MIRION
TECHNOLOGIES

USED FOR FLUORESCENCE, DIFFRACTION, EXAFS, IMAGING AND MORE

Semiconductor Specialty Solutions for Synchrotrons

Monolithic 25 pixel detector for EXAFS application (courtesy of Dr. Uruga, SPring-8)

Comprehensive, Highly Customizable Germanium, Silicon and Si(Li) Detectors for Synchrotron Beamlines

- Monolithic Array Detectors
- Discrete Element Array Detectors
- Double Sided Strip detectors
- Nanofocused Beam Detectors
- High-Z Pixelated chips
- Single and Multi Element X-ray Silicon Detectors
- Photodiodes
- Si(Li) Detectors

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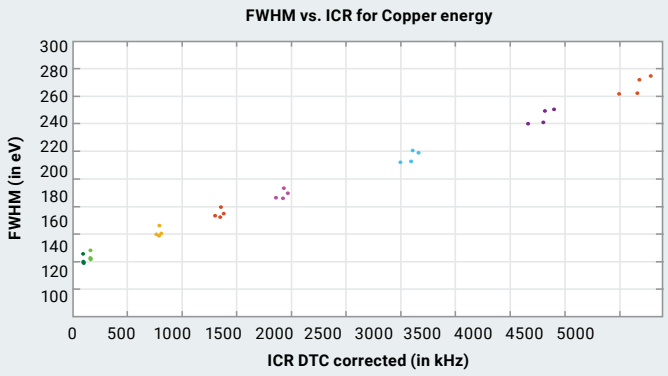
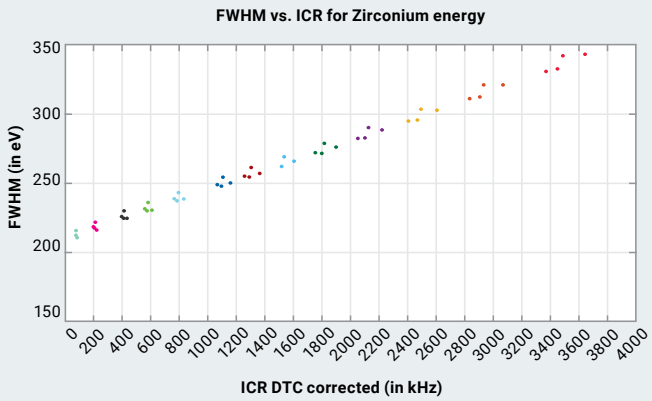
The first 13 Element discrete Ge Array Detector, produced in the 1980s, quickly became highly sought after, with orders for similar detectors from SSRL, Daresbury and many other light sources in the US, Europe, and Japan. Shortly thereafter, users requested more channels than offered by the largest Mirion Discrete Array Detectors (32 element), resulting in the first 100 monolithic Pixel Detector, produced in 1998 for Dr. Oyanagi from SPring-8 (Japan). Since then Mirion has produced several more 100 Pixel Detectors as well as detectors with fewer pixels, 36 being a popular size. Today, Mirion product offerings contain both monolithic array detectors having 3 up to 100 pixels or discrete array detectors of up to 32 channels. More recently, Mirion implemented modifications on the HPGe sensor itself to further reduce its capacitance. The new CMOS front end electronics have shown very impressive improvements to the overall detector performance.

Since 2016 Mirion also offers multi-element silicon drift detector arrays with excellent energy resolution at high count rates (up to at least 3.5 Mcps). Until now, the maximum number of deliverable elements was 13, but the design is easily customizable to more elements or other designs.

Energy Resolutions vs. ICR for Copper Energy Mirion Quad Detector



Energy Resolutions vs. ICR for Zirconium Energy Mirion Quad Detector



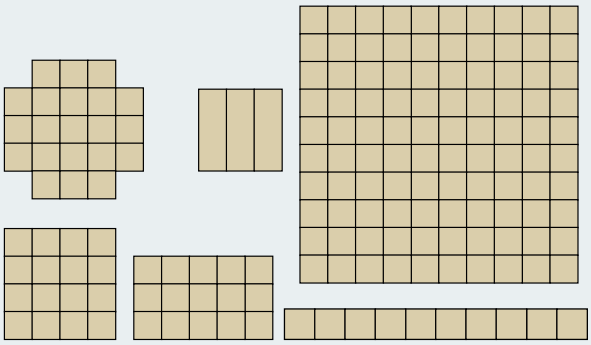
By courtesy of Dr Nicola Tartoni and Dr Sudeep Chatterji – Diamond Light Source

Monolithic HPGe Pixel Detectors

The detectors are based on reliable segmentation using a single planar HPGe slab. It is the only technique offering 100% beam coverage, as well as high reliability with minimal maintenance. The design allows the highest throughput electronics (up to 1 Mcps and more), and outstanding energy resolution with excellent EMI shielding.

