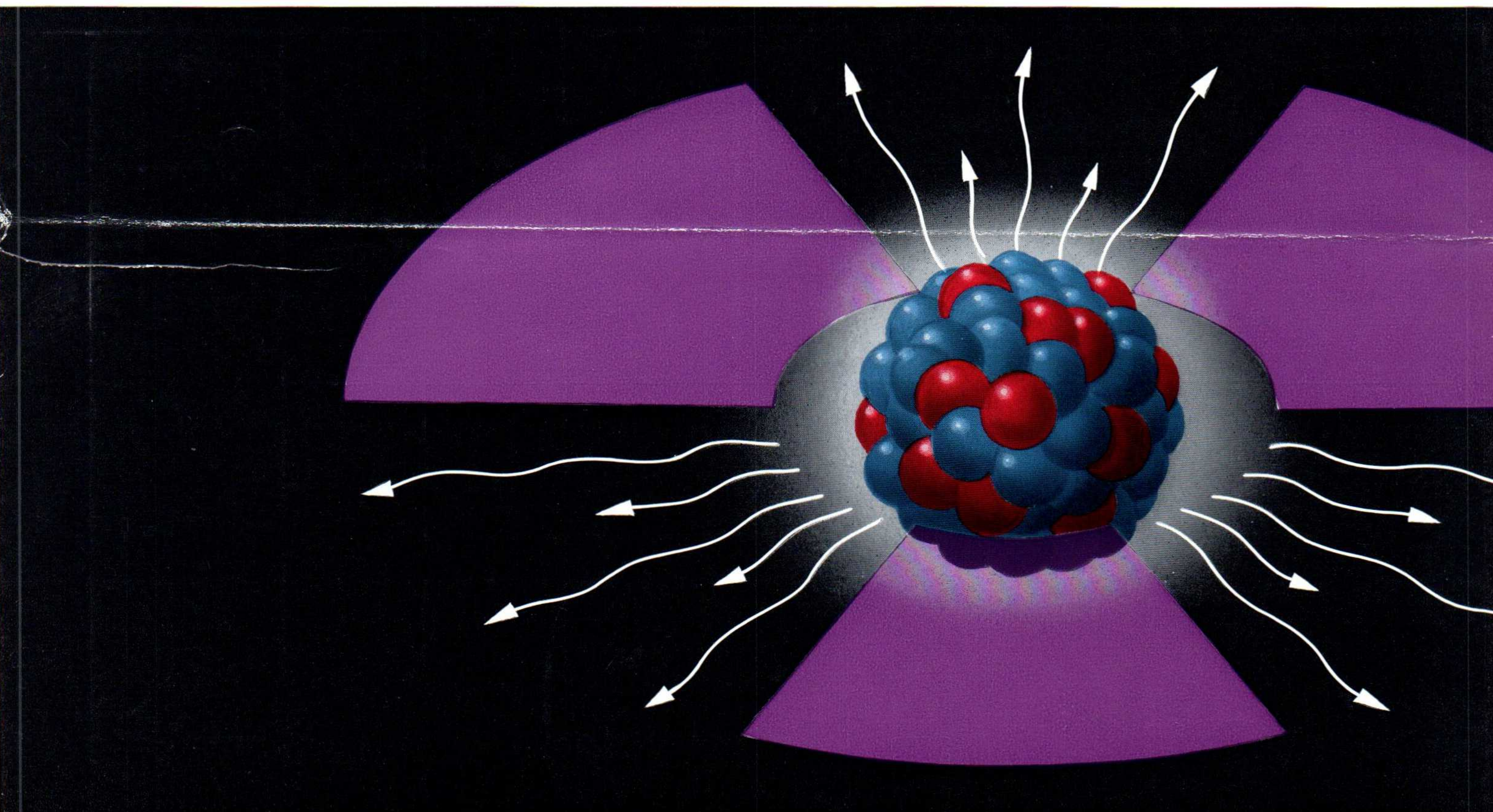
9-04

PHILIPS

RADIATION COUNTER TUBES

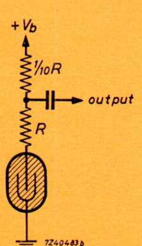


PHILIPS ELECTRON TUBE DIVISION

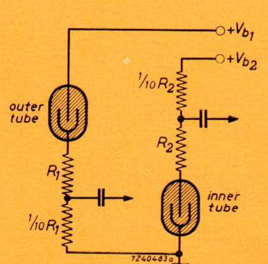
end-window counting tubes

	18504	18505	18506	18515	18516	18526	18536
type number	18504	18505	18506	18515	18516	18526	18536
use	β, γ	α, β, γ	β, γ	α, β	β	α, β, γ	α, β
window							
thickness (mg/cm²)	2—3	1.5—2	2.5—3.5	1.5—2	10	1.5—2	1.5—2
eff. diameter (mm)	9	19.8	27.8	19.8	27.8	27.8	27.8
material	mica	mica	mica	mica	Cr Fe	mica	mica
wall							
thickness (mg/cm² or mm)	250	1.2 mm	1.3 mm	1.2 mm	1.2 mm	1.3 mm	1.2 mm
eff. length (mm)	40	37	37	13	18	37	18
outside diameter (mm)	15	22	30.5	22	30.5	30.5	30.5
material	Cr Fe	Cr Fe	Cr Fe	Cr Fe	Cr Fe	Cr Fe	Cr Fe
tube dimensions							
