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Implementation of calculation codes for corrections of systematic effects in measurement laboratories

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A vast number of papers are reporting on the development of calculation codes for corrections of systematic effects in gamma spectrometry. Many comparison studies have also been performed where differences and similarities between many of those calculation codes are presented. However, most studies performed in this area are performed for the experienced user or program developers. Despite the high quality of those papers and the important information about the calculations codes, when selecting, implementing and using these codes at different laboratories regular users are often struggling with other issues.
This study aimed at considering a user perspective for correction of common systematic effects within gamma spectrometry that measuring laboratories are facing in their daily work.

A coincidence free calibration was established for a volume source at an endcap position by characterising the detector geometry using the calculation code VGSL (Virtual Gamma Spectrometry Laboratory). Furthermore, four different calculation codes (ANGLE, EFFTRAN, GESPECOR and VGSL) were compared by calculating corrections factors for true coincidence summing (TCS), fill degree in the sources and new source-detector geometries. Two of the calculation codes are simulation codes and two are semi-empirical codes. The detector model was optimized with VGSL and thereafter the same model was used in the other softwares.

There are differences in how the correction factors are calculated in the calculation codes, by Monte Carlo simulation or efficiency transfer. Also the degree of details of the detector and source parameters that can be entered varies between the codes. Within the scope of the investigations in this study this has not shown any effects on the results. Furthermore, despite the fact that the detector model only was optimized with one of the calculation codes no clear differences could be observed as a result from this.

The uncertainty of the TCS corrected activities were found to be in the same magnitude as the certified activities in the reference solution itself. When activities were corrected for different filling degrees in the sample sources the deviations from the certified reference solution were generally lower than 5%. Larger deviations were observed, around 10% or less, when activities were corrected for new source-detector geometries. Discrepancies between 5 and 10% are often considered to be acceptable for some applications, i.e. environmental or survey monitoring. This is an important knowledge for cases when it can be motivated to calculate corrections for other source-detector geometries. However, measurements should preferably be performed in source-detector geometries closely resembling the calibration geometry since those corrected activities are associated with lower uncertainties.

The user should carefully select the proper calculation code that will cover the need of the measurements that will be performed, i.e. if TCS corrections are needed and what detectors and sources will be used. When implementing the calculation code at the measuring laboratory it is of greatest importance to validate the calculations and thereby identify within what boundaries the corrections are valid. It can be concluded that all the investigated calculation codes in this study are robust and will give reliable measurement results.

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