



Cycle 26 COS NUV Spectroscopic Sensitivity Monitor

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ABSTRACT

Observations of HST spectrophotometric standard stars show that the COS NUV detector has a time-dependent sensitivity (TDS) that must be monitored and accounted for in flux calibration. Regular observations monitor the changes in sensitivity for three NUV gratings: G230L, G185M, and G225M. Because the sensitivity of the fourth grating, G285M, is now very low, it was removed from the routine monitoring program, and its use is discouraged for General Observer (GO) programs. Results from the Cycle 26 NUV TDS program show that the G230L and G185M gratings, which are coated in MgF₂, exhibit trends consistent with little or no change. On the other hand, the G225M grating, which is bare aluminum, shows a significant sensitivity decline of $-2.87\% \pm 0.18\% \text{ yr}^{-1}$. It was discovered during Cycle 26 that the current NUV TDSTAB overestimates the rate of sensitivity loss for each grating. NUV fluxes have therefore been slightly overcorrected by an amount that grows with time and have, in recent years, become inconsistent with the 5% accuracy specification. Work is underway to correct this.

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1. Introduction

Observations of HST spectrophotometric standard stars show that the COS NUV detector has a time-dependent sensitivity (TDS) that must be monitored and accounted for in flux calibration (Osten et al. 2010). To this end, the Cosmic Origins Spectrograph Near-Ultraviolet Time-Dependent Sensitivity (COS NUV TDS) program executes every cycle and monitors the sensitivity of three NUV gratings. These changes are characterized as a function of grating, cenwave, and detector stripe. The results can be used to update the COS NUV TDS reference file (TDSTAB) as well as synphot files that are used as inputs for the exposure time calculator (ETC).

2. Observations

The Cycle 26 NUV TDS program (15540, PI W. Fischer) comprised two pairs of visits. In the first pair, a one-orbit visit for the M gratings (M1) and a one-orbit visit for the L grating (L1) were carried out on 2019 January 20. Visit M1 observed the white dwarf standard G 191-B2B with gratings G185M (cenwaves 1786, 1921, and 2010) and G225M (cenwaves 2186, 2306, and 2410). Visit L1 observed the white dwarf standard WD 1057+719 with grating G230L (cenwaves 2635 and 2950).

For both visits, the acquisition consisted of the sequence ACQ/SEARCH, ACQ/PEAKXD, and ACQ/PEAKD, using cenwave 2010 for the M visit and cenwave 2635 for the L visit. All data were taken at FP-POS 3. The second pair of visits, M2 and L2, were identical to the first and were carried out on 2019 August 3 and July 27, respectively. All visits executed successfully.

The Cycle 26 program was identical to its Cycle 25 predecessor (15387, PI W. Fischer) except that the monitoring of the G285M grating was discontinued due to its low sensitivity. This reduced each of the M visits from two orbits to one.

3. Analysis and Results

The computation of the time-dependent sensitivities for COS NUV data is described in previous ISRs (Osten et al. 2010; 2011). For each cenwave and stripe, we calculate the ratio of every net counts spectrum to the first one obtained. The ratio as a function of wavelength is condensed to a single value by averaging over the full stripe. The relationship of ratio to observation date obtained for each stripe is then fit with a straight line.

