Variation 1 on 'A first look at occupancies in Layer 00'

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1 Introduction

Variations on the theme, which was presented in 'A first look at occupancies in Layer 00', are now considered. In the original note, it was assumed that the sensors were infinite in length along the z axis. Now, a more realistic design is taken. The detector is assumed to be 80 cm long in z with every 10 cm of the detector being read out separately. Thus only tracks which pass within up to 100μm in the transverse plane and 10 cm in z could produce multiple occupancies: however, even tracks which are closer than this in z will not affect each other provided they pass into different read-out sections.

Figure numbers in this note will be preserved according to the original document.

2 Results

The total numbers of charged tracks for single $t\bar{t}$ events, $t\bar{t}$ with 2 minimum bias events, and $t\bar{t}$ with 5 minimum bias events are, of course, unchanged. The mean numbers of tracks passing into the detector acceptance are now reduced from the original note, on account of the finite size in z. For $t\bar{t}$ events an average of 83 tracks pass, as compared to 94 before. For $t\bar{t}$ with 2 minimum bias events an average of 156 tracks pass, as compared to 199 before. For $t\bar{t}$ with 5 minimum bias events an average of 264 tracks pass, as compared to 354 before. It is noted that the more minimum bias events that are overlaid, the greater the relative reduction. This shows that the minimum bias events tend to lie at smaller polar angles, as might be expected.

The number of strips on which these tracks deposit their charge (Fig. 2 in the original) contain the same proportion of 2,3,4 and 5 or more strips, as in the original note.

The number of strips which have been hit by 1,2 or 3 tracks is shown in Fig. 3 for $t\bar{t}$ events. The upper plot is identical to that in the original note with an infinite z acceptance. The lower plot shows what happens with the present detector arrangement. Two features are noteworthy: firstly, an overall reduction in total number of tracks; and secondly, a considerable reduction in the number of strips which have been hit by 2 or 3 tracks.

The number of strips hit by 2 and 3 tracks are shown in Figs. 4,5 & 6 for $t\bar{t}$ events, $t\bar{t}$ with 2 minimum bias events, and $t\bar{t}$ with 5 minimum bias events. These are to be compared with the same plots in the original note. For $t\bar{t}$ events, the mean percentage of double or triple occupancy strips has decreased from 9% to 5%. For $t\bar{t}$ events with 2 minimum bias events, the decrease is from 15% to 5%, while for $t\bar{t}$ events with 5 minimum bias events, the decrease is from 25% to 6%. These numbers show: firstly, that a segmented finite 'z' readout reduces the strip occupancy rates by up to a quarter; secondly, that the addition of minimum bias events to the top event of interest has a minimal effect on the strip occupancy levels.

Fig. 7 shows the occupancy rates on the track level. Tracks are considered mis-measured if their clusters overlap. In the original note, the average number of mis-measured tracks were 21, 69 and 180 for each of the three pile-up scenarios, $t\bar{t}$ with 0,2 and 5 minimum bias events respectively. Here, with the segmented z detector, the average numbers are 11, 20 and 41, which shows a significant reduction in mis-measured tracks. This is especially noteworthy for the pile-up cases and shows the relatively small effect that minimum bias events have.

Expressed as a percentage of tracks in the detector, the reductions are from 21%, 34% and 50% for the three scenarios in the old detector configuration, to 13%, 12% and 15% here. This scale of number looks much more optimistic in terms of the effective operation of the detector.

Finally, Figs. 8 & 9 are reproduced showing the requirements that were requested in section 4 of the original note. The slope in Figs. 8 is lower since a smaller percentage strip occupancy is now obtained for a given number of tracks. The slope in Fig. 9 is the same as in the original note, but we now operate in a much more restricted range at low strip and track occupancy levels.

3 Conclusions

Things look much better in this more realistic detector description.