MULTIPLE SEGMENTATION LAYOUTS

- Standard pixel sizes of 5 x 5 mm² and 8 x 8 mm²
- Arrays from 3 to 100 pixels on a single substrate
- Standard thickness is 7 mm for energy range from 3 keV to 200 keV+

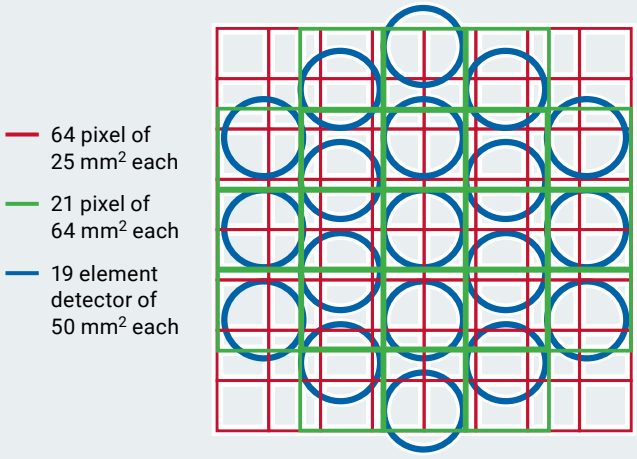


Example of possible segmentations

MAXIMUM BEAM COVERAGE

- Monolithic detectors have no dead space between elements
- Optional internal collimator to reduce charge sharing between pixels and peak/background improvement
- Optional Close-To-Sample detection heads to maximize proximity in a narrow, confined space

Custom square detection head



Intercomparison example between a 19 discrete element configuration, a 21 and 64 monolithic pixel detector

Monolithic HPGe Pixel Detectors

HIGHEST RELIABILITY

- Unique process applied for the whole germanium bulk
- Probability of failure is minimal, no need for ion pump
- High electromagnetics immunity even in harsh environments
- Modular removable electronics for easy on-site maintenance

MINIMAL FOOTPRINT CUSTOMIZATIONS

- Special configuration for Dewars such as Dewar on top, tilted Dewar
- All attitude, compact electrical cooler
- Standard 15 L and 30 L Dewars, can be reduced down to 3 L
- Off-axis detector heads

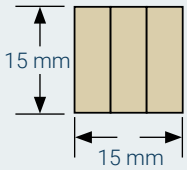
100 pixels detector in a small footprint configuration

Tilted Dewar configuration example of a 100 pixel detector

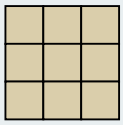
Monolithic HPGe Pixel Detectors

Standard Configuration Examples

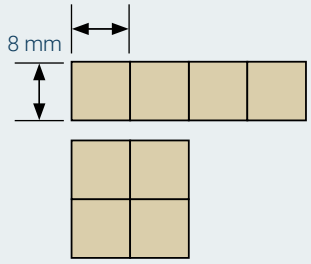
3 PIXEL ARRAY



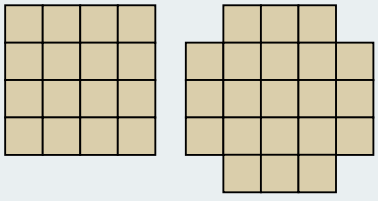
9 PIXEL ARRAY



4 PIXEL ARRAY



16, 21 PIXEL ARRAY



Monolithic HPGe Pixel Detectors

36 PIXEL ARRAY

64 AND 100 PIXEL ARRAY

Small footprint
100 pixel detector

Electrically cooled
detectors

TYPICAL SPECIFICATIONS FOR MONOLITHIC HPGE PIXEL DETECTOR

(other configurations are available)

