Personal Statement Erin Goeke

1 Favorite Research

My favorite experiment is without a doubt calculating the lifetime of a muon. The experiment featured a scintillator hooked up to a photomultiplier tube. The PMT then amplified and converted the photons produced by the scintillator to an electrical current which an embedded circuit used to measure the time in between signals. If the measured time was *clearly* outside the expected lifetime for subatomic particles, that sample was discarded, but samples deemed reasonable were collected.

I loved tuning the PMT and watching the voltage patterns change on the oscilloscope, the cleverness of the circuitry, and desperately attempting to fix the broken software which would only collect two samples before crashing. If the experiment works properly on the first try, is it really an experiment? Debugging and refining is crucial to any experimental work!

But the experiment itself was only half the fun. Analyzing the collected data broadened my understanding of the lifetimes of subatomic. As you know, a histogram of the time it takes a set of muons to decay closely resembles exponential decay. But, by deriving the probability of muon decay as a function of time, the curious resemblance of exponential decay and muon lifetime became clear while the differences between the two became distinct. After all, there is no block of muons decaying in the sky as we have blocks of cesium decaying in our labs.

This lab also mesmerized me because of the properties of the muon. They hail from the decay chain caused by cosmic rays reacting with air molecules in the upper atmosphere. Traveling at 90% of the speed of light, their lifetime is greatly extended in our reference frame. However because it has more mass than an electron, the muon has a momentum about 10 times larger when traveling at .9c than an electron traveling at .99c. Therefore, it is much more difficult to detect than its smaller lepton cousin. Thankfully, the muon has a charge of -1, and is subject to electromagnetic forces. So although it has a higher momentum than the electron, it can be detected much easier than other particles, like say the neutrino, because it is able ionize the plastic in the scintillator!

Muons with ancestors originating from high energy are passing through me every couple of minutes. These particles, like electromagnetic radiation, inform us not only of ourselves, but also of where their journey to us. That is what makes labs like this so much fun! I only wish I could have calculated more than the average lifetime of a muon!