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Quality check of the cut of silicon wafers for the SMD detector

Technical report

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Abstract
The check of the cut of silicon wafers has been done in the clean-room of the INFN-Sezione di Perugia to understand, for future productions, the feasibility of aligning the wafers to each other using the edges. A 3-D coordinate measuring machine has been used. Four cut edges of two silicon microstrip sensors were measured.

Introduction

In this note we report the measurement of cut edges on the long sides of two 4x7 cm^2 silicon microstrip sensors [1] which has been done in the clean-room of the INFN - Sezione di Perugia, using a 3-D measuring machine [2]. The measurement is aimed at checking the quality of the cut process to understand, for future productions, the feasibility of aligning the wafers to each other using the edges.
Quality of the cut can be affected by three factors:
- straightness of the cut;
- rotation of the cut (with respect to the longitudinal direction, i.e. r-phi strips);
- displacement of the cut in the transverse direction.

Measurement and results

A reference cross is located at each corner of the sensor. First we measure the coordinates of these crosses and then we use two opposite crosses on each long side to define a cross-to-cross longitudinal reference line. The design distance of the edge of the wafers from cross-to-cross reference line, after cut, is 300 μm. To check the quality of the cut edges, the coordinates of about 25 points on each long side of the two sensors are measured for a total of 107 points. In the following we present the results of the measurement and analysis of the data.

In fig.1 the coordinates, i.e. the distances of all measured points from the reference line, are plotted. Fig.2 shows the distance distribution for all measured points, from which a mean distance of 307 ± 8.6 μm from the reference line is obtained (maximum and minimum value 322 μm and 290 μm respectively).

In fig.3 we present the distance distributions separately for each of the four measured sides of the sensors. We obtaine the following values: 298 ± 4.3 μm, 317 ± 2.6 μm, 299 ± 3.6 μm and 312 ± 3.7 μm.

In fig.4 the coordinates are plotted separately for each of the measured edges, and then a straight line fit is performed. We can clearly see that the width of the single distance distributions arises from both uneven cuts and rotation of cuts themselves with respect to the longitudinal direction, while the mean values give an indication of the actual transverse displacement of the cut.

In fig. 5 the residue distribution from the above fit lines is shown (all edges mixed together). This histogram is then fitted with a gaussian whose width of 2.9 μm can be used as an overall measure of the roughness of the cuts.

Conclusions

Four cut edges of two silicon microstrip sensors were measured obtaining the following results:
- the width of the overall residue distribution in fig.5 shows that all cuts are sufficiently straight (rms ≈ 3 μm);
- given the previous result, standard deviations from fig.3 imply that rotations of the edges are also negligible (rms < 4.3 μm);
- absolute displacement of the cut is however the most important source of uncertainty (average position of the cut 306.5 ± 8 μm from fig.2).

Given the actual results, an improvement of the quality of the cut is therefore required mostly on the absolute displacement of the cut, in order to bring it down to 300 ± 5 μm.

References

1. C.S.E.M. Recherche et Development, Neuchatel, Switzerland
2. Mitutoyo BHN506 3-D coordinate measuring machine with 100x magnification objective.

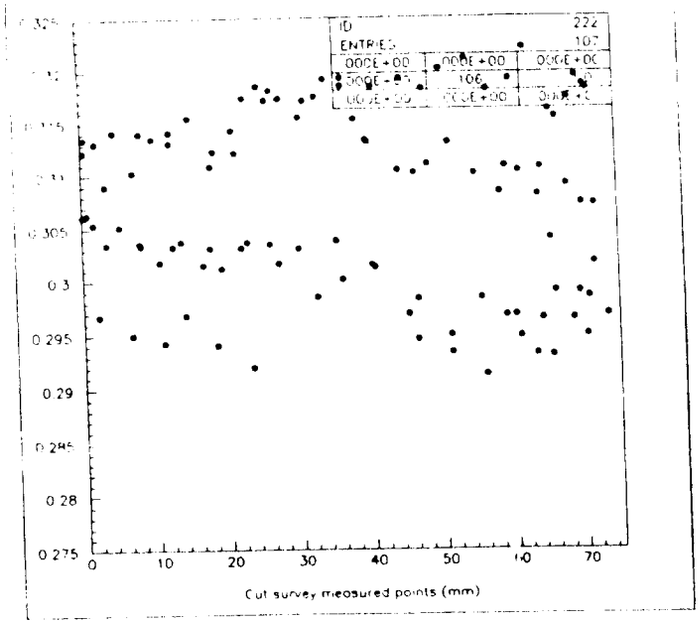

Figure 1 Cut survey measured points (mm)

