Imaging and Control of Magnetic Islands in Tokamaks

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Textor is an ideal tokamak for the study of magnetic islands, due to the unique combination of available tools: a high resolution 2D electron temperature diagnostic (ECE-Imaging), the Dynamic Ergodic Divertor (DED) to create islands in a very controllable way, and a gyrotron to inject highly localized radio frequency waves into the plasma for heating or current drive.

The ECE-Imaging diagnostic enables to directly image the 2D topology of the electron temperature profile with a high spatial (1cm) and temporal (1μs) resolution. With ECE-Imaging one can directly explore the two-dimensional nature of plasma structures in a single measurement and is hence ideal to study the topology of magnetic islands and its evolution.

The DED introduces a perturbed magnetic field which influences the stability of magnetic islands by introducing shielding currents (the plasma tries to expel the perturbed field). When the perturbed DED field is strong enough, this results in the generation of an island, which is 'locked' in phase with the perturbation field. So with the DED we can produce islands at will, with a known rotation frequency. The known DED strength and mode structure, along with the detailed knowledge of the island evolution from ECE-Imaging, enables a thorough investigation of the interaction between islands and perturbation fields.

The suppression of an already existing island can be done by locally injecting electron cyclotron waves onto the island. The effect of the EC waves is to either (non-inductively) drive current, or to heat the island (Electron Cyclotron Resonant Heating ECRH). ECE-Imaging measurements of the island during their suppression by ECRH reveal a peaking of the temperature profile inside the island. The reduced resistivity due to this higher temperature leads to extra current inside the island, giving a suppression of the island. These measurements allow the determination of the transport properties inside the island, and a direct comparison of the observed suppression rates with the theory of island evolution. The results show that the often neglected suppression method by heating is important for the suppression of NTMs in ITER.