



Instruction Manual

Analysis Viewer 1.3 **Becquerel Measurements** **with the SAM 940**

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Low Level Becquerel Measurements
Using the SAM 940 Analysis Viewer
Software Version 1.3.1
October 7, 2011

Introduction

Low level activity measurements are aided by the SAM 940 Quadratic Compression Conversion (QCC). With QCC, all spectral peaks are well defined in 11 channels with enhanced statistics. Therefore, the end points defining a peak's region of interest (ROI) are easily determined. Calculations that determine background counts under the peak and net counts in the peak are easily and accurately accomplished with at least 20% less coding than with conventional spectroscopy. Other calculations such as Minimum Detectable Activity (MDA) and the Critical Level (Lc) from which the lowest level of analysis can be determined and computed, are all important and require a well defined ROI. The user will also be able to view these well defined (colored) peaks in the spectrum even when the activity is very low.

Minimum Requirements

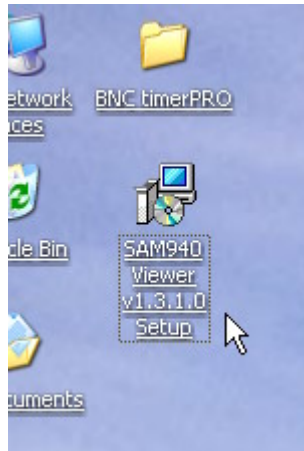
Pentium II or equivalent, 450 MHz, 0.4Mb RAM, Windows 2000 or newer

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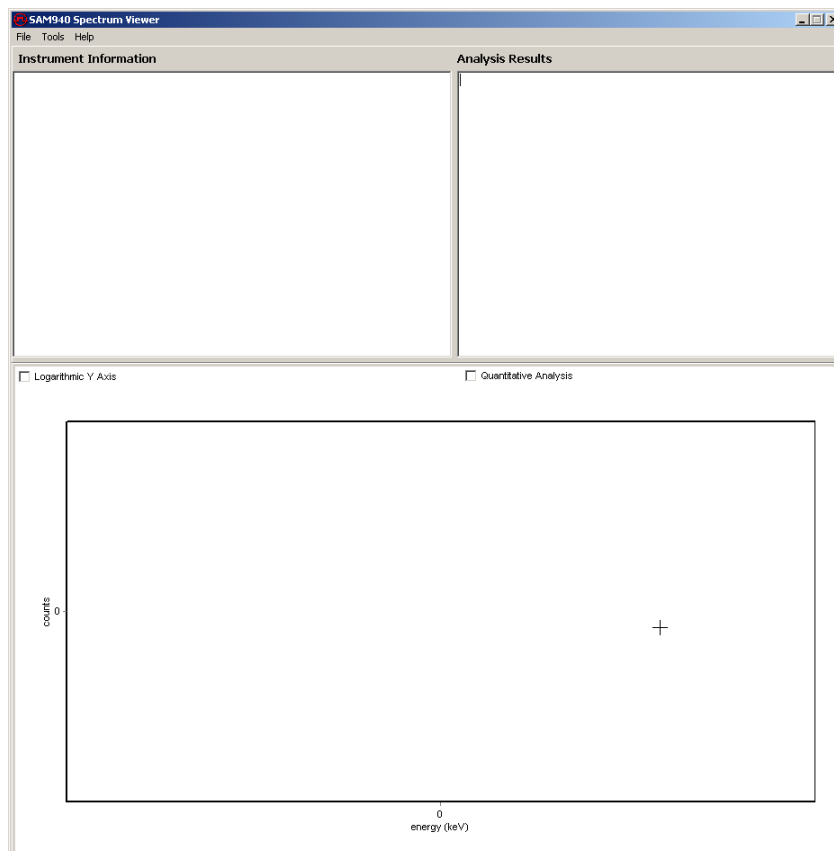
Installing SAM 940 Analysis Viewer

Click on the icon labeled “SAM940 Viewer v1.3.1.0 Setup”



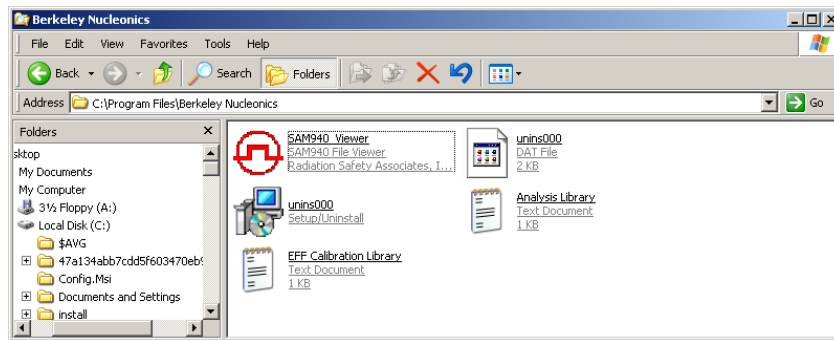
Analysis Viewer Setup

By default, SAM940 Analysis Viewer will install a folder in the location C:\Program Files\Berkeley Nucleonics. Launch SAM 940 Analysis Viewer at the end of the installation process.



SAM 940 Analysis Viewer

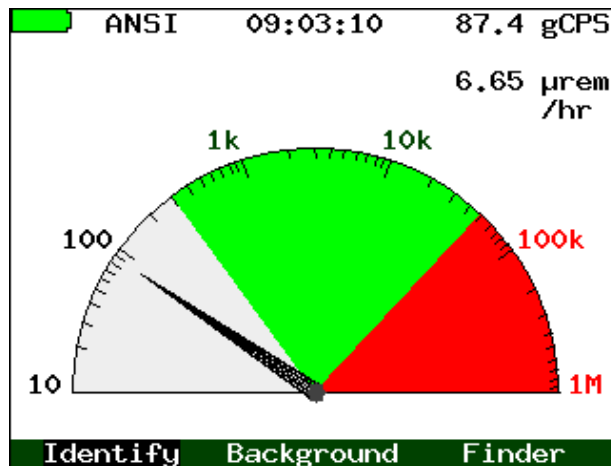
The “Berkeley Nucleonics” folder contains 2 libraries, the SAM940 Viewer configuration file, the SAM940 Viewer.exe program and two uninstall files.



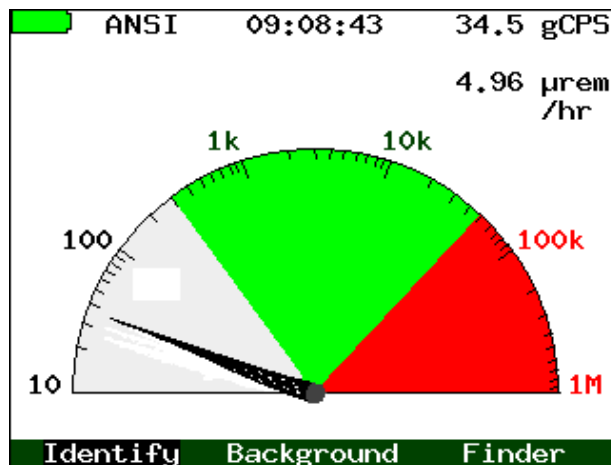
Berkeley Nucleonics Folder

Background Concerns

The best results, in making low level Becquerel (Bq) measurements, are obtained with the detector shielded. Observe the drop in background radiation on the SAM display as an initial indication that your shielding is effective.



Normal Background



Shielded Background

Results will be greatly improved with maximum shielding. This is particularly true if the ambient background shows peaks of radium (seen predominately at 609 keV) and thorium (contributes to higher background throughout the spectrum, but mainly seen at about 2600 keV). Therefore, observe and store a background spectrum with the SAM 940 before attempting to make any measurements.

Minimum Detectable Activity (MDA) is directly related to the square root of the background so it is important to recognize the radium and thorium artifacts in the background spectrum for two reasons:

1) 609 keV is directly in the ROI of Cs134 (604 keV), and in the shoulder of Cs137 (662 keV). This compromises low Bq measurements of Cs 134, and does not allow accurate net peak integration of Cs 137 at very low levels. Thorium can also have a peak close to the 364 keV line of I131. A small amount of radium (seen predominately at 609 keV) will cause low-side tailing with Cs137 – seen as a non-Gaussian tail near the continuum. This tailing will cause some error in the calculation depending on the amount of radium present.

