Measurements of activity of biological samples Low-background γ ray spectroscopy.

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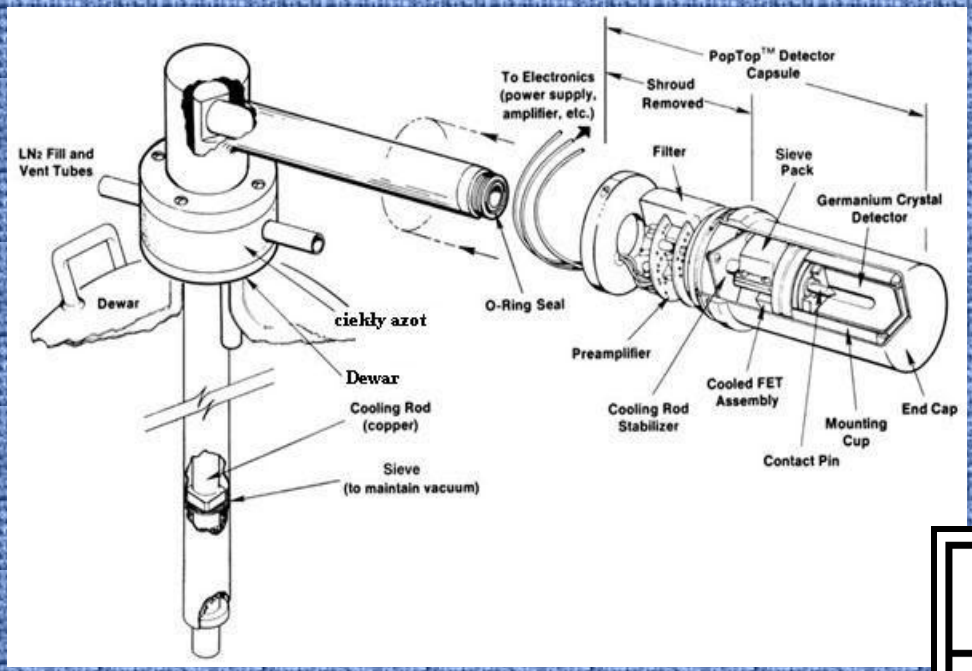
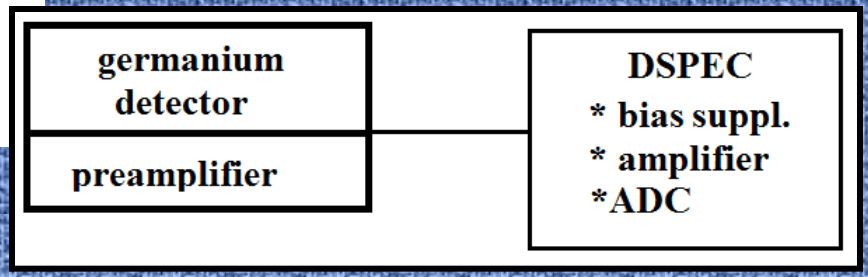
Tutor: dr Agnieszka Trzcińska

Measurement Instruments

- Germanium detector
- Gamma vision programme





Measurement preparation

- Energy callibration:

E = a(channel)+b

- Efficiency callibration:

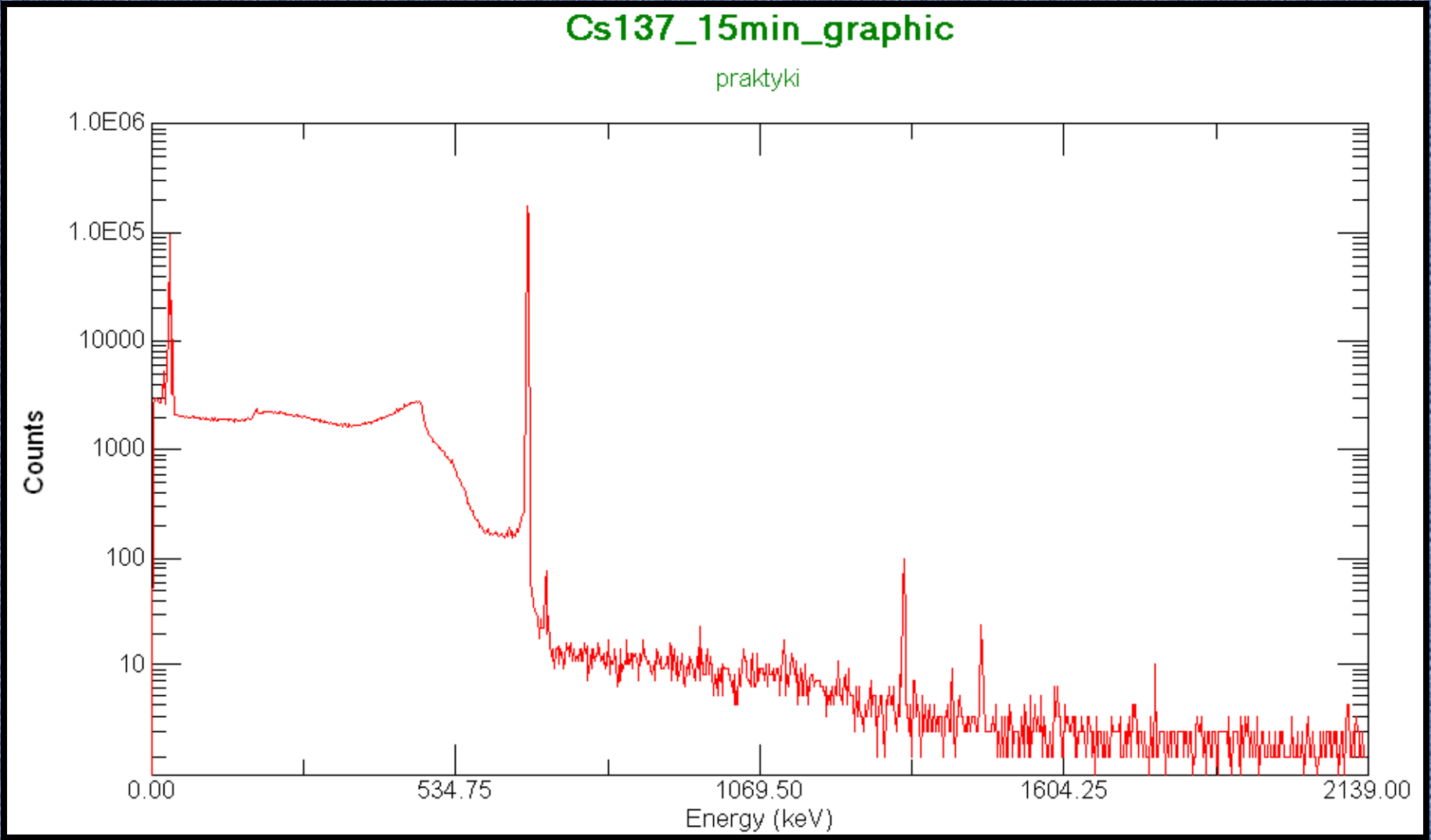
$$\varepsilon = \frac{number\ of\ registered\ \gamma}{emitted\ \gamma} = \frac{net\ area}{A \cdot t \cdot I}$$

- A – activity
- I – intensity
- t – live time of detector
- ε - efficiency

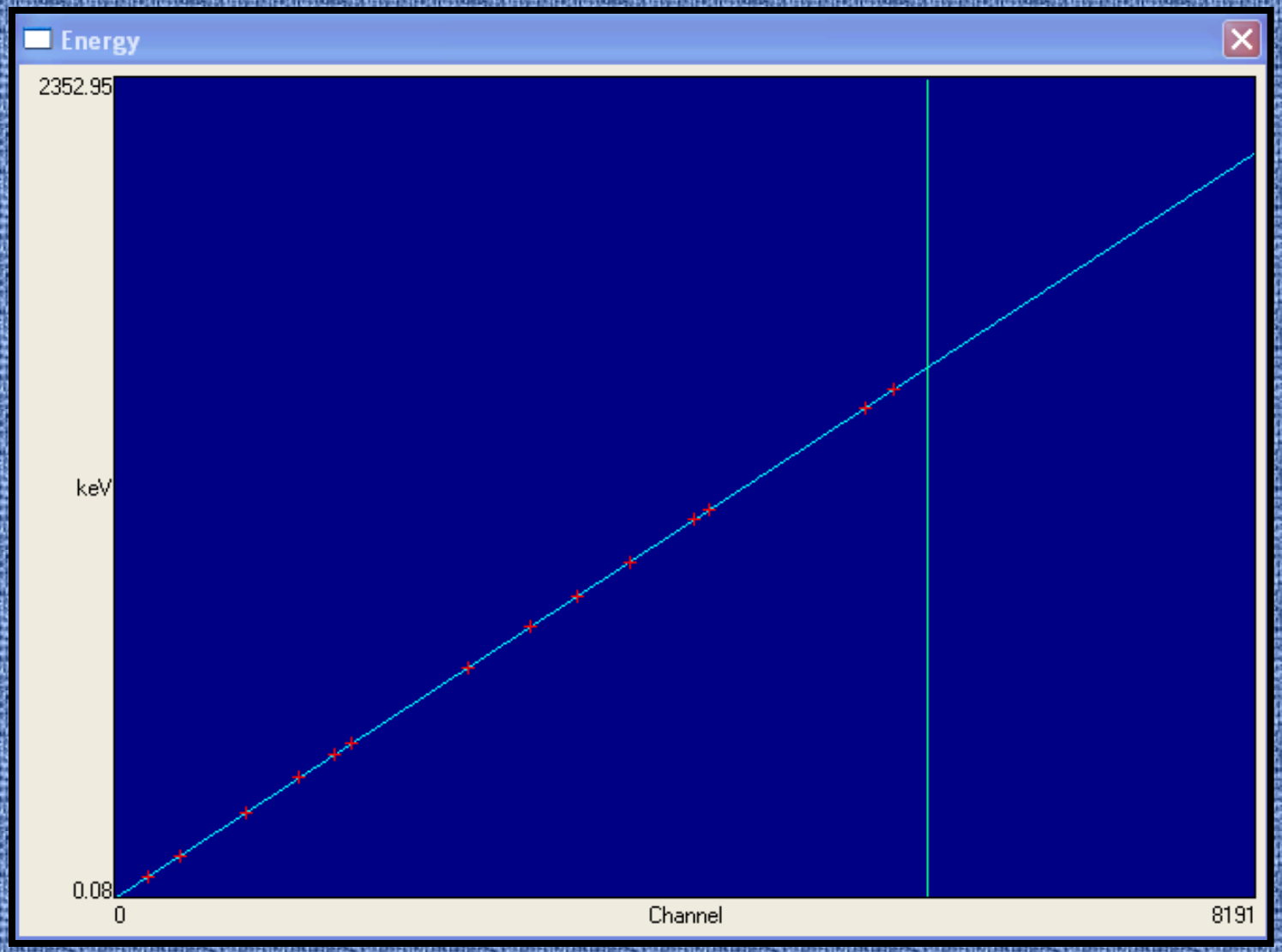
$$A = A_0 e^{-\lambda t} = A_0 e^{-\frac{ln2}{T_{1/2}} \cdot t}$$

