

# Gamma Spectrum Analysis (GSA) Software Manual

edited by

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## I - Introduction

The manual was created to simplify and clarify the gamma spectrum analysis (GSA) software. It shares all the information necessary for the user to better understand the graphical interface. All functions and options are presented. Each option has been uniquely explained. Currently, the main functionality of GSA is to locate peaks, calculate the region of interest and identify radionuclides.

## II - Complete graphical interface of the program.

The first boot program interface is shown in Figure 1. There is still a hidden space under the gray program panel. To appear it, he must double-click on the position marked in figure 2, then slide down. Figure 3 shows the hidden space.

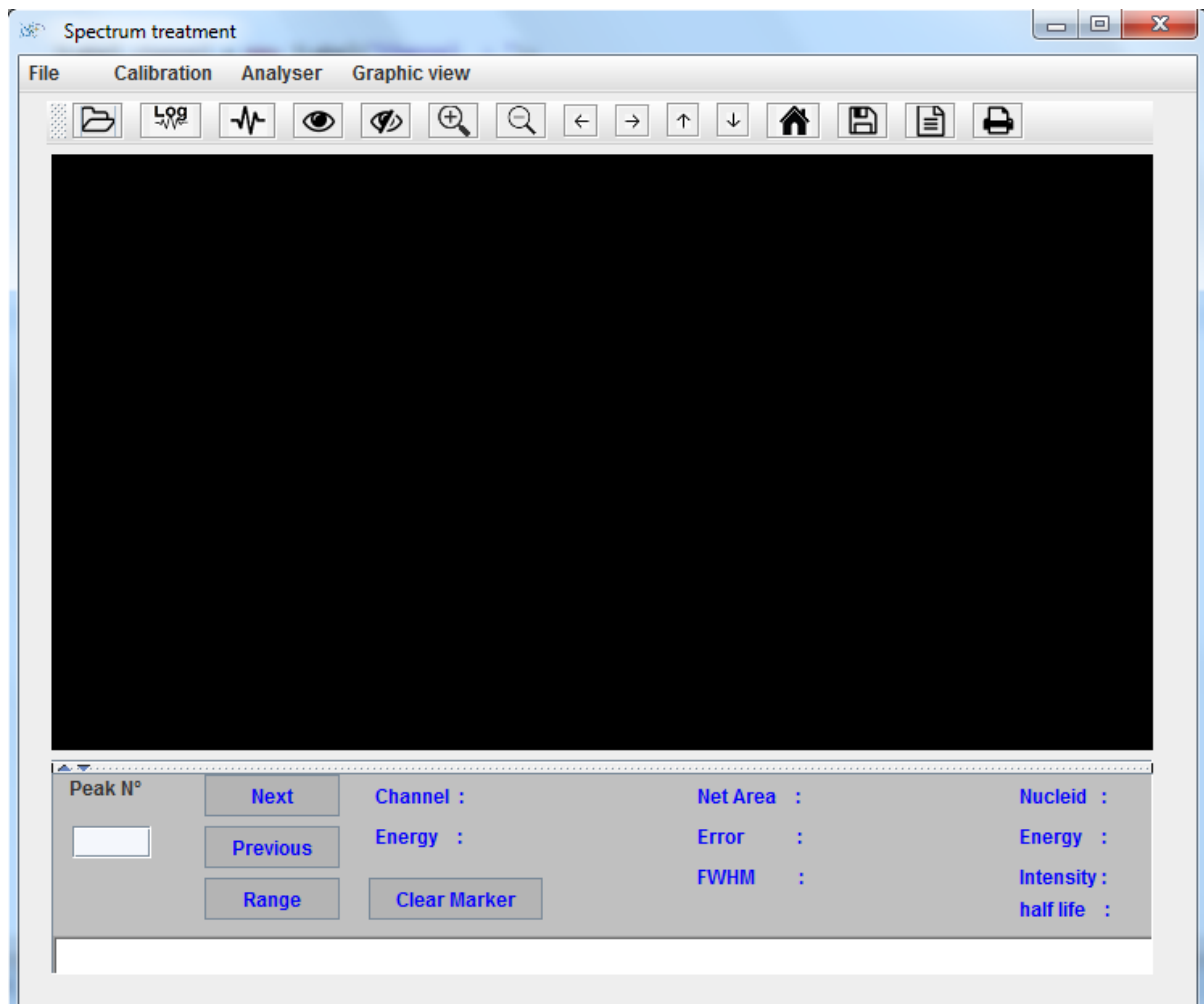


Fig. 1. The graphical interface when the program starts for the first time.



Fig. 2. Fig. 2. show hidden space.

The screenshot shows a software window with a grey background. At the top, there are three columns of labels: 'File name :', 'Energy calibration :', and 'Length of detector description :'. Below these are 'Start time :', 'Peak shape calibration :', and 'Length of sample description :'. Then 'Start date :', 'Detector description :', and 'Real :'. Then 'Live :', 'Sample description :', and 'Dead :'. Then 'Channel range :'. Below these is a section titled 'Info extracted from spectrum file'. This section contains a table with columns: 'Peak N°', 'Channel :', 'Net Area :', 'Nucleid :', 'Energy :', 'Error :', 'FWHM :', 'Intensity :', and 'half life :'. There are buttons 'Next', 'Previous', 'Range', and 'Clear Marker' next to the 'Peak N°' column. The 'Peak N°' column has a text input field.

Fig. 3. The hidden space.

### III- Software presentation

To simplify this guide, the graphical interface has been divided into the following six parts (see fig. 4):

- 1- Menu bar
- 2- Icon bar
- 3- Space of graph
- 4- Space of info extracted from file
- 5- Space for markers and analysis info.
- 6- Space of results

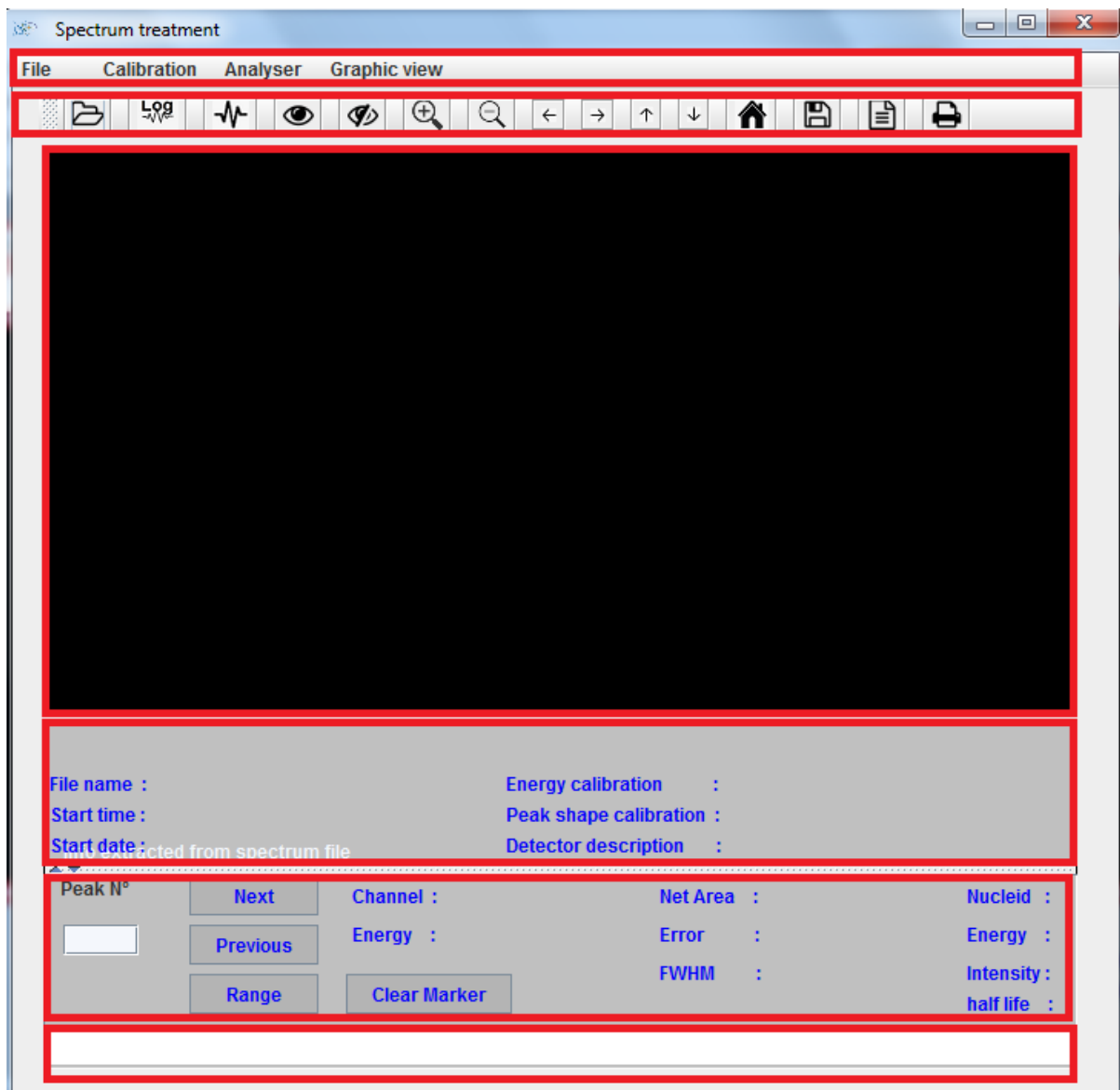


Fig. 4. Six parts of software.

### III.1 Menu bar

It generally has four menus: File, Calibration, Analysis and Graph view (Fig. 5).



Fig. 5. Toolbar.

