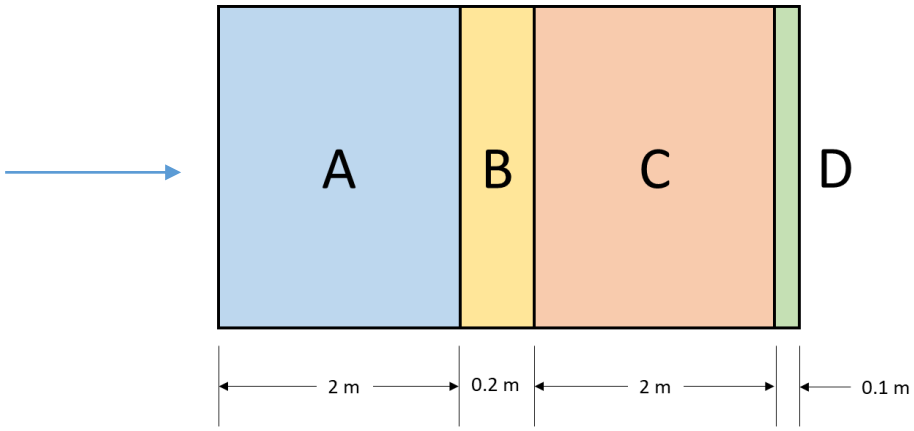
Physics 56400 Assignment #3 – Due September 13th

(New and improved!)

Consider a hypothetical fixed-target particle physics experiment that uses a detector with the following geometry:



The different parts of the detector have the following composition:

A. A 2m gas detector filled with a mixture of 50% Argon/50% Ethane
B. 10 sheets of lead (16 cm total) and 10 sheets of plastic scintillator (4 cm total)
C. 20 sheets of iron (180 cm total) and 20 sheets of plastic scintillator (20 cm total)
D. 10 cm of plastic scintillator

1. Calculate the effective radiation length, nuclear interaction length, and $(dE/dx)_{min}$ of the average material in each part of the detector. Express these as the quantities scaled by the average material density, *ie.* $\mathrm{g \cdot cm^{-2}}$ and $\mathrm{MeV \cdot g^{-1} \cdot cm^{2}}$. Also, calculate the number of radiation lengths, n_{X_0}, the number of nuclear interaction lengths, n_{λ_I}, and the total ionization energy deposited by a MIP in each part of the detector.

2. Calculate the probability that the following types of particles (assume minimum ionizing) would pass through each section of the detector without interacting.
   a. Electron/positron
   b. Photon
   c. Proton
   d. Neutron
   e. Muon

3. If each particle listed in part 2 entered the detector from the left with an initial energy of 50 GeV (treated as minimum ionizing), estimate the energy deposited by each type of particle in each region of the detector.