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Fast scanning of spent nuclear fuel dry storage casks using cosmic ray muons: Monte Carlo simulation study.

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Stable development of fission-based nuclear energy facilities requires the safe management of spent nuclear fuel. The growing number spent nuclear fuel in dry storage casks in intermediate storage sites around the world require efficient tools for non-destructive routine verifications of safe storage of spent fuel assemblies. Using a cosmic ray muon for screening of spent nuclear fuel in dry storage casks appears to be the most suitable solution for non-destructive verifications of fuel casks for safeguard purposes. Fast scanning of a fully or partially loaded dry storage casks is evaluated using Monte - Carlo simulation with Geant4 package and muons produced using CRY event generator. The point of closest approach (POCA) algorithms is used for reconstruction of muon interactions with dry storage casks. A Kolmogorov–Smirnov test was used to classify generated data samples for fully loaded casks and samples with one fuel assemble missing in dry storage casks. We use the Receiver Operating Characteristic (ROC) technique to characterize tradeoff between detection and false alarm rates. For one-hour measurement time detection rate can be achieved ~96%. The developed method of statistical analysis of reconstructed POCA points allows detecting dry storage casks with one fuel assemblies missing in a relatively short time of ~1 hour without full image reconstruction. The results of modelling demonstrate that the scattered muon tomography allows to perform efficient non-destructive scanning of dry storage casks for nuclear nonproliferation purposes.

Primary author: GEORGADZE, Anzori (Kiev Institute for Nuclear Research)

Presenter: GEORGADZE, Anzori (Kiev Institute for Nuclear Research)

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