#### III.1.1 File

File is the first menu the user must start in in order to continue their analyzes (or the Folder icon). It contains the options shown in Figure 6. Each option is explained below.

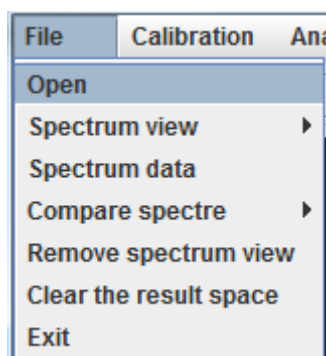


Fig. 6. The File menu options.

**Open** : To open the file (only .chn format, the others not yet).

**Spectrum view:** To see the graph. Logarithm scale and normal scale are available. The graph appears on the graph space.

**Note:** File info automatically appears in the info space (fig.7).

File name :	m0375sc1.Chn	Energy calibration :	$E = -44.55694 + 0.3239517 \cdot C + -2.02589E-7 \cdot C^2$	Length of detector description :	13.0
Start time :	12:00:37	Peak shape calibration :		Length of sample description :	0.0
Start date :	09Mar11	Detector description :	3.102 Compton		
Real :	609.52	Sample description :			
Live :	600.0	Channel range :	From 0 to 8192		
Dead :	1.5618879 %				
Info extracted from spectrum file					

Fig. 7. The appearance of info extracted from file.

**Spectrum data:** Appearance of “Channel” numbers and “counts” values in the results space.

Channel	Counts
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

Fig. 8. The channel numbers and the corresponding “counts” values.

**Compare spectrum:** To compare two spectra in the same graph. Two scales are also available.

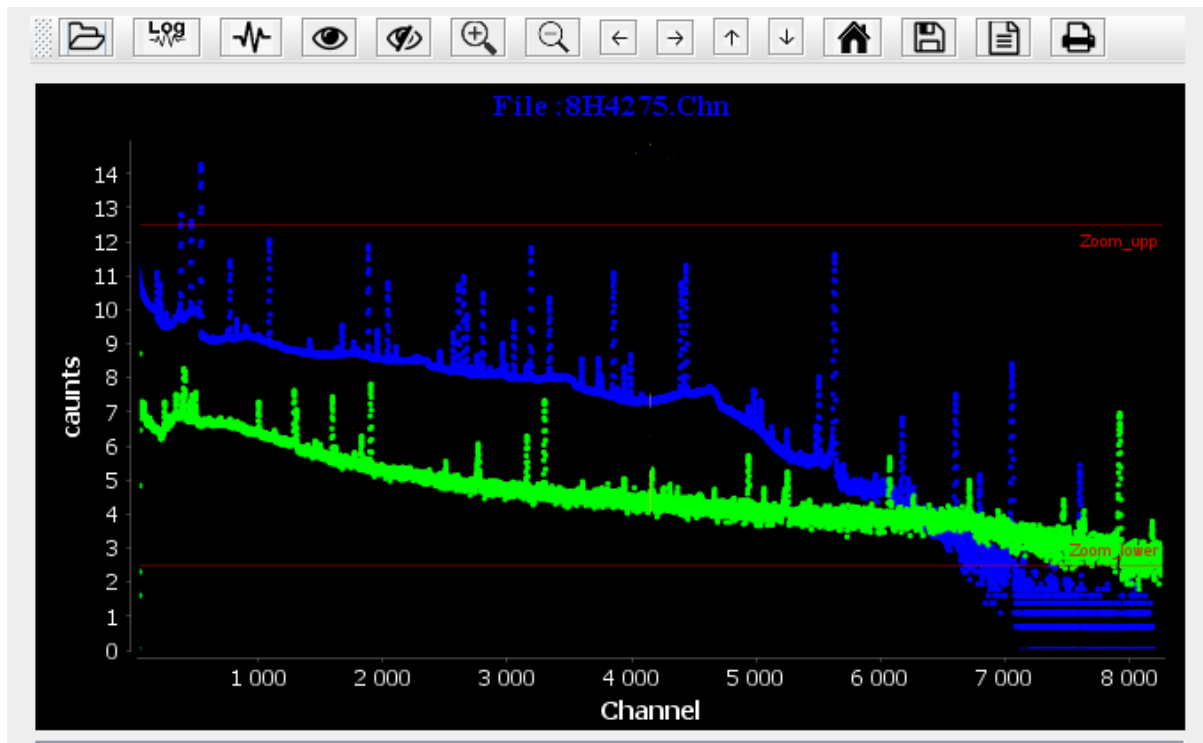


Fig. 9. Comparison of spectra.

**Remove spectrum view** : To remove the graph displayed on the graph space.

**Clear the result space** : To delete the content of the last part.

**Exit** : To close the program.

#### I .1.2 Calibration

The calibration menu has three options: Energy Calibration, Full Width at Half Maximum Calibration (FWHM), and Tail Calibration.

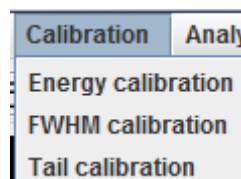
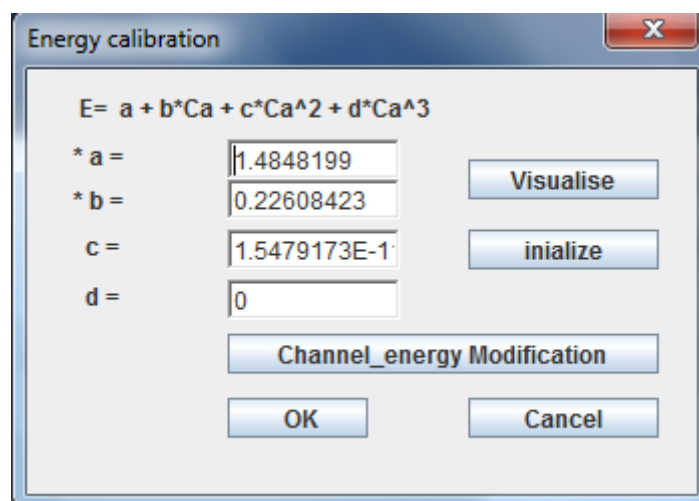


Fig. 10. Calibration options.

**Energy calibration:** The program automatically reads the calibration parameters from the .chn file. Including the possibility of modifying the coefficients in three ways, either manually modifying the coefficients (Fig. 11), or manually entering the energies corresponding to each count (Fig. 12), or graphically (see part of the graph space below).



Energy calibration

$E = a + b \cdot Ca + c \cdot Ca^2 + d \cdot Ca^3$

\* a = 1.4848199

\* b = 0.22608423

c = 1.5479173E-1

d = 0

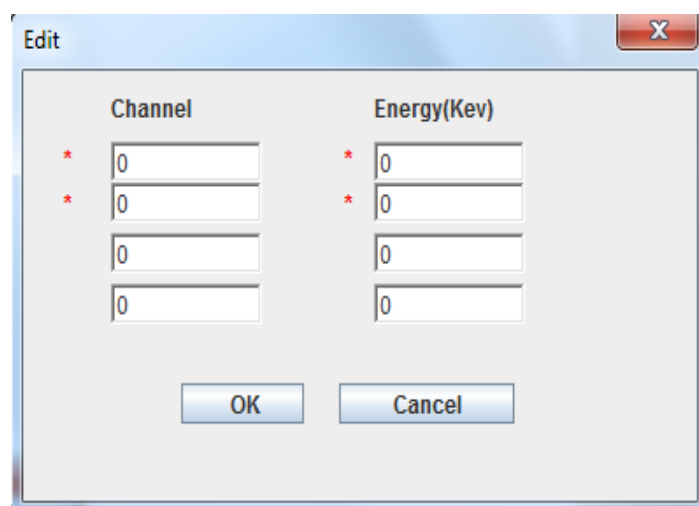
Visualise

inialize

Channel\_energy Modification

OK Cancel

Fig. 11. The coefficients of the energy calibration.



Edit

Channel	Energy(Kev)
0	0
0	0
0	0
0	0

OK Cancel

Fig. 12. Calibration by Channel and corresponding energy.

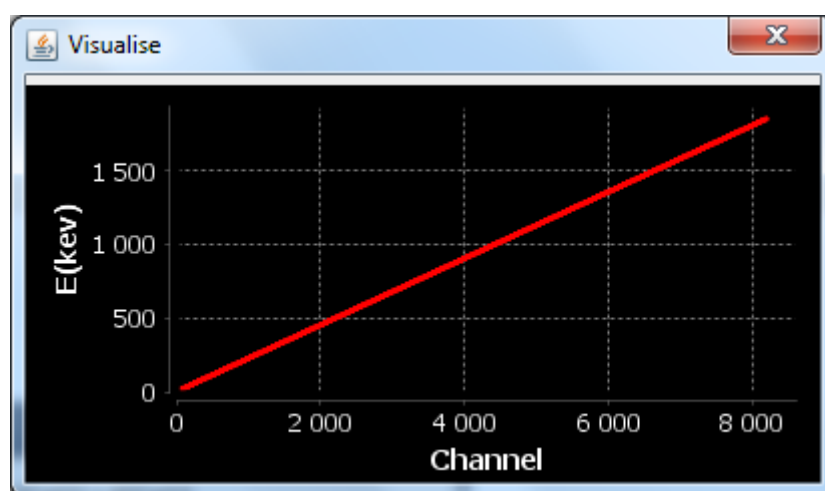


Fig. 13. The energy calibration graph.

