CaTz PAN Week

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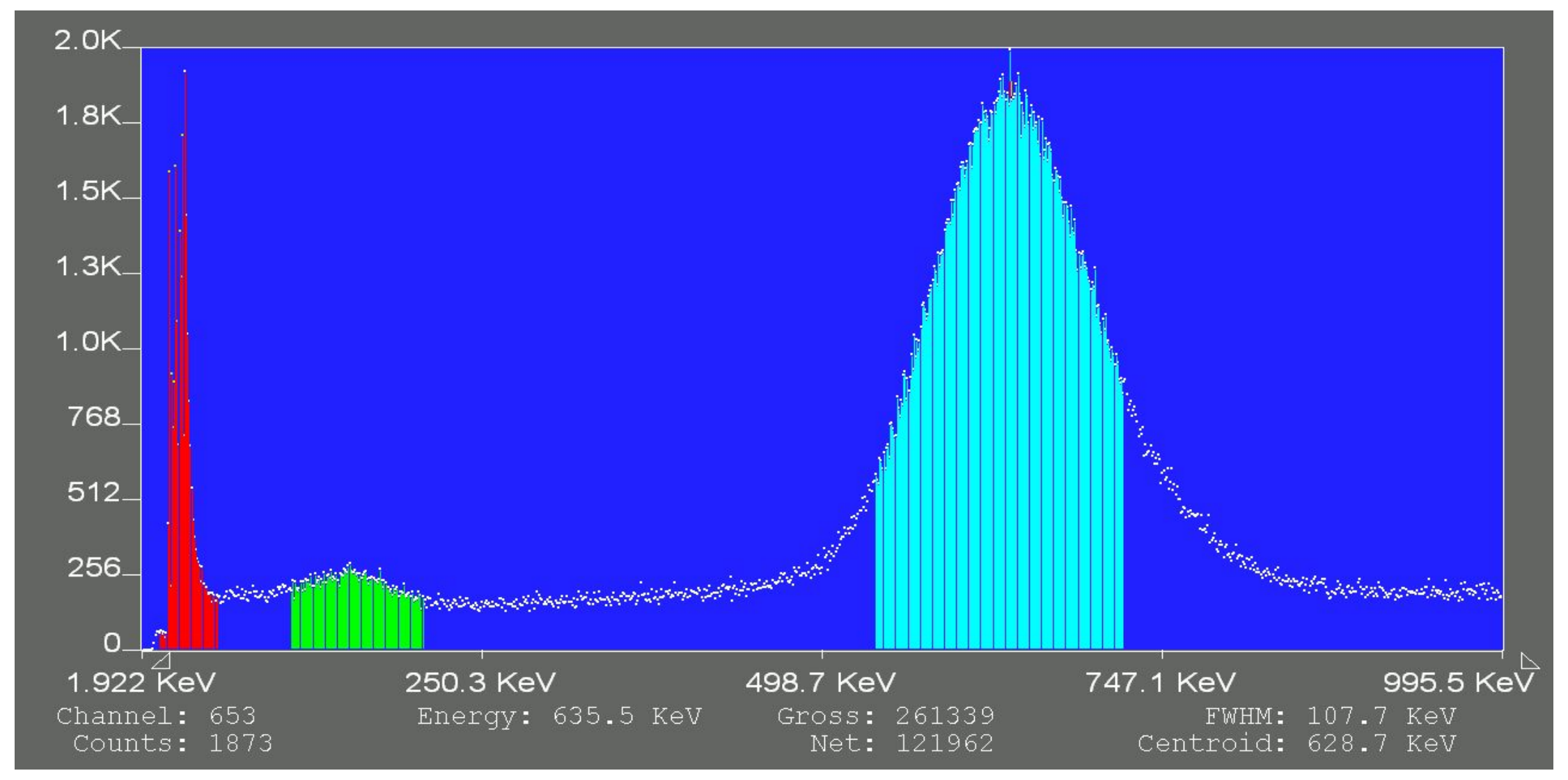
Gamma Spectroscopy (Experiment 1)

During experiment 1, we used special software to determine the number of gamma rays being emitted at each energy level (photopeak). Using the unknown's unique photopeak, we were able to identify it as Manganese-54.

Manganese is a common alkali earth metal with only one stable isotope and an isotope with a half-life of 312.4 days.

