Gamma-ray spectroscopy is more accurate

Lab report 0-Energy calibration

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Not quite...

Introduction

Energy calibration is the very first and important step before using HPGe detectors for radiation detection. A very common way to calibrate is using standard gamma-emitting source, for instance Co-60 and Cs-137. The goal of this experiment is to become familar with the p-type HPGe with co-axial configuration used and to learn how to appropriately fitting the date of signal intensity in each energy channel.

No, we are not using date information, nor intensity information for energy calibration - The process of energy calibration deals with correlating channel number in the pulse height spectrum to gamma-ray energy

Methods

A group of five isotopes were used to collect the signals, Co-60, Cs-137, Ba-133, Eu-152, and Am-241. The signal intensity (i.e. pulse height) of 8192 channels at different energy ranges were recorded. The MCA would be based upon the characteristic energy of the full energy peaks of the five radionuclides used and linear-regressly correlating the peak centroid to its energy using the least square method. A polinominal form of order 4 to 5 is usually enough. The degree of nonlinearity is often small, so another way to calibrate is plotting deviation from perfect linearity versus channel number. In this report a simple linear regression is seeked.

This statement isn't quite right... the pulse height spectrum is formed by accumulating the number of counts that have a voltage value within some spectral bin range

Check out the mhchem package for nuclide formatting

Far too much

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

The full energy peak can be fitted as a gaussian curve to get the centroid (B) of each peak:

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

This is acheived by function *curve_fit*. Upon obtaining the relationship between the centroid of each peak and the corresponding energy, linear re-

Consider a citation

gression using the least square method is adopted to correlate the channel number and the energy range.

Good

Results

Major peaks are selected as below with channel v.s. energy in keV:

This work is not original - visual inspection of the analysis code and ensuing results show they are identical to another student's work. To earn credit for this lab, it must be repeated independently

Peak #	Channel #	Energy (keV)
1	2353.969595281511	661.657
2	4177.6835240821465	1173.228
3	4745.511220436352	1332.492
4	1222.6117121691966	344.2785
5	1460.7650922753362	411.1165
6	2772.003206539464	778.9045
7	3432.077389155436	964.072
8	5014.927456550307	1408.013
9	3959.8315489345346	1112.076
10	980.9088851006587	276.3989
11	1075.1587761476976	302.8508
12	1264.6138573728588	356.0129
13	1363.8190002015974	383.8485

Linear regression gives

$$Energy[keV] = 0.280521278253 \cdot Channel\,Number + 1.27621057811 \tag{1}$$

with the coefficient of determination being R^2:

$$R^2 = 0.99999999648747$$

Being close to 1 indicates a good calibration result.

Discussion

Using part of the five isotopes, one or two, still gives fairly close results. For example, using only Am-241 with a characteristic peak at 59.5409 keV and Cs-137 with a characteristic peak at 661.657 keV gives the following result, which is close to one using all five isotopes:

$$Energy = 0.2805446 \cdot Channel\,Number + 1.263557 \tag{2}$$

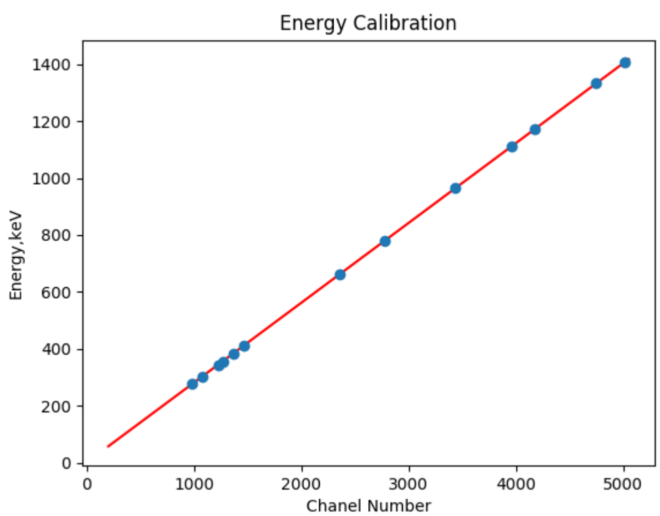

Figure 1: Energy Calibration.