Abstract

We report on the monitoring of the zero points of the COS NUV dispersion solutions during Cycle 28 in program 16330. Select cenwaves were monitored for all NUV gratings except for G285M, which is no longer monitored due to its available but unsupported status. Comparisons to COS monitoring data obtained in previous cycles indicate internal stability within the allowed ranges of zero points. Comparisons to STIS data indicate small but persistent COS offsets of 1 – 3 pixels toward shorter wavelengths. The cause of this is not yet well understood. The March 2022 delivery of a new NUV DISPTAB with a revised zero point for stripe B of the G230L/2950 cenwave reduced this discrepancy for that setting.

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1. Introduction

Analysis of data from thermal-vacuum testing in 2003 (TV03) indicates that grating-dependent offsets may develop in the dispersion solutions for the Cosmic Origins Spectrograph Near-Ultraviolet (COS NUV) channel (Oliveira et al. 2010). To determine whether any such changes are taking place, the COS NUV wavelength scale monitor obtains data annually for select cenwaves with gratings G185M, G225M, and G230L. The spectra are cross-correlated with COS spectra from the Cycle 18 iteration of this program, since that was the first to monitor all current settings, and with STIS data to measure any changes in the zero points of the dispersion solutions.

2. Observations

The Cycle 28 NUV wavelength monitoring program (PID 16330, PI T. Fischer) consisted of one visit of one orbit to check the zero points of the dispersion solutions of the following gratings: G185M (cenwave 2010), G225M (cenwave 2217), and G230L (cenwaves 2635, 2950, and 3000). These cenwaves were chosen for continuity with previous iterations of the program. The target was HD 6655, a star of spectral type F8V. Visit 01, on 2021 October 21, executed successfully.

The acquisition sequence consisted of ACQ/SEARCH followed by ACQ/PEAKXD and ACQ/PEAKD using cenwave G230L/2635. The exposure times were 860 s for the G185M observation, 440 s for the G225M observation, and 80 s for each of the three G230L observations. All data were taken at FP-POS 3.

The Cycle 28 program was identical to its Cycle 27 predecessor (PID 15779, PI W. Fischer), which was summarized by Fischer (2021), except that the G185M exposure time was restored to 860 s after a one-time reduction to 800 s. Starting in Cycle 25, there were two changes that are being retained going forward. First, the monitoring of grating G285M was discontinued due to its rapidly declining sensitivity (Fischer 2019) and lack of general observer use since Cycle 21. This grating is now available but unsupported. Second, the program was reduced from two visits per year to one, due to the relatively low use of the NUV channel compared to the FUV and the stability of the zero points, as shown in the following section.

3. Analysis and Results

To check the internal stability of the zero points, the Cycle 28 COS spectra were cross-correlated with COS spectra of the same star obtained with the same settings in the Cycle 18 instance of the NUV wavelength monitoring program (PID 12422, PI C. Oliveira). Each stripe contains multiple stellar absorption lines and covers a small range of wavelengths, so we cross-correlated the entire stripe instead of select

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1The reduction in Cycle 27 was to facilitate scheduling, but it ultimately proved unnecessary.
windows. The shifts for Cycle 28 and for all previous cycles are plotted in Figure 1. Although G285M is no longer included in the program, we show previous results for G285M/2676, the G285M cenwave with the most complete past monitoring, for reference. Each visit is compared to the Cycle 18 visit that matches it most closely in time of year. For example, Cycle 28 Visit 01 data (2021 October 21) were compared to Cycle 18 Visit 03 data (2011 September 1). All data were reprocessed with the most recent NUV dispersion solutions (Plesha et al. 2017), including the 2022 update to the zero point for stripe B of G230L/2950 (D. French, in prep.).

To check the external stability of the zero points, the Cycle 28 COS spectra were also cross-correlated in the same way with Cycle 17 STIS E230M data (PID 12085, PI C. Oliveira). The shifts for Cycle 28 and all previous cycles are plotted in Figure 2.

