GSA v3

01 August 2025.

Gamma-ray Spectrum Analysis (GSA v3) Software Guide

Edited by:
Dr LAHCEN El Amri
lahssenelamri@gmail.com

[1] Nuclear Reactor Energy and Physics, Nuclear Security and Environment Team (PRESN), Faculty of Sciences, Mohammed V University, 4 Avenue Ibn Battouta, B.P. 1014, Rabat, Morocco.

[2] National Centre for Nuclear Energy, Science and Technology (CNESTEN), B.P. 1382, R.P. 10001, Rabat, Morocco

[3] Laboratory of Condensed Matter and Interdisciplinary Sciences (LaMCScI), Faculty of Sciences, Mohammed V University, 4 Avenue Ibn Battouta, B.P. 1014, Rabat, Morocco.

[4] Higher Institute of Health Sciences (ISSS), Hassan First University, Settat, Morocco.

[5]Materials Physics and Subatomic Laboratory, Physics department, faculty of science, Ibn Tofail University, Kenitra, Morocco

Contents

Figures

1. Introduction

This guide describes the new version of the **GSA v3** software, an advanced and flexible tool dedicated to gamma spectrum analysis. This version introduces numerous enhanced features, enabling users to optimize peak identification and adjustment, manage regions of interest (ROI), and efficiently handle background and overlapping peaks. With an intuitive interface and interactive graphical tools, **GSA v3** allows both manual and automatic adjustments with high precision, displaying results in real time for complete control over the analysis.

The software is designed to meet the needs of researchers, technicians, and students in gamma spectrometry, combining flexibility, speed, and reliability. It not only allows detailed visualization and manipulation of spectra but also generates clear and structured reports, facilitating documentation and result sharing. This guide aims to present all available features, explain their practical use, and provide guidance for making the most of **GSA v3** in conducting precise and professional gamma spectrum analyses.

2. The GSA v3 graphical user interface (GUI)

As soon as the user opens the **GSA v3** software, the **graphical user interface** automatically appears (see Fig. 1). This interface is designed in a clear and ergonomic way to ensure ease of use, and it is generally composed of **four main sections**:

1. **The menu bar**, located at the top of the screen, which gathers all the essential functionalities. It allows the user to load spectra, access different analysis methods, manage calibration options, or export the results.
2. **The toolbar with icons**, placed just below, which provides quick and simplified access to the most frequently used commands. Thanks to these visual shortcuts, the user can, for example, zoom into a specific area of the spectrum, refresh the display, or select a processing method with a single click.
3. **The graph display area**, occupying the central part of the interface. This is where the gamma spectrum is displayed in graphical form. The user can interact with the graph, examine peaks, apply smoothing or background subtraction methods, and visualize in real time the effects of the applied processing.
4. **The results area**, generally located at the bottom, which provides detailed information obtained from the analysis. This section presents numerical parameters such as the energies of the identified peaks, their intensities, the associated uncertainties, as well as derived calculations like efficiency or activity.

Fig.1 illustrates the GSA v3 interface as it appears at the first launch, before any analysis operation. In contrast, **Fig.2** shows the same interface after an analysis has been performed: the spectrum is processed and the corresponding results are displayed in the dedicated area, thus allowing the user to directly interpret the experimental data.

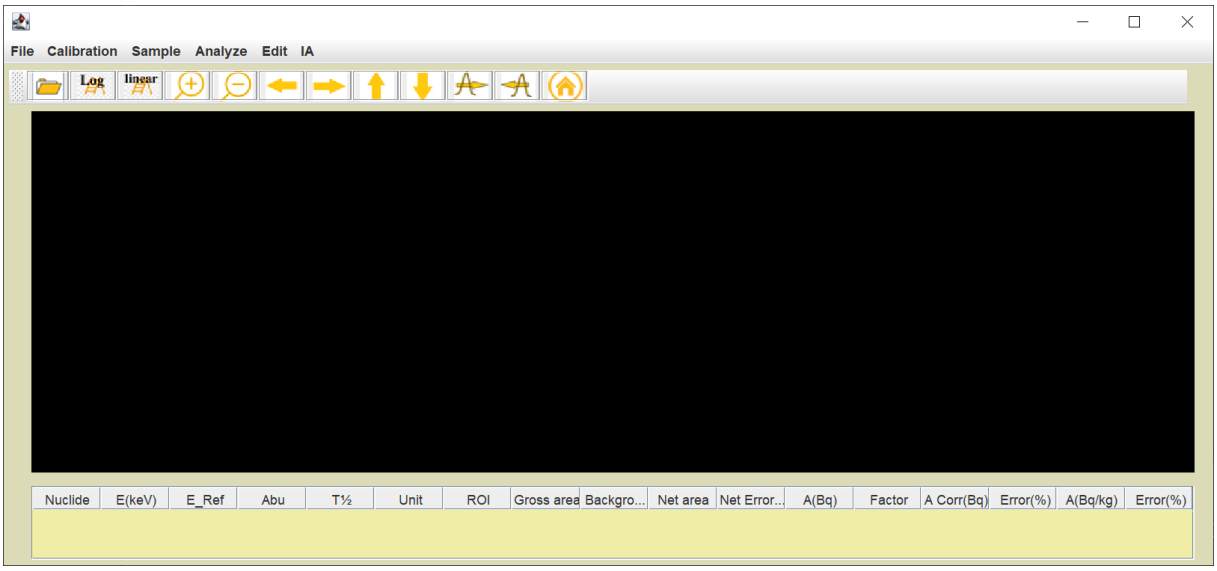


Fig. 1 Screenshot of the GUI at the first launch.

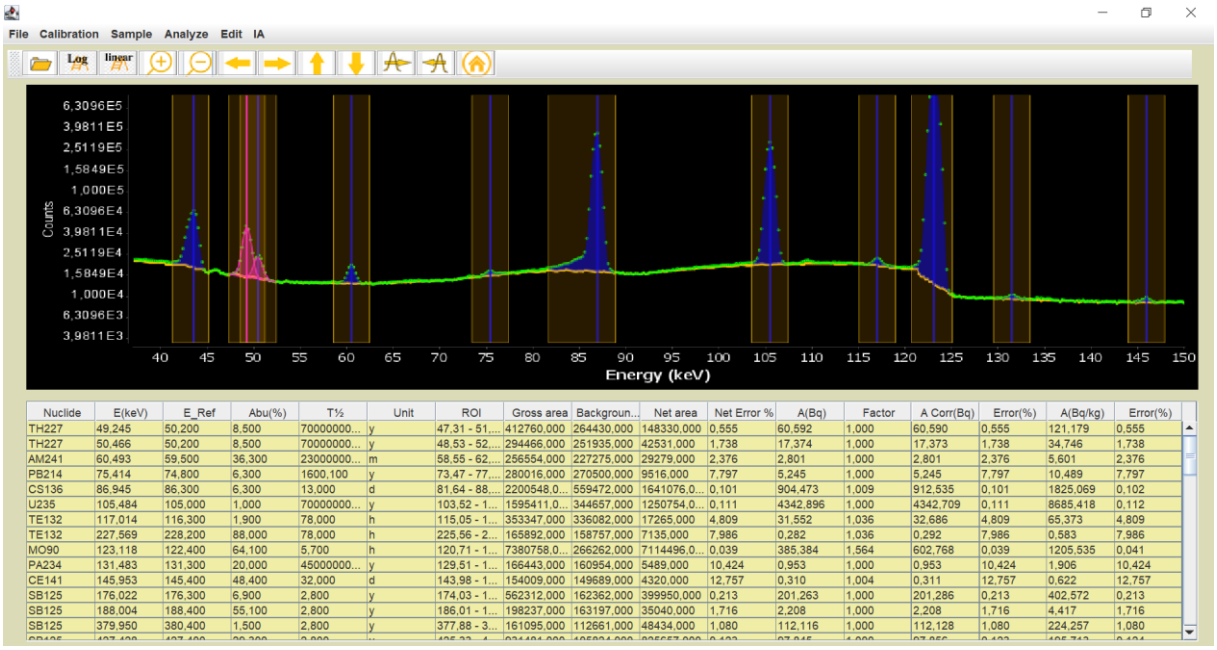


Fig. 2 Screenshot of the GUI during analysis.

3. The menu bar

Currently, GSA v3 includes six menus in the menu bar, as shown in Fig. 3. These are: File, Calibration, Sample, Analysis, Edit, and finally AI.

Fig. 3 Menu Bar

3.1 File menu

The File menu includes three submenus: Open File, Export PDF, and Extract the spectrum .dat file, as illustrated in Fig. 4:

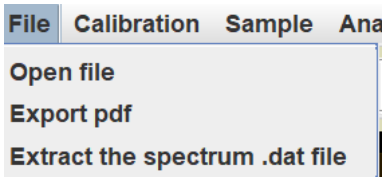


Fig. 4 File submenu

Open File:

This option allows the user to select a previously acquired gamma spectrum file (see Fig.5). Once the file is selected, the spectrum is automatically and graphically displayed in the dedicated graph area. This feature enables the user to immediately visualize the data, examine peak positions, and prepare the spectrum for further analysis.

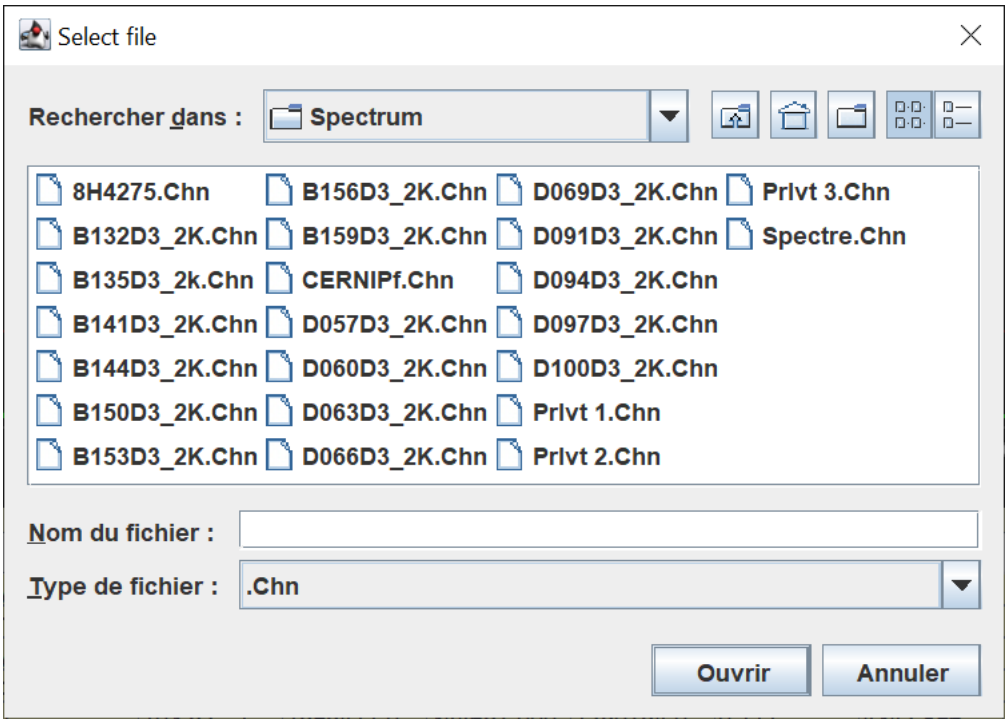


Fig. 5 Gamma Spectrum File Selection Window

Export PDF:

Although the area at the bottom of the spectrum already displays some results, an “Export PDF” **submenu** has been added to provide more data and information, as well as a reference footprint of the GSA v3 software. This feature allows the user to generate a complete PDF report containing all the necessary information about the measurement, the analysis, and

the results, along with additional details such as the date and the acquisition center. Fig. 6 shows a portion of an example screenshot of an exported PDF.

