Gan/Kass
Phys 3700

LAB 4

In this lab we will perform some elementary nuclear physics experiments using radioactive sources that emit γ rays. These experiments involve several pieces of sophisticated equipment, e.g. computer interface, NaI (Sodium Iodide) calorimeter, electronic amplifiers. Therefore a large part of this lab will just be learning about the equipment. You will use much of this equipment for Labs 5 and 6, and possibly in Phys 616.

I) Familiarization with equipment and concepts:

Computer

We will use a program called MCA.

NaI Spectroscopy Amplifier

After making all the adjustments, do not change the settings until Lab 6.

NaI calorimeter

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

Interface box

PM control

This is the photomultiplier power supply. After making all the adjustments, do not change the settings for the rest of labs.

Radioactive sources

Co60, Na22, Cs137

Make sure you read the following handouts before you start the lab:

The Art of Experimental Physics, Preston and Dietz

MCA manual: Nuclear Spectroscopy with the PC

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.

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? Explain your reason.) List the energies and voltages of the five peaks found and label the energy of each peak on each spectrum.

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

Energy = A + B*voltage

Use your calculator or Excel 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 fit values for A and B compare with Kaleidagraph's?