- Pixel size (mm)
  - 5 x 5 mm and 8 x 8 mm
- Thickness
  - 7 mm (X-rays) to 20 mm (gamma rays)
- Layout
  - Linear or square arrays
  - From 1 pixel to 100 pixel and more
- Energy resolution at 5.9 keV (12 µs)
  - 5 mm x 5 mm pixels: Typ <135 eV
  - 8 mm x 8 mm pixels: Typ <145 eV
- Energy resolution at 5.9 keV (0,5 µs)
  - 5 mm x 5 mm pixels: Typ <235 eV
  - 8 mm x 8 mm pixels: Typ <250 eV
- Dewar size
  - 15 L and 30 L; Electrical cooler
- Entrance window
  - 50 µm - 250 µm Beryllium
  - Low fluorescence materials
- Front end electronics
  - Pulsed preamplifier
  - Alarm card for high temperature shutdown
- Options
  - Square head
  - Readout electronics of the latest digitizer technology
  - Preamplifier power supply unit
  - High voltage supply unit
  - On-site installation and training, etc.

Discrete Element Array Detectors

FEATURES

- 2 to 32 individual HPGe or Si(Li) elements
- Energy range:
  - LEGe™ detector (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 detector's to achieve energy sensitivity down to 300 eV
- Optional electrically cooled cryostat

High Count Rate Multichannel Detectors

FEATURES

- New generation Multichannel X-ray detectors with CMOS preamplifier
- From 1 to 25 channels available in highly customizable configurations
- Both pixelated monolithic and multiple individual crystals available
- Major breakthrough in performance compared to JFET-based detectors
  - 10x increase in throughput (up to several Mcps/channel demonstrated on synchrotron beamlines)
  - FWHM divided by two at short shaping time (typical 150 eV@6 keV and 0.125 µs)
  - Rise time divided by five (typical 35 ns/event)
- Electrical cooling for maintenance-free operation and compact footprint (water chiller option available)
- Fully compatible with new generation digital readout electronics (Xia FalconX and Quantum Xspress 3)

18 element detector with electrical cooler, optimized for highest count rate applications

Mono-element detector with electrical cooler and new CMOS preamplifier

Double-Sided Strip Detectors

FEATURES

- Interaction localization
- HPGe or Si(Li) planar detectors
- Particles, X and gamma radiation imaging
- Compton camera using crystals stacked in a single cryostat
- No measurable crosstalk effect

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

13X-13Y DSSD electrically cooled with Cryo-Pulse® 5 Plus cryostat

Nanofocused Beam Detectors

FEATURES

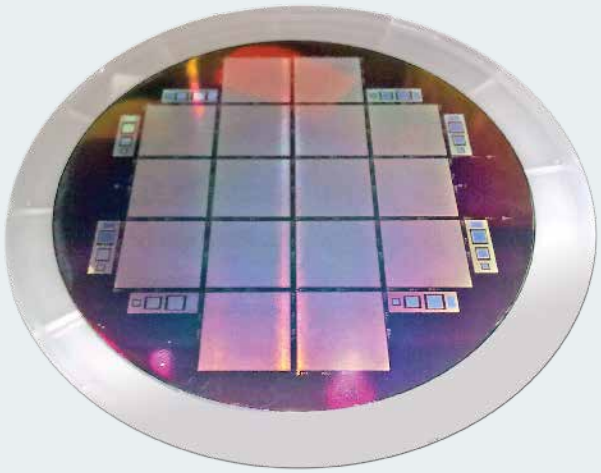
- Electrical cooling for X-ray (LN_2-free)
- Ultimate FWHM performance at low energy X-rays
- Highest throughput for count rates up to 10^6 counts per second
- Zero vibration: no fans needed for cooling
- No heat exchange with the hutch: water coolant circuit for the CP5-PLUS cryostat and the preamplifiers
- Smallest footprint to fit a very limited space
- Best immunity in a highly electromagnetic environment
- Selected material for the hardware in proximity with the U-LEGe™ diodes