Fig. 6 Screenshot of an example portion of a PDF exported by GSA

Extract the Spectrum (.dat) File:

This submenu has been added to provide the user with a gamma spectrum dataset when needed. Indeed, the original gamma spectrum files are in binary format, which prevents the user from understanding their content without decoding. This option therefore serves as **a** conversion tool, transforming unreadable (binary) content into readable and usable (text) data. After clicking this option, a **.**dat file is generated, containing two columns: Energy (keV) and Counts, as illustrated in Fig. 7.

Energy(keV)	Counts
1,485	0
1,711	0
1,937	0
2,163	0
2,389	0
2,615	5
2,841	13
3,067	31
3,293	64
3,520	151

Fig. 7 Screenshot of an example portion of a .dat file generated by GSA v3

3.2 Calibration menu

The Calibration menu includes three submenus, as shown in Fig. 8**:** Energy Calibration**,** FWHM Calibration**,** and Efficiency Calibration. Each submenu contains all the necessary options to perform the corresponding type of calibration, allowing the user to accurately configure and adjust the gamma spectrum parameters.

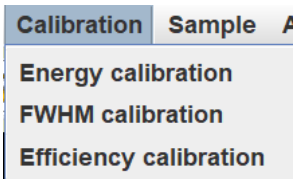


Fig. 8 Submenus of the Calibration menu

Energy Calibration:

This submenu is designed to automatically read the formula coefficients from the acquired spectrum file. If the file does not contain these coefficients, and to prevent any bugs, the software uses default values**.** The user still has the possibility to modify and adjust these values as needed (see Fig. 9).

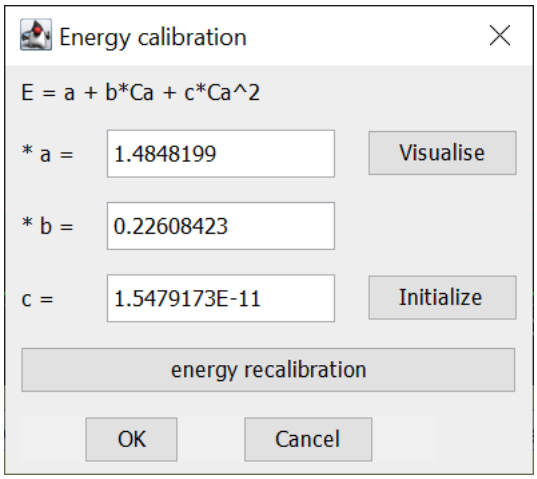


Fig. 9 Screenshot of the Energy Calibration window

When the user clicks the **“Visualise”** button, a new window opens, displaying the **energy versus** channel curve (see Fig. 10).

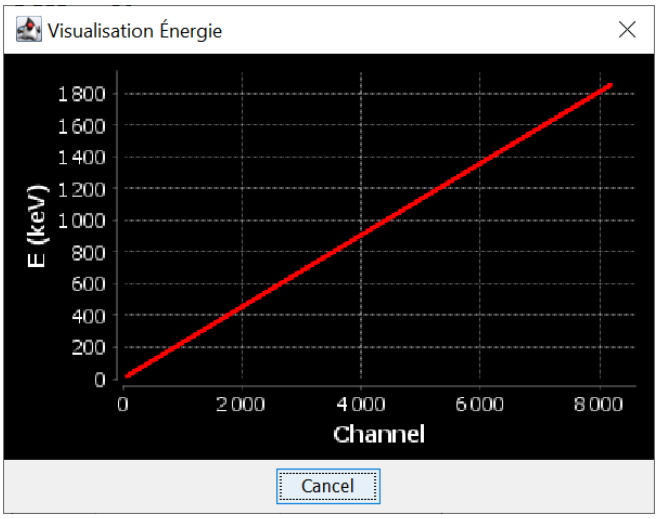


Fig. 10 Energy Calibration Curve

Moreover, when the user clicks the "Energy Recalibration" button, a new window appears, providing all the necessary options for energy recalibration (see Fig. 11). The user must enter the channel value and its corresponding energy value. At least two pairs of values (channel and corresponding energy) are required.

History boxes are integrated next to each channel and energy field to store previous values, simplifying the analysis. When the user clicks "OK", the GSA software automatically calculates the new calibration formula coefficients.

If the user clicks the "Initialize" button (see Fig. 9), the formula coefficients are reset, returning to the original values read during the first file load.

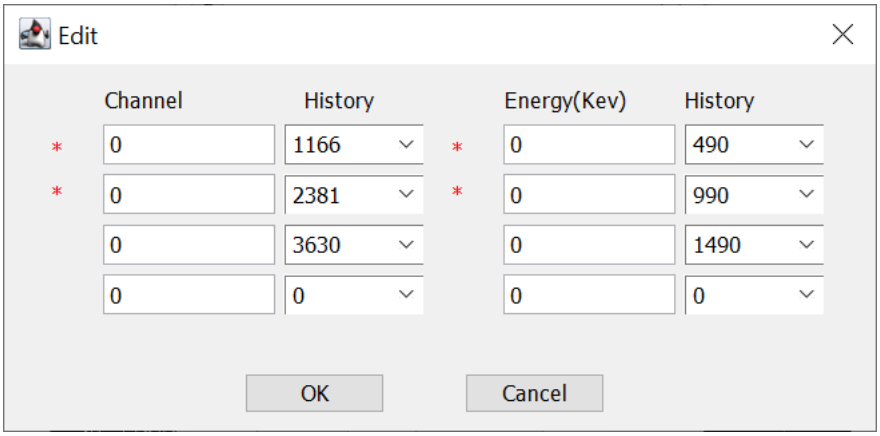


Fig. 11 Energy Recalibration Window

FWHM Calibration:

This submenu is dedicated to calibrating the Full Width at Half Maximum (FWHM) of peaks. This step is essential for accurately determining the **Regions of** Interest (ROI) and correctly calculating the net area of each peak. Two different formulas are integrated (see Fig. 12):

- The first formula is used when the gamma spectrum file **d**oes not have the .CHN extension.
- The second formula applies when the gamma spectrum file has the .CHN extension.

Note: Currently, GSA only reads files with the .CHN extension. Support for other extensions will be added in future versions.

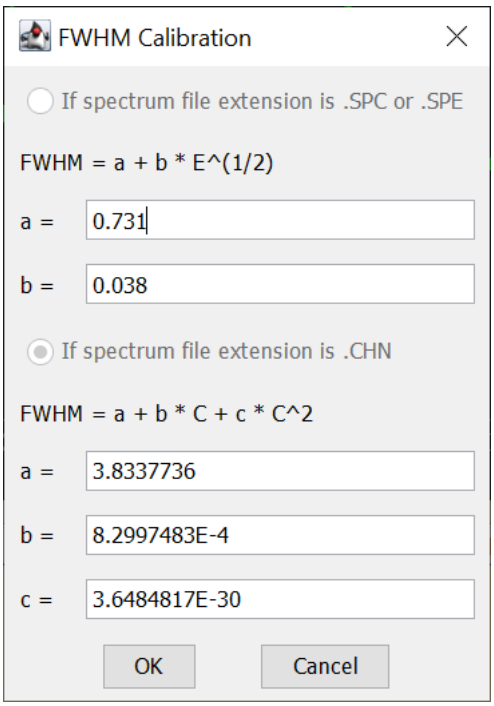


Fig. 12 **Screenshot of the FWHM Calibration Window**

Efficiency Calibration:

An efficiency calibration formula is used to calculate the efficiency value for any desired energy. It is a logarithmic formula of degree n, which the user can modify using a dedicated option (see Fig. 13). When the degree of the formula is changed, the formula coefficients and the graph are updated in real time, providing the user with immediate feedback on the effect of their adjustments.

