Instruments for Radiation Protection

- Contamination Monitors
- Dose and Dose rate Monitors
- Measuring Systems for Air and Waste Water
- Instruments to Search for, Detect and Measure Radioactivity
No Chance for Radioactive Contamination

Radionuclides are needed and useful in many fields of application. However, they may also be dangerous if improperly handled. Therefore working with radioactive materials in Nuclear Medicine, Research or in other fields of radionuclide applications requires continuous monitoring to detect possible contamination of surfaces and objects in working areas, as well as on clothes and on exposed skin.

With Contamination Monitors from BERTHOLD TECHNOLOGIES, contaminations do not have any chance to remain undetected, regardless which radionuclide or location.

The beta-gamma Contamination Monitor LB 124 offers superior performance among hand-held instruments.

The advantages:
- The 150 cm² detector measures beta and photon radiation with highest counting efficiency, in particular for EC emitters like $^{125}$I or $^{99m}$Tc
- The large, easy-to read backlit LCD display shows measured results in cps or Bq/cm² with factory defined, editable calibration factors for more than 50 radionuclides
- Powerful software supports numerous measuring modes and parameter settings, for example: search, clearance measurement, half-life, background measurement mode
- The monitor is easily configured both for the unskilled user and for the demanding measuring expert
- The memory stores up to 1000 measurements with date/time stamp. Data may be downloaded to a PC or printer via the RS232 interface

If you need a portable instrument for monitoring surface contamination, we offer three product families: The handheld monitors LB 122 or LB 124 for single-hand operation with built-in large-area detectors or the versatile LB 123 UMo system with externally connected contamination detectors. To detect possible contamination of personnel, the Hand Foot Monitors LB 145 and LB 146 are available. Moreover, for larger laboratories or nuclear facilities, the Floor Monitors LB 165 and LB 166 are available to reliably assess widespread contaminations.
A proven and widespread hand-held instrument:
The alpha-beta Contamination Monitor LB 122
for reliable assessment of alpha and beta emitting radionuclides.

The advantages:
■ Highly efficient and easily exchangeable 200 cm² detectors to
detect either beta / photon radiation, or alpha-beta radiation
■ The backlit LCD display shows measured results in cps or
Bq/cm² with factory-defined calibration factors for over 40
different radionuclides
■ The software supports various measuring modes and parameter
selections, including background measurement and subtraction.
■ Many accessories such as a docking station for semi-stationary
operation to measure alpha-beta radiation with a gas-flow
proportional detector

A very efficient and versatile instrument for the Health
Physics professional: The Universal Radiation Pro-
tection Survey Meter LB 123 Umo: The LB 123 A
as α–β or the LB 123 B as β–γ contamination monitor

The advantages:
■ A series of detectors to connect to the small, portable LB 1230
electronics unit, to measure alpha-beta, beta-gamma, or Tritium
contamination or even gamma / Neutron dose rate.
■ The electronics unit identifies automatically the connected
probe and selects the appropriate measuring mode and
parameter set.
■ Data storage and serial interface and the features of the LB 122
■ A power supply unit to “dock” the LB 123 for stationary use
with mains connection

For Tritium contamination measurements,
the windowless gas flow-through
detector LB 1239 is used.
For easier and quicker contamination surveys in major laboratories or nuclear facilities:

**Floor Monitors LB 165 and LB 166** with a new generation of extremely large proportional detectors

**The advantages:**
- **Two versions** for beta-gamma (LB 165) and alpha-beta (LB 166) emitting nuclides
- Detector **entrance window** of 2000 cm²
- Alpha-beta monitor LB 166 with **built-in counting gas supply**
- Measuring and display unit LB 1230 with data storage and printer interface
- Dynamic background compensation with additional guard detector available for LB 165 with LB 5330 electronics unit
- Detector ground clearance adjustable from 6 to 24 mm

An indispensable monitor for the safety in radionuclide laboratories and nuclear facilities:

**Hand-Foot Contamination Monitors LB 145/146** for quick and reliable measurement of contaminations on hands, feet and clothing

**The advantages:**
- **Two versions** for beta-gamma (LB 145) and alpha-beta (LB 146) emitting nuclides
- Large screen with **direct display of contamination values and areas**
- Optional detachable frisker probe allows measurement of clothes or objects
- Stored calibration factors for numerous radionuclides
- Automatic compensation for varying background levels
- Optional back-of-hands probes, adapt to different hand sizes for alpha-beta measurements
- Large data storage, Serial interface, Optional Ethernet connection
- Ergonomic design, light sensors to ensure correct measurement procedure

The Hand-Foot Contamination Monitors LB 145/146 can also be provided with additional back-of-hands probes which adapt automatically to different hand sizes in the LB 146 alpha-beta version.
Measuring Radioactivity in Solid and Liquid Samples

In order to meet radiological safety regulations for handling radioactive substances different sampling methods are used in the laboratory to measure activity such as, smear samples, aerosol filters, evaporation residues. Also environmental or foodstuff samples may require the measurement of radioactivity. BERTHOLD TECHNOLOGIES supplies well proven and easy to operate instruments for these tasks.

