GammaVision® 7
High Resolution Gamma Spectroscopy Software

“Compatible, Efficient, and Defendable Results for High Resolution Spectroscopy Applications.”
GammaVision 7

GammaVision is an all-inclusive gamma spectroscopy application for high resolution spectrometer systems. It packs all of the basic and advanced features needed for accurate and consistent measurements in an intuitive interface that is easy to learn and operate. With embedded MCA controls, advanced spectrum analysis functions, automation for routine operations, quality control and security, GammaVision is universally fit for large scale production labs, nuclear power plants, research and education, automated monitoring systems, and many other applications.

Why GammaVision?

Compatibility
- Operates in the most common PC Environments - Windows 8.1, 7 and XP
- Multiple Languages: German, Chinese, French and English
- Extensive Analysis and Detection Limit capability to accommodate a variety of applications
- Optional Report Writer with MS Access Data Storage and Crystal Reports for Custom Reports

Process Efficiency
- Integrated Hardware control
- Automation Scripting for Consistent measurement processes
- Simplified Calibration using Wizards and Interactive Editors
- Customizable Spectrum Display with “Live” update during acquisition and Detailed Peak Evaluation

Defendable Results
- Compliance with Industry Standards such as ANSI N42.14, ANSI N13.30, and ISO/DIS 11929
- Quality Control Reports, Trending, and optional instrument lock-out on violations
- Security to limit access to specified functions
- Comprehensive V&V Test Results available as an option

GammaVision 7 Brings a Broad Spectrum of Improvements!

New! 64-Bit Windows 8.1 and 7 German Language, and Regional Settings Compatibility
New! Enhanced ISO-11929 Compatibility
New! Optimization of Peak Search, Fit and Graphic Display, Library Reduction; and Cascade Summing Correction
New! Nuclide Independent Peak Background Correction
New! Defined Uncertainty for all standard analysis inputs and up to nine User-Defined Uncertainty parameters
New! “List Mode” Time-Correlated event logging for post-acquisition interrogation with sub-second resolution
New! Several additions and improvements in Job Functions to optimize Automation processes
New! Energy and Efficiency Calibration Enhancements
Bringing it all together for the most Compatible, Efficient, and Defendable Results Possible!
The core purpose of GammaVision is the accurate identification and quantification of radioactive material using high resolution gamma spectroscopy. This process requires accurate system calibrations and analysis settings, robust peak search and fit algorithms, and a variety of corrections for background, peak interferences, attenuation, reporting units, and various other factors. It is also important to comply with regulations and standards for reporting measurement uncertainty and detection limits.

For accuracy, efficiency, and standards compliance, GammaVision is the right choice.

**Key Analysis Features:**

- Standards Compliant: ISO/DIS 11929, ANSI N42.14, ASTM E181-82
- Total Uncertainty Propagation from all Standard Inputs and up to 9 User-Defined Parameters
- Analysis Parameters: Peak Search Sensitivity, Peak Uncertainty Cutoff, Peak Match Width, Fraction Limit, Background Determination by Automatic or Fixed Number of Channels with Linear, Parabolic, or Stepped Fit
- User-Defined Nuclide Libraries with Key Line, Peak Activity, and MDA Flags
- Optionally Calculate Nuclide Activity with the Absence of Qualified Peaks
- Graphical Peak Fit and Residuals Display
- Customizable Reports

**Peak Search Methodology**

- Library Driven Peak Location
- Second Difference method ("Mariscotti")
- User-Defined Region of Interest

**Analysis Corrections**

- Nuclide Dependent or Independent Background/Blank Subtraction
- Partial or Complete Peak Overlap (Deconvolution/Peak Stripping)
- Nuclide Decay During Collection, From Collection, and During Acquisition
- Random and Cascade Summing
- Gain/Energy Calibration Shift
- Internal and External Absorption
- Relative Geometry Extrapolation
- Peak-Weighted Average Nuclide Activity
Calibration

An accurate calibration is essential for proper peak identification and quantification – particularly for complex spectra with closely overlapping peaks. This can be a tedious and time-consuming process with some systems, but it’s easy with GammaVision’s Calibration Wizard. Simply acquire a spectrum, load a calibration library and source certificate, and the calibration is complete!

Calibrations can also be automated as part of the routine counting or QA processes.

Key Calibration Features:

- **Calibration Types**
  - Channel to Energy – Quadratic Fit
  - Energy to Shape (FWHM) – Quadratic Fit
  - Energy to Efficiency – Natural Logarithm Polynomial Fit across full energy range; or Linear, Quadratic, and Point-to-Point Interpolation fits for separate high and low energy regions
  - Peak-To-Total (Cascade Summing)

- **Calibration Processes**
  - Automatic Energy Calibration (U.S. Patent No. 6,006,162)
  - Calibration Wizard
  - Semi-Automatic and Manual/Interactive
  - Automation using Job Functions
  - Automatic Energy Calibration Adjustment during Analysis

- **Calibration Reports and Graphic Display**

Quality Assurance

Periodic instrument performance checks are necessary to ensure that the system is operating properly when samples are analyzed. These checks may be required by regulations, standards, or other governing bodies that may audit the results. The minimum performance measures should include validation of the system calibration parameters, limits that define acceptance and a warning when these limits are exceeded. Control charts for trending is also desirable and formally required for some applications.

Key Quality Assurance Features:

- **ANSI N13.30 and ANSI N42.14 Compliant**

- **Parameters Monitored**
  - Background Count Rate
  - Total Source Activity
  - Total Spectrum to Library Peak Energy Difference
  - Average Actual to Calibration FWHM Ratio
  - Average Actual to Calibration FWTM Ratio
  - Individual Peak Details Available in Database

- **Warning and Violation Limits with Optional Detector Lock-out**

- **QA Reports and Trend Charts**
GammaVision provides an intuitive user experience with the MCA Emulator “Spectrum Window” being the focal point of operation. This approach simplifies routine processes, such as hardware control and count rate/peak evaluation, but also provides the base for more advanced operations such as calibration, QA, and spectrum analysis with the most commonly used functions implemented as “hot keys” or toolbar buttons for rapid access.

The spectrum view offers all of the tools needed for basic MCA emulation including Hardware Control, Peak Navigation and Zoom functions, Region of Interest evaluation, Interactive Peak Search, Spectrum Overlay for comparison, Isotope Markers to identify nuclide common peaks, Summing/Subtraction of other spectra, and Spectrum Channel Smoothing. It also enables user preferences for color schemes and spectrum data views.

For easy access to spectra, GammaVision’s Multiple Detector Interface (MDI) mode can display up to 16 interactive windows (8 Detectors and 8 Files) with independent operation. Additionally, multiple detectors can be enabled for efficient group operations by synchronizing routine Start, Stop, and Clear processes from a single command.

Spectra are traditionally collected in Pulse Height Analysis (PHA) mode with data stored in channels related to pulse height. GammaVision 7 now allows the pulse heights to be stored in “List Mode”, or time-correlated events, with the ability to filter the events after acquisition by user-defined time ranges. This process allows long acquisitions to be scanned by shorter time ranges to identify when activity was detected or interrogate a specific period of interest.

Basic sample measurements are simple processes when using the standard “Ask on Start” options. Just check the user inputs required for each measurement and the user is prompted to select the applicable files or input sample data when the acquisition is started. Additional options may be set to automatically save and analyze the spectrum and print the analysis report.

Key User Interface Features:

- **Spectrum View**
  - View up to 8 live detectors and 8 saved spectra simultaneously
  - Real Time display update during acquisition.
  - Zoom In/Out independent of Full Spectrum Window
  - User-Defined Spectrum Properties: Colors, Data Points

- **Interactive ROI/Peak Calculations**
  - Peak Centroid, Shape, Gross/Net Area and Activity with Uncertainty
  - Variable Number of Background Channels
  - Improved FWHM accuracy when peak centroid falls between two channels.

- **Advanced Features**
  - Fast Mariscotti Peak Search to instantly mark Regions of Interest
  - Region of Interest (ROI) reports in Column or Paragraph format
  - Isotope markers with peak amplitude estimation to confirm peak source
  - Interactive “Jump to Peak” by ROI, Library Energy, or Peak Search options
  - Spectrum overlay for direct visual comparison to a reference
  - Combine Spectra by Channel Summing or Stripping
  - Spectrum Smoothing to improve statistically poor peak shape
  - List Mode Spectra filtered by Time Range
  - Ask On Start Basic Measurement process

- **Security**
  - Menu Level Password protection
  - Detector Locking by Owner
Although the toolbar and menus options are simple and intuitive, this method of operation does not guarantee consistent processing that is often needed for measurements performed frequently or by different individuals. In these circumstances a more structured approach using simple text scripts called “Jobs” may be preferred. This feature enables every detail of the process to be defined in advance or created dynamically by a custom user interface. Virtually all of the hardware commands, analysis parameters, and processes required measurements can be programmed for consistent and reliable results every time.

**Key Automation Features:**
- Simple Text Scripts require no prior programming experience
- Define and Set any Analysis Parameter or prompt for user input
- All Hardware Control functions available
- Jobs may be dynamically generated by custom data entry interfaces
- Custom Variables available for advanced programming
- Run External Applications and wait for completion

**Hardware Control**

The interface between hardware and software is provided through the ORTEC CONNECTIONS framework which supports up to 250 detectors across a local network. This application layer encompasses all of the hardware drivers and communication protocols that are necessary for software applications to control the MCB (Multi-Channel Buffer) instruments. Hardware controls are accessed through MCB Property pages that are integrated with GammaVision and other standard ORTEC applications.

Windows 8.1 and 7 64-bit hardware compatibility is available for all ORTEC instruments that use USB and TCP/IP connectivity. These instruments, as well as other legacy hardware, are also supported with Windows 8.1, 7, and XP 32-bit operating systems. Instruments that are dependent on a host computer, such as plug-cards or USB devices, can be shared on a network through the MCB Servers running on each computer. This process allows Windows 8.1 and 7 64-bit computers to operate instruments that are not 64-bit compatible through their 32-bit host.

**Key Hardware Control Features:**
- List Mode Data Acquisition
- High Voltage Bias Control
- Course and Fine Gain Adjustment
- Zero and Gain Stabilizer
- SMART-1 Detector functions
- ZDT loss-free counting correction
- Analog and Digital Amplifier Filters
- Automatic and Manual Optimization
- Sample changer control
- Insight Oscilloscope mode
- Battery Voltage monitoring for portable instruments.
- State-of-Health Monitoring
- Acquisition Presents including Real and Live Time, ROI Peak, ROI Integral, Peak Uncertainty, or MDA
### Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A66-BW</td>
<td>GammaVision High Resolution Gamma Spectroscopy Software for Windows. Includes standalone or first network copy and binary use license.</td>
</tr>
<tr>
<td>A66-NW</td>
<td>Single Use Network Copy. Requires current version of GammaVision. Example: For a three-station network, order one copy of A66-BW and two copies of A66-NW.</td>
</tr>
<tr>
<td>A66-UW</td>
<td>Update from A66-B32, A66-BW, or A66-NW to latest version of GammaVision.</td>
</tr>
<tr>
<td>A66-VW</td>
<td>GammaVision V&amp;V Test Results and Certificate of Validation.</td>
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### Subscriptions

Subscriptions are available for any current GammaVision license acquired through the purchase of A66-B32, A66-BW, A66-NW, A66-BVW, and A66-UVW models. Subscriptions provide automatic updates for one licensed copy as new releases become available.

| A66-2YW | 2 year subscription for GammaVision |
| A66-3YW | 3 year subscription for GammaVision |
| A66-4YW | 4 year subscription for GammaVision |
| A66-5YW | 5 year subscription for GammaVision |

### Options

- **A11-B32** CONNECTIONS Programmer’s Toolkit with ActiveX™ Controls
- **A12-B32** Analysis Results File (UFO) Toolkit
- **A44-BW** Report Writer Option for GammaVision
- **A49-B32** DataMaster Spectrum File Conversion
- **ANGLE-B32** Advanced Efficiency Calibration Software for HPGe Detectors
- **C53-B32** Nuclide Navigator® III Master Library
- **Global Value** Gamma Spectroscopy Automation and Custom Reporting
- **LVIS-B32** Counting Laboratory Application Manager

1Instruments using the IPX/SPX protocol require Windows XP. This may be accomplished on a Windows 8.1 or 7 computer using the XP Mode Virtual Machine. Instruments that have a Dual-Port Memory option can take advantage of the DPM-USB to communicate over a USB connection in the Windows 8.1, 7 or XP environments.

2Additional details for hardware functions are available in the relevant product literature.

3List Mode Data Acquisition is available for specific instrumentation, such as the DSPEC-50/502, DSPEC-Pro, and others.

Specifications subject to change.

073014
Introducing CONNECTIONS Programmer’s Toolkit Version 8

Simplified Hardware Control for Custom Application Developers!

Key Features

• Integrated Control of ORTEC CONNECTIONS Instruments in Custom Applications
• Access to all Instrument Commands, Properties, and Measurement Data
• ActiveX and Traditional DLL Application Interfaces
• Royalty Free Distribution License
• Built-In Support for Local and Networked Instruments
• Ready-To-Run Example Projects in Modern Development Environments
• Extensive Programming Documentation

New in Version 8!

New! 64-Bit Windows 8.1 and 7 Compatibility
New! Ready-to-Run Projects for LabView 2013 and C# 2013
New! “List Mode” Data Acquisition Examples
New! Documentation for Programming in C#, VB.Net, LabView, C++, Visual Basic 6, and MATLAB!
The CONNECTIONS Programmer’s Toolkit provides interface modules and instructions to easily control ORTEC hardware instrumentation from your own custom Windows applications. These modules are native components of the CONNECTIONS communication layer used with all standard ORTEC applications, such as MAESTRO and GammaVision, and allow control of instrumentation connected to the local computer as well as stand-alone network devices and those connected to other networked computers – all through a common programming interface! This common hardware control layer allows some functionality of your custom program to be shared with standard ORTEC applications if desired or take complete control of the hardware and data processing.

The toolkit includes ActiveX Controls to simplify coding in supported software development environments and a standard Dynamically Linked Library (DLL) Application Interface which can be used in both modern and legacy development environments. Example projects for both interfaces are available in different programming languages to demonstrate operations such as instrument connections, properties, and control with data collection in PHA and List Mode, as well as error handling. Automatic hardware configuration is also included with a program that searches for local and networked instrumentation that are compatible with CONNECTIONS.

Once you get your application developed you are ready for business with royalty-free distribution of the run time components for programs written to support operation of ORTEC hardware!

**Supported Hardware**

- All ORTEC CONNECTIONS Multi-Channel Analyzer (MCA) Instruments (i.e. any instrument that can be controlled using ORTEC’s MAESTRO application)
- EASY-NIM 928 MCA/Counter/Timer/Rate Meter Product Suite

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<td>A11-BW</td>
<td>CONNECTIONS Programmer’s Toolkit. Includes Documentation and Binary Use License.</td>
</tr>
<tr>
<td>A11-UW</td>
<td>Update from A11-B32 or A11-BW to latest version</td>
</tr>
<tr>
<td>A11-GW</td>
<td>Additional Hardcopy Documentation for A11-BW</td>
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Specifications subject to change 06/05/14
• Easy extraction of GammaVision® analysis results into custom 32-bit Windows® applications
• For use in conjunction with A11-B32 UMCBI Toolkit, which provides hardware control
• Examples given of usage with Microsoft® C and Visual Basic®

The Analysis Results Programmer’s Toolkit (A12-B32) provides 32-bit Dynamic Link Libraries (DLLs) of functions which can be used to create custom programs to interface with the spectrum and analysis results files used by GammaVision for the analysis of gamma-ray spectra from germanium detectors. The data collection can be controlled from the user program or by GammaVision itself. The analysis is done by the WAN32 or other analysis engine of GammaVision.

A useful combination of ORTEC and user-written software would be to use the ORTEC software to set up and calibrate the MCBs and then implement the special operations in a user-written program. For spectroscopy applications it is expected that MAESTRO™ or GammaVision will be used to configure and perform most of the interactive system functions. User-written programs can then perform any other system functions.

Support and examples are given for Microsoft C and Visual Basic. Other programming language support will be added when available.

The user-written program can perform any function desired for control of the MCBs, reading and writing spectrum files (SPC format), reading unformatted analysis results files (UFO), and writing the values into a report or database.

System functionality is separated into two main sections: one for reading and writing spectrum files and one for reading the results and producing reports. The reading of data from the detector uses the UMCBI Programmer’s Toolkit (A11-B32) which is a prerequisite to A12-B32.

The manual includes a function reference, data structures used, and examples of programs. The details of the spectrum and results files are included in the companion “Software File Structure Manual for DOS and Windows Systems.”

Software Prerequisites
A11-B32 ORTEC UMCBI 32-bit Programmer’s Toolkit.

Ordering Information
To order, specify:
A12-B32 32-Bit Analysis Results File (UFO) Toolkit
A12-G32 Documentation for A12-B32
A12-U32 Update for A12-B32
A12-K32 Upgrade from A12-B1 to A12-B32
Report Writer for ScintiVision™-32
A46-B32

Reports the Way You Need Them from a Searchable Database

- Custom Report Generation from ScintiVision-32
- Multiple custom report formats via specific templates
- Spectral plot included with report
- Creates Access®-compatible results database
- Archival capability

Reports Your Way  Report Writer (A46-B32), in conjunction with ScintiVision-32 software for NaI detectors, lets you produce a wide range of output reports — in exactly the form you require.

Instantly Searchable Database  Report Writer reads in the analysis results from the ScintiVision-32 output file, stores them into an Access-compatible database, and produces the report. Thereby, you progressively generate a PC-searchable database of all your analysis results. Then use Access to quickly generate, for example, daily summaries, exception reports, and cumulative release reports. Report Writer thus acts as a bridge between ScintiVision-32 results and database applications or a laboratory information management system.

Our Template or Yours  The output report is generated using a template file. The default template file supplied reproduces the standard ScintiVision-32 output report. Additional user-defined files1 may be used to produce totally custom output reports via this template development tool.

In addition to automatic output to the printer, the reports may be saved to disk in various industry-standard formats: ASCII, Rich Text, Crystal Reports, WORD, Comma-separated.

Multicolor Plots Automatically  A plotting program is included which permits the spectrum to be plotted to the printer automatically as part of the output report. The plot attributes may be prespecified.

As Automatic as You Want to Be  Report Writer can be run independently in order to regenerate or reformat reports from previous analyses, or automatically as part of the ScintiVision-32 analysis sequence, in which case the standard internal ScintiVision-32 output report is disabled.

Good Housekeeping  A facility is provided to allow database and supporting files to be archived to a specified directory. File types may be chosen from templates, spectral files, output files, and region-of-interest files. The archival process requires only a single click. Similarly a “purge” option allows removal of such files to the system recycle bin or permanent deletion.

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<tr>
<td>A46-B32</td>
<td>Report Writer option for ScintiVision-32</td>
</tr>
<tr>
<td>A46-U32</td>
<td>Update to A46-B32</td>
</tr>
<tr>
<td>A46-G32</td>
<td>Documentation for A46-B32</td>
</tr>
</tbody>
</table>

Prerequisites
A46-B32 will function satisfactorily on any system capable of supporting ScintiVision-32.
For custom report template development, a copy of Crystal Reports Version 5.0 or later is required.

1 In Crystal Report Writer, V5.0 format; trademark of Crystal Software, Vancouver, BC.
• Latest generation system for Materials Holdup Measurements for uranium and plutonium.
• Everything you need — gathers data, analyzes, and documents nuclear materials.
• Lightweight mobile unit.
• Powerful base-station desktop computer stores calibrations, equipment setup, and results.
• Method taught in the Los Alamos National Laboratory (LANL) Holdup Training Course.
• Incorporates the LANL Generalized Geometry Holdup algorithms.
• Available as a complete ready-to-use system.
• Components available for individual system integration.
• Recent HMS4 software updates allow Windows CE based mobile bar-code readers to be used.

Introduction

"Holdup" refers to the accumulation of special nuclear material (SNM) inside the processing equipment of nuclear facilities. Holdup must be minimized and quantified: for radiation and criticality safety, safeguarding against theft or diversion, and economic reasons.

Accurate holdup measurements, while simple in principle, are demanding on the operator. The measurements by their nature are made in situ at specified points in the plant — often in awkward locations where SNM may be deposited, such as valves and ducts. The operator often must wear protective clothing, resulting in additional discomfort during the performance of the measurement under already unpleasant conditions of high temperature and humidity — perhaps up a ladder while holding a detector against a pipe with an outstretched arm. Beside those physical demands, the operator must keep track of the nuclear counting data and associated parameters (e.g., wall thickness, measurement distance).

Operation

The HMS4 holdup measurement system makes it all as easy as possible for the operator, who need carry only a small, lightweight mobile unit which guides the operation and automatically logs the data with unique coding. This nearly eliminates the expense of having to repeat a measurement due to a data entry error.

The mobile unit is set up ready to go at the base station. When the operator completes the measurements, the unit is returned to the base to download the data. The host computer maintains all history and current data in an easy-to-use database. All needed reports and QA are available there.

HMS4 Development

HMS4 was developed as a joint effort between LANL, ORNL and the Y-12 National Security Complex. Its predecessor, HMS3 was originally used and perfected for uranium holdup then extended for plutonium holdup.

The calculations in the HMS4 software are performed in accordance with the Generalized Geometry Holdup (GGH) method, which simplifies the measuring process by reducing the large number of possible geometries to three: point, line, and area. By examining the plant carefully and choosing appropriate measurement points, one of the three standard geometries can assay holdup with acceptable accuracy at each plant location. The GGH methodology gives rapid and accurate quantitative analysis of holdup in literally miles of ductwork, hundreds of valves and pipes, and in dozens of pieces of process equipment — that is, every possible measurement location.
HMS4 Software
The HMS4 software includes two sets of programs; the main program that runs on a host personal computer (PC), and others running on a bar-code reader or portable PC.

The bar-code reader or portable PC is referred to as the Controller. The Host computer program performs setup and calibration of multichannel analyzer/detector pairs, loads the controller with operational parameters, receives measurement data from the controller, maintains measurements and derived results in databases, and prints reports.

The Field Controller programs control multichannel analyzer (MCA) setup functions, data acquisition, store measurement data as accumulated, and allow the user to review previous collected data and spectra.

The Field Measurements screen is the heart of the HMS4 Field MCA Control software. All of the data acquisition is done within this screen.

Four other host computer programs included in the distribution are: (1) the standalone Windows based Controller program, (2) a standalone MCA control selection program, (3) an upgrade program to be used to update existing older HMS3 databases to HMS4 format, (4) and a program for extracting the embedded Region of Interest (ROI) information from a Controller-saved spectrum.

The Windows-based HMS4 software provides the user with several enhancements over HMS3 versions. It offers the user a completely new menu based environment. It contains several new holdup correction algorithms such as the Finite Source correction and the Self-Attenuation correction. These algorithms have been integrated into the software for the capability of full error correction. HMS4 now supports twenty (20) spectral regions-of-interest (ROI) to aid the user measuring plutonium. The data from each Measurement Period (or campaign) is easily accessed from the main menu. All measurement data dumps are date and time stamped and allow for an 80-character comment field, which can be used for extra notes.

Many improvements have been made in the way that HMS4 performs background calculations, and now, the user has the flexibility to make 20 background measurements and reference the order needed.

HMS4 is written in Microsoft Visual Basic .NET® as part of the Microsoft Visual Studio .NET® 2003 development package. It uses Microsoft Access® (Microsoft Office 2000/XP format) database files. The reports are generated with the Crystal Decisions, Inc., Crystal Reports report generator, which is included with the Visual Basic .NET package. The software for the Controller (Pocket PC devices) is written in Microsoft embedded Visual Basic® as part of the Microsoft embedded Visual Tools v3.0® development package for Windows CE.
Holdup Measurement Training
The HMS4 system operation requires some hands-on experience in real world holdup situations. Both operators and supervisors should be knowledgeable of "GGH" methodology. A course is offered at Los Alamos National Laboratory, titled "Nondestructive Assay of Special Nuclear Materials Holdup," (Course # MCA-243); a similar course is offered by Oak Ridge National Laboratory (ORNL). This will give a user the fundamentals of the "GGH" methodology and an introduction to the use of the HMS4 package. Training includes theory and actual measurements using instrumentation supported by the HMS4 package. Contact ORTEC or Los Alamos National Laboratory for further training information.

