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A Tracking Detector for Triggering at SLHC

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We report on preliminary design studies of a pixel detector for CMS at the Super-LHC. The goal of these studies was to investigate the possibility of designing an inner tracker pixel detector whose data could be used for selecting events at the First Level Trigger. The detector considered consists of two layers of 50x50 μm2 pixels at very close radial proximity from each other so that coincidences of hits between the two layers amount to a track transverse momentum cut. This cut reduces the large amount of low momentum data expected at SLHC whilst it keeps the tracking efficiency very high for high transverse momentum tracks

Summary

Currently groups of researchers are actively discussing possible scenarios of upgrades of the LHC machine. According to the most financially realistic scenario the LHC will be upgraded to provide proton beams of an order of magnitude larger intensity (1035 cm-2 sec-1) colliding at twice the frequency (80 MHz) of the present design but have the same centre of mass energy. This machine design is commonly referred as the Super LHC and it is expected to be operational after 2015.
A consequence of this design is that the backgrounds due to minimum bias events will increase by at least a factor of 5. This imposes severe requirements on the CMS detector.

The occupancy of a tracking detector at SLHC has been calculated using a Monte Carlo. As an example a pixel detector of 1.28cm×1.28cm with 256×256 pixels 50×50μm2 each positioned at radius of 10 cm away from the beam will suffer from a background of 4 hits/12.5nsec dominated by low momentum particles. This is clearly an enormous rate of data to be transported out of the detector and be used for the trigger decision. Hence, there is an urgent need for a tracking detector that has the capability to reject the large amount of low momentum background locally.

A two layer pixel detector has been simulated using PYTHIA. The radial separation is of the order of 1-2 mm. The two layers can communicate with each other electronically and several algorithms have been explored which put the hits from the two layers in coincidence using fixed search windows. The effect of the layer reparation versus data reduction and window size has been extensively studied. It has been demonstrated that the data can be reduced by several orders of magnitude without and lose of tracking efficiency for high transverse energy tracks.

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