



**MIRION**  
TECHNOLOGIES



# Rugged Germanium Detector Systems and Solutions





# Germanium Detectors

Germanium Detectors represent the best choice when high resolution gamma spectroscopy is required for accurate nuclide identification and quantification.

## **POTENTIAL PROBLEMS CAN COMPROMISE THE USE OF THESE TECHNOLOGIES WHEN THE SPECTROSCOPY SYSTEM IS USED IN HARSH ENVIRONMENTS SUCH AS:**

- Shock and vibration (transportation by trucks, separation of space launcher stages)
- Industrial use in sites where liquid nitrogen is not available/allowed for detector refilling
- Extreme climatic conditions (underwater operation, very high or low temperatures, etc.) in industrial or space environments
- High level of contamination – extreme radioactive doses.

The combination of Mirion's extensive experience with the evolution of new technologies (encapsulation, ultra-high vacuum, waterproof design, shock absorption devices, electrical coolers, specific and pure materials) make us a world leader in scientific and special applications involving HPGe detectors.

# Mirion's expertise delivers outstanding and reliable detection instruments for the most demanding industries and research centers.

**RESEARCHERS HAVE COME TO DEPEND ON THESE SPECIALIZED INSTRUMENTS FOR THEIR MOST CRITICAL EXPERIMENTS AND STUDIES.**

## **FEATURES ARE:**

- Hardened design, shock and vibration resistant.
- Adapted cooling devices (electrical fanless coolers).
- Multiple references in space missions (INTEGRAL/SPI, Mars Odyssey, SELENE lunar orbiter...).
- Encapsulation techniques allowing easy exchange of each individual detector when mounted in arrays or partial heat cycling.
- Dedicated shapes and materials for cryostats (hexagonal cutting, titanium lightweight capsules, telescope mount, etc.).
- Selected components towards impurities to limit any X-ray fluorescence of materials in the HPGe crystal vicinity.
- Large choice of N-type detectors and associated annealing accessories for on-site repair after radiation damage.
- Ultra-High Vacuum for the best reliability and heat thermal cycle free constraints.
- Waterproof design for outdoor use.
- Easy to decontaminate.
- Complete integrated solutions easy and quick to deploy.

## **VERY DIVERSE AND CHALLENGING APPLICATIONS:**

- Space
- In-situ measurements (environmental monitoring...)
- Dismantling & Decommissioning (D&D)
- Industry
- Emergency response

# Examples of Rugged Detector Solutions

A novel, ultra-compact, gamma spectroscopy detector for high count rates and narrow environments.



[Link to the MicroGe detector presentation video](#)



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

The MicroGe detector is a compact electrically cooled, fanless, lightweight High Purity Germanium detector (HPGe). With a short cooling time, this state-of-the-art detector opens the possibility to do spectroscopic measurement in less than 30 minutes while keeping the benefits of a laboratory grade detector. It implies an excellent energy resolution for gamma-ray energies from about 10 keV to several MeV. In addition, the MicroGe ultra-high vacuum technology provides a thermal cycle free detector: the MicroGe detector can then be switched on and off as needed, without going through an entire time-consuming heat-cycle up to room temperature. This is an effective time-saving feature for optimize use of the MicroGe detector.

Separated from the detector to protect it from radiation damage, the supply station provides electrical power to the cryocooler while monitoring the detector's operating temperature.

The MicroGe detector is typically operated with the DSA-LX® (or Lynx®) Multi-Channel Analyzer (MCA). The MicroGe detector system is fully compatible with the Genie™ analysis software. In addition, ISOCS™/LABSOCS™ characterization of the MicroGe detector can be proposed. A MCNP drawing of the detector is also provided upon request.



### MicroGe™ Ultra-compact HPGe detector

A breakthrough ultra-compact complete spectrometer ideal for measurements in high count rates environments and/or in confined spaces.

