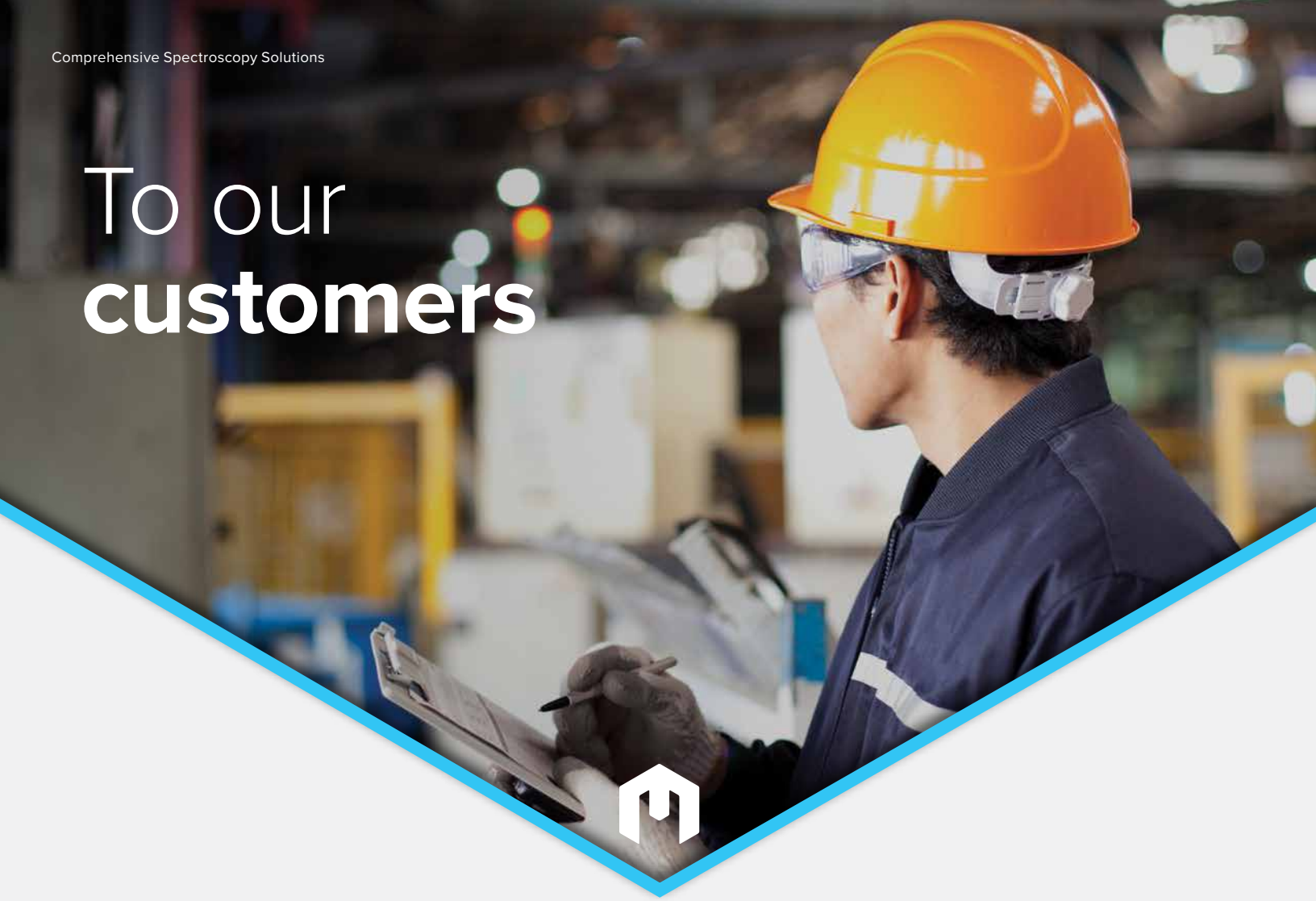
Edition 3.0

COMPREHENSIVE SPECTROSCOPY SOLUTIONS

MIRION TECHNOLOGIES



To our **customers**

Mirion Technologies is a world-leading company in radiation measurement and nuclear related services with a track record of over 60 years.

Our organization is comprised of over 2,500 talented professionals, passionate about delivering world-class products, services, and solutions in the world of radiation detection, protection and measurement. Structured by business divisions focused on innovation and responsiveness to customer needs, Mirion is organized to empower employees and facilitate effective decision-making at all levels.

In partnership with our customers in nuclear power plants, military and civil defense agencies, hospitals, universities, national labs, and other specialized industries, Mirion Technologies strives to deliver cutting-edge products and services that constantly evolve based on the changing needs of our customers.

Mirion offers:

Spectroscopic and radiochemistry solutions for laboratory, field, and personnel applications with experts located throughout the world to provide local support and address any measurement needs.

As with all of Mirion, our goal is to be a valued partner in the nuclear measurements industry.

Mirion has products and expertise, around the world, in the following areas:

- Integrated gamma and alpha spectroscopy hardware and software
- Specialty Germanium and Silicon detectors for research and industrial applications
- Applied systems for whole body counting and in situ measurements
- Low background alpha/beta counting systems
- Data management systems
- Environmental monitors
- Training and technical assistance for all of the above

Visit the Mirion website for the most up-to-date information

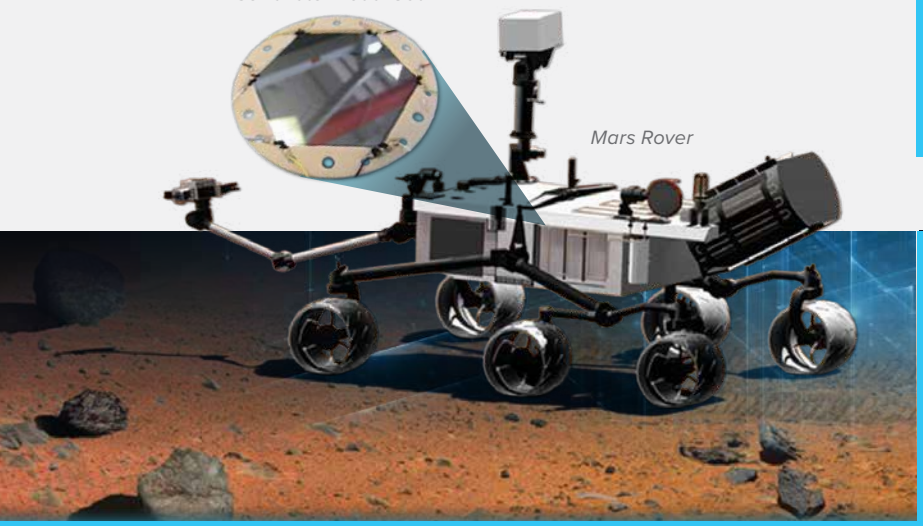
- Detailed product specifications
- New product info
- Videos
- Technical and research literature
- Application notes
- Software downloads
- Literature downloads
- Training and service opportunities
- Current events and shows

Our customers around the world operate in facilities with exacting standards for safety, reliability and defensibility of results.

Integral SPI Project – Array of 19 encapsulated 40% coaxial HPGe detectors

Photo-Diodes for Scintillator Read-Out

Mars Rover



Did you know?

Mirion detectors have been included in many space missions including those exploring Earth (STEREO), Saturn (Cassini), Venus & Mercury (Messenger), Pluto (New Horizons), Mars (MSL-Rad and Odyssey), and Jupiter (JUNO), as well as investigating the sun and space environment (ERNE, EPHIN, ACE, SEPICA and Integral-SPI)

Mirion employees share a customer focus that is:

- Centered in the company's mission and values
- Supported by a rich history of customer commitment at every level
- Driven to deliver advanced technologies, superior solutions, exceptional service and support

Table of Contents

Radiological Counting Labs 7

Gross Alpha/Beta Counting

Series 6LB™ Automatic Low Background Alpha/Beta Counting System 8
Series 5 LB5500™ Automatic Low Background Alpha/Beta Counting System 8
Apex-Alpha/Beta™ Counting Productivity Software 8
LB4200™ Multi-Detector Low Background Alpha/Beta Counting System 9
iSolo® Portable Gasless Alpha/Beta Counting System 9
iMatic™ Gasless Automatic Alpha/Beta Counting System 9

Gamma Spectroscopy

High Purity Germanium (HPGe) Detector Overview 10
The iPA™ Intelligent Preamplifier 11
Standard Electrode Coaxial (SEGe) 11
Reverse Electrode Coaxial (REGe) 11
Broad Energy (BEGe) 11
Extended Range Coaxial (XtRa) 11
Small Anode (SAGe) Well 12
Low Energy (LEGe) 12
Ultra-LEGe (GUL) 12
Cryo-Pulse® 5 Plus Compact Electric Cryostat 13
Intelligent Cryo-Cycle™ Hybrid Cryostat 13
747 Top Opening Lead Shield 14
767 Top and Front Opening Lead Shield 14
777 Ultra Low-Background Shield 15
737 U-Style Lead Shield 15
CosmicGuard™ Cosmic Veto Background Reduction System 15
Lynx® Advanced Digital Signal Analyzer 16
DSA-LX® Digital Signal Analyzer 16
Osprey® Digital MCA Tube Base for Scintillation Spectrometry 17
Osprey-Compatible Scintillation Detectors 17
GR1™ Compact CZT Spectrometer 18
GR1-SHIELD™ Shield and Collimators 18
Apex-Gamma™ Lab Productivity Suite 19
Apex-Guard™ Option 19
S50XC Genie™ Spectroscopy Software Family 19
S574C LabSOCS™ Calibration Software 19

Alpha Spectroscopy

Alpha Analyst™ Integrated Alpha Spectrometer 20
PIPS® Passivated Implanted Planar Silicon Detectors 20
Apex-Alpha™ Alpha Spectroscopy Software Suite 21

In Vivo Measurement 23

FASTSCAN™ High Throughput Whole Body Counter 24
ACCUSCAN II™ Scanning, High Resolution, Germanium Whole Body Counter 24
ACCUSCAN™ Scanning, Horizontal Bed Whole Body Counter 24
2270 Actinide Lung Counter 25
2275 Actinide Lung and Scanning Whole Body Counter 25
Apex-InVivo™ Whole Body and Lung Counting Productivity Software 25

Research and Education 27

Gamma Spectroscopy Products

LABKIT Nuclear Science Experiments for Teaching Laboratories 28
S600C ProSpect® Gamma Spectroscopy Software 28

HPGe Detector Configurations for Nuclear Physics Research

Clover Detectors Array of Four HPGe Detectors 29
High efficiency HPGe Array Solutions 29
Segmented coaxial Ge detectors for position information 30
Inverted & Segment coaxial type Ge detector 31

Mirion Specialty Ultra Low Background “S-ULB” detectors

S-ULB Specialty Ultra-Low Background Cryostats 33
SAGe™ Small Anode Germanium Detectors 33

Silicon Detector Configurations for Nuclear Physics Research

PD, RF and A-Series PIPS® Detectors for Charged Particle Detection 34
FD-Series PIPS Detectors for ΔE-Detection 34
Silicon Photodiodes for Beam Monitoring 34

X-Ray Detectors for Synchrotron Applications

Monolithic HPGe Pixel Detectors 35
Discrete Single and Array Detectors HPGe 35
DSSD HPGe Double-Sided Strip Detectors 35
X-PIPS™ Series Detectors for Photon Detection (From Near UV to 30keV) 35
Encapsulated Ge detectors 36

Custom Detectors for Space and OEM Applications

Ruggedized HPGe Detectors for Space Exploration 36
PIPS Detectors for Space Exploration 37
OEM solutions for XRF-XRD-EDX Benchtop and Handheld 37

In Situ Measurement 39

Aegis™ Transportable HPGe Spectrometer 40
MicroGe™ Ultra-compact HPGe detector 40
S573C ISOCS™ Calibration Software 41
ISOXSHLD™ In Situ Object Counting System 41
DA-PRO™ Data Analyst Continuous Monitoring Solution 42
SPIR-Ace™ RID with the GenieXPort™ Application 42
TRACS™ Transportable Radiation Analysis Counting System 43
Genie-FieldPro™ Gamma Spectroscopy Sample Counting Software 43

Waste Management and Special Systems 45

WM2100 Series Q2 Qualitative and Quantitative Gamma Waste Assay System 46
Auto Q2 Low Level Waste Assay System 46
WM2200 Series Segmented Gamma Scanner 47
WM2900 Series Tomographic Gamma Scanner 47
WM2500 Series Modular Gamma Box and Container Assay Systems 48
HKED Hybrid K-Edge/XRF Analyzer 48
NDA 2000 Non-Destructive Assay Software 49

Environmental Monitoring Solutions 51

Environmental Monitors

iCAM™ Alpha/Beta Particulate in Air Monitor 52
iCAM/MF Moving Filter Head for iCAM 52
G64 Area Gamma Monitor 53
EcoGamma™ Environmental Gamma Radiation Monitor 53

Data Management

Horizon® Supervisory Software System 54
OpenEMS™ Effluent Management System 55

Customer Support Services 57

Mirion Nuclear Services Areas include:

Installation Services 58
Real-Time State-of-Health Monitoring 58
Professional Training Services 58
Routine System Management and Maintenance 59
Calibration Services 59
Procedure Writing 59
Programming 60
Data Review 60
Site Specific Customizations 61
Routine Operations 61
Performance Testing Programs 61
System Audits 62

Intelligent
Cryo-Cycle™
MIRION
TECHNOLOGIES

CANBERRA
CANBERRA
10
9
XRAY 1
11
7
CANBERRA

Radiological Counting Labs

In the laboratory count room, Mirion's time-tested software packages, teamed with a full complement of innovative detectors and signal processing electronics, offer customers sophistication with simplicity. The Apex® family of lab productivity software including Apex-Gamma™ for gamma spectroscopy, Apex-Alpha™ for alpha spectroscopy and Apex-Alpha/Beta™ for alpha/beta counting is designed to handle the work load of a busy lab.

Apex software serves as the user and management interface for the counting systems. It automatically ensures that routine QA checks are performed and automatically keeps records of all system activities – sample counts, calibrations, QA checks – as well as when they were performed and by whom. Unique database facilities make it simple to retrieve and review data – even years after the measurement – to respond to questions or legal challenges.

Alpha Analyst™ Integrated Alpha Spectrometer

ISOCS™ and LabSOCS™ Calibration Software bring a new level of capabilities to gamma sample analysis by eliminating the need for traditional calibration sources during the efficiency calibration process. In addition to the monetary savings from not having to purchase, track or dispose of numerous calibration sources, the ISOCS and LabSOCS calibrations also save time in the field and laboratory respectively.

High Purity Germanium Detectors

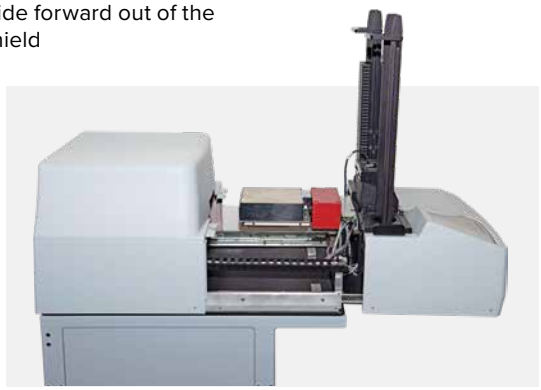
Gross Alpha/Beta Counting

Automatic Gas Flow Counting Systems

Series 6LB™ Automatic Low Background Alpha/ Beta Counting System

Features are:

- New and innovative 50 or 100 sample automatic changer system
- High performance 5.7 cm (2.25 in.) gas flow detector
- Integrated 7" touch screen display for information and control
- Interchangeable 50 and 100 sample Lock and Load stacks
- Complete front access – all critical components slide forward out of the shield
- Gasless guard detector – extends P-10 tank life to more than a year
- Automatic gas monitoring and conservation system
- Integrated self-diagnostics and environmental monitoring for temperature, humidity and barometric pressure
- USB Communication protocol to Apex-Alpha/ Beta computer



Series 5 LB5500™ Automatic Low Background Alpha/Beta Counting System

Features are:

- Automatic sample changer for 50 samples
- 12.7 cm (5 in.) gas flow detector and 50 sample capacity
- Enhanced low background capability
- Gas Stat™ digital gas conservation and monitoring system

Apex-Alpha/Beta™ Counting Productivity Software

Features are:

- Control and Analysis software for most Canberra gas-flow alpha/beta counters
- Compatible with LB4200, LB4100, Mini20, IN20, Series 6LB and Series 5 systems
- Feature by feature replacement for Eclipse
- Express Count for immediate counting with no sample data pre-entry
- Calibration and QC Sequences

- Automated Plateau and Region of Interest setup
- Unattended Calibration on Changer Systems

Manual Gas Flow Counting Systems

LB4200™ Multi-Detector Low Background Alpha/Beta Counting System

Features are:

- Manual drawer-based system for counting up to 16 samples at the same time
- Designed for counting multiple samples with long count times that are not practical for single detector counters
- Up to four 5.7 cm (2.25 in.) or 3.1 cm (1.25 in.) detectors or one 12.7 cm (5 in.) detector per counting drawer
- Configurable and upgradeable from one to four counting drawers
- High performance gas flow detectors with ultra-thin windows
- Gas Conservation and Monitoring System for maximum gas cylinder life
- Full front detector access without lifting lead shielding
- Small foot print and modular design for easy upgrading
- Independent detector start/stop

Gasless Counting Systems

iSeries™ Gasless Alpha/Beta Counting Systems

Common Features are:

- Includes PIPS® silicon gasless detector
- Automatically identifies and compensates for radon, thoron and progeny interference in air filters
- Can be used for other types of samples without radon / thoron compensation
- NiMH battery power for 6+ hours of continuous operation
- No computer required for operation – simple front panel controls
- Compatible with iLink™ iSeries Communications Software

iSolo® Portable Gasless Alpha/Beta Counting System

Unique Features are:

- Portable, manual, single-sample alpha/beta counter
- Compatible with sample diameters from 25 to 101 mm
- Various shielding and guard detector options to minimize background

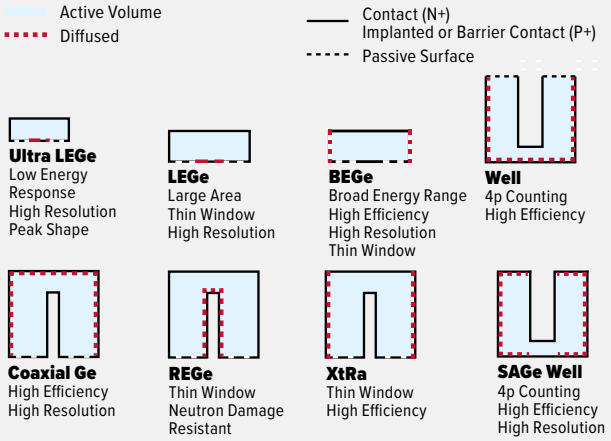
iMatic™ Gasless Automatic Alpha/Beta Counting System

Unique Features are:

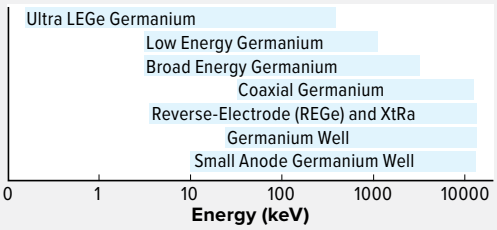
- Automatic sample changer with 50 or 100 sample capacity
- Compatible with sample diameters from 25 to 60 mm
- Molded low background shielding, 10 cm (4 in.) thick

