# CALIFORNIA STATE SCIENCE FAIR
# 2011 PROJECT SUMMARY

**Name(s)**
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**Project Number**
31718

**Project Title**
## Effect of External Magnetic Fields on Superconducting Transitions

**Abstract**

**Objectives/Goals**
My experiment involves measuring how a yttrium-based ceramic (YBCO) superconductor is affected by an external magnetic field. To do this, I measured the temperature at which the YBCO superconductor transitions (Tc) when you change the external magnetic field. I wanted to use my results to develop an equation to show how Tc changes based on an external magnetic field.

**Methods/Materials**
I used a YBCO superconductor disk with attached leads, which were wired up through three hand-held multivolt meters. One meter was wired to the temperature probe. A second meter was wired to circuit including a DC current source with a 100 ohm resistor; and the third meter was wired to a circuit to measure voltage across the YBCO disk. I used combinations of very strong rare-earth magnets that were attached to an optical breadboard to create an external magnetic field which I measured in Gauss using a Hall meter. During my experiments, the YBCO disk, which was in a styrofoam cup with glass beads and liquid nitrogen to cool the disk, was placed next to the magnets where I had measured the magnetic field. I was able to find the critical temperature by recording readings for temperature and volts across the disk. I did two to three runs each for a baseline with no magnetic field and four magnetic fields of increasing strength.

**Results**
I found that the critical temperature was generally slightly lower as the magnetic field increased. This is what I had hypothesized based on preliminary research. However, I was not able to quantify my results because the temperature change was not statistically significant.

**Conclusions/Discussion**
Although the critical temperature for the YBCO disk decreased as the magnetic field increased, I was not able to quantify my results or develop an equation for the relationship between Tc and an external magnetic field. I did some additional research and found that to see the change in critical temperature better I would have needed stronger magnets such as an electromagnet. I would need to do additional runs using at least two magnetic fields over two Tesla. I also learned that published measurements of the effect of an external field on yttrium-based superconductors had been done using thin-film versions, not YBCO disks.

**Summary Statement**
I wanted to find out if an external magnetic field has an effect on the critical temperature of a yttrium-based high temperature superconductor.

**Help Received**
Used space, lab equipment, and supplies at the microfluidics/nanotechnology lab at UCSB under supervision of PhD candidates Michael Gary and Viva Horowitz; parents provided transportation, supplies, and report editing assistance.