SDC-90-00106

SDC
SOLENOIDAL DETECTOR NOTES

HIT RATE STUDIES OF THE STRAW CHAMBERS IN THE HYBRID TRACKER

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October 1990

Hit Rate Studies of the Straw Chambers in the Hybrid Tracker

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We estimated the hit rates of the straw chambers in the hybrid tracker by using the ISAJET event generator and the GEANT detector simulator. Radius dependences of the hit rates are obtained for three models, the "EoI full design" model and 1/2 and 1/3 reduced of the full design. For the innermost layer, the hit rate of a 4 $mm\phi$ straw becomes more than 4 MHz for all of the three models at $\mathcal{L} = 10^{33} cm^{-2}s^{-1}$. Hit rates are not sensitive to the thickness of the tracker.

1 Introduction

Straw chamber tracker is one of the most promising tracker for the central tracking system of the SSC experiments. But for the SSC environments, straw chamber may have a severe difficulty of the high hit rate.

Event rate of the minimum bias event is expected to be 100 MHz at $\mathcal{L} = 10^{33} cm^{-2}s^{-1}$ and the charged multiplicity per unit pseudo-rapidity is about seven. Not only the primary particles but the secondary products such as delta-rays and positron-electron pairs from gamma conversions should be taken into account to estimate the hit rate. Curling tracks inside the tracking volume by the solenoidal field are also expected to increase the hit rate significantly. To estimate effects of these secondary products and curling-ups, we employed GEANT.

In this study, we used the event-generator code ISAJET version 6.21 and selected low-Pt twojet event to generate minimum bias events.

2 Models of the straw chamber tracker

The model straw chamber we used in this study was based on the hybrid tracker system described in the Expression of Interest by the Solenoidal Detector Collaboration. This model (Model#1) has 10 layers of silicon microstrip detector and 13 superlayers of straw chamber tracker. Fig.1 is a schematic view of Model#1. Each superlayer has 10 layers of 4 $mm\phi$ straws and the thickness of a superlayer is 0.8 $\%X_0$. Each straw chamber is divided into two for the Z-segmentation.

We also used two other models to estimate the effect of the tracker thickness. One is the 1/2 reduced of the EoI model (Model#2) and the other is the 1/3 reduced of the EoI model (Model#3). Fig.2 and Fig.3 are the schematic views of these two models. For

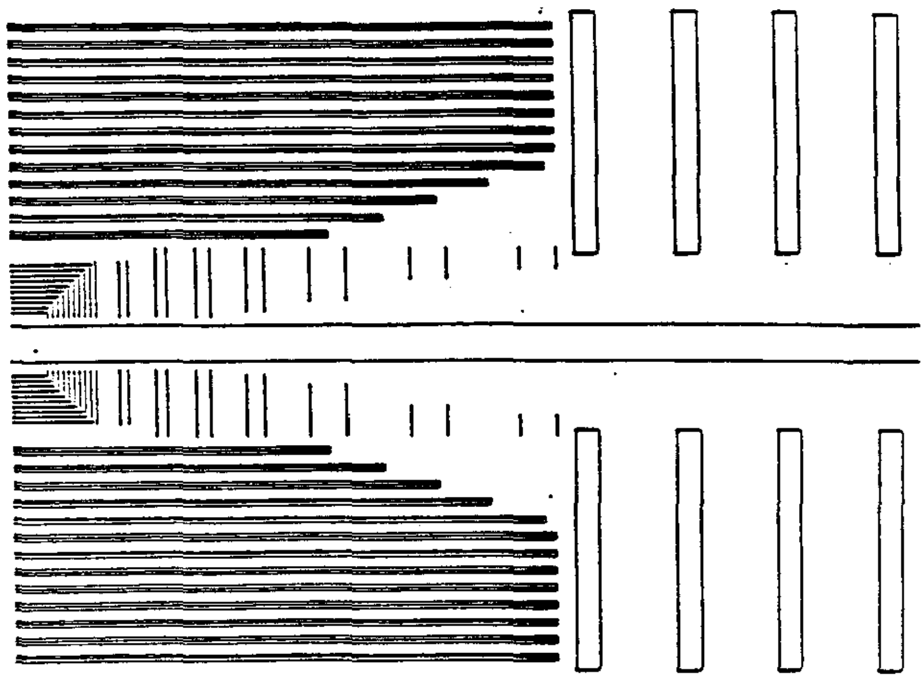


Figure 1: Schematic view of Model#1 (EoI full model)

