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

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A neutron is considered to be "ultra-cold" when it's kinetic energy is on the order of a few hundred nano-eV, the Fermi potential of typical materials. In this case, the neutron will undergo total internal reflection at any angle, and so can be stored in closed vessels with lifetimes approaching the beta decay lifetime (τ~900s). Such neutrons are called Ultra-Cold Neutrons (UCN) and offer new opportunities for precision measurements of the neutron and its decay properties. The UCNA collaboration has developed an experimental program around the UCN source at Los Alamos National Laboratory's LANSCE facility, recently publishing the first measurement of the β asymmetry parameter, A_0, from UCN decay [1]. The statistics-limited result is consistent with – although with ≈4× the uncertainty – than the value currently accepted by the Particle Data Group. In 2008 we collected enough data that the statistical uncertainty will be reduced over a factor of five to 0.8% and we have reduced a number of our dominant systematic uncertainties. We are on the verge of completing our determination of corrections and systematic uncertainties, and will be unblinding the analysis in a collaboration meeting to be held at Texas A&M in May 2010. Preliminary results indicate a total systematic uncertainty of 0.9% (see Table I), dominated by our knowledge of the energy calibration of the beta detectors. Thus we

TABLE I. Error budget for the data collected by the UCNA experiment from 2008–2009.

Source of systematic uncertainty	$\Delta A/A$ [%]
Rate-dependent gain shift	0.08
Gain fluctuations	0.20
Deadtime	0.01
Linearity of scintillator	0.47
UCN background	0.02
Muon veto efficiency	0.30
Live-time uncertainty	0.24
Fiducial cut	0.24
UCN Polarization	0.52
Uniformity of magnetic field	0.20
Radiative corrections (theoretical)	0.05
Total	0.88

* A. Saunders and A.R. Young spokespersons; the collaboration is formed by approximately 30 scientists from the California Institute of Technology, Duke University, Idaho State University, the University of Kentucky, Los Alamos National Laboratory, North Carolina State University, Texas A&M University, Virginia Tech University, the University of Washington and the University of Winnipeg.

expect to publish a 1.2% measurement of A_0 by the summer of 2010 as we start another run at Los Alamos to collect more data and further improve our uncertainty budget.

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