Homework I, Feb 10, 2014 *Due Feb, 17, 2014*

HW 1 (1 point): Very-very large accelerator
With current superconducting magnet technology, e.g. dipole magnets operating at 8.4 T at LHC, what will be maximum energy of the circular particle accelerator possible to built on the Earth surface. Assume that dipole magnets fill 91.56% of the ring circumference. Radius of the Earth is 6,371 km. Compare this energy with projected maximum energy in LHC of 7 TeV.

HW 2 (1 point): Microtron
For a classical microtron having energy gain per pass of 1.22 MeV and magnetic field of 0.5 T (5 kGs) find set of possible operational RF frequencies (Hint: use k=1,2,3,… as multiplier). Assuming that electrons what will be radius of first orbit in the microtron?

HW 3 (2 points): 300 MeV betatron
Assume that the steel in the central yoke reaches maximum average field of 1.6 T (16 kGs) in the betatron when beam reaches energy of 300 MeV.

(a) find the radius of the beam orbit in this betatron;
(b) Assuming that the coil of the magnet has 10 turns and the rated to maximum voltage of 100 kV and that the coil intercepts with 1.25 the flux of that intercepted by the beam orbit, estimate the shortest acceleration time for an electron from 1 MeV (the total energy, kinetic energy 0.489 MeV) to 300 MeV?

Hints: (i) neglect the initial momentum; (ii) note that the field is related to the relativistic momentum, not the energy of the particle.

HW 4 (1 point): C.M. energy
Find available energy from a head-on collision of two particles with different masses and energies: $p^i_{1,2} = \gamma_{1.2}\left(m_{1.2}c, \pm\hat{z}m\mathrm{v}_{1.2}\right)$. Express the leading term for $\gamma_{1.2} >> 1$.

HW 5 (1 point): Luminosity wit ha target.
Calculate luminosity of CEBAF facility delivering 10 microamperes of electron beam on a 1 cm deep liquid HO_2 target at room temperature.