§6. Correlation between Leakage Electric Field around ICRF Oscillators and Plasma Input Power by ICRF Heating System

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The workers can easily access around the heating system of ICRF even though it is in operation. Thus, to protect the workers from harm to the human body by non-ionizing radiation, the leakage electromagnetic field of the ICRF heating systems has to be continuously monitored. To realize the behavior of leakage electromagnetic field around ICRF oscillator under the plasma heating experiments, handy-type personal RF monitors as an area monitoring instrument have been installed in the heating power supply room. A personal RF monitor has many advantages, including cost effectiveness, compact size, light weight, isotropic response, and standards compliance. Also, a personal RF monitor can simultaneously measure electric and magnetic fields in one device. Accordingly we have developed the multipoint monitoring system using handy-type personal RF monitor for leakage electromagnetic field around the ICRF oscillator. In this report, we would discuss the correlation between the leakage electromagnetic field and plasma input power of ICRF heating system.

To continuously measure the leakage of electromagnetic fields from ICRF, three handy-type personal RF monitors with three axes electric and magnetic sensors named “Radman” (Narda S.T.S.) were placed on the stage around the top of ICRF oscillator as shown in Fig.1. The measuring range of magnetic field frequency is between 3 MHz and 1 GHz and that of electric field frequency is from 3 MHz to 7 GHz (slow type) or 40 GHz (fast type). The relative value of field strength is from 0% to 160%, in accordance with the Japan RCR-STD38 standard. Continual data acquisition with the Radman RF monitors was carried out using a personal computer connected by optical fiber via RS-232C. For data acquisition using three monitors, we have developed original software. The sampling interval time is 0.2 s. In the ICRF heating experiments, the leakage magnetic field signal could not be detected by all probes because the value of leakage magnetic field from ICRF devices was extremely low level.

On the day, FPA-2, 3, 6A and 6B were operated with input ICRF heating power into plasma. The heating frequency of ICRF was 38.5 MHz. The leakage electric fields were detected at the place of Radman2 and Radman3 near the FPA device. The maximum leakage electric field of Radman 2 was less than 47.5%. The level was lower than the guideline of RCR-STD 38 standard and not harmful to the human body. Figure 2 shows few measured data under ICRF heating experiment and the correlation between the plasma input power by 3.5L antenna via ICRF amplifier #2 and the leakage electric field measured by Radman2. The lines indicate the liner fitting of data. It seems that the leakage electric field is proportion to the plasma input power and is not affected by the duration of plasma discharge. The amount of leakage electric field might be changed due to the impedance mismatch between the ICRF antenna and plasma. The maximum power of ICRF heating system is 1.2MW per one unit at 38.5 MHz and the pulse length of 5sec.. According to the results of field monitoring, when the ICRF heating system is operated at maximum power, the leakage electric field near the FPA is estimated to be less than 80% within the radiofrequency-exposure protection guideline of Japan, RCR-STD-38.

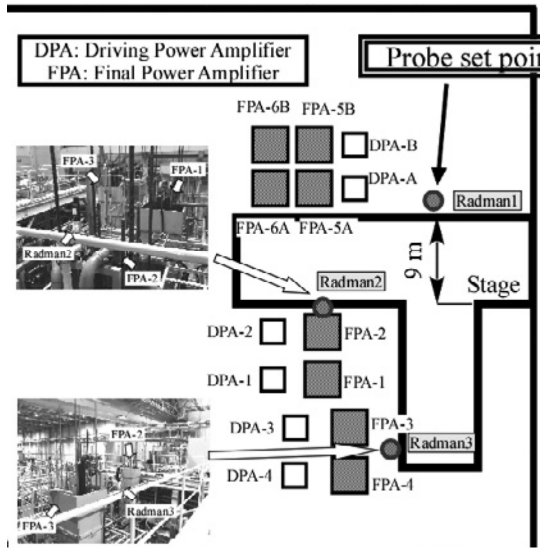

Fig.1 Layout of the ICRF amplifier devices and the measurement probe set points: the photos are the RF monitors and the ICRF FPA devices.

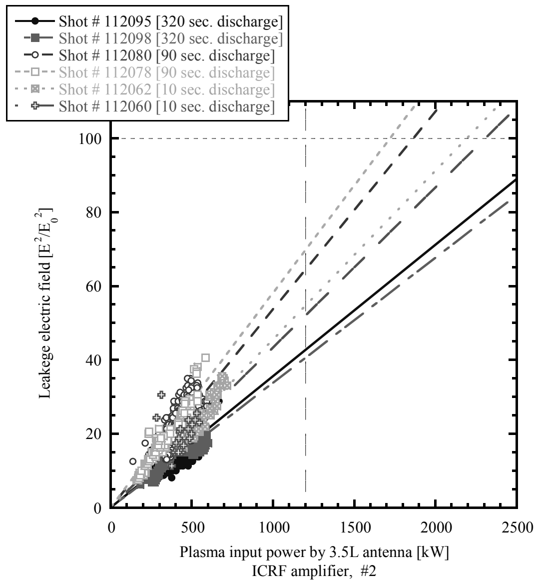

Fig. 2 The correlation between the plasma input power by 3.5L antenna via ICRF amplifier #2 and the leakage electric field measured by Radman2