Position Statement

○ Title: Development of an Array of CZT Detectors for Safeguards Application
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○ Working Group Topic: International Safeguards

Various radiation detectors, such as the HPGe, NaI (Tl), and CdZnTe, have been employed in nuclear safeguards applications. Nuclear material measurements could be conducted under given specific situations where the use of an intrinsic HPGe is cumbersome and energy resolution of NaI (Tl) is not inadequate. These situations include nuclear material holdup measurements, in situ assay of nuclear materials, and unattended monitoring. A radiation detection system used in these situations must have good energy resolution and high detection efficiency. It also must be compact, rugged and simple to use in the field.

Due to of its electronic properties - high atomic number, wide bandgap energy, and low electron-hole pair production energy - a CdZnTe compound semiconductor has been used in the construction of portable hand-held nuclear measurement equipment. This is suitable for such specific situations. However, one of the disadvantages of a CZT is the difficulty of obtaining a large and homogenous single crystal. The limited size of the CZT also imposes restrictions on detection efficiency of the radiation detector and consequently increases measurement time during IAEA safeguards inspections. The problem regarding low detection efficiency has been of major significance in developing a CZT-based nuclear measurement instrument.

Our study deals with how to develop a portable hand-held nuclear material measurement instrument which consists of an array of four-CZT detectors, a data acquisition system, and an operation software (Figure 1). Energy spectral distribution of nuclear material (4.5%-enriched UO_2 uranium powder) was measured by the developed of a CZT array-based detection system and compared with those results obtained by another detection systems (Figure 2). As

shown in Figure 2, there is no difference in between the energy resolution of the 4-CZT array spectra and that of the individual spectrum. However, some photo-peaks which are not clear in a range of 100 keV to 200 keV in one CZT detector, became obvious in the energy spectrum of the CZT-array. That means that that the CZT array detection system combining four single CZT crystals could achieve a higher detection efficiency without degradation of the energy resolution.

Using various bare nuclear materials or nuclear materials in heavy shielding, we will conduct a more detailed experiment in order to characterize the performance of the developed CZT array detection system. The detailed experimental results will be discussed in this symposium.

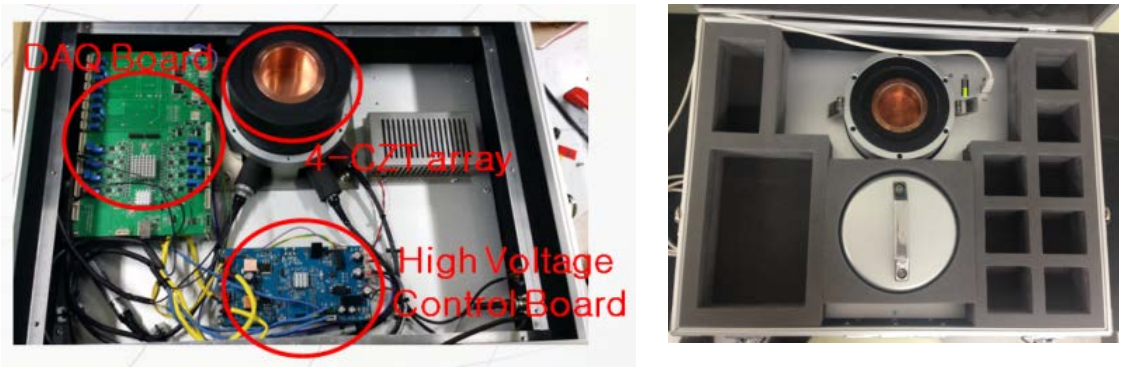

Fig. 1 Inside and outside views of the developed CZT array-based nuclear material measurement system

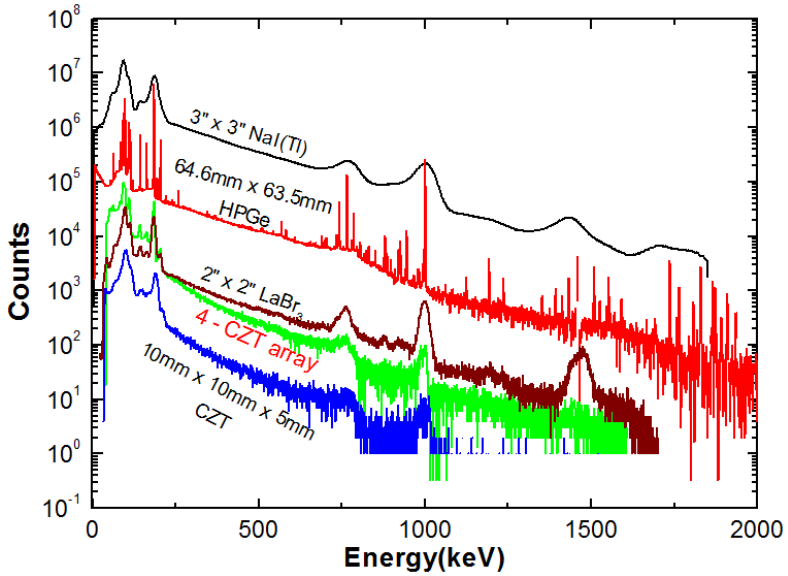

Fig. 2 Comparison of energy spectral distribution of 4.5% enriched UO_2 powder obtained by various radiation detectors