§15. Experiments on High Density Plasma Production by Helicon Waves in Torus Devices

Ogawa, Y., Morikawa, J., Takemoto, T., Sueyoshi, T. (Univ. Tokyo), Seki, T.

In linear devices high density plasmas in the range of 10^{19} m^{-3} have been successfully produced by helicon waves[1], and preliminary experiments of helicon waves have been carried out in torus devices such as a simple torus[2] and helias[3]. We have initiated helicon wave plasma experiments with an internal coil device Mini-RT so as to produce high density plasmas.

The magnetic configuration in the Mini-RT device is shown in Fig. 1, where the major radius of the internal coil made of REBCO high temperature superconductor is 15 cm. The typical magnetic field is 0.02 – 0.1 T, and the plasma with the density of $1x10^{17}$ m^{-3} is produced by 2.45 GHz microwave. For excitation of helicon waves in linear devices several types of antennae have been adopted such as loop antenna, saddle one and so on, as shown in Fig. 2[1]. Here we have, at first, installed a saddle antenna in the Mini-RT device. Since experimental results by helicon waves in linear devices show the higher plasma density can be achievable when the microwave around the lower hybrid frequency has been applied, the microwave frequency of 13.56 MHz was selected in the Mini-RT device. The damping mechanism of helicon waves seems to be not so clear, but the mode conversion from helicon wave to Trivelpiece-Gould (TG) mode is a promising candidate. Figure 3 shows the mode conversion from helicon to TG waves in the Mini-RT device.

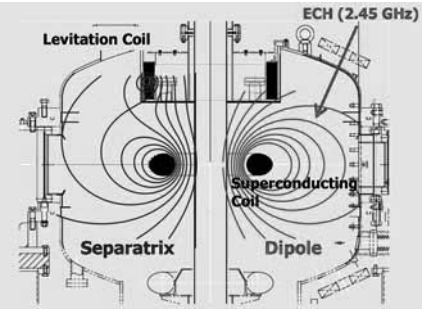

Fig.1 Schematic drawing of the internal coil device Mini-RT.

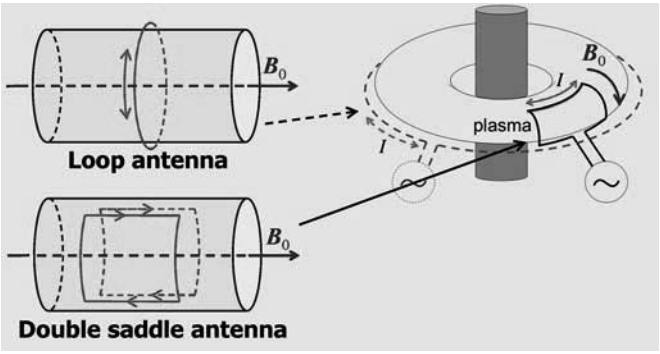

Fig.2 Antenna configurations (loop and saddle antennas)

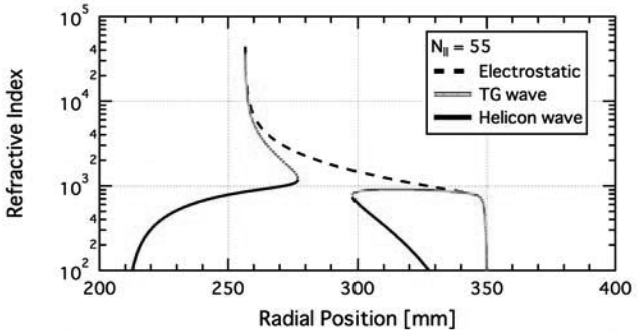

Fig.3 Dispersion relation of helicon waves.

Figure 4 shows a schematic drawing of helicon wave injection system, and Photograph 1 shows the Mini-RT device and RF components such as a power monitor and a matching box.

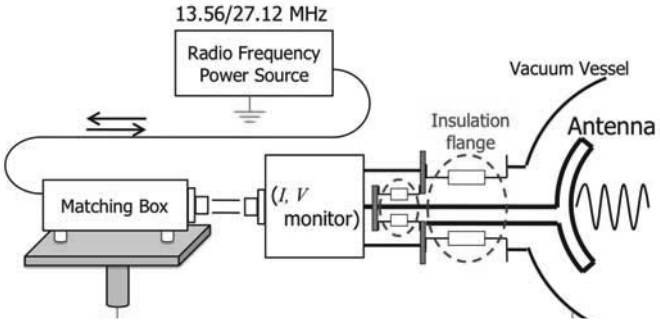

Fig. 4 A schematic drawing of microwave system.

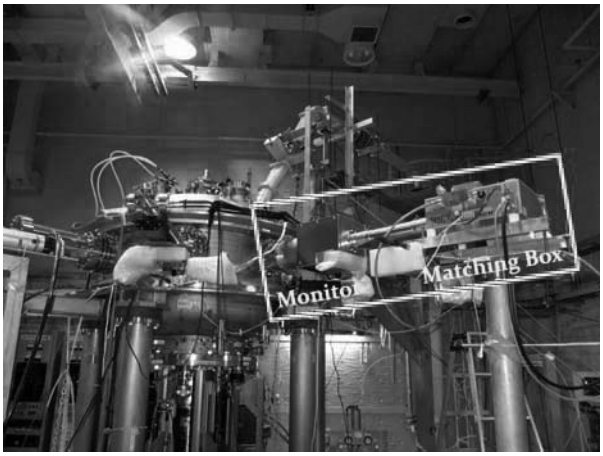

Photo. 1 Mini-RT device and microwave system.

Preliminary experiments have been conducted in the Mini-RT device, and plasma production by helicon waves have been initiated. Since plasma density produced by helicon waves was still quite low, optimization of helicon wave experiments should be considered, e.g., operation gas pressure, antenna configuration, gas species, plasma volume, and so on.

[1] S. Shinohara, Butsuri, **64** (2009) 519-526.
[2] Y. Sakawa, et al., Phys. Plasmas, **11** (2004) 311.
[3] P.K. Loewenhardt, et al., Phys. Rev. Lett., **67** (1991) 2792.