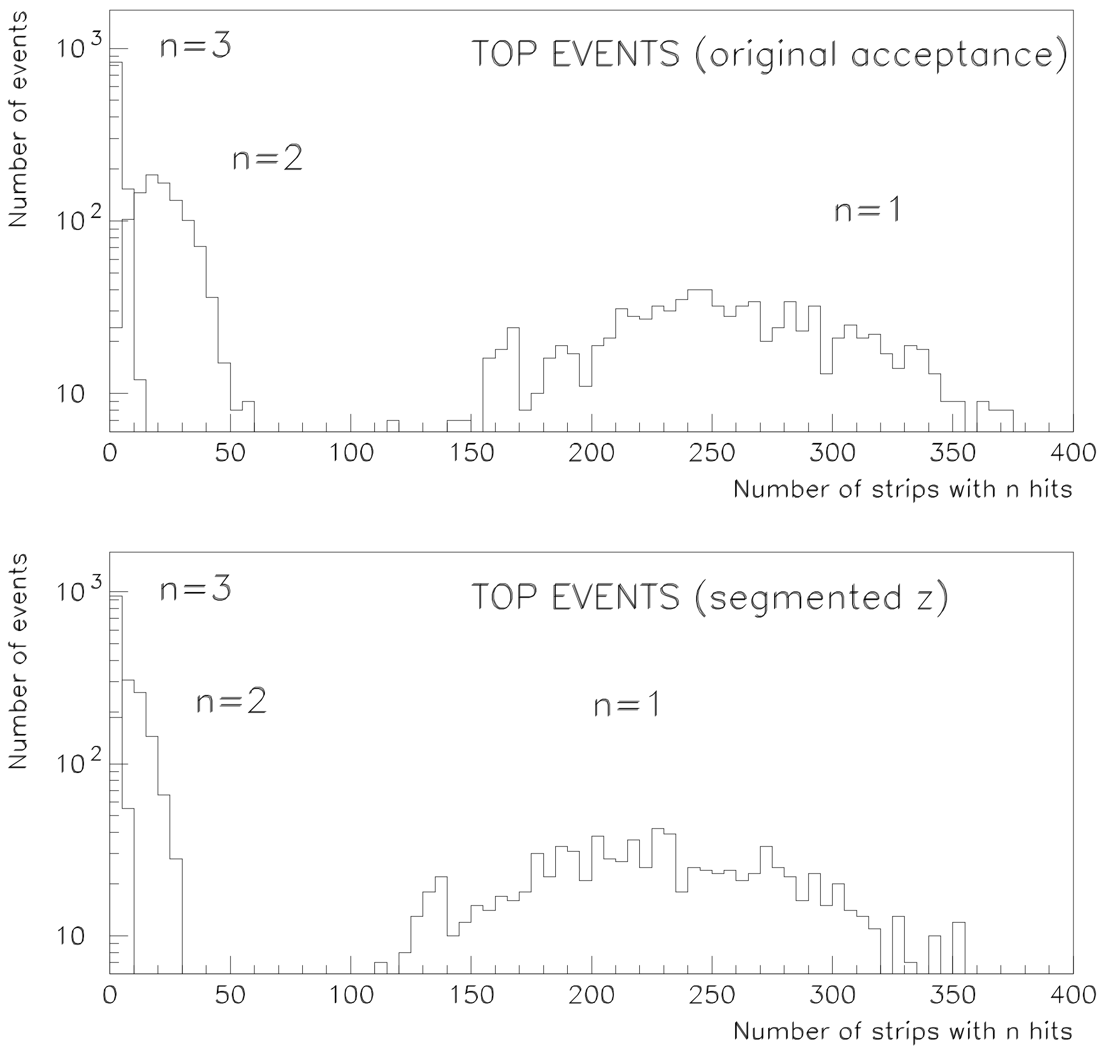

Figure 3: Distribution of Number of Readout Strips which have been hit by 1,2 or 3 tracks for a) (Upper Plot) $t\bar{t}$ events with an infinite z acceptance; b) (Lower Plot) $t\bar{t}$ events with a segmented z acceptance.

