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The Development of Advanced Processing and Analysis Algorithms for Improved Neutron Multiplicity Measurements

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One of the most distinctive and informative signatures of special nuclear materials is the emission of correlated neutrons from either spontaneous or induced fission. Because the emission of correlated neutrons is a unique and unmistakable signature of nuclear materials, the ability to effectively detect, process, and analyze these emissions will continue to play a vital role in the nonproliferation, safeguards, and security missions. While currently deployed neutron measurement techniques based on 3He proportional counter technology, such as neutron coincidence and multiplicity counters currently used by the International Atomic Energy Agency, have proven to be effective over the past several decades for a wide range of measurement needs, a number of technical and practical limitations exist in continuing to apply this technique to future measurement needs. In many cases, those limitations exist within the algorithms that are used to process and analyze the detected signals from these counters that were initially developed approximately 20 years ago based on the technology and computing power that was available at that time. Over the past three years, an effort has been undertaken to address the general shortcomings in these algorithms by developing new algorithms that are based on fundamental physics principles that should lead to the development of more sensitive neutron non-destructive assay instrumentation. Through this effort, a number of advancements have been made in correcting incoming data for electronic dead time, connecting the two main types of analysis techniques used to quantify the data (Shift register analysis and Feynman variance to mean analysis), and in the underlying physical model, known as the point model, that is used to interpret the data in terms of the characteristic properties of the item being measured. The current status of the testing and evaluation of these advancements in correlated neutron analysis techniques will be discussed.

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