HMS4 System
A typical HMS4 System is a complete holdup system with the following components:

Mobile Portion
NaI Detector
The NaI detector, compact and easy to use, includes shielding on the sides and back to minimize background interference from extraneous radiation sources. This improves the signal-to-noise ratio, resulting in short measurement times and accurate results. Several detector models are available to match specific measurement needs. The quality of the data (spectra) is assured by the use of a reference source (\(^{241}\text{Am}\)) attached to the detector, which provides a signal for gain stabilization and resolution monitoring. Any resolution change is reported to the operator.

Portable Multichannel Analyzer
HMS4 supports the following multichannel analyzers (MCAs): the ORTEC digiDART, digiDART-R and the Rossendorf MCA-166. ORTEC recommends the use of the digiDART.

Field Controller
Recent updates to the HMS4 Software have made a new generation of hand-held computers available as HMS4 Field Controllers. The Intermec CN3 Series of Mobile PC with Windows Mobile 5 has been successfully tested with HMS4. It is the Field Controller of choice with full systems purchased from ORTEC. These portable devices with bar-code reader facilitate obtaining holdup measurements. As the operator travels around the facility, the Field Controller controls the MCA data acquisition and stores the count rate data along with a field location bar-code. (Bar-codes positioned around the plant specify the measurement locations.) This procedure, which dramatically simplifies the entire process of obtaining the right data at the right place, ensures reproducible measurements.

There is also a full Microsoft Windows version of the Controller software. This is for use by individuals who wish to use a laptop computer in the field.

Host Computer
The supervisor uses the host computer to set up and calibrate the multichannel analyzer/detector pairs and to program the bar-code readers before the operator takes the mobile unit to perform measurements. All of this is supported by an extensive, easy-to-use menu system. Upon the mobile unit’s return, the supervisor receives the measurement data from the bar-code reader/controllers. The measurement data and the derived results are stored in databases. The associated reports and data summaries can then be viewed and printed. A single host computer can support multiple field systems.

HMS4 Reports
The results report may be sent to the screen or the printer. It is generated using Crystal Reports. Spectra can be re-analyzed as needed. An example of the report is shown in the figure.
Ordering Information
ORTEC offers a complete HMS4 holdup system through our Integrated Systems Group which should be contacted for detailed system specifications and a price quote. The system which follows is an example configuration:

<table>
<thead>
<tr>
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</table>

HMS4 Software ONLY
HMS4-B32 Software for controller and host (supplied on CD-ROM).

Holdup Detector ONLY
1X.5/N 1 in.-diameter by 0.5 in.-thick NaI(Tl) integral detector with 1 in.-depth and diameter collimator, 0.320 in.-thick lead side shield, 0.375 in.-thick lead back shield, with Mu-metal shield surrounding front-end electronics. Cable included. Resolution <8% FWHM at 662 keV; weight ~3.8 lbs.
1X.5/U Same as 1X.5/N, but with side shield wall thickness of 0.170 in., for measuring low-energy gamma emitters such as HEU; weight ~2.6 lbs.
1X2/P Same as 1X.5/N, except with 1 in.-diameter by 2 in.- thick NaI crystal, typically used for high-energy gamma emitters such as plutonium.

Detector Options
1X.5/HSG Extra housing and shielding to allow for added flexibility, converts 1X.5/U to 1X.5/N.
1X.5/2/CBL Extra Cable for above detectors with PVC sleeving for easy cleaning.
INCC-B32 is the latest PC version of the Los Alamos general-purpose Neutron Coincidence Counting program (INCC). It runs under Microsoft Windows 2000/XP. INCC is suitable for nondestructive passive and active neutron applications for U and Pu. Passive neutron verification techniques include known alpha, known multiplication, add-a-source, multiplicity, curium ratio, and truncated multiplicity. Active techniques include multiplicity, collar, and active/passive. Active multiplicity presently determines the neutron multiplication of a uranium item, but does not determine the uranium mass.

Items may be verified using multiple methods simultaneously. For example, plutonium items may be verified via the passive calibration curve and the known alpha techniques simultaneously. (Collar verifications may not be combined with other verification techniques.)

**Hardware Supported**

The following coincidence counting electronics are supported:

- ORTEC/ANTECH Advanced Multiplicity Shift Register AMSR 150
- Canberra JSR-11, JSR-12, and JSR-14
- Los Alamos MSR4 Multiplicity Module
- Canberra 2150 Multiplicity Module
- Aquila Portable Shift Register (PSR)
- Los Alamos Intelligent Shift Register (ISR)
- Los Alamos Dual-Gated Shift Register (DGSR).

**Calibration**

Calibration curves are calculated internally in the program. This is done using calibration standards and the data being fitted by the Deming least squares fitting process. The resulting calibration coefficients are automatically transferred to calibration files and the system is then ready for verification measurements. Calibration curves may be plotted along with the calibration and verification measurement data to produce graphical summaries of calibration and verification results.

**Easy-to-Use Output Reports**

All measurement results are stored in both database and text files. Reports may be created, reviewed, and printed for any measurement data or results at any time.

Summary reports of verification results may be generated, one measurement per line, in comma-separated variable format for input to a spreadsheet program such as Excel®.

Material mass may be calculated, and the results displayed for verification. Measurement data files may be imported from the Radiation Review program, and results for background and normalization measurement data files may also be processed and displayed. (These files are created from measurements made by the Shift Register Collect or Multi-Instrument Collect running in unattended mode.) The results remain in the database, and can be reviewed or reanalyzed at any time.

**Quality Assurance**

Measurement control options are included for quality assurance purposes. They include normalization and precision tests to check the detector efficiency and stability; raw data tests and outlier tests to check for data consistency.
Analysis Details

INCC-B32 provides the following analysis capabilities when used with appropriate neutron-counting hardware:

**Rates Only**
Rates only measurements produce singles, doubles, and triples rates and errors as the only result. The rates are corrected for dead time, passive background, and normalization.

**Background**
Passive background measurements automatically replace previous passive singles, doubles, and triples background rates with the new measured rates. An active background measurement automatically replaces the previous active background singles rate.

**Initial Source**
For americium-lithium (AmLi) initial source measurements, excluding the UNCL, the singles rate and measurement date are stored in the database as the reference values for normalization measurements. For \(^{252}\text{Cf}\) initial source measurements the doubles rate and error and the measurement date are stored in the database as the reference values for normalization measurements. These rates are corrected for dead time and background.

**Normalization**
The normalization measurement determines a normalization constant to correct for a change in the detector efficiency since the initial source measurement.

**Precision**
Precision measurements test the short term system stability by determining whether the observed scatter in a series of doubles measurements is statistically consistent with the expected scatter. The result is the measured chi-squared value, the upper and lower limits, and a pass/fail message.

**Verification Measurements — General**
There are five types of passive verifications and four types of active verifications. The passive verifications determine Pu mass while the active verifications (except for active multiplicity) determine \(^{235}\text{U}\) mass. All verifications start with the measurement of count rates as described above, followed by one or more verification calculations. Each verification type has its own analysis method; the rates from an item can be analyzed with several analysis methods simultaneously. The Pu isotopic composition is used by all of the passive methods to convert the effective \(^{240}\text{Pu}\) mass to Pu mass; it is also used with the \(^{241}\text{Am}\) content in the known alpha method to calculate the alpha value and in the known multiplication method to calculate the effective \(^{239}\text{Pu}\) mass. The Pu and Am content is decay corrected from the analysis date or dates to the verification date.

**Verification Measurements — Passive Calibration Curve**
The verification is based on a calibration curve of corrected doubles rate vs. effective \(^{240}\text{Pu}\) mass. Four curve types are provided with the general form \(D = D(m, a, b, \ldots)\), where \(D\) is the doubles rate, \(m\) is the effective \(^{240}\text{Pu}\) mass, and \(a, b, \ldots\) are calibration constants. The effective \(^{240}\text{Pu}\) mass is calculated from \(D, a, b, \ldots\) and the standard deviation of \(m\) is calculated using standard error propagation techniques. In addition, an extra error term is included to account for additional sources of error. The Pu mass is calculated from \(m\) and the isotopic composition; the error of the Pu mass is calculated with standard error propagation techniques using the errors of \(m\) and the Pu isotopes.

**Verification Measurements — Known Alpha**
The verification is based on a calibration curve of multiplication corrected doubles rate vs. effective \(^{240}\text{Pu}\) mass. The multiplication corrected doubles rate \(D_c\) is calculated from the singles and doubles rates, the alpha value, rho-zero, and a constant \(k\). The calibration curve has the form \(D_c = a + bm\), where \(a\) and \(b\) are calibration constants. Otherwise, the analysis procedure is the same as for the passive calibration curve procedure.

**Verification Measurements — Known M**
The verification is based on a calibration curve of multiplication vs. effective \(^{239}\text{Pu}\). The equations relating the singles and doubles rates to the effective \(^{240}\text{Pu}\) mass, multiplication \((M)\), and alpha are the same as for the known alpha technique. Alpha and the effective \(^{240}\text{Pu}\) mass are the unknowns; \(M\) is determined from the calibration curve. The only function for the calibration curve presently in the software is \(M = 1 + am + bm^2\), where \(m\) is the effective \(^{239}\text{Pu}\) mass, and \(a\) and \(b\) are calibration constants. There is presently no error calculation for the effective \(^{240}\text{Pu}\) mass; the only error assigned to the effective \(^{240}\text{Pu}\) mass is the additional error term.
Verification Measurements — Passive Multiplicity

For conventional multiplicity analysis the verification is based on the monoenergetic, point-model equations that relate the singles, doubles, and triples rates to the effective $^{240}$Pu mass, multiplication, and alpha. For multiplicity analysis with unknown efficiency, the same equations are used, but the neutron multiplication is set to unity and the equations are solved for effective $^{240}$Pu mass, efficiency, and alpha.

For multiplicity analysis with the dual-energy model, the energy-dependent, point-model equations are used to determine the effective $^{240}$Pu mass, multiplication, and alpha. The errors of the verification results from conventional multiplicity analysis are also used for the errors in dual-energy multiplicity analysis.

There is an empirical correction factor that is applied to the effective $^{240}$Pu verification mass to account for a normalization required for items with high neutron multiplication. The correction factor $f$ has the form $f = a + b(M–1) + c(M–1)^2$, where $M$ is the neutron multiplication and $a$, $b$, and $c$ are calibration constants. The correction factor is usually set to 1.

Verification Measurements — Add-A-Source

The add-a-source correction factor $f$ has the form $f = 1 + a + b\delta + c\delta^2 + d\delta^3$, where $a$, $b$, $c$, and $d$ are calibration constants and $\delta = D_{\text{ref}}/D_{\text{meas}}–1$, where $D_{\text{ref}}$ is the reference doubles rate decayed to the measurement date and $D_{\text{meas}}$ is the doubles rate from the verification item with the Cf add-a-source less the doubles rate from the verification item alone. These doubles rates involving the add-a-source are averages over up to five positions of the source. The measured doubles rate from the item is multiplied by $f$ and the Pu verification mass is then determined as described above under “Verification Measurement — Passive Calibration Curve.”

Verification Measurements — Curium Ratio

Curium ratio analysis is an indirect method of determining the mass of plutonium and uranium from an observed curium neutron measurement. The curium ratio method was developed for the analysis of waste streams in spent fuel-reprocessing facilities. In these waste streams, $^{244}$Curium ($^{244}$Cm) is the dominant neutron producing species.

This method requires a chemical analysis of the waste stream, after extraction of the plutonium and uranium has been completed, to determine the concentrations of $^{244}$Cm, plutonium, and uranium. Ratios of grams curium per gram plutonium and grams curium per gram uranium can then be formed. These ratios are used as input parameters for the curium ratio analysis. It has been shown that these ratios remain constant throughout the waste treatment process (concentration, vitrification).

The actual neutron measurement is an observation of $^{244}$Cm spontaneous fission neutrons. Using a typical passive calibration curve analysis, the mass of curium can be determined. The values of the Cm/Pu and Cm/U ratios are then applied to determine the mass of Pu and U from the observed Cm mass. The ratios are decay corrected from the chemical analysis date to the measurement date within the INCC program. Errors in these ratios are propagated and included in the error ascribed to the determined masses. The $^{235}$U mass is also calculated by INCC, but this mass is obtained from the ratio of the operator-declared masses for $^{235}$U and U.

Verification Measurements — Truncated Multiplicity

The truncated multiplicity method is used for the measurement of very small Pu items when the cosmic ray background interferes with the measurement. Truncated multiplicity analysis uses only the first three multiplicity values (the zeros, ones, and twos) in the multiplicity distributions and thus ignores the higher multiplicities that are produced primarily by cosmic rays; this improves the precision of the assay mass.

Verification Measurements — Active Calibration Curve

This is the same as verification by passive calibration curve, except that the calibration mass is $^{235}$U rather than $^{240}$Pu and the doubles rate is corrected for the decay of the AmLi sources.

Verification Measurements — Collar

The verification is based on algorithms for thermal-mode and fast-mode active measurements of LWR fuel.

Verification Measurements — Active Multiplicity

In its present state of development, the active multiplicity technique does not verify the $^{235}$U mass of an item; it is only able to determine the neutron multiplication of the item. The multiplication is determined from the triples and doubles rates using the active multiplicity equations; the doubles and triples rates in the active multiplicity equations are the same as those in the passive multiplicity equations except that the spontaneous fission moments are replaced by the thermal neutron induced fission moments of $^{235}$U, the induced fission moments are replaced by the 2-MeV induced fission moments of $^{235}$U, and the spontaneous fission rate is replaced by the rate of $^{235}$U fissions induced by AmLi neutrons. The calculation requires the first, second, and third factorial moments of the thermal neutron induced fission of $^{235}$U and of the 2-MeV induced fission of $^{235}$U.
Verification Measurements — Active/Passive

Active/passive verification is used for active verification (except UNCL verification) when the item has a significant passive neutron yield. The item is measured with and without the americium-lithium (AmLi) interrogation sources. The net doubles rate is used for the verification exactly as for verification by active calibration curve.

Holdup Measurements

The holdup measurement option performs multiple measurements of a glove box at different positions, and then averages the count rate data from each position into a single value for use in calculating the $^{245}$Pu effective mass in a glove box. The multiple measurements are obtained from scanning the glove box with neutron slab detectors. The INCC software controls the data collection so that all the measurements for a single glove box are stored in one data file.

System Requirements

Any IBM compatible computer which will operate Windows 2000/XP.

One serial port unless using add-a-source, then two serial ports.

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCC-B32</td>
<td>INCC Software and User Documentation</td>
</tr>
<tr>
<td>INCC-G32</td>
<td>INCC Documentation</td>
</tr>
</tbody>
</table>
MGA++ is a suite of three software programs (MGA, U235 and MGAHI) for analysis of Actinide spectra acquired by germanium detectors. MGA++ is the result of years of continuing development at Lawrence Livermore National Laboratory.\(^1\)

The original MGA code was developed to determine plutonium isotopic abundances for gamma-ray data taken with germanium detectors. MGA-B32 consists of 1) an upgraded version of the original MGA code, which relies on the 100-keV region; 2) U235, a uranium isotopic analysis code that uses gamma rays less than 300 keV; and 3) MGAHI, a plutonium isotopic analysis code that uses the 200 keV–1 MeV energy region. The codes analyze gamma-ray data collected with a HPGe detector. All of the executable software is 32-bit Windows compliant.

The programs, requiring no special calibration sources or calculations, use only information obtained from the sample spectra to determine the isotopic ratios.

A full member of the CONNECTIONS-32 software family, MGA++ can display the data being acquired, then rapidly analyze and report results — all from a single, easy-to-use program.

User Interface

For each operational mode, separate “viewer” programs (MGAView, MGAHIView and U235View) and analysis modules (MGA.EXE, MGAHI.EXE and U235.EXE) ensure the integrity of the analytical methods. The Viewer program provides the user interface and the hardware control function. In MGA++ it is possible to suppress all spectral display.

MGAView, MGAHIView and U235View present the same friendly user interface. The MGA mode operator interface is shown in Fig. 1. The current status of the detector is shown on the right. A special count-rate meter mode shows the instantaneous count rate of a selected region. The spectrum may be viewed during acquisition.
The Start/Save/Report feature (Fig. 2) provides one-button collection and analysis — via keyboard or mouse — easing the task for operators in protective suits! When additional counts are deemed necessary, “Restart/Save/Report” continues the current count.

Reanalysis of spectra from disk or in the MCB is easy — just click and select (Fig. 3). All the spectra collected by the MGA++ programs are stored in the ORTEC standard spectrum (SPC) format, which can be read by many programs. The file includes analysis parameters and hardware description records — everything needed to verify the results.

Spectra stored on disk may be analyzed by MGA++ from a wide variety of input file formats in addition to the primary ORTEC SPC file format (Table 1).

The analysis results can be displayed, with zoom function capabilities (Fig. 4), for visual confirmation of the analysis. Peak fit results may be scrutinized along with fit residuals for visual assurance of analysis quality. To aid comprehension, individual peaks on the display can be turned on or off (Fig. 5).

Flexible Analysis

Analysis parameters are specified in clear, easy-to-understand dialog boxes. Analysis parameters may be saved to disk for use on similar samples and recalled as required.

The flexibility of the analysis settings options for U235View are shown in Figs. 6–9, for sample type, peak shape parameters, absorption, and source/detector absorption. For MGAView (Figs. 10–13), they are sample type, source geometry, $^{242}\text{Pu}$ calculation, and low-energy detector. Figures 14–16 show sample type, geometry, and Pu-242 dialogs for MGAHIView.

At the end of each analysis the results are automatically stored in the Access format database and are also printed or displayed for the operator. The three database tables (Analysis, Acquisition, and Isotope; see, for example, Fig. 17) can be viewed by MGAView (using the record function) or by Access. This powerful data storage method makes summary reports, exception reports, and other useful outputs which are easy to create. The standard reporting options are shown in Figs. 18, 19 and 20.

<table>
<thead>
<tr>
<th>File Formats Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLNL/ACCUDUMP (NCD BINARY)</td>
</tr>
<tr>
<td>ASCII (sequential integer) no header</td>
</tr>
<tr>
<td>Nuclear DATA µMCA (ACCUSPEC) (.CNF)</td>
</tr>
<tr>
<td>Canberra S100</td>
</tr>
<tr>
<td>ORTEC ADCAM (.CHN)</td>
</tr>
<tr>
<td>LLNL ASCII</td>
</tr>
<tr>
<td>SPE ASCII</td>
</tr>
<tr>
<td>“Euro” ASCII</td>
</tr>
<tr>
<td>ORTEC MGA (Integer .SPC)</td>
</tr>
<tr>
<td>ORTEC (Real .SPC)</td>
</tr>
</tbody>
</table>

Table 1.
**CONNECTIONS Integration**

The MGA++ programs, operating under Windows 2000/XP, are completely integrated into the ORTEC **CONNECTIONS**-32 environment. All ORTEC multichannel buffer hardware, including the DigiDART, DSPEC, DSPEC Plus and DSPEC jr MCAs, are supported — whether networked or standalone.

The **CONNECTIONS** structure, common to all 32-bit ORTEC application programs, facilitates development of custom applications, e.g., automated measuring systems. (Developer's toolkits are available from ORTEC to aid this process.) Common benefits of all **CONNECTIONS** 32-bit products are multitasking, multi-threading support for concurrent analysis processes under Windows 2000/XP, simultaneous support of both locally connected and remotely connected MCAs over Ethernet links, and detector locking by security password.

**Prerequisites**

MGA++ will operate correctly on any system supporting ORTEC multichannel buffer hardware under Windows 2000/XP. While MGA++ can control compatible MCA hardware directly, MAESTRO-32 is a prerequisite for instrument setup.

**MGA Analysis Mode**

- Produces weight percent results for $^{238,239,240,241}\text{Pu}$, $^{241,243}\text{Am}$, $^{237,239}\text{Np}$, and $^{235,238}\text{U}$
- Determines $^{242}\text{Pu}$
- Operates with a single-planar HPGe detector for 0–300 keV or with a planar and a coaxial HPGe detector for 0–1000 keV
- No calibration standards needed to correct for matrix or container effects
- Automatic energy and peak shape recalibration

MGA mode has two data analysis configurations: one-detector mode and two-detector mode. In one-detector mode, MGA is designed to operate with a planar HPGe detector for the energy range 0–300 keV to obtain the Pu isotopic information. In two-detector mode, intended for highly-attenuated samples, the measurement may be aided by higher energy data up to ~1000 keV obtained from a coaxial HPGe detector. This coaxial detector allows measurement of gamma-ray energies to ~1 MeV. With this additional information, sample homogeneity and isotopic content can be refined. However, in the two-detector mode, the information from the planar detector is required, the coaxial information alone is insufficient. This requirement adds significant limitations when applying the original MGA code to the gamma-ray spectra of heavily shielded samples. This has to some extent been mitigated by the introduction of the ORTEC SGD GEM detectors, which in some cases can be used to perform the function of the planar and coaxial detector in one, by the use of two separate spectra, low and high energy.

There are about ten energy regions in a plutonium gamma-ray spectrum which may be used to calculate isotopic abundances. Those in the 94–104 keV region and the peaks at 129 and 148 keV are the most intense. Although those regions are difficult to analyze, yield precision of 1% or better can be achieved.

**Typical MGA Mode Performance**

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**Comparison of MGA Analysis Results, Measured at LLNL with PIDIE Standards—10 Minute Count**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Std % Declared</th>
<th>Std-Calc % Error</th>
<th>Reported % Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{238}\text{Pu}$</td>
<td>0.0101</td>
<td>0.7</td>
<td>3.87</td>
</tr>
<tr>
<td>3</td>
<td>0.0437</td>
<td>3</td>
<td>1.74</td>
</tr>
<tr>
<td>5</td>
<td>0.1221</td>
<td>3</td>
<td>1.39</td>
</tr>
<tr>
<td>$^{239}\text{Pu}$</td>
<td>93.848</td>
<td>0.084</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>84.927</td>
<td>0.024</td>
<td>0.08</td>
</tr>
<tr>
<td>5</td>
<td>76.534</td>
<td>0.24</td>
<td>0.18</td>
</tr>
<tr>
<td>$^{240}\text{Pu}$</td>
<td>5.987</td>
<td>1.02</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>14.191</td>
<td>0.056</td>
<td>0.49</td>
</tr>
<tr>
<td>5</td>
<td>21.381</td>
<td>0.9</td>
<td>0.61</td>
</tr>
<tr>
<td>$^{241}\text{Pu}$</td>
<td>0.1206</td>
<td>0.08</td>
<td>0.65</td>
</tr>
<tr>
<td>3</td>
<td>0.6049</td>
<td>1.6</td>
<td>0.42</td>
</tr>
<tr>
<td>5</td>
<td>1.26</td>
<td>0.8</td>
<td>0.49</td>
</tr>
<tr>
<td>$^{241}\text{Am}$</td>
<td>0.3048</td>
<td>0.9</td>
<td>0.39</td>
</tr>
<tr>
<td>3</td>
<td>1.012</td>
<td>0.2</td>
<td>0.38</td>
</tr>
<tr>
<td>5</td>
<td>2.55</td>
<td>0.27</td>
<td>0.49</td>
</tr>
</tbody>
</table>

**Total Specific Power**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Declared</th>
<th>Std-Calc % Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.644</td>
<td>0.22</td>
</tr>
<tr>
<td>3</td>
<td>4.068</td>
<td>0.12</td>
</tr>
<tr>
<td>5</td>
<td>6.639</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Sample Age Since Processing
MGA handles both freshly-separated and aged samples — important because recently-processed plutonium samples are usually very low in $^{237}\text{U}$ and $^{241}\text{Am}$. The $^{237}\text{U}$ increases in activity for about 2 months after processing, at which time it reaches equilibrium with the alpha-decay rate of its $^{241}\text{Pu}$ parent. Any analysis method that always assumes an established decay equilibrium between these two isotopes cannot be used on freshly-processed samples.

