Phys 586 Laboratory

Lab 7

Goal: In this lab you will make simple measurements using proportional tubes.

Reading: Class notes and Knoll 173-176.

Lab:

1. Make gas connections to the smaller proportional tube. Set the flow rate to be about 10 bubbles/s for about 5 minutes, then reduce the flow rate to be about 1 bubble/s. Write down the gas used.

2. Connect the HV cable to the proportional tube. What polarity HV should be used? What is the value of the series resistor? What is the purpose of this resistor?

3. Terminate the proportional tube with a blocking capacitor and 1k ohm terminating resistor. Turn up the HV slowly until you can easily see a signal from a source using the oscilloscope. Be careful to make the connection to the oscilloscope AFTER the blocking capacitor. Failure to do so can damage the oscilloscope channel. Sketch the signal and record the pulse amplitude, rise time, and fall time.

4. Repeat for HV settings 100 V above and 100 V below your nominal HV.

5. Repeat the process using 100 ohm, 10k ohm, and 100k ohm resistors. Explain these results.

6. Slowly raise the voltage but do not exceed 3kV. What happens to the pulses? Explain what is happening inside the proportional tube.

7. Make gas connections to the rectangular proportional tube. Set the flow rate to be about 10 bubbles/s for about 5 minutes, then reduce the flow rate to be about 1 bubble/s.

8. Look over the preamplifier circuit. It consists of a transimpedance amplifier and a transconductance amplifier. Explain these terms.

9. Sketch the signal at the output of the preamplifier and the output of the amplifier/shaper using a gamma source. Record the amplitude, rise time, and fall time of each. Terminate each with 50 ohms into the oscilloscope.

10. Record the gain and other settings you used for the amplifier.

11. Calculate the CSDA range in cm for 10 keV, 20 keV, and 700 keV electrons in air.

12. Take a pulse height spectrum with the ^{137}Cs source. Explain your results.

13. Take pulse height spectra with the x-ray source using Cu, Rb, Mo, and Ag targets. What are the characteristic x-ray energies for these targets? A list can be found at http://www.kayelaby.npl.co.uk/atomic_and_nuclear_physics/4_2/4_2_1.h Record the pulse height mean and width for each target.

14. Make a linearity plot of your pulse height data. Comment on the results.

15. Make an energy resolution plot of your pulse height data. Normally one evaluates the energy resolution at the 5.9 keV x-ray from ^{55}Fe but that source is not available to us. Use your energy resolution data to quote an energy resolution at 5.9 keV. Compare with an estimate using Table 6.2 in Knoll. Comment on your results.

In your lab writeup, please include:

1. Answers to the questions embedded in the lab procedure above.

2. Sketches of pulse heights and measurements of pulse height, rise time, and fall times.

3. Plots of pulse height spectra for the ^{137}Cs source and Cu, Rb, Mo, and Ag x-ray sources.

4. Linearity plot using the x-ray sources.

5. Energy resolution plot using the x-ray sources.

6. Estimate the number of electron/ion pairs produced by a MIP passing through the smaller proportional tube. Use the data you collected to make a rough estimate of the proportional tube gain at the nominal HV.