Queen Mary, UoL
Royal Holloway UoL
University College
Brunel University

Intercollegiate Postgraduate Course in Elementary Particle Physics

Paper 2: Friday, 19 January 2001

Time allowed for the Examination: 2 hours

Attempt TWO *questions*

Question 1

Describe and compare the processes of particle detection and readout in double-sided silicon microstrip detectors and in CCD detectors, both used as microvertex detectors at a collider. What are the advantages and disadvantages of each type? How do these change with collision frequency and with radiation level?

Question 2

Give an account of the physical processes involved in the operation of either an electromagnetic or a hadronic calorimeter. Explain the physical structure of such a calorimeter in an experiment (past, present or future), and give details of the performance achieved or expected in key parameters.

Question 3

The main visible two-fermion final states from Z^0 decay at LEP are e^+e^-, $\mu^+\mu^-$, $\tau^+\tau^-$, $u\bar{u}$, $d\bar{d}$, $s\bar{s}$, $c\bar{c}$ and $b\bar{b}$. Give their branching ratios and explain briefly why the quark channel branching ratios are so much larger than the lepton channels.

Rate each of these final states according to whether it is 'easy', 'harder' or 'very hard' to identify events of this type uniquely. Explain why and, for those rated 'hard' or 'very hard', indicate which other channels they are most easily confused with.

What is measured and what is assumed to establish the number of kinds of light neutrinos present in Z^0 decays. How can the systematic errors be minimised?

Question 4

Describe what the terms hard scatter, underlying event and pile-up mean with reference to the production of a W boson at a p-$\bar{\text{p}}$ collider. What is the principal production mechanism and decay mechanism for a light Higgs boson ($m_H < 130$ GeV) at a hadron collider? Why, in practice, is this production mechanism not the most favourable for a Higgs discovery at the Tevatron. Give examples of more favourable discovery channels with examples of the background processes to these channels. What is the discovery channel for a light Higgs at the LHC?