Experimental Particle Physics

ESIPAP 2020

Homework 2: Exercises

1 An electromagnetic calorimeter

The electromagnetic calorimeter for the ATLAS detector is composed of series of lead layers about 2 mm thick layers of lead (Pb). Between the lead layers are 2 mm wide gaps filled with liquid Argon (LAr). Lead has a $Z = 82$, $A = 206$ and a density of 11.34 g/cm^3. Liquid argon has a $Z = 18$, $A = 40$ and a density of 1.4 g/cm^3.

1. At $\eta = 0$ the depth of the ATLAS electromagnetic calorimeter is about 22 radiation lengths X_0. What would be the depth of the detector in cm if it was all made of LAr? And if it was all made of lead?

2. An electron of 5 GeV generated an electromagnetic shower in the calorimeter. Assuming that the detector was all made of LAr, at what depth would the shower reach its maximum?

3. How much energy does a minimum-ionizing-particle (mip) deposit in 22 X_0 of LAr, assuming:

$$\frac{1}{\rho_{\mathrm{LAr}}}\left(\frac{dE}{dx}\right)_{\mathrm{mip}} = 1.52\,\mathrm{MeV}/(\mathrm{g}\cdot\mathrm{cm}^{-2}) \tag{1}$$

4. How deep in cm is the *real* ATLAS electromagnetic calorimeter at $\eta = 0$, assuming a perfect succession of lead and liquid argon layers of the same thickness?

2 A Cherenkov detector

Compute the threshold energies an electron and a proton must have to emit Cherenkov radiation in water ($n_{\mathrm{water}} = 1.3$).