Instrument Science Report COS 2013-04

Summary of the COS Cycle 18 Calibration Program

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ABSTRACT

We summarize the Cycle 18 calibration program for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope covering the time period November 2010 through October 2011. We give an overview of the whole program, and status summaries for each of the individual proposals comprising the program.

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1. Introduction

The Cosmic Origins Spectrograph (COS) was installed on the Hubble Space Telescope in May 2009. Cycle 18 was the second cycle of on-orbit operations of COS, and therefore represents the more "normal" calibration and monitoring programs of a mature instrument. Nevertheless, a few special programs in this cycle included preparations for the future lifetime adjustment move for the far-ultraviolet detector. Cycle 18 observations commenced in November 2010 and ran through October 2011. During this cycle there were only 2 observations lost due to the SI C&DH hang-up in September 2011. Two orbits of sensitivity monitoring were lost due to telescope errors or guide-star issues; one was repeated. None of the lost orbits had any relevant impact on the regular monitoring programs.

In this document we record and summarize the results of the individual calibration programs. Section 2 gives a summary and overview of the calibration program, which comprises 15 unique programs. Of these, 9 programs monitor and track instrument performance. Three special calibration programs were unique to Cycle 18, and an additional 3 programs were devoted to exploring instrument performance at potential future lifetime positions on the FUV detector. Section 3 details results from the individual programs. The Appendix lists reference files and documentation produced as a result of Cycle 18 calibration programs.

2. Overview of Calibration Proposals for Cycle 18

Table 1 summarizes the orbit allocation and usage during the regular Cycle 18 calibration programs, as well as the additional programs to prepare for the FUV lifetime adjustment move.

Table 1. Summary of orbit allocation and use during Cycle 18 COS calibration, including orbits to explore the new lifetime position location.

	External Orbits		Internal Orbits	
	Regular	**Lifetime Move**	**Regular**	**Lifetime Move**
Allocated	67	16	188	28
Executed	67	6	188	28
Withdrawn	1	10	0	0
Failed	2	0	2	0
Repeated	1	0	0	0

The calibration monitoring programs in Cycle 18 are essentially continuations of the monitoring programs from the previous cycle. They monitor instrument throughput and performance; reference files are updated only on an as-needed basis to maintain instrument calibration within the required specifications. The special programs for this cycle provide more detailed calibration of instrument performance in areas that were still uncertain after Cycle 17. Finally, the additional set of three programs explored the FUV detector performance in preparation for the lifetime adjustment to the spectrum location planned for Cycle 19.

Currently available reference files can be found at:
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 request needs to be sent to: **help@stsci.edu**.

Table 2 provides a high-level summary of the calibration programs, noting specifically products and accuracy achieved. The first two columns give the Proposal ID and its title; columns 3 and 4 give the number of executed[allocated] orbits for each proposal, divided into external and internal orbits. Column 5 gives the frequency of visits for monitoring programs. Column 6 describes the resulting products. For several programs, regularly updated reference files are produced. For many others, results are either posted on the web, or simply documented in Section 3 of this report. Column 7 gives the accuracy achieved by the calibration proposal. The last column of Table 2 notes the page in this ISR on which detailed information for that program can be found.

Table 2. Summary of Cycle 18 calibration and monitoring programs. Further details can be found in the following sections.

PID	Title	Orbits Used Executed[allocated]		Frequency	Products	Accuracy Achieved	Page
		External	Internal				
	NUV Monitors						
12419	NUV MAMA Fold Distribution		1[2]	Once	Reported in this ISR	<5% in location of peak of fold distribution	6
12420	NUV Detector Dark Monitor		52[52]	1/week	Reported in this ISR	0.2% in global dark rate uncertainty	8
12421	NUV Spectroscopic Sensitivity Monitor	12[12]		3x2/L, 3x2/M	TDS Reference file	SNR of 30 per resel at λ_{cen}	9
12422	NUV Internal/External Wavelength Scale Monitor	3[3]		3x1	Reported in this ISR	1.7-3.7 pixels in wavelength scale accuracy	11
12430	NUV Detector Recovery after Anomalous Shutdown			contingency	None	N/A	13
	FUV Monitors						
12423	FUV Detector Dark Monitor		130[130]	5/alt. wks	Reported in this ISR	Rate < 10^{-6} cts/pix/s. 0.1% in global dark rate uncertainty	15
12424	FUV Spectroscopic Sensitivity Monitor	34[34]		12x2/ G140L+G130M, 10x1/G160M	TDS Reference file	SNR of 30 per resel at λ_{cen}	17
12425	FUV Internal/External Wavelength Scale Monitor	6[6]		6x1	Reported in this ISR	wavelength scale accuracy 5.7-7.5 pix for G130M, 5.8-7.2 pix for G160M, 7.5-12.5 pix for G140L	19
12431	FUV Detector Recovery after Anomalous Shutdown			contingency	N/A	N/A	22
	Special Programs						
12414	COS Observations of Geocoronal Lyα		5P[5P]		Files on web site	N/A	24
12426	FUV Sensitivity Characterization	10[10]		5x1/G130M, 5x1/G160M	Reported in this ISR	S/N ~ 10/pix	25
12432	COS FUV Detector Gain Sag vs. High Voltage	2[4]	5[2]		Reported in this ISR	N/A	27
	Lifetime Exploratory Programs						
12676	COS/FUV Characterization of Detector Effects		12[12]		Reported in this ISR	S/N ~ 10/pix	29
12677	COS/FUV Mapping of Stray PtNe Lamp Light Through FCA		16[7]		Reported in this ISR	N/A	31
12678	COS/FUV Characterization of Optical Effects	6[6]			Reported in this ISR	8% in relative resolution	33
	Totals	73[73]	216[216]				

P refers to pure parallel orbits.

3. Results from Individual Proposals

The following sections summarize the purpose, status, and results from the individual calibration proposals in the Cycle 18 program.

Proposal ID 12419: COS NUV MAMA Fold Distribution (PI: Thomas Wheeler)

Analysis Lead, Others: Thomas Wheeler, backup: Chris Long

Summary of Goals
The performance of the NUV MAMA microchannel plate can be monitored using a MAMA fold analysis procedure that provides a measurement of the distribution of charge cloud sizes incident upon the anode giving some measure of change in the pulse-height distribution of the MCP and, therefore, MCP gain. The goal of 12419 is the continued monitoring of the NUV MAMA detector and comparing the results with previous tests results to detect trends or anomalous behavior.

Execution
This proposal successfully executed on May 1, 2011.

Summary of Analysis
The engineering telemetry data was examined (voltages, currents, temperatures, relay positions, and status) for agreement with predicted values and previous ground and on-orbit test data. A MAMA time-tag image was used to construct a histogram of the number of counts for each fold. The results were compared and combined with the previous test results. Figure 1 contains the fold histogram. The results are nominal.

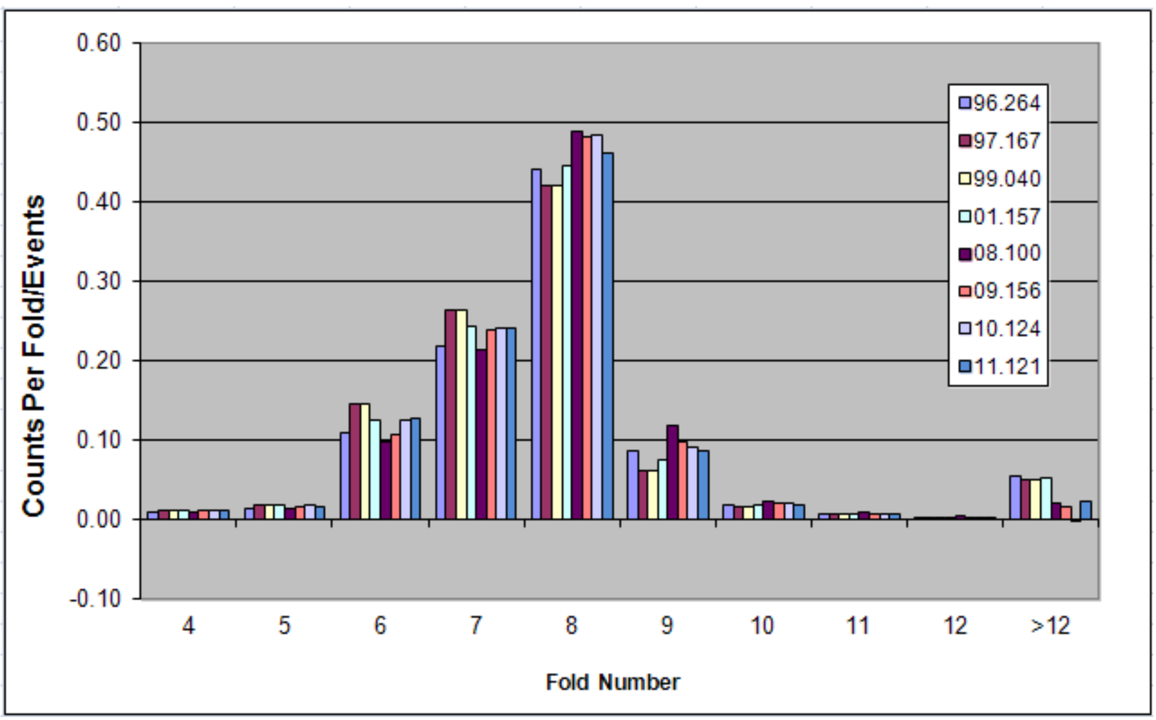


Figure 1. Histogram of COS NUV Fold Test Results – Proposal 12419

Post test, a dark exposure was taken where the counters are cycled and are plotted in a histogram and compared with earlier results. The key in the inset gives the year and day of year for prior fold tests. Figure 2 contains the results. The post-test dark count rate is increasing. This has been attributed to window phosphorescence.