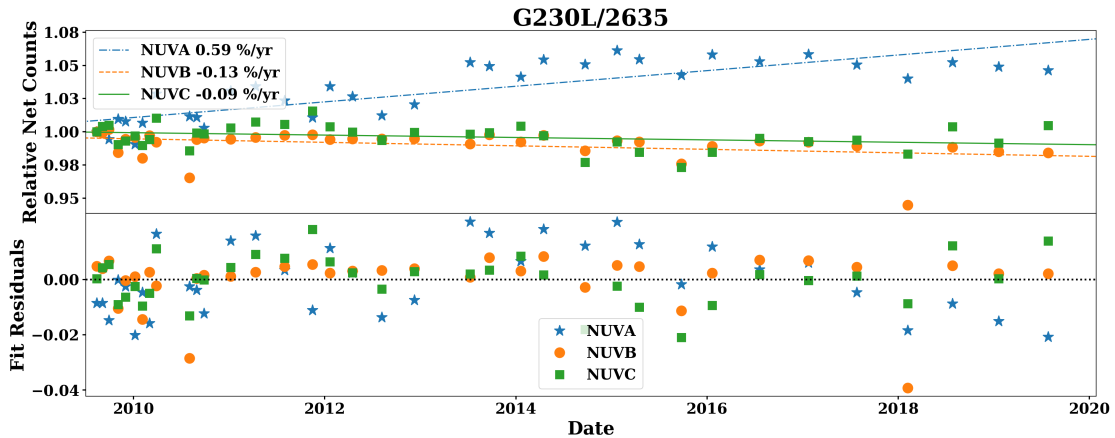


Figure 1. Results for G230L/2635, with blue for stripe NUVA, orange for stripe NUVB, and green for stripe NUVC. *Top:* Relative sensitivity versus time, where the first measurement for each stripe is scaled to 1. The linear fits are shown; they cross at a time that depends on the details of each fit. The slopes are given in the legend. *Bottom:* Residuals from the linear fits.

The code used to perform the analysis is written in Python 3 and can be found in the `cos/ref_files/tdstab_nuv` repository on the internal STScI GitLab site. The main script is `run_tds_analysis.py`; it calls `cos_tds.py`, which in turn calls additional scripts in the repository. This code also can be used to generate an updated reference file; this was not done after the Cycle 26 analysis since the slopes were unchanged from those found in the previous cycle (Fischer 2019).

Figures 1 through 8 show the linear fits for each observed cenwave. The results for each stripe and cenwave are roughly consistent for each grating, so we report the mean and standard deviation of the slopes for all monitored cenwaves and stripes. The G230L and G185M gratings, which are coated in MgF_2 , have slopes that are consistent with no change ($0.02\% \pm 0.30\% \text{ yr}^{-1}$) and a mild increase in sensitivity ($0.24\% \pm 0.19\% \text{ yr}^{-1}$), respectively. The G225M grating, on the other hand, is bare aluminum. It shows a significant decline in sensitivity, $-2.87\% \pm 0.18\% \text{ yr}^{-1}$.

The G285M grating has less than 15% of the sensitivity it had at the beginning of COS science operations (Fischer 2019). This is low enough that the COS team opted before Cycle 26 to discourage future use of the G285M grating for General Observer (GO) programs. It was subsequently removed from this monitoring program.

It was discovered during Cycle 26 that the current NUV TDSTAB, delivered in Cycle 17, overestimates the rate of sensitivity loss for each grating. As a result, NUV fluxes have been slightly overcorrected by an amount that grows with time. The discrepancies are calculated by comparing pipeline-calibrated spectra of the white dwarfs mentioned above to model spectra. While the discrepancies were minor for most of the period since the last TDSTAB delivery, they are now outside of the 5% specification for many combinations of grating, cenwave, and stripe. See the October