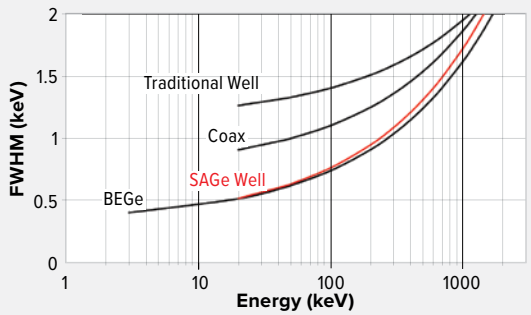
Gamma Spectroscopy

Structure Code:



Detector Type:

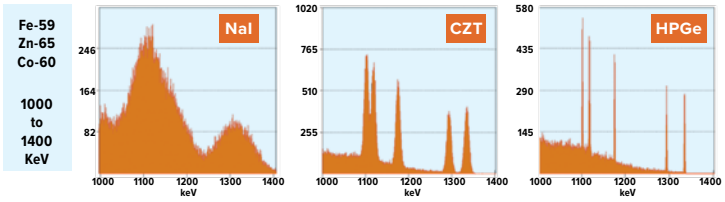




High Purity Germanium (HPGe) Detector Overview

- Wide variety of HPGe detector types and efficiencies are available:
  - Standard Electrode Coaxial (SEGe) – P-type
  - Reverse Electrode Coaxial (REGe) – N-type
  - Extended Range Coaxial (XtRa)
  - Broad Energy (BEGe)
  - Low Energy (LEGe)
  - Ultra-Low Energy (GUL)
  - Small Anode Well (SAGe Well)
  - Ge Well (Well)

- HPGe is the best available detector technology for analysis of complex gamma spectra
  - Below are spectra from three common types of gamma detectors: NaI(Ti), Cadmium zinc telluride (CZT) and HPGe
  - HPGe offers superior peak resolution performance compared to all other detector technologies
  - Broader peaks are harder to segregate from each other



- Conventional liquid nitrogen (LN_2) cryostats are available for all applications
  - **Laboratory** – Vertical or Horizontal w/30-liter or smaller Dewars
  - **Portable** – All-attitude MAC & Big MAC Cryostats
  - **Electrically-cooled** or hybrid electric/LN_2 cooled cryostats also available

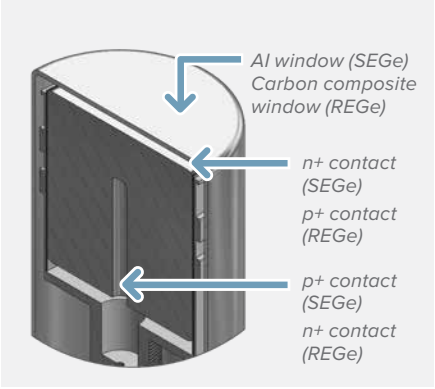
- Ultra Low Background (ULB) for HPGe detectors is possible with special cryostat materials and a Remote Detector Chamber (RDC) to separate the preamplifier from detector crystal
  - Vertical configuration (shown)
  - U-style configuration
    (see 737 Shield, page 15)

The iPA™ Intelligent Preamplifier

Since April 2017, all HPGe detectors with RC-feedback have been shipping with the iPA Intelligent Preamplifier, making key detector parameter data available 24/7 through the built-in USB port.

iPA for Slimline Cryostats

iPA for Flanged Cryostats



Standard Electrode Coaxial (SEGe)

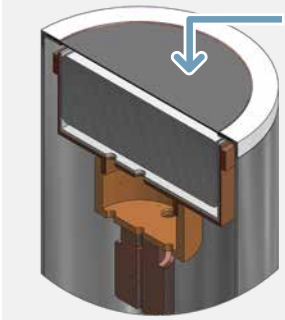
Features are:

- Energy range from 40 keV to >10 MeV
- High resolution – good peak shape
- Excellent timing resolution
- High energy rate capability

Reverse Electrode Coaxial (REGe)

Features are:

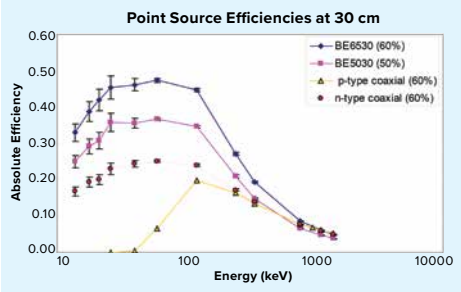
- Spectroscopy from 3 keV to >10 MeV
- Ultra-thin ion implanted contacts
- Radiation damage resistant
- Excellent timing resolution
- High energy rate capability



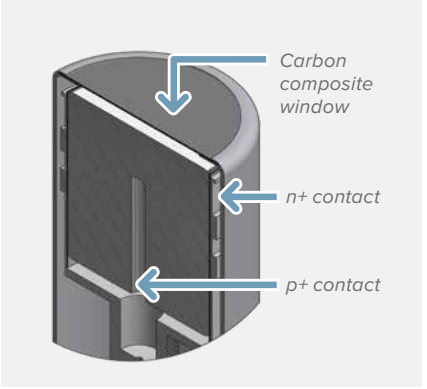
Broad Energy (BEGe)

Features are:

- Energy range from 3 keV to 3 MeV combining advantages of Low Energy and Coaxial HPGe detectors
- Efficiency and energy resolution optimized for 3 keV to 662 keV region where most tightly-grouped peaks of interest are located
- Flat crystals offer optimum efficiencies for samples counted close to the detector
- Lower Compton continuum at lower energies resulting in much better MDA
- Detector of choice for Actinide Lung Counting



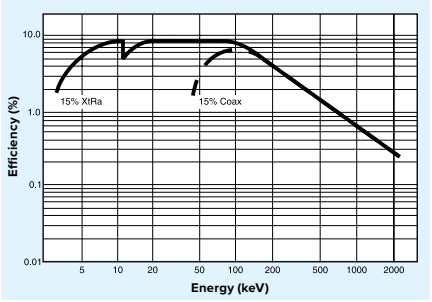
Absolute Efficiency vs. Energy comparison for BE6530, BE5030, GC6020 (p-type coaxial) and GR6022 (n-type coaxial) detectors



Extended Range Coaxial (XtRa)

Features are:

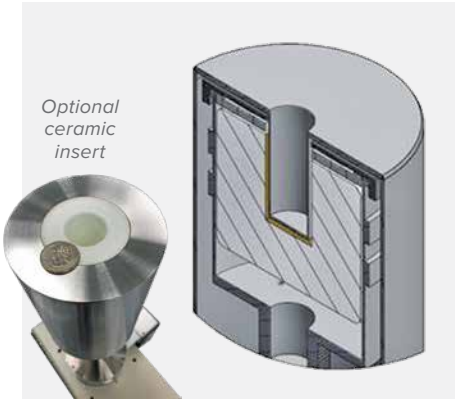
- Spectroscopy from 3 keV to >10 MeV
- Wide range of efficiencies
- High resolution – good peak shape
- Excellent timing resolution
- High energy rate capability

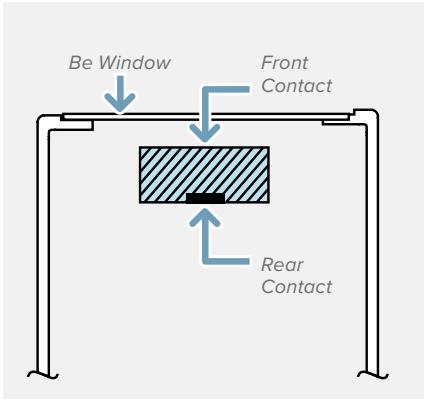


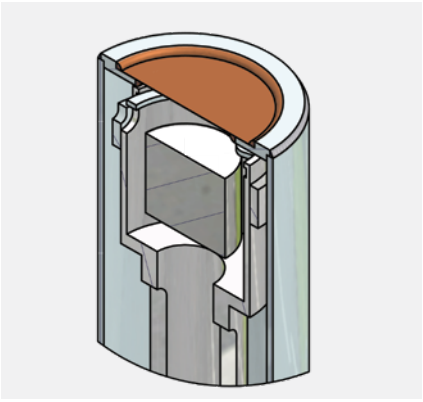
Typical Efficiency curves comparing XtRa with Be window and Coax Detectors with detector-source spacing of 2.5 cm

Gamma Spectroscopy
continued

High Purity Germanium (HPGe) Detectors



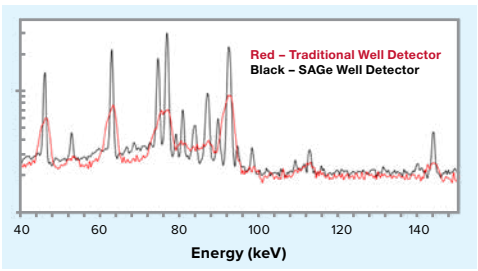




Small Anode (SAGe) Well

Features are:

- Blind well approaches 4π counting geometry yielding high absolute efficiency
- Superior resolution compared to Traditional Well Detectors at both low and high energies
- Thin stable contact inside well and optional ceramic well insert allows spectroscopy from 10 keV up to 10 MeV
- Large well diameter (28 mm) available with the same excellent resolution as the standard (16 mm) well sizes
- Samples can be counted in the well, on the detector face and in Marinelli beakers
- Compatible with LN_2 and electric coolers (Cryo-Pulse® 5 Plus and intelligent Cryo-Cycle)
- Full LabSOCS™ characterization available, allowing True Coincidence Summing correction



Low Energy (LEGe)

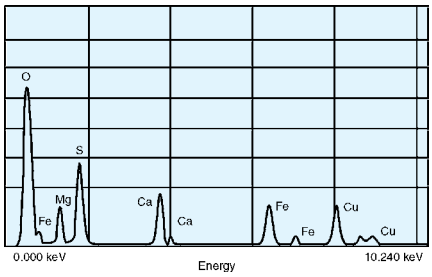
Features are:

- Thin front and side contact, allowing spectroscopy from 3 keV up
- Wide range of sizes allows selecting the best detector for your application
- Low noise and high resolution at low and moderate energies
- Available standalone or in arrays
- Excellent for X-ray absorption spectroscopy, nuclear safeguards and XRD / XRF applications

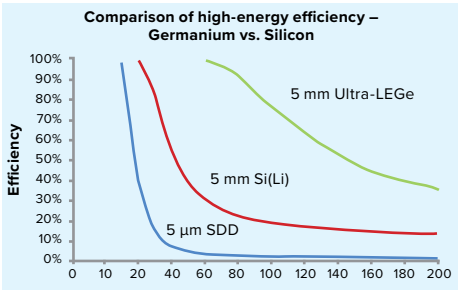
Ultra-LEGe (GUL)

Features are:

- Spectroscopy from 300 eV to 300 keV
- High efficiency compared to Si(Li) and SDD
- Excellent resolution up to very high count rates
- High peak/background ratio
- Available standalone or in arrays
- For XRF, XAS (XAFS, EXAFS, XANES) and X-ray spectroscopy applications



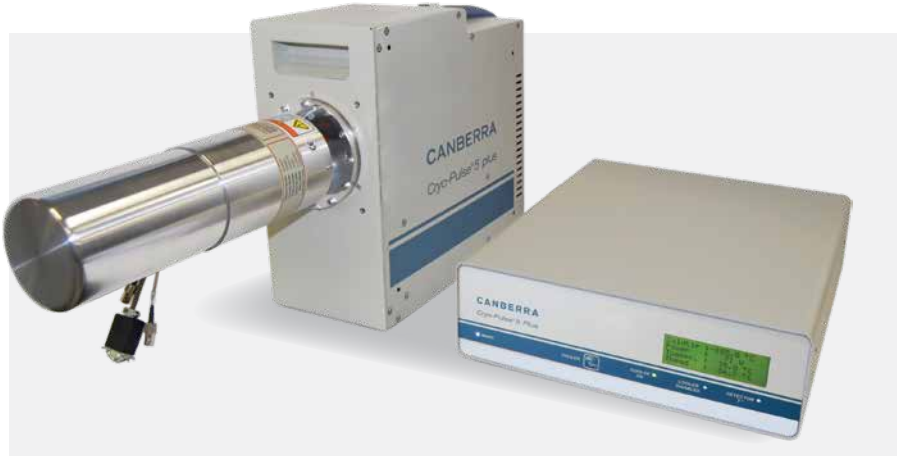
Spectrum from NIST 2063 Thin Film Standard Glass



Electrically-Cooled Cryostats

High Purity Germanium Detectors must be maintained at cryogenic temperatures. Traditionally, this has been done by placing the detector assembly in a Dewar filled with liquid nitrogen (LN_2). The LN_2 must be replaced due to boil-off every week to two weeks which costs money and wastes valuable counting time. The Cryo-Pulse® 5 Plus (CP5-Plus) and intelligent Cryo-Cycle Cryostats described below eliminate the requirement to continually refill the Dewar but still keep the detector at LN_2 temperatures.

Cryo-Pulse® 5 Plus Compact Electric Cryostat



Features are:

- Electrically refrigerated cryostat with no LN_2 requirement
- Sealed system using non-CF4 non-flammable refrigerant
- Low power consumption
- Compact and lightweight – excellent for space-constrained areas
- Long-life cooler with 5 year warranty
- Low maintenance
- No compromise on performance specifications

Intelligent Cryo-Cycle™ Hybrid Cryostat

Features are:

- Low-vibration/low electrical noise even at low energies (no spectral resolution degradation)
- Low audible noise (<50 dB(A) at 1 m)
- LN_2 redundancy
- Non-CFC/non-flammable refrigerant
- Same footprint as standard LN_2 Dewar
- Low power demand (130 W nominal for typical detector configuration)
- Local (via LCD Screen) and remote State-of-Health monitoring
- Four years of onboard system memory for State-of-Health storage
- Lab-Pulse™ Ready
- No maintenance required

Blue LCD backlight: Unit operates normally, no action is required.

Yellow LCD backlight: Unit operates but requires attention, see error message for details.

Red LCD backlight: Unit does not operate properly, see error message for details.

Gamma Spectroscopy
continued

Lead Shield

747 Top Opening Lead Shield

Features are:

- Four inch thick low-background lead shield
- Graded tin and copper liner
- Easy to use lever-actuated door
- Compact – 60 x 60 cm (2 x 2 ft) floor space
- Supports conventional 30-liter Dewar or intelligent Cryo-Cycle Cryostat
- Cryo-Pulse® 5 Plus Cryostat also supported with stand

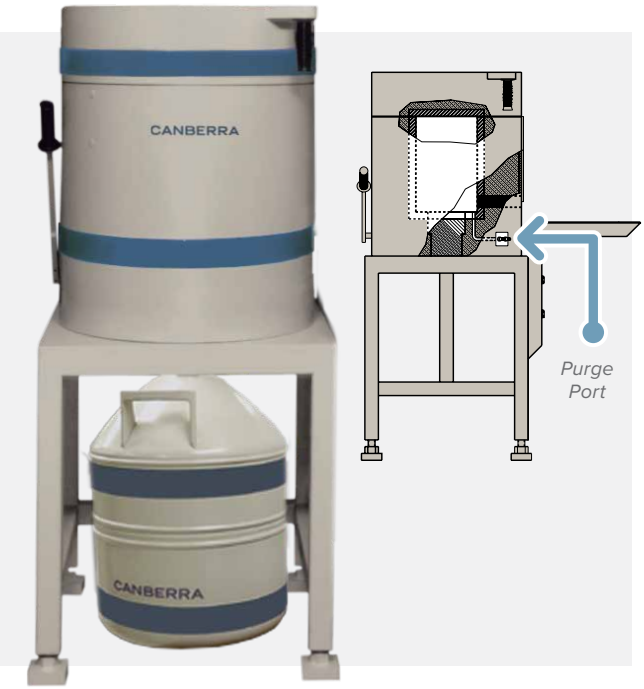
767 Top and Front Opening Lead Shield

Features are:

- Four inch thick low-background lead shield
- Graded tin and copper liner
- Full area front door and synchronized split top door
- Compact – 60 x 60 cm (2 x 2 ft) floor space
- Supports conventional 30-liter Dewar or intelligent Cryo-Cycle Cryostat
- Cryo-Pulse 5 Plus Cryostat also supported with stand

Intelligent Cryo-Cycle Cryostat and Model 747 Lead Shield

Cryo-Pulse 5 Plus Cryostat and Model 747 Lead Shield



777 Ultra Low-Background Shield

Features are:

- 15 cm (6 in.) lead thickness
- Ultra low-background materials
- Versions for vertical or U-style cryostats
- Purge port for radon expulsion
- Supports conventional 30-liter Dewar or intelligent Cryo-Cycle Cryostat
- Cryo-Pulse 5 Plus Cryostat also supported vertically with stand

737 U-Style Lead Shield

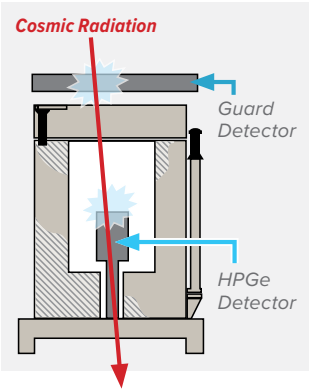
Features are:

- "No stream" design for U-style cryostat
- Low center of gravity
- Four-inch low background lead
- Graded tin and copper liner
- Easy detector installation
- Supports conventional 30-liter Dewar, intelligent Cryo-Cycle or Cryo-Pulse 5 Plus Cryostat

CosmicGuard™ Cosmic Veto Background Reduction System

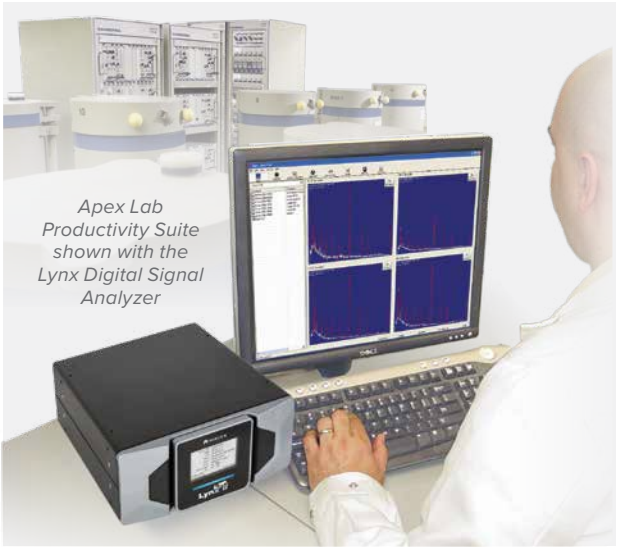
Features are:

- Performs Cosmic background reduction that can't be done with lead shielding alone
- Typical background reduction by 10 – 35% resulting in lower MDA's and count times
- Turnkey solution that can be added to new or existing HPGe detector/shield configurations
- Compatible with most standard HPGe Lead Shields – split or solid top
- Electronics for Veto Guard Detector built into detector module – no other signal processing electronics required
- Single cable connection to the acquisition PC or network hub
- Requires Lynx® Digital Signal Analyzer and Genie™ or Apex-Gamma™ software of current firmware/software versions



Gamma Spectroscopy

continued



Apex Lab Productivity Suite shown with the Lynx Digital Signal Analyzer

Lynx® Advanced Digital Signal Analyzer

Features are:

- Fully Integrated Multichannel Analyzer with 32k channel spectral memory, advanced signal processing filters, digital stabilizer, multi-trace oscilloscope and triple-range HVPS for all spectroscopy detector types
- Multiple counting modes: PHA, MCS, PHA & MCS simultaneous, Time-stamped List and Multispectral scaling
- Communication via Ethernet
- Web enabled set-up/operation and compatible with Genie™ software
- Flexible hardware/software controls for sample changers, external acquisition and MCS start/stop, coincidence gating and auto pole/zero
- Software development kit (SDK) available for custom programming

