ORTEC® News

Autumn/Winter 2008

Welcome to the *ORTEC* Newsletter

Our focus in this issue is high resolution gamma spectrometry and we have a number of articles included covering this topic which are both product and application related. We also highlight a range of new products that have just been introduced including the EASY-MCA, DSPEC-LF, ANGLE software and Harsh Environment detector option.

In this issue we are also introducing a new regular feature “Frequently Asked Questions” . In this new feature we aim to address some typical questions raised by our customers with a the theme for this issue related to Digital Signal Processing techniques in Gamma Spectrometry.

Inside this issue:

Wylfa Implements Global Value	2
DSPEC LF	3
GEM-FX Extended Range Detectors - Product Feature	4
EASY-MCA	5
Detector Manufacturing	6
ANGLE Software	8
Forthcoming Exhibtions & Training	9
IDM	10
GammaVision Training	11
UK Sales Team	11
Frequently Asked Questions - DSP	12

If you would like your details removed from our database, please send an email to: ortec.uksales@ametek.co.uk. All requests will be completed within 5 working days of receipt.

HPGe Detector for Harsh Environment

ORTEC now has a solution for customers needing a sealed HPGe detector for performing measurements in harsh environmental conditions. The Harsh Environment or HE detector represents a step up in HPGe detector reliability and robustness, with no loss in sensitivity to low energy gamma rays.

HE Detector with Gammagage

The HE detector was designed specifically to be as impervious to the environment as possible. It is ready for extreme conditions - the electronics are sealed within a water tight housing, creating a water-tight chamber for the high voltage filter and preamplifier. The endcap is made from corrosion-resistant carbon fibre, which provides a thin radiation entrance window, and isn’t subject to the additional radioactive background found in most metal alloys.

By sealing the electronics within a heavily anodized shroud, HPGe detectors now can be used in situations where dirt, dust, and moisture may have otherwise made their use prohibitive. They are ideal for in-situ applications such as waste assay, radiation clean-up sites, portable survey systems and mobile labs but can also be used in laboratories or any environment with high humidity as the sealed electronics chamber keeps out moisture, dust, dirt and other possible contaminants in the immediate environment. A field-replaceable desiccant pack is provided to ensure the housing containing the preamplifier and high voltage filter stays dry. Once fitted, the desiccant actually dries the electronics chamber to help prevent condensation building near the preamplifier and HV filter.

Figure 1: Submerged HE Detector

The HE detector can be completely immersed in water, as shown in Figure 1. This does not include the cable ends which typically connect to either NIM electronics or the Detector Interface Module (DIM).

The HE detector option is available with endcap sizes of 76mm and larger.

Wylfa Power Station Implements Global Value

Wylfa Power Station

Wylfa Power Station is a nuclear power plant located on the north coast of Anglesey. It was constructed to the 'Magnox' design in the 1960's and began supplying electricity to the national grid in 1971. On a typical day, the station supplies 23 million kilowatt hours of electricity, enough to meet more than 40% of Wales' needs.

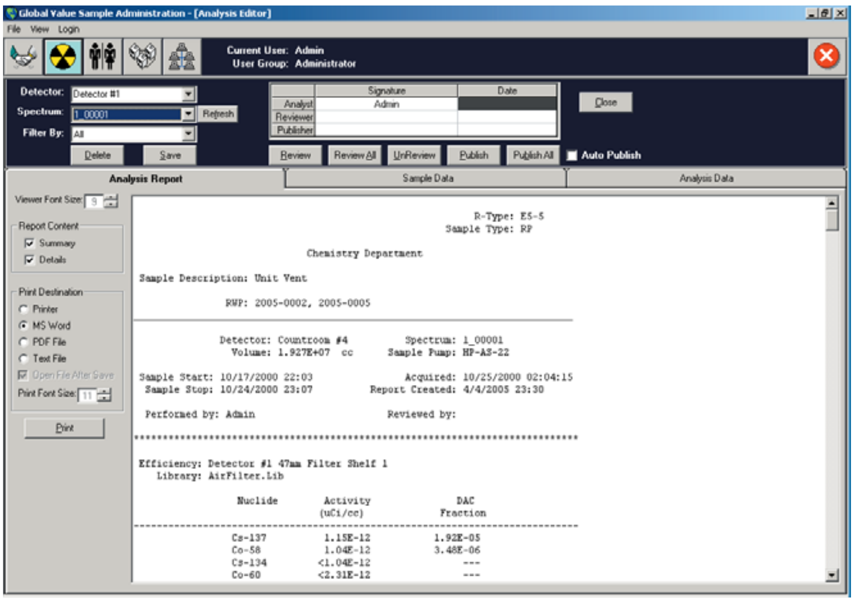
The station uses gamma spectroscopy to identify nuclides and measure activity in a variety of samples, ranging from those taken from the local environment through to process and waste material samples connected with the operation of the plant. ORTEC high purity germanium detectors, electronics and 'Gammavision' spectroscopy software are used in three locations on the site to measure and report on these samples.

Dr Adele Brooksbank explains that the procedure for many years at Wylfa and other similar stations has involved printing spectroscopy data from Gammavision and then transcribing much of the information over to several different reports required for plant operation or regulatory compliance. It was a desire to streamline this process and improve sample data handling generally that motivated her and her colleagues to investigate and then implement Global Value software.

Global Value is essentially a Gammavision 'add-on' package, which provides counting lab automation, custom reporting and data management. It consists of several modules that:

- Streamline sample counting and simplify the operator interface for routine operations.
- Provide data management capabilities including electronic report data review and editing plus data sharing.
- Generate custom reports and calculations with no special programming expertise.
- Enhance quality assurance reporting, review and evaluation capabilities.
- Provide a variety of post analysis processing options such as custom calculations and data transfer using a seamless interface with Microsoft Excel and Word

One of the key features of Global Value is post analysis data management. Not only does it generate concise report summaries using simple templates, it also allows for instant data sharing over a network, paperless review and editing, plus virtually unlimited calculations. The analyst can count samples in the lab and make any adjustments and comments electronically. After that a supervisor is able to review results from another building, add any additional comments and then send an encrypted PDF report directly to the document control system.