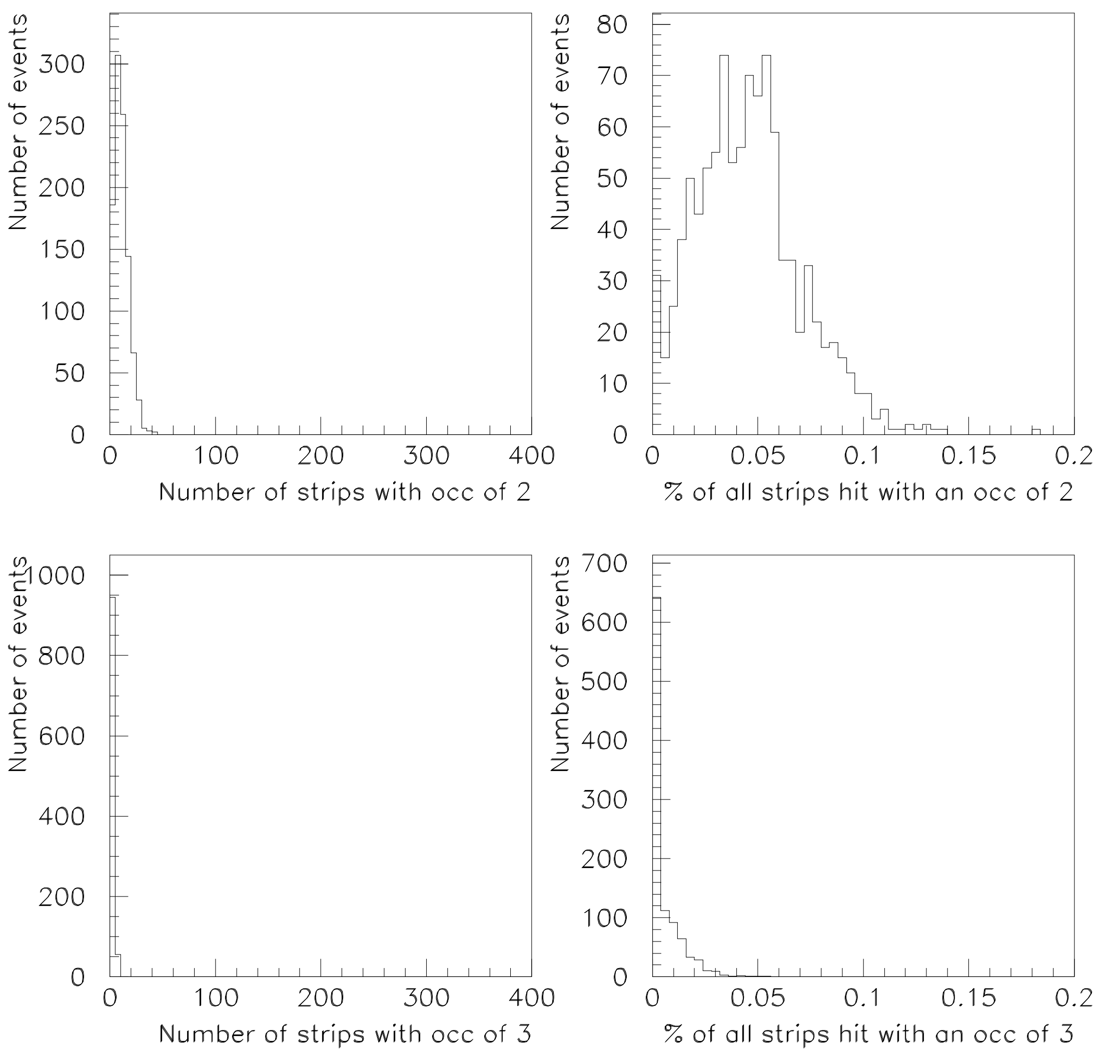

Figure 4: a) Top Left: Number of Readout Strips which have been hit by 2 tracks (double occupancy) in $t\bar{t}$ events.
b) Top Right: Number of double occupancy readout strips as a percentage of the total number of strips hit in an event, for $t\bar{t}$ events.
c) Bottom Left: Number of Readout Strips which have been hit by 3 tracks (triple occupancy) in $t\bar{t}$ events.
d) Bottom Right: Number of triple occupancy readout strips as a percentage of the total number of strips hit in an event, for $t\bar{t}$ events.

