Evaluation of the Effect of Pulse Shape Discrimination on Prompt Neutron Period Estimates

John-Tyler J. Iacovetta, Michael Y. Hua, and Sara A. Pozzi
Department of Nuclear Engineering and Radiological Sciences, University of Michigan, 48109
Sara Pozzi, pozzisa@umich.edu
Consortium for Monitoring, Technology, and Verification (MTV)

INTRODUCTION AND MOTIVATION

- Assemblies exhibiting fission chains are characterized by reactivity and/or multiplication.
- Reactivity is a quantity of interest in nuclear nonproliferation, stockpile stewardship, and criticality safety.
- The Rossi-alpha method is a neutron noise technique that can be used to infer the reactivity of delayed critical or near-critical systems.
- Organic Scintillators can be used in Rossi-alpha measurements of fast, fissioning assemblies.
  - Sensitive to gamma rays (gammas) and neutrons.
  - Sensitivity to different interactions in the scintillator.
  - Previous work shows gamma detections can be detected in the Rossi-alpha method.
  - Pulse Shape Discrimination (PSD) is typically necessary to separate neutron and gamma detections.
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EXPERIMENT

- Detectors: twelve 5.08 cm × 5.08 cm diameter trans-stilbene organic scintillators.
- Source specifications:
  - Weapons-grade, alpha-phase plutonium, driven by spontaneous fission of 239Pu.
  - 4.9 kg reflected by 7.62 mm of copper (Cu), nickel (Ni), iron (Fe), or tungsten (W).
- Each configuration was measured 20 times for 1 minute each time.
- PSD plots were evaluated for each configuration to separate out neutron only data.

CONCLUSIONS AND FUTURE WORK

- Rossi-alpha estimates from neutron-only and composite histograms exhibit agreement.
- Prior work establishes that neutron-only values are correct.
- PSD is not necessary for use in Rossi-alpha measurements using organic scintillators.
- Consider the use of cheaper detectors with greater light output (greater time and energy resolution):
  - Organic glass scintillators.
- Future work will include:
  - Evaluate Rossi-alpha estimates from cross-correlation data.
  - Cross-correlation differences between detectors in various geometries such as on either side of the fissile assembly.

MISSION RELEVANCE AND MTV IMPACT

- Mission Relevance:
  - Organic scintillators augment the current Rossi-alpha toolbox by adding sensitivity to fast metal assemblies → improved nuclear criticality safety and safeguards.
  - Organic scintillators require less measurement time than He-3, thereby saving procedural and operational costs.
  - Further reduce costs by using cheaper, non-PSD-capable detectors (e.g. organic glass).
- MTV Impact:
  - Funds this research (I am a fellow) and enables me to present at conferences.
  - Allowed me to attend the Nuclear Safeguards course at Oak Ridge National Laboratory.

REFERENCES


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