The shifts from the Cycle 28 cross-correlations appear in Table 1 alongside the allowed ranges. These are the estimated contributions to the wavelength uncertainties from internal sources, which include the accuracy of the wavelength scale, the dispersion relation, aperture offsets, distortions, and drifts. They are estimated to be 1.2 – 1.7 pixels for G185M, 1.6 – 2.3 pixels for G225M, and 1.4 – 2.6 pixels for G230L (Oliveira et al. 2010).

The COS-COS shifts are within the specifications. Figure 1 shows that this agreement has generally persisted since the early days of COS.

The COS-STIS shifts are also within the specifications. Fischer (2021) showed that the COS-STIS shift for stripe B of the G230L/2950 cenwave was persistently near and sometimes outside the tolerance. This was corrected with the delivery of a new DISPTAB on 2022 March 25, 63p1559jl objectives-disp.fits, that contains a revised zero point for this stripe (D. French, in prep.). More generally, Figure 2 shows that shifts of a few pixels, always in the positive direction but generally within the allowed ranges, have routinely been observed in the comparison of COS NUV wavelength solutions to those of STIS in this program. The cause of this is not yet well understood.

4. Continuation Plan

This program continues in Cycle 29 as PID 16583 and is identical to the Cycle 28 version.

Change History for COS ISR 2022-11

Version 1: 27 September 2022 – Original Document
Figure 1. Plots of COS-COS shifts for the six cenwaves monitored since Cycle 18 (2011) or before, demonstrating internal stability. Shifts are those required to bring each spectrum into agreement with Cycle 18 data obtained at a similar time of year. Symbol types distinguish among stripes. Dashed lines indicate the maximum of each grating’s allowed range.
Figure 2. Plots of COS-STIS shifts for the five cenwaves monitored routinely since Cycle 18 (2011) or before in which at least one stripe overlaps with the STIS E230M data, demonstrating external stability. Shifts are those required to bring each COS spectrum into agreement with the STIS spectrum. Symbol types distinguish among stripes. Dashed lines indicate the maximum of each grating’s allowed range.
Table 1.  Pixel Shifts from Cycle 28 Cross-Correlation

<table>
<thead>
<tr>
<th>Grating</th>
<th>Cenwave</th>
<th>Stripe A (px)</th>
<th>Stripe B (px)</th>
<th>Stripe C (px)</th>
<th>COS-STIS</th>
<th>Shift (px)</th>
<th>Allowed Range (px)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G185M</td>
<td>2010</td>
<td>−0.5</td>
<td>−0.3</td>
<td>−0.1</td>
<td>C</td>
<td>0.0</td>
<td>1.2 – 1.7</td>
</tr>
<tr>
<td>G225M</td>
<td>2217</td>
<td>−0.2</td>
<td>−0.8</td>
<td>−0.1</td>
<td>C</td>
<td>0.0</td>
<td>1.6 – 2.3</td>
</tr>
<tr>
<td>G230L</td>
<td>2635</td>
<td>· · · 3</td>
<td>−0.7</td>
<td>· · · 4</td>
<td>B</td>
<td>+0.7</td>
<td>1.4 – 2.6</td>
</tr>
<tr>
<td>G230L</td>
<td>2950</td>
<td>−0.6</td>
<td>−0.7</td>
<td>· · · 4</td>
<td>B</td>
<td>+1.0</td>
<td>1.4 – 2.6</td>
</tr>
<tr>
<td>G230L</td>
<td>3000</td>
<td>−0.1</td>
<td>−0.4</td>
<td>· · · 4</td>
<td>B</td>
<td>+0.8</td>
<td>1.4 – 2.6</td>
</tr>
</tbody>
</table>

1. Shifts are those required to bring the Cycle 28 Visit 01 data (2021 October 21) into agreement with the Cycle 18 Visit 03 data (2011 September 1).
2. Shifts are those required to bring the Cycle 28 Visit 01 data into agreement with the STIS data. Cenwave 2010 has no stripes that overlap with the STIS data; the other cenwaves each have one such stripe, as shown.
3. The detector has extremely low sensitivity at these wavelengths.
4. This stripe suffers from contamination by second-order light.

References

Fischer, W. J. 2021, COS ISR 2021-11, “Cycle 27 COS NUV Wavelength Scale Monitor”