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Mathematical vs classical efficiency calibration in routine measurements of gamma emitting radionuclides in environmental samples

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Content

High resolution gamma-ray spectrometry is a nuclear analytical technique widely used for a determination of radionuclides in wide range of their activities in various kind of samples, from nuclear waste samples to the environmental samples and foodstuffs. For the quantitative determination this technique requires a determination of a detector efficiency with a high accuracy. As the detector efficiency depends on an energy of emitted gamma rays, physical properties of materials and a sample geometry, calibration standards with same characteristics should be used for the efficiency calibration. However due to a large variety of the materials that have to be analysed, it is hard to obtain standard materials of the same characteristics. Therefore, the possibility to determine the detection efficiency in a mathematical way by detector and sample setup modeling can significantly facilitate the procedure. The aim of this work is to compare accuracy and precision of the radionuclide determination by using mathematical calibrations and classically source-based ones in routine measurements of specific environmental samples. As Canberra has developed Laboratory SOurceless Calibration Software (LabSOCS) for this aim, spectrometry setup, consisting of the Canberra broad energy germanium detector (BEGe) with the original lead shielding and Genie 2000, LabSOCS/ISOCS softwares are used for the quantitative determination of low-level activities in few specific matrices such as honey samples and borosilicate filters.

Monitoring of the environment pollution by anthropogenic radionuclides (such as the Chernobyl derived Cs-137) at different sites in Croatia is carried out over the years in our laboratory. It was found that ideal samples to reflect the radionuclide pollution over large areas can be honey samples. Namely, honey bees readily fly up to 4 km in all directions from their hive and thus have access to an area of about 50 square kilometers. In that way we get the best composited random sample. However highly representative samples do not guarantee accurate determination because it depends on a choice of the calibration standards. Since it is hard to obtain standards with the matrix of this type for the quantitative determination, materials with closest density to the measured sample, usually soil standards, were used. Therefore, obtained results of the radionuclide determination by classical calibration in honey were compared with results obtained with the mathematical calibration. Before that, an influence of a choice of the matrix composition in the mathematical calibration on the results is investigated. Several different matrix models are compared to find the best suiting mixture. The mathematically obtained efficiency calibration curves for this matrix are checked by inserting a small known amount of the standard with known activities into the same type of samples of honey. The influence of the homogeneity of the standard inserted in the sample is investigated too. Similar procedure is done for the borosilicate glass structure 0.7 μm pore size filter, 47 mm in diameter, 0.42 mm thick, placed in a plastic container. This type of samples can be used for the measurements of the radionuclides contamination in the air and applied in emergency situations, so it is important to have precise calibration curve. Accuracy and precision of the mathematical calibration are also tested with proficiency test samples of water and soil. All these results will be presented in the paper.

About the Presenter

I graduated at Department of Physics, Faculty of Science, University of Zagreb as a graduate engineer of physics (equaling to the Master of science in Physics level by the International classification) in 2011 and I enrolled in the PhD program at University of Rome „Tor Vergata“, Faculty of science, Physics Department. I worked on my PhD thesis at the National Laboratories in Frascati, National Institute of Nuclear Physics, (LNF-INFN), with the KAONNIS Group lead by Dr. Catalina Curceanu working on kaon-nucleon/nuclei interaction in a framework of AMADEUS project. In 2015 I finished

my PhD by defending the thesis titled „Studies of the [U+0245]-triton correlations in the low-energy kaon-nuclei interactions at DAΦNE with the KLOE detector“. In july 2015 I started my work at the Ruder Boskovic Institute of Zagreb, Division for Marine and Environmental Research, in the Laboratory for radioecology where I am involved in determination of activity concentrations/massic activities of radioactive elements by high resolution gamma-spectrometry.

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