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 ratioing 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 repeatibility 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

Park, E. A. and Oliversen, N. A. 1988, NASA IUE Newsletter, No. 37, p. 85.
"Linearity of Low Dispersion Spectra Processed with the New SWP ITF"

Garhart, M. P. and Teays, T. J. 1988, NASA IUE Newsletter No. 35, p. 99
"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

-5.0 kV UVC		-4.5 kV UVC	
Image Number	Exposure Level	Image Number	Exposure Level
LWR 17804	100%	LWR 18014	100%
LWR 17805	40%	LWR 18015	40%
LWR 17806	120%	LWR 18016	120%
LWR 17807	160%	LWR 18017	160%
LWR 17808	100%	LWR 18018	100%
LWR 17810	60%	LWR 18019	60%
		LWR 18020	20%
LWR 17891	100%		
LWR 17892	40%	LWR 18104	100%
LWR 17893	120%	LWR 18105	40%
LWR 17894	160%	LWR 18106	120%
LWR 17895	100%	LWR 18107	160%
		LWR 18108	100%
LWR 17950	100%	LWR 18110	60%
LWR 17951	40%	LWR 18111	20%
LWR 17952	120%		
LWR 17953	160%	LWR 18232	100%
LWR 17954	100%	LWR 18233	40%
		LWR 18234	120%
		LWR 18235	160%
		LWR 18236	100%
		LWR 18238	60%
		LWR 18239	20%