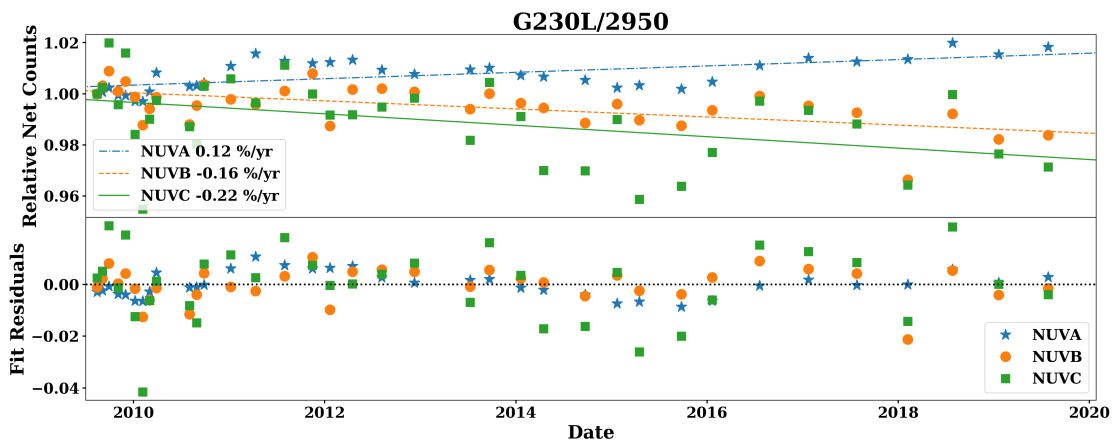


Figure 2. Results for G230L/2950. See the caption to Figure 1 for details.

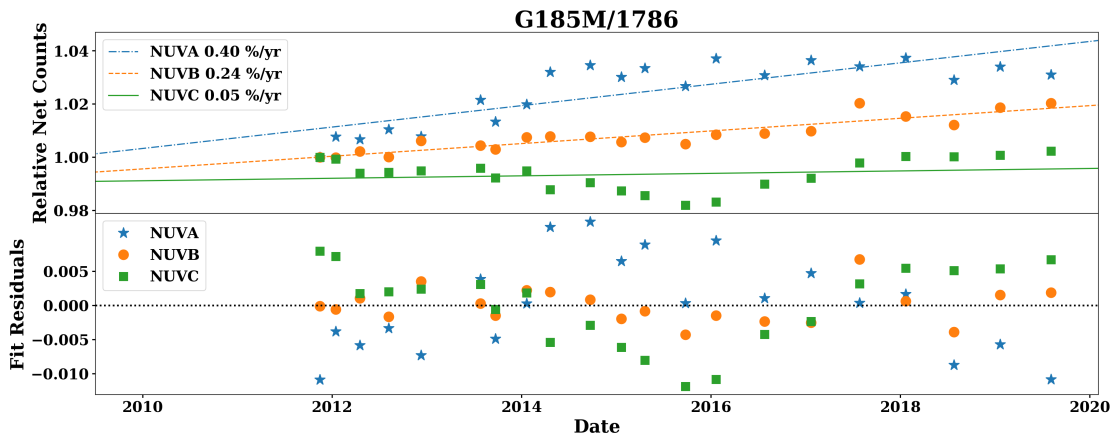


Figure 3. Results for G185M/1786. See the caption to Figure 1 for details.

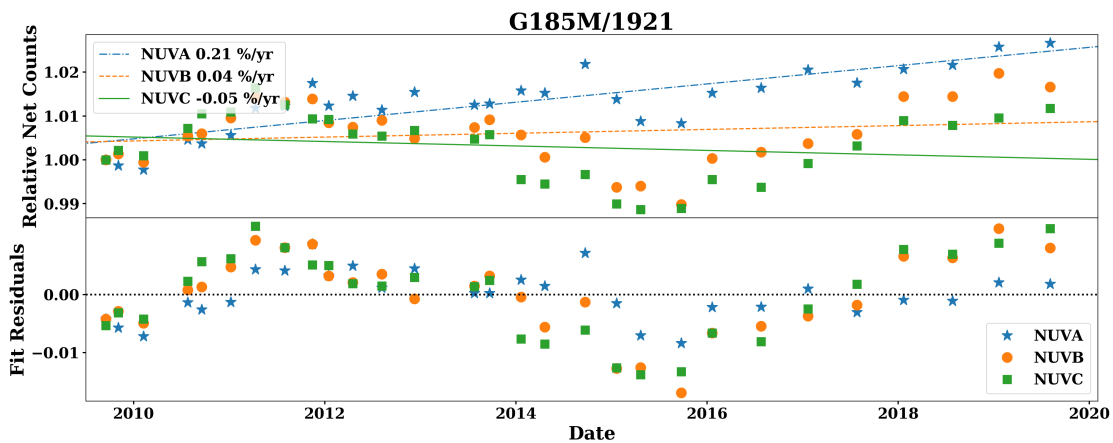


Figure 4. Results for G185M/1921. See the caption to Figure 1 for details.