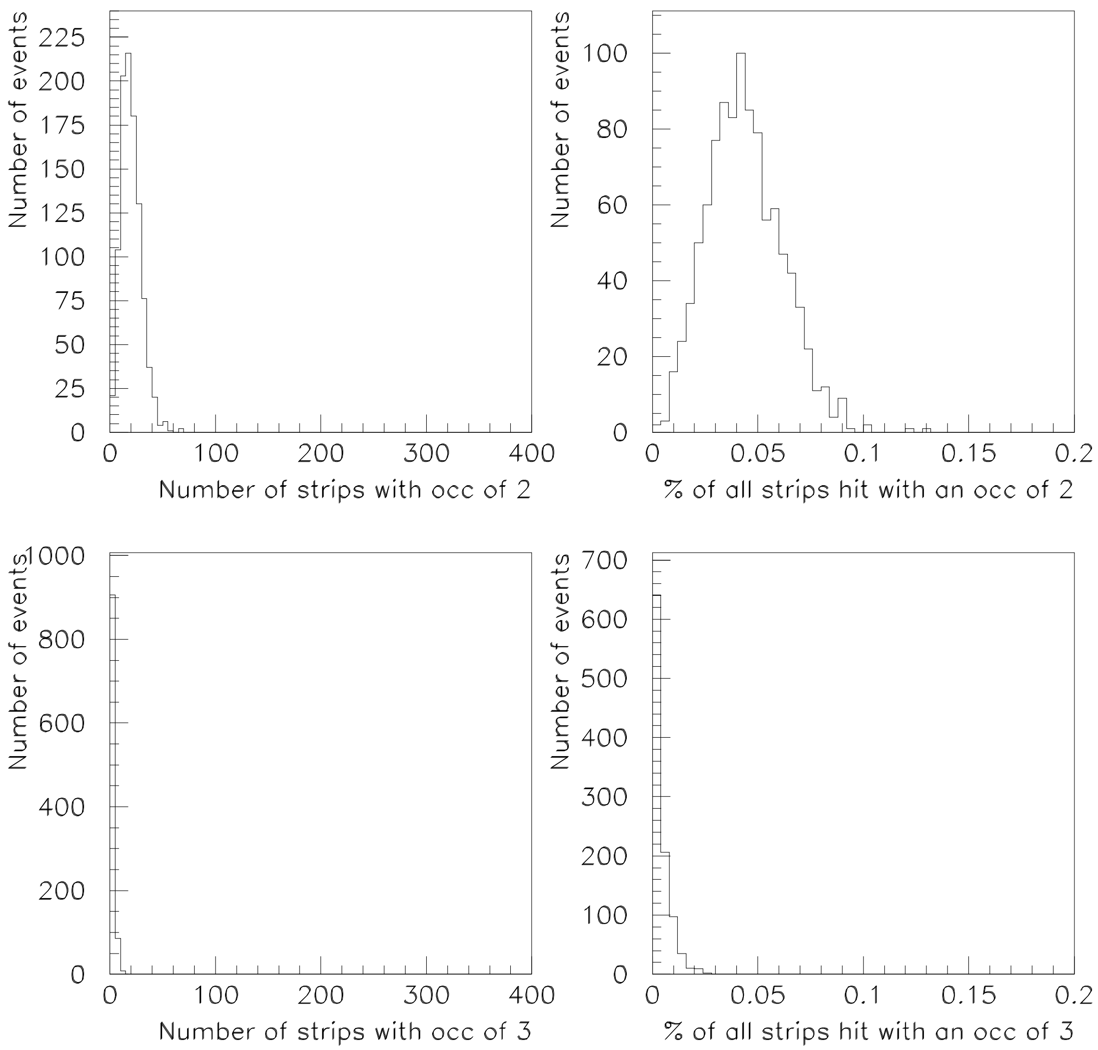

Figure 5: Same scheme as for Fig. 4 but now with two minimum bias interaction superimposed on the $t\bar{t}$ interaction.

