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Cycle 25 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 have monitored the changes in sensitivity for all four NUV gratings: G230L, G185M, G225M, and G285M. Results from the Cycle 25 NUV TDS program show that the G230L and G185M gratings, which are coated in MgF_2, exhibit trends that are consistent with no change in sensitivity. On the other hand, the G225M and G285M gratings, which are bare aluminum, show significant sensitivity declines of $-2.84\% \pm 0.17\%$ yr^{-1} and $-10.43\% \pm 0.37\%$ yr^{-1}, respectively. Because the sensitivity of the G285M grating is now very low, less than 20% of its value at the first monitoring in 2009, we have removed it from subsequent monitoring, and the COS team discourages its use for General Observer (GO) programs.

Contents

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 each NUV grating. These changes are characterized as a function of grating, cenwave, and detector stripe. The results can be used to update the COS NUV time-dependent sensitivity reference file (TDSTAB) as well as synphot files that are used as inputs for the exposure time calculator (ETC).

2. Observations

The Cycle 25 NUV TDS program (15387, PI W. Fischer) comprised two identical pairs of visits. In the first pair, a two-orbit visit for the M gratings, visit M1, was carried out on 2018 January 21. It observed the white dwarf standard G 191-B2B with gratings G185M (cenwaves 1786, 1921, and 2010), G225M (cenwaves 2186, 2306, and 2410), and G285M (cenwaves 2617, 2850, and 3094). A one-orbit visit for the L grating, visit L1, was carried out on 2018 February 6. It observed the white dwarf standard WD 1057+719 with grating G230L (cenwaves 2635 and 2950).

In both cases, 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. These visits were repeated as M2 and L2 on 2018 July 26 and 27, respectively. All four visits executed successfully.

The Cycle 25 program was identical to its Cycle 24 predecessor (14858, PI J. Taylor) except that the exposure time for cenwave 2950 was increased from 800 s to 850 s to bring its signal-to-noise ratio closer to that obtained for cenwave 2635.

3. Analysis and Results

The computation of the time-dependent sensitivities for COS NUV data is described in previous ISRs (Osten et al. 2010; Osten et al. 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.

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 25 analysis since the slopes were consistent with those found in the previous cycle (Taylor 2018).

Four cenwaves were added to the program in Cycle 24. Two (G225M/2410 and G225M/2306) were previously observed in Cycles 17 and 18, providing an anchor to the derived fits. The remaining two (G185M/2010 and G285M/2850) have data only for Cycles 24 and 25; their trends are not surprising, but we do not consider them in the overall assessment of each grating's performance.

Figures 1 through 11 show the linear fits for each observed cenwave. In the cases where monitoring exists for more than two cycles, the results for each stripe and cenwave are roughly consistent for each grating. Thus, for each grating, we report the mean and standard deviation of the slopes for all cenwaves and stripes with sufficient data. The G230L and G185M gratings, which are coated in MgF_2, exhibit trends that are consistent with no change in sensitivity. They have slopes of $0.03\% \pm 0.34\%\ \mathrm{yr}^{-1}$ and $0.13\% \pm 0.23\%\ \mathrm{yr}^{-1}$, respectively. The G225M and G285M gratings, on the other hand, are bare aluminum. They show significant declines in sensitivity, $-2.84\% \pm 0.17\%\ \mathrm{yr}^{-1}$ and $-10.43\% \pm 0.37\%\ \mathrm{yr}^{-1}$, respectively.

The decline in the sensitivity of the G285M grating has leveled out in recent cycles and is therefore not well fit by linear functions (Figures 9 and 11). Nonetheless, the persistent decline has rendered the grating much less sensitive than it was at the beginning of COS science operations. Since the first monitoring in 2009, cenwave 2617 has dropped to $11.1\% \pm 0.2\%$ of its original sensitivity, and cenwave 3094 has dropped to $15.2\% \pm 1.0\%$ of its original sensitivity. These are low enough that the COS team has opted to discourage future use of the G285M grating for General Observer (GO) programs.