Example of multi-element array electrically cooled and vibration free

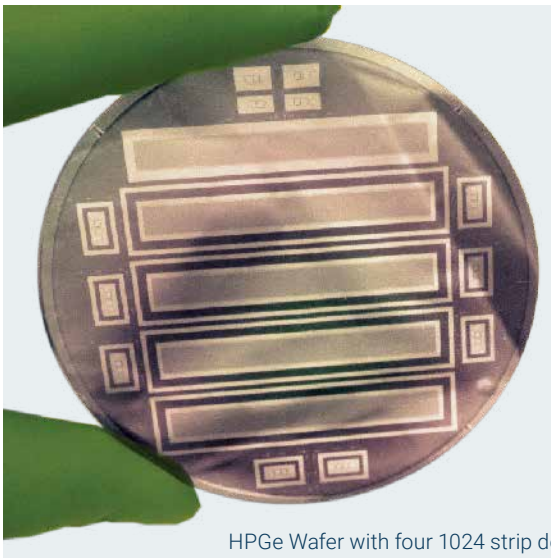
Finely Pixelated GE Sensors

FEATURES

- Micrometrical scale patterned HPGe wafers
- Range from mm to µm
- Application covers medical imaging, non-destructive testing, XRD, radiography, high count rate conditions
- Down to 55 µm pixel



Medipix HPGe chips featuring 55 µm pixels in a 256 x 256 matrix



HPGe Wafer with four 1024 strip detectors (strip pitch 50 µm)

Single Element X-Ray Detectors

FEATURES

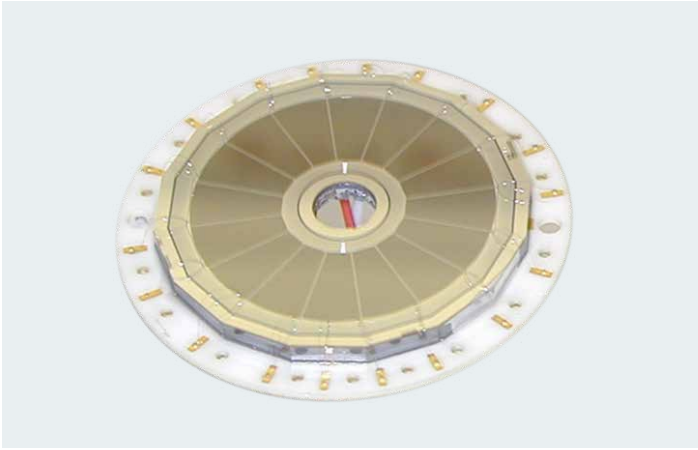
- Low Energy Germanium (LEGe) Detectors for 3 keV and up
- Ultra Low-Energy Germanium Detectors for 1 keV and up (300 eV with windowless cryostat)
- Lithium-Drifted Silicon (SiLi) Detectors for 1-25 keV
- X-PIPS™ Detectors for 1-30 keV (Miniature Peltier-Cooled Devices)

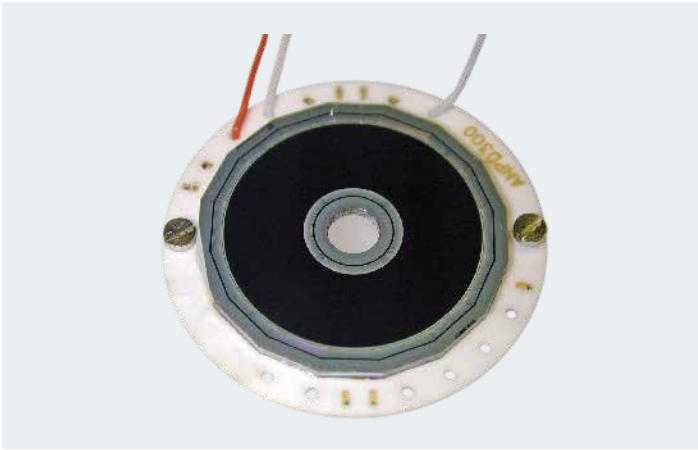
- 1 x 100 mm² Ultra-LEGe Detector
- Windowless, Retractable™ Cryostat