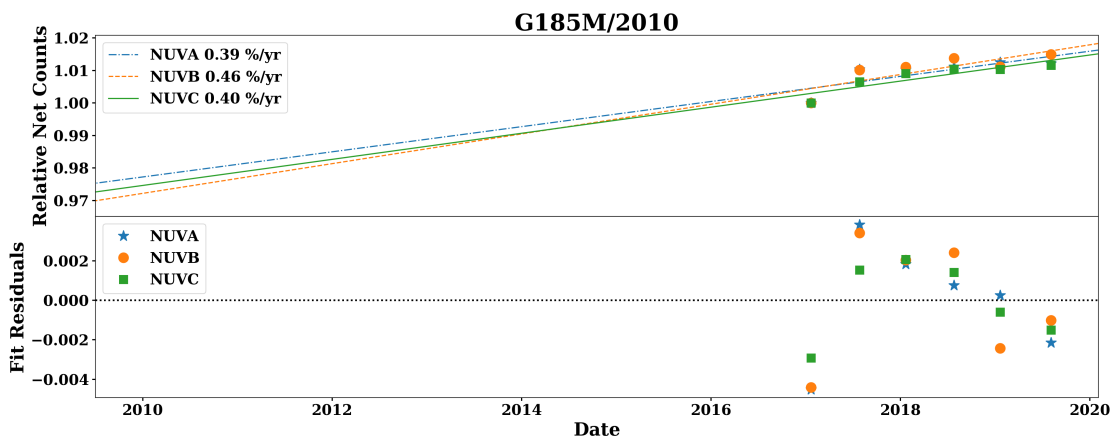


Figure 5. Results for G185M/2010. See the caption to Figure 1 for details.

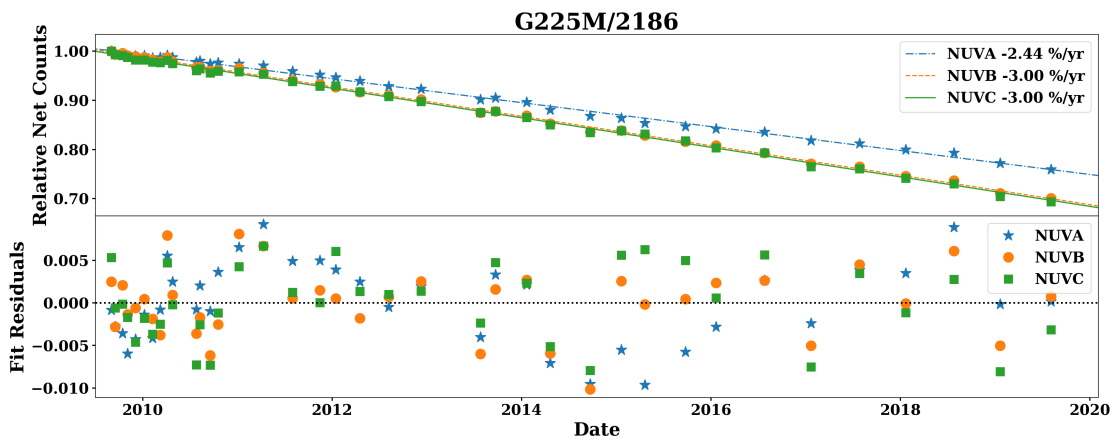


Figure 6. Results for G225M/2186. See the caption to Figure 1 for details.

