Instrument Science Report COS 2020-10

Summary of COS Cycle 24 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 24, which ran from November 2016 through October 2017. We give an overview of the COS calibration plan, 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 24 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 in May 2009. Cycle 24 was thus the eighth cycle of on-orbit operations for COS, running from November 2016 through October 2017. Each cycle, the COS team monitors the performance of the COS instrument through routine calibrations 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 24 calibration plan is composed of 10 regular calibration programs, 2 contingency programs and 2 special NUV calibration programs (Cycle 24 only) that were designed to update the zero-points of the dispersion solutions for all NUV gratings.

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 individual programs that comprise the COS Cycle 24 calibration plan and we summarize the changes applied to some of the regular Cycle 24 calibration programs compared to Cycle 23. Section 4 contains the high level executive summaries for the all calibration programs comprising the Cycle 24 COS plan.

2. Overview of COS Usage in Cycle 24

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 on central storage at /grp/hst/cos/user_support/Cycle24/stats. The numbers presented there are based on the initial Phase II submissions, and thus are subject to change as resubmissions occur and additional programs are accepted. Table 1 summarizes the distribution of GO prime orbits and SNAP orbits among the active HST instruments. Based on phase II submission statistics for Cycle 24, the COS usage comprises 20.5% of all approved GO prime orbits, making COS the third most used instrument. COS SNAP orbits represent ~17% of the total SNAP orbit allocation this cycle. Compared to Cycle 23, the COS GO prime usage has increased slightly (from 18.0%) and SNAP usage more than doubled (from 7.3%).

Table 1 Cycle 24 science orbit allocations

Instrument	GO Prime Orbits	GO SNAP Orbits
ACS	13.9%	25.4%
COS	20.5%	16.8%
STIS	27.6%	0.0%
WFC3	37.9%	57.7%
FGS	0.0%	0.0%

2.2 COS Prime Orbit Usage Statistics by Mode

Based on the initial Cycle 24 Phase II submissions, 98.6% of the total COS prime observing time consists of science exposures, and the remaining 1.4% consists of acquisition exposures. Of the science observing time, 93.5% is used for COS FUV spectroscopic exposures and 6.4% is used for NUV spectroscopic exposures. The breakdown among observing modes is summarized in Table 2. In Cycle 23, 84.3% of the science exposures were in the FUV, and 15.7% in the NUV. These numbers show the continued high demand for FUV spectroscopic capabilities from the HST user community.

Table 2 COS usage statistics by mode for Cycle 24

Configuration/Mode	**Prime Usage (Science Exposures)**	**SNAP Usage (Science Exposures)**
FUV / Spectroscopy	93.5%	100.0%
NUV / Imaging	0.1%	0.0%
NUV / Spectroscopy	6.4%	0.0%

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 24 are very similar to those in Cycle 23. G130M remains the most used of the FUV gratings with 53% of prime science time. The blue mode cenwaves represent <1% of the total G130M observing time with all of the observing time in G130M/1222. This is a significant decrease from Cycle 23, when ~10.5% of the G130M usage was in the Blue Modes. Overall, there were no major changes in the FUV usage between Cycles 23 and 24.

For the NUV channel, the main change in prime orbit usage statistics in Cycle 24 is the fact that G225M, which accounted for 11.3% of the usage in Cycle 23 is not used at all in Cycle 24, and G230L, which was not used in Cycle 23, now accounts for 4% of the orbits.

In Cycle 24, SNAP observations are obtained only with the FUV channel, as in previous cycles. All the SNAP science observing time consists of G130M exposures in both Cycles 23 and 24.