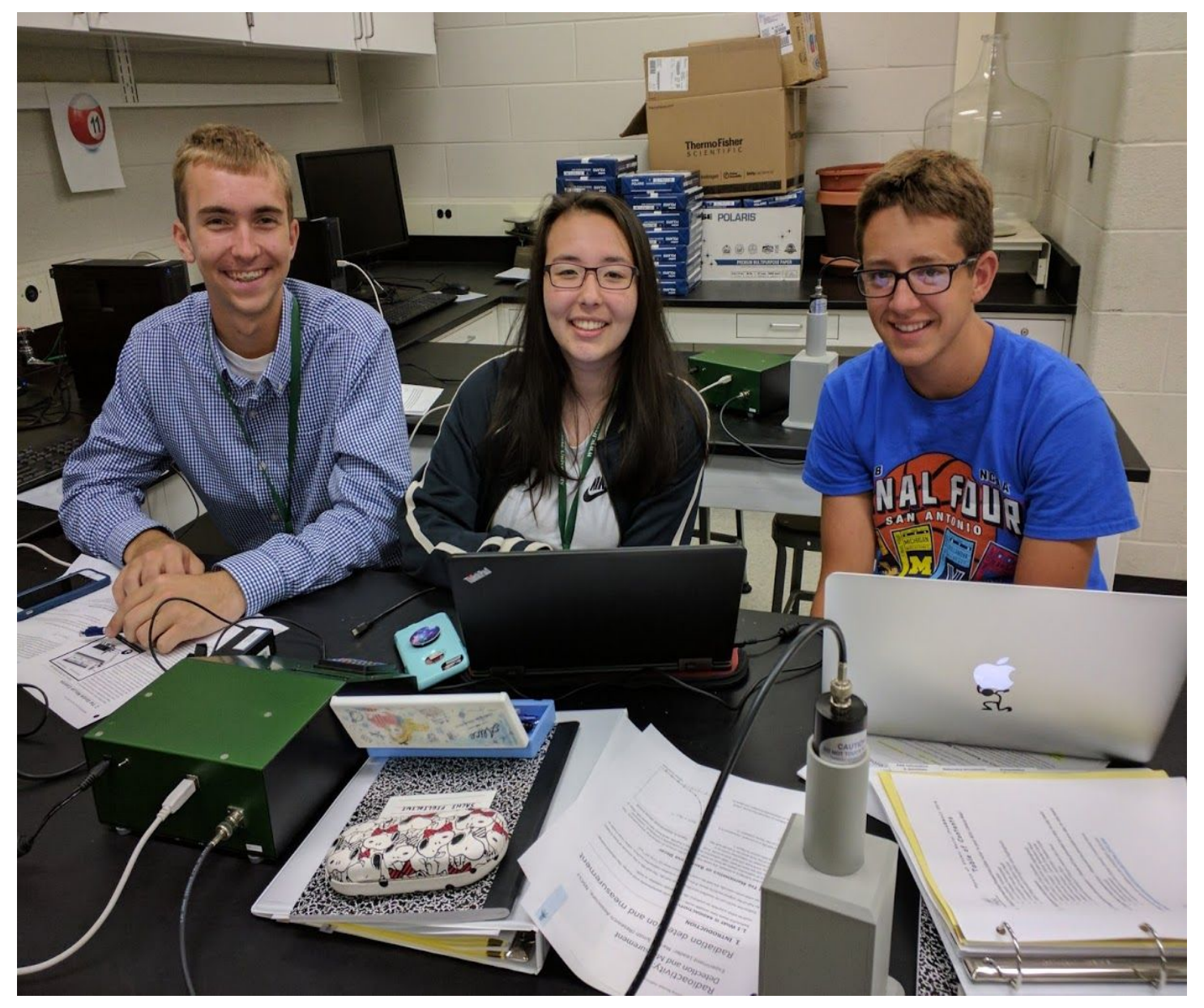


The graph is our result from experiment 1 where the x axis shows the energy level (KeV) and the y axis shows the counts.

Our experimental purpose was to take an unknown sample and use a calibrated detector to identify it with use of a table of standards. The first step was to calibrate the machine with a sample of Cesium-137, which allows us to more accurately determine the energy of the rays collected.

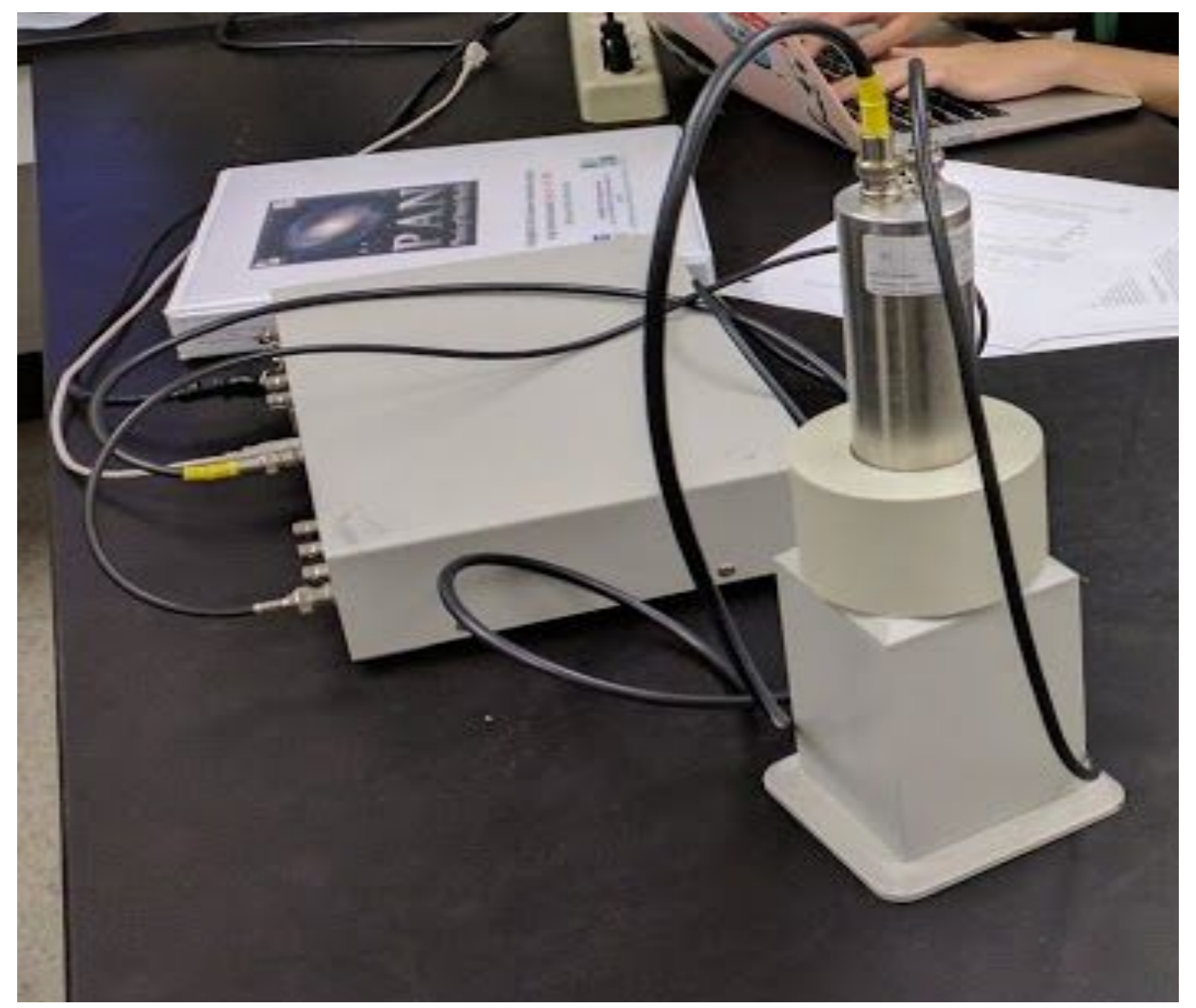
Sachi Figliolini (top), Nathan Ryan (middle), Jack Di Palo (bottom)