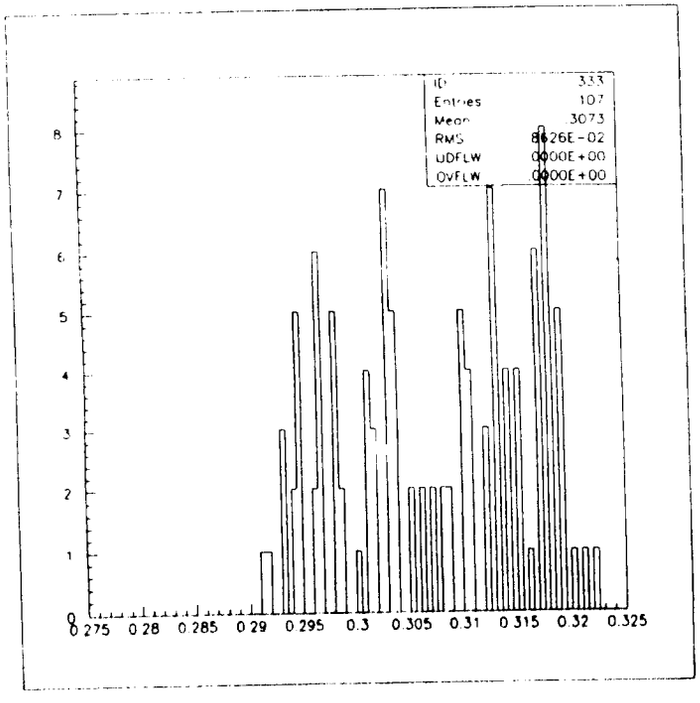

Figure 2 Distance distribution (design value 0.3mm):all points (mm)