**FWHM calibration:** Two coefficients a and b can be modified.

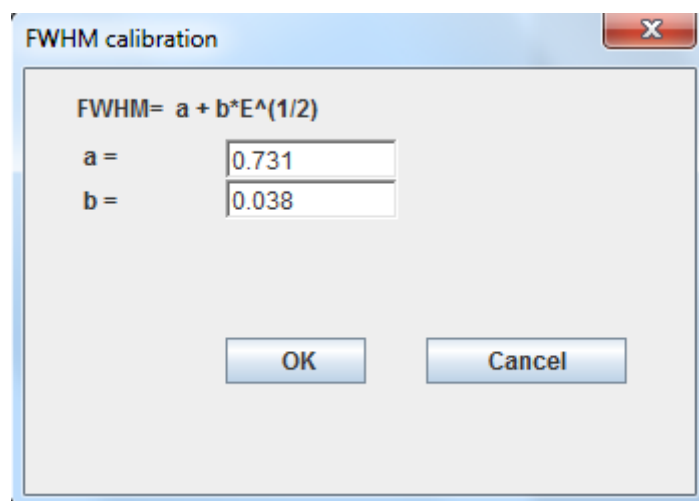


Fig. 14. FWHM calibration window.

**Tail calibration:** To correct the peak shape.

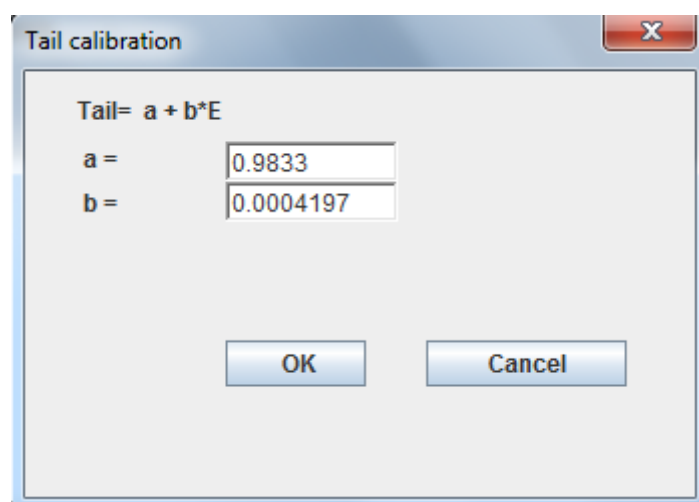


Fig. 14. Peak tail calibration window.

### III .1. 3 Analysis

The analysis menu contains eight options. These are usually options in which the user improves their analyzes.

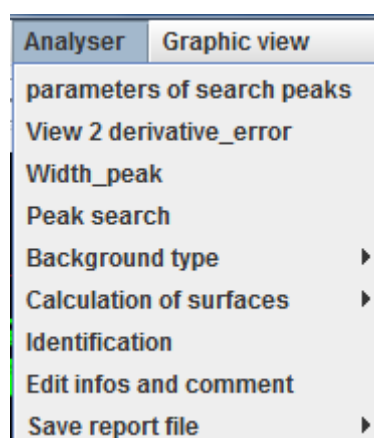
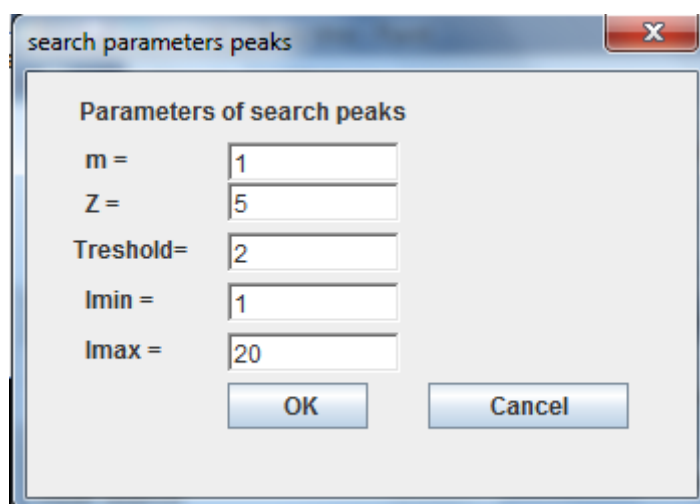


Fig. 15. Analysis menu.



**Parameters of search peaks:** These are parameters to analyze the spectrum.



search parameters peaks

Parameters of search peaks

m = 1

Z = 5

Treshold= 2

lmin = 1

lmax = 20

OK Cancel

Fig. 16. Analysis parameters.

**m** and **z** are coefficients to smooth the spectrum.

**Threshold** is the peak acceptance threshold.

**lmin** and **lmax** are the minimum and maximum number of negative points of the smoothed second derivative to accept peaks.

**View 2 derivative\_error:** It has been integrated to best choose the values of **lmin** and **lmax**.

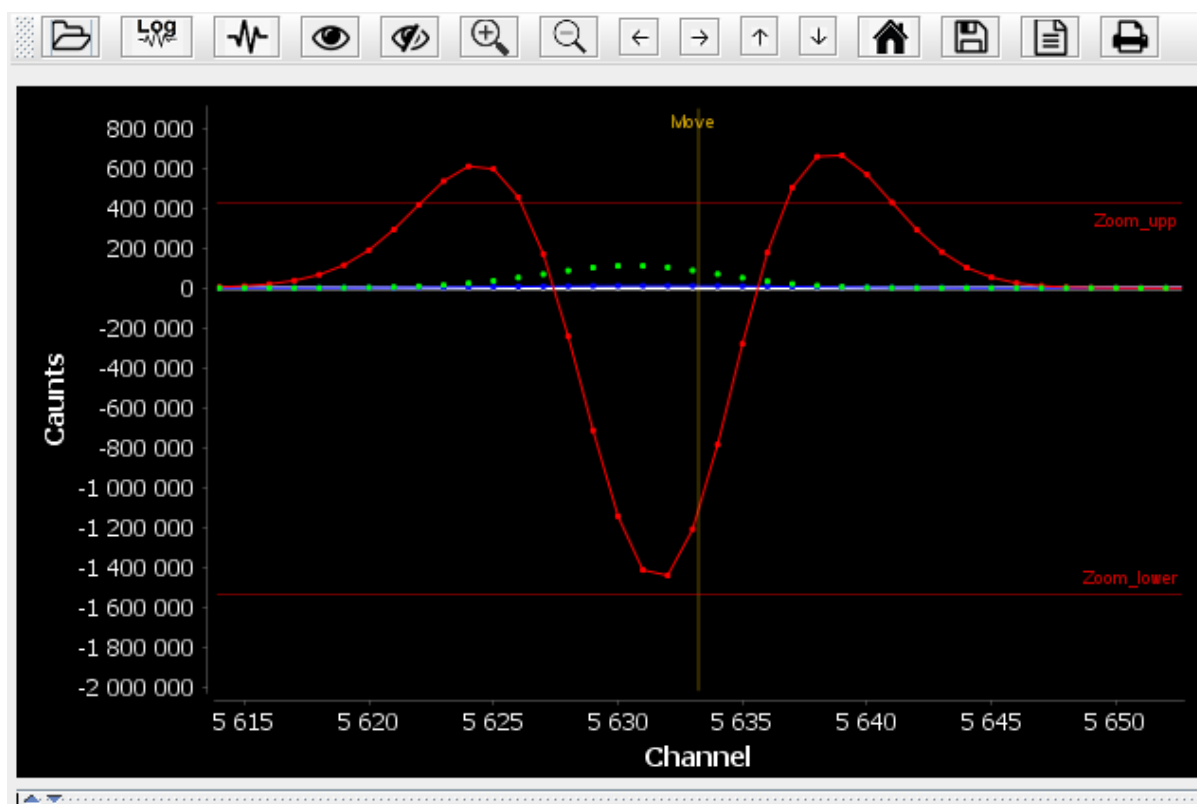


Fig. 17. Graph of the smoothed second derivative and its error.

**Width\_peak:** the sub-peak width in which the program starts to calculate the area.

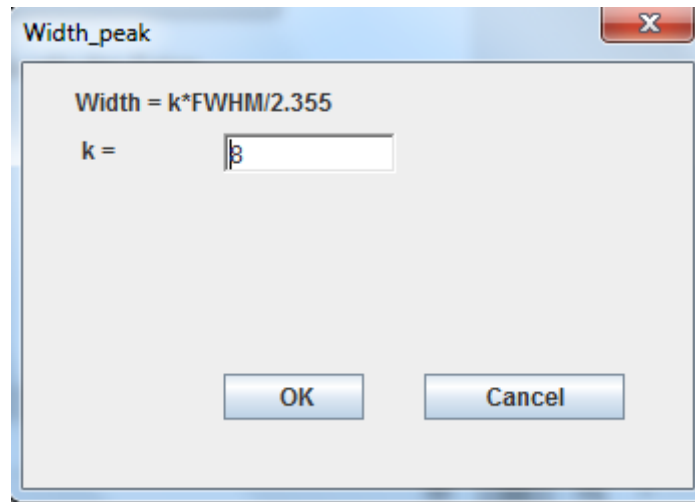


Fig. 18. Window of the width value below peak.

**Peak search:** The program searches for peaks, then displays them in the result space (Fig.20). The peak markers are also displayed on the graph (Fig.19). The scale previously chosen by user.

A "Clear Marker" button in the marker and info space allows to delete all markers.

