

Shrinkage effects in bubble chamber film

Introduction

Films of the CERN 2m bubble chamber, measured on HPD 2, have been used to get an estimate of the fluctuations in the shrinkage of the film. This is particularly easy to do with an HPD, because of the measurement of all fiducials for each frame.

In Fig. 1 the numbering and positions are shown of the 9 glass fiducials which has been used for this study. The film used was roll 508, view 4 of an experiment with 3.6 GeV/c $\bar{p}$ in hydrogen. The type of the film is BCF LL ADOX, which has a triacetate base. The average positions of the fiducials relative to one another are determined. Then for each measurement, by allowing displacements of the complete set in X and Y, a fit is made of the nine measured positions against their average positions.¹⁾ The residual distances, for X and Y directions respectively, are plotted in the two right most columns of Fig. 2 and Fig. 3. The standard deviations of the histograms are given in the two right most columns of Table 1. They are of the order of 6 least counts ($12\text{ }\mu\text{m}$)* compared with the corresponding value of $4\text{ }\mu\text{m}$ for the (smaller) film of the 80 cm bubble chamber, measured on HPD 1. To be able to interpret this result, it was necessary to evaluate the contribution to this scatter from the HPD itself, so a separate test was performed to obtain this.

Reproducibility of HPD 2

To measure the reproducibility of HPD 2, one frame has been measured a hundred times, moving the film after each measurement. In this way all variations due to the film are eliminated from the result. The two left most columns of Fig. 2, Fig. 3 and Table 1 were obtained from these measurements using the method described above. For the X direction the standard deviations of the histograms are about 1 least count ($2\text{ }\mu\text{m}$), which is the same order of magnitude as for HPD 1, if we take into account that in the standard deviation of $4\text{ }\mu\text{m}$ the effects due to the film are still included.

* In this note, distances in both X and Y have a least count equal to $2\text{ }\mu\text{m}$.

If we compare the standard deviations for the reproducibility test in the Y direction with those in the X direction, the former are about 1.5 times greater than the latter. This effect is due to a small rotation of the film in the film gate (and has no influence on the geometrical reconstruction of the events in THRESH). The Y distribution is more changed due to this effect than the X distribution, because of the different dimensions in both directions.

If we assume that for the standard deviations of the histograms for fluctuations of position in the Y direction, 1 least count comes from non-reproducibility of HPD 2 and 1 least count comes from the rotation, (the quadratic sum is then 1.4 least counts), the rotation is over an angle of 0.04 mrad, if 25000 least counts is a representative value for the distance between the fiducials.

Fluctuations in shrinkage of the film

Because a larger film is used on the 2 m bubble chamber, compared with the 80 cm bubble chamber, the fluctuations in shrinkage will be more important. The shrinkage effects can be studied by comparing the distances between the fiducials over several frames. (From here on the distances discussed are the actual measured separations and not the X and Y components used in the previous sections) For the X direction 5 distances between fiducials were used : FID 8 - FID 12, FID 10 - FID 23, FID 22 - FID 21, FID 4 - FID 2 and FID 23 - FID 24, for the Y direction 4 distances : FID 22 - FID 23, FID 4 - FID 10, FID 21 - FID 24 and FID 2 - FID 12. (see Fig. 1). The fluctuations in these distances as a function of frame number are given in Fig. 4.

In THRESH a correction is made for linear effects, separately for the X and Y directions, so only non-linear effects will influence the physical results. For this reason correlation plots were made between pairs of distances in the X direction or in the Y direction. The correlations, which are already visible in Fig. 4 can then be studied more carefully.

In Fig. 5 the distance FID 23 - FID 24 is compared with the distance FID 23 - FID 10. As can be seen from Fig. 1, no important effects due to non-linearity of the shrinkage of the film, are likely to occur in this plot, because about the same region of the film is involved. So this plot again gives the accuracy of measurement of HPD 2. The half width of the correlation plot is about 2 least counts (4 μ m), which is consistent with the combined standard deviations of the distributions for the X and Y components separately. The length of the plot gives an indication of the fluctuations occurring in the linear distortions which here range over about ± 30 μ m.