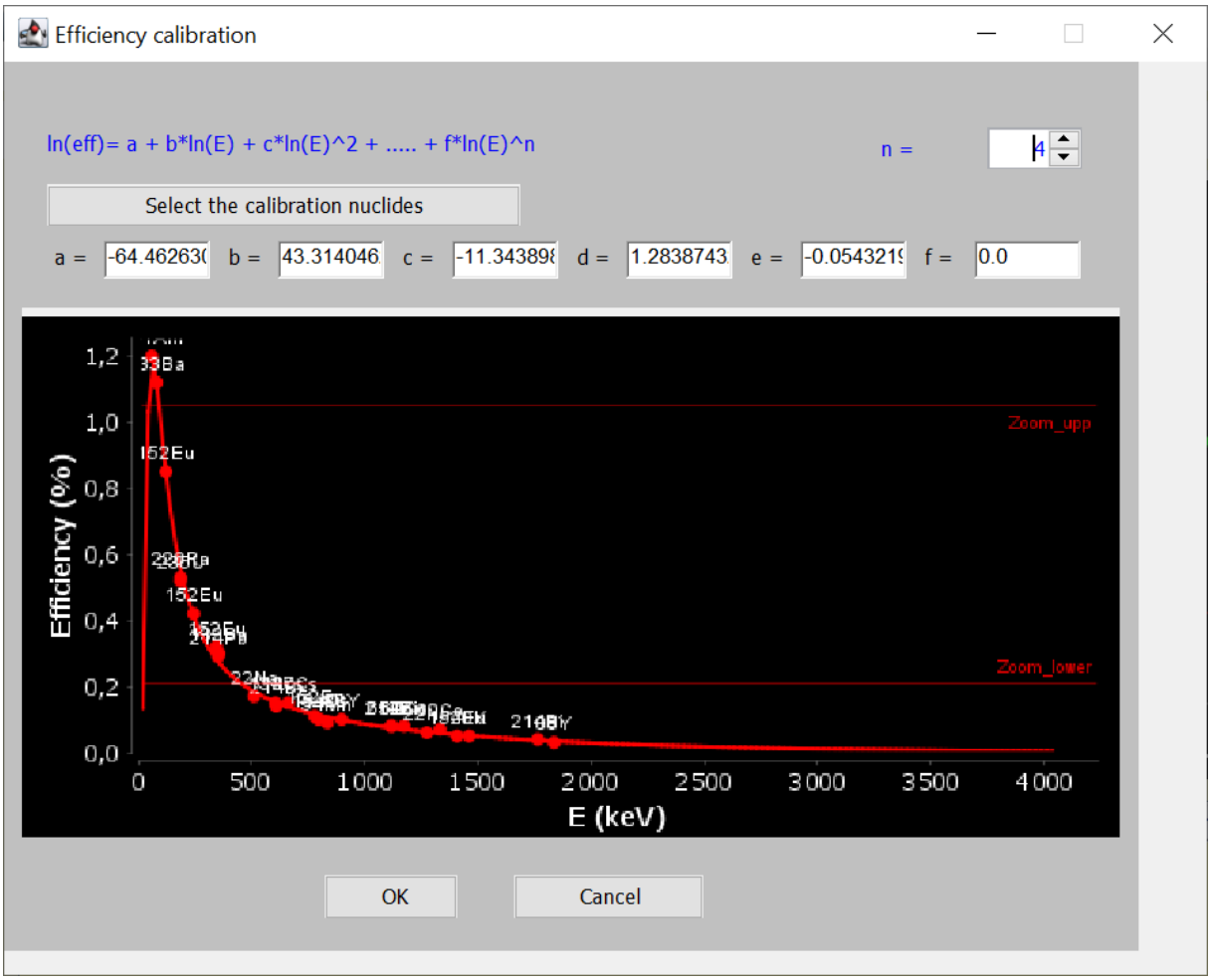


Fig. 13 Efficiency Calibration Window

When the user clicks the **"Select the Calibration Nuclides"** button, a new window appears, displaying the radionuclides used for this calibration (see Fig. 14). These radionuclides serve as **references** for calculating the coefficients of the applied calibration formula.

The window is organized into five columns:

1. **Nuclide**: the name or symbol of the radionuclide used.
2. **Energy**: the energy associated with each peak of this radionuclide (in keV).
3. **Emission Probability (%)**: the probability that a photon is emitted at this specific energy.
4. **Efficiency (%)**: the measured or calculated detector efficiency for this radionuclide.
5. **Error (%)**: the uncertainty associated with the efficiency.

This layout allows the user to select, review, and modify the reference data used for calibration, ensuring a precise and reliable analysis of gamma spectra.

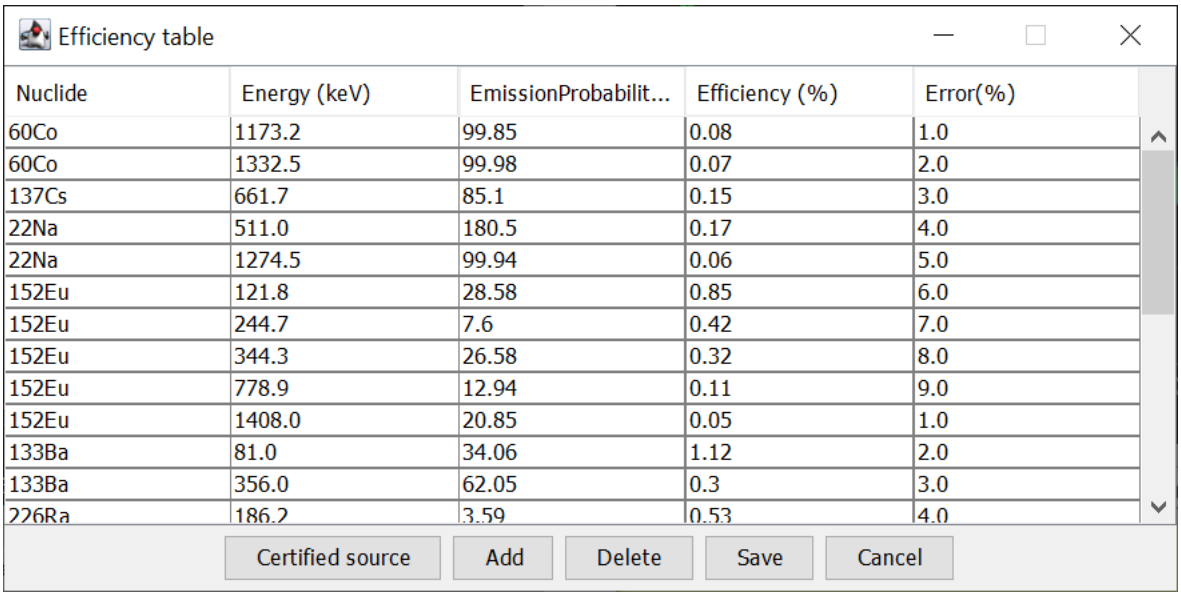


Fig. 14 Table of Radionuclides Used for Efficiency Calibration

At the bottom of this table, five main options are available to manage the data:

1. **"Cancel"**: allows the user to exit the window without saving any changes.
2. **"Save"**: saves the modifications, and also automatically updates the calibration formula coefficients and the efficiency graph.
3. **"Delete"**: removes the **selected row** from the table.
4. **"Add"**: adds a **new row** to the table, which the user can fill with the radionuclide data they want to include.
5. **"Certified Source"**: opens a new window (see Fig. 15) that provides specific options for calibrating efficiency using a recognized standard radioactive source.

This new window includes several essential options for calibration:

- The name of the standard source used.
- The manufacturing date of the source and the measurement date, along with the exact time.
- A table containing seven columns:
    1. **Nuclide**: the name or symbol of the radionuclide.
    2. **Energy**: its energy value (in keV).
    3. **Emission Probability (%)**: the probability that a photon is emitted at this energy.
    4. **Half-life**: the radionuclide's half-life duration.
    5. **Half-life Unit**: 'y' for year, 'm' for month, and 'd' for day.
    6. **Activity (Bq) at the manufacturing date**: automatically corrected according to the **radioactive decay law**.
    7. **Error (%)**: the uncertainty associated with the activity.

Similarly to the previous table, some options at the bottom of this window (Add, Delete, OK, Cancel) perform the same functions, facilitating the management and updating of calibration data.

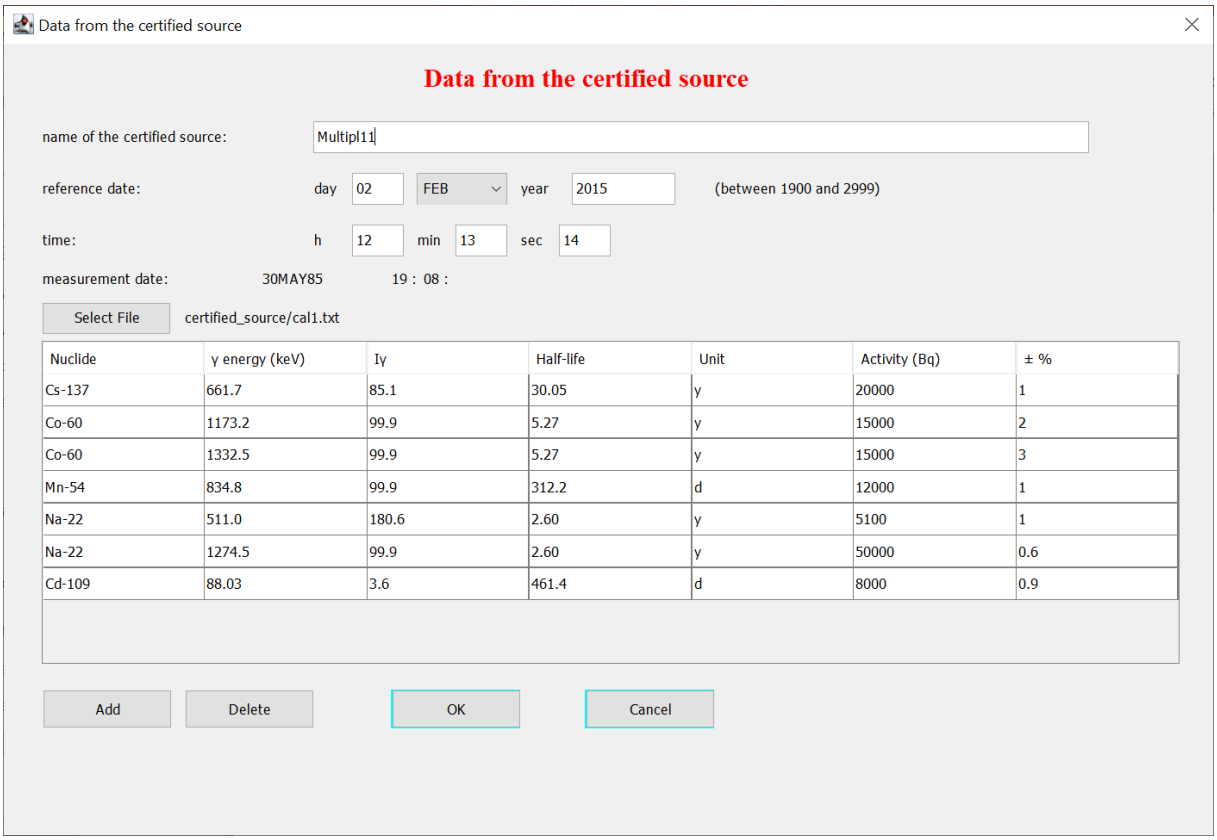


Fig. 15 **Window Designed for Using the Radioactive Source for Efficiency Calibration**

Once the user clicks the **"OK"** button, GSA v3 simultaneously and in real time performs several operations: it searches for peaks**,** identifies them, and calculates their efficiency along with the associated errors **(see** Fig. 16**).**

Additionally, these values can be adjusted graphically in a flexible manner, similarly to adjustments of ROIs**,** peak centroids, or the background, and many others. This approach allows the user to directly correct and refine the data, providing precise control over gamma spectrum analysis and ensuring reliable results tailored to the user's specific needs**.**

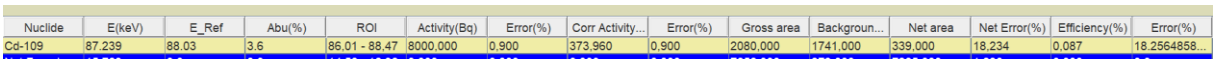


Fig. 16 **Example of Efficiency Calibration Results After Clicking "OK"**

If the user is satisfied with the efficiency calculation results for certain detected radionuclides and wishes to add one or more radionuclides along with their efficiency values to the reference table of radionuclides used for efficiency calculation (see Fig. 14), the procedure is simple and quick.

