Attainment of High Normalized Current by J(r) Manipulation in the Pegasus Toroidal Experiment

G.D. Garstka, D.J. Battaglia, M.W. Bongard, N.W. Eidietis, R.J. Fonck, M.J. Frost, S.M. Gillin, M.B. McGarry, A.C. Sontag, B.J. Squires, E.A. Unterberg
University of Wisconsin-Madison

The operating space defined by the external kink mode boundary in a near-unity aspect ratio ST allows access to very high toroidal beta and IN. Normalized current can be equivalently expressed as the toroidal field utilization factor Ip/Itf, where Itf is the current flowing in the centerpost. Values of Ip/Itf > 2 (IN > 12 MA/m-T) are expected to be stable to ideal MHD modes in the ultra-low-A Pegasus Toroidal Experiment. Simple inductively-driven plasmas on Pegasus had exhibited an operational limit of Ip/Itf ~ 1, which was attributed to the early onset of large-scale low-order tearing modes in the plasma core. The use of point-helicity sources has greatly broadened the operating space of the device in the direction of low toroidal field. These sources can be employed as a preionization technique that facilitates ohmic startup and allows attainment of Ip/Itf $\rightarrow$ 1.5 at low Ip (~ 50 kA). Using these sources for non-inductive startup via helicity injection provides access to Ip/Itf > 2, again at low Ip and at very low field (0.01 T). In both cases, no large-scale tearing modes are evident. These observations, coupled with magnetic reconstructions indicating hollow J(R) with possible reverse shear, suggest that these sources provide significant modifications to the J(R) profile to allow stable discharge evolution. In addition, experiments conducted with strong toroidal field ramps indicate a positive plasma current drive and rapid increase in Ip/Itf above unity until plasma confinement is degraded. Finally, exploitation of the new programmable ohmic current drive system provides more useful V-s and allows much finer control of Vloop than was previously available. This supports a broad startup operating space, enabling control of J(r) during the current ramp. Experimental studies are focusing on extending these techniques to higher Ip, and probing the external kink stability limits at A$\rightarrow$1.

Work supported by the United States Department of Energy Grant DE-FG02-96ER54375