

# AlphaVision<sup>®</sup> 7

## Alpha Particle Spectrum Acquisition and Analysis for Microsoft<sup>®</sup> Windows<sup>®</sup> 10

Software User's Manual

Software Version 7

**INSTALLATION: PAGE 33**

Default Login: ORTEC [all uppercase]  
Password: o [lowercase letter "o"]

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## NOTE!

It is assumed that the user is familiar with Microsoft® Windows® usage and terminology. If the user is not fully acquainted with the Windows environment, read the Microsoft documentation supplied with the Windows software and become familiar with a few simple applications before proceeding.

The convention used in this manual to represent actual keys pressed is to enclose the key label within angle brackets; for example, **<F1>**. For key combinations, the key labels are joined by a + within the angle brackets; for example, **<Alt + 2>**.

# 1. INTRODUCTION

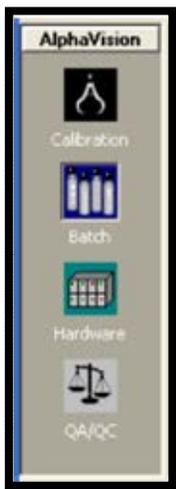
ORTEC® AlphaVision® 7 is the next step forward in alpha spectroscopy for large-scale commercial laboratories with hundreds of alpha detectors or small labs with only a few detectors. AlphaVision 7 delivers the compatibility, efficiency, and defendable results clients require.

All calibration, sample, background, quality assurance/quality control, and analysis results reside in one database. Data integrity is backed by AlphaVision's security controls, ANSI 42.23 and ANSI N13.30 compliant analysis, comprehensive QA/QC, and detailed event logging.

All data acquisition and analysis are based on user-defined *templates* that hold all measurement and analysis parameters for each measurement type. For each project, build a set of data analysis tools including radionuclide libraries for calibration and sample analysis; counting and analysis templates for batches of blanks, controls, and samples; database records listing the spectrum analysis regions for the expected nuclide peaks; and database records documenting the peaks and activities in certified calibration standards, laboratory control solutions, and tracer solutions. Templates also speed up the system performance checks.

AlphaVision can be integrated with the LIMS for automatic transfer of sample information, reducing the risk of transcription error, eliminating a time-consuming step in the data management process, and reducing the overall cost-per-sample. AlphaVision's Microsoft® Access® database allows straightforward extraction and transfer of analytical results back to the LIMS.

Controlling a roomful of detectors is simple with AlphaVision's intuitive Detector Grid, which can be arranged to echo the physical layout of alpha chambers in the laboratory. Distinctive detector status icons tell at a glance which detectors are calibrating, counting samples, waiting for unloading, etc.



The AlphaVision 7 software is divided into four major modules that track the alpha-spectrometry process:

- Calibration
- Batching, Counting Samples, and Reporting
- Hardware
- Quality Assurance/Quality Control

These activities are distinct from one another, so each has its own user interface, accessible by clicking an icon on the *Outlook Bar* on the left side of the screen. In this manual, these separate interfaces are referred to as *modes* or *modules* (e.g., the *Calibration mode* or *Calibration module*).

Note that Appendix A of this manual is a detailed tutorial that takes users through the major AlphaVision setup steps and operations.

## 1.1 THE ALPHAVISION 7 ADVANTAGE

AlphaVision 7 builds on the power and flexibility of Version 6, encompassing almost every aspect of alpha spectrometry:

- 64-bit Windows 10 compatibility.
- ANSI 42.23 and ANSI N13.30 compliant quality assurance/quality control.
- SAP® Crystal Reports v11.5 integration for reliable custom reports compatible with common file formats.
- Control and monitor up to a 100 × 100 array of detectors on the Detector Grid display. Redesigned detector icons display more hardware status information. New multi-chamber hardware control lets the user change the vacuum, pulser, or high voltage status for large detector groups.
- Integrated control of ORTEC AlphaSuite, OCTÊTE-series, and Oxford® OASIS alpha spectrometers. Optionally set chamber pressure, bias, and leakage current thresholds above which AlphaVision 7 automatically suspends data acquisition. When these parameters fall below the threshold, counting automatically resumes.
- Module-specific toolbars provide quick access to the most common menu commands.
- Simple wizard-based calibration, sample, and background analysis setup. Analysis-setup *templates* let users “set and forget” for reliable, consistent analyses. When a template is no longer needed, it can be deleted.
- The Batch Wizard allows the addition reagent blanks and control samples to batches; and to track chemical recovery with tracers.
- Perform interim analyses while data collection is in progress. “Modify Acquisition Presets” feature lets the user add more counting time to a sample while the count is still in progress, so testing does not have to start over. Reanalyze spectra, varying the analysis settings, with one-click comparison of results.
- Automated ROI adjustment for gain shift corrections during analysis.
- Automated spectrum and report export during batch counting for use with external applications.
- LIMS in-and-out data handling capability – the user can enter sample information or build an interface between LIMS and AlphaVision that will take care of it.
- Count to live-time, real-time, and MDA presets. AlphaVision 7 gives count-to-MDA with real-time assessment of the MDA based on the actual recovery, not on an estimate! A great tool for the spectroscopist who wants to maximize detector capacity.
- Spectral data are saved automatically by AlphaVision 7 so already-collected data survive a power failure, system crash, or other major interruption. In fact, if only the PC shuts down, data collection continues. Once the computer is rebooted and

AlphaVision restarted, it interrogates the hardware, updates accordingly, and continues.

- Enhanced ability to create QC Control Charts for evaluating detector/analysis trends. Users can rapidly create a Control Chart for a specific client, period of time, or isotope, and for controls, blanks, backgrounds.
- Database management tools allow users to create a database for each project if desired; and to manage all of the records within each database.
- Formal Verification-and-Validation (V&V) test results package available as an option.

## 1.2 ABOUT THIS MANUAL

Using a tool with such broad capabilities as AlphaVision 7 requires thorough planning. Therefore, this manual is organized to work through all required concepts and procedures.

Chapter 2 introduces the AlphaVision 7 user interface.

Chapter 2.7 is an overview of the major tasks required to start using AlphaVision 7.

Chapters 4 through 6 cover software and hardware installation and system security.

Chapter 7 discusses detector calibration.

Chapter 8 describes how to create the nuclide libraries, ROI sets, tracer sets, control solution records, and other sample analysis tools.

Chapter 9 tells how to organize and use the Batch Explorer Tree.

Chapter 10 covers quality assurance/quality control.

Chapter 11 explains how to calibrate detectors.

Chapter 12 discusses the AlphaVision 7 data management tools.

Chapter 13 is a detailed discussion of how to interface AlphaVision with the Laboratory Information Management System (LIMS).

Appendix A is a tutorial covering AlphaVision 7's major features.

Appendix B details the AlphaVision analysis methods.

Appendix C is an instruction on using the SET920 program (on the AlphaVision installation CD) to optionally change the input number and memory allocation in OCTÈTE®-series MCBs.

## 1.3 WHAT'S NEW IN V7

The information here is aimed at AlphaVision 6 users updating to Version 7.

- 64-bit Windows 10 compatibility
- Enabled the Alpha Mega on the Instrument Group Control
- Added the ability to export a spectrum from the spectrum view window
- Enabled the Export to SPC on completion option in the Calibration Batch Control
- Removed the MCA view from the detector grid
- Updated the Instrument Group Control grid to display COMM ERROR when communication is interrupted instead of static data last read from the instrument prior to the interruption

## 2. THE ALPHAVISION USER INTERFACE

### 2.1 THE FOUR MODULES – SCREEN LAYOUT, MENUS, AND TOOLBAR

The AlphaVision 7 user interface is designed so it takes just a few mouse clicks to access all sample, reporting, hardware, and QA management. The screen is divided into 5 main functional areas:

- 1) **Menu Bar** – The commands on the **File**, **Edit**, **View**, **Process**, and **Help** menus are the same in all modules; and each module except Hardware has one or more additional menus.
- 2) **Toolbar** – The 5 options on the left section of the Toolbar are the same in all modules: **Import**, **Nuclide libraries**, **Standards**, **Tracers**, and **ROIs**. In addition, each module has one or more module-specific Toolbar commands.
- 3) **Outlook Bar** – This sidebar contains icons for each of the 4 modules and is the same in all modules.
- 4) **Detector Grid** – Located at the bottom of the screen, the Detector Grid displays the detectors that are currently configured for the system. It looks and functions the same in all modules (Section 6.4).
  - Actions from the grid include the addition, removal, and organization of the MCBs and detectors; pausing or stopping data acquisition; clearing detector memory; and adjusting grid and system properties.
  - The grid can display up to (100 × 100) 10,000 detectors, each represented by a detector icon that changes to reflect the alpha chamber's operational status. Pausing the mouse over a detector icon opens a hover box that shows the alpha chamber and detector names, real and live times, and, when the detector is counting, the batch and sample names. The size of the grid matrix is set in the Grid Properties dialog (Section 6.4.2.3).
  - The grid has row/column headers to help quickly locate a particular instrument. Grid cell size can be adjusted for easy overall viewing, and the “heads-up” detector icons show the status of every detector at a glance.
  - Reposition the detector icons anywhere on the grid (except detectors that are acquiring) by just clicking and dragging them. Use this feature to simplify sample loading - group the detector icons according to the number and arrangement of alpha chambers in each MCB in the lab.
- 5) **Explorer Panel** – The remainder of the screen is the Explorer Panel. This is the gateway to all of the data analyses in the AlphaVision 7 database.
  - In **Calibration** and **Batch** modes, this panel is divided into 2 parts: The lower section, the Spectrum/Report Window, enables viewing of either the spectrum or

report for a given analysis. The upper section is, respectively, the Calibration Explorer Panel or Batch Explorer Panel.

- The Calibration Explorer displays the calibration history for each detector in the system, and the Calibration reports associated with each calibration spectrum and analysis. To see this calibration history, click one of the detectors in the Detector Grid. The most recent calibration (i.e., the calibration now being used by this detector) will be displayed in the Spectrum Window. Note that if the detector has not yet been calibrated, no data will be displayed for it.
  - The Batch Explorer is used to locate and view the records and reports for the Batch, Background, and Pulser Test batches, samples, spectra, and analyses.
- In **QA/QC** mode, the Limits tab is used to set up and monitor the QA control limits and control charts. Clicking the Charts and Report tabs at the bottom of the panel respectively generates the control charts and QA reports.
  - The **Hardware** panel is used to set up and monitor *only* the alpha chambers of ORTEC Aria, Duo, Mega, Ensemble, and OCTÈTE-series instruments; and the Oxford OASIS.<sup>1</sup> A checkbox on the Toolbar switches the Hardware Panel between a one-detector and multi-detector interface.

Figure 1 through Figure 4 show annotated illustrations of the **Calibration**, **Batch**, **Hardware**, and **QA/QC** interfaces and menus.

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<sup>1</sup> MAESTRO must be used to set up and monitor other instruments.

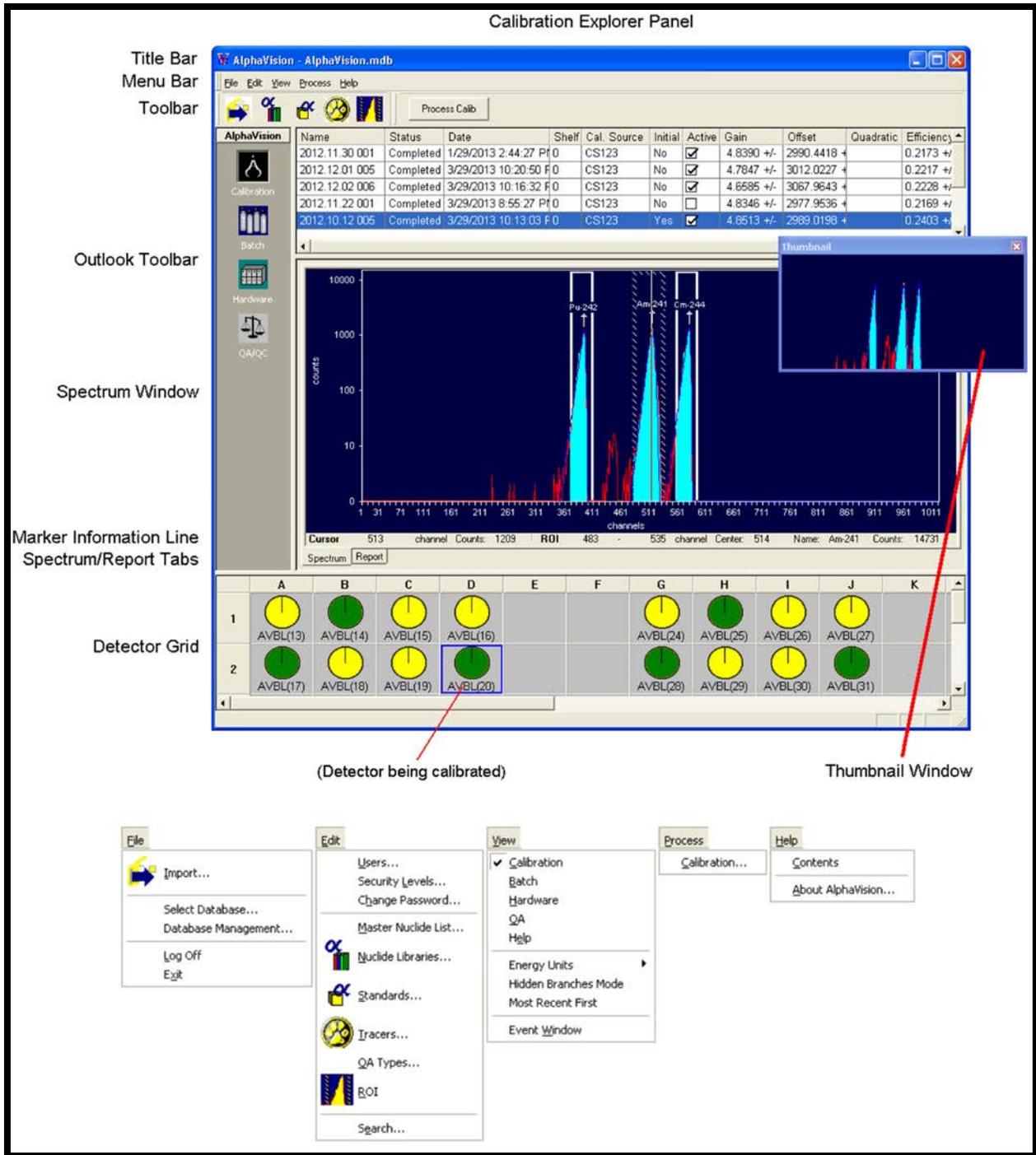


Figure 1. Calibration Mode Screen Features and Menus

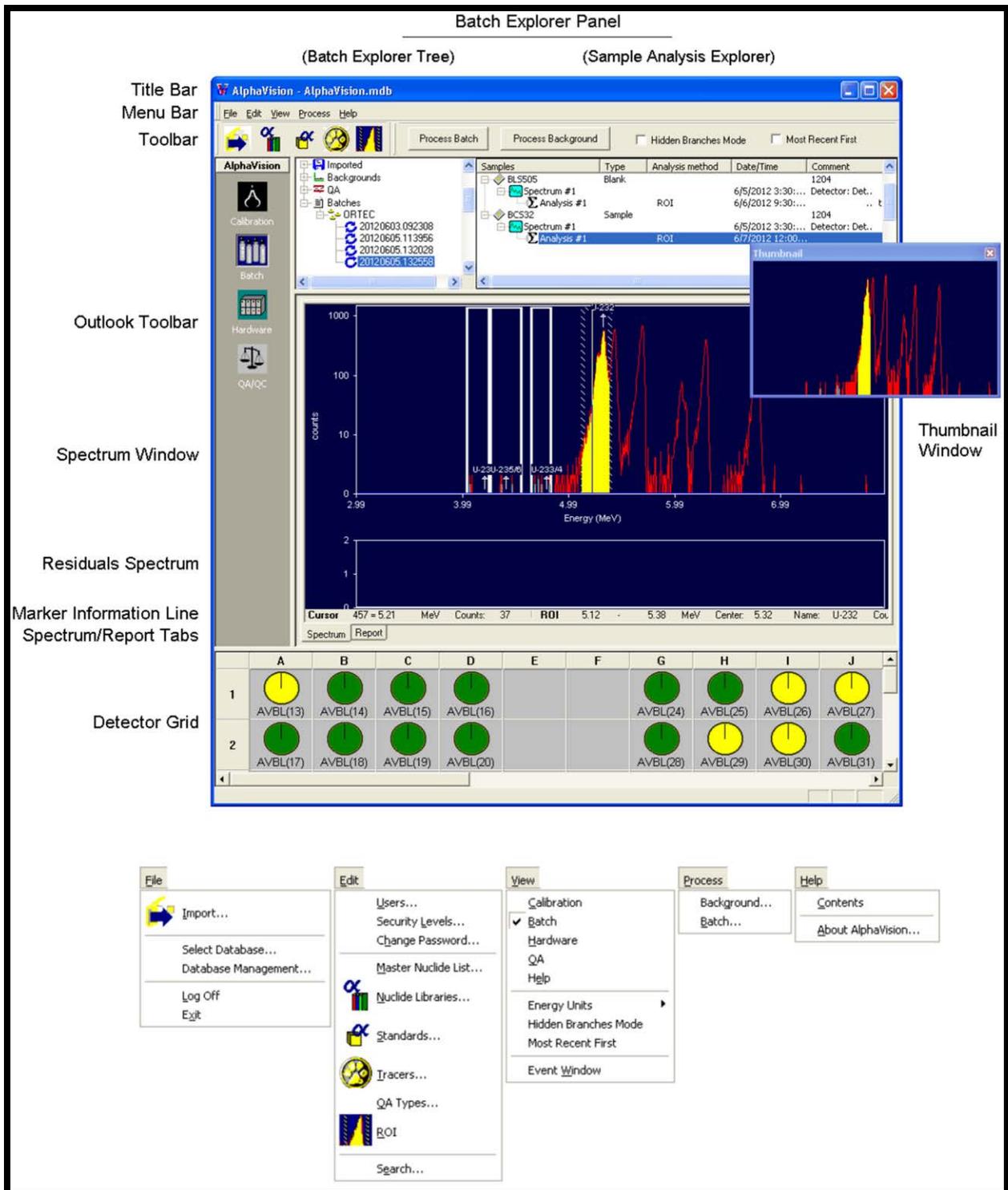


Figure 2. Batch Mode Screen Features and Menus

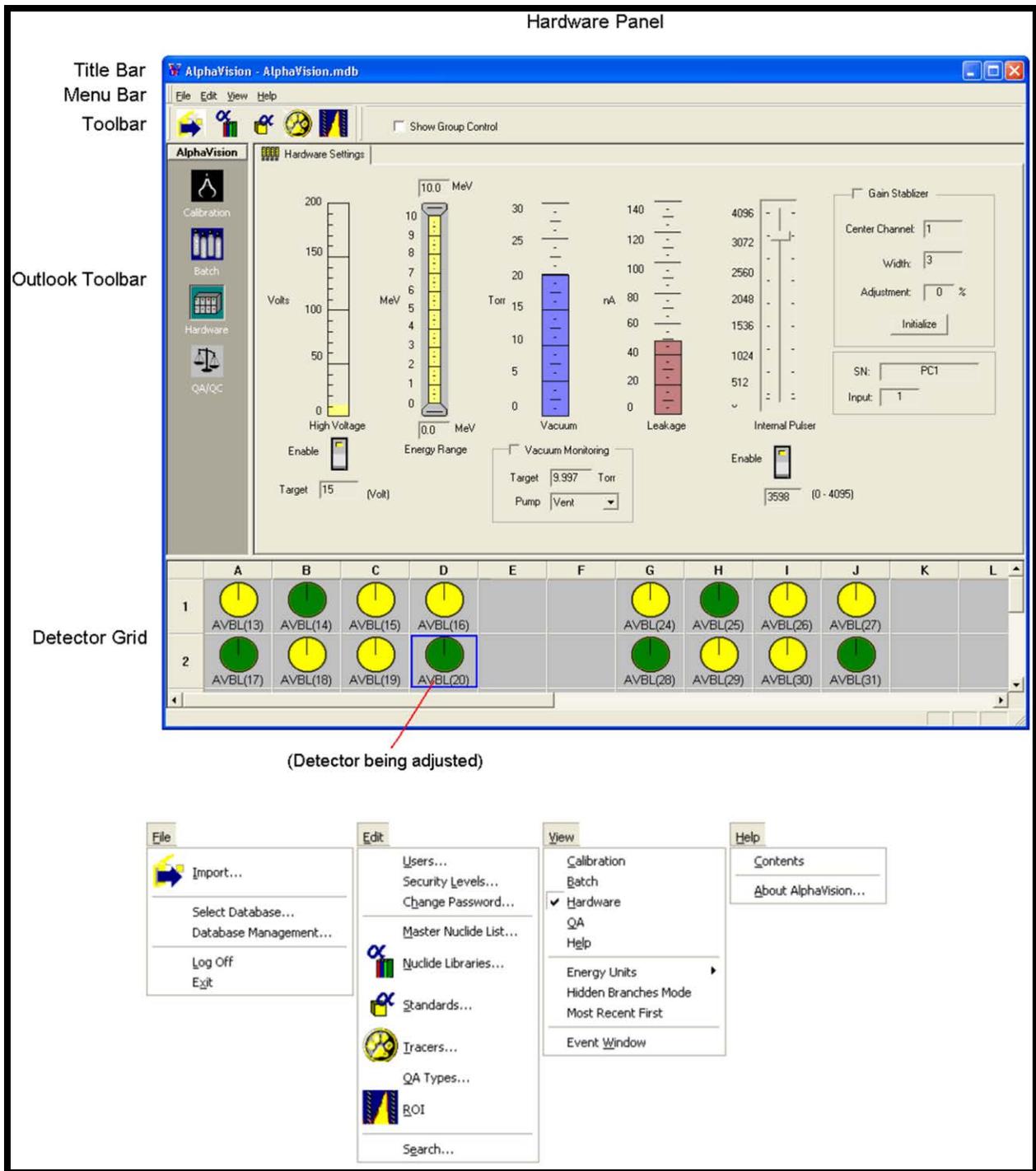


Figure 3. Hardware Mode (Single-Detector) User Interface and Menus

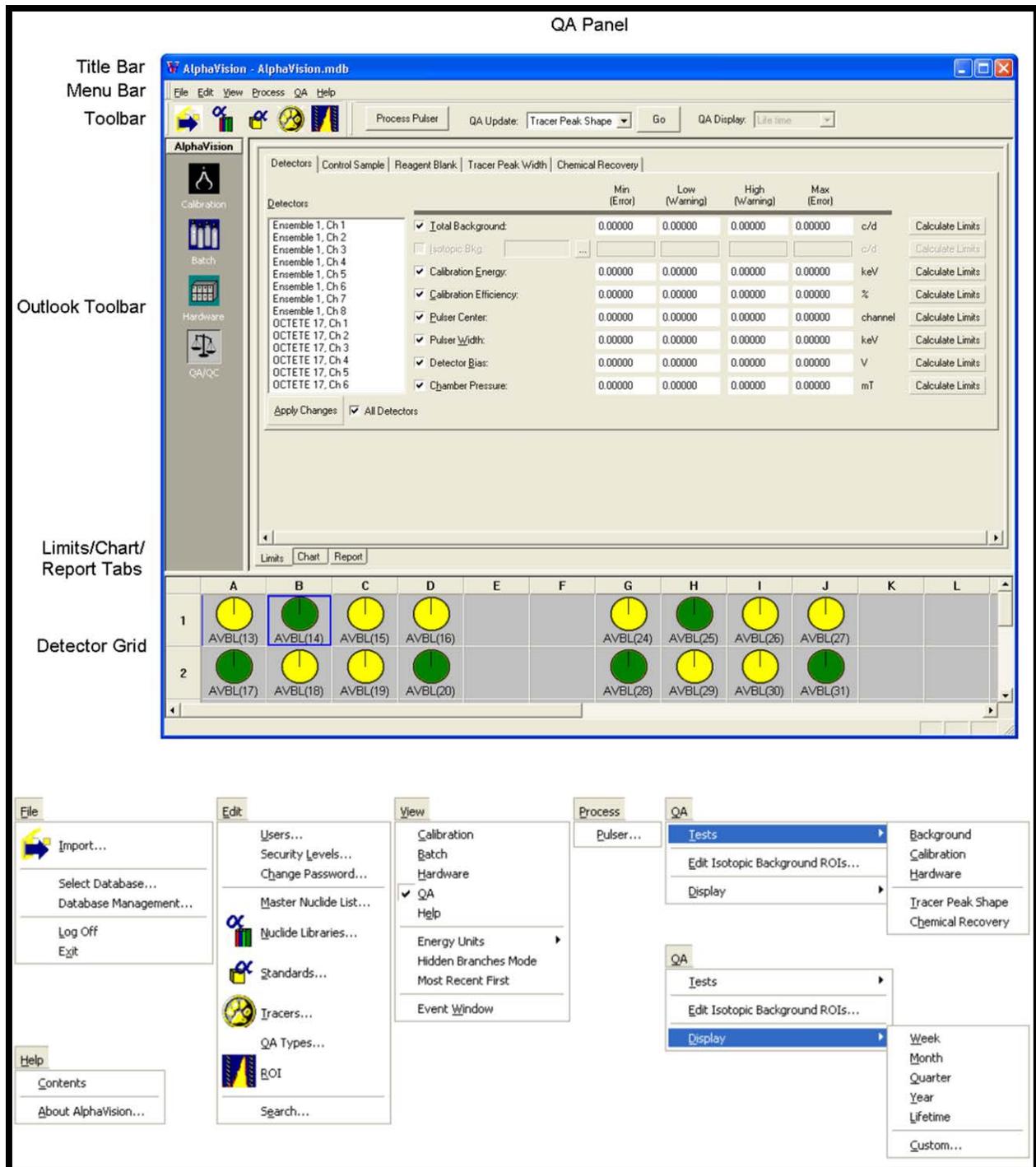


Figure 4. QA/QC Mode Screen Features and Menus

### 2.1.1 The Calibration Explorer Panel

The Calibration Explorer Panel (Figure 5) is ***the tool for viewing and evaluating the results of detector calibrations in the AlphaVision database.*** This panel lists the calibration history for the selected detector (click its Detector Grid icon). Calibration records include data such as the record **Name**, **Status** (new, acquiring, failed, completed), acquisition **Date** and time, **Calibration ID**, the **Cal. Source** (standard), **Gain**, **Offset**, and **Efficiency**. If the detector is not yet calibrated, no records for it are displayed in the Explorer Panel.

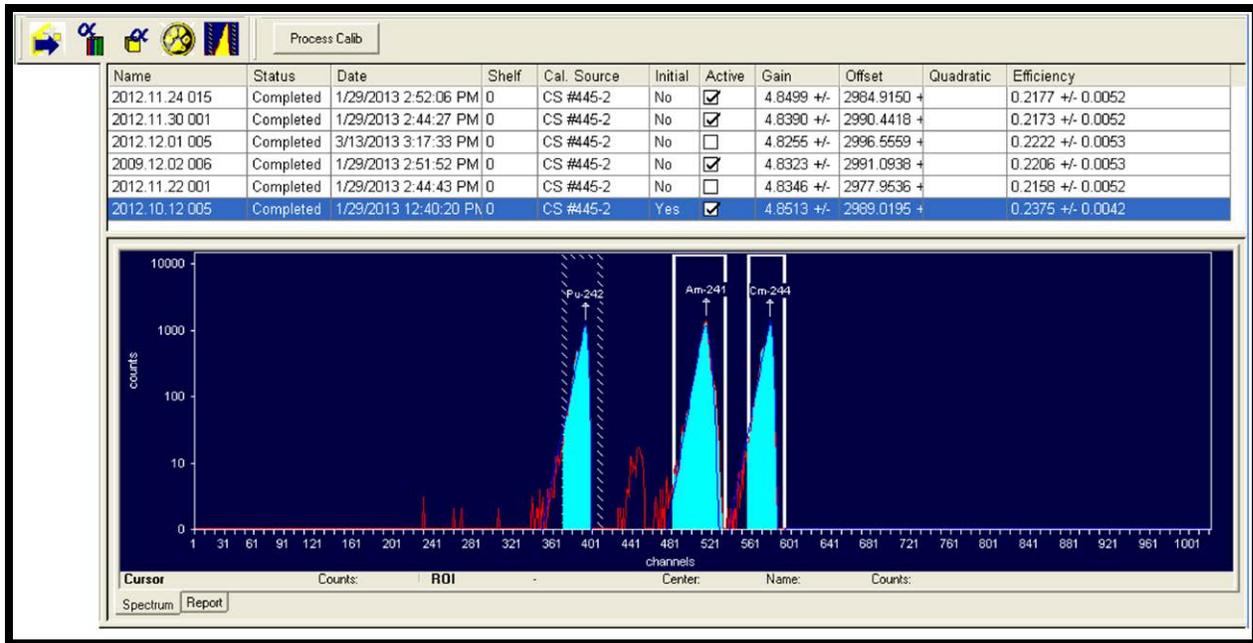


Figure 5. The Calibration Explorer Panel

The Calibration Explorer shows at a glance:

- Which calibration is the detector's current active/working calibration.
- Which calibrations match the selected detector's current geometry/alpha-chamber shelf position.
- Which calibrations have been analyzed and completed versus those still being acquired and analyzed.

Use the Calibration Explorer to:

- Start acquisition for a calibration that has been set up but not yet counted.
- Update a calibration, that is, reanalyze the spectrum using different calibration parameters (typically done to correct data entry errors, for instance, an incorrect calibration source) or ROIs.
- Delete calibrations that are no longer needed.

See also the calibration instructions in the Appendix A tutorial.

## 2.1.2 Accessing Batch, Background, and QA Data in the Batch Explorer Panel

The Batch Explorer Panel (Figure 6) is the **primary organizational tool for and portal to the sample information in the AlphaVision database**. It provides an intuitive, visual representation of all the batch, background, and QA data, organized hierarchically in levels and sub-levels that are defined according to the instructions in Section 9.1. In addition, it is the access point to data imported from earlier versions of AlphaVision.

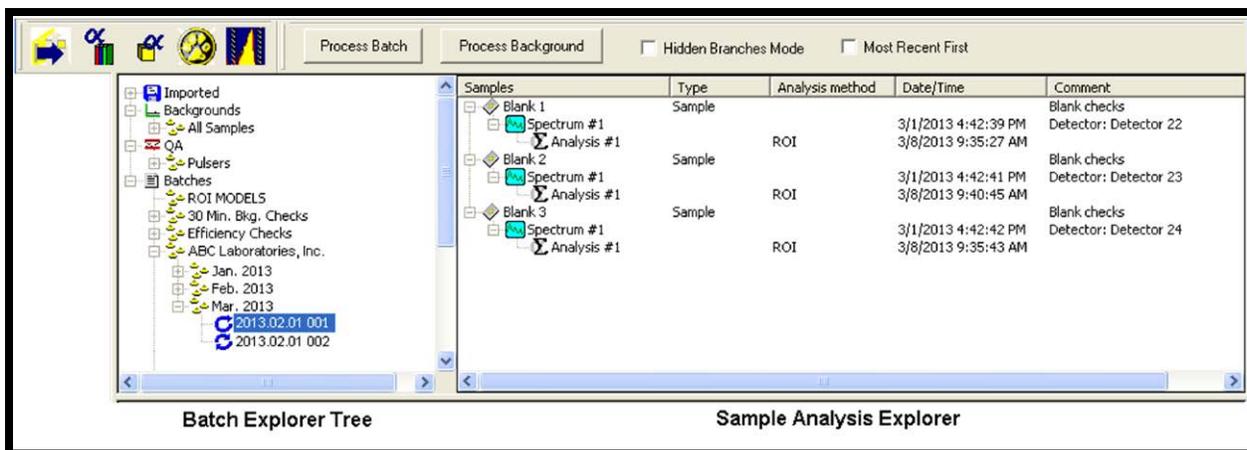


Figure 6. The Batch Explorer Panel: Batch Explorer Tree (Left) and Sample Analysis Explorer (Right)

Use the Batch Explorer Panel to:

- Review setup parameters, spectra, and analyses for batch, background, and QA pulser acquisitions.
- Generate and/or export analysis reports.
- Export AlphaVision 7 spectra to ORTEC .SPC-format spectrum files.
- Make batch-level changes:
  - Modify sample properties any or all samples in the selected batch.
  - Extend or reduce count time during acquisition.
  - Acquire more data after the first acquisition and analyze the cumulative data set.
- Count and recount samples.
- Analyze spectra that have not yet been analyzed.
- Perform interim spectrum analyses while data collection is in progress.
- Perform multiple analyses on a spectrum.

The ability to modify the database from this panel is limited; for instance, the user cannot click, drag, copy, cut, paste, rename, or delete records from it. For these kinds of operations, use the database management tools (Section 12.2).

### 2.1.3 The QA/QC Panel

The QA/QC Panel (Figure 7) is the access point to the QA control limits, control charts, and QA reports. Background and Pulser QA spectra, analyses, and analysis reports are available through the Batch Explorer Panel.

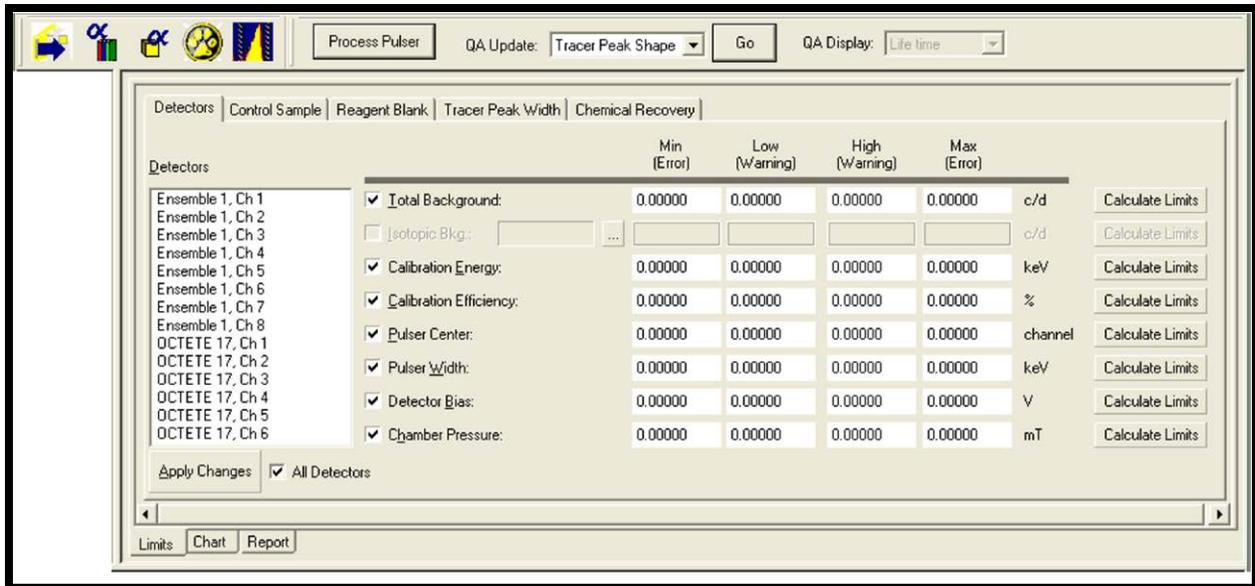


Figure 7. The QA Panel, Limits View, Detectors Tab

The QA window has 3 views governed by the tabs at the bottom of the panel (click the appropriate tab):

### Limits

This view (Figure 7) contains 5 tabs for establishing the **Low** and **High Warning** limits and the **Minimum** and **Maximum Error** limits for all detectors, tracers, and QA Types. The tab selected here governs which control chart and QA report will be respectively generated in the Chart and Report views. QA limits may be defined manually or by using AlphaVision's **Calculate Limits** option (Section 10.3.1). **Calculate Limits** averages the existing values for a parameter and calculates  $2\sigma$  and  $3\sigma$  at the 95% confidence level. The mean  $\pm 2\sigma$  becomes the **Warning** limits, and the  $\pm 3\sigma$  is used for the **Error** limits.

### Chart

QA data are displayed on control charts (Figure 8) that can be produced for weekly, monthly, quarterly, yearly, project lifetime, or customized intervals. These charts display both the data and the set limits for each QA parameter, and update in real time as new information is added to the AlphaVision database. The appearance of the control charts is tied directly to the set points entered on the Limits tab. **Error** limits are drawn in long red dashes and **Warning** limits in short blue dashes.

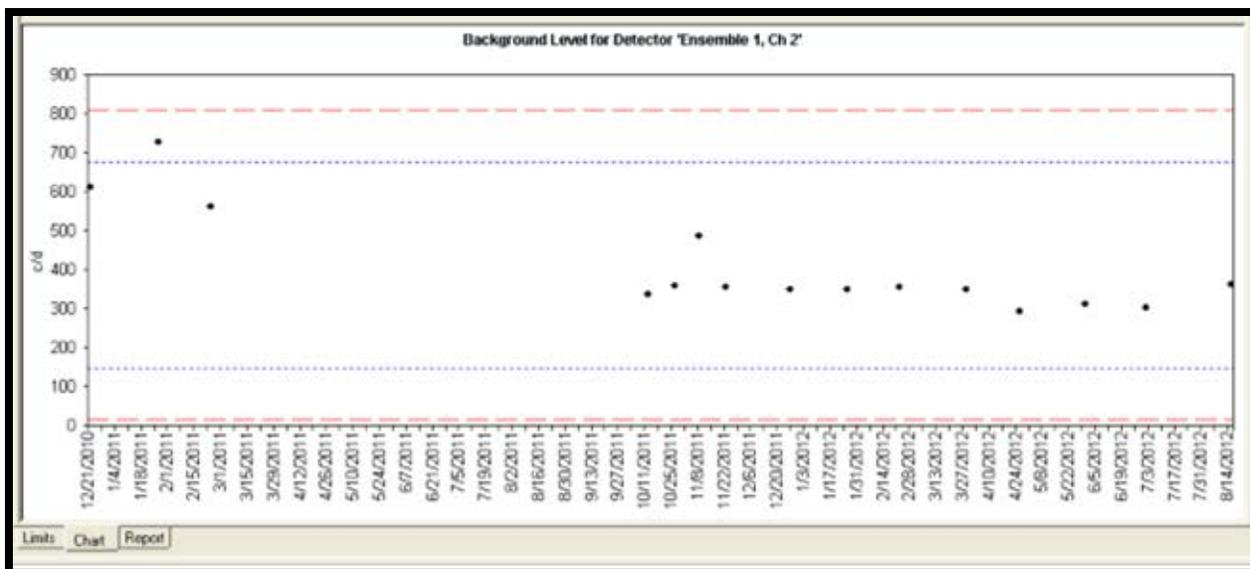


Figure 8. The QA Control Chart for Detector Background

### Report

This opens the standard Report Window discussed in Section 2.6. QA reports include an image of the associated control chart, the QA limits, and the mean and standard deviation of the data displayed.

## 2.1.4 The Hardware Panel

The Hardware mode interface gives access to the hardware setup options for ORTEC AlphaSuite and OCTÊTE-series instruments, and legacy Oxford® OASIS instruments.<sup>2</sup>

For more detailed setup options, and to set up other ORTEC CONNECTIONS instruments, right-click the detector and select **Detector Properties...**, then click **Chamber Properties**. This will open the Properties dialog discussed under **Acquire/MCB Properties...** in the accompanying *MAESTRO User's Manual*.

### 2.1.4.1 Comparison of Single-Detector and Group-Control Views

The Hardware Panel also has a multi-detector interface. Click **Show Group Control** on the Toolbar to toggle between the two interfaces, which are compared in Figure 9.

Use the single-detector interface to adjust the detector-specific hardware settings such as **High Voltage**, detector **Energy Range**, **Pulser** channel, and **Gain Stabilizer**. Then switch to the **Group Control** interface; select one or more detectors from the list with **<Ctrl>** or **<Shift>** plus the mouse; and simultaneously issue the **Pump**, **Vent**, or **Hold** command to all selected detectors; turn their detector bias voltage on/off; turn their pulser on/off; or enable/disable vacuum monitoring.

**NOTE** If the user selects an out-of-service detector, the single-detector interface will display only a "can't open instrument" message.

<sup>2</sup> Note that other MCBs, including units attached directly to OCTÊTE instruments, are not supported by the Hardware interface. To adjust these MCBs, use MAESTRO.

### 2.1.4.2 Alpha Aria/Duo/Mega/Ensemble Interface

The Hardware interface for ORTEC AlphaSuite instruments shows the interface for the selected alpha chamber. The controls let the user set the detector **Target** high voltage and **Enable** it, set the energy range in MeV, control and monitor the chamber **Vacuum**, monitor the read-only **Leakage** current, adjust the **Internal Pulser** channel and turn it on/off, and set up and enable the **Gain Stabilizer**.

For a numerical reading of each setting, pause the mouse over the chamber of interest to open a hover box showing the reading.

The screenshot displays the hardware settings interface for the AlphaSuite instruments. The top section shows various control panels for High Voltage, Energy Range, Vacuum, Leakage, Internal Pulser, and Gain Stabilizer. The bottom section shows a detector group interface with a table of detector status and control options.

ID	Detector Name	Running	HV	Pulser	Vac. Mode	Vac. (Torr)	Vac. Monitor
0013	Ensemble 1, Ch 1	No	53	Off	Pump	10.0	Off
0014	Ensemble 1, Ch 2	No	57	Off	Pump	9.7	Off
0015	Ensemble 1, Ch 3	No	43	Off	Hold	3.8	Off
0016	Ensemble 1, Ch 4	No	62	Off	Pump	10.0	Off
0017	Ensemble 1, Ch 5	No	60	Off	Hold	10.0	Off
0018	Ensemble 1, Ch 6	No	62	Off	Pump	9.9	Off
0019	Ensemble 1, Ch 7	No	58	Off	Hold	9.7	Off
0020	Ensemble 1, Ch 8	No	48	Off	Hold	9.8	Off

Figure 9. Single-Detector vs. Detector Group Interface

#### **Bias Voltage**

Enter the desired Target voltage, then click the Enable “switch.”

If a detector is locked, the user can view its bias voltage but the yellow inset in its Enable switch will be gray, indicating that it is inactive. As soon as the detector is free, the switch will become active again.

### **Energy Range**

The slider and text field for each chamber on the Energy Range tab lets the user set thresholds to discriminate against low-energy and short-lived, high-energy nuclides that are not of interest. In most cases, detector energy range can be set at 3-8 MeV (however, there are some lower-energy alpha emitters, such as  $^{147}\text{Sm}$  at 2.247 MeV). To set the energy range for the selected detector:

- Locate the chamber corresponding to the desired detector.
- Click and drag the lower threshold slider to the desired setting. As the slider is moved, a hover box will provide the user a continuous readout of the current energy range.
- Repeat for the upper threshold slider. Allow a couple of seconds for the hardware to register the changes and read them back to the Hardware screen.
- To keep the same relative energy range but shift its upper and lower threshold values, click the lower slider and drag it to the new low-threshold energy. Both sliders will move together, maintaining the same interval, in MeV, between them.

### **Chamber Vacuum**

These controls allow the user to set the target chamber pressure, control the pressure valve (Pump/Vent/Hold), and optionally select Vacuum Monitoring, which will suspend data acquisition if chamber pressure exceeds the target value.

### **Gain Stabilizer**

To enable the stabilizer, unmark the Gain Stabilizer checkbox if it is marked; click the Initialize button to set the current gain stabilizer Adjustment value to 0%; enter the Center Channel and Width values; then click the Gain Stabilizer box to mark it. Note that if the Adjustment value approaches 90%, the amplifier gain should be adjusted so the stabilizer can continue to function - when the adjustment value reaches 100%, the stabilizer cannot make further corrections in that direction. For more detailed information on gain stabilization, refer to the MAESTRO manual.

#### **2.1.4.3 OCTÊTE-Series Interface**

The Hardware interface for the OCTÊTE instrument family has 4 tabs that monitor all the alpha chambers for the selected OCTÊTE (Figure 10). These tabs have controls for turning each detector's **Bias** on and off, setting each detector's **Energy Range**, and monitoring the **Leakage Current** and **Vacuum** in each chamber.<sup>3</sup>

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<sup>3</sup> The readouts for the OCTÊTE Plus (and 920-16) will show 16 chambers instead of 8.

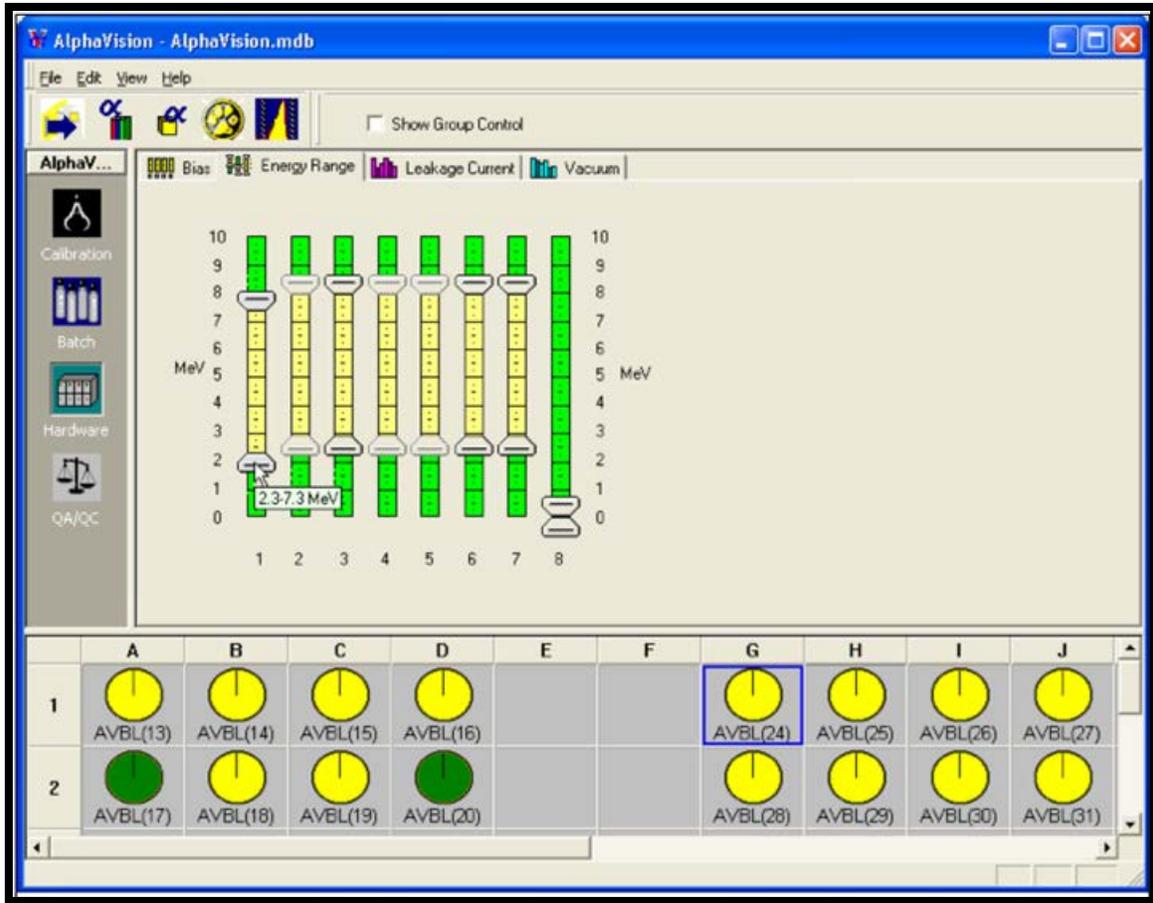


Figure 10. Single-Detector Interface for OCTÉTE: The Energy Range Tab

### Bias

To turn on the bias voltage for an instrument, click the Master “switch.” Once the Master is on, each chamber’s bias voltage can be turned on and off by clicking the appropriate Enable switch. If a detector is locked, the user can view its bias voltage but the yellow inset in its Enable switch will be gray, indicating that it is inactive. As soon as the detector is free, the switch will become active again.

### Energy Range

Adjust the sliders as for the Alpha Aria in the preceding section.

### Leakage Current and Chamber Vacuum

These tabs are read-only.

#### 2.1.4.4 Oxford OASIS

The Hardware interface for the OASIS (Figure 11) has a View drop list that accesses six screens that allow the user to set a target **Vacuum** for each chamber and monitor it; turn each detector’s **Bias** on and off; set an upper leakage **Current** limit and monitor the current; adjust the amplitude of the **Pulsar** peak and turn it on and off; set and monitor the **Fine Gain**; and set a lower-limit **Threshold Energy**.

At the top left of each chamber readout is a set of up/down arrow buttons. Use them to adjust the scale of each chamber’s readout independently. Help/status messages are displayed for

the OASIS at the bottom of the Hardware Panel (immediately above the boundary with the Detector Grid).

When setting **Vacuum**, **Bias**, **Threshold Energy**, etc., if the values are entered from the keyboard, the user must press the **<Enter>** key after keyboard entry or the OASIS will not “accept” the new value. The OASIS immediately accepts values entered with the up/down buttons.

### (0) VACUUM

This screen allows the user to set a minimum required (**RQ**) pressure above which the detector bias voltage switches off and cannot be reapplied. The **HD** parameter is the pressure at which it is desired to hold the chamber. The (**mTorr**) field at the top of each chamber readout shows the current chamber pressure. Bias is restored automatically when chamber pressure falls below **RQ**. Note that the upper limit of the OASIS pressure sensor is 65 Torr.

**NOTE** A chamber pressure threshold can also be set up on the Acquisition Properties page in the AlphaVision wizards. Data acquisition suspends when the set point is exceeded, and automatically resumes when the problem is corrected.

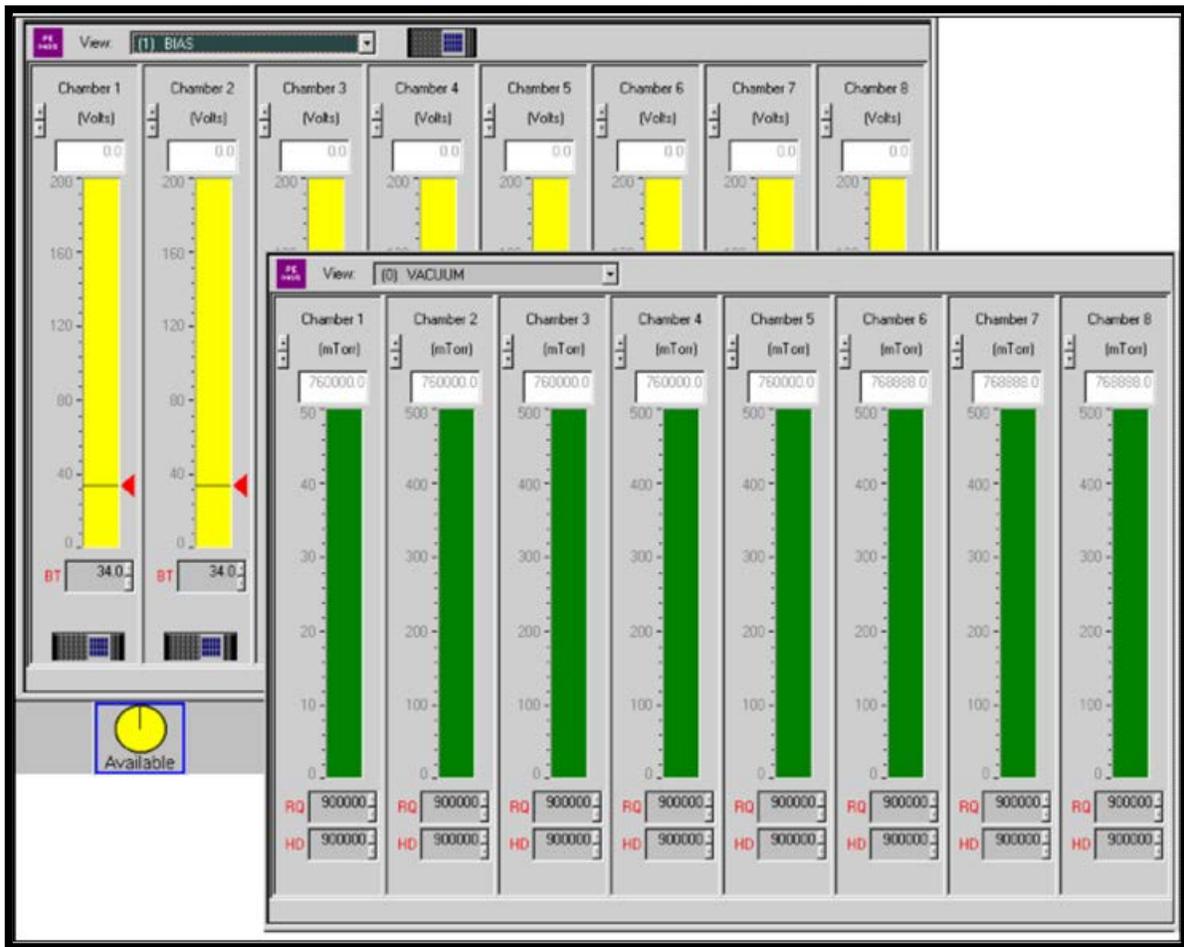


Figure 11. Single-Detector Interface for OASIS

**(1) BIAS**

Use this screen to set the detector bias voltage for each detector. The OASIS supports a bias voltage range of 0V-200V at 10mA in 1V steps. The master bias switch for the MCB is located at the top of the Hardware panel, to the right of the **View** drop list. The on/off switch for each individual chamber is at the bottom of the chamber's readout. Enter the desired bias voltage in the **BT** (bias target) field. The **(Volts)** field at the top of each chamber readout shows the current amount of bias applied.

**(2) CURRENT**

This screen enables the user to set a maximum threshold for detector leakage current in the **CL** field at the bottom of each chamber readout. An indicator line highlighted with a red arrow gives the user a quick visual indication of the set point now in effect. The **(nAmps)** field allows monitoring of the leakage current.

**NOTE** A leakage current threshold can also be set up on the Acquisition Properties page in the AlphaVision wizards. Data acquisition suspends when the set point is exceeded, and automatically resumes when the problem is corrected.

**(3) PULSER**

This screen lets the user adjust the amplitude of the OASIS pulser for each chamber by entering a value in the **(amplitude)** field at the top of each chamber readout. The setting is in energy units if the detector is calibrated, and as 0-100% of full scale for uncalibrated detectors. Each chamber readout has a pulser on/off switch (at the bottom of the panel) and gives a quick visual indicator of the amplitude now in effect.

**(4) FINE GAIN**

On this screen, the user can set the fine gain for each chamber by entering a value in the **(fine gain)** field at the top of each chamber readout. The readout indicates the current fine gain setting.

**(5) THRESHOLD ENERGY**

The fields on this screen let the user set energy thresholds to discriminate against low-energy nuclides that are not of interest. To set a threshold, enter the value in the **(chan.num.)** field. Chambers 1-4 and Chambers 5-8 are ganged together; setting 1 chamber in the gang simultaneously sets the remaining 3.

## 2.2 THE DATA ACQUISITION SETUP WIZARDS

AlphaVision has four wizards (see the **Process** menu in **Batch**, **Calibration**, and **QA** modes) that guide the user, step by step, through the setup of all parameters for Batch, Background, Calibration, and Pulser Test data acquisition and analysis (Figure 12).

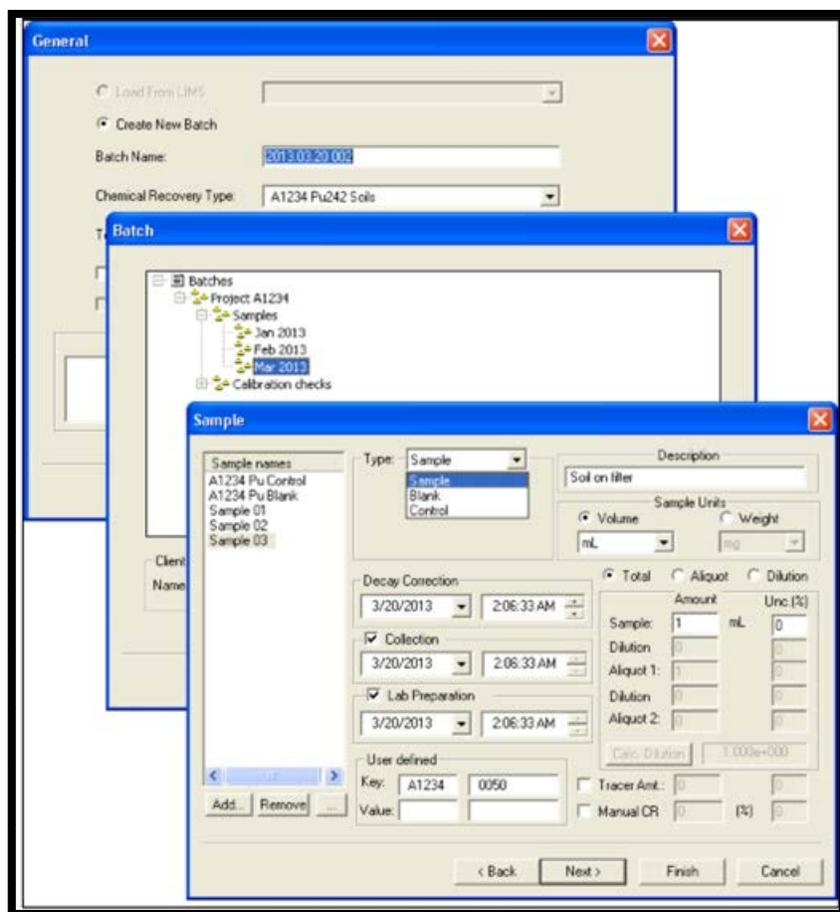


Figure 12. Setting Up the Batch Wizard

Use the wizards to streamline the repetitive aspects of sample analysis by creating special records called *templates*, which hold customized sets of data acquisition parameters, analysis specifications, and reporting preferences. Once templates are created, start one of the wizards, choose the desired template, enter the batch- and/or sample-specific data, and data collection is ready to start.

The Calibration Wizard is discussed in Chapter 7; and the Batch, Background, and QA Pulser Wizards are discussed in Chapter 11.

## 2.3 ASSIGNING DETECTORS AND ACQUIRING DATA

In AlphaVision, calibrations are performed on one detector at a time, so the detector must be selected *before* performing the calibration.

Sample batches, background measurements, and QA pulser tests can be performed on one detector at a time, however, they are typically performed on multiple detectors. AlphaVision's *Detector Assignment Worksheet* (Figure 13), which opens after the Batch, Background, and QA Pulser Test Wizards, is the tool for associating each sample with a detector for counting, as follows:

- **On the Sample Page in the Wizards**
  - **Auto-Sample** - Clicking the auto-sample button displays the list of currently available detectors. Mark the ones it is desired to use, click **OK**, and the Sample Name pane auto-populates with a list of sample names corresponding to the names of the chosen detectors. Edit and configure each sample as needed, finish the wizard, and the Detector Assignment Worksheet displays the samples and their pre-assigned detectors. The system is ready to count. (See Section 11.4.3.1.)
- **On the Detector Assignment Worksheet** (after finishing the wizards)
  - **Auto-Assign** - One click automatically assigns available detectors (i.e., detectors that are not counting and have been cleared) to the samples in this batch.
  - **Manual** - Go to the Detector Grid, click the desired detector, then drag and drop it on the desired sample.

The **Print** option on the Worksheet allows printing of a hard copy of the detector assignments to aid in loading the samples into their assigned chambers.

After detectors have been assigned to the samples, the user can count or delay counting an entire batch, count or delay counting selected samples, recount an entire batch or selected samples (with or without changing the original data acquisition settings), and adjust the batch counting time during or after acquisition. See Section 11.2 for complete instructions on using the Worksheet and data acquisition controls.

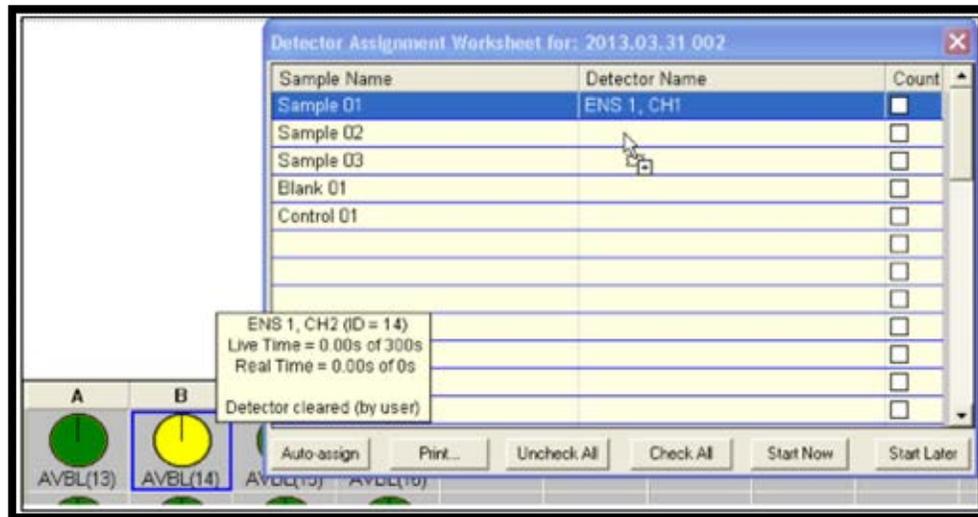


Figure 13. Assigning a Detector by Dropping Its Icon in the Worksheet

### 2.3.1 Acquiring Calibration Data

As noted in the preceding section, the Detector Assignment Worksheet is not used for detector-specific processes such as calibrations. Instead, calibration measurements are controlled by the **Run on close** checkbox (Figure 14) on the first page of the Calibration Wizard.

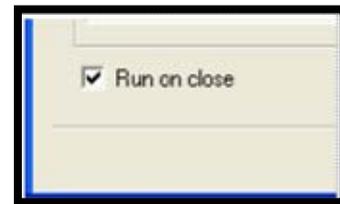


Figure 14. Run on Close Checkbox

- If **Run on close** is marked, acquisition will start as soon as the user clicks **Finish** in the Calibration Wizard.
- If Run on close is unmarked, this calibration will not be performed yet, but will be marked with a New status in the Calibration Explorer Panel. When ready to count, right-click the calibration record and select Start from the menu.

**NOTE** The count time for a calibration cannot be changed after acquisition starts.

## 2.4 THE EVENT WINDOW – ALPHAVISION’S ERROR AND SYSTEM TRACKING TOOL

AlphaVision displays errors and system events in the *Event Window (View/Event Window)* shown in Figure 15. This method is used instead of standard popup messages to streamline interactions with the software when running numerous samples simultaneously. The Event Window records software events, their severity (Information ⓘ, Warning ⚠, Error ❌), the software module in which the events occurred, and the date and time for occurrences including:

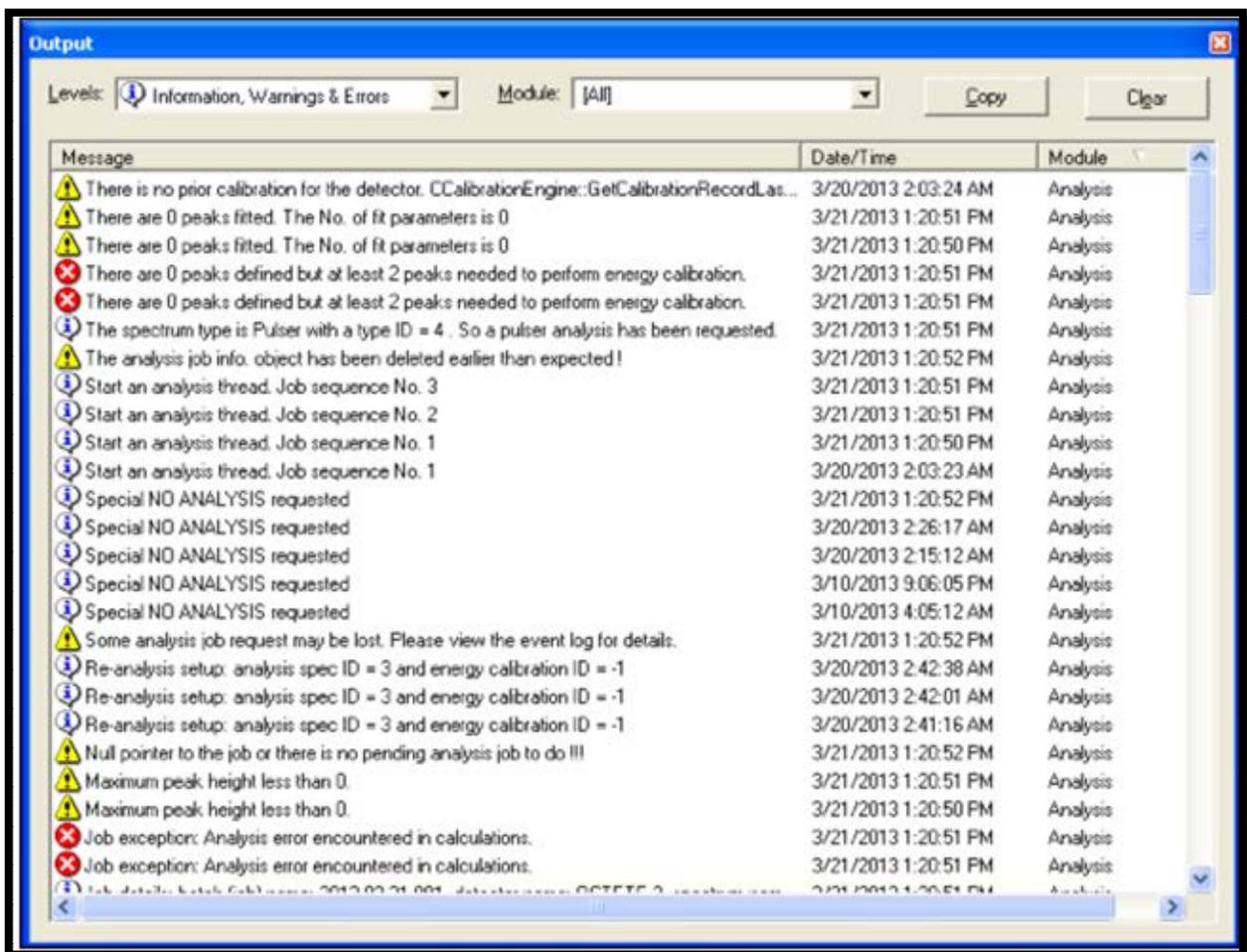


Figure 15. Information, Warning, and Error Messages in the Event Window

- Calibration failures
- Analysis failures
- Sample re-analysis
- Start and end of data collection
- QA warning or error limits exceeded
- Counting interrupted when a detector chamber exceeds pressure or leakage current limits
- Count resumption when detector chamber returns within pressure and leakage current limits
- Detector taken out of or returned to service
- Instrument Configuration program used to update the Master Detector List

Click the column headers to sort ascending/descending. Use the fields at the top of the dialog to selectively display events by event type and/or module. The user can **Copy** one or more events from this window to a word processing file; and **Clear** the list. *There is no “undo” for the **Clear** command.*

Click the upper-right **X** box to close the window.

## 2.5 THE SPECTRUM WINDOW

This section discusses the features and controls for the Spectrum Window, which is available only in **Batch** and **Calibration** modes. To display it, click the Spectrum tab at the bottom of the Batch or Calibration Explorer Panel.

To view a spectrum during acquisition, go to the Batch Explorer Panel, locate the batch (which is marked with an  icon), click the batch icon to expand it  and list its sample entries on the right, in the Sample Analysis Explorer. Click the plus (+) box beside the sample name to display the spectra that have been acquired from this sample. Now click the spectrum icon  then click the Spectrum tab (in Batch mode) or Analysis tab (in Calibration mode).

### 2.5.1 Right-Mouse-Button-Menu

Right-clicking in this window opens a menu (see Figure 16) that lets the user **Zoom In** to see more spectrum details; return to a **Full View** of the spectrum; display the full-spectrum-view **Thumbnail** window, the **Residuals Spectrum**, and/or the **ROI Bars** (which mark the start and end channels of each ROI); modify an existing ROI Set for a sample reanalysis (**Interactive ROI Analysis**, discussed in Sections 8.6.2.1 and 7.3); and adjust the spectrum display **Properties**....



Figure 16. The Right-Mouse-Button Menu

Figure 17 illustrates the Thumbnail window, Residuals spectrum, ROI Bars, and right-mouse-button menu.

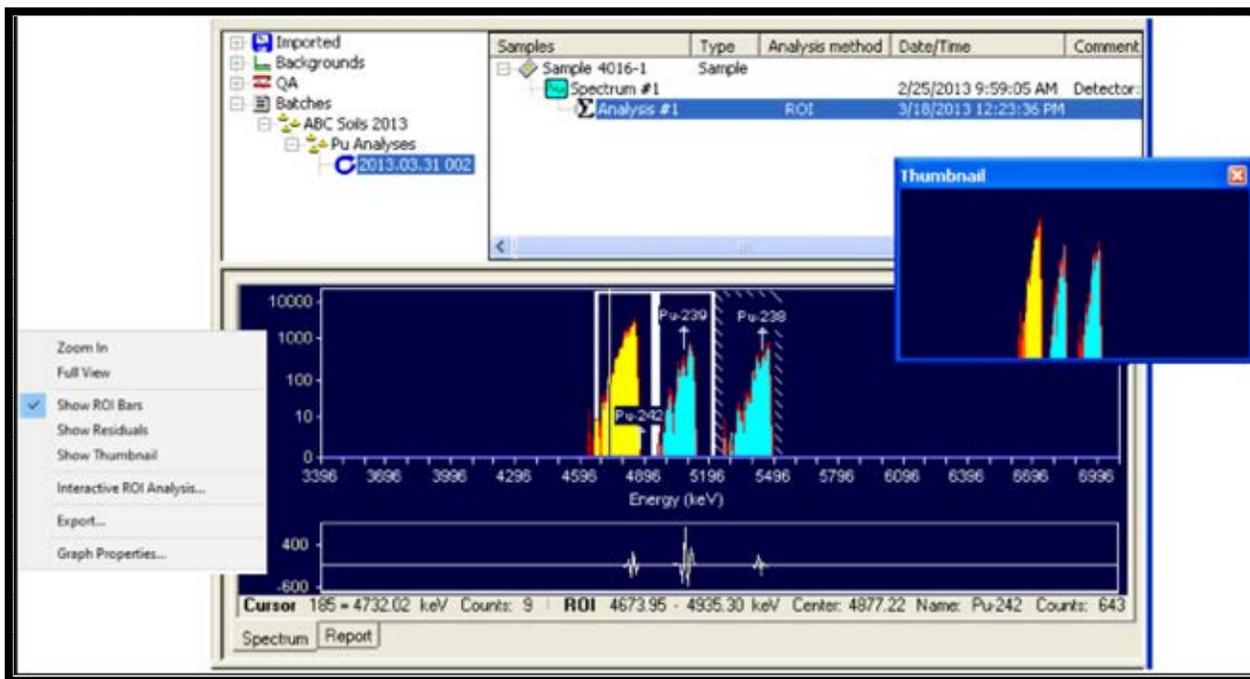


Figure 17. Spectrum Window Features in Batch Mode

Notice the Marker Information Line at the bottom of the Spectrum Window. It reports the position of the vertical *marker line* (located in the  $^{242}\text{Pu}$  peak in this illustration), including the marker location in channels and energy, the counts in the current channel, and any ROI and/or nuclide identification information. Section 2.5.3 describes the accelerator keys that move the marker and adjust the spectrum's horizontal and vertical scaling.

Figure 18 shows the dialog for the **Properties** command. It allows the user to change Spectrum Window colors and scaling.

If the detector for the current spectrum was calibrated when the spectrum was acquired, the spectrum will be displayed in energy units (keV or MeV). If the detector was uncalibrated, the spectrum will be displayed in channels. While viewing a spectrum analysis, clicking on the Report tab at the bottom of the Spectrum Window opens the Report Window and generates the associated report. (Both the Calibration and Analysis reports include a picture of the analysis spectrum.)

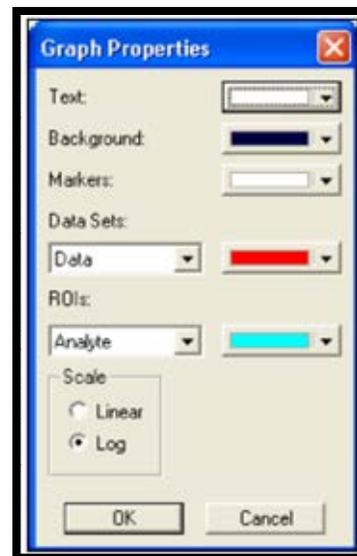


Figure 18. Spectrum Window Color, Scale

## 2.5.2 Zoom Commands

The **Zoom In** command gives the user a second way - in addition to the Thumbnail view - to take a closer look at the spectra. In the Spectrum Window (not the Thumbnail), click and drag the mouse pointer over a portion of the spectrum to surround it with a *rubber rectangle*, then

release the mouse button. The Spectrum Window will automatically adjust the horizontal and vertical scaling to display the area enclosed in the rubber rectangle.

To zoom out to a view of the entire spectrum, simply right-click in the Spectrum Window and select **Full View**. The window scaling will adjust to display the entire horizontal and vertical extent of the spectrum.

### 2.5.3 Scaling and Cursor Accelerator Keys

**NOTE** These accelerators function only when the Thumbnail window is **closed**.

#### Next Channel

<→>/<←>

The right and left arrow keys move the marker by one displayed pixel in the corresponding direction. If the window is zoomed in, expanding the horizontal scale, when the marker reaches the edge of the spectrum window, the next key press past the edge shifts the window to the next block of channels in that direction such that the marker is now in the center of the display.

#### Zoom In/Zoom Out

Keypad<+>/<->

**Keypad<+>** decreases the horizontal scale in the Expanded Spectrum View so the peaks appear larger, and **Keypad<->** increases the horizontal scale, making the peaks look smaller.

#### Taller/Shorter

<↑>/<↓> and <F5>/<F6>

The <↑> and <↓> keys decrease or increase the vertical full scale of the displayed spectrum, so the peaks appear taller or shorter, respectively.

#### Narrower/Wider

<F7>/<F8>

These keys increase or decrease the horizontal scale of the data display so the peaks appear narrower or wider, respectively.

#### Full View

This command restores the spectrum to its default scaling.

## 2.6 THE REPORT WINDOW

All AlphaVision modules use the same Report Window (Figure 19), which allows the user to view, print, or export the report data to a variety of formats. AlphaVision's reports are completely dynamic - that is, previously generated reports are not stored; they generate directly from the pertinent analysis record(s) each time the Report tab is clicked.

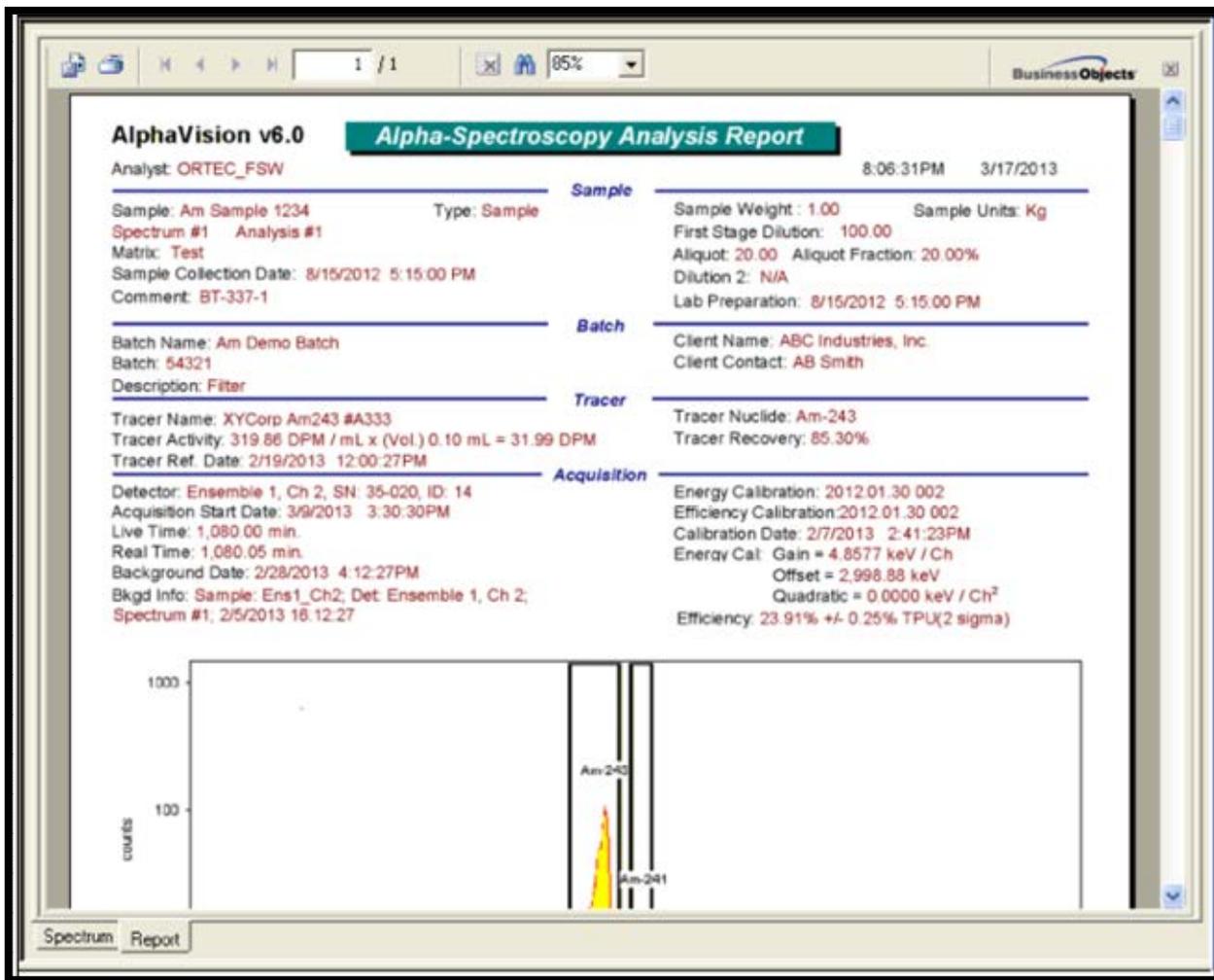


Figure 19. The Report Window (Showing a Sample Analysis)

AlphaVision includes a set of SAP® Crystal Reports v11.5 report templates, which are stored in C:\User\AlphaVision. However, user generated templates can be used.<sup>4</sup> On the Report page of the various wizards, simply mark the **User defined template** checkbox, then browse to desired location.

Report content differs by module. Calibration reports include the calibration analysis histogram. Batch analysis reports include sample spectrum's analysis histogram. Background reports include the background spectrum's analysis histogram. QA reports include the selected control chart.

The first step in reporting is to select the desired spectrum or QA record.

- **Calibration and Batch Modes** - AlphaVision lets the user report on all or part of the spectrum. To report on the entire spectrum, right-click in the Spectrum Window and choose **Full View** before clicking on the Report tab. To report on part of the spectrum,

<sup>4</sup> This requires SAP® Crystal Reports v11.5, not supplied with AlphaVision v7. Assistance is available in developing custom templates; contact the ORTEC representative or Customer Support for more information on this service.

click and drag to choose the desired region, right-click, and select **Zoom In** from the right-mouse-button menu; then click the Report tab.

**NOTE** In both cases, the *Nuclide Summary* section of the report will always contain the information for all ROIs in the spectrum, not just the ROIs currently displayed in the Spectrum Window

- In **Calibration** mode, click a detector, go to the Calibration Explorer and select the desired calibration, then click the Report tab to generate the report.
- In **Batch** mode (batch analysis and background acquisitions), go to the Batch Explorer Panel and locate the desired *analysis* () (not the spectrum ). Click the analysis entry, choose whether to report on all or part of the spectrum, then click the Report tab to generate the report.
- **QA/QC Mode** - Run the QA test (if necessary) then click the tab for the desired test.
  - For the hardware tests (calibration, pulser, background, bias, chamber pressure), go to the Detectors tab and select a particular detector, click the button for the desired test parameter, then click the Report tab.
  - For Control Sample, Reagent Blank, Tracer Peak Width, and Chemical Recovery tests, click the desired tab, select a particular QA Type from the list, then click the Report tab.

Figure 20 illustrates typical QA, calibration, and sample analysis reports.

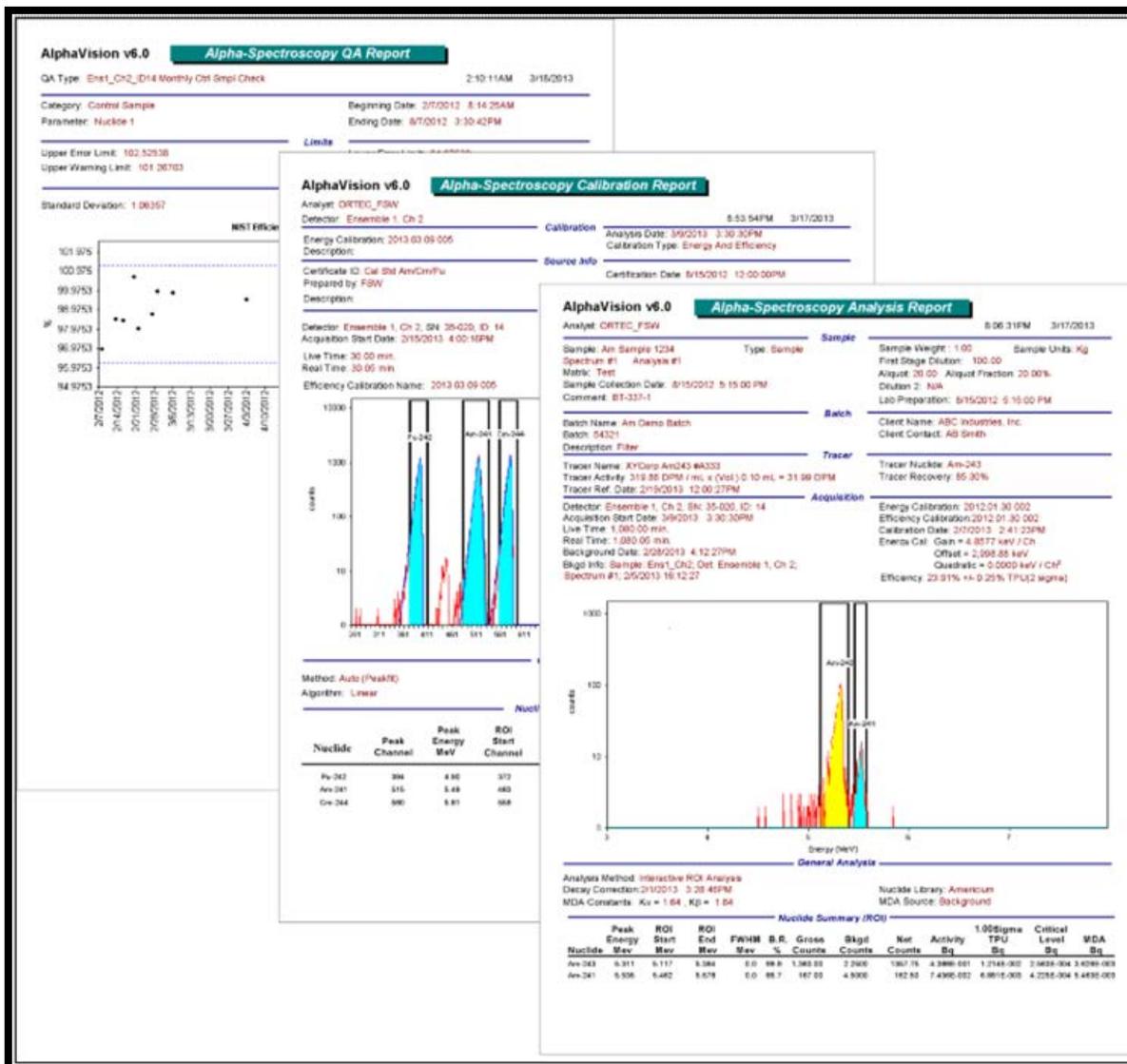


Figure 20. Example QA, Calibration, and Sample Analysis Reports

### 2.6.1 Report Export Formats

If the option “Prompt before export” is checked, AlphaVision 7 reports can be exported in the following formats:

Table 1. “Prompt Before Export” Report Export Formats

Adobe Acrobat (.PDF)	Record Style, Columns with Spaces (.REC)
Crystal Reports (.RPT)	Record Style, Columns Without Spaces (.REC)
HTML 3.2	Report Definition (.TXT)
HTML 4.0	Rich Text Format (.RTF)
Microsoft Excel 97/2000 (.XLS)	Separated Values (.CSV)
Excel 97/2000, Data Only (.XLS)	Tab-Separated Text (.TTX)
Microsoft Word (.RTF)	Text (.TXT)
Microsoft Word – Editable (.RTF)	XML
ODBC	

If the option “Prompt before export” is not checked, AlphaVision 7 reports can be exported in the following formats:

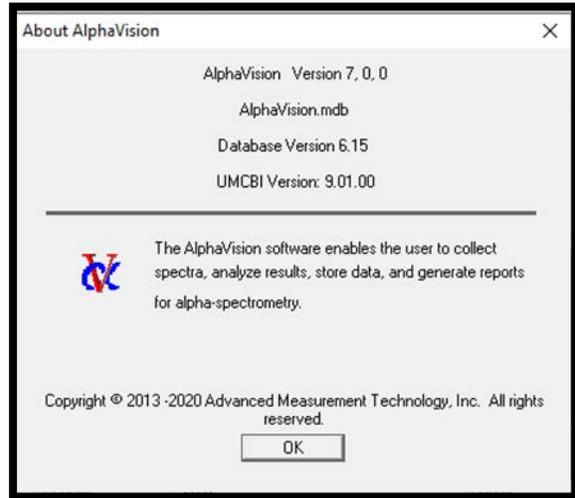
**Table 2. Do Not Prompt Before Export Report Export Formats**

Adobe Acrobat (.PDF)
HTML 4.0
Microsoft Excel 97/2000 (.XLS)
Microsoft Word (.DOC)
Plain Text (.TXT)
Rich Text Format (.RTF)
Tab-Separated Text (.TTX)

If the user exports a PDF to email when no email client is available, a “no email program associated to perform the requested action” message will be displayed. This occurs only for the first export attempt per AlphaVision work session (i.e., the message does not recur until AlphaVision is closed and restarted).

## 2.7 ABOUT ALPHAVISION – SOFTWARE VERSION INFORMATION

Figure 21 shows the About dialog (**Help/About AlphaVision...**), which contains version information that may be useful should customer support be required.



