§22. Development of a Sheet Plasma Ion Source for Beam Probe Imaging Diagnostic

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Studies of plasma dynamics and fluctuations are key issues to understand toroidal plasma confinement and to improve concepts for better confinement. Various diagnostic methods have been improved in the last decade so that spatially resolved profile measurements can be performed. However they are mostly in one dimensional. In non-axisymmetric tori like LHD or CHS, or in the edge region such as separatrix layer in any toroidal confinement devices, one dimensional measurements are not enough to fully understand plasma behaviors. Two dimensional or imaging diagnostics are required.

Beam probe spectroscopy has been used for Tokamak edge diagnostics, where a fast or a thermal lithium neutral beam, a supersonic helium beam or a laser blow-off atomic beam has been used as a probing beam. All these diagnostics have utilized fine beams with a diameter of 1-2 cm. Diagnostic has been one dimensional along the probing beam.

In order to extend the beam probe diagnostics for two dimensional measurements, an idea of using sheet beam has been [1], but no progress has so far been reported. We have proposed to develop a sheet beam extracted from an RF sheet plasma source. A sheet plasma source has been developed for application to industrial plasma processing, where a wide uniform plasma has an advantage in efficient chemical processing.

In this study, we have developed a wide (> 10 cm) uniform (> 90 % uniformity) Argon plasma using an RF power source, which will match the requirement from sheet beam extraction for the diagnostic beam. Argon plasma will be used for the proof of principle experiment. Various rare gas plasmas will be possible depending on the diagnostic purposes.

Figure. 1 shows a schematic drawing of the rectangular wave guide type plasma source. Permanent magnets are used to produce magnetic field inside the chamber. An RF antenna is installed at the opposite end of the chamber to the opening from where ion beam would be extracted. Position of the permanent magnets has been determined in the experiment so that a uniform and dense plasma can be produced near the opening side of the chamber. Density profiles along the antenna current for different pressure of Ar are shown in Fig. 2. At low pressure around 20 mtorr, 140mm wide sheet plasma of the density $2.5 \times 10^{12} cm^{-3}$ within 10% of uniformity is obtained by the RF power of 3kW.

References
1) R. J. Fonck, et al., Rev. Sci. Instrum. 61, 3487 (1990).

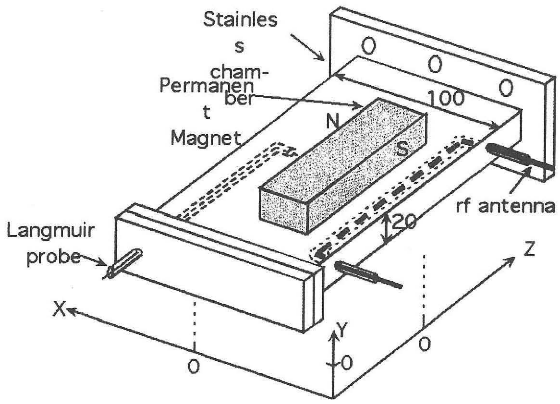

Fig. 1 Schematic view of RF sheet plasma source.

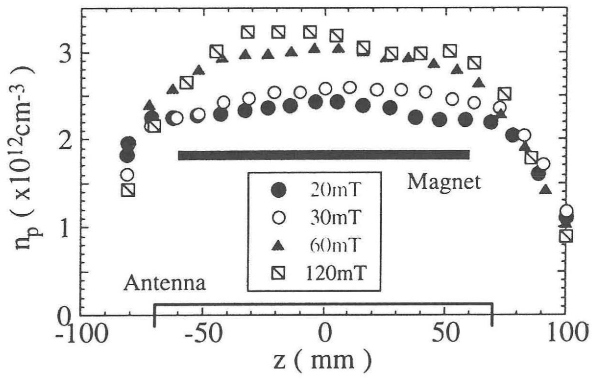

Fig. 2. Density profile along the antenna current and perpendicular to the magnetic field. Prf< 5kW, f=13.5MHz.