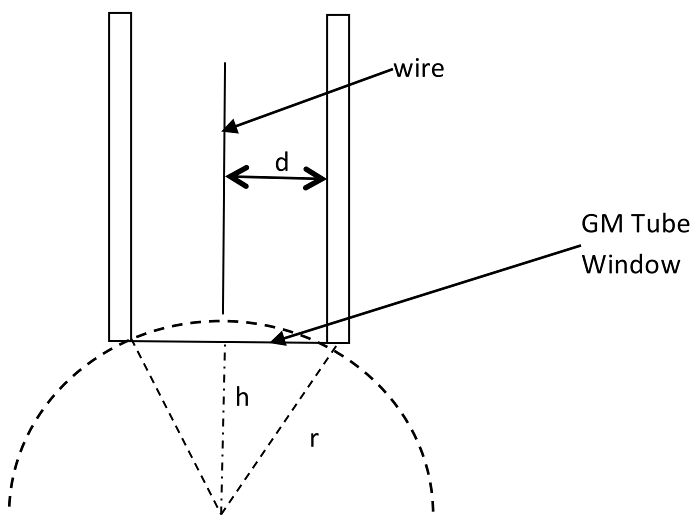
Shelf Ratio and Inverse Square Law

Objective:

To investigate the effect of distance upon the intensity of radiation and to measure the shelf ratios of a sample holder.

Introduction:

Radiation is emitted from a source in all directions, yet only a small part actually enters the G-M tube and gets recorded. This fraction of emission entering the GM tube is a function of the distance, h, from the point of source of radiation to the G-M tube. The figure below depicts the influence of the source to the window distance on the observed count rate.



The semi circle represents half the sphere of the radiation emitted from the source, showing a portion of the spherically distributed radiation emission falling upon the window of the G-M tube. As the distance h, increase the radius, r, of the sphere also increases such that a smaller portion of the sphere falls upon the G-M tube window, which in theory should reduce the number of nuclear events that may be observed within the region that falls upon the G-M tube window.

The count rate of the detector is expected to fall off accordingly with the inverse square law as the source is moved away from the detector window:

$I = 1/r^2$; where I is the intensity as shown by the number of counts.

Taking the log of each yields $\log I = \log r^{-2} = -2 \log r$. A graph of log I vs log r should yield a line whose slope verifies the inverse square law.

Procedure:

1. Use one of the ST360 lab stations. Setup the counter for a nominal/operating tube voltage and a count time of 30 seconds. Obtain a mean count value and its standard deviation for your background counts by taking a minimum of 5 data runs.

2. Obtain a ^{137}Cs source. Place it on a tray in the first shelf position. Obtain a mean count value and its standard deviation for this shelf by taking a minimum of 5 data runs. Repeat until a count value for each shelf has been obtained.

3. Determine the corrected counts for each shelf by subtracting the background from the measured counts.

Just for curiosity sake.
Put the source back into the 2nd level of the stand. Carefully remove the detector from the stand. Hold the detector in the area you are sitting pointing towards the source. Observe the count rate.
Do you feel a little more comfortable?

Analysis

The second shelf is arbitrarily assigned a shelf ratio of 1.00 as it is the shelf most often used. The shelf ratio is determined by

$$\frac{\#\ of\ corrected\ counts\ for\ shelf}{\#\ of\ corrected\ counts\ for\ shelf\ 2}$$

Create a graph log I vs. log r to show the relationship of the inverse square law as applied to the distance away from the detector and the number of corrected counts.
It is also possible to plot a graph of I vs. r and a power fit trend line fitted to the data.

Explain any discrepancies between what is expected and what was measured.

From your data and graph what minimum distance would the detector be placed in respect to the source to obtain only background counts?

Tube __________ tube window diameter is 11.2 mm.

Background Counts ______________ ± ________

Run time _____________

Shelf #	Distance from GM Tube r (m)	Counts (mean value)	Corrected counts I	Shelf ratio
1	0.02	±	±	
2	0.03	±	±	1.00
3	0.04	±	±	
4	0.05	±	±	
5	0.06	±	±	
6	0.07	±	±	
7	0.08	±	±	
8	0.09	±	±	
9	0.10	±	±	
10	0.11	±	±	