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High precision probing of laser-solid interaction with LWFA-generated electron beams

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The collision of ultra-intense laser pulses with solids may initiate processes like current filamentation instability (CFI) and target normal sheath acceleration (TNSA). Studying the interplay of these processes is crucial, as they play an important role in novel particle accelerator concepts and are believed to be present in astrophysical events.

In the scope of this work, laser-solid interaction has been studied with unprecedentedly high temporal and spatial precision. For that, we use electron beams from a laser-plasma accelerator as probe beams. Their inherently small size and duration allow to locally probe the electromagnetic fields generated in the interaction and to distinguish the TNSA and plasma instabilities due to the difference in their effects on the probe beam. In our study we were able to observe expanding surface charge clouds which are responsible for TNSA, as well as strong localized electromagnetic fields, which may be attributed to CFI.

These experimental studies are accompanied by involved simulations, we briefly discuss the numerical approaches and results.

Our work establishes a very important application for laser-accelerated electron beams, particularly for the research on laser-solid interaction, and thus opens new possibilities for understanding important processes in plasma accelerators as well as astrophysical phenomena.

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