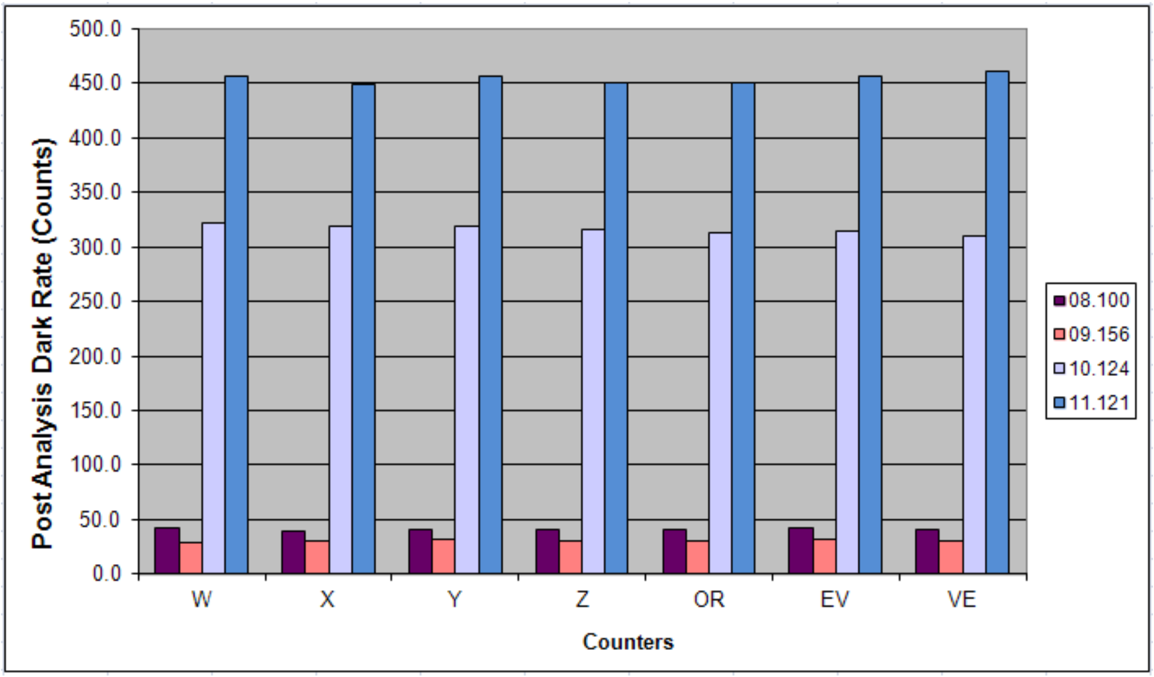


Figure 2. Post-test NUV showing dark count rates. The increase in dark count rate is attributed to window phosphorescence. The key in the inset gives the year and day of year for prior fold tests.

The results were sent to the COS Team at STScI and V. Argabright of Ball Aerospace for review and comments.

Accuracy Achieved
Position of the peak in the fold distribution can be measured to about 5% accuracy from this procedure.

Reference Files Delivered
N/A

Relevant ISRs
No ISRs will be published.

Continuation Plans
This monitoring program continued in Cycle 19 as proposal ID 12723.

Supporting Details
See figures above.

<u>Proposal ID 12420: NUV Detector Dark Monitor (PI: Wei Zheng)</u>

Analysis Lead, Others: Colin Cox, Charles Proffitt, David Sahnow, Rachel Osten, Justin Ely

Summary of Goals
Monitor COS MAMA detector dark rate to track on-orbit time dependence and check for developing detector problems. Measure spatial distribution of dark rates.

Execution
Every two weeks two 22-min exposures were taken with the shutter closed. The two exposures are separated by several orbits to track the effects of temperature changes.

Summary of Analysis
Dark images were reviewed and rates monitored. The data were fit linearly to characterize and predict the dark rate. While all data since SMOV are well fit with a linear relation with a slope of 200 counts per sec per year (as seen in COS ISR 2010-12), an increase in the variation of the dark rate later in the cycle led to an increase in the scatter and a flattening of the relationship to a constant value of 5E-5 counts per sec. It was found that some of this variation was dependent on temperature.

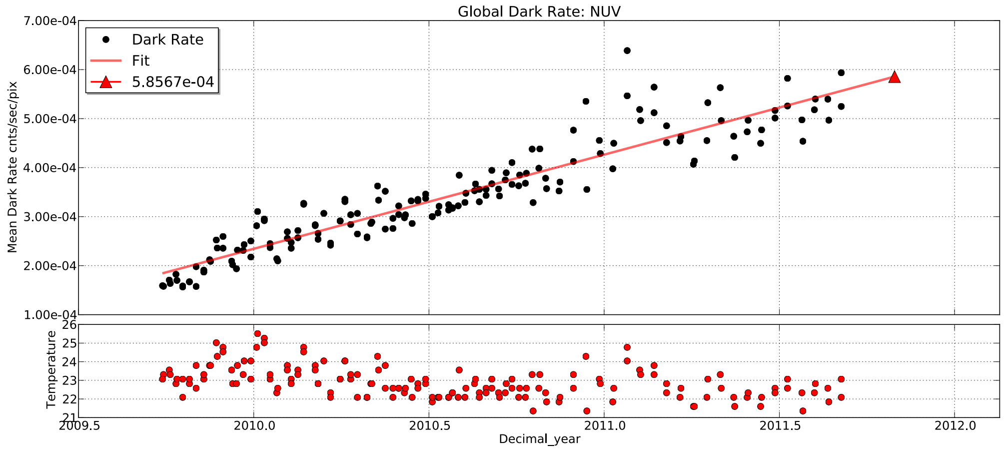
Accuracy Achieved
The trend of the dark rate with time shows variation around a constant rate of approximately 5E-5 counts per sec over Cycle 18, which gives an accuracy of ~10% to the dark rate predictions.

Reference Files Delivered
None

Relevant ISRs
ISR 2010-12, "COS NUV Detector Dark Rates During SMOV and Cycle 17", D. Sahnow et al.
Although nothing was published for cycle 18, ISR 2010-12 describes the dark rate behaviour.

Continuation Plans
Program continued in Cycle 19 as 12720.

Supporting Details


Global Dark Rate: NUV
Dark Rate
Fit
5.8567e-04
Mean Dark Rate cnts/sec/pix
7.00e-04
6.00e-04
5.00e-04
4.00e-04
3.00e-04
2.00e-04
1.00e-04
Temperature
26
25
24
23
22
21
2009.5
2010.0
2010.5
2011.0
2011.5
2012.0
Decimal_year

Proposal ID 12421: COS NUV Spectroscopic Sensitivity Monitoring (PI: R. Osten)

Analysis Lead, Others: Rachel Osten, Alessandra Aloisi, Charles Proffitt

Summary of Goals

Monitor the sensitivity of each NUV grating mode to detect any change due to contamination or other causes. Characterize these changes as a function of wavelength and grating, and update the time-dependent sensitivity reference file, if necessary, for use with pipeline flux calibration. Due to sensitivity differences on medium- and low-resolution gratings, two spectrophotometric white dwarf standard star targets are used in this monitoring: WD1057+719 for G230L, and G191B2B for G185M, G225M, and G285M.

Execution

The program consisted of a total of 12 external orbits. The monitoring frequency was quarterly. Because of the phasing of this program relative to the Cycle 17 version of this program (in which the monitoring frequency was monthly), only three visits per grating type (low- or medium-resolution) were necessary. Each visit lasted 2 orbits. All visits executed nominally.

Summary of Analysis

The computation of time-dependent sensitivities for COS NUV data is described in Osten et al. (2010; COS ISR 2010-15) and Osten et al. (2011; COS ISR 2011-02). The figure summarizes the behavior of the spectroscopic sensitivity through August 2011, when the last visit of this program executed. The G230L and G185M gratings, which have a MgF_2 coating, exhibit a slight increase in sensitivity with time. The two bare-aluminum gratings G225M and G285M continue the linear declines first noticed in Cycle 17 and before launch. Above wavelengths of about 2150 Å, the G225M decline is wavelength-independent; below this value there is less of a decrease in sensitivity. This may possibly be related to the sensitivity increase seen in the MgF_2-coated gratings. The G285M grating now exhibits a wavelength dependence to the sensitivity declines.

Accuracy Achieved

The accuracy goals of the program were to achieve a SNR of 30 per resel at the central wavelength. This was achieved.

Reference Files Delivered

Time Dependent Sensitivity Tables were delivered as v3i16155l_tds.fits on 03/18/2011, and w7h1935dl_tds.fits on 06/17/2012.

Relevant ISRs

ISR 2011-02 (Osten et al. 2011, "Updated Results from the COS Spectroscopic Sensitivity Monitoring Program") includes the results of the first visit of this program. The further behavior of the NUV gratings will be discussed in an ISR in preparation on COS spectroscopic sensitivity trends.

Continuation Plans

The program continued in Cycle 19 as program 12719. Because of the low usage of the NUV gratings, and their fairly stable rate of decay, the number of central wavelengths was reduced. For the G230L grating, only the 2635 and 2950 cenwaves were monitored in Cycle 19, with a slight reduction of exposure times to fit in one orbit that does not affect the determination of rates of sensitivity change. Cenwaves of the G285M grating have been reduced to 2617 and 3094, the bluest and reddest, and the G225M grating has been reduced to a single cenwave (2186) to monitor the short wavelength behavior as well as the wavelength-independent trends longward of 2150 Å. The G185M grating continues to be monitored with the 1921 cenwave, and an additional cenwave (1786) was added as this setting was relatively heavily used in Cycle 19.

Supporting Details

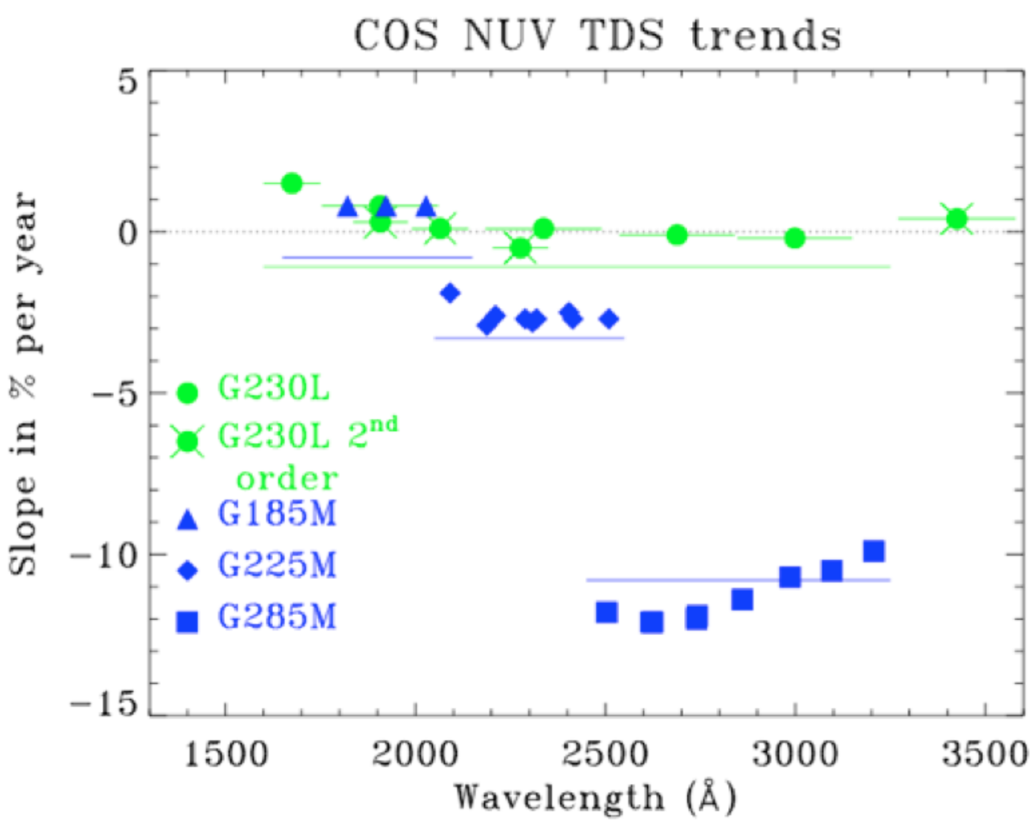


Figure 1: Plot of time-dependent sensitivity trends from NUV gratings up to August 1, 2011, encompassing all of the Cycle 18 program data. The slopes are the fit results of the relative sensitivity versus time of each stripe of each grating assuming a linear function. Low-resolution G230L grating results are shown in green circles; medium-resolution

gratings are shown in blue. Stripe C on G230L records second order light, and this is indicated with an X through the green circle. Green/blue horizontal lines indicate the wavelength-independent values in the currently used reference file for each grating.