**Figure 21. AlphaVision Version Information**

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## 3. GETTING STARTED IN ALPHAVISION

AlphaVision v7 gives unprecedented flexibility and control over all aspects of alpha spectrometry. To exercise this power, some of the software features will need to be set up before using AlphaVision for sample analysis. The following list outlines the setup steps and some key factors to consider during setup.

- **Install the AlphaVision Software** (Chapter 4)
  - Install CONNECTIONS
  - Install AlphaVision
  
- **Configure the Detectors** (Chapter 6)
  - Build a master list of available alpha chambers (detectors)
  - Populate the Detector Grid with detectors from the master list
  
- **Organize the Batch Explorer Panel** (Chapter 9)
  - Create an organizational hierarchy in the Batch Explorer Tree that logically represents the user's alpha spectroscopy operations
    - Create an organizational hierarchy in the Batch section
    - Create an organizational hierarchy in the Backgrounds section
    - Create an organizational hierarchy in the QA section
  
- **Calibrate the Detectors** (Chapter 7)
  - Create a calibration nuclide library for the user's calibration sources
  - Create calibration source records
  - Set up calibrations using the Calibration Wizard
  - Perform initial energy and efficiency calibrations on the detectors just assigned to the Detector Grid. This will mark the first appearance in the QA records of these detectors.
    - Acquire data
    - Create/edit an ROI Set for the calibration
    - Calibrate from the acquired data
    - Review and report
  
- **Quality Assurance/Quality Control Setup** (Chapter 10)
  - Set up QA Types to define the names of the QC Charts needed
  - Define control and specification limits for QA reports and charts (this can also be done later)
  - Establish detector background with the Background Wizard
  - Detector backgrounds
  - Isotope-specific backgrounds
  
- **Nuclide Libraries and Other User-Defined Analysis Tools** (Chapter 8)
  - Create project- or nuclide-specific analysis libraries (this can also be done "as you go" during wizard setup)
  - Create records for the control solutions (this can also be done during wizard setup)
  - Create project- or nuclide-specific analysis ROI Sets (this can also be done during wizard setup)

- Create Tracer Sets as needed (this can also be done during wizard setup)
- Set up templates for the most common types of data acquisitions and geometries (this can also be done during wizard setup)
  - Calibration templates
  - Analysis templates
  - Background templates
  - QA templates
  
- Batch Processing and Analysis (Chapter 11)
  - Set up Sample Batches with the Batch Wizard.
    - The user may also wish to set up peak-search-and-fit records (this can be done “as you go” in the Batch and Calibration Wizards)
    - ROI Sets can be created during calibration
  - Acquire data and perform data analysis
  
- Interface Between User LIMS and the AlphaVision v7 Database (Chapter 13)
  - Set up an interface between the user’s LIMS and the AlphaVision v7 database.

## 4. INSTALLING THE SOFTWARE

This chapter discusses software and hardware installation and configuration, including:

- Installing ORTEC CONNECTIONS and AlphaVision 7
- Reserving a “clean copy” of the AlphaVision 7 database
- (Optional) Selecting a Windows “short date format”

### 4.1 BEFORE INSTALLATION

**NOTE** The user must be logged in as a Windows Administrator-level user to install ORTEC software.

- Be sure to read the accompanying *Installation and Release Notes* (P/N 784550).
- If the software is being upgraded from AlphaVision Version 4.x, *there is no need to uninstall it*. Installing AlphaVision 7 will not affect existing AlphaVision v4.x files, spectra, or data. The user will retain the capability to open AlphaVision v4.x, analyze .SPC files with it, and otherwise use it normally.
- The AlphaVision software includes default report templates for analysis, calibration, background, pulsers, and QA.
- If older versions of CONNECTIONS and/or AlphaVision v5.x or v6 are being used on the AlphaVision PC, remove them using the Control Panel’s software install/uninstall utility.

**IMPORTANT** If upgrading from a version of AlphaVision v5 or v6 **and** the report templates have been modified **and** the default names of those templates have not been changed, *the report template files must be saved to a different location on the hard drive before installing the AlphaVision software or else all modifications will be lost.*

- All user-defined report templates or report templates from older versions of AlphaVision report templates must be updated to SAP® Crystal Reports v11.5.<sup>5</sup>
- If AlphaVision 7 is installed in other than the default location, C:\User\AlphaVision, Crystal Reports v11.5 or higher must be used to edit the paths in the report templates, AnalysisRpt.rpt, BackgroundRpt.rpt, CalibrationRpt.rpt, PulserRpt.rpt, and QARpt.rpt, or else AlphaVision will not be able to find and use the templates.

### 4.2 INSTALLING CONNECTIONS

*The first step* is to install the accompanying CONNECTIONS Driver Update Kit (P/N 797230) according to its instruction sheet (P/N 932721) (note that Connections 9+ is required). *Be sure to read the entire instruction sheet.* It discusses MCB support in detail; and explains how to enable and disable the drivers for ORTEC MCB(s) and share ORTEC MCBs across a network. It also points the user to information on selecting the proper network protocol for older, TCP/IP Ethernet units. At the end of installation, it will be required to restart the PC.

<sup>5</sup> Not supplied with AlphaVision 7.

### 4.3 INSTALLING ALPHAVISION

Insert the AlphaVision CD, select **My Computer**, locate the CD drive, then execute Setup.exe. If a security dialog asks if the program should be installed, answer yes to start the AlphaVision installation wizard. Click **Next**, follow the wizard prompts to completion, and restart the computer if prompted to do so.

AlphaVision is installed in the \Program Files (x86) folder.

### 4.4 RESERVING A “CLEAN COPY” OF THE ALPHAVISION 7 DATABASE

Before using AlphaVision 7 for the first time, it is recommended to make an archive copy of the empty AlphaVision.mdb database file. In the C:\User\AlphaVision folder, create a folder named backup. Copy the empty AlphaVision.mdb file from C:\User\AlphaVision to the new backup folder. The user can then use it with the Database Management utilities (Section 12.2) to create new AlphaVision databases.

### 4.5 OPTIONAL: SELECTING A WINDOWS “SHORT DATE FORMAT”

The current Windows Regional Settings “short date format” is used for all date fields in the dialogs, wizards, reports, control charts, etc. If it is desired to change this, in Windows navigate to Settings-Region and click on Change Date Formats. Select a new short date format from the drop-down menu.

## 5. ADDING USERS AND DEFINING SECURITY LEVELS

The system security commands on the **Edit** menu let users control user access to AlphaVision. AlphaVision is shipped with one factory-defined user with full administrator privileges so the initial user has access to all AlphaVision 7 commands and operations.

- **Users...**
  - Add and remove users from the system.
  - Assign users a username and password,<sup>6</sup> and select their level of access.
  - Assign a new password to users who have forgotten theirs. The new password goes into effect at the next login.
- **Security Levels...**
  - Define classes of users and determine which AlphaVision commands and operations they can access.
  - Alternatively, all users can log in with full access and/or they can all use the default username.<sup>7</sup>
- **Change Password...**
  - Change the password (this can be done at any time).

To start AlphaVision, enter **alphav** in the “search programs and files” box, then click the **AlphaVision 7.0** search result; or open the Windows Start menu and click **AlphaVision 7.0, AlphaVision 7.0**. The login dialog will open (Figure 22).

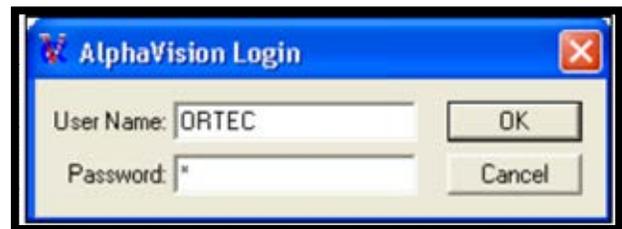


Figure 22. Log In

**NOTE** The factory default **User Name** and **Password** are as follows. *AlphaVision usernames and passwords are case sensitive.*

- Username      ORTEC      [all uppercase]
- Password      o      [lowercase letter o, not zero]

This user is assigned the Administrator security level so immediate access to all AlphaVision 7 commands and operations is provided.

### 5.1 USERS...

To add a new user to the system:

<sup>6</sup> A password must be assigned; however, if desired, the factory default password (lowercase letter o) can be used.

<sup>7</sup> Another alternative is to have all technicians log in under the username *Technician*, all administrators with username *Administrator*, and so on.

- 1) Click **Edit/Security** to open the main Users dialog.
- 2) Click **Add** to open the User dialog.
- 3) Enter a **Username** and **Password** and confirm the password. Both fields are case sensitive. Username is displayed on subsequent reports and QA control charts.
- 4) Select a **Security Level** from the drop list.
- 5) Click **Close**.

Once a new user has been granted initial access, if their security level allows password changes, they can change their password at any time. If a user loses their password, an Administrator can edit the user's account and assign a new password.

Usernames can also be deleted.

## 5.2 SECURITY LEVELS...

Use this command to define user classes with customized levels of access to AlphaVision operations and commands.

- The default security level is Administrator, which grants full access to AlphaVision. If all members of the laboratory have full access, Administrator is the only security level needed.
- Security levels can be modified or deleted at any time.
- Any or all of the following access privileges may be granted with the click of a mouse. Note, however, that only Administrator-level users can access the database management tools, including the ability to select a different working database. For all other users, the database commands are disabled.

Table 3. Access Privileges

Access Privileges	
Add Detectors	Calibrate Detectors
Clear Event Log	Configure Detectors
Edit Batch Tree	Edit Chamber Properties
Edit Client Info	Edit Detector Properties
Edit Master Nuclide List	Edit Nuclide Libraries
Edit QA Limits	Edit QA Types
Edit ROIs	Edit Sample Properties
Edit Security Levels (Admin Only)	Edit Standards (Calibration Source and Control Solution Libraries)
Edit (Chamber Pressure and Leakage Current) Thresholds	Edit Tracers
Edit Users (Admin Only)	Move Detectors (on Detector Grid)
Remove Detectors	Save Batch Template
View Event Log	

Some of these capabilities are embedded in the process Wizard dialogs; some are part of the QA/QC module's setup capabilities (e.g., Edit QA Limits); and others are menu commands (e.g., Edit Master Nuclide List).

### 5.2.1 Adding, Editing, and Removing Security Levels

- 1) Click **Add** to open the Security Level dialog. Enter a unique **Level Name** and, if desired, a **Description**.
- 2) Next, click each of the Actions to be granted at this security level. When finished, click **OK** to return to the main Security Levels dialog.

**NOTE** A security level can only be deleted if no users are currently assigned to it. **There is no "undo" for edits or deletions.**

### 5.2.2 Notes on MAESTRO and System Security

Note that the access privilege **Edit Chamber Properties** stops unauthorized users from opening an alpha chamber's advanced setup dialogs from within AlphaVision. However, any user can start MAESTRO and attempt to change the alpha chamber settings from there. To prevent such unplanned changes, AlphaVision does not poll the settings made in MAESTRO and will not register any chamber settings changed in that program.

MAESTRO also allows users to manipulate a detector from outside of the AlphaVision program, including starting and stopping data acquisition and clearing detector memory. Performed at the wrong time, this could interfere with AlphaVision data collection. To help prevent this, AlphaVision is designed so that when a detector is acquiring under AlphaVision's control, its contents (spectrum, count presets, count status, etc.) can be viewed read-only in

MAESTRO but the detector is locked against accidental destructive access such as stopping and clearing the memory. If someone tries a destructive access, a password dialog opens. In addition, the name of the computer holding the lock is displayed on the bottom left of the MAESTRO screen ("Detector Locked by..."). *If one absolutely must obtain full access to MAESTRO, enter the name of the locking computer as the Password.*

It is not necessary to unlock MAESTRO to stop a count or modify the count presets for an acquisition (these can be done inside AlphaVision).

**NOTE** If a count is accidentally terminated or the detector memory from MAESTRO is cleared, AlphaVision will not "know what happened," and the data and reports for the affected sample will be incomplete. To recover from this error, return to AlphaVision and recount that sample from the Batch Explorer or Calibration Explorer panel.

### 5.3 CHANGE PASSWORD...

Use this command to change the current user's password (presumably the user's own password, since the current password must be known to use this command). Once the user is logged in, the user's password can be changed at any time, regardless of granted access level.

**NOTE** These fields are case sensitive. If a user forgets their password, an Administrator can use **Edit/Users...** to assign a new one.

- 1) Click **Edit/Change Password**.
- 2) Enter the current password, then enter the new password twice.
- 3) Click **OK**. The new password will go into effect at the next Login.

## 6. CONFIGURING THE DETECTORS

### 6.1 USING INTUITIVE NAMES AND NUMBERS FOR MCBS AND ALPHA CHAMBERS

**IMPORTANT** Detector descriptions/names must begin with a letter rather than a number.

**New Users** – It is recommended to assign each MCB and/or individual alpha chamber an intuitive name and number that will help the user find the correct alpha chamber for a particular sample. It may also be useful to physically label each MCB and alpha chamber.

**Upgrading from v6 to v7** – AlphaVision now uses the CONNECTIONS detector **ID** number (instead of the MCB address) to maintain communication between each alpha chamber and the AlphaVision database.

- If upgrading AlphaVision but adding no new alpha chambers to the system, run the **Configure** program in the next section to ensure the existing detectors are recognized by AlphaVision 7.
- If also adding new alpha chambers, it is recommended to plan an intuitive numbering scheme before performing the **Configure** step.

Detectors can be renumbered later using the **Change Detector ID** feature discussed in Section 6.4.1.1.

### 6.2 CONFIGURING AND CUSTOMIZING THE MASTER MCB LIST

- 1) If a new ORTEC spectroscopy hardware has been purchased, connect it and power it on according to its accompanying hardware manual.<sup>8</sup> If using Oxford OASIS MCBs, see the installation instructions in Section 6.6.
- 2) Connect and power on all local and network MCBs in the system, as well as their associated PCs. Otherwise, they will not be detected. (Any instruments not detected can be configured at a later time.)
- 3) If setting up an OCTÊTE-series MCB for the first time and it is desired to customize the number of inputs and memory size (number of channels) for each detector input, read Appendix C before continuing to the next step.
- 4) On the Detector Grid at the bottom of the screen, right-click in any square and click **Show Master List**. This will open the Master Detector List, which will be empty for first-time AlphaVision installments (Figure 23).

<sup>8</sup> The first time a particular MCB model is connected, a “found new hardware” wizard will start up. Choose *not* to “search the internet for a driver” option, then choose to automatically search for the driver.

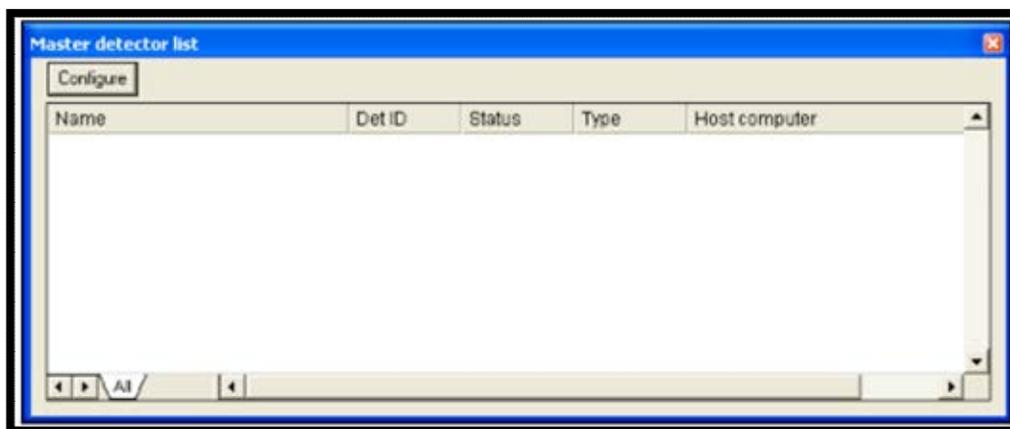


Figure 23. Master Detector List, Unpopulated

- 5) To start the detector search, click the **Configure** button. The MCB Configuration program will locate all of the powered-on ORTEC MCBs and OASIS units on the local PC and the network and display the list of instruments found (see the example in Figure 24). It is suggested to enter customized instrument descriptions as described in Section 6.2.
- 6) The first time a new instrument is detected, the dialog shown in Figure 25 will remind the user that all new instruments must be assigned a unique, *non-zero* ID number.<sup>9</sup> Click OK. The user can either manually change the ID Number and Description as described in the next subsection or can click the **Renumber New** button to renumber only the new instruments.

**NOTE** Unless AlphaVision is being installed in the counting lab for the first time, it is recommended **not** using the **Renumber All** button. In addition, it is strongly recommended not renumbering detectors that “belong” to other users, as this could affect the interaction between their detectors and their ORTEC software, for instance, if they control their detectors with .JOB files.

- 7) If desired, the instrument ID Numbers and Descriptions can be changed by double-clicking an entry in the Configure Instruments dialog. This will open the Change Description or ID dialog (Figure 24). It shows the host PC’s system information (read-only), and lets the user change the **ID Number** and **Description**. As noted earlier, it is recommended to use a naming and numbering system that will help users find the correct alpha chamber for a particular sample.

<sup>9</sup> If this is a first-time installation of ORTEC products, all instruments will be “new.”

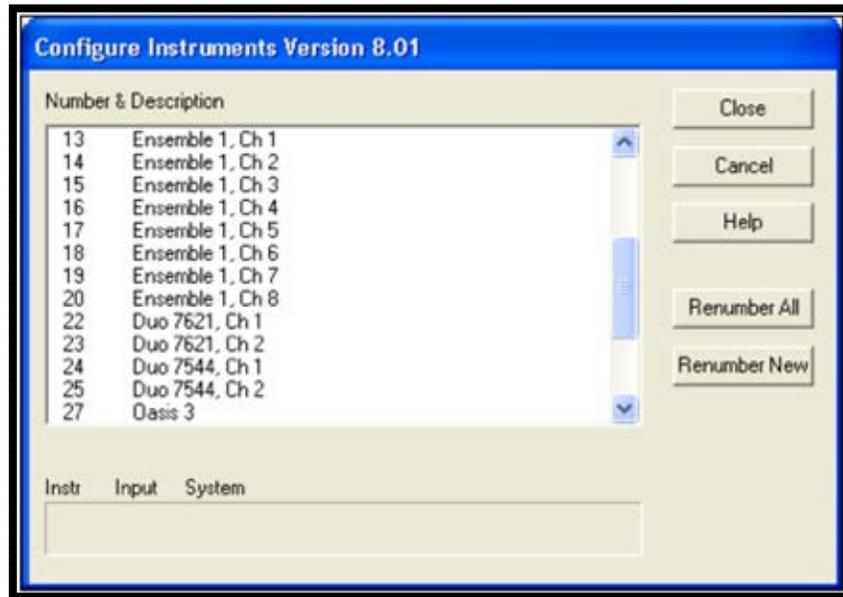


Figure 24. Detector Numbering and Descriptions



Figure 25. New Instruments Must Have a Non-Zero ID Number

Make the desired changes and click **Close**. Any changes made to an ID number or description will then be written back to the corresponding detector. The Master Detector List in AlphaVision will populate and will appear similar to Figure 27 (for a first-time installation where no detectors are yet assigned to the grid).

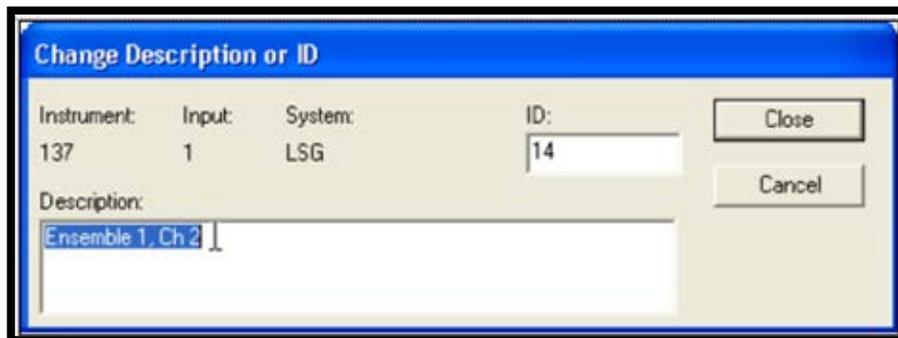


Figure 26. Change Detector Number or Description

Name	Det ID	Status	Type	Host computer
Ensemble 1, Ch 1	13	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 2	14	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 3	15	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 4	16	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 5	17	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 6	18	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 7	19	Available	ADUC-002	RANDT9200
Ensemble 1, Ch 8	20	Available	ADUC-002	RANDT9200

Figure 27. The Master Detector List After Configuration

### 6.3 SETTING PEAK POSITIONS IN THE DETECTORS

This procedure requires an appropriate alpha standard.

- 1) Determine the kev/channel based on the instrument's ADC Conversion Gain as follows:

$$\text{kev/ch} = 10,000 \text{ kev} / \text{ADC Conversion Gain}$$

Examples:

ADC Conversion Gain	Kev/channel
512	19.531
1024	9.766
2048	4.883
4096	2.441

- 2) Set the energy range of interest using one of the following options:
  - a. Set the lower and upper energy on the Hardware Panel (Section 2.1.4), OR
  - b. Calculate the Digital offset and the Display Channels and enter these values on the Alpha tab in the MCB Properties using the kev/ch from the previous step as follows:

$$\text{Digital Offset (channels)} = \text{ADCConversionGain} / (\text{kev/ch})$$

$$\text{Display Channels} = (\text{Upper Energy} - \text{Lower Offset Energy}) / (\text{kev/ch})$$

Examples:

ADC Conv Gain	Kev/ch	Lower Offset Energy	Upper Energy	Digital Offset	Display Channels
512	19.531	3000	8000	153	256
1024	9.766	2000	9000	204	717
2048	4.883	2000	9000	409	1434
4096	2.441	3000	8000	1228	2048

- 3) Determine the target channel for the primary alpha emission energies of the calibration standard as follows:

$$\text{Target Channel} = (\text{Primary Emission Energy} - \text{Lower Offset Energy}) / (\text{kev/ch})$$

Examples:

ADC Conv Gain	Kev/ch	Lower Offset Energy	Nuclide	Target Energy	Target Channel
1024	9.766	2000	U-238	4199	225
2048	4.883	2000	Pu-238	5499	717
4096	2.441	3000	Am-241	5486	1428

- 4) Ensure that the bias voltage is set and enabled using the Hardware Panel (Section 2.1.4), MCB Properties, or at the instrument depending on the hardware in use.
- 5) With the alpha source in the place, acquire spectra and adjust the gain as necessary to position the peak in the target channel. Spectrum acquisition can be accomplished using Maestro or by running a sample batch in AlphaVision. If using Maestro, refer to the Maestro user manual for spectrum acquisition functions.

## 6.4 POPULATING THE DETECTOR GRID

The Detector Grid at the bottom of the screen shows the alpha detectors currently assigned to this AlphaVision spectroscopy system. It looks and functions the same in all modules.

- From the grid the user can add, remove, and organize MCBs and their individual alpha chambers (detectors), pause or stop data acquisition, clear detector memory, and adjust grid and system properties.
- The grid can display up to (100 × 100) 10,000 detectors, each represented by a detector icon that changes to reflect the alpha chamber's operational status. Pausing the mouse over a detector icon opens a hover box that shows the alpha chamber and detector names, real and live times, when the detector is counting, and the batch and sample names.
- The grid has row/column headers to help quickly locate a particular instrument. Grid cell size can be adjusted for easy overall viewing, and the "heads-up" detector icons shows the status of every detector at a glance.
- Reposition the detector icons anywhere on the grid (except detectors that are acquiring) by just clicking and dragging them. Use this feature to simplify sample loading - group the detector icons according to the number and arrangement of alpha chambers in each MCB in the lab.
- After the Configure process, if it is determined one or more detectors on the Master Detector List do not have useful/intuitive detector ID numbers (for instance, one or more MCBs have been moved), the ID numbers in the Detector Properties dialog can be changed, as described in the next section (see the text accompanying Figure 30, page 45).

### 6.4.1 Adding Detectors to the Detector Grid

- 1) Right-click any empty cell on the grid and select **Show Master List...** from the menu to reopen the Master Detector List (Figure 27).

- 2) Locate the desired **Available** detector (detectors marked **In Use** cannot be assigned) and drag it to the desired cell.
- 3) This will open the Properties dialog for the selected detector (Figure 28). Enter the identifying information for the detector and alpha chamber according to their respective data sheets and click **Update**. The dialog will close, and a detector icon will appear in the grid cell. (See the discussion of detector icons in the next section.)
- 4) Repeat until all detectors are displayed on the grid (Figure 29), click and drag icons as needed to arrange them in an intuitive layout, then close the Master Detector List by clicking its upper-left **X** box.
- 5) Before putting a new detector in service, it is recommended that the user sets up its QA warning and error limits<sup>10</sup> so collection of QA data will begin immediately (Section 10.3); then perform an initial calibration (Section 7.1).

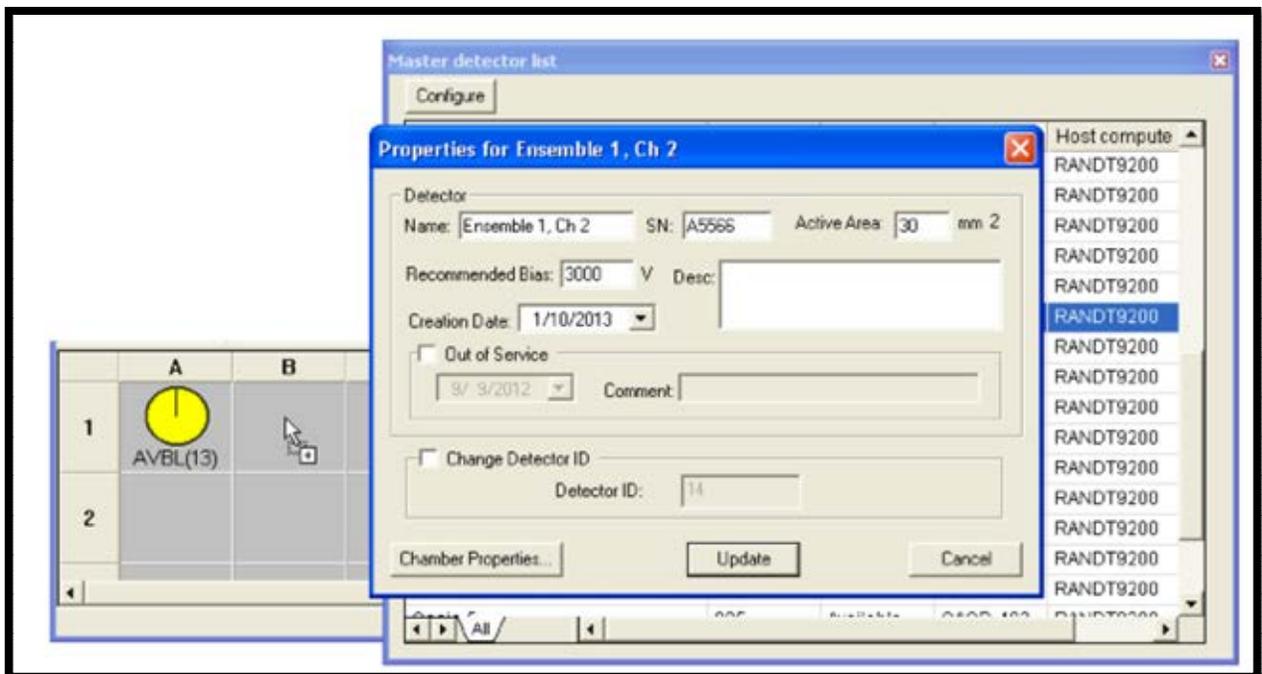


Figure 28. Assigning Detectors to the Grid

<sup>10</sup> These limits can be developed in MAESTRO, in which case the various test acquisitions will not be recorded in the AlphaVision database. Alternatively, the user can perform at least five test acquisitions for a specific QA parameter within AlphaVision, then use the **Calculate Limits** feature to suggest the limits; see Section 10.3.1.

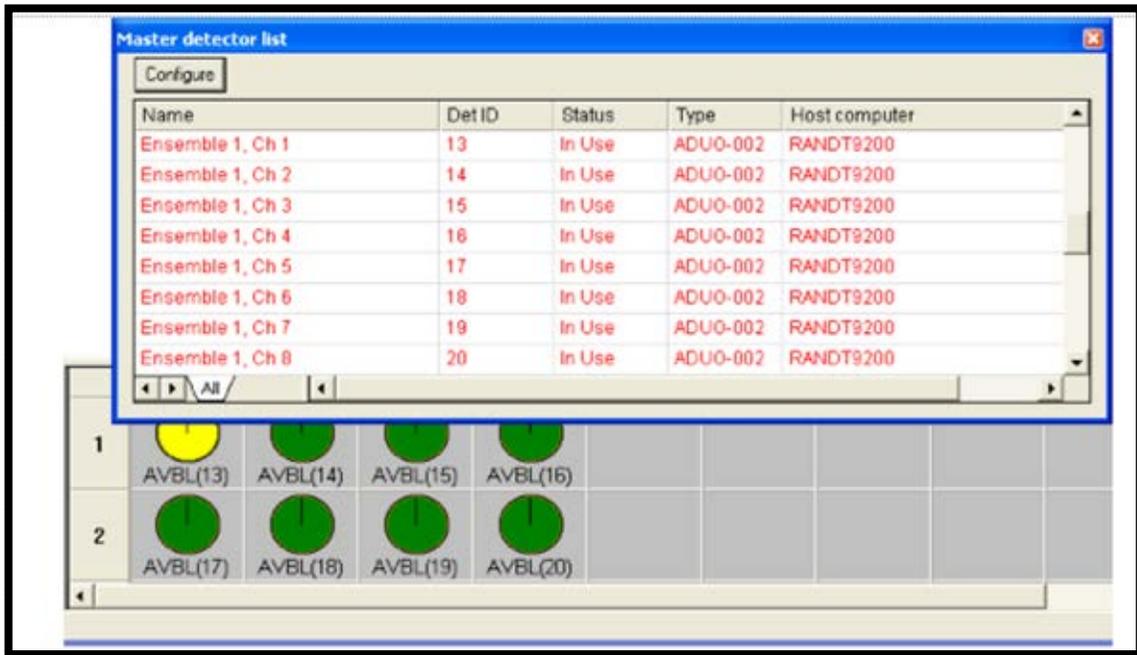


Figure 29. Detector Grid Showing Ensemble Detectors Assigned and Logically Arranged

#### 6.4.1.1 Change Detector ID

If an alpha chamber is found to not be numbered as desired (for instance, suppose an OCTÈTE's chambers were not numbered consecutively, from top left to bottom right, during the **Configure** step), its Detector Properties dialog can be reopened, and the **Detector ID** number changed as follows:

- 1) Right-click the desired detector and select **Detector Properties...** from the menu.
- 2) Mark the **Change Detector ID** checkbox, enter a unique **Detector ID**, and click **Update** (Figure 30).
- 3) AlphaVision will display a message containing the steps for successfully updating to the new **Detector ID**:

- Notice the detector Name listed in the Properties dialog, and the new Detector ID that has been entered.
- Click **Yes** to close the message box and start the configuration routine.
- Click **Yes** to search only for local detectors (those connected directly to the PC) or **No** to search for both local and networked detectors.

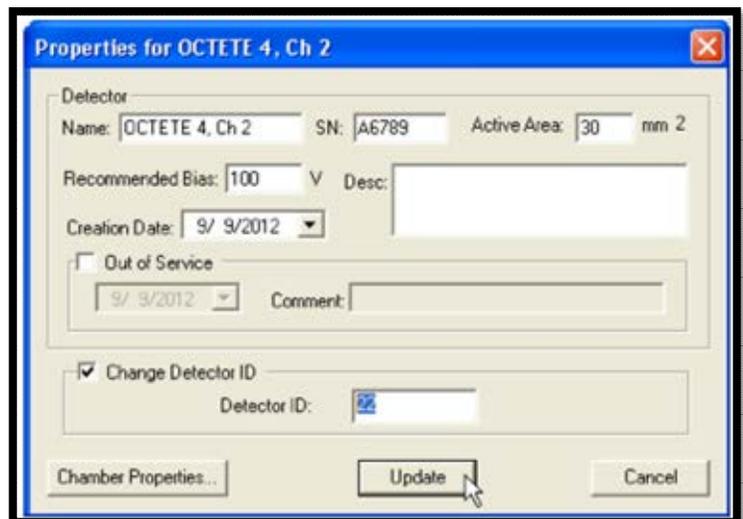


Figure 30. Change the Detector ID Number

- When the Configure Instruments dialog is displayed (see Figure 24, page 41), locate the Detector Name in the **Number & Description** section of the screen, double-click the entry to open its Change Description or ID dialog (Figure 26, page 41), and change the **ID** number to the new **Detector ID** specified in step (2) above.
- Click **Close** to exit the Configure Instruments dialog, then close the detector Properties dialog by clicking its upper-right **X** box. The detector number for the corresponding detector icon will update to the new number.

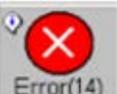
## 6.4.2 The Detector Grid’s “Heads Up” User Interface

### 6.4.2.1 Detector Status Icons, Hover Boxes, and Grid Menus

The detector status icons (below) show the status of all system detectors at a glance. Each icon’s label displays the detector **ID** number, and icons can be grouped to reflect the MCB they are housed in and the arrangement of MCBs in the lab.

Following are the detector icon states:

Table 4. Detector Icon States

Detector Status Icon		Description
	<b>Please Wait</b>	This icon is displayed when AlphaVision is querying for detector status.
	<b>Available</b>	An Available detector is idle (not counting) and the MCB memory has been cleared. The icon is yellow and labeled <b>AVBL</b> .
	<b>Unload</b>	A detector in the <b>Unload</b> state has completed data collection and has spectral data stored in the memory. Once the detector memory is cleared, this detector will be ready for the next data acquisition. The Unload icon is green and is labeled with the sample name until the user <b>Clears</b> it.
	<b>Acquiring</b>	When a detector is acquiring data, the label changes from AVBL to the sample name; and the “clock hand” tracks the acquisition live time, sweeping a clockwise, yellow-to-green arc as the count time elapses. Green represents the time elapsed, and yellow represents the time remaining.
	<b>Pause</b>	One can <b>Pause</b> a detector manually from the Detector menu, or it can be set to pause automatically if the chamber pressure or leakage current exceeds the limits specified on the Acquisition Properties screen in the Calibration or Batch Wizard. The hover box will list the reason for the pause. If the count is manually paused, it resumes when the user selects <b>Continue</b> from the Detector menu. If the count pauses due to a hardware problem, it resumes automatically when the chamber pressure or leakage current drops below the user-defined limits.
	<b>Abort</b>	The <b>Abort</b> icon is displayed when a data acquisition is aborted until the detector is cleared.
	<b>Locked</b>	Once a detector has been assigned to a sample, until that data acquisition is complete, the detector is locked on all but the originating PC. The detector’s status can be monitored from another workstation (and can be assigned to a sample to be counted later) but users cannot interrupt data acquisition or clear the detector memory. If the user tries to access a locked detector, its icon changes to the <b>Locked</b> icon for approximately 3 seconds, then changes back to its previous appearance. The hover box will show the PC that holds the lock.
	<b>Error/Out of Service</b>	Detectors in this state can’t be used until the error condition is corrected. As noted above, the hover box will list the cause of the error or show that the detector has been marked out of service. If the error is not caused by a hardware problem, it may be cleared by issuing the <b>Clear</b> command from the Detector menu. For more information on an out-of-service detector, right-click it and select <b>Detector Properties...</b> from the Detector menu (check the <b>Comment</b> field for remarks).

Each icon also has a *hover box* that displays information including the detector **Name** and **ID** number; live-time and real-time presets; current live and real times; the batch name, during acquisition; and, for locked detectors, the name of the PC that holds the lock. To display the hover box, hold the mouse pointer over the icon for 1–2 seconds. Figure 31 compares this feature for an idle detector vs. one acquiring data.

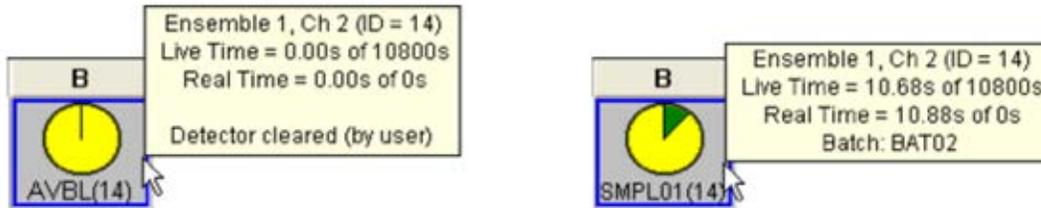


Figure 31. Detector Hover Box - Idle vs Acquiring Data

Detectors in the Error state are marked with an information icon ⓘ. The hover box identifies the detector **Name** and **ID** and the error code or reason (Figure 32).

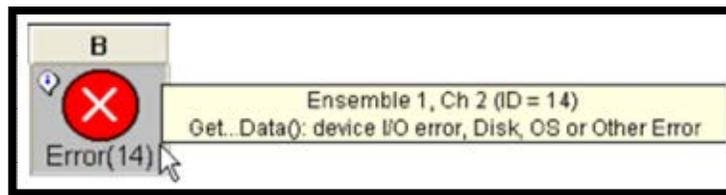


Figure 32. Detector Hover Box - Detector Error

#### 6.4.2.2 Detector Grid Menu

This menu (Figure 33) opens when the user clicks an empty grid square. Its commands allow the user to assign detectors and adjust the grid's appearance and are discussed in the following section.



Figure 33. Detector Grid Menu

#### 6.4.2.3 Detector Menu

This menu opens when the user clicks on a detector icon. Its commands enable the user to control a detector before, during, and after acquisition; change its properties and settings; and remove it from the grid. Figure 34 compares the menu for an idle detector vs. one acquiring data.

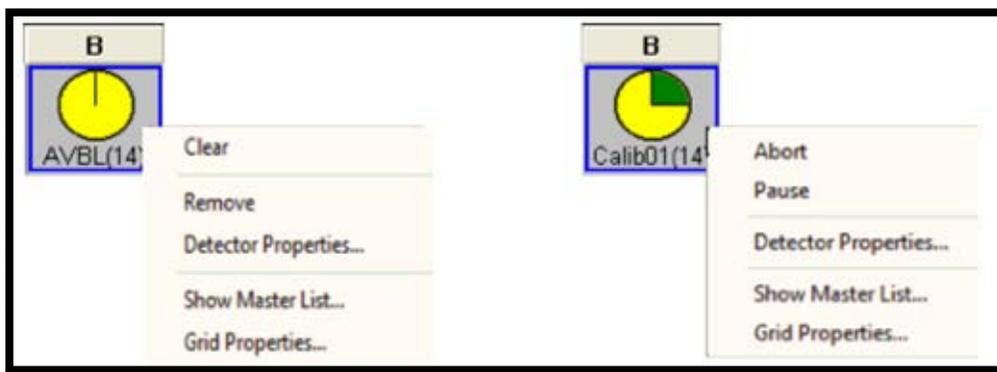


Figure 34. Detector Properties Menu – Idle vs Acquiring Data

Table 5. Detector Menu Commands

Menu Command	Description
Clear	When the detector is not acquiring, the first command on the menu is <b>Clear</b> . It erases an unlocked detector's spectrum data, real time, and live time. The detector icon turns yellow and is labeled available <b>AVBL</b> .
Abort/Stop	<p>During acquisition, the first menu command is <b>Abort</b> (labeled <b>Stop</b> for a paused detector). Clicking it opens a message box listing 3 options:</p> <ul style="list-style-type: none"> <li>— <b>Yes</b> terminates data acquisition and begins analysis and reporting according to the settings entered in the Batch Wizard.</li> <li>— <b>No</b> aborts acquisition; discards the data; and, for calibration and background measurements, reverts to the preceding calibration or background spectrum.</li> <li>— <b>Cancel</b> closes the message box and resumes the current acquisition, analysis, and reporting.</li> </ul>
Pause/Continue	Clicking on <b>Pause</b> temporarily suspends data acquisition without clearing the detector memory. (Counting also pauses if the chamber pressure or leakage current exceeds the limits specified on the Acquisition Properties screen in the Calibration or Batch Wizard). To resume counting using the same analysis parameters, click <b>Continue</b> .
Remove	This command removes the selected detector from the grid. As long as the MCB that houses this detector is on the Master Detector the detector can be added back to the grid at any time. <i>Note that removing a detector does not remove its QA or sample records from the database. These records continue to be available.</i>
Detector Properties...	This dialog allows the user to define or view the identifying information for a particular detector, make detailed adjustments to the alpha chamber settings, and change the detector's <b>ID</b> number on the Master Detector List (Figure 30).
Show Master List...	This opens the Master Detector List of detectors (alpha chambers) connected to this PC either directly or via the network.
Grid Properties...	This opens a dialog that controls the appearance and function of the grid, and the number of grid rows and columns to a maximum of 100 × 100.

## 6.5 SERVICING DETECTORS AND ADDING MCBS

### 6.5.1 Taking a Detector Out of Service

Should a detector require cleaning or replacement, or if for any other reason an alpha chamber must be taken out of service, simply open the **Detector Properties...** dialog, mark the **Out of Service** checkbox, select the **Date**, and enter an optional **Comment**. An event will be entered on the Event List, and no samples can be assigned to the detector until it is returned to service.

### 6.5.2 Replacing a Detector

When a detector requires replacement, the typical procedure for putting the new detector in service is:

- 1) Open the **Detector Properties...** dialog, mark the chamber **Out of Service**, and optionally comment that detector [serial number] is being replaced. AlphaVision does not auto-assign out-of-service detectors to samples.
- 2) Follow the detector's and MCB's instructions for detector replacement.
- 3) Return to **Detector Properties...**, enter the new detector's serial number, diameter, voltage, etc., and enter any relevant comments.
- 4) Perform an initial (manual) energy and efficiency calibration.
- 5) Establish the QA/QC warning and error limits for the new detector.

### 6.5.3 Adding New MCBs to the AlphaVision System

Expanding an AlphaVision system is easy. New ORTEC MCBs are accompanied by a CONNECTIONS Driver Update Kit *that must be installed to ensure the new unit communicates properly with the PC and AlphaVision*. After installation, return here and repeat the instructions in Sections 6.1 through 6.4.1 to add the new alpha chamber(s) to the system.

**NOTE** The 64-bit Windows 10 does not support the OASIS.

#### Installing OASIS Spectrometers

- 1) Install CONNECTIONS according to Section 4.2, being sure to mark the **OASIS** checkbox on the Instrument Families dialog, otherwise AlphaVision and the OASIS will not be able to communicate.
- 2) From the National Instruments website, download and install the free GPIB driver ni4882\_302.exe, using the installation defaults.
- 3) Connect the OASIS to the PC via a National Instruments GPIB-USB-B controller.
  - If multiple OASIS units are being used in a daisy chain or star configuration, attach any GPIB cables that connect to the other instruments first, piggyback the GPIB-

USB-B as the last connector in the stack, and connect the GPIB-USB-B to the PC with a USB cable.

- If using only one OASIS, it can be attached the GPIB-USB-B directly to the spectrometer, then connect it to the PC with a USB cable.
- 4) From the Windows Start menu, run the GPIB Controller's Getting Started Wizard and ensure all OASIS instruments are displayed.
  - 5) Configure the OASIS as described beginning in Section 6.2.

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## 7. CALIBRATING THE DETECTORS



Figure 35.  
Calibration  
Icon

The Calibration Wizard speeds the process of calibrating detectors; managing calibrations for different detector and sample geometries; and viewing the results onscreen, in Calibration reports, and in QC charts.

Energy calibrations are performed in either **Manual** or **Automatic** mode. The user must manually calibrate an uncalibrated detector, as well as calibrated detectors for which the conversion gain, offset, or detector/chamber geometry has changed. Once a detector has been manually calibrated, it can be recalibrated in **Automatic** mode.

Calibrations start from the Calibration Explorer Panel (Figure 36), the portal to all the detector-specific calibrations in the current database. See Section 2.1.1 for a thorough description of the Calibration Explorer Panel features.

Before starting, create a Calibration Source Record for the calibration source according to the instructions Section 8.3.

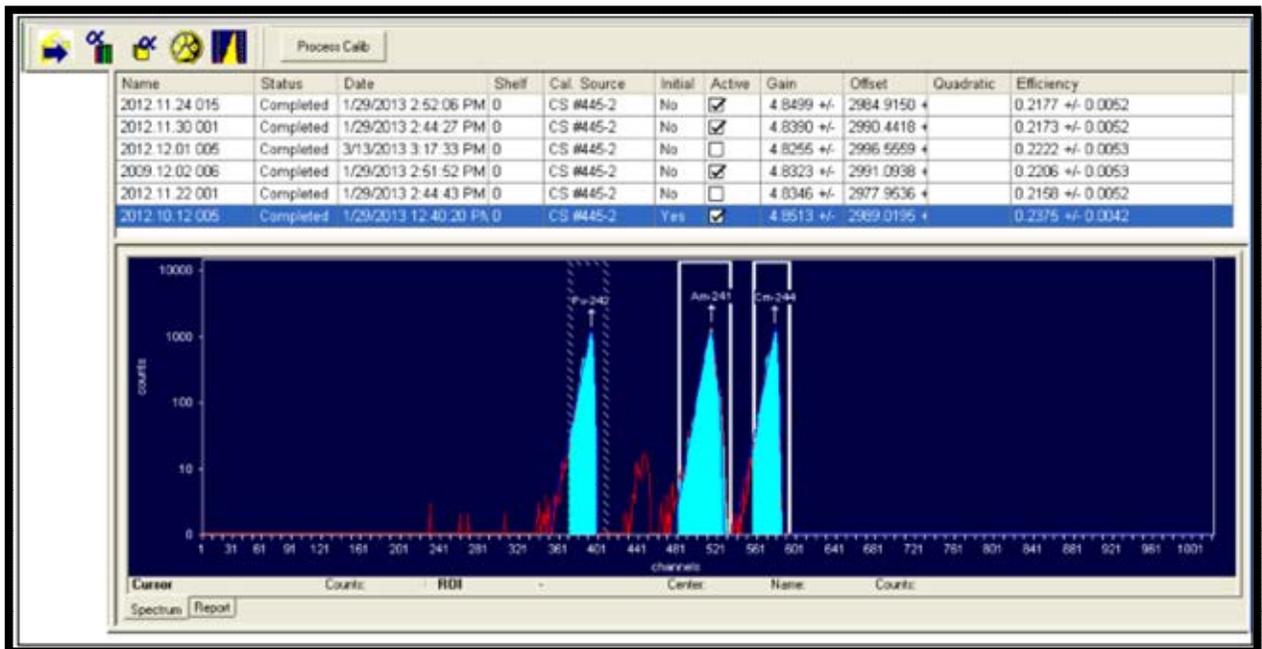


Figure 36. Calibration Explorer Panel

### 7.1 USING THE CALIBRATION WIZARD

Place the calibration source in the alpha chamber in the same geometry as the samples will be counted.<sup>11</sup>

<sup>11</sup> As noted elsewhere, be sure all analysts agree on a consistent **Shelf** numbering/positioning scheme for the alpha chambers so this information can be accurately captured in the templates.

Using the Hardware mode interface, enable the detector high voltage, evacuate the chamber to the appropriate pressure, and start up the Calibration Wizard. Then, in the Detector Grid, click the detector to be calibrated, then the **Process Calib** Toolbar button.

### 7.1.1 Screen 1 - General

To begin calibration, select **Process/Calibration** from the menu bar. This opens the first screen of the AlphaVision Calibration Wizard, General (Figure 37). Use it to name the calibration and, if desired, create a template to use for future calibrations.

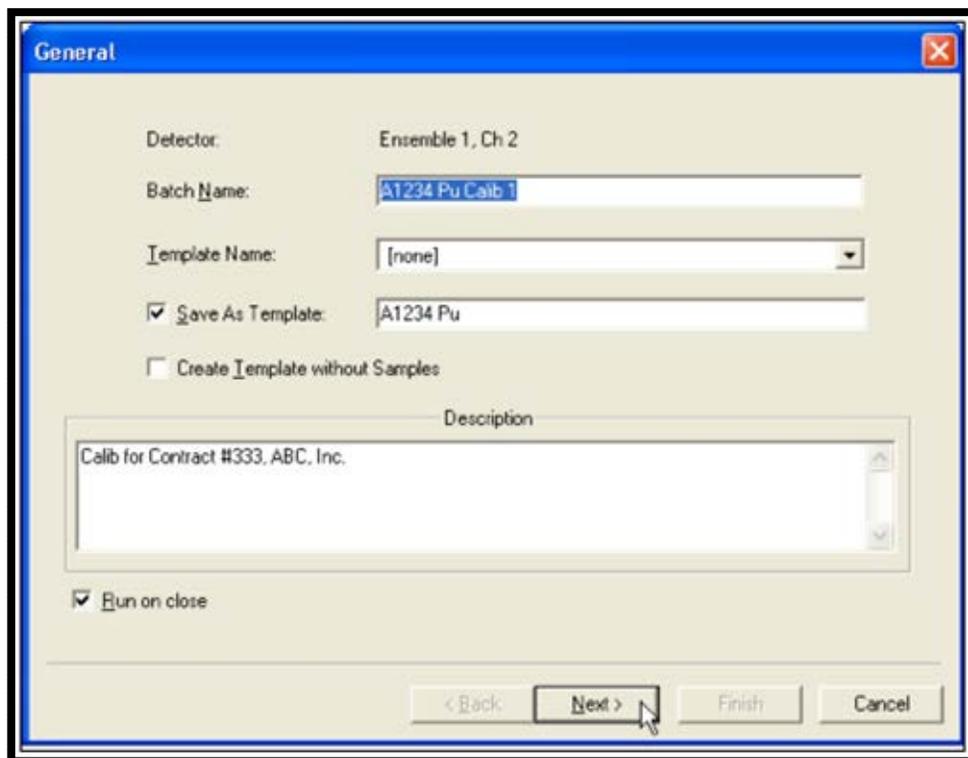


Figure 37. The General Page

#### **Batch Name and Description**

Type a descriptive **Name** for the calibration. The user may choose also to type a **Description**. This description is stored in the database for use in reports and assists other users in understanding the intended use of this template, shelf setting, etc.

#### **Template Name and Save As Template**

To reuse this set of data acquisition and analysis parameters as a *template*, mark the **Save** box and enter a descriptive **Template** name.

To use an existing batch setup template, select it from this list. The remainder of the wizard will be populated with the settings from the template record. Adjust the settings on each page as needed, finish the wizard, assign detectors to the samples, and begin counting.

#### **Create Template without Samples**

This option lets users create all wizard settings without defining any samples. This makes it easy to set up one or more templates before calibration is performed.

### **Run on close**

By default, when the user sets up the wizard and clicks **Finish**, data acquisition will start immediately. If this checkbox is unmarked, the record for this calibration will be posted to the Calibration Explorer Panel marked as **New**. At any time, the user can right-click the calibration and select **Start** to begin the calibration measurement.

## **7.1.2 Screen 2 - Acquisition**

### **Presets**

On the Acquisition page (Figure 38), decide whether to count to a Live Time or Real Time preset, or both; and enter the time. *The count time cannot be changed after acquisition starts.*

**NOTE** If MAESTRO is installed, presets entered in MAESTRO can affect counting time in AlphaVision. If an AlphaVision calibration terminates before the count time entered here, open MAESTRO, clear all presets, then exit MAESTRO and recount the calibration.

### **Thresholds**

The user can elect to use the pressure and leakage current **Thresholds**. If the **Thresholds** checkbox is marked and maximum vacuum (**Max Vacuum**), minimum bias (**Min Bias**), and maximum leakage current (**Max Leakage I**) values are entered, AlphaVision will suspend counting if one or both of the thresholds are exceeded. When these parameters fall below the threshold, counting will automatically resume.

**Max Vacuum** can be set at 30 Torr so the count will pause if a chamber is not being pumped. A **Min Bias** setting of 45 V will ensure a detector bias of 50 V is maintained (note, however, there is some variability in detector bias). The user can choose a value such as 1000 nA as the maximum leakage current that signifies detector “failure.” Alternatively, it may be desired to test the leakage current for the detectors, take the average, then use twice that value as the **Max Leakage I** threshold.



Figure 38. The Acquisition Page

### 7.1.3 Screen 3 - Energy/Efficiency Calibration Setup

On this page (Figure 39), users will set up the analysis method for calibration.

#### **Standard Calibration Source**

First, choose a **Standard Source** to use for calibration. Click **Select** to open the Standard Calibration Source dialog (Figure 39), choose a calibration source, and click **OK**.

#### **Energy / Efficiency / Both**

Decide whether to perform an Energy Only calibration, an Efficiency Only calibration, or Both. However, note that the efficiency calibration cannot be performed independently unless the detector already has a valid energy calibration. Once the detector has a valid energy calibration, just 1 peak can be used to perform the efficiency calibration.

**NOTE** A detector must be energy calibrated before it can be used to count samples with AlphaVision. If all analyses are tracer based, the efficiency calibration is not necessary to obtain an analysis result. However, without an efficiency calibration, the chemical recovery cannot be calculated.

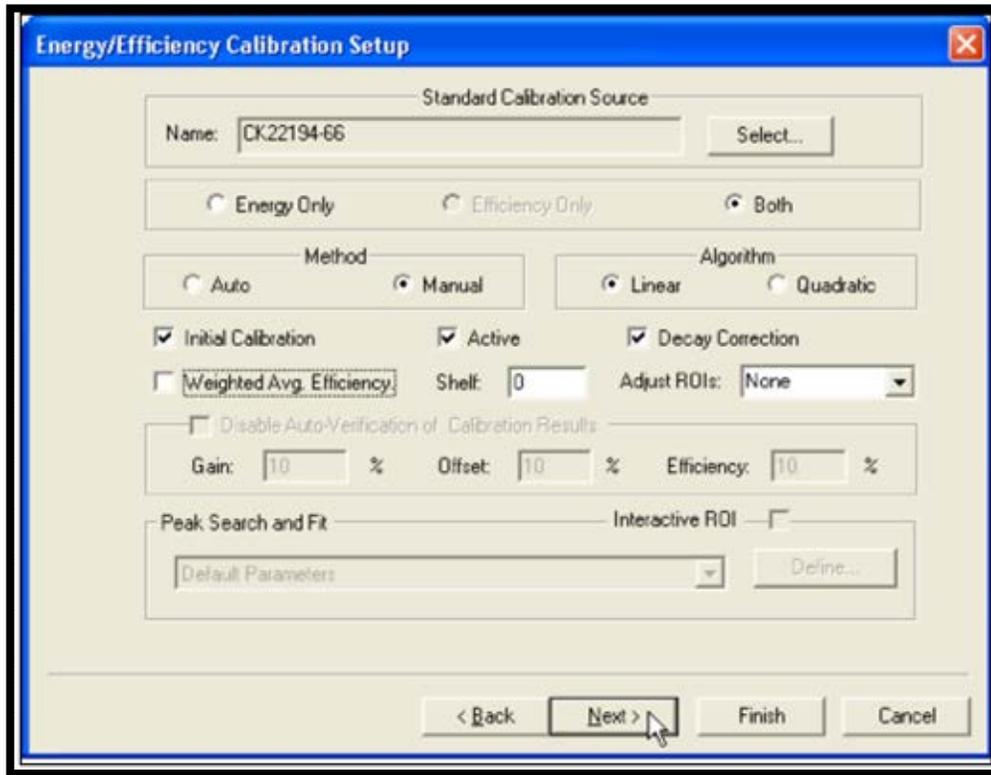


Figure 39. The Energy/Efficiency Calibration Setup Page

### Auto vs. Manual Calibration Method

- Manual** – This calibration is performed to signify the beginning of a QA/QC observation period. It indicates some change in the alpha chamber geometry and/or detector. This includes (but is not limited to) installation of a new detector, detector cleaning, change to the conversion gain or offset, or change in source geometry or shelf height.

The **Manual** method disables the **Peak Search and Fit** section of the screen and requires the user to specify the peak centroid for each nuclide in the calibration source. AlphaVision then uses this manual calibration to locate peaks for subsequent **Auto**-mode recalibrations. It also activates the **Adjust ROIs** option, which can reposition all ROIs based on the centroid of the **Best Peak** in the spectrum or reposition each ROI based on the centroid of **Each Peak**.

- Auto** – For automatic recalibrations, the starting calibration parameters used in the calculation are taken from the existing calibration, rather than from the calibration

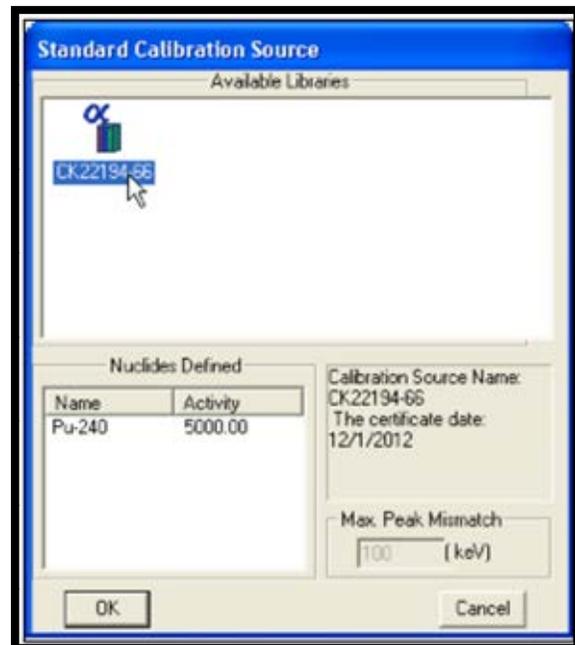


Figure 40. Choose a Standard

source library. The final energy parameters are derived from the actual peak centroids. The **Auto** method uses the **Peak Search and Fit** parameters to integrate the peaks from the calibration source.

### **Initial Calibration**

Each time a new detector is installed in an alpha chamber, it is very important to perform an initial, manual calibration for the new instrument. This calibration becomes the starting point for the new detector's QA records, and is noted in the QA Control Charts and marked on the Calibration Explorer. It also becomes the calibration against which future calibrations for this detector will be compared until another **Initial Calibration** is performed.

Marking this option disables the calibration **Auto-Verification** tool (which requires a pre-existing calibration).

### **Disable Auto-Verification of Calibration Result (%)**

This function is only available for auto-calibrations, i.e., recalibrations. When unmarked, AlphaVision verifies the results of a recalibration, based on the amount of variation the user decides is acceptable for **Gain**, **Offset**, and **Efficiency**. The default values in these fields are derived from the current calibration or, if desired, the user can enter their own values. If the new calibration is within these limits, the software verifies it as "good" and marks it as **Completed** in the Calibration Explorer Panel.

When the **Auto-Verification** box is marked, the user must inspect the calibration report, evaluate the results, and decide whether to use this as an active calibration.

### **Linear vs. Quadratic Algorithm**

Choose the fit type for the energy calibration.

### **Decay Correction**

Mark this box to correct for nuclide decay in the calibration standard, based on the calibration standard's certification date and time and using the half-life values in the calibration source library. See Section B.7.3.24.

### **Shelf**

Use this field to distinguish calibration by shelf position in the alpha chamber.

<p><b>NOTE</b> Make sure all analysts agree on a consistent <b>Shelf</b> numbering/positioning scheme for the alpha chambers.</p>
-----------------------------------------------------------------------------------------------------------------------------------

The **Shelf** column in the Calibration Explorer will display the number entered here so the user can easily tell which calibration to use for different shelf positions. This means multiple calibrations are possible for a single detector.

### **Active**

When this box is marked, a calibration that is successfully **Completed** becomes the active calibration for this detector, superseding the previous active calibration; and is used for detector QA purposes as long as it is active. It is also added to the list of valid calibration records available on Screen 4 (Analysis Setup) of the Batch Wizard.

**NOTE** Unmarking this box lets the user run test calibrations of new sources (geometries or activities) without affecting QA data or saving the test calibrations.

### **Weighted Avg. Efficiency**

This option lets users choose between using a simple or a weighted average in the efficiency calculation. The simple average method sums the calculated efficiency values of the included peaks and divides by that number of peaks. The weighted average method weights the individual efficiencies by their relative net counts. Peaks with higher net counts are given more weight in the final calculation. Calibration calculations are discussed in Section B.8.

### **Peak Search and Fit**

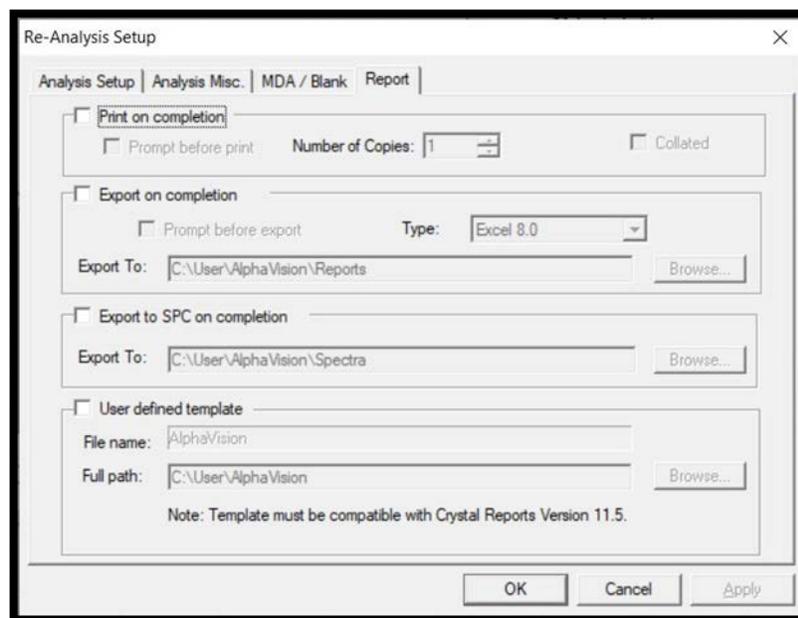
AlphaVision uses a default set of peak search and fit parameters. To customize these parameters, click Setup to open the Peak Search/Fit Setup dialog and see the instructions in Section 7.4.

### **Interactive ROI**

This checkbox is marked only when an existing calibration is reanalyzed with the Interactive ROI Analysis feature discussed in Section 7.3. This will only ever be shown as checked in Batch mode when the Properties context menu is selected.

## **7.1.4 Screen 4 - Report**

Use the features on the Report page (Figure 41) to print the analysis results, export them to other file formats, export the spectrum to an ORTEC .SPC spectrum file, and/or generate Crystal Reports v11.5 report templates. (Users can also do this from the Report Window.)



**Figure 41. The Report Tab**

Click **Finish** to finalize this calibration record and close the wizard. If the **Run on close** box was marked on Screen 1, data acquisition will start immediately. If **Run on close** was unmarked, the record for this calibration will be posted to the Calibration Explorer Panel

marked as **New**. At any time, the user can right-click the calibration and select **Start** to begin the calibration measurement.

## 7.2 PERFORMING THE CALIBRATION

When counting starts, the Status changes to **Acquiring**. The live spectrum is displayed in the Spectrum Window.

At the end of data acquisition, the new calibration is analyzed. If AlphaVision accepts the results (automatically or manually), the **Status** changes to **Completed**. If the results are not accepted, the calibration's status changes to **Failed**.

**NOTE** If a calibration analysis fails, check the Event Window for messages pertaining to the failure. After correcting the problem that caused the failure, users can **Update** it by right-clicking it in the Calibration Explorer Panel.

The **Update** option also allows users to correct other types of calibration setup errors without having to re-run the calibration. Suppose a new calibration is performed, the data is good, but it is discovered that the wrong peak-search-and-fit record or calibration source library was entered. **Update** opens a dialog based on the Energy/Efficiency Calibration Setup wizard screen. Correct the setup parameters as necessary, then click **OK**. AlphaVision will recompute the calibration using the modified parameters and overwrite the existing calibration record with the new, correct data.

### 7.2.1 Completing a Manual Calibration

If this is a manual calibration, when it completes the Manual Energy and Efficiency Calibration dialog will open (Figure 42). In it, users will use the calibration source data to calibrate their detectors.

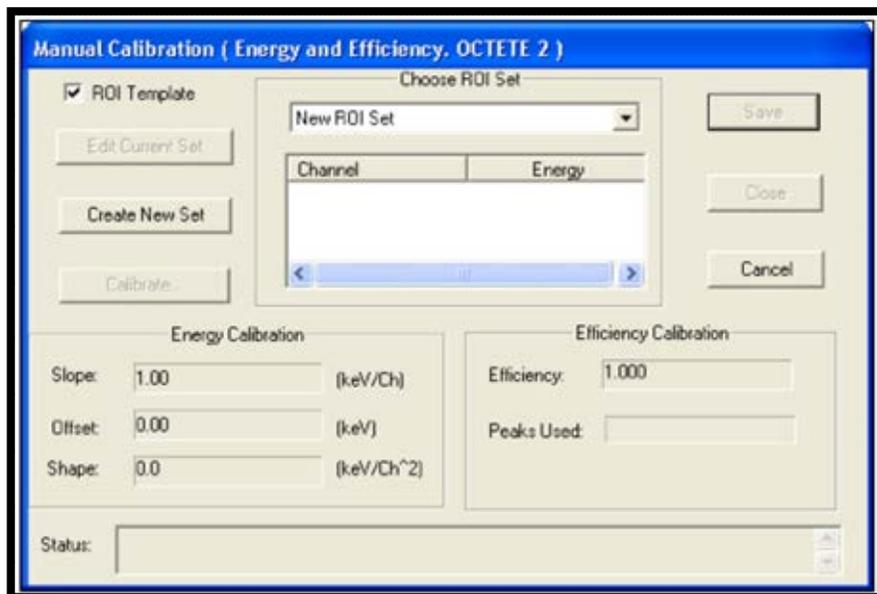


Figure 42. Manual Calibration Dialog

Figure 43 shows the AlphaVision screen and the Manual Energy and Efficiency dialog arranged as they might be seen during a typical calibration.

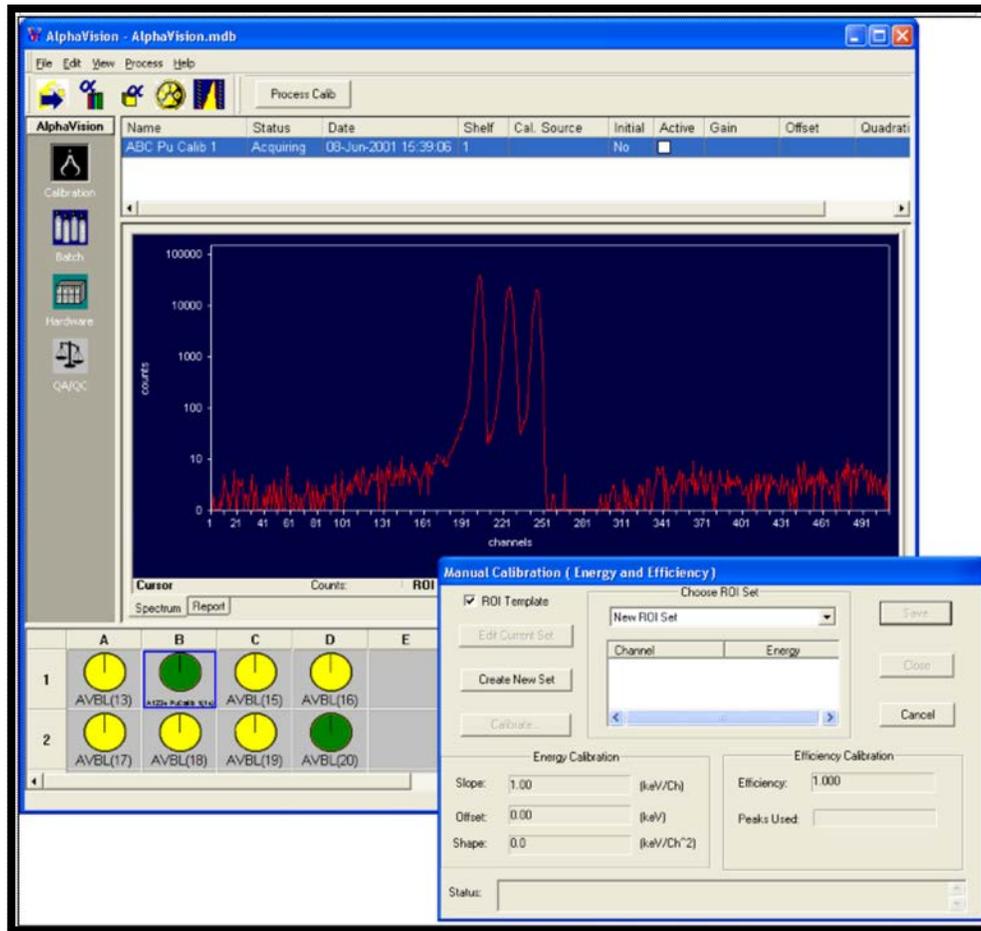


Figure 43. Starting the Manual Calibration

## 7.2.2 Creating an ROI Set for the Calibration Source

- 1) Specify the ROIs for the analysis by creating an ROI Set as explained in Section 8.6.2.1. To summarize, this method involves clicking the **Create New Set** button to open the ROI Editor, zooming in on the calibration source peaks, and clicking on **-Update-** in the center section of the ROI Editor dialog. Then, starting with the lowest-energy peak, use **<Ctrl>** plus the mouse to click and drag from the low-energy to high-energy channel of the ROI to auto-enter the **ROI Low** and **ROI High** fields in the editor (these fields can also be manually entered/edited). Click the **Centroid** to auto-enter that value, select the **Nuclide** represented by the peak, then click the **Update** button. Repeat for the remaining ROIs, save the ROI Set, and close it to return to AlphaVision.
- 2) After returning to AlphaVision, the ROI values are auto entered into the Manual Energy and Efficiency Calibration dialog. Click **Calibrate** (Figure 44).

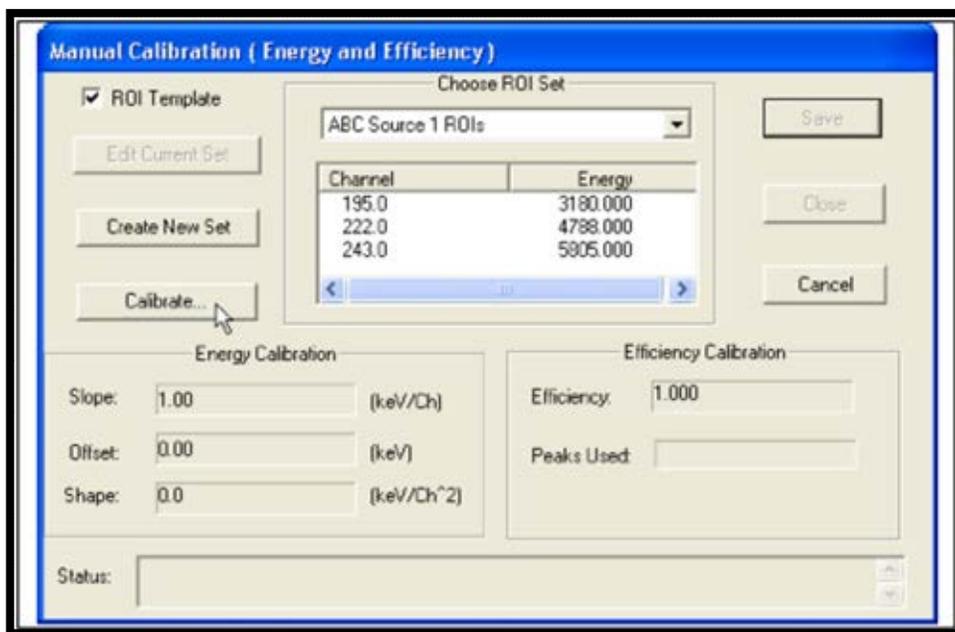


Figure 44. Click the Calibrate Button

- 3) AlphaVision calculates and displays the efficiency and energy calibration factors, including a **Status** note at the bottom of the calibration dialog (which, in Figure 45, reads **Calibration completed**). Always check this status line when **Calibrate** is clicked.
- 4) Note that in **Manual** calibrations, AlphaVision allows users to inspect and modify the calibration data before committing them to the database. This enables users to adjust the ROIs if an error is made in selecting peak channels or ROI limits.
- 5) Click **Save** to save the calibration to the database. Click **Close** to return to the main AlphaVision screen.

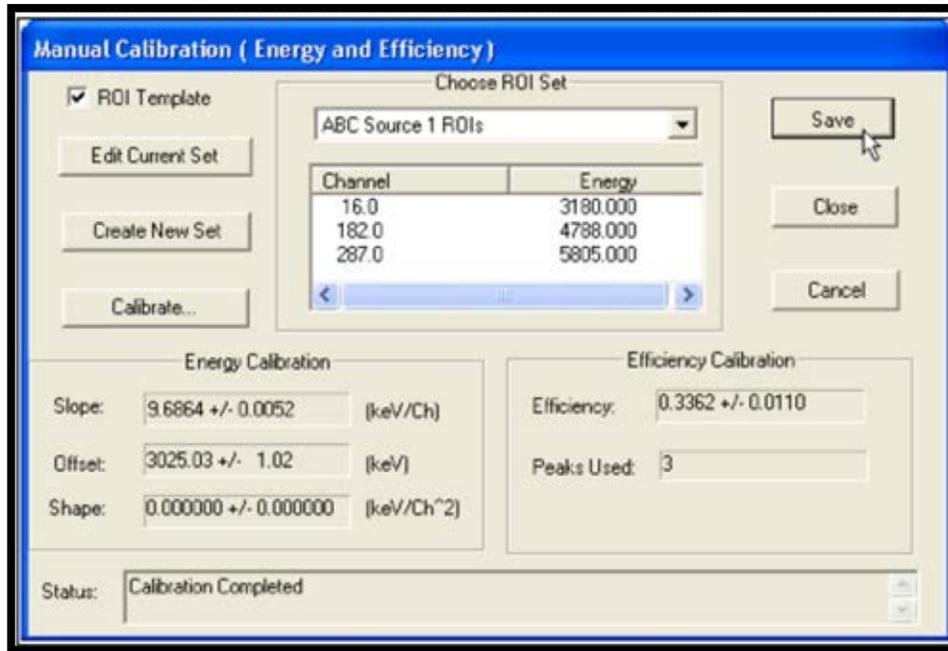


Figure 45. Calibration Results

- 6) And that's it! The parameters for this **Completed** calibration are displayed in the upper Calibration Explorer Panel above the Spectrum/Report Window, and it is automatically marked as **Active** (Figure 46).

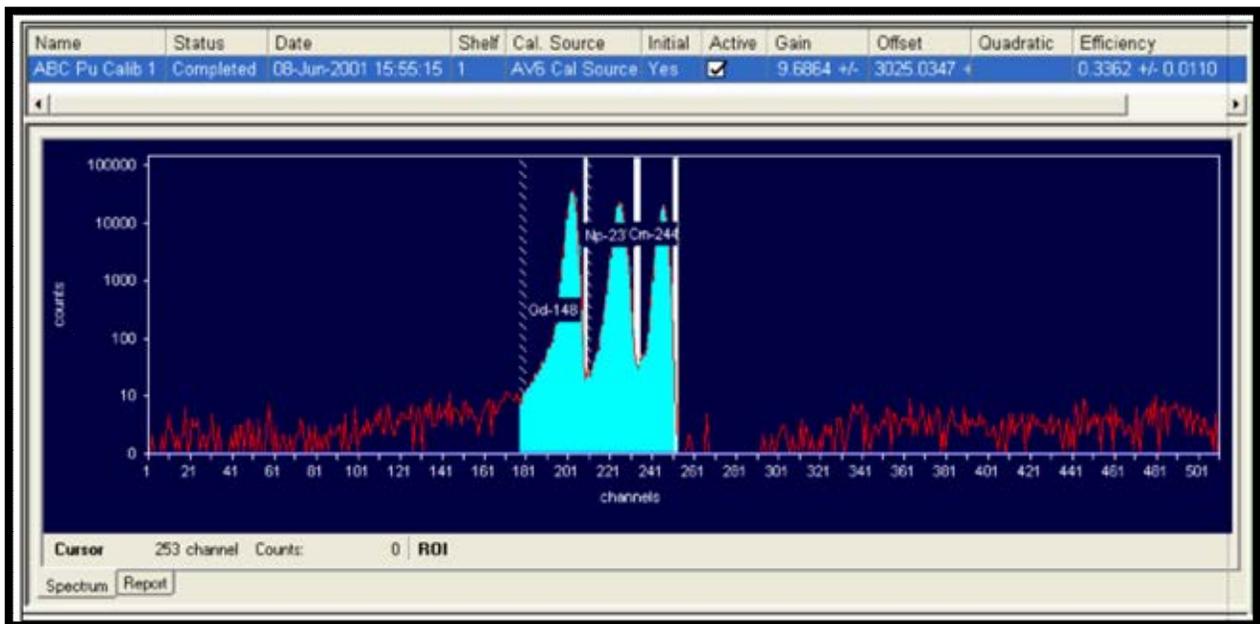


Figure 46. The New Calibration is Now Active

## 7.3 INTERACTIVE ROI REANALYSIS OF CALIBRATION SPECTRA

AlphaVision has an *interactive ROI analysis* option that lets users return to a calibration after the original analysis, and reanalyze it, quickly fine-tuning the ROIs by clicking and dragging the low- and high-channel boundaries in the Spectrum Window, then issuing the Interactive ROI Analysis command to trigger a *recalibration*.

- Changing only the centroid and not the ROI start and end channels recalculates only the energy, not the efficiency.
- Changing only the ROI start and end channels and not the centroid recalculates the efficiency, not the energy.
- Changing both the boundaries and centroid recalculates both calibrations.
- The recalculated calibration(s) overwrite the existing calibration record with the new data. ***There is no undo.***

The ROI information for each customized ROI Set is saved in the database and printed in the Nuclide Activity Summary section of the Calibration report.<sup>12</sup>

- 1) In the Calibration Explorer, locate the desired calibration. Right-click in the spectrum, select **Show Thumbnail**, then click and drag in the Thumbnail View to zoom in on the calibration peaks.
- 2) Click in the first ROI to be adjusted to activate it. The active ROI has a *dashed border* and inactive ROIs have *solid borders*, as shown in Figure 47.
- 3) Click and drag the low-channel and high-channel ROI boundaries to reposition them as desired. Repeat for other ROIs by clicking to activate them and adjusting the boundaries.
- 4) Next, reposition the centroid, if necessary, by rolling the mouse pointer over the small centroid marker until the pointer changes to a four-sided arrow (Figure 48), then click and drag to the new centroid position. The centroid marker will now indicate the new position ().

<sup>12</sup> If a user begins shifting ROI boundaries in the Spectrum Window, then decides not to execute the **Interactive ROI Analysis** command, the original ROI limits are restored. However, once the Interactive ROI Analysis command has been issued, there is no undo for the customized reanalysis.

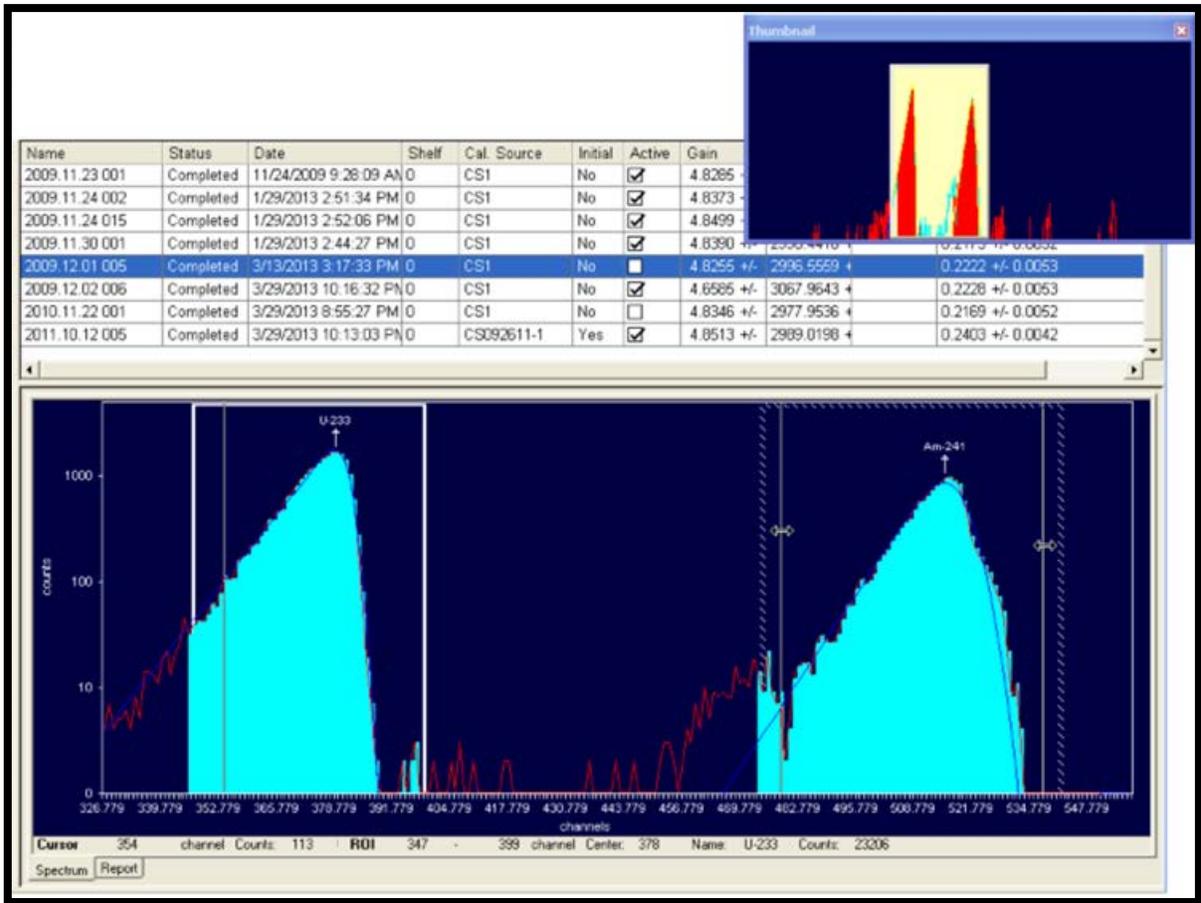


Figure 47. Zoom In on the Peaks and Click and Drag the Two-Sided Arrow to Adjust the Low- and High-Channel ROI Boundaries

- It is now ready to reanalyze. Right-click in the spectrum window and select **Interactive ROI Analysis** from the context menu (see Figure 49). After reanalysis, the energy or channel labels on the X-axis may change.
- Figure 50 shows the entry in the Calibration Explorer with the updated calibration coefficients and analysis **Date/Time** (compare to the highlighted entry in Figure 47).
- The Recalibration properties page and report will indicate that an interactive ROI reanalysis has been performed (Figure 51). In the General Analysis section of the report, the **Analysis Method** field will read **Interactive ROI**. The Nuclide Activity Summary section will show the list of peaks in the customized ROI Set. The **Analysis Method** field will indicate that an interactive ROI analysis has been performed.

