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A laboratory exercise on systematic effects in gamma spectrometry

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High resolution gamma spectrometry is a powerful method for the measurement of gamma emitting radionuclides. It requires most often only a minimum of sample pre-treatment. Moreover, gamma spectrometry is often considered as a transparent measurement method and is for that reason well understood by the users. However, often sample density and composition is different compared to standards used for the calibration of the measurement system. Another example of deviations between the calibration standard and the sample is when the sample container not can be filled to the same volume as the standard. Moreover, measurement of radionuclides emitting gamma photons in cascade, such as 134Cs, will suffer from true coincidence summing (TCS) effects when the samples are measured close to the detector. These systematic effects will often be significant, and have therefore to be corrected.
Everyday users of gamma spectrometry, at measurement laboratories such as within the nuclear industry, might be aware of these situations causing systematic effects and therefore deviations in the measurement results. However, methods for the correction of systematic effects are still rarely implemented in routine laboratories. One attempt to improve this situation was to develop a laboratory exercise for students in a master's course in nuclear chemistry. A spectrum containing peaks from 137Cs and 134Cs with an activity ratio of one was given to the students. The task comprised to evaluate the spectrum with respect to activity of the two radionuclides as well as their activity ratio. First this was done without correction. With the use of a program, EFFTRAN, for calculation of e.g. efficiency transfer factors and correction factors for true coincidence summing effects (TCS), the students could thereafter calculate the corrected activity of 134Cs as well the corrected activity ratio. Moreover, the effect of sample-to-endcap distance on TCS was also evaluated. A third and last task in the exercise was to perform efficiency transfer for cases when volume differed between calibration standard and sample. The use of a calculation program, such as EFFTRAN, enables to illustrate the impact from the systematic effects on measurements with gamma spectrometry. The programs also allow the students to gain a deeper understanding regarding which parameters has the greatest influence on different effects and in which energy regions.

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