Equilibrium and Stability Limit Characterization of Near-Unity Aspect Ratio Plasmas in the PEGASUS Toroidal Experiment*

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The Pegasus Toroidal Experiment is an ohmically-driven spherical torus designed to study the limits of plasma behavior as the aspect ratio A approaches unity. Major parameters are R = 0.25-0.45 m, A=1.15–1.4, elongation < 3.5, Ip < 0.16 MA, and RBt < 0.03 T-m. Magnetic equilibrium analyses of low-A discharges in the Pegasus Toroidal Experiment have been performed using a locally developed code which incorporates a nonlinear least-squares fitting routine coupled to a Grad-Shafranov solver. High toroidal beta is obtained in ohmically-heated plasmas by operation at low field with densities up to the Greenwald limit. Values of toroidal beta up to 20% and normalized beta up to 5 have been obtained without the observation of beta-limiting instabilities. The toroidal field utilization factor, Ip/Itf, reaches values as large as 1 but appears to approach a "soft" boundary at that level related to both power supply limits on ohmic flux and the onset of resistive MHD activity. The m/n=2/1 and 3/2 modes are most frequently observed, in agreement with the inferred safety factor profiles. This internal activity has a strong impact on plasma performance, leading to reduced stored energy and increased Ejima coefficient. Experiments are beginning to access the external kink boundary, where higher current discharges tend to terminate in abrupt disruptions associated with q95=5. Calculations using the DCON code indicate instability to the ideal kink when n=1 magnetic oscillations begin prior to the disruption. New experimental capabilities are being installed to control the plasma evolution and provide tools for suppression of the MHD instabilities. These include improved current drive capability, radial position control, and increased, time-variable toroidal field.

* Supported by U.S. DoE Grant No. DE-FG02-96ER54375

Topical area: Macroscopic equilibrium and stability