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DIII-D Research Advancing the Scientific Basis for Burning Plasmas and Fusion Energy

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The DIII-D tokamak has addressed key issues to advance the physics basis for burning plasmas for ITER and future steady-state fusion devices. Developments on ITER scenarios include the discovery of a new wide-pedestal variant of QH-mode where increased edge transport is found to allow higher pedestal pressure, consistent with peeling-ballooning theory, and complete ELM suppression in steady-state "hybrid"plasmas that is relatively insensitive to q95, having weak effect on the pedestal. Shattered pellet injection (SPI) has been shown an effective technique for runaway electron (RE) plateau dissipation. Mixed species shattered pellet injection (SPI) enabled control of disruption characteristics, while keeping the radiation fraction, divertor heat loads, and current quench times within ITER requirements. Reduced transport models such as TGLF reproduce the reduced confinement associated with additional electron heating in DIII-D ITER baseline plasmas. Density peaking can recover the performance, as can raising the pedestal density, which increases the pedestal pressure and can even give access to Super H-mode for ITER. Both high-qmin and hybrid steady-state plasmas have avoided fast ion instabilities and achieved increased performance by control of the fast ion pressure gradient and magnetic, and use of external control tools such as ECH. In the boundary, ExB drifts are found important for simulating observed asymmetries in divertor detachment, and the erosion rate of high Z materials is found to be reduced through control of the electric field in the presheath. Between-ELM heat flux asymmetries in the presence of RMP fields are eliminated in detached divertor conditions. Higher low-Z impurity concentrations in the background plasma are also found to reduce the net erosion rate of high-Z targets, even to the point of net deposition. These small-sample studies are being used to investigate high-Z impurity contamination efficiency from different divertor locations and impact on the core plasma performance, which in-turn inform the forthcoming metal divertor tile experiments.

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