In Fig. 6 the fluctuations in the distance FID 22 - FID 21 are compared with the fluctuations in the distance FID 23 - FID 10. The lengths are about the same, 22000 and 18000 least counts respectively, but the first is in the lower half of the film and the second is in the upper half of the film (a distance in Y of about 15000 least counts). The half width of the plot is now 4 least counts, which is almost entirely caused by the non-linear effects.

In Fig. 7 the worst situation is shown, where FID 8 - FID 12 is compared with FID 22 - FID 21. The half road width of the plot is 8 least counts. The linear shrinkage is again about 15 least counts.

Non-linear shrinkage of this magnitude is thought to have negligible influence on the physical results, both because of its size and because the large number of fiducials measured minimize the effect due to any particular one. For the film of the 80 cm bubble chamber sometimes non-linear effects occurred of the order of 100 μm , for one particular fiducial¹⁾. Even this was not catastrophic if the fiducial was not inside the fiducial volume.

Conclusion

In the film studied, within the size of one frame non-linear shrinkage effects of up to 16 μm have been measured, compared with linear shrinkage fluctuations of $\pm 30 \mu\text{m}$. By comparison with an earlier study it may be concluded that this effect will have negligible influence on the physical results¹⁾.

Reference

- 1) D. Holthuisen,
A measurement of the position of the fiducials on bubble chamber film,
CERN - DD/DA/67/1.

TABLE 1

Standard deviations of the histograms of Fig. 2 and Fig. 3. Columns 1 and 2 give the reproducibility of the HPD 2, obtained by measuring the same frame 100 times, moving the film after each measurement. Columns 3 and 4 are standard deviations for 80 frames of roll 508 view 4.

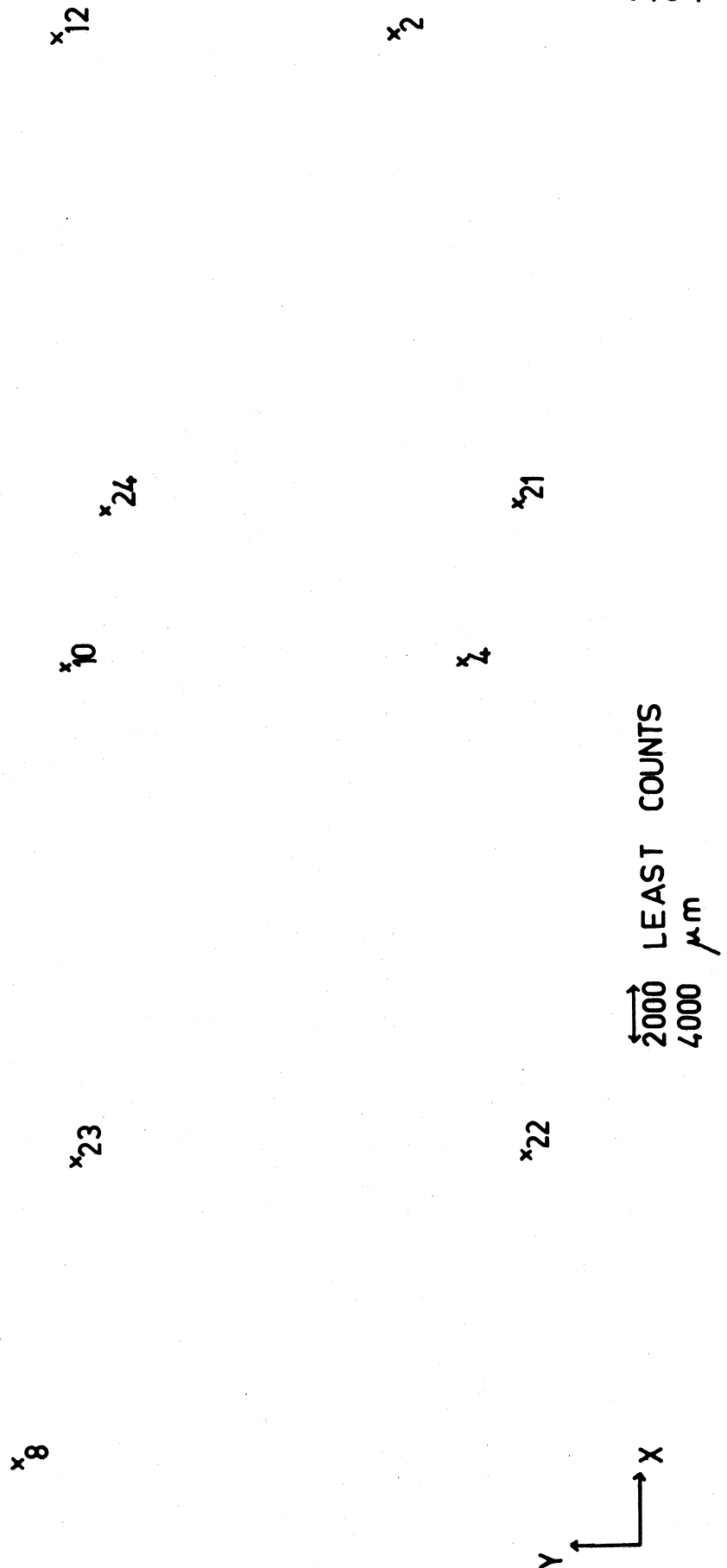
FID	100x same event		80 different events	
	σx	σy	σx	σy
12	1.2	1.5	7.0	10.3
10	0.5	1.6	3.2	7.7
8	1.3	1.9	8.5	6.4
4	0.6	1.1	4.1	5.1
2	1.2	1.3	6.2	9.4
24	0.8	1.3	4.3	6.2
23	1.0	1.6	6.6	7.3
22	0.9	1.7	6.3	6.7
21	0.9	1.4	4.2	5.7