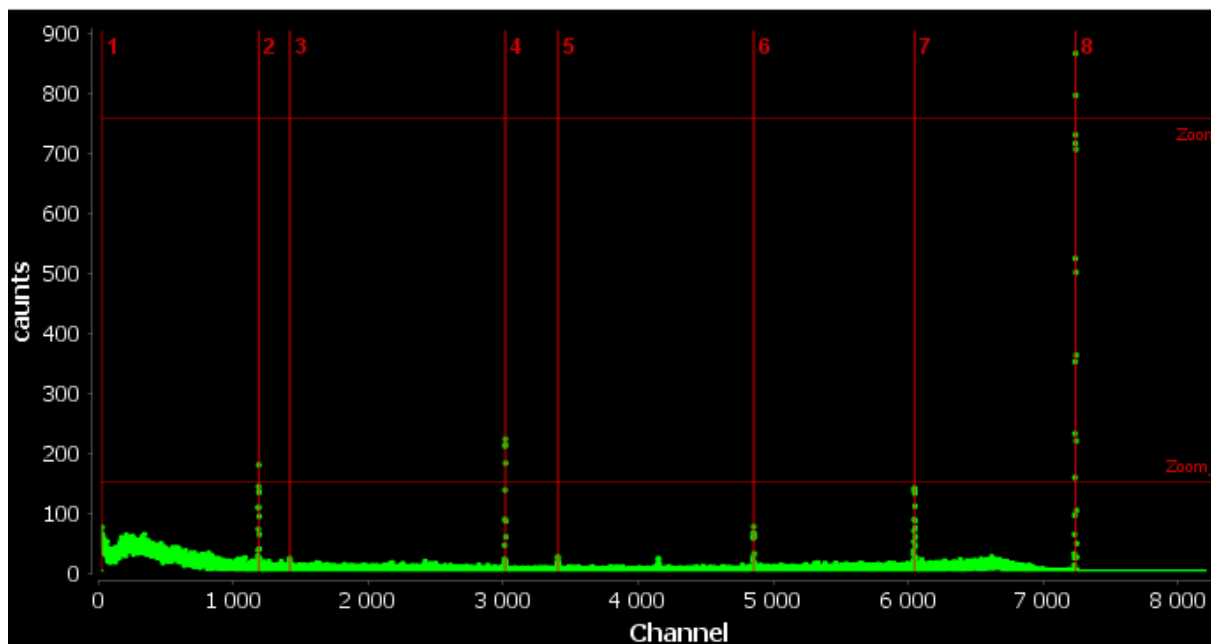


Fig. 19. The markers corresponding to each peak.

N° peak	Centroid_Channel	Energy_kev
001	0026	0013,22
002	1191	0512,07
003	1421	0610,56
004	3016	1293,53
005	3406	1460,53
006	4855	2080,99
007	6046	2590,98
008	7239	3101,82

Fig. 20. The results of the peaks found in the results space.

**Background type:** three types of background can be used: “Straight line background”, “stepped background” and “parabolic background”. Currently, Straight line background is working. The others haven't yet.

**Calculation of surfaces:** Finding peaks and calculating the area of each peak. Two scales are available. The results of the analysis appear automatically in the graph space (Fig. 21) and the results space (Fig. 22). Peak regions are stained red, the tails of each peak are stained blue, and deconvolved peaks are stained red and light blue.

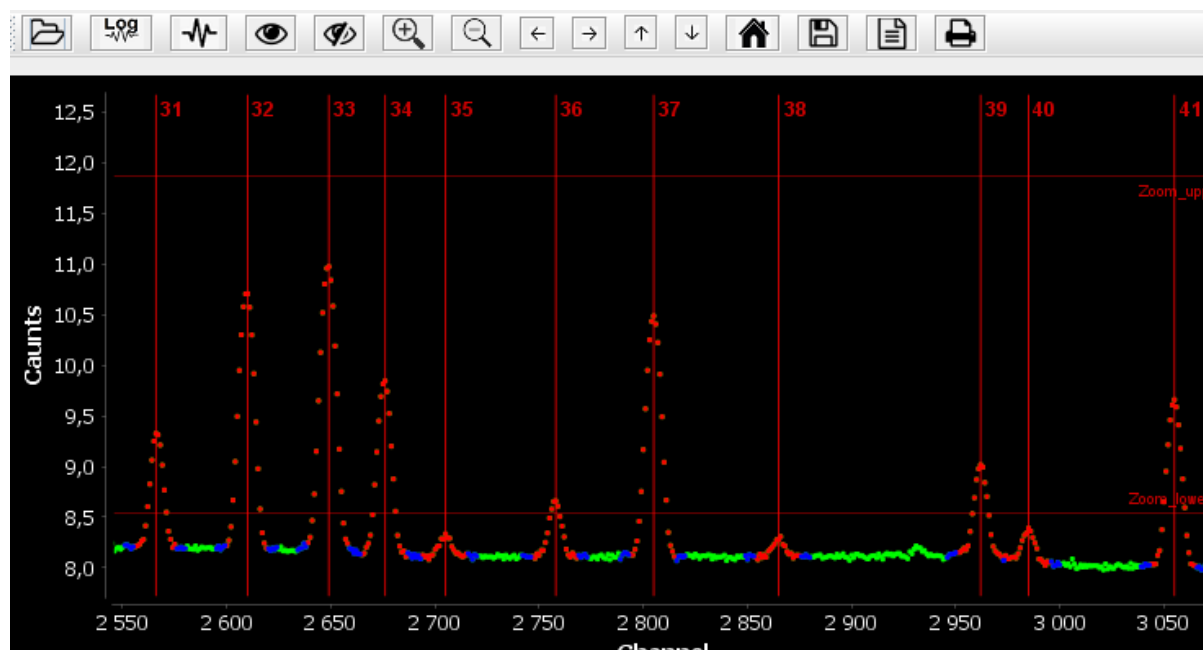
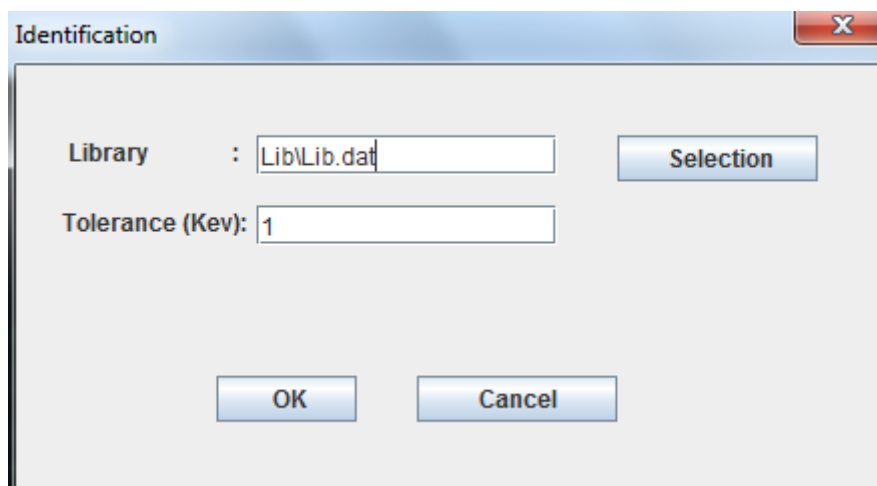


Fig. 21. Graph of peaks in case of calculating peak areas.

Channel	Energy	FWHM	Net area	Background	Error (%)
001M 15,00E00	48,76E-01	81,49E-02	20,92E04	19,64E04	37,05
002M 22,00E00	64,59E-01	82,76E-02	74,97E03	50,06E04	13,84
003S 15,40E01	36,30E00	96,00E-02	35,21E02	25,05E04	20,67
004M 18,60E01	43,54E00	98,17E-02	11,38E04	24,24E04	67,91
005M 19,70E01	46,02E00	98,88E-02	16,43E02	21,20E04	39,71
006M 21,10E01	49,19E00	99,75E-02	79,64E03	18,72E04	84,61
007M 21,80E01	50,77E00	10,02E-01	21,51E03	20,51E04	30,51

Fig. 22. Results of the analysis in case of calculating peak areas.

**Identification:** Here to identify the radionuclides. A standard library selected by default. The user has the option of selecting the desired library. If the user would like to create his own library, the file must have five columns, which are the radionuclide name, energy, intensity, half-life and its unit.



Identification

Library : Lib\Lib.dat

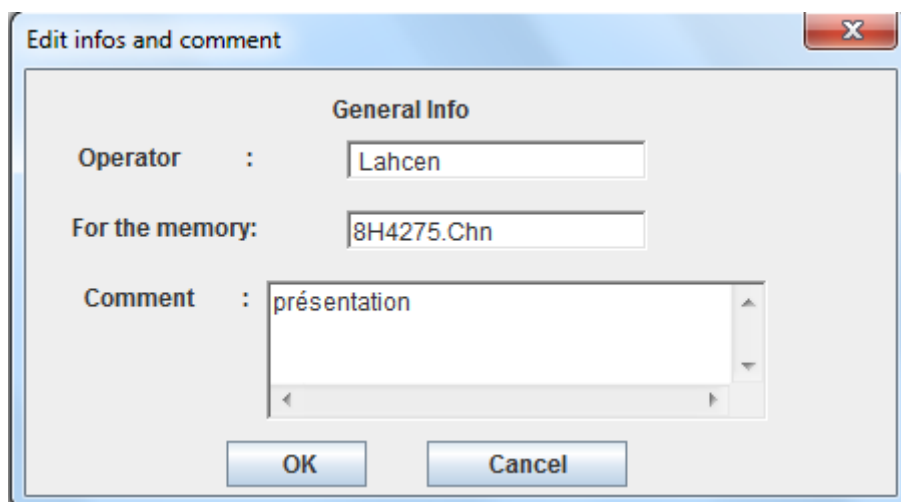
Tolerance (Kev): 1

Selection

OK Cancel

Fig. 23. The library selection of radionuclides.

**Edit infos and comment:** The operator can fill this window. Each Edit will appear in the report file.



Edit infos and comment

General Info

Operator : Lahcen

For the memory: 8H4275.Chn

Comment : présentation

OK Cancel

Fig. 24. Edit info and comment window.

