: 89.7% prime)	G140L	14.6	11.1	–	0.8
	G130M	53.1	50.4	100	84.1
	G160M	25.9	28.2	–	–
COS / NUV (C25: 10.3% prime)	G230L	4.0	7.8	–	15.1
	G185M	2.3	0.5	–	–
	G225M	–	2.0	–	–
	G285M	–	–	–	–
	MIRROR A/B	0.1	< 0.1	–	–

2.3 COS Prime Orbit Usage Statistics by Mode and Grating

Table 3 summarizes the COS science observing time usage by mode and grating for the FUV and NUV channels. For the FUV channel, the prime orbit usage statistics in Cycle 25 are very similar to those in Cycle 24 for the G130M and G160M gratings. G130M remains the most used of the FUV gratings with 50.4% of prime science time. The blue-mode cenwaves represent ~ 25% of total G130M observing time, with a breakdown among the blue-mode cenwaves as follows: G130M/1222 (25%), G130M/1055 (< 1%), and G130M/1096 (0%). The Cycle 25 blue-mode usage has increased somewhat (~ 24%) compared to the Cycle 24 usage, primarily due to the new COS2025 rules. The G140L grating remains the least used of the FUV gratings, with a slight decrease in its prime usage (~ 3.5%) compared to Cycle 24. The G140L/1105 cenwave is the most used cenwave for this grating and represents ~ 83% of the total G140L science observing time. (The other 17% is for the G140L/1280 configuration.)

For the NUV channel, the prime orbit usage statistics in Cycle 25 are somewhat different from those in Cycle 24. Only the G285M grating is not used in Cycle 25, compared to both G225M and G285M not being used in Cycle 24. The usage of G230L has increased by a factor of two in Cycle 25, while the usage of G185M has decreased slightly by a factor of four compared to last cycle. Only a fraction of a percent consists of NUV/Imaging science observations, similar to all previous cycles.

In Cycle 25, SNAP observations are obtained with both the FUV channel (84.9%) as well as the NUV channel (15.1%), unlike those of many previous cycles, which were only obtained with the FUV channel. Almost all the FUV SNAP science observing time consists of G130M exposures this cycle. (Less than 1% consists of G140L exposures.)

2.4 COS FUV Mode and FP-POS Distribution

Starting in Cycle 21, the COS FUV user community was asked to use all four FP-POS positions unless otherwise justified scientifically when observing with the COS FUV channel, in order to mitigate the effect of gain sag on the FUV detector. This requirement is actively monitored and enforced by the COS team Contact Scientists (CS) during the Phase II technical review period. Figure 1 displays the FP-POS usage

