ORTEC®
AMETEK

LabVision

Counting Laboratory Application Manager Software

Software User's Manual

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1. INTRODUCTION

LabVision®, aka LVis, is a software designed for use in nuclear counting laboratories. Its main application is to support gamma spectroscopists. However, it can also be used to perform simple alpha analysis using ROI (region-of-interest) analysis.

Typically, a counting laboratory deals with large numbers of samples, which may arrive in batches from a client, commercial or otherwise. Most commonly, laboratory procedures require that the sample measurements are analyzed by a technician with oversight from an expert-level spectroscopist. In order to maintain quality in this circumstance, the management of large numbers of samples in a simple manner with a minimal change of operator entry is highly desirable. LVis is designed to fill that need.

LVis started as an application manager program combining several programs under one common graphical user interface. Originally, its main purpose was to provide an intuitive but controlled interface to ORTEC's flagship gamma spectrometry software GammaVision. However, over time it evolved, and many more features were added, e.g. a user management system, a change log to track who did what when to the system, and support for simple alpha ROI analysis based on the tracer concept. A major milestone in the long history of LVis was the addition of the ability to automatically apply geometry corrections to gamma spectrometric analyses that were calculated on-the-fly during the analysis process by 3rd party programs such as the free code EFFTRAN.

With the release of Version 4, LVis is no longer only a GUI combining different codes. Instead, it provides everything by itself, becoming a fully comprehensive nuclear spectroscopy application. The analysis engines of GammaVision are now a part of LVis and ORTEC's own seamlessly embedded Monte Carlo algorithm "tRAYcy" is used as the default mathematical correction tool.

The LVis approach is "detector- and sample-type-oriented." The operator works from a left-hand "Configuration" side panel, simply choosing a sample counting routine that is typically counting geometry-specific and is pre-defined by a supervisor for the available detectors. Such parameter sets contain respective data entry fields to collect all the required sample information, instructions on how the particular type of sample should be counted and analyzed, and how the results are to be reported and published. The process is as automated and straightforward for a technician to use as it can be.

LVis is aimed at users who wish to control several nuclear measuring chains (e.g. HPGe detectors and their associated electronic measuring equipment) and manage their different measurement geometries including the individual calibrations, and correction tables. LVis development focused on providing an easy-to-use, clear, and intuitive interface to minimize user errors.

For hardware actuation (start, stop, delete, read spectrum, and hardware parameter adjustment), LVis uses the ORTEC CONNECTIONS-32 communication interface used for all ORTEC spectroscopy hardware.

LVis saves measurements in LVis Measurements **.LVM** files. By default, all **.LVM** files are stored in the LVis Measurements directory under the respective detector subfolder. These **.LVM** files contain not only the spectrum raw data, the analysis parameters, and, if already analyzed, the analysis results but **all** data relevant to the sample measurement like the sample specific information or the

detector and sample geometry as well as copies of the nuclear library, the calibration, and if applicable any correction tables.

Analysis reports are created using SAP Crystal Reports 2020 and respective report templates. In order to create customized report templates a full copy of Crystal Reports must be purchased separately from SAP. ORTEC can create custom report templates as a service.

LVis provides its own quality control system. Within the scope of this quality control, energy and full width half maximum calibration, efficiency calibration, and the background can be verified. As the verifications are specific per detector, QA measurement parameters are assigned to a detector (similar to parameter sets for sample counts). QA control charts over a user-defined time period can be created based upon templates, which can be edited using Crystal Reports.

2. INSTALLATION AND FIRST STEPS

This chapter outlines the general, basic steps that are required to ensure full functionality when installing LVis on a new system. Users must have Administrator access rights in Windows to install LVis.

Each of the steps below is described in detail in the following sections of this chapter.

2.1 Installing ORTEC Connections
2.2 Installing LVis Reporting Tools
2.3 Installing LVis
2.4 Starting LVis for the 1st Time
2.5 Configuring the Global LVis Settings
2.6 LVis User Management – Password-Protecting LVis Functionality
2.7 Adding and Configuring the Detectors
2.8 Creation of Parameter Sets

In addition, there are a few other steps described that may be required when either:
2.9 Saving the LVis Configuration
2.10 Loading a Configuration File
2.11 Creating and Restoring a Complete LVis Backup

2.1 INSTALLING ORTEC CONNECTIONS

The LVis program is accompanied by a CONNECTIONS Driver Update Kit (Part No. 797230). CONNECTIONS must be installed before LVis will install. No error message will be displayed if CONNECTIONS is not installed. Instead, users will not be able to control any hardware.

Be sure to read the Update Kit instruction guide completely! It describes how to install CONNECTIONS, enable/disable the drivers for ORTEC MCB(s), share ORTEC instruments across a network, and control the MCB Configuration program. At the end of installation, users will be directed to restart the computer.

2.2 INSTALLING LVIS REPORTING TOOLS

The analysis reports in LVis are created using CrystalReports templates. CrystalReports is a 3rd party tool developed by SAP that allows creation of text reports from databases based on respective templates. LVis supports CrystalReports version 2020 (14.3.x).

In case users want to create their own LVis reports, they can either contact their local ORTEC sales representative for a respective quotation or they will have to purchase a copy of CrystalReports to modify the existing LVis report templates themselves.

To generate reports LVis requires the CrystalReports engine and several other tools such as an Access database engine and a MS Visual C++ Redistributable file. These will be installed together with LVis.

2.3 INSTALLING LVIS

To install LVis simply execute the Setup_LVis_4.x.x.x.exe and follow the instructions. The first screen will ask users to specify the language of the installer.

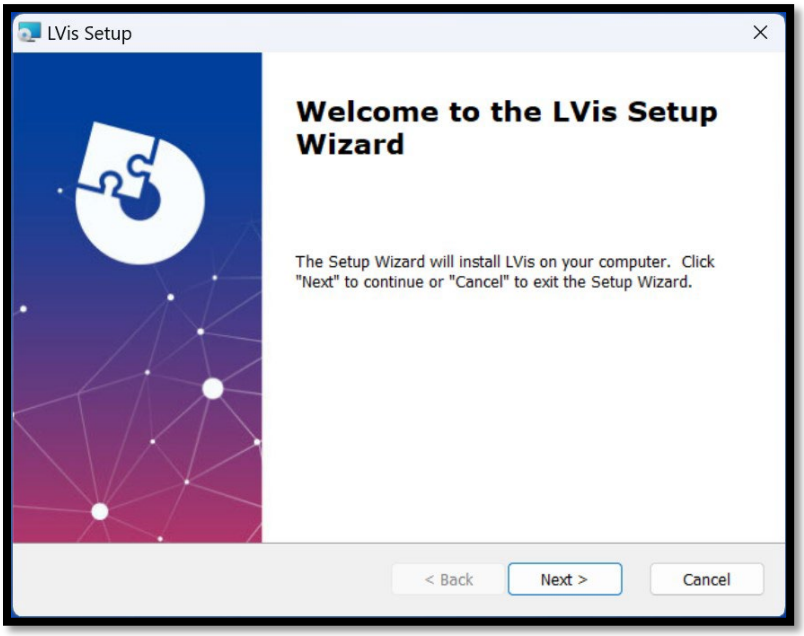


Figure 1. Specify Installer Language

On the “System information” screen, it is recommended to choose a descriptive system name and organization. This information will be saved in all measurement data and can later be used as a reference. For instance, if the user chooses the system name **Chemistry 1** and the organization name **NPP XYZ**, this information will be transferred to the database so that a detector can be described in reports not simply by its name, but by the site or group as well (e.g., Detector 5 from Chemistry 1 @ NPP XYZ).

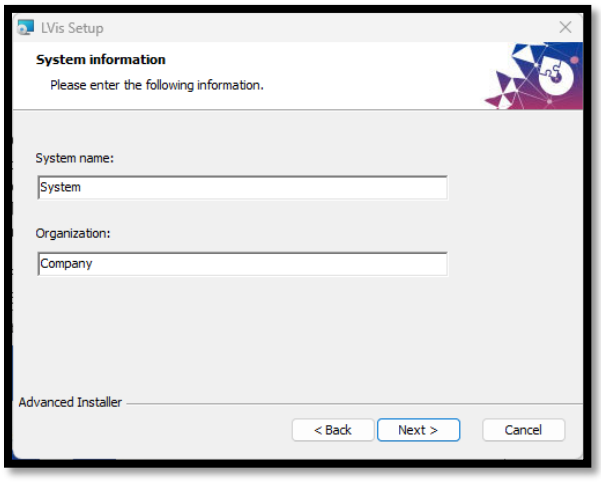


Figure 2. System Information Screen

On the Installation Folder screen, accept the default installation location, **C:\Program Files\LVis** and specify the location for the **LVis Database Folder**. The LVis database folder defines the default folder for all LVis data.

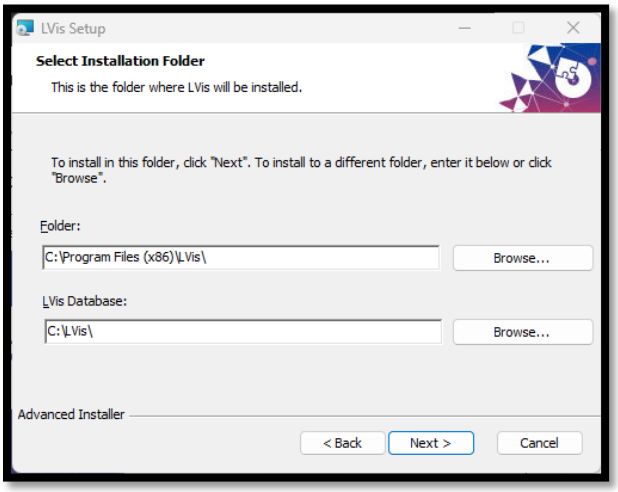


Figure 3. Select Installation Folder Screen

The LVis database folder contains all relevant data for the specific LVis configuration. All measurement data, nuclide libraries, reports, calibrations, counting routines, report templates, detector definitions etc. are saved in respective subfolders in this directory. Amongst these are:

- **\Config** – contains the LVis configuration file config.dat in which all LVis settings are stored. In addition, the configured users as well as the Lab Journal database are saved here.
- **\Help** – contains pdf version of this LVis manual
- **\Libraries** – default location for all nuclide libraries used within LVis. A set of example and master libraries are installed during setup.
- **\Measurements** – this is the default location for all LVis **.LVM** measurement files. For each detector configured in LVis a folder is created in this directory. Every **.LVM** file is automatically saved in this folder. If a measurement was analyzed or started using a predefined parameter sets (See Chapter 5 LVis Parameter Sets) the **.LVM** file is saved in a respective subfolder named after this parameter set.
- **\Reports10xx** – here all report templates are located. Depending on the language(s) used for LVis, this folder is named different. Reports1031 is used for German templates, Reports1033 for English and Reports1036 for French language reports. For more information on reports and the default report templates see Chapter 7.5 Create Reports.

NOTE: The LVis database directory can be on a local hard drive (the default is C:\LVis) or on a shared network location. Multiple LVis installations can point to the same LVis database folder. Note that the LVis database directory must be accessible for LVis to start properly. In case the LVis database folder is not accessible, LVis will not start but instead display the following error message:

"The location of the LVis database folder can only be defined during the installation of LVis. If it is desired to change the location of the LVis database folder after installation users can do this by changing the Windows 'Environment system variables' from the Windows control panel. Note that the entire LVis database folder must be moved to the new location when doing this."

Continue answering the prompts and when installation is complete, click on **Finish.** No reboot is required; however, users will have to allow the LVis User Management to start as a Windows background process and communicate with LVis via a network protocol.

2.4 STARTING LVIS FOR THE 1ST TIME

When starting LVis for the first time after a new installation, the following screen is displayed.

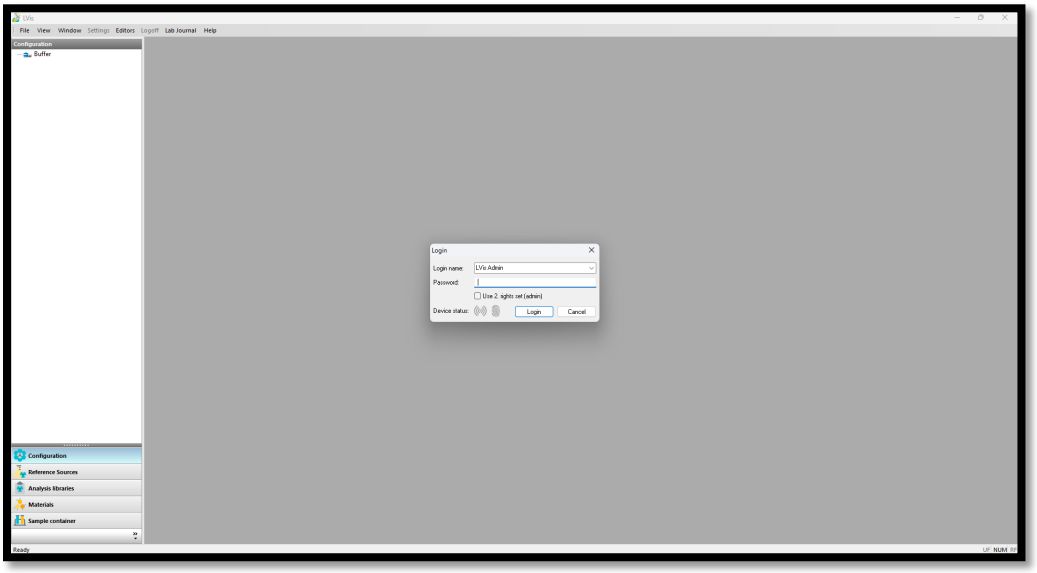


Figure 4. LVis Startup Screen

See Chapter 3 The LVis User Interface for a detailed explanation of the screen features and commands.

If no other users have yet been defined, there are two default users: “LVis Admin” and “LVis User”.

- LVis Admin can perform everything. The password for this account is “admin”.
- LVis User can only execute counting routines but not make any changes to the LVis configuration. The password is “lvis”.

If it is desired to add/modify users, see Section 2.6.

When using LVis for the first time, it is recommended to login as LVis Admin.

2.4.1 LVis Configuration Files

When starting LVis there is no LVis configuration available, and users therefore get the choice of either loading a pre-defined “LVis Configuration” file or starting from scratch with a completely empty configuration.

NOTE: The LVis configuration, representing the detectors configured for the LVis system as well as all their respective settings is saved in a single file called the “LVis configuration file”. This file is located in the “Config” subfolder of the “LVis database directory” which is by default C:\LVis. The file name for the LVis configuration is always “WindowsPCName_LVis_config.dat”.

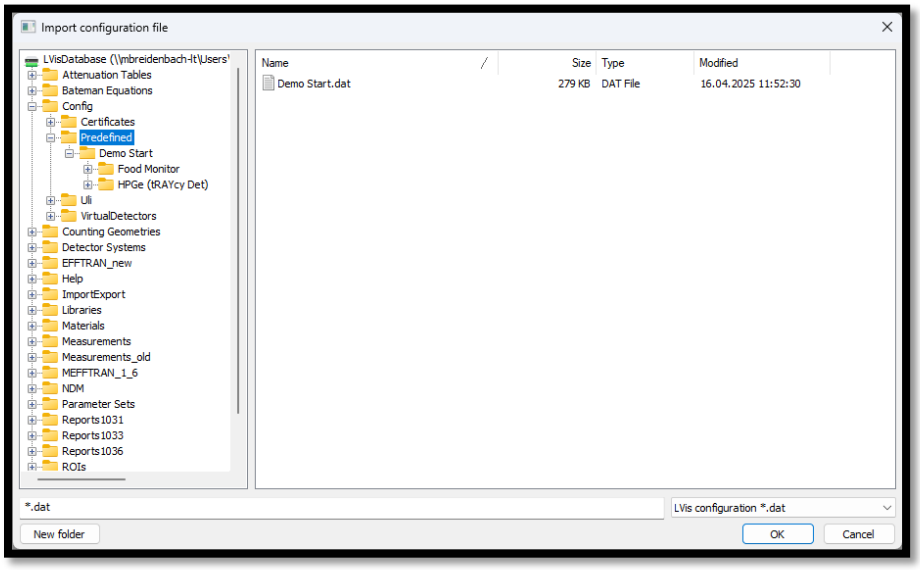


Figure 5. Import Configuration File Screen

A demo LVis configuration called “Demo Start.dat” is installed together with LVis. If it is desired to try LVis, this is likely the best way to start. Simply select the configuration file and import it.

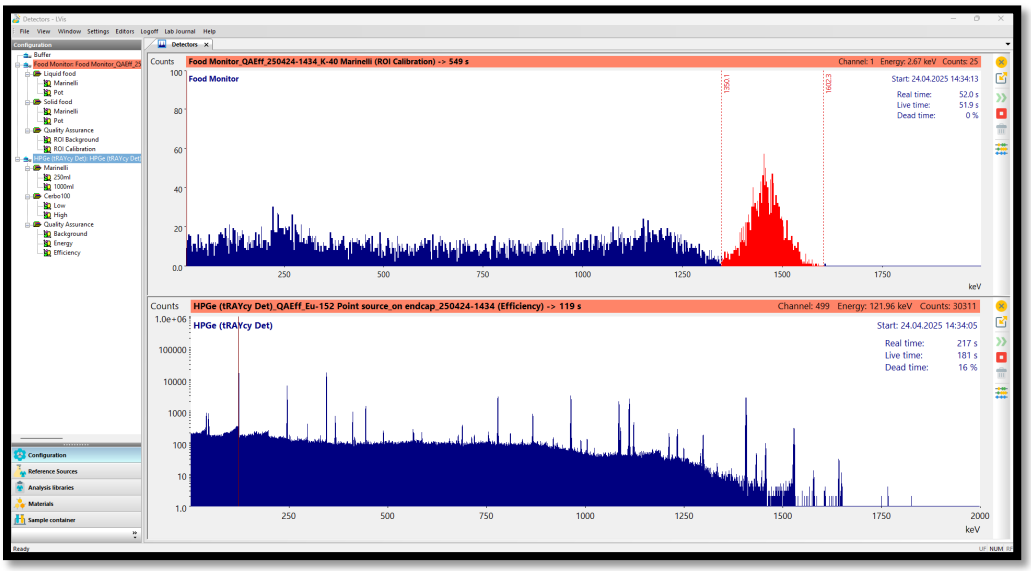


Figure 6. Demo Start.dat Demo Configuration

This demo configuration will have two detectors configured, a NaI based “Food Monitor” and a simple HPGe based detector system. Both detectors are tRAYcy detector simulations and will therefore not require any real hardware to be connected.

- If users want to define their own LVis configuration from scratch, simply click **Cancel**.
- If users want to load an existing LVis configuration file, simply browse to its location and select it.

NOTE: Simply deleting or renaming the LVis configuration file (**while LVis is closed**) will allow users to load another LVis configuration or create a new one after the next start of LVis.

2.4.2 Registering LVis – LVis Licensing

Users must purchase a license for LVis and an LVis installation must be registered for use with a license. After installation of LVis, there is a 30-day evaluation period with all features enabled. Once this period is expired, it is not possible to use LVis any more on the respective computer without purchasing a license and registering the LVis installation.

When starting a non-registered LVis, the following screen will appear:

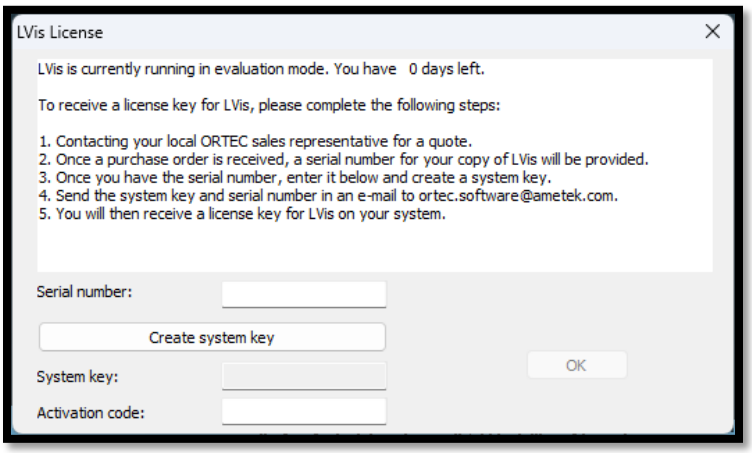


Figure 7. LVis Initial License Screen

To obtain a license, contact a local ORTEC sales representative for a quotation and purchase the license. A serial number will be received for every purchased copy of LVis.

Enter the serial number in the respective field of the above dialogue and then press **Create System Key**.

The LVis serial number and the system key that is unique to the user's computer provide a unique identification of this specific LVis installation. Send both in an email to ortec.software@ametek.com and a LVis activation code will be provided. Enter the activation code and press OK. This installation of LVis is now licensed and registered.

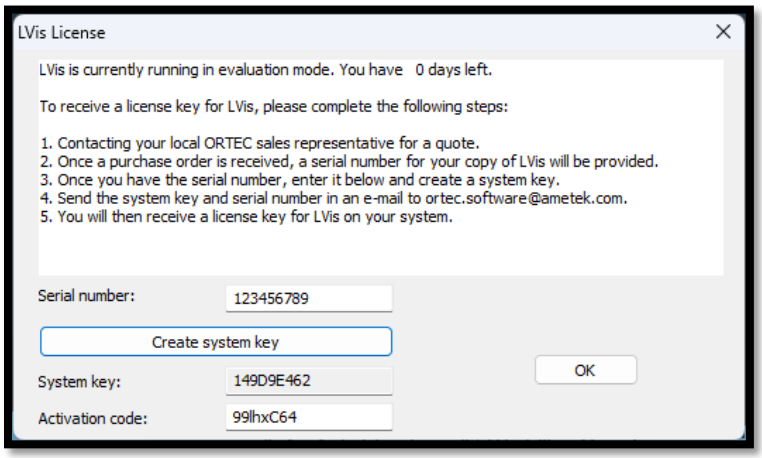


Figure 8. Completed LVis License

Note that depending on the model of LVis that was purchased not all features of LVis might be enabled. Users can always check and review license information by clicking on **Help** in the LVis menu bar and then select **License**.

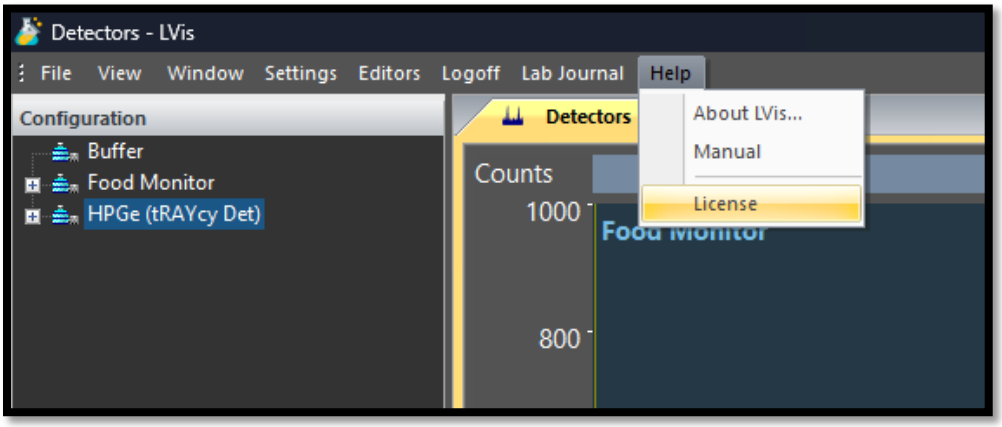


Figure 9. Locating LVis License Information

The following window will summarize the specific LVis license information:

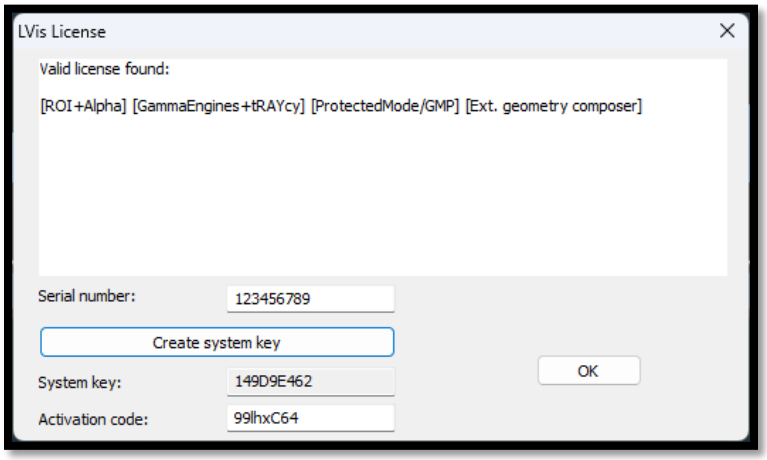


Figure 10. LVis License Information Summary

2.5 CONFIGURING THE GLOBAL LVIS SETTINGS

To ensure proper functionality, several global settings (see Section 3.3) can be adjusted in LVis. To do this, click on **Settings** on the LVis menu bar to open the following window.

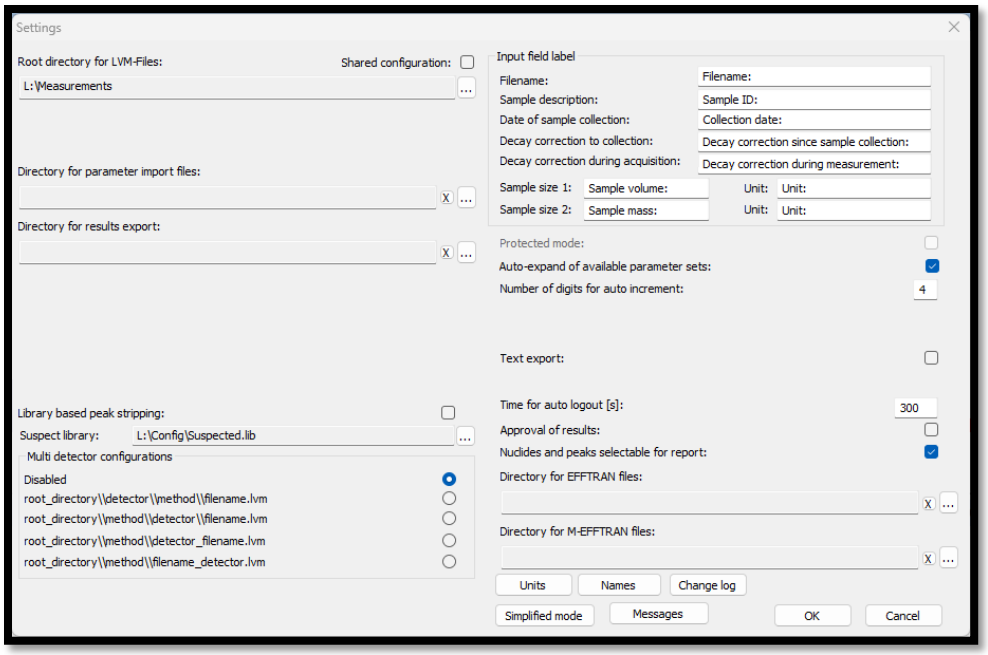


Figure 11. LVis Settings

On the main window, several default field labels that are used when creating new counting routines (aka LVis parameter sets) can be defined. In addition, it is possible to import sample data from a LIMS and respective export of analysis results. See Chapter 3.3 The Global LVis Settings for more detailed information on the options on this screen. In addition, see Section 3.3.1 Units and Section 3.3.2 Names for instructions on populating the pull-down lists on the Parameter Set window.

2.6 LVIS USER MANAGEMENT – PASSWORD-PROTECTING LVIS FUNCTIONALITY

Every user who wants to work with LVis requires an LVis user account to log into LVis from the log-in screen.

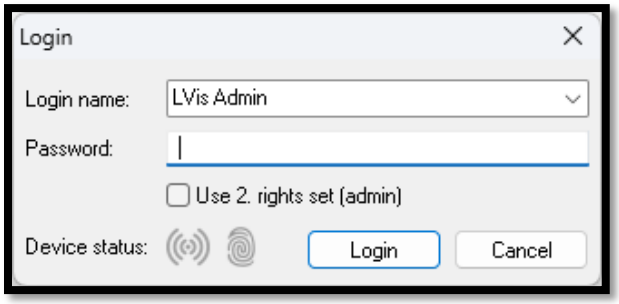


Figure 12. LVis Login Screen

LVis uses a user management program called “Uli” that allows assignment of individual rights to each of the defined users.

“Uli” is a separate program that gets installed with LVis in the LVis program directory (C:\Program Files (x86)\LVis) and will automatically be started with Windows.

In cases where Uli is not running and someone tries to log into LVis the following error message is displayed:

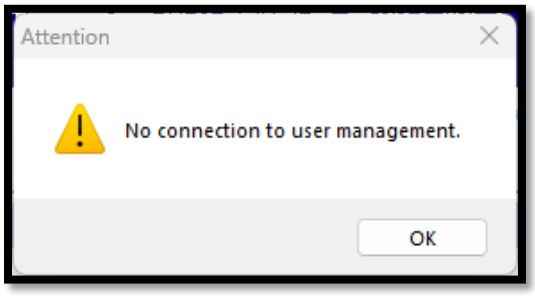


Figure 13. Uli Not Running Error Message

Uli runs as a Windows background process and can be opened by double clicking on its blue key icon shown in the Windows system tray besides the date and time information. Doing so will open the following window:

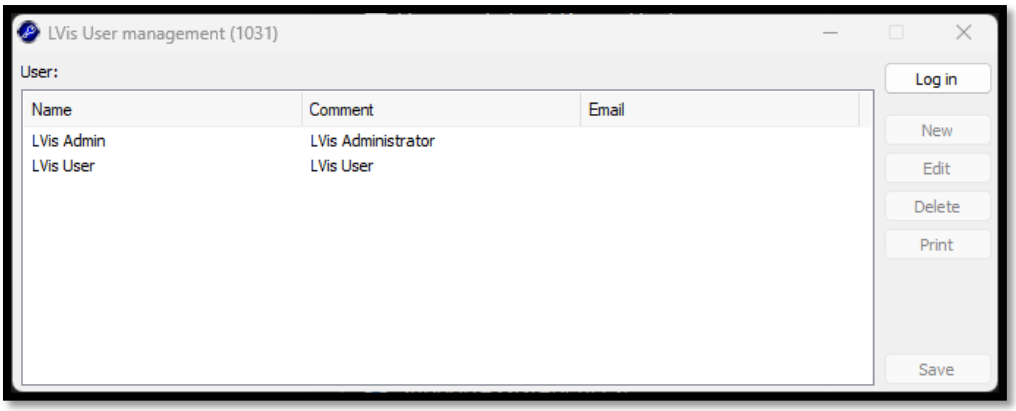


Figure 14. LVis User Management System (Uli)

NOTE: Clicking the “close window” symbol in the top right corner will just close the “Uli” window, it will not end the user management application. To really close “Uli” users need to press the left **Shift** key on their keyboard while clicking the **close window** icon.

Right after installation of LVis, there are two default users: “LVis Admin” and “LVis User”

- LVis Admin can perform everything. The password for this account is “admin”.
- LVis User can only execute counting routines but not make any changes to the LVis configuration. The password is “lvis”.

To add a new user or modify an existing user, administrators will first have to log in with a username that has the right to modify the user management. At the beginning this is LVis Admin. Simply select “LVis Admin” by double clicking on it or select **Log in** and enter the credentials for LVis Admin.

Note that once successfully logged into Uli, all buttons become active.

Click the button **New** to enter the new username and password as well as additional information like the email address (currently not used in LVis). An LVis user account can either be completely generic or could refer to a Windows user account. For a generic user (e.g. the defaults “LVis Admin” or “LVis

User") the person defining the user accounts must provide not only a username but also the respective password.

If a user account should be linked to a local Windows account or a domain account, the "Log in name" for the user must be the name in the Windows domain (e.g. "local*username* or *"domainname\username*"). In this case, the password is handled by Windows (the complexity and validity period etc. can be handled by the domain controller). In Uli, one simply needs to enter a "?" as the password in case the account refers to a Windows account.

Define the rights by ticking the entries in the window.

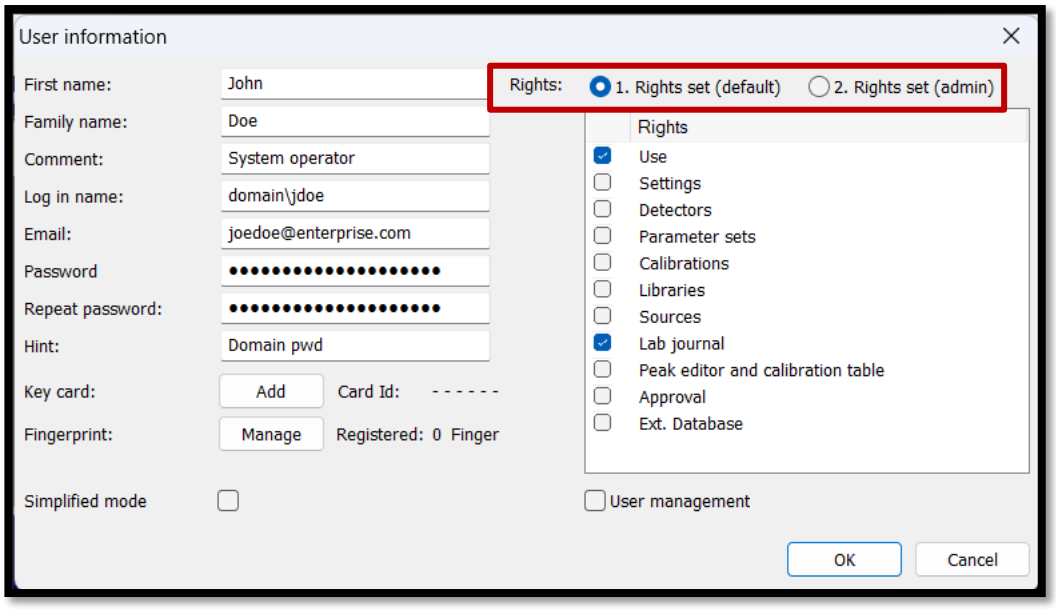


Figure 15. User Account Information

Notice that it is possible to define two set of rights for each user. A default set of rights and a 2nd set of rights typically with more features enabled. It is possible to toggle between the respective set of rights using the buttons above the list of rights (red marking in screenshot above).

It is possible to assign the rights for the following eleven tasks:

1. Possibility to **use** LVis (this is to enable LVis administrators to exclude previously configured users from continuing working with LVis instead of simply deleting the respective accounts)
2. Make changes to the LVis Global Settings (Section 3.3)
3. Add or Remove **detectors**
4. Create new or modify existing **parameter sets**
5. Change existing or create new LVis **calibrations**
6. Modify existing or create new analysis **libraries**
7. Modify existing or create new analysis **reference sources**
8. Use the **Lab Journal** to find LVM files or create reports via the Lab Journal
9. Use the **peak editor** to manually modify peak fits for re-analysis or calibrations
10. **Approve** measurements
11. Add entries to the **external database**

In addition, it is possible to give each user the right to modify the settings of the user management by checking the box **User management** or to enable the LVis simplified mode for the respective user.

2.7 ADDING AND CONFIGURING THE DETECTORS

First locate all ORTEC instruments with the MCB Configuration program, then integrate those detectors into the user's LVis configuration. For on-the fly Monte Carlo corrections using tRAYcy, each detector model must be defined properly. To do this follow these steps:

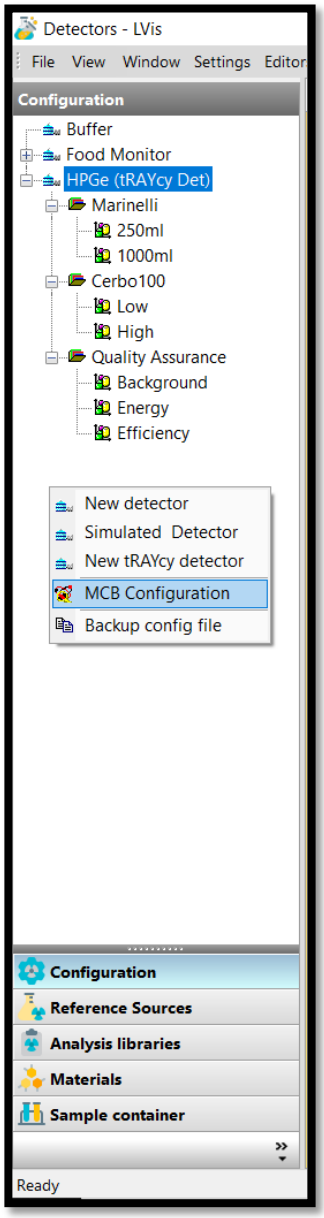


Figure 18. Selecting MCB Configuration

Locate each ORTEC instrument available to the LVis system using "MCB Configuration". To do so, right click in the Configuration area of the management panel and select **MCB Configuration** (see Figure 18 on the left).

Assign a unique identifying number and a name to each measuring chain. Users can change the name and number of the detector by double-clicking on the respective entry in the list and editing the parameters displayed in the Change Description or ID window.

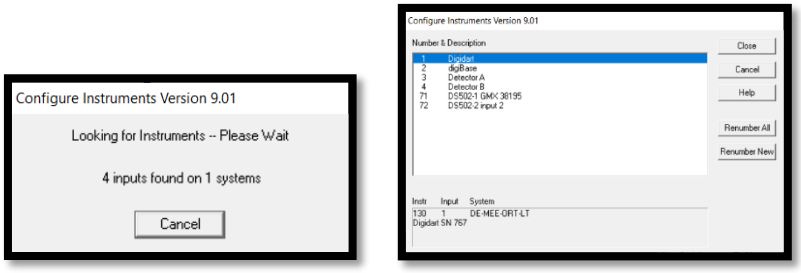


Figure 16. MCB Configuration Locating Instruments

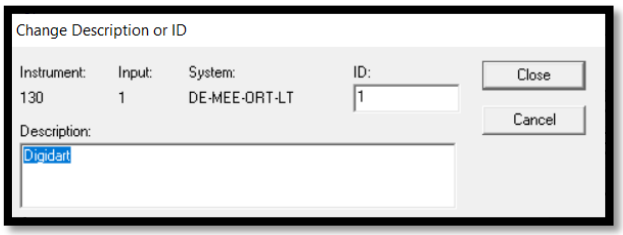


Figure 17. Change Description or ID Window

NOTE: Note that the program MCB Configuration creates a file (MCBCON32.ini) in C:\ProgramData\ORTEC Shared\UMCBI containing information about the identified hardware. LVis will use the hardware address mentioned in this file and neither the name nor the number to identify the counting electronics.

Add the instruments to the LVis configuration by right clicking in the Configuration area of the management panel and selecting **New detector**. A pulldown menu will provide a list of the identified hardware for selection.

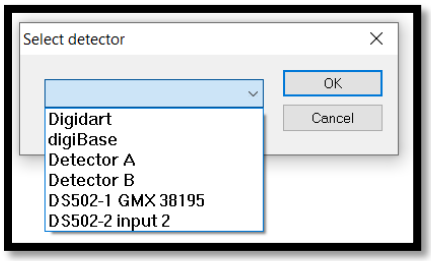


Figure 19. Pulldown Menu for Detector Selection

Configure (see Section 2.7.1) the detector and the electronics according to measuring task and detector used. This will include specifying the detector model for automated MonteCarlo calculations and adjusting the detector high voltage, amplifier gain, conversion gain, pulse shaping factors, etc.

Calibrate (see Section 2.7.2) detectors/measurement chains.

2.7.1 Detector Configuration

The detector configuration involves setting the MCB's hardware parameters, e.g., detector high voltage, amplifier gain, pulse shaping factors, etc. as well as describing the detector setup (x-tal dimensions, endcap material etc.).

This function can only be accessed by LVis users that have the right to add/modify detectors. To reach the detector configuration, right mouse-click on the requested detector in the configuration area of the management panel and select **Detector configuration** in the context menu. This will open the window shown in Figure 21, where details about the "measurement chain", the detector and electronics can be defined.

The Electronics section, on the right side of the window, provides the possibility to describe the hardware by specifying the hardware model, serial number, and additional text information. Clicking **Details** will open the hardware properties control dialog, which contains multiple tabs (sub-screens). The number and type of tabs will depend on the respective ORTEC MCB.

For more detailed information on these settings, see the respective MCB's hardware manual.

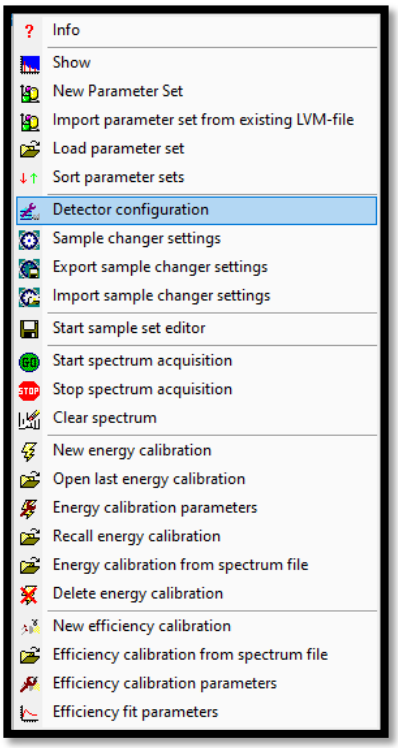


Figure 20. Detector Management Panel

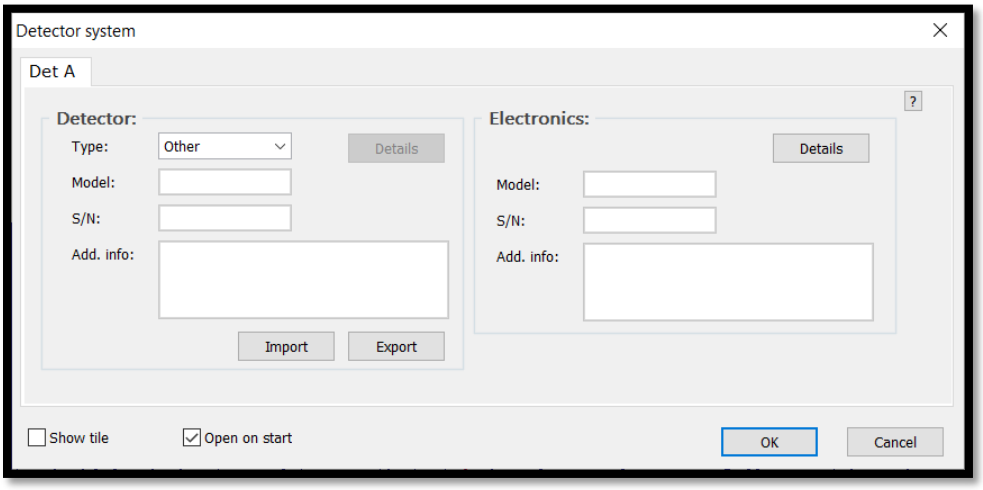


Figure 21. Detector Configuration Window

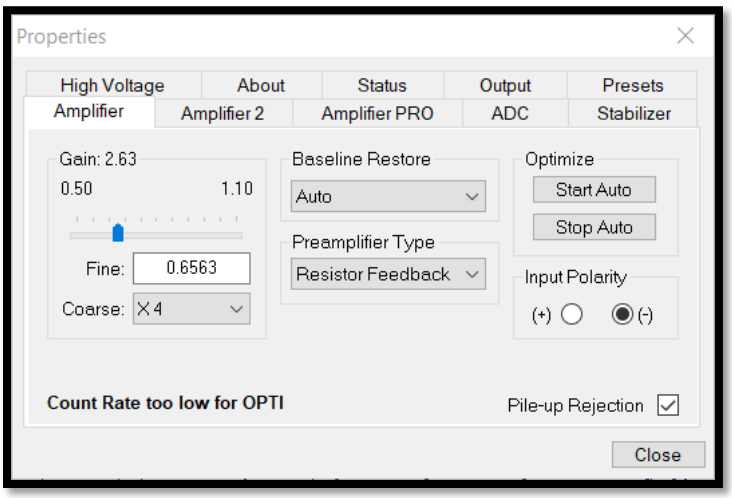


Figure 22. Hardware Properties

Click on **Close** when all parameters have been adjusted.

NOTE: The changes made on most of the hardware property tabs take place immediately. There is no cancel or undo option for these changes.

The Detector section on the left side of the window allows description of the detector type (e.g. Coax, Planar, Well etc.) as well as entry of the detector model name, serial number, and additional information. Clicking **Details** will bring up a window where the geometrical dimensions of the detector crystal and capsule can be specified.

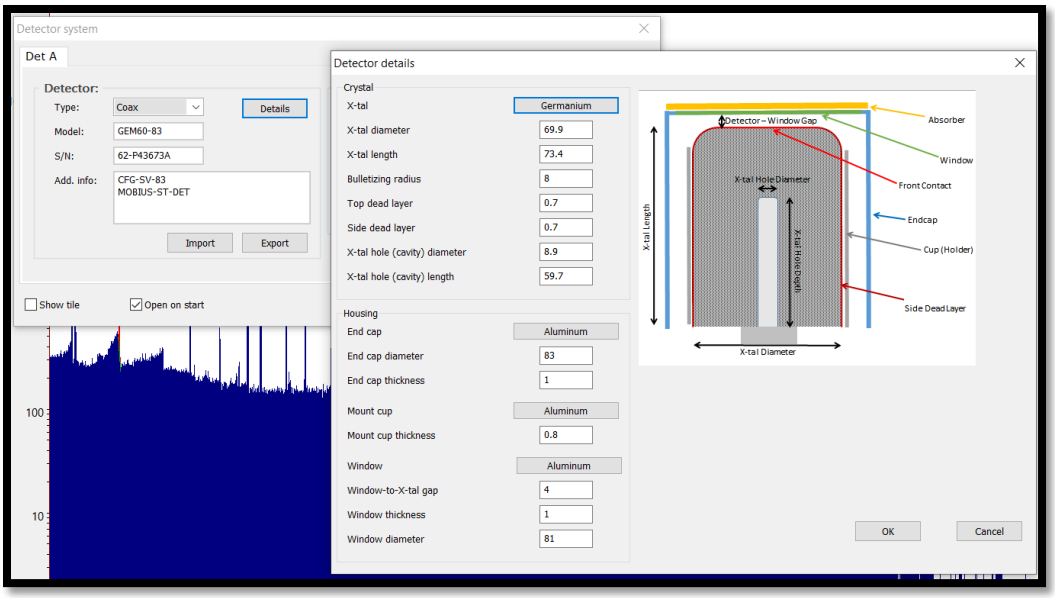


Figure 23. Detector Details Window

NOTE: The information about the detector dimensions is required when performing MonteCarlo calculations in LVis such as calculating geometry corrections, TCS corrections, or simulating spectra.

2.7.2 Detector Calibration

In LVis, calibrations are primarily taken from calibrated measurements (**.LVM** files). It is possible to use old legacy GammaVision CLB files, but these don't contain any information about the calibration geometry and are therefore not very useful in LVis (they don't allow easy, on-the-fly geometry corrections). Although basically every LVM file that contains calibration data can be used as the source of a calibration, typically distinct detector-specific energy and FWHM calibration measurements as well as the sample-specific efficiency calibration measurements are used as the source of calibrations. Users can start either of the two calibration measurements directly from the context menu of a detector by selecting "New energy calibration" (see Section 6.3 Creating an Energy Calibration) or "New efficiency calibration" (see Section 6.4 Creating an Efficiency Calibration). Note that before it is possible to perform a calibration measurement in LVis, a respective reference source or calibration source must be created. For more information on how to calibrate a detector, please refer to Chapter 6 Calibrations.

2.8 CREATION OF PARAMETER SETS

Parameter sets in LVis are predefined measurement and analysis parameters for a detector and sample geometry. They contain all instructions required for a measurement with subsequent analysis. This includes among others sample-specific details such as sample name and quantity, sample origin, sample category, etc., but also specifications regarding measuring time, activity units as well as analysis settings, such as possibly used corrections, maximum acceptable uncertainties, calibrations (Chapter 6 Calibrations), libraries (Section 3.2.3 Analysis Library Editor), etc.

There are different types of parameter sets:

- Gamma analysis based on analysis engines
- ROI gamma analysis

- ROI alpha analysis using the tracer concept
- Multi measurement parameter sets (a loop – repeat a counting routine multiple times)
- Parameter sets for QA checks, calibrations or detector background measurements

Parameter sets are always assigned to detectors and can only be created and edited by LVis users that have the right to modify/create parameter sets. In order to create a new parameter set, right-click on the detector in the Configuration area and select “New parameter set” (see Section 5.1 Creating Parameter Sets) from the context menu.

Alternatively, users can also import LVis parameter set files (**.LVP**) (see Section 2.9 Saving the LVis Configuration or Section 2.10 Loading a Configuration File) or apply parameter sets from saved LVis measurements (**.LVM**) (see Section 2.11 Creating and Restoring a Complete LVis Backup).

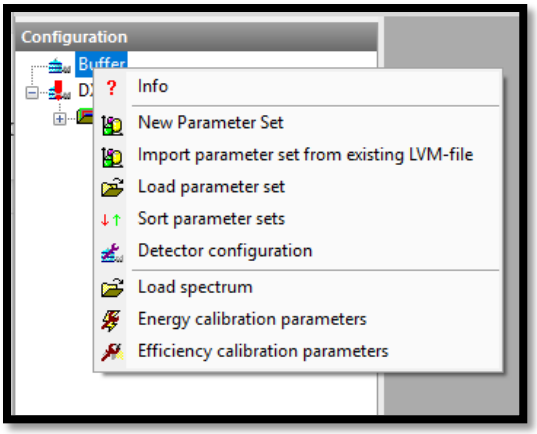


Figure 24. Parameter Set Menu

It is possible to define in a parameter set which settings can or must be changed by an operator prior to starting a measurement and which parameters will be blocked for modification by operators. In general parameter sets are organized in tabs that may be a little different depending on the type of parameter set. On the “Sample data” tab, the sample specific information in entered. The “Counting geometry” tab provides information on the sample material, the respective container, and the position of the container on the detector. The “Reporting” tab defines instructions on when to analyze and how to publish the results.

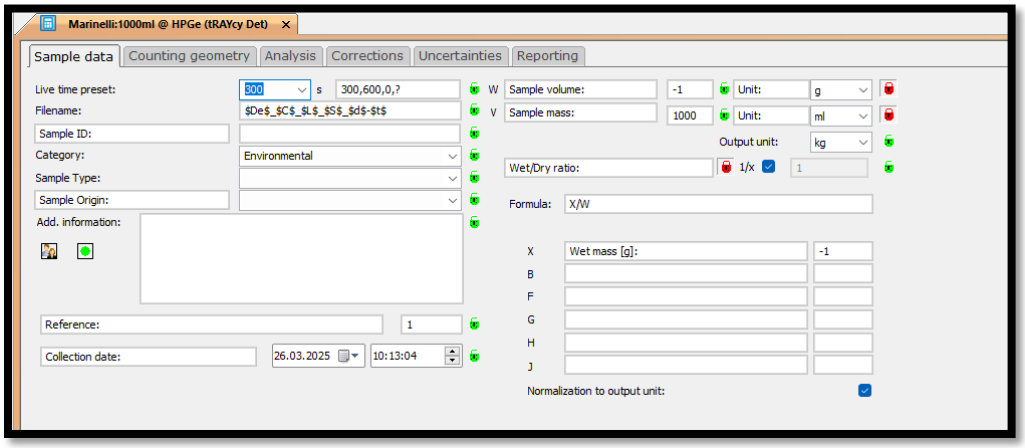


Figure 25. Sample Data Tab

The other tabs like “ROI”, “Alpha”, “Analysis”, or “Corrections” provide specific settings on how to analyze the measurement.

Since parameter sets contain measuring and analysis instructions, they can be used in two different ways, parameterized measurements can be started using parameter sets or existing spectra can be analyzed using the analysis instructions in parameter sets. For more details, please refer to the “Start new (parameterized measurement)” (see Section 7.3.1) and “Analyze current spectrum” (see Section 7.4) menu items in the context menu of a parameter set (right click on parameter set to see context menu).

More information regarding parameters sets for measurement and analysis can be found under Chapter 7 Spectrum Acquisition and Analysis.

2.9 SAVING THE LVIS CONFIGURATION

LVis allows users to save complete configurations (all configured detectors, parameter sets, reference sources, and multi-detector configurations) as well as global settings (including all descriptions, names, and units). ***It is strongly recommended that users do this.*** In the event of a new installation or a hardware problem, the LVis configuration can be quickly and easily restored using this safety backup file.

In order to create a safety backup of the configuration, right-click on the management panel into the configuration area. Select **Backup config file** in the context menu. This **config.dat** file contains the entire configuration.

IMPORTANT Quality assurance databases, calibration files or measurements are not saved in the configuration file. Saving this data must be done separately via backup of the respective data (easiest is to simply backup the complete LVis database folder), which is recommended to be done at periodic intervals.

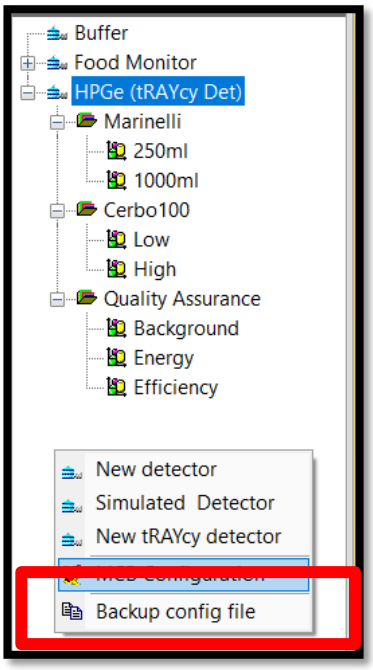


Figure 26. Selecting Backup Configuration

2.10 LOADING A CONFIGURATION FILE

LVis allows users to easily transfer an existing configuration to another computer without having to copy every single parameter set individually. The easiest way to achieve this is to simply copy the complete LVis database folder from one machine to the other. Ensure that LVis is not started when doing this.

When starting LVis and there is no LVis configuration file existing for the respective system (Remember: *The file name for an LVis configuration is always “WindowsPCName_LVis_config.dat”)*, LVis will ask after startup if it is desired to load an existing configuration file. Users can then select the configuration backup file. All adjusted detectors, parameter sets, reference sources, multi-detector configurations as well as global settings (including all descriptions, names, and units) and QA databases will appear on the new computer.

Though the user’s detectors will be listed on the configuration tab in LVis, they will very likely be labeled as “Not Connected”. This is because the respective ports (e.g. USB) to control the hardware

are not necessary the same as they were on the previous system. Simply run “MCB Configuration” and then re-connect the detectors using the respective command from the detector context menu.

In addition, the configuration file contains the parameter sets, but it doesn’t contain the additional files that might be referenced in the parameter sets like calibrations or analysis libraries. So, if these additional files are not available under the same path/location on the new system, respective error messages will pop up when using the parameter sets.

NOTE: When using a shared network location that is mounted as a Windows network drive as the location for the LVis database folder, a configuration file backup is sufficient if the same network drive is mounted on the new system.

2.11 CREATING AND RESTORING A COMPLETE LVIS BACKUP

A full backup of LVis simply consists of the LVis database folder. The LVis database folder includes everything that is required to restore or replicate a complete LVis system on another computer or storage.

So, for full backups, just periodically create copies of the LVis database folder. LVis does not provide internal controls to create automated backups of the LVis database folder. Several 3rd party or freeware tools are available to achieve this.

To restore an LVis system, simply copy the backup of the LVis database folder onto the new computer (or make the backup available to the new computer on a shared network location), then install LVis and specify the respective location of the restored files as the new source for the LVis database when asked during the setup. In case LVis is already installed and it is desired to modify the location of the LVis database folder users can do so by changing the environment variables of Windows. To change the environment settings of Windows start **Windows Settings**. Navigate to **System→ About**. Then click on Advanced system settings and click the **Environment Variables** button. (Note that administrator rights will be required to do that).

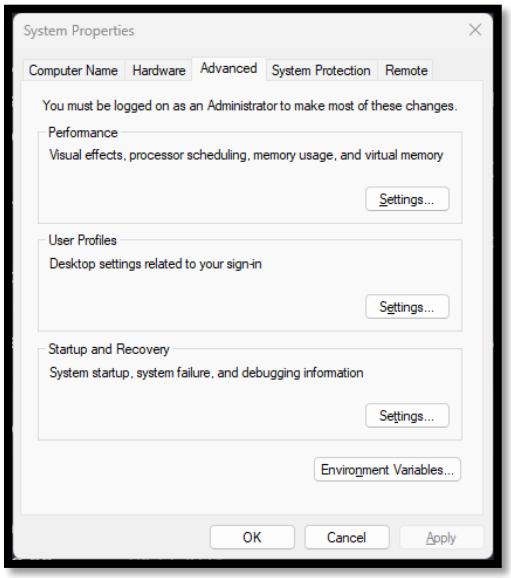


Figure 27. System Properties

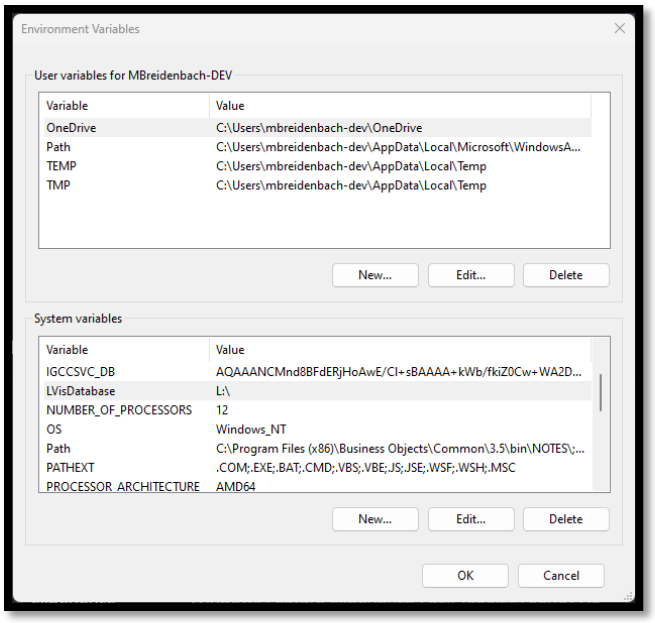


Figure 28. Environment Variables

REMINDER The name of the LVis configuration file includes the name of the respective computer (*"WindowsPCName_LVis_config.dat"*). So, when copying a backup onto a new computer and starting LVis for the first time, LVis will ask for a configuration file. Simply browse to the ~LVis database folder\Config folder and select the old configuration file so that LVis loads it.

3. THE LVIS USER INTERFACE

3.1 GENERAL INTERFACE

3.1.1 Login

After LVis is started, a login window appears. To log in, select a user from the “Login name” drop down menu or enter the name manually. Enter the password for the selected user in the “Password” field and press the **Login** Button to log in. The access control is managed by the user management program “Uli” which can be opened from the windows system tray. A detailed explanation about “Uli” can be found in Section 2.6 LVis User Management – Password-Protecting LVis Functionality.



Figure 29. User Login Screen

After logging in, the general user interface of LVis which is shown in Figure 30 is displayed.

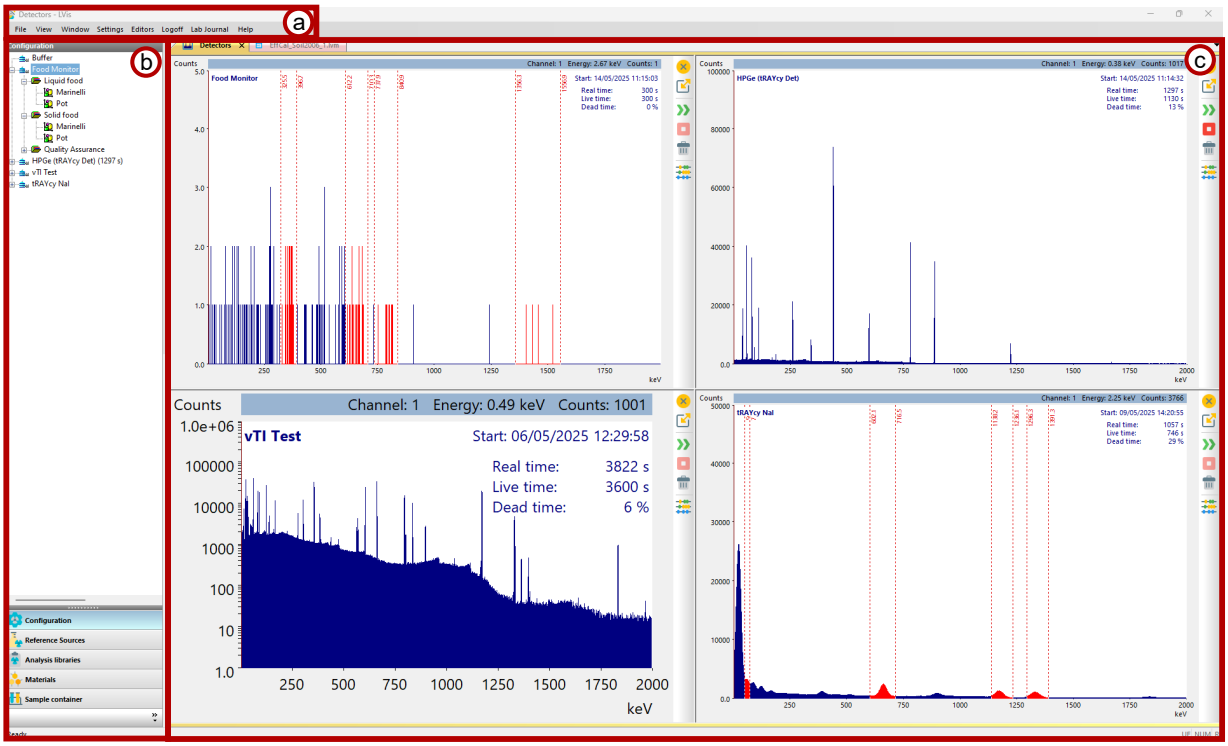


Figure 30. LVis GUI

3.1.2 Top Bar Menu

The menu bar (Section A in Figure 30) contains the following menu items:

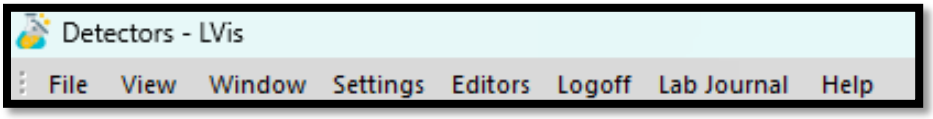


Figure 31. Top Menu Bar

These entries provide general LVis functionalities:

- File – Standard file operations
- View, Window – Display options
- Settings – Global settings – See Section 3.3
- Editors – Configuring an external database – See Section 3.2.6
- Logoff – Logoff from LVis
- Lab Journal – Using the Lab Journal – See Section 11
- Help – Help menu – See Section 3.5

3.1.3 Management Panel

The management panel (Section B in Figure 30), on the left side of the program window, is the main interface to configure LVis. It is used to interact with and configure detectors, define the counting routines, create analysis libraries, load the reference sources, and describe the containers and materials used in the user's laboratory.

The management panel is divided into five sections:

- 3.2.1 Configuration Editor
- 3.2.2 Reference Source Editor
- 3.2.3 Analysis Library Editor
- 3.2.4 Materials Editor
- 3.2.5 Sample Container Editor

A detailed description of these functions is given in Section 3.2.

3.1.4 Work Bench

The work bench (Section C in Figure 30) displays the live detector view of connected detectors (see Chapter 4 Detectors), open parameter sets, and open measurement files (see Chapter 5 LVis Parameter Sets).

3.2 LVIS EDITORS – WORKING WITH THE LVIS MANAGEMENT PANEL

Several editors are available through the configuration side bar (the management panel, Section B in Figure 30). The type of editor can be selected from the buttons placed on the bottom of the configuration.

3.2.1 Configuration Editor

In the Configuration section detectors can be connected, configured and operated. Right-click on a detector entry opens the detector context menu (Figure 32) which is the main interface to interact with the detector (see Chapter 4 Detectors). In addition, parameter sets for Quality Assurance (QA) and regular measurements can be defined and edited in this section (see Chapter 5 LVis Parameter Sets).

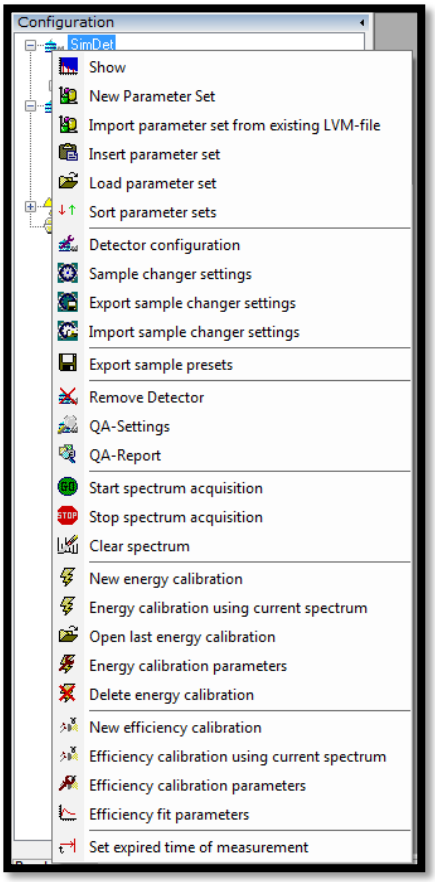


Figure 32. Configuration Section

The *Configuration* section is the gateway for all day-to-day operations; for this reason, the functionalities available here are explained in detail in separate chapters:

- Chapter 4 – Detectors – Explains how to connect, configure, and monitor detectors
- Chapter 5 – LVis Parameter Sets – Explains how to create and manage parameter sets
- Chapter 6 – Calibrations – Explains how to perform and use calibrations
- Chapter 7 – Spectrum Acquisition and Analysis – Explains how to measure and analyze samples
- Chapter 8 – Quality Control in LVis (QA) – Explains how to set and run QA checks

In addition, it is possible to configure automated sample changers from the detector context menu. Their configuration and how to count batches of samples is described in detail in Chapter 12 Sample Changer.

Multidetector configurations, that allow the simultaneous control of multiple detectors are listed in the "Configuration area" as well. More information can be found in Section 4.6 Multi-Detector Configurations.

3.2.2 Reference Source Editor

In this section reference sources can be created and managed. Reference sources are certified sources used to calibrate detectors or monitor their performance through QA checks; see Chapter 8 Quality Control in LVis (QA).

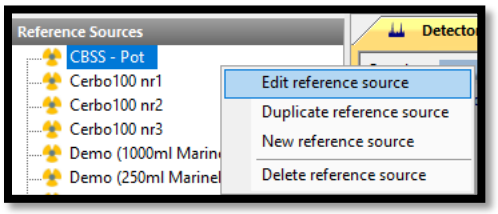


Figure 33. Reference Source Management Menu

3.2.2.1 Deleting a Reference Source

To delete an existing reference source, open the reference source context menu by right clicking on the source in the *Reference Sources* configuration window. Then select **Delete reference source** to delete it.

3.2.2.2 Editing a Reference Source

To edit an existing reference source, open the reference source context menu by right clicking on the source in the *Reference Sources* configuration window. Then select **Edit reference source**. This opens the reference source editor shown in Figure 34.

3.2.2.3 Creating a New Reference Source

To create a new reference source, open the reference source context menu by right clicking anywhere in the *Reference Sources* configuration window. Then select **New reference source** and enter a unique name for the new source in the dialog. Clicking **OK** opens the reference source editor shown in Figure 34.

3.2.2.4 Duplicating a Reference Source

To duplicate an existing reference source, open the reference source context menu by right clicking on the source in the *Reference Sources* configuration window. Then select **Duplicate reference source** to create it.

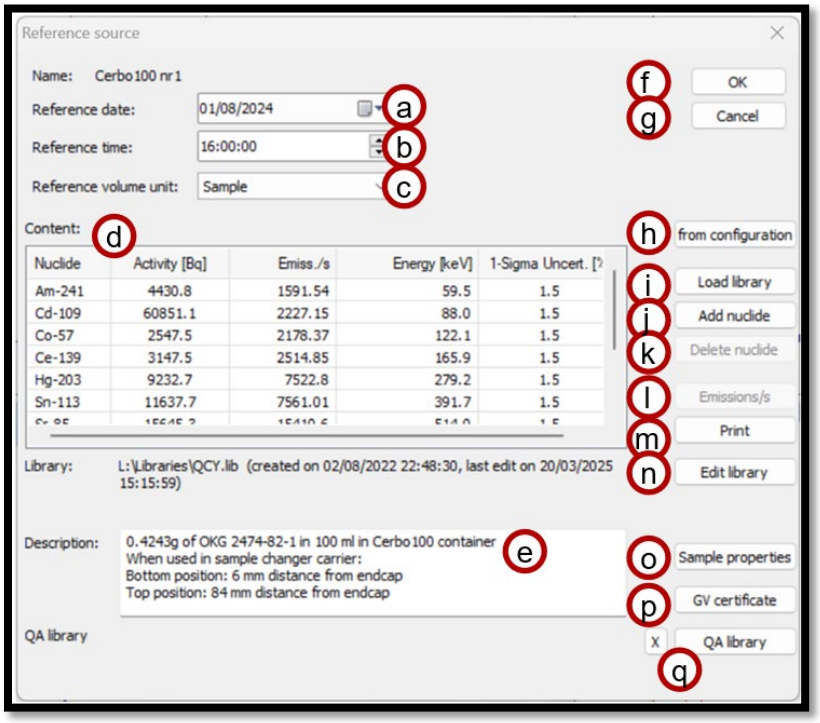


Figure 34. Reference Source Configuration Window

3.2.2.5 Reference Source Configuration Window

The features of the reference source configuration window are explained below:

a. **Reference date:** The reference date of the reported activities given on the certificate of the reference source.

b. **Reference time:** The reference time of the reported activities given on the certificate of the reference source.

c. **Reference volume unit:** The volume unit given on the certificate of the reference source. In most cases the volume unit is given as Activity per sample or Activity per liter.

d. **Content:** The table shows the nuclide composition of the reference source. The activity of each nuclide can be changed by double clicking the “Activity” entry in the respective line. The 1-σ uncertainty of the activity in % can be changed by double clicking the respective entry.

e. **Description:** Text field for miscellaneous information.

f. **OK:** Press to save changes.

g. **Cancel:** Press to ignore changes.

h. **From configuration:** Press to clone data from an existing reference source.

i. **Load library:** Press to copy the nuclides of an existing library into table (section d).

j. **Add nuclide:** Press to select a nuclide from an existing library and inset it into table (section d).

k. **Delete nuclide:** If a line in the table (section d) is selected, delete it by pressing this button.

l. **Emissions/s:** If a line in the table (section d) is selected, enter the nuclides activity in emissions per second for a specific emission.

m. **Print:** Print a report about this reference source.

n. **Edit library:** Press to open the library editor (see Section 3.2.3 Analysis Library Editor). Only emissions listed in the library are used when the reference source is selected for QA or calibration.

o. **Sample properties:** Opens the Sample Container Editor to edit the physical properties of the reference source (see Section 3.2.5 Sample Container Editor).

p. **GV certificate:** Create a *GammaVision* certificate file.

q. **QA library:** Opens the library editor for the QA library (see Section 3.2.3 Analysis Library Editor). If a QA library is defined, this library is used in QA measurements. In some cases, a reduced library is preferred in QA measurements compared with calibrations.

3.2.3 Analysis Library Editor

In this section analysis libraries can be created and managed. Analysis libraries contain the nuclide data used in reference sources and in the analysis of measurements; see Section 3.2.2 Reference Source Editor

In general, LVis uses the GammaVision nuclide library format .LIB.

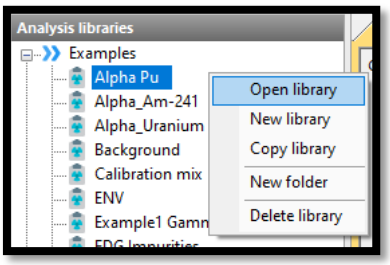


Figure 35. Analysis Libraries Management Menu

IMPORTANT It is currently not possible to use Nuclide Navigator database libraries in LVis.

IMPORTANT A library must be tailored for the measurement task. Only nuclides and emissions that are expected to appear in the spectrum should be part of the analysis library.

3.2.3.1 Adding a Library Folder

Folders are containers that help organize analysis libraries. To add a new folder, right-click anywhere in the *Analysis libraries* configuration window. Then select **New folder** and enter a folder name.

3.2.3.2 Deleting a Library Folder

A folder can only be deleted when it is empty. Delete all libraries in the folder and pick **Remove folder** from the libraries context menu.

3.2.3.3 Deleting an Analysis Library

To delete an existing analysis library, open the analysis library context menu by right clicking on the entry in the *Analysis libraries* configuration window. Then select **Delete library** to delete it.

3.2.3.4 Editing an Analysis Library

To edit an existing analysis library, open the analysis library context menu by right clicking on the entry in the *Analysis libraries* configuration window. Then select **Open library** to edit it.

3.2.3.5 Adding a New Analysis Library

To create a new analysis library, open the analysis library context menu by right clicking anywhere in the *Analysis libraries* configuration window. Then select **New library** and enter a unique name for the new library in the dialog. Click **OK** to open the analysis library editor shown in Figure 36.

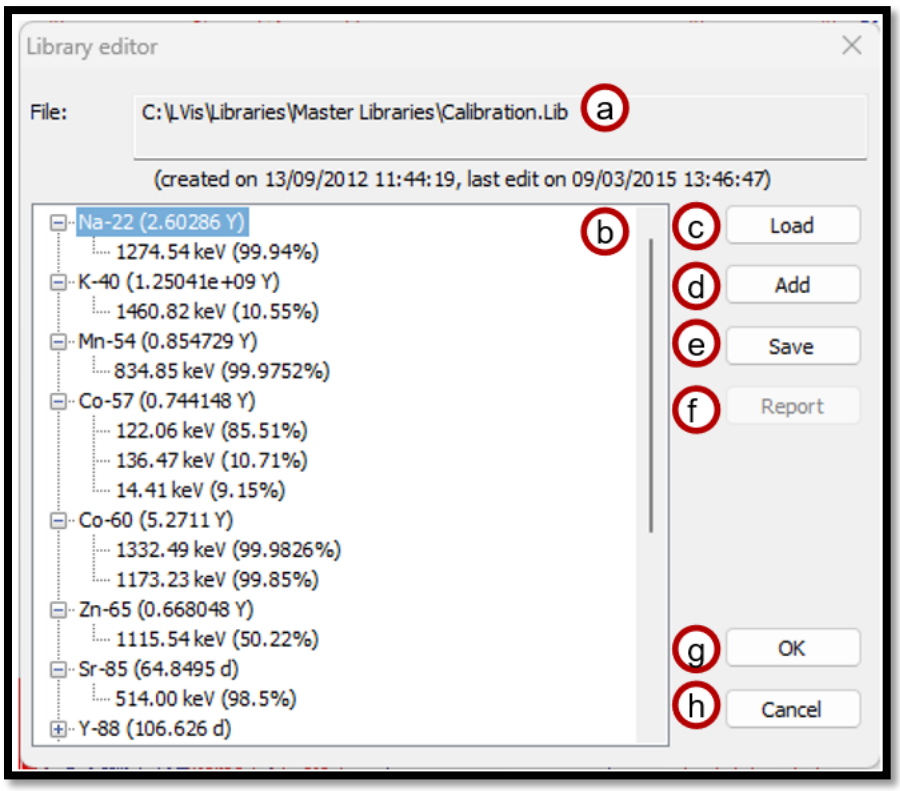


Figure 36. Analysis Library Editor

3.2.3.6 Analysis Library Editor

The features of the Analysis library editor are explained below:

a. **File:** Location of the library file in the file system.

b. **Library table:** A list of the nuclides and emissions in the library. Nuclides and Emissions have their own context menus.

c. **Load:** Press to load an existing library.

d. **Add:** Press to load a nuclide from another library.

e. **Save:** Opens a “Save As” dialog to save the library under a different name or location.

f. **Report:** Creates a report for this analysis library.

g. **OK:** Press to save changes.

h. **Cancel:** Press to ignore changes.

IMPORTANT Adding data from a library adds data for all nuclides that do not exist in the currently open one. The information about nuclides that are already existing is maintained.

3.2.3.7 Adding a Nuclide to the Analysis Library

There are two ways to add a nuclide to the library.

- Press the **Add** button (section d in Figure 36), select a library, and select the respective nuclides.
- Right click on the library table (section b in Figure 36), either next to an existing nuclide or in the empty space below the entries. This opens the nuclide context menu. Select **Add nuclide** to open the nuclide import window.

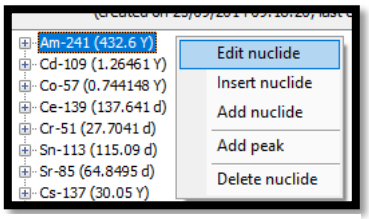


Figure 37. Nuclide Context Menu

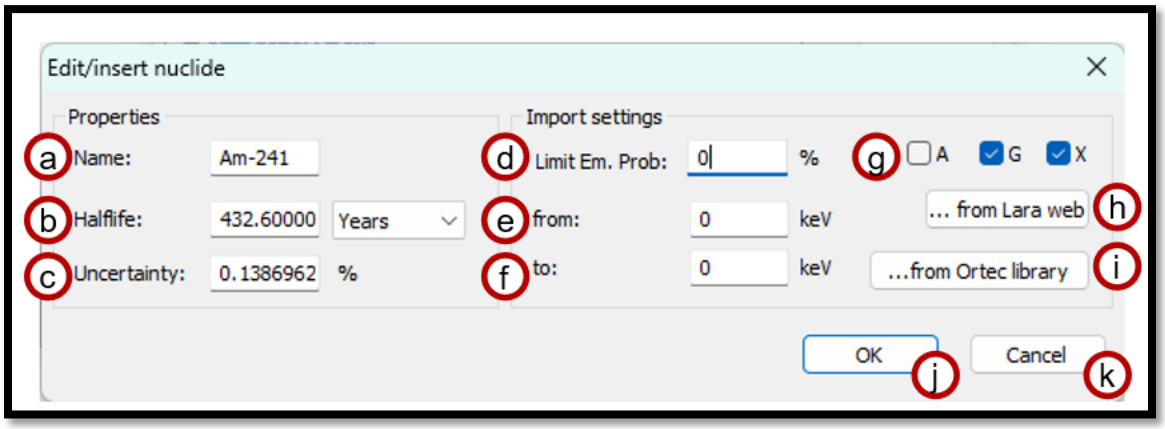


Figure 38. Edit/Insert Nuclide Dialog

The Edit/Insert nuclide screen is described below:

a. **Name:** Nuclide name in the format *Element – Mass*.

b. **Halflife:** Half-life of the nuclide, the unit can be changed in the drop-down menu on the right.

c. **Uncertainty:** Uncertainty of the half-life given in section b.

d. **Limit Em. Prob:** Minimum emission probability of emissions added to the library when the nuclide is imported from Lara (section h) or ORTEC library (section i).

e. **From:** Lower energy range limit of emissions added to the library when the nuclide is imported from Lara (section h) or ORTEC library (section i). Emissions below this energy are not added.

f. **To:** Upper energy range limit of emissions added to the library when the nuclide is imported f from Lara (section h) or ORTEC library (section i). Emissions above this energy are not added.

g. **Emissions type filters:** Check A for alphas, G for gammas, and X for X-rays.

h. **… from Lara web:** Press to import the nuclide given in section a from the LARA database (http://www.nucleide.org/Laraweb).

i. **… from Ortec library:** Press to import the nuclide given in section a from an existing ORTEC library.

j. **OK:** Save changes and add the nuclide to the library.

k. **Cancel:** Close the dialog without saving.

3.2.3.8 The Lara database

The LARA database is published by the French “Laboratoire National Henri Becquerel” and contains the reviewed nuclear data from the DDEP, the Decay Data Evaluation Project. The DDEP is an international collaboration that was formed in 1995. Its members include the BNM-CEA/LNHB (France), PTB (Germany), INEEL (USA), KRI (Russia), LBNL (USA), NPL (United Kingdom) and CIEMAT (Spain), The DDEPs objective is providing carefully evaluated nuclear data (http://www.nucleide.org/DDEP_WG/DDEPdata.htm).

To be able to import data from the LARA database the computer needs an internet connection.

NOTE: If the Lara import returns an error messages like “Unreasonable answer from LARA”, browse to the LARA page and select the respective nuclide for display, then try to import again.

3.2.3.9 Removing a Nuclide from the Analysis Library

To remove a nuclide from the analysis library, right click on its entry in the library table (section b of Figure 36). In the nuclide context menu shown in Figure 37, select **Delete nuclide** and confirm the action in the dialog.

3.2.3.10 Editing a Nuclide from the Analysis Library

To edit a nuclide in the analysis library, right click on its entry in the library table (section b of Figure 36). In the nuclide context menu shown in Figure 37, select **Edit nuclide** which opens the **Edit/insert nuclide** dialog shown in Figure 38.

3.2.3.11 Adding an Emission/Peak to a Nuclide in the Analysis Library

Two ways exist to add an emission, also refered to as peak, to a nuclide.

- Open the *nuclide* context menu shown in Figure 37 and select **Add peak**.

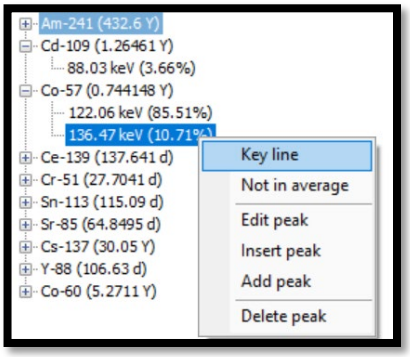


Figure 39. Emissions Context Menu

- Open the emission context menu by right clicking on an existing emission line for the respective nuclide. Then select **Add peak** from the emission context menu shown in Figure 39.

For both options, open the **Edit/insert peak** dialog shown in Figure 40.

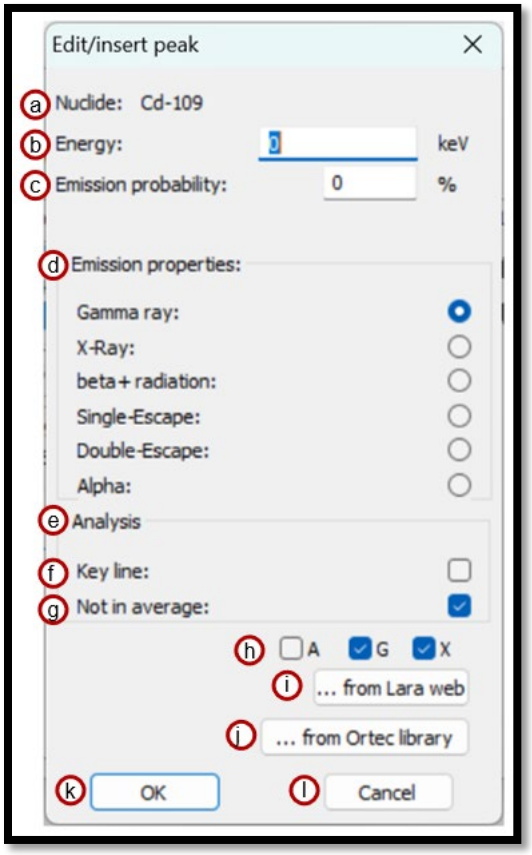


Figure 40. Edit/Insert Peak Dialog

The Edit/Insert peak screen is described below:

a. **Nuclide:** Name of the parent nuclide for this emission.

b. **Energy:** Energy of the emission in keV.

c. **Emission probability:** Emission probability in %.

d. **Emission properties:** Type of the emission. Only one option can be selected.

e. **Analysis:** The settings in this section influence how the emission is treated in the analysis.

f. **Key line:** Key lines *must* be found in a spectrum to identify the nuclide. The peak on position 1 in the list of emissions (section b in Figure 36) for a nuclide is automatically set as a key line (see the GammaVision user manual for more information). This option can also be set from the emission context menu (Figure 39).

g. **Not in average:** Specifies if the activity determined for this emission/peak should be included in the average activity of the nuclide. This option can also be set from the emission context menu (Figure 39).

h. **Emissions type filters:** Check A for alphas, G for gammas and X for X-rays.

i. **… from Lara web:** Press to import the emission given in section b from the LARA database (http://www.nucleide.org/Laraweb).

j. **… from Ortec library:** Press to import the nuclide given in section b from an existing ORTEC library.

k. **OK:** Save changes and add the nuclide to the library.

l. **Cancel:** Close the dialog without saving.

3.2.3.12 Deleting an Emission/Peak from a Nuclide in the Analysis Library

To delete a peak from a nuclide in the analysis library, open the emission context menu (Figure 39) and select **Delete peak**. This option is only displayed when the nuclide has more than one emission.

3.2.3.13 Editing an Emission/Peak of a Nuclide in the Analysis Library

To edit a peak of a nuclide in the analysis library, open the emission context menu (Figure 39) and select **Edit peak**. This opens the **Edit/insert peak** dialog and fills the fields with the information of this peak.

3.2.4 Materials Editor

In this section materials for containers, detectors and other geometries are created and managed. To work with the materials editor, open the Materials section by selecting **Materials** from the options on the bottom of section b shown in Figure 30.

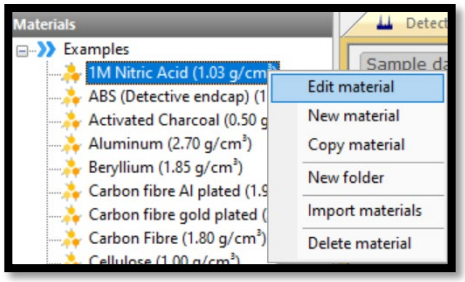


Figure 41. Materials Context Menu

3.2.4.1 Adding a Material Folder

Folders are containers that help organize materials. To add a new folder, right-click anywhere in the *Materials* configuration window. Then select **New folder** and enter a folder name.

3.2.4.2 Deleting a Material Folder

A folder can only be deleted when it is empty. Delete all materials in the folder and pick **Remove folder** from the libraries context menu.

3.2.4.3 Deleting a Material

To delete an existing material, open the material's context menu by right clicking on the entry in the *Materials c*onfiguration window. Then select **Delete material** to delete it.

3.2.4.4 Editing a Material

To edit an existing material, open the material's context menu by right clicking on the entry in the *Materials* configuration window. Then select **Edit material** to open the material editor shown in Figure 42.

3.2.4.5 Importing Material

To import a material from a .LVZ file, open the material context menu by right clicking anywhere in the configuration window shown in Figure 41. Then select **Import materials** and open the material from the file browser dialog.

3.2.4.6 Creating a New Material

To create new material, open the material context menu by right clicking anywhere in the configuration window shown in Figure 41. Then select **New material** to open the material editor shown in Figure 42. Material in LVis is a composition of chemical elements and/or molecules. It is characterized by its name and density.

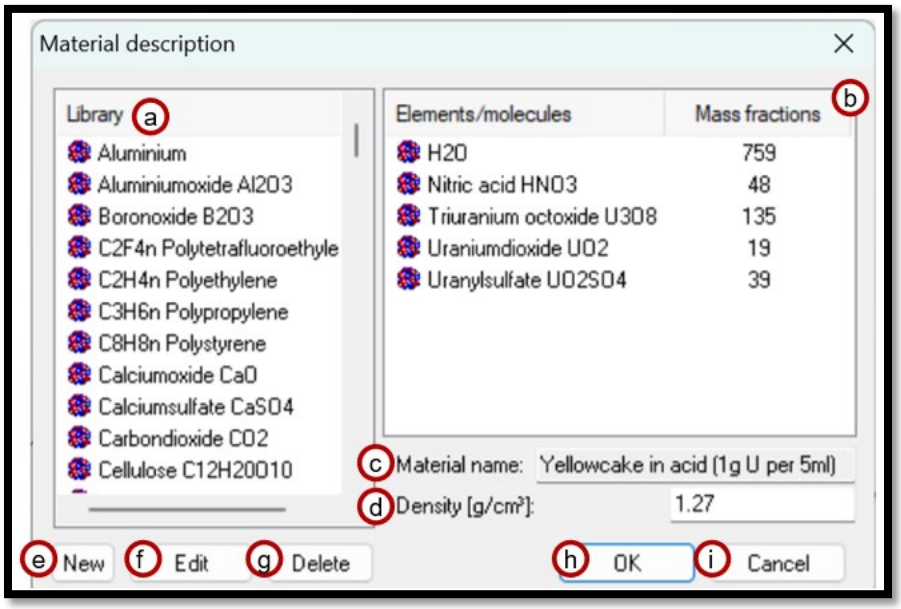


Figure 42. Material Editor

Features of the Material Editor are described below:

a. **Library:** A list of molecules and elements in the library. Move them to the editor (section b) by drag and drop.

b. **Editor section:** Lists the elements and molecules composing the present material. To change the mass fraction of an element, double click on the mass fraction column in the line of the respective element.

c. **Material name:** The name of the material. When "New material" was selected to open the editor, the field is empty and can be edited.

d. **Density:** The density of the material in grams per cubic centimeter.

e. **New:** Press to create a new element or molecule in the element editor shown in Figure 43.

f. **Edit:** Press to edit an existing element or molecule in the element editor shown in Figure 43.

g. **Delete:** Press to delete an existing element or molecule from the library.

h. **OK:** Press to save changes and close the editor.

i. **Cancel:** Press to close the editor without saving the changes.