max. diameter (mm)	17	25.9	34	26	34	34	34
max. overall length (mm)	55	57	57	30	34	57	34
gas-filling	Ne A (halog.)	Ne A (halog.)	Ne A (halog.)	Ne A (halog.)	Ne A (halog.)	Ne A (halog.)	Ne A (halog.)
max. starting voltage (V)	325	350	375	350	375	375	375
plateau (V)	425—650 [1]	450—700 [1]	450—750 [1]	500—700 [1]	500—750 [1]	450—750 [1]	500—750 [1]
maximum slope (%/100 V)	2 [1]	2 [1]	2 [1]	3 [1]	3 [1]	2 [1]	3 [1]
maximum dead time (μs)	100 [1]	160 [1]	180 [1]	70 [1]	70 [1]	200 [1]	70 [1]
maximum background (c/m)	10 [4]	15 [4]	25 [4]	5 [5]	9 [5]	20 [4]	10 [5]
recommended resistance (MΩ)	10	> 2	> 2	> 2	> 5	> 2	> 5
tube capacitance (pF)	2	2.5	3.5	1.5	1.3	3.5	1.3
weight (g)	7	40	50	15	27	50	27
ambient temperature (°C)	—55 to 75	—55 to 75	—50 to 75	—50 to 75	—50 to 75	—50 to 75	—50 to 75

