Development of polarized ^{3}He ion source

M. Tanaka[1], Y. Takahashi[2], T. Shimoda[2], M. Yosoi[3], and K. Takahisa[3]
[1] *Kobe Tokiwa College, Ohtani-cho 2-6-2, Nagata-ku 653-0838, Japan*
[2] *Department of Physics, Graduate School of Science, Osaka University, Machikaneyama-cho 1-1, Toyonaka, Osaka 560-0043, Japan*
[3] *Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

From the last year on, we have developed a bench-test device which checks the validity of principle of the SEPIS polarized $^3He^+$ ion source based on the spin-exchange type [1]. Last year, we measured an energy dependence of electron capture cross-sections for the $^3He^+$ + Rb system and the observed results were in a qualitative agreement with the theoretical calculation based on the close coupling method [2].

One of the serious difficulties encountered in this year was that a large leakage rate of a rubidium sample stored in the Rb cell could not be avoided, which made the further measurement difficult. To solve this problem, we improved a Rb cell; a liquidproof stainless container was inserted in the copper Rb container which was not liquidproof, thus enabling a long running measurement, typically, more than a month use. Another important development in the bench test device was an introduction of a Millennia X (Spectra-Physics), a 10 W diode-pumped, cw visible laser to pump a Ti:Sapphire laser for optical pumping of Rb atom. With this system a 794.9 nm pumping laser exceeding 2 W was extracted as a maximum power. The pumping laser was guided to the Rb cell under a magnetic field of 0.286 T after a linearly polarized laser light was converted to a circularly polarized one by a $\lambda/4$ plate. It was found that an atomic polarization of Rb vapor was 0.67 by observing a Faraday rotation angle of a probe laser tuned at 780.36 nm, where the Verdet constant of the Faraday rotation were based on the formalism referred to Mori et al.[3].

To measure the $^3He^+$ nuclear polarization generated by the SEPIS method we introduced a beam foil spectroscopy (BFS) was employed, where a circular polarization of 389 nm line emitted from ^{3}He-I atom formed after 3He$^+$ ion was penetrating a thin carbon foil was measured. To check the validity of BFS, we generated a ^{3}He nuclear polarization by means of a tilting foil method. We found that the BFS successfully provided an information on the nuclear polarization from the observed tilting-angular dependence of the photon asymmetries. After this success, we started measuring the photon asymmetries by changing the Rb vapor thickness and $^3He^+$ energy incident on the Rb vapor. The first experimental result of the photon asymmetries measured at E($^3He^+$) = 19 keV is shown in Fig. 1, in which an output power of the Mellennia X was varied. From this result, the ^{3}He nuclear polarization was found to be $\sim$0.05 at this energy.

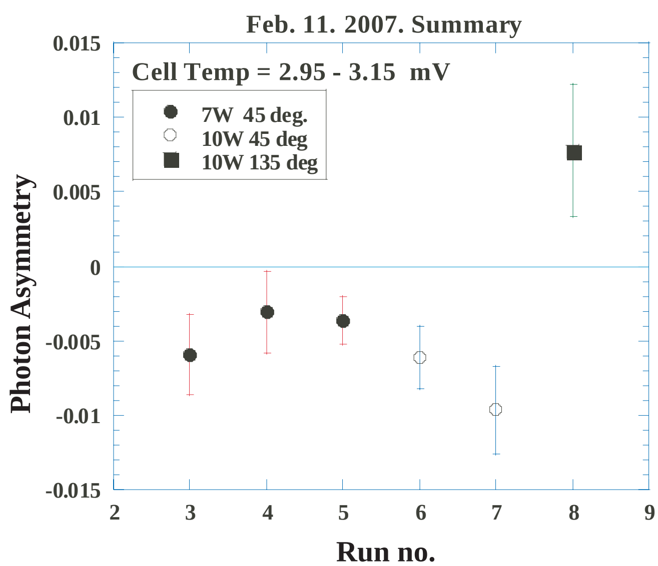

Fig. 1. Observed photon asymmetries taken at E($^3He^+$) = 19 keV. The rightest data was measured by changing the direction of the nuclear polarization.

References

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