4. Continuation Plan

This program is continuing in Cycle 26 as PID 15540. The G285M grating has been removed from the monitoring because its throughput has declined to an extremely low level and because it has not been used by guest observers since Cycle 21. This shortens each of the two M visits from two orbits to one, but the program is otherwise unchanged.

Instrument documentation has been updated to discourage use of G285M. Users interested in spectroscopic coverage of the wavelength range from 2500 to 3200 Å are encouraged to use Hubble's Space Telescope Imaging Spectrograph (STIS) instead. STIS gratings G230L, G230LB, G230M, G230MB, E230M, and E230H cover this wavelength range at various spectral resolutions.

Change History for COS ISR 2019-12

Version 1: 30 May 2019 – Original Document

References

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"

Taylor, J. M. 2018, COS ISR 2018-11, "Cycle 24 COS/NUV Spectroscopic Sensitivity Monitor"

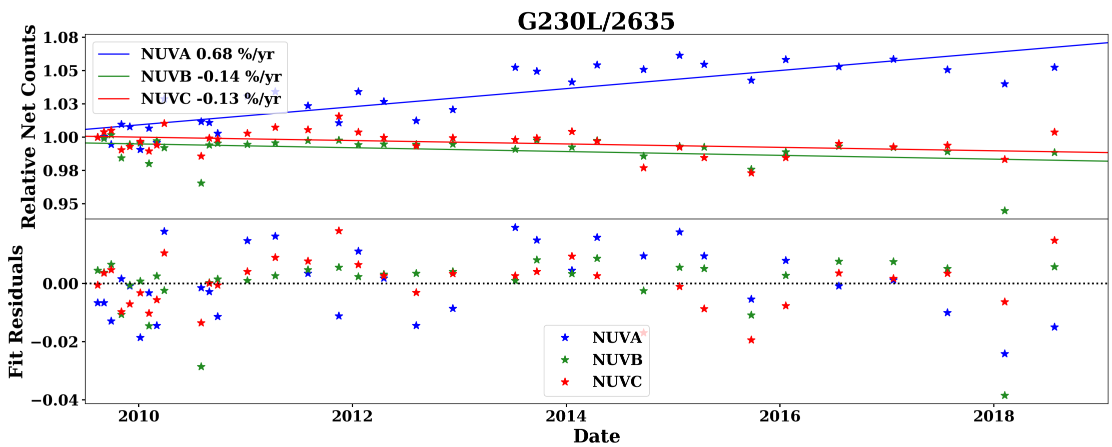

Figure 1. Results for G230L/2635, with blue for stripe NUVA, green for stripe NUVB, and red for stripe NUVC. *Top:* Relative sensitivity versus time, where the first measurement for each stripe is scaled to 1. (Since the three points overlap, a single red star appears.) The linear fits are shown; they 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.