Proposal ID 12422: COS NUV Internal/External Wavelength Scale Monitor (PI: Cristina Oliveira)

Analysis Lead, Others: Cristina Oliveira, Paule Sonnetrucker

Summary of Goals
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 on 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 and stripe dependent. To verify and monitor this, this program observes some cenwaves at different FPPOS.

Execution
This program had 3 visits, each 1 orbit. The wavelength scales of the NUV channel were monitored for all the NUV gratings using HD 6655, with the following settings: G185M/2010, G225M/2217, G285M/2676, and G230L/2635/2950/3000 (all at FP-POS=3). The visits executed on January, May, and September 2011.

Summary of Analysis
For spectra that overlap with STIS E230M data of HD6655, shifts between the COS and STIS data were measured for each setting and epoch. These are given in Table 1. For settings that have no overlap with the STIS E230M data shifts were measured relative to the first epoch of this monitoring program. These are given in Table 2.

Accuracy Achieved
The COS specifications for NUV wavelength accuracies are 1.7 – 2.4 pix for G185M, 2.3 – 3.2 pix for G225M, 2.3 – 3.5 pix for G285M, and 2.0 – 3.7 pix for G230L. The results given in Table 1 seem to indicate that there is a systematic offset, of 1 to ~ 4 pix between the zero point of the COS/NUV and STIS/E230M wavelength scales. There are in addition small variations of the zero point of the COS wavelength scale, which are within the accuracies given above. NUV wavelength monitoring data obtained in Cycles 17, 18, and 19 should be analyzed together to determine if this systematic offset is real and if so the wavelength calibration reference file should be updated accordingly.

Reference Files Delivered
N/A

Relevant ISRs
No ISRs were published.

Continuation Plans
Program was continued in Cycle 19 under PID 12722 with 3 monitoring visits. Each visit is 1 orbit.

Supporting Details
See Tables 1 and 2 on the next page.

Table 1. Offsets in pixels between the COS/NUV spectra of HD 6655, for some of the settings used in the NUV wavelength monitoring program, and the STIS E230M spectrum of the same target. For G230L spectra, stripe C contains mostly second order light; while stripe A covers wavelengths shorter than ~ 2100 Å. For both of these stripes there is no overlap with the wavelength range of the STIS E230M data. The same applies to stripes A and B of G225M/2217 and all the stripes of G185M/2410.

Visit	Stripe	G225M	G285M	G230L	G230L	G230L
		2217	2676	2635	2950	3000
Vis 01	A	…	-2.5	…	…	…
Jan 9 2011	B	…	-2.0	-1.0	-3.0	-1.0
	C	-3.5	-2.5	…	…	…
Vis 02	A	…	-3.0	…	…	…
May 2 2011	B	…	-3.0	-1.0	-2.5	-1.0
	C	-6.0	-4.0	…	…	…
Vis 03	A	…	-2.5	…	…	…
Sep 1 2011	B	…	-2.0	-1.0	-3.0	-1.0
	C	-3.5	-2.0	…	…	…

Table 2. Offsets in pixels between the COS/NUV spectra of HD 6655 obtained in visits 02 and 03 of program 12422 and that obtained in visit 01 for settings that do not overlap with STIS/E230M data. Offsets for stripe B of G230L are included here for completeness.
[1] due to low S/N and lack of features cannot determine shift between visits.
[2] very low sensitivity at the wavelengths seen by these settings

Visit	Stripe	G185M	G225M	G230L	G230L	G230L
		2010	2217	2635	2950	3000
Vis 02	A	…[1]	-1.5	…[2]	…[1]	…[1]
May 2 2011	B	-1.5	-1.5	0	+0.5	0
	C	-1.5	-2.5	…[1]	…[1]	…[1]
Vis 03	A	…[1]	0	…[1]	…[1]	…[1]
Sep 1 2011	B	0	0	0	0	0
	C	0	0	…[1]	…[1]	…[1]

Proposal ID 12430: COS NUV Detector Recovery after Anomalous Shutdown (PI: Thomas Wheeler)

Analysis Lead, Others: Thomas Wheeler, backup: Chris Long, Alan Welty

Summary of Goals
The goal is to verify that the detector has not been damaged and is returned to science operations in safe and orderly manner after an anomalous HV shutdown. The recovery procedure consists of three separate tests (i.e. visits) to check the NUV MAMA's health; they must be completed successfully and in order. Diagnostic time-tag images are obtained in tests 2 and 3. This proposal executes the same tests as Cycle 17 proposal 11892. The tests are:

1. Signal processing electronics check
2. Slow, intermediate voltage high-voltage ramp-up where the MCP HV is slow-ramped to a voltage 300 V below nominal
3. Ramp-up to full operating voltage.

This is followed by a fold analysis test. See COS TIR 2010-01(v1).

Execution
This is a contingency proposal only used in the event of an anomalous HV shutdown. No such event occurred during Cycle 18.

Summary of Analysis
The analysis is divided into three parts with each part supporting one of the defined activities described above:

1. Signal processing electronics check. This is the first test of three to recovering the MAMA detector. The purpose is to check out the low voltage power supply and the signal processing chain. An Excel workbook of all the engineering telemetry mnemonics to be examined (voltage, currents, temperatures), the expected values, and the allowable tolerances will be created. A pass/fail column will be defined. Engineering data will be placed into the workbook and compared to expected values.

Next the charge amplifier threshold voltage will be reduced from its nominal value of 0.48 volts to 0.28 volts. This will allow electronic noise to pass through the charge amplifiers and generate events. The number of OR events per seconds will be compared to the expected number +/- a tolerance for a given MAMA tube temperature.

The pass criteria for this test are that engineering telemetry and the expected number of OR counts are within expected values, and no hot spots or unusual features are observed in the science images.

2. The first high voltage ramp-up will be to an intermediate MCP voltage of 300V below the nominal MCP voltage with plateaus. This voltage ramp-up is to condition the high

voltage power supply and the MCP. All the engineering telemetry described in step one will be re-examined along with the MCP voltage and current. The MCP voltage +/- a tolerance should be the commanded voltage and the MCP current +/- a tolerance should fit the MCP current model.
The pass criteria for this test are that the engineering telemetry is within expected values and no hot spots or unusual features are observed in the diagnostic science images.

3. The final high voltage ramp-up is to the nominal MCP voltage with voltage plateaus followed by a fold distribution test. This is the last high voltage ramp-up to condition the high voltage power supply and the MCP. All the engineering telemetry described in step one will be re-examined along with the MCP voltage and current. The MCP voltage +/- a tolerance should be the commanded voltage and the MCP current +/- a tolerance should fit the MCP current model.

When the MCP successfully reaches the nominal value, a fold test will be performed. This data will be processed using the "standard fold test analysis tool". The results will be compared to previous fold test results.

The pass criteria for this test are that the engineering telemetry is within tolerance, no hot spots or unusual features are observed in the diagnostic science images and the fold test yields the expected results and show no significant degradation when compared to previous fold tests.

Accuracy Achieved
N/A

Reference Files Delivered
N/A

Relevant ISRs
If an anomalous HV shutdown were to occur, this would be reported in a TIR.

Continuation Plans
This is a contingency proposal. A duplicate proposal was created for Cycle 19. The proposal ID is 12724.

Supporting Details
All relevant turn-on telemetry data would be entered into an Excel similar to that done for SMOV4 if this proposal were to be executed.

<u>Proposal ID 12423: FUV Detector Dark Monitor (PI: Wei Zheng)</u>

Analysis Lead, Others: Colin Cox, Justin Ely, David Sahnow, Charles Proffitt, Rachel Osten

Summary of Goals:
Routine monitoring of the COS FUV XDL detector dark rate to track on-orbit time dependence, measure spatial dependence and check for any developing detector problem. Study the effects of SAA passage on dark rate.

Execution
Every two weeks 5 22-minute exposures were taken for a total of 130 orbits.
All were successful with the exception of two lost visits on Sept 27th 2011 due to an HST problem.

Summary of Analysis
After screening for SAA passages, the dark rate of each observation was measured from a region that excluded the noisy edges of the active area. Dark rates were collected both vs time and orbital position, and summed darks for each visit were constructed from all non-SAA impacted events. Analysis of summed dark exposures determined that count rates were too low to provide meaningful superdark reference frames. The overall trend of the dark rate also appears to be increasing with time on Segment A, but remaining approximately constant on Segment B. The scatter towards high values on both segments seems to be correlated to the solar cycle.

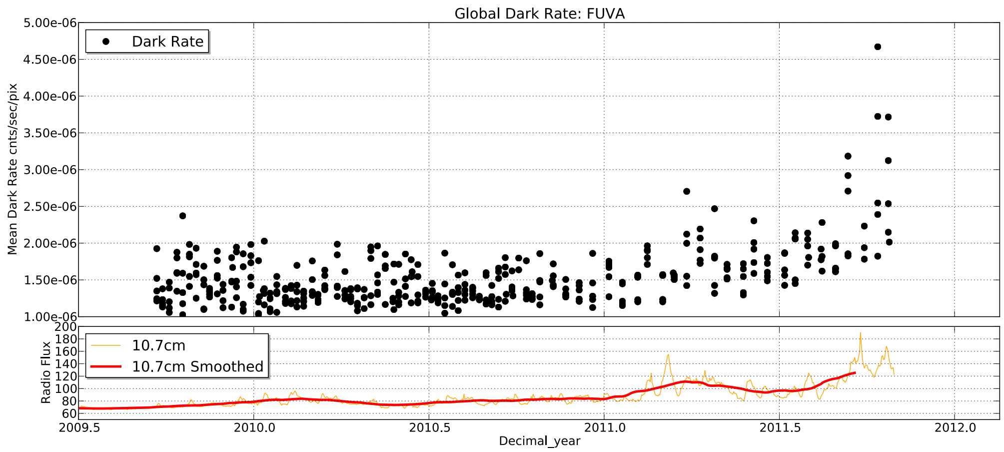
Accuracy Achieved
Extremely low rates of ~2.0×10^{-6} counts per pixel per second are found over the cycle. Analysis of the 5 dark frames taken every other week gave a mean deviation in the observed dark rate of ~4×10^{-7} , which indicates that the dark rate can vary by as much as 20% at any given time.