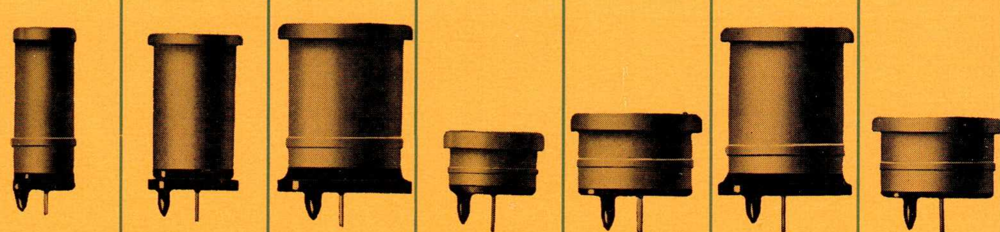
Recommended circuits



for single tubes



for anti-coincidence sets 18515/17 or 18516/18



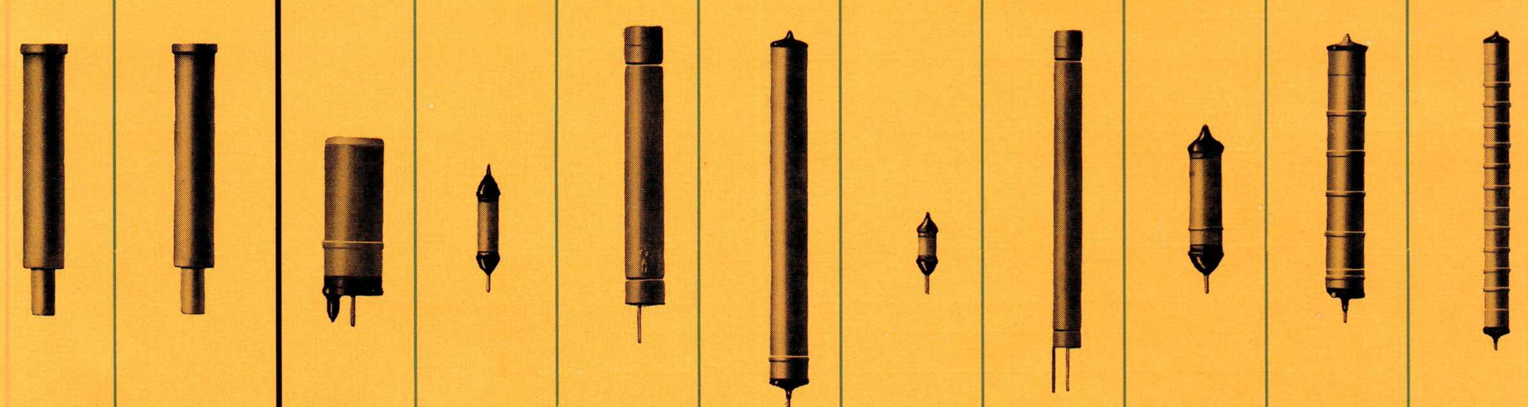
1) Measured at 100 c/s and R = 10 MΩ.

2) Measured at 100 c/s and R = 2 MΩ.

3) Measured at 50 c/s and R = 10 MΩ.

4) Shielded with 5 cm Pb and 3 mm Al.

		cylinder counting tubes										
18537	18538	18503	18509	18520	18522	18529	18545	18550	18552	18553
X-ray 1.2-2.5 Å [10]	X-ray 0.5-0.86 Å [10]	γ	γ-count or current $\leqslant$ 300 r/h $\beta >$0.5 MeV	γ	γ, cosmic ray	γ-count or current $\leqslant$ 1000 r/h $\beta >$0.5 MeV	γ	$\beta >$0.25 MeV γ-count or current	$\beta >$0.3 MeV γ	$\beta >$0.3 MeV γ
3.5—4 20 mica	3.5—4 20 mica									
1.2 mm 110 22.4 Cr Fe	1.2 mm 110 22.4 Cr Fe	250 40 15 Cr Fe	90 ± 10 16 5 Cr Fe	0.7 mm 140 22.2 Cr Fe	0.5 mm 400 39 Cr Fe	90 ± 10 8 5 Cr Fe	525 240 22.2 Cr Fe	36 ± 4 28 8 Cr Fe	50 ± 10 75 15.5 Cr Fe	50 ± 10 192 15.5 Cr Fe
25.4 154	25.4 154	17 55	7 38	22.2 170	41 460	7 27	22.2 270	10 52	18 146	18 280
A (halog.) 1000 1100—1300 8 150 50 [6]	Kr (halog.) 800 900—1100 8 400 [15] 50 [6]	Ne A (halog.) 325 425—650 [1] 2 [1] 100 [1] 10 [4]	Ne A (halog.) 375 500—650 [2][8] 15 [2] 30 [2] 2 [4]	Ne A (halog.) 345 375—475 [2] 15 [2] 200 [2] 40 (avg) [6]	Ne A (halog.) 600 700—1000 [1] 3 [1] 500 [1] 110 [7]	Ne A (halog.) 400 500—650 [2] 25 [2] 20 [2] 1 [4]	Ne A (halog.) 350 380—480 [2] 10 [2] 200 [2] 75 [6] [11]	Ne A (halog.) 380 500—650 [9] 4 [9] 50 [9] 4 [4]	Ne A (halog.) 400 450—800 [2] 2 [2] 70 [2] 30 [4]	Ne A (halog.) 400 450—800 2 150 [2] 60 [4]
2.7 [16] 2.7 85 —55 to 75	2.7 [16] 2.7 85 +10 to 75	10 2 7 —55 to 75	> 2 1 1 —40 to 75	2.7 [16] 4.5 75 —55 to 75	10 15 200 —50 to 75	> 2 0.5 1 —50 to 75	2.7 [16] 10 135 —55 to 75	> 2 1.1 1.2 —50 to 75	> 1 4 8 —50 to 75	> 1 8 15 —50 to 75