λ - decay constant, A_0 = initial activity

The spectrum of cesium 137

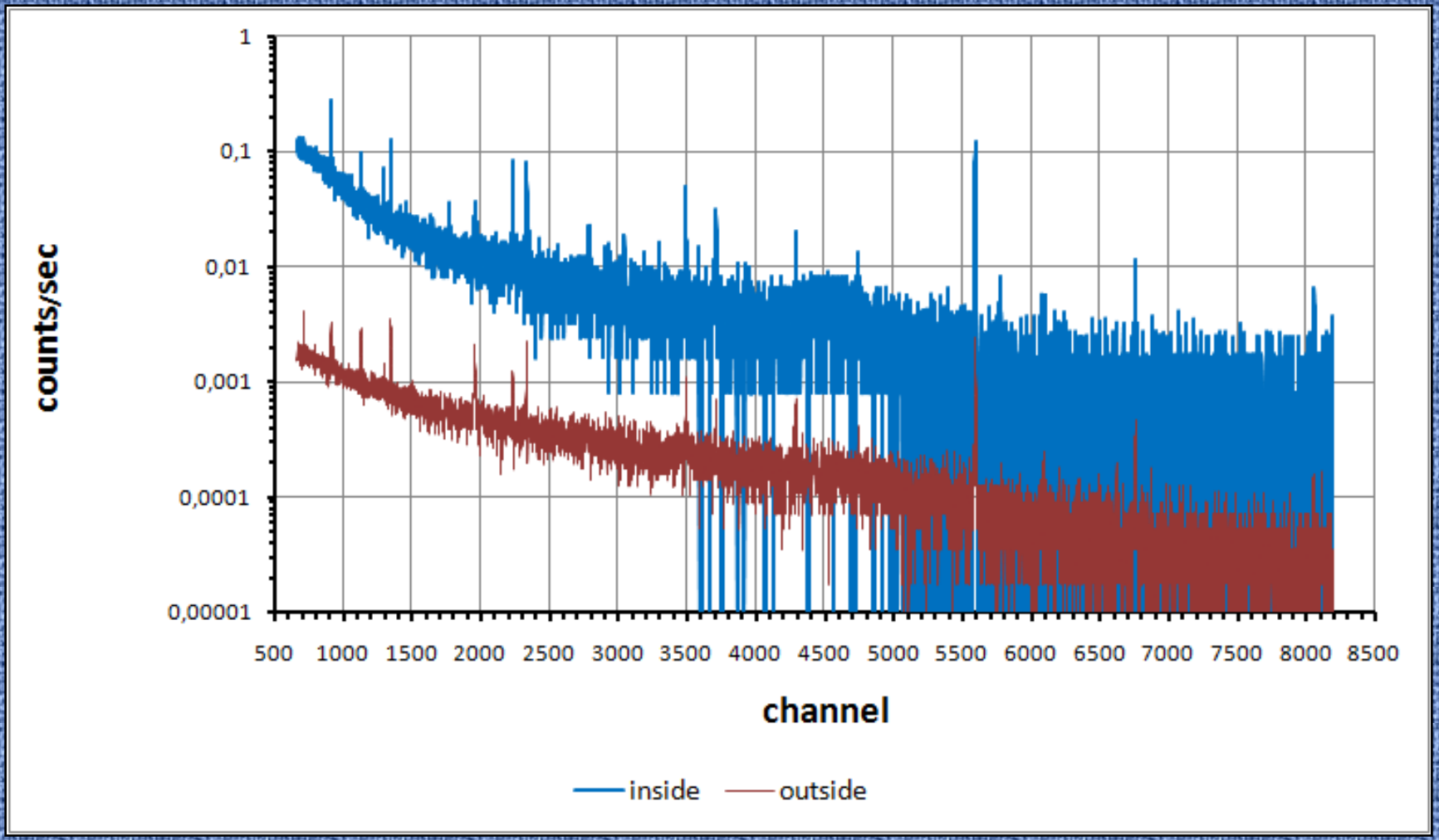


Energy callibration:



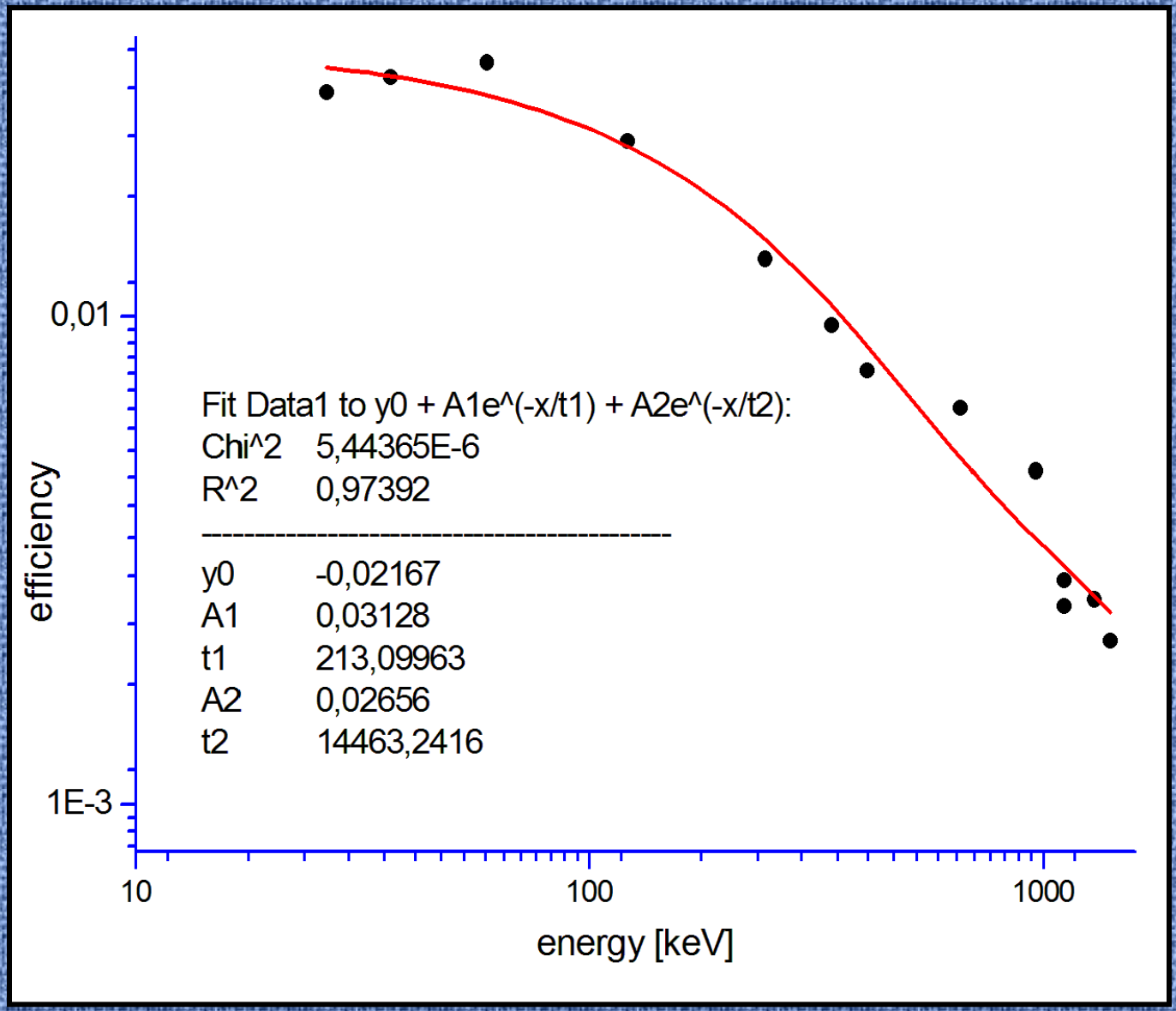
For calibration we used the following sources: ^{137}Cs, ^{241}Am and ^{152}Eu

Comparison of background spectra from inside and outside of shield



Measurements were performed inside a lead shield (thickness of walls - 10 cm).