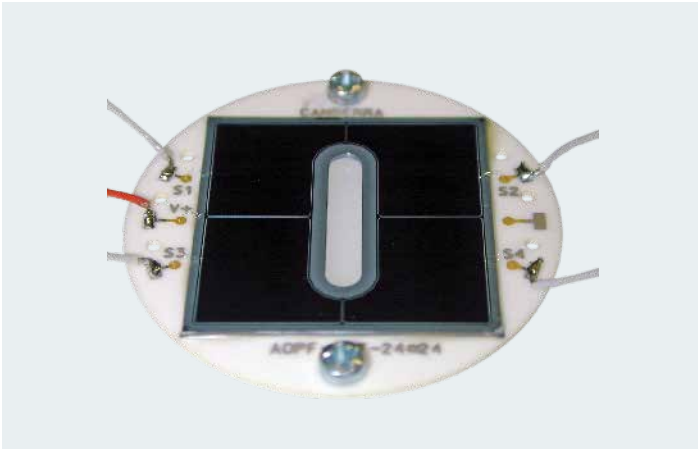
Photodiodes For Beam Alignment

FEATURES

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







Si(Li) Detectors

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

These detectors excel in the spectroscopy of X-rays, charged particles and conversion electrons. They offer optimal performance and excellent long-term reliability even in rough conditions. Si(Li) detectors can be made up to 5 mm thick, which means they have a much higher stopping power than SDD's (max. 500 µm) and can be used with higher energy X-rays. Compared to germanium, however, silicon has a lower stopping power, and thus lower efficiency, for the same detector thickness. The 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.

FEATURES

- Thickness 2 mm and 5 mm (other thicknesses available on request)
- Active area 200 mm² and 500 mm² (other areas available on request)
- Available in multi-element arrays or strip detector configuration
- Stackable for dE/dX measurements

Si(Li) array for backscattered X-ray detection

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

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.

High Count Rate Multi-Element SDD Array

The X-PIPS detector array is a spectroscopy sub-system that is sensitive to X-rays and low-energy gamma rays. It comprises of several (13 or more) Silicon Drift Detectors (SDD) with a low noise CMOS reset type preamplifier, an HV bias supply and a cryogenic cooler. The detector elements and CMOS preamplifiers are cooled and temperature regulated, ensuring stable operation in changing environmental conditions. The Beryllium entrance window is 1 mil (25 µm) thick which allows for measurement of X-rays as low as 1 keV.

The CMOS preamplifiers have a fast reset mechanism which reduces dead time and allows the detector to perform well at high count rate performance. The high performance SDD combined with a CMOS preamplifier provides a fast, low noise response, which results in optimal energy resolution with fast peaking times.

PERFORMANCE

- Collimated Active Area – 30, 50 or 80 mm² per element
- Thickness – 0.5 mm
- Guaranteed resolution – 135 eV FWHM (typ. < 125 eV)
- Energy Range - 1 to 30 keV
- Maximum throughput per element : > 3.5 Mcps
- Peak-to-back ratio: > 10 000:1

FEATURES

- 13 or more elements
- Cryogenic (pulse-tube) cooler
- Easily customized
- Planar of focused configurations
- Air or water cooled heat sink
- No active pumping required (no ion pump)
- Thermal cycle free

13-Element Array

7-Element Array

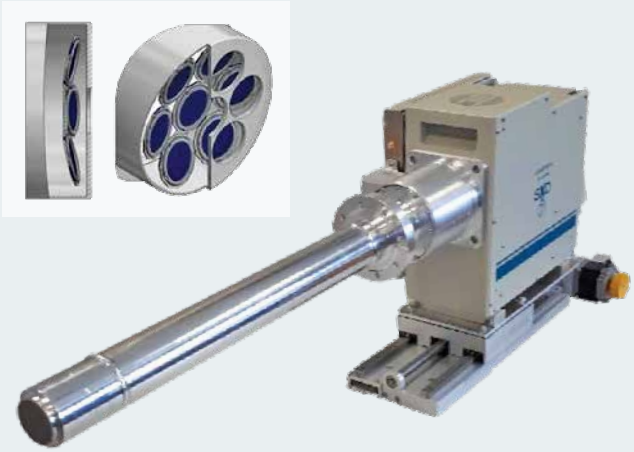
Examples of Custom Configurations

EXAMPLE 1

- 7 x 50 mm² collimated elements
- 1.5 W Pulse-Tube cooler
  - High reliability and long life (> 10 years)
  - Low power consumption (< 50 W)
- Air or water cooled heat sink

EXAMPLE 2

- 7 x 80 mm² collimated elements
- 5 W Pulse-Tube cooler
  - High reliability and long life (>10 years)
- Focused arrangement
- Air or water cooled heat sink



EXAMPLE 3

- 8 x 80 mm² collimated elements
- Focused arrangement

MIRIONSERVICES

Mirion Technologies provides products and services for a wide range of radiation safety, measurement and scientific purposes.