The large diam. 200 mm planchets of the Planchet Counter LB 761 can be used to measure air filters or ash, soil or evaporated water samples.

To measure extremely low alpha and beta activities in solid samples, both the Low-level Planchet Counter LB 761 for 200 mm planchets and the 10-fold Low-level Planchet Counter LB 770 for simultaneous measurement of 60mm planchets are ideally suited. For in-situ gamma measurements of environmental and foodstuff samples up to 1 l volume the portable Foodstuff Monitor LB 200 is available. For radioactivity measurements in small samples, the Universal Radiation Protection Monitor LB 123 UMo is available with several special probes.

Measuring foodstuff and environmental samples anytime, anywhere: The Portable Foodstuff Monitor LB 200 is easy to operate even for an unskilled user and has proven itself more than 1000-fold following Chernobyl.

For the measurement of samples up to 25 mm dia: The Universal Radiation Protection Monitor LB 123 UMo with end window counter tube LB 1238 and lead shielding LB 7431

For $^{210}$Po 60 mBq, $^{90}$Sr 50 mBq

Typ. Detection Limits within 1 h measuring time: $^{241}$Am 60 mBq, $^{90}$Sr 50 mBq

Beta surface contaminations of 1 Bq/cm$^2$ are reliably detected using wipe tests.

MDA’s within 1 h measuring time: $^{241}$Am 5 mBq, $^{90}$Sr 20 mBq simultaneously. Connection of a PC via the LB 530 PC Interface, evaluation and documentation software LB 770 UMS Windows.

To measure large quantities of samples with high sensitivity, the 10-fold Low-level counter LB 770 for 60-mm-planchets is the instrument of choice

For $^{137}$Cs 10 Bq/l minimum detectable activity. The obtained statistical accuracy of the measured value is indicated during the measurement. Therefore, the user can select the optimum measuring time and accuracy.
Measure the Exposure at the workplace

Whoever works with radiation sources or X-ray machines in laboratories, in radiology, in radiography or at other technical irradiation facilities should be informed about current radiation levels at all times.

The advantages:
- The small portable electronics unit LB 1230 accepts alternatively the gamma probe LB 1236, the neutron probe LB 6411 or several contamination probes.
- The basic unit identifies the connected probe and selects automatically the required parameter settings.
- Optical and acoustical warning via adjustable alarm thresholds.
- The basic unit offers various measuring modes from counts or cps, dose rate and dose integration as well as a large data storage and serial interface.
- A (wall mount) power supply unit allows “docking” of the LB 123 for stationary use with mains connection.

With dose and dose rate monitors from BERTHOLD TECHNOLOGIES you will detect reliably and quickly any increase in dose rate at the workplace that could lead to an undesired exposure of personnel.

In Gamma or Neutron radiation field surveys the LB 123 UMo does an excellent job as a dose rate meter. For measurements of gamma- and X-rays in particular, the TOL/F with its ionization chamber is ideally suited. For stationary measurement of dose and dose rate with alarm capability the LB 111 system is available. Our portable or stationary neutron probe LB 6411 evaluates with high sensitivity and precision neutron dose rate levels.

A versatile combination system for the expert:

The universal radiation protection survey meter LB 123 UMo as dose and dose rate monitor
LB 123 D for gamma- and LB 123N for neutron radiation

The advantages:
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- The basic unit identifies the connected probe and selects automatically the required parameter settings.
- Optical and acoustical warning via adjustable alarm thresholds.
- The basic unit offers various measuring modes from counts or cps, dose rate and dose integration as well as a large data storage and serial interface.
- A (wall mount) power supply unit allows “docking” of the LB 123 for stationary use with mains connection.
The well-proven precision measurement device for gamma- and X-rays:

**Dose rate meter TOL/F**
with wide energy and measuring ranges

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**The advantages:**

- Measurement of low energy photon radiation down to 10 keV
- Dose rate measurement over 7 decades in two measuring ranges
- Automatic gain adjustment with built-in $^{90}\text{Sr}$ source
- Optical and acoustical warning with adjustable alarm thresholds
- Measurement of pulsed radiation fields