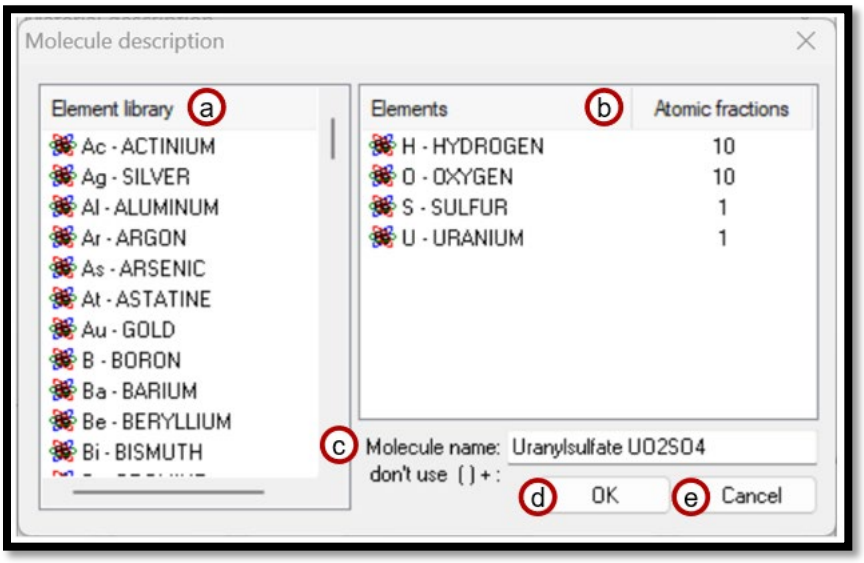


Figure 43. Molecule/Element Editor

Features of the Molecule/Element Editor are described below:

a. **Element library:** A list of all elements in the library. Move elements into the editor (section b) by drag and drop.

b. **Editor section:** Lists the elements composing the present molecule. To change the atomic fraction of an element, double click on the atomic fractions column in the line of the respective element.

c. **Molecule name:** Enter a unique molecule name. Avoid special characters.

d. **OK:** Press ok to save the changes and close the dialog.

e. **Cancel:** Press cancel to close the dialog without saving the changes.

3.2.5 Sample Container Editor

In the Sample container section, users can create and manage the containers that are used for their reference sources and to describe counting geometries. Note that here LVis displays the content of the “Counting geometries” subfolder in the LVis database directory.

LVis supports three different general types of container geometries:

- Cylindrical containers like beakers, jars, petri dishes or filters

- Marinelli beakers
- Point sources

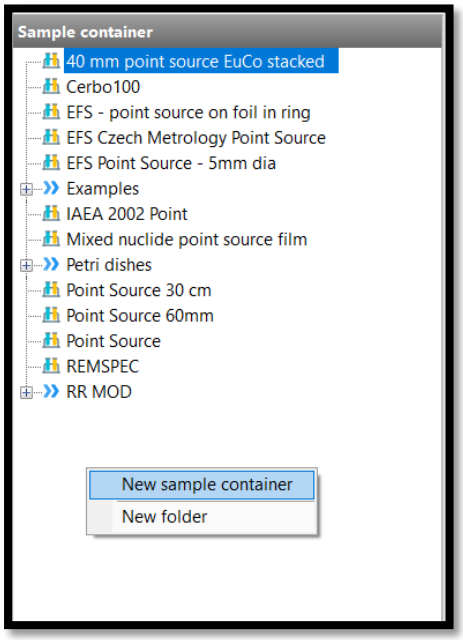


Figure 44. Sample Container Management Panel

To add a new container, or a new folder, right-click on the management panel. When selecting “New sample container” the following dialogues will pop up. In the first it is possible to define the name for the new container



Figure 45. New Sample Container Dialog

In the following menu users can select the “Type” and provide additional descriptive information.

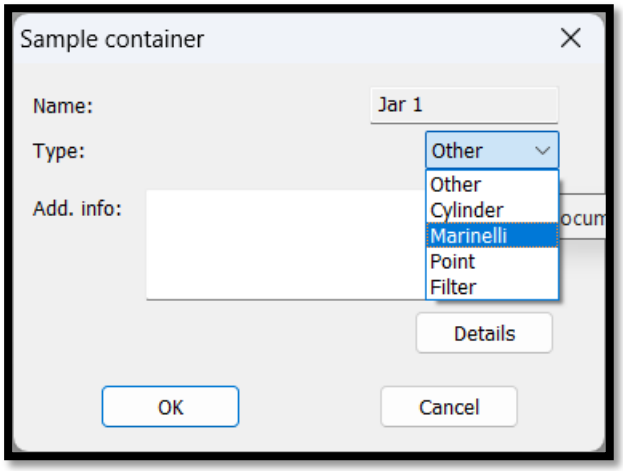


Figure 46. Sample Container Definition

When selecting “Other”, no Monte Carlo calculation will be possible and no further information can be entered. “Cylinder” and “Filter” will both describe a cylindrical sample geometry. “Point” will describe a point source and “Marinelli” a Marinelli beaker geometry. Depending on the selected container type, the “Details” section, where one can define the respective container material and dimensions, will change. The two screenshots below show the dialog for cylindrical and Marinelli type geometries.

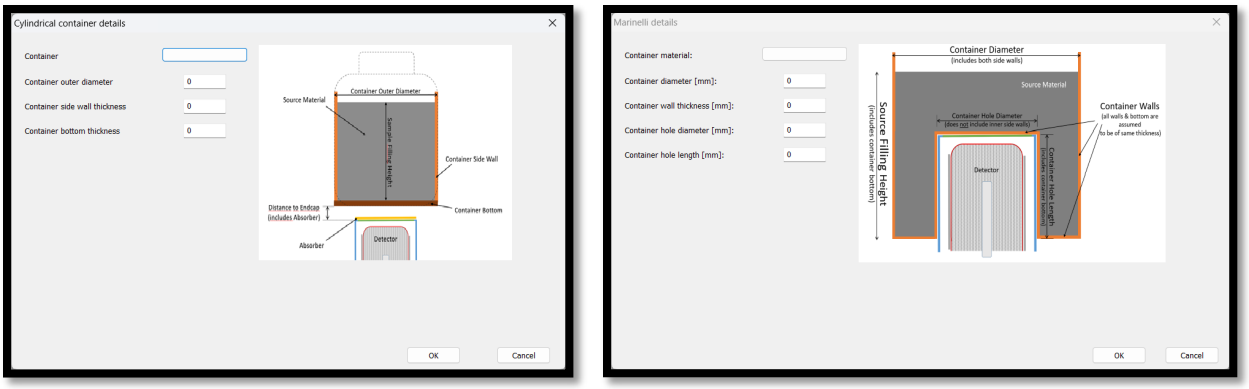


Figure 47. Container Details Dialogs

3.2.6 External Database Editor

With the “External Database” feature of LVis it is possible to link a complete set of additional sample data to a measurement and show this data on a separate tab in an LVM file. Which key value is to be displayed in the respective tag field of the parameter set and what additional data should be shown on the new LVM tab can be defined here in the external database editor. For more information see Chapter 5 LVis Parameter Sets.

3.3 THE GLOBAL LVIS SETTINGS

The Settings window allows users to define global parameters for the entire LVis system.

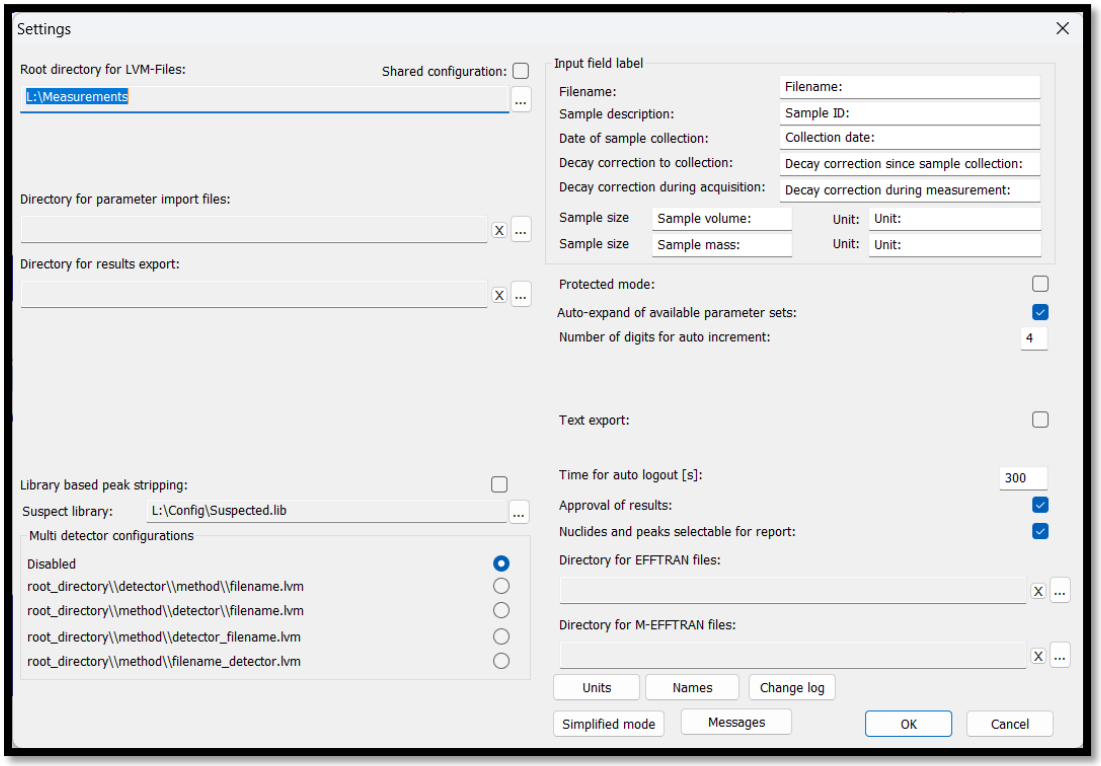


Figure 48. Global Settings

The fields on the Settings dialog are defined as follows:

- **Path to the base directory of all measurement data** – Unless it is defined differently by additional program functions, all measurement data is filed in this directory.

- If LVis is supposed to import sample data from a LIMS users can specify the path here to the respective directory where the sample information files are located. Importing sample data via automated file exchange requires some additional customization. If it is desired to use this feature, contact a local ORTEC sales representative.

- If LVis is supposed to export analysis results to a LIMS users can specify the path here to the directory where LVis will save the analysis results files that are to be imported by the LIMS. Exporting sample data via automated file exchange requires some customization. If users would like to use this feature, contact a local ORTEC sales representative.

- **Activation of library-based peak stripping** – More detailed information can be found in the GammaVision manual. Note that when using the engines ENV32 or NPP32 this setting is not taken into account, but the library based peak stripping is activated by default.

- **Definition of the suspected nuclide library** – Here the path to a library is defined, which is used to retroactively compare unidentified peaks of an analysis in order to propose in the report a nuclide for these peaks. This library is not used for the actual analysis and thus can contain significantly more nuclides.

- **Simultaneous measurement support activation with several detectors using parameters sets of the same names (multi-detector configuration)** - Here users can define the storage location of these multi-detector measurement data as well as the automatic file name generation. For further information, please refer to Section 4.6 Multi-Detector Configurations.

- It is also possible to adjust several input field labels in order to better correspond to the actual laboratory setup. The labels proposed here are default values only. Users can also adjust the names in the respective parameter set.

- **Enable the "Protected Mode"** – In this operating mode, LVis won't allow a user to overwrite an existing file but will instead always display a "Save As" dialogue. In addition, it will never show a standard "Windows file explorer" type window when opening a file manager dialogue but LVis will show its own file manager. This is for GMP compliance.

- **Auto-expand of available parameter sets** – Automatically open the geometry list of a detector in the configuration bar (in case of many geometries or detectors, suppressing this functionality promotes faster operation).

- **Number of digits for auto increment** – Here users can define the number of digits, start value and validity period of indexes. Automatic indexing in file names can be used in the parameter set by adding i in the name field (see Section 5.2 Defining the Parameters).

- **Text export** – Activate here the results export feature via text file export (See Section 7.7.2 Exporting Results From an LVM File).

- **Time for auto logout [s]** – If LVis shall automatically log out a user after a certain idle time, simply enter a time in seconds here.

- **Approval of results** – If measurements shall be approved before being published (e.g. results exported to a LIMS or QA measurements being transferred to the LVis detector QA database), tick this box (see Section 7.7 Approval of Measurements and Exporting Analysis Results for more details).

- **Directory for EFFTRAN Files and Directory for M-EFFTRAN files** – In case the free software EFFTRAN by Tim Vidmar (www.efftran.com) is being used for the calculation of true coincidence summing factors or efficiency transfer, it is possible to automatically have LVis combine all necessary information about the geometrical setup and trigger the calculation. To do this simply enter the EFFTRAN and MEFFTRAN file locations. More information can be found in Section 7.8.2 Using (M)EFFTRAN.

- Clicking on the **Units** and **Names** buttons directs the software to the respective menus where users can define default values for the respective pull down menus in the parameter set (for further information refer to Sections 3.3.1 Units and 3.3.2 Names).

- Under **Change Log** it is possible to specify after which actions in LVis, operators must enter comments/justifications/descriptions for their respective changes. This is typically only used when working under GMP conditions. Comments on the following actions are possible:

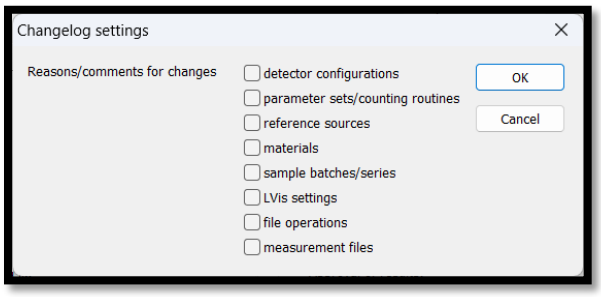


Figure 49. Change Log Settings

- When clicking on **Simplified Mode** two basic settings for the LVis Simple Mode can be defined. In LVis Simple Mode, a “short background” measurement is automatically performed when no sample is being acquired. This short background is used to verify if the detector background has dramatically changed between the acquisitions of samples. Here it is possible to define the “Live time preset for the short background” and what the respective acceptance limit for the quick background measurements is. The tolerance limit is taken from the QA settings for the detector but due to the short counting time of the “short background” and the resulting higher uncertainty of the results, the QA limits are multiplied with the factor defined here.

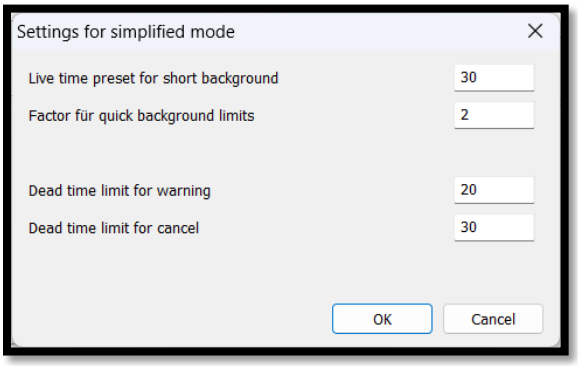


Figure 50. Settings for Simplified Mode

In addition, it is possible to define the “Dead time limits” for the Simple Mode in this dialogue. In Simple Mode, before starting a sample count, LVis will always do a dead time check to ensure that the source activity is not unreasonably high. It is possible to define two thresholds for this dead time check in the “Simplified mode” settings. The lower threshold is considered a “warning limit”. In case the dead time is below the “warning limit” (default 20 %) then the sample is counted immediately. When the dead time is above the “cancel threshold” the measurement will not be started, and a warning message will be displayed.

When the dead time is between the warning and the higher, the “cancel” threshold, then the acquisition will be delayed, the dead time constantly monitored and as soon as it has fallen below the warning limit, the acquisition is automatically started. The default for the “cancel threshold” is 50 %.

For more information see Chapter 13 LVis Simple Mode.

- **Messages** – As described in the parameter sets chapter, the Simple Mode offers an easy way to perform automated contamination checks by ticking the box “Validate gross count rate against QA background” on the “Reporting” tab of a parameter set. At the end of such a contamination check one will get a message displayed summarizing its result. These notifications can be defined when clicking on **Messages** in the LVis Global Settings.

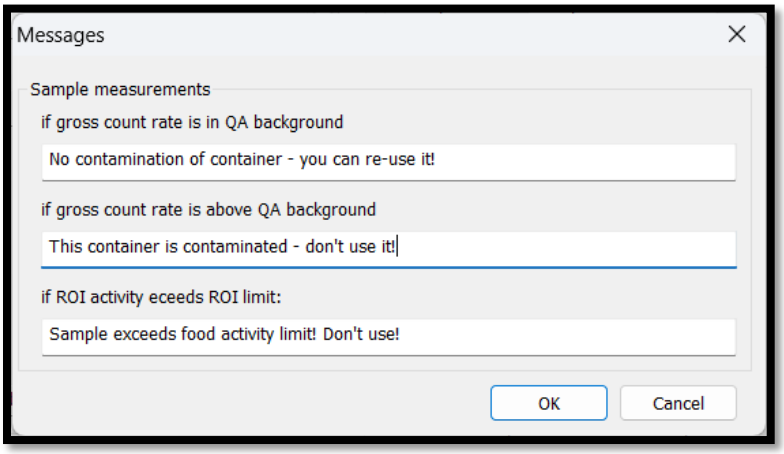


Figure 51. Messages Dialog

3.3.1 Units

Here the sample size and activity units provided for selection in the LVis parameter sets via the respective pull-down menu can be defined.

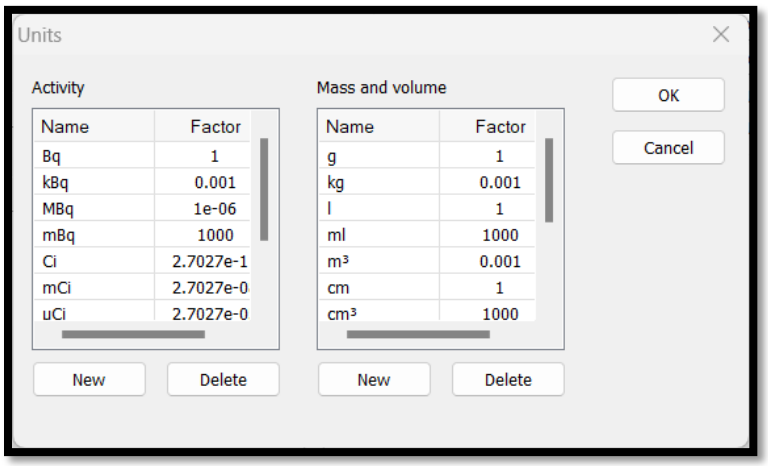


Figure 52. Units Definition Screen

Several commonly used units are already predefined. However, users can add any number of units, which can then be selected in a parameter set.

IMPORTANT Newly added units are only available after their setup has been completed. LVis Measurements and parameter sets that were open, when the new unit was created, will only offer the new unit in their pulldown menus, once they are closed and opened again.

A factor is displayed next to each unit. This factor defines the ratio between this unit and already existing or base units (which have a factor 1).

Example: Liter corresponds to a factor of 1, m³ corresponds to a factor of 0.001 since 1 liter correspond to 0.001 m^3. The volume unit ml has a factor of 1000 since 1 l corresponds to 1000 ml.

To add a new unit, simply click on **New**. The following window opens:

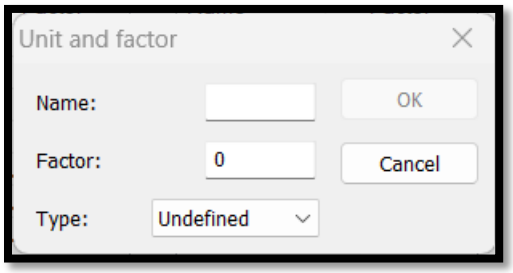


Figure 53. New Unit Window

Enter the respective unit's name as well as the corresponding factor and type then click on **OK**.

The “Type” is important since it defines the dimension of the unit. Only units of the same dimension can be converted into each other. However, note that the sample filling height (a length) and the sample volume can both be used to describe the sample size provided that the sample container dimensions are specified as well. Some other dimensions frequently used like “daily intake DI” or “sample” are simple numbers.

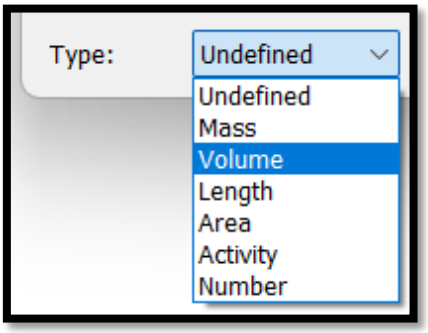


Figure 54. Type Selections

NOTE: Users can also add further explanation to their units. For example, users can differentiate between dried (dry mass) and untreated samples (moist mass). This can easily be indicated in the sample reference unit by using kg (DM) and kg (MM).

3.3.2 Names

In LVis users can add descriptive information to each measurement, so called tags. These tags can be predefined so that they do not have to be manually entered every time when starting a new measurement. Instead, users can simply select them from the respective pull-down menu in the parameter set. To predefine the tags, click on the **Names** button in the global settings window (Figure 48) to open the following dialog.

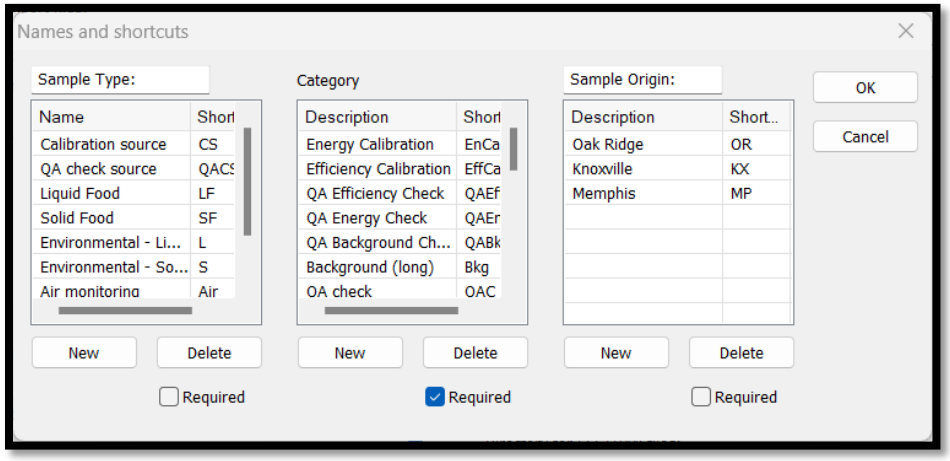


Figure 55. Names and Shortcuts Dialog

The tag “Category” cannot be changed but users can add categories. The tags labelled “Sample origin” and “Sample type” in the above screenshot are variables that can be named differently by clicking in the field above the table.

Note that for parameter sets that are linked to an external database, the “Sample origin” field will be used for the selection of a dataset and will hence not display the entries defined here.

In addition, one can specify, for each tag, whether it is a mandatory, “Required” field that must be entered into the parameter set by an operator prior to starting a parameterized measurement.

Each tag can be assigned with an alias (Shortcut), that is then applied in the parameter set when automatically generating file names using the dollar commands The respective commands are C for the “Category”, U for the “Sample origin” and “L” for the “Sample origin” field, respectively. For further information, refer to 5.2 Defining the Parameters and Table 1. Dollar Commands.

In order to add a new name or description, click on **New** below the respective table. The following window opens:



Figure 56. New Name and Shortcut

Enter the name or description with its corresponding abbreviation, then click on **OK**.

IMPORTANT Newly added units, names, and descriptions become available for use once data entry on the Settings dialog is complete, and the dialog is closed. Measurements and parameter sets that are open when a new description is created will only offer it in the respective pulldown menus after they are closed and opened again.

3.4 THE LVIS LAB JOURNAL

The LVis top menu bar (Section 3.1.2) provides three options under “Lab Journal”:

- “Start Lab Journal” opens the Lab Journal program
- “Import measurements” creates a new or updates an existing Lab Journal database with the data from all LVM files in the …**\LVis *database directory*\Measurements** directory.
- “Change Log” opens the change log database

3.4.1 Lab Journal

The LVis Lab Journal is a log (a database) of all the measurements, their related sample and analysis information, and the corresponding analysis results. The graphical interface of the Lab Journal allows easy file filtering, data retrieval, and reporting data from multiple measurements.

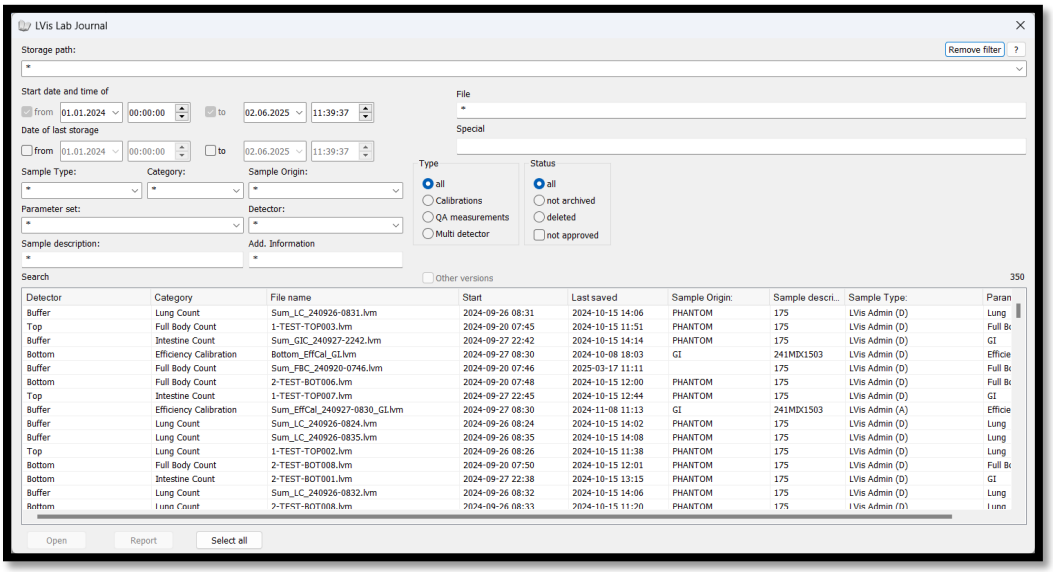


Figure 57. LVis Lab Journal

It is important to note, that there is not one single LVis Lab Journal database (LabJournal.mdb) but one for every year (e.g. “LabJournal2025.mdb”). These are located in the “Config” folder of the LVis database directory. If these files do not exist, **Import measurements** will create them automatically by scanning the LVis database folder and importing the data of all LVM files into the respective Lab Journal database.

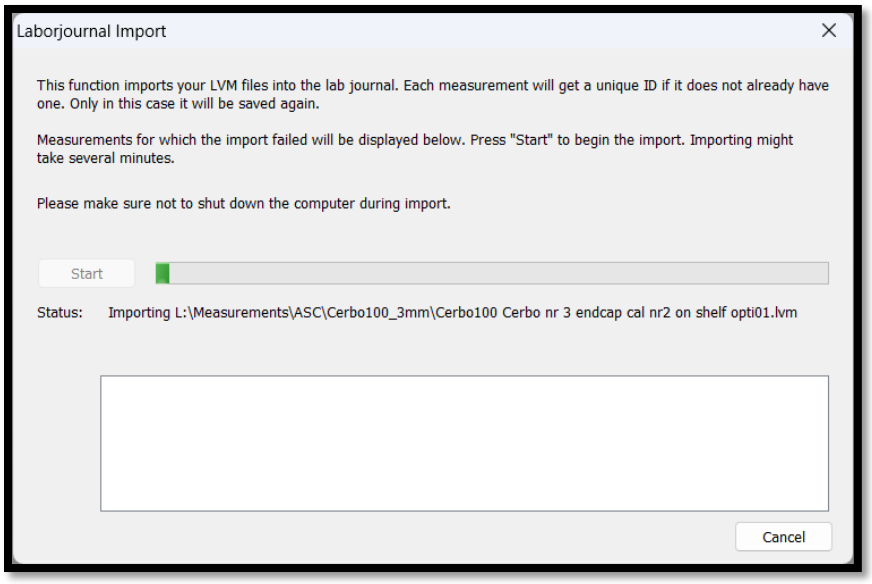


Figure 58. Lab Journal Import

IMPORTANT Depending on the number of LVis LVM files on the system, the import of analyses into the Lab Journal can take some time*. LVis should not be interrupted during the import!*

Every new LVM saved from within LVis will automatically be added to the LVis Lab Journal. More information can be found in Chapter 11 The LVis Lab Journal.

3.4.2 Change Log

The LVis Change log is a database (ChangeLog.mdb located in the Config directory of the LVis database folder) that contains data about who did what, when in LVis. The Change Log database can be started from the top menu bar.

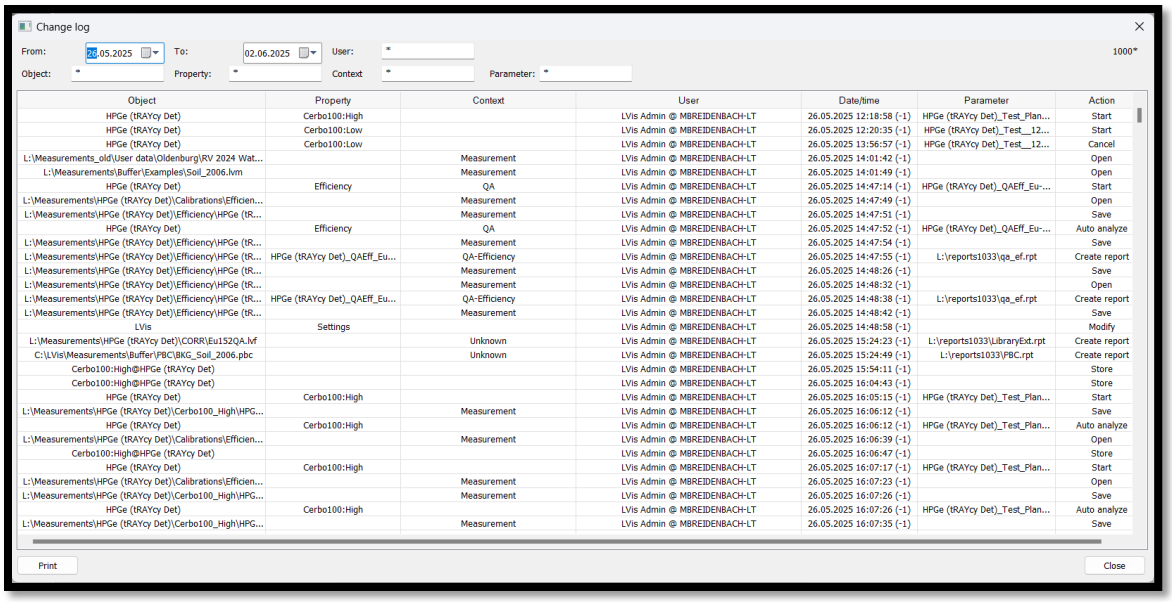


Figure 59. Change Log

It is possible to filter the change log and print the filtered results.

NOTE: The list of results is always limited to 1000 entries.

NOTE: It is possible to show the live change log in LVis. To do this click on **View** in the top menu bar.

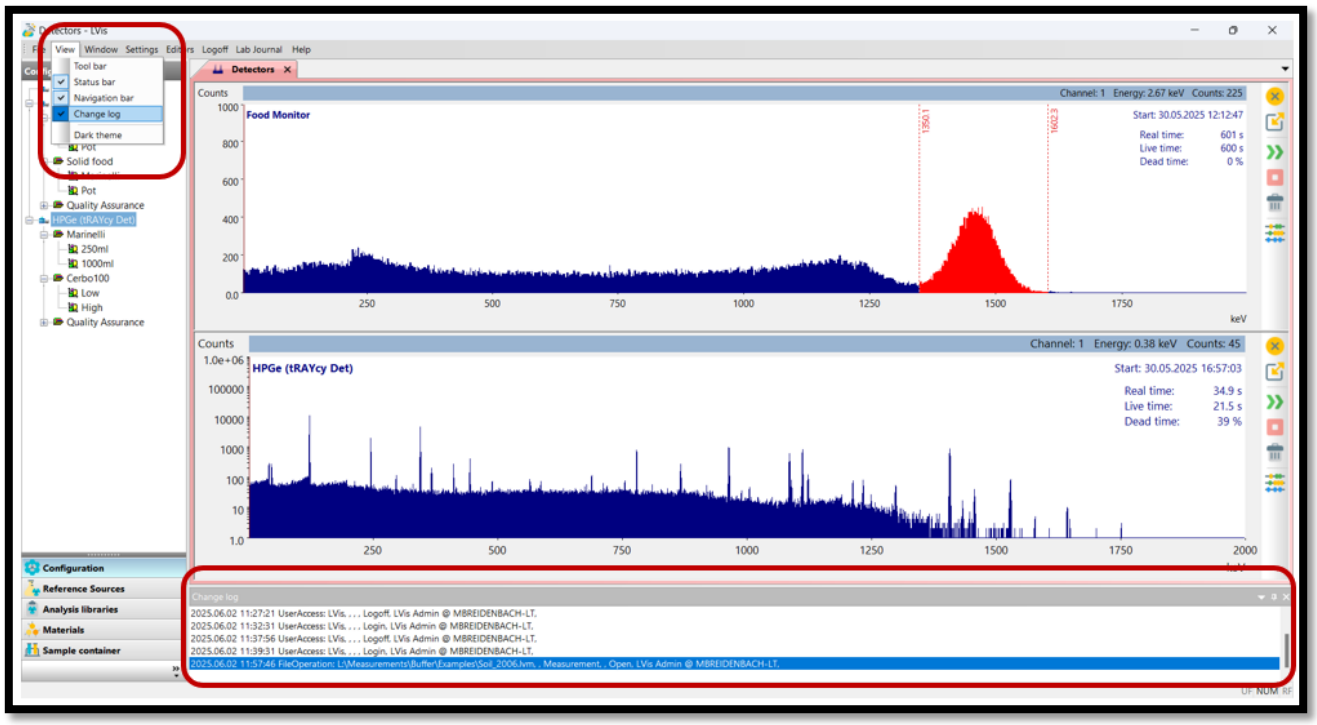


Figure 60. View Drop-Down Menu

3.5 HELP

From the “Help” menu, LVis users have access to the following three topics:

- **About LVis** – provides general information about LVis.



Figure 61. About LVis

- **Manual** – opens the current LVis user’s manual.
- **License** – shows information about the LVis license and what features are activated in the license.

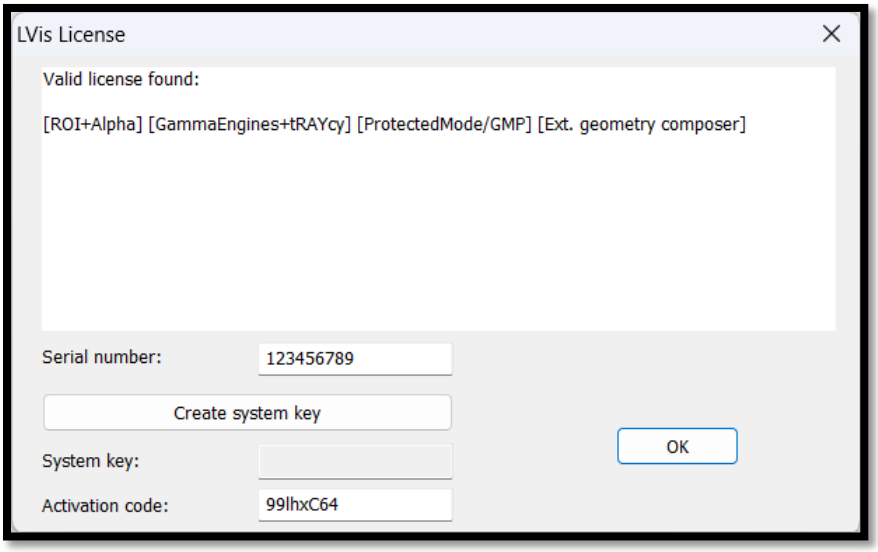


Figure 62. LVis License Information

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4. DETECTORS

In LVis the term “detector” is used to describe the entire measuring chain, i.e., the combination of MCB (Multi-Channel-Buffer), cooler and detector. “Detectors” and their counting routines are listed and configured on the “Management panel” on the “Configuration” tab. The following chapter describes how to:

- 4.1 Adding or Removing Detectors to LVis
- 4.2 Configuring Detectors
- 4.3 Detector Context Menu
- 4.4 Live Detector View – Spectrum Display
- 4.5 The Buffer Detector
- 4.6 Multi-Detector Configurations
- 4.7 Detector Simulations

Only LVis accounts with the right to modify detectors can add or remove detectors to LVis.

4.1 ADDING OR REMOVING DETECTORS TO LVIS

To integrate a new detector into LVis, users must first locate and establish communication between the counting electronics and the computer using the MCB Configuration program (Section 2.1 Installing ORTEC Connections). All local and network detectors located by the MCB Configuration will also be available for LVis. Only hardware that was identified by MCB Configuration can be added to LVis.

4.1.1 Locating MCB’s – MCB Configuration Program

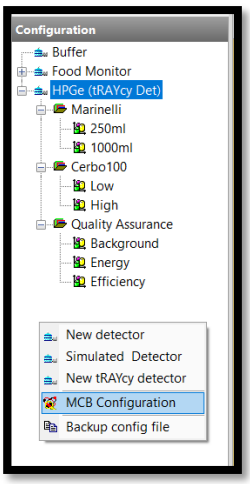


Figure 63. Configuration Panel

Each time a new measuring chain(s) is added to the LVis system, users must (re-)run the MCB Configuration program to establish communication between the computer and the new MCB(s). MCB Configuration is started from LVis by right clicking into empty space of the “Configuration area” and selecting **MCB Configuration**. Once the program is started, the following screen appears, describing the search procedure and the number of measuring chains found:



Figure 64. MCB Configuration Search Window

After the search is completed, all (powered-on and correctly connected) measuring chains found will be displayed:

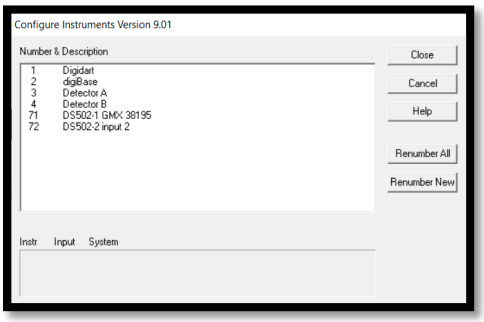


Figure 65. MCB Configuration Found Instrument List

A unique number and name must be assigned to each measuring chain. The name and number of the detector can be changed by double-clicking on the respective entry in the list and editing the parameters displayed in the Change Description or ID window.

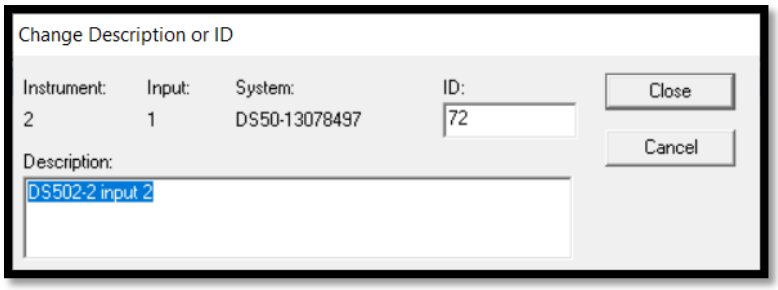


Figure 66. MCB Configuration Change Description or ID

IMPORTANT The MCB Configuration command allows users to "see" all ORTEC instruments available on the entire network. Thus, the **Renumber All** option should only be applied with the greatest care, as it may change the numbers of measuring chains located in different rooms or facilities on the computer network.

NOTE: The MCB Configuration program creates a file (MCBCON32.ini) in C:\ProgramData\ORTEC Shared\UMCBI containing information about the identified hardware. LVis will use the hardware address mentioned in this file and neither the name nor the number to identify the counting electronics.

4.1.2 Adding MCB's to the LVis Configuration

MCBs are added to the LVis configuration by right clicking in the Configuration area of the management panel and selecting **New detector**. A pulldown menu will provide users with a list of the identified hardware for selection.

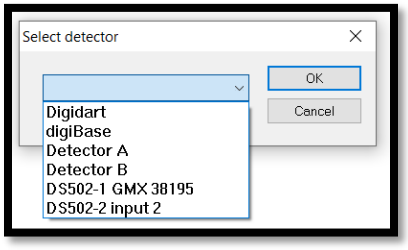


Figure 67. Detector Selection Menu

Once a detector has been added to the configuration, it will be listed in the tree of the configuration and can be used in LVis.

Note that by default detectors will not be automatically displayed on the “Live detectors” tab. To show the live spectrum view of a detector, right click on the detector in the Configuration and select **Show** from the detector’s context menu.

4.1.3 Removing Detectors

Before removing a detector, the respective detector live display must be closed using the yellow “**X**” in the top right corner of the live view. To remove the detector, right-click on it and select **Remove detector** from the detector’s context menu.

IMPORTANT ***If a detector is removed, the detector and all assigned parameters sets will be irrevocably deleted.*** However, measurements acquired with the detector (both those acquired using parameter sets and QA measurements) will be kept in their respective directories.

4.1.4 Reconnecting Detectors (After Replacement of Hardware)

When disconnecting the Multi-Channel Buffer (MCB) of a measuring chain, it will be displayed as not available. When replacing the MCB and integrating the replacement successfully with MCB Configuration, it will first still be listed in LVis as “Not available” even if the assigned name is identical to the old hardware. This is because the respective hardware address will have changed.

The same will happen when users migrate their LVis configuration onto a new computer by copying the config.dat file.

This problem can be fixed by selecting **Reconnect detector** from the unavailable detector’s context menu after the new hardware (or old hardware on new computer) has been installed and configured with MCB Configuration.

Simply select the new hardware (ideally given the same name in MCB Configuration as the old one) from the pulldown menu and link it to the detector entry in LVis.

NOTE: It is occasionally necessary to intentionally disconnect a detector in LVis from one assigned hardware to reconnect it to another. This is typically not possible since “Reconnect detector” is not available when a detector is successfully connected. However, when holding the right Ctrl key while right-clicking on the detector, the “Reconnect detector” command becomes available even when a detector is already connected (this also works for simulated or tRAYcy detectors).

4.2 CONFIGURING DETECTORS

Configuring detectors in LVis involves setting the MCB's hardware parameters, e.g., detector high voltage, amplifier gain, pulse shaping factors, etc. as well as describing the detector setup (x-tal dimensions, endcap material etc.).

This function can only be accessed by LVis users having the right to modify detectors. To do this, right mouse-click on the respective detector in the configuration area of the management panel and select **Detector configuration** in the detector context menu. This will open the window shown below, where details about the "measurement chain", the detector and electronics can be defined.

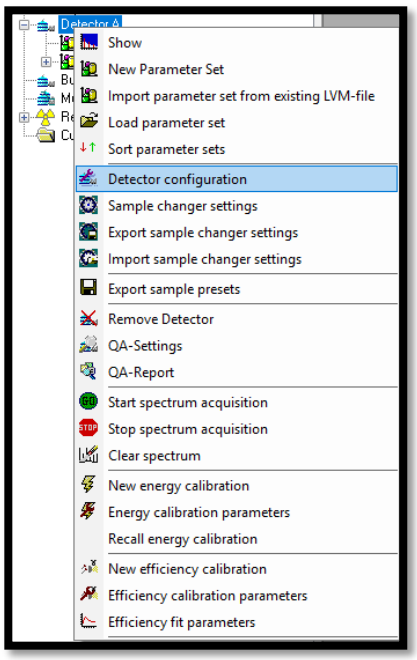


Figure 68. Detector Context Menu

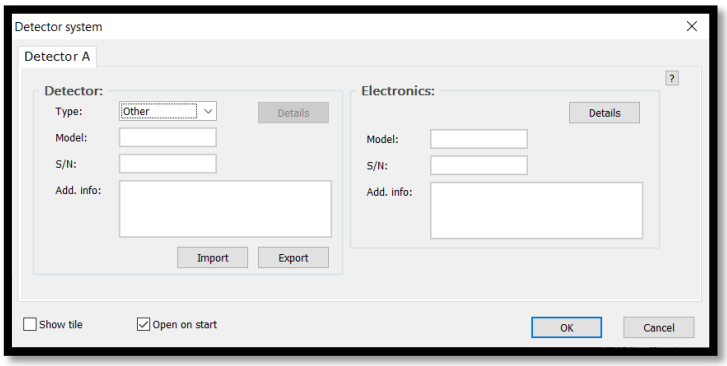


Figure 69. Detector System Configuration

The **Electronics** section, on the right side of the window, provides the possibility to describe the hardware by specifying the hardware model, serial number, and additional text information. Clicking **Details** will open the hardware properties control dialog, which contains multiple tabs (sub-screens). The number and type of tabs will depend on the respective ORTEC MCB. The screenshot below provides the view for a DSPEC-50A:

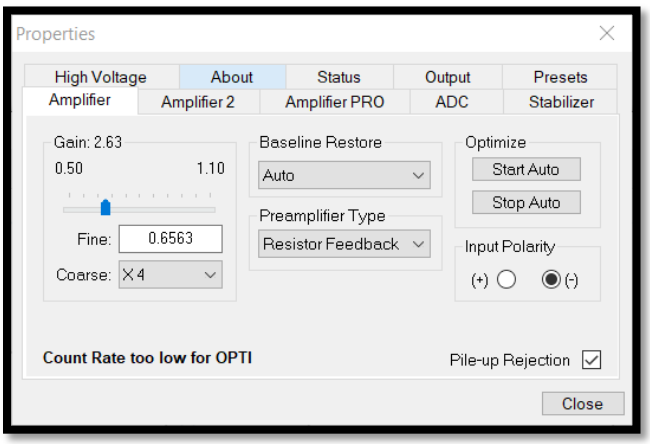


Figure 70. DSPEC 50A Properties

For more detailed information on these settings, see the respective MCB's hardware manual. Click on **Close** when all parameters have been adjusted.

NOTE: The changes made on most of the hardware property tabs take place immediately. There is no cancel or undo option for these changes.

The **Detector** section on the left side of the "Detector configuration" window allows specifying the detector type as well as the detector model name, serial number, and providing additional information. The following detector types are available in LVis: Coax, Planar, Well, NaI, and Alpha.

It is important to note that when selecting "NaI" as the detector type the default analysis engine when performing a gamma analysis will become "NaI32". When selecting "Alpha" the ROI parameter sets will list an additional "Alpha" tab that allows specifying the tracer.

Clicking **Details** will bring up a window where the geometrical dimensions of the detector crystal and capsule can be specified.

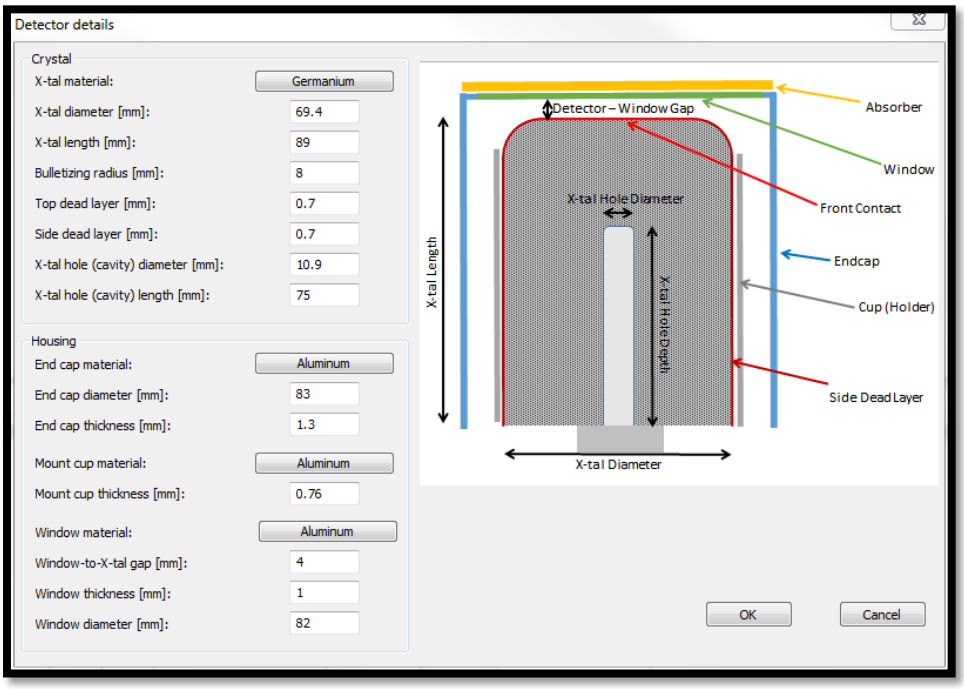


Figure 71. Detector Geometry Entry

The information about the detector dimensions is only used when calculating "Geometry corrections" or "Correction Libraries" with tRAYcy or EFFTRAN. If any corrections based on Monte Carlo calculations are not being used, these fields can be left blank. However, it is still recommended to enter this data since it is saved with every acquisition and hence it would be readily available if it is needed at a later point in time.

The geometrical information about the detector element is available on the respective detector QAD sheet that was supplied with the detector. In case this is not available anymore, please contact ORTEC technical support by e-mail at ortec.tsg@ametek.com and provide the detector serial number and model. An attempt will be made to retrieve a copy of the original QAD.

NOTE: Some of the dimensions that may be found on the detector QAD sheet are not available on the Detector details window such as the thickness of the Mylar foil used as an additional thermal shield above the crystal or the material of the contact pin. This is either because

these values do not change from detector to detector and are therefore considered fixed parameters in the models used or they are simply not relevant for the calculation since their impact on the results is negligible compared to the overall uncertainty of the calculations.

It is possible to export the detector details as an LVis detector configuration file (*.lvd file). To do so press the button **Export**. Note that the **.lvd** file will only contain the detector details and the description of the detector (“Type”, “Model”, “S/N”, and “Additional Information”) and the electronics but it will not include the hardware settings. Use **Import** to import the information of an .lvd file. Note that a few example detector system files like a 3”x3” NaI detector and several different HPGe coax detectors are installed together with LVis.

With the two tick boxes at the bottom of the “Detector system” window one can define how this detector should be presented in LVis. The default is that the detector will be shown in the “Live detector view”. Ticking the box **Open on start** will make sure that the live spectrum of this detector is presented in the “Live detector view” when starting LVis. If the detector should be presented as a tile on the “Tiles” tab instead of the “Live Detectors” tab tick the box **Show tile**. The latter is typically chosen when working with many (> 4 detectors) such as when working with Alpha spectrometers like ORTEC’s Alpha Ensemble or Alpha Duo.

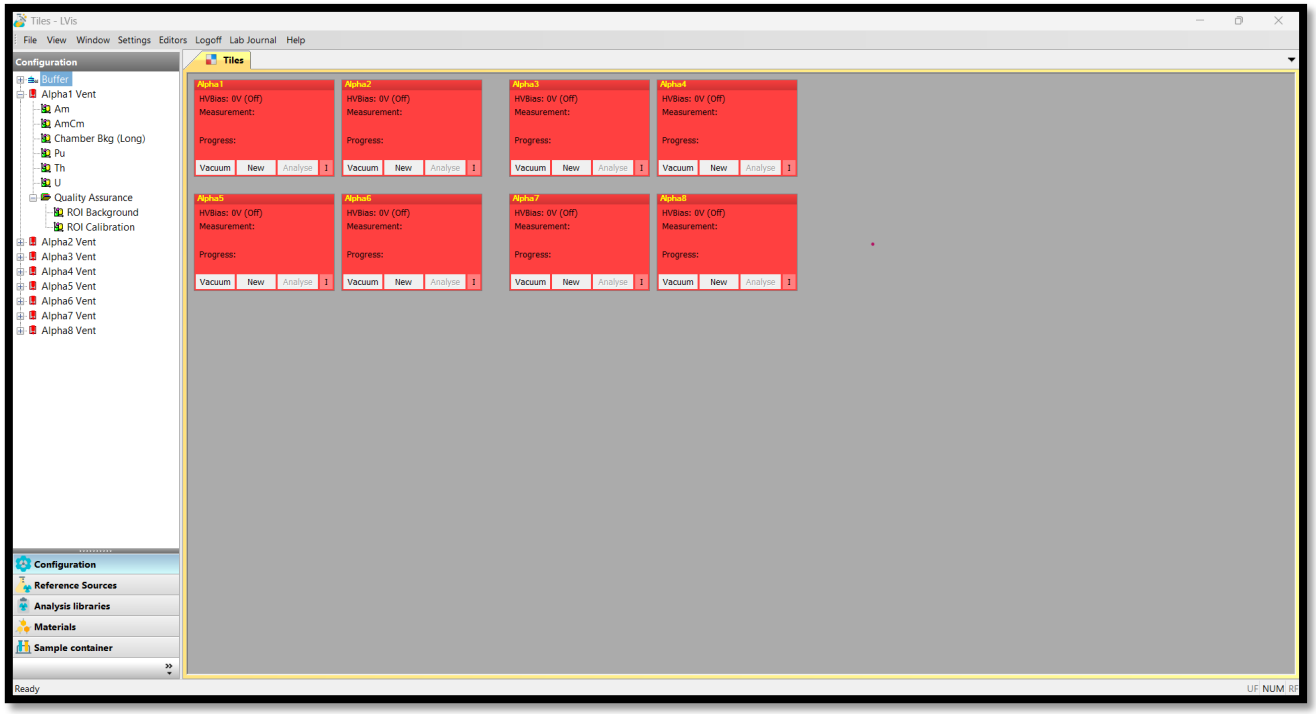


Figure 72. Detector Tiles

4.3 DETECTOR CONTEXT MENU

Right clicking on a detector in the LVis Configuration reveals the detector context menu. The content of the detector context menu is adjusted depending on the user rights and the current status of the detector. The following three figures illustrate all available actions that are accessible from the detector’s context menu. The left-hand figure shows the full context menu when currently no acquisition is active, and a parameter set was copied in order to be inserted. The upper right-hand figure shows the context menu available during an ongoing parameterized measurement. The lower

right-hand figure shows the context menu when the corresponding detector hardware (MCB) is not available.

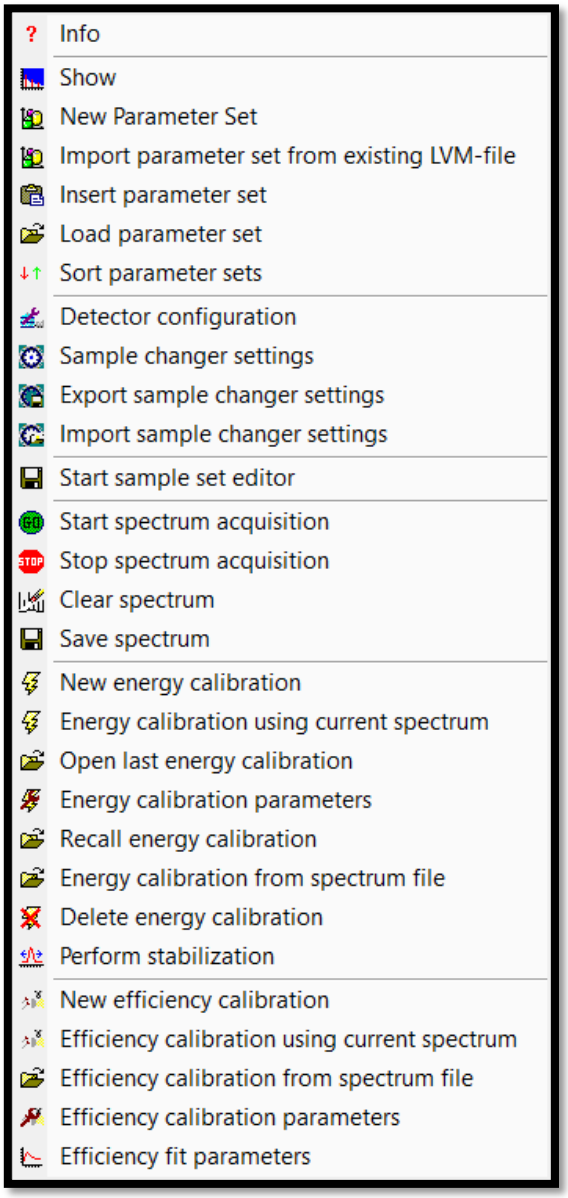


Figure 75. Full Detector Context Menu

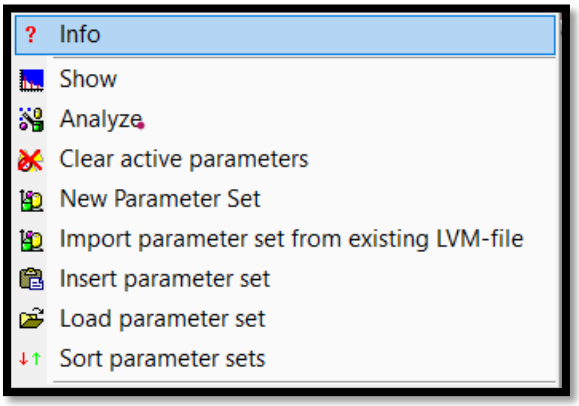


Figure 74. Context Menu During Ongoing Parameterized Measurements

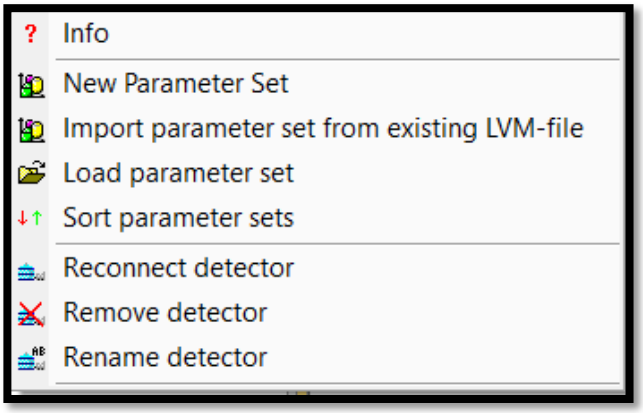


Figure 73. Context Menu When MCB Information is Not Available

The following section describes all possible detector actions in detail:

- **Info** – Presents information about the current health status of the detector like the time and date of the last QA checks or if applicable the battery voltage, HV Bias etc.

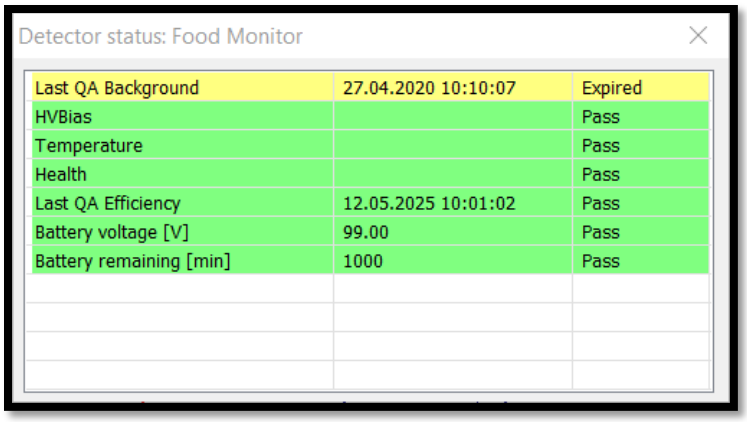


Figure 76. Detector Health Status

- **Show** – Adds the detector to the "Live Detector view" and presents the current content of its memory. This is usually either the currently ongoing measurement or the last measured spectrum. When the box **Open at start** is ticked in the "Detector configuration" screen, the detector will automatically be shown after starting LVis.

- **New parameter set** – Creates a completely new parameter set, and thus a new general measurement instruction with corresponding analysis parameters for the detector. A more detailed description can be found under Chapter 5 LVis Parameter Sets.

- **Import parameter set from Existing LVM-file** – Creates a new parameter set based on an existing **.LVM** file.

- **Insert parameter set** – Adds a copied parameter set to this detector. This function is only available after an already existing parameter set has been copied.

- **Load parameter set** – Inserts a parameter set previously exported as an **.LVP** file to this detector. A more detailed description can be found in Section 2.9 Saving the LVis Configuration or Section 2.10 Loading a Configuration File.

- **Sort parameter sets** – Sorts the parameter sets in numerical and alphabetical order (Numbers are sorted before letter, Shift+left sorts in the opposite direction)

- **Detector configuration** – Configures the hardware settings of the detector and defines the detector model for tRAYcy calculations. A more detailed description can be found in Section 4.2 Configuring Detectors.

- **Sample Changer Settings** – Configures how a sample changer is controlled from LVis.

- **Export sample changer settings** – Exports the sample changer settings in an LVis sample changer configuration file **.LVC** so that they can be used on another system using the same sample changer model and operation mode.

- **Import sample changer settings** – Imports the sample changer configuration from an LVis **.LVC** sample changer configuration file.

- **Start sample set editor** – When operating a Gemini sample changer with bar code functionality the respective LVis Sample Set Editor program to create sample batches can be started from here. See Section 12.2 Sample Changer Control Via Gemini File Handshake.

- **Reconnect detector** – Link new hardware to an existing detector entry in LVis. Useful after replacing broken MCB's or using a config.dat file to migrate a complete system onto a new computer.

- **Remove detector** – Removes the detector from the configuration. A more detailed description can be found in Section 4.1 Adding or Removing Detectors to LVis.

- **Start spectrum acquisition** – Starts a non-parameterized data acquisition using this detector. This is the same as the Start icon on the live detector display.

- **Stop spectrum acquisition/Clear active parameters** – Stops the (unparameterized) data acquisition on this detector. In case of an ongoing parameterized acquisition this command will change to "Clear active parameters" which allows users to discontinue the parameterized measurement without stopping the data acquisition. One can then either select another parameter set to pick up the ongoing acquisition or stop the acquisition. This is the same as the Stop icon on the live detector display. Note that in the live detector view a submenu is displayed in case a parameterized acquisition is in progress (see screenshot below).

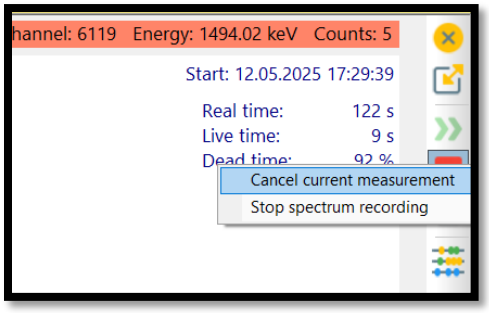


Figure 77. Live Detector View Submenu

One can either cancel the current measurement which is equivalent to clearing the active parameters or one can directly stop the acquisition.

- **Clear spectrum** – Deletes the current spectrum. Note that this is only available when there is no ongoing parameterized measurement. This is equivalent to the icon on the live detector display.

- **Save spectrum** – Opens a "Save As…" dialogue. This provides the possibility to save the spectrum as an ORTEC .**CHN** spectrum file.

- **Analyze** – Analyzes a parameterized started measurement with the corresponding parameter set. This function is only available if a parameterized measurement was started using this detector. It corresponds to the "Evaluate spectrum" icon in the live detector display. Note that the "Evaluate spectrum" icon is always accessible and in case there is no ongoing parameterized measurement, users can select one of the parameter sets for analysis:

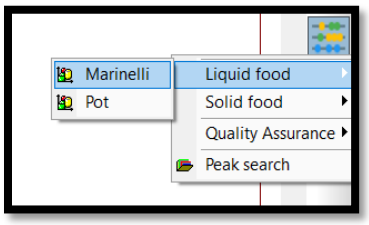


Figure 78. Parameter Set Selection

- **New energy calibration** – Starts a parameterized measurement to create an energy calibration. The measurement is stored in a subfolder Calibration\Energy" in the detector folder. After acquisition, calibration and analysis, the energy calibration can be assigned to the detector to ensure that all following spectra will be automatically calibrated (see Section 6.3 Creating an Energy Calibration)

- Energy calibration using current spectrum – Creates a calibration measurement based on the current spectrum of the detector. No new spectrum acquisition is started, and the spectrum raw data remains unchanged. The current spectrum is not cleared (see Section 6.3 Creating an Energy Calibration).

- **Open last energy calibration** – Opens the calibration measurement, on which the currently active energy calibration of the detectors is based upon.

- **Energy calibration parameters** – Edit the defaults for executing energy calibrations. (See Section 6.1 Setting Up Calibration Parameters).

- **Recall energy calibration** – Load an LVM file to become the new energy calibration for the detector.

- **Energy calibration from spectrum file** – Load a spectrum file (supported formats: **.lvm**, **.spc**, **.chn**, **.spe**, **.cnf**, **.rms**) to create a new energy calibration using the energy calibration parameter set for this detector.

- **Delete energy calibration** – Delete the energy calibration currently assigned to this detector. (The file itself is not deleted, only the assignment of the energy calibration to the detector is deleted).

- **Perform stabilization** – This performs a "gain stabilization" based on a peak defined in the QA Settings for the detector.

- **New efficiency calibration** – This starts a parameterized measurement to create an efficiency calibration. The measurement is stored in a subfolder "Calibration\Efficiency" in the detector folder. After measurement and analysis, the efficiency calibration can be assigned to parameter sets to ensure that when using these for analysis the respective efficiency calibration is used (see Section 6.4 Creating an Efficiency Calibration).

- **Efficiency calibration using current spectrum** – Creates an efficiency calibration measurement based on the current spectrum. No new spectrum acquisition is started, and the spectrum raw data remains unchanged. The current spectrum is not cleared (see Section 6.4 Creating an Efficiency Calibration).

- **Efficiency calibration parameters** – Supports creation or editing of a routine parameter set for efficiency calibration execution.

- **Efficiency fit parameters** – Here the default fit functions of the efficiency calibration for the detector can be defined. Note that this can be changed later during the calibration process.

- **Set expired time of measurement** – Only available on simulated detectors. In order to save time, it is possible by clicking here to jump forward in spectrum acquisition to a specified real time of the "acquiring" **.CHN** file.

4.4 LIVE DETECTOR VIEW – SPECTRUM DISPLAY

The real time spectrum of a detector can be displayed on the LVis workbench by selecting **Show** in the context menu of the detector. This will add the detector live spectrum to the "Detectors" tab. The "Detectors" tab can present up to 8 live spectrum views.

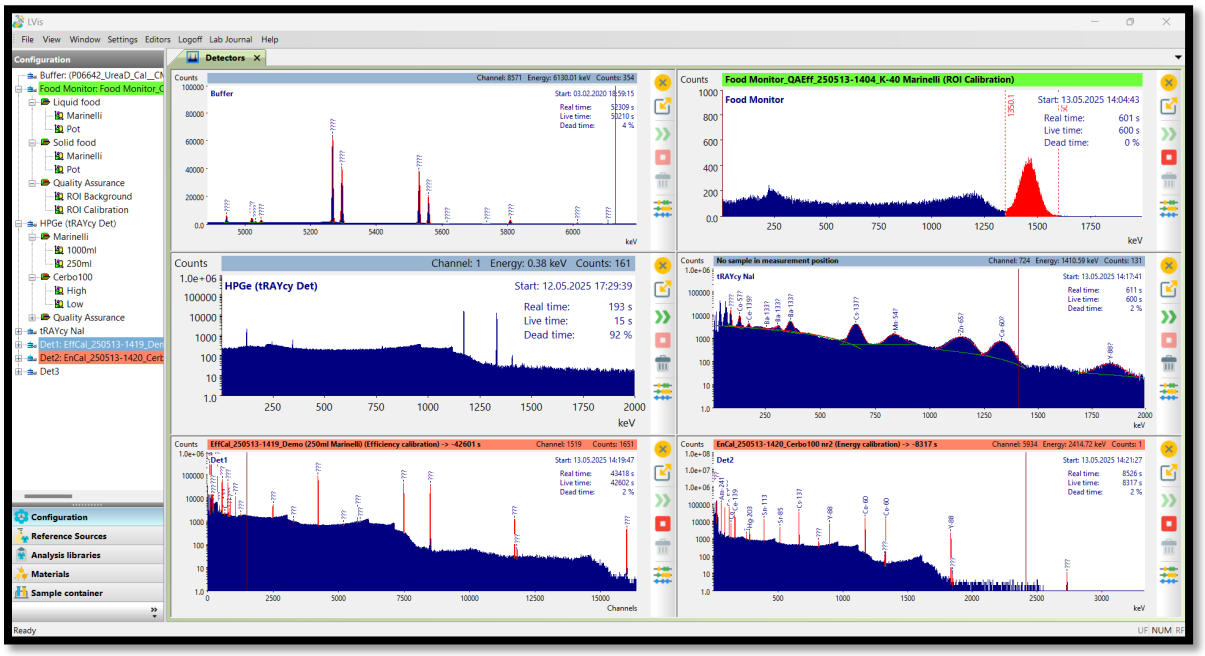


Figure 79. Detectors Tab with Multiple Detectors Displayed

The order of the live detector windows on the "Detectors" tab matches the order of the detectors on the "Configuration" panel. The order in the panel simply corresponds to the time of creation of the detectors (oldest on top). To move a detector to one position up on the Configuration panel, hold the right **Shift** and the right **Ctrl** while right clicking on the respective detector. Note that it is required to close the "Detectors" tab or restart LVis for the changes to take effect.

Every live detector view has a set of icons on the right side that provide quick access to the three basic spectrum acquisition commands **Start**, **Stop,** and **Clear**. In addition, it is possible to **Maximize/Arrange** or **Close** the spectrum view and **Evaluate** the spectrum.

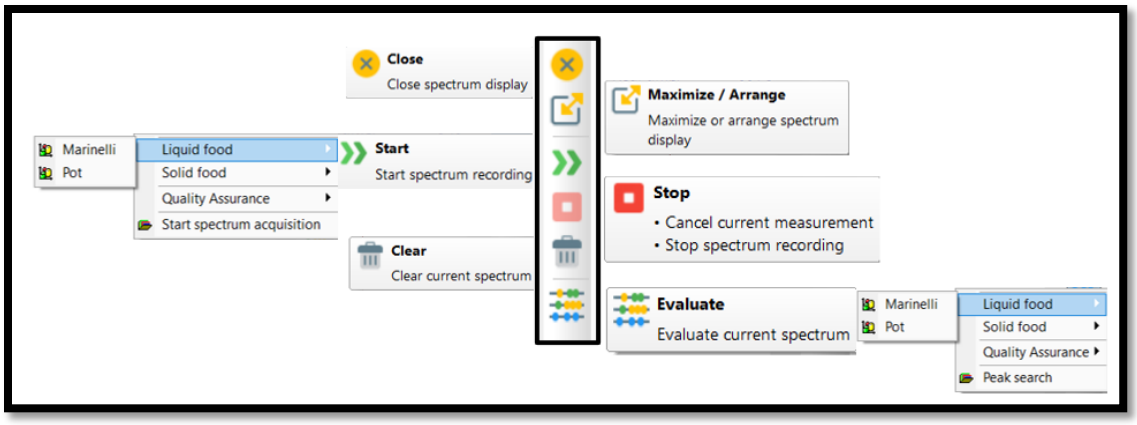


Figure 80. Live Detector View Commands

The **Start** command allows users the ability to either select a parameter set to start a parameterized measurement or to simply start a spectrum acquisition without any further parameters.

Note that a parameterized measurement cannot be simply stopped. Using **Stop**, the recording of the spectrum can either be stopped for analysis or the current measurement can be canceled so that the spectrum acquisition continues but the connection to the parameter set of the measurement is cancelled.

When clicking **Evaluate**, a parameterized acquisition can be analyzed, or users can analyze the spectrum using one of the parameter sets defined for the detector. Users can also perform a peak search.

LVis provides horizontal and vertical zooming functionality in the spectrum windows. By clicking and dragging a window across the energy range of interest, this area can be enlarged and zoomed in horizontally.

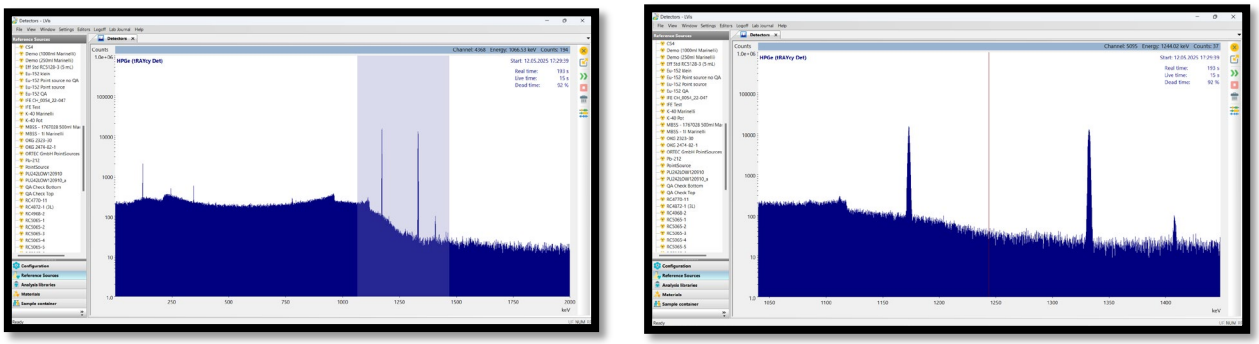


Figure 81. LVIS Zooming Techniques

Clicking the right mouse button zooms out again. Users can also use the hotkey “z” or “+” on the Num pad to zoom in and “u” or “-“ on the Num pad to zoom out.

The mouse wheel allows vertical zooming. Note that the zoom focus depends on the position of the mouse cursor. For example, if the cursor is on the Compton background it will zoom in on this region whereas if the cursor is at the top of the peak the zoom focus is on that part of the peak. Use the hotkey “a” to zoom out vertically.

Use the “Display options” dialog to change the appearance of the spectrum display. To open this dialog, left-click on the spectrum window outside of the actual spectrum (i.e., left of the y-axis and below the x-axis; or on the channel/energy/count readout on the upper right of the spectrum window).

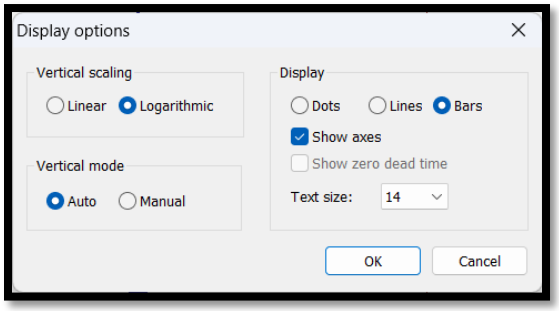


Figure 82. Display Options Dialog

The following settings are available:

- **Vertical scaling:** Linear or logarithmic presentation of the y-axis (counts). Simply pressing the “l” key (small L) does this as well.
- **Vertical mode:** Automatically scales the y-axis according to the incoming spectrum.
- **Display:** Dots, lines, and bars of the spectrum.
- **Axis:** Display/hide axis.
- **ZDT:** For hardware supporting Zero-Dead-Time, the ZDT spectrum is shown for an activated field, otherwise the error spectrum.
- **Text size:** Changes the font size in the spectrum window.

A spectrum cursor allows selection of spectrum content. The position of the spectrum cursor and the respective channel content is shown in the top right of the spectrum display.

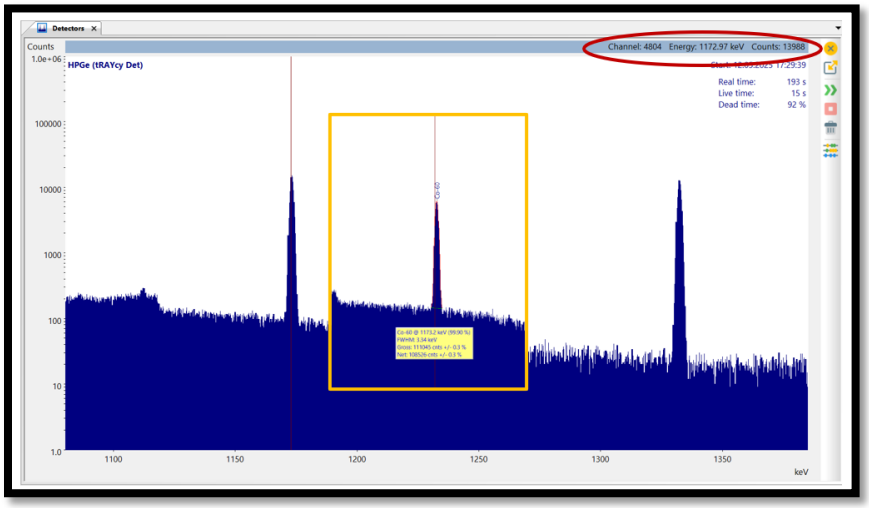


Figure 83. Cursor Position Displayed

Double clicking with the cursor on the spectrum will force LVis to fit a peak at the respective position of the spectrum. In case a reasonable peak fit is possible the fit is shown, and a peak info window presents the results.

4.5 THE BUFFER DETECTOR

The Buffer detector in LVis behaves like a “real” detector system and is used when working with existing spectrum files. It is possible to load the spectra into the Buffer, combine the spectra with a parameter set to an LVis measurement, and analyze and publish the results accordingly. The only difference between the Buffer and a “real” detector is that acquisitions cannot be started but instead users load a spectrum file (supported formats: **.lvm**, **.spc**, **.chn**, **.spe**, **.cnf**, **.rms**). The icons on the live detector view “Start”, “Stop” and “Clear” have no meaning for the Buffer detector.

Note that the Buffer in LVis behaves differently compared to the Buffer in GammaVision. Since the LVis Buffer behaves like a detector, it is not possible to load multiple spectra at the same time into the Buffer for comparison. Only one spectrum at a time can be in the Buffer. The main purpose of the LVis Buffer is to convert existing spectra into LVM files whereas in GammaVision it is simply a way to present spectra.

4.5.1 Summing/Subtracting Spectra with the LVis Buffer

The LVis Buffer provides the possibility to add or subtract spectra by channel or by energy. To do this, load a spectrum into the Buffer using **Load spectrum**. Then select **Add spectrum** from the buffer’s context menu and select the spectrum that should be added to or subtracted from the previously loaded spectrum. The following window as seen in Figure 84 will appear:

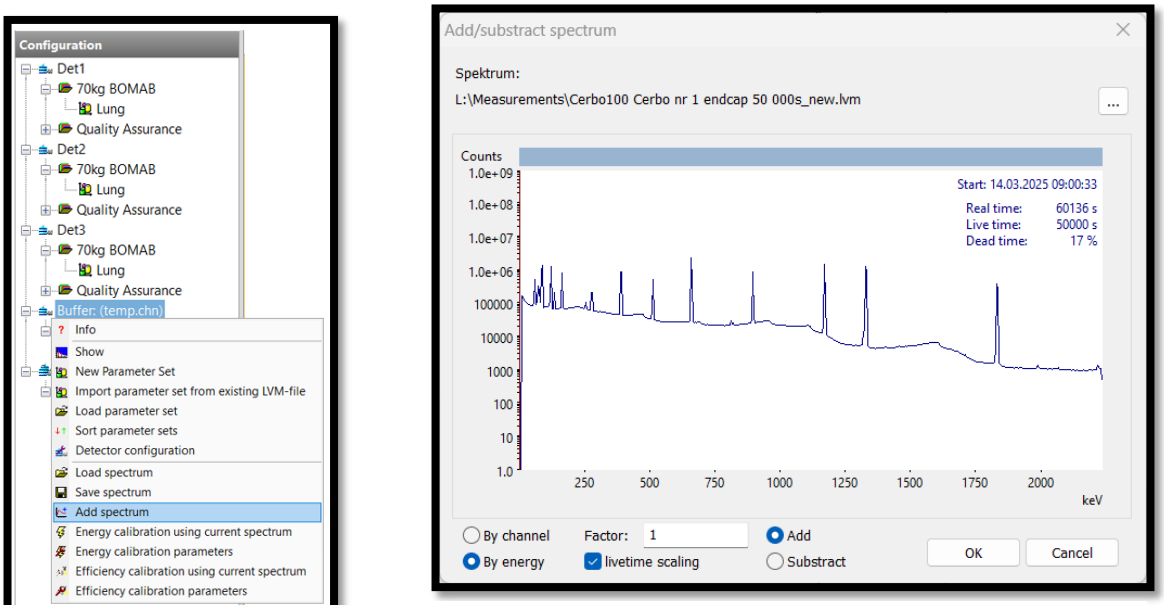


Figure 84. Add/Subtract Spectrum

Figure 85. Buffer Options Menu

Here users can define if the summing/subtraction should be done channel by channel or by energy and if the counts in the spectrum should be scaled to match the lifetime of the first loaded spectrum. Users can also define a scaling factor.

The spectrum summing in the buffer is also utilized and automated when working with multi-detector configurations.

4.6 MULTI-DETECTOR CONFIGURATIONS

Multi-detector configurations are used to start measurements using several detectors at the same time, with identical measuring parameters (measuring time, reference date, sample weight, etc.). These measurements are analyzed with analysis parameters predefined for the individual detectors. For example, this functionality is required when body counters are used or when large objects are measured using multiple detectors.

Multi-detector measurements are usually set up so that analysis and correction parameters are specific to the detector and do not change between measurements. However, measurement and file parameters apply for all detectors, but change for each measurement.

Therefore, multi-detector configurations take analysis and correction parameters for the respective measurement from a predefined parameter set of the corresponding detector. However, measurement and file parameters must be entered prior to starting a multi-detector measurement (see Chapter 5 LVis Parameter Sets). This new input is entered in the parameter set of the first detector of the respective multi-detector configuration, which appears prior to each data acquisition start. There users can enter measurement-specific information, which then is automatically applied to other detectors of the configuration.

To simplify the handling of multi-detector measurements in the Lab Journal, LVis saves (in addition to the respective LVM file for each detector) a LVB Multi-Detector File that includes the information about the multi-detector acquisition. When filtering for Multi-Detector Acquisitions in the Lab Journal only the LVB files are displayed. Double clicking on such a Multi-Detector File in the Lab Journal will open all files from the Multi-Detector Acquisition.

4.6.1 Creation of a Multi-Detector Configuration

In order to use multi-detector configurations, they must be first enabled in Settings (see Section 3.3). By default, the configuration of multiple detectors is deactivated in LVis.

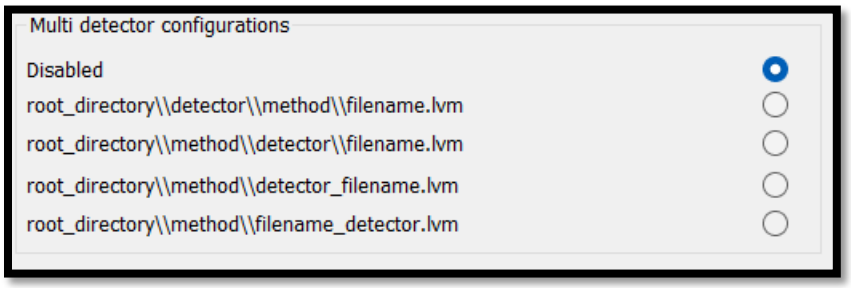


Figure 86. Multi-Detector Configurations Selection

The multi-detector configuration is activated by selecting one of the four file naming conventions.

The first one keeps the file naming convention and file storage logic the same way as always in LVis: Every file is saved under its respective detector folder in a subfolder for the respective parameter set (counting method).

Since the name of the parameter set must be the same for all detectors that are part of a multi-detector configuration, it is also possible to save the LVM files of a multi-detector count under the name of the method (parameter set) and then subfolders for the respective detectors.

In addition, there are two other ways of saving the files where the actual filename is either extended by the name of the detector or the detector's name becomes a prefix to the filename.

Once activated, a new entry called "Multi detector configuration" appears in the Configuration panel.

In order to create a new multi-detector configuration, right mouse-click on **Multi-detector configuration** in the configuration bar and select **New multi-detector configuration**.

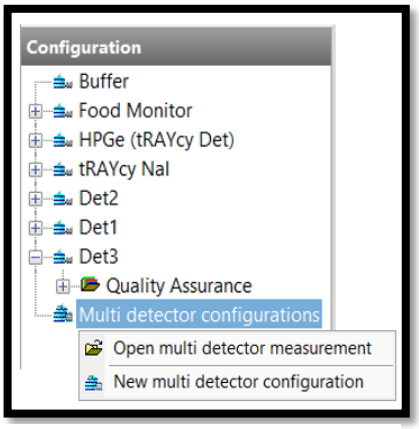


Figure 87. Multi-Detector Configuration Menu

Note that Multi-detector configurations summarize *identically named parameter sets* of *different detectors* and start them at the same time. The name of a new multi-detector configuration specifies the corresponding detector parameter sets. If it is desired to use already existing parameter sets, the new multi-detector configuration must be named the same.

In the following dialog box, users can specify a name for the new configuration. It is possible to define multi-detector configurations for the acquisition of QA measurements. If this is desired simply tick the QA check box.

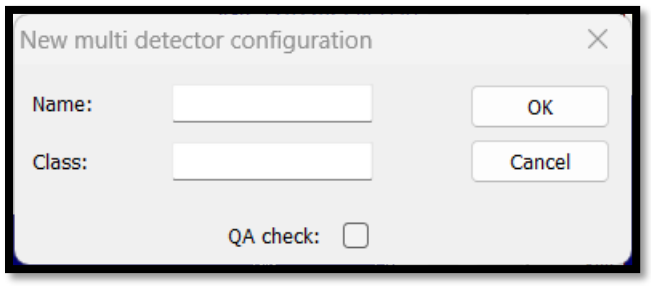


Figure 88. New Multi-Detector Configuration Entry

NOTE: The name of the multi-detector configuration defines the parameter sets that will be concurrently used. So, for QA measurements "Efficiency", "Energy", or "Background" must be used. Spectrum summing is not possible for QA measurements

In the following dialog box, users can specify which detectors will be included in the multi-detector configuration.

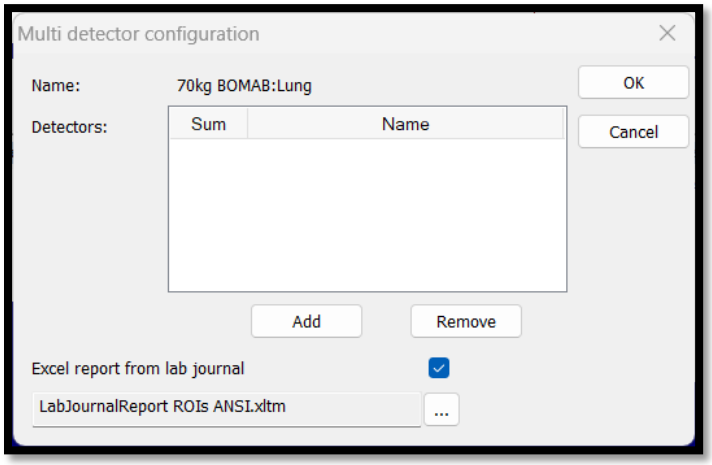


Figure 89. Multi-Detector Configuration Detector Specification Screen

Clicking on **Add** opens a selection menu showing all detectors having a parameter set with the same name as the multi detector configuration.

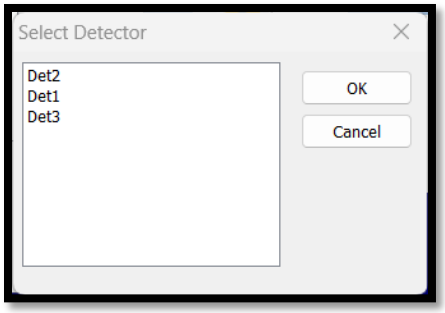


Figure 90. Multi-Detector Configuration Detector Selection

To remove a detector, click to highlight it, then click on **Remove**.

