Noninductive plasma formation and current drive via localized plasma sources on the Pegasus Toroidal Experiment*

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Experiments are being conducted on the ultralow-A Pegasus Toroidal Experiment to use arrays of localized high-current electron sources as a plasma formation and sustainment tool. These sources [1] consist of stacks of BN and Mo washers which distribute the potential between a molybdenum anode and cathode. The guns are located in the lower divertor region of the vessel and are aligned to inject current onto crossed toroidal and poloidal fields. Toroidal plasmas are produced by first forming an arc between the gun anode and cathode. The gun anode is then biased negatively with respect to the vacuum vessel with the upper divertor plate acting as the "bias anode". Each source can inject 1-2 kA of electron current 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 with toroidal current governed by helicity input rate. If the poloidal field produced by this plasma is larger than the vacuum field, the plasma relaxes into a tokamak-like configuration with apparently closed flux surfaces. Relaxed plasmas with toroidal current up to 50 kA have been produced in this manner with less that 4 kA of injected current, and values of I_p/I_{tf} up to 2.3 ($I_N > 12$) have been achieved. 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. Core temperatures are estimated to be 50-70 eV at a toroidal field of 0.01 Tesla. VUV spectra are relatively clean, with little observed nitrogen, boron, or molybdenum. The end-of-shot decay time of these plasmas is up to 4 times longer than in nonrelaxed 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 exhibit high elongation (κ>2) and low internal inductance (l_i<0.3). MHD modes with n=1 have been observed, which are expected from theory and experiment to be the manifestation of the mechanism for current drive in CHI plasmas. Higher order modes (n=2,3) have also been periodically observed. Plans to upgrade these gun sources to increase the helicity and power injection rate are being actively pursued. An array capable of producing I_p>100 kA will be installed in 2007. This technique will be studied both as a noninductive current drive method and as a means for producing target plasmas for handoff to ohmic current drive in support of Pegasus program goals.

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

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