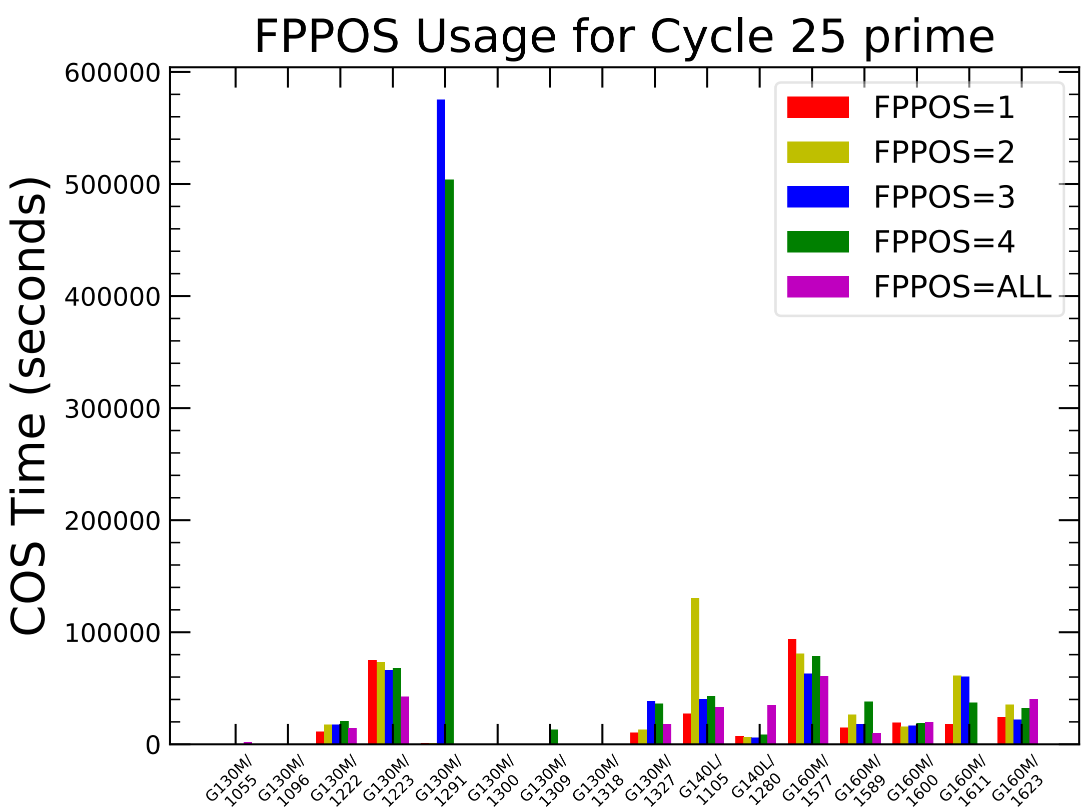

Figure 1. Cycle 25 distribution of FP-POS among COS modes. Due to COS2025 policies enforced in Cycle 25, G130M/1291 usage is now restricted to FP-POS 3+4 only. Other than this, relatively even FP-POS dithering was performed among COS FUV configurations, following the COS team requirements.

by grating and cenwave for Cycle 25. Note that this distribution is based on Phase II submissions only and does not yet reflect any changes that might have been requested by the COS CS team. Due to the COS2025 policies enforced in Cycle 25, G130M/1291 usage is now restricted to FP-POS 3+4 only. Overall, with the exception of G130M/1291, the FP-POS usage is distributed quite evenly for a given grating/cenwave combination for all gratings, indicating that the COS FUV community has successfully integrated our requirement into their science observing plans this cycle. The G130M/1291 cenwave remains the most used of all COS/G130M cenwaves, regardless of the newly enforced restrictions. Noteworthy is the fact that the usage of the FP-POS=ALL feature was clearly the preferred dithering technique for G140L/1280 and for most of the G160M cenwaves in Cycle 25.

3. Overview of the Regular Cycle 25 Calibration Programs

The Cycle 25 calibration plan is composed of ten regular calibration programs, two contingency programs designed to recover science operations in the FUV and NUV in case of an anomalous detector shutdown, and seven special calibration programs (Cycle 25 only) designed to commission two new cenwaves for Cycle 26: G140L/800 and G160M/1533. Table 4 provides a list of the calibration programs with their respective program IDs (Column 1) and title (Column 2). Column 3 reports the number of orbits executed [allocated] for each program, divided into external and internal orbits. Column 4 indicates the frequency of the visits for each monitoring program. Column 5 provides the reference to the ISR summarizing the data analysis and results obtained for each program, and Column 6 lists the accuracy goal required for each program.

Most Cycle 25 programs are essentially continuations of the monitoring programs from the previous cycle. The COS FUV Detector Gain Maps monitoring program was increased from five to eight external orbits, as we are now monitoring three Lifetime Positions (LP) rather than two. The FUV/TDS monitor program was modified from 26 to 20 external orbits for several reasons: The monitoring of G130M/1327 FUVB was removed to comply with COS2025 policies, the monthly monitoring was reduced to bimonthly in order to limit lifetime impact (reduction by six orbits), a further three orbits were removed from Cycle 25 since the LP3–4 reconnection was no longer necessary, and a further three orbits were added to check the sensitivity changes at LP3. The NUV Wavelength Scale Monitor program was reduced to just one orbit (one visit, once per cycle) instead of two visits separated by six months. Due to lack of PI usage since Cycle 21, the G285M grating was also dropped from this monitoring program. Finally, the COS Target Acquisition Monitor program was split into two separate programs: the COS FUV Target Acquisition Monitor (two external orbits, once per year) and the COS NUV Target Acquisition Monitor (three external orbits, once per year). When combined, this is an increase of one external orbit for acquisition monitoring compared to Cycle 24.

