Cycle 32 COS Calibration Plan
Spring Orbit Request
for Unchanging Programs

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for the COS Team

Summary of COS Orbits Requested for Cycle 32
(Programs Remaining Unchanged since Cycle 31)

Title (PI)	External	Internal	Frequency (orbits x repeats)
FUV Monitors			
Cycle 32 COS FUV Target Acquisition Monitor (Indriolo)	4		4x1
COS FUV Spectroscopic Sensitivity Monitor (J. Hernandez)	34		2x6 + 2x6 + 2x5
COS FUV Wavelength Scale Monitor (French)	4		4x1
NUV Monitors			
COS NUV Detector Dark Monitor (Johnson)		52	2 x26
COS NUV MAMA Fold Distribution (Wheeler)		1	1x1
COS NUV Spectroscopic Sensitivity Monitor (J. Hernandez)	4		2x2
COS NUV Wavelength Scale Monitor (French)	1		1x1
COS NUV Target Acquisition Monitor (Indriolo)	6	1	7x1
Contingency Programs			
COS FUV Detector Recovery After Anomalous Shutdown (Wheeler)		(17)	
COS NUV Detector Recovery After Anomalous Shutdown (Wheeler)		(4)	
COS FUV Change in Spectroscopic Sensitivity Trends (J. Hernandez)	(32)		
Cycle 32 Spring Request	53 + (32)	54 + (23)	

Cycle 32 vs. Cycle 31

- We expect changes for three FUV programs, which will be explained in more detail in the changing request later this summer:
  - COS FUV Dark Monitor
  - COS FUV Gain Maps
  - COS FUV Characterization of Modal Gain When Changing High Voltage (contingency)
- All other FUV programs (TA, TDS, and wavelength monitors) need no changes
- All NUV programs are unchanging
- We plan to activate the COS FUV Change in Spectroscopic Sensitivity Trends program again this cycle

COS Side 2 Programs Carried Over to Cycle 32

- Programs are carried along each cycle's calibration plan (keeping the same ID) so that the impact of any changes to operating conditions can be evaluated and modifications to the programs implemented as needed.

- No changes are needed to the programs listed below at this time.

- Engineering programs (22 Internal orbits)
  - 13187 - COS Side 2 Dump Test and Verification of COS Memory Loads (1 internal orbit)
  - 13188 - COS Side 2 Science Data Buffer Check/Self-Tests for CS Buffer RAM and DIB RAM (14 internal orbits)
  - 13189 - COS Side 2 NUV Detector Recovery After MEB Side Switch (2 internal orbits)
  - 13190 - COS Side 2 FUV Detector Recovery After MEB Side Switch (4 internal orbits)
  - 13191 - COS Side 2 NUV MAMA Fold Test (1 internal orbit)

- Science programs (7 Internal + 3 external)
  - 13192 - COS Side 2 Initial NUV Channel Checkout (1 external orbits, 1 internal orbit)
  - 13193 - COS Side 2 Initial FUV Checkout (2 external orbits, 1 internal orbit)
  - 13194 - COS Side 2 Internal NUV Wavelength Verification (2 internal orbits)
  - 13195 - COS Side 2 Internal FUV Wavelength Verification (3 internal orbits)

Total Cycle 32 Carry Over: 29 internal + 3 external orbits

FUV Monitors

COS FUV Spectroscopic Sensitivity Monitor
PI: Jaq Hernandez

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 GD71) every 2 months with all FUV gratings. The monitoring sequence consists of three visits, for a total of 6 orbits. The first 2-orbit visit (GD71) covers the G130M/1096/FUVB, G160M/1533/FUVA, G160M/1577/FUVA, G160M/1611/FUVA and G160M/1623/FUVA modes. Another 2-orbit visit (WD0308-565) covers G130M/1222, G130M/1291, G130M/1327/FUVA, G130M/1055/FUVA, G140L/800, G140L/1105, and G140L/1280 modes. The last 2-orbit visit (WD0308-565) covers G160M/1533/FUVB, G160M/1577/FUVB, G160M/1611/FUVB, G160M/1623/FUVB at LP6, with two of these cenwaves at LP4, alternating between 1533 & 1577 and 1611 & 1623 each visit. The standard shortest and longest wavelength settings for each grating, the G130M "bluemodes" and 1291, and the two new cenwaves are covered in the program. TDS trends can be viewed on the COS Website.
Fraction GO/GTO Programs Supported	82% of COS total exposure time in Cycle 31.
Resources Required: Observations	34 external orbits
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 l> 1030Å for 1096/FUVB, l>1130Å for 1055/FUVA and 1222/FUVB. SNR of 5 per resel in the short wavelength region for G140L/800, which yields SNR of 32 per 20 Å bin (used in the TDS analysis). - TDS calibration better than 2% relative and 5% absolute for standard modes and blue modes
Scheduling & Special Requirements	• Monitoring sequence should occur every 2 months starting in December 2024 • The FUVA turn-off of the GD71 visit should be hidden in the GS-ACQ • GD71 is not visible from late April to early August 2025, resulting in a reduced monitoring sequence for the month of June (2 visits)
Changes from Cycle 31	No changes

