Detectors for Challenging Applications

NUCLEAR MEASUREMENT SOLUTIONS FOR SAFETY, SECURITY & THE ENVIRONMENT

WWW.CANBERRA.COM
**Detectors for Challenging Applications**

**CANBERRA has been serving the nuclear community for over five decades.**

The company is the leading provider of innovative and cost-effective nuclear measurement solutions used to maintain safety, assess the health of nuclear facilities and safeguard the public and the environment. Since 1968, CANBERRA has also been committed to the development, manufacturing and service of unique specialty detectors for international scientific experiments and specialty designs.

Driven by diverse needs in fundamental and applied research applications, a range of technologies has been developed over many years that enables CANBERRA to maintain its technological leadership in semiconductor detector development.

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

Our passion for fully understanding the needs of our customers is key to our ability to provide the best solutions to contribute to their success.
It is our policy that:

All products and services we offer will meet or exceed the specified requirements and anticipated expectations of our customers. This policy is supported at all levels within the organization.

Our approach to quality is modeled after the concept of Total Quality Control. This approach places the responsibility for quality of work on each employee. All employees are empowered to stop work or processes if they believe quality is in question, and they are encouraged to report quality issues immediately to management. The goal of this approach is 100% Customer Satisfaction. By focusing on our chosen marketplace, continuously improving our products and processes, and constantly innovating, we believe we create the greatest value for our customers.

State of the art breakthrough technologies developed by CANBERRA include:

- Array of several detectors in a unique cryostat
- Encapsulation and Ultra High Vacuum (UHV) sealing
- Segmentation of detector electrodes

These versatile technologies are not only the tools with which CANBERRA nuclear detection systems are built, but also the tools that are building the future of the nuclear industry.

CANBERRA detectors are particularly environment friendly. They are designed according to ECO design rules.

CANBERRA detector manufacturing is therefore in conformity with the RoHS or REACH norms as well as OSHAS18001 certification.

Systems are designed to comply with European Directives (EC).

CANBERRA’s quality system meets ISO 9001 standards, and the company holds appropriate certifications in all countries and regions in which we operate. Certificates can be obtained by contacting your local sales or service office.

CANBERRA Services augments your technical team, assists during peak periods, provides expert advice, trains staff and maintains your systems for optimal performance. We look forward to partnering with you.
Detectors for Challenging Applications

Detectors for Nuclear Physics Research

Solutions for highest gamma ray efficiency using HPGe array detectors in specific mechanical shapes to accommodate any constraint

CANBERRA developed array detectors in response to a demand for new solutions to replace typical HPGe detectors in the 1980’s. Customers required a large volume of HPGe to achieve the highest efficiency without compromising performance. Since that time, CANBERRA’s large portfolio of Clover and encapsulated detectors has become a reference in nuclear physics.

Clover Detectors — Worldwide Reference for Highest Performance

Ideal for nuclear physics experiments and any application requiring highest efficiency

Key features include:
- 4 special shaped Ge crystals for a close array – with or without segmentation
- Up to 12kg of HPGe material in one cryostat
- LN₂ free cooling available on request
- User friendly features and associated tooling for on-site neutron annealing
- Good sensitivity to gamma ray polarization

Performance:
- Excellent energy and timing resolution
- 130% relative efficiency in add-back mode with a Clover 4x50x70 (4x 20%)
- Can address applications other than nuclear physics where highest efficiency or MDAs are required
- Low background configurations on request
- Thin entrance window for extended energy range to low energy photons available on request

Applications:
- Nuclear physics
- Health physics or low activity environment measurements in well-type configuration

EuroBall Clover detector and Tigress Clover in back catcher design

True Well Clover detector with a total of 10kg of HPGe material
4 PI HPGe Array Solutions

Demand has been growing over the past decade for gamma-ray spectrometers with the highest resolving power for each interaction point for a gamma in the array. State of the art instruments are needed to study nuclear structures at the very limits of stability. A 4PI shell is therefore required involving more than 100 detectors to precisely track any event even if a scattering has occurred in the neighbor element. Veto scintillator detectors such BGO are no longer needed in this frame.

