Insight into the physics of laser-driven coils for optically-triggered generation of quasi-static magnetic fields

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Laser-driven coil (LDC) targets can generate magnetic-field (B-field) pulses of several ns duration via intense ns laser interactions. The laser-induced discharge current is guided by the target's geometry, which consists of a coil-shaped wire connecting two plates. Recent experiments deepen our understanding of LDC working principle. We used similar ns infrared laser intensities (~10^{15} - 10^{16} W/cm^2) at the LULI2000 and PALS facilities. We generated coil currents of ~20 kA and ~12 kA yielding B-fields of ~50 T and ~30 T at the coil center, respectively, with targets of twice the inductance in the latter case. At LULI2000 the fields were characterized by dual-axis proton-deflectometry, which unraveled the superposed effects of both the B-field and E-fields due to static charging of the coil's wire surface [1]. At PALS, an optical probe laser allowed to simultaneously measure the coil's B-field by Faraday rotation across a nearby-placed birefringent crystal, and the density and self-generated B-field of the plasma plume between the two plates (understood as the discharge current source) by complex interferometry. Additional electron and X-ray diagnostics completed the physical characterization of the process. For the first time, we observe a correlation between coil current and plasma current between plates. Characterized discharge currents are consistent with predictions from a laser-driven diode-current source model.

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