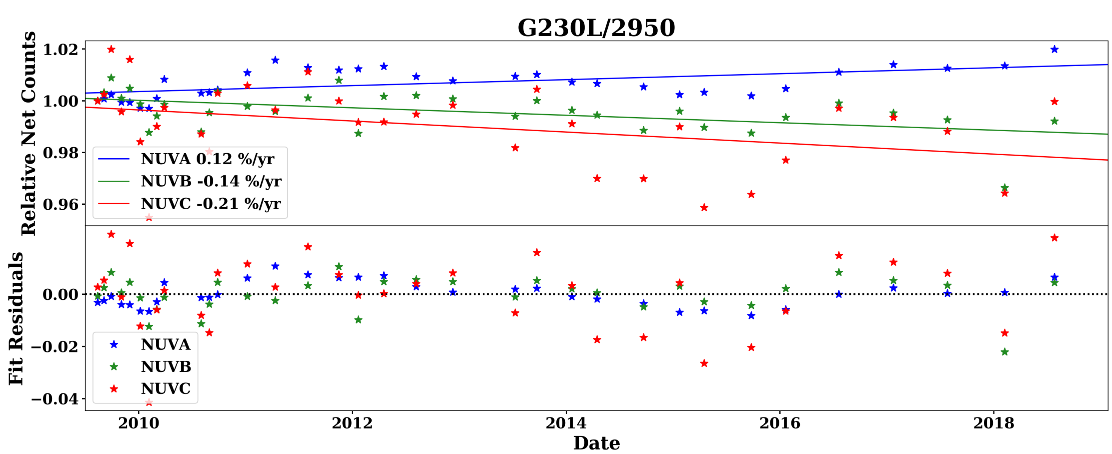

Figure 2. Results for G230L/2950. See the caption to Figure 1 for details.

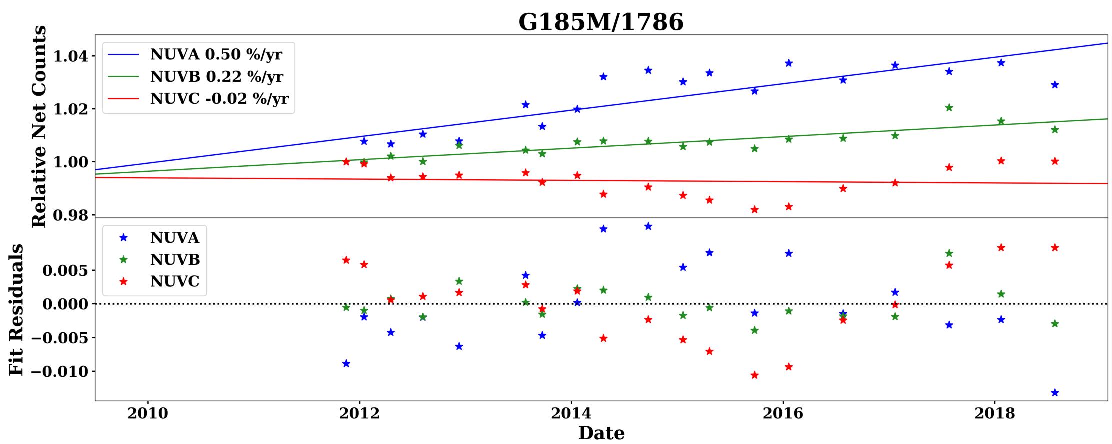

Figure 3. Results for G185M/1786. See the caption to Figure 1 for details.

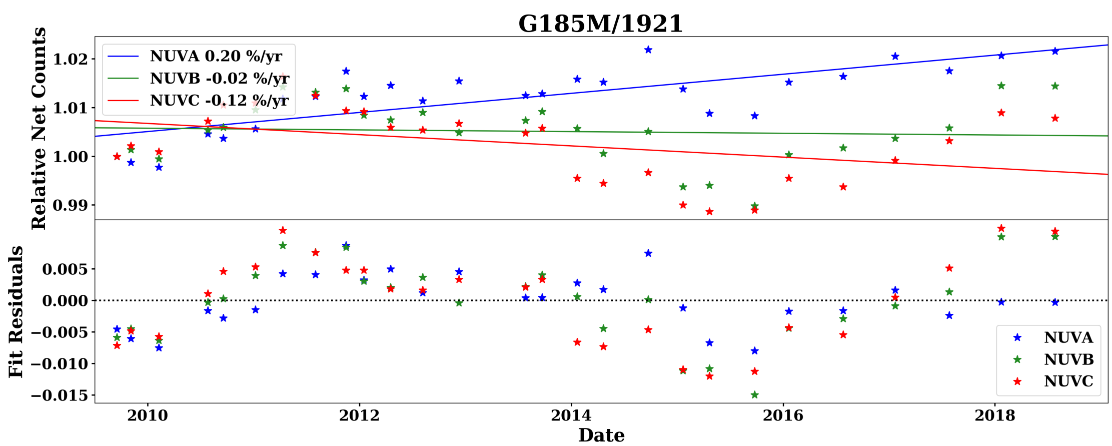

Figure 4. Results for G185M/1921. See the caption to Figure 1 for details.

