Demonstrating dual current paths as a method to preheat and implode a magneto-inertial fusion target

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Magnetized liner inertial fusion (MagLIF) is a magneto-inertial fusion concept in which magnetized, preheated fuel is quasi-adiabatically compressed to achieve fusion temperatures and densities [1]. MagLIF experiments conducted at Sandia National Laboratories have used Helmholtz-like coils to axially magnetize the fuel, the Z-Beamlet laser to preheat the fuel, and the current from the Z facility to implode the target, generating ion temperatures > 3keV and deuterium-deuterium fusion yields >1e13 [2]. MagLIF performance follows computationally predicted trends, but fuel convergence in MagLIF is higher than desired [3]. Fuel convergence can be decreased in MagLIF by simultaneously increasing initial fuel mass and preheat energy, but this is challenging to do with the Z-facility's 4 kJ, 2ω Z-Beamlet laser [4]. We are now evaluating an alternative preheating scheme that leverages a pulsed current to preheat the fuel, which will enable higher initial fuel mass and significantly increased preheat energy (~10 kJ).

We recently demonstrated a new pulsed power configuration, which simultaneously delivers current to both the exterior and interior of the MagLIF target. We accomplished this by connecting two parallel transmission lines to the post-hole convolute, using the relative inductance of the two transmission lines to set the current division. One transmission line was connected to the exterior of a cylindrical beryllium target, and the other was connected to a beryllium rod on axis, using the interior of the beryllium target as a return current path. We coupled approximately 18 MA to the exterior of the target and 5 MA to the interior of the target, and we studied the implosions of both the target and the rod through x-ray radiography. These experiments are being used to benchmark our simulation tools, enabling us to computationally explore this new region of parameter space for MagLIF. Future experiments will leverage a deuterium ice fiber [5] in place of the beryllium rod.

References

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