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A Tracking Trigger for CMS at SLHC

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Investigations on the possibility of designing a First Level Tracking Trigger for CMS at the SLHC based on the data of the inner tracking detector are presented. As a model for the inner tracking detector we have used the current CMS pixel detector with the same pixel size and radial distance from the beam. Extensive simulation studies have been performed using the full CMS simulation package (ORCA/OSCAR). Using these MC samples an electron trigger has been designed which uses both the calorimeter energy depositions and the pixel detector data. Results on the tracker occupancy and the electron trigger performance are presented.

Summary

It is foreseen that 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 having 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. One of the most challenging tasks for SLHC will be the inclusion of the inner tracker data in the First Level Trigger, the so called First Level Tracking Trigger. Based on the HLT studies published in the CMS DAQ TDR, a tracking trigger system is needed that provides every 12.5 nsec: (1)Track-stubs and preliminary vertices from the vertex detector data. (2)Track-stubs based on the outer tracker data.

The Trigger considered in these studies should be free of dead-time. Hence, it has to read data every 12.5ns and use a digital pipeline to process them. To reduce the output data rate electrons, muons, taus, and jets found using the calorimeter and muon triggers are correlated with track stubs and vertices found by the tracking trigger.

Using the CMS Monte Carlo and reconstruction programs OSCAR and ORCA minimum bias events have been generated corresponding to luminosities up to 1035 cm-2 sec-1. These samples have been used to estimate the occupancy of the inner tracking detector at SLHC. The occupancy has been estimated under realistic conditions of inactive material and a 4 T magnetic field. This gives the first picture of the challenge facing a tracking trigger at SLHC.

An electron tracking trigger has also been simulated. This trigger is using the electron objects found by the Calorimeter First Level Trigger in coincidence with stubs found using the inner pixel detector. The performance of such a trigger at SLHC conditions has been studied using simulated decays of a heavy Higgs boson to four electrons.

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