Table 3 COS science usage statistics by mode and grating in Cycles 23 and 24

Configuration	Grating	Prime Science Exposures		SNAP Science Exposures	
		C23 (%)	C24 (%)	C23 (%)	C24 (%)
FUV	G140L	15.4	14.6	-	-
	G130M	45.7	53.1	100.0	100.0
	G160M	23.2	25.9	-	-
NUV	G230L	-	4.0	-	-
	G185M	4.4	2.3	-	-
	G225M	11.3	-	-	-
	G285M	-	-	-	-
	MIRRORA/B	<0.1	0.1	-	-

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 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 by grating and cenwave for Cycle 24. As with the previous information in this section, this distribution is based on Phase II submissions only and does not reflect any changes that might have been requested later. Overall, 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 remains the most used of all COS/G130M cenwaves. 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 24.

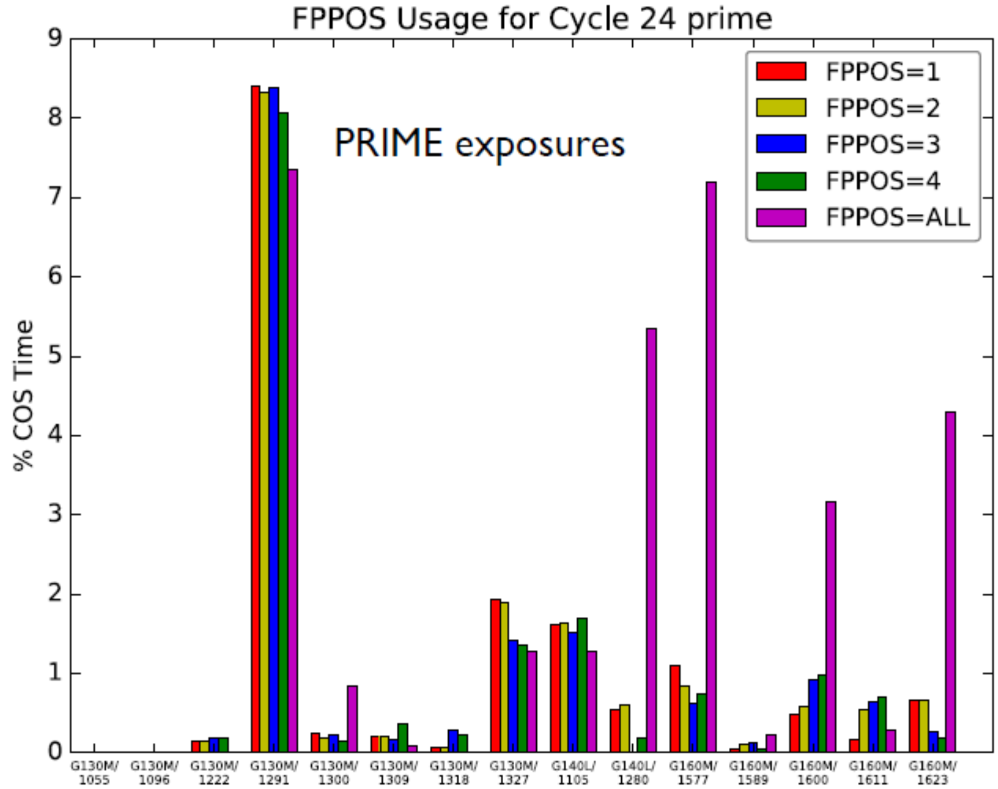

Figure 1 Cycle 24 distribution of FP-POS amoung COS modes

3. Overview of the Regular Cycle 24 Calibration Programs

The Cycle 24 calibration plan consists of 10 regular calibration programs, 2 contingency programs designed to recover science operations in the FUV and NUV in case of an anomalous detector shutdown, and 2 special calibration programs (Cycle 24 only) designed to improve the dispersion solutions of the FUV gratings at LP3. Table 4 provides a list of these 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. The contingency programs, which were not executed, are not listed in this table. Also not discussed in this ISR are the 13 LP4 programs, which are discussed in separate ISRs.

Most Cycle 24 programs are continuations of the monitoring programs from the previous cycle. A few of the programs had minor changes from previous cycles. These differences are listed in the tables in Section 4 and are described in more detail in the ISRs for each program.