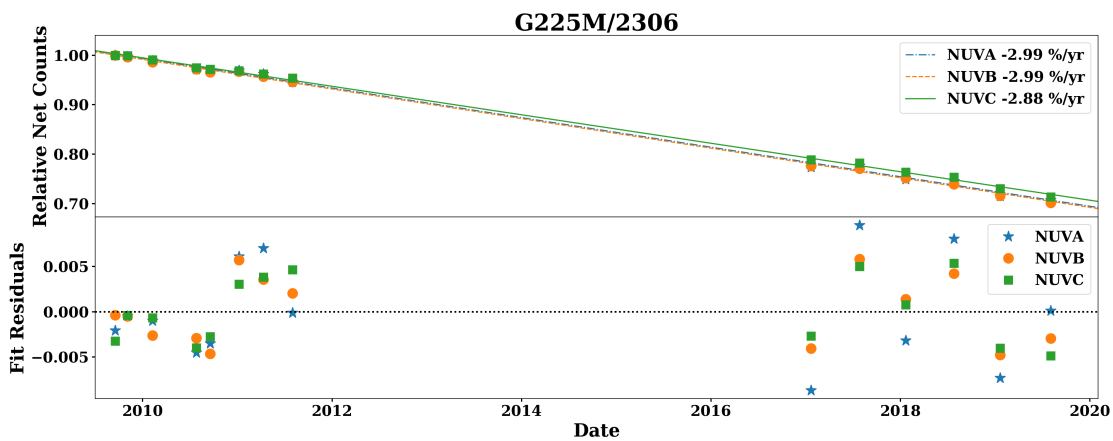


Figure 7. Results for G225M/2306. See the caption to Figure 1 for details.

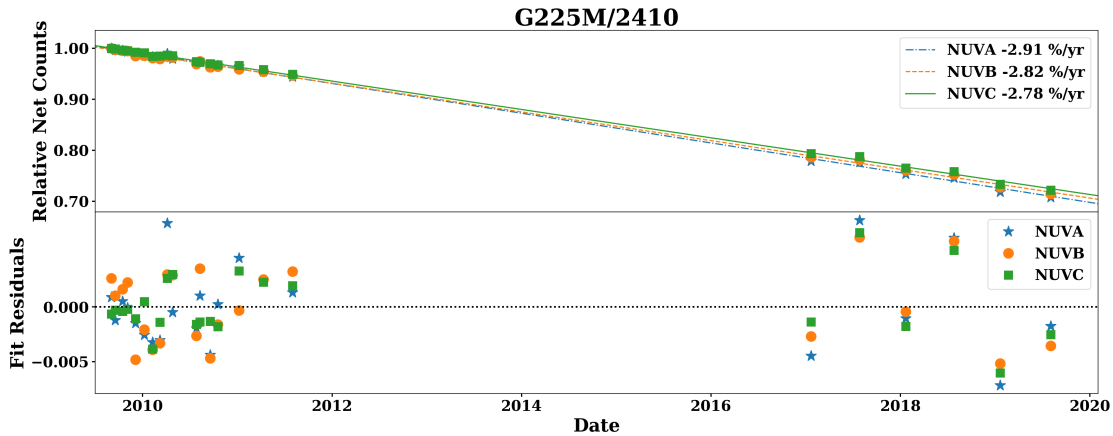


Figure 8. Results for G225M/2410. See the caption to Figure 1 for details.

2019 COS STAN¹ for further details. A revised TDSTAB is being tested and is expected to be delivered before Cycle 28 begins. After delivery of the new TDSTAB, archival NUV data will be recalibrated.

4. Continuation Plan

This program continues in Cycle 27 as PID 15778 and is identical to the Cycle 26 version. Instrument documentation has been updated to discourage use of G285M. Users who are interested in spectroscopic coverage of the wavelength range from 2500 to 3200 Å at the G285M resolution are encouraged to use the G230M or E230M gratings on the Space Telescope Imaging Spectrograph (STIS) instead.

Change History for COS ISR 2020-02

Version 1: 8 June 2020 – Original Document

References

- Fischer, W. J. 2019, COS ISR 2019-12, “Cycle 25 COS/NUV Spectroscopic Sensitivity Monitor”
- Osten, R. A., Ghavamian, P., Niemi, S.-M., et al. 2010, COS ISR 2010-15, “Early Results from the COS Spectroscopic Sensitivity Monitoring Programs”
- Osten, R. A., Massa, D., Bostroem, A., Aloisi, A., & Proffitt, C. 2011, COS ISR 2011-02, “Updated Results from the COS Spectroscopic Sensitivity Monitoring Program”

¹<https://www.stsci.edu/contents/news/cos-stans/october-2019-stan>