PH3520 (Particle Physics)
Problem sheet 4
To be turned in by 5:00 p.m., Friday, 1 November, 2002.

1: A charged pion passing through argon gas with a speed $\beta = 0.96$ is minimum ionising, having an energy loss per unit path length of $dE/dx = 1.5$ keV/cm. What would the dE/dx be for the following cases:

(a) Assume the particle is a proton moving with $\beta = 0.96$.

(b) Assume the particle is a completely ionized lithium nucleus ($Z = 3$) moving with $\beta = 0.96$.

(c) Assume the pion is moving with a speed $\beta = 0.24$. (For this, you can neglect the β dependence of the term in square brackets in equation (5.5); i.e., treat the part in brackets as a constant.)

2: (a) Suppose the momentum measurement accuracy of the drift chamber is 0.5% for 1 GeV electrons. Using the relation for momentum resolution discussed in the lecture, predict the measurement accuracy for 10 GeV electrons.

(b) Suppose the energy measurement accuracy of the electromagnetic calorimeter is 18% for 1 GeV electrons. What will the accuracy be for 10 GeV electrons?

3: Consider a particle detector for use at an electron-positron collider consisting of a cylindrical drift chamber in a magnetic field surrounded by an electromagnetic calorimeter, a hadron calorimeter, and muon detectors, as indicated in Fig. 1.

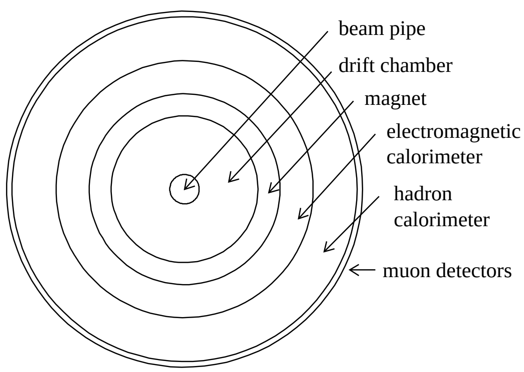


Figure 1: Schematic diagram of a particle detector viewed along the beam line.

Using the drawings on the next page, sketch where in the detector one would find signals from the following events:

(a) $e^+e^- \to \mu^+\mu^-e^+e^-$

(b) $e^+e^- \to \mu^+\mu^-\gamma$

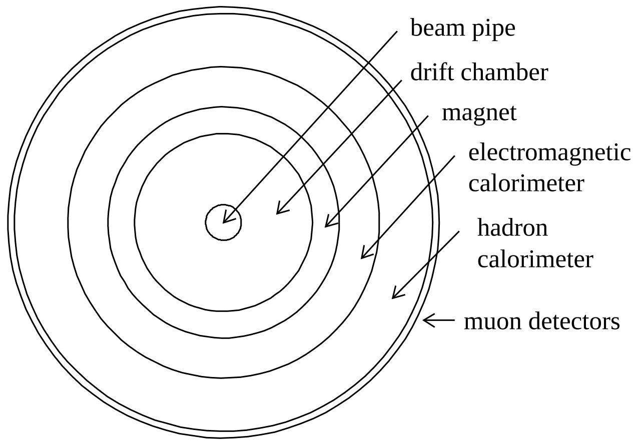
(c) $e^+e^- \to \nu\overline{\nu}\gamma$

(d) $e^+e^- \to \tau^+\tau^-$, where the τ leptons decay $\tau^- \to \nu_\tau e^-\overline{\nu}_e$ and $\tau^+ \to \overline{\nu}_\tau\pi^+\pi^0$.

(e) $e^+e^- \to \pi^+ n\overline{p}\pi^0 K^+K^-$

(f) $e^+e^- \to q\overline{q}g$, where the quarks and gluon result in 'jets' of at least several hadrons each.

