α β γ **ISuS** **Institute for Spectrometry and Radiation Protection**

Logistic, Consulting & Management for α·β·γ-ray Spectrometry and for Radiation Protection
Reference Systems and Software Products for *In Vivo*, *In Vitro* and *In Situ* Application
Virtual Modelling and Simulation of Real Scenarios

Introduction and Examples for *In-Vivo* Counters

Designed, constructed, built-up and installed by
and in co-operation with ISuS

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ISuS

We have more than 25 years experience in the nuclear measurement market. Whether whole body, low-level or waste measurement systems beside standard systems we realized also high-end systems with premium specs with also highly sophisticated users as institutes from universities, hospitals, research centers but also military institutes, official survey authorities and privet institutes. We have provided numerous turn-key systems with outrageous measurement performance, parameters and user-friendliness.

Incorporation Monitoring

When handling open radioactive substances it may occur that radio-nuclides are incorporated into the body, e.g. by inhalation, ingestion, through the skin or through an open wound. This leads to internal radiation exposure. It is the task of incorporation monitoring to assess the internal doses retrospectively.
When handling open radioactive substances, the body dose can be composed of external and/or internal radiation exposure, depending on working conditions, the chemical form of the used substances and the type of radio-nuclides.

Methods and responsibilities

The monitoring of incorporation is regulated in the National Guideline of Physical Radiation Protection Control. The following monitoring methods for the determination of the incorporated activity are commonly used:

- ***In-vivo methods*: Determination of activity in the body and/or in the organs.**
- *In-vitro methods*: Determination of activity concentration in excretions.
- *Room air measurements*: Determination of activity concentration in the air at the work place.

Retrospective dose assessment

It is the task of incorporation monitoring to assess doses retrospectively. In general if people of public or workers are occupationally exposed by handling open radioactive sources or after a nuclear event, in general incorporation monitoring is necessary. The activity possibly incorporated is determined and the body dose resulting from this uptake is assessed using the monitoring data. This means that incorporation monitoring on the basis of measurements serves to determine retrospectively a radiation exposure.

In-vivo monitors

Incorporation monitors (*In-vivo* counters) are designed to protect workers and people of public in the field of medical therapy and diagnostic, fertilizer and oil industry, waste and military applications, NPP's, industry, universities, research institutes as well as miners and further fields of applications.

Types of *in-vivo* monitoring geometries we realised:

- Whole an Partial body counter WBC, PBC
  - Fix and variable detector positions
  - Scanning bed and scanning detector technologies
- Organ counters:
  - Lung & Liver counter LC,
  - Stomach counter SC,
  - Bone counter BC: Head and Knee and Back
- Special counters:
  - Thyroid counter TC and scanner TSc
  - Beta/Gamma counter BGC
  - Individual research counter

Types of shielding geometries we realised:

- Mobile chamber Version with shadow shield inside
- Standard room version with light shadow shield inside
- Heavy chamber version for basements
- Heavy and light labyrinth version for basement and standard rooms

Types of detector:

- All usable types of detector: HPGe-, NaI-, Scintillation-, Proportional Detectors

Important radio-nuclides to be measured:

- All measurable radio-nuclides: natural primordial/cosmogenic and anthropogenic
- Incorporation from medical therapy and diagnostic, fertilizer and oil industry, waste and military applications as well as Phosphate and other mines.
- Natural radio-nuclides: U-238, Th-232, U-235 and there daughters in equilibrium as well as Ra-226, 228, 225 and their daughters like Pb-210 but also K-40, Cs-137 and additional nuclides of interest like actinides as Pu-isotopes.
- Energy range: 20 keV up to 2 MeV
- It covers also fission and activation products, e.g from full-outs and workplaces contamination
- Some radio-nuclides as K-40, Cs-137, Th-isotopes are homogeneously distributed in the body tissue and mussels.
- U-, Ra- and Sr-isotopes and Pb-210: most part are in the bone if ingestion is the primary path of intake and in the lung if inhalation is the primary way of

