ISINN-31

Dataset preparation software for training a neural network to determine the boundaries of full energy peaks in gamma-spectra

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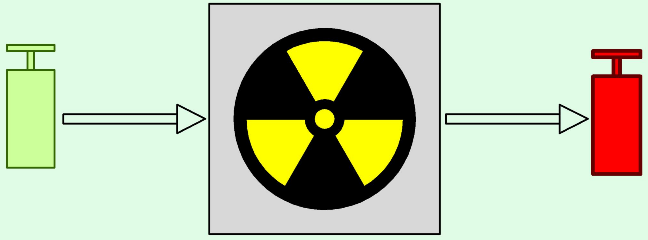
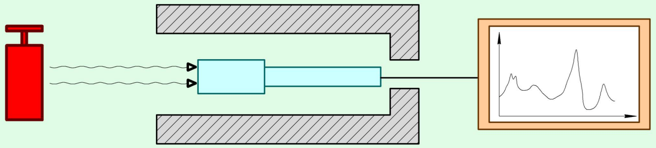
Instrumental NAA: main stages

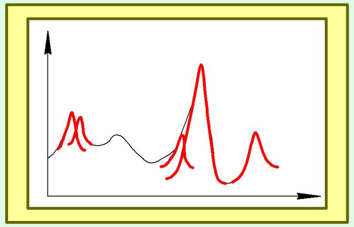
Irradiation



Measurement



Processing



Results

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***********************************************************************
*****   I N T E R F E R E N C E   C O R R E C T E D   R E P O R T   *****
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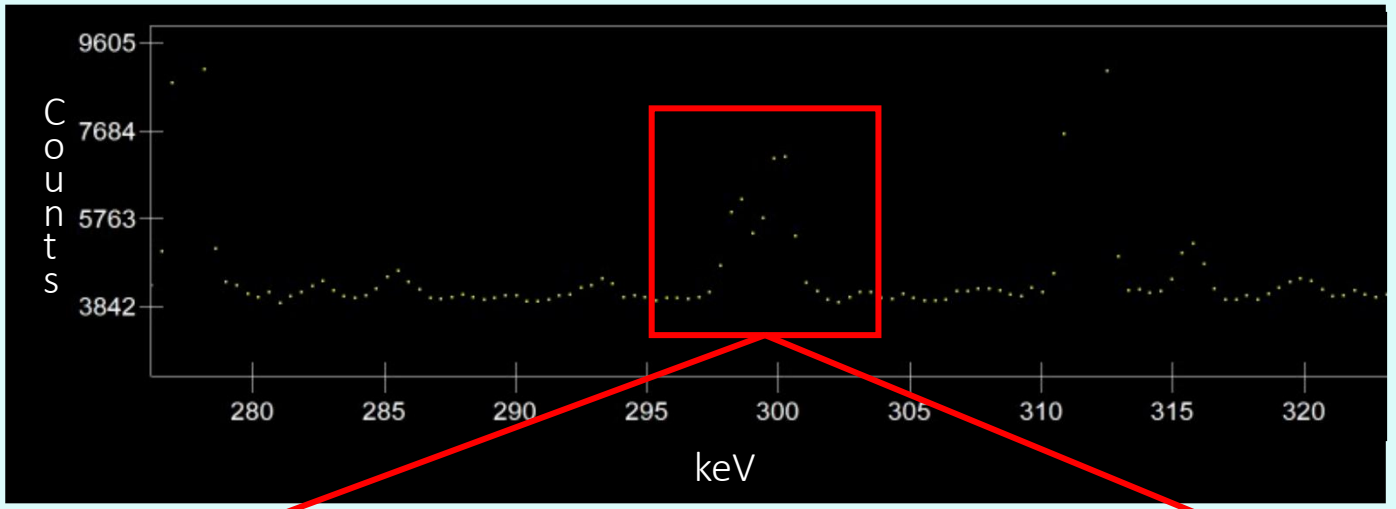
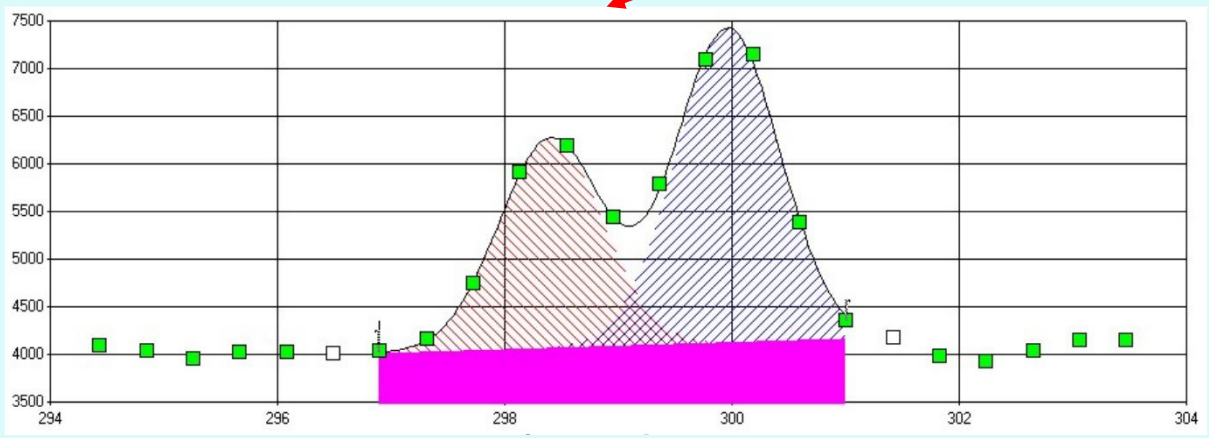
	Nuclide Name		Nuclide Id Confidence	Wt mean Activity (uCi/gram)	Wt mean Activity Uncertainty
	SC-46		0.999	6.4642758E+00	1.4459300E-01
	CR-51		0.991	3.1788769E+00	1.1993185E-01
	CO-58		0.998	5.0256956E-01	1.4996349E-02
	FE-59	@	0.997	6.2239289E+00	2.0263480E-01
	CO-60	@	1.000	5.1262646E+01	1.3066329E+00
