For a dot-shaped γ-radiation source the count rate and hence the local dose rate reduce with the square of the distance, because the area covered by a beam of radiation increases with the square of the distance. From this follows the most important rule of radiation protection for the reduction of radiation exposure – to maintain the largest possible distance from the radiation source.

When proving this dependence of count rate and distance experimentally, deviations occur in the case of small distances, because here the prerequisite of the radiation source being dot-shaped does not get fulfilled. In the case of larger distances, the count rates can approach the area of the zero rate for radiation sources with low activity and hence can lead to big statistical errors.

Equipment

Support clamp for small case	02043.10	1
Clamp on holder	02164.00	1
Support rod, stainless steel	02030.00	1
Counter tube holder on fix. magnet	09201.00	1
Source holder on fixing magnet	09202.00	1
Scale for demonstration board	02153.00	1
Counter tube Type B	09005.00	1
Geiger-Müller-Counter	13606.99	1
Demo-Board for Physics with stand	02150.00	1
Radioactive sources, set	09047.50	1

Set-up and procedure

Fig.1

— Remove the protective cap and fix the counter tube in the counter tube holder and adjust it such that its window is positioned above the front edge of the holder.

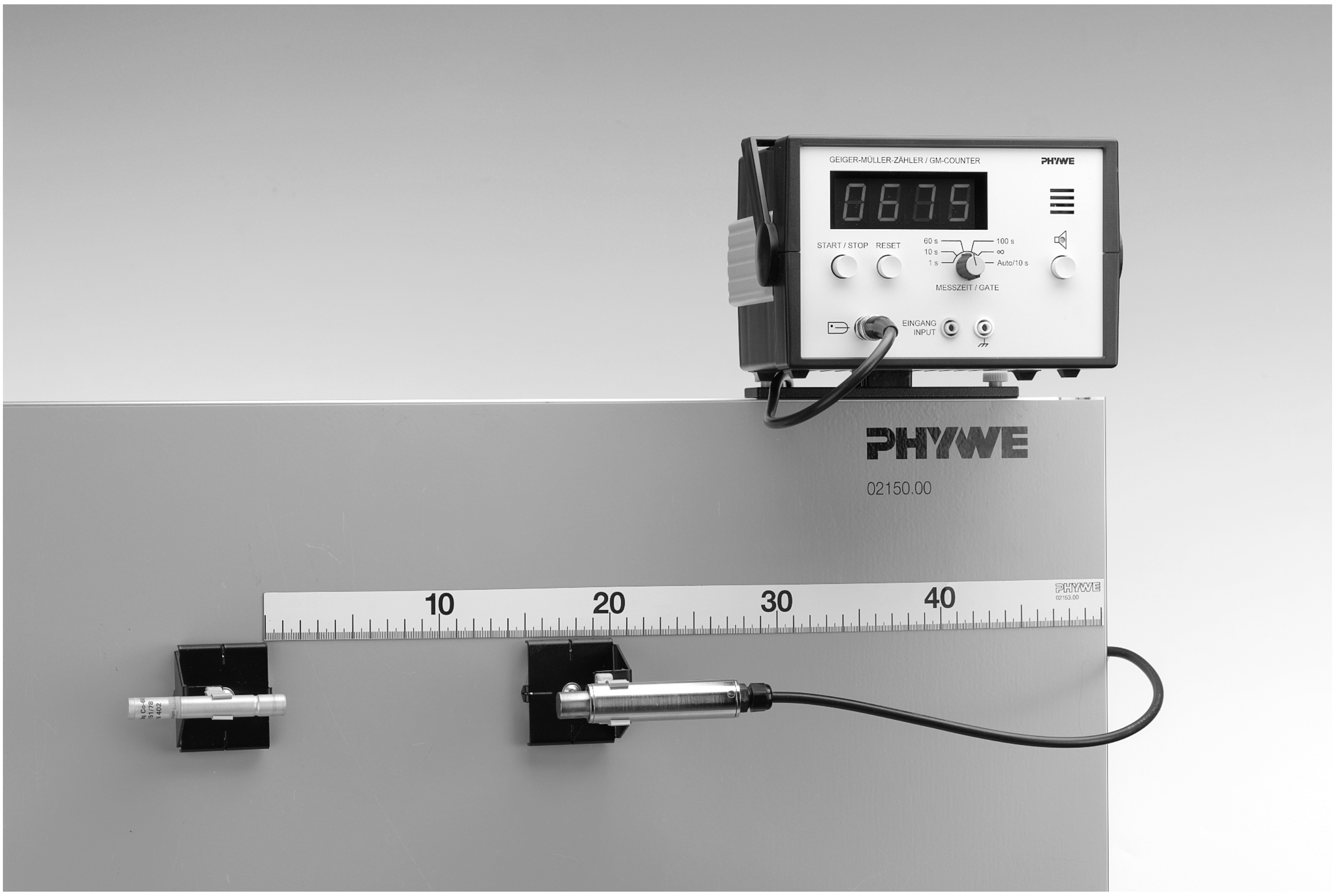
— Place the Co-60-radiation source in the source holder such that the opening of the source is positioned above the edge of the source holder.

