



Gas-dynamic density downramp injection in a beam-driven plasma wakefield accelerator

J. P. Couperus Cabadağ¹, R. Pausch¹, S. Schöbel^{1,2}, M. Bussmann^{3,1}, Y.-Y. Chang¹, S. Corde⁴, A. Debus¹, H. Ding^{5,6}, A. Döpp^{5,6}, F. M. Foerster⁵, M. Gilljohann^{4,5,6}, F. Haberstroh⁵, T. Heinemann^{7,8,9}, B. Hidding^{8,9}, S. Karsch^{5,6}, A. Koehler¹, O. Kononenko⁴, A. Knetsch⁴, T. Kurz^{1,2}, A. Martinez de la Ossa⁷, A. Nutter^{8,9}, G. Raj⁴, K. Steiniger¹, U. Schramm^{1,2}, P. Ufer^{1,2} and A. Irman¹

1) *Helmholtz-Zentrum Dresden - Rossendorf, Institute of Radiation Physics, Bautzner Landstrasse 400, 01328 Dresden, Germany*

E-mail : j.couperus@hzdr.de

2) *Technische Universität Dresden, 01069 Dresden, Germany*

3) *Center for Advanced Systems Understanding, Untermarkt 20, Görlitz, Germany*

4) *LOA, ENSTA Paris, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, 91762 Palaiseau, France*

5) *Ludwig-Maximilians-Universität München, Am Coulombwall 1, 85748 Garching, Germany*

6) *Max Planck Institut für Quantenoptik, Hans-Kopfermann-Str. 1, Garching 85748, Germany*

7) *Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany*

8) *The Cockcroft Institute, Keckwick Lane, Warrington WA4 4AD, United Kingdom*

9) *University of Strathclyde, 107 Rottenrow, Glasgow G4 0NG, United Kingdom*

We present the experimental demonstration of density downramp injection at a gas-dynamic shock in a beam-driven plasma accelerator.

This is realized in a hybrid LWFA-driven PWFA where the ultrashort driver electron beam originates from a preceding laser driven wakefield accelerator [1]. A peak-current exceeding 10 kA allows PWFA operation in the blowout regime and enables injection of electron witness bunches at gentle density ramps, i.e. longer than the plasma wavelength, which nurtures prospects for ultralow bunch emittance.

By precision control over the position of injection we show that these bunches can be energy-tuned in acceleration gradients of near 120 GV m⁻¹.

References

- [1] T. Kurz, T. Heinemann *et al.*, Demonstration of a compact plasma accelerator powered by laser-accelerated electron beams, *Nature Commun.*, (2021, in press). doi: 10.1038/s41467-021-23000-7