**Save report file:** A file created contains Edit info and the results of the analysis.

Operator	: Lahcen					
Date	: Tue Jul 20 18:16:13 CEST 2021					
Name of the analyzed file	: 8H4275.Chn					
Comment	: présentation					
	Channel	Energy	FWHM	Net area	Background	
001M	15,00E00	48,76E-01	81,49E-02	20,92E04	19,64E04	37,
002M	22,00E00	64,59E-01	82,76E-02	74,97E03	50,06E04	13,
003S	15,40E01	36,30E00	96,00E-02	35,21E02	25,05E04	20,
004M	18,60E01	43,54E00	98,17E-02	11,38E04	24,24E04	67,
005M	19,70E01	46,02E00	98,88E-02	16,43E02	21,20E04	39,
006M	21,10E01	49,19E00	99,75E-02	79,64E03	18,72E04	84,
007M	21,80E01	50,77E00	10,02E-01	21,51E03	20,51E04	30

Fig. 25. Report file created.

### III .1. 4 Graphic view

The options under the "Graphic view" menu have been set so that the user has the ability to hide or show certain graph curves. Each option has two possibilities, either view or hidden.

Note: he must click on "Calculation of surfaces" again to display the graph with new option.

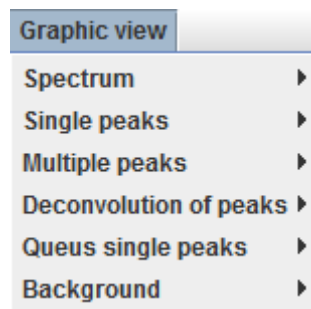


Fig. 26. The “Graphic view” menu options.

**Spectrum:** hidden case. The data spectrum is not showing. On the other hand, the detected peaks appear in the graph space.

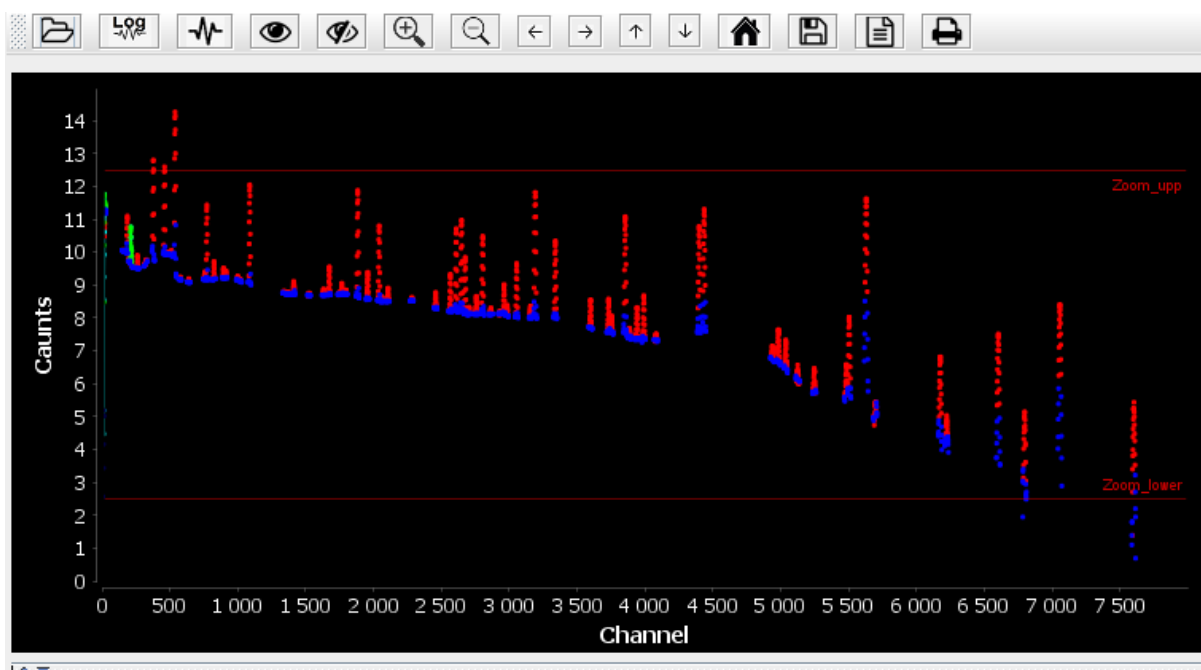


Fig. 27. Case of spectrum data is hidden

**Single peaks:** hidden case. Singles peaks no longer stay colored.

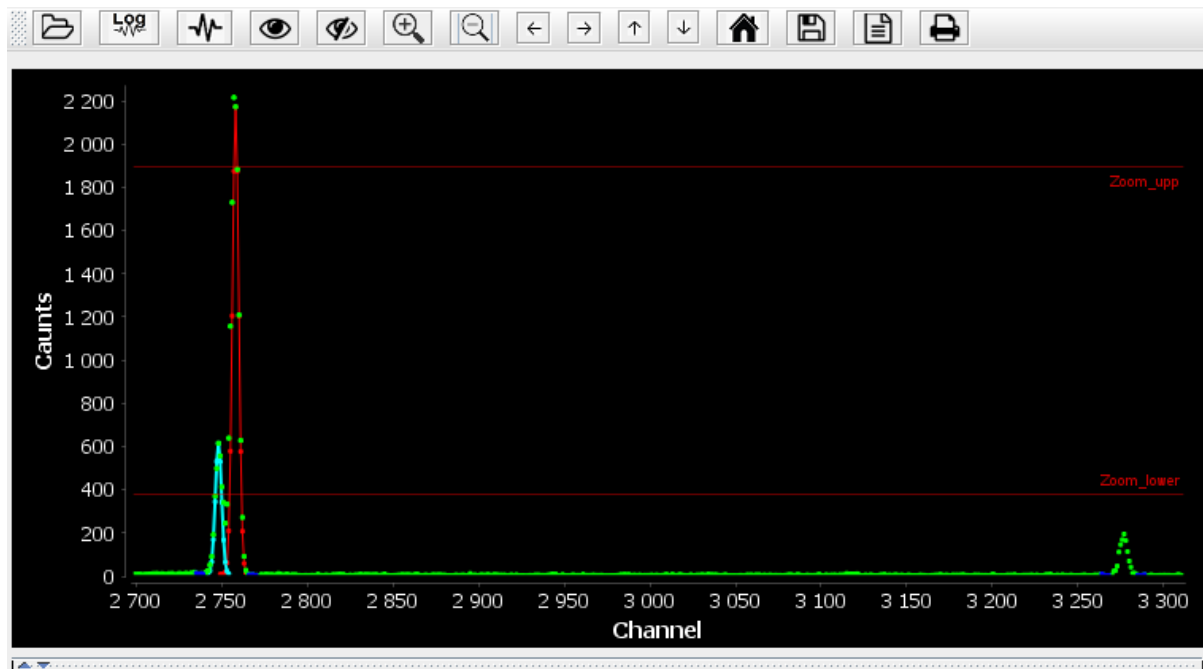


Fig. 28. Case of singles peaks are hidden

**Deconvolution of peaks:** hidden case. Gaussian peaks no longer remain visible.

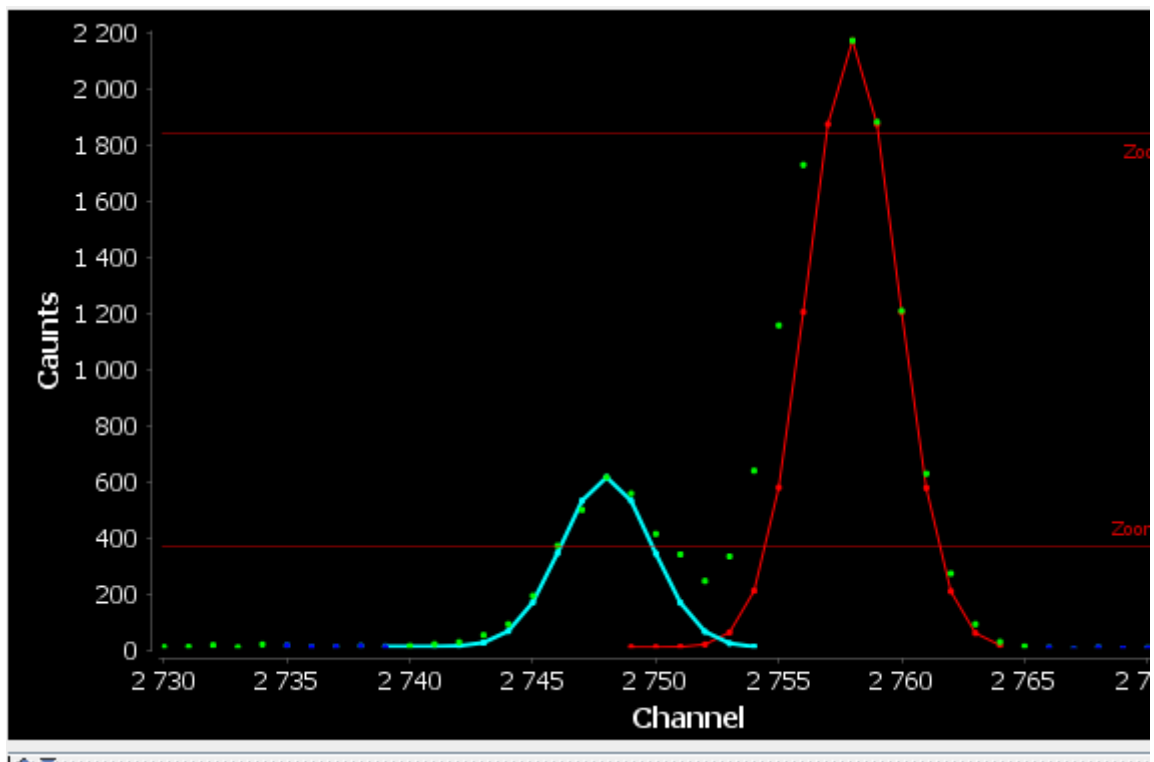


Fig. 29. case of multiple peaks are visible.