Table 4. High-level Summary of Regular Cycle 25 Calibration Programs

PID	Title	Orbits Executed [Allocated]		Frequency	Products	Accuracy Achieved
		External	Internal			
15384	COS FUV Spectroscopic Sensitivity Monitor	20 [20+16[C]]	–	3/2 months + 2/year	TDS ref file ISR 2019-18	< 2% relative TDS calibration (standard modes), < 10% (blue modes)
14940	COS FUV Detector Dark Monitor	–	260 [260]	5/week	ISR 2019-17	0.1% global dark-rate uncertainty
15385	COS FUV Wavelength Scale Monitor	3 [3]	–	1/year	ISR 2019-16	G140L: 150 km s^{-1}, 7.5–12.5 pix G130M: 15 km s^{-1}, 5.7–7.5 pix G160M: 15 km s^{-1}, 5.8–7.2 pix
14941	COS FUV Detector Gain Maps	–	8 [8+2[C]]	4/6 months + Once per HV change	ISR 2019-21	~ 0.1 pulse height bins
15386	COS FUV Target Acquisition Monitor	2 [2]	–	2/year	ISR in prep.	Centering to within ± 0.3″
15387	COS NUV Spectroscopic Sensitivity Monitor	6 [6]	–	3/6 months	ISR 2019-12	< 2% relative TDS calibration
14942	COS NUV Detector Dark Monitor	–	52 [52]	1/week	ISR 2019-19	0.2% global dark-rate uncertainty
15388	COS NUV Wavelength Scale Monitor	1 [1]	–	1/year	ISR 2019-15	G230L: 175 km s^{-1}, 2.0–3.7 pix G185M: 15 km s^{-1}, 1.7–2.4 pix G225M: 15 km s^{-1}, 2.3–3.2 pix
15389	COS NUV Target Acquisition Monitor	3 [3]	–	3/year	ISR in prep.	0.5 NUV pixel
14943	COS NUV MAMA Fold Distribution	–	1 [1]	1/year	ISR 2019-13	< 5% on peak location of fold distribution

[C] Contingency orbits

One regular calibration program was removed from the Cycle 25 calibration program compared to Cycle 24 – the Pure Parallel Observations of Geocoronal Lyman Alpha. This was removed because the newly implemented COS2025 policies now minimize observations of Lyman alpha.

In Cycle 25, seven special calibration programs were approved to commission two new cenwaves for Cycle 26 (G140L/800 and G160M/1533). We list these programs below. Detailed descriptions are provided in the program-related ISRs.

- COS FUV Focus Sweep for G140L/800 (PID 15451)
- COS FUV Focus Sweep for G160M/1533 (PID 15452)
- COS/FUV/G160M/1533 Wavelength Calibration - Dispersion Solution (PID 15457)
- COS/FUV G160M/1533 Profiles and Fluxes (PID 15458)
- FUV COS Lamp Templates for G160M/1533 (PID 15459)
- COS FUV G140L/800 Flux Calibration and Cross-Dispersion Profile (PID 15483)
- COS FUV G140L/800 Lamp Template (PID 15484)

Reference files are updated "as needed" to maintain instrument calibration within the required specifications. For several programs, regularly updated reference files are produced. For many others, results are either posted on the web or simply documented in their respective ISR. Currently available reference files can be found at https://hst-crds.stsci.edu. Other products resulting from the calibration program include COS Instrument Science Reports (ISRs), COS Technical Instrument Reports (TIRs), and updates to the COS Instrument (IHB) and Data (DHB) Handbooks. Links to these documents are found at http://www.stsci.edu/hst/instrumentation/cos/documentation. Note that TIRs are only available on the internal STScI web site. In order to retrieve a TIR from outside STScI, a request needs to made through the HST Help Desk Portal at https://hsthelp.stsci.edu.

4. Executive Summary for Each Individual Program

On the following pages, we provide a high-level summary of the purpose, requirements, and orbit allocation for each of the ten regular calibration programs comprising the regular Cycle 25 calibration plan. Results of the monitoring analysis are reported separately in program-specific ISRs. (See Table 4 for reference numbers.)

