

LINEARITY OF THE LWP^{* †}

SUMMARY

A comparison is made of the accuracies of LWP ITFØ and the later ITF1 which is currently used in IUESIPS. In addition, the results of a study of the ITF1 performance at different FN levels are presented. In general ITF1 shows some improvement over ITFØ but appears to give relatively low FN values at exposure levels in the range 15-60%. On the basis of these results the linearity of ITF1 can be summarized as follows:

	Mean error	RMS error
overall	-1.5%	3%
above net DN~100	+2	2
below net DN~100	-2.5	3.5

(cf. mean repeatability of LWP: 2.5% - Harris & Cassatella, 1983).

Over the full range of exposure levels covered (~ factor 20) only 2 out of 20 data points deviate by more than 5% from perfect linearity; these have errors of 7 and 9%.

The results of this study show that with the present ITF, the linearity of the LWP is considerably better than that of the LWR or SWP.

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†Editor's Note: NASA, ESA and the SERC plan to obtain observations for a new LWP ITF in late September, 1984. The linearity study reported herein uses untrailed spectra and is complementary to the study of trailed spectra reported elsewhere in this Newsletter by Oliverson.

1. COMPARISON OF LWP ITF1 WITH ITF0

The accuracy of ITF0 has been tested by Settle et al. (1981). They took a set of 4 spectra (low dispersion, large aperture) of BD + 28 4211 processed with ITF0 and having different exposure times. Each spectrum was ratioed to every other and a set of 6 observed flux ratios derived for the wavelength range 2000-3000 Å. These were then compared with the corresponding expected flux ratios determined from the ratios of the exposure times (corrected for quantisation by the OBC and camera dead-time of 0.12 secs.).

In the present study essentially the same procedure was followed for ITF1, also using spectra of BD + 28 4211. A set of 6 spectra was used, with 5 different exposure levels (2 spectra with the standard 100% exposure level of 50s were averaged). The FN were summed over the wavelength range 2050-2650 Å. The results are given in Table 1 (see Table 2 for exposure times and image numbers) and plotted alongside Settle et al.'s results in Figure 1. There is significant improvement in linearity with ITF1. The tendency for shorter exposure times (t) to result in relatively low FN/t values remains, but is less pronounced (the reverse trend is evident in the LWR).

The overall RMS deviations from linearity for the LWR and LWP ITFs, based on the data in Figure 1, are LWR: 3.9%, LWP ITF0: 5.1% and LWP ITF1: 2.1% (for exposure time ratios in the range 0.1-0.8).

- TABLE 1 -

Ratio of Exposure Times	Observed Flux Ratio	Error %
0.097	0.095	-2.1
0.130	0.126	-2.8
0.195	0.194	-0.6
0.249	0.242	-2.8
0.332	0.322	-3.1
0.499	0.491	-1.7
0.499	0.493	-1.1
0.666	0.652	-2.1
0.750	0.752	+0.3

RMS error: 2.1%

2. DEPENDENCE OF ITFI LINEARITY ERRORS ON FN LEVEL

For each spectrum of BD + 28 4211 the net FN values were averaged over 2 wavelength intervals of 300 \AA (Table 2). In each wavelength interval the resulting mean values were then ratioed to a value in the range $20 - 30 \times 10^3$ chosen as a reference (underlined values in Table 2). These ratios were divided by the corresponding exposure time ratios to give values of "FN ratio observed/FN ratio expected", assuming perfect ITF accuracy over the small range covered by the reference values. The 8 resulting values are plotted as a function of mean FN in Figure 2. As a check on these results the procedure was repeated using spectra of BD + 75 325 and 4 wavelength bands of 300 \AA (Table 3, Figure 3). The different symbols in the plots identify the points according to the reference value on which they are based.

