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Studies on electron Bernstein wave heating in CHS and LHD at NIFS

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For effective heating of overdense plasmas by waves in electron cyclotron range of frequency, the electron Bernstein (B) wave heating using mode conversion process from an extraordinary (X) mode wave to a B-wave is considered as the most attractive way, and it has been vigorously investigated in many plasma experimental devices. In Compact Helical System (CHS) and Large Helical Device (LHD) at National Institute for Fusion Science (NIFS), both the Ordinary (O)-X-B and slow X-B mode conversion technique has been experimentally investigated.

In CHS, by optimization of the toroidally oblique EC beam direction from low-field side, significant increases in the plasma stored energy for overdense (twice the plasma cutoff density) plasmas were observed. From other experimental results such as: the power injection with O-mode polarization was most effective, and the increment in the stored energy linearly increased with the power of EC waves, the heating effect can be concluded as a result of O-X-B heating. Another way, an EC wave injection with X-mode polarization from the high-field side (slow X-B scheme) was investigated by installing a mirror inside the CHS vacuum vessel. The X-mode wave reflected by the inner-vessel mirror goes over the fundamental resonance layer and reach the upper hybrid resonance layer where the mode conversion from the X-mode wave to the B-wave occurs. Clear increases in the plasma stored energy and the core electron temperature were also observed for overdence plasmas by this slow X-B scheme.

In LHD, the slow X-B scheme was realized by selecting a specific beam path. The beam goes near a helical coil and enters into a plasma from the high-field side. By EC-wave power modulation, corresponding modulation in electron temperature measured with ECE was observed. The change in the modulation amplitude of the electron temperature depends on the selection of the beam path and on the wave's polarization, and it is consistent with the X-B scenario.