§12. Establishment of Wavenumber Measurement Method of Electron Gyro-scale Density Fluctuation with the Use of Microwave Scattering at UHR Layer

Kawamori, E. (National Cheng Kung Univ., Taiwan), Watanabe, T., Yamasaki, K., Kuwahata, A., Inomoto, M., Ono, Y. (Univ. Tokyo), Mase, A. (Kyushu Univ.), Igami, H.

A diagnostic technique for detecting the wave numbers of electron density fluctuations at electron gyro-scales in an electron cyclotron frequency range is proposed. The technique is a modified version of the microwave scattering technique invented by Novik and Piliya[1)]. The novel method adopts forward scattering of injected extraordinary waves (X-waves) at the upper hybrid resonance (UHR) layer instead of the backward-scattering adopted by the original method, enabling the measurement of the wave-numbers of the fine scale density fluctuations in the electron–cyclotron frequency band by means of phase measurement of the scattered waves. We call this technique UHR forward scattering (UFS). In this project, the development of a UFS system has been conducted for verifying the principle of the diagnostics. One of the physics targets which motivate us to initiate this study is experimental identification of electron Bernstein waves (EBWs).

In the proposed scheme, a slow X mode probe wave, whose frequency is set to the UHR frequency at the position of the target density fluctuation, is injected from the high field side (HFS) of a torus plasma. The amplitude of the longitudinal electric field and the wave-number of the probe wave get larger as the inverse of the distance to the UHR layer. If density fluctuation exists in the vicinity of the UHR layer, the probe wave is scattered as a result of a nonlinear coupling between the probe wave and the density fluctuation. The scattered wave has the summed frequency, ω_s, of the frequencies of the probe wave, ω_{probe}, and the density fluctuation, ω_{fluc}; that is, $\omega_s = \omega_{probe} + \omega_{fluc}$. The scattered wave contains information about phase of the target density fluctuation. Therefore, by extracting the phase information from the scattered waves, for example by a frequency scan of the probe wave, group delay measurement, and so on, the wave-number of the fluctuation can be obtained.

We have developed the UFS system for the proof-of-principle experiment in University of Tokyo Spherical Toakamak (UTST) this year. Figure 1 shows schematic diagram of the developed UFS system with the UTST device (top) and photos of the antenna mount system (bottom left) and the antennas (bottom right). The amplitude-modulated probe waves are injected from HFS of UTST plasmas through the Yagi-Uda type launcher into target density fluctuations excited by EBW exciter with the use of the bow-tie antenna. The scattered waves are to be received by another Yagi-Uda antenna and the relation between phase ϕ and ω_{probe} is measured. By combining the ϕ - ω_{probe} relation with a group delay measurement of the probe-wave packet, one can obtain the wave-number of the density fluctuation.

1) K. M. Novik, A. D. Piliya, Plasma Phys. Controlled Fusion **35** (1994) 357-381.

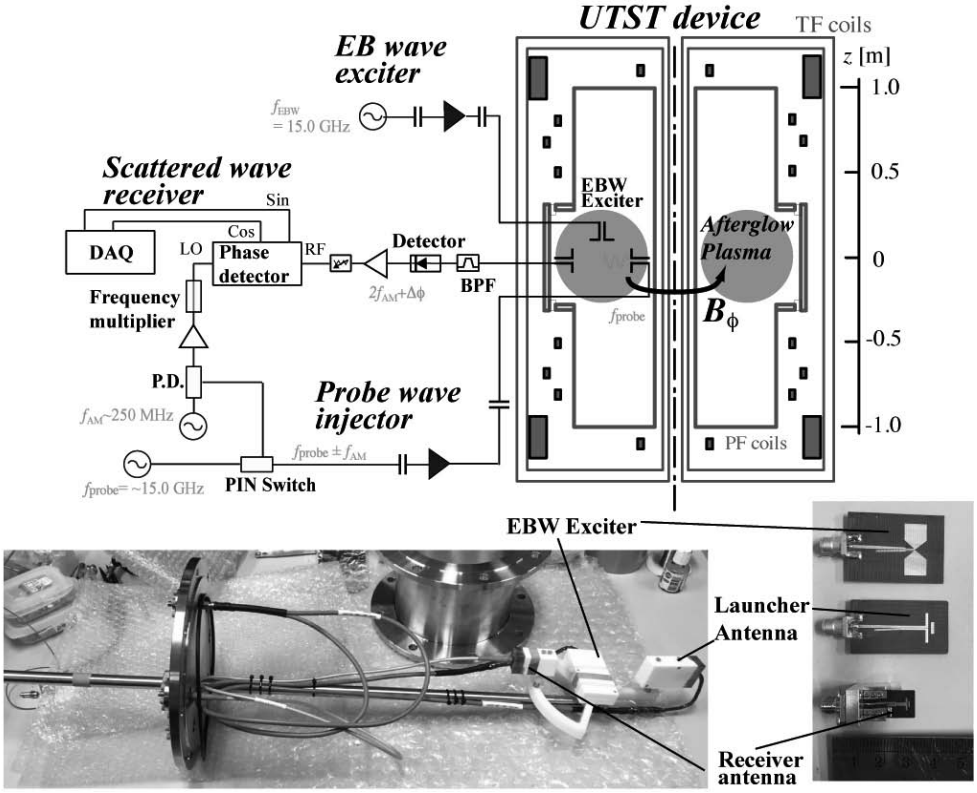

Fig. 1. Schematic diagram of the developed scattering system with the UTST device (top) and photos of the antenna array system (bottom left) and the antennas (bottom right).