Survey of Type I ELM Dynamics Measurements

A.W. Leonard, the ASDEX-Upgrade Team, the MAST Team, EFDA-JET Collaborators, the JT-60U Team, the DIII-D Team and the ITPA Pedestal Topical Group

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

A significant number of diagnostics are now capable of fast measurements of the pedestal profile during an ELM. This report summarizes Type I ELM dynamics measurements from a number of tokamaks, including ASDEX-Upgrade, DIII-D, JET, JT-60U and MAST, with the goal of providing guidance and insight for the development of ELM simulation and modeling. The net perturbations to the pedestal profiles due to an ELM have been made with Thomson scattering, ECE, CER and reflectometry. The perturbation to the pedestal temperature due to an ELM is found to decrease with increasing density and collisionality while the perturbation to the pedestal density remains constant.

The time dependence of the perturbation offers insight into the transport processes that occur during an ELM. Magnetic probes record the period of magnetic fluctuations and the ELM duration is found to be nearly constant across devices and parameter regimes while the magnetic fluctuation magnitude decreases with increasing density. Reflectometry measurements show the low field side pedestal density drops before the high field side. Fast measurements by CER find rapid transport of ion density and a flattening of the rotation and radial electric field shear in the pedestal. The ion temperature appears to drop on a slower timescale while the electron temperature from ECE and SXR decrease on the density timescale.

During an ELM, filamentary structures have been observed in the scrape off layer (SOL) with a number of diagnostics. Characteristics of these filaments offer insight into the mechanisms driving ELM transport. Spatial patterns of the filaments from camera images are consistent with the toroidal mode number expected for peeling-ballooning modes thought responsible for triggering ELMs. Langmuir probes measure a fast radial velocity of the filaments and the decay of their electron density and temperature with increasing distance from the separatrix. A retarding field analyzer measures a higher ion temperature in the filaments far into the SOL. IR cameras quantify the energy deposition profile resulting from ELM transport, and observe a filamentary structure on the main chamber walls and pattern on the divertor target consistent with the mode structure observed in visible camera images.

Several transport mechanisms have been conjectured to be responsible for ELM transport, including: convective transport due to filamentary structures ejected from the pedestal, parallel transport due to edge ergodization or magnetic reconnection and turbulent transport driven by the high edge gradients when the radial electric field shear is suppressed. The experimental observations noted above will be assessed for their validation, or conflict, with these ELM transport conjectures.

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