# Time Reversal Invariance Violation in Polarized Neutron Beta Decay

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The existence of CP-symmetry violation in the weak interaction is established in kaon decay, but the implied consequence, time-reversal-symmetry violation, is yet to be observed. The emiT collaboration is mounting an experiment to search for time-reversal-symmetry violation in free neutron beta decay, using cold, polarized neutrons at the National Institute of Standards and Technology's Cold Neutron Research Facility. This experiment, which was put on-line at the reactor this December, utilizes an octagonal array of detectors to observe neutron decay electron and recoil proton in coincidence. The experiment is designed to detect an angular correlation of the form,

$$\sigma_n \; (\boldsymbol{p}_e \times \boldsymbol{p}_\nu),$$

which is odd under time reversal. The coefficient of this term in the neutron decay correlation has been previously shown to be less than 0.0011. The present experiment aims at a factor of three improvement in sensitivity from the present run.

The neutrons in the cold (T=40 Kelvin) beam are polarized to 96% with a supermirror polarizer. Electrons are detected with four 50 cm long plastic scintillators. The recoil protons, whose maximum energy is only 750 eV, drift in a field free region until they near one of the four proton arrays, where they are accelerated through 30 kilovolts onto thin-window PIN diodes. The characteristic delay time between the decay proton and electron is used to distinguish signal from background. The proton drift time is greater than 0.5 μs and most backgrounds are prompt. Figure 1 shows time versus detected proton energy, illustrating the separation of the proton signal from the large prompt background. Anticipated sources of systematic uncertainty were reduced in the detector design and extensive cross checks and tests of the apparatus are planned.

The experiment is scheduled to run during three six week reactor cycles this year. Set up and shakedown of the experiment was completed during the first cycle. Production data taking is scheduled to begin in February during the second reactor cycle.

*Footnotes and References*

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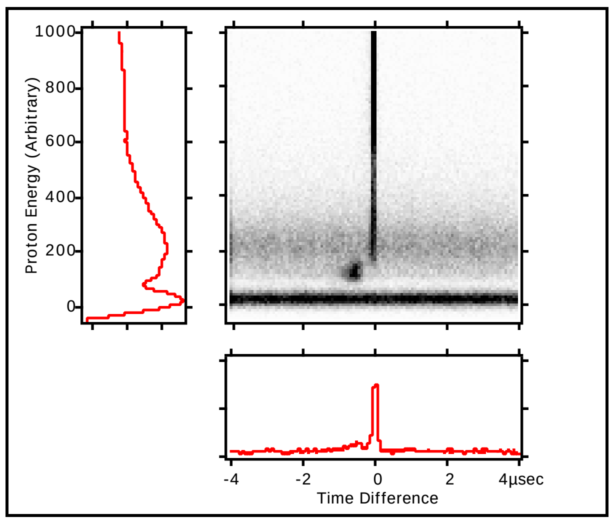


Fig. 1. A plot of proton detector energy versus coincidence time shows clearly the large prompt events, mostly from background gamma rays. Delayed proton coincidences show up to the left of the prompt events in this figure. The enhancement at 0.5 microseconds delay is from neutron decay.