§7. Measurement and Analysis of Burst Electromagnetic Fields in Fusion Facilities

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Introduction

In the fusion facility, many devices such as plasma heating and discharge cleaning leak electromagnetic fields with an irregular variation ranging from several MHz to several hundred GHz. The objective of this study is to clarify how to evaluate the safety for workers in such a special electromagnetic environment. We first measured the time variation of electric field leaked from a heating device in the ion cyclotron range of high-frequency (ICRF). Then we analyzed its statistical characteristic for the specific absorption rate (SAR) evaluation. In addition, we also developed a scanning system for visualizing the electromagnetic field distribution in the working environment of fusion facility.

Measurement Results and Analysis

The signal from the ICRF is amplified with a two-stage amplifier at frequencies of 20 – 100 MHz, and is then sent to the plasma load through a waveguide. Using a real time spectrum analyzers (Tektronix RSA3308B) together with a bi-conical antenna, we measured the time variation and spectrum of the leaked electric field in the vicinity of the amplifier of ICRF for a dummy plasma load. The real time spectrum analyzer can record the time waveform and the spectrum of measured electric field at the same time through a Fourier transform hardware. As a result, the second-stage amplifier is found as a stronger leakage, and the leaked electric field is in a burst form with a varying field level. Figure 1 shows an example of the measured result. The center frequency of the leaked electric field is at 38.5 MHz and most of energies range within ±2 MHz. Within each burst period, we extracted the statistical characteristic of the leaked electric field. Figure 2 shows an example of the possibility density function (PDF) of the leaked electric field. It is much different from a normal distribution, and consequently the mean value of electric field differs from the median value and the mode value. Using one of the three statistical values, the SAR of workers can be obtained based on different biological considerations.

Yet, from the measured results for the dummy plasma load, although the electric field varies with time in a burst form, its maximum level does not exceed 1 V/m. Under such an electric field level environment, the SAR is always much smaller than the ICNIRP safety guideline for any type of statistical variations. Of course, the finding needs to be confirmed for actual plasma loads.

Conclusion

A statistical measurement was made for the leaked electric field from ICRF in the fusion facility. Although the burst electromagnetic field exhibits a very irregular statistical characteristic so that its mean value differs from the median value and the mode value, the SAR is always much smaller than the ICNIRP safety guideline no matter we use which value in the safety evaluation. The measurement and analysis for an actual plasma load will be the future subject.

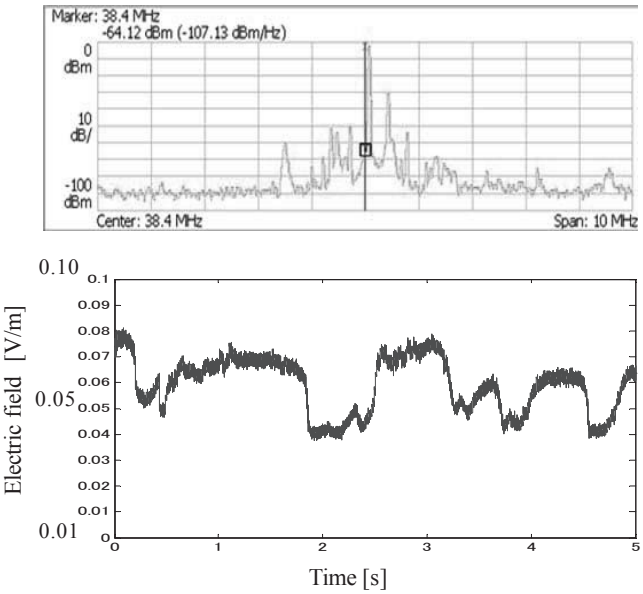

Fig. 1 Spectrum and time waveform of leaked electric field within one burst period.

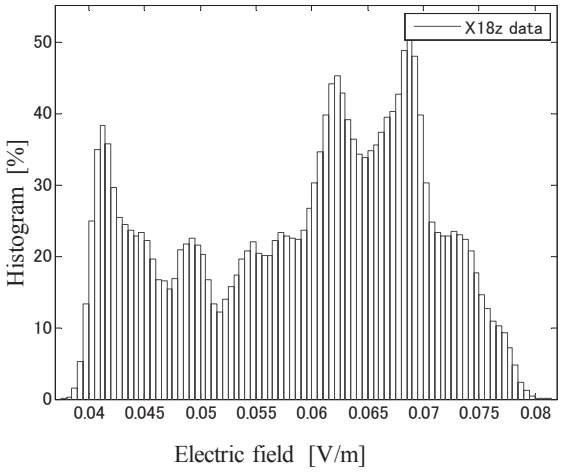

Fig. 2 PDF or histogram of leaked electric field within one burst period.