Magnetization of Permanent Magnet Rotors

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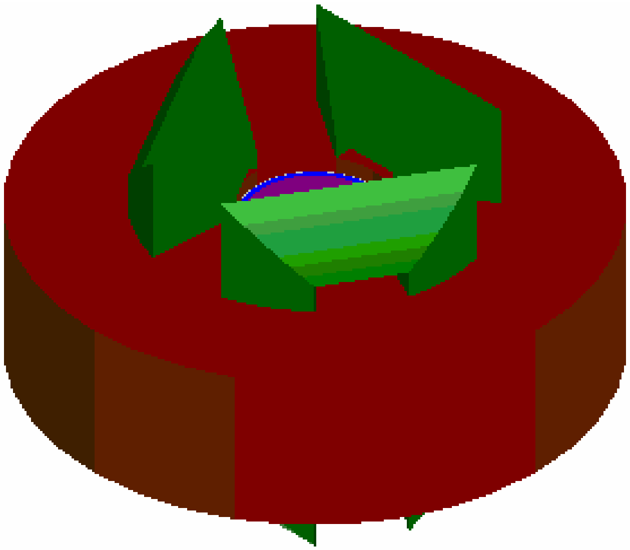
Introduction

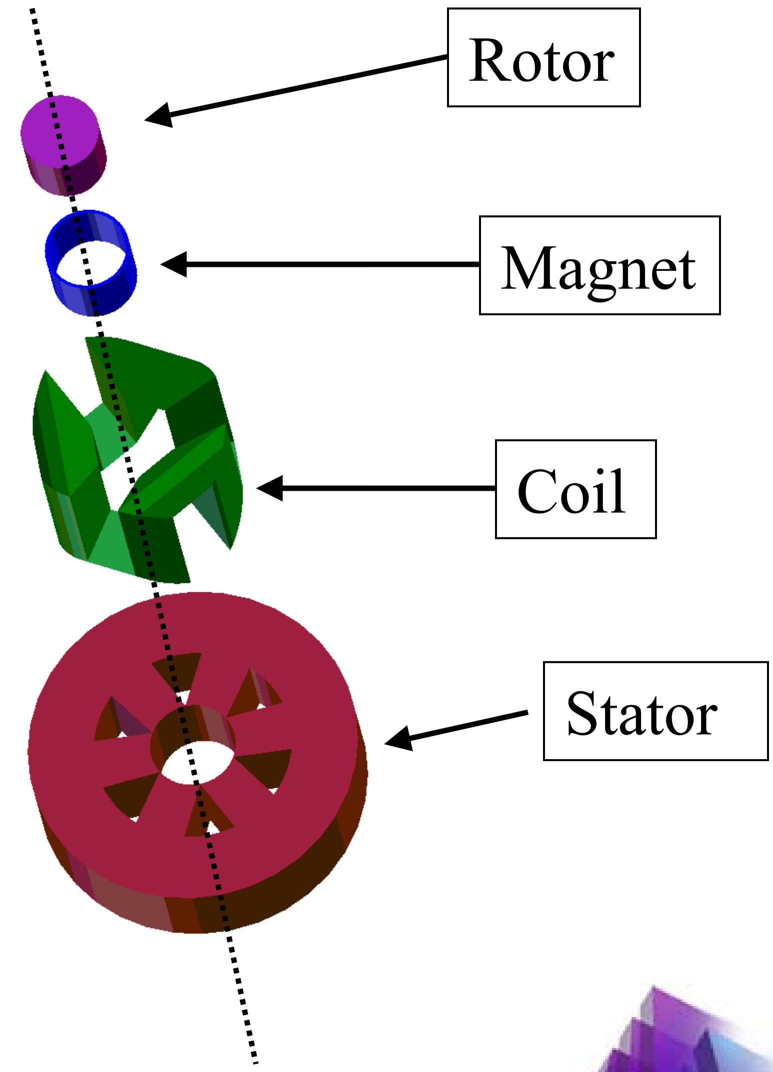
- Permanent magnet material is magnetized using a transient impulse
- Based on the peak current, the maximum flux density B(max) in the magnet is recorded
- This B(max) is located on a BH line with slope close to the recoil permeability
- The crossover point on the H=0 axis is the remenent flux density B(r)



