§16. Measurements of Density/Temperature Fluctuations and its Correlation with Reflectometry and ECE on LHD

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Considerable interest has been focused on the study of plasma fluctuations, such as density, electron temperature, electric field and magnetic field fluctuations, since they are thought to be the main cause of anomalous transport and energy loss in magnetically confined plasmas. The net transport depends not only on the level of each fluctuation but also on the correlation between various fluctuations. In order to determine the fluctuation-induced transport, correlations of these fluctuations have to be measured.

Recently, a sophisticated diagnostic method has been proposed, so called, microwave imaging reflectometry (MIR) [1] in which the plasma reflection layer is imaged onto the detector array. The MIR enables the visualization of the density fluctuations. Combining the MIR with the passive ECE imaging [2], both electron density and temperature fluctuations and correlation between these fluctuations can be measured simultaneously. In FY99 we have started the construction of this method for the purpose of ECE and reflectometric imaging of fluctuations.

The imaging optics, an ellipsoidal mirror, a flat mirror, and polyethylene lenses, are designed by using a ray-tracing method to focus radiation signals onto a detector array. The diameter of the mirrors and lenses are determined in order to obtain desired resolution calculated using diffraction theory. An object plane located at the plasma center is 2.7 m in front of the ellipsoidal mirror. In Fig. 1 the performance of the optics is investigated by the ray tracing method.

The Airy pattern of a point source is measured in order to confirm the performance of the optical system. A 140 GHz source is located at the position corresponding to the plasma center. The source is imaged onto the detector array. The results are shown in Fig. 2. The magnification of the optical system is also investigated experimentally, which agrees well with the designed value of 0.68.

In order to superimpose the incident wave of a reflectometer coaxially to the above imaging optics, a dichroic-type beam splitter was designed and fabricated. It is made of 6 mm thick aluminum with 2.0 mm diameter

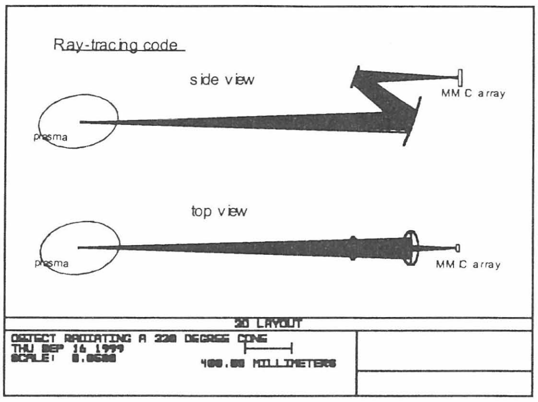

Fig. 1. Ray tracing of the LHD imaging optics

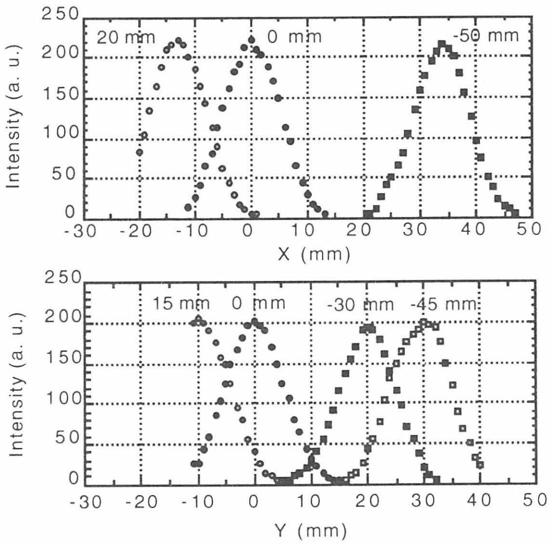

Fig. 2. Airy pattern of the imaging optics in the horizontal (top), and the vertical plane (bottom).

holes and 2.2 mm spacing. Each hole is drilled 45 degree obliquely to the surface. The effective diameter of the beam splitter is 200 mm. The circular holes act as a high-pass filter for the ECE signal with frequency larger than 100 GHz and a reflector for the probe beam of reflectometer system with frequency less than 90 GHz. The performance of the system will be tested soon.

References
[1] E.Mazzucato, Rev. Sci. Instrum. **69** (1998) 2201.
[2] A.Mase *et al*, Fusion Eng. Design. (in press)