

Cycle 23 COS/NUV Spectroscopic Sensitivity Monitor

Joanna M. Taylor¹

¹*Space Telescope Science Institute, Baltimore, MD*

2 August, 2017

ABSTRACT

Observations of HST spectrophotometric standard stars show that there is a time dependence of the COS NUV MAMA sensitivity (Fox et al. 2016). Time-dependent sensitivity (TDS) monitoring is necessary for accurate flux calibration. Regular calibration observations monitor the decline in sensitivity for all 4 NUV gratings: G185M, G225M, G285M, and G230L. Results from the Cycle 23 NUV TDS program show the reflectivity of the G225M and G285M gratings, which are coated in bare-aluminum, exhibit a steep time-dependent degradation at a rate of -3 to -2.5%/year and -11.6 to -10.5%/year respectively. The G185M and G230L gratings, which are coated in MgF₂ over aluminum, show a decline of -0.3 to +0.6%/year and -0.3 to +0.8%/year respectively.

Contents

- Program Design (page 2)
- Analysis and Results (page 2)
- Future Work (page 3)
- Supporting Figures (page 4)
- References (page 7)

1. Program Design

The Cosmic Origins Spectrograph (COS) NUV Time-Dependent Sensitivity (TDS) program executes every cycle and monitors the sensitivity of each NUV grating to detect changes due to contamination or other causes. These changes are characterized as a function of grating, cenwave, and stripe, and are used to update the COS NUV time-dependent sensitivity reference file (TDSTAB) as well as synphot files used which are used by the ETC.

The Cycle 23 NUV TDS program (14441, PI: Joanna Taylor) is identical in setup to its Cycle 22 predecessor (13973, PI: Joanna Taylor, CoI: Hugues Sana) except that the cadence of observations was reduced from three times to two times a year. Program 14441 was allocated 4 external orbits taken in 2 epochs spaced 6 months apart. Each epoch includes one orbit for all the medium-resolution gratings (G185M, G225M, G285M) and one orbit for the low-resolution grating (G230L). All visits executed successfully. The observed central wavelength settings (cenwaves) were G185M/1786, G185M/1921, G225M/2186, G285M/2617, G285M/3094, G230L/2635, and G230L/2950. These cenwaves constitute the reddest and bluest wavelengths containing only first order light for each grating, with the exception of G225M. Due to sensitivity differences on the medium- and low-resolution gratings, two spectrophotometric white dwarf standard star targets are used: WD1057+719 for G230L, and G191B2B for G185M, G225M, and G285M.

2. 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). The same analysis techniques and code used in previous cycles are used in the analysis of Cycle 23 data. The ratio of each NUV spectrum is taken with respect to the first spectrum in time and averaged for each stripe for each date. Fitting of the data is performed using the IDL routine *LINFIT*, which determines a linear fit by minimizing the χ^2 error statistic. This yields slopes and intercepts which can be used in TDSTABs and synphot files.

Figures 1-7 show the linear fit for one cenwave of each NUV grating as well as the residuals of the fit. The G230L (Figure 7) and G185M (Figure 1) gratings, which have a MgF₂ coating, exhibit relatively small sensitivity trends with slopes between +0.8 and -0.3 %/year. The bare-Al gratings G225M (Figure 3) and G285M (Figure 5), continue to decline at a steady rate of approximately -2.8 and -11 %/year respectively. These values are consistent with results from pre-launch grating efficiency tests.

SNR accuracy requirements are 30/resel at the central wavelength for all NUV gratings except G285M. Instead, a SNR of 26 is required for G285M due to its rapidly deteriorating sensitivity. The average measured SNR values per resel at the central wavelength of each cenwave setting is shown in Table 1. These were calculated by fitting a second-order polynomial to the 1-d spectrum and dividing by the deviation of the data from the fit. G225M/2186 and G230L/2950 are both falling slightly below the required SNR of 30. Both G285M cenwaves are falling significantly below the SNR requirement of 26. While some settings are falling below

the required SNR requirements, we are currently meeting the TDS characterization requirement of 2%.

No reference files with updated TDS trends were delivered for this cycle.

Table 1: Measured SNR compared to the required SNR for each grating and cenwave combination.