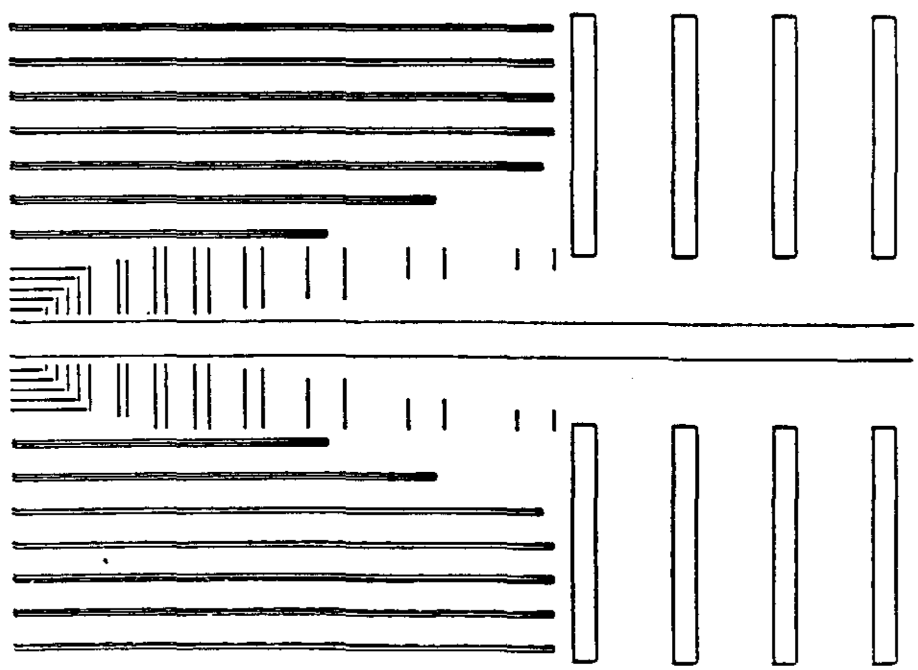


Figure 2: Schematic view of Model#2 (1/2 reduced model)