Presence of Other Radioactive Materials
Other radioactive materials may be present in plutonium samples as decay products, as contaminants from previous processes, or as a result of blending. Uranium is one common radioactive material which is blended with plutonium to form mixed-oxide (MOX) fuels. MGA can accurately determine the relative abundance of $^{238}\text{U}$ in a sample. Other radioactive materials sometimes encountered are $^{237}\text{Np}$-$^{233}\text{Pa}$, $^{243}\text{Am}$-$^{239}\text{Np}$, and low levels of some fission products such as $^{95}\text{Zr}$-$^{95}\text{Nb}$ and $^{137}\text{Cs}$. If a two-detector system is employed, $^{237}\text{Np}$ can be detected down to about 50 ppm by analysis of the 312 keV peak of $^{233}\text{Pa}$, the daughter of $^{237}\text{Np}$. MGA automatically recognizes the presence of interference from $^{243}\text{Am}$ and $^{239}\text{Np}$ isotopes, the fluorescence of x-rays of thorium in the sample, and the presence of $^{137}\text{Cs}$ (if the two-detector system is used).

MGAHI Mode
MGAHI uses physical parameters to take into account both attenuation and emission of gamma rays, and does not require a detector efficiency calibration. The gamma-ray information between 50 keV and 200 keV is not required. MGAHI is useful when sources are heavily shielded, and in a high background, space-limited environment. With too much shielding, the 100-keV energy region could be completely attenuated. In a high-background environment, the detector could see gamma rays from other nearby sources. Also, the spectrometry system could have a very high dead time. Lead shielding can be used in this situation to reduce the dead time, but this could also cut out the low-energy gamma rays. MGAHI employs the original MGA methodology in that it: 1) uses physical parameters to take into account both attenuation and emission of the gamma rays, and 2) does not require detector efficiency calibration. However, unlike the "original MGA", the planar information is no longer required. The MGA analysis relies very heavily on the 100 keV energy region detector efficiencies, absorber thickness and Pu thickness are calculated from the spectral data using known gamma-ray peaks from the decay of $^{239}\text{Pu}$.

MGAHI Mode Performance
MGAHI Pu weight % results of the two Pu (PIDIE) standards. Data was collected using a 75% coaxial detector for 3 hours. Two absorbers (5 mm stainless steel (ss) and 2 mm Pb) were used. Results from destructive analysis (DA) are also tabulated.

<table>
<thead>
<tr>
<th></th>
<th>$^{238}\text{Pu}$</th>
<th>$^{239}\text{Pu}$</th>
<th>$^{240}\text{Pu}$</th>
<th>$^{241}\text{Pu}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIDIE#1 +ss</td>
<td>0.012 ±18%</td>
<td>93.79 ±1%</td>
<td>6.02 ±4%</td>
<td>0.19 ±7%</td>
</tr>
<tr>
<td>PIDIE#1 +Pb</td>
<td>0.011 ±15%</td>
<td>93.85 ±1%</td>
<td>5.98 ±3%</td>
<td>0.18 ±5%</td>
</tr>
<tr>
<td>PIDIE#1 DA</td>
<td>0.01108</td>
<td>93.822</td>
<td>5.969</td>
<td>0.1975</td>
</tr>
<tr>
<td>PIDIE#3 +ss</td>
<td>0.042 ±14%</td>
<td>84.65 ±1%</td>
<td>14.34 ±3%</td>
<td>0.97 ±4%</td>
</tr>
<tr>
<td>PIDIE#3 +Pb</td>
<td>0.044 ±13%</td>
<td>84.91 ±1%</td>
<td>14.04 ±3%</td>
<td>1.01 ±3%</td>
</tr>
<tr>
<td>PIDIE#3 DA</td>
<td>0.0475</td>
<td>84.835</td>
<td>14.128</td>
<td>0.99</td>
</tr>
</tbody>
</table>
U235 Analysis Mode

- Relative ratios for $^{235}\text{U}$, $^{234}\text{U}$, and $^{238}\text{U}$
- Automatically checks for the presence of Pu using the 129 keV peak
- Operates with a single-planar HPGe detector from 0–300 keV
- No calibration standards necessary to correct for matrix or container effects
- Corrects for internal sample absorption and absorbers placed between sample and detector
- Peak shape calibration determined from user-defined spectral peaks, reloadable from file, or from default values

U235 uses a single planar HPGe detector and operates in the energy range 0–300 keV. It determines the relative isotopic ratios for Uranium. In a similar fashion to MGA and MGAHI, no primary calibration is required for efficiency or for absorbers in the matrix or in the sample container.

Typical U235 Mode Performance

U235 gives weight percent results for $^{234,235,238}\text{U}$.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Range (wt. %)</th>
<th>Absolute Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{234}\text{U}$</td>
<td>0.02–2</td>
<td>5.0</td>
</tr>
<tr>
<td>$^{235}\text{U}$</td>
<td>0.02–0.5</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>0.5–70</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>70–93</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>93–99</td>
<td>5.0</td>
</tr>
<tr>
<td>$^{238}\text{U}$</td>
<td>99–99.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

The U235 analysis mode gives relative ratios for $^{235}\text{U}$, $^{234}\text{U}$, and $^{238}\text{U}$; and when operating in this mode, it can warn the user of the possible presence of Pu.

Absolute accuracy depends on the statistics of the sample.

General Considerations

Sample Size and Matrix

In practical terms, the lower limit on sample size is about 100 mg — determined by count time and required statistical accuracy. While in principle there is no upper limit to the size, only the surface of a large sample is actually measured - because plutonium and uranium have short mean-free-paths for low-energy photons. Increasing the sample thickness beyond the “saturation thickness” will not increase the count rate because photons from the back of the sample are fully absorbed.

The extent of fluorescence from uranium or plutonium by their own alpha or gamma emission is much lower than from solid materials. Entering details about the solution will assist the analysis in dealing with the x-rays.

Shielding

A shield or collimator should be used to reduce or eliminate the counts in the spectrum from nearby materials. Cadmium, copper, lead, or tantalum foils are used to reduce the presence of the low-energy gamma rays, specifically those at 59 keV. This reduces the dead time from unusable counts for plutonium samples. These low-energy gamma rays are hardly ever present in uranium samples. Unless they are present, preferential filtering of low-energy photons is almost never required and is of no value.
Germanium Detector
For measurements up to 300 keV with either MGA or U235, a planar HPGe detector with a nominal resolution of 550 eV at 122 keV is required. While this requirement may in some cases be relaxed, the 122-keV resolution should not exceed 700 eV.

A thicker planar detector will have a higher peak-to-Compton (p/C) ratio, so that, assuming that it has an area and 122-keV resolution consistent with the other requirements specific to the measurement, it may deliver superior performance at low energies.

To use the higher energy regions in the analysis of samples containing only plutonium, in two detector MGA mode or in MGAHI mode, a coaxial detector with a resolution of less than 2.0 keV at 1332 keV is adequate. For MGAHI, a detector resolution of 1.1 keV or better at 208 keV is required. The 203-keV gamma ray from $^{239}\text{Pu}$ must be visible. Up to 5 mm of Pb absorber can be placed in front of the detector.

ORTEC’s Safeguard (SGD) Series of coaxial and planar detectors, specifically optimized for the purpose, are highly recommended for use with MGA++.

Ordering Information
To order, specify:

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGA-B32</td>
<td>MGA++ Safeguards Software</td>
</tr>
<tr>
<td>MGA-U32</td>
<td>Update for MGA-B32</td>
</tr>
<tr>
<td>MGA-G32</td>
<td>Documentation for MGA-B32</td>
</tr>
</tbody>
</table>

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1 It is the subject of a cooperative research and development agreement (CRADA TSV-1368-96) and license (License Number TL-1375-96) between ORTEC and the University of California under which ORTEC is integrating those programs into the ORTEC software environment to enhance usability.

PC-based chart of the nuclides for use with gamma spectroscopy analysis software (GammaVision) or as a stand-alone package.

New Features, Additional Libraries, and New Tools to retrieve information and identify isotopes.
The Most Comprehensive Nuclide Library Database Ever Available from ORTEC

NuclideNavigator III has expanded and updated its libraries to comprise the most accurate information available. The TORI database has been added to the list of available databases, and the NUDAT library has been updated from Brookhaven National Laboratory’s latest archive. The Erdtmann and Soyka database remains in the software as well as some handy pre-selected libraries for environmental and nuclear power plant counting and calibration libraries for the standard mixed gamma and mixed europium sources. All libraries supplied with the software are available in Microsoft Access database (MDB) format and ORTEC GammaVision (LIB) format.

Each library contains the appropriate alpha, beta, and/or gamma decay. Viewing the information for a specific isotope allows quick access to both the parent and daughter isotopes with a simple click of the mouse.
Interactive Creation/Editing of Libraries for use with ORTEC Software Products

Creating and editing libraries in Nuclide Navigator is as easy as using a mouse. To add a nuclide simply drag and drop nuclides from the Master Library window to the Target Library.

The source and target libraries can be in Microsoft Access database format or the ORTEC format for GammaVision (LIB) libraries. Once created in Nuclide Navigator, LIB files can be edited and used for analysis directly in the GammaVision software.¹

Search for Unknowns

The comprehensive Search Tool in Nuclide Navigator lets the user define search criteria for specific energy peaks. The search results window gives other associated lines (in order of intensity) to look for in the spectrum.

¹GammaVision 5.20 and higher can also read and edit the Access MDB format database libraries. For GammaVision upgrade information, contact your local sales representative or visit our website at www.ortec-online.com.
Units Converter:
With many built-in and user-defined conversions.

Ordering Information:

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C53-B32</td>
<td>NuclideNavigator III Master Library</td>
</tr>
<tr>
<td>C53-CD32</td>
<td>NuclideNavigator III for 5 additional users</td>
</tr>
<tr>
<td></td>
<td>(Non-Educational)</td>
</tr>
<tr>
<td>C53-CD32-K</td>
<td>Upgrade from B53-CD to C53-CD32</td>
</tr>
<tr>
<td>C53-CD32-M</td>
<td>Upgrade from C53-CD to C53-CD32</td>
</tr>
<tr>
<td>C53-ED32</td>
<td>NuclideNavigator III for 5 additional users</td>
</tr>
<tr>
<td></td>
<td>(Educational Inst. Only)</td>
</tr>
<tr>
<td>C53-ED32-K</td>
<td>Upgrade from B53-ED to C53-ED32</td>
</tr>
<tr>
<td>C53-ED32-M</td>
<td>Upgrade from C53-ED to C53-ED32</td>
</tr>
<tr>
<td>C53-FR</td>
<td>LARA, une création du CEA, est une option</td>
</tr>
<tr>
<td></td>
<td>additionnelle. Requires previous or accompanying</td>
</tr>
<tr>
<td></td>
<td>purchase of C53-B32.</td>
</tr>
<tr>
<td>C53-G32</td>
<td>Documentation for C53-B32</td>
</tr>
<tr>
<td>C53-K32</td>
<td>Upgrade from A53-B1 to C53-B32</td>
</tr>
<tr>
<td>C53-L32</td>
<td>Upgrade from B53-B1 to C53-B32</td>
</tr>
<tr>
<td>C53-M32</td>
<td>Upgrade from C53-B1 to C53-B32</td>
</tr>
<tr>
<td>C53-U32</td>
<td>Update for C53-B32</td>
</tr>
</tbody>
</table>

Decay Scheme View:
In PDF format.
At last! A Universal Solution to Spectrum Data File Format Conversions.

- Converts between most common spectral file formats
- Simple to use Windows user interface
- Single spectrum conversions or multiple spectrum convert mode
- Interactive and command line mode; easily integrated with other programs

The ORTEC DataMaster provides a simple way of converting spectral data files between a variety of formats. It is often the case that a large restriction in making a change from one spectroscopy system supplier to another is the backlog of “legacy” spectra, which must remain readable on the new system. This is especially true when the old system is no longer supported. Some manufacturers are reluctant to even release their file formats in an attempt to make migration more difficult. DataMaster removes that impediment and makes the process simple.

Files are easily converted either by using the intuitively simple Windows user interface, or via command line mode which can be used in conjunction with other programs in automated processing.

Figure 1 shows the interactive mode input and output file dropdown menus.

When a file is loaded into DataMaster during the interactive process, the spectrum is displayed graphically as shown in Figure 2 allowing the user to verify at a glance that the file is the correct one.

Multiple files may be selected in interactive mode for automated sequential conversion.
### Supported File Types

<table>
<thead>
<tr>
<th>Spectrum File Format</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ORTEC ADCAM (*.chn)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2 ORTEC INFORM (*.spc)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3 OXFORD PCA-2 (*.spm)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4 OXFORD PCA-3 (*.spt)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>5 ASCII-1 (*.txt)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>6 ASCII-2 (*.txt)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>7 ROSSendorf ASCII (*.spe)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>8 IEC ASCII (*.iec)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>9 IEEE ASCII (*.asc)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>10 RMS ASCII (*.phd)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>11 LLNL ASCII (*.lll)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>12 SAMPO 90 (*.sam)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>13 APTEC v6.3 (*.s0)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>14 CI S100 (*.mca)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>15 CI ACCUSPEC (*.dat)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>16 CI CAM (*.cnf)</td>
<td>Yes¹</td>
<td>Yes¹</td>
</tr>
</tbody>
</table>

Table 1 summarizes the input and output file formats supported by DataMaster. File format 16, (Canberra .CNF) is proprietary and requires that certain Canberra software components be present on the system. These are automatically included if an appropriate Canberra software package is installed, such as Genie 2000.

### Command Line Mode

The command line mode is used to convert a single spectrum as specified on the MS-DOS command prompt. The syntax of the command line is:

```
DataMaster -i InputFileName -j OutputFileName
```

where `i` is the format type number for the input file, and `j` is the format specifier for the output file. The arguments are separated by spaces. Values of `i` and `j` valid for input and output are shown in Table 1. The following is an example of a valid command line.

```
DataMaster -4 E:\OldData\pca3demo.spt -2 C:\Spectra\Pca3Demo.spt.spc
```

Command line mode may be used in conjunction with the import function of ORTEC MAESTRO-32 or GammaVision-32 to make a seamless import of "foreign" spectral files directly by these programs.

### Ordering Information

To Order, specify:

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A49-B32</td>
<td>DataMaster Spectrum File Format Translator for Windows 2000/XP. (Includes media, documentation, and single use license.)</td>
</tr>
</tbody>
</table>

Tel. (865) 482-4411 • Fax (865) 483-0396 • ortec.info@ametek.com
801 South Illinois Ave., Oak Ridge, TN 37831-0895 U.S.A.
For International Office Locations, Visit Our Website

www.ortec-online.com
Export of Renaissance Results to IMBA Professional Plus

The IMBA Professional Plus software supercedes the IMBA Expert software developed for the U.S. Department of Energy, by the Radiation Protection Division of the UK Health Protection Agency (formerly the UK National Radiological Protection Board) and ACJ & Associates, Inc. (Richland, WA, USA).

This software provides a user-friendly interface with the (HPA's) proprietary suite of Integrated Modules for Bioassay Analysis (IMBA), to analyze measurements of activity in the body and/or excreta and calculate the resulting doses. The software implements the International Commission on Radiological Protection's (ICRP’s) currently recommended respiratory tract, tissue dosimetry, and biokinetic models for the reference worker, for 75 radionuclides.

IMBA Professional Plus consists of a base unit and various Add-Ons which increase the functionality of the software. Users can thus customize the software to meet their individual requirements.

Base Unit

The base unit enables the user to (a) assess an intake from bioassay measurement data; (b) calculate bioassay quantities at different times from a specified intake; (c) calculate equivalent organ doses and effective dose from a single intake. 75 nuclides are supported in the base unit. Output is both tabular and graphical and special tools enable data transfer between Windows™ applications.

Add-Ons

Each Add-On can be purchased individually and increases the functionality of the base unit.

Add-On 1 Multiple Intake Regimes
This add-on enables the user to deal with up to 10 separate intake regimes simultaneously. Thus when calculating doses or predicting bioassay quantities, the software automatically includes the contribution from each intake.

Add-On 2 Multiple Bioassay Types
This add-on enables the user to fit the intake to different bioassay types simultaneously. This add-on also works with Add-On 1 (Multiple Intake Regimes) to enable multiple intakes to be fitted to multiple bioassay data types simultaneously.

Add-On 3 Associated Radionuclides
This add-on enables the user to specify up to 30 additional associated radionuclides, defining the amount of each with respect to the indicator radionuclide. Subsequent dose calculations will include the components from all of the associated radionuclides.

Add-On 4 Uranium Mixtures
This add-on enables the user to specify a mixture of uranium isotopes (U-234, U-235, U-236 and U-238) for dose and bioassay calculations.

Add-On 5 Uptake from Wounds
This add-on enables the user to deal with intakes from a wound site. A generic wound model is specified by the user. This functionality is integrated automatically with all of the calculations (dosimetry, bioassay and intake fitting).

Add-On 6 Errors on Intake
In cases where an intake is being estimated from bioassay data, and all of the data are assumed to be normally distributed with a specified standard deviation, this add-on will propagate the errors to calculate their contribution to the error in the estimate of intake.

Add-On 7 Bayes Implementation
This add-on enables the user to use a Bayesian approach to estimate an intake.

Add-On 8 Tritium Tool
Because the new ICRP tritium model is no longer a single exponential, it is no longer possible to use just the previous measurement to correct the current measurement. This add-on enables the user to select up to 10 previous tritium measurements, and to fit simultaneously the best 10 intakes.
Add-On 9 Compensation Type Calculations
This add-on enables the user to select an organ, and a date on which cancer was diagnosed in the organ. The program then calculates the equivalent dose to the organ in each (of up to 99) calendar years previous to the cancer diagnosis. A simple wizard for exporting this data to other files or databases is also included. This type of information is required as part of the process of estimating causation probabilities for compensation type calculations.

Add-On 10 Ingrowth of Americium
The interpretation of measurements of Am-241 in an individual can be complicated if the individual has also had an intake of Pu-241 because of the continuous ingrowth of Am-241 from Pu-241. This add-on allows the user to take ingrowth into account automatically when performing calculations.

Add-On 11 Statistics Package
This add-on allows the user to bring up useful statistical information immediately after fitting intakes to measurement data. It calculates the chi-square value for each bioassay type, the total chi-square and the associated P value (probability of obtaining a chi-square greater than or equal to the calculated value by random chance).

Add-On 12 ORTEC Import Tool
This add-on allows the user to import information from the Renaissance database directly into IMBA Professional Plus. The user can then use the software directly after a measurement to obtain the best estimate of the intake and the corresponding doses to organs and the total effective dose.

IMBA Professional Plus can be ordered directly from HPA at www.ImbaProfessional.com or can be supplied by ORTEC as part of a complete system.
Global Value 7
Productivity Suite for GammaVision

“Optimizing Gamma Spectrometry Processes through Secure Data Management and Measurement Automation.”
Global Value 7

Global Value was designed to transform the standard GammaVision spectroscopy system into a state-of-the-art production environment with automated measurement processes, custom reporting, quality assurance, and secure data management. These functions greatly simplify measurement and data integration processes by predefining measurement details, minimizing manual data entry, and eliminating labor intensive document control practices.

Getting started with Global Value is quick and easy. The standard automation processes are pre-configured to meet most measurement needs, and Turn-Key operation with data integration to site systems and Subject Matter Expert (SME) training can normally be accomplished within a few weeks on site with our experienced technical staff.

Why GLOBAL VALUE?

Save Time and Money While Improving Data Quality!

<table>
<thead>
<tr>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operates in the most common PC Environments – Windows XP, 7, and 8</td>
</tr>
<tr>
<td>• Easily Configurable Reports with Custom Calculations, Nuclide Data Filters, and Spectrum Graphics</td>
</tr>
<tr>
<td>• Seamless Integration with Microsoft Word, Excel, and Access</td>
</tr>
<tr>
<td>• Flexible Configuration Architecture for Small Systems or Large-Scale Network Environments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Preconfigured Automation Scripting for Consistent measurement processes out of the box</td>
</tr>
<tr>
<td>• Electronic Data review and Automated Integration with Data and Document Management Systems</td>
</tr>
<tr>
<td>• Automated Post-Analysis Calculations, Reports, and Analysis Record Queries</td>
</tr>
<tr>
<td>• Secure Remote Data access to analysis and quality control results</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defendable Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Robust Security Features limit access to sensitive functions and settings</td>
</tr>
<tr>
<td>• Detailed Quality Control Reports, Trending, Warnings, and optional instrument lock-out</td>
</tr>
<tr>
<td>• Analysis Editor Audit Log to track and report post-analysis data modifications</td>
</tr>
<tr>
<td>• Fully Compatible with GammaVision 7 for Analysis Accuracy and Standards Compliance</td>
</tr>
</tbody>
</table>

A World of New Features in Global Value 7!

New! 64-Bit Windows 7/8.1 and GammaVision 7 Compatibility
New! Preconfigured Automation processes for sample and QA measurements
New! Audit Log to capture measurement modifications in the Analysis Editor
New! Standardized Data and Document Management System interfacing
New! Interactive Spectrum Viewer embedded in Sample and QA Administration programs
New! Configurable menus to launch programs and open files directly from the Quick Start Program
New! Analysis Editor Filter options based on User-Defined parameter data
New! Additional reporting parameters including Spectrum Image, all GammaVision nuclide data, and calculated fields
New! Simplified access to Archived Databases
New! Improved QA Options with user-defined date ranges, faster chart loads, and Reporting Options
New! Spectrum Multiplexer with flexible options for spectrum summing in parallel or series acquisition modes
New! QA Measurement Scheduling with alerts when overdue
New! Data Management utilities for file system backup and verification
Global Value 7

Measurement Automation with GammaVision

QA Administration

Sample Administration

Site Systems and Groups

Data Management

Document Control

Other Entities
Gamma Spectroscopy measurements are no longer an intimidating task using Global Value. Simply select a detector and the type of measurement from a simple Windows Explorer style interface, and the automation scripts guide you through the process. These scripts can be pre-configured to minimize data entry errors for the novice or busy multi-tasker by setting nearly all analysis options in advance, or tailored for the more experienced analyst to make more decisions during the measurement process.

Global Value comes preconfigured with a variety of Quality Assurance and Sample measurement processes that are ready to use out of the box and easily modified to meet individual site needs.

Key Automation Features:
- Security to prevent measurements by unauthorized personnel
- Standardized Data Management System Integration to eliminate data entry errors
- Spectrum Re-analysis concurrent with data acquisition measurements
- Automation Scripts based on Templates and Configuration Files simplifies maintenance and multiple detector configurations
- Configurable Data Entry options accommodating typical sample size calculations, such as air filter volume, dilution, and unit conversions
- Completely Customizable Data Entry option using Microsoft Excel
- Software Spectrum Multiplexing (Summing with optional conversion gain adjustment) for Detector Array Configurations while maintaining individual detector performance monitoring
- Dual spectrum analysis processes for more efficient sample throughput of particulate/iodine air filters and other sample types
- Dead Time Verification and Acquisition Start Timer controls for improved measurement accuracy and consistency
- Additional Data Entry Linked to Samples: Sample and Record Types (or document control codes), Site Unit, Batch ID, GDT Pressure, Sample Pump ID, Radiation Work Permits, Radiation Monitor Readings, Unlimited Custom Data Fields and Comments

Core Sample Measurement Process Options
- GVSampleData: Basic sample data entry or customizable Excel interfacing with single sample measurement structure
- GVSampleDataPlus: Configurable sample size calculations based on sample flow rate or unit conversion with single sample measurement structure
- GVSampleDataSC: Comprehensive interface for sample data and analysis settings with optional Sample Changer operation and Data Management System interfacing.

