Summary of the COS Cycle 22 Calibration Program

Paule Sonnentrucker[1,2], George Becker[1], Azalee Bostroem[1], John H. Debes[1], Justin Ely[1], Andrew Fox[1,2], Sean Lockwood[1], Cristina Oliveira[1], Steven Penton[1], Charles Proffitt[1], Julia Roman-Duval[1,2], David Sahnow[1], Hugues Sana[1], Jo Taylor[1], Alan D. Welty[1], Thomas Wheeler[1].

[1] *Space Telescope Science Institute, Baltimore, MD*
[2] *European Space Agency*

September 22, 2016

ABSTRACT

We summarize the calibration activities for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope during Cycle 22 which ran from November 2014 through October 2015. 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 22 are also given here. Results of the analysis attached to each program are published in separate ISRs.

Contents

Operated by the Association of Universities for Research in Astronomy, Inc., for the National Aeronautics and Space Administration

1. Introduction

The Cosmic Origins Spectrograph (COS) was installed on the Hubble Space Telescope in May 2009. Cycle 22 was thus the sixth cycle of on-orbit operations for COS, running from November 2014 through October 2015. Each cycle, the COS team monitors the performance of the COS instrument through routine calibration programs. These programs 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.

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 22 calibration plan and we summarize the changes applied to some of the regular Cycle 22 calibration programs compared to Cycle 21. Section 4 contains the high level executive summaries for the regular calibration programs executed in Cycle 22. The Cycle 22 calibration plan is composed of 10 regular programs calibration programs and 2 contingency programs that are designed to recover science operation in the FUV and NUV in case of anomalous detector shutdown.

2. Overview of COS Usage in Cycle 22

2.1 Prime Orbits Usage Statistics By HST instruments

The HST orbit usage in terms of science time allocation is published yearly shortly after the phase II submission deadline and can be found at http://www.stsci.edu/hst/metrics/SiUsage/COS/. 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 22, the COS usage comprises ~21% (~695 orbits) of all approved GO prime orbits making COS the second most used instrument this cycle. COS SNAP orbits represent ~10% of the total SNAP orbit allocation this cycle. Compared to Cycle 21, the COS GO prime usage has decreased by ~9% and SNAP usage has increased by ~5%.

Table 1: Cycle 22 allocation of science time among HST Instruments.

Instruments	Prime Orbits Usage	SNAP Orbit Usage
ACS	17.4%	8.8%
COS	20.4%	9.8%
STIS	12.6%	68.3%
WFC3	49.7%	13.2%
FGS	0.0%	0.0%

2.2 COS Prime Orbit Usage Statistics by Mode

Based on Cycle 22 phase II submissions, 98.7% of the total COS prime observing time consists of *science* exposures and the remaining 1.2% of the total COS prime observing time consists of NUV Imaging target acquisition exposures. Of the 98.7% of COS *science* observing time, 82.5% is used for COS FUV spectroscopic exposures and 16.2% is used for NUV spectroscopic exposures. The breakdown among observing modes is summarized in Table 2. This distribution is very similar to that obtained in Cycle 21 and reflects the continued high demand for FUV spectroscopic capabilities from the HST user community.

Table 2: COS usage statistics by mode for Cycle 22

Configuration/Mode	COS Prime Usage (science exposures)	COS SNAP Usage (science exposures)
FUV / Spectroscopy	**82.5%**	**95.5%**
NUV / Imaging	**0.1%**	**0.0%**
NUV / Spectroscopy	**16.2%**	**---**

2.3 COS Prime 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 22 are very similar to those in Cycle 21 for the G130M and G160M gratings. G130M remains the most used of the FUV gratings. The blue mode cenwaves represent 7.0 % of total G130M observing time with a breakdown among the blue mode cenwaves as follows: G130M/1222 (83.9%), G130M/1055 (1.7%) and G130M/1096 (14.5%). The Cycle 22 blue mode usage has decreased by a factor ~3 compared to Cycle 21 usage. The G140L is the least used of the FUV gratings with a decrease in Prime usage of 6% compared to Cycle 21. The G140L/1105 is the most used cenwave and represents 77 % of the total G140L science observing time (23% for the G140L/1280 configuration).