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 can be found at the following location: http://www.stsci.edu/hst/instrumentation/cos/documentation. In order to retrieve TIRs from outside STScI, a request should to be sent via the HST Help Desk Portal at https://hsthelp.stsci.edu.

Table 4 Summary of Cycle 24 regular and special calibration programs

PID	Title	Orbits Executed [Allocated]		Frequency	Accuracy	Products
		External	Internal			
14519	COS FUV Detector Gain Maps	0	5 [5]	2/year	0.1 pulse height bin	ISR 2018-01
14520	COS FUV Detector Dark Monitor	0	260 [260]	5/week	0.1% in global dark rate uncertainty	ISR 2018-04
14833	Pure Parallel Observations of Geocoronal Lyα	3^{P} [3^{P}]	0	3×1	N/A	ISR 2017-23
14854	COS FUV Spectroscopic Sensitivity Monitoring	25 [26]	0	1/month	2% for Standard Modes 10% for Blue Modes	ISR 2018-09
14855	COS FUV Internal/External Wavelength Scale Monitor	3 [3]	0	1/year	15 km/s G130M & G160M 150 km/s G140L	ISR 2018-06
14521	COS NUV Detector Dark Monitor	0	52 [52]	1/week	0.2% in global dark rate uncertainty	ISR 2018-03
14526	COS NUV MAMA Fold Distribution	0	1 [1]	1/year	5% accuracy in peak position	ISR 2018-02
14857	COS Imaging TA and Spectroscopic WCA-to-PSA Offset Verifications	3 [3]	0	1/year	0.5 pixel	ISR 2018-12
14858	NUV Spectroscopic Sensitivity Monitoring	6 [6]	0	2/year	2%	ISR 2018-11
14859	COS NUV Internal/External Wavelength Scale Monitor	2 [2]	0	2/year	15 km/s G185M, G225M, G285M 175 km/s G230L	ISR 2018-05
14856	COS/FUV Wavecal Lamp Template Reference Files at LP3	0	5 [5]	Special	N/A	ISR 2018-24
14909	COS/FUV Wavelength Calibration at Lifetime Position 3	$9+1^{H}$ [9]	0	Special	3 pixels	ISR 2018-24

^{C} Contingency orbits ^{P} Parallel orbits ^{H} HOPR

4. Summary of Individual Calibration Programs

We provide a high-level summary of the purpose, requirements and orbit allocation for each of the programs comprising the regular Cycle 24 calibration plan. Results of the monitoring analysis are reported separately in program-specific ISRs (see Table 4 for reference number).

Program ID 14519: FUV Gain Maps after HV Changes
PI: David Sahnow
Analysis: David Sahnow

Purpose	Obtain gain maps of the FUV detector before and after changes to the nominal high voltage levels, and during the cycle based on detector usage. 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 or LP3 region of the COS FUV detector at the following times: • LP3 Standard Modes: Immediately before and after the Segment B HV is increased (2 orbits) • LP3 G130M/1222: Snapshot of gain map to monitor the change in gain during the past year (1 orbit) • LP2 Blue Modes: Snapshot of gain map 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) • Contingency for LP2 Blue Modes: After any change to the Segment A HV for this mode (1 orbit)
Fraction GO/GTO Programs Supported	94 % of observing time in Cycle 24
Resources Required: Observations	5 internal orbits 3 internal contingency orbits
Resources Required: Analysis	2 FTE weeks. Existing CCI / gain map procedures will be used to process these data 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	Immediately before and immediately after any HV change. If the gain sag is larger than anticipated, two of these orbits may be executed near the end of Cycle 23.
Changes from Cycle 23	1 additional orbit + 1 additional contingency orbit due to increasing frequency of Blue Mode monitoring and the possibility of a Segment A HV change in Cycle 24

Program ID 14520: COS FUV Detector Dark Monitor
PI: Mees Fix
Analysis: 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 < 1800s.
Fraction GO/GTO Programs Supported	94% of COS total exposure time in Cycle 24
Resources Required: Observations	260 internal orbits. All orbits < 1800s.
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 23	No changes.

