Performance of the High Intensity Fast Neutron Beam Facility

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Recently, demands for the material irradiations by neutron or ion beams have greatly increased and various irradiation studies have been performed at various facilities. These include the studies of radiation damages in the materials to be used in the high radiation environments at the reactor and/or accelerator facilities, such as permanent and electromagnets[1)], semiconductors and radiation detectors. Also urgent needs exist in the estimation of the radiation-caused soft errors in the integrated circuits of CPU's of the computers, FPGA (Field Programmable Gate Array)[2,3)] and different kinds of memories such as S-RAM's and D-RAM's[4)].

At CYRIC, the 32-course beam line has been put in use in a variety of neutron irradiation experiments, and improvements have been continued to achieve high intensity neutron beams. In this report, the present status of the high intensity fast neutron beam facility is described. Figure 1 shows the schematic view of the neutron beam facility. The primary proton beams in the energy range of 20-80 MeV are transported to bombard the water-cooled ^{7}Li production target. The beam penetrating the target is swept out by the 25° clearing magnet, and stopped in the water-cooled beam dump. High intensity primary beams of several μA are available, and by using the ^{7}Li(p,n)^{7}Be reaction, the intensity of quasi-monoenergetic neutron beams of up to a few 10^{10} n/sr/sec/μA are obtainable.

From March 2010 to February 2011, 10 experiments of 18 days in total (beam time of 32 shifts) were performed at this facility. In about 80% of the experiments, proton beam of 70 MeV to yield 65 MeV quasi-monoenergetic neutrons were used. The typical neutron energy spectrum, which was measured with the time-of-flight method by using a liquid scintillation counter is shown in Fig. 2. In this case, the thickness of the lithium target was 7.8 mm and the neutron yield, normalized to the beam current and integrated over the energy range of 60-70 MeV, was about 0.9×10^{10} n/sr/μA/sec. The highest yield achieved was about 3×10^{10} n/sr/sec for the primary proton beam with a current of 3.5 μA. This means that the flux at the sample placed at 1.2 m distance from the lithium target was about 2×10^{6} n/cm^{2}/sec. The largest amount of the accumulated flux in one experiment was about 5×10^{11} n/cm^{2} at the sample placed at 1.2m from the ^{7}Li target for the practical irradiation time of 50 hours.

The irradiation demands for researches in not only property changes of materials but also soft errors mechanism of working devices are now increasing. To supply higher intensity neutron beams and/or neutron beams with smaller spot size needed to confine the irradiation area precisely, and to prepare user friendly interfaces to allow the beam on/off and the system to realize easy sample changes are currently in consideration.

References

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2) Akiyama M. et al., CYRIC Annual Report (2009) 39.
3) Toba T. et al., CYRIC Annual Report (2009) 46.
4) Hayakawa T. et al., CYRIC Annual Report (2009) 52.

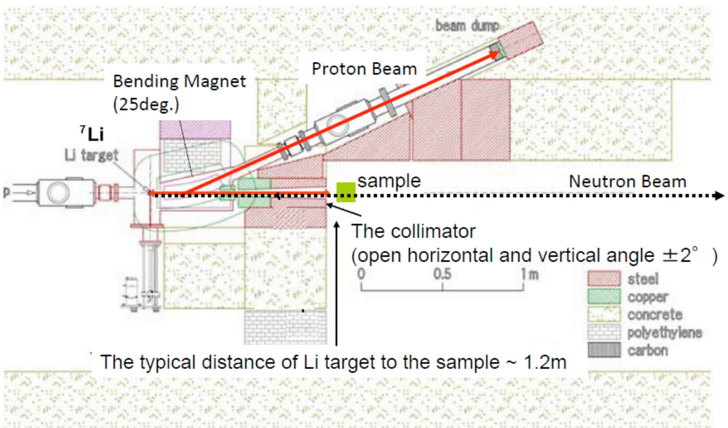

Figure 1. The schematic view of the high intensity neutron beam facility located at the 32-course.

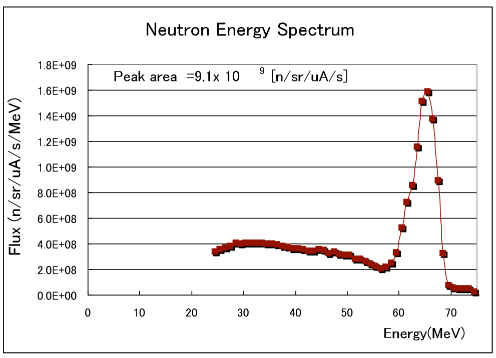

Figure 2. The typical neutron energy spectrum for the primary proton beam of 70 MeV. The obtained energy resolution was about 6 MeV in FWHM, measured by the Time of Flight (TOF) method.