5) Shielded with 10 cm Fe and 5 cm Hg. (Fe outside).

6) Shielded with 5 cm Pb and 6 mm Al; 18520 unshielded: 90 c/m (avg).

7) Shielded with 5 cm Pb and 10 cm Fe (Fe outside).

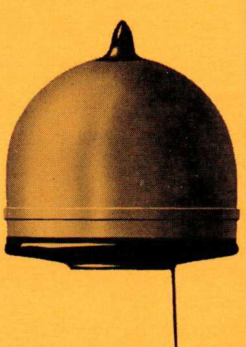
8) If the ambient temperature fluctuates greatly during operation, it is strongly recommended to keep the operation voltage at 500 V for type 18509.

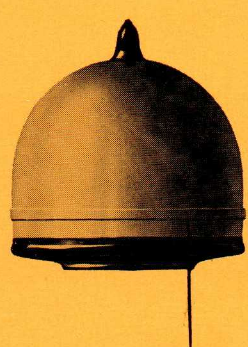
9) Measured at 100 c/s and R = 5 MΩ.

10) For fluorescence techniques type 18537 is used for elements with atomic numbers 19 to 34, and type 18538 for atomic numbers 39 to 53.

11) Unshielded: 160 c/m (avg).

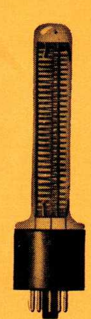
cosmic-ray guard tubes for low-level β-counting		liquid counters		
18517	18518	18510	18524 [12]	18533
in anti-coincidence with 18515	in anti-coincidence with 18516 or 18536	running-liquid counter β	pour-in counter γ, β	dip counter γ, β
1 mm 78 Cr Fe	1 mm 78 Cr Fe	30 [13] 36 5.5 (ID) glass	25 60 glass	30 60 glass
80 90	80 90	24 92	32 235	34 143
Ne A (halog.) 650 800—1200 [3] 3 [3] 1000 [3] 75 [5]	Ne A (halog.) 650 800—1200 [3] 3 [3] 1000 [3] 70 [5]	Ne A (halog.) 375 500—650 [9] 7 [9] 125 [9] 15 [4]	Ne A (halog.) 350 400—500 [2] 15 [2] 100 [2] 12 (avg) [6]	Ne A (halog.) 350 400—500 [2] 15 [2] 100 [2] 12 (avg) [6]
10 5.5 175 —50 to 75	10 8 190 —50 to 75	> 5 4 18 —50 to 75	2.7 [16] 2.5 35 —55 to 75	2.7 [16] 2.5 30 —55 to 75





liquid. cap.
$0.8\ cm^3$

liquid. cap.
$10\ cm^3$



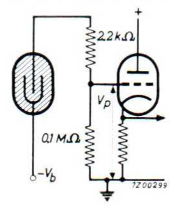
proportional counter

18511

X-ray, side-window type

window		
thickness	2.0-2.5	(mg/cm^2)
dimensions	7 x 18	(mm)
material		mica
wall material		Cr Fe
gas-filling		Xe (org)
geiger threshold		>1900 V
operating voltage		1500-1850 V
operating voltage for pulse amplitude of 1 mV:		1525 ± 25 V
operating voltage for pulse amplitude of 100 mV:		1730 ± 40 V
resolution (Mn, $K\alpha$) (5.9 keV)		< 22 %
background (Mn, $K\alpha$)		15 [14]
tube capacity		2 pF
weight		85 g
gas pressure		25 cm Hg

Recommended circuit



max. diameter 27.5 mm
max. overall length 141 mm

[12]) Also available without glass stopper under type number 18525.