Quality Assurance (QA) Process Options
- Basic Instrument QA and Background Measurements
- Instrument QA with automated Energy and/or Shape Recalibration
- Instrument QA with automated Gain Stabilization
- QA Status verification integrated with sample measurement process
Managing analysis results can be a daunting task with traditional gamma spectroscopy systems. Hard copy analysis reports are lengthy, often require manual mark-up, and are labor intensive to archive. Nuclide data is also frequently used for additional calculations or manually loaded into data management systems – an error prone and time consuming process.

Global Value simplifies these processes and eliminates errors through secure electronic data editing/review and seamless integration with data management and document control systems. The productivity gained by automating document management and reducing the time and errors associated with manual data processing pays for Global Value many times over.

Key Sample Administration Features:

γ Robust security to restrict modification of system configuration parameters or measurement results

γ Electronic Data Editing and Review
  • All report modifications and comments implemented electronically based on security settings
  • User names available to report and query by the original Analyst, Editor, Reviewer, and Publisher
  • Detailed audit log for changes applied during electronic review
  • Filter analysis results by review status or custom parameter settings for validation efficiency
  • Publishing function renders analysis data in various formats (XML, CSV, ASCII Text, and PDF) or transfers data to an unsecured Microsoft Access database to facilitate automated integration with site Document Control and Data Management Systems
  • Publishing function can be automated with electronic review or configured as a separate approval function
  • Integrated Spectrum viewer for detailed peak interrogation

γ Analysis Log queries by all stored analysis and sample data parameters with immediate access to analysis reports

γ Rich Reports with Intuitive Configurable Templates
  • Simple interface requires No Programming Experience
  • Nuclide data calculations such as Dose Equivalent Iodine or Xenon, DAC Fraction, Nuclide Ratios, and Detection Limit evaluation
  • Configurable data table views and evaluation filters for detected and non-detected nuclides
  • Dual analysis results from the same spectrum on a single report

γ Integrated Database Maintenance – No External Database Administration or Licensing, such as Oracle or SQL Server, required

γ Unlimited User-Defined Custom Data Parameters for reporting and system queries for related samples
Instrument performance must be validated on a regular basis to ensure that measurements meet certain quality standards. The performance checks may be dictated by regulations, industry standards, or site procedures. These documents may dictate which parameters to monitor as well as frequency and corrective actions – all of which are easily met using Global Value.

Quality Assurance is one of Global Value’s prominent strengths. It offers a flexible configuration to monitor all of the key indicators with controls to ensure that the instrument performance is validated within the prescribed frequency. The data evaluation and reporting capabilities also simplify proof of performance for auditors, routine data review, and integration of data and reports with existing site systems – all in a secure environment.

Key Quality Assurance Features:

- **Data Evaluation**
  - Failure notification through reports, automation launch pad, and integrated with sample measurement processes with optional instrument lockout
  - Historical data evaluation with extensive data access, trend charts, and optional export to Excel with automated statistics
  - Control and Warning limit evaluation for all QA parameters
  - Parameters Monitored:
    - Background Parameters: Count Rate
    - Peak Parameters: Energy Centroid, Channel Centroid, Peak Shape (FHWM), Net Area, Intensity (count rate), Uncertainty, Activity
    - All instrument parameters can be monitored in terms of Percent Difference from a target value
    - Maximum time interval between QA measurements

- **Electronic Data Review**
  - User names available to report and query by the original Analyst, Editor, Reviewer, and Publisher
  - Detailed history of changes applied during electronic review
  - Filter analysis results by review status and QA Type
  - Publishing function renders QA data in various formats (XML, CSV, ASCII Text, and PDF) to facilitate automated integration with site Document Control and Data Management Systems
  - Publishing function can be automated with electronic review or configured as a separate approval function

- **Lab Notebook to track corrective action and instrument history with flexible reporting options**

- **Integrated Database Management**

- **Configurable QA Reports with user-defined corrective action**

- **Color-coded QA Summary for snapshot status of all detectors**
Global Value is designed to accommodate a broad range of data storage and networking requirements while minimizing the need for system administration programs and Information Technology expertise. This is accomplished through a distributed file and database architecture that works equally well on stand-alone computers or networked systems, and maintenance tools for data backup, validation, and restoration.

Our expert technical staff is available to establish Turn-Key installations to minimize the implementation time, train administrative personnel, and integrate data and reports with site systems. We recognize that you invest significant time configuring applications, changing procedures, and training personnel when system changes are implemented, and our goal is make the transition as smooth as possible.

Key System Configuration and Administration Features:

- **Advanced System Architecture** allows for server centric configurations, stand-alone computer installations, or distributed file storage in a local area network
- **Fully Integrated Database Management functions**
- **Seamless Microsoft Office Integration**
  - Excel Add-In supporting worksheet and Visual Basic for Applications (VBA) functions to automate post-analysis calculations, custom reports, and custom data processing
  - QA Data export to Excel for advanced statistical evaluation
  - Analysis Data Export to unsecured Microsoft Access database for custom data processing
  - Render Reports directly in Microsoft Word
- **Simplified data integration using standard file formats**
  - PDF, XML, CSV, ASCII Text, Microsoft Access and Excel
  - Native integration with GCR’s NuclearIQ data management system
- **Detector Status utility** shows color coded acquisition state for all detectors
- **Configurable File Backup utility** with automatic deletion of specified files from local computers
- **File Compare utility** for verification of critical system files
- **Efficiency Table Converter** simplifies generation of calibration source certificates from master source data
- **Spectrum Multiplexer** for software spectrum summing in parallel or series acquisition modes
- **Gamma Products Sample Changer** operation over serial port communication
Global Value 7

Prerequisites

- Windows 8.1, 7, or XP Operating System
- GammaVision Version 7
- Microsoft Excel/Word 2003 or higher (if integration with Microsoft Office is desired)
- Modern PDF reader programs, such as Adobe Acrobat Reader, can be used to view PDF files generated by Global Value.

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlobalValue-BWS</td>
<td>Global Value Productivity Suite for GammaVision - Site License</td>
</tr>
<tr>
<td></td>
<td>For use with Networked Database Connections.</td>
</tr>
<tr>
<td></td>
<td>Includes 2-days on-site installation and training. [See Note 1] [Travel to site is not included.]</td>
</tr>
<tr>
<td>GlobalValue-UWS</td>
<td>Global Value Productivity Suite for GammaVision - Site License Upgrade</td>
</tr>
<tr>
<td></td>
<td>For use with Networked Database Connections.</td>
</tr>
<tr>
<td></td>
<td>Includes 2-days on-site installation and training. [See Note 1] [Travel to site is not included.]</td>
</tr>
<tr>
<td></td>
<td>Requires previous Site License model (Global Value, Global Value-BWS or GlobalValue-UWLS)</td>
</tr>
<tr>
<td>GlobalValue-UWS-SC</td>
<td>Global Value Productivity Suite for GammaVision - Site License Upgrade - Service Contract</td>
</tr>
<tr>
<td></td>
<td>Includes 4-days on-site installation and training. [Travel to site is not included.]</td>
</tr>
<tr>
<td></td>
<td>Requires previous Site License model within the previous 12 months.</td>
</tr>
<tr>
<td></td>
<td>For use on a single computer with databases stored on the same computer.</td>
</tr>
<tr>
<td></td>
<td>No on-site time included.</td>
</tr>
<tr>
<td>GlobalValue-UWL</td>
<td>Global Value Productivity Suite for GammaVision - Single Computer License Upgrade</td>
</tr>
<tr>
<td></td>
<td>For use on a single computer with databases stored on the same computer.</td>
</tr>
<tr>
<td></td>
<td>Requires previous version of Global Value-BWL.</td>
</tr>
<tr>
<td></td>
<td>No on-site time included.</td>
</tr>
<tr>
<td>GlobalValue-UWLS</td>
<td>Global Value Productivity Suite for GammaVision - Single Computer to Site License Upgrade</td>
</tr>
<tr>
<td></td>
<td>For use with Networked Database Connections.</td>
</tr>
<tr>
<td></td>
<td>Requires previous version of Global Value-BWL.</td>
</tr>
<tr>
<td></td>
<td>No on-site time included.</td>
</tr>
<tr>
<td>GlobalValue-ADD</td>
<td>Additional day of installation, customization, or training. [Excludes associated expenses]</td>
</tr>
</tbody>
</table>

NOTES: Additional days of Global Value Add required for Turn Key setup. Duration is dependent on the extent of system configuration, integration, and training required.

Options

- A66-BW GammaVision High Resolution Gamma Spectroscopy Software for Windows
  Includes standalone or first network copy and binary use license.
WHAT'S NEW!
Windows 7/64-bit Compatible,
Expanded Counting Geometries,
Extensive Reporting Tools,
Command Line Operation
ISOTOPIC provides an integrated, practical solution to a wide range of gamma-ray measurement problems encountered in radioactive waste assay and characterization applications. High resolution, high purity germanium (HPGe) spectra are analyzed and assay results determined for large-scale bulk samples.

ISOTOPIC can be used "out of the box" as part of a simple to operate mobile system, such as an ORTEC ISO-CART-85 or it can be integrated into an automated system, for example, for high throughput measurements of large containers in decommissioning projects.

Why ISOTOPIC?

Practical
- Practical, easy-to-use solution to quantitative assay of gamma-emitting waste samples in a variety of configurations.
- Supports additional HPGe detectors and electronics or as part of an integrated measurement system.
- Calibrate ANY detector on site, TRACEABLY, in minutes.
- Easy system expansion.

Flexible
- Analyzes all types of gamma-emitting waste, fissile and non-fissile.
- Measures various container shapes and sizes, surfaces and even soils using independently verified analysis methods.
- CLOSE geometry measurements for "on-endcap" applications such as bottle counting.
- Easily combine multiple measurements on a single object.
- Expanded Report Writer with MS Access Data Storage and Crystal Reports for Custom Reports.
- Supports software integration into large, automated measurement systems.

Defendable
- Robust algorithms developed and refined by multiple US DOE sites as well as the US Energy Measurements Laboratory.
- Third party "round-robin" testing to validate results accuracy.
- Results traceability guaranteed via simple user- or factory-calibration with traceable source.

5. For use in M-1 mode for soil characterization, an HPGe with crystal length/diameter in the range of 0.5 to 1.3 is recommended. 80% of HPGe detectors meet this criterion. The ORTEC PROFILE M Series detectors are ideal for this and the ISOTOPIC container measurements.
Applicability

The following geometries are easily accommodated:

- Boxes, Drums, Pipes or Surfaces (collimated detector)
- Close Geometry small containers (e.g. bottles on-endcap)
- Wide Area Assay of Soils and Surface (uncollimated detector: M-1 methodology)

ISOTOPIC provides a number of standard geometry “templates” from which a specific measurement configuration may be developed. These include cylinders (from top and side; including lined cylinders (pipes)), boxes, point source (far field), close geometry small containers on-endcap, and infinite plane. The bottle counting option on the ISO-CART-85 is an example of an “on-endcap” close geometry. The infinite plane (soils) mode provides uncollimated measurement of contamination, fall out or wide area spills, either washed into or on top of an infinite plane surface, most typically soil on the ground.

Pre-defined Configurations and Analysis Defaults
Methodology

In container mode, for the counting of packages, pipes and surfaces, the detector is characterized by a single point-source measurement, even when a collimator is to be used. This primary calibration, which can be traced to a certified standard, for any detector, is extrapolated or modeled to match the physical situation of the sample; container geometry, material, and matrix composition. The model is based on "point-kernel" methods in which the entire measurement problem is broken down into multiple source/matrix voxels and their contribution to the composite spectrum are calculated and summed. The approach, which is similar to Monte-Carlo Methods, utilizes detector parameters [crystal diameter, crystal length, dead layer, and end cap thickness] which the user supplies as part of the measurement configuration. No special separate measurements are needed to characterize the detector other than one point-source calibration.

ISOTOPIC includes improved algorithms for “close geometry” where the detector to container distance is less than 15 cm.

For the uncollimated wide-area counting of soils, the "1-meter" methodology developed by the US DOE EML2 and later extended is used. It is applicable in many situations:

- Decontamination assessment of previously used sites
- Assessment of nuclides deposited during emergencies
- Routine environmental monitoring near nuclear facilities

The EML methodology reduces a complex measurement problem to the product of three, simply-determined factors. The gamma-ray peak areas are related to the nuclide-specific activity by the product of the three factors. These factors have been determined for a range of detector types and soil conditions and are tabulated within the program. The efficiency calibration is determined using the stated efficiency according to the usual ANSI/IEEE 325-1996 convention at 1.33 MeV, and from the crystal length and diameter.

For improved accuracy at low energy, the user can use the same calibration used for container mode as an alternate to the EML method.

No special (and costly) Monte-Carlo characterizations of the detector are necessary. The attenuation correction is determined by selection of the soil type and type of nuclide distribution: recent [surface] deposits, older [washed-in] deposits or natural [uniform] deposits. The energy and peak shape calibration are performed using any multiline source and may be entirely automated. However you plan to use ISOTOPIC, there will be no unexpected detector calibration costs.
Multiple Measurements of a Single Container

In the measurement of any large container of waste, several measurements are usually made from different directions to ensure the best results are obtained. This will be done sequentially if only one hardware system is available or simultaneously if there is access to multiple sets of hardware. ISOTOPIC can automatically combine the results taken either way by a user-defined weighted average. When multiple detectors are used at the same time, live spectra may be displayed on screen simultaneously from each detector, increasing user confidence.

Standard and Custom Reporting

ISOTOPIC provides flexibility in reporting within the standard product. All changeable parameters may be included in the standard output report. Analysis results are stored in an MS Access compatible database, from which they are easily printed or exported for further processing into summary reports. Fully customized reports may be generated through the use of Crystal Reports.

Hardware Compatibility

ISOTOPIC like all ORTEC CONNECTIONS Applications software products, is compatible with all ORTEC MCA hardware. In particular, it is ideal for use in conjunction with the IDM-200-V, a complete rugged and portable HPGe spectrometer system which does NOT require the use of liquid nitrogen.

Support for Systems Integrators

Systems integrators often need to be able to develop automated systems in which the details of hardware control and analysis are largely concealed from a human operator under a software layer which provides a greatly simplified user interface and/or allows unattended operation. Extensive documentation is provided in the standard user documentation set explaining how the analysis engine may be controlled from a command line along with example material. Analysis parameters and analysis results are saved to an ACCESS compatible database. All necessary file structure information is provided, including the ISOTOPIC database file structures. The spectrum or “SPC” file structures are provided in a separate accompanying manual.

ORTEC hardware control is achieved through the so called UMCBI which provides a common API to all supported spectroscopy hardware. A programmer’s toolkit is available as an option to provide instruction to the systems integrator as to how to easily achieve MCA hardware control from his/her own developed program. Often, the basic ISOTOPIC program is used to set up the system hardware and calibration, and then the system is controlled by the integrator’s application for the routine cycle of operations. With these tools and the level of documentation provided, system integrators can easily develop sophisticated measurement systems.
ISO TO PIC

ISOTOPIC In Use

ISOTOPIC has two modes: supervisor and operator. The operator need make choices only from the minimum subset of system options defined by the supervisor. The supervisor mode defines what operations the operator is allowed to carry out. A wizard guides the supervisor through the process of setting up the operator procedures. The wizard presents the parameters on logically grouped screens, with an emphasis on clarity of approach.

The supervisor/operator partitioning means that even semi-skilled operators in the field will collect good data with less wasted time for repeats (lower cost per measured item). Of course a skilled user may choose to run both modes.

Supervisor calibrates the system, creates libraries, defines sample geometries, matrices, collimators to be used, and other functions for later use by the operator. Supervisor can also define which features operator may access.

The operator main screen, which is customized by the permissions granted by the supervisor, is much simpler than the supervisor screen. In routine use, for container analysis, the operator need only start the acquisition, select the configuration (nearest standard container configuration), and enter the “book keeping data” such as container ID, type, weight, and the critical measurement data, such as detector-to-container distance.

The standard container configurations and collimator configurations are defined and specified by the supervisor. A container configuration includes the default dimensions, materials, and matrix detail. Any number of these configurations may be specified and recalled by the operator when needed.

Simple OPERATOR MODE GUI: Controls Hardware with Minimal Data Entry
**Analysis Tools**

**Interactive Results Plot**
When the analysis is complete, the operator can adjust the container/matrix physical parameters (such as matrix density or container wall thickness) to optimize the results by use of the nuclide plot.

The plot shows the percentage difference between the corrected measured activity and the activity calculated for the reference peak for each nuclide. The supervisor selects the reference peak. The operator may optimize the analysis, adjusting the container, matrix, and weight fraction uranium, to refine the results. The visual evidence of a good result is immediately seen when the points from a multi-peaked nuclide are distributed normally about the “zero-line.” In the case of uranium analysis, if the U-235 enrichment is known, it may be entered and then the U-238 and U-234 values are computed more accurately for samples containing weak uranium activity. Homogeneous and inhomogeneous samples are analyzed with increased accuracy by this method. A good indication that a package contains an inhomogeneous distribution of materials is that the user can obtain a combination of parameters which makes the activity plot flat for some nuclides but not others. This plot can form part of the output report, along with a plot of the spectrum itself.

**Field of View Calculator**
The detector field of view is an important parameter in the measurement. The software algorithm “corrects” or adjusts from what is “seen” in the field of view of the collimator to an assay of the contents of the whole container. In general, the field of view is chosen so that it is filled by container, further back from this will reduce signal to noise in the spectrum, nearer than this makes the measurement more susceptible to localized inhomogeneities (the effects of which can be further minimized by making multiple measurements in different orientations). A convenient field of view calculator allows the operator to assess what portion of the container is actually within the field of view of the collimated detector.
Reports

When the fine-tuning is finished, the operator selects a report for each nuclide showing the activity and weight. These results may then be printed and archived. The report files are written in either a database summary or as complete reports showing all input and correction information. Custom reports may be generated by the use of the report generator option. The tabulated components of error estimates can be used to help reduce overall uncertainties, for example, by extending count time or repositioning the detector. The user is also warned if any of the corrections appear to be excessively large. Minimum Detectable Activities (MDA) are calculated for each nuclide. Activities, grams of U or Pu, or MDAs from multiple measurements may be reported as weighted averages. The weighting is user definable.

Comprehensive and Custom Reporting

Accuracy of Results

The underlying assumption for a single measurement is that the entire object contains the same matrix and specific activities as the sub-volume which is under measurement. Inaccuracies due to this assumption being incorrect may be reduced by making multiple measurements from different points on the surface of the object and comparing similarities. These comparisons may be used to develop measurement strategies for an individual object, thereby reducing such systematic errors. ISOTOPIC can provide weighted average reports including the relevant minimum detectable activities, if required.

Overall, the major influencers of the accuracy of the achievable results are: statistics and counting time, calibration uncertainty, and the number of replicate measurements carried out on a single object (random uncertainties), inhomogeneity of matrix density and nuclide distribution, and the number of measurements carried out on a single object from different directions (systematic errors).

A range of 10 to 50% accuracy should be considered representative, the smaller being for well-defined geometries in homogeneous and light matrices.
Analysis Library Manager
ISOTOPIC includes a comprehensive library editor for building custom analysis libraries. The editor allows the operator to cut and paste nuclides and peaks from master libraries, add flags to individual peaks for identification (single escape peak, x-ray, or other) and analysis (key line or exclude from activity calculation), and save the library as any name. It also includes full integration of the Nuclide Navigator library tool. ISOTOPIC will use Nuclide Navigator if installed, and can read Nuclide Navigator libraries in Microsoft Access Database format (no conversion necessary), and save libraries in database format for use by Nuclide Navigator.

Quality Assurance
ISOTOPIC quality assurance complies with the demands of ANSI N13.30. For each detector the following are monitored:
- Total detector background
- Total (decay corrected) activity for all calibration nuclides
- Average FWHM ratio (spectrum to calibration standard)
- Average FW1/10M ratio (spectrum to calibration standard)
- Average peak shift from library values
- Actual peak centroid energies

Calculational Details
Summary of the ISOTOPIC Mode Methodology for Containers
The activity of an isotope in a container is given by:

\[
A_{\text{isotope}} = \frac{PA_{\text{meas}} (CF_{\text{item}})(CF_{\text{col}})}{BR_{\gamma\text{ray}} (\varepsilon_{\text{det}})}
\]

where

- \(A_{\text{isotope}}\) = activity of the isotope to be reported [Bq/µCi].
- \(PA_{\text{meas}}\) = measured peak area count rate for a reference gamma ray of the isotope [c/s]. This quantity is determined directly from the spectrum and the acquisition Live Time. If short half life isotopes are present or if sample activities in a flowing sample are varying rapidly, the ORTEC patented ZDT dead-time correction algorithm may prove beneficial.
- \(CF_{\text{item}}\) = container, matrix, and sample self-attenuation correction factors. ISOTOPIC calculates these based on the physical data supplied in the configuration.
- \(CF_{\text{col}}\) = collimator correction factor. Some gamma rays will penetrate any collimator surrounding the germanium detector. The collimator correction factor is heavily dependant on the diameter of the collimator, the depth of collimation, and the wall thickness of the collimator, as well as the angle of the radiation and its energy. The collimator correction factor is determined by computing the fraction of the activity that is not shadowed by the collimator and then computing the penetration length through the collimator for the remaining activity. This is determined for each voxel of the item being measured. If no collimator is present this is set = 1.
- \(BR_{\gamma\text{ray}}\) = gamma-ray branching ratio. This information is contained in the nuclide library.
- \(\varepsilon_{\text{det}}\) = detector efficiency measured using a NIST-traceable point source [cps per Bq, µCi]. A typical calibration distance is 30 cm, at which detector and source may be regarded like point objects. At close distances the detector length and diameter dimensions become significant. These dimensions are provided during the calibration process, and the correction to the simple "point detector" assumption is applied automatically. The close geometry correction is described in the ISOTOPIC supervisor manual.
When gram quantities, \( \text{Mass}_{\text{isotope}} \), of reported isotopes are needed, these are given by:

\[
N = \frac{A_{\text{isotope}}}{\lambda_{\text{isotope}}} \quad \text{Mass}_{\text{isotope}} = \frac{N(At)}{Av}
\]

where
- \( N \) = number of atoms of a reported isotope.
- \( \lambda_{\text{isotope}} \) = decay constant of a reported isotope [sec\(^{-1}\)].
- \( At \) = atomic number of the measured isotope [g/Av].
- \( Av \) = Avogadro’s number.

**Result Averaging of Multiple Measurements**

When results of multiple measurements are combined, a weighted average is calculated according to:

\[
A_{\text{average}} = \frac{\sum A_i w_i}{\sum w_i}
\]

where
- \( A_i \) = individual activity (gram or MDA) results.
- \( w_i \) = user-defined weighting factors.

**Methodology for Soils**

The specific activity, \( A \) [Bq/m\(^2\) or Bq/g], is related to the net peak count rate \( N_f \) by:

\[
A \, (\text{activity}) = \frac{N_f (\text{net peak count rate})}{\left( \frac{N_f}{N_0} \right) \left( \frac{N_0}{\Phi} \right) \left( \frac{\Phi}{A} \right)}
\]

where
- \( N_f/N_0 \) = angular correction factor of the detector at that energy for a given source distribution in the soil.
- \( N_0/\Phi \) = peak count rate per unit uncollided flux for a parallel beam of gamma rays of the peak energy that is incident normal to the detector face [cpm/\( \gamma \, \text{s}^{-1} \)].
- \( \Phi/A \) = total uncollided flux at the peak energy arriving at the detector per unit inventory or concentration of the nuclide in the soil [\( \gamma \, \text{cm}^{-2} \, \text{s}^{-1} \)] or [\( \gamma \, \text{g}^{-1} \, \text{s}^{-1} \)].

