LAB 5

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 6 and 7, and possibly in Phys 5700.

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 7.
> 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 handout before you start the lab:
>> 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. You can export the data to LabPlot2.

III) Make an energy calibration curve for your spectrometer.
> a) For each peak found in part II) look up the corresponding gamma ray energy. There should be five peaks and the shape of each peak should be Gaussian like. 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.) Plot the three spectra with the energies of the five peaks indicated.
> 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 do the calculation to extract A and B. Include the formula for A and B in your report (You can cut and paste from the lecture note.)
> c) Use LabPlot2 to fit your data to a straight line. How does your fit values for A and B compare with LabPlot2's?