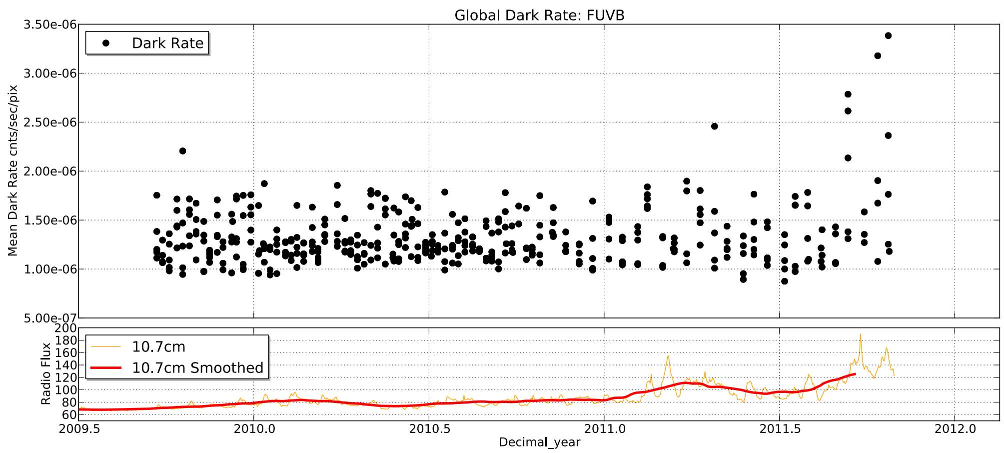
Reference Files Delivered
None. Rates are too low to supply a useful 2-D image.
Analysis is continuing to make a suitably smoothed 1-D file.

Relevant ISRs
ISR 2010-11, "COS FUV Detector Dark Rates During SMOV and Cycle 17", Sahnow et al. Although this refers to Cycle 17 it describes the effects which continue in Cycle 18.

Continuation Plans
Program continued in Cycle 19 as proposal 12716 with PI Colin Cox and Co I Justin Ely.

Supporting Details


Global Dark Rate: FUVA
Dark Rate
Mean Dark Rate cnts/sec/pix
Radio Flux
10.7cm
10.7cm Smoothed
Decimal_year


Global Dark Rate: FUVB
Dark Rate
Mean Dark Rate cnts/sec/pix
Radio Flux
10.7cm
10.7cm Smoothed
Decimal_year

Proposal ID 12424: COS FUV Spectroscopic Sensitivity Monitoring (PI: R. Osten)

Analysis Lead, Others: Rachel Osten, Alessandra Aloisi, Tony Keyes, Dave Sahnow

Summary of Goals

Monitor the sensitivity of each FUV grating mode to detect any changes due to contamination or other causes. Characterize these changes as a function of wavelength, grating, and segment, and update the time-dependent sensitivity reference file, if necessary, for use with pipeline flux calibration. Due to differences in spectral energy distributions, two spectrophotometric white dwarf standard star targets are needed to cover the G130M+G140L (WD0947+857) and G160M (WD1057+719).

Execution

A total of 34 orbits was allocated to this program. The program consisted of monthly monitoring of the spectroscopic sensitivity. Visit 23, a G160M monitoring visit, failed due to an on-board attitude determination (OBAD) problem, and was repeated as visit 33. The next visit of the G160M monitoring, visit 24, had a guide star re-acquisition failure and the final spectrum (G160M/1623) was lost. This visit was not repeated, since two spectra were obtained without incident. Visit 29 was withdrawn as its timing overlapped with the Cycle 19 version of this program.

Summary of Analysis

The computation of time-dependent sensitivities for COS FUV data is described in Osten et al. (2010; COS ISR 2010-15) and Osten et al. (2011; COS ISR 2011-02). Continued monitoring of the FUV channel in Cycle 18 revealed the existence of a second break in the time-dependent sensitivity trends around 2011.2 (mid-March 2011). The figure depicts the wavelength-dependence of the rates of sensitivity decline seen between 2010.2-2011.2, and from 2011.2 until the end of the Cycle 18 program. For the time interval between 2010.2, the time of the first break, and the second break in 2011.2, the sensitivity trends were nearly wavelength-independent, with rates of decline between 2 and 5%/year for all FUV gratings with sufficient signal to characterize. From 2011.2 until the end of the Cycle 18 program in September 2011, the third trend is characterized by an increase in the rates of decline at long wavelengths, reaching 7-10% per year degradation at the longest wavelengths. Later analysis suggests that this third trend may be related to an increase in atmospheric oxygen at the altitude of HST's orbit due to increasing solar activity.

Accuracy Achieved

The accuracy goals of the program were to achieve a SNR of 30 per resel at the central wavelength. This was achieved.

Reference Files Delivered

Time Dependent Sensitivity Tables were delivered as v3i16155l_tds.fits on 03/18/2011, and w7h1935dl_tds.fits on 06/17/2012.

Relevant ISRs

ISR 2011-02 (Osten et al. 2011, "Updated Results from the COS Spectroscopic Sensitivity Monitoring Program") includes the results of this program up through the end of December 2010. The further behavior of the FUV gratings will be discussed in an ISR in preparation on COS spectroscopic sensitivity trends.

Continuation Plans

The program continued in Cycle 19 as 12715.

Supporting Details

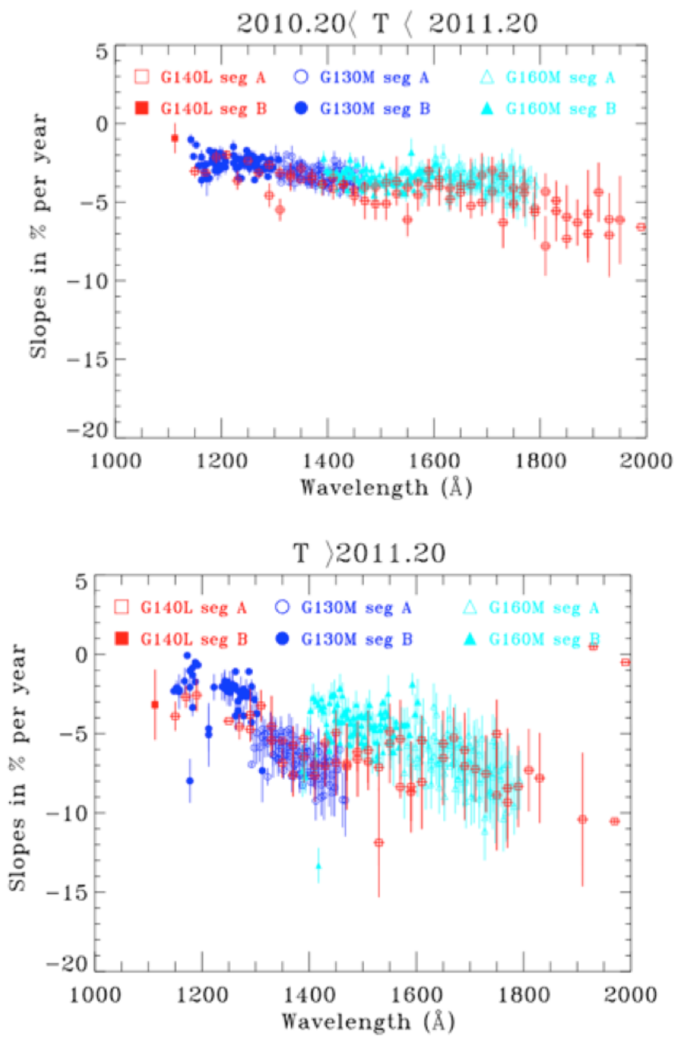


Figure 1. Summary of the wavelength dependence of the rates of sensitivity decline for all FUV gratings during the interval 2010.2-2011.2 (top plot) and 2011.2 to the end of the cycle 18 program (Sept. 11, 2011; bottom plot). Gratings and segments are indicated in the legend.

Proposal ID 12425: COS FUV Internal/External Wavelength Scale Monitor (PI: Cristina Oliveira)

Analysis Lead, Others: Cristina Oliveira

Summary of Goals
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 on orbit: $(\text{WCA - PSA})_{\text{TV03}}$ - $(\text{WCA - PSA})_{\text{orbit}}$. Analysis of TV data indicates that this DELTA (offset) is cenwave and FPPOS independent for a particular grating, but it is grating and stripe dependent. To verify and monitor this, this program observes some cenwaves at different FPPOS.

Execution
Visits 01, 02, and 03 monitored the wavelength scales of the G130M and G160M gratings with SK 191, while visits 04, 05, and 06 monitored the wavelength scale of the G140L grating with NGC330-B37 (CL NGC 330 ELS 4). Visits for the M and L gratings were executed in January, May, and August 2011 (each visit is one orbit).

Summary of Analysis
The centroids of several ISM lines were measured (see Table 1), by fitting gaussians to the absorption profiles, for the COS exposures obtained at different epochs. The centroids of the same absorption lines were measured in STIS E140M data, and the offsets between centroids, in pixels, were determined. These are presented in Figures 1 through 8 below.

Although the number and distribution in wavelength space of absorption lines available for this study is not optimal, the plots below show that there are no systematic offsets of the wavelength scales and that the offsets are within the 1σ error goals for the COS/FUV wavelength scales, of 5.7-7.5 pix for G130M, 5.8-7.2 pix for G160M, and 7.5-12.5 pix for G140L.

Accuracy Achieved
The offsets are within the 1σ error goals for the COS/FUV wavelength scales, of 5.7-7.5 pix for G130M, 5.8-7.2 pix for G160M, and 7.5-12.5 pix for G140L.

Reference Files Delivered
N/A

Relevant ISRs
No ISRs were published

Continuation Plans

Program was continued on Cycle 19 under PID 12717, with one monitoring visit for G130M+G160M and another for G140L for a total of 2 orbits.

Supporting Details

Target	Grating	l (Å)	l (Å)	l (Å)	l (Å)	l (Å)	l (Å)	l (Å)
SK 191	G130M	1250.6309	1251.2095	1253.8602	1254.4357	1259.5661	1302.8152	1305.0165
SK 191	G160M	1527.4736	1548.2266	1550.7693	1608.4882	1609.2367	1670.7970	1671.5944
NGC330-B37	G140L	1176.20137	1260.5263	1335.4060	1393.4706	1402.6293	1527.2227	1671.3402

Table 1. Wavelengths of the ISM lines, as measured from STIS E140M data, used to determine the offsets of the same lines in the COS FUV data.