Figure captions

- Fig. 1 The mean coordinates of the fiducials.
- Fig. 2, 3 Deviations from the mean position for each fiducial, plotted for each frame. Columns 1 and 2 : reproducibility in X and Y direction of HPD 2, same event measured 100 x, moving film after each measurement. Columns 3 and 4 : histograms for 80 different frames.
- Fig. 4 The distances between the fiducials as function of the frame number. The first 5 graphs are for horizontal lines, the last 4 graphs for vertical lines (see Fig. 1).
- Fig. 5 Correlations between fluctuations in the distance FID 23 - FID 24 (23000 least counts) compared with fluctuations in the distance FID 23 - FID 10 (18000 least counts).
- Fig. 6 Same as Fig. 5, but now between FID 22 - FID 21 (22000 least counts) and FID 23 - FID 10 (18000 least counts).
- Fig. 7 Same as Fig. 5, but now between FID 8 - FID 12 (48000 least counts) and FID 22 - FID 21 (22000 least counts).

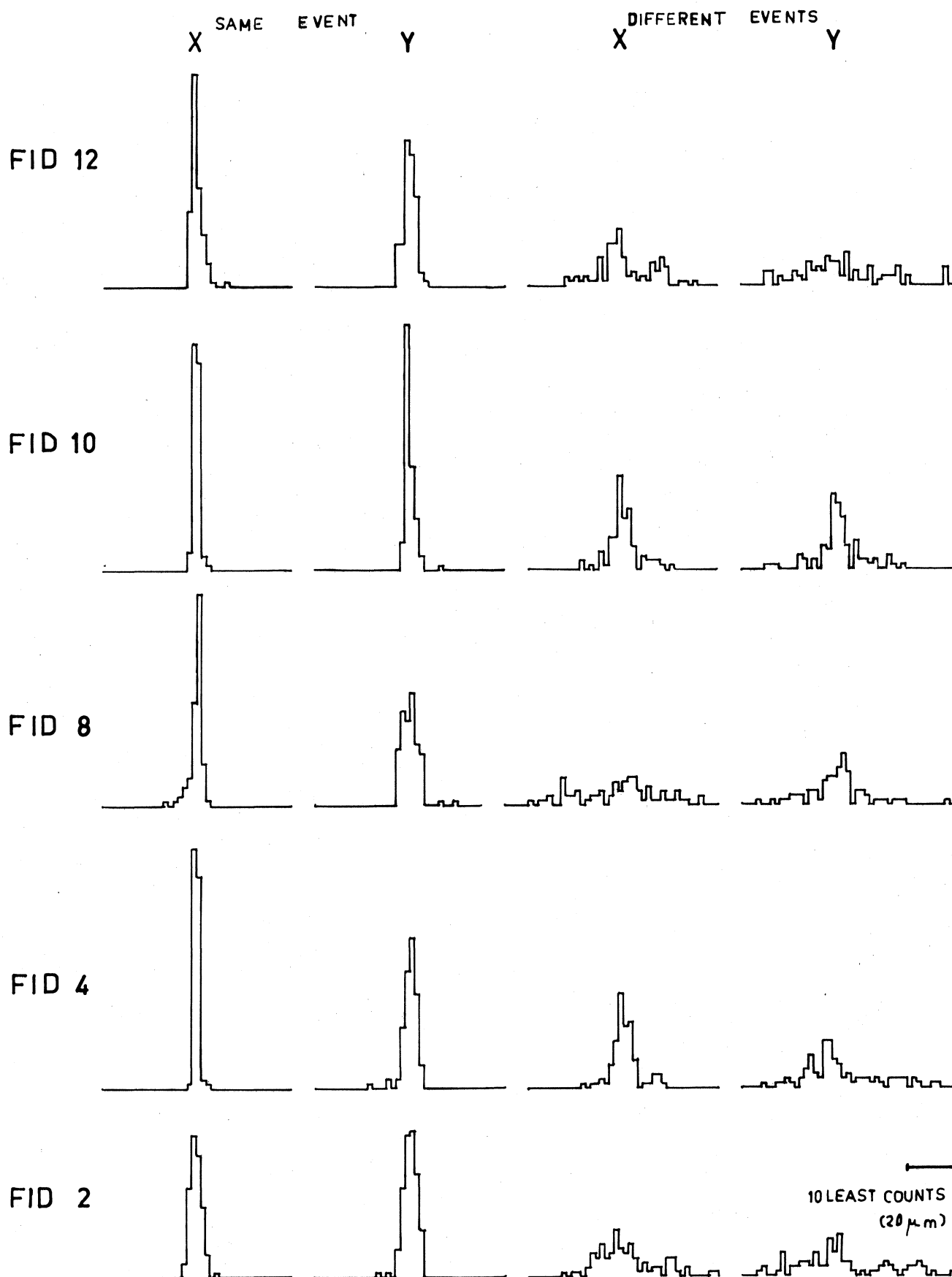
Fiducial Coordinates

ROLL: 508 view 4



