The UCN-A experiment : measuring the β asymmetry using ultra-cold neutrons

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Ultra-cold neutrons (UCN) offer the opportunity to measure properties of the neutron and its β-decay with unprecedented precision. The interest in using UCN over traditionally used cold neutrons are the fact that UCN are easily polarized and that they can be guided and bottled far away from production sources. At Los Alamos National Laboratory's LANSCE facility, a source of UCN has been developed where neutrons are produced via proton spallation from a Tungsten target and then converted into UCN by phonon downscattering in a solid deuterium "superthermal" moderator. These UCN are then guided through 12 m of shielding to the experimental area where the neutrons are polarized and observed in a very clean environment.

The UCNA collaboration recently published the result of the first measurement of the β asymmetry parameter, A_0, from UCN decay data collected in 2006 and 2007 [1]. The result is $A_0 = -0.1138(46)(21)$ where the first uncertainty is statistical and the second is systematic. This is in agreement with the currently accepted (Particle Data Group's) value of $A_0 = -0.1173(13)$ which is an average of cold neutron measurements (see Fig. 1).

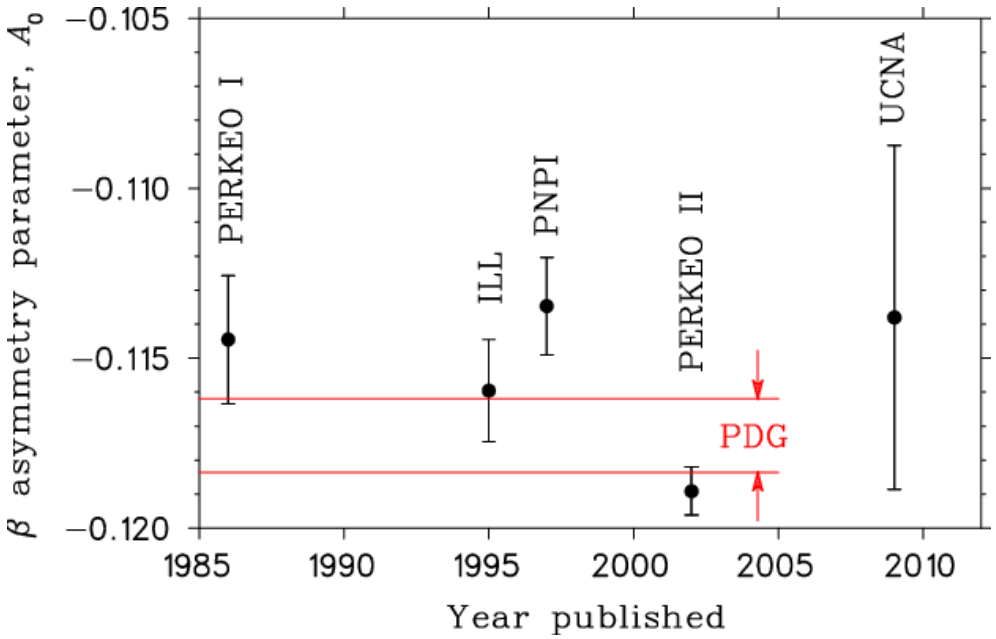

FIG. 1. Measurements of the β asymmetry of the neutron.

In 2008, we collected more data by running longer, increasing our transport efficiency and taking advantage of increased proton current for UCN production. Overall, our statistical uncertainty will be ≈5× better at less than 0.8%. New calibration sources have improved our energy calibration such that this, our dominant systematic uncertainty, has also been improved by a factor of five to 0.3%. Detailed depolarization measurements have reduced the systematic uncertainty due to depolarized UCN from 1.3%

to what we expect will be less than 0.4%. Once the analysis of the 2008 data is completed, we expect to have a statistics-limited measurement of A_0 below the 1% level of uncertainty, with systematics at the 0.6% level. This will resolve the scatter of results in the cold neutron measurements and represent the best measurement of the beta asymmetry in the neutron to date. Our ultimate goal is to measure A_0 to better than 0.3%.

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[1] R. W. Pattie Jr. *et al.*, Phys. Rev. Letts. **102**, 012301 (2009).