SAND2015-9480R

**Single-Volume Neutron Scatter Camera for High-Efficiency Neutron Imaging and Source Characterization**
**173113**

**Year 2 of 3**
**Principal Investigator:** E. Brubaker / 08127
**Investment Area(s):** International, Homeland, and Nuclear Security

**Project Purpose:**

The neutron scatter camera (NSC), an imaging spectrometer for fission energy neutrons, is an established and proven detector for nuclear security applications such as weak source detection of special nuclear material (SNM), arms control treaty verification, and emergency response. Relative to competing technologies such as coded aperture imaging, time-encoded imaging, neutron time projection chamber, and various thermal neutron imagers, the NSC provides excellent event-by-event directional information for signal/background discrimination, reasonable imaging resolution, and good energy resolution. Its primary drawback is very low detection efficiency due to the requirement for neutron elastic scatters in two detector cells. We will develop a single-volume double-scatter neutron imager, in which both neutron scatters can occur in the same large active volume. If successful, the efficiency will be dramatically increased over the current NSC cell-based geometry. If the detection efficiency approaches that of e.g. coded aperture imaging, the other inherent advantages of double-scatter imaging would make it the most attractive fast neutron detector for a wide range of security applications.

There are significant technical challenges to implementing this concept, especially when resolving nearby scatter events, which we contend can be resolved using recent advances in photodetection technology and associated electronics. If we are successful, a calculation of the achievable improvement in effective area is at least an order of magnitude. The detector footprint will also be greatly reduced.

This is a high-risk, high-payoff detector R&D project. The key hurdle is the difficulty of resolving two proton recoils in a single scintillator volume at spatial and temporal separations of order 1 cm and 1 ns, respectively, via the isotropically emitted scintillation light. We intend to demonstrate the ability to achieve this using state-of-the-art photodetectors and electronics.

**Refereed Communications:**