Instrumentation of Wiggler Magnets Cryostats

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In the Cornell Energy Storage Ring there are currently installed six wiggler magnets and my project was to create a method to be able to check individual performance in the cryostats of each magnet. The method I used to check performance of the magnets was one of gas flow rates.

I. INTRODUCTION

The wiggler magnets operate at superconducting temperatures for greater efficiency and reduction in size. The magnets are made on site at Cornell University, after the magnets are made they are tested before installation. Once installed in CESR the magnets cannot be monitored individually. It would be a great if each magnet's individual performance could be checked.

II. SETUP

To begin the project my mentors and I had to think about how the wiggler magnets are situated in CESR and mock that setup. I was unable to use an actual wiggler magnet because once they are built the magnets are prepared for CESR. Thus, we used a liquid helium dewar and built an apparatus for this experiment. After looking at multiple solutions we chose to read gas flow though a gas flow meter such as the ones connected to a house.

The apparatus that was submerged in the liquid helium dewar was built mostly of stainless steel. Stainless steel was chosen because of its low thermo conductivity. Other materials used were 56 k-ohm thick film chip resistors (thermometer), phosphor bronze wire, vacuum pump, two power supplies, and Evanohm.The apparatus consisted of two tubes. A quarter inch in diameter (inner tube) was palce inside a one inch in diameter tube (outer tube). Eleven 56 k-ohm thick chip resistors were epoxied to the inner tube. Each resistor was placed one inch apart from each other starting five inch from the bottom of the tube. Phoshor bronze wire was connected to each resistor and two heaters.The outer tube was connected to a precision ohm meter, two power supplies, and a vacuum pump. A vacuum pump was needed to ensure that there was no heat transfer between the atmosphere and the inner tube. The Vacuum pump ran continuously while in the dewar. Two Hewlett-Packard 3478A multi-meters were used to read the thick chip resistors.

III. GRAPHS

Starting at resistor 11 (this is the resistor closest to the liquid helium) it is seen that the resistance is around 95 k-ohm went any amount of voltage is applied to the bottom heater. Once the gas flow hit resistor 8 where the tube heater was the resistance dropped to 67 k-ohm. From this I saw that applying heat to the gas flow is definitely changing the resistance. (Graph 1)