The user simply needs to right-click on the selected row in the results table (see Fig. 17) and choose the corresponding option from the context menu that appears. This action automatically adds the selected row to the relevant reference table. This allows the user to easily update and enrich the radionuclide table without manually re-entering the data, simplifying the process and reducing the risk of errors.

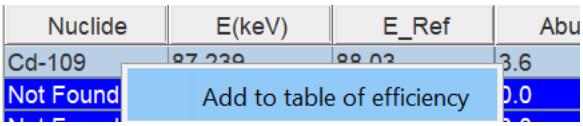


Fig. 17 Adding the Efficiency Value of a Radionuclide as a Reference, Calculated Using a Standard Source

Fig. 18. Shows clearly how this row was added to the radionuclide table for efficiency calibration.

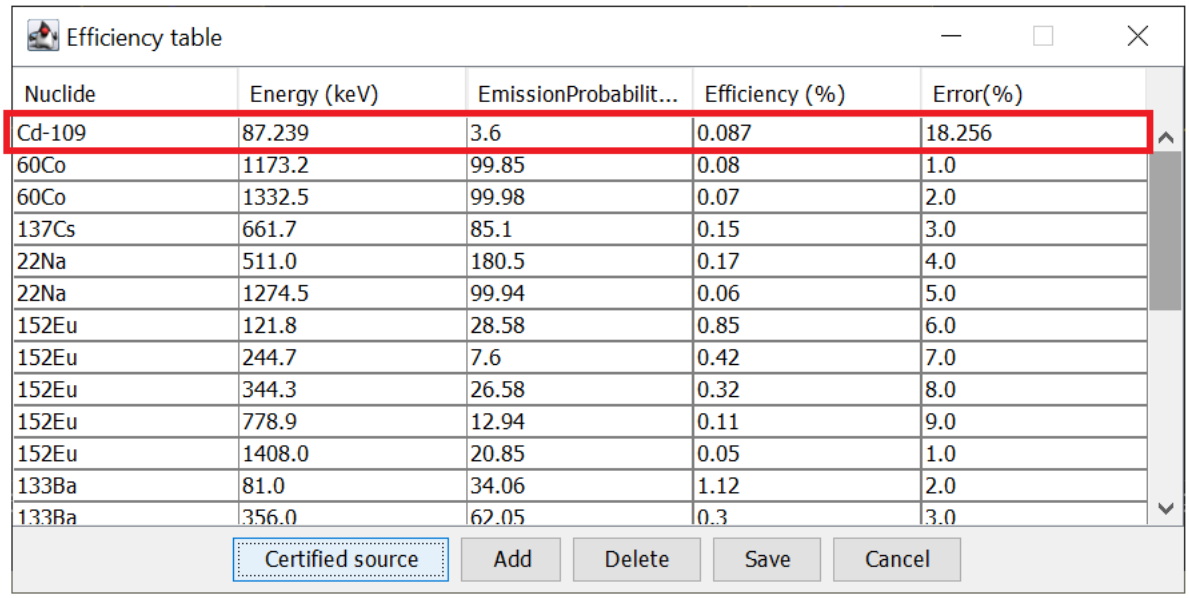


Fig. 18 Adding a Row Using the Standard Source and Analyzed by GSA v3

3.3 Sample menu

The **"Sample"** menu currently contains a single sub-menu called **"Sample infos"** (see Fig. 19). This sub-menu allows the user to access all the necessary information automatically extracted from the gamma spectrum file under analysis, while also providing the option to add additional details. All of these data will be included in the content of the PDF file generated through the **"Export PDF"** menu.

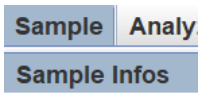


Fig. 19 Sub-menu of the Sample menu

When the user clicks on this sub-menu, a window automatically opens, displaying several fields to be filled in or verified (see Fig. 20). This interface gathers all the essential information related to the sample and the measurement, ensuring correct data processing and complete export into the PDF report. The available fields are as follows:

- **Sample name**: This field is automatically filled with the name of the loaded gamma spectrum file. However, the user can manually edit it if needed.
- **Operator**: An optional field allowing the user or operator to enter their name, which will then appear in the PDF report generated after the analysis.

- **ID**: The identifier of the analyzed sample. Some laboratories assign unique IDs to their samples for traceability.
- **Sample geometry**: Field used to specify the geometry of the sample (e.g., cylinder, disk, container, etc.).
- **Type**: The physical state or nature of the sample (e.g., solid, powder, liquid, etc.).
- **Quantity**: A mandatory field, expressed in grams (g). The user must provide the sample mass (e.g., 563.49 g). This information is essential for the software to correctly calculate the specific activity. If left empty, the software may return an error or malfunction.
- **Uncertainty**: Also a mandatory field, corresponding to the uncertainty of the entered mass, expressed in grams (g). This value enables *GSA v3* to properly calculate the error associated with the computed specific activity.
- **Sample description**: If the gamma spectrum file contains a description of the sample, this field will be automatically populated with that information, which the user may edit if necessary. Otherwise, the user can manually provide their own description.
- **Detector description**: Works similarly to the previous field. If detector information is available in the file, it is automatically displayed; otherwise, the user can manually enter it.
- **Offset of data**: This value is directly read from the gamma spectrum file and corresponds to the first channel of the spectrum. It cannot be modified.
- **Length of data**: Also read directly from the file, this field indicates the last channel of the spectrum. It cannot be modified.
- **Date**: The measurement date recorded in the file.
- **Time**: The measurement time recorded in the file.
- **Real time**: The actual measurement duration (including dead time).
- **Live time**: The effective counting time (excluding dead time).
- **Dead time**: The fraction of dead time recorded during the measurement.

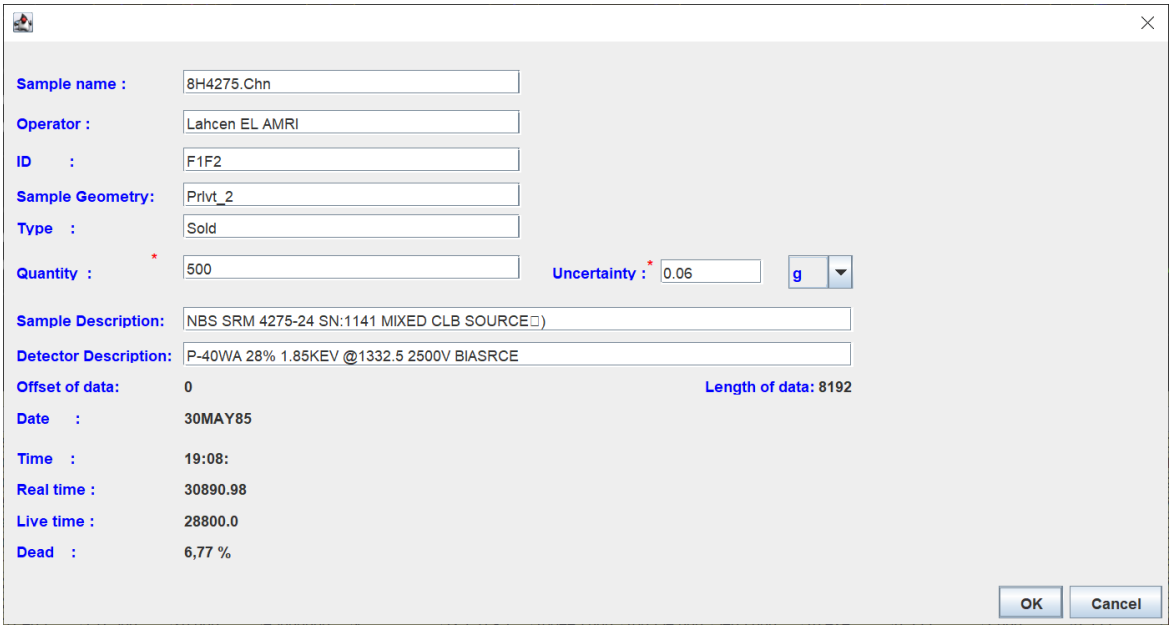


Fig. 20 Window designed for sample information and data to be analyzed

3.4 Analyze menu

The "Analysis" menu contains two main sub-menus (see Fig. 21), each dedicated to the management and processing of peaks, regions of interest (ROI), and background in gamma spectra.

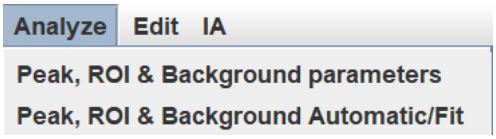


Fig. 21 Sub-menus of the "Analysis" menu

Peak, ROI & Background Parameters:

The **"Peak, ROI & Background Parameters"** sub-menu allows the user to manually configure and adjust several settings related to peak detection, definition of regions of interest (ROI), and background subtraction. It provides a flexible tool to optimize analysis conditions according to the specific needs of the user.

The main sections of this interface (see Fig. 22) are as follows:

a. ***Parameters of Search Peaks***
   This section is dedicated to configuring peak detection parameters.
   - The **m** and **z** parameters correspond to **spectrum smoothing parameters** (without graphical or numerical visualization) applied by the software to improve and adapt peak detection. The method used is the **Mariscotti method**. By default, the values are **m = 1** and **Z = 3**.
   - The **Threshold** field is crucial: it sets the detection threshold for peaks. Increasing the threshold reduces the number of detected peaks, while lowering it increases sensitivity, allowing the detection of weaker peaks. This flexibility is particularly useful for adapting the search to various experimental conditions (simple or complex spectra).

b. ***Background***
   This section allows the user to select and manage the method used for calculating and subtracting background noise from the ROI. Two main options are available:
   - **SNIP Method**: based on spectrum smoothing and iterative calculation using parameters **N** and **Z**. This method is the default, but its parameters can be adjusted to refine background subtraction.
   - **Background File Method**: this approach uses a spectrum measured without the sample, recorded under the same experimental conditions (same detector, same measurement time, etc.). When the user selects this option, a background file selection window appears automatically. Clicking the **"Show file information"** button opens a window displaying all details of the background file (see Fig. 23).

c. ***FWHM/X***
   This section contains a single field to define the value of **X**, which affects the width of the ROIs around peaks.
   - Increasing **X** reduces the graphical and numerical width of the ROIs.

- Conversely, a smaller **X** value enlarges the ROIs.
  This parameter is essential for precisely controlling ROI extents and improving the reliability of peak area calculations.

d. ***Radionuclide Library***

Located at the bottom of the window (see Fig. 22), this section allows the user to configure the radionuclide library used for automatic identificationn.

- A display field shows the path of the currently loaded library.
- The **"Select"** button allows the user to choose a different radionuclide library.
- The **Tolerance** field defines the energy window around experimental peaks within which the software searches for matches with library radionuclides. A higher tolerance broadens the range of possible matches, while a lower tolerance restricts the search to radionuclides very close in energy.

