§33. Development of High Performance Neutron Measuring System for LHD

Iguchi, T., Umemura, N., Kawarabayashi, J., Uritani, A. (Dept. Nucl. Eng., Nagoya Univ.), Sasao, M.

A fast neutron spectrometer is the most prominent candidate as a means of plasma ion temperature diagnostics in experiments with large magnetically confined fusion devices such as the LHD. In developing the spectrometer, it is important to fulfill compatibility between the energy resolution and the detection efficiency, and to secure the radiation hardness. We have newly developed a compact counter-telescope-type neutron spectrometer. Although the principle of operation of the spectrometer is similar to that of COTETRA$^{1)}$, it has higher potential ability on the detection efficiency and the energy resolution.

Figure 1 shows a schematic view of the spectrometer. The spectrometer consists of a Silicon surface barrier semiconductor detector (SSD) and sixteen thin plastic scintillators (NE102A) that work as radiators. When a recoiled proton produced in the scintillator by an incident fast neutron is detected by the SSD, the energy of the incident neutron can be obtained from the energies deposited in the scintillator and the SSD with a simple kinematic consideration. It is necessary to minimize the energy deposited in the scintillator to obtain high-energy-resolution performance, because the energy resolution of the scintillator is much worse than that of the SSD. Therefore a thin scintillator must be used. The scintillators are supported by light guides made of quartz glass. The scintillating photons are detected by a segment-type photomultiplier that consists of sixteen (4x4) independent small photomultipliers. The segmentation enables high counting operation of the scintillators, hence improves the overall detection efficiency. A Monte Carlo simulation shows the detection efficiency of 10^{-5} [counts/(n/cm^2)] and energy resolution of less than 3% for an ideal geometrical condition. These performances are enough for the ion temperature diagnostics.

The performance of the prototype spectrometer was examined by using 14MeV neutron beams at the FNS, JAERI. The prototype had only two scintillators with a size of 0.4cm x 0.8cm x 500μmt. The collimators with an aperture diameter of 1cm and a length of 10 cm were set between the scintillators and the SSD, so that only protons whose recoil angle was 30 degree could be detected by the SSD. Figure 2 shows the response to the 14MeV neutrons. Although a continuum component due to interactions between the neutrons and Si atoms are observed, a clear 14MeV neutron peak is observed. The energy resolution was 15.0% and the detection efficiency was 3.4×10^{-7} [counts/(n/cm^2)] for the peak. The energy resolution can be improved by using much thinner scintillators and the small recoil angle, and by improving the light collection efficiency of the scintillators. The detection efficiency can be improved by using more scintillators and a much larger SSD.

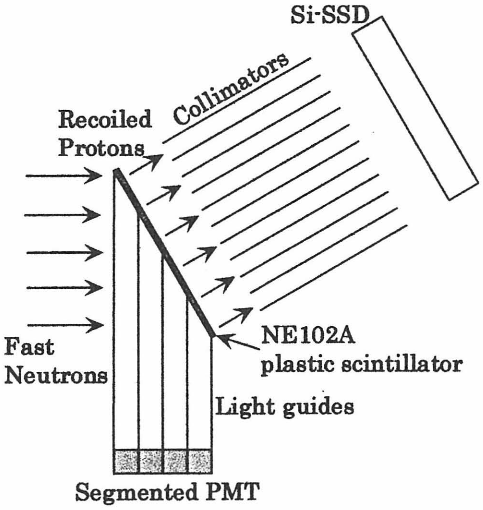

Fig. 1. A schematic view of the spectrometer.

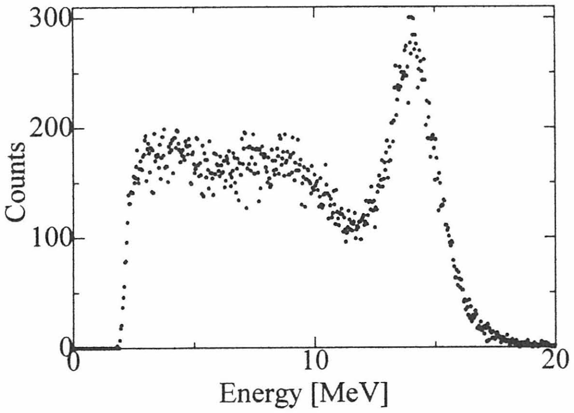

Fig. 2. Detector response to 14MeV neutrons.

Reference
1) Osakabe, M. *et al.*, Rev. Sci. Instr. **65** (1994) 1636.