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lpaw23@tecnico.ulisboa.pt

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

Y. Mankovska[1], X. Davoine[2,3], M.F. Gilljohann[1], L. Gremillet[2,3], A. Knetsch[1], O. Kononenko[1], A. Matheron[1], S. Passalidis[2], P. San Miguel Claveria[1], S. Corde[1], and the Hybrid Collaboration[1,4–11]

[1] *LOA, ENSTA Paris, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, Palaiseau, France,*
[2] *CEA, DAM, DIF, Arpajon, France*
[3] *Université Paris-Saclay, CEA, LMCE, Bruyères-le-Châtel, France*
[4] *Ludwig-Maximilians–Universität München, Garching, Germany*
[5] *Max Planck Institut für Quantenoptik, Garching, Germany*
[6] *Technische Universität München, Garching, Germany*
[7] *Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany*
[8] *Technische Universität Dresden, Dresden, Germany*
[9] *Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany*
[10] *University of Strathclyde, Glasgow, United Kingdom*
[11] *The Cockcroft Institute, Warrington, United Kingdom*

yuliia.mankovska@ensta-paris.fr

The collision of ultra-intense laser pulses with solids may initiate such processes as current filamentation instability (CFI), target normal sheath acceleration (TNSA) etc. These processes have important implications in e. g. novel particle accelerator concepts and are also believed to be present in the physical phenomena during astrophysical events, for which the understanding of the interplay of these different processes is crucial.

In the scope of this work laser-solid interaction has been studied with unprecedentedly high temporal and spatial precision using an LWFA-generated electron beams. Performed measurements show influence of laser-solid interaction on the electron beams. In contrast to previous studies (like in [1], [2]), we utilize the inherently small size of the LWFA electron beams, which allows to locally probe the magnetic fields generated in the interaction and measure their temporal and spatial evolution by rastering the beams in space and time. The different processes that lead to TNSA and plasma instabilities have different effects on the probe beam divergence and steering due the feature size of created magnetic fields. This may allow to distinguish these processes with high-precision data scans. In our study we were able to observe expanding surface charge clouds which are responsible for TNSA, as well as localized and long-lasting magnetic fields.

This study establishes an important application for LWFA-generated electron beams, particularly for the research on laser-solid interaction, and thus opens new possibilities for understanding the processes which occur in plasma accelerators as well as the ones that are believed to be behind some astrophysical phenomena.

References

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