	ZN-65		1.000	5.0691109E+00	1.1561605E-01
	SE-75	@	0.968	1.0801266E-01	2.2550778E-02
	SR-85		0.998	3.9145565E-01	2.0979421E-02
	RB-86		0.980	2.3116070E+01	2.6734247E+00
	ZR-95		0.998	2.5742626E-01	1.6054004E-02
	AG-110m		0.993	1.2552729E-01	2.2758927E-02
	SN-113		0.943	4.5661207E-02	1.5835803E-02
	SB-124	@	0.998	7.0006138E-01	3.5306036E-02
	BA-131	@	0.954	9.6609002E-01	1.0097001E-01
	CS-134	@	1.000	3.5649815E+01	8.7409276E-01
	CE-141		0.994	3.7573415E-01	1.7949708E-02
	ND-147	@	0.940	2.8148913E-01	6.6516303E-02
	EU-152	@	0.995	2.1340488E+01	1.2251060E+00
X	GD-153		0.892		
	EU-154	@	0.974	9.0694523E+00	4.6999308E-01
	TB-160	@	0.996	2.8079023E+00	7.4354135E-02
	YB-169		0.994	2.7761590E-01	1.8929230E-02
	HF-181		0.993	4.8591655E-01	1.6799102E-02
	TA-182	@	0.999	4.7029986E+00	1.0753240E-01
X	HG-203		0.980		
	PA-233	@	0.989	9.6525106E+00	3.2430384E-01

? = Nuclide is part of an undetermined solution
X = Nuclide rejected by the interference analysis
@ = Nuclide contains energy lines not used in Weighted Mean Activity

