§ 2. First Plasma Experimetns on an Internal Coil Device with a High Temperature Superconductor

Ogawa, Y., Morikawa, J., Ohkuni, K., Nihei, H., Hori, D., Yamakosi, S. (The Univ. of Tokyo)
Iwakuma, M. (Kyushu Univ.)
Mito, T., Yanagi, N.

Several devices with internal coils have been constructed in the 1970's, and plasma confinement and MHD stability have been studied[1]. Since the internal coil device is suitable for studying basic physics in fusion plasmas, it is recently revived for exploring high beta plasmas based on new relaxation theories[2,3]. Here we have constructed an internal coil device with a high temperature superconductor (HTS), called Mini-RT. This is a first challenge for utilizing a HTS coil in a plasma experimental device.

The major radius of the internal coil is 0.15 m and the nominal coil current is 50 kA. Three different types of Ag-sheathed Bi-2223 tapes are employed; i.e., a high critical current tape with a low silver ratio for the main HTS coil, a 0.3wt%Mn-doped one for the persistent current switch and a 3at%Au-doped one for the coil-leads. Cold gas helium is provided by a GM refrigerator and supplied to the coil through a check valve, and the coil current is directly excited with the external power supply through removable electrodes. It took about 11 hours to cool the coil down to 21 K from the room temperature, and the nominal cable current of 118 A (overall coil current: 50 kA) has been achieved. A decay time constant of the persistent current is a few tens of hours.

After achieving the persistent current, the inserted electrodes and transfer tubes are removed, and the internal coil is mechanically lifted up to the middle position of the vacuum vessel. The magnetic field strength around the internal coil is around 0.1 T, and a radio-frequency wave of 2.45 GHz is applied for the plasma production. The first plasma with a dipole configuration is shown in Photo. 1.

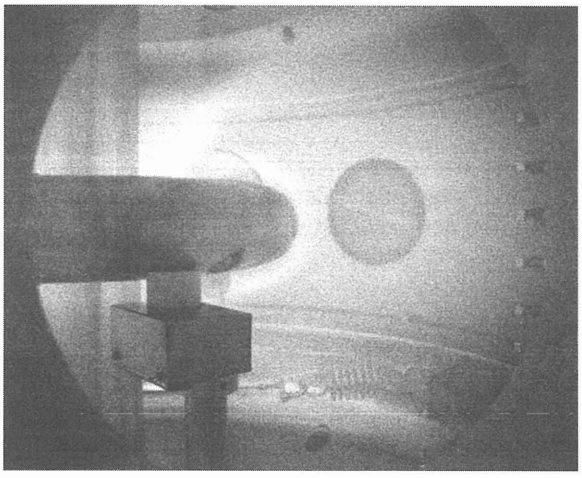

Photo 1. A photograph of a dipole plasma.

The magnetic surface in a dipole configuration is shown in Fig. 2(a), where the coil current is 20 kA. The magnetic field strength around 0.1 T is located at the inner region of the torus. The microwave power is less than 1 kW. The plasma density and temperature are measured with a double probe at the mid-plane of the outer region of the torus. The spatial profile of the plasma density and temperature is shown in Fig. 2(b), where the plasma density is around 2×10^{15} m^{-3}, and the plasma temperature is 10 eV. It seems that the profile is relatively flat.

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References

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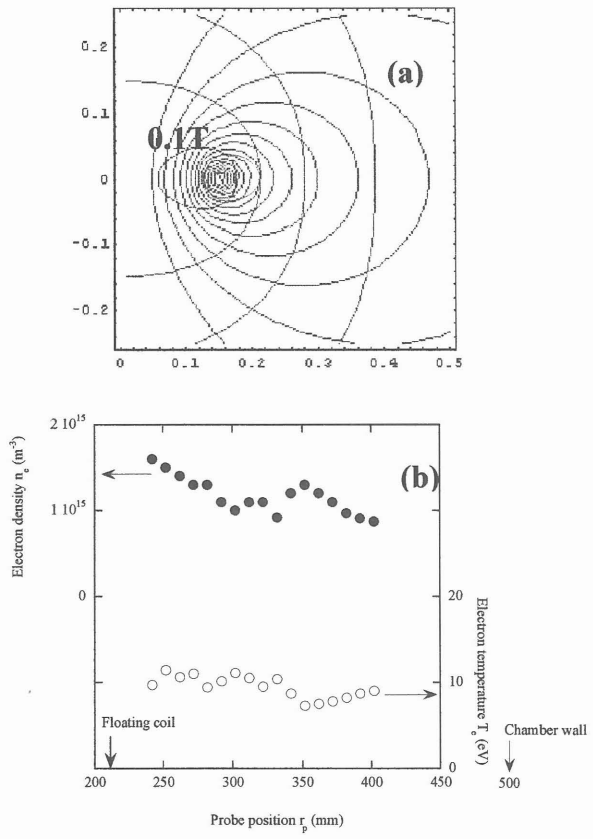

Fig.2. (a) Magnetic field configuration and the field strength at Icoil = 20 kA, and (b) plasma temperature and density.