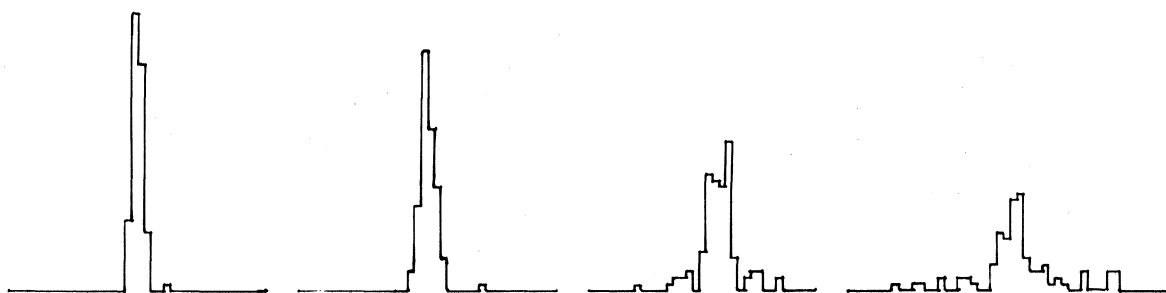
ROLL: 508 view 4

FIG 2

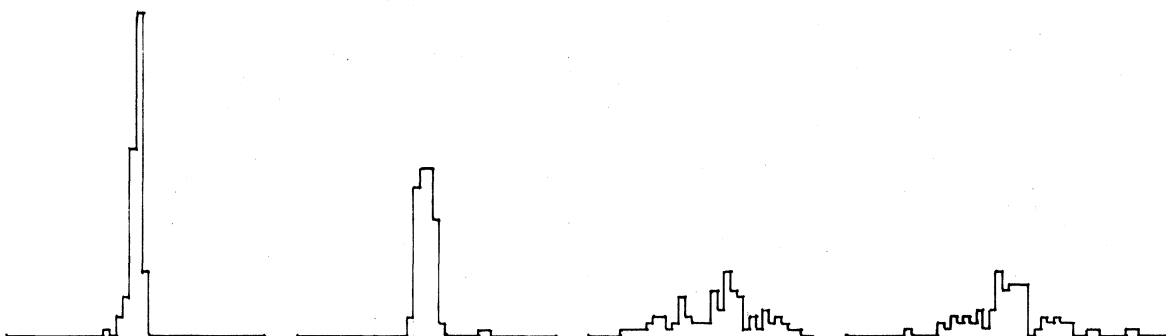


SAME	EVENT		DIFFERENT	EVENTS
X		Y	X	Y

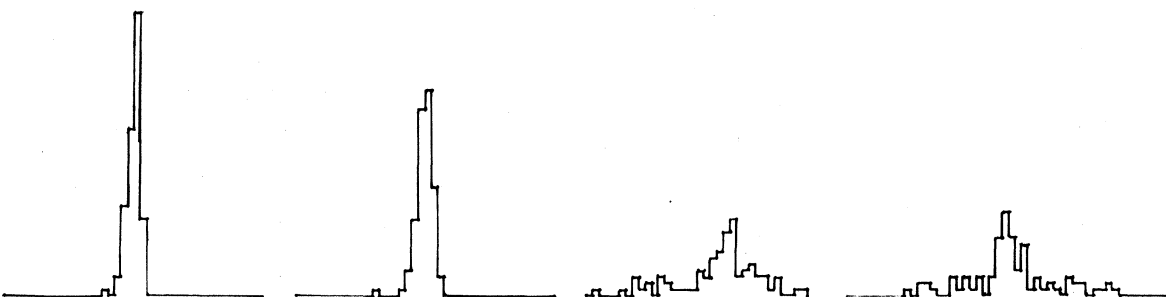
FID 24



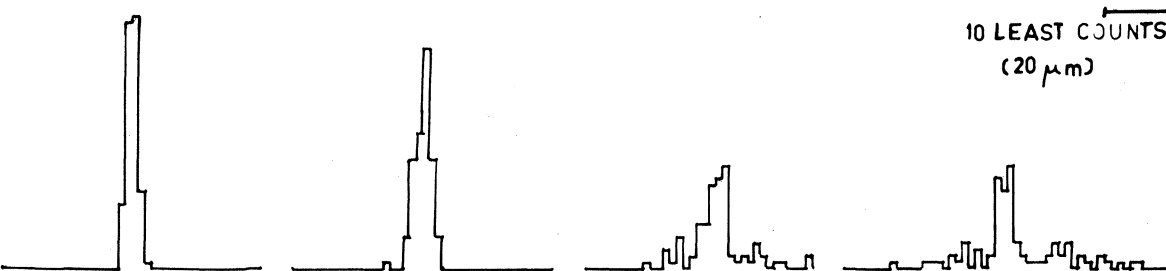
FID 23



