Study of the performance of the new LWP ITF (ITF2)

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1. Introduction

The performances of the new LWP ITFs (ITF2) are analyzed and compared with those of the current ITFs (ITF1). In particular, we study the linearity, the flux ratio ITF2/ITF1, the flux ratio of point with respect to trailed spectra, and the signal-to-noise ratio (S/N) of ITF1 and ITF2.

2. Linearity of ITF1 and ITF2

Linearity test data were obtained on Oct. 20, 1986 and processed with both ITF1 and ITF2. As shown in Table 1, several images of BD+28 4211 were obtained (both point and trailed), with exposure times ranging from 20% to 200% of the optimum exposure time (set, as usual, in the region of maximum sensitivity around 2700-2900A).

The spectra from both ITF1 and ITF2, were averaged in four bands 100 A wide centered at 2300 A , 2500 A, 2800 A, and 3100 A. The flux ratio [FN/t]/[FN/t(opt)], taken as a measure of the non-linearity errors of ITF1 and ITF2, is plotted in Fig. 1 as a function of the percent of the optimum exposure time near 2800 A, t/t(opt). The following conclusions can be drawn from the inspection of Fig. 1:

a) both ITF1 and ITF2 underestimate underexposed spectra and overestimate spectra exposed above the 100% level.

b) ITF2 is generally better than ITF1 as far as linearity is concerned. In fact, the maximum departure from linearity is about 3% for ITF2 compared with about 4-5% for ITF1. Only in one band (2300 A), there is a marginal indication that ITF1 could behave better than ITF2. However, at such short wavelengths, the S/N ratio from ITF1 spectra is lower than that from ITF2 (see following), so that the information derived from ITF1 data is comparably less accurate.

The above results are consistent with those reported by Harris (1984) for ITF1 and by Oliversen (1986) for ITF2.

It is worth mentioning that LWP ITF2 are considerably more linear than the test LWR ITFs (ITF2) (Cassatella 1985).

3. Fluxes from spectra processed with ITF2 and ITF1.

It is important to know how FNs obtained through ITF2 compare with those obtained through ITF1, especially at the moment of deciding whether the same absolute calibration can be applied to both ITFs, or not.

To this purpose, we have compared the average of two pairs of point and trailed spectra of BD+28 4211 processed with ITF1, with the average of the same spectra processed with ITF2.

In Fig. 2, we show how the ratio FN(ITF2)/FN(ITF1) varies for point spectra (bottom of figure) and trailed spectra (top). Both sets of data give consistent results, although the data obtained from point spectra are more noisy than trailed spectra , as expected. The figure confirms that, as reported by Oliversen (1986), the flux ratio ITF2/ITF1 is not constant with wavelength. Note that a similar effect was shown to exist for LWR images processed with the LWR ITF2 and ITF1 (Cassatella 1985). In particular, the LWP ITF2 provide about 4% more flux than ITF1 in the region of maximum sensitivity (2700-2900 A), and about 8-9% around 3100A. On the contrary, ITF2 provide typically lower fluxes than ITF1 below about 2000 A. For convenience, the flux ratio FN(ITF2)/FN(ITF1) obtained from the trailed spectra in Fig. 2 is given also in Table 2, in 50 A bins.

4. Trailed vs. Point spectra

The problem of using trailed spectra for the determination of the IUE absolute calibration has been addressed recently in more than one occasion. In particular, it has been shown (Harris and Cassatella 1985) that the flux ratio of point to trailed spectra is not grey with wavelength when using LWP spectra processed with ITF1. We have used the data of BD+28 4211 in Table 1, together with other data of HD60753 obtained on Apr. 18, 1986, to study the flux ratio FN(Point)/FN(Trailed) as a function of wavelength. As the effective exposure times of trailed spectra are uncertain, the fluxes derived from trailed spectra were previously normalized to those from point spectra in the ragion 2600 - 2800 A.

The results of the test, shown in Fig. 3 and Table 3, can be summarized as follows:

a) the flux ratio of point to trailed spectra is wavelength dependent for both ITF1 and ITF2.

b) fluxes from point spectra processed with either ITF, are systematically lower than those derived from trailed spectra in the regions below about 2350 A and above 2950 A. The effect is large enough to explain most if not all the

SWP-LWP overlap discrepancy discussed by Harris and Cassatella (1985) and Cassatella (1984).

c) the ratio FN(Point)/FN(Trailed) is systematically noiser for ITF1 data. This is in agreement with the results reported in the next section.

5. Signal-to-noise ratio with ITF1 and ITF2.

We have tested the S/N ratio in data processed with ITF1 and ITF2 using the point and trailed spectra of BD+28 4211 and HD60753 listed at the bottom of Table 3. The S/N ratio was measured in three bands free from stellar or instrumental features: 1950-2150 A, 2530-2720 A and 2900-3000 A. In each band, we measured the r.m.s. deviation of any individual spectrum from the local continuum (estimated through a heavy smoothing of the spectrum itself), and normalized to the mean flux in the band. The results, given in Table 4, indicate that the S/N is generally better or comparable for data processed with ITF2. This is true for both trailed and point spectra.

In particular, the S/N ratio from ITF2 is better in the regions of of lower spectral sensitivity of the LWP. The effect shows up clearly in Fig. 4, where a point-by-point comparison is performed between one trailed and one point spectrum of BD+28 4211 processed with both

ITFs. We conclude that, as far as S/N characteristics are concerned, ITF2 offers important advantages over ITF1, which will hopefully contribute to solve the problem of the SWP-LWP overlap discrepancy.

Finally, we note that the S/N of the LWP camera is anyhow about a factor two better than the LWR camera, and comparable to that of the SWP camera, at least in the regions of maximum sensitivity (see Cassatella et al. 1984).

