Fast neutron interrogation systems for detection of explosive materials

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Fast neutron interrogation systems (FNIS) based on associated particle imaging method (APIM) using a neutron generator with an imbedded alpha particle detector is one of the perspective methods for detecting hidden hazardous materials. As a result of researches in many centers the characteristics of FNIS were greatly improved in recent years and prototypes of systems for practical application were designed. Using of fast neutrons for detecting hidden materials is based on measuring prompt gamma ray spectra from the fast neutron inelastic scattering reactions in hidden object. High penetration ability of fast neutrons and gamma rays allows obtaining such spectra from an object hidden among others objects behind metal screen that is impossible using x-ray. Prompt gamma-ray spectra can identify many nuclides so that elemental composition of the object can be determined. The main problem in methods using fast neutrons is high level of background in gamma-ray spectra measured with gamma-detector. The associated particle imaging method which is actively developing in many research centers considerably increases the signal-to-background ratio. The method proved itself in laboratory experiments and prototypes of devices for industrial application was developed in several research centers. The size of one pixel in alpha detector should be much larger than size of ion beam. Spatial resolution in transverse direction depends on number of pixels and distance between neutron source and interrogating object. There are two types of alpha detectors, scintillator and Si, which can be imbedded in neutron generator. The alpha scintillator detectors are more resistant for radiation damages and can provide high spatial resolution but the background is very high because they are sensitive to light, gamma rays, electrons and neutrons. Background in Si alpha detectors is much lower because it can be easily made not sensitive to gamma rays, light and electrons. The main draw back of Si detector is deterioration of their characteristics under irradiation. There were reports about nine pixel (3x3) alpha detector which had remained operational after irradiation by integral alpha particle flux of 1014, which corresponds to about 5000 hours of work inside neutron generator with intensity of 108n/sec in 4π. The prototype for luggage inspection was proposed in with the following design characteristics: inspected volume - 0.55 x 0.85 x 1.3 m3, inspection time - 20sec, spatial resolution -11 x 11 x 10 cm3, minimal detected amount of explosive – 200g.