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Ultracold Neutron Time Focusing Experiment and Performance Evaluation of an Improved UCN Rebuncher at J-PARC/MLF

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Abstract: We have developed and improved an ultracold neutron (UCN) decelerator named "UCN rebuncher." The rebuncher can give continuously changing deceleration to pulsed polarized UCNs by the combination of an adiabatic fast passage spin flipper, a frequency sweeping resonator, and a gradient magnetic field. By using this apparatus, we can control the longitudinal velocity of UCNs and time-focus UCNs on an arbitrary point. In a neutron electric dipole moment measurement at a spallation pulsed superthermal UCN source with a solid deuterium converter, the apparatus makes it possible to recover the spatial density of diffusing pulsed UCNs and store them in a cell efficiently. We carried out the UCN focus experiment with the improved rebuncher at BL05 (NOP) in J-PARC/MLF. We succeeded in decelerating 5.5-m/s UCNs, focusing them on the detection timing of 4.8-m/s UCNs, and confirming an obvious peak in the time-of-flight spectrum. The count rate at the peak was 2.2 times higher than without the rebuncher.

KEYWORDS: electric dipole moment, ultracold neutron, accelerator, nuclear magnetic resonance

1. Introduction

The permanent neutron electric dipole moment (nEDM) is measured aiming for the discovery of new symmetry-breaking sources and the physics beyond the Standard Model (SM) in low energy experiments [1, 2]. If a particle with spin has an EDM, it breaks the Time reversal (T-) symmetry, and the T-violation is equivalent to a CP-violation on the assumption of CPT-symmetry. In addition, some beyond SM models predict extremely larger nEDMs than the SM predicted value of 10^{-32} e· cm. The current upper limit of nEDM is 3.0×10^{-26} e· cm (90% C.L.) [3], while a predicted nEDM in a supersymmetry model, for example, can be the size of 10^{-27} e· cm and within reach of the