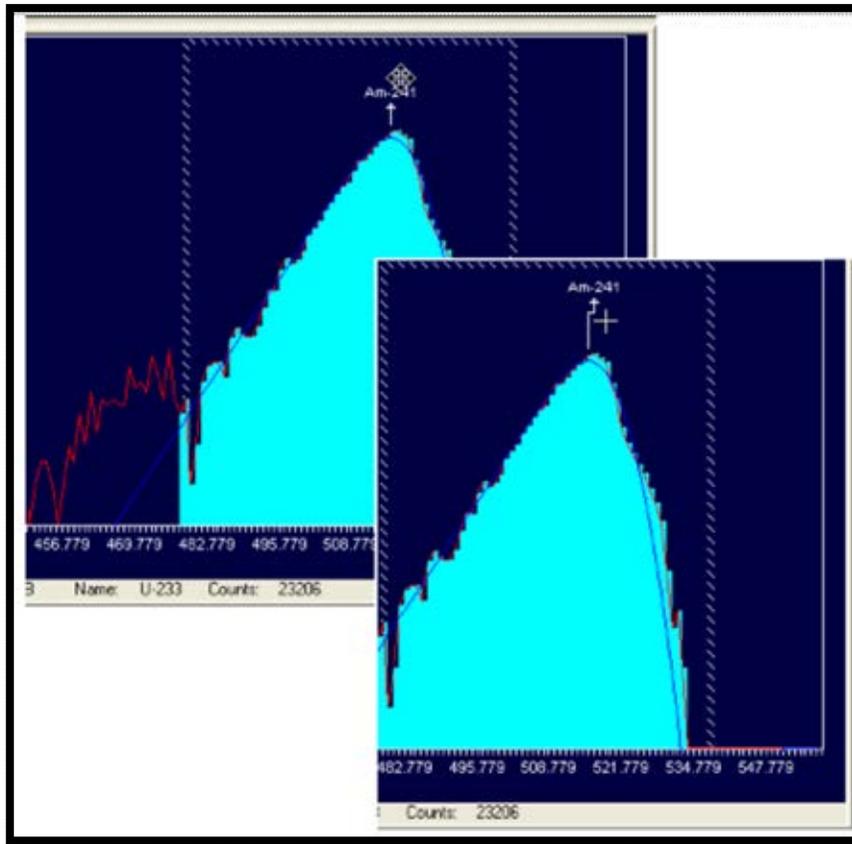


Figure 48. Click and Drag the Four-Sided Arrow to Reposition the Centroid, If Necessary

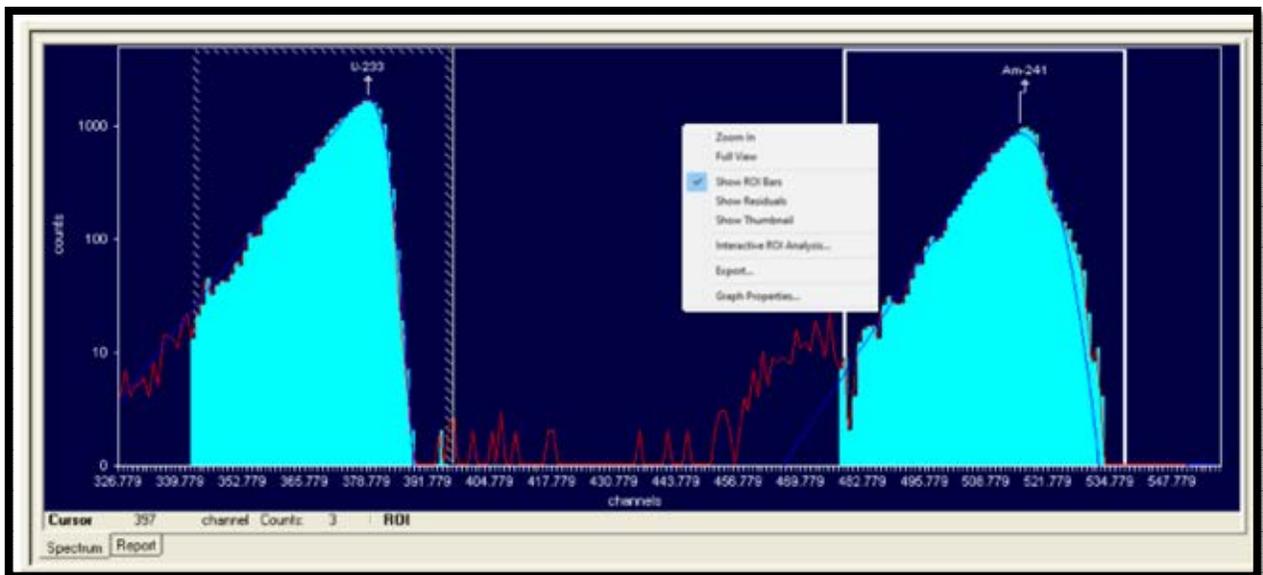


Figure 49. Right-Click and Select Interactive ROI Analysis to Reanalyze

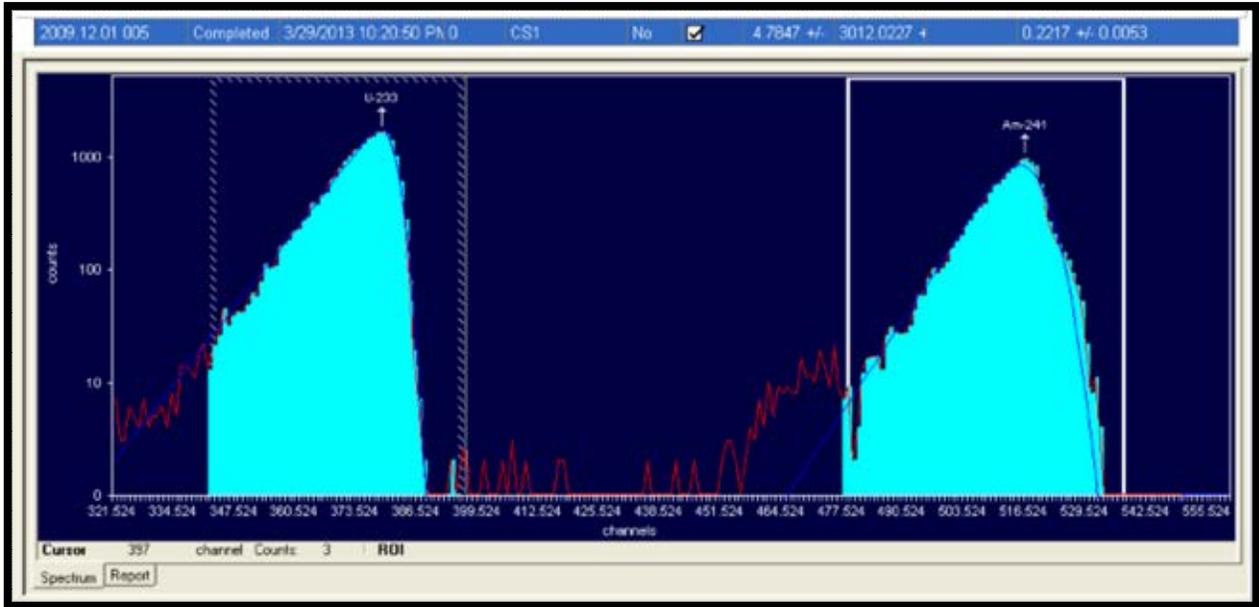


Figure 50. Recalibration Calculated, Analysis Date/Time Updated

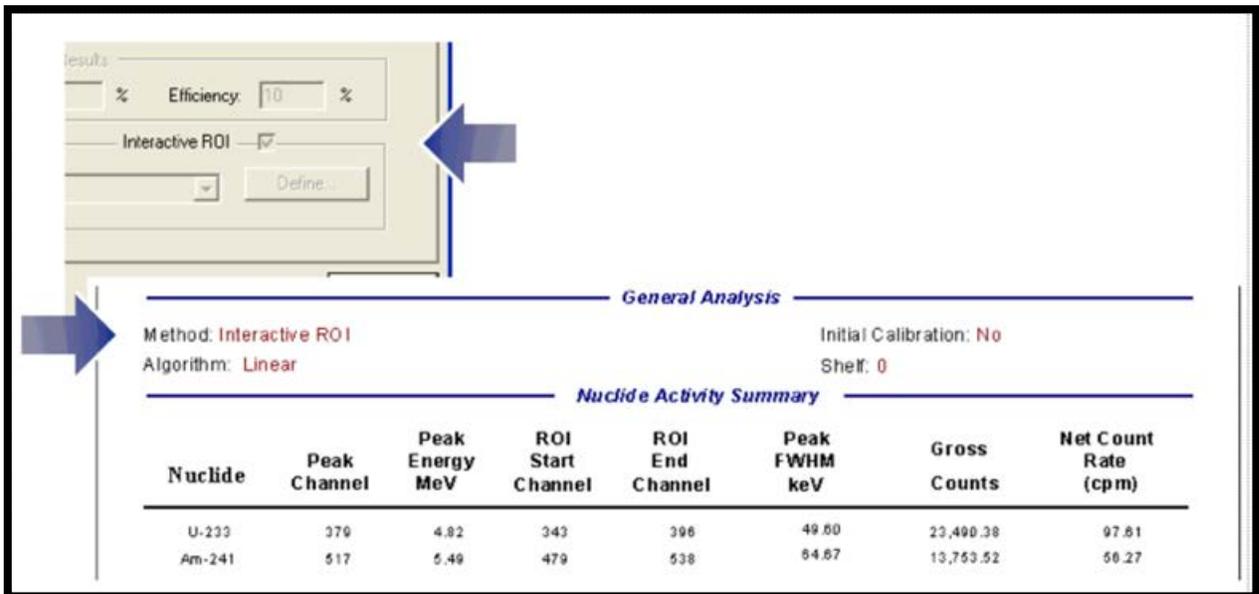


Figure 51. Interactive ROI Method Noted on Recalibration Screen and Report

## 7.4 PEAK SEARCH AND FIT

AlphaVision offers a default set of peak-search-and-fit parameters for both sample analysis and calibration. To customize these parameters from either the Calibration or Batch Wizard, click **Setup**.

Peak search, deconvolution, and fitting techniques are performed using mathematical interpretations of the shape and position of spectrum data. AlphaVision lets users adjust the various input parameters to obtain the best fit for a given spectrum.

**NOTE** The AlphaVision peak search algorithm uses (1) the **Nuclide Library** assigned on the Batch Wizard's Analysis setup screen or (2) the **Standard Calibration Source** library selected on the Energy Efficiency Calibration setup screen in the calibration wizard. This library is used to find the peak closest in energy to the identified peak in the spectrum. If a library is used that contains alpha-emission ratio energies that overlap or are very close to one another (for instance, the AlphaVision Master Library, which contains all peaks for all alpha emitters), a peak may be misidentified. Therefore, it is recommended to create libraries that match as closely as possible the expected nuclides in the samples. That is, the more known about the spectrum, the easier it will be to use the peak search. Using this tool requires experience or else guidance from an application specialist.

### 7.4.1 Peak Search

This feature is used in both calibrations and sample analysis. The parameters on this page (Figure 52) are discussed in detail in the Peak Search section of Analysis Methods, Section B.1.

#### Search Engine

Choose whether to perform a Mariscotti 2nd derivative or top-hat correlation peak search on the spectrum.

#### Mariscotti 2nd Derivative Search

The **Mariscotti (Derivatives)** test compares the magnitude of the second difference with the weighted error of the channel counts. The second difference must be greater than the weighted error to be accepted. The weighting factor is based in part on the **Minimum Peak Sensitivity** discussed below. This search works best for spectra with high counts, does not require prior knowledge of peak width, and is useful for resolving overlapping peaks.

#### Top-Hat Correlation Search

For the **Top-Hat Correlation** search to succeed, the **Expected "Gaussian" Width** must be very close to the peak FWHM. This search works best for spectra with low counts.

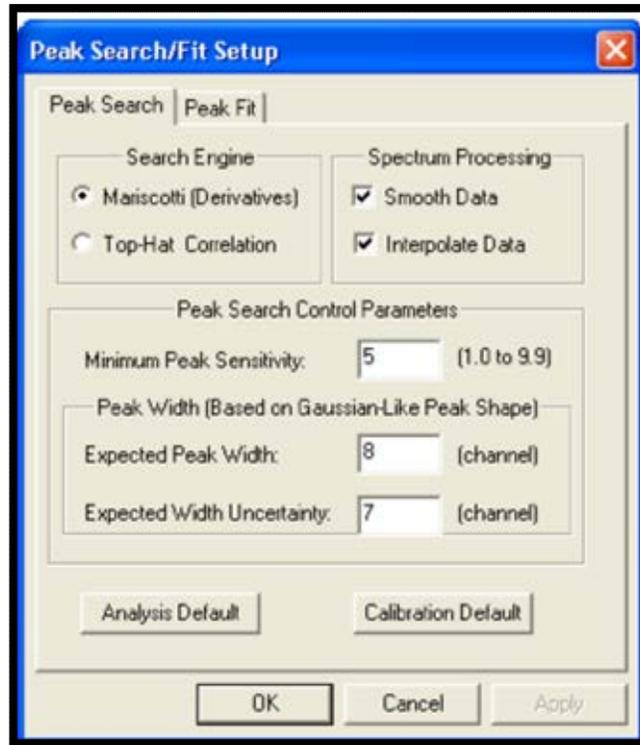


Figure 52. Peak Search Tab

### Spectrum Processing Before the Peak Search

AlphaVision gives two options for processing the spectrum before the peak search is performed. Select one, both, or neither.

- **Smooth Data** applies a Savitsky-Golay smoothing routine.
- For spectra containing less than 2048 channels, the **Interpolate Data** feature performs a cubic spline interpolation to augment peak shape for better peak-search success. Three extra points are interpolated for 512-channel spectra, and 1 extra point for 1k spectra.

### Peak Search Control Parameters

- **Minimum Peak Sensitivity** sets the peak search sensitivity from 1.0 to 9.9 (values can be fractional). Suspected peaks must pass this sensitivity test to be accepted. Low values will find small peaks but may also cause the program to accept some false peaks. High values will locate large peaks but will miss some small peaks. For a Mariscotti search, a sensitivity of 4 or higher will find well-defined, bell-shaped peaks. A setting of 6 is a good starting point for the Top-Hat Correlation.
- **Peak Width** – The values entered here depend on the search engine chosen. See the discussion of Expected “Gaussian” Width and Gaussian Width Uncertainty in the Search Engine section of Analysis Methods.

### Resetting to the Default Analysis or Calibration Values

To restore all peak-search-and-fit values to their defaults, click the appropriate Default button.

## 7.4.2 Peak Fit

The parameters on this page (Figure 53) and guidance on using them are discussed in detail in the Peak Fit section of the Analysis Methods chapter, Section B.2.

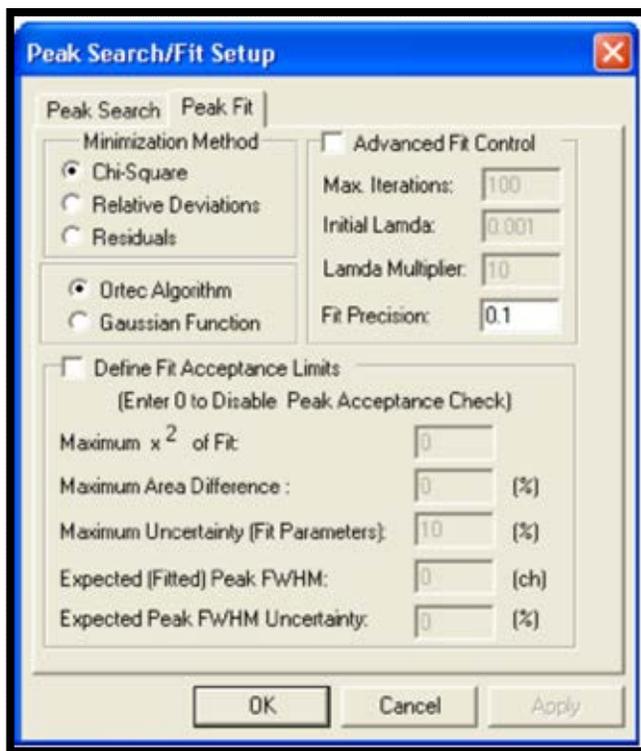


Figure 53. Peak Fit Tab

## 7.5 DATA REVIEW

- 1) Review all calibrations, ensuring the ROIs fully encompass the desired peak area and peak centroids are properly located.
- 2) Records containing errors should be removed from the database using the Database Management tools (Chapter 12) before they are exported, or the database is statistically analyzed.

## 8. NUCLIDE LIBRARIES AND OTHER USER-DEFINED ANALYSIS TOOLS

### 8.1 THE LIBRARY EDITOR

AlphaVision uses three types of libraries:

- The Master Nuclide Library of alpha-particle-emitting nuclides (**Edit/Master Nuclide List...**).
- User-defined analysis libraries (**Edit/Nuclide Libraries...** or the **Nuclide libraries** button on the Toolbar).
- Libraries for calibration sources and stock control solutions (**Edit/Standards...** or the **Standards** button on the Toolbar).

#### 8.1.1 The Master Nuclide Library

The Master Nuclide Library (**Edit/Master Nuclide List...**) is supplied as part of AlphaVision 7. It is a compilation of nuclear data from PCNuDat (National Nuclear Data Center, Brookhaven National Laboratory), and contains the **Nuclide Name**, **Half-Life**, alpha-particle **Peak** energies, and **Branching Ratios** for all alpha-emitting nuclides. Use this library as the basis for analyte and calibration source libraries, and for tracer and ROI records. Alternatively, users can supply their own values.

**NOTE** While users can add, edit, or remove values in the master nuclide library, it is strongly recommended that the master library be cloned instead (use **Edit/Nuclide Libraries...**) and modify the values in the clone.

#### 8.1.2 Creating and Maintaining Libraries

The AlphaVision nuclide library interface is intuitive and takes just seconds to use. From inside the library editor, simply open the Master Nuclide List; select the desired nuclides, using the mouse and the **<Shift>** and **<Ctrl>** keys to select multiple nuclides, or adding one nuclide at a time (Figure 54); then click **OK**.

AlphaVision libraries contain the nuclide name, half-life, alpha-particle peak energies, and branching ratios for each constituent.

- In an analysis, AlphaVision sums the branching ratios of the peaks contained within the energy limits of the peak region - whether a user-defined ROI from an ROI Set, or a software-derived region from a Peak Search and Fit analysis.

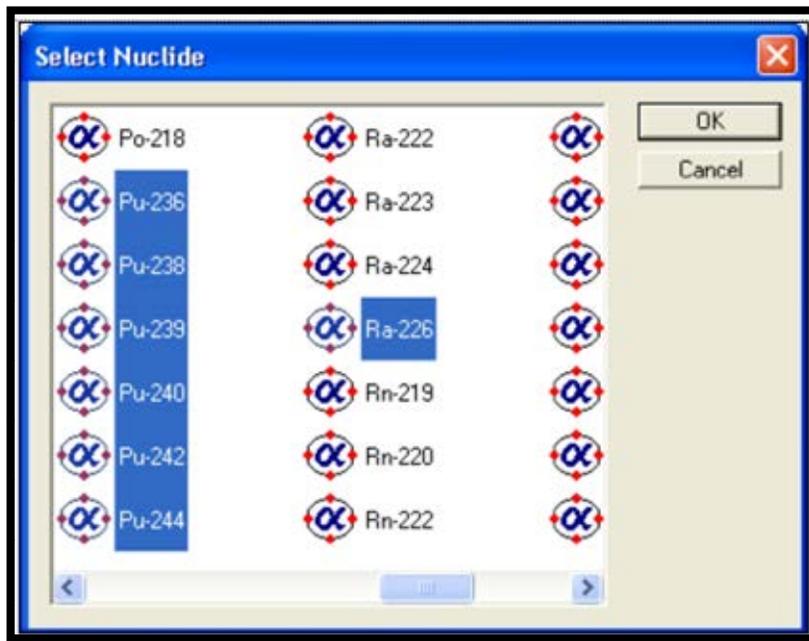


Figure 54. Select Library Nuclides with a Few Mouse Clicks

- There is no limit to the number of peak energies per nuclide (unlike earlier versions of AlphaVision, which were limited to four peaks per nuclide).

**NOTE** The nuclide peak with the highest branching ratio is used for the peak search.

- For peak-search-and-fit analyses, it is recommended users create libraries that match as closely as possible the expected nuclides in the samples. This is because the AlphaVision peak search algorithm looks through the analysis library for the peak closest in energy to the identified peak in the spectrum. Too many nuclides with close or overlapping alpha-emission energies may lead to incorrect identification of a peak. In addition, while require a large number of libraries may not be required for routine work, it is suggested that users create different libraries for each analyte type (e.g., Am, Pu, U, Th).
  - If it is known that each alpha peak in the sample is well separated from the others, creation of specialized analysis libraries may not be required. In this case, because AlphaVision can sum the branching ratios included within a region of interest (ROI), all users might need is the Master Library. Just select it within the sample processing wizards and let AlphaVision do the rest.
  - Once a library has been created in AlphaVision, users can easily customize it at any time, adding or removing peak energies and changing energy values. When the library is no longer needed, it can be deleted.
- 1) Click **Edit/Nuclide Libraries...** or the **Nuclide libraries** button on the toolbar. This will open the dialog shown in (Figure 55).

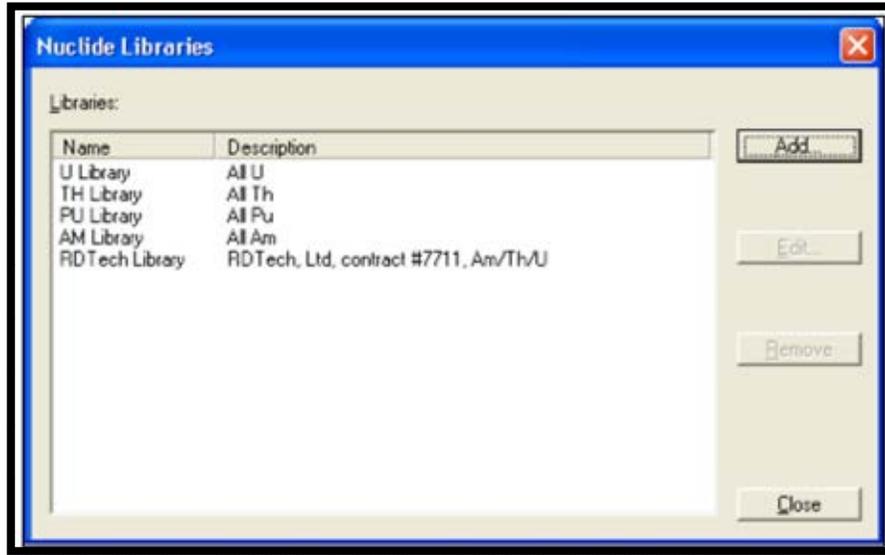


Figure 55. Existing Nuclide Libraries

- 2) Click **Add...** to open the Nuclide Library dialog. Enter a **Name** and **Description** for the new library (Figure 56). The read-only **Created** field shows the library's creation date/time, assigned by AlphaVision when the library is completed. It may be desired to enter a **Description** that further identifies the library.

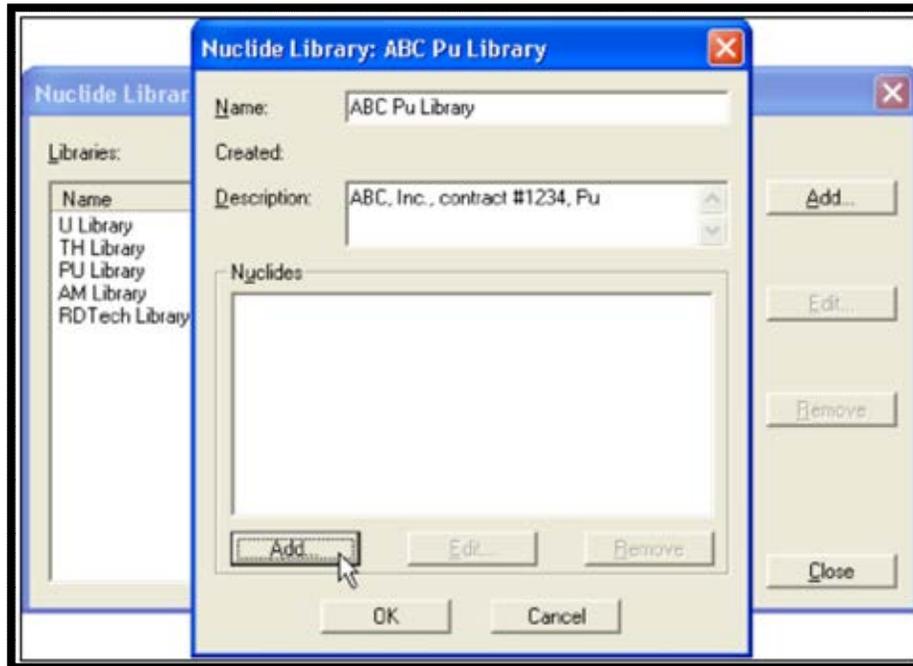


Figure 56. Enter the Name and (Optionally) a Description

- 3) To add one or more nuclides to the library, click **Add...** This will open the Master Nuclide Library's contents in the Select Nuclide dialog (Figure 57). Select the desired nuclides then click **OK**. This will copy all highlighted nuclides into the new library and close the master list dialog (Figure 58).

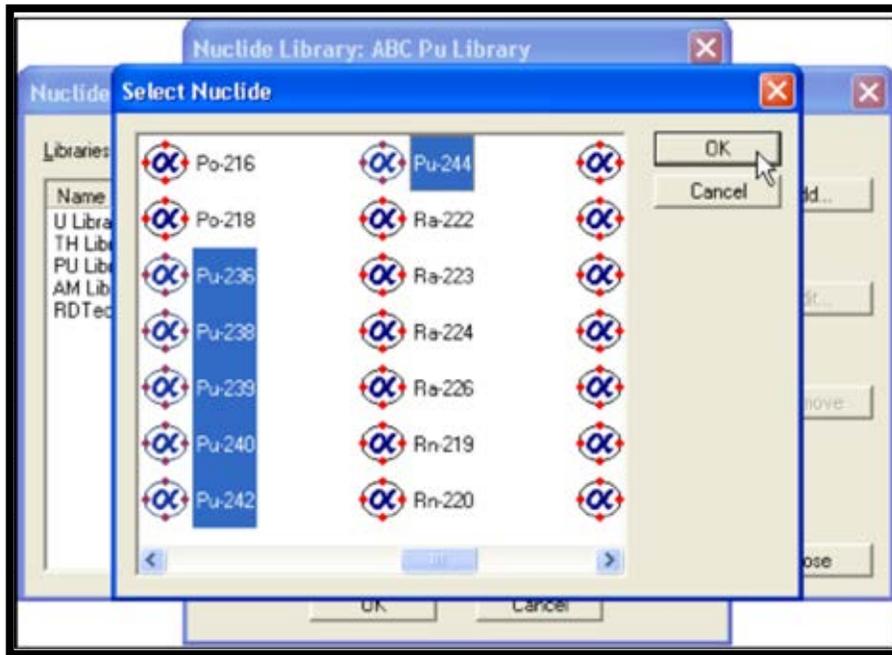


Figure 57. Add Nuclides from Master List

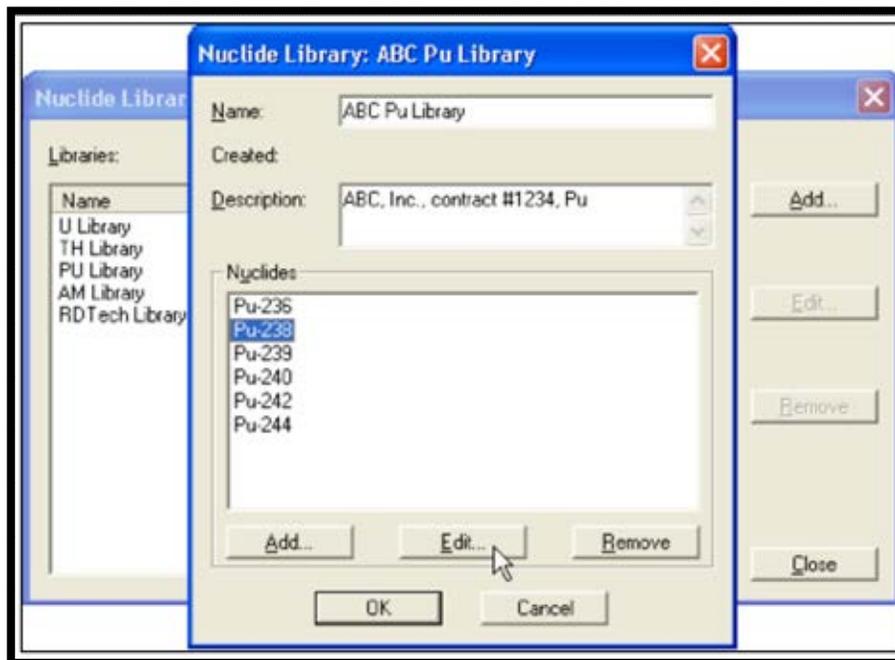


Figure 58. Edit the Peak Energies for the Selected Nuclide

- 4) To view, edit, add, or delete peaks for a particular nuclide, click the nuclide then select the appropriate button. The user may also add/edit the energy and branching ratio of a specific peak. Click the peak then the appropriate button, make the changes, and click **OK** (Figure 59).

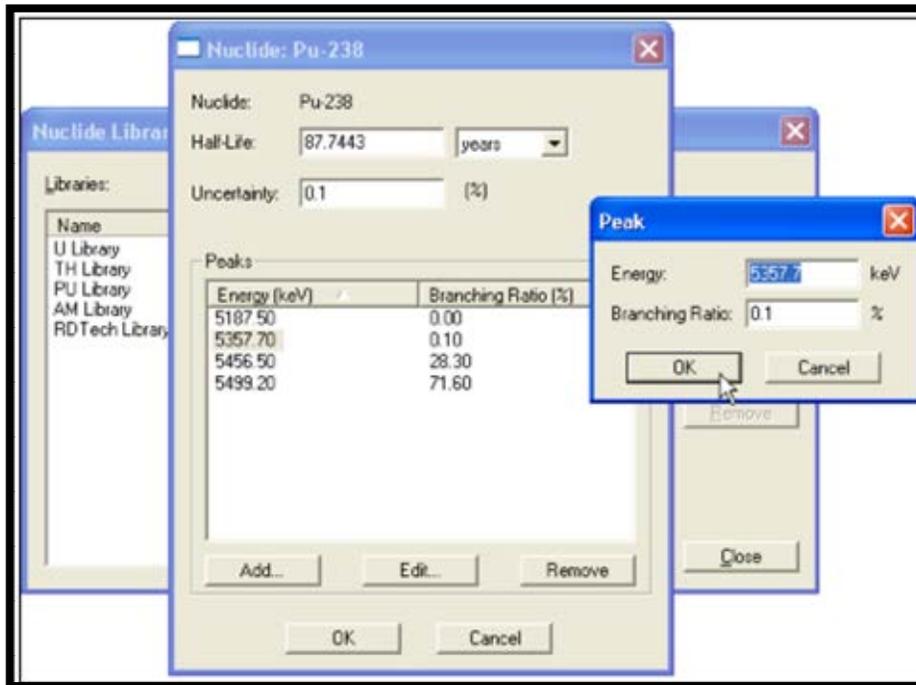


Figure 59. Add Peak

- 5) Click **OK** as needed to return to the Nuclide Libraries dialog (Figure 60).

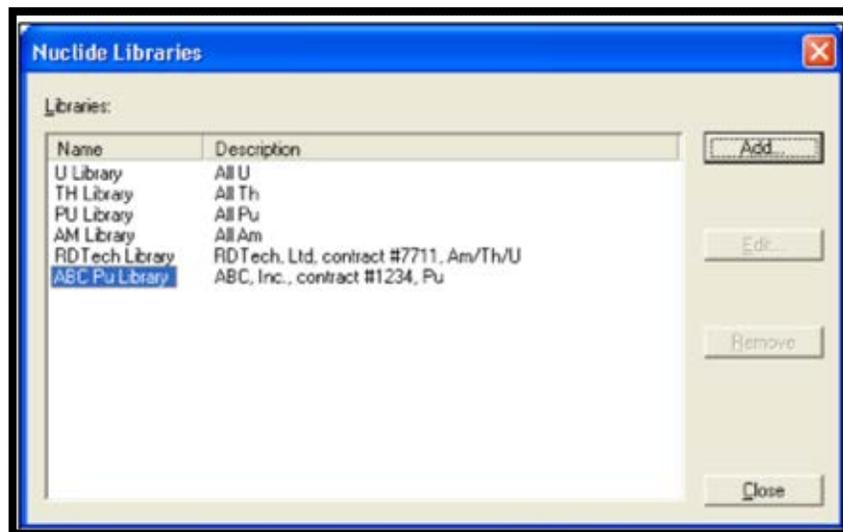


Figure 60. New Library Added

- 6) Click **Close** to complete the library and return to the main AlphaVision screen.

## 8.2 CREATING TRACER SETS

A tracer is a laboratory control solution standard used to calculate the chemical recovery for samples. AlphaVision lets users create a *tracer set* for a particular element and vary the volume added from batch to batch – the software tracks the recovery regardless of the volume added. In general, these standard solutions are prepared by diluting standard reference

materials obtained from NIST or another reference laboratory or source manufacturer or are purchased in diluted form directly from the source manufacturer.

The tracer nuclide is typically an isotope of one of the analytes and emits an alpha that is energetically distinct from the analytes (for example, if a client is looking for  $^{239}\text{Pu}/^{240}\text{Pu}$ ,  $^{238}\text{Pu}$ , and  $^{236}\text{Pu}$ , a typical tracer would be  $^{242}\text{Pu}$ ). The tracer is added to all samples in a batch, including the blank and the control.

- 1) Open the Tracer Editor (Figure 61) by clicking **Edit/Tracers...** or the **Tracers** button on the toolbar.
- 2) Click the **Tracer Nuclide** drop list and select the desired nuclide (Figure 62).
- 3) Enter the **Tracer Certificate Date/Time** using the date and time tools (Figure 63). This date/time is used to decay-correct the tracer to the date acquisition start time.
- 4) Enter the tracer's certified **Activity Concentration** and select the desired activity units/mL. Optionally a percent uncertainty (+/-; entered at a one-sigma level) can be associated with the activity of the tracer solution (Figure 64).



Figure 61. Choose a Standard

- 5) For laboratories that frequently add tracer to sample aliquots, users can choose between adding the tracer to **Aliquot** or **Total**.

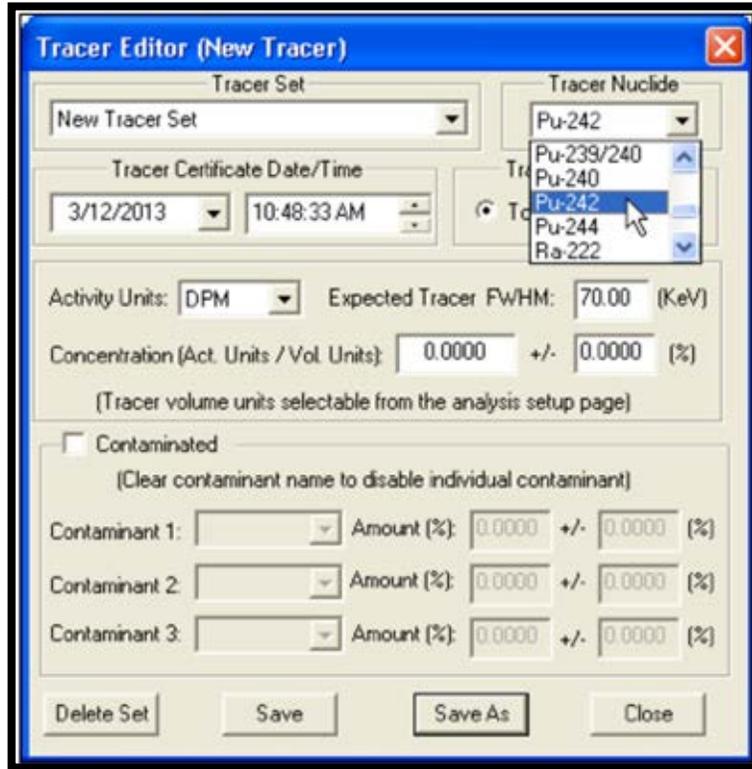


Figure 62. Tracer Nuclide Drop-Down List



Figure 63. Tracer Certificate Date/Time

Figure 64. Activity Concentration

- 6) **Expected Tracer FWHM** is used for peak-search-and-fit and ROI analyses. It works in conjunction with **Adjust ROIs** in the Batch Wizard and allows the software to adjust the width of analyte ROIs based on the width of the tracer peak. This reduces the number of adjustments required to make ROIs during the analysis process. The value entered here is used by the analysis algorithm as a starting point for this adjustment.
- 7) Use the **Contaminated** section of the screen to correct for up to 3 alpha-emitting contaminants in the tracer solution (Figure 64).
- 8) The last step is to name the new Tracer Set. Click **Save As** and assign a unique **New Name** to the new record (Figure 65).
- 9) Click **Close** to exit the dialog and return to the main AlphaVision screen.

This Tracer Set record is now available for sample analysis.

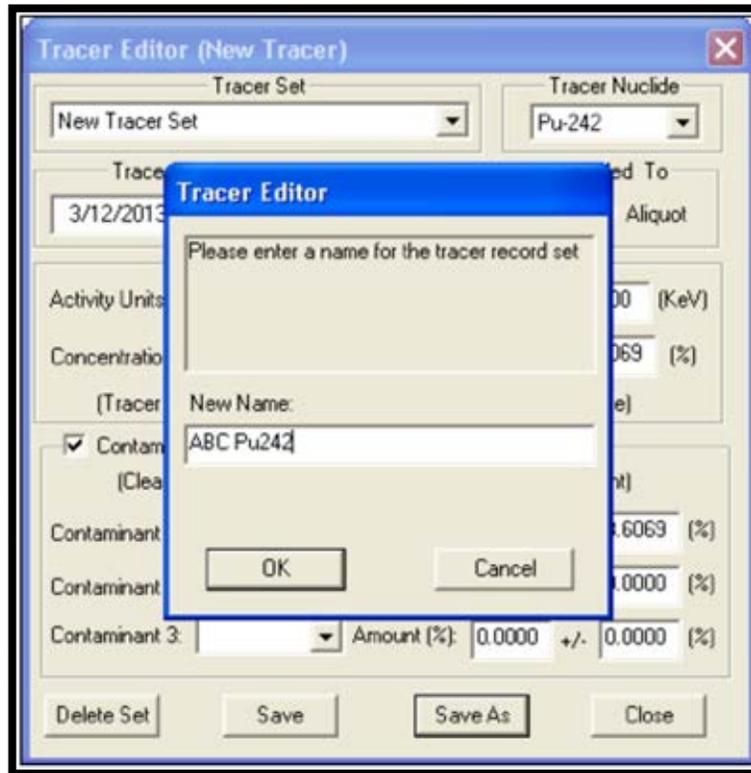


Figure 65. Name Tracer Set

### 8.3 CREATING CALIBRATION SOURCE RECORDS

This requires a certified calibration source and its certificate.

- 1) On the Outlook Bar, click the **Calibration** icon.
- 2) From the menu bar, select **Edit/Standards**. This will open the Standards dialog (Figure 66).

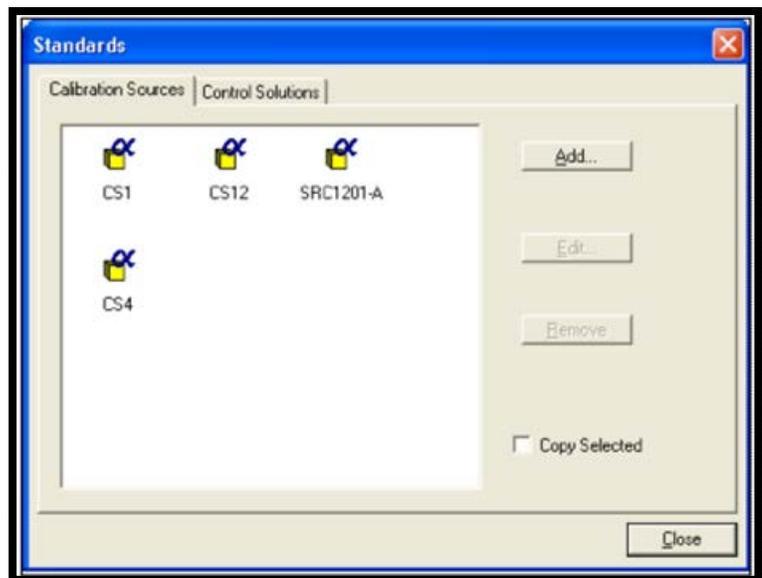


Figure 66. Standards Dialog

- 3) Click the Calibration Sources tab, then click **Add** to open the Calibration source dialog (Figure 67).

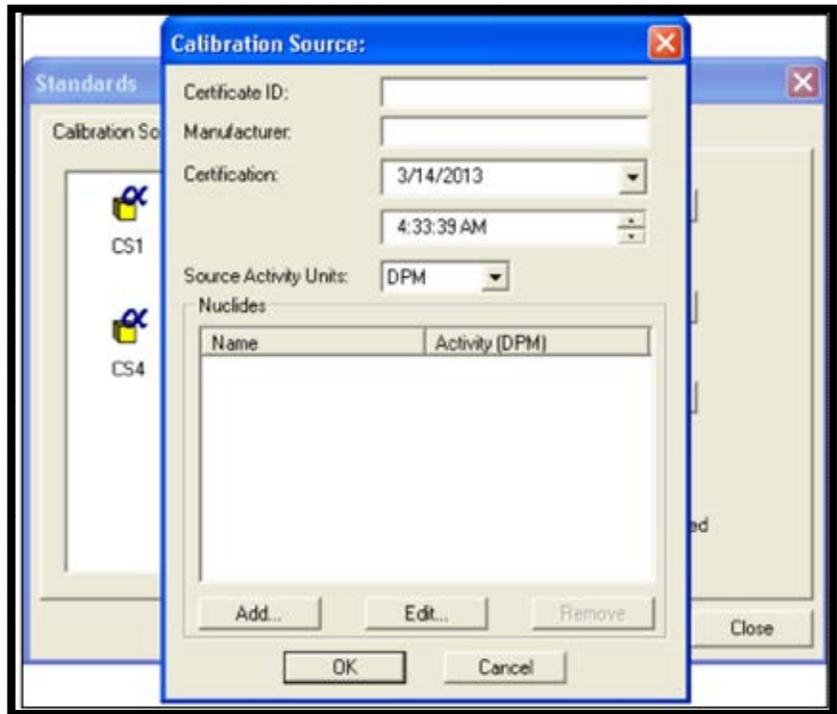


Figure 67. Add Calibration Source

- 4) Enter the name of the calibration source (**Certificate ID**), **Manufacturer** (whether in-house or company), and **Certificate Date/Time** (Figure 68). The certification date is used to decay correct the activity of each of the nuclides contained on the standard source.

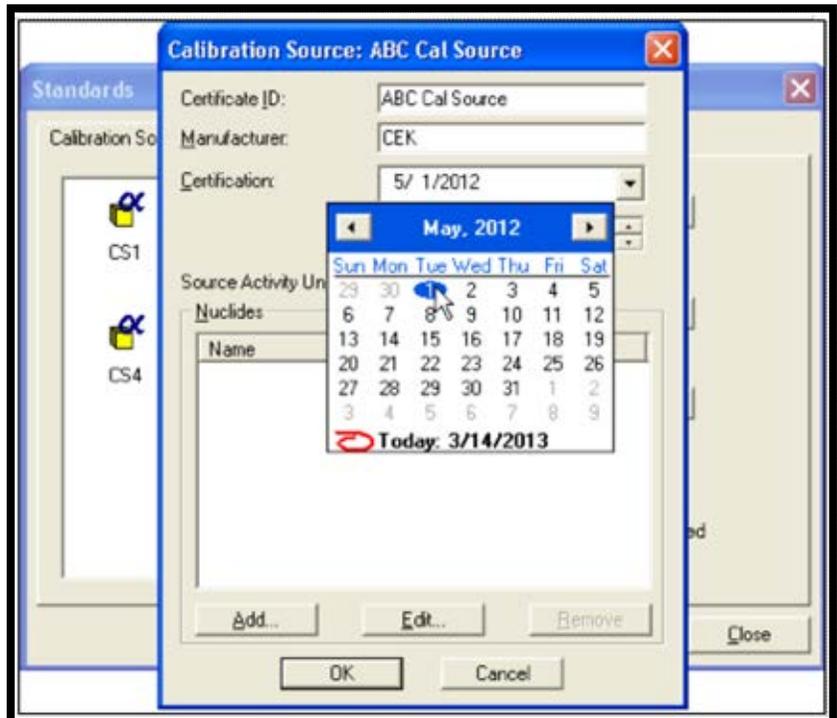


Figure 68. Add Certificate Date/Time

- 5) Select the desired **Source Activity Units** from the drop list (Figure 69).

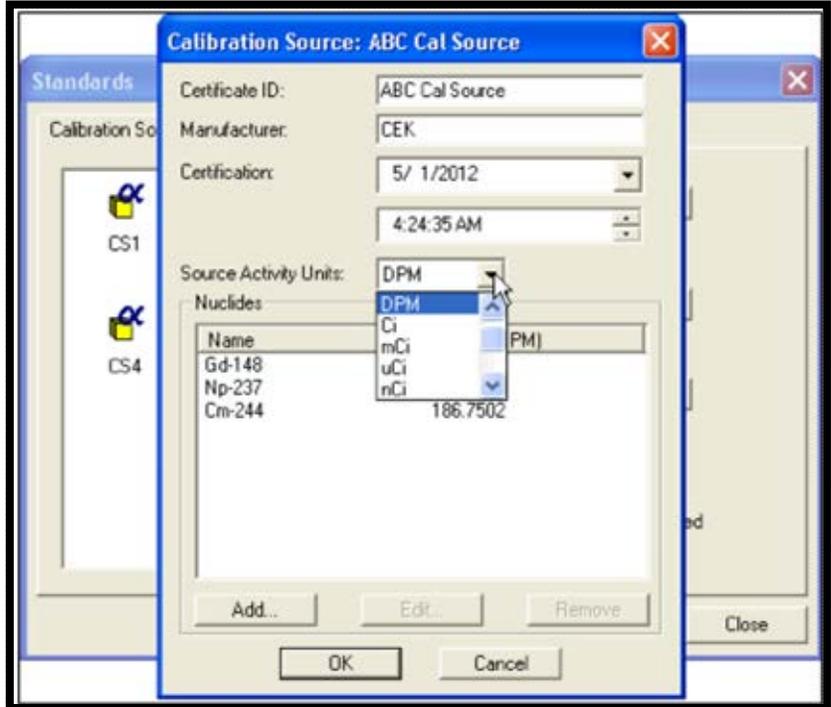


Figure 69. Select Source Activity Units

- 6) To add a nuclide to the Calibration Source record, click **Add** to open the Nuclide Information dialog (Figure 70).

Choose each nuclide from the **Nuclide** drop list and enter the certified **Activity**. Optionally the **Activity Uncertainty** associated with the diluted standard (otherwise, leave it set to zero) can also be entered. This user-defined uncertainty is at the one-sigma level (and is normally based on uncertainty associated with the preparation of the diluted standard and the stated uncertainty on the standard certificate). Click **OK**.

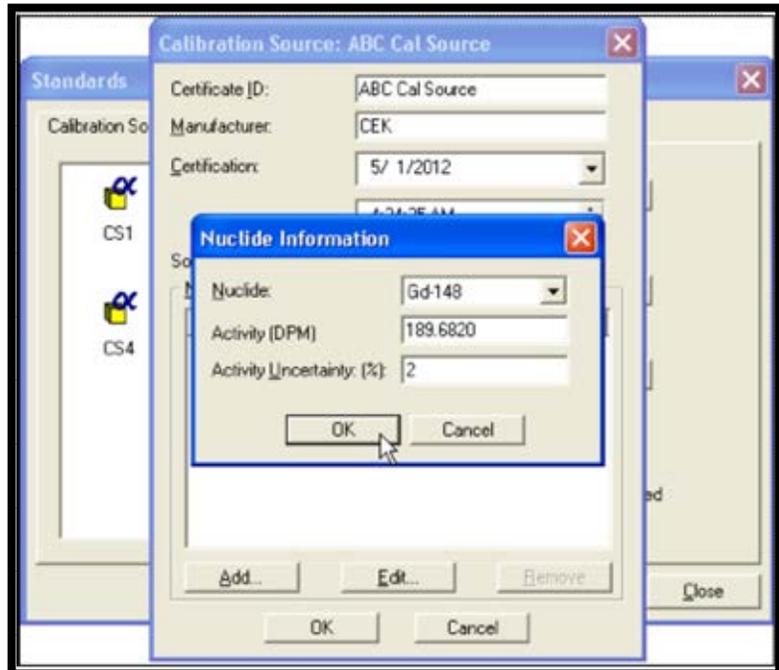


Figure 70. Add Nuclide

- 7) To modify an existing nuclide entry, click the nuclide, click **Edit**, make the changes, and click **OK**.
- 8) Click **OK** to return to the Standards dialog and click **Close** to return to the main AlphaVision screen.

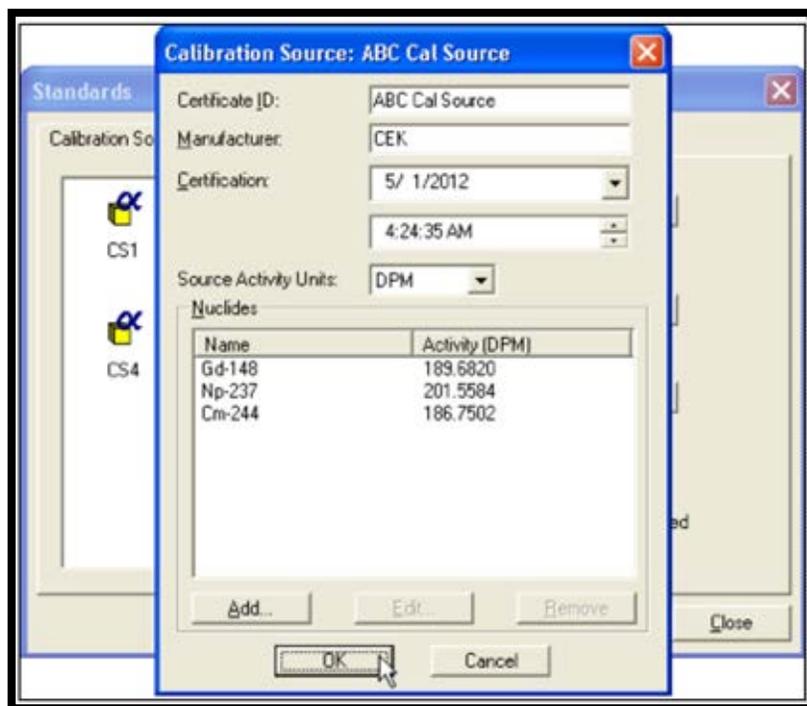


Figure 71. Completed Calibration Source

## 8.4 CREATING QA CONTROL SOLUTIONS

A *QA control solution* is a stock solution containing 1 or more analytes of interest. Typically, these are prepared by diluting laboratory control standards obtained from NIST or another reference laboratory or source manufacturer or are purchased in diluted form directly from the source manufacturer. An aliquot of control solution is added to the control sample in the batch, and the analysis lets the user track the recovery of the control standards for a specific project. AlphaVision lets users vary the volume of the control added from batch to batch. As long as the control sample's source, volume, and units are entered correctly, AlphaVision accurately tracks the recovery regardless of batch-to-batch variations in the amount of control added (this includes decay correction based on the **Certification** date/time).

Users can create and maintain an unlimited number of control solution libraries tailored to their needs. These are then available on the Sample Properties screen in the Batch Wizard whenever a particular sample as a Control is specified.

- 1) To open the Standards dialog (Figure 72), click **Edit/Standards** or the **Standards** button on the Toolbar.
- 2) Click the Control Solutions tab, then **Add** to open the Control Solution dialog.

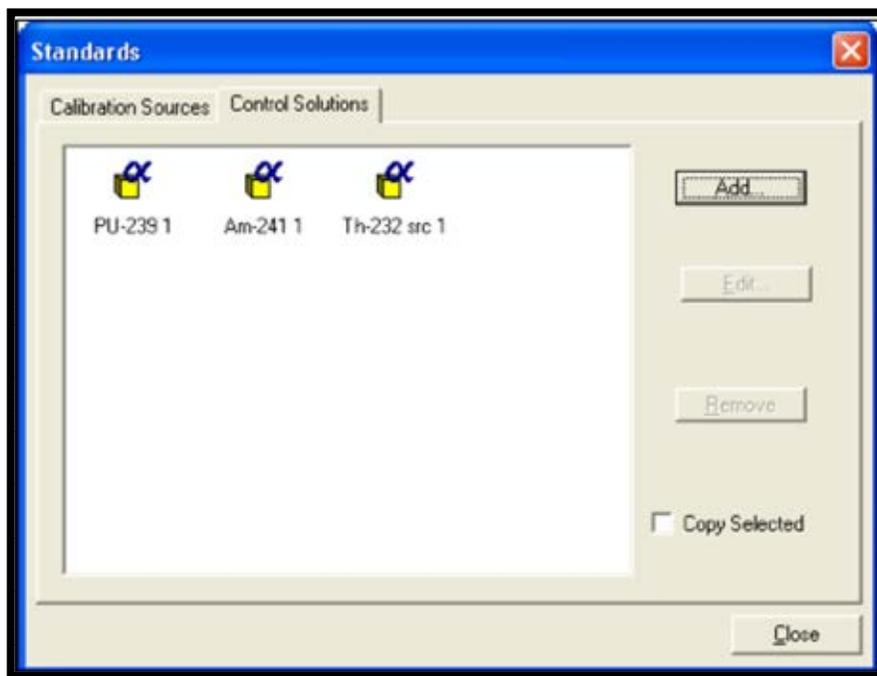


Figure 72. Control Solutions Tab

- 3) Enter the name of the control solution (**Certificate ID**), **Manufacturer** (whether in-house or vendor), a note about the **Solution Composition**; and a **Certification** date/time using the date and time tools (Figure 73).

The **Certification** date is used to decay correct the activity of each of the nuclides contained in the control solution. Typically, control solutions contain only one nuclide, however, but if desired it is possible to include more, e.g.,  $^{241}\text{Am}$  and  $^{244}\text{Cm}$  can be included for Am/Cm analyses. If more than one nuclide is used, users will have to decay correct the activity of each nuclide to a *common date and time*, which should then be used as the **Certification** date/time for this record.

Select the **Solution Activity Units** from the drop list and choose **mL** or **g** for the **Quantity Units**. The resulting activity-per-volume units will be displayed beside the **Activity** field on the Nuclide Information dialog (Figure 74).

- 4) To add a nuclide to the Control Solution record, click **Add** to open the Nuclide Information dialog (Figure 74). Select  $^{239}\text{Pu}$  from the **Nuclide** drop list and enter its certified **Activity** in the selected activity-per-volume units. If desired, the percent **Activity Uncertainty** associated with the diluted standard can also be entered. This user-defined uncertainty is at the one-sigma level (and is normally based on the uncertainty associated with the preparation of the diluted standard and the stated uncertainty on the laboratory control standard certificate).

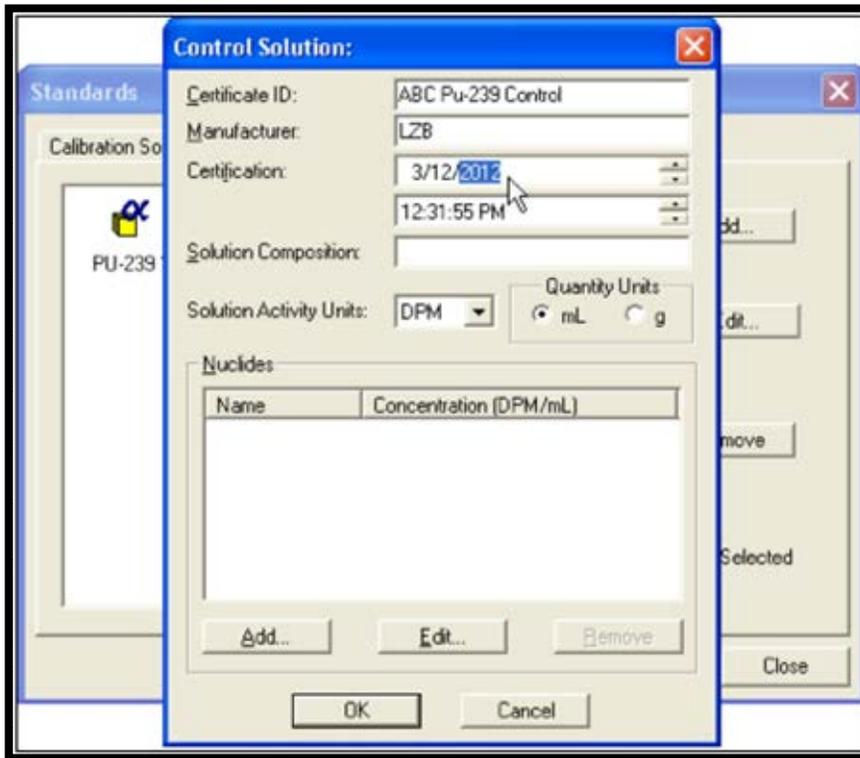


Figure 73. Certification Date/Time Tools

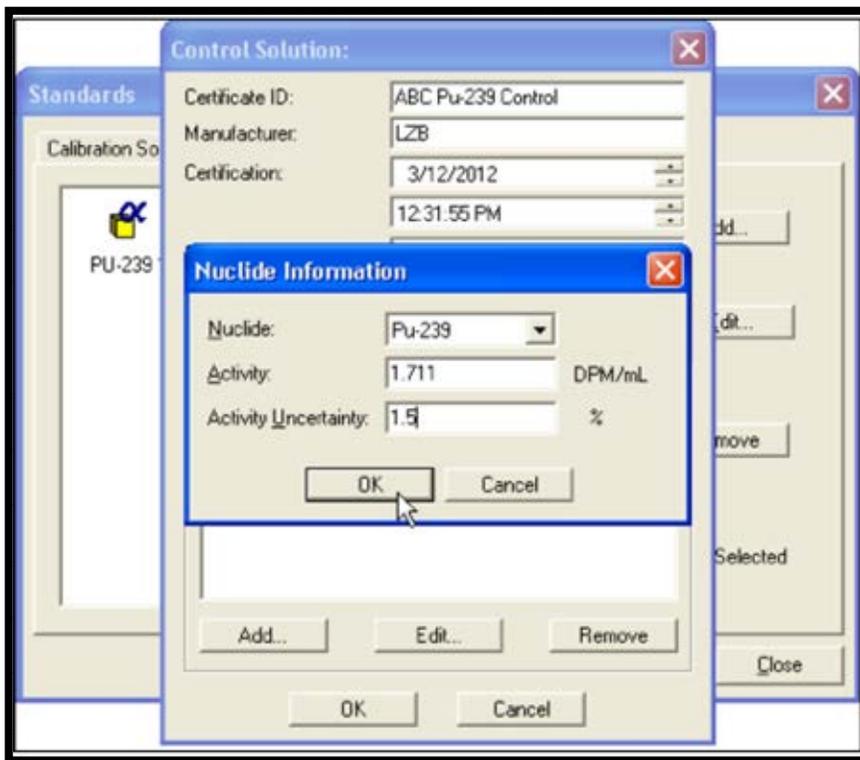


Figure 74. Nuclide Information

- 5) Click OK to return to the Control Solution dialog (Figure 75).
- 6) To modify an entry, click the nuclide, click **Edit**, make the necessary changes, and click **OK**.
- 7) When all the nuclides in the standard source have been added, click **OK** to return to the Standards dialog (Figure 76), then click **Close** to return to the main AlphaVision screen.

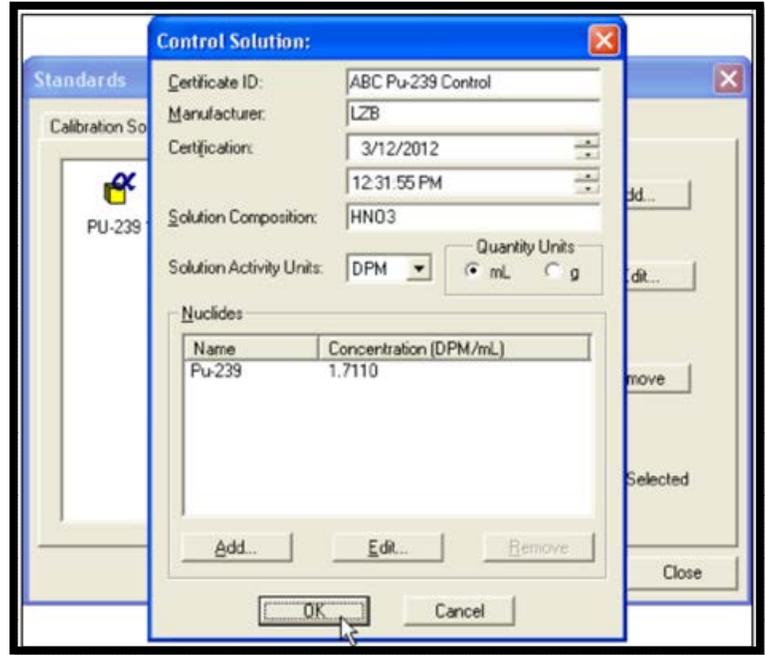


Figure 75. Control Solution

## 8.5 THE QA TYPE EDITOR

AlphaVision uses QA Types (**Edit/ QA Types...**; Figure 77) as tools for tracking the recovery history of tracers and control samples, and the count rate of reagent blanks for specific projects. Creating them is fast and easy. Users may create as many of each type as desired, at any time; and edit and delete them. **However, note that if a QA Type is deleted, the corresponding control charts can no longer be accessed.**

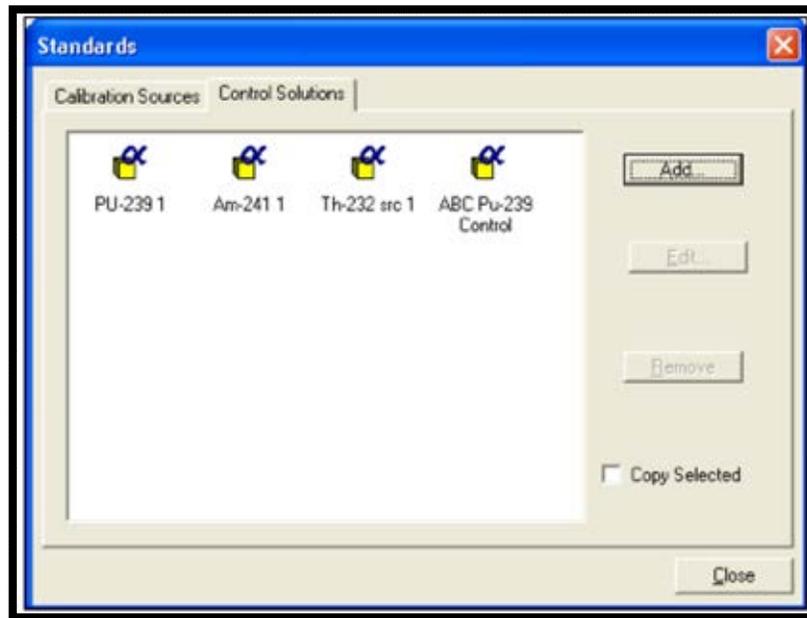


Figure 76. New Control Solution Added

There are three QA Types:

- **Chemical Recovery** – Tracks the chemical recovery (or yield) of a tracer and is selected at the Batch Properties level. It allows users to quickly discriminate between different sample types within a project, and between similar (but perhaps not quite identical) sample types for different projects.
- **Control Sample** – Tracks the recovery of control standards for specific projects and is selected at the Sample Properties level. In conjunction with Control Solution records, it allows users to create one Control Solution for a given element and vary the volume added from batch to batch within 1 or more projects. AlphaVision tracks the recovery regardless of the volume added from batch to batch.
- **Reagent Blank** – Tracks the count rate of batch blanks for specific projects and is selected at the Sample Properties level.
  - For Control Samples and Reagent Blanks, users must select an appropriate nuclide library to be used in determining nuclide recoveries.
  - Each time a new Control Sample or Reagent Blank QA Type is created, *and before analyzing samples that use the new QA Type*, go to the corresponding Control Sample and Reagent Blank tabs on the QA/QC Panel, select the new **QA Type**, choose the **Nuclides**, and enter limits for them. This activates AlphaVision's automatic QA records update for these two QA Type categories. ***If this step is forgotten, the user will have to go to QA mode, choose the nuclides, set limits, and update the affected analyses.***



Figure 77. Create QA Types to Track Recoveries and Count Rates

To create a QA Type:

- 1) On the menu bar, click **Edit/QA Types...** to open the main QA Types dialog (Figure 78). Click **Add...** to open the QA Type dialog (Figure 79).

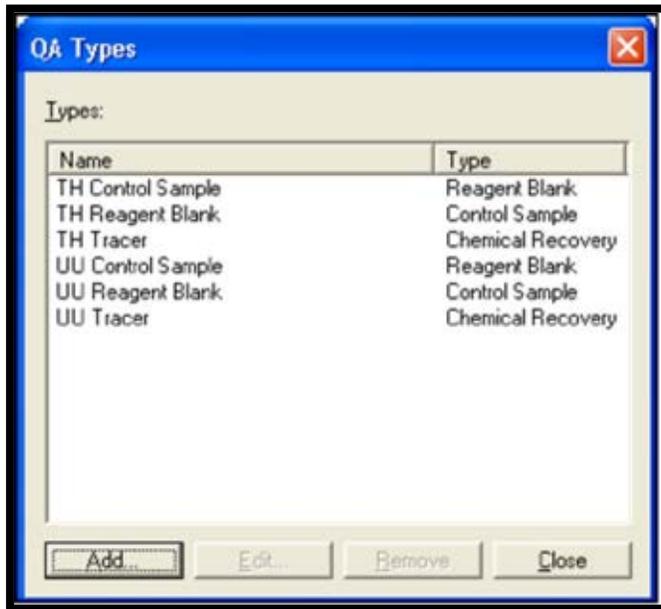


Figure 78. QA Types

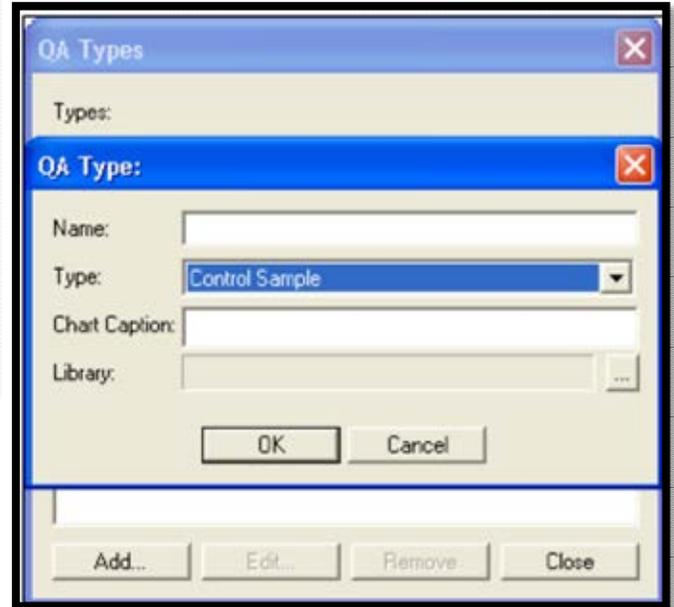


Figure 79. Adding New QA Type

- 2) Click the **Type** drop list and select a type.
- 3) Enter a descriptive **Name** for the new type.
- 4) Enter a **Chart Name** that describes the purpose of the resulting QA/QC control chart.
- 5) If a **Control Sample** type is chosen, a **Library** field will also be displayed. Click the browse (...) button and select the library created for this analysis (Figure 80), then click **OK** to return to the main QA Types dialog (Figure 81).
- 6) Click **Close** to return to the main AlphaVision screen.

**NOTE** In this release of AlphaVision, QA Types cannot be edited. Users must remove the QA Type then **Add** it back with the desired changes.

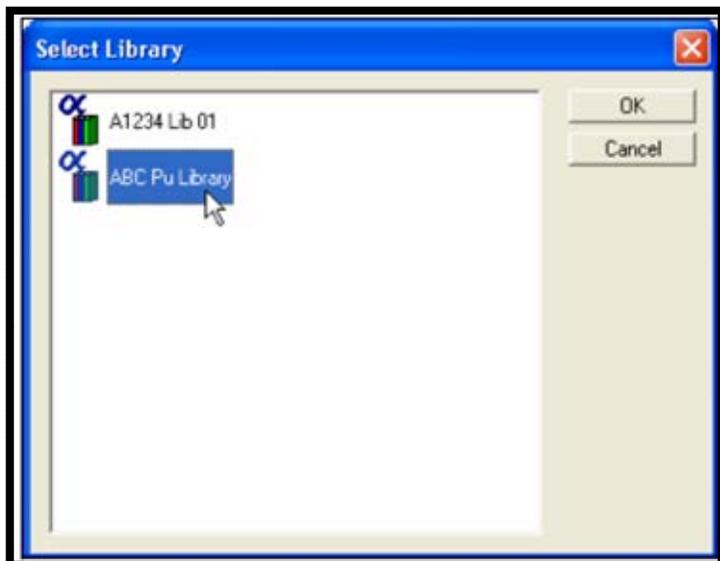


Figure 80. Select Library



Figure 81. QA Type Completed

## 8.6 THE ROI EDITOR

Analysis in AlphaVision is guided by *ROI Sets*, which are based on the nuclides to be monitored in a project's samples and their expected position within the spectrum. The ROI Editor lets users create and edit ROI Sets interactively in the Spectrum Window (Section 8.6.2.1) or manually from within the ROI Editor dialog (Section 8.6.2.2).

- The ROI Editor can be accessed by clicking **Edit/ROI...** or the **ROIs** button on the Toolbar; selecting **ROI Setup** on the Analysis Setup page in the Batch and Background Wizards; or opening the ROI Editor during manual calibration.
- ROIs can be defined in terms of channels or energy.
- Users may create as many ROI Sets as desired. Therefore, over time, the list of ROI Sets can become lengthy. The ROI Editor dialog lets users control the number of ROI Sets available on the drop lists in the Batch and Background Wizards with a "template/non-template" flag, as described in the next section.
- ROI Sets that are no longer needed can be deleted.

**NOTE** ROIs set in a background (as shown in a background report for example) are not directly used in a sample.

## 8.6.1 Managing ROI Sets with the “Template/Non-Template” Filter

As noted above, an unlimited number of ROI Sets can be created. The ROI Editor dialog lets users control the number of ROI Sets available on the drop lists in the Batch and Background Wizards by marking and unmarking the sets with a Template flag. Marking or unmarking the Template checkbox on various wizard dialogs and in the ROI Editor lets users see either the list of flagged ROI Sets or the unflagged sets.

This designation can be changed as often as desired to keep the ROI Set list uncluttered. Just open the ROI Editor, select the desired record, click **Save**, and mark or unmark the **Save as Template** checkbox.

## 8.6.2 Creating and Editing ROI Sets

The ROI Editor is designed to flow most smoothly when users create ROI peaks starting with the low channel and proceeding to the high channel; and when users work with the peaks in ascending energy order; that is, starting with the lowest-energy peak, continuing to the next highest, and so forth.

For the interactive method, a spectrum is needed. This can be a spectrum from the Batch or Calibration Explorer, or a live spectrum from a detector currently being calibrated. For the manual method, users will need a spectrum and/or a list of ROIs.<sup>13</sup>

### 8.6.2.1 Interactive Method

- 1) If creating this ROI Set at the end of a calibration, go to the Manual Energy and Efficiency Calibration dialog and click **Create New Set**. Otherwise, display the desired spectrum and click the **Edit/ROI** command or the **ROIs** button on the Toolbar.
- 2) The ROI Editor will open. Figure 82 shows AlphaVision screen, ROI Editor, and calibration dialog as they might be seen during a typical calibration.

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<sup>13</sup> It may be desired to run MAESTRO, select this detector, measure a test sample containing the tracers and expected analytes, and use the resulting spectrum to determine the ROI boundaries and centroids to be manually entered in the ROI Editor.

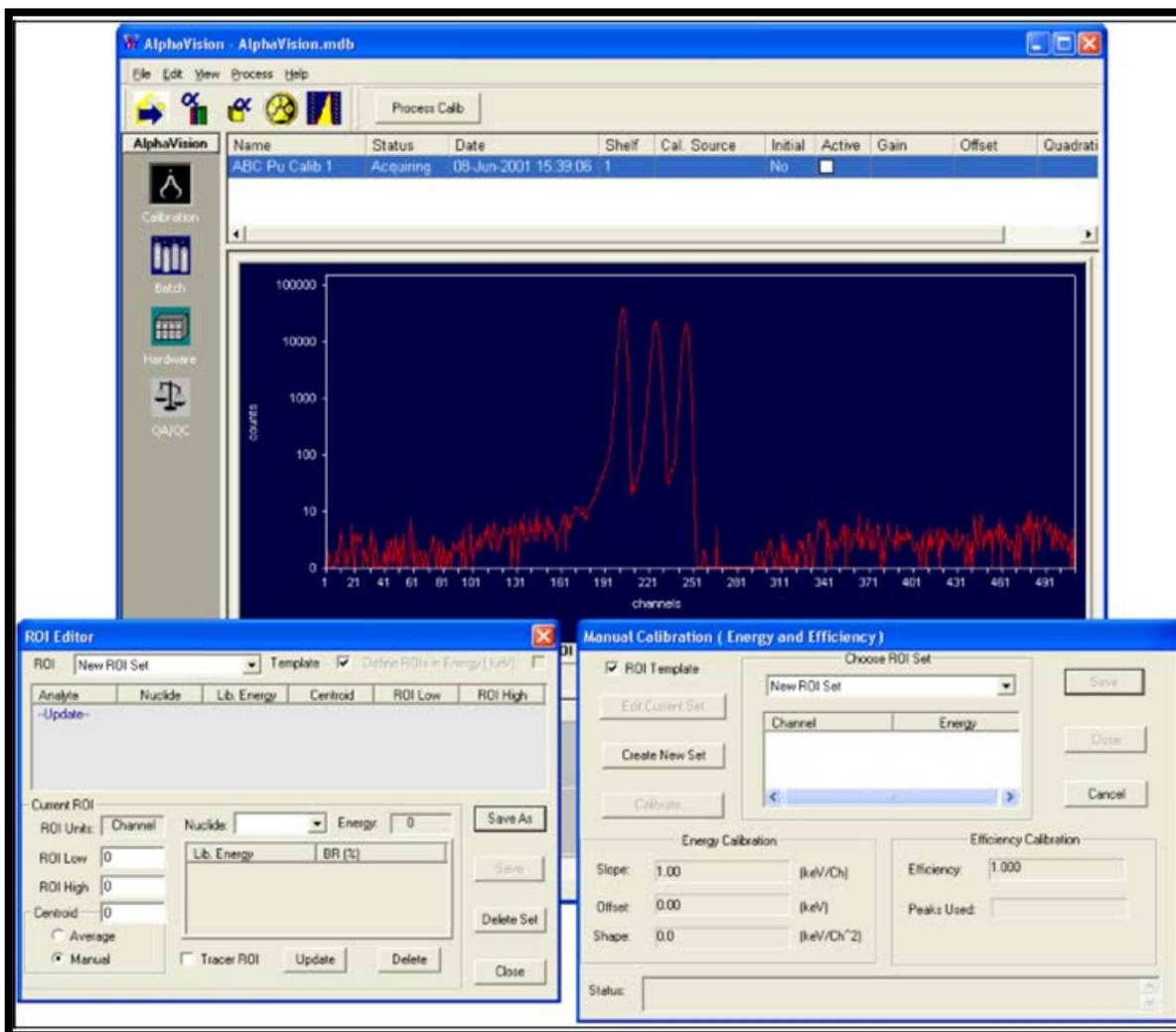


Figure 82. Ready to Create ROI Set as Part of Calibration

- 3) Go to the ROI list in the center of the editor and click the **-Update-** entry. This prepares AlphaVision to read the ROI start and end channels as users click and drag the mouse in the Spectrum Window.
- 4) Notice the **Define ROIs in Energy (keV)** checkbox in the upper right corner of the dialog. In Batch mode, AlphaVision 7 lets users define ROI Sets either in channels or energy (keV) by marking this box. In Calibration mode, ROI Sets are always expressed in channels. Mark the box as needed.
- 5) Next, zoom in on the lowest-energy peak(s) to be included in the ROI Set. Right-click in the Spectrum Window and select **Show Thumbnail** (Figure 83), then click and drag the mouse diagonally across the section of spectrum to be expanded. The spectrum window will zoom in and the Thumbnail will highlight the zoomed section of spectrum, as shown in Figure 84.



Figure 83. Show Thumbnail Selection

- 6) Users are now ready to define the ROIs. In the Spectrum Window, locate the lowest-energy peak to be included in the ROI Set.
- 7) Pressing and holding the **<Ctrl>** key, left-click the low-channel end of the ROI, drag the mouse to the high-channel end, then release the mouse button and the **<Ctrl>** key. This will mark the ROI and automatically enter its **Low** and **High** channels (or energies) in the ROI Editor (Figure 85).

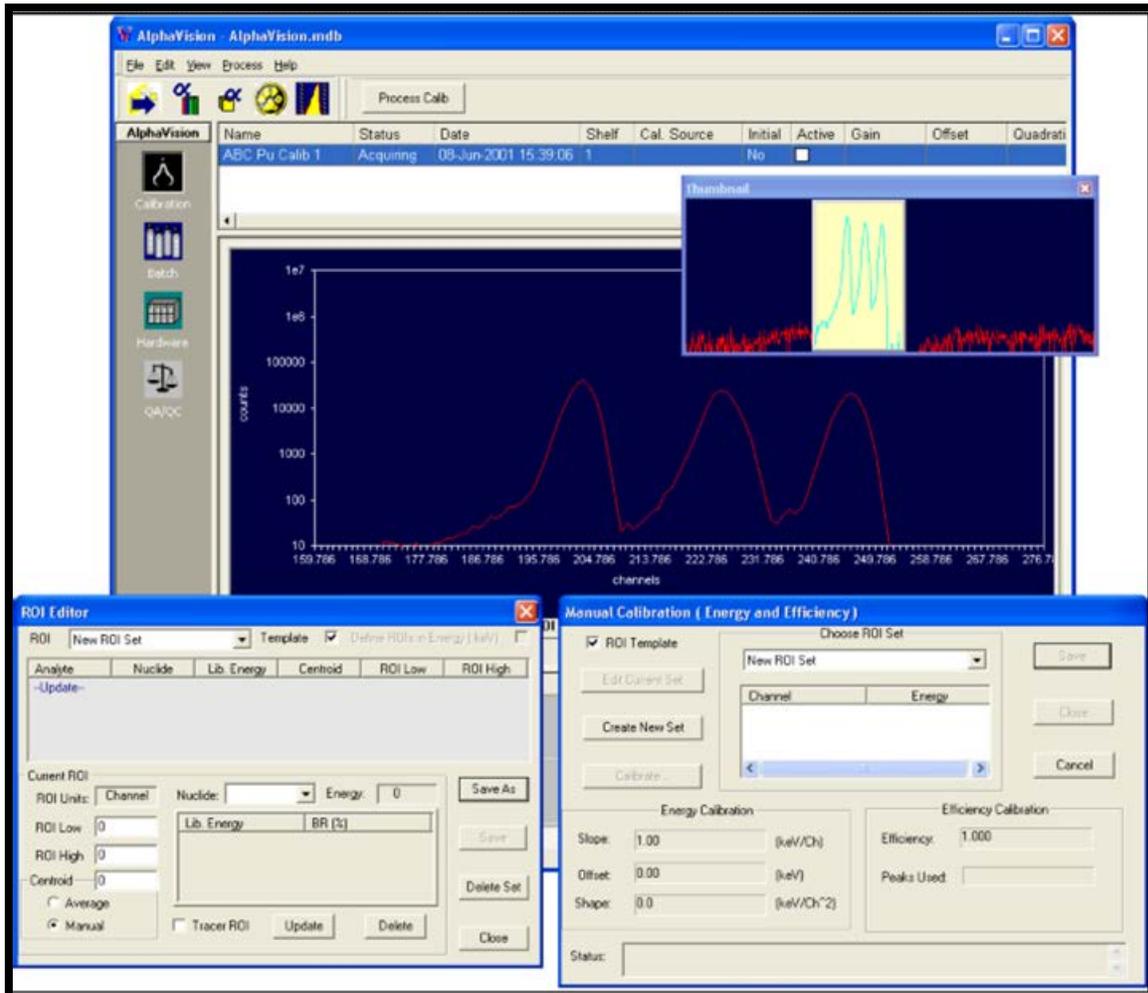


Figure 84. Zoom In on the ROI Peaks

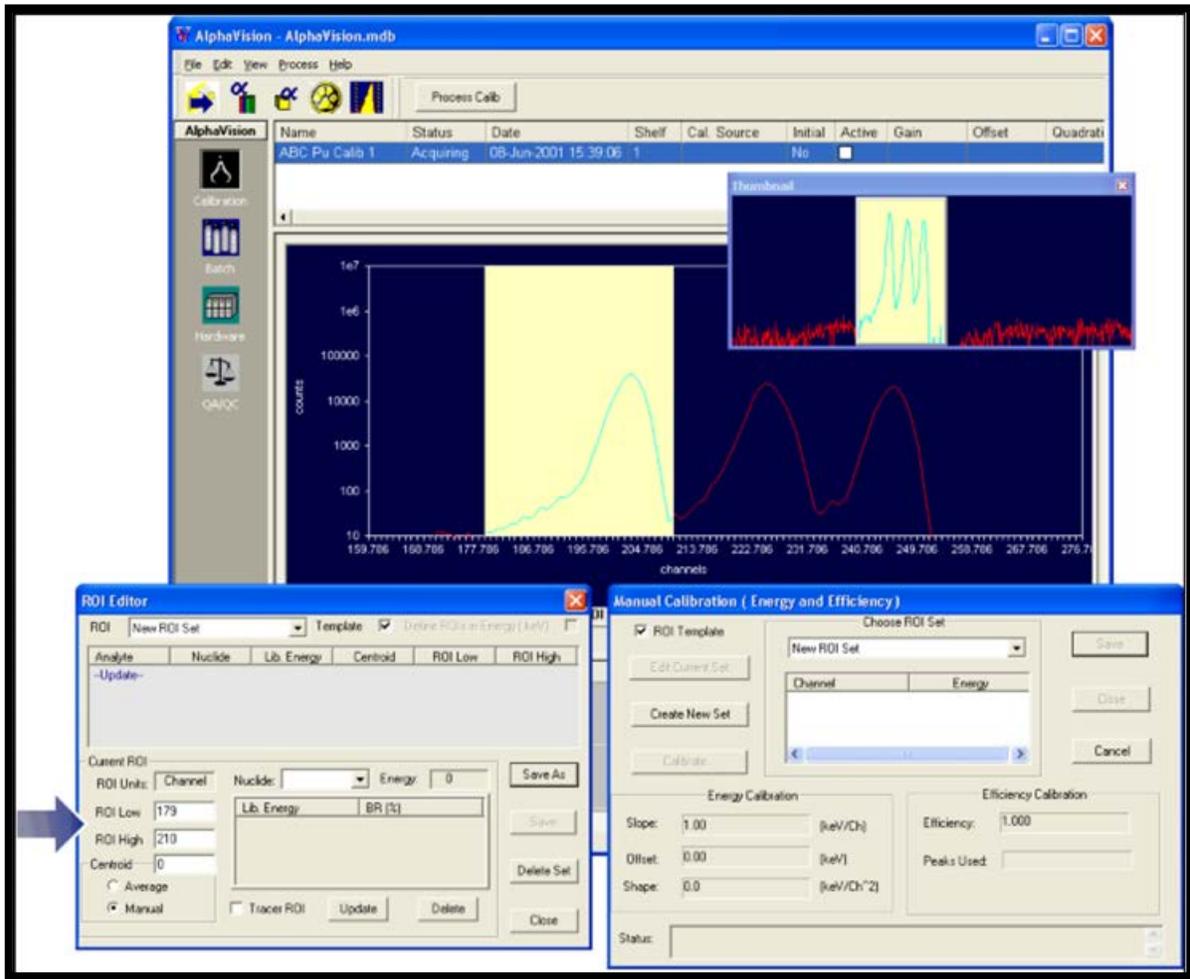


Figure 85. With <CTRL> + Mouse, Mark the ROI by Dragging the Cursor from Low to High Channel

- 8) Next, locate the peak centroid and click it. The channel (or energy) clicked will automatically be entered in the **Centroid** field (Figure 86). If the intended channel is missed, click again as needed to position it (or enter it from the keyboard).

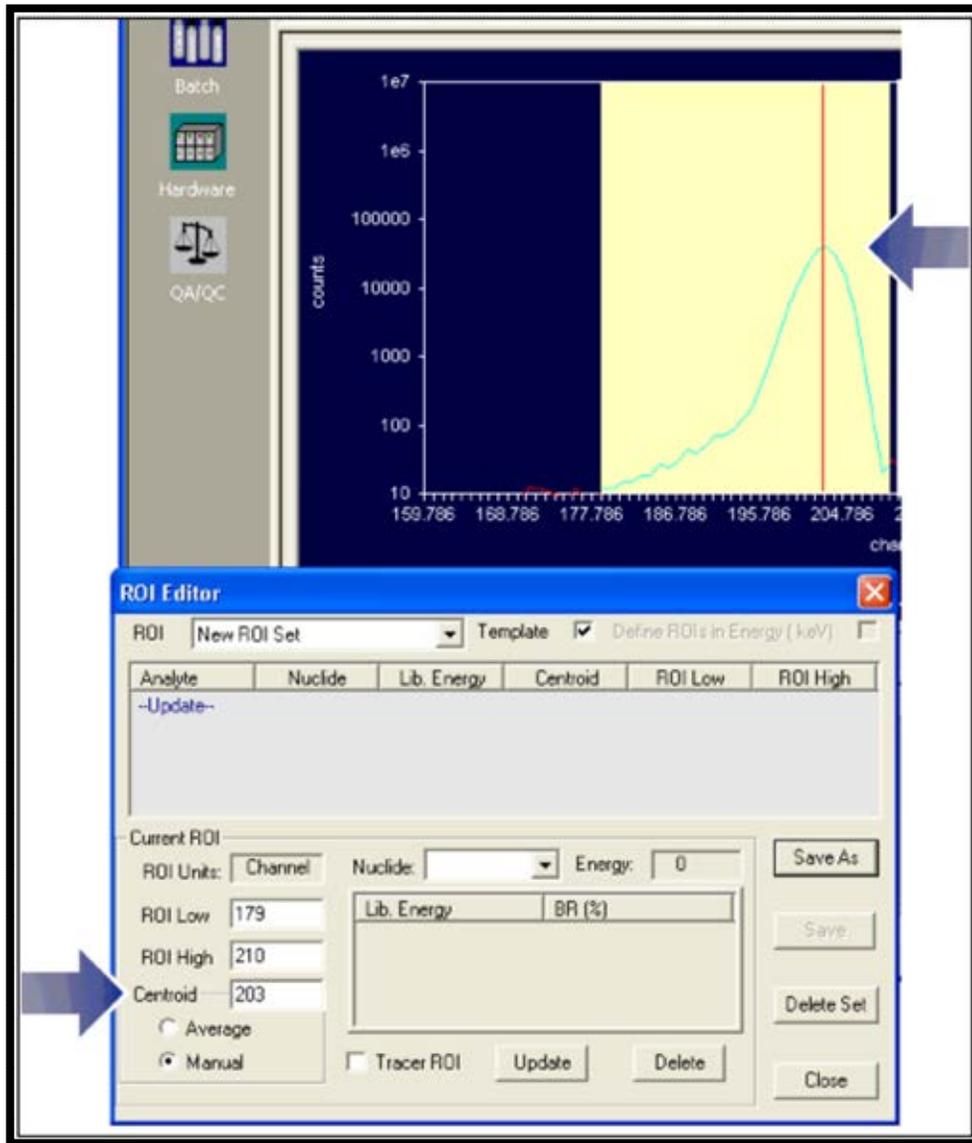


Figure 86. Click ROI Centroid to Enter it in Editor Window

- 9) In the ROI Editor, click the **Nuclide** drop list (Figure 87) and choose the nuclide that corresponds to the peak ( $^{148}\text{Gd}$  in this example).
- 10) Finally, click **Update** (Figure 87). The values selected will now be displayed in the main section of the ROI Editor (Figure 88). The first ROI for the ROI Set has now been successfully created.
- 11) Moving to the next-lowest-energy ROI, repeat this procedure; and continue until all peaks of interest have been added (Figure 89).

