Delayed action of suprathermal electrons inside kJ laser accelerated solid density matter

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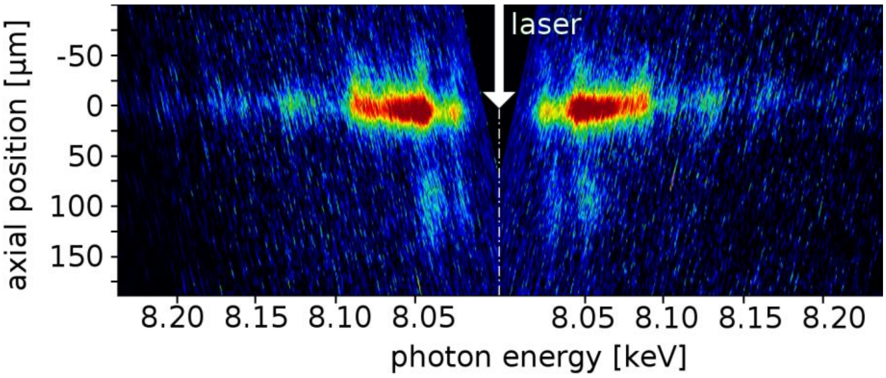
A role of suprathermal electron (SE) production accompanying laser matter interaction at conditions relevant for shock ignition ICF approach is two-fold: They can enhance the ablation pressure but also prevent hotspot ignition by preheating the fuel. In general, a detailed characterization of SE generation and transport is of paramount importance for development of advanced ICF schemes. In experiments performed at Prague PALS laser (0.35 ns, 400 J, 1:315 µm), timing aspects including onset and duration of SE action complementing determination of the SE fraction inside near solid density matter have been studied via application of X-ray spectroscopy.



Spatially resolved Cu Kα spectrum recorded by a vertical-geometry Johann spectrometer.

High-resolution spectra from the laser-deflected part of the 1.5-µm-thick Cu foil reveal the action of SE. They are penetrating the accelerated foil and visualize the plasma displacement via the K-shell emission of rather cold dense matter that otherwise would not emit X-rays. Non-thermal atomic states of the kJ-laser accelerated plasma are studied with respect to relative time shifts between the laser pulse and the effective duration of SE. A quantitative analysis based on two-dimensional hydrosimulations and non-Maxwellian kinetics indicates that hot electrons are produced significantly after the laser maximum with duration shorter than the laser pulse width.

This approach offers a novel method to obtain critical temporal characteristics of SE from the interior of laser accelerated solid density matter. The particular link between 2D-hydro-simulations, non-thermal atomic kinetics and highly-resolved (in frequency and space) x-ray emission can also be understood as a benchmark spectroscopic data that is going beyond a simple post-processing, i.e. beyond the state-of-the-art.