Rare earth magnet 6-pole magnetizing fixture

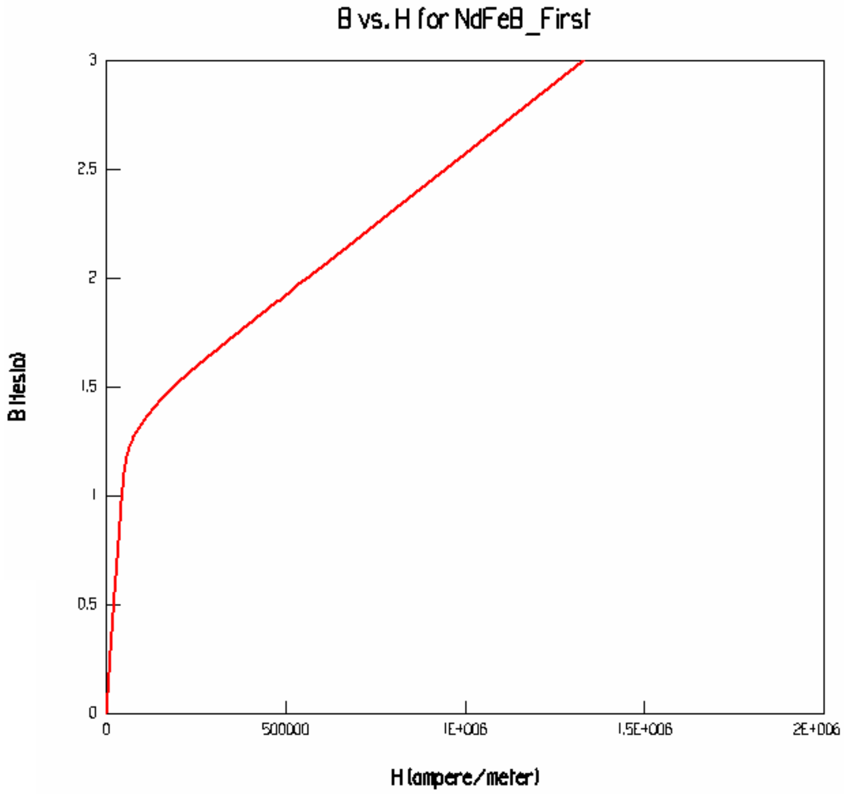
Project Setup

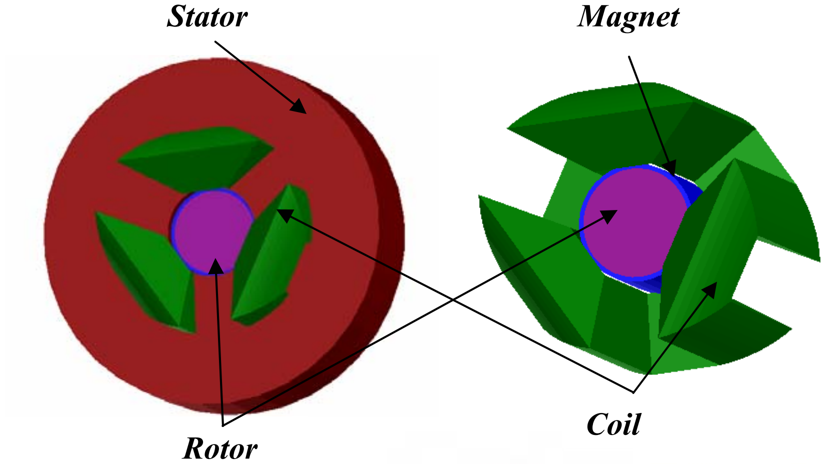
- 3D transient solver used
- External circuit used for excitation to model capacitor discharge
- Magnet material is nonlinear and conductive
- Time diffusion of magnetic fields and eddy currents are considered