Figure 1a

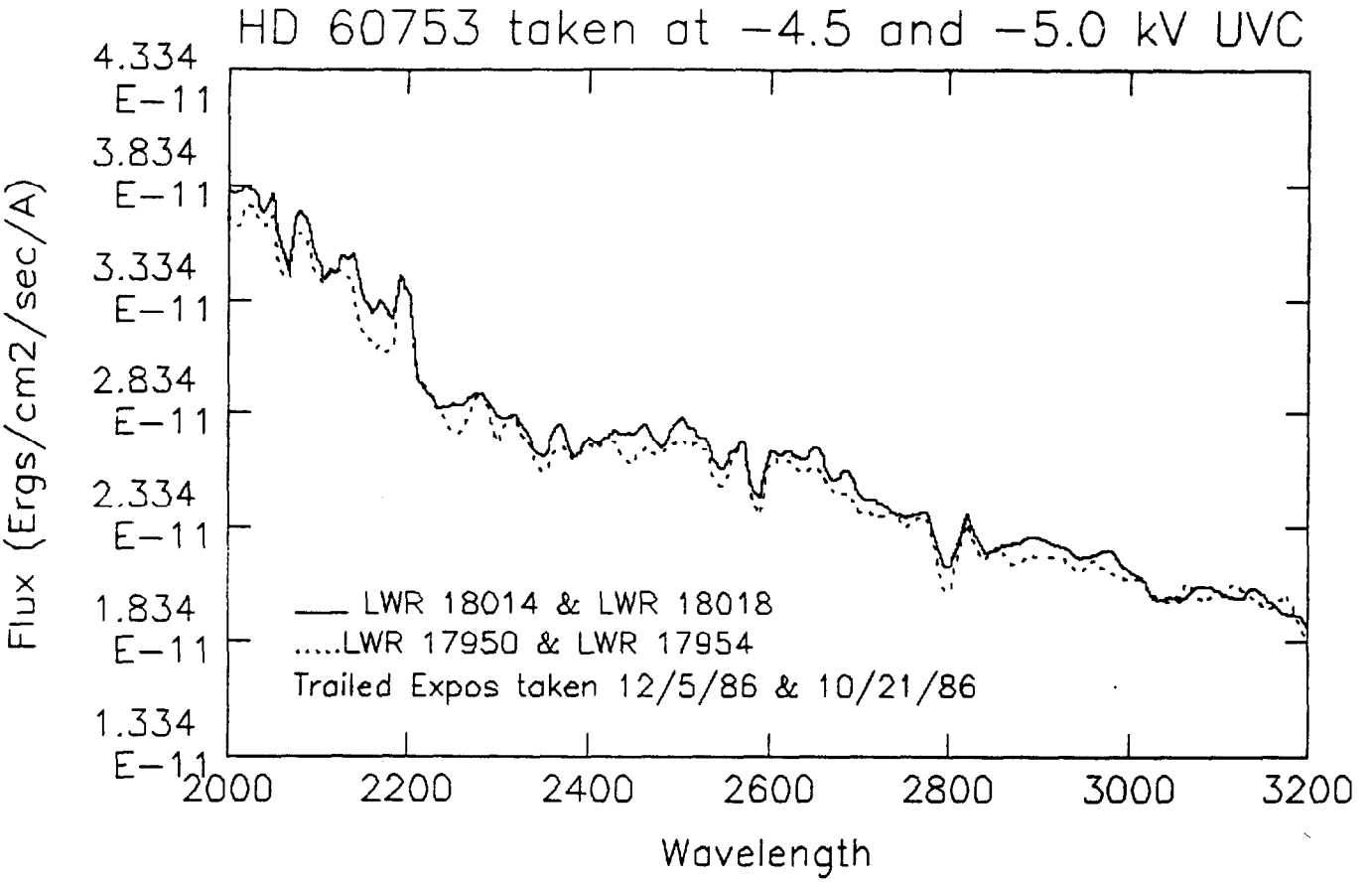


Figure 1b

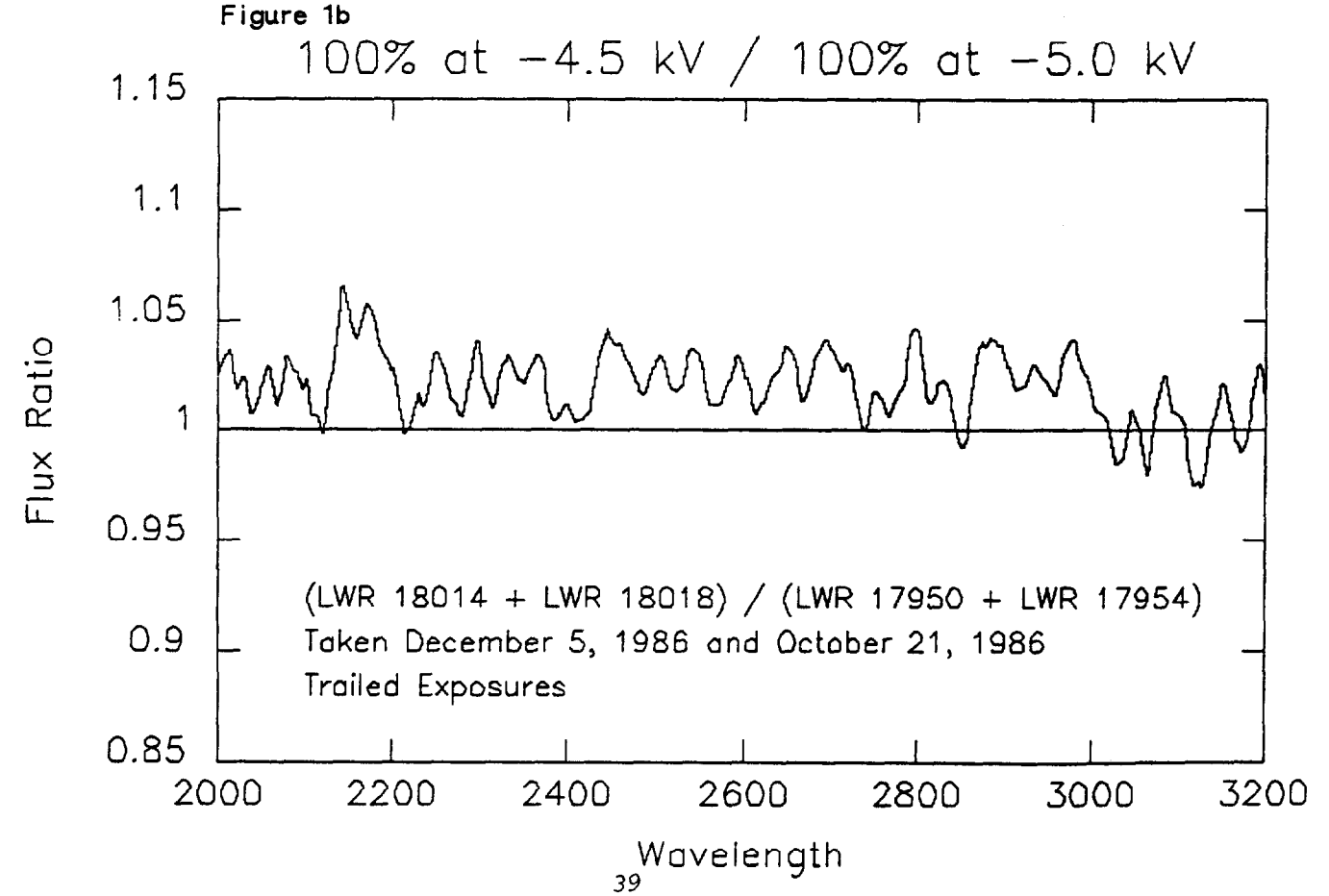


Figure 2a 100% / 100% at −5.0 kV UVC

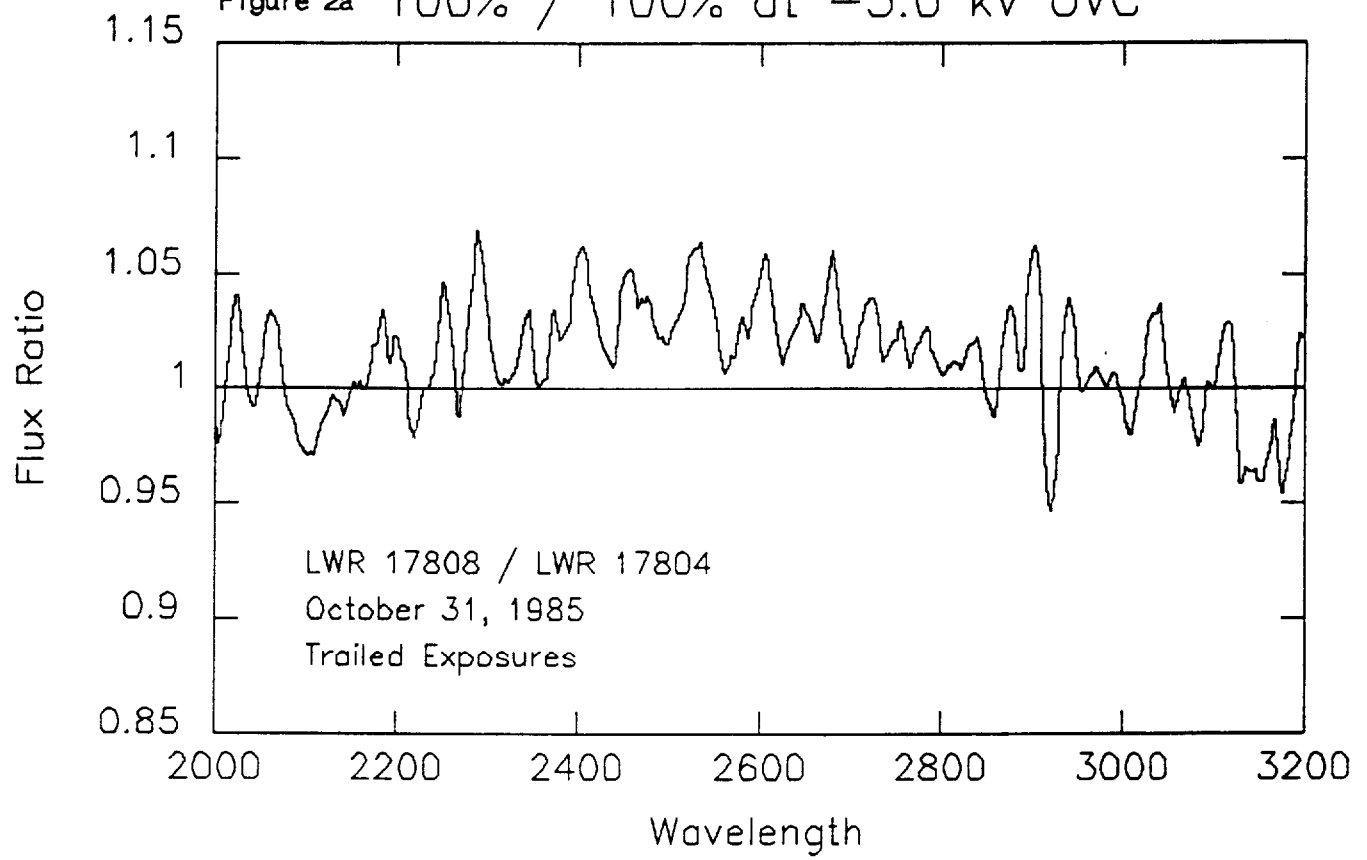
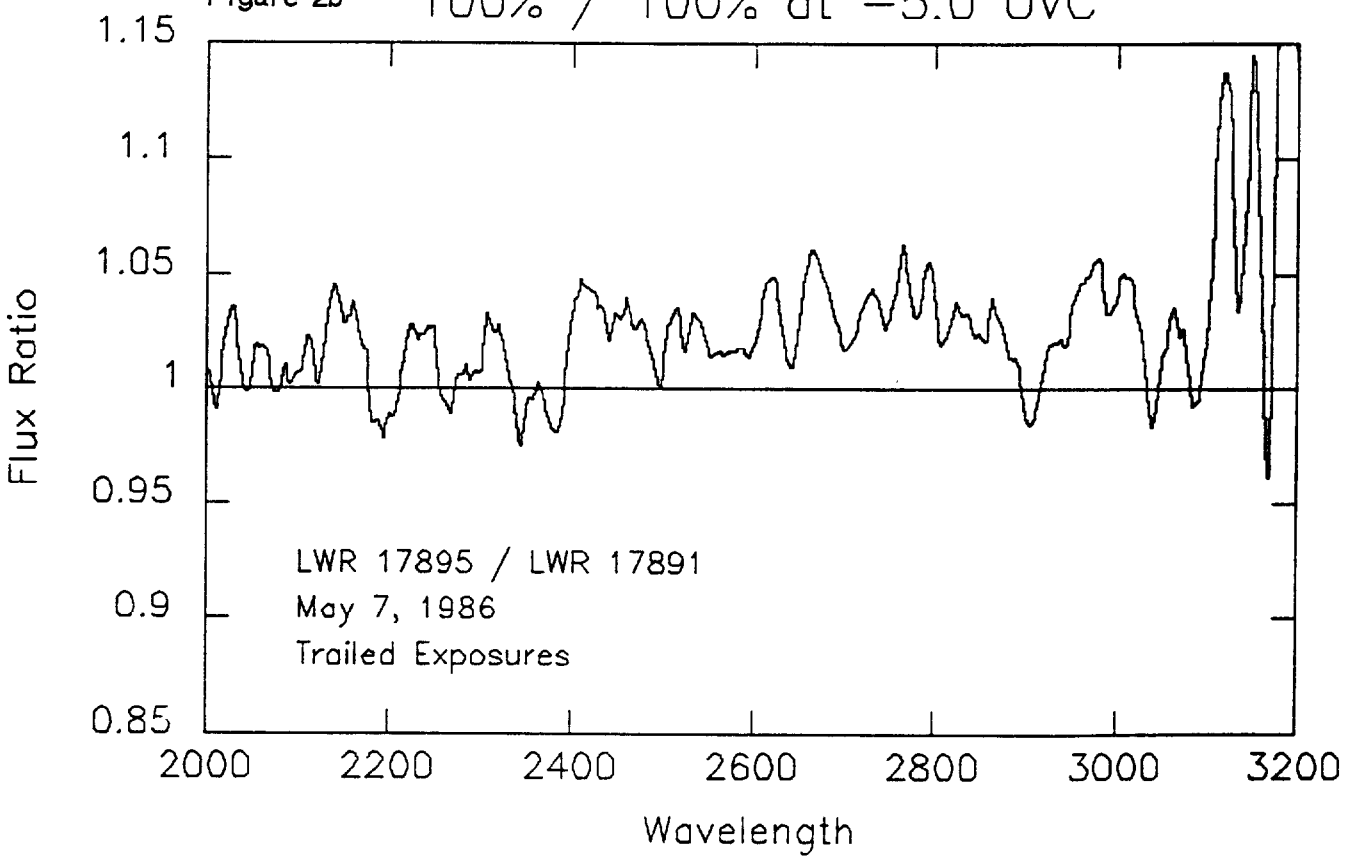


