

§7. High Density Plasma Experiment

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HYPER-I is a linear plasma device capable of generating large-diameter and high-density plasmas, and started its operations in Dec. 1996. The main activities on HYPER - I devices are the experimental studies on (1) high density plasma production and its application to plasma neutralizer, (2) flow pattern formation in the plasma production region, (3) magneto-hydrodynamic wave such as kinetic Alfvén wave, and (4) advanced plasma physics, which commonly need high-density and/or large diameter plasmas.

The plasma is produced by microwaves through the electron cyclotron resonance (ECR). A magnetron oscillator with output of 15 kW is used to generate a 2.45GHz microwave, which is converted to a circular TE_{11} mode and is launched from an open end of the field line. An electron cyclotron wave is excited in the plasmas and its energy is fully absorbed near the ECR point in the weakly diverging magnetic field. The electron cyclotron wave has no density-cutoff and is always accessible to any high density plasmas as far as $\omega/\omega_{ce} < 1$ is satisfied. Figure 1 shows the schematic of HYPER-I device.

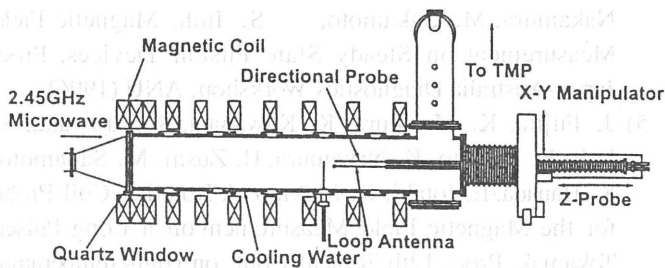


Fig. 1 Schematic of HYPER-I device

The plasma production experiments have been carried out using argon gas and microwave input of 11 kW, the result of which is shown in Fig.2. As seen in this figure, the plasma density increases as a function of pressure, and exceeds a density $1 \times 10^{13} \text{ cm}^{-3}$ at

the operation pressure of 2×10^{-2} Torr. This value is two order of magnitude higher than the cutoff density of ordinary mode of the same frequency ($7 \times 10^{10} \text{ cm}^{-3}$), and is same as that for plasma neutralizer application. The electron temperature decreases with increasing the operation pressure, and exhibits 3 eV at the operation pressure of 2×10^{-2} Torr.

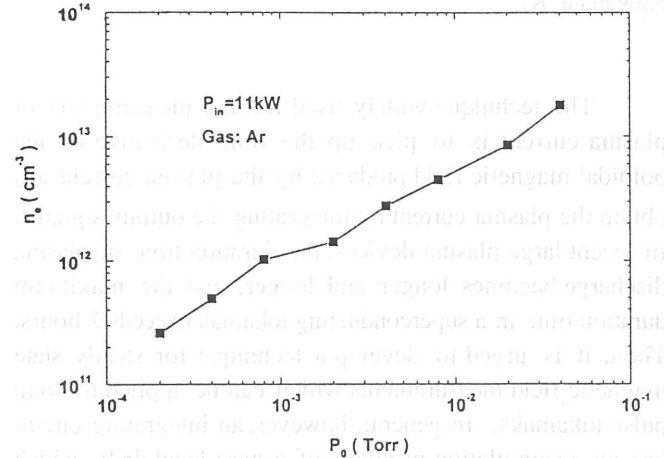


Fig. 2 Density as a function of pressure

The radial density profile is shown in Fig.3, in which the operation pressure is 8×10^{-3} Torr. When the input microwave power is low (5 kW), the radial profile is weakly hollow, however it becomes remarkable in the 15 kW input case. This result means that the neutral gas feed rate is insufficient in the central region of the plasma, because the plasma diameter is larger than the ionization mean free path of argon. Hence, the gas feeding system should be improved to realize the homogeneous density profile.

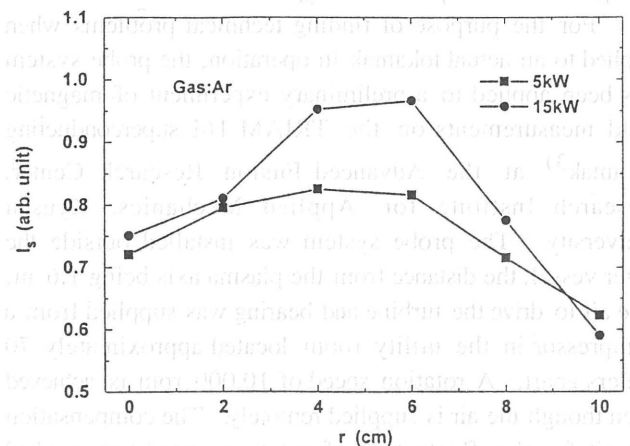


Fig. 3 Radial density profile

Reference

Tanaka M. Y. *et al.*, Rev. Sci. Inst. 69 (1998) 980