Phys 586 Laboratory

Lab 6

Goal: In this lab you will measure the range of alpha particles in air and produce a Bragg curve.

Reading: Knoll pp 30-36, 377, lab documentation, article on range.

Lab:

1. See the additional writeup for the experimental setup. We are not doing that lab, however the writeup contains a diagram of the electronics setup, settings to use, calibration procedure, and geometrical information associated source and detector inside the metal cylinder.

2. Write down the decay scheme for ^{241}Am. What is the energy of the principal alpha?

3. With the cylinder evacuated and the source close to the detector, collect a pulse height spectrum using MAESTRO. Compare this spectrum with the gamma spectra you have been working with. What is the energy resolution of this detector for alphas of this energy? You'll need to save the peak location, width, and the total number of counts.

4. With the cylinder still evacuated, collect data at 6-8 different source - detector distances between "0" and 4 cm. Plot the number as a function of source - detector distance and comment on the results.

5. Allow air to pressurize the chamber. Repeat the measurements. Do a quick estimation of the range of the alpha particle. Later you can use the data collected above to improve your estimate. Why is this an unsatisfactory method of determining the range of the alpha?

6. Again evaculate the cylinder. Using the pulser, calibrate the energy scale by setting the correct energy on the Pulse Height knob. Then use the Normalization knob and attenuation settings to set the pulser peak equal to that from the "0" source - detector distance you measured above. Then lock the Normalization knob. Now you can use the Pulse Height knob to measure other peak energies below.

7. An alternative method to measure the range is to fix the source - detector distance and vary the pressure. Collect data at 10-12 different pressures. You'll want to take finer steps near the end of the range so that you can accurately determine the range.
8. At each pressure, determine both the number of counts and the new energy. You'll have to use the pulse to get the energy value.
9. You will be making two plots. One is the number of counts versus the pressure. The other is the energy of the alpha versus the pressure.
10. However we really want these plots in terms of the effective distance in air at STP. Search your memory for the ideal gas law and calculate the effective distance in air at STP. Make a table of pressure versus the effective distance.
11. Plot the number of counts as a function of the effective distance in air. Determine the mean range of this alpha particle in air. Estimate the error on your measurement.
12. Plot the energy of the alpha as a function of the effective distance. Using this curve, make the Bragg curve for this alpha in air. You'll do this of course by taking the derivative of your energy - effective distance curve.

In your lab writeup, please include:

1. Plots of counts versus source - detector distance for the cylinder evacuated and not.
2. Plots of the counts and energy versus pressure.
3. Plots of the number of counts and energy versus effective distance in air.
4. Bragg curve from the energy versus effective distance in air curve.

Also, please answer the following questions:

1. What is the expected mean range of alpha particles with this energy in air at STP? Compare this value with your result. Comment on the results.

2. Using the Bragg-Kleggman rule, estimate the range of these alpha particles in tissue.