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Improved Determination of the Neutron Lifetime

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The most precise determination of the neutron lifetime using the beam method reported a result of $\tau_n = (886.3 \pm 1.2\,[\mathrm{stat}] \pm 3.2\,[\mathrm{sys}])$ s. The dominant uncertainties were attributed to the absolute determination of the fluence of the neutron beam (2.7 s). The neutron beam fluence was determined with a monitor that counted the neutron-induced charged particles from absorption in a thin, well-characterized ^{6}Li deposit. The detection efficiency of the monitor was calculated from the areal density of the deposit, the detector solid angle, and the ENDF/B-VI ^{6}Li(n,t)^{4}He thermal neutron cross section. We have used a second, totally-absorbing neutron detector to directly measure the neutron detection efficiency of this monitor on a monochromatic neutron beam of precisely known wavelength. This method does not rely on the ^{6}Li(n,t)^{4}He cross section or any other nuclear data. The monitor detection efficiency was measured to an uncertainty of 0.06\,\%, which represents a five-fold improvement in uncertainty. We have verified the temporal stability of the neutron monitor through ancillary measurements, which allows us to use the measured neutron monitor efficiency to improve the fluence determination from the 2005 experiment. An updated neutron lifetime based on the improved fluence determination will be presented.

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