#### Features are:

- Compact and lightweight
- Fanless electrically cooled HPGe detector
- Ready to use in less than 30 minutes (including cooling)
- Thermal cycle free
- Laboratory grade energy resolution

#### Design:

- Small HPGe crystal, ideal for high gamma-ray flux environments
- Compact, low-power and efficient electrical cooling system
- Wide range of operating temperature: -20 °C up to +55 °C
- Perfectly adapted to challenging measurement environments: industrial constraints, narrow spaces, mobile/remote applications, warm ambiance...
- System design options:
  - Collimator
  - Watertight housing
  - Custom mounting interface depending on the application



Pelicase Protector Case to ease any storage/transportation



### Sealed Probe: Breakthrough for Harsh Environments Applications Requiring HPGe Performance

The ideal tool that provides the best possible energy resolution for measurements in harsh or contaminated environments.

#### Benefits:

- Optimized survey productivity:
  - shorter measurements thanks to the ultimate Minimal Detectable Activities provided by the excellent HPGe energy resolution
  - thermal cycle free
- High mobility and small footprint
- Easy to clean and to decontaminate
- LN<sub>2</sub> free
- Submersible in water
- Best energy resolution available

#### Applications:

- Decontamination operations
- Emergency response and Defense
- Mining and well logging
- Underwater operations (monitoring, oceanography...)
- Decommissioning & Dismantling
- Drinking water monitoring
- In-situ soil analysis





## EXAMPLES OF SEALED PROBE APPLICATIONS:



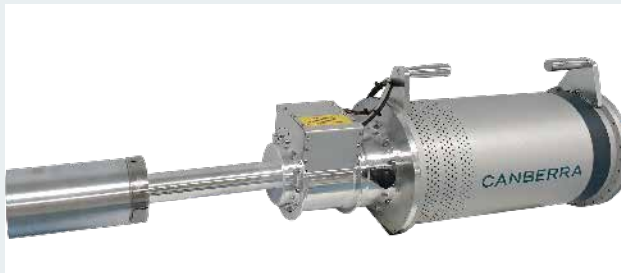
### Spent Fuel Pool Spectroscopy Applications

- Customized industrial solution
- Special shape to fit available footprint
- IP68 water tightness and decontaminable
- Specific interface
- Complete embedded Mirion solution
- ISOCS characterization



### Underwater Applications

Electrical cooled HPGe detectors of various sizes in special pressure housing certified for underwater applications (fuel storage pools or river/lake/sea). Different depths can be addressed even with a complete system including an MCA and a PC with Genie software.



### Whole Body Counter (WBC) for Mobile Lab

- Electrically cooled detectors for a mobile WBC system with new CP5-Linear™ (CL5) Cryo Electric cooler.
- The new CP5-Linear (CL5) cooler requires the same room as a Big MAC cryostat and is therefore adapted to the upgrade of an existing system with room constraints. CL5 cooler will accommodate high ambient temperature through a specific water cooling chiller.



### ANTARES: Deep Underwater Gamma-ray measurement – Project NuMerEnv

- HPGe detector embedded in a Titanium pressure housing with Lynx MCA for gamma spectroscopy at a 2500 m depth in the Mediterranean Sea complementary to the Cosmic Neutrino Experiment (ANTARES).
- Use of Mirion electrical cooler with a proven high reliability due to limited possible access (only twice a year).

## Examples of Rugged Detector Solutions

continued

### Ground radioactivity mapping with HPGe detectors

Compact and fully integrated array detector for airborne survey with excellent spectroscopy performance.

#### Features are:

- High efficiency assembly with large detectors
- Modular detector design for easy maintenance
- Add-back enhanced relative efficiency up to 1300% at 1.33 MeV
- Full embedded system with electrical cooling and digital MCA
- Typical MDA: 1.85 MBq (50  $\mu$ Ci) for  $^{137}\text{Cs}$  (speed: 180 km/h ; altitude: 100 m)
- Excellent energy resolution. See spectrum below: comparison between HPGe detection performance (red) and typical scintillator detection performance (blue)
- All crystals are included in the same cryostat

