§15. Development of Neutron Measurement Systems for Study of High-Energy Particle Physics

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We have been developing the following neutron measurement systems and related items for D-D burning plasma experiments, especially for study of high-energy particle physics.

1) The combined neutron transportation code consisting of MCNP, FIT3D-DD and GNET.
2) The neutron flux monitor and the signal processing unit for neutron counters.
3) The artificial diamond neutron energy spectrometer.
4) The neutron profile monitor using scintillating fibers and the digital signal processing unit for discrimination of neutrons and gamma rays.
5) The neutron profile monitor using stacked nuclear emulsions.
6) The neutron energy spectrometer using recoil proton detector.

In this report, we describe the tentative results of 3), 5) and 6) among the above items because of the limitation of writing space given.

i) The artificial diamond neutron energy spectrometer

Diamond single crystals for radiation detectors were grown on (001) off-axis surface of type IIa diamond single crystal substrate with several growth conditions, i.e., methane concentration, RF power density etc. In this year, the best result was obtained at methane concentration of 1% with relatively low RF power density; charge collection efficiency of 100 % for holes and 97% for electrons were achieved. The charge loss on electrons was assumed to occur by nitrogen impurity from residual gas in a reactor. Measurement of the response function of the CVD diamond radiation detectors for 14 MeV neutrons was carried out at JAEA FNS facility. Figure 1 shows an example of these response functions; a peak caused by the $^{12}C(n, \alpha)^{9}Be$ reaction with energy resolution of 3.5 % was clearly observed.

ii) The neutron profile monitor using stacked nuclear emulsions

We made a pinhole collimator made of tungsten alloy for neutron imaging and adapted the stacked nuclear emulsions for the fusion neutron pinhole camera. We evaluated the point spread function of the neutron pinhole camera using the accelerator based DT neutron point source at FNS. Figure 2 shows the reconstructed image of DT neutron source 110 cm apart from the camera. The point-spread function was clearly obtained and its FWHM well agreed with the calculated value.

iii) The neutron energy spectrometer using recoil proton detector

Toward application of neutron energy spectrometer (NES) to planned deuterium plasma experiment in LHD, we installed the Associated Particle Coincident Counting NES (APCC-NES) as the DD neutron spectrometer at KSTAR. We confirmed that the count rate of the recoiled proton detector in the APCC-NES showed a good agreement with that of the conventional neutron flux monitor at KSTAR as shown in Fig. 3.

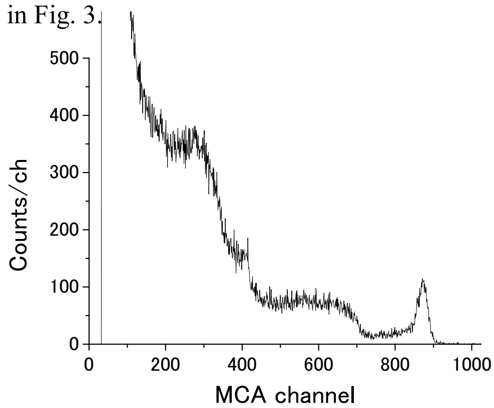

Fig. 1. An example of response function for 14 MeV neutrons obtained by a CVD single crystal diamond detector made by Hokkaido University.

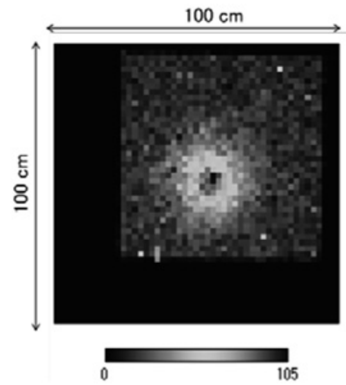

Fig.2. Reconstructed image of DT neutron at the source position.

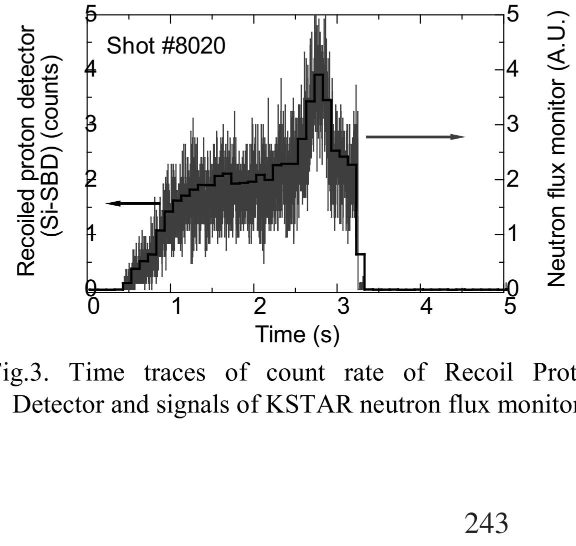

Fig.3. Time traces of count rate of Recoil Proton Detector and signals of KSTAR neutron flux monitor.