



Cycle 27 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 27 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 sensitivity decline of $-2.86\% \pm 0.18\% \text{ yr}^{-1}$. It was discovered during Cycle 26 that the existing NUV TDSTAB overestimated the rate of sensitivity loss for each grating. NUV fluxes had therefore been overcorrected by an amount that grew with time and had, in recent years, become inconsistent with the 5% accuracy specification. This was improved with a new NUV TDSTAB, delivered on 2020 July 30.

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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 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 27 NUV TDS program (15778, PI W. Fischer) was identical to its Cycle 26 predecessor (15540, PI W. Fischer). It 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 2020 January 20–21. 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). The second pair of visits, M2 and L2, were identical to the first and were carried out on 2020 August 1–2. All visits executed successfully.

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 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%.

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 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, a uniform reference date is needed, and rescaling so the ratios are 1 on the reference date results in slight changes from what is presented here.

Figures 2 through 9 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 MgF₂, have slopes that are consistent with no change ($0.01\% \pm 0.26\% \text{ yr}^{-1}$) and a mild increase in sensitivity ($0.21\% \pm 0.14\% \text{ yr}^{-1}$), respectively. The G225M grating, on the other hand, is bare aluminum. It 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 it is now available but unsupported for General Observer (GO) programs and has been removed from this monitoring program.

4. Delivery of a New NUV TDSTAB

It was discovered during Cycle 26 that the NUV TDSTAB at the time, delivered in Cycle 17, overestimated the rate of sensitivity loss for each grating. As a result, NUV fluxes had been overcorrected by an amount that grew with time. The discrepancies were calculated by comparing pipeline-calibrated spectra of the white dwarfs mentioned in Section 2 to model spectra. While the discrepancies were minor for most of the period since the Cycle 17 TDSTAB delivery, Figure 1 shows how they had increased by Cycle 26 to beyond the 5% specification for many combinations of grating, cenwave, and stripe. To address this, a revised NUV TDSTAB `47u1435r1_tds.fits` was created, tested, and delivered on 2020 July 30. Archival NUV data were subsequently recalibrated. Table 1 compares the slopes in the old and new TDSTABs. Note that the slopes are now dependent on stripe.

¹The 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.

