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Low background Ge gamma spectrometry of thick samples

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Gamma-spectrometry has been a crucial technique for the analysis of natural and anthropogenic radionuclides in nuclear, astrophysical, and environmental investigations, although recently mass spectrometry techniques such as ICPMS (Inductively Coupled Plasma Mass Spectrometry) and AMS (Accelerator Mass Spectrometry) have reached the lowest detection limits. The great advantage of gamma-spectrometry is the possibility of analyzing samples nondestructively without any pretreatment, especially if samples are of high scientific value (e.g. meteorites), but also in the case when we have large samples of a few kg scale available (e.g. for rare nuclear decay experiments). However, there are also limitations in gamma-spectrometry applications for analysis of very low activity samples, mainly because the radionuclides of interest (e.g. K-40, Tl-208, Pb-210, Bi-214, Ra-226, etc.) are also present in the background of gamma-spectrometers.
Gamma spectrometry of construction materials used in underground experiments has been a dominant technique for their radionuclide screening at very low levels, which has been an important prerequisite for reaching desired nuclear physics results. Radiopurity investigations of construction materials usually require relatively large amounts of sample material to achieve the required precision. However, this causes complications in measurement evaluations and activity determinations. The addition of sample material changes the background of the Ge detector in two ways. The sample material itself acts as a shielding for the detector and affects its background. The addition of large volume samples also changes the internal volume of the detector shielding, and therefore changes the amount of radon and its decay products around the detector. These effects require careful consideration of the measured spectra before the activity determination. A demonstration of these effects by measuring thick copper samples using a BEGe semiconductor detector in a low background shield (also supported by Monte Carlo simulations), will be presented.

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