

U.S. Particle Accelerator School

Fundamentals of Detector Physics and Measurements Lab - Problems

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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 = $11.35 \text{ gm}/\text{cm}^3$.



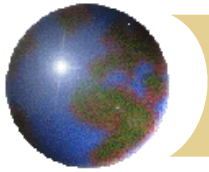
Problem – I - 3

- ✚ 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?



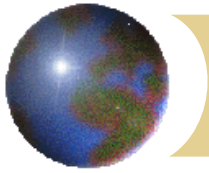
Problem – I - 4

- ✚ 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?



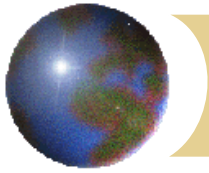
Outline

✚ 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