$LaBr_3$ Spectrometry for Environmental Monitoring

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Abstract. The suitability of a $LaBr_3$ detector for continuous environmental monitoring was tested. Spectra were acquired at 10 min intervals and then sent to a central database for further processing. The detector material has excellent properties, such as good energy resolution, high density and large-enough size. However, there are some serious drawbacks. The energy response is non-linear and the gain changes in a varying environment. A fitting algorithm, based on the La-138/K-40 multiplet at 1440 - 1470 keV, was developed to keep the gain stable. In addition, an enhanced version of the multiplet deconvolution code was made under Java programming language for the spectrum analysis. This code is able to cope with non-perfect energy calibration. The spectrometry system is an excellent add-on for a countrywide radiation monitoring network providing nuclide identification at an early stage of fall-out, albeit it cannot be adopted at all stations because of high costs.

KEYWORDS: $LaBr_3$, environmental monitoring, nuclear accident, iodine

1. Introduction

In 2005-2007, Finland renewed its countrywide monitoring network of 260 stations. In the new network, the ambient dose rate is measured with Geiger counters and transferred in real time to the headquarters of the Radiation and Nuclear Safety Authority (STUK) and to regional Emergency Response Centres. The use of NaI spectrometers was considered when the update was initiated. However, these, do not have energy resolution good enough for resolving I-131 (364.9 keV) from natural radiation (Pb-214 at 351.9 keV). It was envisaged that better detectors would emerge in the future and the station infrastructure was designed to support spectrometric measurements.

Nowadays, detectors based on $LaBr_3$ are on the market. These devices are compatible with standard nuclear electronics and can be easily connected to a data acquisition system, such as the Linux-based computer at STUK's monitoring stations.

$LaBr_3$ detectors have excellent properties for environmental monitoring. The detectors are large enough (sensitivity) and have good energy resolution (2.5 - 3 % at 662 keV) compared to NaI (6 - 7 %). There are, however, two major technical drawbacks, which may prevent the use of $LaBr_3$ detectors for monitoring purposes. Firstly, the material contains La-138 and Ac-227 impurities, which give a complex background disturbing the analysis of the monitoring signal. Secondly, the gain variation of the detector, including the photomultiplier (PMT), may be several percentages, depending on ambient temperature, detector orientation (terrestrial magnetic field) and count rate [1]. However, in a stationary *in-situ* monitoring application for the detection of small amounts of man-made activity, only the temperature gradient has an important effect on the energy calibration. In the present paper we show that the problems related to the properties of the $LaBr_3$ detector can be solved and a nuclide-specific monitoring system with excellent quality can be constructed.

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