NUCENG 204 Lab 0

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Introduction

Peak fitting is a fundamental and essential exercise for conducting gamma ray spectroscopy. The ability to take raw data from a detector and turn it in to the initial stage of usable data is a task all individuals studying nuclear science should know and understand. We first begin to understand the information contained in each particle by determining its energy. The methods to make this determination vary, but for this lab a HPGe detector with a 13-bit resolution MCA, producing 8192 bin spectra was used. Through proper analysis and manipulation of this data, a wealth of information can be determined. This lab facilitated the usage of modern data analysis techniques to take gamma ray energy data from multiple sources and conduct an energy calibration.

Motivation

The purpose of this report has three key elements:

1. To learn how to write lab reports using LaTeXand the NE 204 template.
2. To learn to use `numpy` and `scipy` to fit models to data.
3. Te lean how to collaborate with others in the field to achieve a common goal.

Each one of these elements, will better prepare us to undertake for advanced experiments in the future. The ability to properly manage and store data, as well as to collaborate with our peers can not be overlooked.

Methods

Figure 1 shows the uncalibrated spectral data for ^{241}Am and ^{137}Cs where the x axis is still the channel number from the detector output.

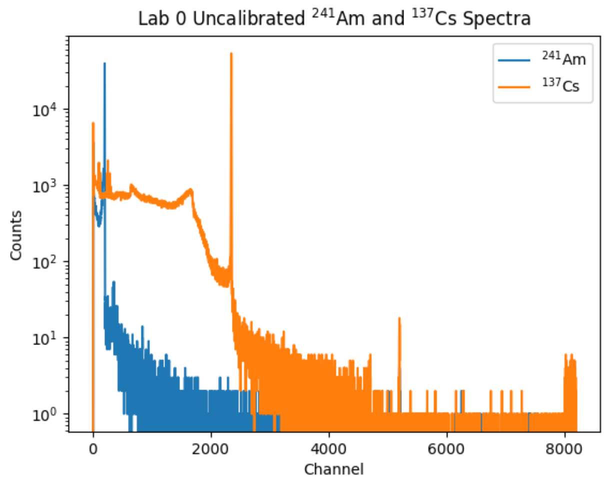


Figure 1: Uncalibrated spectra for ^{241}Am and ^{137}Cs

The next step is to take the accepted values for the full energy peaks for ^{241}Am and ^{137}Cs and preform a linear calibration to fit the data to the proper energy.

$$y = mx + b \tag{1}$$

where

$$m = \frac{E_{Cs} - E_{Am}}{Ch_{Cs} - Ch_{Am}} \tag{2}$$

and the intercept is found by

$$b = -m * Ch_{Am} + E_{Am} \tag{3}$$

Good, nice detail on analytic approach

Well-labelled, but not terribly interesting in terms of relevant information - okay for lab 0 as part of the stated goal is practicing plots etc, but in general want to make sure the plots communicate relevant data

Applying this fit yields our linear model:

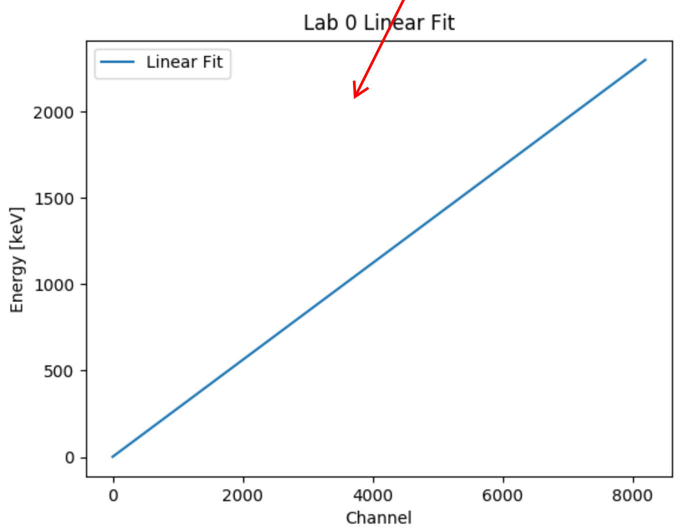


Figure 2: Linear Fit Model

When we apply this fit to the data and you can clearly see the 662 keV peak of ^{137}Cs is properly calibrated.