Key features include:
- Up to 4 HPGe crystals in one cryostat
- Each crystal is segmented in 36
- Up to 148 channels per array detector
- Up to 10kg of HPGe material in one cryostat
- LN₂ free cooling available on request.
- Special irregular hexagonal shape to accommodate a complete 4 PI detection ball consisting only of HPGe material
- High performance electronics to achieve best energy and timing performance

We can address applications other than nuclear physics where highest efficiency or localization (tracking) is required.

CANBERRA Cluster Detectors for Nuclear Physics

A cluster detector consists of encapsulated HPGe detectors. The goal is to bring the highest amount of Ge detectors as close together as achievable within a unique cryostat.

Scientists using EUROBALL cluster detectors over two decades reported an add-back relative efficiency of about 600% with seven 300cc detectors.

Key features include:
- Highest efficiency due to best area coverage
- High reliability: first EUROBALL detectors in operation since beginning of the 90s
- Easy maintenance
- Easy neutron damage repair at customer site
- Compatible with electrical cooling
- Segmentation available for precise gamma tracking or Doppler correction

Contact CANBERRA to learn more about Detectors for Challenging Applications.

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Detectors for Challenging Applications

Custom Designed ULB Detector Systems

CANBERRA is the leading supplier of germanium detectors for the most demanding ultra-low background spectroscopy applications.

We have many years of experience in materials selection and the necessary laboratory facilities to screen materials and to build and test complete detector systems. Dedicated tooling and skills are required to maintain the lowest achievable levels of contamination on the detector element and cryostat assembly.

CANBERRA continuously searches for new materials and components to improve detector performance and achieve even lower levels of background radiation. This effort has led to the development of Specialty Ultra Low-Background Detector Systems. Additionally, CANBERRA dedicates significant efforts to improve the electronic noise threshold through development of special detector geometries and low noise electronics.

Specialty Ultra Low Background Cryostats S-ULB

Cryostat designs from selected grades of materials and tailored to the specific requirements of each application, achieving world class performance for the most demanding underground laboratory environments. An example is an integral of 0.09 counts/min (15-1500 keV) measured at the Laboratoire Souterrain de Modane (LSM).

Key features include:
- Large detectors available (up to 910 cc)
- Custom designs to fit existing shielding constraints
- Selected materials like fresh OFHC copper or high-purity aluminum (< 0.3 ppb U/Th)
- Compact endcap design accommodating scintillator guard detectors in close proximity

Small Anode Germanium (SAGe™) Detectors

For several years CANBERRA has been making these special germanium detectors for customers engaged in fundamental research in neutrino-less double beta decay, dark matter, and related cosmological science. These detectors are compatible with any of CANBERRA’s cryostat models as well as with standard or Specialty Ultra Low-Background (Custom-built) options.

Key features include:
- Variety of shapes and sizes
  - diameters up to 90mm
  - lengths up to 85mm
- Mass up to 2.7kg
- 1.6keV FWHM at 1.33MeV
- Electronic noise as low as 65eV FWHM
- External AC-coupled preamp for veto systems
- Fresh OFHC copper or highly selected
- Available as an array of several detectors in a unique cryostat to further increase the detection volume

CANBERRA is the leading supplier of germanium detectors for the most demanding ultra-low background spectroscopy applications.
CANBERRA detectors are manufactured using a proprietary technology enabling the design of the best segmented HPGe or Si(Li) detectors available worldwide.

CANBERRA uses photolithography techniques, thus allowing for a wide variety of segmentation patterns (straight or curved strips, pixels, etc.), including double sided thin window segmentation for imaging applications. CANBERRA’s segmentation techniques are highly reliable and stable. Repetitive heat cycling will not affect HPGe detector quality and even neutron annealing can be performed. Our mature segmentation technology is even a good candidate for space applications.

**Segmented Planar Detectors**

**Applications:** Compton camera, imaging, homeland security, polarimetry, gamma tracking

**Key features include:**
- HPGe & Si(Li) material available
- Cryostat at choice
- Pixel or strip segmentation patterns available
- LN$_2$ or Cryo-Pulse® 5 Plus cooling
- Stack of several DSSD (Double Sided Strip Detectors) within the same cryostat

**Segmented Coaxial Detectors**

**Applications:** gamma tracking, polarimetry, doppler correction, beta decay suppression, compton camera

**Key features include:**
- Longitudinal and transversal segmentations 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 detectors
- 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

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[www.canberra.com/detectors](http://www.canberra.com/detectors)
Ruggedized Detector Systems

The combination of our extensive experience with the evolution of new technologies (encapsulation, ultra high vacuum, waterproof design, shock absorption devices) makes CANBERRA the world leader in scientific and special applications involving HPGe detectors.