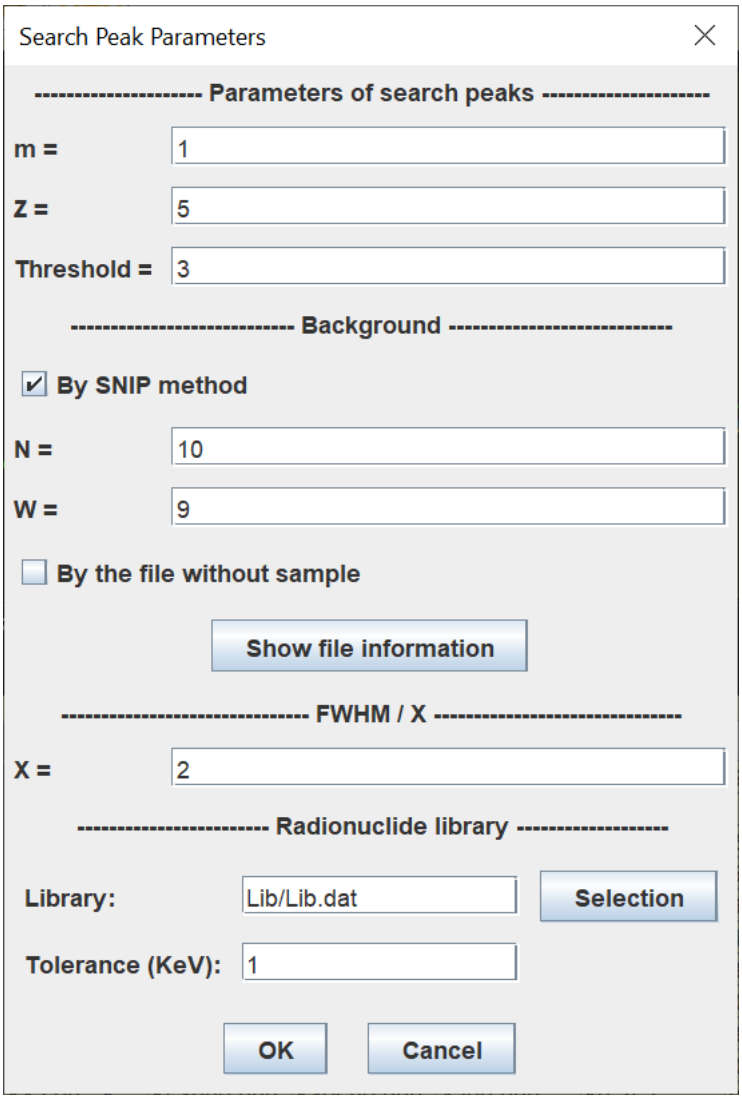


Fig. 22 Window dedicated to analysis parameters

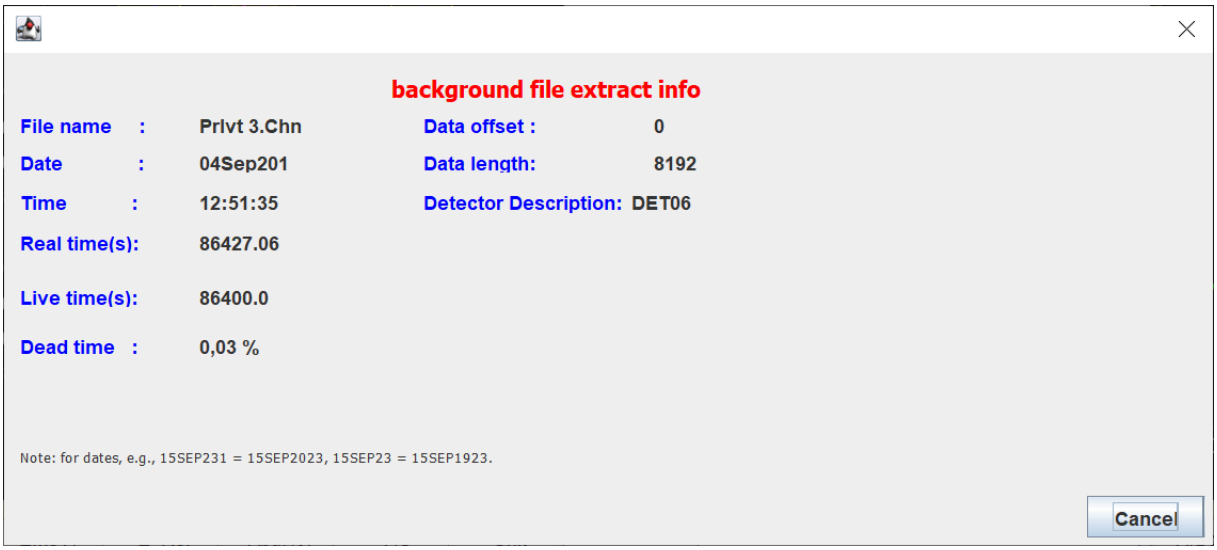
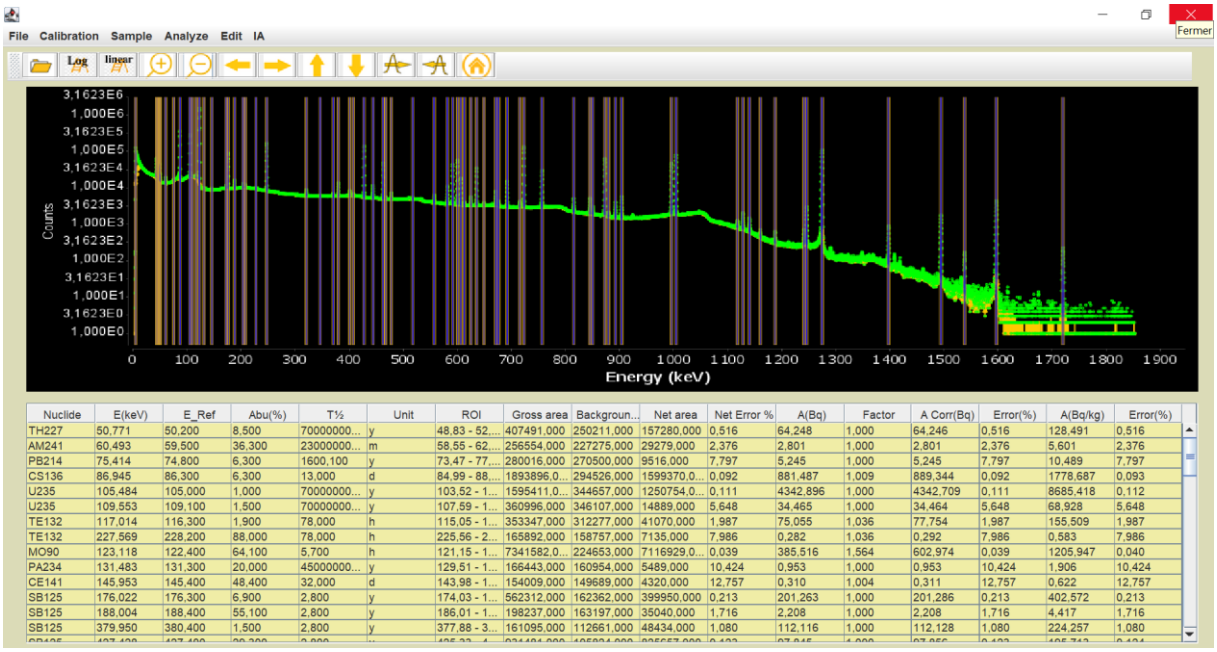


Fig. 23 Example of information extracted from the background file used

Peak, ROI & Background Automatic/Fit:

When the user clicks on this sub-menu, the software instantly displays the analysis results both graphically and in a well-organized table (see Fig. 24). This sub-menu automatically performs all treatments related to peaks and background, including adjustments using appropriate fitting methods. It enables fast and reliable analysis, minimizing manual intervention while ensuring high accuracy in the extraction of spectral data (see the section on fitting methods).



Nuclide	E(keV)	E_Ref	Abu(%)	T½	Unit	ROI	Gross area	Backgroun...	Net area	Net Error %	A(Bq)	Factor	A Corr(Bq)	Error(%)	A(Bq/kg)	Error(%)
TH227	50,771	50,200	8,500	70000000...	y	48,83 - 52,...	407491,000	250211,000	157280,000	0,516	64,248	1,000	64,246	0,516	128,491	0,516
AM241	60,493	59,500	36,300	23000000...	m	58,55 - 62,...	256554,000	227275,000	29279,000	2,376	2,801	1,000	2,801	2,376	5,601	2,376
PB214	75,414	74,800	6,300	1600,100	y	73,47 - 77,...	280016,000	270500,000	9516,000	7,797	5,245	1,000	5,245	7,797	10,489	7,797
CS136	86,945	86,300	6,300	13,000	d	84,99 - 88,...	1893896,0...	294526,000	1599370,0...	0,092	881,487	1,009	889,344	0,092	1778,687	0,093
U235	105,484	105,000	1,000	70000000...	y	103,52 - 1...	1595411,0...	344657,000	1250754,0...	0,111	4342,896	1,000	4342,709	0,111	8685,418	0,112
U235	109,553	109,100	1,500	70000000...	y	107,59 - 1...	360996,000	346107,000	14889,000	5,648	34,465	1,000	34,464	5,648	68,928	5,648
TE132	117,014	116,300	1,900	78,000	h	115,05 - 1...	353347,000	312277,000	41070,000	1,987	75,055	1,036	77,754	1,987	155,509	1,987
TE132	227,569	228,200	88,000	78,000	h	225,56 - 2...	165892,000	158757,000	7135,000	7,986	0,282	1,036	0,292	7,986	0,583	7,986
MO90	123,118	122,400	64,100	5,700	h	121,15 - 1...	7341582,0...	224653,000	7116929,0...	0,039	385,516	1,564	602,974	0,039	1205,947	0,040
PA234	131,483	131,300	20,000	45000000...	y	129,51 - 1...	166443,000	160954,000	5489,000	10,424	0,953	1,000	0,953	10,424	1,906	10,424
CE141	145,953	145,400	48,400	32,000	d	143,98 - 1...	154009,000	149689,000	4320,000	12,757	0,310	1,004	0,311	12,757	0,622	12,757
SB125	176,022	176,300	6,900	2,800	y	174,03 - 1...	562312,000	162362,000	399950,000	0,213	201,263	1,000	201,286	0,213	402,572	0,213
SB125	188,004	188,400	55,100	2,800	y	186,01 - 1...	198237,000	163197,000	35040,000	1,716	2,208	1,000	2,208	1,716	4,417	1,716
SB125	379,950	380,400	1,500	2,800	y	377,88 - 3...	161095,000	112661,000	48434,000	1,080	112,116	1,000	112,128	1,080	224,257	1,080

Fig. 24 Screenshot of the GUI after clicking on the "Peak, ROI & Background Automatic/Fit" sub-menu

When the user clicks on a row in the results table, the graph automatically zooms in on the peak corresponding to that row (see Fig. 25). The user can also easily navigate between peaks

using the keyboard arrow keys: the ↑ key moves to the peak corresponding to the previous row, while the ↓ key moves to the peak of the next row (see Fig. 25).

