

PHY 554. Homework 1.

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HW 1 (5 point): Future Circular Collider (FCC,) is under consideration by world physics community as a potentially next high energy collider.

- (a) 1 point: The tunnel circumference would be 100 km https://en.wikipedia.org/wiki/Future_Circular_Collider. What average magnetic field is required to circulate 50 TeV proton beam?
- (b) 1 point: It is also considered for electron-positron collider with beam energy up to 175 GeV. What average magnetic field is required to circulate 175 GeV electron or positron beam?
- (c) 2 points: Show that the same ring (set of magnets) can be used to circulate electrons and positrons with the same energy but moving in opposite (colliding) directions. Specifically, write equation of motion for an electron and a positron and show that they can travel by the same trajectory but in opposite directions
- (d) 1 point: Can we use the same trick to circulate and collide two proton beams?

HW 2 (2 points): For a classical microtron having energy gain per pass of 1.022 MeV and operational RF frequency 3 GHz (3×10^9 Hz) find required magnetic field (Hint: use $k=1$). What will be radius of first orbit in this microtron?

HW 3 (3 points): Find available energy (so called C.M. energy) for a head-on collision of electrons and protons in two proposed electron-hadron colliders eRHIC and LHeC:

- (a) eRHIC plans to collide 18 GeV electrons with 275 GeV protons;
- (b) LHeC plans to collide 60 GeV electrons with 7 TeV protons