DIII-D Contributions Toward Development of the Scientific Basis For Sustained Burning Plasmas

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C.M. Greenfield
General Atomics, San Diego, California 92186-5608, USA
greenfield@fusion.gat.com

DIII-D is making significant contributions to a scientific basis for burning plasma operation in ITER and future devices. These include explorations of increasingly reactor relevant scenarios, studies of key issues for projecting performance, development of techniques for handling heat and particle efflux, and assessment of key issues for the ITER Research Plan. The four main ITER operating scenarios are a major focus. The baseline H-mode exhibits a ~15% confinement decrease at low rotation, but still projects to Q=10 in ITER. These experiments included a first demonstration of preemptive neoclassical tearing mode suppression in this scenario. Joint DIII-D/JET ρ^* scans in the hybrid regime imply Bohm-like confinement scaling. A variety of q profiles were evaluated to optimize high performance steady state operation. Startup and shutdown techniques were developed for the restrictive environment of future devices while retaining compatibility with advanced scenarios. With its flexible heating and current drive systems and broad diagnostic set, DIII-D provides key tests of theory based physics models. Detailed sets of turbulence measurements are being obtained for comparison with GYRO. Studies of intrinsic rotation and non-resonant magnetic fields (NRMF), which "drag" the plasma to a non-zero velocity, increase our understanding of rotation. Joint DIII-D/JET experiments indicate a weak, inverse dependence of the pedestal width on ρ^*. DIII-D research also addresses methods to control particle and energy flows leaving the plasma. Recently, resonant magnetic perturbation (RMP) edge localized mode (ELM) suppression was demonstrated with a radiative divertor. ELM-free QH-mode operation has been extended to low applied torque via application of NRMF. Massive gas injection and large shattered pellets have demonstrated delivery of particles for safe shut down to mitigate a disruption. The application of an RMP field to deconfine runaway electrons can reduce the delivery system requirements. DIII-D also addresses specific issues for ITER. The L-H threshold increases from D to He (30-50%) to H (×2 above D). Experiments carried out with a mockup of one of ITER's TBMs indicate that no serious effects are anticipated. Detailed analysis will aid in validating physics models for the effects of 3D fields. This work was supported by the US Department of Energy under DE-FC02-04ER54698.