Global Value Analysis Editor

The seamless interface with Microsoft Excel can be exploited in a number of ways to help with post analysis processes and custom calculations. It allows the end user to define their own calculations and write applications in VBA to automate nearly any post analysis task using secure data. The Excel interface can be modified to pull data directly from a LIMS, eliminating the need for duplicate data entry.

An additional advantage of Global Value is enhanced quality assurance (QA). Any parameter monitored by Gammavision plus background count rate can be reported for individual peaks. The programme also monitors and trends the percentage difference from a target value.

After a QA check, data can be electronically reviewed and evaluated by a supervisor from a remote location, in a similar process to the sample review described earlier. Information is stored in a secure database, which can be accessed by password, across the network.

Wylfa Power Station opted for a turn key installation and customisation of Global Value, which they purchased as a site license. An ORTEC software engineer customised the programme on site allowing station specific reports and calculations to be quickly implemented with the minimum of disruption to day to day operations. One of the key objectives was to generate the reports the Power Station is required to supply the Environment Agency (for their environmental monitoring programme) directly from the Global Value database.

Three months on, Dr. Brooksbank explains the benefits they have noticed at the site: 'The customised reporting has really saved us time and eliminated the potential for transcription errors. It is also easier to access and review historical data using the in-built database compared with the sample log book and paper archives we used previously. We are particularly impressed with the quality assurance component of the programme and our own QA procedures have been improved as a result.' She has also had positive feedback from plant operators, who are finding the Global Value user interface has simplified the process of running gamma spectroscopy on reactor gas and flask samples.

APPENDIX E
HERBAGE ACTIVITY ANALYSIS
First Quarter 2008

GAMMA SPECTROMETRY ANALYSIS

Sampling Location	Gamma Activity ($Bqkg^{-1}$ wet)					
	K-40	Uncertainty	**Cs-137**	Uncertainty	**Co-60**	Uncertainty
Nearest Site	117.3	16.7	<0.7	-	<0.8	-
Inner Farm	266.6	7.4	0.8	62%	<0.7	-

Time of count detection limits for each group of radionuclides measured are detailed in the table below.
No specified radionuclides above limits of detection unless stated otherwise

	Co-60, I-131, Cs-134, Cs- 137	Nb-95, Zr-95, Ru-106, Sb-125 Ce-144, Eu-154, Eu-155, Ag-110
Time of count Detection Limit ($Bq\,kg^{-1}$ wet)	0.9*	4.0

SULPHUR-35 ANALYSIS

Sampling Location	Activity $Bq\,kg^{-1}$ (wet)	Activity $Bq\,m^{2}$
Nearest Site	26.7 +/- 6.8	5.34 +/- 1.4
Inner Farm	3.37 +/- 1.2	0.24 +/- 0.09

CARBON-14 ANALYSIS

Sampling Location	Activity $Bq\,kg^{-1}$ (C)	Activity $Bq\,kg^{-1}$ (wet*)	Activity $Bq\,m^{-3}$
Nearest Site	N/A	N/A	N/A
Inner Farm	N/A	N/A	N/A

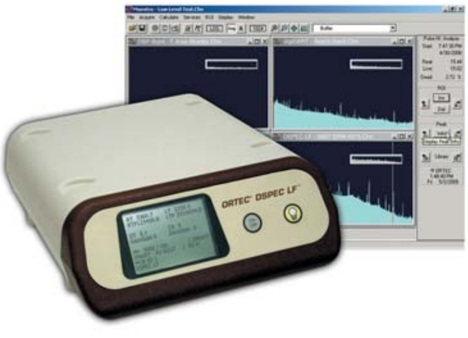
Example Custom Report

Further improvements are planned. Some records are still archived in a paper form, but once additional back up facilities are available the system will go completely paperless. There is also a plan to incorporate Maypack Inhalation Dose Assessment or 'MIDA' calculations inside Global Value, to improve safety and emergency monitoring procedures.
There is more information available on Global Value at: http://www.ortec-online.com/pdf/global_value.pdf

New Product: DSPEC LF Digital Signal Processor

In an HPGe spectroscopy system, Digital Signal Processing (DSP) replaces the shaping amplifier, correction circuits, and ADC with a single digital system that processes the sampled waveform from the preamplifier with a variety of mathematical algorithms. DSP techniques have been used in the field of HPGe detector gamma-ray spectrometry for some time as they offer improved stability and performance over their analogue counterparts.

For some customers, the extensive features and extra power which comes with the DSPEC-JR-2.0 or DSPEC Pro DSP units, have been more than they've needed and in response to this ORTEC recently introduced an economical 'entry-level' model - the DSPEC LF. It comes complete with the excellent temperature and count-rate stability of ORTEC DSP spectrometers, in conjunction with the speed and ease of set-up through the 'plug and play' abilities of USB 2.0. Key benefits of the unit include:



DSPEC LF with MAESTRO-32 software

- Solid digital stability resulting in better peak stability over both long measurements, and many measurements made in a single day. This means users need not worry about changing the detector's energy calibration as often as in analogue systems.
- Digital Filter Fine-Tuning - simple to set shaping parameter, rise time, flat-top width and flat-top tilt.
- 16k Channel Memory, with up to 16 millions counts per channel ensuring there will always be enough 'channels per keV', or counts per channel.
- Automatic Parameter Setup
- InSight Oscilloscope Mode
- Compatible with all ORTEC software, programmer's toolkits and the MS Vista operating system.

The DSPEC LF offers a 'drop in' replacement for many 92X, DSPEC and NIM based spectrometers and is ideal for system applications such as whole body counters and installed waste assay systems. Please contact us if you would like to find out more or visit http://www.ortec-online.com/pdf/dsp_lf.pdf

Product Highlight: GEM-FX Extended Range Detector

GEM-FX detectors were introduced in 2003 as part of the ORTEC Profile range of products. The concept of the profile range detectors is to optimise the shape of the detector to make maximum use of Germanium crystal Volume, depending on the size and shape of the sample to be measured. The improvements offered by the GEM-FX certainly belong within profile range but due to its unique design it may occasionally not command the attention it deserves as a separate product with additional excellent properties.

