TEST EXPERIMENT FOR THE PRODUCTION OF POLARIZED ^{12}N WITH THE SPIN-TRANSFER $^{12}\mathrm{C}(\vec{p},^{12}\vec{\mathrm{N}})n$ REACTION AT 295 MeV

S. Sakoda[a], H. Sakai[a], S. Fukusaka[a], J. Kamiya[b],
H. Okamura[c], T. Ohnishi[a], K. Sekiguchi[a], A. Tamii[a], T. Wakasa[b],
K. Yako[a], G. Yokoyama[a], and K. Hatanaka[b]

[a]Department of Physics, University of Tokyo, Bunkyo, Tokyo 113-0033, Japan
[b]Research Center for Nuclear Physics, Osaka University, Ibaraki, Osaka 567-0047, Japan
[c]Department of Physics, Saitama University, Saitama 338-8570, Japan

A measurement of the polarization correlation between a beta-emitted positron and the parent nucleus provides information on possible contributions from right-handed currents in the weak interaction mediated by $W_R^{\pm}$ bosons [1]. For that purpose a beta emitting polarized nucleus which has a large end-point energy as well as a large asymmetry parameter (A) is needed. In such a high precision measurement, high nuclear polarization is essential to cancel various false asymmetries produced by instruments. The ^{12}N nucleus is an ideal candidate since its positron end-point energy is 16 MeV with nearly $A = 1$, if we can produce a high spin-polarized ^{12}N [2].

The polarized ^{12}N nucleus suffers from solid-state perturbations such as electric quadrupole interactions, spin-lattice relaxation, and/or effects of damages produced by the recoiling nuclei or the beam. Although natural graphite is very convenient material as a ^{12}C target, it is known that the polarization of ^{12}N is quickly lost in graphite. Therefore it is of crucial importance to search for carbon material or chemical compound in which the nuclear polarization of ^{12}N can be maintained as much as possible during the detection period.

The measurement was carried out at NTOF facility [3]. The spin polarized ^{12}N nuclei were produced by the $^{12}\mathrm{C}(\vec{p},^{12}\vec{\mathrm{N}})n$ reaction at 295 MeV. The polarization of a vertically polarized proton beam was typically 0.63. Targets were located within a static magnetic field (5.0 kG). The experimental technique to measure the nuclear polarization of ^{12}N is a conventional one: it utilizes the parity-violating asymmetry in the beta decay of ^{12}N. Thus we just measured the normalized positron intensity difference along and opposite to the nuclear spin direction. The positrons were detected by two sets of $\Delta E - E$ telescopes, one above the target and one below the target. The trigger rates were around 0.2-1.2$\times 10^3$ s^{-1}.

Last year, we measured positron emission asymmetries for solid targets [4]. Obtained asymmetries were small for solid targets. This year, we have measured asymmetries for liquid targets because large asymmetries were expected by reason of the “motional narrowing” mechanism [5].

A closed liquid target system was newly developed (Figure 1). The system consisted of a target cell, a circulation pump, and a liquid reserver. The cell has a thickness of 5 mm, and 16 mmϕ beam windows covered by 6 μm havar-foils. An amount of 120 cc liquid was enclosed in the system, and circulated by 0.2 cc/sec. The energy loss of the proton beam (295 MeV, 1 nA) in the liquid was about 2 mW. The temperature of the liquid fluctuated less than 1 C°.

The measured asymmetries averaged over 0-10 ms are listed in Table 1 together with

material	thickness	asymmetry
HOPG(thick)	2655 (mg/cm^2)	0.0438 ± 0.0037
HOPG(thin)	80 (mg/cm^2)	0.0477 ± 0.0049
diamond	350 (mg/cm^2)	0.0217 ± 0.0036
propanol(C_3H_7OH)	400 (mg/cm^2)	0.0105 ± 0.0032
liquid scintillator(BC519)	440 (mg/cm^2)	0.0118 ± 0.0048

*HOPG : Highly Oriented Pyrolytic Graphite

Table 1: Averaged asymmetries in 0-10 ms for various targets.

Figure 1: The target cell (the left-end of the rod) of the liquid target system.

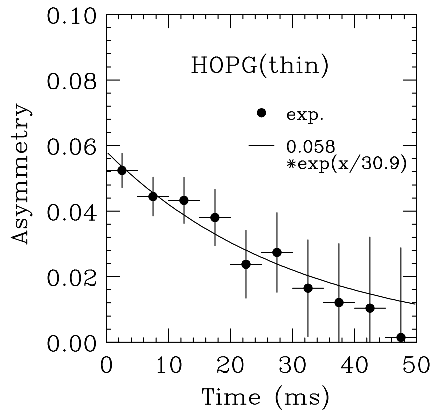

Figure 2: Time spectrum of the asymmetry for the thin HOPG target.

results of solid targets. Large asymmetries were not observed for the liquid targets.

The largest asymmetry was 0.0477 ± 0.0049 for the thin HOPG target. Time spectrum of the asymmetry for the thin HOPG target is shown in Figure 2. These asymmetries are not enough for the search for $W_R^{\pm}$ bosons with high precision. More suitable material or a new technique to maintain the polarization of ^{12}N is required.

References

[1] P. A. Quin and T. A. Girard, Phys. Lett. B **229**, 29 (1989).
[2] J. Liecht *et al.*, Nucl. Phys. **A533**, 292 (1991).
[3] H. Sakai *et al.*, Nucl. Instrum. Methods Phys. Res. A **369**, 120 (1996).
[4] H. Sakai *et al.*, RCNP Annual Report 1997, pp.66.
[5] C. P. Slichter, *Principles of Magnetic Resonance 3rd Enlarged and Updated Edition* (Springer-Verlag, New York, 1990)