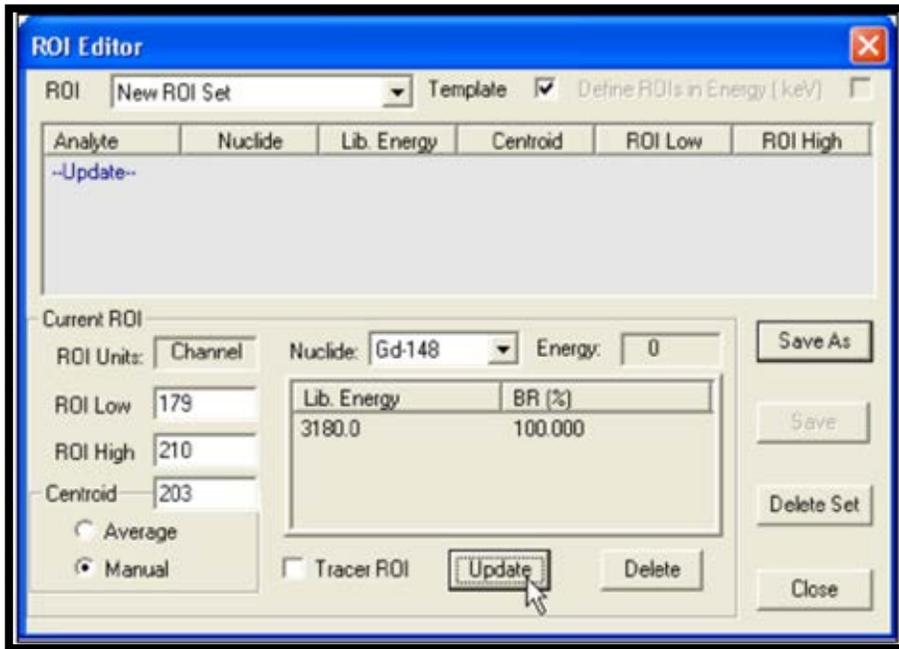


Figure 87. Select Library Nuclide and Click Update

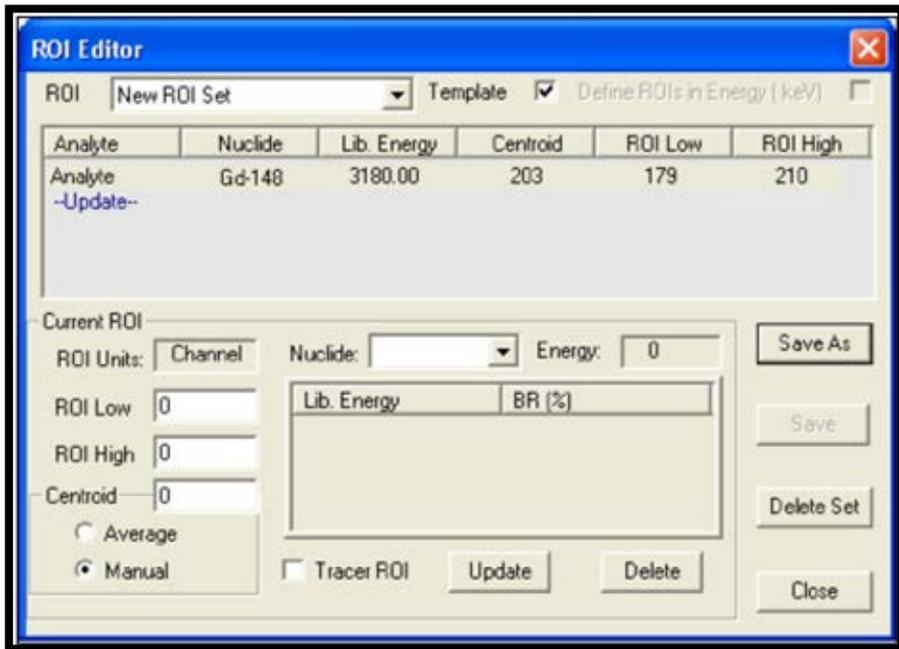


Figure 88. ROI Has Been Added to the ROI Set

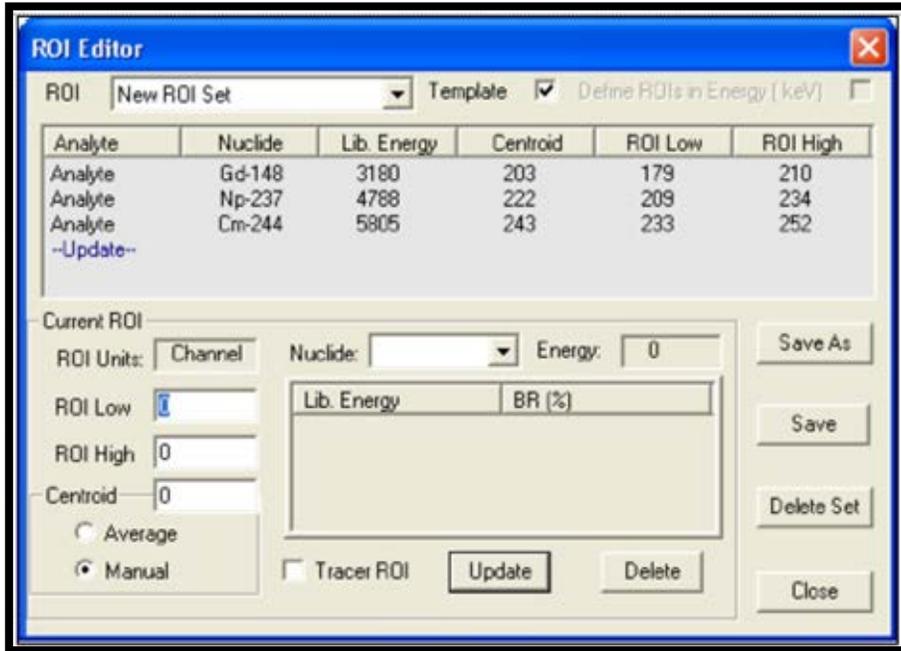


Figure 89. All Peaks Added to ROI Set

- 12) The new **ROI Set** is now ready to use. Click **Save**, enter a **New Name**, decide whether or not to mark the **Save As Template** checkbox, and click **OK** to close the editor window (Figure 90). If the user entered the ROI Editor from the Manual Energy and Efficiency Calibration dialog, AlphaVision will automatically load the contents of the new ROI Set into the calibration dialog.

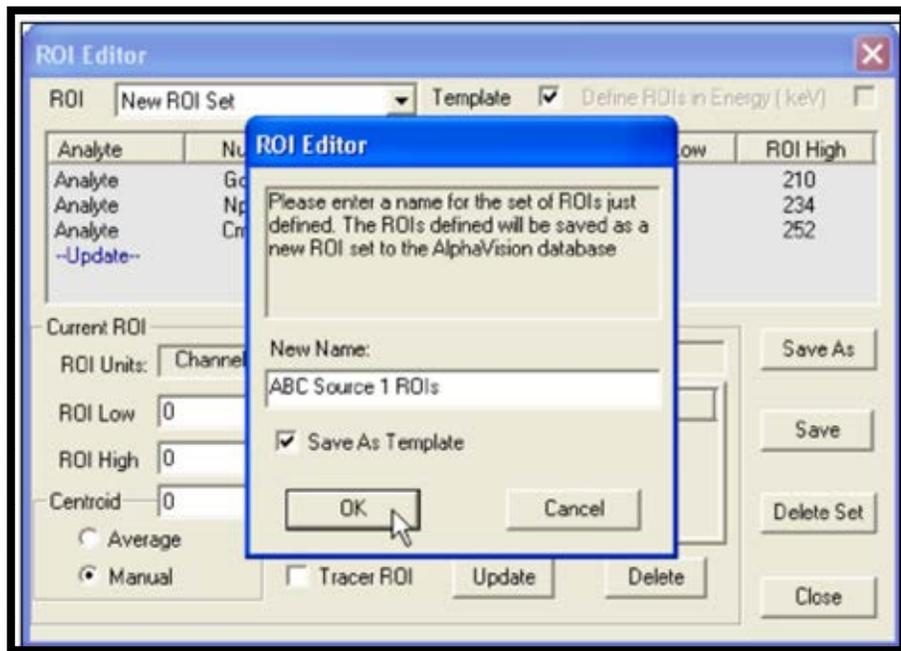


Figure 90. Save New ROI Set

### 8.6.2.2 Creating a New ROI Set Manually

All fields can be entered manually, with or without a detector and spectrum selected. Alternatively, *AlphaVision can use the detector's current calibration to suggest a starting channel for each ROI.* To use this feature, go to the Detector Grid and click a detector before opening the ROI Editor. When a **Nuclide** is chosen from the list, AlphaVision will associate the known energy with a channel number based on the selected detector's calibration. This value can then be edited as needed.

To create a new ROI Set:

- 1) Click **Edit/ROI** or the **ROIs** Toolbar button to open the ROI Editor.
- 2) Click the **-Update-** entry in the ROI list.
- 3) Notice the **Define ROIs in Energy (keV)** checkbox in the upper right corner of the dialog. In Batch mode, AlphaVision 7 lets the user define ROI Sets either in channels or energy (keV) by marking this box. In Calibration mode, ROI Sets are always expressed in channels. Mark the box as needed.
- 4) Click the **Nuclide** field and select from the drop list (which is drawn from the Master Library).
- 5) Nuclides in this list are considered by default to be **Analytes**. If this is a tracer, mark the **Tracer** checkbox. When the **Update** button is clicked, the designation will change from **Analyte** to **Tracer**.
- 6) Enter the **Low** and **High Channels**. To pinpoint the proper values to enter, click the spectrum and read the marker position from the Marker Information Line.
- 7) By default, the ROI **Centroid** feature is set on **Manual** so users can enter the centroid channel number from the keyboard (this is useful for peaks that tail markedly on one side). Instead click **Average** and AlphaVision will use the arithmetic mean of the low and high channel numbers to determine the **Centroid** channel.
- 8) To complete the entry, click **-Update-**. The new ROI will be added to the list. If the user is modifying an existing ROI Set, AlphaVision will automatically highlight the next ROI in the list so it is ready to edit. If desired, users can click any other ROI in the list and edit it at any time.
- 9) Repeat for the remaining ROIs.
- 10) To save the new ROI Set, click **Save As**. Enter a unique and descriptive name for this record. To designate this ROI Set as an ROI template, mark the **Save as Template** checkbox. Click **OK** to save and exit the ROI Editor.

### 8.6.2.3 Editing an ROI Set

This can be done manually, interactively, or using a mixture of both methods. This procedure also lets users modify an existing ROI Set and save it under a new name; or change an existing template ROI Set to non-template status, or vice versa.

**NOTE** If the ROIs for this set were originally defined in channels, the user cannot change to energy units and vice versa. In addition, the original library peak energies or branching ratios cannot be changed.

- 1) For interactive editing, click the desired detector and calibration spectrum or the desired Batch mode spectrum.
- 2) For both methods, click the **Edit/ROI** command or the **ROIs** button on the Toolbar to open the ROI Editor.
- 3) Unmark/mark the **Template** checkbox to locate and select the ROI Set to be edited.
- 4) Click the **Analyte** or **Tracer** peak to be edited. Manually change the low and high channels, centroid, and analyte/tracer status, and add or remove analytes/tracers as needed. In interactive mode, press and hold **<Ctrl>** while clicking and dragging to revise the low/high ROI channels, and click in the spectrum to reposition the centroid.
- 5) Put the changes into effect by clicking the **Update** button.
- 6) Repeat as needed for other ROIs in the set.
- 7) When finished editing and updating, click **Save** to overwrite the current record's contents.

To save the modified record as a new ROI Set, click **Save As** and assign a new name.

To change an ROI Set's template/non-template status, click **Save** (not **Save As**), answer **Yes** to the "do you really want to modify" query, change the marking in the **Save As Template** checkbox, and click **OK** to save and exit the editor.

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# 9. ORGANIZING AND USING THE BATCH EXPLORER PANEL



Figure 91.  
Batch Icon

The Batch Explorer Panel (Figure 92) is the most powerful feature in AlphaVision. As noted in the user interface chapter, it is the **primary organizational tool for and portal to the sample information in the AlphaVision database**. It is also the point of access to data imported from earlier versions of AlphaVision, detector background records, and QA pulser test spectra. It provides a visual representation of data organized in user-defined levels and sub-levels. This chapter explains how to use its many features and capabilities:

- Setting up the Batch Explorer Tree (Section 9.1)
- How samples, spectra, and analyses are displayed (Sections 9.2, 9.3)
- Analyzing and reanalyzing samples, changing batch properties (Section 9.4)
- Locating a specific batch or sample (Section 9.5)
- Exporting AlphaVision 7 spectra to .SPC spectrum files (Section 9.6)

The Batch Explorer Panel also has commands for counting and recounting samples, and changing counting presets. These are discussed in Section 11.2.1.1.

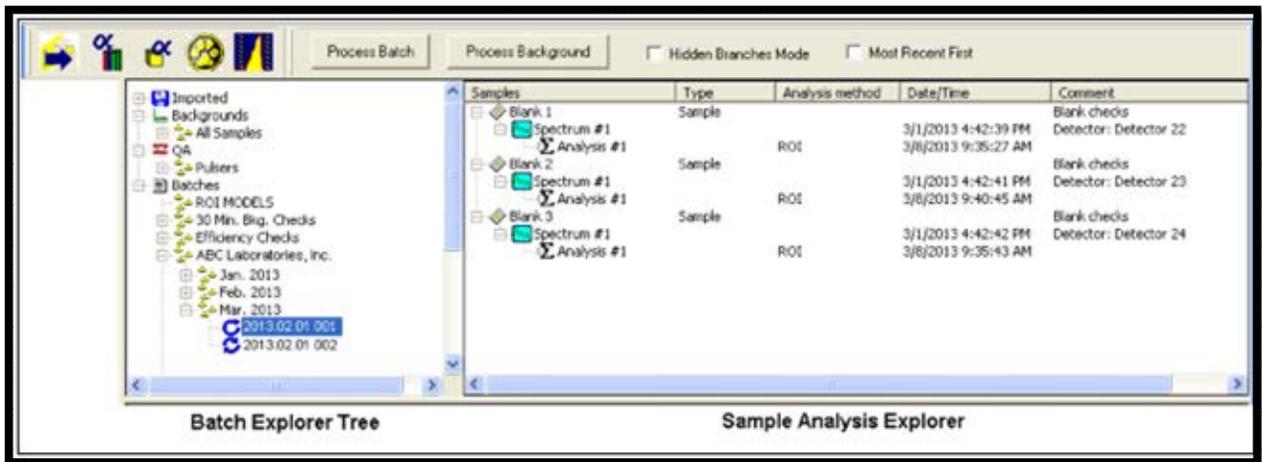


Figure 92. The Batch Explorer Panel: Batch Explorer Tree (Left) and Sample Analysis Explorer (Right)

## 9.1 SETTING UP THE BATCH EXPLORER TREE BEFORE A NEW PROJECT

AlphaVision does not allow users to modify the Batch Explorer Tree from within the various sample setup wizards. Therefore, it is recommended to create a sample tree structure at the start of each new project.

Headings with plus (+) boxes beside them contain subordinate entries. As users click a plus box, its subordinate “branches” expand one level. Click the minus box to collapse the branch.

- 1) In the left-hand side of the Batch Explorer Panel, the Batch Explorer Tree, right-click the part of the default tree labeled **Batches** and choose **Insert Branch...** from the right-mouse-button menu.
- 2) Enter the desired branch name in the Insert Branch dialog and click **OK**. A branch can be removed (right-click and select **Remove Branch...**) *until a batch has been assigned to it*.
- 3) Add as many branches and sub-branches as the project requires. Figure 93 illustrates this process.

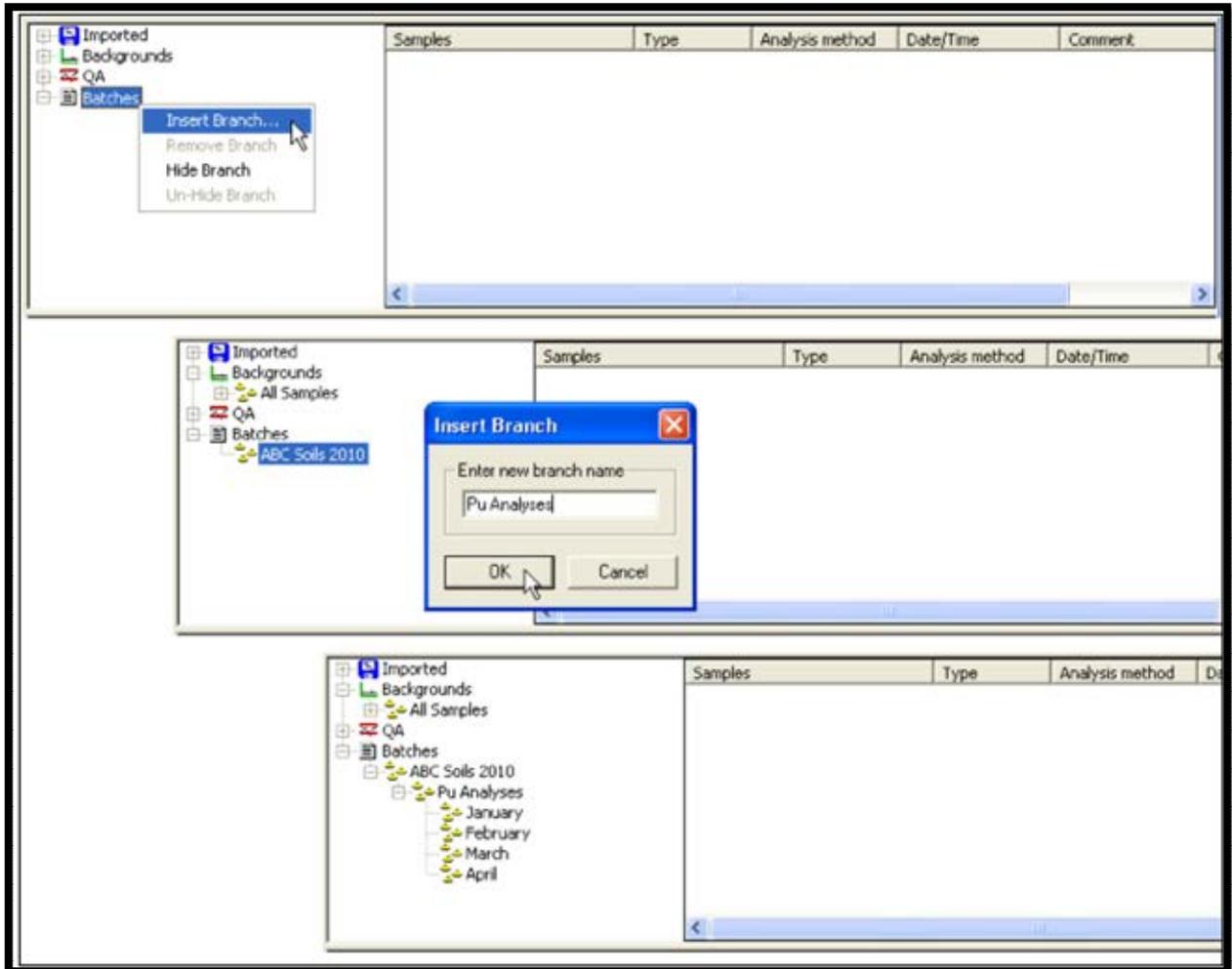


Figure 93. Creating a Three-Tiered Project "Tree"

- 4) Repeat this process as needed, including in the **Background** and **QA Pulser** sections of the tree.

## 9.2 BATCH, SPECTRUM, AND ANALYSIS DISPLAY

As soon as users click a wizard's **Finish** button, the record for the new batch or sample (indicated with an  icon) is added to the Batch Explorer Tree. Clicking on a batch record icon "opens" or expands the batch  and lists its sample entries on the right, in the Sample Analysis Explorer.

- As soon as data acquisition begins on a batch, spectrum records  are created in the Sample Analysis Explorer for each sample now being counted.
- A sample without a plus (+) box has not been counted yet, so it has no spectrum associated with it.
- A sample displaying a plus box has been counted at least once.
- Clicking on the plus box opens the list of all spectra collected for this sample. The number of spectrum icons indicates the number of times this sample has been counted. To display a spectrum, click its entry in the list, then click the Spectrum tab at the bottom of the Spectrum/Report Panel.

When acquisition ends, analysis automatically begins (if all of the required analysis elements have been entered). Once analysis is complete, an analysis record  is displayed beneath each analyzed spectrum.

- A spectrum without a plus box has not been analyzed (i.e., the **No Analysis** option was selected on Screen 5 of the Batch Wizard or not all of the necessary analysis elements were entered).
- A spectrum displaying a plus box has been analyzed at least once.
- Clicking on the plus box displays the most recent analysis performed on this spectrum. To display the analysis, click its entry in the list and then on the Spectrum tab.

Each analysis contains the information necessary to generate a report. To view, print, and/or export a Batch Report, locate and click the analysis of interest, then click the Report tab (Section 2.6). Report generation takes a few seconds.

## 9.3 MANAGING DATA DISPLAY IN THE BATCH EXPLORER PANEL

### 9.3.1 Simplifying the Batch Tree

It doesn't take long to fill the Batch Tree with the entries for completed projects. AlphaVision 7 gives two ways to keep the Batch Tree uncluttered and easy to read:

#### Hiding and Displaying Branches

Flag one or more of the branches in the tree as **Hidden**, then use the **View/Hide Branch** menu command or the **Hidden Branches Mode** on the Toolbar to control whether all flagged branches are displayed or hidden.

- To flag a branch for hiding, right-click it and select **Hide Branch**.

- To remove the flag, right-click and select **Un-Hide Branch**.

**NOTE** Keep in mind that the **Edit/Search** function cannot “see” hidden data.

### Creating New Databases

The other way to simplify the Batch Tree is by creating multiple databases with the **File/Database Management...** tools (Section 12.2).

## 9.3.2 Sorting the Batch Explorer Entries in Ascending or Descending Order

The **Most Recent First** checkbox on the Toolbar and the **View/Sort Descending** menu command invert the Batch Explorer Tree, reversing the order of the sample categories (e.g., **Imported, Background, QA, Batches**), and sorting the entries in each category newest-entry-first. Unmarking **Sort Descending** returns the sample categories to their original order and sorts the entries oldest-entry-first. Figure 94 compares the ascending and descending sorts.

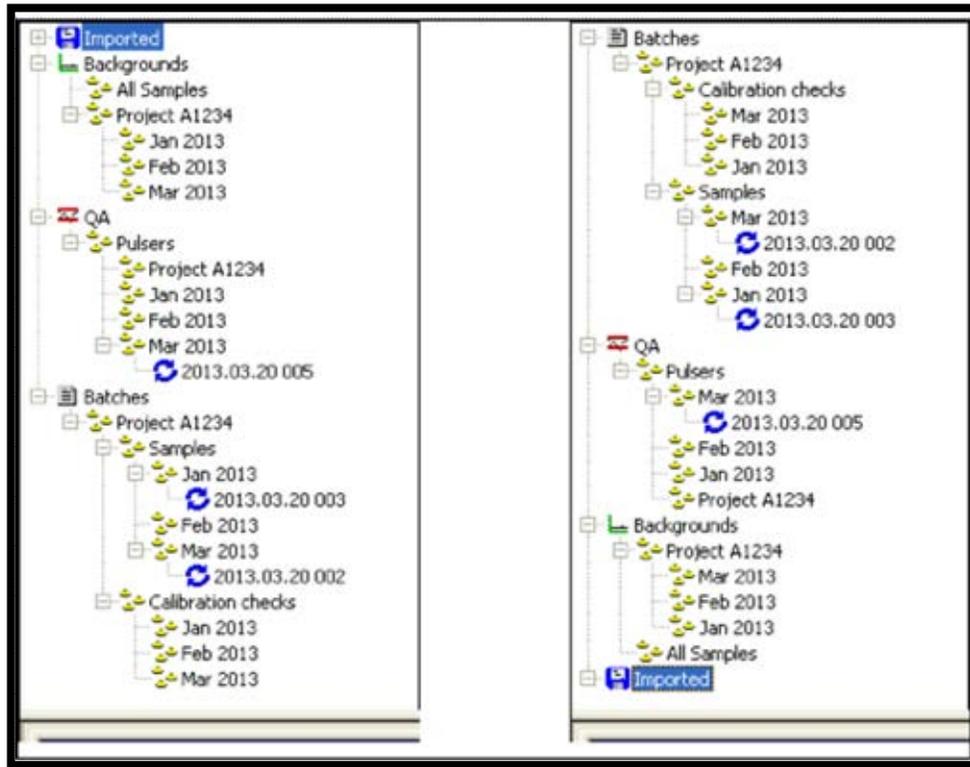


Figure 94. Batch Explorer Tree in Ascending and Descending Order

## 9.4 ANALYZING, REANALYZING, AND CHANGING SAMPLE PROPERTIES

The Batch Explorer Panel enables users to:

- Perform delayed analyses on one or more spectra in a batch.
- Reanalyze a spectrum with different parameters and add it to the list of analyses for that spectrum.

- Update (overwrite) an analysis after adjusting one or more parameters.
- Adjust the batch properties for one or more samples and update the analysis.

### 9.4.1 Delayed Spectrum Analysis

There are some circumstances in which users can acquire data without analyzing it – for instance, if a particular type of analysis (such as **ROI Based**) is specified without supplying the pre-defined information required for the analysis (such as a suitable ROI Set). The spectrum-level **Analyze** command lets users manually analyze one or more spectra at a time. To reanalyze a spectrum that has already been analyzed, see **Update Analysis**.

- 1) In the Batch Explorer Tree, locate the batch of interest and double-click to expand its spectrum and analysis list.
- 2) Use the mouse and the **<Ctrl>** and **<Shift>** keys to select the spectra to be analyzed.
- 3) Right-click one of the selected spectra and click **Analyze** on the right-mouse-button menu. This will open the Reanalysis Setup dialog. The 3 tabs in this dialog are identical to Screens 5, 6, and 7 of the Batch Wizard.
- 4) Adjust the analysis parameters and click **OK**. Analysis will start immediately and the resulting analyses for each spectrum will be added in the Sample Analysis Explorer.

### 9.4.2 Updating an Analysis

AlphaVision lets users reanalyze a spectrum after changing analysis method; calibration, back-ground, tracer, and ROI records; typographic errors; and/or peak-search-and-fit parameters. The reanalysis overwrites the previous analysis. *There is no “undo” except to restore the original settings.*

- AlphaVision uses *the detector’s most recent background* for the background subtraction during analysis.
- If updating an analysis and the background spectrum for that analysis is no longer in effect (i.e., a new background measurement has since been performed for that alpha chamber), users must *reselect the background in use when the spectrum was acquired*. The name of the correct background will be listed on the most recent Analysis Report for the sample. When the Batch Wizard opens, go to the **Background Spectrum** drop list on the Analysis Setup page and selecting the correct entry. (In this case, one sample at a time will need to be updated, making sure to select the correct background for each sample.)
- Also, if the calibration used in the analysis has been superseded (i.e., the detector has since been recalibrated), inactivated, or removed, AlphaVision will use the active calibration performed *closest to and before the acquisition date*.

To update an analysis:

- 1) Locate the batch of interest and double-click to expand its contents. Each sample will list of all spectra acquired from the sample, and each spectrum will list the most recent analysis performed on that spectrum. Click to highlight the analysis of interest.

- 2) Determine whether or not to adjust the ROIs and reanalyze with the **Interactive ROI Analysis** feature (Section 11.5).
- 3) Right-click one of the selected analyses and select **Update Analysis...** from the menu. This will open the Reanalysis Setup dialog. The three tabs in this dialog are identical to Screens 5, 6, and 7 of the Batch Wizard.
- 4) Change the analysis parameters as desired and click **OK**. Reanalysis will start immediately, and the new analysis will overwrite the previous record.

### 9.4.3 Changing Sample Properties

The **Modify Sample Properties** command lets users the sample properties for any or all samples in a selected background or sample batch (not QA Pulser Test batches). If users change a parameter involved in the calculation of results – for instance, a sample volume – a message asks if it is desired to update and overwrite the original analysis. ***There is no “undo” except to restore the previous values.***

Locate the batch to be modified, click to highlight it, then right-click and select **Modify Sample Properties...** from the right-mouse-button menu. This will open a dialog similar to Screen 3 of the Batch Wizard. Make the necessary changes, then click **OK**. Reanalyzed samples will show a current date/time stamp, and the Report will reflect the changes.

### 9.4.4 Performing Multiple Spectrum Analyses

AlphaVision lets users reanalyze one or more spectra in a batch and add the new analysis record(s) to the list of previous analyses. This gives the chance to change analysis method; calibration, background, tracer, and ROI records; corrections; and peak-search-and-fit parameters.

- 1) Locate the batch of interest and double-click to expand its contents. In the Sample Analysis Explorer pane, select one or more spectra to be reanalyzed (not analyses)
- 2) Right-click on one of the selected spectra and click **Analyze** in the right-mouse-button menu. This will open the Reanalysis Setup dialog. The three tabs in this dialog are identical to Screens 5, 6, and 7 of the Batch Wizard.
- 3) Change the analysis parameters as desired and click **OK**. Reanalysis will start immediately.
- 4) When the analysis is complete, an additional analysis icon (Figure 95) will be displayed for each reanalyzed spectrum.

Samples	Type	Analysis method	Date/Time
Batch A20 Pu Control	Control		
Spectrum #1			01/11/13 18:22:50
Analysis #1		ROI	01/11/13 18:22:53
Batch A20 Blank Control	Blank		
Spectrum #1			01/11/13 18:22:51
Analysis #1		ROI	01/11/13 18:22:54
Sample 01	Sample		
Sample 02	Sample		
Sample 03	Sample		
Spectrum #1			01/11/13 18:22:51
Analysis #1		ROI	01/11/13 18:22:54
Analysis #2		Peak	01/12/13 12:02:45
Analysis #3		ROI	01/12/13 15:06:52

Figure 95. Multiple Analyses of a Spectrum

## 9.5 SEARCHING FOR A SPECIFIC (UNHIDDEN) BATCH OR SAMPLE

The Search command on the Edit menu is only enabled in Batch Mode. This command helps quickly locate a specific *unhidden* batch or sample in the current database. *All data categories in the Batch Explorer panel are searched, including imported records.* The search dialog is shown in Figure 96.

Before selecting Edit/Search, decide whether to (1) search all entries in the Batch Explorer panel by turning View/Hide Branch off; or (2) use the Hide Branch and View/Hide Branch commands to mask certain parts of the database from this search tool.

- 1) Select **Edit/Search**.
- 2) Choose either **Batch** or **Sample**, then narrow the search by entering all or part of the record **Name** and/or a range of dates.
- 3) If the database is large, it may be desired to specify the **Maximum** number of records to be retrieved.
- 4) Click **Search** to generate the list of records matching the criteria. The **Found** field shows the number of hits.
- 5) Locate the desired **Batch Name** or **Sample Name** in the results list, then double-click it or highlight it and click **View**. When a batch is selected for viewing, its component samples are displayed in the Sample Explorer panel. When a sample is viewed, it is highlighted in the Sample Explorer, and its spectrum is displayed.

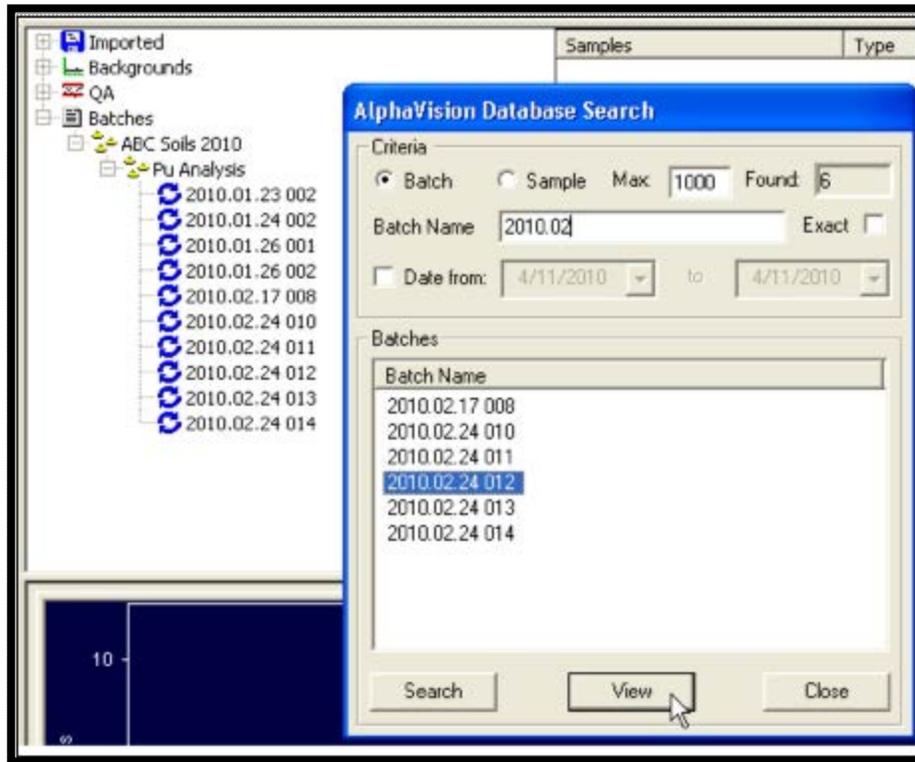


Figure 96. Quickly Locate and Display a Specific Batch or Sample Record

## 9.6 EXPORTING SPECTRA TO .SPC SPECTRUM FILES

AlphaVision 7 lets users export spectra as .SPC-format spectrum files, which can then be viewed and manipulated in MAESTRO and other CONNECTIONS applications. To do this, right-click in the Batch Explorer Panel on the desired spectrum  (Figure 97) or on the spectrum Windows, then choose **Export...** from the right-mouse-button menu. A message box will display the name of the new spectrum file. The .SPC files are exported to the user specified folder, which by default is C:\User\AlphaVision\Spectra folder. Filenames are based on the batch name, sample name, and comment string.

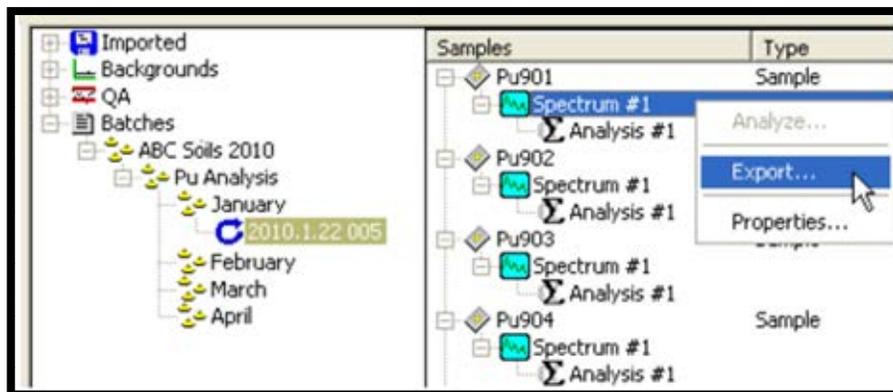


Figure 97. Export Spectra as .SPC Files

## 10. QUALITY ASSURANCE/QUALITY CONTROL



Figure 98.  
QA/QC Icon

AlphaVision's quality assurance (QA) tools allow users to collect and analyze data to ensure that the spectroscopy system meets the requirements of ANSI N13.30. Users define the QA *warning limits* and *error limits*<sup>14</sup> required to satisfy reporting requirements. If the control limits are exceeded, the event is posted to the Event Window and reflected in the control charts and reports.

AlphaVision can track any or all of the following parameters:

- Background (Total and Isotope-specific) (Section 10.4)
- Calibration (Energy and Efficiency) (Section 10.5)
- Hardware (Detector Bias and Chamber Pressure) (Section 10.6)
- Pulser (Center and Width) (Section 10.7)
- Control Sample Activity (Section 10.8)
- Reagent Blank Activity (Section 10.8)
- Tracer Peak Shape (Section 10.9)
- Chemical Recovery (Section 10.10)

Test results are stored in the AlphaVision database for review, control charting, and reporting.<sup>15</sup>

*As soon as a new detector is added to the Detector Grid, it is recommended to perform an initial calibration and defining its QA control limits so data collection for the new detector starts immediately.*

### 10.1 HOW ALPHAVISION CAPTURES QA/QC DATA

- AlphaVision uses a type of data record called a QA Type as a tool for tracking the recovery history of tracers and control samples, and the count rate of reagent blanks for specific projects. The QA Type Editor is discussed in Section 8.5.

**NOTE** If a QA Type is deleted, the corresponding control charts can no longer be accessed.

- The background, calibration, bias, and chamber pressure tests are performed from the **QA/Tests** submenu based on current operating conditions. When users run one of these tests, AlphaVision analyzes the detector's current/working background or calibration records or monitors alpha-chamber operating conditions. It then updates the corresponding control chart.
- Tracer peak shape and chemical recovery tests are also performed from the **QA/Tests** submenu, based on existing analysis results. When users run one of these tests, AlphaVision locates and evaluates database records that have not yet been tested.

<sup>14</sup> Error limits were called "alarm limits" in earlier versions of AlphaVision.

<sup>15</sup> AlphaVision v4 and earlier had a separate QA database.

Tracer peak shape is performed by nuclide across all QA Types. Chemical recovery is based on the existing Chemical Recovery QA Types.

- QA data for control sample and reagent blank activities are extracted continuously from the analysis records, based on the Control Sample and Reagent Blank QA Types. Each QA Type has its own user-defined control limits and a corresponding QA/QC control chart.
- Pulser amplitude and width are determined from a data acquisition with the **Process Pulser** command on the Toolbar and the QA **Process** menu (Section 10.7). For this test, AlphaVision uses a wizard to guide users through the setup of all test parameters. Users can optionally streamline pulser test setup by creating one or more pulser templates with a customized set of data acquisition and reporting preferences. Once the pulser test template(s) have been created, just start the QA Wizard, choose the desired template, and data collection is ready to start.

### 10.1.1 Deleting QA Data Points from the Database

The **Database Management** tools allow users to delete bad QA measurements from the database, hence, from the QA/QC control charts. See Section 12.2.

## 10.2 QA/QC CONTROL CHARTS

The QA results are tracked on *control charts* that show both the data and QC limits (see Figure 8). Users can also view individual background and QA test spectra and analysis results from the **Backgrounds** and **QA** sections of the Batch Explorer Panel. Once a specific analysis has been retrieved, users can view, print, or report it from the Report Window.

## 10.3 SETTING UP QA/QC

AlphaVision QA/QC requires a well-planned setup and the periodic performance of hardware tests according to the user's laboratory's standard procedures and contractual agreements, but otherwise proceeds with very little effort on the user's part. The remainder of the chapter discusses the following:

- Setting up QA/QC control limits, generating control charts, and generating QA reports.
- Setting up the QA Pulser wizard and creating pulser test templates.
- Using the Batch Explorer Panel to access QA, background, and isotope-specific background spectra, analyses, and reports

(See also the QA testing example in the Tutorial, Appendix A.)

The Limits view (Figure 99) contains 5 tabs for establishing the **Low** and **High Warning** limits and the **Minimum** and **Maximum Error** limits for all detectors, tracers, and QA Types. The tab selected here governs which control chart and QA report will be generated in the Chart and Report views.

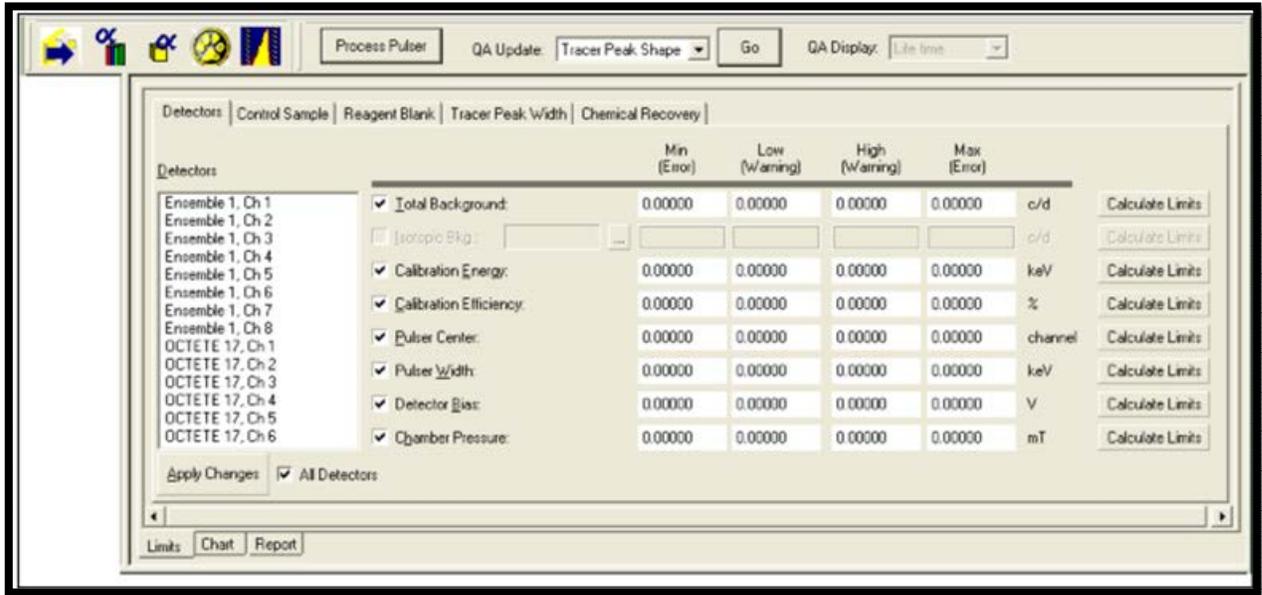


Figure 99. The QA Panel Detectors Tab

### 10.3.1 Calculate Limits

Notice that each parameter has a **Calculate Limits** button beside it. This feature does not function until at least 5 data sets have been collected for that parameter. **Calculate Limits** averages the existing values for a parameter and calculates  $2\sigma$  and  $3\sigma$  at the 95% confidence level. The mean  $\pm 2\sigma$  becomes the **Warning** limits, and the  $\pm 3\sigma$  is used for the **Error** limits. Users can then manually modify the calculated limits if desired.

## 10.4 THE BACKGROUND TEST

The **Background** test is detector-specific and evaluates the overall background and isotope-specific background. It can be used to detect contaminated chambers, even when contamination builds up over a long period of time. The background is expected to be small and hence have high counting uncertainty. The warning and error levels are determined by viewing a representative background in MAESTRO. Setting very small (but non-zero) minimum values will show when there are no counts in the spectrum at all, which usually indicates a problem.

Each detector's current background spectrum is used for the test. If a detector has no background spectrum or its current background has already been tested, it is skipped.

**Isotopic Background** is calculated the same way, but only for the counts in the user-defined ROI for the nuclide being tested.

### 10.4.1 Total Background Limits

To set the **Total Background** control limits for a detector:

- 1) Click the QA screen's Detectors tab.

- 2) On the Detector Grid, click the desired detector. To assign the same limits to more than one detector, select them with the **<Ctrl>** key and mouse. To assign the same limits to all detectors, mark the **All Detectors** checkbox.
- 3) Enter the **Min**, **Low**, **High**, and **Max** control limits.
- 4) Mark the **Total Background** checkbox.
- 5) Click **Apply Changes**.

## 10.4.2 Isotopic Background Limits

There are 2 ways to set up the ROIs used in the Isotopic Background QA test. Both ROI setup methods are available only in QA mode, and both are fast and easy to use. ROI settings can be changed at any time.

- Click **QA/Edit Isotopic Background ROIs...** and set ROIs for 1 or more nuclides in the Isotopic Background ROI Editor.
- On the QA Panel's Chart view, click the Detectors tab, select the **Isotopic Background** radio button, and set up the ROI for 1 nuclide by clicking **Edit ROI**.

### 10.4.2.1 Using the Isotopic Background ROI Editor

Setting up nuclide ROIs in the editor dialog is simple and quick:

- 1) Select the nuclide of interest and click **Edit** to open the ROI dialog for the selected nuclide.
- 2) Enter the ROI **Start** and **End** fields in keV and click **OK**.

This is illustrated for <sup>243</sup>Am in Figure 100.

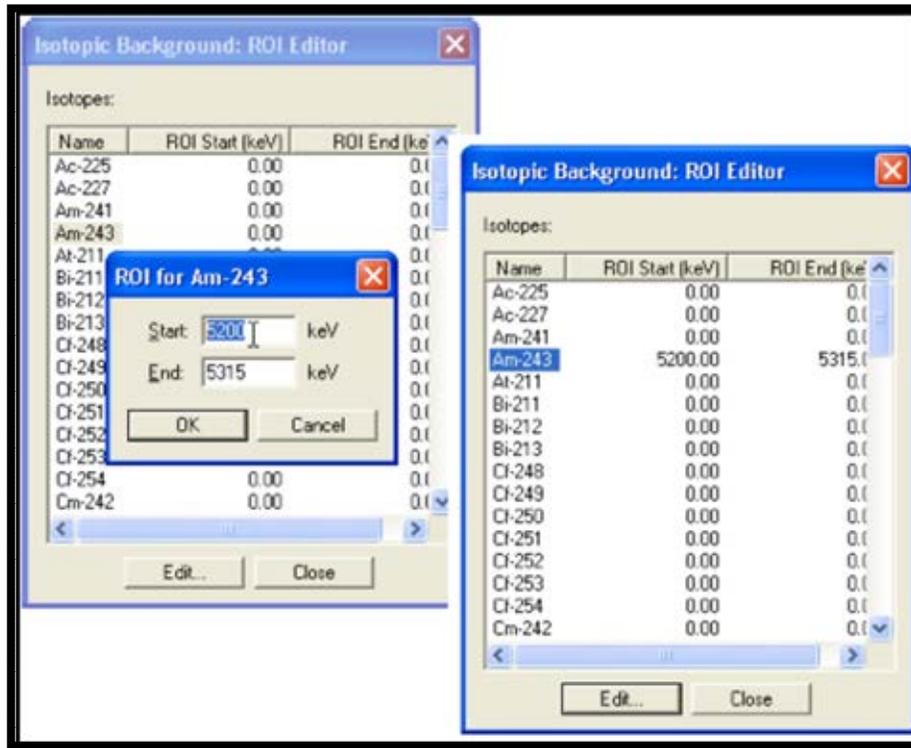


Figure 100. Set Isotopic Background ROI in Editor Dialog

#### 10.4.2.2 Using the QC Chart View

ROI setup on the Chart view is just as easy:

- 1) Click the Detectors tab at the top of the QA Panel, then click the Chart view at the bottom of the panel. Click the **Isotopic Bkg** button to display that chart and the ROI fields.
- 2) If the nuclide of interest is not currently displayed, click the browse (...) button to open the nuclide list and choose the nuclide whose ROI it is desired to enter or modify.
- 3) Click **Edit ROI**. This will open the ROI dialog for the selected nuclide.
- 4) Enter the ROI **Start** and **End** fields in keV and click **OK**.

Figure 101 illustrates this for  $^{243}\text{Am}$ .

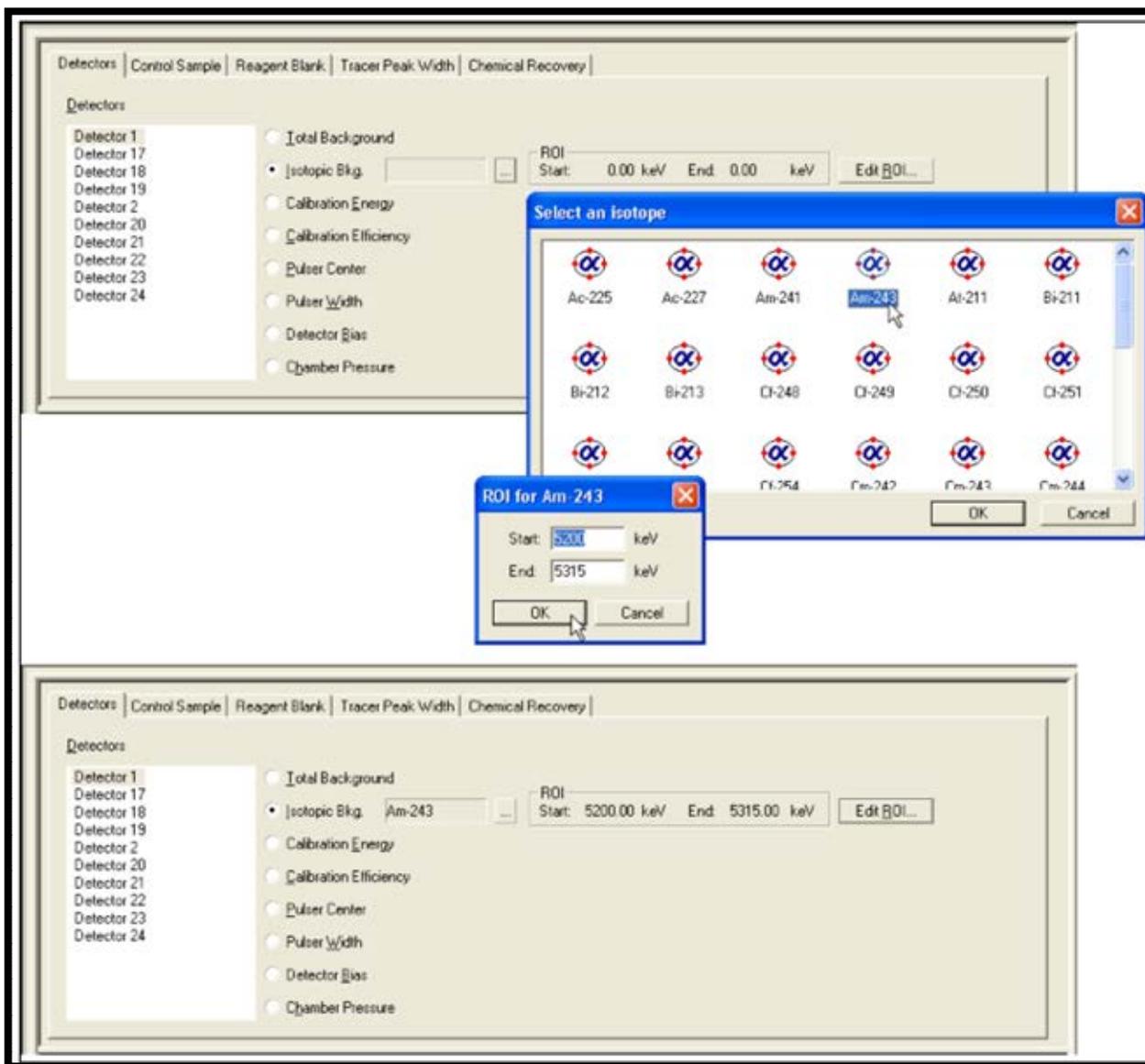


Figure 101. Configuring an Isotopic Background

### 10.4.3 Performing the Background Tests

- 1) On the Detector Grid, click the detector to be tested.
- 2) Click **QA/Tests/Background**. AlphaVision will analyze the data for this detector.
- 3) When the analysis is finished, click the Detectors tab at the top of the QA panel. In the Detectors list, click the detector just tested.
- 4) Go to the bottom of the QA Panel, click the Chart view and the button for the Control Chart to display.
- 5) To view the Isotopic Background Control Charts:

- If the nuclide of interest is not displayed, click the browse (...) button and choose the nuclide (nuclides can be switched at any time).
  - The ROI boundaries can be changed at any time with either **Edit ROI** or **QA/Edit Isotopic Background ROIs....** AlphaVision will recalculate new Control Charts as the ROIs are changed.
- 6) Click the Report tab to view the QA Report, from which users can print and/or export the analysis results and a picture of the corresponding chart.

## 10.5 THE CALIBRATION TEST

This test is detector-specific and uses the detector's current energy and efficiency calibrations. If a detector has no calibration or has already been tested, it is skipped. The calibration **Energy** value is calculated as the energy at the midpoint of the spectrum (i.e., for 512 channels, the energy is calculated at channel 256). Detector **Efficiency** is directly checked with the control limits.

The warning and error levels are determined by examining the energy and efficiency Calibration Reports. The expected variation is small for both of these parameters. Set up the control limits as described for Total Background.

To perform the Calibration tests:

- 1) On the Detector Grid, click the detector to be tested.
- 2) Click **QA/Tests/Calibration**. AlphaVision will poll for current operating conditions and analyze the data for this detector.
- 3) When the analysis is finished, click the Detectors tab at the top of the QA panel. In the Detectors list, click the detector just tested. In addition, check the Chart and Report views.

## 10.6 THE HARDWARE TEST

This test monitors the **Bias Voltage** and **Chamber Pressure** for MCBs supported by the Hardware mode interface (e.g., OCTÊTE-series, AlphaSuite, and OASIS instruments). Unlike the other QA tests, it is performed on one alpha chamber/detector at time, which is selected on the Detector Grid just before testing. The warning and error levels for the bias voltage are determined from the detector data sheet and allow a 25% to 50% tolerance. The warning and error levels for the chamber pressure are determined by experience.

- The OCTÊTE PC pressure gauge has an upper limit of 999 mTorr and reports 1000 mTorr for all values above this. The OCTÊTE-PLUS pressure gauge has a range of 10 mTorr to 30000 mTorr. (For other MCAs, see the hardware manual.) The lower limit of the chamber is a few mT, so the low warning and error limits can be set very small (or at zero) to detect *electronic failures* rather than *pressure failures*. Set up the control limits as described for Total Background.

To perform the Hardware tests:

- 1) The bias voltage and chamber pressure used in the test are acquired from the detector when the test executes so make sure the bias voltage is on and the chamber evacuated.
- 2) On the Detector Grid, click the detector to be tested.
- 3) Click **QA/Tests/Hardware**. AlphaVision will poll for current operating conditions and analyze the data for this detector.
- 4) When the analysis is finished, click the Detectors tab at the top of the QA panel, then select the detector just tested. See also the Chart and Report views.

## 10.7 THE PULSER TEST

The Pulser QA test is different from the other hardware QA tests. It requires a data acquisition, so it is performed with the **Process Pulser** Toolbar button or the **Process/Pulser...** command, which starts the QA Wizard.

This test monitors the center and width of the electronically generated pulser peak in MCAs with a built-in pulser (such as the Alpha Aria, Duo, Mega, and Ensemble; OCTÊTE series; and OASIS). This allows users to verify the long-term stability of the preamplifier, amplifier, and ADC. The position of the pulser peak is fixed by the electronics and should not vary as a function of time. The width of the pulser peak is normally very small, but some instruments, such as the OCTÊTE and Alpha Suite series, are designed to add the detector noise to better assess overall performance. The warning and error limits are determined by examining the pulser peak in MAESTRO or by using the **Calculate Limits** feature described in Section 10.3.1. Set up the control limits as described for Total Background.

Perform this test as follows, referring to the instructions for the Background Wizard (Section 11.1) with the exception that no control solutions, tracer records, etc., are required:

- 1) From the Hardware mode interface and/or MCB front panel, turn on the pulser for the alpha chamber(s) to be tested and, as applicable, adjust the pulser channel.
- 2) On the Toolbar, click **Process Pulser**, set up the QA Wizard with a null sample for each alpha chamber to be tested. If the **Auto-sample** feature is used (Section 11.4.3.1), it will automatically create samples labeled with the names of the detectors selected for testing.
- 3) Click **Finish** to open the Detector Assignment Worksheet. If **Auto-assign** was not used, refer to the instructions in Section 11.2 to assign the alpha chamber(s) to be tested, then click **Start Now** to begin the test. Figure 102 shows the first 4 QA Wizard screens (the Report screen is not shown) and Figure 103 the corresponding Detector Assignment Worksheet.
- 4) While acquisition is in progress, users can monitor the accumulating spectrum by locating the Pulser test in the QA section of the Batch Explorer Panel and clicking on the spectrum icon .

- 5) Notice that if MAESTRO is installed the presets entered in MAESTRO can affect counting time in AlphaVision. If an AlphaVision pulser test terminates before the count time entered here, open MAESTRO and clear all presets, then exit MAESTRO and recount the pulser batch.

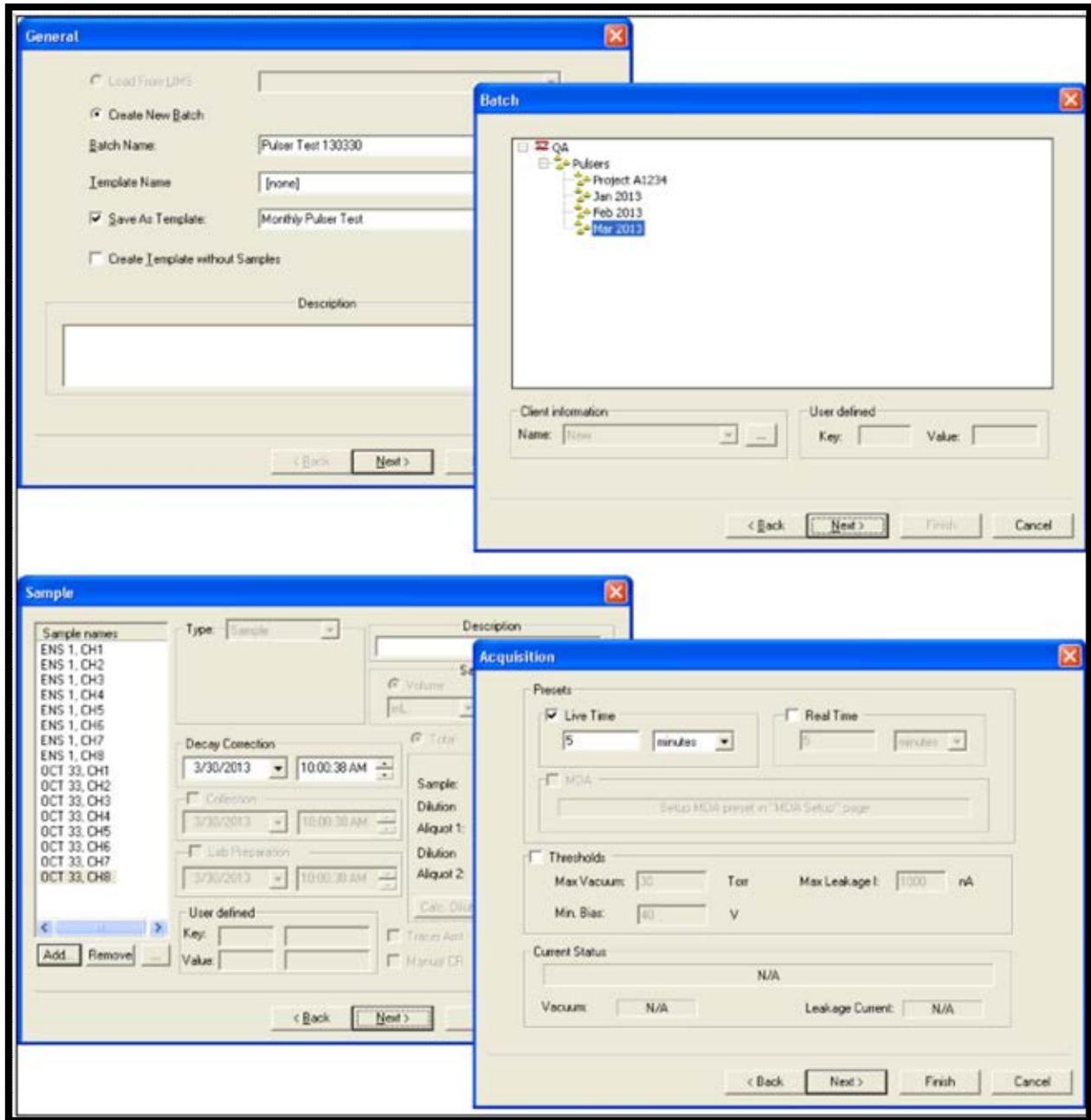


Figure 102. QA Wizard with Samples for Each Alpha Chamber to be Tested

- 6) When acquisition is complete, switch back to QA mode and click the Detectors tab at the top of the QA Panel. In the Detectors list, click the detectors just tested, and view the corresponding Chart and Report views.

Sample Name	Detector Name	Count
ENS 1, CH1	ENS 1, CH1	<input checked="" type="checkbox"/>
ENS 1, CH2	ENS 1, CH2	<input checked="" type="checkbox"/>
ENS 1, CH3	ENS 1, CH3	<input checked="" type="checkbox"/>
ENS 1, CH4	ENS 1, CH4	<input checked="" type="checkbox"/>
ENS 1, CH5	ENS 1, CH5	<input checked="" type="checkbox"/>
ENS 1, CH6	ENS 1, CH6	<input checked="" type="checkbox"/>
ENS 1, CH7	ENS 1, CH7	<input checked="" type="checkbox"/>
ENS 1, CH8	ENS 1, CH8	<input checked="" type="checkbox"/>
OCT 33, CH1	OCT 33, CH 1	<input checked="" type="checkbox"/>
OCT 33, CH2	OCT 33, CH 2	<input checked="" type="checkbox"/>
OCT 33, CH3	OCT 33, CH 3	<input checked="" type="checkbox"/>
OCT 33, CH4	OCT 33, CH4	<input checked="" type="checkbox"/>
OCT 33, CH5	OCT 33, CH5	<input checked="" type="checkbox"/>
OCT 33, CH6	OCT 33, CH6	<input checked="" type="checkbox"/>
OCT 33, CH7	OCT 33, CH7	<input checked="" type="checkbox"/>
OCT 33, CH8	OCT 33, CH 8	<input checked="" type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

Figure 103. QA Pulser Test Detector Assignments

### 10.7.1 Data Review

- 1) Review all pulser tests, ensuring the peak appears in the expected channel with the expected width.
- 2) Records containing errors should be removed from the database using the **Database Management** tools (Chapter 12) before they are exported, or the database is statistically analyzed.

## 10.8 THE CONTROL SAMPLE AND REAGENT BLANK TABS

The **Control Sample** and **Reagent Blank** QA tests are performed for each Control Sample and Reagent Blank **QA Type**, and are calculated only for samples collected on efficiency-calibrated detectors. These two tests monitor control and blank activity to verify that the reported activity for a particular QA Type is the same each time it is measured. This effectively monitors the complete data collection and analysis chain – detector, electronics, background, calibration, and analysis program. The warning and error levels depend on the control or blank and are best determined by experience.

Each test calculates the recoveries of up to 3 tracer nuclides, based on the contents of the nuclide library for the **QA Type** being tested.

Each time users create a new Control Sample or Reagent Blank QA Type, before analyzing samples that use the new QA Type be sure to choose the **Nuclides** and enter limits for them. This activates AlphaVision's automatic QA records update for these QA Type categories. If this step is forgotten, users must go to QA mode, choose the nuclides, set limits, and update the affected analyses.

To set up the control limits:

- 1) Click either the Control Sample or Reagent Blank tab and select the **QA Type** to be configured.
- 2) In the **Recovery** or **Activity** field for **Nuclide 1**, click the drop list button and choose a nuclide from the library list.
- 3) Set the **Min**, **Low**, **High**, and **Max** control limits.
- 4) Repeat for **Nuclide 2** and **3** if desired or leave them set to **[none]**.
- 5) Click **Apply Changes**.
- 6) On the Control Sample or Reagent Blank tab, click the Chart view, then the **QA Type** and nuclide (**1**, **2**, or **3**). See also the Report view and the Event Window.

## 10.9 THE TRACER PEAK WIDTH TAB

This test monitors the width of the tracer peak across all QA Types, based on sample analysis records. Variations in the peak shape may indicate poor sample preparation, bad electronics, failing detectors, or other malfunctions. The peak width in an alpha spectrum depends on sample preparation so the warning and error limits must reflect the values expected for the range of samples encountered. The warning and error levels can be determined by the values from a typical analysis and the expected variation from sample to sample based upon experience.

To perform the Tracer Peak Shape test:

- 1) On the Tracer Peak Shape tab, click the nuclide to be tested.
- 2) Click **QA/Tests/Tracer Peak Shape**. AlphaVision will scan the database for all untested records that contain measurements for this tracer nuclide and analyze them.
- 3) When the analysis is finished, go to the Tracer Peak Shape tab, select the nuclide just tested (if it is not already displayed), then click the Chart and Report views.

## 10.10 THE CHEMICAL RECOVERY TAB

This test monitors the chemical recovery of each Chemical Recovery QA Type and its associated tracer. The test is detector independent. The recovery value calculated by the analysis program determines the fraction of the tracer (and hence unknown) isotope that passes through the chemical preparation of the sample. The warning and error levels can be determined initially from expected values (based upon experience) and the expected variation from sample to sample. Variations in the chemical recovery value may indicate bad chemical processes, loss of sample, bad detectors, or other malfunctions.

This test is performed automatically each time a batch is ran that uses a Chemical Recovery QA Type.

To view the results of the Chemical Recovery test, switch to Chart view then click the button for the **QA Type** of interest. Check the Event Window and optionally view the Report.

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# 11. BACKGROUND, BATCH PROCESSING, AND ANALYSIS



Figure 104.  
Batch Icon

This chapter explains how to use the Background and Batch Wizards, which take users step by step through the setup of all parameters for background and batch data acquisition and analysis. They enable the user to streamline the repetitive aspects of sample analysis by creating special records called *templates* that hold customized sets of data acquisition parameters, analysis specifications, and reporting preferences. Once the templates needed for a project have been created, select the Batch Mode from the Outlook Bar, start the desired wizard, choose the template to be used, tailor the batch- and sample-specific information, and data collection is ready to start.

## 11.1 THE BACKGROUND WIZARD

After a detector has been calibrated, a background count analysis should be performed so the AlphaVision analysis engine can perform background subtraction on sample batches. The Background Wizard uses only the ROI Based analysis method, which integrates the net counts over specified regions of interest in the spectrum.

- If monitoring multiple ROIs, particularly for nuclides whose peak energies are very similar (for example,  $^{230}\text{Th}$ ,  $^{237}\text{Np}$ , and  $^{234}\text{U}$ ), it may be best to set up one ROI for this region, then keep in mind that all 3 nuclides may be present there.

Alternatively, users can create multiple ROI Sets that together cover a required list of nuclides (for this example, a set that includes an ROI for  $^{230}\text{Th}$ , a second set with the  $^{237}\text{Np}$  ROI, and a third with a  $^{234}\text{U}$  ROI). Then go to the Batch Explorer Panel, locate the spectrum of interest, right-click it, and select **Analyze** from the right mouse button menu. When the analysis setup dialog opens, choose one of the ROI Sets for the analysis, and generate the corresponding analysis and Background Report. Click the spectrum again (not the analysis) and repeat this analyze-and-report step for each of the remaining ROI Sets. For additional information, see Section 11.6.

- Background spectra can optionally be reanalyzed with the “interactive ROI” method explained in Section 11.5. Note that the ROIs established for sample measurements are applied to the background spectra when determining background correction, so background correction for samples is not affected when using the Interactive ROIs to adjust the background measurements. If background ROIs require adjustment due to a significant gain shift, then ROIs for sample measurements should also be evaluated.

Before starting the Background Wizard:

- All detectors should be calibrated (energy calibrated at minimum; and both energy and efficiency calibrated unless all batch samples will have a tracer added; Chapter 7).
- An analysis library and a background ROI set containing the project’s expected analytes should be created (Chapter 8).

- Locations (branches) for background measurements should be pre-defined in the Batch Tree (Chapter 9) under **Backgrounds/All Samples** (or users can simply store backgrounds in the default **All Samples** branch).
- QA settings for all detectors should be established (Section 10.3).

To start the Background Wizard, click the **Process Background** button on the Toolbar or **Process/Background...** from the menu.

### 11.1.1 Screen 1 - General

Figure 105 shows the first Background Wizard page. Use it to name the batch and, if desired, designate it as a template for future use.

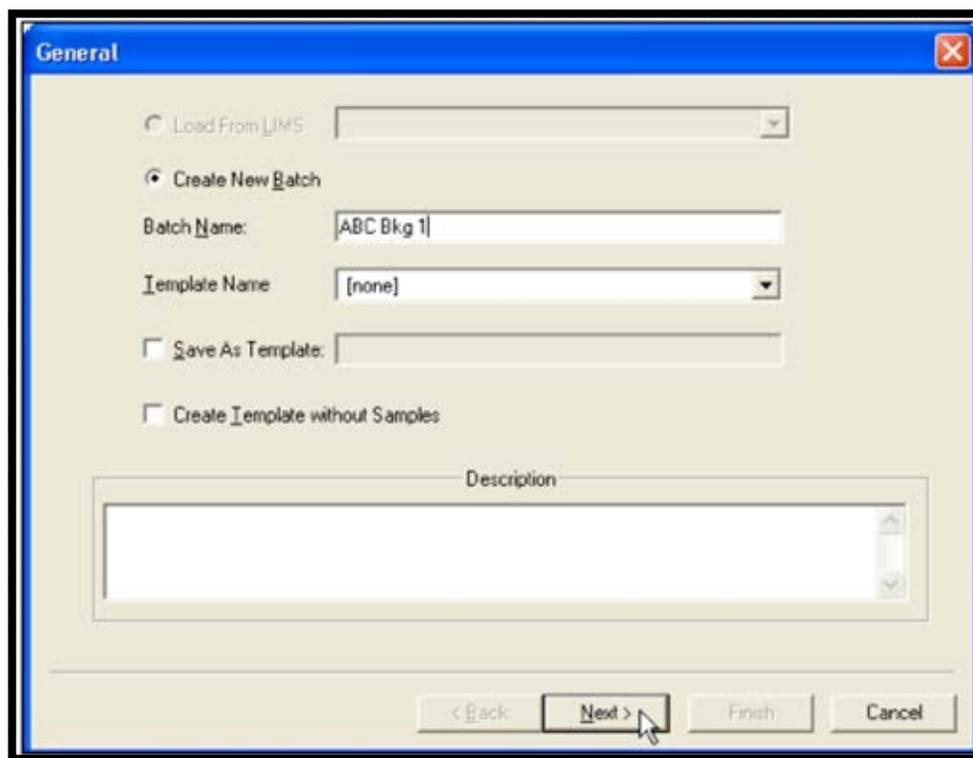


Figure 105. The General Screen

#### **Batch Name**

Use the default **Name** in the format *yyyy.mm.dd 001* (002, 003, etc.), or enter any combination of alphanumeric characters. It may be useful to assign a name that includes the alpha chamber name. This will enable clear identification of background records should it be desired to use an older background in a sample analysis.

#### **Description**

This is optional. It is displayed on the report and assists other users in understanding the intended use of this template.

#### **Template Name and Save As Template**

To reuse this set of data acquisition and analysis parameters as a *template*, mark the **Save** box and enter a descriptive **Template** name.

To use an existing batch setup template, select it from this list. The remainder of the wizard will be populated with the settings from the template record. Adjust the settings on each page as needed, finish the wizard, assign detectors to the samples, and begin counting.

### **Create Template without Samples**

Use this option to create all wizard settings without having to choose a database location (branch) for the batch or define samples. All other setup steps are the same. This makes it easy to set up one or more templates before processing samples.

## **11.1.2 Screen 2 - Batch**

Use the Batch Properties page (Figure 106) to assign this background to the proper “location” in the AlphaVision database.

### **Database Destination**

In the upper pane of the screen, click as needed to expand the Backgrounds branch, then click to highlight the desired location. The spectra analyses and reports for this background batch will be viewable at this location in the Batch Explorer.

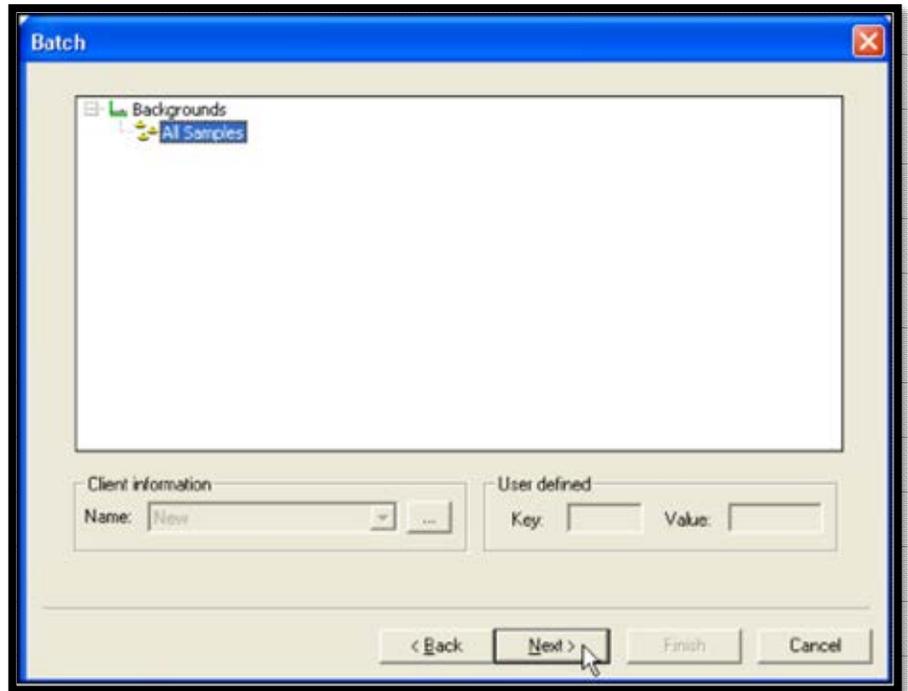


Figure 106. The Batch Screen

## **11.1.3 Screen 3 - Sample**

Use the Sample screen to define each background sample in the batch. There are two ways to do this:

- **Manual** – Define the samples one-at-a-time without linking them to a currently available detector; finish the wizard; assign detectors to each sample; and count. This method is discussed in detail in this section.
- **Auto-Sample** – Click the auto-sample button (...) to display a list of currently available detectors, mark the desired ones, click **OK**, and the Sample Name pane will populate with a list of preliminary sample names corresponding to the names of the selected detectors. Click the first sample name, optionally edit the name, and define the sample; repeat for all remaining samples; finish the wizard; and count. For more details, see Section 11.4.3.1.

### **Add**

Click **Add** to create a new sample entry, enter the new sample name in the Sample dialog (Figure 107) and click **OK** to return to the main Sample screen. Repeat for each background sample to be counted (Figure 108).

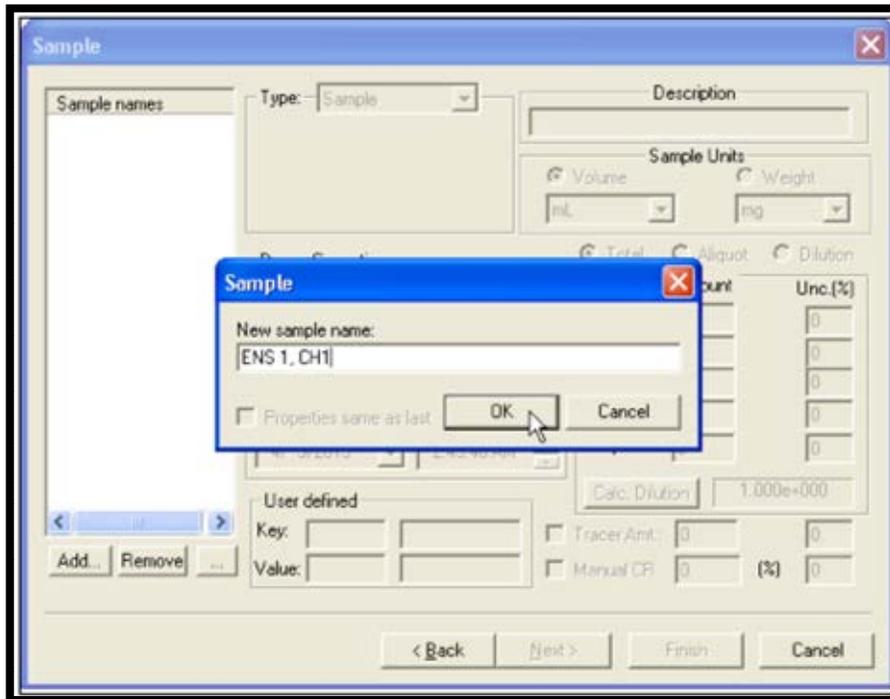


Figure 107. Add Background Sample

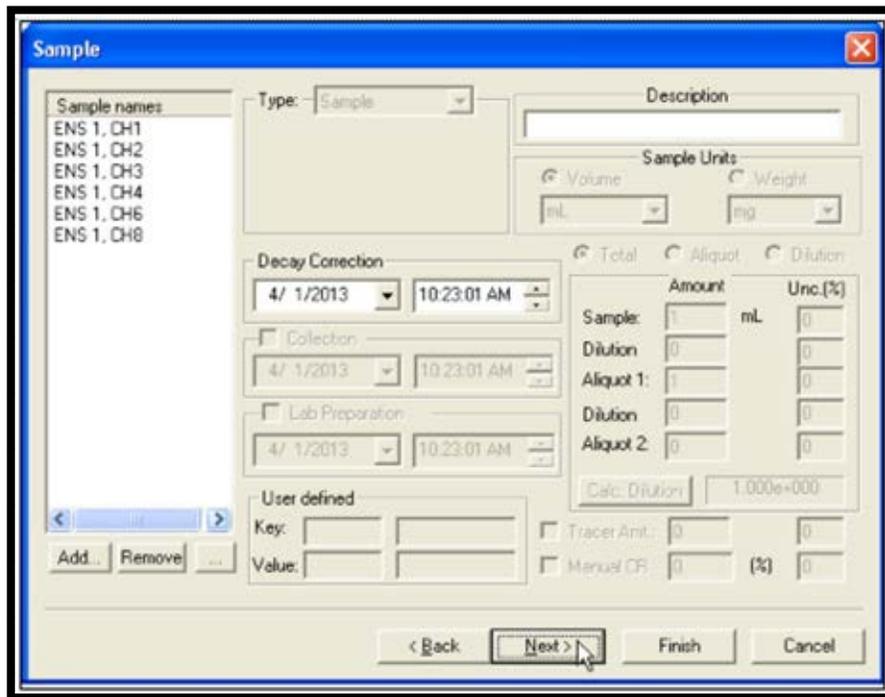


Figure 108. All Samples Added

### 11.1.4 Screen 4 - Acquisition

#### Presets

On the Acquisition page (Figure 109), decide whether to count to a **Live Time** or **Real Time** preset, or both; and enter the time.

**NOTE** If MAESTRO is installed, pre-sets entered in MAESTRO can affect counting time in AlphaVision. If an AlphaVision calibration terminates before the count time entered here, open MAESTRO, clear all presents, then exit MAESTRO and recount the calibration.

#### Thresholds

Users can elect to use the pressure and leakage current **Thresholds**. If users mark the **Thresholds** checkbox and enter maximum vacuum (**Max Vacuum**), minimum bias (**Min Bias**), and maximum leakage current (**Max Leakage I**) values, AlphaVision will suspend counting if one or both of the thresholds are exceeded. When these parameters fall below the threshold, counting will automatically resume.

**Max Vacuum** can be set at 30 Torr so the count will pause if a chamber is not being pumped. A **Min Bias** setting of 45 V will ensure a detector bias of 50 V is maintained (note, however, there is some variability in detector bias). Users can choose a value such as 1000 nA as the maximum leakage current that signifies detector "failure." Alternatively, it may be desired to test the leakage current for the detectors, take the average, then use twice that value as the **Max Leakage I** threshold.

The screenshot shows the 'Acquisition' dialog box with the following settings:

- Presets:**
  - Live Time: 300 minutes
  - Real Time: 5 minutes
  - MDA: Setup MDA preset in "MDA Setup" page
- Thresholds:**
  - Thresholds:
    - Max Vacuum: 30 Torr
    - Max Leakage I: 1000 nA
    - Min. Bias: 45 V
- Current Status:**
  - N/A
  - Vacuum: N/A
  - Leakage Current: N/A

Navigation buttons at the bottom: < Back, Next >, Finish, Cancel.

Figure 109. Acquisition Screen

### 11.1.5 Screen 5 – Analysis

Use this screen to set up the analysis method for this background batch.

### **Nuclide Library**

Click **Select...** to open the Nuclide Library dialog and choose from the list of **Available Libraries** (Figure 110). In the Nuclide Library dialog, enter the maximum allowable peak shift (**Max. Peak Mismatch**) and click **OK**. This value sets the maximum allowable difference between the expected tracer peak energy and the observed peak energy for a given count. Define this value according to the user's operating procedures.

### **ROI Set**

Select the **ROI Set** for both sample and background analysis from the list. Mark or unmark the **Template** checkbox to display the ROI Sets flagged or not flagged as templates (Section 8.6.1). Alternatively, users can click **Edit ROI** and create a new set or modify an existing one (Figure 111). The **Use ROI Name** checkbox forces AlphaVision to use the nuclide name defined in the ROI Set, even if another peak is very close to it in energy.

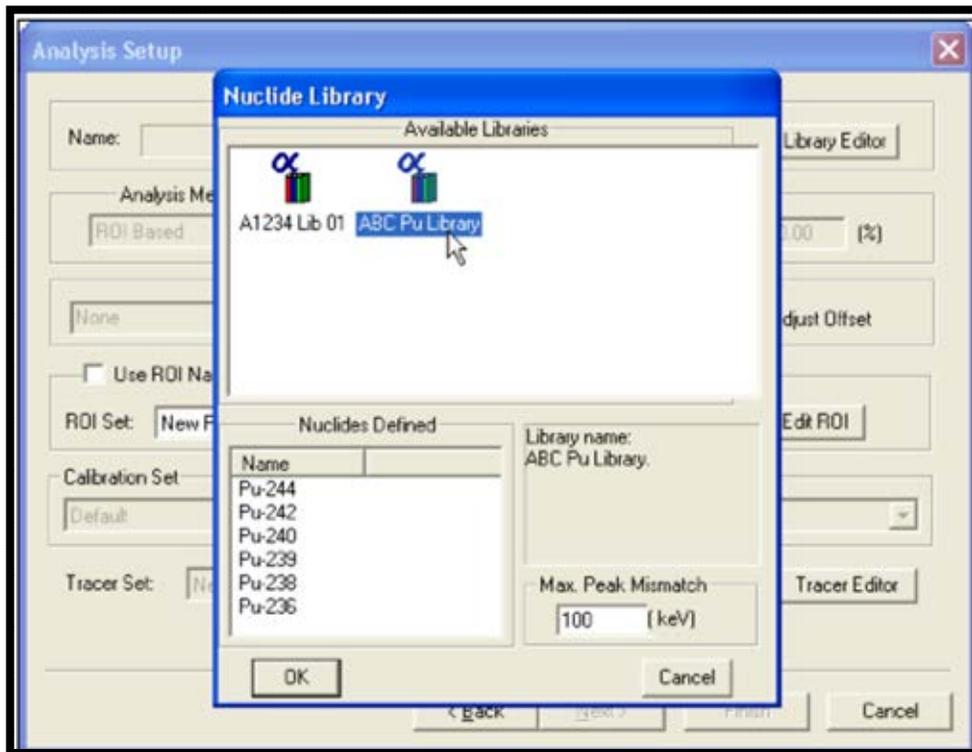


Figure 110. Select the Analysis Library

The screenshot shows the 'Analysis Setup' dialog box with the following settings:

- Nuclide Library:** Name: ABC Pu Library, buttons: Select..., Library Editor
- Analysis Method:** ROI Based (dropdown),  Relative Analysis
- Tracer Amount:** 0 mL +/- 0 (%)
- Adjust ROIs:** None (dropdown),  Width
- Recalibrate:**  Recalibrate,  Adjust Gain,  Adjust Offset
- Use ROI Name:**  Use ROI Name,  Interactive ROI
- ROI Set:** ABC Pu ROI (dropdown),  Template, Edit ROI (button)
- Calibration Set:** Default (dropdown)
- Background Spectrum:** Default (dropdown)
- Tracer Set:** New Tracer Set (dropdown), Tracer Editor (button)

Navigation buttons at the bottom: < Back, Next >, Finish, Cancel.

Figure 111. Background Analysis Settings

### 11.1.6 Screen 6 - Report

The Report screen (Figure 112) is the final screen in the Batch Wizard. Use the features on this screen to print the analysis results, export them to other file formats, export the spectrum to an ORTEC .SPC spectrum file, and/or generate reports using personalized Crystal Report v11.5 report templates. (This can also be completed from the Report Window.)

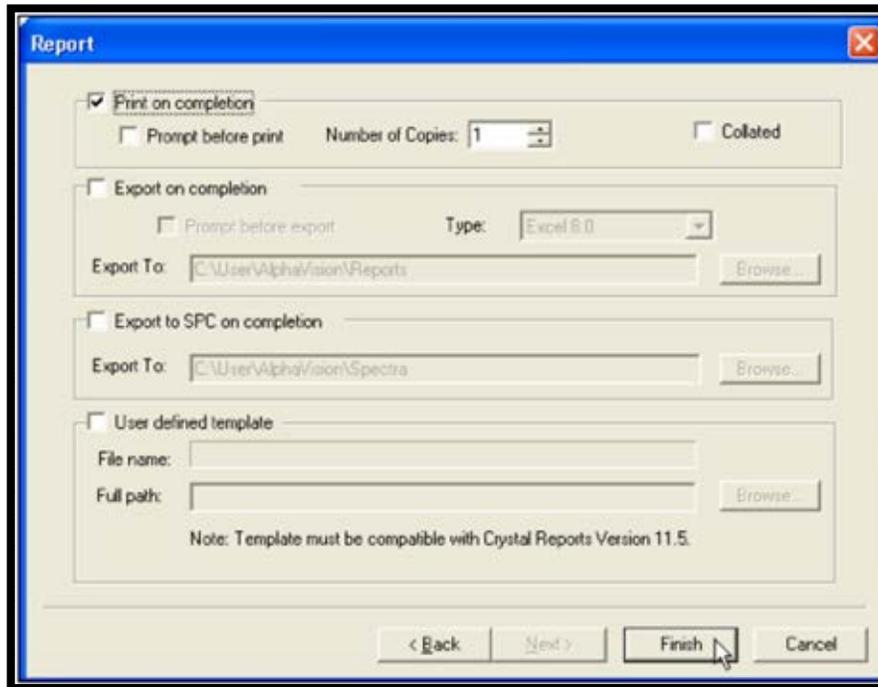


Figure 112. Report Screen

The Batch Wizard setup is now completed. The next step is to click **Finish**, after which detectors will be assigned to each sample in the batch and begin counting.

## 11.2 ASSIGNING DETECTORS AND ACQUIRING DATA

When the wizard closes, the Detector Assignment Worksheet will open. This is the control dialog for assigning detectors to batch samples and starting data acquisition.

- If the **Auto-Sample** option for creating batch samples is used, the detectors will already be assigned, as shown in Figure 113, and the system is now ready to start counting.

