Cycle 29 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, has become very low, it was removed from the routine monitoring program, and it is now available-but-unsupported for General Observer programs. Results from the Cycle 29 NUV TDS program show that the G230L and G185M gratings, which are coated in MgF_2, exhibit trends consistent with little or no change. On the other hand, the G225M grating, which is bare aluminum, shows a sensitivity decline of $-2.86\% \pm 0.18\%\ yr^{-1}$.

Contents

1. Introduction

Observations of HST spectrophotometric standard stars show that the COS NUV detector has a time-dependent sensitivity 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 functions 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.

2. Observations

The Cycle 29 NUV TDS program (16537, PI W. Fischer) was designed with two pairs of visits. The first pair, a one-orbit visit for the L grating (L1) and a one-orbit visit for the M gratings (M1) ran on 2022 February 11 and 12, respectively. Visit L1 observed the white dwarf standard WD 1057+719 with grating G230L (cenwaves 2635 and 2950). 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). The second pair of visits, L2 and M2, were identical to the first and ran on 2022 August 11 and 13, respectively. Three of the four visits executed successfully. For Visit L2, on the other hand, the Fine Guidance Sensors lost lock on the guide stars a few minutes before the COS acquisition sequence began. The resulting spectra had very low counts, approximately a few percent of what was expected, suggesting that the target was very poorly centered in the aperture. Visit L2 was repeated as Visit L3, which ran successfully on 2022 September 5.

For all visits, the acquisition consisted of the sequence ACQ/SEARCH, ACQ/PEAKXD, and ACQ/PEAKD. Cenwave 2010 was used for the M visits, and cenwave 2635 was used for the L visits. All data were obtained at the default FP-POS 3, because the fixed-pattern noise when a single FP-POS is used in the NUV limits the signal-to-noise ratio to 50 per resolution element, in excess of what is needed to characterize TDS to better than 5%.

The program was identical to its Cycle 28 predecessor (16329, PI W. Fischer) except that the exposure and buffer times were updated for the G225M exposures. Exposure times were increased by about 25%, and buffer times were increased by about 15%. This and previous ISRs on this topic (e.g., Fischer 2022) show that the TDS of G225M is $\sim -3\%\,\mathrm{yr}^{-1}$, enough to warrant occasionally lengthening the exposure times, while the TDS of the other supported gratings is close enough to 0 to generally retain the same exposure times.

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).[1] For each cenwave and stripe, we calculate the ratio of every net-counts spectrum to the first one obtained. (The first observations were in 2009 August for G230L, 2009 September for G225M and G185M/1921, 2011 November for G185M/1786, and 2017 January for G185M/2010.) 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. Here we report the slopes of the lines when the ratios are taken to be 1 at the time each cenwave was first monitored. In the TDSTAB, because a uniform reference date is needed, rescaling so the ratios are 1 on the reference date results in slightly different values from those presented here.

Figures 1 through 8 show the linear fits for each observed cenwave. For each grating, the spread in slopes among the monitored cenwaves and stripes is generally small, so here we report their means and standard deviations. The G230L and G185M gratings, which are coated in MgF_2, have slopes that are consistent with no change $(0.03\% \pm 0.22\% \text{ yr}^{-1})$ and a mild increase in sensitivity $(0.19\% \pm 0.08\% \text{ yr}^{-1})$, respectively. The G225M grating, on the other hand, is bare aluminum and shows a significant decline in sensitivity, $-2.86\% \pm 0.18\% \text{ yr}^{-1}$.

The G285M grating has shown an exceptionally steep decline and now has less than 15% of the sensitivity it had at the beginning of COS science operations (Fischer 2019). This is low enough that, in Cycle 29 (2021), its status was changed to available-but-unsupported for General Observer programs, and it was removed from this monitoring program.

The most recent update to the NUV TDSTAB was on 2020 July 30. It characterizes the TDS slopes with a constant value for each grating and stripe, listed in Table 1 of Fischer (2021). Work is in progress to improve the NUV TDS correction by using a wavelength-dependent correction for each grating and stripe instead of a constant value.

4. Continuation Plan

This program continues in Cycle 30 as PID 16937 and is identical to the Cycle 29 version. Instrument documentation reflects the available-but-unsupported status of the G285M grating. Users who are interested in spectroscopic coverage of the wavelength

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[1] The code used to perform the analysis is written in Python 3 and can be found in the main branch of the `cos/ref_files/tdstab_nuv` repository on the internal STScI GitLab site. The script `run_tds_analysis.py` calls `cos_tds.py`, which in turn calls additional scripts in the repository. This code can also be used to generate an updated reference file.