Program ID 15384: COS FUV Spectroscopic Sensitivity Monitor

PI: Ravi Sankrit

Analysis Lead, Others: Gisella De Rosa

Purpose	Monitor the sensitivity of each FUV grating to detect any change due to contamination or other causes. The FUV gratings are the most heavily used modes on COS and have also experienced several changes in the time-dependent spectroscopic sensitivity since launch. These trends are grating, segment, and wavelength dependent.
Description	To track the TDS as a function of wavelength, we obtain exposures of two standard stars (WD0308–565 and GD 71) every 2 months with all FUV gratings. The monitoring sequence consists of two visits for a total of three orbits. The one-orbit visit (GD 71) covers the G130M/1096/FUVB, G160M/1577/FUVA, and G160M/1623/FUVA modes. The two-orbit visit (WD0308–565) covers the G130M/1222, G130M/1291, G130M/1327/FUVA, G130M/1055/FUVA, G160M/1577/FUVB, G160M/1623/FUVB, G140L/1105, and G140L/1280 modes. These comprise the reddest and bluest central wavelengths of each grating, with additional coverage of the G130M blue modes.
Fraction GO/GTO Programs Supported	89.7% of COS exposure time in Cycle 25
Resources Required: Observations	20 external orbits (+ 16 contingency external orbits needed if major changes in trends are seen during the cycle)
Resources Required: Analysis	6 FTE weeks
Products	Time-Dependent Sensitivity reference file as necessary; update to ETC throughputs, the COS monitoring webpages, and a summary ISR
Accuracy Goals	• SNR of 15 per resel at wavelength of least sensitivity for the standard modes, SNR of 25 per resel at wavelength of most sensitivity for the blue modes. For the blue modes, this will ensure S/N > 15 for λ > 1030 Å for 1096/FUVB, λ > 1130 Å for 1055/FUVA and 1222/FUVB • TDS calibration better than 2% for standard modes and 10% for blue modes
Scheduling & Special Requirements	• Monitoring sequence should occur every 2 months starting in 2017 December • The FUVA turn-off of the GD 71 visit should be hidden in the GS-ACQ • GD 71 is not visible from late April to early August 2018, resulting in a reduced monitoring sequence for the month of June (1 visit) • One set of visits for monitoring of LP3 should occur near end of cycle
Changes from Cycle 24	• Removed monitoring of 1327 FUVB to comply with COS 2025 guidelines • Reduced monitoring to bi-monthly to limit lifetime impact – saves 6 orbits with respect to Cycle 24 • Reduced by 3+(1) additional orbits from Cycle 24 since LP3–LP4 reconnection is not needed • Added 3 orbits to check sensitivity changes at LP3

Program ID 14940: COS FUV Detector Dark Monitor

PI: Mees Fix

Analysis Lead, Others: Mees Fix

Purpose	Perform routine monitoring of FUV XDL detector dark rate. The main purpose is to look for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for a developing detector problem.
Description	Monitor the FUV detector dark rate by taking TIME-TAG science exposures with no light on the detector. Five times every week, a 22 min exposure is taken with the FUV detector with the shutter closed. The length of the exposures is chosen to make them fit in Earth occultations. All orbits < 1800 s.
Fraction GO/GTO Programs Supported	89.7% of COS exposure time in Cycle 25
Resources Required: Observations	260 internal orbits. All orbits < 1800 s.
Resources Required: Analysis	2 FTE weeks
Products	Provide ETC and IHB dark rate estimates, along with weekly monitoring for changes and a summary in the end-of-cycle ISR. Update monitor and COS webpages. As allowed by resources and necessitated by data quality: Improve dark subtraction method and update bad-pixel tables.
Accuracy Goals	Obtain enough counts to track 1% level changes on timescales of ~ 1–3 months
Scheduling & Special Requirements	5x / week at nominal HV during Earth occultation
Changes from Cycle 24	No changes

Program ID 15385: COS FUV Wavelength Scale Monitor
PI: Will Fischer
Analysis Lead, Others: Will Fischer