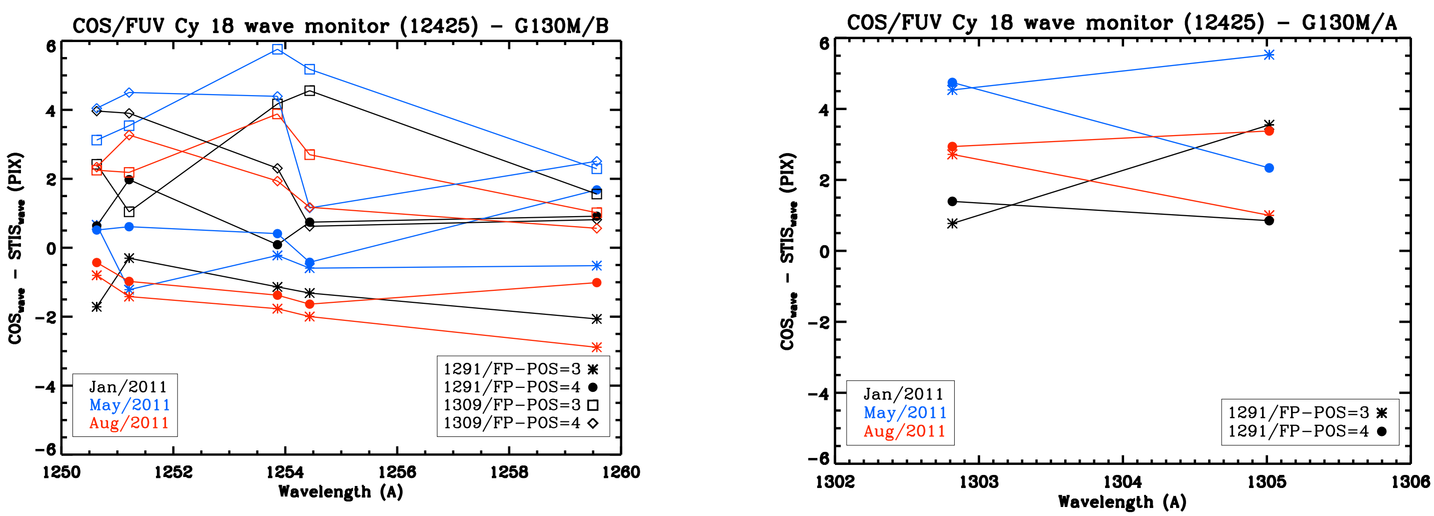


Figure 1. Offsets between absorption features seen by COS and STIS E140M, in three different epochs in 2011. The target observed is SK 191. *Left*: G130M, segment B, for the 1291 and 1309 cenwaves. *Right*: Same, for segment A.

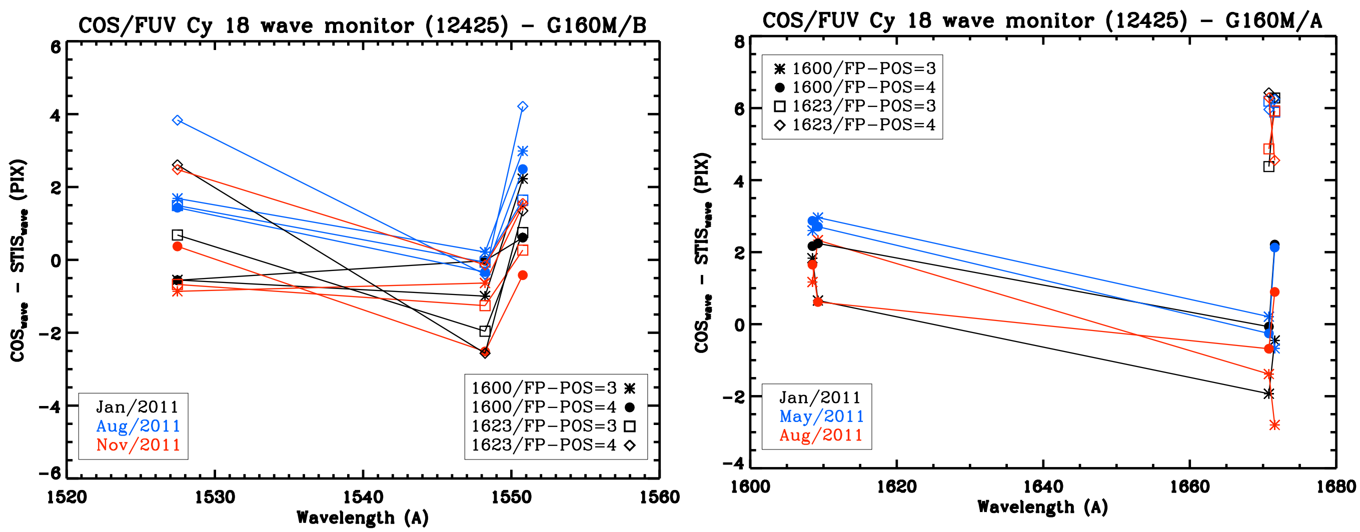


Figure 2. Offsets between absorption features seen by COS and STIS E140M, in three different epochs in 2011. The target observed is SK 191. *Left*: G160M, segment B, for the 1600, and 1623 cenwaves. *Right*: Same, for segment A.

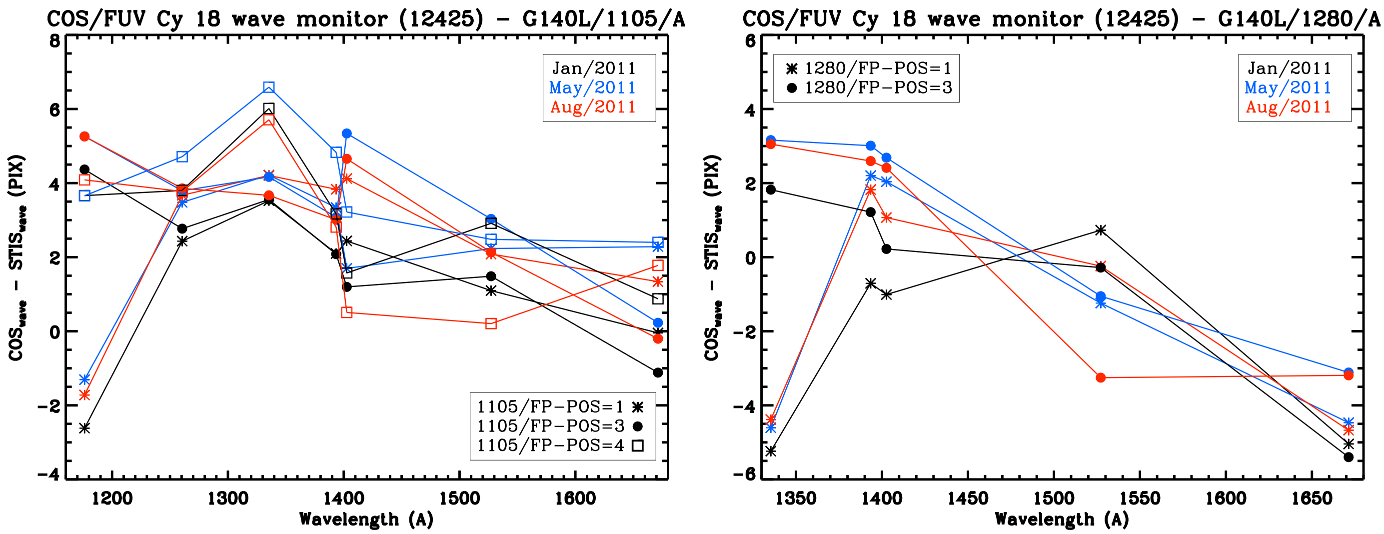


Figure 3. Offsets between absorption features seen by COS and STIS E140M, in three different epochs in 2011. The target observed is NGC330-B37. *Left*: G140L, segment A, for the 1105 cenwave. *Right*: Same, but for the 1280 cenwave.

Proposal ID 12431: COS FUV Recovery after Anomalous Shutdown (PI: Thomas Wheeler)

Analysis Lead, Others: Thomas Wheeler, J. McPhate (UC Berkeley), J. Bacinski, A. Welty, D. Sahnow

Summary of Goals
The goal is to verify that the detector has not been damaged and is returned to operations in safe and orderly manner after an anomalous HV shutdown. The recovery procedure is divided into two distinct parts with Part 1 consisting of a slow HV ramp-up with diagnostics and darks and Part 2 consists of a normal ramp-up with diagnostics and darks. Each part must be completed successfully and in order. This is based on Cycle 17, proposal 11893.

Execution
This is a contingency proposal only used in the event of an anomalous HV shutdown. No such events occurred during Cycle 18.

Summary of Analysis
The recovery procedure is divided into two distinct parts with Part 1 consisting of a slow HV ramp-up with diagnostics and darks, followed by a ramp-down, HV off, and setting of event Flag 3 (a NSSC-1 flag to protect from inadvertent ramp-ups). Time is allotted for cognitive UC Berkeley, COS Instrument Scientist, and engineering to examine data dumps, science exposures, and housekeeping telemetry. If all is well, the go-ahead will be given to clear Flag 3 and proceed with the second HV ramp-up.

Part 2 consists of a normal ramp-up with diagnostics and darks, followed by a ramp-down, HV off, and setting Flag 3. Again, UC Berkeley, COS Instrument Scientist, and engineering will examine data dumps, science exposures, and housekeeping telemetry. If all is well, the go-ahead will be given to clear Flag 3 and proceed with normal FUV science programs.

Prior to the beginning of Visit 1, Flag 3 must be cleared by the ground via real-time commanding. This can be done as soon as the anomalous HV shutdown is understood and the go-ahead is given to proceed with the recovery.
An outline of the activities follows. Each numbered item corresponds to a visit.

1. Uninhibit the DCE. (Set dce_FUVInhibitMode = FALSE and do other CS cleanup), take diagnostic data (DCE RAM dump), and transition the detector from Boot to Operate. (Boot will be the state of the detector after it is Inhibited.) Special commanding is used to uninhibit the DCE and to dump the DCE RAM. Regular recon commanding is used for the Boot to Operate transition.

2. Turn on the FUV HV and ramp to HVLOW. Special commanding will be used to execute the FUV Operate to HVLOW recon. Diagnostics are taken (DCE RAM dumps) after each transition.

3. Take a 1-hour dark exposure followed by diagnostics (DCE RAM dump).

4. Ramp the HV from HVLOW to HVNOM for each segment (169,167) during a 1080.0 second DARK exposure. Take diagnostics (DCE RAM dumps) after.

5. Take a 2nd 1-hour dark exposure followed by diagnostics (DCE RAM dump).

6. Ramp the HV down, turn it off, and set Flag 3.

At this point, UC Berkeley, COS Instrument Scientist, and engineering will examine data dumps, science exposures, and housekeeping telemetry. If all is well, this time the go-ahead will be given to proceed with the Part 2. A requirement is that diagnostic and science data is fast-tracked to the Science Team.