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 2023-27

Version 1: 8 December 2023 – Original Document

References

Fischer, W. J. 2019, COS ISR 2019-12, "Cycle 25 COS/NUV Spectroscopic Sensitivity Monitor"

Fischer, W. J. 2021, COS ISR 2021-09, "Cycle 27 COS/NUV Spectroscopic Sensitivity Monitor"

Fischer, W. J. 2022, COS ISR 2022-09, "Cycle 28 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"
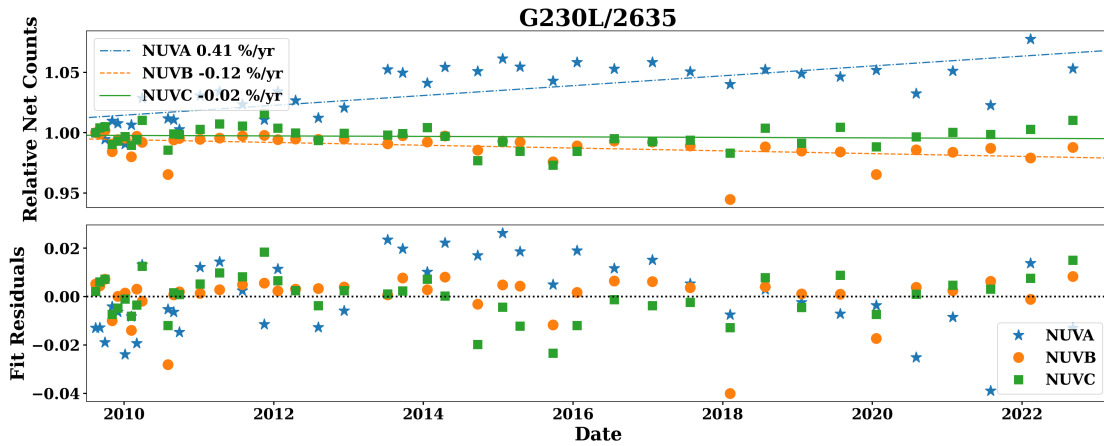
Figure 1. Results for G230L/2635, with blue for stripe NUVA, orange for stripe NUVB, and green for stripe NUVC. *Top:* Relative sensitivity versus time, where the first measurement for each stripe is scaled to 1. The linear fits are shown; they cross at a time that depends on the details of each fit. The slopes are given in the legend. *Bottom:* Residuals from the linear fits.
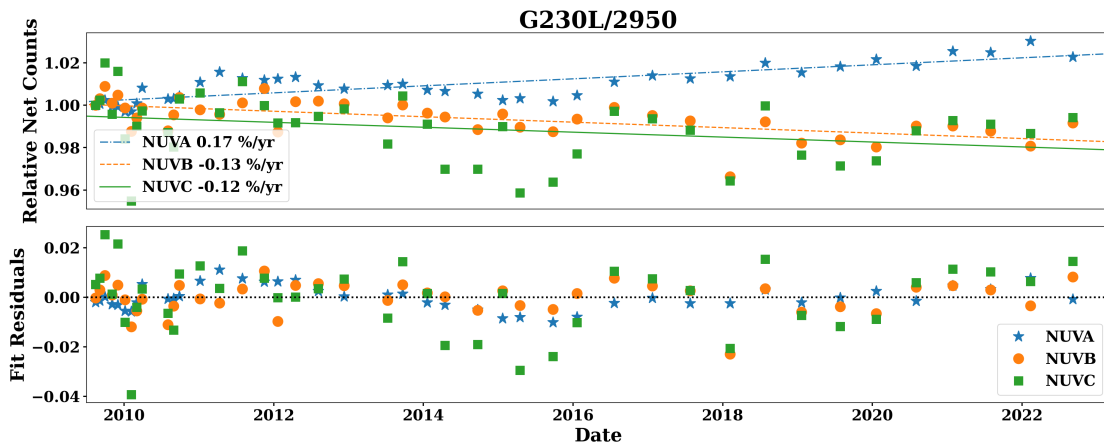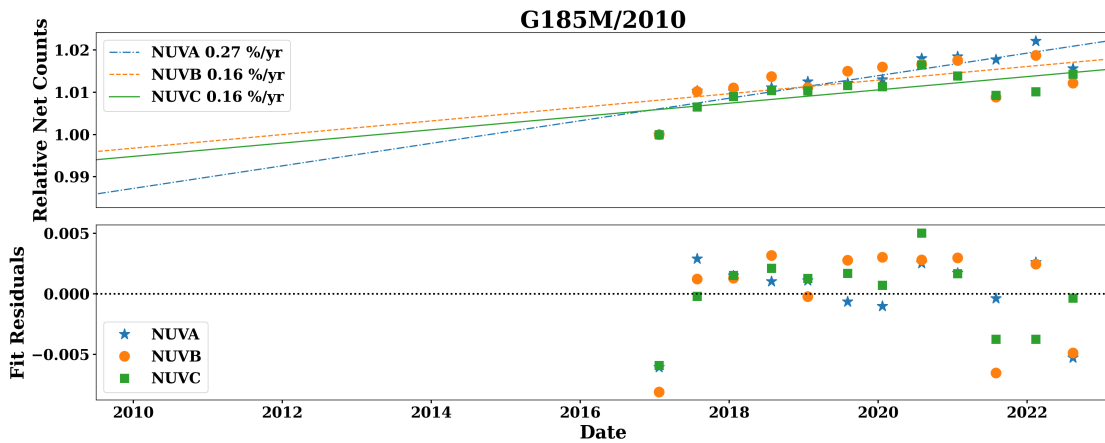