Purpose	This program monitors the offset (zero-point) between the wavelength scale set by the internal wavecal versus that defined by absorption lines in external target AV 75 obtained through the PSA
Description	This program monitors the zero-point offset between the internal and external wavelength scales. To verify and monitor this, the program takes spectra of AV 75 with the G130M/1096-1222-1291-1327, G160M/1577-1623, and G140L/1105-1280 cenwaves. Spectra are compared to convolved STIS spectra and those obtained with previous iterations of the program.
Fraction GO/GTO Programs Supported	89.7% of COS exposure time in Cycle 25
Resources Required: Observations	3 external orbits
Resources Required: Analysis	4 FTE weeks
Products	Update of wavelength dispersion reference file, if necessary, and a summary ISR
Accuracy Goals	G140L 150 km s^{-1}, 7.5–12.5 pixels G130M 15 km s^{-1}, 5.7–7.5 pixels G160M 15 km s^{-1}, 5.8–7.2 pixels
Scheduling & Special Requirements	Executes once per cycle. ORIENT is set to avoid bright field targets, so visibility is restricted. March (15 days): Preferred window to maintain pattern of ~ 12 months between visits.
Changes from Cycle 24	In accordance with the COS 2025 rules, FP-POS 2 of cenwave 1291 is changed to 3, and segment B of cenwave 1327 is not observed. Exposures are rearranged within the existing orbits due to the overhead associated with turning a segment off.

Program ID 14941: COS FUV Detector Gain Maps

PI: David Sahnow

Analysis Lead, Others: David Sahnow

Purpose	Obtain gain maps of the FUV detector before and after changes to the nominal high voltage levels and periodically during the cycle. These data will be used to check that the expected modal gain is achieved for HV changes and to track the modal gain as a function of time.
Description	Use the deuterium lamp to illuminate the appropriate LP2/LP3/LP4 region of the COS FUV detector at the following times: • LP4 Standard Modes: Snapshot to monitor the change in gain every 6 months (2 orbits) • LP4 G130M/1222: Snapshot to monitor the change in gain every 6 months (2 orbits) • LP3 Standard Modes: Snapshot to monitor the change in gain every 6 months (2 orbits) • LP2 Blue Modes: Snapshot to monitor the change in gain every 6 months (2 orbits) • Contingency for LP3 Standard Modes: Immediately before and after a Segment A HV change (2 orbits)
Fraction GO/GTO Programs Supported	89.7% of COS exposure time in Cycle 25
Resources Required: Observations	8 internal orbits 2 internal contingency orbits
Resources Required: Analysis	2 FTE weeks. Existing CCI / gain map procedures will be used to process these data as part of normal gain monitoring.
Products	Gain map files. These will be used to update the GSAGTAB (and possibly the BPIXTAB) and also improve the models of gain vs. HV and gain vs. exposure.
Accuracy Goals	0.1 pulse height bin
Scheduling & Special Requirements	Every 6 months and immediately before and immediately after any HV change
Changes from Cycle 24	3 additional orbits since we are now monitoring three Lifetime Positions instead of two. 1 less contingency orbit.

Program ID 15386: COS FUV Target Acquisition Monitor
PI: Steven Penton
Analysis Lead, Others: Steven Penton, David Sahnow

Purpose	Monitor COS FUV ACQ/PEAKD and PEAKXD performance at LP4 (with NUM_POS > 1)
Description	At LP4 the cross-dispersion (XD) target acquisition (TA) uses the new NUM_POS > 1 algorithm for ACQ/PEAKXD. This is the same algorithm used for ACQ/PEAKD, but oriented in the XD direction. This method moves the telescope through a linear pattern of XD steps that completely or partially vignette the target light with the PSA. This allows the target position relative to the edges of the aperture to be defined, and allows the target to be centered. This pattern moves the target up and down on the FUV detector (in Y). Because there are detector effects such as gain sag and Y-walk and areas of the detector with non-uniform response (like previous LPs), it is desirable to monitor the FUV PEAKXD centering over multiple cycles to watch for unexpected changes. Each FUV grating is tested, and the G130M test includes an along-dispersion ACQ/PEAKD to verify the NUV-to-FUV LP4 SIAF entries in both AD and XD.
Fraction GO/GTO Programs Supported	~ 5% of Cycle 25 target acquisitions use the FUV channel
Resources Required: Observations	2 external orbits
Resources Required: Analysis	1 FTE week for analysis and documentation
Products	Summary ISR
Accuracy Goals	FUV Spectroscopic XD TAs are required to center the target to within ± 0.3″ (~ ± 3 rows), with the goal of routine centering to ± 0.1″ (~ 1 row). Targets not centered to within 0.3″ are subject to vignetting and loss of spectral resolution. Along-dispersion centering requirements are cenwave-specific, but the strictest requirement is ± 0.106″ for the G130M grating.
Scheduling & Special Requirements	Executes annually and should execute within ± 30 days from Visit PB of NUV program (same target)
Changes from Cycle 24	New program. The FUV monitoring was moved from a combined NUV+FUV program in previous cycles to a FUV+LP4-specific program beginning in Cycle 25. Centered and offset spectra (by ± 1.3″) are taken with each grating prior to a 3×1.3″ PEAKXD. For G130M, an ACQ/PEAKD has also been added to test FUV and NUV along-dispersion co-alignment.