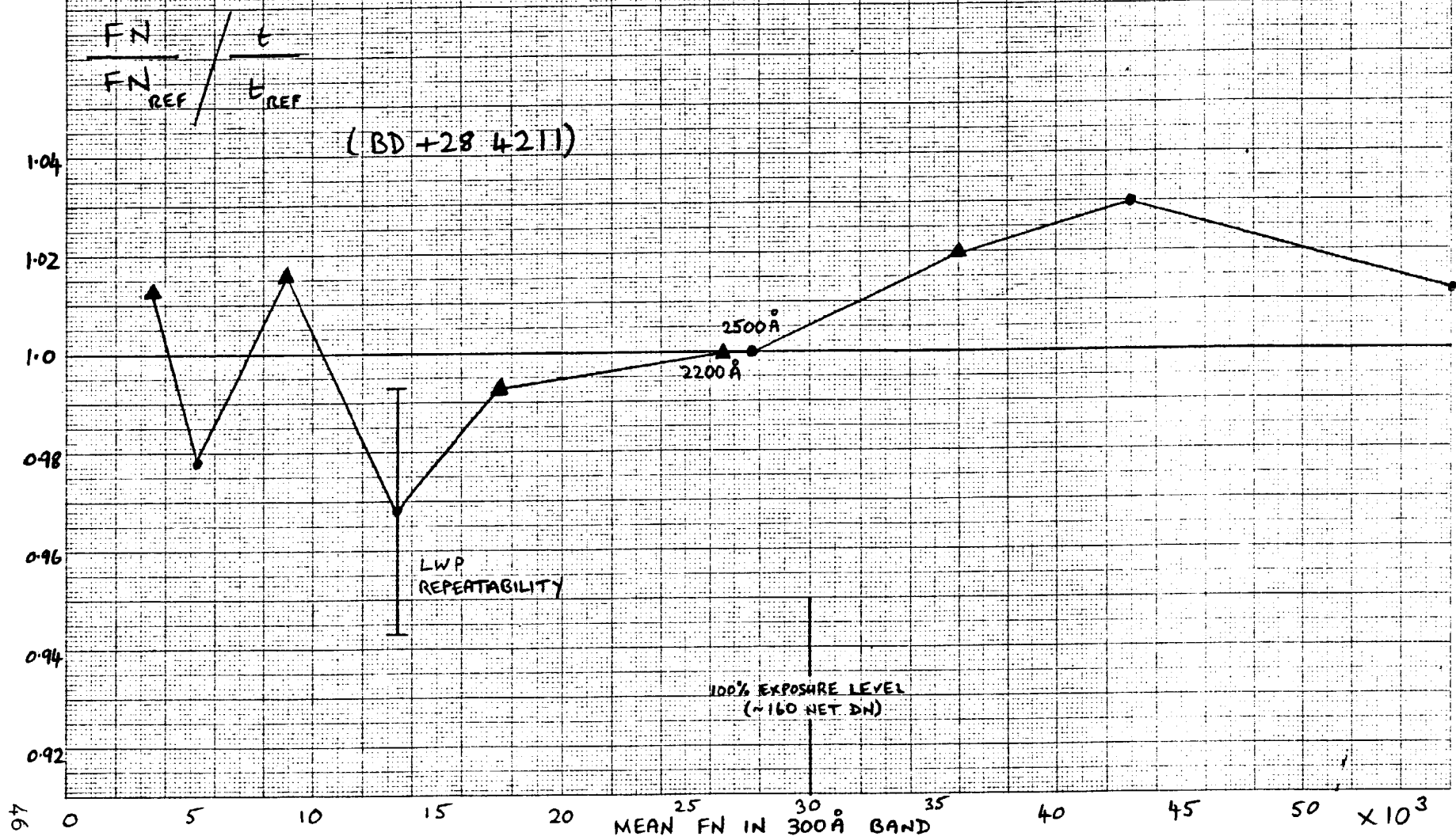
- TABLE 2 -

Exposure Time (s)	Image Nos. LWP	Mean FN ($\times 10^{-3}$)	
		2200 \AA	2500 \AA
9.710	1444	3.48	5.30
24.866	1445	8.95	13.43
49.851*	1568, 1443	17.53	<u>27.83</u>
74.837	1448	<u>26.50</u>	43.05
99.822	1447	36.06	56.42

NOTES: Exposure times have been corrected for quantisation and camera dead-time.

* This is the standard 100% exposure time for BD + 28 4211. In this case the FN values given are averages from 2 spectra.

Fig. 2



The plots demonstrate that ITF1 is accurate through the entire range of exposure levels represented. There is a general tendency for FN values in the range $FN < 20 \times 10^3$ (net DN $< \sim 100$) to be relatively low, although the significance of the sharp dip at $FN \approx 7 \times 10^3$ in Figure 3 is questionable since it is not reproduced in Figure 2. The quantitative assessment of the accuracy of ITF1 given in the summary was derived by combining the results for both stars. The results of this study are consistent with those reported by T. Ake (1983) which give an approximate overall linearity error of 5%.

- TABLE 3 -

Exposure Time(s)	Image Nos. LWP	Mean FN ($\times 10^{-3}$)			
		2100 Å	2400 Å	2700 Å	3000 Å
4.795	1335	4.01	5.38	6.75	3.11
9.710	1334	7.40	10.80	14.22	6.36
19.541	1331,1336,1339	15.89	<u>22.51</u>	<u>29.60</u>	13.05
29.781	1332	<u>24.87</u>	35.02	44.82	<u>20.28</u>

REFERENCES:

- Ake, T., 1983, Report to the IUE 3-Agency Meeting, London, March, 1983
- Harris, A.W., and Cassatella, A., 1983, ditto.
- Settle, J., Shuttleworth, T., and Sandford, M.C.W., 1981, IUE NASA Newsletter, No. 15, P 97.

