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SOLENOIDAL DETECTOR NOTES

SELF CENTERING MEASUREMENT FOR 8 LAYER TRAPEZOID

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Self centering measurement for 8 layer trapezoid

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Straw Chambers

The basic drift cell is constructed with a plastic based cylindrical cathode structure and a 0.025 mm diameter wire along the axis. The straws are formed by winding several centimeter strips of the plastic wrap on a mandrel and then overlaying and gluing a second layer. This results in a rather uniform overall straw, but tension variations and gluing variation result in a diameter variation of about ± 25 microns and a deviation from circularity of about ± 50 microns. All methods proposed for using the straws for drift chambers require that the straws be held straight in some manner and be formed in regular array by some means. These two aspects of the design of a straw module are critical. The ultimate precision of the drift chamber is obtained by knowing the positions both at the ends of the wire positions and at the intermediate wire support points.

The proposed scheme for positioning the straws with respect to each other requires clamping and gluing the straws at the points along the straw where the internal wire supports are located. The layout is shown in Fig. 1. This technique relies on the wire supports (double V's) close packing in a regular array when clamped and glued. The array must maintain this configuration when freed from the clamp.

The design of the wire support (Double V) is shown in Fig. 2. The diameter has been measured to be 3.972 mm (0.1564 in.) The double V's are injection molded and are uniform to about 0.005 mm.

This memo reports on the first series of tests we have carried out on a 8 layer trapezoidal array that we are preparing for a one meter test module.

Description of the clamp

The clamp is shown in Fig. 3. It is designed to be used along with 4 other identical pieces in a linear array to clamp 228 straws in a one meter module. In this test, however, we used short (about 2 cm) sections of straws with the double V's inserted and then clamped in only one clamp. The clamp dimensions are set by assuming a straw + double V diameter of 4.043 mm (0.1592 inches). The wall thickness is taken to be 0.035 mm (1.4 mils). The reference blanks were cut by Liberty Advanced Machining of Columbus IN, using a numerically controlled mill. The clamps were then precision cut using a electrodischarge cutting technique at Wirecut Technologies in Indianapolis, IN. The drawing tolerance of 0.013 mm (0.5 mil) appears to have been achieved by this technique.

Clamping and gluing tests

Two types of tests were performed. First, the straws and wire spacers were clamped without gluing. This array was measured while still inside the clamp. The positions of the double V's were determined by using a Nikon optical comparator with a measuring accuracy of about 0.005 mm (0.2 mil). However, it is estimated that the location of the vertex of the double V could be found to about 0.025 mm (1 mil).

The second measurement was made on an array of straw sections that had been be glued with Eccobond 45 epoxy. This particular array was formed layer by layer with a bead of glue applied on the surface of each layer before the next was laid down. The bottom, top and sides (in contact with the clamp) were not glued. After the array had dried it was removed from the clamp and measured in the same manner as the first array.

Determination of the self centering errors

The determination of the self centering errors of the double V's was made by fitting the measurements to an ideal close packed cylindrical array. This was done using MINUIT and using the x, y centroid, the rotation angle, and the close packed diameter as fitting parameters in a chi squared minimization procedure. The details were reported in IUHEP 91-6. .

The resulting fits gave the following results:

<u>Clamped array (no glue)</u>

fitted diameter- 4.044 ± 0.00025 mm (0.15921 inches)

Sigma- 35 microns (1.33 mils)

The deviations of the fit in both X and Y are shown in Fig. 4 a, b.

<u>Unclamped glued array</u>

Fitted diameter 4.046 ± 0.001 mm (0.15930 inches)

Sigma 30 microns (1.2 mils)

The deviation of the fit in both X and Y is shown in Fig. 5 a, b.

Conclusions

The resulting fits showed several interesting effects. For the clamped array the fitted diameter was 4.046 mm (0.15921 inches) which corresponds to a midline width of 115.2525 mm (4.5375 inch.) The unclamped, glued array had a fitted straw + Double V diameter of 4.044 mm (0.15930 inches.) Along the midline of the trapezoid this corresponds to a width of 115.3185 mm (4.5401 inches). So, it appears that the array expanded when unclamped by less than 0.066 mm (2.5 mils). We suspect that this is the

effect of the elasticity of the double V. Depending on how reproducible the gluing procedure is we can compensate for this when designing the shell structure.

