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Development of Compact Neutral Source using D-D Reaction

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In X-ray imaging, light elements are transmitted through light elements and scattered and absorbed by high-density metals, so the transmitted image shows the metal portions well. In contrast, neutron imaging transmits light elements such as hydrogen through metal and is scattered and absorbed by light elements such as hydrogen, so that the transmitted image shows the areas containing light elements. Thus, x-rays and neutrons have complementary characteristics. However, the practical application of neutron imaging systems is difficult because they require the use of a large accelerator or nuclear reactor as a neutron source, which is a large-scale facility. Therefore, the objective of this study is to realize a compact neutron source for practical use of neutron imaging devices. In this study, a vacuum chamber with a diameter of 0.20 m and a cathode with a diameter of 0.04 m were used. As a neutron generation method, we used the DD reaction, which is expected to be a small-scale facility, because it can cause fusion at lower energy than using an accelerator and because deuterium is a non-radioactive material. Deuterium gas flows into the vacuum chamber, and by applying electric power, the deuterium ions generated are accelerated by the electrodes and collide at the center of the cathode, causing the DD reaction and producing neutrons. The neutron dose rate was then measured at different vacuum levels in the chamber. The actual results were 0.04 μSv/h at 0.1 Torr and 0.08 μSv/h at 0.06 Torr.

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