§14. Study of the Electrostatic Potential Effect to the GAMMA 10 Low Frequency Fluctuation

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In order to study the electrostatic potential effect to the GAMMA 10 low frequency fluctuation, we performed the preliminary simulation study of the Doppler reflectometry. We used the simulations solving the Maxwell's equations with use of a finite difference time domain (FDTD) code method in two dimensions. At first, a moving corrugated metal target is utilized as a plasma cutoff layer in order to study basic features of the Doppler reflectometry. We examined the effects of full width at half maximum (FWHM) of electromagnetic wave and corrugation depth of the metal target. Doppler reflectometry is considered to be a hopeful diagnostic to measure a poloidal plasma flow and radial electrostatic field in magnetically confined plasmas. When an electromagnetic wave is injected into the plasma with a finite tilt angle, it is reflected and scattered with the Bragg condition at the cutoff density layer. By detecting the Doppler frequency shift in reflected wave signals, we can measure the plasma poloidal flow velocity and thus obtain the radial electrostatic field which is the origin of $E\times B$ drift. However, the interpretation of the reflected signals is difficult and must be usually validated with other diagnostic results or with help of theoretical model. In a low turbulence level, we can use the Born approximation which can be applied to the analysis. The relationship between the moving velocity of a metal target and the Doppler shift of the reflected waves is studied with varying FWHM of the incident beam width and the depth of the corrugation. We obliquely launch the electromagnetic wave in the two-dimensions (x, z) analytic space. The simulation parameters are selected as follows; the tilt angle of θ, the pulse duration time, and the frequency are 15°, 1/3 ns, and 36.23 GHz, respectively. We chosed a pulse duration time of 1/3 ns, if there is interference between the incident and reflection waves in the measurement of the electric field. Reflected (scattered) signal at the metal surface satisfies Bragg conditions. We apply first Fourier transform (FFT) analysis to the reflected signal at the incident point. Bragg condition is given by the following equation, $k_{\perp} = 2k_0 \sin\theta_{tilt}$, where k_0 is the incident wavenumber. The model of the metal target and electromagnetic wave propagation is shown in Fig.1. The function of the incident wave is divided into time dependence and space dependence on the z axis and is given by;

$$f(z) = \sin(k_z z)\exp[-((z-100)/\sigma)^2]$$

$$f(t) = \sin(\omega t)$$

The FWHM of the incident beam width is varied with changing the value of σ. The frequency of the reflected wave is analyzed by FFT for various values of FWHM of incident beam width (Fig. 2). The reflected wave contains both effects of flow velocity and partial shape of the reflection surface. When the FWHM (σ) is larger than 30, the Doppler peak frequency reaches the constant value. Then we can study the relation between the plasma velocity and the Doppler shift.

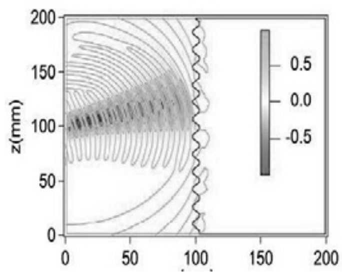

Fig. 1: Analytic metal model in two dimensional space and electric field patterns.

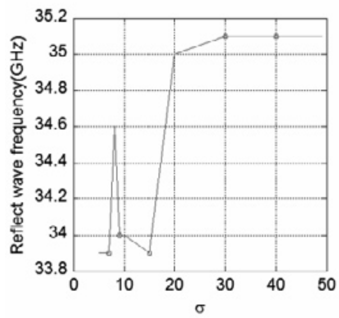

Fig. 2: FWHM and reflect wave frequency