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 Packages for _In Vivo_, _In Vitro_ and _In Situ_ Applications.
Virtual Modelling and Simulation of Real Scenarios.

HR-LE-PS-03

Highest-Resolution for Low-Energy γ-Spectrometer

- ☙ Highest diagnostic power photon spectrometers for the low-energy measurements.

- ☙ Best analyses algorithms for low-energy peak-shape analyses and calculation of isotopic ratios.

- ☙ Based on an spectrometer developed by ISuS

We have committed all of our experience in Spectrometry as well as all of our enthusiasm to realize systems which are "state-of-the-art"

Description

Hardware

Photon germanium detectors developed for highest-resolution in the field of low-energies spectrometry (1 keV up to 300 keV) are used for direct assessment of emitting low-energy photons: gamma & x-rays from radioisotopes.

As an important element in the field of radiological protection the direct and fast measurement of nuclear materials for their accounting treatments, requires the best energy resolution. It can be achieved only using germanium detector crystals technologies with the best manufacturable diagnostic power.

This is the most important requirement for direct and fast measurements, e.g., of isotopic ratios of plutonium and uranium. Therefore, it is indispensable in case of an accident or an unexpected contamination.

These "State of the Art" systems from ISuS are designed to measure the low-energy photon emissions from actinides, to calculate their isotopics.

The ISuS Radionuclide Handbook contains all these isotopes and all the special particle interaction processes concerning actinide production and decay processes important for this application.

Software

For the interpretation of the measured pulse-height-distribution, the analyses algorithms have to be developed not only for the special low-energy peak shapes but also for calculation of isotopic ratios.

Usually this is possible with special, i.e., separate analysis packages.

One of the first developments was presented and realized by Gunnik more than 20 years ago.

Based on these algorithms, two software packages are available on the market:

- **MGA-U/P** for U, Pu, Am and other Isotopes
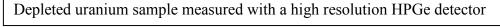- **FRAM** also for U, Pu, Am and other Isotopes

and a new method based on a non-linear fitting algorithm usable for both, gamma-ray spectrometry analysis for different peak shapes and determination of isotopic ratios all simultaneously:
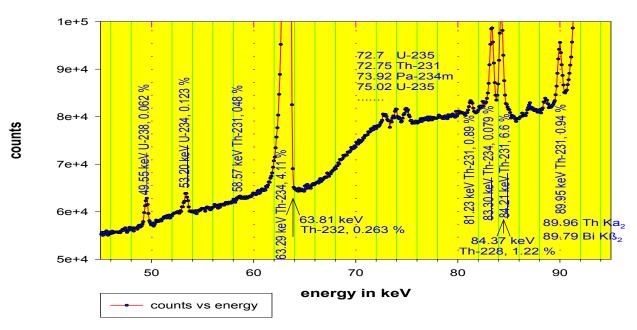
- **VRF (Visual Robot Fit)**

available via ISuS.

All of these programs are supported, but having different priorities and applicability's. MGA und FRAM can only be used in combination with the corresponding firmware software. Depleted uranium analyses U235/U238=0.200:

Example from an measurement by ISuS:

Depleted uranium sample measured with a high resolution HPGe detector

Result of Isotopic ratios for a soil sample measurement

Detector Material	Pu-240 / U-238	U-236 / U-238	Am-241 / U-238
HPGe planar			
Sample Nr. 1	< 0.07	< 0.04	< 0.0001

Isotopics-what it is:

Isotopics is the estimate of the percentage by weight or percentage by atom of a selected isotope to the sum of all isotopes of a selected element. Two important measurements of isotopics are the percentage by weight of U-235 in uranium, and the percentage by weight of Pu-240 in plutonium. Normally, in cases of interest, uranium is almost entirely composed of U-238 and U-235, and plutonium is almost entirely composed of Pu-239 and Pu-240.

Information to **"Isotopics"** from the ISuS "**Radionuclide Handbook**":

Isotope	Relative Isotopic Abundance		Activities →		Ratios	
	by atom %	by weight %	kBq/gU	%	$^{234}U/^{238}U$	$^{235}U/^{238}U$
Natural	[6]		[8]			
^{238}U	99.2745_{60}	99.284	12.356_{10}	48.9		
^{234}U	0.0055_{5}	0.0053	12.356_{10}	48.9	1.00	
^{235}U	0.7200_{12}	0,711	0.5685_{12}	2.2		0.046
Depleted						
^{238}U		99.8000	12.356_{10}	83.7		
^{234}U		0.0010_{1}	2.26	15.2	0.18	
^{235}U		0.2000	0.16	1.1		0.013

Performance

HR-LE HPGe γ-Detectors

- Small planar crystals   **Diameter:** e.g. 500 mm^2; **Thickness:** 2, 3 cm
- Small coaxial crystals   **Diameter:** 5, 7, 8 cm; **Thickness:** 1.5, 2, 3 cm
- Ultra low-background (ULB) version
- Be or carbon windows

Sample Geometry

- For planar/coaxial crystals   Optimal for point & filter sources & Petrie shells

Spectrometry Electronics, Hardware and Software

- State-of-the-Art digital spectrometry electronic
- High performance PC systems
- Gamma spectrometry Software (Gamma-Vision, Genie, VRF Visual-Robot-Fit, …)
- Actinide software for uranium, plutonium, americium:
  (MGA R. Gunnik, FRAM-BW, Visual-Robot-Fit G. Lasche, ..)

Low Background Sandwich Shielding Design

- Excellent passive sandwich lead shield for background reduction
- Inner layer of lowest-level lead and 4-8 mm electrolytic copper

Additional

- Installation
- Training
- Handbooks

Distributor

Example of a Results

Isotopics

Group1, U235[6d], U238[150d], U234, U236

Attenuation group: ⦿ 1   ○ 2

Isotope of interest: U235[6d]_X_WW ▼

Other major isotope: U238[150d]_X_WW ▼

Other major isotope: ▼

Other major isotope: ▼

Calculate isotopics

Weight percent: 0.2022

Uncertainty: 0.01085