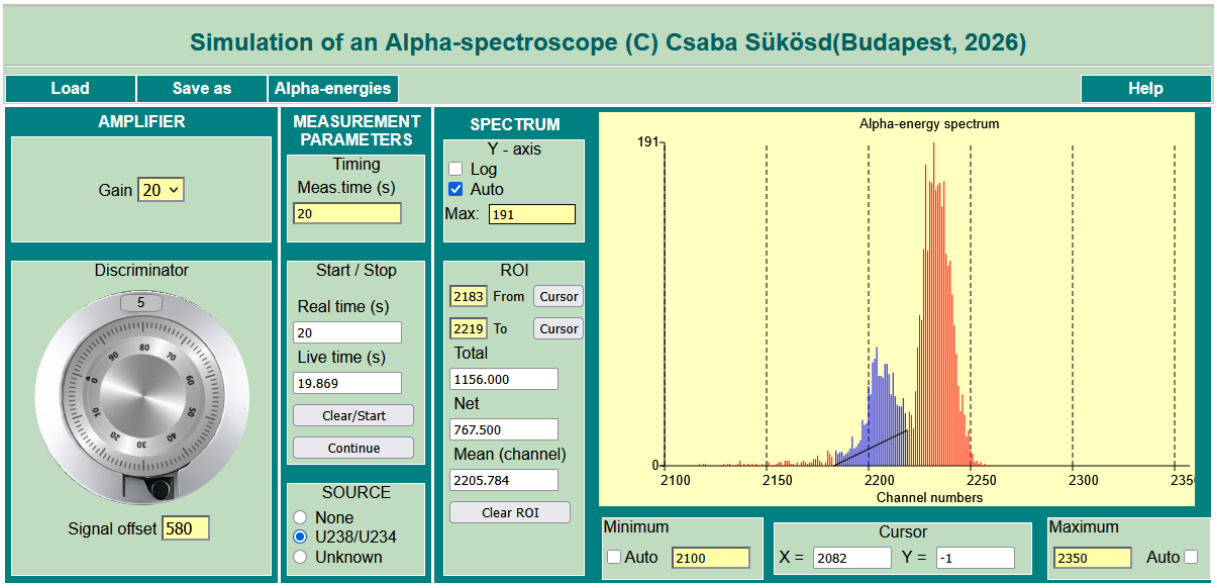
National Leó Szilárd Physics Competition Final
2026. Computer Simulation Task
Program manual

Measurement of Alpha Radiation Energy and the Activity of a Sample

After starting the program (and selecting the language), an image of an "***Alpha spectroscope***" can be seen in the middle of the screen. Three clearly distinguishable panels separate the individual controls.



The menu bar

The ***Load*** and ***Save as*** menu items in the top menu bar are used to save the measured values and load them later. The ***Alpha-energies*** menu item opens a list (PDF) on a new page, where the energies and percentage strengths (intensities) of alpha radiation emitted by different types of nuclei are listed. This can be used to determine the energy - channel number function of our detector (see: ***Theoretical introduction***), and on the other hand, knowing this, it is possible to determine the energy of alpha radiation coming from an unknown sample and thus identify unknown nuclei. The submenus of this menu item allow you to choose whether the list should be sorted in ascending order according to the atomic number of the nuclei (***Nuclide***) or according to the energy of the alpha radiation (***Energy***). The ***Help*** submenus of the menu bar (***About***, ***Theoretical introduction***, ***Program manual***) do not require any special explanation.

The AMPLIFIER

The panel on the left side of the screen, called AMPLIFIER, has two controls: ***Gain***, since the electronic signals coming from the alpha detector must be amplified in order to obtain electronic pulses that can be evaluated well. All electronic equipment – and this system too – has electronic noise, which consists of low-amplitude signals. These noises may mask useful signals or represent unnecessary load for electronic devices performing more important and complex operations. Therefore it is advisable to suppress them. The ***Discriminator*** is used for this, which raises the zero level of the subsequent electronic circuits, thus placing them above the electronic noises. A so-called helical potentiometer (variable resistor) is used to change this in this simulation. Its value can be changed with the circular metal rotary knob. Since its position affects the measured values, it is advisable to fix it – after setting it. This is done by the small black lever at the bottom, which can be clicked to lock or unlock the knob (it is locked when the program starts). The knob can be turned several times, so it can be adjusted quite finely. The discrimination level can also be entered directly in the ***Signal offset*** field if the potentiometer

is unlocked. In this case, the color of the field changes to yellow. (Note that in the program you can only write inputs into the yellow fields.)

MEASUREMENT PARAMETERS

In this panel, in the frame named ***Timing*** at the top, we can enter a single data: the measurement time in seconds (***Meas. time (s)***). If this value is zero, the measurement is not timed, and can be stopped manually.

In the frame named ***Start / Stop***, there are two buttons for starting and stopping the measurement, as well as two information fields: the **real time** elapsed since the start of the measurement, and the **live time**. The latter is related to the **dead time**. We can read more about this in the ***Theoretical Introduction*** section. These white fields are for display only, we cannot write anything in them.

In the ***SOURCE*** group, we can have three choices, the captions of two of them are self-explanatory. The middle choice is important for determining the energy and efficiency: then ^{238}U and ^{234}U in secular equilibrium with it are placed in the sample holder of our detector. According to the measurements, the activity of the standard ^{238}U nuclide is exactly 10,000 Bq.

The ***SPECTRUM***

This panel occupies the right side of the window. The largest part of it is a rectangle suitable for displaying a graph. Its horizontal axis is divided into 4100 parts, these are the channels. The vertical axis shows the number of counts per channel. During the detection process, the measured energy of the alpha particle is converted into digital numbers – channel numbers. After defining the energy-channel number (linear) function (see ***Theoretical Introduction***), we can convert the channel numbers (the horizontal coordinates) back into energy. By clicking on the appropriate place on the graph, the ***Cursor*** shows the number of the given channel (X) and the number of counts (Y) in it. We can also enlarge smaller parts of the graph by changing the ***Minimum*** and ***Maximum*** limits of the representation. The vertical axis can be modified by changing the ***Y-axis*** field. By selecting ***Auto***, the representation is automatically adjusted to the maximum. When ***Log*** is selected, the vertical axis will be logarithmic.

The ***ROI*** („Region of Interest”)

In the program a range can be selected, on which the program will perform some simple operations. The ***from*** and ***to*** fields show which channel the selected range is from and to. If the end point of the range is greater than the start point of the range, the program calculates and displays the following:

- Sums the channel counts and displays them in the ***Total*** field.
- Assumes a linear background (also draws it in black) between the start and end of the selected range, and subtracts the area below it from the ***Total***. This will be the ***Net*** value.
- Calculates the X coordinate of the centroid of the selected range (***Mean (channel)***) taking the background into account.
- Displays the channel contents within the ROI range in blue.

The ROI can be selected not only by typing in the ***From*** and ***To*** fields, but also by using the **Cursor** buttons next to the fields. By clicking the appropriate button, the minimum or maximum value of the ROI (the two end points of the range) takes on the value of the cursor's X coordinate. The ***Clear ROI*** button is self-explanatory.