Steady state dose rate and dose measuring ranges 0.1 $\mu$Sv/h to 100 Sv/h, dose from 0.01 $\mu$Sv
Energy range 10 keV to 7 MeV

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Rugged and versatile:

**Dose rate monitor LB 111**
for gamma and neutron radiation with data memory and data transfer

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**The advantages:**

- Two-channel system for gamma and neutron probes
- High dose rate range with optional ion chamber detectors
- Light beacon with horn for warning of levels exceeding adjustable alarm thresholds
- Rugged casing with protection IP 65 for wall assembly
- Data transfer in LAN's and WAN's

Dose rate measuring ranges 0.05 mSv/h to 1 Sv/h in two ranges, with ionization chamber LB 6701N to 1000 Sv/h
Energy ranges from 20 keV depending on probe type

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Detect and identify Gamma radiation and radioactive sources and measure the dose rate:

**Gamma Analyzer LB 125** a hand-held instrument for field and laboratory application

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**The advantages:**

- Easy acquisition of the gamma spectrum
- Automatic peak and nuclide identification
- Dose rate measurements with alarm thresholds and acoustical warning
- Search and identify mode
- Stores up to 30 spectra
- Data transfer and remote operation

Dose rate measuring range 0.01 $\mu$Sv/h to 100 $\mu$Sv/h
Energy range 25 keV to 2 MeV
Analyzer with 512 channels
Facing Challenging Tasks with Customized Systems

In large installations and facilities, the regulatory requirements for radiation protection very often translate into a site-specific approach. Therefore, only systems tailored to the customer’s needs will optimally solve the individual measuring tasks.

A close cooperation between manufacturer and customer early in the planning phase is a key for an effective implementation. There are more and more requirements for turnkey solutions. Widespread use of Quality Systems imposes ever-higher demands on documentation and project management.

A highly modern facility for nuclear waste disposal: ZWILAG Intermediate Radioactive Waste Storage

Centralised for Switzerland, radioactive waste from medicine, industry, research and nuclear power plants is conditioned for permanent disposal, and stored intermediate in the ZWILAG facility. BERTHOLD TECHNOLOGIES has installed the following instrumentation:

- Dose rate measurement for both gammas and neutrons
- Room air monitoring
- Exhaust air monitoring
- Isokinetic sample extraction from stacks and ventilation ducts
- Stack monitoring at the plasma incineration facility

The National Institute for Public Health and Environment of the Netherlands RIVM monitors with 14 measuring stations the airborne alpha and beta activity in the Netherlands

These measuring stations are equipped with particulate moving filter tape monitors BAI 9128 from BERTHOLD TECHNOLOGIES.

The National Agency for Environmental protection ANPA operates in Italy a measuring network to monitor the airborne radioactivity

Data acquisition takes place with nuclide specific filter tape instruments BAI 9100DG from BERTHOLD TECHNOLOGIES from Piemont in the North down to Sicily. The data are transferred to central stations in Rome and Milan. The high-resolution gamma spectroscopy with Germanium detectors ensures extremely low detection limits and identification of the measured radionuclides.

In numerous PET Centres like e.g. Bonn, Berlin, Juelich, Munich, Geneva or Vienna, the exhaust air is monitored with monitors from BERTHOLD TECHNOLOGIES

Our concept for measuring PET nuclides such as $^{11}$C, $^{15}$O or $^{18}$F is based on the detection of positrons, which is superior to the detection of annihilation radiation. BERTHOLD TECHNOLOGIES is capable of planning and installing these systems meeting all requirements of regulations, standards, EU laws, and licences of the authorities.
Monitoring Airborne Radioactivity

The permanent supervision of radioactivity in room and exhaust air of larger laboratories or nuclear facilities and the environmental monitoring of nuclear power plants is an important radiation protection task. In recent years, the number of applications in nuclear decommissioning, processing and storing radioactive waste is increasing.

BERTHOLD TECHNOLOGIES offers for this purpose a complete range of mobile instruments to customized, complete measuring installations for particulates, gas, Iodine and Tritium monitoring. The data from different measuring instruments including dose rate meters, e.g. for PET centres or in environmental networks, can be visualized and archived, by the MEVIS Central Station. Get in touch with our product specialists if air monitoring is your problem.

Below is a summary of our airborne activity sampling and measuring systems:

**Particulates:** Fixed filter instruments for diam. 47, 50, 60 and 200 mm filters; filter tape systems with scintillation and solid state detectors.

**Iodine:** Monitors for gaseous and organic $^{125}$I, $^{131}$I or $^{129}$I with collection on industrial standard cartridges, refillable Marinelli beakers or active charcoal filters.