DSA-LX® Digital Signal Analyzer

Features are:

- Integrated desktop MCA based on Digital Signal Processing (DSP)
- Performs pulse height analysis (PHA) and/or multi-channel scaling (MCS)
- USB 2.0 interface allows simple connection to computer
- Web-based digital oscilloscope spectrum viewer and maintenance utility
- Advanced patented auto pole/zero, base line restoration and digital stabilization capability

Osprey® Digital MCA Tube Base for Scintillation Spectrometry

Features are:

- All-in-one HVPS, preamplifier, and digital MCA
- Compatible with all standard 14-pin scintillation detectors, including NaI(Tl), $CeBr_3$ and $LaBr_3$(Ce)
- Optional temperature-stabilized* detectors
- USB 2.0 connection and Ethernet 10/100T (PoE) connection
- Three programmable general purpose I/O connectors
- PHA, MCS, SCA, MSS, List, and Time-stamped List modes
- Supported by Genie™ software and a software development kit (SDK) with examples
- Diagnostic web GUI
- Compatible with Model 727, 7F7 and TRACS shields

*US Patents 7,005,646 B1 and 7,049,508 B1

Osprey-Compatible Scintillation Detectors

Including:

- **802 Detector Family:** NaI(Tl) Scintillation Detectors
- **NAIS-2x2:** NaI(Tl) LED Temperature-Stabilized Scintillation Detector
- **NAIS-3x3:** NaI(Tl) LED Temperature-Stabilized Scintillation Detector
- **NAIS-3x5x16:** NaI(Tl) LED Temperature-Stabilized Scintillation Detector
- **LABR-1.5x1.5:** $LaBr_3$(Ce) Scintillation Detector
- **CEBRS-1.5x1.5:** $CeBr_3$ LED Temperature-Stabilized Scintillation Detector
- **CEBRS-2x2:** $CeBr_3$ LED Temperature-Stabilized Scintillation Detector

Features are:

- Standard NaI(Tl) Scintillation Detectors of various sizes with and without a well
- Temperature-Stabilized* NaI(Tl) Scintillation Detectors of various sizes including model compatible with the FASTSCAN™ Whole Body Counter
- $LaBr_3$(Ce) Scintillation Detector
- $CeBr_3$ Temperature-Stabilized* Scintillation Detectors
- Temperature-stabilized detectors only compatible with the Osprey Digital MCA Tube Base (3x5x16 also with Lynx)
- ISOCS Characterization available or included with most detector models
- Choose the detector with the resolution, efficiency and background performance that best suits your application and budget

*US Patents 7,005,646 B1 and 7,049,508 B1

Comparison of Scintillation Detector Types

Property	NaI	$LaBr_3$	$CeBr_3$
Resolution at 662 keV (%)	7%	3 - 3.5%	4.3%
Efficiency	Standard	Above Standard *	Above Standard *
Internal Background	None	Low (La-138, Ac-227)	Very Low** (Ac-227)
Decay time (ns)	250	30	17
Temp. Stabilization Available	Yes	No	Yes
Cost	$ - $$	$$$	$$$ - $$$$

* Energy dependent - greatest difference from NaI at higher energies

** Mirion offers only detectors meeting a premium low background specification.

Gamma Spectroscopy
continued

GR1-A

GR1

GR1™ Compact CZT Spectrometer

Features are:

- All-in-one detector, electronics and MCA
- Pre-set Gain, 1 cm³ CZT solid state detector
- Miniaturized package: 25 x 25 x 63 mm, 60 g
- USB connection to PC for control and power
- Optional I/O ports for energy and timing outputs and gate inputs
- Interface to Genie™ software for spectral analysis
- Optional Generic ISOCS™ characterization available

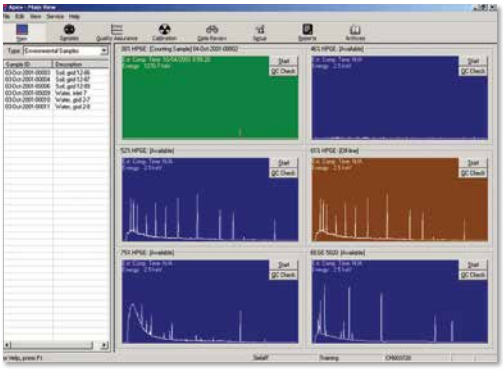
GR1 Family Variants	Resolution at 662 keV	USB	Gate Input	Timing Output	Energy Output
GR1	<2.5%	✔	–	–	–
GR1+	<2.0%	✔	–	–	–
GR1-A	<2.5%	✔	✔	✔	✔
GR1-A+	<2.0%	✔	✔	✔	✔

GR1-SHIELD™ Shield and Collimators

Features are:

- Two cm thick tungsten shield with handle for any GR1 CZT Spectrometer
- Includes collimators (2mm, 8mm and 35mm) and collimator lock tool
- ISXCZT-GR1 Generic ISOCS Characterization allows the GR1 to provide nuclide activities for in situ measurements
- Optional GR1-ACC Carrying Case with Tripod
- Case holds laptop PC, shield, collimators and tripod

Apex-Gamma



Apex-Gamma™ Lab Productivity Suite

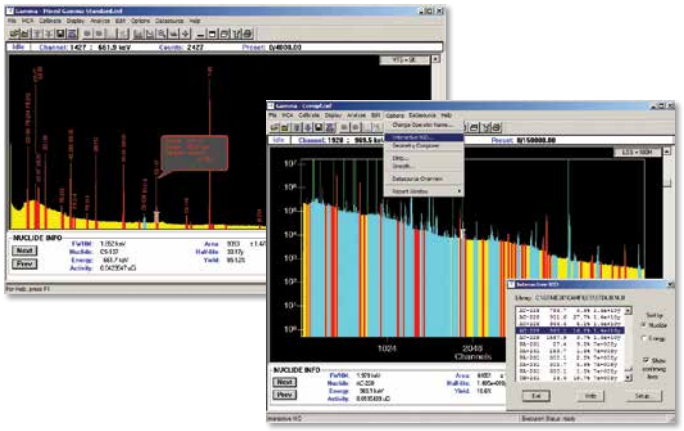
Features are:

- Comprehensive operation and management software for production-oriented gamma spectroscopy
- Distributed multi-user functionality provides access and control of the system from any client workstation
- Sample database tracks samples from log-in through final data review
- Enforces periodic QA/QC counts and approvals
- Comprehensive security system controls access to system functions
- Seamless integration of gamma spectroscopy results with Canberra NPP effluent management package – OpenEMS™

Apex-Guard™ Option

Augments the security of Apex-Gamma with the following features:

- Role-based security with Windows Credentials Authentication
- Automatic timed log-off
- Electronic signatures
- Enhanced security for analysis and data processing files
- Dramatically improved auditing capabilities



S50XC Genie™ Spectroscopy Software Family

Features are:

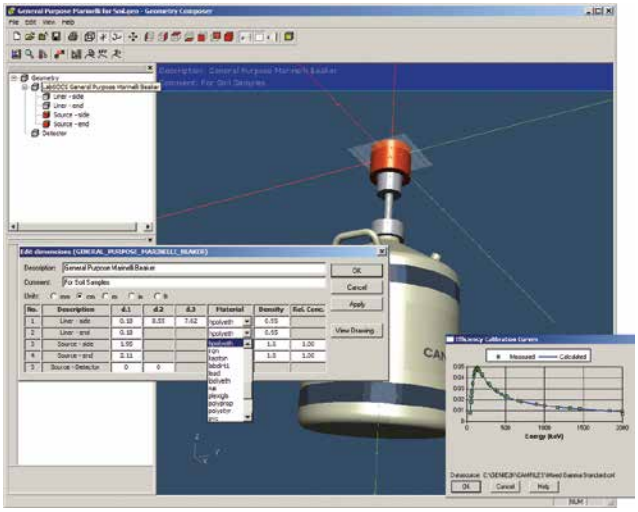
- Integrated data acquisition and analysis software platform
- Independent support for over 250 detector inputs
- Networking for distributed MCA operation and centralized data management
- Comprehensive and flexible user programming capability
- Compatibility with the full Canberra MCA line
- Wide variety of layered software options available for specialized spectroscopy applications
- Interactive Spectral Analysis
- Nuclide identification and quantification
- Library Correlation NID peak locate with background compensation
- Interference correction and weighted mean activity calculations
- Patented* true coincidence (Cascade) summing correction

*US Patent 6,225,634 B1

S574C LabSOCS™ Calibration Software

Features are:

- Eliminates requirement for expensive radioactive efficiency source standards and their disposal
- Calibrations valid from zero distance to 500 meters (1640 ft) – more than would ever be needed in the count room
- Calibrations valid from 10 keV to 7000 keV and accurate to within a few percent
- Operates with any size or type of germanium detector which has been characterized by Mirion
- Optimized for laboratory applications where complex shaped containers are used repetitively
- Includes model library of commonly available sample containers and tools to easily create custom models for other containers
- Compliant with 2009 U.S. NRC Regulatory Guide 1.21



Alpha Spectroscopy

Alpha Analyst™ Integrated Alpha Spectrometer

Features are:

- Completely integrated alpha spectroscopy instrument
- 100% computer controlled electronics and vacuum
- Automatic recoil suppression control
- Clean vent port to reduce moisture and contamination buildup in chambers
- Modular for ease of expansion in floor or bench top cabinets
- Connects directly to Ethernet network

PIPS® Passivated Implanted Planar Silicon Detectors

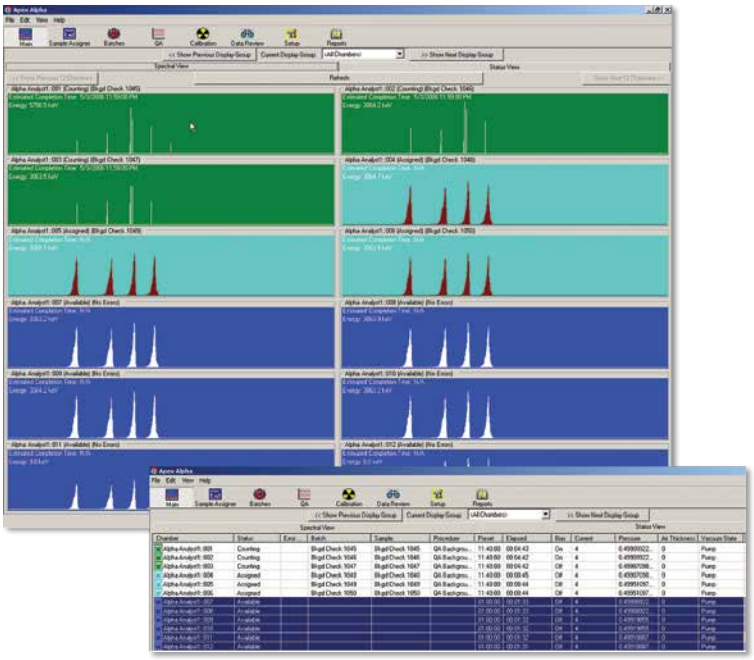
Features are:

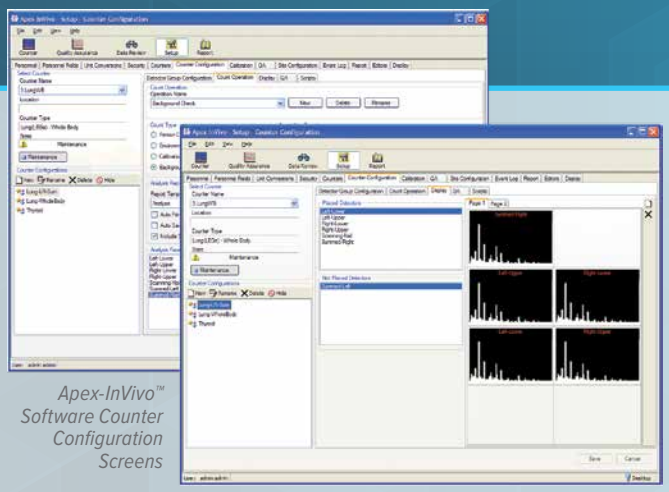
- Contacts are ion-implanted to form precise, thin, abrupt junctions for good alpha resolution
- Entrance window is stable and rugged – it can be cleaned readily and reliably
- Standard detectors are bakeable to 100 °C – higher for special models
- Leakage current is typically 1/8 to 1/100 of that of SSB and DJ detectors
- Low dead layer (window) thickness
- All junction edges are buried – no epoxy edge sealant is needed or used
- A450-18AM is, by far, the most popular model for alpha spectroscopy but other sizes are available

Apex-Alpha™ Alpha Spectroscopy Software Suite

Features are:

- Comprehensive operation and management software for the production-oriented alpha spectroscopy lab
- Supports manual alpha spectrometers and provides complete computer control of Alpha Analyst Spectrometer
- Distributed multi-user functionality for access to system resources from any client workstation
- Includes sample database that tracks batches of samples through log-in, counting and final data review/approval processes
- Intuitive tools for easy creation of sample batches with associated counting and analysis procedures
- Extensive quality assurance capability for scheduling of QA checks, failure identification and response and data trending
- Single screen data review and advanced reanalysis facilities
- Genie™ spectroscopy software core provides well established algorithms for analysis of spectral data



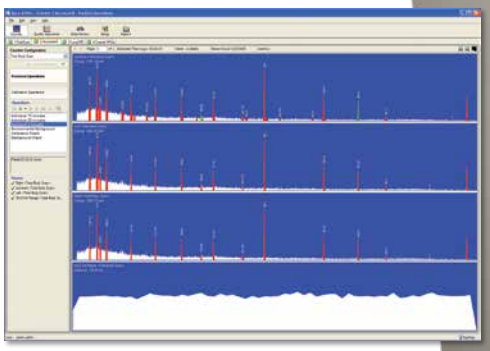


Apex-InVivo™ Software Counter Configuration Screens

In Vivo Measurement

Mirion is the leading global supplier for In Vivo Counting systems and has two systems specifically designed for personnel monitoring at nuclear facilities – the FASTSCAN™ and the ACCUSCAN™ whole body counters. Both systems employ gamma spectroscopy to provide nuclide identification as well as the activity of any contamination found during a count. This level of detail is not possible with contamination monitors using gas flow or plastic scintillator detectors.

The FASTSCAN whole body counter is a routine monitoring device which provides very low MDAs and short count times due to its large, moderate resolution/high sensitivity NaI(Tl) detectors.



Apex-InVivo software

The ACCUSCAN whole body counter is available in either a lay-down bed (ACCUSCAN) or a vertical stand-up configuration (ACCUSCAN II™). The ACCUSCAN Bed can accommodate a combination of Sodium Iodide (NaI(Tl)) and High Purity Germanium (HPGe) detectors for high resolution and high sensitivity while the ACCUSCAN II is designed for one or two HPGe detectors. Both ACCUSCAN models are scanning systems that can determine the location of contamination as well as its identity and amount.

Additionally, Actinide Lung Counting Systems are available that are capable of measuring low energy actinides in the lungs with or without the ability to also scan the whole body for fission products. Like the ACCUSCAN systems, the lung counters use High Purity Germanium (HPGe) detectors to detect and resolve low-energy, low-yield gamma rays from uranium, plutonium, and other actinides located specifically in the lungs. These systems are excellent for use at nuclear fuel fabrication and reprocessing facilities.

All of these counting systems employ Apex-InVivo™ Whole Body and Lung Counting Productivity Software for operation, data analysis and reporting. The software's scalable architecture supports standalone counter workstations or the creation of a site-wide network of client/server computers for counter operation and data review.

ACCUSCAN II with Cryo-Pulse 5 Plus Electrically Cooled Cryostats

Features Common to Canberra In Vivo Counters:

Features are:

- Shielded in all straight-line directions by 10 cm (4 in.) of low background steel
- Modular shield construction for easy assembly
- Rapid on-site analysis and presentation of results
- Full spectroscopy systems; not just gross count screening counters
- Flexibility and ease of operation through Apex-InVivo Whole Body Counting software
- Standalone Apex-InVivo workstations or networked client/server systems
- Extensive QA data collection program

FASTSCAN™ High Throughput Whole Body Counter

Features are:

- Processes 30-50 people per hour
- One minute count time for typical operation
- Two very large, 7.6 x 12.7 x 40.6 cm (3 x 5 x 16 in.), NaI(Tl) detectors
- Temperature-stabilized detectors available to eliminate spectral peak shifts
- 150 Bq (4 nCi) ^{60}Co LLD typical for personnel counts
- Vertical linear geometry for accuracy over a wide range of personnel sizes

ACCUSCAN II™ Scanning, High Resolution, Germanium Whole Body Counter

Features are:

- High resolution, standup whole body counter
- Scanning detector mechanism accommodates one or two high purity germanium (HPGe) detectors
- Count times as low as five minutes
- Simultaneous energy and positional spectrum for accurate interpretation of data
- Available with LN_2 or electrically-cooled detectors

ACCUSCAN™ Scanning, Horizontal Bed Whole Body Counter

Features are:

- Horizontal, lie-down linear geometry whole body counter
- One 7.6 x 12.7 x 40.6 cm (3 x 5 x 16 in.) NaI detector (standard)
- Count times as low as five minutes
- Computer controlled scanning bed
- Simultaneous energy and positional spectrum for accurate interpretation of data

Available Options:

- One or two HPGe detectors instead of NaI
- Two or three large NaI detectors
- Two HPGe detectors and two NaI detectors
- LN_2 or electrically-cooled HPGe detector

2270 Actinide Lung Counter

Features are:

- Detector positioner mechanism with six degrees of freedom
- Positioner accommodates BE6530 detectors
- Digital Signal Analyzers for high-resolution signal processing
- Comfortable reclining chair for subject positioning
- Flexibility and ease of operation with Apex-InVivo whole body counting software
- Extensive QA data collection program
- Lung Counting software for automatic chest wall thickness correction
- Turnkey system delivered calibrated and ready to count

System Options and Upgrades for both Counters:

- 15 cm (6 in.) or 10 cm (4 in.) thick low-background steel shield
- The BE6530 with 6500 mm2 area and 60% relative efficiency offers excellent minimum detectable activities (MDAs) and shorter counting times
- Cryo-Pulse 5 Plus electrically-refrigerated cryostat for use with BE6530

2275 Actinide Lung and Scanning Whole Body Counter with and without shield

2275 Actinide Lung and Scanning Whole Body Counter

Features are:

- Lung detector positioner mechanism with six degrees of freedom
- Lung positioner accommodates BE6530 detectors
- Digital Signal Analyzers for high-resolution signal processing
- Sliding bed for easy subject/patient loading
- 7.6 x 12.7 x 40.6 cm (3 x 5 x 16 in.) scanning sodium iodide detector for whole body counting
- Flexibility and ease of operation with Apex-InVivo whole body counting software
- Extensive QA data collection program
- Lung counting option for automatic chest wall thickness correction
- Detector Anti-Compton Shields to reduce subject-generated background
- Turnkey system delivered calibrated and ready to count

Apex-InVivo™ Whole Body and Lung Counting Productivity Software

Features are:

- Comprehensive operation and management features for in vivo counting systems
- Distributed multi-user functionality provides access to counters from any client workstation
- Flexible calibration facilities including a verification report and calibrations that are automatically shared across different configurations
- Quality assurance facilities with enforced scheduling policies, and failure response option
- Advanced database features help manage all personnel count data, multiple analyses, and advanced search capabilities in key activities
- Live summed detector groups as well as multi-channel scaling (MCS) groups with defined energy ranges

