Novel Active Interrogation Techniques for the Detection of Special Nuclear Material

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Active interrogation techniques for the detection of special nuclear material are being investigated for many applications in the areas of nuclear safeguards, nuclear nonproliferation, and homeland security. The performance assessment of existing techniques and the development of new, more advanced ones rely on accurate simulation of realistic threat scenarios. The analysis of non-threat scenarios is also crucial to correctly evaluate the detection probability and to minimize the occurrence of false-positive alarms.

In active interrogation systems, an external neutron or gamma-ray source is used to induce fission in the nuclear material, and appropriate radiation detectors are used to measure prompt and delayed neutrons and gamma rays emitted from fission. The readings from these detectors are subsequently analyzed to identify unique features that can be used to detect, identify, and characterize the special nuclear material. Thus, the simulation systems used in this research must be able to (1) accurately model the physics of various particle interactions *and* (2) correctly evaluate the detector response.

To address this problem, research and development efforts at the Oak Ridge National Laboratory (ORNL) and elsewhere have been focused on the development of accurate and robust Monte Carlo codes to model the interactions of neutrons and gamma rays with nuclear and nonnuclear materials and to evaluate the responses of various radiation detectors. In this presentation, I will discuss current needs in the area of nuclear security and review recent ORNL advances in developing Monte-Carlo-based analysis tools and assessment capabilities. In particular, I will present (1) our model for the simulation of organic scintillators and its use in neutron-spectrum unfolding procedures, (2) our new simulation model of photonuclear physics, (3) a comparison between simulation results and experimental data acquired at a linear accelerator facility, and (4) an analysis of the benefits of the use of *isotopic photon sources* for active interrogation.

References

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Sara Pozzi earned her M.S. and Ph.D. in nuclear engineering at the Polytechnic of Milan, Italy, in 1997 and 2001, respectively. Her research interests include the development of new methods for nuclear-materials identification for nuclear nonproliferation, nuclear material control and accountability, and national security programs. Dr. Pozzi is a coauthor of the Monte Carlo code MCNP-PoliMi, which is being used at more than 50 institutions worldwide. Her experience includes experimental work on fissile material performed in the United States, Italy, and Russia. Dr. Pozzi has authored or coauthored 122 publications: 21 journal articles, 23 technical reports, 66 articles in proceedings of national and international conferences, 1 U.S. Department of Energy publication, and 11 publications in progress.

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