Grating/Cenwave	Measured SNR	Required SNR
G185M/1786	32	30
G185M/1921	30	30
G225M/2186	27	30
G285M/2617	15	26
G285M/3094	15	26
G230L/2635	42	30
G230L/2950	28	30

3. Future Work

To investigate a possible wavelength dependence on the TDS, additional orbits were added to the Cycle 24 program, 14858, in order to observe a more complete sample of cenwaves for each grating. Taking advantage of these extra orbits, the exposure times for the medium-resolution grating exposures will also be increased to boost the SNR.

4. Supporting Figures

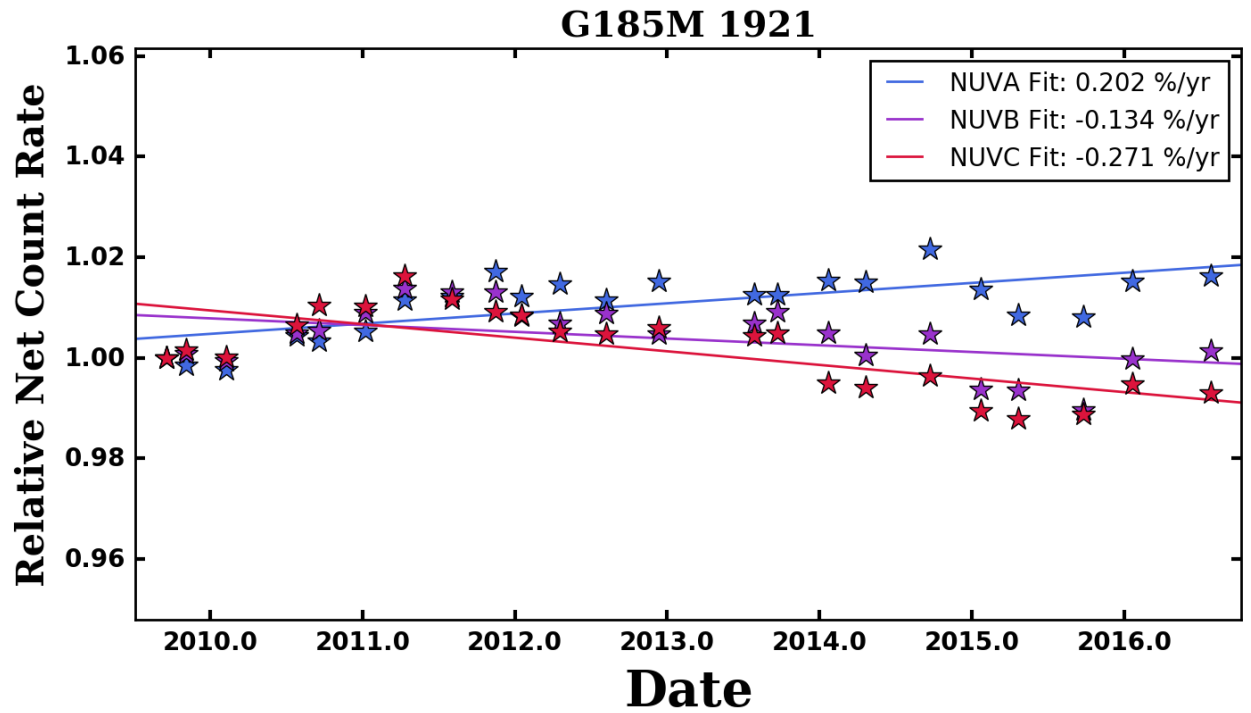


Figure 1: Relative sensitivity as a function of time for G185M/1921

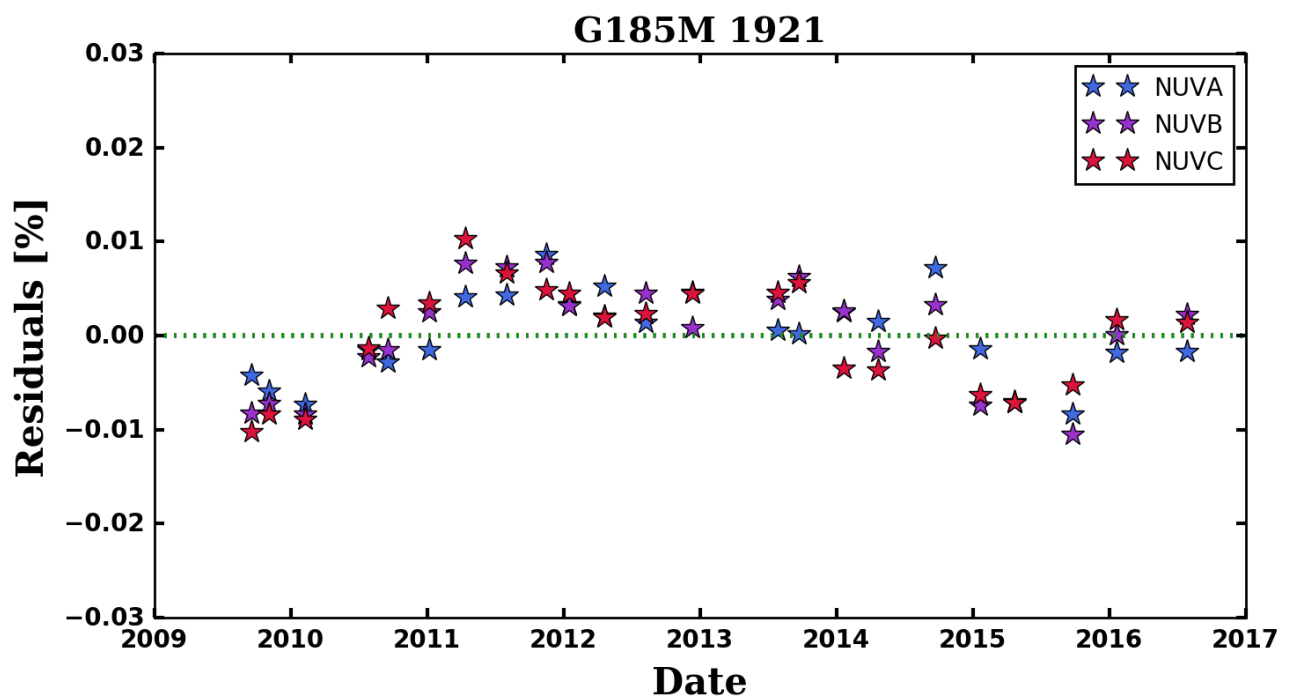


Figure 2: Residuals to the empirical fit as a function of time for G185M/1921.