The method of estimating calibration factors uses information about the detector and the distribution(s) of radionuclides being measured:
- Detector Efficiency (expressed as %)
- Detector Orientation (up or down)
- Detector Aspect Ratio (calculated as crystal length/crystal diameter)
- Deposition Profile Parameter \( \alpha/\rho \) value(s)

\( \alpha/\rho \) is assumed to be 0 (for uniform distribution) for all natural emitters. \( \alpha/\rho \) is assumed to be infinite (for surface only distribution) for fallout on undisturbed soil.

Beck’s method is implemented in ISOTOPIC by calculating values for each of the calibration parameters. The calculation is carried out for each gamma ray of all the nuclides identified.
ISOTOPIC Specifications

General
The acquisition control and quantitative analysis functions are integrated into a concise package for use in PC-based in situ gamma spectroscopy systems for the determination of radioactive content of containers, objects, surfaces, and soils.

Operating System
Windows 7 64-bit hardware compatibility is available for all ORTEC instruments that use USB and TCP/IP connectivity. These instruments, as well as other legacy hardware, are also supported with Windows 7 and XP 32-bit operating systems.

Spectroscopy Hardware Support
ISOTOPIC is recommended for use with the ORTEC IDM-V-200 Integrated HPGe Spectrometer. However, all ORTEC MCBs (past and present) and all other devices supported by ORTEC CONNECTIONS are compatible. Support is built-in for advanced operations (where provided in hardware): amplifier gain/shaping control, Auto-PZ, "optimize" and InSight™ mode, digiDART field mode, graphical setting of MCB spectrum stabilizer and statistical uncertainty peaks. Specifically, the IDM-200-V is recommended for in situ measurements.

File Formats Supported
ORTEC .SPC and .CHN, and ASCII "SPE" are supported as standard in file save, recall, and compare functions. Other file formats may be imported by the use of A49-B32 Data Master.

Quantitative Spectrum Analysis Methods

Peak Search
Peak Search by library direction for specified nuclides, plus Mariscotti peak search for non-specified nuclides, both main library and supplemental ("suspect") library are used.

Interactive Bulk Sample Parameter Adjustments
Interactive Matrix and container adjustments and automatic attenuation correction for new matrix. Easy to use graphical display of relative analysis results to show the best matrix.

Deconvolution Method
Both peak finder and library are used to direct the deconvolution process. Automatic recalibration of Energy/channel based on identified peaks where possible.

Choice of Detection Limit Formalisms

- ORTEC Traditional
- ORTEC Critical Level
- No MDA (report zeros if less than MDA)
- KTA Rule
- Detection Limit 2 sigma — Japan
- Detection Limit 3 sigma — Japan
- Currie Limit
- RISO MDA
- ORTEC LLD
- Peak Area
- Air Monitor — Gimrad method
- Reg. Guide 4.16 Method
- Counting Lab — USA
- DIN 25 482.5 Erkennungsgrenze
- DIN 25 482.5 Nachweisgrenze
- GTNS/CEA/EDF (France)
- Nureg 0472

Decay Corrections
- Decay correct to any date/time, either back or forward

Spectral Corrections
- Peaked Background Correction
- Random summing [high-rate counting losses]
- Library-based peak interference correction

Reporting
Choose any ORTEC Standard report option:
- Direct to printer
- Automatically written to database
- Crystal Report formatted output
- Report in HTML format. From there it can be saved as a disk file.

Calibration

Energy Calibration
- Multipoint, quadratic for energy and FWHM
- Automatic Energy Calibration (Patent No. 6,006,162)

Semi-Empirical Efficiency Calibration Fit Options:

ISOTOPIC Mode
A point source calibration is established via one of the following methods:
- Single Function Polynomial [x-Point]
- Interpolative above and below "knee"
- Quadratic above or below user-set "knee"
- Linear above or below user-set "knee"

The point source calibration is extrapolated to the physical geometry-matrix situation via point-source Kernel calculations internal to the program.

Infinite Plane Mode (for Soils and Surfaces: Uncollimated Detector)
The Beck2 1-meter methodology, with extension to large detector sizes, as used by US DOE Environmental Measurements Laboratory (EML). The EML methodology is used to produce an efficiency curve based on detector dimensions and IEEE efficiency value. The soil density and attenuation is specified in user-editable alpha/rho files.

Soil Attenuation Factors
In soil, attenuation depends on the soil thickness and density, which is modeled by the parameter $\alpha/\rho$ (where $\alpha$ is the reciprocal of the relaxation length, defined to be the soil thickness required to reduce the flux at a particular energy by a factor of $e$, and $\rho$ is the soil density in gm/cc). For a surface distribution $\alpha/\rho$ is infinite, while for uniform [natural emitters] distribution, $\alpha/\rho$ is 0. Values of $\alpha/\rho$ ranging from 0.05 to 0.5 have been found to describe realistic fallout distributions accurately, the more aged fallout being represented by the smaller $\alpha/\rho$ values.

The $\alpha/\rho$ values are nuclide-specific and are stored in a table which may be edited by the user to reflect the measurement conditions.
## Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISOPLUS-BW</td>
<td>ISOTOPIC Advanced Gamma-Ray Waste Assay Analysis Software</td>
</tr>
<tr>
<td>ISOPLUS-GW</td>
<td>Documentation for ISOTOPIC</td>
</tr>
<tr>
<td>ISOPLUS-NW</td>
<td>ISOTOPIC Network Copies</td>
</tr>
<tr>
<td>ISOPLUS-UW</td>
<td>Update to ISOTOPIC</td>
</tr>
<tr>
<td>ISOPLUS-2YW</td>
<td>2 year update subscription for ISOTOPIC</td>
</tr>
<tr>
<td>ISOPLUS-3YW</td>
<td>3 year update subscription for ISOTOPIC</td>
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<tr>
<td>ISOPLUS-4YW</td>
<td>4 year update subscription for ISOTOPIC</td>
</tr>
<tr>
<td>ISOPLUS-5YW</td>
<td>5 year update subscription for ISOTOPIC</td>
</tr>
</tbody>
</table>
MAESTRO® 7
Multichannel Analyzer (MCA) Application Software
MAESTRO®

Advanced Features

• Windows 7 (32-bit and 64-bit) and Windows XP (32-bit) compatible.

• ORTEC CONNECTIONS 32- and 64-bit network connectivity: local and remote control for all supported instruments via a common GUI.

• Intuitive User Interface consistent with other ORTEC application software such as GammaVision and ScintiVision.

• Advanced “smart” analysis functions: Fast Peak Search, Region of Interest (ROI), Peak Fit, and Overlay Spectrum Comparison.

• Password protected functions.

• Multiple Detector Interface (MDI): choose to view up to eight “live” and eight stored spectra simultaneously on a single PC.

• Automated “Jobs” for consistent and reliable data acquisition and reporting.

• NEW “List Mode,” time-tagged data event gathering; create time-sliced spectra of any period during data acquisition.

Real Benefits

• Integration with the most popular PC platform in the world maximizes compatibility, productivity, and cost-effectiveness.

• Low Total Cost of Ownership with hardware/software compatibility and remote control operations.

• Rapid implementation with minimal training.

• Robust data evaluation for accurate and reliable results.

• Eliminate unauthorized changes to system parameters and loss of acquiring data.

• Efficiency improved through instant access to detector status and spectrum data.

• Maximize productivity with consistent processes and data integrity.

• Ability to select acquisition of “period of interest” enhances detection sensitivity.

MAESTRO is a multichannel analyzer (MCA) “emulation” software package. When used in conjunction with a personal computer, and appropriate MCB hardware, MAESTRO constitutes an advanced “smart” multichannel analysis environment for use in a wide variety of scientific applications in industry, teaching, and research, including nuclear counting laboratories.

The MAESTRO user interface provides live spectral display and control of hardware and provides a number of “smart” analysis tools. The spectrum display and manipulation has a common “look and feel” with other ORTEC spectroscopy products, such as GammaVision and ScintiVision.

Full control of acquisition and all MCB hardware features is provided. The software auto-detects the attached hardware, presenting the user with only those features specifically available for that hardware. For example, members of the ORTEC DSPEC series of digital HPGe gamma spectrometer systems provide full control of the digital filter, auto-PZ and Insight® oscilloscope mode. These features are displayed by the MAESTRO software when the DSPEC hardware is connected to the system.

As a member of the ORTEC CONNECTIONS suite of software products, MAESTRO has the capability to fully support up to 250 detector systems across a local area network; a remote detector appearing to a local operator is no different to one physically attached to the local PC workstation.
For over two decades, MAESTRO has set the standard for Windows-based MCA Emulation. MAESTRO Version 7.0 advances further, adding the following new features:

- **New!** Windows 7 64-Bit Compatibility with CONNECTIONS Version 8
- **New!** List Mode Data Acquisition for Time Correlated Spectrum Events
- **New!** Improved Peak fit calculations
- **New!** Improved graphics handling for multiple displays
- **New!** Open spectrum files directly from Windows Explorer
- **New!** Improved performance with Job Functions and display updates

It’s really no surprise that MAESTRO continues to be the world’s most popular nuclear MCA software!
Display and User-Interface Features

MAESTRO provides an intuitive user interface to simplify hardware control and both routine and advanced measurement processes. The most commonly used functions are implemented as "hot keys" or toolbar buttons for rapid access.

The spectrum window is often the primary user focus when using MAESTRO and up to eight live detectors and eight saved spectra can be displayed concurrently. Full and expanded views of each spectrum are shown simultaneously. The spectrum expanded view can be zoomed in to examine a specific peak or energy region. Both windows display any marked Regions of Interest (ROIs), and the zoomed region is easily repositioned by simply clicking the new position in the full spectrum display.

When viewing a live detector, the spectrum view is updated in real time and provides current spectral data, live peak calculations, and hardware properties — even for remote instruments connected to different computers on the network. Viewing spectrum peaks, library energies, or regions of interest is simple with the convenient side panel buttons.

Working with individual Regions of Interest (ROIs) or calculating peak areas is easily accomplished with either the advance peak search or "rubber rectangle" features. As many regions as desired may be marked, and these may be saved to an "ROI" file that can be recalled and applied later to a different spectrum.

MAESTRO permits a wide choice of display options. Choose from a variety of color schemes, and display the spectrum as dots or filled bars. These settings can be used to create the optimal view for various lighting conditions or simply to suit your preference.
Advanced Features

Aside from the basic MCA Emulation functions, MAESTRO has advanced features to rapidly assess spectrum data such as:

- Multipoint Energy and Peak Shape Calibration for accurate peak calculations.
- Fast Mariscotti Peak Search to instantly mark Regions of Interest based on user-defined sensitivity settings.
- Nuclide Identification from libraries tailored to the application. Isotope markers show the location of library energies with amplitude estimation at each peak to confirm identification.
- Peak Calculations including centroid, shape, gross and net area with uncertainty, and semi-quantitative nuclide activity based on peak abundance corrections.
  - **New!** Choice of number of channels averaged to determine background.
  - **New!** Improved FWHM accuracy when peak centroid falls between two channels.
- Region of Interest (ROI) reports consisting of all Peak Calculation parameters for each marked region.
- Interactive "Jump to Peak" using ROI marker, Library, or Peak Search options.
- Spectrum overlay for direct visual comparison of sample results to a reference.
- Spectrum Stripping to clearly reveal differences or remove background.
- Spectrum Smoothing to improve statistically poor peak shape.

These features are available with saved spectra or when operating on a detector. When data collection is in progress peak calculations shown in the "Peak Info" window are updated in real time for immediate results.

Automation with Jobs

Although interfacing with MAESTRO from the toolbar and menus is simple and intuitive, this method of operation does not guarantee consistent processing that is often needed for measurements performed frequently or by different individuals. In these circumstances a more structured approach may be preferred, and simple text scripts called "Jobs" provide this capability in MAESTRO. The command set includes the most common operations, and has been expanded in Version 7 to include List Mode functions, closing MCB or Buffer windows, and enhancements to the "WAIT" command to improve efficiency. Custom processes can also be implemented with the "RUN" command which launches any external application.

Job Files may be run automatically when MAESTRO starts by including the path to the Job file as a command line argument in Windows shortcuts. This approach is frequently used to establish consistent processes from a common initiation point, and provides a simple method to run multiple Jobs in separate instances of MAESTRO.
Hardware Control

With the release of CONNECTIONS Version 8, 64-bit Windows 7 compatibility is available for all instruments that use USB1 and TCP/IP connectivity. This update also retains compatibility for instruments that were previously supported in 32-bit Windows XP and/or Windows 7. Instruments that are dependent on a host computer, such as plug-cards or USB devices, can be shared on a network through the MCB Servers running on each computer. This process allows 64-bit Windows 7 computers to operate instruments that are not 64-bit compatible through their 32-bit host computers.

The interface between hardware and software is provided through the ORTEC CONNECTIONS framework. This application layer encompasses all of the hardware drivers and communication protocols that are necessary for software applications to control the MCB (Multichannel Buffer) instruments. The hardware controls are accessed through MCB Property pages that are integrated with MAESTRO and other standard ORTEC applications.

The MCB Properties pages are tailored to the specific instrument such that only the applicable features are presented to the user. Common features for various instruments include:

- Detector HV bias control
- Course and Fine Gain Adjustment
- Zero and Gain Stabilizer
- SMART-1 Detector functions
- ZTD loss-free counting correction
- Analog and Digital Amplifier Filters
- Automatic and Manual Optimization
- Sample changer control
- ID results for Detective instruments
- Insight® Oscilloscope mode
- Battery Voltage monitoring for portable instruments.
- Acquisition Presents including Real and Live Time, ROI Peak, ROI Integral, Peak Uncertainty, or MDA

Further details for hardware functions are provided in the relevant product literature.

1 Excludes the microBase which has been obsolete for several years.
2 Instruments using the IPX/SPX protocol require Windows XP. This may be accomplished on a Windows 7 computer using the XP Mode Virtual Machine. Instruments that have a Dual-Port Memory option can take advantage of the DPM-USB to communicate over a USB connection in the Windows 7 or XP environments.
“List” Mode Spectrum Acquisition

The most commonly used acquisition mode in nuclear spectroscopy is pulse height analysis or PHA mode. In this mode a spectrum is gathered for a period, usually known as the acquisition time, of the incoming pulse-height data, event by event. These data are stored in a histogram versus pulse height (usually proportional to energy). The spectrum is the histogram of all events in the acquisition period.

List mode acquisition adds another dimension to PHA mode. During the acquisition every event is “time tagged,” that is to say its time of occurrence is recorded along with its pulse height. After the acquisition is completed, the data may be sorted and spectra constructed to represent the measurement situation during some period of interest, for example, when the detection system was experiencing a transient of high activity.

List mode data acquisition has been available in certain ORTEC instruments, such as the digiBASE, digiBASE-E, DSPEC Pro, and more recently the DSPEC-50/502 for some time, but was only accessible through custom applications using the CONNECTIONS Programmer’s Toolkit. With the release of MAESTRO Version 7 this functionality is now accessible in a standard application!

In MAESTRO Version 7, post-acquisition evaluation of list mode data is simplicity itself! When loaded into a buffer window, the collection start and stop time range can be varied to instantly create a complete spectrum that represents that selected time period. This process allows the “period of interest” to be selected directly, or the software can scan through the entire collection period with a user-defined window. Identifying transient activity periods is as easy as that!

When a particular time period of interest has been defined, this data set may be saved to a new List Mode file consisting of this subset of data, or to any of the traditional ORTEC spectrum formats that are compatible with all standard ORTEC applications. These formats include:

- **CHN** A compact binary format that contains the basic MCA emulation data — such as detector and sample description, energy calibration, acquisition information, and the spectrum.
- **SPC** A compact binary format that contains more advanced parameters used by products such as GammaVision.
- **SPE** A simple ASCII text format contains data similar to the CHN files.
### Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>A65-BW</td>
<td>MAESTRO Multichannel Analyzer (MCA) Application Software. Includes standalone or first network copy binary use license.</td>
</tr>
</tbody>
</table>
| A65-GW | Hard Copy Documentation for MAESTRO.  
Note: A PDF version of the MAESTRO manual is installed with the application. Hard copy documentation must be ordered separately if desired. |
| A65-NW | Single Use Network Copy. Requires current version of A65-BW. |
| A65-UW | MAESTRO update from A65-BW or A65-B32 models. |
| A65-VW | MAESTRO V&V Test Results and Certificate of Validation. |
| A65-2YW | 2 Year Software Subscription for A65-UW. |
| A65-3YW | 3 Year Software Subscription for A65-UW. |
| A65-4YW | 4 Year Software Subscription for A65-UW. |
| A65-5YW | 5 Year Software Subscription for A65-UW. |

### Options

- **A11-B32** CONNECTIONS Programmer’s Toolkit with ActiveX™ Controls.
- **A12-B32** Analysis Results File (UFO) Toolkit.
- **A49-B32** DataMaster Spectrum File Conversion Software.
- **C53-B32** NuclideNavigator III Master Library.

Note: Software Subscriptions provide automatic updates when new versions of MAESTRO become available. These options are available to users holding a Binary Use License (BUL) for the current version of MAESTRO (A65-BW).
Streamlines Counting Laboratory operation

Administrator and operator modes

Detector and Sample user focus

Easy installation and easily learned

All data in one place “.LVM” data files

Configurable auto filename generation

Advanced peakeditor

Comprehensive Quality Assurance

Custom Report generation from Access database files

Detector Simulation mode

LVis from ORTEC is an application manager software package designed to simplify the routine operation of ORTEC GammaVision-32 within a busy counting laboratory environment. All of the powerful features of the widely used GammaVision-32 analysis package are still available, but routine sample counting operations are greatly simplified. In addition, a number of new and enhanced features are added. It is assumed that the reader is familiar with the features of GammaVision, an overview is provided in the GammaVision-32 brochure available for download from www.ortec-online.com.
The LVis Approach to Sample Management: Clear and Logical

The configuration sidebar to the left of the main screen (Figure 1), illustrates the “hierarchical” approach of LVis, in which the focus is on detectors before sample types as opposed to the standard Gamma Vision GUI which tends to be “spectrum-focused.” In this sidebar, each configured detector is listed in order (four are shown in Figure 1); the two “red detectors” are counting. Pre-defined sample types are associated with each detector through “parametersets” which guide the appropriate sample acquisition-analysis-report sequence on the chosen detector. In principle, an unlimited number of detectors can be managed in this way, although in practice eight might be considered a realistic maximum for a single PC workstation. (Multiple networked workstations can control different groupings of detectors essentially without limit.) The sample type parametersets allow an administrator or supervisor to: PREDEFINE fixed parameters (an example might be acquisition time), REQUIRE certain operator responses, such as sample weight or origin, and ALLOW optional operator entries such as textual comments.

ATypicalRoutineAnalysisUndertheLVisApplicationManager

What follows illustrates how an operator would carry out the simplest routine sample sequence on a system which has already been set up by an administrator. (The operator must first log onto the system through a password before gaining access to any system functions.)

Step one: Choose the detector to be used and the sample type to be counted on that detector. (Here, a marinelli sample is chosen to be analyzed on detector 1.)

Step two: The sample parameters window appears. Here, the operator may review all parameters and change those which have been “authorized” as changeable at administrator level. Assuming the operator is satisfied with the parameters on view, he or she then clicks on “start,” and the sequence proceeds.

Step three: As soon as the acquisition starts, the live display (shown partially in Figure 4) appears. The active detector in the configuration window is highlighted in red and labeled with the filename, applied parameterset, and percentage of the preset acquisition time which has elapsed. The highly flexible filename convention is described in detail later in this brochure.
Step four: The analysis proceeds to completion and a report is produced as a PDF file if desired. It can really be that simple!

Multi-Detector Acquisition Configurations

In addition to the support of independent acquisitions on multiple detectors as described above, LVis also supports multi-detector acquisitions which are associated with each other. In some measurement situations, it is desirable to automate the control of simultaneous acquisitions on multiple detectors in which they are all measuring the same sample. (An example is whole-body counting.) In this case, sample description information is common to all detectors, but calibration data are not. This capability is built into LVis.

The Role of the LVis Administrator

The LVis administrator function, which has its own access password, controls how the analysis proceeds through the ability to redefine, require entry of, or allow change to sample parameters by the operator. In order to make these settings up of the system and of the various sample parameters set to be used, the various settings and parameters accessible to the administrator are grouped logically:
**Globalor “SystemSettings”: Set and Forget**

The Globalor System Settings (Figure 6), under administrator control, apply to the system as a whole and relate to the operational preferences of the laboratory itself. They apply to every sample. Activity and mass/volume units can be defined as well as a set of “Names”: User, Category and a third definable classification (shown above as “location,” but which equally could be “customername” etc.). These can be defined as mandatory selections for the operator and appear on the output report.

**Detector/Sample Parameters: Flexibly Powerful**

These parameters are set by the Administrator, and define the analysis process and operator interactions when a sample is chosen to be run on a specific detector.

Each parameter can be set by the administrator as “locked” or “unlocked” as defined by the red and green symbols in Figure 7. The values on the fields are the default values which will be seen by the operator as fixed or editable according to the choice of the administrator. This is a powerful means of making LVIS closely conform to laboratory operational practice.

**LVFiles**

An important aspect of the LVIS design is the use of the “.LV” or “LV Measurement” files. The LVFile is a comprehensive record of a complete sample measurement in binary format, which therefore may be used for archival purposes. All internal data can be easily exported from an LVFile to the standard GammaVision file required.

The internal (binary) information in an LVFile can be automatically exported to an Access® database. By activating this feature in the LVIS settings, an mdb database is created for each LVFile in the same directory once it is saved. This database can then be used in conjunction with such systems as laboratory information management systems (LIMS).

**The LVFile can be Reanalyzed at Any Time**

When an LVFile of a previous sample is opened, all the data in the file are presented in a highly informative, logical form where all data are easily located through a series of Window tabs.

The report is easily regenerated through a “print” button on the analysis page.
LVisReportGeneration: Standard or Customized

LVis reports are generated through the use of Crystal Reports\textsuperscript{\textregistered} templates. Standard templates for reporting of results, library, calibration and quality assurance are included. It is possible to compose report formats specific to the requirements of the counting laboratory via the use of the Crystal Reports product itself. Currently, Crystal Reports XI is required to generate customized LVis reports.

Interactive Peak Editor

A powerful interactive peak editor is accessible through the "spectrum" tab of the LVM file (Figure 9). Its purpose is to assist in diagnostics by allowing trial adjustment of peak data relating to the peak search phase of the analysis such as energy centroid, peak background integration limits and peak width. It may also be used to manually adjust peak fit data during the calibration process to ensure the best possible calibrations.

Powerful Automated File Naming and Sequencing

In a busy counting laboratory, logical sample management is key to success. Through the use of a very powerful "dollar command" ($) feature, LVis can automatically generate filenames which include character strings to represent:

- Current date and time
- Sampling date and time
- Incrementing sequence number
- Abbreviated username
- Abbreviated sample category
- Administrator-defined name (location in Figure 6)
- Sample parameter set name

For example, defining the filename using a parameter set by the $command string $d$_$i would result in filenames starting with 080307_0001 on March 7th 2008 and beginning with sample 1. This powerful feature alone greatly simplifies and rationalizes the storage of data, and aids in overall data management.

LVis Calibration

LVis uses the GammaVision calibration engines to perform the energy and shape calibration based on source certificate files, which are accessed directly from the references source icons located in the configurations sidebar (Figure 1). The patented GammaVision automatic energy calibration feature is available through LVis. The peaks proposed to be used for the calibration may be examined and the "fine-tuned" in order to achieve the best possible result through the use of the interactive peak editor. New calibrations are automatically associated with the detector for which they were performed, and the highly automated process is driven by the use of detector and sample specific calibration parameter files.
When both energy and efficiency calibration are complete, a convenient single display of energy, FWHM and efficiency calibration curves is provided.