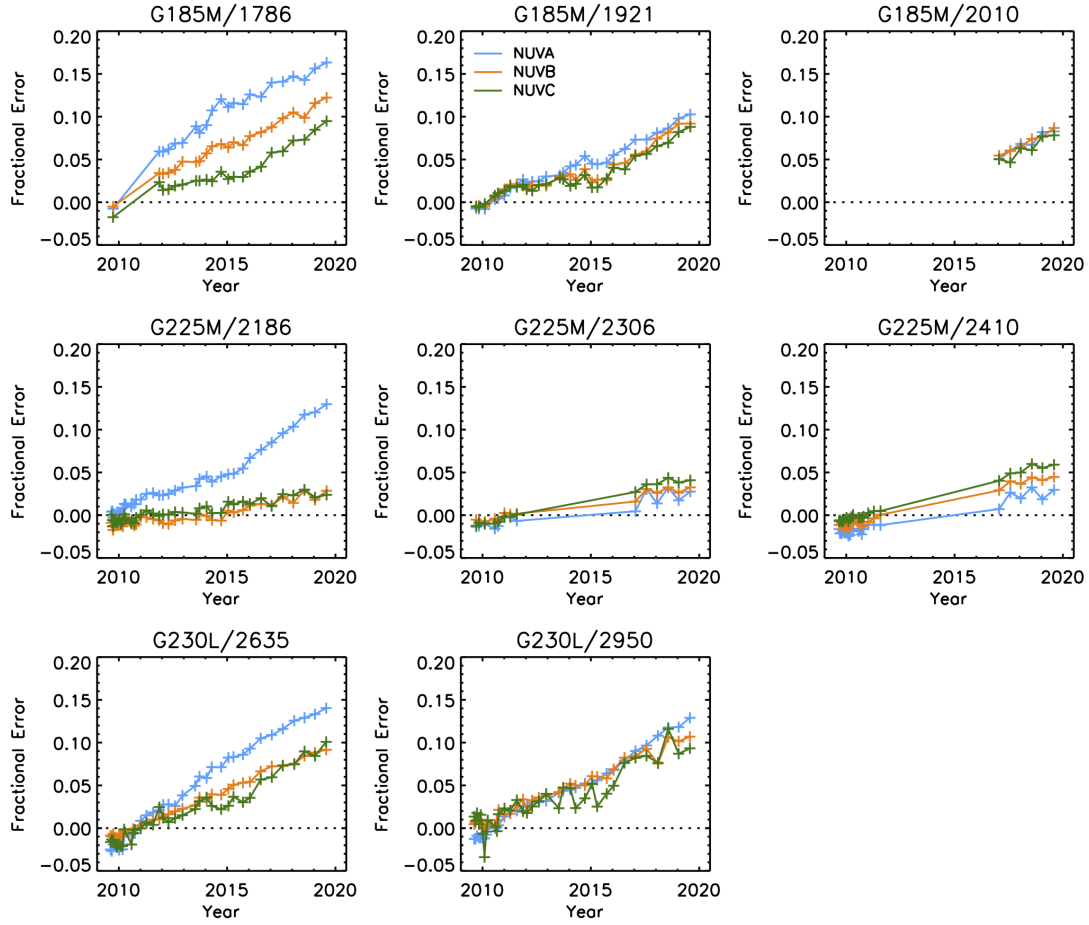


Figure 1. With the Cycle 17 NUV TDSTAB, fractional error in the NUV flux calibration versus time for each monitored cenwave and stripe in each of the three monitored gratings: G185M, G225M, and G230L. These errors were improved with the new NUV TDSTAB delivered on 2020 July 30.

Table 1. Comparison of Old and New NUV TDSTABs

Grating	Old Slopes (% yr ⁻¹)	New Slopes (% yr ⁻¹)		
	All Stripes	Stripe A	Stripe B	Stripe C
G185M	−0.8	+0.55	+0.28	+0.05
G225M	−3.3	−2.63	−2.90	−2.90
G230L	−1.1	+0.10	−0.10	+0.05

5. Continuation Plan

This program continues in Cycle 28 as PID 16329 and is identical to the Cycle 27 version. Instrument documentation has been updated to reflect the available but unsupported status of the G285M grating. 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 2021-09

Version 1: 27 October 2021 – 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”

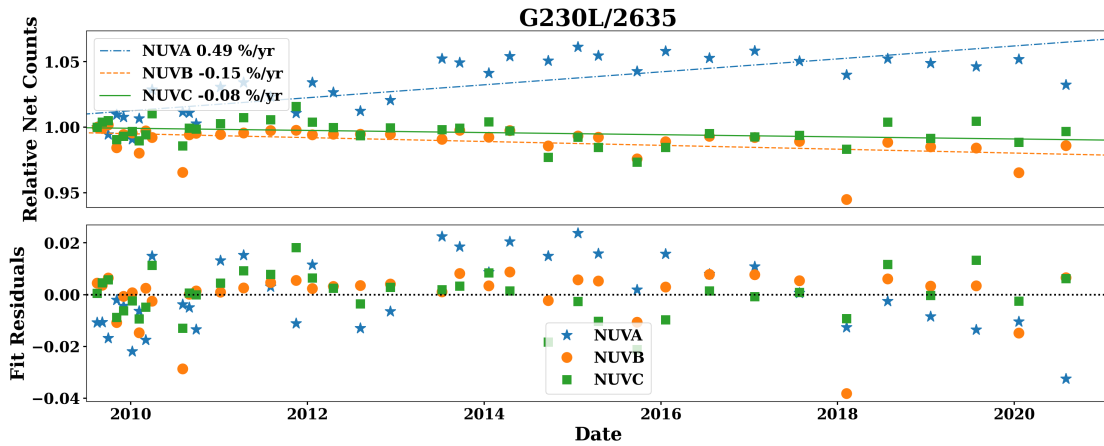


Figure 2. Results for G230L/2635, with blue for stripe NUVA, orange for stripe NUVB, and green for stripe NUVC. *Top:* Relative sensitivity versus time, where the first measurement for each stripe is scaled to 1. The linear fits are shown; they cross at a time that depends on the details of each fit. The slopes are given in the legend. *Bottom:* Residuals from the linear fits.