The more important result is the self-centering error we have determined. We conclude that the unclamped array can be modeled by a perfect array with an error at each wire position of less than 0.030 mm (1.2 mils). (We believe that much of this error is measurement error due to a lack of precision in determining the vertex of the double V.) This error is well with in the requirements set for the tracking precision in the SDC. We intend to use this modeling technique for the final modules, so that a rather restricted number of parameters will be used to determine the wire position at the four wire support points along a module.

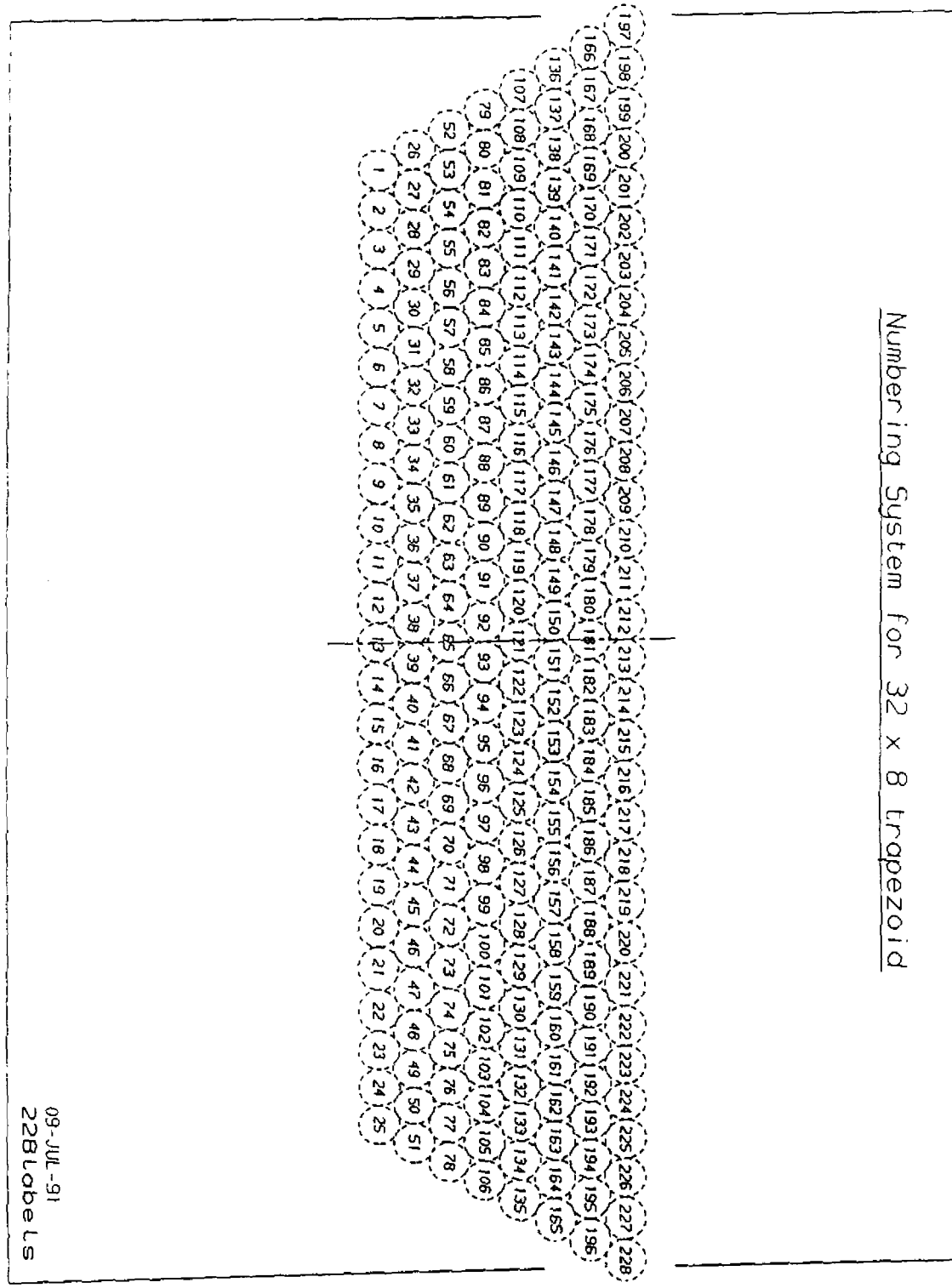