Figure 2b 100% / 100% at −5.0 UVC



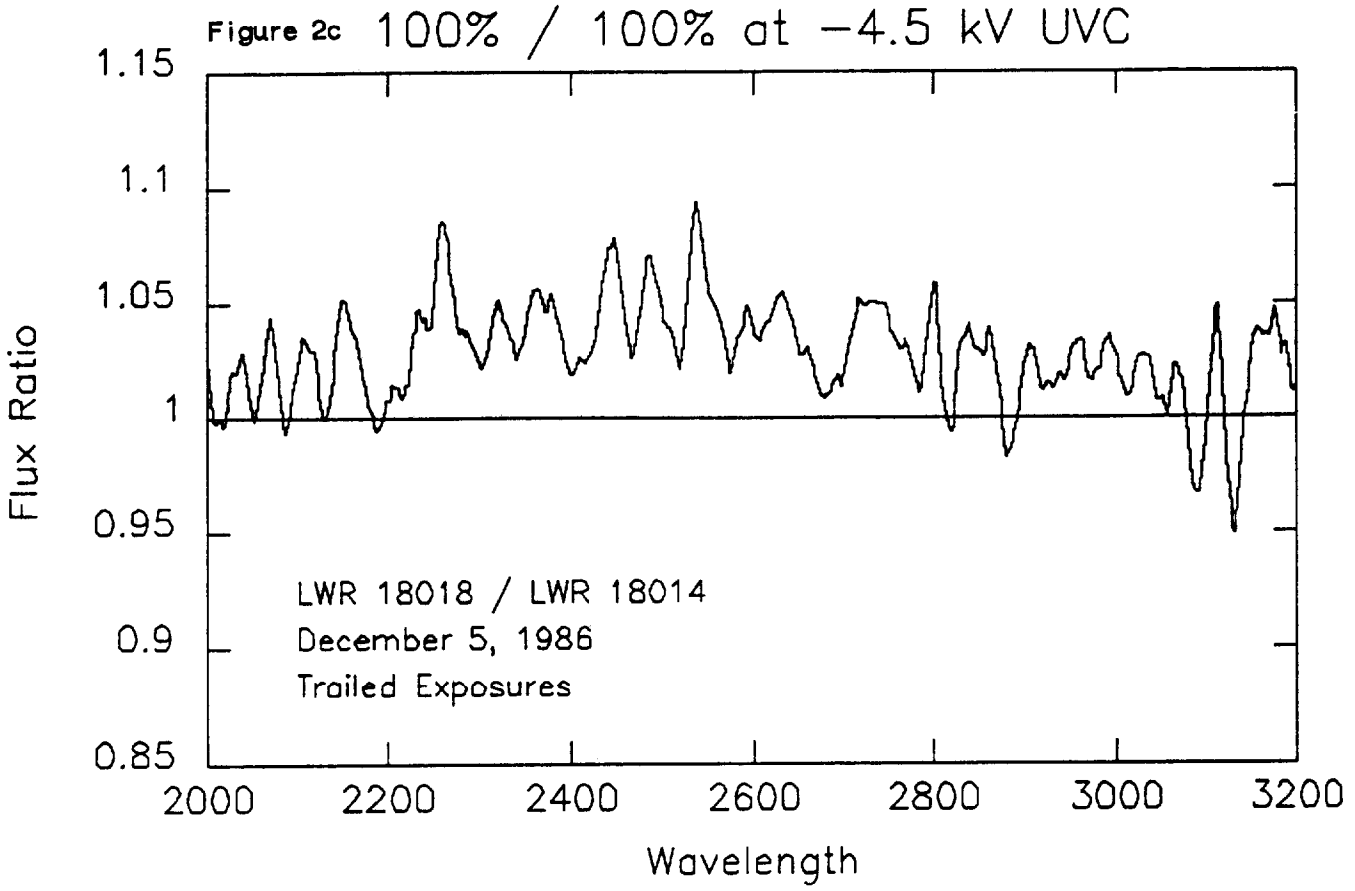


Figure 2c

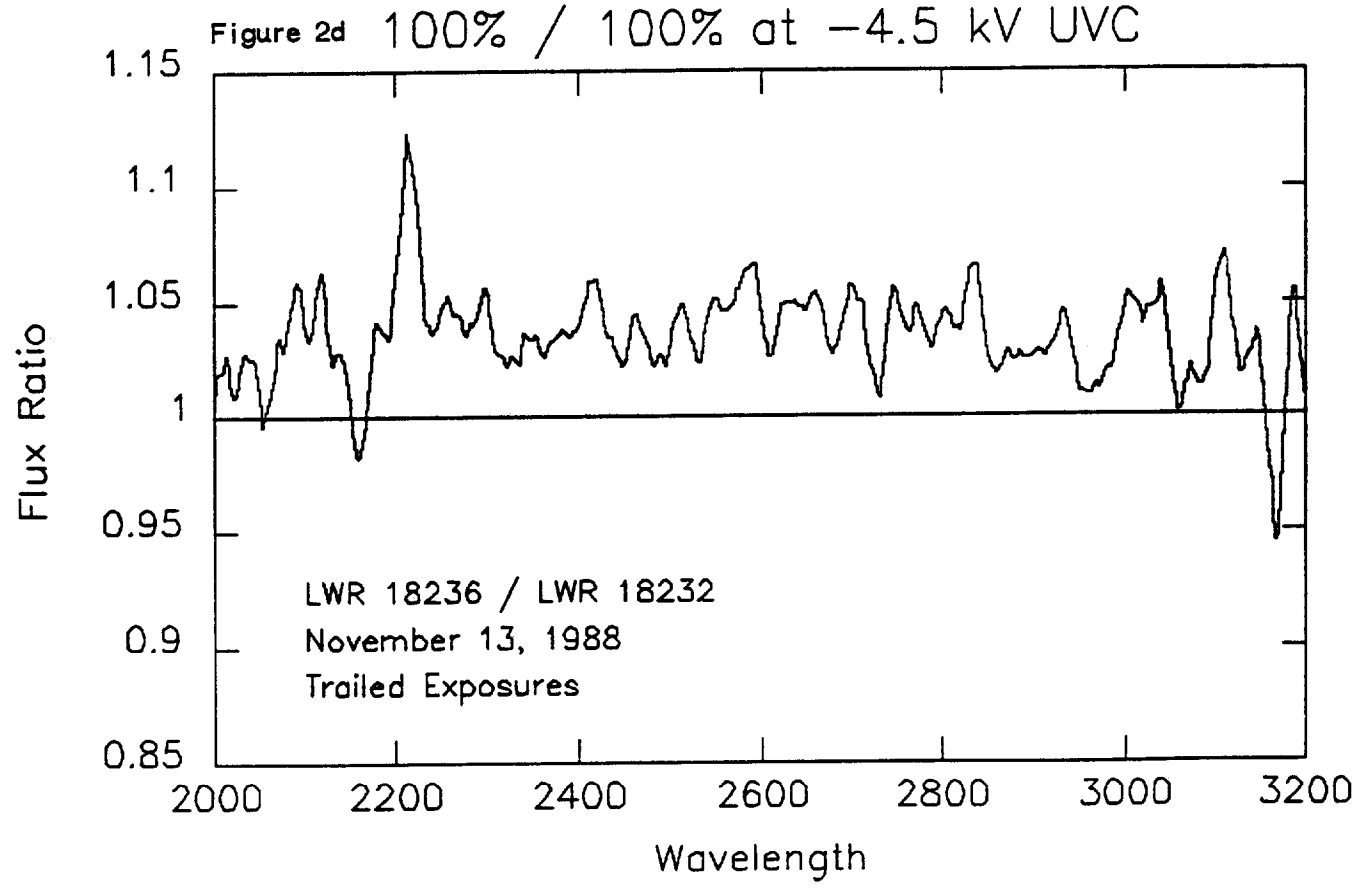


Figure 2d

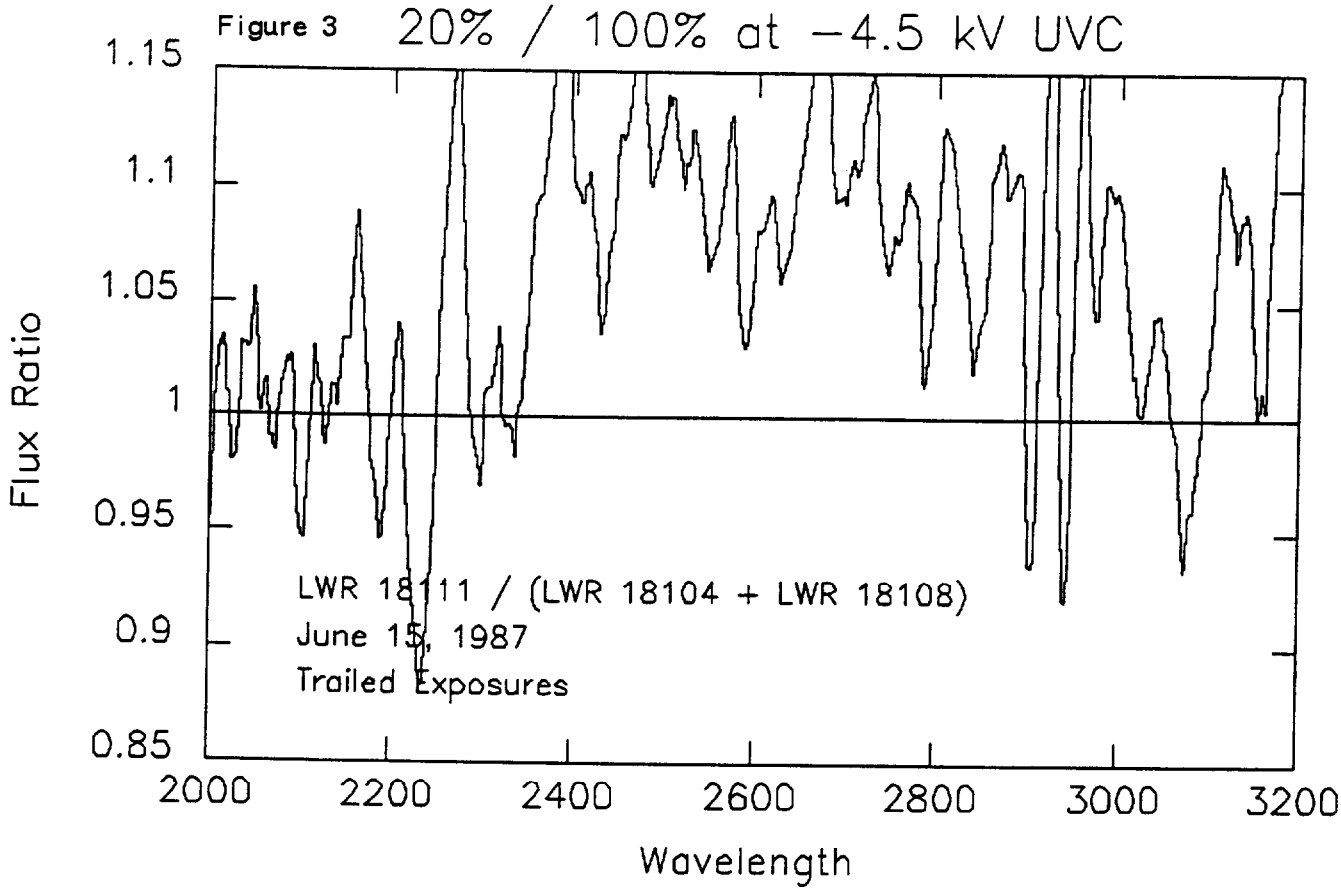


Figure 3
20% / 100% at −4.5 kV UVC
1.15
1.1
1.05
1
0.95
0.9
0.85
Flux Ratio
LWR 18111 / (LWR 18104 + LWR 18108)
June 15, 1987
Trailed Exposures
2000
2200
2400
2600
2800
3000
3200
Wavelength