2) If an ambient background containing small radium and thorium peaks is stored for background subtraction, then a significant part of the Cs134, Cs137, and I131 peaks could be subtracted when performing low level measurements. This has the affect of lowering the measured nuclide activity.

Hint - Observe a clean background spectrum to also be sure that the lead used in the shielding material is not contaminated.

Setup for Low Level Becquerel Measurements

1) Turn the SAM 940 off, connect the SAM 940 to the detector using the optional 5 foot cable (coiled or straight cable), and place the detector in the shielded measurement configuration.

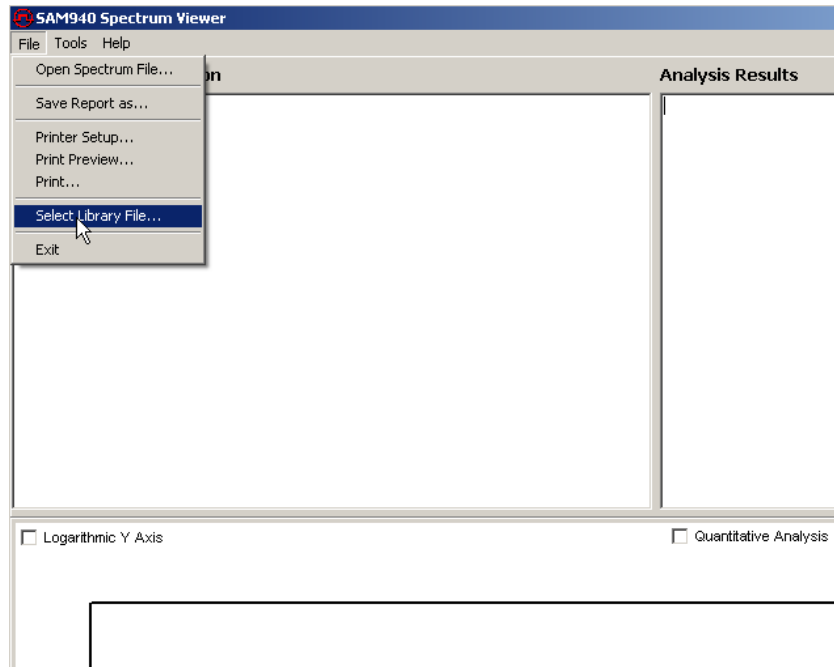


Coiled 5 Foot Cable

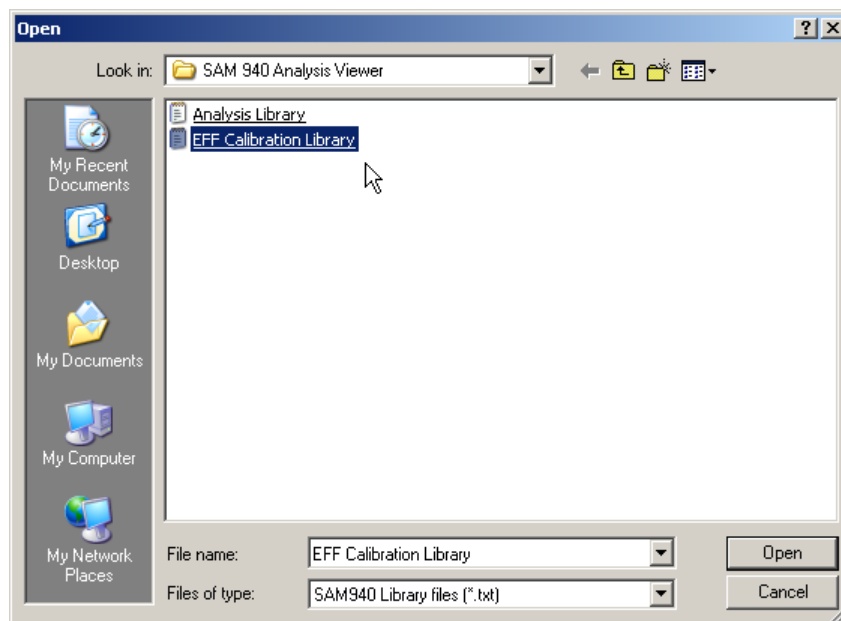
- 2) Turn the SAM 940 on and allow Auto Calibration to complete.
- 3) After calibration let the SAM 940 stabilize for at least 10 minutes before removing the K40 ring. In a stable environment (same temperature with no warm or cool drafts), the SAM should stay in calibration for one hour or more without the K40 ring. Tests have shown less than 0.5% drift (a small fraction of 1 channel) for one hour without the K40 ring. It is a good practice to keep K40 near the detector between measurements and when not in use. This is made easy with an optional K40 plug that is inserted directly next to the detector.
- 4) In the SAM Configuration menu set the Capture Time to at least 15 minutes. Measurements in the 5-20 Bq area may take 20 - 30 minutes depending on how low the background is or how well the detector is shielded (Hint - Always use copper under the lead shield to eliminate lead's characteristic x-rays.).
- 5) If the dose rate on the SAM display is not already in nSv/hr, go to the SAM Configuration menu and set the Dose Rate Scale to nSv/hr.
- 6) In the Admin menu, set the Dose Rate Display Threshold value to 0.3. In the Admin menu leave the Sample Time at 1 second - this is not the Capture time, nor the Acquisition time. Rather it is the time-slice and update time of the instrument.
- 7) When storing the background reference, be sure the background is acquired for a time equal to, or more than, the Identify acquisition time. When performing Marinelli measurements, also be sure to acquire and store the background without the K40 ring. The Marinelli container used for taking the background must have the same matrix as the source sample to be measured – this is called a paired blank.

Detector Efficiency Calculations

Before performing analysis, the detector efficiency must be calculated for the energy associated with each isotope to be analyzed. A library called EFF Calibration will be used initially.



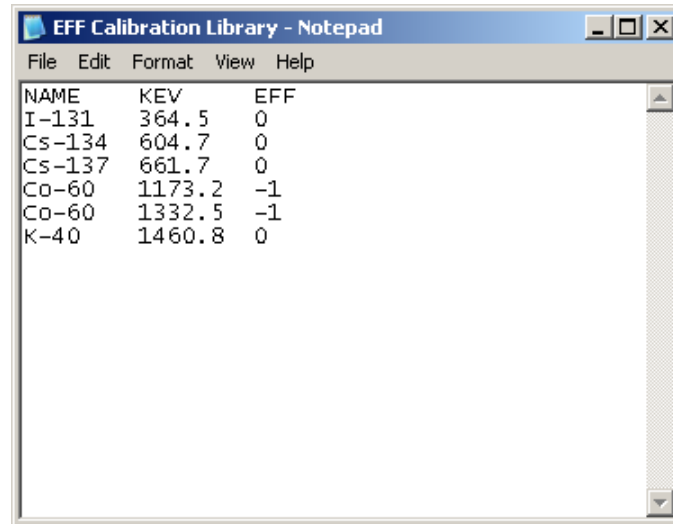
Selecting Library File



Selecting EFF Calibration Library

Though it is the active reference library initially used by the Analysis Viewer program, the EFF Calibration Library does not open when selected from the program menu. If opened from the Berkeley Nucleonics folder with a text editor (Notepad for example), you will see that the EFF Calibration Library contains I131, Cs134, Cs137 and K40 (Co60 was used during development and is turned off). The energy lines chosen represent the most intense line of each isotope.

Efficiencies are set to “0” to allow calculating the efficiency value for each energy line.



