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

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Ultra-cold neutrons (UCN) are loosely defined as neutrons which have kinetic energies below a few hundred neV. Certain materials, like $^{58}$Ni, are able to efficiently transport and bottle UCN because the Fermi potential is larger than $E_{UCN}$ so the UCN will undergo complete internal reflection when interacting with the material walls. In addition, they are strongly influenced by magnetic fields and so are easily polarized. UCN therefore offer the opportunity to measure properties of the neutron and its β-decay with unprecedented precision. At Los Alamos National Laboratory's LANSCE facility, a source of UCN has been developed [2] where neutrons are produced via proton spallation from a Tungsten target and then converted into UCN by phonon downscattering within 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.

Currently, there is an inconsistency between measurements of $A_\beta$ [1], the β-asymmetry parameter which describes the correlation between the neutron's spin and the decay electron's momentum. The goal of the UCN-A experiment is to resolve the issue by measuring $A_\beta$ with a precision four times better than in previous experiments.

The β spectrometer of the UCN-A experiment is shown schematically in Fig. 1: it is a five meter long superconducting solenoid with Multi-Wire Proportional Chambers (MWPC) and plastic scintillator detectors at each end to observe the decay electrons. At the end of 2006, we produced the first measurement of UCN β decay with a counting rate of ≃ 2 Hz. Through 2007, the production and transmission of UCN were improved resulting in a 10× increase in the detection rate, the signal-to-noise ratio was improved to 21:1 (see Fig. 2) and the neutron polarization was shown to be greater than 99%.

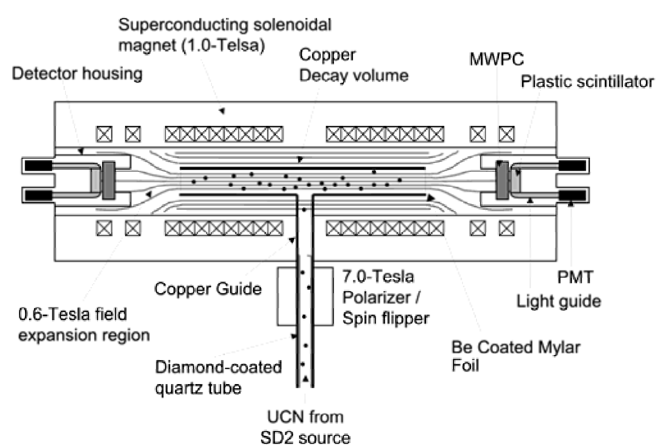


**Figure 1.** Schematic diagram of the β spectrometer for the UCN-A experiment at Los Alamos.

We have shown our system is able to perform a high precision measurement of the β asymmetry. With the expected ≃ 8× further increase in rate for 2008, we will be

[1] A. Saunders and A. Young, spokespersons; the collaboration is formed by approximately 30 scientists from Caltech, Univ. of Kentucky, Los Alamos National Lab., North Carolina State University, Texas A&M, Virginia Tech, Univ. of Washington and Univ. of Winnipeg.

in a position to acheive our goal of measuring $A_\beta$ to 0.2%.

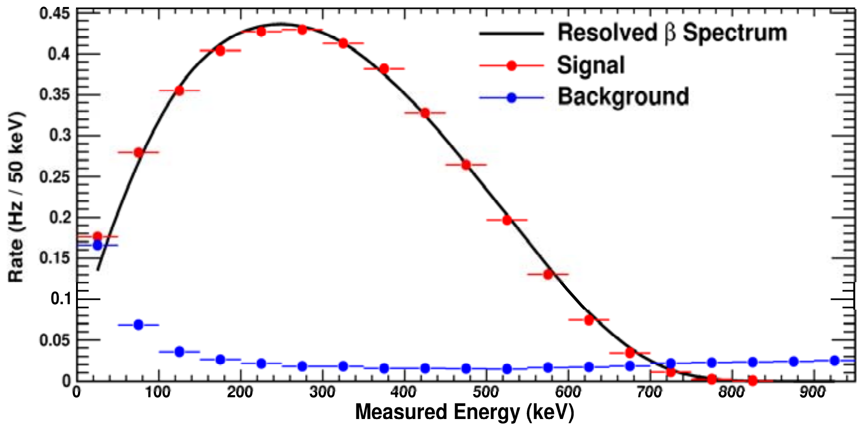


**Figure 2.** UCN β spectrum taken at the end of 2007 in one of the UCN-A detectors.


[1] A. Saunders *et al.*, Phys. Lett. B **593**, 55 (2004).

[2] W. -M. Yao *et al.* (Particle Data Group), J. Phys. G **33**, 1 (2006) and 2007 partial update for the 2008 edition.