Calculate the activity of 1 kg KCl. 0.012 % of the K atoms is radioactive ^{40}K. The half life of ^{40}K is $1.13 \cdot 10^{9}$ years.

We prepared a ^{35}S labelled protein at 12:00, 10 September 2014. The half life of the pure β^{-} emitter is 88 days. This sample was measured at noon on 26 September and the intensity was found 7000 imp/s. The overall effieciency of the measurement was 22 %. Calculate the activity of the sample in the time of synthesis.

The linear absorption coefficient of gamma radiation of 660 keV in aluminum is 3,4 cm^{-1}. Calculate the half thickness. How efficiently will attenuate this radiation an 10 cm aluminum wall ?

Laboratory practise

3 measurements
(30 October, 6 November, 13 November)

2 groups

Tests before the measurement

http://oktatas.ch.bme.hu/oktatas/konyvek/fizkem/PHCR
→ Lab practise

Test

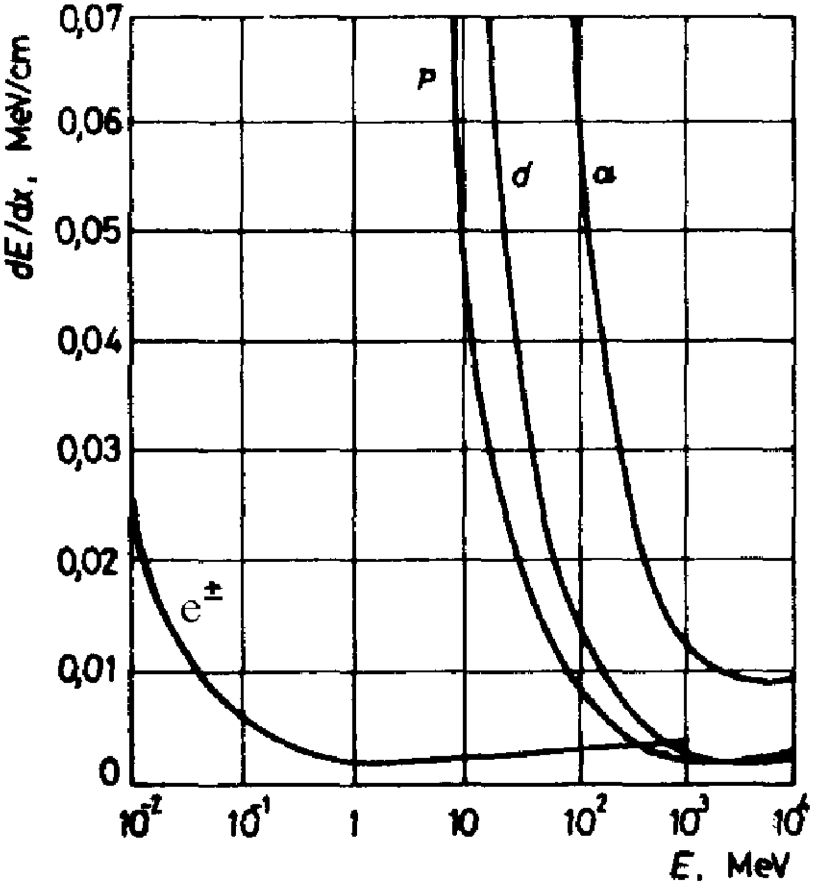
Next week (22 October)

CH 306!!!

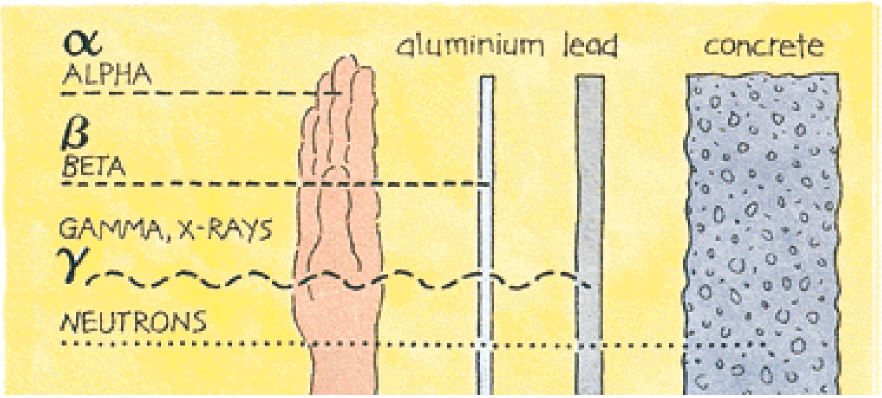
Detection of nuclear radiations

Interaction with matter: Linear energy transfer (LET)

air



Path



$$dE/dx \approx 1/v^2$$

The first step of the ionizing radiation in the matter:

1. Neutral excitation

$$A + radiation \rightarrow A^* + radiation'$$

2. External ionization

$$A + radiation \rightarrow A^+ + e^- + radiation'$$

$$A_2 + radiation \rightarrow A^+ + A^- + radiation'$$

$$A_2 + radiation \rightarrow A_2^+ + e^- + radiation'$$

$$A_2 + radiation \rightarrow 2\,A\cdot + radiation'$$

3. Internal ionization

$$A + radiation \rightarrow A^{*+} + e^- + radiation'$$

$$A^{*+} \rightarrow A^+ + X_{char}$$

$$A^{*+} \rightarrow A^{2+} + e^-_{Auger}$$

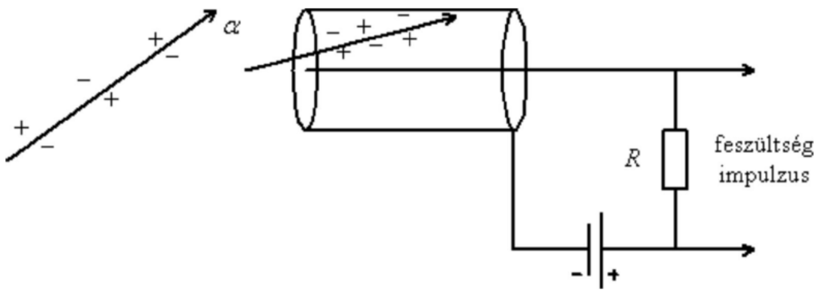
4. Bremsstrahlung (breaking radiation)

$$A + radiation^{\pm} \rightarrow A + X_b + radiation^{\pm\prime}$$

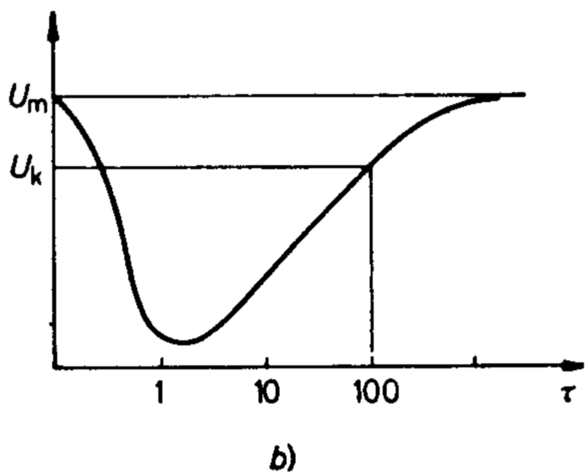
What do we want to know?

- yes/no
- type of radiation
- energy of radiation
- source
- activity ($I=k\eta A$)
- integral
  - real time evaluation
  - delayed evaluation
- rate

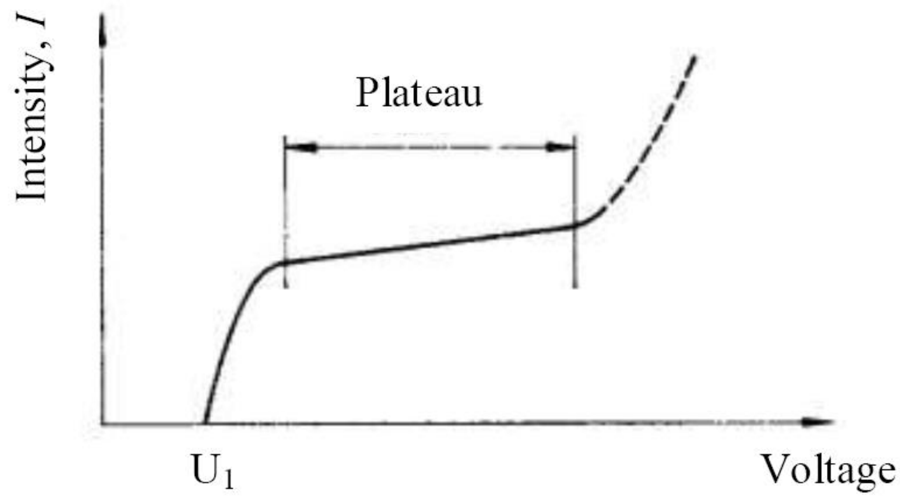
Geiger-Müller (GM) counter
(gas ionisation detector)



