Exercise set 4 (Unit 7 and 8)

Exercise 4.1

A sector dipole has 50 mm coil width and 450 A/mm2 overall current density.

1. Estimate the magnetic field in the bore ; *(1 point)*
2. Assuming a 20% margin on the loadline, a filling factor of 0.3, what is the requirement on the superconductor in terms of superconductor current density/field on the critical surface ? Consider a ratio of peak field/bore field equal to 1. *(1 point)*
3. Repeat the previous computation, assuming a ratio peak field/bore field equal to 1.04. *(1 point)*
4. Assuming that the slope of the superconductor critical surface is 400 A/mm2/T, compute using the factor *X* (see slides 7.22 to 7.29) the increase of the loadline margin if the filling factor is increased from 0.3 to 0.33. *(2 points)*

Exercise 4.2

The accelerator shown in the Terminator-II movie has a 5.76 TeV energy, a bending radius of order of 30 m, and a tunnel diameter of about 4 m. The Terminator T-1000 gets blocked on the dipole cryostat due to the fringe fields.

1. Compute the magnetic field of the dipole ; *(1 point)*
2. Assuming that the coil width is 20 cm, estimate the overall current density ; *(1 point)*
3. Verify that the thickness of the iron needed to totally shield the magnet, i.e. to avoid fringe fields in the tunnel, is not compatible with the tunnel size (Note : you have to make a reasonable assumption on the aperture radius); *(1 point)*
4. Assuming that there is no iron to shield the magnetic field, estimate the magnetic field on the cryostat, assuming that its diameter is 1 m, and verify if it is larger than 3 mT, a safety value given to avoid that ferromagnetic objects are driven by the magnetic field. *(3 points)*