REFERENCES

Cassatella, A., 1984, Rep. 3 Agency Meeting, VILSPA, May 1984

Cassatella, A. 1985, Rep. 3 Agency Meeting, GSFC, Oct. 1985

Cassatella, A., Gry, C., Gilmozzi, R. 1984, Rep. 3 Agency Meeting, GSFC, Oct. 1983

Harris, A.W. 1984, Rep. 3 Agency Meeting, GSFC, Mar. 1984

Harris, A.W., Cassatella, A. 1985, ESA IUE Newsl. 22, p. 9

Oliversen, N. 1986, Rep. 3 Agency Meeting, ESTEC, Jun. 1986

Table 1: Linearity test data with BD+28 4211
(Oct. 20, 1986)

LWP	t(sec)	THDA	Exposure Level	Type
9363	50	8.5	100%	Point
9364	50	8.8	100	"
9365	10	9.2	20	"
9366	20	9.5	40	"
9367	30	9.5	60	"
9368	40	9.5	80	"
9369	65	9.5	130	"
9370	75	9.8	150	"
9371	100	9.5	200	"
9372	200	9.5	100	Trailed
9373	200	9.5	100	"
9374	400	9.5	200	"

Table 2: Ratio of FNs ITF2/ITF1 from trailed spectra

Lambda (A)	FN ratio ITF2/ITF1
1900	.9242896E+00
1950	.9035311E+00
2000	.9832344E+00
2050	.9918675E+00
2100	.1026933E+01
2150	.1021261E+01
2200	.1003799E+01
2250	.1004139E+01
2300	.1024477E+01
2350	.1038624E+01
2400	.1024679E+01
2450	.1023444E+01
2500	.1016528E+01
2550	.1026055E+01
2600	.1027509E+01
2650	.1034724E+01
2700	.1037318E+01
2750	.1039952E+01
2800	.1042750E+01
2850	.1043112E+01
2900	.1042791E+01
2950	.1062625E+01
3000	.1072499E+01
3050	.1083504E+01
3100	.1093354E+01
3150	.1078025E+01
3200	.1075074E+01
3250	.1050883E+01
3300	.1041354E+01

Images used: LWP9372, 9373
(100% exposures)

Table 3 : Ratio of point to trailed spectra using ITF1 and ITF2

Lambda (A)	Point/Trail ITF1	Lambda (A)	Point/Trail ITF2
1900	.8669380E+00	1900	.9438553E+00
1950	.1003872E+01	1950	.9343773E+00
2000	.9754965E+00	2000	.9938627E+00
2050	.9945741E+00	2050	.9524280E+00
2100	.1017580E+01	2100	.9524647E+00
2150	.1015736E+01	2150	.9984446E+00
2200	.9724541E+00	2200	.9362233E+00
2250	.9977539E+00	2250	.9592748E+00
2300	.9804302E+00	2300	.9628739E+00
2350	.9895957E+00	2350	.9962213E+00
2400	.1010803E+01	2400	.1004624E+01
2450	.1019123E+01	2450	.1014246E+01
2500	.10050000+01	2500	.9998342E+00
2550	.1001284E+01	2550	.1005772E+01
2600	.9972594E+00	2600	.1013378E+01
2650	.9973902E+00	2650	.9976212E+00
2700	.1003152E+01	2700	.1003370E+01
2750	.1001376E+01	2750	.9964696E+00
2800	.9990942E+00	2800	.9933304E+00
2850	.1009784E+01	2850	.9978050E+00
2900	.1000652E+01	2900	.9993277E+00
2950	.9853023E+00	2950	.9916177E+00
3000	.9665020E+00	3000	.9771503E+00
3050	.9628000E+00	3050	.9604443E+00
3100	.9738176E+00	3100	.9637702E+00
3150	.9858748E+00	3150	.9607075E+00
3200	.9224113E+00	3200	.9213114E+00
3250	.9596367E+00	3250	.9158193E+00

LWP images used:

9363, 9364 (Point)
9372, 9373 (Trail) } BD+28°4211

6904, 6315
5874, 5313 (Point)
8052, 8053
8054 (Trail) } HD60753

Table 4: S/N ratio for LWP spectra processed with ITF1 and ITF2

Point spectra

Range:	1950-2150	2530-2720	2900-3000 A
ITF1	5.1	16.3	18.7
ITF2	6.0	16.0	22.2

Trailed spectra

Range:	1950-2150	2530-2720	2900-3000 A
ITF1	14.0	28.6	41.8
ITF2	13.7	32.5	48.9

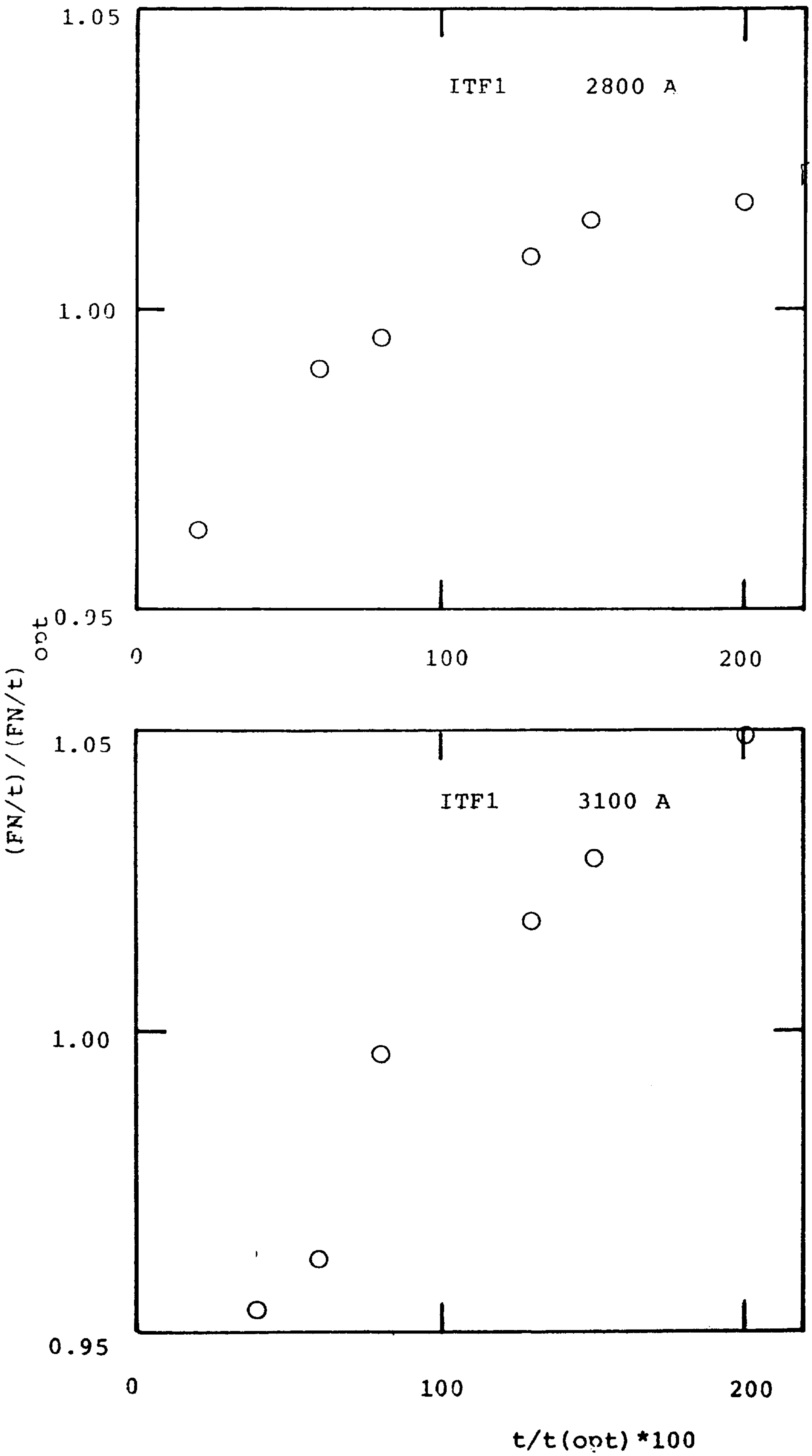
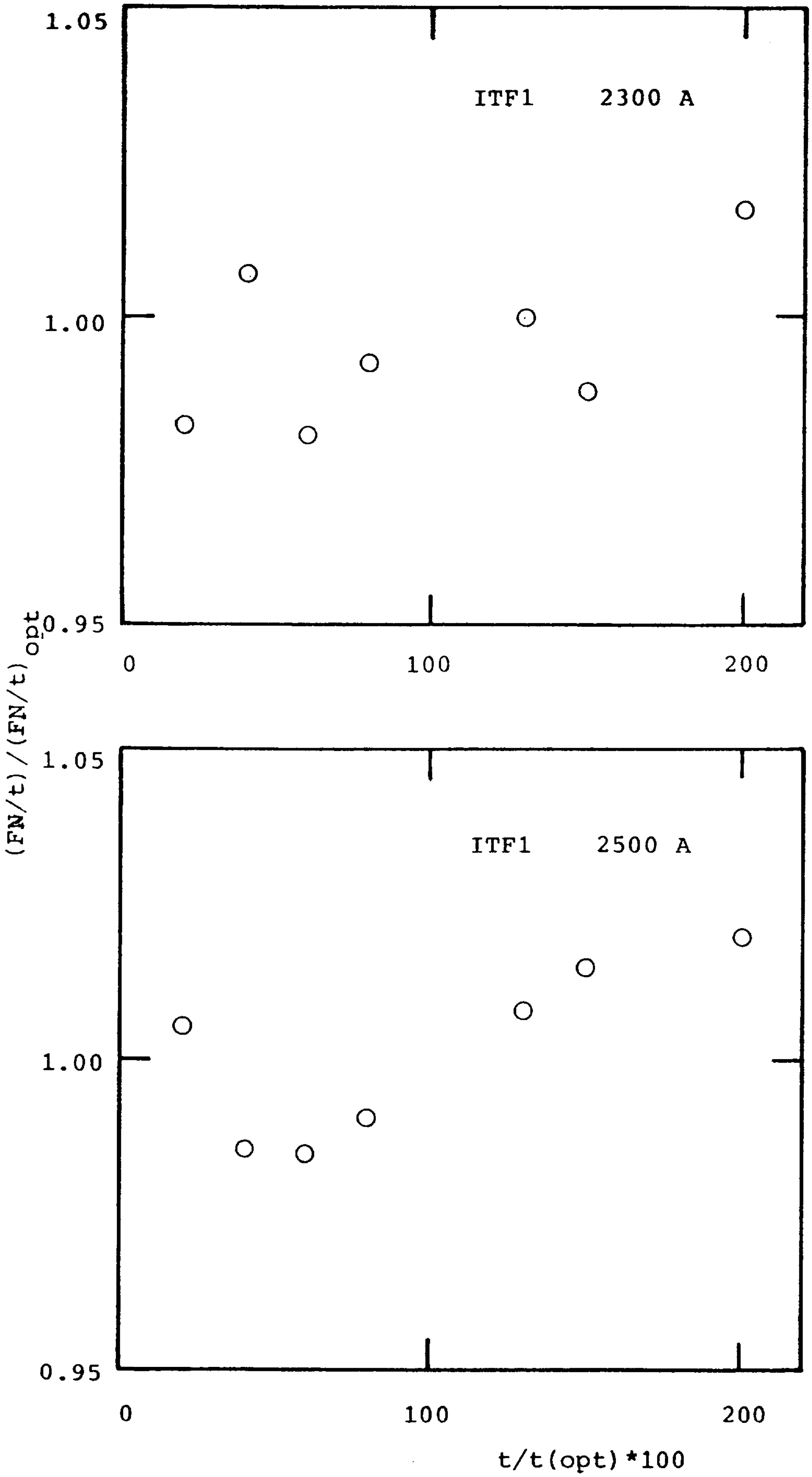

1.05
ITF1 2800 A
1.00
0.95
0
100
200
(FN/t)/(FN/t)opt
1.05
ITF1 3100 A
1.00
0.95
0
100
200
t/t(opt)*100

Fig. 1a



ITF1 2300 A
ITF1 2500 A
1.05
1.00
0.95
0
100
200
$(FN/t)/(FN/t)_{opt}$
t/t(opt)*100