Fig. 1 Eight Layer array convention

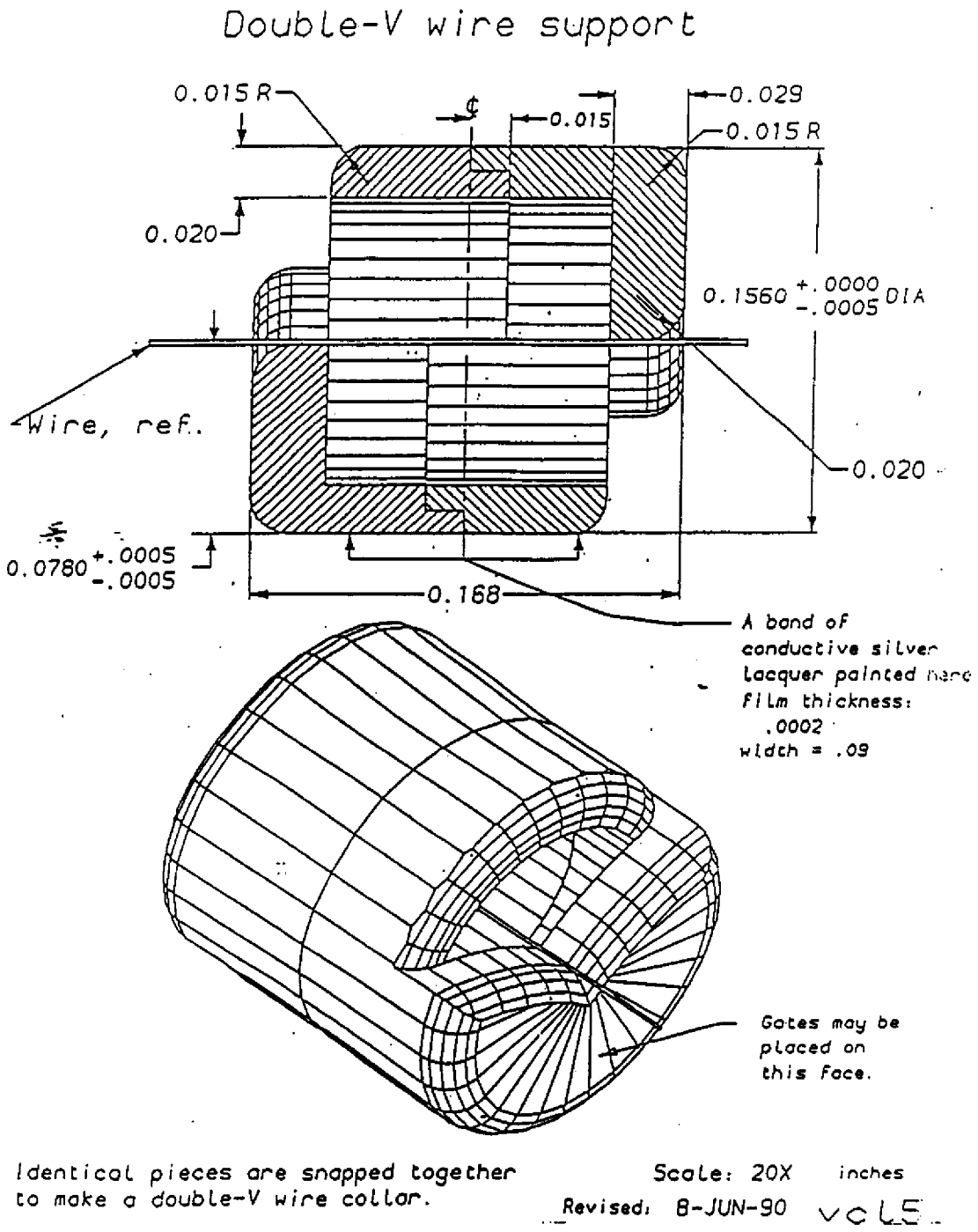

Fig. 2 Double V dimensions

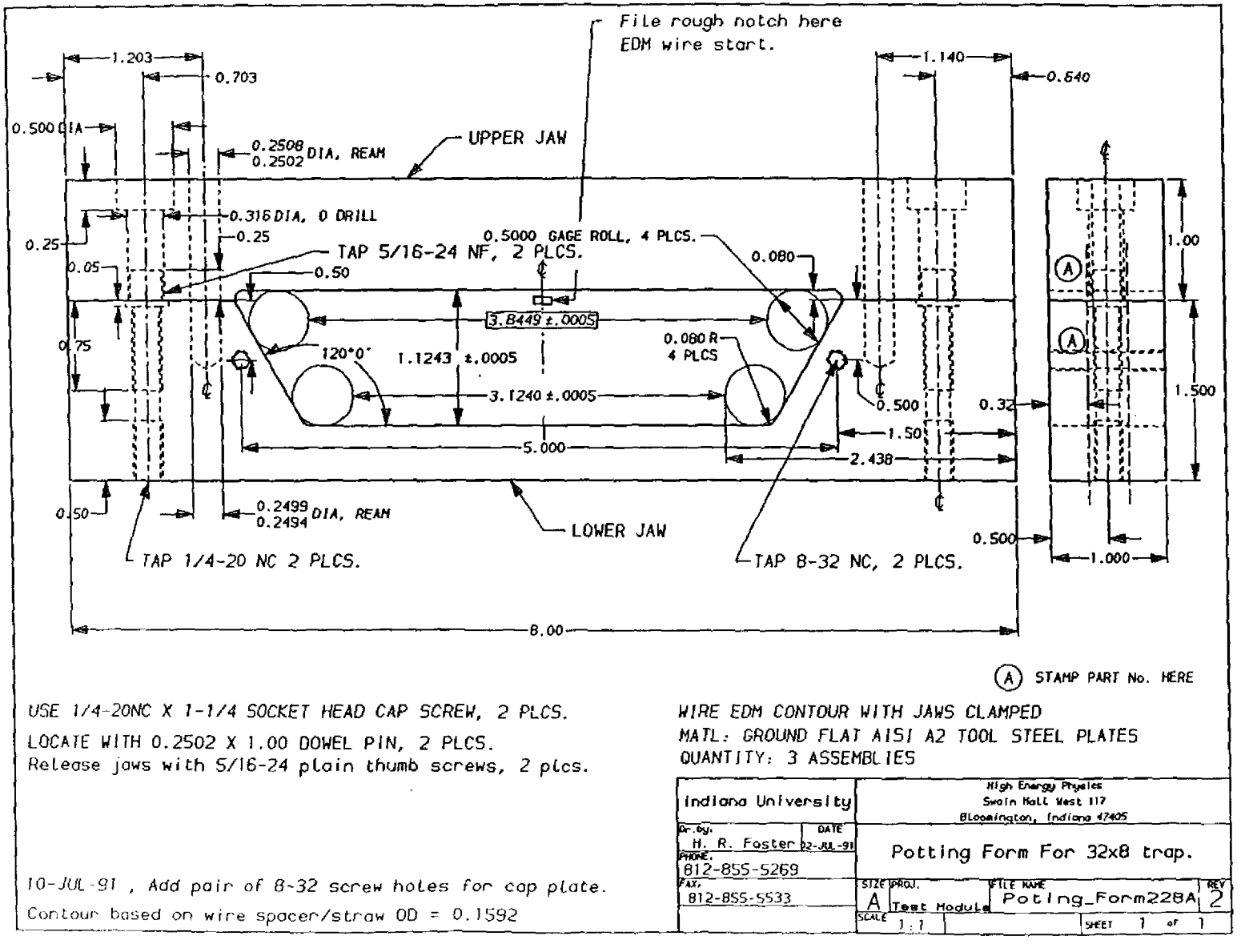

Fig. 3 Clamp design

