JUAS 2013: Superconducting Magnets Tutorial 2

Question (a): U(θ) function

It is often useful to talk about a magnet quench decay time, defined by:

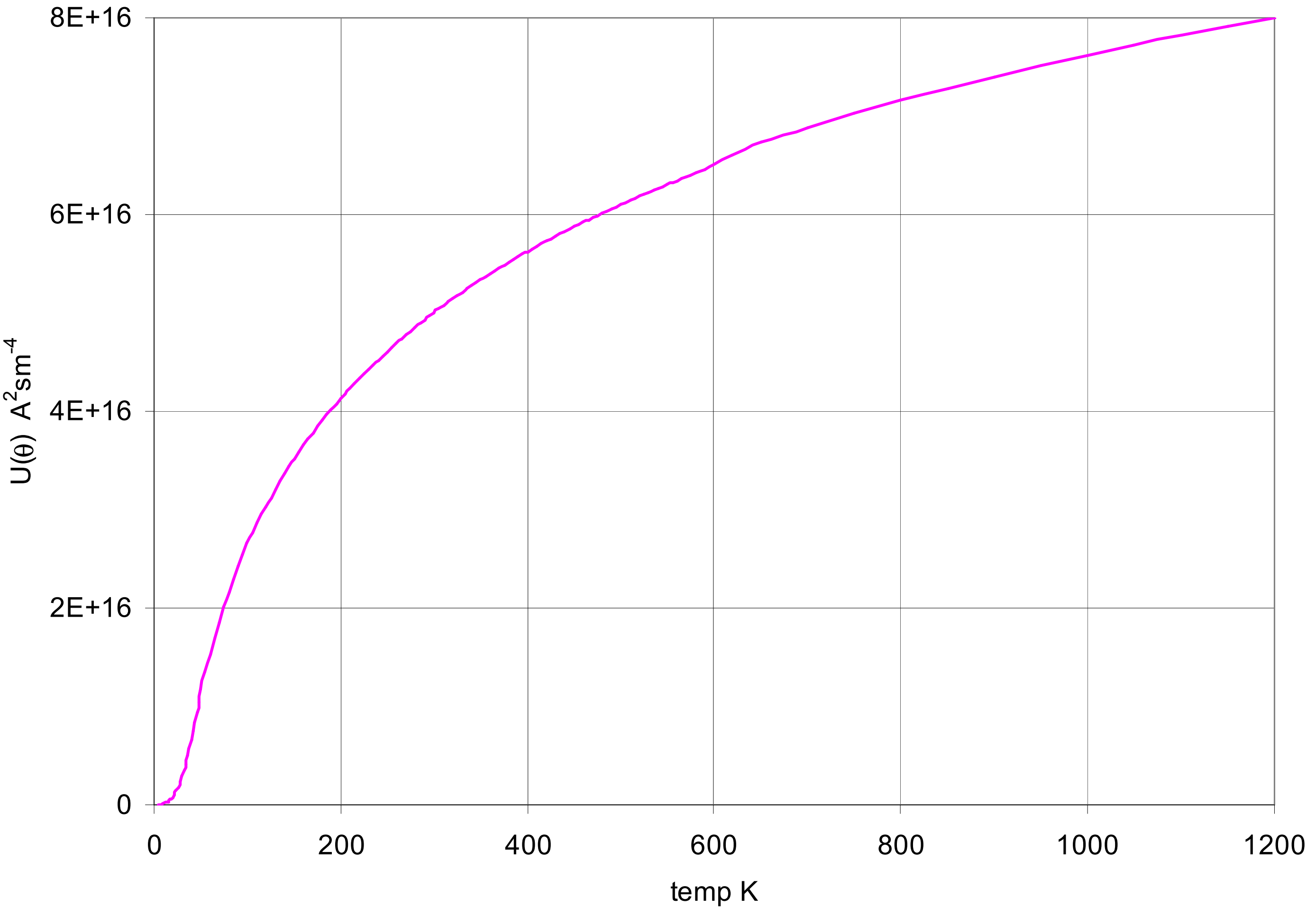
$$\int_{\theta_o}^{\theta_m} J^2 dt = J_o^2 T_d$$

i) For the example of magnet GSI001, given in Lecture 4, T_d = 0.167 sec. Use the U(θm) plot below to calculate the maximum temperature.

ii) This was a short prototype magnet. Supposing we make a full length magnet and compute T_d = 0.23 sec. - should we be worried?

iii) If we install quench back heaters which reduce the decay time T_d to 0.1 sec, what will the maximum temperature rise be?

Data
Magnet current Io = 7886 Amps
Unit cell area of one cable A_u = 13.6 mm^2

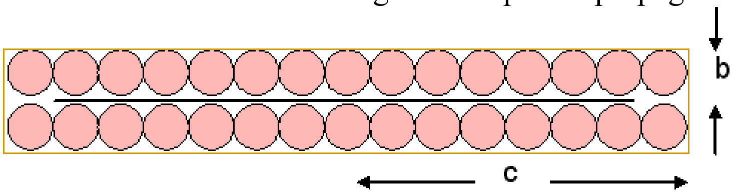


Question (b)

For the dipole GSI001, mentioned in Lecture 4 calculate:

i) the longitudinal quench propagation velocity

ii) the ratio a between the transverse and longitudinal quench propagation velocities



Data

magnet current at start of quench	$I_o = 7886$ Amp
unit cell area of cross section	$A_u = 13.6$ mm^2
base temperature	$\theta_o = 4.2K$
critical temperature for NbTi at 4T	$\theta_c = 7.8K$
temperature margin at operating current	$\Delta\theta = 0.6K$
specific heat / volume at transition temperature (averaged over unit cell)	$\gamma C_u = 5.32\times10^3 Jm^{-3}K^{-1}$
Lorentz number	$L_o = 2.45\times10^{-8}$ W□K^{-2}
effective longitudinal thermal conductivity	$k_{lu} = 237 Wm^{-1}K^{-1}$
effective thermal conductivity in transverse direction	$k_{te} = 0.048 Wm^{-1}K^{-1}$

How to proceed

- use formulae from Lecture 4
- from the temperature margin calculate the current sharing temperature
- from current sharing temperature and critical temperature calculate the transition temperature
- calculate the overall current density