NOTE: If it is desired to work with multi-detector configurations, first create a respective parameter set for one of the detectors to be used. Next, copy this parameter set and insert it using the same name under all other detectors. Subsequently, change respective detector-specific parameters in the created parameter sets. Finally, create a multi-detector configuration using the same name.

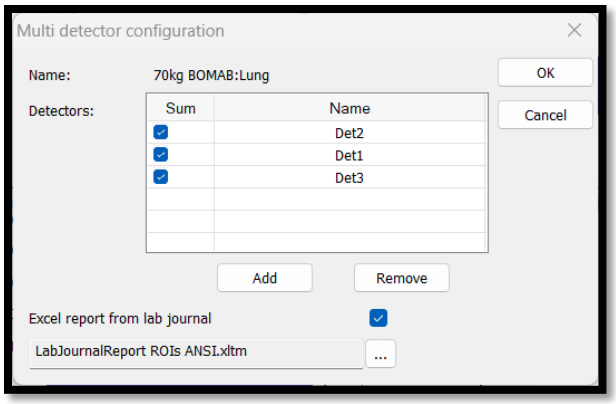


Figure 91. Multi-Detector Configuration with Multiple Detectors Selected

It is possible to automatically create a sum spectrum using all the individual spectra from a multi-detector configuration. If this is desired tick the respective box. The automatic summing within the procession of a multi-detector configuration will always be “by energy”, with a live time scaling and a factor of 1. Since the file name of LVM files acquired by multi-detector configurations usually includes the detector name (see above) it is important to know that the detector name for the sum spectrum is always “detector_name_1 + detector_name_2 + detector_name_3 + ……”.

NOTE: When using the auto-creation of sum spectra with multi-detector configurations, it is recommended to use short detector names because otherwise the path and/or filename of the sum LVM measurement file can become very long.

Ticking the box **Excel report from lab journal** will automatically create a single Excel VBA report including the analysis reports of all detectors involved in the multi-detector configuration (see as well Reporting with the LVis Lab Journal (Section 11.2) for more information).

4.6.2 Starting a Multi-Detector Configuration

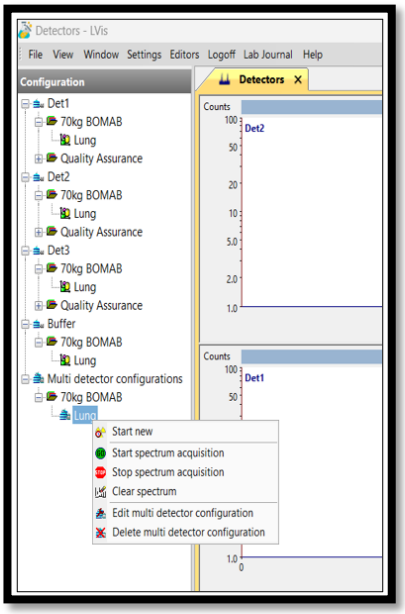


Figure 92. Multi-Detector Options

Users can start a multi-detector measurement from the Configuration panel by right mouse-clicking on the respective parameter set of the multi-detector configuration and selecting **Start new**.

The parameter set appearing next is the routine of the first detector of the multi-detector configuration.

All measurement and file parameters (everything entered on the “Sample data” tab) entered here, will be applied to *all* parameter sets of all other detectors.

After all these parameters are entered, click on **Start** to start all configured detectors of the multi-detector configuration.

IMPORTANT The file name entered in the appearing parameter set is the same for all detectors of the multi-detector configuration. Due to the file name creation option for multi-detector configurations specified in the global settings, the created **.LVM** files will be different.

4.6.3 Edit or Delete a Multi-Detector Configuration

Provided that the respective user has the right to modify parameter sets, an existing multi-detector configuration can be edited or deleted from its context menu.

After **Edit multi detector configuration** is selected, the editor described in the Section 4.6.1Creation of a Multi-Detector Configuration appears. To delete, select **Delete multi detector configuration**.

4.7 DETECTOR SIMULATIONS

There are two different detector simulations available in LVis. The traditional LVis detector simulation is based on existing spectrum files that are simply scaled to the respective counting time when starting an acquisition. The tRAYcy detector simulation is a true Monte Carlo based simulation of the detector response and as such requires a properly defined detector and counting geometry. We recommend using tRAYcy detector simulations for training purposes.

4.7.1 Working with tRAYcy Detectors in LVis

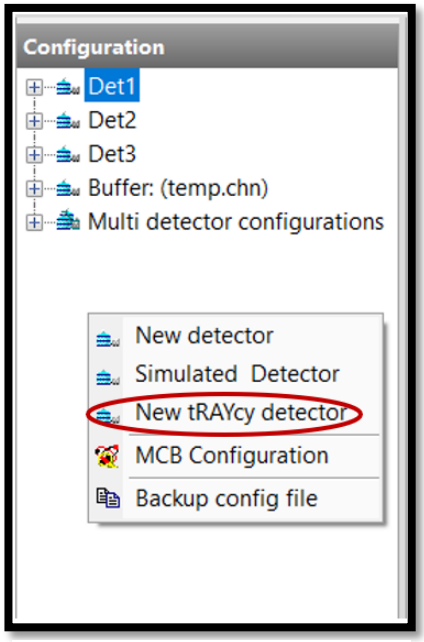


Figure 93. New tRAYcy Detector Selection

To add a new tRAYcy detector to LVis, right click in the empty area of the Configuration panel, select **New tRAYcy detector** and define a name for the new detector. Note that the tRAYcy detector is added to the LVis configuration. Then right click on the newly created tRAYcy detector and select **Detector configuration** to define the detector model and the spectrum properties. The definition of the detector model works identically to “real detectors” simply by entering the details of the detector dimensions or loading a respective LVis detector .lvd file (see Section 4.2 Configuring Detectors). The configuration of the “Electronics” however, is somewhat different. The tRAYcy algorithm doesn’t simulate any electronic noise so in order to provide a real spectrum, one must define the resolution of the detector. In addition, it is possible to define the “gain”, so the energy range that is simulated.

tRAYcy also simulates the pulse procession to provide an estimate for the dead time of the spectrum. To do that, users need to enter a rise time and flat top width.

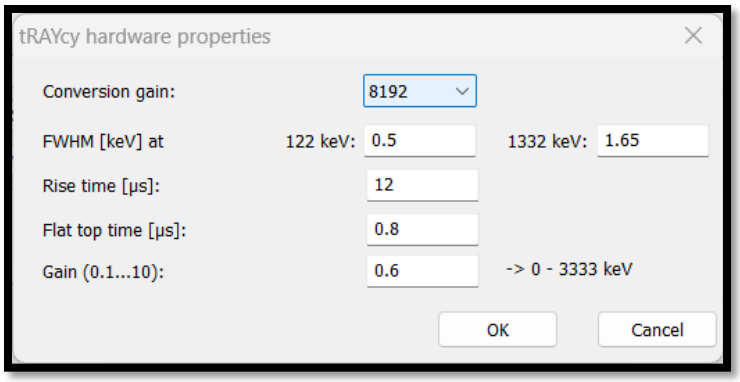


Figure 94. tRAYcy Hardware Properties

Once a tRAYcy detector is configured, it basically behaves like a real detector in LVis with the only difference being that when starting an acquisition users have to define the nuclide mix and – depending on how the acquisition is started – the counting geometry that is to be simulated.

For example, when starting an acquisition from the live detector view using the quick icon, a window pops up where a source can be selected.

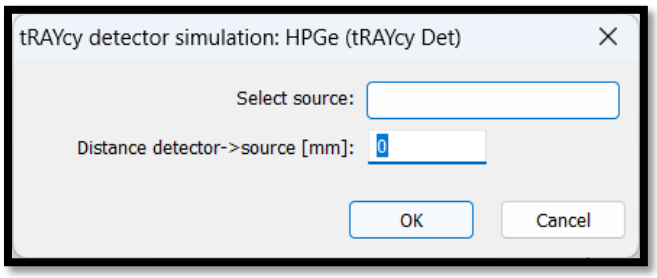


Figure 95. tRAYcy Source Selection

In LVis, a properly defined reference source contains not only a list of nuclides and respective activities at a reference date/time but also the dimensions of the respective source geometry. It is also possible to define the distance between the detector and the source. Note that it is always assumed that the source is positioned centric on the detector. For the simulation, the source activities are corrected to the current date.

When starting a parameterized acquisition on a tRAYcy detector, the sample geometry must be defined in the respective parameter set. It is also important for the simulation that all sample data is entered correctly. Especially, a reasonable sample mass and sample volume are required to calculate the corresponding filling level and density which are required by tRAYcy.

After clicking **Start** the following window opens to define the nuclide mix for the simulation:

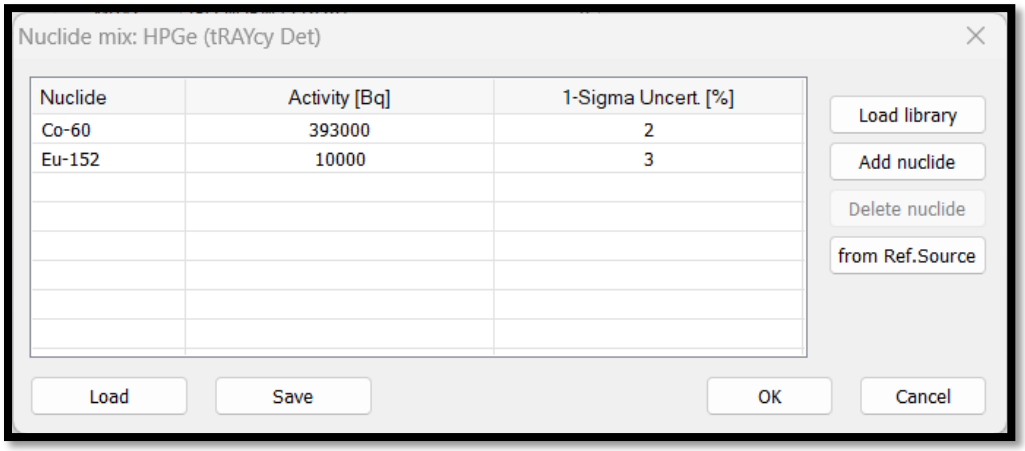


Figure 96. tRAYcy Nuclide Mix Definition

It is possible to define nuclides by either selecting a library or by adding individual nuclides from a library. The nuclide activities are entered by double clicking into the respective cell of the table. It is also possible to save and load nuclide mixes. Using **from Ref. Source** loads the nuclides and respective activities from an LVis .lvs reference source file.

IMPORTANT Note that the activities as entered in the nuclide mix are decay corrected to the reference date/time entered on the “Sample data” tab of the parameter set. This will have an impact when specifying nuclides with short half-lives since they may have decayed completely. The tRAYcy detector simulation only simulates single nuclide decays. It doesn’t take decay chains into account.

The respective nuclide data that is used for the simulation is not based on the selected library or reference source but based only on the NUDAT3 data for the respective nuclide name specified in the nuclide mix.

A special case is the parameterized execution of QA checks or calibrations. For these routines, respective calibration or QA check sources are already defined in the parameter sets which is why these can simply be started directly from the Configuration panel.

In a tRAYcy spectrum calculation, every count in the spectrum can be tracked back to the respective nuclide in the sample that emitted the gamma. When analyzing tRAYcy generated spectra in LVis, users can show the individual contribution of every nuclide to the total spectrum. On the spectrum tab a table is displayed listing all the nuclides where users can turn off/on the respective single nuclide spectrum.

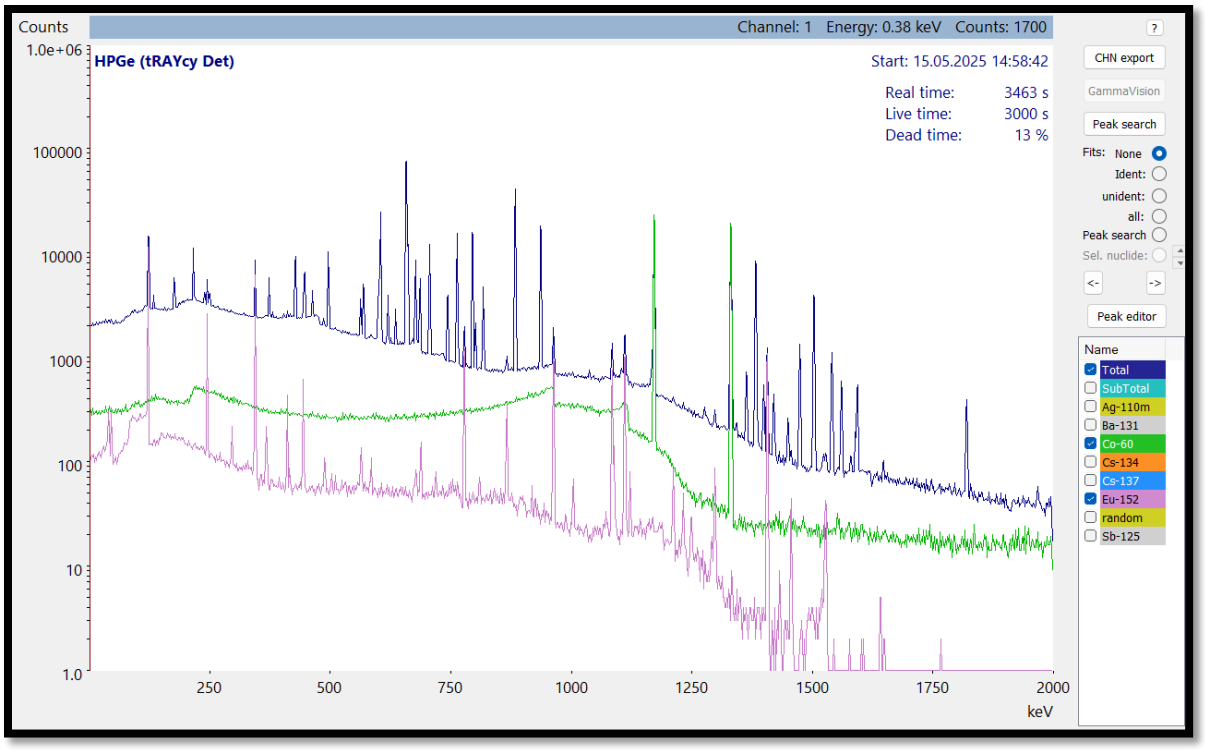


Figure 97. tRAYcy Spectrum

4.7.2 Working with “Simulated Detectors”

“Simulated detectors” is the “old”, pre-tRAYcy, way of simulating detectors in LVis. Traditionally this method was used when preparing LVis configurations and the respective hardware was not available.

“Simulated detectors” work like real detectors in LVis. The simulation is based on existing spectrum files that are simply scaled to the respective counting time when starting an acquisition.

Note that when starting a new spectrum acquisition on a simulated detector, the acquisition date and time is the actual date and not the original date from the loaded spectrum file.

It is not recommended to use simulated detectors for training purposes.

5. LVIS PARAMETER SETS

Parameter sets are the core of the sample-oriented approach of LVis. They contain all the instructions required to measure and analyze a specific sample on a given detector. This includes, among others, sample-specific details such as the sample name and its quantity, measurement-specific details such as the measuring time, and analysis-specific details such as calibrations, libraries, or spectroscopic corrections.

The settings and/or fields contained in a parameter set vary depending on the type of analysis needed. In the most general terms, it is possible to distinguish between two major analysis types: an automatic gamma analysis based on analysis engines and a simpler user-directed region-of-interest (ROI) analysis that can be used for low-resolution gamma detectors or alpha detectors. It is also possible to combine both analysis types in a single parameter set. Moreover, every detector in LVis has by default predefined parameter sets for QA measurements, for both the automatic and the ROI analyses.

This chapter focuses on parameter sets for the automatic gamma analysis of samples. Parameter sets for the ROI analysis are described in Section 9.3, while parameter sets for QA measurements (for both the automatic analysis and the ROI analysis) are described in Section 8.2.

5.1 CREATING PARAMETER SETS

Parameter sets can only be created and edited by LVis users with the respective right (see Section 2.6). They are always assigned to detectors, and they appear in the configuration tree below the respective detector once created. It is possible to create a new parameter set for only one detector at a time. If a certain parameter set represents a counting routine carried out with different detectors, it is possible to copy the parameter set to other detectors after its creation. It is also possible to create a new parameter set by importing the parameters from a saved measurement. Finally, it is possible to export a parameter set to disk and load it in another LVis configuration.

In order to create a completely new parameter set, right-click on the desired detector in the configuration area, and select *New parameter set* from the context menu. The following window, containing the general settings of a parameter set, will be displayed:

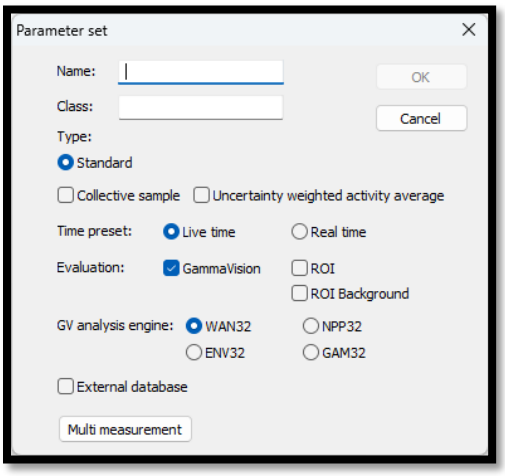


Figure 98. New Parameter Set

Insert the desired Name of the parameter set in the respective field. An optional Class name can also be defined. Classes provide convenient grouping of different parameter sets belonging to the same detector, and they allow creating different parameter sets with the same name for the same detector, as long as the parameter sets are not in the same class. The class and parameter set names also define the default location for measurement files: a measurement analyzed with a particular parameter set is saved in the folder:

"LVisDatabaseLocation\Measurements\DetectorName\ClassName_ParameterSetName"

If it is desired to assign the parameter set to a new class, insert the desired class name. If users wish to assign the parameter set to an already existing class, insert the corresponding class name. If users do not wish to assign the parameter set to any class, leave the class field empty and the parameter set will be assigned directly to the detector. Right-clicking on a class in the configuration tree will show the same options for creating or loading a parameter set as right-clicking on a detector, but the class name in the general settings window will already be inserted.

The grouping of parameter sets in different classes is optional and does not influence the measurements, since classes do not contain any acquisition or analysis parameters. Parameter sets belonging to the same class do not need to share any of their settings. The use and names of classes are left to the users, who can organize the configuration tree based on their functional and/or aesthetics preferences. (The only exception is the Quality Assurance class and their respective parameter sets, which are present by default and cannot be deleted.)

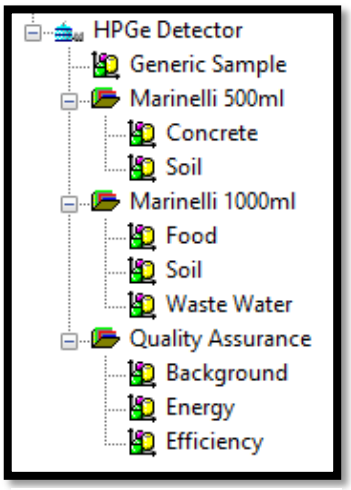


Figure 99. Parameter set Navigation Tree

Consider the example shown in the picture in Figure 99. The *HPGe Detector* has two user-defined classes, called *Marinelli 500ml* and *Marinelli 1000ml*, and the default *Quality Assurance* class. The *Marinelli 500ml* class contains two user-defined parameter sets, called *Concrete* and *Soil*, while the *Marinelli 1000ml* class contains three user-defined parameter sets, called *Food*, *Soil,* and *Waste Water*. A *Generic Sample* parameter set does not belong to any class and is assigned directly to the detector. In this example, the parameter sets are grouped based on their container geometry, and a counting routine to measure soil samples is carried out with Marinelli beakers of different sizes. Assuming that the LVis database is located in the *"C:\LVis"* folder, measurements analyzed with the *Concrete* parameter set will be saved in the folder:

"C:\LVis\Measurements\HPGe Detector\Marinelli 500ml_Concrete" folder

While measurements analyzed with the *Generic Sample* parameter set will be saved in the folder:

"C:\LVis\Measurements\HPGe Detector\Generic Sample"

The **Type** of a parameter set is always **Standard** (this is a legacy option from older LVis versions).

It is possible to create a **Collective sample** parameter set, which activates a special decay correction useful when a sample is collected over an extended period of time. One common use is that of an air filter left exposed for a prolonged time before being counted, where it would be necessary to correct for the activity on the filter that decays during the collection period. If it is not desired to use this special decay correction but only a standard decay correction to a reference date, leave the box unchecked (see Section 9.7.9 for more information about the available activity decay corrections).

When a nuclide emits multiple gamma rays, more than one peak associated with that nuclide is typically present in a spectrum. By default, in order to calculate the final activity for the nuclide, the

analysis engines calculate the activity, and its uncertainty based on each associated peak, and then perform a weighted average using the peak branching ratios as weights. If users wish instead to use the activity uncertainties for each peak as weights, select the **Uncertainty weighted activity average** option.

Users can choose whether the counting **Time preset** of a parameter set, and consequently of the sample measurements started from that parameter set, should be based on either the **Live time** or the **Real time**.

In **Evaluation**, users can choose the type of analysis that will be performed with the parameter set, which greatly influences the available settings. If it is desired to use an automatic gamma analysis based on analysis engines, select the **GammaVision** option; if it is desired to use a simpler user-directed region-of-interest (ROI) analysis, select the **ROI** (and optionally **ROI Background**) option. The remainder of this chapter focuses on the GammaVision option; for the ROI option, see Chapter 9 ROI Analysis With LVis.

For the automatic gamma analysis, users can choose which **GV analysis engine** will be used to analyze spectra: **WAN32**, **NPP32**, **ENV32**, or **GAM32**. As a general fact, the differences among them are primarily related to the peak search algorithm, yielding different results in terms of false positives and false negatives. It is generally recommended to use either NPP32 or ENV32. If the detector type is selected as NaI, the **NAI32** analysis engine is used by default and the choice in the general settings window has no effect.

The two additional options, Section 5.1.2 Multi Measurement and Section 5.1.1 External Databases, are described in separate chapters below.

Once all the options have been selected, clicking **OK** adds the parameter set (and optionally the class) below the chosen detector in the configuration tree and automatically opens the parameter set in the work bench area for further editing. Clicking **Cancel** closes the general settings window without adding the parameter set in the configuration tree.

Except for the name, all the general settings of a parameter set can be modified at any time after creation. With the parameter set opened to be edited (see the next section), right-click on the small calculator symbol  on the left of the parameter set name in the upper part of the work bench and then choose **Settings**. This opens the general settings window of a parameter set where users can modify the desired options.

5.1.1 External Databases

The External database option activates the use of an external database from which users can automatically import data, creating an additional tab in the parameter set. Which key value is to be displayed in the respective tag field of the parameter set and what additional data should be parsed from the database into an LVM file to be shown on the new tab can be defined in the external database editor.

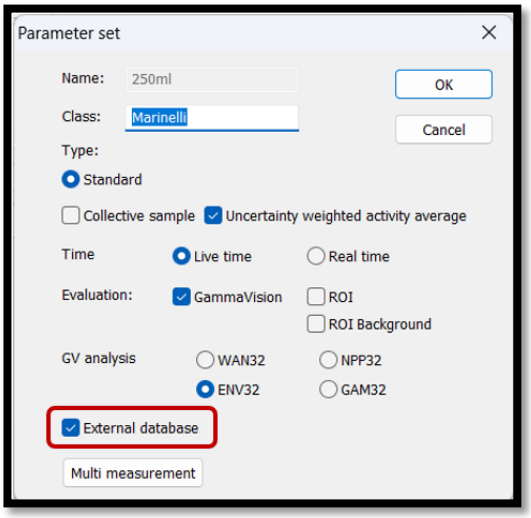


Figure 100. Parameter Feature Set

This feature needs to be activated in the Settings of a parameter set (see Figure 100). The selection of the data set is then achieved by simply selecting a respective key value in the “Sample origin” field of a parameter set when starting a new parameterized acquisition (see Figure 101).

In the example below a set of personal data related to the origin of the sample are presented on a new tab “Personal data”. New data is either entered at the beginning of the count by selecting **Add…** from the pulldown menu in the “Sample origin” field or by selecting an existing entry from the database.

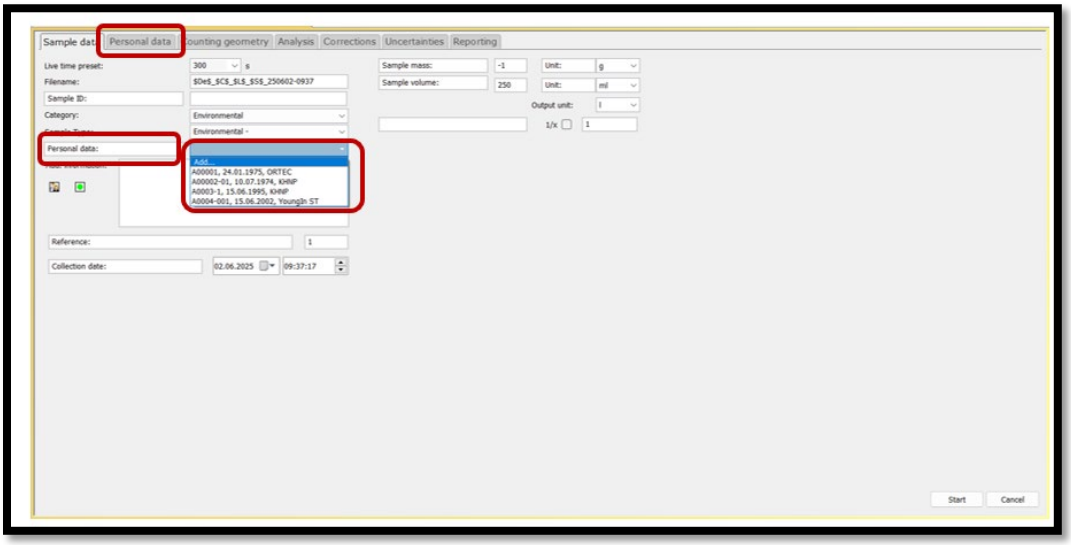


Figure 101. Personal Data Information

Such a dataset is usually imported from a LIMS or any other database by csv file import/export. However, prior to any importing or linking, it is necessary to configure the database fields that are to be displayed on the LVis LVM file. This configuration can be defined with the “External Database Editor”. The very first time when the external database editor is started the following configuration window will pop up.

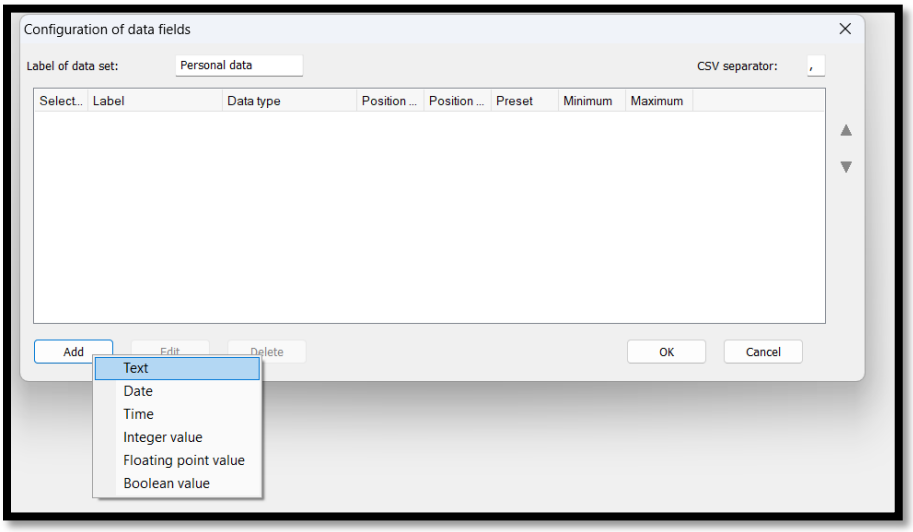


Figure 102. External Database Editor

The first thing to do is to define the name of the data set (give it a label). In the example above this is “Personal data”. Note that this label will later be displayed as the name of the tab in the LVM file. In addition, it is possible to define the separator in the CSV file that will be used to import data into the database.

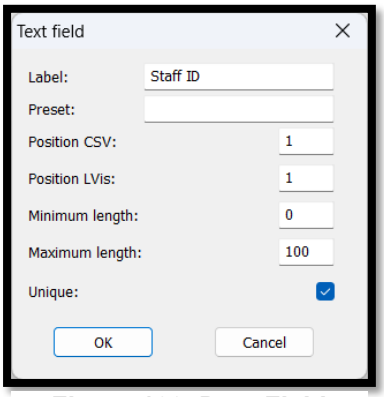


Figure 103. Data Field Editor

Clicking on **Add** will allow the definition of a new data field in the database. It is possible to select from six different types of data (see Figure 102). For each data field, one has to specify a name (label), a preset (default value), the position of the value in the csv file, the position of the respective field on the tab in LVis as well as the limits for the size of a value and if the entry is unique. The “Position in LVis” is referring to the location of the respective data entry on the database tab in an LVM file.

The following dataset of “Personal data” is used in the example (see screenshot below):

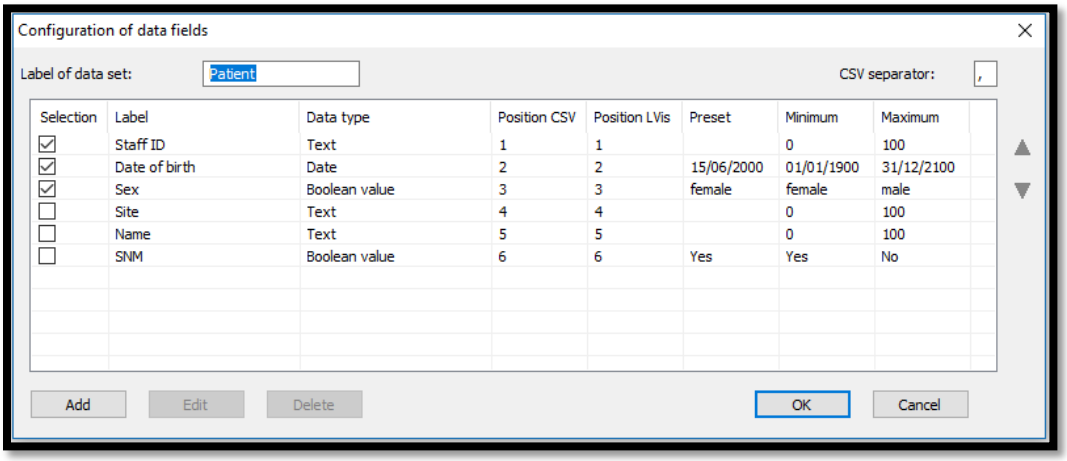


Figure 104. External Database Editor Personal Data Example

And will show the database entries on the tab like this:

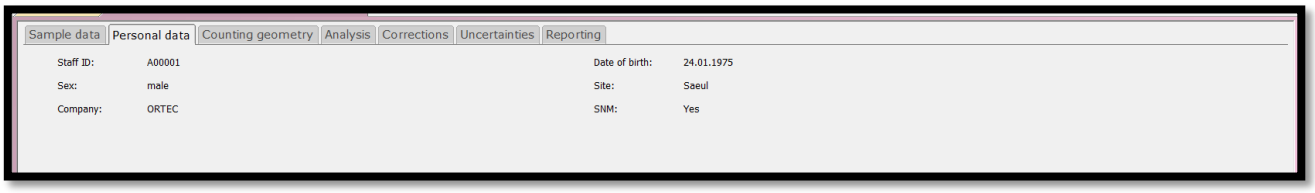


Figure 105. Database Entries Tab Example

Note that the pulldown menu for the Location field of the parameter set will be different depending on which of the database fields were ticked for “Selection” in this configuration. The three entries selection shown above will bring up a selection menu like this:

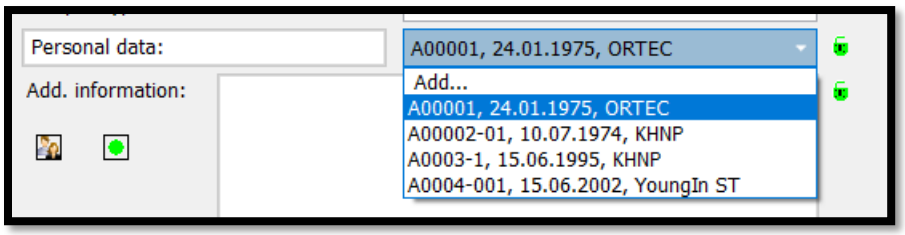


Figure 106. Location Field Example

Once the database fields are defined and configured, the “External Database Editor” will come up with the default editor that allows adding new entries to the database.

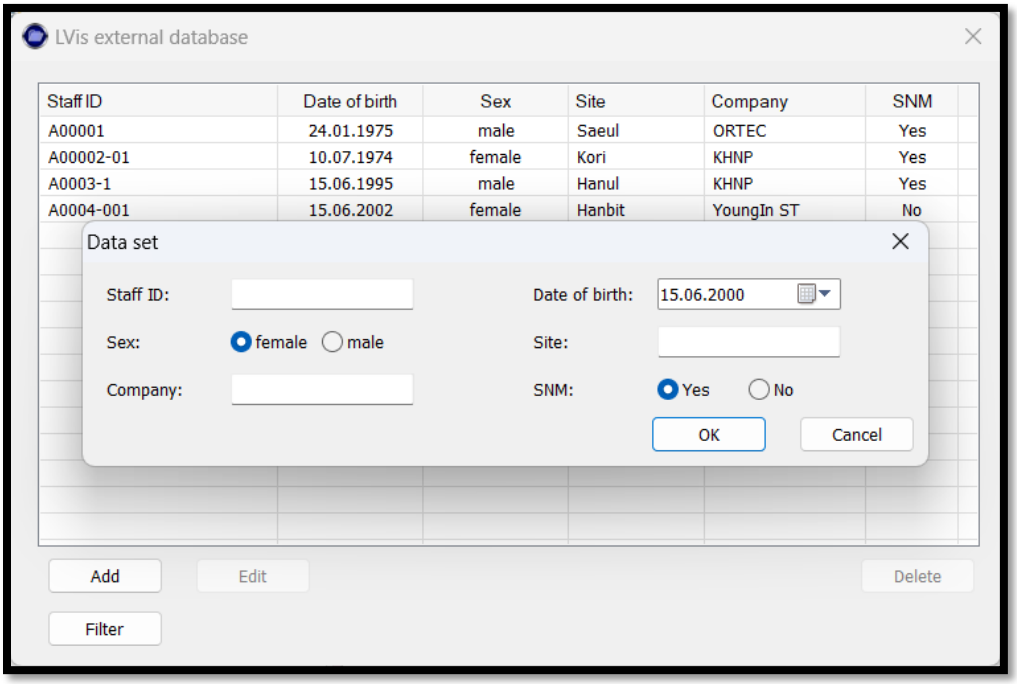


Figure 107. External Database Data Set Editor

Note that “Import of datasets via a csv file” (see blue marking below) as well as re-configuring or editing the “Database Settings” (see red marking) can be achieved by clicking on the icon in the top left corner of the database editor.

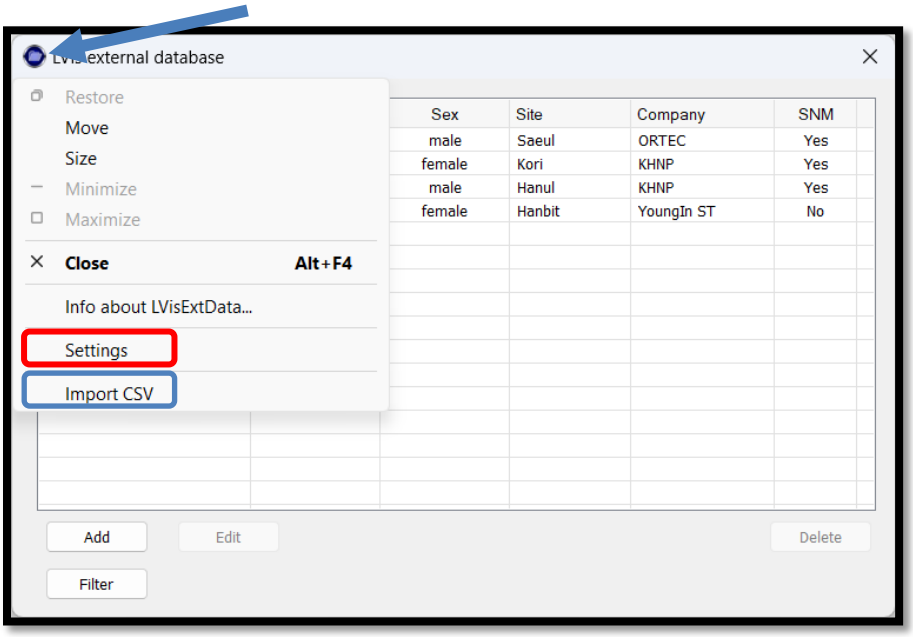


Figure 108. External Database Settings

5.1.2 Multi Measurement

It is possible to measure a sample multiple times in a row using the Multi measurement option. When clicking on the respective icon in the general settings dialogue for parameter sets, the following window opens:

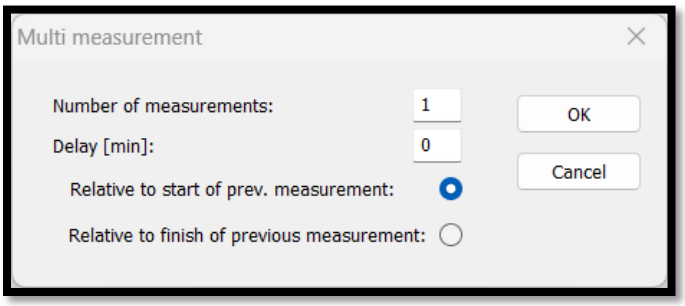


Figure 109. Multi Measurement Screen

Number of measurements – defines the total number of repetitions of the respective routine. It is possible to define what delay or waiting time in minutes should be between the acquisitions and if this delay should be calculated from the start or the end of the previous measurement.

NOTE: It is mandatory to automatically create file names based on $-Commands in counting routines that utilize the multi measurement feature. Use either Mi or i in the file name presets. Mi will simply add the respective loop number into the file name.

5.2 DEFINING THE PARAMETERS

The parameters inserted or selected when creating or modifying a parameter set become the default values. As described in details in Section 7.3 Working with Parameterized Measurements, when a

parameterized measurement is started, the corresponding parameter set window appears with the default values already in place; it is then possible to complete the remaining fields or change the default values. The underlying idea is that parameters common to a certain counting routine (e.g., container geometry, analysis library, calibration file, etc.) are preselected and always present as default values, while parameters specific to a particular sample (e.g., filename, sample ID, reference date, etc.) are left open by default and inserted only when the corresponding measurement is started.

Each parameter can be independently locked by clicking on the lock symbol next to it. When a given parameter is locked (red lock), users without the permission to edit Parameter sets will not be able to modify the default value when starting a measurement, even if no default value is present. When a given parameter is unlocked (green lock), every user will be able to modify the default value.

None of the parameters are mandatory when creating or modifying a parameter set, so in principle all of them can be chosen at the start of a measurement if they are unlocked. Typically, the more parameters are set as default values and locked, the more control a laboratory administrator has over the sample analyses. At the same time, more parameter sets in the configuration tree are required, since variations in locked parameters lead to the creation of new parameter sets. The ultimate choice in setting and/or locking parameters is thus left to the laboratory administrator based on his/her preferences.

When a parameter label is an editable field (see for example the Sample ID in the Sample data tab), it is also possible to modify the corresponding text as well. Default values for the editable text labels can also be defined in the Global Settings (see Section 3.3 The Global LVis Settings).

Parameter sets are composed of six tabs: **Sample data**, **Counting geometry**, **Analysis**, **Corrections**, **Uncertainties,** and **Reporting**. An additional tab appears if the External database option is selected in the general settings window.

5.2.1 Sample Data

The **Sample data** tab contains general information about the sample being measured. The figure below shows the appearance of the Sample data tab when a parameter set is first created without selecting the Collective sample option.

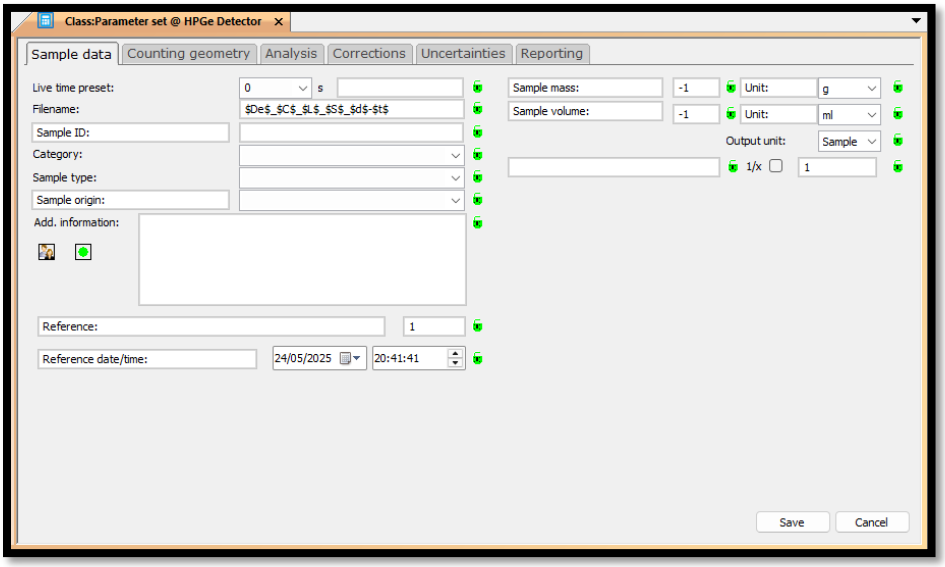


Figure 110. Sample Data Tab

- **Live/Real time preset** – defines the measuring time in seconds based on either the live or the real time, depending on the choice made in the general settings window. The field on the right can be optionally used to predefine different time presets. Entering values separated by a comma will make them appear in the drop-down list of the left field when a measurement is started. If the right field is not empty, only values in the list can be used for a measurement, even with the field unlocked. If users wish to be able to enter a different preset than those available when starting a measurement, add a question mark (*?)* symbol to the comma-separated list in the right field. If the field is locked, only the value in the left field can be used by a standard user, irrespective of the values in the right field. If it is not desired to use a time preset for a measurement (i.e., the acquisition will continue until stopped manually), enter 0 in the left field.

- **Filename** – defines the name of the measurement file (**.LVM** file); as such, it is typically entered at the beginning of each measurement. However, it is possible to automatically generate a filename, or part of it, based on other sample parameters, the start date and time of the measurement, the detector, or other options using *dollar commands*. This is explained in more details at the end of this section.

- **Sample ID** – an optional text field that can be used to enter information specific to the sample being counted. For example, if each measured sample has an organization-specific identification number, the field may be used for recording such number.

- **Category**, **Sample type**, and **Sample origin** – optional text fields that can be populated either by directly entering the text or by choosing an entry from the drop-down list. Entries in the drop-down list for each field can be added or removed in the Global Settings (see Section 3.3 The Global LVis Settings). If the External database option is active, the Sample origin field is used to select a data set.

- **Add. information** – an optional text field that can be used to enter any additional information about the measurement.

- **Reference** – can be used when it is required to report the activity in relation to a reference value that has been determined otherwise. For example, it can be used when the gamma activity must be compared to the alpha activity, or when the sum of decay corrected MDAs must be compared to the total sample activity determined in an earlier measurement in radiopharmaceuticals applications. In order to use the reference value, a customized report template is needed. Contact ORTEC technical support or a local ORTEC representative for further information.

- **Reference date/time** – used when it is necessary to report the activity values at certain date and time; the corresponding decay correction in the Analysis tab must be selected. It is possible to enter the date manually or through a standard calendar.

  When using a Collective sample parameter set, two additional date and time fields, **Start of sample collection** and **End of sample collection**, become available; see the Analysis tab to know how these additional dates are used in the analysis.

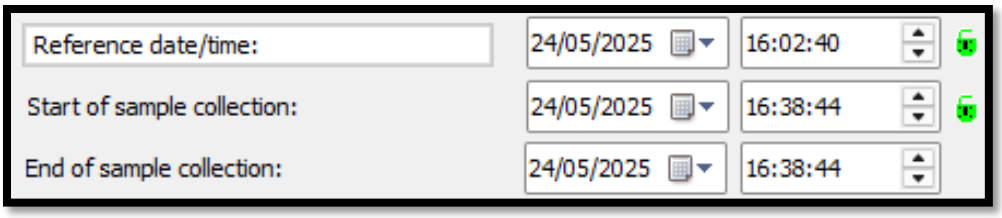


Figure 111. Additional Date/Time Fields for a Collective Sample Parameter Set

- **Sample mass and volume** – The first two rows in the right area of the Sample data tab defines the **sample size** in terms of its **mass** and **volume**. It is very important to note that *only the units of measurement selected in the drop-down lists are used by LVis to determine which dimension the values entered correspond to.* That is, the text labels (shown as Sample mass and Sample volume in the picture) do NOT have any effect on how LVis determines the sample size. When a counting geometry is defined in the Counting geometry tab, it is possible to specify the sample **filling height** inside the container instead of the sample volume. Based on the entered container dimensions, LVis automatically converts the filling height to the corresponding volume.

- **Output unit** – defines the dimension and unit used to calculate the specific activity of the nuclides. When a unit of measurement is selected, the normalization by the sample size happens automatically during the analysis (except in a case explained later). That is, when analyzing a measurement, LVis reads the selected Output unit and looks for the corresponding dimension in the two rows above. Then, it divides the total activity by the entered value for the sample size of the matching dimension. The conversion among different powers of ten within the same dimension is also performed automatically. Thus, it is important that the units selected in the sample size rows do not refer to the same dimension.

The relationships among units of measurement and dimensions, and the conversion factors for the powers of ten are defined in the Global Settings (see Section 3.3 The Global LVis Settings). The default units and dimensions are the standard ones; for example, *g* (grams) and *kg* (kilograms) are both defined to be units of measurement of the *mass* dimension, and a kilogram is defined to be 1000 grams. However, it is possible not only to create new units, but also to modify the existing ones. Since this affects the automatic normalization of the analysis, care must be taken when dealing with the units of measurement.

It is also important to note that both sizes (mass and volume/filling height) of a sample are needed only when the geometry and/or the library corrections are selected in the Corrections tab. This is because tRAYcy needs to know the density of the sample material, which is calculated from the sample mass and volume/filling height entered. If users do not wish to use the tRAYcy corrections, then only the size corresponding to the Output unit is needed to calculate the specific activity.

If it is desired to report the total activity of the nuclides, select *Sample* from the Output unit drop-down list. Note that this is independent from the use of the tRAYcy corrections; that is, it is still possible to use the corrections by specifying both the mass and the volume/filling height, and at the same time report the total activity.

5.2.1.1 Additional Scaling Factor and Normalization

It is possible to use an additional scaling factor that is applied to the calculated activity result. It is also possible to prevent the automatic normalization by the sample size based on the output unit.

By default, some fields in the right area of Sample data tab are hidden. To see all the possible options, first type any string (for example *Additional scaling factor*) in the field below the Output unit row: a new field appears below. Then type any string in that field (for example the number *1*): other new fields appear. The right area of the Sample data tab with all the possible parameters is shown in the following figure:

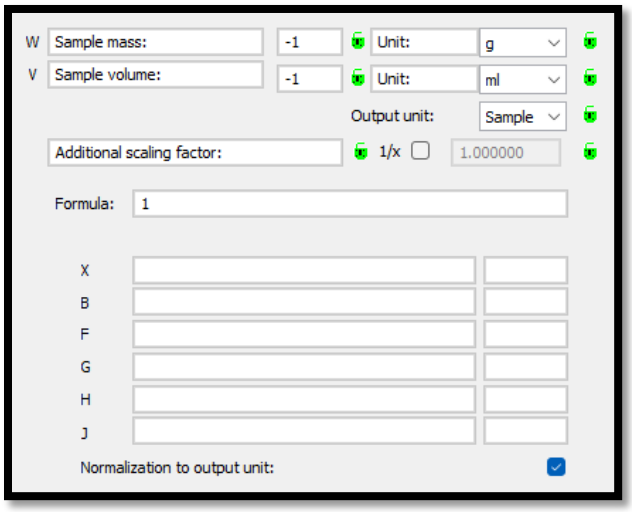


Figure 112. Sample Data Tab with All Possible Sample Size Parameters

The first option to consider is the **Normalization to output unit**, which by default is selected. In this case, during the analysis process LVis automatically calculates the specific activity based on the sample sizes entered, as described above. If users do not wish to use the automatic normalization, uncheck the box. In this case, the Output unit selected in the drop-down list has no effect on the calculated activity value. If the additional scaling factor is 1 (see below), the result is the total activity, irrespective of the sample sizes and the output unit. However, the output unit is still used as the label for the activity (e.g., Bq/g if grams are selected) in the measurement file and on the report. Basically, if the Normalization to output unit option is not selected, then the output unit acts only as a text label for reporting purposes and is not linked anymore to any dimension.

The **Additional scaling factor** and its label are located directly below the Output unit row, and it can be used as a multiplier or a divisor depending on the **1/x** option: if the box is checked, then the value is used as a divisor; otherwise, the value is used as a multiplier.

The additional scaling factor acts on the activity result *after* the Normalization to output unit has been considered. If the Normalization to output unit option is selected, LVis first calculates the specific activity based on the output unit, then multiplies/divides the specific activity by the entered scaling factor. If instead the Normalization to output unit option is not selected, LVis first calculates the total activity, then multiplies/divides the total activity by the entered scaling factor.

There are two ways to input the additional scaling factor: entering the value directly into the field or calculating it through a formula involving multiple factors.

In the first case, simply enter the desired text label in the left field, then enter the scaling value in the right field leaving the Formula field completely empty (this will hide everything below).

In the second case, it is possible to calculate the scaling value through a **Formula,** using six user-defined factors (**X**, **B**, **F**, **G**, **H**, **J**) and the sample size values (**W**, **V**). Each user-defined factor has

its own text label (left field) and value (right field). A standard mathematical formula using these factors can be written in the corresponding field. LVis then automatically calculates the scaling values based on the entered factors. Note that, for the Formula purposes, the sample size values are treated as pure numbers, which means that no conversions related to their associated units of measurement are performed.

5.2.1.2 Dollar Commands

In order to automatically generate a filename, or part of it, it is possible to use *dollar commands*. Dollar commands are text variables that represent certain strings and can be entered in the filename field. When a parameterized measurement is started and/or saved (depending on the command), the dollar commands entered are replaced by their corresponding strings according to the following table:

Table 1. Dollar Commands

Description	Command	Format
Current Date	D	20250215
	$D_$	2025_02_15
	d	250215
	$d_$	25_02_15
Current Time	T	163217
	$T_$	16_32_17
	t	1632
	$t_$	16_32
Current Year	Y	2025
	y	25
Generates a Number Index	i	
Applies the current alias/shortcut defined in the Names and Shortcuts dialog under Settings for the first tag	U	
Applies the alias/shortcut defined for sample category in the Names and Shortcuts dialog under Settings	C	
Applies the alias/shortcut defined for third tag in the Names and Shortcuts dialog under Settings	L	
Sample Reference Date	R	20251129
	$R_$	2025_11_29
	r	251129
	$r_$	25_11_29
Sample Reference Time	Z	163217
	$Z_$	16_32_17
	z	1632
	$z_$	16_32
Applies the complete sample description as a string	S	
Applies the name of the parameter set	P	
Applies the barcode number (only possible when using a sample changer with a barcode reader support)	B	
Applies the current week	W	
For multi-measurements only – Creates a loop index in the filename	Mi	

For example, assuming that a measurement is started on 24/05/2025 at 10:45, the dollar commands *d_t* will be replaced by *250524_1045* in the filename.

5.2.2 Counting Geometry

The **Counting geometry** tab contains geometric and chemical information about the sample container and the sample matrix being measured. The figure below shows the appearance of the Counting geometry tab when a parameter set is first created.

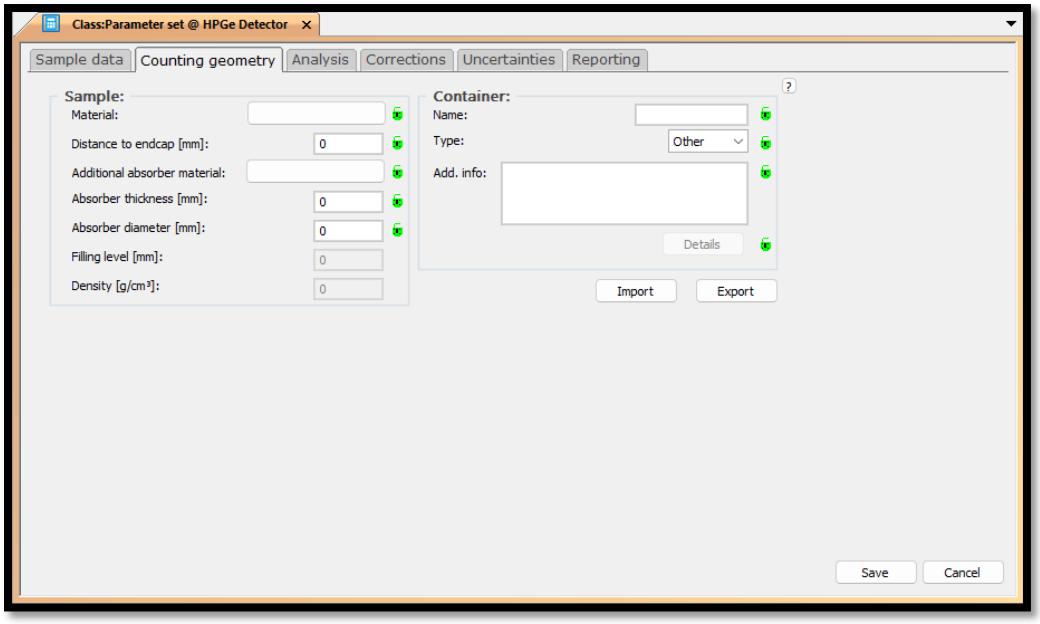


Figure 113. Counting Geometry Tab

The details of the empty container can be defined in the **Container** frame. Usually, the empty containers used in the laboratory are first created in the sample container section of the management panel, as described in Section 3.2.5 Sample Container Editor. To import an already defined container, click on the **Import** button. A list with the same structure of the sample container section appears, from which it is possible to select the desired container. It is also possible to define a new container directly in the parameter set in the same way as the Sample container section and then **Export** it. Once a name is chosen, LVis automatically adds the newly defined container to the management panel.

The **Sample** frame defines the **Material** of the sample, the **Distance to endcap** from the bottom of the container, and optional parameters about an **Additional absorber** if present (its **material**, **thickness** and **diameter**). To select the material of the sample and/or additional absorber, click on the respective field to reveal the list of materials with the same structure of the Material section of the management panel and select the desired material.

The **Filling level** and the **Density** of the sample are automatically calculated by LVis based on the sample mass and the sample volume/filling height entered in the Sample data tab.

The information in the Counting geometry tab is only needed when the tRAYcy corrections are selected, otherwise it is possible to leave the tab empty.

5.2.3 Analysis

The **Analysis** tab contains parameters that must be adjusted for a proper spectrum analysis. In general, these parameters depend on the hardware (e.g., which energy range can be meaningfully used), the sample geometry (e.g., which calibration) and the measuring task (e.g., which library). The descriptions provided in this section are intended as a general overview of the analysis parameters. For a detailed explanation, refer to the GammaVision manual. The figure below shows the appearance of the Analysis tab when a parameter set is first created.

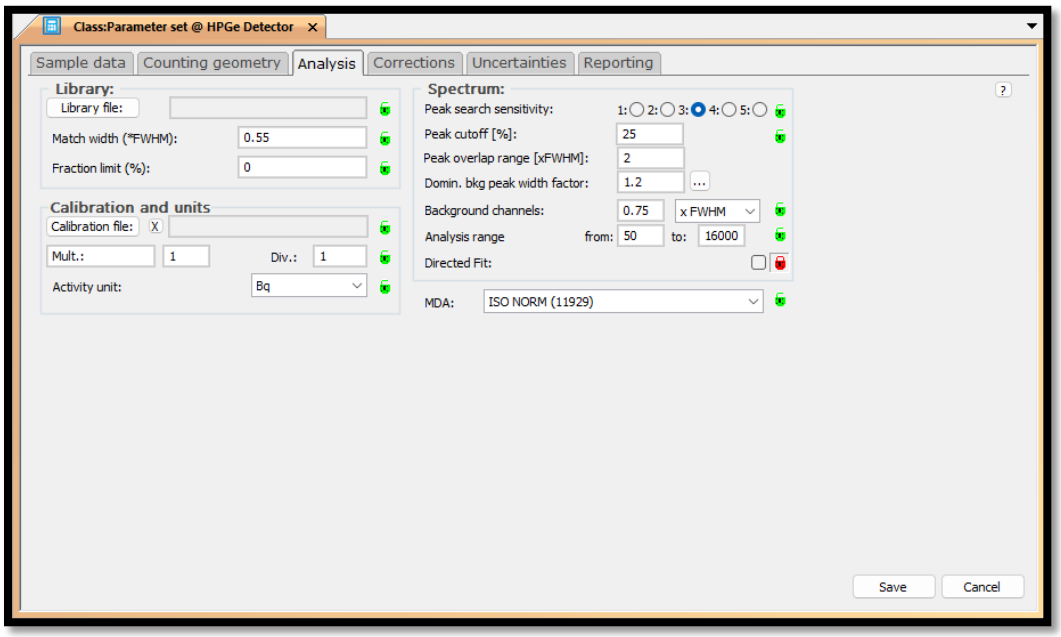


Figure 114. Analysis Tab

The Analysis tab is divided into three frames (**Library**, **Calibration and units,** and **Spectrum**) and a drop-down list for the selection of the **MDA** method.

5.2.3.1 Library

The **Library file** defines which nuclide library is used for the analysis. Libraries are created in the Analysis libraries section of the management panel (see Section 5.2.3.1 Library). To select a library, click on the Library file button. A list with the same structure as the Analysis libraries section appears, from which it is possible to select the desired library.

The **Match width (*FWHM)** sets the maximum amount by which a peak centroid can deviate from the nearest library peak energy and still be associated with that library peak. The value entered is multiplied by the FWHM at the peak energy to get the width used.

Values between 0.4 and 1 are permitted; a match width of 0.5 to 0.6 is typical for gamma spectroscopy with HPGe detectors. If the value is too small, some spectrum peaks will be misidentified due to statistical variation in the centroid; if it is too large, some library peaks will be incorrectly identified.

For example, using Co-60 with a library entry of 1332.51 keV, based on the calibration, FWHM at this energy amounts to 2 keV. This means, for a match width of 0.5, that a found peak with a centroid in the range between 1332.51 +/- 1 keV will still be assigned to this Co-60 line.

The **Fraction limit (%)** is one of the parameters used to determine the presence or absence of a nuclide. The sum of the emission probabilities of the peaks in the spectrum identified with the nuclide is divided by the sum of the emission probabilities of all peaks of the nuclide in the energy range being analyzed. If the result is greater than the fraction limit, the nuclide is marked as being present. To turn off this test, set the limit to zero.

If the value is too high, nuclides may not be found only because one line of the nuclide with low transition probability was not found in the spectrum. A value of 100% means that all lines specified in the library must be found in the spectrum. If the value is too low, one line, even a line with low transition probability compared to other lines of the nuclide, is sufficient to identify the nuclide; a value of 0% means that the test is disabled, that is, one peak (even the one with the lowest transition probability) is sufficient to assume that the nuclide is present.

5.2.3.2 Calibration and Units

The **Calibration file** defines which efficiency calibration is used for the analysis; see Chapter 6 on how to create and store calibrations. To select a calibration, click on the Calibration file button. A list with the same structure as the Calibrations folder for the respective detector appears, from which it is possible to select the desired efficiency calibration.

Mult. (multiplier) and **Div.** (divisor) are additional factors directly contributing to the activity scaling factor calculation. This is a legacy option from the GammaVision analysis; since in LVis the activity scaling factor is defined in the Sample data tab, simply leave a value of 1 for both parameters.

The **Activity unit** defines which unit for the activity is used in the report. The most common units are predefined and can be selected in the drop-down list. If new units are needed, it is possible to add them to the Global Settings (see Section 3.3.1).

5.2.3.3 Spectrum

The **Peak search sensitivity** sets the sensitivity for the peak search used in the analysis. Before a suspected peak is accepted, the magnitude of the second difference must be greater than the weighted error of the channel counts. The Peak search sensitivity is a multiplicative factor used in error weighting.

The sensitivity can be set at any integer value from 1 to 5, with 1 the most sensitive (that is, “1" finds the most peaks). A value of 1 will find small peaks but will also “find” many false peaks. A value of 5 will locate all the large peaks but might miss some of the smaller peaks. In general, a sensitivity of 2 or 3 is sufficient and delivers the most meaningful results.

The **Peak cutoff [%]** defines the maximum 1-sigma counting uncertainty that will be accepted for an identified peak in order to treat this peak as valid during the analysis. If the uncertainty of a peak found in the spectrum is above the entered value, then the peak will not be used in the activity calculation. However, it will be listed in the report as a peak. The Peak cutoff prevents incorporation of peaks with too high uncertainty into the activity calculation. In general, a value between 10% and 40% is reasonable.

During the analysis, peaks within the **Peak overlap range [xFWHM]** plus peak background points are deconvoluted. This value must include a decimal point; the minimum value is 1.0.

The **Domin. bkg peak width factor** defines the FWHM multiplier that dictates the peak integration range (i.e., 1.2 * FWHM) when background is dominant. The fixed width factor is used to determine peak background when the peak is not part of a multiplet. This value must include a decimal point.

It is possible to select three different methods to calculate the **Background channels** for a peak:

- With the **Auto** method, the background is automatically calculated as a 5-, 3-, or 1-point average, depending on which value best approximates the spectrum data.

- With the **points** method, the entered number of points are used for the average, starting from a value of 1 point. In general, more points provide a better approximation of peak background; however, a very large number of background points could result in the deconvolution of nearby peaks that may be fitted more accurately as singlets.

- With the **x FWHM** method, the number of background points is calculated by multiplying the calibration FWHM (in channels) at the specified energy by the entered decimal value and rounding up to the next highest integer value. This methodology can provide a more robust peak background determination than the static points average by scaling the number of background points to the expected peak width at low or high energies and across varying ADC conversion gains. A value of 1-1.2 x FWHM should give reasonable results for most applications.

The **Analysis range** (in channels) defines the starting and the ending points in the spectrum of the analysis. This option is commonly used to exclude the border regions of the spectrum, where no significant analysis data can be found. The analysis range should be large enough to encompass all the gamma peaks required for the analysis. If the analysis range is too narrow, the correction between different peaks of a nuclide cannot be verified if a part of these lines is not within the range to be analyzed.

The **Directed Fit** option allows for negative peak areas in low-level spectra. This is a specialized option when negative activity values are needed; thus, it is usually not used unless required by specific regulations.

In addition to the analysis settings shown in this tab, there are several other secondary parameters that can be adjusted. Since these additional parameters are typically not changed, and should be modified only after careful consideration, they are set in a special text file called *b30winds.ini*, that is located inside the *LVisDatabaseLocation\Config* folder. The content of this file can be seen by clicking on the three dots button above the background channels drop-down list and can be edited using any text editor directly from the Config folder. Refer to the GammaVision manual for a detailed description of the b30winds.ini file.

5.2.3.4 MDA

Several **MDA** calculation methods are available in the drop-down list. Refer to the GammaVision manual for the respective formulas.

5.2.4 Corrections

The **Corrections** tab contains additional analysis options. The parameters in the Corrections tab are all optional, which means that none of them is required by LVis to perform an analysis. The figure below shows the appearance of the Corrections tab when a parameter set is first created.

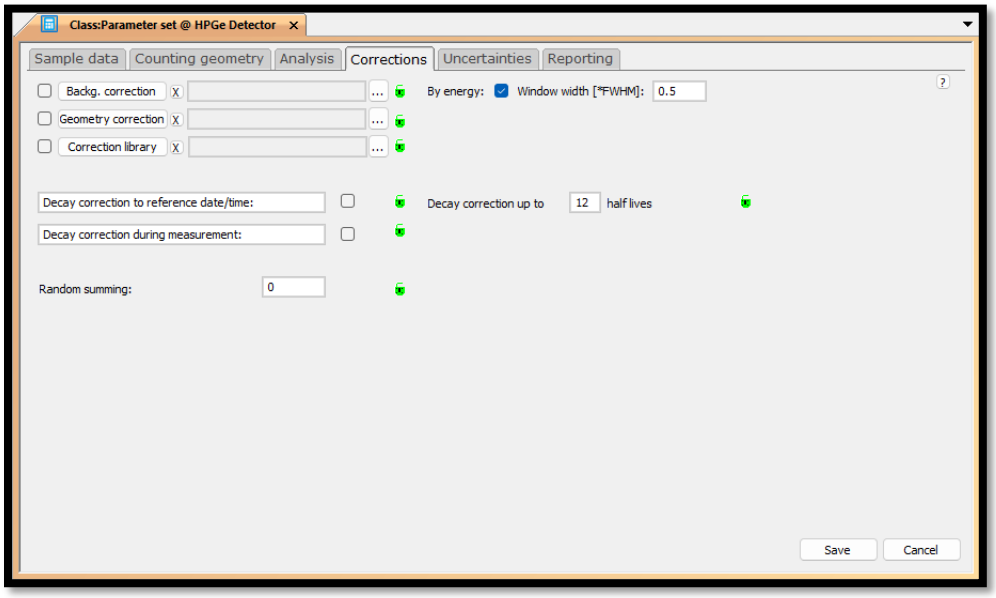


Figure 115. Corrections Tab

5.2.4.1 Peaked Background Correction

The Peaked Background Correction (PBC) is used to correct for the presence of peaks in the background spectrum that also occurs in the sample. If the peak is not of interest in the analysis results, there is no need to make this correction. The values in the **.PBC** file are the counts per second at each library energy. These count rates are multiplied by the sample live time to calculate background counts, and the resulting background counts are added to the respective peak background. *Note that this background subtraction may raise the peak uncertainty above the peak cutoff such that a peak is no longer considered as identified.*

Background files can be created from the analysis results of any measurement by clicking on the Create PBC button in the Analysis results tab of a measurement file (see Section 7.4). The background file is automatically saved in the PBC folder of the detector.

To enable the background correction, check the corresponding box and select a background file.

To select a background file, click on the **Backg. correction** button. A list of the available files in the PCB folder appears, from which it is possible to select the desired file. If no background file is available, a standard Windows file dialog opens, allowing users to select the desired file from anywhere in the Windows file system. Once selected, it is possible to view and edit the content of the background file by clicking on the three dots button next to it.

The **By energy** option defines the method of background subtraction: by nuclide or by energy. It is recommended to always use the By energy method.

Background subtraction by nuclide

To use the background subtraction by nuclide, leave the By energy box unchecked. In this case, the background correction is applied to identified peaks that have matching nuclide names in the analysis library and the background file, and peak energy within the **Window width [*FWHM].**

The background window width parameter works in the same way as the library match width in the Analysis tab. For each peak, the value entered is multiplied by the FWHM at the peak energy to get the energy range used. A background peak is considered a matching peak if the background peak energy is within this energy range.

Background subtraction by energy

To use the background subtraction by energy, check the By energy box. Background correction is applied to spectrum peaks as described above regardless of whether or not the spectrum or background peak is associated with a matching nuclide name. Multiple background peaks, including those associated with different nuclides in the background file, can be applied to the same spectrum peak if they are within the specified energy range. If a background peak is within the match width of more than one spectrum peak, then it will only be applied to the closest peak.

5.2.4.2 Geometry Correction

A **Geometry correction** is needed when the sample geometry (i.e., container shape/dimensions, sample material/density/mass/volume/filling height, and additional absorber presence/dimensions) is different from the reference source geometry used for the efficiency calibration selected in the Analysis tab. The activities calculated using the selected efficiency calibration are corrected by the energy-dependent factors describing the efficiency difference between the sample and the calibration geometries.

To enable the geometry correction, simply check the corresponding box leaving the field to the right empty; if the field is not empty, click on the **x** button. In this way, the geometry correction will be automatically calculated by tRAYcy and applied to the activity results during the analysis process (see Section 7.8.1).

The automatic calculation requires that all the necessary information about the sample and calibration geometries (i.e., sample sizes in the Sample data tab and parameters in the Counting geometry tab, as well as Geometry properties for the reference source used for efficiency calibration) are correctly specified.

It is still possible to use the free software EFFTRAN instead of tRAYcy to calculate the automatic geometry correction. EFFTRAN is enabled in the Global Settings (see Section 7.8.2 Using (M)EFFTRAN and Section 3.3 The Global LVis Settings).

It is also possible to use a GammaVision geometry correction file (**.GEO**) instead of the automatic calculation. To select a geometry correction file, click on the Geometry correction button. A list of the available files in the *GEO* folder for the detector appears, from which it is possible to select the desired file. If no geometry correction file is available, a standard Windows file dialog opens, allowing users to select the desired file from anywhere in the Windows file system. Once selected, it is possible to view and edit the content of the geometry correction file by clicking on the three dots button next to it. Note that the box still needs to be checked to enable the correction, even when a geometry correction file is selected. For more information about the geometry correction file, refer to the GammaVision manual.

5.2.4.3 Correction Library

A **Correction library** is needed to account for true coincidence summing (TCS). The branching ratio of each peak in the analysis library is multiplied by a factor describing the virtual gain or loss of counts in that peak due to the summing of gamma rays from the same decay.

To enable the TCS correction, simply check the corresponding box leaving the field to the right empty; if the field is not empty, click on the **x** button. In this way, the TCS correction will be automatically calculated by tRAYcy and applied to the analysis library during the analysis process (see Section 7.8.1).

The automatic calculation requires that all the necessary information about the sample (i.e., sample sizes in the Sample data tab and parameters in the Counting geometry tab) are correctly specified.

It is still possible to use the free software EFFTRAN instead of tRAYcy to calculate the automatic TCS correction. EFFTRAN is enabled in the Global Settings (see Section 7.8.2 Using (M)EFFTRAN and Section 3.3 The Global LVis Settings).

5.2.4.4 Decay Corrections

There are three types of decay corrections that can be used. The corrections to reference date/time and during measurement can always be turned on or off in the Corrections tab, irrespective of the parameter set type. The correction during collection is always active if the collective sample option is selected in the general settings window, otherwise it is not applied.

Decay correction to reference date/time

The **Decay correction to reference date/time** projects the activity measured at the time of count back to the reference date/time entered in the Sample data tab. This is useful when there is a long time relative to the half-life of a nuclide, between the sample collection time and the sample count time. To enable this correction, simply check the corresponding box. It is determined as follows:

$$DRD = e^{\left(\frac{(ln2)\Delta t}{t_{1/2}}\right)}$$

Where:
Δt = elapsed time between the reference date/time and the measurement start date/time
$t_{1/2}$ = half-life of the nuclide

If Δt is greater than the entered value of **Decay correction up to X half-lives**, this decay correction will not be applied and accordingly documented in the report. Typically, a limit of twelve half-lives is used, which corresponds to a decay factor of above 4000.

Decay correction during measurement

The **Decay correction during measurement** is used to correct the activity of a nuclide whose half-life is short compared to the spectrum real time. To enable this correction, simply check the corresponding box; it is determined as follows:

$$DDM = \frac{(ln\ 2) * \frac{RT}{t_{1/2}}}{1 - e^{-\left((ln\ 2) * \frac{RT}{t_{1/2}}\right)}}$$

Where:
RT = real time of the measurement
$t_{1/2}$ = half-life of the nuclide

This can be viewed as scaling up the activity measured to the value of the activity at the start of the measurement. The correction goes to 1 (no change) as the acquisition time becomes much smaller than the half-life.

Decay correction during collection

The decay correction during collection is useful if the sample was collected over an extended time, and the half-life of a nuclide is short compared to the collection time. This correction will account for the buildup of the nuclide activity in the sample and its subsequent decay during the collection time, which cannot be seen in the spectrum because it happens before the measurement. To enable this correction, select the Collective sample option in the general settings window of the parameter set. It is determined as follows:

$$DDM = \frac{(ln\ 2) * \frac{ET}{t_{1/2}}}{1 - e^{-\left((ln\ 2) * \frac{ET}{t_{1/2}}\right)}}$$

Where:
ET = elapsed time between the start and end of the sample collection date/time as entered in the Sample data tab
$t_{1/2}$ = half-life of the nuclide

This can be viewed as scaling the activity as if all of it would have been collected on the sample at the end of the sample collection. Thus, if the decay correction to reference date/time is enabled as well, the reference date/time should be entered equal to end of sample collection date/time.

Random Summing Correction
If more than one gamma-ray photon signal is absorbed by the detector during a pulse sampling cycle, the sum of the energies of the two (or more) is recorded in the spectrum. Since the two gamma rays are not related in any way, this is random coincidence. Random coincidence sum peaks can be formed at double the energy of the primary peaks. Any full energy photon that is summed with another pulse is not recorded in the single photon peak and represents a loss of counts or efficiency. This loss is count rate dependent.

The random summing correction factor is:

$$RSF = \frac{1}{1 - \frac{\sum CT}{F * LT}}$$

Where:
RSF = random summing factor (multiplier)
Ct = contents of all channels
F = user-entered slope of the correction curve
LT = live time

This value is set to 1.0 if it is calculated at less than or equal to zero. A more detailed description of the determination of the correction curve can be found in the GammaVision manual. The slope *F*, determined experimentally and multiplied by -1, is entered into the **Random Summing** field. It is important to note that the random summing correction is necessary only if the counting rates between the calibration measurement and the sample measurement are significantly different.

5.2.5 Uncertainties

The **Uncertainties** tab contains information about user-defined uncertainties and confidence levels. The figure below shows the appearance of the Uncertainties tab when a parameter set is first created.

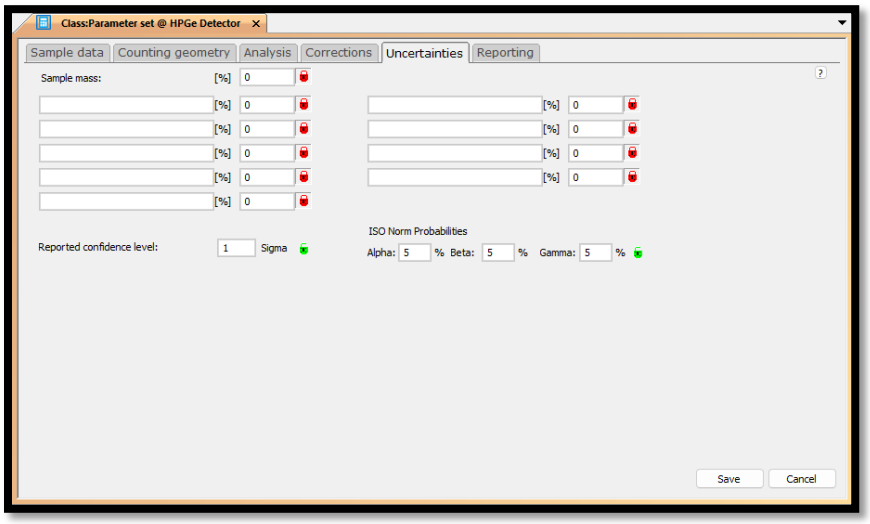


Figure 116. Uncertainties Tab

It is possible to enter up to 10 additional uncertainties (in percentage) that will be considered for the total uncertainty estimate. The label for the first uncertainty (shown in the figure as *Sample mass*) is by default the same as the label of the upper sample size entered in the Sample data tab. For the other nine uncertainties, it is possible to enter any needed text label (left field) and value (right field).

The analysis engines perform all calculations at a 1-sigma level. All the uncertainties on the report are then reported based on the desired **Reported confidence level**.

The **ISO Norm Probabilities** define the values used for the three probabilities in the *ISO NORM (11929)* MDA method that can be selected in the Analysis tab. Refer to the corresponding ISO standard or the GammaVision manual for the explanation of these confidence levels.

5.2.6 Reporting

The **Reporting** tab contains options related to the analysis process and the final measurement report. The figure below shows the appearance of the Reporting tab when a parameter set is first created.

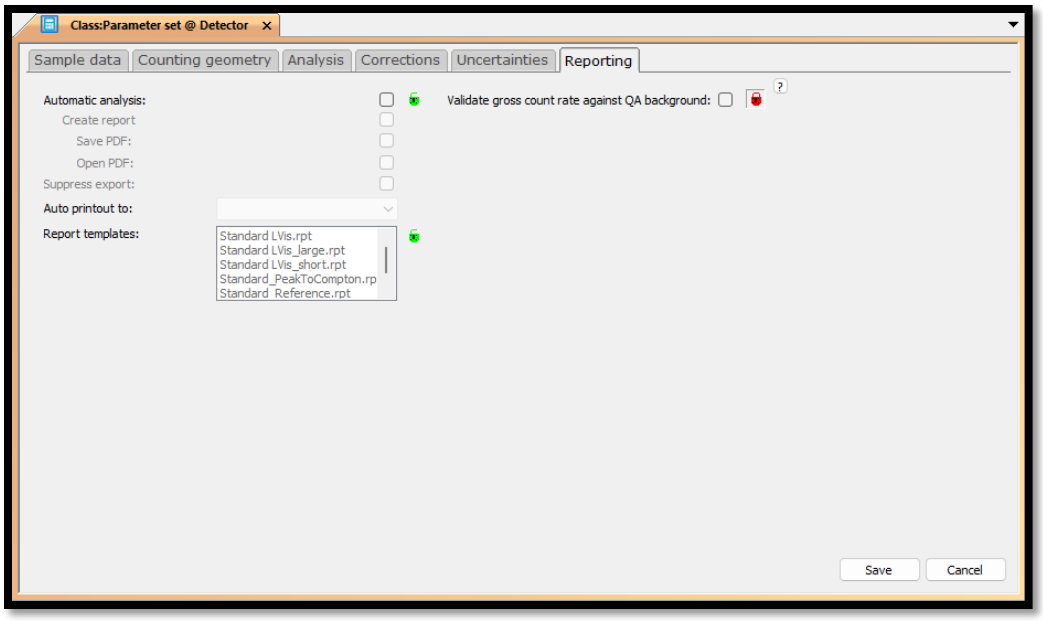


Figure 117. Reporting Tab

When the **Automatic analysis** option is selected, LVis automatically performs the analysis of the spectrum at the end of a measurement and saves the corresponding file without any user input. Of course, in order for the analysis to be meaningful, every parameter must be correctly set before starting the measurement. If this option is not selected, all the other options below remain disabled and the manual analysis and reporting processes are necessary.

It is also possible to automatically create the analysis report after the automatic analysis process is finished. Once the **Create report** option is selected, the **Report template** list becomes available, where the desired report template can be selected. It is possible to select multiple templates and all the corresponding reports will be created. If this option is not selected, all the other options below remain disabled and the manual reporting process is necessary.

By default, once a report is created, it is attached to the measurement file but a corresponding pdf file is not automatically saved to disk. If instead users wish for LVis to automatically save the pdf file to disk with the same name and in the same folder of the measurement file, simply check the **Save PDF** box. If multiple report templates are selected from the list, a corresponding number of pdf files will be saved. The name of the template will be attached to the name of the report to distinguish among the different pdf files.

It is also possible for LVis to automatically open the pdf report(s) once created, using the default pdf viewer of the computer. Check the **Open PDF** box for this. This option is independent from the Save PDF option. If a pdf file is saved in the same folder of the measurement file, LVis opens this pdf file. If a pdf file is not saved, LVis opens a temporary pdf file that is then deleted once closed. Note that, in the second case, only the temporary pdf file is deleted. The report remains attached to the measurement file, thus available to be saved manually.

If LVis is configured to exchange data with a LIMS, by default the needed files are generated in the export directory once the report is created. If it is not desired to exchange the analysis data obtained with this parameter set with the LIMS in use, simply select the **Suppress export** option.

If a physical printer is connected to the computer, it is possible for LVis to automatically print a paper copy of the report(s) once created; simply select the desired printer in the **Auto printout to** drop-down list.

In the LVis Simple Mode, LVis offers a simple contamination check by counting an empty bottle container and comparing the gross count rate of the acquisition with the nominal gross count rate for the QA background checks and validating it against the respective QA background limits. This feature is activated by ticking the box for **Validate gross count rate against QA background** on the "Reporting" tab. In case the gross count rate from the contamination check measurement is within the alarm range a message will be displayed that the container is not contaminated. In case the gross count rate is higher than the nominal count rate plus the alarm level then a message will pop up warning about contamination. The individual messages appearing on screen in the LVis Simple Mode as a result of a contamination check measurement can be defined in the Global Settings of LVis.

5.3 OPERATING ON PARAMETER SETS

There are several options in the configuration tree that allow users to modify, copy and paste, save and load, and remove parameter sets. These options are available in the context menus of parameter sets, classes, and detectors. To access the context menus, right-click on the desired element in the configuration tree. The options related to parameter sets in the class menu are the same as those in the detector menu (except for the sort one described later). the only difference between the detector and the class menu options is that, when using the class entries, the name of the class will already be entered in the general settings window. The figures below show the parameter set menu (left) and the detector menu (right), with the relevant entries inscribed in the red rectangles.

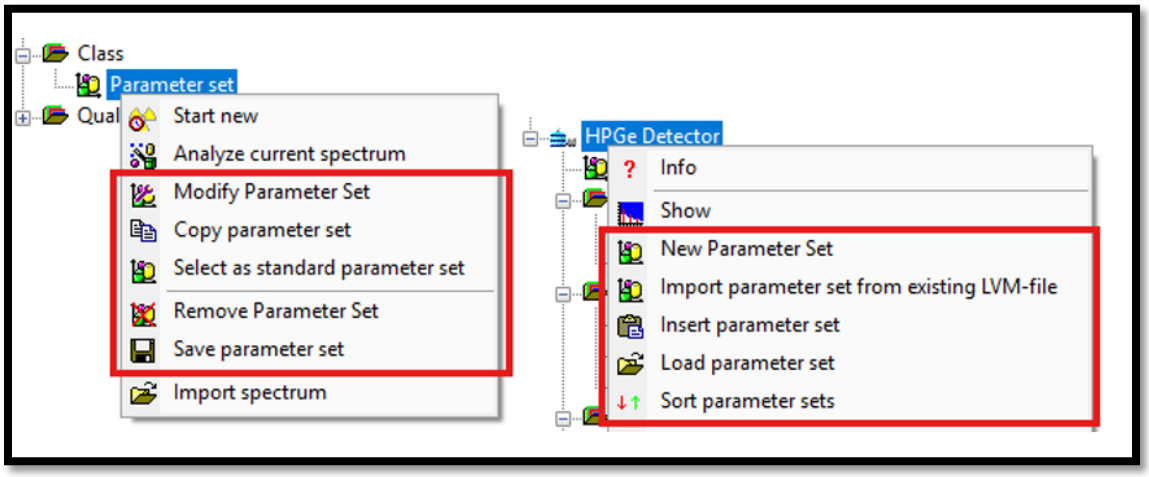


Figure 118. Parameter Set and Detector Menus

To edit any setting of a parameter set, including the ones in the general setting window, select **Modify Parameter Set** in the desired parameter set menu. To save the changes, simply click on the **Save** button in the bottom right part of the parameter set.

To move a parameter set from one class to another within the same detector, select **Modify Parameter Set**, go to the general settings window, then insert the desired class name in the respective field. If the class does not already exist, a new one will be automatically created.

It is not possible to directly rename a parameter set. The easiest way to do this is to copy the parameter set, change the name in the general settings window when inserting the parameter set in the same class, and then remove the old parameter set as explained below. Since the default path to save parameterized measurements includes both the class and the parameter set names (see Section 5.3), modifying either one will result in a new folder being created.

To create a copy of a parameter set, either within the same detector or associated with another one, select **Copy parameter set** in the desired parameter set menu. Then open the detector or class menu where it is desired to paste the parameter set and select **Insert parameter set** (this entry is available only when a parameter set has been previously copied). The general settings window appears, and clicking **OK** will add an exact copy of the parameter set below the selected detector and/or class. It will then be possible to modify the new parameter set as needed. It is important to note that, if a parameter set is copied from one detector to another, files that are detector-specific (like the calibration or the background file) must be modified to obtain meaningful analysis results.

To move a parameter set from one computer running LVis to another, select **Save parameter set** in the desired parameter set menu. A standard Windows file dialog will open, allowing users to save the parameter set to an **.LVP** file (the default directory is *LVisDatabaseLocation\Parameter Sets*, but it is possible to save the file wherever needed). Once the file has been moved, on the other computer open the detector or class menu where it is desired to load the parameter set and select **Load parameter set**. The general settings window appears, and clicking **OK** will add an exact copy of the parameter set below the selected detector and/or class. It will then be possible to modify the new parameter set as needed.

It is also possible to create a parameter set using the parameters from a measurement file (**.LVM**). Open the detector or class menu where it is desired to create the parameter set and select **Import parameter set from existing LVM-file**, then select the desired file in the standard Windows file dialog. The general settings window appears, and clicking **OK** will add a parameter set below the selected detector and/or class with exactly the same parameters as the measurement. It will then be possible to modify the new parameter set as needed.

To remove a parameter set from the configuration tree, select **Remove Parameter Set** in the desired parameter set menu, and then confirm in the subsequent message box. It is important to note that the action is not reversable. If a parameter set is removed by mistake, the easiest way to recreate it is to import the parameters from the last measurement file analyzed with the removed parameter set.

Selecting **Sort parameter sets** from the detector menu will sort the associated parameter sets by numerical and alphabetical order (numbers are sorted before letters). Pressing the left shift key while selecting Sort parameter sets will sort the parameter sets in the opposite way.

6. CALIBRATIONS

To operate the detector system for gamma spectrometry, it must be calibrated. Three calibration types are distinguished: energy calibration, full width at half maximum (FWHM) calibration, and efficiency calibration.

- **Energy calibration** – The energy calibration describes the channel to energy relationship of the multi-channel analyzer (MCA). It gives the energy in keV as a function of the channel number. It is usually given by a quadratic/ second order polynomial. This is required for the identification of peaks in the spectrum.

- **FWHM calibration** – The FWHM calibration describes the resolution as a function of the channel number. The resolution is given in channels, and it is a function of the channel number. Like the energy calibration, a second order polynomial is used to describe the channel-FWHM relationship. It is needed for peak fitting and spectrometer QA. The FWHM calibration is always performed in connection with an energy calibration.

- **Efficiency calibration** – The efficiency calibration describes the response of the detector system to photon radiation across the energy range. It relates the probability for detecting the full energy of a photon to its initial energy. Due to the shape of the response, higher order polynomials and composite functions are used to describe the relationship.

After these calibrations are performed they are stored in **.LVM** files. These can be selected and loaded for analyses (see Section 5.2.3 Analysis). In LVis, GammaVision calibrations (.**CLB** files) or any calibrated LVis measurement file (**.LVM** files) can be used as a source of calibration. In each LVis measurement, the calibration is presented in its own “Calibration/Library” tab (see Section 6.5 Changing Calibrations in LVM Files).

