Phys 360AB/460AB Intermediate Physics Laboratory
Experiment 14: Nuclear Counting

References

Brown “Experimental Nucleonics”

General Procedure and Analysis Requirements

Read the handouts from Browns Experimental Nucleonics before arriving to perform the experiment. They should be posted on Learn.

A computer is attached to the voltage measuring and counting devices. LabView programs are used to accumulate data and do some of the statistical calculations for you. When you arrive in the lab turn the voltage on the HV power supply to zero and turn on all the equipment. Program specific instructions are presented on the LabView interfaces. The source tray should always be placed in the fourth slot down from the detector. The voltage should be adjusted when the source is NOT under the Geiger tube.

To login to the computer use:
Username: Phys1xx
Password: fIzz1xx (the second letter is a capital i)

Save your data into the C:\expt14\xx folder where xx is your name. IE: Make a folder using your name to save your data.

Include in your report a description of the principles of operation of a Geiger tube and how count rate is related to voltage as well as any other relevant theory for each section of the experiment.

Part A: Characteristics of Geiger Tubes (see Brown 10.1)

Procedure

Open the LabView program tubchar.vi.

Hook up one of the Geiger tubes using the correct measurement control box. NOTE: It is very important to use the proper measurement circuit box for each Geiger tube or you risk damaging the equipment. Make sure the HV power supply is set to 0V whenever you are changing wires/tubes. Measure the count throughout the voltage range given below and then repeat your measurements with the other Geiger tube provided. Make sure the source is NOT under the tube when setting the voltages. Use the single Chlorine-36 source. Use a voltage step of 25V and a sampling time of 60 seconds for each count measurement. Use a voltage range of 300V-650V for the LND 712 Geiger tube and a range of 300V-700V for the LND 72314 Geiger tube. Based off of your measurements choose the most suitable tube and operating voltage combination for subsequent work

Analysis

Plot the count rate versus voltage for each tube. Evaluate the quality of both Geiger tubes compared to the conditions given in Brown.

Part B: Measuring the Dead Time (see Brown 10.2)

Procedure

Open the LabView program deadtime.vi.

Measure the count for background, source 1 alone, source 2 alone, and both sources together five times each using the double beta Cl-36 source. Each trial should be run for 60 seconds at the operating voltage chosen in Part A.

Analysis

Determine the dead time and its uncertainty for your chosen Geiger tube using the two source method from Brown. Use a statistical approach to find the best deadtime (IE: Your analysis should contain the use of averages and standard deviations). Compare to the accepted deadtime range from Brown and discuss any discrepancies.

Part C: Statistics of Radioactive Decay (see Brown 10.3)

Procedure

Open the LabView program stasti.vi.

Determine the measurement time necessary to measure 20 counts with the single Cl-36 source at your chosen operating voltage. For datasets consisting of 10, 100, 300, and 500 trials; record the number of counts in your calculated measurement time.

Analysis

Plot a histogram of the count values for each dataset. Calculate the quantities referred to in Brown and compare with the expected relationships. Discuss how well each dataset matches the expected relationships and how the data trends as sample size is changed.

Part D: Range of Beta Particles in Aluminum (see Brown 10.4)

Procedure

Open the LabView program betarang.vi.

Measure the number of counts for the single Cl-36 source with several different Aluminum thicknesses shielding the detector. Place the shielding on the second rack from the top. Use a measurement time of 60 seconds. Measure from thinnest to thickest shielding. Make sure you do not expose the detector to the source without shielding at any point during or between the measurements. To do this remove the source before removing the shielding, switch the aluminum thickness, and put the shielding back in before the source.

Note: You do not need to measure every available thickness of Aluminum. Stop performing trials when you measure five trials on the tail of the plot.

Analysis

Plot the count rate versus the absorber thickness. Remember to adjust your counts for deadtime loses. Determine the range of beta particles from Cl-36 in Aluminum. Using the curve in Halliday (chapter 7 pg 159) estimate the maximum decay energy. Compare to the accepted value for Cl-36 beta decay from the Chart of the Nuclides in the lab.