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Development of five-moment two-fluid modeling for Z-pinch physics[1] ERIC MEIER, Zap Energy Inc., YU. TAKAGAKI, U. Washington, URI SHUMLAK, U. Washington and Zap Energy Inc. — The FuZE experiment [Y. Zhang et al., PRL 122 (2019)] has generated pinches with 300-kA current, radii near 1 mm and Ti,e = 1-2 keV. In a reactor, the required current is 1.5 MA, with pinch radius <0.1-mm and Ti,e >30 keV. A five-moment two-fluid (5m2f) model is being developed to support experimental progress, aiming to capture the essential Z-pinch physics at modest computational cost. The model is implemented in WARPXM, a DG framework developed at U. Washington. In axisymmetric 5m2f simulations without dissipation, growth of the m=0 mode is studied in a scan of a/rLi, where a is the pinch radius, and rLi is the ion Larmor radius. At the extremes of small and large rLi, the simulated growth rates agree with linear MHD and Hall MHD analysis [V. I. Sotnikov et al., PoP 9 (2002)]. At a/rLi ˜= 2, electron drift speed exceeds the plasma sound speed, and electron drift instabilities appear. At a/rLi = 5.8, corresponding to FuZE conditions, the growth rate peaks at wavenumber kza ˜= 6, consistent with PIC results [K. Tummel et al., PoP 26 (2019)], and falls with increasing kza. Initial results with a Braginskii-based transport model show damping of growth rates to the PIC-predicted values, supporting the idea that 5m2f modeling will be a valuable tool in future Z-pinch development.

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