Magnetic Coils for LLPD

Part One
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Objective

-To determine the length of the copper wire (L) required to build 1 magnetic coil with the following specifications:
Magnetic Field:
B_{max}=1000 \text{ Gauss}
I_{max}=500 \text{A}
Biot–Savart law

- To determine the Magnetic Field generated by the coil, we will use: The Biot–Savart law.
- It is used to compute the magnetic field generated by a steady current (a continual flow of charges).

\[
B = \int \frac{\mu_0}{4\pi} \frac{I dl \times \hat{r}}{|r|^2},
\]
For 1 circular wire:

\[ B = \frac{\mu_0 IR^2}{2(R^2 + x^2)^{3/2}} \]

Where:
\[ \mu_0 = \text{the permeability constant} = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A} = 1.26 \times 10^{-6} \text{ T} \cdot \text{m/A} \]

\( I \) = coil current, in amperes
\( R \) = coil radius, in meters
\( x \) = coil distance, on axis, to point, in meters

For 1 coil with \( N \) turns we get:

However the coil consists of a number of wire loops, the total current in the coil is given by

\[ nI = \text{total current} \]

Where:
\( n \) = number of wire loops in one coil

Adding this to the formula:

\[ B = \frac{\mu_0 nIR^2}{2(R^2 + x^2)^{3/2}} \]
Finding the length

- Solving for this equation:
- Taking \( x=0 \):
- We get that \( N=47.4 \)
- \( N_2= 23.85 = 24 \) turns

- \( L= 32.04 \) m
Calculating for Resistance:
R(copper) = 1.7 \times 10^{-8} \frac{L}{A}

Area = Area of square – Area of circle inside =

Calculating for the area:
3.6 \times 10^{-5} \text{ m}^2

Calculating for Voltage:
U = RI (Ohm’s Law)
We get: U = 7.5 V
Copper Wires in the LAB
Magnetic Coil already built in the lab:
Next Step for Magnetic Coils

- To determine $B$ at any point along the axis taking into account the coils.

- To investigate how to build multiple magnetic coils for the LLPD
Cooling System