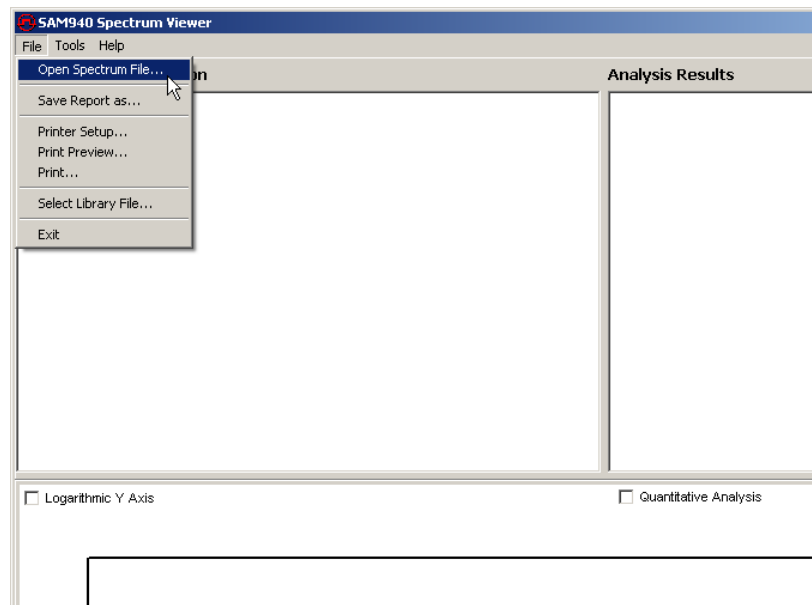
NAME	KEV	EFF
I-131	364.5	0
Cs-134	604.7	0
Cs-137	661.7	0
Co-60	1173.2	-1
Co-60	1332.5	-1
K-40	1460.8	0

EFF Calibration Library

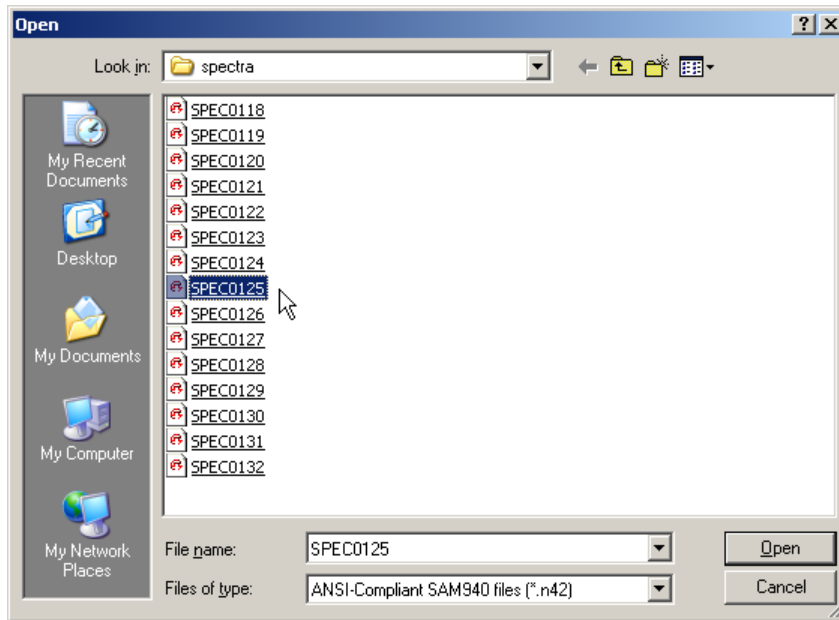
Using a Marinelli source, select a known activity much larger than the maximum activity to be measured. If the calibration activity is small then there will be quite a bit of statistical error built into the efficiency determination. Therefore, use a source large enough to get good statistics within a 15 minute acquisition (for example a 1,000 Bq calibration source may be used for good accuracy at 15 Bq). A Cs137 calibration source can be used for both Cs134 and Cs137 (they will both use the same efficiency number since their two energy lines are very close).

The most important objective is to have a calibration source with a matrix similar to the sample being measured. For example, if the sample being analyzed is damp soil then the background sample and calibration source must both be damp soil. If the sample is leafy material then background and calibration source must be leafy material.

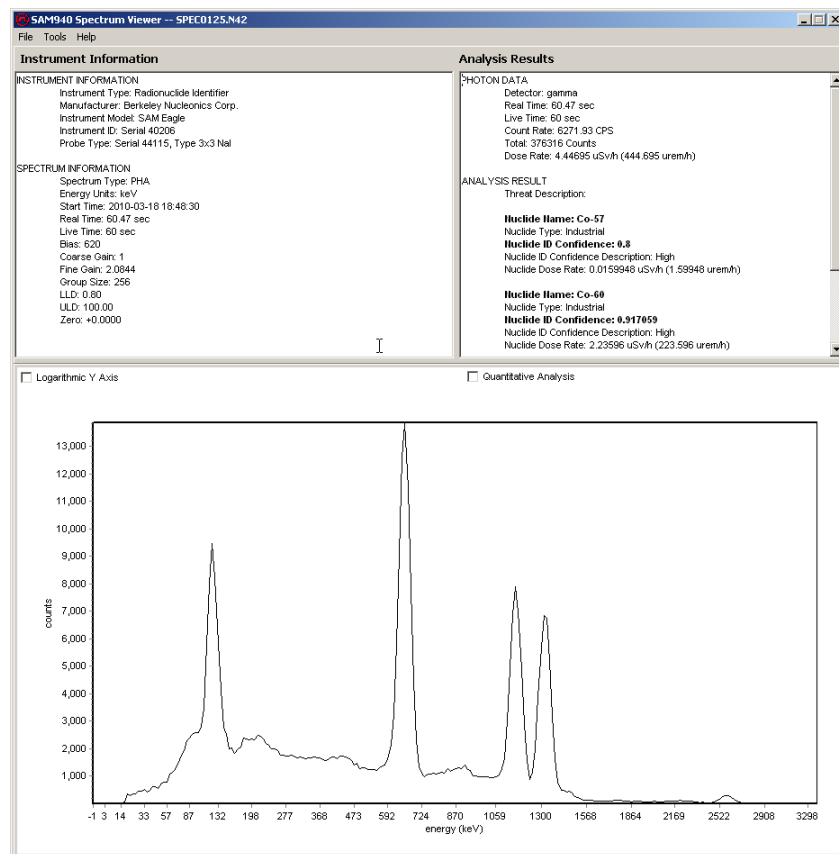
When the acquisition of the calibration source is complete, install the SAM's CF card onto your PC, then open the .N42 format spectrum file in the Analysis Viewer.



