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Gamma and fast neutron detection systems based on combined scintillators for nuclear safeguards and security applications

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The presented device is a compact gamma and fast neutron data acquisition system (DAQ) for passive and active NDA of SNM (Special Nuclear Materials). The DAQ weights just 8 kg, including batteries for more than 8 hours of continuous operation. It connects up to 4 organic detectors with Pulse Shape Discrimination (PSD) capabilities and runs PSD in real time on the radiation signals. It measures the energy of the interaction of gamma and neutron radiation separately and combines these values with an accurate determination of the Time-of-Flight at level of 1 nanosecond, to uniquely characterize the material under essay. It provides identification of neutron sources such as Cf-252, Am-Be, Pu, U, Am-Li, Pu-Be, also in presence of high gamma field, and covers scenarios where is present heavy shielding, moderating material, and masking sources.
The paper reports laboratory measurements performed with the use of samples of weapon, fuel, and reactor grade Pu. The laboratory measurement demonstrate the capability of easily determinate spontaneous fission and (⍺,n) reactions.
The device is already in use by the IAEA Safeguards for the assay of critical assemblies and its technology is already implemented in the fast neutron collar (FNCL) deployed by the IAEA Safeguards for fresh fuel verification. Moreover, it has been demonstrated the capability of the system to identify SNM isotopic composition using the spectrum of the energy deposited by gamma and neutron radiation in the organic scintillator.
Starting from these results, we extrapolated and described the potential use in major identified unattended scenarios. The system could be deployed for attended inspection and is already designed for scalability to variate detection efficiency as well as different level of gamma resolution.

Collaboration

MATTEO CORBO, PAOLA GAROSI, CRISTIANA DEL BENE

Role of Submitter

I am the presenter

Primary author: MORICHI, Massimo (CAEN SpA)

Presenter: MORICHI, Massimo (CAEN SpA)

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