Nuclide	E(keV)	E_Ref	Abu(%)	T½	Unit	ROI	Gross area	Backgrou...	Net area	Net Error %	A(Bq)	Factor	A Corr(Bq)	Error(%)	A(Bq/kg)	Error(%)
Y92	1004,621	1005,400	4,300	3,500	h	1000,92 - ...	698594,000	53165,000	645429,000	0,134	608094,014	1,993	1211983,7...	0,134	2423967,5...	0,135
NB96	850,431	849,900	20,700	23,000	h	848,16 - 8...	49099,000	39980,000	9119,000	3,273	1461,019	1,125	1644,212	3,273	3288,423	3,273
KR89	904,013	904,300	7,200	3,200	m	901,72 - 9...	66096,000	31721,000	34375,000	0,910	17013,593	103,972	1768938,6...	0,910	3537877,1...	0,910
KR89	1274,566	1273,700	1,400	3,200	m	1272,12 - ...	1021304,0...	12162,000	1009142,0...	0,101	4004756,1...	103,972	41638281...	0,101	83276562...	0,101
KR88	1140,498	1141,300	1,300	2,800	h	1138,11 - ...	20908,000	12944,000	7964,000	2,310	29212,563	2,298	67115,906	2,310	134231,812	2,310
I132	1397,782	1398,600	7,100	2,300	h	1395,29 - ...	9946,000	1727,000	8219,000	1,315	7365,373	2,649	19507,979	1,315	39015,958	1,315
RB89	1538,406	1538,100	2,600	15,000	m	1535,54 - ...	1832,000	326,000	1506,000	3,085	4284,819	22,181	95040,321	3,085	190080,643	3,085
Not Found	4,876	0,000	0,000	0,000	---	2,96 - 6,79	1117735,0...	202754,000	914981,000	0,126	0,000	1,000	0,000	0,126	0,000	0,126
Not Found	43,536	0,000	0,000	0,000	---	41,60 - 45,...	588727,000	316502,000	272225,000	0,350	0,000	1,000	0,000	0,350	0,000	0,350
Not Found	172,405	0,000	0,000	0,000	---	170,42 - 1...	175930,000	163078,000	12852,000	4,530	0,000	1,000	0,000	4,530	0,000	4,530

Fig. 25 Peak zoomed from a row in the results table

3.5 Edit menu

The **"Edit"** menu contains a single sub-menu called **"Radionuclide Library"** (see Fig. 26). It is designed to allow the user to manage the radionuclide library used in analyses. This sub-menu enables adjusting existing parameters, adding new radionuclides, or modifying existing data. Each radionuclide can be reviewed, and its information updated according to the user's needs. This functionality ensures that the library remains accurate and suitable for ongoing analyses. It is an essential tool for customizing and maintaining the radionuclide database used by the software.

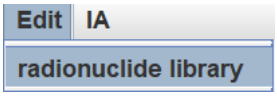


Fig. 26 Sub-menu of the "Edit" menu

When the user clicks on this sub-menu, a window automatically opens, providing several options to manage and edit the radionuclide library (see Fig. 27).

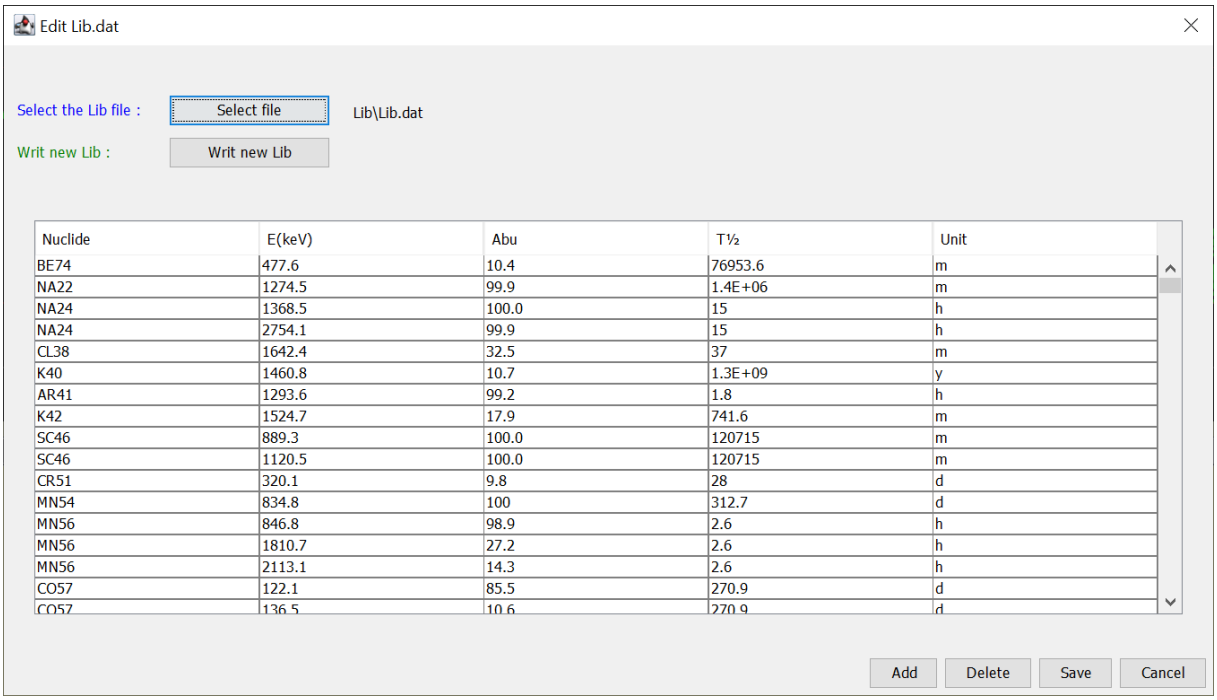
The window includes a **"Select File"** button, which allows the user to choose the library to be used for the analysis. Once the file is selected, the contents of the library are displayed in a well-organized table, where the user can make any necessary modifications.

The table has five columns: Nuclide**,** Energy**,** Abundance**,** Half-life**, and** Half-life Unit (where **h** = hour, **d** = day, **m** = month, and **y** = year).

If the user wants to create a new library, clicking the **"Write New Lib"** button automatically opens an empty table ready to be filled.

Below the table, four buttons are available for data management:

- **Add**: adds a new row with the five columns mentioned above.
- **Delete**: removes the selected row.
- **Save**: saves all modifications.
- **Cancel**: exits the window without saving any changes.



Nuclide	E(keV)	Abu	T½	Unit
BE74	477.6	10.4	76953.6	m
NA22	1274.5	99.9	1.4E+06	m
NA24	1368.5	100.0	15	h
NA24	2754.1	99.9	15	h
CL38	1642.4	32.5	37	m
K40	1460.8	10.7	1.3E+09	y
AR41	1293.6	99.2	1.8	h
K42	1524.7	17.9	741.6	m
SC46	889.3	100.0	120715	m
SC46	1120.5	100.0	120715	m
CR51	320.1	9.8	28	d
MN54	834.8	100	312.7	d
MN56	846.8	98.9	2.6	h
MN56	1810.7	27.2	2.6	h
MN56	2113.1	14.3	2.6	h
CO57	122.1	85.5	270.9	d
CO57	136.5	10.6	270.9	d

Fig. 27 Library adjustment window used in analysis

4. Icon Bar

The icon bar has been integrated primarily to allow manipulation of the graph and improve its visualization (see Fig. 28). Currently, this bar contains twelve icons.

Fig. 28 Icon Bar

- **Folder icon** : allows the user to select and open the gamma spectrum file to be analyzed.

- **Log icon** : displays the graph on a logarithmic scale for better visualization of peaks with large intensity differences (fig. 29).

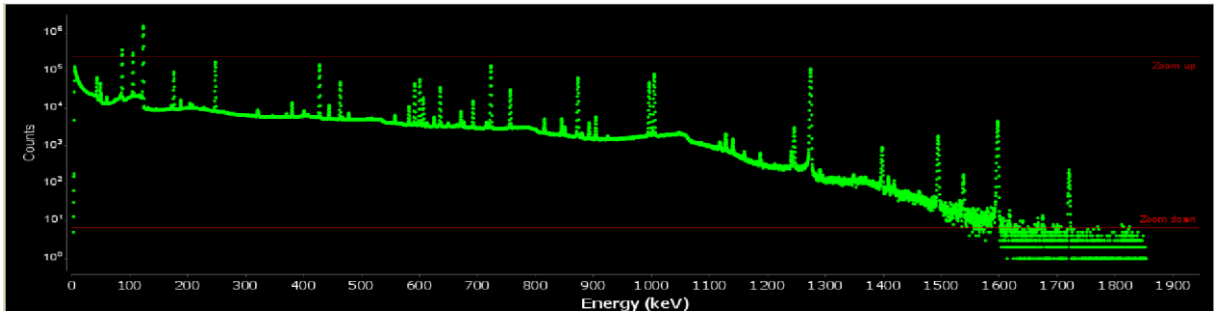


Fig. 29 Example of a graph displayed on a logarithmic scale

- **Linear icon** : displays the graph on a normal linear scale (Fig.30).

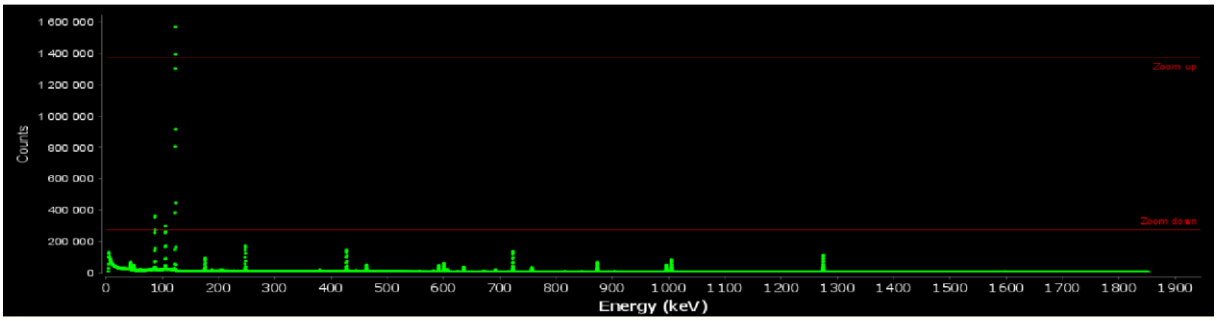


Fig. 30 Example of a graph displayed on a normal scale

- **Plus icon** : zooms in on the graph, enlarging the view for a closer examination of specific peaks.