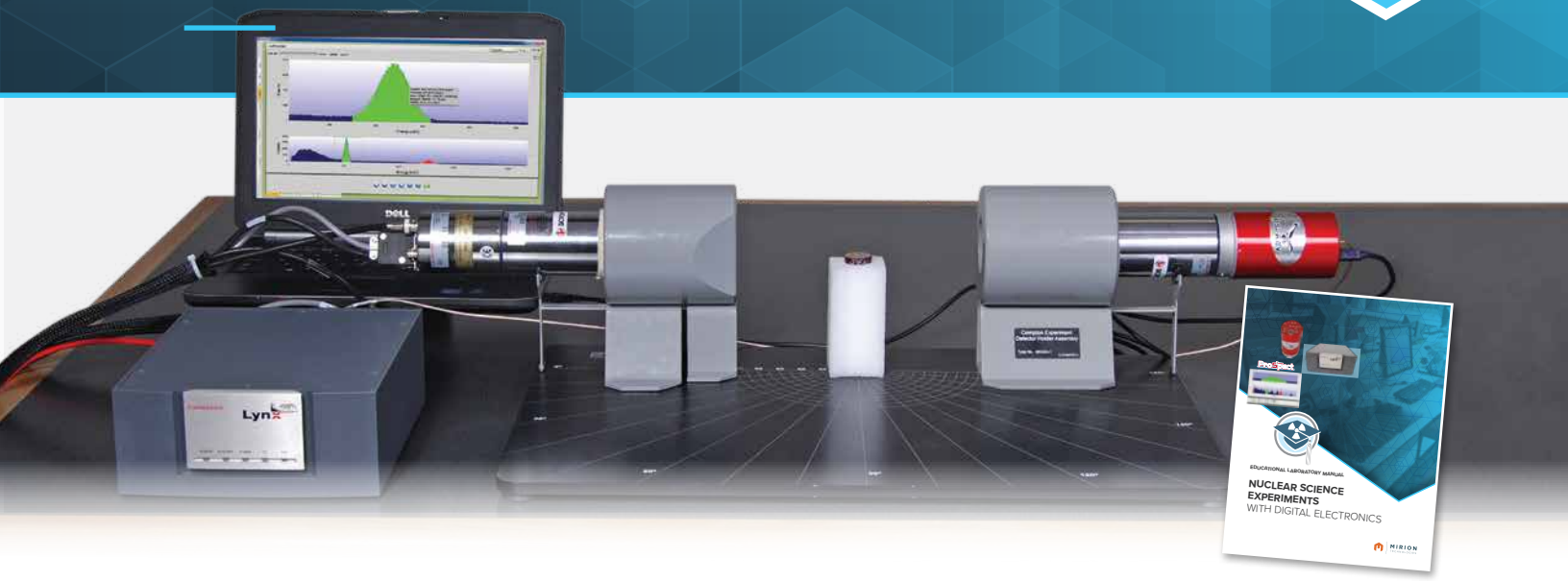
Detectors for Diffraction & Imaging

Electrical cooling for synchrotron applications

Courtesy of the GRETA collaboration (taken by S. Noji)

Section 3

Research and Education



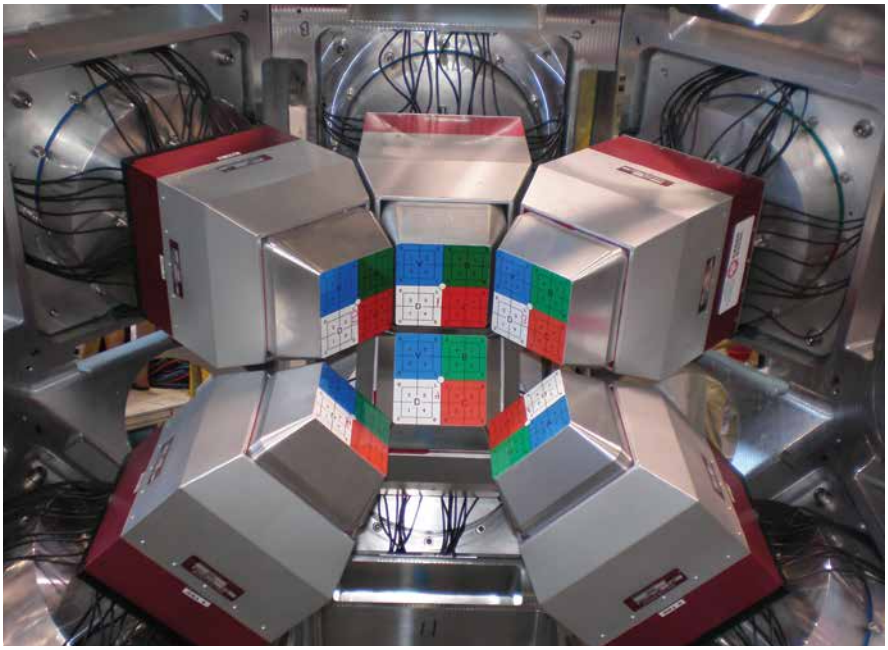
Mirion detectors and instrumentation have been used in materials analysis, physics, and space studies in some of the world's leading industries and research institutes. A dedicated R&D structure allows us to deliver innovative nuclear detection systems based on a comprehensive exploration of all available and emerging technologies.

A detailed Nuclear Science Experiments with Digital Electronics Lab Manual and associated Lab Kits are also available to assist with hands on exposure to fundamental and advanced topics of gamma-ray measurement and gamma spectroscopy in teaching and research laboratories.

Detectors such as the Passivated Implanted Planar Silicon variety are used in core products for alpha spectroscopy and alpha/beta counting. They also play critical roles in systems for XRF materials characterization, the space program and physics research.

High Purity Germanium (HPGe) detectors offer the unique blend of cutting edge technology and proven reliability. From standard coaxial detectors to sophisticated array detectors for scientific research and industrial applications – you can count on consistent quality, high technology and reliability. Electrically-cooled, LN_2-free cryostats are available in most configurations.

Mirion Digital Signal Processing products and spectroscopy software are at the heart of our gamma spectroscopy systems. These versatile technologies offer solutions that serve the most demanding requirements of the world's leading researchers and educators. They are not only the components with which the systems are built – but also the tools that are building the future of the nuclear industry.



TIGRESS Clover detector array at TRIUMF Vancouver BC. The array consists of 16 large and highly segmented Mirion Clovers 4x60x90-seg32 (32 position information) (Photo by courtesy of Prof Carl Svensson - Univ Guelph)

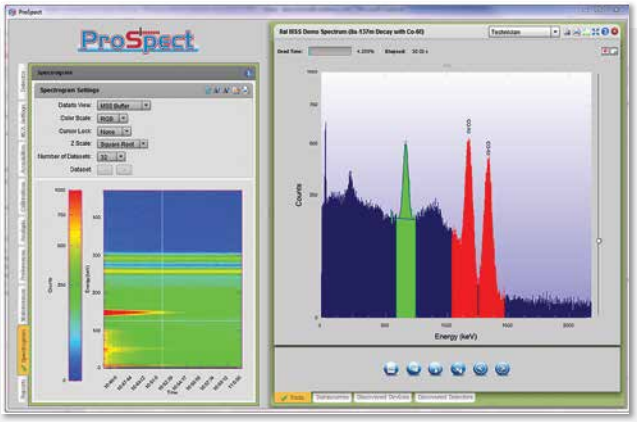
Gamma Spectroscopy Products

LABKIT lab manual

LABKIT Nuclear Science Experiments for Teaching Laboratories

Features are:

- Turn-key solutions for 12 gamma nuclear science experiments
- Easy to order, set-up and use
- Cutting edge and modern digital equipment for these and other custom experiments
- Two kits (Basic scintillation-based and Advanced HPGe-based) allow for easy planning and budgeting
- Basic Kit supports Experiments 1 – 5
- Advanced Kit adds to Basic to support Experiments 6 – 12
- Free lab manual includes all information needed to set up and perform the exercises

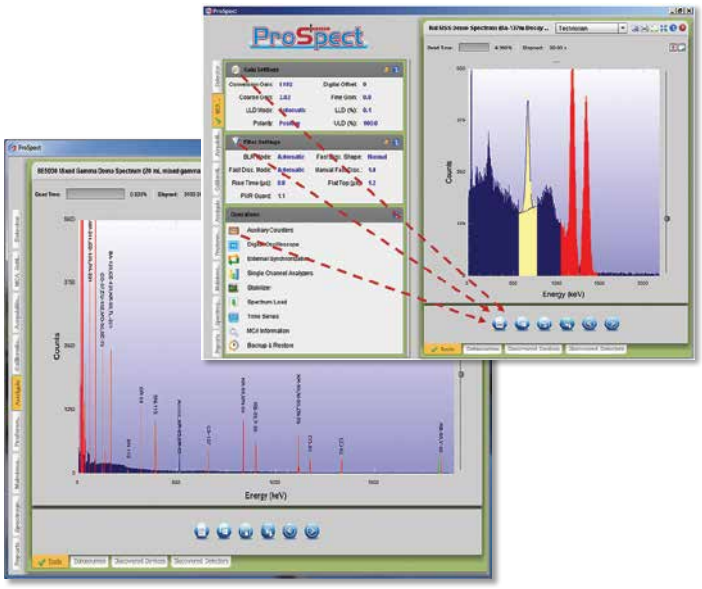


ProSpect

S600C ProSpect® Gamma Spectroscopy Software

Features are:

- Gamma Spectroscopy Software with an ergonomic, intuitive user interface
- Rapid connection to devices through 'Discover' functionality
- Compatible with Osprey and Lynx DSPs
- Full acquisition mode support, including all the advanced modes of the Lynx and Osprey
- Supports ProSpect XML-based and Genie™ .CNF data storage format
- Streamlined export functionality to CSV format



HPGe Detector Configurations for Nuclear Physics Research

Euroball Clover Detector 4x50x70 a great detector success designed by Mirion in early 90s with more than 130 identical detectors delivered worldwide.

New COMPEX clover: the first electrical cooled Clover ever done with a special RDC cryostat designed for windowless operation. Four of these Clovers are currently in use at GSI in Germany as a decay box to study new exotic nuclides.

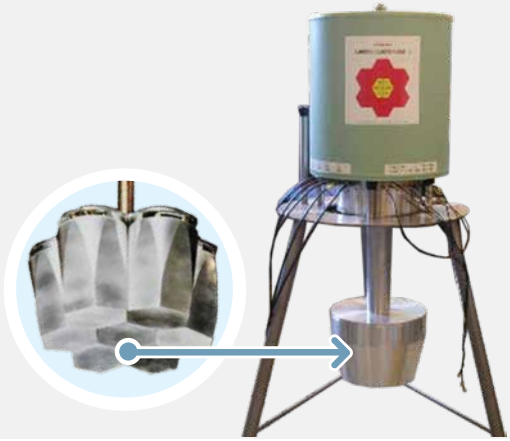
The GRETA detector consisting of 4 encapsulated HPGe crystals each segmented in 36.

Total number of channels per detector: 148

- *144 position*
- *4 full volume channels*

The Euroball Cluster detector is consisting of 7 encapsulated HPGe crystals. Mirion delivered 180+ individual capsules for Euroball Cluster detectors and Miniball at CERN.

The photo shows a design for JAEA: only the center crystal is segmented in six the surrounding capsule are not segmented.



Clover Detectors Array of Four HPGe Detectors

Features are:

- Clover Array-Detector design is consisting of four special shaped Ge crystals for a close array – with or without segmentation of the individual crystals
- Excellent energy and timing resolution due to dedicated crystal quality and low electrical noise electronics
- 130% relative efficiency in addback mode with a Clover 4x50x70. More is achievable with bigger crystals.
- Can address applications where highest efficiency or MDAs are required
- Low background configurations available with specifically selected materials for their radio-purity
- Thin entrance window for extended energy range to low energy photons available on request.
- Optional electrical cryocooling for LN_2-free operation

High efficiency HPGe Array Solutions

Features are:

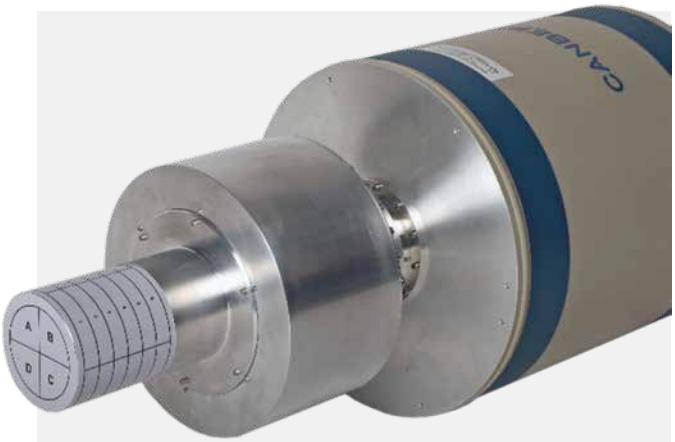
- Up to seven HPGe crystals in one cryostat
- Encapsulation techniques for a modular design easy to handle in case of maintenance.
- At request segmentation of the outer contact of the individual crystals
- Embedded low power and low noise preamplifiers with fast rise time.
- Special irregular hexagonal shape to accommodate a complete 4 PI detection ball consisting of only HPGe material where Veto scintillator detectors such as BGO/CSI are no longer needed due to the close HPGe array detector system.

HPGe Detector Configurations for Nuclear Physics Research
continued

Segmented coaxial Ge detectors for position information

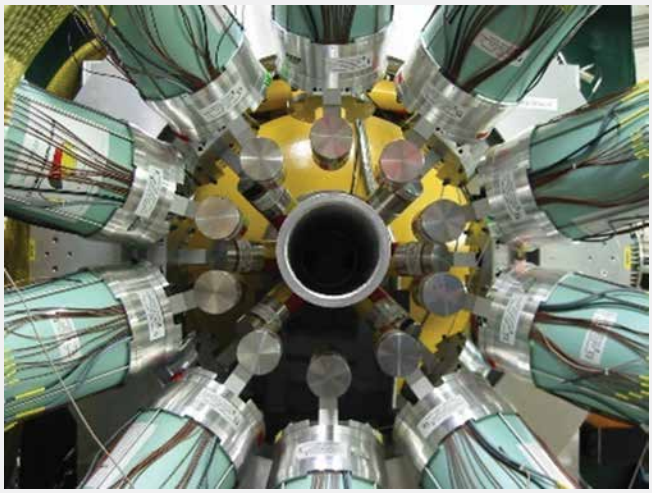
Features are:

- For gamma tracking, polarimetry, Doppler effect correction, ß decay suppression
- Longitudinal and transversal segmentation of the outer contact by photolithography (up to 36 segments), on various N-type crystal geometries
- No dead zone or absorbing material between segments
- Monolithic or multielement segmented detectors
- Reliable segmentation technology over three decades not sensitive to heat cycling nor neutron annealing operation in-situ.
- No measurable crosstalk effects
- Increased granularity of multi-detector systems
- Localization of the interaction and gamma-ray tracking capability through coincidence between internal core signal and segment contact signals.



Applications are:

- Nuclear physics:
  - Doppler effect correction
  - Multiple site energy deposit and ß decay suppression
  - Polarimetry
  - Tracking
- Compton cameras – gamma imager: Gamma-ray sources location
- Compton suppression



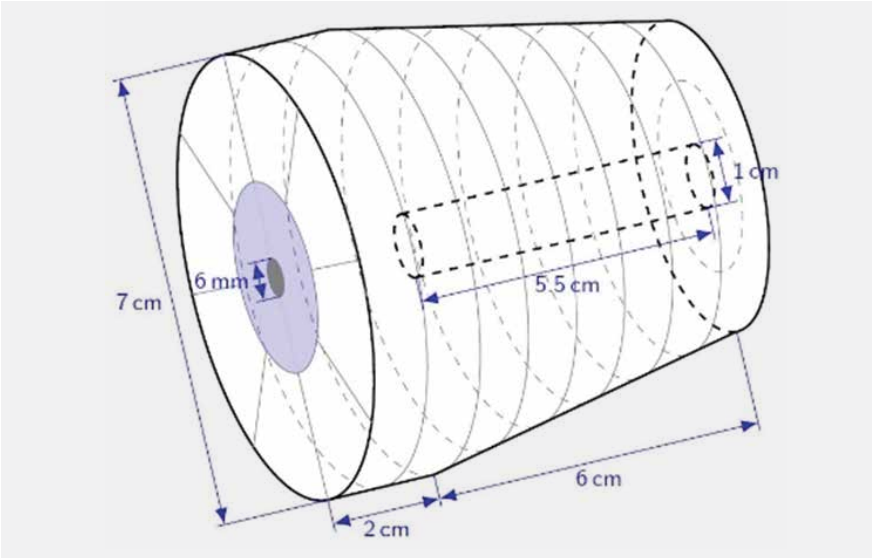
MSU "SeGA" system

CNS Ge array "GRAPE"

Inverted & Segment coaxial type Ge detector

Features are:

- Novel Germanium Detector technology for in-beam gamma-ray spectroscopy.
- Gamma-ray tracking for background suppression and multiple interaction analysis.
- Up to 20 segments including a central electrode (point contact) and surrounding segments as well inside the core.



Mirion Specialty Ultra Low Background "S-ULB" detectors

The Mirion Technologies (Canberra™) product catalog has offered Ultra Low Background "ULB" detectors for more than four decades.

ULB detector performance can now be significantly enhanced by new technologies to address demanding nuclear physics research like astrophysics with ultimate level of background as required in deep underground labs for low radioactive environmental samples.

Below is a list of features for Canberra Specialty Ultra Low Background (S-ULB) HPGe detectors now available from Mirion Technologies:

- Ultimate Level of Background.
- Customized HPGe crystals and electronics.
- Tailored cryostat to fit special constraints.
- Electrical cooling as a proven and mature technology for underground HPGe detector labs.
- New array detector systems for unprecedented detection efficiency.
- Novel Small Anode (SAGe) detector technology.
- New Small Anode Well (SAGe Well) detector technology.
- Customized Well or true Well detectors for 4π detection geometry.
- Minimized exposure to cosmic radiation due to Mirion storage cave with 800 mwe overburden.

Below performance on ULB and S-ULB detectors could be disclosed thanks to the kind contribution of our customer very willing to share the information requiring up to many weeks of counting time per spectrum due to the very low level of radioactivity.

Background performance difference between ULB and S-ULB detector in Underground Lab conditions:

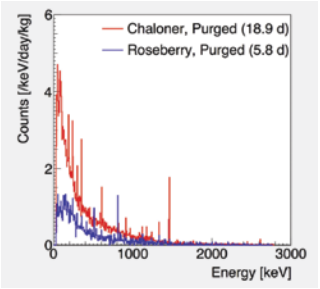
This table below from the deep underground Lab "Canfranc" ("LSC") in Spain provides the integral counts in ULB and S-ULB cryostats for a coaxial 400 cc P-type detector with "U" style type cryostat.

Integral counts on a 400cc P type detector	"Specialty" S-ULB (counts/kg/day)	"Specialty" S-ULB (counts/kg/day)
20-2700 keV	1932	190
40-2700 keV	689	179
60-2700 keV	641	165
100-2700 keV	598	143

By courtesy of Dr Iulian Bandac - LSC

Background performance difference of BEGe6530 detectors at Boulby UnderGround Screening Lab ("BUGS") in the UK with ULB and S-ULB cryostat grade assessment occurred in 2018:

- **Involved detectors:**
  - "Chaloner" nickname of a BEGe6530 with ULB cryostat (delivered in 2015).
  - "Roseberry" nickname of a BEGe6530 with S-ULB cryostat (delivered in fall 2017).
- Typical minimum activities (computed values) from the S-ULB detector at Boulby Underground Lab:
  - 210Pb < 0.7 mBq/kg
  - 234Th < 0.5 mBq/kg



NOTE: There is not an insignificant amount of Co^{58} (511 keV 810 keV 863 keV 1674 keV) and Co^{57} (122 keV 136 keV) in the S-ULB detector background spectra in blue shown above. This is just activation from being on the surface and it is something that will disappear with time due to the very short half life of Co^{58} (71 days) and Co^{57} (270 days).