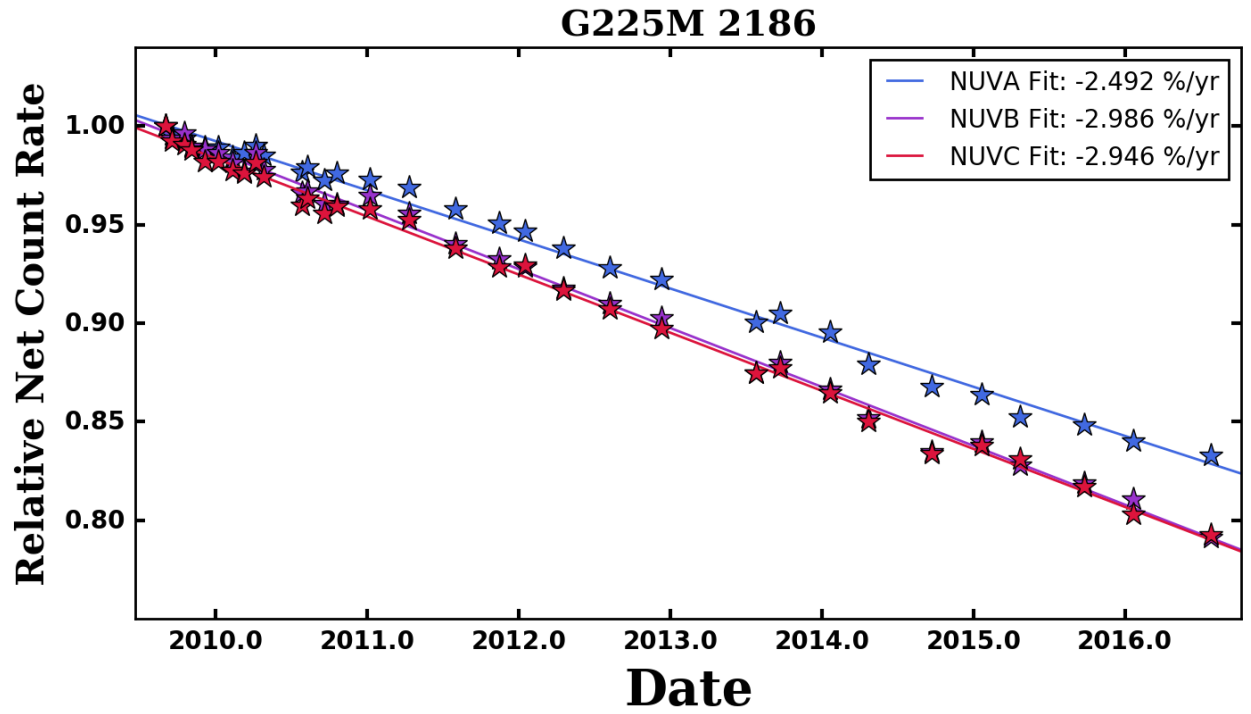


Figure 3: Relative sensitivity as a function of time for G225M/2186.

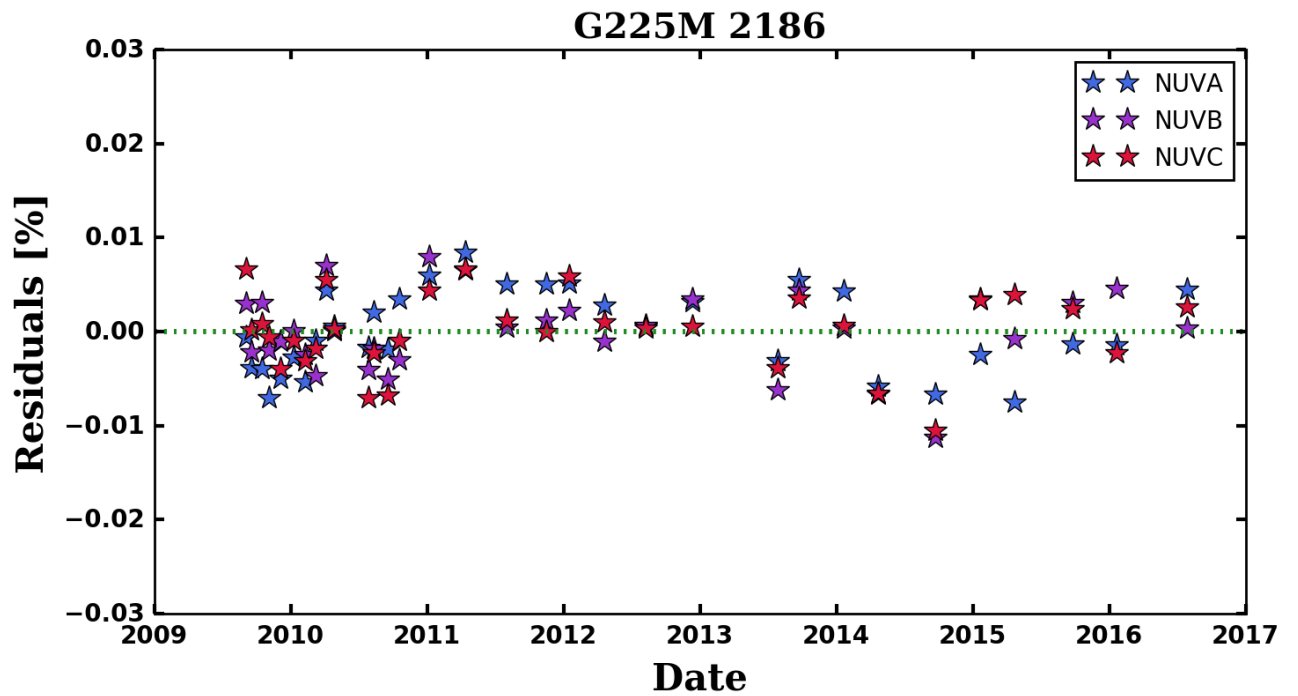


Figure 4: Residuals to the empirical fit as a function of time for G225M/2186.

