DIII-D research in support of ITER*

E.J. Strait and the DIII-D Team

General Atomics, San Diego, California, USA

Abstract. DIII-D research is providing key information for the design and operation of ITER. Investigations of axisymmetric stability and of edge localized mode (ELM) suppression with resonant magnetic perturbations have helped provide the physics basis for new axisymmetric and non-axisymmetric control coils in ITER. Discharges that simulate ITER operating scenarios in conventional H-mode, advanced inductive, hybrid, and steady state regimes have achieved normalized performance consistent with ITER's goals for fusion performance. Stationary discharges with high β_N and 90% noninductive current that project to $Q = 5$ in ITER have been sustained for a current relaxation time (~2.5 s), and high-beta wall-stabilized discharges with fully noninductive current drive have been sustained for more than one second. Detailed issues of plasma control have been addressed, including the development of a new large-bore startup scenario for ITER. DIII-D research also contributes to the basis for reliable operation in ITER, through active control of the chief performance-limiting instabilities. Simultaneous stabilization of neoclassical tearing modes (NTMs) (by localized current drive) and resistive wall modes (RWMs) (by magnetic feedback) has allowed stable operation at high beta and low rotation. In research aimed at improving the lifetime of material surfaces near the plasma, recent experiments have investigated several approaches to mitigation of disruptions, including injection of low-Z gas and low-Z pellets, and have shown the conditions that minimize core impurity accumulation during radiative divertor operation. Investigation of carbon erosion, transport, and co-deposition with hydrogenic species, and methods for the removal of co-deposits, will contribute to the physics basis for initial operation of ITER with a carbon divertor. A broad research program provides the physics basis for predicting the performance of ITER. Recent key results include the discovery that the L-H power threshold is reduced with low neutral beam torque, and the development of a successful model for prediction of the H-mode pedestal height in DIII-D. Research areas with the potential to improve ITER's performance include the demonstration of ELM-free "QH-mode" discharges with both co and counter neutral beam injection, and validation of the predicted torque generated by static, non-axisymmetric magnetic fields. New diagnostics provide detailed benchmarking of turbulent transport codes and direct measurements of the anomalous transport of fast ions by Alfvén instabilities. Successful comparison of experiment and modeling for off-axis neutral beam current drive provides the basis for more flexible current profile control in advanced scenarios .

---

*This work was supported by the US Department of Energy under DE-FC02-04ER54698.