A.W. Harris
VILSPA, September 1983

Figure 1. Figure showing the extent of non-linear photometry in the LWR (⊗) and LWP ITFs. A value of 1.0 represents linear photometry.

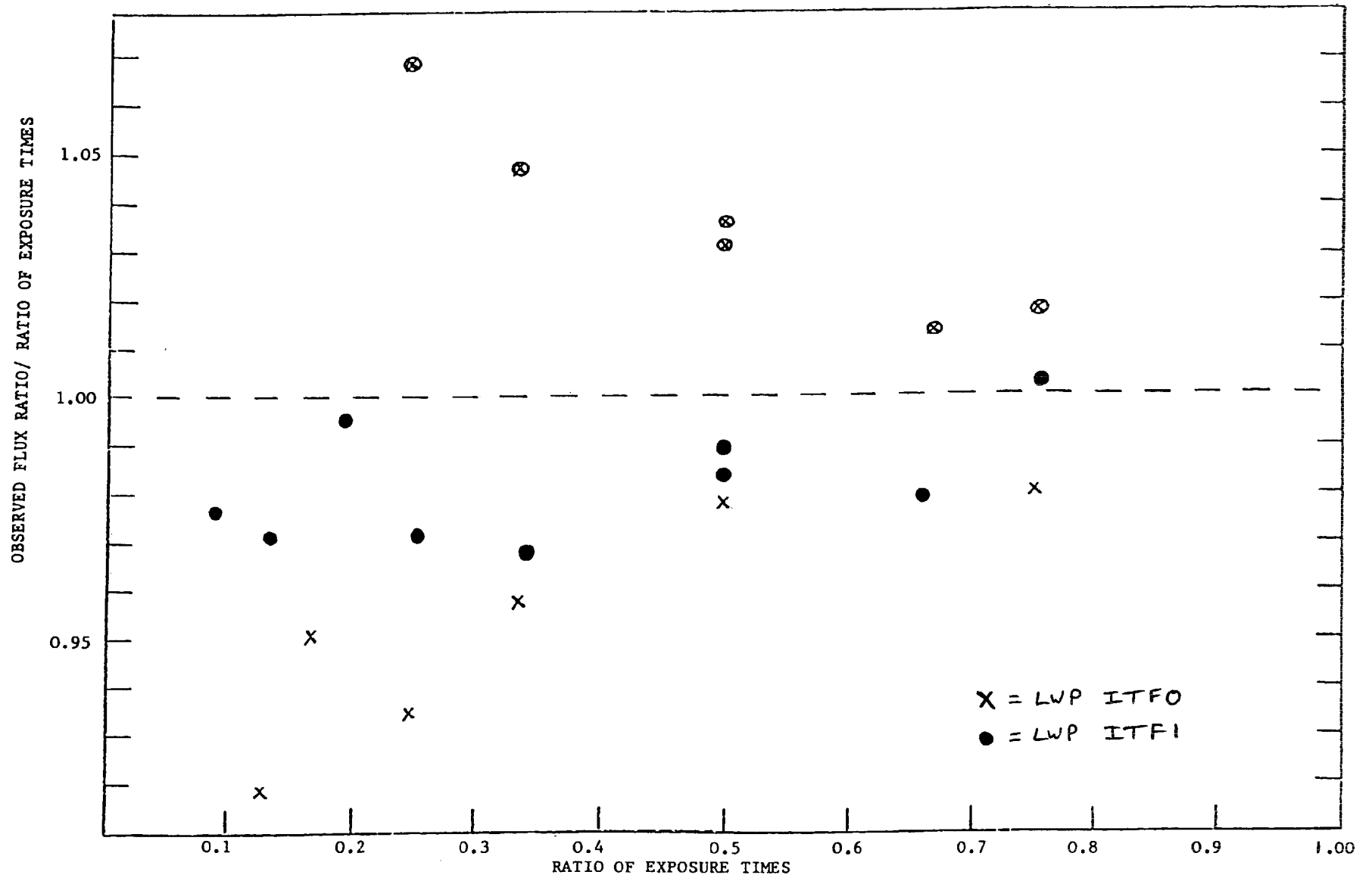


Fig. 3

$$\frac{FN}{FN_{REF}} / \frac{E}{E_{REF}}$$

(BD+75 325)