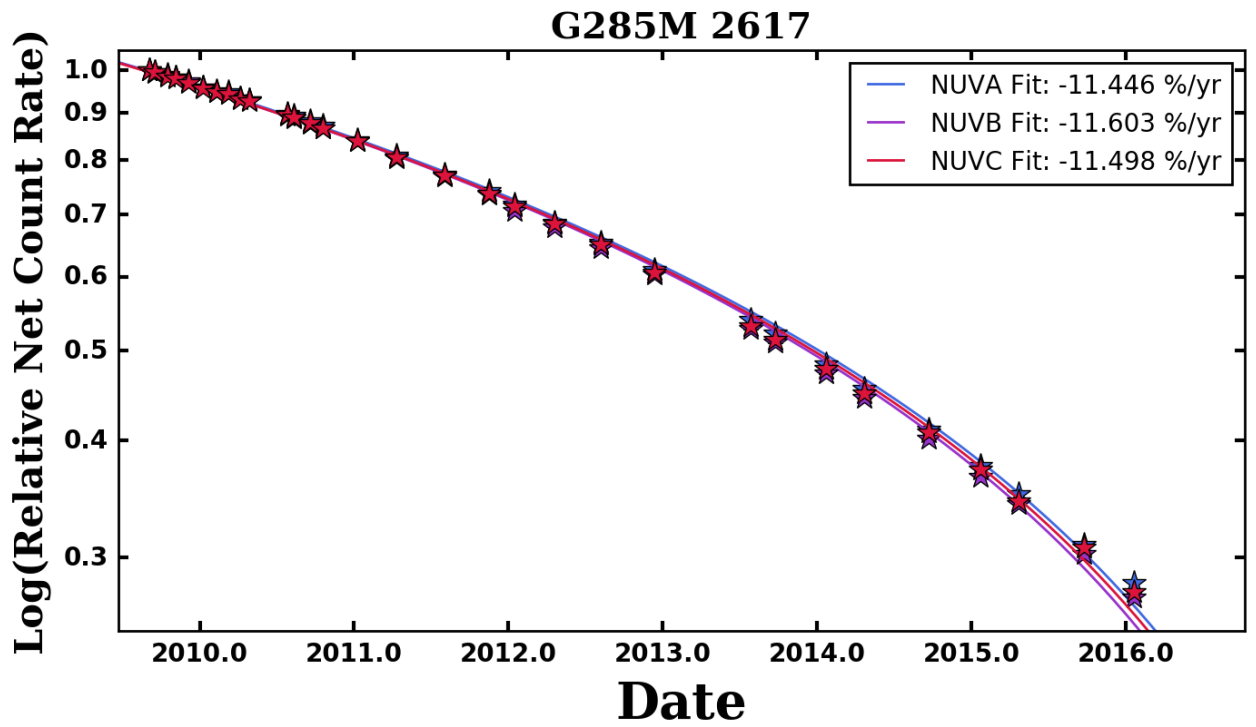


Figure 5: Relative sensitivity as a function of time for G285M/2617.