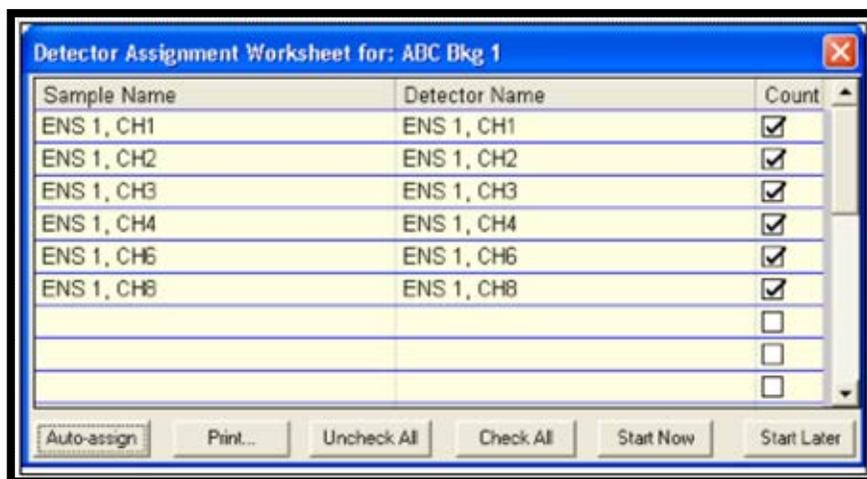


Figure 113. All Alpha Chambers Pre-Assigned a Detector

- Otherwise, assign detectors either with the **Auto-assign** button or by dragging an available detector from the Detector Grid to each of the samples on the worksheet (Figure 114).<sup>16</sup>

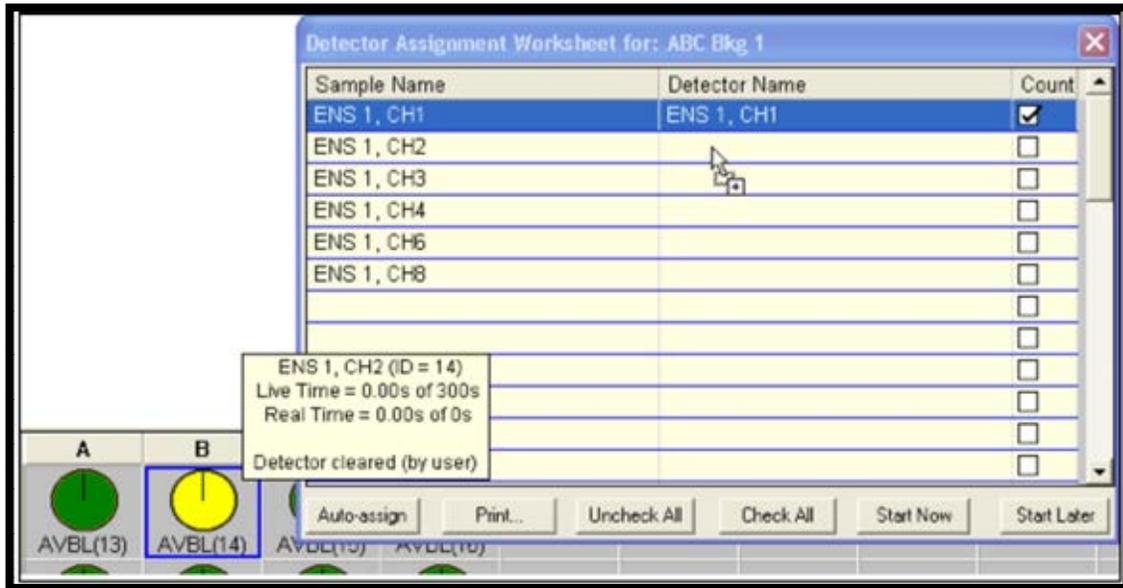


Figure 114. Assigning a Detector by Dropping its Icon in the Worksheet

- *If more samples are present than available detectors, some samples on the worksheet will not have detectors assigned to them yet.* These can be counted later from the Batch Explorer Panel, as discussed in Section 11.2.1.1.
- When an available detector is assigned to a sample, its **Count?** checkbox is automatically marked. To delay counting a sample until later, unmark its **Count?** checkbox.
- To delay counting the entire batch, click **Start Later**. The worksheet will close, and the batch can be counted later from the Batch Explorer Panel, as discussed in Section 11.2.1.1.
- Background and QA pulser measurements are detector specific. However, analysis samples can be counted by any available detector. To change a detector assignment for an analysis sample, simply drop another detector icon on the sample of interest. If this detector has already been auto assigned to another sample, AlphaVision will count the first of the 2 samples (i.e., the one closest to the top of the list) now and the second sample later. To count both samples now, simply choose another available detector and drop it on either sample.
- After all detector assignments have been made and all count-now/count-later decisions have been made, users can optionally **Print** the worksheet (see Figure 115) as an aid in loading each sample into the correct alpha chamber. Notice that the

<sup>16</sup> Note that while the Detector Grid can be arranged to reflect the laboratory's arrangement of MCBs, this visual arrangement onscreen does not affect how **Auto-assign** assigns detectors. However, users can manually change detector assignments after running **Auto-assign**.

printout indicates which samples will and will not be counted according to the marked **Count?** check boxes.

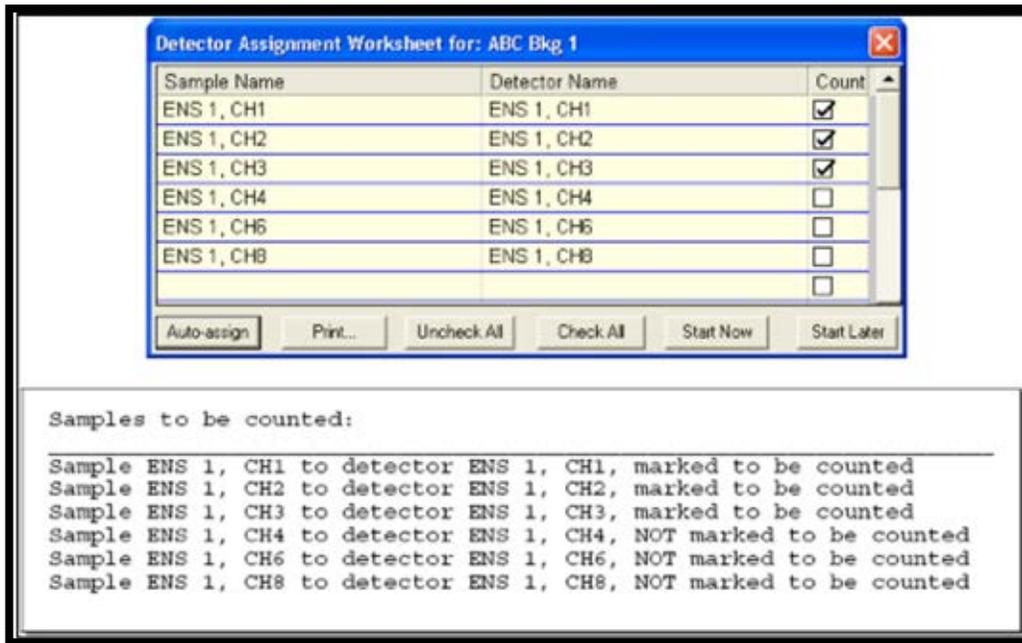


Figure 115. Example Detector Worksheet and Corresponding Printout

### 11.2.1 Data Acquisition and Analysis

- To start data collection, click **Start Now**. The worksheet will close, acquisition will start, and the new batch will be posted in the Batch Explorer Tree in the location selected on the Batch screen (for example, background samples will be displayed under *Backgrounds /All Samples*).

In the right-hand column (the Sample Analysis Explorer) as soon as data acquisition starts, a spectrum record  will be created for each sample in the batch.

- To change the counting time for a batch, see **Changing/Adding Count Time** in the next section. To pause or abort a specific detector, see Section 11.2.1.1.
- When analysis is complete, an analysis record  $\Sigma$  will be displayed beneath each spectrum analyzed. To view the unanalyzed spectrum in the Spectrum Window, click the spectrum record. Click the desired analysis record for the spectrum to see the analysis ROIs and peak identifications superimposed on the spectrum.
- Users may perform as many analyses on background and sample spectra (but not QA control and blank samples) as desired. To perform an interactive ROI analysis, see the instructions in Section 11.5.

### 11.2.1.1 Count Later, Recount, Interim Analysis, Change Count Time, Pause/Abort Counting and Recounting Samples

To count remaining or delayed samples, or to recount samples, locate the batch of interest in the Batch Explorer Tree, click to select the sample(s) to be counted or recounted, right-click one of the highlighted samples, and issue the **Count** command (Figure 116). This will open the Detector Assignment Worksheet, which will display the samples marked for counting or recounting. Assign detectors automatically or manually, load the samples as indicated, and click **Start Now**. Repeat until all samples in the batch have been processed.



Figure 116. Count Command

#### Changing/Adding Count Time

If counting to a real-time or live time preset (not an MDA preset), users can increase or decrease the count time during data acquisition, and/or count for additional time after the original data acquisition has completed. These options are available for batch, background, and QA pulser test samples.

**NOTE** Once the spectrum has been analyzed, its count time cannot be extended.

- While a count is in progress, locate the desired batch in the Batch Explorer Tree, right-click, and select **Modify Acq. Presets...** (Figure 117). Change the **Live Time** and/or **Real Time** presets as needed, then click **Start/Continue**.

— If adding count time, the count time will extend to the new preset(s) and will be reflected in each detector's hover box.

— If the count presets are reduced to a period that has not yet elapsed, counting will stop at the shortened time and analysis will begin. The hover boxes will reflect the shortened count time for each detector.

— If the count presets are reduced to a time less than the current elapsed count time, counting will stop and analysis will begin. The hover boxes will reflect the actual elapsed count time for each detector.

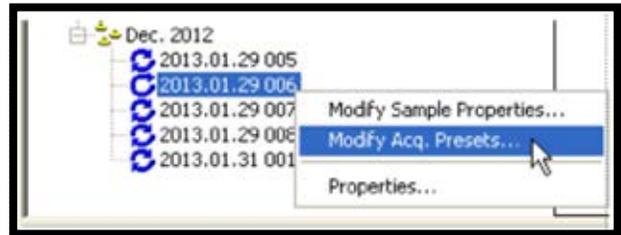


Figure 117. Modify Acq. Presets

- After a count has ended, locate the desired batch in the Batch Explorer Tree, right-click, and select **Modify Acq. Presets...**. Increase the **Live Time** and/or **Real Time** presets as needed, then click **Start/Continue**.

— The total count time will extend to the new preset(s) entered and will be reflected in each detector's hover box.

— Because the original acquisition has ended, the original detector assignments will have lapsed. The Detector Assignment Worksheet will open when users click **Start/Continue** and must make new detector assignments. If changing to a

different detector, *remember to transfer samples as needed to their newly assigned alpha chambers.*

- At the end of the new count, the original analysis will be overwritten with the cumulative analysis of the original and added data.

### **Interim Analysis During Acquisition**

Every 5 minutes during data acquisition, users can perform “on-the-fly,” interim analyses. In the Batch Explorer Tree, right-click the batch of interest to display its samples. Right-click a sample and select **Analyze...** (Figure 118). AlphaVision will analyze the current data in the detector memory (not the database) and record it as a “snapshot” of this point in the count. The interim analysis will be added to the Sample Explorer Panel along with the regular analysis results and will become a permanent part of the data record for the batch.

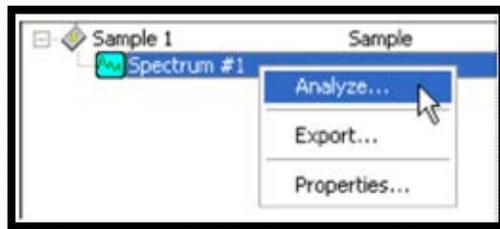


Figure 118. Analyze

### **Detector-Level Controls**

Section 6.4.2.1 explains the detector-level controls available on through Detector Grid, e.g., **Pause**, **Continue**, **Abort**, **Stop**, and **Clear** detector memory. These operate only on the currently selected detector.

## **11.3 DATA REVIEW**

- 1) Review all backgrounds, ensuring that pulsers were off, bias was on, samples were not left in the chambers, and the chambers were pumped to the proper pressure.
- 2) Records containing any of these errors should be removed from the database using the **Database Management** tools (Chapter 12) before they are exported, or the database is statistically analyzed.

## **11.4 THE BATCH WIZARD**

Before starting the Batch Wizard:

- All detectors should be calibrated (energy calibrated at minimum; and both energy and efficiency calibrated unless all batch samples will have a tracer added; Chapter 7).
- The necessary analysis library, control solutions, QA types, (optional) tracer set, and ROI set should be created (Chapter 8).
- Locations (branches) for batches must be pre-defined in the Batch Explorer Tree (Chapter 9).
- QA settings for all detectors should be established (Section 10.3).
- A background measurement for each detector should already have been performed (Section 11.1). Note that the ROIs established for sample measurements are applied to the background spectra when determining background correction.

To start the Batch Wizard, click the **Process Batch** button on the Toolbar or **Process/Batch...** from the menu.

### 11.4.1 Screen 1 - General

Figure 119 shows the first Batch Wizard page. Use it to name the batch and, if desired, designate it as a template for future use.

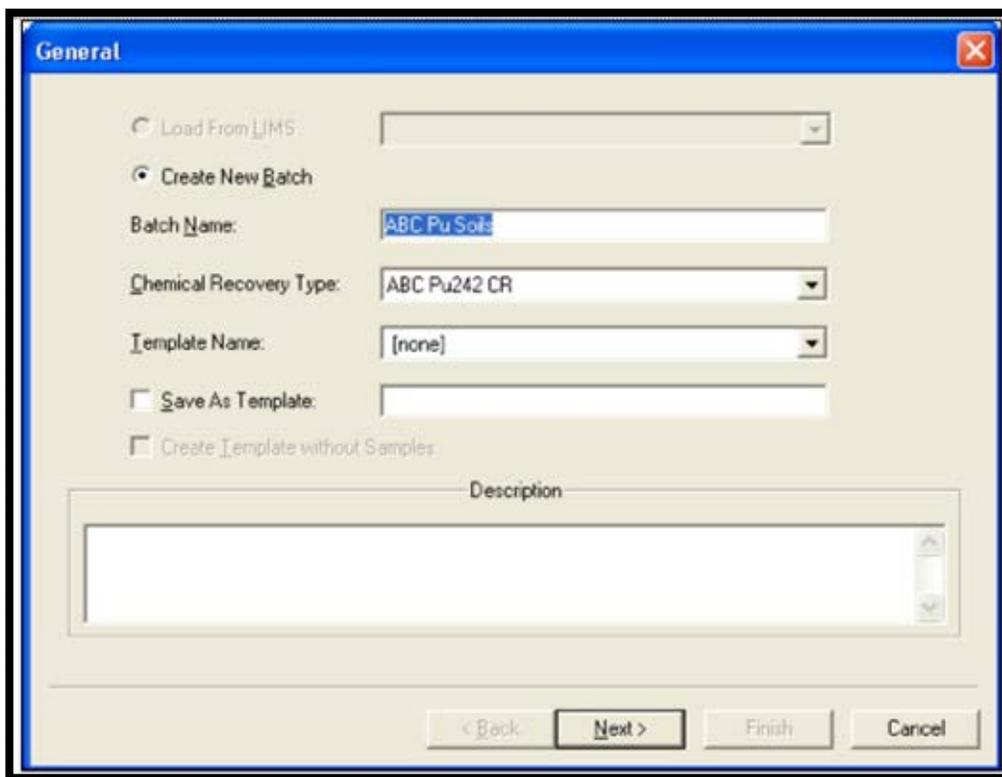


Figure 119. The General Screen

#### **Batch Name**

Use the default **Name** in the format *yyyy.mm.dd 001* (002, 003, etc.), or enter any combination of alphanumeric characters.

#### **Chemical Recovery Type**

If users will be tracking chemical recovery with a tracer solution, select the predefined Chemical Recovery QA Type from this list.

#### **Description**

This is optional. It is displayed on the report, and assists other users in understanding the intended use of this template, tracer, shelf geometry, etc.

#### **Template Name and Save As Template**

To reuse this set of data acquisition and analysis parameters as a *template*, mark the **Save** box and enter a descriptive **Template** name.

To use an existing batch setup template, select it from this list. The remainder of the wizard will be populated with the settings from the template record. Adjust the settings on each page as needed, finish the wizard, assign detectors to the samples, and begin counting.

### **Create Template without Samples**

Use this option to create all wizard settings without having to choose a database location (branch) for the batch or define samples. All other setup steps are the same. This makes it easy to set up one or more templates before processing samples.

## **11.4.2 Screen 2 - Batch**

Use the Batch Properties page (Figure 120) to assign this batch to the proper “location” in the AlphaVision database and, optionally, to capture client and batch/sample identifiers. As noted above, the destination “branch” to which this batch will be assigned must be defined (Chapter 9) before using the wizard.

### **Database Destination**

In the upper pane of the screen, click as needed to expand the Batch Explorer Tree, then click to highlight the desired location. The spectra, analyses, and reports for this batch will be viewable from this location in the Batch Explorer.

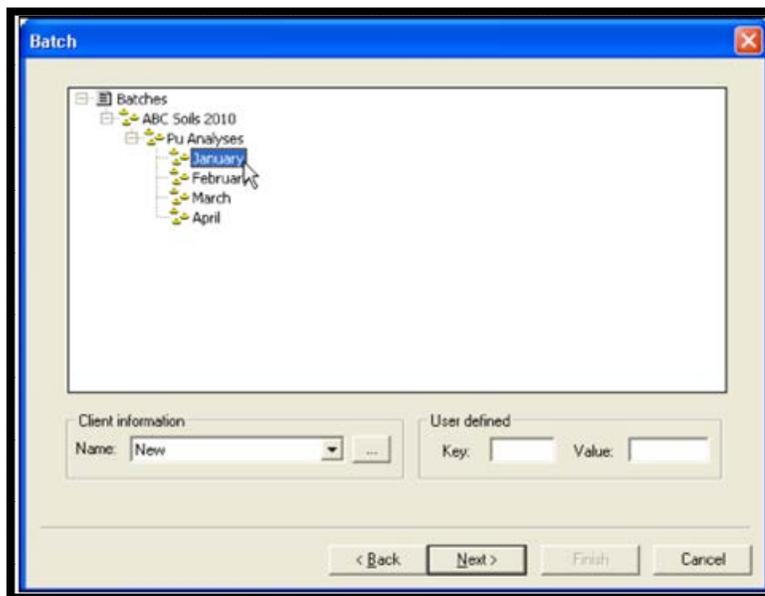


Figure 120. The Batch Screen

### **User-Defined Key/Value**

This is an optional batch- and sample-identification tool. It allows for variation in the way different laboratories identify samples and batches. A **Key** is the name of an attribute that can be attached to the batch or to individual samples. A **Value** is a subcategory that further elaborates on the key. This feature is only available in the Batch Wizard.

There are three user-defined **Key/Value** pairs in the Batch Wizard – one for the batch (set on this screen), and two for each sample (set on the Sample screen). The standard analysis report lists the pair from the Batch screen and the top-most pair from the Sample screen. To see all three pairs, locate the batch in the Batch Explorer Panel, right-click the batch name, select **Properties...** from the context menu, and view the batch record. (Users can also set up a customized report with Crystal Reports v11.5 to print all three pairs.)

**EXAMPLE** An example **Key** is *Sample Matrix*, with corresponding **Values** of *Soil*, *Sludge*, *Tissue*, and *Water*. Another key might be an *Internal Tracking Number*, with unique, sequential numbers as the values. (Notice that if users are creating batch information in and transferring it from the LIMS, this internal tracking number would be in addition to the Sample ID value from the LIMS.) Or it might be desired to use a key for *Prep Analyst Initials* with the analysts’ initials as the values.

### 11.4.2.1 Client Information

AlphaVision maintains an optional client information directory. The contents are stored in the database, and **Company Name** and **Contact Name** are printed on the Analysis reports. Once a client record has been created here, it is available on the client **Name** list for future batches. If this batch information was created in and transferred from the LIMS, these fields may already contain the correct entries. Otherwise, click the browse (...) button to open the Client Information dialog (Figure 121), complete the desired field(s), and click **OK**.

Figure 121. Enter Client Contact Information

### 11.4.3 Screen 3 – Sample

Use the Sample screen to define each sample in the batch. There are two ways to create a set of batch samples:

- **Manual** – Define the samples one-at-a-time without linking them to a currently available detector; finish the wizard; assign detectors to each sample; and count. This method is discussed in detail in this section.
- **Auto-Sample** – Click the auto-sample button (...) to display a list of currently available detectors, mark the ones desired, click **OK**, and the Sample Name pane populates with a list of preliminary sample names corresponding to the names of the selected detectors. Click the first sample name, optionally edit the name, and define the sample; repeat for all remaining samples; finish the wizard; and count. For more details, see Section 11.4.3.1.

#### Add

Click **Add** to create a new sample entry, enter the new sample name in the Sample dialog (Figure 122) and click **OK** to return to the main Sample screen.

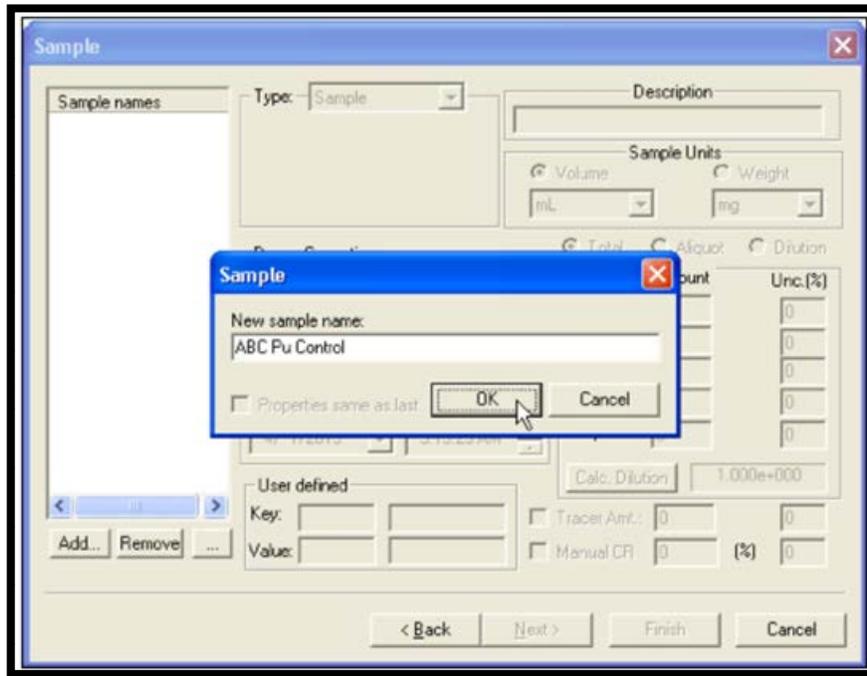


Figure 122. Add New Sample

### Sample Units

Click to specify the **Sample Units** in terms of volume or weight and select the unit of measure.

### Description

Optionally enter a sample description.

### Sample Type

- **Blank** – When **Blank** is selected from the list, AlphaVision adds a **QA Type** field immediately below it. Select a predefined QA Type from the list.
- **Control** – For **Control** samples, AlphaVision add fields for **QA Type**, control solution (**Cntrl Sol**), and the **Amount** of control solution used (Figure 123). Select the predefined QA Type and Control Solution Record from the lists and enter the **Amount** of control solution added to this sample.
- **Sample** – Samples are not associated with QA types or control solutions, therefore no additional fields open when this entry is chosen from the list.

Figure 123. Control Sample and its Additional Data Fields

### Sample Amount/Sample Dilution Setup

To measure all of the sample, click the **Total** button, then enter the **Sample Amount** (as volume or weight, set with the Sample Units buttons above these fields) and uncertainty. This is illustrated in Figure 124. Notice the Calc. Dilution button is inactive.

To use an aliquot of the sample, click the Aliquot button, then enter the amount and uncertainty of the total Sample and of the Aliquot (Figure 125). The Calc. Dilution button is also inactive in this mode.

If the sample will be diluted in one or two stages, click the Dilution button to activate all fields and enable the Calc. Dilution button (Figure 126). Enter the appropriate amount and uncertainty for the total sample, the volume into which it has been diluted, and the aliquot to be measured, then click Calc. Dilution to perform the arithmetic. Click the calculation button as often as desired while setting up the dilution(s) but be sure to click it one final time when all of the dilution and aliquot information has been entered.

Figure 124. Using Total Sample (Calc. Dilution Button Inactive in this Mode)

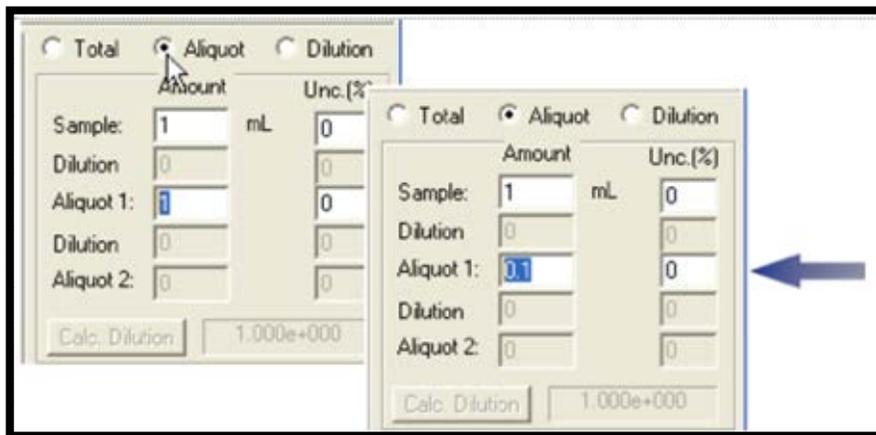


Figure 125. Using Aliquot of Total Sample (Calc. Dilution Button Inactive in this Mode)

Figure 126 shows a Sample volume of 1.0 mL being diluted into 10 mLs (a dilution of 1:10, denoted in the Dilution calculation field as  $1.000e+001$ ). A 0.1-mL Aliquot is subsequently diluted into 100 mL, then a 0.1-mL aliquot – a final dilution of 1:100000 – is taken for the sample measurement.

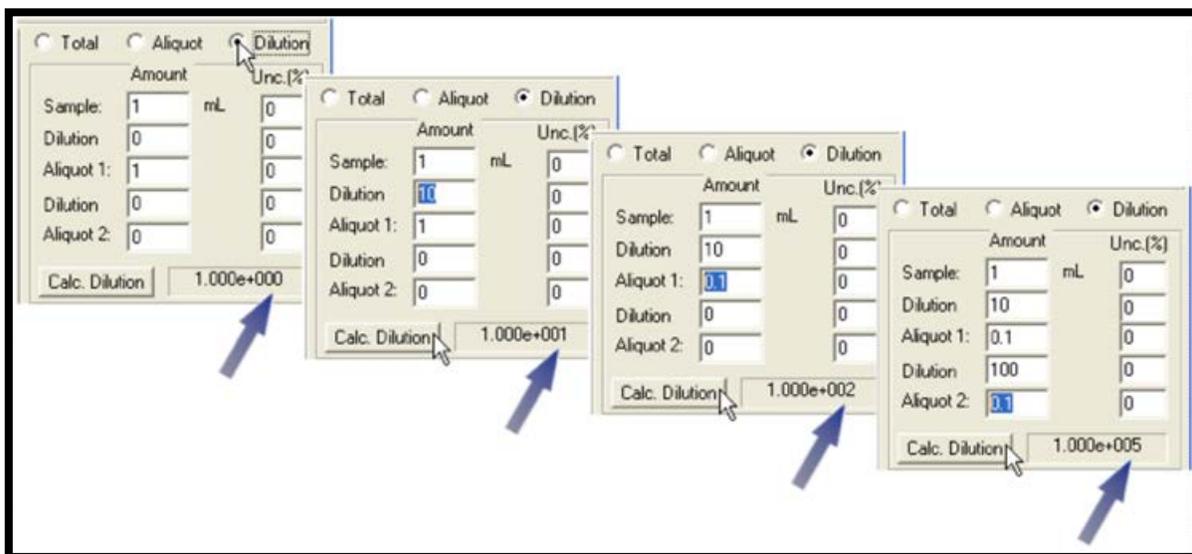


Figure 126. Two-Stage Dilution (Calculated at Each Step)

### Chemical Recovery Setup

AlphaVision 7 gives three ways to determine chemical recovery:

- By adding a fixed quantity of a predefined tracer solution to every sample in the batch. To do this, use **Relative Analysis** fields on the Analysis screen to indicate the amount of tracer added to every sample (see page 175 in Section 11.4.5).

- By adding different quantities of tracer to one or more samples in the Batch. Setup is performed on this screen, sample-by-sample, by marking the **Tracer** checkbox at the bottom right (Figure 127), then entering the tracer volume in the left-hand field and, optionally, the percent uncertainty in the right-hand field. Users will select the units of measure for the tracer beside the **Tracer Amt** field in the **Relative Analysis** section of the Analysis screen (see page 139 in Section 11.4.5).
- By entering a percent chemical recovery determined by an alternative method (e.g., a gamma counting technique). Examples of this approach are the use of  $^{234}\text{Th}$  (a beta emitter) for chemical recovery determination of thorium analyses and  $^{239}\text{Np}$  (also a beta emitter) for chemical recovery for neptunium analyses. In these cases, the user typically opts for a **No Analysis**, then returns later and analyzes each sample – using the laboratory-determined chemical recovery – at the completion of alpha counting.

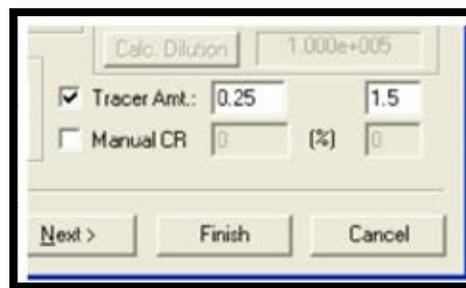


Figure 127. Enter Per-Sample Tracer Amount or Manual Percent Recovery

No Tracer Set is used in the analysis. There are two ways to set up a manual recovery batch: either mark the **Manual CR** checkbox at the bottom right of this screen, then enter the percent recovery and optional percent uncertainty for each sample; or use the **Manual Chemical Recovery** fields on the Analysis Misc. screen (Section 11.4.6) to apply the same percent recovery and uncertainty to all samples in the batch. To use the latter method, at least one **Control** sample must be defined in order to activate the manual chemical recovery fields on the Analysis Misc. screen. Marking the **Manual CR** box on this screen inactivates the fields on the Analysis Misc. screen.

### Choose a Decay Correction Method

By default, AlphaVision decay-corrects to the data acquisition date/time. However, users can instead specify a different decay correction date/time *for each sample in the batch* using the date and time fields on this screen. If it is decided later to apply the default decay correction date to all samples in the batch (either for this data acquisition or if using this batch as a template for other batches), simply unmark the **Decay Correction** checkbox on the Analysis Misc. page (see page 142 on Section 11.4.6).

### Collection and Lab Preparation Date/Time

These optional fields let users capture additional information about each sample.

### User Defined Key/Value

This option is discussed on page 132 in Section 11.4.2.

#### 11.4.3.1 Auto-Define Samples

The **Auto-Sample** feature reduces batch setup time by linking each sample with an available detector. To use it:

- 1) On the Sample page, click the auto-sample button (...) below the **Sample names** pane.
- 2) AlphaVision 7 will poll the system and return the list of currently available detectors (i.e., those calibrated and available for counting) in a modified Detector Assignment Worksheet.

- 3) Select the detectors for this batch by marking the desired **Use** check boxes in the worksheet, then click **OK** to return to the Sample screen.
- 4) AlphaVision will automatically populate the **Sample names** pane with one sample entry per detector. The samples names will echo the detector names. This process is illustrated in Figure 128.
- 5) Click each sample entry and modify and/or define it as needed, finish the wizard, and start data acquisition.

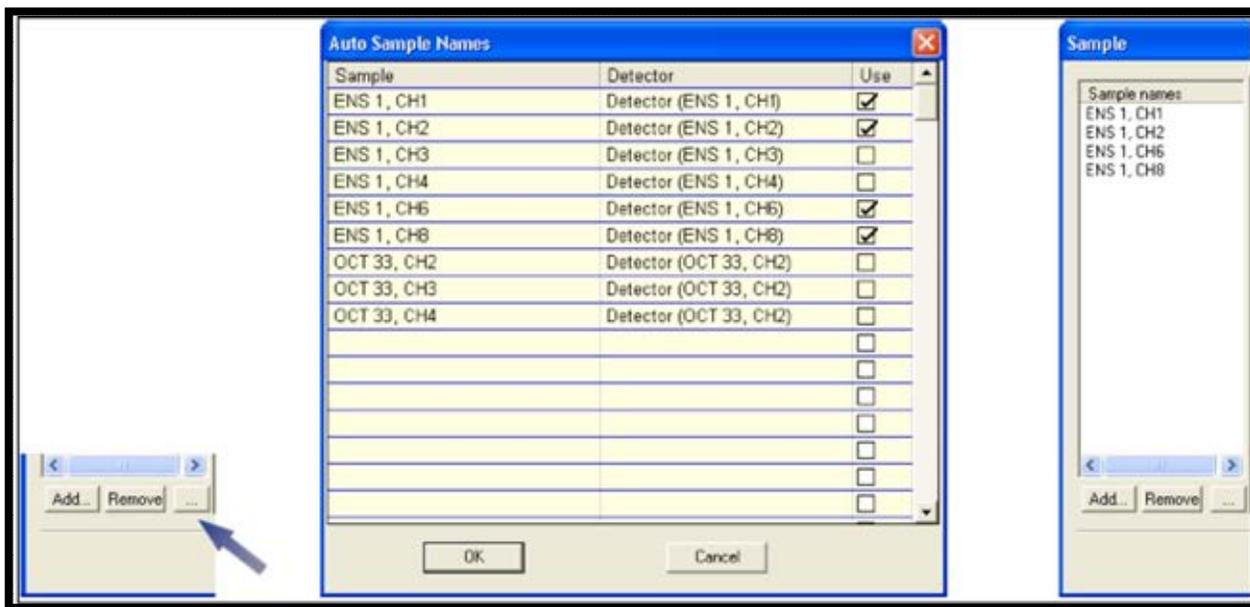


Figure 128. Populating the Sample List with Auto-Sample

#### 11.4.4 Screen 4 – Acquisition

##### Presets

On the Acquisition page (Figure 129), decide whether to count to a **Live Time** or **Real Time** preset, or both; and enter the time.

**NOTE** If MAESTRO is installed, pre-sets entered in MAESTRO can affect counting time in AlphaVision. If an AlphaVision calibration terminates before the count time entered here, open Maestro, clear all presents, then exit MAESTRO and recount the calibration.

##### Count to MDA Preset

Mark this checkbox if the sample will be counting to an MDA preset, then set up the parameters on the MDA/Blank screen (Section 11.4.7).

##### Thresholds

Users can elect to use the pressure and leakage current **Thresholds**. If users mark the **Thresholds** checkbox and enter maximum vacuum (**Max Vacuum**), minimum bias (**Min Bias**), and maximum leakage current (**Max Leakage I**) values, AlphaVision will suspend

counting if one or both of the thresholds are exceeded. When these parameters fall below the threshold, counting will automatically resume.

**Max Vacuum** can be set at 30 Torr so the count will pause if a chamber is not being pumped. A **Min Bias** setting of 45 V will ensure a detector bias of 50 V is maintained (note, however, there is some variability in detector bias). The user can choose a value such as 1000 nA as the maximum leakage current that signifies detector “failure.” Alternatively, it may be desired to test the leakage current for the detectors, take the average, then use twice that value as the **Max Leakage I** threshold.

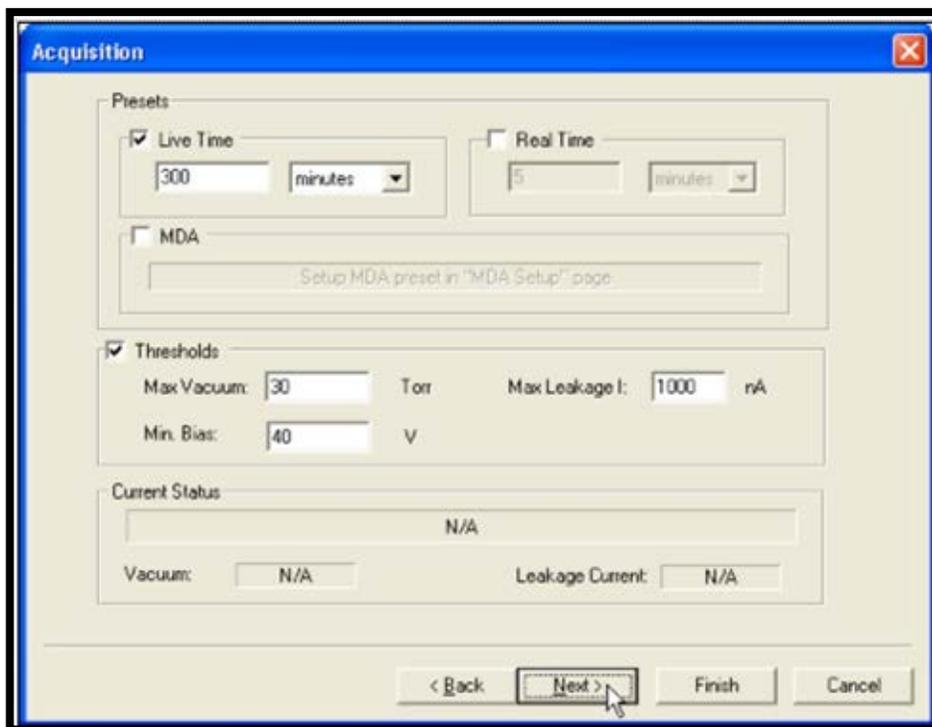


Figure 129. Acquisition Page

#### 11.4.5 Screen 5 – Analysis

Use this screen (Figure 130) to set up the analysis method for this batch.

##### Nuclide Library

Click **Select...** to open the Nuclide Library dialog and choose from the list of **Available Libraries** (Figure 131). Click on **Library Editor** to make last-minute changes to the library if needed. As each available library is clicked, the library name and contents are displayed. A maximum allowable peak difference can also be entered (**Max. Peak Mismatch**). This value is the maximum allowable difference between the expected tracer peak energy and the observed peak energy for a given nuclide. It is applied to all peaks in the library and must be greater than zero.

##### Analysis Method

AlphaVision can perform **No Analysis**, an **ROI Based** analysis, or more sophisticated **Peak Search/Fit** and **Library Search/Fit** techniques.



Figure 130. Select Analysis Method

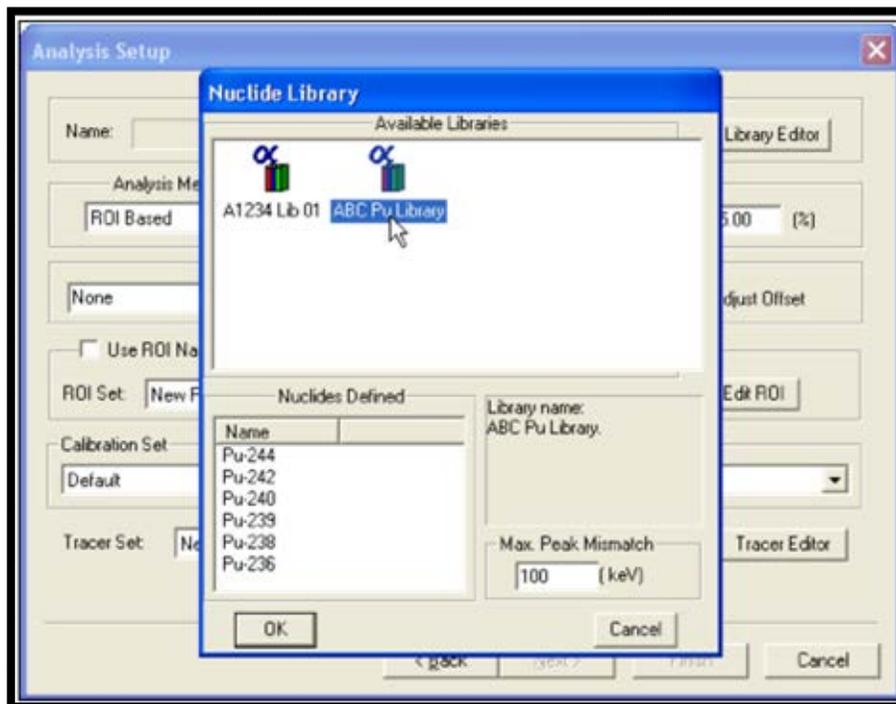


Figure 131. Select Nuclide Library

- **No Analysis** bypasses the analysis algorithms.
- **ROI Based** analysis integrates the net counts over specified regions of interest in the spectrum and works best when the spectrum peaks are well separated. Selecting this option activates the **Use ROI Name** section of the dialog and the **ROI Set** field.

If the **Template** checkbox is marked, the **ROI Set** drop list will show the ROI Sets that have been saved as ROI templates (Section 8.6.1); otherwise, the non-template ROI Sets will be listed. To use an existing **ROI Set**, select it from the list. To modify that set or create a new one, click **Edit ROI**. (Alternatively, users can perform a **No Analysis**, count the samples, then return later and complete the analysis with an appropriate ROI Set.)

The **Use ROI Name** checkbox forces AlphaVision to use the nuclide name defined in the ROI Set, even if another peak is very close to it in energy.

- **Peak Search/Fit** or **Library Search/Fit** – Choosing one of these options inactivates the fields associated with the **Relative Analysis**. Go to next screen, Analysis Misc., to configure the search/fit settings.

### Relative Analysis

To set up an analysis relative to a tracer, mark the **Relative Analysis** checkbox. This activates the **Recalibrate**, **Adjust ROIs**, and **Tracer Set** fields; and the **Tracer Amt** field, if the user did not add individualized tracer amounts to one or more samples on the Sample screen.

- **Tracer Amt** – Enter the fixed amount of tracer added to each sample and the optional percent uncertainty of the measurement (+/-); and select the units of measure.
- **Tracer Set** – Choose an existing Tracer Set from the drop list. Alternatively, users can click **Tracer Editor** and create a set or modify an existing one.
- **Adjust ROIs** – There are three Adjust ROIs methods:
  - The **Tracer** method adjusts the boundaries of all **Analyte** ROIs based on the tracer peak centroids and optionally the tracer peak width.
  - The **Best Peak** method shifts all analyte and tracer ROIs relative to the peak with the greatest number of counts in the centroid channel.
  - The **Each Peak** method shifts all ROIs centroids and boundaries based on the position and width of each peak.
- **Width** – This option operates together with the Tracer Set's **Expected Tracer FWHM** value. If marked, the width of the analyte ROIs is adjusted according to the ratio of the expected tracer FWHM to the actual tracer FWHM. This reduces the number of adjustments need to make to ROIs during the analysis process. The Expected Tracer FWHM is used by the analysis algorithm as a starting point for this adjustment.
- **Recalibrate** – The spectrum can optionally be recalibrated based on the ROI shift (decide whether to **Adjust Offset** or **Adjust Gain**; usually the offset is adjusted). The library energy for each peak is used for the analysis. By contrast, unmarking the **Recalibrate** checkbox reports the peak energies observed with the shift. In this case, the reported energies will be based on the most recent calibration performed on the detector. Leave this option unmarked if recalibration is not desired.

### ROI-Guided Peak Search for Low-Count, Asymmetric Peaks

Use this peak search/fit methodology when it *must* fit a peak, even when count statistics, poor shape, or overlap could make it a poor candidate for the standard AlphaVision peak search/fit algorithm. It uses an ROI Set to direct the analysis to certain regions of the spectrum, as well as an iterative peak stripping technique. To use this method:

- Create or select an appropriate **ROI Set**.
- Select **Peak Search/Fit** as the analysis method, then specify the **ROI Set**. If no ROI Set is specified, AlphaVision reverts to the default peak search/fit algorithm.

This analysis routine will start with the highest-energy ROI in the set and calculate a peak fit based on the contents of the ROI. The counts in the fitted peak will be stripped from the spectrum. The routine will then move to the next-highest-energy ROI in the set and repeat the peak fitting and stripping. When all ROIs in the set have been analyzed in this way, the remainder of the spectrum will be analyzed according to the standard peak search/fit criteria.

#### **Substituting Another Calibration Set or Subtracting a Different Background Spectrum**

While seldom used, the **Calibration Set** and **Background Spectrum** fields allow users to reanalyze spectra that were not collected on the local system. They can also be used to filter this information from the analysis algorithm. Under normal conditions, background and calibration information are stored with the detector, and the analysis algorithm uses the most recent active calibration. Selecting a **Calibration Set** causes the analysis algorithm to use the calibration information from that record instead of the data currently associated with the detector. Similarly, choosing a **Background Spectrum** causes the analysis algorithm to use the background associated with that record instead of the background currently associated with the detector. To use the current calibration and background data, leave these fields set on **Default**.

If updating an analysis and the background spectrum for that analysis is no longer in effect (i.e., if a new background measurement has since been made for that alpha chamber), click the **Background Spectrum** drop list and choose the correct background record. In this case, it must be updated one sample at a time. The name of the correct background will be on the most recent Analysis Report for that sample.

If updating an analysis and the calibration for that analysis has been superseded (i.e., if the detector has been recalibrated since the previous analysis was performed), inactivated, or removed, AlphaVision will use the active calibration performed closest to and before the acquisition date.

### **11.4.6 Screen 6 – Analysis Misc.**

The Analysis Misc. settings (Figure 132) specify how AlphaVision calculates and reports the analysis results.

#### **Activity Units and Reporting Calculated Activity**

Choose the **Activity Units** to be used for reporting (in conjunction with the unit of volume or weight selected on the Sample Properties page). Next, choose whether to report total activity per sample (**Activity/Sample**) or activity normalized per unit of volume or weight (**Activity Concentration**).

#### **Total Propagated Uncertainty (TPU) Reporting**

AlphaVision defaults to a **Predefined TPU Sigma** of 1 (users can also choose 2 or 3 from this drop list). To enter a non-integer value, click the **Enter TPU Sigma** checkbox, then enter the corresponding value. Users can also add **Systematic** and **Random** uncertainties that are not included in mass and volumetric uncertainties input when creating tracers, entering sample properties, etc. These uncertainties can be input as **Unc. in Percentile** or **Unc. in Activity Units**; activity units are restricted to the units chosen for reporting. If users choose **Unc. in Activity Units**, percent uncertainties are converted to the appropriate units for reporting.

Figure 132. Analysis Misc. Settings

### Manual Chemical Recovery

If users marked the **Manual CR** box on the Sample page (refer back to Figure 127, page 137), this section of the screen will be active. Enter the laboratory-determined chemical percent recovery and optional percent uncertainty. (For this type of analysis, it is typical to choose the **No Analysis** option on the Analysis page, count the samples, then reanalyze each sample by entering the recovery percent here.)

### Decay Correction

This is the “master control switch” for decay correction. It works as follows: By default, AlphaVision decay-corrects all samples to the data acquisition date/time. However, users can alternatively specify a different decay correction date/time for each sample in the batch on the Sample page. Should it be decided later to apply the default decay correction date to all samples (either while setting up this data acquisition or if using these settings as a template for other batches), simply unmark the **Decay Correction** checkbox here on the Analysis Misc. page. This saves the time involved in returning to the Sample Properties page and turning off the correction for each sample. Decay correction calculations are discussed in detail in Section B.7.3.24.

### Subtract Contaminants

If the Tracer Set selected on the previous page was marked as contaminated (to review the Tracer Set, return to the previous page and click **Tracer Editor**), marking this checkbox enables the contaminated-tracer calculations in the analysis algorithm.

### **Negative Activity**

Mark this box to allow the use of negative values for the net counts. Under normal conditions, net counts (calculated as Gross Counts minus Background Counts) are limited to zero if the background count exceeds the gross count.

### **Correct Partial Channels**

If an ROI is not an integer number of channels, marking this checkbox makes the analysis engine interpolate the counts as described in Section B.5.

### **Analyze Peak Stripped Spectrum**

This option is meaningful only for Peak Fit analyses. For the residual spectrum, the residual counts in each channel are calculated according to Section B.3. When users select this option in an ROI analysis, the program will do a peak search and fit, then calculate the residual spectrum from Eq. 9. This residual spectrum will then be used instead of the original spectrum in all the relevant calculations (such as the gross counts, activity, etc.). To view the residuals spectrum along with the original spectrum, right-click in the Spectrum Window and select **Show Residuals** from the right-mouse-button menu.

### **Set Up Peak Search/Fit**

This section of the screen is active only if the **Peak Search/Fit** option was selected as the **Analysis Method** on the Analysis screen. To customize these parameters, click **Setup** to open the Peak Search/Fit Setup dialog and see the instructions in Section 7.4 (page 67).

## 11.4.7 Screen 7 – MDA/Blank

Screen 7 of the Batch Wizard is the MDA/Blank setup (Figure 133). The elements of configuring an appropriate MDA calculation are discussed in the Analysis Methods in Section B7.2.2.

### **Blank Spectrum**

If this batch does not have a blank, AlphaVision lets users use the data from a blank spectrum already in the database by selecting from the **Blank Spectrum** list. The **Sort Blanks** list allows users to filter the **Blank Spectrum** list by Reagent Blank QA Type. Choose the desired Reagent Blank QA Type from the **Sort Blanks** list (Figure 134), then select a suitable entry from the **Blank Spectrum** (Figure 135).

**NOTE** If the batch has no blank and the **Default** entry in the **Blank Spectrum** list is selected, the analysis will fail. Should this occur, users can locate the failed analysis in the Sample Explorer Panel, right-click its entry  $\Sigma$ , choose **Update Analysis** and select an appropriate blank to complete the analysis successfully.

### **Subtracting Net Blank Activity**

This option subtracts the activity (not the counts) for a selected blank from the activity of all samples in the batch. If this batch contains a blank, mark the **Subtract** checkbox and use the **Default** entry in the **Blank Spectrum** drop list.

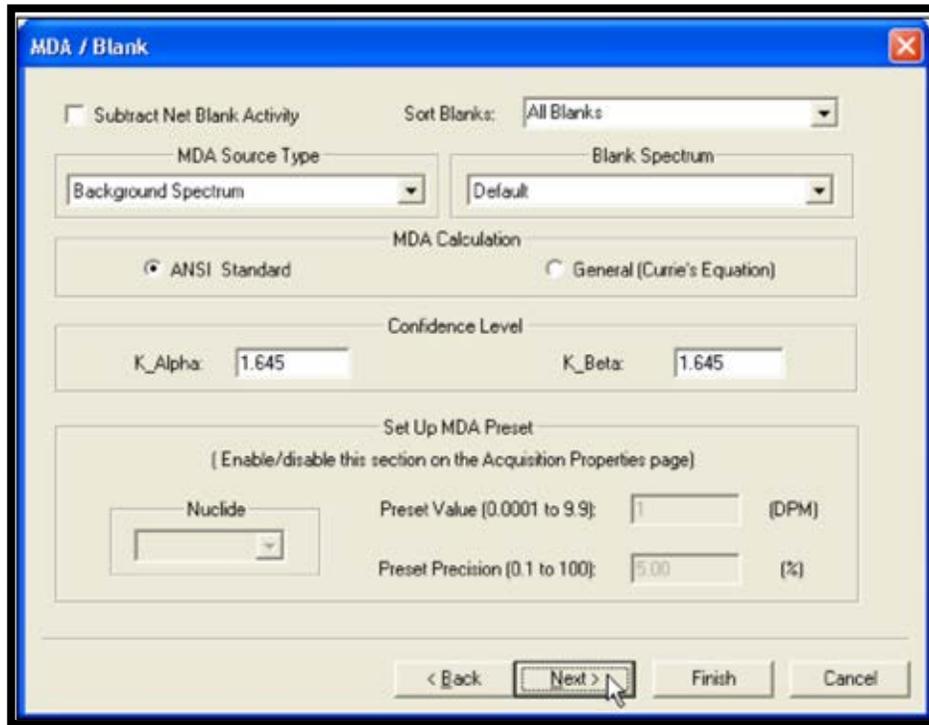


Figure 133. MDA/Blank Setup

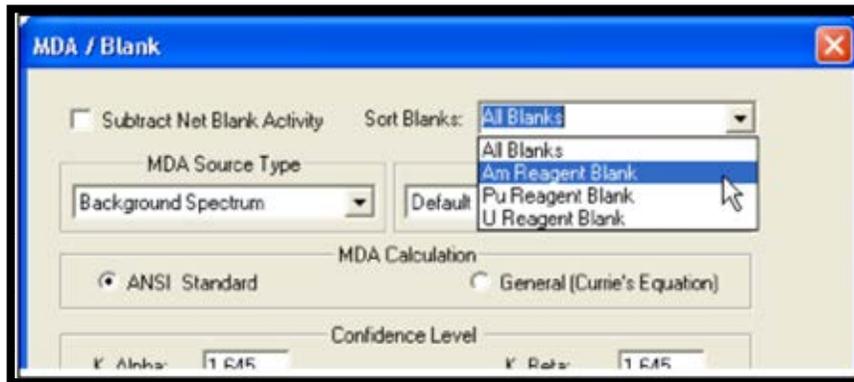


Figure 134. Select a Reagent Blank QA Type

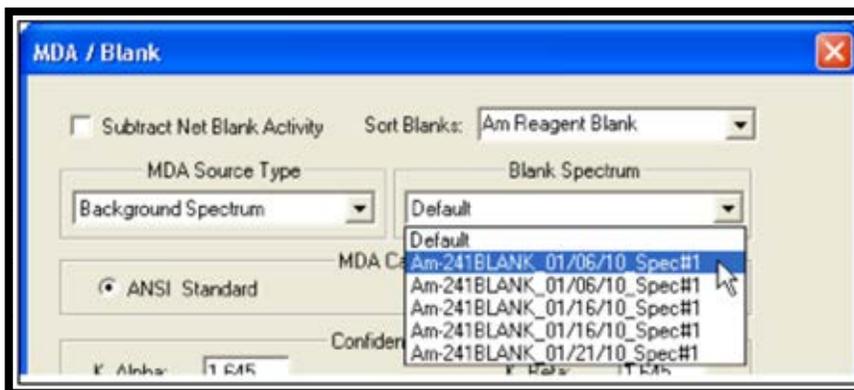


Figure 135. Choose a Blank Spectrum

### **MDA Calculation**

See the Analysis Methods (Appendix B) for details on selecting **MDA Source Type** and **Blank Spectrum** (if the **MDA Source Type** is **Blank Spectrum**); and setting up the **MDA Calculation** and **Confidence Level**.

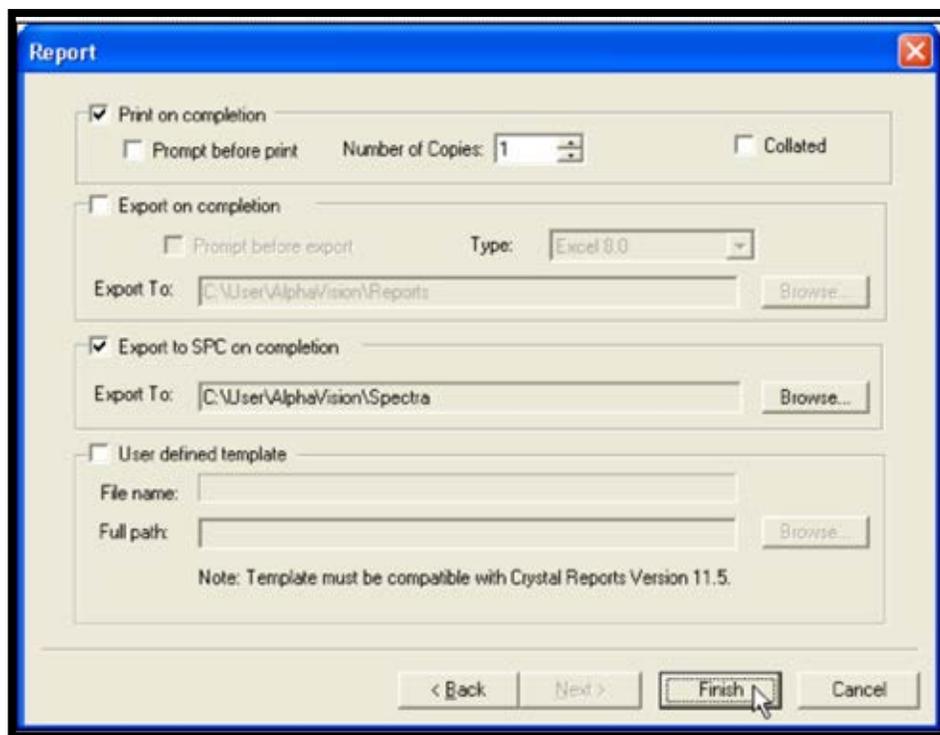
### **Set Up MDA Preset**

This section of the screen is enabled only if the MDA Preset checkbox on the Acquisition screen is marked. Select a **Nuclide** from the drop list, then enter the desired **Preset Value** in DPM and a **Preset Precision** percentage.

## **11.4.8 Screen 8 - Report**

The Report screen (Figure 136) is the final screen in the Batch Wizard. Use the features on this screen to print the analysis results, export them to other file formats, export the spectrum to an ORTEC .SPC spectrum file, and/or generate reports using personalized Crystal Report v11.5 report templates. (This can also be done from the Report Window).

The Batch Wizard setup is now completed. The next step is to click **Finish**, after which assign the detectors that will acquire the data for this batch according to the instructions in Section 11.2.



**Figure 136. Report Screen**

When acquisition and analysis are done, the Batch Explorer Panel will display the new batch, its component samples and the analysis for each spectrum; Figure 137 shows an example.

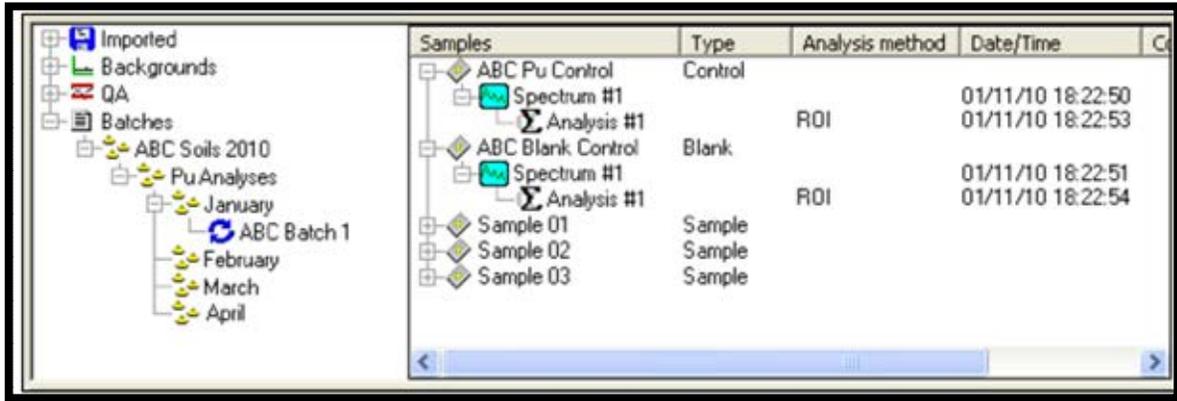


Figure 137. Batch Explorer Panel

## 11.5 INTERACTIVE ROI REANALYSIS OF BATCH AND BACKGROUND SAMPLES

AlphaVision has an *Interactive ROI analysis option* that allows ROIs to be fined-tuned by clicking and dragging ROI boundaries in the Spectrum Window. The updated ROI set is applied to the background and sample spectra, saved in the database, and reflected in the Spectrum image and Nuclide Summary on the analysis report.

**NOTE** This option cannot be used for the initial spectrum analysis, only for reanalysis.

The original ROI Set is not changed. Regardless of the original analysis method, if users reanalyze using the interactive ROI-based option, an ROI Based analysis is performed with the **Recalibration** and **Adjust ROI** features turned off.<sup>17</sup>

- 1) Use the Batch Explorer to locate the desired batch, then locate the spectrum (📊) to be reanalyzed. Click its Analysis results entry (Σ) to display the current spectrum and analysis.
- 2) In the Spectrum Window, zoom in as necessary to accurately change ROI boundaries and centroids. Click inside the first ROI to be adjusted to activate it. The active ROI has a *dashed border* and inactive ROIs have *solid borders*, as shown in Figure 138.
- 3) Click and drag the low-channel and high-channel ROI boundaries to reposition them as desired.
- 4) Next, reposition the centroid, if necessary. To do this, roll the mouse pointer over the small centroid marker until the pointer changes to a four-sided arrow (Figure 139), then click and drag to the new centroid position. The centroid marker will now indicate the new position (📍).

<sup>17</sup> If users begin shifting ROI boundaries in the Spectrum Window, then decide not to execute the **Interactive ROI Analysis** command, the original ROI limits are restored. However, once the Interactive ROI Analysis command has been issued, there is no undo for the customized reanalysis.

- 5) It is now ready to reanalyze. Right-click in the spectrum window and select **Interactive ROI Analysis** from the right-mouse-button menu (Figure 140). After reanalysis, the energy or channel labels on the X-axis may change.

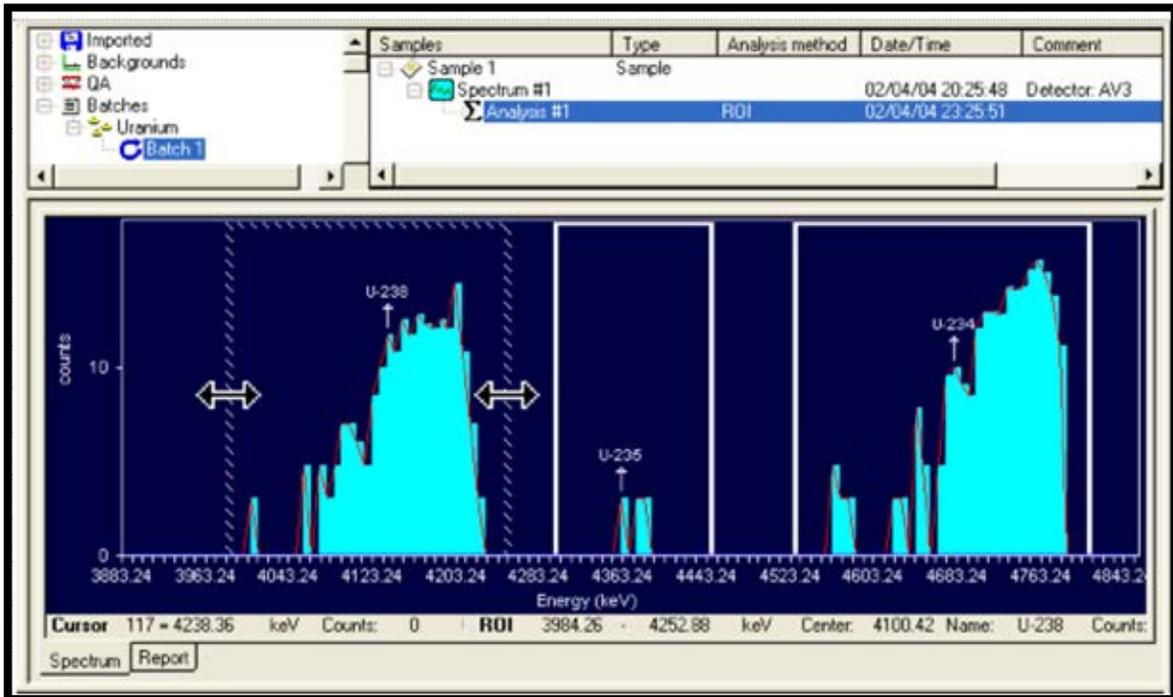


Figure 138. Click and Drag the Two-Sided Arrow to Adjust the Low- and High-Channel ROI Boundaries. Status Line Will Update to New ROI Boundaries

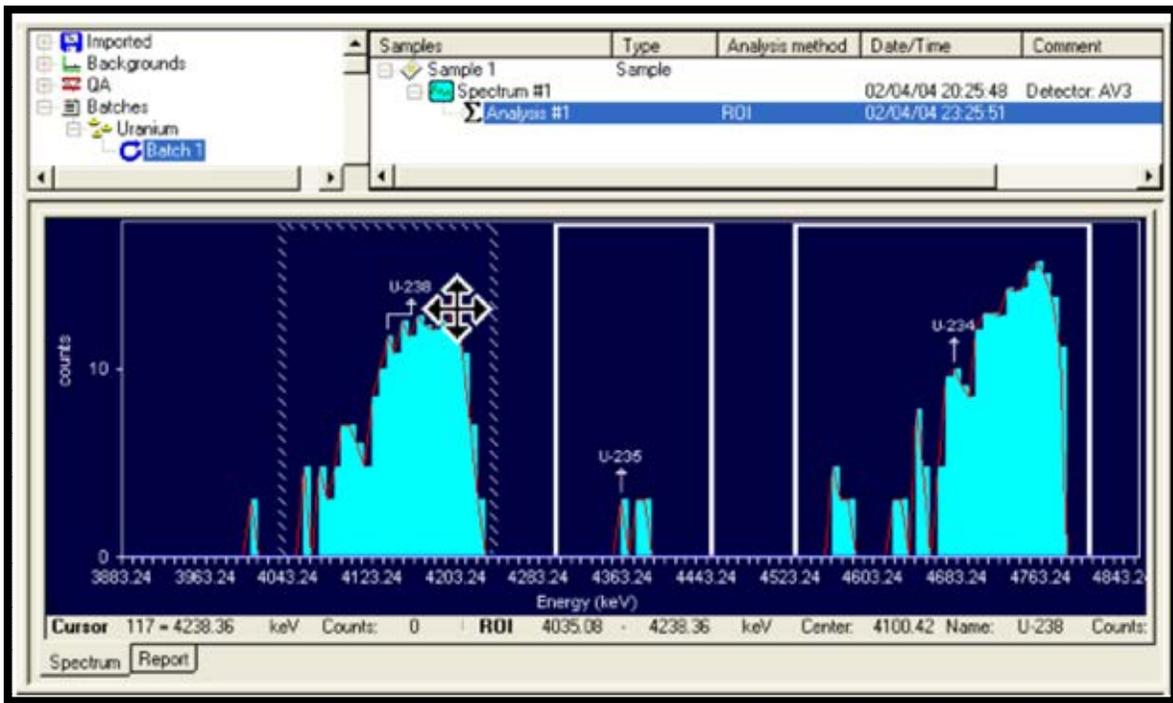


Figure 139. Click and Drag the Four-Sided Arrow to Reposition the Centroid, If Necessary. Status Line Will Update to Show New Centroid

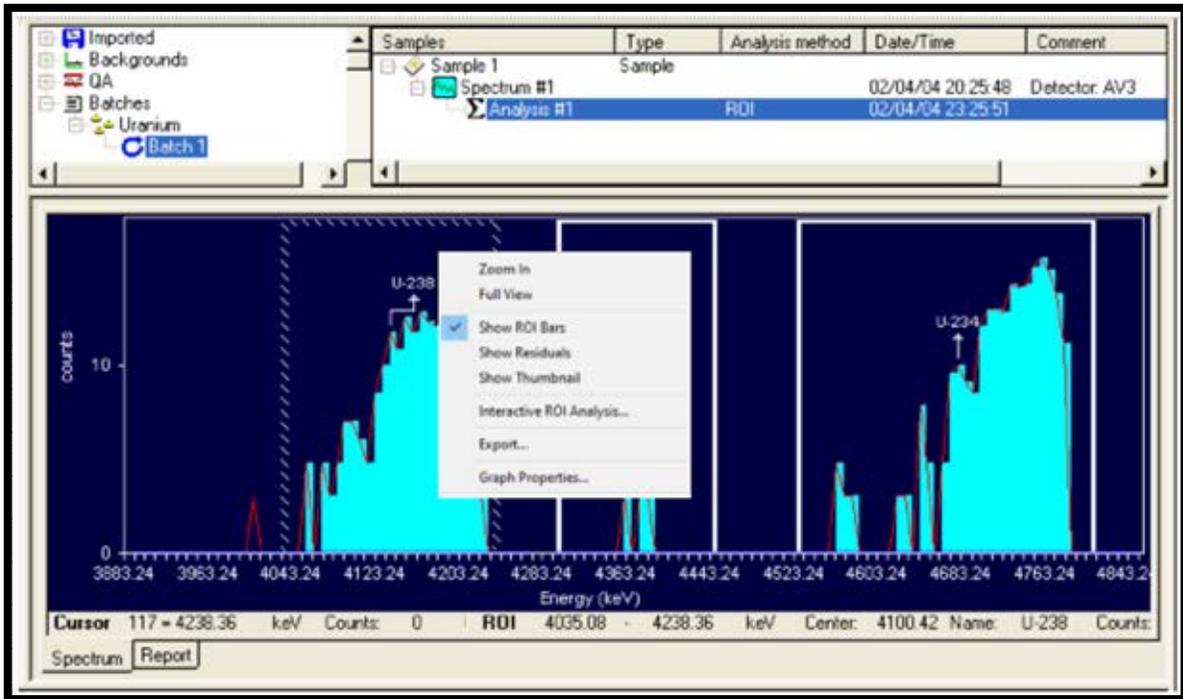


Figure 140. Right-Click and Select Interactive ROI Analysis to Start the Reanalysis

- 6) Figure 141 shows the completed reanalysis. Notice that the analysis **Date/Time** in the Sample Explorer has been updated.
- 7) The analysis properties and report will indicate, as follows, that a reanalysis has been performed with a customized ROI Set:
  - Right-click the Analysis entry and select **Properties** from the right-mouse-button menu. The Batch Properties dialog will show a checkmark in the disabled/gray **Interactive ROI** checkbox (Figure 142).
  - In the General Analysis section of the report, the **Analysis Method** field will read **Interactive ROI Analysis**. The Nuclide Summary (ROI) section (Figure 143) will show the list of peaks in the customized ROI Set. The **Analysis Method** field will indicate that an interactive ROI analysis has been performed.

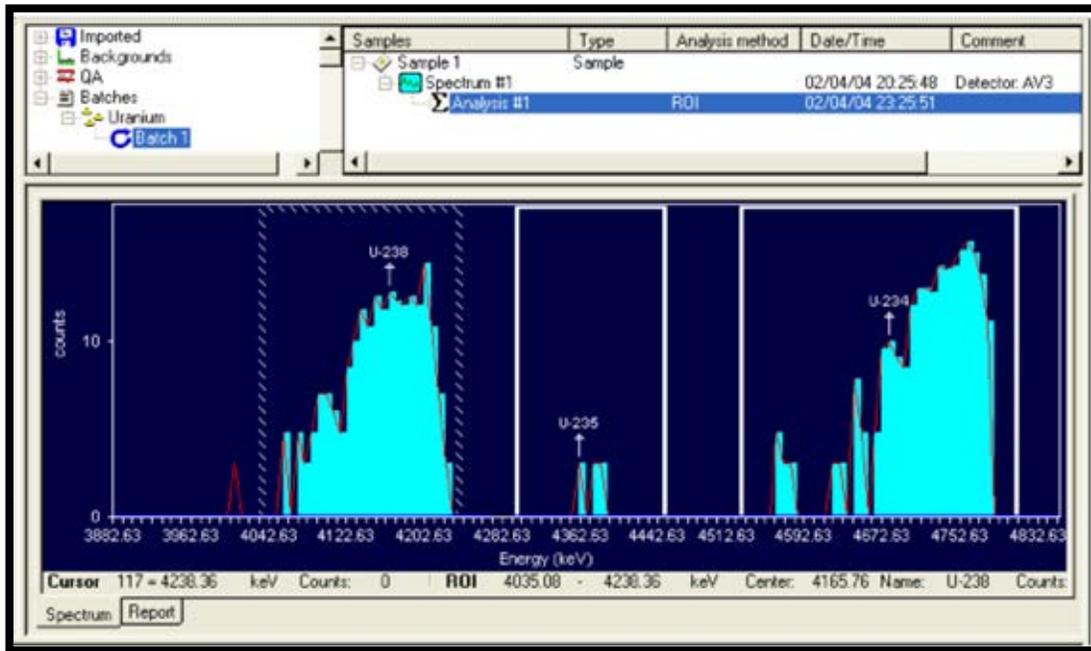


Figure 141. Reanalysis is Complete and the Analysis Date/Time Has Updated

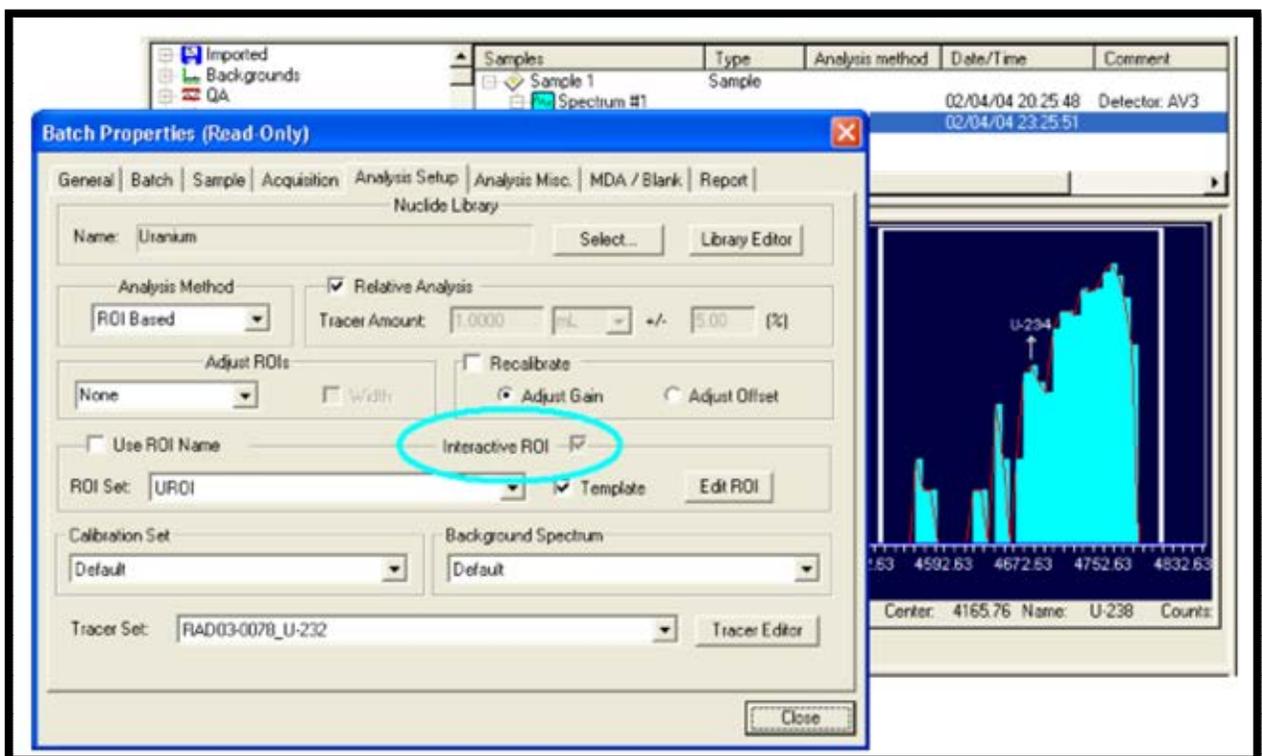


Figure 142. Analysis Properties for This Sample (Note Interactive ROI Checkbox is Now Marked and Recalibrate and Adjust ROI Width are Turned Off)

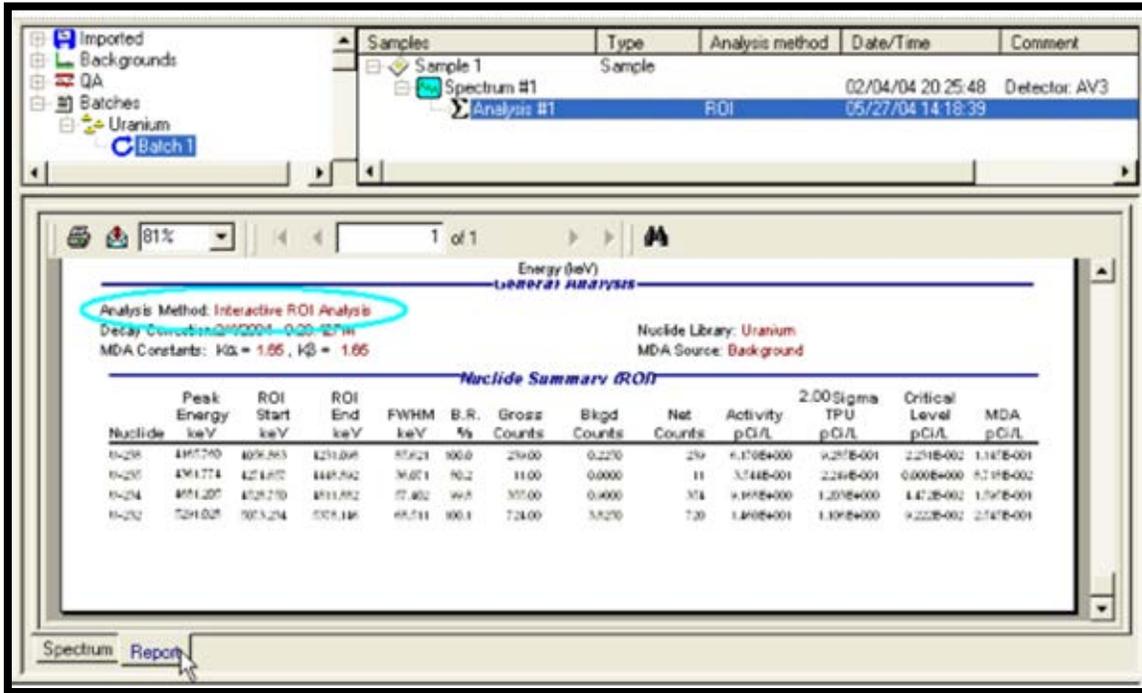


Figure 143. Report Indicates an Interactive ROI Analysis and Lists the ROIs Used

## 11.6 GAIN SHIFT AND INTERACTIVE ROI ANALYSIS

If the gain has shifted between the background and the sample measurements, the background measurement can be taken again. The most recently measured background will be the default background for subsequent sample measurement taken from the same detector. In the sample batch process, select default background, or select the new background spectrum just acquired from a dropdown list on the analysis setup page, then the new background will be used.

If the gain shift has not been noticed and the sample measurement has been taken already, users can use the interactive ROI method to update the background analysis for the background spectrum affected. Once updated, the visually adjusted ROIs can be found on the corresponding analysis report. Create a new set of ROIs based on the adjusted ROIs on the background analysis report. Then update the sample analysis with the new ROIs. The updated analysis results will have the desired background subtracted. If the gain shift is relatively minor and if the adjusted ROIs are suitable for both background and sample analysis, this method eliminates the need to measure the background again, which could be time consuming. However, if the gain shift is significant enough, it is preferred to measure the background again.

## 11.7 DATA REVIEW

Records containing errors should be removed from the database using the **Database Management** tools (Chapter 12) before they are exported, or the database is statistically analyzed.

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## 12. DATA MANAGEMENT AND IMPORTING OLDER ALPHAVISION DATA

Data management is key to (1) maintaining a comprehensive chain of custody over clients' samples and (2) keeping control of hundreds of data records. AlphaVision's data management tools include:

- Switching databases and creating new databases (Section 12.1)
- The database management and archival tools (Section 12.2)
- Importing data from previous versions of AlphaVision (Section 12.3)
- The Calibration Explorer Panel, gateway to all calibrations (Section 2.1.1)
- The Batch Explorer Panel, gateway to all records in the database (Section 2.1.2)
- The QA/QC Panel, gateway to QA limits, charts, and reports (Section 2.1.3)
- Exporting analysis results from the Report Window (Section 2.6.1)
- Exporting spectra as .SPC spectrum files (Section 9.6)
- The LIMS/AlphaVision 7 database interface (Chapter 13)

This chapter highlights the data management commands on the **File** menu.

**IMPORTANT** ***DO NOT attempt to modify AlphaVision databases!*** Use only the LIMS interface tables discussed in Chapter 13. It is encouraged to query the database, and it's easy to set up personalized Crystal Report formats. However, if the database must be "explored," make a copy of the database file(s) and explore that copy. It is also recommended that backup copies of the database(s) be frequently created.

### 12.1 SELECT DATABASE

The **Select Database...** command on the **File** menu lets users choose a particular AlphaVision 7 database for their project data. This makes it fast and easy to store all of the batch and background results, calibrations, users, detector data, libraries, templates, and QA results for a project in its own database, simplifying Batch Tree construction and project records archival.

**IMPORTANT** AlphaVision 7 can use only databases created with the new Database Management archive tool or cloned from an existing AlphaVision database.

#### 12.1.1 Switch to a Different Database

To switch to a different database, click **File/Select Database...** to display a standard Windows file-open dialog (Figure 144).

Choose a valid AlphaVision database and click **Open**. AlphaVision will notify users that it must close and reopen to put the change into effect. Click **Yes** to automatically exit and restart AlphaVision. Click **No** to manually exit and restart.

Spectrum and analysis data, users, passwords, security levels, libraries, templates, calibrations, QA results, and Detector Grid assignments travel with the database. When databases are changed, users may see invalid detectors (red with a black X), and may have to add, remove, and/or rearrange detectors.

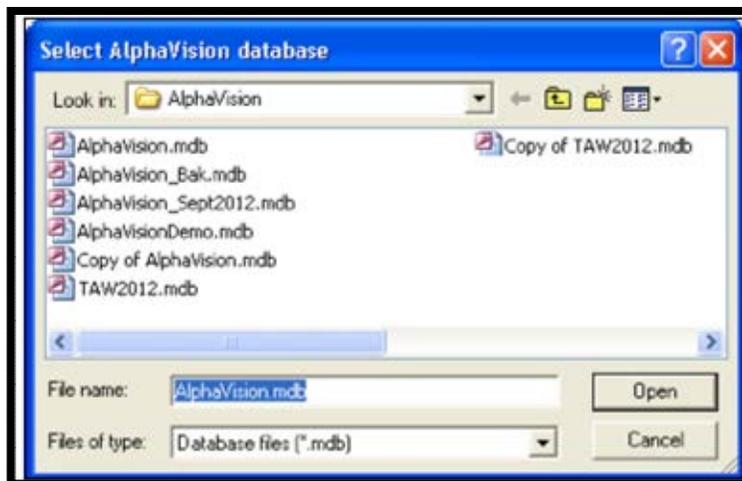


Figure 144. Selecting a New Target AlphaVision Database

**NOTE** The Login screen will offer the name of the last user to log in to *the previous database*. If necessary, change to a username valid for this database and enter the appropriate password. Especially for infrequently used databases, be sure to document at least one Administrator and password.

AlphaVision 7 can open AV v5.x & v6.x databases. The first time an older database is opened, it is automatically updated to the AlphaVision v7 database format. The records in this updated database will be displayed according to the settings in the v7 report templates (not the templates that were in effect when the older database was created).

### 12.1.2 Switch to a Clean, Empty Database

Using the Windows file explorer, locate the reserve copy of the AlphaVision.mdb database file reserved in the C:\User\AlphaVision\backup folder (Section 4.4). Copy it to C:\User\AlphaVision, rename it, then use **File/Select Database...** to select it. Populate the Detector Grid, assign users and security levels as desired, calibrate the detectors, and set up QA limits as needed.

### 12.1.3 Clone and Empty an Existing Database

If it is desired to use some or all of an existing database's Detector Grid assignments, QA Types, etc., use the Windows file explorer to locate the desired database, copy it to C:\User\AlphaVision, rename it, then use **File/Select Database...** to select it. Add or change assignments on the Detector Grid as desired and use the database management tools discussed in Section 12.2 to remove unwanted records (except calibrations and imported records, which cannot be removed).

## 12.2 DATABASE MANAGEMENT

The **Database Management...** command is located on the **File** menu. Figure 145 shows the Database Management dialog, which allows the following:

- Archive the current database by saving a copy in .MDB file format (giving a “snapshot” of the current database contents). This archive database can then be recalled at any time with the **File/Select Database...** command (Section 12.1).
- Permanently delete one or more sample records from a batch or delete an entire batch (Section 12.2.1). This, in conjunction with the Batch Explorer, allows users to tailor the contents of their databases as needed.
- Compact a database to recover disk space after deleting records.

The dialog’s title bar shows the name of the current target database. To select a different database, use **File/Select Database...**

The branches in the left-hand panel of the Database Management dialog mirror those in the main screen’s Batch Explorer, with two exceptions: Unlike the Batch Explorer, this dialog displays the various template records (T Templates) in the current database, and, except for calibrations, can be removed as needed. However, imported records (I Imported) are not shown here because, once imported, they cannot be deleted.

To view and/or delete QA pulser and QA background data, highlight the desired record and click **Edit** to open the QA Results Management dialog shown in Figure 146. Use the list box at the top of the dialog to view either pulser records or background records.

The **Status** indicator in the lower right corner indicates whether a deletion, archival, or compaction is in progress.

Click **Done** to return to AlphaVision.

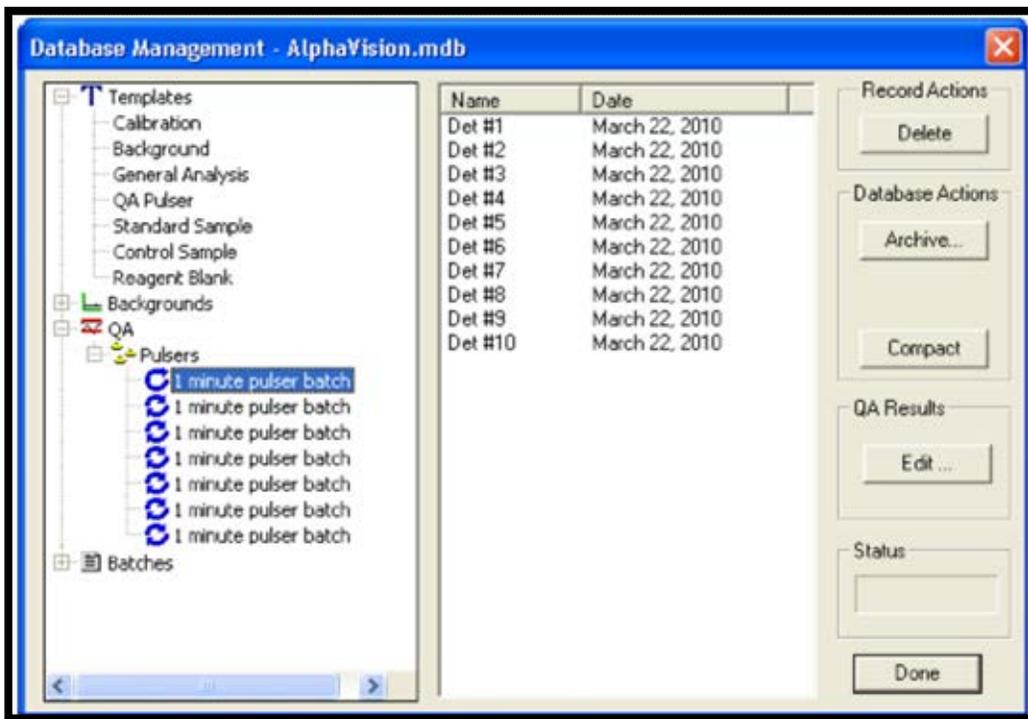


Figure 145. Database Management Dialog, Showing Current Target Database

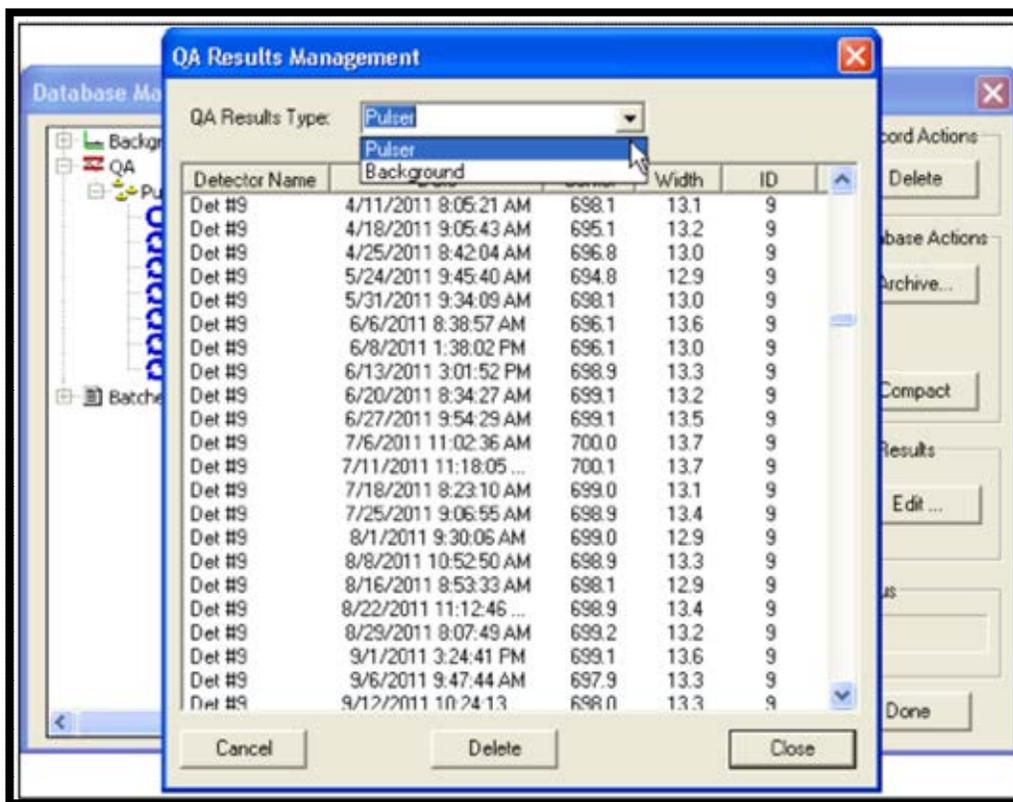


Figure 146. Manage QA Pulser and QA Background Records

## 12.2.1 Deleting Records

Note that calibrations cannot be deleted, however, users can delete calibration *templates* using this dialog. In addition, users cannot remove a background that is in use by an analysis (users will receive an **Unable to delete some or all of the selected records. Background spectrum is used by other samples** message). All samples using that background must first be deleted.