Figure 4a 40% / 100% at −5.0 kV UVC

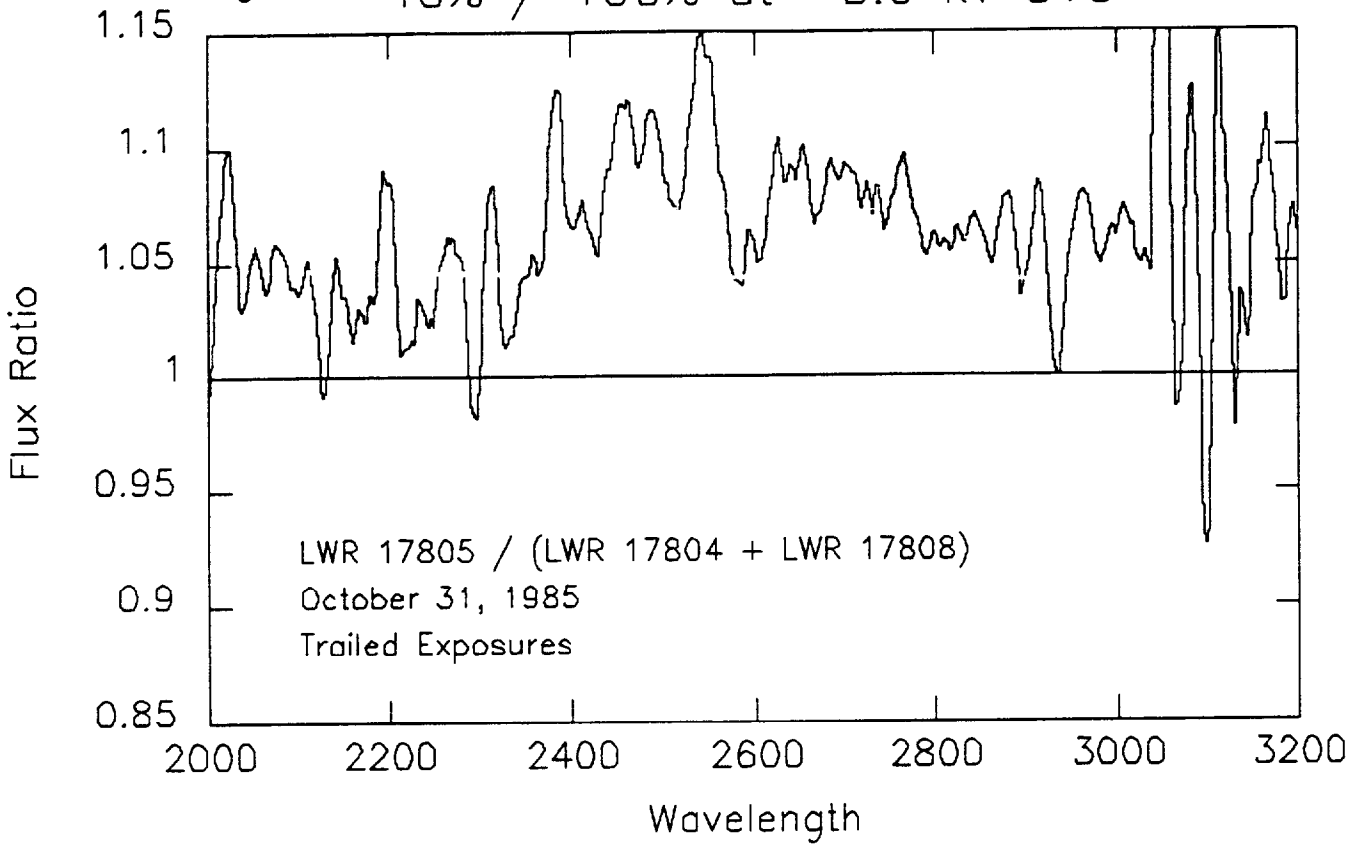


Figure 4b 40% / 100% at −5.0 kV UVC

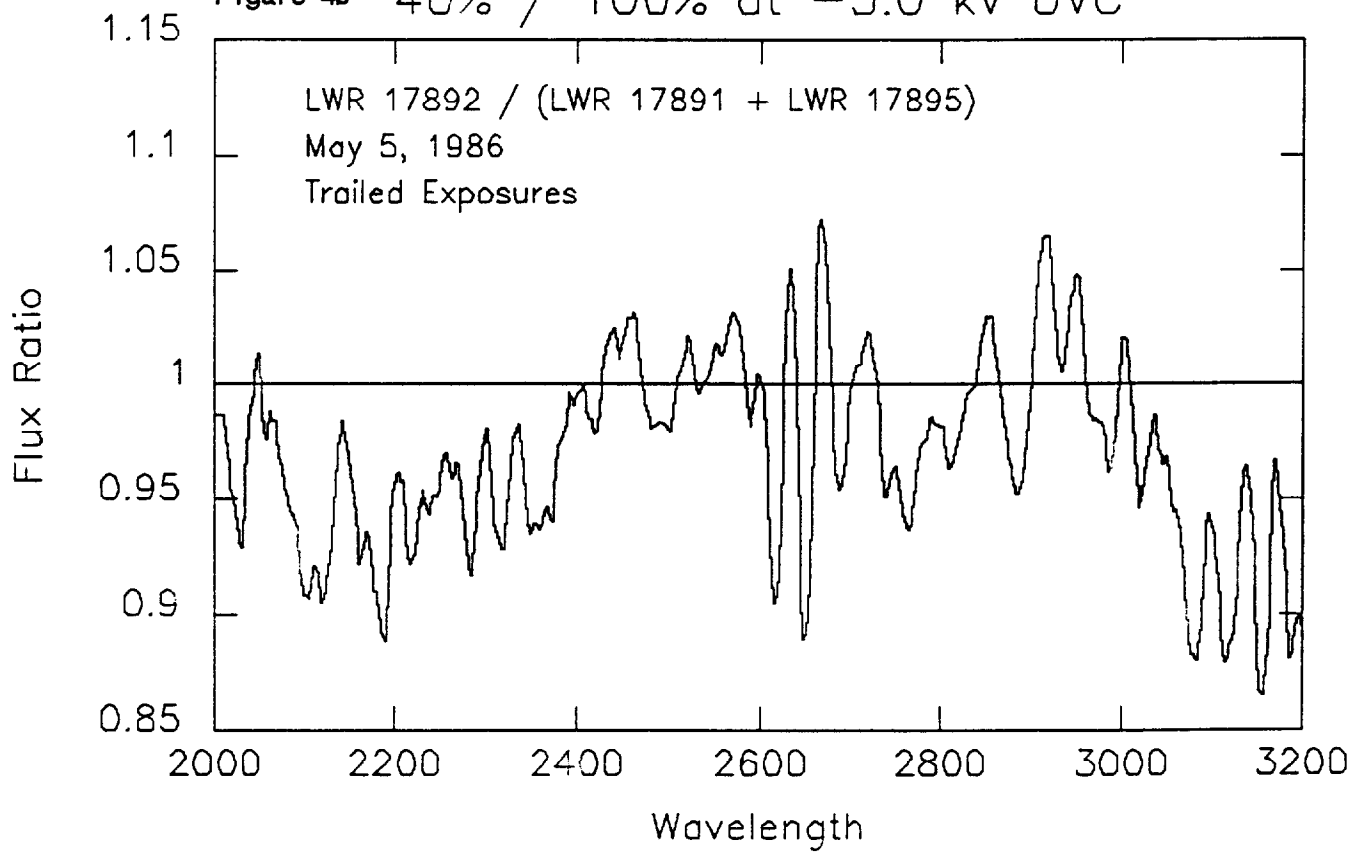


Figure 4c 40% / 100% at −4.5 kV UVC

