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Axial magnetic field injection on scaled-down MagLIF platforms

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MagLIF is a promising inertial fusion based platforme studied on the Z machine, at Sandia National Laboratories. This fusion scheme combines z-pinch liner implosion, laser heating and magnetic field confinement. A wealth of physical processes can be studied using this platform, from electron heat conduction to magnetic field compression, from magnetic Rayleigh-Taylor instabilities to particle confinement. Critical plasma parameters of the MagLIF concept are dimensionless. This suggests that most of the physics can be studied using university-scale pulsed-power drivers. However other parameters do not scale. One of them is the electrical resistivity, that is much larger on smaller devices. So one can expect magnetic field compression on mega-ampere-class pulsed-power drivers to be much less effective. This work uses numerical simulations to demonstrate that if the return current posts surrounding the liner are tilted, a time-varying axial magnetic field is generated by the pulsed power driver. This field can diffuse inward, across the liner wall at the same speed that the initial axial field diffuses out. By picking the right angle for the posts, the inward and outward diffusions of both axial fields completely balance out, allowing to reach much more relevant dimensionless parameters. In fact, the rate of injection of the outer axial field can be much faster than the rate at which the inner axial field escapes, increasing the total field inside the liner even when no compression takes place. The injected axial field distribution is also much different from the initial compressed field. The inward diffusion generates a magnetic well that can improve particle confinement from inward gradB drifts. We will conclude by showing that axial field injection can also work for MagLIF on Z.

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