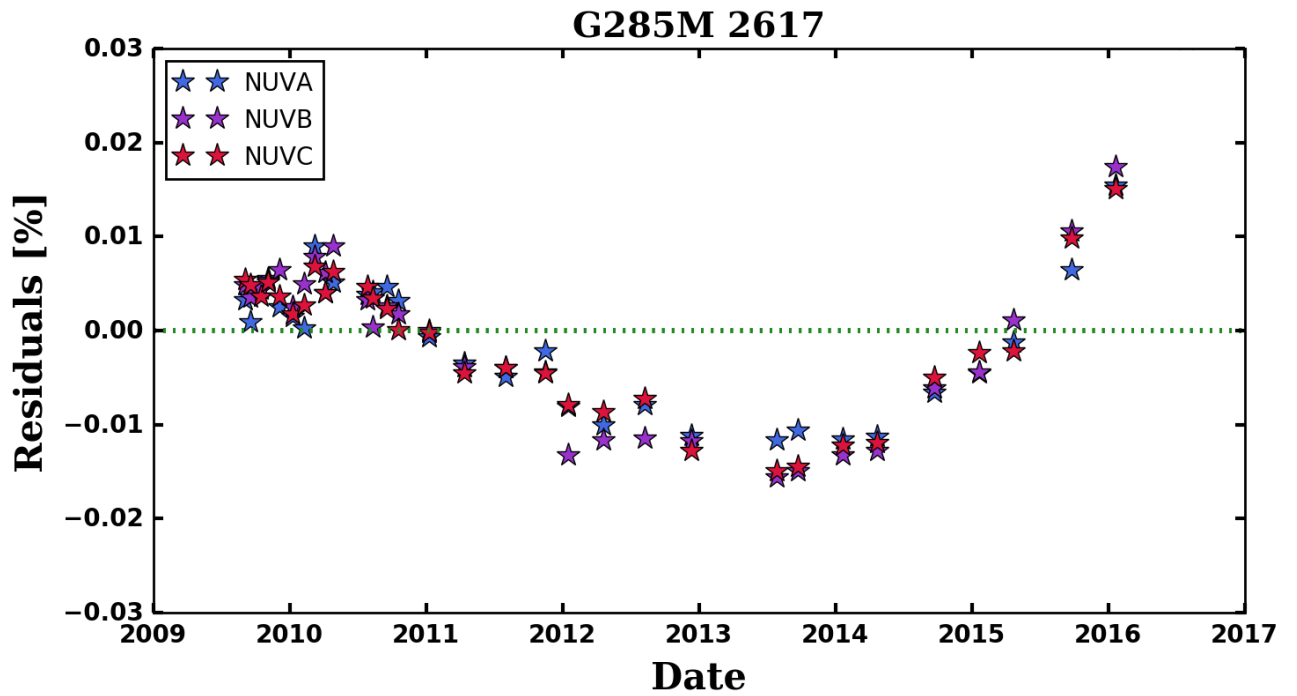


Figure 6: Residuals to the empirical fit as a function of time for G285M/2617.

