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On the helical instability and efficient stagnation pressure production in thermonuclear magnetized inertial fusion

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Magneto-inertial fusion experiments produce thermonuclear neutrons from plasma compressed to high convergence via z-pinch. Fusion fuel contained within a cylindrical metal liner is premagnetized with an axial field and laser-preheated prior to the liner's implosion by the JxB force. Convergence greater than 40 is inferred from x-ray self-emission spectroscopy and backlit x-ray radiography. The unprecedented stability is enabled by helical modes induced in the magnetized liner, the cause of which will be discussed, because of the suppression of the ubiquitous m=0 modes of the magneto-Rayleigh-Taylor instability found in many z-pinch implosions. The plasma temperature and flux are compressed to several keV and 100 MG at stagnation, enough to magnetically trap alpha particles and provide "bootstrap" self-heating when scaled to larger fusion yields with DT fuel. We present quantitative comparison between experimental observables and 3D modeling in support of the interpretation that this approach to laboratory fusion can scale to larger thermonuclear yields. Namely, the implosions efficiently convert liner kinetic energy to stagnated fuel internal energy with the expected pressures of 1 Gbar and burn durations of 2 ns, in agreement with both 2D and 3D modeling. Therefore, the analysis indicates the magnetized hot-spot dynamics are not dominated by implosion instability or residual kinetic energy in our best-performing experiments, wherein laser-induced non-fuel mix into the forming hot spot is low.

References: T. J. Awe, et al., *Phys. Rev. Lett.* **111**, 235005 (2013); A. B. Sefkow, et al., *Phys. Plasmas* **21**, 072711 (2014); M. R. Gomez, et al., *Phys. Rev. Lett.* **113**, 155003 (2014); S. B. Hansen, et al., *Phys. Plasmas* **22**, 056313 (2015); T. J. Awe, et al., *Phys. Rev. Lett.* **116**, 065001 (2016).