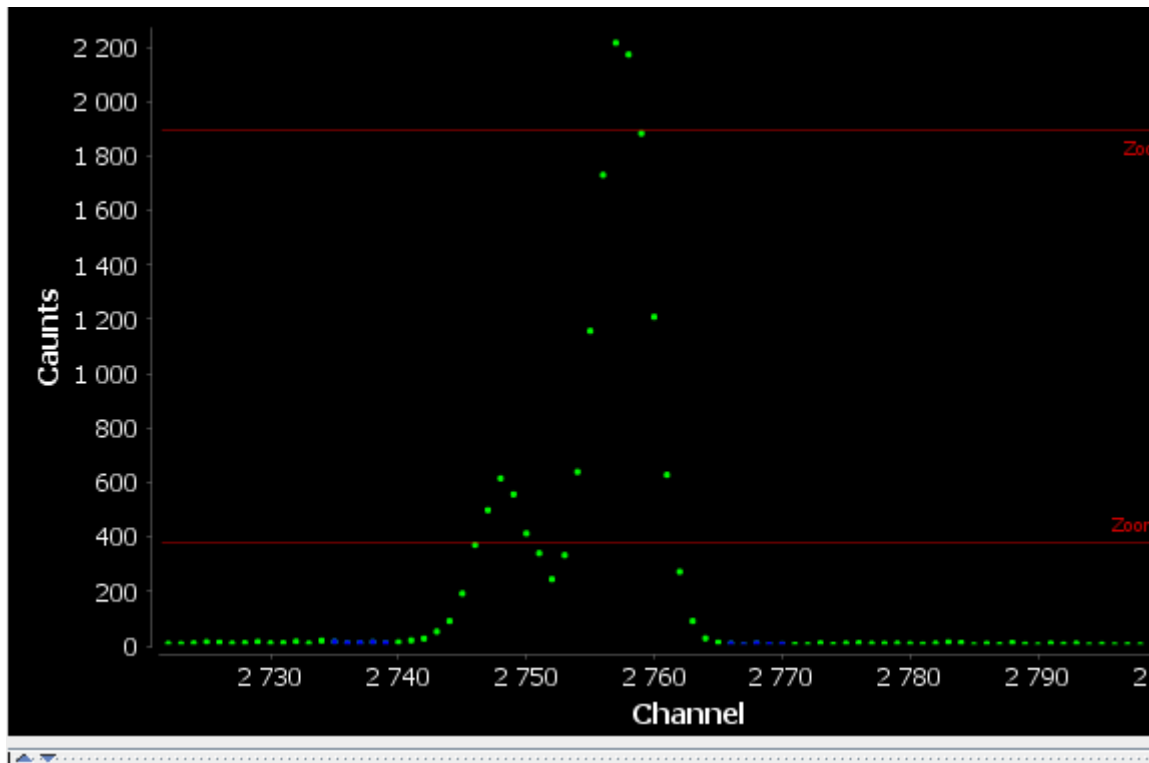


Fig. 30. Case of multiple peaks are hidden.

The same goes for the rest.

### III.2 Icon bar

The icon bar has fifteen icons. Each icon has a different functionality to the other. Usually these are shortcuts of menu bar. Including options for zooming and moving graphics.



Fig. 31. Icons bar.

- 1: the input file
- 2: display of the spectrum graph in logarithmic scale.
- 3: display of the spectrum graph in normal scale.
- 4: display of data in the results space.
- 5: erasing the content of the graph space and the results space.
- 6: zoom (+).
- 7: zoom (-).
- 8: graph movement to the left.
- 9: movement of the graph to the right.
- 10: zoom up.

11: zoom down.

12: return the graph to the initial state.

13: not yet

14: creation of a report file.

15: not yet.

Note: The icons six to twelve are also available by using the mouse (Fig. 22).

### III.3 Graph space

From menu options, mouse, icons and buttons, the user could see graphs in this space. Currently, this is the only space in which the user could view their graphs.

As soon as the graph is displayed, two options are available to control it. Either by icons or by the mouse. Figure 33 explains how to control the graph with the mouse.



Fig. 32. Graph space.



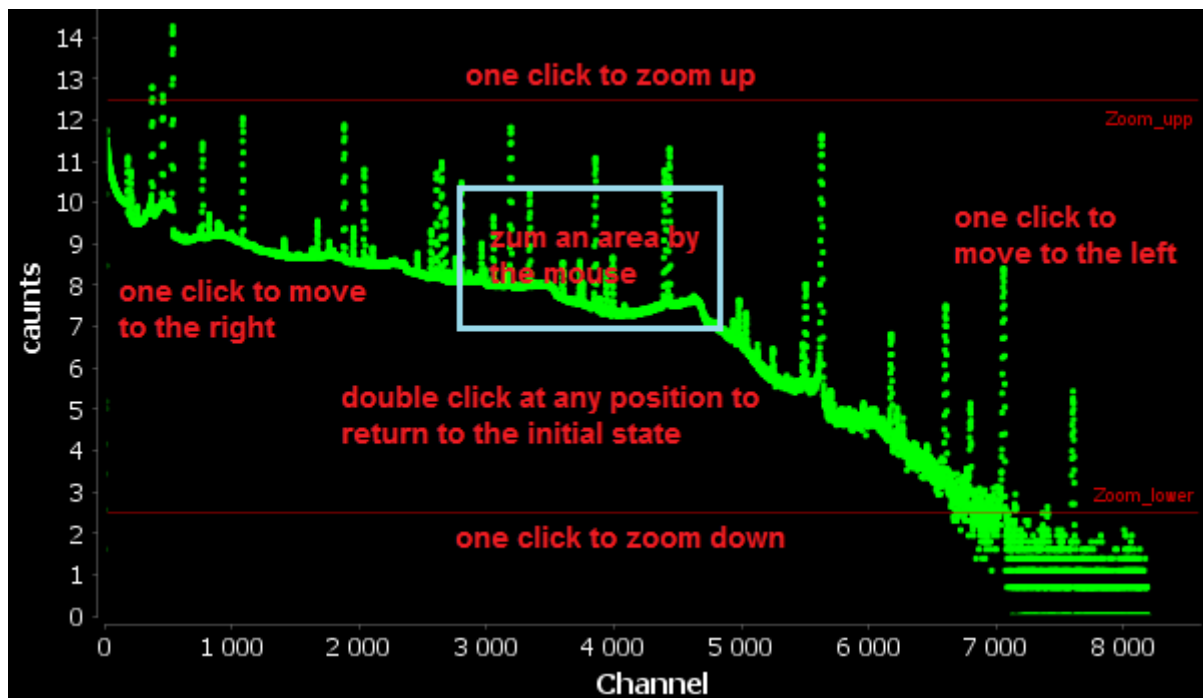


Fig. 33. Use of the mouse on the graph.

Another graphical energy calibration option is available in this part. Right click, then choose the last option (Fig. 34). When the user enters the energy value corresponding to the value of Channel (Fig. 35), the calibration coefficients will automatically change.

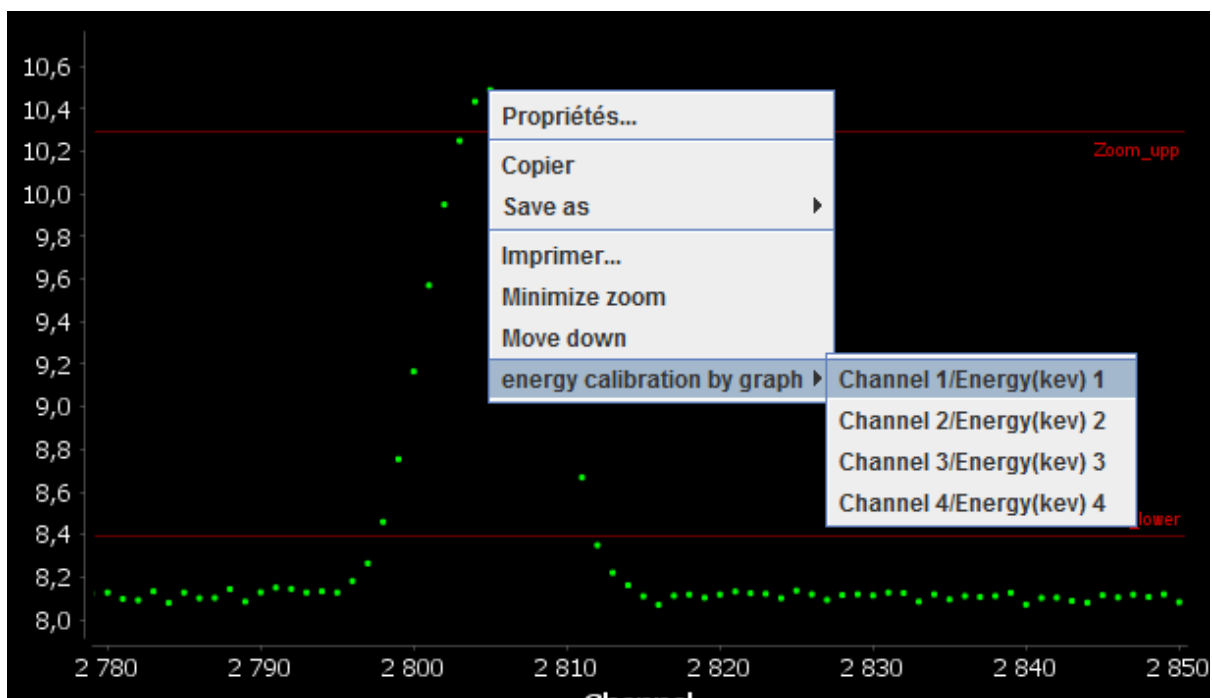


Fig. 34. Graphical energy calibration option.