- **Minus icon** : zooms out from the graph, providing a wider view of the spectrum.

- **Left arrow icon** : shifts the graph view to the left.

- **Right arrow icon** : shifts the graph view to the right.

- **Up arrow icon** : zooms in vertically, allowing a closer view of the upper portion of the graph.

- **Down arrow icon** : zooms out vertically, showing a broader view of the lower portion of the graph.

- **Left arrow with peak icon** : moves the focus from one peak to the previous peak on the left.

- **Right arrow with peak icon** : moves the focus from one peak to the next peak on the right.

- **Home icon** : resets the graph to its original state, returning to the default view.

5. Manual Adjustment of the Graph and Results

Several adjustment options have been integrated into this new version of GSA v3, providing both flexibility and precision. The user can directly modify the graph using the mouse, adjusting various points to refine the results. These adjustments help improve the quality of the analysis and ensure more accurate values, while maintaining an intuitive and user-friendly interface.

5.1 Zone Selection:

The user can select any portion of the graph for a more detailed examination. The selection is made directly with the mouse by outlining the desired area, allowing focus on specific parts of the gamma spectrum. This feature facilitates detailed analysis of peaks or regions of interest (ROI) and provides precise control over the data to be studied. The selected area can then be used for fine adjustments or to extract more accurate information from the spectrum. It is an essential tool for optimizing the interpretation of results (see Fig. 31).

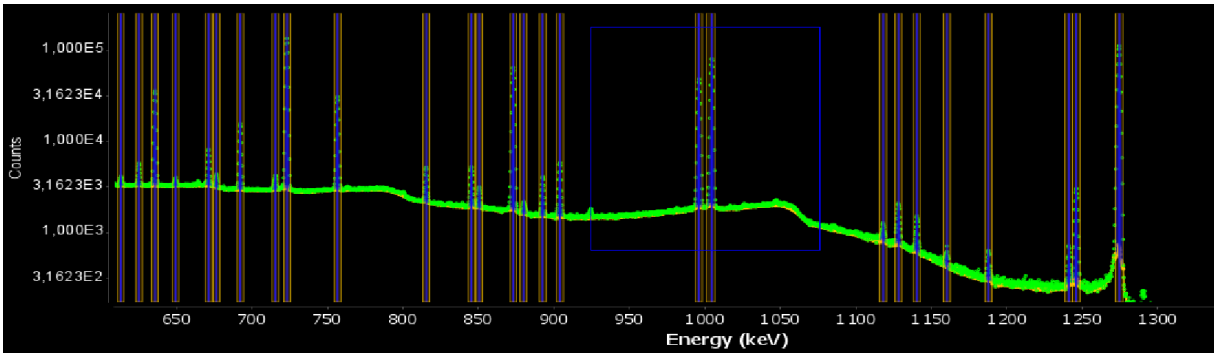


Fig. 31 Selecting a graph area with the mouse

Fig. 32 clearly illustrates the previously selected area.

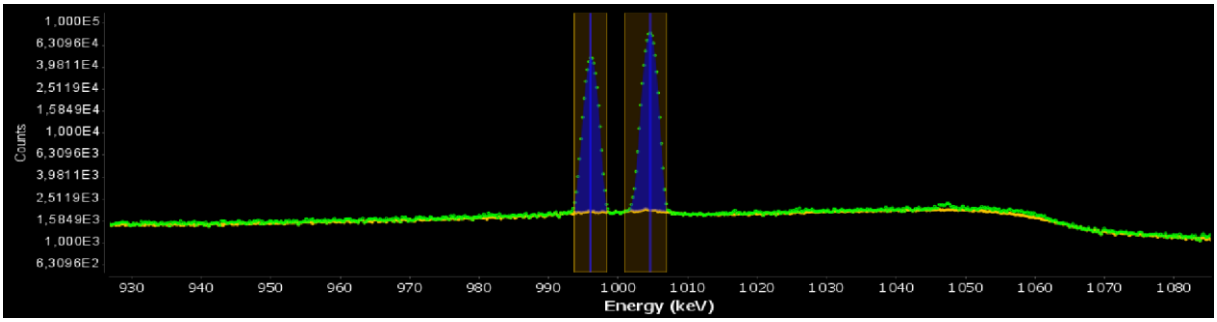


Fig. 32 Display of the selected area

5.2 Peak ROI Adjustment:

If the user wishes to modify the ROI of a specific peak, they simply need to select the vertical line corresponding to the peak's ROI by double-clicking without releasing. They can then

drag this line to the desired position to precisely redefine the peak's area (see Fig. 33). This allows the user to easily reposition the ROI boundaries to optimize the analysis of peak areas and intensities. The results of this adjustment are displayed in real time in the results table below the graph. This feature provides precise control over peak measurements and enhances the reliability of the extracted data.

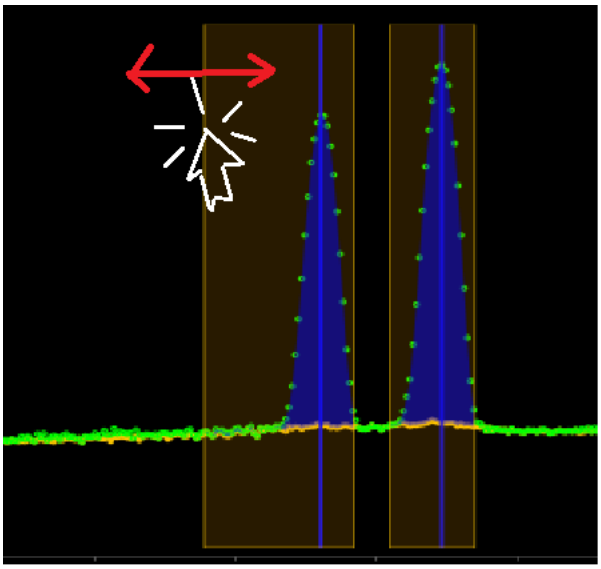


Fig. 33 Graphical ROI Adjustment

5.3 Peak Centroid Adjustment:

In the same way as for the ROI, the user can adjust the centroid of a peak or move it to a different position (see Fig. 34). This allows precise repositioning of the peak center for more accurate analysis. Each modification automatically triggers several background calculations performed by the software, so that the results are updated in real time. The software instantly recalculates parameters such as the net peak area, radionuclide identification, specific activity, and other relevant values. This feature ensures dynamic and precise analysis, giving the user full control over measurements and the reliability of the results.

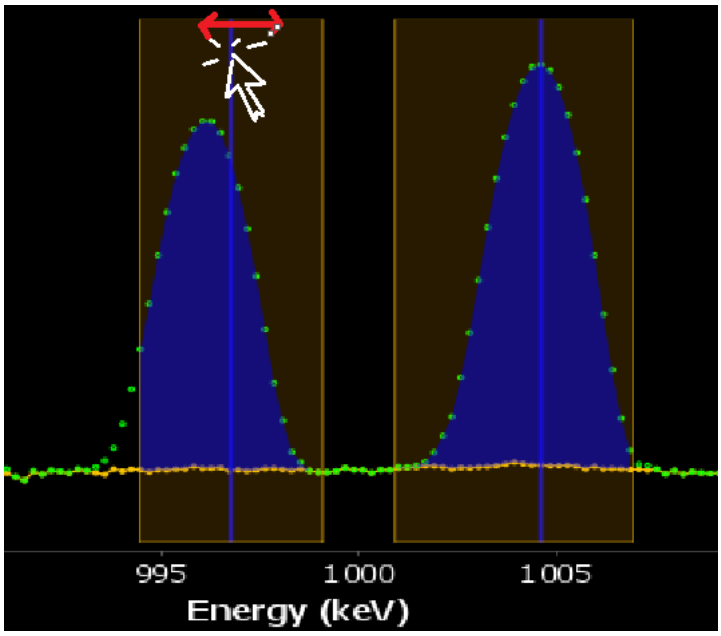


Fig. 34 Repositioning the peak centroid or moving the peak using only the mouse

5.4 Background Adjustment:

After determining the background using either the SNIP method or the background file method, the user can also manually adjust the background of the relevant peak. To do this, simply double-click on a background point without releasing, then drag it to the desired position (see Fig. 35). This allows precise fine-tuning of the background level for each peak. All modifications are automatically updated in real time in the results table below the graph. This provides the user with full control over background adjustment while obtaining immediate and reliable results for peak analysis.

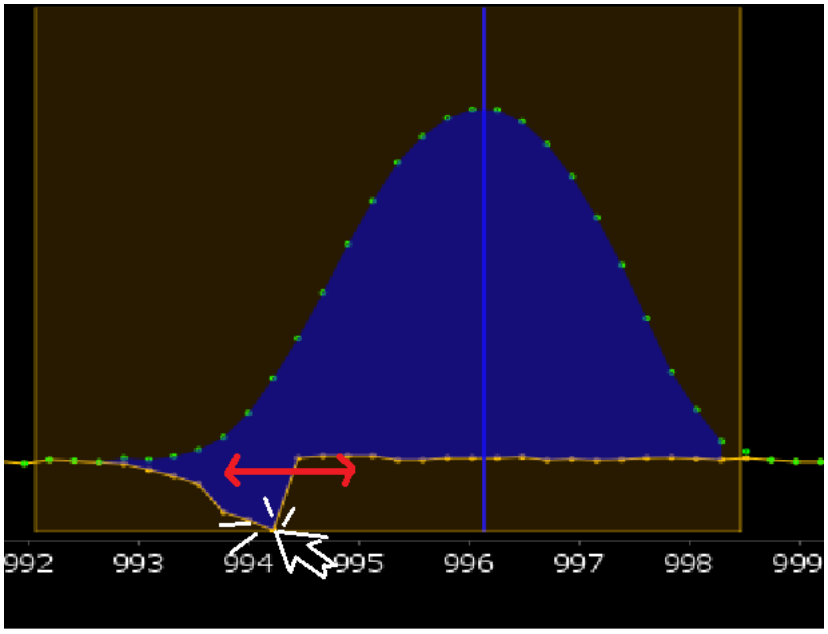


Fig. 35 Graphical Background Adjustment

5.5 Peak Deletion:

Sometimes the user may wish to remove one or more peaks from the spectrum. To facilitate this, an easy-to-use option has been added to the software. The user simply right-clicks on the vertical line corresponding to the peak centroid (blue vertical line), which brings up a context menu (see Fig. 36). By selecting the **"Delete the selected peak"** option, the chosen peak is immediately removed from the graph. This deletion is also automatically reflected in the results table, ensuring that all data associated with the peak is removed from the analysis without any further manual action. This feature provides a quick and intuitive way to manage and clean the analysis results.

