

Fall Quarter 2007

UCSD Physics 214 & UCSB Physics 225

Homework 2

This homework set let's you explore the CMS detector a bit.

1. This questions is meant to have you explore the CMS physics TDR volume 1 a bit. I will refer to information in the printed copy. However, there's also an online copy at <https://cmsdoc.cern.ch/cms/cpt/tdr/> . You can find the material budget of the tracking system versus η in Figure 6.1 on p.226. The basic parameters of the tracking system are summarized in 1.5.5. Efficiencies are given in Figure 1.12 on p.23. The ECAL performance is summarized in 1.5.3.
 - a. Figure 1.5 shows the tracking resolution for muons using the tracker only for two different ranges in η . In class we discussed a simplified model for the tracking resolution. Take that model and plot the corresponding resolution vs momentum. As inputs assume a point resolution of 40 microns for all layers. Plot the resolution for $\eta=0$ and $\eta=1.6$, and determine the momentum at which intrinsic resolution and multiple scattering are equal. How does this compare with the typical momentum for muons from Z decay?
 - b. Given the material budget of the tracker, what fraction of pions undergo hadronic interaction before they reach the ECAL? Calculate this for $\eta=0$ and $\eta=1.6$. Compare this with the efficiency for pions given in Figure 1.12.
 - c. What's the minimum momentum required to reach the outer most silicon layer at $\eta=0$?
 - d. For a 50GeV electron, compare the expected loss of energy due to radiation with the intrinsic resolution of the ECAL at that energy. Do so for $\eta=0$ and $\eta=1.6$. At what energy is the intrinsic resolution roughly equal to the average energy radiated for these two values of η . To be fair, the electron reconstruction algorithm in CMS accounts for this by allowing a much larger shower size in phi than η . A significant fraction of the radiated photon energy is thus measured in the ECAL, and attributed correctly to the electron track.
 - e. Electrons from pair production are a significant source of "fake" electron backgrounds. The tracking algorithm in CMS used to requires hits in all three layers of the pixel detector. What percentage of high energy photons at our two favorite η points (0 and 1.6) produce conversion electrons that might fake electrons from the interaction region? (Hint: Assume that 1/3 of the total material in the pixel detector is the relevant material budget for this question.)