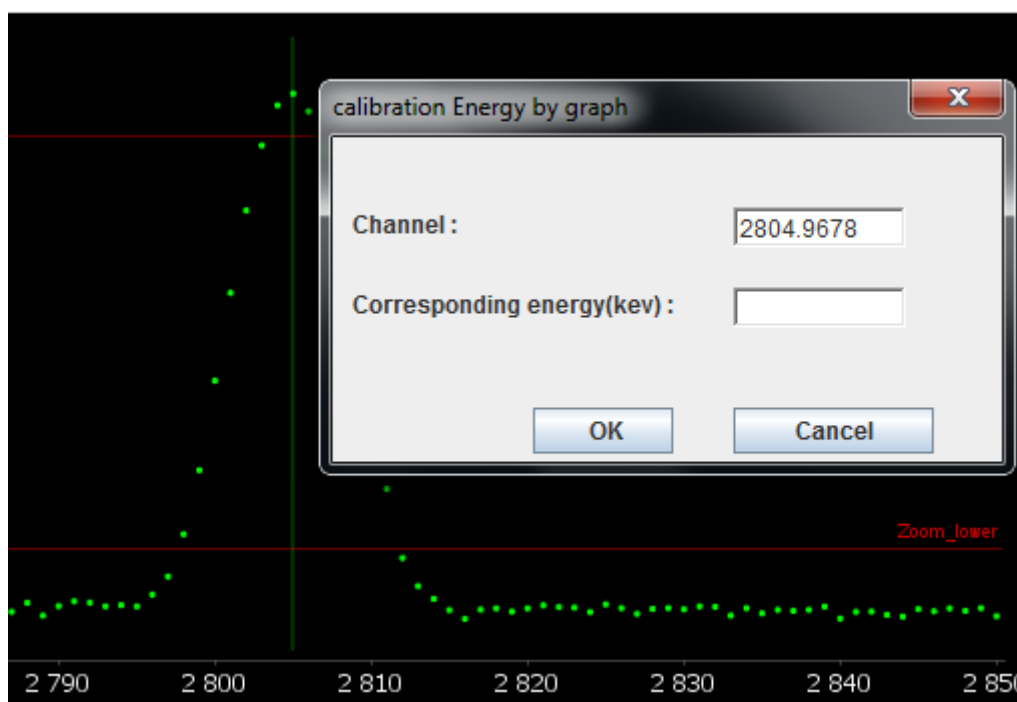


Fig. 35. Window to enter the energy value corresponding to the Channel.

### III .4 Space of Information extracted from file

Before entering the spectrum file, the space of information extracted from file was empty as shown in figure 36. As soon as the file opened in the program, the information is extracted from the file and then automatically displayed in this space (Fig. 37).

File name :	Energy calibration :	Length of detector description :
Start time :	Peak shape calibration :	Length of sample description :
Start date :	Detector description :	
Real :	Sample description :	
Live :	Channel range :	
Dead :		

Info extracted from spectrum file

Fig. 36. Space of Info extracted from file.

File name :	m0375sc1.Chn	Energy calibration :	$E = -44.55694 + 0.3239517 \text{ } ^\circ\text{C} + -2.02589\text{E-}7 \text{ } ^\circ\text{C}^2$	Length of detector description :	13.0
Start time :	12:00:37	Peak shape calibration :		Length of sample description :	0.0
Start date :	09Mar11	Detector description :	3.102 Compton		
Real :	609.52	Sample description :			
Live :	600.0	Channel range :	From 0 to 8192		
Dead :	1.5618879 %				

Info extracted from spectrum file

Fig. 37. The info extracted after putting the spectrum file.

### III .5 Space for markers and analysis information

This space is useful after finding peaks or calculating areas. It has two functions. The first is to display the information for each peak found. The second is to clarify and simplify the vision of the peaks.

Four buttons manage these two functions (Fig. 38). If the user has not yet searched peaks or calculated areas, a dialog box will appear asking the user to search peaks first (Fig. 39).

Peak N°	Next	Channel :	Net Area :	Nucleid :
<input type="text"/>	Previous	Energy :	Error :	Energy :
	Range	Clear Marker	FWHM :	Intensity :
				half life :

Fig. 38. Space for markers and analysis info.

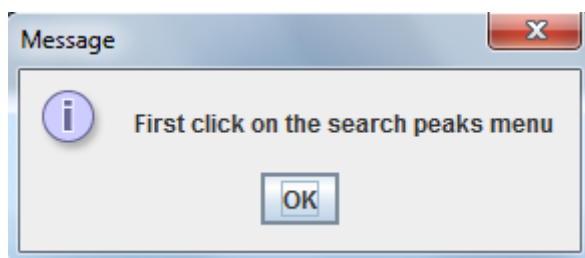


Fig. 39. Dialog box.

After searching for peaks or calculating areas, the following four buttons are ready:

**Next** : To move the peak marker to the next peak.

**Previous** : To move the peak marker to the previous one.

**Range** : To appear the peak marker on the complete graph. Then the word "Range" becomes "Not Range" and vice versa.

**Not Range** : To appear the peak marker on the peak range.

**Clear Marker**: To clear the marker.

As soon as the user clicks on "Next" or "previous", the information about the peak appears. If the area calculation was not done, the peak number, channel number and energy value displayed. If not, the area, error and FWHM info is also displayed (Fig. 40).

Peak N°	Next	Channel :	81.0	Net Area :	14372.0 Cnts	Nucleid :	TH231
3	Previous	Energy :	58.8211 Kev	Error :	13.741328 %	Energy :	59.0 Kev
	Range	Clear Marker		FWHM :	1.0224407 Kev	Intensity :	0.2 %
						half life :	7E+8 y

Fig. 40. The pic info.

The marker includes information on each peak (Fig. 41). Both scales are working.

Note: To clarify the peak vision in case of "Not Range", it is preferable to use the normal scale.

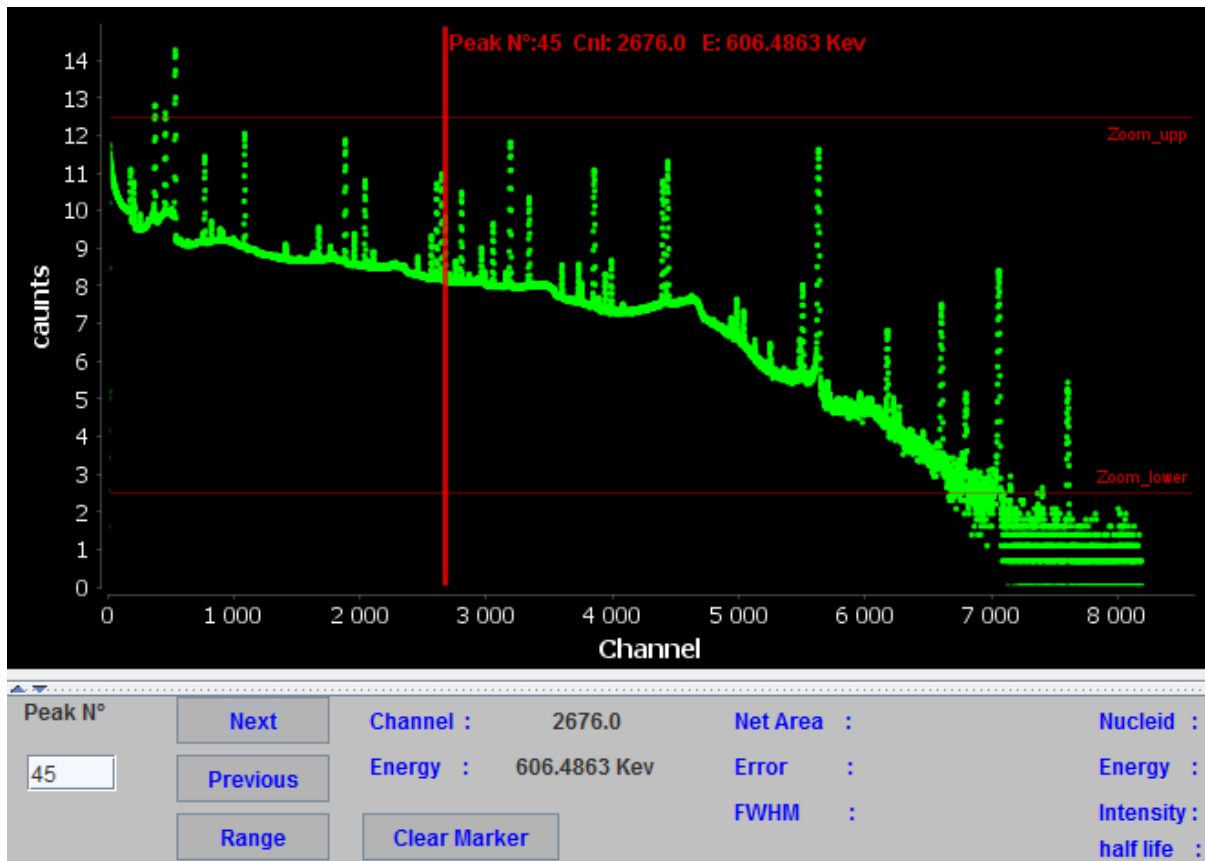


Fig. 41: Marker in the "Range" option before having calculated the areas of the peaks.

