LAB 8 - MAGNETIC FIELD MAPPING(TPL2)

Objectives:

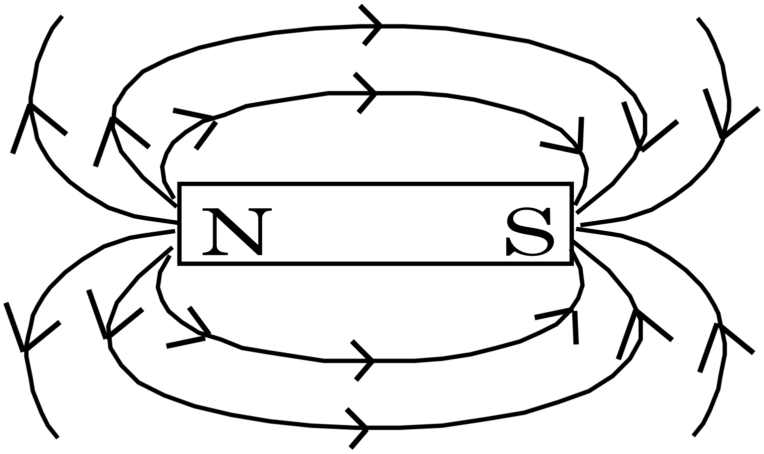
- Investigate magnetic fields created by bar magnets
- Investigate components of magnetic field (x and y components)

Preliminary activities

1. Prepare equipment. Plug the magnetic field sensor → USBLink→laptop.
2. Load the experiment file. Download the experiment file **Lab08_Magnetic_Field_Map.DS** from the lab schedule webpage, and load it in DataStudio.

Part 1 - Introduction

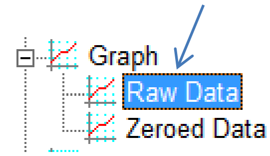
Bar Magnet: We have probably all seen the picture of the magnetic field around a bar magnet:



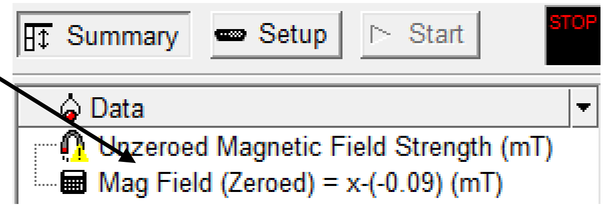
In this lab, we will have a chance to measure the field due to a bar magnet, and plot it in three dimensions in Excel.

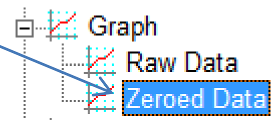
The magnetic field sensor is shown below, which measures field strength along the probe axis. **A field pointing into the probe along the axis generates a positive reading; while a field pointing out of the probe along the axis generates a negative reading**. The probe will report field strength in the unit of milli-Tesla (mT).

1. Setting the Zero offset for the Magnetic Probe. In DataStudio, double click to select the Raw Data graphs.

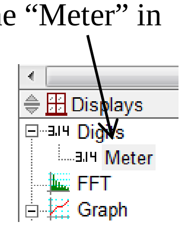


Hold the magnetic sensor **horizontal** and away from any magnets and click the START button in DataStudio and record a few seconds. You should get a nice horizontal line. Using the mouse, click and drag to highlight a section of that line, and then click on the button Σ ▾ and check MEAN to show the average reading. That reading will be likely in the −0.09mT range. Double-click on the "Mag Field (zeroed)" data line in the DATA window. A window should pop up with an equation "$Mag\ Field\ (Zeroed)\ =\ x - (-0.09)$(mT)". **Replace the number "−0.09" with the mean reading**, and accept the change. Switch to the Zeroed Data graph, from then on, the graphs should be reasonably zeroed.



