Fast-ion dynamics at ITER-relevant densities in ASDEX Upgrade measured with collective Thomson scattering

J. Rasmussen[1], T. Verdier[1], S. K. Nielsen[1], A. S. Jacobsen[1], T. Jensen[1], S. B. Korsholm[1], M. Salewski[1], M. Garcia-Muñoz[2,3] , M. Vallar[4], the ASDEX Upgrade Team*

[1] *Technical University of Denmark, Dept. of Physics, Lyngby, Denmark*

[2] *Centro Nacional de Aceleradores, University of Seville (CSIC), Seville, Spain*

[3] *Dept. of Atomic, Molecular and Nuclear Physics, University of Seville, Seville, Spain*

[4] *Ecole Polytech. Fédérale de Lausanne (EPFL), Swiss Plasma Center, Lausanne, Switzerland*

Energy transfer from confined fast ions will play a key role in maintaining the core plasma at fusion-relevant conditions in future fusion devices such as ITER. The dynamics of such ions is experimentally well characterized in low-density plasmas, owing to good fast-ion coverage with fast-ion D-α spectroscopy, other charge-exchange based measurements, neutron/γ-ray spectrometry, and collective Thomson scattering. In contrast, this applies much less to high-density discharges, in which the relevant diagnostic performance is generally limited by the shorter slowing-down time of energetic particles, the reduced neutral beam (NBI) penetration, and the significantly increased Bremsstrahlung emission.

Collective Thomson scattering (CTS) is less hampered by the latter of these limitations and will be the main diagnostic for measuring confined fast ions in ITER across their full energy range [1, 2]. Here we present the first results of CTS measurements of fast-ion dynamics in ASDEX Upgrade performed at a local density of $n_e \approx 9 \times 10^{19}$ m^{-3}, i.e., comparable to projections for the high-density ITER baseline scenario. These measurements were obtained in H-mode plasmas heated partly by 5 MW of NBI using both on-axis and off-axis deposition. Forward modelling of the acquired CTS spectra demonstrate that a measurable fast-ion population is present in the plasma core ($\rho_p \approx 0.15$) at a level of 3–5% of n_e. Comparison to TRANSP simulations indicates slowing-down dynamics broadly consistent with neoclassical relaxation in these MHD-quiescent discharges. This suggests that classical slowing-down without strong anomalous diffusion remains a valid description of core fast-ion dynamics at high density in ASDEX Upgrade, and it provides encouraging validation of the ability of CTS to infer ion distribution functions under conditions that may be challenging for other diagnostics.

References

[1] S. B. Korsholm et al., EPJ Web of Conf. **203**, 03002 (2019)

[2] J. Rasmussen et al., Nucl. Fusion **59**, 096051 (2019)

* See author list of H. Meyer et al. 2019 Nucl. Fusion **59** 112014