For the NUV channel, the prime orbit usage statistics in Cycle 22 are quite different from those in Cycle 21. The G285M grating is not used in Cycle 22 at all. The usage of the G185M and G225M have increased by 4-6% in Cycle 22 while the usage of G230L has decreased slightly by 2% in Cycle 22 compared to last cycle. Only a faction of a percent consists of NUV/Imaging science observations, a percentage fraction similar to all previous cycles as well.

In Cycle 22, SNAP observations are obtained only with the FUV channel, as in previous cycles. Two-third of the SNAP science observing time consists of G130M exposures and the remaining one-third uses the G140L grating.

Table 3: COS science usage statistics by mode and grating in Cycle 22

Configuration	Grating	Percentage of COS Prime Science Exposures (93%)		Percentage of COS SNAP Science Exposures (7%)	
		C21	C22	C21	C22
COS/FUV	G140L	18.9%	13.5%	94.7%	31.1%
(C22: 82.5% prime)	G130M	41.5%	42.5%	---	68.9%
	G160M	26.1%	27.6%	---	--
COS/NUV	G230L	3.5%	1.5%	---	--
(C22: 16.2% prime)	G185M	1.9%	8.0%	---	--
	G225M	2.7%	7.1%	---	--
	G285M	2.7%	---	---	--
	MIRROR A/B	0.7%	0.1%	5.3%	--

2.4 COS FUV mode & FP-POS distribution

Starting in Cycle 21, the COS FUV user community was requested 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 22. 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. 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. Noteworthy is the fact that the G130M/1291 is the most used of all COS/G130M cenwaves.
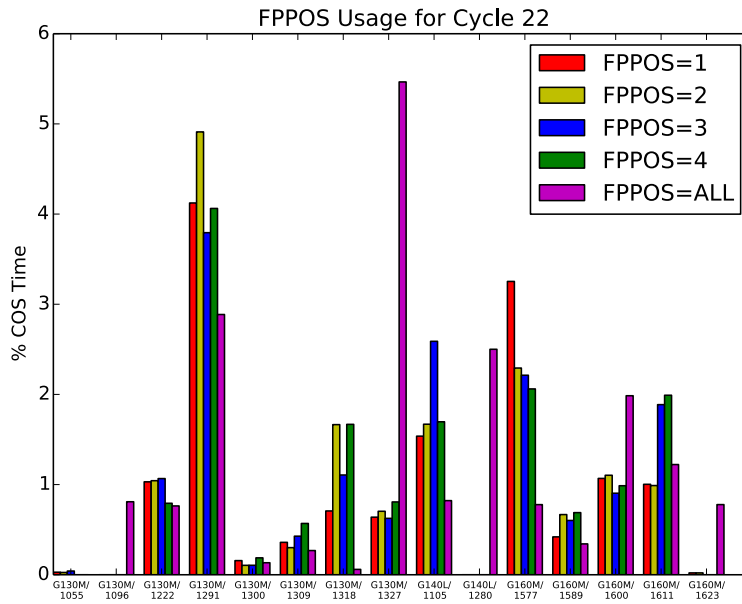
Figure 1: Cycle 22 distribution of FP-POS among COS modes. Relatively even FP-POS dithering was performed among COS FUV configurations following the COS Team requirements.

3. Overview of the Regular Cycle 22 Calibration Programs

The Cycle 22 calibration plan is composed of 10 regular calibration programs and 2 contingency programs designed to recover science operations in the FUV and NUV in case of an anomalous detector shutdown. 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 22 programs are essentially continuations of the monitoring programs from the previous cycle. Four COS FUV programs, however, were significantly modified to accommodate the move of operations from Lifetime Position 2 (LP2) to Lifetime Position 3 (LP3) which took place on February 09, 2015. We briefly summarize those changes below. Detailed descriptions are provided in the program-related ISRs (see Table 4).

- *The COS FUV dark monitor program (PID13968)* was increased by a total 170 internal orbits in order to monitor the COS FUV dark rate at 2 lifetime positions with different operating HV values: the previous LP2 position where blue modes have remained positioned (G130M/1055-1096, and the new LP3 position where all other standard FUV modes were moved to. The monitoring cadence was increased from 5 orbits/week at LP2 to 5 orbits/week at LP2 and 5 orbits/week at LP3 after the lifetime position move to LP3 (Feb 9, 2015).