**Noble gases and PET nuclides:** Monitors for noble gases like $^{85}$Kr, $^{133}$Xe, $^{41}$Ar and PET nuclides like $^{11}$C, $^{15}$O or $^{18}$F. Monitors with fixed geometry in by-pass or detectors for installation directly in the stack.

**Combined measurements:** PIN monitors for particulates (P), Iodine (I) and noble gases (N).

**Tritium:** As vapour or gas $^{3}$H-monitoring systems with compensation of the influence of $^{14}$C, noble gases and background.

Monitors from BERTHOLD TECHNOLOGIES guarantee safe and reliable measurements. But there is even more: make use of our know-how and our expertise for:

- Concept, design and layout
- Customized engineering and manufacturing
- Installation and Commissioning
- Calibration
- Documentation
- Service
Particulate Monitors

Applicable in all locations:
Filter tape particulate monitor BAI 9128
with silicon solid state detector for continuous measurement of alpha and beta particulate activity

The advantages:

■ Transportable compact unit
■ Advance speed of filter tape selectable
■ Compensation of influence from Radon decay products
■ Dose rate probe optional

For simultaneous evaluation of artificial alpha and beta particulates with highest sensitivity:
The fixed filter monitor LB 150 D-R with measurement and compensation of natural radioactivity

The LB 150 D-R fixed filter air monitor with integrated electronics Gracon LB 3404-S samples particulates on filters with diam. 200 mm. For natural background compensation a combination of ABPD and alpha range discrimination is used.

The advantages:

■ Isokinetic airflow with correction for retention of particulates
■ Energy independent compensation method
■ Nearly independent of Radon/Thoron ratio
■ Continuous measurement and alarm checking during air sampling

The flagship of the air monitors from BERTHOLD TECHNOLOGIES:
The filter tape monitor BAI 9100DG measures continuously the alpha and beta particulate activity in exhaust or environmental air and analyses the nuclide composition of the gamma component.

This filter tape monitor finds special application in measuring the activity release from nuclear facilities. It provides fast and reliable automatic detection of airborne activity in environmental measuring networks with data storage and data transfer.

The advantages:

■ For the measurement of artificial activity concentrations the influence of natural radioactivity is compensated by using the alpha/beta ratio or the alpha-beta pseudo-coincidence (ABPD) method.
■ Air flows of up to 25 m³/m are measured and these values are used to calculate the volumetric activity concentration in Bq/m³
■ The PC-based spectroscopy system offers, together with the proven GammaVision software, the user an easy to operate instrument for more sophisticated measurements.
Iodine, noble gas and combined monitors

Ideally suited to survey laboratory air in nuclear medicine facilities are the mobile iodine monitors BAI 9122 and BAI 9123 in various versions.

The monitor BAI 9122 is designed to measure $^{131}$I, the BAI 9123 for $^{125}$I. Lead shields with different thicknesses are available to optimise the performance for the laboratory conditions.

The advantages:
- Self-contained mobile system for application at various locations
- Compact design
- Networkable
- Easy accessible components
- Optimised for low noise

If radioactive noble gases such as $^{85}$Kr or $^{133}$Xe are to be assessed, then the noble gas monitors LB 101 or BAI 9109 are the most suitable instruments. Detection limits down to 1 kBq/m$^3$ can be achieved.

However, most frequently noble gas measurements are required in combination with iodine and/or particulate measurements. In this case, PIN monitors as described below are required.

A monitor for all applications: The mobile air monitor BAI 9850-19/PINN measures simultaneously beta particulates (P), $^{131}$I (I) and noble gases (N) in low and high volumetric activity concentrations.

The compact and environmently – resistant design makes the monitor BAI 9850-19/PINN an ideal instrument for routine and intervention measurements in the operation or decommissioning of nuclear installations. This monitor is also available as P, PI or PIN monitor.

The advantages:
- All relevant components of airborne radioactivity will be measured simultaneously and separately in whatever combinations
- Measurement is effected with highest sensitivity and over wide range
- Built-in optical and acoustical alarm signalisation

Measuring ranges and detection limits for 10 min measuring time, in Bq/m$^3$:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Measuring Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{125}$I</td>
<td>$2.5 \times 10^5$ to $5 \times 10^6$</td>
</tr>
<tr>
<td>$^{131}$I</td>
<td>$1 \times 10^5$ to $1 \times 10^7$</td>
</tr>
</tbody>
</table>

Instrumental measuring ranges and detection limits for 10 min measuring time in Bq/m$^3$:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Measuring Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate beta activity</td>
<td>$3 \times 10^4$ to $8 \times 10^5$</td>
</tr>
<tr>
<td>$^{131}$I activity</td>
<td>$72 \times 10^6$ to $1 \times 10^7$</td>
</tr>
<tr>
<td>$^{85}$Kr activity</td>
<td>$2 \times 10^9$ to $8 \times 10^{10}$ and $5 \times 10^9$ to $2 \times 10^{11}$</td>
</tr>
</tbody>
</table>
Tritium monitors

If the requirements is for mobile application or a high measuring range in surveying Tritium-in-air at nuclear installations, the flow-through ionisation chamber monitor LB 671 is the instrument of choice.