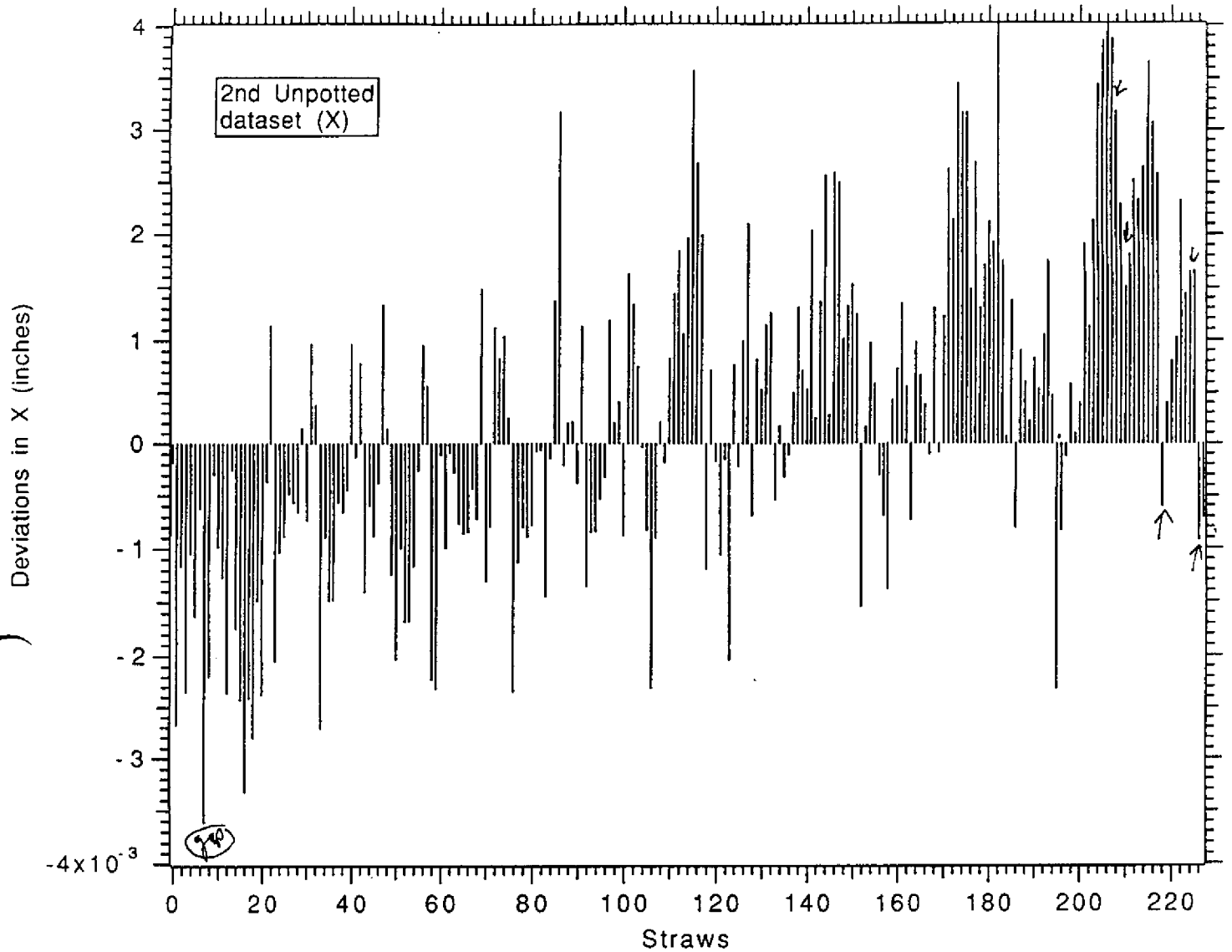

Fig. 4 a X deviations for clamped array

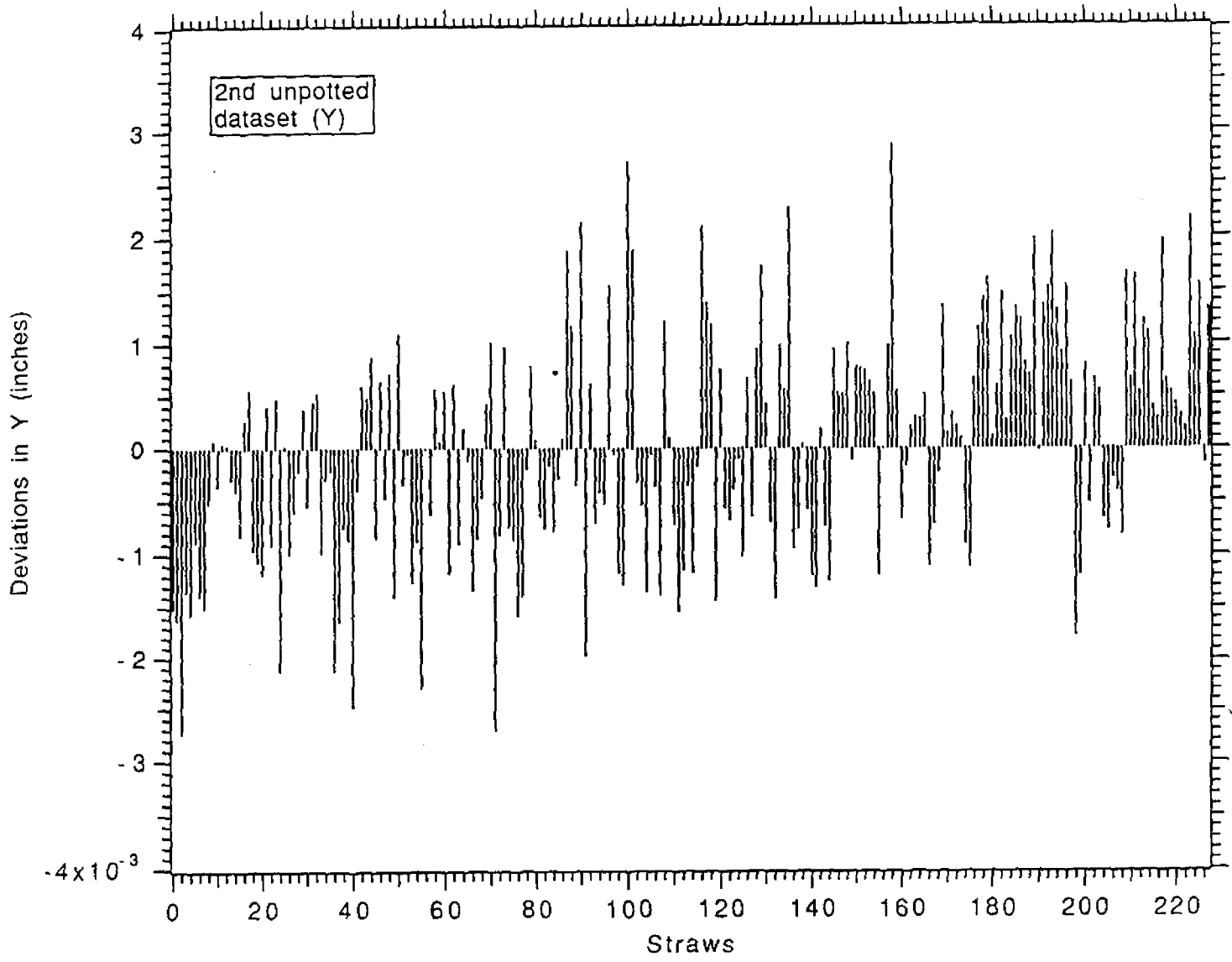

Fig. 4 b. Y deviations for clamped array