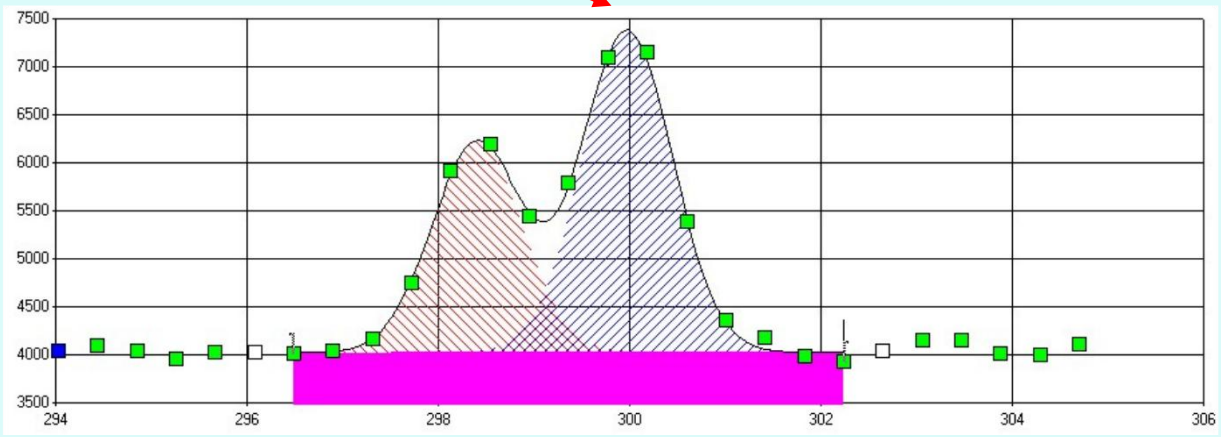
Errors quoted at 1.000 sigma

Gamma-spectra Processing





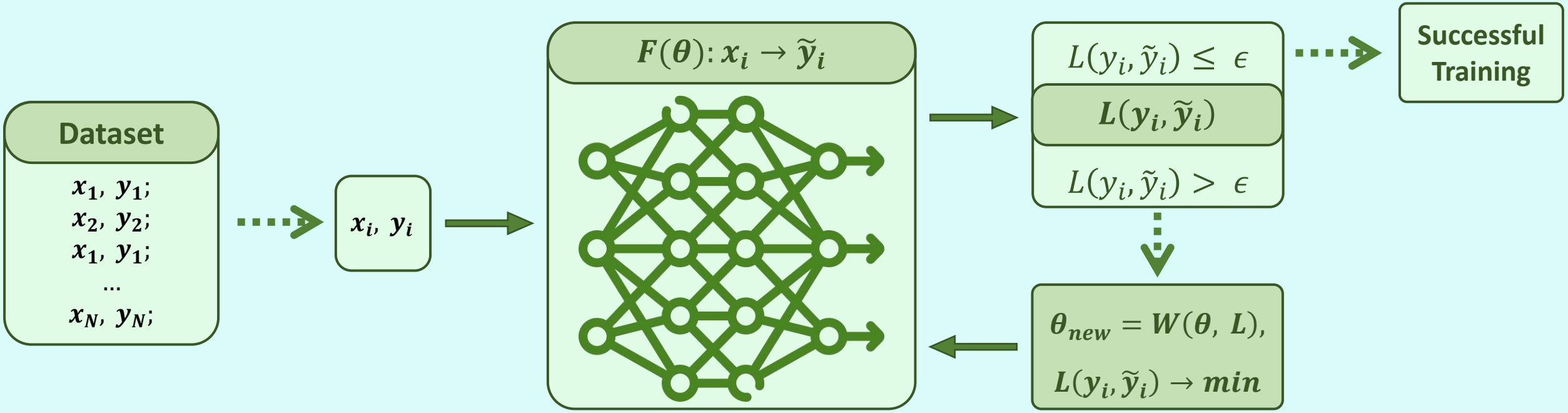
Automatic Processing



Manual Processing

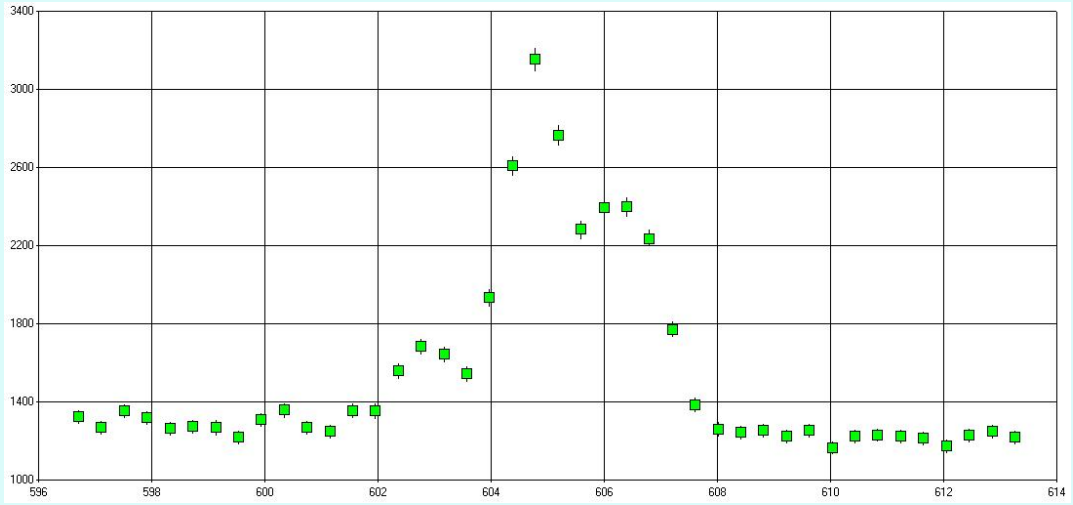
Neural Network: training scheme

The main advantage of neural network is **ability to learn from data**

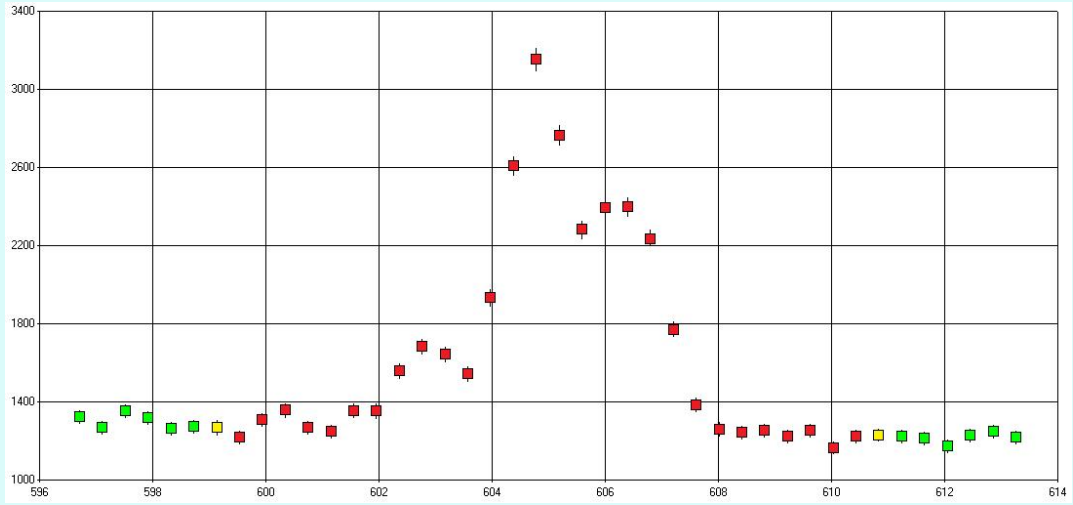


Dataset: introduction

Input data



Output data



- Mathematical methods of gamma-spectra processing are successful in finding centroid peaks => **no need to use the full γ-spectrum**;
- **The input data** is represented by vectors of length n_i, each associated with a particular region of the γ-spectrum.

$$[1331, \ldots, 1939,\ 2615,\ 3160,\ 2770,\ 2289, \ldots, 1095\ ]$$

- The segmentation task is solved => each channel of the input spectrum segment belongs to **one of three classes (background, boundary, peak)**;
- **The output data** is represented by $(3 \times n_i)$-dimensional matrices.