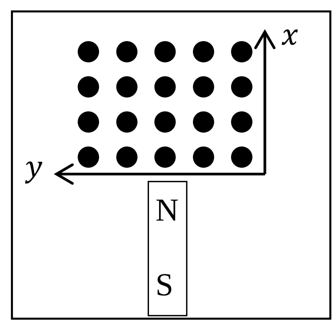


2. Magnet strengths. There are two bar magnets in your lab station, labeled A and B. You need to record the maximum field strength at both poles of each bar magnets. Double click the "Meter" in DataStudio; place the probe in front of each pole, line up their axes, measure and record the maximum strength. You might find that the opposite ends of the same magnet might have different strengths – that is not unusual.



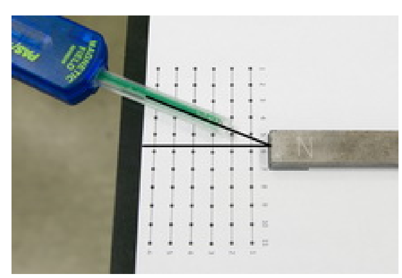
Magnet A : North = ________ mT South = ________ mT

Part 2 - Mapping North Pole of a Bar Magnet



There is a laminated paper with a grid marked on it, and a bracket for a magnet to be taped down. Tape one of the bar magnets in the location shown, with the North pole aligned in the place-mark near the grid as shown to the left

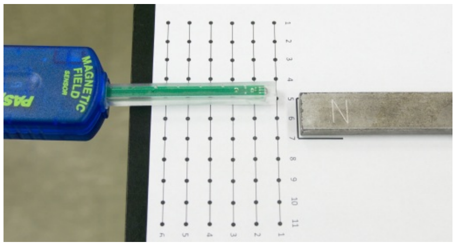
1. Mapping the field. For this section of the lab, we will try to look for the maximum value of the field at the grid of points shown. Because of the symmetry of the field, we only have to map half the points, and the other half will be reasonably similar. Orient and **keep the probe horizontally**; scan the field in front of the magnet at each point on the grid. When you do this, you will need to adjust the angle the axis of the probe makes with respect to the axis of the magnet, as shown to the right, until you reach the maximum reading. Record the measurements in the chart on the Data/Question sheet.



2. Load the Excel template. We will use Excel to make a graph based on a magnetic field measurement. Download the Excel file **Magnet.XLS** from the lab schedule webpage and open it in Excel.

3. Graphing. Using the data you collect, fill in the cells on the first page of the Excel spreadsheet file. You will only have to fill in the part of the cells (1,1 to 6,6 on the magnet paper), the other side is a mirror image Notice that the graph is "live" while you are typing in data.

Part 3- Graphing the x Component of B Field (One Pole)



We want to map the x component of the B field at each point on the grid. So in this section, we need to **keep the axes of the probe and the magnet parallel**, as shown to the right.

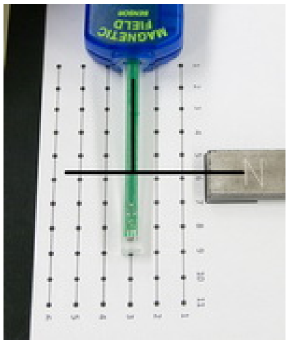
1. Graphing B_x field across the grid in DataStudio. Switch back to the Zeroed Data graph. Set the probe up so that it is near the (1,1) location in the grid. Click START button in DataStudio to start graphing. Move the probe along the y direction at a slow but constant pace; keeping the axes parallel. Sketch the resulting graph on the Data/Question sheet. [If the probe is moved steadily, then this plot is a reasonable Field vs. Distance plot as well.]
   Rename the run "x-comp of B". Print this graph as part of your report.

2. Values of B_x at points 1,1 and 1,6. Go back and record the values of B_x at points 1,1 and 1,6.

Question Answer on the Data/Question sheet:
Remember that the graph depicted is only the B_x component. Does the graph seem reasonable for the B_x component? What features of the graph lead you to believe that? (Discuss this with your lab group before forming an answer.)

Part 4- Graphing the y Component of B Field

1. Graphing B_y field across the grid in DataStudio. Repeat the previous steps, but this time, keep the axis of the probe perpendicular to that of the magnet, as show to the right.
   Sketch the resulting graph on the Data/Question sheet.
   Rename this run "y-comp of B". Print this graph as part of your report.