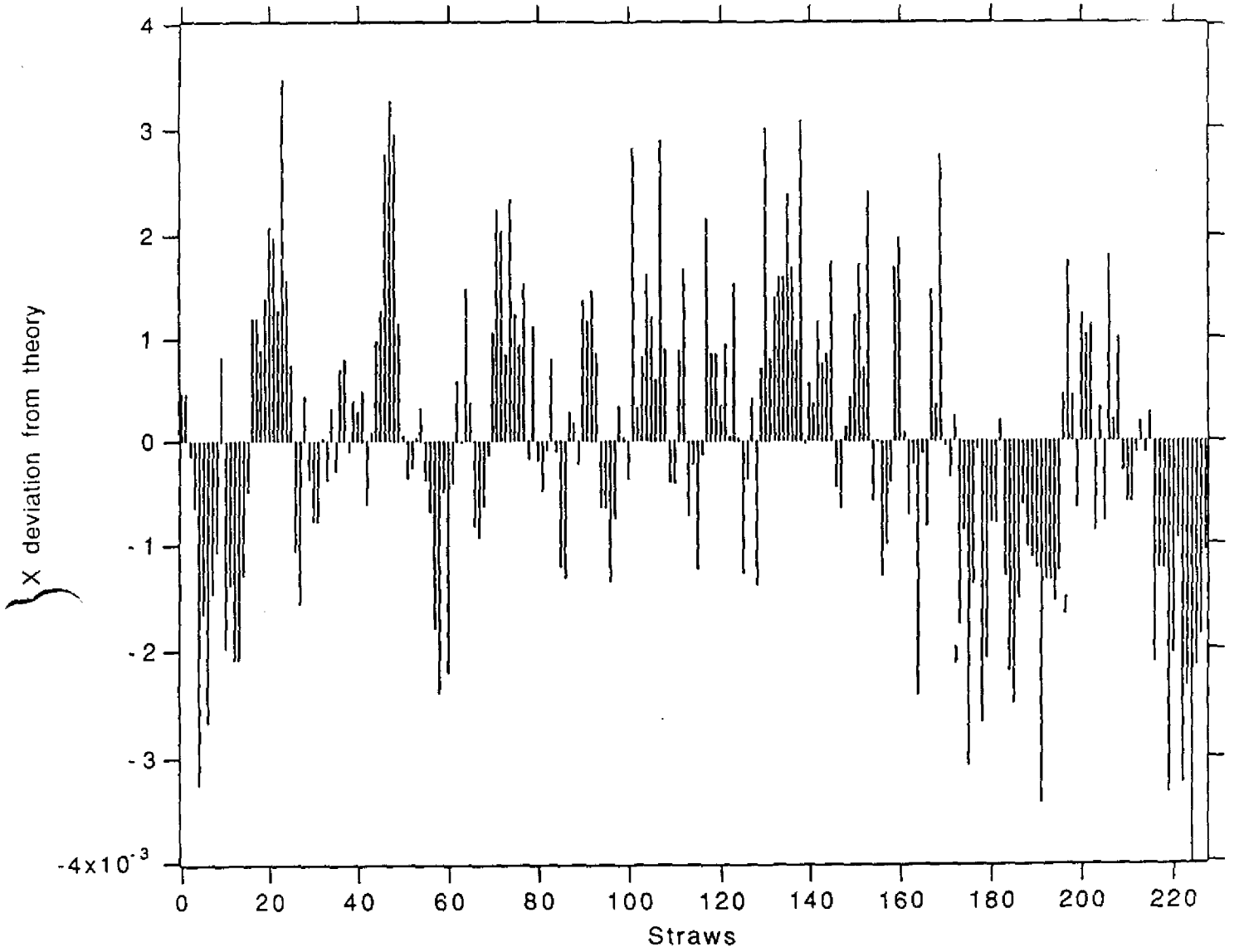

Fig. 5 a X deviations for glued,unclamped array

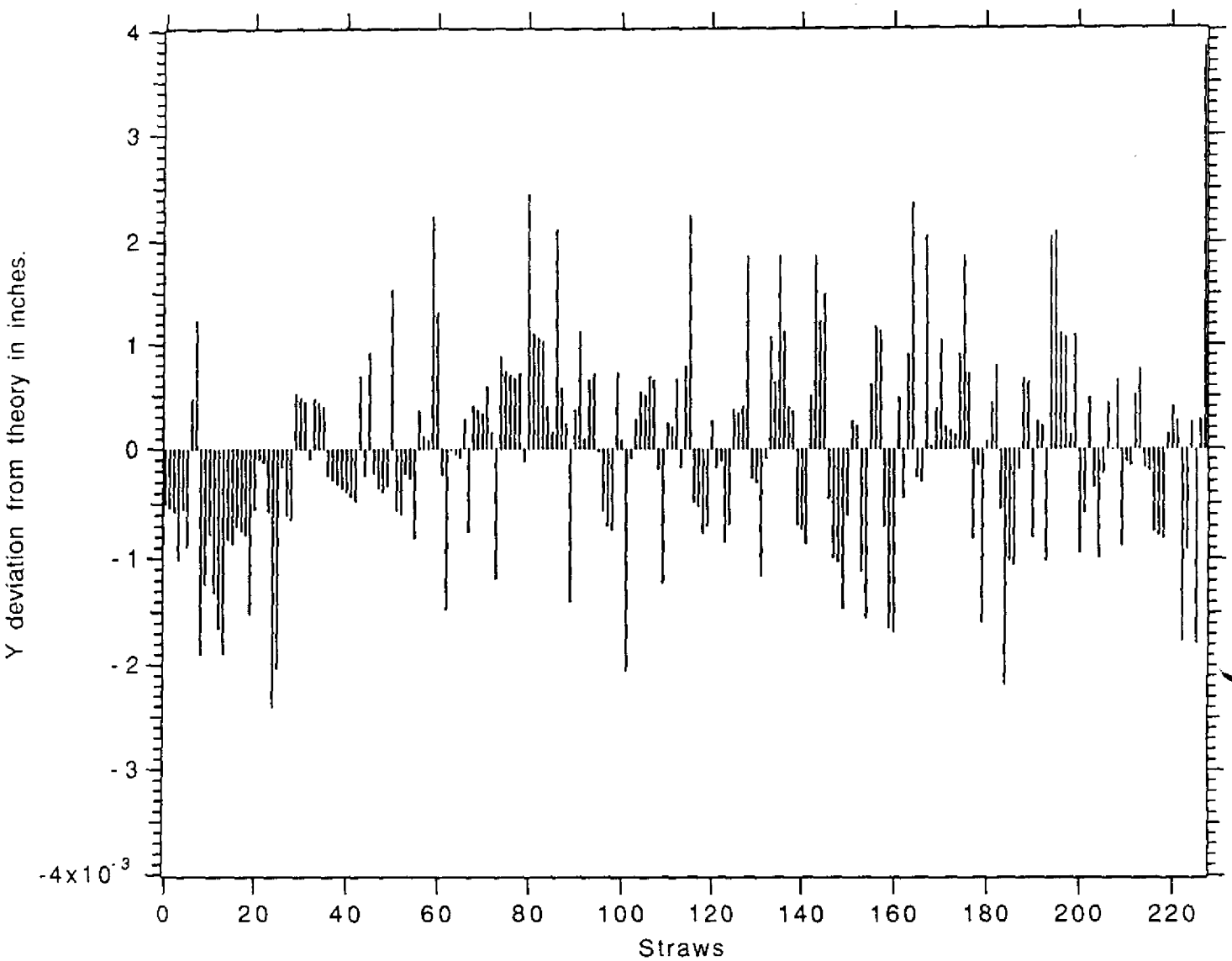

Fig. 5 b. Y deviations for glued,unclamped array