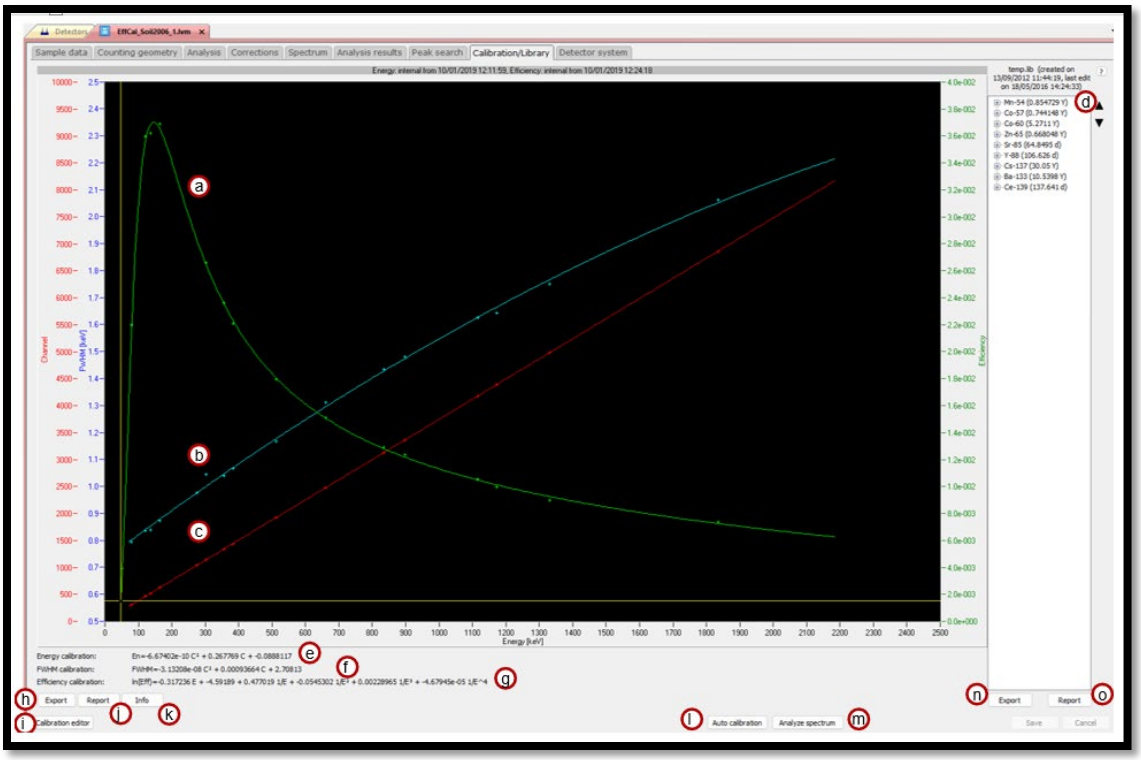


Figure 119. Calibration/Library Tab of an LVis Measurement

a. **Efficiency calibration**: The green line shows a plot of the efficiency calibration function

b. **FWHM calibration**: The blue line shows a plot of the FWHM calibration function

c. **Energy calibration**: The red line shows a plot of the energy calibration function

d. **Library table**: Displays the library used for calibration.

e. **Energy calibration function**: Shows the polynomial and its parameters

f. **FWHM calibration function**: Shows the polynomial and its parameters

g. **Efficiency calibration function**: Shows the function and its parameters

h. **Export**: Press to export the calibration to a .CLB file

i. **Calibration editor**: Press to open the calibration editor

j. **Report**: Prints a calibration report

k. **Info**: Show information about the source that was used for the calibration

l. **Auto calibration**: Press to perform an automatic calibration

m. **Analyze spectrum**: Press to analyze the spectrum with the present settings

n. **Export**: Exports the library to a .LIB file

o. **Import**: Import another library to a .LIB file

6.1 SETTING UP CALIBRATION PARAMETERS

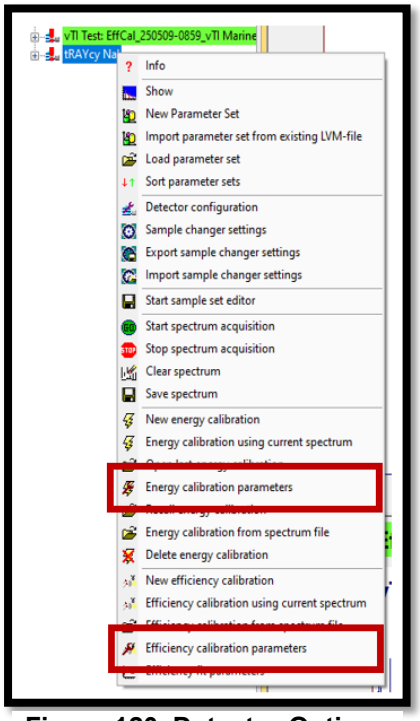


Figure 120. Detector Options

In contrast to other counting routines/parameter sets (see Section 5.2.3 Analysis), calibrations routines are directly related to a detector. To modify the parameter sets, right-click the detector in the configurations tree and select “Energy calibration parameters” or “Efficiency calibration parameters”. The setup of each calibration parameter-set is analogous to regular parameter sets for measurement routines with a few differences:

- Instead of defining sample volume and mass a reference source is selected. This reference source should be the source that is used for calibration. The “Counting geometry” tab is filled automatically from the info in the selected reference source.
- No analysis library or calibration can be selected in the “Analysis” Tab. The analysis library is supplied by the selected reference source.
- For efficiency calibrations “Correction library” and “Decay correction since sample collection” should always be switched on in the “Corrections” tab.

6.2 DETECTOR CALIBRATION

In principle, energy and FWHM calibration (channel-energy relation and channel-resolution relation) and efficiency calibration (energy - efficiency relation) are performed in two separate steps. First, the detector is calibrated for energy and FWHM in one measurement and then for efficiency in a subsequent measurement. While energy and FWHM calibration are universal for all measurements performed with the detector, the efficiency calibration is unique for a detector <-> sample configuration. Therefore, energy and FWHM calibrations are directly connected to a detector, while efficiency calibrations are connected to individual parameter sets. Despite their differences, the procedure of performing the respective calibrations is similar and there is no difference made in the following.

To start the calibration, select the desired calibration type “New energy calibration” or “New efficiency calibration”, from the context menu of the detector (Figure 120). Put the selected reference source on the detector and start the measurement. When the measurement has finished, select **Analyze** from the detector context menu. This will open the calibration measurement.

In LVis, calibrations can be performed either **automatically** or **manually**. Both techniques will be outlined in the following chapters. The designated way to calibrate a detector system is **automatic** calibration.

6.2.1 Automatic Calibration

Automatic calibrations are based on the selected *reference source*, which contains all necessary nuclide (library), activity (certificate file), and geometry information. To perform the automatic calibration, press the **Auto calibration** button (I in Figure 119). The calibration runs automatically, searches for peaks, relates peaks to an entry of a photon line in the library and fits the calibration

function to the analyzed data. The calibration results are shown on the “Calibration” tab as shown in Figure 121. To save the results, press the **Save** button. If the measurement was an energy calibration, the calibration can be connected to the detector. If the measurement was an efficiency calibration, the parameter sets that should use this calibration can be selected in a pop-up dialog.

In some cases, the results of the automatic calibration need to be post-processed. To do so, the techniques described in the *Manual calibration* section can be used.

6.2.2 Manual Calibration

The designated way to perform a manual calibration is by using the peak editor (see Section 10 The LVis Peak Editor). It provides an interface to locate, fit, and identify peaks for calibration. To start the peak editor, open the calibration editor by clicking button **i** in Figure 119 and select the peak editor, **g** in Figure 121.

In the peak editor (for details see Section 10 The LVis Peak Editor), place individual peaks using the **New peak** button, or run a peak search using the **Peak search** button. Finally, identify the origin of each peak using the **Nuclide selection** button in the “Peak shape” tab. Hit **Close and apply changes** to transfer the results to the calibration table.

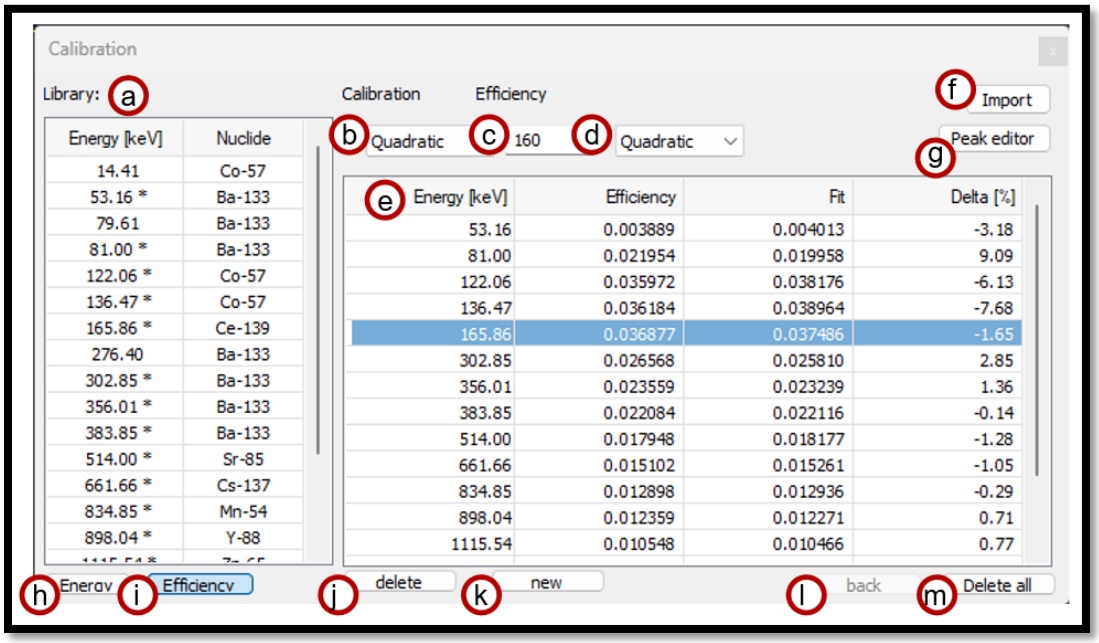


Figure 121. Calibration Editor

a. **Library**: A list of all emissions in the library. Click an entry to move to the expected position in the spectrum

b. **Calibration function**: First part of the efficiency calibration function. The selected function is fitted to datapoints until reaching the value in Section c.

c. **Calibration function split**: Enter energy in keV. Points below this energy are fitted with the function selected in Section b. Points above this energy are fitted with the function set in Section d.

d. **Calibration function**: Second part of the efficiency calibration function. The selected function is fitted to data points above the value in Section c.

e. **Calibration table**: List the values used for calibration. Click and entry to move the cursor to the position. Double click an entry to manually edit it.

f. **Import**: Click to import values from another calibration file, **.LVM**, **.CLB** or **.EFT** file.

g. **Peak editor**: Opens the Peak Editor. See Section 10 The LVis Peak Editor for details.

h. **Energy**: Switch to energy calibration table.

i. **Efficiency**: Switch to efficiency calibration table.

j. **Delete**: Use to delete entries from the table.

k. **New**: Add a new line to the calibration table. When the cursor is placed inside the spectrum, the selected position is added.

l. **Back**: Undo the last action.

m. **Delete all**: Deletes all entries in the calibration table.

NOTE: If the wrong energy calibration has been assigned to a detector by mistake, it can be changed. Delete the "wrong" calibration by clicking on **Delete energy calibration** in the detector context menu.

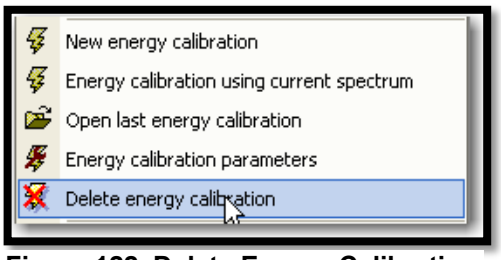


Figure 122. Delete Energy Calibration

6.3 CREATING AN ENERGY CALIBRATION

The default way to create an energy calibration for a detector is to analyze a spectrum with the energy calibration routine specified in the context menu of the detector. This can either be done by selecting **New energy calibration** from the context menu of a detector (starts a new parameterized energy calibration measurement) or by selecting **Energy calibration based on current measurement,** if an energy calibration spectrum has already been recorded and is in the live spectrum view of the detector. It is also possible to use an existing spectrum file by selecting **Energy calibration from spectrum file**.

When a detector is not energy calibrated, the x-axis will be displayed in channels, and the energy calibration table doesn't contain any channel-energy pairs.

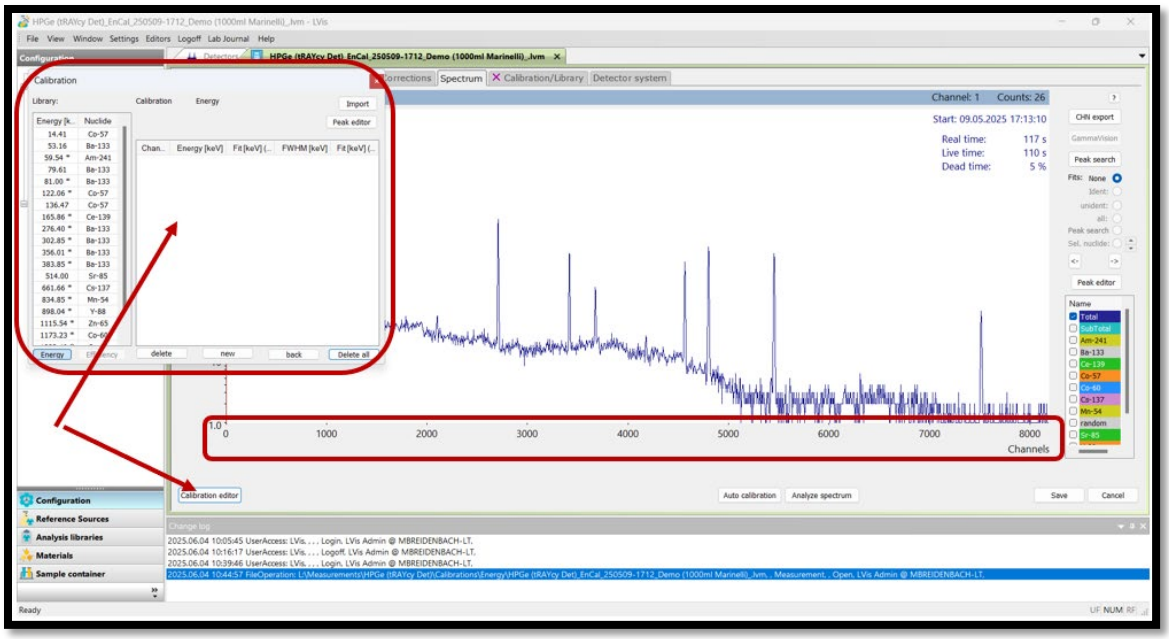


Figure 123. Empty Energy Calibration Table Example

When **Auto calibration** is clicked, LVis will try to find the peaks specified in the reference source, and then accordingly calibrate the spectrum.

IMPORTANT The nuclide library (Section 3.2.3) used for creating the reference source should be absolutely unique. It should *only* contain nuclides specified in the corresponding certificate. If energies are present in the reference source which cannot be found in the spectra (e.g., due to the short half-life of the corresponding nuclide), problems may occur during automatic calibration.

The “Calibration editor” will show the results in the energy table.

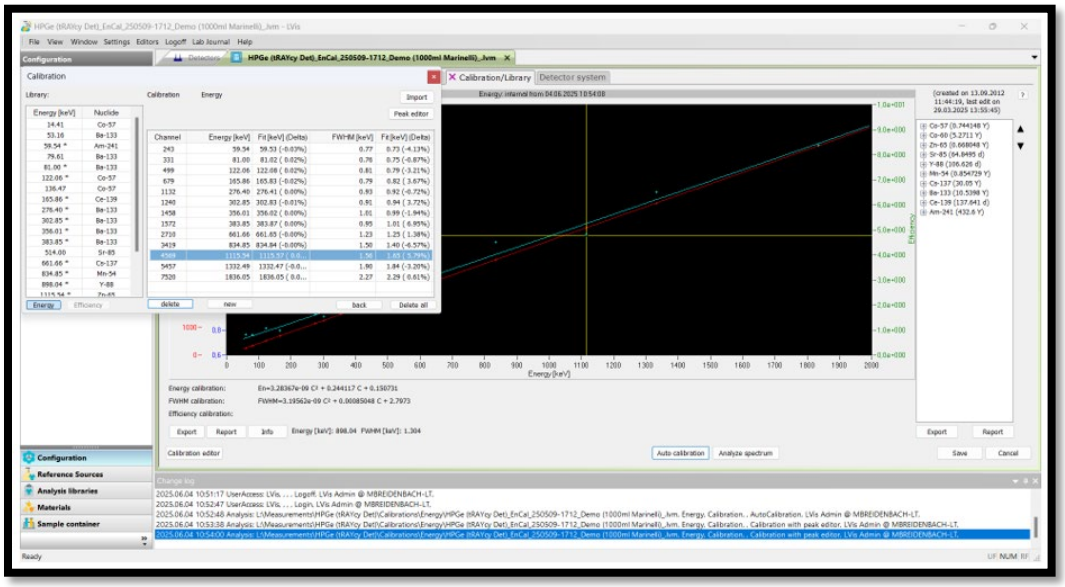


Figure 124. Calibration Editor with Energy Table

Corresponding nodes and fit results of the automatic energy calibration can now be found and, if necessary, edited in the calibration editor (simply by clicking on the respective entry in the energy calibration table). All identified peaks used for calibration from the reference source are marked with an asterisk (*) in the left library table of the calibration editor. Note that double clicking on an entry in the library table will display to the respective peak in the spectrum view.

In case the automatic energy calibration missed peaks or fitted peaks unreasonably, one can use the “Peak editor” to manually fit peaks, assign the fits to nuclides and respective energies and add these to the energy calibration table. To do this open the “Peak editor” from the “Calibration editor”, then add the “New peak” and fit it. Then select a nuclide and apply the changes and update the energy table when being asked to do so.

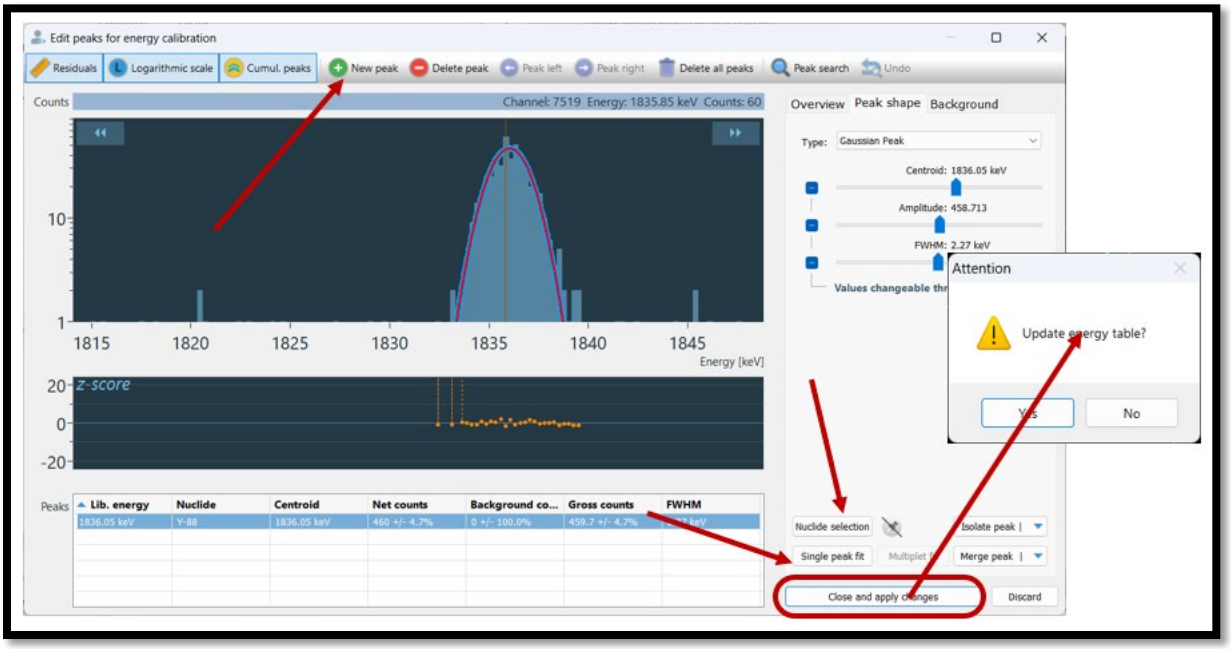


Figure 125. Updating an Energy Calibration

When the energy calibration LVM is saved (or in case “Approval” is activated, when the energy calibration LVM is approved), LVis will ask whether to assign this energy calibration to the detector.

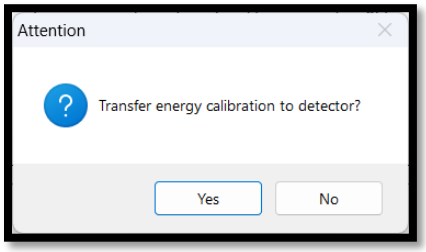


Figure 126. Transfer Energy to Calibration Confirmation

This will ensure that each new spectrum from the respective detector will automatically be using the energy calibration.

Users can always review the measurement corresponding to the currently active energy calibration of a detector by selecting **Open last energy calibration** in the context menu of the detector.

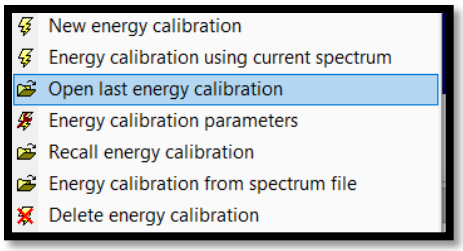


Figure 127. Open Last Energy Calibration

If it is desired to delete the internally stored energy calibration, then select **Delete energy calibration** in the context menu.

6.4 CREATING AN EFFICIENCY CALIBRATION

Efficiency calibrations are not specifically created for detectors, but for parameter sets, as they depend on the sample geometry. Consequently, efficiency calibrations are not directly assigned to a detector but to counting routines (parameter sets) configured for a detector.

To create an efficiency calibration, select **New efficiency calibration** from the detector's context menu. This will guide LVis users through the acquisition of the source spectrum and calibration using the respective efficiency calibration parameter set.

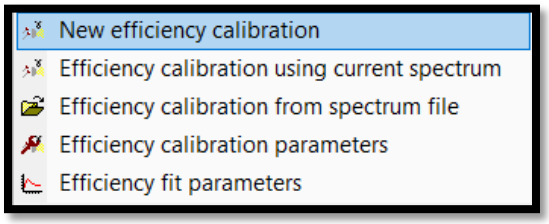


Figure 128. New Efficiency Calibration Selection

It is also possible to use existing spectrum files with **Efficiency calibration from spectrum file** or spectral data in the counting electronics with **Efficiency calibration based on current measurement** for the creation of new efficiency calibration LVM files.

LVis offers different fit functions for the creation of an optimum efficiency calibration (e.g., polynomial, square-square, linear, etc.; a detailed description can be found in the GammaVision manual). Fit functions are usually detector-specific (e.g., n-type detector – square/square, p-type detector – polynomial). Thus, it is possible to specify the default fit function for a detector by selecting **Efficiency fit parameters** in the context menu of the detector.

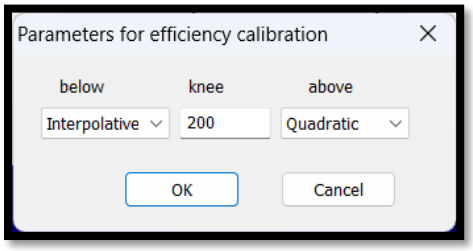


Figure 129. Parameters for Efficiency Calibration

The fit functions specified here are automatically used for efficiency calibrations executed per calibration parameter set.

Note that it is possible to change the fit function afterwards in the “Calibration editor” at any time.

If the detector is already energy-calibrated, then respective nodes and fit information are displayed on the calibration table. Clicking **Auto calibration** will make LVis analyze the spectrum, fit the peaks, and calculate the respective detection efficiencies.

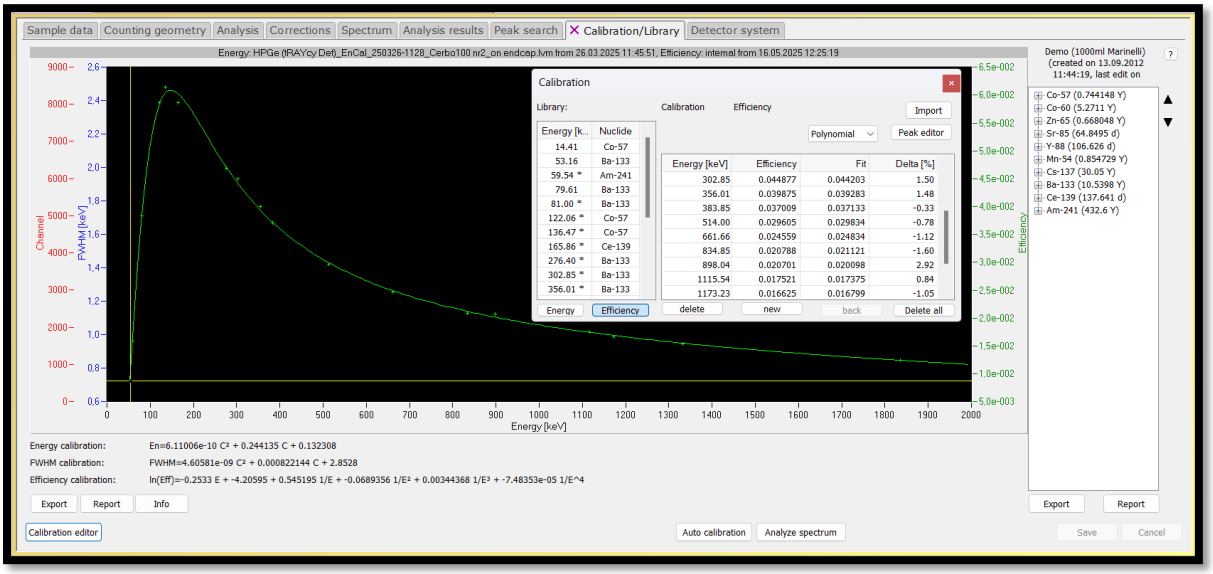


Figure 130. Calibration Editor with Efficiency Table

If no energy calibration exists, clicking on **Auto calibration** first creates a new energy calibration. Then by clicking **Auto calibration** a second time, the actual efficiency calibration is performed.

After the calibration is completed, the calibration results are displayed in the respective tab. The **Calibration editor** contains energy/FWHM calibration entries as well as efficiency calibration entries and it is possible to toggle between the two by clicking on the respective buttons. When the **Calibration editor** is open, only the graphs of the calibration selected in the calibration table are displayed in the calibration tab.

Corresponding nodes and fit results of the efficiency and energy calibration can be found below the calibration fit display and, if necessary, edited in the calibration table (simply by clicking on the respective entry in the calibration table). All identified peaks used for calibration from the reference source are marked with an asterisk (*) in the left library table of the calibration editor. Note that double clicking on an entry in the library table will display the respective peak in the spectrum view.

In case the automatic efficiency calibration missed peaks or fitted peaks unreasonably, the “Peak editor” can be used to manually fit peaks, assign the fits to nuclides and respective energies and add these to efficiency calibration table. To do this open the “Peak editor” from the “Calibration editor” while having the efficiency table open, then add peaks or modify the peak fits. Then select a nuclide and apply the changes and update the efficiency table when being asked to do so.

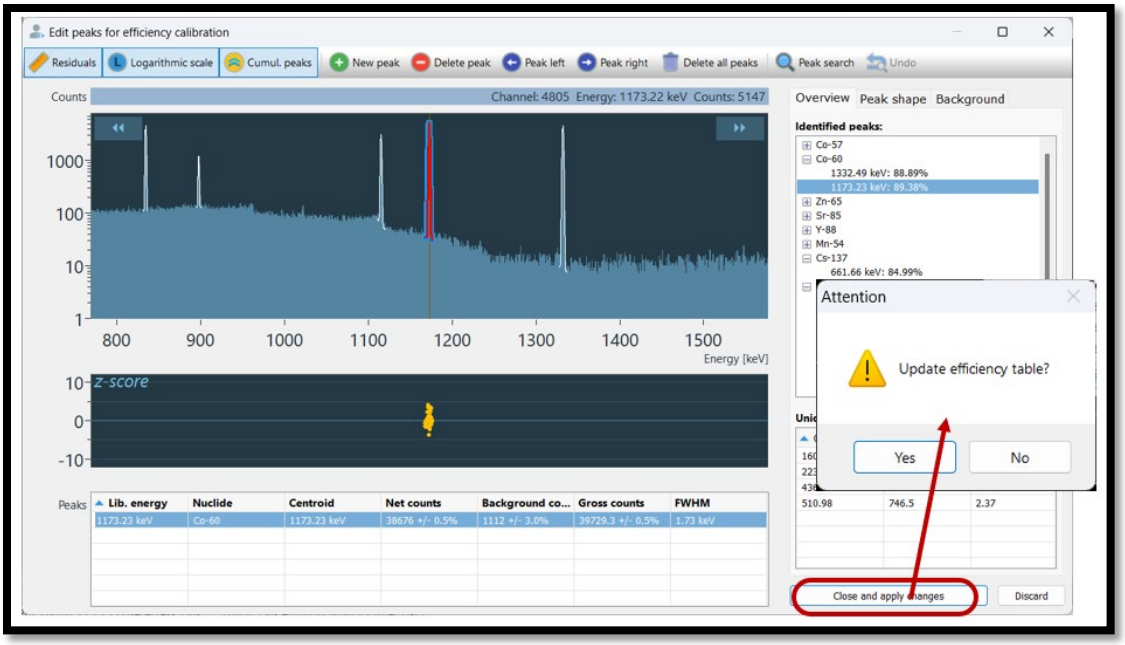


Figure 131. Updating an Efficiency Calibration

IMPORTANT The efficiency fit represents the detector efficiency for gammas of respective energies and not for the respective nuclides used for the efficiency calibration. As a consequence, one must apply true coincidence summing (TCS) correction when using nuclide for the efficiency calibration that is affected by TCS. To do this, simply tick the box **Correction library** on the **Corrections** tab (and make sure that the detector and source are properly defined for Monte Carlo calculations). LVis will then trigger tRAYcy to calculate the TCS correction factors before performing the automated efficiency calibration.

When the efficiency calibration is saved (or in case “Approval” is activated, when the efficiency calibration LVM is approved), LVis will ask first, whether to assign the energy calibration to the detector (only when a new energy calibration was created within the scope of the efficiency calibration).

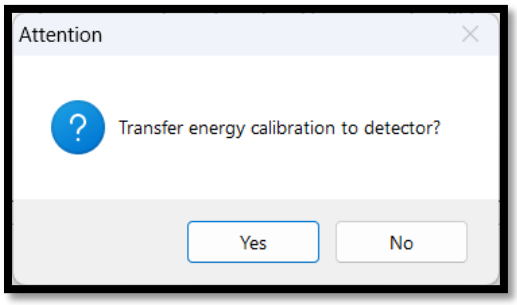


Figure 132. Transfer Energy Calibration Confirmation Message

Next, a list of all configured counting routines for the detector will be presented and the efficiency calibration can be assigned to one or more of these parameter sets.

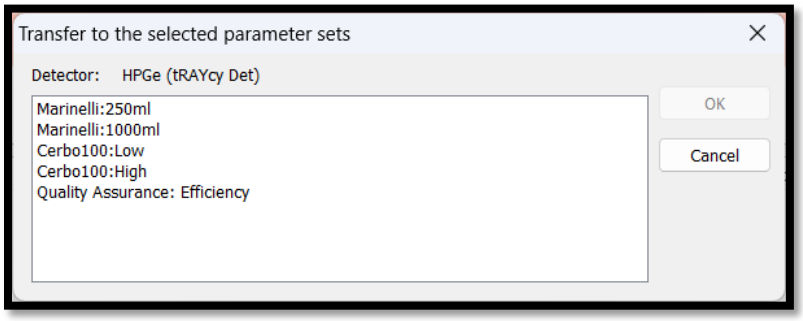


Figure 133. Available Parameter Sets

6.5 CHANGING CALIBRATIONS IN LVM FILES

Two ways exist to change the calibration in already existing LVis measurement (**.LVM** files). Either the “Calibration editor” is used to directly change the internal calibration tables by adding or deleting entries, or a new calibration is specified on the “Analysis” tab.

This can be done by clicking on **Calibration file** in the Analysis tab. After a file is selected, it is possible to decide in the following dialog with which parts of this file the internal calibration should be overridden.

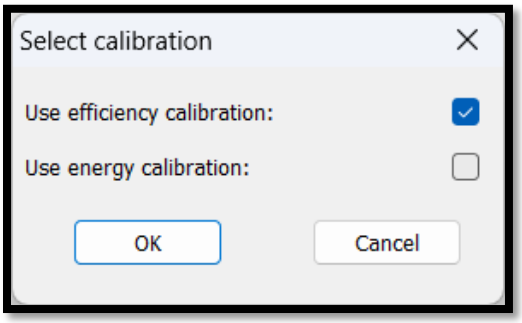


Figure 134. Select Calibration Type Menu

When using the “Calibration editor”, the calibration tables show all nodes of both calibrations. Users can switch between them via the **Energy** and **Efficiency** buttons in the bottom left of the calibration table window (see green marking in screenshot below).

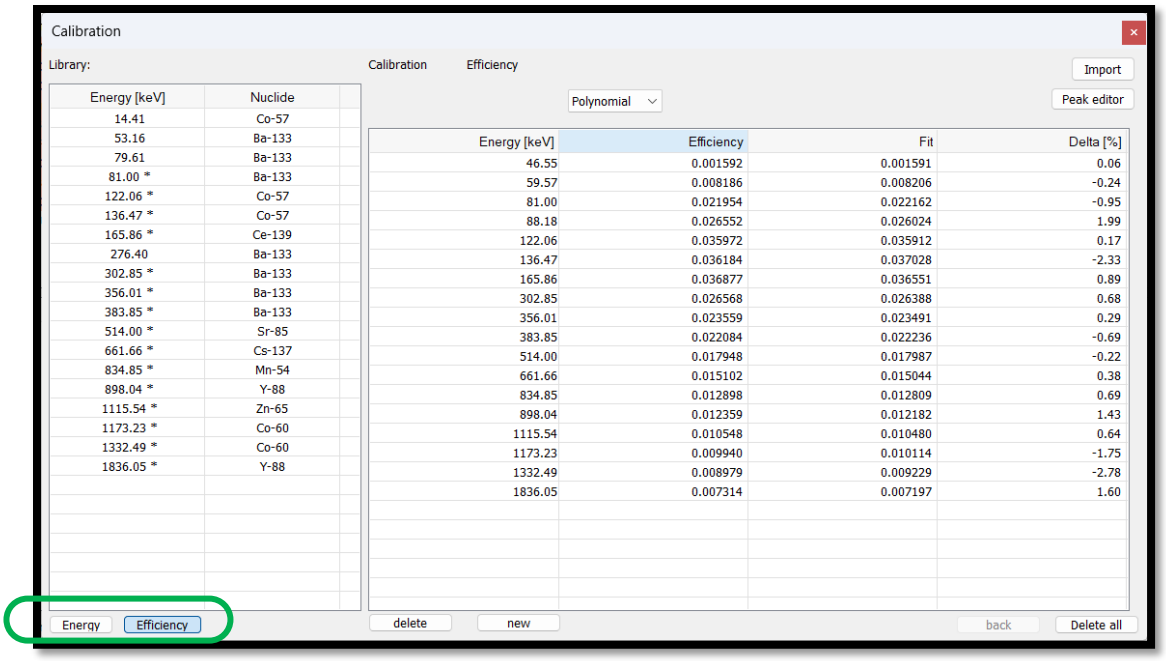


Figure 135. Energy and Efficiency Selection Buttons

It is possible to delete individual table entries as well as all data (**Delete** and **Delete all**).

New will add a data point at the current spectrum cursor position.

Changes can be made undone via the **Back** button.

All changes will be immediately displayed in the Calibration/Library tab and new data will be considered in the fit. If the calibration table is open, the Calibration/Library tab will only show the graph valid for the respective calibration.

To manually add a new entry to the calibration table based on the spectrum data, the respective peak parameters must be adjusted in the “Peak editor” first.

Note that any analysis results displayed on the “Analysis results” tab of the LVM file are set to “0” when changing data in the calibration file.

All fits on the “Calibration/Library” tab are re-calculated. And the reference of the calibration data on top of the graph changes to “internal” (see red marking in picture below).

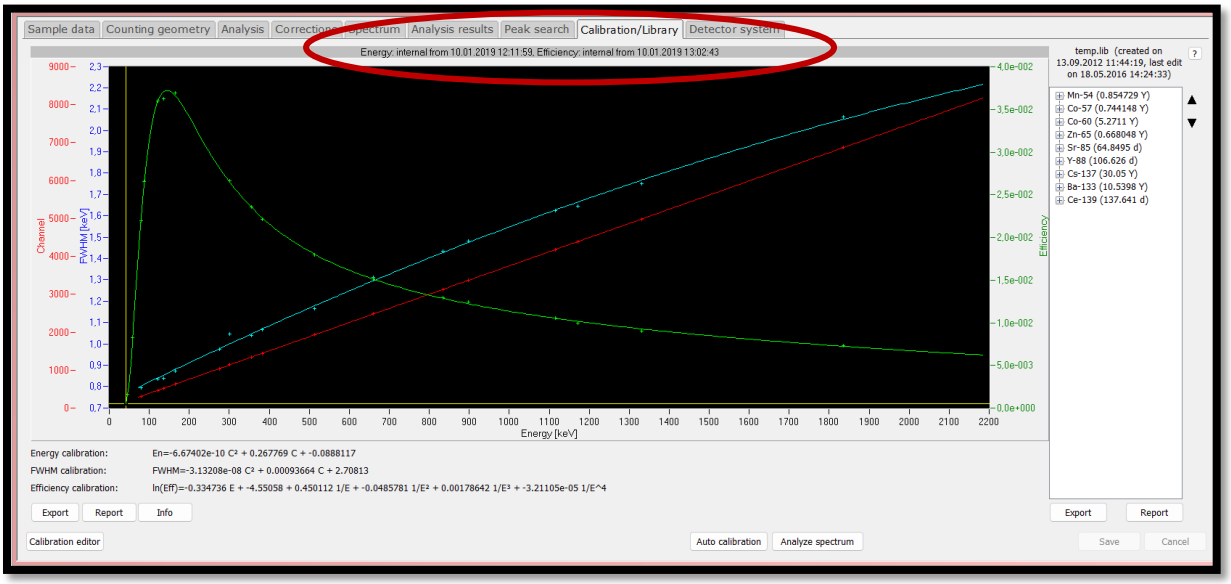


Figure 136. Calibration/Library Tab Internal Efficiency

6.5.1 Merging Calibration Data

It is possible to add calibration data from GammaVision **.ENT**, **.EFT**, **.CLB**, or LVis **.LVM** files to a calibration LVM file. Simply click the **Import** button in the right top corner of the calibration table and select the file from which the calibration data shall be added.

In case “Import” was selected while working with the energy table, the additional energy calibration points will simply all be imported.

When importing data into the efficiency calibration, the following dialogue will be presented:

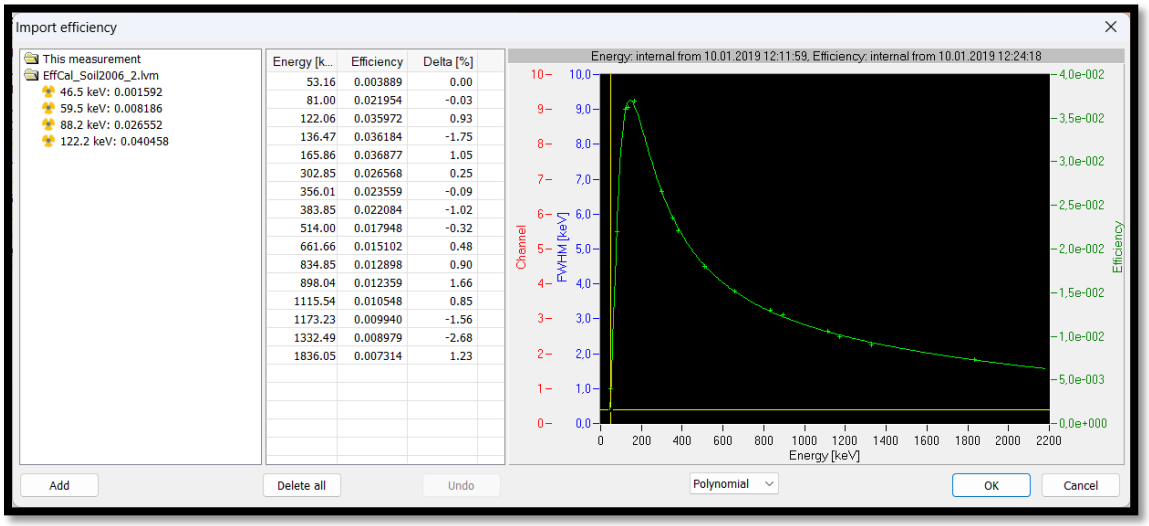


Figure 137. Importing Efficiency

On the left side of the window, an overview about the efficiency calibration points from “This measurement” and the one that was selected for import is given. In the middle the combined efficiency table is shown and, on the right, the respective efficiency graph displayed.

Selecting an entry in the left table and clicking **Add** will add it to the combined table in the middle.

It is also possible to add all entries from the selected LVM by double clicking on the respective LVM file name (“EffCal_Soil2006_2.lvm” in the screenshot above).

6.6 GAIN STABILIZER

Photon detector electronics are sensitive to temperature changes in the environment. This can cause a shift of the amplifier gain resulting in an incorrect channel to energy relationship. Instead of performing a new energy calibration it is often sufficient to adjust the gain of the detector system. The LVis gain stabilizer automates this process.

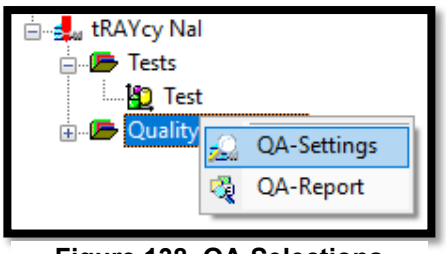


Figure 138. QA Selections

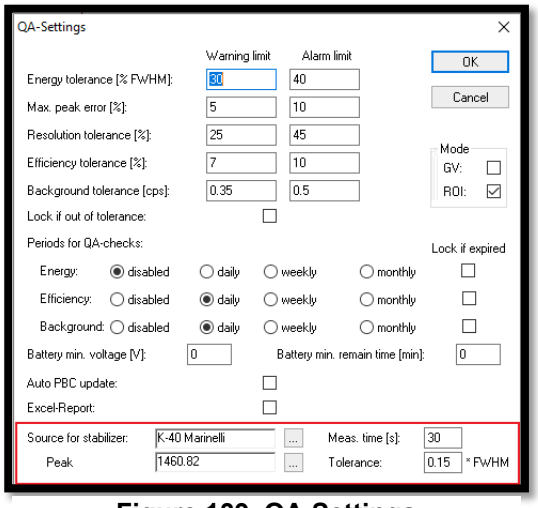


Figure 139. QA Settings

To use the automatic gain stabilizer, open the QA-Setting from the QA context menu and select a reference source in the “Source for stabilizer” section. The peak used for stabilization should be isolated in the spectrum and the parent nuclide should have a strong activity. The measurement time for the gain stabilization process can be set by entering a time in seconds in the “Meas. Time [s]” interface. A tolerance window in fractions of FWHM can be set in the “Tolerance” section.

After the gain stabilizer is set up, it can be started from the detector context menu. Follow the instructions to place the selected source on the detector and start the measurement. If a peak is found in the tolerance region, the system gain is adjusted until the peak is centered on its library position, see Figure 140.

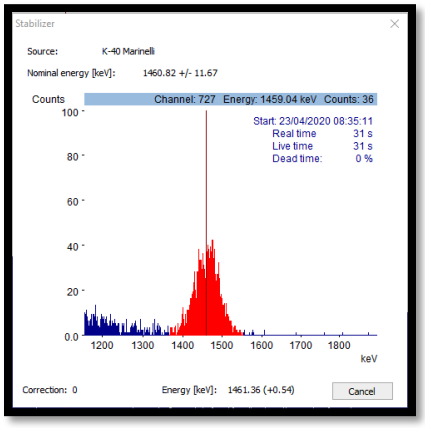


Figure 140. Stabilizer

7. SPECTRUM ACQUISITION AND ANALYSIS

Whether processing a sample, performing a calibration or running a QA check, in LVis all of the respective data is always stored in a single file: The LVis measurement lvm file.

Typically, every measurement in LVis consists of the following basic steps:

1. Select a pre-defined counting routine.

   Counting routines are called “parameter sets” in LVis. Note that there are parameter sets for calibrations, QA checks and sample counts. Typically, these parameter sets contain fixed presets (defined by a system administrator) that remain constant for the respective type of measurement.

2. Enter the missing sample information and start the parameterized acquisition.
3. Analyze the spectrum according to the preset analysis settings in the parameter set. Review and save the results.
4. Create a report and possibly also digitally sign the report.
5. If desired, publish the report as a pdf or print a hardcopy.

In the following the recording of spectra as well as the automated creation of LVis measurement files including respective analysis and report creation is explained in detail. The chapter is divided into the following sections:

- 7.1 The Concept of LVM Files
- 7.2 Record Spectrum Files
- 7.3 Working with Parameterized Measurements
- 7.4 Analyze Measurements
- 7.5 Create Reports
- 7.6 Re-evaluate Existing Measurements
- 7.7 Approval of Measurements and Exporting Analysis Results

7.1 THE CONCEPT OF LVM FILES

The traditional spectrum centric concept of most gamma spectrometry software where a spectrum is recorded and then analyzed using a set of additional files such as calibrations, libraries, or correction files has its disadvantages, especially related to the traceability of results. One needs to know which additional file (what version of it?) was used during the analysis. This is even more a problem when applying Monte Carlo based corrections since these are only useful when the applied geometry model is known. In LVis, simple spectrum files – although supported – are therefore not the intended way of operation. Instead, LVis uses so called LVis measurement files **.LVM**.

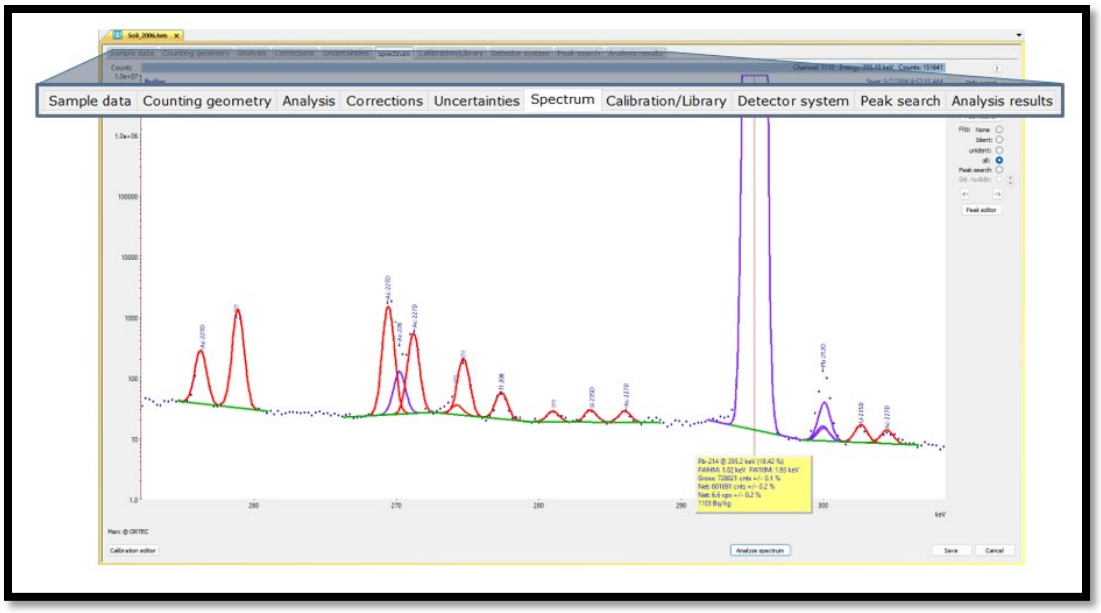


Figure 141. LVM File

LVM files contain all the sample information and everything that is required for the analysis. This information is organized and presented on different tabs (see Figure 141). The tabs will be slightly different depending on the type of measurement and analysis. Sample measurements applying ROI analysis differ with those used with gamma analysis engines. LVM files resulting from calibrations are different than QA checks.

LVM files basically represent the spectrum together with all the sample information and analysis settings provided in a parameter set plus the detector configuration and – if available – analysis results and reports.

By default, all LVM files are saved in the LVis database directory in the subfolder \Measurements. A subfolder is created for every detector configured in LVis in this measurement folder. In the detector folder, a subfolder is created for the respective parameter set. The folder structure can be seen below:

~ LVis database\Measurements\Detector name\Parameter set name\

7.1.1 The LVM Specific Change Log and Audit Trail

When an LVM file is created, information about who did what, when to the measurement is added to the “Sample data” tab providing a detailed audit trail for the measurement. Also, information about the system’s health status is available.

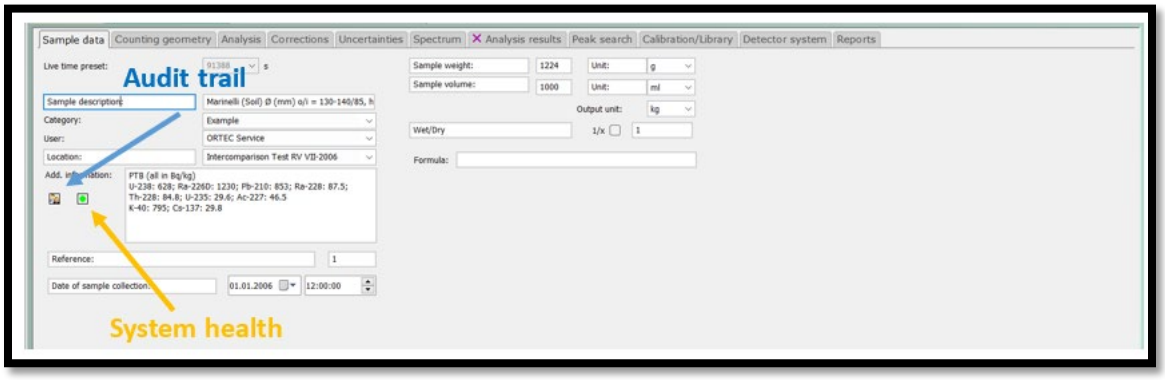
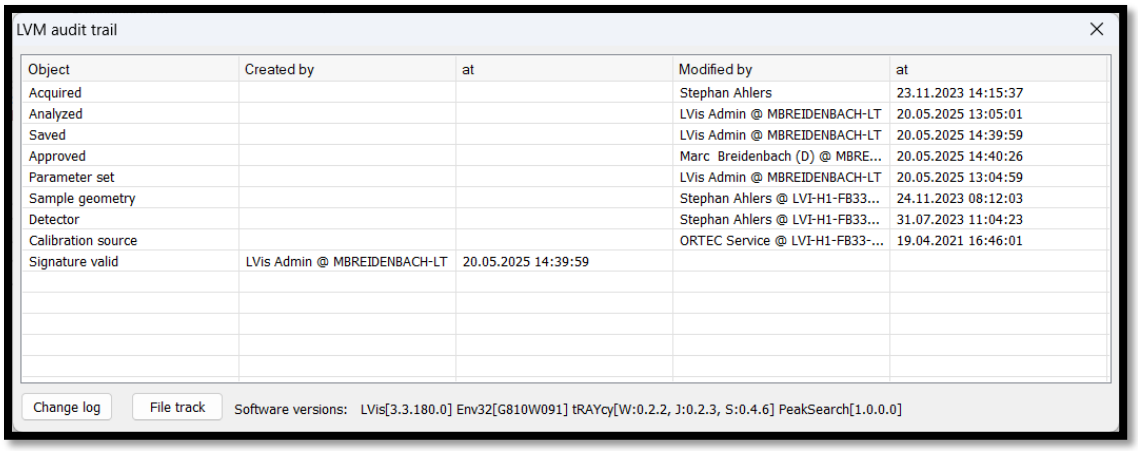


Figure 142. Sample Data Tab

7.1.1.1 The Audit Trail in an LVM File

The audit trail of an LVis file provides a quick overview about who did what, when with the measurement. It is possible to trace back who acquired the spectrum and when and who analyzed the measurement and saved it. It is also possible to check who defined the parameter set (the analysis settings), the sample and detector geometry, or the source that was used for the calibration. Every LVM file has a signature based on a hash key to provide traceability in case a file was modified outside of LVis.

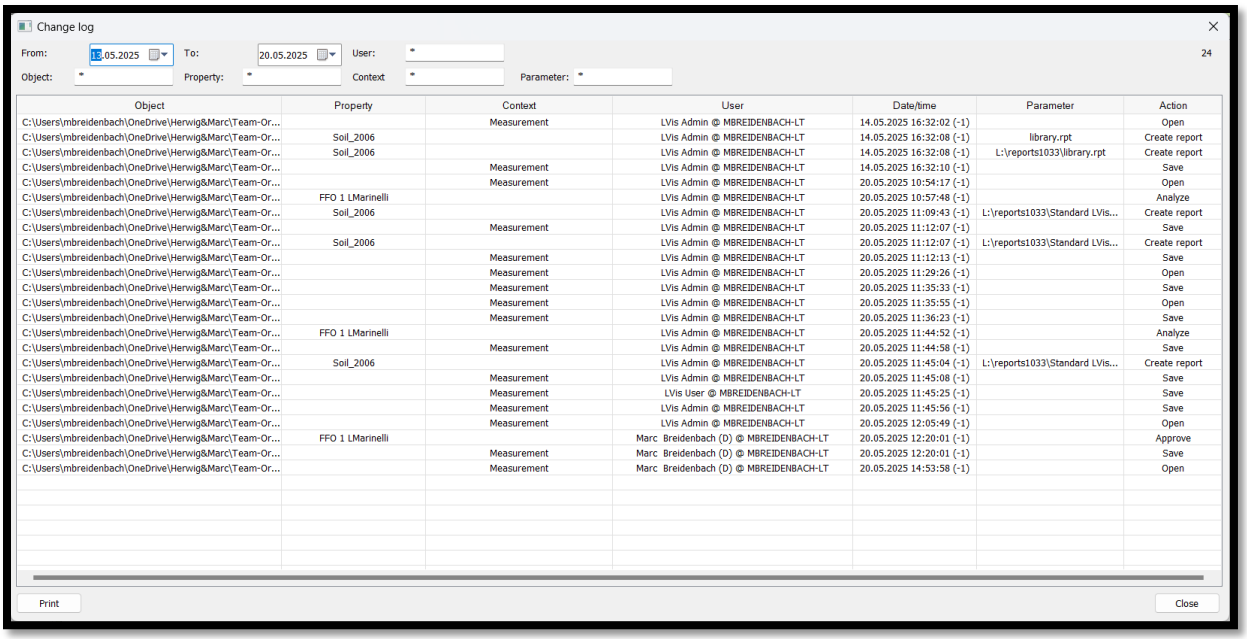


Object	Created by	at	Modified by	at
Acquired			Stephan Ahlers	23.11.2023 14:15:37
Analyzed			LVis Admin @ MBREIDENBACH-LT	20.05.2025 13:05:01
Saved			LVis Admin @ MBREIDENBACH-LT	20.05.2025 14:39:59
Approved			Marc Breidenbach (D) @ MBRE...	20.05.2025 14:40:26
Parameter set			LVis Admin @ MBREIDENBACH-LT	20.05.2025 13:04:59
Sample geometry			Stephan Ahlers @ LVI-H1-FB33...	24.11.2023 08:12:03
Detector			Stephan Ahlers @ LVI-H1-FB33...	31.07.2023 11:04:23
Calibration source			ORTEC Service @ LVI-H1-FB33-...	19.04.2021 16:46:01
Signature valid	LVis Admin @ MBREIDENBACH-LT	20.05.2025 14:39:59		

Figure 143. LVM File Audit Trail

Below the table, information about the versions of the different software tools used to create the LVM file is provided. The LVis version, the gamma analysis and peak search engine, and the tRAYcy version are given.

Pressing **Change log** opens the LVis Change Log showing an excerpt of the log database related to this particular file.



Object	Property	Context	User	Date/time	Parameter	Action
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	14.05.2025 16:32:02 (-1)		Open
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	Soil_2006		LVis Admin @ MBREIDENBACH-LT	14.05.2025 16:32:08 (-1)	library.rpt	Create report
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	Soil_2006		LVis Admin @ MBREIDENBACH-LT	14.05.2025 16:32:08 (-1)	L:\reports1033\library.rpt	Create report
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	14.05.2025 16:32:10 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 10:54:17 (-1)		Open
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	FFO 1 LMarinelli		LVis Admin @ MBREIDENBACH-LT	20.05.2025 10:57:48 (-1)		Analyze
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	Soil_2006		LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:09:43 (-1)	L:\reports1033\Standard LVis...	Create report
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:12:07 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	Soil_2006		LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:12:07 (-1)	L:\reports1033\Standard LVis...	Create report
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:12:13 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:29:26 (-1)		Open
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:35:33 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:35:55 (-1)		Open
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:36:23 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	FFO 1 LMarinelli		LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:44:52 (-1)		Analyze
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:44:58 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	Soil_2006		LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:45:04 (-1)	L:\reports1033\Standard LVis...	Create report
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:45:08 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis User @ MBREIDENBACH-LT	20.05.2025 11:45:25 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 11:45:56 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	LVis Admin @ MBREIDENBACH-LT	20.05.2025 12:05:49 (-1)		Open
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...	FFO 1 LMarinelli		Marc Breidenbach (D) @ MBREIDENBACH-LT	20.05.2025 12:20:01 (-1)		Approve
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	Marc Breidenbach (D) @ MBREIDENBACH-LT	20.05.2025 12:20:01 (-1)		Save
C:\Users\mbreidenbach\OneDrive\Herwig&Marc\Team-Or...		Measurement	Marc Breidenbach (D) @ MBREIDENBACH-LT	20.05.2025 14:53:58 (-1)		Open

Figure 144. Change Log

This provides visibility about all operations that occurred to the measurement.

Pressing **File track** provides information about other LVM files on this computer (or better “the LVis system” since several computers could use the same LVis database folder) that are based on the same measurement but saved under different names or locations. The screenshot below shows an example for the file “Soil_2006-rev1.lvm” that is a re-analysis of the file “Soil_2006.lvm”. Soil_2006.lvm was re-analyzed five times and two of these re-analyses were re-analyzed again.

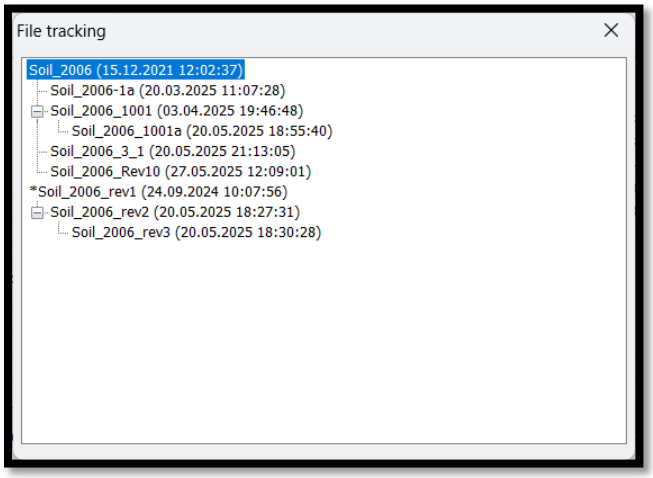


Figure 145. File Tracking

7.1.1.2 The System Health Information in an LVM File

Here, the information about the system’s health at the time of the acquisition of the measurement is provided.

- **Health** – returns “Pass” or a “Fail” message indicating a problem with detector power or bias circuits.

- **HV Bias** – indicates if HV was applied or not.
- **Temperature** – a used by SMART-1 detectors or Detective type products and displays “Pass” for non-SMART-1 detectors in case the system is not in Shutdown.
- **QA Checks** – information about the date/time of the last QA checks and their respective results

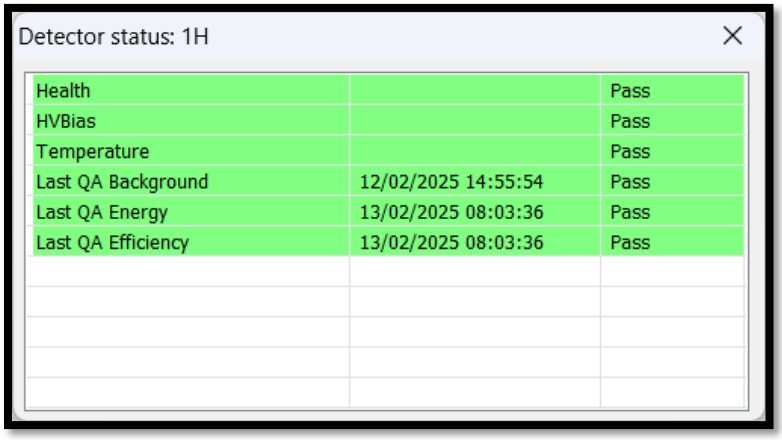


Figure 146. Detector System Information

NOTE: The parameters shown here will depend to some extent on the respective counting electronics. For systems that provide measuring the live detector temperature, the exact value will be shown here in addition to the Pass/Fail categorization. For systems that are battery powered, one will also get information here about the remaining battery time or the charging status.

7.1.2 Internal Storage of Calibration, Library, and Correction Files in LVM Files

LVis stores library and calibration files as well as background, geometry, or library correction files used for the analysis in the measurement (**.LVM** file) and displays the content on an individual tab.

IMPORTANT The internal data will be used when re-evaluating a measurement. In case the original files are manually changed after the lvm file was created, the file will have to be re-selected to update to the latest version. In case it is not clear, note the modification/creation date of the respective file.

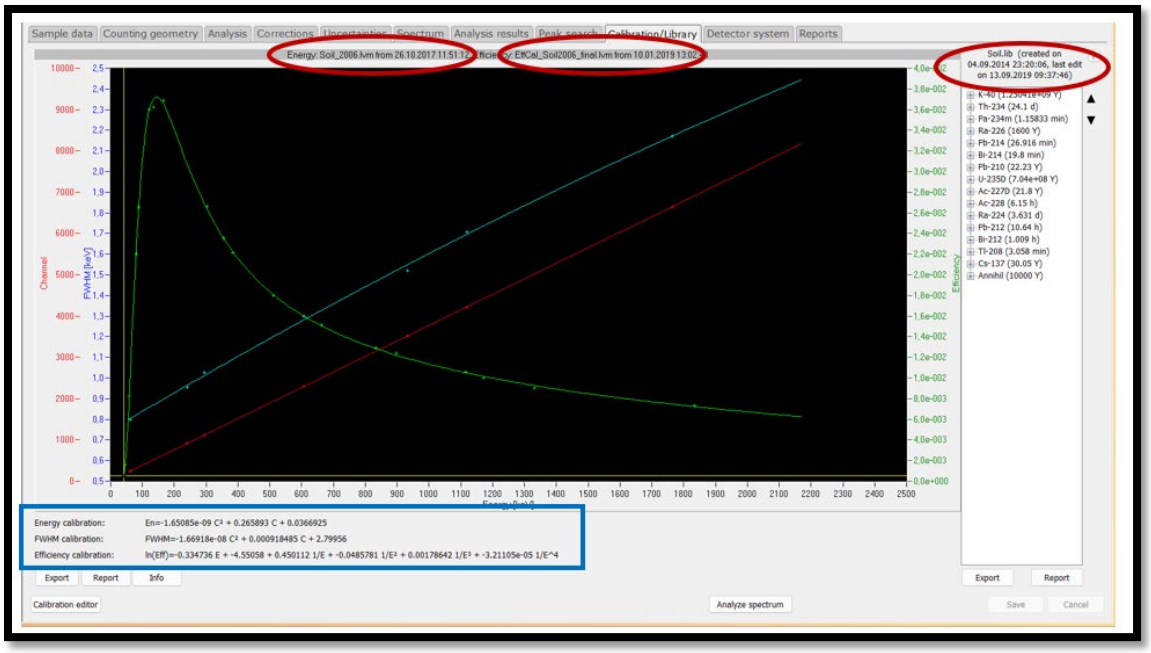


Figure 147. Calibration/Library Tab

On the “Calibration/Library” tab, all three calibrations (channel energy, energy full width at half maximum, and energy efficiency relation) as well as the library content are presented. For the calibration, the corresponding nodes (sampling points) are presented in a graph on the left side of this tab. The cursor can be moved over the functions to display the respective pair of values at the current cursor position.

The filename of the originally used calibration and the date the calibration was created can be found in the graph title (see red marking on the screenshot above).

The fit functions are displayed in explicit mathematical form underneath the graph as well (see the blue box in the screenshot above).

The internal calibration can be manually modified by editing the calibration table (see Section 7.1.2.1 Modifying the Internal Nuclide Library of an LVis Measurement File). Click **Calibration editor** to do that.

On the right side of the tab, users can find basic data of the library as well as the nuclides contained, including the respective (radioactive) half-life and corresponding peaks and energies with emission probabilities. The original library name and its date of creation and last modification is located in the header. To save this internally stored library as a **.LIB** file, click on the **Export library** button. The library can be modified from within the LVM file (see 7.1.2.1 Modifying the Internal Nuclide Library of an LVis Measurement File).

All corrections applied during the analysis are summarized on the “Corrections” tab. Here users can find applicable information about the respective background correction (.PBC file), the geometry correction(.GEO file), and the true coincidence summing correction (the correction library .LVF file). Click on the icon with the three dots to review the respective correction file and to check its creation date.

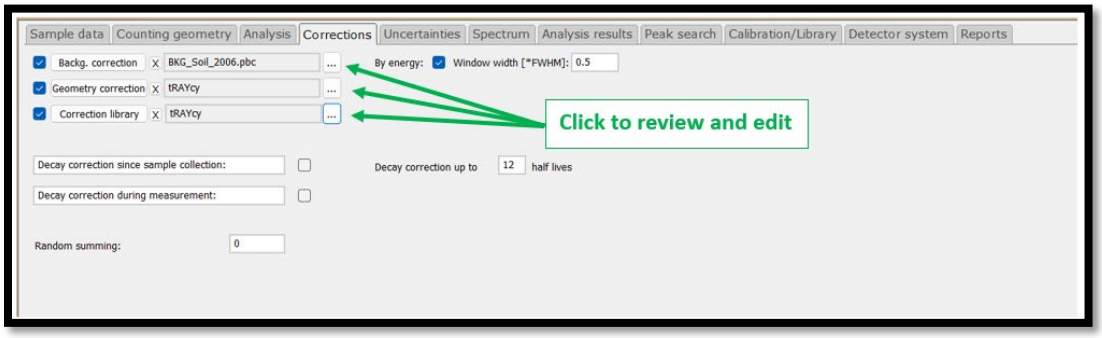


Figure 148. Corrections Tab

7.1.2.1 Modifying the Internal Nuclide Library of an LVis Measurement File

The analysis library can be modified directly from the "Calibration/Library" tab of an LVM file. The library information is displayed on the right side of the tab. Users can edit nuclide or peak energy information by right clicking the respective information.

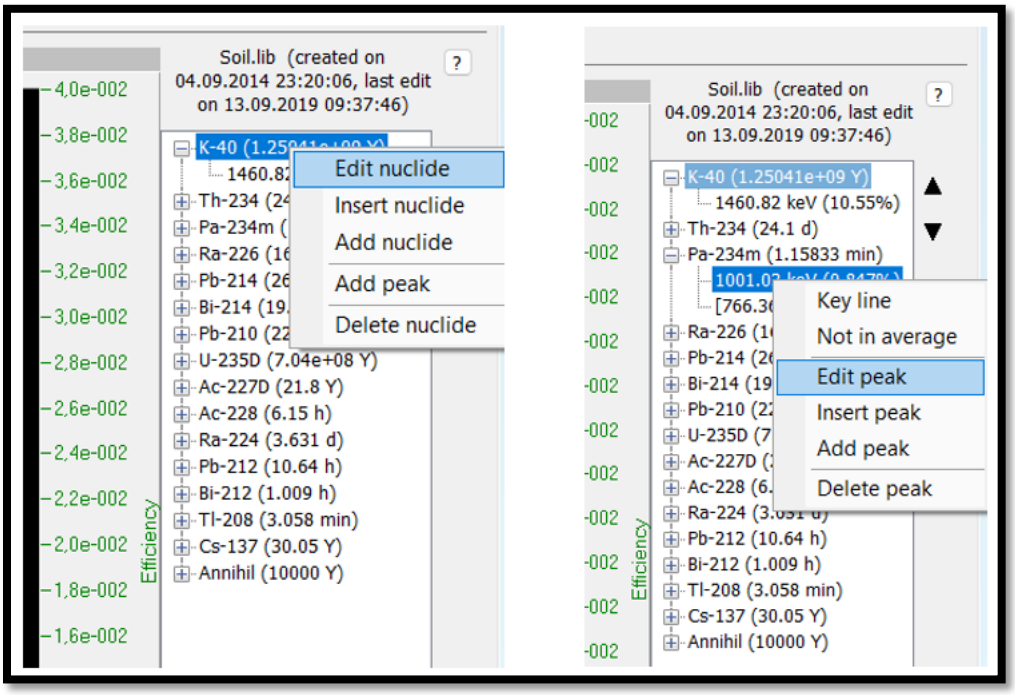


Figure 149. Analysis Library Modification Options

Choosing from these menus will lead users directly to the same library editor described in detail in the 5.2.3.1 Library of this manual.

The rank of a peak or the position of a nuclide in the library can be modified with the up and down arrows on right side of the library information.

NOTE: When the library information is changed, the library name will switch to **internal.lib** indicating that its information is only available in this LVM file. If the library shall be available for use in routine analysis procedures (see: Section 5 LVis Parameter Sets) or other LVis measurements, it will have to be exported and saved as a library file *.lib and then selected for analysis in one of the parameter sets.

IMPORTANT When modifying the internal library of an LVis measurement, only the library information stored inside the particular LVM file is changed. The library file *.lib that was originally specified on the “Analysis” tab of the LVis measurement will remain unchanged. When re-analyzing the measurement after a library was internally modified, the new internal library will be used even though another library may be mentioned on the “Analysis” tab. On the analysis report and on the “Calibration/Library” tab it will however clearly be indicated that an internal library is used.

7.1.2.2 Modifying the Internal Calibration of an LVis Measurement File

The internal calibration can be modified directly from the “Calibration/Library” tab of an LVM file.

The currently valid energy, FWHM, and efficiency calibrations are displayed in the graph. Note the different scaling for the three curves.

Information about the origin of the energy/FWHM and efficiency calibrations is displayed above the graph (see red marking in picture below).

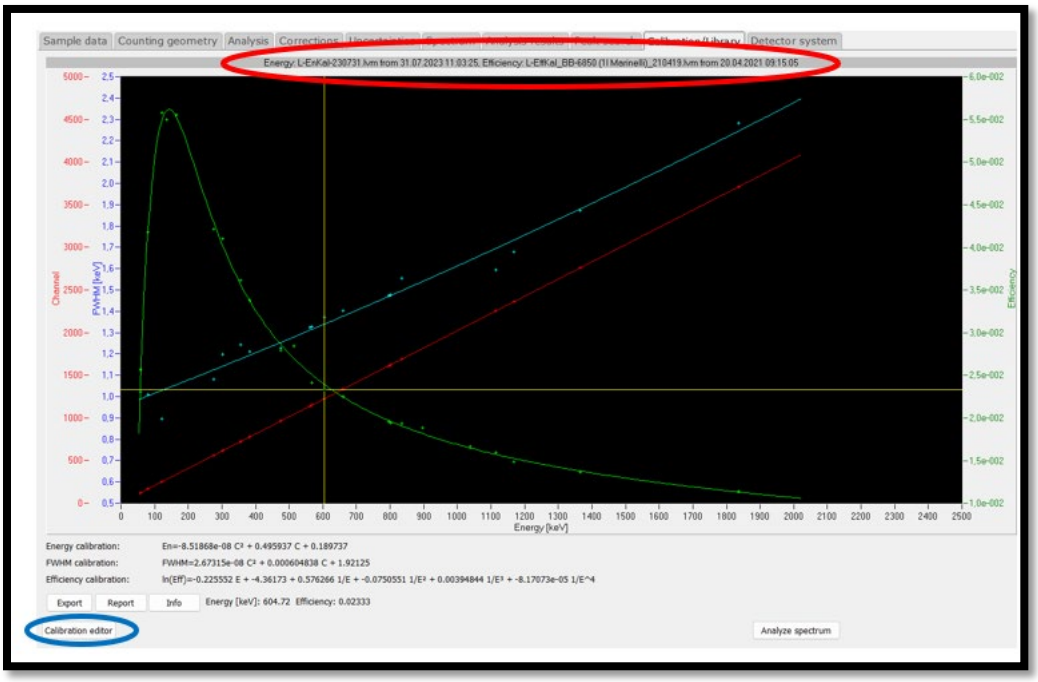


Figure 150. Calibration/Library Tab with Internal Calibration

The calibration data can be reviewed in detail and edited by opening and editing the information in the Calibration table. To open the Calibration table editor, click the button **Calibration editor** on the bottom left (see blue marking on screenshot above). The following screen will open:

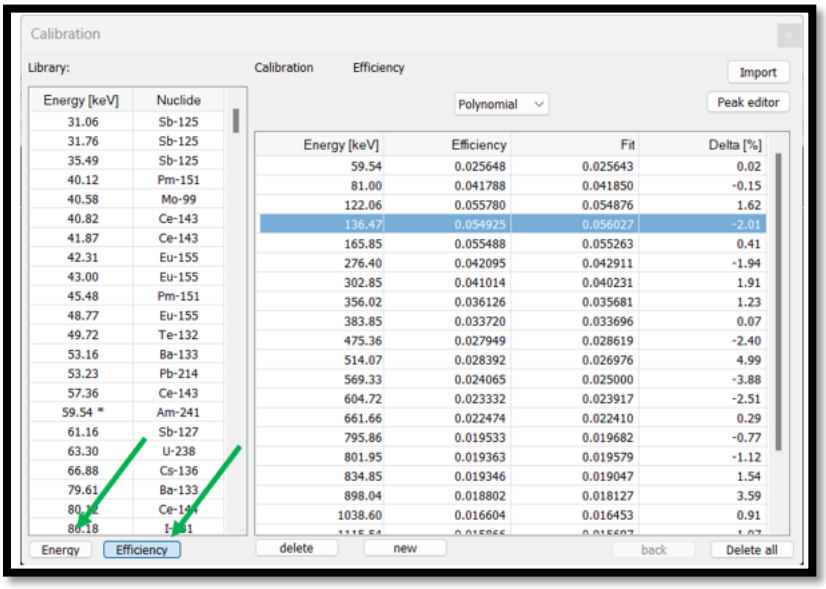


Figure 151. Calibration Table Editor

By clicking the **Energy** or **Efficiency** button in the lower left corner (green arrows in picture above) of the Calibration table editor it is possible to select which set of data is displayed in the main table. Double clicking an entry in the table allows for modification which is applied immediately to the calibration.

Note that any analysis results displayed on the “Analysis results” tab of the LVM file are set to “0” when changing data in the calibration file. All fits on the “Calibration/Library” tab are re-calculated. The reference of the calibration data on top of the graph changes to “internal” (see red marking in picture below).

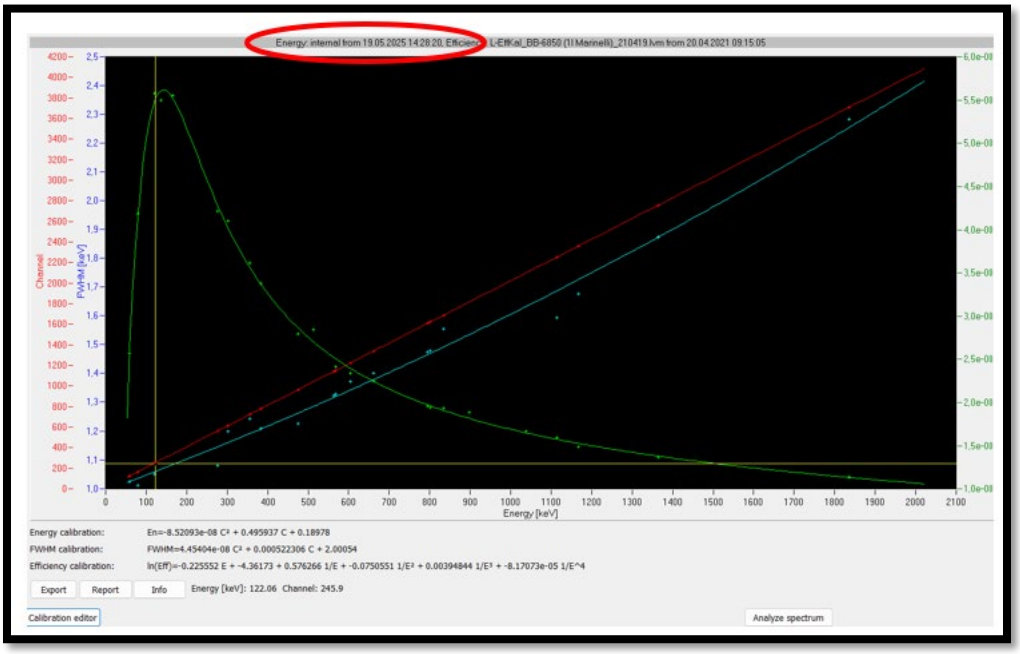


Figure 152. Calibration/Library Tab with Internal Displayed

IMPORTANT When modifying the internal calibration of an LVis measurement, only the calibration information stored inside the particular LVM file is changed. The calibration referenced on the “Analysis” tab of the LVis measurement will remain unchanged. When re-analyzing the measurement after a calibration was internally modified, the new internal calibration will be used even though another calibration may be mentioned on the “Analysis” tab. On the analysis report and on the “Calibration/Library” tab it will however clearly be indicated that an internal calibration is used.

7.1.3 The Analysis Results in an LVM File

When a measurement was analyzed, the analysis results are graphically presented in tabular form on two new tabs “Analysis results” and “Peak Search”.

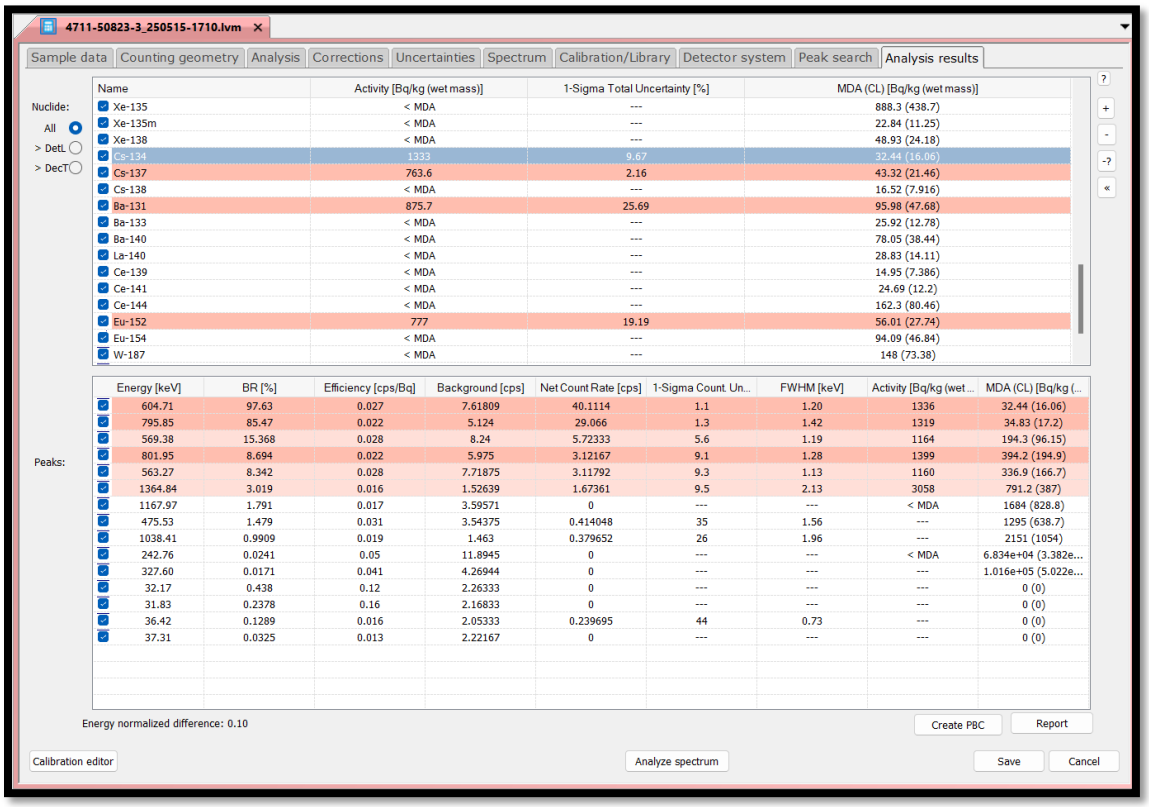


Figure 153. Analysis Results Tab

The upper table on the “Analysis results tab” contains a list of all nuclides listed in the library, plus the identified (decay-corrected) activities, the corresponding errors and the respective detection limits. If users select a nuclide in the upper table, the analysis results of all respective nuclide peaks are shown in the lower table. All results of nuclides and peaks whose activity exceeds the detection limit are highlighted in red.

NOTE: Compare the consistency of different peak activities of a nuclide. This will provide a good indication as to whether the analysis was meaningful or not.

Double-clicking on a nuclide in the upper table will show the peak first of all nuclides in the spectrum. Double clicking on a peak entry in the lower table will show the respective peak fit in the spectrum.

Note that in both cases, the respective nuclide is selected and on the “Spectrum” tab it is possible to switch through the nuclides by using the Sel. nuclide: icon.

From the analysis results tab it is possible to either create a report or a PBC background correction file using the respective buttons below the table.

7.1.4 The Peak Search Results in an LVM File

Within the scope of a spectrum analysis, a mathematic peak search is conducted as well.

The results of this peak search are compared to the analysis library specified in the parameter set. The comparison only considers the peak energy specified in the library and the centroids of peaks found in the peak search. The nuclide, whose peak energy is closest to this centroid, and which is inside the specified match width, will be assigned to the found peak.

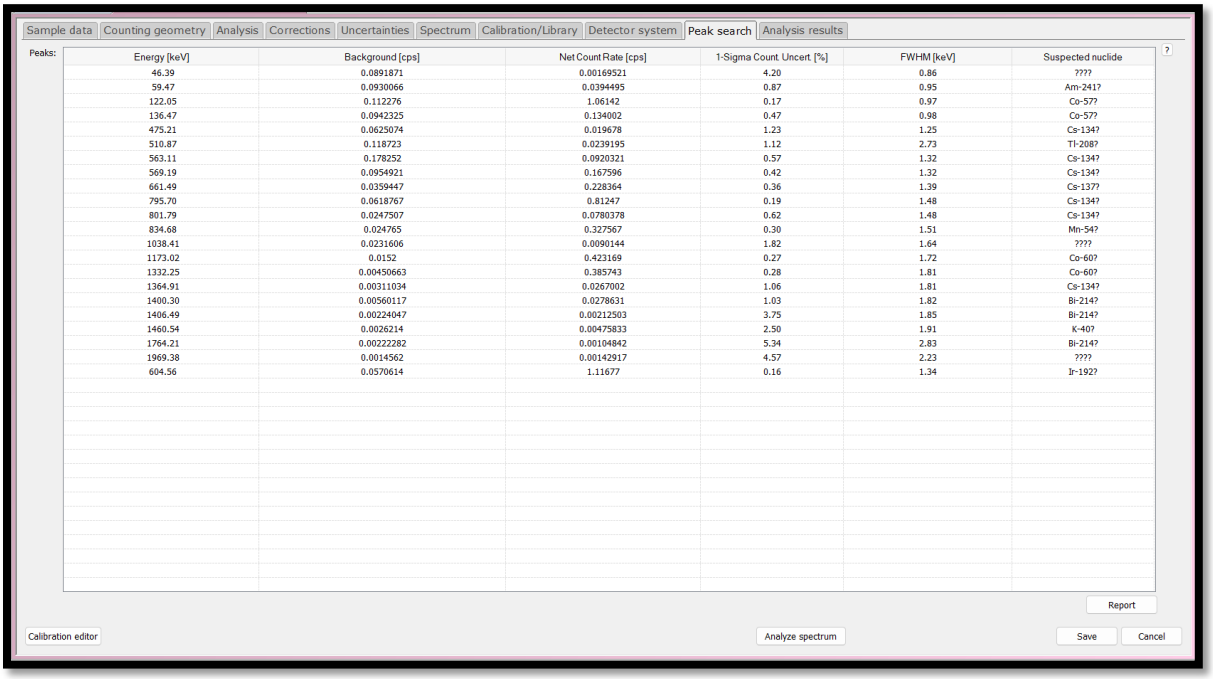


Figure 154. Peak Search Tab

The peak search results are presented in tabular form on the “Peak search” tab. Double-clicking on an entry in the table takes users to the respective energy in the spectrum and displays the peak search fit. In order to distinguish between analysis results, the respective nuclide assignment is displayed using a question mark next to the nuclide name.

7.1.5 The Spectrum Display in LVM Files

In an LVM file, the spectrum is displayed on the tab “Spectrum”. The spectrum manipulation like zooming in/out or changing the vertical scale works the same way as in the LVis live detector view.

When the LVM is analyzed, however, it is possible to show the peak fits and respective nuclide assignments. To do so, the fit selections on the right side of the spectrum window can be used (see the red box in Figure 155):

- **All** – displays identified and unidentified peak fits
- **Ident** – only shows identified
- **n. Id.** – only the unidentified peaks

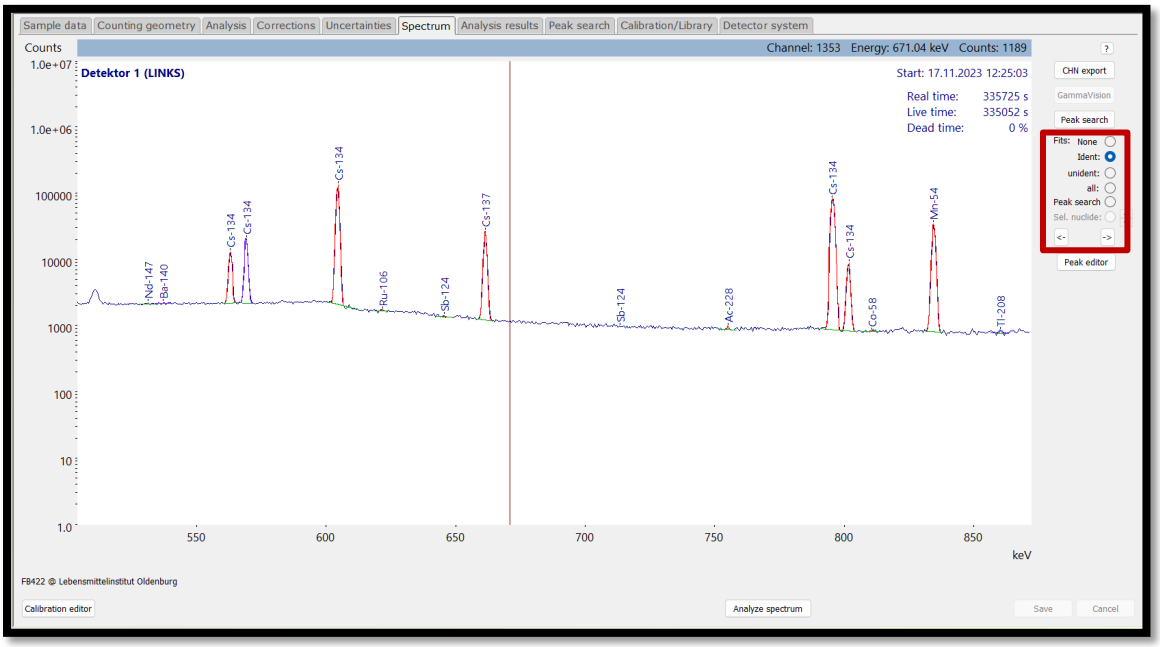


Figure 155. Spectrum Tab Fit Options

Using the left/right arrow keys on the keyboard (<- ->), users can move within the spectrum from peak to peak. Pressing the key will change to the next peak in the peak fit presentation (also potentially moving to an unidentified peak if any are currently displayed).

It is also possible to jump from peak to peak within the currently selected nuclide Sel. nuclide: . By using the up and down arrows users can switch from one nuclide to another and get all the respective peaks displayed.