Opening a Spectrum File

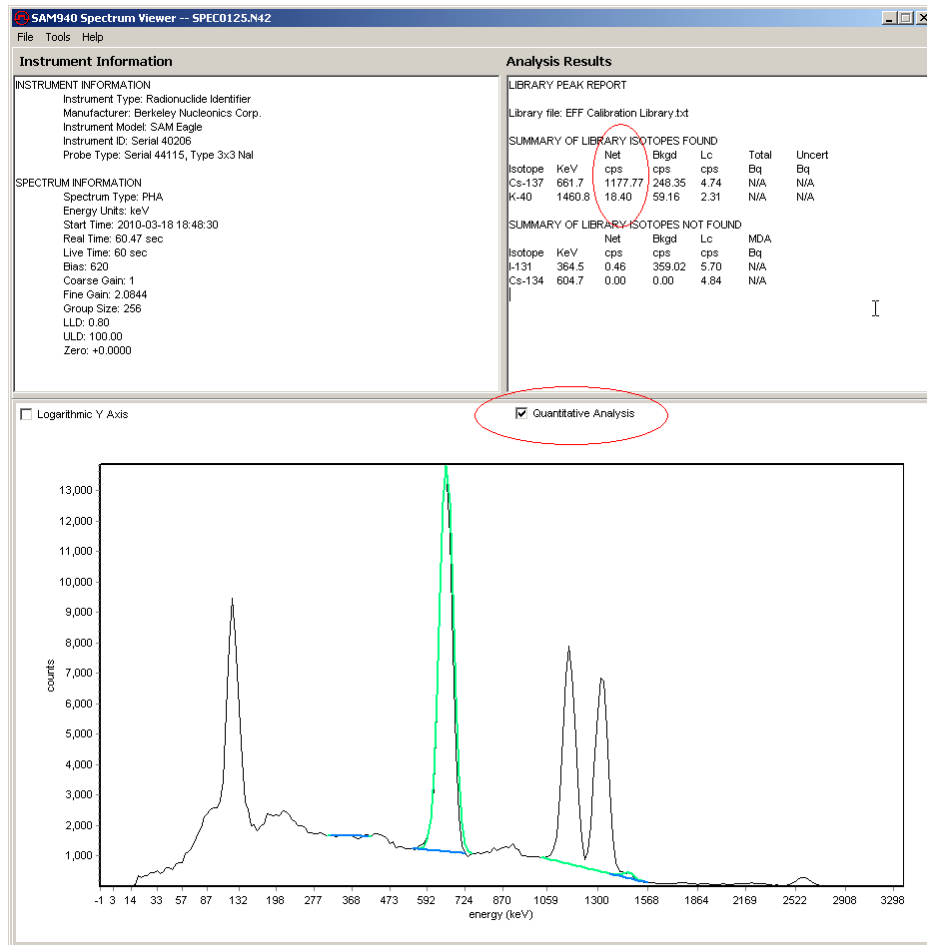


Selecting a Spectrum File



Opened Spectrum File

Place a check in the Quantitative Analysis box.



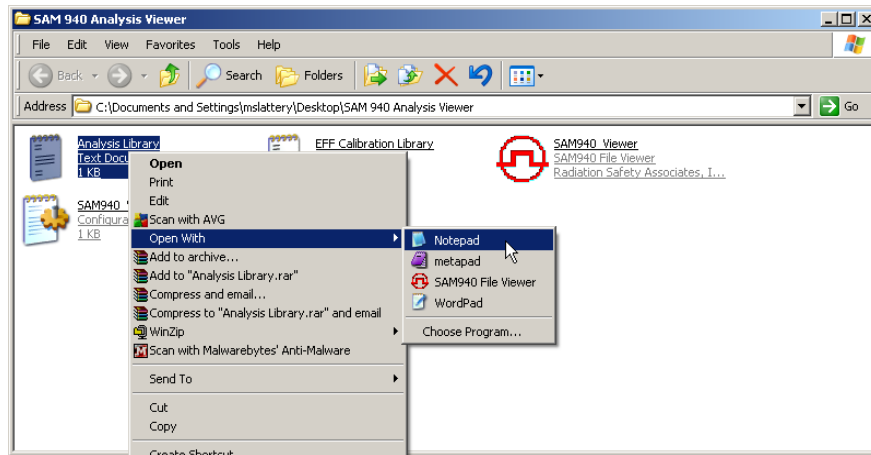
Quantitative Analysis

Record the Net gamma counts per second (cps) calculated for that particular isotope's energy line. (Cs137 in this example) Next, calculate the efficiency by dividing the Net cps by the activity of the known calibration source.

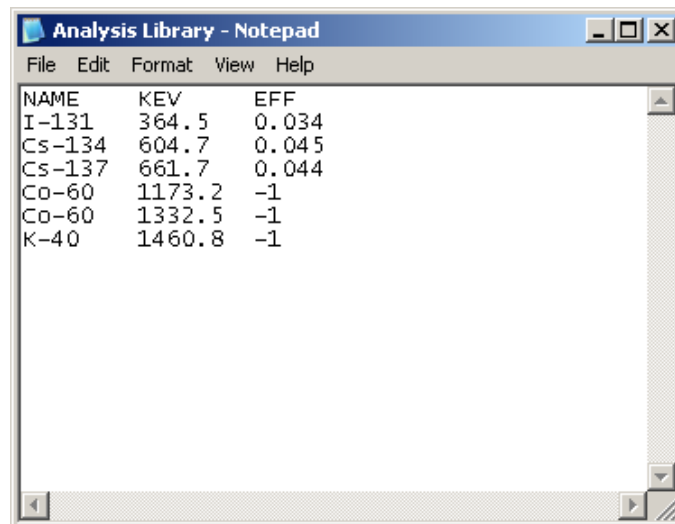
$$\text{EFF} = \text{cps}_{\text{net}} / \text{Bq}$$

$$\text{EFF} = 1177.77 / 34040 \text{ Bq} = 0.0345995 = 0.035$$

Use a text editor (Notepad for example) to open the Analysis Library text file in the SAM 940 Analysis Viewer folder.

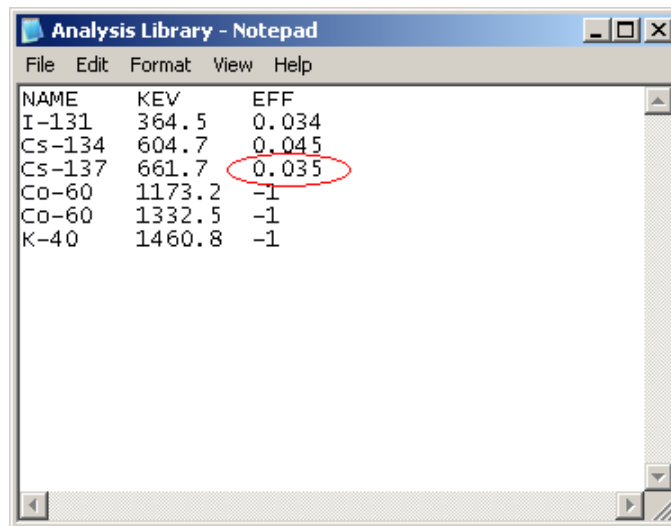


Open Text Editor



Open Analysis Library.txt

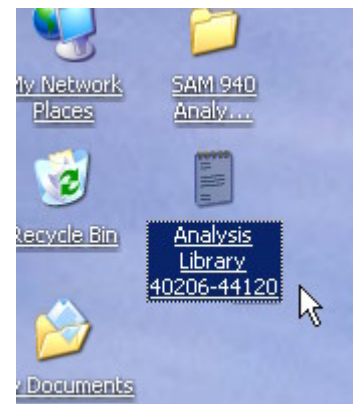
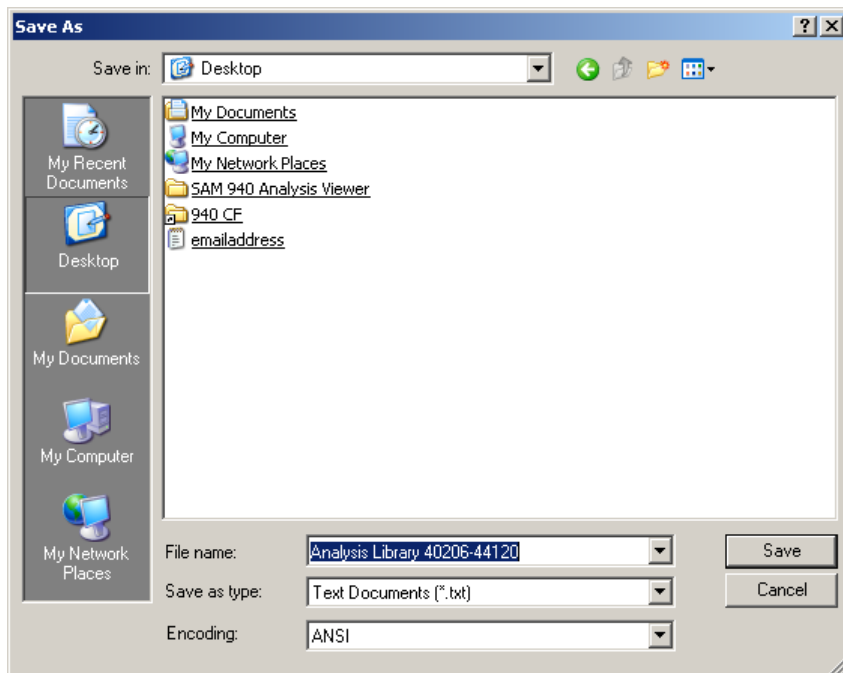
Edit the EFF column with the calculated efficiency value for the particular isotope. (Again, Cs137 in this example)