The radiation detector counted the number of gamma rays emitted at each specific energy level by the unknown sample. When a photon was emitted, it would ionize the gaseous atoms in the radiation detector, and send an electric pulse to the computer, allowing us to track the number of counts at each energy level. Our sample of Cesium allowed us to reduce inaccuracies in the system.



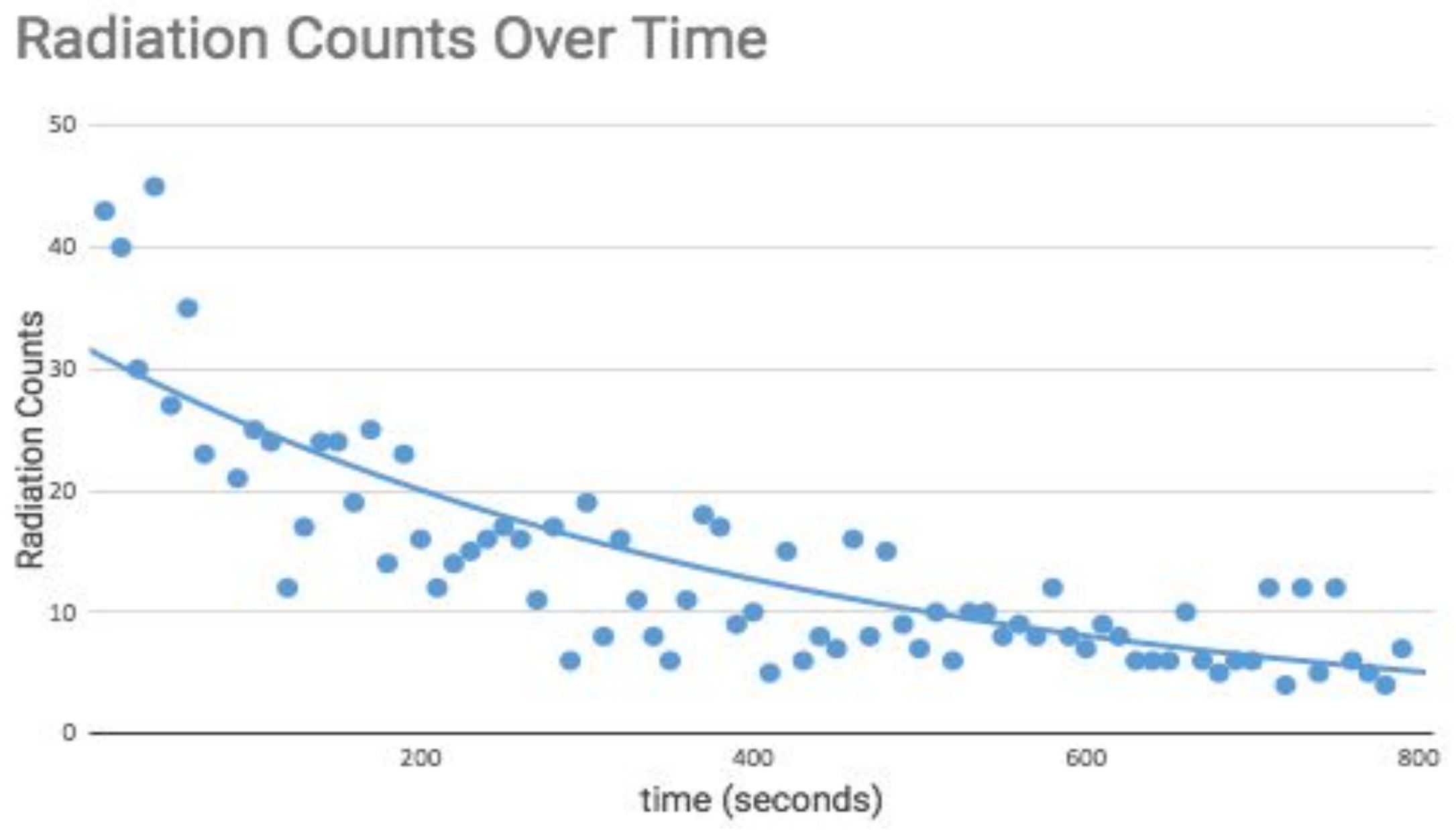
Nathan Ryan (left), Sachi Figliolini (middle), Jack Di Palo (right)