COS FUV Wavelength Scale Monitor
PI: David French

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. G160M spectra are taken at both LP4 and LP6. Spectra are compared to convolved STIS spectra and those obtained with previous iterations of the program.
Fraction GO/GTO Programs Supported	82% of COS total exposure time in Cycle 31.
Resources Required: Observations	4 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, 9 pixels G130M 7.5 km/s, 3 pixels (G130M/1096 15 km/s, 6 pixels) G160M 7.5 km/s, 3 pixels
Scheduling & Special Requirements	Executes once per cycle. ORIENT is set to avoid bright field targets, so visibility is restricted. June-July (15 days): preferred window to maintain pattern of ~12 months between visits.
Changes from Cycle 31	No changes

COS FUV Target Acquisition Monitor
PI: Nick Indriolo

Purpose	Monitor COS FUV ACQ/PEAKD and PEAKXD Performance at LP4, LP5 and LP6
Description	The FUV acquisition algorithms compute the centroiding of raw counts falling on the acquisition subarrays at several NUM-POS offsets, which cause the light from the target to be partially blocked by the aperture. In the cross dispersion (XD) direction, these offsets also cause the spectrum to move along the Y direction in the detector. Because there are detector effects such as gain sag and Y-walk, areas of the detector with non-uniform response, and asymmetric vignetting for the off-axis beam, it is desirable to monitor the FUV PEAKXD centering over multiple cycles to watch for unexpected changes and to compare the results at different LPs. All FUV gratings (G130M, G160M, G140L) are tested in PEAKXD. G130M at LP5 is also tested in PEAKD to verify the NUV to FUV LP5 SIAF entries for the FUV acquisition subarrays in both AD and XD. In this program grating G160M is tested at its LP4 and LP6 configuration. The default NUM-POS is 3 for PEAKXD and 5 for PEAKD. G130M and G140L PEAKXD are also tested with NUM-POS=5. Any difference in centroiding of a point source in PEAKXD with NUM-POS=3 and NUM-POS=5 would most likely be indicative of disparages in flux due to the PSF's asymmetry as it moves off-axis.
Fraction GO/GTO Programs Supported	3% of Cycle 31 target acquisitions used the FUV channel.
Resources Required: Observations	4 external orbits.
Resources Required: Analysis	2 FTE weeks 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 and flux calibration. 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 31	No changes

NUV Monitors

COS NUV Detector Dark Monitor
PI: Christian Johnson

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 any developing detector problems.
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 are < 1800s. Dark rate trends can be viewed on the COS website at https://www.stsci.edu/hst/instrumentation/cos/performance/monitoring.
Fraction GO/GTO Programs Supported	18% of COS total exposure time in Cycle 31.
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 31	No changes.

COS NUV MAMA Fold Distribution
PI: 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	18% of COS total exposure time in Cycle 31.
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 31	No changes

COS NUV Spectroscopic Sensitivity Monitor
PI: Jaq Hernandez

Purpose	Monitor sensitivity of 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-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 NUV gratings using external targets WD1057+719 (G230L) and G191B2B (G185M, G225M). The following modes are monitored: G230L/2635-2950, G185M/1786-1921-2010, and G225M/2186-2306-2410. Due to its rapidly declining sensitivity, G285M was removed from the monitoring in Cycle 26. These cenwaves constitute the reddest, middle, and bluest central wavelengths containing only first-order light, with the exception of G230L. TDS trends can be viewed on the COS website at https://www.stsci.edu/hst/instrumentation/cos/performance/sensitivity.
Fraction GO/GTO Programs Supported	18% of COS total exposure time in Cycle 31.
Resources Required: Observations	4 external orbits – 2 closely spaced visits of 1 orbit each, repeated ~6 months later.
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 31	No changes

COS NUV Wavelength Scale Monitor
PI: David French

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	18% of COS total exposure time in Cycle 31.
Resources Required: Observations	1 external orbit. Schedulability is set to 40% 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, 1.4-2.6 pixels G185M 15 km/s, 1.2-1.7 pixels G225M 15 km/s, 1.6-2.3 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 31	No changes

COS NUV Target Acquisition Monitor
PI: Nick Indriolo

Purpose	Monitor COS NUV Target Acquisition (TA) Parameters and Performance. Verifies that all combinations of MIRROR(A,B) and science apertures (PSA or BOA) produce co-aligned acquisitions.
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. We verify the ACQ/IMAGE co-alignment in a similar manner, and verify with a target sweep in every visit. The target sweep takes images in steps in X and Y using POSTARGs, sweeping the aperture across the target, that we use to define the absolute centering. Three targets of different brightness are required to bootstrap across the pairings. This program also includes a "family portrait" of all the P1/P2 MIRRORA/B WCA lamp images to track any drifting of the centroids, or changes in the flux of the lamps; this has been moved into its own separate internal-only visit.
Fraction GO/GTO Programs Supported	97% of Cycle 31 target acquisitions use the NUV.
Resources Required: Observations	6 external and 1 internal orbit for the lamp family portrait. 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	Verification of co-alignment of NUV ACQ/IMAGE modes and summary ISR.
Accuracy Goals	Co-alignment of ACQ/IMAGE modes need to be better than 0.5 NUV pixels in both the dispersion and cross-dispersion directions.
Scheduling & Special Requirements	Executes annually (in the Fall). All four visits should execute within 30 days of each other.
Changes from Cycle 31	No changes