Efficiency callibration and curve fitting

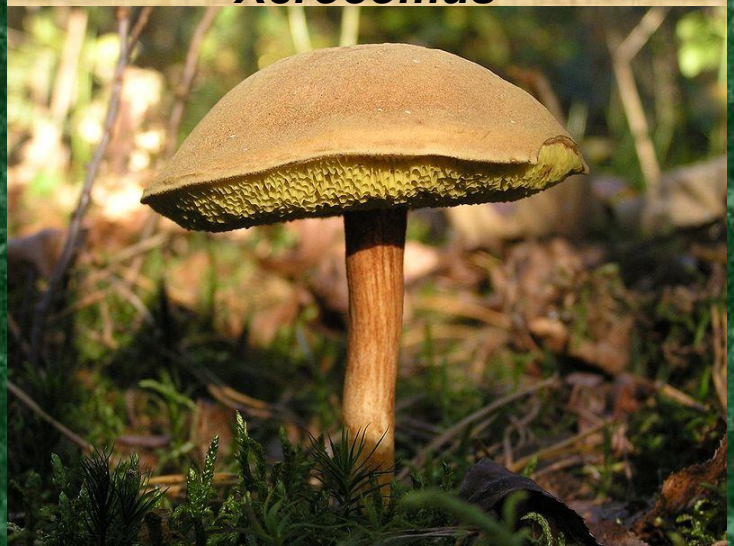


Mushrooms under investigation

king bolete

Suillus

Xerocomus



forest complex "Bory Tucholskie"

Calculation of the activity of mushrooms samples

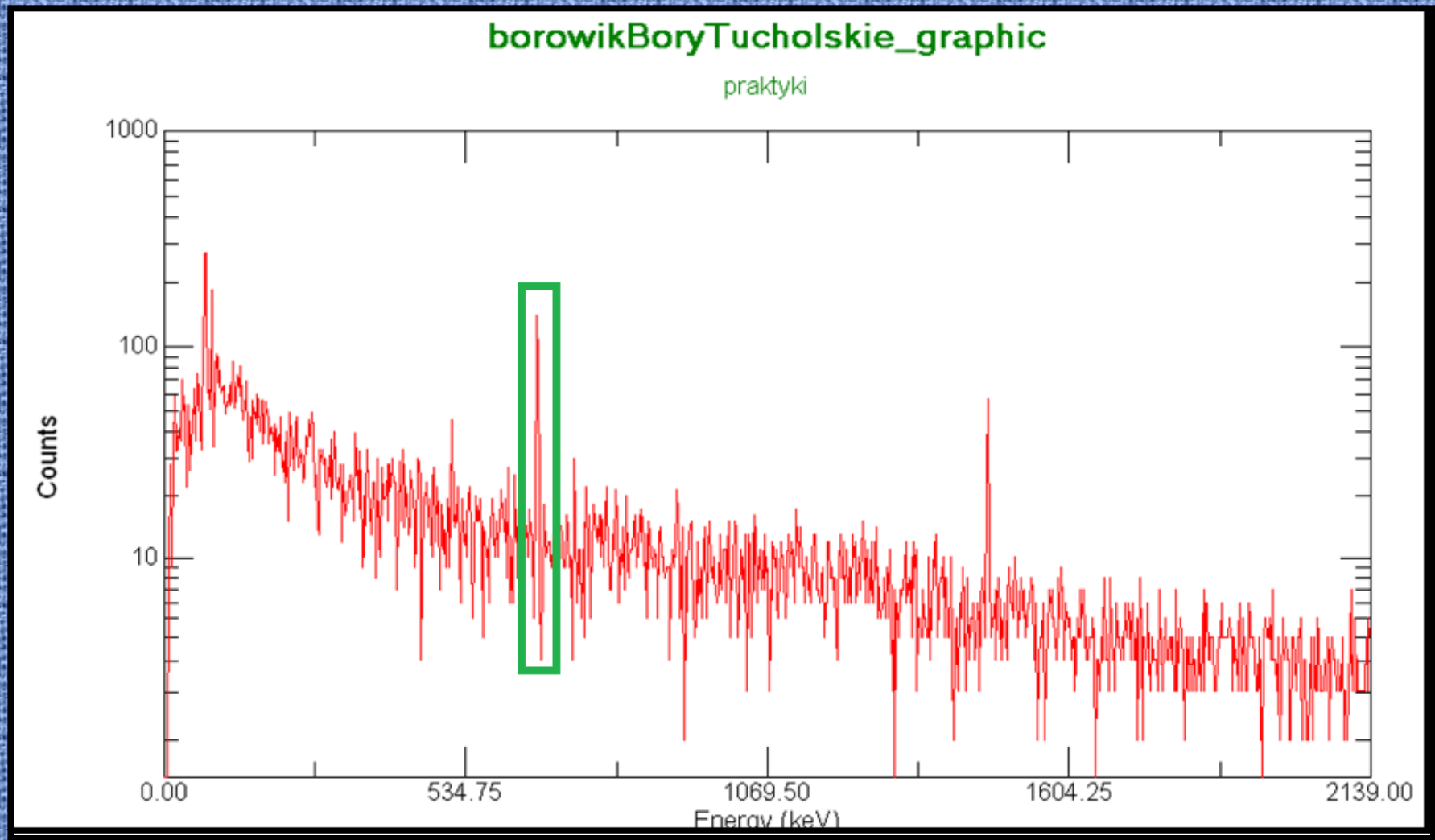
For cesium ^{137}Cs:

- Energy of main peak is: 661,660 keV
- It's intensity: 85,2%
- Efficiency: 0,006491

$$A = \frac{N}{\varepsilon \cdot t \cdot I}$$

- N – net area of cesium peak
- ε - efficiency
- t - live time
- I - intensity

The spectrum of boletus from Bory Tucholskie

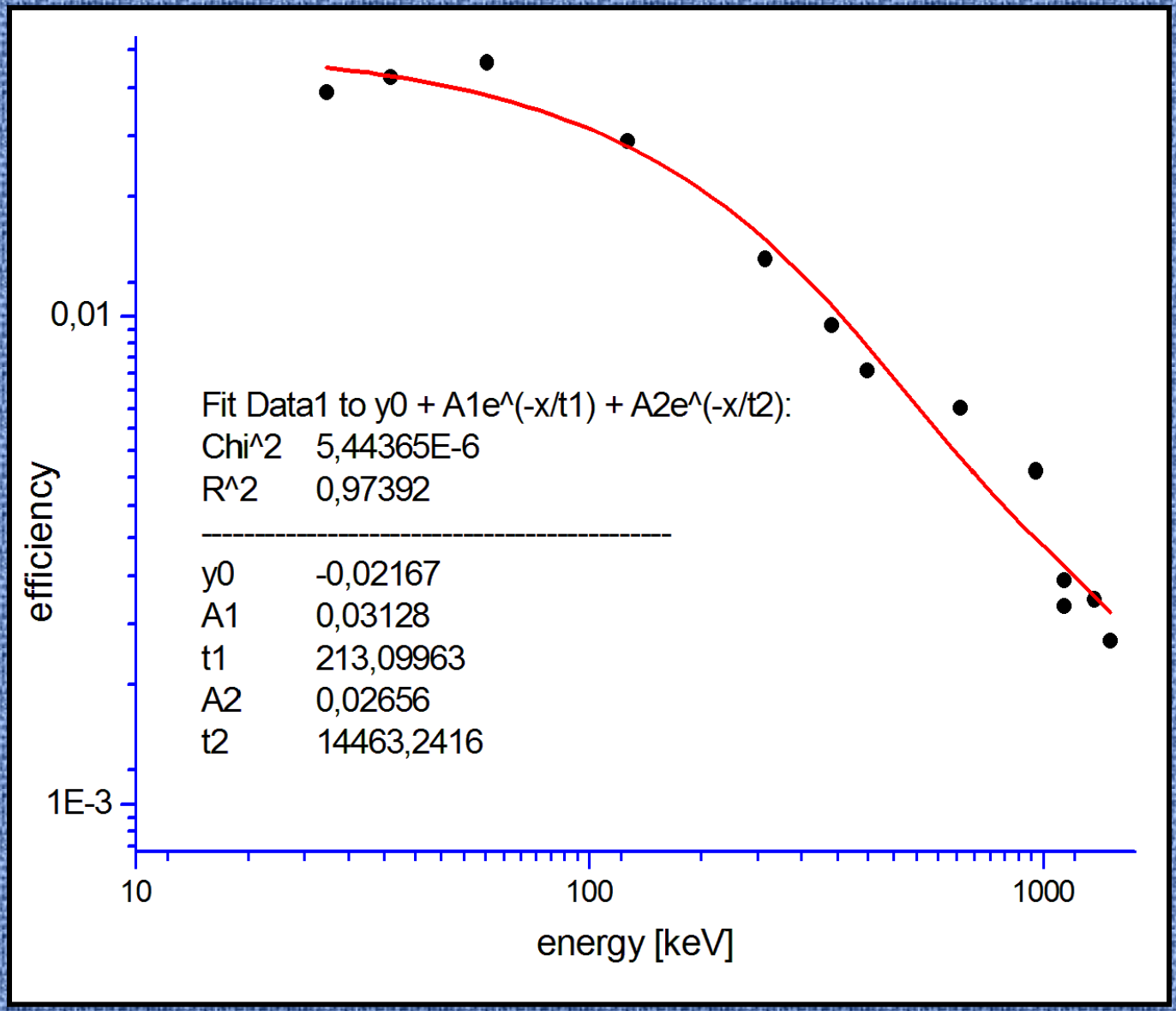


Radioactivity of mushrooms

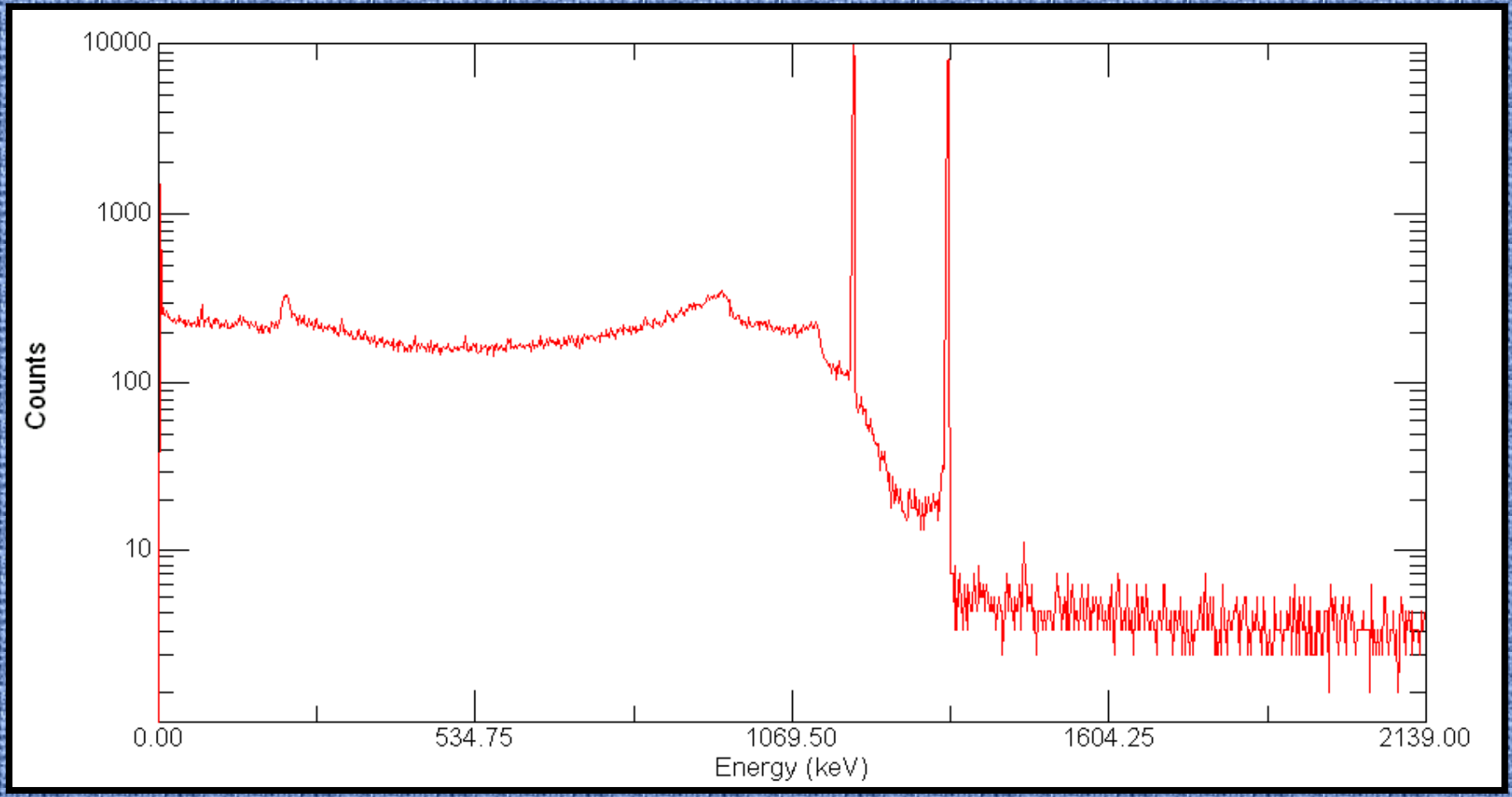
- Radiation dose permitted by law is 1mSv/year.
- Effective dose, derived from the nuclide of activity 1 Bq and absorbed by ingestion, for cesium-137 is $1{,}3 \cdot 10^{-8}$ Sv.
- To receive a dose of 1 mSv we should eat nuclides with activity: $7{,}69 \cdot 10^{4}$ Bq.