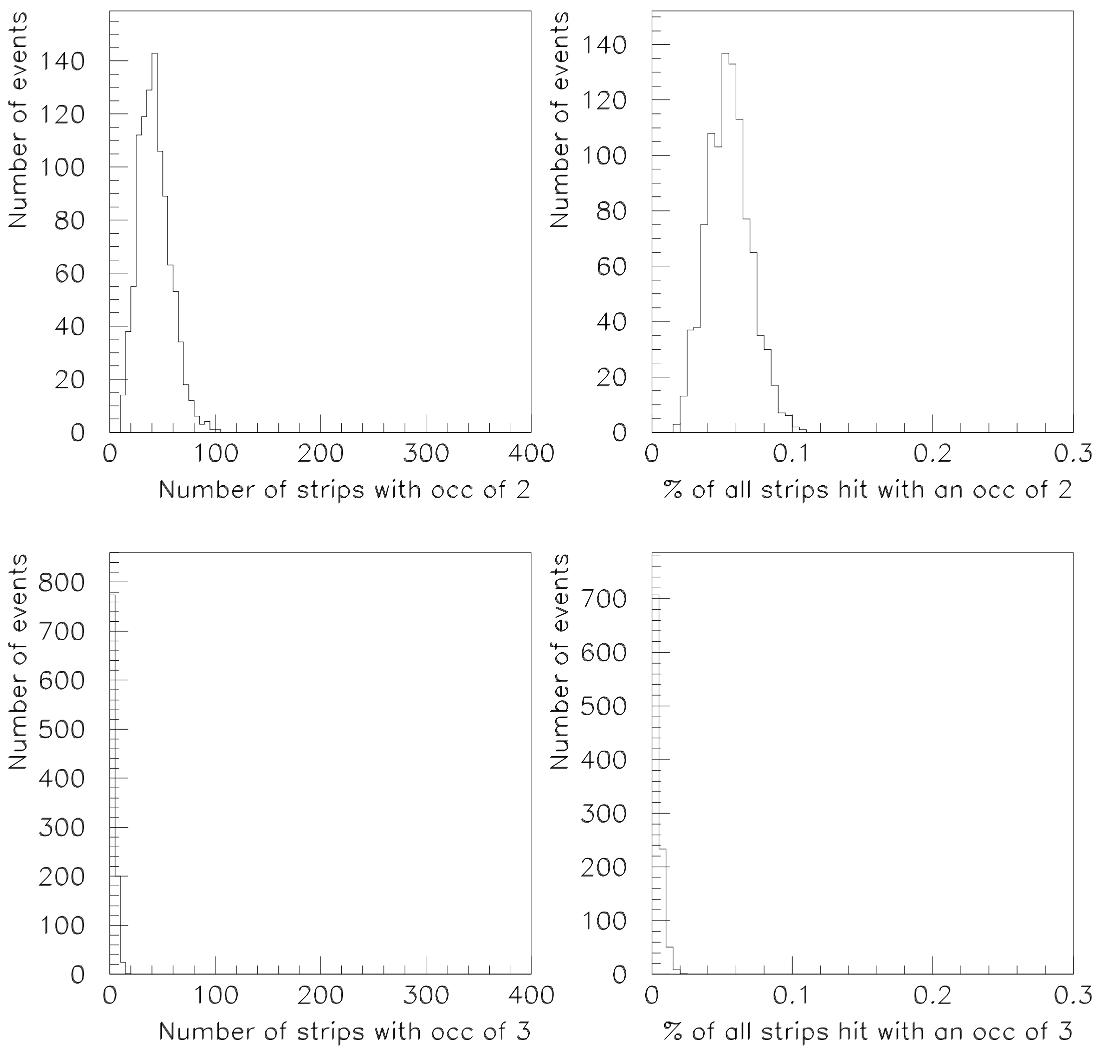

Figure 6: Same scheme as for Fig. 4 but now with five minimum bias interaction superimposed on the $t\bar{t}$ interaction.

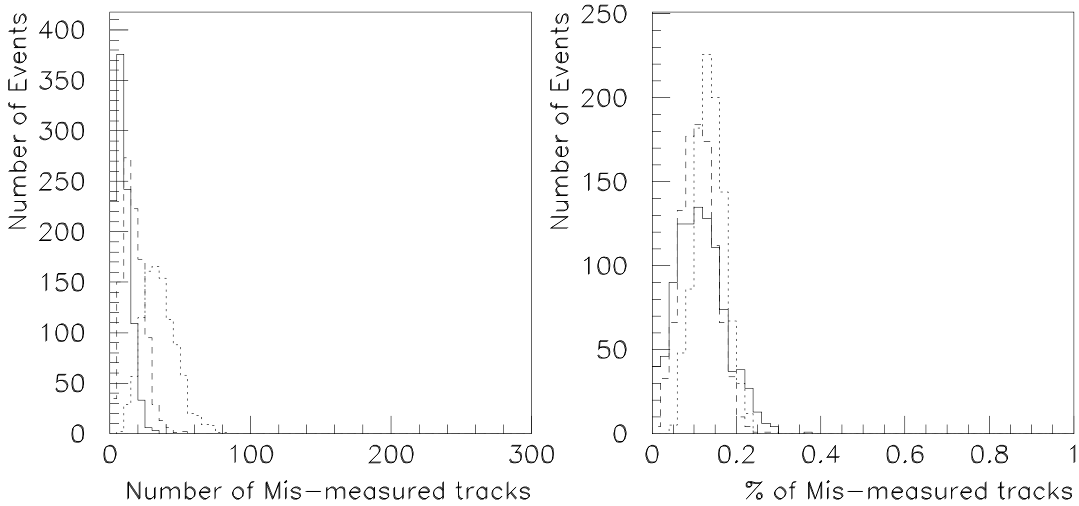

Figure 7: a) Left: Number of mis-measured tracks per event due to overlapping clusters for:
$t\bar{t}$ events (solid line);
$t\bar{t}$ + 2 minimum bias events (dashed line);
$t\bar{t}$ + 5 minimum bias events (dotted line).
b) Right: Mis-measured tracks as a percentage of the total number of tracks inside the Layer 00 acceptance.

