The first measurement of polarization degree and relaxation time of polarized Hydrogen-Deuteride (HD) target at RCNP

S.Y. Wang[1,2], S. Bouchigny[3], J.P. Didelez[3], M. Fujiwara[4], K. Fukuda[4], T. Hotta[4], H. Kohri[4], T. Kunimatsu[4], C. Morisaki[4], T. Ohta[4], G. Rouille[3], M. Tanaka[5], K. Ueda[3], M. Uraki[4], M. Utsuro[4] M. Yosoi[4].

[1] *Department of Physics, National Kaohsiung Normal University, Kaohsiung 824, Taiwan*

[2] *Institute of Physics, Academia Sinica, Taipei 11529, Taiwan*

[3] *IN2P3, Institut de Physique Nucleaire, F-91406 Orsay, France*

[4] *Research Center for Nuclear Physics (RCNP), Osaka University,Ibaraki, Osaka 567-0047, Japan*

[5] *Kobe Tokiwa College, Kobe 654-0838, Japan*

The polarized Hydrogen-Deuteride (HD) target is developed mainly for the study of ϕ meson photoproduction on the proton and neutron. The polarized HD system consists of five large refrigerators. At RCNP, pure HD gas with an amount of 1 mol is produced by using the HD gas distillator, and the HD gas is solidified in a dilution refrigerator system (DRS). The polarization of the solid HD is made and frozen by aging at B=17 T and at T=14 mK. The polarized HD is moved from the DRS to a ^{4}He refrigerator (SC) by using another ^{4}He refrigerator (TC1). The SC is moved to SPring-8/LEPS by using a truck. At SPring-8/LEPS, the polarized HD is moved from the SC to a dilution refrigerator(IBC) by using another ^{4}He refrigerator (TC2). The IBC provides a magnetic field of 1 T and a temperature of 300 mK during the physics experiment for a few months [1]. The staying time of HD target in each refrigerator is summarized in Table. 1.

A polarized HD target was produced for the first time in 2008. After the aging time of 53 day, the polarization degree and the relaxation time (T_1) of the hydrogen (H) and deuterium (D) in the HD were measured by using the NMR system [2]. NMR signals of H and D observed are shown in Fig. 1. The reference data of H (B=1T, T=4.2K) and D (B=7T, T=4.2K) at thermal equilibrium state were measured. The polarization degree is assumed to be proportional to the area of the NMR signals (A). The T_1 was obtained by fitting the function, $A(t) = A(0)\exp(-t/T_1)$, to the data as shown in Fig. 2. The T_1 measured is summarized in Table. 1.

These results show that the relaxation times are long enough for loss of polarization during transportation. We plan to start a production of HD and move it to SPring-8/LEPS and carry out a performance check by using circularly polarized photon beams in 2010 [4].

	TC1, TC2	SC	IBC
Staying time of HD target	0.5 hours	3 hours	about 3 months
T_1 of H	147 hours	277 hours	100 days
T_1 of D	48 hours	303 hours	73 days

Table 1: The staying time of HD target and relaxation time in each refrigerator.

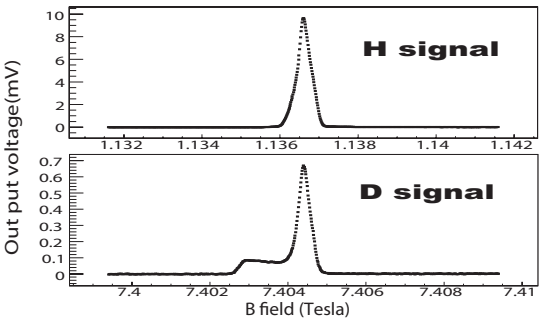

Figure 1: NMR signals observed for H and D. The different shapes of H and D NMR signals are caused by non-uniformity of magnetic field.

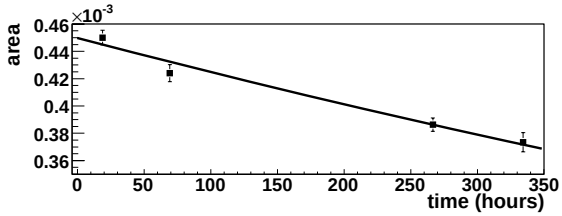

Figure 2: The relaxation time can be estimated by life time equation of polarization. This plot shows the time dependence of the area of the D NMR signal for two weeks at B=1 T and T=300 mK.

References

[1] M. Fujiwara *et al.*, Photoproduction Experiment with Polarized HD Target at SPring-8, LEPS/RCNP proposal (2003).

[2] T. Kunimatsu *et al.*, Annual report of RCNP Osaka university, 9 (2007).

[3] C. Morisaki, Master thesis of Osaka university (2009).

[4] H. Kohri *et al.*, Performance check of the polarized HD target, LEPS/RCNP proposal (2009).