Exercise set 2 (Unit 3 and 4)

Exercise 2.1

A dipole for FCC-ee requires 60 mT nominal field.

* Considering a magnet purely based on currents (no iron), and a 60 degrees sector coil, compute the required coil width for a current density of 1 A/mm2. *(1 point)*
* Assuming a 50 mm aperture diameter, estimate the b5 at a reference radius of 16.7 mm. *(2 points)*
* Keeping the same reference radius of 16.7 mm, estimate how much one should increase the aperture to have a b5 satisfying the beam dynamics requirements (smaller than one unit). *(2 points)*
* What is the increase in the coil mass due to the aperture increase to satisfy field quality requirements ? *(1 points)*

Exercise 2.2

As shown in exercise 1.1, an LHC lattice with quadrupole spacing *L*=150 m would allow an energy increase of 5% but would require an aperture increase in the dipoles from 56 to 83 mm.

1. Assuming that the LHC dipole are made with a sector coil of 30 mm width and neglecting the grading, compute the increase in the quantity of conductor needed to increase the aperture from 56 to 83 mm. *(1 point)*
2. We now assume that the quadrupole spacing is kept at 150 m, but the the energy is kept as in the LHC, and therefore the dipole field is reduced by 5% to compensate for the higher filling factor. Assuming the same current density as in the LHC dipoles, compute the coil width required to obtain the 5% lower field. Estimate the quantity of conductor with this coil width and the 83 mm aperture. Is it larger or smaller than the quantity needed for the LHC dipoles ? *(3 points)*