Development of a sCMOS Position-Sensitive UCN Detector

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Position-Sensitive Detection (PSD) of particles on a two-dimensional detection plane can be useful in experiments that require characterization of free-moving particles. PSD can aid in the study of systematic effects such as depolarization and phase space evolution in trapping experiments such as the ultracold neutron (UCN) free neutron lifetime experiment UCNτ. PSD is demonstrated using a relatively inexpensive "scientific" complementary-symmetry metal-oxide-semiconductor (sCMOS) camera from PCO to image an Ag enriched ZnS scintillator coated in 10Boron from a distance of 1.2 meters away. This scintillator was excited using a ^{241}Am source which emits alpha particles at 5.48 MeV. The optical design of this PSD system will be discussed, along with details of signal characterization.

Efficiently Simulating Neutron Spin Evolution in the UCNτ Experiment

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The goal of the UCNτ experiment is to measure the free neutron lifetime τ_n with an uncertainty on the order of 0.02% (an error of about 0.2 s). The experiment uses a magneto-gravitational trap to store polarized (low-field seeking) ultracold neutrons (UCN) which undergo β-decay inside the trap. To achieve such a high precision measurement, UCN must not leave the trap for reasons other than decay. One possible source of systematic error occurs when UCN spin-flip and become depolarized (high-field seeking). This causes UCN to be pulled towards the permanent magnets that comprise the trap instead of being repelled by them and thus allows UCN to leave the trap undecayed. In order to reduce the number of UCN depolarizing, the trap is surrounded by coils that produce a magnetic holding field perpendicular to the trap 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. In this presentation, the focus will be on a practical study of the most efficient way to integrate the Bloch equations. The differences between the Bloch and MCWF methods and the caveats of using the expectation value of the spin to model spin dynamics will also be discussed.