mushroom name	act/mass [Bq/g]	mass for 1 mSv [kg]
suillus	0,147	522,66
Xerocomus	2,001	38,43
boletus from Bory Tucholskie	0,250	308,12
king bolete	0,175	439,85

Determination of ^{60}Co source activity



The spectrum of cobalt-60



name of isotope	activity [Bq]	activity [kBq]
kobalt 60 (1173,238keV)	91154,44	91,1544
kobalt 60 (1332,502 keV)	88088,85	88,0889
kobalt 60 (mean)	89621,64	89,6216

Information for Tomasz Abraham

Preparation of targets for nuclear physics and thickness measurement

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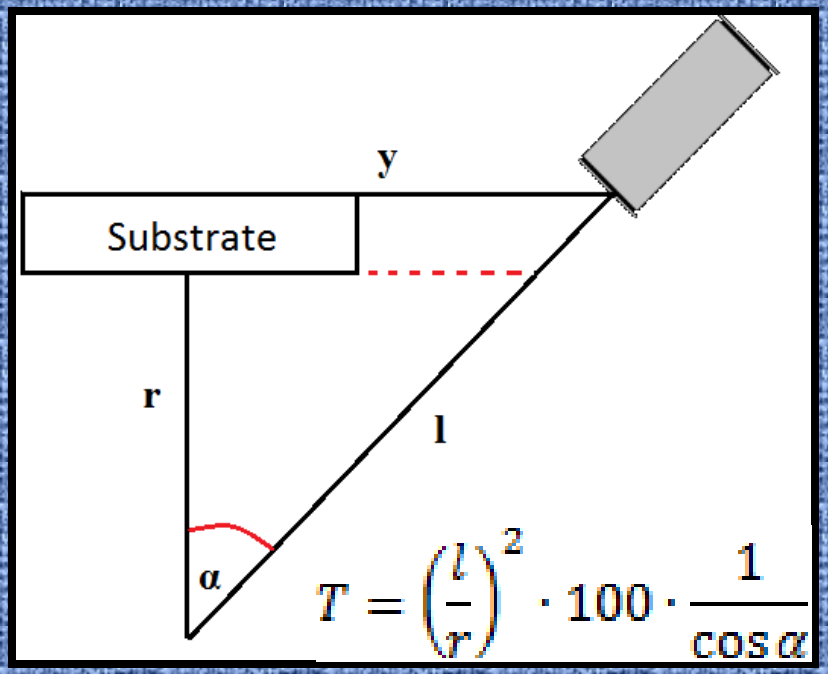
Rolling