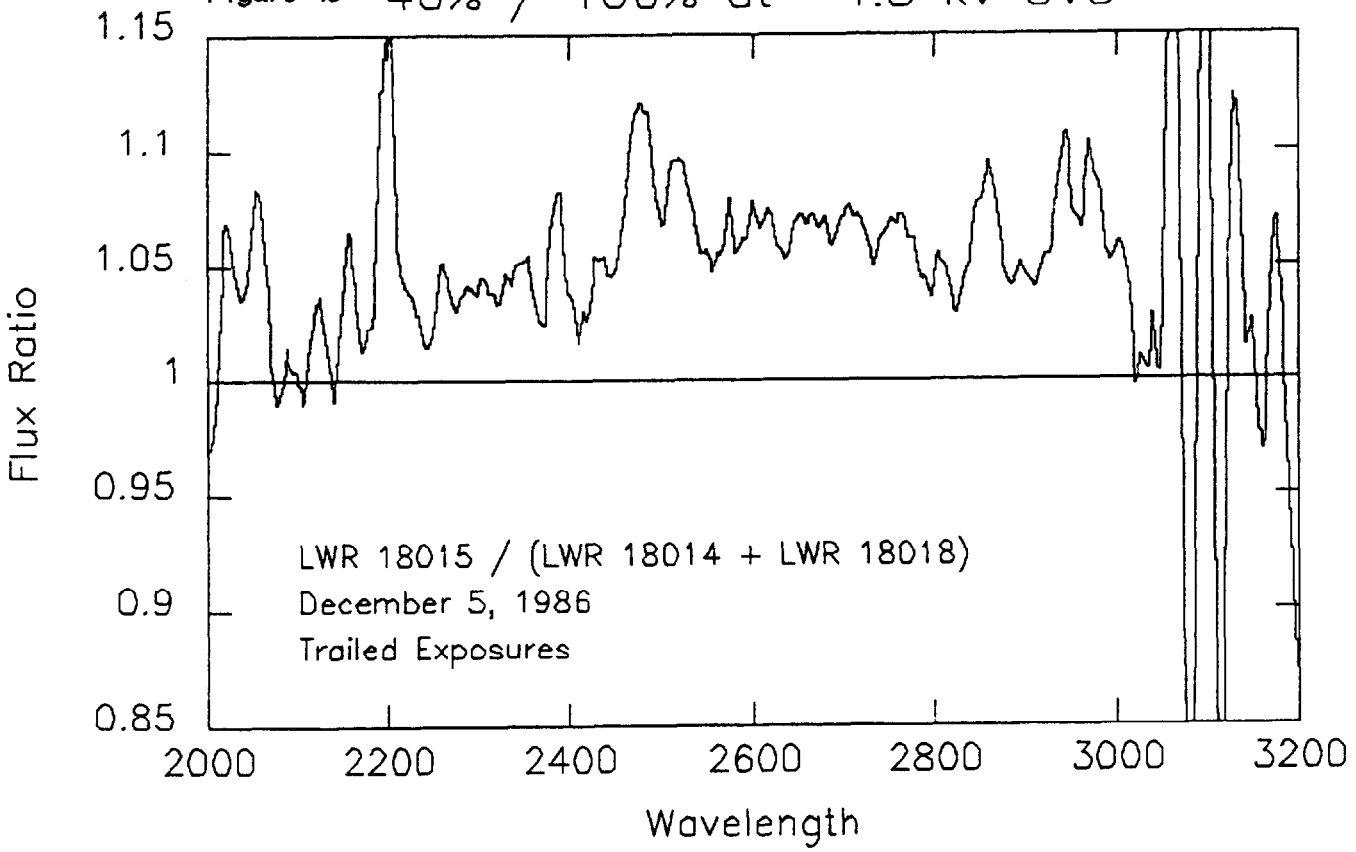


Figure 4d 40% / 100% at −4.5 kV UVC

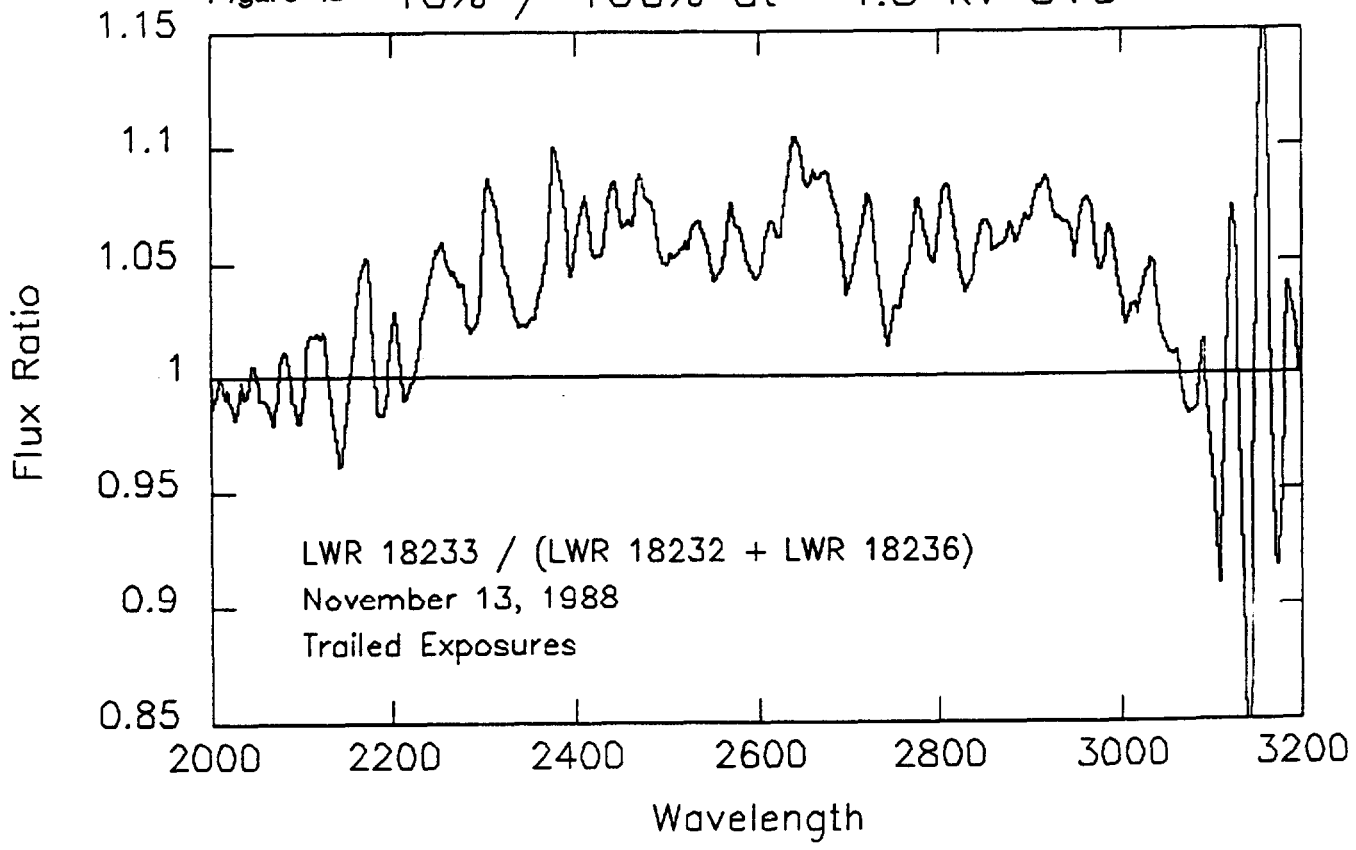


Figure 5a 60% / 100% at −5.0 kV UVC