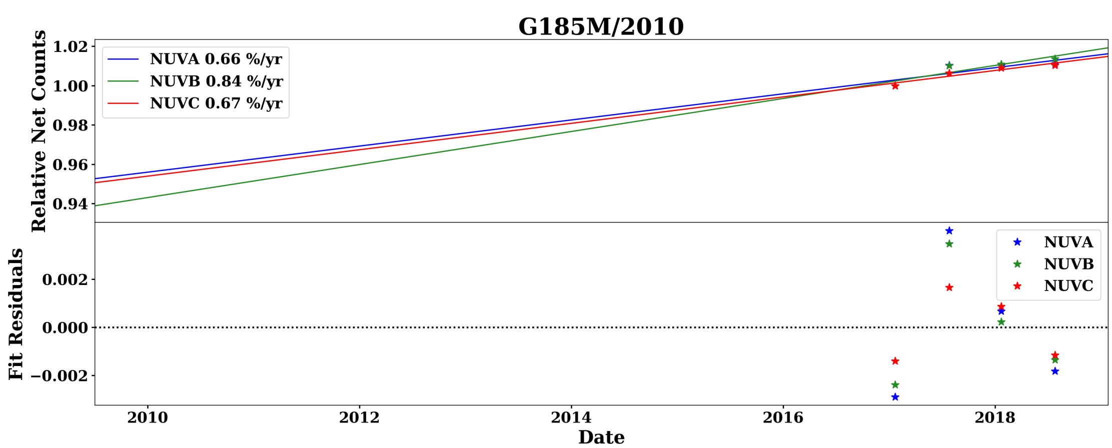

Figure 5. Results for G185M/2010. See the caption to Figure 1 for details.

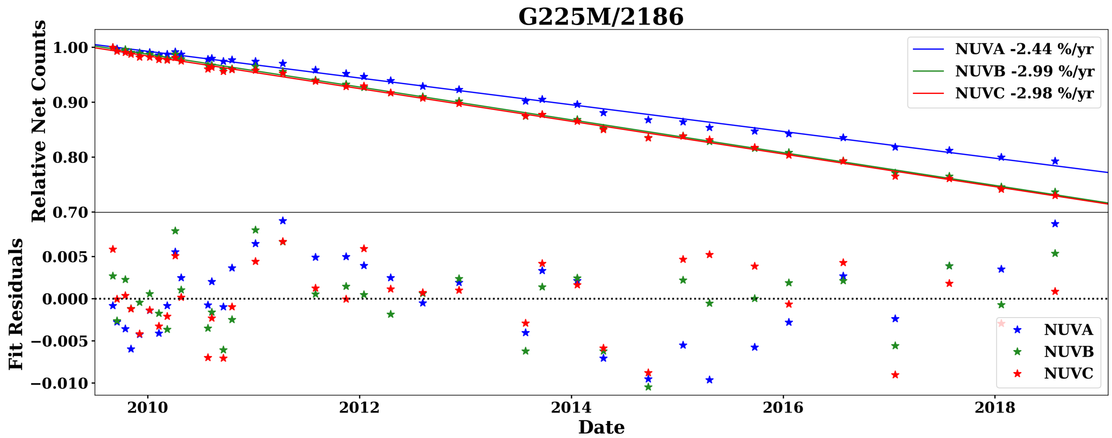

Figure 6. Results for G225M/2186. See the caption to Figure 1 for details.