Fig. 1b

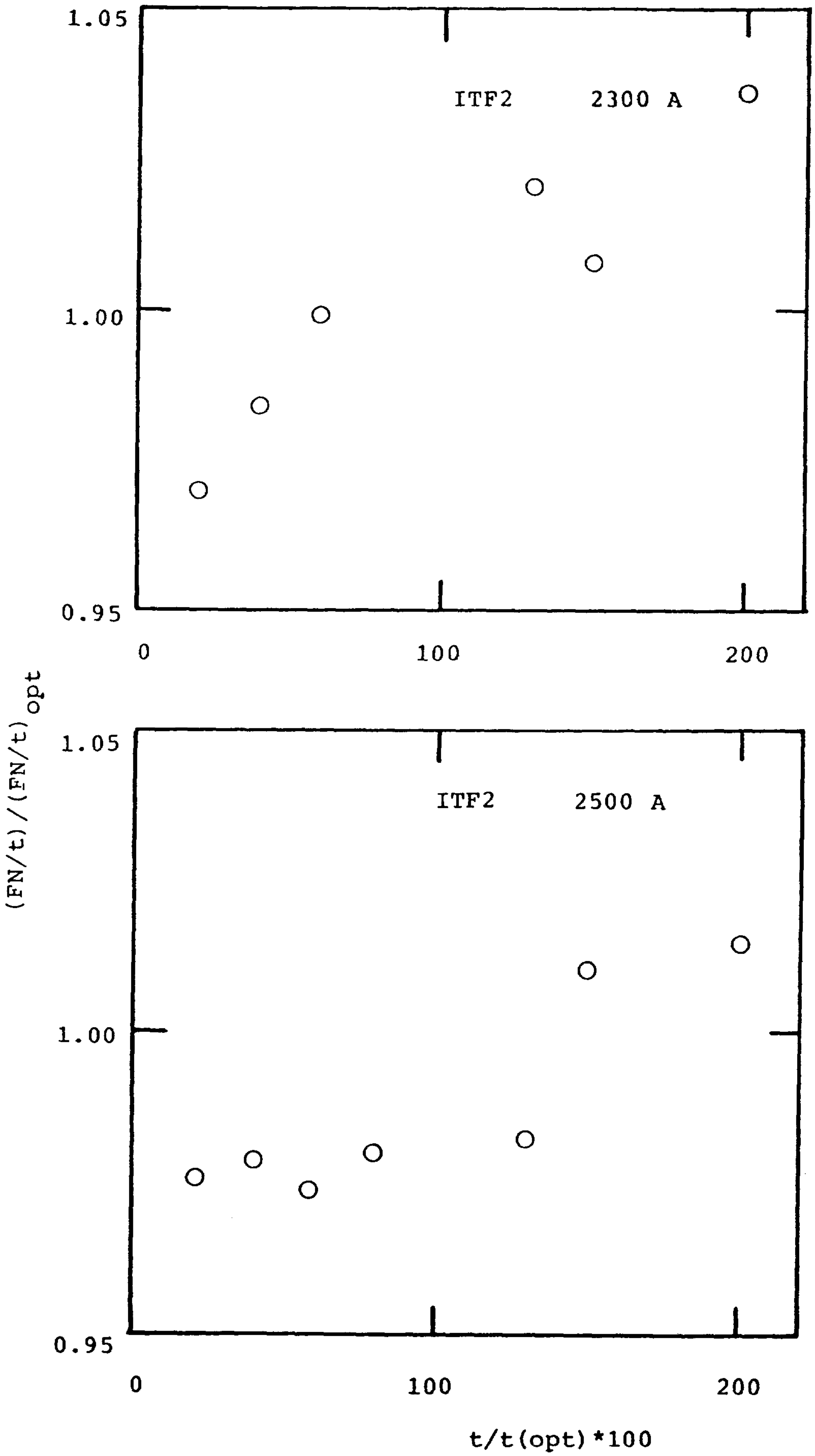
