WG6 IPNDV Experimental Technology Data Sheet

January 16, 2020, Wirz, Switzerland

Name of Experimental Campaign:
Belgium exercise to investigate performance of measurement methods

Technology Name: High-resolution Gamma-ray Spectroscopy (HRGS)

Physical Principle/Methodology of Technology:
Detection of gamma lines of radionuclides by means of high-purity germanium detectors. Spectral analysis with Multi Group Analysis (MGA) and Fixed energy Response function Analysis with Multiple efficiencies (FRAM).

What Does the Method Determine/Measure (e.g., presence of nuclear material, isotopics, mass):
Presence of nuclear material U and Pu, Pu isotopics

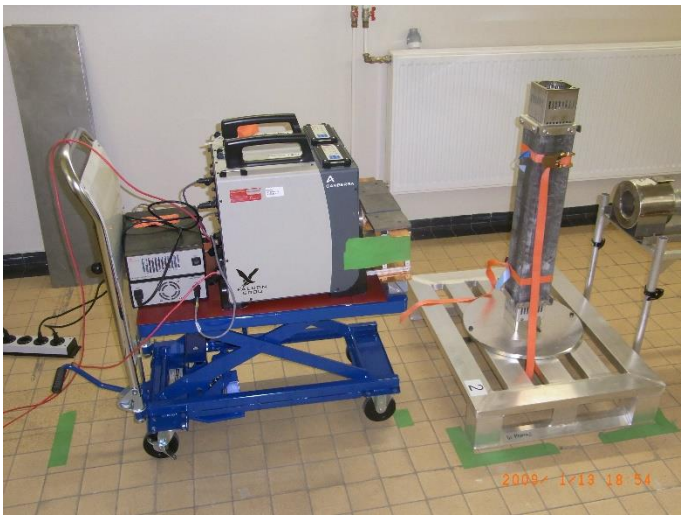
What Is the Applicability to IPNDV:
To measure U and Pu isotopics in conditions where shielding is not an issue

Type of Data Collected by the Technology:
Two gamma spectra from each sample were collected, one in a lower energy range from 4–614.4 keV and the other one from 4–2048 keV.

Constraints (e.g., time to install the equipment, measurement times including distance from object, dose rate required, required Cd shielding to limit the count rate):
Within 30 minutes the equipment is easily installed. It usually takes more time to get the equipment through all the controls and near to the object to be measured.

If the detectors are not cooled during transport, they have to be cooled down to liquid nitrogen temperature (−196 °C), which takes for the equipment used approximately 4 hours.

Physical Description/Diagram/Photos of the Experimental Setup/Layout:



Two Falcon 5000, electrically cooled Ge detectors were placed on a lifting lab trolley.

The detector crystals were at the same height as the center of the MOX rods. Depending on the signal strength a distance between the centers of the detectors and the center of the rods was chosen between 54–155 cm. The gain of the two detectors was 75 eV/channel and 250 eV/channel respectively. With these gains and 8k channels one detector took spectra from 4–614.4 keV and the other one from 4–2048 keV.

Specific Objects Measured (which of the experimental objects were measured; if not described elsewhere, describe experimental objects here):

19 pins configuration of:

- 100 cm H-MOX 62%
- 50 cm 0.7/5.1 79% 239Pu
- 50 cm 0.7/4.3 96% 239Pu

Each one was measured without shielding, with 1.1 mm Cd shielding and with a 5 mm Pb shielding. Three configurations and three different shieldings per configuration results in a total of nine arrangements. As we took simultaneously two spectra, we collected 18 spectra.

Process Required to Analyze the Data (include any software used):

MGA, FRAM, efficiency curves calculated with ISOCS and Geant4

Preliminary Results (qualitative, not quantitative; e.g., did the method perform as expected, if not how was it different):

The analysis of the spectra with the two programs MGA and FRAM in determining the Pu239 fraction yielded comparable results. As expected, the gamma peaks below 200 keV in the spectra of the Pb

shielded samples were too weak to be evaluated. Here the evaluation of the spectra at higher energies also gave comparable results, but with an increased uncertainty. This means that the method performed as expected.

Monte Carlo simulations are not finished yet.

Final Results (if available; if not, estimate of when final results will be available):
We intend to calculate some efficiency curves with ISOCS and Geant4, which should be realized by March 2020.

Lesson Learned (e.g., what went well, what went wrong or not as expected, do the results confirm what we said in the technology tables?):
The results confirm what was said in the technology table.