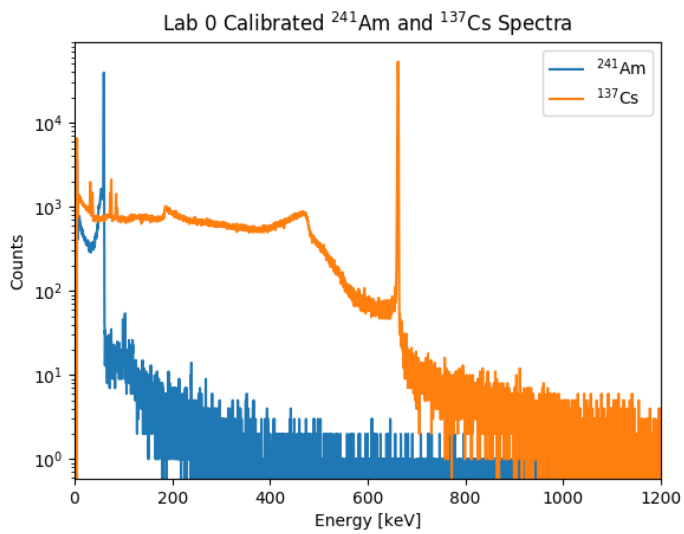
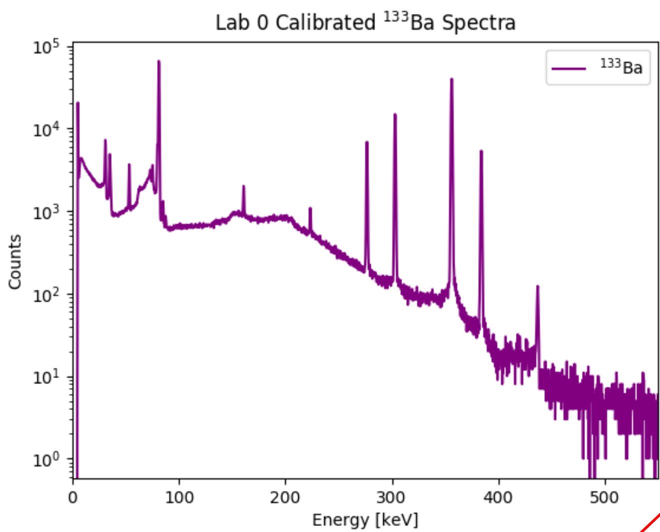


Figure 3: Calibrated Spectra for ^{241}Am and ^{137}Cs

This model will then be applied to the ^{133}Ba data, then compared to the accepted gamma energy values to evaluate the effectiveness of our calibration.

Results

Using a linear fit from the energy calibration earlier, we applied this to the ^{133}Ba data to yield the plot below.



Not clear that your measured "peak" actually corresponds to this "accepted" peak - 5 keV is probably below the LLD

Figure 4: Calibrated ^{133}Ba Spectra

The accepted values were then compared against the energy values found thought the energy calibration, calculating the percent difference between the two.

Calculated Energy [keV]	Accepted Value [keV]	Precent Difference %
81.14525+/-0.00010	80.9979+/-0.0011	0.1819+/-0.0014
356.39031+/-0.00005	356.0129+/-0.0007	0.10601+/-0.00020
5.10916+/-0.00011	4.47	14.2988+/-0.0024
303.08087+/-0.00006	302.8508+/-0.0005	0.07597+/-0.00017
30.92215+/-0.00010	32.194	3.95059+/-0.00033
276.70673+/-0.00006	275.925+/-0.007	0.2833+/-0.0025
384.16733+/-0.00005	383.8485+/-0.0012	0.08306+/-0.00031

This comparison shows that the linear fit is good for higher gamma energies but is significantly degraded for lower energy events

Discussion

Cite source of nuclear data

In the future more accurate peak fitting methods should be used to increase the performance of the energy calibration.

References