— Set the scale in such a way, that its zero mark is present at a distance of 8 mm from the opening of the radiation source i.e. at the point, where the radioactive substance is embedded.

— Select a measurement time of 60 s, determine the count rate two times for all the distances given in the table and enter the values in Table 1.

— After concluding the measurements replace the radiation source back in the container and remove it from the vicinity of the counter tube; Determine the zero rate three times and enter the values in Table 2.

Fig. 1: Experimental setup



Result
See Table 1.

Table 2: Zero rate

Running no.	Z_0
1	16
2	19
3	23
$\overline{Z_0}$	19

Evaluation

1. The mean values of the count rate are to be determined for each distance and entered in the table.
2. The mean value of the zero rate is calculated and subtracted from all the mean values of the count rates. The corrected count rates $(\overline{Z} - \overline{Z}_0)$ are entered in the table.
3. For checking the validity of the square of the distance law $Z \sim 1/a^2$ the products $(\overline{Z} - \overline{Z}_0)\,a^2$ are calculated and entered in the last column of the table.
4. The relationship of the corrected count rates $(\overline{Z} - \overline{Z}_0)$ with the distance a is shown in Fig. 2.
   The products $(\overline{Z} - \overline{Z}_0)\,a^2$ lie in the range of $(14.3 \cdot 10^4$ to $15.6 \cdot 10^4)$ cm^2 Imp/60 s. Upon considering the specified conditions it follows that the square of the distance law can be proved in good approximation for γ-rays. The graphic representation in Fig. 2 shows the extent to which the radiation intensity decreases when the distance is increased.
   Note:
   For verifying the validity of the square of the distance law the values can also be represented in a coordinate system, in which the count rates $(\overline{Z} - \overline{Z}_0)$ above $1/a^2$ are entered. Fig.3.

Fig. 2

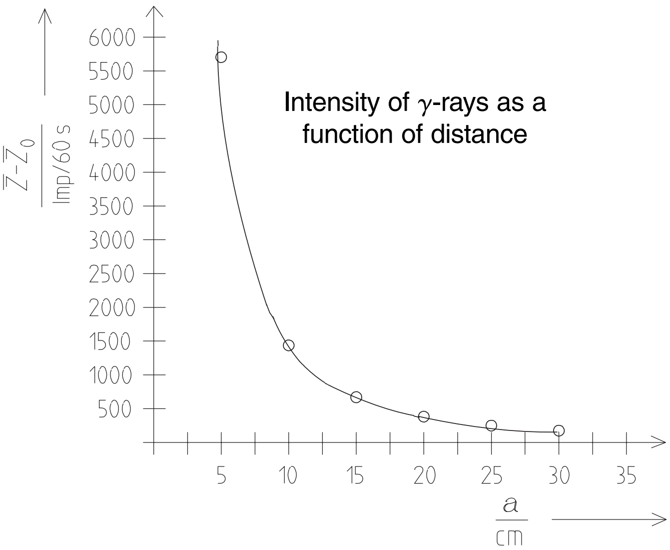


Fig. 3

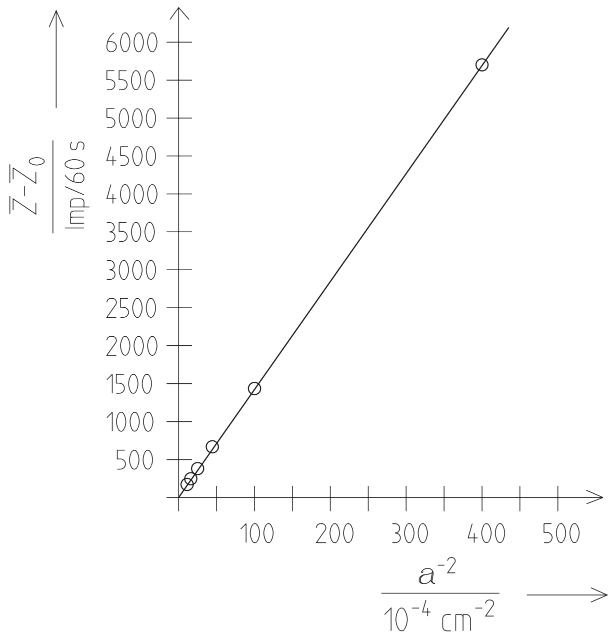


Table 1

$\frac{a}{cm}$	$\frac{Z_1}{Imp/60\,s}$	$\frac{Z_2}{Imp/60\,s}$	$\frac{\overline{Z}}{Imp/60\,s}$	$\frac{\overline{Z} - \overline{Z}_0}{Imp/60\,s}$	$\frac{(\overline{Z} - \overline{Z}_0)\,a^2}{cm^2 \cdot Imp/60\,s}$
5	5712	5727	5720	5701	142525
10	1472	1441	1456	1437	143700
15	696	680	688	669	150525
20	405	397	401	382	152800
25	258	275	267	248	155000
30	185	199	192	173	155700