- *The COS FUV dispersion solution verification program (PID13969)* was reduced from 3 to 1 external orbit in Cycle 22 to monitor only the G140L configurations and the G130M/1096 configuration. The standard G130M and G160M configurations were monitored as part of the LP3 Calibration effort in special program LCAL2 (PID13931).

- *The COS FUV TDS monitor program (PID13967)* was increased by 2 external orbits to allow for reconnection of the TDS from LP2 to LP3.

- *The COS FUV Gain map program (PID13970)* was increased by 1 internal orbit to accommodate the move of COS FUV operations to LP3.

Table 4. High-level summary of regular Cycle 22 calibration programs

PID	Title	Orbits used Executed [Allocated]		Frequency	Products	Accuracy Achieved
		External	Internal			
13976	COS NUV MAMA Fold Distribution	--	1 [1]	1/yr	ISR 2016-14	<5% on peak location of fold distribution
13974	COS NUV Detector Dark Monitor	--	52 [52]	1/week	ISR 2016-11	0.2% in global dark rate uncertainty
13973	COS NUV Spectroscopic Sensitivity Monitor	6 [6]	--	3x2/(L+M)	ISR 2016-10	S/N of 30 per resel
13975	COS NUV Internal/External Wavelength Scale Monitor	3+ 1[H] [3]	--	3x1	ISR 2016-12	1.7-3.7 pixels in wavelength scale accuracy
13972	COS Imagine TA and Spectroscopic WCA-PSA/BOA offset Verification	2 [2+1[C]]	--	2x1	ISR 1026-09	0.5 NUV pixel
13968	COS FUV Detector Dark Monitor	--	425+ 5[F] [430]	5/week/HV 2HV	ISR 2016-05	0.1% in global dark rate uncertainty
13967	COS FUV Spectroscopic Sensitivity Monitor	25 [25+10[C]]	--	1x/month	TDS Ref file	<2/5% relative/absolute TDS calibration
13969	COS FUV Internal/External Wavelength Scale Monitor	1 [1]	--	1/yr	ISR 2016-06	l scale accuracy: 5.7-7.5 pix G130M, 5.8-7.2 pix G160M, 7.5-12.5 pix G140L
13970	COS FUV Detector Gain Maps	--	3 [5]	Once per HV change	ISR 2016-07	~0.1 Pulse Height bins
13994	COS observations of geo-coronal Lyman alpha emission (COS pure parallel)	4[P] [4[P]]	--	2x2	See STIS ISR	N/A
13978	COS NUV recovery after Anomalous Shutdown	--	0 [4[C]]	Contingency	None	N/A
13977	COS FUV Recovery After Anomalous Shutdown	--	0 [17[C]]	Contingency	None	N/A

[C] Contingency orbits, [P] Parallel orbits, [H] HOPR, [F] Failures not repeated

Reference files are updated only "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 the following web address: www.stsci.edu/hst/observatory/cdbs/SIfileInfo/COS/reftablequeryindex. 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: www.stsci.edu/hst/cos/documents. Note that TIRs are only available on the internal STScI web site. In order to retrieve TIRs a document from outside STScI, a request needs to be sent to help@stsci.edu.

4. Executive Summary for each Individual Program

We provide a high-level summary of the purpose, requirements and orbit allocation for each of the 12 calibration programs comprising the regular Cycle 22 calibration plan. Results of the monitoring analysis are reported separately in program-specific ISRs (see Table 4 for reference number).

Program ID 13976: COS NUV MAMA Fold Distribution

PI: Thomas Wheeler

Analysis Lead, Others: Thomas Wheeler, Alan D. Welty (CoI)

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	All NUV observations (17% of COS time)
Resources Required: Observations	1 internal orbit
Resources Required: Analysis	0.5 FTE day.
Products	The results will be sent to the COS Team and V. Argabright.
Accuracy Goals	
Scheduling & Special Requirements	This proposal is executed annually.
Changes from Cycle 21	None

Program ID 13974: COS/NUV Detector Dark Monitor
PI: Justin Ely
Analysis Lead, Others: Justin Ely, David Sahnow, Charles Proffitt