NAME	KEV	EFF
I-131	364.5	0.034
Cs-134	604.7	0.045
Cs-137	661.7	0.035
Co-60	1173.2	-1
Co-60	1332.5	-1
K-40	1460.8	-1

Edit Analysis Library.txt

You may edit the Analysis Library and replace the example efficiency numbers with the newly calculated numbers, or you may create an entirely new library if you have more than one detector. (See Appendix)

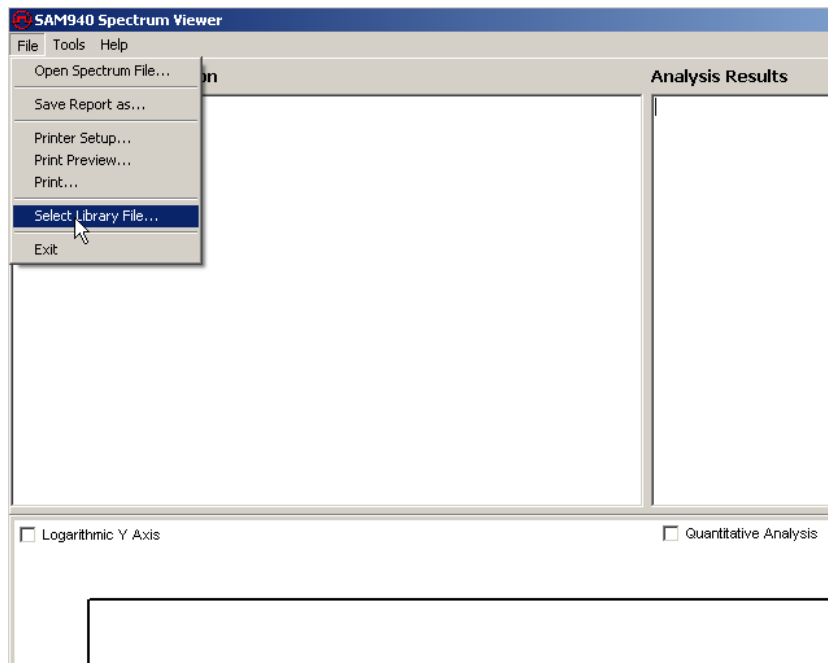


Hint – Rename the Analysis Library with the Serial Number of the SAM or the Detector.

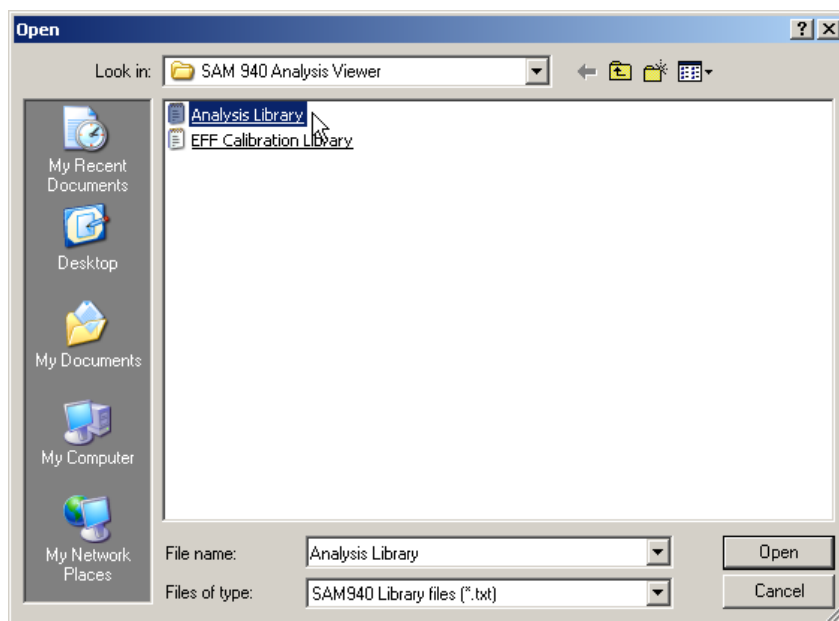
NOTE: AT THIS POINT, YOU ARE FINISHED WITH PERFORMING THE EFFICIENCY CALIBRATION FOR YOUR DETECTOR, NOW YOU MAY START WITH YOUR ANALYSIS.

Analysis

When you are ready to perform analysis, open SAM 940 Analysis Viewer and select the newly created Analysis Library from the File menu.

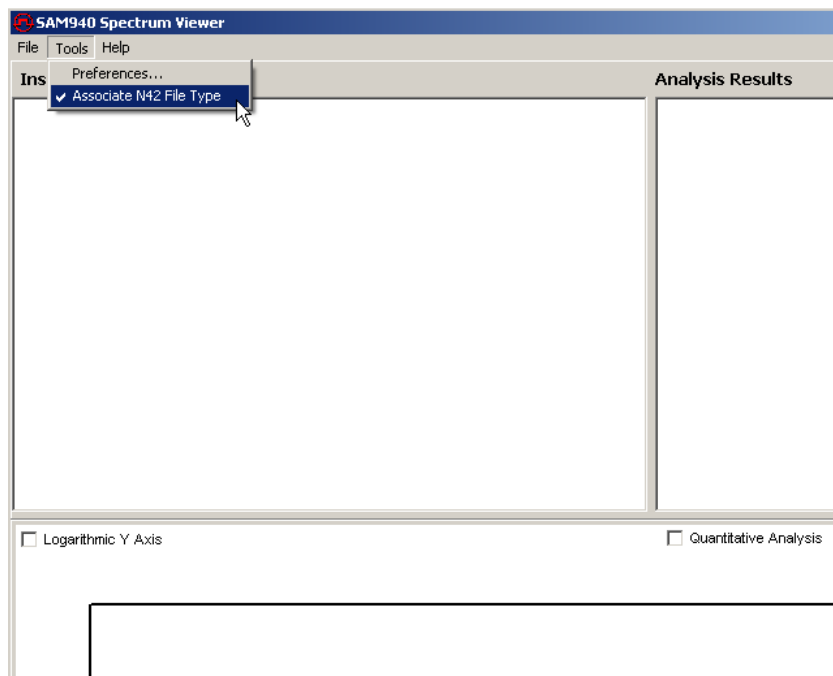


Selecting Library File



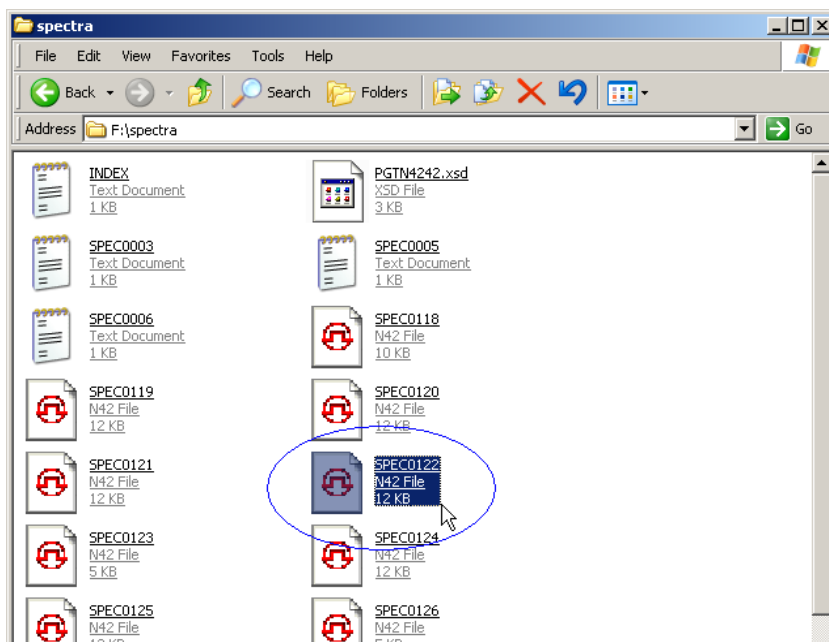
Selecting Analysis Library

Next, pull down the Tools menu to select Associate N42 File Type.