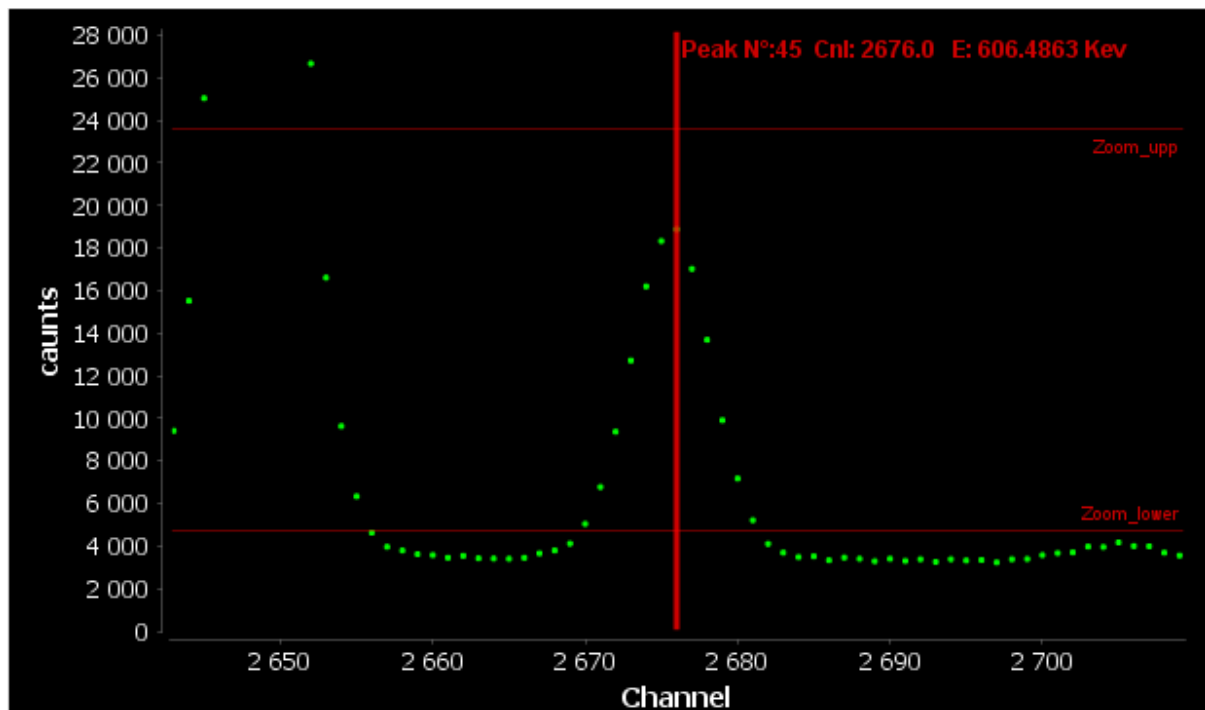


Fig. 42: Marker in the "Not Range" option before having calculated the areas of the peaks.

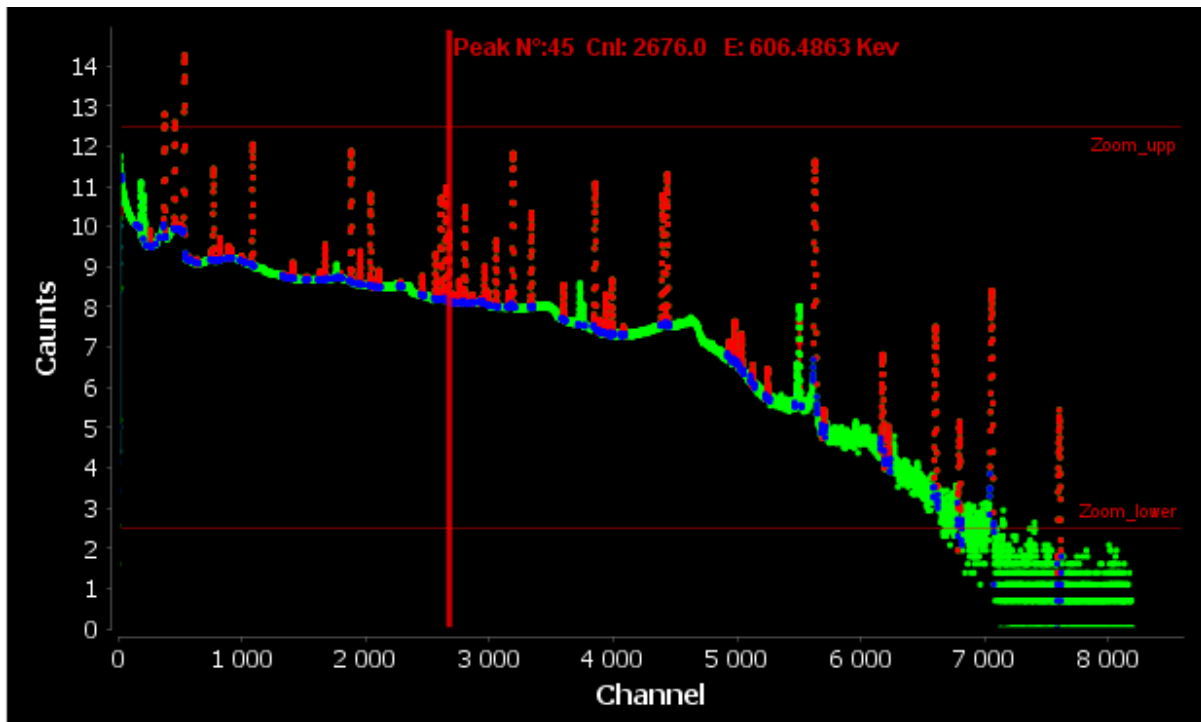


Fig. 43. Marker in case of choosing the "Range" option after having calculated the areas of the peaks.

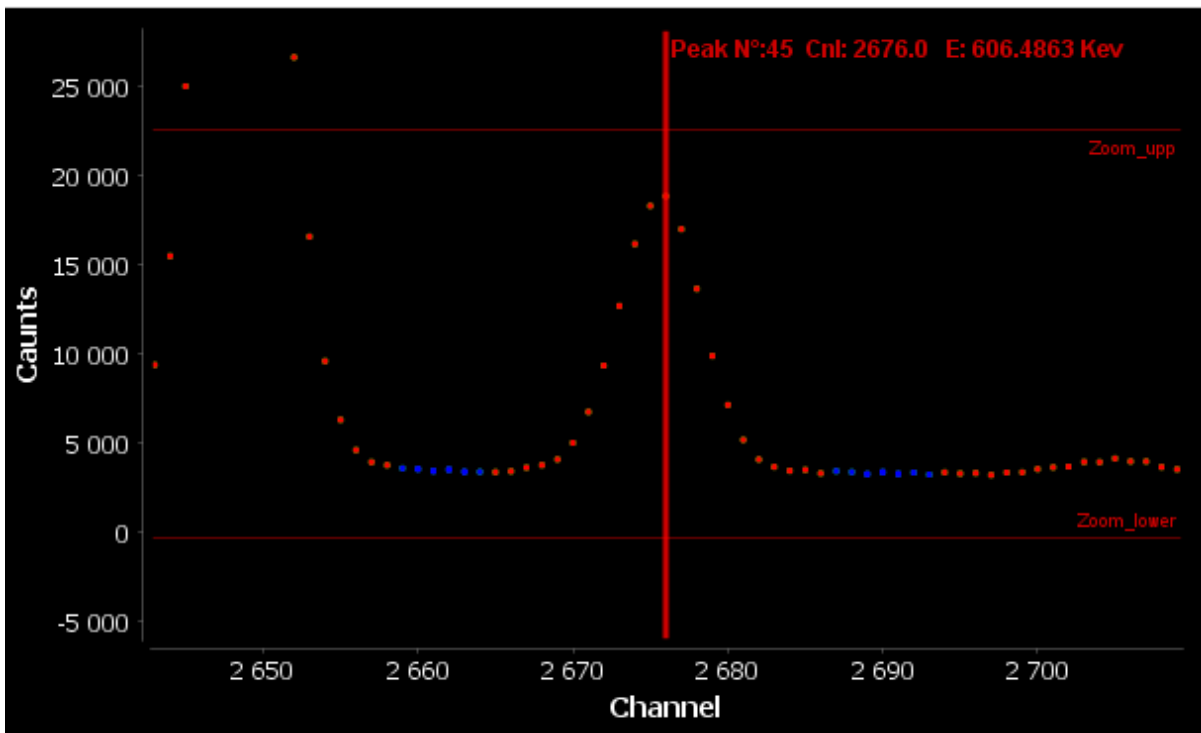


Fig. 44. Marker in case of choosing the "Not Range" option after having calculated the areas of the peaks.

### III .6 Space of results

It is a display space. It is possible to see in this space: spectrum data, the peaks found and the results of the analysis. The copy and cut options are still working. Including, the modification.

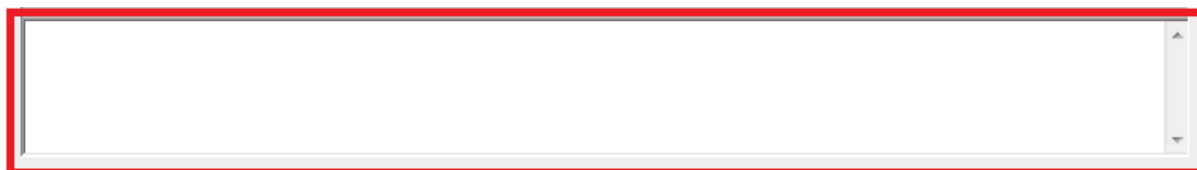


Fig. 45. Results space.