Fast-ion transport study in the plasma periphery of ASDEX Upgrade using fast-ion D-alpha spectroscopy

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Good confinement of fast ions in the plasma periphery is of particular importance for fusion devices since these particles can easily be transported to unconfined orbits, become lost and potentially damage first wall components. Several mechanisms exist that can redistribute fast ions, of which the mode-induced transport might be the most critical one. However for a detailed fast-ion transport analysis first, charge exchange (CX) losses and drifts in perturbed equilibria must be considered.

Low density experiments were performed at ASDEX Upgrade with 5 MW of off-axis NBI heating that show high fast-ion densities at the edge. During those experiments strong CX losses were observed by a new edge fast-ion D_α (FIDA) diagnostic that measured intense signals originating from CX reactions between fast ions and background neutrals. In order to model this so called passive FIDA light first, the background neutral density is modelled with KN1D and EMC3-EIRENE. The neutral density is then incorporated in TRANSP simulations which include CX losses in the prediction of the fast-ion distribution. Finally the predicted fast-ion and background neutral-density profiles are translated into synthetic passive FIDA spectra using FIDASIM. When comparing measured and simulated spectra the best agreement is found for high neutral densities that cause a reduction of up to 15% of the total fast-ion density. This shows that CX losses can have a strong impact on the fast-ion density at the edge of ASDEX Upgrade.

In addition, the experimental measurements show a clear modulation of the passive FIDA signal during edge localised modes (ELMs) and after the application of RMPs. This is partly explained by a modification of the background neutral density and possibly by fast-ion losses, as observed using the fast-ion loss detectors [1]. Detailed modelling results will be presented, including ELM resolved simulations and predictions of the 3D perturbations induced by RMPs.

References

[1] M. García-Muñoz et al, Plasma Phys. Control. Fusion **55**, 12 (2013)

[*] See H. Meyer et al, Nucl. Fusion **57** 102014 (2017)