Calibration Lab report

Dajie Sun

September 16, 2018

Introduction

Energy calibration of a HPGe detector is an ubiquitous task in radiation detection laboratories, in this experiment, the main purpose is to practice generating lab reports using the reproducible workflow required for this course.

Methods

This is not a real lab in the sense that we don't need to collect data by ourselves. The data is given by the instrutor and can be downloaded by students. Because this experiment is actually used to practice writing lab reports, so what we have to do is doing energy calibration using the data given us.

The data file consists of pulse height spectra taken with a coaxial HPGe detector using 5 different radionuclide calibration sources: 241 Am, 133 Ba,137 Cs, 60 Co, and 152 Eu. The MCA with which the data was collected had 13-bit resolution, yielding 8192 channels. As the charteristical energy of the full energy peaks of these 5 radionuclide is already known, which is to say you can find their spectrum in textbook or nuclear data website, we only need to find out the centroid of each peak and correlate it with its energy using least square method.

See mhchem package for nuclide formatting in LaTeX

Gaussian curve

$$Energy = slope \cdot Channel\,Number + intercept$$

As for each full energy peak, we use gaus curve to simulate and get the centroid (B) of each peak:

$$f(x) = A \cdot e^{-\frac{(x-B)^2}{2 \cdot C^2}}$$

We are not simulating here, but rather using the Gaussian as a model for fitting our data

and this is acheived by function $curve\_fit$.

This should include a citation to scipy

Now, the centroid of each peak and its corresponding energy are known, we can make linear regression using least square method to find the relationship between the channel number and its corresponding energy value.

Results

Far too many digits here... no way the precision is that good!

Totally, we found 17 peaks and their corresponding energy, listed as the table below:

Use LaTeX \label \ref system!

Table 1: Peaks with Corresponding Energy.

Peak #	**Channel #**	**Energy(keV)**
1	207.72934164066072	59.5409
2	2353.969595281511	661.657
3	4177.6835240821465	1173.228
4	4745.511220436352	1332.492
5	429.56728236065885	121.7817
6	867.77043054316	244.6974
7	1222.6117121691966	344.2785
8	1460.7650922753362	411.1165
9	2772.003206539464	778.9045
10	3432.077389155436	964.072
11	5014.927456550307	1408.013
12	3959.8315489345346	1112.076
13	284.28923089774975	80.9979
14	980.9088851006587	276.3989
15	1075.1587761476976	302.8508
16	1264.6138573728588	356.0129
17	1363.8190002015974	383.8485

Table is missing a caption

Good mention of units: could include units of calibration parameters as well

Consider sorting by energy and/or including the originating radionuclide to make this table easier to interpret

Making a linear regression of the table above, we have

$$Energy[keV] = 0.280521278253 \cdot Channel\,Number + 1.27621057811 \quad (1)$$

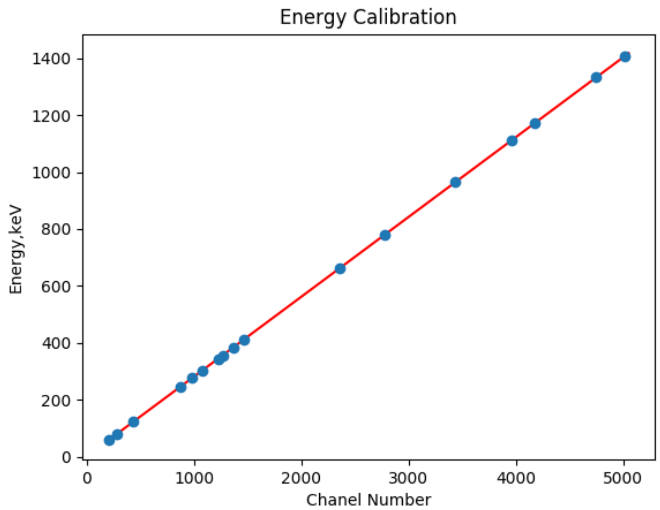
with the coefficient of determination R^2:

$$R^2 = 0.999999997516$$

Quantitative results are always more meaningful that qualitative ones, so you're on the right track, but there are more meaningful ways to dislay the residuals for this task.

which is very close to 1. so the calibration result is very good.

Again, be careful of the level of precision you are presenting!



More detail in the caption: what sources were used? etc.

Figure 1: Energy Calibration.

Discussion

If only using the peak of Am-241(59.5409 keV) and the peak of Cs-137 (661.657 keV), an approximation result is got as:

$$Energy^* = 0.2805446 \cdot Channel\,Number + 1.263557 \qquad (2)$$

Compare Equation (1) with Equation (2), it is found they are still very close, especially with respect to the slope.

Quantify relationship here