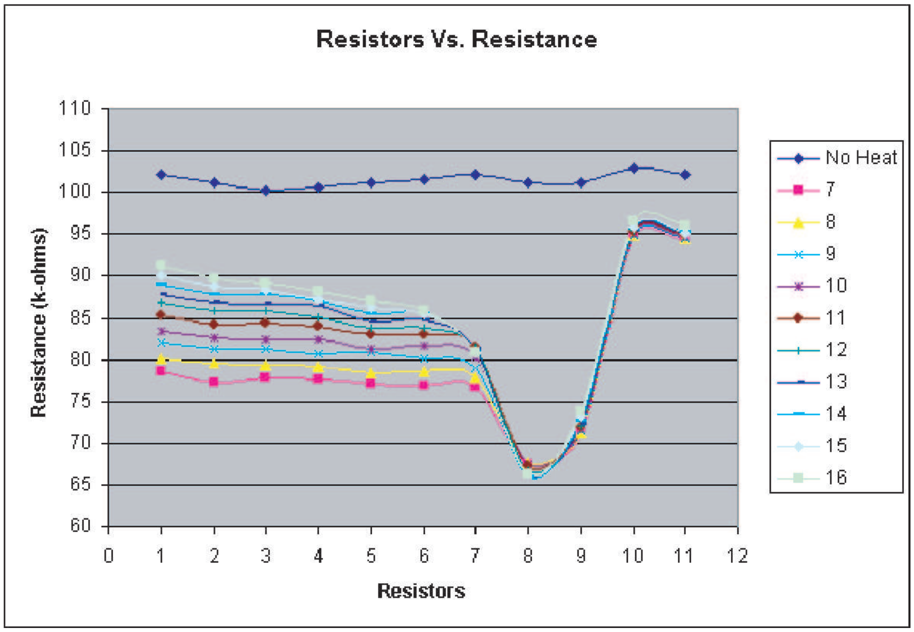

FIG. 1: Graph 1

I was able to use a calibration curve to change resistance value into more meaningful temperature value (Graph 2). As a less amount of heat was placed in the bottom heater the gas remained more warm after passing through the tube heater. Just as well at the higher voltage input to the bottom heater the gas flow was moving so rapidly that the gas flow cooled down more after passing through the tube heater.

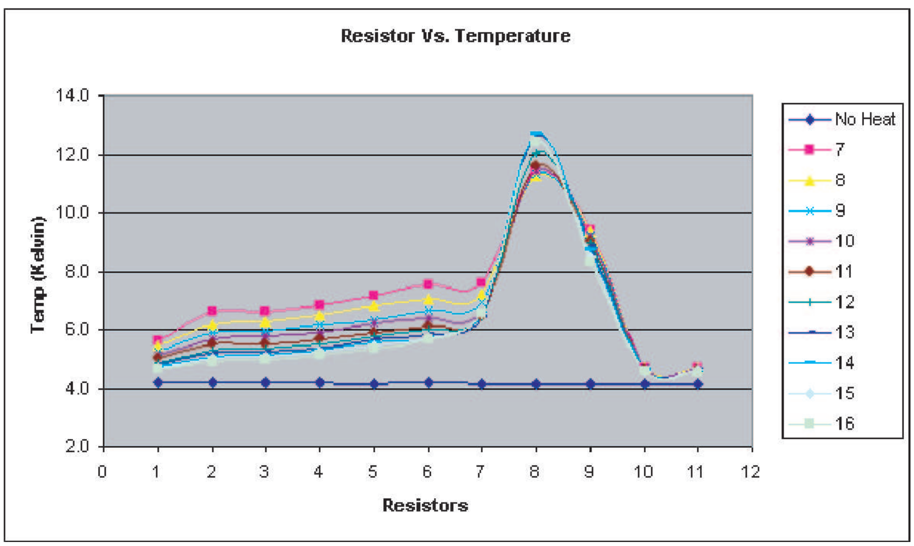

FIG. 2: Graph 2

Graph 3 shows how each thermo meter's temperature was affect by the voltage differences on the bottom heater. This graph has three interesting thermo meters to inspect a bit further. Resistor 2, 3, and 4 all have fairly linear slopes and are very close to each other. This gives excellent information about where to place the thermometer.