By examining the energy given off by the radioactive Manganese sample, and the energy peaks formed by the number of times a gamma ray hit the detector over the course of the collection period, we were able to identify the material. The gamma rays had an energy of 805.4 KeV which is within a percent error of 30.7% of the actual value.



Power source and radiation detector

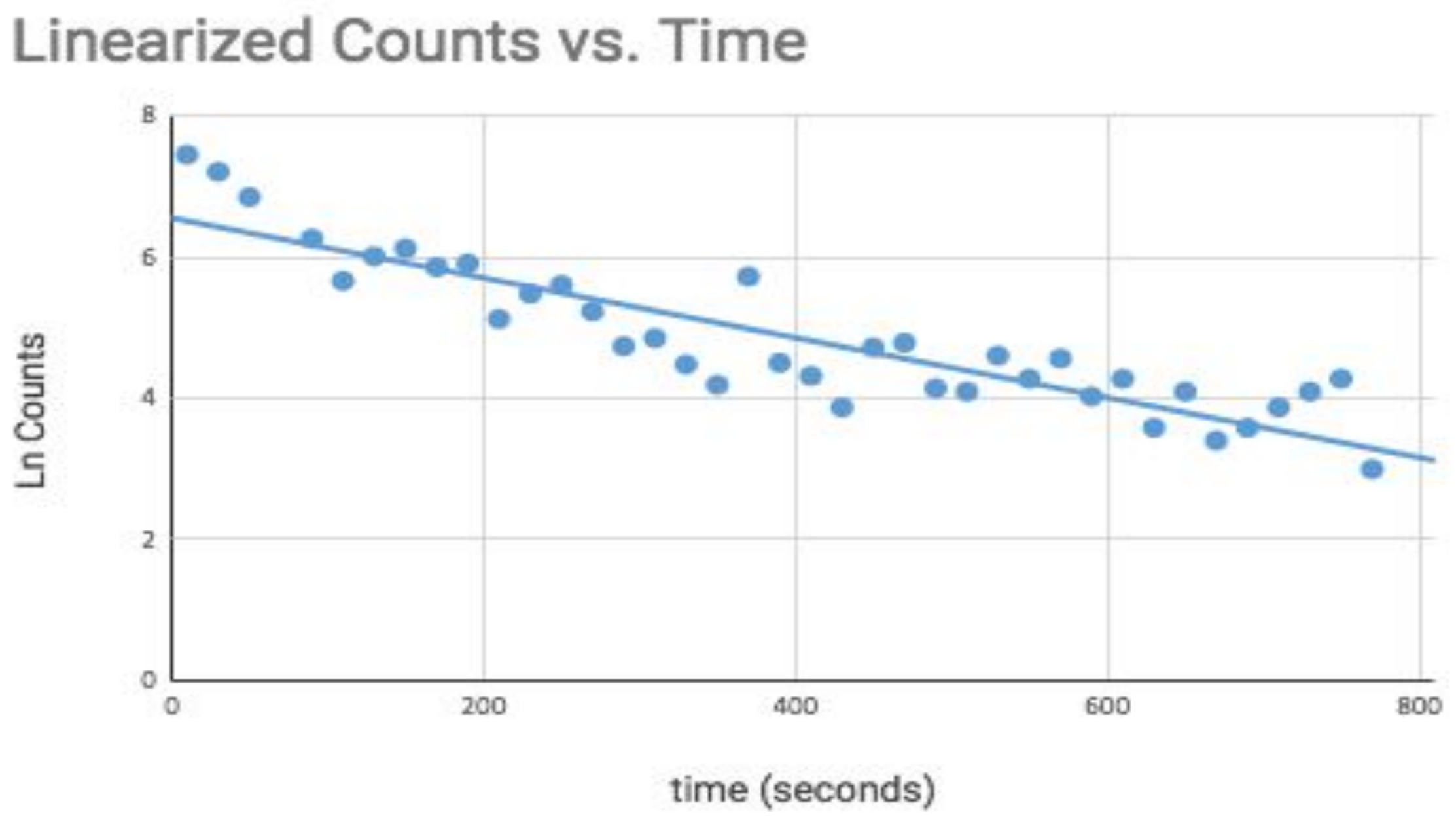
Half-life Radiation (Experiment 2)



This graph was generated by a Geiger-MÜller counter and represents the number of times the system detected radiation.

