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# Assessing simple models for density build up and impurity exhaust in the island divertor of W7-X

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In the previous operation campaigns of W7-X stable, detached divertor plasmas were demonstrated [1,2,3,4]. These plasma also showed particle exhaust that enables high density steady-state operation and provided good impurity retention [5]. Hence, the initial results from W7-X operation show a potential of the island divertor concept used in W7-X for a reactor. Spectroscopic measurements and other edge diagnostics indicate the existence of a high-density divertor regime in W7-X ($n_{div} > n_{up}$). Such a regime was not observed in the predecessor W7-AS, but its occurrence had been predicted for W7-X by modeling [6,7]. However, the achieved neutral divertor pressures so far have been limited to low values of $< 0.1Pa$. Given the crucial role of the neutral pressure as a design variable of ITER divertor [8] and its exhaust regime, this makes the understanding of the density build-up in the island divertor a crucial task, in particular to assess the particle exhaust properties and their scaling towards a reactor device. It is important to understand what sets and limits the neutral pressures and to identify the key physics parameters that drive the density evolution. To this end simplified models and comparison to modeling is used to assess their applicability to the W7-X data and their usefulness to understand the relevant dynamics in the density-build up in the island divertor. Adaptations of the two-point model accounting for cross-field transport channels in the island divertor [2] will be used to compare with experimental measurements of the density build-up in the divertor in density ramp experiments. The model implies a crucial role of the pressure loss factors and its dependence on temperature as well as on the fieldline pitch $\Theta$ of the island. Both quantities are expected to be fundamentally different in the island divertor compared to a tokamak.
The relevance of the divertor density with respect to the impurity exhaust, most notably for He, will be discussed in light of the recent analysis of the impurity retention capabilities of the island divertor [9] and the more challenging core transport properties of stellarators due to unfavorable neoclassical transport.
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