Lawrence Berkeley National Laboratory

Recent Work

Title

High-Yield Neutron Source for Cargo Container Screening

Permalink

<https://escholarship.org/uc/item/5s8696qb>

Authors

Ludewigt, B.A.

Bleuel, D.L.

Kwan, J.W.

et al.

Publication Date

2006-07-21

High-Yield Neutron Source for Cargo Container Screening

B.A. Ludewigt, D.L. Bleuel, J.W. Kwan, D. Li, A. Ratti, J.W. Staples, S.P. Virostek,
R.P. Wells

Lawrence Berkeley National Laboratory
1 Cyclotron Rd., Berkeley, CA 94720

Advanced neutron interrogation techniques offer great promise for the detection of shielded special nuclear materials (SNM) in sea-land cargo containers. Neutrons are able to penetrate cargo and shielding materials and to stimulate SNM signatures, e.g., the emission of delayed gamma-rays and neutrons, that can be detected. Such active interrogation systems require high-yield neutron sources to achieve the desired detection probability, false alarm rate, and throughput. An accelerator-driven neutron source has been designed for a proof of concept system that produces a forward directed beam of high-energy (up to 8.5 MeV) neutrons utilizing the $D(d,n)^3\text{He}$ reaction. The key components of the neutron source are a high-current radio-frequency quadrupole (RFQ) accelerator and a high-power neutron production target. A D^+ -beam current of up to 40 mA from a microwave-driven deuteron source can be injected into a 5.1 meter-long, 200 MHz RFQ and accelerated to 6 MeV. The RFQ accelerator is capable of operating at a duty factor that produces a time-average beam current of more than 1.2 mA. The beam is transported to a deuterium gas target and spread out to reduce the power density on the target. The critical part of the target is a specially-designed, thin entrance window that minimizes the energy loss of the deuteron beam and can withstand gas pressures exceeding 2 atm. The source will be capable of delivering a neutron flux of $>2 \cdot 10^7$ n/(cm²·s) at a distance of 2.5 m from the target, i.e., near the center of a container, and will enable the comprehensive testing and demonstration of active neutron interrogation.

This work was supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 and by the Department of Homeland Security's Domestic Nuclear Detection Office under Award No. HSHQPB-05-X-00033.