MITIGATION OF MAGNETO-RAYLEIGH-TAYLOR INSTABILITY USING DENSITY PROFILING AND EXTERNAL MAGNETIC FIELD IN GAS PUFF Z-PINCH PLASMAS*

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The gas puff Z-pinches [1] are intense sources of X-ray and/or neutrons and are excellent tools to study the physics of high energy density matter. Gas puff experiments were conducted on the CESZAR linear transformer driver (LTD) with 500 kA, 160 ns current pulses [2] and a double nozzle producing an annular shell and a central jet. The effect of changing gas species was studied using metrics like instability amplitude and energy coupling [3]. We show that low-impedance LTDs can implode a variety of gas puff loads with energy coupling efficiency of order of ~10% from the primary storage. Higher atomic number gases result in a more unstable outer plasma boundary. The addition of the central jet improves pinch stability, reproducibility, and energy coupling compared to a hollow shell gas puff. Pre-embedding an axial magnetic field, B_{z0}, can further improve pinch stability, but at cost of reduced compression. 2-D magnetohydrodynamic simulations of Ne-liner, deuterium-target gas-puff loads predict that this tradeoff can be reduced by the use of density profile tailoring, i.e., by adding a second liner [4]. By combining mitigation approaches, the required B_{z0} to stabilize the pinch is reduced by half with a reduced compression penalty. When the central jet is deuterium, this can significantly improve thermonuclear neutron production. Furthermore, our simulations predict the concept scales favorably with current to 10 MA, at which level thermonuclear yields of ~10^{13} neutrons/shot are predicted.

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