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Laser-driven strong magnetostatic fields with applications to charged beam transport and magnetized high energy-density physics[1]

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Powerful laser-plasma processes are explored to generate discharge currents of a few 100 kA in coil targets, yielding magnetostatic fields (B-fields) in the ˜kTesla range. The B-fields are measured by proton-deflectometry and high-frequency bandwidth B-dot probes [New J. Phys. **17**, 083051 (2015); App. Phys. Lett. **108**, 091104 (2016)]. According to our modeling [Phys. Rev. E (2017, submitted)], the quasi-static currents are provided from hot electron ejection from the laser-irradiated surface, accounting for the space charge neutralization and the plasma magnetization. The major control parameter is the laser irradiance $I\lambda^2$. The B-fields ns-scale is long enough to magnetize secondary targets through resistive diffusion. We applied it in experiments of laser-generated relativistic electron transport into solid dielectric targets, yielding an unprecedented enhancement of a factor 5 on the energy-density flux at 60 m depth, compared to unmagnetized transport conditions [Nat. Comm. (2017, submitted), arXiv:1608.08101]. These studies pave the ground for magnetized high-energy density physics investigations, related to laser-generated secondary sources of radiation and/or high-energy particles and their transport, to high-gain fusion energy schemes and to laboratory astrophysics.

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