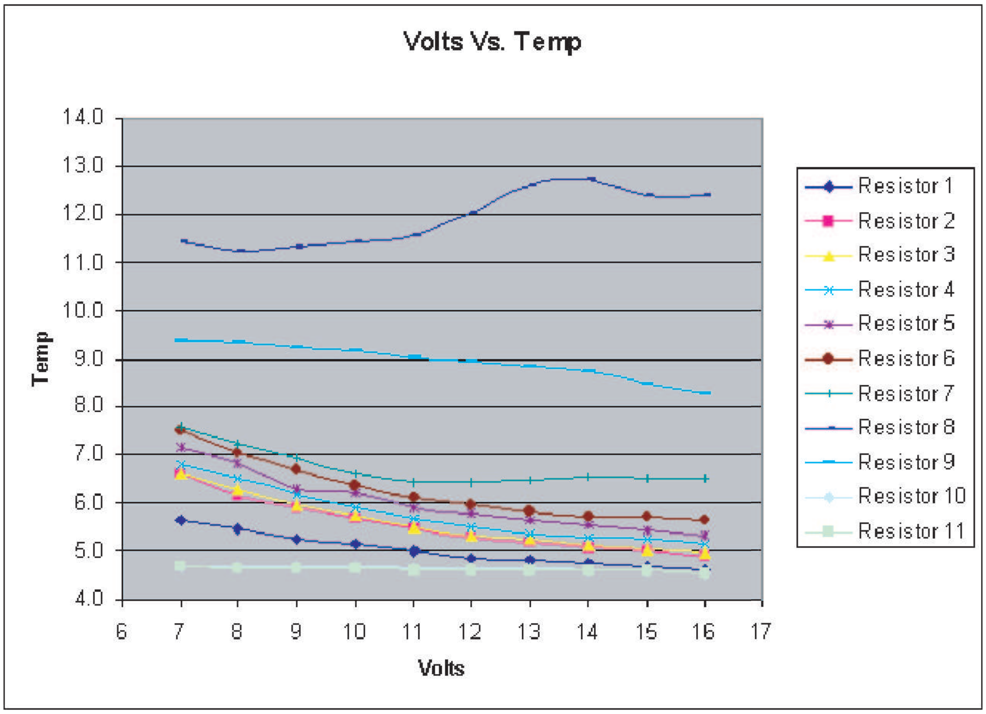

FIG. 3: Graph 3

Graph 4 displays how as more of an heat load is place of the helium heater the gas flow rate increases. This is exactly what was expected from this part of the experiment. As more power is put into the gas flow the slope of the line will keep increasing. Although at lower heat loads the gas flow rate does not change much. One thought is that the flow meter I was using could read the gas flow of small amounts at lower heat power.

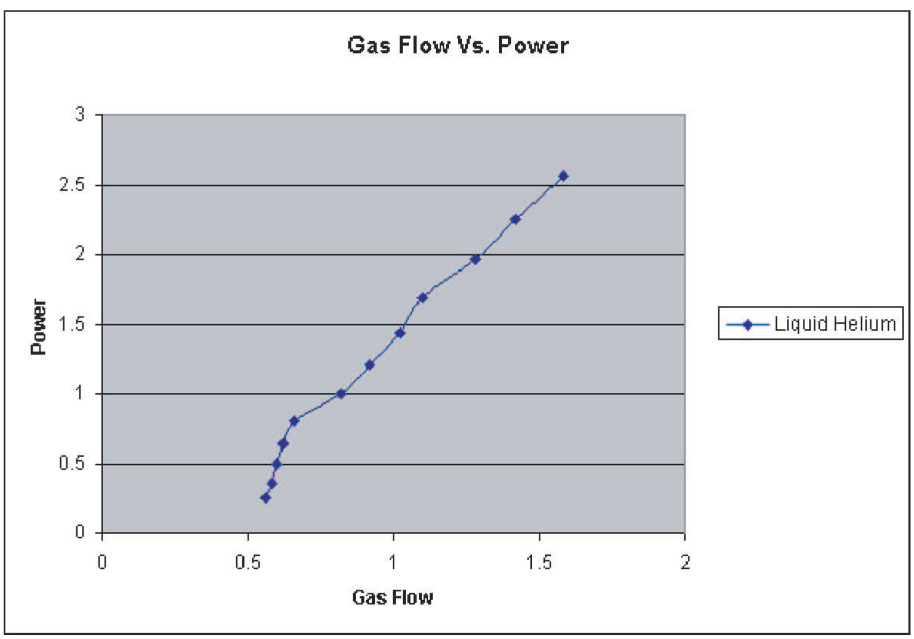

FIG. 4: Graph 4

IV. CONCLUSION

From graph 1 and 3 we see that the gas flow can be easily be manipulated by placing a constant amount of heat along the tubing. Also, graph 4 gives an idea as to where the best location for the thermometers to be placed after the heat is put into the gas stream. Since the tube heater is a little below resistor 8, it seems that between 4 and 6 inch of distance would be ideal after the gas goes through the tube heater. Therefore, by using gas flow measurements each wiggler can be individually monitored.

V. ACKNOWLEDGEMENTS

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