Mirion solutions are employed to protect people from radiation exposure and limit the spread of contamination. Since 1968, the company has also been committed to the development, manufacturing and service of unique specialty detectors for international scientific experiments, as well as industrial applications.

Driven by the diverse needs of our customers, Mirion has developed a range of solutions to maintain its technological leadership in the nuclear measurements industry.

Mirion supplies detectors and instrumentation used in laboratory and in-situ radiological analysis, and for cutting-edge materials analysis, physics, and space studies in some of the world's leading research institutes.

Our 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.

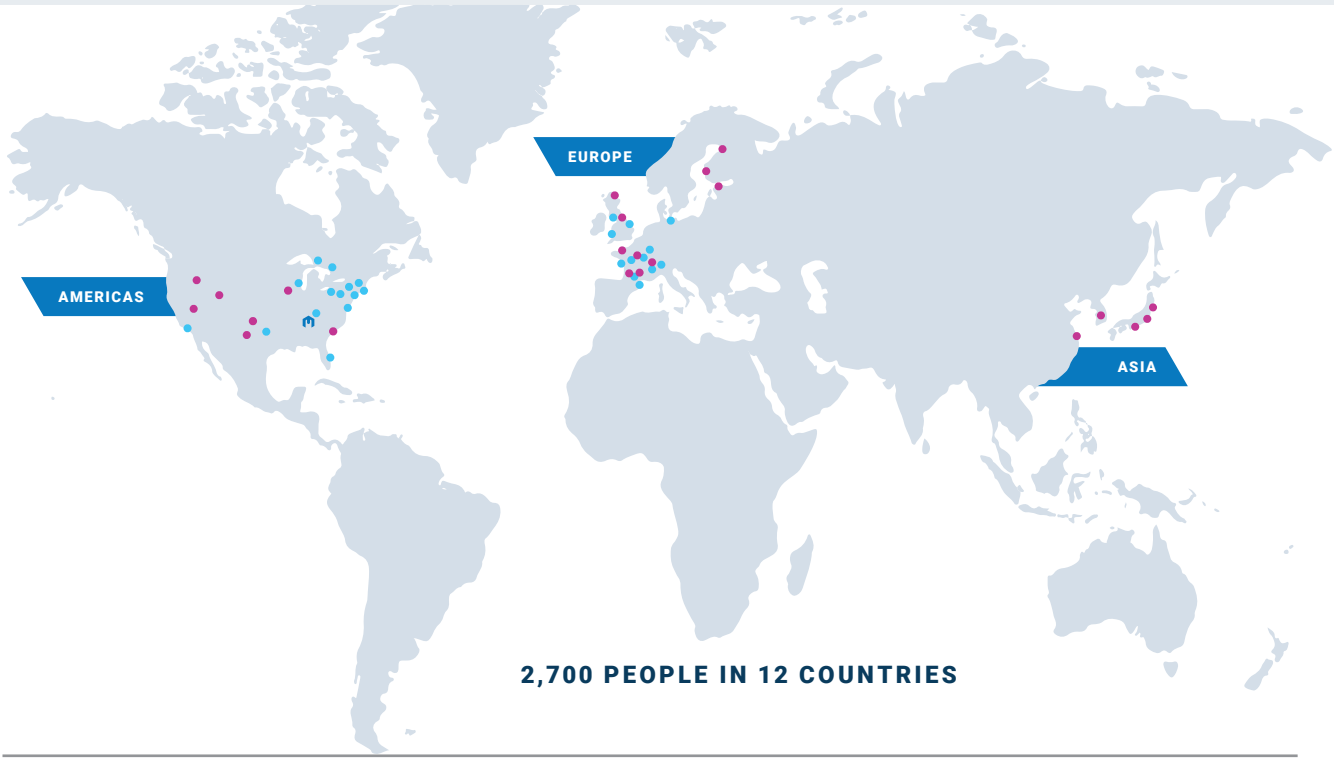
Mirion Services augments your technical team, assists during peak periods, provides expert advice, trains staff and maintains your systems for optimal performance. We look forward to partnering with you.

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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OPS-6112 - 10/2023