7. Take diagnostics (DCE RAM dumps). The ground must clear Flag 3 before the next step of Visit 12.

8. Turn-on the HV and ramp to HVLOW with diagnostics (DCE RAM dumps).

9. Take a 1-hour dark exposure followed by diagnostics (DCE RAM dump).

10. Ramp the HV from HVLOW to HVNOM (nominal value for each segment 169,167) during a 1000.0 second DARK exposure. Take diagnostics (DCE RAM dumps) after.

11. Take a 2nd 1-hour dark exposure followed by diagnostics (DCE RAM dump).

12. Ramp the HV down, turn it off, and set Flag 3.

UC Berkeley, COS Instrument Scientist, and engineering will again examine data dumps, science exposures, and housekeeping telemetry. If all is well, this time the go-ahead will be given to clear Flag 3 and proceed with normal FUV science. It is requested that diagnostic and science data be fast-tracked to the Science Team. No FUV activities will be scheduled within 48 hours of completion to allow for data analysis.

Accuracy Achieved
N/A

Reference Files Delivered
N/A

Relevant ISRs
N/A

Continuation Plans

This is a contingency proposal. A duplicate proposal was created for Cycle 19. The proposal ID is 12718.

Supporting Details

Relevant figures, tables, and plots would be provided after detector recovery if this proposal were executed.

Proposal ID 12414: MAMA Spectroscopic Sensitivity and Focus Monitor Cycle 18
AKA: COS Observations of Geocoronal Lyman-Alpha Emission (PI: Osten)

Analysis Lead, Others: K. Azalee Bostroem

Summary of Goals
Monitor sensitivity of each MAMA grating mode to detect any change due to contamination or other causes. Also, monitor the STIS focus in spectroscopic and imaging modes.
Whenever possible, obtain parallel airglow spectra with COS.

Execution
Due to observing constraints the COS parallel observations were only executed on the E* visits of this program.
Visits executed on the following dates:
E1: November 20, 2010
E2: January 17, 2011
E3: May 15, 2011
E4: August 13, 2011

There were no missed visits or anomalies. This program originally used the 1309 central wavelength of the G130M grating. This central wavelength put the OI airglow line in the gap between segment A and segment B. For this reason, the central wavelength was changed for the E3 visit to 1291.

Summary of Analysis
These observations are posted on the COS airglow web site for GO use.

Accuracy Achieved
Analysis did not yield accuracy estimates.

Reference Files Delivered
None

Continuation Plans:
This program continued in Cycle 19 as proposal ID 12775 using the 1291 central wavelength setting for all G130M observations.

Supporting Details:
None

Proposal ID 12426: FUV Sensitivity Characterization (PI: Massa)

Analysis Lead, Others: Derck Massa, Justin Ely

Summary of Goals

To fully characterize the flux calibration, we require high S/N spectra at each CENWAVE setting at the same time. This, in turn, requires spectra with S/N greater than about 10 per pixel (or 25 per resolution element) at each of the 4 FP-POS settings so that a high S/N spectrum that is free of flat field effects can be derived. For the standard stars available, this requires 1 orbit per CENWAVE setting, or 10 orbits in all. We cannot adopt brighter standards, since then we would be forced to either:

1. use the ACCUM mode, or;
2. use the time tag mode and accept that some counts will be lost because the electronics cannot keep up with the count rate.

In the first case, the PHA information needed to calibrate time-tagged data (which are PHA filtered) is lost. In the second case, it seems unwise to pin a precise flux calibration on data which require an additional level of assumptions (i.e., that the missed counts are randomly distributed in position and that the detector remains linear in the high count rate regime) compared to typical data. Although we do have recent high S/N standard star data for 2 G160M CENWAVE settings, it is best to obtain all of the flux calibration at the same epoch, since the instrumental sensitivity is time dependent. Finally, although these data will have about half the counts of the flat-field data, they will be adequate to examine the time dependence of the COS flat fields. This is very important since we have already detected differences between the flats derived from program 12086, FUV Sensitivity Characterization, in Cycle 17 and those derived from the SMOV data high S/N program 11494 obtained 11 months earlier as a result of gain sag.

Execution

All data were obtained and found to be of expected quality.

Summary of Analysis

After this program was executed, absolute flux calibration was determined to be low priority and all work was halted. However, plans to move to a new lifetime position have created renewed interest in these data. The data were used to create two short notes. One describes a peculiar feature in the G130M response near 1180Å, which changes magnitude and location with grating angle. The other quantifies how the response at the same wavelength changes with CENWAVE setting. It shows that this can be as large as 15% across a 110Å wavelength range common to the longest and shortest CENWAVE settings for both G130M and G160M FUVA spectra. These changes appear to arise from variations in the FUVA detector response.

Accuracy Achieved

Achieved expected S/N (10/pixel or 25/resel)

Reference Files Delivered
No files delivered.

Relevant ISRs
No ISRs have been published yet using these data.
The research reports cited above are:
Massa, D. 2011, "The COS G130M feature near 1180 Å",
http://www.stsci.edu/institute/org/ins/cos_stis/internal/Documents/prelim_reports/g130m_feature.pdf
Massa, D. 2012, "CENWAVE Dependent Response",
http://www.stsci.edu/institute/org/ins/cos_stis/internal/Documents/prelim_reports/cenwave.pdf

Continuation Plans
This program was not continued in Cycle 19, but a similar program was carried out at the new lifetime position executing in Cycle 19.

Supporting Details
The following figures show the CENWAVE dependent response for G160M FUVA spectra.

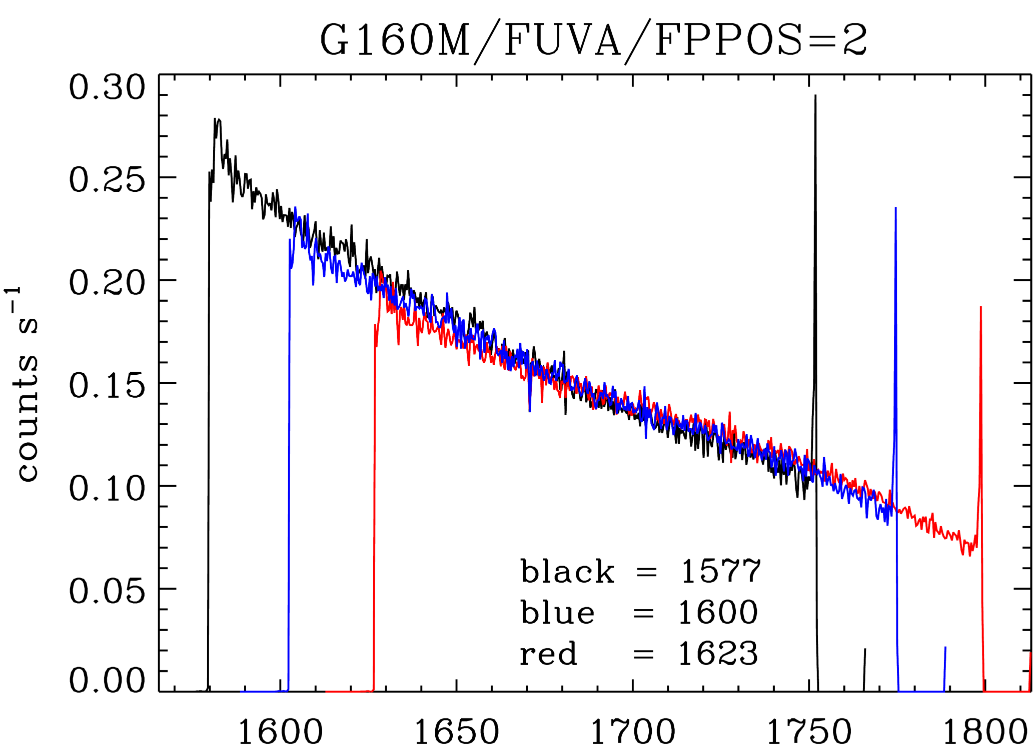


Figure 1. G160M FUVA NET spectra of WD1057+719 and the wavelength overlap of the CENWAVE = 1577, 1600 and 1623 settings.

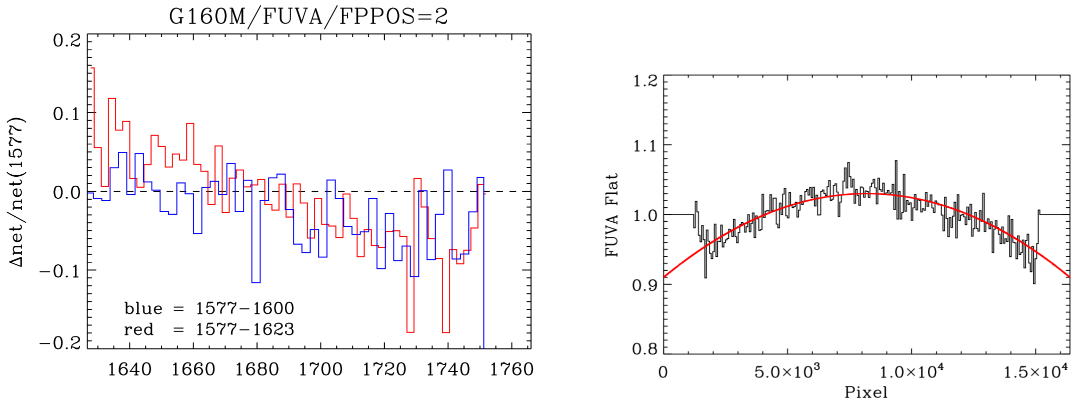


Figure 2. (Left) ratios of the difference between the 1577 spectrum and the two longer wavelength spectra divided by the 1577 spectrum. Both ratios have a distinct slope, which is steeper for the 1623 data. The FUVA G130M data behave similarly, suggesting the effect is due to the FUVA detector. (Right) the L-flat derived from the data. Application of this flat removes the CENWAVE-dependent response for FUVA spectra.

Proposal ID 12432: COS FUV Detector Gain Sag vs. High Voltage (PI: Sahnow)

Analysis Lead, Others: David Sahnow, Rachel Osten, Charles Proffitt, Derck Massa, Alan Welty, Jason McPhate (UC Berkely), Cristina Oliveira

Summary of Goals
The purpose of this program was to determine how much the FUV detector gain increased when the commanded high voltage was raised back to the original on-orbit values (178 for Segment A and 175 for B) from the then-nominal values of 169 and 167. The spectrum of a standard star (WD1057+719) was obtained with the G160M/1577 setting, along with dark exposures.

Execution
Executed without any problems on 21 December 2010.

Summary of Analysis
The modal gain of both segments increased by about 3 pulse height bins when the voltage was raised. Calculations showed that the life of the detector could be extended by 7 – 12 months by permanently raising the voltage.

The flat field at the two voltage levels was compared, and found to be the same except where gain sag was a problem.

The detector dark rate was compared at the two voltages, and found to increase by less than 10% when the voltage was increased.