$$\begin{bmatrix} 0,\ 0,\ 0\ldots0,\ 0,\ 1\ldots1,\ 1,\ 1\ldots1,\ 0,\ 0\ldots0,\ 0,\ 0 \\ 0,\ 0,\ 0\ldots0,\ 1,\ 0\ldots0,\ 0,\ 0\ldots0,\ 1,\ 0\ldots0,\ 0,\ 0 \\ 1,\ 1,\ 1\ldots1,\ 0,\ 0\ldots0,\ 0,\ 0\ldots0,\ 0,\ 1\ldots1,\ 1,\ 1 \end{bmatrix}$$

Dataset: Where to get the data from?

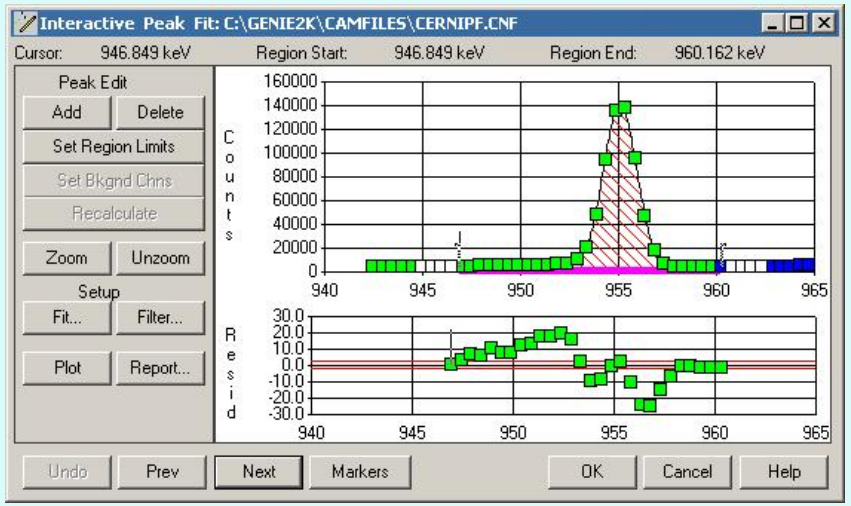
During the existence of the Sector of Neutron Activation Analysis and Applied Research, a large number of spectra have been collected (around 70,000)

However, these spectra are not fully processed, as only the calculated peaks were fitted, while the others remained unchanged

Thus, since it is impossible to separate processed peaks from unprocessed ones, it was decided to re-perform peak fitting in the available gamma spectra using a new methodology

Dataset: GENIE-2000 for data preparation

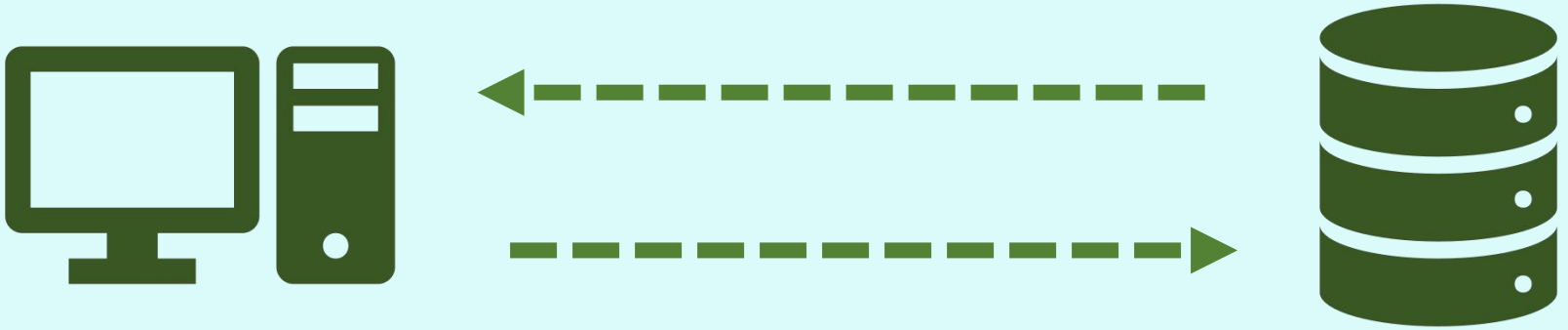
Powerful tool for precise gamma spectrum analysis, combining automation and manual control. It is particularly useful for tasks requiring high peak-fitting accuracy, such as working with complex spectra or low-activity samples



