Core and edge aspects of quiescent double barrier operation on DIII–D, with relevance to critical ITB physics issues

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Abstract. Recent results from DIII-D address critical internal transport barrier (ITB) research issues relating to sustainability, impurity accumulation and ITB control, and have also demonstrated successful application of general profile control tools. In addition, substantial progress has been made in understanding the physics of the Quiescent Double Barrier (QDB) regime, increasing the demonstrated operating space for the regime and improving performance. Highlights include: (1) A clear demonstration of q-profile modification using electron cyclotron current drive (ECCD); (2) Successful use of localized profile control using electron cyclotron heating (ECH) or ECCD to reduce central high-Z impurity accumulation associated with density peaking; (3) Theory-based modeling codes are now being used to design experiments; (4) The operating space for Quiescent H-mode (QH-mode) has been substantially broadened, in particular higher density operation has been achieved; (5) Absolute ($\beta 3 \leq 8\%$, neutron rate $S_n \leq 5.5\times10^{15}\ s^{-1}$) and relative ($\beta_N H_{89} = 7$ for 10 τ_E) performance has been increased; (6)With regard to sustainment, QDB plasmas have been run for 3.8 s or 26 τ_E. These results emphasize that it is possible to produce sustained high quality H-mode performance with an edge localized mode (ELM)-free edge, directly addressing a major issue in fusion research, of how to ameliorate or eliminate ELM induced pulsed divertor particle and heat loads.