

1 Questions on the interaction of charged heavy particles in matter

1. What is the reason of the decrease of energy deposit described by the Bethe-Bloch curve with increasing energy of a particle up to the MIP energy?
2. Why is there a minimum in the Bethe-Bloch curve?
3. What is the expected mean energy deposit of an alpha particle and a proton with the same kinetic energy (use 10 MeV as an example)?
4. What is the answer of the previous question if the two particles have the same value for $\beta\gamma$?
5. What is the mean energy deposit of a MIP particle traversing 1 mm of polystyrene?
6. Is the mean energy deposit of a 100 TeV proton well described by the formula of Bethe-Bloch?
7. Explain the well defined Bragg peak phenomenon based on the Bethe-Bloch curve.
8. At LHCb, charged pions of $p = 1 \text{ TeV}/c$ are produced. Calculate if the 2 m thick concrete walls are sufficient to stop the pions at this momentum if only ionisation loss is taken into account.
9. How much energy deposit is expected for a MIP particle in 300 μm of Si?

2 Gas detector efficiency

An ionization gas detector consists of a layer of 1 mm thick oxygen. What is the maximal efficiency of a MIP particle?

($\langle n_p \rangle (O_2) \approx 22 \text{ cm}^{-1}$, Poisson distribution.)

3 Photon interactions

1. For the three most important processes for the photon interaction with matter (photo effect, Compton effect and pair production) find which process is the most important in the following setups :
 - (a) photons at 1 MeV incident on Al
 - (b) photons at 100 keV incident on H
 - (c) photons at 100 keV incident on Fe
 - (d) photons at 10 MeV incident on C
 - (e) photons at 10 MeV incident on Pb
2. Compton effect : show the kinetic energy of the electron is given by:

$$T_e = \frac{E_\gamma^2(1 - \cos \theta)}{m_e + E_\gamma(1 - \cos \theta)}$$

where θ is the scattering angle.

What is the maximum energy of the electron and what is this point named to in the literature ?