Long-pulse operation of the PFRC-2 device

S.A. Cohen, B. Berlinger, A. Bosh, C. Brunkhorst, E. Evans, A. Glasser, P. Jandovitz, J. Matteucci, C. Swanson

Plasma Physics Laboratory, Princeton University, Princeton NJ

Studies that resolve many time scales are important for understanding FRC physics. Perhaps the most difficult time scale to achieve is that of the classical inductive time, L/R, of the plasma. We have extended FRC plasmas to 300 ms, nearly 100x longer than the classical L/R, allowing studies of plasma stability and transport in a true steady state. Measurements of the time dependence of plasma density and electron temperature in long-duration plasma pulses were performed in the PFRC-2, a field-reversed-configuration device heated by odd-parity rotating magnetic fields at powers near 20 kW. Long-pulse operation is made possible by a set of eight high-temperature-superconductor BN-coated internal passive flux conserving rings, each with an inductive decay time of 1 sec and a critical current of 3 kA. With prefill hydrogen gas only, the line-average density rose to 2 x10^{12} cm^{-3} in less than 1 ms and the electron temperature typically reached 150 eV, as ascertained by X-ray emission. Under certain conditions the density decayed to near 0 in about 10 ms. Using a PV-10 gas valve modified to provide supersonic gas injection, we have found operational regimes where in-discharge fueling with a single 1-ms-duration hydrogen puff produced stable high density (2 x 10^{12} cm^{-3}) plasma discharges that persisted for 200 ms. Two or more 1-ms-duration gas pulses extended the pulse to in excess of 300 ms.

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