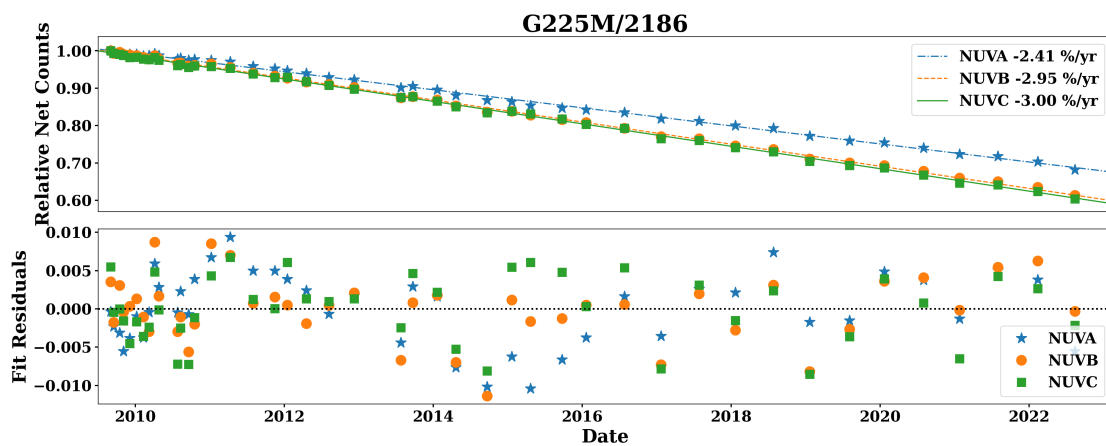**Figure 2.** Results for G230L/2950. See the caption to Figure 1 for details.
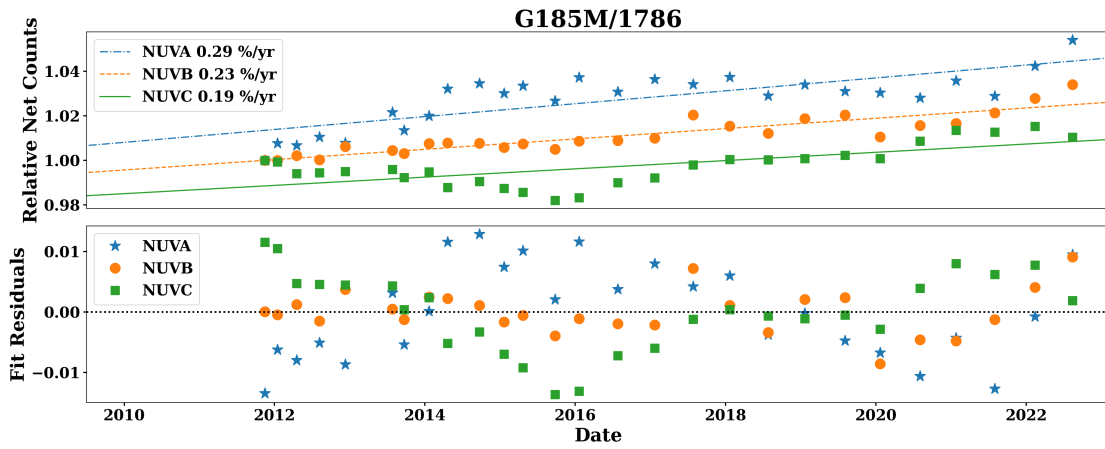
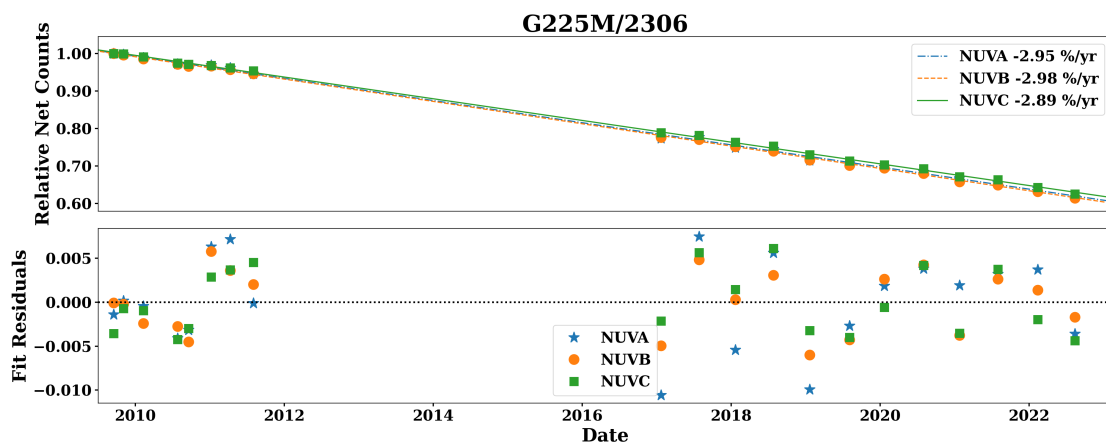**Figure 3.** Results for G185M/1786. See the caption to Figure 1 for details.
