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GAMMA10セントラル部におけるフラウンホーファー回折法を用いた密度揺動計測

Density fluctuation measurements by using Fraunhofer diffraction method in GAMMA10 central cell

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Instabilities in plasmas are one of the major causes of plasma confinement degradation in nuclear fusion plasmas. It is important to measure spatially and temporally resolved frequency and wave number spectra of those fluctuations. Fraunhofer diffraction (FD) method is one of the forward scattering methods to measure the fluctuations in the plasmas. In this study, we applied FD method to measure density fluctuations in the central cell of the GAMMA10 tandem mirror.

GAMMA10 is an effectively axisymmetrized minimum-B anchored tandem mirror with thermal barrier at both end-mirrors. The x-axis and y-axis are perpendicular to the magnetic field in the vertical and horizontal directions, respectively. The z-axis is parallel to the magnetic field. The main plasma confined in GAMMA10 is produced and heated by ion cyclotron range of frequency heating(ICH). The potentials are produced by means of electron cyclotron heating (ECH) at the plug/barrier region. Density and other fluctuations in several kilohertz are excited in the central cell[1]. Present studies show the suppression of low-frequency fluctuations of the density and the potential during axial confining potential formation during plug-ECH[2].

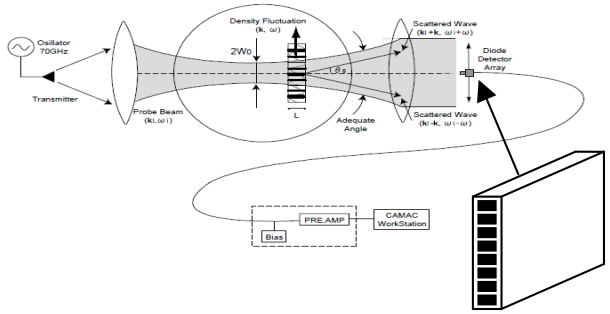

Fig.1 FD method system

We show a schematic diagram of FD method system in Fig.1. A beam of 70 GHz frequency is focused on the plasma center by a fused quartz lens (f = 400 mm, φ= 105 mm). The frequency-shifted FD signal and the unshifted transmitted wave are focused via another lens (f = 400 mm, φ= 125 mm) onto GaAs Schottky barrier diode mixers bonded to gold bow-tie antennas which form a monolith with a fused quartz substrate. In the FD system used in this study, a heterodyne detection is applied to the scattered and incident beams to detect them within the undeviated incident beam, i.e. within the divergence of the probing beam. The wave number spectrum is calculated by using the Bragg relation. The scattering angle has to be larger than the divergence angle of the incident beam in order to avoid stray light[3]. The sampling rate of the data aquisition system is 100 kS/s. The eight channel detector is used in GAMMA10. The detector can be moved in the y-axis direction. This technique makes it possible to investigate long wavelength waves, which are considered to be relevant to anomalous transport. In GAMMA10, we clearly observed the fluctuation suppression during the application of ECH by using the FD method.

[1] M. Yoshikawa, et al., Rev. Sci. Instrum. 79, 10E706 (2008).

[2] M. Yoshikawa, et al., Plasma Fusion Res. 5 (2010) S2010, pp. 1-7.

[3] A. Mase, A. Itakura, M. Inutake, K. Ishii, J.H. Jeong, K. Hattori, and S. Miyoshi, Nucl. Fusion **31** (1991) 1727.