In order to understand the device a little better it might be beneficial to recap on the basic P type closed end coaxial device design, i.e. ORTEC GEM products. Here, the bulk of the crystal is high purity (high resistance) P type Germanium with a 600μm front surface layer forming an N type junction. The surface of a deep hole in the rear of the crystal is implanted with a thin P layer that forms the rear P type contact. In operation, the high voltage bias allows an electric field to extend from the junction at the front across the high purity bulk region to the P type contact at the rear. Charge carriers (electrons and holes) produced in the high purity region between the N type junction and the rear contact are collected by the field and form a pulse of charge in the associated circuitry.

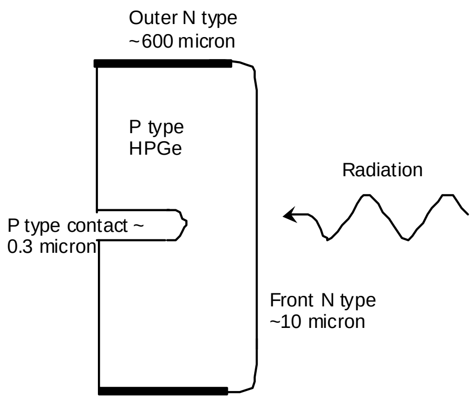


Figure 1: Structure of a GEM-FX Detector

When a broad energy range, optimum relative efficiency and low cost of ownership are important, the GEM provides excellent general performance up to 10MeV energy. The low energy response of the GEM device however, is limited by the thick outer layer (dead layer). Low energy photons are preferentially absorbed in this outer surface but due to the heavy doping in the layer they immediately recombine into the Germanium and cannot release charge into the circuit.

The two key methods to improve the low energy performance of a detector are to address the outer dead layer problem and modify the shape of the detector to reduce the capacitive noise.

The outer dead layer problem is addressed in our Gamma-X (GMX) detectors, where the structure of the GEM device is reversed. The bulk Germanium is changed from high purity P-type to high purity N-type meaning that the thin P type layer can be moved to the outer surface and the thick N type (Lithium diffused) layer is moved to the back (inside the hole). Absorption in the outer thin dead layer is therefore significantly reduced.

To address the capacitive noise issue the shape of the crystal is changed from a square profile, where the diameter and length are approximately equal, to a large diameter short length device. This reduces the capacitive noise which improves the energy resolution at low energy (with a trade-off in loss of high energy efficiency). The ORTEC LOAX devices work on this principal.

The GEM-F profile device has the same structure as the GEM p-type device but with a crystal geometry optimised (larger diameter/smaller depth) for detecting radiation impinging on the front surface of the detector. This makes the GEM-F ideal for use when counting large samples placed on the front surface such as beakers, filters or other large extended sources. The GEM-FX is an F profile device maintaining the P type GEM structure but with a thin front surface N type layer (Figure 1). For the most part this means (allowing for changes in shape) that all the advantages of the GEM device are maintained while allowing the useable energy response to extend below approximately 10keV. Note that these improvements only apply to radiation entering the front of the device.

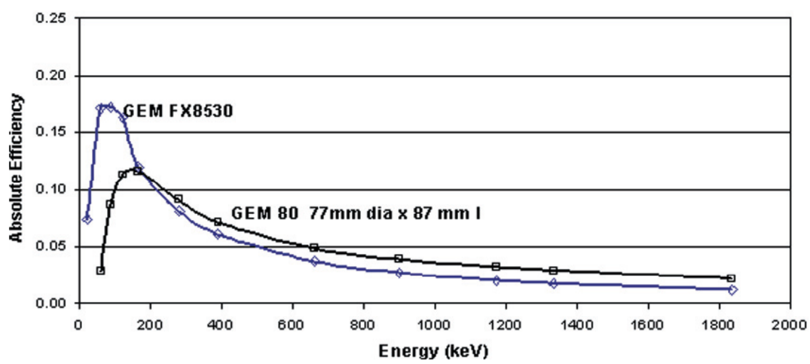


Figure 2: GEM-FX85 & GEM80 Efficiency/Energy Comparison

Figure 2 shows the absolute efficiency curves for a 70 mm diameter x 15 mm thick source on the endcap of a GEM-FX8530, compared to a GEM80 with 76 mm diameter x 87 mm depth. The GEM-FX85 has higher absolute efficiency at all energies below 160 keV. At 59 keV, the FX is **six** times more efficient, and below that the efficiency of the GEM80 falls off due to the thick (~600 μm) contact.

The three GEM-FX detectors that are currently available from ORTEC are listed with some of their specifications in Table 1. They are provided as pop top detectors with carbon fibre windows as standard and can also be configured in all reduced background versions and the new Harsh Environment (HE) package. As with all profile detectors the dimensions are warranted and matched to the intended application rather than the relative efficiency. This is because relative efficiency (IEEE standard) is measured using a ^{60}Co point source at 25cm from the front face of the detector and so is not very representative of the attainable absolute efficiency in a real sample measurement such as filter paper placed directly on the detector.

Each application is different and the GEM-FX is only one of a number of options that may be available for any project. We would always be pleased to discuss your application but our selection guides entitled 'The best Choice of High Purity Germanium (HPGe) Detector', see http://www.ortec-online.com/pdf/best_choice_det.pdf, and 'PROFILE Series – GEM HPGe Coaxial Detectors', see http://www.ortec-online.com/detectors/photon/pdf/B03%20-%20Profile.pdf might also be useful reference points.

	Crystal dimensions		Resolution		Shape	Efficiency
Model	Depth (mm)	Length (mm)	@14.4keV Warranted (eV)	@1.33MeV Warranted (keV)	Peak:Compton Ratio Warranted	Relative Efficiency(%)
GEMFX5825P4	58	25	450	1.8	35	15
GEMFX7025P4	70	25	525	1.9	40	20
GEMFX8530P4	85	30	600	1.9	55	50

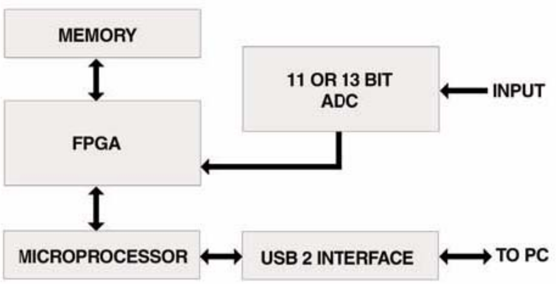
Table 1: GEM-FX availability

New Product: Stand-alone MCA - negates the need for a PCI slot

With advances in PC technology, many older ISA and PCI bus MCA cards are being rendered obsolete as newer PCs no longer support Plug in MCA cards. To help cope with the advances in technology ORTEC has recently released the EASY-MCA - a low cost, compact MCA unit which operates independently of the PC.