Program ID 14833: Pure Parallel Observations of Geocoronal Lyα Emission
PI: James White
Analysis: James White

Purpose	To obtain COS G130M and G140L spectra of geocoronal Lyman-α and other airglow emission lines with S/N ratios sufficient to trace the line wings of Lyman-α
Description	Obtain parallel airglow spectra with COS/FUV to characterize the profile of airglow lines. Visible in G130M/1291: H I 1215.67; O I 1302.2, 1304.9, 1306.0, 1355.6, 1358.5; N I 1199.5-1200.7
Fraction GO/GTO Programs Supported	53% (G130M observations) in Cycle 24
Resources Required: Observations	3 external parallel orbits (in parallel with STIS MAMA TDS and focus monitor) in Cy 24 ~0.75% of lifetime at brightest Ly-α pixel for each FP-POS (2 FP-POS used) in Cy 24
Resources Required: Analysis	1 FTE week
Products	Update of the website listing airglow datasets. Observers must reduce these data themselves. Summary in end of cycle ISR
Accuracy Goals	SN = 1.5 per pixel at 1213 A
Scheduling & Special Requirements	Parallel with STIS MAMA TDS monitor. Roll angle must be chosen to avoid objects in the COS PSA or BOA apertures.
Changes from Cycle 23	Decrease by 1 orbit. Requirements have been achieved (10,000s) for G130M/1291A at LP3. In Cy24, we will continue accumulating data for G130M/1327A and G140L/1105A at LP3; only 3 external orbits are needed to achieve requirements. We plan to continue in future cycles at future LPs to reach S/N requirements.

Program ID 14854: COS FUV Spectroscopic Sensitivity Monitor
PI: Gisella De Rosa
Analysis: 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 with all FUV gratings every month. There are 2 types of monitoring sequences which occur on alternating months. (i) Full monitoring sequence every other month (except May – July when GD71 is unavailable): 3-orbits in 2 visits. The 1-orbit visit (GD71) covers the G130M/1096/FUVB, G160M/1577/FUVA, and G160M/1623/FUVA modes. The 2-orbit visit (WD0308) covers G130M/1222, G130M/1291, G130M/1327, G130M/1055/FUVA, G160M/1577/FUVB, G160M/1623/FUVB, G140L/1105, G140L/1280 modes. These comprise the reddest and bluest central wavelengths of each grating with additional coverage of the G130M blue modes. (ii) Reduced monitoring sequence in alternating months: 1-orbit visit. WD0308 used to monitor the complete wavelength range of the standard modes with G130M/1291, G160M/1623, and G140L/1280. To transition from LP3 to LP4 we request: (i) to execute complete April TDS visit at LP3 within 2 weeks of special LP4 calibration program and (ii) to change the July TDS visit from a reduced 1-orbit visit to a full 2-orbit visit at LP3 and to add a full 2-orbit visit at LP4 (WD0308 only since GD71 is not visible). One contingency orbit is also requested to observe GD71 at LP4 and will only be activated if the April and July data are in disagreement.
Fraction GO/GTO Programs Supported	94% of COS exposure time
Resources Required: Observations	26 external orbits + (11 contingency external orbits needed if changes in trends are seen during cycle)
Resources Required: Analysis	10 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 l> 1030 Å for 1096/FUVB, l>1130 Å for 1055/FUVA and 1222/FUVB - TDS calibration better than 2% for standard modes and 10% for blue modes
Scheduling & Special Requirements	•Reduced monitoring sequence should occur every 2 months starting in November 2016 •Complete monitoring sequence should occur every 2 months starting in December 2016 •The FUVA turn-off of the GD71 visit should be hidden in the GS-ACQ •GD71 is unschedulable May – July 2017 LP3-LP4 reconnection: April complete visit to be executed @LP3 within 2 weeks from LP4 special calibration program

Changes from Cycle 23	Increase by 3 external orbits and 1 contingency orbit for LP3-LP4 reconnection.