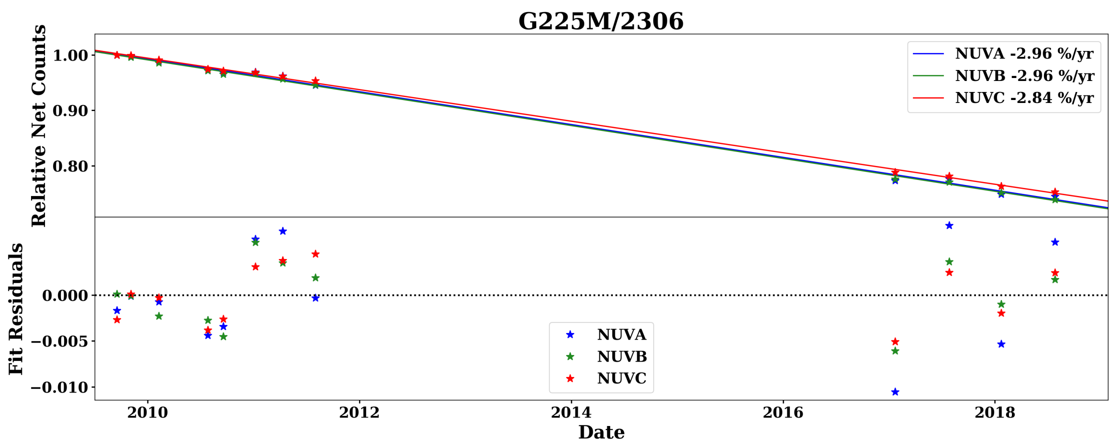

Figure 7. Results for G225M/2306. See the caption to Figure 1 for details.

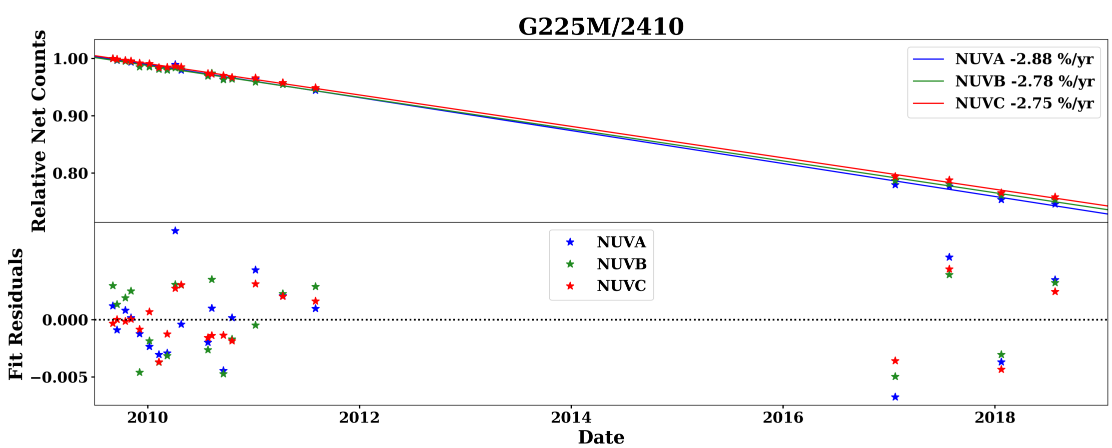

Figure 8. Results for G225M/2410. See the caption to Figure 1 for details.

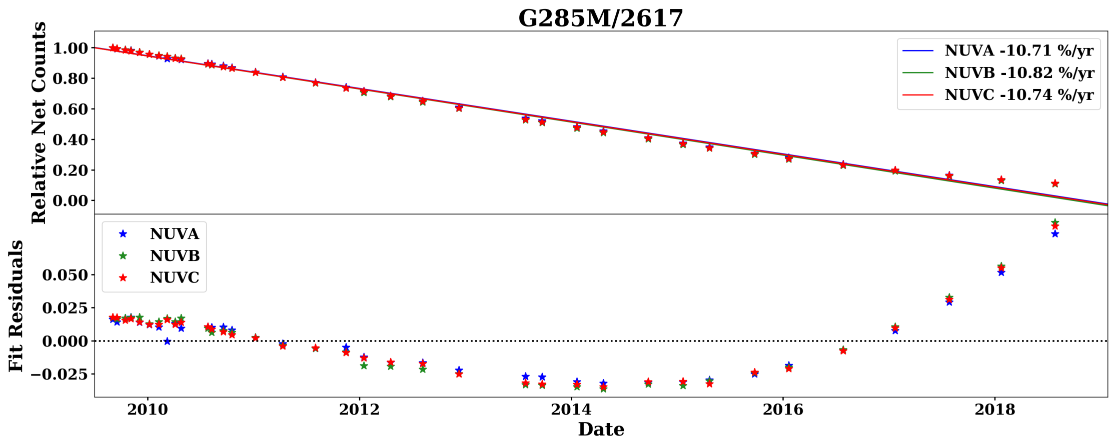

Figure 9. Results for G285M/2617. See the caption to Figure 1 for details.