The EASY-MCA has a fast conversion time (<2µs) and comes complete with ORTEC's MAESTRO-32 MCA emulation software to provide control spectral display and analysis. This software offers the ability to view up to eight detectors and windows simultaneously, which ties in with most modern PC systems being able to accommodate up to eight EASY-MCAs on a single PC.

Each EASY-MCA has memory capable of holding the complete spectrum, and is available with either 2k or 8k channels of resolution. It interfaces to a PC via a USB 2.0 cable - multiple ports can be controlled using USB ports within the PC, or a powered USB hub. EASY-MCA will accept inputs from a shaping amplifier for Pulse Height Analysis (PHA). In addition, it also accepts an ADC Gate input, a Pile-Up Rejection input (PUR), and a BUSY input used by the live-time correction circuits.



Simplified EASY-MCA Block Diagram

To mark the introduction of the EASY-MCA, ORTEC have announced a 25% trade-in against any comparable, fully operational MCA, of the same or higher resolution of the unit to be purchased. Note that other manufacturers' MCA units are also valid in this trade-in allowance.

Please contact us at ortec.uksales@ametek.co.uk for further details on this excellent offer. Further details on the EASY-MCA can be found at http://www.ortec-online.com/electronics/mca/easy_mca.htm

Germanium Detector Manufacturing - Science or Black Art?

The production of High Purity Germanium or HPGe photon detector involves an extremely complex manufacturing process. ORTEC was the first commercial company to develop its own germanium crystal growth technology in addition to its existing detector manufacturing capability. In the following section we describe the typical manufacturing processes to produce a working HPGe detector from scratch, as you will see it is not a trivial process!

Zone Refining

The initial starting material, electronic grade polycrystalline germanium "metal" (because of its metallic appearance), is zone refined in a quartz "boat" having a pyrolytic graphite coating (Figure 1). A zone refiner uses the principle that most impurities concentrate in the liquid phase as the material begins to freeze. The RF heating coils of the zone refiner melt a small section of the germanium ingot or bar held in the quartz boat. The RF coils are slowly moved along the length of the ingot, causing the liquefied portion beneath the coils to move also.

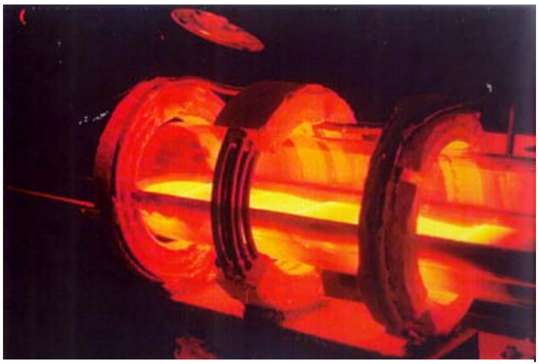


Figure 1: Zone Refining

Thus, the ingot is continuously melting at the advancing solid-liquid interface and freezing at the receding interface. The impurities tend to remain in the molten section and hence are "swept" to one end of the ingot by this process. This "sweeping" operation is repeated many times, until the impurities are concentrated at one end of the ingot. This end is then removed, leaving the remaining portion much purer than the original starting material. The improvement or reduction in impurity concentration actually realised is about a factor of 100 or more at the completion of this process.

Figure 2 shows a zone-refined ingot. The tapered end contains the high concentration of impurities and is cut off. The impurity concentration of the remaining portion is then determined by a Hall Effect measurement, and the ingot is sliced into pieces suitable for loading into the crystal-growing equipment.

Figure 2: Zone Refined Bar

Crystal Fabrication

Large single crystals of germanium are grown using the Czochralski technique. A precisely cut seed crystal is dipped into the molten germanium and then withdrawn slowly, while maintaining the temperature of the melt just above the freezing point. The rate of crystal withdrawal and temperature of the melt are adjusted to control the growth of the crystal.

Figure 3 shows a crystal during the growth process. High-purity germanium crystals suitable for detector fabrication are almost always grown in a quartz crucible under a hydrogen atmosphere. Near the completion of the growth process, the crystal is tapered gradually at the tail to minimize thermal strain. It is imperative that the crystal be grown to the exhaustion of the melt, because germanium both wets quartz and expands on freezing. The valuable quartz crucible might be fractured if any germanium were left after completion of the crystal growth.

Figure 3: Crystal Growth

After the crystal is grown and cooled, it is mounted in a Plaster-of-Paris cast for slicing.

The completed crystal is cut by an ORTEC-designed string saw that causes virtually no damage to the crystal. A slurry of water and silicon carbide is pulled along by a wire, resulting in a sawing action. Sections of the crystal from both top and bottom are checked by Hall Effect measurements to determine the impurity concentration and type (n or p). On the basis of the Hall Effect results, that part of the crystal which contains detector-grade material is selected. The rejected material is returned to the zone refining operation.

The section of crystal which has both adequate purity and crystallographic perfection for coaxial detector fabrication is then ground perfectly cylindrical. The edge at one end is bevelled to a radius ("bulletized") to improve charge collection and timing performance. Afterwards, a hole is machined into the unbeveled end so that the central contact of the device may be made later. The detector subsequently is hand lapped all over to remove damage caused by the machining processes.

The Contacts

A lithium diffusion to form the n+ contact is then performed over the entire outer surface except the flat, unbeveled end for p-type coaxial detectors and on the "walls" of the central hole for n-type coaxial detectors. This lithium-diffused layer is about 600-µm thick. After the lithium diffusion operation, the detector is lapped once more, chemically polished, and a surface protective coating applied. The coating is amorphous germanium hydride deposited by a sputtering process. Next, the p+ contact is formed by the ion implantation of boron ions. This last step completes the fabrication process for the coaxial detector element itself. Figure 4 opposite shows schematically the structure of both p-type and n-type coaxial detectors.