[13]) Pressure of liquid on inside of the tube: max. 90 cm Hg absolute.

[14]) Integrated background for pulses > 50 % of the pulse amplitude for Mn, $K\alpha$; unshielded.

[15]) Measured at 20 °C; temperature coeff. of counting rate is 2 % per °C.

[16]) In recommended circuit use R instead of $^1/_{10}$ R.

In recent years a fast growing field has been opened up for the use of radiation counter tubes. Originally Geiger-Müller tubes were almost exclusively used for nuclear research in laboratories, but gradually they have evolved into indispensable implements for the application of radio-activity in science, health physics, industry, agriculture, and so forth.
Today an impressive range of reliable, high-quality radiation counter tubes are at our customers' disposal. The table in this folder, containing full technical information, shows the excellent properties which make that these tubes are in so great demand, such as:

- outstanding plateau characteristics,
- very high stability,
- short dead time,
- low operating voltage, and
- practically unlimited life.

Pulse amplitude

The pulse amplitude of the radiation counter tubes may generally be estimated at $P \geqslant 1/10\ (V_b—V_s)$. In this formula V_b is the applied voltage and V_s the tube starting voltage. The factor 1/10 originates from the tapping on the resistor R at 1/10 of its value, as indicated in the recommended circuit. The influence of the connected capacitive load is thus minimised.
A pulse occurring during the decay time of a preceding pulse, however, will be smaller; the above formula will therefore hold good only when the tube operates at moderate intensities, when the recommended circuit is used, and when the parasitic capacitances are as low as possible.

Scaler or amplifier

For normal use in the recommended circuit and at moderate counting rates, an input sensitivity of approx. 0.5 V for a scaler or an amplifier will be sufficient. At very high counting rates (e.g. 5.10^5 c/m with type 18504) the mean voltage level at the anode of the counter tube will drop appreciably below V_b, the pulse amplitude will decrease accordingly and the smallest pulses will be lost at the input of the scaler or the amplifier. In this case it is possible that the plateau will show a sudden drop, so that a higher input sensitivity combined with pulse-shaping circuits may be necessary.

Load

Normally the tubes should be operated with a resistance having a value as indicated in the table, or a higher value. Decrease of the anode resistance not only shortens the dead time, but also the plateau length. In general a decrease of the resistance below the indicated value causes the tube to oscillate.

The anode resistance should be connected directly to the anode clip; this prevents parasitic capacitances of leads from considerably increasing the capacitive load of the tube. An increase of the capacitive load has the tendency of increasing the pulse amplitude, the pulse duration, the dead time, the charge per pulse and the plateau slope, whereas the plateau length will be shortened appreciably. Though it is generally not recommended to use shunt capacitances, because otherwise the good characteristics given in the table will hold no longer, it can be done in special cases, but then it is advisable to keep such a shunt capacitance as low as possible. In most cases where a shunt capacitance of about 20 pF is used — and particularly with the bigger types of tube — there is not much of a plateau left. Raising of this value may lead to destruction of the tube.

