Seminar

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Institute for Plasma Research

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Title: Development of a rotating tritium target based D-T Neutron generator system for fusion neutronics studies

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Time: 11:00 AM

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Weblink: https://bharatvc.nic.in/join/5016396254

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Abstract

14 MeV neutron, which will be generated during the Deuterium-Tritium (D-T) plasma reaction at the core of fusion reactors, irradiation on the reactor materials is one of the prime concerns of future fusion reactor technology demonstration. In addition, there is a high demand for benchmark experiments for the Fusion Evaluated Nuclear Data Library (FENDL), neutron spectroscopy measurements, double differential cross-section measurements, testing of electronics components in fusion environment and neutron diagnostics in order to develop the future fusion reactor. Therefore, lab-scale devices are gaining popularity in generating various nuclear databases in the context of 14 MeV neutron interactions with Materials and developing fusion-based materials.

In this thesis, the new design for a lab-scale D-T neutron generator has been developed using a 2.45 GHz ECR ion source and water-cooled rotating tritium target, which produces ~10^{12} n/s. It will serve the purpose of performing fusion neutronics studies. In this device, Neutrons are going to be generated from the nuclear reaction 3H(D, n)4He by bombarding solid tritium (TiT) target with accelerated deuterium ion (D+) up to 300 keV via electrostatic accelerator. However, the realization of this device depends on the availability of an accelerator capable of delivering 20 mA D+ ion beams at energies up to 300 keV easily, reliably, stably, and affordably. It also depends upon the tritium target to handle the high beam power up to 6 kW.

The main subsystems of this D-T neutron generator are ECRIS, High voltage deck, Low Energy Beam Transport (LEBT) system, Acceleration column, Medium Energy Beam Transport (MEBT) system, 300kV HVPS, Tritium handling & recovery system, and Rotating tritium target. The LEBT transports the extracted deuterium ion beam from ECRIS to the acceleration system. The MEBT transports the accelerated deuterium beam and bombards the Tritiated target, which produces the 14-MeV neutron. A rotating tritium target has been designed and developed to handle excess heat load due to the beam interception for maintaining continuous neutron yield and reducing the sputtering of tritium from the tritium target.

The thesis covers a detailed experimental setup of the neutron generator, the results of the deuterium ion beam and neutron yield measurement. The deuterium ion beam has been characterized by the measurement of beam current, beam diameter, and beam emittance. The achieved D+ beam current, beam diameter and beam emittance are 19.94 mA, ~20 mm, and 0.19 π·mm·mrad, respectively. The neutron generator has been tested for continuous operation with an average neutron yield of ~1.4×10^{12} n/s.

1. Sudhirsinh Vala et al, Fusion Engineering and Design 123, Nov 2017, Pages 77-81.
2. Sudhirsinh Vala, et al, Nuclear Inst. and Methods in Physics Research, A, 959 (2020) 163495.
3. Sudhirsinh Vala et al, Journal of Instruments, Journal of Instrumentation, Volume 14, April 2019
4. Sudhirsinh Vala et al., International Workshop on ECR ion source (ECRIS 2020), Michigan University, USA.