Credit: 'STFC-Boulby Underground Laboratory' and the 'UCL, High Energy Physics Group'

During the LZ (Lux Zeplin) collaboration meeting Dr Cham Ghag from the University College London (UCL) compared the Mirion BEGe6530 detector in S-ULB cryostat with two world known reference detectors homemade specifically by MPI in Heidelberg for the Gran Sasso underground lab (LNGS) in Italy. It is important to highlight how close the Mirion S-ULB detector (called Roseberry) comes to the GATOR and GeMPI detectors recognized as world reference detectors, with respect to background performance.

Enery [keV]	Chain/nuclide	Counts/day		
		Gator	GeMPI	Roseberry
239	$^{232}Th/^{212}Pb$	<0.5	–	<0.3
911	$^{232}Th/^{228}Ac$	<0.5	<0.2	<0.3
352	$^{238}U/^{214}Pb$	0.7±0.3	<0.5	1.1±0.4
609	$^{238}U/^{214}Bi$	0.6±0.2	0.50±0.45	0.6±0.3
1120	$^{238}U/^{214}Bi$	0.3±0.1	–	<0.3
1765	$^{238}U/^{214}Bi$	0.08±0.06	–	<0.3
662	^{137}Cs	<0.5	–	<0.3
1173	^{60}Co	0.5±0.1	0.6±0.4	0.8±0.3
1332	^{60}Co	0.5±0.1	0.6±0.3	1.2±0.4
1461	^{40}K	0.5±0.1	0.6±0.4	0.5±0.3
2615	$^{232}Th/^{208}Tl$	0.2±0.1	–	<0.3

"Roseberry" is a nickname of a Mirion BEGe6530 with S-ULB cryostat (delivered in fall 2017)

"GATOR" (2010) and "GeMPI" (2005) are nicknames of 400 cc HPGe detectors with highly customized cryostat designed by MPI scientists in Heidelberg for the Gran Sasso underground Lab in Italy.

Credit: 'STFC-Boulby Underground Laboratory' and the 'UCL, High Energy Physics Group'

Isotopes		Peak(keV)	Efficiency (%)
^{232}Th	^{228}Ac	911	5.8
		968	5.5
	^{212}Pb	238	9.7
	^{212}Bi	727	6.8
	^{208}Tl	2616	2.0
		583	4.7
		860	4.7

S-ULB Specialty Ultra-Low Background Cryostats

Features are:

- Cryostat designs using selected grades of materials and tailored to the specific requirements
- Large detectors available (up to 910 cc)
- Custom designs to fit existing shielding constraints
- Selected materials like fresh OFHC copper or high-purity aluminum
- Compact endcap design accommodating scintillator guard detectors in close proximity
- Can be used with standard or array detectors
- 14 detector elements of 70% relative efficiency
- Global relative efficiency 980%
- High sensitivity measurement of U + Th contamination (see table to the left)

Applications are:

- Assay of MoO_3 enriched powder
- Rare decay exploration like ^{180m}Ta with T1/2 > 4,5 1016 years).

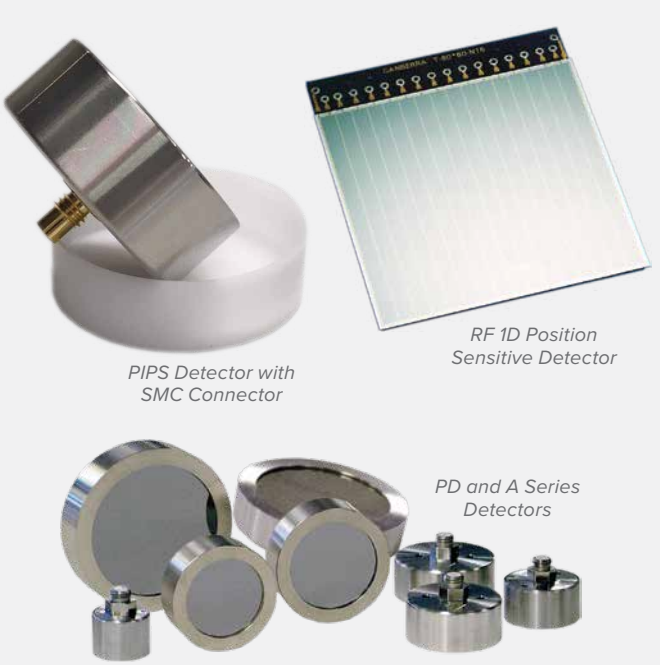
1kg Small Anode Ge detector with preamplifiers on both contacts for neutrino search

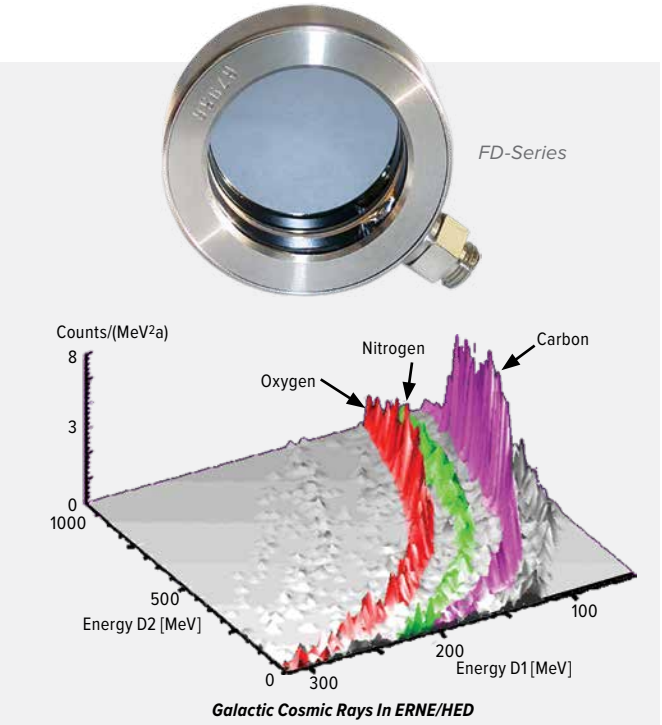
SAGe™ Small Anode Germanium Detectors

Features are:

- Large crystal sizes: 1.5 kg or larger
- Typical energy resolution 50 eV (FWHM with pulser).
- Energy threshold of about 150 eV.
- Complex assemblies of several detectors in S-ULB probes to be dipped directly in LN_2 or LAr.
- One or two preamplifiers per crystal (readout on both contacts for signal vetoing).
- Compact front cryostat without any flange for close veto detector operation.
- Electrical cooled SAGe for LN_2 free operation without any compromise on performance.
- Also available as a SAGe Well detector providing best noise threshold in a 4π detection geometry with optimized well sizes

Silicon Detector Configurations for Nuclear Physics Research





PD, RF and A-Series PIPS® Detectors for Charged Particle Detection

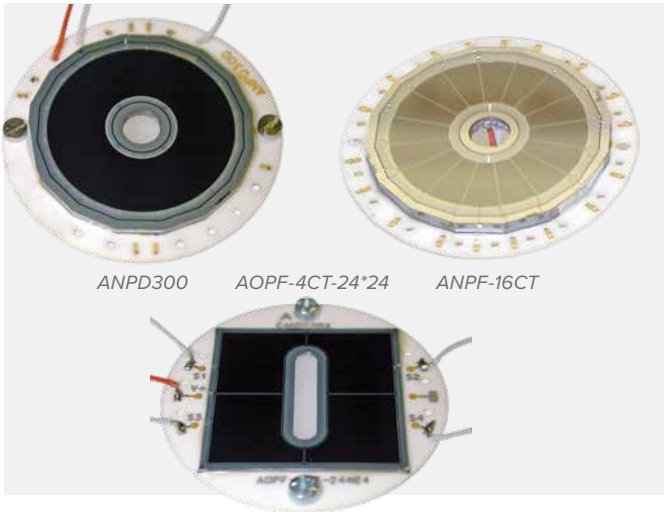
Features are:

- Excellent Resolution for Alphas, Betas, Protons, Electrons and Heavy Ions
- Entrance window < 50nm on all models
- Low Energy Beta's and Electron detection
- Single junction or strip, pixel detectors
- Assembles in housing or on PCB
- Connectors include: Microdot, BNC and SMC; SMC typical for research applications

FD-Series PIPS Detectors for ΔE-Detection

Features are:

- Thin window on entrance and exit
- Excellent resolution performance
- Single junction or pixel detectors
- Assembles in housing or on PCB



Silicon Photodiodes for Beam Monitoring

Features are:

- Single or multiple junction on ceramic board
- Thin junction entrance window: <50 nm
- Low dark current, typically below 1 nA/cm^2
- No optical window

X-Ray Detectors for Synchrotron Applications

64 and 100 pixel array

Monolithic HPGe Pixel Detectors

Features are:

- Pixel sizes of 5x5 mm² and 8x8 mm² in arrays from 3 - 100 pixels on a single substrate
- Only technique offering 100% beam coverage
- Design allows the highest throughput electronics and outstanding energy resolution with excellent EMI shielding

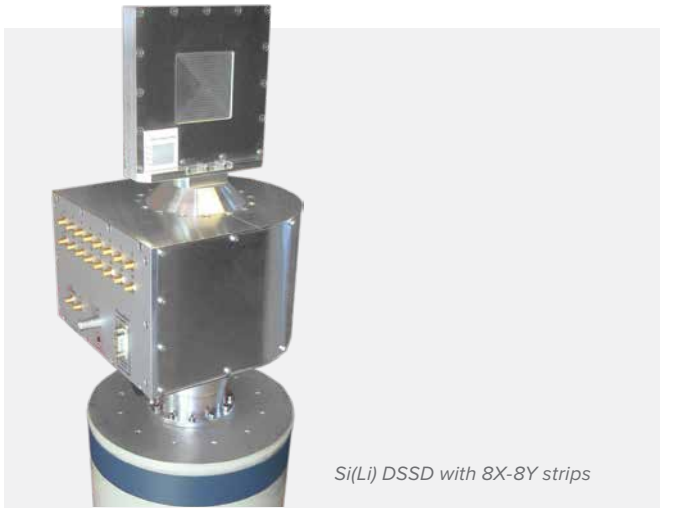
5 x 50 mm² Ultra-LEGes with Retractable, Multi-Attitude Cryostat

18 x 50 mm² Ultra-LEGes with Electrically refrigerated cryostat

Discrete Single and Array Detectors HPGe

Features are:

- Single or 2 - 32 individual HPGe elements
- Energy range: LEGe (3 keV and up); Ultra-LEGe (1kev and up)
- Windowless cryostats available for Ultra-LEGe energy sensitivity down to 300 eV
- High resolution even with very short pulse processing times



Si(Li) DSSD with 8X-8Y strips

DSSD HPGe Double-Sided Strip Detectors

Features are:

- HPGe planar detectors for interaction localization
- X and gamma radiation imaging
- Compton camera using crystals stacked in a single cryostat
- No measurable crosstalk effect

7-Element Array

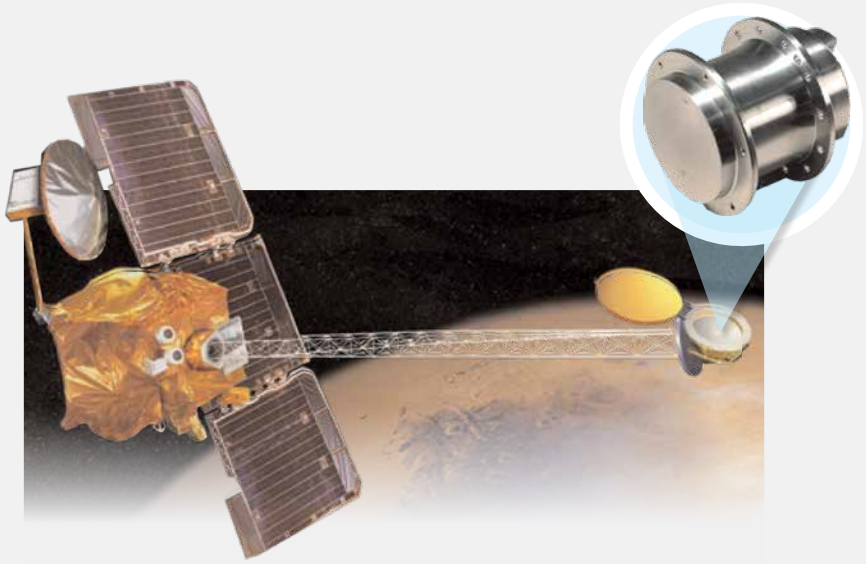
13-Element Array

X-PIPS™ Series Detectors for Photon Detection (From Near UV to 30keV)

Features are:

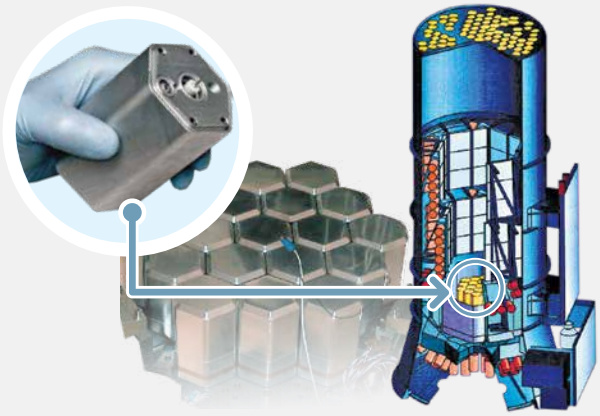
- Silicon Drift Detector (SDD) technology
- Pioneers in large area silicon drift detectors (CERN Alice)
- FET or CMOS preamplifiers
- Single element and 7- to 13- element arrays
- Pulse-tube cryo cooling
- Industrial manufacturing fully in house

Custom Detectors for Space and OEM Applications



The Mars Odyssey Mission: Launched in 2002 to detect the presence of water (ice) on Mars by using (n,γ) reactions. Coaxial HPGe, N-type detector, titanium encapsulated. Vibration specifications 50 g. Still in operation.

Integral SPI Project: Launched in 2002 to study the origin of gamma bursts in the universe. Compact array of 19 encapsulated coaxial HPGe detectors. Vibration level 50 g. Still in operation.



Selene (JAXA) Lunar orbiter mission "KAGUYA". Mission duration: one year. Encapsulated coaxial HPGe detector for the GRS. The GRS had an excellent energy resolution 20 times superior to those used in past lunar missions.

Ruggedized HPGe Detectors for Space Exploration

Applications are:

- Suitable for stratospheric balloons, space telescopes and satellites
- For accurate gamma cartography in galaxies (study of supernovae, black holes, etc.)
- Advanced encapsulation, ultra-high vacuum, waterproof and shock absorption design allows survival in the harsh environment of space
- Shock proof capability (100g) to survive vehicle take off
- Remote neutron repair ability
- Compatible with electrical cooling
- Mission examples: Mars ODYSSEY, Integral-SPI, CLAIRE Stratospheric balloon, SELENE Lunar orbiter

Encapsulated Ge detectors

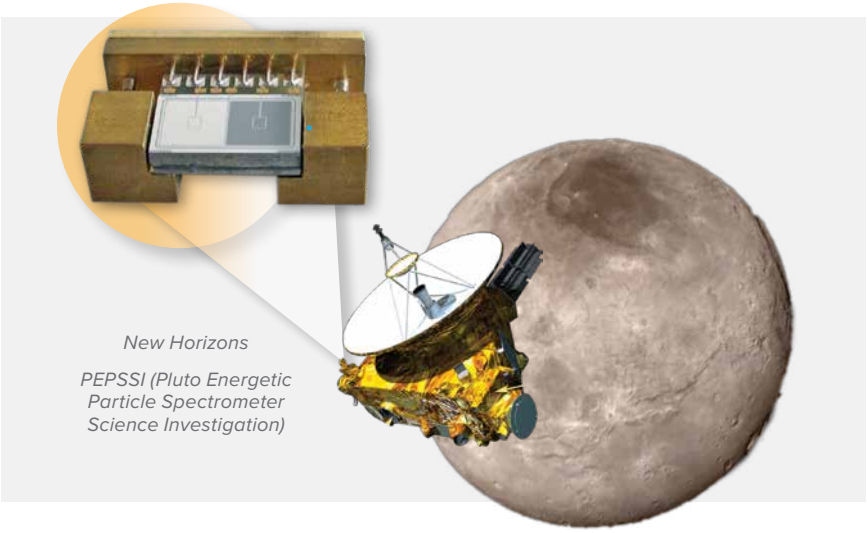
Features are:

- For compact construction of multi-element detectors for gamma-ray applications
- For very large efficiency and solid angle coverage
- For high sensitivity and low detection limit gamma-ray spectroscopy even in harsh environments
- Easy annealing in standard ovens, without pumping, in case of radiation damage
- In situ annealing in space applications
- Long detector life time
- Large choice of shapes (pentagonal, hexagonal) for compact matrix assemblies
- Essential for complex cryostat development, particularly with segmented detectors
- Total reliability Ultra High Vacuum technology
- Easy detector handling and exchange

PIPS Detectors for Space Exploration

Features are:

- Thickness: 200 to 500 µm
- Anti-reflective coating with QE > 80%
- Low dark current and direct coupling to scintillator
- Extremely rugged and low power requirement
- Awarded by NASA for the contribution to the Mars ROVER MSL Rad project
- PIPS detectors are deployed on the following current or recent missions:
  - STEREO and DOUBLE STAR studying solar storms, MESSENGER studied Mercury, NEW HORIZONS passed Pluto to outer space in a second extended mission, JUNO exploring Jupiter



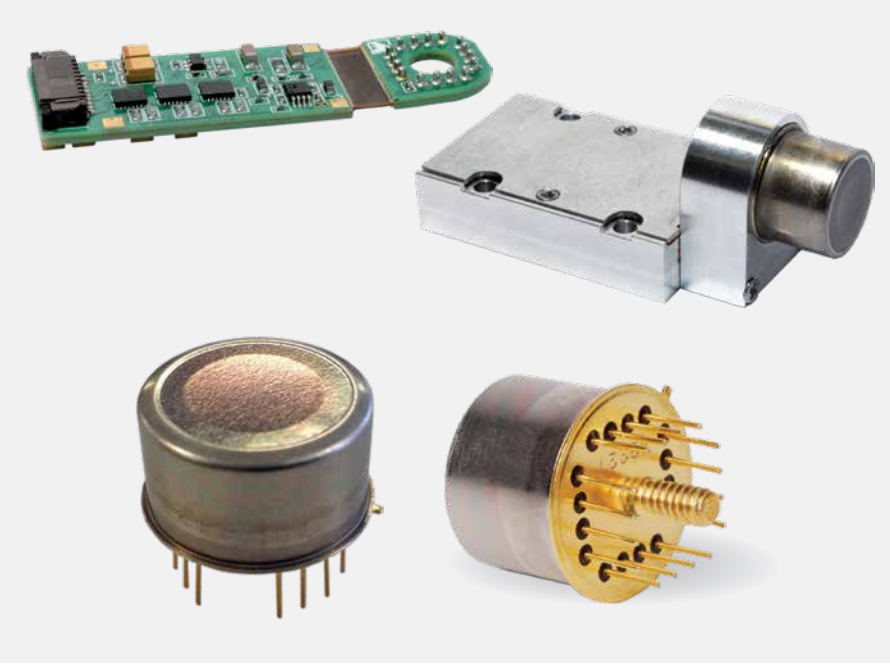
New Horizons

PEPSSI (Pluto Energetic Particle Spectrometer Science Investigation)

OEM solutions for XRF-XRD-EDX Benchtop and Handheld

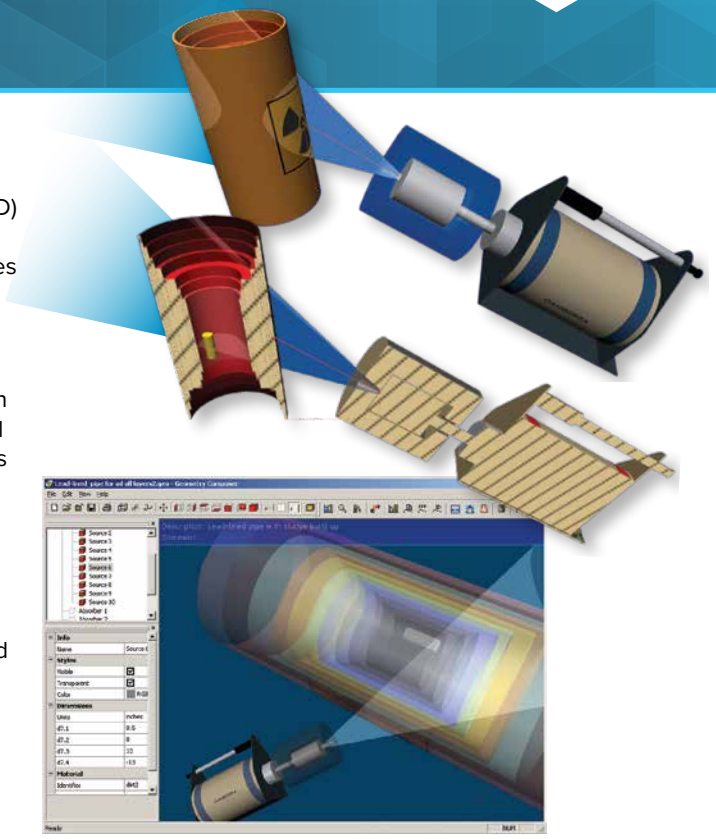
Features are:

- Silicon Drift Detector (SDD) product range is targeted for integration in handheld and benchtop XRF systems
- All products are developed, designed, manufactured and assembled in house to customer specifications
- Includes compact preamplifier
- JFET or CMOS based front stage amplification



CANBERRA

In Situ Measurement



In situ gamma spectroscopy is a valuable tool for supporting applications such as decontamination and decommissioning (D&D) at nuclear facilities. These measurements save money and time when compared to the conventional process of extracting samples and sending them to a remote laboratory for analysis.

