Precise neutron lifetime experiment using pulsed neutron beams at J-PARC

Naoki Nagakura[1], Katsuya Hirota[2], Sei Ieki[1], Takashi Ino[3], Yoshihisa Iwashita[4], Masaaki Kitaguchi[5], Ryunosuke Kitahara[6], Kenji Mishima[3], Aya Morishita[7], Hideyuki Oide[8], Hidetoshi Otono[9], Risa Sakakibara[2], Yoshichika Seki[10], Tatsushi Shima[11], Hirohiko M. Shimizu[2], Tomoaki Sugino[2], Naoyuki Sumi[7], Hirochika Sumino[12], Kaoru Taketani[3], Genki Tanaka[7], Tatsuhiko Tomita[7], Takahito Yamada[1], Satoru Yamashita[13], Mami Yokohashi[4], Tamaki Yoshioka[9],
[1]Department of Physics, Graduate School of Science, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan
[2]Department of Physics, Graduate School of Science, Nagoya University, Nagoya 464-8602, Japan
[3]KEK, High Energy Accelerator Research Organization, Tsukuba 305-0801, Japan
[4]Institute for Chemical Research, Kyoto University, Uji, Kyoto 611-0011, Japan
[5]Kobayashi-Maskawa Institute for the Origin of Particles and the Universe (KMI), Nagoya University, Nagoya 464-8602, Japan
[6]Department of Physics, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan
[7]Department of Physics, Graduate School of Science, Kyushu University, Fukuoka 819-0395, Japan
[8]CERN, CH-1211 Geneve 23, Switzerland
[9]Research Center for Advanced Particle Physics (RCAPP), Kyushu University, Fukuoka 819-0395, Japan
[10]Neutron Science Section, Materials and Life Science Division, J-PARC Center, Japan Atomic Energy Agency, Tokai 319-1195, Japan
[11]Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan
[12]Department of Basic Science, Graduate School of Arts and Sciences, The University of Tokyo, Meguro-ku, Tokyo 153-8902, Japan
[13]International Center for the Elementary Particle Physics (ICEPP), The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan

The neutron decay lifetime ($\tau_n \sim 880$ sec) is the most crucial parameter for the Big Bang Nucleosynthesis, which predicts light element synthesis in the early universe. However, there exists a significant discrepancy of 8.4 sec (3.8 σ) in the measured value of τ_n, depending on which of the two current methods is used. One is to measure the number of protons produced from the beta decay of pulsed neutrons, using the method called Penning trap. The other is to store ultra-cold neutrons in a chamber and count the number of remaining neutrons after a certain period of time.

In order to resolve this problem, we conduct a new experiment to measure τ_n using a different method, which is carried out at the polarized beam branch of BL05, MLF, J-PARC. In this method, both the total neutron flux and the number of electrons produced in the beta decay are measured in the Time Projection Chamber (TPC). Here, the total neutron flux is evaluated using the number of $^3He(n,p)^3H$ reactions in the TPC. Since our method has different types of systematic uncertainties with respect to the previous two methods, the result will be a powerful approach in resolving the current discrepancy. The first set of data, acquired in April of 2016, yields a statistical uncertainty of O(10) sec on τ_n. This talk will present the analysis results of the acquired data.