Abstract 2

The second week of my research project experience heavily focused on carrying out my first hands-on experiment: the crystal light yield experiment. The light yield experiment is a fundamental testament to the performance of a crystal as a scintillator. To briefly explain the experimental setup (see diagram), initially, the scintillator to be examined was the lead tungstate crystal I chose from last week. The sample is wrapped in Teflon tape and electrical tape due to the reflectivity properties of Teflon tape. This supplements the light collectivity efficiency of the experiment, as photons being emitted from the crystal that might have radiated outward, missing the photomultiplier tube and consequently, detection, will instead be redirected inward toward the PMT. The sample is then placed in front of a radioactive source, in this case, 22Sodium, which emits radiation through Beta-plus decay. This decay radiation instantiates the scintillation process in the crystal sample and triggers a system for data collection. The photons emitted from the crystal are then passed through a photomultiplier tube to produce a measurable current from the emission process. This current is digitized through a Charge ADC, which is rendered in the computer via a data acquisition software called Coda. My job was rather simple, after carefully powering on the experiment and initializing Coda, I waited for approximately four hours for enough samples to be taken. In the meantime, I worked on my computation project: optimizing my code for electron-proton scattering.

Previously, my model implemented Rutherford Scattering, a powerful, but approximate way of representing e+p scattering. It is non-relativistic, and it does not consider the recoil of the proton (it was originally a formula for alpha particles recoiling off of a Gold nucleus, where this approximation was valid). The Mott Scattering Formula, however, describes e+p scattering while considering relativistic effects (Beta->1) and by considering the recoiling energy of the proton. Yet again, this is an approximation, as it treats the proton as a point-like structure with no spin (with therefore no magnetic interaction). However, the empirical results show that for low momentum transfer (which is the corrective term in this approximation), this is quite a good approximation. The next steps would be to introduce quantum effects, that is, take into account the entire nature of the proton; namely, its extended charge distribution and the magnetic interactions due to its spin. The formula consolidating this is known as Rosenbluth Scattering and is the foundation of modern e+p scattering. My goal for next week is to represent this, as well as Moller, e+e, Scattering successfully in my code.

After enough events were sampled, I conducted data analysis on the results to calculate the light yield. By using a Gaussian fit to characterize the distinct distributions and the means of these 3 distinct fits, I was able to calculate the light yield giving: 12.91 photoelectrons/MeV for my sample. With some elementary error analysis using the error values of the mean of the 3 peaks generated by my fits, I got an uncertainty of ± 1.96 pe/MeV. I conducted a similar analysis for a reference lead tungstate crystal in the lab and got a result of 12.56 ± 1.96 pe/MeV. Looking forward experimentally, I wish to analyze the systematic uncertainties of the experimental setup by conducting light yields where I control a variable (such as the time waiting for a crystal temperature to equilibrate) and see if that impacts the light yield. I also wish to conduct transmittance experiments, essentially a determinant of how much light a crystal allows to pass through itself.