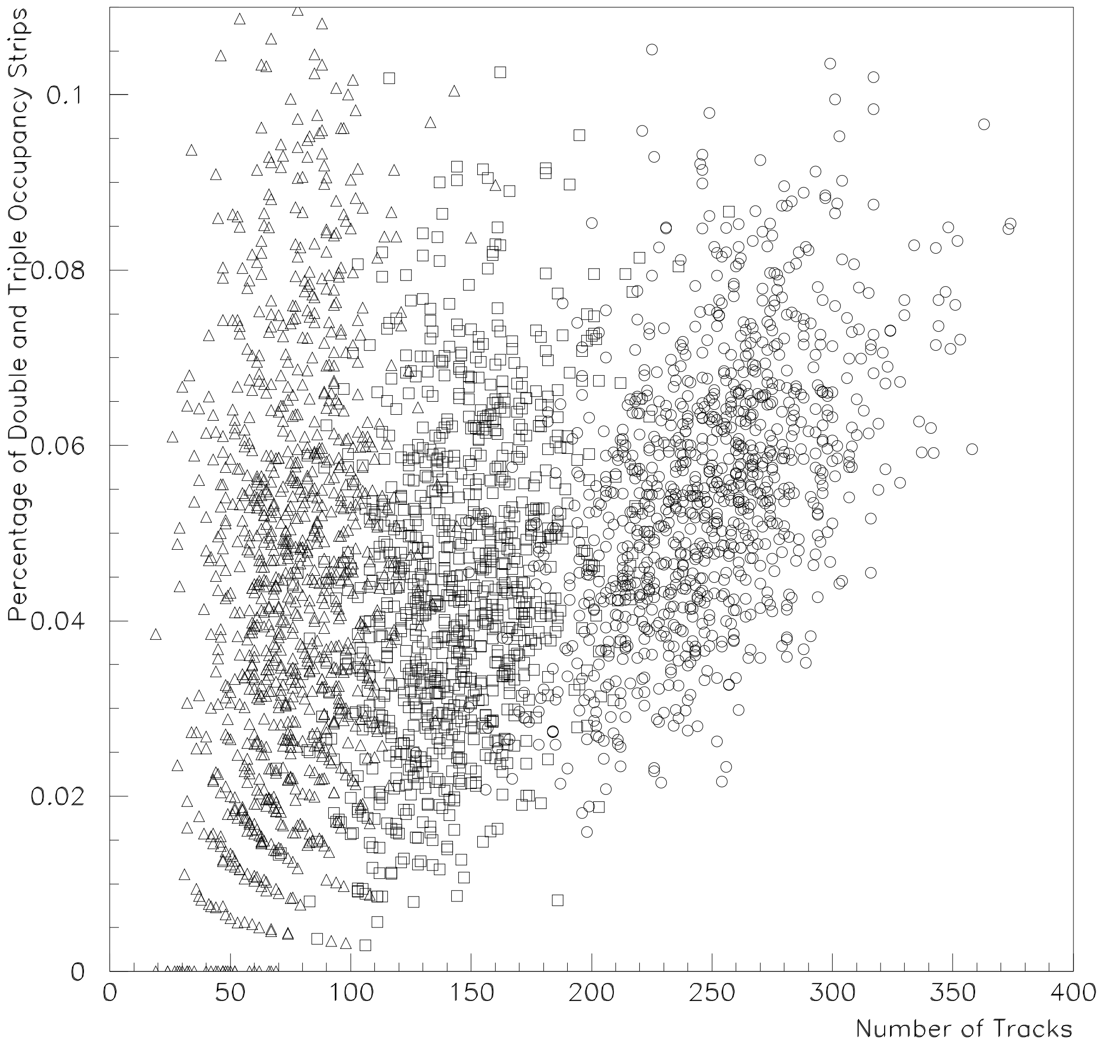

Figure 8: The relationship between the Number of Tracks and the Percentage of Strips having double or triple occupancy. Each point on the plot corresponds to one event from the samples of $t\bar{t}$ events (triangles), $t\bar{t}$ + 2 minimum bias events (squares), and $t\bar{t}$ + 5 minimum bias events (circles). The three distinct samples can just about be discerned in the plot.