**Quality Assurance within LVis**

Naturally, Quality Assurance (QA) is important in any piece of software destined for use in a counting laboratory. LVis provides the following quality assurance monitoring:

**Energy check:** Compares the identified peaks with the library (peak energy) and calibration (FWHM) data. The result for each individual peak is stored in the QA database.

**Efficiency check:** The activity of three different nuclides is specified (at a reference date) and compared to the identified activity during the efficiency check. The results for the three different nuclides are saved in the QA database.

**Background check:** Counts rate or nuclides in the background spectrum. The latter mode can automatically update related detector parameters sets.

The administrator can define the frequency at which QA measurements must be taken via a settings dialog (Figure 12).

The QA measurements are detector-specific as can be seen in the configuration menu sidebar in Figures 1 and 13. Under administrator control, a detector may be “locked out” should the operator not perform the required QA measurements in a timely fashion or if one or more parameters are found to be outside the limits. In the case of an out-of-limits result, the “!” symbol marks the detector and an “info” provides the explanation.

Quality assurance reports may be easily extracted between specified dates in support of a laboratory quality accreditation program.
Getting to Know LVis: The Detector Simulator

A counting laboratory is a busy place and "detector time" is usually at a premium in order to maximize sample throughput and revenue in the case of a commercial counting lab. The provision of a detector simulation mode means that operators may train on the use of LVis offline from the day-to-day "real" counting operations in the lab. The simulated detector and all functions associated with it behave just like the actual detectors, but instead of actual detector hardware the user is asked to nominate a stored spectrum, which is then used to simulate the live display, counting to a preset time in the usual way.

Ordering Information

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<th>Model</th>
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<td>LVis Counting Laboratory Application Manager Software (Single user copy or first network copy). Includes documentation and Binary Use License (BUL). Requires licensed copy of A66-B32 Gamma Vision-32 V6.08 or later.</td>
</tr>
<tr>
<td>LVIS-U32</td>
<td>Upgrade of LVIS-B32 to latest version. Requires BUL from existing version of LVis.</td>
</tr>
<tr>
<td>LVIS-N32</td>
<td>Additional Network Copy of LVIS-B32. Includes BUL, disks, and documentation. Requires previous purchase of LVIS-B32.</td>
</tr>
</tbody>
</table>

Calibrate all your gamma-spectrometry systems with one software tool!
Geometrically identical standards no longer required!

- Generate efficiency calibrations for new geometries instantly; no new standards needed.
- Never again wait for delivery of new standards.
- Applies to a wide range of detectors and container types.
- Highly accurate, typically to a few percent.
- Reduces disposal costs of old radioactive standards.
- Universal: use with any or all of your HPGe detectors regardless of the vendor!
- “Efficiency transfer” principle: the best combination of absolute and relative methods.
- No expensive and time-consuming detector “factory characterization”.
- Simple to use, transparent and verifiable by the user: results traceable to traceable standards.

Version 3.0 is the latest version of ANGLE software which has evolved over more than 16 years of development and testing. The new version incorporates many user suggestions for improvement. Generally speaking, ANGLE solves the familiar counting room problem of needing an appropriate efficiency calibration with which to analyze a sample, but not having an identical or “replicate” traceable standard from which to determine that calibration.

Based on a technique called “efficiency transfer” or “ET”, ANGLE calculates a transfer function between the absolute efficiency data for the detector-sample-matrix geometry which is experimentally known (the “reference geometry”) and the new detector-sample geometry (the “sample”).

The “semi-empirical” approach used in ANGLE differs from absolute methods, in that rather than start with a Monte Carlo model of the detector and then correct the model via measurement (or “characterization”), ANGLE starts from a measured calibration which is then “transferred” to the new geometry by calculation of the transfer function. Different from absolute methods, small errors in, for example, the assumed thickness of a detector dead layer will tend to self cancel in the ANGLE method, whereas in absolute methods they do not. Obviously, the more closely the calibration source resembles the sample, the better the ANGLE result.1 As the sample gets more and more similar to the reference, the ET result converges on the reference, which is a good “boundary condition” for the method.

1 The most common or “replicate standard” method can be referred to as the relative method. So-called “absolute” methods may rely purely on detector and sample physical data with no “reality check” by use of a standard. Many studies have shown the non-ideal behaviour of HPGe detectors due to areas of crystal defect or errors in physical data. The actual efficiency is not the same for “identical” detectors for these reasons. Also detector response may change over time, for example, because of dead layer lithium diffusion into the crystal. Absolute methods always require checking with real world sources.
**ANGLE V3.0**

**Advanced Efficiency Calibration Software for High Purity Germanium Gamma-Ray Detectors**

**ANGLE V3.0**

- Improved user interface.
- User input is “remembered”.
- Self teaching.
- Multiple Reference sources may be used, and results compared.
- Short computation times, typically seconds.
- Direct transfer of data to/from ORTEC GammaVision.

Version 3.0 of ANGLE incorporates a greatly improved user interface. User input is “remembered” so that with repeated use the user and the software defaults become more “in tune”. All input and output for all detectors can be displayed on a single screen.

The semi-empirical efficiency transfer method has now been extended to allow multiple (different) reference geometry sources to be used. In other words ANGLE V3.0 calibrations may be based on other than point source reference calibrations. For example, if available, a one liter marinelli beaker standard can be used to generate a two liter marinelli calibration. This improves accuracy and greatly adds to the assurance that the generated calibration is valid, because it can be checked by using different reference standards. Validation of the calibrations can be carried out at point of use, not in a manufacturers test facility.

**ANGLE V3.0 in Use**

The main window is clear, informative and logically organized into five groups.

In order to explain these five groupings, a step-by-step explanation of how to set up ANGLE V3.0 and generate a calibration follows. Most typically, some of the data (for example, data on a specific detector, or on a source container) will already have been entered previously, so that there may be fewer steps required than actually given here.
Step 1
Entry of Detector data.
Detector templates are supplied ready to take the physical data for the detector in use. The following Germanium detector types are supported:
- Closed end coaxial HPGe
- True coaxial HPGe
- Closed end coaxial Ge(Li)
- Open end coaxial Ge(Li)
- Planar (GLP)
- GWL (well type)

Usually the data for the specific detectors on the system will already be present. This is a one time only exercise.

Steps 2, 3 and 4 which follow are completed once for the reference: container-geometry-source and once for the “sample”: container-geometry-source, (“sample” is the unknown efficiency being calculated). First the reference data are entered and saved and then the sample data are entered. Once the reference data are entered and saved, further sample geometries are calculated as needed. ANGLE supports unlimited numbers of reference and sample geometries.

Step 2
Entry of Container data.
Container templates exist for Cylindrical and Marinelli configurations, and the “no container” option can deal with point sources or filters. The Cylindrical can also be used for Point (or quasi-point) and disc (or quasi-disc, e.g. air filters) sources by entering height and/or radius as zero.
Step 3

Entry of Geometry information.

The Geometry information screen also utilizes the graphical display to make data entry simple. ANGLE V3.0 includes materials databases to make data entry simple. Up to five layers of intercepting absorbing material can be included.

Step 4

Entry of Source information.

The source is defined by its height, radius and material. Height and radius can be changed by simply clicking the appropriate option in Source group in the main ANGLE window and entering the new value.

Steps 2, 3, and 4 are carried out first for the reference, and the data saved and then repeated for the sample.

Step 5

Creation of Reference Efficiency data. ("Other" window on main screen).

Here the efficiency data points (experimental values) and the relevant detector, reference container, reference source, and reference geometry are combined. The measured reference efficiency points are easily imported from GammaVision by a single mouse click.
Step 6
Calculating the new Sample calibration.
Clicking the “from current data set” item will result in the efficiency curve data entered about the reference standard being “adjusted” to reflect the parameters entered for the sample geometry.

The new calibration may then be exported to GammaVision... it's that simple!

Accuracy
The method, which is referred to as a “semi empirical” method, is highly accurate because it is based on experimentally determined reference geometry data. The calibration accuracy is limited by the accuracy to which the physical data for the sample and the detector are known, given the condition that a reliable source of accurately known activity is used for the reference.

There are many factors that can affect the accuracy of the results. However, with the correct entry of the information about the detector, container, geometry and source, and with a reliable reference calibration source, routine applications can expect 3–4% accuracy.
ANGLE Simplified Methodology

ANGLE relies on the concept of “Effective Solid ANGLE”: The absolute detector crystal photopeak efficiency for the sample $\varepsilon_p$ is related to that for a reference standard $\varepsilon_{p,\text{ref}}$ by:

$$\varepsilon_p = \varepsilon_{p,\text{ref}} \frac{\bar{\Omega}}{\Omega_{\text{ref}}}$$

Where the $\bar{\Omega}$ factors are the “effective solid angle” factors for sample and reference (“ref”). The effective solid angle is a “catch-all” term which takes account of sample/reference geometry, and gamma attenuation in all intercepting layers between radionuclide and active detector crystal, in the sample and in the detector itself. If $\varepsilon_{p,\text{ref}}$ is obtained by a calibration measurement of the reference source and the $\bar{\Omega}$ factors are calculable from the physical data of detector, reference and sample, $\varepsilon_p$ may be calculated and be used to determine the actual activities in the sample.

Determination of the $\bar{\Omega}$ effective solid angle factors for reference and sample are the challenge!

Below is an example of the mathematics applicable to a Marinelli geometry.

\[
\bar{\Omega} = \int_{(V_1+V_2),S_1} d\bar{\Omega} + \int_{V_2,S_2} d\bar{\Omega} + \int_{V_3,S_3} d\bar{\Omega} + \int_{(V_5+V_4),S_2} d\bar{\Omega} + \int_{V_5,S_5,S_2+S_1} d\bar{\Omega} =
\]

\[
= \frac{4}{r_s^2 L + \left(\frac{r_s^2 - r_p^2}{\Phi}\right) L_\Phi} \int_0^L (d + l) \frac{\pi}{2} \int_0^{\frac{\pi}{2}} r_0 \int_0^{r_0} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot R \, dR}{R^2 - 2Rr\cos\varphi + r^2 + (d + l)^2} \, dl +
\]

\[
+ \frac{4R_s}{r_s^2 L + \left(\frac{r_s^2 - r_p^2}{\Phi}\right) L_\Phi} \int_0^r \frac{\rho}{r_0} \int_0^{\frac{1}{2}} \rho \int_0^{\rho} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot R \, dR}{R^2 - 2R\rho\cos\varphi + \rho^2 + (d + l)^2} \, d\rho \, d\varphi \, d\rho +
\]

\[
+ \frac{4}{r_s^2 L + \left(\frac{r_s^2 - r_p^2}{\Phi}\right) L_\Phi} \int_0^d \frac{\rho}{r_0} \int_0^{\pi} \int_0^{\rho} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot R \, dR}{R^2 - 2R\rho\cos\varphi + \rho^2 + (d + l)^2} \, d\rho \, d\varphi \, d\rho +
\]

\[
+ \frac{4R_s}{r_s^2 L + \left(\frac{r_s^2 - r_p^2}{\Phi}\right) L_\Phi} \int_0^r \frac{\rho}{r_0} \int_0^{\frac{1}{2}} \rho \int_0^{\rho} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot (r\cos\varphi - R_y) \, db}{R_y^2 - 2R_yr\cos\varphi + r^2 + (d + l)^2} \, d\rho \, d\varphi \, d\rho +
\]

\[
+ \frac{-4}{r_s^2 L + \left(\frac{r_s^2 - r_p^2}{\Phi}\right) L_\Phi} \int_0^d \frac{\rho}{r_0} \int_0^{\frac{1}{2}} \rho \int_0^{\rho} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot (r\cos\varphi - R_y) \, db}{R_y^2 - 2R_yr\cos\varphi + r^2 + (d + l)^2} \, d\rho \, d\varphi \, d\rho +
\]

\[
+ \frac{-4}{(L + H)} \int_0^r \frac{\rho}{r_0} \int_0^{\frac{1}{2}} \rho \int_0^{\rho} \frac{F_{\text{att}} \cdot F_{\text{eff}} \cdot R \, dR}{R^2 - 2R\rho\cos\varphi + \rho^2 + (L + H)^2} \, d\rho \, d\varphi \, d\rho \]

ANGLE V3.0 “protects” the user from the complexity of these calculations making efficiency transfer calculations simple to perform through its user-friendly graphical user interface.

Would you like to know more about ANGLE? Visit the ANGLE website at www.dlabac.com/angle.
Prerequisites
Windows 2000/XP/Vista.
Detailed detector dimensional and material information. (Contact the detector manufacturer.)
Detailed container dimensional and material information. (Contact the container manufacturer.)

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
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<td>Advanced Efficiency Calibration software for HPGe detectors.</td>
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<tr>
<td>ANGLE-G32</td>
<td>Documentation for ANGLE-B32.</td>
</tr>
<tr>
<td>ANGLE-U32</td>
<td>Update for ANGLE-B32.</td>
</tr>
</tbody>
</table>

References
References 1 and 2 are highly recommended to the interested reader.

7. ANGLE: A PC-code for semiconductor detector efficiency calculations, S. Jovanović, A. Diškač, N. Mihaljević and P. Vukotić, Journal of Radioanalytical and Nuclear Chemistry, Volume 218, Number 1/April,


A **Unique** Software Solution for the Quantitative Analysis of Gamma-Ray Spectra from NaI(Tl) Detectors

- Simple to operate — with toolbars for fast action
- Sophisticated quantitative analysis of "known" and "unexpected" isotopes
- Robust nuclide identification technique, resistant to false positives
- Deconvolution of spectral multiplets
- Easy, automatic calibration
- Interactive re-analysis mode
- Multiple, live spectrum displays
- Graphic display of analysis results — see what’s been done
- Quality Assurance to ANSI N13.30 ensures regulatory compliance

**With the “usual” ORTEC**

**CONNECTIONS-32 benefits:**

- True 32-bit preemptive multitasking operation
- Multi-user, network-wide acquisition control and spectral display
- Connects easily into existing networks
- Uses standard Windows and standard protocols
- User Menu password security, and detector locking
- “Class C2” Security of data with Windows NT operation
- Supports all ORTEC MCA/MCB hardware and non-ORTEC systems via MatchMaker™ Acquisition Interface Module
- Operates side by side with other analysis programs such as GammaVision™
- Easy integration with industry-standard products such as Access®
- Configurable reporting
- Helpful developers’ toolkit options
- On-line help
ScintiVision™-32
A35-B32

ScintiVision-32, a Completely Integrated Solution for NaI Detector Gamma Spectroscopy

Acquisition Control of all ORTEC Multichannel Buffer and MatchMaker™ Supported Hardware

A Smart Multichannel Analyzer with Multiple Spectral Displays
Powerful Automation Features
Advanced Analysis Options
Quality Assurance Support
User-Definable Report Options, Plus Optional Report Writer
Import and Export of Foreign File Formats
On-Line Context Sensitive Help
Interactive Reanalysis with Display of Residuals

ScintiVision configures automatically, seeking out all connected detectors (even those running on older systems) and allowing you to set up a workstation-specific “picklist.”

Security is built into CONNECTIONS products such as ScintiVision. Event Logging means no nasty surprises.

Share your data with co-workers without fear of losing it. Any detector on the network can be locked to protect against data loss.

Protect ANY menu function. “Set and forget” analysis options may be password protected: they stay as YOU set them.
ScintiVision™-32
A35-B32

ScintiVision: Seamless Integration at Every Level.

A smarter Multichannel Analyzer for NaI detectors . . .
With Integrated Control of the Latest Hardware . . .

... and an array of qualitative analysis tools to provide RAPID answers.
Interactive Reanalysis resolves difficult spectral regions.

“Set and forget” options provide all the flexibility you could want while retaining simplicity of operation.

Select options unique for any sample type.

Select system-wide options.

Select advanced features.

Specify just what you want on the report.
ScintiVision™-32
A35-B32

ScintiVision Automatically the Optimum Tool . . .

Simple Automation

. . . via Menu Settings options

. . . User-written Job files

. . . Smart, library-assisted calibration. Do it once, and ScintiVision "learns" how to do it automatically the next time! Interactive graphics show you the fit results. Use single or multiple spectra for the best calibration possible.

Integrated “copy and paste” library editing . . .
no data entry repetition!!
Quality Assured Results...

Check on the QA status of a detector at any time

Automatic charting of QA results

Integral hard-copy plotting of spectrum

Automatic lock-out feature upon QA failure

ScintiVision Output Report...
Clear, Concise, and Flexible

Optional Report Writer (A46-B32) allows TOTAL flexibility in reporting!
Overview

Seamlessly Simple
ScintiVision provides a new array of analytical tools to simplify analysis of NaI detector spectral data — all in a “seamless” design requiring minimum operator interaction. Operation is easy with the toolbar buttons for common functions.

Remote Control Made Easy
All ORTEC spectroscopy hardware is supported within the CONNECTIONS architecture — with the entire sample analysis process controlled from a single screen, and remote PC workstations able to control, analyze, and display data being gathered in the counting room. ScintiVision, a true 32-bit implementation, operates securely, either standalone or networked.

Compatibility
All ORTEC “multichannel buffer” hardware (circa 1983 on) is supported by CONNECTIONS-32 products. ScintiVision is no exception. The exciting MatchMaker hardware brings ScintiVision and CONNECTIONS-32 benefits to non-ORTEC ADC hardware! Both new 32-bit and older 16-bit workstations can work together on the same network. Other MCAs, such as the LANL MCA, are also supported.

Security is Standard
System event logging means that interventions such as file deletions may be traced to the originator; System security meets the “Class C2” Security standards of the U.S. Department of Defense.

Password Protection and Automation
All ScintiVision menus are easily password protected. A detector may be also locked with a password. Built-in job file capability allows minimal intervention procedures to be set up quickly.

Reports the Way You Need Them
Scintivsion includes a flexible report format and an optional report generator (A46-B32 for customized results output.

Analysis Methods Specifically for NaI Detector Gamma Spectroscopy
ScintiVision has been designed specifically for the unique characteristics of NaI detector spectra which are quite different than those from germanium detectors. Sodium iodide’s broader peaks lead to more interferences and poorer signal-to-noise ratios. ScintiVision’s special analysis techniques are not available elsewhere!
Here’s how it’s done: ScintiVision’s Gaussian cross correlation peak search is adapted to the resolution and peak shape of the particular NaI detector being used. Multiplets located by the peak search process are deconvoluted by a method which allows the number of peaks, the peak positions, and their width and area to vary until the minimum value of Chi-squared is obtained. The user may vary the fitting parameters from the defaults. (These settings are then password protected.)

Nuclide identity candidates are tested statistically. Before a nuclide is reported as present, it must, in addition, pass a “Fraction Limit” test which checks to see that a sufficient number of peaks of the nuclide have been individually identified; this ensures that positive identification is statistically reasonable. These tests all but entirely eliminate “false alarm” misreporting of nuclides not present in a sample.

Reported nuclide activities are calculated for each peak and then used to calculate a weighted average activity in the final output report.

Peaks found but not identified by the library can be reported.
A detection limit may be calculated according to NUREG 4.16 for nuclides in the library but not found in the spectrum.

Peaked Background Correction
ScintiVision can correctly analyze for a nuclide in the sample which is also present in the environmental background. The treatment is statistically rigorous, and the feature is useful in many application situations in which non-ideal shielding conditions exist.

Automated Calibration
Conveniently, ScintiVision may be calibrated from a single standard with multiple lines, or from multiple standards. More crucially, ScintiVision can LEARN the calibration sequence, making recalibration a totally “hands off” and automatic procedure.

QA and Flexible Reporting Ensure Regulatory Compliance
The QA capability, combined with flexible reporting options ensures regulatory compliance. The optional A46-B32 ScintiVision Configurable Report Writer may be used to generate totally custom output from an Access-compatible results database. To ensure traceability, all hardware parameters are saved along with the spectral data.

Developer’s Support
The optional A11-B32 UMCBI Toolkit provides easy hardware access and acquisition control, even across networks! The A46-B32 Report Writer option allows easy customizing of output reports via the use of well-known Crystal Reports.

Specifications

General
Integration of acquisition and control, “Smart” MCA, and quantitative analysis functions for use in conjunction with PC-based gamma spectroscopy workstations. On-line help; Operator Menu password protection. Can display multiple spectra.

Operating System
32-bit application for Windows 2000/XP network capabilities; support for preemptive multitasking; and ORTEC CONNECTIONS-32 compliant.

Spectroscopy Hardware Support
All ORTEC MCBs (past and present) and all other devices supported by ORTEC CONNECTIONS-32 (see CONNECTIONS literature). Non-ORTEC ADCs from Canberra, Nuclear Data, and Silena are supported via the MatchMaker EtherNIM acquisition interface. Built-in support for advanced operations (where supported by hardware amplifier gain/shaping control, Auto-PZ’, DSPEC™ “optimize” and InSight™ mode, DART™ field mode, graphical setting of MCB spectrum stabilizer and statistical uncertainty presets. Integrated support is included for non-ORTEC MCAs such as the LANL MCA.

Detector Locking password protection.
File Formats Supported
ORTEC SPC and CHN are supported as standard in the file save, recall, and compare functions. **Most non-ORTEC file formats are supported** by loadable modules, in a “set and forget” fashion for save and recall. Check for availability of specific modules.

Semi-Quantitative “Smart” MCA Functions
“Instant” Mariscotti peak search, with ROI marking and “nearest match” suspected nuclide identification.
Net/Gross peak areas with uncertainty calculation, peak centroid, and shape
Spectrum Strip
Spectrum Smooth
Spectrum Compare

Analysis Methods
Isotope Identification Mode: Multi-line gamma fraction method
Peak Search: Optimized Gaussian Cross-Correlation
Background Methods: Least squares for singlets with stepped background fit for multiplets
Correction for Peaked Background (e.g., from other sources in the laboratory)
Decay correction both to sampling date and for decay during acquisition of short half-life nuclides.
Automatic deconvolution of multiplet peaks
Nuclide Activity Averaging: based on peak uncertainty and peak strength
Limit of Detection Calculation: Minimum Detectable Activity (MDA) may be calculated for library peaks NOT found in the spectrum according to the method of NUREG 4.16:

\[
MDA = \frac{2.71 + 4.66 \cdot \sigma_b}{LT}
\]

Reporting
Choose any ORTEC standard report option (output to file, printer, or to any Windows application, e.g., NOTEPAD):
- Unknown peaks
- Library peak list by energy
- Library peak matrix by isotope
- Activity summary

Uncertainty reporting options:
- Percent or activity
- Counting or Total
- 1, 2, or 3 sigma


Interactive Re-Analysis Mode
Iterative fitting of multiplets, addition or deletion of peak centroids, and adjustment of energy calibration with graphical display of residuals.

Calibration
Energy calibration: Multipoint, quadratic for energy and FWHM, from single or multiple spectra. (Linear FWHM model also selectable.)

Efficiency Calibration fit options:
- Linear
- Quadratic
- Interpolative
- Polynomial

Analysis Library Manager

Quality Assurance
Complies with the demands of ANSI N13.30. For each detector, QA tracks:
- Total detector background
- Total (decay corrected) activity for all calibration nuclides
- Average FWHM ratio (spectrum to calibration standard)
- Average peak shift from library energy values
- Actual peak centroid energies
- Automatic lock-out feature upon QA failure

Control Charts
Selecteble plotting variable
- Selectable time window
- Auto-scaling with the alarm limits shown
- Display or hard copy

Automation Features
Extensive built-in Job Streaming (Macro language), allowing “one-click” analysis from a user-built icon.

