May 8th, 2017

Shah Faisal Mazhar

Experimental Methods

Prof. Elena Aprile

Answers to the Final Questions

1. The asymmetry of the photopeak can be understood by looking at the whole spectrum. The spectrum is the combination of the backscatter peak, the Compton edge and the photopeak. So, the other parts of the spectrum have contributed to the slight asymmetry of the photopeak.

2. The correlation between the mean and the standard deviation is,

$$\frac{Mean}{Standard\ deviation} = \frac{39000}{1400} = 27.86$$

3. Resolution of the photopeak,

$$R = \frac{\sigma}{\mu} = 0.036 = 3.6\%$$

Uncertainty = $\frac{(2.35\ \sigma).1000}{0.662X\ 1000000} = 0.496\ \%$

So, R = 3.6 ± 0.496 %

4. The width in the photopeak measurement depends on intrinsic peak efficiency. Intrinsic peak efficiency is determined by the density and the average atomic number of the scintillation detector medium.

5. If R= Resolution, k = constant and E =energy, then,

$$R = \frac{k}{\sqrt{E}}$$

For Cs 137, R = 3.6% and E = 0.662 MeV,

$$k = R.\sqrt{E} = (3.6\%).\sqrt{0.662} = 2.929$$

For Co 57, E = 122 keV = 0.122 MeV

$$R_{Co} = \frac{2.929}{\sqrt{0.122}} = 8.39\%$$

6. We would have used semiconductor detectors to measure energy with excellent resolution. Because, semiconductor detectors directly produce an electric signal without the conversion. Such process creates less fluctuation in the energy resolution.

7. PMT transforms the light intensity into the proportional current output. When a photon hits the photocathode layer of the PMT, the layer emits electrons using photoelectric effect. Then, the number of electrons gets multiplied by hitting the electron multiplier diodes which are aligned to ensure the highest number of electron emission. At the end, these highest number of electron emission comes out as the current output.

SiPM results the same, although it is much smaller and uses much lower voltage. It is made of Avalanche Photodiode (APD) array on the common Si substrate. These APD operates in Geiger mode and is coupled with polysilicon quenching resistor.

8. For any photodetector, linearity is important to ensure less deviated data. Deviation in the linearity happens due to the sensor or the front-end electronics saturation. To avoid such saturation, the calibration of linearity is necessary.

9. To calibrate the SiPM, the system linearity as the function of energy needs to be found. To do so, data needs to be taken for various sources. By fitting the photo-peaks with a Gaussian curve, the system linearity for various sources can be verified.

10. I have used scipy:curve_fit to fit my data. I have found curve_fit simple but useful especially fitting the Gaussian distribution. With an appropriate guess of the variable, curve_fit is easy to fit data.