MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2012B0219 (2009S03) 実験課題名 Title of experiment Measurement of neutron lifetime by using pulsed neutron beam 実験責任者名 Name of principal investigator Kenji Mishima 所属 Affiliation ICEPP, the university of Tokyo	装置責任者 Name of responsible person Takashi Ino 装置名 Name of Instrument/（BL No.） BL05 実施日 Date of Experiment 2013/03/6-2013/03/14

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

We didn't use any sample. See next paragraph.

2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

We are developing a new experiment for the neutron lifetime measurement to be going to achieve to 0.1% accuracy. In this experiment, we determines neutron lifetime as the ratio of decay count of the beta decay to cold neutron beam flux. We use a time projection chamber to count of electrons of the beta decay, and $^3He(n,p)^3H$ reactions from ^3He doped in the gas to estimate the neutron flux. Neutrons are delivered as bunches of 30-40 cm length, shaped by a spin flip chopper (SFC), to TPC of 1 m length in order to define fiducial volume and reduce neutron induced background. The cross section of $^3He(n,p)^3H$ reaction is known to follow 1/v low, which means that the reaction rate of $^3He(n,p)^3H$ is independent of velocities of neutrons or ^3He but only dependent on densities of ^3He and neutron. Because event rate of the neutron decay is also proportional to the time, the neutron lifetime can be obtained ratio of events of the neutron decay and $^3He(n,p)^3H$.

We carried out measurements for basic and systematic study for the neutron lifetime experiment.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

1) Improvement of the beam catcher

In the experiment, bunched neutrons are used. Events occurred only in time when the neutron bunches are completely inside of detection region of the TPC are used to evaluate the neutron lifetime. Therefore, events caused at neutron window, collimator, and beam catcher hardly affect to the value of the lifetime. The most part of such events can be rejected by TOF of the bunch structure, however neutrons out of bunches can coincidently hit walls and/or the beam catcher and produce backgrounds of beta decay and/or $^{3}He(n,p)^{3}H$ since the present contrast of the SFC was 300-400. Indeed, many events were observed around the beam catcher in past measurements. As a result of an investigation, a gap between the beam catcher and ^{6}Li shield was found. Energy spectra of pulse height of the TPC before and after of the improvement of the gap are shown in Fig.1. The effect by the beam catcher could be reduced by factor of 2.

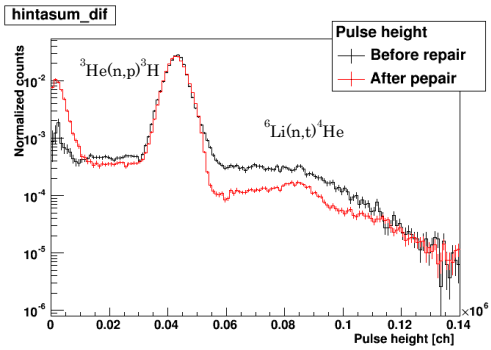

Fig.1. A plot of pulse heights before and after the improvement of the beam catcher. A bump caused by $^{6}Li(n,t)^{4}He$ on the beam catcher could be reduced.

2) Repair of leak on the vacuum chamber

In the experiment, detector gas is used with sealed condition. Therefore, an existence of leak on the vacuum chamber contaminates the detector gas and makes air accumulate in the gas. Because $^{14}N(n,p)^{14}C$ reaction has Q-value of 626 keV which is close to 764 keV of $^{3}He(n,p)^{3}H$, the neutron flux is possible to be overestimated by the contamination of nitrogen.

A large increase by time of $^{3}He(n,p)^{3}H$ like events has been observed with gas pressure of 50 kPa but not 100 kPa in past measurements. After an investigation by a He leak detector, a leak was found and repaired by polishing. The increase rate of $^{3}He(n,p)^{3}H$ with 50 kPa reduced from 0.98±0.06 mPa/day to 0.21±0.03 mPa/day by the repair. The increase rate after the repair corresponds to 0.2% change for 5 days run with ^{3}He of 500 mPa.

3) Measurement of the beam structure in the TPC

The beam structure in the TPC is important information to define the fiducial volume. The beam structure in the TPC was measured by using a position sensitive detector with scanning a pinhole of 2mm at 1.4 m upstream. As the results, the phase space distribution of the neutron beam could be determined. Reconstructed beam structure in XZ and YZ planes are shown in Fig.2. Major part of the beam was in the beam catcher as designed.

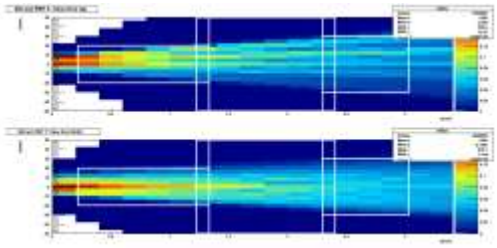

Fig.2. Reconstructed beam structure in XZ (top) and YZ (bottom) planes. White lines show positions of the beam aperture, the TPC and the beam catcher.