Fundamentals of Detector Physics and Measurements Lab - Problems

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June 18-22, 2012

Problem –I-1

- Take a cross section for 1 10 eV e on liquid Ar to be 10^-16 cm^2 or 100 million barns.
- LAr has A = 40 and a density 1.4 gm/cm^3
- Compute the e mean free path in cm of LAr and in gm/cm^2

Problem – I -2

- Estimate the cross section for p – Pb using a 30 mb p-p cross section and scaling by A ^2/3. The PDG value is 1.77 b. Is the estimate close?
- Calculate the mean free path in cm and gm/cm^2 using the PDG cross section for p-Pb. For Pb, A = 207 and density = 11.35 gm/cm^3.

Problem – I - 3

- Assume a 1 cm thick scintillator. For a 20% quantum efficiency of the photocathode how many p.e. are there? How many Coulomb?
- Assume a 10 stage PMT with a gain of 3 per dynode. How many anode Coulomb are there? Assume a rise time/pulse width of 2 nsec. How many amps are there? What is the voltage into a 50 Ohm termination?

Problem – I - 4

- Look at TOF separation for pions and kaons. Take the pion mass = 0.14 GeV and the kaon mass = 0.49 GeV. c = 0.3 m/nsec.
- Assume a flight path of 1 m and a timing device with a 100 psec resolution. Up to what momentum can the device separate

Problem – I - 5

- LAr has n = 1.23. Find the threshold values of beta and gamma for pions and kaons. What is the threshold momentum for pions and kaons?
- Assume tracking has found a 1 GeV track. Show that: $\beta = (P/M)/\sqrt{1+(P/M)^2}$
- Find beta for pions and kaons. Find the Cerenkov angle.
- Find the ring diameter at a distance of 10 cm from the radiation. What is the difference for pions and kaons?

Outline

- Lecture I
  - Constants, atoms, cross sections
  - Photoelectric, TOF
  - PMT, SiPM Scint, Cerenkov
- Lecture II
  - Collisions, cross sections
  - Multiple scattering, radiation length
  - dE/dx, MIP, Range
  - Critical Energy

Outline II

- Lecture III
  - B fields, trajectories
  - Quadrupoles, focal length
  - Drift and Diffusion
  - Pulse formation in unity gain and gas gain
- Lecture IV
  - Radiation NR, Thompson, Compton
  - Relativistic radiation
  - Bremm, Pair Production