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Characterizing hot electrons in ensemble PIC simulations of high-intensity, laser-plasma interactions with machine learning.

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In the interaction of high-intensity lasers with over-dense plasmas, the hot electron population dictates system dynamics, driving ion acceleration and x-ray generation, and fast ignition, for example. The primary method for modeling these systems are particle-in-cell simulations (PIC), where macroparticles approximate the kinetics of a distribution of particles. A problem shared with experiments, PIC simulations are inherently noisy given the statistical nature of the algorithm, particularly at lower fidelities. Individual electron energy distributions are easily analyzed with expert examination, but 'by hand' analysis is impractical for the hundreds of thousands of case examples produced by ensemble simulations, and this is exacerbated by noisy data. In this work, data from an ensemble of PIC simulations is analyzed and quantified using machine learning (ML) techniques to more reliably extract the hot electron temperature and other physical parameters. We present the dependency of the hot electron temperature and other electron sheath properties on various input parameters such as laser intensity and pulse length across a wide parameter space (~10^18-10^21 W/cm^2, 30-500 fs).

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