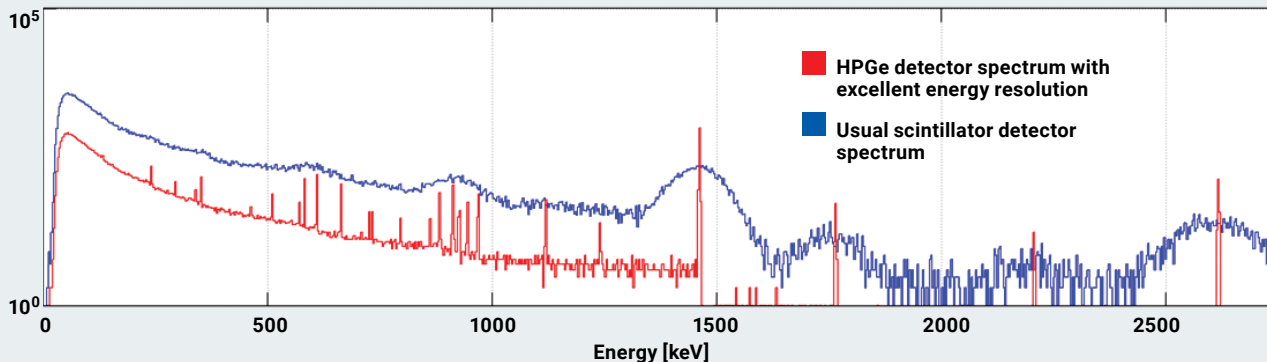


Hardware overview of the Mirion airborne system consisting of two cabinets (one for the detectors array, the other for the acquisition system)



View of detector cap through a hole in aircraft cabin. Each colored circle shows the location of an individual coaxial detector. The 7 detectors are in a single common cryostat.

Simulated spectra of typical natural ground radioactivity with a 37 MBq (1 mCi) Cs-137 source, comparison between a NaI(Tl) detector and a HPGe detector





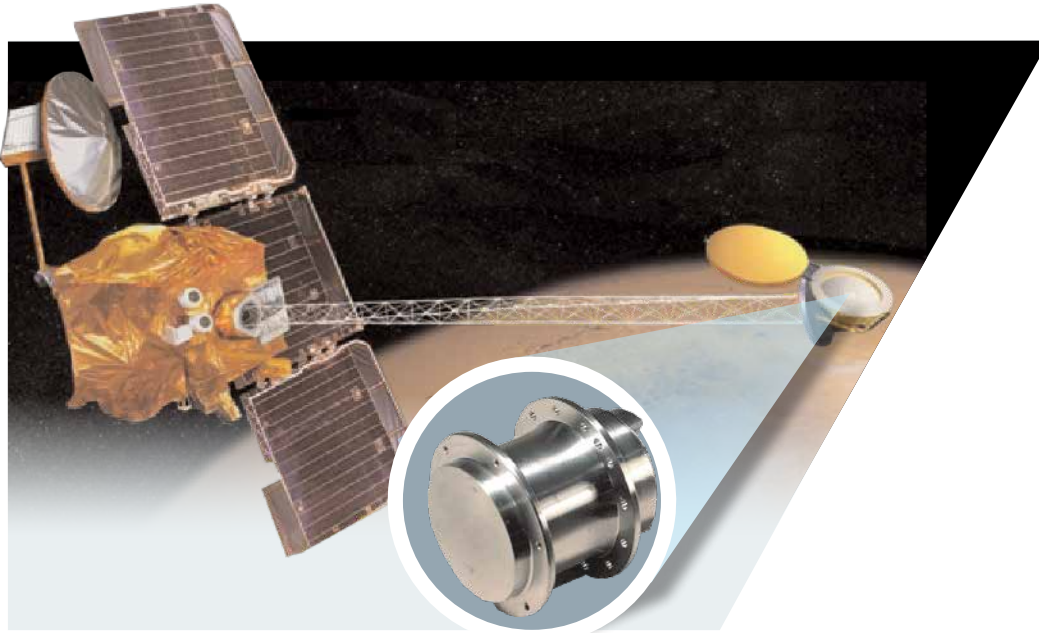
# Space Applications



## ENCAPSULATION TECHNOLOGY: MAKING DETECTORS SUITABLE FOR SPACE

Encapsulation offers sealed ultra-high vacuum conditions, therefore long life and the possibility to anneal the detector from radiation damage without pumping or opening to the deep space environment.

