Non-inductive startup using localized washer gun plasma sources on the Pegasus Toroidal Experiment*

N.W. Eidietis, D.J. Battaglia, M.W. Bongard, R.J. Fonck, M.J. Frost, G.D. Garstka
B.J. Squires E.A. Unterberg, G.R. Winz
University of Wisconsin-Madison, Madison, WI USA

Non-inductive startup experiments are being conducted on the ultralow-A Pegasus Toroidal Experiment using an array of localized high current density plasma guns for plasma formation and current drive. This DC helicity injection technique has yielded tokamak-like plasmas of I_p/I_{tf} up to 2.3 ($I_N > 12$), far exceeding that achieved by ohmic induction. The guns are located in the lower divertor region of the vessel and are aligned to inject current onto crossed toroidal and poloidal fields when biased relative to the vacuum vessel. Each gun can inject 1-2 kA depending on design. At low input power, the injected current remains on the field lines that intersect the gun aperture. As the injected power is increased, the current filaments merge to form a cylindrical plasma. If the poloidal field produced by this plasma is larger than the vacuum field, the plasma relaxes into a tokamak-like configuration that exhibits characteristics of closed flux surfaces. The magnetic flux at the central column is observed to strongly reverse sign as these plasmas form, indicating flux closure. T_e increases significantly as observed by oxygen line ratios, and soft X-ray emission peaks in the plasma core. The end-of-shot decay time of these plasmas is up to 4 times longer than in non-relaxed configurations, indicating a large increase in L/R. Visual evidence from the fast plasma camera shows an elongated shape with a defined edge. Reconstructed equilibria, constrained by external magnetics, exhibit high elongation ($\kappa>2$), low internal inductance ($l_i<0.3$), strong reverse central shear, and high q_0 .The deleterious low m/n tearing modes often observed in ohmically driven plasmas at $I_p/I_{tf} \approx 1$ are not observed in these cases, possibly indicating the stabilizing effect of current profile modification. Rotating MHD modes with n=1 are associated with strong current drive, similar to those observed on other DC helicity injection experiments. The driven I_p is in rough agreement with predictions based upon a simple helicity conservation model. Experiments exploring coupling ohmic induction to non-inductive seed plasmas are underway.

1. G. Fiksel *et al.,* Plasma Sources Sci. Technol. **5** (1996) 78.

* Work supported by U.S. D.O.E. Grant DE-FG02-96ER54375