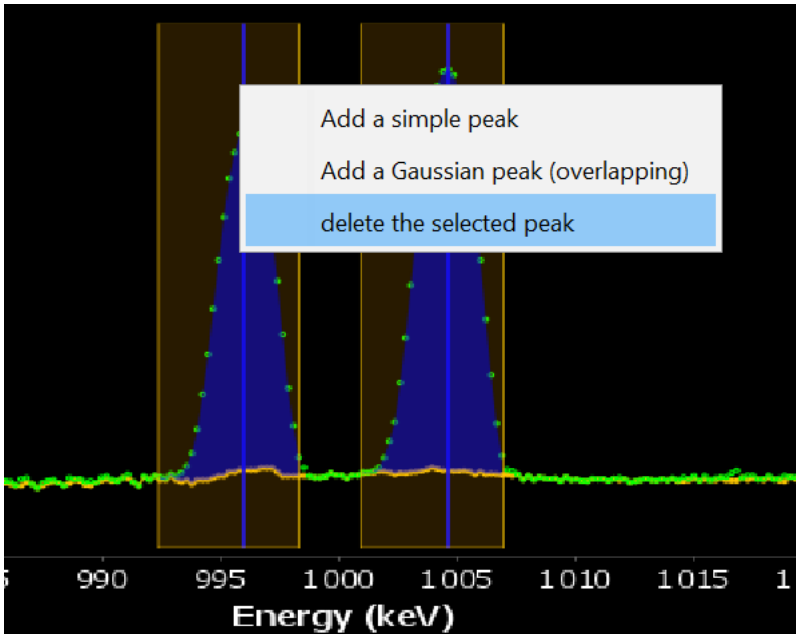


Fig. 36 Graphical Peak Deletion

5.6 Adding a Simple Peak:

In the same way as peak deletion, the user can add a simple peak at a desired position on the graph. To do this, simply right-click at the desired location and select the **"Add a simple peak"** option from the context menu. The peak is immediately added at that position on the graph (see Fig. 37 and Fig. 38). This feature allows new peaks to be easily integrated to complete the analysis or correct anomalies in the spectrum. All results associated with the new peak are automatically updated in the results table, ensuring real-time updates and maximum accuracy.

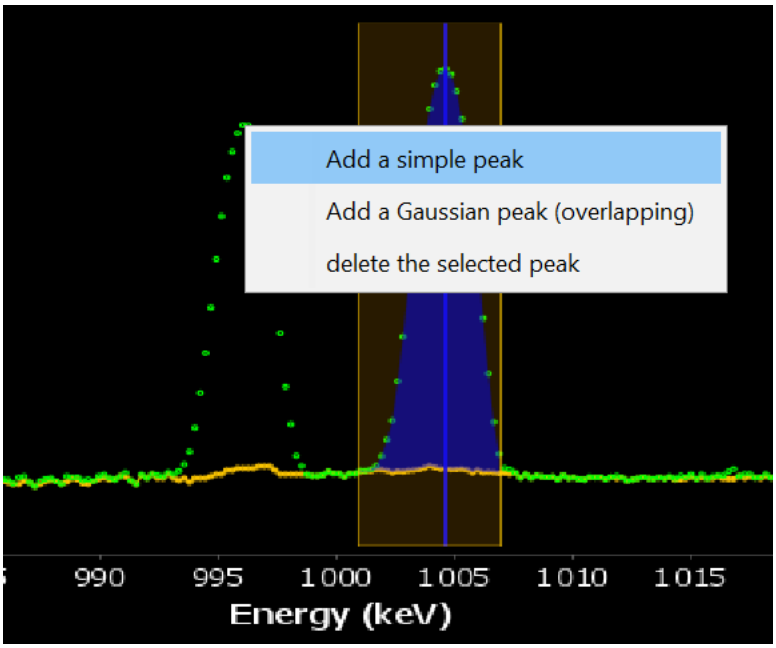


Fig. 37 Before Adding the Peak

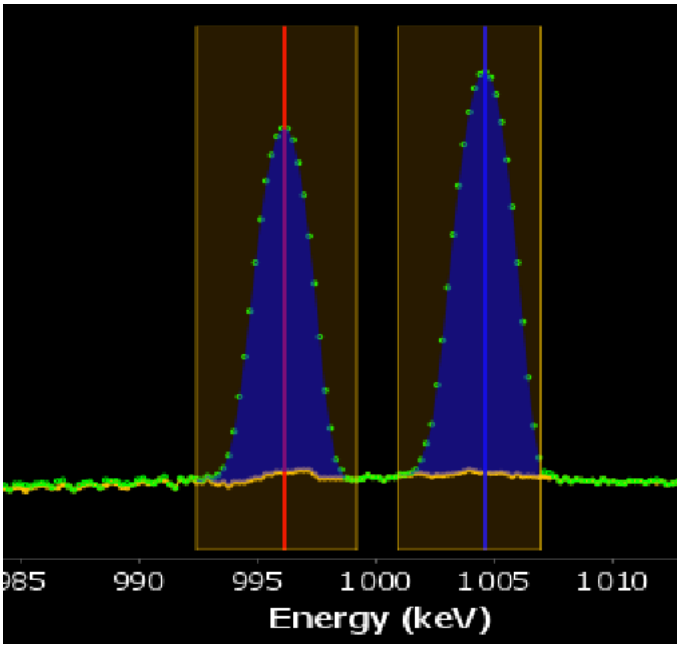


Fig. 38 After Adding the Peak

5.7 Adjustment of Overlapping Peaks:

In some gamma spectra, peaks can overlap, which can distort calculations and lead to inaccurate results. To address this issue, a flexible option has been added to correct the peaks and accurately recalculate the net areas (see Fig. 41). To perform this correction, simply right-click on the relevant area, as before, and select the **"Add a Gaussian peak (overlapping)"** option from the context menu. This action allows an additional Gaussian peak to be added to model overlapping peaks (see Fig. 39 and Fig. 40). The software then automatically adjusts the peak parameters and recalculates the net areas, ensuring accurate results even in cases of

overlapping peaks. This feature significantly enhances the reliability of complex gamma spectrum analyses.

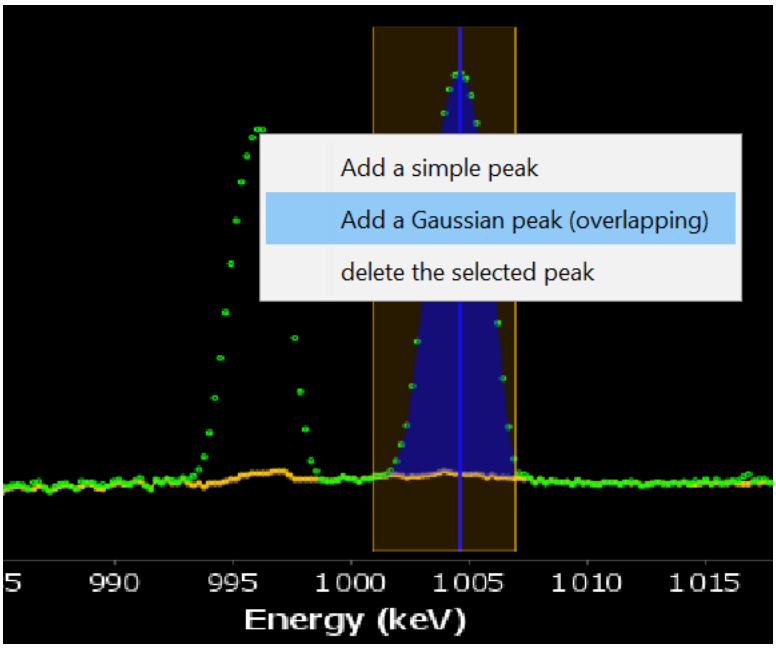


Fig. 39 Before Adding the Gaussian Peak

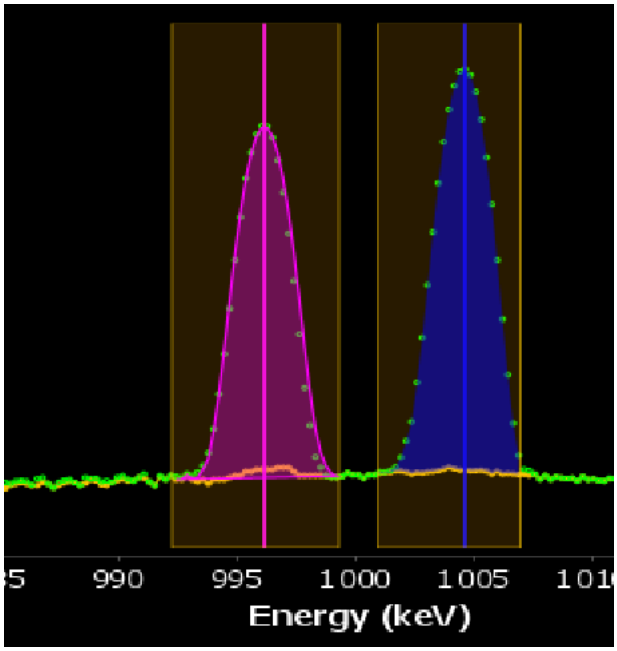


Fig. 40 After Adding the Gaussian Peak

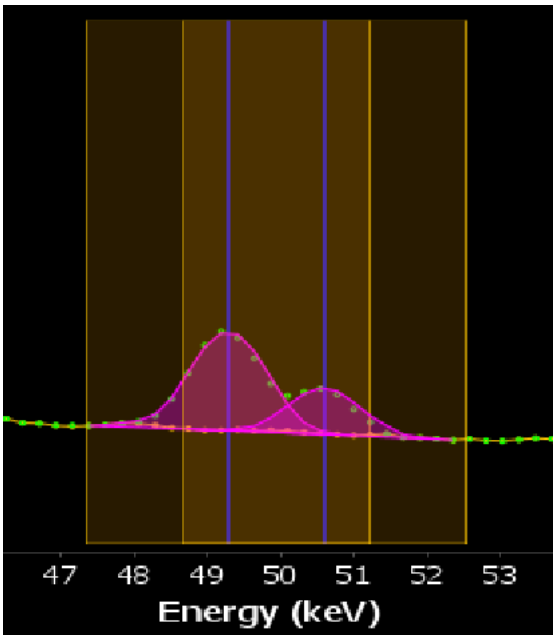


Fig. 41 Graphical Adjustment of Overlapping Peaks

Conclusion

This guide presents the new version of the **GSA v3** software, which now includes numerous flexible and advanced features, enabling precise and customizable analysis of gamma spectra. The software provides comprehensive tools for manual and automatic peak adjustment, management of regions of interest (ROI), background manipulation, as well as for adding, deleting, and correcting peaks, including overlapping peaks. **GSA v3** is designed to be intuitive while ensuring reliable and accurate results, tailored to the needs of researchers and technicians in gamma spectrometry. It is available for free, either via our full website or by contacting the email address mentioned at the top of this guide.