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GAMMA 10ダイバータ模擬実験のための マイクロ波イメージング干渉計システムの開発

Development of microwave imaging interferometer system for divertor simulation experiments in GAMMA 10

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In GAMMA 10, divertor simulation studies have been started as a new research plan by using end-loss plasma flux at the end-mirror region [1, 2]. Recently a large-scale divertor simulation experimental module (D-module) was installed in the west end-cell as shown in Fig. 1.

D-module has a rectangular chamber (500 ×480 mm, 700 mm in length) with an inlet aperture (ϕ 200 mm). Two tungsten plates (350 × 300 mm) are mounted in V-shape inside the chamber. The open-angle of the V-shaped target can be changed from 15 to 80 degree. Gas injection lines are installed for investigation of radiation cooling and plasma detachment. The module also has a movable exhaust door for pumping on its rearward side.

Several diagnostic tools are installed to investigate various plasma parameters inside the module. For example, a high-speed camera is used for 2-dimensional image measurement of visible emission from plasma-target interactions. Langmuir probes and spectrometers are used for electron temperature and density measurements.

In order to obtain precise plasma density distribution for the divertor simulation study, we plan to introduce a 2D microwave interferometer system with phase imaging method. The system design is based on the microwave imaging reflectometry (MIR) system with a 2D microwave imaging device which has been newly developed in LHD at NIFS [3, 4]. A stack of pieces of 1D horn-antenna mixer array (HMA) is used for the 2D microwave imaging device. HMA consists of an upper aluminum frame, a thin printed circuit board (PCB), and a lower aluminum frame. The upper and lower frames have half apertures of pyramidal horn antennas and rectangular waveguide sections. By sandwiching the PCB with the upper and lower frames, a 1D HMA is constructed. HMA for MIR in LHD is designed for V-band (50–75 GHz), which is available for an interferometer in GAMMA 10 having densities with order of 10^{17}~10^{18} m^{-3}. Schottky barrier diodes (SBD) are mounted on the PCB. SBD mixes the signal wave (RF) and the local oscillation wave (LO), which enter from the horn aperture, and converts to the intermediate frequency (IF) signal. The IF signals are amplified by monolithic microwave integrated circuits (MMIC). A 2D antenna array is formed by stacking the 1D antenna arrays.

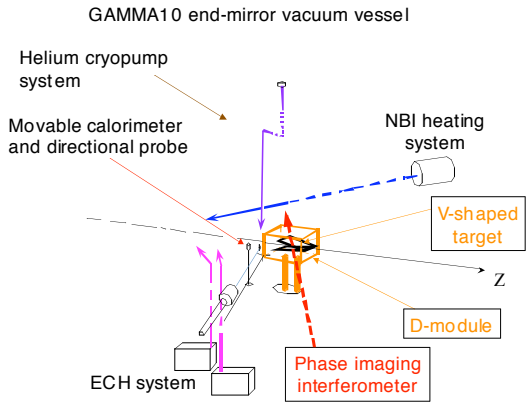

Fig. 1. Schematic view of the GAMMA 10 end-mirror vacuum vessel.

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