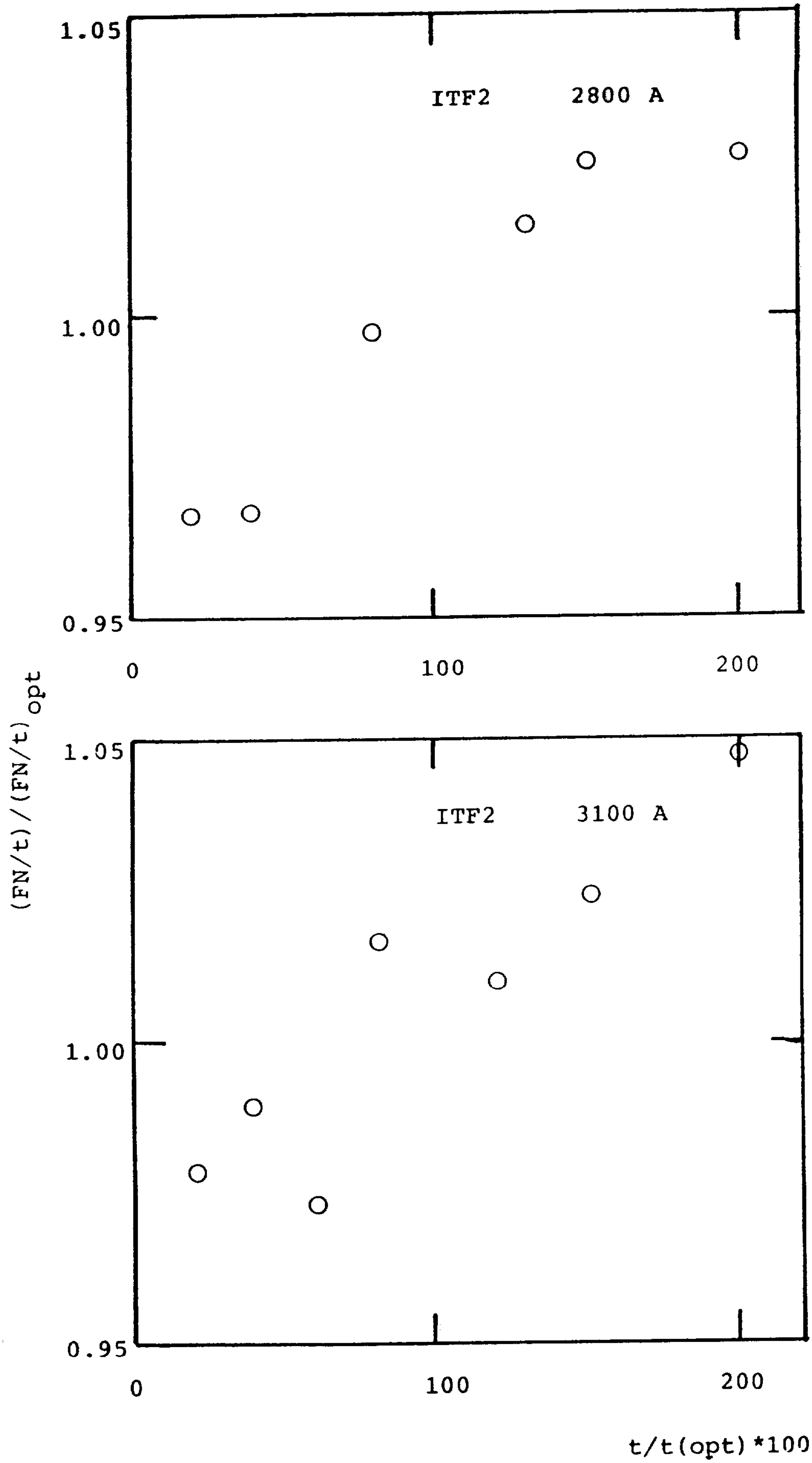
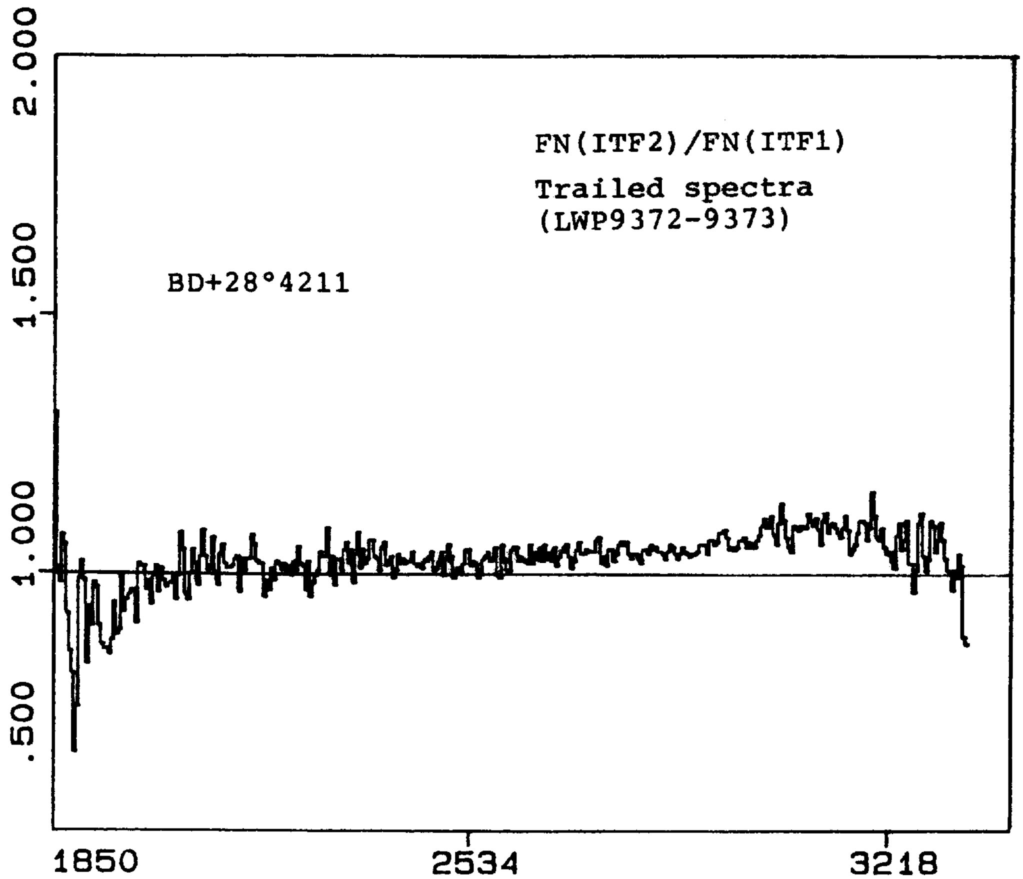