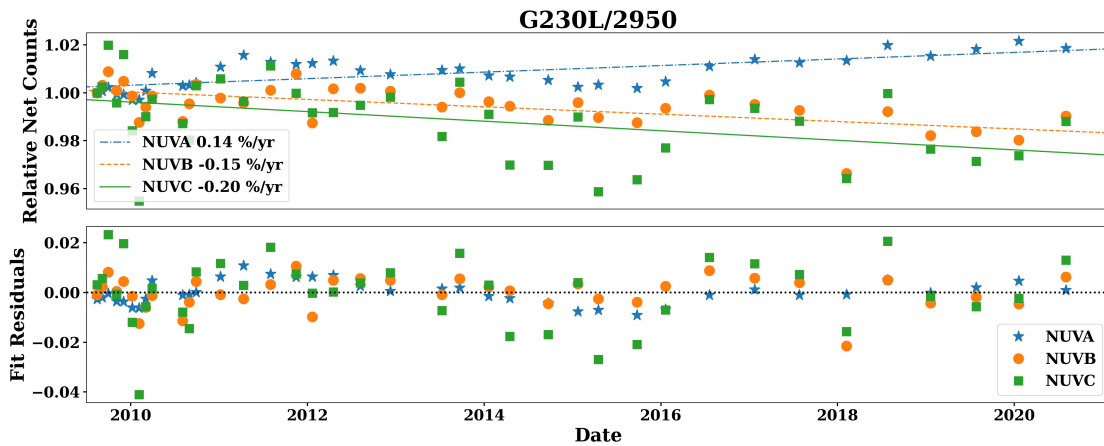


Figure 3. Results for G230L/2950. See the caption to Figure 2 for details.

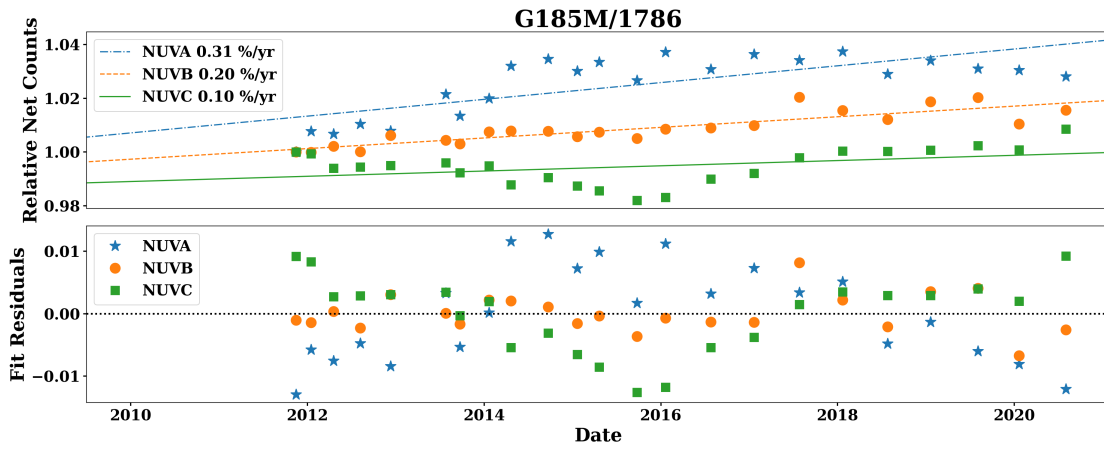


Figure 4. Results for G185M/1786. See the caption to Figure 2 for details.