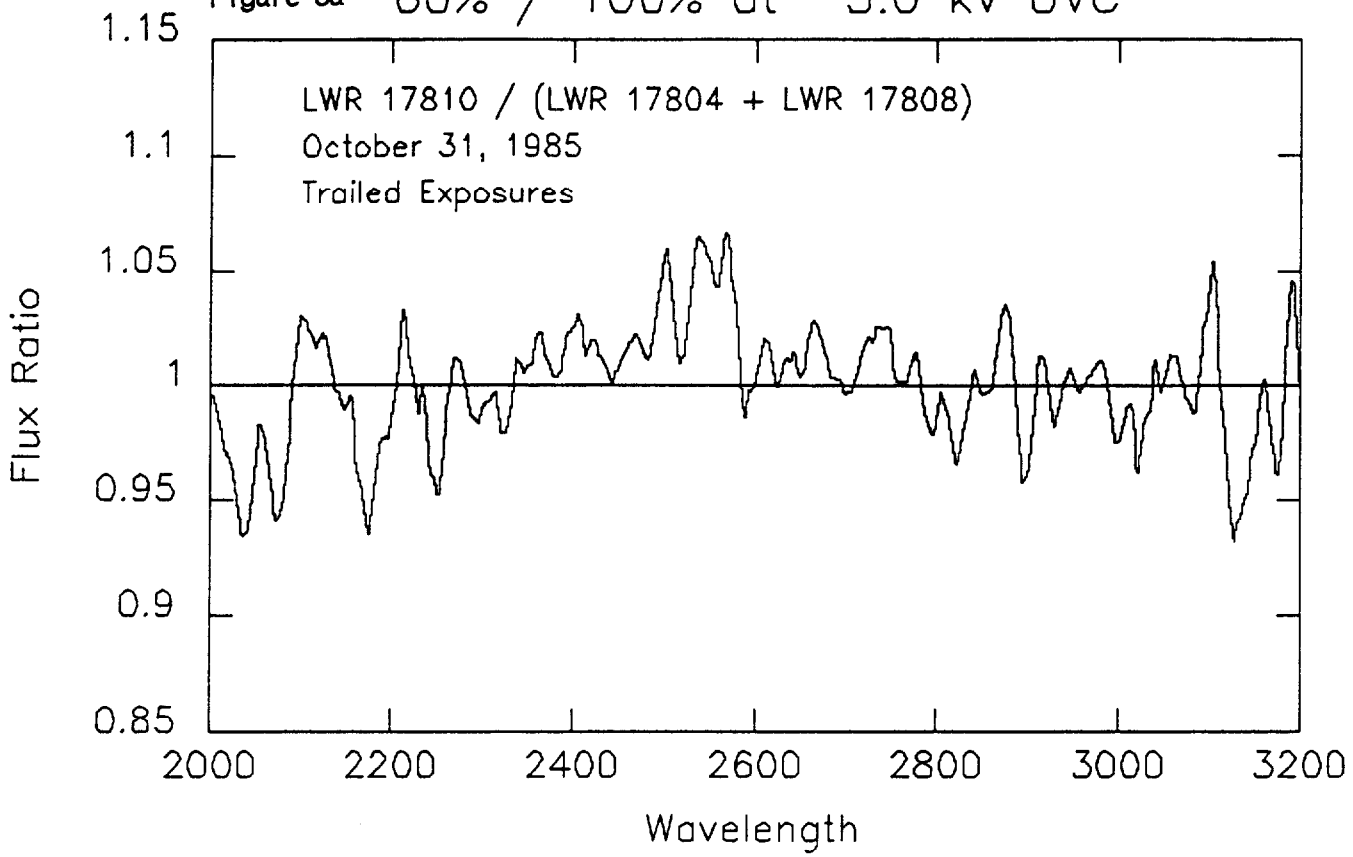


Figure 5b 60% / 100% at −4.5 kV UVC

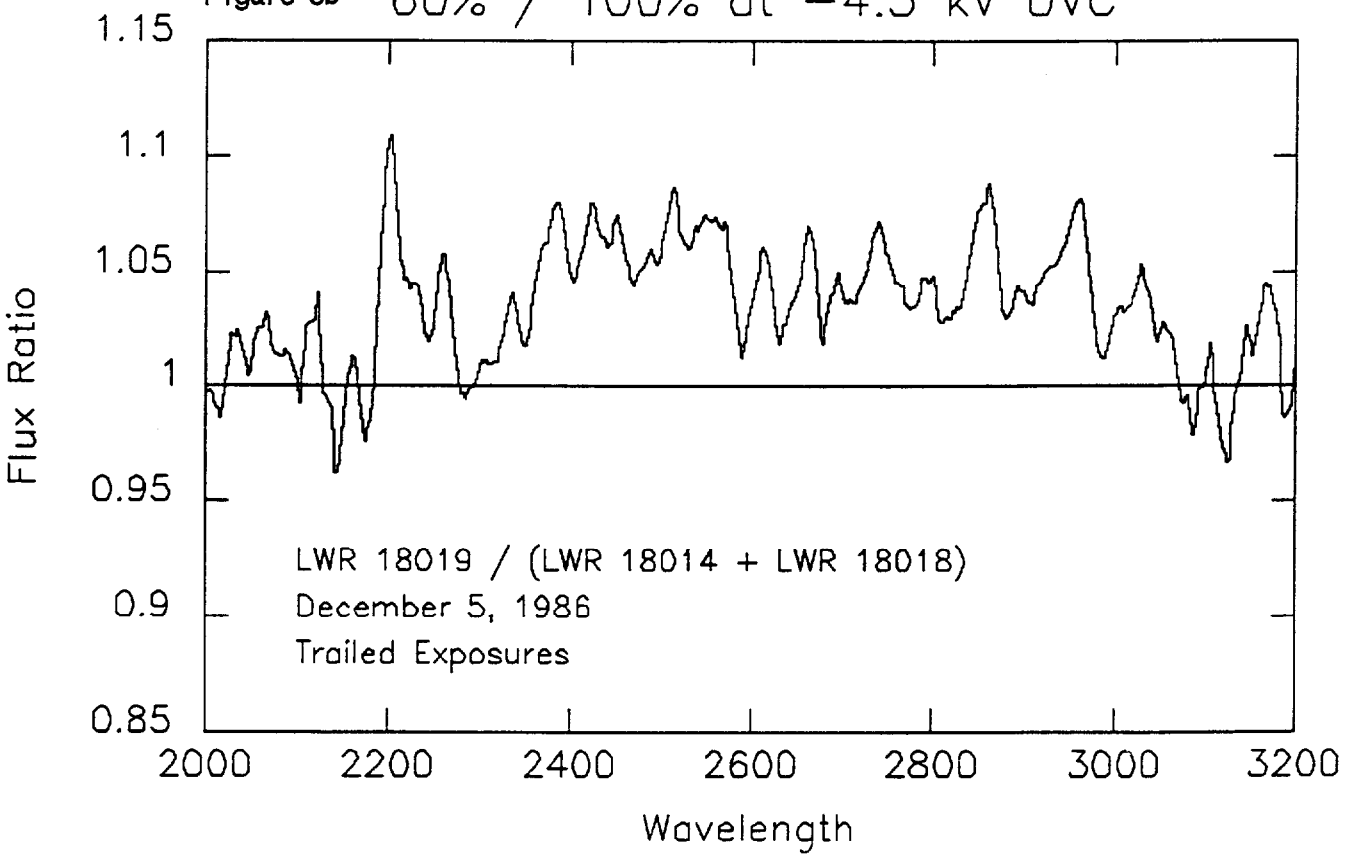


Figure 6a 120% / 100% at −5.0 kV UVC

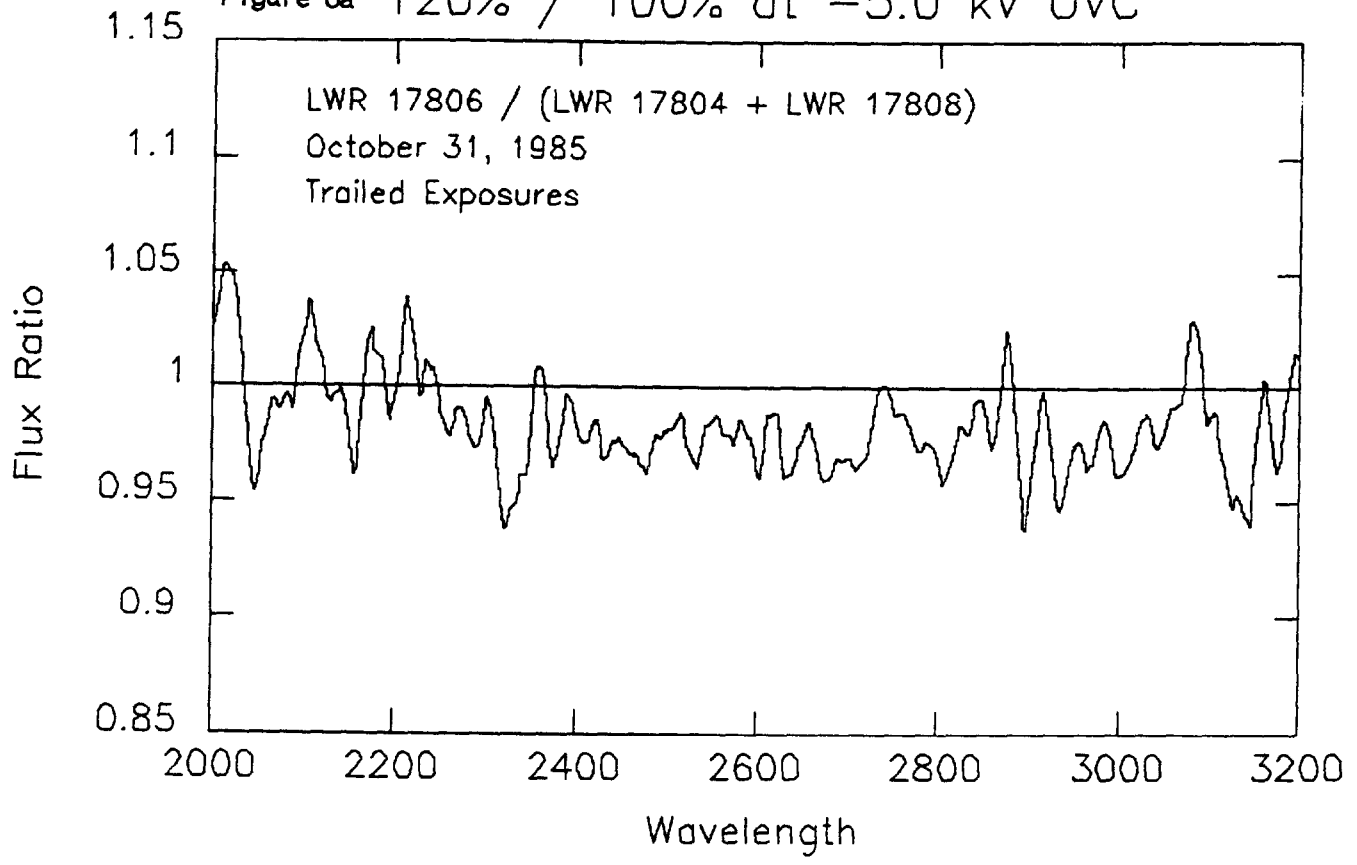


