Physics 225b Lab Report

Experiment: Attenuation of Gamma Radiation by matter

Hypothesis to test: Attenuation of photons at a single energy through a given thickness of material, x, obeys the relationship:

$$N_{Surviving}(x) = N_0 e^{-mx}$$

Additional Procedural Information not in Write-up: We followed a procedure described by Professor Johns. (see attached sheet for a write-up of the procedure) We used a NaI counter coupled with a SCA to try and pick out the darkest pulse on the scope. This was an attempt to select a single gamma energy. This was done in both Period 1 and Period 2 with slightly different settings for the SCA, although I didn't record the settings for Period 2.

Analysis: The data were fit several ways to try and see if the effect of the sheet thickness or the error on our background estimate made a large difference in the final result. We found that the major statistical error in the result is described by the counting errors.

Results: The results from the analysis indicate that in Period 1, the data is consistent with the exponential behavior predicted by the hypothesis, but in Period 2, the fit returned a poor Chi-square per degree of freedom (2.3 for 12 DOF). This indicates that there is a less than 1% chance that the data from Period 2 obey the relationship. Additionally, our values for the Absorption Coefficient in lead, μ, differ from the expected value by many standard deviations:

$$Period\,1:\ m = (1.057 \pm 0.007)/cm$$

$$Period\,2:\ m = (0.955 \pm 0.007)/cm$$

$$Expected = 1.2/cm$$

This suggests that there are sources of uncertainty other than the sources we have identified.

Discussion: There is reason to believe that our results are sensitive to the setup and/or procedure we chose. The literature suggests that a collimated source and some spacing between sheets are useful for preventing gammas that are scattered from reaching the detector. We thought that by using the SCA that this effect would be diminished (scattered gammas have less energy in general). There is some evidence to the effect that the window of the SCA was wider in Period 2 (larger background rates), and one notices a larger deviation from the expected result from this data. It is also useful to note that the Period 2 data seems a little problematic as well, since we had some trouble getting consistent results for similar trials.

What's next: I would like to try the experiment again with some changes that can be added or taken away from the procedure we used:

1) Use the Solid State Detector. The peak from the source should be much narrower and we can tighten up the window in the SCA to try and ensure a single gamma energy.
2) Use a collimated source. This is an attempt to see if scattering is a big deal. I can imagine a kinked path a gamma might take to get to the detector otherwise. Also, I think I could test the uniformity of the lead sheets we used. Some of them looked pretty bumpy, although our fits indicate the uncertainty in the thickness is a small contribution to the overall error.
3) Get some space between the sheets without adding any significant additional material in the path of the radiation. Along with this can be to see if there are effects from the way we held the source in place.