**The advantages:**
- Wide measuring range
- Compensation natural alpha emitters (Radon gas)

Measuring range 300 kBq/m³ to 300 GBq/m³

When monitoring of gamma emitting radionuclides with highest sensitivity is required, then the waste water monitor BAI 9125 is the instrument of choice.

**The advantages:**
- Low detection limit and wide measuring range
- Polished stainless steel vessel ensures high contamination resistance
- Alarm indication and electronic signals for automatic control of waste water processing

Measuring ranges in kBq/m³ for 1 h measuring time:
- $^{60}$Co $1 \times 10^7$ to $1 \times 10^9$
- $^{131}$I $5 \times 10^4$ to $3 \times 10^6$
- $^{137}$Cs $6 \times 10^4$ to $6 \times 10^6$

Detect Radioactivity in Waste Water

Waste water from radionuclide laboratories and nuclear facilities may contain radioactive substances. It therefore must be controlled by measurements when release limits of radioactivity concentrations are observed. To that purpose, BERTHOLD TECHNOLOGIES offers various on-line measuring systems for beta and gamma emitting radionuclides.

For laboratories in nuclear medicine in particular, the Waste Water Monitor LB 127 has been designed. The BAI 9125 instrument, on the other hand, is primarily meant for application in nuclear facilities.

When monitoring of gamma emitting radionuclides with highest sensitivity is required, then the waste water monitor BAI 9125 is the instrument of choice.

**The advantages:**
- Compensation of $^{14}$C or noble gas radionuclides
- Compensation of external gamma radiation
- Separate registration of the above mentioned radionuclides in a second measuring channel
MEVIS collects the measured data from the connected monitors, displays the data graphically in relation to place and time, creates tables, checks and reports alarms. For documentation, the data may be presented in various file formats. Via pull-down menus or F-keys, from the overview screen all submenu functions and screens may be reached to control the communication with the measuring systems, to display data in tabular, listing or graphic format. Extensive possibilities for configuration and customizing.

An example MEVIS application: The Synchrotron Light Source (SLS) at the Paul Scherrer Institute (PSI) in Switzerland is a modern accelerator facility, where numerous international research groups are doing experiments. BERTHOLD TECHNOLOGIES has installed a number of mobile dose rate systems at this installation, which are connected, to a MEVIS Central Data Unit to display and archive the results.

Example of graphical data visualization over 24 hours: Shown on the curves are activity concentrations in the exhaust air, the stack airflow, the total release and the local dose rate values.
Search and Analyse
Radioactive Materials
and Sources

To find radioactive scrap, lost sources or hidden nuclear fuel material, - with measuring and analysing instruments from BERTHOLD TECHNOLOGIES you are well equipped for the job.

An easy-to-handle gamma tracing instrument that finds sources in obscure locations is the universal monitor LB 123 UMo with NaI-probe. The portable Gamma Analyzer LB 125 detects even weak radiation fields, displays the energy spectrum and allows the identification of peaks and radionuclides. The highly sensitive Pu monitor LB 6414 discovers even the smallest amounts of plutonium.

Search and Identify gamma emitters:
Gamma Analyzer LB 125
as hand-held monitor for field and laboratory application

The advantages:
■ Easy acquisition of the gamma spectrum
■ Rapid and reliable nuclide identification
■ Intelligent software for displaying and analysing measured data
■ Search mode facilitates source finding
■ Stores up to 30 spectra, 512 channels, max 20 μs dead time
■ Data transfer and remote operation possible

About 10 g reactor Pu will be detected at 1 m distance within a few seconds. Therefore optimally suited to search for illegal Pu or to check nuclear waste.

The portable Neutron Survey Meter LB 6414 is optimised for fission neutrons.

The advantages:
■ Highest possible sensitivity in a hand-held equipment
■ Certified by Research Centre Seibersdorf/IAEA VIENNA

Another version of the versatile combination system for the measurement expert: the universal radiation protection survey meter LB 123 UMo with NaI probe to track radiation sources

With the separate high-sensitive gamma probe even hidden sources, e.g. in scrap or wastes will be detected reliably.