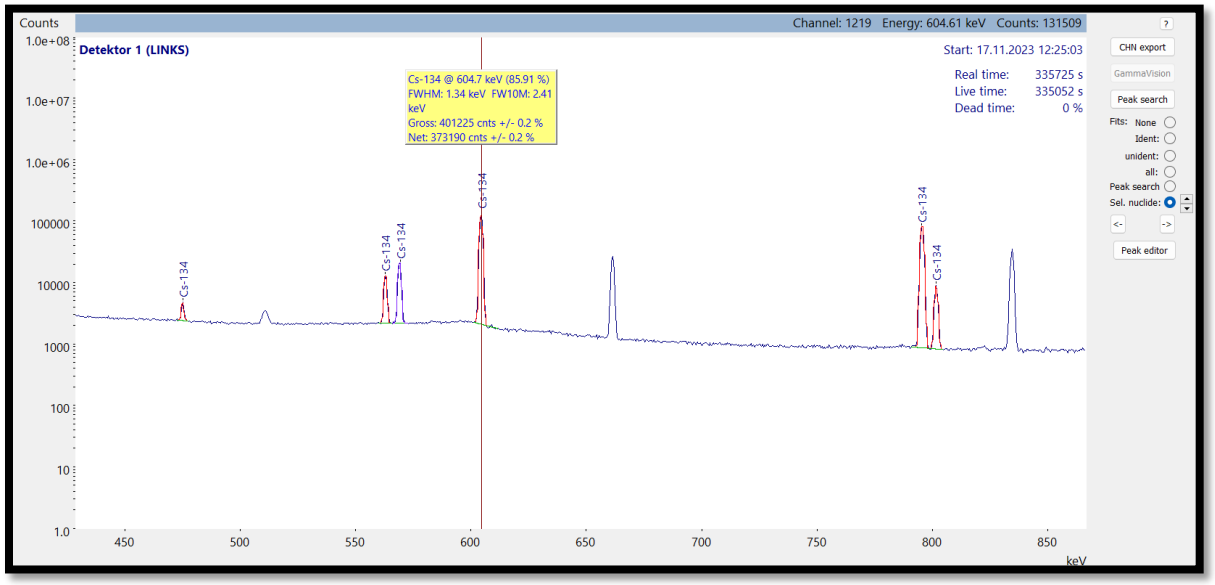


Figure 156. Spectrum with Peak Information Displayed

7.2 RECORD SPECTRUM FILES

To record a new spectrum, right-click on the desired detector in the Configuration panel and select **Start spectra acquisition** (see blue marking in Figure 157). The quick start icons in the live detector view can also be used (see Figure 158). Make sure that there is no previously acquired spectrum still in the buffer – clear it before starting a new spectrum acquisition.

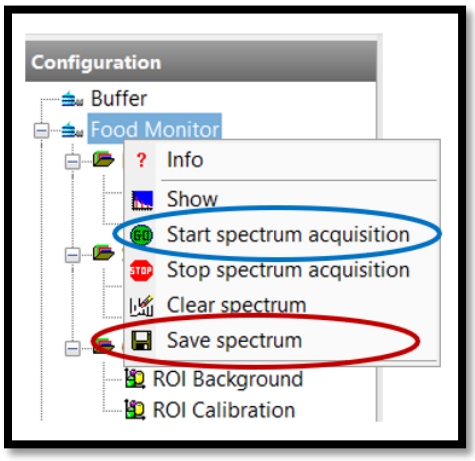


Figure 157. Configuration Panel – Start Spectrum Acquisition

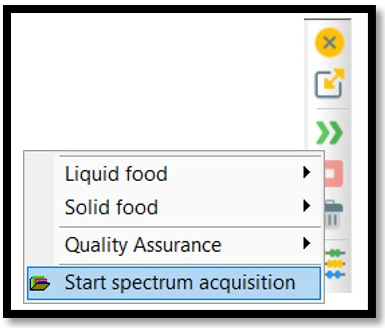


Figure 158. Start Spectrum Acquisition – Live Detector View

The spectrum acquisition will start immediately. A spectrum file can be saved from the detector context menu by selecting **Save spectrum** (see red marking in Figure 157).

7.3 WORKING WITH PARAMETERIZED MEASUREMENTS

7.3.1 Starting Parameterized Measurements

The intended way of processing a sample, performing a calibration, or conducting a QA check is by using respective pre-definable counting routines. The spectrum acquisition is then triggered by right-clicking on the parameter set and selecting **Start new**.

This will open the respective parameter set, showing on different tabs the current preset sample data, analysis and reporting settings, and the defined counting geometry. The screenshot in Figure 160 shows a sample counting routine. Depending on the LVis user account rights it is possible to modify the settings or to only enter respective information.

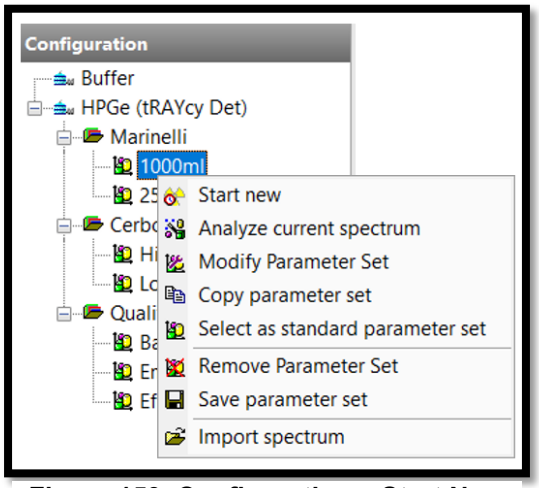


Figure 159. Configuration – Start New

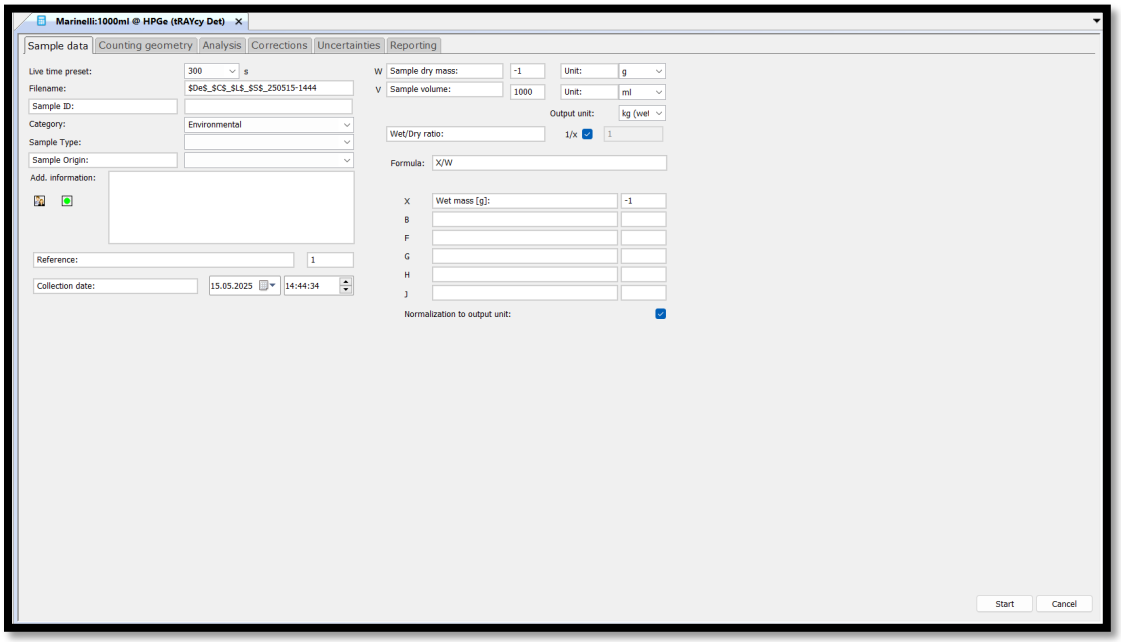


Figure 160. Sample Counting Routine

Typically, only information on the “Sample data” tab like the sample ID, the reference date, or the sample mass and volume must be entered since this is what changes from sample to sample. The settings on the other tabs are typically not changing and remain fixed. When all sample data was entered, click **Start** at the bottom right to start the parameterized sample count.

NOTE: Optionally, it is possible to import sample data from a LIMS system. When activated, a respective prompt to select the transfer file for import will pop up when selecting **Start new**. The information from the import file will then automatically be entered in the respective fields of the parameter set. This feature is described in more detail in 7.3.1.1 Importing Sample Data when Starting a New Acquisition.

As soon as the parameterized measurement has started, the new status of the detector is indicated in the Configuration panel and the live spectrum view by a red color coding. The name of the new measurement, the parameter set used, and the remaining time are displayed in the configuration tree next to the respective detector as well as in the header of the spectra view.

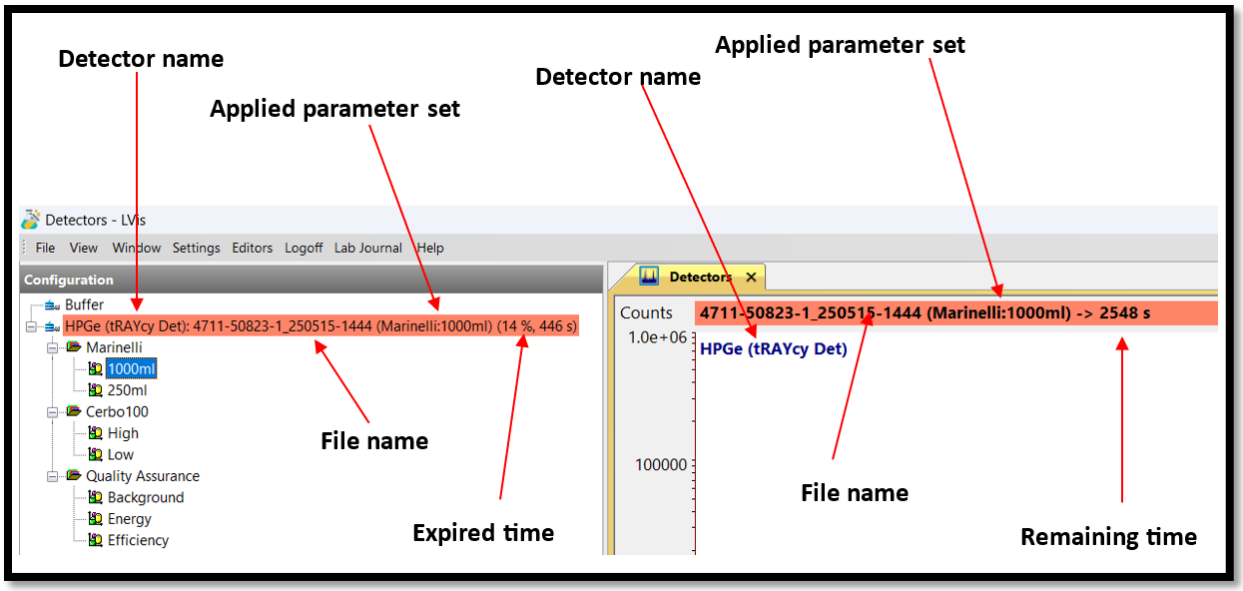


Figure 161. Parameterized Measurement Applied Information

As soon as the preset counting time is reached, LVis will, depending on the “Reporting” settings in the parameter set, either stop and indicate the new status by changing the detector color coding to green or it will automatically analyze the measurement and create a report.

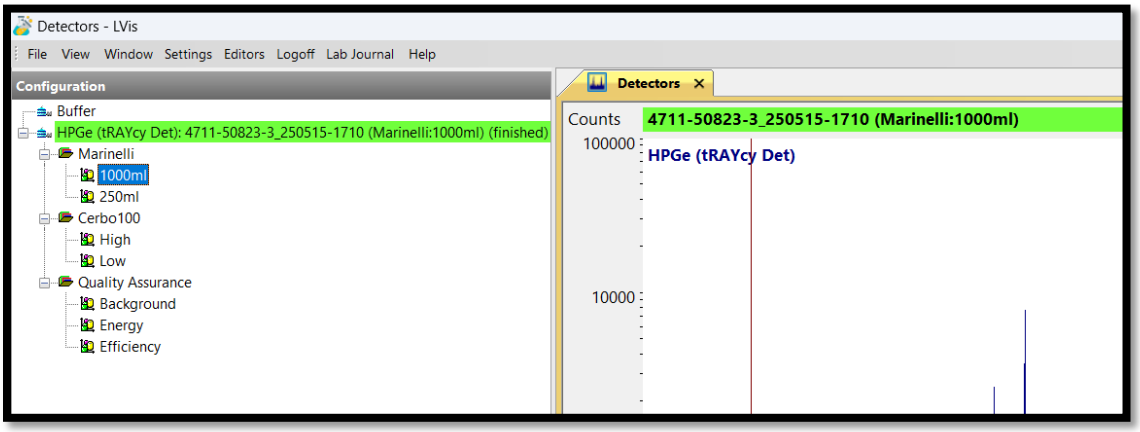


Figure 162. Preset Counting Time Reached

7.3.1.1 Importing Sample Data when Starting a New Acquisition

It is possible to import sample data into a parameter set. The sample data must be available in an import file, typically in text, xml, or csv type format. Such import files are created in a distinct location from the LIMS for every sample that is to be counted in LVis. This location of the import files must be specified in the LVis Settings to enable the data import feature (see green marking in screenshot below).

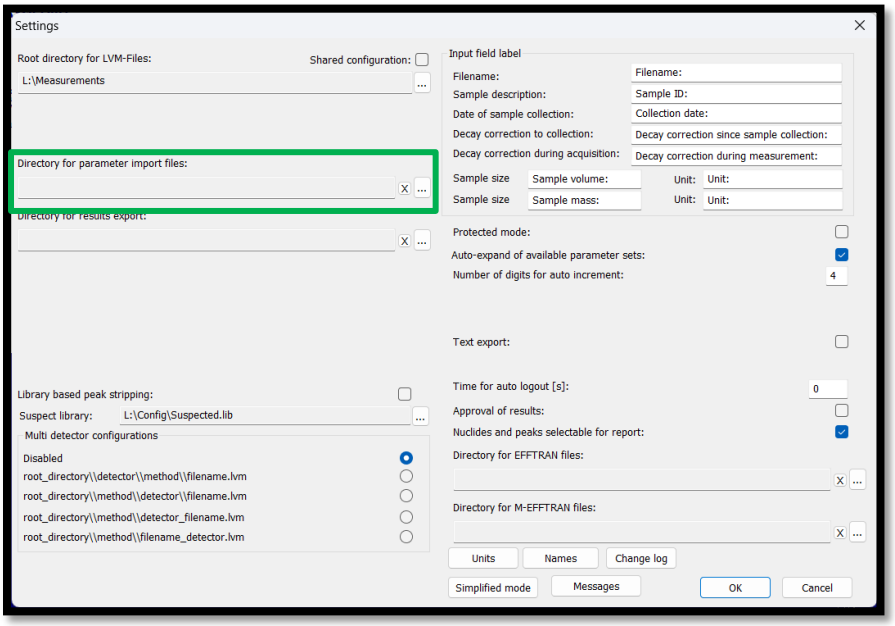


Figure 163. Settings – Import File Parameters

Once activated, when selecting a parameter set in LVis to start a new parameterized acquisition, LVis will first ask the operator to select the respective import file.

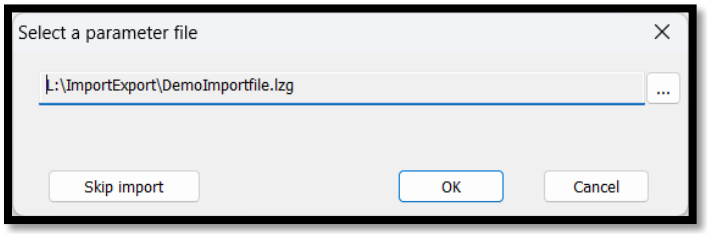


Figure 164. Selection of Parameter File

Note that there is an example demo import file called “DemoImportfile.lzg” in the “ImportExport” folder of the LVis database directory that was installed together with LVis. Its content is shown in the screenshot below:

```
Importfile (.lzg) created by hand as an example for the data import in LVis
%Sample%
Datatset_S          2
Networkname                    "12"
LabCode                        "12010"
Username            "Elvis the Pelvis"
Sample_ID                      "000008165302X"
Sample_NR           "A0096MP1601G1"
MeasurementProgram      "1"
LabLocation             "OBG"
ReferenceDateTime       20160702145500
Collection          1
CollectionEnd           20160727150000
SampleType              "Magermilchpulver"
SampleOrigin                   "Cottbus"
SampleOriginCode            12069270
SampleOriginCoordinates     5 "33475353" "5773645"
%ACQUISITION%
ActivityUnit            "mCi"
SampleSizeUnit          "kg"
SampleSize                  "1.234"
SampleSizeUnit2         "ml"
SampleSize2         "1000"
SpecActUnit         "g"
AddInfo             "This is just an example on how to import data from a LIMS into LVis!"
SampleAmountFactorName      "Wet/Dry ratio"
SampleAmountFactor      "0.71234"
ReferenceLabel          "Sample code"
SampleCode          "855"
%ENDE%
```

Figure 165. Import File

In the import file there is always a keyword specifying the respective field in the parameter set and then either separated by a comma, tab, or other separator, the respective import value. The keyword in the import file can be any word, but it must be unique for the respective sample parameter.

A VBA script embedded in “Import.xlsm” is executed by LVis that reads the import file and parses the data into the parameter set. As a result, the respective fields on the “Sample data” tab will be filled with data:

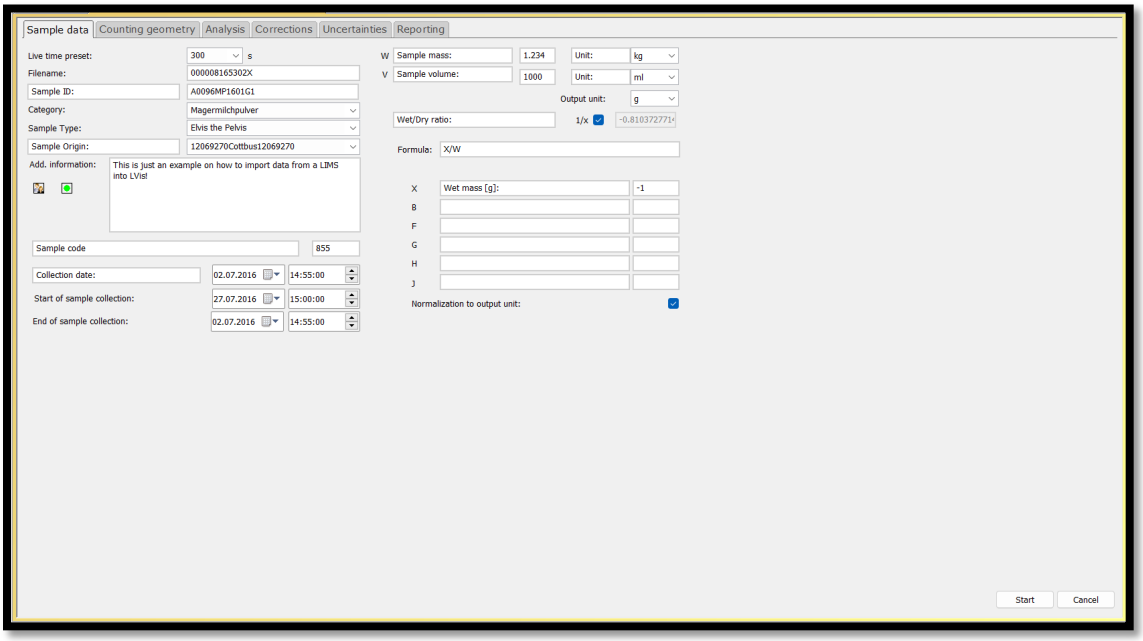


Figure 166. Sample Data Tab

NOTE: The “Import.xlsm” script provided with LVis is just intended as an example. If it is desired to import results into LVis, the VBA script in this Excel file can be used by someone familiar with VBA programming to adjust the import if needed. For users not familiar with VBA programming, it is strongly recommended to contact ORTEC’s technical support for help.

7.3.2 Stop/Delete Measurement – Stop Data Acquisition – Continue with Other Parameters

Once started, a parameterized measurement can be stopped in two ways:

1. Via the context menu of the detector by choosing “Clear active parameters“ and in a 2nd step **Stop acquisition**.

   Note that “Clear active parameters“ will not stop the recording of the spectrum. This will only delete the link between the spectrum acquisition and the parameter set. This is to provide a possibility to continue a spectrum acquisition with other parameters without having to completely restart it. Instead of stopping the acquisition after clearing the parameters, one has the option to select **Analyze current spectrum** from the context menu of another parameter set and then **Continue acquisition** to re-link the acquisition to this other routine.

2. Via the red symbol on the quick icon list of the live detector view. During an ongoing parameterized acquisition, this is where users can select between **Stop spectrum recording** or **Cancel current measurement**. The first will stop the spectrum recording but leaves the connection between the parameter set so that the spectrum can still be analyzed using the settings from the original parameter set. The second will cancel the link between the parameter set but will continue the spectrum acquisition so that users can choose another parameter set to continue the measurement.

7.4 ANALYZE MEASUREMENTS

In LVis, spectra can only be analyzed using parameter sets and creating LVis measurement LVM files. This can be done either manually with an existing spectrum or automated by starting parameterized acquisitions. In case automatic analysis and reporting are activated in the parameter set, the measurement will be analyzed once the preset counting time has been reached. If a report template was specified in the routine, a report will also be created automatically.

It is also possible to perform an intermediate analysis during a parameterized measurement to check whether the required limit of detection has already been reached. An intermediate analysis can either be triggered from the configuration panel by selecting **Analyze** from the context menu of the respective detector’s context menu or from the live spectrum view using the **Evaluate** quick icon.

Note that the data acquisition will continue in the background and will not be affected by the intermediate analysis.

A spectrum analysis in LVis contains several automatically executed steps that differ depending on the respective type of measurement and the settings in the parameter set.

Typically, the first step in the analysis is the calculation of geometry and true coincidence summing correction factors using either tRAYcy or EFFTRAN. LVis will indicate this by showing a respective status window:

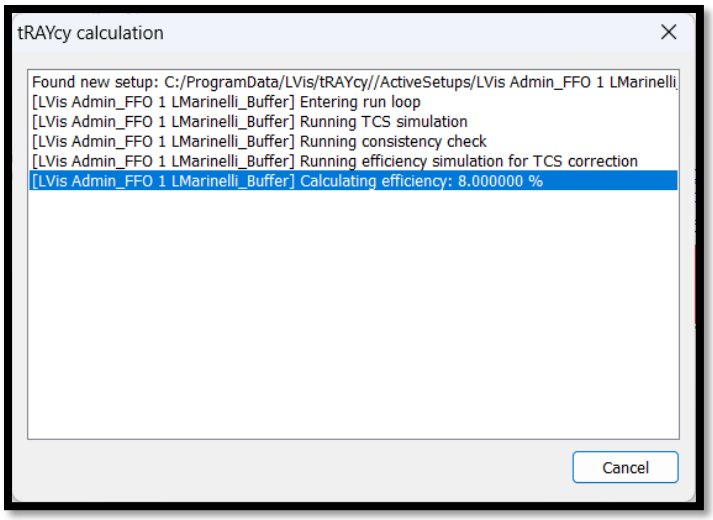


Figure 167. tRAYcy Status Window

Depending on the type of parameter set, this is followed by either an ROI analysis or a sophisticated gamma analysis using one of the analysis engines and the respective settings defined in the counting routine.

In addition, a mathematical peak search is performed.

Upon completion, if an analysis of the measurement was completed before the specified live time preset was reached (intermediate analysis) and users would like to continue the measurement (e.g., because the required limit of detection has not been reached), then select **Continue acquisition**.

IMPORTANT Only if **Continue measurement** is used, does LVis maintain the connection of used measurement parameters, assigned spectrum name, etc. with the current data acquisition of the detector. If users click on **Reject** or on the Windows **Close** icon (**x**) in the upper-right corner, the reference is lost and cannot be restored. *Therefore, always use **Continue measurement**!*

7.5 CREATE REPORTS

One can either create an analysis results report for a measurement automatically within the scope of a sample counting routine by activating **Automatic analysis and report** in the parameter set or manually, following a spectrum analysis by clicking on the **Report** button on the Analysis results tab.

When a report is created automatically the LVis measurement is first saved, the report is created and added to the LVM file where it is displayed on the “Reports” tab, and a respective pdf file is created in the same location as the LVM file (under *~LVis database folder\Measurements\detector name\parameterset name*\). Depending on the settings in the parameter set, the report is also automatically printed as a hard copy.

In the latter case, when the report is created manually after an analysis, a selection menu pops up asking users to select a report template. Note that it is possible to use either Crystal Report (*.rpt) or Excel (*.xltm) templates. See also Section 5.2.6 Reporting.

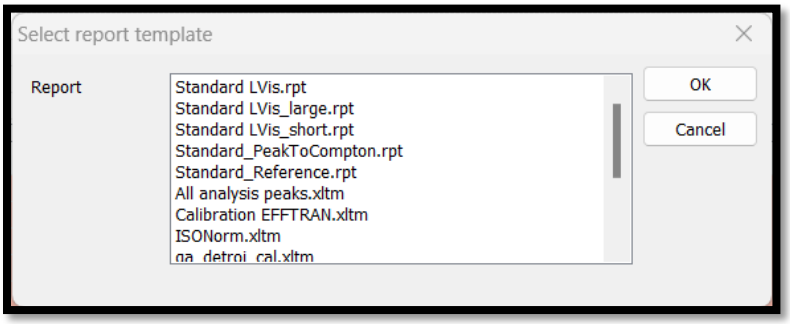


Figure 168. Select Report Template

In case the LVM file is saved, the report is created and displayed on a new “Reports” tab.

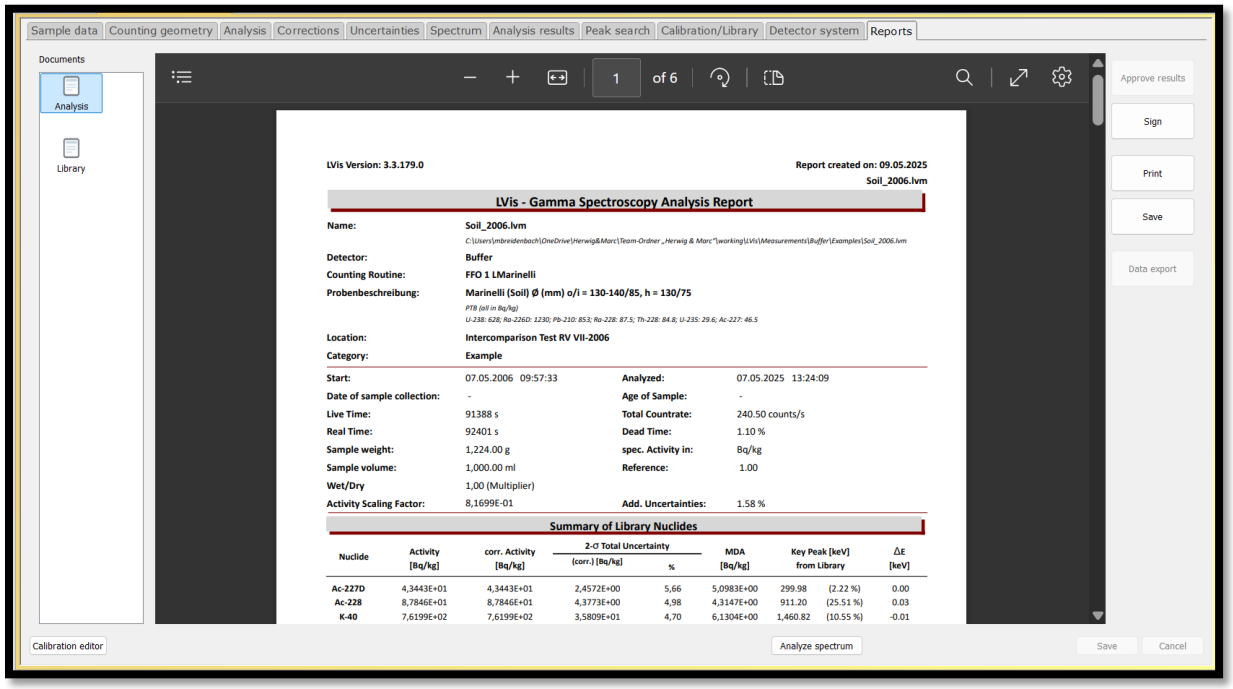


Figure 169. Reports Tab

Not that it is possible to attach multiple reports to an LVM file. All reports available for an LVis measurement are displayed on the left side bar on the “Reports” tab.

In case the LVM file is not saved, the following message is displayed asking users to either save the file or create the report in a temporary view only.

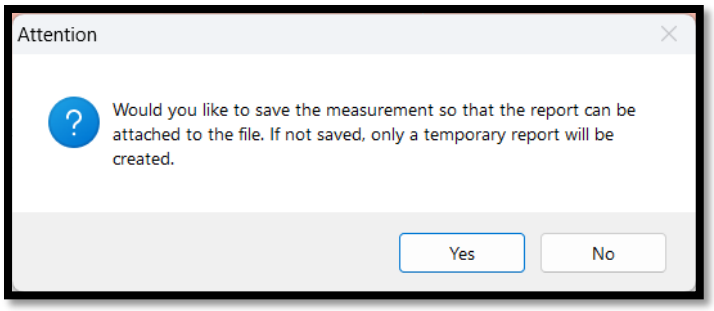


Figure 170. File Save Confirmation

Note that permanent reports can only be created for LVis measurements that were saved. The temporary reports can only be viewed. They cannot be saved or published as pdf files.

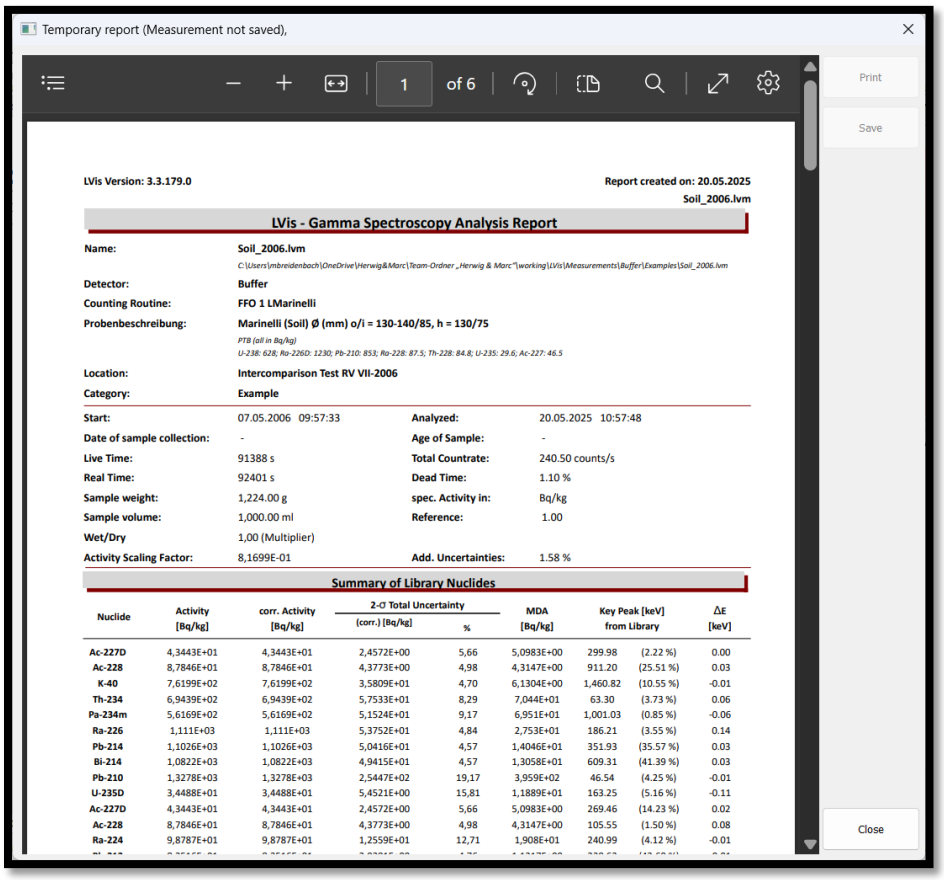


Figure 171. Temporary Report

From the “Reports” tab of an LVM file, users can export the report and save it as a pdf file using the **Save** button. It is also possible to print a hard copy using **Print**.

It is also possible to digitally sign the report that is attached to an LVM. To do this, select the respective report on the “Reports” tab and click on **Sign**. The following window pops up:

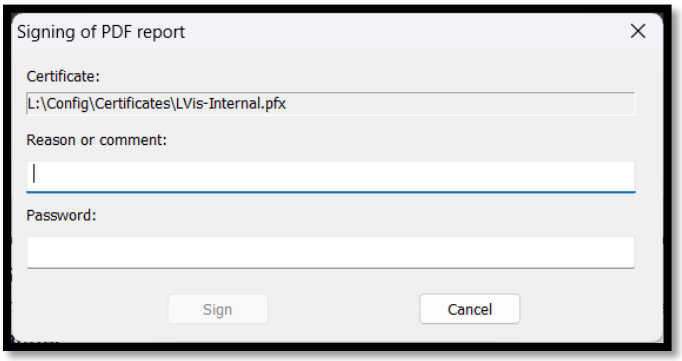


Figure 172. Digital Signing of PDF Report

The user can add a comment or reason for signing the report. To finalize the signature process, the user must enter a password. The signature is then added to the very end of the report.

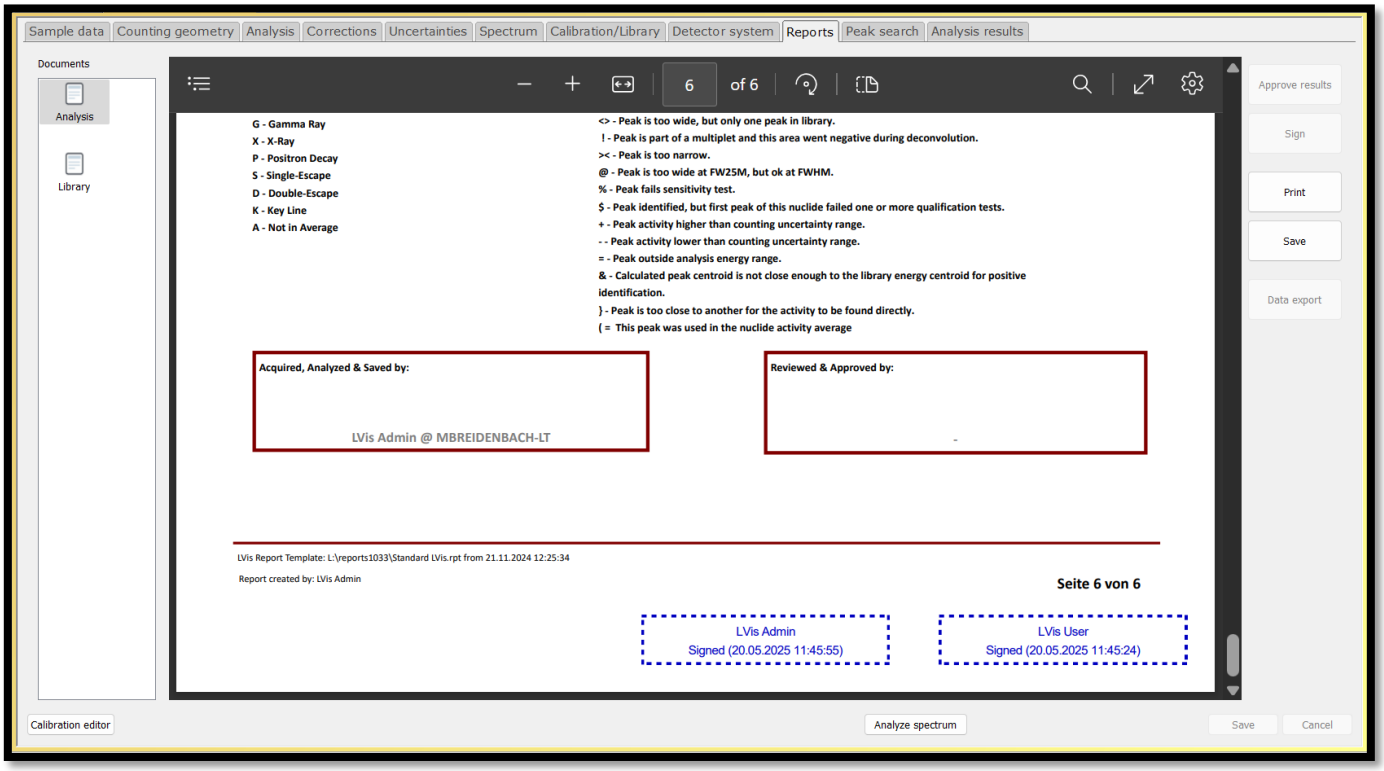


Figure 173. Report Signature Process

Note that digitally signing the report automatically saves the file and the user is not required to save the file again.

NOTE: Multiple LVis users can sign reports.

By default, the certificate to sign the pdf is a generic, internal LVis certification that only uses the respective LVis accounts password. If user specific certificates should be used for Qualified Electronic Signatures (QES), simply copy the pfx certificates into *~LVis database folder\Config\Certificates*. Note that the name of the pfx certificate file must match the name of the respective LVis user.

7.6 RE-EVALUATE EXISTING MEASUREMENTS

A measurement saved as an **.LVM** file can be re-evaluated at any time.

To re-analyze with different analysis parameters, change the respective settings and click **Analyze**. The current analysis results will be overwritten, and a new report can be created.

If the calibration or library on the “Analysis” tab is not changed, the internally stored data will be used. *This means that in this circumstance, the original, separately available files are not read again.* Therefore, if users have changed these external files (by preparing a new energy calibration or adding a nuclide to the analysis library), then the external files must be explicitly selected one more time (although they may have the same file name) in order to consider the changes in the re-analysis and import the new files into the **.LVM** file.

If a new calibration file is specified for reevaluation in the Analysis tab, then LVis offers the option of either selecting the energy (and full width at half maximum) calibration or efficiency calibration or both. Correspondingly, users can either replace the entire internally stored calibration file or only selected parts.

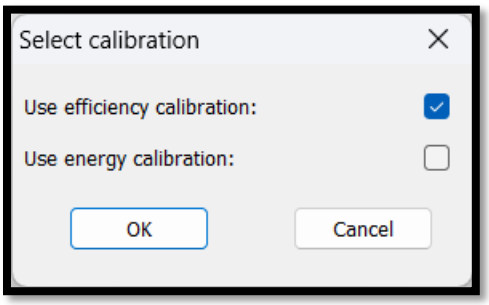


Figure 174. Specifications for Selected Calibration

NOTE: If the measurement is saved after a re-analysis, the previous settings will be overridden. Users can only reproduce the former results by resetting the analysis and correction parameters to the previous settings and re-running the analysis. Thus, for better orientation, the analysis date and time can always be found in the report.

When changing any of the analysis settings, the existing “Analysis results” tab will be deleted. All analysis reports on the “Reports” tab will also be deleted.

7.7 APPROVAL OF MEASUREMENTS AND EXPORTING ANALYSIS RESULTS

In LVis it is optionally possible to approve LVM files, respective analysis results, and reports and to export analysis results into a format so that they can be later imported into a LIMS system. Both of these features can be activated in the global Settings (see green markings in Figure 175) and are triggered from the “Reports” tab of an LVM file (so these operations are only possible when an LVM file was analyzed, and a report was created).

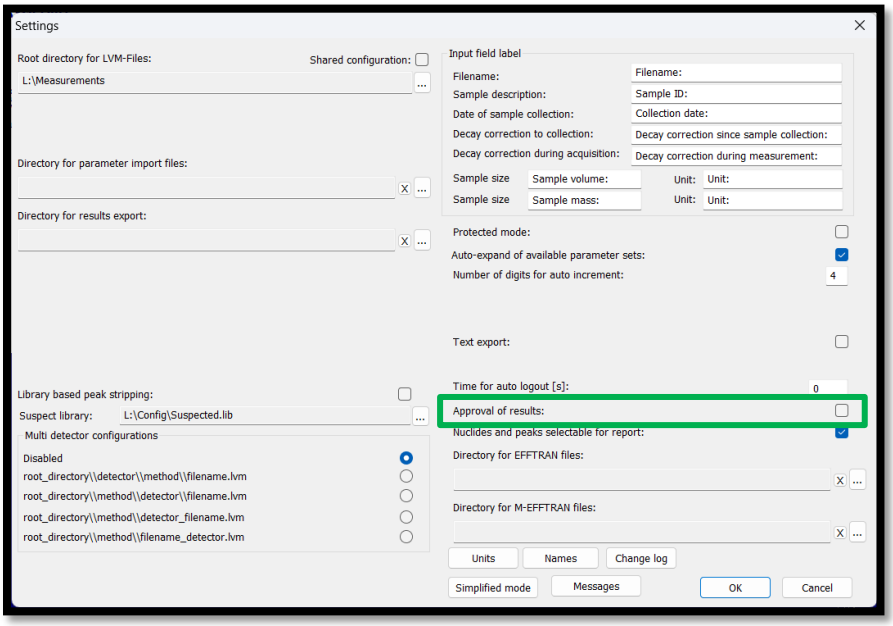


Figure 175. Settings Highlighting Approval of Results Selection

7.7.1 Approving LVM Files

The approval of LVM files adds an additional tag/status to LVM files.

Approving LVM files is a right that must be given to a user in the LVis user management. Anyone with the appropriate right to approve measurements (see Section 2.6 LVis User Management – Password-Protecting LVis Functionality) can approve or disapprove analysis results.

The status of approval is indicated by a purple or a green symbol besides the header of the “Analysis results” tab (see green markings in Figure 176).

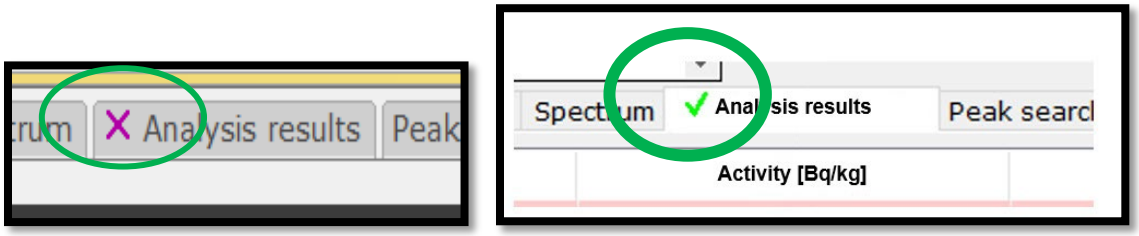


Figure 176. Analysis Approval Results

Only LVM files that are saved and for which analysis reports have been created can be approved. To change the approval status, go the “Reports” tab and click **Approve results**.

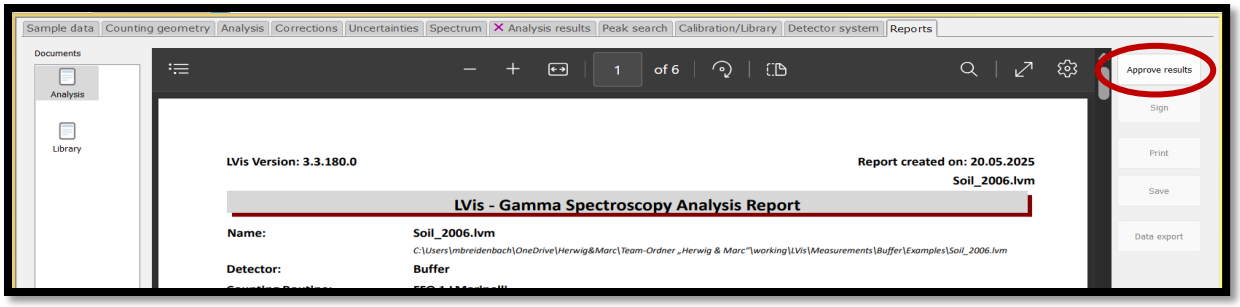


Figure 177. Approval Results Selection

NOTE: When approving analysis results users do not need to save the file again. The respective change of the status will automatically be applied to the LVM file. However, when removing an approval, users will have to save the file afterwards to apply the change.

The process of approval is identical to the process of digitally signing a report. After the button **Approve results** is clicked, a window pops up asking users to enter a comment and their password.

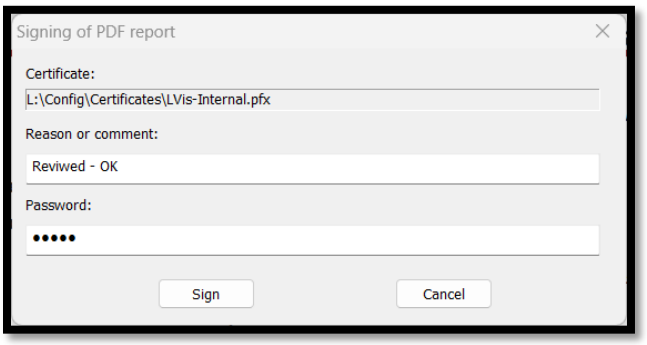


Figure 178. Report Approval Steps

The approval will be added to the end of the report similar to the digital signature.

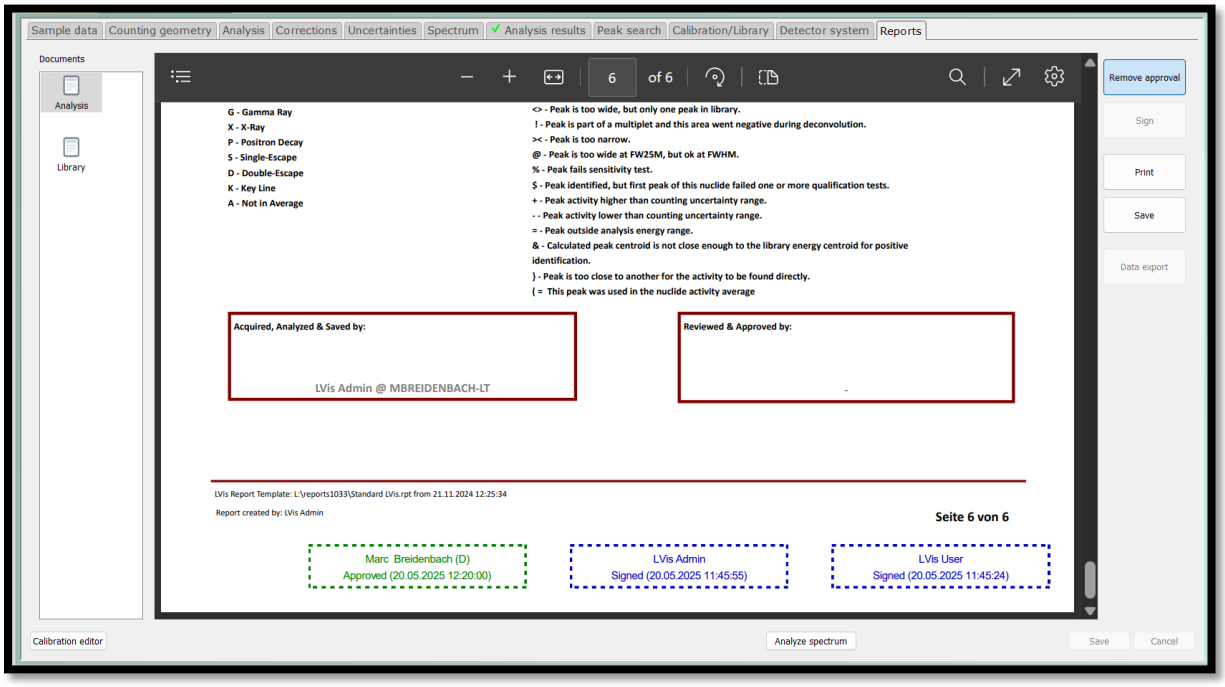


Figure 179. Reports Tab – Approval Process

The information about the approval status will be listed in the LVis Lab Journal and can hence be used for filtering and file retrieval. It is also listed in the audit trail of the LVM file.

In addition, there are specific additional things that may happen to an LVis file when being approved (depending on the type of measurement):

1. If the LVM file is a QA measurement, the QA results will be transferred to the QA detector database.

2. If the LVM file is a calibration file, users will be asked if the energy calibration shall be applied to the detector and if the efficiency calibration shall be updated in a parameter set.

7.7.2 Exporting Results From an LVM File

LVis can export analysis results. The export basically consists of the execution of a VBA script that creates a text file (or similar formats like XML, CSV, etc.) containing all the sample information and results of interest in a specified format under a distinct location, the export folder. The name of the export file is typically the name of the LVM file or ID of the sample. A LIMS monitors the respective folder and automatically imports the data from the export files into its database. So, to use the export feature in LVis, **Text export** must be activated in the “LVis Settings”, and the location of the respective export folder must be defined (see screenshot below).

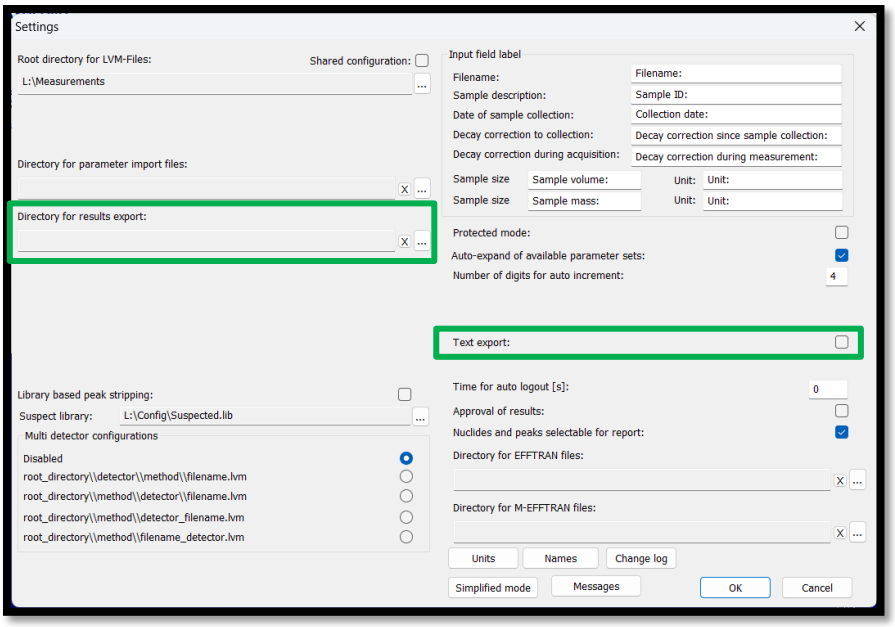


Figure 180. LVis Settings Test Export

An example export script “Export.xlsm” is located in the folder “ImportExport” of the LVis database folder.

To export data from an LVM file, click the button **Data export** on the “Reports” tab of an LVM file.

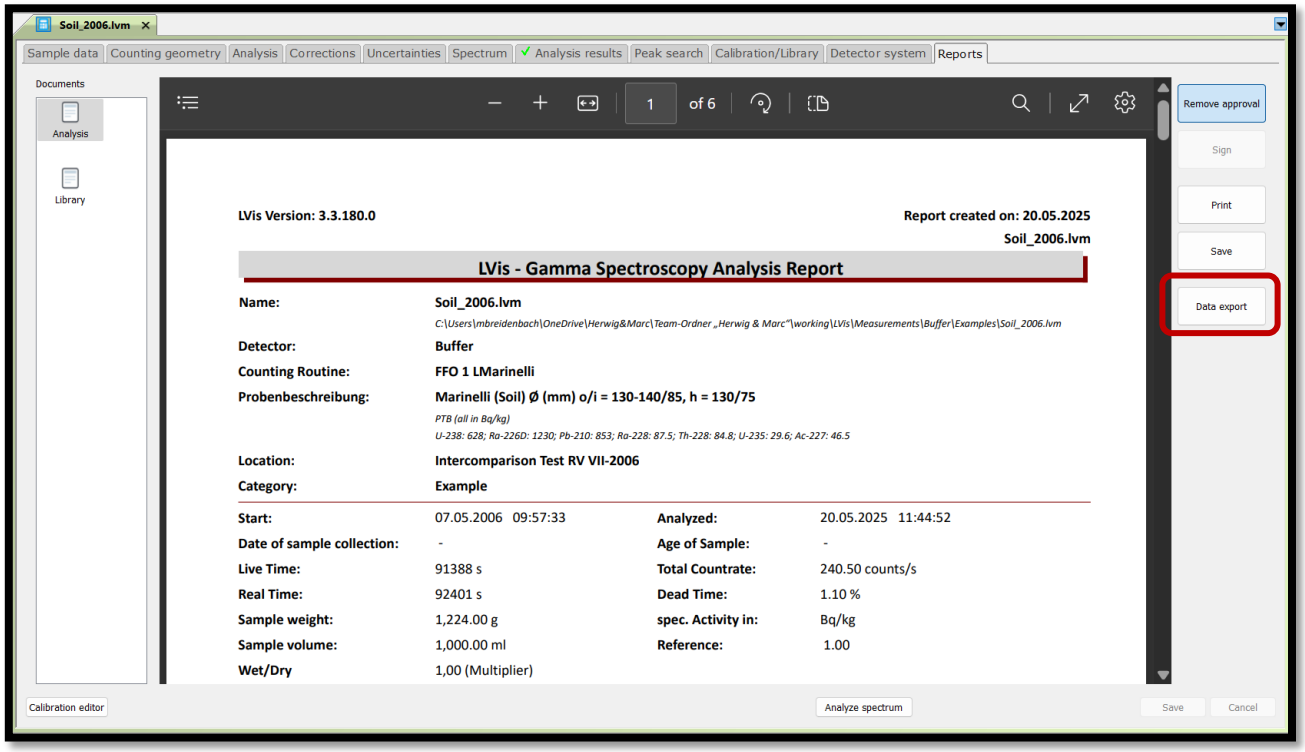


Figure 181. Data Export Button Highlighted

This will execute the script and create the respective file.

The default export file for the “Soil 2006.lvm” example measurement under ~LVis database folder\Measurements\Buffer\Examples\ is shown in the screenshot below:

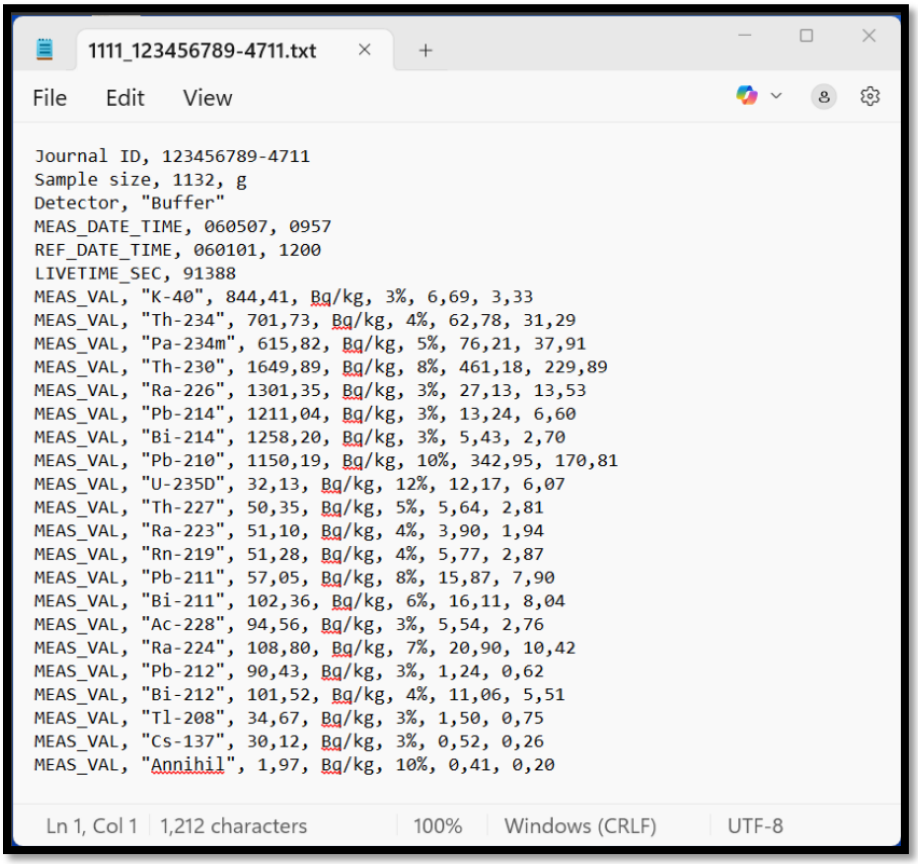


Figure 182. Default Export File for Soil 2006.lvm

NOTE: The “Export.xlsm” script provided with LVis is just intended as an example. If users would like to export results from LVis, this VBA script can be used by someone familiar with VBA programming to adjust the output format if needed. For users not familiar with VBA programming, it is strongly recommended to contact ORTEC’s technical support for help.

7.8 MONTE CARLO CORRECTIONS IN LVIS

LVis extremely simplifies the correction for geometrical differences between the sample geometry and the counting geometry or for true coincidence summing (TCS). When activated in the parameter sets, these corrections are calculated on-the-fly during the gamma analysis using either ORTEC’s Monte Carlo algorithm tRAYcy or the free software codes EFFTRAN and/or MEFFTRAN (www.efftran.com). For the **geometry correction** an energy dependent efficiency transfer function is applied by creating a respective geometry correction file (*.GEO). The nuclide/peak specific correction factors to account for the TCS are implemented by creation of a correction library (*.LVF) file. Both of these corrections, LVF and GEO are saved in every LVis measurement file (*.LVM) as internal data.

To activate the corrections, one only needs to tick the respective boxes on the “Corrections” tab of a parameter set.

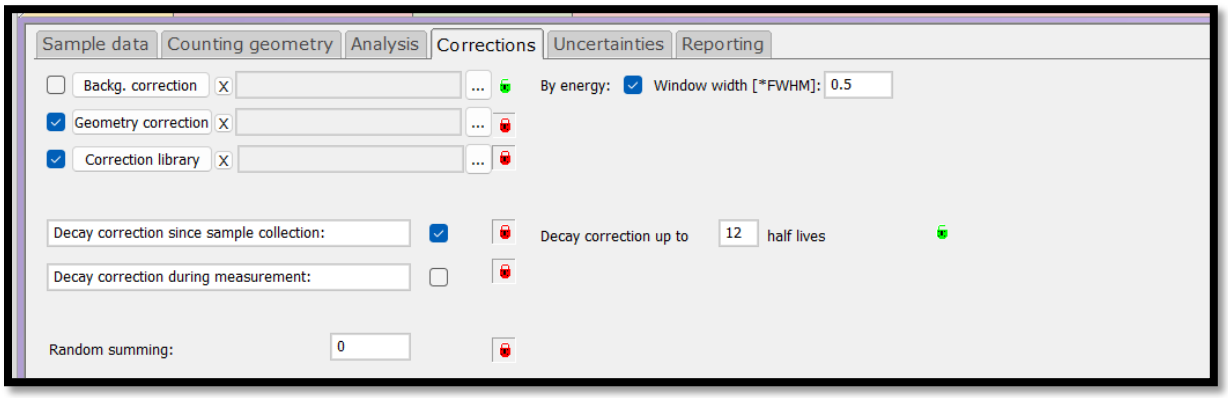


Figure 183. Parameter Set Corrections Tab

LVis then automatically triggers these calculations and uses its results during an analysis process.

In order to perform these calculations, the Monte Carlo codes require lots of input information. These are:

- **Valid detector data** – This is dimensional and requires (Section 3.2.4 Materials Editor) for description of the geometrical details of the detector element. (Usually, this info is given on the detector data sheet). For a detector that is configured in LVis, this data can be entered from the detector configuration menu. Any new measurement that is acquired will then automatically have this information available. For existing measurements (LVM files) this information can be entered on the “Detector system” tab (See Section 2.7.1 Detector Configuration for more information).

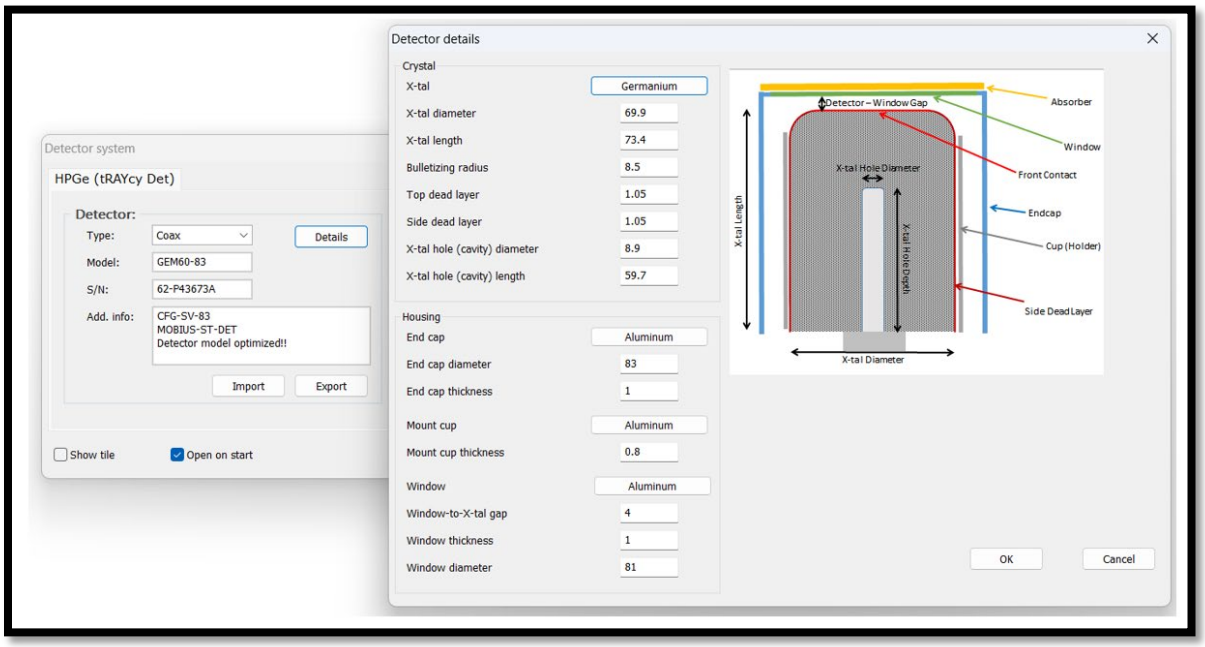


Figure 184. Detector Details

- **Valid information about the calibration geometry (sample container, position on endcap, matrix, etc.)** – This information is only available when the calibration is taken from an LVM file, it is not possible to do efficiency transfer calculations when using GammaVision CLB files for the calibrations. When creating LVM calibrations in LVis, the container and matrix information is automatically taken from the reference source information. In case a "normal", sample LVM file is used for the calibration make sure that the respective data is specified on the "Counting Geometry" tab. It is possible to check the respective calibration geometry via the "Info" button under the calibration graph on the "Calibration/Library" tab of an LVM file (see **a** to **d** in the screenshot below).

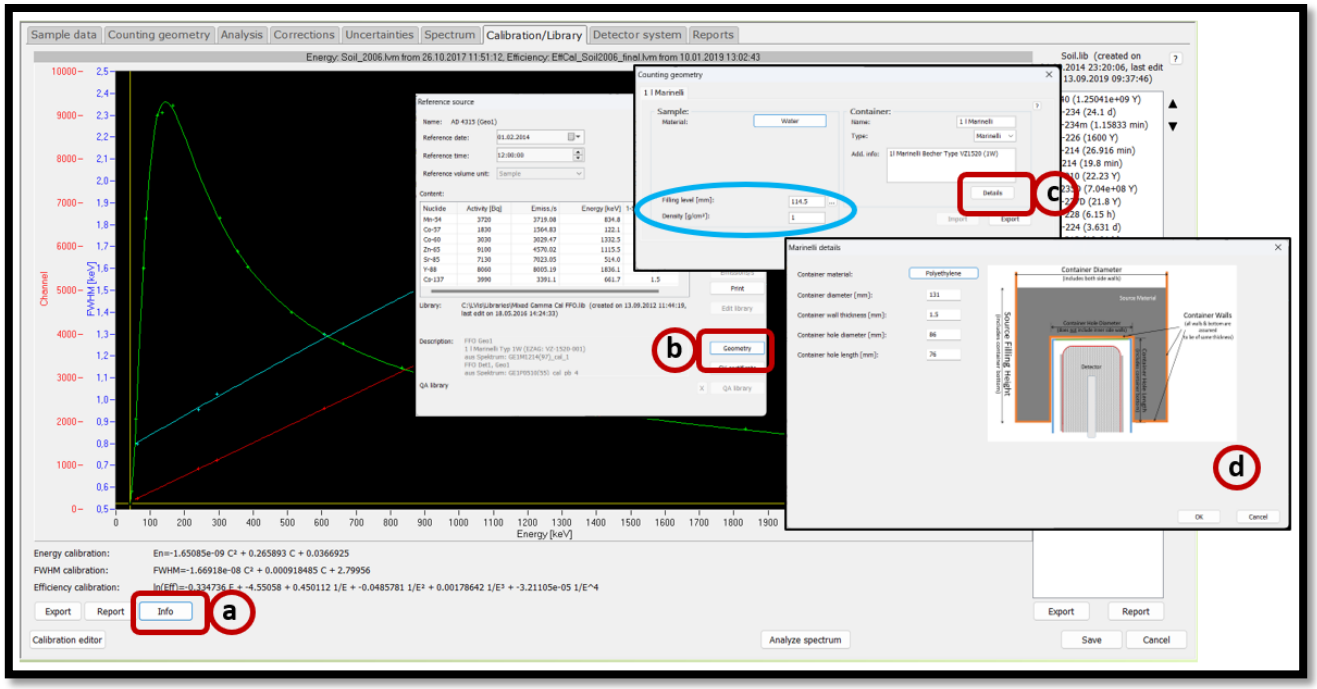


Figure 185. Calibration/Library Tab Showing Counting Geometry

- **Valid information about the sample counting geometry (sample container, position on endcap, matrix etc.)** – This can be specified on the "Counting Geometry" tab (see orange marking on the screenshot below).

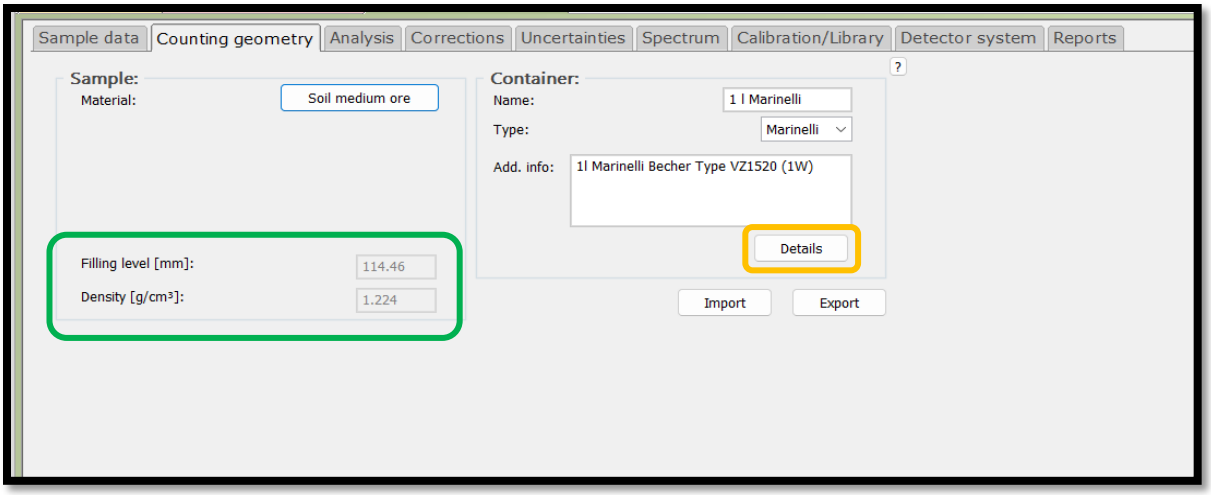


Figure 186. Counting Geometry Tab

Note that LVis always calculates an average density for the specified sample material (and the respective filling level – see green marking in Figure 186 above) based on what was entered in the sample mass and volume fields (see red marking in Figure 187 below).

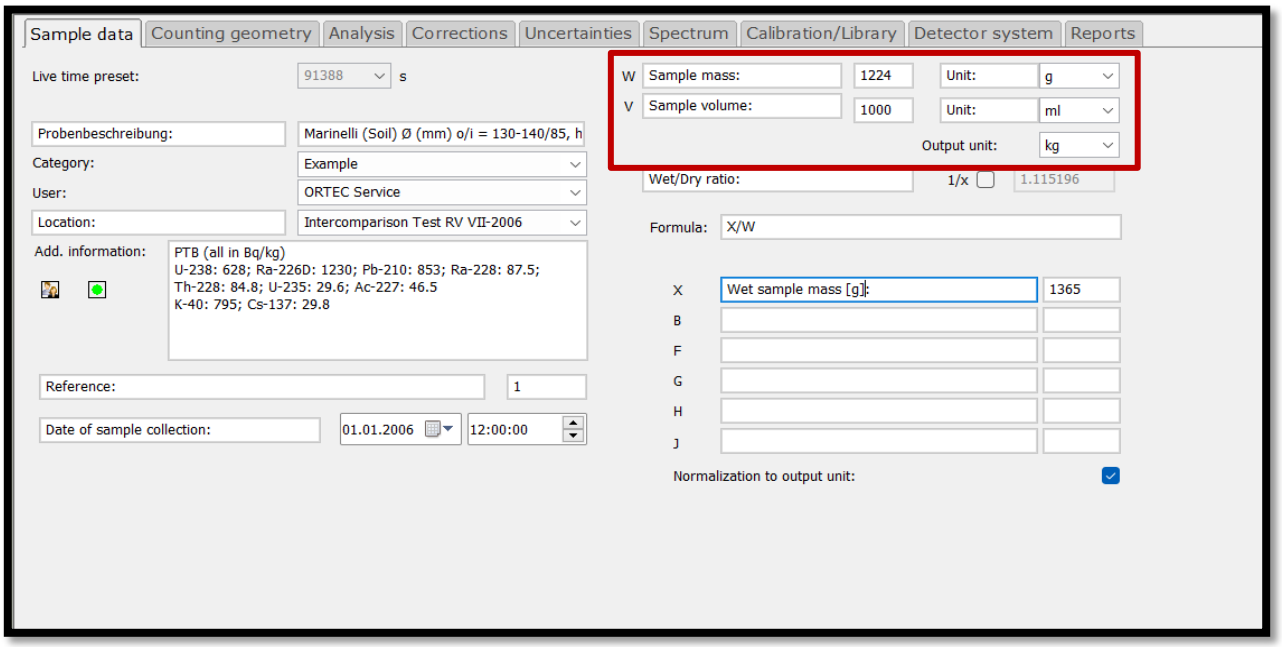


Figure 187. Sample Data Tab Highlighting Sample Mass and Volume

NOTE: The density that is specified in the materials editor for the respective sample material will not be used. Instead of the sample volume users can specify the sample filling height in the "sample size input fields".

7.8.1 Using tRAYcy

tRAYcy is the default Monte Carlo algorithm in LVis. No further settings are required to use it. The status of tRAYcy calculations during a spectrum analysis is displayed in a separate window:

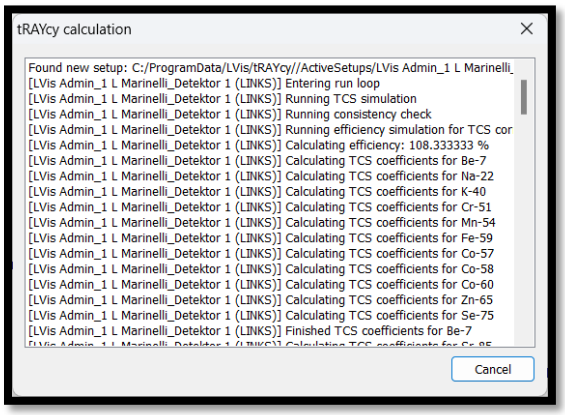


Figure 188. tRAYcy Calculation Status

Note that tRAYcy is utilized by LVis not only for the calculation of geometry or TCS correction factors but also for the calculation of efficiencies or to simulate spectra. The program “tRAYcy Whisperer”, which is started automatically by LVis, manages the tRAYcy calculations and is capable of handling multiple tasks parallel. However, note that the calculation time increases significantly when multiple geometries are being calculated at the same time. The “tRAYcy Whisperer” program can be opened by double clicking on its icon in the Windows system tray. It will present a log of all tRAYcy calculations since it was last started. At the very beginning (right after start) an overview of the tRAYcy settings is provided (see screenshot below).

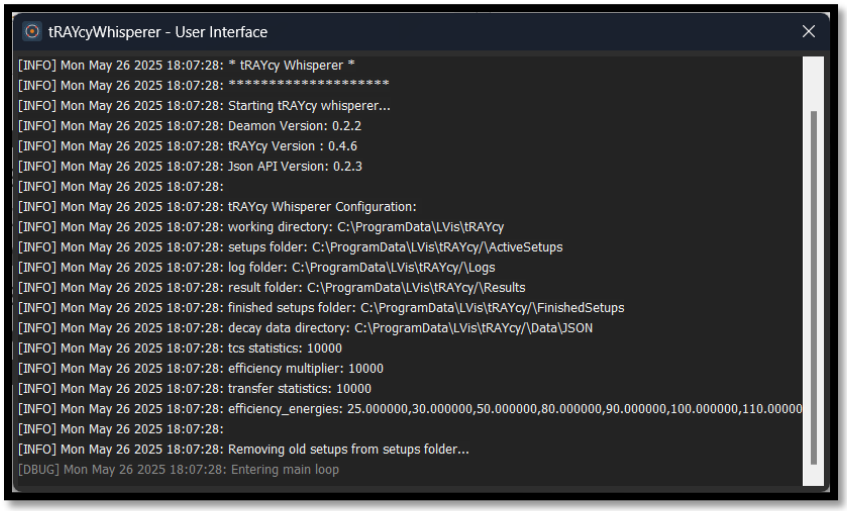


Figure 189. The “tRAYcy Whisperer” Program

IMPORTANT In order to calculate TCS correction factors, tRAYcy matches the nuclide names and peak energies from the analysis library with its internal database of decay data (created from ENSDF downloaded from NNDC website: Evaluated and Compiled Nuclear Structure Data). The respective peak will only be corrected if the nuclide name is identical and the energy is within a very small energy window. So, for example if Iodine-131 is listed in the analysis library as J-131 it will **not** be corrected,

because the correct elemental symbol for Iodine is “I” and not “J” and hence J-131 is not existing in the tRAYcy decay data. Therefore, always check the correction factors in the LVF file and double check if a correction factor is 1 (so no correction is applied).

7.8.2 Using (M)EFFTRAN

To make use of (M)EFFTRAN, copy EFFTRAN and MEFFTRAN onto the user’s computer. The file location of these programs must be defined in the LVis Global Settings (see Figure 190 below). Users can download EFFTRAN or MEFFTRAN from the official site on github (Efficiency transfer and true coincidence summing corrections for environmental gamma-ray spectrometry | EFFTRAN).

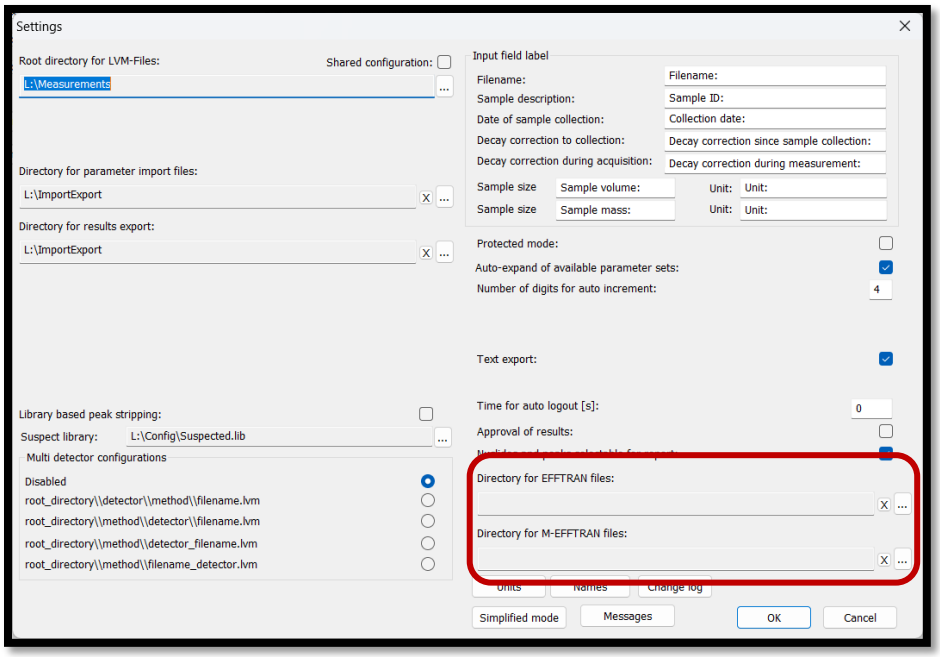


Figure 190. Settings with EFFTRAN and M-EFFTRAN Directories Highlighted

When clicking “Analyze Spectrum”, LVis will then combine all the required information and will send it to (M)EFFTRAN. The status of the EFFTRAN calculation is displayed in a separate window:

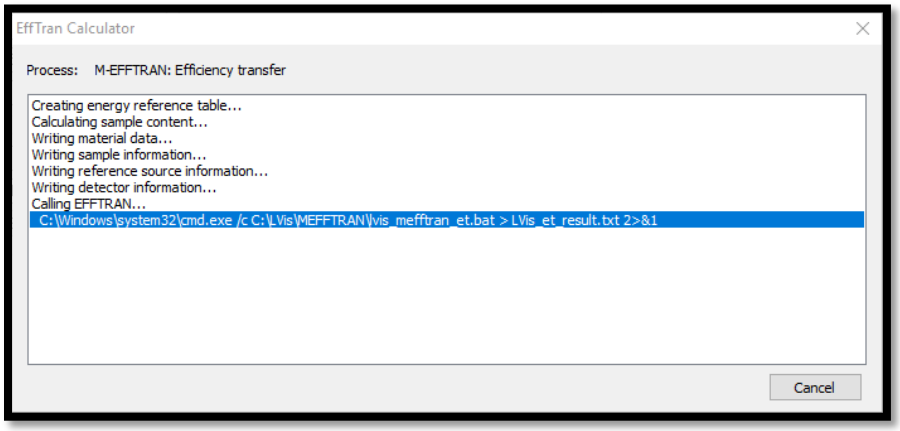


Figure 191. EFFTRAN Calculator Status

The resulting correction factors will automatically be used to correct the analysis and can be reviewed on the “Corrections” tab by clicking the button on the right side of the respective correction type field.

IMPORTANT Pay attention to the analysis library setup when using EFFTRAN for the calculation of true coincidence summing (TCS) factors. In order to calculate the correction factors, EFFTRAN matches the nuclide names and peak energies from the analysis library with its internal database of decay data (KORDAT) and only if the nuclide name is identical and the energy within a very small energy window, the respective peak will be corrected. So, for example if Iodine-131 is listed in the analysis library as J-131 it will **not** be corrected, because the correct elemental symbol for Iodine is “I” and not “J” and hence J-131 does not exist in the EFFTRAN decay database. The same applies for the peak energies. The correct Co-60 peak energies are 1332.49 and 1173.23 keV. An analysis library using 1332.51 keV and 1173.24 will leave the first peak uncorrected and the second corrected, simply because the 1332.51 keV peak is too far away from the EFFTRAN database entry. Therefore, always check the correction factors in the LVF file and double check if a correction factor is 1 (meaning no correction is applied).

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8. QUALITY CONTROL IN LVIS (QA)

The accuracy and reproducibility of results, and the overall correct functioning of both the hardware and the software of a system should be verified on a periodic basis through Quality Assurance (QA) measurements. Standard QA practices dictate that measurements are conducted according to certain specified parameters and the analysis results are compared against expected values to determine the overall status of the system.

For each detector in the configuration tree, LVis provides a default Quality Assurance class with predefined parameter sets that, generally speaking, monitor the main parameters of an alpha- or gamma-spectrometry system: the energy calibration and resolution, the efficiency, and the background.

LVis is designed so that the set-up and run of QA measurements follow the same principles and flow of sample measurements. Default values are entered into the QA parameter sets and, when starting a measurement, the corresponding parameter set window appears with the possibility of modifying or completing the fields. At the end of the counting time the spectrum is analyzed with the entered parameters, and the results are presented in a measurement file (**.LVM**). Thus, many operations within the software for QA are very similar, if not the same, as for unknown samples. It is recommended to read Spectrum acquisition and analysis (Chapter 7) on the acquisition and analysis process and LVis Parameter Sets (Chapter 5) on parameter sets before approaching the QA class.

Naturally, QA measurements also have their own specific settings and parameters due to their scope, including the limits of acceptability for a control value, the possibility of locking a detector if a QA measurement fails or is not periodically performed, and the ability to track and display results over time with control charts to monitor the stability of a system.

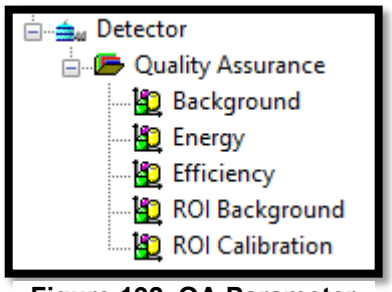


Figure 192. QA Parameter Sets

LVis provides QA parameter sets for both the automatic gamma analysis and the simpler user-directed region-of-interest (ROI) analysis, as shown in Figure 192. Usually, only one type of analysis is used depending on the system available. The general settings, however, are common to both types, and are thus discussed in the next section.

8.1 QA SETTINGS

The general QA settings for a detector can be accessed only by a user with rights to the detector. Right-clicking on the "**Quality Assurance**" class and then selecting **QA-Settings** displays the following window:

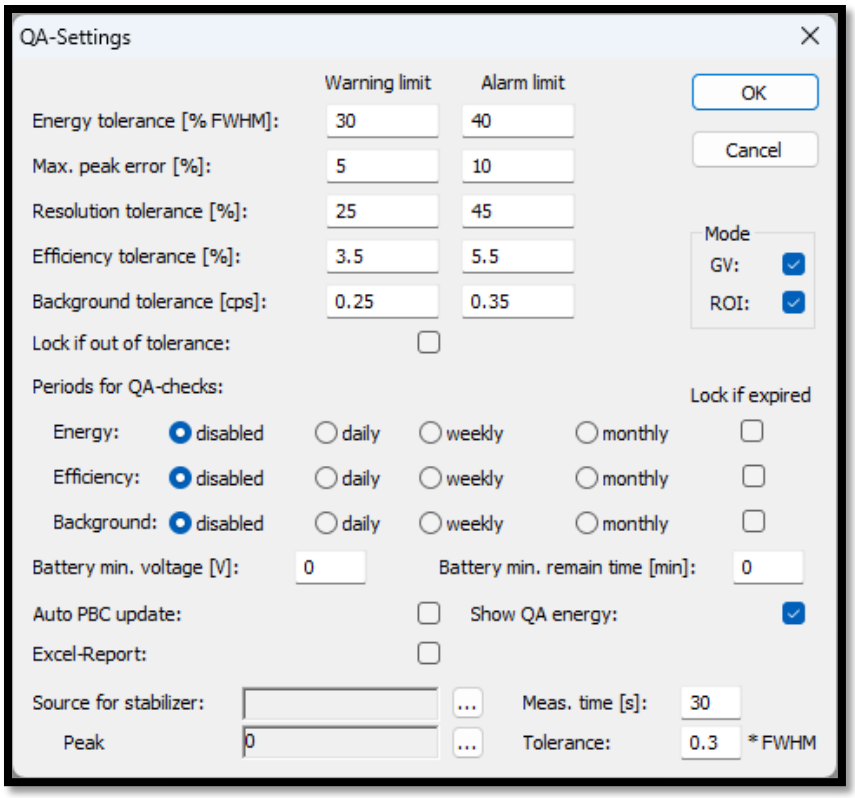


Figure 193. QA-Settings

The first setting to be adjusted is usually the **Mode**, located below the Cancel button. Selecting **GV** displays the QA parameter set for the automatic gamma analysis (i.e., Background, Energy, and Efficiency) in the Quality Assurance class, while selecting **ROI** displays the QA parameter sets for the simpler ROI analysis (i.e., ROI Background and ROI Calibration). If users wish to hide either type because they are not in use in their system, simply uncheck the corresponding box (by default both types are checked).

There are four control parameters in LVis:

- Energy tolerance [% FWHM]
- Resolution tolerance [%]
- Efficiency tolerance [%]
- Background tolerance [cps]

The Energy parameter set checks the energy and resolution. The Efficiency parameter set checks the energy, resolution, and efficiency. When doing a QA efficiency measurement, a QA energy check is also automatically performed. The Background parameter set checks the background. For the ROI analysis, only the efficiency and the background control parameters are checked through the ROI Calibration and ROI Background parameter sets, respectively.

The Max. peak error [%] is not directly a control parameter, rather it is used to exclude peaks from a QA energy or efficiency measurement (see below for further details).

For each control parameter, it is possible to specify two tolerance values within which the analysis results of the QA measurements should and/or must fall to be accepted. The **Warning limit** is usually used to warn that something is not entirely right. Care should be taken to understand the reason for

the warning, but the system could be kept operative. If any of the parameters exceed the warning limit (but not the alarm limit), a yellow exclamation mark appears next to the detector's name. The **Alarm limit** is usually used to indicate that something is not working as it should. An investigation into the reason for the alarm is necessary, and the system should not be used until the root cause has been identified and resolved. If any of the parameters exceed the alarm limit, a red exclamation mark appears next to the detector's name. Of course, these are just general suggestions, and the ultimate interpretation of the warning and alarm limits is not prescribed in LVis.

The **Energy tolerance [% FWHM]** measures the validity of the energy calibration of the detector. For each peak in the QA analysis library, the deviation of the peak centroid in the spectrum from the library energy is calculated and expressed as a percentage of the FWHM at that energy. This parameter is directly comparable to the Match width (*FWHM) parameter in the Analysis tab of a sample parameter set. If the limits specified here are less than the Match width value in a parameter set, then a passing QA measurement assures that peaks in a sample spectrum analyzed with that parameter set have a high probability of being correctly identified.

The **Resolution tolerance [%]** measures the validity of the FHWM calibration of the detector. For each peak in the QA analysis library, the deviation of the peak FWHM in the spectrum from the FWHM in the calibration curve at that energy is calculated and expressed in percentage.

The **Efficiency tolerance [%]** measures the validity of a user-selected efficiency calibration curve. For each of the three reference nuclides in the QA analysis library, the deviation of the nuclide activity from the reference activity is calculated and expressed in percentage.

The **Max. peak error [%]** is used to exclude peaks with a high counting uncertainty from a QA energy or efficiency measurement. Any peak in the spectrum with a counting uncertainty above the Alarm limit is not used in the QA check, even if that peak is present in the QA analysis library or it is a peak of a reference nuclide.

The **Background tolerance [cps]** measures the validity of the background of the detector, that is, the presence of contamination inside the detector shield and/or electronic noise in the measurement chain. The deviation of the total count rate in the spectrum (i.e., the sum of all the counts in the spectrum divided by the live time) from the reference value is calculated and expressed in counts per second (cps).

The QA analysis library, the reference nuclides, and the reference values for each control parameter are entered into the respective parameter sets, described in detail in the next section.

If it is desired to prevent a detector from being used after a failed QA measurement, it is possible to select the **Lock if out of tolerance** option. In case a parameter exceeds the alarm limit, it will only be possible to perform QA measurements until all the parameters fall back below their limits.

It is also possible to set a reminder on the **Periods for QA-checks**. If the selected period from the last QA measurement is exceeded, a message in the detector status is displayed. If in addition the **Lock if expired** option is selected, it will only be possible to perform QA measurements.

The **Battery min. voltage [min]** and **Battery min. remain time [min]** values can be used to check the battery status of an instrument that is equipped with one.

The **Auto PBC update** option allows automatic updating of the background file for all parameter sets of the detector using a successful QA background measurement. For further information, see the corresponding section later in this chapter.

Since a QA energy check is automatically included when running a QA efficiency measurement, it is possible to use just the Efficiency parameter set to check the energy, resolution, and efficiency control values. In this case, it is possible to hide the Energy parameter set by deselecting the **Show QA energy** option.