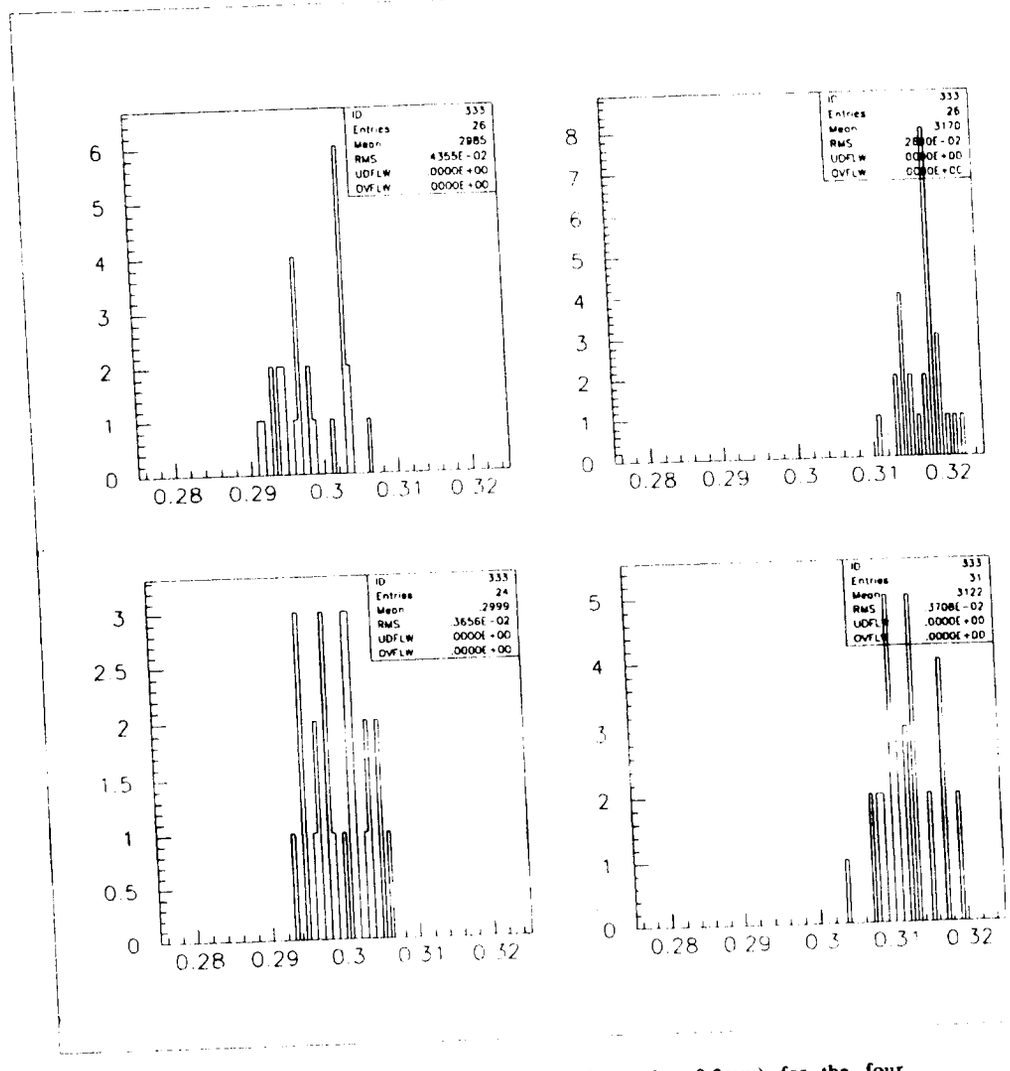

Figure 3 Distance distribution (design value 0.3mm) for the four measured cut edges

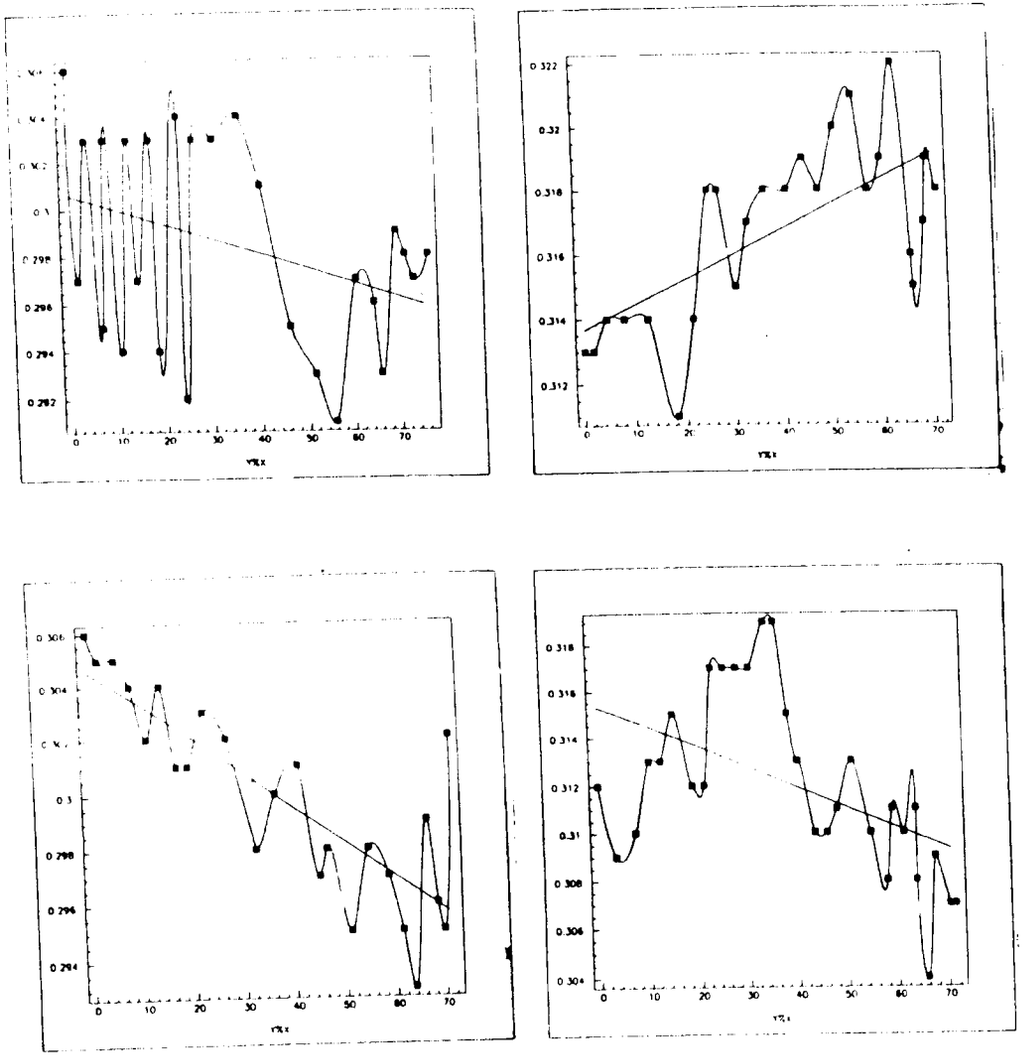

Figure 4 The coordinates for the four measured cut edges.