1.05
1.00
0.95
ITF2 2300 A
0
100
200
(FN/t)/(FN/t)opt
1.05
1.00
0.95
ITF2 2500 A
0
100
200
t/t(opt)*100

Fig. 1c



1.05
1.00
0.95
0
100
200
ITF2 2800 A
(FN/t)/(FN/t)$_{opt}$
1.05
1.00
0.95
0
100
200
ITF2 3100 A
t/t(opt)*100

Fig. 1d


2.000
1.500
1.000
.500
FN(ITF2)/FN(ITF1)
Trailed spectra
(LWP9372-9373)
BD+28°4211
1850
2534
3218

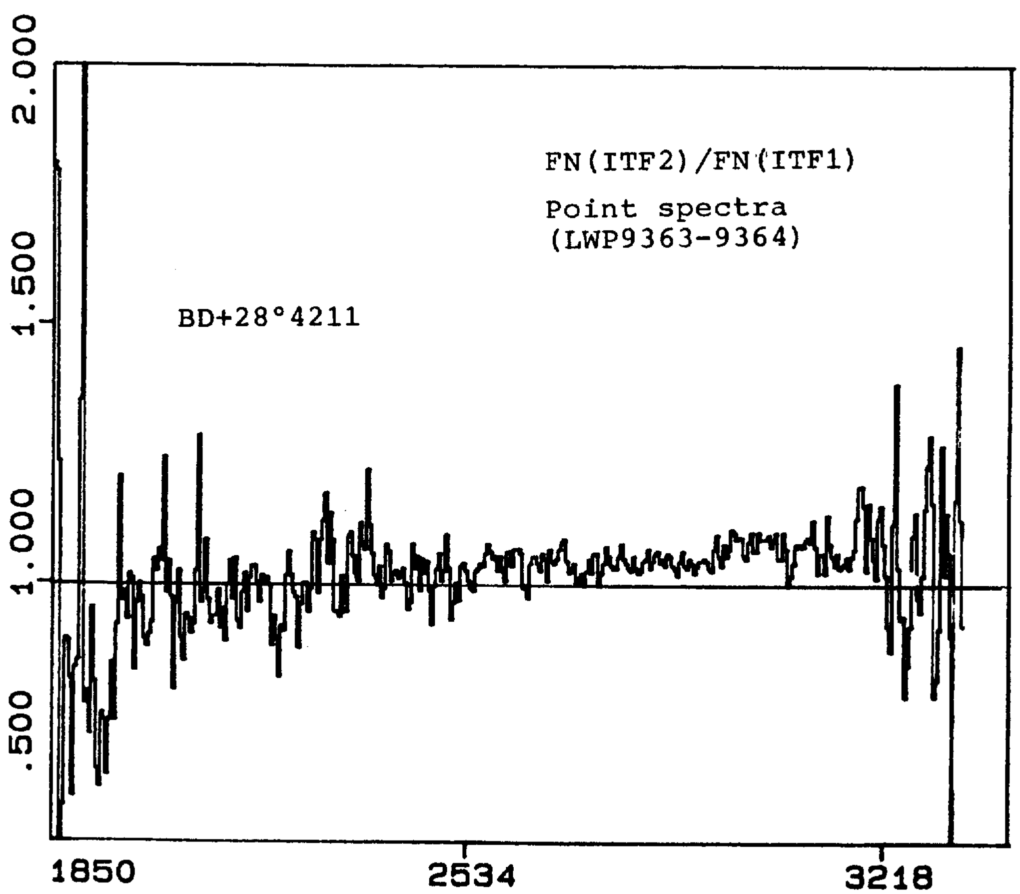
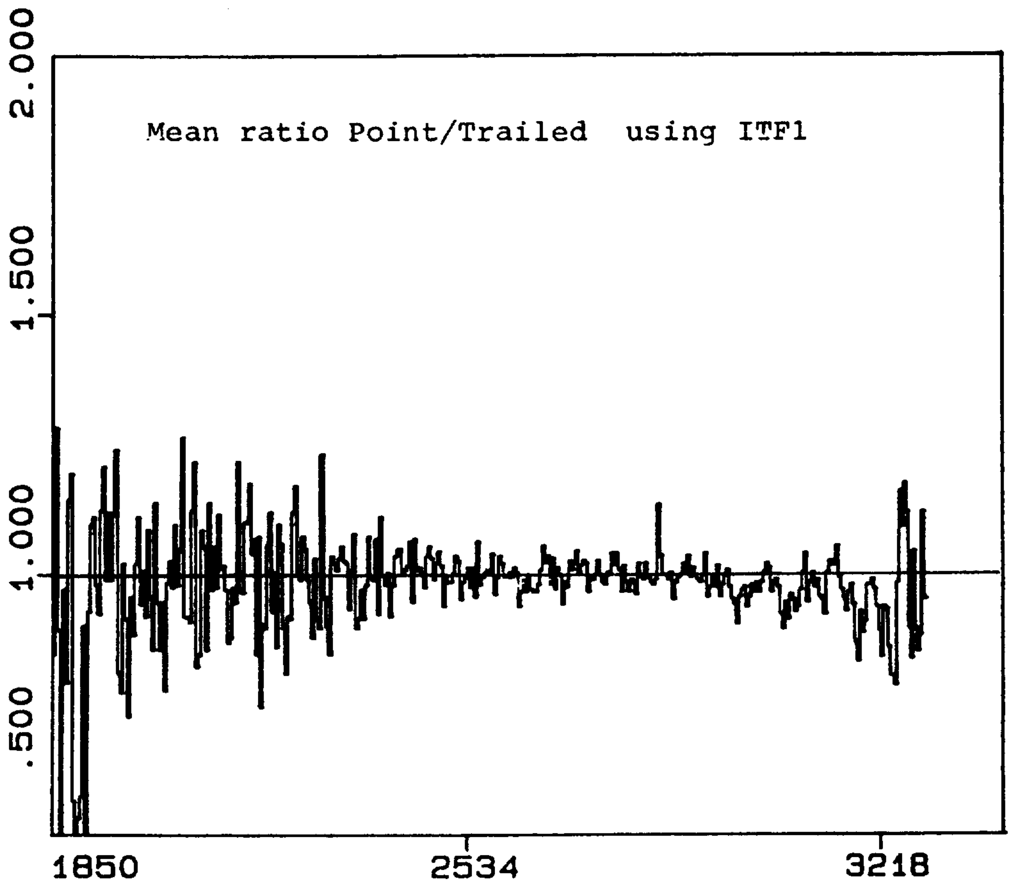
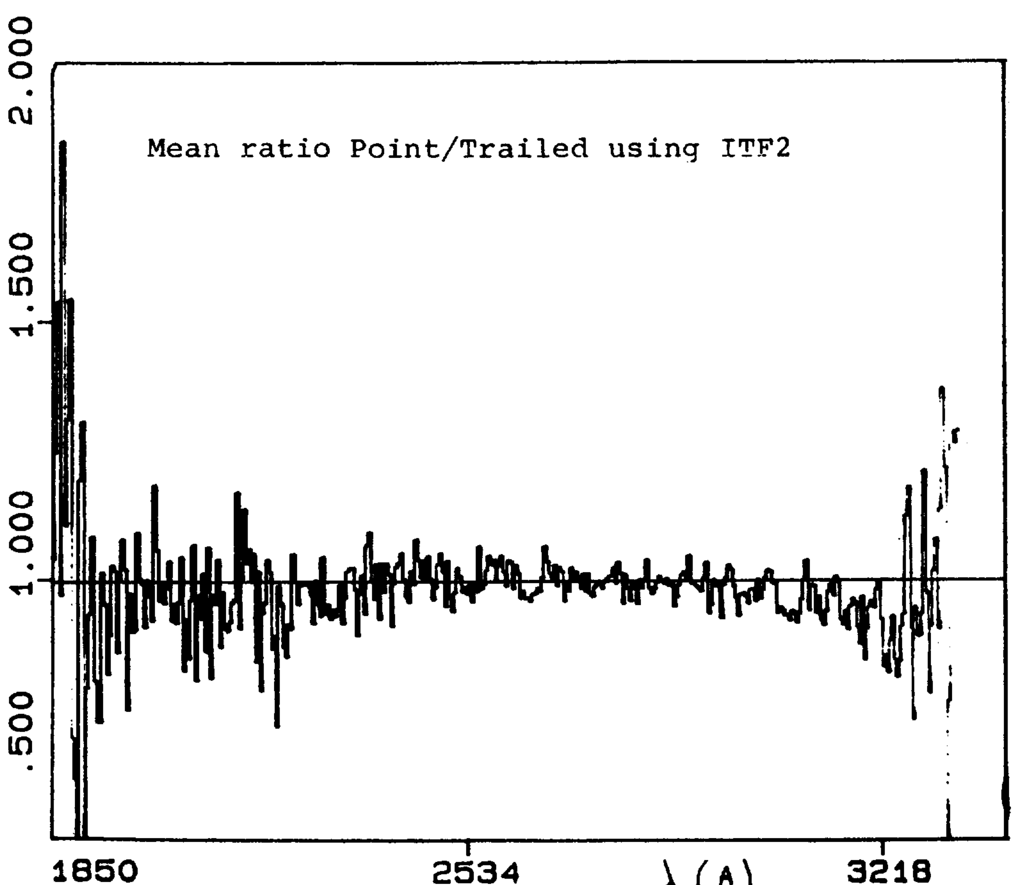