The **Excel-Report** option allows the use of Excel templates instead of the standard Crystal Report templates to print the QA control charts. For further information, see the corresponding section later in this chapter.

The remaining parameters (**Source for stabilizer**, **Peak**, **Meas. time [s]**, and **Tolerance**) are typically used with scintillator detectors to stabilize the position of the peaks in the spectrum, since these types of detectors are notoriously unstable against variations in the ambient conditions.

8.2 QA PARAMETER SETS

QA parameter sets are very similar to sample parameter sets described in Chapter 5 for the automatic gamma analysis and in Chapter 9 for the ROI analysis. Thus, this section focuses on tabs and parameters that are specific to QA measurements only. When a tab or parameter is not discussed, it means that it is exactly the same as a sample parameter set.

8.2.1 Energy

The Energy parameter set is used to check the energy and resolution control parameters.

The figure below shows the default Sample data tab. It is much simpler than the corresponding tab for a sample parameter set since many parameters are not needed or already specified elsewhere.

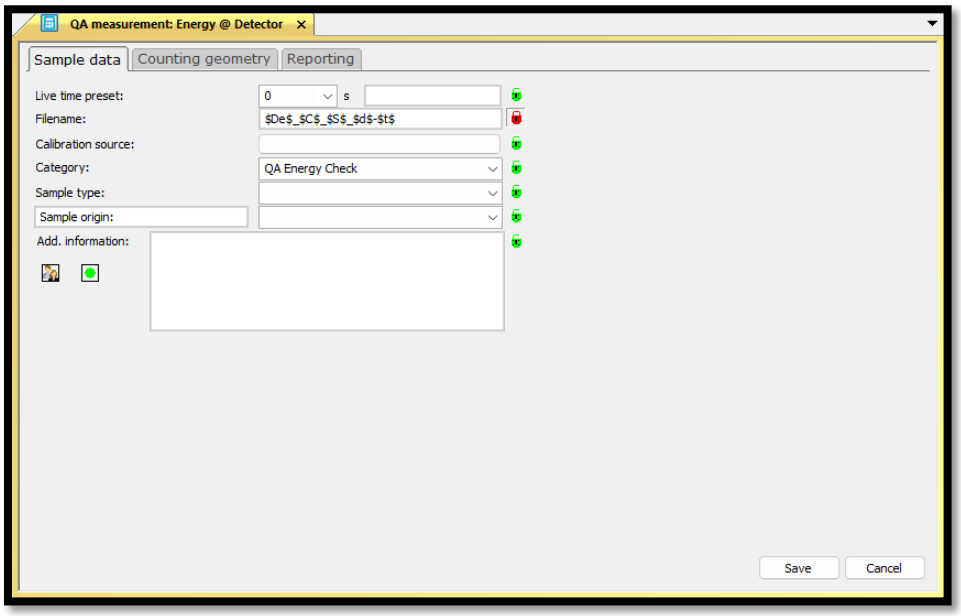


Figure 194. QA Measurement Sample Data Tab

The only specific parameter is the **Calibration source**. To select the source used for the QA measurement, click in the respective field to reveal the list of sources defined in the Reference Sources section of the management panel (see Section 3.2.2) and select the desired source.

The QA library associated with the Calibration source defines the peaks that will be used in the QA energy analysis. Even though the Energy tolerance [% FHWM] and the Resolution tolerance [%] limits are the same for every peak, LVis tracks their centroids and FWHM values independently. During the QA energy analysis, LVis calculates the deviations of the measured values from the library or calibration values peak by peak. If any of the deviations exceeds a warning or alarm limit, a corresponding action (e.g., yellow/red exclamation mark or detector locking) is triggered. Likewise, the QA energy report and the control charts display the deviations peak by peak.

The **Counting geometry** is automatically populated based on the selected Calibration source. Although it is possible to modify the parameters here, for best practices it is recommended to modify the geometry of the calibration source in the respective editor and then reselect the source in the Sample data tab. Note that for a QA energy check the counting geometry parameters are not needed, as no tRAYcy corrections are involved. This tab is included for reference purposes.

The report template for a QA energy measurement is predefined, thus the template list in the **Reporting** tab is not available.

8.2.2 Efficiency

The Efficiency parameter set is used to check the energy, resolution, and efficiency control parameters, since a QA energy check is performed automatically together with a QA efficiency check.

The **Sample data** tabs follow the same considerations as the Energy parameter set. In addition, the Reference date/time field in the Sample data tab is automatically populated from the reference date and reference time fields of the selected Calibration source.

The **Counting geometry** tab follow the same consideration as the Energy parameter set. This time, however, the counting geometry parameters are needed if the tRAYcy corrections are used in the Corrections tab.

The **Analysis** tab contains the same parameters as a sample parameter set, except that it is not possible to select a library, since the one associated with the selected Calibration source is used by default.

The **Corrections** tab contains the same parameters as a sample parameter set, except that it is not possible to modify the decay corrections.

The **Reporting** tab follow the same consideration as the Energy parameter set.

The figure below shows the default **Nuclides** tab, which is specific to the Efficiency parameter set.

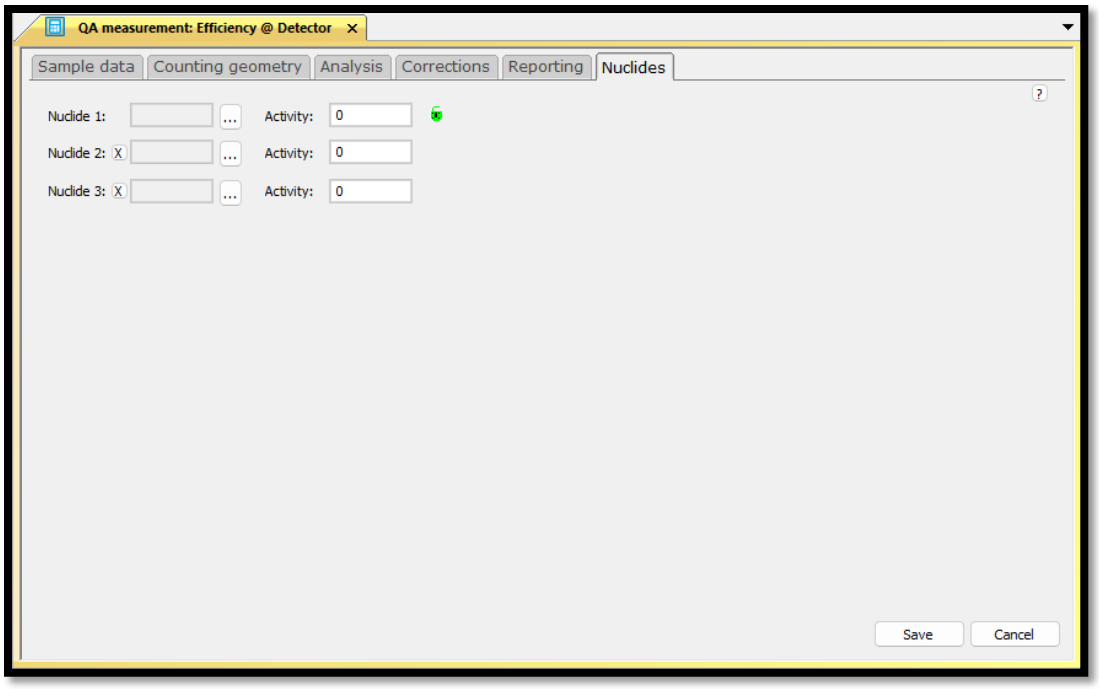


Figure 195. QA Measurement Nuclides Tab

It is possible to select up to three nuclides from the Calibration source to be used as reference nuclides for the Efficiency tolerance [%] control value. Clicking the three dots button next to a **Nuclide** field reveals the list of nuclides present in the QA library of the Calibration source, from which it is possible to select the desired nuclide. Once selected, the respective activity from the Calibration source is automatically entered in the **Activity** field. Although it is possible to modify the activity here, for best practices it is recommended to modify the Calibration source in the respective editor, then reselect it in the Sample data tab and finally reselect the nuclide.

Even though the Efficiency tolerance [%] limits are the same for every nuclide, LVis tracks their activities independently. During the QA efficiency analysis, LVis calculates the deviations of the measured activities from the reference activities nuclide by nuclide; if any of the deviations exceeds a warning or alarm limit, a corresponding action (e.g., yellow/red exclamation mark or detector locking) is triggered. Likewise, the QA efficiency report and the control charts display the deviations nuclide by nuclide.

8.2.3 Background

The Background parameter set is used to check the background control value.

The **Sample data** tabs follow the same considerations as the Energy parameter set. Since no source is used when measuring a background, the Calibration source is omitted.

The **Counting geometry** tab is included in case the background is measured with a blank sample (i.e., the same geometry of real samples, only free of radioactivity besides the natural nuclides). It is then possible to define the blank counting geometry. It is important to note that this is only for reference purposes, as no tRAYcy corrections are involved in the background analysis.

The **Analysis** tab contains the same parameters as a sample parameter set. Note that the analysis parameters are only needed if users wish to create a background file (**.PBC**) based on the QA

background measurement, which is an optional setting. If it is desired to only measure the total count rate in the spectrum, which is the only necessary control parameter for the background, the Analysis tab is not used.

The **Reporting** tab follow the same consideration as the Energy parameter set.

The figure below shows the default **Background** tab, which is specific to the Background parameter set.

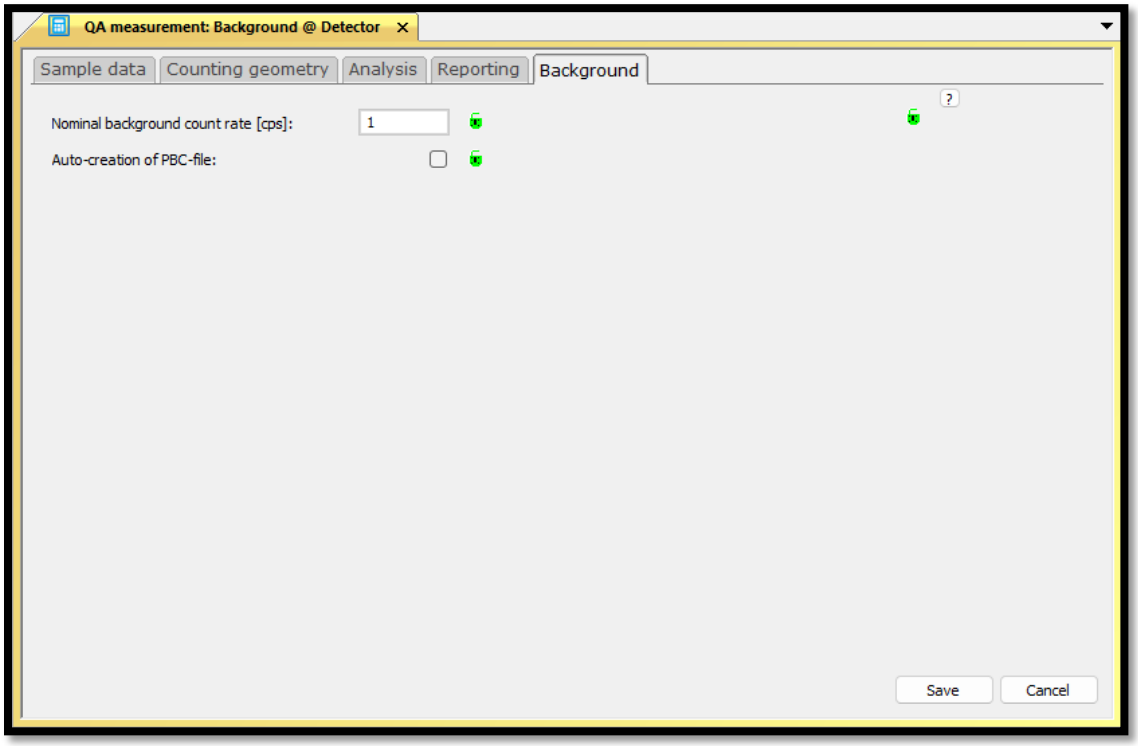


Figure 196. QA Measurement Background Tab

The **Nominal background count rate [cps]** is the reference value for the background control parameter. In a QA background analysis, LVis calculates the total counts in the spectrum divided by the live time and compares the measured value with the entered reference value.

It is possible to automatically create a new background file (**.PBC**) using the QA background spectrum and the parameters of the Analysis tab at the end of the QA measurement by checking the **Auto-creation of PBC-file** option. The new background file is automatically saved in the *PBC* folder in the detector. Note that this option alone only saves the background file but does not automatically update the sample parameter sets of the detector with it. If users also wish to use the newly created background file for the subsequent sample measurements, select the Auto PBC update option in the QA settings window. If the QA measurement is successful, all the parameter sets of the detector will be automatically updated with the new background file in the Analysis tab.

It is important to remember that for a good background file, at least a few days of background measurement are typically necessary. Thus, the Auto-creation of PBC-file and Auto PBC update options should be used only when the QA background measurement is sufficiently long. If users only wish to perform a periodic quick contamination check (say, on the order of half an hour), then creating a new background file is not recommended.

8.2.4 ROI Calibration

The ROI Calibration QA check works like the Efficiency QA using GammaVision analysis. The only difference is that the evaluation is based on ROIs instead of peak fits. These ROIs must be defined when the routine for ROI Calibration QA checks is set up. ROIs can either be imported from the detector itself, from an existing LVM, or from an LVis ROI .LVR file using the buttons on the bottom of the ROI Tab in the Calibration QA parameter set.

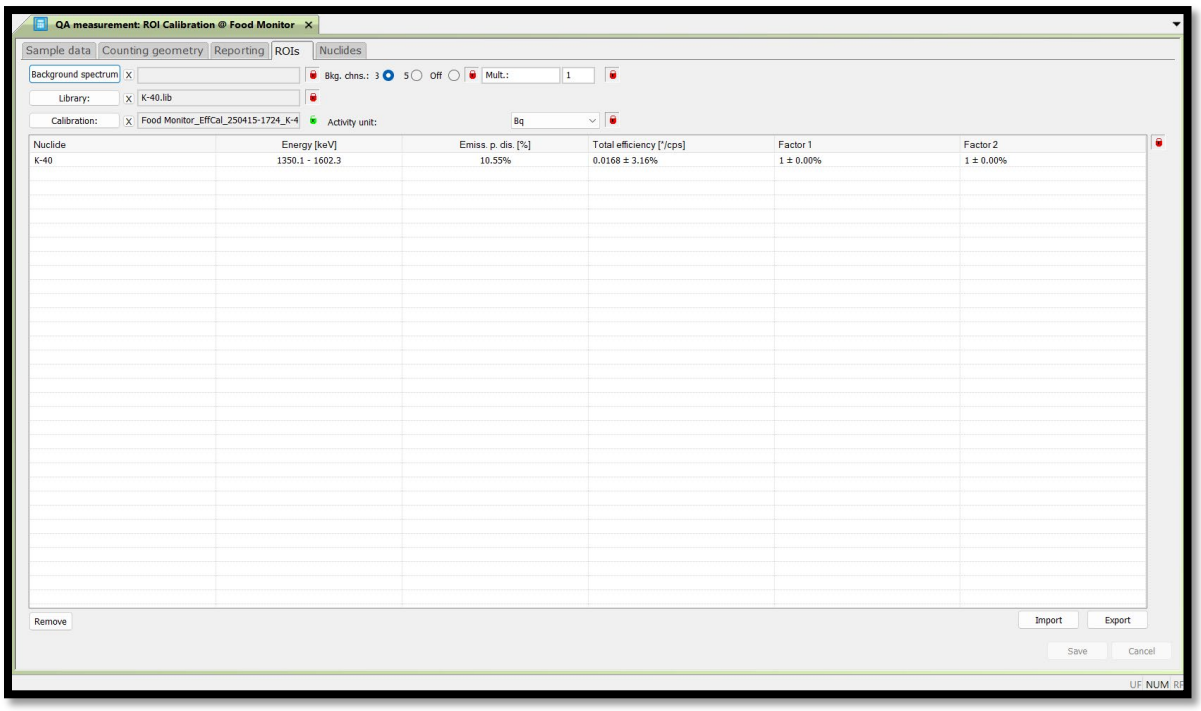


Figure 197. QA Measurement ROI Calibration

After importing the ROIs and relating them to a nuclide and an emission in the library, move to the “Nuclides” tab and select the nuclides that should be used for the QA check. This is analogous to the QA in GammaVision analysis efficiency QA checks described above.

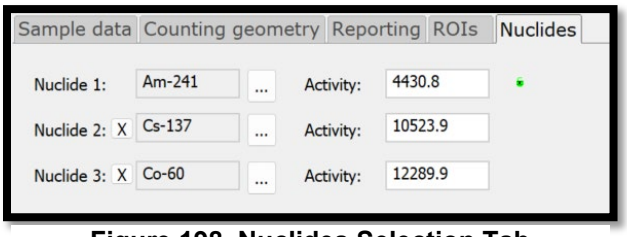


Figure 198. Nuclides Selection Tab

Note that the available nuclides are based on the library of the “Calibration Source” in the “Sample Data” tab. If no calibration source was selected in that field, no nuclides show up on the “Nuclides” tab. After saving the parameter set, an efficiency QA can be performed as usual.

8.2.5 ROI Background

The goal of the ROI background QA is to verify that the background of the detector system has not changed. The counting routine works analogous to the background QA with GammaVision analysis. To determine the “Nominal background count rate” perform and analyze an initial QA Background measurement. Enter the measured background count rate in the respective field (see Figure 199 below). From now on, the count rate of a QA Background measurement is compared to this value. If

the deviation is larger than what is defined in the QA-Settings, the system will produce a warning or an alarm.

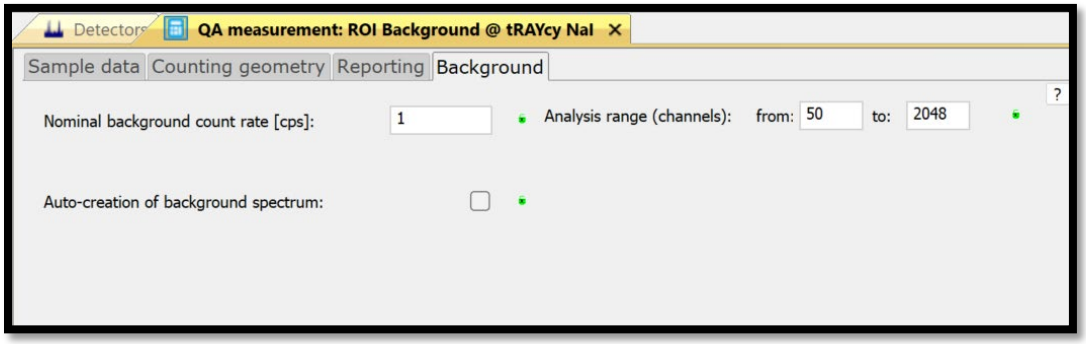


Figure 199. QA Measurement Background Tab

NOTE: For ROI QA Background checks, the gross count rate in the defined analysis range is used.

8.3 QA MEASUREMENTS

The QA measurement and analysis process is exactly the same as for sample parameter sets, both for the automatic gamma analysis and for the ROI analysis. The differences rely on the available tabs in the measurement file (**.LVM**) after the analysis. Specific tabs containing the results for the control parameters of the corresponding QA check are created, so that it is immediately possible to know whether a QA measurement has been successful or not.

The figure below shows an example of the **Energy QA results** tab. The control parameters for the energy and resolution calibrations are shown in the **Dev. [% FWHM]** and **Dev. [%]** columns, respectively. Each peak in the QA analysis library is checked for the control parameters. If the result is below the Warning limit, a **Pass** string is displayed. If the result is between the Warning and the Alarm limits, a ***Pass*** string is displayed. If the result is above the Alarm limit, a **Failed** string is displayed. In the example, the 136.47 keV peak has a 1-sigma counting uncertainty exceeding the Alarm limit of 10% set in the QA settings window, thus it is excluded from the QA results.

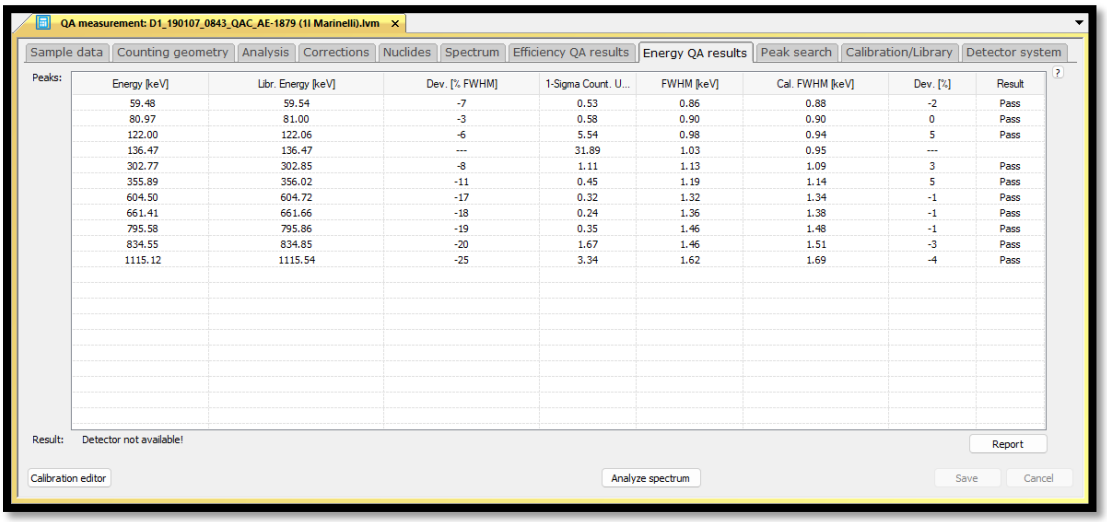


Figure 200. Energy QA Results

The figure below shows an example of the **Efficiency QA results** tab. The control parameter for the efficiency is shown in the **Deviation [%]** column. Each reference nuclide selected in the Nuclides tab is checked for the control parameter. The strings displayed are the same as the Energy QA results tab. Note that this is an example of a QA efficiency measurement, where both the QA energy and QA efficiency checks are performed, thus both tabs are attached to the measurement file. In case an Energy parameter set is used, only the Energy QA results tab is attached.

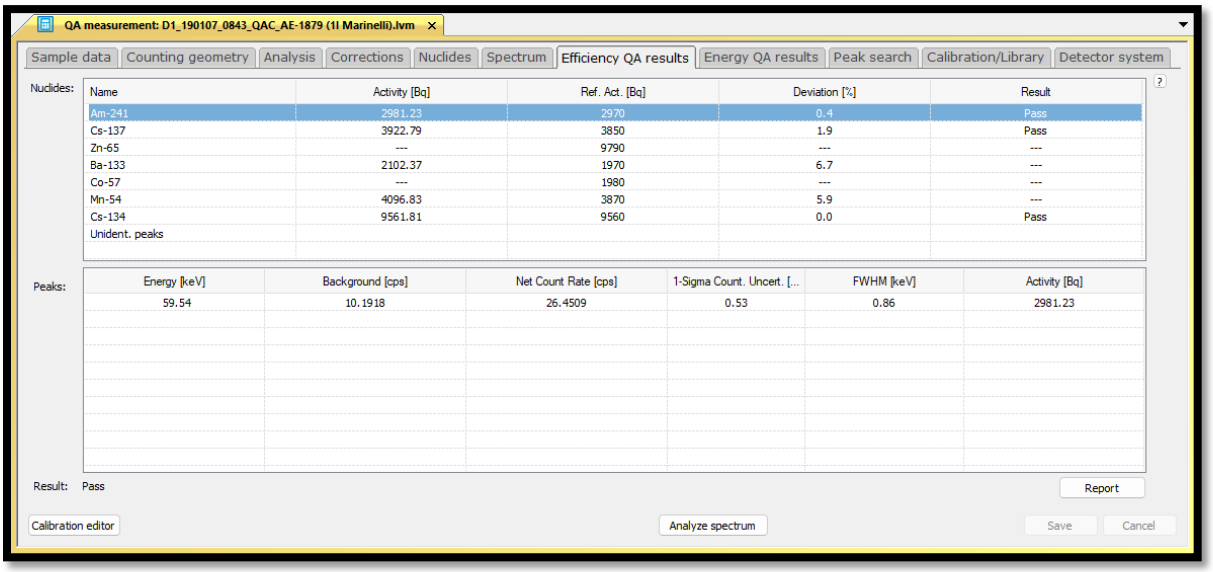


Figure 201. Efficiency QA Results

The figure below shows an example of the **Analysis results** tab of a QA background check. The control parameter for the background and the corresponding result string are displayed in the three rows above the table. This is an example of a Background parameter set where the Analysis tab parameters are correctly defined (importantly, a library is selected). Thus, the **Peaks** table is shown, which is used to automatically create the background file if the respective option is selected or can be used to create it manually with the **Create PBC** button otherwise.

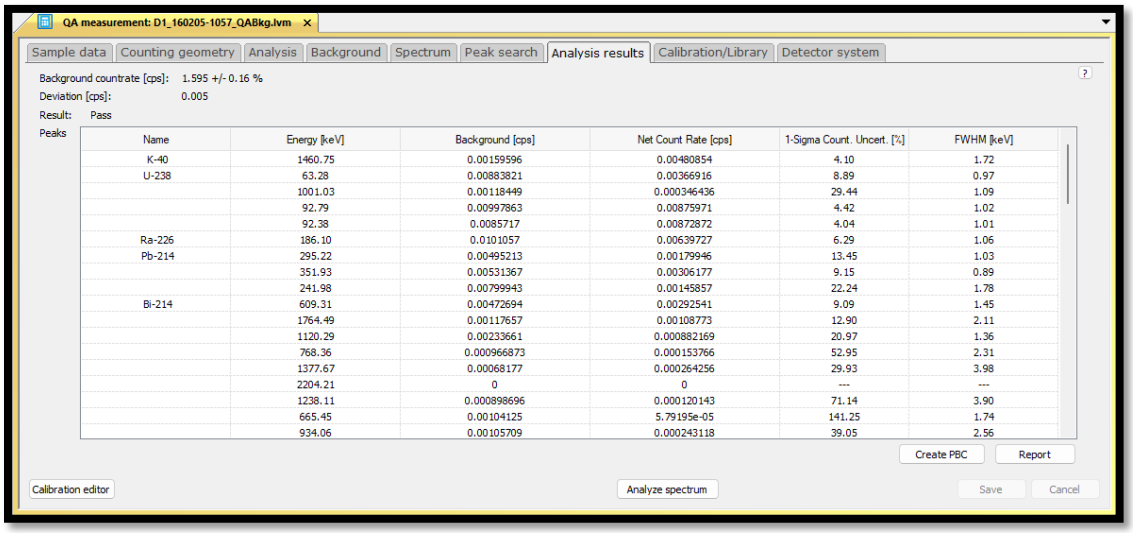


Figure 202. Analysis Results

After a QA measurement is analyzed and saved, the status of the detector is updated with the most recent QA results. To see the detector status, right-click on the detector and the select **Info**. An example is shown in the figure below:

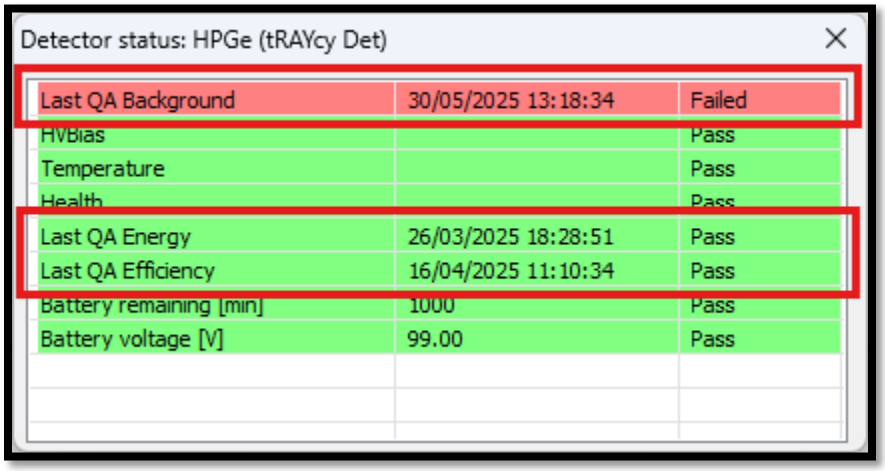


Figure 203. Detector Status

In this example, the latest QA energy and efficiency checks were successful, thus it is indicated in green. However, the latest QA background check exceeded the Alarm limit, thus it is indicated in red with a failure message. Correspondingly, a red exclamation mark is present next to the detector name ( HPGe (tRAYcy Det)). If the Lock if out of tolerance option were selected in the QA settings window, only new QA measurements would have been available.

8.4 QA REPORT

A QA report summarizes the results of different QA measurements of a detector over an extended period of time (trending). To create such a report, right-click on **QA report** in the context menu for the desired detector.

The following menu is opened, where users can select the QA method, for which the report should be created.

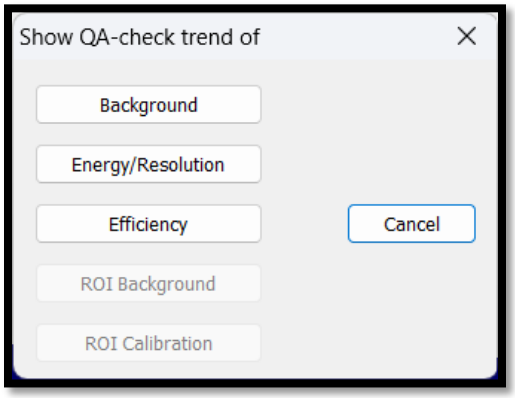


Figure 204. QA Method Selection

After the requested date range is selected, click on **OK** and the report is created.

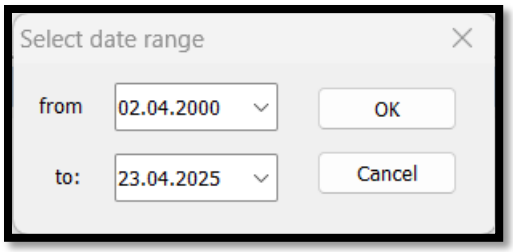
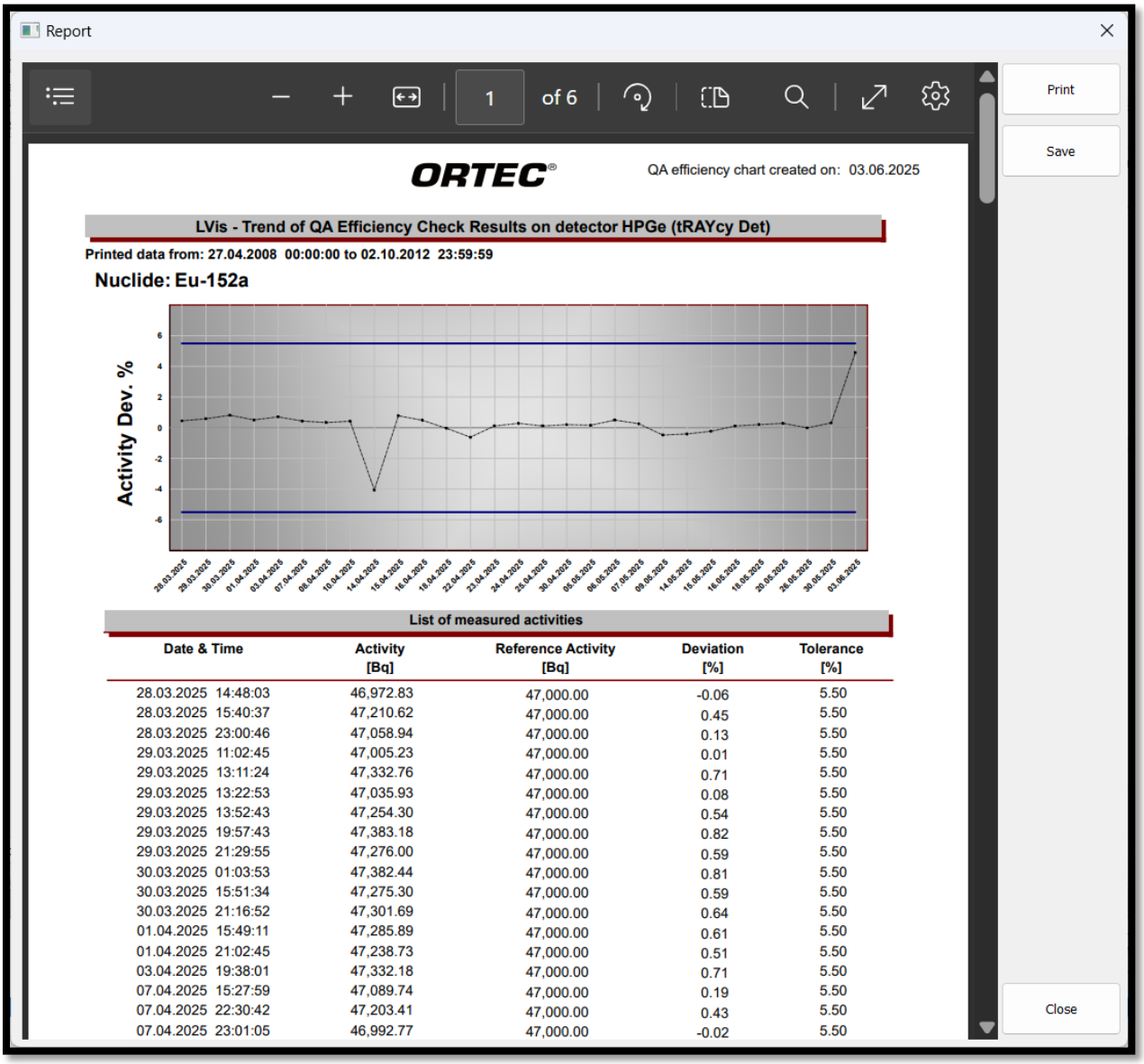


Figure 205. Date Range Selection



Date & Time	Activity [Bq]	Reference Activity [Bq]	Deviation [%]	Tolerance [%]
28.03.2025 14:48:03	46,972.83	47,000.00	-0.06	5.50
28.03.2025 15:40:37	47,210.62	47,000.00	0.45	5.50
28.03.2025 23:00:46	47,058.94	47,000.00	0.13	5.50
29.03.2025 11:02:45	47,005.23	47,000.00	0.01	5.50
29.03.2025 13:11:24	47,332.76	47,000.00	0.71	5.50
29.03.2025 13:22:53	47,035.93	47,000.00	0.08	5.50
29.03.2025 13:52:43	47,254.30	47,000.00	0.54	5.50
29.03.2025 19:57:43	47,383.18	47,000.00	0.82	5.50
29.03.2025 21:29:55	47,276.00	47,000.00	0.59	5.50
30.03.2025 01:03:53	47,382.44	47,000.00	0.81	5.50
30.03.2025 15:51:34	47,275.30	47,000.00	0.59	5.50
30.03.2025 21:16:52	47,301.69	47,000.00	0.64	5.50
01.04.2025 15:49:11	47,285.89	47,000.00	0.61	5.50
01.04.2025 21:02:45	47,238.73	47,000.00	0.51	5.50
03.04.2025 19:38:01	47,332.18	47,000.00	0.71	5.50
07.04.2025 15:27:59	47,089.74	47,000.00	0.19	5.50
07.04.2025 22:30:42	47,203.41	47,000.00	0.43	5.50
07.04.2025 23:01:05	46,992.77	47,000.00	-0.02	5.50

Figure 206. Generated Report

9. ROI ANALYSIS WITH LVIS

In addition to a peak-fit based analysis (GammaVision analysis) it is possible to perform a regions-of-interest (ROI's) analysis with LVis. A ROI measurement is saved as an LVM file very similar to the LVM files. In fact, it is possible to combine a GammaVision analysis and a ROI analysis in one LVM file. In this chapter detailed information is provided about:

- 9.1 Setup of a NaI Detector for ROI Analysis in LVis
- 9.2 Defining ROIs
- 9.3 Creation of ROI Parameter Sets
- 9.4 Calibrating the Detector for ROI Analysis
- 9.5 Creating a Background Correction Spectrum for a ROI Detector
- 9.6 ROI QA
- 9.7 The ROI Analysis in Detail – The Mathematics

9.1 SETUP OF A NAI DETECTOR FOR ROI ANALYSIS IN LVIS

LVis can control any ORTEC Multi Channel Buffer. In most cases a gamma spectrometry system for ROI analysis consists of a scintillation detector that is operated with a digiBase or digiBase-E. For that reason, such a setup will be used as an example throughout this manual. Any other ORTEC hardware should be configured accordingly. The respective configuration in *LVis* is identical. To connect the detector system to LVis please refer to Section 2.7 Adding and Configuring the Detectors. After connecting the detector with LVis, please configure it as described in Section 2.7.1 Detector Configuration. Note that the detector type should be set to **NaI**, as shown in Figure 207 below.

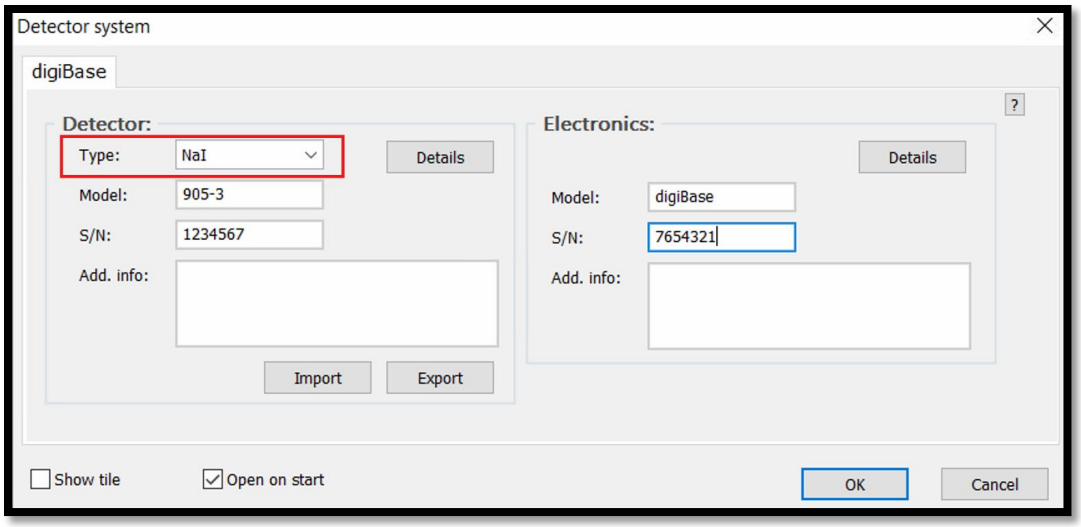


Figure 207. Detector System Type

Another typical application where ROI analysis is used is alpha spectrometry with ORTEC's Alpha-Duo or Alpha-Ensemble spectrometers. When using such an Alpha system with LVis, simply set the detector type to "Alpha". This will enable an additional "Alpha" tab in parameter sets and LVM files that supports the activity calculation based on tracers.

9.2 DEFINING ROIS

In LVis, ROIs are defined in the spectrum by marking channels with the mouse cursor while pressing the SHIFT key. Simply draw a rectangle over the area of interest in the spectrum by moving the cursor over the area while holding the left mouse button. The area will be highlighted in light blue (release the mouse button and the spectrum will zoom into the respective area). Pressing the SHIFT key will cause the area to turn light red and when releasing all keys, the area will be marked red as an ROI. Figure 208 shows a ROI. Its limits are displayed by the dotted lines with the respective energies.

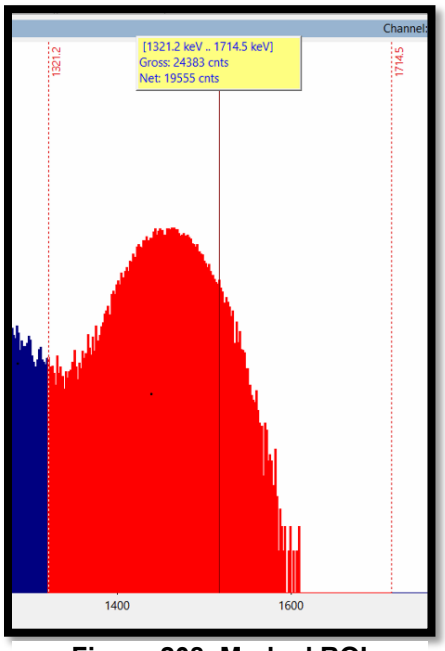


Figure 208. Marked ROI

NOTE: When placing the mouse cursor over the dotted lines it becomes an arrow that allows the ROI limits to move with the mouse.

It should also be noted that it is possible to define ROIs that overlap. In this case, the region of overlap will turn into a darker red.

zoom in	Hold the **left mouse-key** down and drag the region users wish to zoom into
zoom out	Right click
mark ROI	Hold the **left mouse-key** and the **Shift** key down at the same time and drag the region it is desired mark as ROI
modify ROI/ unmark ROI	Hover the mouse over one edge of the ROI until the double arrow appears. Use it to move the limits with the mouse while holding the left mouse-key. To delete/unmark the ROI pull the left edge over the right or vice versa.

9.3 CREATION OF ROI PARAMETER SETS

The creation of a new ROI parameter set is analogous to regular GammaVision parameter sets as is described in Section 2.8 Creation of Parameter Sets. Whether an acquisition should be evaluated with GammaVision, ROI analysis, or both is decided when creating a new parameter set by selecting the desired parameters as shown in Figure 209.

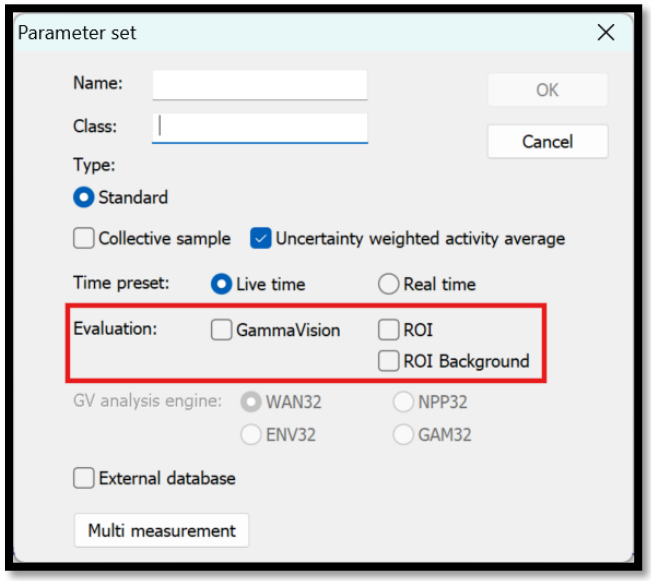


Figure 209. Parameter Set Evaluation Parameter Selection

Select **ROI** to create a sample counting routine for LVis measurements with ROI analysis. ROI parameter sets are very similar to standard parameter sets for “GammaVision” analysis but have a slightly modified “Sample data” tab and a unique “ROIs” tab for the definition of ROIs for the analysis.

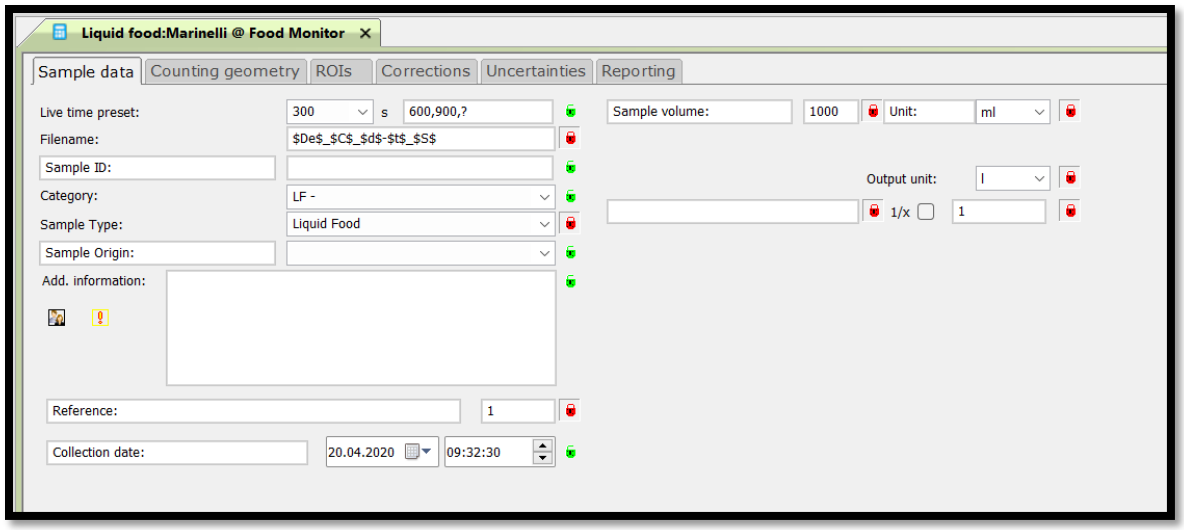


Figure 210. ROI Parameter Set Sample Data Tab

If **ROI background** (see Figure 209 above) is also selected, another button will be shown on the "ROI Results" tab of the LVM file that provides an easy way to use the measurement as a background correction file in ROI parameter sets. See more information in Section 8.2.5 ROI Background.

It is also possible to change or add one type of analysis to an existing LVM file/measurement by clicking in the left top corner of an LVM file and choosing **Settings**. It is recommended to save, close, and reload the respective measurements to update all settings.

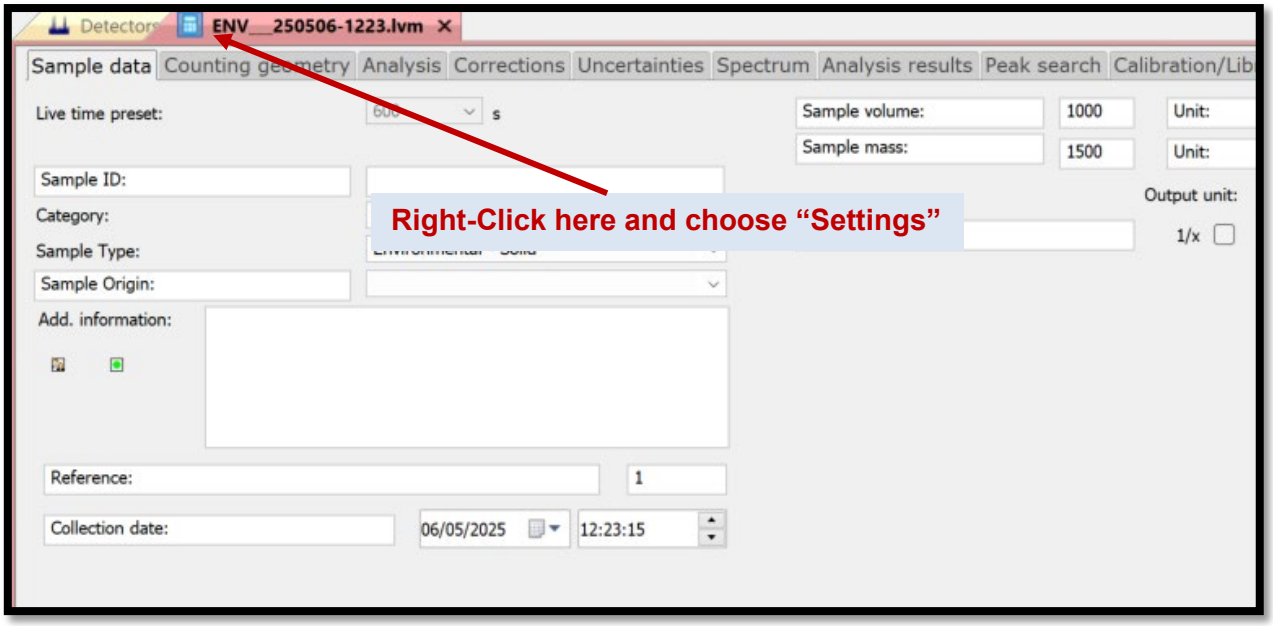


Figure 211. LVM File Highlighting Settings Selection

9.3.1 The ROIs Tab

All settings for the ROI analysis are organized on a dedicated tab labeled "ROIs".

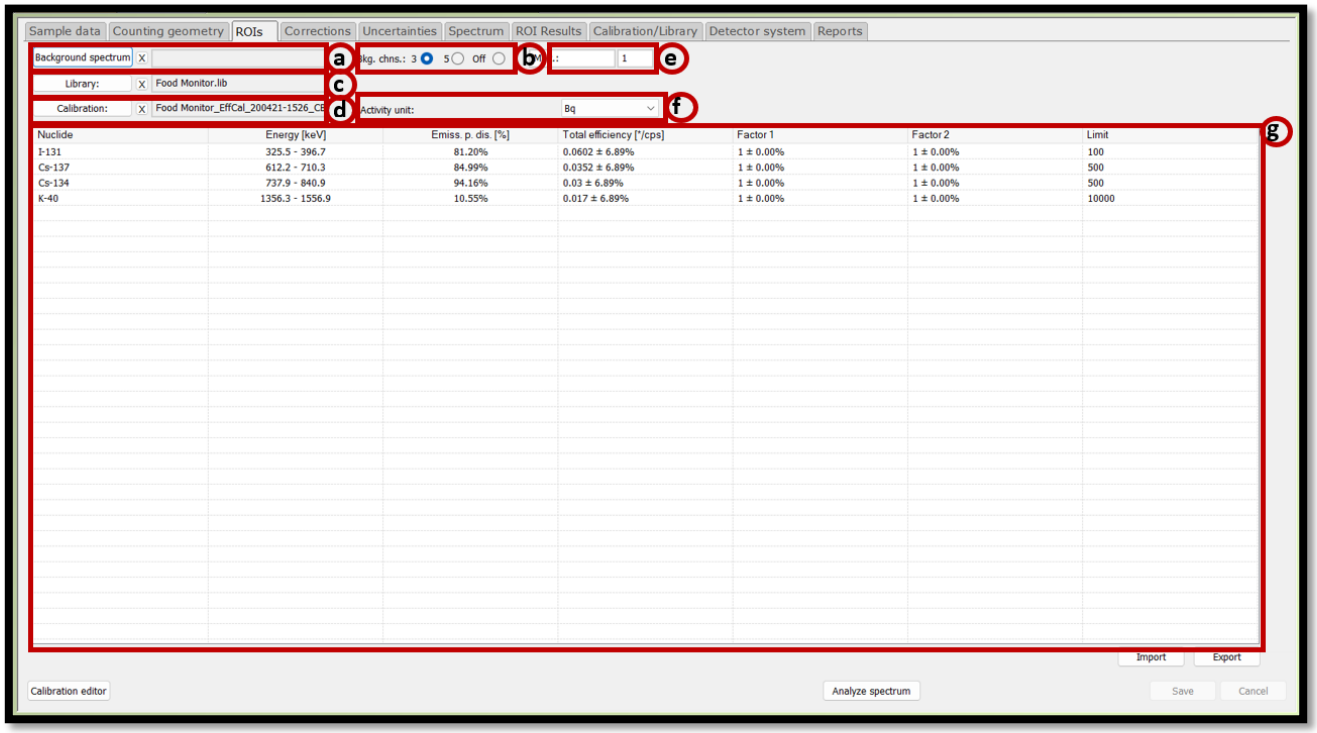


Figure 212. ROIs Tab

This tab provides adjustments of the following settings:

a. **Background Spectrum**: Clicking the **Background spectrum** button opens a file browser. Here, users can select a spectrum from an **.LVM** or **.CHN** file. If a background spectrum is chosen, the background subtraction will be performed based on this spectrum and the buttons in section d will disappear. See Section 9.7 The ROI Analysis in Detail – The Mathematics.

b. **Background Channels**: The background of each ROI can be calculated by averaging the content of the channels left and right to it. The number of channels can be set to either 3 or 5 channels. It is also possible to choose “Off”. In this case the gross cps is used, and no net area is calculated.

c. **Library**: Clicking the **Library** button opens a drop-down menu. From this drop-down menu an analysis library can be selected. If an analysis library is chosen, ROIs are matched to their closest entry in the library. Activities for ROIs can only be calculated when an ROI is related to an emission in the library.

d. **Calibration**: Clicking the **Calibration** button opens a drop-down menu. A calibration related to the present detector can be chosen from this menu. When an efficiency calibration is selected, the efficiency for all ROIs in the table in section g is updated automatically.

e. **Multiplier**: An additional multiplier to scale the activity of the sample.

f. **Activity Unit**: Changes the unit of the activity in the results after the analysis and the reports.

g. **ROIs Table**: This table lists all ROIs that are defined in the spectrum of this measurement. Their related library information, efficiency and activity warning limit is given. Double clicking

a line opens a dialog. In this dialog, the related nuclide, two additional activity multipliers, and warning limits can be edited.

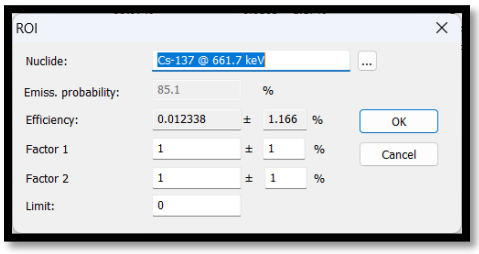


Figure 213. ROI Table Dialog

h. **Import and Export**: ROIs can be exported and imported to and from .LVR files. This is a simple interface for sharing ROIs between detectors and measurements.

In contrast to the GammaVision based analysis, only one method exists for the calculation of Confidence Levels and the MDAs for ROI measurements. This method is based on the ISO11929 norm.

Two methods of ROI analyses are possible:

- Net ROI count-rate determination by subtracting a background ROI count-rate obtained from a background or blank spectrum
- The trapezoidal method where the background in the ROI is determined by averaging the count rate in the channels above and below the ROI

A detailed description of the mathematics for both methods is described in Section 9.7 The ROI Analysis in Detail – The Mathematics.

9.4 CALIBRATING THE DETECTOR FOR ROI ANALYSIS

The energy and efficiency calibration for ROI based detectors differs from GammaVision in the fact that the automatic calibration function is not available. As a result, calibrations must be performed manually. A detailed description of the manual calibration procedure is given in Section 6.2.2 Manual Calibration. Here, only an outline of the procedure is illustrated.

1. Start an ROI energy calibration from the detector context menu. Choose the correct calibration source.
2. After the spectrum aquisition of the ROI calibration measurement has finished, select **Analyze** from the detectors dropdown menu:

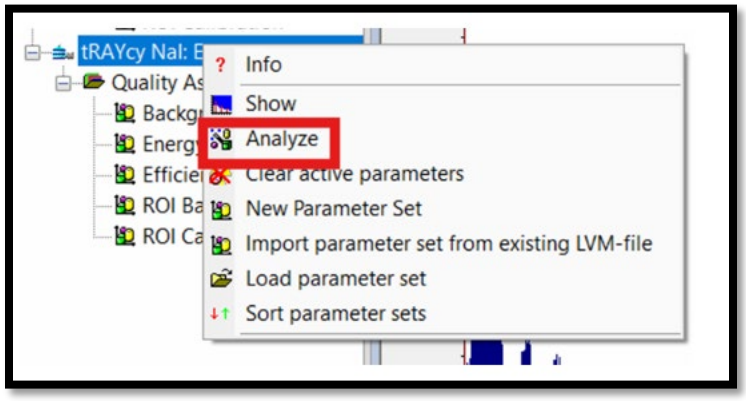


Figure 214. Detectors Menu with Analyze Highlighted

3. In the open measurement, move to the “Calibration” tab (a), open the “Calibration Editor”, (b) and then the “Peak Editor”. (c)

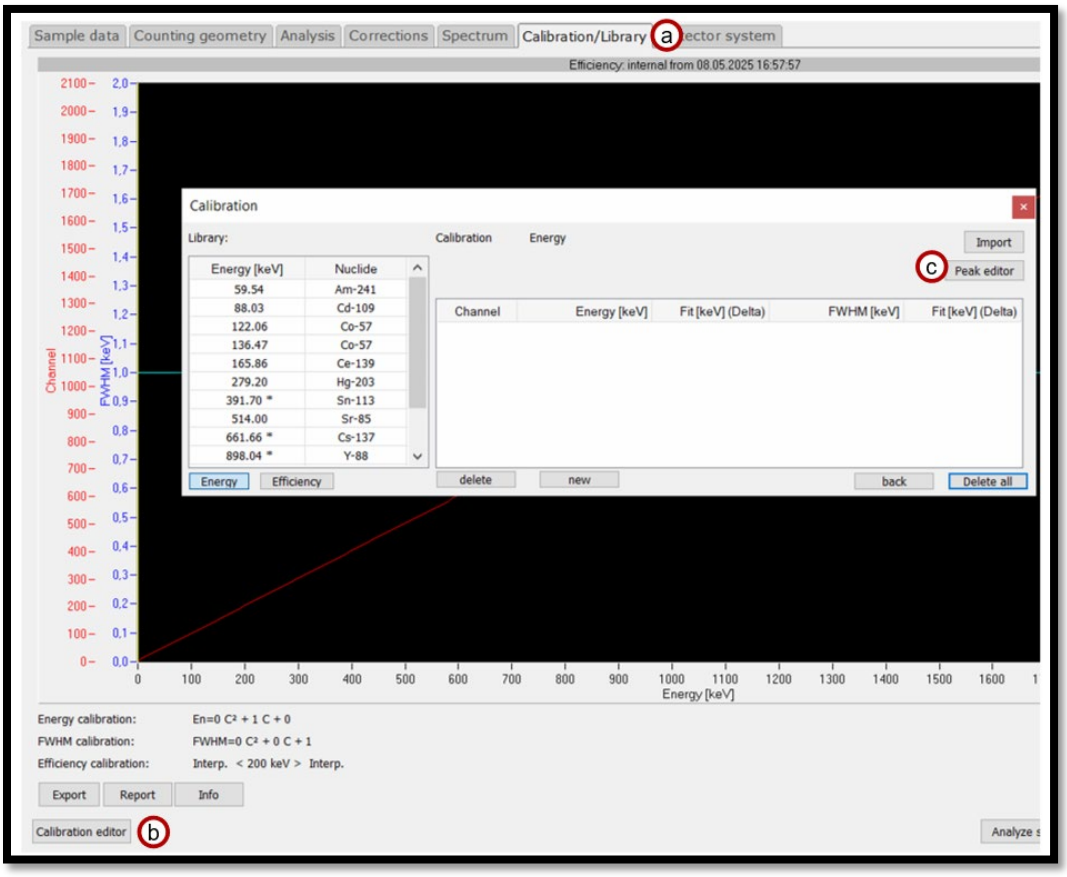


Figure 215. Calibration/Library Tab with Steps Highlighted

4. In the *Peak Editor* run a peak search (a), select the “Peak shape” tab (b), assign the peaks by pushing the **Nuclide selection** button (c), and then selecting the respective line from the library table (d). When finished, click **Close and apply changes** (e).

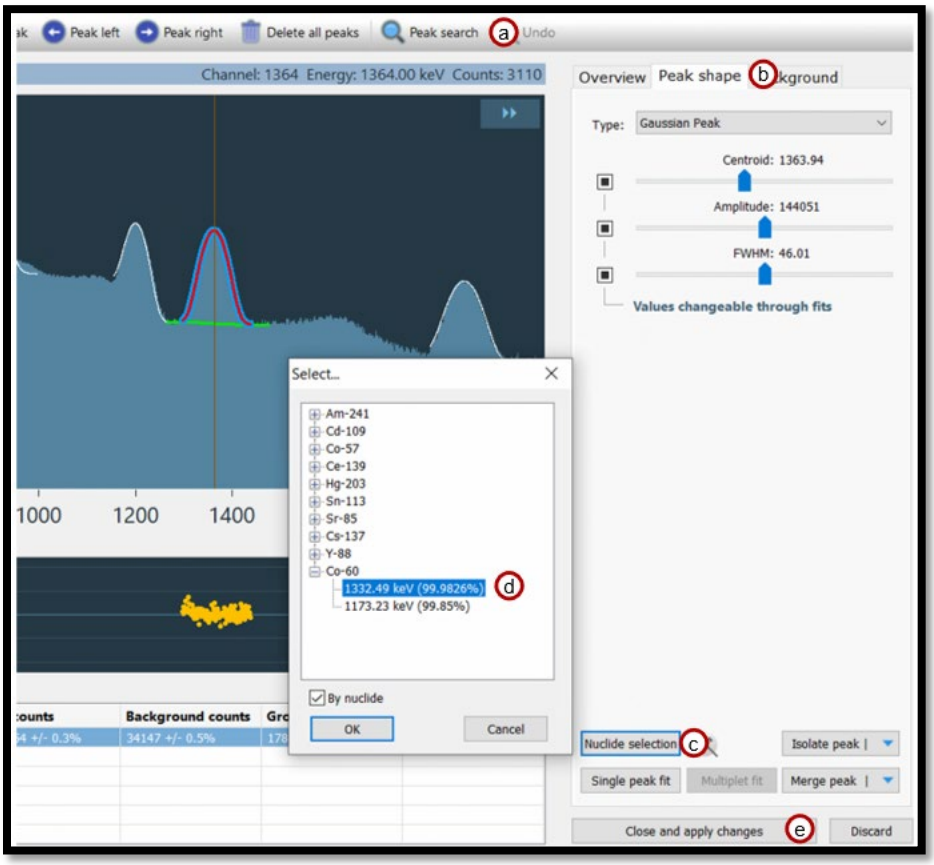
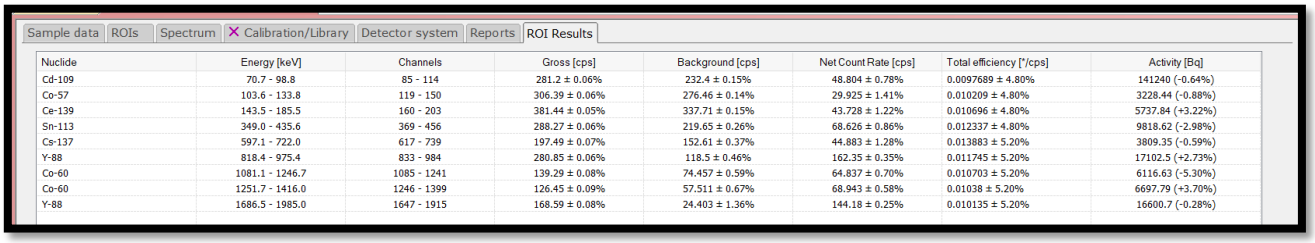


Figure 216. Peak Editor with Steps Highlighted

5. Close the calibration editor and save the measurement to conclude the energy calibration.

The efficiency calibration can either be performed in the same way as the energy calibration via the LVis peak editor or the ROIs defined in the spectrum can be used. To do this, first load or create the respective ROIs that match the nuclides in the calibration source. Then start a new ROI efficiency calibration from the context menu of the detector. Check the assignment of the nuclides to the defined ROIs and simply analyze. The resulting efficiencies are shown on the “ROI results” tab.



Nuclide	Energy [keV]	Channels	Gross [cps]	Background [cps]	Net Count Rate [cps]	Total efficiency [*/cps]	Activity [Bq]
Cd-109	70.7 - 98.8	85 - 114	281.2 ± 0.06%	232.4 ± 0.15%	48.804 ± 0.78%	0.0097689 ± 4.80%	141240 (-0.64%)
Co-57	103.6 - 133.8	119 - 150	306.39 ± 0.06%	276.46 ± 0.14%	29.925 ± 1.41%	0.010209 ± 4.80%	3228.44 (-0.88%)
Ce-139	143.5 - 185.5	160 - 203	381.44 ± 0.05%	337.71 ± 0.15%	43.728 ± 1.22%	0.010696 ± 4.80%	5737.84 (+3.22%)
Sn-113	349.0 - 435.6	369 - 456	288.27 ± 0.06%	219.65 ± 0.26%	68.626 ± 0.86%	0.012337 ± 4.80%	9818.62 (-2.98%)
Cs-137	597.1 - 722.0	617 - 739	197.49 ± 0.07%	152.61 ± 0.37%	44.883 ± 1.28%	0.013883 ± 5.20%	3809.35 (-0.59%)
Y-88	818.4 - 975.4	833 - 984	280.85 ± 0.06%	118.5 ± 0.46%	162.35 ± 0.35%	0.011745 ± 5.20%	17102.5 (+2.73%)
Co-60	1081.1 - 1246.7	1085 - 1241	139.29 ± 0.08%	74.457 ± 0.59%	64.837 ± 0.70%	0.010703 ± 5.20%	6116.63 (-5.30%)
Co-60	1251.7 - 1416.0	1246 - 1399	126.45 ± 0.09%	57.511 ± 0.67%	68.943 ± 0.58%	0.01038 ± 5.20%	6697.79 (+3.70%)
Y-88	1686.5 - 1985.0	1647 - 1915	168.59 ± 0.08%	24.403 ± 1.36%	144.18 ± 0.25%	0.010135 ± 5.20%	16600.7 (-0.28%)

Figure 217. ROI Results

9.5 CREATING A BACKGROUND CORRECTION SPECTRUM FOR A ROI DETECTOR

Besides selecting a measurement for background subtraction manually in each ROI parameter set, there are two additional methods available in LVis that provide easy creation of *Background Correction Spectra* and automated assignment to the existing ROI counting routines:

1. In case “ROI Background” was ticked in the settings of the parameter set, a button **Apply as background** on the “ROI Results” tab will allow easy transfer of the spectrum to the existing ROI parameter sets of the detector.

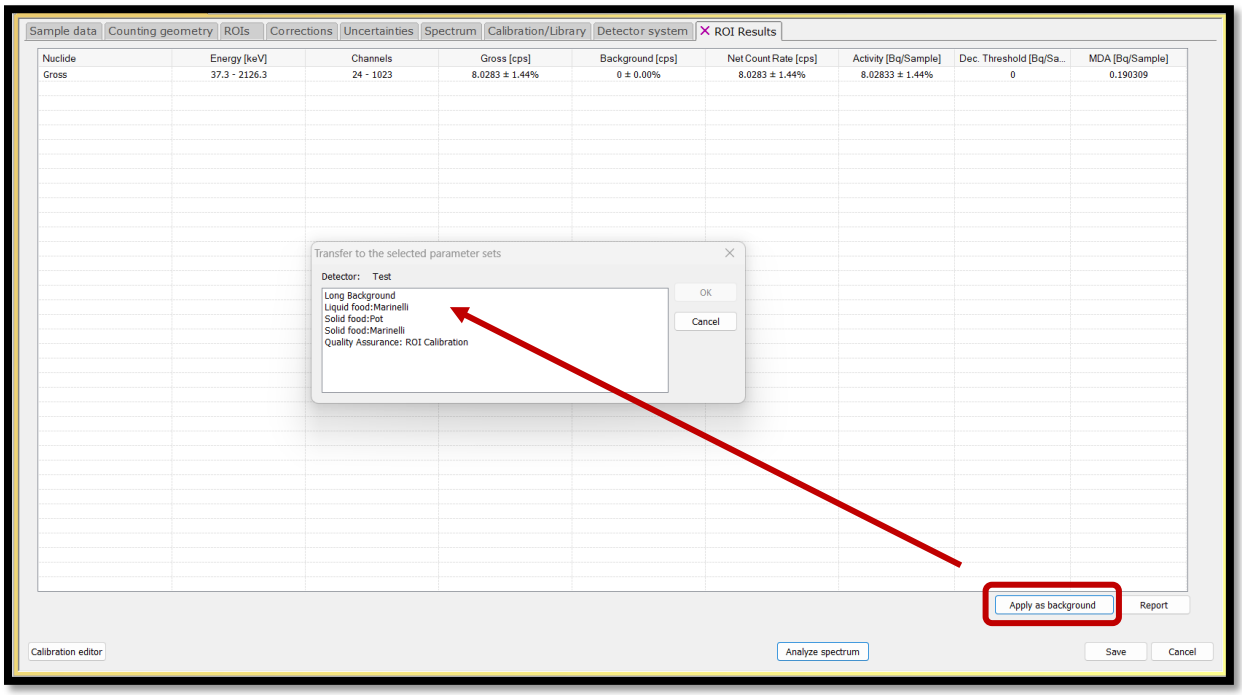


Figure 218. ROI Results Tab with Apply as Background Highlighted

A dialog will allow selection of the parameter sets that the respective measurement should be linked to as the current background for correction.

2. Another option is to do this within the scope of a QA Background measurement. On the “Background” tab of QA ROI Background checks it is possible to activate **Auto creation of background spectrum**. If this is ticked, the respective measurement will automatically be applied as the new background correction spectrum to all parameter sets already using a background spectrum. Pass/Fail has no impact if the background spectrum is entered.

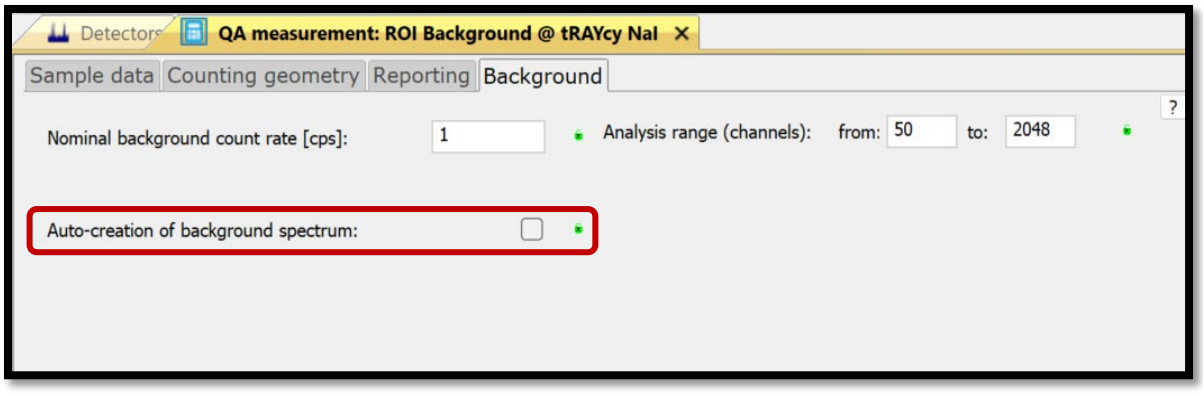


Figure 219. Background Tab with Auto-Creation Highlighted

9.6 ROI QA

Every detector in LVis has a “Quality Assurance” submenu that lists the counting routines for the respective detector’s QA checks. By enabling ROI based analysis, two ROI QA routines, the “ROI Background” check and the “ROI Calibration” check, are added to the QA parameter sets. A detailed description of QA in LVis is given in Chapter 8.

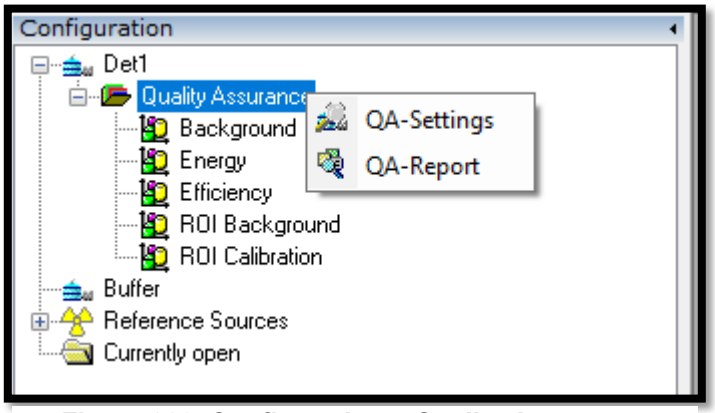


Figure 220. Configuration – Quality Assurance

Right-clicking on “Quality Assurance” will allow users to either change the “QA-Settings” for the respective detector or to create a “QA-Report”. Under “QA-Settings” (see screenshot in Figure 221) users can decide if the QA checks should be based on GammaVision analysis method only, ROI analysis only, or both. It is also possible to define what variations are tolerated for each QA check (causing the QA check to “Pass”), what QA check results create a warning, and which results are not acceptable and will be indicated by an alarm.

NOTE: Warnings are indicated by a yellow and alarms by a red exclamation mark in front of the detector’s name. Alarms can be used to trigger a lockdown of the detector until either an LVis Admin user handles the alarm, or the QA check is repeated and passed.

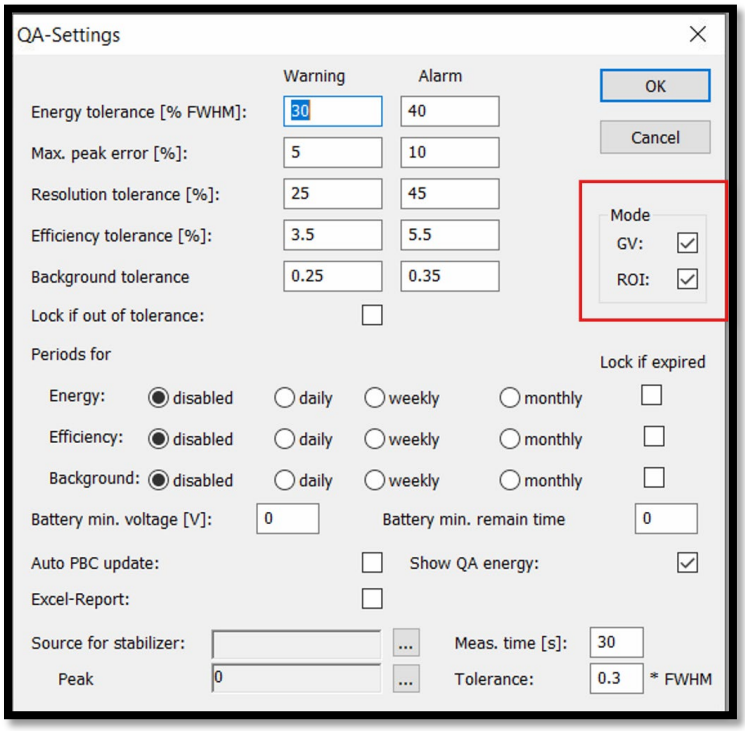


Figure 221. QA Settings

NOTE: In case only ROI analysis are performed on the detector, untick GV. This will omit the GammaVision based QA routines from the detector menu.

The two relevant settings for the ROI QA routines are the “Efficiency tolerance [%]” and the “Background tolerance [cps]”. Because the gain of NaI spectrometers is sensitive to changing physical conditions (e.g. room temperature) in the environment of the detector the gain can fluctuate over time. As a result, peaks change their position/energy in the spectrum. When an ROI calibration check fails, this is usually related to an energy drift causing the peak not to be fully covered by the ROI. In such a case, users can either recalibrate the energy or simply adjust the gain to move the peak back to its initial position. To do that, LVis has an internal gain stabilizer. By comparing a pre-defined peak’s energy with its postion/energy in the spectrum, the gain shift can be measured. The gain is then adjusted dynamically to move the peak back to its correct position/energy in the spectrum. A detailed description of the Gain Stabilizer is given in Section 6.6.

9.7 THE ROI ANALYSIS IN DETAIL – THE MATHEMATICS

9.7.1 Gross ROI Counts

$$G = \sum_{i=l}^{h} C_i$$

Where

G: Gross counts
c_i: Number of counts in channel i
l: Channel number on left (low energy) side of ROI (ROI start channel)
h: Channel number on right (high energy) side of ROI (ROI end channel)

The uncertainty of the gross ROI area G is simply the square root of the ROI gross area:

$$gross\ area\ uncertainty = \sqrt{gross\ area}$$

$$u(G) = \sqrt{G}$$

And the gross ROI count-rate is:

$$g = \frac{G}{T_S}$$

And its uncertainty is:

$$u(g) = \frac{\sqrt{G}}{T_S}$$

9.7.2 Net area calculation when only subtracting a blank spectrum

When only the blank spectrum subtraction method is used (background spectrum defined and trapezoidal method set to “Off”), the net ROI counts are simply the result of the subtraction of the background ROI gross counts from the sample ROI gross counts:

$$N = \sum_{i=l}^{h} C_{i,S} - \frac{T_S}{T_O} \sum_{i=l}^{h} C_{i,0} = G - \frac{T_S}{T_0} B_0$$

Where:

N: Net ROI counts
G: Gross ROI counts from sample or calibration measurement
B_0: Gross ROI counts from background / sample measurement
T_S: Livetime of sample measurement
T_0: Livetime of background/blank measurement
$c_{i,0}$: Number of counts in channel i of the background/blank spectrum
$c_{i,S}$: Number of counts in channel i of the sample or calibration measurement
l: Channel number on left (low energy) side of ROI (ROI start channel)
h: Channel number on right (high energy) side of ROI (ROI end channel)

And the net count rate n is:

$$n = \frac{N}{T_S} = \frac{1}{T_S} \cdot \left(G - \frac{T_S}{T_0} B_0 \right) = \frac{G}{T_S} - \frac{B_0}{T_0}$$

The uncertainty of the net area is:

$$net\ area\ uncertainty = \sqrt{(gross\ area\ uncertainty)^2 + (bkg\ area\ uncertainty)^2}$$

The uncertainty of the ROI background area is simply the square root of the ROI background area:

$$background\ area\ uncertainty = \sqrt{background\ area}$$

$$u(B_0) = \sqrt{B_0}$$

And the uncertainty of the background ROI count-rate is then:

$$u(b) = \frac{\sqrt{B_0}}{T_0}$$

The uncertainties for the net area and count rates are calculated using:

$$u(N) = \sqrt{\sum_{i=l}^{h} C_{i,S} + \sum_{i=l}^{h} C_{i,0}} = \sqrt{G + B_0}$$

$$u_{rel}(N) = \frac{1}{N}\sqrt{\sum_{i=l}^{h} C_{i,S} + \sum_{i=l}^{h} C_{i,0}} = \frac{\sqrt{G + B_0}}{N}$$

$$u(n) = \sqrt{\frac{G}{T_S^2} + \frac{B_0}{T_0^2}}$$

$$u_{rel}(n) = \frac{1}{\left(\frac{G}{T_S} - \frac{B_0}{T_0}\right)} \cdot \sqrt{\frac{G}{T_S^2} + \frac{B_0}{T_0^2}} = \sqrt{\frac{\frac{G}{T_S^2} + \frac{B_0}{T_0^2}}{\left(\frac{G}{T_S} - \frac{B_0}{T_0}\right)^2}}$$

Where:

- N: Net number of ROI counts
- T_S: Livetime of the calibration measurement
- G: Gross ROI counts from sample measurement
- B_0: Gross ROI counts from background measurement
- T_0: Livetime of the background/blank measurement
- c_i: Number of counts in channel i from sample or calibration measurement
- k: Number of background channels left and right of the ROI
- l: Channel number on left (low energy) side of ROI (ROI start channel)
- h: Channel number on right (high energy) side of ROI (ROI end channel)

n: net count-rate N/T

9.7.3 Net area calculation when no background spectrum is defined – only Compton background estimation

When no blank/background spectrum is defined, the trapezoidal method is used to estimate the Compton background of the ROI and to calculate the net area. The background per channel is estimated by averaging the channel content over either 3 or 5 channels on the low and high energy side of the ROI (this can be selected by the user and is denoted as k in the following equations). Then, this background per channel is multiplied by the number of channels in the ROI to obtain the total background of the ROI. By subtracting that background from the ROI gross counts, the ROI net counts are determined.

$$N = G - B$$

In case k channels left and right of the ROI are used to average the background per channel, the formula is:

$$N = G - \left(\sum_{i=l-k}^{l-1} C_i + \sum_{i=h+1}^{h+k} C_i \right) \frac{h-l+1}{2k}$$

Where:

N: Net ROI counts
G: Gross ROI counts from sample or calibration measurement
B: Estimated background in ROI
c_i: Number of counts in channel i from sample or calibration measurement
l: Channel number on left (low energy) side of ROI (ROI start channel)
h: Channel number on right (high energy) side of ROI (ROI end channel)
k: Number of background channels left and right of the ROI

And hence the count rate for this trapezoidal method is calculated with:

$$n = \frac{N}{T_S} = \frac{1}{T_S} \cdot \left(G - \left(\sum_{i=l-k}^{l-1} C_i + \sum_{i=h+1}^{h+k} C_i \right) \frac{h-l+1}{2k} \right)$$

NOTE: A special case is when the trapezoidal method is set to “Off” (no channels, k = 0). In this case the net area is equal to the gross area.

For the trapezoidal method the uncertainties for the background, the net area, as well as respective count-rates are given by:

$$background\ area\ uncertainty = \sqrt{\frac{(background\ area) \cdot (peak\ width)}{(width\ of\ low\ average + width\ of\ high\ average)}}$$

$$u(B) = \sqrt{B \cdot \frac{h-l+1}{2k}}$$

$$u(b) = \sqrt{\frac{B \cdot \frac{h-l+1}{2k}}{T_S}}$$

$$u(N) = \sqrt{(u(G))^2 + (u(B))^2}$$

$$u(N) = \sqrt{G + B \cdot \frac{h-l+1}{2k}}$$

$$u_{rel}(N) = \frac{1}{N} \cdot \sqrt{G + B \cdot \frac{h-l+1}{2k}}$$

$$u(n) = \frac{u(N)}{T_S} = \frac{1}{T_S} \cdot \sqrt{G + B \cdot \frac{h-l+1}{2k}}$$

$$u_{rel}(n) = \frac{u(n)}{n} = \frac{u(N)}{n \cdot T_S} = \frac{1}{(G-B)} \cdot \sqrt{G + B \cdot \frac{h-l+1}{2k}}$$

Where:

- N: Net ROI counts
- G: Gross ROI counts from calibration measurement
- B: Estimated Compton background in ROI
- c_i: Number of counts in channel i from sample or calibration measurement
- l: Channel number on left (low energy) side of ROI (ROI start channel)
- h: Channel number on right (high energy) side of ROI (ROI end channel)
- k: Number of background channels left and right of the ROI
- T_S: Livetime of the sample measurement
- T_0: Livetime of the background/blank measurement

9.7.4 Net area calculation when subtracting a background spectrum and estimating the Compton background

When both methods are used (a background spectrum is defined and the number of channels for estimating the Compton background under a peak by using the trapezoidal method is not set to “Off”), then a corrected spectrum is created by subtracting the background spectrum from the sample spectrum (subtraction by energy and scaled for the respective live time).

The gross area of the original, uncorrected sample or calibration measurement G_{orig} the live time scaled gross area of the background spectrum G_{bkg} and the gross area of the background corrected spectrum (which is basically the same as the net area when the trapezoidal method is turned off) G_{corr} are calculated using:

$$G_{orig} = \sum_{i=l}^{h} C_{i,original}$$

$$G_{bkg} = \frac{T_S}{T_0} \sum_{i=l}^{h} C_{i,background} = \frac{T_S}{T_0} B_0$$

$$G_{corr} = \sum_{i=l}^{h} C_{i,subtracted} = G_{Orig} - \frac{T_S}{T_0} B_0$$

The respective uncertainties are:

$$u(G_{orig}) = \sqrt{G_{orig}}$$

$$u(G_{bkg}) = \sqrt{G_{bkg}} = \sqrt{B_0}$$

$$u(G_{corr}) = \sqrt{G_{orig} + B_0}$$

The Compton background in the ROI is calculated based on the trapezoidal method:

$$B_c = \left(\sum_{i=l-k}^{l-1} C_{i,subtracted} + \sum_{i=h+1}^{h+k} C_{i,subtracted} \right) \frac{h-l+1}{2k}$$

And their respective uncertainties are:

$$u(B_C) = \sqrt{B_C \cdot \frac{h-l+1}{2k}}$$

$$u(b_C) = \sqrt{\frac{B \cdot \frac{h-l+1}{2k}}{T_S}}$$

The net area is then:

$$N = G_{corr} - B_C = G_{Orig} - \frac{T_S}{T_0} B_0 - \left(\sum_{i=l-k}^{l-1} C_{i,subtracted} + \sum_{i=h+1}^{h+k} C_{i,subtracted} \right) \frac{h-l+1}{2k}$$

And its uncertainty:

$$u(N) = \sqrt{\left(u(G_{orig})\right)^2 + (u(B_c))^2 + \left(u(G_{bkg})\right)^2}$$

9.7.5 Efficiency

The detection efficiency is given by:

$$\varepsilon_D = \frac{1}{p_\gamma \cdot A_S \cdot T_S} \cdot N$$

In case the background is determined based on the trapezoidal method the formula translates to:

$$\varepsilon_D = \frac{1}{p_\gamma \cdot A_S} \cdot \frac{N}{T_S} = \frac{1}{p_\gamma \cdot A_S \cdot T_S} \cdot \left(G - \left(\sum_{i=l-k}^{l-1} c_i + \sum_{i=h+1}^{h+k} c_i \right) \frac{h-l+1}{2 \cdot k} \right)$$

In case a background spectrum is subtracted, the efficiency is calculated by:

$$\varepsilon_D = \frac{1}{p_\gamma \cdot A_S} \cdot \frac{N}{T_S} = \frac{1}{p_\gamma \cdot A_S} \cdot \left(\frac{G}{T_S} - \frac{B}{T_0} \right)$$

Where:

- ε_D: Efficiency
- p_γ: γ-Emission probability of the calibration nuclide (at the energy that is covered by the ROI)
- A_S: Activity of the calibration nuclide at the time of acquisition
- N: Net number of ROI counts in the calibration spectrum
- G: Gross ROI counts from calibration measurement
- B: Gross ROI counts from background measurement
- T_S: Livetime of the calibration measurement
- T_0: Livetime of the background/blank measurement
- c_i: Number of counts in channel i from sample or calibration measurement
- k: Number of background channels left and right of the ROI
- l: Channel number on left (low energy) side of ROI (ROI start channel)
- h: Channel number on right (high energy) side of ROI (ROI end channel)

9.7.6 Relative Uncertainty of the Efficiency

The relative uncertainty of the efficiency is given by:

$$u_{rel}(\varepsilon_D) = \sqrt{(rel.net\ count\ rate\ uncertainty)^2 + (rel.\ \ calibration\ source\ uncertainty)^2}$$

When calculating the net ROI area with the trapezoidal method, the relative uncertainty of the net count-rate is:

$$u_{rel}(\varepsilon_D) = \sqrt{\frac{G + B \cdot \frac{h - l + 1}{2 \cdot k}}{(G - B)^2} + \left(u_{rel}(A_S)\right)^2}$$

Where:

$u_{rel}(\varepsilon_D)$: relative uncertainty of the efficiency
$u_{rel}(A_S)$: relative uncertainty of the reference activity (calibration source)
G: Gross ROI counts from calibration measurement
B: Estimated background in ROI
c_i: Number of counts in channel i from sample or calibration measurement
l: Channel number on left (low energy) side of ROI (ROI start channel)
h: Channel number on right (high energy) side of ROI (ROI end channel)
k: Number of background channels left and right of the ROI

In case the net area is determined based on the subtraction of a blank/background spectrum, the relative uncertainty of the efficiency is

$$u_{rel}(\varepsilon_D) = \sqrt{\frac{\frac{G}{{T_S}^2} + \frac{B}{{T_0}^2}}{\left(\frac{G}{T_S} - \frac{B}{T_0}\right)^2} + \left(u_{rel}(A_S)\right)^2}$$

Where:

$u_{rel}(\varepsilon_D)$: relative uncertainty of the efficiency
$u(A_S)$: relative uncertainty of the reference activity (calibration source)
T_S: Live time of calibration measurement
T_0: Live time of blank/background measurement
G: Gross ROI counts from calibration measurement
B: Gross ROI counts from blank/background measurement

9.7.7 Nuclide and Method Specific Calibration Factor

$$\varpi = \frac{F}{p_\gamma \cdot \varepsilon_D \cdot \varepsilon_P \cdot V}$$

Where:

ϖ: Nuclide and method specific calibration factor
p_γ: Emission probability for the ROI nuclide
ε_D: Efficiency
ε_P: Handling factor (usually 1 – if there are no additional multipliers or divisors specified)
F: sample size conversion factor
V: sample size

9.7.8 Relative Uncertainty of the Nuclide and Method Specific Calibration Factor

$$u_{rel}(\varpi) = \sqrt{\left(u_{rel}(\varepsilon_D)\right)^2 + \left(u_{rel}(\varepsilon_P)\right)^2}$$

Where:

$u_{rel}(\varpi)$: relative uncertainty of the nuclide and method specific calibration factor
$u(\varepsilon_D)$: relative uncertainty of the efficiency
$u(\varepsilon_P)$: relative uncertainty of the handling factor (This is the sqrt of the sum of the individual additional uncertainties from the “Uncertainties” tab in *LVis* added in quadrature)

9.7.9 Activity

$$A = \frac{F}{p_\gamma \cdot V \cdot \varepsilon_D \cdot \varepsilon_P} \cdot n = \varpi \cdot n$$

Where:

A: Specific activity of the sample
n: net ROI count-rate N/t
p_γ: γ-Emission probability for the ROI nuclide
ε_D: Efficiency
ε_P: Handling factor (usually 1 – if there are no additional multipliers or divisors specified)
F: sample size conversion factor
V: sample size
ϖ: Nuclide and method specific calibration factor

9.7.10 Uncertainty of the Activity

$$u(A) = \sqrt{n^2 \cdot \varpi^2 \cdot \left(u_{rel}(\varpi)\right)^2 + \varpi^2 \cdot (u(n))^2}$$

So, for the trapezoid's method:

$$u(A) = \frac{\varpi}{T_S} \cdot \sqrt{(G-B)^2 \cdot \left(u_{rel}(\varpi)\right)^2 + G + B \cdot \frac{h-l+1}{2 \cdot k}}$$

And for the spectrum subtraction method:

$$u(A) = \varpi \cdot \sqrt{\left(\frac{G}{T_S} - \frac{B}{T_0}\right)^2 \cdot \left(u_{rel}(\varpi)\right)^2 + \left(\frac{G}{{T_S}^2} + \frac{B}{{T_0}^2}\right)}$$

Where:

$u(A)$: uncertainty of the activity
$u(\varpi)$: relative uncertainty of the nuclide and method specific calibration factor
ϖ: Nuclide and method specific calibration factor
G: Gross ROI counts from sample measurement
B: Gross ROI counts from blank/background measurement or calculated from trapezoidal method
T_S: Livetime of sample measurement
T_0: Livetime of blank/background measurement
k: Number of background channels left and right of the ROI

9.7.11 Critical Level (Detection Threshold)

The Critical Level is calculated based on the ISO11929 norm based on the formula:

$$A_E = F_E \cdot \varpi \cdot u(n_{CL})$$

Above this detection threshold (or critical level) the net ROI counts are above the expected statistical variation of the background (recognizing false positive errors), and it is assumed that there was a contribution of a nuclide in the sample to the counts in the ROI. As a result, it is a decision criterion for whether there was just background or statistically valid counts from the ROI nuclide in the sample.

