Ion Heat and Particle Transport in the ASDEX Upgrade H-Mode Pedestal from Ultra-fast CXRS measurements

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Ultra-fast charge exchange measurements (CXRS) of the H-mode pedestal reveal new physics insights into the edge localized mode (ELM). For the first time, the dynamics of both the ion and electron pedestal were measured with a time resolution of 100 μs during an entire ELM cycle [1]. At the ELM crash, the ion temperature (T_i) at the separatrix is three times larger than the electron temperature (T_e) indicating that the parallel ion heat transport is not negligible and can be comparable to that of the electrons in the SOL. The measurements are consistent with the presence of high T_i filaments in the far SOL during the ELM crash. Furthermore, the characterization of the edge gradient recovery reveals a difference between the ion and the electron channels: the ion temperature gradient is re-established on similar timescales as ∇n_e, which is faster than the recovery of ∇T_e. After the clamping of the maximum temperature gradients, T_i and T_e at the pedestal top continue to rise while n_e stays constant which means that the temperature pedestal and the resulting pedestal pressure widen until the next ELM. The phases in the pedestal recovery are correlated with the onset of magnetic fluctuations and the effect of underlying instabilities on the electron and ion transport is characterized by means of predictive simulations.

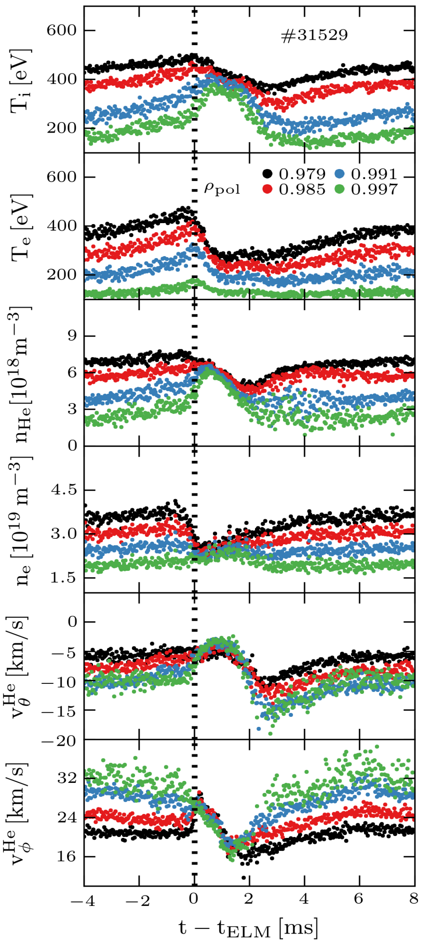

Fig. 1: Edge profiles evolution during an ELM cycle

The radial electric field (E_r) is determined via the radial force balance equation from the measurements of the poloidal and the toroidal impurity flows. At the ELM crash, E_r is found to reduce to typical L-mode values and its maximum recovers to its pre ELM conditions on a similar time scale as n_e and T_i. Within the uncertainties, the measurements of E_r align with their neoclassical predictions for most of the ELM cycle, thus indicating that E_r is dominated by collisional processes. However, between 2 and 4 ms after the ELM crash, other contributions to the ExB velocity, e.g. zonal flows or ion orbit effects, could not be excluded within the uncertainties. Similarly the ion heat transport in the pedestal is found to be close to the neoclassical level except between 0 and 4 ms after the ELM onset.

[1] M. Cavedon, et al., Plasma Phys. Control. Fusion **59**, 105007 (2017)