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Solid Liner Implosions on Z for Producing Multi-Megabar, Shockless Compressions[1]

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Recent experiments with cylindrical liners [1] on the Z-machine have utilized unshaped current drives where the early time drive pressure launches a shock into the initially solid liner. We explore the use of current pulse shaping techniques, originally developed for dynamic materials experiments on the Z-machine [2], to perform controlled cylindrical liner implosions. By driving the liner with a current pulse shape that prevents shock formation we avoid shock heating and melting the liner material and the corresponding decrease in electrical conductivity. This results in an imploding liner with a significant amount of its material in the solid phase and at multi-megabar pressures. Pressures in the solid region of a shaped pulse driven beryllium liner are expected to exceed 10 Mbar and have implosion velocities greater than 50 km/s. The solid liner experiments are diagnosed with multi-frame monochromatic X-ray backlighting which is used to infer the material density and pressure. These developments have lead to a new platform on the Z-machine that can be used to perform off-Hugoniot measurements at higher pressures than are accessible through magnetically driven planar geometries. This work was performed in collaboration with R.W. Lemke, R.D. McBride, M.D. Knudson, D.H. Dolan, and J P. Davis.

[1] Measurements of magneto-Rayleigh–Taylor instability growth during the implosion of initially solid metal liners, D. B. Sinars et al, Phys. Plasmas 18, 056301 (2011)
[2] Magnetically accelerated, ultrahigh velocity flyer plates for shock wave experiments, R. W. Lemke et al, J. Appl. Phys. 98, 073530 (2005)

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