Program ID 15387: NUV Spectroscopic Sensitivity Monitor

PI: Jo Taylor
Analysis Lead, Others: Jo Taylor

Purpose	Monitor sensitivity of all NUV gratings to detect any change due to contamination or other causes. Track time-dependence of the sensitivity with wavelength. The NUV gratings on COS have degraded at an overall steady rate since the start of on-orbit operations, with the bare-Al gratings (G225M and G285M) degrading at a faster rate (~ –3 and –11% yr^{-1}) than the MgF_2 coated gratings (G185M and G230L, < 1% yr^{-1}).
Description	This program obtains exposures with all NUV gratings using external targets WD1057+719 (G230L) and G 191-B2B (G185M, G225M, G285M). The following modes are monitored: G230L/2635-2950, G185M/1786-1921-2010, G225M/2186-2306-2410, and G285M/2617-2850-3094. These cenwaves constitute the reddest, middle, and bluest central wavelengths containing only first-order light with the exception of G230L. Current data indicate a wavelength dependence of the TDS. To better characterize this effect, observations of G185M/2010, G225M/2306-2410 and G285M/2850 were added to the monitoring program in Cycle 24 to provide data at both the extreme cenwaves and the middle cenwaves for the M gratings. Data from another cycle are needed before reliable fits and conclusions can be made.
Fraction GO/GTO Programs Supported	10.3% of COS total exposure time in Cycle 25
Resources Required: Observations	6 external orbits: 2 visits of 3 orbits each
Resources Required: Analysis	5 FTE weeks
Products	Time-Dependent Sensitivity reference file and a summary ISR. As permitted by resources and data quality: Add wavelength dependence to TDS reference files.
Accuracy Goals	Characterize evolution of TDS within 2%
Scheduling & Special Requirements	Observe at 6 month intervals
Changes from Cycle 24	None

Program ID 14942: COS NUV Detector Dark Monitor
PI: Mees Fix
Analysis Lead, Others: Mees Fix

Purpose	Perform routine monitoring of the MAMA detector dark rate. The main purpose is to look for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for a developing detector problem.
Description	Monitor the NUV detector dark rate by taking TIME-TAG science exposures without illuminating the detector. Twice every other week, a 22 min exposure is taken with the NUV (MAMA) detector with the shutter closed. The length of the exposures is chosen to make them fit in Earth occultation. All orbits < 1800 s.
Fraction GO/GTO Programs Supported	10.3% of COS total exposure time in Cycle 25
Resources Required: Observations	52 internal orbits. All orbits < 1800 s.
Resources Required: Analysis	2 FTE weeks
Products	Provide ETC and IHB dark rate estimates along with weekly monitoring for changes and a summary in the end-of-cycle ISR. As allowed by resources and necessitated by data quality: Update bad-pixel tables. Update monitor webpage.
Accuracy Goals	0.2% in global dark rate uncertainty
Scheduling & Special Requirements	Twice every other week, in Earth occultation
Changes from Cycle 24	No changes

Program ID 15388: COS NUV Wavelength Scale Monitor
PI: Will Fischer
Analysis Lead, Others: Will Fischer

Purpose	This program monitors the offset (zero-point) between the wavelength scale set by the internal wavecal versus that defined by absorption lines in external target HD 6655 obtained through the PSA
Description	This program monitors the zero-point offset between the internal and external wavelength scales. To verify and monitor this, the program takes spectra of HD 6655 with the G185M/2010, G225M/2217, and G230L/2635-2950-3000 cenwaves. Spectra are compared to convolved STIS spectra and those obtained with previous iterations of the program.
Fraction GO/GTO Programs Supported	10.3% of COS total exposure time
Resources Required: Observations	1 external orbit. Schedulability is set to 60% to fit all observations within the orbit.
Resources Required: Analysis	3 FTE weeks
Products	Update of wavelength dispersion reference file, if necessary, and a summary ISR
Accuracy Goals	G230L 175 km s^{-1}, 2.0–3.7 pixels G185M 15 km s^{-1}, 1.7–2.4 pixels G225M 15 km s^{-1}, 2.3–3.2 pixels
Scheduling & Special Requirements	Executes once per cycle. Star is in a crowded field, and all the stars have significant proper motion. Careful selection of guide stars is required. Aug/Sept (31 days): Preferred window to maintain pattern of ~ 12 months between visits, acquire good GS pair
Changes from Cycle 24	Grating G285M is dropped from the monitoring due to ~ 10% yr^{-1} decline in sensitivity and lack of PI use since Cycle 21. Changed from two visits separated by six months to just one.

