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# Magnetized ICF: studies of the transport of heat and magnetic flux in pre-magnetized cylindrical implosions

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The external addition of a magnetic field (B-field) in high-power laser installations opens interesting perspectives for inertial confinement fusion (ICF). An initial B-field advected by the implosion of fuel capsules can be amplified up to $10^4$-$10^5$ T. Such strong fields can mitigate hydrodynamic instabilities, reduce energy losses by thermal conduction of electrons, and better confine the products of fusion reactions. This may result in a hotter fuel core that can ignite at lower densities and with slower implosions, less prone to hydrodynamic instabilities.

Axially symmetric (cylindrical instead of spherical) implosions facilitate studies of the transport of heat and magnetic flux, under an initial uniform B-field that is everywhere perpendicular to the radial compression [1]. Our initial experiments of magnetized cylindrical implosions at the OMEGA facility (USA), with 15 kJ of laser drive, have shown that an initial B-field of 30 T increases the core temperature by 50% and reduces its density by a factor of 2, compared to unmagnetized implosions, consistent with the effect of a 10 kT B-field at stagnation [2].

We scaled our studies for 20 times higher laser energy aiming at spatially-resolved measurements of the core temperature (out of dual-dopant K-shell emission spectroscopy) [3] and of the B-field compressibility (from angularly-resolved ToF spectra of secondary neutrons) in two distinct designs for the cylindrical compression ratio, at the National Ignition Facility (NIF, USA) and at the Laser Mega Joule (LMJ, France). Recent data obtained at NIF show, compared to unmagnetized implosions, a more symmetric compression and a three times higher neutron yield for implosions with an initial B-field of 16.5 T. Ongoing extended-magnetohydrodynamic modeling is helping to interpret the results and to improve the design of future experiments.

[1] C.A. Walsh *et al.*, Plasma Physics and Controlled Fusion **64**, 025007 (2022).

[2] M. Bailly-Grandvaux *et al.*, Physical Review Research **6**, L012018 (2024).

[3] G. Pérez-Callejo *et al.*, Physical Review E **106**, 035206 (2022).

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