Ordering Information
Model | Description
--- | ---
A35-B32 | Single-User Copy of ScintiVision
A35-U32 | Update of existing A35-B32
A35-N32 | Network Copy of A35-B32 (Prerequisite: First licensed copy of A35-B32)
A35-K32 | Upgrade from A70-BI or A25-BI to A35-B32

5. PCNUDAT Nuclear Data file used by permission of NNDC at Brookhaven National Laboratory.
Multiple Instrument Remote Monitoring and Control Software

“The right software, the right solution, the right answer!”
Detective-Remote is a Windows®-based software application to remotely monitor one or more ORTEC Detective-200 radionuclide identifiers, or other compatible ORTEC Detective instruments. The application integrates instruments, communications and data management to provide users with the necessary decision support capability that nuclear security missions demand.

With support for any ORTEC Detective, simple setup, and an easy-to-navigate tabbed environment, critical nuclear data is easily accessed, monitored, and managed from the convenience of a single laptop.

The viewing flexibility of Detective-Remote makes it the ideal solution for many nuclear threat monitoring applications such as mobile and maritime search and interdiction, choke point monitoring, and radiological emergency response, which require alarm monitoring and rapid assessment of the source of the threat.

With Detective-Remote software, Detective-200 identifier hardware, necessary cables and laptop computers and other ancillaries, solutions may be easily configured for:

- **Wide Area Mobile Search Applications**
  Detective-Remote software can analyze spectral data from one or multiple vehicle mounted Detective instruments, (in drive-by or fly-by mode) simultaneously. The software processes the composite data through advanced Detective ID algorithms and posts alarms IN REAL TIME when illicit sources are detected. All data points are stored along with time of capture and GPS co-ordinates. The data can be exported into other applications, spreadsheets, GIS applications, or reports.

- **Maritime Interdiction and Nuclide Identification**
  In maritime applications, the Detective-200 rugged packaging for harsh environments is a vital prerequisite. Coupled with the Detective-Remote software, the system meets the requirement for stand-off [stationary] detection in order to survey a vessel at sea. For distant stand-off objects a “long count” mode is provided.

- **Portable Choke Point Monitoring**
  Detective-Remote supports missions that require easy setup and deployment of temporary portal monitoring. The combination of multiple Detectives configured to communicate to a laptop creates an ad-hoc choke point solution for monitoring people, vehicles or packages in a pass through or “wait in” measurement mode. Examples include:
  - Monitoring of traffic flows on a highway. For example, at a toll both or passing under a bridge, or passing by a vehicle containing the measurement system.
  - Monitoring of individuals entering a major public event such as a sports arena.
  - “Ad-Hoc” contamination or health physics measurements after a nuclear incident.

Detective-Remote software offers state-of-the-art, real-time radionuclide detection and identification from a simple-to-operate user interface. For mobile operation, GPS data are also stored for offline integration with the radiation profile. Detective-Remote provides unambiguous results in “drive-by” or “fly-by” modes, while being also useful in stationary applications.
Advanced Algorithm Analysis for Special Nuclear Material
- Supports single or multiple Detective arrays operating at a conversion gain of 8192 channels.
- Combines the data from multiple detectors for the most sensitive and accurate detection and identifications.
- Searches in energy, time, and position for the highest possibility of detection of point source and distributed sources.
- Uses the optimum combination of data to get the most sensitive results in real time.
- Proprietary analysis approach:
  - Multiple sliding windows examine 1 second slices of data in use configurable groups such as 2, 4, and 8 seconds simultaneously.
  - Detector data results are analyzed in different combinations to optimize detection sensitivity.
  - Up to 32 different analysis passes for each analysis result point.
  - Analysis result points are posted every second.

Detective-Remote Software Features
- Software runs on a standard PC with Microsoft® Windows® 7 operating systems, 32-bit or 64-bit.
- Highly intuitive Graphical User Interface optimized for the needs of remote monitoring professionals.
- Scalability easily manages 2 to 4 of any model combination of Detective-200, Micro-Detective, and Detective-100T devices simultaneously.
- Integrated event and alarm monitoring and management interface.
- Support for integrated Detective neutron count rates.
- Real-time alarm indication, auto radionuclide identification, and event type filter.
- Add comment function.
- Increased sensitivity Low Confidence Expert (LCX) identification mode.
- Color-coded alarms based on the threat level: “threat” (red), “suspect” (yellow; LCX mode only), and “innocent” (green).
- Audio alerts on alarms (NORM, Suspect, Threat).
- Independent status monitoring of each Detective.
- Offline survey data review.
- Convenient reconfigurable user interface.
- Stored user interface configuration.
- System self-test function.
- "Long Count" mode.
- Integrated configuration and administration interface provides full-management capability for all components.
- Generates ORTEC .CHN-format spectrum files, if required, for any entry on the Measurement tab. These spectrum files can then be viewed with the accompanying MAESTRO-32 MCA Emulation Software (A65-B32).

Detective-Remote in Use, the Simple Operator Interface
The Detective-Remote software system is easy to use with minimal training required. The system automatically begins collecting data and analyzing information in real time. If an alarm limit is exceeded, an alarm notification occurs showing the alarm condition. All alarms must be acknowledged or they will persist.

Surveys: Data Collection, Analysis, and Storage
The Detective-Remote system performs radiation surveys that identify the source of radiation, based on the radionuclide identification library. A survey maintains a complete record of all the spectroscopic data, location data (if a GPS is being used), and analysis results collected over a period of time.

Detective-Remote receives a continuous stream of data from one or more Detectives, the system constantly verifies the data to all of the radionuclides in the library, and posts IDs and alarms as appropriate.

Each Detective is polled every second. As mentioned earlier the algorithm combines the data from multiple detectors for the most sensitive and accurate detection and identifications.

The survey database records the following:
- Raw spectrum data from each detector, collected at least once per second.
- A list of the identifications present along with their confidence values and the combination of detectors and data integrators that produced each radionuclide identification.
- The time and GPS coordinates associated with the data.
- Signal Index and Threat Index values.
- The Data Record for each measurement point contains:
  - Identified source(s) list.
  - Time and location.
  - Threat and Signal indices.
  - Spectroscopic data.
  - Gamma ray (and optional neutron) gross count rate data.
Threat and Signal Indexes and Long Count Mode

In the measurements tab (below), the lower part of the display shows “Threat” and “Signal” Indices in order to alert the operator to changes in the gamma-ray flux below the alarm level.

The Threat Index is an indication of the highest peak confidence level currently occurring for any of the nuclides designated as “threat” in the table of nuclides. The Signal Index is similar, but count rate related. A raised Threat or Signal Index indicates where stationary measurements or further investigations should be performed.

In Long Count Mode, there is no scrolling of data. The System could be used as an ad-hoc contamination monitor for screening personnel in the event of a nuclear terrorism incident such as a RDD. Long Count Mode also allows intensive stationary analysis in suspicious locations without sliding window averaging.

LCX (Low-Confidence Expert) identification mode (shown in yellow below) allows increased sensitivity in high threat level security situations.
Real-Time Alarm Indicator

Each time an alarm is generated, the alarm ID and the corresponding alarm color are posted on the bottom left corner of the window and/or in a "pop-up" alarm dialog box, along with the alarm Acknowledge button. If multiple alarms are generated at one time, they are presented highest priority first.

Data Point Information Area

- Tracks each new data point in the current search, updating once per second; or
- Shows the readouts for a data point chosen from the Events, Alarms, or Measurements tab in either the active survey or an existing survey.

The upper fields show the Point number, acquisition date and UTC time, GPS Location, and gamma and optional neutron count rates.

The lower field shows the IDs for this data point, their associated alarm colors, and the individual detector node and/or combination of detector nodes that generated each ID. In an active survey, this area updates in real-time.

The Signal Index and Threat Index are displayed on the lower left section of the Measurement tab. These “virtual strip charts” can indicate the presence of nearby radioactivity even before IDs and alarms are generated helping to locate “hotspots” for long counts. Both charts scroll from right to left with time, providing short-term trend data. The Threat Index always reflects the highest-confidence ID of threat nuclides from any detector [no summation involved]. The Signal Index is based on the sum of the net count rate from all detectors.
Detective-Remote Radionuclide Library

The following table lists the threat and innocent identifications for the standard identification mode.

<table>
<thead>
<tr>
<th>THREAT</th>
<th>INNOCENT</th>
<th>INNOCENT</th>
<th>INNOCENT</th>
<th>INNOCENT</th>
<th>INNOCENT</th>
<th>INNOCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Am-241 (shielded)</td>
<td>Ac-225</td>
<td>Cf-252/Cf-249</td>
<td>Ga-64 (shielded)</td>
<td>Ir-192 (shielded)</td>
<td>Pd-103</td>
<td>Tc-99M</td>
</tr>
<tr>
<td>Am-241</td>
<td>Ac-227</td>
<td>Cm-242</td>
<td>Ga-67</td>
<td>Os-194/Ir-194</td>
<td>Rh-105</td>
<td>Te-132</td>
</tr>
<tr>
<td>Am-241 (59.5 keV)</td>
<td>Ag-110m</td>
<td>Cm-243</td>
<td>Ge-68/Ga-68</td>
<td>Ir-194 (shielded)</td>
<td>Ru-97</td>
<td>Tl-201</td>
</tr>
<tr>
<td>Enriched Uranium</td>
<td>Ar-41</td>
<td>Cm-244</td>
<td>Gd-153</td>
<td>K-40</td>
<td>Ru-106/Rh-106</td>
<td>Ti-200</td>
</tr>
<tr>
<td>HEU</td>
<td>As-72</td>
<td>Co-56 (shielded)</td>
<td>Gd-159</td>
<td>Kr-87</td>
<td>Po-210</td>
<td>Ti-202</td>
</tr>
<tr>
<td>Neutron Cr (0)</td>
<td>As-74</td>
<td>Co-55</td>
<td>Hf-181</td>
<td>Kr-88</td>
<td>Pr-144</td>
<td>Ti-204</td>
</tr>
<tr>
<td>Neutrons Present</td>
<td>At-211</td>
<td>Co-56</td>
<td>Hg-203</td>
<td>Kr-88 (shielded)</td>
<td>Ra-223</td>
<td>Th-229</td>
</tr>
<tr>
<td>Np-237</td>
<td>Au-198</td>
<td>Co-57</td>
<td>Ho-166m</td>
<td>La-140</td>
<td>Ra-226</td>
<td>Th-230</td>
</tr>
<tr>
<td>Pu-239</td>
<td>Ba-133</td>
<td>Co-58</td>
<td>Ho-166m (shielded)</td>
<td>Lu-172</td>
<td>Ru-103</td>
<td>Th-232</td>
</tr>
<tr>
<td>U-232</td>
<td>Ba-140</td>
<td>Co-60</td>
<td>Ho-166</td>
<td>Lu-176</td>
<td>Sb-124</td>
<td>Tm-170</td>
</tr>
<tr>
<td>U-233</td>
<td>Be-7</td>
<td>Cr-51</td>
<td>I-123</td>
<td>Lu-177</td>
<td>Sb-124 (shielded)</td>
<td>Tm-171</td>
</tr>
<tr>
<td>U-238</td>
<td>Bi-212 (Th232/U232 daughter)</td>
<td>Cs-134</td>
<td>I-124</td>
<td>Mn-52</td>
<td>Sb-127</td>
<td>W-188/Re-188</td>
</tr>
<tr>
<td>Suspect (LCX Mode only)</td>
<td>Br-76</td>
<td>Cu-64</td>
<td>I-126</td>
<td>Mn-56</td>
<td>Se-75</td>
<td>Xe-133</td>
</tr>
<tr>
<td>375/414 Peak Present</td>
<td>Br-77</td>
<td>Eu-152</td>
<td>I-131</td>
<td>Na-22</td>
<td>Sm-153 (shielded)</td>
<td>Xe-135</td>
</tr>
<tr>
<td>Ce-139</td>
<td>Neutrons on Fe</td>
<td>I-135</td>
<td>Nd-147</td>
<td>Sr-90/Sr-89/Y-90</td>
<td>Zn-62</td>
<td></td>
</tr>
<tr>
<td>Ce-141</td>
<td>Elevated radiation or beta emitter</td>
<td>In-111</td>
<td>Pa-231</td>
<td>Ta-182</td>
<td>Zr-95</td>
<td></td>
</tr>
<tr>
<td>Ce-144</td>
<td>Ga-64</td>
<td>Ir-192</td>
<td>Pb-203</td>
<td>Tc-96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Configure to CONOPS

DETECTIVE-200 systems may be configured to meet the concept of operations (CONOPS) for the job in-hand in a wide variety of applications by the use of Detective-Remote. Multiple Detective-200 instruments may be combined into a single Detective-Remote system to provide enough sensitivity to eliminate false negatives in the measurement situation (speed, distance, level of shielding), expected.

Unlike low resolution solutions whose performance is heavily influenced by the local radiation background, the high resolution Detective-200 spectra lead to predictable performance in every case. Detective-Remote can be configured to accept signals from various types of occupancy sensors, and to save camera image data along with spectra. Various types of mapping programs can be integrated with Detective-Remote. Custom programming support is available to exactly configure Detective-Remote to the CONOPS requirement.
Detective-Remote™

Ordering Information

DETX-200
Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifier (Gamma Only) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETX-200-2
Includes 2 each DETX-200 Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifiers (Gamma Only) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and 1 each Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETX-200-4
Includes 4 each DETX-200 Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifiers (Gamma Only) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and 1 each Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETEX-200
Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifier (Gamma and Neutron) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETEX-200-2
Includes 2 each DETEX-200 Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifiers (Gamma and Neutron) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and 1 each Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETEX-200-4
Includes 4 each DETEX-200 Ultra-High-Sensitivity, Ruggedized, Transportable HPGe Radioisotope Identifiers (Gamma and Neutron) with AC/DC power adapter charger, automobile power cable, external battery kit, and wheeled transport case, and 1 each Detective-Remote software with Laptop computer, external GPS, and MAESTRO software.

DETECTIVE-REMOTE-MOB-SYS
Detective-Remote software with Detective software update, Laptop computer, external GPS, and MAESTRO software.

For price and delivery, email ortec.info@ametek.com.

Specifications subject to change
08/11/2
“The Comprehensive Alpha Spectrometry Solution for Compatible, Efficient, and Defendable Alpha Measurements.”
AlphaVision is a comprehensive PC-based alpha spectrometry application that combines rich features and intuitive processes to meet the demands of modern Radiochemistry Laboratories.

In large scale commercial laboratories with hundreds of alpha detectors or small labs with only a few detectors, AlphaVision is your solution to optimize routine measurement processes and monitor system performance.

Why AlphaVision?

**Compatibility**
- Operates in the most common PC environments — Windows 7 (32 & 64 bit) and Windows XP.
- Microsoft Access Database with Data Management tools and LIMS integration capability.
- Extensive Analysis capability to accommodate a wide variety of Radiochemistry processes.

**Process Efficiency**
- Batch Configuration process with LIMS¹ integration to maximize throughput and minimize errors.
- Intuitive Sample Management including Query tools to quickly locate Batches and Samples.
- Rapid Data Review and Analysis modification process.
- Integrated Hardware control for up to 256 detectors in a common interface.

**Defendable Results**
- Security controls to limit user access to authorized functions.
- Compliance with Industry Standards such as ANSI N13.30 and N42.23.
- Comprehensive Quality Control features.
- Historical Analysis retention when re-analyzing samples.
- Detailed Event Logging for routine operations, warnings, and errors.

Now Introducing AlphaVision 6.0!

**New!** 64-Bit Windows 7 Compatibility.
**New!** Crystal Reports Version 11.5 Integration for reliable custom reports compatible with common file formats.
**New!** Integrated Hardware Control to instantly change vacuum, pulser, or high voltage status on large detector groups.²
**New!** Automated ROI Adjustment for gain shift corrections during analysis.
**New!** Automated Spectrum and Report Export during batch counting processes for use with external applications.
**New!** Formal Verification and Validation test results available as an option.
**New!** Toolbar Controls for rapid access to the most common menu functions.

¹ Laboratory Information Management System.
² Hardware control is available for instruments with software control capability.
Bringing it all together for the most Compatible, Efficient, and Defendable Results Possible!
Calibration

- Energy and Efficiency Calibration
- Automated and Interactive Peak Fit
- Traceable Historical Calibration Records
- Active/Deactivate Calibrations
- Customizable Calibration Report
- Unlimited Calibration Standards
**Batch Automation**

- Analysis Templates for Consistent Processes
- LIMS Integration Capability
- Extensive Analysis Options for Peak Fit, Activity Calculations including Tracer and Dilution Schemes, and Detection Limits
- Custom Reports with Crystal Reports 11.5
- True “Count to MDA” Presets
- Interactive Review/Reanalysis
Hardware Control

- Rapid Detector “Group” Operations
- Integrated Instrument Control Based on Instrument Type
- Detector Status Indicators “at a glance”
- Automated Instrument Setup
- Configurable Detector Grid
AlphaVision

Quality Assurance

- ANSI N42.23 and ANSI N13.30 Compliant
- Automated Control Charts and Reports
- Warning/Alarm Limit Calculations
- Monitoring Parameters:
  - Detector Background (Total and Isotopic)
  - Calibration Energy and Efficiency
  - Pulser Centroid and Width
  - Detector Bias and Chamber Pressure
  - Reagent Blank Nuclide Activity
  - Control Sample Nuclide Activity
  - Tracer Peak Width
  - Chemical Recovery

AlphaVision - AlphaVision.mdb
AlphaVision v6.0
Alpha-Spectroscopy QA Report
### Specifications

**Operating System Requirements**  
Windows 7 (32 and 64-bit) and Windows XP (32-bit)

**Supported Hardware**  
ORTEC Alpha Suite integrated spectrometers (Alpha Aria, Duo, Ensemble, and Mega) are recommended in order to take advantage of the software controlled operations and Windows 7 64-bit USB connectivity.

Legacy instrumentation compatible with ORTEC CONNECTIONS such as ORTEC OCTÊTE-PC, OCTÊTE-Plus, 576A, Soloist, 920 series, and Oxford OASIS, as well as the ORTEC 676 Alpha King, Tennelec TC-256, and Canberra 7401/7404 models which are supported through ORTEC MCBs. Connectivity to these devices may be limited to Windows XP or Windows 7 32-bit operating systems depending on the communication protocol employed.

Contact your local representative to determine if your instrument is supported in the desired operating systems, or if an alternative communication protocol, such as the DPM-USB, is available.

**Analysis Methodology**  
- **Peak Search/Fit Methods:** Second Derivative (Mariscotti), Top Hat Correlation, Peak Interference Correction, ROI (Regions of Interest) including automatic shift of ROIs based on the Tracer Peak, Best Peak, or All Peak positions, and Interactive ROI Adjustment to optimize peak fit during reanalysis.
- **Nuclide Activity Calculations:** Absolute (no Tracer), Tracer Recovery Correction, Chemical Recovery Correction (Automatic and Manual), Background Subtraction, Blank Subtraction, Total Propagated Uncertainty.
- **MDA Methods:** KTA, Currie, ANSI N13.30, [corrections such as dilution scaling, tracer and chemical recovery, etc. included].
- **Presets:** Real and Live Time, Tracer Peak Area, MDA.

**System Management**  
- Select, Archive, and Compact Database.
- Search Samples by Batch/Sample ID or Batch Tree Navigation.
- Event Log captures process information, warnings, and errors.
- Purge Data.
- Security:
  - Detector Management – Add, Remove, Configure, Move, Edit Properties, Calibrate, Edit Chamber Pressure and Leakage Current Thresholds.
  - Quality Assurance – Edit QA Types and Limits.
  - System – View and Clear Event Log, Edit Batch Tree, Edit Users and Security Levels.

**Ordering Information**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A36-BW</td>
<td>AlphaVision Alpha Spectrometry Management Software for Windows. Includes standalone or first network copy and binary use license.</td>
</tr>
<tr>
<td>A36-BVW</td>
<td>AlphaVision software (A36-BW) with V&amp;V Test Results and Certificate of Validation (A36-VW).</td>
</tr>
<tr>
<td>A36-NW</td>
<td>Single Use Network Copy. Requires current version of AlphaVision. Example: For a three-station network, order one copy of A36-BW and two copies of A36-NW.</td>
</tr>
<tr>
<td>A36-UW</td>
<td>Update from A36-B32, A36-BW, or A36-NW to latest version of AlphaVision.</td>
</tr>
<tr>
<td>A36-UWW</td>
<td>AlphaVision software update (A36-UW) with V&amp;V Test Results and Certificate of Validation (A36-VW).</td>
</tr>
<tr>
<td>A36-GW</td>
<td>Additional Hard Copy Documentation for AlphaVision.</td>
</tr>
<tr>
<td>A36-VW</td>
<td>AlphaVision V&amp;V Test Results and Certificate of Validation.</td>
</tr>
</tbody>
</table>


K. Debertin and R.G. Helmer. Gamma- and X-Ray Spectrometry with Semiconductor Detectors, Elsevier Science, 1988. (If peak shapes are well-controlled [through good sample preparation] the Top-Hat method is likely to yield better results than the Mariscotti method in which peak width is a free parameter.)
Introducing GammaVision Report Writer V3.10

Why Report Writer?

Compatibility
- Windows 7 (32 & 64 bit) and Windows XP
- Microsoft Access Database
- Crystal Reports 11.5
- GammaVision 7 and earlier

Process Efficiency
- Automated Custom Reports with Spectrum Image
- Extensive Report Export Options (Word, Excel, PDF)
- Simplified LIMS Data Integration
- Data Management for Search, Archive, Purge functions

Defendable Results
- Populated directly from GammaVision Analysis
- Automated Calculations and Data Validation through Custom Report Templates
- Analysis Data supported by Spectrum Graphics

Version 3.10 Updates

New! 64-Bit Windows 7, Crystal Reports 11.5, and GammaVision 7 Compatibility.
New! Export compatibility with newer file formats (Word, Excel, Rich Text, and PDF).
New! Over 75 new Analysis Parameters Available.
New! Crystal Report 11.5 Templates with New Analysis Parameters.
New! Improved Printing and Report Export capability.
**GammaVision Report Writer**

**Reporting Options**
- Different Report Templates by Application or Sample Type
- Automatic Print Option
- Include Spectrum Image Report Option
- Spectrum Image Report Format:
  - Customizable Plot Title and Color Scheme
  - Optional Axis Labels and Sample Description
  - Acquisition Date/Time and Real/Live Time Reported
  - Regions of Interest Outlined or Filled
  - Horizontal Axis
    - Energy or Channels
    - Tick Marks or Grid Lines
    - Full Scale or User-Defined Range
  - Vertical Axis
    - Log or Linear Scale
    - Tick Marks or Grid Lines
    - Auto Scale or User-Defined Maximum
- Custom Reports
  - Example Crystal Report Templates are provided to produce lengthy detailed reports or a short summary of key data.
  - Extensive report customization available through Crystal Reports 11 or 11.5 as well as Visual Studio 2010.
  - Microsoft Access Reporting functions can be enabled with the Report Writer database. (Requires Microsoft Access)

**Report Export Options**
- Automatic Export on Analysis Option
- Export File Format:
  - Microsoft Word and Excel
  - PDF
  - ASCII Text
  - Rich Text
  - Crystal Reports
  - Additional formats available for manual export from the Crystal Reports Built-In Viewer Control.

**Data Management**
- Query Samples by Spectrum Name, Date Range, Sample Description and Detector by exact match or wild card criteria.
- Move/Copy selected analysis data and (optionally) associated files to a specified database and file folder for Archive functionality.
- Delete selected analysis data and (optionally) associated files for system Purge and Clean-up functionality.
- Use Microsoft Access or custom applications to run queries, combine multiple sample results, generate exception reports, or integrate with Laboratory Information Management systems.

**Specifications**
**Operating System:** Windows 7 (32 and 64-bit) and Windows XP (32-bit) Operating Systems.
**Report Template Editors:** Crystal Reports XI and Visual Studio 2010 (not included with Report Writer).
**Database Format:** Microsoft Access.