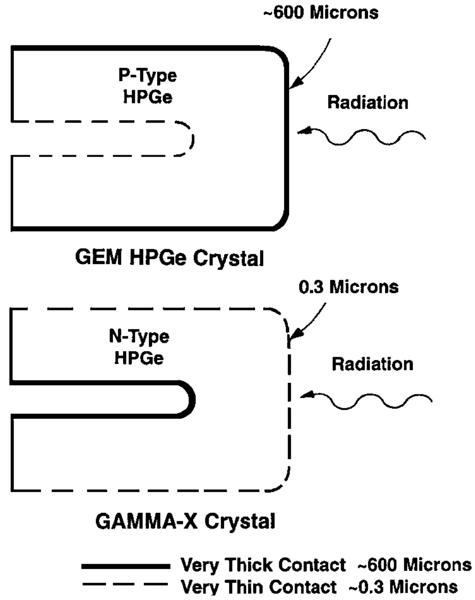


Figure 4: Detector Schematics

And finally the cryostat

At this point the detector is ready to be mounted in a cryostat. The basic function of a cryostat is to cool the germanium detector to its near-liquid-nitrogen operating temperature. For best performance the first stage of the preamplifier is also cooled to low temperature, the entire cold assembly being maintained by the cryostat under high vacuum for both thermal insulation and protection of the internal components from contamination. Cryosorption material (such as selected zeolite or activated charcoal) is used as a residual gas getter or pump to maintain the vacuum for long periods of time. After being loaded into the cryostat, the detector is tested for several parameters, including leakage current and energy resolution. If the device fails a test, it is returned to some previous stage of the process. Below we see a drawing of a detector configured in a conventional liquid nitrogen cooled cryostat. ORTEC has pioneered the development of mechanical cooling systems that remove the need for liquid nitrogen and a high proportion of our detectors are now supplied with this type of cooling system.

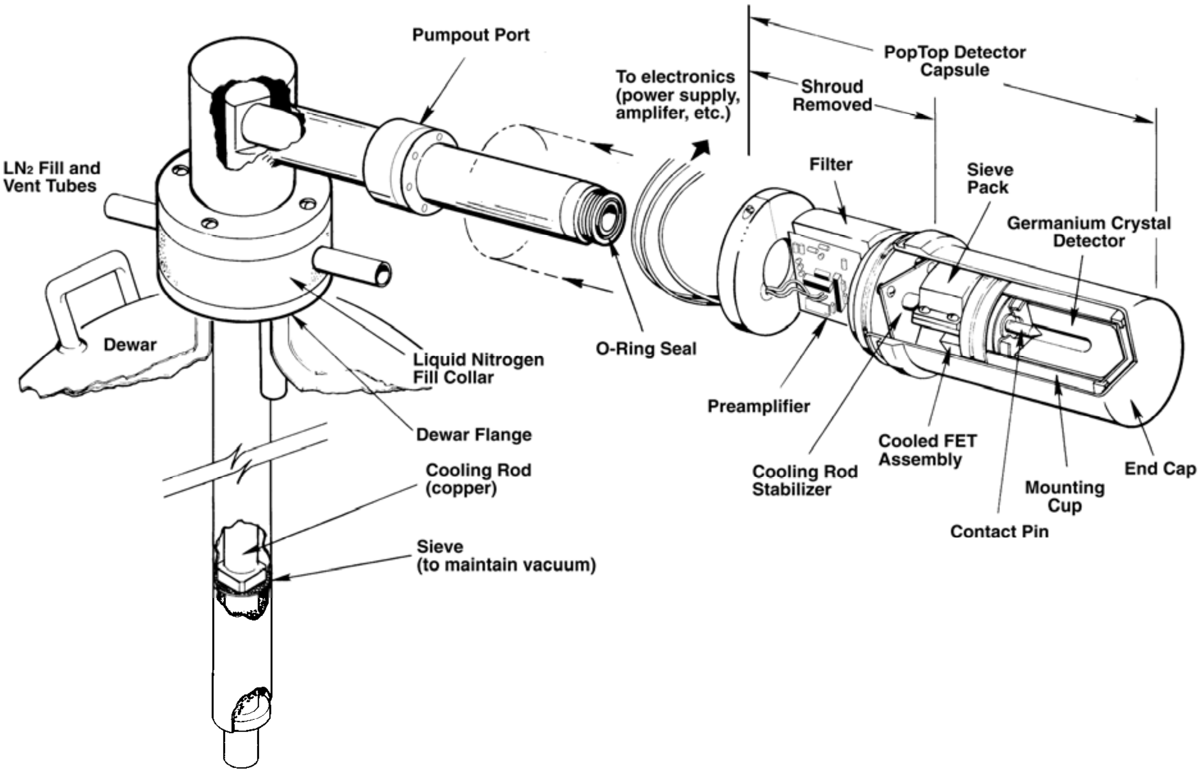


Figure 5: Detector Drawing

ANGLE Software - Simplifies Calibration for Counting Labs

Gamma spectroscopy is a powerful technique that can be used to identify and quantify isotopes using high purity germanium detectors. A key step in the process is an accurate efficiency calibration using a traceable mixed nuclide gamma source.

The typical counting laboratory maintains one calibration source for each type of sample that they analyse on a routine basis. The source must duplicate the container type, be it Marinelli beaker, bottle, can or Petri dish. It should also mimic the matrix in which the sample is dispersed, for example sand, water or soil.

Purchasing a number of sources involves a significant investment of money, and since some of the nuclides present in the sources are short lived, they have to be purchased again on a regular basis. Even just maintaining and safeguarding such an inventory takes time, and then there is the cost associated with disposal when the source comes to the end of its life.

ORTEC is now offering a new approach to address these issues through the use of 'ANGLE ' software.

ANGLE software derives efficiency calibrations for multiple geometries from a single point source calibration. As a result, if you have ANGLE and a single point source you can create calibrations for all your laboratory geometries such as Marinelli beakers, bottles, and filter papers from one count. You no longer need to repeat a calibration using a separate source for each geometry, saving time and money. The software can be used with any type of commercially available semiconductor detector.

ANGLE is a separate stand alone programme designed to run alongside ORTEC's comprehensive gamma spectroscopy analysis software package, Gammavision. A Windows based programme, it has the same look and feel of other ORTEC software products, giving it an air of familiarity. All of the various components of the software can be accessed from one main screen using drop down menus or by right clicking with the mouse.