To remove one or more sample measurements from the database, use the left-hand explorer panel to locate the batch, then click the batch to display its component samples in the right-hand panel. Click the sample to highlight it, then click **Delete**. A message box will ask to confirm the deletion (Figure 147). To remove more than one sample at a time, use the **<Shift>** and **<Ctrl>** keys with the mouse to mark the desired records, then click Delete.

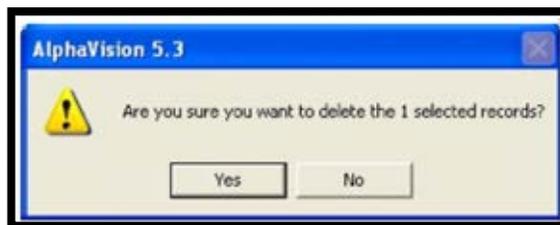


Figure 147. Deleting One or More Sample Records

To remove an entire batch, click to highlight it *but do not highlight any of the samples within the batch*, then click Delete. A message box will ask to confirm the deletion (Figure 148). While multiple samples can be removed from a batch at one time, only one batch can be deleted at a time.

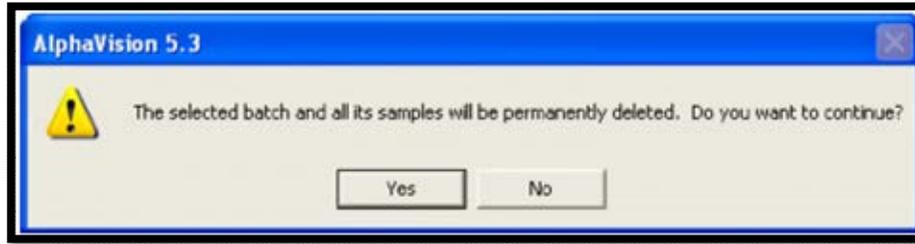


Figure 148. Deleting an Entire Batch

**IMPORTANT** *There is no undo for a deletion. It is strongly recommended that the database be archived before deleting any records!*

Once all of the batched in a branch have been removed, the Batch Explorer can be used to remove the branch; see Section 2.1.2.

### 12.2.2 Archiving a Database

To create a backup of the current database, click **Archive...** to open a standard Windows file-save dialog. Enter the path and desired filename and click **Save**.

### 12.2.3 Creating a “Clean” AlphaVision Database

If, after installation, a copy of the default, empty AlphaVision database was not created for future use, the **Archive** and **Delete** features together with the Batch Explorer can be used to create a new, “clean” database for the next project. The AlphaVisionDemo.mdb file is a convenient starting database. Create a backup copy of it with the **Archive** feature, choose it as the target database with **File/Select Database...**, restart AlphaVision, use the database management tools to remove all records from it, the Batch Explorer to remove all unwanted branches, the **Edit** menu commands to remove all but one Administrator, and the Detector Grid to remove all detectors. Now there is a blank AlphaVision database, ready to use.

## 12.3 IMPORTING OLDER ALPHAVISION .SPC FILES

Use the **File/Import...** command to import older AlphaVision .SPC files into the new AlphaVision database, one or more files at a time. Once older data has been imported, it’s quick and simple to analyze them within AlphaVision, adding their results to the database. ***This import operation leaves the original data files completely intact.*** .CHN files can be converted to the .SPC format in MAESTRO.

Note the following about imported files:

- Imported files must contain 4096 channels or less. If a file being imported has more than 4096 files, an error message will be displayed, and the file will not be imported.
- Imported files are displayed in the Batch Explorer Panel under **Imported/SPC Files**, in the order in which they are imported, and are labeled according to their original filename, without the .SPC extension. ***Before importing, ensure that the .SPC files have uniquely identifiable names.***
- The timestamp for each record is displayed in the Batch Window’s sample column under the **Acquired Date/Time** header. However, it may be easiest to locate an

imported record if its filename (at the time of import) provides information about acquisition date or project.

- Duplicate record names **are allowed**.
- Once imported into the AlphaVision database, **records cannot be deleted**.
- Previous versions of AlphaVision had a separate QA database. The contents of those QA databases cannot be imported directly into the AlphaVision database.
- Default analysis, report, and sample properties are used.

Once the .SPC files have been imported, they can be analyzed one-at-a-time in AlphaVision 7.

Before analysis, users will need to obtain each spectrum's tracer information and build a corresponding Tracer Set. If the sample did not have tracer added, a manual chemical recovery value will be needed.

If it is desired to derive Control Sample, Reagent Blank, and Chemical Recovery QA data from these analyses, users will also need to create appropriate analysis library and Control Solution records, and set up representative Control Sample, Reagent Blank, and Chemical Recovery QA Types.

- 1) In the Batch Explorer Tree, locate the imported record of interest, right-click it, and select **Modify Sample Properties....** Set up the sample **Type** (e.g., sample, blank, control), **Decay Correction**, **Volume** or **Weight**, and **Aliquot** size, and click **OK**.
- 2) In the Sample Analysis Explorer, right-click the imported record's spectrum, and select **Analyze** from the right-mouse-button menu. When the analysis setup dialog opens, select the corresponding **Tracer Set**. On the 3rd tab of the analysis setup dialog, choose a valid **Calibration Set** and **Background Spectrum** (generated in AlphaVision 7).
- 3) For absolute analyses, enter a value for the Manual Chemical Recovery on the 2nd tab in the analysis setup dialog.
- 4) Click **OK** to close the analysis setup dialog and perform the new analysis.
- 5) Click the resulting analysis and view its spectrum and report.

### 12.3.1 Analyzing an Imported .SPC File

This procedure serves two purposes: it explains how to analyze an imported .SPC file; and demonstrates that users can analyze a spectrum, export it, re-import it, reanalyze it, and obtain the same analysis results.

- 1) Switch to an unaltered copy of the AlphaVisionDemo.mdb database with the **File/Select Database...** command. AlphaVision will close for a few seconds then present the log-in dialog. The default username is ORTEC and the password is the lowercase letter "o" (not zero).
- 2) In Batch mode, locate a suitable spectrum, and adjust its sample properties.

- In the Batch Explorer Panel, locate the **Pu Demo Batch** record under the **Batch | Demo Spectra** branch and click to expand its entries in the Sample Explorer Panel.
  - In the Sample Explorer Panel, locate **Spectrum #1** for the **Demo\_01\_Pu** sample, right-click it, and select **Properties...** from the context menu.
  - Click the Sample tab and note the sample volume and units (1 L) and uncertainty (2%).
  - Click **Close** to exit the Properties dialog.
- 3) Reanalyze the spectrum using a different calibration set and background.
- Right-click **Spectrum #1** and select **Analyze...** from the context menu.
  - Click the Analysis Setup tab and in the **Relative Analysis** section note the **Tracer Amount** (0.5 mL) and the uncertainty (2%). Note also the Nuclide Library, ROI Set, and Tracer Set names.
  - In the **Calibration Set** field, select **Demo 5 - Initial** as the **Calibration Set**; and select **BkdDemo5\_DT200108215091249\_Spectrum#1**.
  - Click the Analysis Misc. tab and record the **Predefined TPU Sigma** value (2).
  - Click **OK** to reanalyze. This will create a new **Analysis #** entry under the spectrum name.
  - When the new analysis is displayed, click to highlight it, then click the Report tab at the bottom of the spectrum window and print the report to PDF or hardcopy.
- 4) Export **Spectrum #1** to the C:\User\AlphaVision\Spectra folder by right-clicking it and selecting select **Export...** AlphaVision will display a message listing the filename of the new .SPC file.
- 5) Import the just-created .SPC file by clicking the **Import** button on the Toolbar, navigating to C:\User\AlphaVision\Spectra, and selecting the just-created .SPC file.
- 6) Analyze the imported .SPC file using the same sample and analysis settings.
- In the Batch Explorer Tree, click to expand the **Imported | SPC Files** branch, locate the .SPC file just imported, right-click the file, and select **Modify Acquisition Presets**. Set the sample volume and units (1 L) and uncertainty (2%) and close the dialog.
  - AlphaVision will alert users that they have changed 1 sample's settings and ask if they wish to analyze. Answer **No**.
  - In the Sample Explorer Panel, locate **Spectrum #1** for the imported .SPC file, right-click it, and select **Analyze...** from the context menu.

- In the **Relative Analysis** section set the **Tracer Amount** and uncertainty to the same values as the **Demo\_01\_Pu** sample before export (0.5 mL and 2%, respectively); and confirm the same Nuclide Library, ROI Set, and Tracer Set are selected.
  - In the **Calibration Set** field, select **Demo 5 - Initial**; and in the **Background Spectrum** field, select **BkdDemo5\_DT200108215091249\_Spectrum#1**.
  - Click the Analysis Misc. tab and confirm the **Predefined TPU Sigma** setting of 2.
  - Click **OK** to analyze. This will create an **Analysis #1** record for the imported spectrum. Click it, then click the Report tab under the spectrum window and print the report to PDF or hardcopy.
- 7) Compare the two reports, including the **Tracer Recovery**, calibration, spectrum, and **Nuclide Summary (ROI)** sections at the bottom of each report. The analysis-related results should be identical. (Note that there may be minor differences in text [non-analytical] fields at the top of the report such as spectrum name, sample comments, etc.)

## 12.4 EXPORTING SPECTRA TO .SPC-FORMAT SPECTRUM FILES

This is done from the Batch Explorer Panel; see Section 9.6.

## 13. THE LIMS-TO-ALPHAVISION-DATABASE INTERFACE

AlphaVision gives users the unique ability to interface alpha-spectrometry software with their Laboratory Information Management System (LIMS). The AlphaVision database includes LIMS-interface tables that are linked with the Batch Wizard. Users can upload the data in these tables from their LIMS, reducing the number of transcription errors as well as the time needed for batch setup within the Batch Wizard.

The batch analysis results in the AlphaVision database are linked referentially to the input parameters. After sample counting and analysis, these data can be easily extracted and transferred to their LIMS.

*Some knowledge of databases, Microsoft Access, and database programming are required.* The company's LIMS administrator will have to create the link between the LIMS and the AlphaVision database. Only two AlphaVision tables are allowed to be modified, **LIMS-Batches** and **LIMS-Samples**.

There is a one-to-many relation between the **LIMS-Batches** to **LIMS-Samples** records, so the idea is that, through their LIMS, users will first input a new Batch record, fill it in with the desired batch- and sample-level information, then add all of its component samples to the **LIMS-Samples** table, setting the **BatchID** field to the new batch record's ID.

### 13.1 HOW THE PROCESS WORKS

As a batch of samples arrives at the laboratory, enter the batch and sample information into LIMS. These data will be transferred to the AlphaVision database through a process created by the LIMS administrator.

- 1) Start the Batch Wizard and on Screen 1, General, open the **Load from LIMS drop list**, pick one of the Batch IDs that were entered in LIMS, then click **Next**.
- 2) On the Batch Properties screen, choose the location in the Batch Explorer Tree where this batch will be displayed. (The LIMS/AlphaVision interface cannot perform this task for the user.)
- 3) If the **Client information** and **User-defined keys** were entered in the LIMS, this information will already be present at the bottom of the Batch Properties screen. If it is not present, enter it at this time. Click **Next**.
- 4) On the Sample Properties screen, the sample information will already be displayed (if it was entered in the LIMS). Any information that was not entered into the LIMS can be entered at this time.
- 5) It may be desired to click each of the samples in the batch and confirm their individual sample properties. Modify as necessary, then click **Next**.
- 6) If users are using a template that includes all of the acquisition, analysis, and reporting options they want, they can now click **Finish**. If not using a template or if changes

need to be made to the current template's settings, continue through the remainder of the wizard.

- 7) When users click **Finish**, if the **AutoDelete** flag in the **LIMS-Batches** table is Yes (True), the batch and all its samples will automatically be cleared from the interface tables so they're ready for the next data transfer (this step affects only the data-transfer tables and does not affect the other information in the LIMS or AlphaVision database).
- 8) The Detector Assignment Worksheet will open so detectors can be assigned.
- 9) Click the **Start Now** button.

## 13.2 LIMS/ALPHAVISION INTERFACE TABLES

### 13.2.1 LIMS-Batches

This information loads into the Batch Properties screen.

Table 6. LIMS-Batches Interface Table

Field Name	Data Type	Description
ID	Auto Number	Used for record sequencing only.
Name	Text (50 chars)	Name of this batch of samples.
QAType	Text (50 chars)	Name of Chemical Recovery Type for this batch (must be exactly the same as the QA Type name created in AlphaVision). Leave blank for no Chemical Recovery Type.
Template	Text (50 chars)	Name of Template to use for this batch (must be exactly the same as the batch Template name created in AlphaVision). Leave blank for no Template.
Description	Memo	Description of this batch.
ClientInfo	Text (50 chars)	Name of Client info for this batch (must be exactly the same as the Client Name created in AlphaVision). Leave blank for no Client Information.
User1Key	Text (50 chars)	User-defined Key.
User1Value	Text (50 chars)	User-defined Value associated with the Key.
CreationDate	Date/Time	Date/Time when this batch was created.
AutoDelete	Yes/No	The default for this value is TRUE. When TRUE, the batch and its samples will be deleted from this table when their data have been transferred and are no longer needed.
EditManualCRInSamplePage	Yes/No	The Manual CR value can be associated with either the Sample setup for all samples in this Batch; or it can be set for a single sample acquisition if defined in the analysis wizard on the Analysis Misc. screen. A value

		of "Yes" defines Manual CR with the Sample setup. A value of "No" defines Manual CR with the Analysis Wizard setup.
ManualCRDefined	Yes/No	Indicates if a Manual CR is established for this Batch. A value of "Yes" indicates that a Manual CR is established. A value of "No" indicates that no Manual CR is established.
ManualCR	Number (Single)	The Manual Chemical Recovery value (if known). Manual chemical recovery values (i.e., from an external tracer) can be added via this field. For instance, if chemical recovery has been determined by an alternative method, e.g., gamma spectroscopy, this manual chemical recovery feature allows calculations to be performed based upon this externally calculated value.
ManualCRUnc	Number (Single)	The Uncertainty associated with the Manual Chemical Recovery value.
EditTracerInSamplePage	Yes/No	

### 13.2.2 LIMS-Samples

This information loads into the Sample Properties screen.

Table 7. LIMS-Samples Interface Table

Field Name	Data Type	Description
ID	Auto Number	Used for record sequencing only.
BatchID	Number (Long)	Numerical ID for this batch of samples.
Name	Text (50 chars)	Name of this batch of samples.
Type	Number (Long)	One of the following values: 0=Sample, 1=Blank, 2=Control, 3=Background, 4=Pulser
CollectionDate	Date/Time	
UseCollectionDate	Yes/No	
DecayCorrDate	Date/Time	
UseDecayCorrDate	Yes/No	
LabPrepDate	Date/Time	
UseLabPrepDate	Yes/No	
Volume	Number (Single)	
VolumeUnits	Number (Long)	One of the following values: 0=L, 1=mL, 2= $\mu$ L, 3= $m^3$ , 4= $cm^3$ , 5= $ft^3$ , 6= $in^3$
VolumeUnc	Number (Single)	Uncertainty in percent

Weight	Number (Single)	
WeightUnc	Number (Single)	
WeightUnits	Number (Long)	One of the following values: 0=g, 1=kg, 2=mg, 3=μg
Aliquot	Number (Single)	Aliquot volume
AliquotUnc	Number (Single)	Uncertainty in percent
Comments	Text (255 chars)	Per-sample comments
QATypeID	Number (Long)	Name of QA Type for this sample (must be exactly the same as the QA Type name created in AlphaVision)
BulkVolume	Number (Double)	
BulkSourceID	Number (Long)	
User1Key	Text (50 Chars)	User-defined key 1
User1Value	Text (50 Chars)	User-defined value associated with key 1
User2Key	Text (50 Chars)	User-defined key 2 (does not appear on default report)
User2Value	Text (50 Chars)	User-defined value associated with key 2 (does not appear on default report)
IsVolume	Yes/No	If using volume select TRUE; if weight select FALSE
UseAliquot	Yes/No	TRUE if using an aliquot
TracerAmountDefined	Yes/No	If TRUE, tracer amount is defined for this sample in this table. Set to TRUE only if tracer amount for each sample is different.
TracerAmount	Number (Single)	Tracer amount in mL for this sample.
TracerAmountUncPct	Number (Single)	Tracer amount in mL for this sample
UseDilution	Yes/No	If TRUE, this sample has been diluted.
Dilution1	Number (Single)	The first dilution factor (D1).
Dilution1UncPct	Number (Single)	The first dilution factor (D1) uncertainty.
Dilution2	Number (Single)	The second dilution factor (D2).

Dilution 2UncPct	Number (Single)	The second dilution factor (D2) uncertainty.
Aliquot2	Number (Single)	The second aliquot amount.
Aliquot2UncPct	Number (Single)	The second aliquot amount uncertainty.

#### NOTES

- If tracer has been defined for a sample in batch, it must be defined for all other samples of the same batch.
- The first aliquot amount is in the field Aliquot (instead of Aliquot1).

### 13.2.3 SQL Example to Set Up a LIMS-Initiated Measurement

The following SQL example shows how to populate the LIMS batch in preparation for performing a batch measurement:

```
INSERT INTO [LIMS-Batches] ([Name], QAType, Template, [Description], ClientInfo,
User1Key, User1Value, CreationDate, AutoDelete, EditTracerInSamplePage,
EditManualCRInSamplePage) VALUES('<Name>', <QAType>, '<Template>',
'<Description>', '<ClientInfo>', '<User1Key>', '<User1Value>', '<CreationDate>',
<AutoDelete>, <EditTracerInSamplePage>, <EditManualCRInSamplePage>)
```

Note that <Batch Name> should be replaced with the LIMS Batch Name desired to retrieve from the database.

Note that within this SQL example, the values shown within '< >' brackets should be formatted as shown in Section 13.2.1.

Executing this append-style SQL command will populate the LIMS-Batches table with the values noted. These values will then be propagated to a Batch when the **Load from LIMS** option is enabled on Screen 1 of the Batch Wizard.

### 13.2.4 SQL Example to Read Measurement Results into LIMS

The following SQL example shows how to interrogate the AlphaVision 7 database for LIMS Batch results:

```
SELECT DISTINCT Sample.Name, AnalysisDetails.RegionName,
AnalysisDetails.Activity, AnalysisDetails.ActivityUnc, AnalysisDetails.SpecificActivity,
AnalysisDetails.SpecificTotalPropagatedUncPercent,
AnalysisDetails.BranchingRatio, AnalysisResults.DetectorEfficiency,
HWPParameters.LiveTime, AnalysisResults.ChemicalRecovery, Sample.Volume,
JobSpec.JobSpecName, Sample.IsVolume, AnalysisResults.Archive,
AnalysisSpec.ReportActivityPerSampleIndex FROM Tracer INNER JOIN (((Sample
INNER JOIN Spectra ON Sample.SampleID = Spectra.SampleID) INNER JOIN
(AnalysisSpec INNER JOIN JobSpec ON AnalysisSpec.AnalysisSpecID =
JobSpec.AnalysisSpecID) ON Sample.BatchID = JobSpec.BatchID) INNER JOIN
HWPParameters ON Spectra.HWPParametersID = HWPParameters.HWPParametersID)
INNER JOIN (AnalysisResults INNER JOIN AnalysisDetails ON
AnalysisResults.AnalysisResultsID = AnalysisDetails.AnalysisResultsID) ON
```

```
(Spectra.SpectrumID = AnalysisResults.SpectrumID) AND
(AnalysisSpec.AnalysisSpecID = AnalysisResults.AnalysisSpecID)) ON
Tracer.TracerRecordID = AnalysisSpec.TracerRecordID WHERE
JobSpec.JobSpecName = '<Batch Name>'"
```

Note that <Batch Name> should be replaced with the desired LIMS Batch Name to retrieve from the database.

Executing this query will produce a resulting table with the following values:

Name, RegionName, Activity, ActivityUnc, SpecificActivity,  
SpecificTotalPropagatedUncPercent, BranchingRatio, DetectorEfficiency, LiveTime,  
ChemicalRecovery, Volume, JobSpecName, IsVolume, Archive, and  
ReportActivityPerSampleIndex.

# APPENDIX A. ALPHAVISION 7 TUTORIAL

This tutorial illustrates the functions and features of the calibration, batching, background, and QA/QC processes in AlphaVision. It highlights the typical tasks users will encounter in alpha spectrometry - defining, storing, and retrieving project analyses and data; and creating, storing and retrieving quality assurance records associated with a given project, and so on - and how these tasks are simplified using AlphaVision. The tutorial takes users through all of the steps necessary to calibrate their detectors, including creating Calibration Source and Tracer records; build and use nuclide libraries for calibration, analysis, and QA; create QA Types and QC charts for tracking the recoveries for each of their projects; and analyze sample batches.

The tutorial covers the following topics:

- Step 1:** Creating a clean database for the tutorial (Page 168)
- Step 2:** Adding detectors to the AlphaVision system (Page 168)
- Step 3:** Calibrating detectors (Page 170)
  - Creating calibration source records
  - Setting up the Calibration Wizard, acquiring data, and creating an ROI record for the calibration
- Step 4:** Creating the control solution, nuclide library, tracer, ROI, and QA Type records necessary for sample analysis (Page 181)
  - Control solution records
  - Nuclide libraries
  - Tracer records
    - ROI sets
    - QA Types and QC charts for tracking control sample and blank activities and chemical recoveries
- Step 5:** Analyzing sample batches (Page 185)
  - Setting up the Batch Explorer Tree for a new project
  - Setting up the Batch Wizard and acquiring data
- Step 6:** Measuring isotope-specific background (Page 199)
- Step 7:** Setting up and generating control charts and reports (Page 204)

## A.1 Project – Plutonium in Soil for ABC, Inc.

This example is a project for ABC, Inc., that is expected to continue for 4 months. The first shipment consists of 3 soil samples to be measured for  $^{239}\text{Pu}$ . ABC requires a blank and a control for every batch of samples. It further requires that a control chart of the control spike recoveries ( $^{239}\text{Pu}$ ) be submitted once per month for this project. In addition, the contract specifies that the background count rate in the  $^{239}\text{Pu}$  region of interest be monitored and reported once per month for the detectors used to count samples and blanks. Uncertainties

are to be reported at a 95% confidence interval (using 1.96 as the sigma multiplier). The MDA calculation is to use the batch blank and the ANSI equation (where  $k_{\alpha} = k_{\beta} = 1.645$ ).

## A.1.1 Materials

### A.1.1.1 Samples

The examples below use  $^{239}\text{Pu}$  as analyte and control, and  $^{242}\text{Pu}$  as a tracer. To most effectively use this tutorial, it is recommended that users create 3 “samples” of  $^{239}\text{Pu}$  (containing  $^{242}\text{Pu}$  as a tracer), one reagent blank, and one  $^{239}\text{Pu}$  control.

### A.1.1.2 Calibration Standards

To create a calibration source for AlphaVision, users will first need to prepare a source in their wet-chemistry laboratory (or purchase it from a source manufacturer). Good references for the preparation and documentation of Standard Calibration Sources are ASTM C1128, 1989, Preparation of Working Reference Materials for Alpha-Spectroscopy and ASTM C1163, 1993, Preparation of Neodymium Fluoride Micro Precipitated Sources for Alpha-Spectroscopy. It is recommended that the nuclide energies for calibration encompass the entire region of interest for analytes of interest. For this tutorial, calibration sources containing  $^{148}\text{Gd}$  ( $E_{\alpha} = 3.18$  MeV),  $^{237}\text{Np}$  ( $E_{\alpha} = 4.782$  MeV), and  $^{244}\text{Cm}$  ( $E_{\alpha} = 5.805$  MeV) were used - the peak energies shown here are the largest abundance peak energies for these nuclides.

### A.1.1.3 Tracers and Control Solutions

Before creating tracer and control solution records in AlphaVision, users will need to prepare these solutions in their wet-chemistry laboratory. A tracer is a solution standard that is used to calculate the chemical recovery for their samples. A control solution is a solution standard consisting of the analyte-nuclide of interest. In general, these standard solutions are prepared by diluting standard reference materials obtained from NIST or another reference laboratory or source manufacturer or are purchased in diluted form directly from the source manufacturer.

## A.2 Step 1 – Creating a Clean Tutorial Database

Referring to the instructions in Section 12.1, copy the reserved AlphaVision.mdb file from C:\User\AlphaVision\backup to C:\User\AlphaVision and rename it Tutorial.mdb; then use **File/Select Database...** to make it the active database. AlphaVision will close briefly then restart, asking for the factory default database username and password.

## A.3 Step 2 – Adding Detectors to the AlphaVision System

The next task is to add a detector to the Detector Grid so that it can be accessed in AlphaVision.

- 1) Referring to Section 6.4, right-click an empty cell on the Detector Grid and select **Show Master List...** from the right-mouse-button menu.
- 2) Figure 149 shows the Master Detector List. To add a detector to the grid, go to the Master Detector List, and click and drag the desired detector from the list to the grid.

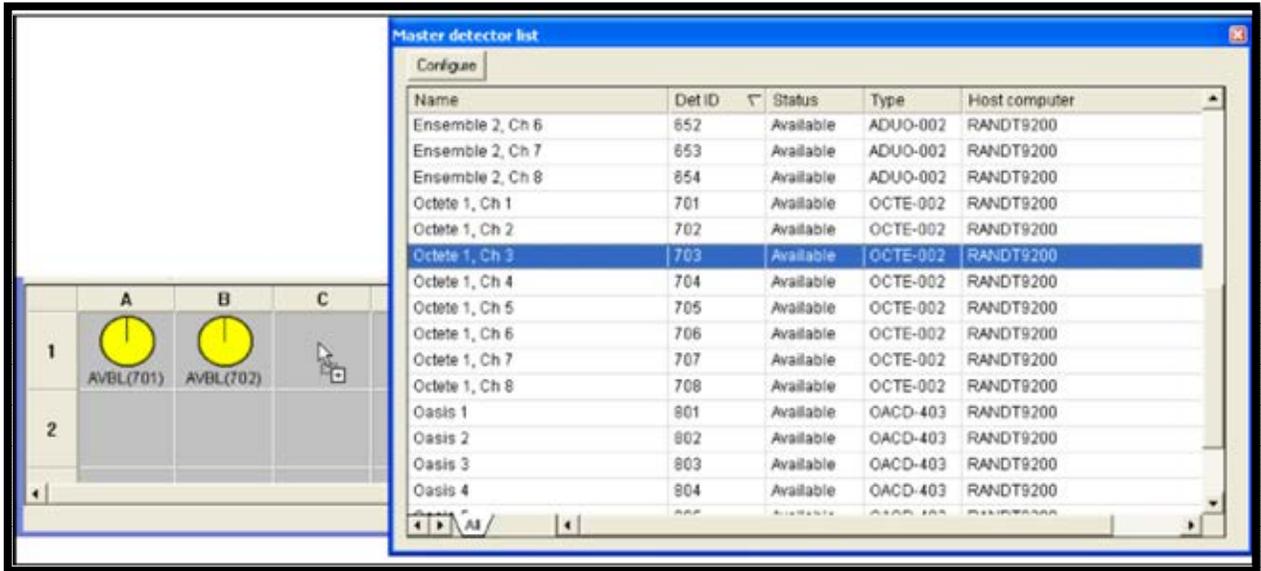


Figure 149. Master Detector List

- 3) The detector's Properties dialog will open (Figure 150). *Users must at minimum enter a **Detector Name** for QA tracking purposes.* It is suggested to use an intuitive name that specifies the MCB and alpha chamber. The remaining fields are not mandatory; however, they provide useful hardware documentation (such as the **SN** field, which captures the detector serial number), and the information is saved in the AlphaVision database.

Complete the remainder of the dialog as desired and click **OK**. The detector icon will change from the "Please Wait" hourglass to a "clock-face" icon.

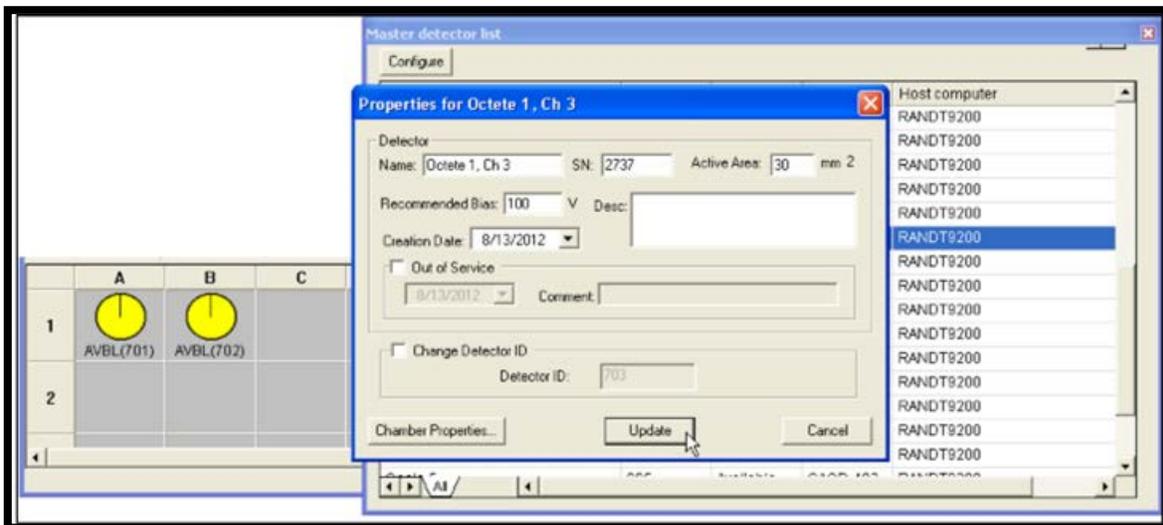


Figure 150. Detector Properties Dialog

- 4) Figure 151 shows the Detector Grid after the detector has been added. Detector icons can be positioned anywhere on the grid (when they are not acquiring) by clicking and dragging them - for example, if there are three Ensembles it may be desired to cluster the icons for each instrument in different sectors of the grid. To simplify sample

loading, it is suggested that the icons be arranged to reflect the relative positions of the hardware in the counting lab.

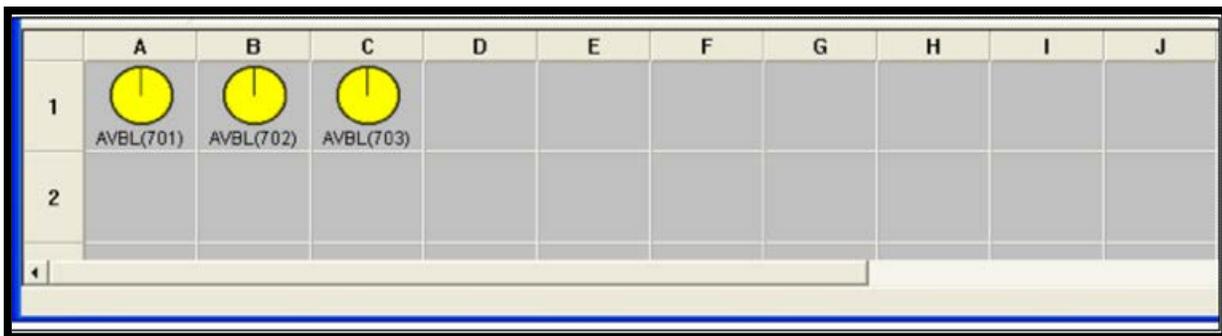


Figure 151. Detector Grid

That's all it takes to prepare the detector system for calibration!

## A.4 Step 3 – Calibration

The next task is to calibrate the detector. AlphaVision uses a friendly setup wizard to speed the process of calibrating detectors; storing calibration data; and viewing the results onscreen, in Calibration reports, and in QC charts.

**NOTE** The calibration source must have at least two energy peaks for a calibration.

### A.4.1 Creating a Calibration Source Record

First, referring to Section 8.3, create a data record for the calibration source to be used (see also Section A.1.1). This will require information from the source certificate.

- 1) On the Outlook Bar, click the **Calibration** icon.
- 2) From the Toolbar, click the **Standards** button to open the Standards dialog (Figure 152). On the Calibration Sources tab, click **Add** to open the Calibration Source dialog.

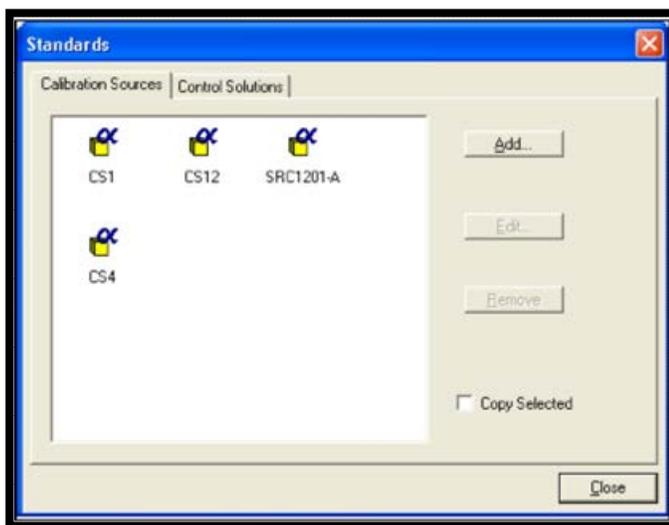


Figure 152. Add Calibration Sources

- 3) In this example, create a Calibration Source record named *ABC Cal Source* containing the nuclides  $^{148}\text{Gd}$ ,  $^{244}\text{Cm}$ , and  $^{237}\text{Np}$ . Leave the percent **Activity Uncertainty** at zero on the Nuclide Information dialog.
- 4) The resulting record for *ABC Cal Source* should look like Figure 153.
- 5) Click **OK** to return to the Standards dialog, then click **Close** to return to the main AlphaVision screen.

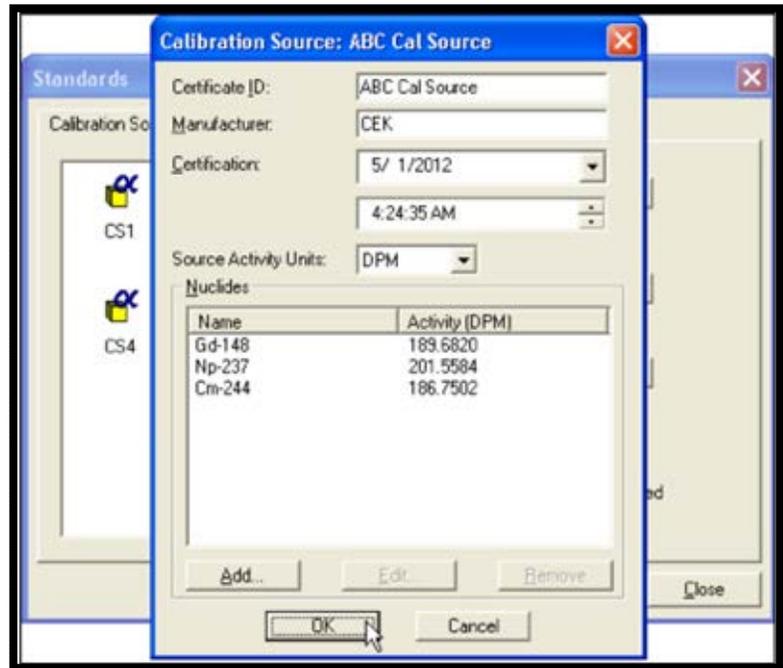


Figure 153. Calibration Source Record

- 6) The new standard has been added (Figure 154). The system is now ready to calibrate the detectors using the Calibration Wizard.

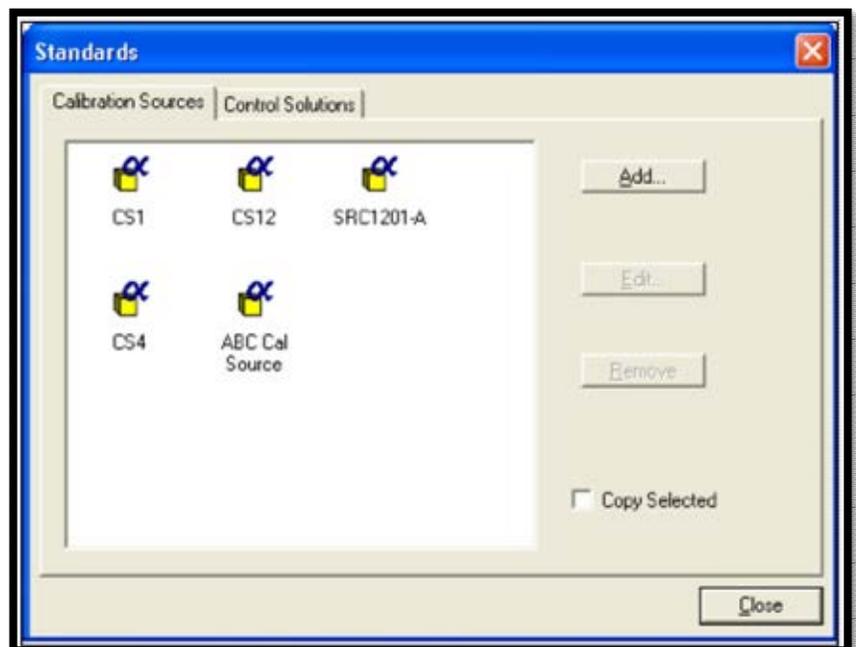


Figure 154. Standards Showing New Standard Added

#### A.4.2 Calibrating the Detectors

Referring to Section 7.1, place the calibration source in the detector in the same geometry as the samples that will be counted. Evacuate the chamber to the appropriate pressure and start the calibration count.

- 1) To begin the count, click **Process Calib** on the Toolbar. This will open the first screen of the AlphaVision Calibration Wizard, General (Figure 155).

The descriptive **Name** for the calibration will be *ABC Pu Calib 1*. Choose whether to enter a **Description**. Mark this example for use as a **Template** for reuse in the future. Click **Next**.

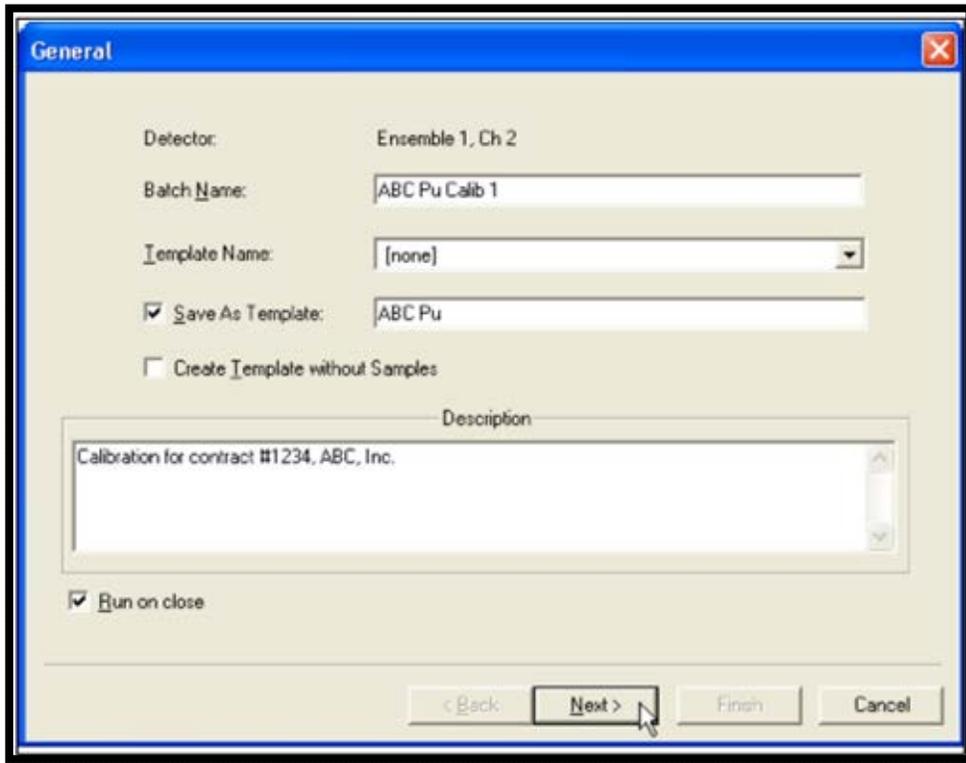


Figure 155. Calibration Wizard Screen 1 – General

- 2) The Acquisition page (Figure 156) is discussed in Section 7.1.2. Enter a **Live Time** for the calibration. Users may also elect to use the pressure and leakage current **Thresholds**. In this exercise, use a **Max Vacuum** of 30 Torr, a **Min Bias** of 45V, and a **Max Leakage I** of 1000 nA.

Click **Next** to advance to the Energy/Efficiency Calibration Setup page (Figure 157), which is discussed in Section 7.1.3.

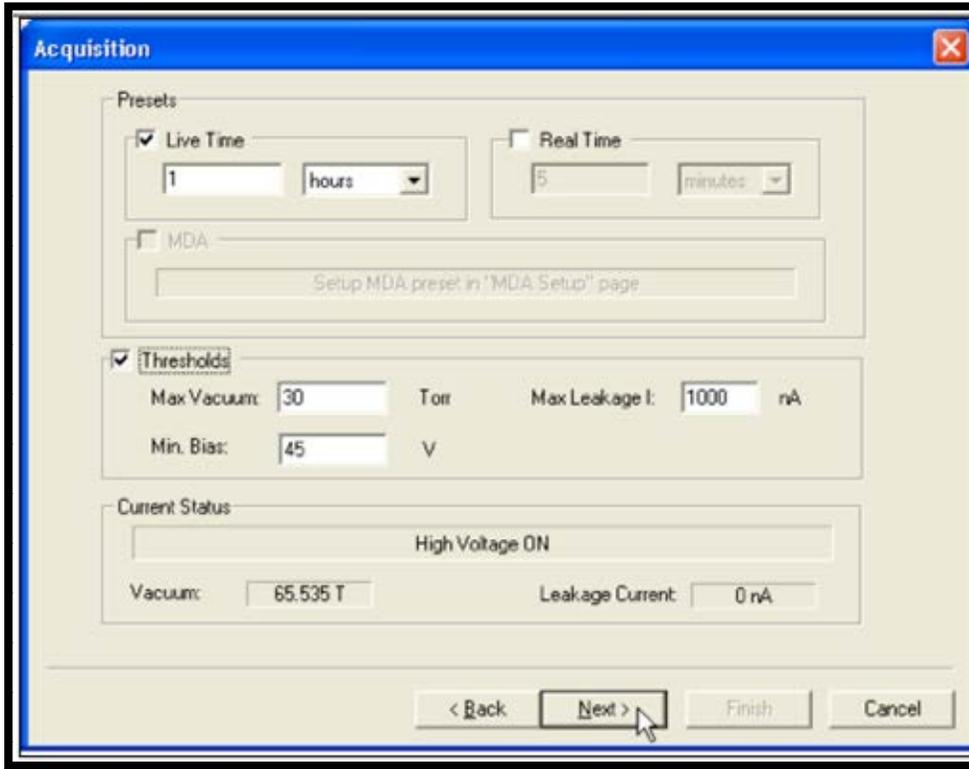


Figure 156. Acquisition Page

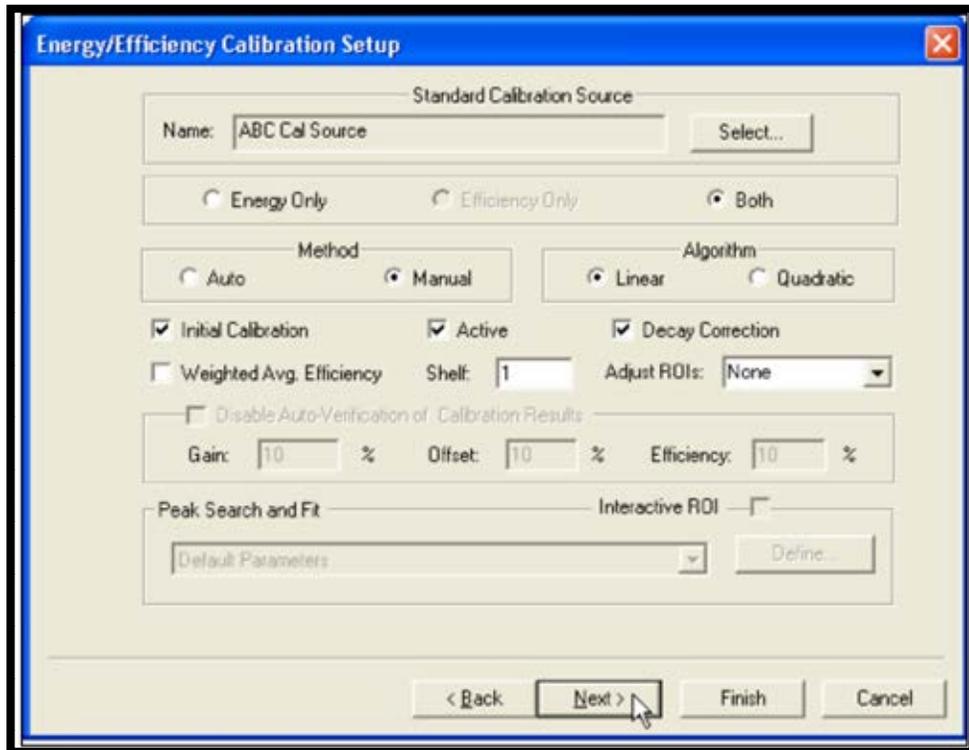


Figure 157. Energy/Efficiency Calibration Setup Page

- 3) On this page, users will set up the analysis method for their calibration, selecting *ABC Cal Source* as the Standard Calibration Source.
- 4) Click the **Manual** peak-search-and-fit method, which will require users to hand-select ROIs for the efficiency calibration and peak energies for the energy calibration.
- 5) Click the **Initial Calibration** button to mark this as the calibration against which future calibrations for this detector will be compared until another **Initial Calibration** is performed.
- 6) Mark the **Active** checkbox. When this box is marked, a calibration that is successfully **Completed** becomes the active calibration for this detector, superseding the previous active calibration.
- 7) Mark the **Decay Correction** checkbox to correct to the **Certificate Date/Time** entered when creating the source record.
- 8) Click the **Quadratic** radio button to include a quadratic term in the energy calibration.
- 9) The next step is to decide how the average efficiency is to be calculated. AlphaVision allows users to choose between a weighted average and a simple arithmetical average (mark or unmark the **Weighted Avg. Efficiency** checkbox). The weighted average weights the contribution to the average of each peak by the number of counts in the peak. In this example, the peak activities of the nuclides used are roughly equal so the difference between the weighted average and simple average will be small. Therefore, use the simple average by unmarking the **Weighted Avg. Efficiency** box. See Section B.8.
- 10) The **Shelf** feature enables users to distinguish calibrations by shelf position in the alpha chamber. For this example, enter a "1" in the **Shelf** field to indicate the source is being counted with the planchet holder in the uppermost position. The **Shelf** column in the Calibration Explorer will display the number entered here so users can easily tell which calibration to use for different shelf positions. This means that it is possible to have multiple calibrations for a single detector.

**NOTE** The default calibration for an analysis is always the most recent active calibration performed for the detector the sample is counted with. If users decide to count a sample in a different shelf position, the Batch Wizard lets them choose another calibration, prior to analysis, from the Calibration Set drop list on the Analysis Setup screen (see Figure 181).

Setup of the calibration parameters is now completed. Click **Next** to continue to the Report page.

- 11) Use the features on the Report page (Figure 158) if it is desired to automatically print the analysis results and/or export them to other file formats or custom report templates. (This can be completed from the Report Window.) In this case, click **Print on Completion**.

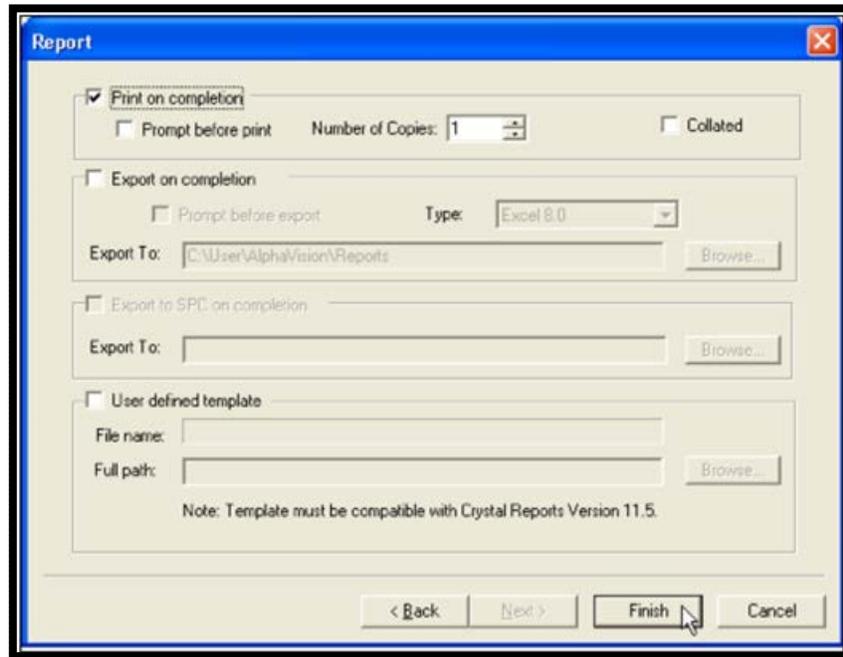


Figure 158. Report – Print on Completion

- 12) Click **Finish** to begin counting the calibration source. The live spectrum will be displayed in the Spectrum Window during acquisition.
- 13) When the count is complete, the Manual Energy and Efficiency Calibration dialog will open (Figure 159). In this window, users will use the calibration source data to calibrate the detector. Note, however, that users will be able to change these data to match the spectrum more precisely if desired. Users may find it useful to move the dialog away from the Spectrum Window (click and drag by the dialog's title bar).

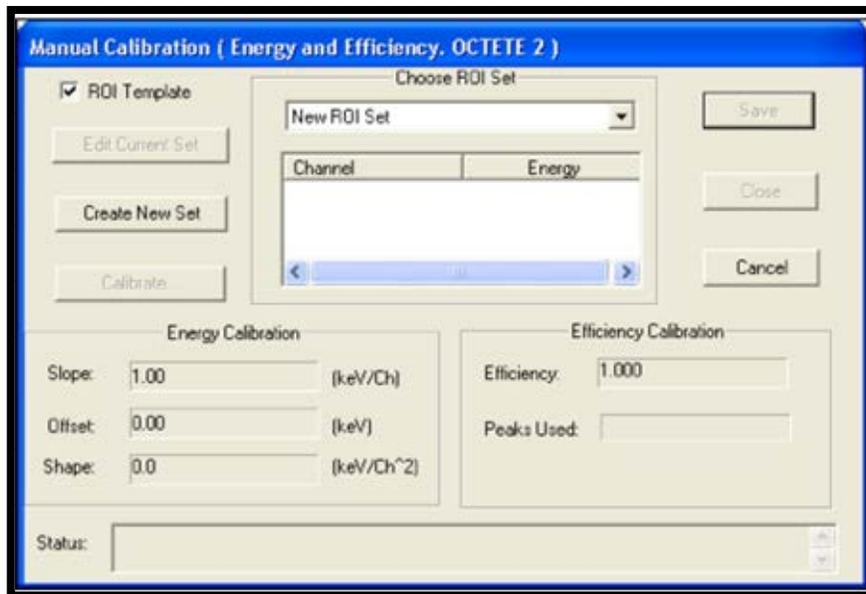


Figure 159. Manual Calibration Dialog

#### 14) Creating an ROI Set for This Calibration Record

The next step is to specify the ROIs for the analysis by creating a type of database record called an **ROI Set**. The ROI Editor gives two ways to enter the ROI **Low** (start) and **High** (end) channels: interactively, using the mouse in the Spectrum Window; and manually from the keyboard. The interactive method detailed in Section 8.6.2.1 will be used here.

- a. Referring to Figure 82 in Section 8.6.2.1, go to the Manual Energy and Efficiency Calibration dialog and click **Create New Set**. This will open the ROI Editor.
- b. Next, limits will need to be set for each of the 3 ROIs by designating a **Low** channel, **High** channel, and **Centroid** for each peak. To determine the precise channels, zoom in on the 3 peaks. In this example, the screen will be zoomed in using the Thumbnail window, however, users can also click and drag a rubber rectangle around the area of interest, then right-click, and select **Zoom In** from the right-mouse-button menu. As discussed in Section 8.6.2.1, right-click in the Spectrum Window, choose the Thumbnail view, and zoom in on the 3 peaks. The system is now ready to define the ROIs.
- c. In the ROI Editor, go to the ROI list and click the **-Update-** entry. This prepares AlphaVision to read the ROI start and end channels from the position of the mouse in the Spectrum Window, as explained in the next step.
- d. In the Spectrum Window, locate the lowest-energy peak to be used in this set. In this example that will be  $^{148}\text{Gd}$ . Hold down the **<Ctrl>** key, left-click the low-channel end of the ROI, drag the mouse to the high-channel end, then release the mouse button and the **<Ctrl>** key. The **Low** and **High** channels (in this example, 179 and 210, respectively) will be automatically entered in the ROI Editor (Figure 160).
- e. Next, use the mouse to manually mark the peak **Centroid**. In the Spectrum Window, locate the peak centroid and click it once. The channel clicked will automatically be entered in the **Centroid** field (Figure 161); in this example, the centroid is at channel 203. (If the intended channel is missed, click again as often as desired until satisfied with the position, or enter it from the keyboard.)

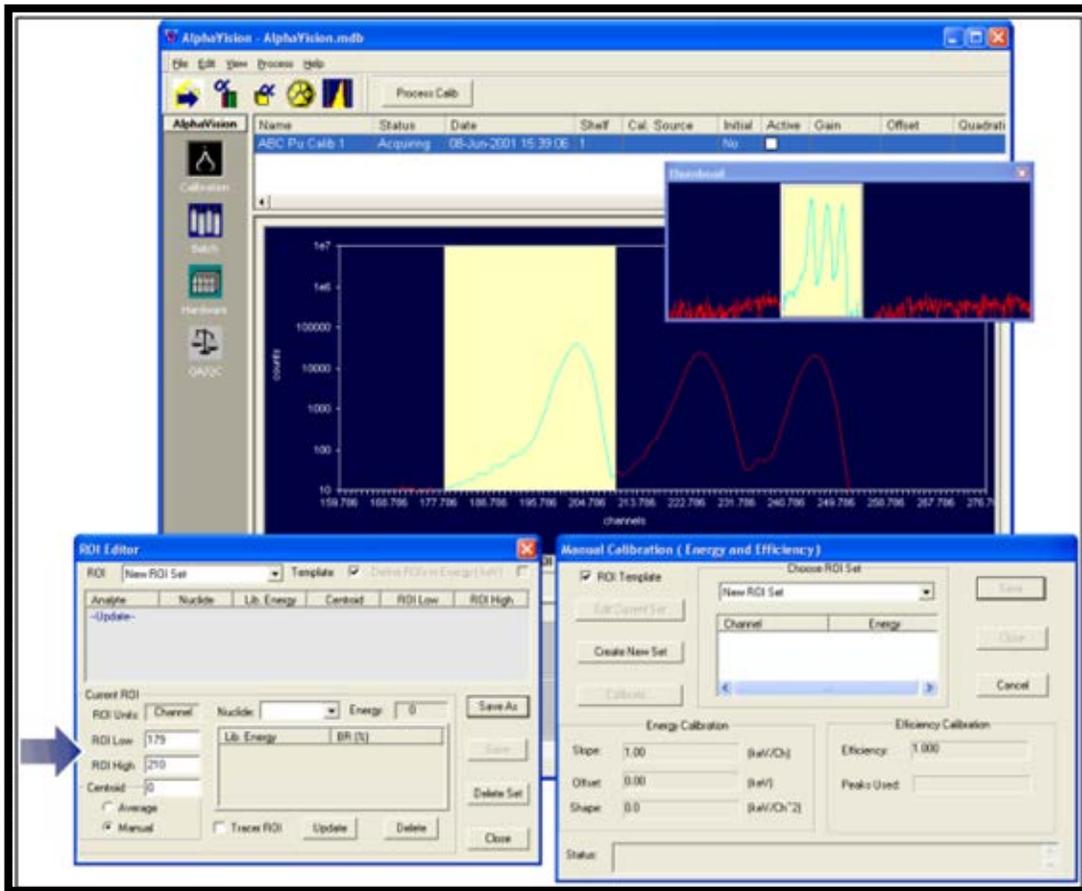


Figure 160. With <Ctrl>+Mouse, Mark the ROI by Dragging the Cursor from Low to High Channel

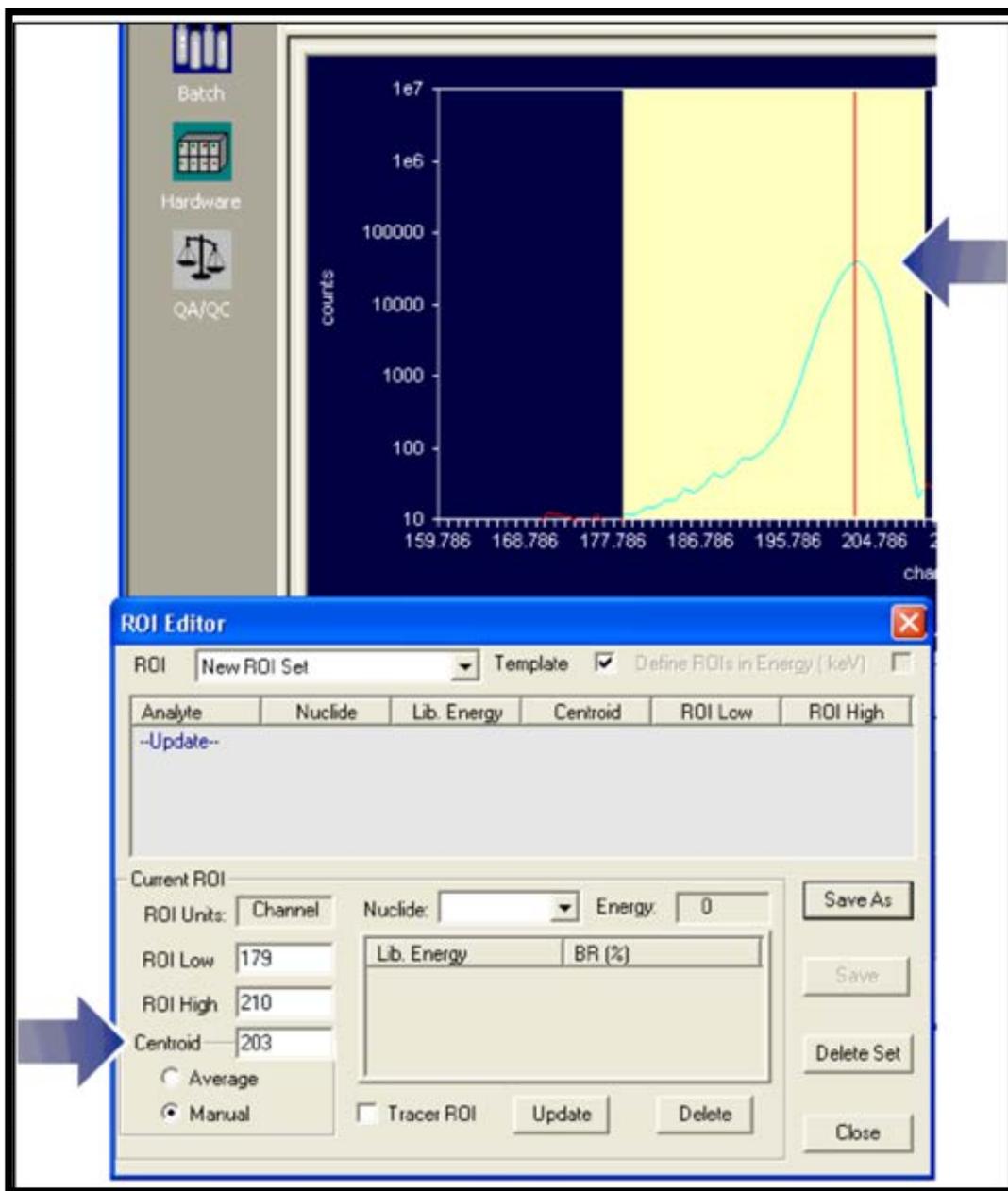


Figure 161. Click to Mark the Centroid Channel or Enter with Keyboard

- f. In the ROI Editor, click the **Nuclide** drop list and choose  $^{148}\text{Gd}$ , then click the **Update** button. The values selected will now be displayed in the main section of the ROI Editor. Repeat this procedure for  $^{244}\text{Cm}$  and  $^{237}\text{Np}$  (Figure 162).

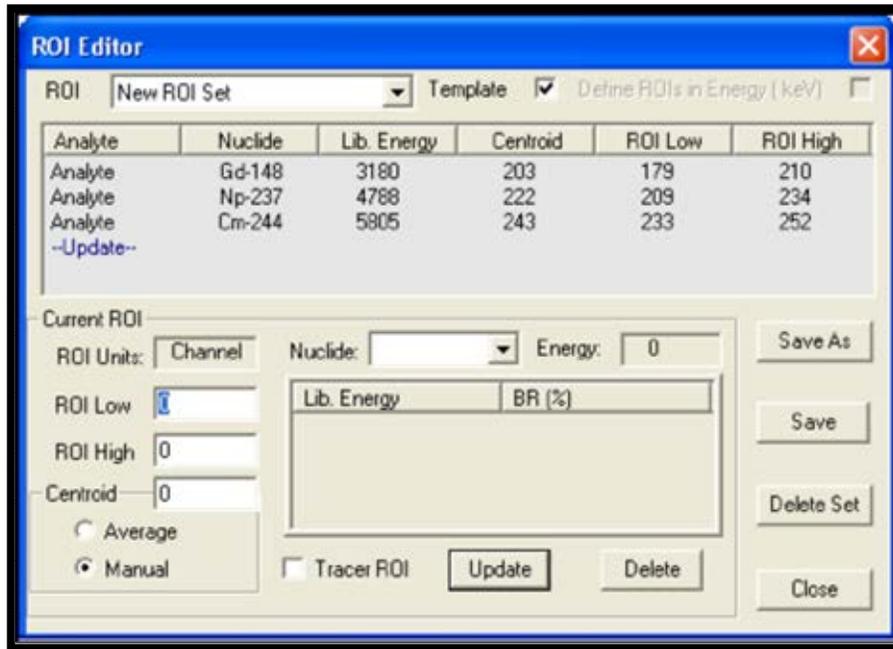


Figure 162. ROI Editor

- g. The new **ROI Set** is now ready to use. Click **Save**, enter *ABC Source 1 ROIs* as its **New Name**, make sure the **Save As Template** checkbox is marked, and click **OK** to return to the Manual Energy and Efficiency Calibration dialog. AlphaVision will automatically load the contents of the new ROI Set into the calibration dialog.
- 15) In the calibration dialog, click **Calibrate** (Figure 163). AlphaVision will calculate and display the efficiency and energy calibration factors, including a **Status** note at the bottom of the calibration dialog (which, in Figure 164, reads **Calibration completed**). Always check this status line when clicking **Calibrate**. In addition, monitor the AlphaVision Event Window for error messages pertaining to this calibration.

**NOTE** In **Manual** calibrations, AlphaVision allows users to inspect and modify the calibration data before committing them to database. This lets users adjust the ROIs if they made an error in selecting peak channels or ROI limits.

- 16) Click **Save** to save the calibration to the database. Click **Close** to return to the main AlphaVision screen.

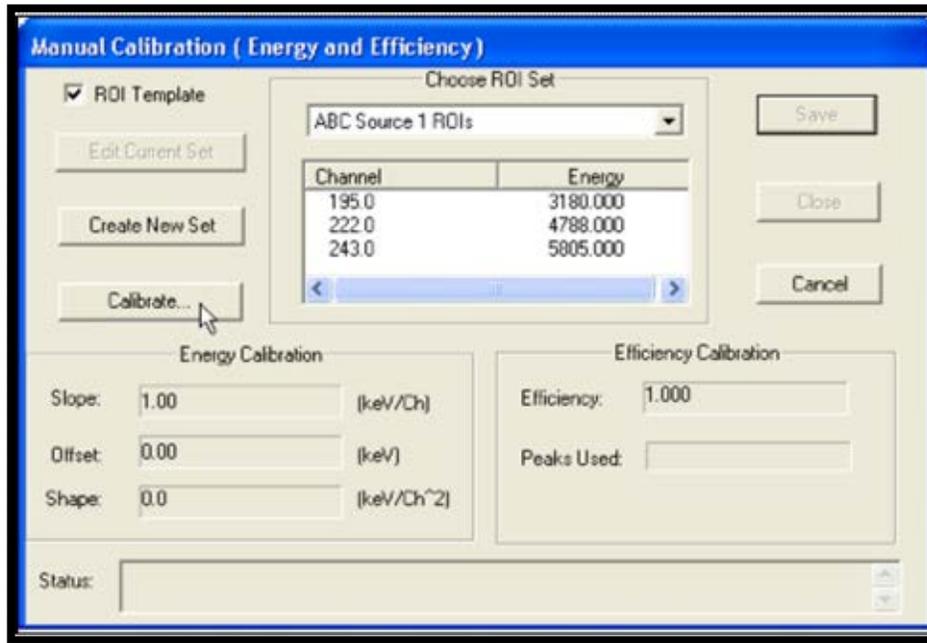


Figure 163. Manual Calibration Dialog

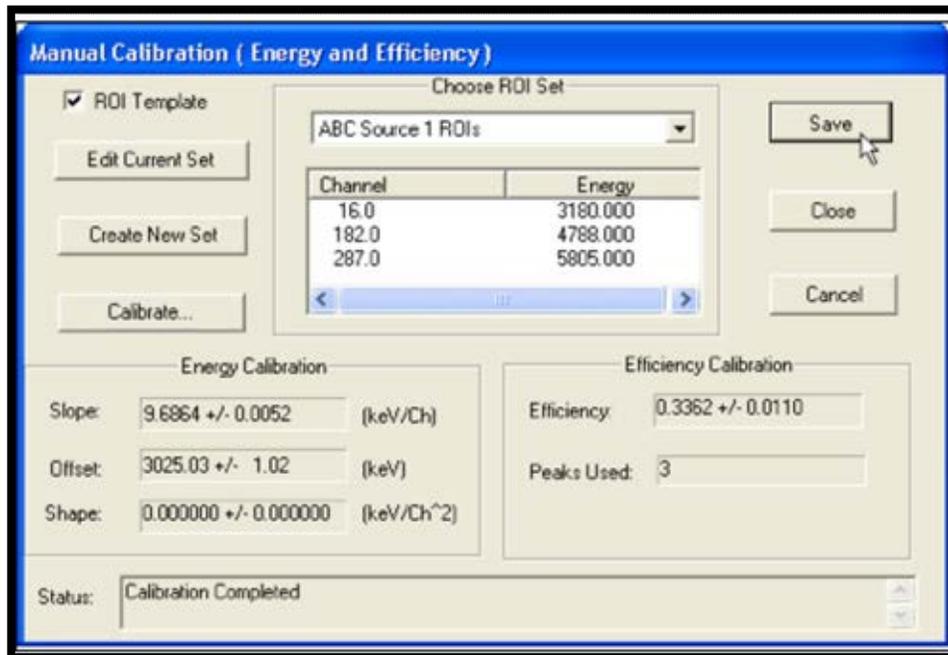


Figure 164. Calibration Complete

- 17) The parameters for this **Completed** calibration are displayed in the upper Calibration Explorer Panel above the Spectrum/Report Window (Figure 165).

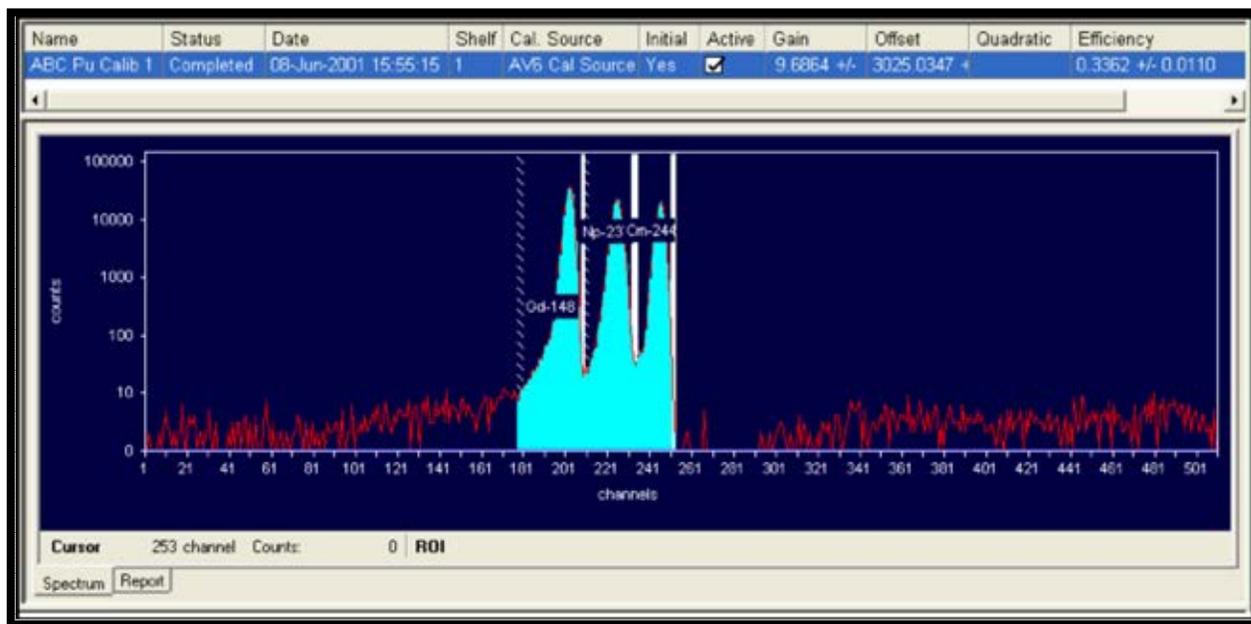


Figure 165. Spectrum/Report Window

And that's it. The system is now ready to begin creating the next set of records needed for processing sample batches.

## A.5 Step 4 - Before Batching: Creating Libraries, QA Types, and Tracer Sets

Next, prepare the Tracer Set and Control Solution data records the software needs to track the quality of sample preparation and hardware conditions.

Before creating these data records, users will need to prepare the corresponding solutions in their wet-chemistry laboratory. A tracer is a solution standard used to calculate the chemical recovery for samples ( $^{242}\text{Pu}$  is used in this example). A control solution is a standard solution consisting of the analyte/nuclide of interest ( $^{239}\text{Pu}$  is used in this example). In general, these standard solutions are prepared by diluting standard reference materials obtained from NIST (or some other reference laboratory or source manufacturer) or purchased in diluted form directly from the source manufacturer. In either case, users will need to input some information about these standards into AlphaVision before counting samples. AlphaVision makes this simple and straightforward to do.

### A.5.1 Creating a QA Control Solution

AlphaVision allows users to create a control solution for a particular element and vary the volume added from batch to batch – the software tracks the recovery regardless of the volume added.

- 1) On the Toolbar, click the **Standards** button.
- 2) Referring to Section 8.4, click the Control Solutions tab, choose **Add**, and create a control solution containing one nuclide,  $^{239}\text{Pu}$ . Give it the **Certificate ID** *ABC Pu-239 Control*.

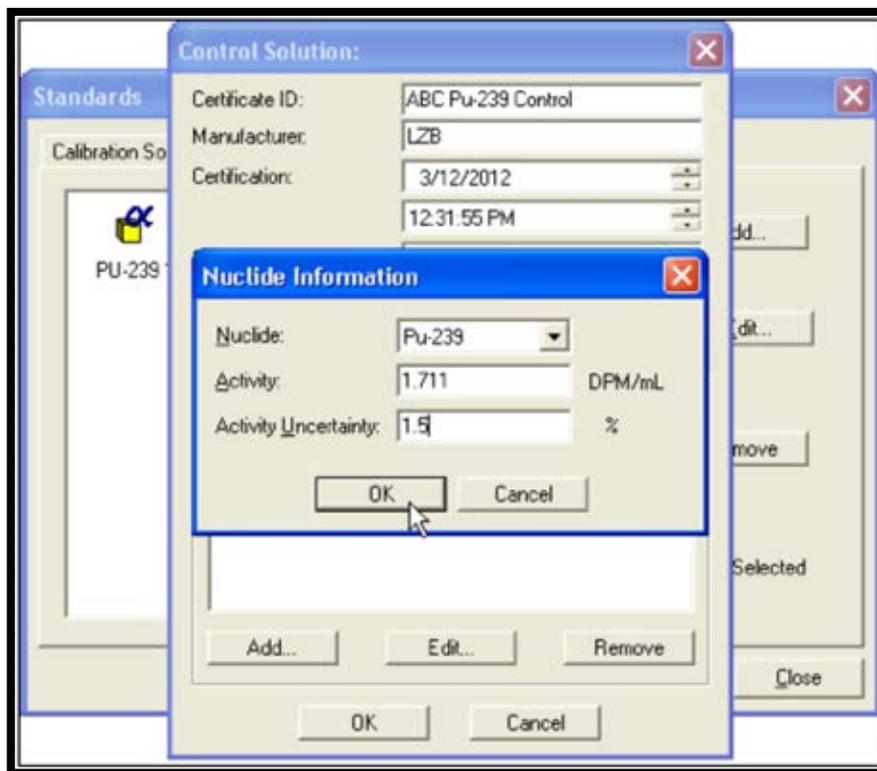


Figure 166. Add Nuclide Information

- 3) Click **OK** to return to the Control Solution screen, then **Close** to return to the main AlphaVision screen.

## A.5.2 Creating a Nuclide Library

A nuclide library is simply a list of nuclides used for an analysis. AlphaVision analysis libraries are created in the Nuclide Library Editor (**Edit/Nuclide Libraries...** or the **Nuclide libraries** button on the Toolbar). These libraries are drawn from AlphaVision's Master Nuclide List of alpha-emitting nuclides (**Edit/Master Nuclide List**). All library entries include the nuclide name, half-life, alpha-particle peak energies, and branching ratios.

In an analysis, AlphaVision sums the branching ratios of the peaks within the energy limits of the peak region – whether (1) a user-defined ROI from an ROI Set or (2) a software-derived region from a Peak Search and Fit analysis.

For routine analyses, it is recommended to create a nuclide library for each element of interest. Since the AlphaVision peak search algorithm finds the library energy that is closest to an identified peak, the more nuclide-specific the libraries are, the less chance there is of incorrectly identifying a peak.

- 1) Go to the Toolbar and click the **Nuclide libraries** button on the toolbar. This will open the library editor.

- 2) Following the instructions in Section 8.1.2, create a library for Pu analyses named *ABC Pu Library*, populated by all Pu isotopes in the Master Library. Users may also wish to enter a **Description** that clarifies the library contents and use.
- 3) To complete library setup, click **OK** to return to the Nuclide Libraries dialog, then click **Close** to return to the main AlphaVision screen.

### A.5.3 Creating a Tracer Set

The tracer nuclide is typically an isotope of one of the analytes and emits an alpha that is energetically distinct from the analytes (for example, if a client is looking for  $^{239}\text{Pu}/^{240}\text{Pu}$ ,  $^{238}\text{Pu}$ , and  $^{236}\text{Pu}$ , a typical tracer would be  $^{242}\text{Pu}$ ). The tracer is added to all samples in a batch, including the blank and the control. To track the use of a tracer in AlphaVision, create a *Tracer Set* with the Tracer Editor.

In this tutorial, the Tracer Set will be called *ABC Pu242*.

- 1) On the Toolbar, click **Tracers** to open the Tracer Editor.
- 2) Referring to the instructions in Section 8.2, create a Tracer Set for  $^{242}\text{Pu}$ . For laboratories that frequently add tracer to sample aliquots, users can choose between adding the tracer to **Aliquot** or **Total**. For this example, use **Total**. In addition, use the default **Expected Tracer FWHM** of 70 keV, and assume the tracer is free of contaminants.
- 3) Save the new Tracer Set as *ABC Pu242*, then click **Close** to return to the main AlphaVision screen.

### A.5.4 Creating Control Sample, Reagent Blank, and Chemical Recovery QA Types

There are three **QA Types** in AlphaVision:

- The **Control Sample QA Type** is used to track the recovery of control standards for a specific project.
- The **Reagent Blank QA Type** is used to track the count rate of batch blanks for a specific project.
- The **Chemical Recovery QA Type** tracks the chemical recovery (or yield) of a tracer.

All three QA Types are set up similarly. Following the instructions in Section 8.5, create QA Types for the project control sample, a reagent blank, and a chemical recovery sample.

- 1) On the menu bar, click **Edit/QA Types...** to open the QA Types dialog, then click **Add**.
- 2) Click **Type** and select the **Control Sample** QA Type from the drop list. An additional field, **Library**, will be added to the dialog. Assign the **Name** *ABC Pu Control*.
- 3) Enter a **Chart Name** that describes the purpose of the chart – for this example, use *Pu-239 in Soils, Control, ABC contract #1234*.

- 4) Click the **Browse (...)** button and select the library that was created earlier for this analysis, *ABC Pu Library*. This QA Type is now defined (Figure 167). Click **OK** to return to the main QA Types dialog.



Figure 167. QA Type Dialog

- 5) Next, set up a Reagent Blank using *ABC Pu Library* for analysis, name it *ABC Pu Blank*, and assign the **Chart Caption** *Pu-239 in Soils, Blank, ABC contract #1234*.
- 6) Click again on **Add** and select **Chemical Recovery QA** Type from the drop list. Assign *ABC Pu242 CR* as the **Name**; and *Pu-242 CR, ABC contract #1234* as the **Chart Name**.
- 7) Click **Close** to return to the main AlphaVision screen.

### A.5.5 Creating an ROI Set that Includes <sup>239</sup>Pu and <sup>242</sup>Pu Peaks

The last step before creating batches is to create an ROI Set, which will be named *ABC Pu ROI*, containing peaks for <sup>239</sup>Pu and <sup>242</sup>Pu. (Note that this ROI Set could instead be created in the Batch Wizard.) This ROI Set will be used during the batching tutorial to guide the analysis for these isotopes.

In the calibration step, an ROI Set was created interactively using the mouse and the Spectrum Window. Here, manually create *ABC Pu ROI* based on the calibration just performed for this detector.<sup>18</sup>

- 1) Before opening the ROI Editor, go to the Detector Grid and click the detector just calibrated.
- 2) Click **Edit/ROI** to open the ROI Editor.

<sup>18</sup> Alternatively, users can run MAESTRO, select this detector, measure a test sample containing the tracers and expected analytes, and use the resulting spectrum to determine the ROI boundaries and centroids to be manually entered in the ROI Editor.

- 3) Click the **-Update-** entry in the ROI list.
- 4) Click the **Nuclide** field and select  $^{242}\text{Pu}$  from the drop list. Because users are using the detector's current calibration to provide a starting point channel for each ROI, AlphaVision will associate its energy with the appropriate channel number based on the calibration. This value can then be modified as desired to best fit actual spectra.
- 5) Nuclides in this list are marked as **Analytes** by default. When adding  $^{242}\text{Pu}$ , be sure to mark the **Tracer ROI** checkbox. When the **Update** button is clicked, its designation in the list will change from **Analyte** to **Tracer**.
- 6) To complete the entry, click **Update**. The new ROI will be added to the list.
- 7) Repeat for  $^{239}\text{Pu}$ , but do not mark the **Tracer** checkbox because it is an analyte.
- 8) Click **Save As**, name the set *ABC Pu ROI*, mark the **Save as Template** checkbox, and click **OK**.
- 9) Click **Close** to exit the ROI Editor.

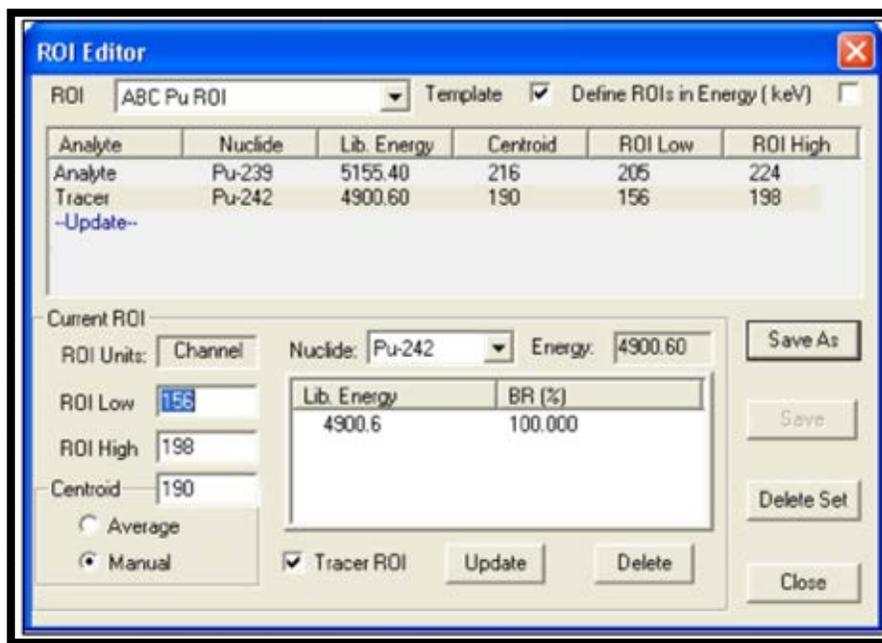


Figure 168. ROI Editor

The system is now ready to create batches, start counting samples, and track QA parameters.

## A.6 Step 5 – Creating and Running Batches

### A.6.1 Setting Up the Batch Explorer Tree Before a New Project

The *Batch Explorer Panel* is an intuitive, visual representation of the batch and sample data and its “location” in the AlphaVision database. Batches are organized hierarchically in levels and sublevels that users define. Therefore, before batching is started, the *Batch Explorer Tree*

(the left-hand column of the Batch Explorer Panel) needs to be set up to reflect the nature of the project. Chapter 9 discusses this powerful feature of AlphaVision in detail.

- 1) In the left-hand column of the Batch Explorer Panel, locate the part of the default tree labeled Batches. Right-click this branch and choose **Insert Branch...** from the right-mouse-button menu (Figure 169).



Figure 169. Choose Insert Branch

- 2) Enter *ABC Soils 2010* in the Insert Branch dialog (Figure 170) and click **OK** to return to the main screen.

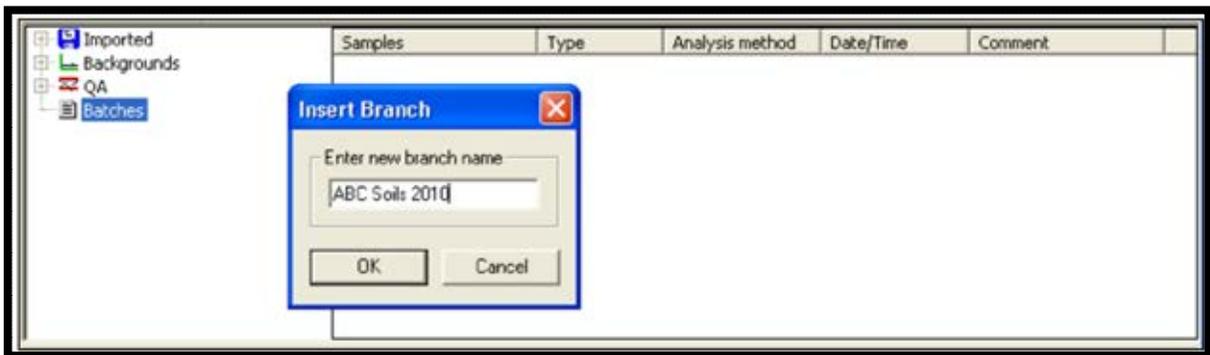


Figure 170. Insert Branch Dialog

- 3) To further refine the Batch Explorer Tree for this project, right-click the *ABC Soils 2010* branch, choose **Insert Branch...** again, enter *Pu Analyses* in the Insert Branch dialog and click **OK** (Figure 171).