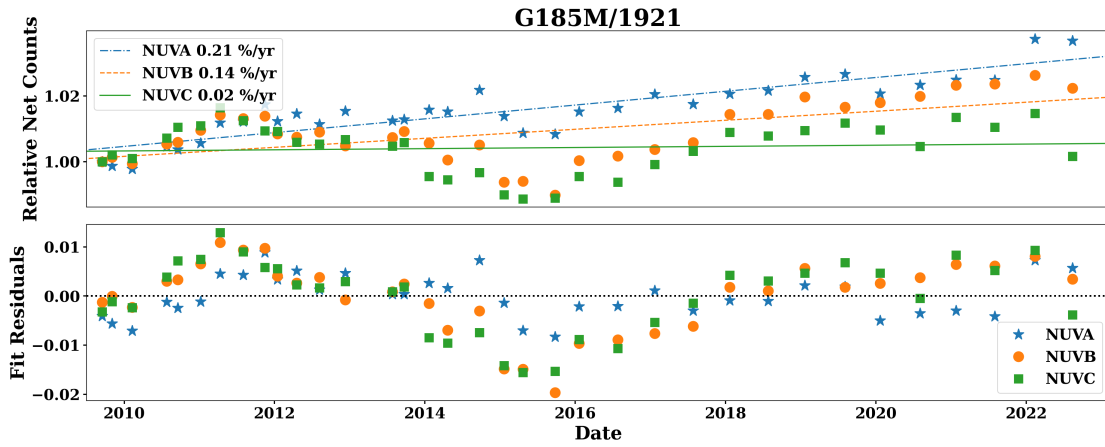
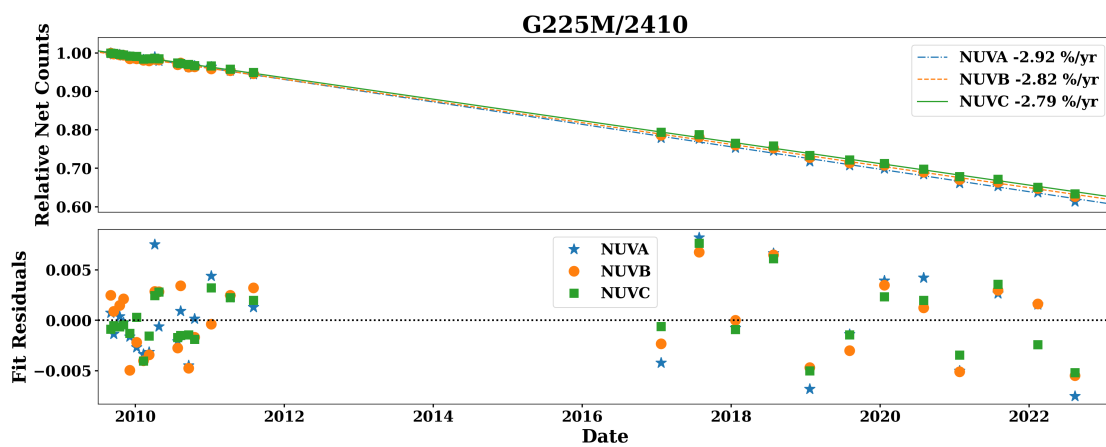**Figure 4.** Results for G185M/1921. See the caption to Figure 1 for details.

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.