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There is a need in many fields, such as nuclear medicine, non-proliferation, energy exploration, national security, homeland security, nuclear energy, etc, for miniature, thermal neutron detectors. Until recently, thermal neutron detection has required physically large devices to provide sufficient neutron interaction and transduction signal. Miniaturization would allow broader use in the fields just mentioned and open up other applications potentially. Recent research shows promise in creating smaller neutron detectors through the combination of high-neutron-cross-section converter materials and solid-state devices.   Yet, till recently it is difficult to measure low neutron fluxes by solid-state means given the need for optimized converter materials (purity, chemical composition and thickness) and a lack of designs capable of efficient transduction of the neutron conversion products (x-rays, electrons, gamma rays). Gadolinium-based semiconductor heterojunctions have detected electrons produced by Gd-neutron reactions but only at high neutron fluxes. One of the main limitations to this type of approach is the use of thin converter layers and the inability to utilize all the conversion products. In this LDRD we have optimized the converter material thickness and chemical composition to improve capture of conversion electrons and have detected thermal neutrons with high fidelity at low flux. We are also examining different semiconductor materials and converter materials to attempt to capture a greater percentage of the conversion electrons, both low and higher energy varieties. We have studied detector size and bias scaling, and cross-sensitivity to x-rays and shown that we can detect low fluxes of thermal neutrons in less than 30 minutes with high selectivity by our approach. We are currently studying improvements in performance with direct placement of the Gd converter on the detector. The advancement of sensitive, miniature neutron detectors will have benefits in energy production, non-proliferation and medicine.