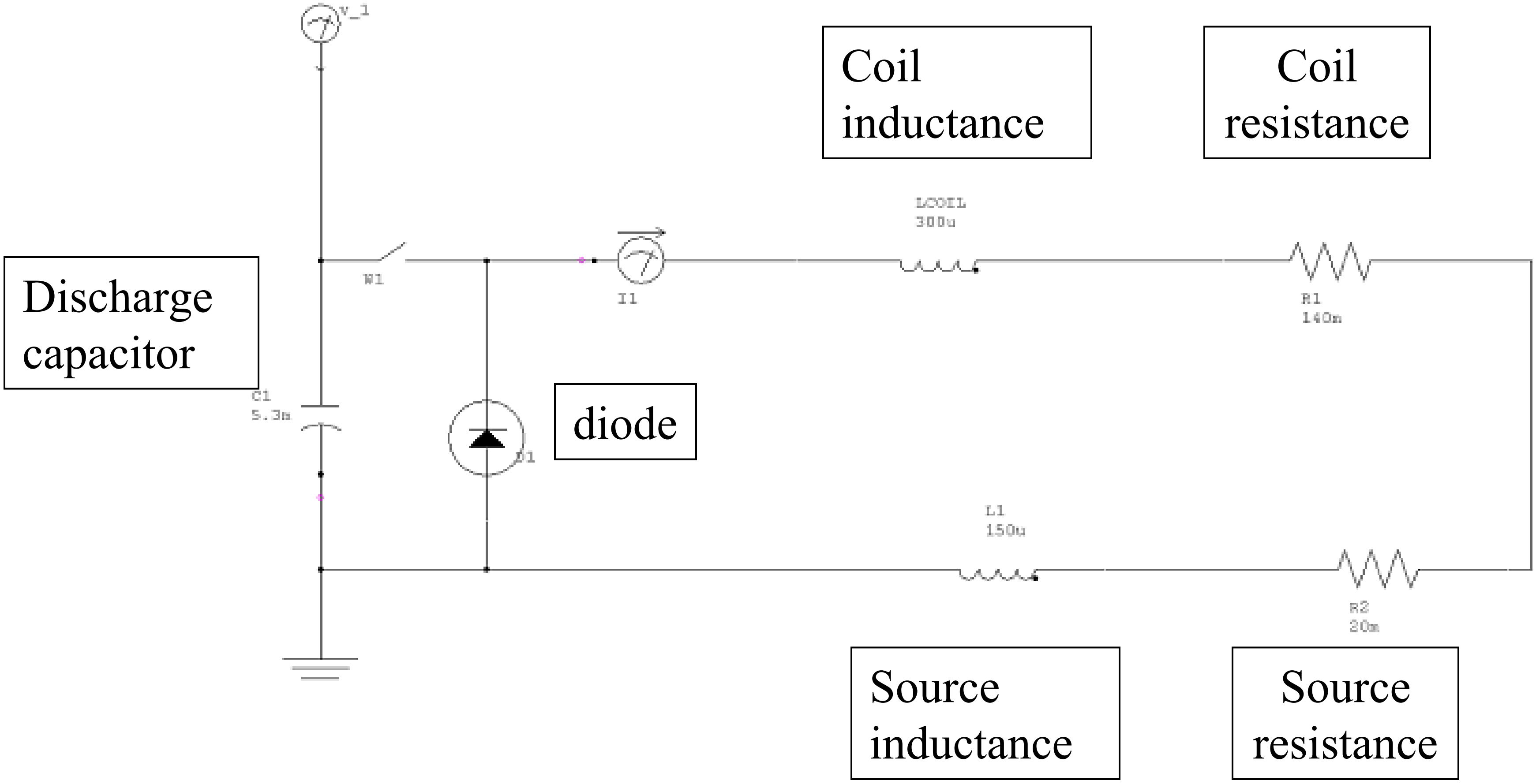
Material Setup

- Rotor and stator are laminated steel_1010 (eddy effects are neglected)
- Coil is stranded copper
- Magnet is virgin curve for NdFeB



