Contribution ID: **138** Type: **not specified**

LEP3: A High Luminosity e+e- Collider to Study the Higgs Boson

The LHC experiments have discovered a new particle with a mass around 125 GeV that is a strong candidate for the scalar Higgs boson expected in the Standard Model. An e+e− collider operating close to the ZH threshold (at a centre-of-mass energy of 240 GeV) could be the tool of choice for studying this unique particle in detail.

We present here the concept of a storage ring collider, which we call LEP3. Preliminary studies show that at a centre-of-mass energy of 240 GeV, near-constant luminosities of 10^34 cm-2s-1 are possible in up to four collision points, while respecting a number of constraints including beamstrahlung limits. With an integrated luminosity of 100fb-1 per year and per interaction point, 20,000 e+e− –> ZH events would be produced per year and per experiment. LEP3 could also operate in multi-bunch mode at the Z resonance, with luminosities of several×10^35cm-2s-1, yielding O(10^11) Z decays per year, as well as just above the WW threshold, potentially improving our knowledge of W and Z properties by large factors.

The short luminosity lifetime requires the use of top-up injection, which, in turn calls for a full-energy injector. Thus the present design uses two rings (as in the BBbar factories): a low-emittance collider storage ring operating at a constant energy, and a separate “accelerator” ring that tops up the collider ring every few minutes. The LHeC lattice design has been used as a basis for our studies. Maximum luminosity is achieved with four bunches per beam. The estimated beam lifetime is about 8 minutes (for four simultaneous experiments) dominated by e+e− Bhabha interactions. Finally the synchrotron radiation losses are 50 MW per beam. Further optimization of the design is possible.

LEP3 could be installed in the LHC tunnel, serving the two LHC general-purpose detectors ATLAS and CMS, and possibly up to two dedicated ILC-type detectors. Alternatively, it could be installed in a new, longer tunnel; using a tunnel circumference of 80km, a machine operating up to the ttbar threshold can be conceived.

This preliminary study has identified no show-stoppers for the concept of the design. A number of basic questions about LEP3 are discussed and we have tried to identify the areas where R&D will be needed.

We consider the concept to be highly interesting and deserving of a detailed study.

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