2. Values of B_y at points 1,1 and 1,6. Go back and record the values of B_y at points 1,1 and 1,6.

Question Answer on the Data/Question sheet:
Remember that the graph depicted is only the B_y component. Does the graph seem reasonable for the B_y component? What features of the graph lead you to believe that? (Discuss this with your lab group before forming an answer.)

<u>FINAL NOTE-TRANSFER ALL SAVED FILES TO YOUR OWN LAPTOP</u>

DATA/QUESTION SHEET FOR LAB 8 - MAGNETIC FIELD MAPPING

Part 1 - Introduction

2. Field strengths.

Magnet A : North = ________ mT South = ________ mT

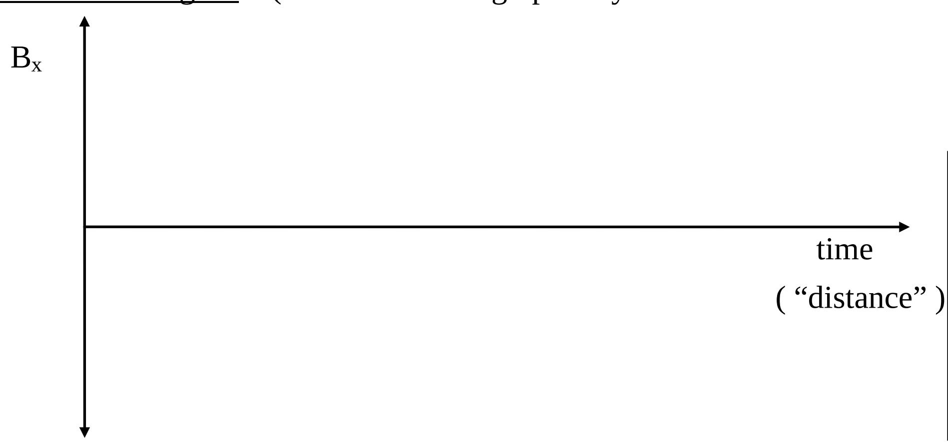
Part 2 - Mapping North Pole of Bar Magnet

1. Mapping the field, B_{meas}

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Part 3- Graphing X Component of B Field (One Pole)

1. B_x field across the grid. (The DataStudio graph may be used instead of the sketch.)



(Since our velocity is supposed to be constant as we move the probe .. the time axis on the ULI is similar to distance.)

2. Values of B_x at 1,1 and 1,6.

At 1,1 B_x = _______ mT ; at 1,6 B_x = __________ mT

Question Answer below:
Remember that the graph depicted is only the B_x component (as outlined in the convention). Does the graph seem reasonable for the B_x component? What features of the graph lead you to believe that? (Discuss this with your lab group before forming an answer.)

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Part 4 - Graphing Y Component of B Field (One Pole)

1. B_y field across the grid. (The DataStudio graph may be used instead of the sketch.)

2. Values of B_y at 1,1 and 1,6.

At 1,1 B_y = __________ mT ; at 1,6 B_y = ___________ mT

Question Remember that the graph depicted is only the B_y component (as outlined in the convention). Does the graph seem reasonable for the B_y component? What features of the graph lead you to believe that? (Discuss this with your lab group before forming an answer.)

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Question You have values for B_x and B_y at 1,1 and 1,6. Is there any relationship between the B_x , B_y, and B_{meas} (from the table Part 2.1) values at these points? Remember **B** is a vector quantity and B_x and B_y are at right angles then $B_{cal} = \sqrt{B_x^2 + B_y^2}$. How does B_{cal} compare to B_{meas}?

At 1,1; Calculate B_{cal} from B_x and B_y. Use the value of B_x from Part 3.2, the value of B_y from Part 4.2

At 1,6; Calculate B_{cal} from B_x and B_y. Use the value of B_x from Part 3.2, the value of B_y from Part 4.2

Calculate the %diff between B_{cal} and B_{meas} for the location 1,6. Use the usual %diff formula.

Can you think of any reason for any discrepancy between the B_{meas} (Part 2.1) and the B_{cal} (above) at this point 1,6?

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Questions/Suggestions -> James Nolta - jnolta@LTU.EDU