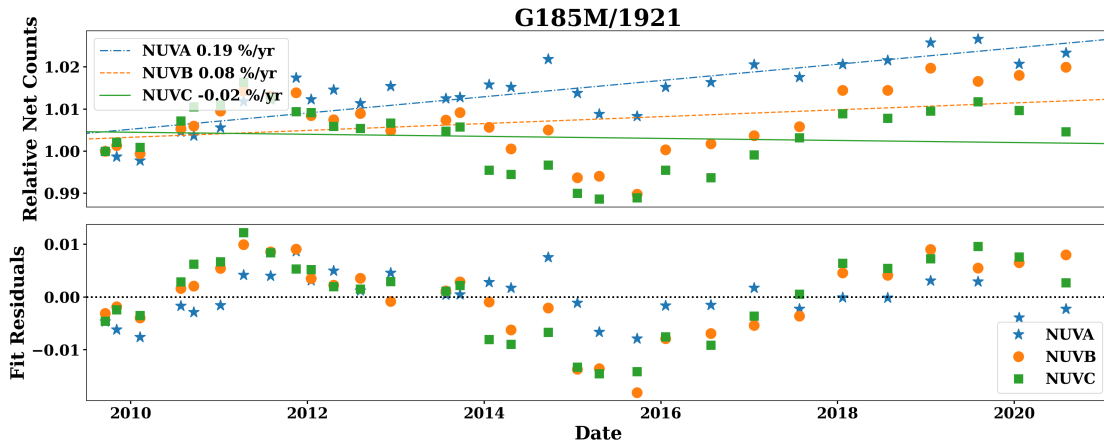


Figure 5. Results for G185M/1921. See the caption to Figure 2 for details.

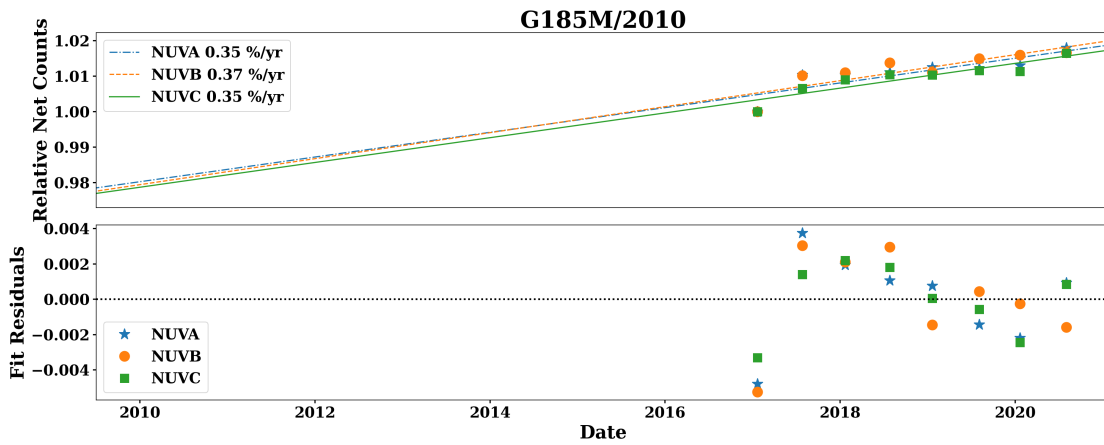


Figure 6. Results for G185M/2010. See the caption to Figure 2 for details.