The use of the programme can be broken down into the following steps:

1. A mixed nuclide point source is used to efficiency calibrate the detector using Gammavision software in the usual way. A calibration curve is generated and this is called the 'reference efficiency'.

2. Dimensional and material data for the detector, sample container, source and geometry are entered into ANGLE. (Figure 1)

3. The reference efficiency is imported into ANGLE and the software uses the data previously given to quickly calculate a corrected efficiency, called the 'effective efficiency' for the new geometry.

This new 'effective efficiency' calibration curve is exported to Gammavision and then the system is ready to start counting samples in the new geometry. (Figure 2)

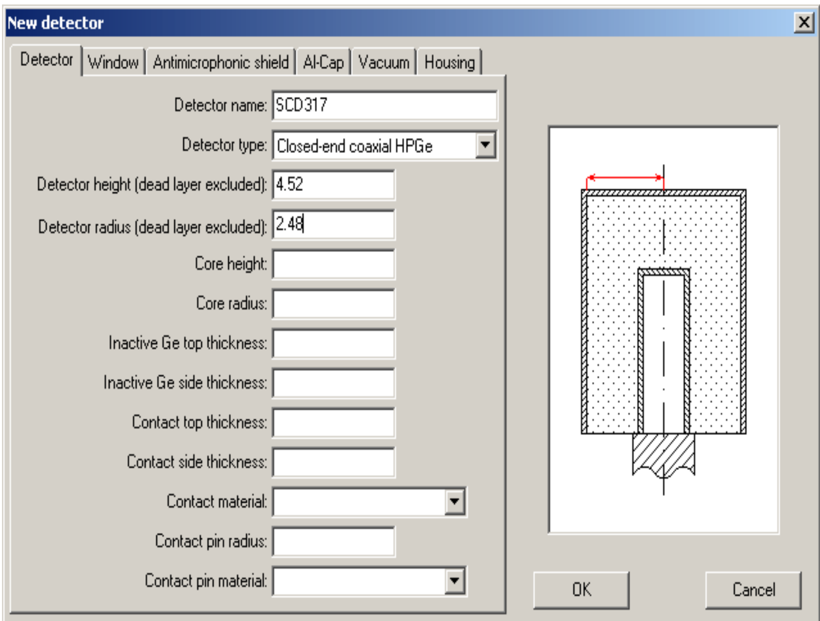


Figure 1: Detector Information Screen

Comparisons between using ANGLE and the conventional approach of multiple geometry calibrations have shown differences of around 3 to 4 % in routine use, rising to 7% for the most unfavourable geometries, which is usually more than acceptable given the uncertainties inherent in gamma spectroscopy generally.

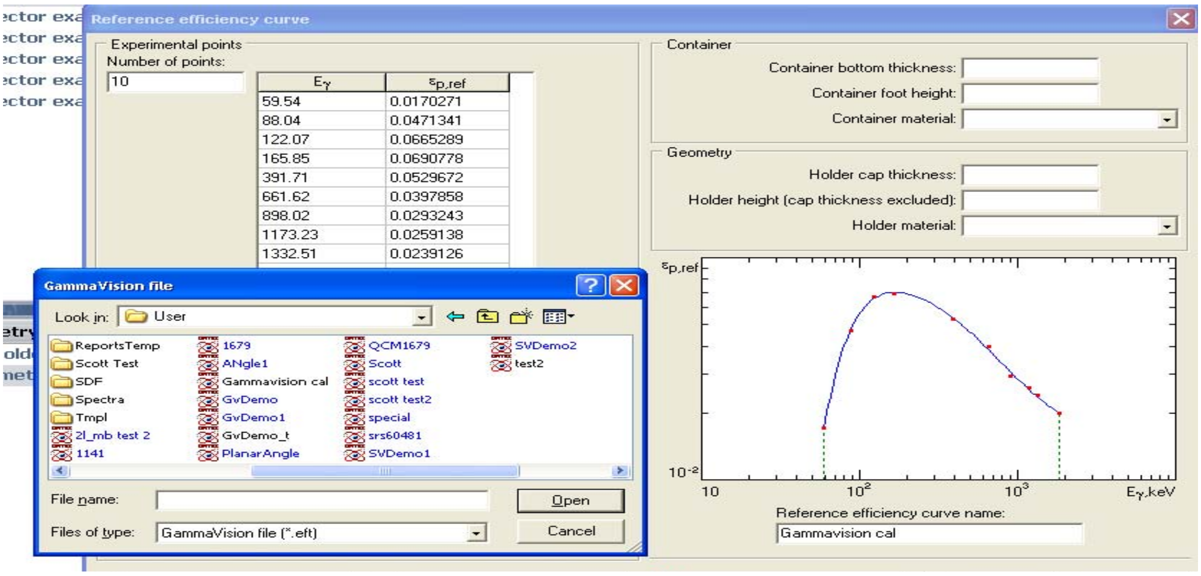


Figure 2: Reference efficiency curve screen, showing file import from GammaVision

How does ANGLE compare to similar products that are commercially available?

Software packages that perform a similar function to the ANGLE software have been available for some time. Typically these other software packages use 'Monte Carlo' simulations of the calibration, basically a statistical approach, to generate the efficiency calibration. The main disadvantage of a purely statistical approach like this is its dependence on a lengthy and expensive initial 'characterisation' of the detector at the factory. Often the detector needs to be characterised again after any servicing leading to more delay and costs.

In contrast, the technique used in ANGLE enables the user to generate their own reference efficiency using a single point source calibration. This allows greater flexibility as additional detectors are purchased or existing detectors serviced. The software can also be used with detectors from any manufacturer.

An additional advantage of ANGLE is that even though measurements are made using a calculated efficiency curve, a link can be demonstrated back to the original point source 'reference efficiency' curve calibrated by the user against a traceable source of known activity.

There is technical paper on Angle available for free download from the ORTEC website at http://www.ortec-online.com/papers/angle-vs-Labsocs.pdf

Forthcoming Exhibitions & Training Courses

There are no further shows in 2008 which we will be attending. However, in 2009 we expect to be at a number of events, including:

- Home Office Scientific Development Branch (HOSDB)
- Technology Show at Dounreay
- Technology Show at AWE
- Technology Show at Sellafield
- Nuclear Spectrometry Users Forum, NPL
- Society of Radiological Protection, Annual Meeting
- ICEM 2009

GammaVision Training Course

The 2009 GammaVision training course will run from the 20th to the 23rd April from our offices in Wokingham. Further details can be found on Page 11 of this newsletter. Please contact Clare Payne if you would like to attend or find out more about any of these events.

