Summary

A non-destructive inspection of a hidden material is indispensable for a secure society. Especially for security of the nuclear energy, the detection of hidden special nuclear materials (SNMs) is an essential issue after 9.11 events. Several methods have been proposed and tested at the field, however it still needs further study for establishing the inspection system. Recently a new method for the non-destructive detection of the isotopic composition, which uses monochromatic γ-ray beam to excite a specific nuclear level and detect the de-excitation γ-ray, has been proposed. One of the key technologies of this method is the development of a γ-ray detector that should have a good energy resolution, good detection efficiency, fast response, cheap and robust.

The research in the field of γ-ray detectors always provides better characteristics for the detectors. Recently, lanthanum halides scintillators, newly developed γ-ray detectors, have been commercially available. The properties of these detectors have been known and many reports have shown that the lanthanum halides detectors offer good resolution, excellent efficiency, and very fast response.

The feasibility of using $LaBr_3$(Ce) scintillation detectors to detect nuclear resonance fluorescence (NRF) excitations is explored experimentally via a series of investigation during two rounds. Firstly, NRF experiment has been performed on B_4C target to excite the strong energy level of ^{11}B at 2.12 MeV using two different-size $LaBr_3$(Ce) detectors. Analytical framework based on real time background subtraction by means of sensitive iterative nonlinear peak (SNIP) clipping algorithm is applied on the ^{11}B results. The background subtraction technique was essential because the intensity of the NRF interaction is small compared with the intensity of the self-activity levels existing in the $LaBr_3$(Ce) crystals near 2 MeV region.

The results of the first phase showed that the $LaBr_3$(Ce) detectors exhibited a good potential for measuring NRF excitations near 2 MeV and suggested the implementation of the smaller size detector to decrease the effect of the self-activity. In the light of conclusions of the first round, a $LaBr_3$(Ce) detector array (LABRA) has been constructed to investigate the ability of $LaBr_3$(Ce) detector array to measure NRF excitations from ^{235}U for the non-destructive assay purposes. Using the LABRA detector, the cross section of the NRF excitation of ^{235}U at 1733 keV was measured. Results obtained with LABRA on the NRF excitation of ^{235}U, are benchmarked by results obtained with HPGe detector array for the same NRF level. The results show an excellent agreement with the available data and indicate a good performance of LABRA to detect ^{235}U using the NRF technique.