Pulsed kTesla Dipolar Magnetic Field Generation by Laser and Applications

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The generation of strong magnetic fields (B-field) through laser-matter interaction [1, 2, 3] is opening new frontiers in several research areas, such as atomic-, nuclear- and astro-physics, and, more specifically, in inertial fusion science. We studied the B-fields generated by the interaction of an intense laser beam (1 ns, 500 J, 10^{16}-10^{17} W/cm^2) with capacitor-coil targets, testing different target resistivity, magnetic permeability and geometry. The B-field evolution with time was characterized by the measurements of both an inductor coil (B-dot probe) and laser-accelerated proton-trajectory deflections. The latter technique also allowed characterizing the B-field dipole-like spatial distribution, with magnetic energy distributed over a characteristic volume of 1 mm^3. The data analysis for the best set of parameters reveals the maximum B-field amplitude of the order of 800 T at the coil center, 1.5 ns after the laser pulse and with a typical duration of 3.5 ns. The experimental results are successfully compared with a theoretical model describing the mechanism of the target charging due to the charge separation between the target's capacitor disks, issuing from the laser interaction, and discharging by a quasi-static electric current on the coil connecting the disks.

Such B-fields can be used for efficient and compact control of the collimation of intense electron and ion beams. We will present preliminary results of a proof-of-principle experiment on the magnetic-collimation, by imposed longitudinal B-field, of a relativistic fast electron beam propagating in a solid target, relevant for fast ignition in inertial confinement fusion.

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