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#6-71 NaTIF a Radiation Portal Monitor: multiparametric analysis towards performances optimization, source anisotropy and threats tracking.

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The NaTIF (NaI-based Threats radiation emitters Finder) project is developing a patented next generation Radiation Portal Monitor (RPM) at CEA List Institute. This technology highlights a RPM that can be deployed, on the ground or mounted on vehicles, in highly frequented civilian areas and at national borders. The main goals are to ensure the monitoring and protection of these areas against radiological and nuclear threats, while providing, in addition, the capability to respond to such threats.

The technology uses inorganic scintillators [NaI:Tl(6Li)], denoted hereafter as NaILTM. NaILTM are price attractive, compared to He-3 based detectors, and relevant for the identification of both radiological and nuclear signatures. Regarding gamma spectrometry, the energy resolution of the Cs-137 gamma ray at 661.7 keV is estimated at 6-8% that is very close to classic NaI(Tl) detectors. Besides, NaILTM are doped with Li-6 that enables efficient thermal neutron detection in the most widely used gamma-ray scintillator, while still preserving the favorable scintillation characteristics of standard NaI(Tl). Each neutron and gamma contribution can be separated by using Pulse Shape Discrimination (PSD) method. In case of NaILTM, the discrimination power is important and given by a Figure of Merit (FoM), around the thermal bump, estimated at 3.8 in the scope of the current work.

The RPM consists in the combination of two NaILTM detectors with three surrounding EJ-200 plastic scintillators. Each inorganic and organic scintillator has an active scintillation volume of 1000 cm³. EJ-200 detectors serve the dual function of fast neutron detectors and moderators, thereby enhancing the RPM's overall sensitivity.

Our study focuses on optimizing the technical and the operational performance of the global RPM through a multi-parametric analysis. This was carried out by tuning parameters of the NaILTM detectors, specifically the high voltage, triggering threshold, and Constant Fraction Discrimination (CFD) settings. The goal was to minimize the energy resolution, maximize gamma/neutron discrimination capability, and improve the detection of low-energy gamma rays emitted by radiological threats, such as Am-241. Moreover, additional studies were conducted by changing orientation of the sources to highlight their anisotropy. Other studies involving the tracking of threats through the relative response of both NaILTM were also performed. The reported results were obtained in a laboratory environment using Cs-137, Cf-252 and Am-241 as radiological simulants.

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