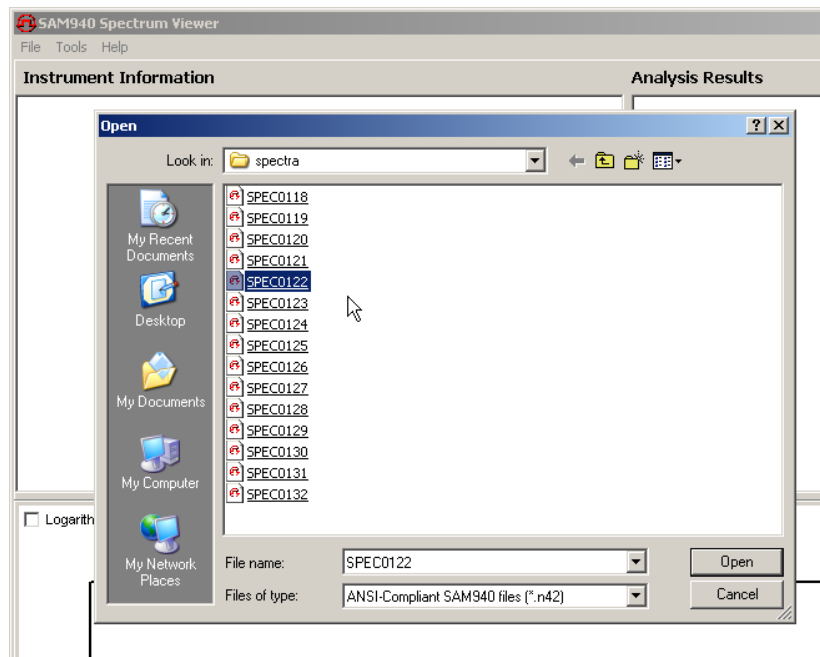
Associating File Types

When this function has been checked, the user can now double click on the N42 spectrum file (red, circled pulse icon), and SAM 940 Analysis Viewer will open automatically.



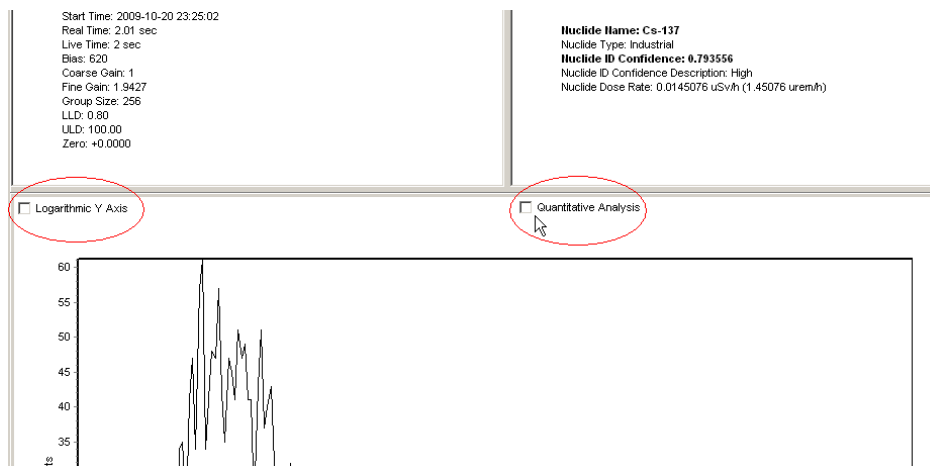
Open Analysis Viewer Automatically

The pull-down File menu from SAM 940 Analysis Viewer can also be used to browse for the N42 spectrum file.



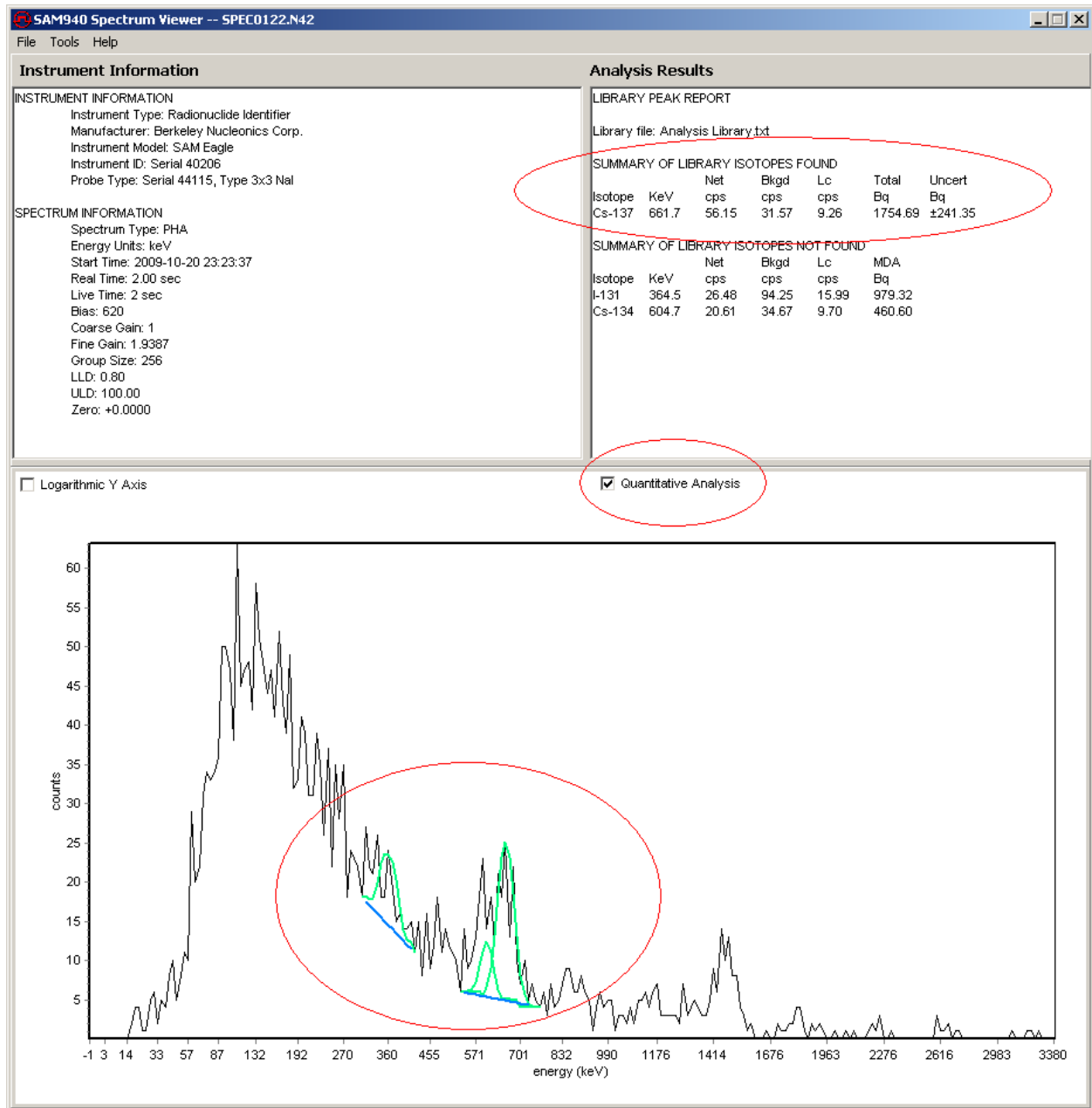
Open File with Analysis Viewer

Upon opening a file, note that there are two checkbox options above the spectrum: One for displaying the vertical axis in log value (Logarithmic Y Axis), and one for performing the analysis (Quantitative Analysis).



Check boxes

When clicking on the Quantitative Analysis checkbox, the recently selected Analysis Library will be used to analyze I131, Cs134, Cs137, and K40 for any or all isotopes present.

