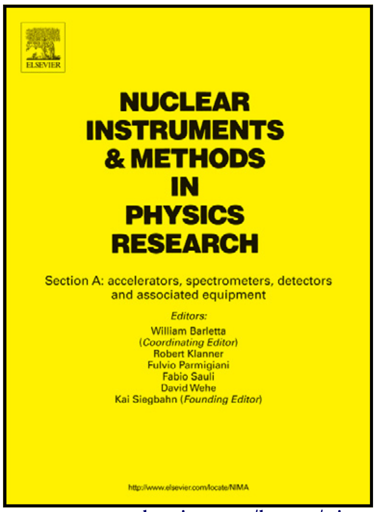

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DRAFT

Plutonium Measurements with a Fast-Neutron Multiplicity Counter for Nuclear Safeguards Applications[1]

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Abstract—Measurements were performed at the Joint Research Centre in Ispra, Italy to field test a fast-neutron multiplicity counter developed at the University of Michigan. The measurements allowed the assessment of the system's photon discrimination abilities, efficiency when measuring neutron multiplicity, ability to characterize $^{240}Pu_{eff}$ mass, and performance relative to a currently deployed neutron coincidence counter. This work is motivated by the need to replace and improve upon ^{3}He neutron detection systems for nuclear safeguards applications.

1. Introduction

In 1970, the Treaty on the Nonproliferation of Nuclear Weapons (NPT) entered into force with the objective to prevent the spread of nuclear weapons and associated technology, while encouraging the peaceful use of nuclear technology(Depositary Governments: Russian Federation, United Kingdom, United States, 1970). Through the NPT, an international nuclear safeguards system was solidified. Given the growing complexity of nuclear facilities and current proliferation threats across the world, new technologies are needed to maintain successful safeguards efforts. Specifically, technologies that can aid in the direct detection of the diversion of fissile material are crucial to this effort.

Current field instruments used in domestic and international nuclear safeguards to detect neutrons primarily rely on ^{3}He detectors(N.Ensslin) (H.O. Menlove, 1985). Neutron detectors containing ^{3}He have a high efficiency for detection of thermal neutrons. Well-established theories exist for analyzing the signals (neutron coincidence or multiplicity) that come from systems containing ^{3}He-based detectors to provide important quantities such as the mass of special nuclear material (SNM)(N.Ensslin)(I. Pázsit, 2009). Measurement of mass with low uncertainty is needed in accountancy to verify nuclear material declarations; new technologies are sought to deal with the current shortage of ^{3}He and to improve upon existing capabilities.

Advancements in nuclear safeguards equipment should consider non-traditional neutron detectors to replace and potentially improve the capabilities of current safeguards measurement systems. A fast-neutron multiplicity counter (FNMC) that utilizes neutron elastic scattering for fast-neutron detection was developed at the University of Michigan (UM) using the MCNPX-PoliMi simulation code(E.Padovani, 2012) and the MPPost detector-response processing code(E.C. Miller, 2012). Detectors based on fast-neutron scattering allow for accurate neutron timing and energy information. These additional capabilities can prove useful in addition to neutron-multiplicity information.

Characterization measurements with the FNMC system were first performed at UM with ^{252}Cf and ^{137}Cs sources. With successful results from this initial phase, the system was tested on plutonium-containing materials at the Joint Research Centre (JRC) in Ispra, Italy. This paper presents new results

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