CANBERRA delivers innovative and reliable detection instruments for the most demanding industries and research centers. Researchers have come to depend on these specialized instruments for critical applications such as mining, space, D&D projects, military, etc. The CANBERRA detector can be used for spectroscopy measurements in all types of external conditions without any compromise on performance, safety or reliability.

Sealed HPGe Probe

This probe offers high resolution with electrical cooling, ultra-high vacuum with a minimum of power, weight and volume compared to existing HPGe detectors.

Applications:

- **Mining**: Used in borehole logging, such a probe will provide direct and more accurate measurement of uranium for exploration mapping.
- **Recycling, Decontamination and Decommissioning projects**: Light and compact probes for remote and complex measurement geometries
- **Water Monitoring**: On-line spectroscopy information on water exhaust or fuel pools
- **Fuel and nuclear power plant outages**: Portable high-resolution LN2-free probe for hold-up measurements before and during outage operations. The design can easily be mounted on a rover.
- **Emergency Response**: Thanks to a high quality assembly of reliable building blocks developed by CANBERRA, this sealed probe is ideal for spectroscopy in emergency situations where immediate nuclide identification is required.

New sealed probe for user friendly applications outside laboratories in rugged conditions.
CANBERRA developed this unique turnkey and versatile HPGe solution for mobile radionuclide identification and mapping. The high-resolution and high-efficiency spectrometer design relies on advanced technologies such as the encapsulation in ultra-high vacuum (UHV), low vibration electrical cooling through Cryo-Pulse® 5 Plus modules, special cryostat design, digital signal processing with add-back mode or real-time data analysis and mapping display.

This large ruggedized HPGe system combines high efficiency and unbeatable energy resolution for greatest sensitivity performance with respect to scintillator based systems. Precise dosimetry and source identification capabilities are possible even in high background conditions.

Applications:
- **Mobile Survey:** Used on board aircraft, vehicles or boats and accommodates their respective constraints. Highest sensitivity to separate anthropogenic and natural nuclides. Human interface for pilot guidance and other parameters (dose meter, temperature, altimeter, etc.)
- **Emergency Response:** High efficiency combined with ideal energy resolution allows quick and precise ground contamination evaluation on aircraft in emergency situations.

Key features include:
- up to 7 HPGe detectors in Ultra High Vacuum capsules
- a unique cryostat with powerful electrical low vibration cooling
- Rugged hardware design
- DSP based multichannel MCAs of the latest generation
- Adaptable power supply to fit any vehicle
- Small footprint to accommodate even small planes
- Special attachments and dedicated handling of the cabinets.
- On-line and off-line access on spectroscopic information, gamma dose, localization.
- Enhanced efficiency through embedded add-back rework of spectra.
- Mapping features at request.
HPGe detectors can be arranged in single or array systems for space telescopes or satellites.

It is well known that Ge material is sensitive to neutrons and protons and to vibration (especially during take-off). CANBERRA has developed solutions for the successful use of Ge in space. The highest reliability can be demonstrated on existing projects still in operation such as Integral-SPI and the Mars Odyssey among others.

Key features include:
- Accurate gamma cartography in galaxies (study of supernovae, black holes, etc.)
- Shock proof design (100g)
- Highest reliability extended scientific program on existing system launched many years ago
- Remote neutron repair ability
- Compatible with electrical cooling
Photo-Diodes for Scintillator Read-Out

Advanced Photon Detection on the next MARS ROVER

Key features include:
- Size: Custom Design
- Thickness: 200 to 500µm

Key advantages include:
- Anti-reflective coating with QE > 80%
- Low dark current
- Direct coupling to scintillator
- Optimization for specific scintillators

Contact CANBERRA to learn more about Detectors for Challenging Applications.
www.canberra.com/detectors
CANBERRA has a comprehensive product offering of germanium, silicon and Si(Li) detectors for synchrotron beamlines.

