§7. Monitoring of Leakage Electromagnetic Field by Handy-type Personal RF Monitor around ICRF Oscillator

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Considering the safety for workers, it will become ever more increasingly necessary and important to observe the ionizing radiation as well as the non-ionizing radiation on the plasma experiments with high power auxiliary heating systems. Among these auxiliary heating systems, 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 from the ICRF heating systems has to be continuously monitored. In previous report, two kinds of Isotropic Radiation Meter EMC-300EPs and SRM-3000 (Narda. S.T.S) was used to monitor the electromagnetic field. It was found that they were suitable for monitoring environmental electromagnetic field in terms of performance. However, the construction of a multipoint monitoring system would be expensive because of the instrument's high cost. Then, we proposed to use a handy-type personal RF monitor as an area monitoring instrument. 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 probe. Accordingly we developed the multipoint monitoring system using handy-type personal RF monitor for leakage electromagnetic field around the ICRF oscillator.

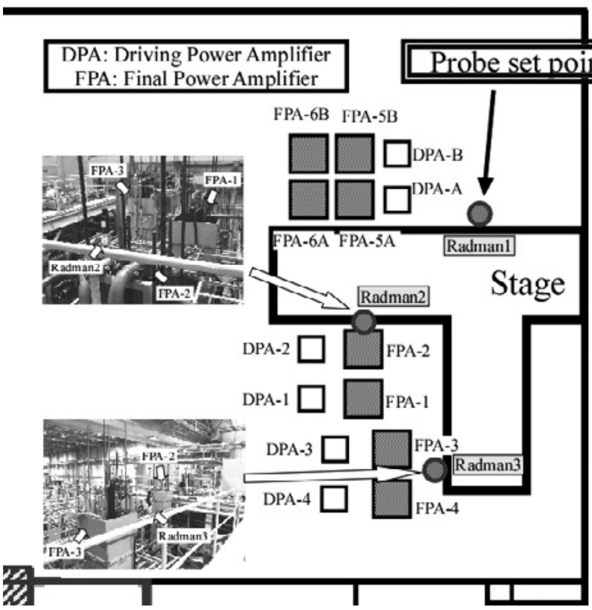

Fig.1 Layout of the ICRF devices and the measurement probe set points: the photos are the probe and the ICRF FPA.

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 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. According to RCR-STD38, the relative value of field strength is expressed by the following equations:

$$IR_E\ (\%) = 100 \times E^2/E_0^2, \qquad (1)$$
$$IR_H\ (\%) = 100 \times H^2/H_0^2. \qquad (2)$$

Here, E is measured electric field (V/m) and E_0 is the standard regulation level. For magnetic field, IR_H (%) is expressed as H^2/H_0^2. 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.

Figure 2 shows the example of the measured electric field in a single day by Radman 2 and 3 shown in Fig.1. On the day, FPA-2, 3, 6A and 6B were operated to input ICRF heating power into plasma. The heating frequency of ICRF was 38.47 MHz. The maximum power of ICRF was totally 1.3 MW. The leakage electric field signal from FPA-2 and FPA-3 could be detected by Radman 2 and 3, successfully. However, the Radman 1 could not detect the electric field, because the probe was placed at a distance. The maximum leakage electric field of Radman 2 reached 47.5% on 2011/9/26. The level of that was lower than the guideline of RCR-STD 38 standard and not harmful to human body. On the other hands, the magnetic field signal could not be detected by all probes because the value of leakage magnetic field from ICRF devices was extremely low level.

Next year, the Radman1 will be moved and placed near the FPA-6A and monitor the leakage electric filed from FPA-6 and 5.

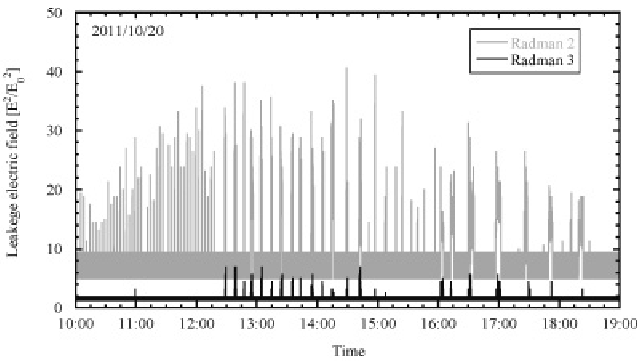

Fig.2 Example of measured electric field in a single day [20 Oct. 2011]