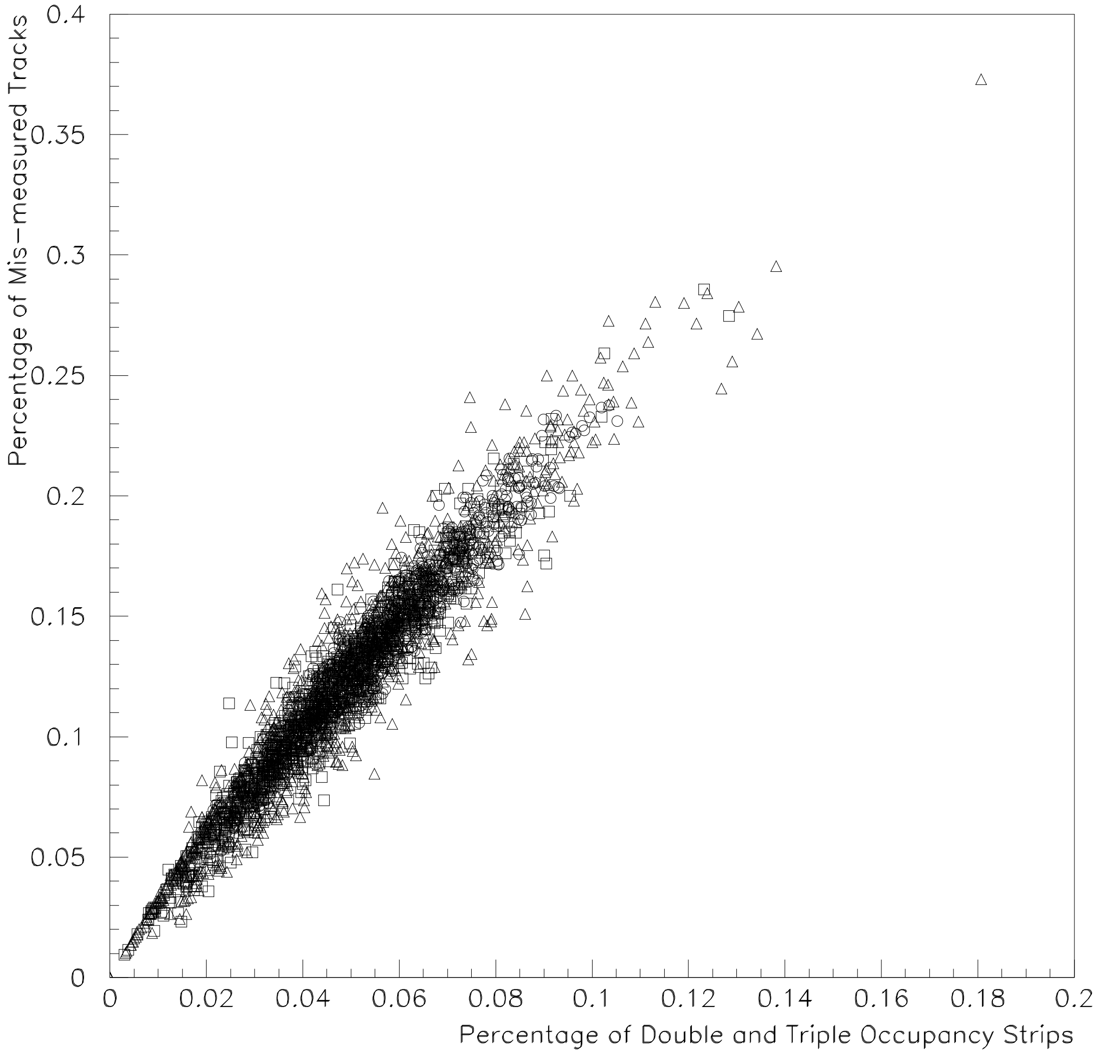

Figure 9: The relationship between the Percentage of Strips having double or triple occupancy and the Percentage of Mis-measured Tracks. Each point on the plot corresponds to one event from the samples of $t\bar{t}$ events (triangles), $t\bar{t}$ + 2 minimum bias events (squares), and $t\bar{t}$ + 5 minimum bias events (circles). A strong linear relationship is observed.