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Instrument Science Report COS 2018-06(v1)

Cycle 24 COS FUV Internal/External Wavelength Scale Monitor

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15 February 2018

ABSTRACT

We report on the monitoring of the COS FUV wavelength scale zero-points during Cycle 24 in program 14855. Select cenwaves were monitored for all FUV gratings at Lifetime Position 3. The target and cenwaves have remained the same since Cycle 21, with a change only to the target acquisition sequence. All measured offsets are within the error goals, although the G140L cenwaves show offsets at the short-wavelength end of segment A that are approaching the tolerance. This behavior will be closely monitored in subsequent iterations of the program.

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1. Introduction

This program monitors the offset between the internal and external FUV wavelength scales. This offset is referred to as DELTA in the wavelength dispersion solution reference file and corrects for the shift between the wavelength calibration aperture (WCA) and primary science aperture (PSA) in the 2003 thermal vacuum testing (TV03) versus the shift between the WCA and PSA on orbit: $(WCA - PSA)_{TV03} - (WCA - PSA)_{orbit}$. Analysis of TV03 data indicates that this offset is cenwave and FP-POS independent for a particular grating, but it is grating dependent (Oliveira et al. 2010, ISR 2010-06). To monitor this effect, this calibration program observes the extreme cenwaves for all FUV gratings as well as the G130M “blue modes” at cenwaves 1096 and 1222.

2. Execution

This program comprises one visit of three orbits to monitor the wavelength scales of the following gratings: G130M (cenwaves 1096, 1222, 1291, and 1327), G160M (cenwaves 1577 and 1623), and G140L (cenwaves 1105 and 1280). For the M gratings, two FP-POS settings, either 1 and 3 or 2 and 4, were used to mitigate the effects of gain sag. For G140L, only FP-POS 3 was used. The target was AV 75, a star in the Small Magellanic Cloud of spectral type O5.5I. Visit 01 executed successfully on March 18, 2017.

The program has monitored the same target and cenwaves in each cycle since Cycle 21 (PID 13522), except that the Cycle 22 observations were divided between PIDs 13931 and 13969. Beginning with a repeat visit (V51) in Cycle 23 (PID 14437), the acquisition sequence was changed to ACQ/SEARCH followed by ACQ/IMAGE to avoid previous difficulties.

3. Analysis and Results

For most settings, cross-correlation analysis was performed with archival STIS E140M data and the COS data using known interstellar absorption lines present along the line of sight to AV 75 (see Sonnentrucker et al. 2013, ISR 2013-06). For segment A of cenwave 1096 and segment B of cenwave 1222, which lie below the STIS wavelength range, the analysis was performed against a line-of-sight model. The results of the COS-STIS analysis appear in Table 1. Offsets were also measured relative to the Cycle 23 instance of this program (PID 14437). The results of the COS-COS analysis appear in Table 2. The specifications for FUV wavelength accuracies are 3.0 – 4.0 px for G130M, 3.1 – 3.8 px for G160M, and 4.0 – 6.6 px for G140L (Oliveira et al. 2010, ISR 2010-06). We find that the measured offsets are within the error goals for all observed cenwaves.

Individual lines at the short-wavelength end of segment A in the G140L cenwaves show negative offsets of 3 – 5 px when the Cycle 24 spectra are compared to those of Cycle 23, approaching the tolerance. The cause of this behavior is not understood, but it will be closely monitored in subsequent iterations of the program.

Table 1. Pixel shifts from COS-STIS Cross-correlation¹

Segment	G130M 1096	G130M 1222	G130M 1291	G130M 1327	G160M 1577	G160M 1623	G140L 1105	G140L 1280
A	-0.9 ²	+1.1	-3.4	+1.3	-1.4	... ³	-2.7	-1.4
B	... ³	+2.2 ²	+0.5	-1.0	-0.6	+0.1	... ⁴	... ³

¹Shifts are those required to bring the COS data into agreement with the STIS or model template.

²Due to the lack of STIS coverage, a model was used.

³No STIS or model template is available; the shift is likely similar to that of the other segment.

⁴Data are not collected at this setting.

Table 2. Pixel shifts from COS-COS Cross-correlation (Cycle 24 vs. Cycle 23)¹

Segment	G130M 1096	G130M 1222	G130M 1291	G130M 1327	G160M 1577	G160M 1623	G140L 1105	G140L 1280
A	-0.6	-0.9	0.0	+0.5	-0.7	+2.4	-2.2	-4.0
B	-0.8	-0.4	-0.3	-0.7	+1.7	+0.2	... ²	-1.3

¹Shifts are those required to bring the Cycle 24 data into agreement with the Cycle 23 data.

²Data are not collected at this setting.

4. Continuation Plan

This program continues in Cycle 25 at Lifetime Position 4 under PID 15385. The same target and cenwaves are being observed, but minor changes were made to the structure of the program. It avoids the use of segments and FP-POS that are prohibited by the COS 2025 policies, which are intended to preserve the life of the FUV detector.

Change History for COS ISR 2018-06

Version 1: 15 February 2018 - Original Document

References

Oliveira, C., Beland, S., Keyes, C., & Niemi, S. 2010, Instrument Science Report COS 2010-06, "SMOV COS FUV Wavelength Calibration"

Sonnentrucker, P., Roman-Duval, J., Ely, J., Oliveira, C., Proffitt, C., & Aloisi, A. 2013, Instrument Science Report COS 2013-06, "COS FUV Dispersion Solution Verification at the New Lifetime Position"