FID 22



FID 21



10 LEAST COUNTS
(20 μ m)

Roll 508 View 4

FIG 4

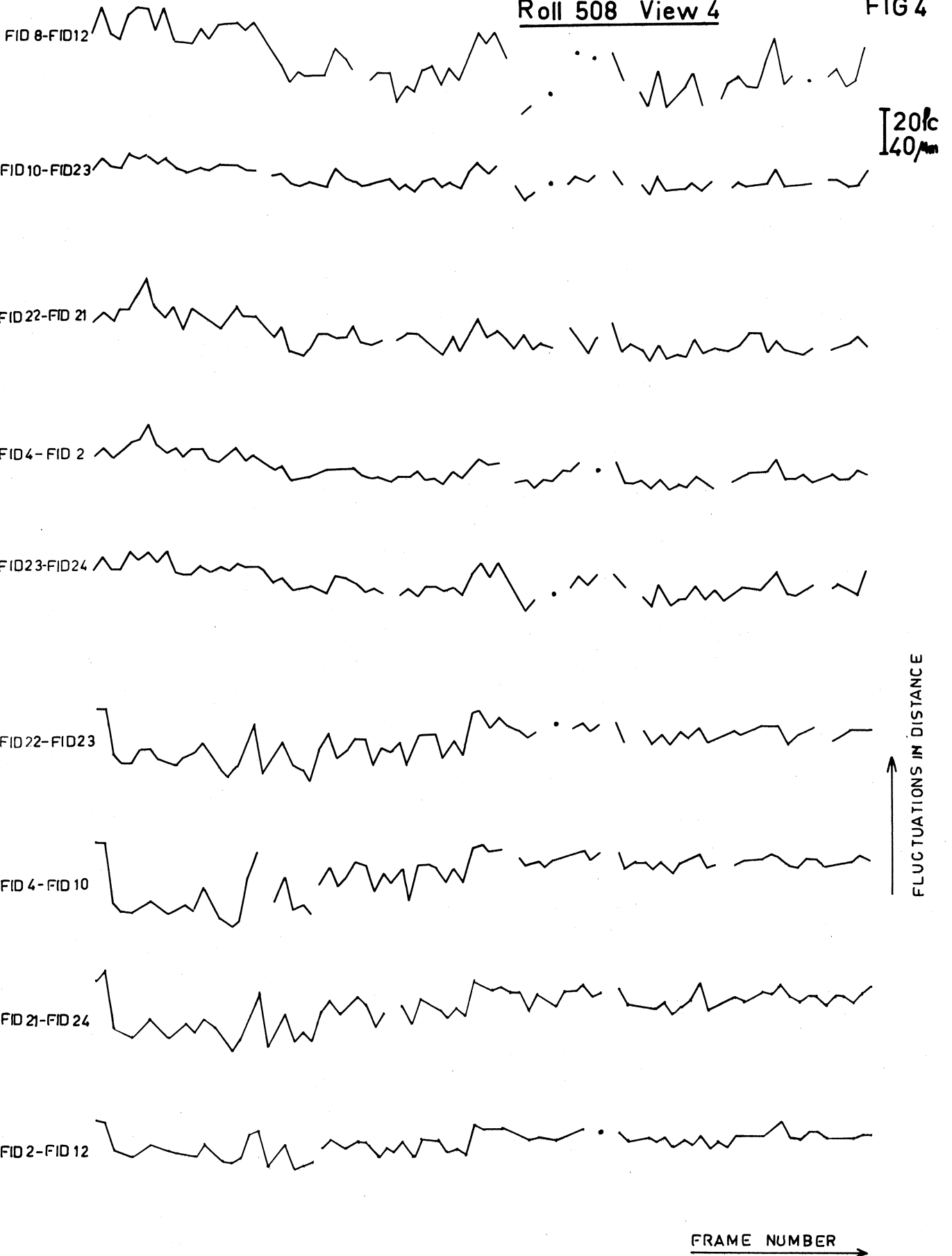
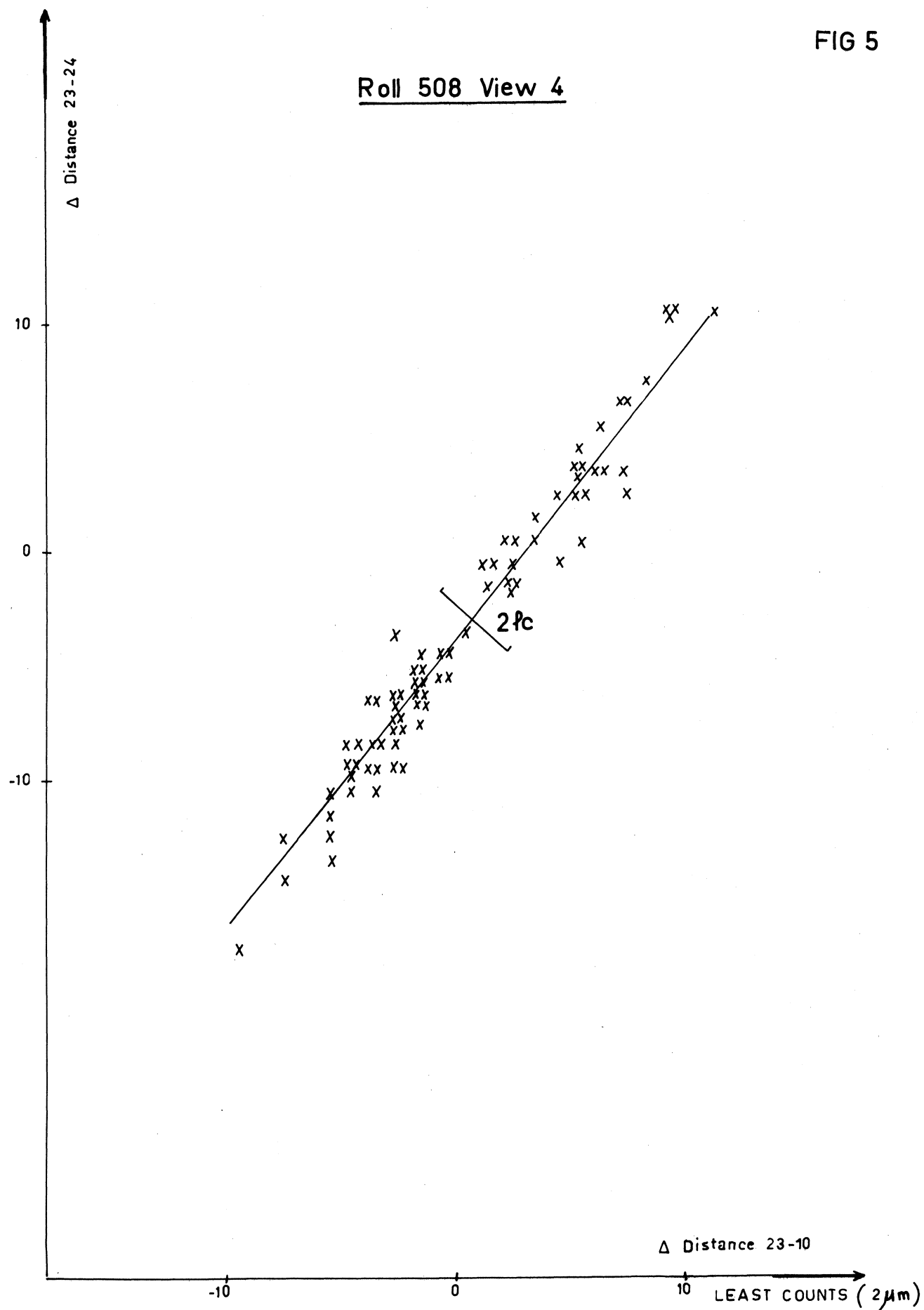
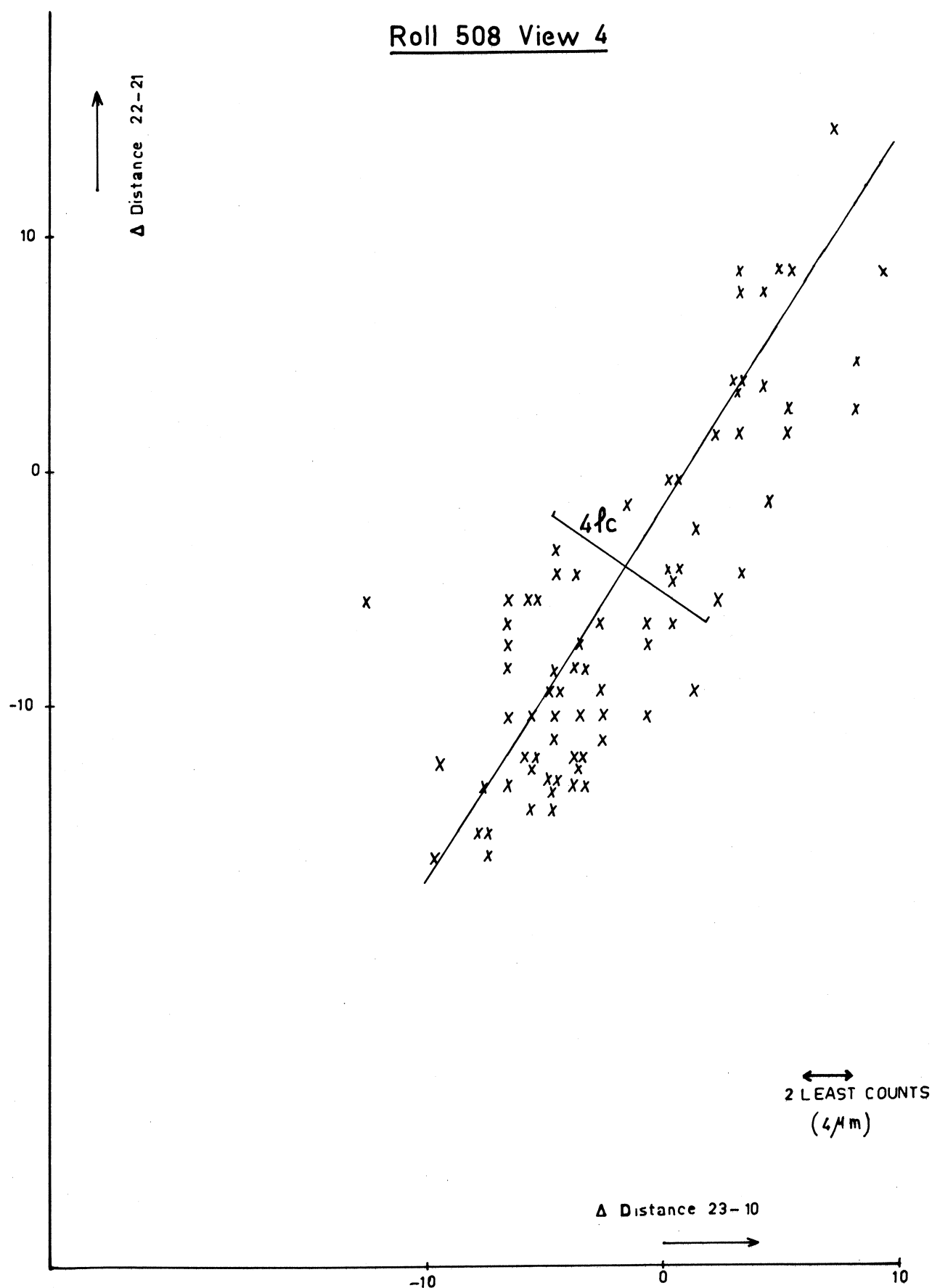


FIG 5



Roll 508 View 4



Roll 508 View 4

FIG 7