Program ID 14855: FUV Internal/External Wavelength Scale Monitor
PI: Paule Sonnentrucker
Analysis: Paule Sonnentrucker

Purpose	This program monitors the offsets between the wavelength scale set by the internal wavecal versus that defined by absorption lines in external target AV75 obtained through the PSA.
Description	This program monitors the offset between the internal and external wavelength scales: this offset is referred to as "DELTA" in the wavelength dispersion reference file and corrects for the shift between the WCA and PSA in TV03 versus the shift between the WCA and PSA in orbit : (WCA-PSA)_TV03 - (WCA-PSA)_orbit. Analysis of TV data indicates that this DELTA (offset) is cenwave and FP-POS independent for a particular grating, but it is grating dependent. To verify and monitor this dependency, this program observes the G130M/1096-1222-1291-1327, G160M/1577-1623 at different FP-POS and G140L/1105-1280 cenwaves
Fraction GO/GTO Programs Supported	94% of COS total exposure time
Resources Required: Observations	3 external orbits. Schedulability set to 30% to fit all observations within requested orbits.
Resources Required: Analysis	4 FTE weeks
Products	Update of wavelength dispersion reference file if necessary, ISR, and a summary ISR.
Accuracy Goals	G140L 150km/s, 7.5-12.5 pixels G130M 15km/s, 5.7-7.5 pixels G160M 15km/s, 5.8-7.2 pixels
Scheduling & Special Requirements	Executes once per cycle. ORIENT is set to avoid bright field targets-> restricted visibility March (10 days): preferred window for monitoring. To be executed before July 2017 (LP4 move) External target used is AV75 (target used since Cy 20).
Changes from Cycle 23	No changes

Program ID 14521: COS NUV Detector Dark Monitor
PI: Mees Fix
Analysis: Mees Fix

Purpose	Perform routine monitoring of the MAMA detector dark current. 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 < 1800s.
Fraction GO/GTO Programs Supported	6% of COS total exposure time in Cycle 24
Resources Required: Observations	52 internal orbits. All orbits < 1800s.
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	30%
Scheduling & Special Requirements	Twice every other week, in Earth occultation
Changes from Cycle 23	No changes.

Program ID 14526: COS NUV MAMA Fold Distribution
PI: Thomas Wheeler
Analysis: 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 globally 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	~50% of COS (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 23	No changes.

Program ID 14857: COS Target Acquisition Monitor
PI: Steven Penton
Analysis: Steven Penton

Purpose	Measure/monitor the WCA-to-PSA/BOA offsets used for imaging target acquisition (TA), and WCA-to-PSA for NUV spectroscopic TAs. It also verifies improved PEAKXD algorithm for FUV spectroscopic TAs.
Description	There are 4 NUV ACQ/IMAGE mechanism combinations: 2 science apertures (SAs: PSA & BOA) x 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. Changes in the PSA+MIRRORA-to-PSA+MIRRORB offset are monitored in the Focal Plane Calibration program (Focal Plane Calibration program 14452: SI-FGS Alignment). All NUV spectroscopic WCA-PSA offsets, all WCA-SA imaging offsets, and co-alignment for all ACQ/IMAGE modes are monitored by the present program. It obtains PSA spectra of the targets with all NUV gratings to track any changes in the spectroscopic WCA-to-PSA offsets. The improved PEAKXD algorithm required to perform Spectroscopic TA at LP4 is also tested for all FUV gratings.
Fraction GO/GTO Programs Supported	100% of COS total exposure time (all COS exposures depend on WCA-SA offsets)
Resources Required: Observations	2 external one-orbit visits + 1 external orbit contingency visit. The PSA+MIRRORA and PSA+MIRRORB co-alignment is periodically tested in the SIAF file verifications of HST program 14035. If this program has not been run with the current SIAF file, a contingency visit would be needed to measure the PSA+MIRRORA-to-PSA+MIRRORB offset
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).
Products	Updated NUV imaging WCA-to-SA offsets, 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 within 45 days of visit 02 of program 14452 and after each COS SIAF adjustment; executes after July 2017

