EFFECT OF PILE-UP OF MINIMUM BIAS EVENTS ON TRACKING IN A MAGNETIC FIELD

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The pileup of minimum bias events in a tracking detector at the LHC has been simulated for a luminosity of $4 \times 10^{34}$ cm$^{-2}$s$^{-1}$. The effect of the magnetic field on tracking and muon isolation in top quark production has been studied and shown not to be large.

At LHC energies the inelastic cross-section is around 100mb and so at the highest LHC luminosities ($4 \times 10^{34}$ cm$^{-2}$s$^{-1}$) there will be on average 60 minimum bias events in a single bunch crossing. As the particles have a soft momentum spectrum, the large number of low momentum tracks which spiral in the magnetic field lead to a large number of hits in tracking detectors.

We studied the effect of these soft tracks on tracking in a 4T magnetic field. Four-vectors were generated using EUROJET and the UA5 Monte Carlo, GENCL, and tracked through the magnetic field. The number of tracks and their hits on a cylindrical detector covering $|\eta| \leq 2$ at various radii are shown in figs. 1 and 2. There are a large number of hits per track at small radii due to the spiralling of the tracks in the magnetic field. However at radii above about 1.0m the number of hits per track <1 because the tracks spiral inside the detector. The discrepancy between the GENCL data and the EUROJET data is due to the lack of tuning of EUROJET. The GENCL generator had been tuned to reproduce UA5 minimum bias data at various energies and then used to generate minimum bias events at 16 TeV.

To assess the effect of the minimum bias tracks on a physics process, we looked at the number of extra hits within 10cm of a decay muon from a 100 GeV t-quark. The muon isolation, defined in this way, is shown as a function of radius using EUROJET events in fig. 3. Again there is a rapid drop with radius and for radii above 1.0m the muon is very isolated.

We also studied the dependence on the magnetic field strength for a detector of radius 0.7m. The results for EUROJET events are shown in figs. 4, 5 and 6. At low fields there are only a few hits per track as the tracks hit the calorimeter before spiralling. At medium fields there are many hits per track because of the tracks spiralling. At high field the number of hits per track falls again as the tracks spiral inside the detector radius. The muon isolation does not significantly depend on the magnetic field.

The effect of minimum bias events on magnetic tracking is not significant for detectors of radii >0.7m. A strong magnetic field is an advantage as it confines the spiralling tracks to inside the detector radius. The effect of pileup on the isolation of muons is not significant for radii >0.7m and is effectively independent of magnetic field.

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