

LAB 4

In this lab we will perform some elementary nuclear physics experiments. These experiments involve a lot of sophisticated equipment, e.g. computer, NaI (Sodium Iodide) calorimeter, electronic amplifiers, so a large part of this lab will just be learning about the equipment.

I) Familiarization with equipment and concepts:

There's lots of boxes and stuff here!

Computer

We will use a program called MCA.

NaI Spectroscopy Amplifier

NaI calorimeter

This consists of a NaI crystal, a photomultiplier, and a phototube base.

MAC/LC interface

PM control

This is the photomultiplier power supply.

Radioactive sources

Co60, Na22, Cs137

References located in Room 3081:

The Art of Experimental Physics, Preston and Dietz

Techniques for Nuclear and Particle Physics, Leo

Experiments in Modern Physics, Melissinos

Make sure you read the handout notes from *The Art of Experimental Physics, Preston and Dietz* before you start the lab.

II) Measure the gamma ray energy spectrum of Co60, Na22, and Cs137.

Measure each of the spectra separately. For each gamma ray "line" that you find in your spectra record the voltage of the peak of the line. Write each spectrum out to a data file. These files can be read in by Kaleidagraph. As an exercise you should learn how to read and plot these files using Kaleidagraph.

III) Make an energy calibration curve for your spectrometer.

a) For each peak found in part II) look up the corresponding gamma ray energy. These energies can be found in *The Art of Experimental Physics* handout. Also, a good description of this experiment can be found in *Experiments in Modern Physics* by Melissino. Note: for Na22 one of the peaks in the spectrum is due to positron annihilation ($e^+e^- \rightarrow \gamma\gamma$). Here each γ has an energy equal to the rest mass energy of an electron 0.511 MeV. However only one of the γ 's goes into the NaI crystal (where does the other γ go?).

b) Make an energy calibration curve by fitting the peak voltages vs. gamma ray energy to a straight line:

$$\text{Energy} = A + B \cdot \text{voltage}$$

Write a program to fit the data to a straight line and find A and B.

c) Use Kaleidagraph to fit your data to a straight line. How does your least squares fit values for A and B compare with Kaleidagraph's?