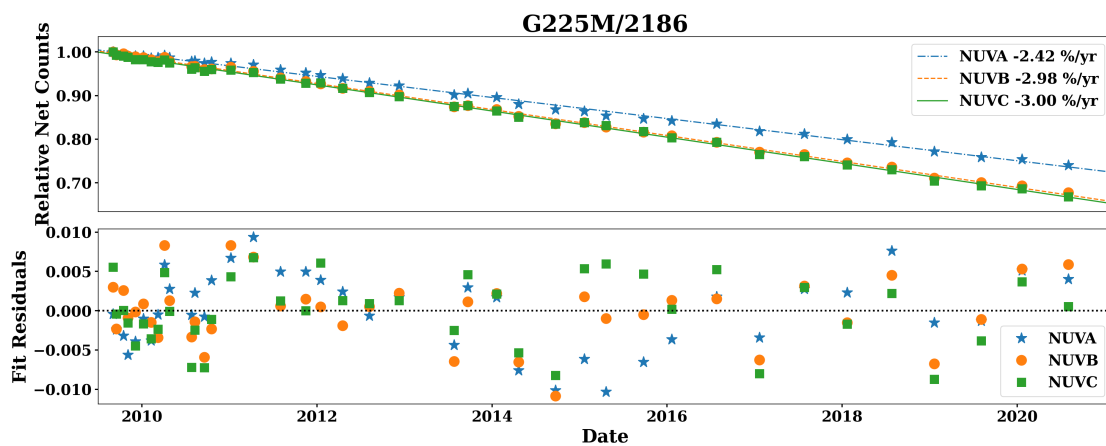


Figure 7. Results for G225M/2186. See the caption to Figure 2 for details.

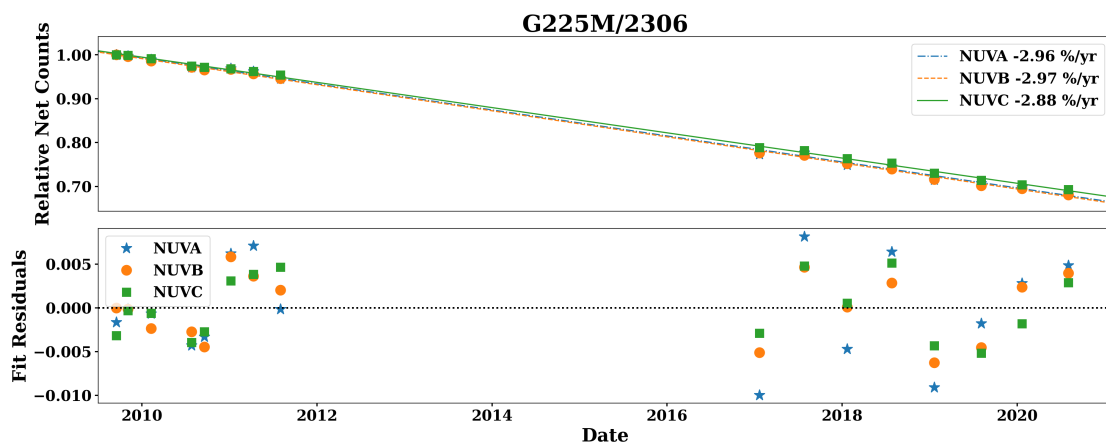


Figure 8. Results for G225M/2306. See the caption to Figure 2 for details.

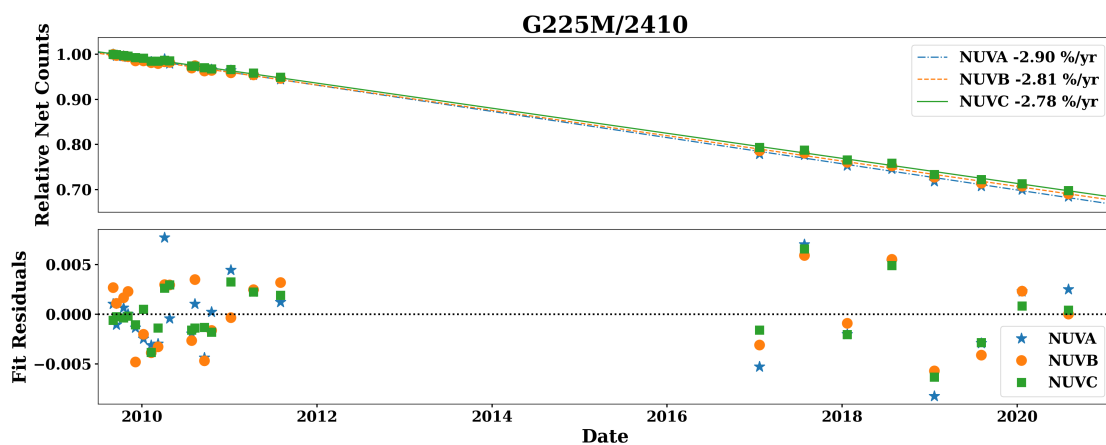


Figure 9. Results for G225M/2410. See the caption to Figure 2 for details.