Development in the DIII-D tokamak of advanced operating scenarios and associated control techniques for ITER

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Abstract. Significant progress has been made on the DIII-D tokamak in the capability to control key plasma features and using such control to expand the operational limits of stationary and steady-state tokamak operation. Recent experiments have demonstrated the capability to suppress several key plasma instabilities of concern for ITER, including edge localized modes, neoclassical tearing modes, and resistive wall modes. In addition, the ability to regulate the rotation and current density profiles through feedback control has been demonstrated. The use of these control techniques has allowed an expansion of the envelope of viable, stationary tokamak operation, highlighted by the demonstration of sustained (~2 s) operation of $\beta_N \simeq 4$ (50% above the no-wall stability limit) as well as fully noninductive operation with $\beta \simeq 3.5\%$. This development is supported by a vigorous basic fusion science program, which has provided new insights into turbulence dynamics over a large range in spatial scales, new measurements of the structure of fast-ion instabilities and their effect on the fast ion population, and important information on the transport of carbon and associated tritium co-deposition on plasma facing surfaces.