§1. Optimizing Method of ECH Absorption Efficiency by Real-Time Feedback Control of Injection Polarization

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The effective ECH requires an appropriate wave polarization, which is characterized by polarization angle α and the ellipticity β, at the plasma boundary, depending on the injected mode and injection angle. The polarization state of the injected wave is usually controlled by a pair of rotatable corrugated mirrors ($\lambda/4$ and $\lambda/8$ plates) installed in the miterbends. Since the optimum polarization possibly changes during plasma shot, according to the change of plasma density at the boundary, a feedback control of an injected wave polarization during a single pulse becomes important to obtain maximum wave absorption. We have planned the feedback control of the injected wave polarization corresponding to the response of plasma electron temperature. The conceptual illustration is shown in Fig. 1. Electron temperature at the heated area is monitored by ECE signals. The polarizer-reflectors installed in the miterbends are automatically adjusted to maximize core ECE signals based on a feedback algorithm.

The proof-of-principle study has been done with a pair of corrugated polarizers and developed a polarization monitor in the low power millimeter-wave test stand under collaboration with CRPP group of Lausanne, Switzerland.

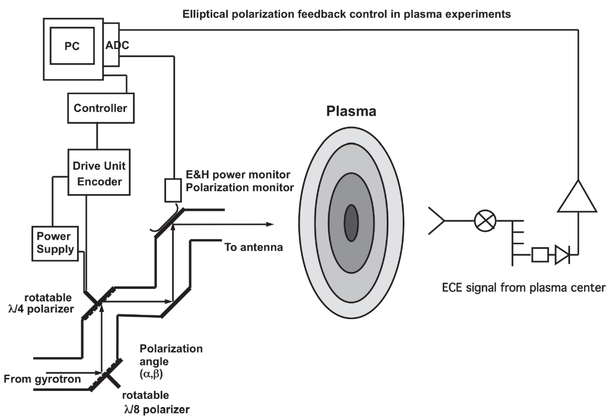

Fig. 1: Conceptual illustration of the feedback control of the injected wave polarization.

Figure 2 shows the low power test set for the proof-of-principle study. The system consists of a pair of corrugated reflectors such as $\lambda/4$ and $\lambda/8$ polarizers, rotating stages controlled by PC through GPIB, and a polarization monitor. The polarization monitor includes a orthomode transducer for detecting two orthogonal electric field components, two mixers which down-convert the detected signals to hundred several Mega-Hertz range and a gain/phase detector.

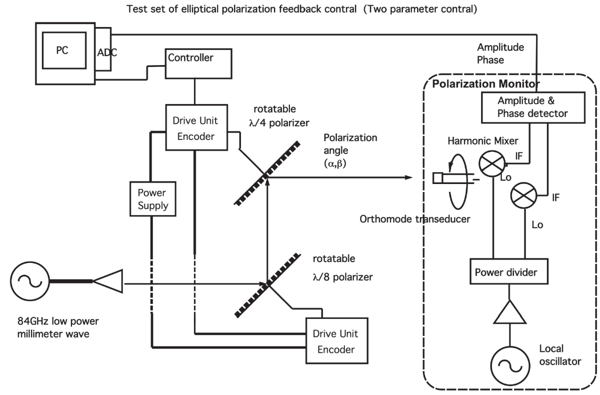

Fig. 2: The low power test set for the proof-of-principle study.

Figure 3 is a photograph of the low power test set and the polarization monitor. 84GHz power was generated by Gunn oscillator and radiated by a horn antenna. The millimeter-waves are reflected by two corrugated reflectors which can be rotated. The reflected waves are detected by the polarization monitor. So far we have tested a system performance for the linear polarization control based on the simple feedback algorithm and obtained good results.

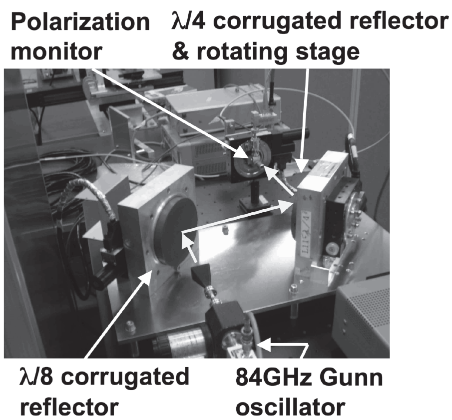

Fig. 3: Photograph of the low power test set consisting of two corrugated reflectors and a polarization monitor.

The developed polarization monitor was also tested. The measured amplitude and phase information are well agreed with the expected calculation results. This system is planned to be installed in the real ECH system of LHD in the next experimental campaign.