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EX/P6-08: Development of Electron Cyclotron Wave Absorption Measurement for Real-Time Polarization Optimization and Studies of Quasilinear Effects

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Electron Cyclotron Resonance Heating (ECRH) and current drive (ECCD) is in widespread use in today's tokamaks and is planned for ITER, from plasma breakdown through the current ramp-down. The ITER control system must avoid coupling to the first-harmonic X mode (X1) at full field since any polarization mismatch of O1 at the plasma surface will be immediately reflected from the X-cutoff, which is close to the plasma edge, and the power from the focused beams will strike the wall and cause localized heating during the long pulse length in ITER. Accurate knowledge of the power absorption efficiency is also clearly beneficial to an intelligent application of these techniques but is notoriously difficult to obtain. A promising candidate is the measurement of stray power escaping the plasma using microwave radiation detectors.
To this end, fast polarizers on TCV are used on a receiver antenna while one launching antenna acts as a transmitter of short perturbation pulses, and additional antennas heat the plasma. Non-absorbed launched power is reflected off the inner wall and is incident on the receiver permitting a two-pass-transmission measurement. These experiments can provide a detailed check of ray-tracing, absorption and transmitted polarization calculations, and of the maximization routine to be used with the fast polarizers to determine that polarization, in the presence of scattered power. The key point here is that the transmitted signal (determined by the input polarization) to noise (scattering from blobs, plasma surface, various MHD modes, etc.) ratio in the undesired mode can be varied intentionally from shot-to-shot using the input polarizers. The TCV experiments provide input data for designing a protection system and quantify the measurable lower power limits that can be expected using ITER relevant polarizers.
Once characterized, the double-pass transmission and stray radiation measurements will also be used during experiments on TCV to quantify the quasilinear (QL) effects in ECRH absorption and compare them with theory. In conditions where the optical thickness is ~0.6, we explore the transition region where QL flattening should show up in the total absorption. A power scan should reveal a decreasing fraction of power absorption with increasing power.

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