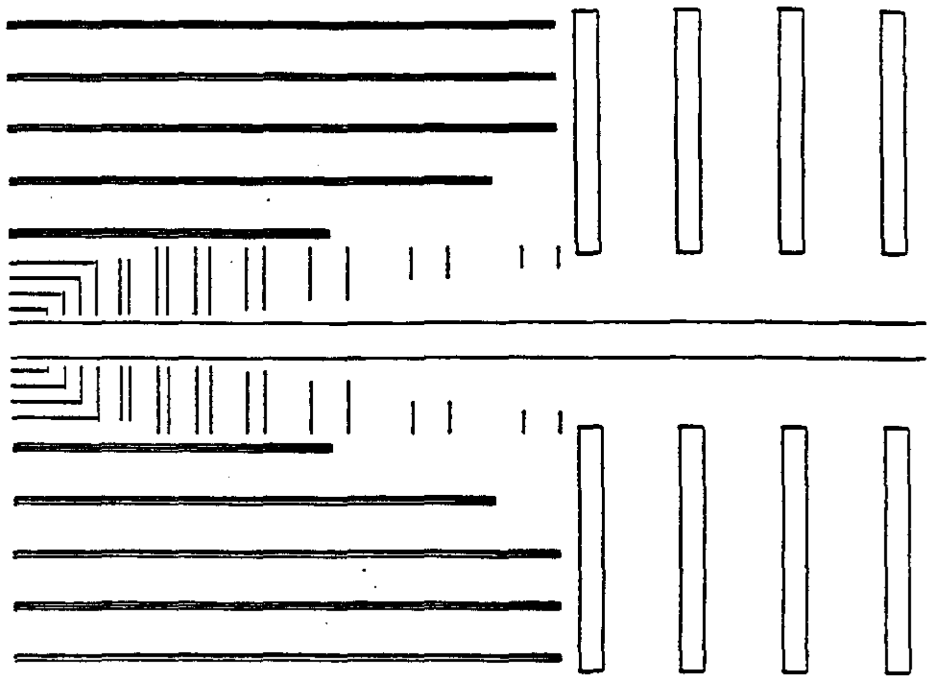


Figure 3: Schematic view of Model#3 (1/3 reduced model)

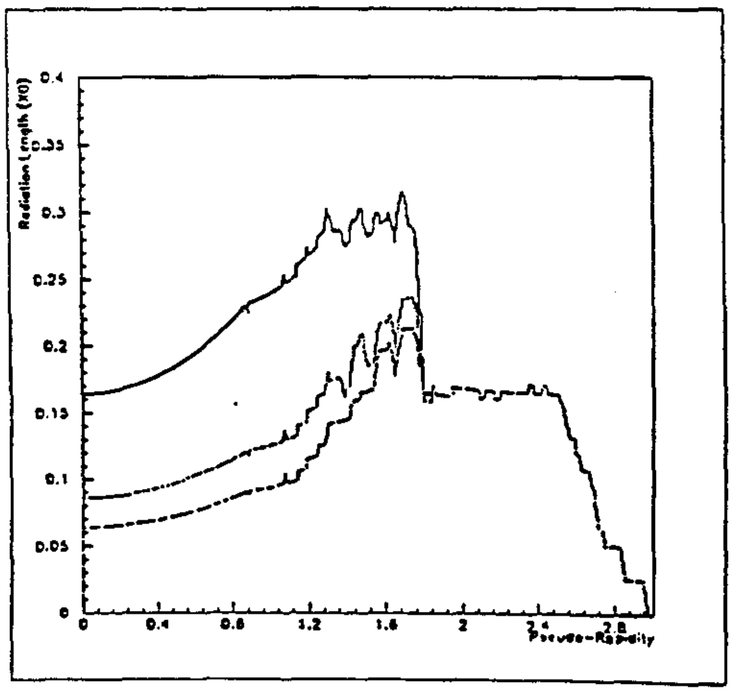


Figure 4: Total thickness of three models with respect to pseudo-rapidity

these reduced models, the thickness of each superlayer is not changed but the numbers of the superlayers are reduced.

Fig.4 shows the total thickness of these three models against the pseudo-rapidity. At $\eta = 0$, thickness of three models are 16.5 $\%X_0$, 8.5 $\%X_0$, and 6.5 $\%X_0$, respectively, while at $\eta = 1.6$, where the thickness become the maximum, thickness of the models are 33 $\%X_0$, 23 $\%X_0$, and 21 $\%X_0$, respectively.

3 Estimation of the hit rates

Secondary interactions such as pair production, decay in flight, hadronic interaction, delta-ray, multiple scattering, ionization loss, etc., were taken into account by using GEANT. All the cut-off energies used in this study were set to 1 MeV. No backward scattering from the calorimeter or the solenoid magnet is considered. The solenoidal field was set to 2 Tesla.

We put 32 test straw tubes into the each superlayer to estimate the hit rate. These tubes were divided into two, the number of Z-segmentation. The probability that a test tube in a superlayer was hitted by at least one charged track was obtained by the average over the 32 test tubes and over two segmentations. Hit rate was estimated by the product of this probability and the minimum bias event rate.

The radius dependences of the hit rate with respect to three models are shown in Fig.5. 200 minimum bias events were used and the statistical error is arround 10 % at 1 MHz point. So, the detail structures in the figure indicate statistical fluctuation. Table 1 shows the summary of the hit rate.