The in situ measurement product line includes a full complement of gamma spectroscopy systems and detector technologies from hand-held scintillation detector spectrometers to cart-based, high resolution HPGe spectroscopy systems. The products cover a full range of portability, sensitivity and spectral resolution capabilities and form the basis for Mirion's automated waste assay systems. Systems are also available with a simplified user interface for non-expert operators taking field measurements.

For in situ measurements, the ISOCS™ system has become the most widely accepted measurement tool in the world. The ISOCS system is commonly used to measure contaminated materials and areas, both in place or after removal from the facilities. It is also used for final status measurements to allow release of areas for general use, or general demolition activities.

The ISOCS sourceless efficiency calibration software can be used with instrumentation from hand-held spectrometers to large, multi-detector assay systems to provide both qualitative and quantitative results meeting stringent user requirements and governmental regulations.

Aegis™ Transportable HPGe Spectrometer

Features are:

- Integrated solution combining a thermal cycle-free HPGe detector system, MCA and electronics platform
- Portable and battery-powered with choice of electrically-cooled HPGe detector:
  - Detector options: BE5030, GX40 and GC40 with or w/o RDC-6 Remote Detector Chamber
  - RDC-6 is compatible with ISOXSHLD Cart and with standard laboratory lead shields
- Built-in GPS and dual, hot-swappable batteries
- Wired or wireless communication to host computer
- Operation from -20°C to 50°C without cooling fans
- IP65-rated enclosure enabling operation in harsh environments
- Access to system through web browser
- Web UI allows:
  - Setup, diagnostics and maintenance
  - Spectrum viewing
  - Firmware updates
  - User account and network management
- Genie software used for data acquisition and analysis
- ISOCS™ characterization is available which allows radionuclide activities to be calculated for complicated geometries

MicroGe with Supply Station, DSA-LX® MCA and Genie Software for Windows PC computer

MicroGe™ Ultra-compact HPGe detector

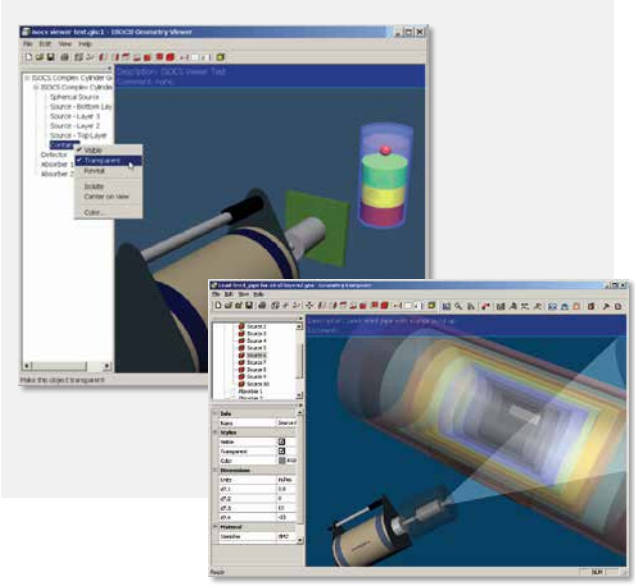
Features are:

- High count measurement in extreme environments
- Compact and lightweight portable Ge
- Can be used almost anywhere
- Thermal cycle free

Design:

- Small HPGe crystal: 0.1 % relative efficiency
- Electric cooling system (lightweight, short cool-down time power saving)
- Ultra-low noise electronics circuit
- System design options:
  - Collimator
  - Watertight housing
- Hardened vacuum allowing partial thermal cycles

MicroGe detector integration on a rover



S573C ISOCS™ Calibration Software

Features are:

- Eliminates the cost of purchasing, tracking, and disposing of radioactive standards
- No radioactive efficiency source standards needed for accurate efficiency calibrations
- Calibrations valid from 10 to 7000 keV
- Calibrations valid from detector face out to 500 meters
- Sample size can be point-like, or up to 500 meters in size
- Advanced Collimator designs include liners and back shielding
- Calibrations accurate at any angle from detector, not just on center line
- Operates with germanium, scintillation and CZT detectors characterized by Mirion
- Ideal for In Situ applications, where large and various sample types are often encountered
- 3D visualization speeds geometry creation and error identification
- Uncertainty Estimator and Assay Planning tool
- Custom templates can be provided to meet special application needs
- Multi-Efficiency program allows creation of compound efficiencies for multiple detectors, multiple locations or multiple sources
- Compliant with 2009 U.S. NRC Regulatory Guide 1.21

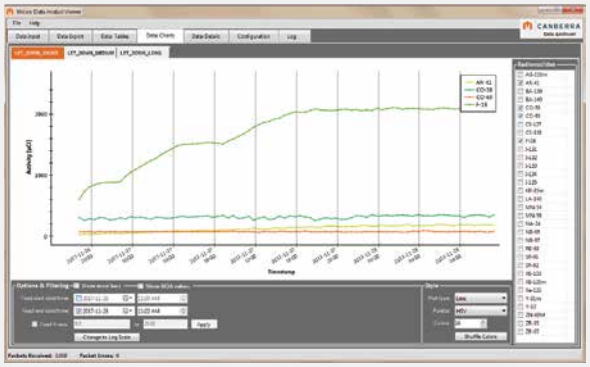
ISOXSHLD™ In Situ Object Counting System

Features are:

- Portable Germanium detector shield system for in situ assays
- Compatible with the Aegis Transportable HPGe Spectrometer and LN_2-cooled HPGe detectors
- Includes 25 mm and 50 mm thick lead shields
- Reduces interfering 1000 keV radiation by a factor of 7.5 (25 mm) and 60 (50 mm)
- Modular design for easy handling
- Includes 30°, 90°, and 180° collimators (each thickness) plus solid end caps for background measurements
- Includes a rear shield set (requires RDC option on detector)
- Wheeled mounting stand with brakes for ease in moving the shield from one sample to the next
- Large wheels for easy movement: 40 cm (16 in.) at rear, 20 cm (8 in.) in front

- Upper and lower detector mounting positions, with 180° detector rotation at either location
- Easy to assemble and to change detector positions
- Built-in laser aiming device
- Components from 25 mm and 50 mm shields may be combined to build a sample counting chamber

DA-PRO with GR1 Spectrometer and Shield



DA Prospector Nuclide Trend Plot

DA-PRO™ Data Analyst Continuous Monitoring Solution

Features are:

- Portable CPU platform including embedded Genie and ISOCS™ software algorithms
- Can perform multiple analyses simultaneously with different count times, nuclide libraries, and analysis parameters
- Completely unattended operation once installed and turned on
- Compatible with:
  - Lynx® DSA and HPGe or scintillation detectors
  - Osprey® Tube Base MCA and scintillation detectors
  - GR1™ family of Compact CZT Spectrometers
- Supports EcoGamma™ monitor for local dose rate
- Can also be used for trending of non-spectroscopic sensors (temp., pressure, flowrate, etc.)
- Wired Ethernet, USB and wireless communications
- Internal memory for storage of months of spectral results
- Web-based GUI for control and data review
- DA-Prospector™ Application used to display nuclide results trends from live or historical data
- Compatible with the Horizon® Supervisory System for monitoring one or more DA-PRO systems
- Provided with:
  - Custom ISOCS modeling and efficiency calibration based on detector and sample geometry to be used
  - Customized analysis workflow configurations to best suit the measurement
- Can be used for continuous radiation monitoring of effluent stacks, liquid or gas in pipes, tanks, waste processing systems, environmental or emergency conditions, etc.

SPIR-Ace™ RID with the GenieXPort™ Application

Features are:

- SPIR-Ace Radionuclide Identification Device (RID) with GenieXPort application for Genie™ compatibility
- Ultra-fast and accurate compact identifier
- Simple operation with versatile alarm modes
- Automatic sourceless gain stabilization
- Radiological performance exceeds current standards for RIIDs and RIDs
- Live data transmission and reachback capability
- Optional alpha/beta probe and integrated neutron detection
- Battery life: 4.5 to 11 hours, depending on display use
- Onboard GPS for trajectory and mapping
- Remote display and control via web browser
- *Each SPIR-SPEC™ package includes:*
  - *SPIR-Ace Radionuclide Identification Device*
  - *GenieXPort application providing compatibility with Genie software for proven activity determination and reporting*
  - *Generic ISOCS™ characterization of the SPIR-Ace detector*
  - *Preloaded efficiency calibrations for easy nuclide quantification*
- *Use ISOCS software to create efficiency calibrations for unique geometries that can be loaded to the SPIR-Ace device as well*

TRACS™ Transportable Radiation Analysis Counting System

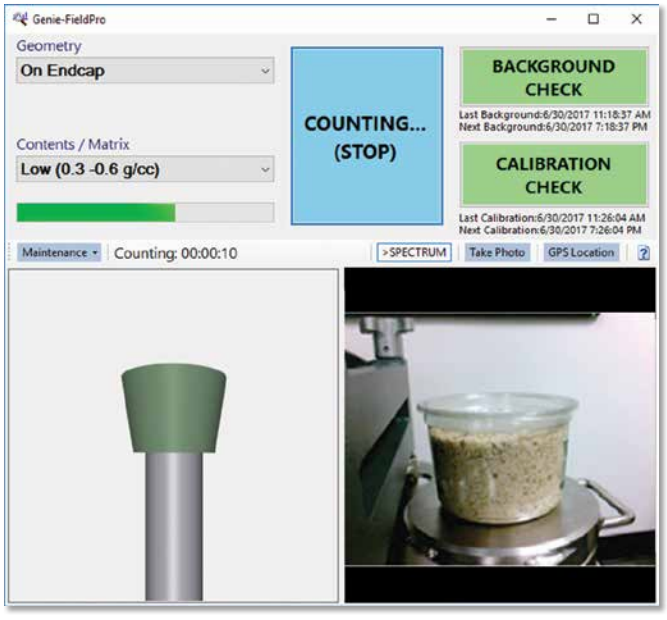
Features are:

- Complete and mobile gamma counting system
- Assembly in less than 10 minutes without tools
- Each item weighs less than 9.1 kg (20 lb); can be transported in a car
- Minimum 1.3 cm (0.5 in) stainless steel shielding
- Includes Osprey® Digital Tube Base and can be used with a variety of standard or temperature-stabilized 2x2 and 1.5x1.5 scintillation detectors
- Includes Camera and GPS and for recording sample images and measurement location
- Operated with Genie-FieldPro software for ease of sample counting and automated analysis by field users
- Automated sample data export to Apex-Gamma System for remote expert review

Genie-FieldPro™ Gamma Spectroscopy Sample Counting Software

Features are:

- Simplified user interface for gamma sample counting by non-experts
- Uses powerful and familiar Genie analysis algorithms
- Sample count time and analysis automated by user selection of sample size and matrix
- Automated “Clear” or “Above action limit” results report generation
- Single click operation for background check and calibration check
- Automated sample data export to Apex-Gamma™ System for remote expert review
- Color-coded calibration check and background check status
- Calibration check and background check failure/overdue lockout
- Count-to-MDA acquisition option
- Can be used with any scintillation detector that is compatible with the Osprey Digital Tube Base
- Optional Camera and GPS integration
- Standard part of TRACS Transportable Radiation Analysis Counting system



SGS™ Standard Segmented Gamma Scanner

Box Counter

Section 5

Waste Management and Special Systems

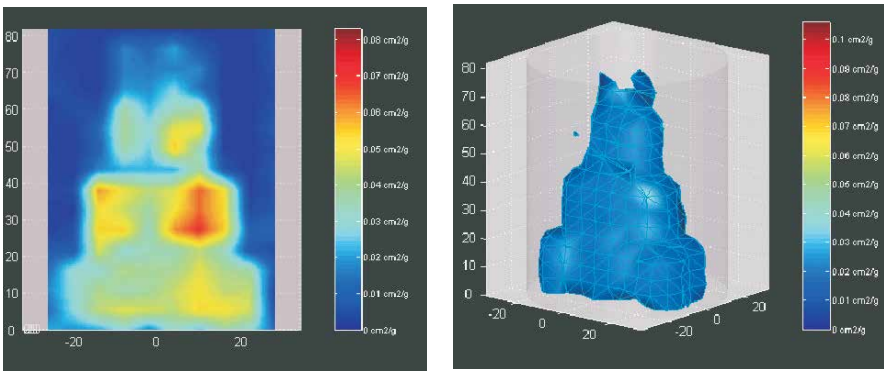
Integrated Crate Interrogation System

Waste disposal is a major concern, whether a facility is operational and routinely generating radioactive wastes or closed and undergoing decontamination and decommissioning (D&D). The ability to accurately measure and characterize the nature of radioactive waste is critical to minimize associated costs and environmental impact.

By working closely with nuclear facilities and regulatory agencies worldwide, Mirion has developed an advanced family of assay systems that can effectively measure materials in the widest variety of matrices and container geometries. In fact, Mirion has designed, built and operated waste assay systems for many years. This wealth of experience goes into all systems offered now and in the future.

For systematic waste characterization and disposal, a system including one or more Germanium detectors is recommended. Systems of this type include WM2100, WM2200 and WM2900 Series gamma scanners for drum or small boxed wastes. The WM2500 Series Gamma Box and Container Assay System is appropriate for measuring large volumes of low to moderately contaminated material, such as debris from D&D operations, in a short amount of time. Additionally, the Hybrid K-Edge/XRF Analyzer is used by the safeguards community for routine special nuclear material inspections. All these systems offer excellent sensitivity along with simple, operation and built-in record keeping.

All items are integrated, tested and calibrated as a system before shipment. Mirion can offer standard or customized solutions for performing gamma, neutron or gamma and neutron waste or safeguards measurements to suit any application. The systems described in this section are just a few examples.



NDA 2000 Non-Destructive Assay Software and WM2900 Drum Scan

WM2100 Series Q2 Qualitative and Quantitative Gamma Waste Assay System

Features are:

- Provides qualitative and quantitative gamma assays for waste in 208 L (55 gal) drums or similar sized boxes
- Sensitivity better than 370 Bq (10 nCi) for 208 liter (55 gal) drums
- Factory calibrated for turnkey operation, and includes QA check source and holder
- Low background 10 cm (4 in.) steel shield
- Automatic weighing system for matrix attenuation corrections due to sample density
- PC-based control and analysis system featuring the user-friendly Canberra NDA 2000 Waste Assay Software package

Auto Q2 Low Level Waste Assay System

Features are:

- Complete quantitative gamma analysis for fission/activation products or TRU radionuclides
- Multiple large coaxial or broad energy detectors for optimal performance
- PC-based control and analysis system featuring the user-friendly Canberra NDA 2000 Waste Assay Software package
- ^{239}Pu detection levels <1 mg
- Container sizes up to 208 L (55 gal); optional up to 400 L
- PLC-based electromechanical control system with optional capabilities including:
  - Automatic weighing system
  - Automatic attenuators
  - Automated conveyor system

CP-5 Plus Cryostats can be used for LN_2-free detector cooling

WM2200 Series Segmented Gamma Scanner

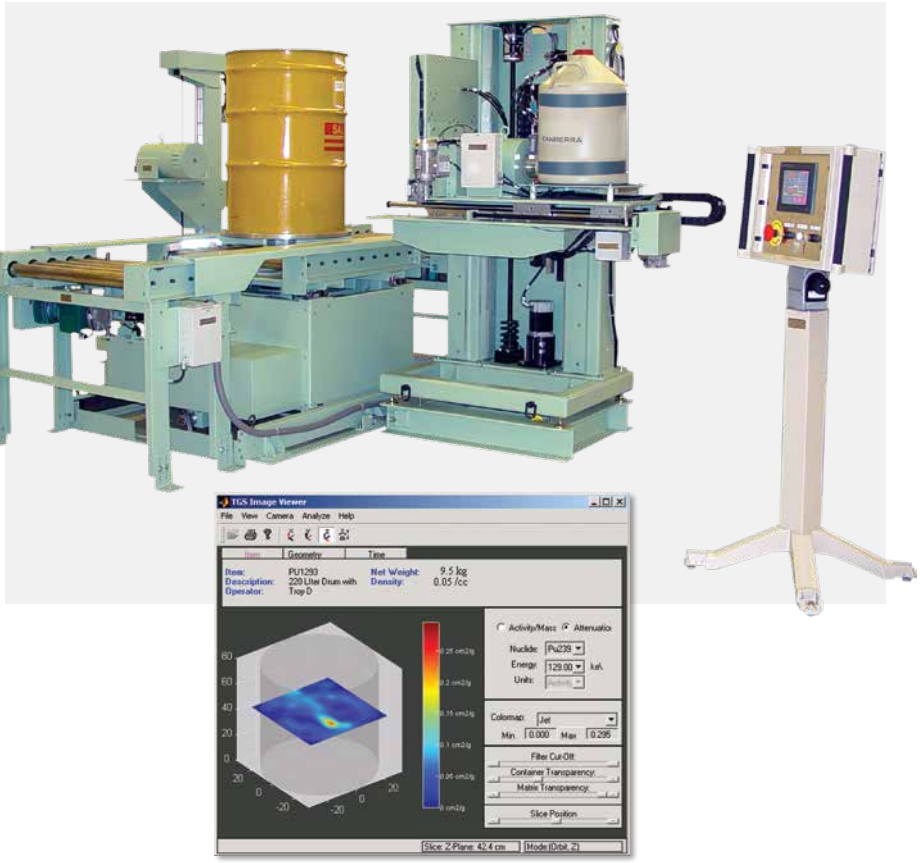
Features are:

