Magnetic Rayleigh-Taylor Instability Mitigation and Efficient Radiation Production in Gas Puff Z-Pinch Implosions
HENRY SZE, L-3 Pulse Sciences Division

For a long time it was believed that tightness and uniformity of Z-pinch plasmas imploded from large radii are inherently low because the adverse effect of the magnetic Rayleigh-Taylor (RT) instability that distorts the imploding plasma column is stronger for a longer acceleration path. None of the wire-array implosions from a diameter exceeding 7 cm were successful; a significant decrease of the argon K-shell radiation yield was observed when a 2.5 cm diameter annular shell load was replaced with a 4 cm diameter one. We report how we solved the problem of imploding z-pinch plasmas from large initial radii, making it possible to efficiently produce x-ray radiation with z pinches driven by longer current pulses than previously thought possible. Our novel load design[1] that mitigates the RT instability and enhances energy coupling to the radiating plasma column consists of a “pusher,” outer region plasma that carries the current and couples energy from the driver, a “stabilizer,” inner region plasma that stabilizes the implosion and a “radiator,” high-density center jet plasma that radiates. It increased the Ar K-shell yield at 3.46 MA in 200-ns implosions from 12-cm initial diameter by a factor of two, to 21 kJ, matching the yields obtained earlier on the same accelerator with 100-ns implosions. Test results of this load on all other major US accelerators will be presented [2]. Using laser shearing images, we illustrate the RT growth, its suppression and stabilization of an imploding plasma in a structured gas puff load that lead to a high compression, high yield z pinch. Similar images obtained for gas puff loads whose design does not ensure stabilization show the evolution of highly unstable z pinches which perform poorly as radiators. This research points the way to improved z-pinch implosions from large initial radii, either in the form of wire arrays or gas puffs.


1This work was sponsored by the Defense Threat Reduction Agency. The author is grateful to all the other participants of the DTRA-sponsored research program for their contributions that made this progress possible.