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Title: Real-Time Analysis of Organic Scintillator Neutron Noise Measurements

Abstract

A fissionable assembly's reactivity and k-effective multiplication factor and a sample's mass have applications in nuclear nonproliferation and safeguards, criticality safety, and emergency response. Subcritical reactivity cannot be measured directly; instead, the reactivity is inferred using the prompt neutron decay constant, α, that can be estimated from neutron noise measurements, such as the Rossi-alpha and Feynman-alpha methods. Such techniques require a list of neutron detection times that can be obtained using organic scintillation detectors, which are sensitive to neutrons and photons. Data processing for neutron noise measurements is typically performed after the entire measurement. The goal of real-time neutron noise measurement analysis is to instead process data at regular intervals during the measurement to identify potential errors and to run until a desired precision is achieved. Cost and probability of unusable data are reduced in both cases. Some potential errors that may be encountered are the misclassification of neutron and photon particles, abrupt increases in the uncertainty of the prompt neutron decay constant, and an unexpected distribution of neutrons encountered across different detectors (potentially indicating detector failure or miscalibration). Real-time analysis can verify that detectors have been wired properly and are calibrated. Real-time analysis can also determine the required measurement time to achieve a desired precision for the prompt neutron decay constant and other estimations. Currently, real-time analysis simultaneously generates six graphs that allow users to visualize data and observe trends during the measurement process. Additionally, this work verifies whether individual detectors have consistent responses, identifying detectors that provide less accurate results.