IDM: an Industrial Solution to High Resolution Gamma Spectroscopy

Complete Detector Sub-system
The ORTEC Interchangeable Detector Module or IDM is a gamma-ray detection "building block." It is a completely self-contained subsystem, comprising a single, mechanically cooled high-purity germanium (HPGe) detector of standardised crystal dimensions and all data processing electronics in a single rugged, compact package.

IDM

An HPGe crystal with nominal dimensions of 85mm diameter by 30mm deep is incorporated into the system. The crystal dimensions are specified to optimise the absolute efficiency of the detection system when measuring large area extended sources. The crystal is cooled and maintained at operating temperature by a high capacity Stirling cycle mechanical cooling system.

Internal to the IDM is a high performance Digital Signal Processor which processes the signals from the detector and sends either the energy histogram or digitised pulse stream to a PC for analysis. The system interfaces to the PC using standard USB-2 interface and is compatible with standard ORTEC software such as Maestro-32, GammaVision-32, Isotopic-32 or our Connections-32 toolkit software for custom applications. In addition to the traditional histogram mode used for pulse-height analysis, the IDM also incorporates a List Mode of operation. In List Mode each count or event detected is stored directly to memory with information on the pulse height and a time stamp with 200 nanosecond resolution. This data can then be reconstructed into separate spectra by time/position or energy.

"Hardened" Cryostat
Unlike a conventional HPGe detector the IDM design incorporates a "hardened" cryostat, a design which evolved from our highly successful Detective Hand Held Identifier.

In the conventional cryostat design used for HPGe detectors, partial thermal cycling of the detector should be avoided as this can degrade the vacuum system. In the hardened cryostat this is no longer a concern; the temperature may be cycled at any time, even from partial warm-up. This feature eliminates the potential problems associated with loss of electrical power on a conventional system using a mechanical cooler. In the IDM, if the power is turned off, the cooling system will automatically restart when the power is turned on.

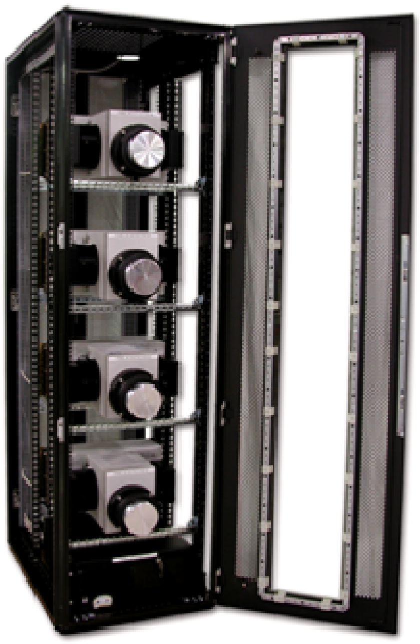


Figure 2: Portal Monitoring System

Portal Monitoring or Waste Assay ?
The combination of features included in the IDM makes it the ideal choice for applications such as Portal Monitoring, Process Monitoring and Waste Assay. In these applications key requirements are energy resolution and detection sensitivity but in a rugged industrial package without the need for routine maintenance or the handling of liquid nitrogen. These applications also demand a system that can operate over a range of environmental conditions. By virtue of its hardened cryostat design the IDM is able to operate over a temperature range from -10^{o}C to +50^{o}C and relative humidity up to 100% non-condensing without the use of climate controlled enclosures.

Figure 2 shows four IDM units configured to simulate a Portal Monitoring system. With their modular design IDM's can be used as building blocks in detection systems, with the number of unit's configured dependent on the operational requirements. Several technical papers are included on the ORTEC web-site which discusses the performance and characteristics of the IDM in the Portal Monitoring application and include: **Performance of a Small Portal Using Integrated Germanium Detector Modules,** see http://www.ortec-online.com/papers/INMM_239_08.pdf and **False Positive Probability as a Function of Background for Short Data Collection Times in a Germanium Detector Portal Monitor,** see http://www.ortec-online.com/papers/INMM_233_08.pdf .

GammaVision Training Course

GammaVision, a windows based Gamma-ray spectroscopy software package is the industry standard for radio-activity acquisition, analysis and reporting, and enables users to analyse any spectrum format and provide precise reports for the region of the spectrum needed. For a number of years, ORTEC has offered a comprehensive training program which gives an overview and understanding of gamma spectroscopy in relation to GammaVision. All the features of GammaVision are reviewed and students will end the training confident and ready to use it for their gamma-ray spectroscopic measurements.


Dr Ron Keyser

The GammaVision software training course provides an introduction to gamma-ray spectroscopy for those new to the subject, as well potential improvements to existing working practices to those already engaged in the field. It is primarily intended for analysts, technicians, and anyone else undertaking gamma-ray spectroscopy, although quality assurance officers and data reviewers who need an understanding of gamma-ray spectroscopic measurements will also benefit.

The course tutor is Dr. Ron Keyser, Senior Scientist at ORTEC, Oak Ridge, USA, who specialises in the area of systems and analysis software for gamma and alpha spectra. He received the PhD from the University of Florida in 1970 and since 1972, has been at ORTEC working on nuclear instrumentation, software and medical scanners. He has written over 50 papers on these subjects. He is a member of the American Physical Society, American Nuclear Society, INMM, Sigma Xi, a Senior Member of IEEE, and Technical Committee 45 of the IEC.

