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デジタルミリ波干渉計の開発による密度分布測定の高精細化の研究

Development of digitally-controlled millimeter-wave interferometer for precise electron density distribution measurement

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We have proposed a new technique for electron-density distribution measurement based on an interferometer. This interferometer can easily use tens of line integration chords spatially for density reconstruction. Even during the plasma experiment, the measurement chords can be scanned spatially by a digital-electronics. Even such many channel system, measurement system become relatively simple. Temporal response of the new interferometer is not slow.

The core device for the new interferometer is a special antenna. This antenna has a capability of spatial scan by changing input frequency into the transmitting antenna. We have successfully fabricated the antenna, that is called image non-radiative dielectric (INRD) guide antenna. It is confirmed that the radiation direction changes from 95 degree to 125 degree by changing the input frequency from 68 GHz to 78 GHz shown in Fig.1. By injecting signals with many frequencies, a fan shape like radiation pattern can be realized. An electron density distribution in a cross-section of a plasma will be measured simultaneously by using this antenna.

The second idea of this interferometer is using a high-speed digitizer. We do not prepare a phase detector for each channel. Instead of the detector, we use the high-speed digitizer and a digital processing program. In the program, a phase detection function as well as a base-band transformation function, i.e., mixing, filtering, and phase detection, is implemented. We have simulated this digital process as follows. The A/D converter measures the signal with frequencies from 1 MHz to 80MHz in 1MHz step. A test signal made from 80 frequencies signal with random amplitude and phase is synthesized in the program. In addition to that, a Gaussian noise component with various amplitudes is added to the test signal. We apply a digital filter (finite impulse response filter) to separate an individual signal with monotonic frequency from the test signal. We successfully separate the signal by the 3000 order digital band-pass filter. Furthermore, it is also found that signal to noise ratio must be larger than 1 to keep the phase information at the specific frequency between the test signal and the processed signal.

In the conference, we will present the detail of the new diagnostic system, and antenna evaluation of the INRD guide antenna.

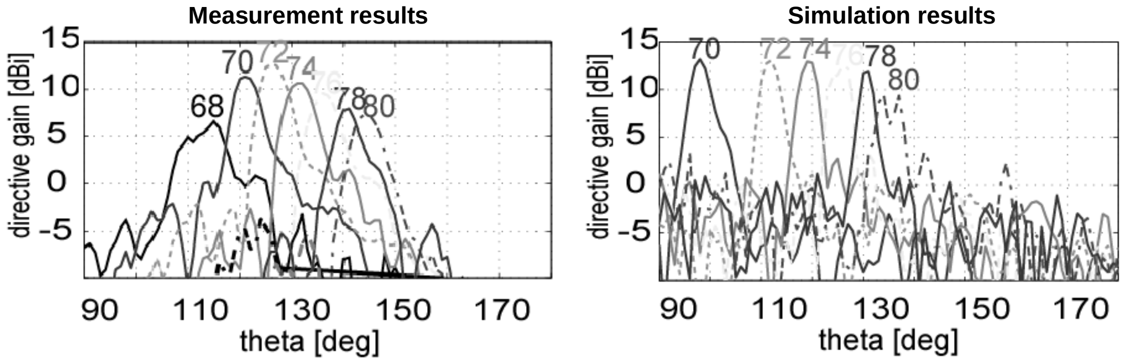

Fig.1 Radiation characteristics of the INRD guide antenna