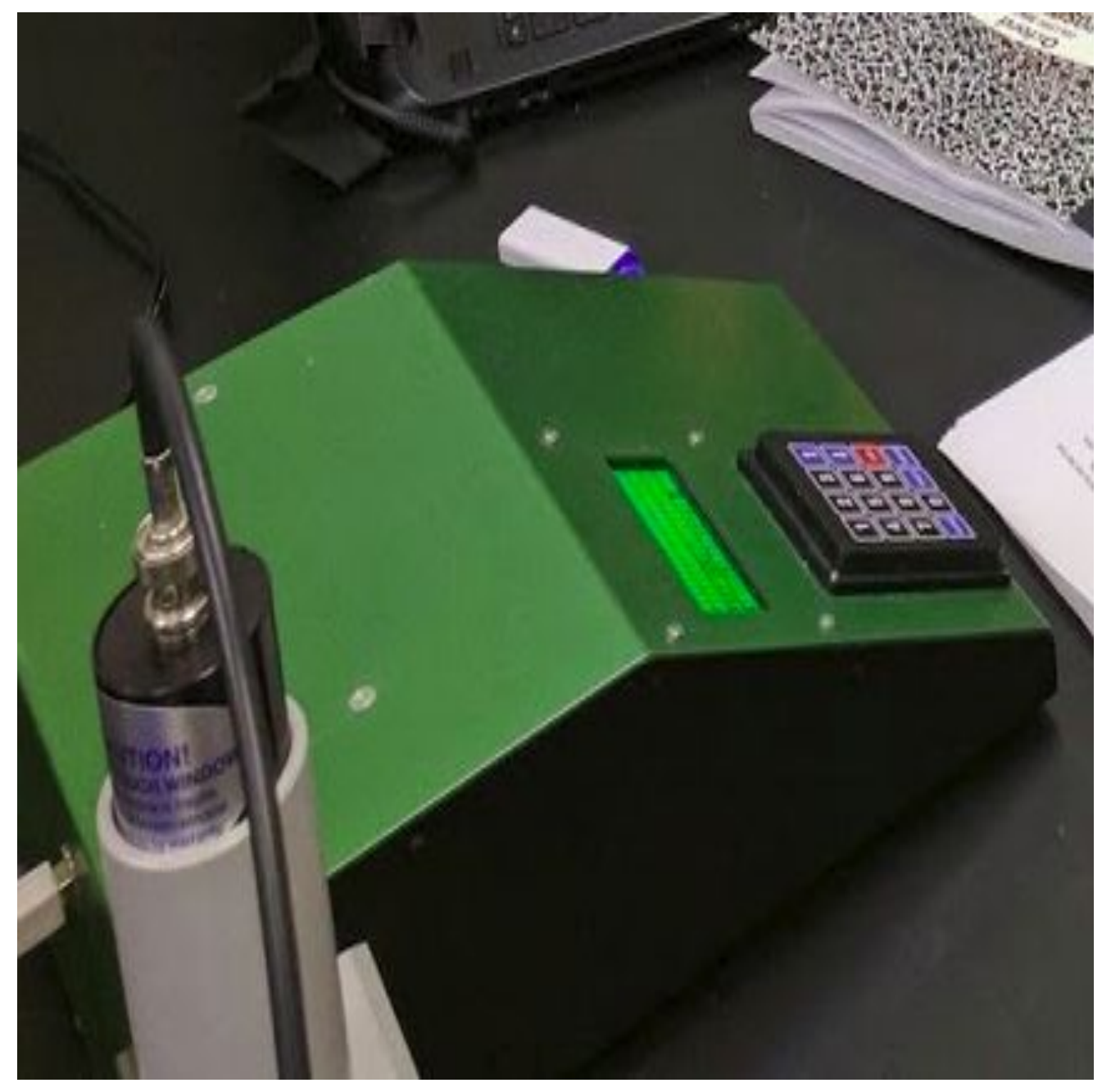
In this experiment, we were given a special rock with both silver and cadmium present in it. A normal sample would contain Ag-107, Ag-109, Cd-106, Cd-108, Cd-110, Cd-111, Cd-112, and Cd-114. However, this sample only contained Ag-107, Ag-109, Cd-108, and Cd-110. We discovered that Ag-110, and Ag-108 are radioactive, and so we hypothesized that if Ag-107 and Ag-109 had been hit with a neutron they could've become radioactive and decayed into other elements.

We determined the half life of a sample of silver using specialized technology. The half life of the two common isotopes of silver found in this sample (^{110}Ag, ^{108}Ag) have half-lives of 24.6 seconds and 2.37 minutes.



