Laser-driven high magnetic field generation in shaped targets

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In laser-plasma interaction, strong quasi-stationary magnetic fields can be generated using a certain geometry, defining current direction. This process is a subject of particular interest both as a special physical phenomenon and as a necessary part of astrophysical studies in laboratory, magnetized solutions of Inertial Confinement Fusion and of many others applications. For ns beams, the capacitor-coil assembly has shown good results, while in ps regime the optimal configuration is yet sought. We have found the snail-shaped targets to be promising optical magnetic field generators [1]. For these targets, it was theoretically predicted [2] and proven experimentally [3] that the magnetic field value generated under the action of a relativistically intense picosecond laser pulse can reach several kT with the lifetime of about tens of picoseconds.

In this work, analysis of both theoretical and experimental data on field generation in different shaped targets, all having some kind of a broken rotational symmetry, is presented. The experimental investigation was carried out using proton deflectometry as a main diagnostic tool. A new perspective approach for the assessment of such an experimental data, based on machine learning algorithms, is proposed. The presented numerical simulations results are in agreement with the experiment and clarify the field generation mechanisms and importance of transient processes.

References

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