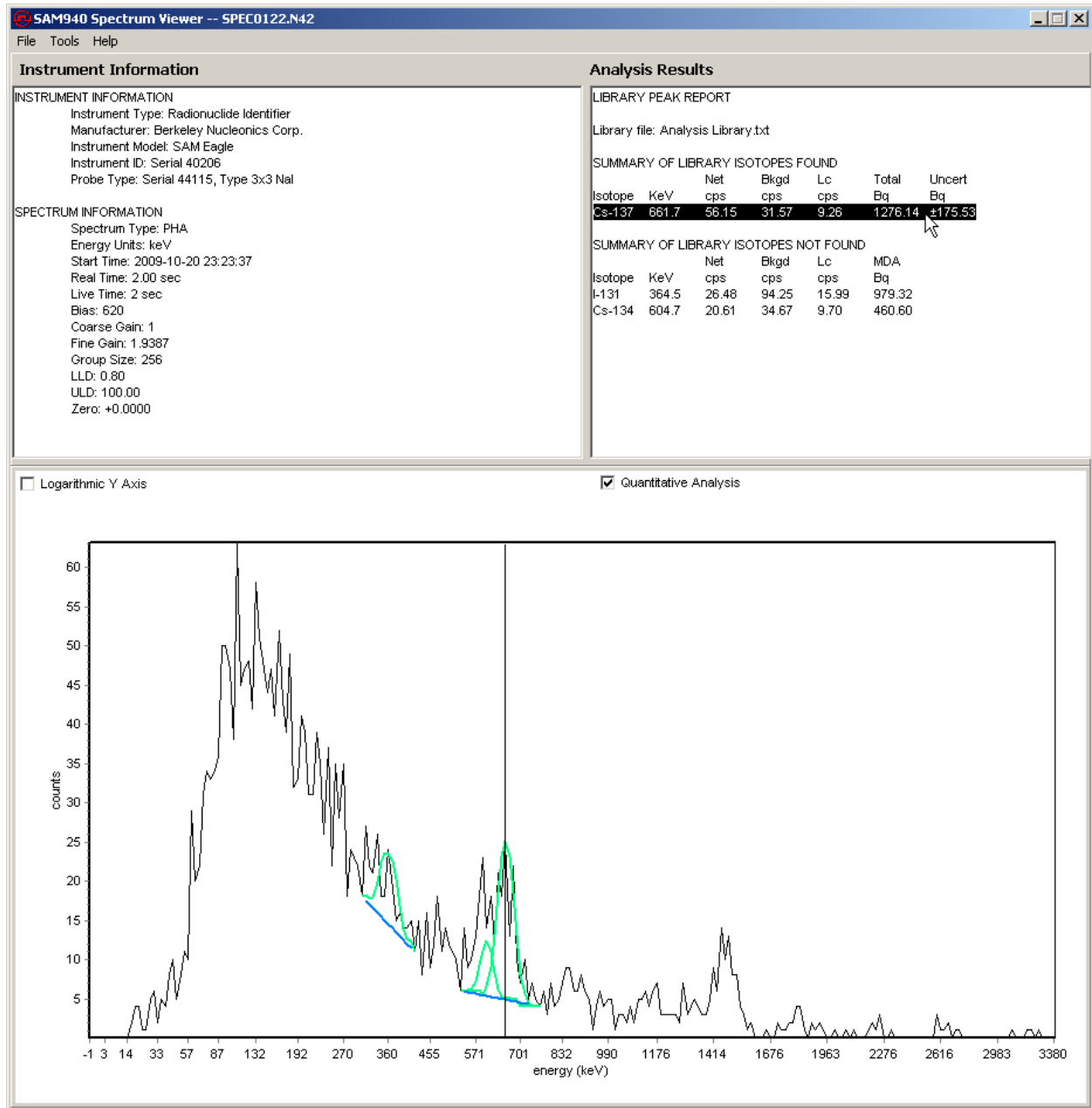


Quantitative Analysis

Tabulations of the results are immediately shown giving **Net cps, Background cps, Lc cps, Total Bq and Uncertainty Bq.**

Lc is the Critical Level that detectable activity must exceed in order to obtain an accurate activity calculation. If the net peak integral (Net cps) is greater than the Lc, the activity will be calculated. If Net cps is less than Lc then activity will not be calculated, and the isotope will be listed under isotopes not found. In this event, calculations will indicate an MDA.

To find the ROI associated with the isotope just click on the isotope line, and a black marker will appear on the spectrum indicating which peak is being analyzed.



Select ROI

If Cs134 and Cs137 are both present the multiplet, (overlapping peaks) will be deconvoluted, resulting in analysis of both isotopes.

Two helpful selections can be made while using the Analysis Viewer.

Use the Tools menu to open Preferences where the first item allows an uncertainty check for the quantitative analysis. When statistical anomalies appear due to background/shielding effects or lack of statistics (for example acquisition may be too short), there may be situations that there is no significant peak in the spectrum, but rather fluctuation in the continuum that is perceived to be a peak. In these circumstances, the calculation for very small activities will have a large variance. Since good measurements will have uncertainty of 10% or less, it is good practice to limit calculations that exceed 10 to 15 % uncertainty by entering the uncertainty percentage desired (the suggested default is 15%).

Secondly, there is the matter of a good Gaussian fit in determining the net peak integral. Since detectors vary slightly in resolution, this necessary adjustment will only need to be made once for a specific detector. During analysis, the green colored curve should have a very close fit to the photo peak being analyzed. A default Gaussian fit of “5” can be adjusted in increments of 0.1, but generally, incremental adjustments of 0.5 will work well. This number represents the full width of the peak at half of the maximum amplitude or height (FWHM) expressed in channels. Each SAM 940 controller is factory configured for a particular detector, so the adjustment for a proper Gaussian fit will only need to be made once for any particular SAM system. However, if another detector is substituted, a new adjustment may be necessary.

Using Non-Marinelli Samples

Alternatively, a quick and somewhat less accurate method of analyzing food samples can be achieved. For example, meat samples can be prepared in small, identically shaped sizes and placed under the detector for fast screening of samples. Following the same procedures above and ensuring adequate shielding, samples can be analyzed in 90 to 120 seconds. A uniformly “spiked” sample using Cs137 can be used to perform the efficiency calibration. Once calibrated, samples can be placed under the detector in a uniform manner with the diameter of the sample being less than the diameter of the detector. This type of screening allows a large volume of material to be sampled in a much shorter time. Samples that indicate a need to be further analyzed, can be subjected to a longer count, processed by the Marinelli method, or declared unsafe according to established protocol.

Appendix 1

Creating/Editing a Library

Multiple libraries may be used when the analysis software is to be used on several systems (each with its own set of efficiencies). To create a new library, use Note Pad with straight text. Use ENTER at the end of each line and create as follows:

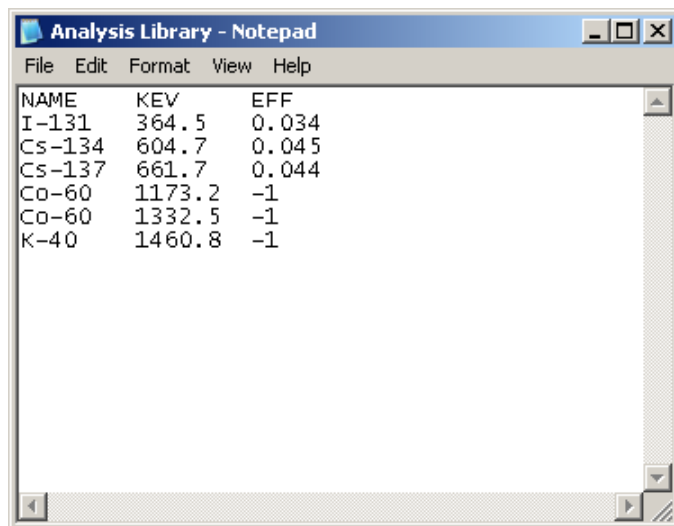
The actual content of the first line does not matter – just a convenient header for listing isotope name, keV, and efficiency.

The next lines must list the Isotope, keV, and efficiency with a tab between each entry. Isotopes must be listed in the order of their keV energies from low to high.

If the efficiency is set to “0” the activity will not be calculated, but Net cps in the ROI will be calculated. Therefore, the Efficiency Calibration Library will have all isotopes set to “0”.

