ABSTRACT

Purity Demonstration for Liquid Argon Protection Chamber
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In the field of particle physics detectors, more experiments are turning to the noble gases, specifically argon or xenon to try to detect elusive particles. I have worked on an experiment called the Liquid Argon Time Projection Chamber (LArTPC), which aims to detect neutrinos using ionization and electron drift. Before anything can be detected, it first has to be demonstrated that the argon in this 6 000 gallon tank can be made pure enough to function (with an oxygen level of 100 parts per trillion) without the chamber being evacuated. I have been testing materials and writing programs in order to aid in the construction of the tank and in the demonstration of the argon's purity. I tested several types of G10 material in order to find their individual resistivity so that it could be determined which would work best for the structural components inside the chamber. The material needs to have a large resistance to prevent current flow but which will still allow for some movement, preventing charge buildup. I tested these materials under both room and cryogenic temperatures so as to simulate the conditions in the chamber. I also worked with a xenon flashlamp. The purity in the chamber is measured with a detector which needs multiple but consistent light sources. The light needed is transferred using quartz fibers of from a single xenon flashlamp. I used a device that holds and aims multiple fibers at a central focus and constructed a test to measure the differences in the amount of light traveling through each fiber. In this way I was able to figure out how to use the flashlamp most efficiently. I also spent time with a fellow intern programming a stepper motor and a temperature monitor so as to measure the temperature throughout the chamber, confirm that it is uniform, and therefore rule out the possibility of eddy currents forming. Such currents would affect the function of the chamber (as it depends on electron drift, which the currents would disrupt). We wrote a program for the motor to raise and lower temperature sensors up and down the chamber. These sensors would then be read by the temperature monitor. I was able to find resistivities for the G10 materials, but as our equipment wasn't as sensitive as I could have wished, no conclusive results have been found as to which material should be used in the chamber. I did find, however, the position in which flashlamp works most efficiently, and found that even with multiple fibers, it could be positioned so that there was less than a 30% light loss between the most central and extreme fibers. The process of preparing the chamber will continue into the fall of 2010 and the purity demonstration is scheduled to occur sometime in November. If the chamber can be proven to achieve the appropriate purity without a vacuum, then neutrino detection and study will become a little simpler, hopefully unfogging the fundamentals of the world a little more.