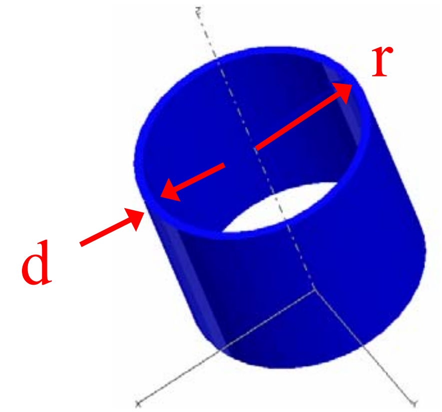


Electric Circuit Components



Magnetic Field Diffusion

$$\begin{cases} \nabla \times \overline{E} = -\dfrac{\partial \overline{B}}{\partial t} \\ \nabla \times \overline{H} = \overline{J} \\ \overline{J} = \sigma \overline{E} \\ \overline{B} = \mu \overline{H} \\ t < 0 \rightarrow H = H_1 \\ t = 0 \rightarrow H = H_2 \end{cases}$$

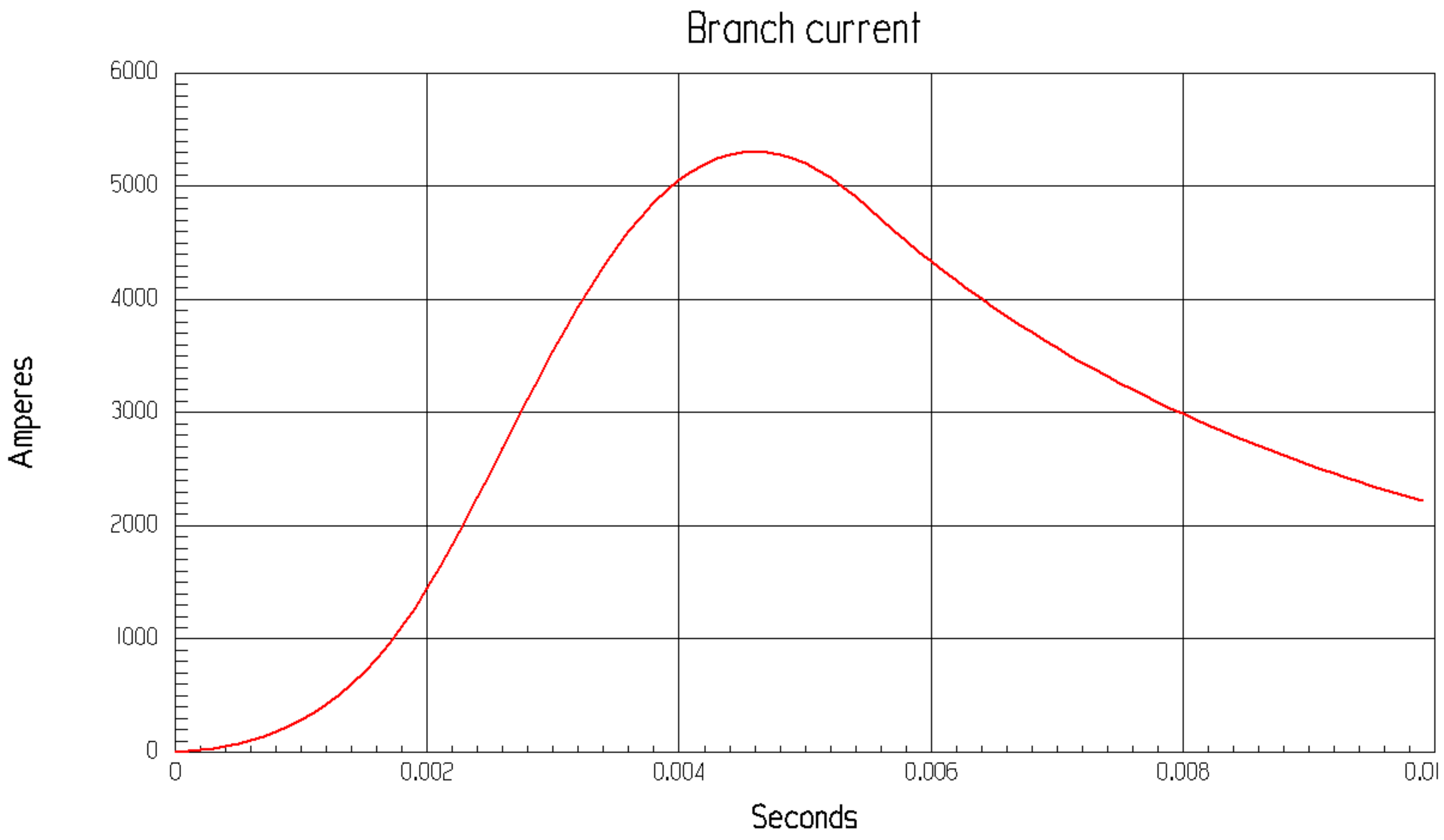


For a cylindrical shell, diffusion time is:

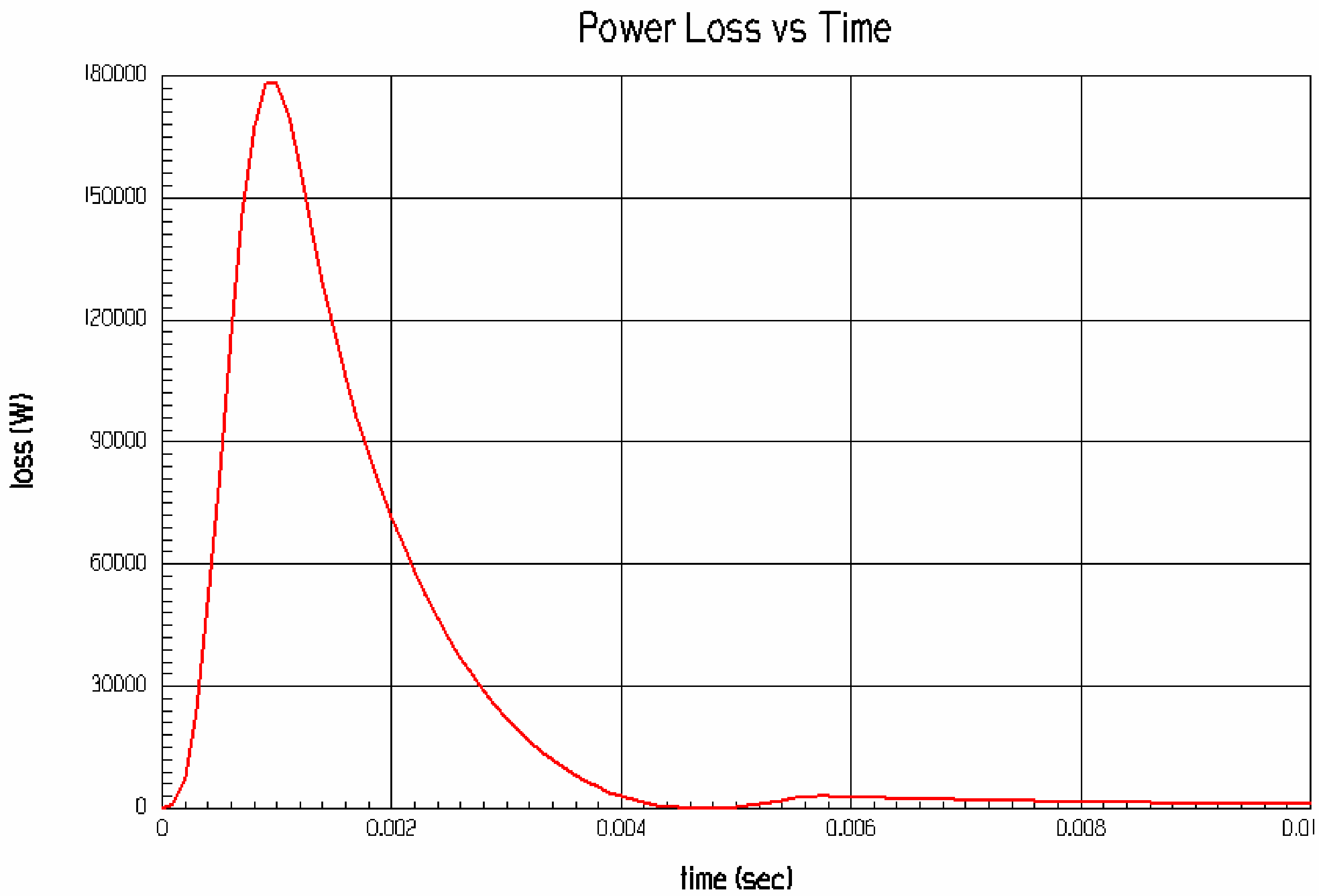
$$t = \frac{\sigma \mu d r}{2} = \frac{6.25e^{5} * 4\pi e^{-7} * 1.04 * 0.0034 * 0.0409}{2} = 56.8\, u \sec$$