- Preparation of stainless steel protection sandwich.
- Insert material to it’s interior and roll it in order to obtain a specified thickness.
- Measuring the thickness of the material using an induction device.



Evaporation

- Material was inside the boat or coil.
- It evaporated and condensed on the glass covered with sugar or soap (parting agents).
- Quartz indicated the thickness of the evaporated material and rate of the process.

Targets

- Releasing foils from the glass.
- Fishing foils from water using frames.
- Leaving the foils to dry

Thickness measurement

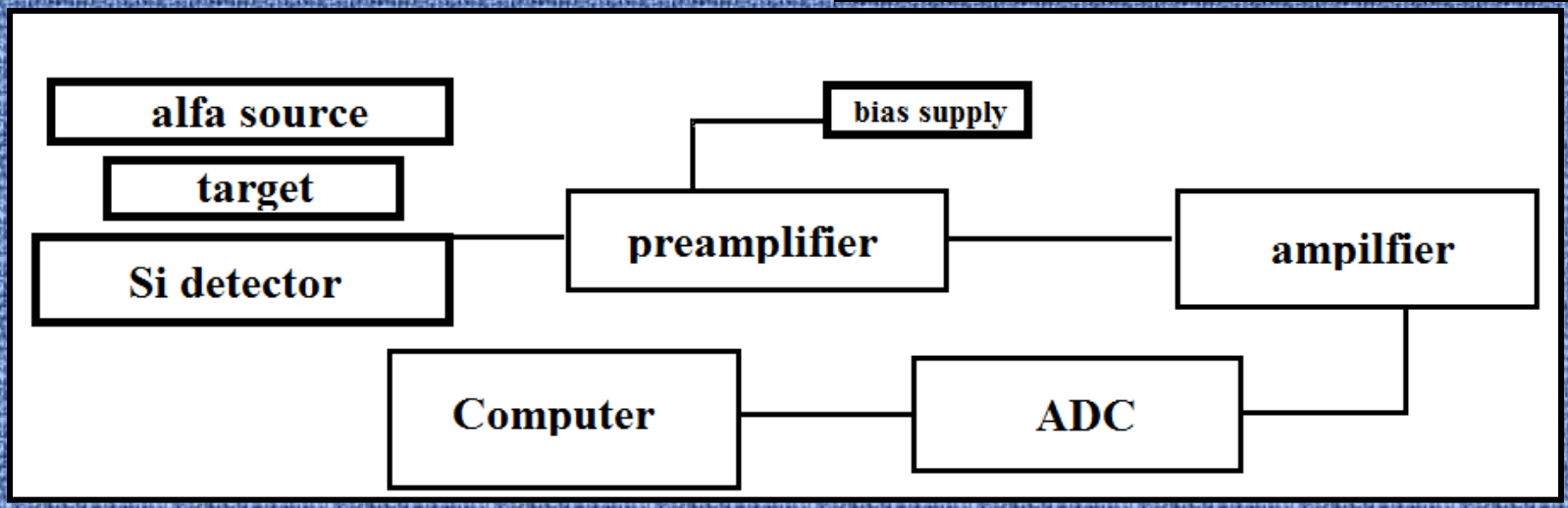
- Energy loss = initial α energy – α energy after passing through material.
- Knowledge of the energy loss and stopping power for the particular material allows us to calculate the thickness:

$$th = \frac{\Delta E}{S(E)}$$

- Stopping powers were calculated by SRIM code.

Mesurement setup

- Vacuum chamber
- ^{241}Am alfa source
- Table with targets
- Silicon detector
- Multichannel analyzer



Results

Target	Method of Preparation the Material	S(E)	Thickness (μm)			
			by α	Quartz Crystal Microbalance	induction	Rutherford
Al	Reference	154,6	4,813	-	4,8	-
Al	Rolling	154,6	2,596	-	2,5	-
Al	Evaporation	154,6	0,553	0,533	0,5	-
Cu	Evaporation (B)	361	0,456	0,2956	0,40 - 0,45	0,415
Mylar	Commercial	111,5	12,871	-	13	-
Ag	Rolling (B)	340,7	0,914	-	0,8 - 0,85	0,838
Cu	Rolling	361	2,292	-	2,5	-
Cu (detergen	Evaporation	361	0,253	0,2832	-	-
Cu (betaine)	Evaporation	361	0,321	0,2832	-	-


Thank you for your attention