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Investigation of trailing mass in Z-pinch implosions and comparison to experiment[1]

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Wire-array Z pinches represent efficient, high-power x-ray sources with application to inertial confinement fusion, high energy density plasmas, and laboratory astrophysics. The first stage of a wire-array Z pinch is described by a mass ablation phase, during which stationary wires cook off material, which is then accelerated radially inwards by the JxB force. The mass injection rate varies axially and azimuthally, so that once the ablation phase concludes, the subsequent implosion is highly 3D in nature. In particular, a network of trailing mass and current is left behind the imploding plasma sheath, which can significantly affect pinch performance. In this work we focus on the implosion phase, electing to model the mass ablation via a mass injection scheme. Such a scheme has a number of injection parameters, but this freedom also allows us to gain understanding into the nature of the trailing mass network. For instance, a new result illustrates the role of azimuthal correlation. For an implosion which is 100% azimuthally correlated (corresponding to an azimuthally symmetric 2D r-z problem), current is forced to flow on the imploding plasma sheath, resulting in strong Rayleigh-Taylor (RT) growth. If, however, the implosion is not azimuthally symmetric, the additional azimuthal degree of freedom opens up new conducting paths of lower magnetic energy through the trailing mass network, effectively reducing RT growth. Consequently the 3D implosion experiences lower RT growth than the 2D r-z equivalent, and actually results in a more shell-like implosion. A second major goal of this work is to constrain the injection parameters by comparison to a well-diagnosed experimental data set, in which array mass was varied. In collaboration with R. Lemke, M. Desjarlais, M. Cuneo, C. Jennings, D. Sinars, E. Waisman

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