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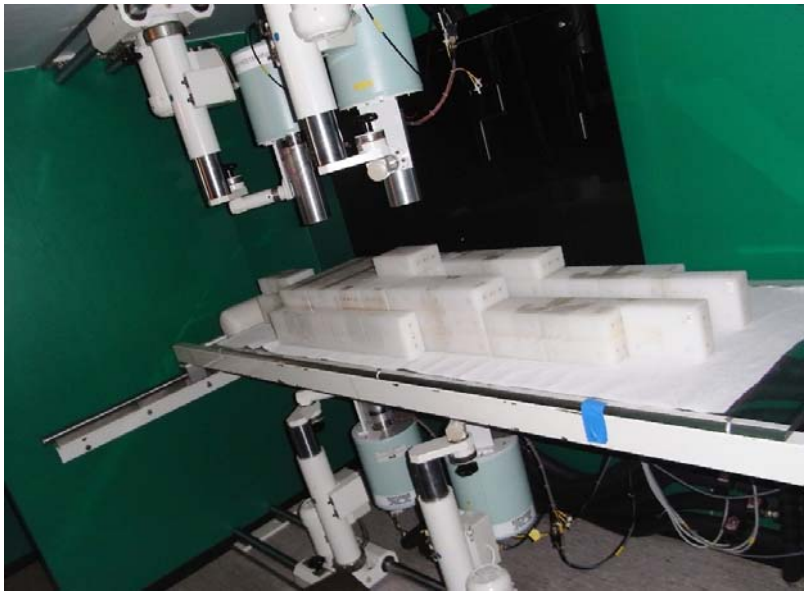
Our example for health and hospital application (lightweight version):

Partial body counter in chair and bed geometry with light shadow shield usable for adults and children, installed at Graz Austria:
Chair in variable geometry reclining to bed in scanning or variable geometry, with one very big high efficient HPGe detector surrounded by passive lead and active shielding and lead collimators embedded in a shadow lead shield. This system can be installed in most of standard rooms.

Two examples for official survey authorities, institutes as well as health and hospital application (heavy weight version):

Whole body counter in bed geometry with a heavy steel/lead shield camber with door, usable for adults and children, installed at Leipzig Germany:
Bed version in scanning or variable geometry with four very big high efficient HPGe detectors embedded in a steel/lead shield camber. This system can be installed in basements or stable, robust ceilings/floors.

Whole body counter in bed geometry during the calibration process using an IGOR phantom embedded in a heavy steel/lead shield camber with a labyrinth access usable for adults and children installed at BfS Munich:



Two examples for organ (lungs, liver, head) counting, compact chamber version (middle weight versions):

Organ body counter in chair and bed geometry with a steel/lead shield

Chair in variable geometry reclining to bed in scanning or variable geometry, with four planar HPGe high efficient low energies detectors embedded in a standard rectangular steel/lead shield with door installed at KWU Germany.

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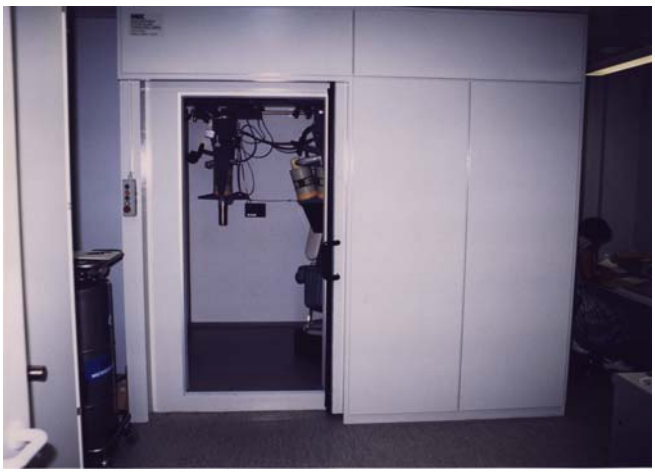


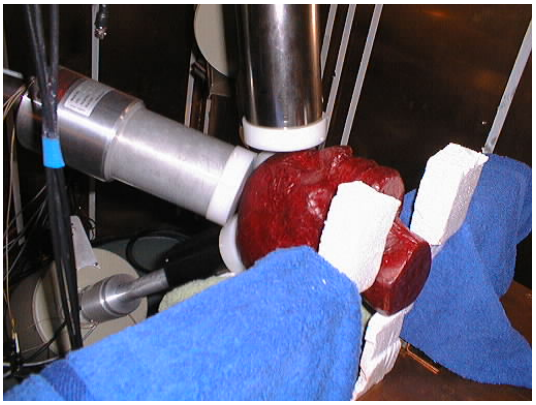
Organ body counter in bed geometry with labyrinth sandwich shielding

Bed geometry in variable positioning or scanning mode with four planar HPGe high-efficient low-energies detectors embedded in a standard labyrinth sandwich shield installed at BfS Munich.

Two examples for research application:

Individual head and organ body counter in bed geometry with labyrinth sandwich shielding

Bed geometry in variable positioning with large four/five planar HPGe detectors, highly efficient for low energies application embedded in a standard labyrinth sandwich shield installed at HMGU (GSF) Munich.



Individual research application for head and knee geometry at Prague

Example for combined beta and photon application:

Mobile incorporation monitor chamber using a shadow shield design for beta and photon head measurement geometry as well as simultaneously photon stomach measurement geometry at BfS Munich Germany.
We designed and installed this mobile monitor for measurements of man-made and natural incorporated radio-nuclides in highly contaminated areas at Russia in the “South of Ural” at Tscheljabinsk.