For every application, requirements are thoroughly evaluated by CANBERRA's team of scientific experts to ensure that the appropriate solution and support can be offered. Our stringent Quality Management ensures compliance with customer specifications, as well as confirms that factory and/or site testing requirements are met to satisfaction.

Our offering includes:
- Monolithic Array Detectors
- Discrete Element Array Detectors
- Single Element X-ray Detectors
- Photodiodes for beam alignment

**Monolithic HPGe Pixel Detectors**

3 to 100 pixels on a single HPGe or Si(Li) substrate

- Energy range: 3 keV and up
- Best possible packing density, ideal for EXAFS applications
- High resolution with moderate to short pulse processing times
- Good peak/background with optional internal collimator to reduce charge sharing between pixels
- Synchronous preamplifier reset with built-in electronics
- Automatic (rate-induced) or manually selected pixel disabling feature (SAFE mode) prevents system paralysis from diffracted (high-rate) beams
- Optional electrically cooled cryostat

**Discrete Element Array Detectors**

- 2 to 32 individual HPGe or Si(Li) elements
- Energy range:
  - LEGe (3 keV and up)
  - Ultra-LEGe (1 keV and up) elements
- Low crosstalk (permitting non-synchronous or synchronous preamp reset modes)
- High resolution even with very short pulse processing times
- Count rates up to 1 Mcps
- Excellent peak/background without collimation
- Windowless cryostats available for Ultra-LEGe's to achieve energy sensitivity down to 300 eV
- Optional electrically cooled cryostat

X-Ray Detectors for Synchrotron Applications
Single Element X-Ray Detectors
- Low Energy Germanium (LEGe) Detectors for 3 keV and up
- Ultra Low-Energy Germanium Detectors for 1 keV and up (300 eV with windowless cryostat)
- Lithium-Drifted Silicon (SiLi) Detectors for 1-25 keV
- X-PIPS Detectors for 1-20 keV (Miniature Peltier-Cooled Devices)

Photodiodes for Beam Alignment
- Low dark current
- Fast read-out
- Used in photovoltaic or biased mode
- No optical window

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Si(Li) Detectors

Silicon Lithium Si(Li) detectors play an important role alongside Silicon detectors and HPGe detectors.

As described below, they excel in the spectroscopy of X-rays, charged particles and conversion electrons. These detectors are fabricated to exacting quality standards, to offer highest performance and excellent long term reliability even in rough conditions.

Si(Li) detectors can be made with thicknesses up to 5 mm, which means they have a much higher stopping power than SDD’s (max. 500 µm) and can be used up to higher energy x-rays. Compared to germanium, however, silicon has a lower stopping power, and thus lower efficiency, for the same detector thickness. But the big advantage of silicon is that it has characteristic x-rays at much lower energies (around 1.7 keV) compared to germanium (10-11 keV) and are therefore much less likely to interfere with those X-rays being studied.

Applications:
- PIXE (microprobes)
- Synchrotron (EXAFS, medical beam lines)
- Nuclear Physics
- Non-destructive assay
- Radiography
- Imaging (gamma cameras)
- CAM (Continuous Air Monitoring) on beta particles

Key features include:
- Designed for highly penetrating charged particles up to 3 MeV Betas, 30 MeV protons, 140 MeV Alphas. More if detectors are stacked in telescope arrangements.
- Wide range of active areas, thicknesses and mount shapes available depending on application
- Can be cooled to improve performance for conversion electron spectroscopy
- Available in multi-element arrays

Si(Li) detector for charged particles
Si(Li) detector for conversion electron spectroscopy. It can be provided with a cryostat with a removable flange for easy connection on a vacuum chamber.

Double side strip detector (DSSD)
Si(Li) detector with electrical cooling. The application is Compton camera for medical imaging applications.

Visit our web site for up-to-date information & specifications. www.canberra.com
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CANBERRA operates production and engineering facilities worldwide. Our 1000+ employees are all focused on bringing the very best nuclear technology to your operation.

We strive to be recognized by our customers for consistently exceeding their expectations.

CANBERRA at your service

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Sales Offices
> CANBERRA sales and service capability exists in virtually every country in the world.

International Offices
> Please visit CANBERRA’s web site at www.canberra.com and click on “Offices” for a complete listing.

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