§12. Strong Focusing Mirror System for Elliptically Polarized Wave

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In order to study the method of improvement of local control ability of ECH and ECCD for LHD, we are developing a strong focusing mirror system for elliptically polarized wave. For development and test we employ the ECH system using a gyrotron (89.6 GHz, 170 kW) for the WT-3 tokamak at Kyoto University as shown in Fig.1. The system consists of (1) polarizer for generation of elliptically polarized wave for good coupling to X mode at the plasma surface where the waves are injected on and (2) focusing injection mirror to overcome the plasma refraction effect1)

The polarizer consists of two corrugated mirrors of 30 cm diameter each, where the first mirror controls mainly ellipticity and the second mirror does the direction of major axis of polarization. It has been confirmed by the hot test using the gyrotron power as well as by the cold test that elliptically polarized wave in the ellipticity range from β = -37° to +37° can be obtained from linearly polarized wave in the horizontal direction. With this range of β obliquely injected waves along the equatorial plane can be converted into X-mode waves with the parallel refractive index in the range from Nz= -0.63 to +0.63 in the present WT-3 case.

The final focusing mirror, of which launching angle is adjustable both in horizontal and vertical directions, is designed to produce a strongly focused hot spot at R=62.5 cm (plasma center usually locates at Rp=65-68 cm) for the perpendicular injection to toroidal field. The spot size measured by IR camera is 2.6 cm (horizontal diameter) x1.6cm (vertical diameter), in consistent with the designed value.

We examine local control ability of this ECH system by ECH and ECCD suppression experiments for sawtooth oscillations appeared in OH plasmas in line averaged electron density range of ne=4-6x10^{12}cm^{-3} in WT-3. When EC waves injected obliquely to the anti-electron drift direction in the OH plasma with second harmonic EC resonance layer located slightly inboard side of the plasma center (Rp-Rec=2 cm), sawtooth oscillation in the OH plasma is suppressed. While, sawtooth is enhanced when waves injected to the electron drift direction. These results suggest that an EC driven current is generated on the axis, and sawtooth disappears because on-axis current density decreases in the anti-electron drift direction case. The EC driven current is estimated to be Iec=5-10 kA from the difference of loop voltage between the two different injection shots.

In order to study the locality of suppression, we scan the launching angle of the focusing mirror in the vertical direction. As shown in Fig.2, where sawteeth periods are plotted versus z coordinates of the ECR layer where injected waves would intersect, sawteeth are suppressed only when ECCD currents are generated on the magnetic axis. In the ECH case where waves are injected in the perpendicular direction to the toroidal field, the suppression is obtained only when the sawteeth inversion surface is heated.

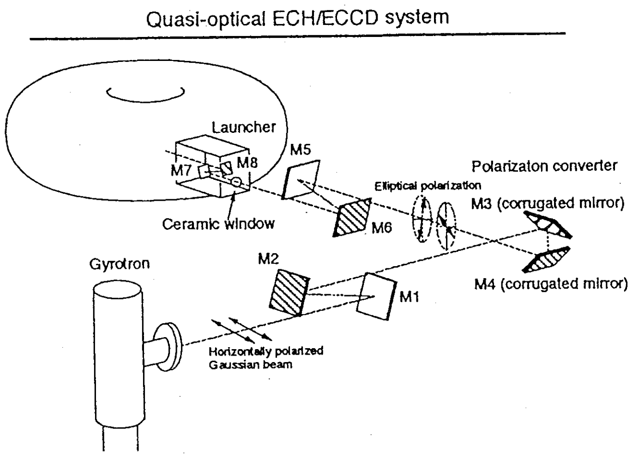

Fig.1

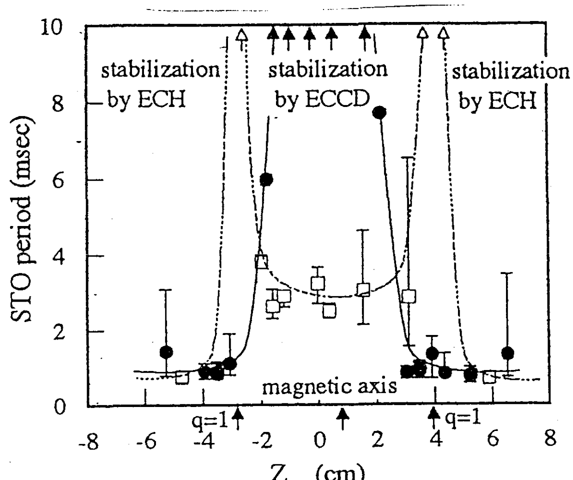

Fig.2

References

1) Asakawa, A. et al, to be published in Journal of Plasma and Fusion Research (in Japanese) 75 (1999)