Figure 6b 120% / 100% at −5.0 kV UVC

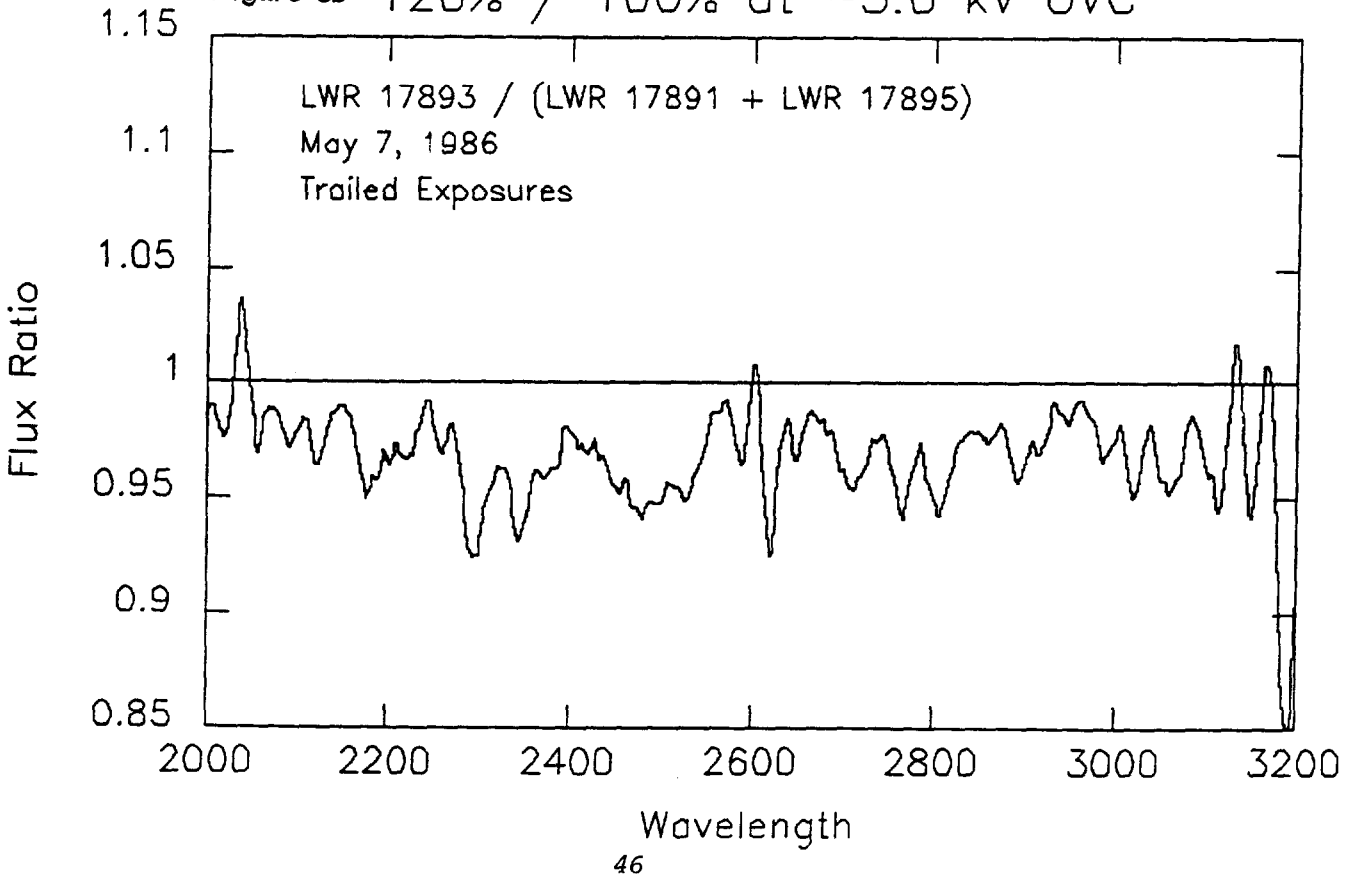


Figure 6c 120% / 100% at −4.5 kV UVC

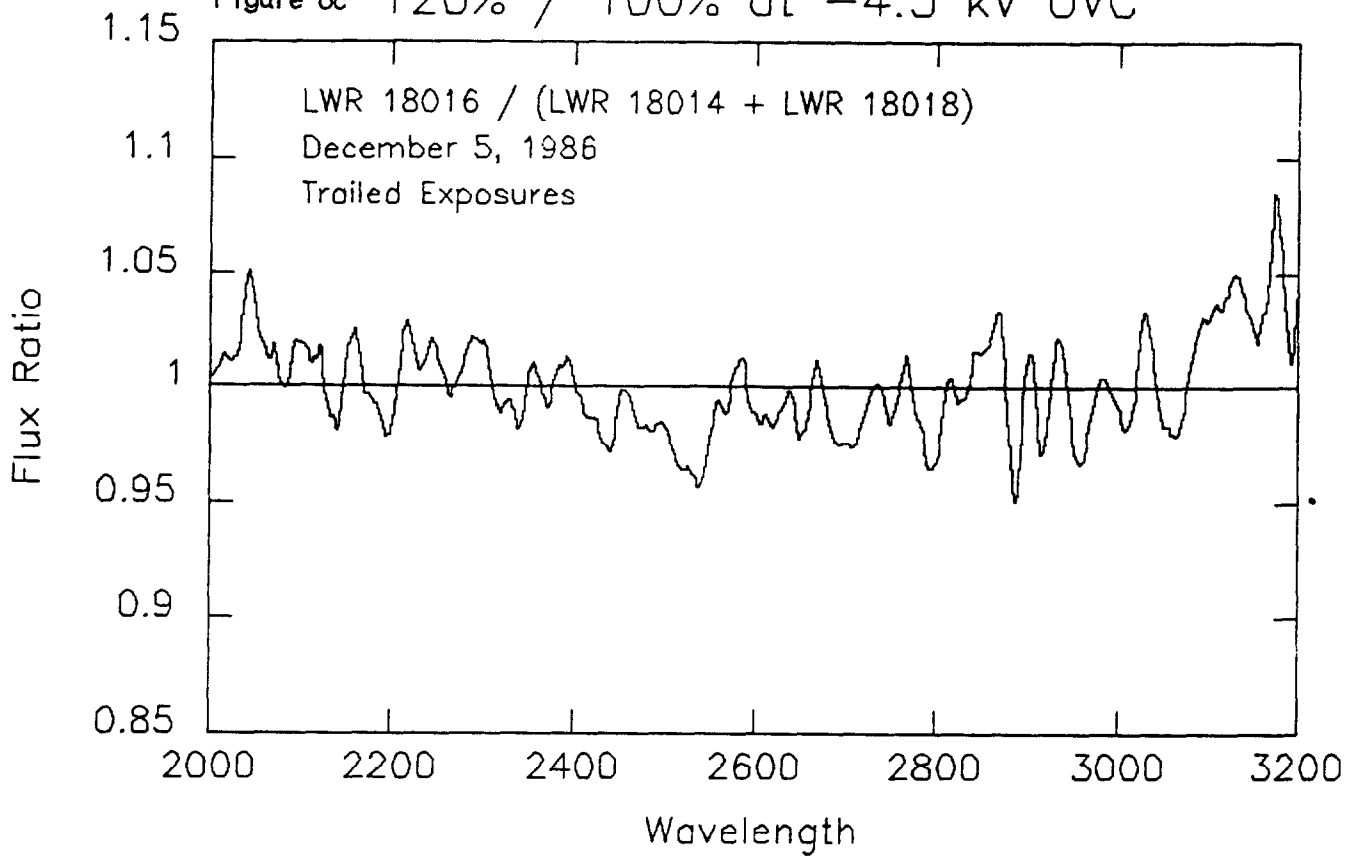


