## Development of a CMOS Position-Sensitive UCN Detector

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Position-Sensitive Detection (PSD) of particles in two-dimensional space can be useful in experiments that require mapping the location of particle hits on a planar surface. Detecting position on a flat surface can aid in the study of "ultracold" neutron (UCN) depolarization and UCN phase space evolution in trapping experiments such as the neutron lifetime experiment UCNτ. PSD is envisioned using a "scientific" complementary-symmetry metal-oxide semiconductor (sCMOS) camera from PCO to image a Ag enriched ZnS scintillator coated in $^{10}B$. Preliminary tests using the alpha radiation source $^{210}Po$, which emits alpha particles at 5 MeV, have been conducted. The design of this PSD system will be discussed, along with preliminary results.

## Semiclassical Simulation of Spin Evolution in the UCNτ Experiment

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The free neutron lifetime $\tau_n$ is a β-decay observable used in Big Bang Nucleosynthesis predictions of light element abundances, and along with other β-decay observables allows testing of the unitarity of the CKM matrix. The goal of the UCNτ experiment is to measure $\tau_n$ with a maximum uncertainty of 0.01% (an error of about 0.1 s). The experiment uses a magneto-gravitational trap consisting of a permanent magnet Halbach array within a vacuum jacket to hold low-field-seeking, ultracold neutrons (UCN) which undergo β-decay inside the trap. To achieve a high precision measurement, UCN must not leave the trap for reasons other than decay. One possible reason for UCN to leave the trap is depolarization, which is when UCN become high-field-seeking and get sucked into the walls of the trap instead of being repelled by them. In order to reduce the number of UCN depolarizing, the vacuum jacket is surrounded by coils that produce a magnetic holding field perpendicular to the Halbach field. To better understand the spin dynamics of UCN within the trap, two different spin-tracking simulations were developed; one uses a Monte Carlo Wave Function (MCWF) approach and the other integrates the Bloch equations to evolve the expectation value of the spin. These were first applied in modeling depolarization rate dependence on holding field strength. Calculations will be presented using the semiclassical approach and compared to results of the MCWF approach and empirical data.