

Testing experiment of Biot-Savart law

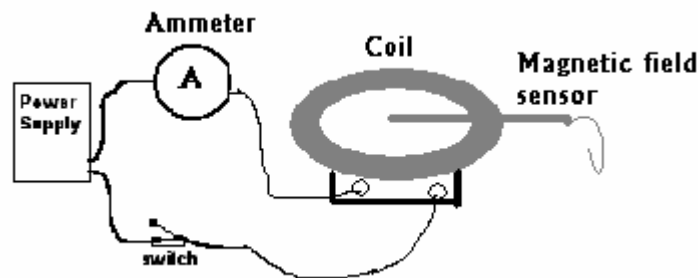
Question: How do we know if Biot-Savart law is valid or not in real life situations? Or how can we convince a friend that Biot-Savart law is valid in physics?

Equipment: Laptop, LabPro, magnetic field sensor, momentary switch, DC power supply, masking tape, plastic ruler, current coil

1. Task: Using the given current coil and other equipment on your table, design and conduct an experiment to test Biot-Savart law. To conduct a scientific testing experiment in engineering practice or research lab, the following steps are essential:

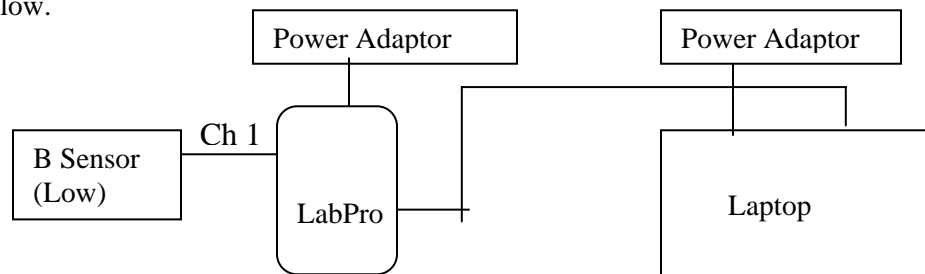
2. Identify the model to be tested: What is the model to be tested in this experiment? Discuss it within your group and write it down in your lab notebook.

3. Make a plan: To test Biot-Savart law, we can use a current coil and set it up as shown in the following:



To protect the power supply, don't let the current go over 2.0 A.

Computer Setup: Make sure the magnet field sensor connect to Channel 1 of the LabPro Interface. Set the switch on the sensor to *Low*. Then connect LabPro to the laptop following the diagram below.



Open Logger Pro 3.3 on the laptop. Click **4BLab** on the desktop, and then click on **CurrentCoils**.

4. Make a prediction: Making a prediction means to apply the *logical reasoning of if...then....* As we have discussed in the class, IF Biot-Savart law holds, THEN the magnitude of the magnetic field at the center of a current coil with N turns is

$$B = \frac{N \mu_0}{2a} I,$$

where I is the current in the coil, a is the radius of the coil, and $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$. Sketch in your notebook the graph of B versus I and predict the magnitude of the slope of the graph.

5. Conduct the experiment and collect data: Make sure to have one of your group members hold the magnetic field sensor, place its white dot facing down, locate the white dot at the center of the current coil, and have the white dot perpendicular to the magnetic field at the center. **Please zero the sensor without running the current.** Turn on the power supply and change the current gradually by increasing the voltage. Please make sure **don't let the current go over 2.0 A.** Carefully record the current readings and corresponding magnetic field readings.

6. Analyze data and make conclusion: Go to **Analyze > Linear Fit** to get the slope of the B versus I function and the uncertainty of the slope. To obtain the uncertainty, you can double-click the fit box and check the box for the standard deviation in the slope. Print out or sketch this graph in your notebook. Discuss any discrepancies between your prediction and actual result. Make your conclusion.