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The development of LaBr3 detection system which can realize rapid identification and analysis of radionuclides

With the development of nuclear power, nuclear application and the challenge of nuclear terrorism threats, it is indispensable to monitor and control nuclear and other radioactive materials effectively in order to prevent proliferation and smuggling.
Generally, radioactive materials can be identified by passively detecting and analyzing their characteristic gamma rays. Traditionally, energy spectrum analysis method, which statistically analyzes the gamma ray energy distribution based on Gaussian hypothesis, has been well developed and established and this method incorporating with HPGe (high-purity germanium detector) detector can identify radioactive material and precisely calculate its radioactivity. However, due to the long counting time resulted from the measurement of a large number of gamma ray events for low uncertainty of results, the energy spectrum analysis method is not suitable to be applied in security checking circumstance including customs, seaports, airports and checking points at borders. Typically, these radioactive materials waiting for inspection are put in shielded packages or cargo containers so that their characteristic gamma rays are easily attenuated and distorted.
This project studies the application of sequential Bayesian analysis method in the rapid identification of radionuclides, In this method, three "fingerprint"features of radionuclide, e.g. the decay half life, the gamma ray energy and the emission probability of characteristic gamma rays from different radionuclides, are jointly input into a model-based signal processor using the Bayes theorem and the sequential probability ratio tests theory, to make a judgment that whether the targeted radionuclides exists or not.
We developed a prototype of sequential Bayesian analysis system incorporating with a LaBr3 (Ce) scintillator detector to verify the feasibility of the sequential Bayesian analysis approach and to illustrate the detection performance (detection probability, mean detection time and false alarm probability) of this method varying as function of equivalent activity of the radionuclides. At the same time, the lower detection limit of the method is quantitatively evaluated.

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