2.000
1.500
1.000
.500
FN(ITF2)/FN(ITF1)
Point spectra
(LWP9363-9364)
BD+28°4211
1850
2534
3218

Fig. 2



Mean ratio Point/Trailed using ITF1
2.000
1.500
1.000
.500
1850
2534
3218



Mean ratio Point/Trailed using ITF2
2.000
1.500
1.000
.500
1850
2534
λ (A)
3218

Fig. 3

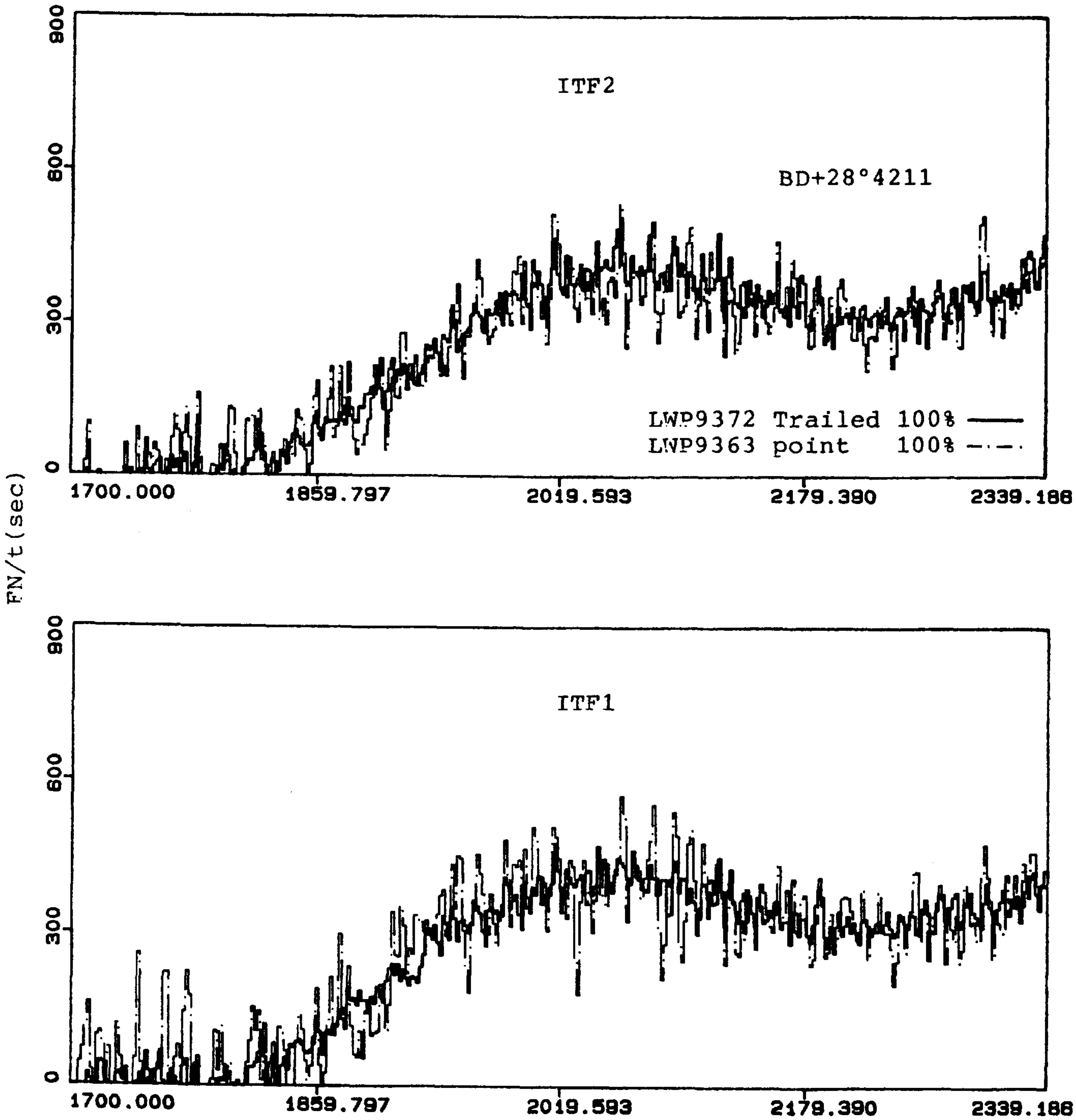

FN/t(sec)
ITF2
BD+28°4211
LWP9372 Trailed 100%
LWP9363 point 100%
0
300
600
900
1700.000
1859.797
2019.593
2179.390
2339.186
ITF1

