§65. Investigation of Polarization and Deposition of EC Wave Beams

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It is required to adjust an injection polarization for optimizing absorption efficiency of Electron Cyclotron (EC) waves. In the 8th cycle experiments, we investigated the polarization dependences for three lines 168GHz #2, 84GHz #4 and 82.7GHz #11, which were remaining lines in the previous experimental campaign.

The polarization condition of the incident EC wave can be defined by two angles, α and β shown in Fig. 1. The linear polarization corresponds to $\beta = 0$ and α defines the angle between the reference axis of the system, which is the toroidal direction in this case, and the principal axis of the polarization ellipse.

The experiment was performed in the magnetic configuration of R_{ax}=3.5m and B=2.829T. The target plasmas were produced by the other EC power sources except the line under test. The plasma electron density and temperature were $\overline{n}_e = 0.5 \times 10^{19}\mathrm{m}^{-3}$ and $T_{e0} \sim 1.5 - 2.0$ keV. The injection power of 168GHz lines under test was modulated with the frequency of 40Hz. The measured electron temperature by ECE was Fourier analyzed. Figure 2 shows the FFT amplitude dependences on the polarization angle of a) α and b) β. The maximum amplitude was obtained at about $\alpha = -45$ deg., which corresponded to a perpendicularly linear-polarized wave (X-mode) at the plasma boundary. The β angle dependence of the amplitude was shifted to the minus value from the expected one ($\beta = 0$). This is because the angle between the wave vector and the magnetic lines of force a little differed from 90 deg.

The power deposition position was investigated by the same manner. Since the modulation frequency on the EC power was not so high (40Hz, this is a hardware limitation), the profile of the FFT amplitude does not represent a deposition profile, but it includes heat diffusion process. However the minimum of the FFT phase indicates the deposition center. Figure 3 shows the FFT amplitude and phase profiles for 168GHz #2 line for the antenna focal point of R_{foc}=3.53m and R_{foc}=3.48m. In the figure the calculated deposition profiles by the ray-tracing code were also plotted. The deposition center well agreed with the minimum of the FFT phase profile, though the amplitude profiles considerably differs in both cases. In Fig. 3 a), there is another phase minimum around $\rho = 0.4$. This suggests the existence of a magnetic island around here, which requires more investigation in relation to the heat diffusion process.

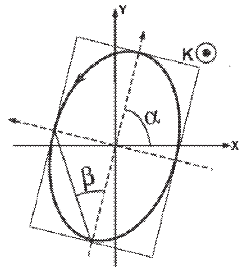

Fig. 1: Polarization ellipse: The polarization state is defined by the angle of α and β. The x-axis corresponds to the toroidal direction in this case

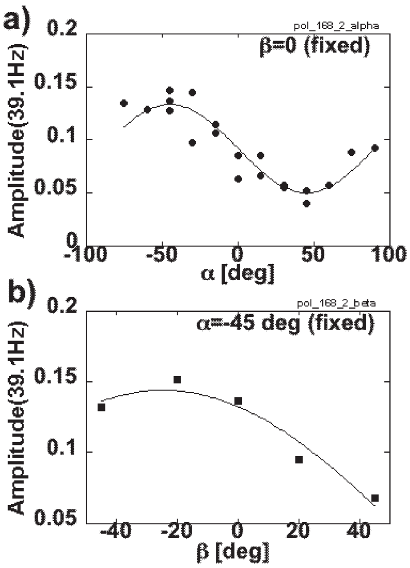

Fig. 2: Fourier amplitude of electron temperature at $\rho = 0.1$ is plotted as a function of a) α and b) β.The line under test was 168GHz #2 line.

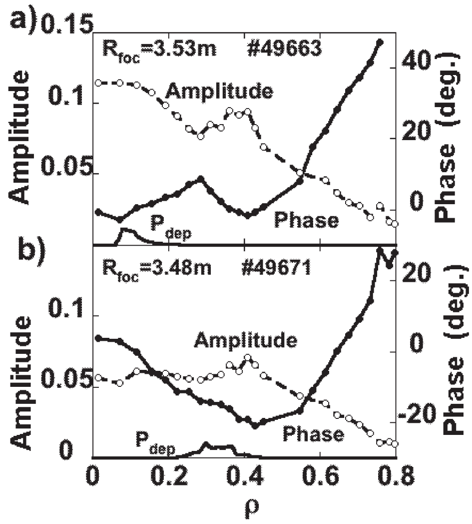

Fig. 3: FFT amplitude and phase profiles are plotted for the antenna focal point settings of a) R_{foc}=3.53m and b) R_{foc}=3.48m with calculated absorption power profiles