Abstract

Ethan Klein
Massachusetts Institute of Technology
eklein@mit.edu

Neutron Resonance Analysis of Warheads Using the Near-Threshold 7Li(p,n)7Be Reaction

Robust verification of nuclear arms control treaties requires an ability to confirm the authenticity of nuclear warheads. However, standard techniques used for material identification and isotopic composition analysis, such as X-ray imaging and passive radiation detection, are not suitable for warhead analysis due to the high-Z content. In this work, we propose the design of a mobile warhead verification apparatus to analyze epithermal (1–10eV) neutron resonances of the high-Z elements (e.g. U, Pu, W) present in nuclear warheads. Monte Carlo simulations were previously performed to optimize a design for an apparatus based on a commercially available, D-T portable neutron generator. This talk will present GEANT4 simulation results for a modified design using a near-threshold 7Li(p,n)7Be reaction for neutron generation and discuss Li target selection, detection of (n, gamma) reactions in the warhead, and moderation considerations. The near-threshold reaction presents several advantages over a D-T neutron source, including greater epithermalization efficiency and preferentially forward-directed neutron flux. Calculations of epithermal neutron transmission demonstrate that an authentic uranium warhead pit and tungsten tamper could be distinguished from a hoax object of low enriched uranium (< 20% 235U) with high certainty. The potential of using the near-threshold 7Li(p,n)7Be reaction for warhead verification is currently limited by the mobility of available compact proton accelerators, which has improved considerably in recent years. Development of a mobile warhead verification apparatus for use in nuclear treaty inspections would improve trust between nuclear weapons states and validate the importance of future nuclear arms control treaties.