Contingency Programs

COS FUV Change in Spectroscopic Sensitivity Trends
PI: Jaq Hernandez

Special Note	We plan to activate this program at the beginning of Cycle 32. We will withdraw visits if we see trends stabilizing and won't request repeats for failed visits.
Purpose	To supplement the COS FUV Spectroscopic Sensitivity Monitor that runs every 2 months in the event that TDS trends change rapidly. With the extra orbits in this program, the TDS trends will be observed monthly.
Description	To track the TDS as a function of wavelength we obtain exposures of two standard stars (WD0308-565 and GD71) every 2 months with all FUV gratings. The monitoring sequence consists of three visits, for a total of 6 orbits. The 2-orbit visit (GD71) covers the G130M/1096/FUVB, G160M/1533/FUVA, G160M/1577/FUVA, G160M/1611/FUVA and G160M/1623/FUVA modes. One other 2-orbit visit (WD0308-565) covers G130M/1222, G130M/1291, G130M/1327/FUVA, G130M/1055/FUVA, G140L/800, G140L/1105, and G140L/1280 modes. The other 2-orbit visit (WD0308-565) covers G160M/1533/FUVB, G160M/1577/FUVB, G160M/1611/FUVB, G160M/1623/FUVB at LP6, with two of these cenwaves at LP4, alternating between 1533 & 1577 and 1611 & 1623 each visit.
Fraction GO/GTO Programs Supported	87% of COS total exposure time in Cycle 30.
Resources Required: Observations	32 external orbits
Resources Required: Analysis	6 FTE weeks
Products	These data will be used along with the data obtained in the COS FUV Spectroscopic Sensitivity Monitor to create a new Time-Dependent Sensitivity reference file, update ETC throughputs, update the COS monitoring webpages, and write 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. SNR of 5 per resel in the short wavelength region for G140L/800, which yields SNR of 32 per 20 Å bin (used in the TDS analysis). • TDS calibration better than 2% for standard modes and 5% for blue modes
Scheduling & Special Requirements	• This is a contingency proposal only activated in the event that TDS trends are seen to be changing rapidly • The extra monitoring sequence should occur every 2 months starting in the month the program is activated and should be the alternate month of the standard COS FUV TDS program • The FUVA turn-off of the GD71 visit should be hidden in the GS-ACQ • GD71 is not visible from late April to early August 2023, resulting in a reduced monitoring sequence for the months of May and July (2 visits)
Changes from Cycle 31	No changes

COS FUV Detector Recovery after Anomalous Shutdown
PI: Thomas Wheeler

Purpose	The safe and orderly turn-on and ramping-up the COS FUV high voltage in a conservative manner after a HV anomalous shutdown.
Description	Day 01 activities, visits 01-07, contain both QE grid off and on HV ramping to HVLow (100/100) with diagnostics (DCE dumps) and darks to exclude QE grid involvement in the shutdown. Subsequent to day 01, all HV rampings, diagnostics and darks will be with the QE grid on. The HV commanded values for the subsequent days are: 154/151, 160/157, 167,163, etc. until the desired HV is obtained.
Fraction GO/GTO Programs Supported	This is a contingency proposal and only activated in the event of an anomalous shutdown of the FUV detector.
Resources Required: Observations	17 internal orbits
Resources Required: Analysis	If activated, 0.5 FTE day per test.
Products	After thorough data analysis for each test day, a Go/No-Go to proceed will be given.
Accuracy Goals	
Scheduling & Special Requirements	This is a contingency proposal activated only in the event of an anomalous shutdown.
Changes from Cycle 31	No changes

COS NUV Detector Recovery after Anomalous Shutdown
PI: Thomas Wheeler

Purpose	The safe and orderly recovery of the NUV-MAMA detector after an anomalous shutdown.
Description	The recovery procedure consists of four separate tests (i.e. visits) to check the MAMA's health after an anomalous shutdown. Each must be successfully completed before proceeding onto the next. They are: (1) signal processing electronics check, (2) slow, intermediate voltage high-voltage ramp-up, (3) ramp-up to full operating voltage, and (4) fold analysis test.
Fraction GO/GTO Programs Supported	This is a contingency proposal and only activated in the event of an anomalous shutdown of the NUV detector.
Resources Required: Observations	4 internal orbits
Resources Required: Analysis	If activated, 0.5 FTE day per visit.
Products	For tests 1-3, only a Go/No-Go to proceed will be given. For test 4, the results will be sent to the COS Team and Ball Aerospace (Steve Franka).
Accuracy Goals	
Scheduling & Special Requirements	This is a contingency proposal activated only in the event of an anomalous shutdown.
Changes from Cycle 31	No changes