At the detection threshold, the gross ROI count-rate from the sample measurement is equal to the gross ROI count-rate from the background ($\frac{G}{T_S} = \frac{B}{T_0}$).

$$A_E = F_E \cdot \varpi \cdot u(b_{CL})$$

$$A_E = F_E \cdot \varpi \cdot \sqrt{\frac{B}{T_0} \cdot \left(\frac{1}{T_S} + \frac{1}{T_0}\right)}$$

With:

A_E: Detection Threshold or Critical Level of the activity concentration in the sample

F_E: Confidence level $k_{1-\alpha}$ (if the probability of a false positive is 5 %, the confidence level is 1.96)

$u(b_{CL})$: Uncertainty of the net count-rate when $\frac{B}{T_S} = \frac{U}{T_0}$

ϖ: Nuclide and method specific calibration factor

U: Gross ROI counts from blank/background measurement or calculated from trapezoidal method

T_S: Livetime of sample measurement

T_0: Livetime of blank/background measurement

9.7.12 Detection Limit

The Detection Limit (or Minimum Detectable Activity MDA) is calculated iteratively based on the ISO11929 norm. The formula is:

$$A_N = A_E + F_N \cdot \sqrt{{A_N}^2 \cdot \left(u_{rel}(\omega)\right)^2 + \omega^2 \cdot \left(u(n_{DL})\right)^2}$$

With the starting value of the iteration for the trapezoidal method:

$$A_{N(0)} = (F_N + F_E) \cdot \frac{\omega}{T_S} \cdot \sqrt{G + B \cdot \frac{h-l+1}{2 \cdot k} + (G-B)^2 \cdot \left(u_{rel}(\varpi)\right)^2}$$

And for the spectrum subtraction method:

$$A_{N(0)} = (F_N + F_E) \cdot u(A) = (F_N + F_E) \cdot \omega \cdot \sqrt{\left(\frac{G}{{T_S}^2} + \frac{B}{{T_0}^2}\right) + \left(\frac{G}{T_S} - \frac{B}{T_0}\right)^2 \cdot \left(u_{rel}(\varpi)\right)^2}$$

When using the trapezoidal method, the iteration is then:

$$A_{N(i)} = A_E + F_N \cdot \sqrt{\left(A_{N(i-1)}\right)^2 \cdot \left(u_{rel}(\varpi)\right)^2 + \frac{\varpi^2}{{T_S}^2} \cdot \left(G + B \cdot \frac{h-l+1}{2 \cdot k}\right)}$$

And for the spectrum subtraction method:

$$A_{N(i)} = A_E + F_N \cdot \sqrt{\left(A_{N(i-1)}\right)^2 \cdot \left(u_{rel}(\varpi)\right)^2 + \varpi^2 \cdot \left(\frac{G}{{T_S}^2} + \frac{B}{{T_0}^2}\right)}$$

With:

$A_{N(i)}$: Detection Limit after the i-th iteration

A_E: Detection Threshold

F_N: Confidence level $k_{1-\beta}$ (if the probability of a false negative is 5 % under the conditions of $k_{1-\alpha}$ for the probability of false positives, then this confidence level is 1.96)

F_E: Confidence level $k_{1-\alpha}$ (if the probability of a false positive is 5 %, the confidence level is 1.96)

$u(A)$: Uncertainty of the activity

ϖ: Nuclide and method specific calibration factor

$u_{rel}(\varpi)$: **r**elative uncertainty of the nuclide and method specific calibration factor

T_S: Livetime of sample measurement

T_0: Livetime of blank/background measurement

k: Number of background channels left and right of the ROI

IMPORTANT The termination condition for the iteration is either when the change from one iteration to the next is less than 1% or after 30 iterations were performed.

10. THE LVIS PEAK EDITOR

With the LVis “**Peak editor**” it is possible to manually add or remove peaks and to define their respective peak fit parameters before refitting. This is either used to create an entry for the energy or efficiency calibration table or to manually adjust analysis results. The analysis algorithms in LVis always use a Gaussian Peak shape function to approximate the peak areas during the analysis, however, sometimes a different shape function might provide a better fit. With the LVis Peak editor, expert spectroscopists have a tool to fit even such distorted peaks.

Depending on the desired application, calibration or adjustment of analysis results, the LVis **Peak editor** is either started from the spectrum tab of an LVM file or from the calibration table.

When starting the **Peak editor** in an analyzed LVM on the “Spectrum” tab, it will open with the peak fit results from the spectrum analysis (see screenshot below).



Figure 222. Peak Editor

When starting the peak editor from the LVis “Calibration editor”, it will present the peak fits used for the respective calibration.

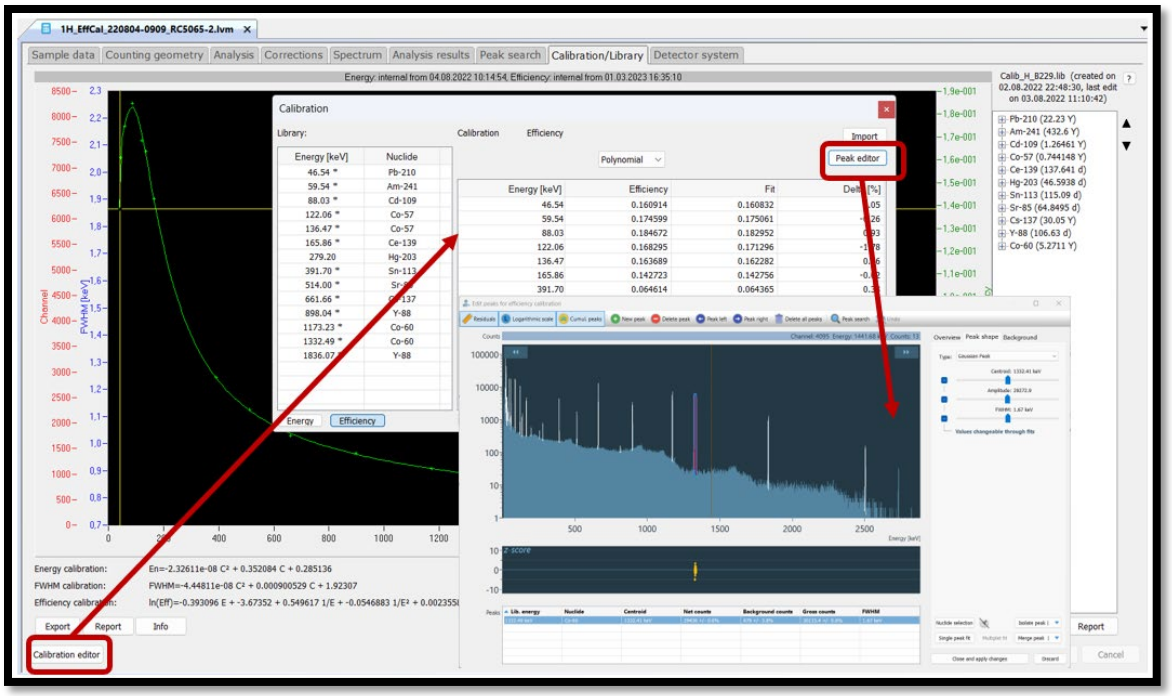


Figure 223. Peak Editor Started From Calibration Editor

The GUI of the LVis Peak editor can be divided into three basic sections:

- A spectrum view showing the spectrum, peak and background fits and the respective residuals
- A peak fit results table showing the fit results for a peak or multiplet
- A panel providing on three tabs an overview of all peaks and definitions of the “Peak shape” and “Background” fit parameters for the active, selected peak.

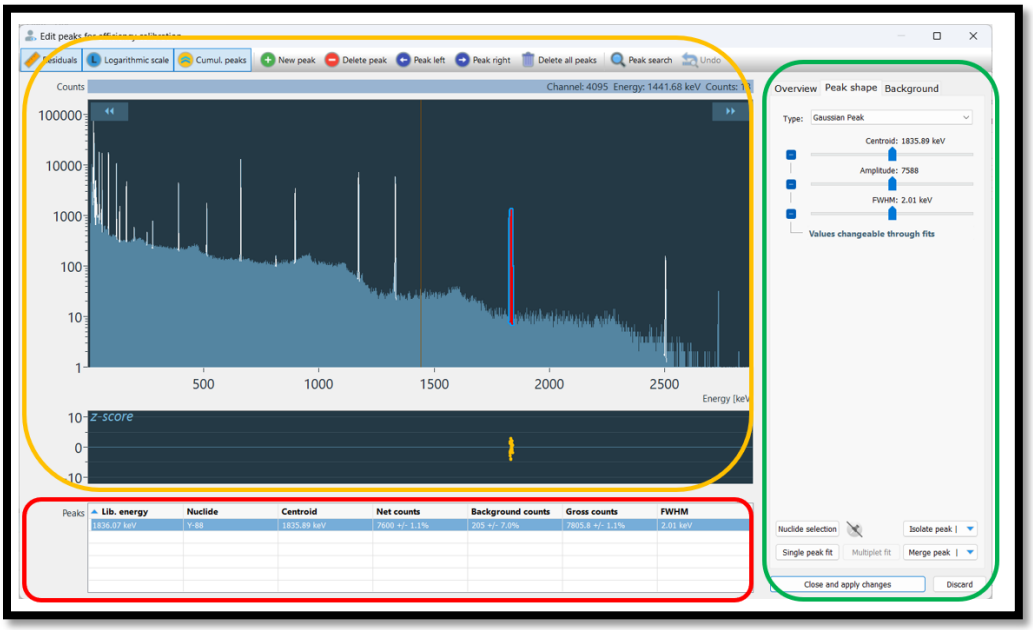


Figure 224. Peak Editor GUI Explained

10.1 THE SPECTRUM VIEW OF THE LVIS PEAK EDITOR

The spectrum view presents the spectrum and – if available – respective peak fits. Peaks are selected using the mouse cursor. The exact cursor position and the respective channel counts are shown on the right side above the spectrum view (green marking in the screenshot below). When the cursor is placed on a peak or a multiplet, the peak fit is highlighted indicating the selection and the residuals are displayed in the chart below. The fitted peak or multiplet data is shown in the peak fit results table below the spectrum view.

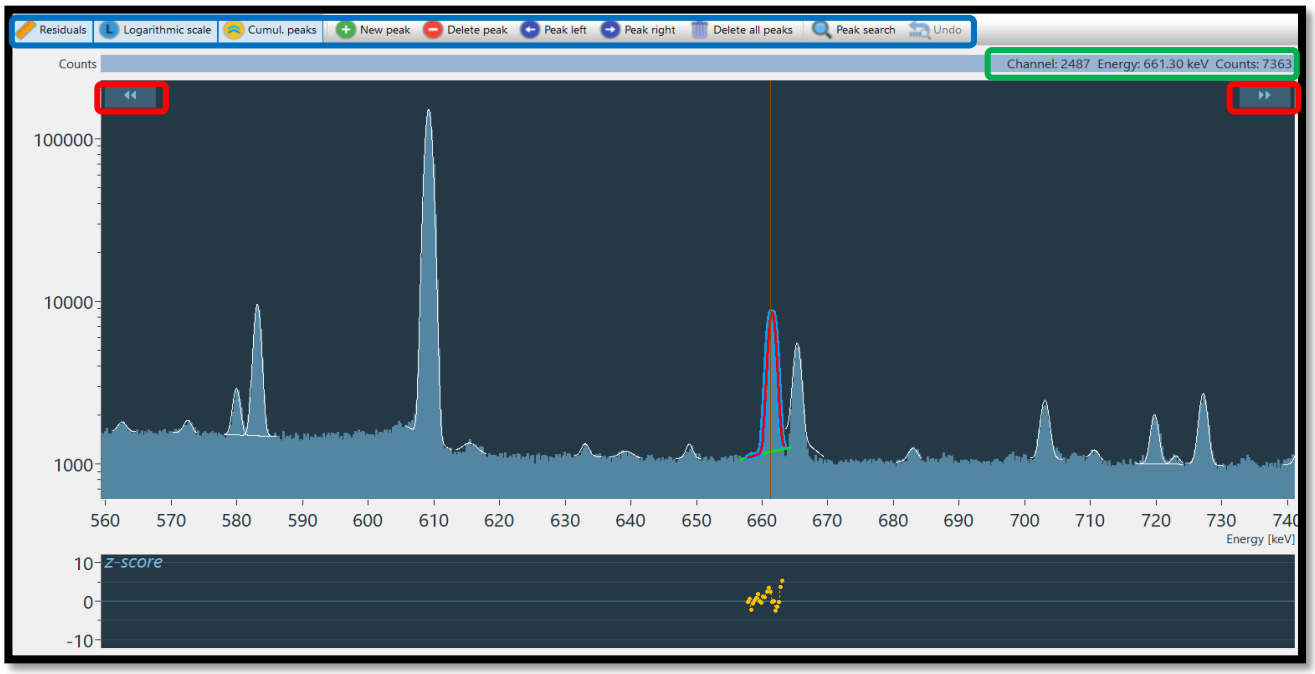


Figure 225. Peak Editor Spectrum View

Spectrum manipulation in the Peak editor spectrum view works the same way as in the LVis spectrum view:

- Horizontal zooming in on the spectrum data (reducing the presented energy range) is possible by using the mouse while holding the left mouse key and dragging over the energy range of interest.
- Zooming out horizontally is achieved by right mouse clicking into the spectrum view.
- Vertical zooming is done with the mouse wheel. Rolling upwards zooms in, downwards out. Note that the mouse position decides the zooming focus. For example, when the intention is to zoom in on the Compton background place the mouse at the background. When instead the intention is to zoom in on the top of a peak, place the mouse there.

In addition, there are two arrow icons in the top left and right corners of the spectrum view that can be used to scroll left or right (red marking in Figure 225 above).

Above the spectrum view is a list of icons that provide access to several tools to work with the spectrum view (blue marking in Figure 225 above). It is possible to “Delete all peak fits” or to delete all current fits and replace with results from a new peak search. Arrow buttons allow “jumping” from peak to peak. One can also “Delete a peak” or “Add a peak” at the current cursor position.

The spectrum data can either be presented in a linear or logarithmic vertical scale. Users can toggle whether to show the peak fit residuals or “Cumulative peaks”. Cumulative peaks are the composite fits of multiplet peak regions (see screenshots below).

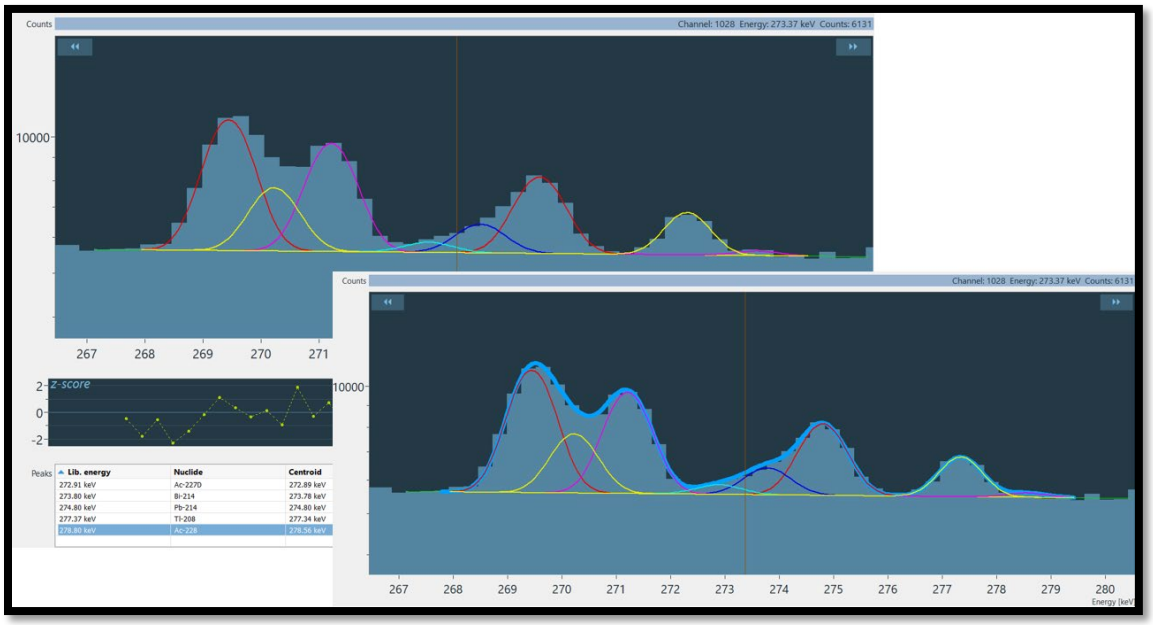


Figure 226. Cumulative Peaks

10.2 THE PEAK FIT RESULTS TABLE OF THE LVIS PEAK EDITOR

The peak fit results table of the LVis peak editor is shown below the spectrum view. It presents the energy, areas, and the width of the selected peak, and if assigned to a nuclide, the respective nuclide name and the library energy. When a peak multiplet is selected (several peaks together for which a common background fit is applied), the results for all multiplet peaks are shown in the table. Clicking on a peak in the table will move the cursor in the spectrum to the respective peak centroid.



Figure 227. Peak Fit Results Table

The peak results presented in this table are used for the activity calculations (or in the calibration table when starting the LVis Peak editor from the “Calibration editor”) when clicking on **Close and apply changes** on the peak panel of the LVis Peak editor.

10.3 THE PEAK PANEL OF THE LVIS PEAK EDITOR

The peak panel of the LVis Peak editor is organized on three tabs that are shown in Figure 228.

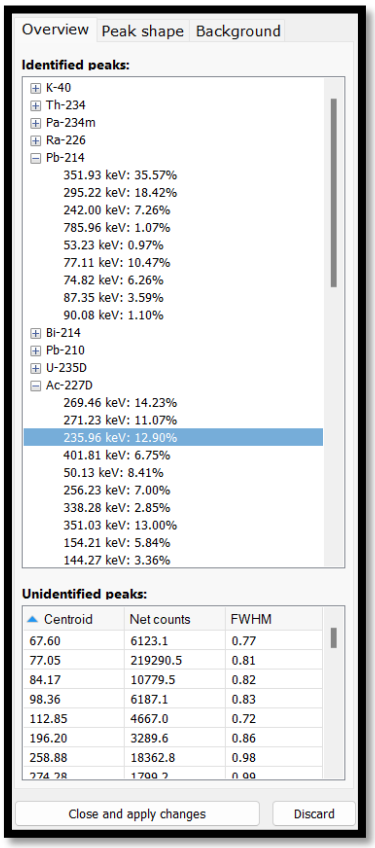


Figure 228. Peak Panel Overview Tab

The first tab provides an “Overview” about all peak fits of the current spectrum. These fits are sorted and listed in two sections.

- **Identified peaks** – peaks that were assigned to nuclides are presented in the upper list and sorted by their respective nuclides and branching ratios

- **Unidentified peaks** – peaks that were not assigned to a nuclide are listed in the lower table

Clicking on an entry in either of the two sections will select the respective peak and update the spectrum view and peak fit results table accordingly.

The tab “Peak Shape” provides information about the fitted peak shape and its respective parameters. The parameters of a gaussian peak fit are displayed in the screenshot in Figure 229. The Gaussian function is given by:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} = Ae^{-\frac{1}{2}\left(\frac{x-c}{w}\right)^2}$$

With:

A = amplitude
c = centroid
w = full-width-half-max (FWHM) of the peak

When applying a Gaussian peak fit to spectral data, these three variables are optimized using a least square fit minimizing the difference between the counts in the spectrum and the gaussian function.

Each of the three gaussian variables can be adjusted manually using the respective sliders. Note that the respective fit in the spectrum view automatically updates and shows the peak results based on the manual adjustments.

With the tick boxes every parameter can be set fixed such that they are not optimized when fitting the remaining parameters.

In Figure 229, below the peak fit parameters are buttons to assign a peak to a nuclide (or delete an assignment) and to re-fit a singlet or a multiplet using the adjusted and fixed parameters from above. It is also possible to merge a singlet with a nearby multiplet or isolate a multiplet peak from the multiplet. When clicking the respective buttons users can select if the merger (or isolation) should occur only on the left, only on the right, or on both sides of the peak. Note that an automated re-

fitting is done when a peak is merged. Figure 230 shows a typical four step workflow of merging two multiples and then adding a peak to the multiplet to improve the overall fitting.

NOTE: The least square optimization may sometimes stop at an unreasonable FWHM or centroid because the overall deviation reaches a minimum. In this case, use the sliders to first set the parameter to a reasonable value and untick the respective box so that the value is not optimized during re-fitting.

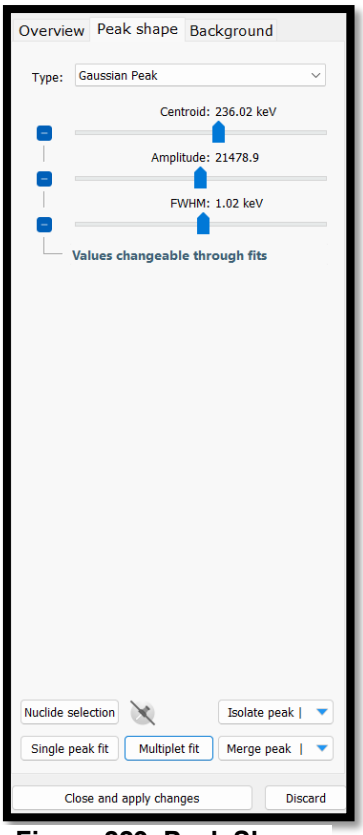


Figure 229. Peak Shape Tab

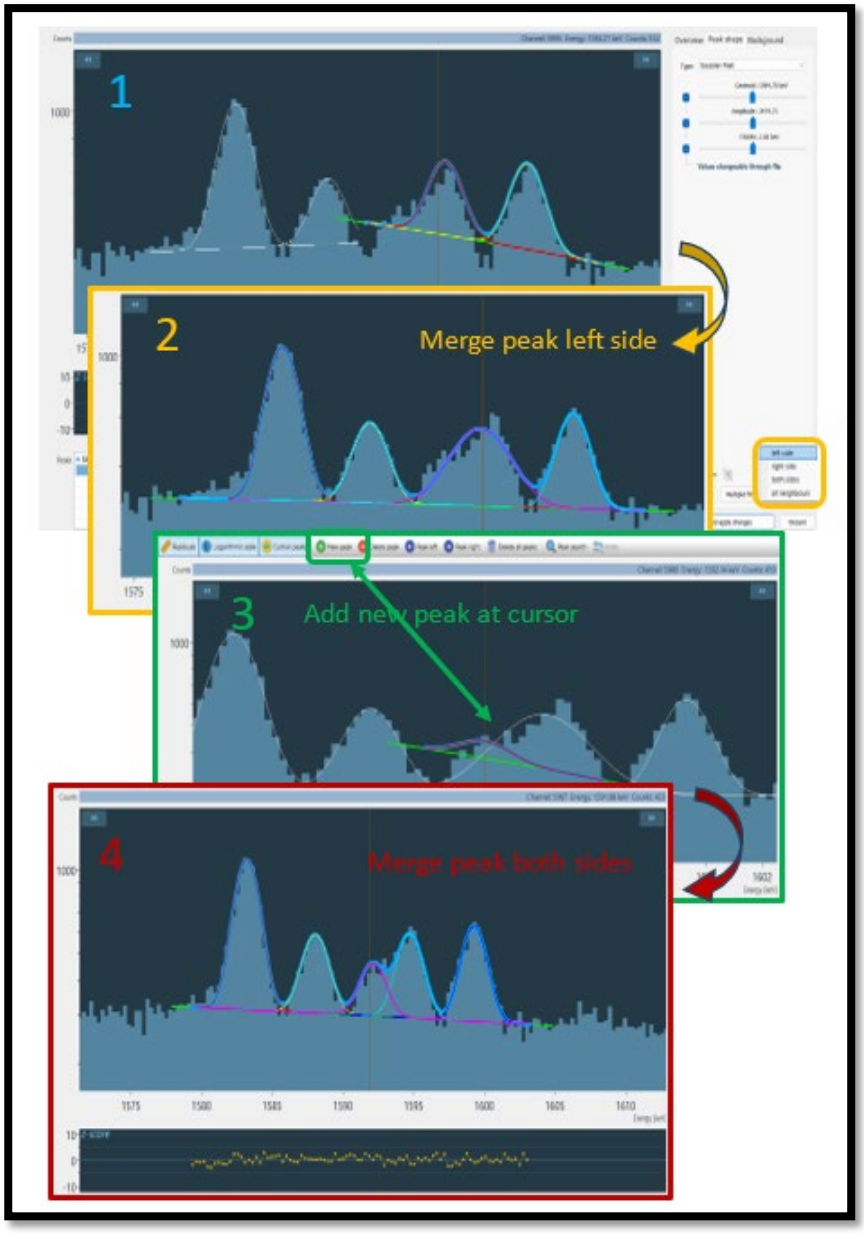


Figure 230. Four Step Workflow for Merging Peaks

In addition to the Gaussian peak fit, the LVis Peak editor supports three other peak fits:

1. "**Gaussian with a low energy tailing**",
2. "**Gaussian with a low- and high energy tailing**"
3. "**Pseudo – Voigt**" function

These can be selected from the "Type" pulldown menu at the top of the "Peak shape" tab. Depending on the selected fit, the respective parameters change. The different mathematical fit functions and parameters are explained below:

- The mathematical expression used as the overall fitting for a "**Gaussian with low energy tailing**" is taken from a paper written by Marroyo et al ("*ALFITeX: a new code for the deconvolution of complex alpha-particle spectra", Radioanal Nucl Chem (2013) 296:1247–1252; Formula 1*). With this method, the peak is formed by the convolution of a Gaussian curve with two left-handed exponentials in the low-energy-tail region. "Sigma" is the Gaussian distribution parameter, "Eta" is the weight of the first exponential (with 1 - Eta being the weight of the second exponential), "Tau 1" and "Tau2" the exponential parameters.

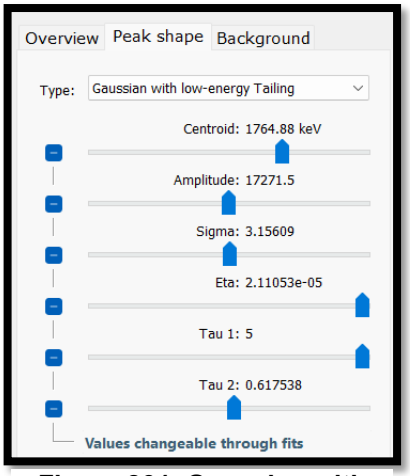


Figure 231. Gaussian with Low-Energy Tailing

- The method used in the LVis Peak editor when fitting peaks with a "**Gaussian with low – and high-energy tailing**" is best described in a paper from Collins et al. *("The impact of high-energy tailing in high-purity germanium gamma-ray spectrometry on the activity determination of ^{224}Ra using the 241.0 keV emission", App. Rad. Isotopes 157 (2020) 109021; Formulae 3 to 5*). An exponential truncated at the peak position convoluted with a Gaussian represents the respective tailing on each of the sides of a peak. The exponential parameters represent the steepness. Note that the amount of tailing can be defined differently for the high and low energy part.

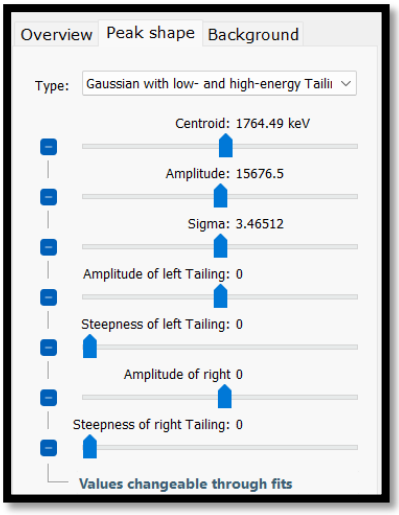


Figure 232. Gaussian with Low- and High-Energy Tailing

- A Voigt profile results from the convolution of two broadening mechanisms, one of which alone would produce a Gaussian profile G(x,f), and the other would produce a Lorentzian profile L(x,f) (usually as a result of the Doppler broadening). X-ray peaks are often best fitted using a Voigt function. A numeric approximation for the Voigt profile is the "**Pseudo-Voigt**" approximation, a linear combination of a Gaussian curve with a Lorentzian curve instead of their convolution. The weighing factor is "Eta".

$$V(x,f) = \eta \cdot L(x,f) + (1-\eta) \cdot G(x,f)$$

Gamma is the scale parameter of the Lorentz function which specifies its half-width at half-maximum (HWHM).

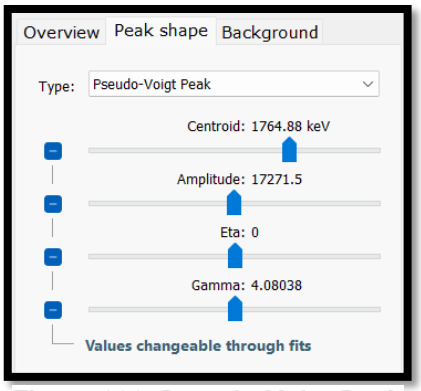


Figure 233. Psuedo-Voigt Peak

The "**Background**" tab allows adjustments to how the background of a peak, the Compton continuum, is calculated.

Three different background methods are available in LVis. All three methods require the peak start and stop channel (the peak limits) and a low energy and high energy background range outside this peak (or multiplet) range. It is possible to define the peak limits as well as the number of channels outside these limits using the respective sliders.

- "Linear Background" applies a linear fit to the low energy background average and the high energy background average. The counts in each of the background ranges are summed and divided by the respective number of channels to calculate the low and high energy averages.
- "Constant Background" applies a constant linear background by averaging the background counts per channel on both sides together and using this as the constant background per channel.
- "Integrated Background" uses the following expression:

$$C(x) = \frac{B_{low}}{n} + \frac{B_{high} - B_{low}}{nG} \sum_{i-1}^{i} y_i$$

Where

G = total sum of counts in the ROI

y_i = counts per channel in channel i of the ROI

n = number of continuum channels on each side of the ROI

B_{low} or B_{high} = the sum of counts in the continuum channels on each side of the ROI.

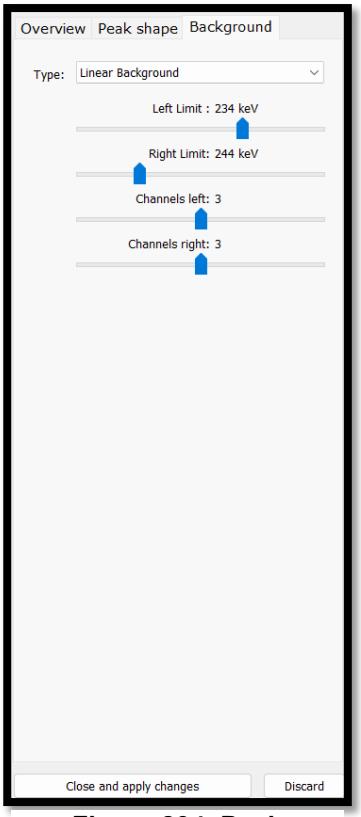


Figure 234. Peak Background Tab

11. THE LVIS LAB JOURNAL

In the Lab Journal and its related database, LVis keeps track of all measurements that are analyzed and saved. Thus there is not only the analysis results database inside each LVM file which includes all data belonging to a single acquisition but there is also the Lab Journal database which stores the most important information from all measurements available in the LVis database folder. Namely this is the geometry, ufopeaks, and ufonuclides as well as the ufoheader table information (see Section 5.1.1 External Databases for more information).

The LVis Lab Journal is a separate program (LVisLabJournal.exe) that gets installed together with LVis in the LVis program directory. It allows easy file filtering, data retrieval, and reporting among multiple measurements.

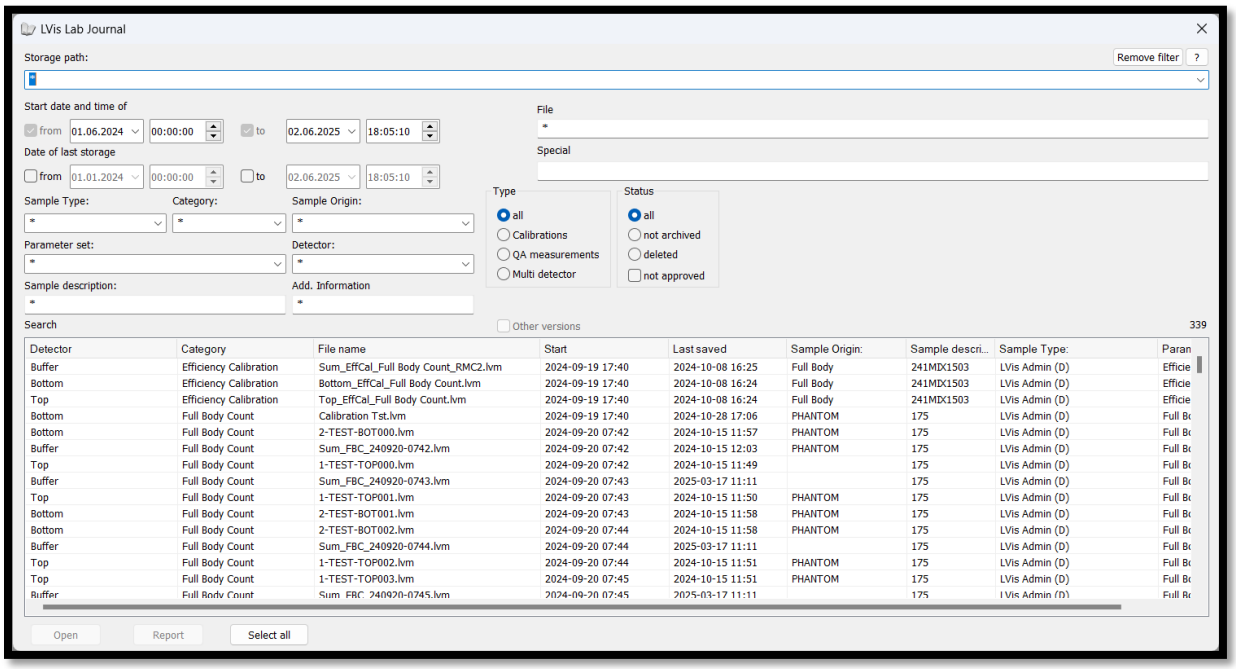


Figure 235. Lab Journal

LVis will automatically log information about all new acquisitions and from all existing LVM's that are re-analyzed and then saved in the Lab Journal's database. However, it is also possible to have LVis scan the \Measurements folder in the LVis database directory to import all LVM files. This can be done by clicking on the Lab Journal entry in the top menu bar. **Import measurements** will create or update an existing database and will then scan through all LVM files available in the LVis database folder. Their data will then be added into the LabJournalyyyy.mdb located in the Config folder of the LVis database directory.

IMPORTANT Depending on the number of LVis LVM files on the system, the import of measurement data into the Lab Journal can take some time. *LVis should not be interrupted during the import!*

The following window will appear during import and will list and summarize all errors:

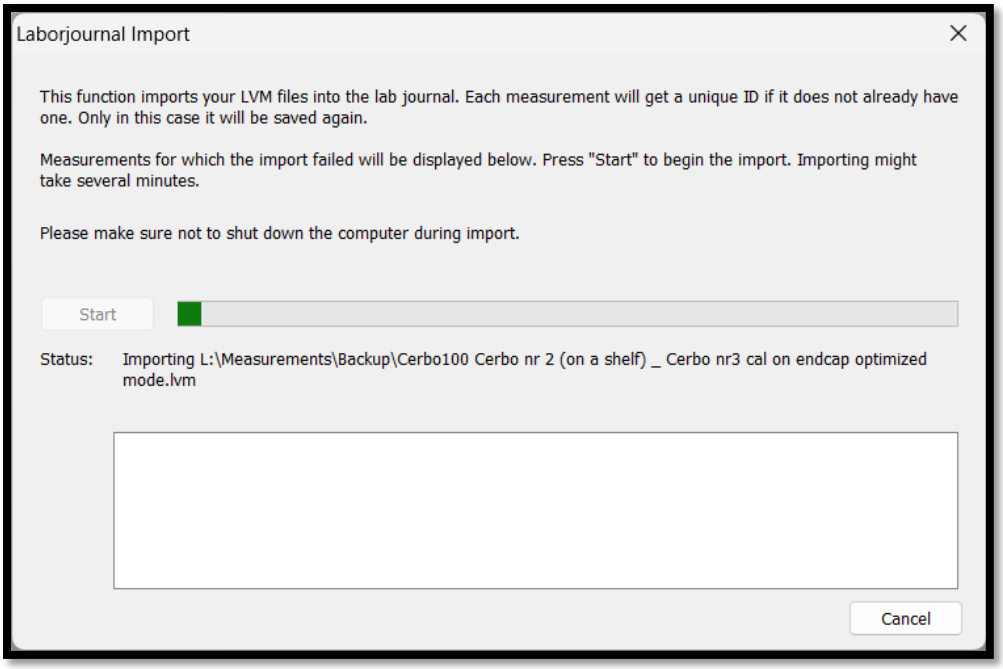


Figure 236. Lab Journal Import

The Lab Journal allows users to search all LVM's in the database by use of several filters. The search results are displayed in a table and users can either open the files in LVis by double clicking on the respective entry in the table or create customized Microsoft Excel reports (Section 11.2) for detailed QA analyses or trend charts.

11.1 USING THE LAB JOURNAL TO FIND EXISTING MEASUREMENTS

The LVis Lab Journal finding measurements by providing the possibility to search for files based on filters.

IMPORTANT In cases when no filter should be applied, an asterix "*" must be used as a wild-card.

Any combination of the following filters can be applied to the Lab Journal search:

1. **Storage Path** of LVM files
2. **Date/Time Range** (From – To) **of spectrum acquisitions**
3. **Date/Time Range** (From – To) **of last storage** of LVM files
4. **File** name **filter** of LVM files
5. **Sample Type** – This filters the displayed LVM files by the name specified in the "Sample type" field of a parameter set. The "Sample type" is the tag located below the "Category" field on the "Sample data" tab of a parameter set. Note that it may be labelled differently in some of the LVM files.

6. **Category** – This filters the displayed LVM files by the Category specified in the “Category” field (see Section 5.2.1) of a parameter set.
7. **“Sample Origin”** – This filters the displayed LVM files by the name specified in the “Sample origin” field of a parameter set. The “Sample origin” is the second field below the “Category” and may be labelled differently in some of the LVM files.
8. **Parameter Set** – This filters all LVM files by the name of the parameter set that was used to analyze or acquire the spectrum.
9. **Detector** – Only those LVM’s will be listed, that were acquired with the detector (name!!) defined here.

It is possible to define the type of LVM that the Lab Journal should search across. The respective types can be “Calibrations”, “QA measurements”, “Multi Detector measurements” (including LVB files), or simply “All” LVM file types.

In addition users can filter by the status of the LVM file. More information about the status of an LVM file can be found in the next chapter.

The search results are presented in the table of the Lab Journal. The results can be sorted by clicking the respective column header. This is especially useful when creating Microsoft Excel reports from the LabJournal. The VBA scripts parse data out of the database and into Excel in the same order as the LVM files are listed in the Lab Journal.

The number of files that match the search criteria is given on the top right of the search results table.

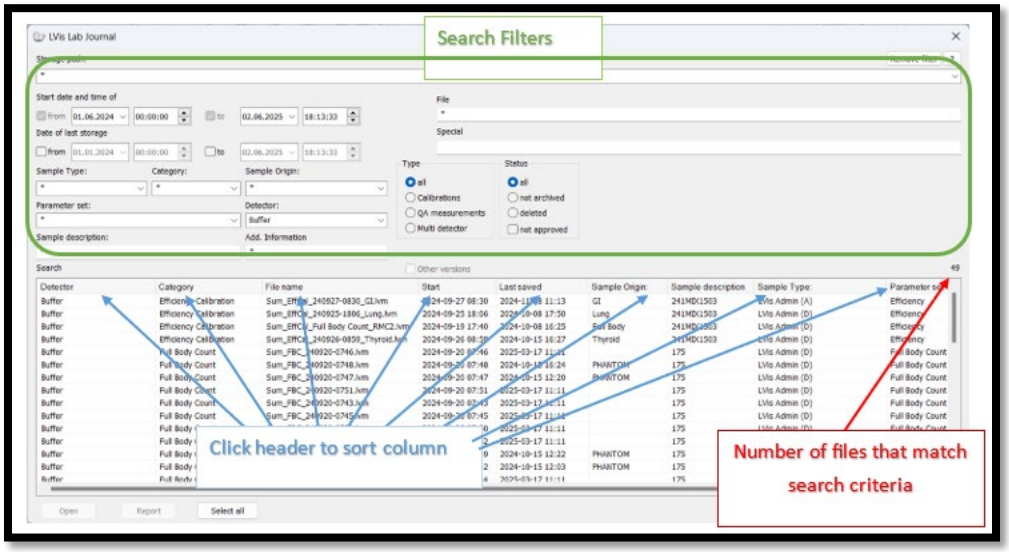


Figure 237. Lab Journal Search

Double clicking any entry in the table will open the respective file in LVis.

11.2 REPORTING WITH THE LVIS LAB JOURNAL

With the LVis Lab Journal it is possible to create reports using the data from multiple acquisitions. To do this simply select the acquisitions that are desired to use for the report in the Lab Journal and click the button **Report** underneath the Lab Journal table.

Clicking this button will open a window where it is possible to select the report template.

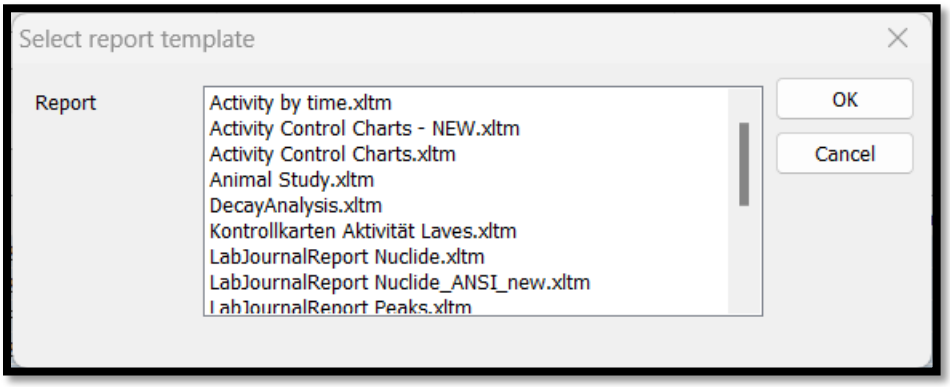


Figure 238. Selecting a Report Template

All templates used for the Lab Journal reporting will be located in a subfolder of the report template directory called “LabJournal”. (Note that the Report folder used by the LVis installation will depend on the language being used within LVis. The default location is **…\LVis *database directory*\Reports10XX** where XX will differ based on the language being used with XX=33 for English, XX=36 for French, and XX=31 for German.)

These Lab Journal reports will not be created with CrystalReports like the reports from a single acquisition but the data from the selected acquisitions will be parsed into a Microsoft Excel template (*.xltm) using VBA scripts. This is especially useful when creating trend charts or doing statistical analyses of data, however in order to be able to use this reporting capability from the LVis Lab Journal, a version of Microsoft Office will have to be installed on the computer that includes Microsoft Access.

12. SAMPLE CHANGER

LVis offers the possibility to control automatic sample changers and to conveniently predefine the samples that are to be counted in a sample series. There are basically two ways how LVis can control a sample changer: Either by the two ORTEC hardware I/O's "sample ready" and "change sample" or by software handshaking via text files.

The latter is only possible in cases where sample changers from GEMINI Technology Ltd, Hidex, or innoRIID are used. Please note that not every sample changer from these companies can be controlled by LVis. Please contact ORTEC technical support in case there are questions.

The sample changer feature in LVis does not necessarily require a real hardware changer. It is possible to use this feature simply to predefine a series of samples which are then subsequently counted (similar to the loop command in Gamma Vision job files).

To enable the sample changer feature, make sure that LVis is in admin mode, right click on the detector, and choose **Sample changer settings** from the detector context menu. Then tick the box **Sample changer active** (see red circle on screenshot). Several other parameters can be predefined on this screen to control different types of sample changers. These controls will be explained in the next chapters.

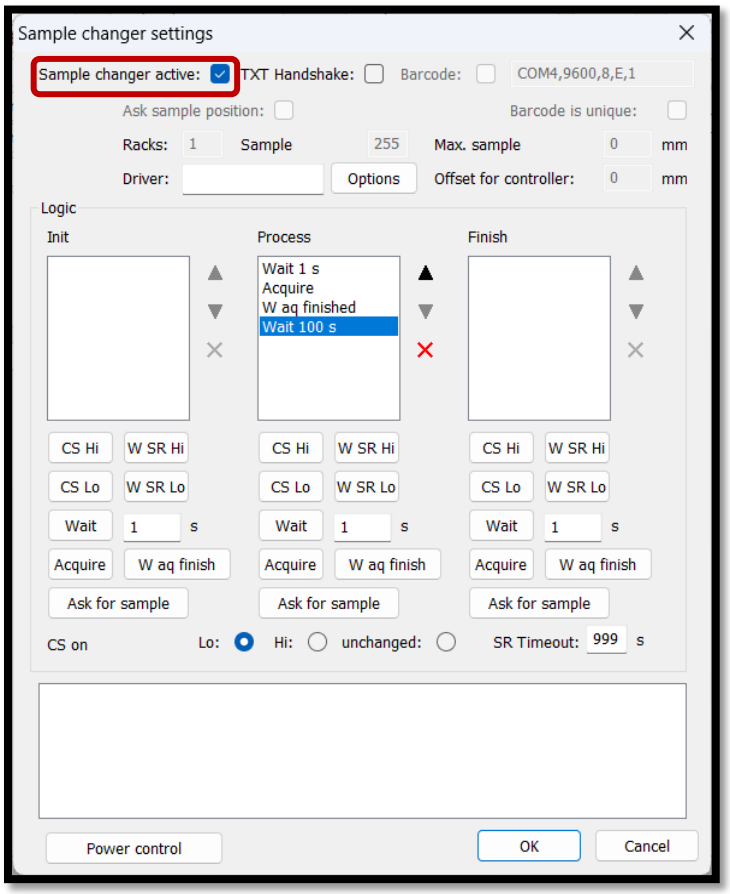


Figure 239. Sample Changer Settings

As soon as the sample changer is activated a “Sample stack” will be listed under the respective detector.

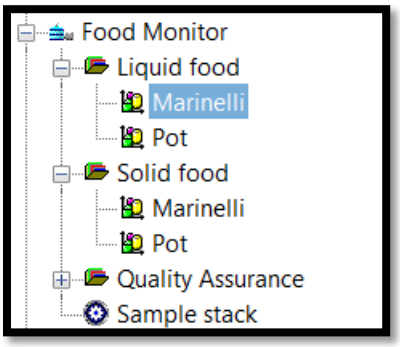


Figure 240. Navigation Tree Showing Sample Stack

The basic idea behind the sample changer feature in LVis is that instead of starting a predefined acquisition directly after the respective sample specific information has been entered into the parameter set by clicking on **Start**, users can add it to the sample stack.

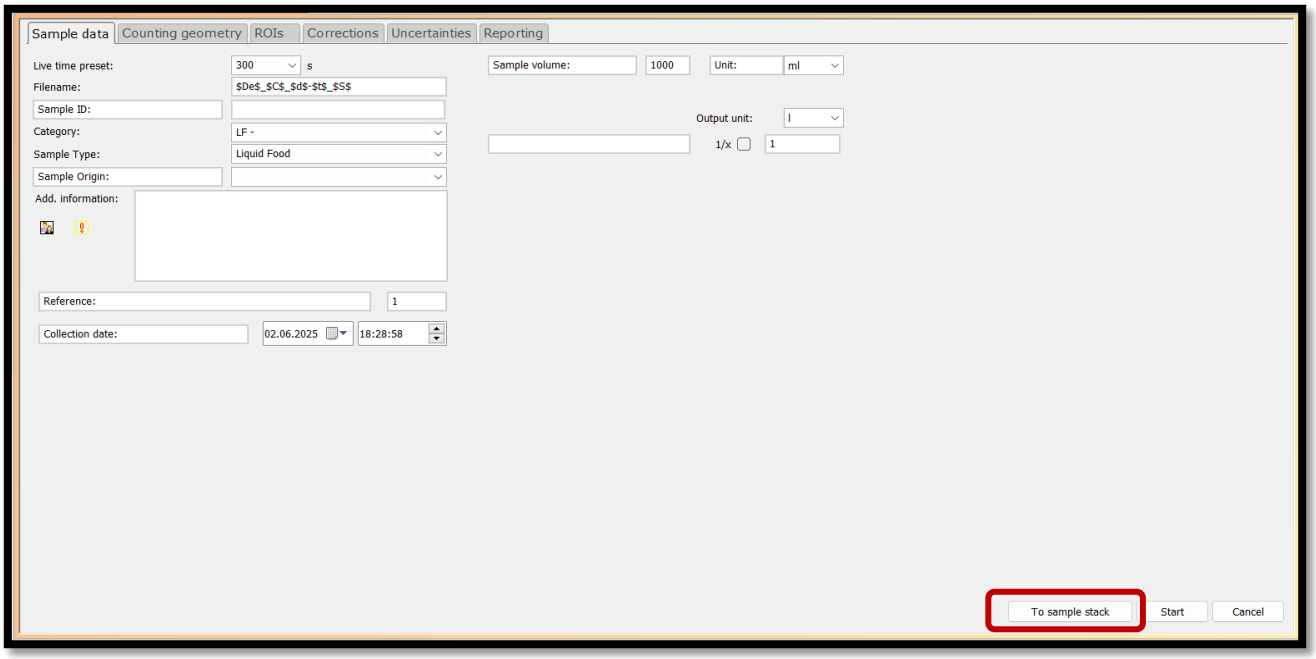


Figure 241. Sample Data Tab with Sample Stack Button Highlighted

Every sample specific parameter set that has been added to the sample stack will be listed with the name of the parameter set and the sample description under the sample stack icon of the detector.

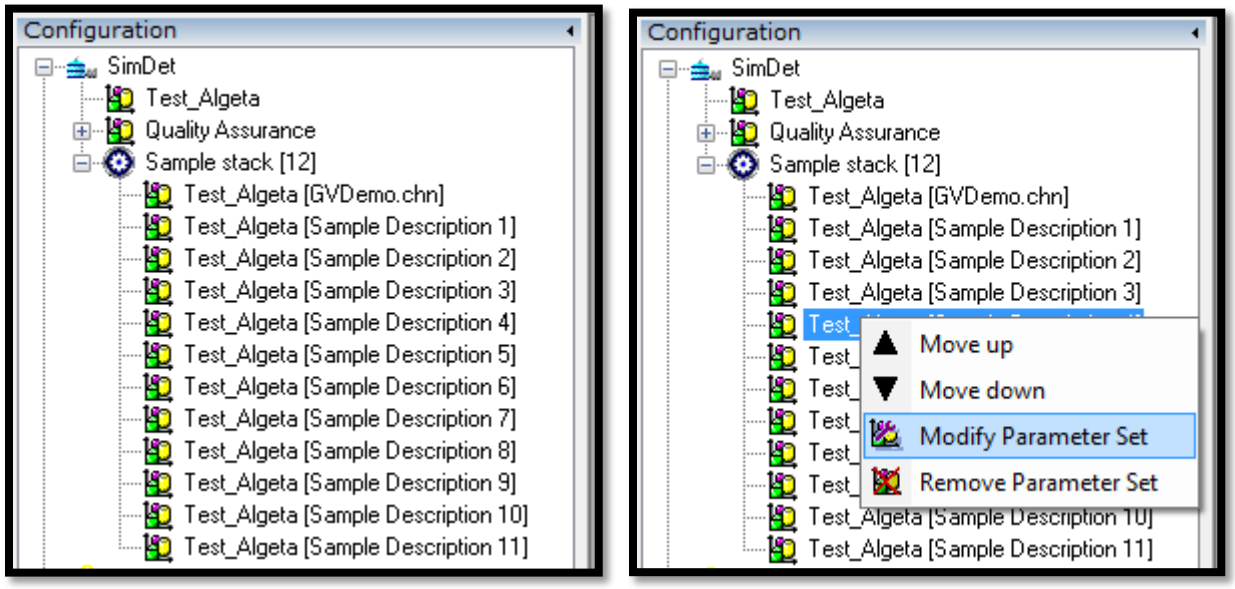


Figure 242. Configuration Tree Showing Sample Stack Modifications

Right clicking on a parameter set that is listed in the sample stack allows modification, change of position within the stack, and complete deletion of the respective parameter set (see right picture in Figure 242).

Once a complete sample series has been defined, the batch can be started by right clicking on the "Sample stack" and choosing **Start**.

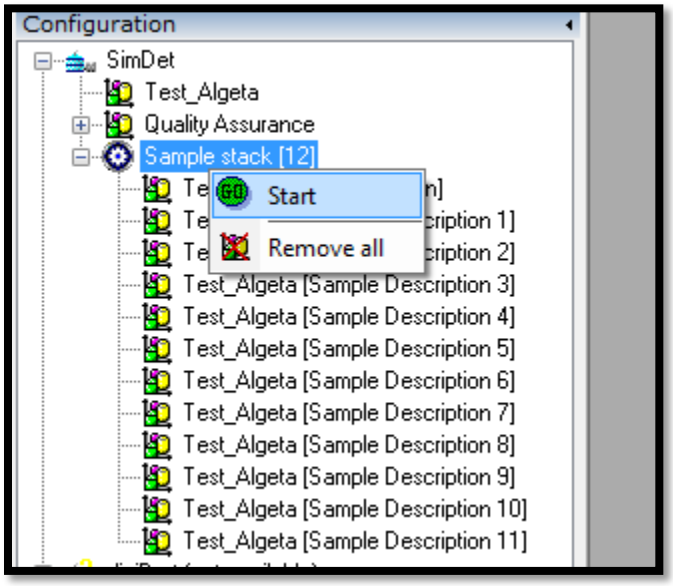


Figure 243. Starting a Sample Stack

The detector as well as the sample stack will be highlighted in red to indicate that there is currently a sample series processed. Every sample that has been counted and analyzed will disappear from the sample stack list. A sample stack that is currently processed can be stopped by right clicking on the "Sample stack" and selecting **Stop**.

NOTE: Stopping a sample series from LVis with this command requires different adjustments in order to bring the system back to a reasonable state (usually no sample on detector and changer in home position). The necessary adjustments depend on the way the sample changer is controlled (see the rest of this chapter).

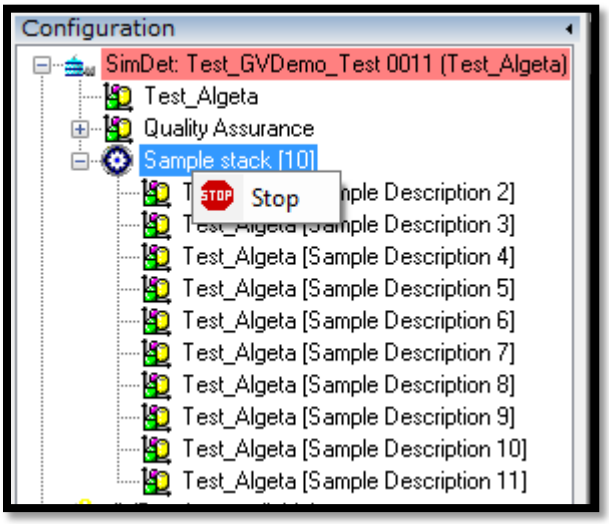


Figure 244. Stopping a Sample Stack

If a processed sample series is stopped before its end or somehow interrupted, a sample changer log file will be displayed. This file is located in the LVis database \config folder and can be used for error analysis.

12.1 SAMPLE CHANGER CONTROL BY ORTEC HARDWARE I/O

In LVis, the default operation mode for sample changers is by use of the two ORTEC hardware I/O's *"sample ready"* and *"change sample"*. Thus, as soon as the sample changer feature is activated (by ticking the box "Sample changer active") a definition of the different logic levels at the two I/O's during the processing of a sample change, insert, count, and removal has to be defined. Since the necessary levels on these I/O's might be different depending on what type of sample changer is used (and sometimes even what sample position is to be counted, e.g. first or last), it is just possible to explain the basic concept of operation within this manual and give typical examples.

On the "Sample changer settings" window (only accessible when LVis is unlocked) it is possible to define the logic levels at the two I/O's similar to how this is done in a Gamma Vision job file. It is possible to do this differently for three states: **Init**, **Process**, and **Finish**.

- **Init** describes either an initializing step at the beginning of a sample batch or the logic used for the first sample if it is different to the others.
- **Process** defines the logic during processing of the sample batch.
- **Finish** is either the one for the last sample or needed in cases where a finalizing step needs to be defined.

Init and **Finish** are usually not necessary and the respective command fields can be left empty.

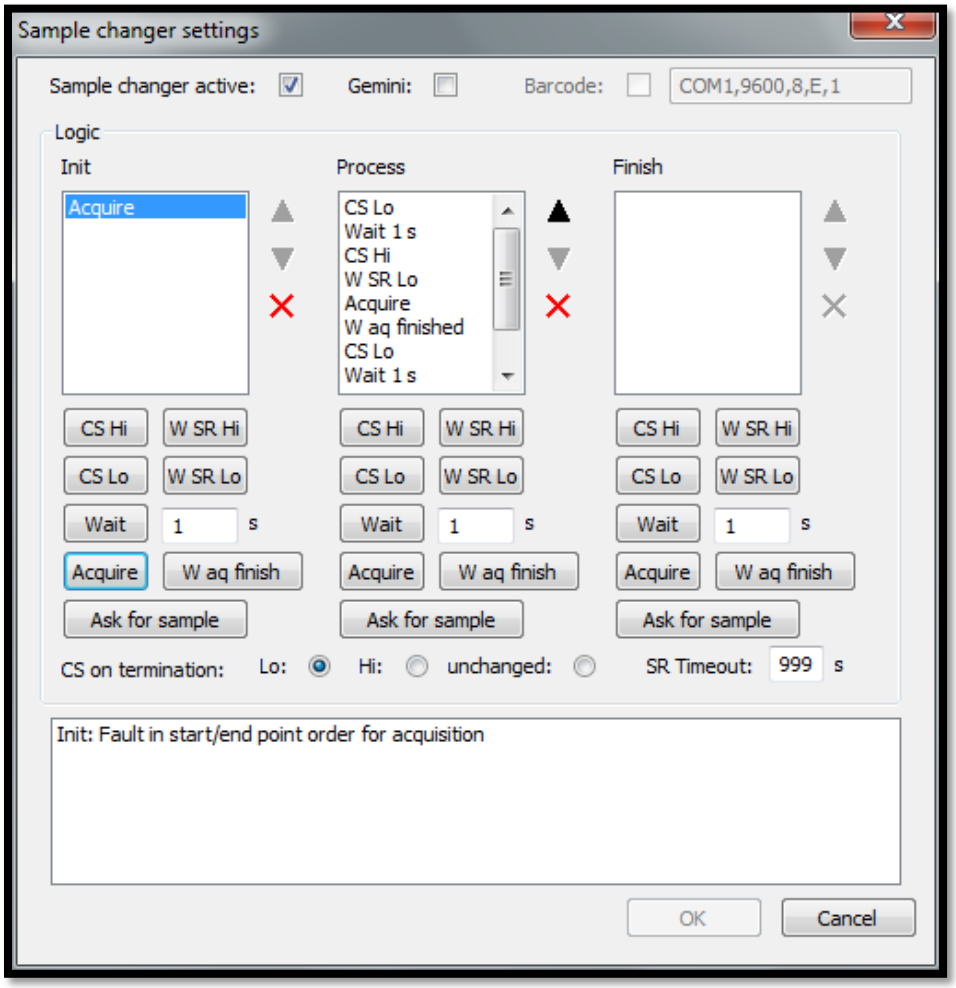


Figure 245. Sample Changer Settings Defining Steps

There are eight different commands available that can be selected by clicking on the respective command buttons.

The available commands are:

"**CS Hi**" and "**CS Lo**"	sets the TTL level at the Change Sample Connector high or low.
"**W SR Hi**" and "**W SR Lo**"	waits until the TTL level at the Sample Ready Connector changes to high or low
"**Wait**"	Waits for the specified number of seconds (max. 99999 s)
"**Acquire**"	Acquires a spectrum and processes it according to the sample definitions in the next parameter set.
"**W aq finish**"	Waits until the acquisition is finished
"**Ask for Sample**"	A window is displayed that asks for the next sample to be placed on the detector. Window needs to be confirmed by clicking **OK** before series is continued.

The lower white area is used to display information in cases where the chosen sample changer settings are somehow wrong or not logical. Figure 245 above shows an example of an incorrect command (acquire) at the beginning of the init process.

In addition, it is possible to define what signal level should be applied to the *change sample* output in cases where the sample batch is terminated and how long LVis will wait for a *sample ready* signal to be applied before a timeout is assumed.

A typical example for an LVis sample changer configuration that can be used to control a standard ORTEC sample changer model ASC-2 is:

CS Lo
Wait 1 s
CS Hi
W SR Lo
Acquire
W aq finish
CS Lo
Wait 1 s
CS Hi
W SR Lo

In order to bring the sample changer to a reasonable state (usually bring the current sample back to its position and move back home) when terminating a sample stack before it is finished users have to define what level has to be applied on the Change Sample output for this case. This can be done by selecting the appropriate level (usually CS Hi) on the “Sample Changer Settings” window under “CS on termination”:



Note that when operated in ORTEC I/O mode the sample changer will always start a sample series from position 1.

12.2 SAMPLE CHANGER CONTROL VIA GEMINI FILE HANDSHAKE

When using sample changers manufactured by Gemini Technology Ltd. it is possible to control the sample changers from LVis via software handshaking (this will have to be activated in the Gemini sample changer software ini file – see respective manual). Systems using this feature employ two text files. These files, located by default in the “C:\temp” folder, are called CS.TXT and SIP.TXT.

While the system is initializing, the SIP.TXT file contains the text “SIP---“, indicating that there is not a **s**ample **i**n **p**osition. When initialization is complete, this changes to “SIP000”, indicating that the system is ready to accept “Change” commands.

To load the first sample, or to change samples, the text “CHANGEnnn” is written by LVis to the CS.TXT file, where nnn is a 3-digit number in the range 001 to (Max. sample number). After recognizing the change command, the Gemini system will write “SIP---“ to the SIP.TXT file. When the sample is in the castle and the lid is closed, this changes to “SIPnnn”, where nnn is the number of the current sample.

To remove a sample and return the mechanics to the home position, LVis writes “CHANGE000” to CS.TXT. When the sequence is complete, the text “SIP000” is again written by Gemini software to SIP.TXT.

The software handshaking sample changer mode is activated by ticking the box Gemini on the “Sample changer settings” windows.

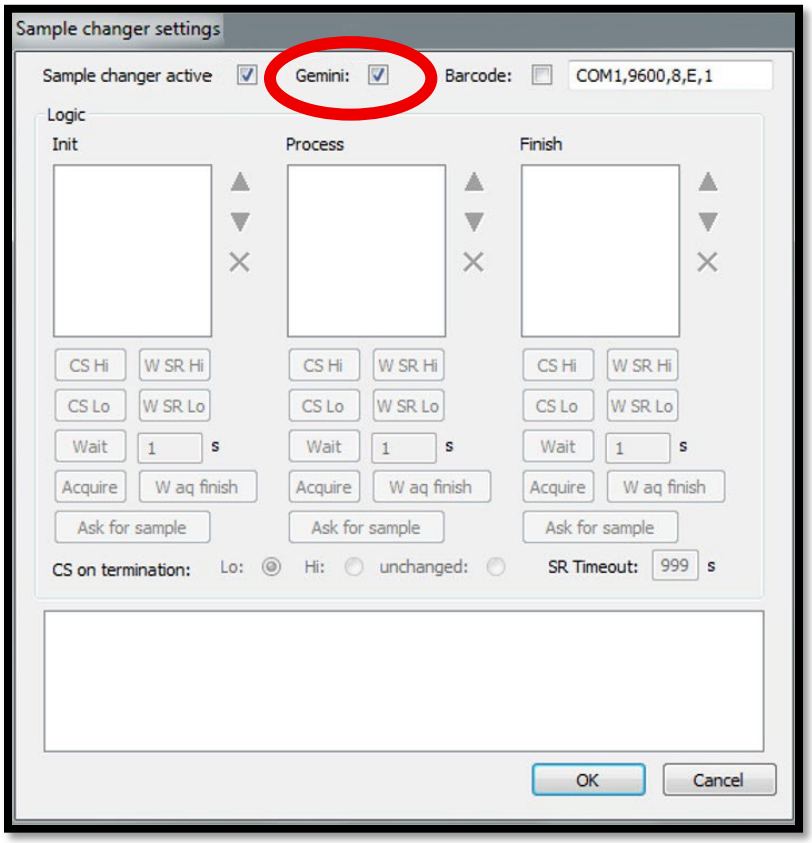


Figure 246. Sample Changer Settings Highlighting Gemini

Note that any configuration based on the ORTEC I/O’s will be deactivated and existing logic definitions will be deleted. Therefore, back up any existing sample changer configurations before activating this operation mode by using the **Export sample changer settings** command from the detector context menu.

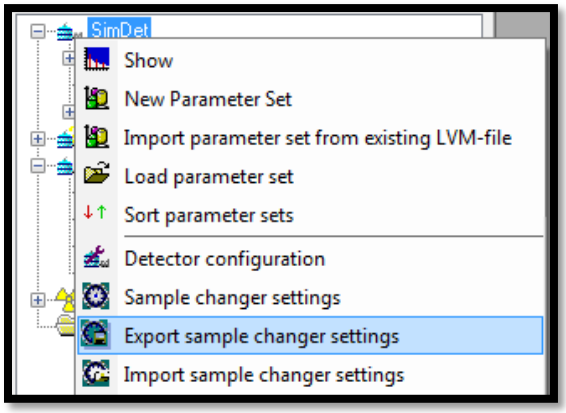


Figure 247. Export Sample Changer Settings Selection

The control of the sample changer by txt-file handshaking offers the advantage that LVis can define exactly the sample position which is to be picked up and counted.

LVis is able to use a barcode reader option when controlling a Gemini sample changer.

In case a sample stack is terminated by the use of the “Stop” command before it is completely processed (right clicking on the “Sample stack” and choosing **Stop**) any current sample acquisition will be stopped, the sample should be taken out of the shield, transferred back to its position on the rack, and the grabber should go back to home position.

In case this process should not work for whatever reason (e.g. because of a sudden power breakdown), a manual reset to a reasonable state (usually bringing the current sample back to its position and moving it back to home) may require the use of the Gemini Control software.

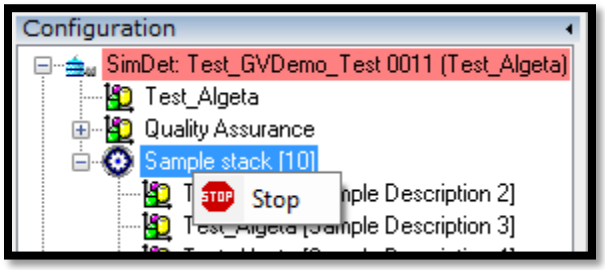


Figure 248. Configuration with Stopped Sample Stack

In order to reset the sample changer, maximize the Gemini S/C Control software from the Windows tray. Users should then see a similar window like this:

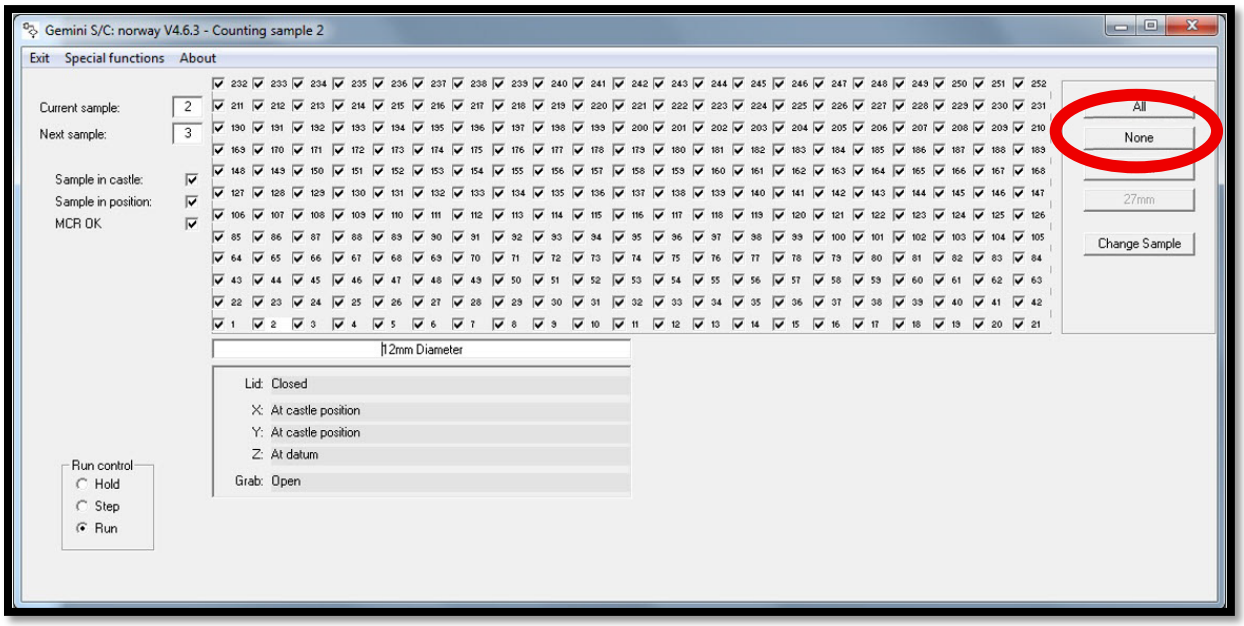


Figure 249. Gemini Control Software

Click on **None** to unselect all selected sample positions and then choose **Change Sample**.

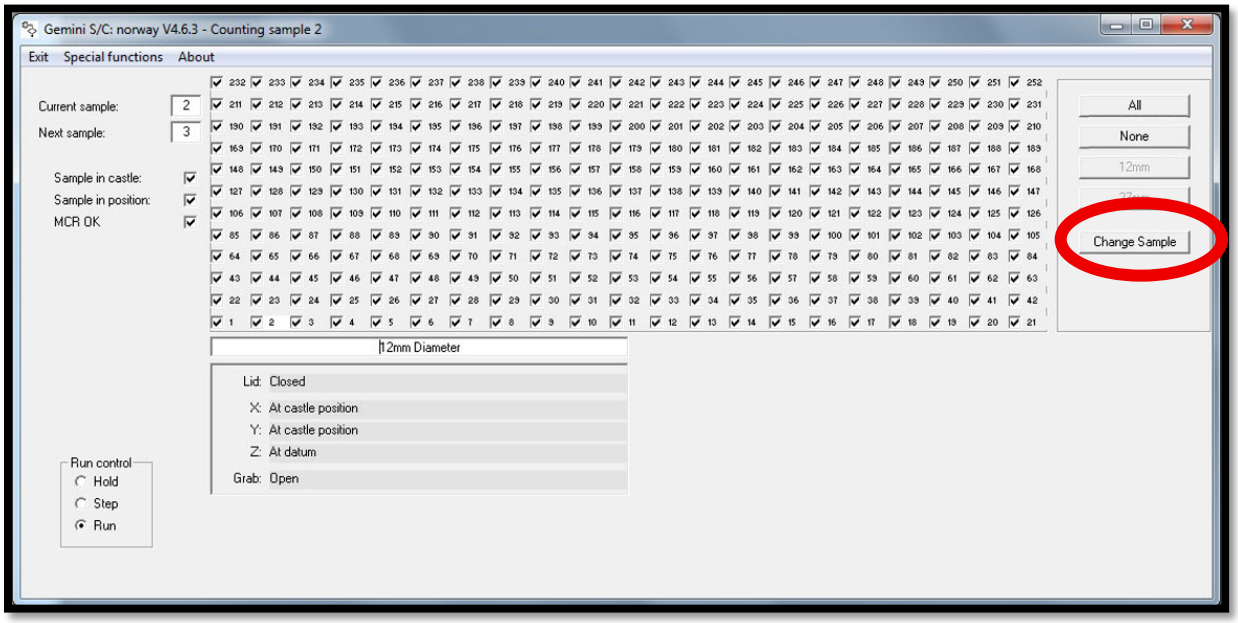


Figure 250. Gemini Control Software – Change Sample

The sample changer will then bring the current sample back to its position and go afterwards to its home position.

12.2.1 LVis Sample Set Editor

The control of the Gemini sample changer from within LVis is possible in two ways, either by adding parameter sets to the sample stack as it is done with the hardware I/O (see previous chapter) or by the use of a separate program called “LVis sample set editor” that helps to conveniently define sample series or sample batches.

The “LVis sample set editor” can be found either in the Windows Start menu under LVis, in the LVis program directory (C:\Program files\LVis\), or in the icon bar of LVis (only when Gemini sample changer control is activated for a detector).



Figure 251. LVis Icon Bar

When the LVis Sample Set Editor is started the following window appears:

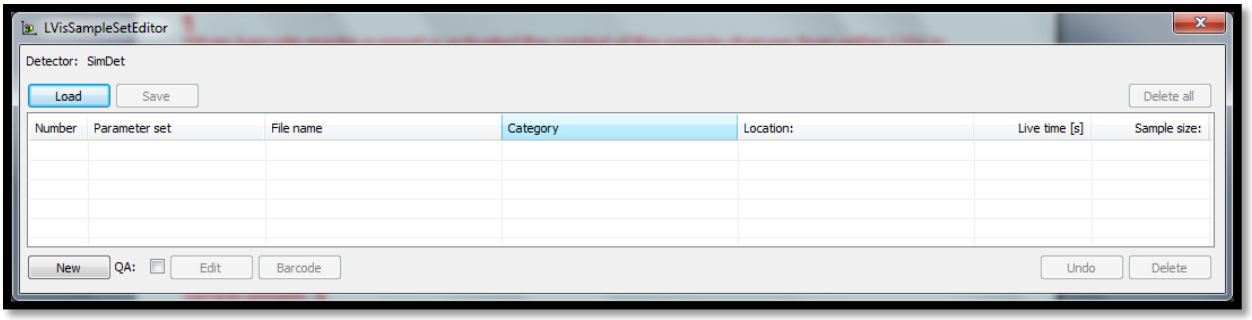


Figure 252. LVis Sample Set Editor

To add a new sample simply click on **New** and fill in the sample specific information in the opening window. A QA Check can be added to the sample series by ticking the box **QA** before clicking on **New**.

However, before users are able to define a sample batch in the “LVis sample set editor” they will have to export all of their sample presets (basically all the parameter sets for the respective detector including the defined defaults as well as the text labels defined in the global settings). This can be done from the context menu of the detector by choosing **Export sample presets**.

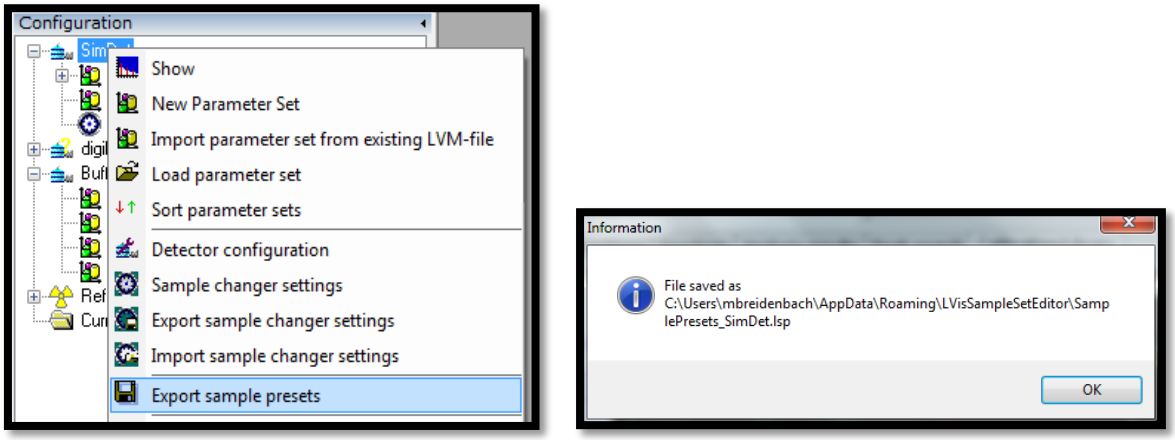


Figure 253. Context Menu Export Sample Presets

This will have to be done any time an existing configuration is modified (for example by adding a new parameter set to the detector) and it is desired to have this available for selection in the sample set editor.

The sample data dialogue that’s displayed after clicking on **New** looks different depending on what type of measurement was selected. If a standard sample was chosen, the window shown on the left in Figure 254 will be displayed. If a QA measurement was selected, the window shown on the right in Figure 254 will be displayed.

IMPORTANT All fields that are left blank on the sample data sheet of the Sample Set Editor will be populated with the default information taken from the respective parameter set.

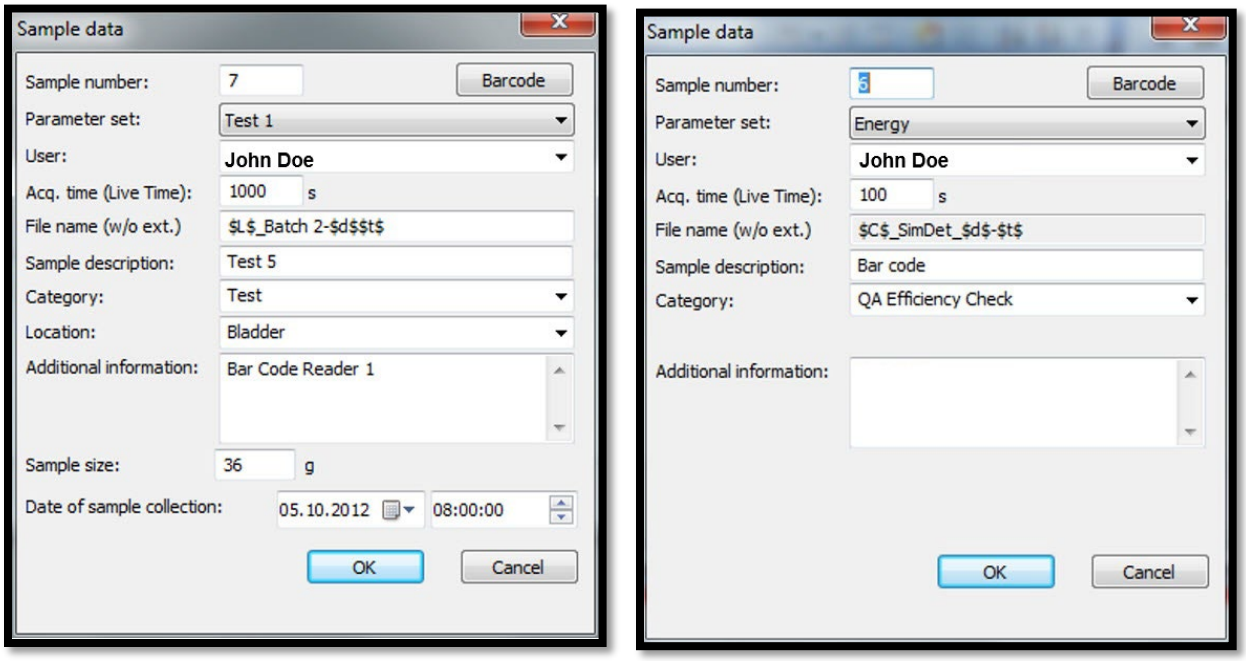


Figure 254. Sample Data Options

The first input is the unique **sample number** within the series. This is a three-digit number that is basically the only information stored in the bar code. When adding a sample to the batch by clicking **OK** this number is automatically increased by one so that usually there is no need to update this field.

Users can print the respective barcode by clicking the **Barcode** button. The number that is represented by the bar code is always also printed on the label. For the 252-position sample changer 29x90 mm labels are being used. The only bar code printer supported by LVis is the model Brother QL-570.

In the next selection field, the **Parameter set** needs to be selected from the pull-down menu. Keep in mind that only those parameter sets listed here are from those that were available in LVis the last time the sample presets were exported.

User, **Category,** and **Location** can also be selected from the predefined pull-down menus.

The **acquisition time** preset (live time) can be defined individually for every sample as well as the **reference date for decay correction** (date of sample collection). Be aware that decay correction needs to be activated in the respective parameter set to make real use of this field.

The **Filename** should be entered without the extension. $-Commands (see Table 1) can be used as in “normal” LVis parameter sets.

Sample description and **Add. Information** are simply text fields that can be filled with sample specific information.

The **Sample size** is the sample volume or mass. Which input unit is displayed depends on the default in the parameter set.

When all relevant sample specific data has been added simply click **OK** to transfer the sample in the sample series.

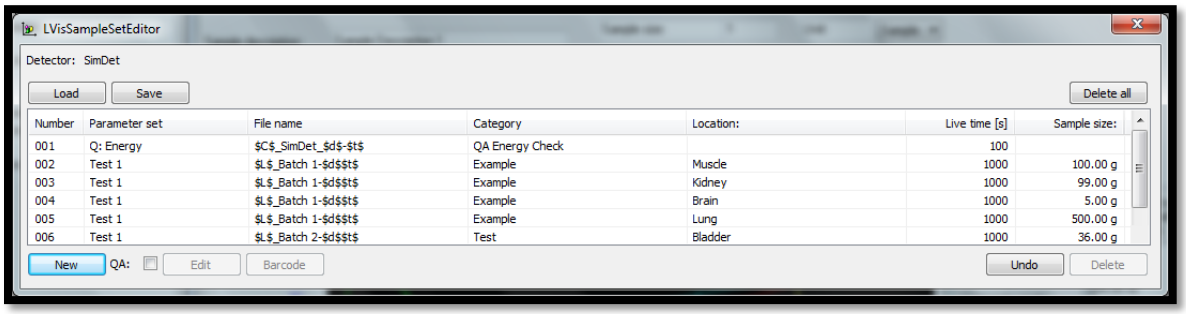


Figure 255. Defined Sample Set

It is possible to modify an existing sample in the sample series by selecting it and then clicking on **Edit**.

Barcode will print the barcode of the highlighted sample. Multiple barcodes can be printed by selecting multiple entries (using the “Shift” or “Strg” key) and then pressing **Barcode**.

Save will export the complete sample series as a text file. This text file will be needed to define/load the sample batch into LVis.

The format of this sample batch TXT file is defined as this:

- Every sample data is represented by a single text string that ends with “||*” (without the quotation marks).
- Every single data entry is separated by a vertical dash.
- The date and time string is defined according to ISO8601.

Each sample is represented in the text file by the following string:

Sample#|Filename|User|ParameterSet|LiveTime|SampleDescription|Category|Location|
Add.Information|ReferenceDate|Sample Size||*

Example:

00002|Test2|John Doe|Marinelli|000100|Description 2|Category A|Lab 1|Add Information ABC|2012-09-20T10:29:27Z|2.000000||*

The use of this .TXT file gives the possibility to create complete sample series on an external machine simply by using notepad or from a separate program such as a LIMS system.

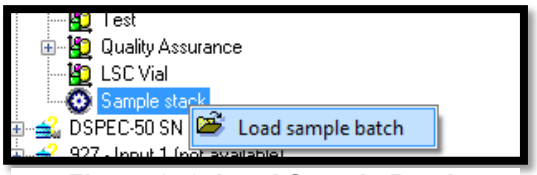


Figure 256. Load Sample Batch Selection

To process a sample series, the series will first have to be added to the “Sample stack” of a detector in LVis. To do this, simply right click on the “Sample stack” entry of the detector and choose **Load sample batch** from the menu.

The next steps are slightly different, depending on whether the sample changer is equipped with a barcode reader or not.

12.2.2 Sample Set Editor Without Barcode Reader Support

When a Gemini sample changer is operated via the txt-file handshaking but without any barcode reader support there is nothing else to adjust apart from ticking the Gemini box in the sample changer settings screen.

The definition and procession of samples when not working with barcode reader support can be achieved in two ways.

- By doing the same as when using the ORTEC I/O mode – Enter the sample specific information into a parameter set and add one sample after the other to the “Sample stack”.
- By loading a complete sample batch definition text file (created with the SampleSetEditor) into the sample stack by right clicking on the sample stack, choosing **Load sample batch** and selecting the appropriate txt file. The parameter sets for each defined sample in this series will be parsed and listed in the stack. The number of samples will be displayed in the sample stack and the whole stack can be started by right clicking on it and choosing **Start**. Note that its not possible to modify a processed sample stack.

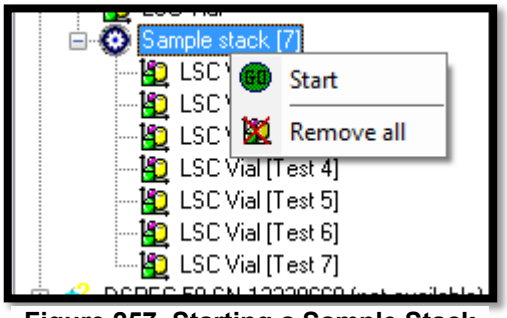


Figure 257. Starting a Sample Stack

12.2.3 Sample Changer with Barcode Reader Support

The txt-file handshaking communication mode in Gemini sample changer control is capable of giving barcode reader support for more convenience which is especially useful in cases when lots of samples have to be measured. To activate the barcode support, simply tick all the boxes on top of the “Sample changer settings” window.

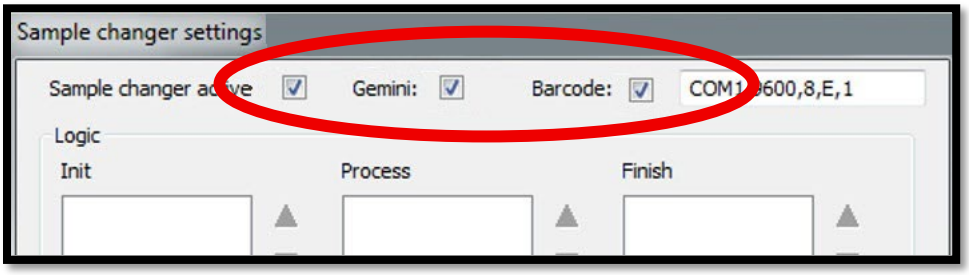


Figure 258. Sample Changer Settings Window with All Boxes Checked

Currently the Leuze BCL 8 SM 102 (for more information see: http://www.leuze-electronic.com/) is the only one barcode reader model supported. The values in the field to the right of the barcode tick box specify certain parameters for correct integration of the barcode reader into LVis. The only part that might have to be adjusted is the information about the serial port that the reader is connected to. Default is COM1.

