Dynamics of Mesoscale structures in Tokamak Plasmas studied by Multi-pulse Thomson Scattering

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The efficient operation of tokamaks for longer durations requires a clear understanding and total control over mesoscale plasma structures such as confinement-unfriendly *magnetic islands*, and confinement-friendly *internal transport barriers*. In order to reliably diagnose the plasma structures, we have developed and installed at TEXTOR, the world's first 10 kHz Multi-Pulse Thomson scattering (MPTS) system based on an innovative intra-cavity ruby laser and a spectrometer equipped with ultra-fast CMOS cameras. The MPTS system enables us to obtain, simultaneously, high resolution electron temperature, T_e, and density, n_e, profiles from both core and edge plasma with a time resolution of 100 μs. The complete system operates in the so-called burst mode. Up to four laser bursts are feasible, each consisting of a maximum of 40 laser pulses. The core setup has been fully tested with a single burst of about 20 laser pulses delivered at 5 kHz.

The MPTS system has been used to study the DED generated rotating magnetic islands at TEXTOR, thus providing the dynamics of T_e and pressure profiles in the island. The n_e contours, obtained by this method, clearly show a large island of 10 cm width located at 28 cm above/below mid-plane. A strong suppression of the island is observed when 800 kW of ECRH power is deposited locally in the island.

The highly accurate T_e profiles obtained with MPTS show that T_e remains flat for some time after switch-on of ECRH in Ohmic plasma. Subsequently, development of 'ears' on the T_e profile has been observed at the heat deposition location. The MPTS data in the ECRH switch-off phase show that the central T_e remains flat and constant over the decay phase, whereas the profile outside the deposition location shrinks continuously. The maximum delay is found to be of the order of the energy confinement time, which is about 45 ms.

This presentation covers the key features of the multi-pulse Thomson scattering system on TEXTOR, and the physics results on magnetic islands and transient transport processes in the ECRH heated plasma.