- Accurate quantification of gamma emitting waste
- Multiple correction techniques for matrix attenuation
- Self-absorption correction algorithms for lump correction
- Calculates Pu and U isotopics using optional MGA code
- High activity versions available for surface dose rates up to 1.0 Sv/h (100 R/h)
- PC-based control and analysis system featuring the user-friendly Canberra NDA 2000 Waste Assay Software package

WM2900 Series Tomographic Gamma Scanner

Features are:

- Most accurate gamma measurement available for waste drums
- Optimal measurement range is for gram quantities of plutonium or uranium
- Available in manual, semi-automated, and fully automated modes
- Options available for high activity measurements up to 1.0 Sv/h (100 R/h)
- Interactive graphics package provides color plots of hot spots in container
- PC-based control and analysis system featuring the user-friendly Canberra NDA 2000 Waste Assay Software package



WM2500 Series Modular Gamma Box and Container Assay Systems

Features are:

- Performs full gamma spectroscopy and accurately characterizes containers of waste
- Saves time and labor by assaying waste in a large container or its shipping container
- Modular design can be configured for samples from B-25 (1 x 1 x 3 m3) boxes through ISO shipping containers
- Fully assays a B-25 box in 30 min. and an ISO container in 2-3 hours
- 0.01 Bq/g (0.3 pCi/g) typical detection limit for a B-25 box
- Available with manual, powered, or automatic conveyor systems for sample handling
- PC-based control and analysis system featuring the user-friendly Canberra NDA 2000 Waste Assay Software package

HKED Hybrid K-Edge/XRF Analyzer

Features are:

- Used for routine inspections by the international safeguards community
- Non-destructive, on-site analysis of heavy elements in a wide variety of materials, including highly radioactive samples
- Analysis for several elements simultaneously
- No sample preparation required
- Only 2 mL of the sample material is required
- Precision typically better than 0.5%
- Typical assay time of 5 to 20 minutes
- Hybrid K-Edge software offers fully integrated operation, measurement, calibration and analysis capability for HKED systems
- Capable of analyzing U:Pu 1:1 MOX (high concentration – generalized KED analysis)

NDA 2000 Non-Destructive Assay Software

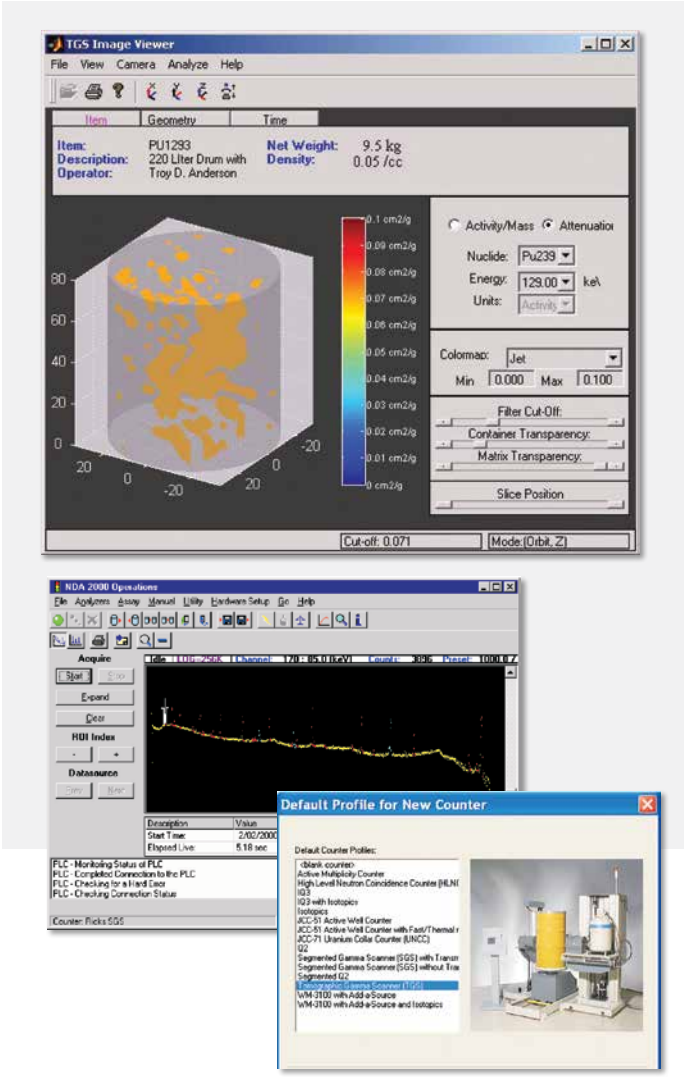
NDA 2000 software is designed to be a complete acquisition, analysis and archival package for use with all Canberra gamma waste assay systems and neutron counters. The software offers fully integrated gamma and neutron analysis for either combined or sequential assay operations and is based on the Genie Spectroscopy Software Suite providing ease and flexibility of operation. Various counter arrangements, detector arrangements, analysis sequences, hardware control, and reports can be generated from the standard software. This provides the advantage that as the customer's assay requirements change, the software can be easily adapted to handle the new requirements.

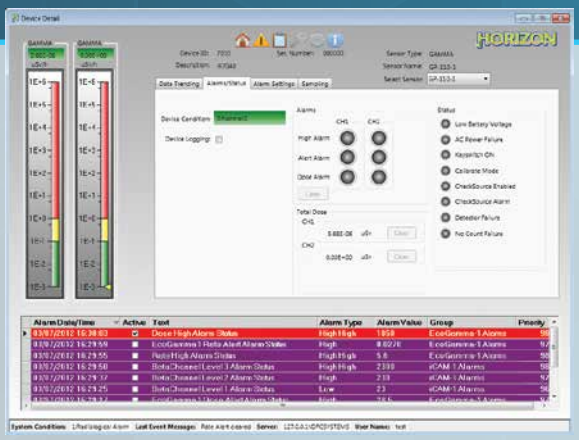
Integrated gamma-neutron assay sequences can acquire data simultaneously, sequentially or independently. Following completion of both measurements, the neutron and gamma assay results can be combined automatically even if the measurements were performed days apart.

The Genie Quality Assurance software, required with NDA 2000, provides daily measurement checks on the system performance. The software can be configured to enforce the use of the quality control checks and ensure that system operating parameters are within the desired bounds.

Features are:

- Supports all Canberra safeguards and waste assay systems
- Based on Genie software
- Supports neutron and gamma assay systems — both separate and integrated systems
- Provides full control of data acquisition electronics
- Controls automated assay system operation
- Menu structure for ease of operation
- Includes automated evaluation of different measurement modalities
- Customer editable report formats
- Multi-level password control





Horizon® Supervisory Software System

EcoGamma portable monitor

Environmental iCAM monitors

MIRION TECHNOLOGIES

Section 6

Environmental Monitoring Solutions

Comprehensive environmental monitoring is essential to the safe operation of nuclear facilities for workers and the surrounding public. In many areas where workers are present, there is a potential for radiation exposure with the associated risk of both internal and external contamination.

The internal radiation hazard results from ingestion of airborne radioactive particulates or gases. For alpha and beta emitting particulates (from fuel and its fission products), environmental air is passed through a particulate filter, and radiation from the particulate is analyzed to assess the hazard level. The monitor must be able to reject potentially high levels of background due to the decay products of naturally occurring radon and thoron. The iCAM™ Alpha/Beta Particulate in Air Monitor performs this analysis 24/7 as air is continuously drawn through the instrument by house vacuum or a local pump.

The external radiation hazard (primarily gamma radiation) can be monitored by gamma dose rate monitors such as the EcoGamma™ or G64 Gamma Area Monitors.

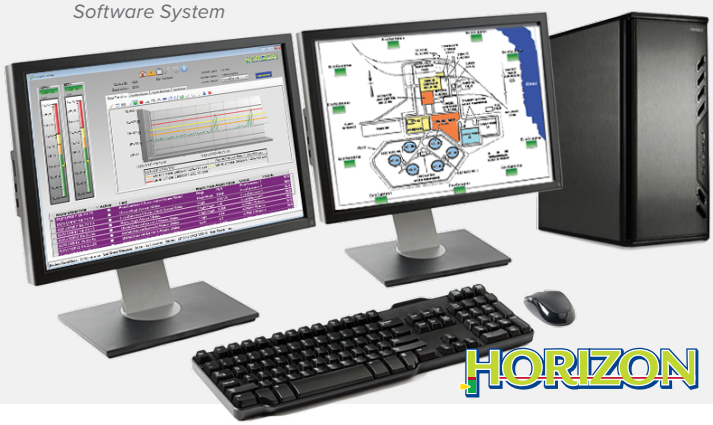
In order to collate and present the data from a wide range of monitors, a product such as the Horizon® Supervisory Software System is required. This system gives operators and health physicists a real-time overview of the radiation environment in the plant, assisting with normal operations and managing emergencies.

iCAM™ Alpha/ Beta in Air Monitor on Cart

Other database software is needed to track radiological effluents from nuclear power plants. OpenEMS combines the results of radioisotopic analysis with release point monitors and performs all required RETS/ODCM calculations to generate the required permits and reports for liquid and gaseous releases as mandated by the US NRC. A flexible limit checking routine is included to ensure technical specification compliance at all times.

EcoGamma™ Environmental Gamma Monitor with Solar Power and Wireless Communication Options

Horizon® Supervisory Software System

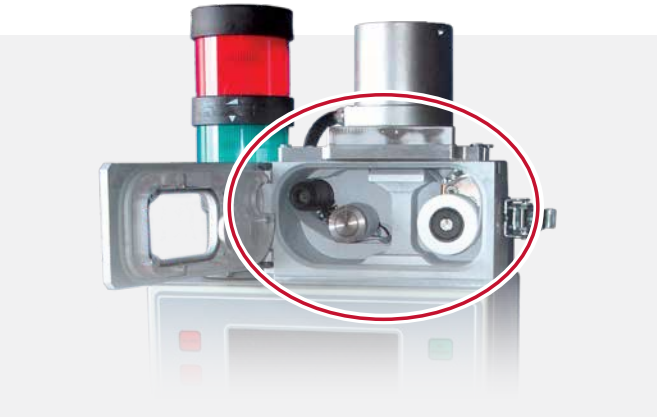


Environmental Monitors

iCAM™ Alpha/Beta Particulate in Air Monitor

Features are:

- For environmental monitoring or stack/duct discharge monitoring
- Simultaneous alpha and beta particulate monitoring in one instrument
- Lowest false alarm rates due to patented radon compensation algorithms
- Rapid response to accidental releases – typ. 5 DAChr alpha alarm in five minutes
- Rugged construction and high reliability
- Comprehensive I/O facilities (RS-232 and RS-485, 4–20 mA, 4 x relays etc.)
- Card mounted changeable filter for ease of handling or auto- changing roll filter for long term unattended operation (up to six months)
- Mobile/portable systems available



iCAM/MF Moving Filter Head for iCAM

Features are:

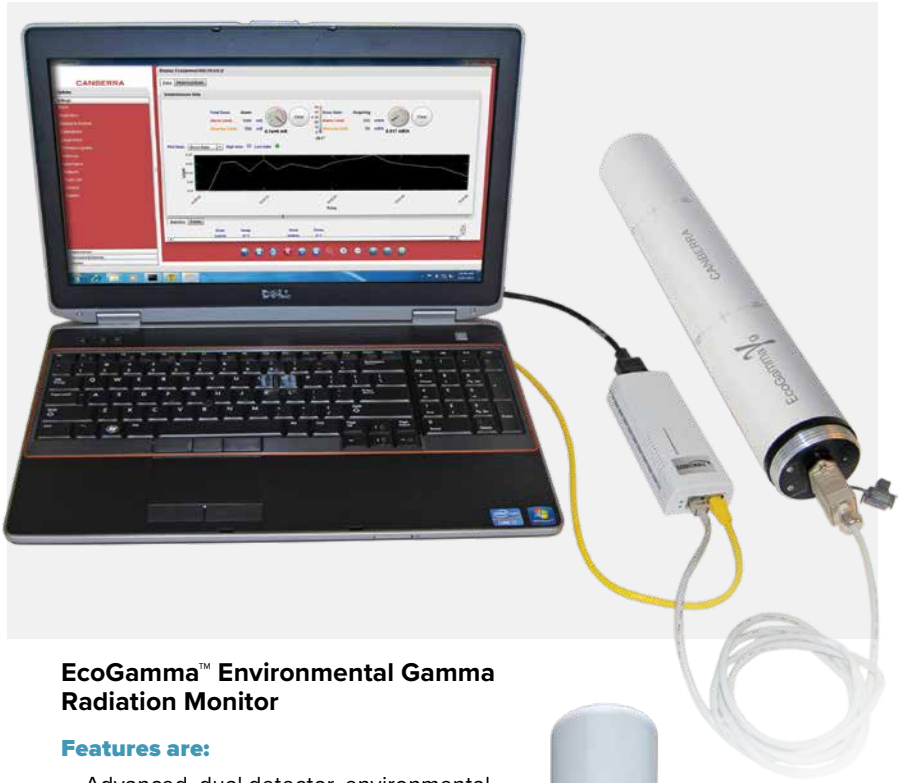
- Automatic filter change mechanism
- Twelve months autonomous Operation
- Retrofittable to existing iCAM monitors
- Automatically detected and configured

iCAM shown below installed in a mobile radiation monitoring system

G64 Area Gamma Monitor

Features are:

- Wide range area gamma monitor 0.1µ Sv/h to 100m Sv/h (10 µR/h –10 R/h)
- Options for remote detector, high range ion chamber detector to 100 Sv/h (10K R/h), scintillation and Geiger detectors
- Interlock operation built in
- Compact, rugged industrial construction
- High reliability
- Comprehensive I/O facilities (RS-232 and RS-485, 4–20 mA, relays, etc.)



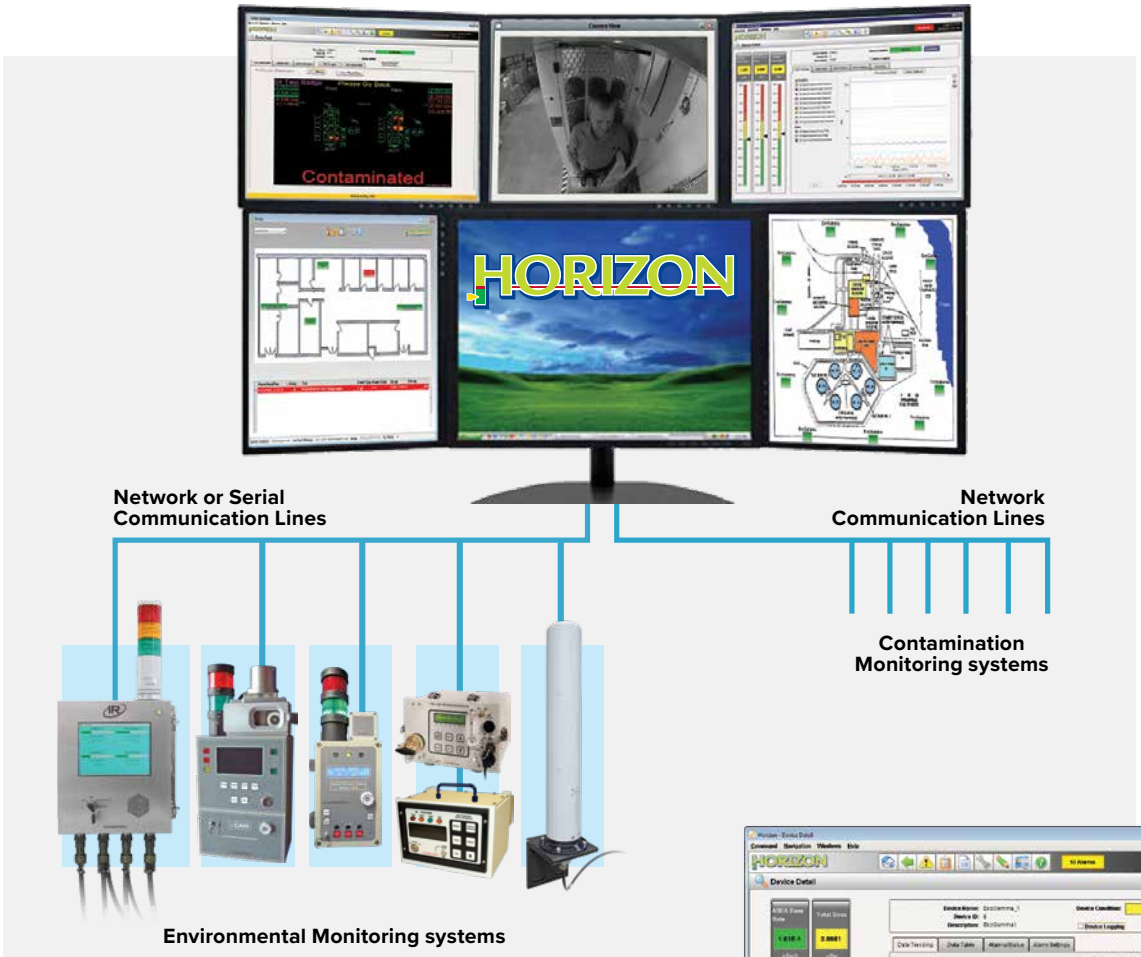
EcoGamma™ Environmental Gamma Radiation Monitor

Features are:

- Advanced, dual detector, environmental gamma radiation monitor designed for unattended monitoring in demanding operating conditions
- Total Range: 10 nSv/h to 10 Sv/h (1.0 µR/h to 1000 R/h) Linearity ±10% referenced to Cesium-137
- Energy Response Range: 30 keV to 5.0 MeV (H*10)
- User-friendly, platform-neutral interface
- Built-in temperature and total integrated dose information associated with serial number and IP address of each monitor

EcoGamma mounting option

Data Management



Horizon® Supervisory Software System

Features are:

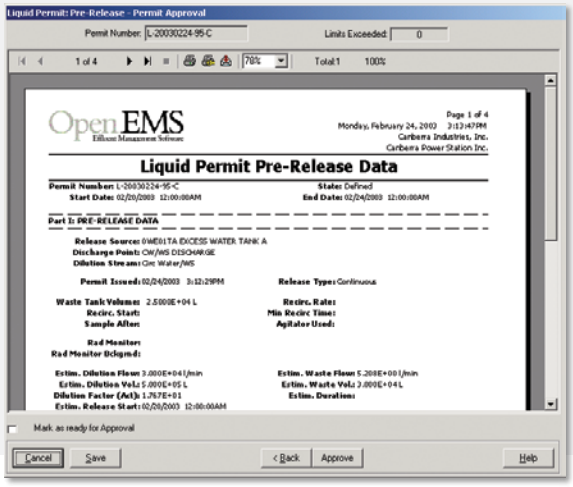
- Network access to Canberra Environmental Monitoring Systems as well Contamination Monitors
- Built-in support for Canberra EcoGamma™, G64 Area Monitor, iCAM™ Air Monitor and other RMS/EMS products
- Preconfigured instrument array provides easy and fast setup and configuration
- Detail screens for each Instrument
- Advanced Alarm & Event Management
- User configurable screens to depict monitored areas
- Records events from all connected equipment in a central location at the site
- Web-based client application provides access to data and control functions from multiple workstations
- Rich SCADA tools provide advanced graphic controls for visualizing your data
- Simple navigation between monitored areas and individual instruments

OpenEMS™ Effluent Management System

The OpenEMS Effluent Management System provides a solution that integrates with nuclear power plant equipment and offers a user-friendly, automated method for tracking radiological effluents. While there are many techniques throughout the world for estimating the impact of radiological effluents, they all require extensive calculations and drawing on large amounts of data to produce accurate, reliable results. With OpenEMS, this process is simplified and reduced to a few simple steps that can be carried out with minimal operator training. A flexible limit checking routine is included to ensure regulatory compliance at all times.