Purpose	Perform routine monitoring of MAMA detector dark current. The main purpose is to look for evidence of a change in the dark, 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	17% of COS total exposure time.
Resources Required: Observations	52 internal orbits
Resources Required: Analysis	4 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 21	None

Program ID 13973: NUV Spectroscopic Sensitivity Monitor

PI: K. Azalee Bostroem, Jo Taylor

Analysis Lead, Others: Jo Taylor

Purpose	Monitor sensitivity of each NUV grating mode to detect any change due to contamination or other causes. The NUV gratings on COS degrade with a rate that has been steady since the start of on-orbit operations, with the bare-Aluminum grating degrading at a faster rate (~3 and 11%/yr) than the MgF coated gratings (~0%/yr). Additionally, track the time dependence of the sensitivity as a function of wavelength.
Description	Obtain exposures in all NUV gratings – G230L (target: WD1057+719), G185M, G225M, and G285M (target: G191828) – 3 times a year. We will monitor the following modes: G230L/2635, G230L/2950, G185M/1786, G185M/1921, G225M/2186, G285M/2617, and G285M/3094. These central wavelengths constitute the reddest and bluest central wavelengths containing only first order light with the exception of the G225M which was unused in Cycles 19 and 20 and was minimally used in Cycles 21. NUV trends are stable, therefore we will continue to monitor the central wavelengths used in previous cycles.
Fraction GO/GTO Programs Supported	17% of COS exposure time
Resources Required: Observations	6 external orbits
Resources Required: Analysis	5 FTE weeks
Products	Time-Dependent Sensitivity Reference File and a summary in the end of cycle 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	Space observations at 4 month intervals
Changes from Cycle 21	None

Program ID 13975: COS NUV Internal/External Wavelength Scale Monitor

PI: Sonnentrucker

Analysis Lead, Others: 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 targets obtained with the PSA.
Description	This program monitors the offsets 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 observes some cenwaves at different FP-POS. All orbits > 1800s.
Fraction GO/GTO Programs Supported	17 % of COS total exposure time.
Resources Required: Observations	3 external orbits and all orbits > 1800s.
Resources Required: Analysis	3 FTE weeks
Products	Update to wavelength dispersion reference file as needed, ISR, and a summary in the end of cycle 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	These observations are taken every 4 months. External target is HD6655 (target used since Cy 17)
Changes from Cycle 21	No changes

Program ID 13972: COS Target Acquisition Monitoring

PI: Steven Penton

Analysis Lead, Others: Steven Penton

Purpose	Measure/monitor the WCA-to-PSA and WCA-to-BOA offsets used for target acquisitions (both IMAGING and SPECTROSCOPIC).
Description	There are four NUV ACQ/IMAGE mechanism combinations: 2 science apertures (PSA & BOA) x 2 mirror modes (MIRRORA & MIRRORB). During SMOV, the WCA-to-PSA+MIRRORA offset was determined by an aperture scan; the other offsets were bootstrapped from this offset. In Cycle 20, changes in the PSA+MIRRORA-to-PSA+MIRRORB offset were detected in the Focal Plane Calibration (SI-FGS Alignment) program (13171). This, and the background-related issues with MIRRORB ACQ/Images, motivates the need to monitor all WCA-ScienceAperture offsets. This program repeats the SMOV process for ACQ/IMAGE co-alignment (without the aperture scan). In addition, this program obtains spectra of the centered targets with all COS gratings to track any changes in the spectroscopic WCA-to-Science Aperture offsets used for spectroscopic target acquisitions.
Fraction GO/GTO Programs Supported	~100% of COS total exposure time (all COS exposures with target acquisitions depend on WCA-to-Scientific Aperture offsets)
Resources Required: Observations	2 external one-orbit visits + 1 external orbit contingency visit. Visit 1: WD1657+343 is used to co-align the PSA/MIRRORB and BOA/MIRRORA modes. Visit 2: HID66578 is used to co-align the BOA/MIRRORA and BOA/MIRRORB modes. Contingency visit: 206W3 would be used to co-align the PSA/MIRRORA and PSA/MIRRORB modes. The PSA+MIRRORA and PSA+MIRRORB co-alignment is periodically tested in the HST SI-to-FGS verification program (13616 in C21). We rely upon these observations as our verification of the PSA+MIRRORB alignment upon which the other combinations are bootstrapped. If for some reason this program has not been run as scheduled (twice a year), a contingency visit would be needed to measure the PSA+MIRRORA-to-PSA+MIRRORB offset.
Resources Required: Analysis	4 FTE weeks for analysis, creating new offsets, and writing an ISR.
Products	Updated NUV imaging WCA-to-Science Aperture offsets, NUV & FUV Spectroscopic WCA-to-Science Aperture offsets, summary in end of cycle ISR
Accuracy Goals	Imaging WCA-to-Science Aperture offsets should be known to better than 0.5 NUV pixels in both dispersion and cross-dispersion. Spectroscopic WCA-to-Science Aperture offsets also need to be known to 0.5 XD pixel.
Scheduling & Special Requirements	Annually.
Changes from Cycle 21	None

