Experiment: 02

Objective: To determine the dead time of a given G-M detector using split source method.

Apparatus:

- Geiger-Müller tube
- Shelf stand
- High voltage supply
- Scalar, counter and timer setup
- Split radioactive sources (e.g., Cs-137, Sr-90, Tl-207).
- Source holder.

Theoretical Background

Immediately after an avalanche due to ionizing radiation, the electric field in the G-M tube is below the normal because of the presence of the positive ion sheath. Due to this the approaching electrons do not gain sufficient energy to start new avalanches. The detector is then inoperative (dead) for the time required for the ion sheath to migrate outward far enough for the field gradient to recover above the avalanche threshold. This time interval during which the detector is inoperative is called the dead time t_d of the detector. Complete recovery of the pulse size requires some additional time known as the recovery time t_r . The dead time sets a lower limit on the time interval between the arrivals of particles, if they are to be resolved. For a system using a sensitive voltage amplifier, resolving time τ approaches t_d. For a less sensitive amplifier, τ lies between t_d and $t_d + t_r$.

If the resolving time τ is comparable with the average interval between the two counts, an appreciable number of counts are lost. If m is the observed count rate, then the counter remains insensitive for the time of $m\tau$. If n is the true count rate (assuming τ is negligible), then the number of counts lost if $nm\tau$. Therefore the correction which must be made in the observed count rate because of finite dead time is given by,

$$n - m = nm\tau$$

i.e $\qquad n = \dfrac{m}{1 - m\tau}$ $\qquad\qquad$ ... (2)

A commonly used method for dead time measurements is known as *two source method*. The method is based on observing the count rate from sources individually and in combination. Because the counting losses are non-linear, the observed rate due to the combined sources will be less than the sum of the rates due to the two sources counted individually and the dead time can be calculated using the formula:

$$\tau = \frac{m_1 + m_2 - m_{12}}{2m_1 m_2}, \qquad t = \qquad \qquad \qquad \dots (3)$$

where m_1, m_2 and m_{12} are the corrected counts for background due to two sources individually and in combination.

Procedure:

1. Set the G-M detector at the operating voltage.
2. To find the dead time we have to use two identical split sources of nearly equal activity.
3. Keep a split source S_1 on one side the pit in the source holder. Keep a dummy source in the other side of pit. Record the counts for a preset time (say 600s) thrice and take the average (m_1).
4. Without removing source S_1 remove the dummy source from thepit and keep another split source S_2 in its place. Record the number of counts thrice for the combined sources S_1 and S_2 for the same preset time and take the average (m_{12}).
5. Remove source S_1 very carefully and measure the counts thrice due to source S_2 alone, for the same preset time (m_2). Put dummy soucr.
6. Remove source S_2 as well and record the background counts for the same preset time.
7. Calculate the dead time using the Eq. (3).

Result:
Dead time of G-M detector =