RECENT RESULTS FROM THE DIII-D PROGRAM*

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To enhance the commercial attractiveness of the tokamak, the DIII–D program is focussed on developing the scientific basis for advanced tokamak (AT) operation. The high stability and confinement in an AT require the use of both current and pressure profile control and an active feedback system for control of plasma instabilities. Recent engineering and scientific results from the DIII–D program have permitted significant progress toward these goals and to the realization of a future AT reactor.

A major focus of our recent work has been in the active control of the plasma instabilities that limit high performance plasmas: the resistive wall mode (RWM) and the neoclassical tearing mode (NTM). Improved stabilization of the RWM has been achieved using external control coils coupled with a set of newly installed internal saddle loops and magnetic probes. A new set of 12 internal, water cooled control coils are being designed that should permit the stabilization of the RWM up to near the ideal wall limit. In addition, by optimizing the error field correction, plasma rotation has been maintained at high beta and this has resulted in stabilization of the RWM by the conducting wall at values up to twice the no-wall β limit.

The use of electron cyclotron current drive (ECCD) is essential to AT operation and our system of four gyrotrons with steerable launchers have routinely provided up to 2.5 MW for 2 s pulses. Stabilization of the m=3, n=2 NTM and a subsequent increase in β_N of 50% has been achieved using 2.3 MW of ECCD and a newly develop "search and suppress" control algorithm. When the mode amplitude exceeds a threshold value, either the plasma position is varied or the toroidal field amplitude is adjusted to find the optimal location for the ECCD resonance location to suppress the mode.

A successful technique for disruption mitigation has been developed on DIII–D that scales favorably to a reactor class tokamak. Using a fast acting valve to provide a high pressure Ne or Ar gas puff, a rapid and reliable termination of the plasma discharge has been developed that radiates all the thermal and magnetic energy without producing high halo currents or runaway electrons.

A critical element of our program is the continued development of our plasma control and diagnostic systems with the goal of providing integrated, real-time control of plasma profiles with active instability control. Progress in both these areas will be discussed.

Progress toward an AT has been achieved as demonstrated by the achievement of a wall stabilized discharge with $\beta_N H_{89}$~12 for ~5 τ_E with 80% non-inductive current, density control, and ECCD consistent with theory and our future AT needs.

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