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

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Studies of plasma dynamics and fluctuations in the edge region such as separatrix layer in non-axisymmetric torus are important for understanding the plasma confinement. Two-dimensional imaging diagnostics for density and electron temperature in the plasma edge region are useful tools for this purpose. We developed the compact RF sheet plasma source for CHS edge diagnostic.

The rectangular wave-guide type RF plasma source with the permanent magnet arrangement was developed to make high density sheet plasmas [1]. The plasma is produced by the inductive electric field induced by the antenna current at the magnetic null line, which is produced by the permanent magnets. At the pressure around 20 mtorr, 140mm wide sheet plasma (Ar) of the density $2.5\times10^{12}cm^{-3}$ within 10% of uniformity is obtained by the RF power of 3kW at 13.5MHz. In order to minimize the size of the plasma source, the dependence of the length of the permanent magnets along the magnetic field (Lmag) on the plasma density is studied. For larger Lmag case, the plasma loss to the chamber wall increases under the magnets and the reduction of the density is observed. The density profile along the magnetic field for Lmag=20, 60mm are measured (Fig. 1), where the antenna length across the magnetic field is 100mm. Even for Lmag=20mm, the uniform sheet plasma of the density $\sim5\times10^{12}cm^{-3}$ (100mm in width and 10mm in FWHM) is obtained at 10mm down stream from the edge of the magnets, where the magnetic null line locates.

Based on those results, we designed and made the compact sheet plasma source for CHS edge diagnostic. Argon or Xenon plasmas are used for the probing beam because those heavier gases can be possibly used for radiative cooling of the divert plasma and also the high beam current can be obtained by this RF discharge. The width of the sheet plasma can be extended easily by using the wider permanent magnets in this source, so 200mm wide sheet beam source is designed for CHS as is shown in Fig. 2. The multi hole extraction electrodes are attached to the end flange of the source, which is nearly placed around the magnetic null line formed by the permanent magnets.

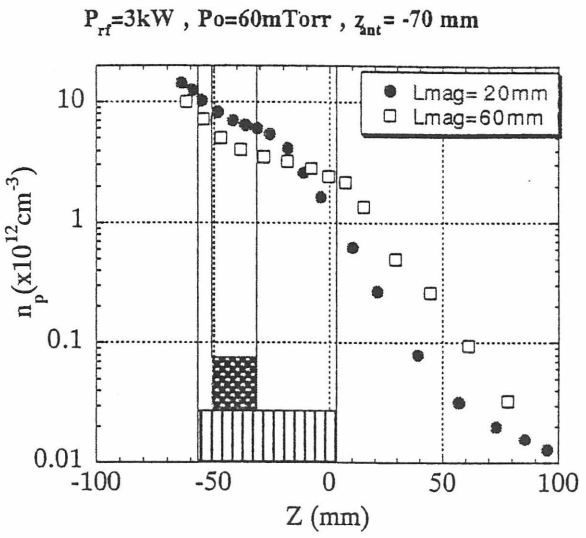

Fig.1 Density profiles along the magnetic field for the length of the permanent magnets of 20 and 60mm. Ar plasma, f=13.5 MHz.

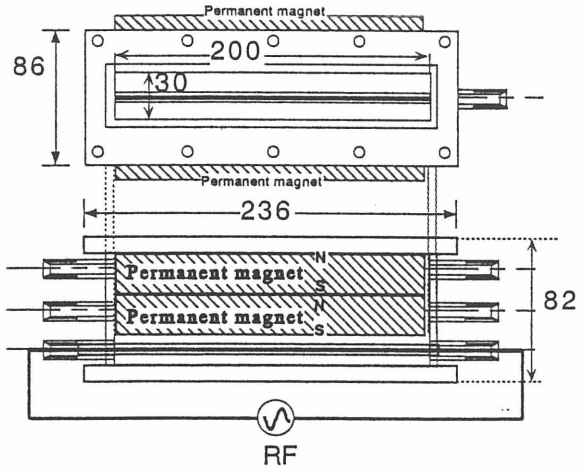

Fig. 2 Sheet plasma source for edge diagnostics in CHS

References

[1] Shoji, T., Sakawa, Y., Yano, K., Iguchi, H. and Nakamura, K., Ann. Rep. NIFSm (2001) 169