Design of a scattering chamber for double differential cross-section measurement with an accelerator based 14 MeV neutron generator

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Introduction

The measurement of double-differential cross-sections (DDX) for the fast neutron induced charged particle reactions on fusion technology relevant structural materials are very important for estimating the level of nuclear heating, radiation damage in a reactor environment. Such reactions are induced on bombardment of fast neutrons on the first wall, structural, and blanket components of the reactor thereby leading to formation of gases (helium, hydrogen, deuterium etc.) in the bulk of materials.

It is obvious that DDX data play an important role for the design and development of fusion reactor technology. Therefore at IPR, Fusion Neutronics Laboratory (FNL) has decided to build a facility for DDX measurement of charged particle emitted through 14 MeV neutron-induced reactions on various structural materials. To achieve this objective, it has been decided to design and construct scattering chamber at FNL as a first step. In view of this, a general purpose 30 cm diameter scattering chamber has been designed at FNL.

A general purpose scattering chamber will be coupled with indigenously developed particle accelerator based 14 MeV neutron generator at FNL [1]. The partly assembled 14 MeV neutron generator is shown in Fig. 1. The chamber has been designed for experiments using silicon surface barrier (SSB) detectors for on-line detection of charged particles. It offers great flexibility in the arrangement of SSB detectors. The simplicity and economy are stressed throughout the design. This facility will be used to perform fundamental nuclear physics experiments to measure reaction cross-sections.

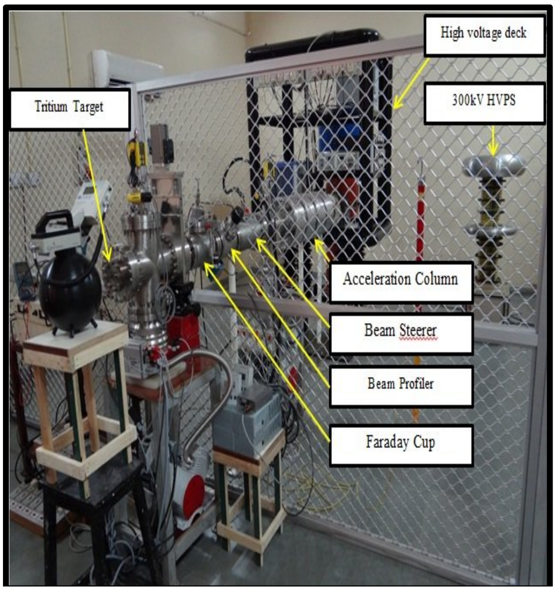

Fig. 1 Partly assembled 14 MeV DT neutron generator at FNL, IPR.

Mechanical Design

The chamber is made of stainless steel (SS 316). It is a cylinder of 30 cm diameter and 20 cm height having entry and exit ports to couple it to the beam line. The wall thickness of the chamber has been kept 3 mm. It has four major ports each 90º apart on the curved surface. The four ports are as follows: (1). Beam entry port (2). Beam exit port (3) Turbo Molecular

Pump (TMP) port and (4). View port. Apart from these four ports, the chamber has two additional ports at 45º along the beam direction for BNC feedthroughs and vacuum gauge. The top and bottom lids of the chamber have thickness of 16 mm. Further, one additional view port of 35 CF has been provided on the top lid of the chamber to view the positioning of detectors. A special mechanical assembly has been fitted on the bottom lid of the chamber to hold the target. So the distance between neutron production source and target can be varied depending upon experimental requirements. The chamber has a rotatable disc to mount detectors at precise position with its angle index wheels and Vernier scale to read angular position with a least count of 0.05º without disturbing the vacuum.

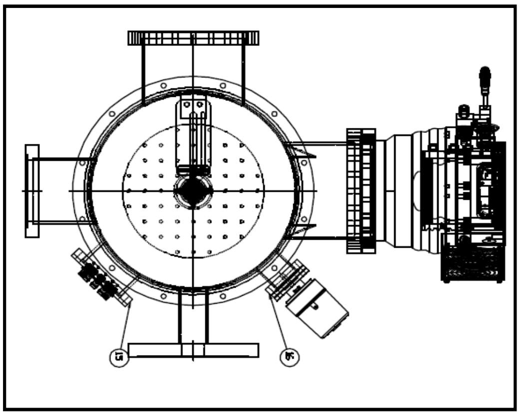

Fig. 2 Sectional view of 30 cm diameter scattering chamber at FNL, IPR

Vacuum System

The vacuum system of the chamber consists of Electroneumatic Gate-Valve, Turbo Molecular Pump (TMP), rotary pump and pirani gauge. The entire vacuum system will be controlled and monitored by means of programmable logic unit (PLU) to ensure the automatic switch from roughing to turbo pumping of the chamber. The chamber is provided with a 200 lts/sec TMP with rotary pump for roughing and back-up through a 100 CF pumping port at 90º along the beam direction as shown in Fig. 3. The TMP is connected to the scattering chamber through 4´ diameter Electroneumatic Gate-Valve. A gauge will be provided through 35 CF port at 45º along the beam direction to measure pressure in the chamber. It is designed to achieve a vacuum of the order of 10^{-6} to 10^{-7} mbar.

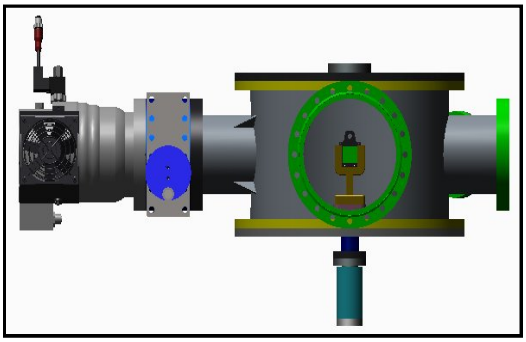

Fig.3 3D view of 30 cm diameter scattering chamber

Acknowledgment

The authors (P.M. Prajapati and Bhawna Pandey) are grateful to Prof. S. D. Dhole, Pune University for his valuable suggestions and advice in the present work.

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