Since, the diffusion time is much less than the current waveshape rise time, fields will penetrate magnet (56.8µsec << 5msec)

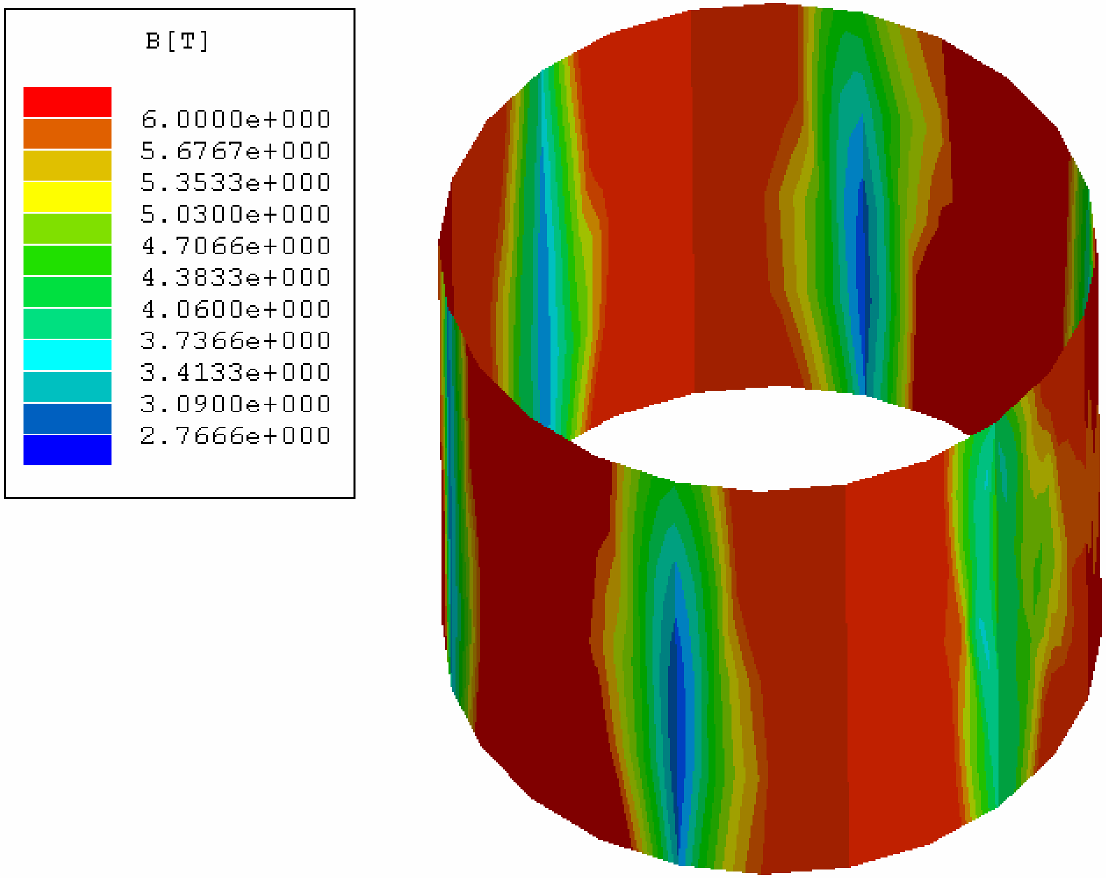
Results - Discharge Current



Results - Power Loss



Results - B magnitude



Results - B Vector