**Ordering Information**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A44-UW</td>
<td>Report Writer Update from A44-B32 or A44-BW models.</td>
</tr>
<tr>
<td>A44-GW</td>
<td>Documentation for GammaVision Report Writer</td>
</tr>
<tr>
<td>Options</td>
<td></td>
</tr>
<tr>
<td>A44-CR</td>
<td>Crystal Reports Professional</td>
</tr>
</tbody>
</table>

Specifications subject to change 010614
Advanced Isotopic Ratio Analysis Software for HPGe Gamma-Ray Spectra

- Analyzes Pu, and a wide variety of heterogeneous samples containing Pu, Am, U, and other nuclides including $^{242}$Pu.
- Operates with a single HPGe detector, including ORTEC Detective and trans-SPEC families.
- No calibration standards necessary.
- Works with shielded samples.
- Select from a large number of supplied sample/geometry conditions or add more types.
- Auto-analysis function for samples of unknown characteristics.
- Command-line mode of operation allows easy incorporation into other applications.
- Windows 64-bit and 32-bit compatible.
- Significant enhancements over previous versions.

The FRAM code\(^1\) has been under evolutionary development at Los Alamos National Laboratory since the mid 1980s. It analyzes the gamma-ray spectrum taken with a germanium detector, of items containing plutonium or uranium, or both and quantifies the distribution of plutonium or uranium isotopes. $^{241}$Am and other transuranic isotopes (including uranium in mixed uranium-plutonium oxides) that contribute measurable gamma rays to the spectrum can also be quantified relative to plutonium.

It also analyzes spectra from items containing only uranium, and can quantify the uranium isotopic distribution. These measurements can be performed on samples of any size, geometry, and physical and chemical composition.

Easy-to-Use Windows User Interface

ORTEC FRAM is a member of the ORTEC CONNECTIONS family of products. It operates within the ORTEC CONNECTIONS network spectroscopy architecture, giving greater flexibility in choice of MCA hardware, including the latest DSPEC 50 and DSPEC 502 digital spectrometers, and fully integrated spectrometers such as the Detective, trans-SPEC and IDM series.

The highly graphical FRAM user interface complies with the latest Windows conventions and is easy to use. Version 5.1 has a new look that, for simplicity, provides a single interface for all data displays. A single dialog bar controls all aspects of spectrum and results display, making it easy for the user to verify the quality of the data or analysis without leaving the FRAM main window.

FRAM provides acquisition control of all MCA hardware supported by ORTEC CONNECTIONS. The ORTEC MAESTRO\(^2\) MCA software program is used for hardware system setup prior to use, and can be removed from the PC to secure the MCB from changes. [A separate MAESTRO brochure may be downloaded at http://www.ortec-online.com/download/MAESTRO.pdf.]

\(^1\)FRAM: Fixed-energy Response function Analysis with Multiple efficiency. FRAM is also a word of Scandinavian origin meaning “forward” or “onward”, being the name of the ship used by the polar explorers Nansen, Sverdrup, and Amundsen between 1893 and 1911.
FRAM Analysis Capabilities

Sample Type

The versatility of FRAM and its ability to analyze a wide variety of samples stems from its reliance upon generic analysis algorithms. Specific information needed to guide the analysis is encoded into a set of parameters and stored in a database. This information includes the regions and peaks to be examined, the isotopes to be used in the analysis, and special information for performing a number of diagnostic tests on the spectrum. For analysis of well characterized “routine” samples, a single analysis parameter set may be easily constructed; for less well known samples, an automatic mode is provided in which the optimum sample parameter set is determined iteratively in an automated fashion.

Analysis Methods

FRAM analyzes photopeaks from the spectrum of plutonium or uranium gamma rays. The spectrum contains peaks from the plutonium isotopes $^{238}\text{Pu}$ to $^{241}\text{Pu}$, $^{241}\text{Am}$, and often other isotopes such as $^{235}\text{U}$ or $^{237}\text{Np}$. FRAM combines this information to produce isotopic ratios independent of sample size, shape, physical and chemical composition, measurement geometry, and container characteristics. The results are obtained using only the spectral data and known fundamental nuclear constants. Calibration with standards is NOT necessary.

Peak Area Determination

FRAM uses response function methods to determine all peak areas, fitting a Gaussian with a single exponential on the low-energy side to model the gamma-ray peak shapes and uses a Lorentzian to model x-ray peaks.

Material Categories Analyzed:

- 2–95% $^{240}\text{Pu}$
- 0.01–50% $^{241}\text{Am}$
- Interferences from $^{243}\text{Am}$–$^{239}\text{Np}$, $^{237}\text{Np}$, and $^{244}\text{Cm}$
- 80% $^{238}\text{Pu}$
- Shielded samples (>13mm Pb for Pu, >16mm Steel for U)
- Heterogeneous Am/Pu
- Nonequilibrium $^{241}\text{Pu}$–$^{237}\text{U}$
- MOX: $^{238}\text{U}$/Pu from 0.005–35
- Pu with 80–95% $^{242}\text{Pu}$
- $^{238}\text{U}$/Pu in pure U (no Pu)
- $^{235}\text{U}$: $^{241}\text{Am}$: Pu = 24:1:1

Fitting in the 640 keV region from the spectrum of a 1 kg PuO$_2$ sample with 16% $^{240}\text{Pu}$. 

![Image of FRAM analysis results](image-url)
Relative Efficiency
FRAM uses a separate efficiency curve for each isotope. This allows it to measure the specific power of pyrochemical residues with biases that are reduced by as much as a factor of ten from analyses that do not use multiple efficiency curves.

The multiple efficiency feature of FRAM may also be used for other heterogeneous samples. The physical and chemical characteristics of the sample may not be uniform or even well known. Items may contain mixtures of solids and powders with no ill effect so long as the plutonium is isotopically uniform. Both physical and empirical efficiency models are provided.

Analysis for Isotopic Ratios
The approach used is that of finding a least squares solution to a set of linear equations involving peak areas, relative efficiency, and isotope ratios as unknowns. The method allows use of multiple peaks in the analysis with resulting improved measurement precision.

Analysis Parameters Database
The analysis parameters database is important in the power and flexibility of FRAM. These parameter sets are grouped into five categories: peak fitting parameters, gamma-ray peaks to be searched for, energy regions to be searched, isotopes to be used, and special application constants. Multiple parameter sets can be easily accommodated.

Auto-Analysis Feature
The auto-analysis feature in FRAM allows automatic reanalysis of the spectrum, with changed parameters, based upon the current results. Auto analysis can start with any parameter set and works with both plutonium and uranium in all the energy ranges. The user has the freedom to program the analysis (by means of the Application Constants in the parameter set) to determine the properties of the material such as: shielded, MOX, plutonium burnup, uranium enrichment, interference isotope, or heterogeneous. For example, after an analysis of the mid energy region (120–500 keV) of a plutonium spectrum, it can check both the lower energy (~100 keV) and higher energy (~700 keV) regions to see if those regions are more favorable.
Plutonium or Uranium Analysis

A parameter set can be set up for uranium (only) spectra. In this case, different isotopic ratios are calculated and the summary is formatted differently.

Estimation of $^{242}$Pu

The estimation of $^{242}$Pu is done via a correlation model using an industry standard formula with user specified parameters. Their values may be stored in any one of the parameter sets used for analysis. This model accommodates most of the commonly proposed correlations for $^{242}$Pu.

Decay Correction of Isotopic Fractions

For samples which are at least 5 years old, the 14.35-year half life of $^{241}$Pu can lead to a significant change in the $^{242}$Pu fraction, which, if unaccounted for, can lead to (relative) errors on the order of 4% in the $^{239}$Pu fraction.

FRAM can decay correct the isotopic fractions of Pu and Am.

New Command Options in Application Constants

Many of the new changes in FRAM can be turned on or off with the built-in commands in the Application Constants section of the parameter set.

- Correction for peaks in the 100-keV region,
- Systematic uncertainties,
- Sum peak correction option,
- Improved $^{236}$U correlation option,
- Number of iterations.

New Command-Line Mode of Operation

The Command-Line Operation mode is intended for users who want to incorporate FRAM into their own applications. This mode allows the user to make a very simple interface to the FRAM analysis engine.

New Measure-Compare Option

This new option allows the user to directly compare the results of an analysis with a decay-corrected declared value. The differences between the measured and declared values are expressed in terms of the standard deviations of the measured and declared values.
Analysis Improvements.

Version 5.1 and 5.2 of FRAM incorporates many analysis improvements:

- Pu 100-keV region analysis,
- U 100-keV region analysis,
- Provision for inclusion of systematic uncertainties in output results,
- Maximum channel range extended to 32k channels,
- Maximum energy range for physical model efficiency extended to ~10 MeV,
- Improved energy calibration peak search,
- Improved $^{236}$U correlation,
- Error bars and error band for relative efficiency points and fit,
- Interactive, real-time parameter editing,
- Improved compatibility with commercial formats for multiple spectra,
- Excel-compatible results file for multiple spectra analysis and comparison,
- Improved parameter set version control,
- Fill and line spectrum display modes.
- Extensive auto-analysis.

V5.2 only:
- Improved parameter sets.
- Improved uncertainty calculation.
- Improved handling of multiple efficiency curves.
- Improvements to command line mode operation.

Germanium Detector Requirements

FRAM can perform a complete isotopic analysis using either a single planar or a single coaxial detector. The benefits of being able to operate with a single HPGe detector are obvious: cost, space, convenience, ease of use, and reliability. When used with the "traditional" single planar detector, it is used often (but not always) to collect and analyze data in the 120–420 keV range. The most common energy range used in conjunction with a coaxial detector is 0–1024 keV. Various analysis modes can be used in this wide data range. If the 120–200 keV range is available, FRAM will work best analyzing in the range of 120–450 keV. If this is not possible (for example, if the sample is shielded or in a thick-walled container), FRAM can still obtain a complete analysis using only those gamma rays above 200 keV from a single coaxial detector.

The optimum choice of detector depends on the applications expected to be encountered. A planar detector is usually the detector of choice if all measured items are unshielded or are in "thin-walled" containers. If shielded containers, thick-walled containers, or a mixture of all container types are encountered, a single coaxial detector is optimum. The ORTEC Safeguards Series HPGe detectors are highly recommended.

In many applications the ORTEC Detective and trans-SPEC portable spectrometers have proven highly effective. FRAM software includes starting analysis parameter sets for the ORTEC Detective.
Password Protection and Security

An access control system within FRAM stores a list of users, their passwords, and access rights granted to them. Three of the items listed in the Edit menu are protected by this mechanism: the Parameters option, the General Defaults option, and the User List. When all these options are in operation, the user will be asked to supply a name and a password. If the security check fails, control returns to the main menu.

Output Display and Listings

Three levels of output display (Short Result, Med Result, and Long Result) may be selected in the FRAM dialog bar and displayed in the FRAM window for all analysis results. A screen copy of the Short Result is automatically sent to the monitor after each analysis.

Prerequisites

As a CONNECTIONS family member, FRAM-BW will operate correctly on any system supporting CONNECTIONS compatible hardware. The software operates under all currently supported Windows operating systems. Windows 7 64-bit hardware compatibility is available for all ORTEC instruments that use USB and TCP/IP connectivity. These instruments, as well as other legacy hardware, are also supported with Windows 7 and XP 32-bit operating systems.

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRAM-BW</td>
<td>FRAM-BW Version 5.2 Gamma-Ray Isotopic Analysis Software. Includes MAESTRO MCA Emulation software.</td>
</tr>
<tr>
<td>FRAM-GW</td>
<td>Documentation for FRAM-BW</td>
</tr>
<tr>
<td>FRAM-UW</td>
<td>Update for FRAM-BW</td>
</tr>
</tbody>
</table>
Renaissance® 7
Whole Body Counting Software

Renaissance is a comprehensive gamma spectroscopy solution for internal contamination monitoring using High and Low Resolution detectors (High Purity Germanium and Sodium Iodide) in a broad spectrum of rapid screening, detailed investigation, and fit for purpose measurement systems. It is easily configured for single or multiple detector measurements using fixed position or automated scanning systems, such as Standup, Chair, and Bed counters.

And with a secured system configuration, quality control, customized reporting capability, and an intuitive interface for routine operations and measurements, you can be confident in the quality of your personnel monitoring program!

**Why Renaissance?**

**Compatibility**
- Operates in the most common PC Environments – Windows XP, 7, and 8.1
- Easily Configurable Reports with Crystal Reports XI
- Seamless Integration with Microsoft Access and Data Import to IMBA Professional Plus
- Flexible Configuration Architecture for Small Systems or Large-Scale Network Environments

**Process Efficiency**
- Integrated Detector Communication and Motion control
- Intuitive Operator Interface for Consistent measurement processes
- Simplified Calibration using Wizards and Interactive Editors
- High and Low Resolution spectrum analysis capability

**Defendable Results**
- Compliance with Industry Standards such as ANSI N42.14 and ANSI N13.30
- Quality Control Reports, Trending, and optional Instrument Lock-out on violations
- Security to limit access to specified functions
- Operator Startup features ensure proper operation prior to personnel measurements

**Renaissance 7 New Features to Count On!**

*New!* 64-Bit Windows 8.1 and 7 Compatibility
*New!* Crystal Reports Version 11.5 Integrated Controls and Report Templates
*New!* Maximum Dead Time Limit for Operator Measurements
*New!* Operator Module Password Protection
*New!* High Purity Germanium Analysis Engines from GammaVision 7
*New!* Compatibility for Multiple Networked Instruments on a Common Database
*New!* Improved Spectrum Stripping Functionality for Sodium Iodide Analysis
Renaissance

Supervisor
System Configuration Module

Operator
Routine Operation Module

Instrument Control

Calibration

Motor Control

Quality Assurance

Spectrum Analysis

Measurement Systems

Standup Counters

Chair Counters

Scanning Beds

Lung Counters
Renaissance has two distinct interface modules to manage Supervisory/Expert functions from those associated with routine measurement operations.

The **Supervisor module** is used for the initial system configuration, setting Operator permissions, and more detailed spectrum analysis evaluations. This module can also be used for customized measurement processes using automation Jobs similar to ORTEC’s flagship GammaVision application with the ability to analyze High and Low resolution spectra.

The **Operator module** provides a simple and intuitive interface for all routine operations including personnel measurements and instrument checks with minimal experience or training.

Key User Interface Features:

**γ Supervisor Module**
- Detector Configuration (HPGe and NaI)
- Scan Type Configuration based on Detector Type, Analysis and Reporting options, and Motor Controlled Scan settings
- Operator Permissions
- Full System Calibration
- Nuclide Library and Activity Alarm Configurations
- Custom Automation processes
- Detailed Spectrum Analysis Evaluation for peak fit, interferences, and energy or library adjustment
- Editable Attenuation Correction Tables for Muscle and Tissue
- Quality Control Configuration and Measurements
- MCA Emulation and Spectrum Navigation

**γ Operator Module**
- Startup Wizard for routine instrument checks including High Voltage and Gain adjustments, Energy Recalibration, QA Measurements, and Background Correction File generation
- Preconfigured Scan Type measurements for identical operation in fixed position or scanning systems configured with a single or multiple high or low resolution detectors
- Personnel Information Logging
- Count rate Plots for each detector in a multiple detector configuration or by position for scanning systems
- Optional Acquisition Extension
- Quality Control Measurement and Status
- MCA Emulation and Spectrum Navigation

**γ Security**
- Optional Password access for Supervisor and Operator modules
Renaissance provides accurate identification and quantification of radioactive material using high and low resolution gamma spectroscopy in personnel monitoring systems. These systems can be supplied in a variety of physical and operational configurations with different combinations of High Purity Germanium and Sodium Iodide detectors that can be analyzed as a group or individually.

Analysis reports are highly customizable with Crystal Reports using results stored in a Microsoft Access database, and these reports are easily accessed from the Operator module.

When more detailed spectrum analysis evaluation is warranted, the Supervisor module can be used to graphically display peak fits and adjust analysis settings as necessary to optimize results.

Key Analysis Features:

- Standards Compliant: ANSI N42.14 and N13.30
- Application Specific High Resolution Analysis Engines
  - ENV32: Complex spectra with a large list of possible nuclides
  - NPP32: Complex spectra with a small or well-characterized nuclide mix
  - WAN32: Simple spectra with a small list of possible nuclides
  - GAM32: Simple spectra with a large list of possible nuclides
  - ROI32: WAN32 with the addition of user-defined regions of interest
- Low Resolution Analysis for Sodium Iodide Screening Systems
- Microsoft Access Database with seamless data integration to IMBA Dose Assessment Software
- User-Defined Nuclide Libraries with Key Line, Peak Activity, and MDA Flags
- Graphical Peak Fit and Residuals Display for Expert Analysis Evaluation
- Standard Text Reports and Customizable Reporting with Crystal Reports XI
- Warning and Alarm Limits for routine personnel measurements
- Total Uncertainty Propagation in units of Activity or Percent
- Peak Search Methodology
  - Library Driven Peak Location
  - Second Difference method ("Mariscotti")
  - User-Defined Regions of Interest
- Analysis Corrections
  - Nuclide Peak Background/Blank Subtraction
  - Channel by Channel Background Spectrum Stripping
  - Partial or Complete Peak Overlap (Deconvolution/Peak Stripping)
  - During Correction to Time of Uptake
  - Random Summing Corrections
  - Gain/Energy Calibration Shift Correction
  - Chest Wall Thickness Absorption Correction
  - Optional Directed Peak Fit to force Nuclide Activity in the absence of significant peaks

1 Data integration is available with the ORTEC Import Tool available with IMBA Professional Plus from Public Health England.
Calibration

An accurate calibration is essential for proper peak identification and quantification—particularly for complex spectra with closely overlapping peaks. Renaissance ensures this accuracy using automated or interactive calibration methods along with concise reports and graphical calibration curves for efficient validation.

Key Calibration Features:

- Calibrations for High and Low Resolution Detectors
  - High Purity Germanium, Sodium Iodide, and Others
- Calibration Types
  - Channel to Energy – Quadratic Fit
  - Energy to Shape (FWHM) – Quadratic Fit
  - Energy to Efficiency – Natural Logarithm Polynomial Fit across full energy; or Linear, Quadratic, and Point-to-Point Interpolation Fits for separate high and low energy regions
  - Peak-To-Total (Cascade Summing)
- Calibration Processes
  - Automatic Energy Calibration (U.S. Patent No. 6,006,162)
  - Calibration Wizard
  - Semi-Automatic and Manual/Interactive
  - Automation using Job Functions
  - Automatic Energy Calibration Adjustment during Analysis
  - Automated Gain Adjustment and Energy Recalibration as Operator Startup Options
- Calibration Reports and Graphic Display

Quality Assurance

Periodic instrument performance checks are necessary to ensure that the system is operating properly when samples are analyzed. These checks may be required by regulations, standards, or other governing bodies that may audit the results. The minimum performance measures should include validation of the system calibration parameters, limits that define acceptance and a warning when these limits are exceeded. Control charts for trending is also desirable and formally required for some applications.

Key Quality Assurance Features:

- ANSI N13.30 and ANSI N42.14 Compliant
- Parameters Monitored
  - Background Count Rate
  - Total Source Activity
  - Total Spectrum to Library Peak Energy Difference
  - Average Actual to Calibration FWHM Ratio
  - Average Actual to Calibration FWTM Ratio
  - Individual Peak Details Available in Database
- Low/High Warning and Minimum/Maximum Violation Limits with Optional Detector Lock-out
- QA Reports and Trend Charts
Instrument Control

The interface between instrumentation and software is provided through the ORTEC CONNECTIONS framework which supports up to 250 detectors across a local network. This application layer encompasses all of the hardware drivers and communication protocols that are necessary for software applications to control the MCB (Multi-Channel Buffer) instruments. Instrumentation controls are accessed through MCB Property pages that are integrated with Renaissance and other standard ORTEC applications.

Windows 8.1 and 7 64-bit hardware compatibility is available for all ORTEC instruments that use USB and TCP/IP connectivity. These instruments, as well as other legacy hardware, are also supported with Windows 7 and XP 32-bit operating systems. Instruments that are dependent on a host computer, such as plug-cards or USB devices, can be shared on a network through the MCB Servers running on each computer. This process allows Windows 8.1/7 64-bit computers to operate instruments that are not 64-bit compatible through their 32-bit host.

Key Hardware Control Features:
- List Mode Data Acquisition
- High Voltage Bias Control
- Course and Fine Gain Adjustment
- Zero and Gain Stabilizer
- SMART-1 Detector functions
- ZDT loss-free counting correction
- Analog and Digital Amplifier Filters
- Automatic and Manual Optimization
- Sample changer control
- Insight® Oscilloscope mode
- Battery Voltage monitoring for portable instruments
- State-of-Health Monitoring
- Acquisition Presents including Real and Live Time, ROI Peak, ROI Integral, Peak Uncertainty, or MDA

Further details for hardware functions are provided in the relevant product literature.

Motor Control

Renaissance enables automated scanning systems through standard Galil Motor Controllers. These scanning systems are calibrated for the start (HOME) position, scan length, scan speed, return speed, and maintenance positions to optimize system operation and ensure that measurements are consistent with the configuration implemented with system calibration.

Scanning systems are typically configured at the factory for Turn-Key operation. Adjustments to the position and speed calibrations are then easily implemented at the customer site with the comprehensive Motor Control Setup program included with Renaissance.

2 Instruments using the IPX/SPX protocol require Windows XP. This may be accomplished on a Windows 7 computer using the XP Mode Virtual Machine. Instruments that have a Dual-Port Memory option can take advantage of the DPM-USB to communicate over a USB connection in the Windows 8.1, 7 or XP environments.

3 List Mode Data Acquisition is available for specific instrumentation, such as the DSPec-50/502, DSPec-Pro, and others.
# Renaissance 7

## Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RENP-BW</td>
<td>Renaissance Whole Body Counting Software. Includes standalone or first network copy and binary use license.</td>
</tr>
<tr>
<td>RENP-NW</td>
<td>Renaissance Whole Body Counting Software. Single Use Network Copy. Example: For a three-station network, order one copy of RENP-BW and two copies of RENP-NW.</td>
</tr>
<tr>
<td>RENP-UW</td>
<td>Update from RENP-B32, RENP-BW, or RENP-NW to latest version of Renaissance.</td>
</tr>
<tr>
<td>RENP-GW</td>
<td>Additional Hard Copy Documentation for Renaissance.</td>
</tr>
</tbody>
</table>

## Additional Software Options

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11-B32</td>
<td>CONNECTIONS Programmer's Toolkit with ActiveX™ Controls.</td>
</tr>
<tr>
<td>A49-B32</td>
<td>DataMaster Spectrum File Conversion.</td>
</tr>
<tr>
<td>C53-B32</td>
<td>Nuclide Navigator® III Master Library.</td>
</tr>
</tbody>
</table>

## Personnel Monitoring Solutions

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>StandFAST II</td>
<td>Stand-Up Whole-Body Counter.</td>
</tr>
<tr>
<td>WBC-200</td>
<td>Sodium Iodide Based Chair with one detector.</td>
</tr>
<tr>
<td>WBC-200-2</td>
<td>Sodium Iodide Based Chair with two detectors.</td>
</tr>
<tr>
<td>WBC-200-DFX8530</td>
<td>High Resolution HPGe Based Chair with two detectors and LN₂ free cooling.</td>
</tr>
<tr>
<td>WBC-BSCAN</td>
<td>High Resolution HPGe Based Scanning Bed with one detector and LN₂ free cooling.</td>
</tr>
<tr>
<td>WBC-T</td>
<td>NaI Based Counter Top Thyroid Screening System with one detector.</td>
</tr>
<tr>
<td>WBC-LB-2</td>
<td>High Resolution HPGe Based Lung Burden Analysis System with two detectors.</td>
</tr>
<tr>
<td>WBC-LB-4</td>
<td>High Resolution HPGe Based Lung Burden Analysis System with four detectors.</td>
</tr>
</tbody>
</table>

Specifications subject to change 012715