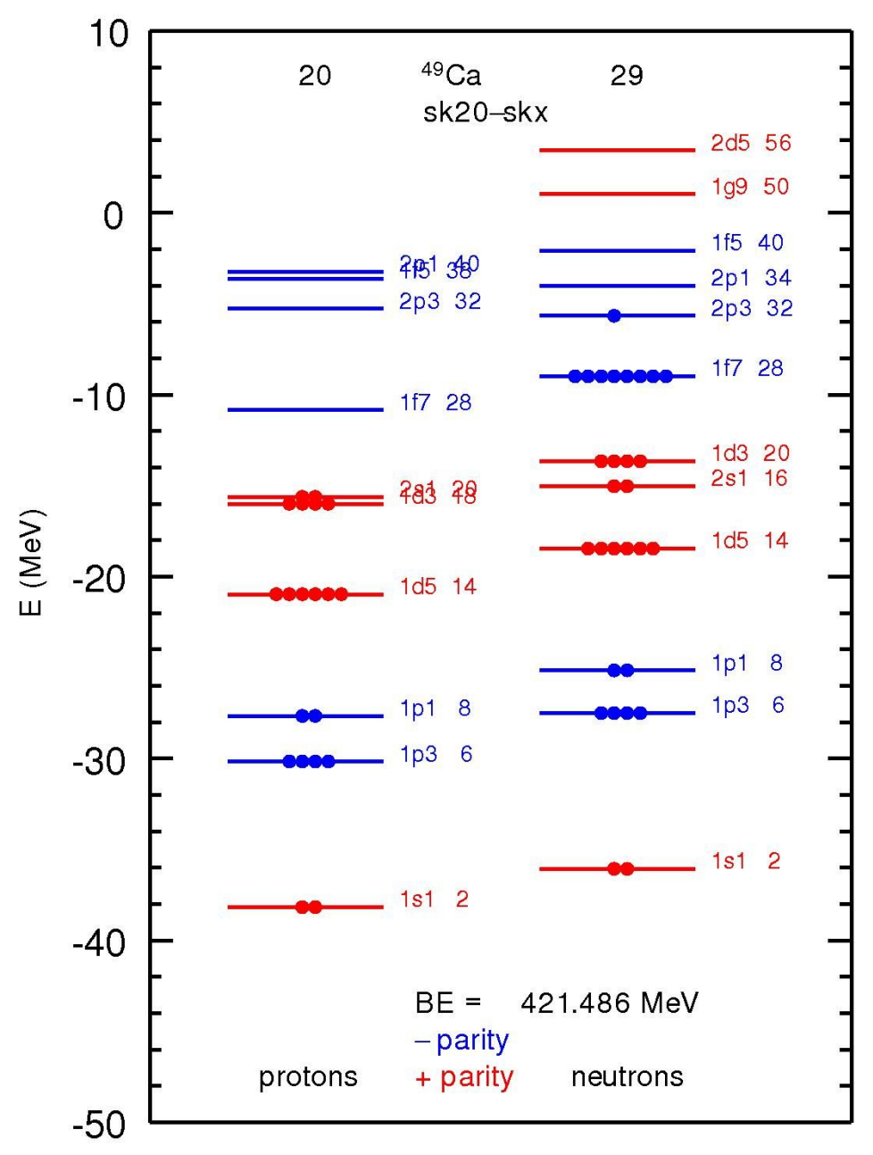
By taking the natural log of the number of counts, we linearized the exponential decay to determine the slope and decay constant.

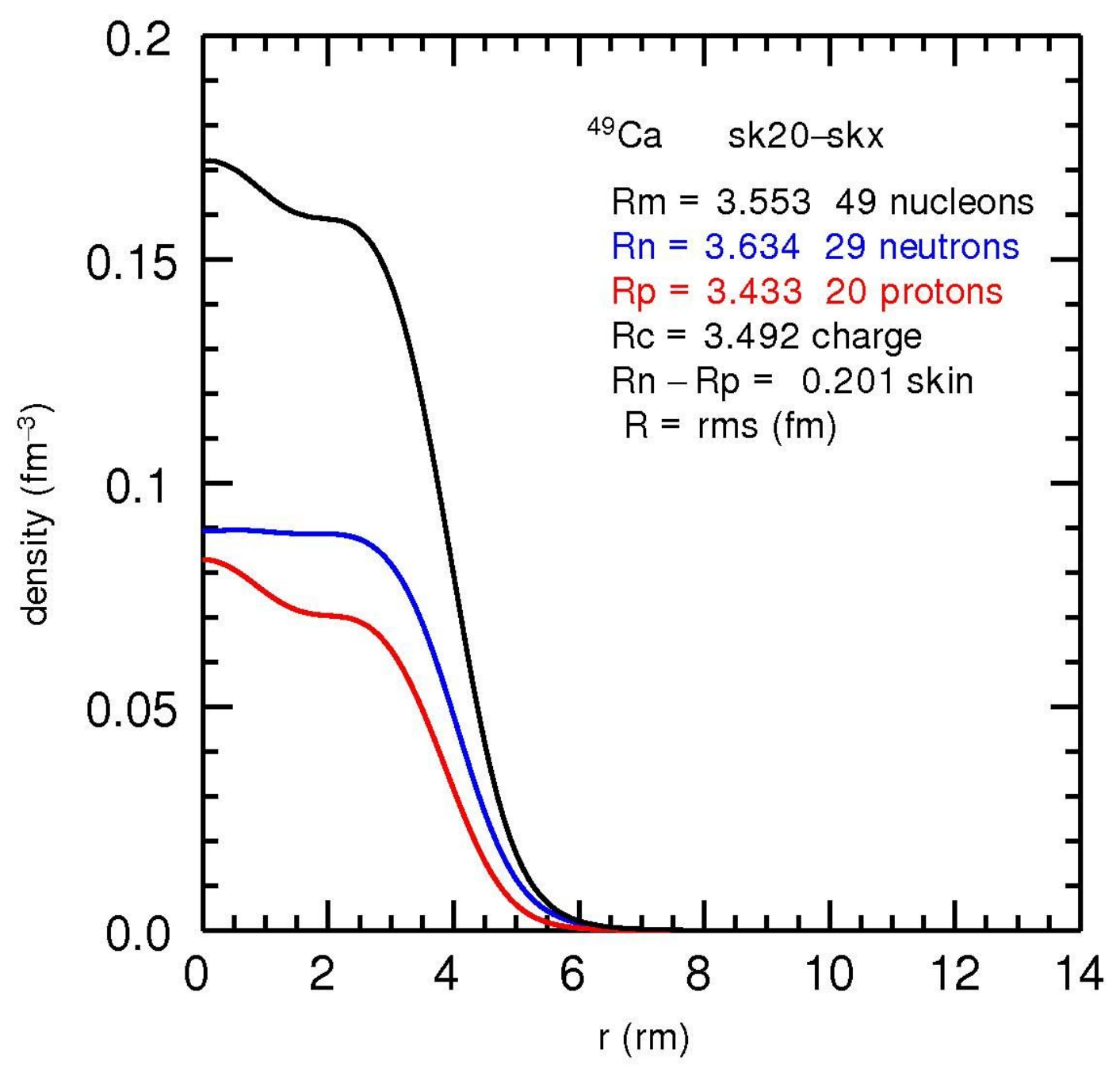
We determined our half-life values by taking the natural log of the count values over time to linearize the data. A linear data set in this case would give the decay constant (a variable which, when the ln of two is divided by it, can give the half-life of an individual sample).



