(NU3-2) Dead Time of Geiger Detector by Variable Area Method

Aim of experiment

Determination of dead time of Geiger detector by variable area method

Apparatus

GM Tube Counting Station Consists of GM Counter – Radioactive Source- Source Holder- Stop watch, Source Cabinet Made of Thick Lead.

Theory of experiment

In an earlier discussion it was mentioned that an ionizing particle enters the GM tube through the window and loses its energy by creating electron-ion pairs. The electrons that are produced in the resulting avalanche are accelerated to the anode and collected in a short period of time. The positive ions, however, are more massive and make their way slowly to the cylindrical cathode. If electron-ion pair average transient time is called Δt_1, the GM tube is busy during Δt_1. If another ionizing particle enters the GM tube during Δt_1, it will not be counted. This time $\tau = \Delta t_1$ is called the "dead time" of the tube, *figure 1*. Then the dead time is defined as the time following the counting of ionizing radiation at which the counter in not detecting. Also the recovery time is that time elapsed for the detector to be ready to count. If the dead time of the GM tube and the correction factor which can account for these lost events is determined, the number of actual incident detected radiation is obtained.

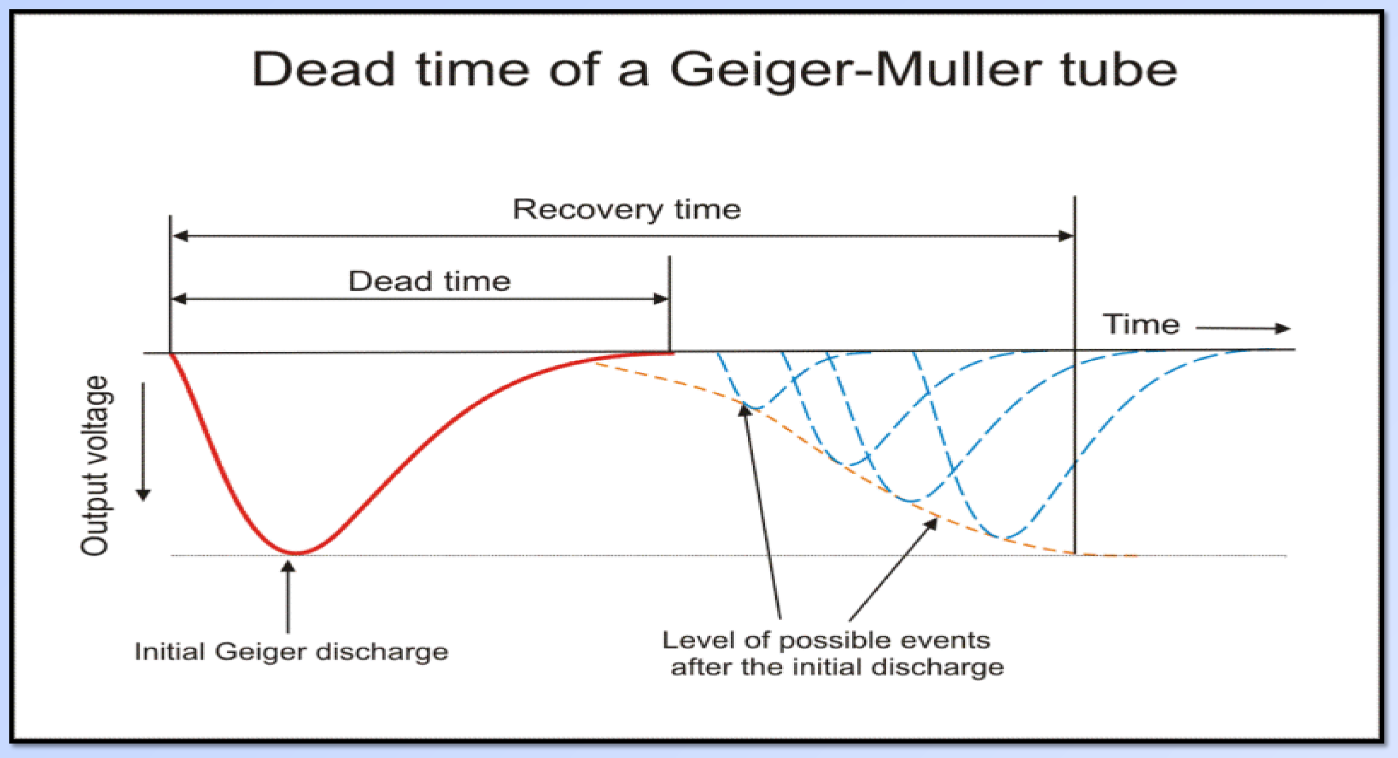

Figure 1. The dead and recovery times corresponding to the measured pulse

If the counting rate for incident ionizing particles or radiation is R_i, and that detected by the counter is R_d, then the number of undetected radiation in time t is given by:

$$R_i - R_d = R_i R_d \tau$$

Rearranging this equation gives:

$$\frac{1}{R_d} - \frac{1}{R_i} = \tau$$

Since $R_i = kA$, *where* A is the area of the detector, then

$$\frac{1}{R_d} - \frac{1}{kA} = \tau$$

$$\frac{1}{R_d} = \frac{1}{kA} + \tau$$

The relation between $\frac{1}{R_d}$ *and* $\frac{1}{A}$ is a straight line intersecting the y-axis at τ.

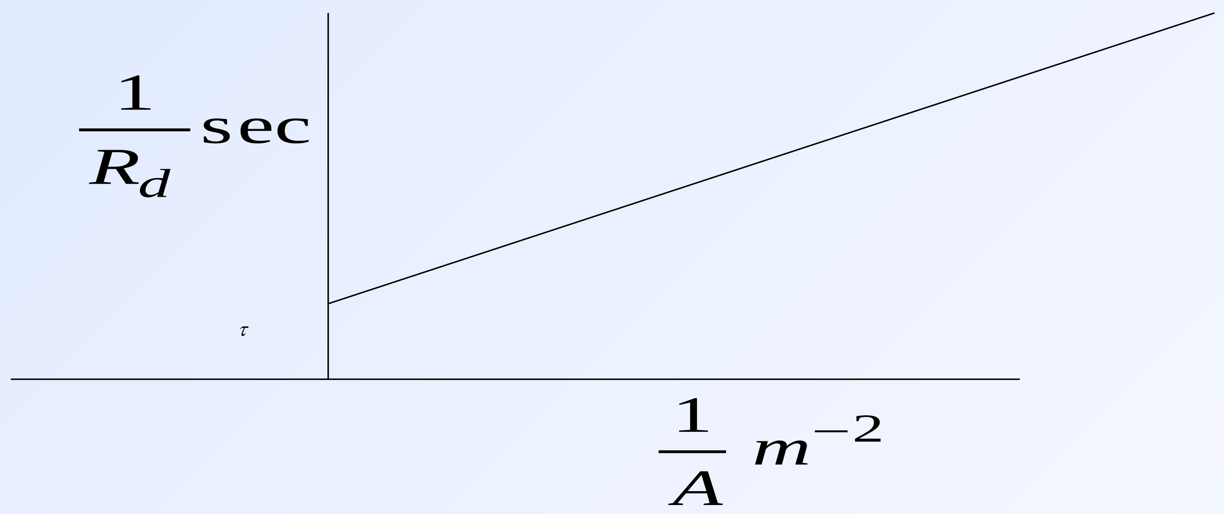

Figure 2. The relation between $\frac{1}{R_d}$ *and* $\frac{1}{A}$ is a straight line intersecting the y-axis at τ.

Procedure

1. Put a sheet of opening area A in front of the GM tube window. Be sure that the sheet thickness is enough to absorb the incident particles, and only those passing through the opening are detected.
2. Switch on the power of the counting station, and leave to warm up for few minutes.
3. Record the counts, N, for a suitable time, t and then calculate the rate R.
4. Remove the source and record the background, N_{BG} for the same time, t, and then R_{bg}.
5. Repeat for sheets of different opening area. Make sure that the source is always placed in the same position.
6. Record your data in a table
7. Correct your results for the dead time of the tube, mentioned in the specification sheet.
8. Draw the relation between $\frac{1}{R_d}$ *and* $\frac{1}{A}$, from which determine τ.

Results

R_{bg}=

A	$1/A$	$R=N/t$	$R_d(s^{-1}) = (R - R_{bg}) \pm \sqrt{R_d}$	$1/R_d$
τ =		s		

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