Strong Laser-Driven Magnetostatic Fields for Investigations of Magnetized High Energy-Density Plasmas

João Jorge Santos

Univ. Bordeaux, CNRS, CEA, CELIA, UMR 5107, Talence, France

The portability and compactness of laser-driven strong magnetostatic-field (B-field) generators using coil-shaped targets makes them easily implementable in high-energy/power laser facilities, paving the way for novel, magnetized high energy-density (HED) physics investigations. We will review results [*e.g.* 1, 2, 3, 4] and physical understanding [5] of the laser driving of strong discharge currents in the coils and B-fields, obtained in experiments carried out at the LULI2000, Gekko-XII, Vulcan, PALS, Omega and LMJ laser facilities.

With sufficiently small inductance coils, we successfully generated B-fields above 500 T and applied them to magnetize solid-density targets. The B-field soak-in then allowed us to radially confine a beam of relativistic electrons over 60 μm-thick dielectric targets, yielding a 5-fold enhancement on the energy-density flux into the bulk of dense matter [6].

More recently, we have tried to characterize the effect of magnetization with fields >10 kT in laser-driven cylindrically imploded hot dense plasmas using dopant spectroscopy techniques [7]. Our first implosion experiments were carried out at the OMEGA laser using 15 kJ laser drive with externally-delivered 24 T seed B-fields along the axis of the cylindrical targets. Dopant-Ar emission spectra allowed us to observe distinct changes in the deuterium plasma conditions of the compressed core in the cases with and without the applied B-field, revealing changes in the implosion dynamics due to the B-field compression. An extension of this technique was designed and accepted for beam time at the LMJ laser facility, using a 20 times greater laser drive and, this time, seed B-fields issued from laser-driven coil-targets. The predicted increase in compressed B-field is significant, which would allow us to reach more extreme regimes of magnetized HED plasmas.

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