Changes from Cycle 23	Minor change: tests of the improved PEAKXD algorithm are included for all FUV gratings using G130M/1318, G160M/1623 and G140L/1280 at no additional orbit cost.

Program ID 14858: NUV Spectroscopic Sensitivity Monitor
PI: Jo Taylor
Analysis: 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 degrade at an overall steady rate since the start of on-orbit operations, with the bare-Aluminum gratings (G225M and G285M) degrading at a faster rate (~3 and 11%/yr) than the MgF_2 coated gratings (G185M and G230L, ~0%/yr).
Description	This program obtains exposures with all NUV gratings using external targets WD1057+719 (G230L) and G191B2B (G185M, G225M, G285M). The following modes are monitored: G230L/2635-2950, G185M/1786-1921, G225M/2186, and G285M/2617-3094 since C19. These cenwaves constitute the reddest and bluest central wavelengths containing only first order light with the exception of the G225M. Current data indicate a wavelength dependence of the TDS. To better characterize this effect, observations of the G185M/2010, G225M/2306-2410 and G285M/2850 are added to the monitoring program in Cycle 24 to provide data at both the extreme cenwaves and the middle cenwaves for the M gratings. The G230L monitoring coverage is adequate and left unchanged.
Fraction GO/GTO Programs Supported	6.5% of COS exposure time
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 23	Orbit request increased by 2 external orbits. Monitoring of additional cenwaves is required to characterize TDS wavelength dependency.

Program ID 14859: COS NUV Wavelength Scale Monitor
PI: Paule Sonnentrucker
Analysis: Paule Sonnentrucker

Purpose	This program monitors the offsets between the absolute wavelength scale (zero-point) set by the internal wavecal versus the absolute wavelength scale defined by absorption lines in external target HD6655 obtained with the PSA.
Description	This program monitors the zero-point offset between the internal and external wavelength scales: this offset is referred to as “DELTA” in the wavelength dispersion reference file and corrects for the shift between the WCA and PSA in TV03 versus the shift between the WCA and PSA in orbit: (WCA-PSA)_TV03 - (WCA-PSA)_orbit. Analysis of TV data indicates that this DELTA is cenwave and FP-POS independent for a particular grating, but it is grating and stripe dependent. To verify and monitor this dependency, this program takes spectra of HD6655 with G185M/2010, G225M/2217, G285M/2675 and G230L/2635, 2950 & 3000. Monitoring suggests small, long-term temporal variations that require maintaining frequency of this monitoring in Cycle 24: 2 visits separated by 6 months.
Fraction GO/GTO Programs Supported	6.5 % of COS total exposure time.
Resources Required: Observations	2 external orbits - 2 visits of 1 orbit each.
Resources Required: Analysis	3 FTE weeks
Products	Update to wavelength dispersion reference file as needed and a summary ISR.
Accuracy Goals	G230L 175km/s, 2.0-3.7 pixels G185M 15km/s, 1.7-2.4 pixels G225M 15km/s, 2.3-3.2 pixels G285M 15km/s, 2.3-3.5 pixels
Scheduling & Special Requirements	2 visits of 1 external orbit each separated by 6 months. BETWEEN are added to take data within 2 visibility periods with known, good GS and can be relaxed if needed for scheduling purposes.
Changes from Cycle 23	No changes.

Change History for COS ISR 2020-10

Version 1: 10 November 2020 – Original Document

References

Sonnentrucker, P., et al., 2016, COS ISR 2016-04, "Summary of COS Cycle 23 Calibration Plan"