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Title: Neutron Activation Analysis for Flux Measurements during Active Interrogation

Abstract

Detection of special nuclear material (SNM) can be improved by employing photon active interrogation (PAI). When shielded, SNM such as uranium can be difficult to detect due to limited passive emissions. In PAI, a high-intensity photon beam induces photonuclear reactions in SNM, increasing emitted neutron flux, improving detection capabilities over passive detection systems. A major challenge in PAI stems from the presence of a large photon flux during experiments, which can dominate the neutron flux and cause significant pile up in the detector. A measurement technique that is insensitive to photons would eliminate these obstacles. Neutron activation analysis (NAA) is one such technique wherein a foil, or small sample of interest, is placed near an object emitting neutrons (typically, a reactor). The emitted neutrons activate the foil nuclei, which will then decay. The foil is placed near a detector to count the gamma rays emitted during the decay. Using well-known reaction parameters, we can examine certain gamma energies for peaks in the detector spectra corresponding to activation reactions in the foil material. Then, parameters such as the cross-section and irradiation times can be used to calculate the flux incident on the foil. This process can be used to determine high-fidelity neutron fluxes emitted by targets in the aforementioned photon beam with no concern about photon misclassification or pileup, as the activation reactions examined are insensitive to photons. We are investigating the use of this technique to develop benchmarks for other PAI detection methods, as well as to detect SNM during PAI.