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Development and performance evaluation of 3He neutron spin filters at J-PARC

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The ^{3}He neutron spin filter (^{3}He NSF) is a neutron polarization device that uses polarized ^{3}He nuclei. It can polarize a wide range of neutron energies, including the epithermal neutron, making it a suitable polarization device for spallation neutron sources. The polarization of ^{3}He nuclei is achieved through the Spin-Exchange Optical Pumping (SEOP) method. The SEOP method, using a high-intensity laser, slight heating (200 ℃), and a small magnetic field (2 mT), enables the achievement of a very high ^{3}He polarization with compact setup. Our group is developing and operating a ^{3}He NSF at J-PARC. Since the first user experiment in 2017[1], we have conducted more than 80 days of operational use per year. Recently, we developed compact in-situ SEOP systems for the ^{3}He NSF, specifically designed to fit within the limited installation space at J-PARC' s neutron beamlines. This advancement is expected to increase experimental applications. On the other hand, there is an unanswered puzzle about the ^{3}He NSF. It concerns the relaxation mechanism of ^{3}He nuclei. The complex behavior of ^{3}He atoms contained in glass cells creates a barrier to the fabrication of high-performance ^{3}He cell for the ^{3}He NSF. We are investigating the relationship between the fabrication method and performance of the ^{3}He cell, aiming to contribute to the understanding of the relaxation mechanism.
We have developed an evaluation system for the ^{3}He cell. This system features the ability to directly and precisely measure magnetic fields, which are an environmental factor included in conventional evaluation methods using NMR. This capability allows for quantitative evaluation independent of the ^{3}He cell's shape. Using this method, we evaluated multiple ^{3}He cells and obtained consistent results.
In this presentation, we will describe an overview of the ^{3}He NSF development at J-PARC and discuss the results of the performance evaluation of the ^{3}He cells.

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