

2. A) The CDF and ALEPH detectors have many similarities in construction and design; however, the CDF detector is constructed to examine collisions of protons and antiprotons at the Tevatron at Fermilab whereas the ALEPH detector was constructed to detect e^+e^- collisions at LEP.

a) Sketch a cross section of the principal components of the CDF or ALEPH detector. Take care to place them in the correct order relative to the origin and justify the order.

Describe with a sketch what happens to each of the following particles as they traverse the various elements of the detector:

- i) electron
- ii) muon
- iii) neutrino
- iv) pion

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b) List two features that distinguish a hadron collider from a lepton collider.

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c) When a Higgs particle having a mass of $m_H = 200 \text{ GeV}/c^2$ is produced in the Tevatron, it can decay to two Z^0 s which can in turn decay into all the modes that were studied at LEP.

It is possible for both Z^0 s to decay to muon pairs in the reaction

$$H \rightarrow Z^0 Z^0 \rightarrow \mu^+ \mu^- \mu^+ \mu^-$$

This four muon final state is considered to be easy to detect. Sketch how this would look in the detector.

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By choosing other decay modes for each of the two Z^0 s, write down three other final states into which the Higgs can decay.

{5}

Choose one of the modes you indicated above and indicate if you expect it to have the same difficulty in detecting as the four muon final state. Explain your reasoning. **{3}**