The sensitivity was unchanged with the change in voltage, as long as the lower pulse height threshold was set at 2

Accuracy Achieved
N/A

Reference Files Delivered
No reference files.

Relevant ISRs
None.

Continuation Plans
Based on the analysis of the data from this program, the high voltage on Segment B was increased to 175 in March 2011. The Segment A voltage was increased in March 2012 to 178.

Supporting Details
Figure 1 on the next page shows the effect of raising the high voltage on Segment B.

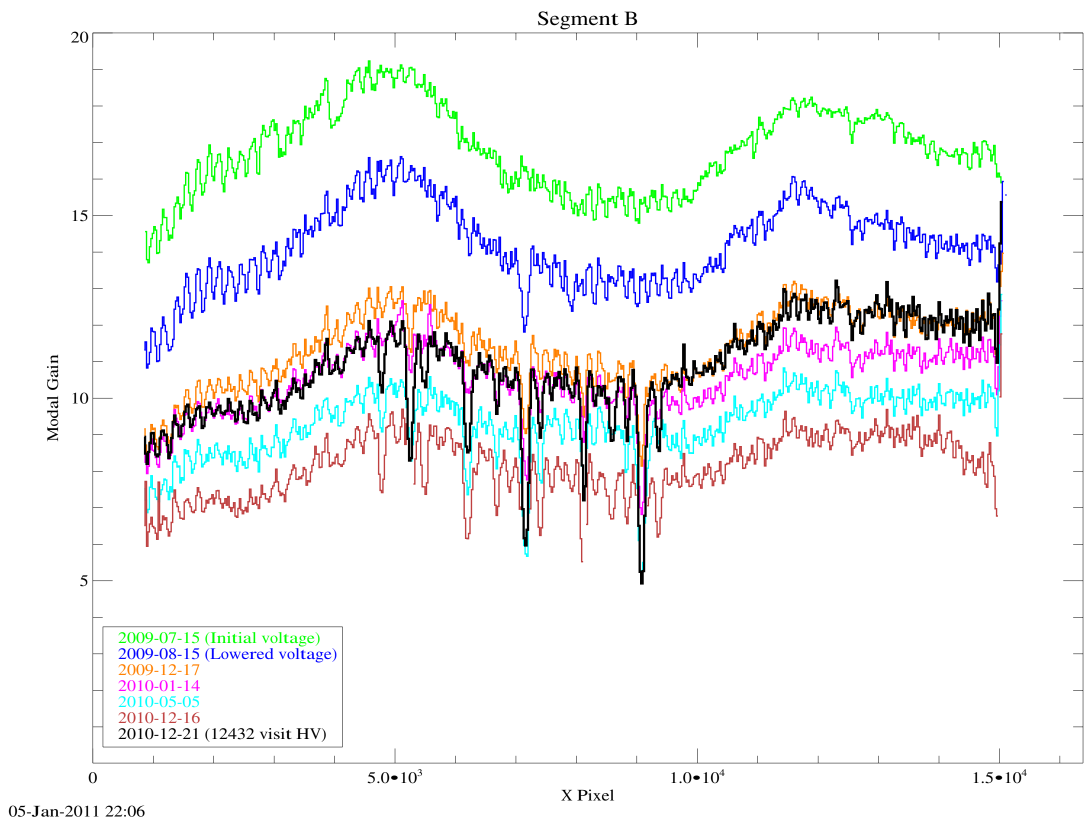


Figure 1. The modal gain as a function of x pixel in the most illuminated Y region of the detector is plotted at several epochs. Just after FUV detector turn on, in July 2009, the modal gain peaks at ~19 (green). In August 2009 the voltage was lowered to 169/167 (SegmentA/SegmentB), and the gain decreased to approximately the level measured on the ground (blue). The gain decreased through 2009 and 2010 as it was further exposed to photons, and gain sag holes appeared at the Lyman-alpha positions (orange, pink, turquoise, brown). When the voltage was increased in this program (black), the gain in the continuum region returned to the value seen approximately one year earlier, while the holes recovered about seven months of life.

<u>Proposal ID 12676: COS/FUV Characterization of Detector Effects (PI: Massa)</u>

Analysis Lead, Others: Derck Massa, Dave Sahnow, Cristina Oliveira

Summary of Goals

This program examines the two COS FUV detectors in order to find the best lifetime locations for the first change in lifetime position and all subsequent moves. The objective is to determine which regions of the detector are least affected by dead spots, fixed pattern noise and low gain regions. This is determined by exposing the active area which can be used for science (and accessed by the deuterium lamp) to the deuterium lamp through the FCA. This requires moving the FCA in Y to locations that will expose as much of the detectors as possible. Because the energy distribution of the deuterium lamp is strongly peaked at intermediate wavelengths, to uniformly illuminate an entire detector segment it is necessary to use the G130M for the FUVA and the G160M for the FUVB.

Execution

These were all internal visits. Positioning on the detector and count rates were as expected, except that there was some vignetting of the deuterium source at the extreme positions -- an effect that should have been anticipated.

Summary of Analysis

This program was part of the exploratory observations for the new COS FUV lifetime position. The data were used to construct a gain map covering nearly all of the useable detector, and to locate dead spots and other detector flaws. The gain map was used to create a model for how PHAs evolve with usage at the current location and to explore how far the new lifetime location must be from the current location in order to avoid being compromised by the damage already done at the current location.

Accuracy Achieved

The S/N of this program was set by the goal to simulate 1-D templates for each grating. To produce a reasonable 1-D template using the iterative approach, exposures at all 4 FPPOS with a S/N of roughly 10/1 in each collapsed X pixel are required. Since the G160M has the narrowest (in Y) cross-dispersion profile, the S/N requirement was to achieve a S/N of 10/1 at an X pixel summed over 10 Y pixels, or about 10 counts for each individual pixel. This objective was obtained by the observations for effectively all X FUVB pixels and for about 85% of the FUVA X pixels (see Figure 1 on the next page).

Reference Files Delivered

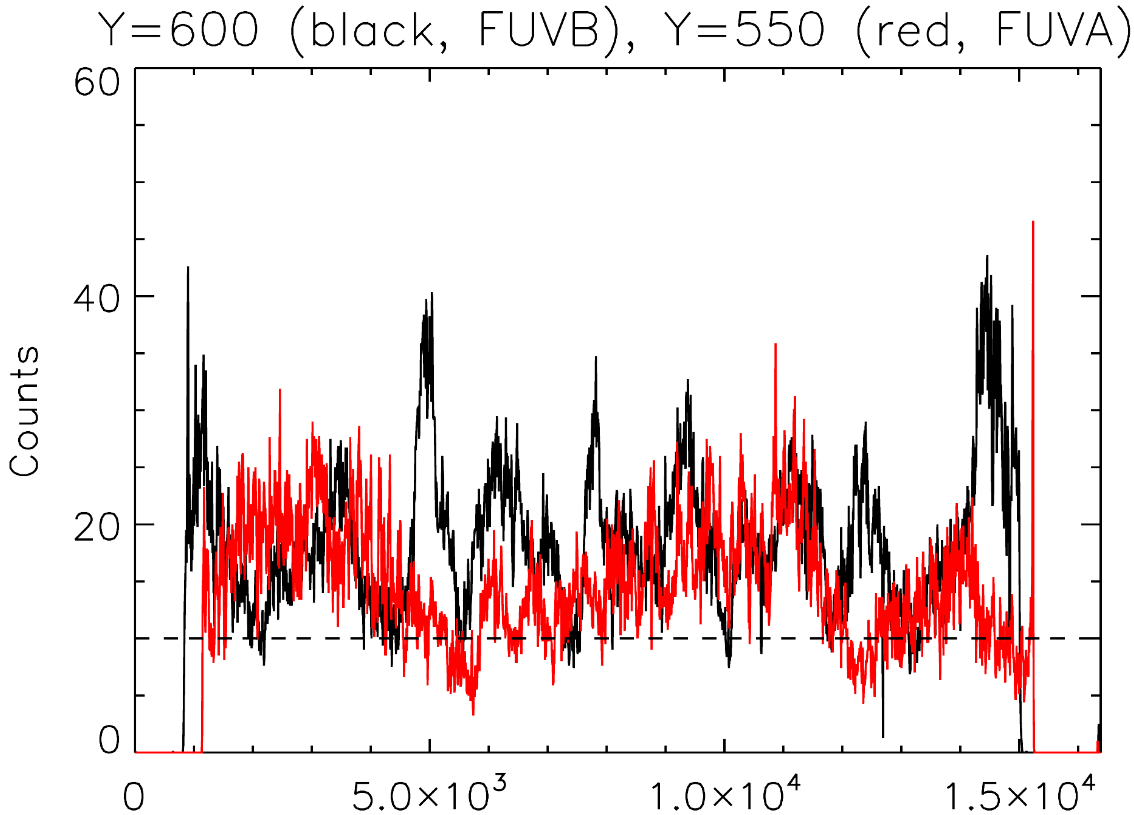
No reference files were generated.

Relevant ISRs

There will be an ISR describing this program by Massa et al. as part of the set which describe how the COS team determined the new lifetime location for COS FUV operations.

Continuation Plans
This is a one-time program.

Supporting Details
See the figure below.



Total counts in a single row from images formed by the sum of all the G130M FUVA observations and all G160M FUVB observations from program 12676. The rows are Y = 600 for FUVB (black) and Y = 550 for FUVA (red).

Proposal ID 12677: COS/FUV Mapping of Stray PtNe Lamp Light Through FCA (PI: Oliveira)

Analysis Lead, Others: Cristina Oliveira, Alessandra Aloisi, Charles Proffitt, Dave Sahnow, Derck Massa, Steven Penton, Steven Osterman

Summary of Goals

This program determined which cross-dispersion locations lead to wavecal lamp (PtNe) light leaking through the flat-field calibration aperture (FCA) in the FUV. This unexpected effect, observed initially in program 12096, led to a shut down of the COS/FUV detector due to a global count rate violation in Segment A of the G140L/1230 setting. Detector threshold is 600,000 FEC counts in 10 seconds on each segment. If this level is exceeded, the detector shuts down the HV.

In program 12096, for the G140L/1230 setting, at +6" from the nominal position in the cross-dispersion direction, 180,000 cts/sec were observed through the FCA in Segment A, and 49,000 cts/sec in Segment B (PtNe/FCA). The corresponding wavecal count rate (PtNe/WCA) is 685 cts/sec in Segment A, implying that there is a scale factor of 263 between the FCA and WCA count rates. This scale factor could not be verified for Segment B, given that the PtNe lamp does not produce counts at the short wavelengths seen by G140L/1230/FUVB. However, this scaling factor is expected to be the same for both segments. The scaling factor derived from program 12096 is then used to predict the FCA count rates seen with all the gratings, in off-nominal positions where light might leak through the FCA in the current program.

