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New neutron and gamma detection capacity for preventing illicit trafficking of nuclear and radioactive material

Neutron emission is a typical signature from the presence of nuclear material (particularly uranium and plutonium isotopes that may be potentially involved in illicit trafficking of material out of regulatory control - MORC). Certain sources like 241Am Be or 252Cf have a significant neutron component and could be potentially used in the manufacture of dirty bomb.

The measurement of the neutron signature is therefore a major objective from the point of view of nuclear security, in order to prevent illicit trafficking of nuclear and radioactive material. Neutron detection is usually performed using 3He counters, sensitive to thermal neutrons (effective cross section of about 5400 barns for neutrons with energy close to 25 meV). Knowing that most of the neutrons to be detected are fast neutrons (emission according to a Watt spectrum for the isotopes undergoing spontaneous fission, average energy of the order of 2 MeV) and with 3He detectors it's necessary to add a moderator (generally polyethylene) in order to optimize their detection sensitivity.

Since 2010, the strong demand for 3He on the nuclear security market has led to a shortage and a very significant increase of its price. For around eighteen years, research on credible alternatives to 3He, in terms of cost and detection efficiency, has been a major challenge for the research community. Numerous technologies have been studied: non-exhaustively, mention may be made of CLYC-type inorganic scintillators sensitive to thermal and fast neutrons, liquid scintillators and finally plastic scintillators.

On this specific problem of neutron detection, the CEA has focused its research for several years on solutions based on plastic scintillators, standard and modified.

The use of chemically modified plastic scintillators, thanks to the doping of our plastic scintillators by an organolithium complex, allows the detection of fast neutrons, thermal neutrons and gamma. This subject is studied as part of a CBRN-E counter terrorism research program aimed at developing a prototype of a fast neutron / thermal neutron / gamma discriminating handle detector. This new detector, allowing a triple discrimination, has been integrated in a measurement system in order to give the capacity to detect in the same time neutron and gamma emission to characterize for example a suspicious package.

In this article, we will present this new system developed and carried out by CEA LIST, we will also describe its associated features. Then a focus will be made on the use of this type of system and latest results obtained during an experiment in the field.

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