MLF Experimental Report	提出日 Date of report 2013/09/03
実験課題番号 Project No. 2012P0801	装置責任者 Name of responsible person Kenichi OIKAWA
実験課題名 Title of experiment Development and application of on-beam SEOP based ^{3}He spin filter at BL10	装置名 Name of Instrument/（BL No.） NOBORU / BL10
実験責任者名 Name of principal investigator Takayuki OKU	利用期間 Dates of experiments 2012.10.20 21:00 – 2012.10.24 9:00 2012.11.22 21:00 – 2012.11.24 21:00 2013.02.14 09:00 – 2013.02.16 21:00
所属 Affiliation J-PARC Center	

1．研究成果概要（試料の名称、組成、物理的・化学的性状を明記するとともに、実験方法、利用の結果得られた主なデータ、考察、結論、図表等を記述してください。

Outline of experimental results (experimental method and results should be reported including sample information such as composition, physical and/or chemical characteristics.

For expanding measurable neutron energy region up to epithermal neutrons in polarized neutron experiments [1], we developed the portable Polarized ^{3}He Spin Flipper (PHSF), constructed a neutron spin analysis system with the developed PHSFs at the BL10, carried out its feasibility test, and attempted to visualize a magnetic field generated by a Rectangular Coil (RC). Fig. 1 shows the experimental setup at the BL10. The portable PHSF consisted of a cylindrical glass cell filled with ^{3}He gas which was installed in an oven, and a Solenoid Coil (SC) of 20 cm in diameter and 30 cm long for holding the ^{3}He polarization. They were brought into the beam line after polarizing ^{3}He gas sufficiently by our SEOP system. In Fig. 1, pulsed neutron beams from the spallation neutron source transmitted along the *z* axis through a PHSF-1 for polarizing neutrons, a sample area, a PHSF-2 for analyzing neutron spins, and were counted by a 2D-PSND consisting of a neutron scintillator and photomultiplier tube. In attempting to visualize the magnetic field, the RC of 50×5×18mm^3 size are placed at the sample area so as to apply the magnetic field $\boldsymbol{H}_R$ of the RC along to the *x* axis. The cells containing ^{3}He gases of 17 and 11 atm·cm thicknesses were installed in the PHSF-1 and the PHSF-2. The ^{3}He spin polarizations P_1 and P_2 of the PHSF-1 and PHSF-2 were monitored by the NMR signal V_1 and V_2.

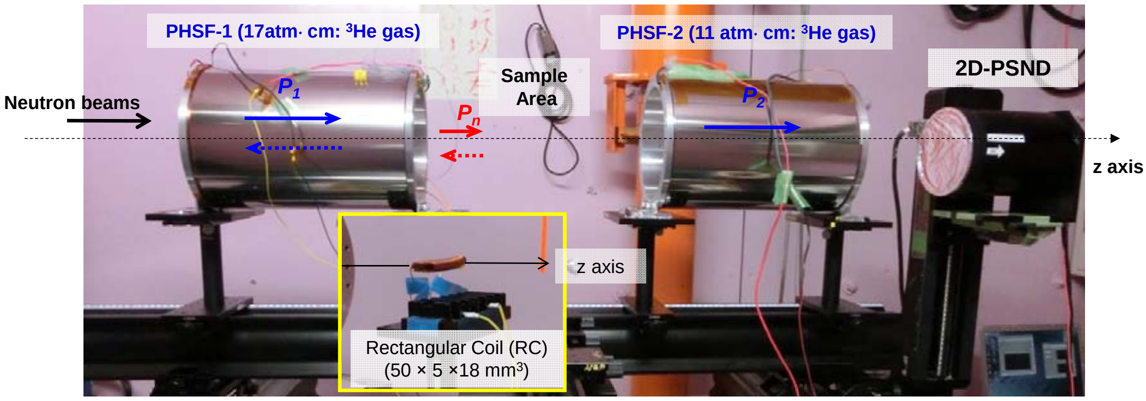

Figure 1　Experimental Setup with the developed PHSFs at the BL10

１．研究成果概要（つづき） Outline of experimental results (continued).

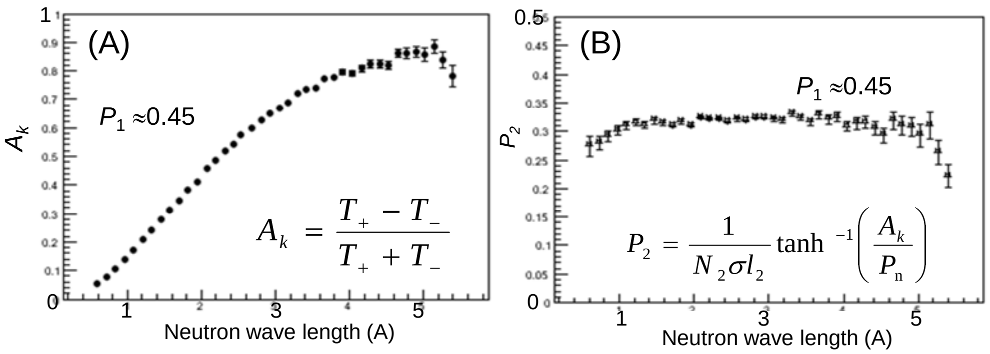

Figure 2 (A) A_k as a function of neutron wave length λ without the RC.
(B) P_2 deduced by substituting the A_k and $P_1 \approx 0.45$ for Eq. (1)