Program ID 13968: COS/FUV Detector Dark Monitor
PI: Justin Ely
Analysis Lead, Others: Justin Ely, David Sahnow

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. Adjustments for LP3 multiple HV operations: an additional 5 exposures/week @ the HV used for the G140L setting as long as it operates at a different HV than the M-modes
Fraction GO/GTO Programs Supported	83% of COS total exposure time
Resources Required: Observations	260 internal orbits + 170 additional internal orbits starting at LP3 (# estimate based on LP3 move @Feb 01, 2015)
Resources Required: Analysis	4 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	At LP2 : 5x / week during Earth occultations. At LP3: 5x / week at nominal HV for M modes and 5x/week at G140L operational HV [also during Earth occultation].
Changes from Cycle 21	Adjusted for LP3 multiple HV operations

Program ID 13967: COS FUV Sensitivity Monitor
PI: K. Azalee Bostroem
Analysis Lead, Others: Hugues Sana

Purpose	Monitor the sensitivity of each FUV grating mode 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 appear to be grating-, segment-, and wavelength dependent.
Description	To track the TDS as a function of wavelength we will obtain exposures in all FUV gratings every month. There will be 2 types of monitoring sequences which will occur on alternating months. (i) Full monitoring sequence (every other month except May – Jul 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/1230 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) to monitor the complete wavelength range of the standard modes using one central wavelength per grating. The modes covered are G130M/1291, G160M/1623, and G140L/1230. An additional full sequence (3 orbits) is added compared to C21 to transition the TDS from LP2 to LP3.
Fraction GO/GTO Programs Supported	83% of COS exposure time
Resources Required: Observations	26 external orbits + (10 contingency external orbits)
Resources Required: Analysis	10 FTE weeks
Products	Time-Dependent Sensitivity Reference File as necessary and a summary in the end of cycle 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
Scheduling & Special Requirements	- Complete monitoring sequence should occur every 2 months starting in December 2014. - The reduced monitoring sequence should occur every 2 months starting in November 2014. - GD71 is unschedulable May - July 2015. - The FUVA turn-off during the GD71 visit should be hidden in the GS-ACQ
Changes from Cycle 21	1 Full monitoring sequence (3 orbits) added to transition the TDS from LP2 to LP3

Program ID 13969: COS FUV Internal/External Wavelength Scale Monitor

PI: Paule Sonnentrucker
Analysis Lead, Others: 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 targets 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 FPPOS independent for a particular grating, but it is grating dependent. To verify and monitor this dependency, this program observes he G130M/1096 and G140L/1105 &1280 cenwaves at different FPPOS in cycle 22 alone. All orbits > 1800s. Data to monitor the dispersion solutions for some standard modes of G130M and G160M are obtained as part of LP3 calibration effort LCAL2.
Fraction GO/GTO Programs Supported	83% of COS total exposure time.
Resources Required: Observations	1 external orbit> 1800s. Schedulability set to 30%
Resources Required: Analysis	4 FTE weeks
Products	Update of wavelength dispersion reference file if necessary, ISR, and a summary in the end of cycle ISR.
Accuracy Goals	G140L 150km/s, 7.5-12.5 pixels G130M 15km/s, 5.7-7.5 pixels (will be checked using LCAL2 data) G160M 15km/s, 5.8-7.2 pixels (will be checked using LCAL2 data)
Scheduling & Special Requirements	ORIENT for some exposures to avoid bright field targets. These observations are taken once per cycle. External target used is AV75 (target used since Cy 20).
Changes from Cycle 21	1 orbit for monitoring of the G130M/1096 and G140L/1105 &1280 settings for cycle 22 only. The other standard modes are observed in LCAL2 and will be used for this monitoring.

