Linearity of Low Dispersion LWR Spectra
Taken at -5.0 kV UVC and -4.5 kV UVC

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I. Introduction

In 1983 the development of a “flare”, or discharge, in the LWR camera required that its default UVC setting be changed from -5.0 kV to -4.5 kV in order to reduce the adverse effects of the flare. Studies done at the time indicated that a new ITF would not be needed (Imhoff, 1985). Another way to test this is to compare the linearity characteristics of images obtained at both UVC settings. Standard star spectra at both UVC settings, obtained between October 31, 1985 and November 13, 1988, have been analyzed to study the linearity errors of non-optimum exposures. The observational and analysis techniques are summarized in section II. The differences between optimum trailed spectra taken at -5.0 kV UVC and -4.5 kV UVC are discussed in section III. In section IV we will consider the reproducibility of optimum exposures at both UVC settings. Finally, we will discuss the linearity of non-optimum trailed spectra in section V.

II. Observation and Data Analysis Techniques

The observation and analysis techniques used for this study are similar to the methods used in Park and Oliversen (1988). The standard star HD 60753 is routinely observed for linearity monitoring twice per year. This monitoring sequence typically consists of an initial optimum (100%) trailed exposure followed by a series of under- and over-exposed trailed spectra and terminates in a final optimum exposure.

As in the last linearity report (Park and Oliversen 1988), the linearity errors were determined by rationing a test exposure to the average of the two 100% exposure level images. It should be noted that 100% exposures are scaled to optimize the 2600 to 3000 Å range, and wavelengths outside of that range will be underexposed. Each exposure is corrected for the camera head amplifier temperature-induced sensitivity changes (Garhart and Teays, 1988), and is then smoothed with a 5 point median filter and with an 11 point boxcar filter before taking the ratio. Table 1 lists the images used for this study; representative examples of the ratio plots are shown in the figures.
III. -5.0 kV UVC versus -4.5 kV UVC for Optimum Trailed Spectra

Figure 1a shows a sample plot of optimum trailed exposures of HD 60753, taken at both -5.0 kV and -4.5 kV UVC. The images were chosen to be close together in time, in order to minimize any effects of long-term sensitivity changes. For each UVC setting two exposures were smoothed as above, and averaged before being plotted. The 4.5 kV fluxes were multiplied by a factor of 1.37 in order to compensate for the different exposure times and thus absolute calibration at that configuration. The corrected fluxes for the -4.5 kV setting can be seen to closely match the fluxes for the -5.0 kV UVC setting.

The ratio between the two average fluxes is shown in Figure 1b. This ratio averages about 2–3% above unity for wavelengths below 3000 Å. This deviation from unity is within the LWR camera reproducibility RMS of ± 3.5%, as given in Garhart and Teays (1988).

IV. Reproducibility

Figures 2a–d show the ratio of pairs of identical, optimally exposed trailed spectra of HD 60753. Ratios for the -5.0 kV UVC setting show 0–4% deviation from unity below 3000 Å, while typical errors for -4.5 kV are 1–6%. Reproducibility of the two UVC settings are similar overall, but the -4.5 kV setting may have slightly greater repeatability errors due to infrequent use of the LWR camera during the time period considered.

V. Non-Optimum Trailed Spectra

The flux ratios for several under- and over-exposed spectra at both -5.0 kV and -4.5 kV UVC are shown in Figures 3 through 7b.

The 20% linearity monitoring exposures were taken in only the -4.5 kV setting for the time period considered. The 20%/100% ratios (Figure 3) are very noisy and show a maximum average error of 9–10% between 2400 and 3000 Å. There is some evidence for wavelength dependence; the derived fluxes increase from 2200 to 2400 Å, and decrease from 2800 to 3200 Å.

The 40%/100% flux ratios (Figures 4a–d) are similar for the two UVC settings. Typical ratios for the -5.0 kV setting are 1–5% too high from 2000–2400 Å and 5–8% high between 2400 and 3100 Å. The fluxes are 0–3% high below 2200 Å and 5–6% high above that for the -4.5 kV setting. Most of these flux ratios are basically the same; an exception is shown in Figure 9. For unknown reasons, this flux ratio follows the same curve but lies nearly 10% lower than the other ratios. Additional noise in this 40% exposure is introduced by a ping, which lies near 2650 Å.

The -5.0 kV and -4.5 kV UVC 60%/100% flux ratios are similar (Figures 5a–b). Maximum average errors for both settings are 0–4% too high below 2400 Å, and 2–7% high above. The fluxes derived for the -4.5 kV setting are slightly higher than those for -5.0 kV, but follow the same curve. These errors are near the repeatability limit.

