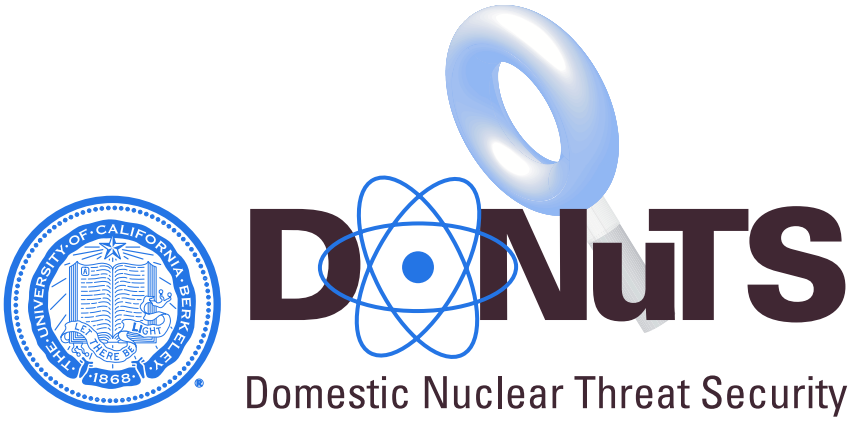

DoNuTS Technical Meeting

Time: **1600 Monday, 27 July 2009**

Place: **NE Conference Room, 4101 Etcheverry**

Speaker: **Robert Cooper, Unversity of Michigan and NIST**

Subject: **The Radiative Decay Mode of the Free Neutron**

The beta-decay of the neutron has been extremely important in understanding the framework of the Standard Model of physics. The neutron is an important laboratory to verify predictions from this and other new, exotic theories. The well-established theory of quantum electrodynamics predicts that neutron beta-decay, consisting of an emitted proton, electron, and anti-neutrino, can be accompanied by high-energy photons. Our work is the first observation of this rare decay mode, and it was made by measuring the proton, electron, and photon in coincidence. A high magnetic field from a superconducting magnet was used to guide the charged particles to a silicon surface-barrier detector. To efficiently detect the photons, we developed a large area detector capable of operating in the cryogenic, high magnetic field environment of the superconducting magnet. This detector consisted of a bismuth germanate scintillating crystal coupled to an avalanche photodiode. Furthermore, an electrostatic mirror was used to change the available phase space for decays by reflecting the low energy protons towards the surface-barrier detector that were initially emitted in the wrong direction for detection. Extensive Monte Carlo simulation was used to predict the decay rate versus applied mirror voltage. A branching ratio of $(3.13 \pm 0.34) \times 10^{-3}$ was measured, consistent with the theoretical prediction of 2.85×10^{-3} for photons of energy $15 \rightarrow 340$ keV. Also described is work to improve the overall uncertainty to the 1% level and accurately measure the photon energy spectrum. In order to increase the number of events collected, the design and testing of a new 12-element detector is described.