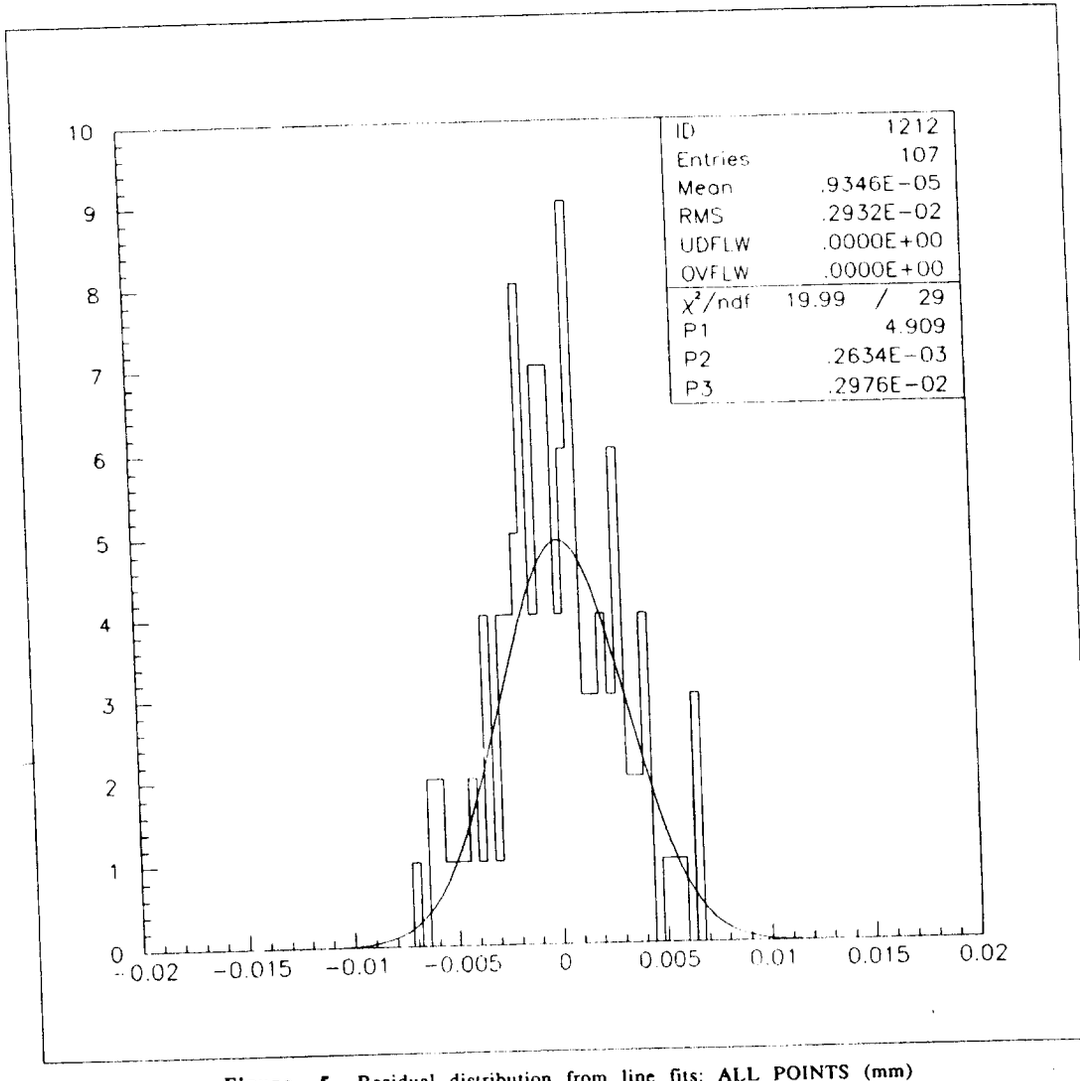

Figure 5 Residual distribution from line fits: ALL POINTS (mm)