Fig. 4a

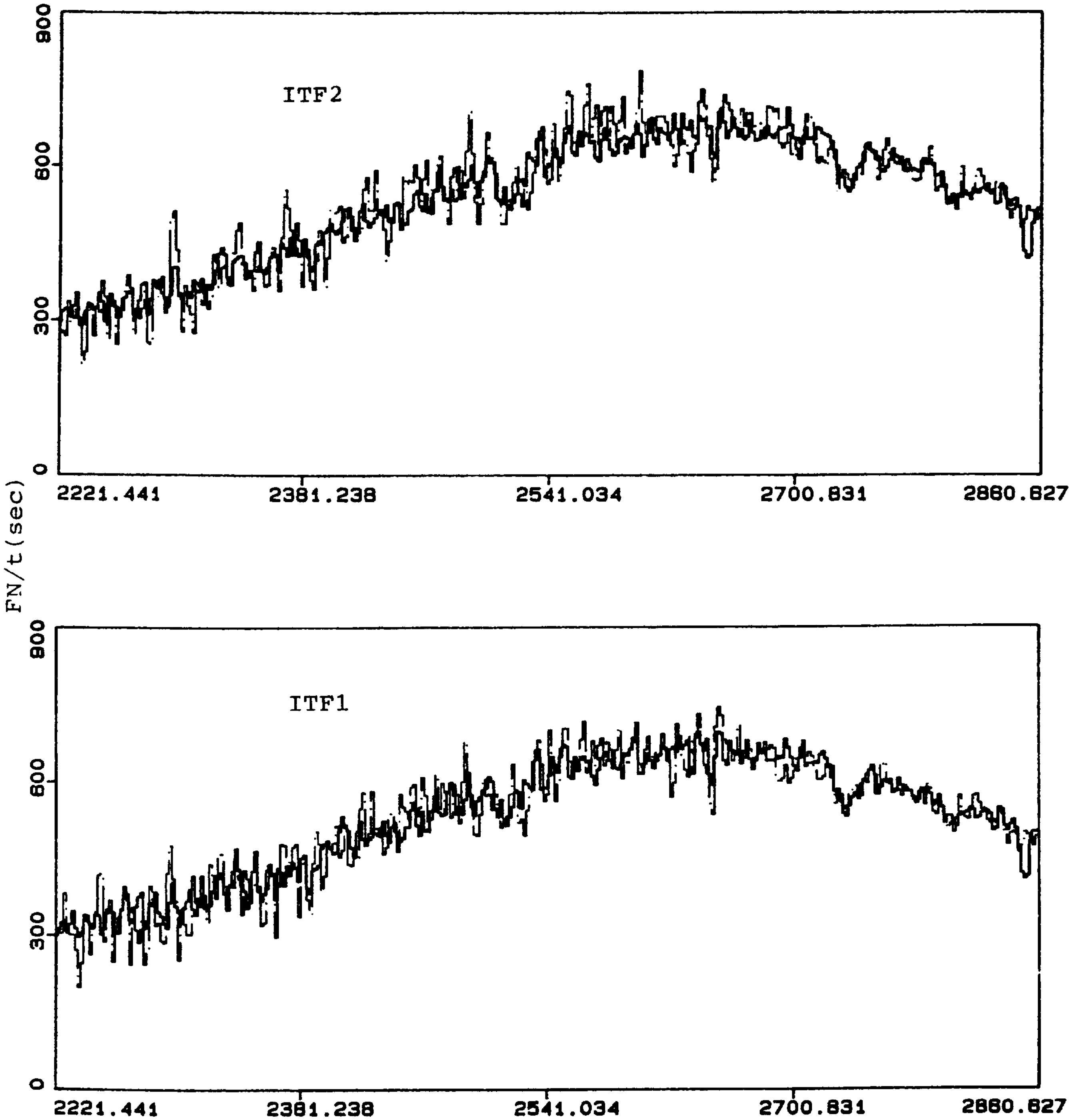

ITF2
ITF1
FN/t(sec)
0
300
600
900
2221.441
2381.238
2541.034
2700.831
2860.827

Fig. 4b

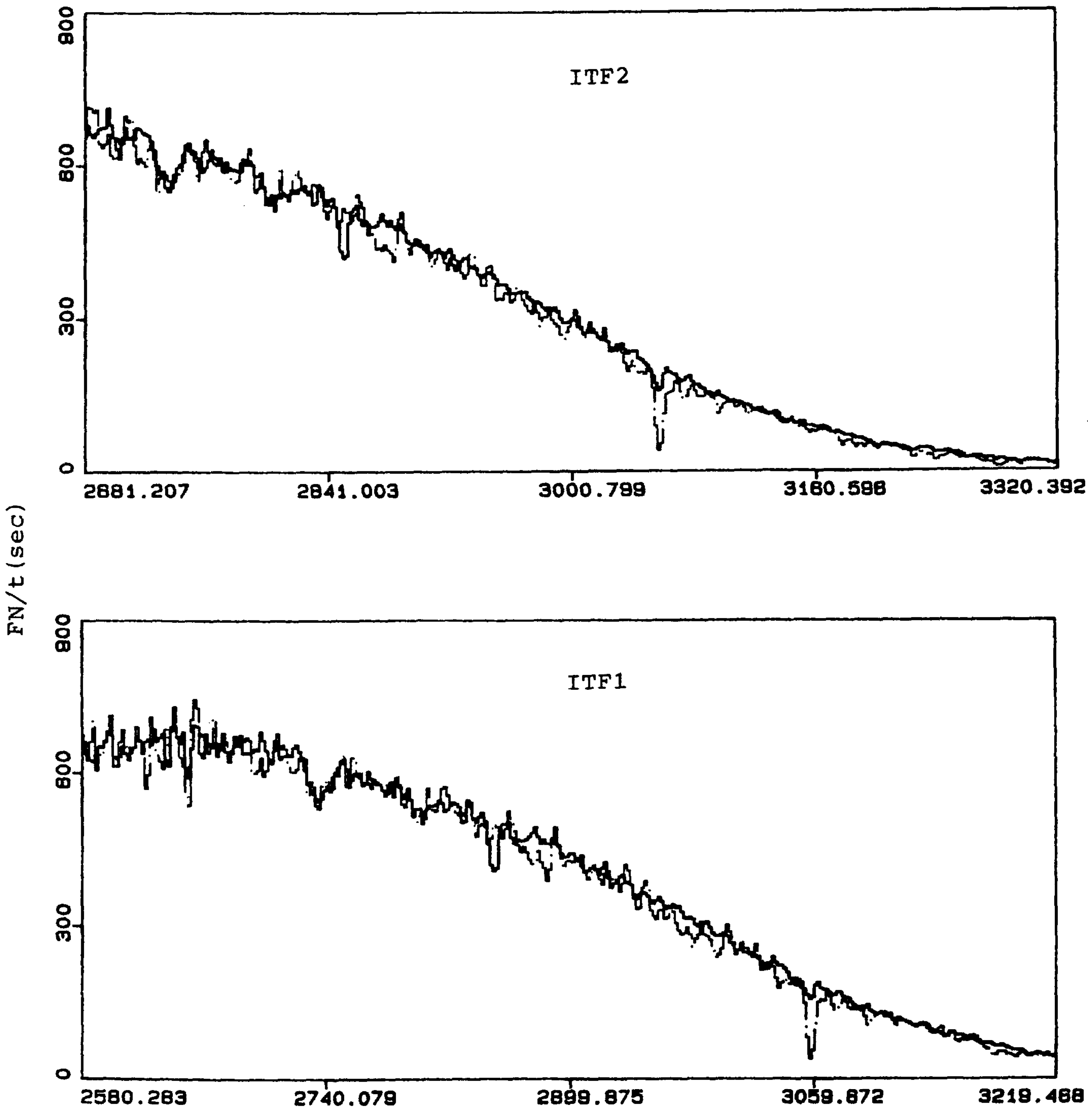

FN/t(sec)
ITF2
800
600
300
0
2681.207
2841.003
3000.799
3160.596
3320.392
ITF1
800
600
300
0
2580.283
2740.079
2899.875
3059.872
3219.468

Fig. 4c