There is no substantial difference between the two UVC settings in the 120%/100% flux ratios (Figures 6a–d). Fluxes are 0–4% too low for the -5.0 kV UVC, and 1–2% low for
-4.5 kV. Between about 2600 and 2800 Å, fluxes were derived by extrapolation above the highest level of the ITF.

The 160%/100% flux ratios (Figures 7a–b) are nearly identical for -5.0 kV and -4.5 kV UVC. For either setting, the fluxes average 3–5% too low in the range of 2000 to 2600 Å, approach unity between 2600 and 2900 Å (mostly saturated pixels), and are 2–4% too low above 2900 Å. Between 2500 and 2950 Å, fluxes were derived by extrapolation above the highest level of the ITF, and saturated pixels appear between 2600 and 2800 Å.

VI. Discussion

There appears to be no significant difference in linearity between the -5.0 kV and -4.5 kV UVC settings in the LWR camera. While there is some deviation from unity in each of the non-optimum linearity ratios, it is generally within the camera’s reproducibility errors. The similarity in linearity errors of the -4.5 kV to the -5.0 kV setting supports the earlier conclusion that a new LWR ITF is not needed for the -4.5 kV UVC setting.

References

“Linearity of Low Dispersion Spectra Processed with the New SWP ITF”

“IUE Low Dispersion Sensitivity Monitoring XIV”

Imhoff, C. L. 1985, NASA IUE Newsletter, No. 28, p. 10
“LWR Camera and ITF Performance with 4.5 kV UVC”
**Table 1**

*LWR Images Analyzed for This Study*

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Figure 1a
HD 60753 taken at -4.5 and -5.0 kV UVC

LWR 18014 & LWR 18018
LWR 17950 & LWR 17954
Trailed Expos taken 12/5/86 & 10/21/86

Wavelength

Figure 1b
100% at -4.5 kV / 100% at -5.0 kV

(LWR 18014 + LWR 18018) / (LWR 17950 + LWR 17954)
Taken December 5, 1986 and October 21, 1986
Trailed Exposures

Wavelength
Figure 2a  100% / 100% at -5.0 kV UVC

LWR 17808 / LWR 17804
October 31, 1985
Trailed Exposures

Figure 2b  100% / 100% at -5.0 UVC

LWR 17895 / LWR 17891
May 7, 1986
Trailed Exposures
Figure 2c 100% / 100% at -4.5 kV UVC

LWR 18018 / LWR 18014
December 5, 1986
Trailed Exposures

Figure 2d 100% / 100% at -4.5 kV UVC

LWR 18236 / LWR 18232
November 13, 1988
Trailed Exposures
Figure 3  20% / 100% at -4.5 kV UVC

LWR 18111 / (LWR 18104 + LWR 18108)
June 15, 1987
Trailed Exposures
Figure 4a 40% / 100% at -5.0 kV UVC

LWR 17805 / (LWR 17804 + LWR 17808)
October 31, 1985
Trailed Exposures

Figure 4b 40% / 100% at -5.0 kV UVC

LWR 17892 / (LWR 17891 + LWR 17895)
May 5, 1986
Trailed Exposures
Figure 4c 40% / 100% at -4.5 kV UVC

LWR 18015 / (LWR 18014 + LWR 18018)

December 5, 1986

Trailed Exposures

Figure 4d 40% / 100% at -4.5 kV UVC

LWR 18233 / (LWR 18232 + LWR 18236)

November 13, 1988

Trailed Exposures
Figure 5a  60% / 100% at -5.0 kV UVC

LWR 17810 / (LWR 17804 + LWR 17808)
October 31, 1985
Trailing Exposures

Figure 5b  60% / 100% at -4.5 kV UVC

LWR 18019 / (LWR 18014 + LWR 18018)
December 5, 1986
Trailing Exposures
Figure 6a 120% / 100% at -5.0 kV UVC

LWR 17806 / (LWR 17804 + LWR 17808)
October 31, 1985
Trailed Exposures

Figure 6b 120% / 100% at -5.0 kV UVC

LWR 17893 / (LWR 17891 + LWR 17895)
May 7, 1986
Trailed Exposures
Figure 6c 120% / 100% at -4.5 kV UVC

LWR 18016 / (LWR 18014 + LWR 18018)
December 5, 1988
Trailing Exposures

Figure 6d 120% / 100% at -4.5 kV UVC

LWR 18234 / (LWR 18232 + LWR 18236)
November 13, 1988
Trailing Exposures
Figure 7a 160% / 100% at -5.0 kV UVC

LWR 17894 / (LWR 17891 + LWR 17895)
May 7, 1986
Trailed Exposures

Figure 7b 160% / 100% at -4.5 kV UVC

LWR 18017 / (LWR 18014 + LWR 18018)
December 5, 1986
Trailed Exposures