Practical no 21

DETERMINATION OF THE DEAD TIME OF GEIGER-MÜLLER COUNTER BY THE TWO-SOURCE METHOD

Aim of the practical

The aim of the practical is determination of a parameter characteristic for the Geiger-Müller counter, which is the dead time of the counter.

Equipment

Gamma-Scout counter with the Geiger-Müller (GM) pipe, two crystals of monazite as the radiation source, stopwatch

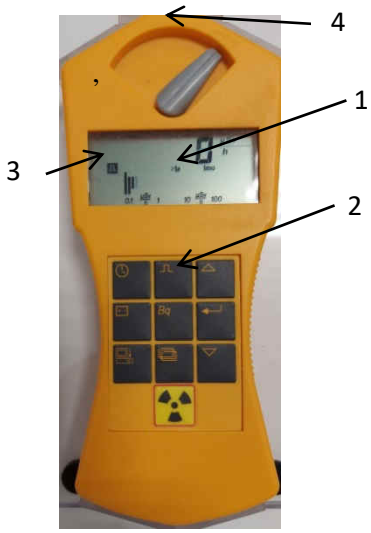

Figure 1. The GM counter used during the practical, where:

1 – display screen
2 – start/stop/reset button
3 – Icon showing the working mode of the counter (flickering – measurement in course, constant shining– stop)
4 – window of the counter

ATTENTION! IONISING RADIATION SOURCES ARE PROVIDED BY TUTORS OF THE PRACTICAL

ATTENTION! PRESSING THE BUTTON NO 2 ONCE STARTS THE PROCESS OF RECORDING OF IMPULSES AND RESETS THE VALUE PREVIOUSLY RECORDED (ICON NO 3 IS FLICKERING), NEXT PRESSING OF THIS BUTTON STOPS THE MEASUREMENT WITHOUT ERASING OF THE MEASURED VALUE

I. MEASUREMENTS OF NUMBER OF COUNTS OF TWO SOURCES

Course of measurements:

1. Put the source No 1 in the shortest distance (in the middle of the window of the counter), then measure the number of counts (C_1) during the time of 15 minutes, write down the results to the **Table no 1** of the final report sheet. After 15 minutes, stop the measurement.

ATTENTION! DURING THE MEASUREMENTS ANSWER THE QUESTIONS IN THE FINAL REPORT SHEET POINT III

2. Add the source No 2 to the second half of the of the counter (do not touch the source No 1, save the geometry of the system), then measure the number of counts for both sources ($C_{1,2}$) during the time of 15 minutes, write down the results to the **Table no 1** of the final report sheet. After 15 minutes, stop the measurement.
3. Remove the source No 1, then measure the number of counts for the source No 2 (C_2) during the time of 15 minutes, write down the results to the **Table no 1** of the final report sheet. After 15 minutes, stop the measurement.

II. CALCULATIONS OF THE FINAL RESULTS

1. Calculate the dead time of the counter applying the following formula:

$$\tau = \left(\frac{C_1+C_2-C_{1,2}}{2\cdot C_1\cdot C_2}\right)\cdot t \qquad 1$$

and write down the result to the final report sheet.

2. Taking into account the data from Table 1, calculate the measured counting rates (n) and write down the values to the Table 2 of the final report sheet.

3. Applying below-given formulas, calculate the corrected counting rates of both sources (N):

$$N_1 = \frac{n_1}{1-n_1\cdot\tau} \quad , \; N_2 = \frac{n_2}{1-n_2\cdot\tau} \quad , \; N_{1,2} = \frac{n_{1,2}}{1-n_{1,2}\cdot\tau} \qquad 2$$

and write down the result to the Table 2 of the final report sheet.

4. Taking into account the formula for a relative error $B_{rel} = \frac{S-Z}{S}$ calculates this error for the measured and the corrected counting rates. In the above-mentioned equation, the S stands for the SUM of counting rates (measured or corrected) for the source no 1 (n_1 and N_1) and the source 2 (n_2 and N_2), whereas Z means the measured or corrected counting rates for both sources ($n_{1,2}$ and $N_{1,2}$). Write down obtained results to the Table 2 in the final report sheet.

Required theoretical knowledge:

1. Natural radioactivity: alpha (α), beta (β), gamma (γ) radiation.
2. Ionising radiation decay law.
3. Principles of work of the Geiger-Müller counter and the semiconductor detector of ionising radiation
4. Explain definition of the dead time of ionising radiation detectors
5. Units of ionising radiation activity
6. Radioactive series.

Recommended literature:

1. P.R. Bergethon "The Physical Basis of Biochemistry", Springer 1998
2. R. Cotterill "Biophysics An Introduction", Wiley 2003

Wrocław Medical University Department of Biophysics and Neuroscience	**Practical No 21** **Determination of the dead time of Geiger-Müller counter by the two-source method**
……..…… ……..…….. ……...……. Student names	Faculty: …….. Group number: …… Date: ……
Grade:	Tutor's signature:

I. MEASUREMENTS OF NUMBER OF COUNTS OF TWO SOURCES

Table 1

Sources	Time of measurement t [s]	Number of counts C
(1)		
(2)		
(1,2)		

II. CALCULATIONS OF THE FINAL RESULTS

Calculated value of the dead time

Table 2

Sources	Measured counting rate n	Corrected counting rate N
(1)		
(2)		
(1,2)		
Relative error		

Please, make comment about the obtained measured and corrected counting rate in the context of calculated value of the relative error:

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III. QUESTIONS

1. Explain, what is the „dead time" of a counter of ionising radiation?

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2. What is the „avalanche discharge" and what is its role in the process of recording of ionising radiation by the Geiger-Müller counter?

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3. What types of radiation can be recorded by the GM counter?

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4. What technical parameters are characteristic for the GM counter?

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5. Why is the two-source method applied to determine the dead time of GM counter? Is it possible to determine the dead time by applying one source only?

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