Our initial parameters were at a level of specificity that diluted all of our actual data with background noise, so we went through all the data and re-binned it so as to better represent the nature of our statistics. Our final percent error was 33.37 % with an observed half-life of 94.75 seconds. The multiple radioisotopes contributed to uncertainty in the initial few minutes, however our concern was with the isotope Ag-108, as its half-life is long enough to give significant chance on interacting with the Cd.

Nuclear Properties with EDF Theory (Experiment 3)

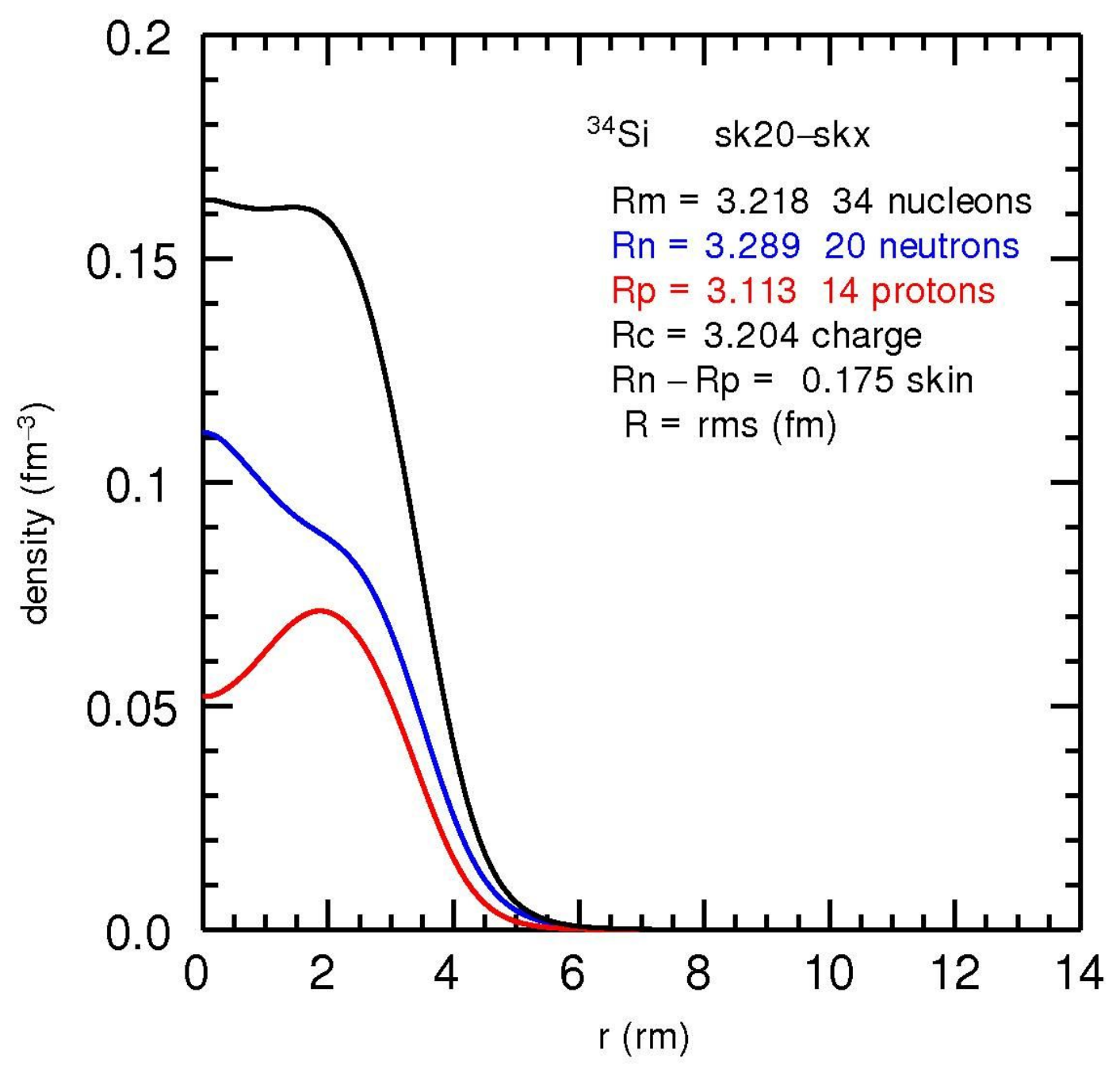


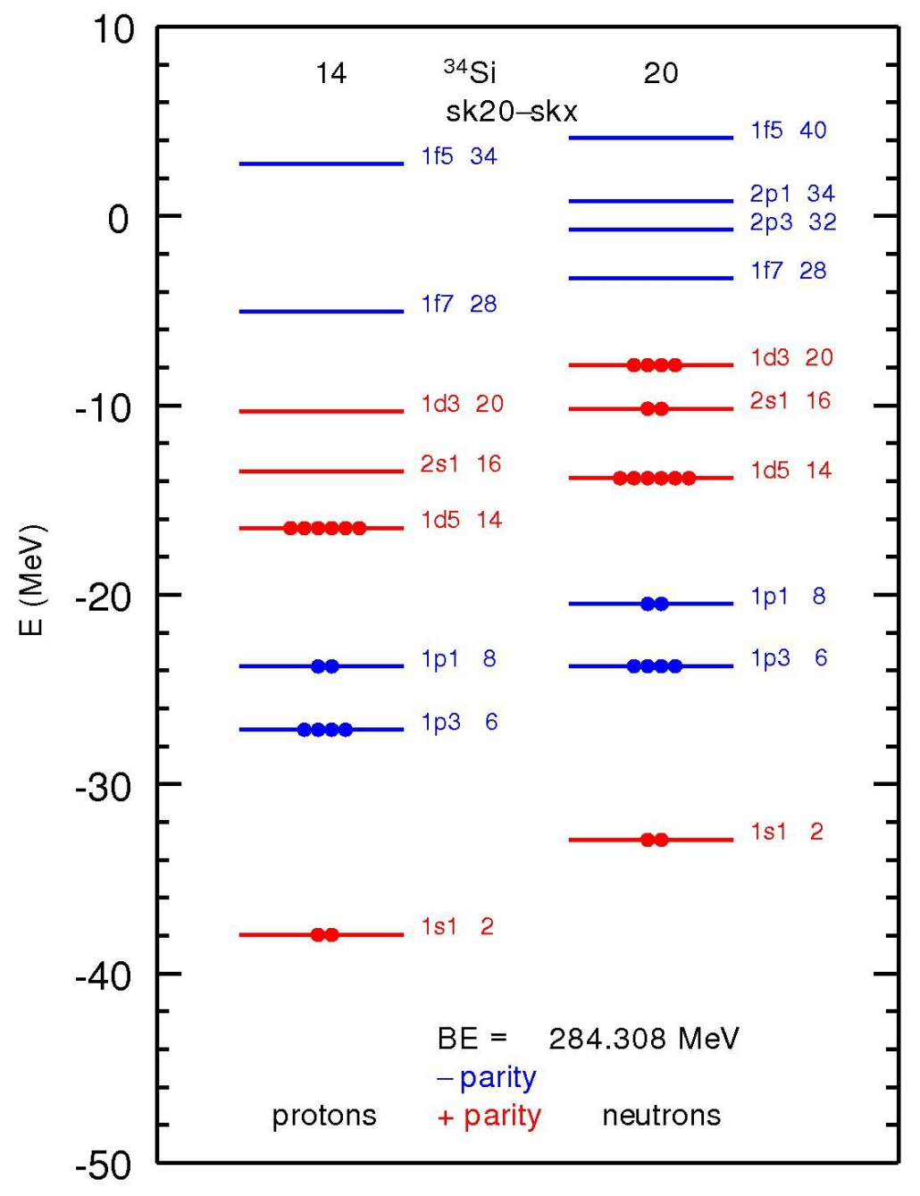


For our third day of experiment, we studied rare isotopes in theoretical models. These predictions were generated by an open source DENS code created by Dr. Alex Brown for use in theoretically predicting the nuclear structure and density of rare isotopes. This isotope is interesting because it has a noticeable neutron skin around 6 fermi's from the nucleus.

The 2018 PAN group showing the slow and rapid neutron capture process graphs we completed.

These graphs represent an isotope of Silicon that was recently confirmed to exhibit a proton bubble formation due to the neutron: proton distribution in the inner 1 and 2 s orbitals of the nucleus. This isotope is especially interesting because the core of the nucleus is predominantly made of neutrons and it has shells that will fill up at the 1s orbital (2), 1p (8) orbital and d (14 and 20).





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