If efficiency is set to “-1” the activity will not be calculated, the isotope will not appear in the report, or highlighted on the spectrum. However, the ROI will be examined for effects on multiplets and background continuum. This is useful when there are peaks in which the user may have no interest (such as K40), that may also interfere with the peaks in which there is interest.

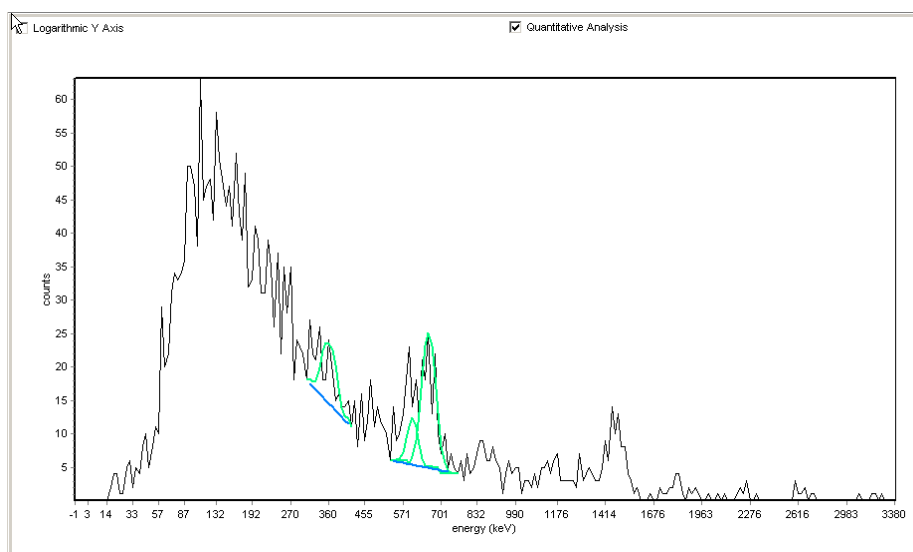
If there is some K40 in the sample, and the user wants to determine the efficiency with a standard, the EFF Calibration Library is set up to do this (efficiency is set to “0”). The user can proceed with using K40 just as with the other isotopes.



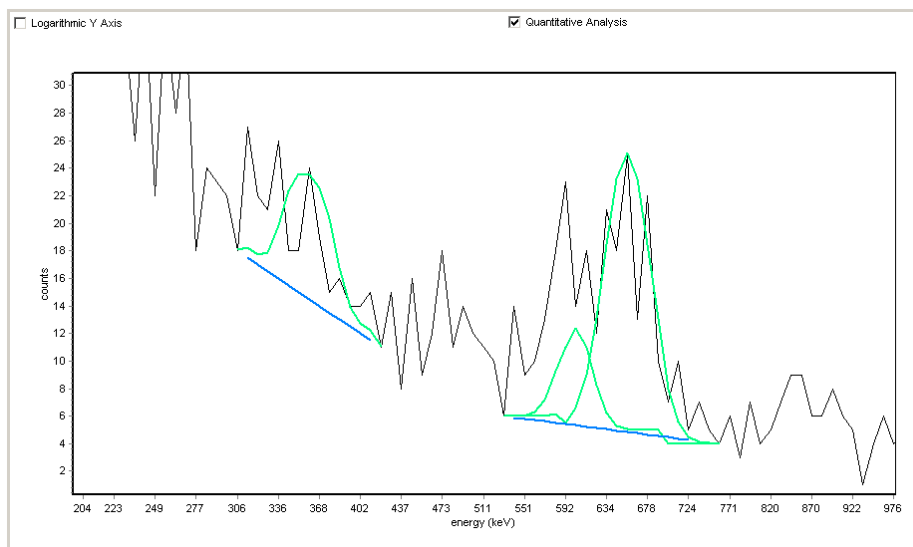
NAME	KEV	EFF
I-131	364.5	0.034
Cs-134	604.7	0.045
Cs-137	661.7	0.044
Co-60	1173.2	-1
Co-60	1332.5	-1
K-40	1460.8	-1

Expanding the Energy Scale

SAM 940 Analysis Viewer can zoom in on a portion of the energy scale. The portion of the spectrum that is to be expanded can be examined by click-dragging a box down, and to the right. To unzoom, click-drag up and to the left. This action will bring the spectrum back to normal view. A QCC spectrum does not appear across a large number of channels, therefore this feature will be rarely used.



Normal Energy Scale



Expanded Energy Scale

Analysis Report

The library selected for the analysis will be included in the Analysis Report. This serves as a good check to make sure the correct efficiencies were used. Isotopes not found will also be listed. This will occur because they were not present, they did not meet the uncertainty check, they were turned off in the library, or they did not meet the Lc criterion.

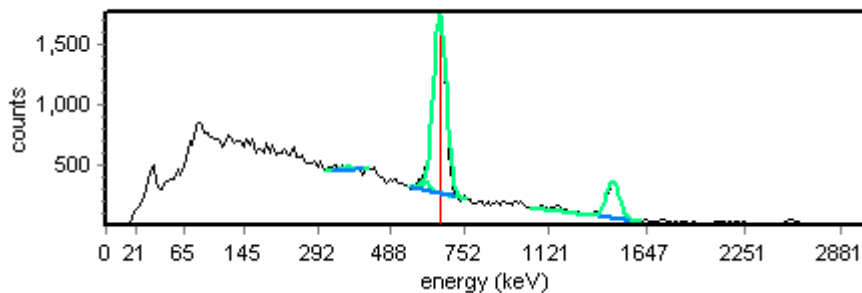
Filename: SPEC0036.N42

INSTRUMENT INFORMATION

Instrument Type: Radionuclide Identifier
 Manufacturer: Berkeley Nucleonics Corp.
 Instrument Model: SAM Eagle+
 Instrument ID: Serial 40766
 Probe Type: Serial 48130, Type 3x3 NaI

SPECTRUM INFORMATION

Spectrum Type: PHA
 Energy Units: keV
 Start Time: 2011-08-22 04:42:13
 Real Time: 900.08 sec
 Live Time: 900 sec
 Bias: 610
 Coarse Gain: 1
 Fine Gain: 1.1397
 Group Size: 256
 LLD: 0.80
 ULD: 100.00
 Zero: +0.1383



RED Marker: chn 112, 661 keV, 1741 counts

LIBRARY PEAK REPORT

Library file: Analysis Library(3x3).txt

SUMMARY OF LIBRARY ISOTOPES FOUND

Isotope	KeV	Net cps	Bkgd cps	Lc cps	Total Bq	Uncert Bq
Cs-137	661.7	8.74	3.21	0.14	111.73	±1.66
K-40	1460.8	1.86	0.68	0.06	37.26	±1.20

SUMMARY OF LIBRARY ISOTOPES NOT FOUND

Isotope	KeV	Net cps	Bkgd cps	Lc cps	MDA Bq
I-131	364.5	0.12	5.56	0.18	10.85
Cs-134	604.7	0.46	3.54	0.15	6.56

Example of Analysis Report

Appendix 2

Additional Support

- For additional instruction, watch the tutorial videos on www.berkeleynucleonics.com

The screenshot shows the BNC website interface. At the top, there's a header with the BNC logo, contact information (800.234.7858), and a welcome message for David Brown. Below the header is a navigation bar with links like Home, Company, Products, Resources, Events, International, Support Center, and Live Help. A sidebar on the left contains links for Live Support, Quick Links, and various download/translation options. The main content area is titled 'SAM 940 Defender / Revealer with Reachback Program' and features tabs for Overview, Specifications, Options, Accessories, Media, and Datasheet. Under the Media tab, there are links to a High Resolution Image and a Description. Below the description, there are four video players: 'Click to start tutorial - General Overview', 'Model 940 Viewer 1.3 Video 1 of 3', 'Model 940 Viewer 1.3 Video 2 of 3', and 'Model 940 Viewer 1.3 Video 3 of 3'.

- Contact the factory at info@berkeleynucleonics.com or 800-234-7858
- Contact your regional distributor