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Environmental Radioactivity Analysis by a Sequential Approach

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Abstract : Quantitative environmental radioactivity measurements are needed to determine the level of exposure of a population to ionizing radiations and for the assessment of the associated risks. Gamma spectrometry remains a very powerful tool for the analysis of radionuclides present in an environmental sample but the basic problem in such measurements is the low rate of detected events. Using large environmental samples could help to get around this difficulty but, unfortunately, new issues are raised by gamma rays attenuation and self-absorption. Recently, a new method has been suggested, to detect and identify without quantification, in a short time, a gamma ray of a low count source. This method does not require, as usually adopted in gamma spectrometry measurements, a pulse height spectrum acquisition. It is based on a chronological record of each detected photon by simultaneous measurements of its energy ε and its arrival time τ on the detector, the pair parameters [ε,τ] defining an event mode sequence (EMS). The EMS serials are analyzed sequentially by a Bayesian approach to detect the presence of a given radioactive source. The main object of the present work is to test the applicability of this sequential approach in radioactive environmental materials detection. Moreover, for an appropriate health oversight of the public and of the concerned workers, the analysis has been extended to get a reliable quantification of the radionuclides present in environmental samples. For illustration, we consider as an example, the problem of detection and quantification of 238U. Monte Carlo simulated experience is carried out consisting in the detection, by a Ge(Hp) semiconductor junction, of gamma rays of 63 keV emitted by 234Th (progeny of 238U). The generated EMS serials are analyzed by a Bayesian inference. The application of the sequential Bayesian approach, in environmental radioactivity analysis, offers the possibility of reducing the measurements time without requiring large environmental samples and consequently avoids the attached inconvenient. The work is still in progress.

Keywords : Bayesian approach, event mode sequence, gamma spectrometry, Monte Carlo method
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