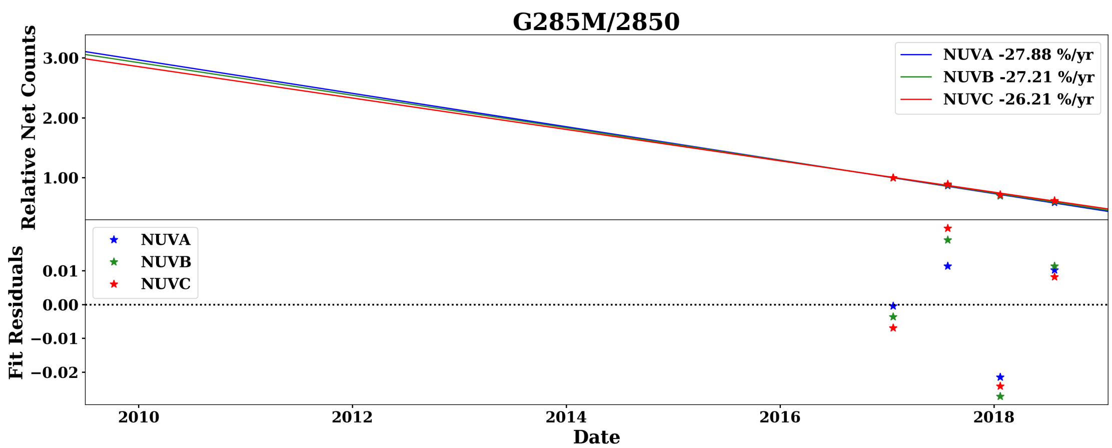

Figure 10. Results for G285M/2850. See the caption to Figure 1 for details.

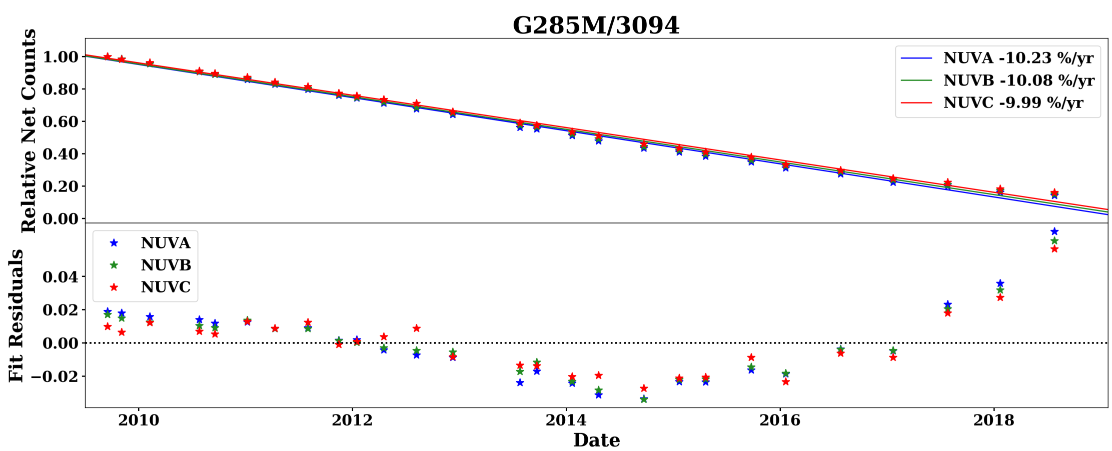

Figure 11. Results for G285M/3094. See the caption to Figure 1 for details.