It is possible to use the same barcode multiple times in a batch (e.g. in cases when the way the samples are to be counted and analyzed is always identical and it is just the file name that changes which is achieved by the use of $ Commands (see Table 1), users could set up a batch with only

one sample in the sample series). However, if this is not intended then LVis can stop the procession of a sample batch and inform in the log file about a barcode being not unique. This is achieved by ticking the box **Barcode is unique**.

NOTE: When barcode reader support is activated, it is only possible to define a sample batch with the LVis Sample Set Editor (Section 12.2.1) and/or the use of the respective sample batch txt files. It is not possible any more to add parameter sets to the stack.

When barcode reader support is activated and users right click on the sample stack to load the sample batch, the following window will be displayed first.

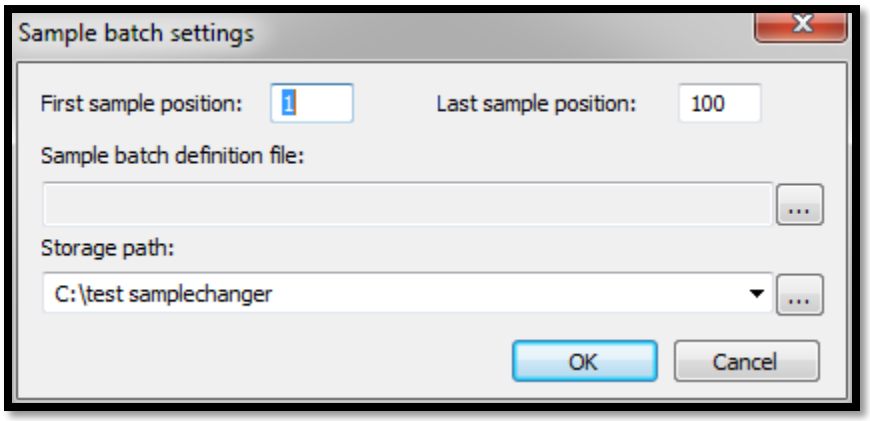


Figure 259. Sample Batch Settings

Here users can select the sample batch definition text file, and they can define the sample position from where it is desired to start and where the changer should stop. The possibility to define a start and end position is of great use when a sample batch was interrupted or samples were added to a series. In addition, it is possible to define a storage path for all samples from the defined sample batch. If the “storage path field” is left blank, the default will be used and the LVM files will be saved under **…*LVis database directory*\Measurements*detector name**parameter set name***

As soon as the sample batch is added to the sample stack just the batch will be listed with the respective start and end positions of its samples on the rack.

To start the procession of a sample stack, right click on it and choose **Start** from the menu.



Figure 260. Sample Stack Listed in Navigation Tree

12.2.4 Counting Multiple Sample Batches and Changing Their Priority

Unlike systems that do not offer barcode reader support, it is possible to add sample batches to the stack while another one is currently processed. It is even possible to change the priority of sample batches such that urgent samples can be pushed up in the stack.

To add another series to the stack right click on it and choose **Load sample batch**. There is no limitation so that an endless operation of the sample changer is possible when counted samples are replaced on the sample changer rack whilst others remain on the stack.

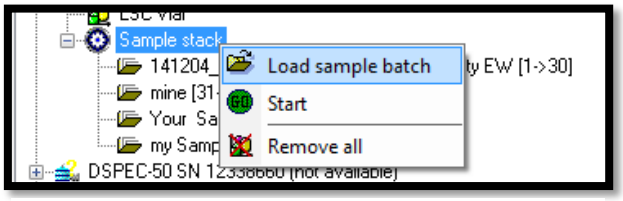


Figure 261. Load Sample Batch

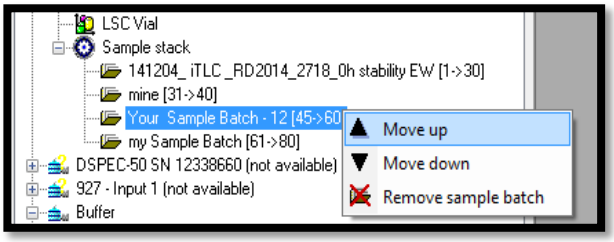


Figure 262. Changing Sample Priority

Changing the priority of sample batches can be achieved by right clicking on a sample batch and moving it either up or down on the stack. Note that even a currently processed sample batch can be moved "backwards". The sample currently in procession will be finished and placed back to its position on the rack. The prioritized sample series will then be counted and when finished the interrupted sample series will be continued at the correct position.

12.2.5 Automatic QA Checks During Sample Changer Operation

Since it is possible to operate the sample changer endlessly when the barcode reader option is activated, LVis has the option to automatically perform QA checks during sample changer operation at specified times. To do this, a sample series definition file for the QA checks will have to be created with the LVis Sample Set Editor. In addition, fixed sample positions have to be reserved for the QA check samples on the sample changer rack. Typically, these are a blank for QA Background Checks and a traceable source for QA Energy and/or QA Efficiency checks.

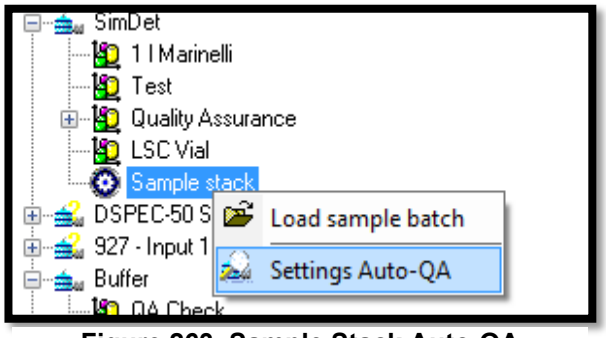


Figure 263. Sample Stack Auto-QA

To enable and setup the auto QA feature, right click on the sample stack in LVis when no sample batch is loaded and choose **Settings Auto-QA**. Note that this menu will only be accessible when no sample batch is loaded into the sample stack.

The following window will appear:

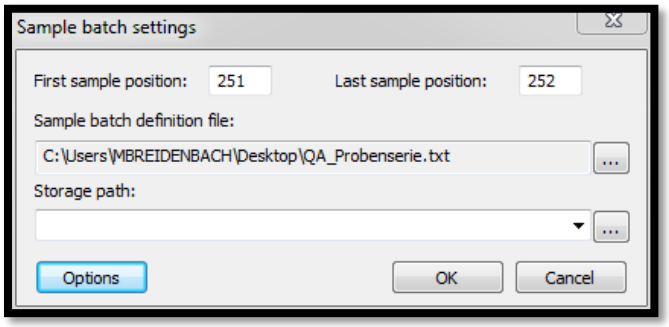


Figure 264. Sample Batch Settings

Here users can select the previously created QA sample batch definition file and can define the respective QA sample positions on the sample changer rack.

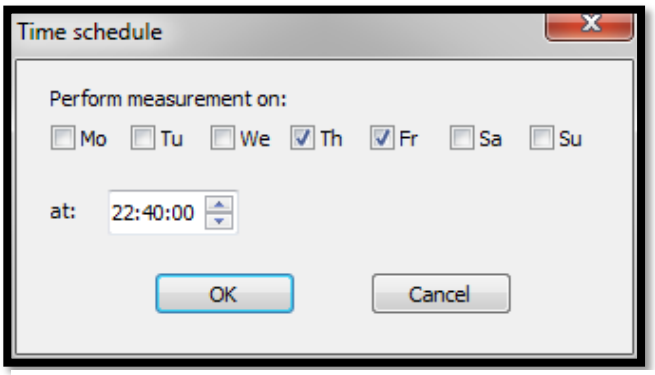


Figure 265. QA Check Time Schedule

Clicking on **Options** will allow users to define the time schedule for the QA checks. Auto QA can be done a maximum once every day. In addition, the time of the day can be defined. Note that just sample batches but no acquisitions will be interrupted for QA checks. Any currently ongoing acquisition at the specified time will be finished before the QA checks are performed. The Auto QA feature will only become active when the sample changer is actually in operation (processing sample series). Auto QA will not start a sample changer that is stopped or in home position, however a warning message will be displayed as soon as a new batch is started, informing the user about the fact that an automatic QA is pending.

13. LVIS SIMPLE MODE

The “LVis Simple Mode” was developed to enable even untrained staff to reliably perform gamma spectroscopic measurements with LVis.

It is neither possible to calibrate a detector from LVis Simple Mode or to modify or add counting routines. Only pre-configured sample counting routines and QA check routines can be started from the LVis Simple mode.

Therefore, every detector and its counting routines must first be configured and calibrated in the LVis normal mode as described in the other chapters of this manual.

IMPORTANT Only parameter sets where “Automatic analysis” is turned on will be used in the LVis Simple mode.

Only users for which the LVis Simple Mode is explicitly activated in Uli, the LVis User management program (Section 2.6) , can use the simple mode.

13.1 THE SIMPLE MODE USER INTERFACE

In the LVis Simple Mode, every live detector spectrum is displayed together with its color-coded health status and four push buttons. The spectrum can be manipulated in the same way as in normal mode. On top of each detector window, the current action status of the detector is indicated (see red marking in Figure 267 below).

Via the four buttons, operators can utilize pre-configured counting routines to process sample counts and QA checks. The LVis Simple mode will guide operators through these processes.

Additionally, the software continuously monitors the condition of the measurement system and displays its health status.

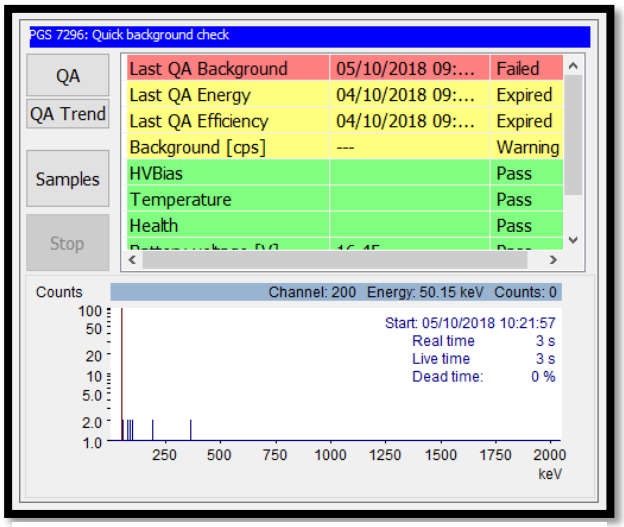


Figure 266. Simple Mode User Interface

The following parameters are continuously monitored and displayed for health status information:

- **Health** – this is the overall Health status as provided by the hardware
- **HV Bias** – this indicates if the HV bias is applied to the detector
- **Temperature** – this indicates if the detector is too warm (in Shutdown)
- **Background [cps]** – this is the gross count rate of the last “Quick Background Check”. It needs to be smaller than the nominal reference background count rate for QA background checks (see QA background counting routine) plus the alarm tolerance defined for the background in the QA settings of the detector (right click on detector and choose **QA Settings**).

- **Battery Voltage [V]** – this is the voltage supplied by the battery of a portable gamma spectrometer. The alarm level can be defined in the QA Settings of the detector (default 15V). Note that this is only displayed when the hardware has a built-in battery.
- **Battery remaining [min]** – this is the remaining lifetime of the portable gamma spectrometer in case the system is only running on battery. The respective limit can be defined in the QA Settings of the detector (default 70 min). Note that this is only displayed when the hardware has a built-in battery.
- **Last QA Background** – result and time and date of last QA background check
- **Last QA Energy** – result and time and date of last QA energy check
- **Last QA Efficiency** – result and time and date of last QA efficiency check

Every LVis user that is allowed to use the Simple mode will always start in the Simple mode after logging into LVis.

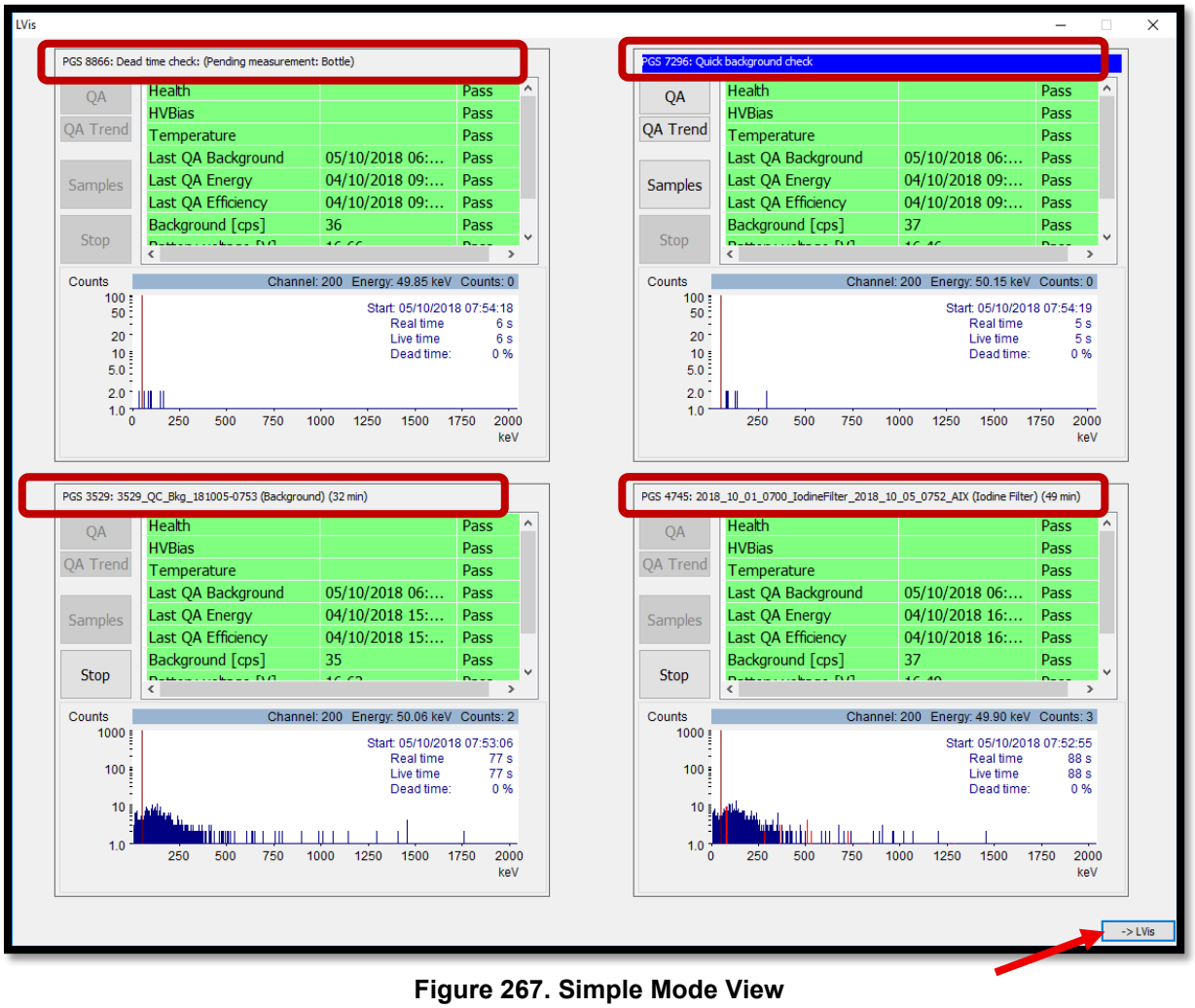


Figure 267. Simple Mode View

It is possible to leave the LVis Simple Mode by clicking on the **-> LVis** button in the right lower corner (see red arrow). Users will then end up at the log-in window of the LVis Normal Mode. However, note that it is not possible to leave the Simple Mode when there is a sample or QA count in progress.

In case the requested period during which a QA check should have been performed has expired (the period is defined in the QA Settings of a detector), a yellow “Warning” detector health message will be displayed. The same yellow “Warning” detector health message will be displayed when the “Quick background check” has crossed the limits. In case an alarm level was violated during a QA check measurement or critical hardware data is out of spec (e.g. no HV bias applied) a red “Failed” indication will be given.

13.2 PERFORMING QA BACKGROUND CHECKS IN LVIS SIMPLE MODE

The QA background check is designed to determine the background of the detector and validate it by comparing the gross count rate of the background check measurement to a nominal reference value defined in the QA background parameter set. In case the determined gross count rate is within the acceptable limits that are defined in the “QA settings” of the detector, the check will “Pass” (green). A “Fail” (red) or a “Warning” (yellow) in the Health Status information table indicates that the warning or alarm level were violated.

To perform a QA background check, press the button **QA** and select **Background** from the following menu.

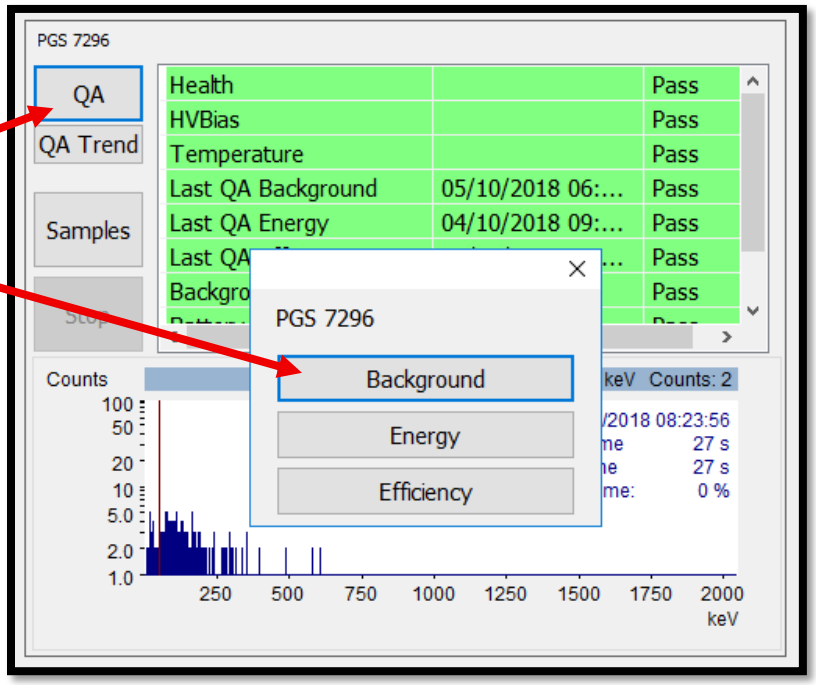


Figure 268. QA Background Check Selection

The simplified QA background counting routine will be displayed. Typically, it is not required to enter any data prior to a QA background check:

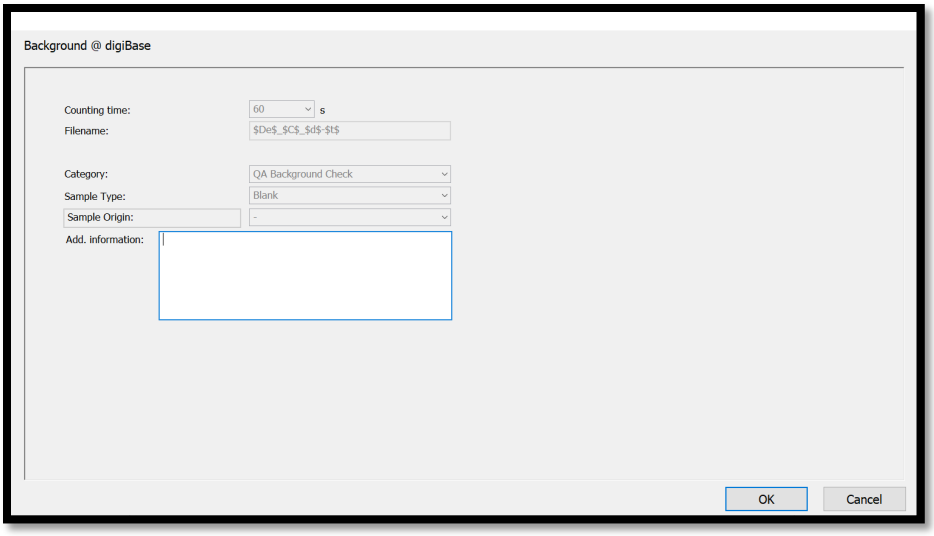


Figure 269. Background Check Start Screen

Clicking **OK** triggers a message, warning that all sources should be removed from the detector.

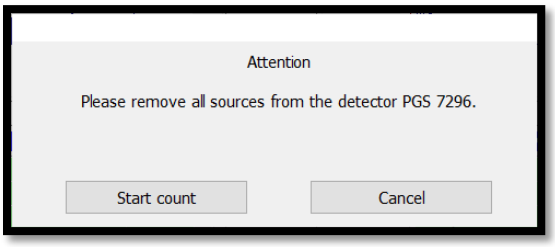


Figure 270. Source Removal Warning Message

Pressing **Start count** will begin the acquisition. The progress and status will be displayed on the detector screen.

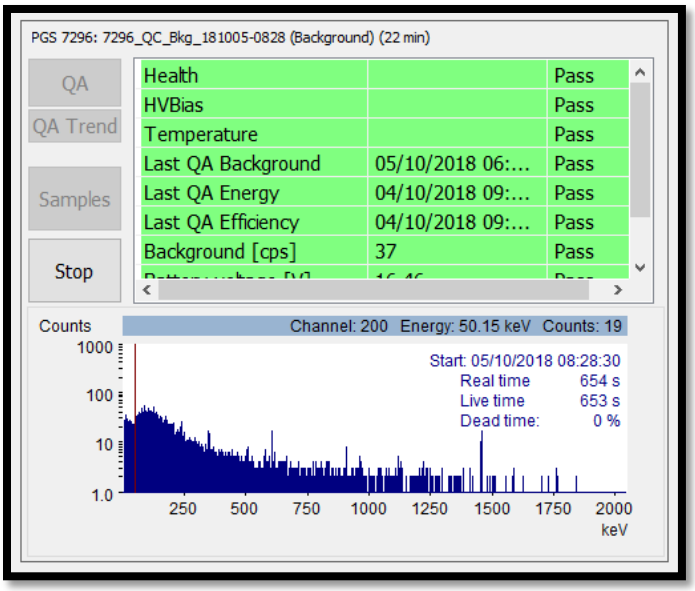


Figure 271. Detector Screen Background Progress

When the preset counting time was reached, the acquisition will stop automatically, the measurement file will be created, and the analysis results will be displayed on screen:

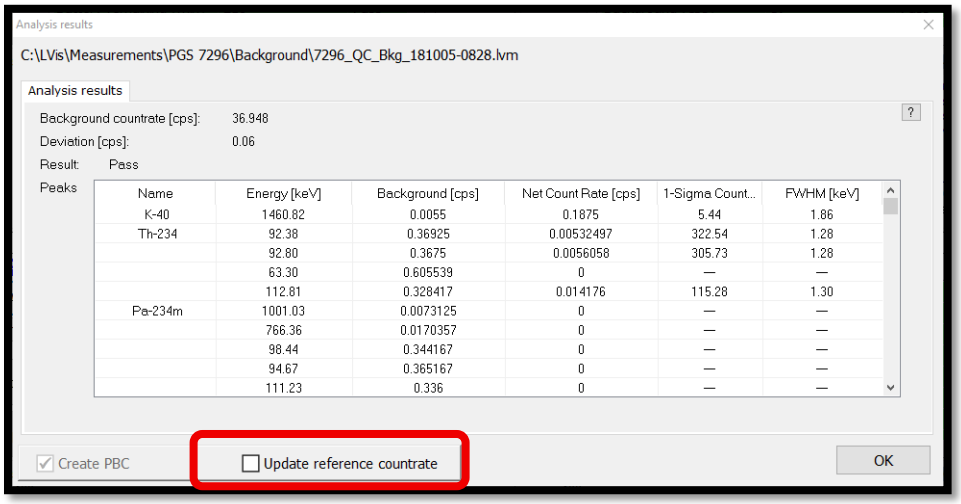


Figure 272. Background Analysis Results

In case the deviation was higher than the specified background tolerances, the QA check resulted in an alarm, or even failed otherwise, the check will “Pass”. In case it did not pass, it is possible to “Update the reference count rate” to account for the change in background levels (see red marking in Figure 272 above) when repeating the QA background check.

The results will be accepted when clicking **OK** and the QA database for the detector will be updated. A QA trend chart will be displayed, showing the results of the last 20 QA checks.

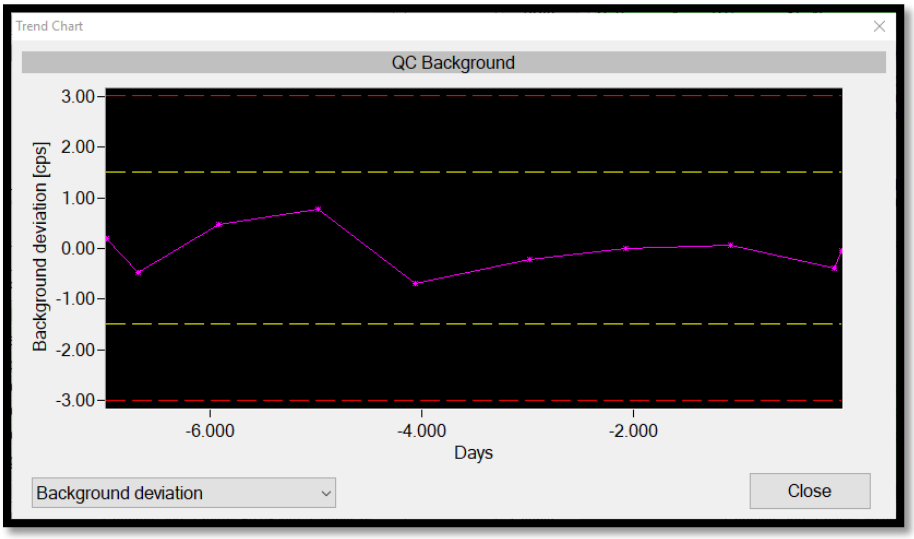


Figure 273. QA Trend Chart

Closing this graph will return the system to its “Quick background check” mode, ready to count new samples.

13.3 PERFORMING QA ENERGY CHECKS IN LVIS SIMPLE MODE

A QA Energy check monitors the peak position (the energy calibration) and the peak shape (FWHM calibration) by comparing them against the calibration values currently assigned to the detector. In cases when the position and resolution of the peaks are within specification (acceptable limits are defined in the QA Settings of a detector), the check will “Pass” (green). If not within specification, “Fail” (red) or “Warning” (yellow) messages will be triggered in the Health Status information table.

The peaks used within the QA Energy check are taken from the QA library that is specified for the selected QA source (Calibration source). Note that from this library only the peaks that are not flagged as “Not in average” will be compared against the QA energy limits and can hence lead to a “Fail” or “Warning”.

IMPORTANT It is not necessary to perform QA Energy checks when one regularly performs QA Efficiency checks. QA Energy checks are always included when doing QA Efficiency checks.

To perform a QA Energy check, press the button **QA** and select **Energy** from the following menu.

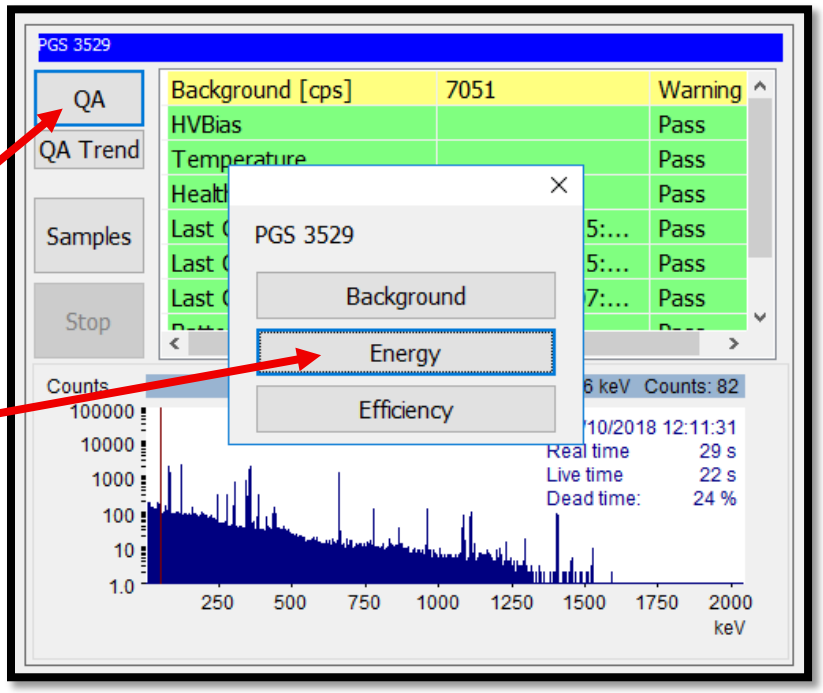


Figure 274. QA Energy Check Steps

The counting routine for the QA Energy check will be displayed.

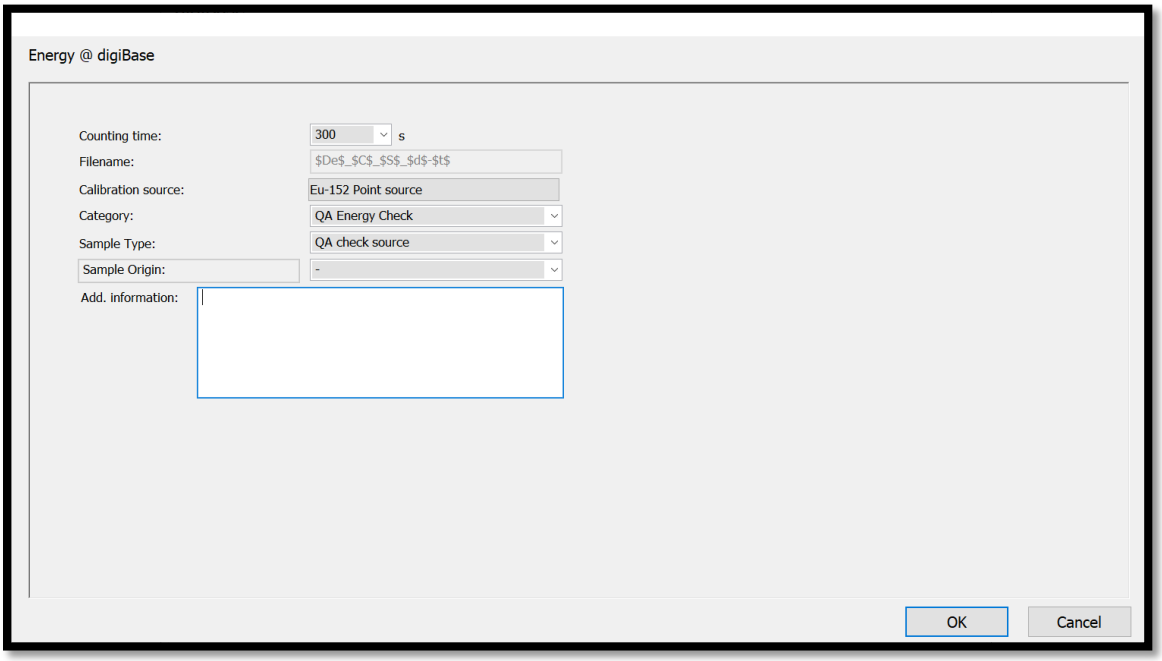


Figure 275. QA Energy Check Count Routine

Clicking **OK** triggers a message, warning that the selected QA check source should be placed on the detector.

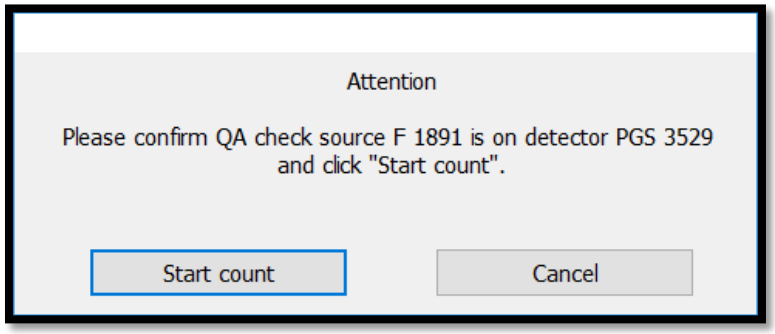


Figure 276. QA Check Source Start Count Message

Pressing **Start count** will begin the acquisition. The progress and status will be displayed on the detector screen.

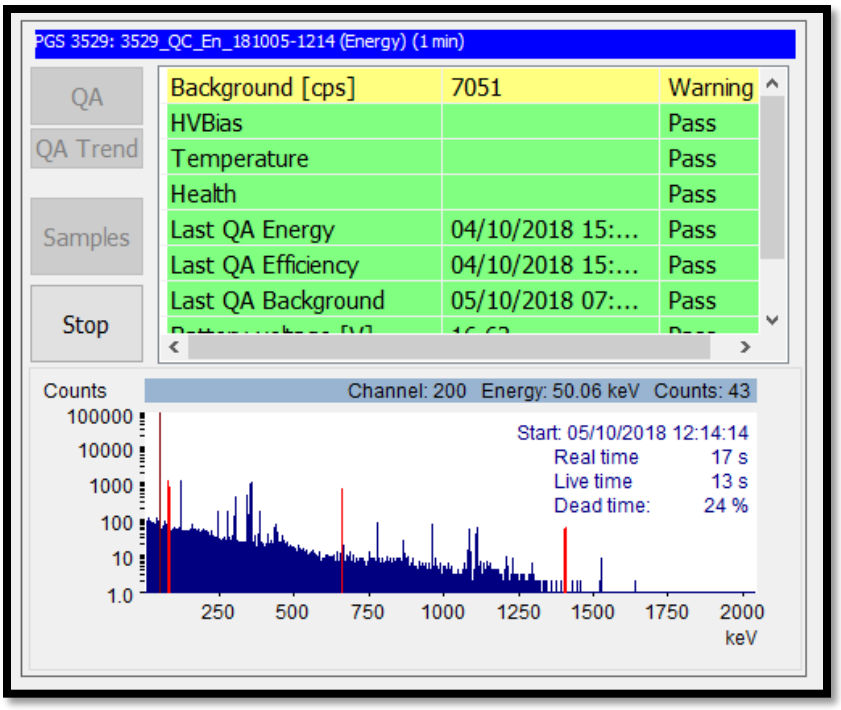


Figure 277. Energy Check Status

When the preset counting time was reached, the acquisition will stop automatically, the measurement file will be created, and the analysis results will be displayed on screen:

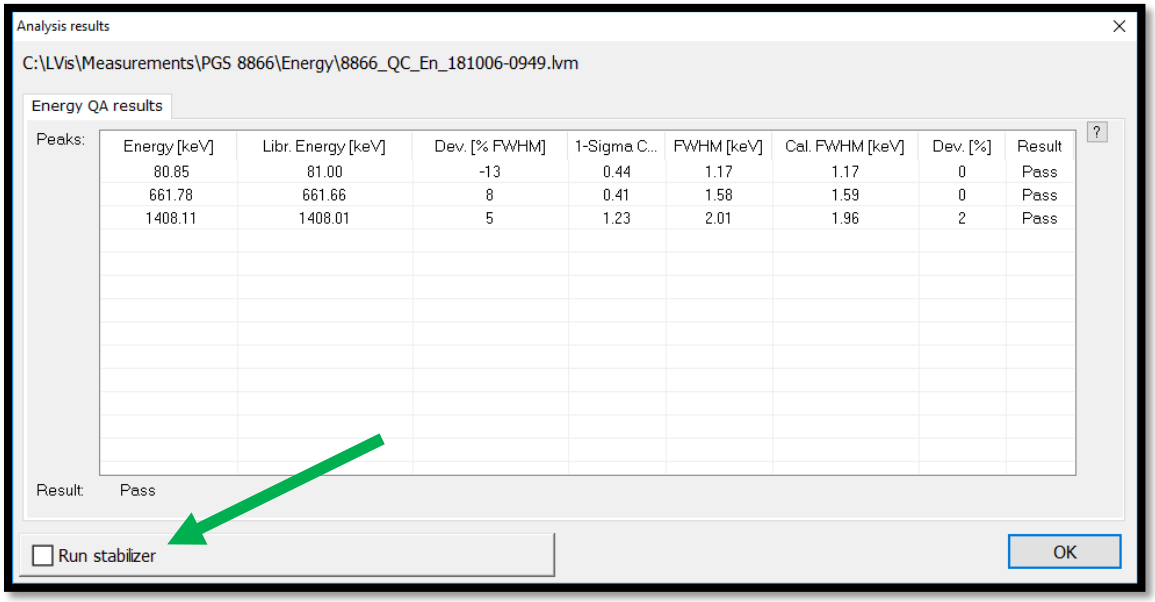


Figure 278. Energy Check Analysis Results

In case the deviation was higher than the specified tolerances, the QA check results in an alarm or even fails. When a QA Energy check fails, the “Run stabilizer” option (see green arrow in screenshot above) will automatically be activated.

The results will be accepted when clicking **OK** and the QA database for the detector will be updated. Either the “Gain stabilizer” will then be started (see Section 13.5 Failed QC – Auto Gain Adjustment for further explanation) or the QA trend chart will be displayed, showing the results of the last 20 QA checks.

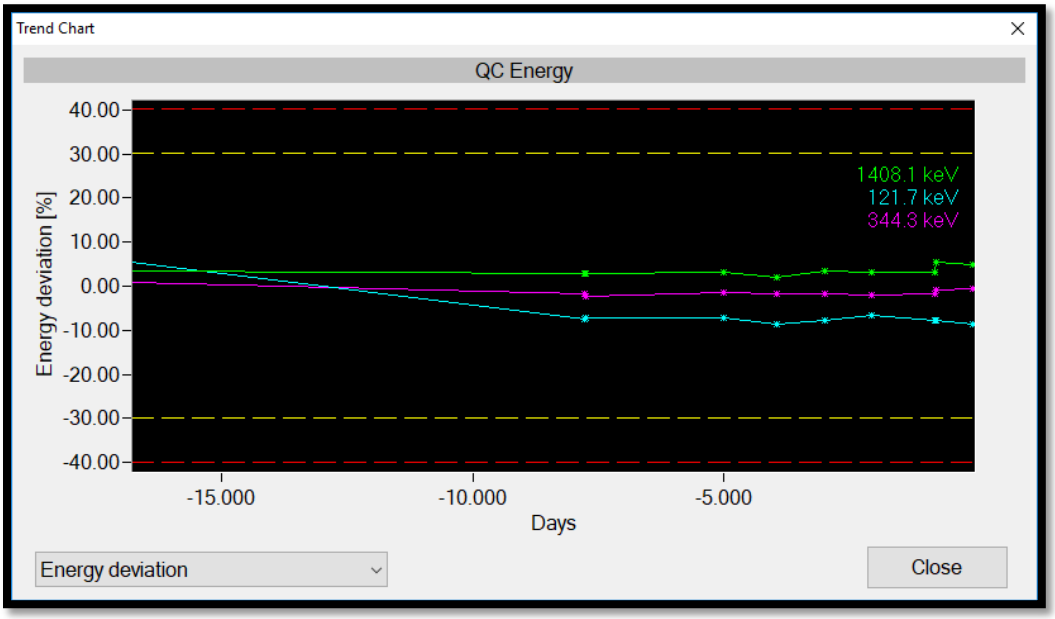


Figure 279. QA Energy Trend Chart

Note that the pulldown menu in the bottom left allows users to toggle between a trend chart showing the deviation of the peak centroid energy or a chart showing the deviation of the peak’s FWHM for this detector.

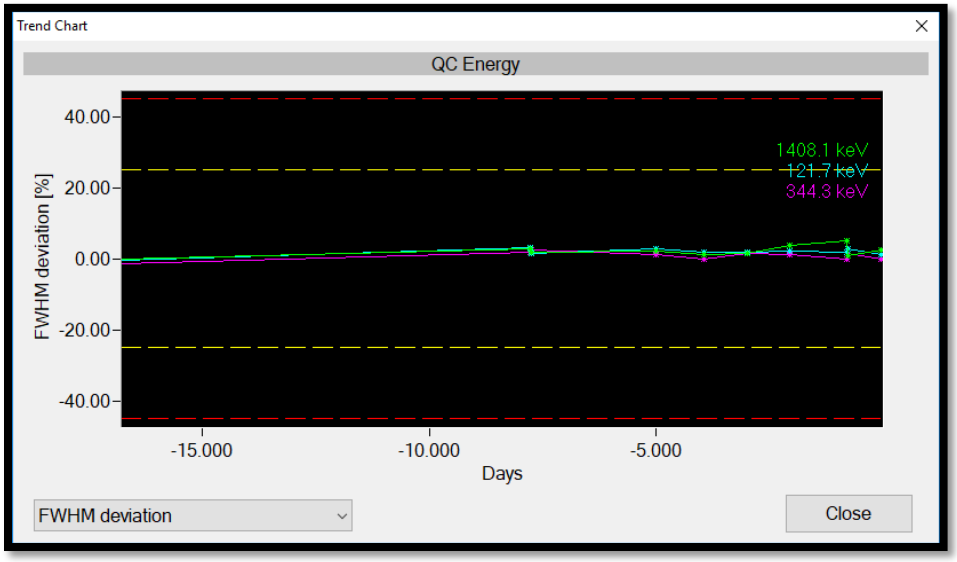


Figure 280. FWHM Deviation - Energy Trend Chart

13.4 PERFORMING QA EFFICIENCY CHECKS

A QC Efficiency Check monitors source activity while accounting for sample container geometry and the detector's efficiency calibration. This is done by counting a source of known activity, analyzing the respective spectrum with the appropriate calibration, and comparing the decay corrected results with the reference values of the source. In cases when the position and resolution of the peaks are within specification (acceptable limits are defined in the QC Settings of a detector), then the check will "Pass" (green). If not within specification, "Fail" (red) or "Warning" (yellow) messages will be triggered in the Health Status information table.

During a QC Efficiency check, the energy (the position) and the resolution are monitored in the same way as the QC Energy checks.

The peaks used within the QC Efficiency check are taken from the QC library that is specified for the selected QC source (LVis reference source). The nuclides to be monitored are specified in the QC efficiency check parameter set. Note that from this library only the peaks that are not flagged as "Not in average" will be compared against the QC efficiency and energy limits and can hence lead to a "Fail" or "Warning".

To perform a QC efficiency check, press the button **QA** and select **Efficiency** from the following menu.

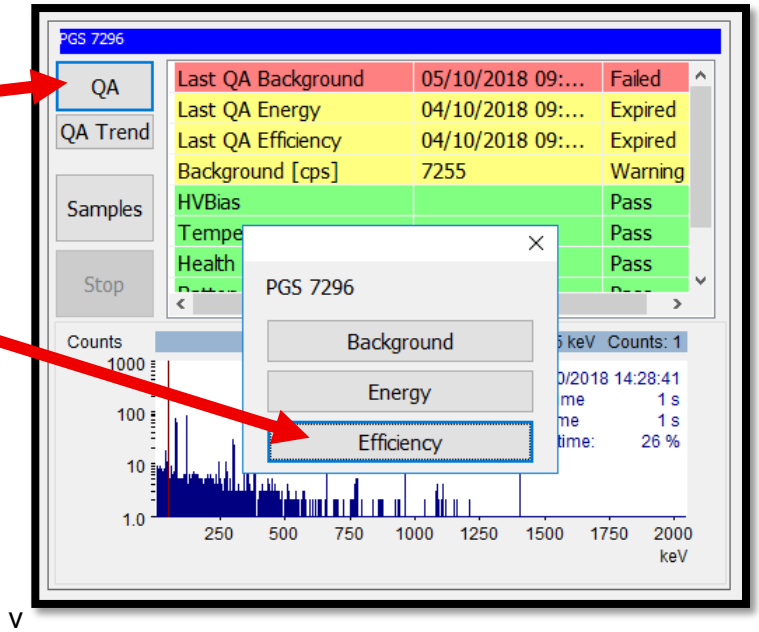


Figure 281. QC Efficiency Selection

The counting routine for the QA Efficiency check will be displayed and missing data can be entered.

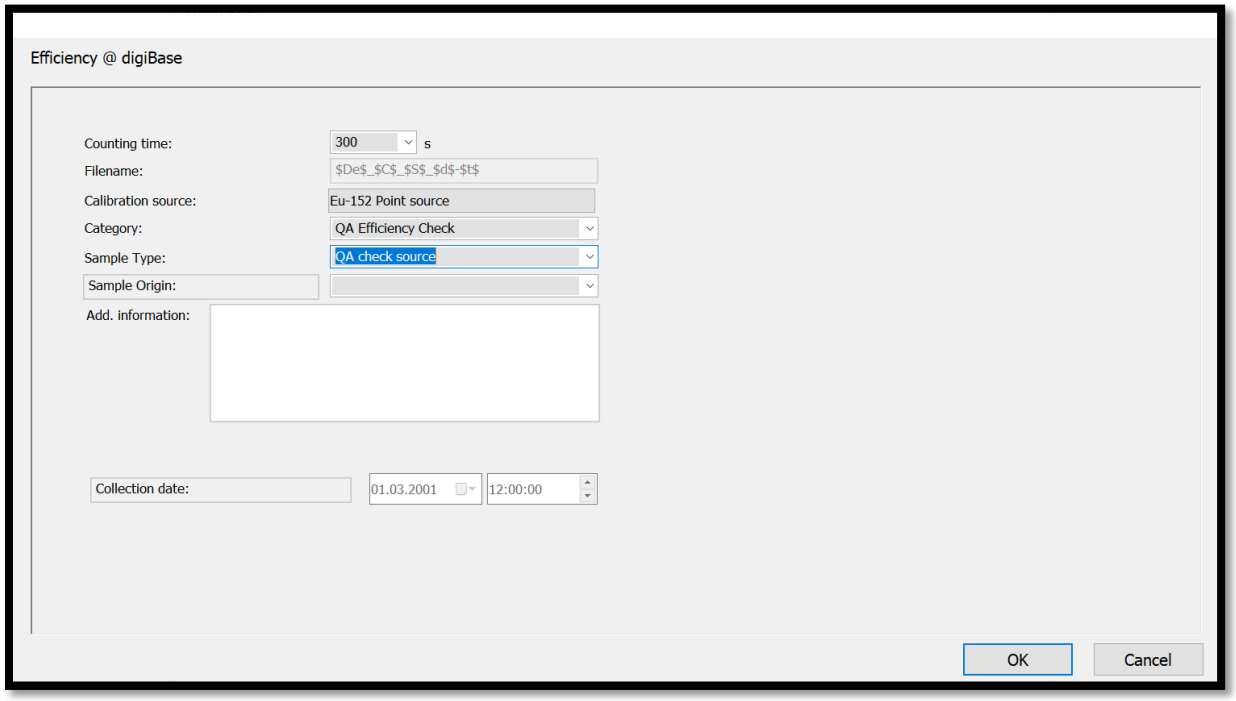


Figure 282. Efficiency Check Counting Routine

Clicking **OK** triggers a message, asking to put the respective QA check source on the detector.

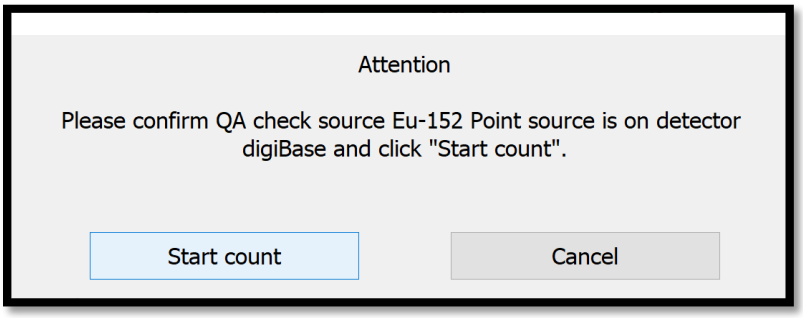


Figure 283. QA Source Start Count Message

Pressing **Start count** will begin the acquisition. The progress and status will be displayed on the detector screen.

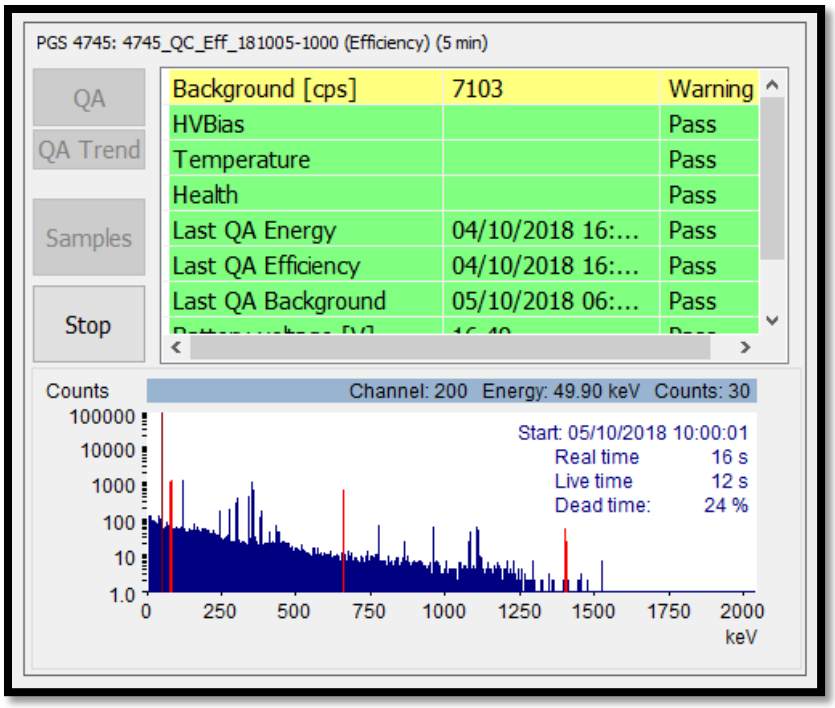


Figure 284. QA Status Screen

When the preset counting time is reached, the acquisition will stop automatically, the measurement file will be created, and the analysis results will be displayed on screen:

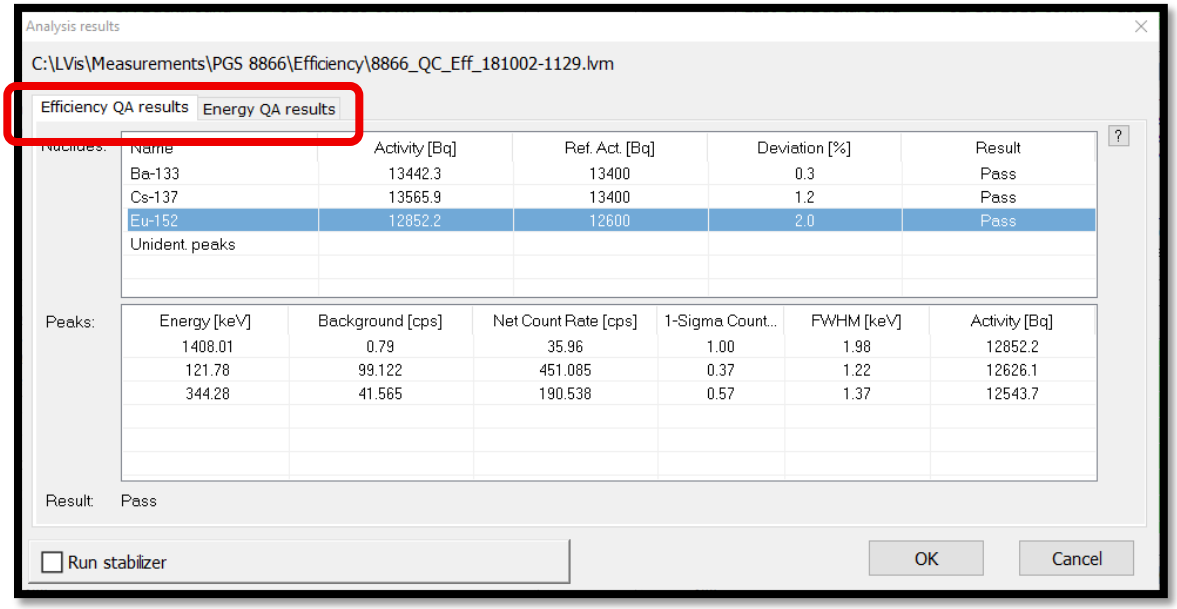


Figure 285. Efficiency QA Analysis Results

In case the deviation is higher than the specified tolerances the QC check results in an alarm or failure. Note that users can toggle between the “Efficiency QA results” and the “Energy QA results”.

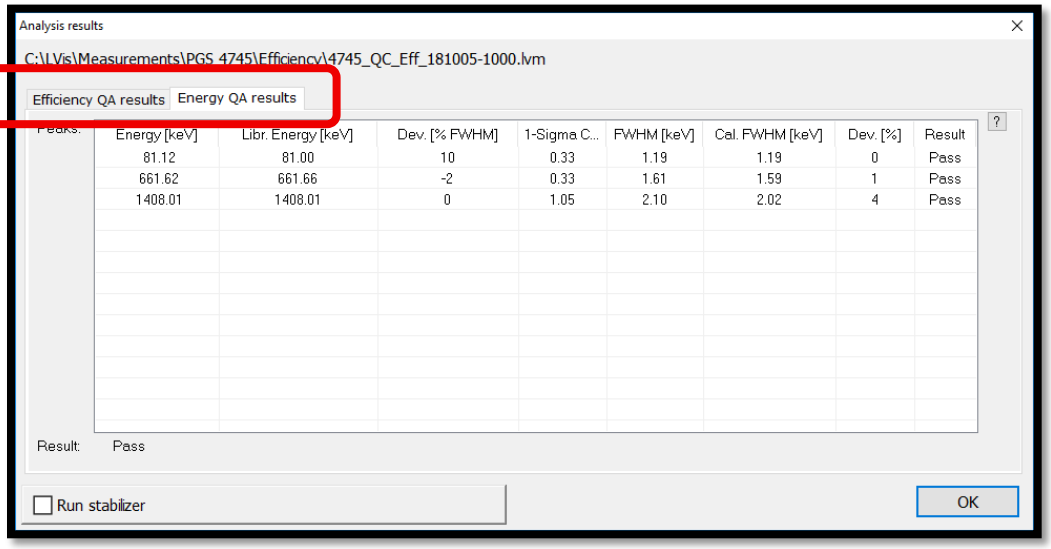


Figure 286. Energy QA Results

The results will be accepted when clicking **OK** and the QA database for the detector will be updated. A QA trend chart will be displayed, showing the results of the last 20 QC checks.

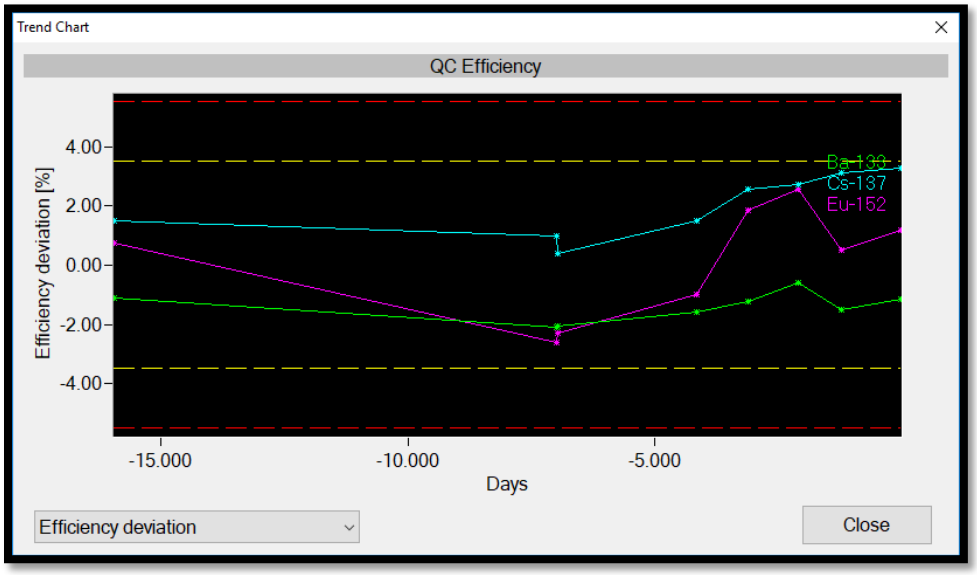


Figure 287. QA Trend Chart

Closing this graph will return the spectrometer to its “Quick background check” mode, ready to count new samples. Prior to this a warning message will pop up informing the user to remove the Calibration source (QA check source) from the detector.

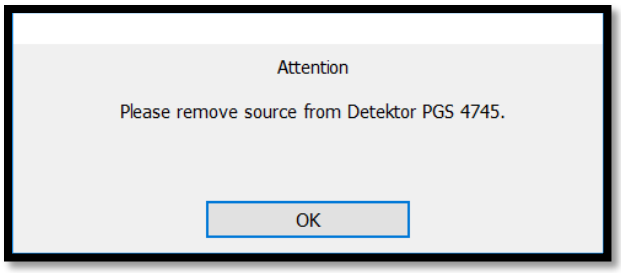


Figure 288. Remove Calibration Source Warning Message

13.5 FAILED QC – AUTO GAIN ADJUSTMENT

When a QC measurement fails, the most likely reasons are either a drift in the peak position (energy drift) or an incorrect positioning of the check source. The latter would result in a “Warning” or “Fail” in the QC efficiency results and can be corrected by verifying the ID and positioning of the QA check source and repeating the QA efficiency check. The drift in the peak position, however, would result in a failure of the QC energy results which can only be corrected by either doing a new energy calibration or starting the “Gain Stabilizer”. The “Stabilizer” can be activated from the QC Energy and Efficiency results screen (see red arrow in screenshot below). By default, it will be activated in case one of the parameters failed.

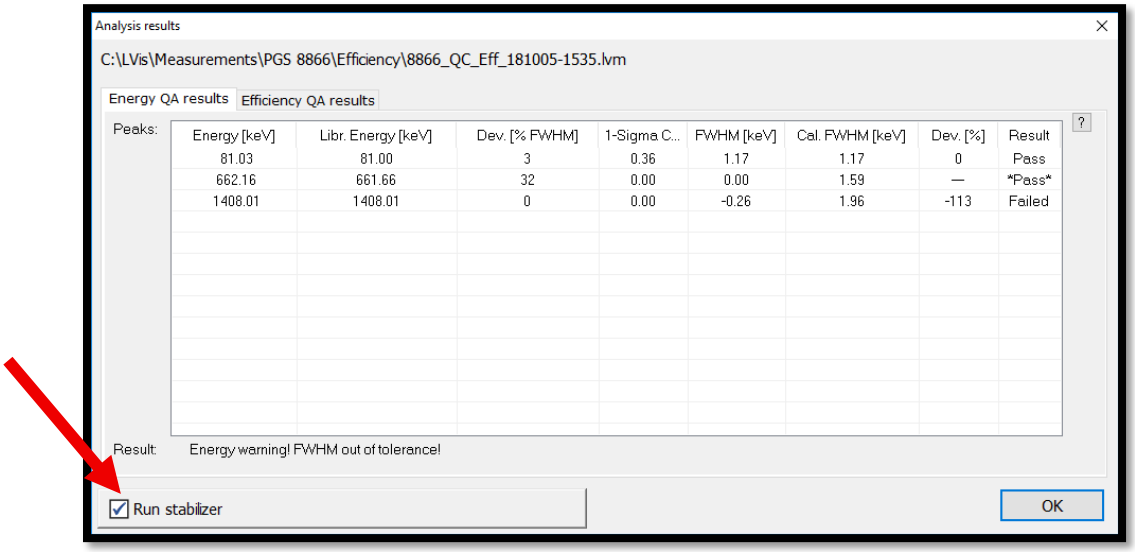


Figure 289. QA Results Activating the Stabilizer

During the gain stabilization a defined spectrum area (energy range) is monitored for a peak while a spectrum of a reference source is being collected. The peak centroid is permanently determined, and the system will try and change the gain such that the peak will end up at the position where it is supposed to be. Note that the settings for the “Gain Stabilizer” are made in the QA Settings of each detector (see red circle in the screenshot below).

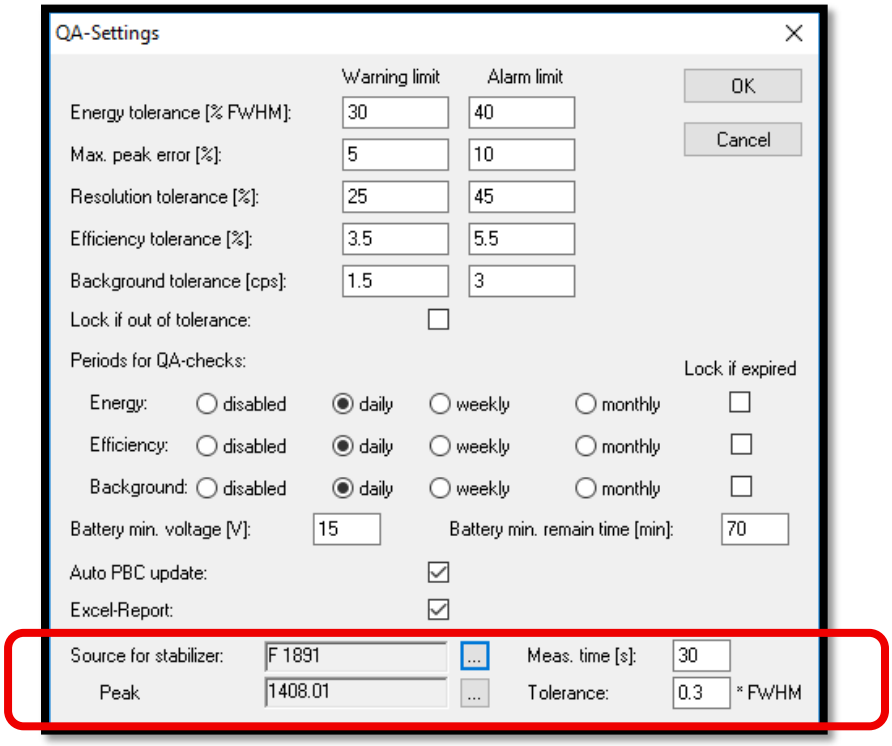


Figure 290. QA Settings for Stabilizer

Here users can define the stabilization peak energy, the counting time for each stabilization process, and the tolerance.

In the example above, the peak for the stabilization is defined as the 1408.01 keV peak of Eu-152. A counting time of 30 s and a tolerance of 0.3 x FWHM were also defined. The system will try to stabilize the gain until the peak centroid maintains its reference energy (+/- the tolerance).

Clicking **OK** will ask to place the source in position and will then start the stabilizer.

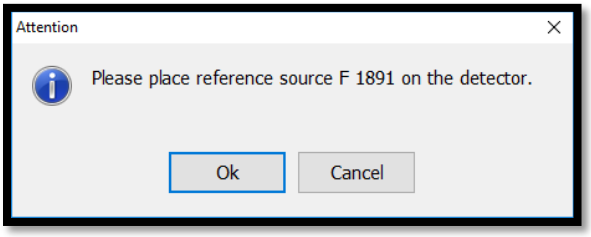


Figure 291. Place Reference Source Message

During the stabilization process the monitored peak is permanently displayed. A red marked region-of-interest indicates where the peak is supposed to be located.

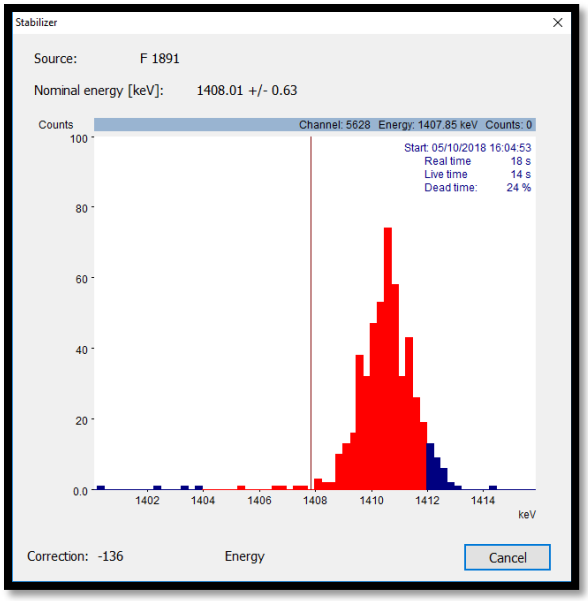


Figure 292. Stabilization Process Monitored Peak

When the peak position has been moved back to normal and no further gain correction is necessary, the stabilizer will prompt a message box. Afterwards the system is ready to count samples again. However, it is strongly recommended to do a new efficiency QA Check after a gain stabilization.

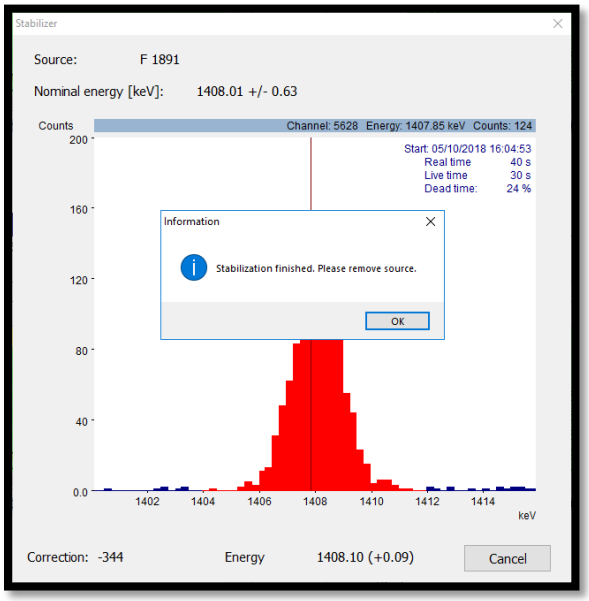


Figure 293. Stabilization is Finished Message

13.6 PERFORMING SAMPLE COUNTS

In the example in Figure 294, there are four sample counting routines defined. These are named: “Cesium Filter”, “Iodine Filter”, “Bottle”, and “Bottle CC” respectively. The counting routines are pre-configured allowing users to process sample counts with a minimum of additional data entry.

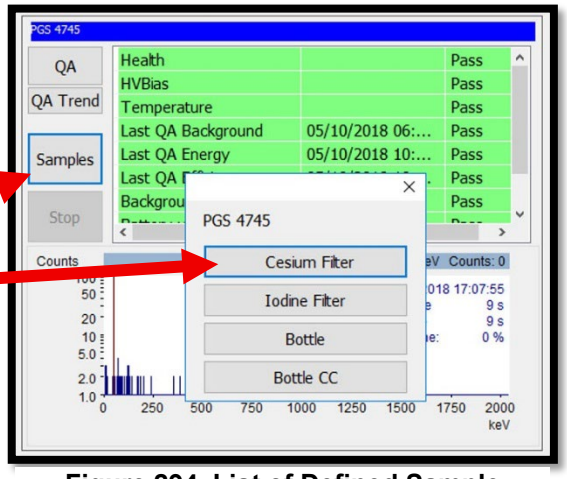


Figure 294. List of Defined Sample Counting Routines

Among the four routines, “Bottle CC” is special since it describes a contamination check measurement used to assess the activity levels in empty bottle containers. This is used to decide if bottles can be re-used for counting gamma samples. This decision is made by comparing the gross count rate of the empty bottle with the nominal gross count rate for the QA background checks and validate if it is less than the nominal value plus the background QA alarm level as defined in the QA detector settings.

To do a sample count, simply click on **Samples** and then select one of the sample counting routines from the window.

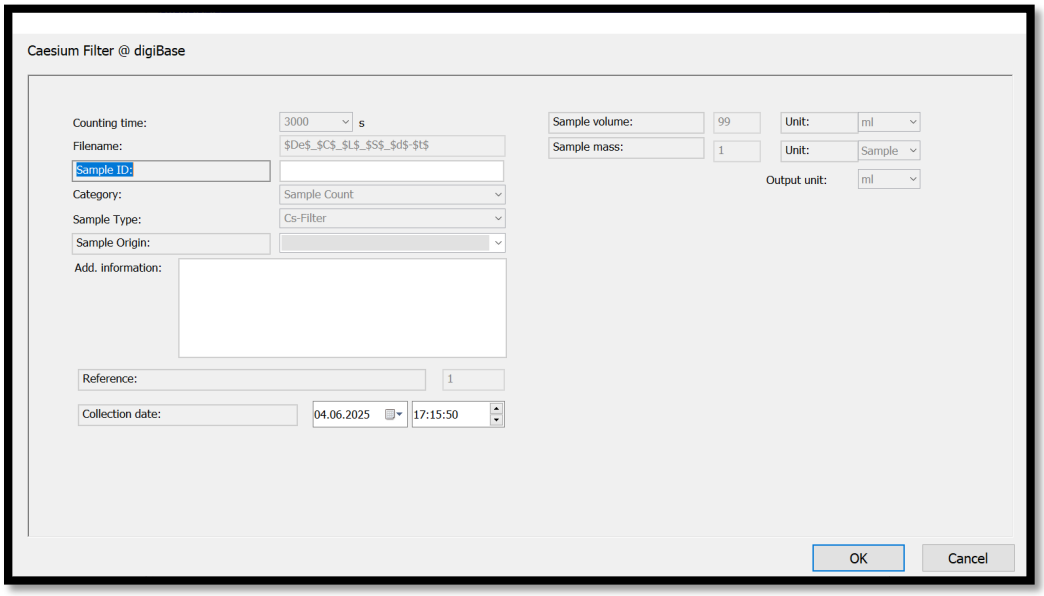


Figure 295. Sample Count Routine Definition

When all missing information is provided, clicking **OK** will first bring up a message asking the user to put the sample on the detector and then start the acquisition.

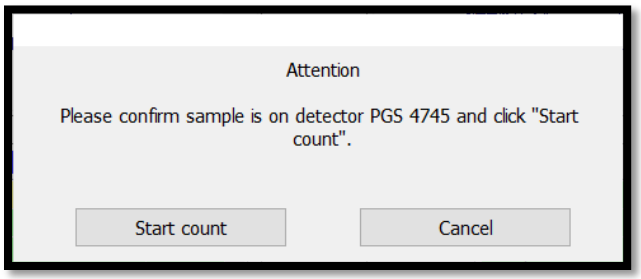


Figure 296. Place Sample and Start Count Message

For all sample counts, LVis in Simple Mode will always first do a dead time check before actually starting the acquisition. This is to ensure that the activity in the sample is reasonable and not too high. During the dead time check the dead time will be monitored and if above a “warning threshold” (default 20%) the acquisition will be delayed until dead time has decreased. As soon as the dead time has fallen under the “warning threshold” the acquisition will automatically be continued. The information about the dead time check is displayed on top of the detector window.

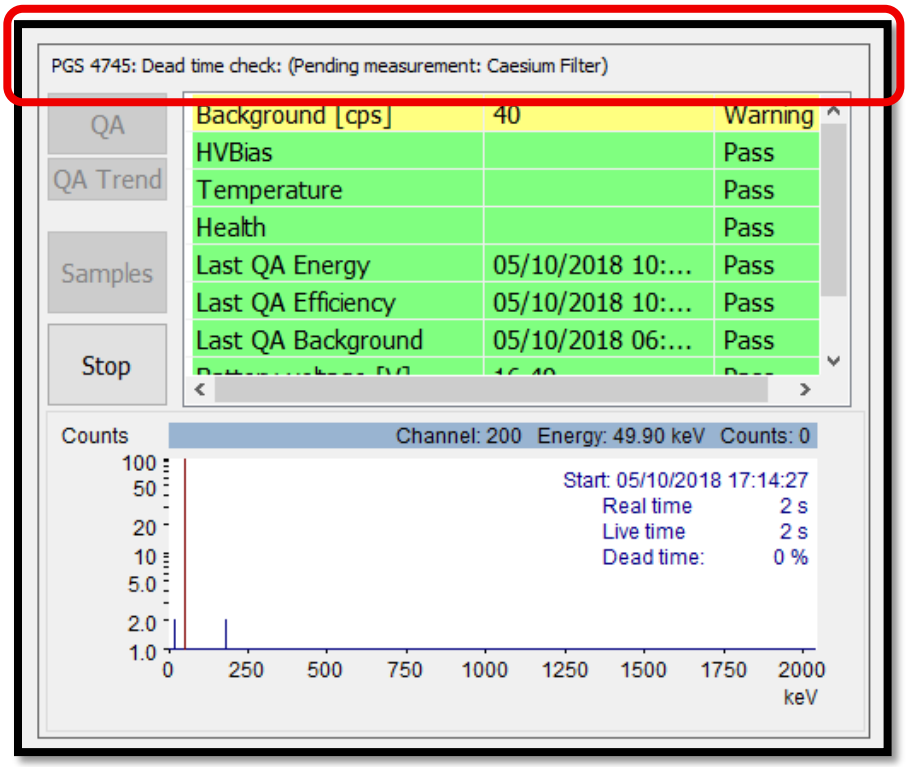


Figure 297. Dead Time Check Information

When the dead time is above the “warning threshold”, a message will be displayed, informing the user about the high activity but still giving the possibility to start the count anyway.

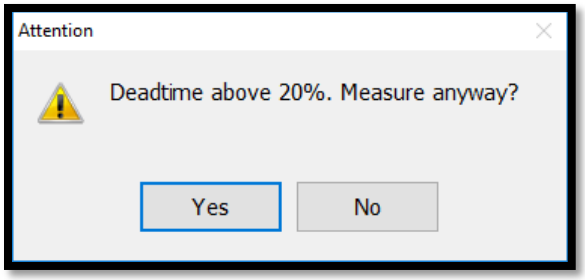


Figure 298. Dead Time Warning Message

In case dead time is above a “cancel threshold” (default 50%), LVis will refuse to count the sample. See Section 3.3 The Global LVis Settings on how to set these thresholds.

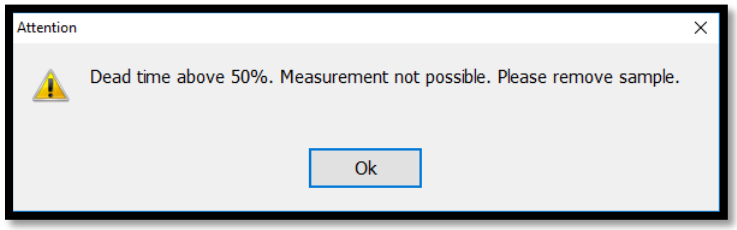


Figure 299. Dead Time Warning Measurement Not Possible

During an ongoing sample acquisition, the name of the detector (in the screenshot below PGS 4745), the name of the measurement (2018_10_04_1500_CaesiumFilter_2018_10_05_1714_AIX), the name of the counting routine (Cesium Filter) as well as the remaining time (50 min) is displayed in the header of the detector window:

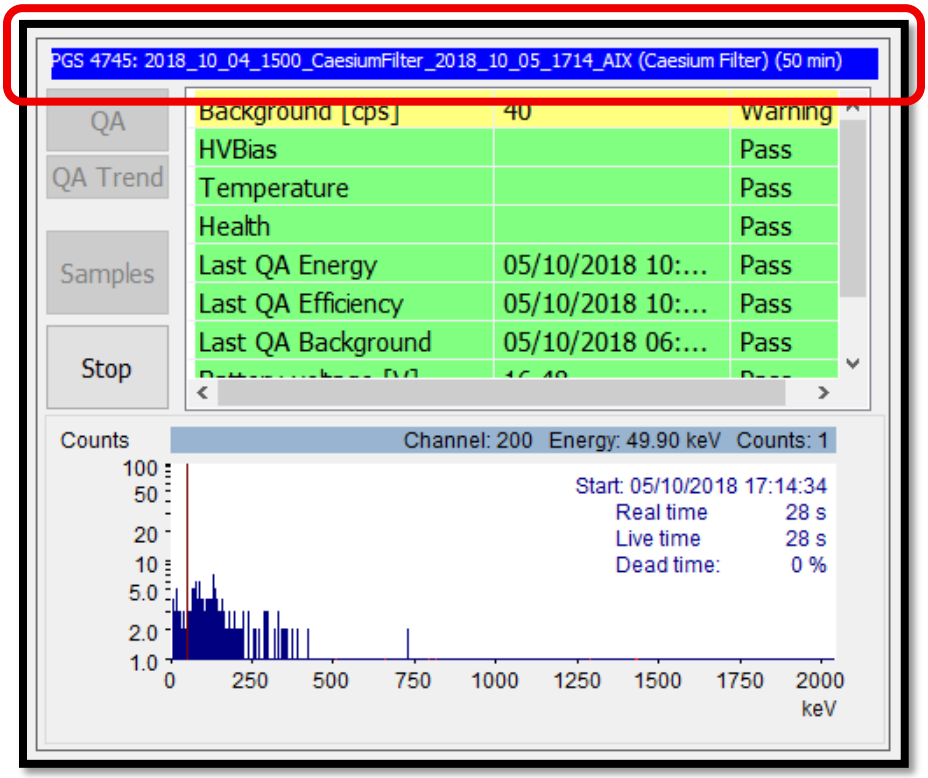


Figure 300. Ongoing Sample Acquisition Header

When the preset counting time is reached, the acquisition will stop automatically, the measurement file will be created, and the analysis results will be displayed on screen:

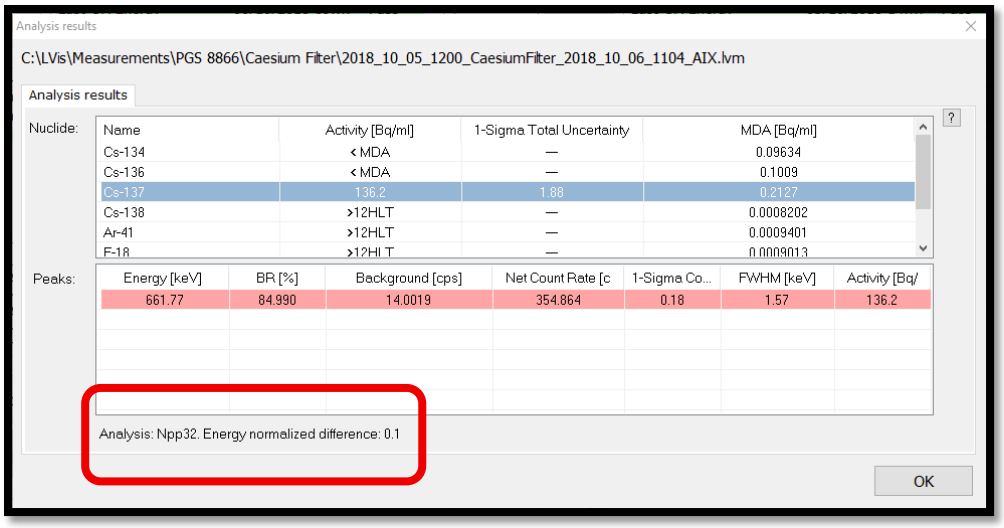


Figure 301. Sample Acquisition Results

The table on top lists the nuclide activity results and the MDA. Clicking on a nuclide provides the peak analysis results. Peaks marked in red are used in the nuclide activity average.

Information below the analysis results table (see red marking in Figure 301) provides the GammaVision analysis engine and, in the case, that peaks were identified during the analysis, the "energy-normalized difference" is given (< 0.3 is OK – otherwise energy calibration is not good - see GammaVision manual for a more detailed explanation). In the case that no peak was identified during the analysis, LVis will show the gross count rate (for the total analysis range) and inform that this spectrum just seems to be background (longer counting time should be considered?).



When clicking **OK**, a background process will create the reports, and a message box opens asking the user to remove the sample.

The system is then ready to be used for a new sample count or QA check.

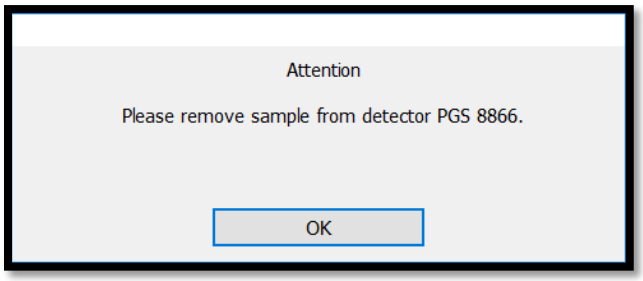


Figure 302. Remove Sample Warning Message

The process described above of doing a measurement, performing a sample count, or performing a QA check, with the example of a Cesium filter sample, is identical for all other counting routines. Only the parameter set "Bottle CC", the routine for counting empty bottle containers to check whether they are good for re-usage or contaminated and need to be replace, is somewhat different.

Unlike with sample counts, there is no need to specify a sampling date because the analysis is about current contamination levels. Thus, the field is greyed out.

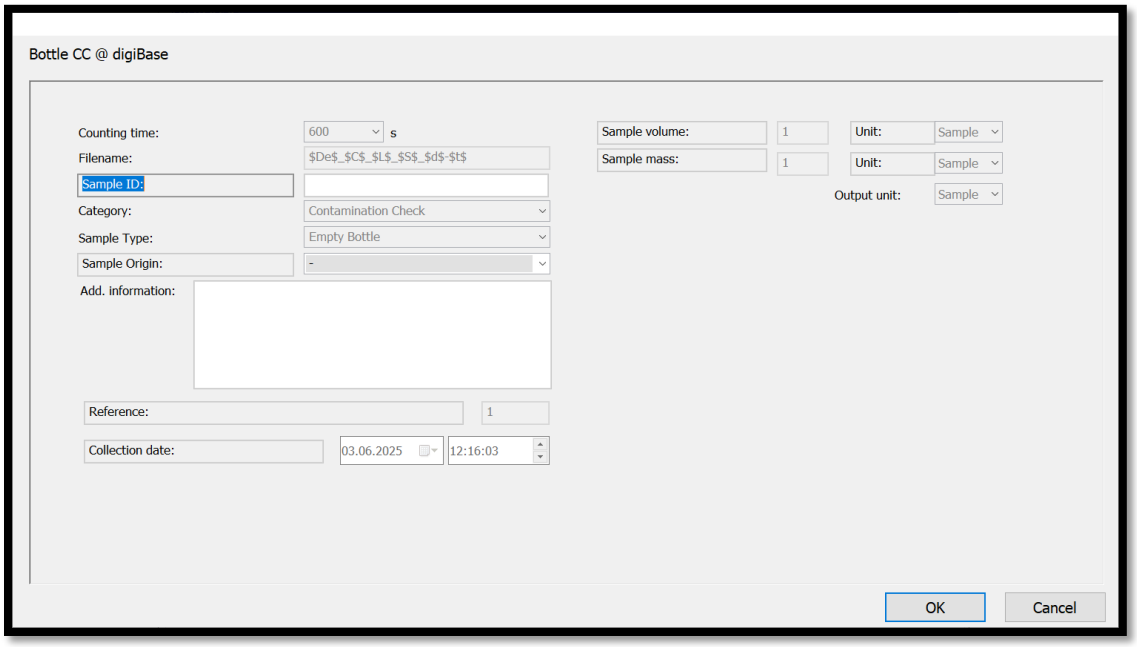


Figure 303. Routine Settings with Sampling Date Disabled

The results of the gross count rate validation to the QA background level (as defined for this counting routine see Section 5 LVis Parameter Sets) are displayed according to the text messages defined in the LVis Settings (see Section 3.3 The Global LVis Settings). For those bottle counts resulting in a gross count rate that is significantly higher (> nominal background plus the background QA alarm level for this detector) than what is considered current background, the contamination check will “Fail”.

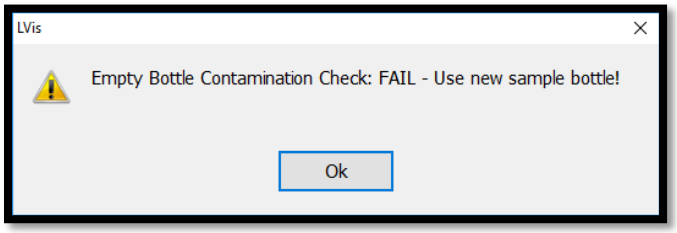


Figure 304. Empty Bottle Check Fail Message

And in the following, the detailed nuclide and peak analysis results will be displayed.

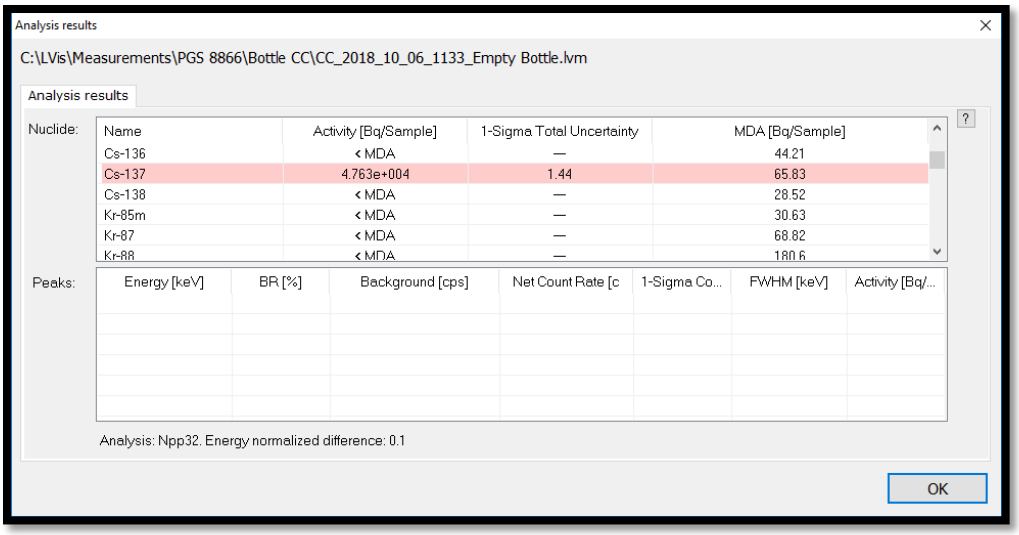


Figure 305. Bottle Count Detailed Nuclides

In case the gross count rate of the empty bottle count is within the tolerance (smaller than the nominal background plus the background QA alarm level) the “Empty Bottle Contamination Check” passes and the respective message box will be displayed informing the user that re-usage of this bottle is “OK”.

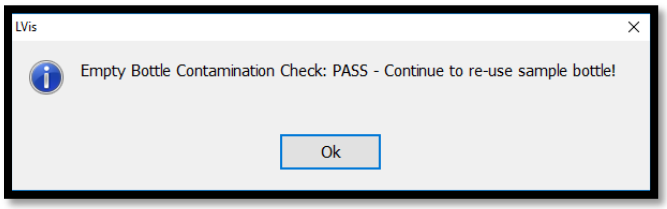


Figure 306. Empty Bottle Check Pass Message

The detailed nuclide MDA results will be displayed, and the user is informed about the actual gross count rate of this count.

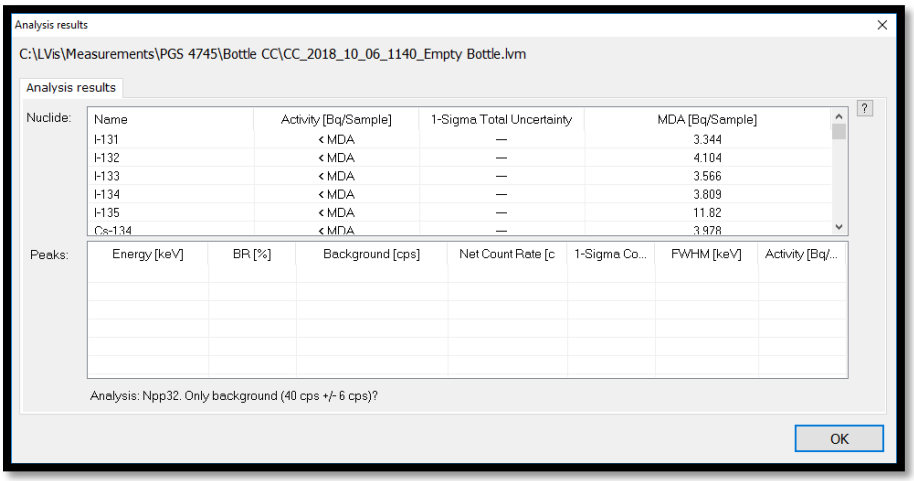


Figure 307. Passed Bottle Detailed Nuclides

NOTES:

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