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Control of neutral particle fueling and exhaust by plasma edge topology optimization in Wendelstein 7-X and HSX[1]

LAURIE STEPHEY[2], Univ of Wisconsin, Madison

Comparative experiments at the HSX and Wendelstein 7-X stellarators are being performed. At W7-X it was shown that fine control of the edge magnetic structure in W7-X is a feasible actuator to control global particle confinement. During the startup campaign of W7-X, the edge magnetic structure is defined by five poloidal limiters. Inside of the last closed flux surface in the standard magnetic configuration, the 5/6 resonance and corresponding magnetic island are located directly inside of the plasma source region. Inward movement of the island in a predominantly electron-root transport regime has been found to increase the effective helium confinement time τ_p^* He, a critical metric for plasma purity control in future burning plasmas, by a factor of two. The experimental analysis is supported by fully 3-D fluid plasma and kinetic neutral modeling using the EMC3-EIRENE code and will be compared to these experimental results from both devices. A single reservoir, single species particle balance will be extracted from experimental measurements aided by the fully 3-D modeling analysis from EMC3-EIRENE to quantify the causal link established above based on measured parameters. At HSX, similar investigations to those performed at W7-X are ongoing. HSX has substantial flexibility in both its edge magnetic configuration and also in edge connection lengths via limiter insertion. Both are being examined to study any resulting changes global particle confinement and provide insight into the physics of the underlying mechanism. Together with the results from W7-X, both experiments will provide information on the link between the plasma edge topology and the global particle confinement.

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[2]On behalf of the W7-X Team.