The technology developed also offers lightweight sensors, a very important criteria for devices in space. The use of titanium offers another important asset: aluminum would conflict with gamma rays of interest.



### The Mars Odyssey Mission

(ref.: Intespace - Toulouse, NASA, University of Arizona)

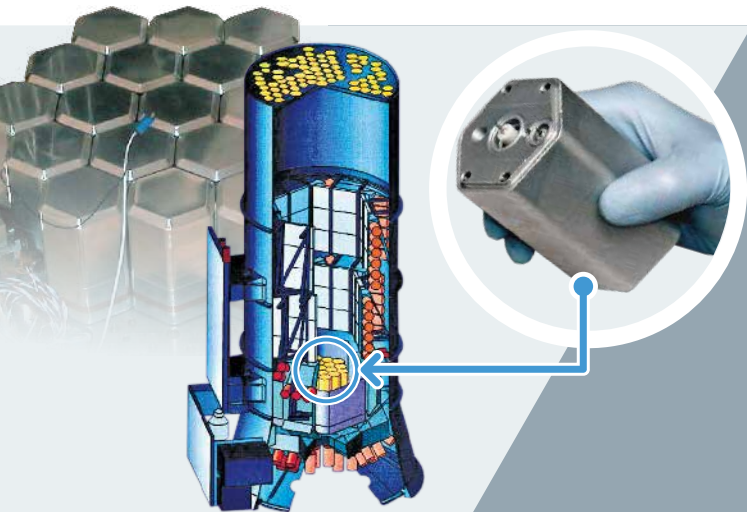
- The goal of this mission consisted of launching a satellite in 2002 to detect the presence of water (ice) on the planet Mars by using  $(n,\gamma)$  reactions. Mission lifetime: successful two year mission with extended operations until 2017.

#### Detector features:

- Coaxial HPGe
- N-type, titanium encapsulated efficiency 50%
- Vibration specifications 50 g



## Space Applications continued



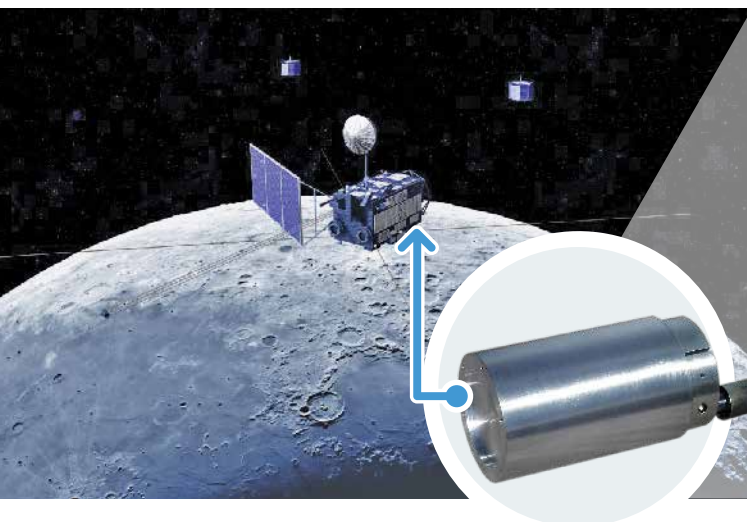
### Integral SPI Project

(ref.: Intespace - Toulouse)

- This mission launched in 2002 consists of the equipment for a satellite in orbit around the Earth to study supernova, black holes, and other emitters of gamma bursts.

#### Detector features:

- Compact array of 19 encapsulated coaxial HPGe detectors 40% efficiency each. Special mount with coded mask allowing an accurate cartography of gamma emitters.
- Vibration level 50 g on the three axis.



