

Inter-machine comparison of SOL particle dynamics in ASDEX Upgrade and Wendelstein 7-X

D. Gradic, V. Perseo, A. Burckhart^a, F. Reimold, D.M. Kriete^b, R. König, M. Krychowiak, R. Dux^a, M. Bernert^a, T. Lunt^a, S.S. Henderson^c, D. Brida^a, Y. Gao, M. Jakubowski, V. Winters, T. Sunn Pedersen, the W7-X Team^{*}, the ASDEX Upgrade Team^{**} and the EUROfusion MST1-Team^{***}

Max-Planck-Institute for Plasma Physics (IPP), D-17491 Greifswald, Germany

^a *Max-Planck-Institute for Plasma Physics (IPP), D-85748 Garching, Germany*

^b *Department of Physics, Auburn University, Auburn, Alabama 36849, USA*

^c *CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK*

An inter-machine study of the impurity flow velocity behavior has been carried out in the Scrape-off-Layer (SOL) of the medium-sized tokamak ASDEX Upgrade (AUG) and the optimized stellarator Wendelstein 7-X (W7-X). As main diagnostic, a Coherence Imaging Spectroscopy (CIS) system [1] was used at both devices, providing 2D flow velocity derived from the Doppler shift of atomic emission lines. By exploiting the 2D imaging capabilities and high sensitivity of CIS [2], large parts of the divertor and SOL regions can be diagnosed in one camera measurement, equivalent to hundreds of sightlines from traditional spectroscopy. Therefore, many new insights into the Scrape-off-Layer (SOL) and divertor dynamics have recently been gained, such as the confirmation of counter-flows in the magnetic island divertor of W7-X [3] or the dominance of convective plasma transport from the X-point towards the target in detached divertor plasmas in DIII-D [4].

By performing an inter-machine comparison of impurity flow velocities in the island divertor of W7-X and the poloidal field divertor of AUG, a broad characterisation of SOL particle transport at the edge of high-temperature plasma experiments can be undertaken. Even though very different divertor concepts are realized in AUG and W7-X, impurity flow velocities on the order of a few tens of km/s parallel to the magnetic field lines are observed in both their SOLs, with their magnitude and direction depending on X-point location(s) and primarily being driven by pressure gradients along the open magnetic field lines. In both machines, the flow velocity magnitudes and dynamics are found to be remarkably sensitive to magnetic topologies (upper-, lower- and double-null in AUG as well as the different island topologies in W7-X) and consistent with pressure drive. Notable differences in flow behaviour are observed, for example, during the transition to detachment, where a strong flow decrease is measured in W7-X [5], however only a small one in AUG. This could be related to the fundamental differences between the island and poloidal field divertor [6] and, consequently, their detachment processes, which has only recently been better understood in W7-X with new EMC3-Eirene simulations [7].

References:

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* See author list: T. Klinger et al 2019 Nucl. Fusion 59 112004 ** author list: H. Meyer et al 2019 Nucl. Fusion 59 112014 *** author list: B. Labit et al 2019 Nucl. Fusion 59 086020