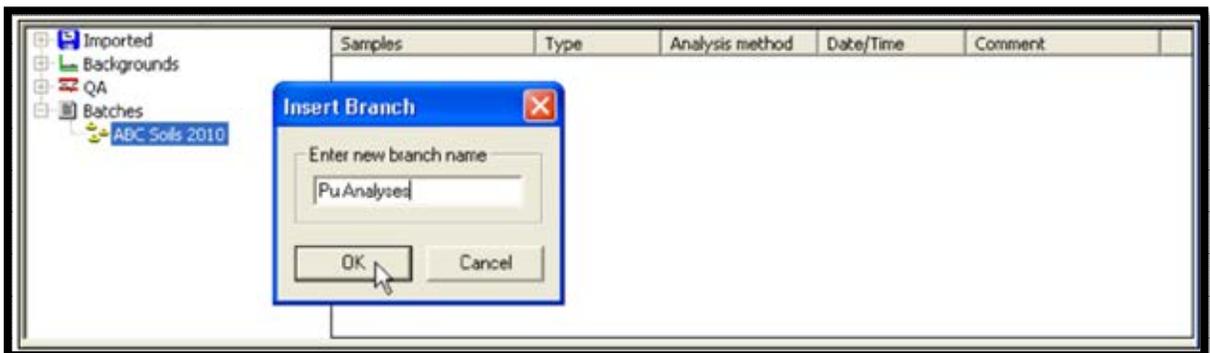


Figure 171. Insert Additional Branch

- 4) Finally, because the example project is expected to last 4 months, insert the four sub-branches *January*, *February*, *March*, and *April* under the *Pu Analyses* sub-branch. Figure 172 shows the completed Batch Explorer Tree for the project.

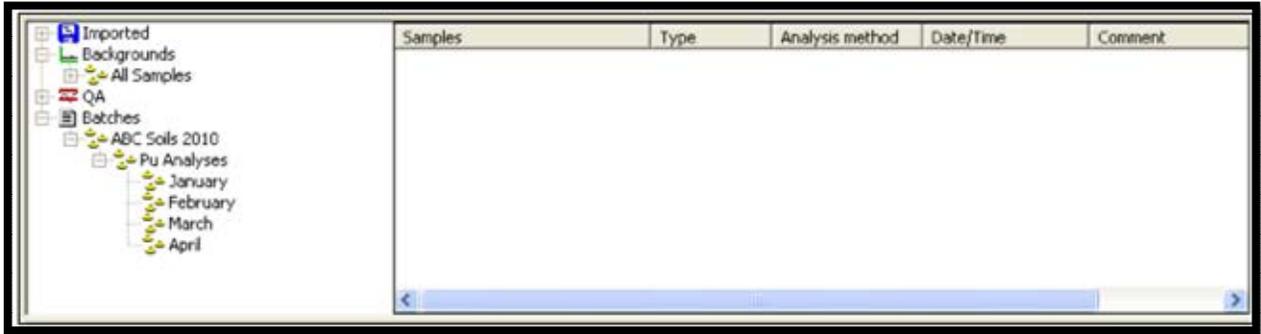


Figure 172. Completed Branch Explorer Tree

### A.6.2 Batching Samples with the Batch Wizard

- 1) Start the Batch Wizard by clicking **Process Batch** on the Toolbar. This will open the first Batch Wizard page, General (Figure 173).

Figure 173. Batch Wizard Page - General

- 2) Following the instructions in Section 11.4.1, assign this batch of 5 samples *ABC Pu Soils*, skip the **Template Name** field, and leave the **Save As Template** unmarked.
- 3) Because  $^{242}\text{Pu}$  chemical recovery will be tracked with a tracer, select the *ABC Pu242 CR* QA Type that was created earlier. Users may also enter an optional batch

**Description.** This will be stored in the database for use in the Analysis report. Click **Next** to go to the Batch Properties page.

- 4) Use the Batch Properties page (Figure 174) to assign this batch to the proper “location” within the AlphaVision database so the results can easily be found in the future. Users must choose a destination branch before they can move to the next page of the wizard. Following Section 11.4.2, expand the *ABC Soils 2010* project by clicking the plus (+) boxes, then click *January*. The spectra, analyses, and reports for this batch will now be viewable from this location in the Batch Explorer.

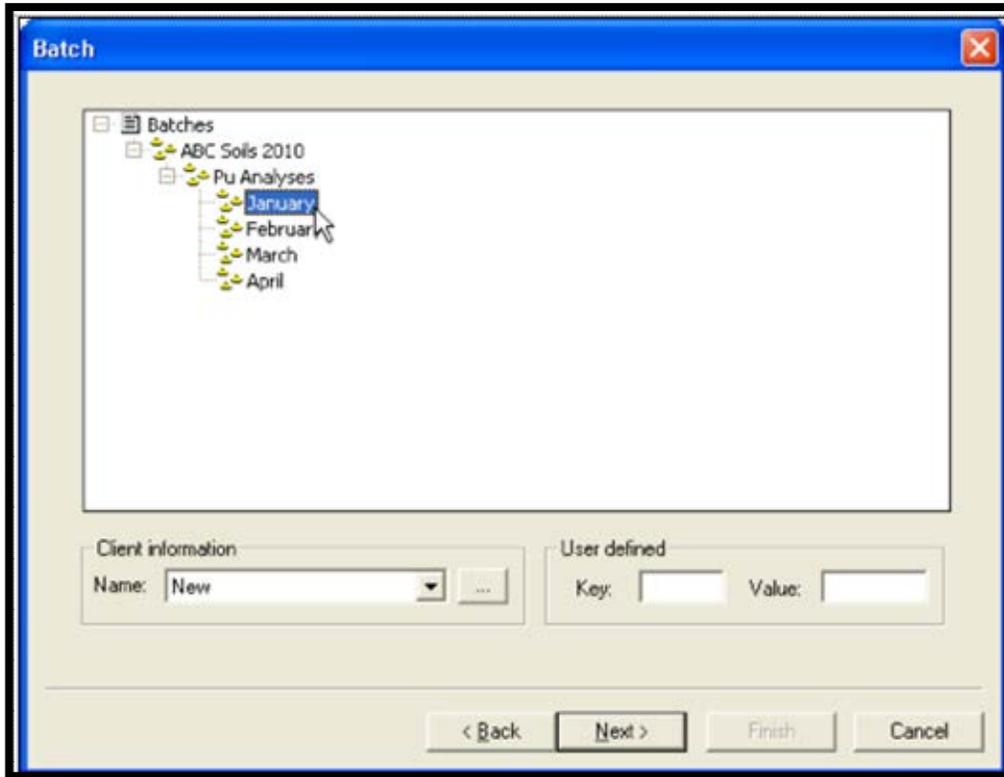


Figure 174. Batch Properties

- 5) Next, input **Client information**. This is the integrated client information directory. The contents are stored in the database, and **Company Name** and **Contact Name** are printed on the Analysis reports. Click the browse (...) button to open the Client Information dialog (Figure 175). Enter the desired contact information and click **OK** to return to Batch Properties (Figure 176), then click **Next** to go to the Sample Properties page.

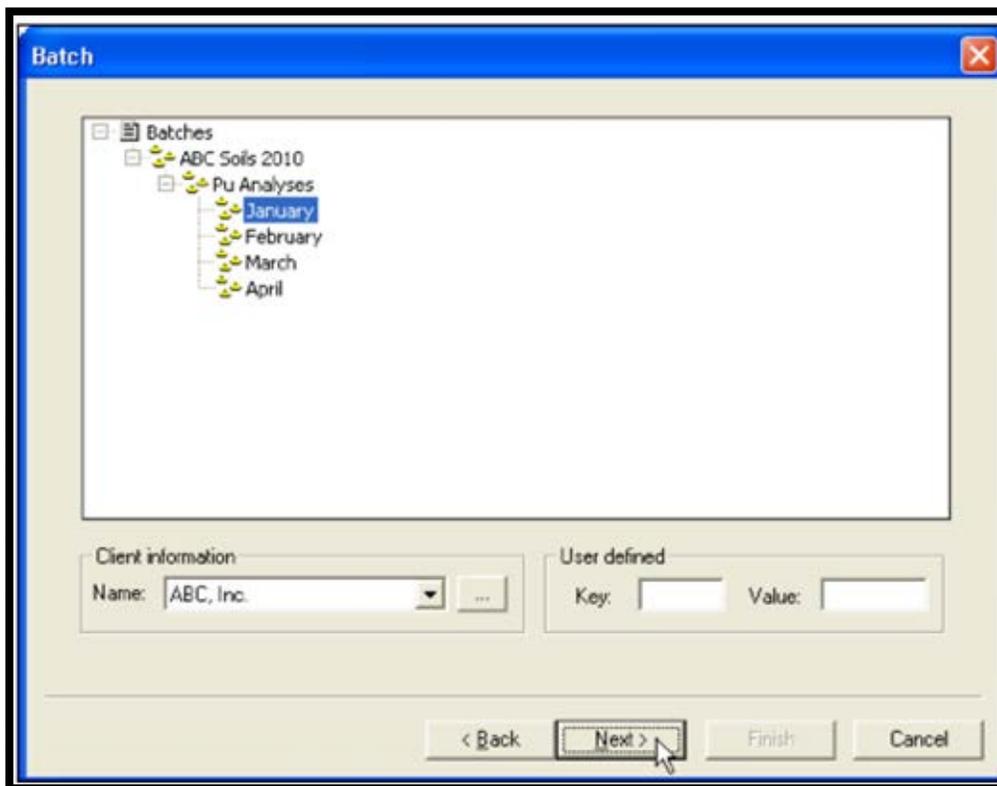


The 'Client information' dialog box contains the following fields:

Company Name: ABC, Inc.	Contact Name: TC Spottswood
Address: 12345 Industrial Park Blvd. Suite 123 City State	Country: USA Phone: (999) 999-9999 Ext.111 Fax: ( ) -
Comments:	E-Mail: tcs@abcind.com

Buttons: OK, Cancel

Figure 175. Client Information Dialog



The 'Batch' dialog box displays a tree view of batches:

- Batches
  - ABC Soils 2010
    - Pu Analyses
      - January
      - February
      - March
      - April

Client information: Name: ABC, Inc. (dropdown menu)

User defined: Key: [ ] Value: [ ]

Buttons: < Back, Next >, Finish, Cancel

Figure 176. Batch Properties

- 6) Use this screen to document each sample in the batch in detail and specify its treatment, including sample name, QA Type, volume and other physical characteristics, a descriptive comment, and the date to which the sample should be decay corrected. Note that AlphaVision also has an automatic sample-creation feature (Section 11.4.3.1), however, this will not be used in this tutorial.

The contract requirements for the ABC Project call for a blank and a control for each batch. Referring to Section 11.4.3, click **Add** to create the first entry, which will be

the control. Enter the name *ABC Pu Control* in the Sample dialog and click **OK** to return to the Sample Properties dialog.

Next, click the sample **Type** drop list and select **Control**. For a control sample, AlphaVision will add fields for **QA Type**, control solution record (**Cntrl Sol**), and the **Volume** of control solution used. Choose the already defined *ABC Pu Control QA Type*; use *ABC Pu-239 Control* as the **Cntrl Sol**; and enter a **Volume** of 0.5 mL. Next, select **Volume** as the **Sample Units** and use the default unit, mL. The lower right section of the dialog allows users to set up 1 or 2 dilutions. In this case, the entire sample volume of 1.0 mL will be used, so keep the default **Total** selection and volume entry, with no uncertainty, as shown in Figure 177. (The dilution feature is discussed in Section 11.4.3.)

- 7) Page 134 details the three options for determining chemical recovery in AlphaVision 7. In this tutorial, a fixed quantity of a predefined tracer solution will be added to each sample in the batch. The setup for this method is performed on the batch wizard's Analysis screen.

Users can also specify the **Decay Correction**, sample **Collection**, and **Lab Preparation** dates by marking the associated checkboxes and setting the date/time. To decay correct to other than the batch acquisition date/time, select another **Decay Correction** date with the date/time tool (presumably users will be setting all samples in the batch to a common decay correction date). In this exercise, these features will not be used.

- 8) Next, create the reagent blank record. Click **Add**, enter *ABC Pu Blank* in the Sample dialog, and click **OK**. Select **Blank** from the **Type** list. In response, AlphaVision will add a **QA Type** field to the screen. Select the example *ABC Pu Blank QA Type*, then enter the sample **Weight** or **Volume**, uncertainty, and **Aliquot** size as needed (again, the default values are being used; see Figure 178).
- 9) Finally, add *Sample 01*, *Sample 02*, and *Sample 03* to the list. Select **Sample** from the **Type** list and use the default weight/volume values (Figure 179). Click **Next** to advance to the Acquisition page.

**Sample**

Sample names: ABC Pu Control

Type: Control

QA Type: ABC Pu Control

Cont Sol: ABC Pu-239 Contr

Amount: 0.5 mL

Description:

Sample Units:  Volume mL  Weight mg

Decay Correction: 4/ 1/2013 5:20:15 AM

Collection: 4/ 1/2013 5:20:15 AM

Lab Preparation: 4/ 1/2013 5:20:15 AM

User defined: Key: Value:

Total  Aliquot  Dilution

	Amount	Unc. (%)
Sample:	1 mL	0
Dilution:	0	0
Aliquot 1:	1	0
Dilution:	0	0
Aliquot 2:	0	0

Calc. Dilution: 1.000e+000

Tracer Amt.: 0

Manual CR: 0 (%)

< Back **Next >** Finish Cancel

Figure 177. Define the Control Sample

**Sample**

Sample names: ABC Pu Control, ABC Pu Blank

Type: Blank

QA Type: ABC Pu Blank

Sample Units:  Volume mL  Weight mg

Decay Correction: 4/ 1/2013 5:20:15 AM

Collection: 4/ 1/2013 5:20:15 AM

Lab Preparation: 4/ 1/2013 5:20:15 AM

User defined: Key: Value:

Total  Aliquot  Dilution

	Amount	Unc. (%)
Sample:	1 mL	0
Dilution:	0	0
Aliquot 1:	1	0
Dilution:	0	0
Aliquot 2:	0	0

Calc. Dilution: 1.000e+000

Tracer Amt.: 0

Manual CR: 0 (%)

< Back **Next >** Finish Cancel

Figure 178. Define the Reagent Blank

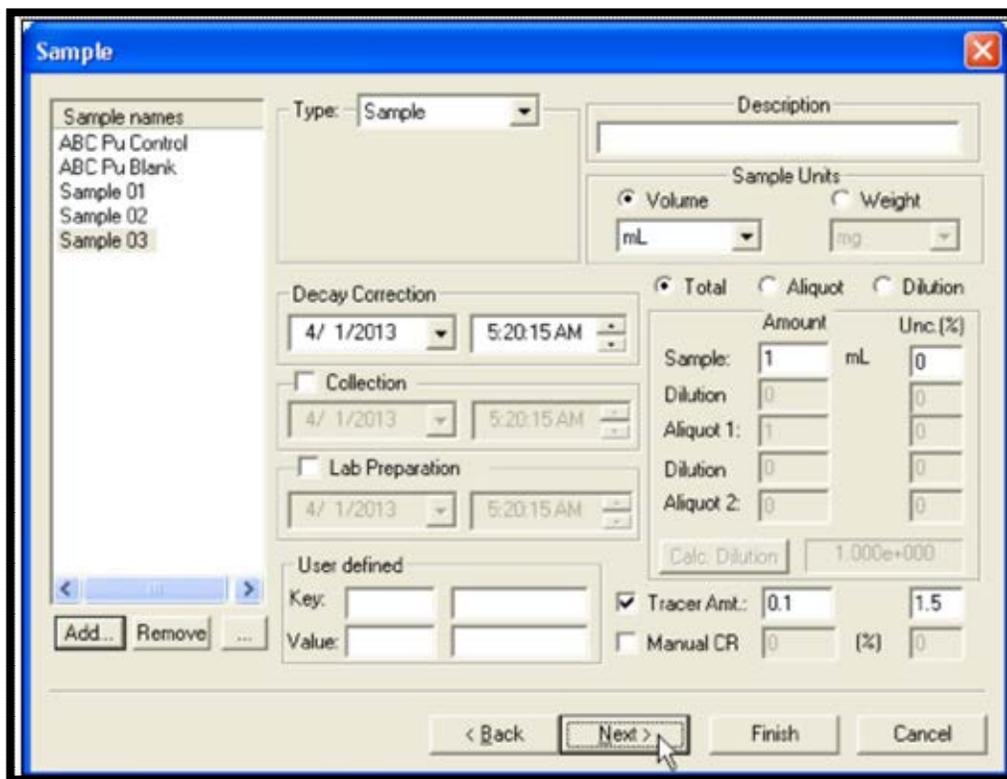
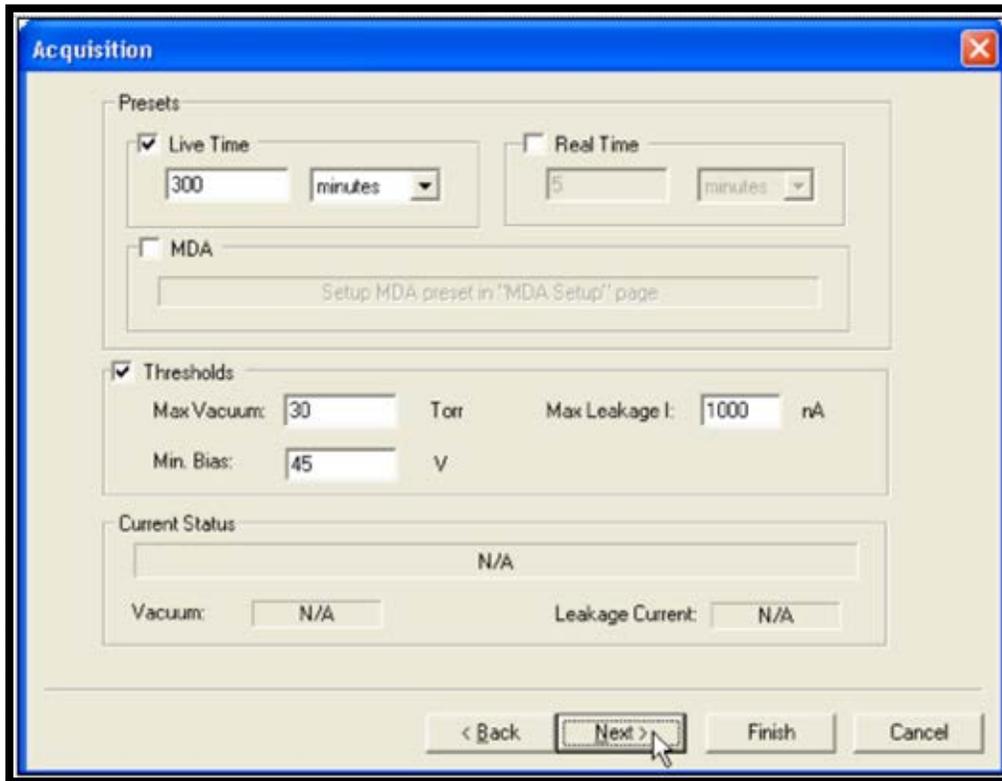


Figure 179. Define the Samples

- 10) Figure 180 shows the Acquisition page, which is discussed in Section 11.4.4. For the tutorial use the default **Live Time** preset, so leave the box checked and enter a count time; this example is 5 hours. An MDA preset will not be used so leave the **MDA** checkbox unmarked.
- 11) Users may also elect to use the pressure and leakage current **Thresholds**. In this exercise use a **Max Vacuum** of 30 Torr, a **Min Bias** of 45 V, and a **Max Leakage I** of 1000 nA.

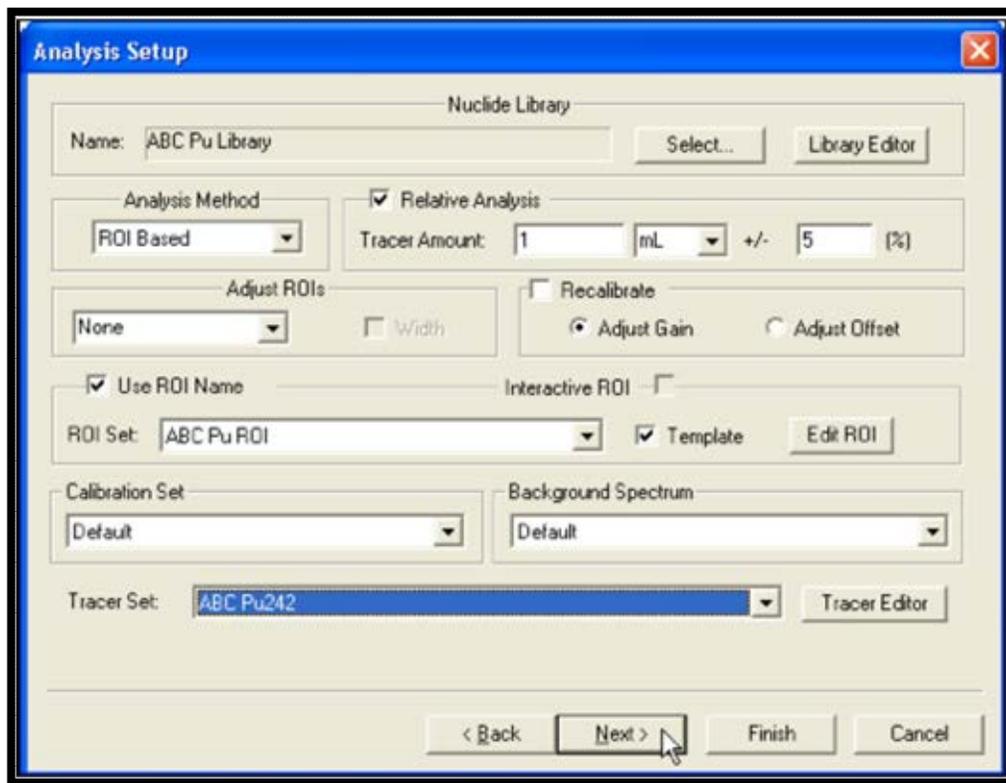
Click **Next** to go to the Analysis page.

- 12) Referring to Section 11.4.5, use the Analysis page to set up the analysis method for the batch. First, select a **Nuclide Library**. Click **Select...** and choose the library, *ABC Pu Library*, from the list of **Available Libraries**. For this tutorial, the default maximum allowable peak shift (**Max. Peak Mismatch**) setting will be used, 100 keV. Click **OK** to return to the Analysis Setup page (Figure 181).



The Acquisition dialog box features a blue title bar with the text "Acquisition" and a close button. The main area is divided into several sections: "Presets" with checkboxes for "Live Time" (set to 300 minutes) and "Real Time" (set to 5 minutes); an unchecked "MDA" checkbox with a note to "Setup MDA preset in 'MDA Setup' page"; "Thresholds" with checkboxes for "Max Vacuum" (30 Torr) and "Max Leakage I" (1000 nA), and "Min. Bias" (45 V); and a "Current Status" section showing "N/A" for both "Vacuum" and "Leakage Current". At the bottom, there are four buttons: "< Back", "Next >" (highlighted with a mouse cursor), "Finish", and "Cancel".

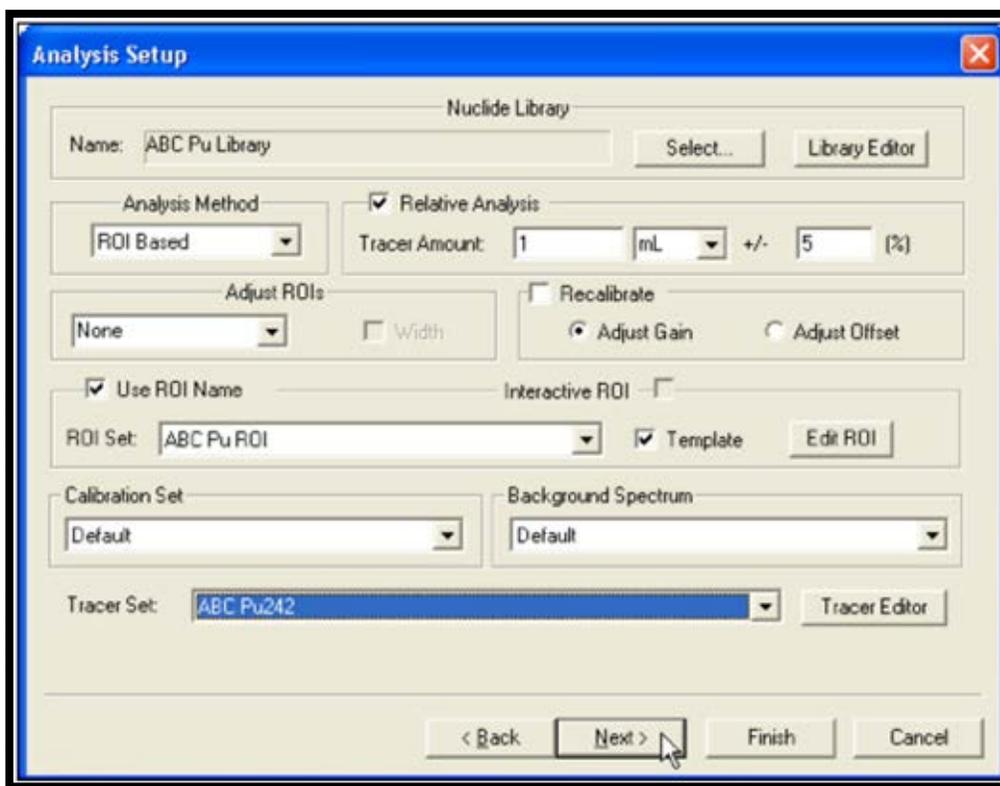
Figure 180. Acquisition Page



The Analysis Setup dialog box has a blue title bar with "Analysis Setup" and a close button. It is organized into several sections: "Nuclide Library" with a "Name" field (ABC Pu Library), "Select..." and "Library Editor" buttons; "Analysis Method" (ROI Based) and "Relative Analysis" (checked) with "Tracer Amount" (1 mL) and " +/- 5 (%)" field; "Adjust ROIs" (None) with an unchecked "With" checkbox and "Recalibrate" options (Adjust Gain selected, Adjust Offset unselected); "Use ROI Name" (checked) and "Interactive ROI" (unchecked) with "ROI Set" (ABC Pu ROI), "Template" (checked), and "Edit ROI" button; "Calibration Set" (Default) and "Background Spectrum" (Default) dropdowns; and "Tracer Set" (ABC Pu242) with a "Tracer Editor" button. The bottom navigation includes "< Back", "Next >" (highlighted with a mouse cursor), "Finish", and "Cancel" buttons.

Figure 181. Analysis Setup

- 13) Next, choose the Analysis Method. In this example, choose the **ROI Based** analysis. To complete an ROI analysis, specify an ROI Set. Select the set created earlier, *ABC Pu ROI*, from the **ROI Set** drop list.
- 14) Because an alpha-emitting tracer is being used in this batch ( $^{242}\text{Pu}$ ), a **Relative Analysis** is being performed, so leave this checkbox marked and enter the **Tracer Amt.** that was added to all of the samples (Figure 182). It may also be desired to enter the uncertainty (+/-) associated with the tracer amount. Next, choose the example **Tracer Set**, *ABC Pu242*, from the drop list. (Instead of a predefined Tracer Set, users can also create a new one or modify an existing one with the Tracer Editor.) Click **Next** to go to the Analysis Misc. page.



The screenshot shows the 'Analysis Setup' dialog box with the following settings:

- Nuclide Library:** Name: ABC Pu Library, buttons: Select..., Library Editor
- Analysis Method:** ROI Based (dropdown)
- Relative Analysis:**  Relative Analysis, Tracer Amount: 1 mL +/- 5 (%)
- Adjust ROIs:** None (dropdown),  Width,  Recalibrate,  Adjust Gain,  Adjust Offset
- Use ROI Name:**  Use ROI Name, ROI Set: ABC Pu ROI (dropdown),  Template, Edit ROI (button)
- Interactive ROI:**  Interactive ROI
- Calibration Set:** Default (dropdown)
- Background Spectrum:** Default (dropdown)
- Tracer Set:** ABC Pu242 (dropdown), Tracer Editor (button)

Navigation buttons at the bottom: < Back, Next > (highlighted with a mouse cursor), Finish, Cancel.

Figure 182. Analysis Setup – Tracer Set

- 15) Referring to the discussion in Section 11.4.6, use the Analysis Misc. page (Figure 183) to specify how AlphaVision calculates and reports the analysis results. In this example, ABC, Inc., has required that the results be reported in DPM/mL. Therefore, choose **DPM** from the **Activity Units** drop list (the volume has already been specified as **mL** on the Sample Properties page). Click **Activity Concentration** to report in specific activity units.

The screenshot shows the 'Analysis Misc.' dialog box with the following settings:

- Activity Units: DPM
- Report Calculated Activity:  Activity/Sample,  Activity Concentration
- Total Propagated Uncertainty (TPU):
  - Predefined TPU Sigma: 1
  - Systematic Uncertainty: 0 (%)
  - Random Uncertainty: 0 (%)
  - Enter TPU Sigma: 1
  - Unc. in Percentile
  - Unc. in Activity Units
- Manual Chemical Recovery (%): 100 +/- 0 (%)
- Decay Correction
- Negative Activity
- Analyze Peak Stripped Spectrum
- Subtract Contaminants
- Correct Partial Channels
- Set Up Peak Search/Fit
- Record Set: Default Parameters
- Buttons: < Back, Next >, Finish, Cancel

Figure 183. Analysis Misc. Page

- 16) ABC further requires that uncertainties be reported at the 95% confidence level using a sigma multiplier of 1.96. AlphaVision defaults to a **Predefined TPU Sigma** of 1 (users can also choose 2 or 3 from this drop list). To enter a non-integer value, mark the **Enter TPU Sigma** checkbox, and enter the corresponding value. A sigma multiplier of 1.96 will be used, as shown in Figure 184. The other uncertainty options will not be used in this tutorial.

The screenshot shows the 'Analysis Misc.' dialog box with the following settings:

- Activity Units: DPM
- Report Calculated Activity:  Activity/Sample,  Activity Concentration
- Total Propagated Uncertainty (TPU):
  - Predefined TPU Sigma: 1
  - Systematic Uncertainty: 0 (%)
  - Random Uncertainty: 0 (%)
  - Enter TPU Sigma: 1.96
  - Unc. in Percentile
  - Unc. in Activity Units

Figure 184. Analysis Misc. – Sigma Multiplier

- 17) The **Manual Chemical Recovery** option is disabled in this example because it was opted to perform a **Relative Analysis** on the Analysis Setup page. **Manual Chemical Recovery** refers to methods, other than using an alpha-emitting nuclide, of estimating the chemical recovery of analytes. Examples of this approach are the

- use of  $^{234}\text{Th}$  (a beta emitter) for chemical recovery determination of thorium analyses and  $^{239}\text{Np}$  (also a beta emitter) for chemical recovery for neptunium analyses. In these cases, the user typically opts for a **No Analysis**, then returns later and analyzes each sample – using the laboratory-determined chemical recovery – at the completion of alpha counting.
- 18) Decay-correct all samples to the data acquisition date/time (instead of specifying different dates/times for the various samples). Therefore, leave the **Decay Correction** checkbox marked (the default setting). Decay correction is discussed in detail in Section 11.4.6.
  - 19) Because an **ROI Analysis** has been selected on the Analysis Setup page, the **Set Up Peak Search/Fit** section of the screen is inactive. Click **Next** to move to the MDA Setup page.
  - 20) Screen 7 of the Batch Wizard is the MDA/Blank setup (Figure 185), which is discussed in Section 11.4.7. The elements of configuring an appropriate MDA calculation are beyond the scope of this tutorial and are discussed in Section B.7.2.2. Subtracting net blank activity is discussed in Section B.7.4.15. In this example, use the default settings to determine the MDA for each sample: a paired-background solution (the ANSI N13.30 equation [**ANSI Standard**]), **Background Spectrum** as the **MDA Source Type**, and the default **Confidence Levels** of 1.645 (95%, one-sided confidence interval). Click **Next** to go to the Report Options page.
  - 21) The Report screen (Figure 186) is the final screen in the Batch Wizard (Section 11.4.8). This screen allows users to print out the analysis report to the default printer. In addition, users can export the results in other formats (see Section 2.6.1). Users can also export to a user-defined Crystal Reports template of their choice.<sup>19</sup> For this tutorial, click **Print on completion** to print a single copy of the results for each analysis.
  - 22) The Batch Wizard setup is now completed. Click **Finish** to close the wizard and begin assigning the detectors that will acquire the data for this batch.

---

<sup>19</sup> Note that the Report Window also allows printing of the report and exporting to a wider choice of formats.

**MDA / Blank**

Subtract Net Blank Activity      Sort Blanks: All Blanks

MDA Source Type: Background Spectrum      Blank Spectrum: Default

MDA Calculation:  ANSI Standard       General (Currie's Equation)

Confidence Level: K\_Alpha: 1.645      K\_Beta: 1.645

Set Up MDA Preset  
(Enable/disable this section on the Acquisition Properties page)

Nuclide: [ ]      Preset Value (0.0001 to 9.9): 1 (DPM)  
Preset Precision (0.1 to 100): 5.00 (%)

< Back    Next >    Finish    Cancel

Figure 185. MDA/Blank

**Report**

Print on completion  
 Prompt before print      Number of Copies: 1       Collated

Export on completion  
 Prompt before export      Type: Excel 8.0  
Export To: C:\User\AlphaVision\Reports      Browse...

Export to SPC on completion  
Export To: C:\User\AlphaVision\Spectra      Browse...

User defined template  
File name: [ ]  
Full path: [ ]      Browse...

Note: Template must be compatible with Crystal Reports Version 11.5.

< Back    Next >    Finish    Cancel

Figure 186. Report Screen

- 23) When the wizard closes, the Detector Assignment Worksheet will open (Figure 187). This is the tool for assigning a detector to each sample in the batch and starting data acquisition. It is discussed in detail in Section 11.2. For this tutorial, it will be assumed there are enough alpha chambers available to count the 5 samples. Assign detectors automatically by clicking the **Auto-assign** button.
- 24) To start data acquisition, click **Start Now**. The worksheet will close, acquisition will start, and the sample entries just made in the wizard will be displayed up in the Batch Explorer Tree under *Batches/ABC Soils 2010/Pu Analyses/January/ABC Batch 1*. In the right-hand column (the Sample Analysis Explorer) as soon as data acquisition begins on a sample, a spectrum record  will be created for it. When analysis is complete, an analysis record  will be displayed beneath each spectrum analyzed. Then click the spectrum record to display the spectrum in the Spectrum Window and click the analysis record to see the analysis ROIs and peak identifications superimposed on the spectrum.

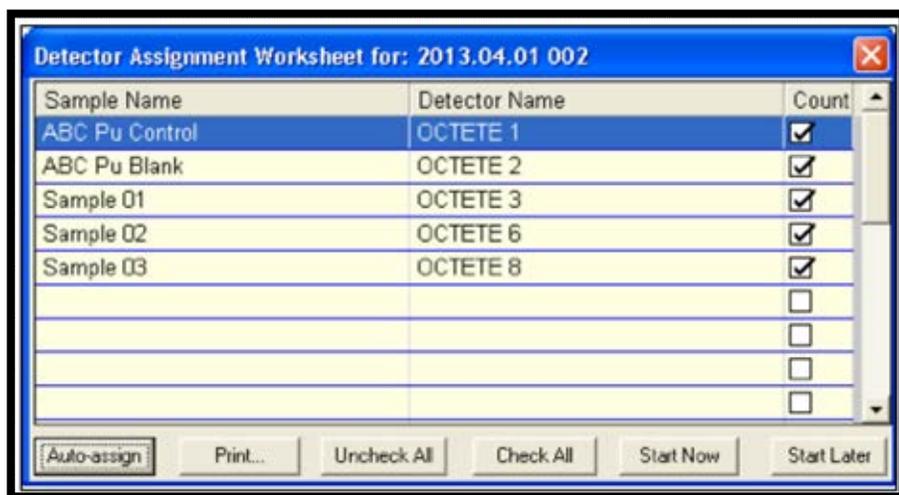


Figure 187. Detector Assignment Worksheet

When acquisition and analysis are done, the Batch Explorer Panel should resemble Figure 188.

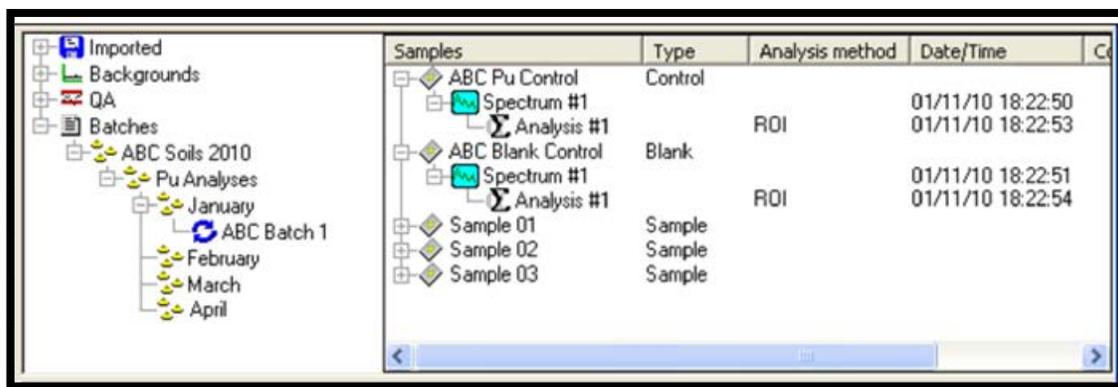


Figure 188. Batch Explorer Panel

*Congratulations – AlphaVision is now collecting sample data!* Next comes measuring detector backgrounds for QA/QC.

## A.7 Step 6 – Measuring Isotope-Specific Detector Background

The sixth step in satisfying the contractual agreement with ABC, Inc., is to measure the  $^{239}\text{Pu}$  background for each of the detectors used to collect batch data above. The Batch Explorer Tree already has a predefined **Backgrounds** section (Figure 189) so users are ready to use the Background Wizard, which is an abbreviated version of the Batch Wizard. Users can create branches and sub-branches in the **Backgrounds** section, but in this tutorial, it will not be performed.



Figure 189. Backgrounds

- 1) On the Toolbar, click **Process Background**. This will open the first Background Wizard page, General. It is essentially identical to the General page of the Batch Wizard (see the discussion in Section 11.1.1).

In this example the group of background measurements will be named *ABC Bkg 1* and a template will not be used or created (Figure 190). Click **Next** to go to the Batch page.

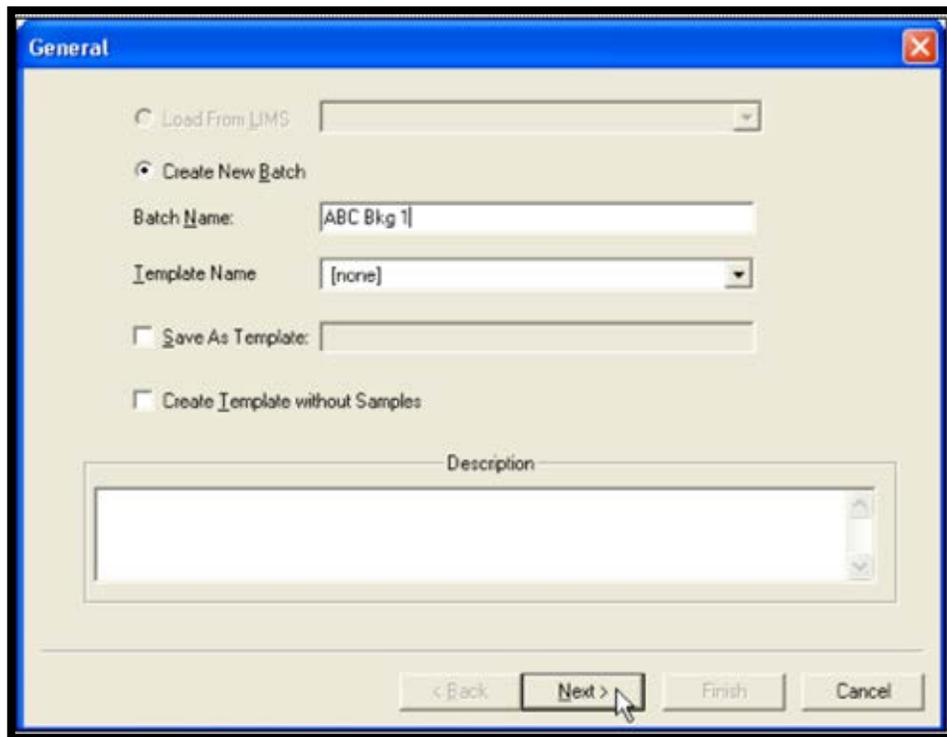


Figure 190. General - Create New Batch

- 2) The Batch page requires users to assign this batch to the proper “location” within the database. It is identical to the Batch page in Batch Wizard (see Section 11.1.2). A

destination branch must be selected before moving to the next page. For this tutorial, simply click the **All Samples** branch in the Sample Explorer tree, as shown in Figure 191. Click **Next** to go to the Sample Properties page.

- 3) The Sample properties screen (Section 11.1.3) allows entry of a **Name** and **Comment** for each background spectrum (the remaining fields are inactive). In this example, name the backgrounds based on the names of the 5 detectors used for batching. Click **Add** to create the first entry, enter the name *Bkg 1-1*, and click **OK** to return to the Sample Properties dialog. Repeat this for the other 4 background entries, *Bkg 1-2*, *Bkg 1-4*, *Bkg 3-2*, and *Bkg 3-3* (Figure 192). Click **Next** to advance to the Acquisition page.
- 4) On the Acquisition Properties page (Section 11.1.4), use the default **Live Time** preset, so leave the box checked and enter a count time; the example is 5 hours (Figure 193). Leave the **Thresholds** option unmarked and click **Next** to go to the Analysis page.

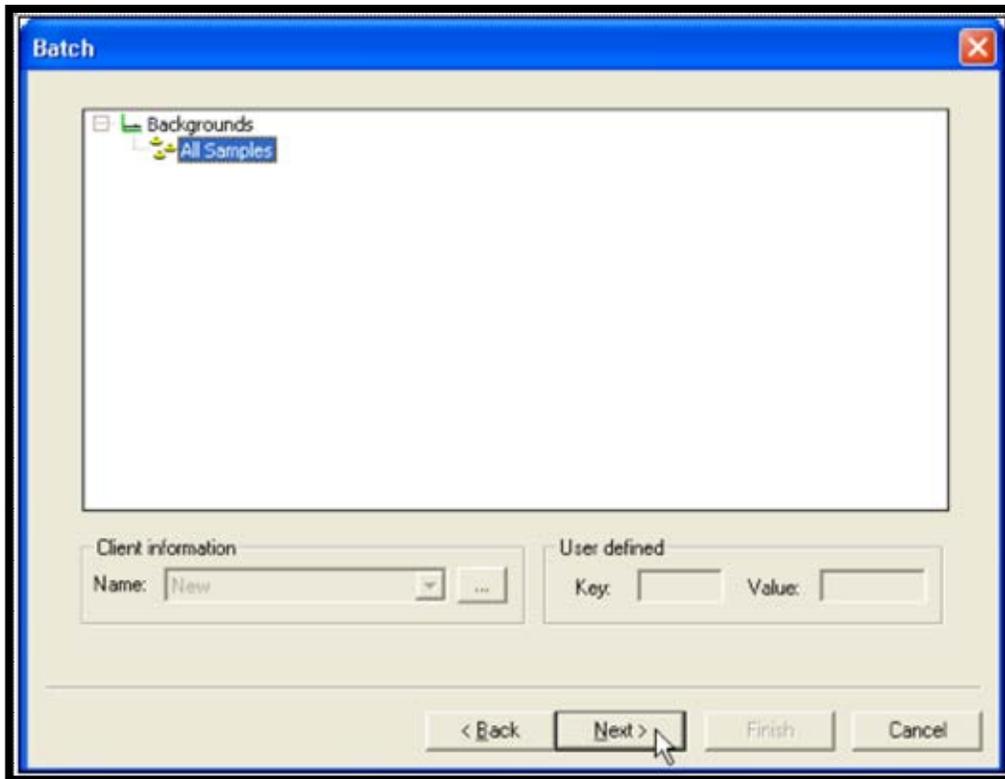


Figure 191. Sample Explorer Tree - All Samples

**Sample**

Sample names  
Bkg 1-1  
Bkg 1-2  
Bkg 1-4  
Bkg 3-2  
Bkg 3-3

Type: Sample

Description

Sample Units  
 Volume  Weight  
mL mg

Decay Correction  
4/ 1/2013 10:23:01 AM

Collection  
4/ 1/2013 10:23:01 AM

Lab Preparation  
4/ 1/2013 10:23:01 AM

User defined  
Key: Value:

	Amount	Unc. (%)
Sample:	1 mL	0
Dilution	0	0
Aliquot 1:	1	0
Dilution	0	0
Aliquot 2:	0	0

Calc. Dilution: 1.000e+000

Tracer Amt.: 0 Manual CR: 0 (%)

< Back Next > Finish Cancel

Figure 192. Add Background Entries

**Acquisition**

Presets

Live Time 5 hours  Real Time 5 minutes

MDA  
Setup MDA preset in "MDA Setup" page

Thresholds  
Max Vacuum: 30 Torr Max Leakage I: 1000 nA  
Min. Bias: 40 V

Current Status  
N/A  
Vacuum: N/A Leakage Current: N/A

< Back Next > Finish Cancel

Figure 193. Live Time Preset

- 5) The Analysis page (Figure 194) is discussed in Section 11.1.5 and is used to set up the analysis method for the batch. First, select a **Nuclide Library**. Click **Select...** to open the Nuclide Library dialog and choose the library *ABC Pu Library*. The default maximum allowable peak shift will be used (**Max. Peak Mismatch**), 100 keV. Click **OK** to return to the Analysis Setup page, then click **Next** to go to the Report Options page.
- 6) The Background Wizard uses the **ROI Based** analysis. To complete the ROI analysis, specify an **ROI Set** that correspond to the nuclide(s) being monitoring in the background spectrum. In this tutorial, select the *ABC Pu ROI* set from the **ROI Set** drop list (Figure 194). Click **Next** to go to the final page of the wizard, Report.

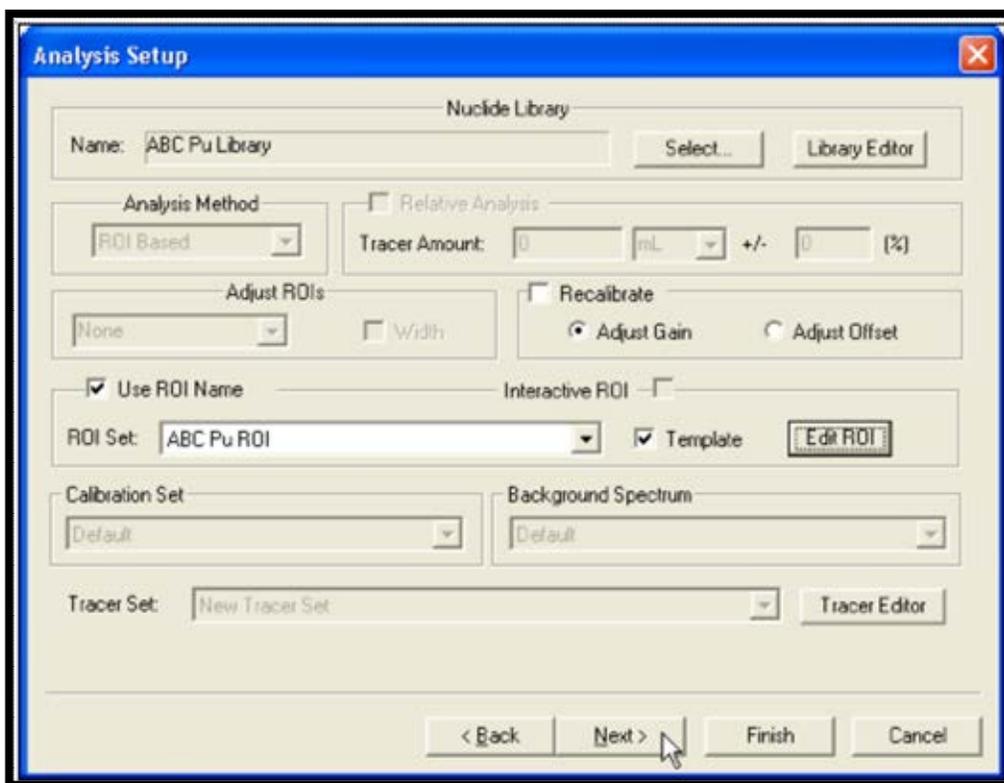


Figure 194. Analysis Setup - ROI Set

- 7) The Report screen (Figure 195) has a print option, and additionally allows users to export the results to various formats (see Section 2.6.1) or a user-defined Crystal Reports v11.5 template. The spectrum can also be exported to an ORTEC .SPC file. (Also remember the Report Window gives a wider choice of export formats.) In this example, click **Print on completion** to print a hardcopy of the results for each background analysis.
- 8) The Background Wizard setup is now complete. The next step is to click **Finish**, after which the detectors that will acquire the data for this set of backgrounds will be assigned.

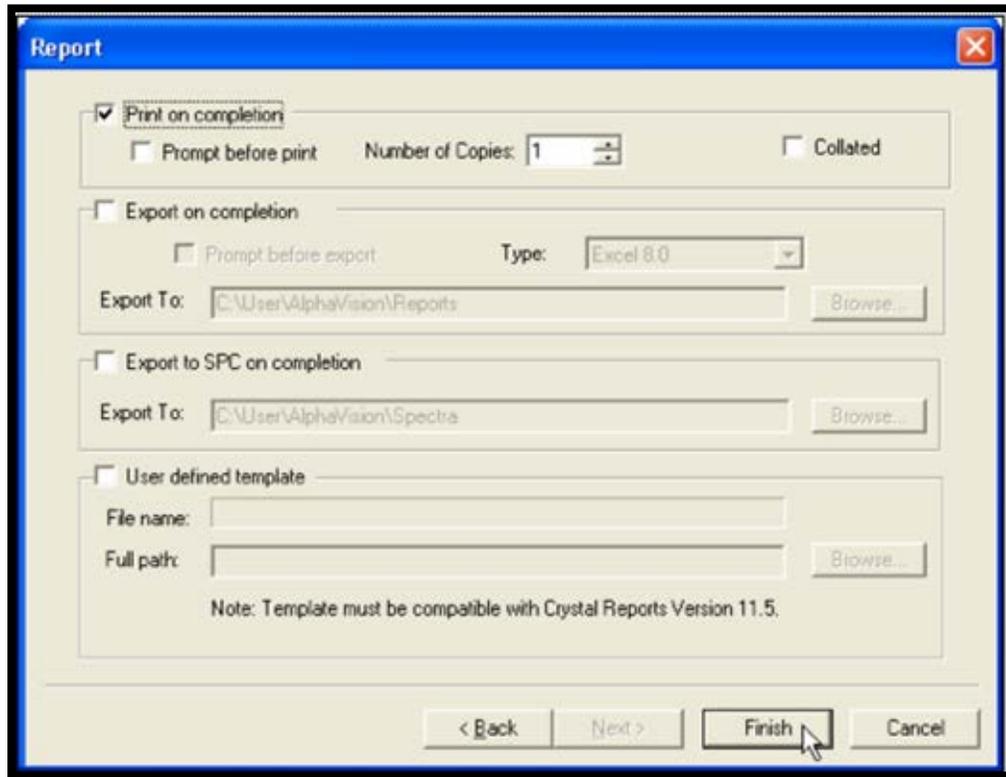


Figure 195. Report – Print on Completion

- 9) When the wizard closes, the Detector Assignment Worksheet will open (Figure 196). This is the tool for assigning a detector to each background and starting data acquisition. It is discussed in detail in Section 11.2. For this tutorial, it will be assumed there are enough alpha chambers available to count the 5 samples. Assign detectors automatically by clicking the **Auto-assign** button, then click **Start Now** to start the background measurement.

The worksheet will close, acquisition will start, and the sample entries just made in the wizard will be displayed up in the Batch Explorer Tree under *Background/All Samples/ ABC Bkg 1*. As soon as data acquisition begins on a sample, its spectrum record will be created in the right-hand Sample Explorer Panel. When analysis is complete, an analysis record will be displayed beneath each spectrum analyzed. Click the spectrum record to display its histogram in the Spectrum Window and click the analysis record to see the analysis ROIs and peak identifications superimposed on the spectrum.

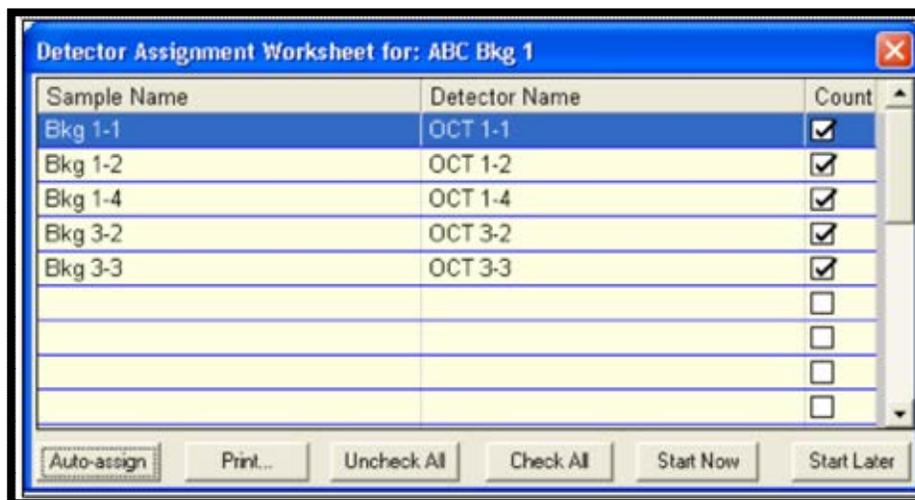


Figure 196. Detector Assignment Worksheet

- 10) When acquisition and analysis are done, the Batch Explorer Panel should resemble below.

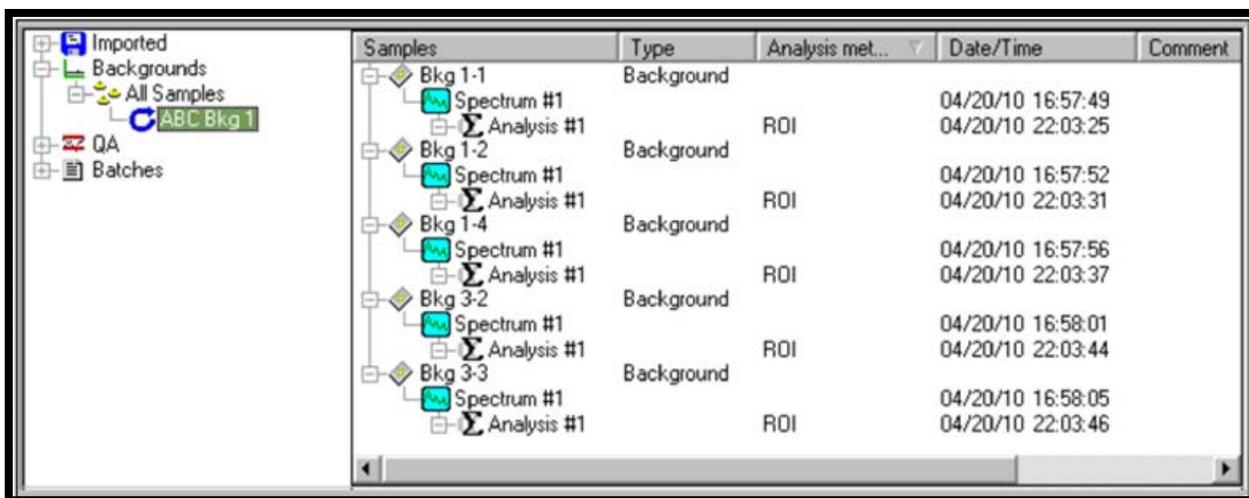


Figure 197. Batch Explorer Panel

It is now ready for the final step: tracking QA/QC.

## A.8 Step 7 – Viewing and Reporting the Chemical Recovery QA/QC

QA tests are fast and easy to run in AlphaVision. Control sample and reagent blank QA are performed automatically as each batch is analyzed. The remaining QA tests (except Pulser, which requires a brief data acquisition) are performed in QA mode from the **QA/Tests** submenu. Just click the QA test name to evaluate all samples that have not yet been tested for that aspect of QA. AlphaVision then flags these records so they are not tested again.

Viewing the QA control charts is just as easy. Simply set up the control limits, then click the Charts tab at the bottom of the QA/QC Panel and AlphaVision will generate the charts. Change the control limits, click back on the Charts view and AlphaVision will regenerate the charts to reflect the new limits.

Now that a Tracer Set has been created for the  $^{242}\text{Pu}$  tracer, a Chemical Recovery QA Type has been set up to track the  $^{242}\text{Pu}$ , and both have been used in counting the example batch of 5 samples, it's time to prepare QC charts to view the chemical recovery of the tracer solution.

- 1) On the Outlook Bar, select the **QA** icon. At the bottom of the QA Panel, make sure it is on the Limits view. Next, go to the top of the QA Panel and click the Chemical Recovery tab.
- 2) In the list of Chemical Recovery types, select *ABC Pu242 CR*. Click the **Chemical Recovery** checkbox so *ABC Pu242 CR* will be evaluated during the Chemical Recovery QA test that follows. Now enter the **Min**, **Low**, **High**, and **Max** control limits. When the limits are finished updating, click **Apply Changes** (Figure 198).
- 3) Next, perform the QA test for Chemical Recovery. This will scan the AlphaVision database for all data records in which the *ABC Pu242 CR* QA Type has been used, locate those records that have not yet been QA tested (1 so far), and test them. From the menu bar, select the **QA/Tests/Chemical Recovery** (Figure 199).
- 4) It is now time to view the control chart. Make sure *ABC Pu242 CR* is highlighted on the Limits view, then, at the bottom of the panel, click the Chart view.

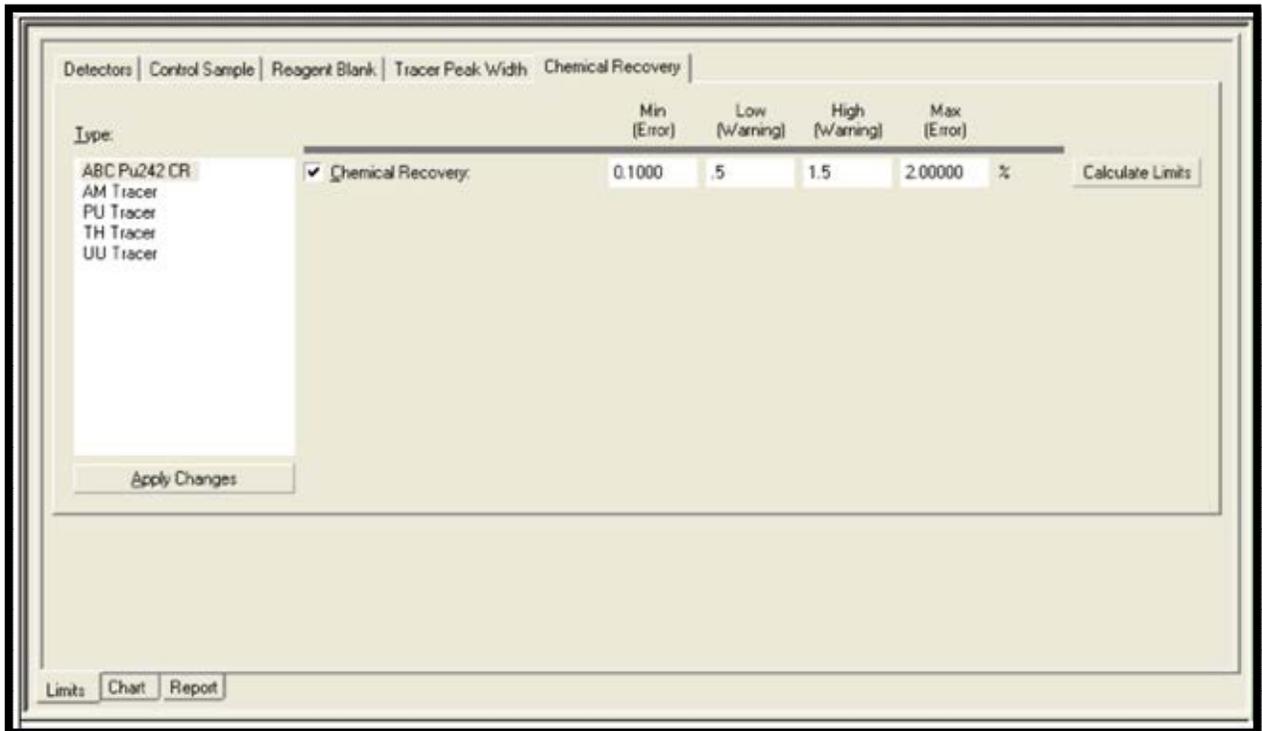


Figure 198. Chemical Recovery Checkbox - Apply Changes

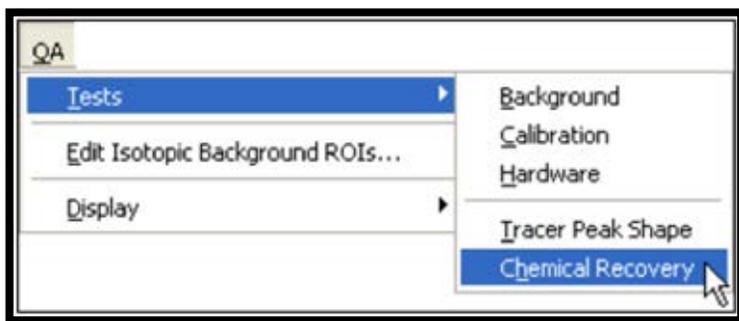


Figure 199. QA-Tests-Chemical Recovery

- 5) Next, choose the reporting interval for the QC chart. From the menu bar, click **QA/Display/Custom...**, and select a suitable time interval (e.g., **Weekly**, **Monthly**, etc.) from the submenu. Use the last entry on the submenu, **Custom...**. It allows the use of the date tool to tailor the start and end dates for a control chart. In this example, choose to display the Chemical Recoveries for ABC Soil Pu Analyses from *June 1, 2001 to July 1, 2001* (Figure 200).

Users can also either specify the **Minimum** and Maximum values of the **Y-axis** (which allows exclusion of outlying points) or allow the software to automatically set the scale.

When users set up the start and end dates and click on **Ok**, the control chart will redisplay with the new reporting interval (Figure 201).

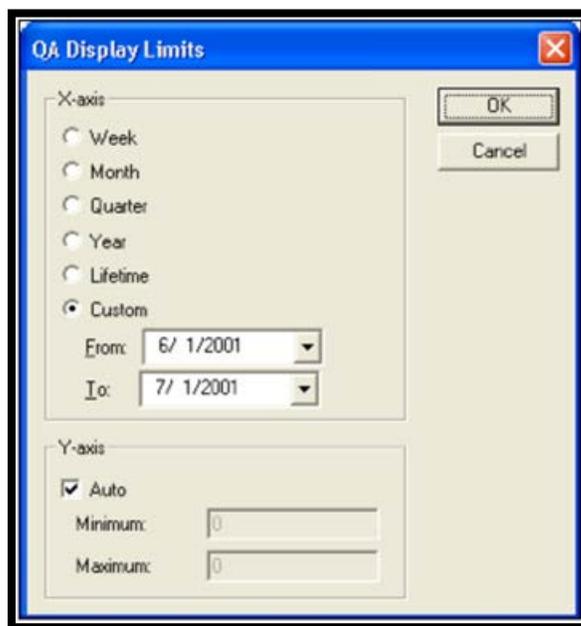


Figure 200. QA Display Limits - Custom

- 6) To view the QA report for this analysis, click the Report view at the bottom of the QA/QC Panel. Use the scroll bar at the right of the Report Window to view the entire report. Click the print button to print a copy of the report (which shows the name of the QA parameter being reported and includes the corresponding QC chart and control limits).
- 7) The steps for creating and viewing the other QC charts and reports are very similar to the ones covered here for Chemical Recovery.

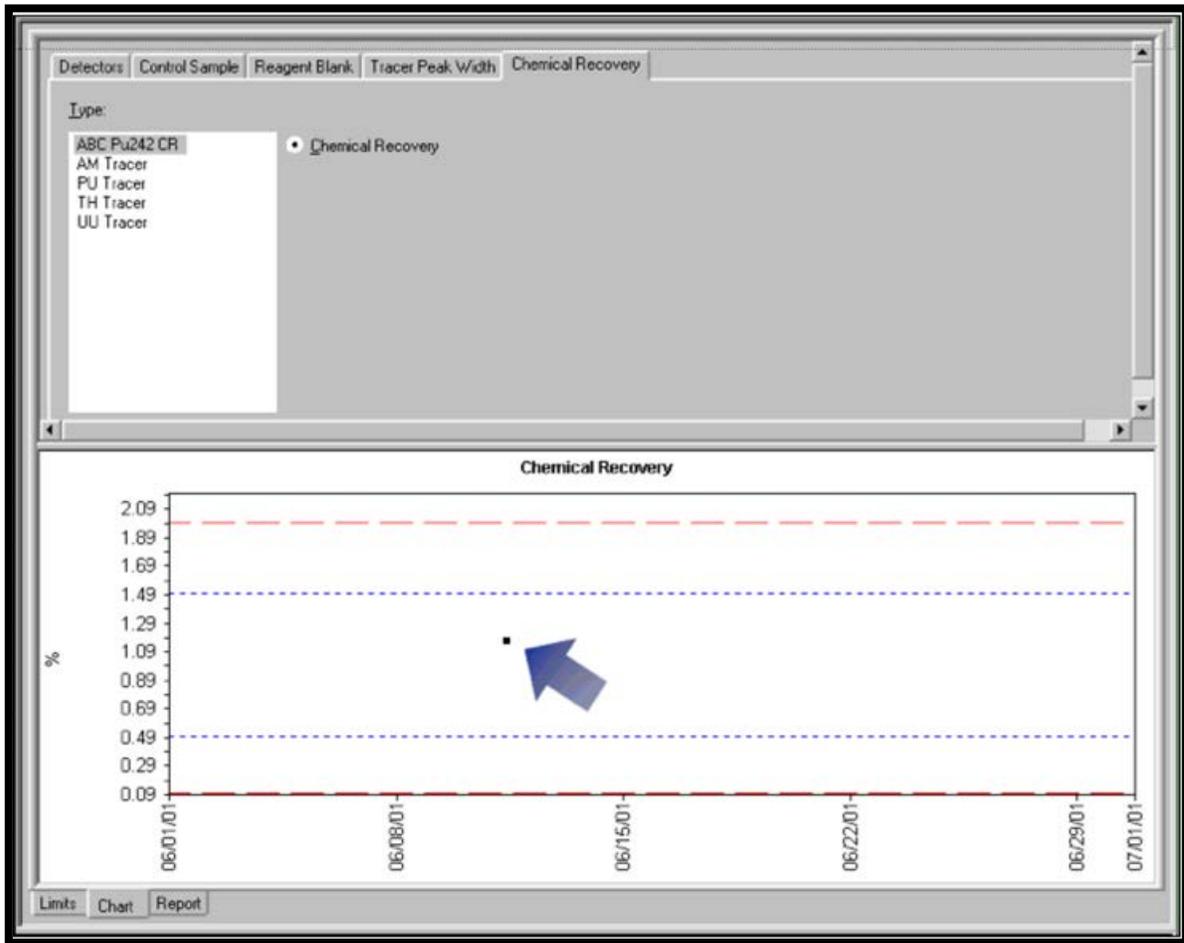


Figure 201. Control Chart - Chemical Recovery

- 8) Use **File/Select Database...** to switch back to the AlphaVision.mdb database (or the database of choice).

**\*\*\*This concludes the tutorial. Enjoy using AlphaVision!\*\*\***

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# APPENDIX B. ANALYSIS METHODS

This appendix explains the AlphaVision analysis calculations and how the data inputs are used.

AlphaVision uses two main categories of spectrum analysis tools:

- Peak and library-based search and fit methods, which use mathematical algorithms to find peaks in the spectrum and “fit” the spectral data.
- Region-of-interest (ROI) analysis, in which users select specific channels that define the starting and ending points of regions of interest.

AlphaVision analyzes spectra and produces peak lists containing the backgrounds, activities, peak shape parameters, and ROIs for peaks found in the spectrum. Nuclides specified in the sample type but not found by the analysis program are also included in the resulting peak list. If a nuclide is identified by the analysis algorithm, the nuclide name, activity, critical level ( $L_c$ ), and minimum detectable activity (MDA) are also included in the peak list.

In addition to the peak list, each analysis also generates a single record containing data common to the analysis as a whole. Items such as the energy calibration constants, sample volumes, hard-ware descriptions, and efficiencies are stored with the analysis data. The combination of a single analysis record and its associated peak list provides a complete history of the analysis.

The results of the analysis are stored in the AlphaVision database and can be exported in custom report formats; and saved in various formats (see Section 2.6.1).

## B.1 Peak Search

There are two peak-search algorithms to choose from: **Mariscotti 2nd Derivative** and **Top-Hat Correlation**.

### B.1.1 Search Engine

#### B.1.1.1 Mariscotti Method

In the Mariscotti method,<sup>20</sup> the second derivatives of the spectrum are calculated according to Eqn. (8) in the Mariscotti paper. The standard deviation of the second derivatives is calculated according to Mariscotti Eqn. (10) and multiplied by a weighting factor, the **Minimum Peak Sensitivity**, to yield the weighted error of the channel counts. The software finds a peak if the absolute value of the second derivative is greater than the weighted error for more than 3 consecutive data points.

The **Minimum Peak Sensitivity** factor can be set from 1.0 to 10 in increments of 0.5. Low values will find small peaks but may also cause the program to accept some false peaks. High values will locate large peaks but will miss some small peaks. For a Mariscotti search, a sensitivity setting of 4 or higher will find well-defined peaks. A setting of 6 is a good starting point for the **Top-Hat Correlation**. A rule of thumb is to collect at least 100 counts to obtain a

<sup>20</sup> M.A. Mariscotti. “A Method for Automatic Identification of Peaks in the Presence of Background and its Application to Spectrum Analysis,” *Nuclear Instruments and Methods* 50, 309–320 (1967).

“well-defined” peak. However, with some experience, you can quantify and fit much smaller peaks.

To further refine the peak fitting parameters, enter an **Expected “Gaussian” Width** in channels for the peak (denoted here as  $W_g$ ), and its **Expected Gaussian Uncertainty** in channels (denoted as  $\Delta W_g$ ). If the peak width found is  $W_f$ , the peak is validated if:

$$|W_f - W_g| \leq \Delta W_g \quad \text{Equation 1}$$

### B.1.1.2 Top-Hat Correlation

For the Top-Hat Correlation, AlphaVision uses a zero-area top-hat filter.<sup>21</sup> You must enter an **Expected “Gaussian” Width** for the peak (which, for best results, should be within 10-30% of the actual FWHM). This peak width value is used to calculate a correlation factor,  $F_{corr}$ , and the background. If the standard deviation of the background is  $STD_{bkg}$  and the **Minimum Peak Sensitivity** is  $SENS$ , the software finds a peak if:

$$F_{corr} > SENS * STD_{bkg} \quad \text{Equation 2}$$

Since the peak width is known *a priori*, there is no need to use Eqn. (1) to check the width.

For both methods,  $W_g$  is the estimated Gaussian width of the peak. Because alpha peaks have long tails on the low-energy side,  $W_g$  is best estimated from the high-energy side of the peaks since the high-energy side of the peak can be fitted rather well with a Gaussian function.

## B.1.2 Spectrum Processing

### B.1.2.1 Spectrum Soothing

The Savitzky-Golay algorithm<sup>22</sup> is used to smooth the spectrum before the peak search.

### B.1.2.2 Cubic Spline Data Interpolation

The main characteristic of the cubic spline method<sup>23</sup> is that it ensures the continuity of the first and second derivatives of the extrapolated curves. By default, if the original spectrum contains 1024 channels or less, the spectrum will be extrapolated to 2048 data points. This helps to better define the peak shape and thus improve the success of peak search and fit.

## B.2 Peak Fit

### B.2.1 ORTEC Algorithm

The **ORTEC Algorithm** fit function is given by:

$$Y_f(E_i) = p_1 e^{p_2 E_i} \operatorname{erfc}[p_3 * (E_i - p_4) + (p_2 / 2p_3)] \quad \text{Equation 3}$$

<sup>21</sup> K. Debertin and R.G. Helmer. *Gamma- and X-Ray Spectrometry with Semiconductor Detectors*, Elsevier Science, 1988.

<sup>22</sup> Bromba, M.U.A. and Horst Ziegler. “Application Hints for Savitzky-Golay Digital Smoothing Filters,” *Anal. Chem.* 53, 1583-1586 (1981).

<sup>23</sup> Press, W.H. et al. *Numerical Recipes in C – The Art of Scientific Computing*, 2nd Ed., Cambridge University Press, Cambridge, 113-117 (1992).

where:

- $p_1 - p_4$  = fit parameters
- $E_i$  = the energy at channel  $i$
- $erfc$  = the complimentary error function<sup>24</sup>

The complimentary error function is derived by convoluting an exponential tail function with a Gaussian function. The task of all minimization methods is to find the best possible set of parameters  $p_1$  to  $p_4$  such that the function  $Y_f$  can best represent the measured counts throughout the spectrum.

## B.2.2 Minimization Method

### B.2.2.1 Chi-Square

In this method, the peak fit routine tries to minimize the following quantity  $F$ :

$$F = \sum_{i=1}^N \frac{(Y_f(E_i) - Y_i)^2}{S_i^2} \quad \text{Equation 4}$$

where:

- $Y_i$  = the counts at channel  $i$
- $Y_f(E_i)$  = the counts of the calculated value at energy  $E_i$  (Eqn. [3])
- $S_i$  = the standard deviation of  $Y_i$ , which is  $S_i = \sqrt{Y_i}$
- $N$  = the total number of channels
- $F$  = the *chi-square* of the fit

### B.2.2.2 Relative Deviation

In the relative deviation method,  $F$  is defined as:

$$F = \sum_{i=1}^N \frac{|Y_f(E_i) - Y_i|}{S_i} \quad \text{Equation 5}$$

where:

- $Y_i$  = the actual counts at channel  $i$
- $Y_f(E_i)$  = the value calculated by the fit function at energy  $E_i$  (Eqn. [3])
- $S_i$  = the standard deviation of  $Y_i$ , which is  $S_i = \sqrt{Y_i}$
- $N$  = the total number of channels

Upon a successful fit, the  $F$  value defined in Eqn. (3) is minimized.

### B.2.2.3 Residuals

In this method,  $F$  is defined as:

$$F = \sum_{i=1}^N |Y_f(E_i) - Y_i| \quad \text{Equation 6}$$

where:

- $Y_i$  = the actual counts at channel  $i$
- $Y_f(E_i)$  = the value calculated by the fit function at energy  $E_i$  (Eqn. [3])
- $S_i$  = the standard deviation of  $Y_i$

<sup>24</sup> *ibid.*, 220.

$N$  = the total number of channels

In this minimization method, the routine tries to minimize the difference at each data point between the fitted value and the measured counts. That is, the sum of absolute residuals is minimized.

The **Chi-Square** method is the widely accepted method. You may wish to use the **Relative Deviation** or **Residuals** methods if the spectrum contains badly overlapping peaks.

### B.2.3 Advanced Fit Control Parameters

In the Marquardt nonlinear fitting method (adapted according to Press et al.<sup>25</sup>), the fitting is done in an iterative process. The user-entered maximum number of iterations (**Max Iterations** on the Peak Fit dialog) controls the maximum number of loops to iterate (to find the minimum value of  $F$  in Eqns. [4], [5], and [6]).

AlphaVision uses results obtained from the peak search to calculate initial values of  $p_1$  through  $p_4$  and, hence, an initial  $F$  value. Then, based on the minimization method selected, the Lavenberg-Marquardt method is used to change fit parameters  $p_1$  through  $p_4$  and calculate another  $F$  value. In each iterative calculation, the  $F$  value of the current run is compared with the previous one. The fitting is done (or converges) if this difference is less than a user-defined value,  $\epsilon$ , as follows:

$$|F(j) - F(j - 1)| < \epsilon \quad \text{Equation 7}$$

where:

$F(j)$  = the  $F$  value calculated after the  $j^{\text{th}}$  iteration  
 $F(j-1)$  = the  $F$  value of the previous iteration  
 $\epsilon$  = the precision desired

For the **Chi-Square** minimization method (Eqn. [4]),  $\epsilon$  is user-defined in the **Fit Precision** field on the Peak Fit dialog (in this case, the fit precision is the chi-square precision). Since the chi-square value should be approximately 1.0, a value of 0.01 or 0.001 should be adequate.

If the **Relative Deviation** method (Eqn. [5]) is used, the value in the **Fit Precision** field is the precision of the total relative deviation desired, and roughly the same values can be used here as for **Chi-Square** minimization.

However, for the **Residuals** method (Eqn. [6]), the value in the **Fit Precision** field is the precision of absolute residuals desired. In this case, the precision desired should depend on the total counts of the peaks. A value between 1% to 0.1% of the total counts in each peak is adequate.

The dimensionless **Initial Lambda** and **Lambda Multiplier** values control how “quickly” the Marquardt routine adjusts its fitting parameters (which are the parameters in the fit function, Eqn. [3]) from one iteration to the next. The default values are suitable for most applications. If peak fit fails, we suggest that you adjust the peak search parameters or the **Max Iterations** and **Fit Precision** before trying to adjust **Initial Lambda** and **Lambda Multiplier**.

<sup>25</sup> Press, W.H. et al. *Numerical Recipes in C – The Art of Scientific Computing*, 2nd Ed., Cambridge University Press, Cambridge, 633-683 (1992).

## B.2.4 Fit Acceptance Limits

The program verifies the validity of the peak fit according to the criteria you have entered. If you are using the **Relative Deviation** method, a maximum chi-square value (**Maximum $\chi^2$  of Fit**) is used. If the chi-square value for the fit exceeds that value, the fit to that peak (or peaks) is not valid and no fitted values are calculated for that peak. After fitting, the fit routine not only finds the values for  $p_1$  through  $p_4$ , but also calculates the uncertainties of  $p_1$  through  $p_4$ , denoted as  $\Delta p_1$  through  $\Delta p_4$ . If the percentage uncertainty ( $\Delta p_1/p_1 * 100$  and so forth) exceeds the user-entered **Maximum Uncertainty**, the fit is invalid.

You can also enter the **Expected (Fitted) Peak FWHM** value, denoted here as  $FWHM_{exp}$ , and the **Expected Peak FWHM Uncertainty**, denoted as  $\Delta FWHM$ . For each fitted peak, if the calculated peak FWHM is  $FWHM_i$ , then a valid peak must meet the following criterion:

$$|FWHM_i - FWHM_{exp}| \leq \Delta FWHM \quad \text{Equation 8}$$

Finally, the fit routine calculates the peak start channel,  $ch_1$ , and end channel,  $ch_2$ , and then integrates the gross counts between  $ch_1$  and  $ch_2$  to obtain the sum of the measured counts from  $ch_1$  to  $ch_2$ .  $ch_1$  is calculated as  $5 \times FWHM$  on the low-energy side of the centroid.  $ch_2$  is calculated as  $3 \times FWHM$  on the high-energy side of the centroid.

If the calculated peak area is  $A$  (see "ORTEC Algorithm," Section B.2.1), then the percent difference between  $A$  and the gross counts should be less than the user-defined percent area difference for valid peaks (the **Maximum Area Difference**). This is a very coarse check since there is no algorithm that can unequivocally determine a peak's start and end channels. Therefore, the **Expected Peak FWHM Uncertainty** should not be set too small.

## B.3 Analyze Stripped Spectrum (Residuals)

This option is meaningful only for ROI analyses. For the residual spectrum, the residual counts in channel  $i$  are calculated as:

$$R_i = Y_i - Y_f(E_i) \quad \text{Equation 9}$$

where the fit function  $Y_f(E_i)$  is described in Eqn. (3).

In ROI analysis, if analyze residuals is desired, the program will do a peak search and fit, and calculate the residual spectrum from Eqn. (9). This residual spectrum will then be used instead of the original spectrum to calculate activities in the ROIs.

## B.4 ROI Calculations

### B.4.1 Shift ROI with Tracer and Adjust ROI Width

Prior to AlphaVision 7, when the **Adjust ROI | Tracer** option was used in the Batch wizard, the tracer peak was found with the peak-search-and-fit method, even for ROI-based analysis. This sometimes led to failures in finding the tracer peak.

In AlphaVision 7, the tracer centroid and width are calculated based on the ROI peak evaluation method. Therefore, this method works the same as the **Best Peak** method except the tracer peak is always chosen as the best peak. Note that only the **ROI Width** can be adjusted in this method.

When the **Adjust ROI | Tracer** option is marked, the actual FWHM and the expected tracer FWHM are compared. The difference between those two widths is calculated and that difference is converted into channels to decide how many channels wider the ROI should be. In the AlphaVision demo database, AlphaVisionDemo.mdb, this value is approximately 10 keV per channel. Even where the peak widths are very different, the change in width may still be minimal. For example, if the tracer actual width is 80 keV and the expected width is 40 keV, the ROI will only be about 4 channels wider and rounding errors could leave the adjusted channels less precise. Thus, in AlphaVision 7, the increase in width has been changed as follows:

Where  $f$  is the ratio of the actual width to the expected width:

$$f = (\text{Actual Tracer FWHM}) / (\text{Expected Tracer FWHM}) \quad \text{Equation 10}$$

Using the example above,  $f$  would be  $80/40 = 2.0$ . Therefore, the ROI width would be doubled.

In calculating the new ROI bounds, the ROI centroids are always preserved (as in all versions of AlphaVision). But the ratio of the new ROI width to the original width is required to be the same as the above ratio,  $f$ . That leads to the following:

$$\text{Adjusted Start} = [(1 + f) * \text{Start} + (1 - f) * \text{End}] / 2 \quad \text{Equation 11}$$

$$\text{Adjusted End} = [(1 - f) * \text{Start} + (1 + f) * \text{End}] / 2 \quad \text{Equation 12}$$

It can be proved that, for the above calculations, the new ROI centroid is the same and the ratio of the ROI widths is the ratio of the FWHM values.

#### B.4.2 ROI Centroid Adjustment for Sample Analysis and Calibration

AlphaVision 7 supports two **Adjust ROI** methods, for both sample analysis and calibration, in addition to the existing **Tracer** method, which applies only to sample analysis:

- **Each Peak** – The actual centroid is determined from counts-weighted centroid within the ROI. If the centroid thus found is different from the predefined ROI centroid, then the whole ROI is shifted from the predefined centroid to the actual centroid (maintaining the same width). The amount of shifting is limited to the width of the ROI. If the ROI shifts outside this range, a warning message will be generated in the Event Log.
- **Best Peak** – If there is only one ROI in the whole ROI set, this method works the same as the **Each Peak** method. If there are several ROIs, then the amount of centroid shift is determined from the ROI with the highest counts. This method can be used for ROIs where the counts are expected to be low so that the FWHM and the centroid cannot be determined very well for the ROI. But it can also be used so that all ROIs are shifted to the same degree so as to avoid the potential ROI overlapping of the **Each Peak** method. In this method, the amount of shifting is limited to the half of the ROI width.

The ROI centroid is calculated and normalized as follows. This discussion applies to ROI shifting in both calibration and batch analysis.

### B.4.2.1 ROI Centroid Calculation

To calculate the ROI centroid, the channel containing the most counts is taken as the initial peak centroid and the FWHM is calculated. Then a region centered on the initial peak centroid and one FWHM wide is established for centroid calculation. The counts weighted channel in that region, as calculated below, is taken as the ROI centroid:

$$C = \frac{(\sum c_i X_i)}{(\sum c_i)} \quad \text{Equation 13}$$

where  $c_i$  is the counts at channel  $x_i$ . The summation is over the whole, one-FWHM-wide region. If the FWHM is <3 channels, then 3 channels are used.

### B.4.2.2 ROI Normalization with ROI Adjustment Option Selected

In this process, if the high channel of a lower ROI overlaps with the low channel of a higher ROI, then the low channel of the higher ROI is set to one channel above the high channel of the lower ROI. This process is applied when any ROI shifting is requested.

## B.5 Partial Channel Correction

If the count value at channel  $ch_1$  is  $c_1$  and the count value at channel  $ch_2$  is  $c_2$ , a “partial” channel with a non-integer channel number of  $x$  where  $ch_1 < x < ch_2$ , has interpolated counts according to the following calculation:

$$C_x = c_1 + (c_2 - c_1) * (x - ch_1) \quad \text{Equation 14}$$

If an ROI contains partial channels but you have not chosen to **Correct Partial Channels**, the counts at channel  $x$  are calculated as follows:

$$c_x = c_1 \text{ if } x < ch_1 + 0.5 \quad \text{Equation 15}$$

$$c_x = c_2 \text{ if } x > ch_1 + 0.5$$

### B.5.1 Region-of-Interest Analysis

A region-of-interest analysis integrates the net counts over a specified region in the spectrum and works best with well-separated peaks. The net counts are determined using Eqn. (17) for an absolute analysis or Eqns. (19) or (20) for an analysis relative to a tracer.

#### B.5.1.1 Recalibrate

In a relative analysis, you can mark the **Recalibrate** checkbox and AlphaVision performs a peak search and fit to find the tracer peak first. The ROI centroid energies are then shifted by the same amount that the calibrated tracer peak energy has shifted. Under **Recalibrate**, choose **Adjust Gain** or **Adjust Offset**. **Adjust Gain** and **Adjust Offset** allow you to correct for peak shifts in alpha spectra. The software uses the peak position of the tracer (and the library energy for the tracer peak) to determine if a shift in the energy of the peak has occurred. If you have selected, **Adjust Offset**, AlphaVision adjusts the offset term in the calibration equation to reflect the shift in the tracer peak; this adjusts all other peaks in the spectrum as well. If you have selected **Adjust Gain**, the software adjusts the gain term in the calibration equation to reflect the shift in the tracer peak position.

### B.5.1.2 Absolute Channels

The ROI is entered as absolute channel numbers and is not adjusted if a recalibration is performed. To perform an “absolute channels” ROI analysis, leave the **Width** and **Recalibrate** checkboxes *unmarked* and select **None** from the **Adjust ROIs** list box.