Figure 6d 120% / 100% at −4.5 kV UVC

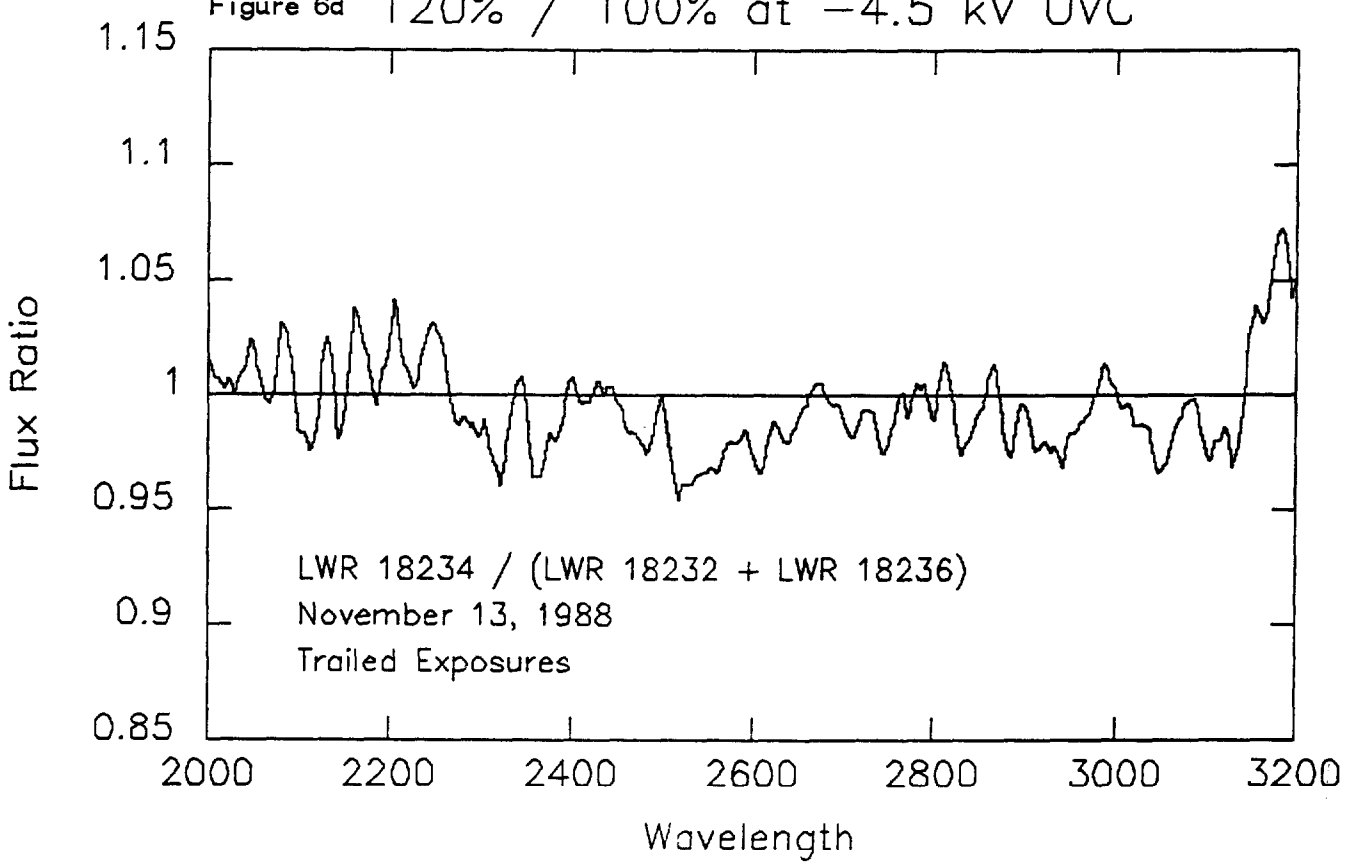


Figure 7a 160% / 100% at −5.0 kV UVC

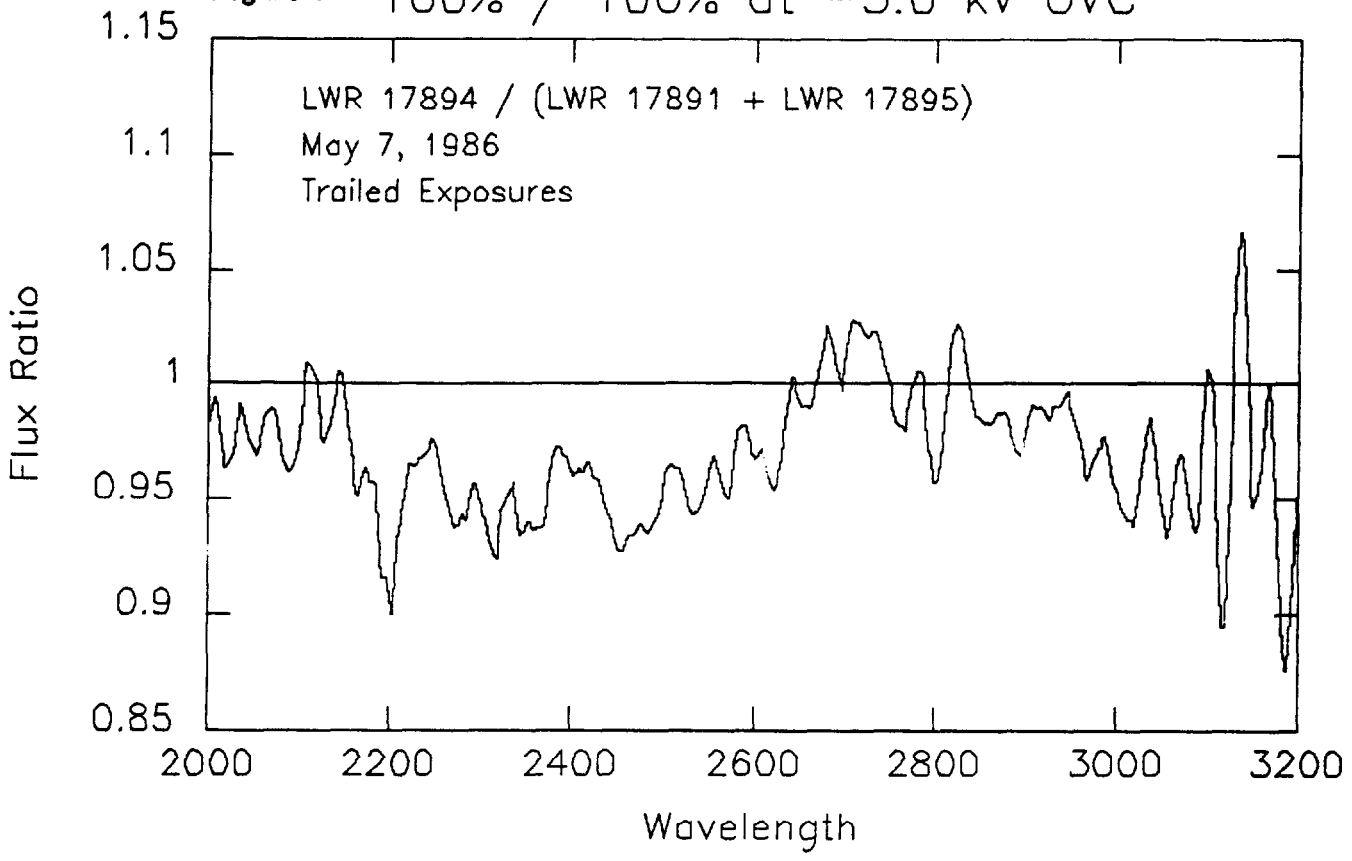


Figure 7b 160% / 100% at −4.5 kV UVC