Interactive Peak Fit Module

"Unfriendly" interface significantly increases the processing time of one spectrum

Software Architecture



Client **Database**

Console app

For pre-processing spectra and adding information about them to the database

Windows app

For automatic spectrum selection from the database and peak fitting

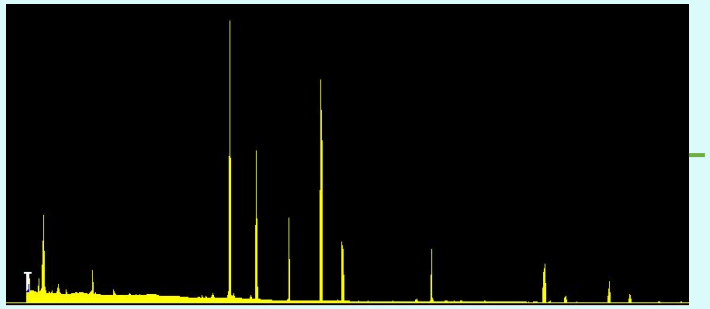
Administrator

- Full database access;
- Adds spectra for processing.

Processor

- Has access to a list of spectra;
- Inserts information about processed peaks.

Console Application



Is this a processed spectrum?

Yes

Load the peak data to the database

No

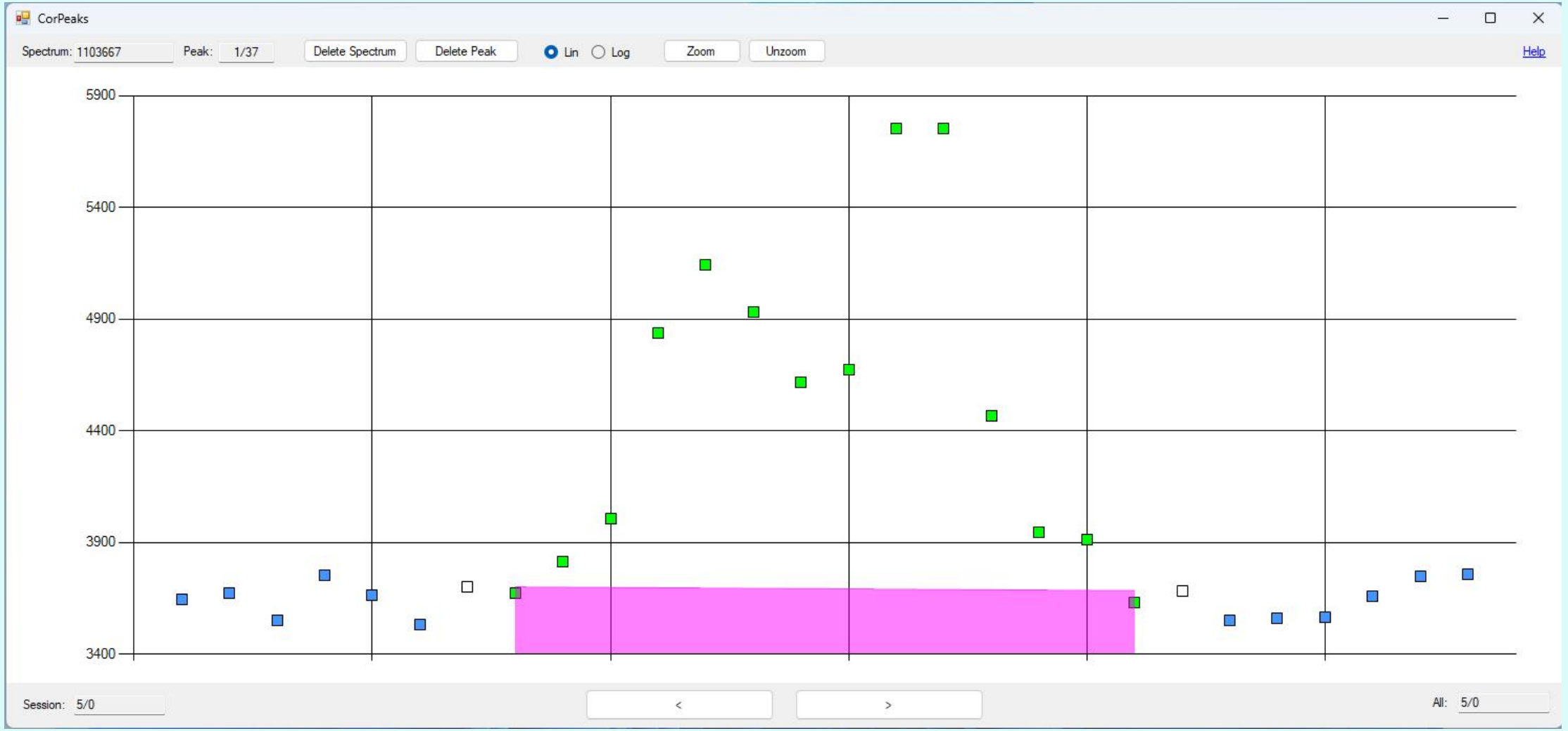
Search peaks and define their boundaries

