Long-pulse operation of the PFRC-2 device
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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 $2 \times 10^{12} \text{ cm}^{-3}$ 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 ($2 \times 10^{12} \text{ cm}^{-3}$) 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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