The spin analyzing ability in Fig. 1 was evaluated by measuring a neutron spin asymmetry defined as

$$A_k = (T_+ - T_-) / (T_+ + T_-) = P_n \tanh(N_2 \sigma l_2 P_2), \quad (1)$$

where T_+ (T_-) denote the neutron transmittance with its spin ***s*** parallel (antiparallel) to the ^{3}He nuclear spin $\boldsymbol{I}_1$ of the PHSF-1, σ is a neutron absorption cross section of ^{3}He, N_2 and l_2 are a number density and thickness of the PHSF-2. The P_n is the neutron polarization after passing through the PHSF-1 which can be determined by the P_1. Fig. 2 (A) represents the A_k as a function of neutron wave length λ without the RC. Fig. 2 (B) represents the P_2 deduced by substituting the A_k in Fig. 2 (A) and $P_1 \approx 0.45$ obtained from the NMR signal V_1 for Eq. (1). The P_2 is almost constant as expected, but it decreases more than λ>5Å by the background with decreasing neutron transmittance. While the A_k with the RC is redefined as

$$A'_k = (T_+ - T_-) / (T_+ + T_-) = P_n \tanh(N_2 \sigma l_2 P_2) \sin(\gamma_n H_R t), \quad (2)$$

where γ_n and t is a neutron gyromagnetic ratio and a time of the ***s*** rotation around the $\boldsymbol{H}_R$ direction which is named a Larmor precession. Fig. 3(A) and (C) represent neutron 2D images measured around the λ≈2.7Å and λ≈3.6Å, where the beam cross section is about 10×15mm^2 and the neutron transmittance is T_+. Fig. 3(B) and (D) denote the projection components of T_+ in Fig. 3 (A) and (C) to the y axes. The areas enclosed by broken lines in Fig. 3 (A) and (C) denote inner parts of the RC where the $\boldsymbol{H}_R$ is applied along to the x axis. Difference between the T_+ in the inner part of the RC in Fig. 3 (B) and that in Fig. 3 (D) suggests to measure the ***s*** rotation effects based on the A'_k . Fig. 4 (A), (B) and (C) represent the T_+, T_- and A'_k as a function of λ at the inner part of the RC. In Fig. 4 (A) and (B), the T_+ and T_- are divided by the neutron transmittance without the RC. From the A'_k in Fig. 4 (C), the value of 1.8 Å/turn can be obtained as the ***s*** rotation period. Its value corresponds to $\boldsymbol{H}_R \approx$4.2mTesla in Eq. (2), and it is consistent with the $\boldsymbol{H}_R$ measured by a magnetic sensor directly.

These preliminary results suggest that our apparatus has the sufficient spin analyzing ability and can visualize the magnetic field with the λ range from 0.5 to 5 Å. The measurable λ range will be expanded to both sides of the lower and upper by keeping the P_1 and P_2 highly and stable.

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1．研究成果概要（つづき） Outline of experimental results (continued).

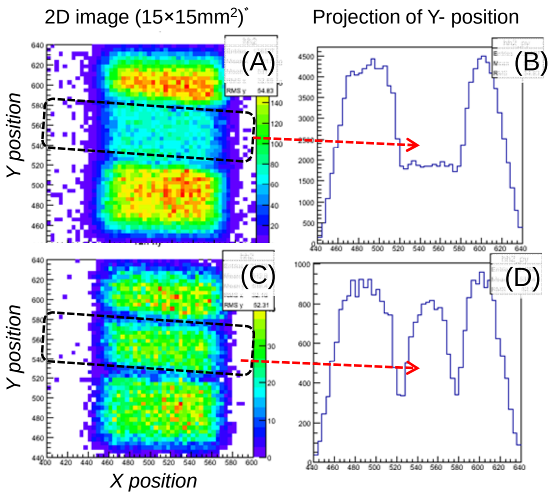

Figure 3 (A) Neutron 2D image around the λ≈2.7Å, (B) Projection of the T_+ to the y axis in Fig. (A), (C) Neutron 2D image around the λ≈3.6Å, (D) Projection of the T_+ to the y axis in Fig. (C).

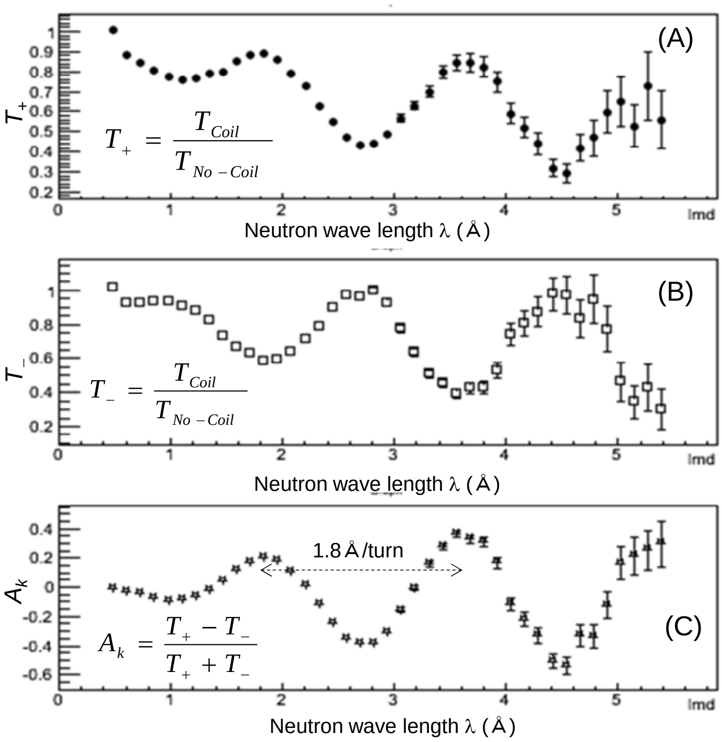

Figure 4 (A) T_+ in the RC as the function of λ, (B) T_- in the RC as the function of λ, (C) A'_k in the RC as a function of λ

[1] K. Sakai, J. Phys.: Conf. Ser. **340,** 012037 (2012)

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