2023 MTV Workshop Abstract

Author List:

F. B. Darby[1], Michael Y. Hua[1,2], Jesson D. Hutchinson[2], Robert A. Weldon[2], George E. McKenzie[2], Juliann R. Lamproe[1,2], Shaun D. Clarke[1], Sara A. Pozzi[1]

[1] Department of Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI 48109, United States of America

[2] NEN-2: Advanced Nuclear Technology Group, Los Alamos National Laboratory, Los Alamos, NM 87545, United States of America

Title:

Rossi-α with Organic Scintillators Measuring Highly Enriched Uranium

Abstract (Up to 300 words):

Neutron noise techniques constitute several analysis methods applicable to non-destructive assay. One technique is the Rossi-α method to calculate the prompt neutron decay constant (α) or its inverse, the prompt neutron period (1/α), for special nuclear material. This work evaluates measurements with organic scintillators measuring eight subcritical assemblies of kilogram quantities highly enriched uranium metal (93% ^{235}U) hemi shells stacked together to form fully closed shells and driven by a ^{252}Cf source at the center. The configurations have respective k_{eff} values of 0.64, 0.74, 0.81, 0.88, 0.91, 0.95, 0.98, and 0.99, according to MCNP6.2 KCODE. Measurements were acquired with an array of three-by-four 5.08 cm diameter by 5.08 cm length trans-stilbene crystals offset 166 cm from the source center. The Rossi-α method is applied to pulse-shaped discriminated neutron detection times taking all forward time differences from triggering neutron signals and building a neutron coincidence distribution. By fitting this distribution, we calculate the prompt neutron decay constant and its inverse, the prompt neutron period with high precision. The prompt neutron period ranges from 15-200 ns from most subcritical to the closest to critical configuration. α^{-1} provides an indicator of increasing criticality that, unlike raw neutron counts, is independent of the driving source for fission chains. The Rossi-α method provides a useful and effective method for monitoring sources with fission chain reactions.