Load the spectrum name to the database and save pre-processed spectrum

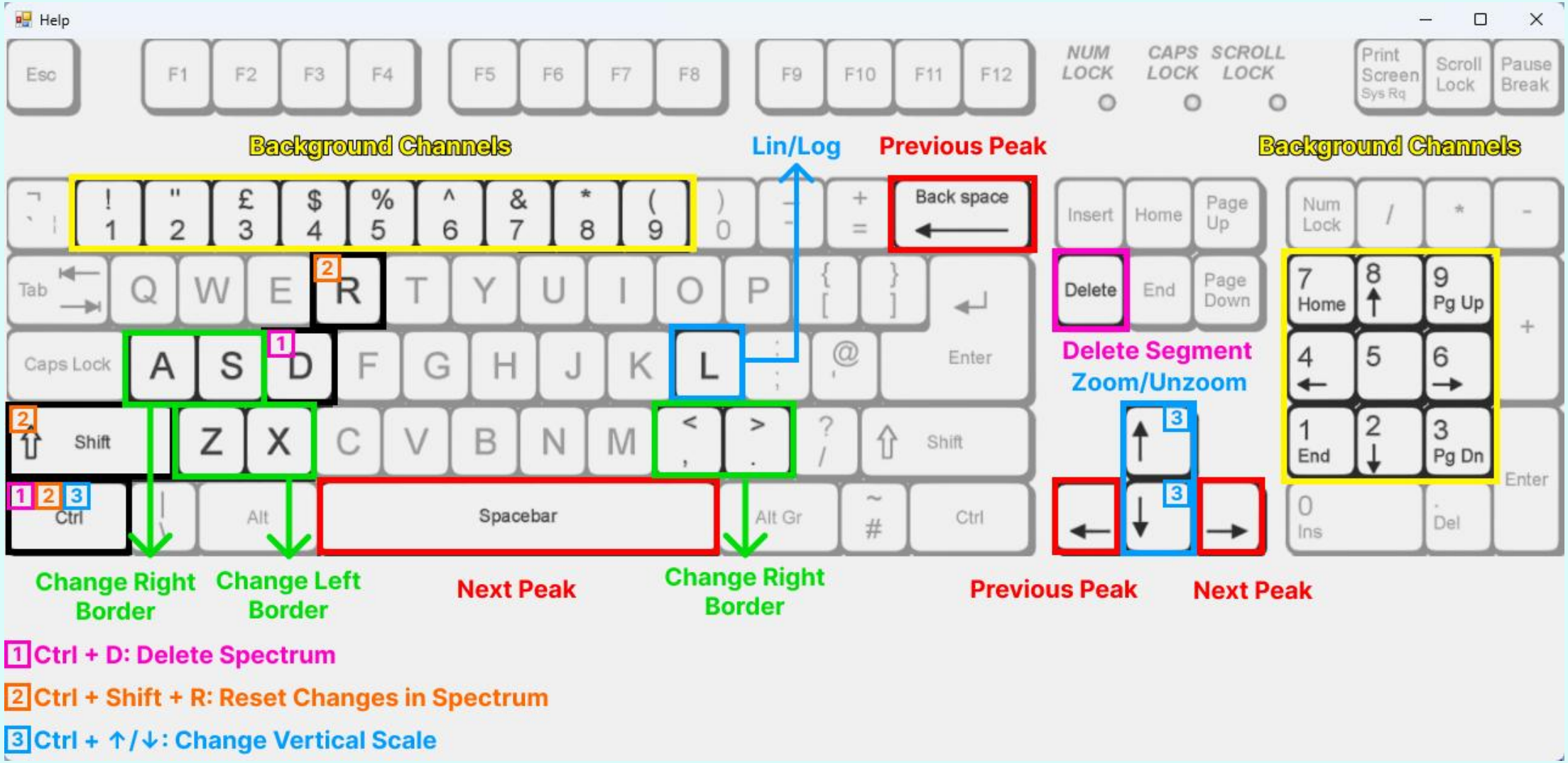
CAMSRCLib.lib

Analysis Sequence File (.ASF)

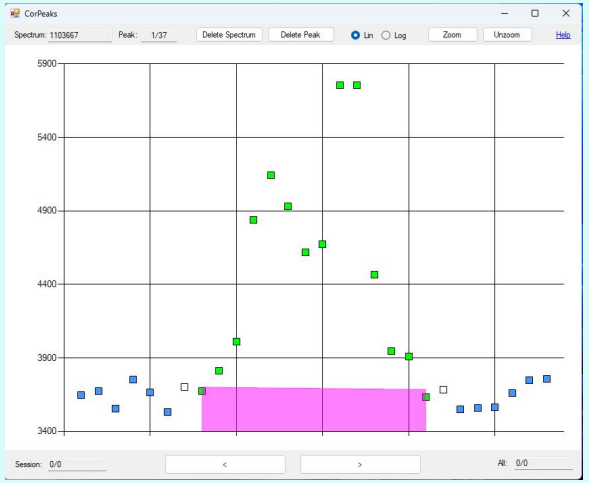
Windows Application: main functions



Windows Application: ”hotkeys”



Windows Application: work scheme



After the last peak in spectrum was processed

After “Delete Spectrum” button was pressed

Spectrum segment,
Peak left channel,
Peak region width,
Background channels

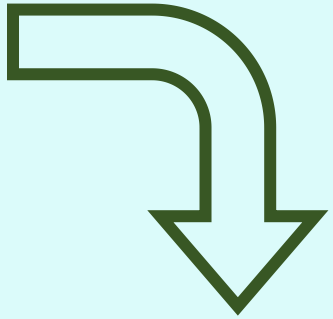
Spectrum is labelled by the remote user

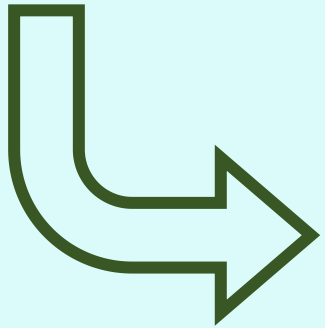
Next unprocessed spectrum

Processing continues

Conclusions

The software for determining the boundaries of full energy peaks in gamma-spectra and inserting results into the database was developed





The resulting dataset will be used for training a neural network to determine the boundaries of full energy peaks in gamma-spectra.

Thank you for your attention

感謝諸位的時間