G. Cowan
24 October, 2002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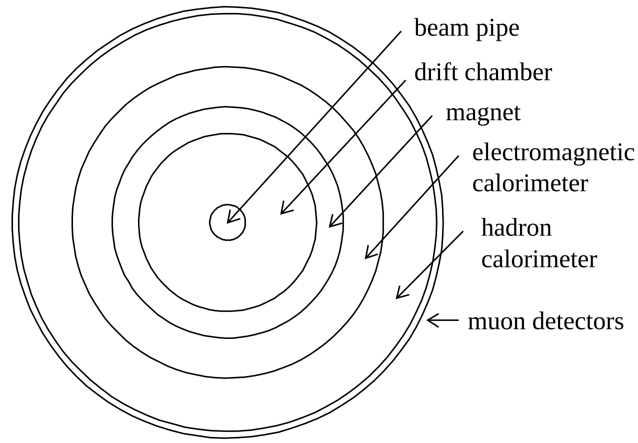
muon detectors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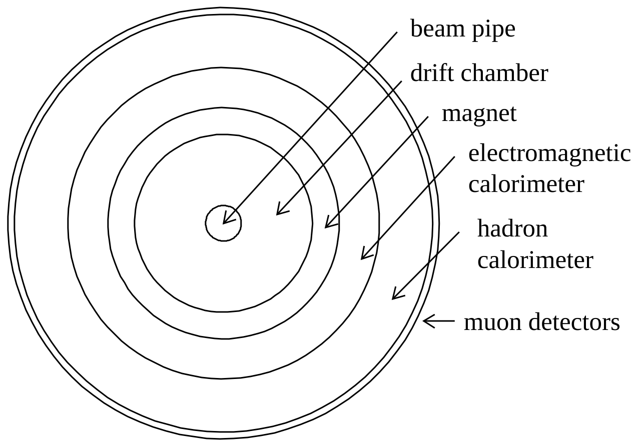
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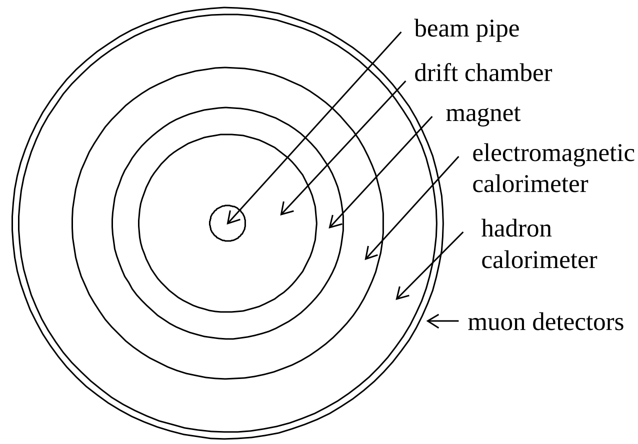
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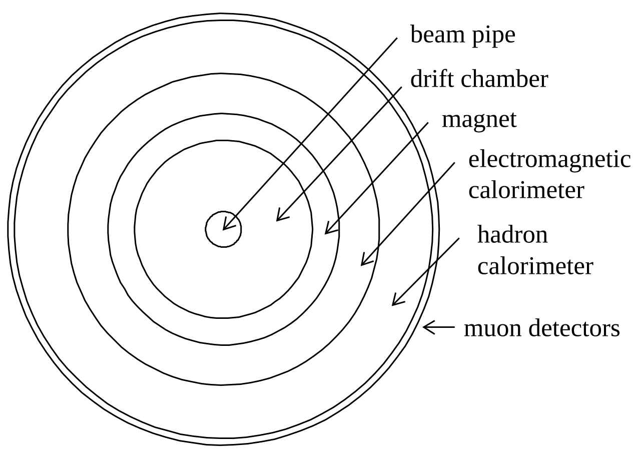
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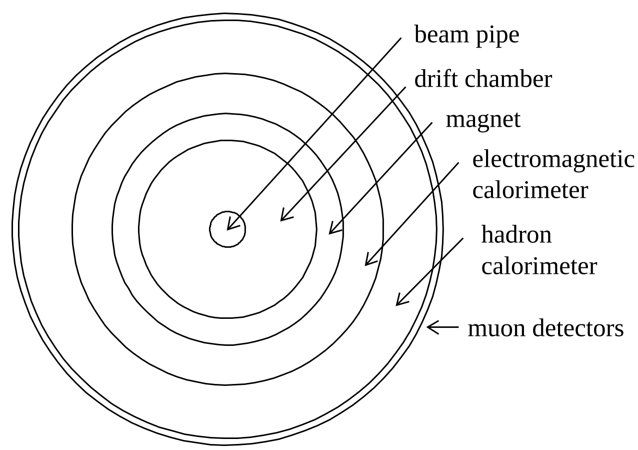
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