## B.6 QA Limits Calculation

For a set of QA values, the averaged value is calculated from:

$$V_a = \sum_i^N \frac{V_i}{N} \quad \text{Equation 16}$$

where:

$V_i$  = the *i*th QA value  
 $N$  = total number of QA values  $N$

The estimated standard deviation is calculated from:

$$STD = \sqrt{\frac{\sum (V_i - V_a)^2}{(N-1)}} \quad \text{Equation 17}$$

The QA limits calculated with the **Calculate Limits** button (Section 10.3.1) are:

$$\begin{aligned} \text{Minimum} &= V_a - 3 * STD \\ \text{Low} &= V_a - 2 * STD \\ \text{High} &= V_a + 2 * STD \\ \text{Maximum} &= V_a + 3 * STD \end{aligned}$$

## B.7 Methods for Calculating Nuclide Activity, MDA, Critical Level, and TPU

This section presents the detailed methods used to calculate the primary values – nuclide activity, MDA, critical level, and TPU – on the typical AlphaVision report. As such, all values, functions and calculations herein are included as supporting information for these calculations. To reproduce the analysis results on the AlphaVision report based on the “recipes” provided in this section, an Excel spreadsheet is recommended. Understanding of the AlphaVision database structure is also required.

Section B.7.1 presents the algorithms for calculation of the activity, MDA, critical level, and TPU.

Sections B.7.2.1 through B.7.2.2 show the detailed methods used to calculate these primary values.

Sections B.7.3.1 through B.7.3.73 detail the intermediate calculation performed in support of the calculation of the Activity, TPU, Critical Level and MDA values.

The final subsections, B.7.4.1 through B.7.4.52, detail constants, flags, parameters, acquired data, etc., that form the basic inputs to the calculations listed earlier.

## B.7.1 Algorithms for Absolute and Relative Analysis

### B.7.1.1 Nuclide Activity

The activity for a specific nuclide is calculated as follows:

$$DPM_n = \frac{CPM_n}{Ef_t * Br_E} \quad \text{Equation 18}$$

where:

- $DPM_n$  = disintegrations per minute computed for the nuclide
- $Br_E$  = branching ratio for alpha energy  $E$
- $Ef_t$  = total detector efficiency
- $CPM_n$  = net counts per minute for the nuclide

For absolute analysis, the total efficiency of the system is computed using the following equation:

$$Ef_t = Ef_d * C_{rm} \quad \text{Equation 19}$$

where:

- $Ef_t$  = total efficiency
- $Ef_d$  = detector efficiency
- $C_{rm}$  = manual chemical recovery

For relative analysis, the total efficiency of the system is computed using the following equation:

$$Ef_t = Ef_d * C_{tr} \quad \text{Equation 20}$$

where:

- $C_{tr}$  = chemical recovery of the tracer

The tracer chemical recovery is calculated from:

$$C_{tr} = \frac{CPM_{tr}}{Ef_d * Br_{tr} * DPM_e} \quad \text{Equation 21}$$

where:

- $C_{tr}$  = tracer chemical recovery
- $CPM_{tr}$  = net counts per minute for the tracer
- $DPM_e$  = disintegrations per minute expected for the tracer
- $Br_{tr}$  = branching ratio for the tracer nuclide

### B.7.1.2 MDA

In the **ANSI Standard** method<sup>26</sup>, the MDA is calculated as:

$$MDA = \frac{k_\alpha^2 + 2 k_\beta \sqrt{\mu}}{Ef_t * Br * Ts} \quad \text{Equation 22}$$

<sup>26</sup> ANSI N13.30, *Performance Criteria for Radiobioassay*, American National Standards Institute, 1996

where:

- $Ef_t$  = total detector efficiency
- $T_s$  = sample live time
- $Br$  = branching ratio, taken from the nuclide library
- $\mu$  = variance of the background counts
- $k_\alpha$  = confidence level (**K\_Alpha** on the MDA Setup screen in the Batch Wizard) for Type I error
- $k_\beta$  = confidence level (**K\_Beta** on the MDA Setup screen in the Batch Wizard) for Type II error

The variance of the background counts,  $\mu$ , is calculated as:

$$\mu = B_s * \left(1 + \frac{T_s}{T_b}\right) \quad \text{Equation 23}$$

where:

- $B_s$  = sample background counts, calculated from the background spectrum as  $(B * T_s / T_b)$ , where B is the total background counts.
- $T_s$  = sample spectrum live time
- $T_b$  = background spectrum live time

If you choose **General (Currie's Equation)**,<sup>27</sup> the MDA is calculated as:

$$MDA = \frac{L_d}{Ef_t * Br * T_s} \quad \text{Equation 24}$$

where  $L_d$  is the detection limit, in counts, defined as:

$$L_d = L_c + \frac{k_\beta^2}{2} \left(1 + \left(1 + \frac{4L_c}{k_\beta^2} + \frac{4L_c^2}{k_\alpha^2 k_\beta^2}\right)^{1/2}\right) \quad \text{Equation 25}$$

$L_c$  is defined as follows:

$$L_c = k_\alpha * \sqrt{\mu} \quad \text{Equation 26}$$

and the remaining factors are defined above.

If  $k_\alpha = k_\beta$  then the MDA values calculated from both the ANSI and Currie methods are identical.

### B.7.1.3 Critical Level

The critical level,  $CL$ , establishes a statistical lower limit above which one may conclude that a signal has been detected. It is calculated as follows:

$$CL = \frac{L_c}{T_s * Ef_t * Br} \quad \text{Equation 27}$$

<sup>27</sup> L. A. Currie. "Limits for Qualitative Detection and Quantitative Determination – Application to Radiochemistry," *Analytical Chemistry* 40(3), 586-593, March 1968.

### B.7.1.4 Total Propagated Uncertainty (TPU)

The TPU is calculated as:

$$TPU = \sqrt{\sigma_a^2 + \sigma_r^2 + \sigma_s^2} \quad \text{Equation 28}$$

where:

- $\sigma_a$  = activity uncertainty
- $\sigma_r$  = additional random uncertainty
- $\sigma_s$  = additional systematic uncertainty

The activity uncertainty is calculated using the standard error propagation rules with the assumption that all variables are independent of each other. Counting uncertainty, sample size uncertainty, detector efficiency uncertainty, decay correction uncertainty and uncertainty of all quantities used in arriving at the activity value are propagated to calculate the total activity uncertainty (or total activity concentration uncertainty).

## B.7.2 Calculation “Recipes” for Activity, MDA, Critical Level, and TPU

### B.7.2.1 Reported Nuclide Activity (dRptNucAct)

This value is a floating-point number calculated as follows:

```
If(Nuclide = Tracer)then
    dRptNucAct = dTrcrCalcActDecCorrToAssDtUsrUnitsConc * dNucRatio
Else
    dRptNucAct = dNucActDecCorr * 60 / dDPMConvFact * dNucRatio
End If
```

where:

- dDPMConvFact is described in Section B.7.3.6.
- dTrcrCalcActDecCorrToAssDtUsrUnitsConc is described in Section B.7.3.64.
- dNucActDecCorr is described in Section B.7.3.24.
- dNucRatio is described in Section B.7.3.40.

### B.7.2.2 Reported Nuclide MDC (dRptNucMDC)

This value is a floating-point number calculated as follows:

```
If(bRptActConc = true)then
    dRptNucMDC = dNucMDA / dSmpISz * dNucRatio
Else
    dRptNucMDC = dNucMDA * dNucRatio
End If
```

where:

- bRptActConc is described in Section B.7.4.27.
- dSmpISz is described in Section B.7.4.29.
- dNucMDA is described in Section B.7.3.32.
- dNucRatio is described in Section B.7.3.24.

**B.7.2.3 Reported Nuclide MDC (dRptNucMDC)**

This value is a floating-point number calculated as follows:

```

If(bRptActConc = true)then
    dRptNucMDC = dNucMDA / dSmplSz * dNucRatio
Else
    dRptNucMDC = dNucMDA * dNucRatio
End If

```

where:

bRptActConc is described in Section B.7.4.27.  
dSmplSz is described in Section B.7.4.29.  
dNucMDA is described in Section B.7.3.32.  
dNucRatio is described in Section B.7.3.24.

**B.7.2.4 Reported Nuclide TPU (dRptNucTPU)**

This value is a floating-point number calculated as follows:

```

If(Nuclide = Tracer)then
    If(bNucTPUPerc = true)then
        dRptNucTPU = dNucRelUncTPUPerc * dRptNucAct / 100
    Else
        If(bRptActConc = true)then
            If(bErrInPerc = true)then
                dRptNucTPU = dNucAdnlNoEffTPU / dSmplSz
            Else
                dRptNucTPU = dNucAbsUncTPU / dSmplSz)
        End If
    Else
        dRptNucTPU = dNucAbsUncTPU
    End If
End If
Else
    If(bErrInPerc = true)then
        dRptNucTPU = dNucAdnlNoEffTPU
    Else
        dRptNucTPU = dNucAbsUncTPU
    End If
End If
Else
    dRptNucTPU = |dNucTPU|
End If

```

where:

dRptNucAct is described in Section B.7.2.1.  
bErrInPerc is described in Section B.7.4.7.  
bRptActConc is described in Section B.7.4.27.  
dSmplSz is described in Section B.7.4.29.  
dNucRelUncTPUPerc is described in Section B.7.3.42.  
dNucAbsUncTPU is described in Section B.7.3.12.  
dNucAdnlNoEffTPU is described in Section B.7.3.15.  
bNucTPUPerc is described in Section B.7.3.47.  
dNucTPU is described in Section B

### B.7.3 Intermediate Calculations

#### B.7.3.1 Bq to User Selected Units Conversion Factor (dBqConvFact)

This is the Bq to User Selected Units conversion factor (used as a divisor). The user indicates the desired Units via the selection list box on the 'Analysis Misc.' tab of the Analysis Setup wizard. This conversion factor is calculated as:

$$dBqConvFact = FactUnits / BqFact$$

where:

FactUnits and BqFact are stored in the ActivityUnits table of the AlphaVision database.

BqFact is a known value of 1.00. As such, this equation simplifies to:

$$dBqConvFact = FactUnits$$

#### B.7.3.2 Count Rate to Activity Conversion Factor (dCntRtToActConvFctr)

This conversion factor, multiplied by the net count rate, yields the sample activity in Bq or Bq per sample size units, depending on the usage. It is a floating-point number and is defined as a temporary variable for the uncertainty calculations. It is calculated as follows:

```

If(Nuclide = Tracer)then
  If(bRptActConc)then
    dCntRtToActConvFctr = dNucDecCorr / dNucBR / dTrcrTotEff / dSmplSz
  Else
    dCntRtToActConvFctr = dNucDecCorr / dNucBR / dTrcrTotEff
  End If
Else
  If(bRptActConc)then
    dCntRtToActConvFctr = dNucDecCorr / dNucBR / dNonTrcrTotEff / dSmplSz
  Else
    dCntRtToActConvFctr = dNucDecCorr / dNucBR / dNonTrcrTotEff
  End If
End if

```

where:

dTrcrTotEff is described in Section B.7.3.73.

dNonTrcrTotEff is described in Section B.7.3.11.

bRptActConc is described in Section B.7.4.27.

dNucDecCorr is described in Section B.7.3.27.

dNucBr is described in Section B.7.4.16.

dSmplSz is described in Section B.7.4.29.

#### B.7.3.3 Count Rate to Activity Conversion Factor Absolute Uncertainty (dCntRtToActConvFctrAbsUnc)

This is the uncertainty associated with the dCntRtToActConvFctr calculation. It is a floating-point number and is defined as a temporary variable for uncertainty calculations. It is calculated as follows:

```

If(bRelAnal AND Nuclide <> Tracer)then
  If(bRptActConc = true)then
    dCntRtToActConvFctrAbsUnc = dCntRtToActConvFctr * (dDetEffRelUnc^2 +
      dDecayCorrRelUnc^2 + dTrcrRcvrRelUnc^2 + dMnlCRRelUnc^2 +
      dSmplSzRelUnc^2)^0.5
  Else
    dCntRtToActConvFctrAbsUnc = dCntRtToActConvFctr * (dDetEffRelUnc^2 +
      dDecayCorrRelUnc^2 + dTrcrRcvrRelUnc^2 + dMnlCRRelUnc^2)^0.5
  End If
Else
  If(bRptActConc = true)then
    dCntRtToActConvFctrAbsUnc = dCntRtToActConvFctr * (dDetEffRelUnc^2 +
      dDecayCorrRelUnc^2 + dMnlCRRelUnc^2 + dSmplSzRelUnc^2)^0.5
  Else
    dCntRtToActConvFctrAbsUnc = dCntRtToActConvFctr * (dDetEffRelUnc^2 +
      dDecayCorrRelUnc^2 + dMnlCRRelUnc^2)^0.5
  End If
End If

```

where:

dCntRtToActConvFctr described in Section B.7.3.2.  
 bRelAnal is described in defined in Section B.7.4.24.  
 dDetEffRelUnc is described in Section B.7.3.5.  
 dDecayCorrRelUnc is described in Section B.7.3.4.  
 dSmplSzRelUnc is described in Section B.7.4.30.  
 dTrcrRcvrRelUnc is described in Section B.7.3.70.  
 dMnlCRRelUnc is described in Section B.7.4.13.

The unit of measure is Bq per sample size units.

#### B.7.3.4 Decay Correction Relative Uncertainty (dDecayCorrRelUnc)

This is the uncertainty associated with the decay correction calculation. It is a floating-point number calculated as follows:

```

If(bDoDecCorr = TRUE)then
  If(Nuclide = Tracer)then
    dDecayCorrRelUnc = dNucHalfLifeRelUnc * LN(2) * dTrcrDecTm / dTrcrHalfLife
  Else
    dDecayCorrRelUnc = dNucHalfLifeRelUnc * LN(2) * dNucDecTm / dNucHalfLife
  End If
Else
  dDecayCorrRelUnc = 0.0
End If

```

where:

bDoDecCorr is described in Section B.7.4.10.  
 dTrcrHalfLife is described in Section B.7.4.36.  
 dNucHalfLife is described in Section B.7.4.20.  
 dTrcrDecTm is described in Section B.7.3.67.  
 dNucDecTm is described in Section B.7.3.28.  
 dNucHalfLifeRelUnc is described in Section B.7.4.21.  
 LN(2) is the natural log of 2.

### B.7.3.5 Detector Efficiency Relative Uncertainty (dDetEffRelUnc)

This is the uncertainty associated with the dDetEff calculation. It is a floating-point number and is calculated as follows:

```
If(dDetEff <> 0)then
    dDetEffRelUnc = dDetEffAbsUnc / dDetEff
Else
    dDetEffRelUnc = 0
End if
```

where:

dDetEff is described in Section B.7.4.8.

dDetEffAbsUnc is described in Section B.7.4.9.

### B.7.3.6 DPM to User Selected Units Conversion Factor (dDPMConvFact)

This is the DPM to User Selected Units conversion factor (used as a divisor). The user indicates the desired Units via the selection list box on the 'Analysis Misc.' tab of the Analysis Setup wizard. This conversion factor is calculated as:

$$dDPMConvFact = FactUnits / DPMFact$$

where:

FactUnits and DPMFact are stored in the ActivityUnits table of the AlphaVision database.

DPMFact is a known value of 1/60. As such, this equation simplifies to:

$$dDPMConvFact = FactUnits * 60$$

### B.7.3.7 Expected Tracer Activity at Assay Date (dExpTrcrActAtAssDt)

This value is a floating-point number calculated as follows (herein referenced in fixed unit terms of DPM).

```
If (bTrcrAddToAliquot) Then
    dExpTrcrActAtAssDt = dTrcrActAtAssDt * dTrcrSz * dNucRatio
Elsec
    dExpTrcrActAtAssDt = dTrcrActAtAssDt * dTrcrSz
End If
```

where:

dTrcrActAtAssDt is described in Section B.7.4.32.

dTrcrSz is described in Section B.7.4.39.

bNucRatio is described in Section B.7.3.24.

This activity should be converted to DPM if it is not in DPM units.

### B.7.3.8 Expected Tracer Activity at Assay Date Relative Uncertainty (dExpTrcrActAtAssDtRelUnc)

This is the uncertainty associated with the expected tracer activity on the total sample, based on the tracer concentration and the tracer amount used. It is a floating-point number and is calculated as follows:

```
If(bTrcrAddToAliquot = True)then
    dExpTrcrActatAssDtRelUnc = (dTrcrRefConcRelUnc^2 + dTrcrSzRelUnc^2 +
    dNucRatioRelUnc^2)^0.5
Else
    dExpTrcrActatAssDtRelUnc = (dTrcrRefConcRelUnc^2 + dTrcrSzRelUnc^2)^0.5
End If
```

where:

- bTrcrAddToAliquot is described in Section B.7.4.33.
- dAliquot is described in Section B.7.4.2.
- dTrcrRefConcRelUnc is described in Section B.7.4.38.
- dTrcrSzRelUnc is described in Section B.7.3.72.
- dNucRatioRelUnc is described in Section B.7.3.41.

### B.7.3.9 Live Time for MDA Count Rate (dBLT)

This value is a Boolean flag determined as follows:

```
If(bBlankMDASourceType)then
    dBLT = dBlnkLT
Else
    dBLT = dBkgLT
End If
```

where:

- bBlankMDASourceType is described in Section B.7.4.42.
- dBLT is described in Section B.7.3.9.
- dBkgLT is described in Section B.7.4.5.

### B.7.3.10 Manual Chemical Recovery Per Sample (bMnlCRPerSmpl)

This flag is set when a sample is created. If it is set, then the manual chemical recovery and associated uncertainties are defined for each sample in a batch. Otherwise, it can be defined on the analysis setup page for the whole batch. This flag is stored in the Sample table of the AlphaVision database.

### B.7.3.11 Non-Tracer Total Efficiency (dNonTrcrTotEff)

This value is a floating-point number calculated as follows:

```
If(bRelAnal = true)then
    dNonTrcrTotEff = dDetEff * dTrcrMnlCR * dTrcrRcvr
Else
    dNonTrcrTotEff = dDetEff * dTrcrMnlCR
End If
```

where:

- bRelAnal is described in Section B.7.4.24.
- dTrcrMnlCR is described in Section B.7.4.37.

dDetEff is described in Section B.7.4.8.  
dTrcrRcvr is described in Section B.7.3.69.

### B.7.3.12 Nuclide Absolute Uncertainty TPU (dNucAbsUncTPU)

This value is a floating-point number calculated as follows:

```

If(Nuclide = Tracer)then
    dNucAbsUncTPU = (dTrcrCalcActDecCorrToAssDtAbsUnc^2 + dRndErr^2 + 1
    * dSysErr^2)^0.5 * dSigma
Else
    dNucAbsUncTPU = (dRptNucActAbsUnc^2 + dRndErr^2 + 1 * dSysErr^2)^0.5 *
    dSigma
End If

```

where:

dSigma is described in Section B.7.4.40.  
dSysErr is described in Section B.7.3.57.  
dRndErr is described in Section B.7.3.54.  
dTrcrCalcActDecCorrToAssDtAbsUnc is described in Section B.7.3.63.  
dRptNucActAbsUnc is described in Section B.7.3.55.

### B.7.3.13 Nuclide Activity Calculated from Conversion Factor (dNucActCalcByConvFact)

This is a floating-point number and is defined as a temporary variable for uncertainty calculations. It is calculated as follows:

$$dNucActCalcByConvFact = dNucNetCntRt * dCntRtToActConvFctr$$

where:

dNucNetCntRt is described in Section B.7.3.34.  
dCntRtToActConvFctr described in Section B.7.3.2.

### B.7.3.14 Nuclide Activity Relative Uncertainty (dNucActRelUnc)

This variable is used in the TPU calculations. It is a floating-point number calculated as follows:

$$dNucActRelUnc = dRptNucActRelUnc$$

where:

dRptNucActRelUnc is described in Section B.7.3.56.

### B.7.3.15 Nuclide Additional No Effect TPU (dNucAdnlNoEffTPU)

This value is a floating-point number calculated as follows:

$$dNucAdnlNoEffTPU = dRptNucActAbsUnc * dSigma$$

where:

dSigma is described in Section B.7.4.40.  
dRptNucActAbsUnc is described in Section B.7.3.55.

**B.7.3.16 Nuclide ANSI Detection Limit (dNucANSIDetLim)**

This value is a floating-point number calculated as follows:

$$\text{dNucANSIDetLim} = (\text{dK\_Alpha} * \text{dK\_Alpha} / \text{dSmpILT} + 2 * \text{dK\_Beta} * \text{dNucMDACR}) * 60 / \text{dDPMConvFact}$$

where:

dDPMConvFact is described in Section B.7.3.6.

dK\_Alpha is described in Section B.7.4.11.

dK\_Beta is described in Section B.7.4.12.

dSmpILT is described in Section B.7.4.28.

dNucMDACR is described in Section B.7.3.33.

**B.7.3.17 Nuclide Background Count Rate (dNucBkgCntRt)**

This value is a floating-point number calculated as follows:

$$\text{dNucBkgCntRt} = \text{dNucRprtBkgCnts} / \text{dSmpLT}$$

where:

dNucRprtBkgCnts is described in Section B.7.3.43.

dSmpILT is described in Section B.7.4.28.

**B.7.3.18 Nuclide Background Counts Absolute Uncertainty (dNucBkgCntsAbsUnc)**

This value is a floating-point number calculated as follows (this does not include contaminant uncertainty).

```
If(dNucBkgCntsBkgSpc = 0)then
    dNucBkgCntsAbsUnc = (dSmpILT / dBkgLT)
Else
    dNucBkgCntsAbsUnc = (dNucBkgCntsBkgSpc)^0.5 * dSmpILT / dBkgLT
End If
```

where:

dNucBkgCntsBkgSpc is described in Section B.7.3.19.

dSmpILT is described in Section B.7.4.28.

dBkgLT is described in Section B.7.4.5.

**B.7.3.19 Nuclide Background Counts from Background Spectra (dNucBkgCntsBkgSpc)**

This value is a floating-point number calculated as follows:

$$\text{dNucBkgCntsBkgSpc} = \text{dNucRprtBkgCnts} / \text{dSmpILT} * \text{dBkgLT}$$

where:

dNucRprtBkgCnts is described in Section B.7.3.43.

dSmpILT is described in Section B.7.4.28.

dBkgLT is described in Section B.7.4.5.

**B.7.3.20 Nuclide Contaminant Variance (dNucContVar)**

This value is a floating-point number calculated as follows:

$$dNucContVar = dNucTrcrContCalcCntsAbsUnc * dNucTrcrContCalcCntsAbsUnc$$

where:

$dNucTrcrContCalcCntsAbsUnc$  is described in Section B.7.3.49.

### B.7.3.21 Nuclide Counts for MDA Count Rate (dBCnts)

This value is a floating-point number calculated as follows:

```
If(bBlankMDASourceType)then
    dBCnts = dNucBlnkCnts
Else
    dBCnts = dNucBkgCnts
End If
```

where:

$bBlankMDASourceType$  is described in Section B.7.4.42.

$dNucBlnkCnts$  is described in Section B.7.4.15.

$dNucBkgCnts$  is described in Section B.7.4.14.

### B.7.3.22 Nuclide Critical Level (dNucCritLvl)

This value is a floating-point number calculated as follows:

```
If(dNucBR<>0)then
    dNucCritLvl = dNucDecCorr * dNucLCInCps / dNonTrcrTotEff / dNucBR
Else
    dNucCritLvl = 0.0
End If
```

where:

$dNucBR$  is described in Section B.7.4.16.

$dNucDecCorr$  is described in Section B.7.3.27.

$dNucLCInCPS$  is described in Section B.7.3.31.

$dNonTrcrTotEff$  is described in Section B.7.3.11.

### B.7.3.23 Nuclide Currie Detection Limit (dNucCurDetLim)

This value is a floating-point number calculated as follows:

$$dNucCurDetLim = (dNucLCInCPS + dK\_Beta * dK\_Beta / 2 / dSmpILT * (1 + (1 + 4 * dNucLCInCPS * dSmpILT / dK\_Beta / dK\_Beta + 4 * dNucLCInCPS * dNucLCInCPS * dSmpILT * dSmpILT / dK\_Alpha / dK\_Alpha / dK\_Beta / dK\_Beta)^{0.5})) * 60 / dDPMConvFact$$

where:

$dDPMConvFact$  is described in Section B.7.3.6.

$dK\_Alpha$  is described in Section B.7.4.11.

$dK\_Beta$  is described in Section B.7.4.12.

$dSmpILT$  is described in Section B.7.4.28.

$dNucLCInCPS$  is described in Section B.7.3.31.

**B.7.3.24 Nuclide Decay Corrected Activity (dNucActDecCorr)**

This value is a floating-point number calculated as follows:

```

If(bNegAct = true)then
  If(bRptActConc = true)then
    dNucActDecCorr = dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff /
    dNucBR / dSmplSz
  Else
    dNucActDecCorr = dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff /
    dNucBR)
  End If
Else
  If(bRptActConc = true)then
    If(dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff / dNucBR / dSmplSz>0)then
      dNucActDecCorr = dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff /
      dNucBR / dSmplSz
    Else
      dNucActDecCorr = 0.0
    End If
  Else
    If(dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff / dNucBR>0)then
      dNucActDecCorr = dNucDecCorr * dNucNetCntRt / dNonTrcrTotEff / dNucBR
    Else
      dNucActDecCorr = 0.0
    End If
  End If
End If

```

where:

bRptActConc is described in Section B.7.4.27.  
 bNegAct is described in Section B.7.4.4.  
 dSmplSz is described in Section B.7.4.29.  
 dNucBR is described in Section B.7.4.16.  
 dNucDecCorr is described in Section B.7.3.27.  
 dNucNetCntRt is described in Section B.7.3.34.  
 dNonTrcrTotEff is described in Section B.7.3.11.

**B.7.3.25 Nuclide Decay Corrected Activity Absolute Uncertainty (dNucActDecCorrAbsUnc)**

This is the uncertainty associated with the dNucActDecCorr calculation (in terms of Bq, or Bq per sample size units if activity concentration is reported). This is a floating-point number determined during analysis and is calculated as follows:

$$dNucActDecCorrAbsUnc = ((dNucNetCntRt * dCntRtToActConvFctrAbsUnc)^2 + (dCntRtToActConvFctr * dNucNetCntRtAbsUnc)^2)^{0.5}$$

where:

dNucNetCntRt is described in Section B.7.3.34.  
 dNucNetCntRtAbsUnc is described in Section B.7.3.35.  
 dCntRtToActConvFctr is defined in Section B.7.3.2.  
 dCntRtToActConvFctrAbsUnc is described in Section B.7.3.3.

Even if the sample activity is zero, above absolute activity uncertainty should not be zero in general.

### B.7.3.26 Nuclide Decay Corrected Activity Relative Uncertainty (dNucActDecCorrRelUnc)

This is the relative uncertainty associated with the dNucActDecCorr calculation. This is a floating-point number determined during analysis and is calculated as follows:

```
If (dNucActDecCorr > 0) Then
    dNucActDecCorrRelUnc = dNucActDecCorrAbsUnc / dNucActDecCorr
Else
    dNucActDecCorrRelUnc = 0
End If
```

where:

dNucActDecCorr is described in Section B.7.3.24.

dNucActDecCorrAbsUnc is described in Section B.7.3.25.

### B.7.3.27 Nuclide Decay Correction Factor (dNucDecCorr)

This value is a floating-point number calculated as follows:

```
If(Nuclide = Tracer)then
  If(bRelAnal = TRUE)then
    If(bDoDecCorr = TRUE)then
      dNucDecCorr = EXP(LN(2) * (dTrcrDecTm / dTrcrHalfLife))
    Else
      dNucDecCorr = 1.0
    End If
  Else
    dNucDecCorr = 1.0
  End If
Else
  If(bDoDecCorr = true)then
    dNucDecCorr = EXP((LN(2) * dNucDecTm / dNucHalfLife))
  Else
    dNucDecCorr = 1.0
  End If
End If
```

where:

bRelAnal is described in Section B.7.4.24.

bDoDecCorr is described in Section B.7.4.10.

dTrcrHalfLife is described in Section B.7.4.36.

dNucHalfLife is described in Section B.7.4.20.

dTrcrDecTm is described in Section B.7.3.67.

dNucDecTm is described in Section B.7.3.28.

### B.7.3.28 Nuclide Decay Time (dNucDecTm)

This value is a floating-point number calculated as follows:

$$dNucDecTm = (tAcqDt - tNuclideDecayDt)/365.25$$

where:

The difference between tAcqDt and tNuclideDecayDt is evaluated in terms of days.  
tAcqDt is described in Section B.7.4.1.  
tNuclideDecayDt is described in Section B.7.4.18.

### B.7.3.29 Nuclide Gross Count Rate (dNucGrCntRt)

This value is a floating-point number calculated as follows:

$$dNucGrCntRt = dNucGrCnts / dSmplLt$$

where:

dNucGrCnts is described in Section B.7.4.19.  
dSmplLT is described in Section B.7.4.28.

### B.7.3.30 Nuclide Gross Counts Absolute Uncertainty (dNucGrCntsAbsUnc)

This value is a floating-point number calculated as follows:

```
If(dNucGrCnts = 0)then
    dNucGrCntsAbsUnc = 1.0
Else
    dNucGrCntsAbsUnc = (dNucGrCnts)^0.5
End If
```

where:

dNucGrCnts is described in Section B.7.4.19.

### B.7.3.31 Nuclide Lower Count Limit in Terms of CPS (dNucLCInCPS)

This value is a floating-point number calculated as follows:

$$dNucLCInCPS = dK\_Alpha * dNucMDACR$$

where:

dK\_Alpha is described in Section B.7.4.11.  
dNucMDACR is described in Section B.7.3.33.

### B.7.3.32 Nuclide MDA (dNucMDA)

This value is a floating-point number calculated as follows:

```
If(dNucBR<>0)then
    dNucMDA = dNucDecCorr * dNucSelDetLim / dNonTrcrTotEff / dNucBR
Else
    dNucMDA = 0.0
End If
```

where:

dNucBR is described in Section B.7.4.16.  
dNucDecCorr is described in Section B.7.3.27.  
dNucSelDetLim is described in Section B.7.3.44.  
dNonTrcrTotEff is described in Section B.7.3.11.

**B.7.3.33 Nuclide MDA Count Rate (dNucMDACR)**

This value is a floating-point number calculated as follows:

$$dNucMDACR = (dBCnts * (1 + dSmpILT / dBLT) + dNucContVar)^{0.5} / dSmpILT$$

where:

dBCnts is defined in Section B.7.3.21.

dBLT is described in Section B.7.3.9.

dNucContVar is defined in Section B.7.3.20.

dSmpILT is described in Section B.7.4.28.

**B.7.3.34 Nuclide Net Count Rate (dNucNetCntRt)**

This value is a floating-point number calculated as follows:

```

If(Nuclide = Tracer)then
  If(bSubCont = true)then
    dNucNetCntRt = dNucNetCnts / dSmpILT
  Else
    dNucNetCntRt = dNucGrCntRt - dNucBkgCntRt
  End If
Else
  dNucNetCntRt = dNucGrCntRt - dNucBkgCntRt
End If

```

where:

bSubCont is described in Section B.7.4.31.

dNucNetCnts is described in Section B.7.3.37.

dSmpILT is described in Section B.7.4.28.

dNucGrCntRt is described in Section B.7.3.29.

dNucBkgCntRt is described in Section B.7.3.17.

**B.7.3.35 Nuclide Net Count Rate Absolute Uncertainty (dNucNetCntRtAbsUnc)**

This value is a floating-point number calculated as follows:

$$dNucNetCntRtAbsUnc = dNucNetCntsAbsUnc / dSmpILT$$

where:

dNucNetCntsAbsUnc is described in Section B.7.3.38.

dSmpILT is described in Section B.7.4.28.

**B.7.3.36 Nuclide Net Count Rate Relative Uncertainty (dNucNetCntRtRelUnc)**

This value is a floating-point number calculated as follows:

```

If(dNucNetCntRt <> 0)then
  dNucNetCntRtRelUnc = dNucNetCntRtAbsUnc / dNucNetCntRt
Else
  dNucNetCntRtRelUnc = 0.0
End If

```

where:

dNucNetCntRt is described in Section B.7.3.34.

dNucNetCntRtAbsUnc is described in Section B.7.3.35.

### B.7.3.37 Nuclide Net Counts (dNucNetCnts)

This value is a floating-point number calculated as follows:

$$dNucNetCnts = dNucGrCnts - dNucRprtBkgCnts$$

where:

dNucGrCnts is described in Section B.7.4.19.

dNucRprtBkgCnts is described in Section B.7.3.43.

### B.7.3.38 Nuclide Net Counts Absolute Uncertainty (dNucNetCntsAbsUnc)

This value is a floating-point number calculated as follows:

$$dNucNetCntsAbsUnc = (dNucBkgCntsAbsUnc^2 + dNucGrCntsAbsUnc^2)$$

where:

dNucBkgCntsAbsUnc is described in Section B.7.3.18.

dNucGrCntsAbsUnc is described in Section B.7.3.30.

### B.7.3.39 Nuclide Random Relative Uncertainty (dNucRndRelUnc)

This value is a floating-point number calculated as follows:

```

If(bErrInPerc = true)then
    dNucRndRelUnc = dRndErr
Else
    If(dRptNucAct<>0)then
        dNucRndRelUnc = |dRndErr / dRptNucAct|
    Else
        dNucRndRelUnc = dRndErr
End If
End If

```

where:

dRptNucAct is described in Section B.7.2.1.

bErrInPerc is described in Section B.7.4.7.

dRndErr is described in Section B.7.3.54.

### B.7.3.40 Nuclide Ratio (dNucRatio)

This value is a floating-point number calculated as follows:

```

If(bUseSmplAliquot = False and bUseSmpIDilution = False) then
    dNucRatio = 1.0
Else If(bUseSmplAliquot = true and bUseSmpIDilution = False) then
    dNucRatio = dSmplSz / dAliquot
Else If (bUseSmplAliquot = False and bUseSmpIDilution = True) then
    If (dSmpIDilution2 > 0 And dSmpAliquot2 > 0) then
        dNucRatio = (dSmpIDilution1/dSmpAliquot1) * (dSmpIDilution2/dSmpAliquot2)
    Else

```

```

    dNucRatio = (dSmpIDilution1/dSmplAliquot1)
End If
End If

```

where:

dSmpISz is described in Section B.7.4.29.  
dAliquot is described in Section B.7.4.2.  
dSmpIDilution1 is described in Section B.7.4.45.  
dSmplAliquot1 is described in Section B.7.4.46.  
dSmpIDilution2 is described in Section B.7.4.47.  
dSmplAliquot2 is described in Section B.7.4.48.  
bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmpIDilution is defined in Section B.7.4.44.

#### B.7.3.41 Nuclide Ratio Relative Uncertainty (dNucRatioRelUnc)

Nuclide Ratio Relative Uncertainty is a floating-point number and is calculated as follows:

```

If(bUseSmplAliquot = False And bUseSmpIDilution = False)then
    dNucRatioRelUnc = 0
Else If(bUseSmplAliquot = true And bUseSmpIDilution = False)then
    dNucRatioRelUnc = (dSmpISzRelUnc^2 + dAliquotRelUnc^2)^0.5
Else If (bUseSmplAliquot = False And bUseSmpIDilution = True)then
    dNucRatioRelUnc = (dDilution1RelUnc^2 + dAliquot1RelUnc^2 +
    dDilution2RelUnc^2 + dAliquot2RelUnc^2)^0.5
End If

```

where:

dSmpISzRelUnc is described in Section B.7.4.30.  
dAliquotRelUnc is described in Section B.7.4.3.  
dDilution1RelUnc is defined in Section B.7.4.49.  
dAliquot1RelUnc is defined in Section B.7.4.50.  
dDilution2RelUnc is defined in Section B.7.4.51.  
dAliquot2RelUnc is defined in Section B.7.4.52.  
bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmpIDilution is defined in Section B.7.4.44.

#### B.7.3.42 Nuclide Relative Uncertainty TPU Percent (dNucRelUncTPUPerc)

This value is a floating-point number calculated as follows:

$$dNucRelUncTPUPerc = (dNucActRelUnc^2 + dNucRndRelUnc^2 + dNucSysRelUnc^2)^{0.5} * 100 * dSigma$$

where:

dSigma is described in Section B.7.4.40.  
dNucActRelUnc is described in Section B.7.3.14.  
dNucSysRelUnc described in Section B.7.3.45.

#### B.7.3.43 Nuclide Reported Background Counts (dNucRprtBkgCnts)

This value is a floating-point number calculated as follows:

```

If(bSubCont = true)then
    If(Nuclide = Tracer)then

```

```

        dNucRprtBkgCnts = dNucBkgCnts + dTrcrContCnts
    Else
        dNucRprtBkgCnts = dNucBkgCnts + dNucTrcrContCalcCnts
    End If
    Else
        dNucRprtBkgCnts = dNucBkgCnts
    End If

```

where:

bSubCont is described in Section B.7.4.31.  
dNucBkgCnts is described in Section B.7.4.14.  
dTrcrContCnts is described in Section B.7.4.35.  
dNucTrcrContCalcCnts is described in Section B.7.3.48.

#### **B.7.3.44 Nuclide Selected Detection Limit (dNucSelDetLim)**

This value is a floating-point number calculated as follows:

```

    If(bANSIMDA = true)then
        dNucSelDetLim = dNucANSIDetLim
    Else
        dNucSelDetLim = dNucCurDetLim
    End If

```

where:

bANSIMDA is described in Section B.7.4.41.  
dNucANSIDetLim is described in Section B.7.3.16.  
dNucCurDetLim is described in Section B.7.3.23.

#### **B.7.3.45 Nuclide Systematic Relative Uncertainty (dNucSysRelUnc)**

This value is a floating-point number calculated as follows:

```

    If(bErrInPerc = true)then
        dNucSysRelUnc = dSysErr
    Else
        If(dRptNucAct<>0)then
            dNucSysRelUnc = |dSysErr / dRptNucAct|
        Else
            dNucSysRelUnc = dSysErr
        End If
    End If

```

where:

dRptNucAct is described in Section B.7.2.1.  
bErrInPerc is described in Section B.7.4.7.  
dSysErr is described in Section B.7.3.57.

#### **B.7.3.46 Nuclide TPU (dNucTPU)**

This value is a floating-point number calculated as follows:

```

    If(bNucTPUPerc = true)then
        dNucTPU = dNucRelUncTPUPerc * dRptNucAct / 100
    Else

```

```

    If(bRptActConc = true)then
      If(bErrInPerc = true)then
        dNucTPU = dNucAdnlNoEffTPU / dSmplSz
      Else
        dNucTPU = dNucAbsUncTPU / dSmplSz)
    End If
  Else
    If(bErrInPerc = TRUE)then
      dNucTPU = dNucAdnlNoEffTPU
    Else
      dNucTPU = dNucAbsUncTPU
    End If
  End If
End If

```

where:

dRptNucAct is described in Section B.7.2.1.  
 bErrInPerc is described in Section B.7.4.7.  
 bRptActConc is described in Section B.7.4.27.  
 dSmplSz is described in Section B.7.4.29.  
 dNucRelUncTPUPerc is described in Section B.7.3.42.  
 dNucAbsUncTPU is described in Section B.7.3.12.  
 dNucAdnlNoEffTPU is described in Section B.7.3.15.  
 bNucTPUPerc is described in Section B.7.3.47.

#### **B.7.3.47 Nuclide TPU Percent (bNucTPUPerc)**

This value is a Boolean flag determined as follows:

```

If(Nuclide = Tracer)then
  If(dTrcrCalcActDecCorrToAssDt<>0)then
    bNucTPUPerc = TRUE
  Else
    bNucTPUPerc = FALSE
  End If
Else
  If(dNucActDecCorr<>0)then
    bNucTPUPerc = TRUE
  Else
    bNucTPUPerc = FALSE
  End If
End If

```

where:

dTrcrCalcActDecCorrToAssDt described in Section B.7.3.58.  
 dNucActDecCorr is described in Section B.7.3.24.

#### **B.7.3.48 Nuclide Tracer Contaminant Calculated Counts (dNucTrcrContCalcCnts)**

This value is a floating-point number calculated as follows:

```

If(bSubCont = true)then
    dNucTrcrContCalcCnts = dNucNetCnts *
    dNucTrcrContConcFracAtMeasTmPercOfTrcr
Else
    dNucTrcrContCalcCnts = 0.0
End If

```

where:

bSubCont is described in Section B.7.4.31.

dNucNetCnts is described in Section B.7.3.37 for the Tracer nuclide.

dNucTrcrContConcFracAtMeasTmPercOfTrcr is described in Section B.7.3.51.

### **B.7.3.49 Nuclide Tracer Contaminant Calculated Counts Absolute Uncertainty (dNucTrcrContCalcCntsAbsUnc)**

This value is a floating-point number calculated as follows:

$$dNucTrcrContCalcCntsAbsUnc = dNucTrcrContCalcCnts * dNucTrcrContCalcCntsRelUnc$$

where:

dNucTrcrContCalcCnts is described in Section B.7.3.48.

dNucTrcrContCalcCntsRelUnc is described in Section B.7.3.50.

### **B.7.3.50 Nuclide Tracer Contaminant Calculated Counts Relative Uncertainty (dNucTrcrContCalcCntsRelUnc)**

This value is a floating-point number calculated as follows:

$$dNucTrcrContCalcCntsRelUnc = (dNucTrcrContConcAtAssDtPercOfTrcrRelUnc^2 + dNucNetCntRtRelUnc^2)^{0.5}$$

where:

dNucTrcrContConcAtAssDtPercOfTrcrRelUnc is described in Section B.7.4.23.

dNucNetCntRtRelUnc is described in Section B.7.3.36.

### **B.7.3.51 Nuclide Tracer Contaminant Concentration Fraction at Measurement Time (dNucTrcrContConcFracAtMeasTmPercOfTrcr)**

This value is a floating-point number calculated as follows:

$$dNucTrcrContConcFracAtMeasTmPercOfTrcr = dNucTrcrContConcAtAssDtPercOfTrcr * dNucTrcrContToTrcrDecCorrRatio$$

where:

dNucTrcrContConcAtAssDtPercOfTrcr is described in Section B.7.4.22.

dNucTrcrContToTrcrDecCorrRatio is described in Section B.7.3.53.

### **B.7.3.52 Nuclide Tracer Contaminant Decay Correction Factor (dNucTrcrContDecCorr)**

This value is a floating-point number calculated as follows:

$$dNucTrcrContDecCorr = \text{EXP}(- (\text{LN}(2) * dTrcrDecTm) / dNucHalfLife)$$

where:

dNucHalfLife is described in Section B.7.4.20.  
dTrcrDecTm is described in Section B.7.3.67.

### **B.7.3.53 Nuclide Tracer Contaminant to Tracer Decay Correction Ratio (dNucTrcrContToTrcrDecCorrRatio)**

This value is a floating-point number calculated as follows:

```
If(bDoDecCorr = true)then
  dNucTrcrContToTrcrDecCorrRatio = dNucDecCorr / dNucTrcrContDecCorr
Else
  dNucTrcrContToTrcrDecCorrRatio = 1.0
End If
```

where:

bDoDecCorr is described in Section B.7.4.10.  
dNucDecCorr is described in Section B.7.3.27.  
dNucTrcrContDecCorr is described in Section B.7.3.52.

### **B.7.3.54 Random Error (dRndErr)**

This value is a floating-point number calculated as follows:

```
If(bErrInPerc = TRUE)then
  dRndErr = dRawRndErr / 100
Else
  dRndErr = dRawRndErr
End If
```

where:

bErrInPerc is described in Section B.7.4.7.  
dRawRndErr is described in Section B.7.4.25.

### **B.7.3.55 Reported Nuclide Activity Absolute Uncertainty (dRptNucActAbsUnc)**

This value is a floating-point number calculated as follows:

$$dRptNucActAbsUnc = dRptNucAct * dRptNucActRelUnc$$

where:

dRptNucAct is described in Section B.7.2.1.  
dRptNucActRelUnc is described in Section B.7.3.56.

### **B.7.3.56 Reported Nuclide Activity Relative Uncertainty (dRptNucActRelUnc)**

This value is a floating-point number calculated as follows:

```
If(Tracer)Then
  If(bUseSmplAliquot = True Or bUseSmplDilution = True)then
    dRptNucActRelUnc = (dTrcrNucCalcActDecCorrRelUncUsrUnitsConc^2 +
      dNucRatioRelUnc^2)^0.5
  Else
    dRptNucActRelUnc = dTrcrNucCalcActDecCorrRelUncUsrUnitsConc
  End If
```

```

Else
  If(bUseSmplAliquot = True Or bUseSmplDilution = True)then
    dRptNucActRelUnc = (dNucActDecCorrRelUnc^2 + dNucRatioRelUnc^2)^0.5
  Else
    dRptNucActRelUnc = dNucActDecCorrRelUnc
  End If
End If

```

where:

dTrcrNucCalcActDecCorrRelUncUsrUnitsConc is described in Section B.7.3.62.  
dNucRatioRelUnc is described in Section B.7.3.41.  
dNucActDecCorrRelUnc is described in Section B.7.3.26.  
bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmplDilution is defined in Section B.7.4.44.

### B.7.3.57 Systematic Error (dSysErr)

This value is a floating-point number calculated as follows:

```

If(bErrInPerc = TRUE)then
  dSysErr = dRawSysErr / 100
Else
  dSysErr = dRawSysErr
End If

```

where:

bErrInPerc is described in Section B.7.4.7.  
dRawSysErr is described in Section B.7.4.26.

### B.7.3.58 Tracer Calculated Activity Decay Corrected to Assay Date (dTrcrCalcActDecCorrToAssDt)

This value is a floating-point number calculated (in fixed unit of Bq) as follows:

```

If(bRelAnal = TRUE)then
  dTrcrCalcActDecCorrToAssDt = dNucDecCorr * dNucNetCntRt / dTrcrTotEff / dNucBR)
Else
  dTrcrCalcActDecCorrToAssDt = 0.0
End If

```

where:

bRelAnal is described in Section B.7.4.24.  
dNucBR is described in Section B.7.4.16.  
dNucDecCorr is described in Section B.7.3.27.  
dNucNetCntRt is described in Section B.7.3.34.  
dTrcrTotEff is described in Section B.7.3.73.

The activity units are Bq.

### B.7.3.59 Tracer Calculated Activity Decay Corrected to Assay Date Absolute Uncertainty in Terms of User Selected Units (dTrcrCalcActDecCorrToAssDtAbsUncUsrUnits)

This value is a floating-point number calculated as follows:

$$\text{dTrcrCalcActDecCorrToAssDtAbsUncUsrUnits} = \text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnits} * \text{dTrcrCalcActDecCorrToAssDtUsrUnits}$$

where:

dTrcrCalcActDecCorrToAssDtRelUncUsrUnits is described in Section B.7.3.60.

dTrcrCalcActDecCorrToAssDtUsrUnits is described in Section B.7.3.65.

### **B.7.3.60 Tracer Calculated Activity Decay Corrected to Assay Date Relative Uncertainty in Terms of User Selected Units (dTrcrCalcActDecCorrToAssDtRelUncUsrUnits)**

This value is a floating-point number calculated as follows:

$$\text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnits} = \text{dTrcrCalcActDecCorrToAssDtRelUnc}$$

where:

dTrcrCalcActDecCorrToAssDtRelUnc is described in Section B.7.3.66.

When the activity is converted to the user units, there is no extra uncertainty added since the conversion factors are all well known.

### **B.7.3.61 Tracer Calculated Activity Decay Corrected to Assay Date Absolute Uncertainty in Terms of User Selected Units Concentration (dTrcrCalcActDecCorrToAssDtAbsUncUsrUnitsConc)**

This value is a floating-point number calculated as follows:

$$\begin{aligned} \text{dTrcrCalcActDecCorrToAssDtAbsUncUsrUnitsConc} = \\ \text{dTrcrCalcActDecCorrToAssDtUsrUnitsConc} * \\ \text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnitConc} \end{aligned}$$

End If

where:

dTrcrCalcActDecCorrToAssDtRelUncUsrUnitConc is described in Section B.7.3.62.

dTrcrCalcActDecCorrToAssDtUsrUnitsConc is described in Section B.7.3.64.

### **B.7.3.62 Tracer Calculated Activity Decay Corrected to Assay Date Relative Uncertainty in Terms of User Selected Units Concentration (dTrcrCalcActDecCorrToAssDtRelUncUsrUnitsConc)**

This value is a floating-point number calculated as follows:

If(bRptActConc = TRUE)then

$$\text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnitsConc} = ( \text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnits}^2 + \text{dSmplSzRelUnc}^2 )^{0.5}$$

Else

$$\text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnitsConc} = \text{dTrcrCalcActDecCorrToAssDtRelUncUsrUnits}$$

End If

where:

bRptActConc is described in Section B.7.4.27.

dTrcrCalcActDecCorrToAssDtRelUncUsrUnits is described in Section B.7.3.60.

dSmplSzRelUnc is described in Section B.7.4.30.

### **B.7.3.63 Tracer Calculated Activity Decay Corrected to Assay Date Absolute Uncertainty (dTrcrCalcActDecCorrToAssDtAbsUnc)**

This is the uncertainty associated with the dTrcrCalcActDecCorrToAssDt calculation, in fixed activity units of Bq. It is a floating-point number determined during analysis and is calculated as follows:

```
If(Nuclide = Tracer)then
  dTrcrCalcActDecCorrToAssDtAbsUnc = dTrcrNucCalcActDecCorrRelUnc *
  dTrcrCalcActDecCorrToAssDt
Else
  dTrcrCalcActDecCorrToAssDtAbsUnc = 0
End If
```

where:

dTrcrCalcActDecCorrToAssDt described in Section B.7.3.58.

dTrcrNucCalcActDecCorrRelUnc is described in Section B.7.3.68.

For tracer nuclides, the nuclide activity is assumed to be always positive.

### **B.7.3.64 Tracer Calculated Activity Decay Corrected to Assay Date User Units Concentration (dTrcrCalcActDecCorrToAssDtUsrUnitsConc)**

Tracer Calculated Activity Decay Corrected to Assay Date (Activity Concentration) is a floating-point number determined during analysis and is stored in the AnalysisDetails table of the AlphaVision database.

```
If(bRptActConc = True)then
  dTrcrCalcActDecCorrToAssDtUsrUnitsConc = dTrcrCalcActDecCorrToAssDtUsrUnits /
  dSmplSz
Else
  dTrcrCalcActDecCorrToAssDtUsrUnitsConc = dTrcrCalcActDecCorrToAssDtUsrUnits
End if
```

where:

bRptActConc is described in Section B.7.4.27.

dSmplSz is described in Section B.7.4.29.

dTrcrCalcActDecCorrToAssDtUsrUnits is described in Section B.7.3.65.

### **B.7.3.65 Tracer Calculated Activity Decay Corrected to Assay Date in Terms of User Selected Units (dTrcrCalcActDecCorrToAssDtUsrUnits)**

This value is a floating-point number calculated as follows:

$$dTrcrCalcActDecCorrToAssDtUsrUnits = dTrcrCalcActDecCorrToAssDt / dBqConvFact$$

where:

dBqConvFact is described in Section B.7.3.1.

dTrcrCalcActDecCorrToAssDt described in Section B.7.3.58.

### **B.7.3.66 Tracer Calculated Total Activity Decay Corrected to Assay Date Relative Uncertainty (dTrcrCalcTotActDecCorrToAssDtRelUnc)**

Tracer Calculated Total Activity Decay Corrected to Assay Date Relative Uncertainty is a floating-point number and is calculated as follows:

```

If(Nuclide = Tracer)then
  dTrcrCalcTotActDecCorrToAssDtRelUnc = dTrcrNucCalcActDecCorrRelUnc
Else
  dTrcrCalcTotActDecCorrToAssDtRelUnc = 0
End If

```

where:

dTrcrNucCalcActDecCorrRelUnc is described in Section B.7.3.68.

When a sample aliquot is involved, this term could be changed to include the additional aliquot uncertainty so that when the uncertainty for the chemical recovery is calculated, only this term and the expected tracer activity uncertainty are needed. See Section B.7.3.70.

### B.7.3.67 Tracer Decay Time (dTrcrDectm)

This value is a floating-point number calculated as follows:

$$dTrcrDecTm = (tAcqDt - tTracerAssDt) / 365.25$$

where:

The difference between tAcqDt and tTracerAssDt is evaluated in terms of days.

tAcqDt is described in Section B.7.4.1.

tTracerAssDt is described in Section B.7.4.34.

### B.7.3.68 Tracer Nuclide Decay Corrected Calculated Activity Relative Uncertainty (dTrcrNucCalcActDecCorrRelUnc)

This is the uncertainty associated with the calculated tracer activity on the whole sample. It is a floating-point number determined during analysis and is calculated as follows:

```

If(Nuclide = Tracer)then
  dTrcrNucCalcActDecCorrRelUnc = (dNucNetCntRtRelUnc^2 + dDetEffRelUnc^2 +
  dDecayCorrRelUnc^2 + dMnlCRRelUnc^2) ^0.5
Else
  dTrcrNucCalcActDecCorrRelUnc = 0
End If

```

where:

dNucNetCntRtRelUnc is described in Section B.7.4.23.

dDetEffRelUnc is described in Section B.7.3.5.

dDecayCorrRelUnc is described in Section B.7.3.4.

dSmpISzRelUnc is described in Section B.7.4.30.

dMnlCRRelUnc is described in Section B.7.4.13.

### B.7.3.69 Tracer Recovery (dTrcrRcvr)

This value is a floating-point number calculated as follows:

```

If(bRelAnal = TRUE)then
  If(dExpTrcrActAtAssDt<>0)then
    If(bUseSmplAliquot=False And bUseSmplDilution=False) then
      dTrcrRcvr = 60 * dTrcrCalcActDecCorrToAssDt / dExpTrcrActAtAssDt
    Else

```

```

                dTrcrRcvr = 60 * dTrcrCalcActDecCorrToAssDt * dNucRatio /
                dExpTrcrActAtAssDt
    End If
    Else
                dTrcrRcvr = 1.0
    End If
    Else
                dTrcrRcvr = 1.0
    End If

```

where:

bRelAnal is described in Section B.7.4.24.  
dExpTrcrActAtAssDt is described in Section B.7.3.7.  
bTrcrAddToAliquot is described in Section B.7.4.33.  
dNucRatio is defined in Section B.7.3.24.  
bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmplDilution is defined in Section B.7.4.44.

### B.7.3.70 Tracer Recovery Relative Uncertainty (dTrcrRcvrRelUnc)

Tracer Recovery (or Chemical Recovery) Relative Uncertainty is the uncertainty associated with the tracer chemical recovery calculation. It is a floating-point number and is calculated as follows:

```

If(bRelAnal = true AND Nuclide = Tracer)then
    If(bUseSmplAliquot=False And bUseSmplDilution=False)) then
        dTrcrRcvrRelUnc = (dTrcrCalcTotActDecCorrToAssDtRelUnc^2 +
        dExpTrcrActAtAssDtRelUnc^2)^0.5
    Else
        dTrcrRcvrRelUnc = (dTrcrCalcTotActDecCorrToAssDtRelUnc^2 +
        dExpTrcrActAtAssDtRelUnc^2 + dNucRatioRelUnc^2)^0.5
    End If
    Else
        dTrcrRcvrRelUnc = 0
    End If

```

where:

bRelAnal is described in Section B.7.4.24.  
dTrcrCalcTotActDecCorrToAssDtRelUnc is described in Section B.7.3.66.  
dExpTrcrActAtAssDtRelUnc is described in Section B.7.3.8.  
dNucRatioRelUnc is described in Section B.7.3.41.  
bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmplDilution is defined in Section B.7.4.44.

### B.7.3.71 Tracer Size Defined per Sample (bTrcrSzPerSmpl)

Tracer Size Defined per Sample is a flag set when a sample is created. It is stored in the Sample table of the AlphaVision dataset. If this flag is set, then the tracer size and its associated uncertainty are defined for each sample. Otherwise, the tracer size and its associated uncertainty are defined for the whole batch on the analysis setup page.

```

If(bTrcrSzPerSmpl = True)then
    dTrcrSz = tracer size defined in the Sample table

```

```

dTrcrSzRelUnc = tracer size relative uncertainty (%) in the Sample table
Else
dTrcrSz = tracer size defined in the AnalysisSpec table
dTrcrSzRelUnc = tracer size relative uncertainty (%) in the Sample table
End If

```

where:

dTrcrSz is described in Section B.7.4.32.  
dTrcrSzRelUnc is described in Section B.7.3.72.

### B.7.3.72 Tracer Size Relative Uncertainty (dTrcrSzRelUnc)

Tracer Volume (or mass) Relative Uncertainty is the uncertainty associated with the tracer size, in volume or mass units. It is a floating-point number set during Tracer configuration and stored in the either the Sample or AnalysisSpec table (depending on if Tracer size is defined per sample) where the tracer size is stored in the AlphaVision database.

```

If(bTrcrSzPerSmpl = True)then
dTrcrSzRelUnc = Tracer Size Relative Uncertainty in the sample table / 100
Else
dTrcrSzRelUnc = Tracer Size Relative Uncertainty in the AnalysisSpec table / 100
End if

```

### B.7.3.73 Tracer Total Efficiency (dTrcrTotEff)

This value is a floating-point number calculated as follows:

$$dTrcrTotEff = dDetEff * dTrcrMnlCR$$

where:

dTrcrMnlCR is described in Section B.7.4.37.  
dDetEff is described in Section B.7.4.8.

## B.7.4 Constants, Flags, Parameters, Acquired Data, and Other Basic Inputs

### B.7.4.1 Acquisition Date (tAcqDt)

This is a Time and Date string set during data acquisition and is stored in the Spectra table of the AlphaVision database.

### B.7.4.2 Aliquot (dAliquot)

This is a floating-point number set during analysis configuration (via the 'Aliquot 1' text box on the 'Sample' tab of the Sample Properties Wizard) and is stored in the Sample table of the AlphaVision database.

```

If(bUseSmplAliquot = True And bUseSmplDilution = False)then
dAliquot = dAliquot1
Else
dAliquot1 = 0
End if

```

where:

bUseSmplAliquot is defined in Section B.7.4.43.  
bUseSmplDilution is defined in Section B.7.4.44.  
dAliquot1 is defined in Section B.7.4.46.

### B.7.4.3 Aliquot Size Relative Uncertainty (dAliquotRelUnc)

This is the uncertainty associated with the amount of aliquot defined on the Sample setup page. It is a floating-point number and is set or calculated from sample setup parameters.

```
If(bUseSmpAliquot = True And bUseSmpDilution = False)then
  dAliquotRelUnc = dAliquot1RelUnc
Else
  dAliquotRelUnc = 0
End if
```

where:

bUseSmpAliquot is defined in Section B.7.4.43.

bUseSmpDilution is defined in Section B.7.4.44.

dAliquot1RelUnc is defined in Section B.7.4.50.

### B.7.4.4 Allow Negative Activities (bNegAct)

This flag is set during analysis configuration (via the 'Negative Activity' checkbox on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

### B.7.4.5 Background Live Time (dBkgLT)

This a floating-point number (in seconds) set during acquisition configuration and is stored in the HWPParameters table of the AlphaVision database.

### B.7.4.6 Blank Live Time (dBInkLT)

This is a floating-point number set during Blank measurement acquisition configuration and is stored in the HWPParameters table of the AlphaVision database.

### B.7.4.7 Calculate Error in Terms of Percent (bErrInPerc)

This flag is set during analysis configuration (via the 'Unc. In Percentile' radio button on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

### B.7.4.8 Detector Efficiency (dDetEff)

This is a floating-point number in percent set during detector calibration and is stored in the EfficiencyCalibration table of the AlphaVision database. This value is reported as a percent but stored in the database as a fraction.

### B.7.4.9 Detector Efficiency Absolute Uncertainty (dDetEffAbsUnc)

This is the uncertainty associated with the dDetEff calculation. It is a floating-point number determined during detector calibration and is stored in the EfficiencyCalibration table of the AlphaVision database.

### B.7.4.10 Do Decay Corrections (bDoDecCorr)

This flag is set during analysis configuration (via the 'Decay Correction' checkbox on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database. This flag is focused on the sample calculations (versus the tracer).

**B.7.4.11 KAlpha (dK\_Alpha)**

This is a floating-point number set during analysis configuration (via the 'K\_Alpha' text box on the 'MDA / Blank' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.12 KBeta (dK\_Beta)**

This is a floating-point number set during analysis configuration (via the 'K\_Beta' text box on the 'MDA / Blank' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.13 Manual Chemical Recovery Relative Uncertainty (dMnICRRelUnc)**

This is a floating-point number and is set when the sample is created or set on the analysis setup page. It is stored in the Sample table if the flag bMnICRPerSmpl (defined in Section B.7.3.10) is set to true. Otherwise, it is stored in the AnalysisSpec table. The values in the database are in percent. See Section B.7.3.10 for more details. This uncertainty is associated with the manual chemical recovery described in Section B.7.4.37.

```
If(bMnICRPerSmpl = True)then
    dMnICRRelUnc = manual chemical recovery relative uncertainty defined in the Sample
    table
Else
    dMnICRRelUnc = manual chemical recovery relative uncertainty defined in the
    AnalysisSpec table
End if
```

where:

bMnICRPerSmpl is defined in Section B.7.3.10.

**B.7.4.14 Nuclide Background Counts (dNucBkgCnts)**

This is determined during sample data acquisition and stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.15 Nuclide Blank Counts (dNucBlnkCnts)**

This is determined during sample data acquisition and stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.16 Nuclide Branching Ratio (dNucBR)**

This (from Analysis Library) is the nuclide branching ratio and is stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.17 Nuclide Branching Ratio Relative Uncertainty (dNucBRRelUnc)**

This (from Analysis Library) is stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.18 Nuclide Decay Date (tNuclideDecayDt)**

This is a Time and Date string set during batch configuration (via the 'Decay Correction' date / time controls on the 'Sample' tab of the Sample Properties Wizard) and is stored in the Sample table of the AlphaVision database.

**B.7.4.19 Nuclide Gross Counts (dNucGrCnts)**

This is determined during sample data acquisition (and subsequent analysis) and stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.20 Nuclide Half-Life (dNucHalfLife)**

This is stored in the Nuclides table of the AlphaVision database.

**B.7.4.21 Nuclide Half-Life Relative Uncertainty (dNucHalfLifeRelUnc)**

This is the uncertainty associated with the nuclide Half-Life. It is a floating-point number set when a nuclide library is created or edited and is stored in the Nuclide or the Nuclide Library Nuclides table of the AlphaVision database. The default relative uncertainty for the nuclide is 0.1%.

**B.7.4.22 Nuclide Tracer Contaminant Concentration as Assay Date (dNucTrcrContConcAtAssDtPercOfTrcr)**

This value (% of Tracer) is a floating-point number set during analysis configuration and is stored in the AnalysisDetails table of the AlphaVision database.

**B.7.4.23 Nuclide Tracer Contaminant Concentration as Assay Date Relative Uncertainty (dNucTrcrContConcAtAssDtPercOfTrcrRelUnc)**

This value (% of Tracer) Relative Uncertainty is a floating-point number set during tracer configuration (if the nuclide in question is a contaminant) and is stored in the Tracer table of the AlphaVision database.

**B.7.4.24 Perform Relative Analysis (bRelAnal)**

This flag is set during analysis configuration (via the 'Relative Analysis' checkbox on the 'Analysis Setup' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.25 Raw Random Error (dRawRndErr)**

This is a floating-point number set during analysis configuration (via the 'Random Uncertainty' text box on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.26 Raw Systematic Error (dRawSysErr)**

This is a floating-point number set during analysis configuration (via the 'Systematic Uncertainty' text box on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.27 Report Activity Concentration (bRptActConc)**

This flag is set during analysis configuration (via the 'Activity Concentration' radio button on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.28 Sample Live Time (dSmplLT)**

This floating-point number set during acquisition configuration and is stored in the HWPParameters table of the AlphaVision database.

**B.7.4.29 Sample Size (dSmpISz)**

This is a floating-point number set during sample configuration (via the 'Sample' amount text box on the 'Sample' tab of the Sample Properties Wizard) and is stored in the Sample table of the AlphaVision database.

**B.7.4.30 Sample Size Relative Uncertainty (dSmpISzRelUnc)**

This is the uncertainty associated with the sample size. It is a floating-point number set as a percent value when a sample is created and is stored in the Sample table of the AlphaVision database as a percent value. For more details, see Section B.7.3.71.

**B.7.4.31 Subtract Contaminants (bSubCont)**

This flag is set during analysis configuration (via the 'Subtract Contaminants' checkbox on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

**B.7.4.32 Tracer Activity at Assay Date (dTrcrActAtAssDt)**

This value (herein referenced in fixed unit terms of DPM per mL or per gram) is a floating-point number set during Tracer configuration (as the 'Concentration [Act. Units / Vol. Units]' text box on the Tracer Editor wizard) and is stored in the Tracer table of the AlphaVision database.

**B.7.4.33 Tracer Added to Aliquot (bTrcrAddToAliquot)**

This flag is set when a tracer certificate is created and is stored in the Tracer table of the AlphaVision database. When the flag is true, tracer is added to the aliquot. When it is false, tracer is added to the total sample. If there is no aliquoting or no dilution, the tracer is added to the sample (which is the total sample).

**B.7.4.34 Tracer Assay Date (tTracerAssDt)**

This is a Time and Date string set during tracer configuration (as the 'Tracer Certificate Date / Time' controls on the Tracer Editor wizard) and is stored in the Tracer table of the AlphaVision database.

**B.7.4.35 Tracer Contaminant Counts (dTrcrContCnts)**

This is a floating-point number set during analysis configuration and is stored in the AnalysisDetails table of the AlphaVision database (in the 'ContaminantCounts' column). For normal usage, this evaluates to zero.

**B.7.4.36 Tracer Half-Life (dTrcrHalfLife)**

This is a floating-point number stored in the Nuclides table of the AlphaVision database.

**B.7.4.37 Tracer Manual Chemical Recovery (dTrcrMnlCr)**

This value (%) is a floating-point number set during Sample configuration (via the 'Mnl CR' text box field on the 'Sample' tab of the Sample Properties wizard) configuration and is stored in the Sample table of the AlphaVision database. When set to zero in the database, this value is automatically scaled to 1 for the purpose of the calculations herein.

```

If(bMnlCRPerSmpl = True)then
  dTrcrMnlCR = manual chemical recovery defined in the Sample table
Else
  dTrcrMnlCR = manual chemical recovery defined in the AnalysisSpec table

```

End if

where:

bMnICRPerSmpl is defined in Section B.7.3.10.

#### **B.7.4.38 Tracer Reference Concentration Relative Uncertainty (dTcrRefConcRelUnc)**

This is the uncertainty associated with the tracer concentration on the tracer certificate. It is a floating-point number set when a tracer certificate is created and is stored as a percent value in the Tracer table of the AlphaVision database.

#### **B.7.4.39 Tracer Size (dTcrSz)**

This value (volume or mass) is a floating-point number set during Tracer configuration (via the 'Tracer Amount' text box on the 'AnalysisSetup' tab of the Analysis Setup wizard) and is stored in the Tracer table of the AlphaVision database.

```
If (bTrcrSzPerSmpl = True)then
  dTcrSz = tracer size defined in the Sample table
Else
  dTcrSz = tracer size defined in the AnalysisSpec table
End if
```

where:

bTrcrSzPerSmpl is defined in Section B.7.3.71.

#### **B.7.4.40 Uncertainty Sigma (dSigma)**

This is a floating-point number set during analysis configuration (via the 'Predefined TPU Sigma' list box or the 'Enter TPU Sigma' text box on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

#### **B.7.4.41 Use ANSI MDA Method (bANSIMDA)**

This flag is set during analysis configuration (via the 'ANSI Standard' radio button on the 'Analysis Misc.' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database.

#### **B.7.4.42 Use Blank MDA Source (bBlankMDASourceType)**

This value is a boolean value that indicates if the MDA Source is the Background or the Blank spectra. This flag is set during analysis configuration (via the 'MDA Source Type' list box on the 'MDA / Blank' tab of the Analysis Setup wizard) and is stored in the AnalysisSpec table of the AlphaVision database (stored as an index where a value of one indicates Blank source for MDA, zero indicating a Background source for MDA).

#### **B.7.4.43 Use Sample Aliquot (bUseSmplAliquot)**

This flag is set on the sample setup page and is stored in the Sample table of the AlphaVision database. When this flag is true, the use sample dilution flag bUseSmplDilution must be false and vice versa.

#### **B.7.4.44 Use Sample Dilution (bUseSmplDilution)**

This flag is set on the sample setup page and is stored in the Sample table of the AlphaVision database. When this flag is true, the Use Aliquot flag (see bUseSmplAliquot) is false and vice versa.

**B.7.4.45 Sample Dilution1 (dSmpIDilution1)**

Sample Dilution1 (dSmpIDilution1) is a floating-point number and is set on the sample setup page when the Dilution radio button is selected. It is stored in the Sample table of the AlphaVision database.

**B.7.4.46 Sample Aliquot1 (dSmpAliquot1)**

Sample Aliquot1 (dSmpAliquot1) is a floating-point number and is set on the sample setup page when the Dilution radio button is selected. It is stored in the Sample table of the AlphaVision database.

```
If(bUseSmpAliquot = True And bUseSmpIDilution = False)Then
    dAliquot = dAliquot1
Else
    dAliquot = 0
End If
```

where:

bUseSmpAliquot is defined in Section B.7.4.43.  
bUseSmpIDilution is defined in Section B.7.4.44.

**B.7.4.47 Sample Dilution2 (dSmpIDilution2)**

Sample Dilution2 (dSmpIDilution2) is a floating-point number and is set on the sample setup page when the Dilution radio button is selected. It is stored in the Sample table of the AlphaVision database.

```
If(dSmpIDilution2 <= 0)then
    dSmpIDilution2 = 1.0
End If
```

**B.7.4.48 Sample Aliquot2 (dSmpAliquot2)**

Sample Aliquot2 (dSmpAliquot2) is a floating-point number and is set on the sample setup page when the Dilution radio button is selected. It is stored in the Sample table of the AlphaVision database.

```
If(dSmpAliquot2 <= 0)then
    dSmpAliquot2 = 1.0
End If
```

**B.7.4.49 Sample Dilution1 Relative Uncertainty (dDilution1RelUnc)**

Sample Dilution1 Relative Uncertainty (dDilution1RelUnc) is a floating-point number and is set on the sample setup page. It is stored in the Sample table of the AlphaVision database.

```
If(bUseSmpAliquot = False And bUseSmpIDilution = False)then
    dDilution1RelUnc = 0
End if
```

where:

bUseSmpAliquot is defined in Section B.7.4.43.  
bUseSmpIDilution is defined in Section B.7.4.44.

**B.7.4.50 Sample Aliquot1 Relative Uncertainty (dAliquot1RelUnc)**

Sample Aliquot1 Relative Uncertainty (dAliquot1RelUnc) is a floating-point number and is set on the sample setup page. It is stored in the Sample table of the AlphaVision database.

```
If(bUseSmpAliquot = False And bUseSmpDilution = False)then
  dAliquot1RelUnc = 0
End if
```

where:

bUseSmpAliquot is defined in Section B.7.4.43.  
bUseSmpDilution is defined in Section B.7.4.44.

**B.7.4.51 Sample Dilution2 Relative Uncertainty (dDilution2RelUnc)**

Sample Dilution2 Relative Uncertainty (dDilution2RelUnc) is a floating-point number and is set on the sample setup page. It is stored in the Sample table of the AlphaVision database.

```
If(bUseSmpDilution = False)then
  dDilution2RelUnc = 0
End if
```

where:

bUseSmpDilution is defined in Section B.7.4.44.

**B.7.4.52 Sample Aliquot2 Relative Uncertainty (dAliquot2RelUnc)**

Sample Aliquot2 Relative Uncertainty (dAliquot2RelUnc) is a floating-point number and is set on the sample setup page. It is stored in the Sample table of the AlphaVision database.

```
If(bUseSmpDilution = False)then
  dAliquot2RelUnc = 0
End if
```

where:

bUseSmpDilution is defined in Section B.7.4.44.

**B.8 Calibration Calculations**

The following sections show the methods used in AlphaVision to calculate the detector efficiency and the associated uncertainty. During analysis, if default detector calibration is to be used, then the last active detector calibration will be the calibration for that analysis. In analysis setup, if there are multiple calibrations for the detector, users can select which one to use.

**B.8.1 Detector Efficiency (dDetEff)**

This floating-point number is stored in the EfficiencyCalibration table of the database and is calculated as follows:

```
If(bUseWghtAvg = True)then
  dDetEff = dTotDetEffWghtAvg
Else
  dDetEff = dTotDetEffSmpAvg
End if
```

where:

bUseWghtAvg is described in Section B.8.20.

dTotDetEffWghtAvg is described in Section B.8.5.

dTotDetEffSmplAvg is described in Section B.8.3.

### B.8.2 Detector Efficiency Absolute Uncertainty (dDetEffAbsUnc)

This floating-point number is calculated as follows:

```

If(bUseWghtAvg = True)then
    dDetEffAbsUnc = dTotDetEffWghtAvgAbsUnc
Else
    dDetEffAbsUnc = dTotDetEffSmplAvgAbsUnc
End if

```

where:

bUseWghtAvg is described in Section B.8.20.

dTotDetEffWghtAvgAbsUnc is described in Section B.8.6

dTotDetEffSmplAvgAbsUnc is described in Section B.8.4.

dDetEffAbsUnc is used Section B.8.19.

**NOTE** For the purpose of this calculation, the value stored in the Efficiency Calibration table of the database (as calculated above) is 1 sigma absolute fractional uncertainty. However, the value reported on the calibration report is 2 sigma in percent (that is, 0.01 is reported as 2%).

### B.8.3 Total Detector Efficiency Simple-Average (dTotDetEffSmplAvg)

This floating-point number is calculated as follows:

$$dTotDetEffSmplAvg = \left(\frac{1}{n}\right) \sum_1^n \varepsilon_i$$

where:

$\varepsilon_i$  is the nuclide detection efficiency (dNucDetEff) for the  $i$ -th nuclide described in Section B.8.17.

$n$  is the total number of calibration nuclides in the calibration certificate.

The summation index  $i$  takes on all the values from 1 to  $n$ .

### B.8.4 Total Detector Efficiency Simple-Average Absolute Uncertainty (dTotDetEffSmplAvgAbsUnc)

This value is a floating-point number calculated as:

$$DTotDetEffSmplAvgAbsUnc = \left(\frac{1}{n}\right) \sqrt{\sum_1^n \sigma_{\varepsilon_i}^2}$$

where:

$\sigma_{\epsilon_i}$  is the nuclide detection efficiency absolute uncertainty (dNucDetEffAbsUnc) for the  $i$ -th nuclide described in Section B.8.19.

The summation index  $i$  takes on all values from 1 to  $n$ .

### B.8.5 Total Detector Efficiency Weighted-Average (dTotDetEffWghtAvg)

This floating-point number is calculated as follows:

$$dTotDetEffWghtAvg = \left( \sum_1^n (\epsilon_i / \sigma_{\epsilon_i}^2) \right) / \left( \sum_1^n (1 / \sigma_{\epsilon_i}^2) \right)$$

where:

$\epsilon_i$  is the nuclide detection efficiency (dNucDetEff) for the  $i$ -th nuclide described in Section B.8.17.

$\sigma_{\epsilon_i}$  is the nuclide detection efficiency absolute uncertainty (dNucDetEffAbsUnc) for the  $i$ -th nuclide described in Section B.8.19.

$n$  is the total number of nuclides in the calibration certificate.

The summation index  $i$  takes on all values from 1 to  $n$ .

### B.8.6 Total Detector Efficiency Weighted-Average Absolute Uncertainty (dTotDetEffWghtAvgAbsUnc)

This floating-point number is calculated as follows:

$$dTotDetEffWghtAvgAbsUnc = 1 / \left( \sum_1^n (1 / \sigma_{\epsilon_i}^2) \right)$$

where:

$\sigma_{\epsilon_i}$  is the nuclide detection efficiency absolute uncertainty (dNucDetEffAbsUnc) for the  $i$ -th nuclide described in Section B.8.19.

$n$  is the total number of nuclides in the calibration certificate.

The summation index  $i$  takes on all values from 1 to  $n$ .

### B.8.7 Nuclide Net Counts (dNucNetCnts)

This floating-point number is calculated as follows:

$$dNucNetCnts = dNucGrCnts - dNucBkgCnts$$

where:

dNucGrCnts is described in Section B.8.27.

dNucBkgCnts is described in Section B.8.28.

For a calibration to succeed, the net counts must be greater than 0.

### B.8.8 Nuclide Net Counts Absolute Uncertainty (dNucNetCntsAbsUnc)

This floating-point number is calculated as follows:

```

If(dNucBkgCnts > 0)Then
    dNucNetCntsAbsUnc = (dNucBkgCnts + dNucGrCnts)^0.5
Else
    dNucNetCntsAbsUnc = (1 + dNucGrCnts)^0.5
End if

```

where:

dNucGrCnts is described in Section B.8.27.

dNucBkgCnts is described in Section B.8.28.

### B.8.9 Nuclide Net Count Rate (dNucNetCntRt)

This floating-point number is calculated as follows:

$$dNucNetCntRt = dNucNetCnts / dCalLT$$

where:

NucNetCnts is described in Section B.8.7.

dCalLT is described in Section B.8.23.

### B.8.10 Nuclide Net Count Rate Absolute Uncertainty (dNucNetCntRtAbsUnc)

This floating-point number is calculated as follows:

$$dNucNetCntRtAbsUnc = dNucNetCntsAbsUnc / dCalLT$$

where:

dNucNetCntsAbsUnc is described Section B.8.8.

dCalLT is described in Section B.8.23.

### B.8.11 Calibration Nuclide Decay Correction (dCalNucDecCorr)

This floating-point number is calculated as follows:

$$dCalNucDecCorr = \text{EXP}(- \text{LN}(2) * (tCalAcqDt - tCalRefDt) / dCalNucHalfLife)$$

where:

LN(2) is the natural log of 2.

tCalAcqDt is described in Section B.8.29.

dCalRefDt is described in Section B.8.30.

dCalNucHalfLife is described in Section B.8.25.

The half-life units should be the same as the time difference ((tCalAcqDt – tCalRefDt) in the equation) units.

### B.8.12 Calibration Nuclide Decay Correction Relative Uncertainty (dCalNucDecCorrRelUnc)

This floating-point number is calculated as follows:

$$dCalNucDecCorrRelUnc = (\text{LN}(2) * (tCalAcqDt - tCalRefDt) / dCalNucHalfLife) * dCalNucHalfLifeRelUnc$$

where:

LN(2) is the natural log of 2.

tCalAcqDt is described in Section B.8.29.

dCalRefDt is described in Section B.8.30.

dCalNucHalfLife is described in Section B.8.25.

dCalNucHalfLifeRelUnc is described in Section B.8.26.

The half-life units should be the same as the time difference ((tCalAcqDt – tCalRefDt) in the equation) units.

### B.8.13 Calculated Nuclide Activity (dCalcNucAct)

This floating-point number is calculated as follows:

$$dCalcNucAct = dNucNetCntRt / dCalNucBR$$

where:

dNucNetCntRt is described in Section B.8.9.

dCalNucBR is described in Section B.8.24.

### B.8.14 Calculated Nuclide Activity Relative Uncertainty (dCalcNucActRelUnc)

This floating-point number is calculated as follows:

```
If(dNucNetCnts > 0)Then
    dCalcNucActRelUnc = dNucNetCntsAbsUnc / dNucNetCnts
Else
    dCalcNucActRelUnc = 0
End if
```

where:

dNucNetCntsAbsUnc is described in Section B.8.8.

dNucNetCnts is described in Section B.8.7.

Note that only counting uncertainty is accounted here. Decay correction uncertainty is taken care of in the expected nuclide activity relative uncertainty in Section B.8.16.

### B.8.15 Expected Calibration Nuclide Activity (dExpCalNucAct)

This floating-point number is calculated as follows:

$$dExpCalNucAct = (dCalNucRefActDPM / 60) * dCalNucDecCorr$$

where:

dCalNucRefActDPM is described in Section B.8.21.

dCalNucDecCorr is described in Section B.8.11.

This is the expected nuclide activity (in Bq) of the calibration nuclide at the date and time the calibration is performed. So, the decay correction factor as defined is used a multiplier here.

### **B.8.16 Expected Calibration Nuclide Activity Relative Uncertainty (dExpCalNucActRelUnc)**

This floating-point number is calculated as follows:

$$dExpCalNucActRelUnc = (dCalNucRefActRelUnc^2 + dCalNucDecCorrRelUnc^2)^{0.5}$$

where:

dCalNucRefActRelUnc is described in Section B.8.22.

dCalNucDecCorrRelUnc is described in Section B.8.12.

### **B.8.17 Nuclide Detection Efficiency (dNucDetEff)**

This value is a floating-point number calculated as follows:

$$dNucDetEff = dCalcNucAct / dExpCalNucAct$$

where:

dCalcNucAct is described in Section B.8.13.

dExpCalNucAct is described in Section B.8.15.

### **B.8.18 Nuclide Detection Efficiency Relative Uncertainty (dNucDetEffRelUnc)**

This floating-point number is calculated as follows:

$$dNucDetEffRelUnc = (dCalcNucActRelUnc^2 + dExpCalNucActRelUnc^2)^{0.5}$$

where:

dCalcNucActRelUnc is described in Section B.8.14.

dExpCalNucActRelUnc is described in Section B.8.16.

### **B.8.19 Nuclide Detection Efficiency Absolute Uncertainty (dNucDetEffAbsUnc)**

This floating-point number is calculated as follows:

$$dNucDetEffAbsUnc = dNucDetEff * dNucDetEffRelUnc$$

where:

dNucDetEff is described in Section B.8.17.

dNucDetEffRelUnc is described in Section B.8.18.

### **B.8.20 Use Weighted-Average Efficiency (bUseWghtAvg)**

This flag is set during the calibration setup and stored in the CalibrationSpec table of the AlphaVision database.

### **B.8.21 Calibration Nuclide Reference Activity in DPM (dCalNucRefActDPM)**

This is a floating-point number set when a standard nuclide is created and stored in the Standard Nuclide table of the AlphaVision database. In the Excel file for calibration verification, the activity units must be in DPM (although users can enter the nuclide activity in different activity units).

### **B.8.22 Calibration Nuclide Reference Activity Relative Uncertainty (dCalNucRefAcRelUnc)**

This is a floating-point number set as a percentage when a standard nuclide is created and stored (as %) in the Standard Nuclide table of the AlphaVision database.

### **B.8.23 Calibration Live Time (dCalLT)**

This value (in seconds) is a floating-point number set during acquisition configuration and is stored in the HWParameters table of the AlphaVision database.

### **B.8.24 Calibration Nuclide Branching Ratio (dCalNucBR)**

This is the sum of all the nuclide branching ratios in the ROI for the nuclide and is stored in the CalibrationPeaks table of the AlphaVision database.

### **B.8.25 Calibration Nuclide Half-Life (dCalHalfLife)**

This is stored in the (master) Nuclides table of the AlphaVision database. The nuclide is selected when a calibration certificate is created.

### **B.8.26 Calibration Nuclide Half-Life Relative Uncertainty (dCalNucHalfLifeRelUnc)**

This floating-point number is stored in the (master) Nuclide table of the AlphaVision database. The default relative uncertainty for the nuclide is 0.1%.

### **B.8.27 Nuclide Gross Counts (dNucGrCnts)**

This is determined during calibration data acquisition (and subsequent analysis) and stored in the CalibrationPeaks table of the AlphaVision database.

### **B.8.28 Nuclide Background Counts (dNucBkgCnts)**

This is determined during calibration analysis and stored in the CalibrationPeaks table of the AlphaVision database.

### **B.8.29 Calibration Acquisition Date (tCalAcqDt)**

This time and date string is set during data acquisition and stored in the Spectra table of the AlphaVision database.

### **B.8.30 Calibration Reference Date (tCalRefDt)**

This time and date string is set during calibration certificate setup and stored in the Standard table of the AlphaVision database.

## APPENDIX C. CONFIGURING OCTETES WITH THE SET920 PROGRAM

The number of inputs (1–16) and memory size (number of channels) for each detector input in OCTÊTE-series MCBs can be modified with the **SET920** program, supplied on disk with your hardware and included on the AlphaVision installation CD. Normally you will only run it when you add a new MCB to the system and will not use it again except to change the number of inputs or the total memory size. If you have already set up the number of inputs and memory size for each detector in your OCTÊTE-series MCBs, or wish to use the factory default settings, skip this appendix. To run SET920 from the AlphaVision installation disk:

- Insert the CD, open the Windows Start menu's **Computer** option, navigate to the CD drive, open the \set920 folder, and run SET920.exe.
- Figure 202 shows the SET920 dialog. Click the MCB drop list and select the input to be changed (SET920 displays only the OCTÊTEs and 920s on your current Master Detector List).

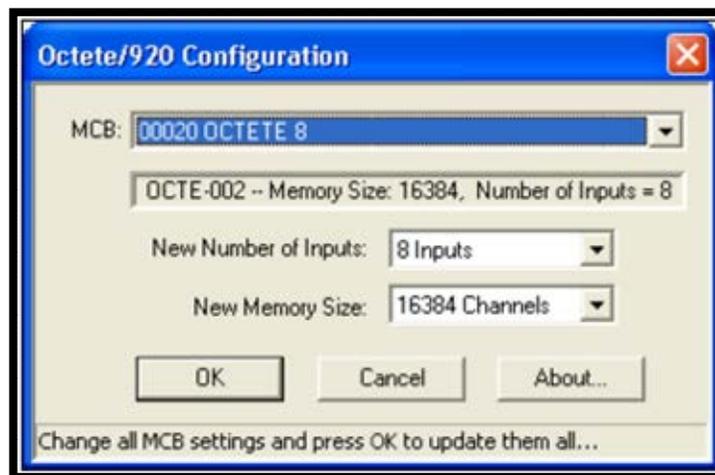


Figure 202. The SET920 Configuration Dialog

- The second field shows the current memory size and number of inputs. The **New Number of Inputs** is the number of detectors to be used by this OCTÊTE. For example, the OCTÊTE Plus can have 1, 2, 4, 8 or 16 detectors. The normal selection, however, will be either 8 (all internal) or 16 (8 internal and 8 external).
- The **New Memory Size** is the total number of channels available for all of the inputs. The individual number of channels is *Memory Size / Number of Inputs*. For example, in an OCTÊTE Plus, a setting of 16 inputs and 8K memory will allot 512 channels for each input spectrum. This can be equal to, greater than, or less than the ADC conversion gain for each detector.

The ADC conversion gain and offset can be set for each MCB in AlphaVision (right-click the detector of interest, select **Detector Properties...**, then click the **Chamber Properties...** button), or MAESTRO (**Acquire/MCB Properties...**).

- When finished editing all the MCBs, click **OK** to exit the program. The changes will be stored in the MCBs at this point; however, *you must run the MCB Configuration program again before ORTEC applications such as AlphaVision can detect and use the changes*. If you have made any changes, SET920 will ask if you want to automatically run the Instrument Configuration program. Click **Yes**, allow the search to proceed, review the resulting list, then click **Close**. For additional instructions on the MCB Configuration program, see the CONNECTIONS Driver Update Kit instructions.