JUAS 2013: Tutorial 1 on Superconducting Magnets

Question

The cable used in dipole GSI 001 has the parameters listed below.

For an injection field of either 0.2T or 1T and a ramp rate of $1Ts^{-1}$, calculate the magnetization averaged over the winding volume coming from:-

a) screening currents flowing within the filaments

b) coupling currents flowing between the filaments in the wire

c) coupling currents flowing between wires in the cable (for field perpendicular to the broad face of the cable)

In order to assess whether this will give significant field errors, express these magnetizations as a fraction of each of the two possible dipole aperture fields.

Data

a) Superconducting Filaments

Kim Anderson parameters $J_o = 4\times10^{10}Am^{-2}$ $B_o = 0.375T$ (lecture 3 slide 25)

filament diameter $d_f = 6\mu m$ filling factor of superconductor in unit cell $\lambda_{su} = 22\%$,

b) Wire

resistivity of matrix copper $\rho_{Cu} = 1.6\times10^{-10}\Omega m$

the NbTi filaments are in good contact with the copper matrix and the filling factor of superconductor in wire $\lambda_{sw} = 31\%$

twist pitch of wire $p_w = 10mm$

rate of change of field $dB/dt = 1Ts^{-1}$

filling factor of wire in unit cell $\lambda_{wu} = 73\%$

c) Cable

cable twist pitch $p_c = 74mm$, filling factor of cable in unit cell $\lambda_{cu} = 84\%$,

cable crossover resistance $R_c = 15\mu\Omega$, number of wires in cable $N = 30$

cable half width $c = 4.9mm$, cable half thickness $b = 0.58mm$