Program ID 15389: COS NUV Target Acquisition Monitor

PI: Steven Penton

Analysis Lead, Others: Steven Penton, David Sahnow

Purpose	Monitor COS NUV Target Acquisition (TA) parameters and performance. Measure/monitor the WCA-to-PSA/BOA offsets used for imaging target acquisition and WCA-to-PSA offsets for NUV spectroscopic TAs.
Description	There are 4 NUV ACQ/IMAGE mechanism combinations: 2 science apertures (SAs: PSA & BOA) × 2 mirror modes (MIRRORA & MIRRORB). During SMOV, the WCA-to-PSA+MIRRORA offset was determined by an aperture scan; the other WCA-to-SA offsets were bootstrapped from this offset. We verify the ACQ/IMAGE co-alignment in a similar manner. Three targets of different brightnesses are required to bootstrap across the pairings. All NUV spectroscopic WCA-PSA offsets, all WCA-SA imaging offsets, and co-alignment for all ACQ/IMAGE modes are monitored by this program. PSA spectra of the targets are obtained with all NUV gratings to track any changes in the spectroscopic WCA-to-PSA offsets. All FUV TA monitoring is now done in a separate program.
Fraction GO/GTO Programs Supported	~ 95% of Cycle 25 target acquisitions use the NUV
Resources Required: Observations	3 external one-orbit visits. Each visit uses a target of different brightness to match the ACQ/IMAGE modes being verified.
Resources Required: Analysis	2 FTE weeks for analysis and verifying WCA-to-SA offsets. Should changes be warranted to existing offsets, additional effort will be needed, as this requires changes to the COS flight software (FSW) or SIAF.
Products	Updated NUV imaging WCA-to-SA offsets, updated NUV spectroscopic WCA-to-PSA offsets, and summary ISR
Accuracy Goals	Imaging WCA-to-SA offsets need to be known to better than 0.5 NUV pixels in both dispersion and cross-dispersion (XD). Spectroscopic WCA-to-PSA offsets to 0.5 XD pixel.
Scheduling & Special Requirements	Executes annually (in the fall). All three visits should execute within 30 days of each other.
Changes from Cycle 24	FUV exposures moved to a new program. The PSA+MIRRORA to PSA+MIRRORB verification orbit is now a permanent visit (no longer contingency) as the Telescopes Group's FGS-to-SI alignment program can no longer support these verification exposures (COS cannot be the prime instrument).

Program ID 14943: COS NUV MAMA Fold Distribution
PI: Thomas Wheeler
Analysis Lead, Others: Thomas Wheeler

Purpose	The fold analysis provides a measurement of the distribution of charge cloud sizes incident upon the anode, providing some measure of changes in the pulse-height distribution of the MCP and, therefore, MCP gain
Description	While illuminating the detector with a flat field, the valid event (VE) rate counter is monitored while various combinations of row and column folds are selected
Fraction GO/GTO Programs Supported	~ 99% of COS total exposure time in Cycle 25 (includes COS/FUV programs with NUV TA acquisitions)
Resources Required: Observations	1 internal orbit
Resources Required: Analysis	0.5 FTE day
Products	The results are sent to the COS Team and Ball Aerospace (Steve Franka)
Accuracy Goals	5% accuracy on the peak position of the fold distribution
Scheduling & Special Requirements	This proposal is executed annually
Changes from Cycle 24	No changes

Change History for COS ISR 2019-20

Version 1: 21 August 2019 – Original Document
Version 2: 30 April 2020 – Update to ISR numbers in Table 4

References

Sahnow, D., et al. 2019, COS ISR in prep., "Summary of COS Cycle 24 Calibration Plan"