§13. R&D of Alpha Particle Induced Gamma-ray Imaging System with Tandem Accelerator

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It is important to study plasma physics on the confinement of energetic particles, which are produced by DT and/or DD reaction in burning plasma. The diagnostics of the distribution of energetic particle loss site have been proposed. The fundamental principle is the detection of 4.44-MeV gamma rays produced by the interaction between the energetic particles came from the plasma and the first wall. To study the loss of the high energy alpha particles, it is need to get image of gamma generation on the first wall. The aim of this study is a development of the imaging system for high energy gamma rays.

Gamma rays were produced with a tandem accelerator at Kobe University. A beryllium target has been set at the end of the P45 beam line. The incident ion is 3.5-MeV helium and it collides with the target. The nuclear reactions, Be(α, nγ), are occurred in the target, and 4.4-MeV gamma rays and neutrons are produced. The spectrum was measured with a HP-Ge detector. The detection efficiency of the HP-Ge must be obtained to determine the number of gamma rays generated with the accelerator.

The detection efficiency of the HP-Ge is a function of the incident energy of a gamma ray. It is expected that the efficiencies are considerably small for high energy gamma rays (several MeV). The efficiency was experimentally obtained with some standard gamma emission sources. The efficiencies for the gamma energy were calculated with the yield of the gamma rays, the radio activity of the source, and solid angle of the experimental system. The experimental result and the exponential fitting curve are shown in Fig. 1. It is found that the detection efficiency for 4.44-MeV gamma rays is smaller than 1%. The precise value must be obtained by future experiments.

The HP-Ge detector was set at the end of beam line on the tandem accelerator. Gamma rays were generated by the reaction of Be(He,nγ), and were detected by the detector. For neutron shielding polyethylene blocks including boron was used. Lead blocks are used to shield the environmental gamma rays. Typical gamma ray spectrum is shown in Fig. 2. The photoelectron peak at 4.4 MeV is discriminated clearly, and single escape peak and double escape peak are also observed. The absolute numbers of gamma rays produced in the experiment are obtained with the detection efficiency.

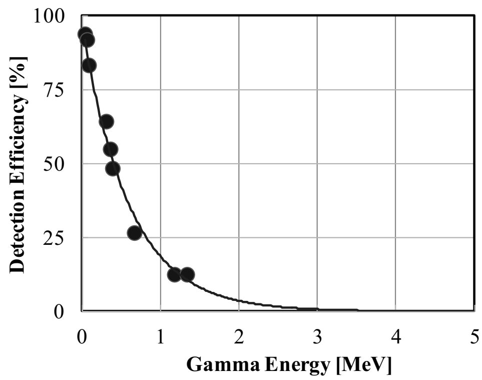

Fig. 1. The detection efficiency of HP-Ge.

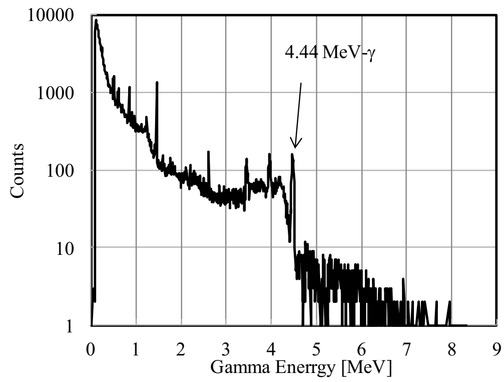

Fig. 2 An example of an energy spectrum for gamma rays measured by HP-Ge detector.

We tried to use a multi channel detector for gamma ray imaging. The preliminary images of the gamma rays were obtained. We will conduct the additional experiments for the development of the multi channel detector. Gamma rays is also produced in Be(p, γ) and C(d, γ) reactions. We have been demonstrated the production of the gamma rays with the reaction and the preliminary results are obtained. Because high energy protons are produced in DD plasma, the same system is applied to fast ion diagnostics in DD experiment on LHD and other fusion devices.

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