Experiment of Neutron Generation by Using Prototype D-D Neutron Generator

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1. Introduction

Experiment of neutron generation was performed by using a prototype D-D neutron generator [1,2,3]. The characteristics of D-D neutron generation in drive-in target was studied. The increment of neutron yield by increasing ion beam energy was investigated, too.

2. Experimental apparatus

The detailed of the device construction and measurement system was written in reference [4]. Some modification was made in this work. First, the ion beam collimator made of stainless steel was replaced by another which was made of brass. Second, the electrode for suppression of secondary electrons, which had been placed in front of the target, was removed. Third, the Si detector was placed at 150 mm away from the center of target and 148° off the beam direction.

3. Experiment and results

The source plasma was turned on with 1.2 kW RF power, and the deuteron beam was extracted at 15 kV from the ion source [5,6]. Deuteron beam current was 57 μA at target. The target was biased to -30 kV, and the proton spectra from D(d,p)T reaction were acquired consequently. The measurement was performed until the count rate of proton peak got saturated. After the proton peak count rate got saturated, target bias voltage was raised to -35 kV, -40 kV and the increment of proton peak count rate was investigated.

After deuteron beam irradiation was terminated, the beam left a mark on the target. It was elliptic and metallic white. It was 27.5 mm in width and 23 mm in height. The mark was regarded as the region of neutron generation, and the detector solid angle was determined. The detector solid angle was 7.8×10^{-4} str. The proton peak spectrum was observed at 2.4 MeV with 113 keV FWHM when the target was biased to -30 kV. When target bias was raised, the peak was broadened, while peak position was not changed. FWHM of the peak was 122 keV, 160 keV, when the target was biased to -35 kV, -40 kV, respectively. The measured spectrum of proton from D(d,p)T reaction by using Si detector is shown in Fig. 1.

The count rate of proton peak and the determined neutron yield is shown in Fig. 2 according to the accumulated charge density of deuteron beam. In the figure, until the deuteron beam charge was accumulated to 160 mC/cm^2, the target was biased to -30 kV and ion beam energy was 45 keV. In this period, neutron yield was increased as an exponential decay function, and the asymptotic upper bound was 4.5×10^5 n/s. After this period, the target bias was raised to -35 kV, -40 kV and neutron yield was increased by 40%, 95%, respectively. Response of neutron yield to deuteron beam energy was prompt.

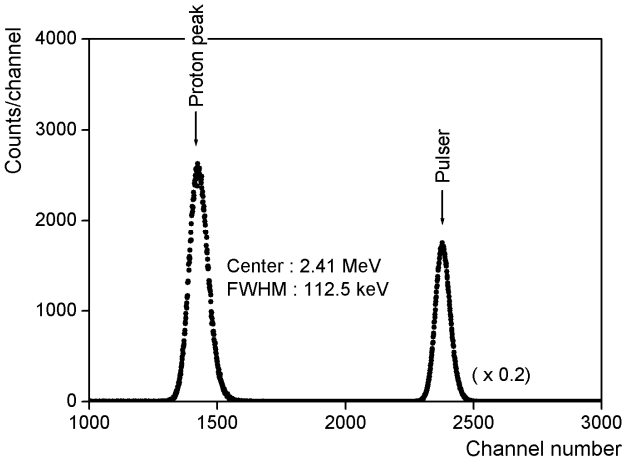

Figure 1. Measured proton peak spectrum from D(d,p)T reaction. Incident deuteron beam energy was 45 keV.

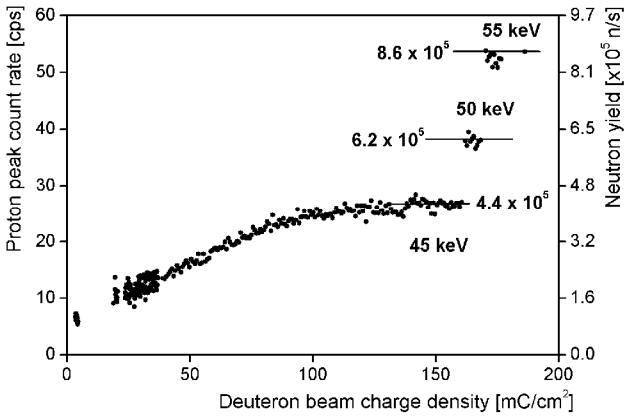

Figure 2. Proton peak count rate and determined neutron yield according to deuteron beam charge density.

4. Conclusion

The characteristics of D-D neutron generation in drive-in target was studied in the case of thick Ti target. Neutron yield was increased as an exponential decay function. And neutron yield of 0.9×10^6 n/s was achieved by accelerating deuteron beam to 55 keV.

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