Program ID 13970:   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 Lifetime Position or nominal high voltage levels, to check that the expected modal gain is achieved, and to constrain dependence of modal gain on HV.
Description	Use the deuterium lamp to illuminate the entire LP2 or LP3 region of the COS FUV detector as follows: • At LP2, immediately before the Segment A HV is increased while still operating at LP2 • At LP2, immediately after the Segment A HV is increased while still operating at LP2 • At LP2, after nominal LP2 operations have ended, using the final LP2 HV levels • At LP3, immediately before nominal LP3 operations begin (at the two LP3 HV levels) • Contingency: At LP2, if additional data is needed to make a gain map for the Blue Modes once nominal operations has shifted to LP3 • Contingency: At LP3, before and after any changes to nominal HV levels
Fraction GO/GTO Programs Supported	83%
Resources Required: Observations	5 internal orbits 3 internal contingency orbits
Resources Required: Analysis	Existing CCI / gain map procedures will be used to process these data
Products	Gain map before and after HV change, constrain models of gain vs. HV. Updates to GSAGTAB and BPIXTAB.
Accuracy Goals	0.1 pulse height bin
Scheduling & Special Requirements	Immediately before and immediately after any HV change or LP move
Changes from Cycle 21	Modified to accommodate move to LP3

Program ID 13994: COS Observations of Geocoronal Lyman-alpha Emission COS - Pure Parallel

PI: Hugues Sana

Analysis Lead, Others: Sean Lockwood

Purpose	To obtain COS G130M 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	43% (G130M observations)
Resources Required: Observations	2 external parallel orbits (in parallel with STIS MAMA TDS and focus monitor) in Cy 22 ~0.75% of lifetime at brightest Ly-α pixel for each FP-POS (2 FPPOS used) in Cy 22
Resources Required: Analysis	2 FTE day
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 21	Requirements have been achieved (10,000s) for 1105, 1291, and 1327 at LP2. In Cy22, we will start accumulating data for 1291 (most used cenwave) at LP3. We plan to continue in future cycles to reach S/N requirement and monitor other cenwave (as done at LP2).

Program ID 13971 : Characterization of HV Change Effects on Sensitivity

PI: Dave Sahnow
Analsyis Lead, Others: Dave Sahnow

Purpose	Determine the effect of the commanded high voltage on the measured sensitivity. Identify dependencies of this effect on other variables such as detector segment, detector pixel, wavelength, shape of the pulse height distribution.
Description	Measure the effect of the commanded high voltage on the sensitivity by collecting spectra of an external target at a variety of HV levels. Identify other contributing factors by taking similar data with all three gratings. The program will consist of three two-orbit visits. Each visit will obtain data for a single grating and cenwave, but at multiple HV levels to cover the range of voltages used on orbit. No mechanisms will be moved after the initial science exposure, and the voltage will be changed in a semi-random manner – including some repeated values - in order to identify drift or hysteresis effects in the instrument. The first visit will be a proof of concept using G130M/1291. The following two visits will be used to disentangle the dependencies (e.g. pixel vs. wavelength effects) in the measurements. All visits use the TDS target WD0308
Fraction GO/GTO Programs Supported	All FUV exposure
Resources Required: Observations	6 external orbits
Resources Required: Analysis	8 FTE Weeks
Products	Curves of sensitivity as a function of detector high voltage and as a function of some or all of the following: segment, detector x pixel, wavelength, pulse height distribution shape, gain, etc. Eventually provide a new reference file so that CalCOS can include the effect. An ISR will be written + summary for end of cycle ISR
Accuracy Goals	Determine Sensitivity vs. HV to 1%
Scheduling & Special Requirements	First visit (2 orbits) to be scheduled soon after move to LP3 in order to sample maximum HV range. Remaining visits will follow after analysis of data from first visit shows the effect is measurable and stable.
Changes from Cycle 21	N/A: this is a new program