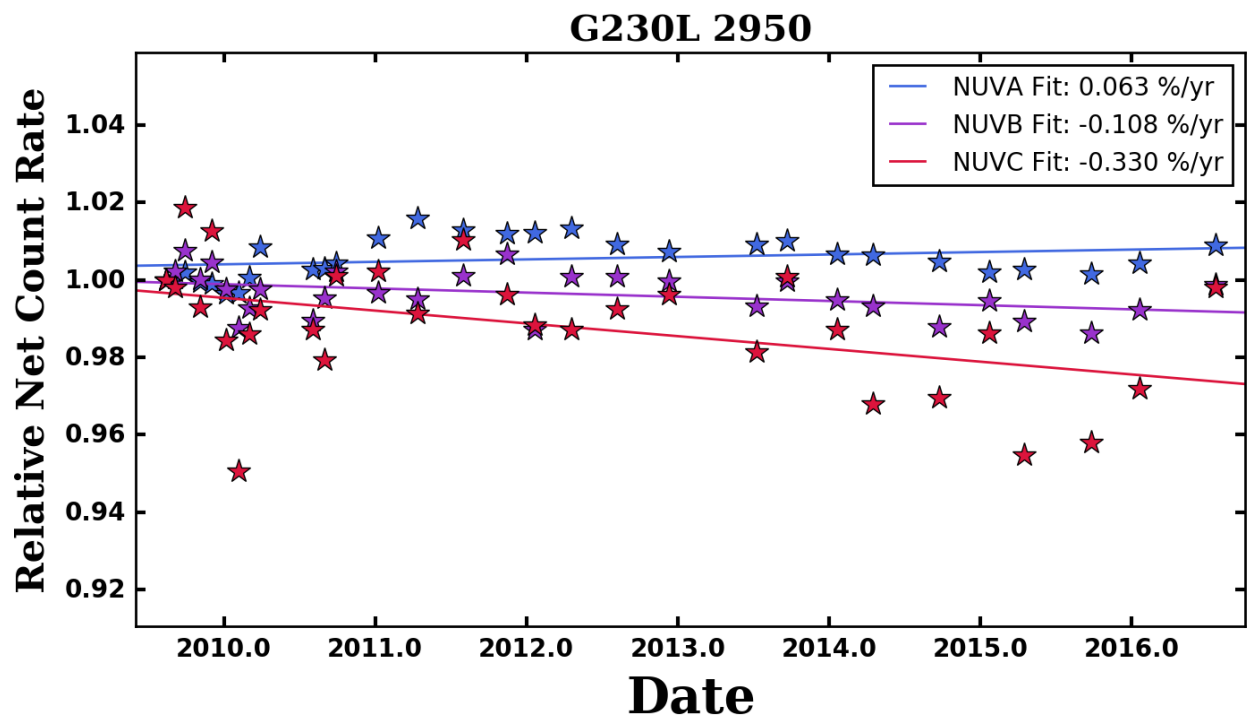


Figure 7: Relative sensitivity as a function of time for G230L/2950.

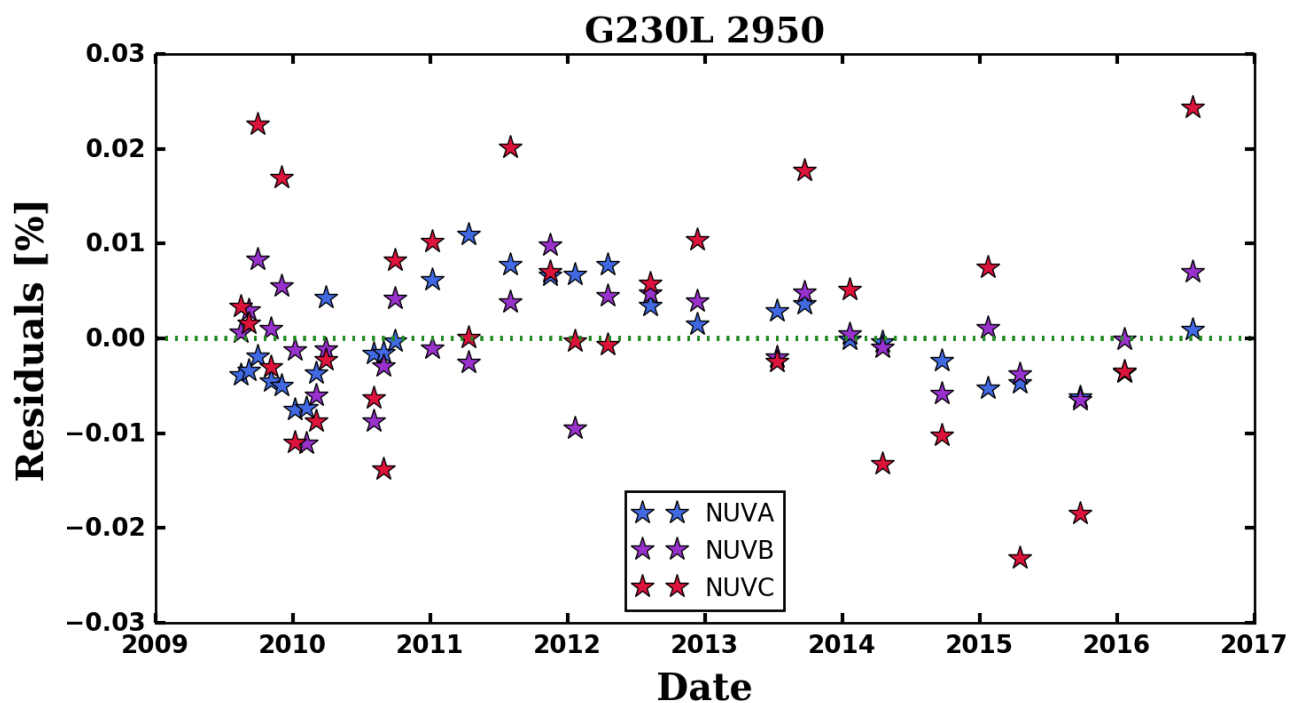


Figure 8: Residuals to the empirical fit as a function of time for G230L/2950.

References

Fox, A. J. et al., 2017, COS Instrument Handbook, Version 9.0, Baltimore: STScI

Osten, R.A., et al., 2011, COS Instrument Science Report 2011-02, “Updated Results from the COS Spectroscopic Sensitivity Monitoring Program”

Osten, R. A., et al., 2010, COS Instrument Science Report 2010-15, “Early Results from the COS Spectroscopic Sensitivity Monitoring Programs”