### The Selene Mission

(ref.: JAXA - ISAS - NASDA)

- Lunar orbiter mission "KAGUYA"
- Mission duration: one year
- The GRS had an excellent energy resolution 20 times superior to those used in past lunar missions

#### Detector features:

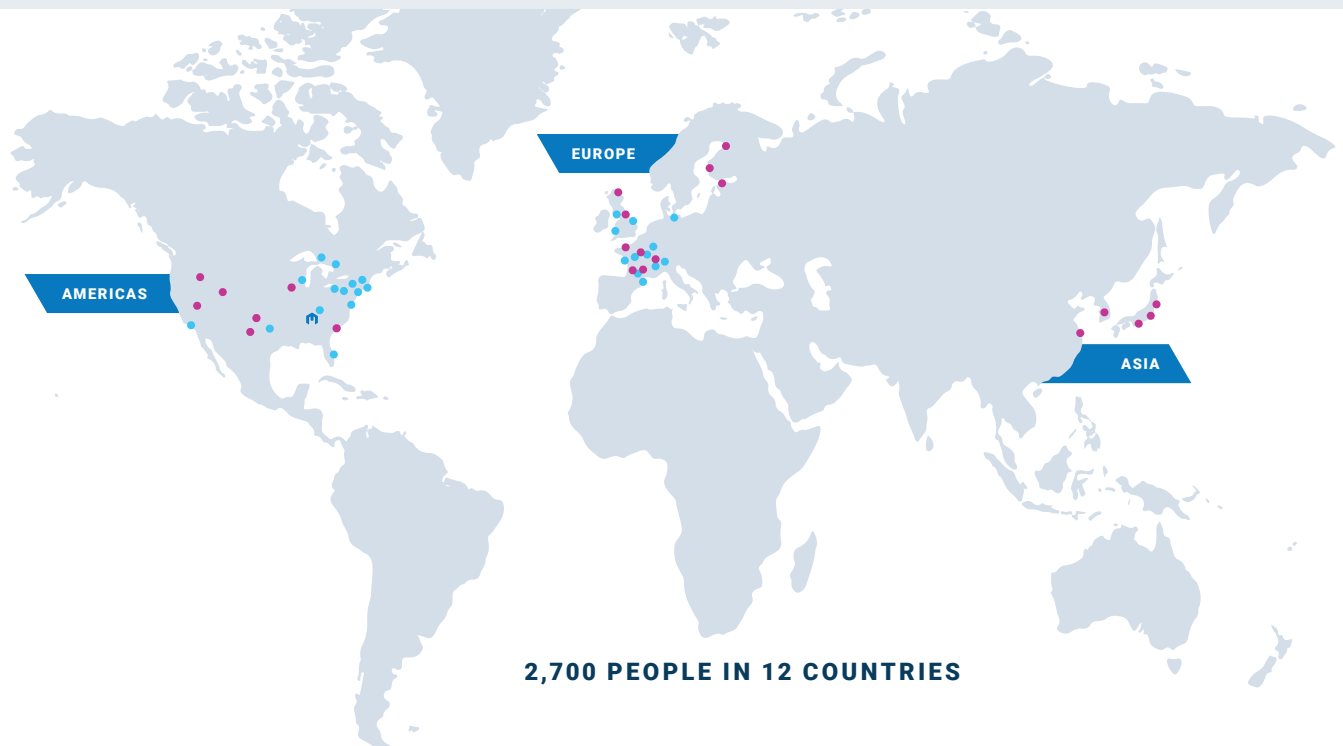
- Encapsulated coaxial HPGe detector for the GRS.
- Detector size: 60% efficiency.

# Empowering Progress Across Continents

Mirion Technologies combines innovative radiation safety technologies with unrivaled expertise, cultivated over decades of collaboration with reactor manufacturers and operators, nuclear fuel facilities, regulators, national labs (such as the U.S. DOE), nuclear institutes, universities, and national military/security organizations worldwide.

Trust us to provide the solutions and support you need to safeguard your valuable assets and ensure a secure and sustainable future.

 CORPORATE HQ (ATLANTA, GA)     MANUFACTURING SITES     SERVICE & SALES CENTERS



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# Protect What's Next™



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