Phys 586 Laboratory

Lab 10

Goal: In this lab you will use a Geiger counter to look at counting statistics and measure the resolving time.

Reading: Knoll 202-213 and 119-123.

Lab:

1. Set the HV to +1100V. Use the oscilloscope with no termination to measure the the pulse height and rise and fall times using a ^{137}Cs source.

2. Comment on these results comparing them to the plastic scintillation counter and proportional chamber.

3. Next hook up the output of the G-M tube to the amplifier. Using a HV setting of +1100V, make a quick sketch of the pulse at the output of the amplifier. Why is this pulse smaller than the signal you initially observed above?

4. Send the output to the SCA. The SCA is effectively a discriminator with a threshold set by the lower dial. Send the output of the SCA to the scaler.

5. In the past, this lab asked students to calculate the efficiency of the G-M tube using the ^{90}Sr and ^{137}Cs sources. Here just answer the question. Is the G-M tube a more efficient counter for the ^{90}Sr source or the ^{137}Cs source? Or is the efficiency the same?

6. Using one or possibly none of the sources, make a set of 50 measurements such that the mean number of counts is between 3 and 5 for some short time interval. It may be necessary to remove the G-M tube from the housing and place the source a distance from the tube. If so, ask your instructor for help since the window of the G-M tube is extremely fragile. Record the data for each of these 50 measurements.

7. Repeat the previous step except now require that the number of counts be approximately 25. Record the data for each of these 50 measurements. You'll analyze both data sets later below.

8. Not only are the pulses of the G-M tube relatively large, they are also relatively long. Because of the G-M avalanhe, a second count cannot be registered until the discharge caused by the previous one has been extinguished. The minimum time after the start of a pulse that a second pulse is recordable is known as the dead time of the system. The sources of dead time include the detector, the electronics associated with the detector, and the readout of the data. In the case of the G-M tube it's usually the detector that is the largest source of dead time.

9. Using the digital scope, estimate the dead-time using one or more of the ^{137}Cs sources.

10. Take measurements of the activity on both sides of the ^{137}Cs source. Explain your results.

11. Now estimate the dead time using the two-source method discussed in Knoll p122. This may not work because of the low activity of the sources but we'll give it a try. First, measure the background rate in the G-M tube.

12. Use two of the ^{137}Cs sources and measure the rate for two minutes. Make a total of three measurements. Now add two more ^{137}Cs sources and make three more two minute measurements. Finally carefully remove the first two sources and again make three two minute measurements with the remaining two sources. Use this data to estimate the deadtime.

In your lab writeup, please include:

1. Sketches of the pulse heights with amplitude, rise and fall time noted.

2. Raw data and histograms of the two 50 count measurements. Comments on the shapes of the histograms.

3. Calculation of the mean and standard deviation of these histograms. Comparison of the measured standard deviation with its expected value.

4. Calculation of the χ^2 values using a Poisson distribution for the two histograms.
5. Estimation of the deadtime using the digital oscilloscope.
6. Calculation of the deadtime using the two source method.
7. Comments comparing these two results.