WG6 IPNDV Experimental Technology Data Sheet

Tore Ramsøy, Naeem Ul Syed, Kjell Johansson, Norway

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

Technology Name: Gamma-ray Attribute

Physical Principle/Methodology of Technology:
HPGe measurement

What Does the Method Determine/Measure (e.g., presence of nuclear material, isotopics, mass):
Presence/absence of SNM, Isotopic rate Pu239:Pu240

What Is the Applicability to IPNDV:
Test of information barrier algorithm for determining presence of Pu239 and that the Pu239 to Pu240 ratio is above treaty agreed limit

Type of Data Collected by the Technology:
Gamma-ray spectra
Measurements on assembly with 19 and 61 pins (100 cm). Best statistics on 50 cm pins, section 3 with 96% Pu239. Measured with and without Pb shielding.

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):
Measurement time approximately one hour. Use of Pb collimator with interchangeable opening to limit dose rate.

Physical Description/Diagram/Photos of the Experimental Setup/Layout:
Experimental set up consisted of:

- Ortec HPGe portable detector;
- FAST Comtech MCA4 Series ADC: Four channel Multichannel Analyzer;
- Ortec Minibin and power supply;
- Ortec 570 Amplifier;
- Ortec Dual 5kV Detector Bias supply;
- Pb collimator with opening 0 mm, 5 mm, 10 mm, 20 mm, and 65 mm (open). Pb thickness 30mm;
- Purpose made detector stand.

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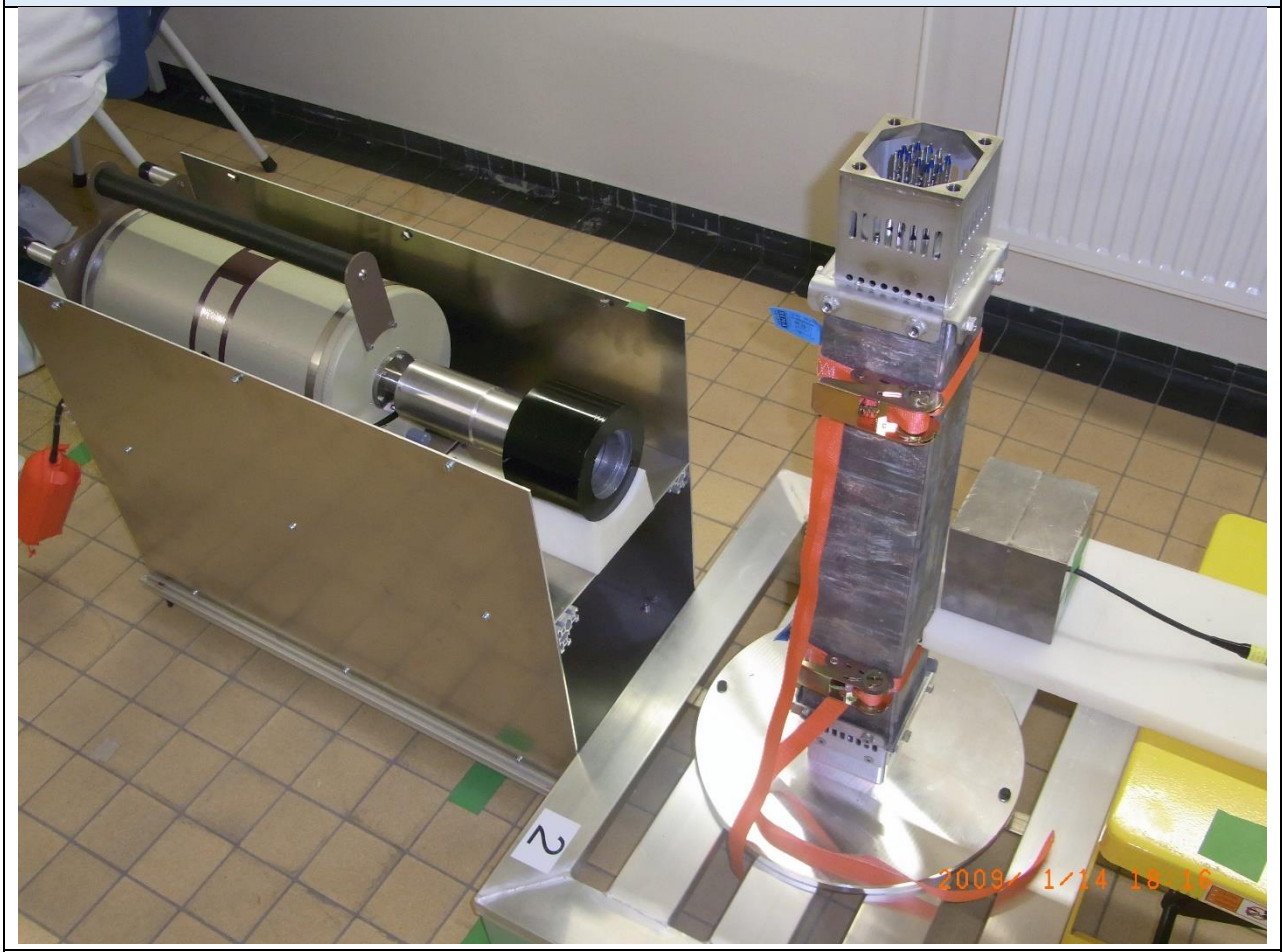

Specific Objects Measured (which of the experimental objects were measured; if not described elsewhere, describe experimental objects here):

Process Required to Analyze the Data (include any software used):
Spectra analyzed with FRAM plutonium and uranium isotopic analysis code.

Preliminary Results (qualitative, not quantitative; e.g., did the method perform as expected, if not how was it different):
Identification of Pu239 went well. The isotopic ratio is calculated using the relative intensity of the Pu239 peak at 645 keV and the Pu240 peak at 642 keV by the UKNI IB algorithm. The Pu240 peak is initially difficult to analyze because it is mixed with a contribution from the Pu230 photopeak and Am241 at 640 keV. Initial analysis showed that the number of counts in the latter multiplet was very low.

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Final Results (if available; if not, estimate of when final results will be available):

Analysis with FRAM code have provided following values for enrichment of Pu239:

- 100 cm, 19 pins, Pb shield: 74%
- 100 cm, 61 pins, unshielded: 63%
- 100 cm, 61 pins, Pb shielded: 52%

(target value 62%)

- 50 cm, 61 pins, Pb shielded: 90%
- 50 cm, 61 pins, unshielded: 91%

(target value 96%)

The discrepancy from true values will be investigated further using the FRAM code. Furthermore, evaluation of the UKNI IB algorithm will be performed.

Final results are estimated to be ready by July 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?):

High-dose rate resulted in loss of resolution. Necessary to assess dose rate effects when planning the inspection and use appropriate distance and shielding during measurement as the dose rate effect will be hidden for the inspecting team using an IB.