Taking place over 4 days, the course is designed to give students the knowledge required to correctly operate systems for the detection, monitoring, recording and analysis of radioactive materials. It is a mixture of lectures and hands-on laboratory-type exercises using representative spectra. The course is aimed at explaining why and how GammaVision produces gamma-ray spectroscopic results, and begins with an overview of the fundamental physical processes for basic radioactive decay and interaction of radiation with matter. It reviews how these processes impact the spectrum and explains spectral features along with how they are interpreted in the analysis. An overview of high purity germanium (HPGe) detectors, signal processing and techniques employed in gamma-ray spectroscopy follows, with special emphasis given to the advances in Digital Signal Processing (DSP). These topics will provide the fundamentals of gamma-ray spectroscopy while emphasising areas the operator needs to optimise system parameters as well as understand the effects of true coincidence summing, interference peaks, and source-detector geometry. The methods for energy and efficiency calibration are discussed, including the efficiency correction for True Coincidence Correction (TCC). Other corrections are explained, both their operation and when they should be used. The nuclear gamma-ray "fingerprints" are used for identification and the making and editing of "libraries" is discussed as is Laboratory QA, automation (JOB files), and good practices. Finally, the analysis results report is examined with emphasis on verifying the results.

The 2009 GammaVision course will be held at our offices in Wokingham from the 20th - 23rd April. Some places have already been reserved so if you would like to attend, please contact Clare Payne to confirm your place.

UK Sales Team

Trevor Hatt, UK Sales Manager

Tel: 0118 936 1224

Email: trevor.hatt@ametek.co.uk

Nigel Rimmer, Sales Engineer, North

Tel: 01244 677746

Mobile: 07971 063709

Email: nigel.rimmer@ametek.co.uk

Shane Toal, Sales Engineer, South & Ireland

Tel: 0118 936 1239

Mobile: 07818 097235

Email: shane.toal@ametek.co.uk

Clare Payne, Sales & Marketing Co-ordinator

Tel: 0118 936 1223

Email: clare.payne@ametek.co.uk

Frequently Asked Questions - Digital Signal Processing

This new section aims to offer miscellaneous advice under a broad theme. Here we address some problems that arise in gamma spectroscopy which are common to all systems but in many cases highlight the beneficial features offered by ORTEC Digital Signal Processing Systems (DSP).

Peak Drift - What causes it and what can be done?
All spectroscopy systems have some drift associated with them. Instability can be caused by gain and/or zero drift. Gain drift changes the slope of the ADC calibration curve line (stretches or squeezes the spectrum as energy increases), while zero drift changes the point corresponding to zero volts (shifts the entire spectrum back and forth) see Figure 1.

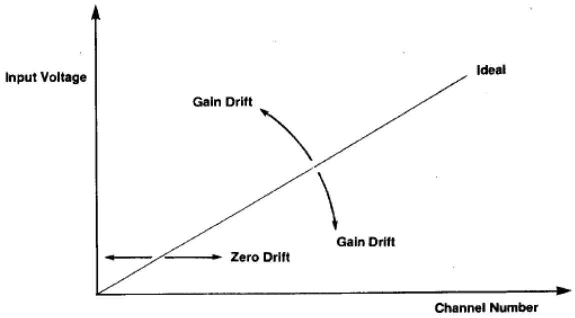


Figure 1: Ideal ADC Gain Calibration Curve

Gain drift can be caused by changes in the ambient temperature of the system (especially important in scintillation detectors). In situations where count rates vary, in addition to loss of resolution at high rates, systems can suffer from apparent peak shifts. In very long counts even slight drift can cause significant degradation of the spectrum. ORTEC DSP systems incorporate gain stabilisation and zero stabilisation functions. Each works by monitoring the centroids of user-designated peaks in the energy spectrum. The fine gain or offset is automatically and continuously adjusted to maintain the centroid of the peaks at their desired positions.

What is pole zero and pole zero cancellation?
In normal circumstances, there is a long exponential decay on the detector preamplifier output pulse which generates a noticeable undershoot in the shaping amplifier output as it attempts to return to the baseline (Figure 2). At medium to high counting rates, a substantial fraction of the amplifier output pulses will ride on the undershoot from a previous pulse. The apparent pulse amplitudes measured for these pulses will therefore be too low, which leads to a broadening of the peaks recorded in the energy spectrum. Most spectroscopy amplifiers incorporate a pole-zero cancellation circuit to eliminate this undershoot. Traditionally this adjustment involved the use of an oscilloscope to observe the undershoot on the amplifier output allowing a manual pole zero adjustment to remove it.

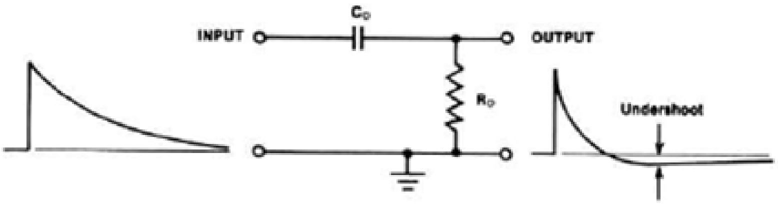


Figure 2: Pole zero undershoot at shaping amplifier output

This procedure was no longer required when automatic pole zero adjust circuits were added to the analogue shaping amplifier systems. The ORTEC DSP systems incorporate auto pole zero adjustment in the Optimise function.

Ballistic Deficit - what is it? What systems might it affect and what can be done?
The shaping time constants used in a pulse processing system are chosen so they exceed the rise times output by the preamplifier. This means the full amplitude of each pulse is (effectively) reached before the system starts to look for the next pulse. At high rates it is necessary to reduce the shaping time constant so that more pulses can be processed. Decreasing the shaping time means that the shaping amplifier output might not have time to reach the full amplitude. If the charge collection time for each gamma photon is the same, any error in the height of the shaped pulse will be constant, so the energy calibration eliminates the error. With smaller detectors this is often a reasonable assumption. However, for larger detectors the difference in time delay due to the various positions of photon absorption in the crystal and the constant field drift velocity introduces a ballistic deficit. Collection time for different pulses varies, leading to deterioration of resolution when shorter pulse processing times (to enable higher throughput) are required by the system.

In analogue systems, the ballistic deficit was corrected using gated integrators or resolution enhancer modules. The solution in digital systems is relatively simple, our DSP systems such as the DSPEC range and digiDART use a trapezoidal pulse shape, meaning the pulse shape has a flat top rather than a finite peak position (e.g. Gaussian). Our DSP systems allow the width of the flat-top of the trapezoidal shape to be adjusted appropriately to eliminate any degradation in resolution. The Insight mode (virtual oscilloscope) of these systems allows the user to observe these effects in order to optimise the flat top.

AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY

Spectrum House
1 Millars Business Centre
Fishponds Close
Wokingham
RG41 2TZ