Investigations of scrape-off layer ion flows in the low-iota magnetic configuration of W7-X using coherence imaging spectroscopy

D.M. Kriete[1], J.C. Schmitt[1], V. Perseo[2], D. Gradic[2], D.A. Ennis[1], D.A. Maurer[1], R. König[2],
and the W7-X Team[2]

[1] *Auburn University, Auburn, USA*

[2] *Max-Planck-Institut für Plasmaphysik, Greifswald, Germany*

A key mission of the W7-X stellarator is demonstrating the reactor viability of the island divertor concept. Understanding the effects of particle drifts and bootstrap current on the scrape-off layer (SOL) is important for ensuring safe and efficient operation of the island divertor. To investigate these effects, SOL carbon impurity ion velocities are measured in the low-iota magnetic configuration of W7-X using coherence imaging spectroscopy (CIS). The CIS technique encodes ion velocity information from a line-integrated emission line into a spatial interference pattern that is overlaid on an image of the line emissivity. CIS has high spatial resolution and optical throughput, enabling detailed study of SOL physics in the complex magnetic island topology of W7-X. The low-iota configuration exhibits a large 5/6 island at the plasma edge and is chosen for this investigation because it has the longest average connection lengths and largest bootstrap current drive of any W7-X configuration. Flow measurements in discharges with matched core plasma parameters but reversed magnetic field show significant differences in the structure and direction of the flows, suggesting that field-dependent particle drifts contribute significantly to SOL flows. Due to the long connection lengths, the perpendicular flows resulting from these drifts substantially alter divertor strike line positions [1]. SOL flows are also measured during a 20 second discharge with monotonically increasing bootstrap current up to 13 kA. The flows initially evolve continuously with bootstrap current until it reaches 9 kA, whereupon the flows change precipitously and thereafter no longer evolve with bootstrap current. This behaviour might be caused by the plasma transitioning from a diverted to a limited configuration at sufficiently high bootstrap current, a phenomenon previously observed in the standard magnetic configuration [2].

Work supported by US DOE grant DE-SC0014529 and EUROfusion grant 633053.

References

[1] K.C. Hammond *et al.*, Plasma Phys. Control. Fusion **61**, 125001 (2019)

[2] C. Killer *et al.*, Plasma Phys. Control. Fusion **61**, 125014 (2019)