Identifying Nuclear Material via Prompt Photo-Neutron Multiplicity Measurements

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Prompt neutron emissions from photonuclear interrogation are more numerous by orders of magnitude than beta-delayed neutrons from fission fragments. However, prompt neutrons have not been used for the purpose of identifying the presence of nuclear material in part because of the difficulty in discriminating between neutrons originating from fissionable and fissile materials and neutrons originating from other high-atomic-number materials. In the present work, proof-of-principle multiplicity measurements of prompt neutron emissions were performed, both for depleted uranium (DU) metal and Pb. The present work has shown that photo-fission neutrons can be distinguished from photo-detachment neutrons, via multiplicity techniques, for the purpose of identifying nuclear material under circumstances where the neutrons are already naturally bunched in time by the pulsed nature of the accelerator. These techniques work for bremsstrahlung endpoint energies up to 20 MeV, where fission yields are dramatically improved compared to 10 MeV endpoint energies, but where neutron energy discrimination techniques fail. Measurements with the 44-MeV short-pulse accelerator at the Idaho Accelerator Center indicate that such measurements can be performed rapidly with a high-repetition-rate accelerator. Furthermore, the sensitivity of multiplicity techniques to multiplication suggests that these techniques can be used to distinguish DU from highly enriched uranium.

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