Experiment 3

Introduction to Gamma Detectors

In this laboratory session, you will be introduced to the NaI multi-channel analyser (MCA). The NaI crystal is used to detect **gamma** particles. This experiment consists of three parts: Identifying the different features of the gamma spectrum from the NaI detector, measuring the resolution of the NaI detector, and an energy calibration of the detector. During the energy calibration part, you will determine the energies of an unknown isotope and identify it.

Part I: Identifying the features of the NaI gamma spectrum

In the introduction to this experment, we discussed the different parts of the NaI gamma spectrum. You will be given a printout of three different gamma spectra taken with one of the NaI detectors in the laboratory. They are from the isotopes: Na^{22}, Cs^{137}, and Co^{60}. The spectra are also posted just after this writeup on my home page.

a) Identify which graphs belongs to which isotope.

b) Identify all the different features of each of the spectra. If the following features are present, be sure to indicate them on the graphs:

a) photopeak(s)
b) Compton Region(s)
c) Compton Edge(s)
d) Backscattering peak(s)
e) Characteristic X-rays

Part II: Resolution of the NaI Detector

In the introduction to this experiment, we will discuss what is meant by the resolution of the detector and how to measure it. The **F**ull **W**idth at **H**alf **M**aximum (FWHM) is defined as:

$$FWHM \equiv \frac{C_+ - C_-}{C_0} \times 100\% \qquad (1)$$

where C_0 is the channel number of the center of the photopeak, C_- and C_+ are the channel numbers where the counts equal one-half of the peak value, left and right of the photopeak center, C_0. An easy way to determine the $FWHM$ is to use the parameters of the Gaussian fit:

$$FWHM = 2\sqrt{ln(2)}\frac{\sigma}{C_0} \times 100\% \tag{2}$$

where σ is the width parameter.

a) Determine the resolution of the photopeak for Cs^{137}. To do this, first record a spectra for Cs^{137}. Then, using the fitting program developed by previous Cal Poly Physics students find the channel number of the peak center, C_0, and the width parameter σ.
Note: the manufacturer of the detector claims the FWHM should be between 6% and 8%.

Part III: Energy Calibration of the MCA

Your goal in this part is to calibrate the MCA, determine the energies of the unknown, and identify it. **Do not change the amplifier setting during this part**. If you do, your calibration will change. Be sure that both peaks of Na^{22} are present in your spectra before you start. As calibration standards, you will be given ^{22}Na, ^{137}Cs, and ^{54}Mn. The CRC lists the energies of the primary gamma rays of these sources to be:

^{137}Cs: 661.64 KeV
^{22}Na: 511.0034 and 1274.5 KeV
^{54}Mn: 834.827 KeV

For your analysis, you can assume that the energy increases linearly with the channel number.

a) Make a calibration graph of energy vs. channel number. You can use Excel, and display the equation on the graph. From the channel numbers of your unknown and the calibration equation, determine the energies of the gamma rays of the unknown.

b) Use the link on my home page to deterine the unknown isotope.

Laboratory Writeup for Experiment 2

Your lab writeup will consist of the following:

1) (3 points) Identify the isotopes of the three spectra passed out in class (and also posted on my home page just after this writeup). For each one, point out the different features (photopeak, compton edge, etc.).

2) (2 points) Show your measurements and calculations for determining the FWHM for the Cs^{137} photopeak.

3) (5 points) Turn in your data for the energy calibration and your calibration graph and the calibration equation.

4) (2 points) Show how you determined the unknown gamma energies and identify the unknown isotope.