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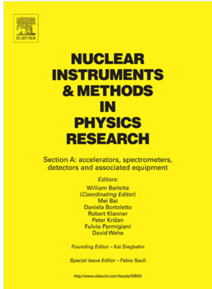

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Characterization of a Deuterium-Deuterium Plasma Fusion Neutron Generator

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Abstract

We characterize the neutron output of a deuterium-deuterium plasma fusion neutron generator, model 35-DD-W-S, manufactured by NSD/Gradel-Fusion. The measured energy spectrum is found to be dominated by neutron peaks at 2.2 MeV and 2.7 eV. A detailed GEANT4 simulation accurately reproduces the measured energy spectrum and confirms our understanding of the fusion process in this generator. Additionally, a contribution of 14.1 MeV neutrons from deuterium-tritium fusion is found at a level of 3.5%, from tritium produced in previous deuterium-deuterium reactions. We have measured both the absolute neutron flux as well as its relative variation on the operational parameters of the generator. We find the flux to be proportional to voltage $V^{3.32\pm0.14}$ and current $I^{0.97\pm0.01}$. Further, we have measured the angular dependence of the neutron emission with respect to the polar angle. We conclude that it is well described by isotropic production of neutrons within the cathode field cage.

1. Introduction

Neutron generators are a convenient, commercially available source of neutrons widely used in science and engineering. They can easily achieve a tuneable neutron flux of 10^6 n/s with some generators operating above the 10^{10} n/s range, they pose no or only minimal safety concerns when turned off, and they are available in a variety of configurations. The latest advances in the field of compact sealed-tube neutron generators toward the development of smaller, lighter and less expensive systems further extend their applicability.

Two main reactions are exploited in such generators: deuterium-tritium fusion yielding 14.1 MeV neutrons, and deuterium-deuterium fusion yielding 2.45 MeV neutrons in the center-of-mass frame. Two operating principles are commonly employed to induce fusion. One is to accelerate a beam of deuterium ions onto a solid state target which contains either deuterium or tritium. Another principle is the fusion of ions in a plasma in the presence of a high voltage potential. Indeed, there are detailed discussions of the characteristics of deuterium-tritium generators [1], deuterium-deuterium generators [2–4] as well as neutron