Counting rate

After every pulse the tube is temporarily insensitive during a period called the dead time (τ_D). Consequently, the pulses that would have occurred during this period are not counted. At a counting rate of N counts per second the tube will be dead during $100\ N\tau_D\ \%$ of the time, so that approximately $100\ N\tau_D\ \%$ of the counts will be lost. If in an experiment the accuracy must be greater than 1 %, N should be less than $\frac{1}{100\tau_D}$ counts per second. To give an example: if $\tau_D = 20\ \mu s$, an accuracy of 1 % is reached at a counting rate of approximately 500 counts per second. The maximum counting rate is $N \approx \frac{1}{\tau_D}$

Dose rate meters

Another most interesting application possibility of the types 18509, 18529 and 18550, apart from using them in counting devices, lies in dose rate meters, the current in the range of 1 to 100 μA being proportional to the logarithm of the dose rate.
The type 18509 covers the range of 1 to 300 r/h, type 18550 the range of 0.1 to 10 r/h and type 18529 that of 1 to 500 r/h. The tubes 18550 and 18529 can be connected in parallel (each with a series resistance of its own) to make them cover the range of 0.1 to 500 r/h.

Low-level β-counting

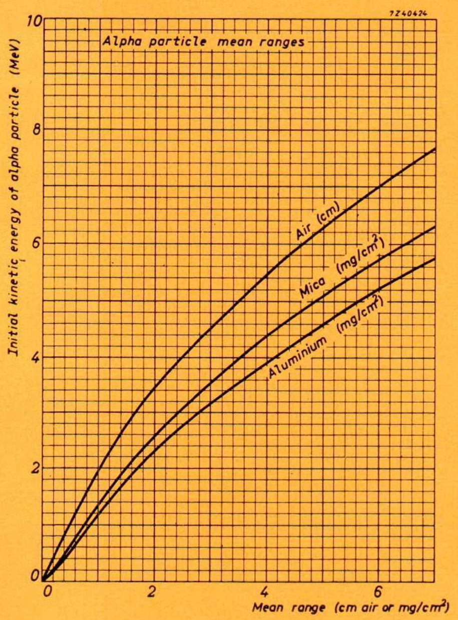
The low γ-sensitive, high-efficiency β-counters 18515, 18516 and 18536 in anti-coincidence with the cosmic-ray guard tubes 18517 or 18518 find their specific application in low-level counting in a compact shielding arrangement; the background level of these types is less than 1.2 c/m (< 1.3 c/m for the combination of the types 18516 and 18518, and < 2 c/m for 18536/18).