There is no light leak between the nominal position and positions up to and including +3" (at least not in Mar 2010 when program 12096 executed), but somewhere above +3", and certainly at +6", the PtNe light starts leaking through the FCA.

Light is not predicted to leak at negative POS-TARG positions from the nominal, and the purpose of this program was to verify that as well. In order to minimize shutdown risk, should a light leak occur, a combination of settings, lamps and currents, and flash times was chosen, to produce worst-case-scenario count rates well below the shutdown limit.

Execution

Visits 1N through 6N took internal wavecal data at positions offset in the cross-dispersion direction, from +1.0” to +6.0”, while visits 1S through 6S took internal wavecal data at positions offset in the cross-dispersion direction by −1.0” to −6.0”. For each of these visits the first exposure in the visit always occurs at the nominal operating position (no cross-dispersion offset) and then the aperture is moved to the cross-dispersion position used for each particular visit. A combination of settings, lamps and currents, and flash times was chosen to produce worse-case-scenario count rates well below the shutdown limit. These are given in Table 1.

Visits 10 through 13 obtained internal wavecal data at the nominal operating position, with no cross-dispersion offsets. Different combinations of settings and flash times were used for these visits. Pt/Ne LAMP1 (default wavecal lamp) as well as Pt/Ne LAMP2 were used with different current values. The purpose of these visits was to determine the ratios of the different lamp settings at different wavelengths, to help analyze the data obtained in visits where only LAMP2 with low current (LAMP2/LOW) is used.

Constraints were placed in the scheduling of the visits so that un-executed visits could be modified without disrupting the schedule if any unexpected overlight conditions were to occur.

Summary of Analysis
A light leak through the FCA was only observed in visit 6N, i.e., at +6.0” from the original operating position. More details on the analysis of the data obtained in this program are given in COS ISR 2013-02.

Accuracy Achieved
N/A

Reference Files Delivered
N/A

Relevant ISRs
An ISR has been published with the detailed analysis of the data obtained on this program (COS ISR 2013-02).

Continuation Plans
This was a special calibration program; no follow up is needed in Cycle 19.

Supporting Details

Setting	Lamp Setting	Flash Duration	Segment A counts (predicted)	Segment B counts (predicted)
G130M/1055/4	LAMP1/MED	10 sec exposure	52,000 total counts	~0 total counts
G130M/1055/4	LAMP2/LOW	10 sec exposure	7,543 total counts	~0 total counts
G130M/1291/3	LAMP2/LOW	8 sec exposure	65,170 total counts	37,413 total counts
G130M/1327/1	LAMP2/LOW	8 sec exposure	65,472 total counts	55,515 total counts
G160M/1577/4	LAMP2/LOW	Two 3 s flash spaced by 11 s	21,273 tot counts in 10 s	64,491 tot counts in 10 s
G160M/1623/1	LAMP2/LOW	Two 3 s flash spaced by 11 s	24,891 tot counts in 10 s	62,229 tot counts in 10 s
G140L/1280/1	LAMP2/LOW	Two 3 s flash spaced by 11 s	55,063 tot counts in 10 s	1,923 tot counts in 10 s
G140L/1105/1	LAMP2/LOW	Two 3 s flash spaced by 11 s	57,175 tot counts in 10 s	~0 tot counts in 10 s

Table 1. Layout of the exposures used in visits 1N through 6N and visits 1S through 6S. Predicted total counts are also given for each of the segments. These are based on the count rate seen in the WCA and scaled by a factor of 263 to account for the FCA. For exposures longer than 10 sec, the total counts are reported over 10 sec only, which is the

interval of time used by the flight software to check for global rate violations. The current setting used with each lamp is indicated after the lamp name.

Proposal ID 12678: COS/FUV Characterization of Optical Effects (PI: Sahnow)

Analysis Lead, Others: David Sahnow, Derck Massa, Justin Ely, Cristina Oliveira, Alessandra Aloisi, Steven Penton, Steven Osterman, Charles Proffitt

Summary of Goals
The purpose of this program was to obtain spectra of an external target at a variety of off-nominal positions in the dispersion and cross-dispersion directions and determine the changes in resolving power as a function of position.

Execution
Visits 01, 02: completed on 14 October 2011
Visit 11: completed on 17 November 2011

Summary of Analysis
The resolution peaks between 0.0” and +2.0” in the dispersion direction. The resolution peaks between 0.0” and +3.0” in the cross-dispersion direction.

Accuracy Achieved
Relative resolutions are determined to better than 8%.

Reference Files Delivered
No reference files created.

Relevant ISRs
None.

Continuation Plans
Based on the analysis of the data from this program and others (primarily 12676 and 12677), the second lifetime position was chosen to be +3.5” (41 pixels) in the cross-dispersion direction from the initial position. This was a one time special calibration program.

Supporting Details
Figure 1 and Table 1 show the measured resolution as a function of cross-dispersion position of the spectrum, assuming a nominal resolution of 19,000. In the table, interpolated values have been included to give more complete coverage. It can be seen that motions in the positive direction lead to a smaller loss of resolution than motions in the negative direction.

Adding offsets in the dispersion direction showed that the resolution at (−3.0”, −3.0”) in (dispersion, cross-dispersion) is worse than that at (0”,−3.0”), and the resolution at (+2.0”,−3.0”) is similar to that at (0”,−3.0”). These measurements are consistent with raytrace models. The final conclusion is that in order to optimize resolution, it is best to move as close as possible to +3.0” in cross-dispersion, with or without a +2.0” dispersion move.

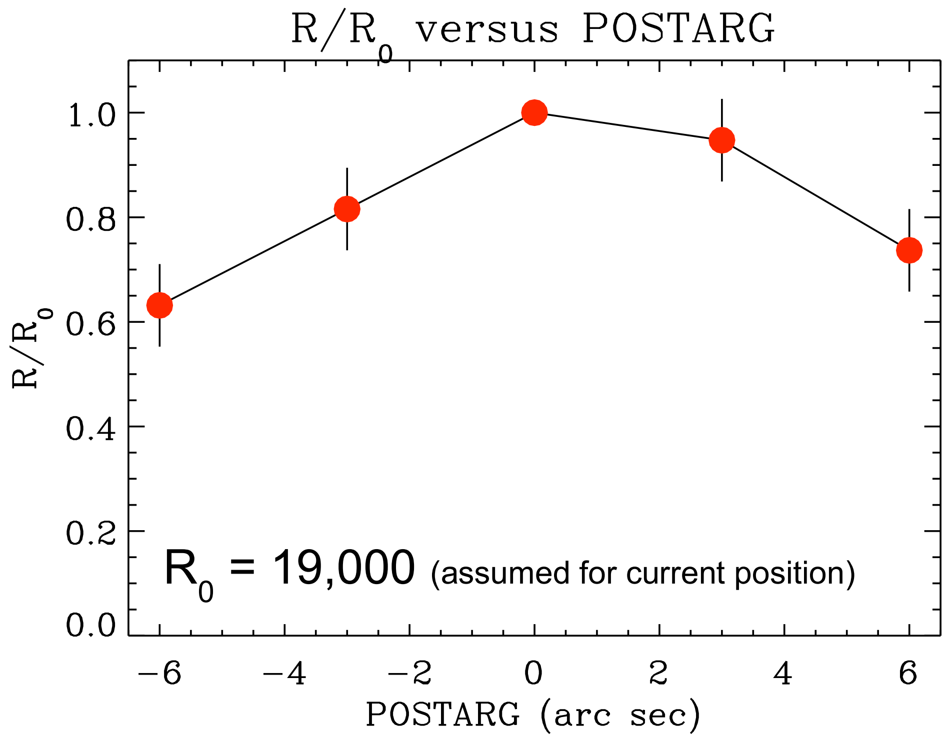


Figure 1. Measured resolution as a function of cross-dispersion position of the spectrum, assuming a nominal resolution of 19,000.

Table 1. Measured resolution as a function of cross-dispersion position of the spectrum, assuming a nominal resolution of 19,000. Interpolated values have been included to give more complete coverage.

X	Y	R	R/R_0
0.0”	-6.0”	12000	0.63
0.0”	-5.0”	13000	0.68
0.0”	-4.0”	14000	0.74
0.0”	-3.5”	14500	0.76
0.0”	-3.0”	15000	0.79
0.0”	0.0”	19000	1
0.0”	+3.0”	18500	0.97
0.0”	+3.5”	17750	0.93
0.0”	+4.0”	17000	0.89
0.0”	+5.0”	15500	0.82
0.0”	+6.0”	14000	0.74

-3.0”	-3.0”	12000	0.63
+2.0”	-3.0”	15000	0.79

4. Change History for COS ISR 2013-04

Version 1: 25 April 2013 - Original Document

5. References

COS IDT, "Cosmic Origins Spectrograph (COS) Science Operations Requirements Document (OP-01)," 1999.

Massa, D. 2011, "The COS G130M feature near 1180 Å", http://www.stsci.edu/institute/org/ins/cos_stis/internal/Documents/prelim_reports/g130m_feature.pdf.

Massa, D. 2012, "CENWAVE Dependent Response", http://www.stsci.edu/institute/org/ins/cos_stis/internal/Documents/prelim_reports/cenwave.pdf.

Osten, R. et al. 2011, "Updated Results from the COS Spectroscopic Sensitivity Monitoring Program", ISR COS 2011-02.

Sahnow, D. et al., "COS FUV Detector Dark Rates During SMOV and Cycle 17", ISR COS 2010-11.

Sahnow, D. et al., "COS NUV Detector Dark Rates During SMOV and Cycle 17", ISR COS 2010-12.

Wheeler, T., & Sahnow, D., "COS SMOV4 NUV MAMA Fold Analysis", TIR COS 2010-01(v1).

6. Appendix

Table 4 lists the COS reference files delivered as part of analysis of data taken in COS Cycle 18 calibration programs. Table 6 lists the Instrument Science Reports and Technical Instrument Reports produced as a result of analysis of Cycle 18 calibration programs.

Table 4. COS Cycle 18 Reference File Deliveries

Reference File	File type	Delivery Date	Contributing Programs
v3i16155l_tds.fits	Time Dependent Sensitivity Table	03/18/2011	11897,12424
w7h1935dl_tds.fits	Time Dependent Sensitivity Table	06/17/2012	11897,12424, 12715

Table 5. Instrument Science Reports & Technical Instrument Reports produced from Cycle 18 Calibration Programs

Number	Contributing Programs	First Author	Title
ISR 2013-01	12796	C. Oliveira	Second COS FUV Lifetime Position Results from the Focus Sweep Enabling Program, FENA3 (12796)
ISR 2013-02	12677	C. Oliveira	COS/FUV Mapping of Stray PtNe Lamp Light Through the FCA
ISR 2013-03	12795	C. Proffitt	Second COS FUV Lifetime Position: Verification of Aperture and FUV Spectrum Placement (FENA2)