Temporal characteristics of hot electron generation inside kJ-laser irradiated Cu foils

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Hot electron (HE) production driven by instabilities accompanying the laser plasma interaction [1] is of paramount interest for the inertial confinement fusion science and high energy density physics. Their accurate characterization is crucial for interpretation of high-intensity laser matter experiments. Here we report studies of non-thermal atomic states in kJ-laser produced plasmas allowing to characterize HE generation with respect to their fraction and temporal evolution. The action of HE was visualized via high-resolution x-ray spectra emitted from the laser-deflected part of the 1.5-μm-thick Cu foil. Hot electrons are penetrating the accelerated foil and produce the K-shell emission in rather cold dense matter that otherwise would not emit x-rays. A quantitative analysis of the measured spectra based on 2D hydrosimulations [2] and non-Maxwellian kinetics [3] indicates that hot electrons are produced significantly after the laser maximum. Good agreement between experimental observations and simulations indicates that a combination of advanced high-resolution x-ray spectroscopy and non-thermal atomic physics spectral modelling offers a novel method to characterize hot electrons inside the laser accelerated solid density matter. In the same time, fine spectral features identified in x-ray emission originating from several Cu charge states represent a set of precise spectroscopic data capable to benchmark the state-of-the-art multiscale nonlinear hydrodynamic modelling of the laser-plasma interaction.

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