SIMPLE EXTENSION OF THE CALIBRATION COEFFICIENTS FOR A GAMMA COUNT RATE MONITOR

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Abstract:
Count rate calibration coefficients for nuclide-specific activity concentration in constant monitoring surroundings are typically determined for only selected 2 or 3 radionuclides. In case there is a need to utilize gamma count rate monitoring also for nuclides other than those selected, the number of nuclides having calibration coefficients must be increased. A simple way of estimating the calibration coefficients for a variety of gamma-emitting radionuclides is presented. The estimation utilizes the properties of the detector material, the gamma energies and the gamma yields per transformation of each radionuclide, energy window of the count rate monitoring system and the count rate coefficients of the selected nuclides.

When the unscattered radiation dominates the count rate, as is the case in monitoring homogeneous activity concentration in a small volume and excluding the photons having lowest energy, the impact of the scattered radiation can be neglected without remarkably losing the accuracy of the result. Based on this reasoning the author has assumed, that the count rate observed by a detector can be calculated by equation

$$CR = K \cdot \sum_n A_n \cdot \left[\sum_i \mu_{a_{i,n}} \left(E_{i,n}\right) \cdot y\left(E_{i,n}\right) \cdot E_{i,n} \right]$$

where
CR is the count rate
K is the fitting coefficient
n is an index of different nuclides
A_n is the activity concentration of nuclide n
i is an index of different photon energies
E_i is the photon energy of the index i
$\mu_a(E)$ is the mass-absorption coefficient for the detector material for photon energy E
$y(E_i)$ is the yield per transformation for photon energy E_i

The fitting coefficient K can be assessed using the calibration coefficient of the detector determined for selected gamma emitting nuclides in constant operating surroundings. The calibration coefficient can be determined e.g. by Monte Carlo calculations.

If the accuracy of the calibration coefficients does not have to be at a laboratory level, a very simple method can be used to extend the list of nuclides having calibration coefficients. The data utilized are the mass-absorption coefficient of the detector, gamma energies and yields per transformation of each radionuclide, energy window of the monitoring system and a known count rate coefficient for at least one nuclide. The mass-absorption coefficient can be estimated by a fitting function, and thus a simple Excel calculation can be used.

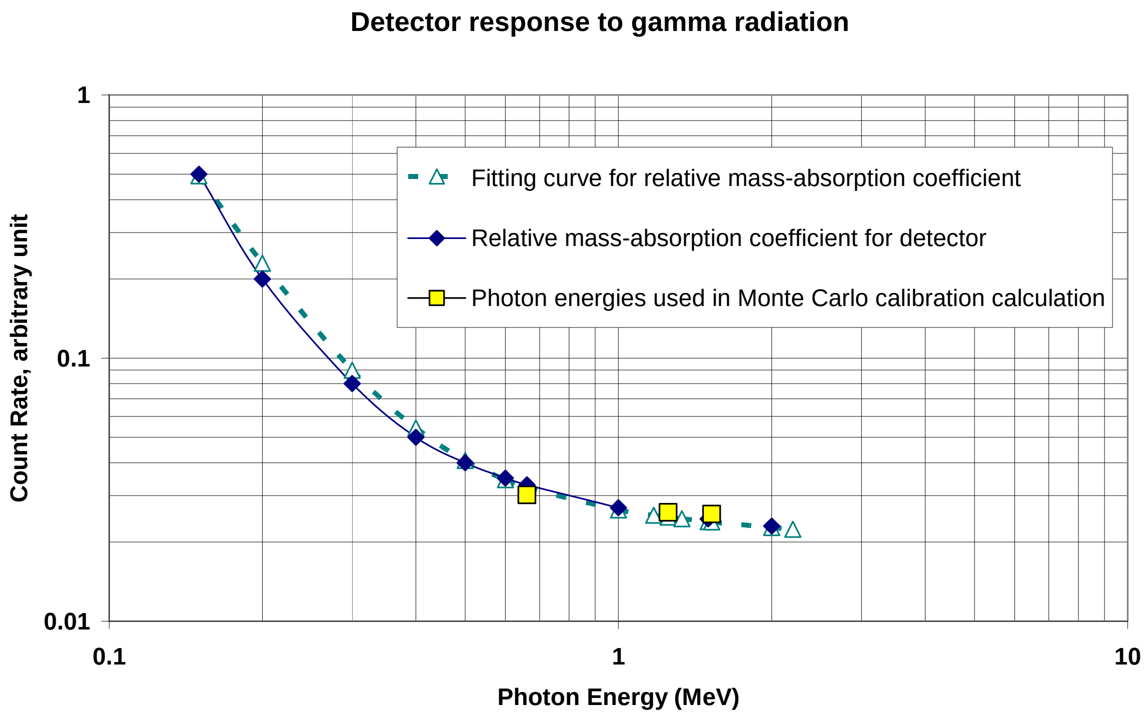

Fig 1. Mass-absorption coefficient for the detector and its fitting curve. Calibration points based on Monte Carlo simulation are shown by squares (□). In this case the calibration is determined for ^{137}Cs (^{137m}Ba) and ^{60}Co. The energy dependence of the response of the detector is shown by the mass-absorption coefficient scaled to arbitrary units relative to the count rate and marked by diamonds (◊). The fitting curve used in the Excel calculation is marked by triangles (Δ). The lowest and highest energy in the Figure indicate the energy window of the monitoring system.