Dead time

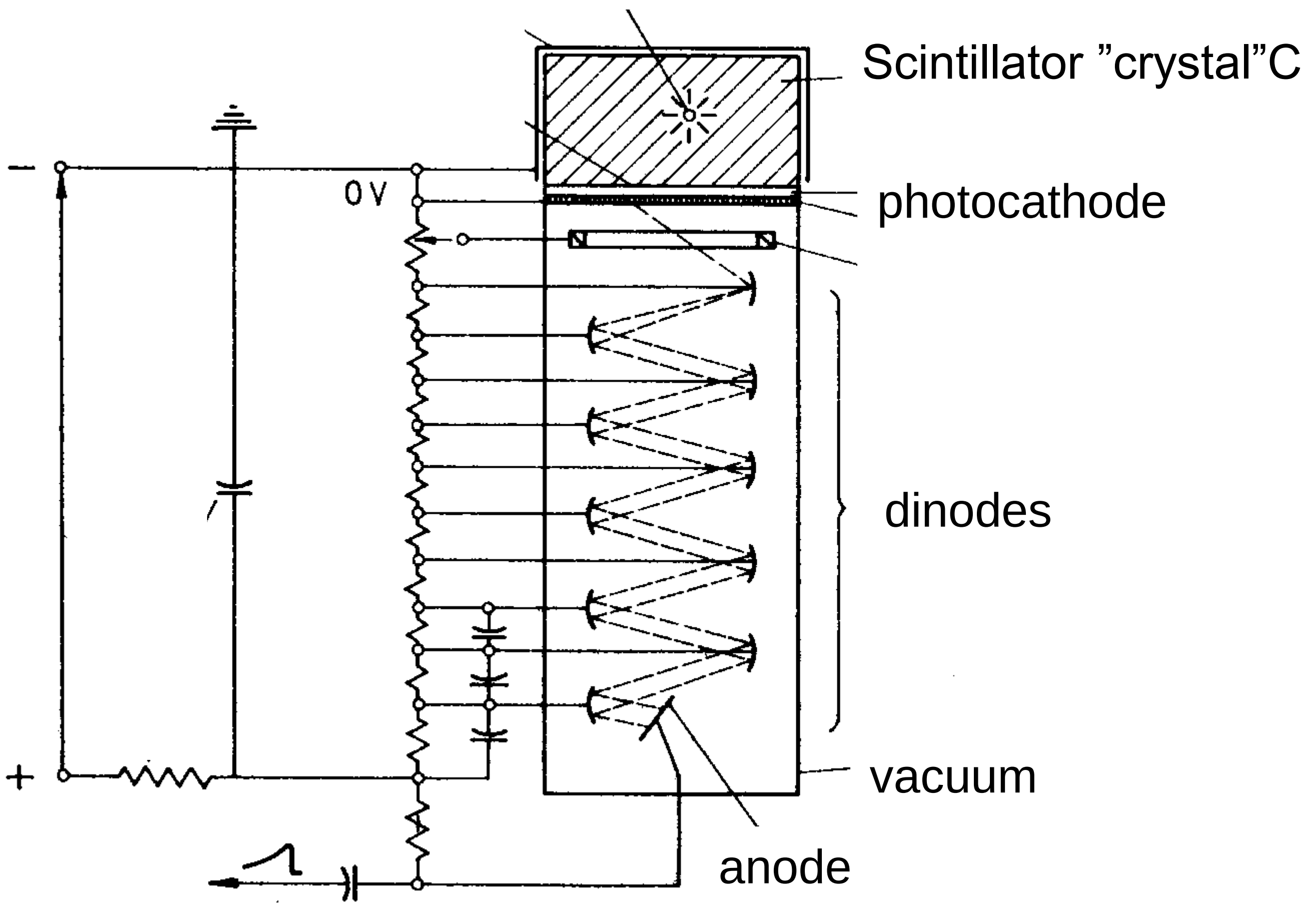


Characteristic curve



Scintillation detectors

Scintillator (material depends on the radiation) + photomultiplyer



Typical scintillation crystals

Depends on the type of radiation

NaI(Tl)	gamma
Plastic	beta
ZnS	alpha

Liquid scintillation technique

for low *E* isotopes (^{3}H, ^{14}C)

