

## Homework for Physics 456/656

Introduction to Accelerator Physics and Technology (Hoffstaetter)

Due Date: Thursday, 09/11/03 - 11:40 in 311 Newman Laboratory

### Exercise 1:

The main dipole magnets of the Large Electron Positron (LEP) collider had a bending radius of 3096 m.

- (a) How strong was their magnetic field when LEP accelerated electrons to 100 GeV?
- (b) This field strength is relatively small, why was the field not increased to increase the energy?
- (c) The LEP tunnel was about 26.6km long. What fraction of it was used for bending the beam?

### Exercise 2:

LEP produced about 20MW of synchrotron radiation when it stored electrons at 100GeV. How much would the same number of electrons have radiated at 200GeV?

### Exercise 3:

Consider a storage ring built around the 40 Mm circumference of the earth, where 100% of the tunnel were used for bending particles on a circular trajectory.

- (a) How large would the energy be for protons when the LHC magnets with a magnetic field of 8.7 T were used? Could one produce the highest proton energies of the universe in this way?
- (b) How much power of synchrotron radiation would they approximately produce for the same current as in LEP (scaled from the LEP data given above)? Do not forget to scale so that the current stays the same, the number of particles in the ring is then not the same as in LEP.
- (c) How large would the electron energy in this tunnel be if its synchrotron radiation load per length of the tunnel should be the same as that in LEP when the same current is stored (scaled from the LEP data given above)? Again, the number of particles in the ring is not the same as in LEP.