Features are:

- An automated effluent records management application for ensuring regulatory compliance
- Easy generation of gaseous and liquid release permits with the permit-processing wizard
- Automatic checks of technical specifications online for worry free regulatory compliance
- Seamless interface to your Canberra Apex-Gamma™ countroom management systems without complex procedures
- Implementation of site-specific requirements without complex software modification
- Generation of site specific dose projections based on effluent data without expensive software customization
- Management of composite samples
- Distributed multi-user functionality providing access and control of the system from any client workstation
- Comprehensive security to control access to the system

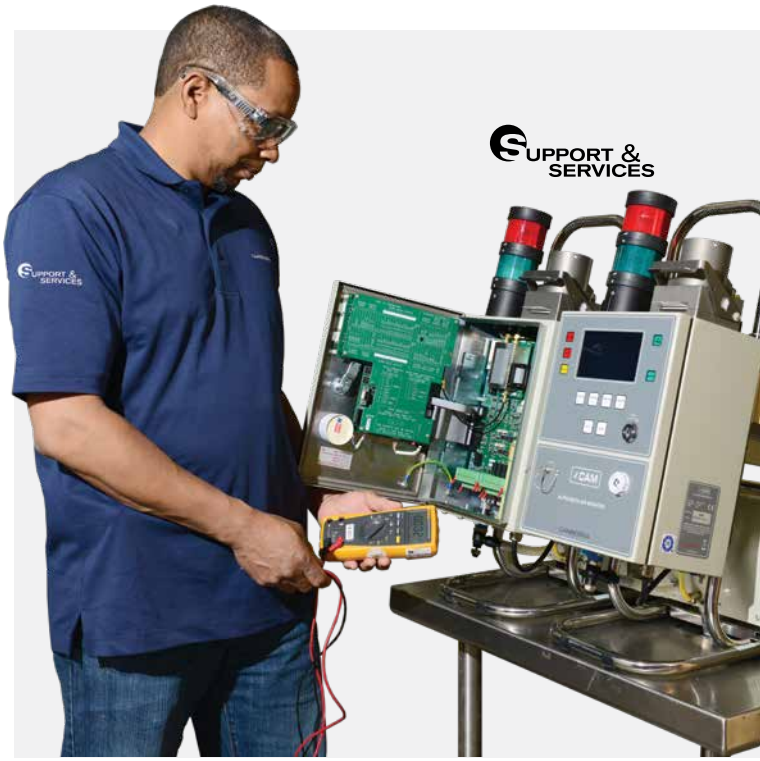


OpenEMS
Effluent Management System

SUPPORT &
SERVICES
SUPPORT &
SERVICES

Customer Support Services

MIRION**SERVICES**



While radiological measurements are an essential element to continued safe operation of a nuclear facility, developing and maintaining a dedicated staff to manage a comprehensive radiological measurements program can be a time consuming and costly endeavor. Likewise, for facilities that have reached the end of their operating life, the need for radiological expertise and resources is high, but only short term.

Mirion offers a wide variety of solutions to address your nuclear measurement application, project and staffing needs. The solutions include services of all levels, including basic system installation, setup and training, calibration services, consulting services, and partnered service agreements tailored to fit site specific needs.

The company maintains an international support organization of scientists, engineers, operators, health physicists, and technicians whose members have decades of real world experience solving complex customer problems. With these resources, Mirion is able to provide a range of services to help you address the nuclear measurement challenges faced at your site.

Mirion Nuclear Services Areas include:

Installation Services

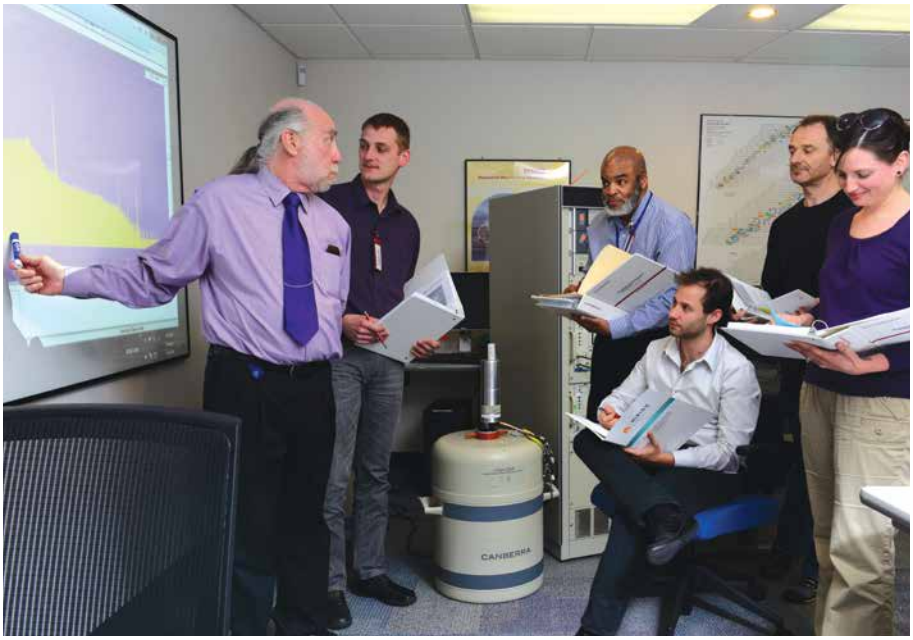
Installation and familiarization of new products or product upgrades are provided to insure that the customer gets the most value from their Mirion products in the shortest possible time frame. Installation services can range from simple connection and startup assistance to comprehensive setup, calibration, and applications implementation.

Real-Time State-of-Health Monitoring

NEW

Designed to insure that your critical instrumentation is always ready when you need it, our new real-time Lab-Pulse™ service represents the start of a new era in instrumentation quality control. This service tracks and trends key parameters in your detectors, counting system electronics and count room environment to alert you and Mirion Service personnel that a problem may be on the horizon – even before it appears in your QC checks. Whether you are on-site at your laboratory or continents away observing remote monitoring equipment, get the data you need from our exclusive state-of-health sensors to assure you of proper instrument operation. And if your instrumentation should start to show signs of a future failure, a Lab-Pulse message will give you the earliest possible warning so your maintenance plans can be proactive instead of reactive.

Lab Pulse



MIRION TECHNOLOGIES
UNIVERSITY
School of Nuclear Measurement

Training Trax
Fundamentals
Technician
Specialist
Subject Matter Expert

Professional Training Services

Mirion offers a comprehensive portfolio of standard and custom training courses available at one of our 10 training facilities in North America, the UK, and Europe or on-site at customer facilities worldwide. These courses cover fundamentals, applications, and in-depth product training and are presented by technical experts with professional training qualifications.

Our training courses are designed to provide deliberate, progressive, incremental learning opportunities to new personnel and experienced users. Courses are flexible in terms of course content and length and are offered in both classroom and laboratory environments to ensure adequate hands on experience.

We have also begun to distribute professional quality training content on-line and are expanding our on-line training continuously.

Routine System Management and Maintenance

Part of any successful program is regular, scheduled maintenance of equipment. This maintenance allows you to maximize your up time by keeping equipment performing to original specifications and spotting potential problems before they have a chance to adversely affect operations.

We recognize the importance of your operations and the substantial cost implications of equipment being out of service. We, therefore, offer a range of support services with response times commensurate with your needs. This can range from critical (same day) support to “best effort” support for less critical activities. We use locally-based staff to ensure the most rapid response wherever possible.

Calibration Services

Complete calibration services are available using a variety of phantoms and sources (including fissile material) for Whole Body Counting, Gamma Spectroscopy, Waste Assay, Low Background Alpha/Beta Counting, Contamination Monitors etc. Our specialists can manage all aspects of the work, from preparation of risk assessments / method statements, to preparation of the final report and assistance with customer’s documentation.

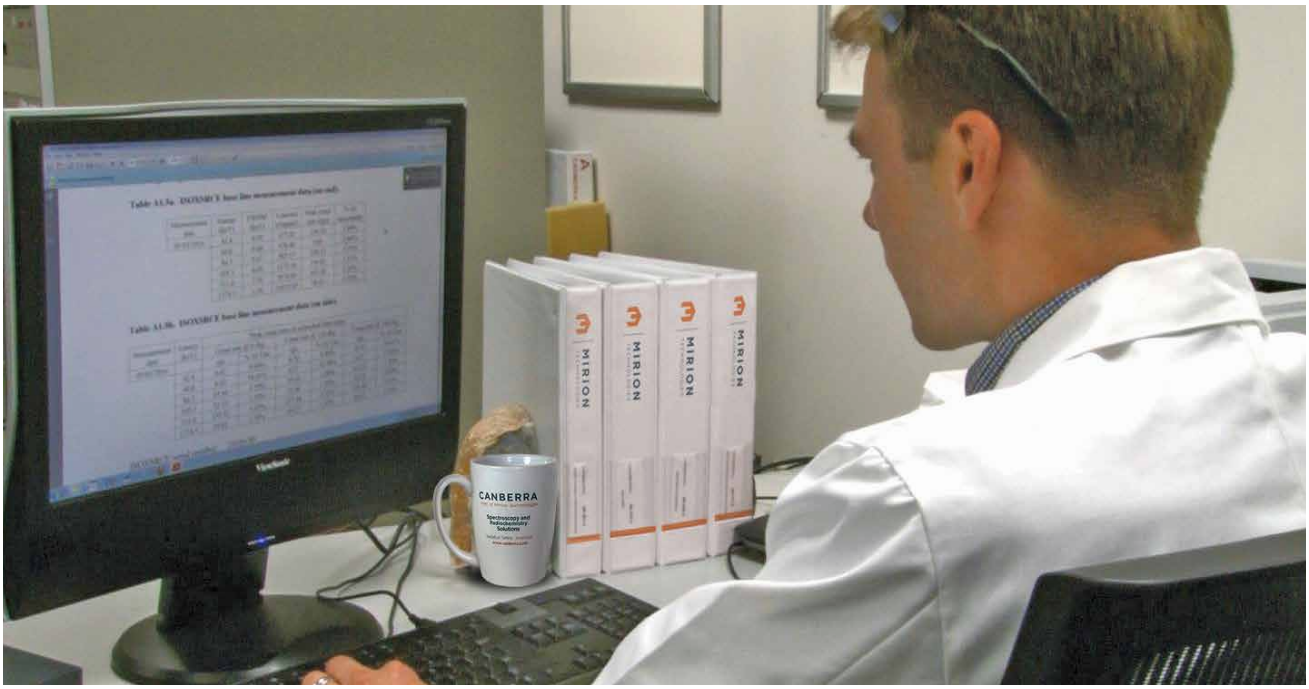
We can also provide comprehensive LabSOCS and ISOCS characterization and calibration services, providing the customer with NIST-traceable calibration verifications while relieving the customer of the burden of source acquisition, storage, and disposal.

Procedure Writing

Mirion has considerable experience in development of radiochemistry and health physics procedures and programs for commercial nuclear power plants, sites undergoing decommissioning, hospitals, radiographic firms, radiochemical analysis laboratories and private industries that work with various radioactive materials.

Mirion’s staff of scientists, health physicists, and engineering professionals is available for the development or review of plant procedures and programs.

7 Customer Support Services



Programming

Often, the unique needs of a given application dictate a custom solution and Mirion's extensive applications engineering resources to construct a solution to the specific application problem.

Much of the solution can be derived from the tools we use in building standard products, such as:

- Full suite of Mirion MCAs, and Spectroscopy Software
- Wide range of Ge, Si(Li), and Scintillation detectors
- Basic modules from standard systems (PLC controls, shielding, etc.)
- Mathematical modeling of detection systems to predict the performance
- Extensive radiological measurement application experience
- Implementation of Mirion's wide range of specialized customization tools

Data Review

Mirion can provide professional review of measurement results (for example, waste drums or whole body counting results) generated at customer sites. This review performs several important functions, including:

- Complete administrative review
- Comprehensive technical review
- Comprehensive Quality Assurance review
- Data summarization
- Simplified presentation of program data
- Assessment of measurement results for items which cannot be dealt with by the normal system calibrations
- Recommendation for future action by the customer
- Recommendation for system enhancements / remedial action

A standard Data Review package typically will consist of:

- Written narrative
- Summary of data
- Individual analysis results

Although the general format is consistent, the exact package contents can be customized for each site/project.

Site Specific Customizations

Mirion software and hardware solutions are designed, developed and implemented with maximum flexibility as a keystone feature. These flexible platforms give the end user the most cost beneficial solution available.

Mirion's team of technical support engineers has decades of combined experience utilizing our flexible off the shelf solutions to create highly customized site-specific applications.

Routine Operations

Mirion offers trained personnel to assist customers with staff augmentation from short-term projects to full time operators of specific systems. We have personnel with expertise in all areas of routine plant operations including:

- NDA Systems operation
- WBC operations
- ISOCS/site characterization
- Chemistry lab management
- Health Physics operation

Performance Testing Programs

A fundamental component in any laboratory Quality Assurance program is stringent performance testing. Mirion's technical services group has years of experience developing and maintaining world class methods and procedures, and in the performance assessment of radiometric systems according to national standards and best practice guidelines.

Our customers can leverage this experience in their performance testing programs for laboratory equipment and plant-installed radiometric assay systems.

Our services include:

- Complete Quality Assurance program development
- Development of performance standards for all phases of laboratory testing
- Development of inter-laboratory comparison check procedures
- Review of sample collection procedures
- Development and administration of qualification programs for laboratory personnel
- Independent oversight of laboratory QA testing protocols and results
- Provision of "Best practice" advice in operation of equipment
- Consulting as a 3rd Party reviewer of your radio-analytical methods and results
- Performance assessment for radiometric assay systems using measurement with "phantom" sample containers, supplemented by modeling

System Audits

Periodic and planned audits, assessments and surveillances of systems and processes can be provided to assure compliance with regulatory and site requirements. These oversight activities are planned, performed, documented and reported to appropriate management personnel using approved written procedures.

The process consists of monitoring or observing to verify whether an item, activity or process conforms to specified requirements. These oversight activities can be performed on an almost unlimited number of topics; however Mirion specializes in counting practices, spectral interpretation methodologies, quality assurance, quality control practices and system management.

Mirion Services ... How may we help you?

Whether you need assistance with commissioning or maintaining a new counting system, theoretical or practical training in the nuclear field or planning and implementing a future radiation measurement application, Mirion Sales and Service organizations are available with more local field service engineers and technical resources than any other nuclear measurements supplier in the industry.

MIRIONSERVICES

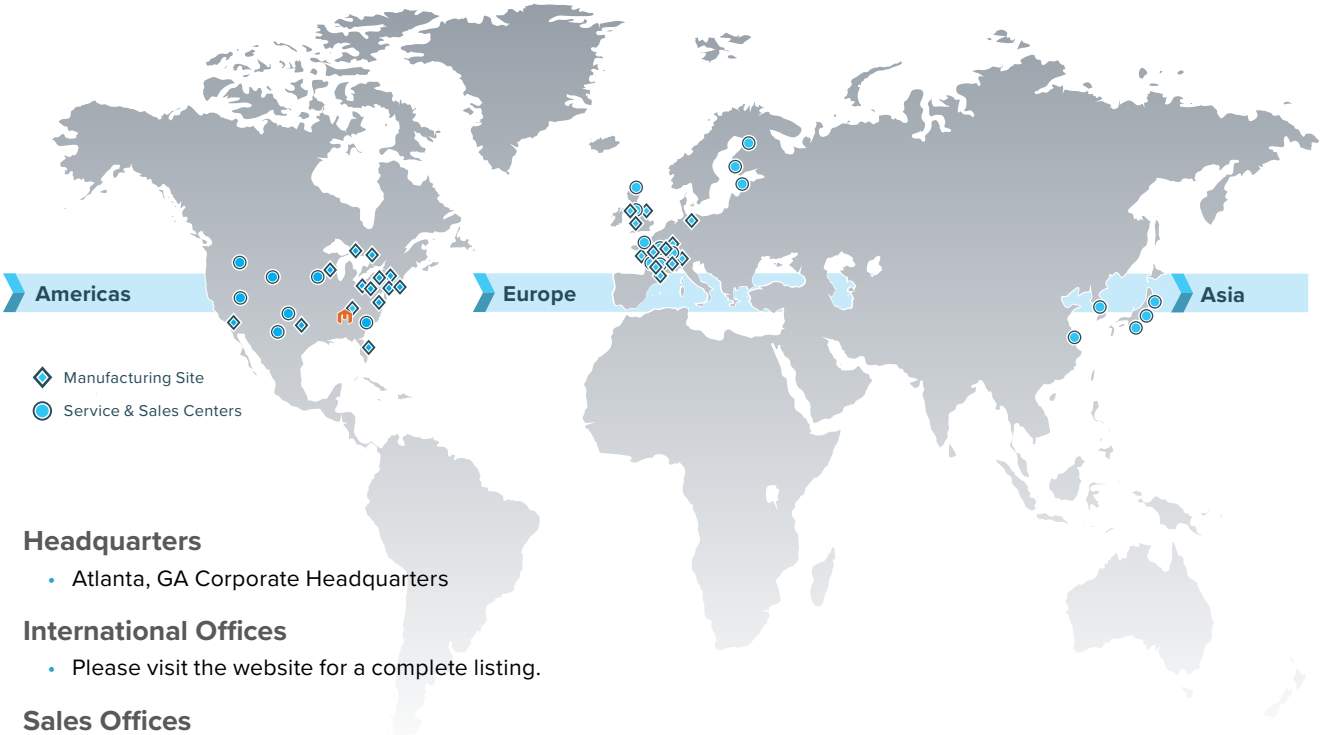
We can be there to do what you need, when you need it.

Contact us today.

Mirion at Your Service ...

Our global service team will ensure that you have the support that you require when you need it with:

- Consulting Services to help you select the best technical solution and, if necessary, customize it to your needs
- 270+ distributed Field Service Engineers for close proximity to customer sites to provide quick response
- Four fully operational and certified Calibration facilities to simplify calibration and recalibration of equipment
- Service Partnership Agreements for telephone and on-site support of equipment to keep it at peak performance
- In-person or virtual training in fundamentals and/or in-depth product usage to enhance plant personnel application knowledge and efficiency



Headquarters

- Atlanta, GA Corporate Headquarters

International Offices

- Please visit the website for a complete listing.

Sales Offices

- Mirion sales and service capability exists in virtually every country in the world.

Mirion Technologies represents over 2800 people in 13 countries.

MIRION TECHNOLOGIES

www.mirion.com

Copyright © 2022 Mirion Technologies, Inc. or its affiliates. All rights reserved. Mirion, the Mirion logo, and other trade names of Mirion products listed herein are registered trademarks or trademarks of Mirion Technologies, Inc. or its affiliates in the United States and other countries. Third party trademarks mentioned, including Bluetooth, are the property of their respective owners.

OPS-2385 - 07/2022