scintillator and radioactive material dissolved in the same solution

Semiconductor detectors

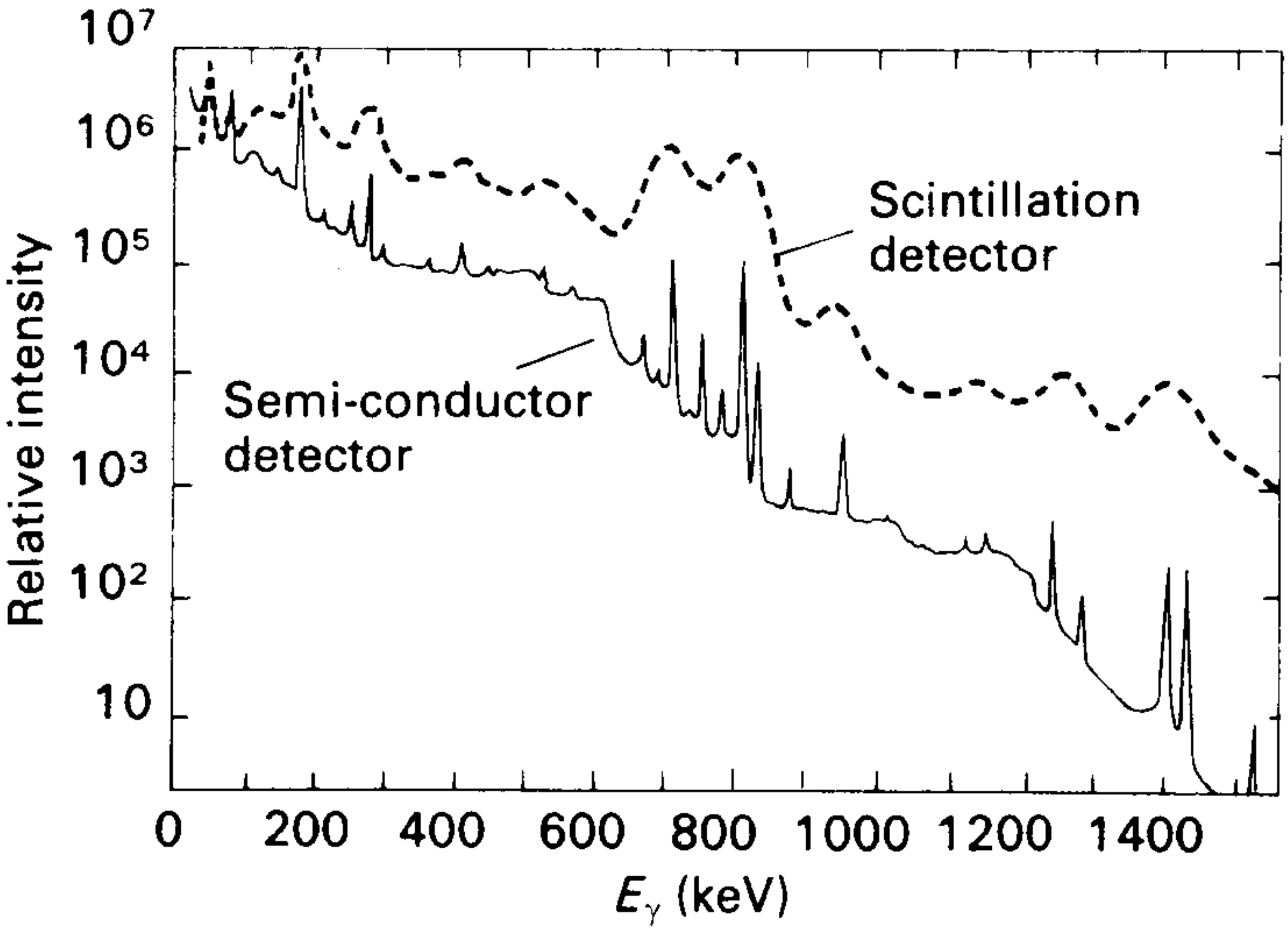
Typical semiconductors

	Si	Ge	CdTe
Atomic number, *Z*	14	32	48 - 52
Energy gap, eV	1.12	0.74	1.47
Ionisation energy, eV	3.61	2.98	4.43

Ge(Li)

HPGe, Si(Li)

Comparison of a scintillation and a semiconductor spectrum



Comparison of the features of the main detector types

Properties	GM counter	Scintillation detector	Semiconductor detector
Field of application	Primarily for particle radiation measurements	Measurements of any radioactive radiation types	Measurements of any radioactive radiation
Measurement efficiency	For particle radiation (α, β, n) near 100% for electromagnetic radiation 1 or 2%	Generally good	Generally good strongly temperature dependent at some types
Dead time	< 1 ms	<1 μs	<0.1 μs
Energy selectivity (qualitative identification of the radioactive source)	Non-selective	Selective	Very selective
Costs	Low	High, due to accessories	High
Other aspects	Limited but usually long life time	High counting rates	For drifted semiconductors, cooling required both for measurement an storage