PHILIPS

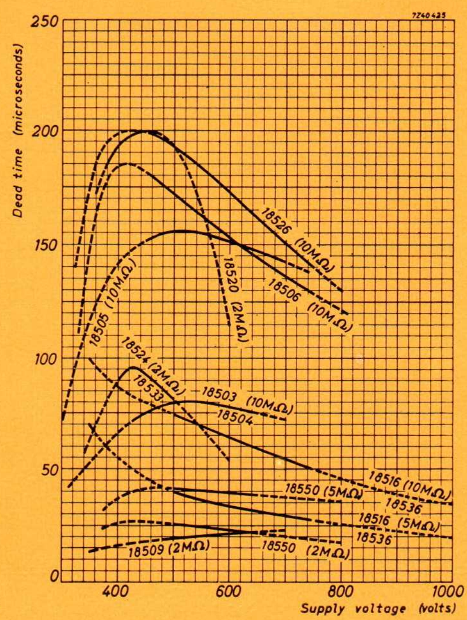
RADIATION COUNTER TUBES

REMARKS

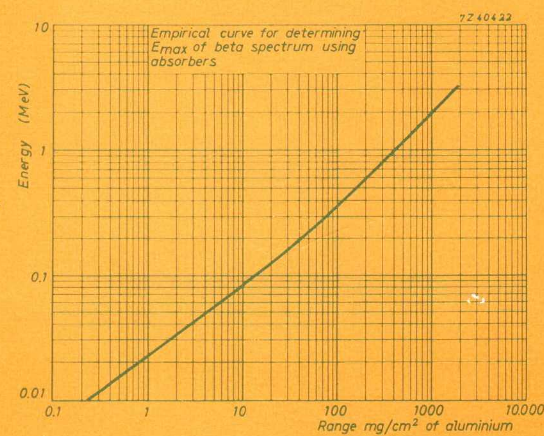
1. As shown in the recommended circuit the output signal should be taken from a tapping at 1/10 of the total anode resistance R.
2. Low-capacity mounting of the counter tubes is required, which implies the shortest possible connection between anode and R, and small parasitic capacitances between anode and earth.
3. To prevent leakage, the tubes should be kept dry and well-cleaned.
4. The thin-wall types should be handled with utmost care; the mica-window types are provided with an aluminium cap to protect the window when not in operation.
5. The gas pressure outside the window types should not be lower than 25 cm Hg, nor higher than the atmospheric pressure. Also for thin-wall types care should be taken not to apply pressures that exceed the atmospheric pressure.
6. No attempt should be made to solder directly to the stainless-steel cathode, since this will destroy the tube.



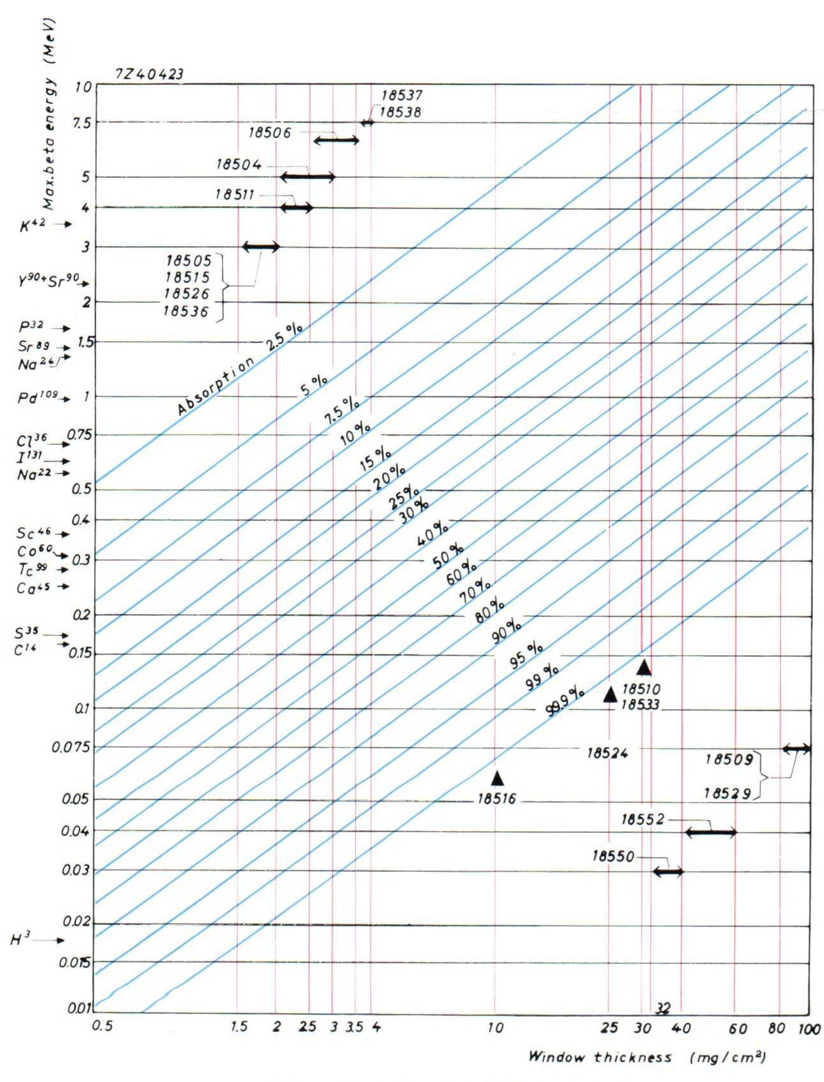
Alpha particle mean ranges



Dead-time characteristics of the tubes



β-ray absorption in aluminium



β-ray absorption in window or wall