Optimising Central Electron Bernstein Wave Deposition via O-X-B Double Mode Conversion in the TCV Tokamak

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High-density operation is beneficial to the plasma confinement and fusion reaction rate. However, in high-density plasmas, standard microwave heating is hampered by the cutoff layer that prevents propagation to the resonance. The electrostatic Electron Bernstein Wave (EBW) undergoes no cutoff and hence allows extension of the operation domain to higher densities [1]. On the other hand, EBW cannot propagate in vacuum and thus must be excited by mode conversion of an externally launched electromagnetic wave.

Experiments on TCV demonstrated EBW Heating (EBWH) via a double mode-conversion process from ordinary (O) mode, to extraordinary (X) mode and finally to B-mode in a standard aspect-ratio tokamak for the first time [2]. Steep edge density gradients necessary for a broad O-X conversion window were achieved in high-triangularity H-mode at low safety factor. Using off-midplane launch of modulated Electron Cyclotron (EC) power, far off-axis local deposition well inside cutoff was indicated by a high-spatial-resolution multiwire-chamber soft X-ray detector. Global absorption was simultaneously measured using the signal from a diamagnetic loop. EBW Emission (EBE) measured with a recently installed steerable receiver [3] reproduced the calculated cutoff density at the EBE onset for several frequencies.

Ray tracing simulations are used to investigate the radial deposition sensitivity of EBW to changes in main plasma parameters for scenarios aiming at central heating and EBW current drive. Initial results of high power (2MW) EBWH are presented along with experiments of EC wave injection at the equator of H-mode target discharges to optimise central deposition.

References

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