4 Discussions

As shown in Fig.5, while the thickness is reduced to 1/3, the hit rate of Model#3 is almost the same as the hit rate of Model#1. This means that hit rate is not sensitive to the thickness of the tracker. The less the tracker material is, the less secondary interactions occur, but the longer the loopers live. If one consider about the maximum drift time of liberated electron and event pile-up, one had better uses a straw chamber at less than 1 MHz. So, if the segmentation in Z-direction is kept to two, the available

Table 1: Summary of the hit rate

Radius (cm)	Model#1 (MHz)	Model#2 (MHz)	Model#3 (MHz)
60	4.2	4.2	3.7
120	1.5	1.4	1.3
180	0.3	0.3	0.3

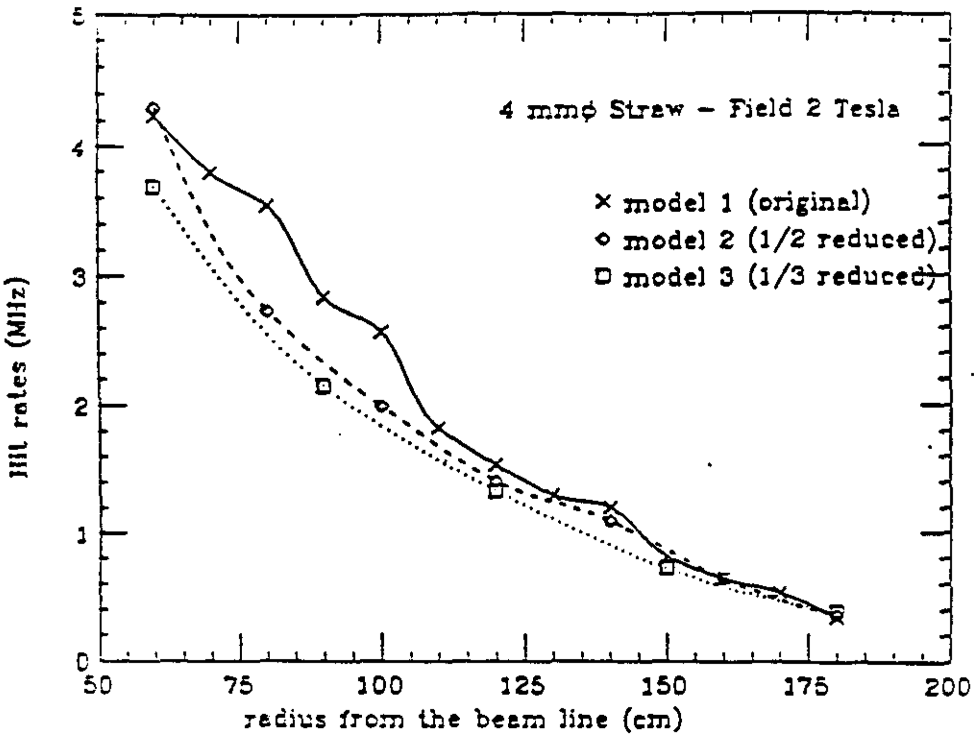
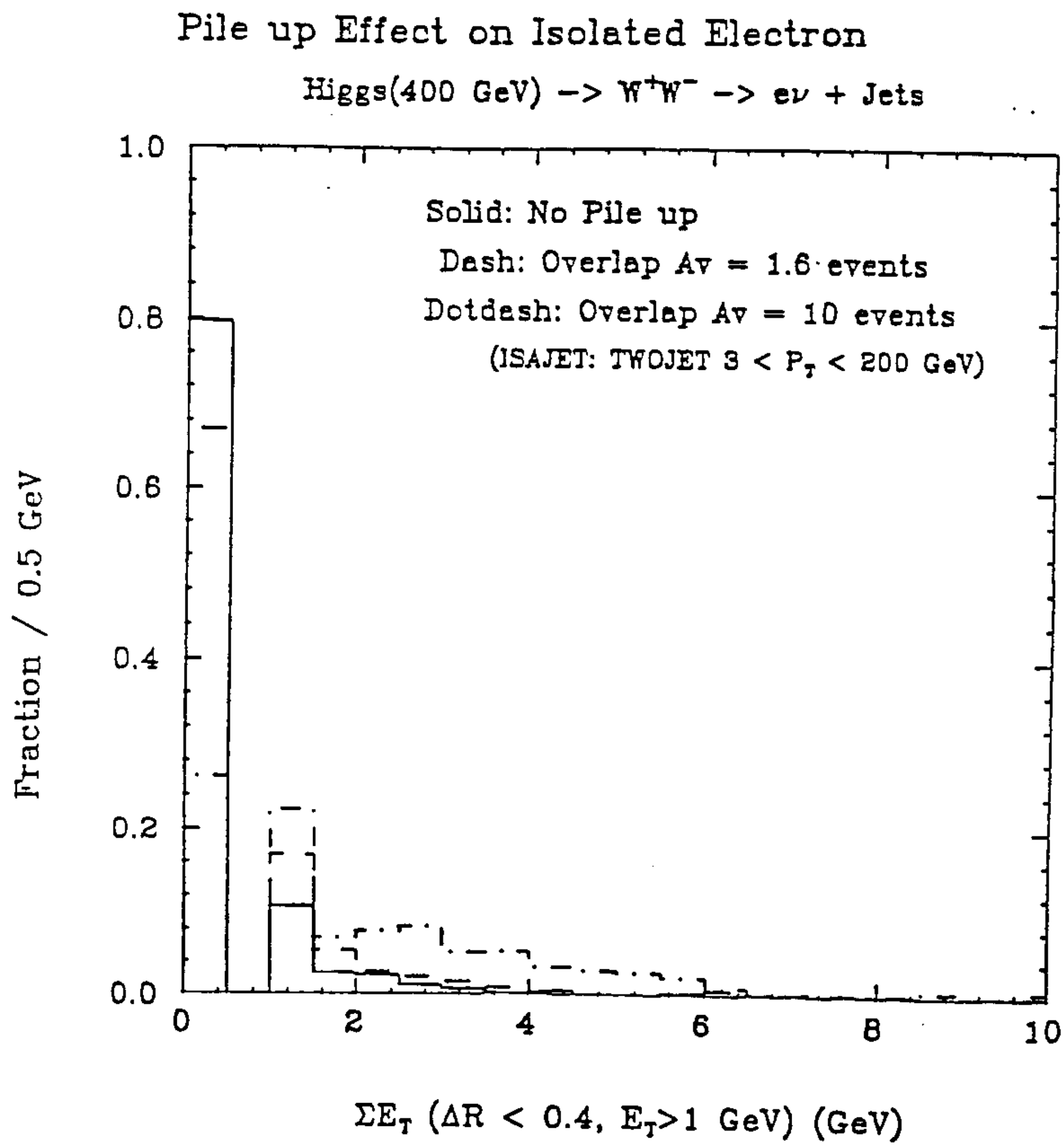


Figure 5: The radius dependences of the hit rate

region for straw chamber tracker is limited to regions whose radii are outer than about 140 *cm*.

If the number of Z-segmentation can be increased from 2 to 6, hit rate will reduced to almost 1/3. The cost of the tracker system is linearly proportional to the number of the channels. So, increasing the Z-segmentation and reducing the number of the superlayers is the right way to realize the straw chamber tracking system.



Pile up Effect on Isolated Electron
Higgs(400 GeV) -> W⁺W⁻ -> eν + Jets
Solid: No Pile up
Dash: Overlap Av = 1.6 events
Dotdash: Overlap Av = 10 events
(ISAJET: TWOJET 3 < P_T < 200 GeV)
Fraction / 0.5 GeV
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
ΣE_T (ΔR < 0.4, E_T>1 GeV) (GeV)

Fig. 8