Overview of Recent Experimental Results From the DIII–D Advanced Tokamak Program

K.H. Burrell for the DIII–D Team

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

email: burrell@fusion.gat.com

Abstract. The DIII-D research program is developing the scientific basis for advanced tokamak (AT) modes of operation in order to enhance the attractiveness of the tokamak as an energy producing system. Since the last International Atomic Energy Agency (IAEA) meeting, we have made significant progress in developing the building blocks needed for AT operation: 1) We have doubled the magnetohydrodynamic (MHD) stable tokamak operating space through rotational stabilization of the resistive wall mode; 2) Using this rotational stabilization, we have achieved $\beta_N H_{89} \geq 10$ for 4 τ_E limited by the neoclassical tearing mode; 3) Using real-time feedback of the electron cyclotron current drive (ECCD) location, we have stabilized the (m,n) = (3,2) neoclassical tearing mode and then increased β_T by 60%; 4) We have produced ECCD stabilization of the (2,1) neoclassical tearing mode in initial experiments; 5) We have made the first integrated AT demonstration discharges with current profile control using ECCD; 6) ECCD and electron cyclotron heating (ECH) have been used to control the pressure profile in high performance plasmas; and 7) We have demonstrated stationary tokamak operation for 6.5 s (36 τ_E) at the same fusion gain parameter of $\beta_N H_{89}/q_{95}^2 \cong 0.4$ as ITER but at much higher $q_{95} = 4.2$. We have developed general improvements applicable to conventional and advanced tokamak operating modes: 1) We have an existence proof of a mode of tokamak operation, quiescent H-mode, which has no pulsed, ELM heat load to the divertor and which can run for long periods of time (3.8 s or 25 τ_E) with constant density and constant radiated power; 2) We have demonstrated real-time

disruption detection and mitigation for vertical disruption events using high pressure gas jet injection of noble gases; 3) We have found that the heat and particle fluxes to the inner strike points of balanced, double-null divertors are much smaller than to the outer strike points. We have made detailed investigations of the edge pedestal and SOL: 1) Atomic physics and plasma physics both play significant roles in setting the width of the edge density barrier in H-mode; 2) ELM heat flux conducted to the divertor decreases as density increases; 3) Intermittent, bursty transport contributes to cross field particle transport in the scrape-off layer (SOL) of H-mode and, especially, L-mode plasmas.