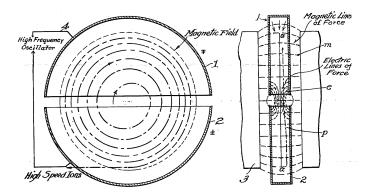
Particle Physics Phenomenology I

HS 10, Series 9

Due date: 03.12.2010, 1 pm

Exercise 1

In 1939, E.O. Lawrence won the Nobel prize for the development of the first cyclotron. It had a radius of R = 12.5 cm and a magnetic field of B = 1.3 T. The figure below was used to illustrate the principles of a cyclotron in his U.S. Patent 1948384.



- (i) What is the maximal momentum to which protons can be accelerated with this cyclotron?
- (ii) What should be the frequency of the AC voltage applied to this cyclotron?
- (iii) Do relativistic effects impose any limitation to this kind of circular accelerators? How can we modify a cyclotron and overcome these limitations?
- (iv) What should be the radial shape of a magnetic field B in order to maintain the synchronisation between the cyclotron and orbital movement of accelerated particles (so called isochronism) at constant frequency ω ? Relativistic effects should not be neglected.
- (v) How should the cyclotron frequency ω_n change with each turn n, so that we can maintain the isochronism in the case of a uniform magnetic field B? In this case assume that the energy gain turn is tuned to be equal to the rest mass of the accelerated particle.

Exercise 2

The graph below shows how the cross-section for various processes depends on the center of mass energy at a proton-proton collider.

- (i) Fill a table with the (approximate) values of the cross-section for all processes shown, at 7, 10 and 14 TeV. For each process, evaluate the ratio of cross-sections at 7 and 14 TeV.
- (ii) Assuming that the LHC collected 200 pb⁻¹ at a center of mass energy of 7 TeV in the last year, calculate the number of events it should have produced for each process.

