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Drift-driven divertor asymmetries in the transition from attached to fully detached conditions[1]

A.G. MCLEAN, LLNL

Inboard/outboard asymmetries have been directly measured in 2D for the first time in a tokamak revealing divertor plasma parameters (n_e, T_e, p_e), heat flux, and parallel flow in opposite toroidal field directions. Results are consistent with fluid modeling [Chankin 2015], indicating that radial $E \times B$ drifts across both divertor legs is the dominant process leading to observed target asymmetries in the case of toroidal field direction with ion $B \times \nabla B$ toward the diverter ("toward"), and relative symmetry in the opposite case ("away"). In the former, $E \times B$ drifts through the private flux region carry additional particle flux to the inner divertor target leading to detachment at lower upstream density. In the opposite toroidal field case, drifts in the opposing direction lead to symmetric detachment of both targets at about the same upstream density. The toward case also results in a doubling of the high field side scrape off layer (SOL) width ultimately leading to a MARFE along the inboard SOL, approaching the X-point. In the away case the outboard SOL width is broader and no MARFE formation is apparent. Dominant parallel plasma flow in the divertor, as measured by coherence imaging, is found to carry plasma towards the targets in both toroidal field directions. However, in the towards case, this leads to counter-streaming plasma flow near the X-point region, while in the away case, the flow near the X-point stagnates. These results underscore the need to include drifts in boundary modeling in order to adequately reflect the dominant physical processes at play in the divertor.

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