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UCNtau: A Precision Measurement of the Neutron Beta-Decay Lifetime[1]

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Eighty years after Chadwick discovered the neutron, physicists today still debate over how long the neutron lives. Measurements of the neutron lifetime have achieved the 0.1% level of precision ($\sim$ 1 s), however, experiments using the bottle technique yield lifetime results systematically lower than those using the beam technique. Measuring the neutron lifetime is difficult due to several limitations: the low energy of the decay products, the inability to track slow neutrons, and the fact that the neutron lifetime is long (880.3 ± 1.1 s, PDG2014). In particular, slow neutrons are susceptible to many loss mechanisms other than beta-decay, such as upscattering and absorption on material surfaces; they act on time scales comparable to the neutron beta-decay and thus make the extraction of the beta-decay lifetime very challenging. In the UCNτ experiment, we trap ultracold neutrons (UCN) in a magnetic-gravitational trap. The apparatus, installed at the Los Alamos UCN source, has been used to develop new techniques–using field confinements with attentions to the phase space evolution of trapped neutrons–with an aim to reduce the uncertainty to 1 s (and better). I will report first competitive results and discuss plans to quantify systematic effects.

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