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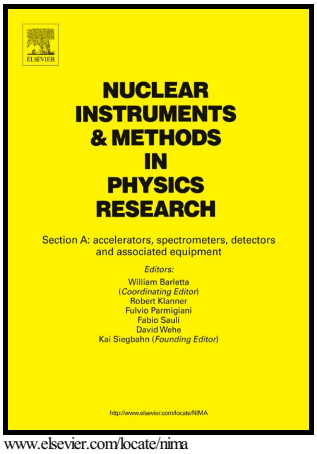

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Applying ISO 11929:2010 Standard to detection limit calculation in least-squares based multi-nuclide gamma-ray spectrum evaluation

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Abstract

The concepts of ISO 11929 (2010) are applied to evaluation of radionuclide activities from more complex multi-nuclide gamma-ray spectra. From net peak areas estimated by peak fitting, activities and their standard uncertainties are calculated by weighted linear least-squares method with an additional step, where uncertainties of the design matrix elements are taken into account. A numerical treatment of the standard's uncertainty function, based on ISO 11929 Annex C.5, leads to a procedure for deriving decision threshold and detection limit values. The methods shown allow resolving interferences between radionuclide activities also in case of calculating detection limits where they can improve the latter by including more than one gamma line per radionuclide. The common single nuclide weighted mean is extended to an interference-corrected (generalized) weighted mean, which, combined with the least-squares method, allows faster detection limit calculations. In addition, a new grouped uncertainty budget was inferred, which for each radionuclide gives uncertainty budgets from seven main variables, such as net count rates, peak efficiencies, gamma emission intensities and others; grouping refers to summation over lists of peaks per radionuclide.

Keywords

Gamma-ray spectrometry; Nuclide identification; Weighted total least-squares; Detection limit; Peak efficiency covariances; Grouped uncertainty budget

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1. Introduction

In software for gamma-ray spectrometry the activities of radionuclides measured, e.g., in a sample from environmental monitoring, are often calculated serially, radionuclide by radionuclide, because in routine spectrum evaluations severe interferences between gamma-ray peaks of different radionuclides do not occur that often. The activity is then calculated as a weighted mean of the activities obtained for each individual line of that radionuclide. If interferences with gamma-ray peaks of other radionuclides occur these are often re-

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