AKBP 1: New Accelerator Concepts 1

Time: Monday 14:00–15:30 Location: AKBP-H13

AKBP 1.1 Mon 14:00 AKBP-H13

A new transport line for transverse gradient undulator experiments at the JETI laser plasma accelerator in Jena — •Maisui Ning, Samira Fatehi, Axel Bernhard, Robert Rossmanith, and Anke-susanne Müller — KIT,Karlsruhe,Germany

In this contribution, we describe the current status of the ongoing upgrade of an electron beam transport line employed in the successful experimental demonstration of capture and matching of a laser plasma-accelerated beam at the JETI laser facility, University of Jena. This upgrade aims at adapting the beam line to the higher electron energies achievable with the new JETI laser and enabling an experimental proof of the transverse gradient undulator concept to be performed in a collaboration between KIT and the University of Jena. The upgrade comprises the redesign of both the beam transport line magnets and of the beam optics, which will be described and discussed in detail. This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 1.2 Mon 14:15 AKBP-H13

Synthetic shadowgrams of laser-plasma accelerators computed by a PIConGPU in-situ plugin — •Finn-Ole Carstens[1,2], Klaus Steiniger[1], Richard Pausch[1], Yen-Yu Chang[1], Susanne Schöbel[1], Jurjen Couperus[1], Arie Irman[1], Max Lehmann[1,2], Rene Widera[1], Michael Bussmann[1,3], Ulrich Schramm[1,2], Thomas Cowan[1,2], and Alexander Debus[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden — [3]Center for Advanced Systems Understanding Görlitz

Few-cycle shadowgraphy is a valuable diagnostic for laser-plasma accelerators to obtain insight into the μm- and fs-scale relativistic plasma dynamics. To enhance the understanding of experimental shadowgrams we developed a synthetic shadowgram diagnostic within the fully relativistic particle-in-cell code PIConGPU.

In an initial version of the synthetic shadowgraphy diagnostic, the probe laser is propagated through the plasma using PIConGPU, and then extracted and propagated onto a virtual CCD using a post-processing code based on Fourier optics. However, the latter step requires 3D-FFTs, which results in performance and scaling limitations in large-scale simulations. To circumvent this, we develop an in-situ plugin for PIConGPU, in which we extract the probe laser slice-wise to obtain the synthetic shadowgrams during the simulation without post-processing.

In this talk, we present the development of the PIConGPU plugin and show preliminary results of synthetic shadowgrams for laser and plasma wakefield accelerators.

AKBP 1.3 Mon 14:30 AKBP-H13

Simulating hybrid laser-plasma wakefield accelerators using PIConGPU — •R. Pausch[1], J. P. Couperus[1], S. Schöbel[1,2], S. Bastrakov[1], Y.-Y. Chang[1], S. Corde[4], H. Ding[5,6], A. Döpp[5,6], F. M. Foester[5], M. Gilljohann[4,5,6], F. Haberstroh[5], T. Heinemann[7,8], B. Hidding[8], S. Karsch[5,6], A. Koehler[1], O. Kononenko[4], A. Knetsch[4], T. Kurz[1,2], A. Martines de las Ossa[7], A. Nutter[8], G. Raj[4], K. Steiniger[1], U. Schramm[1,2], P. Ufer[1,2], R. Widera[1], A. Irman[1], M. Bussmann[3,1], and A. Debus[1] — [1]HZDR — [2]TU Dresden — [3]CASUS — [4]LOA — [5]LMU — [6]MPQ — [7]DESY — [8]University of Strathclyde

An LPWFA accelerator uses electrons from a laser wakefield accelerator stage to drive a second plasma wakefield accelerator stage. This approach makes it possible to downscale PWFAs from kilometer-sized facilities to tabletop experiments and makes the improved beam quality of PWFAs available to LWFA laboratories. The experimental realization of the hybrid accelerator at HZDR was accompanied by a simulation campaign with the fully GPU accelerated, 3D3V particle-in-cell PIConGPU. Running simulations on modern GPUs allowed reducing simulation time while modeling different experimental settings in a fully three-dimensional setup. The latter enabled studying the influence of tilted shock fronts and few-cycle probes, among others. In this talk, we will not only introduce the general concept but also discuss some of the recent results obtained using particle-in-cell simulations. Moreover, the technical innovations in PIConGPU that have enabled these new types of simulations will also be briefly addressed.

AKBP 1.4 Mon 14:45 AKBP-H13

Investigation of beam quality enhancement with tailored down-ramp profiles in laser wakefield accelerators using particle-in-cell simulations — •Jonas Günzl[1,2], Richard Pausch[1], Sergei Bastrakov[1], Michael Bussmann[3,1], Yen-Yu Chang[1], Jurjen Couperus[1], Arie Irman[1], Susanne Schöbel[1,2], Klaus Steiniger[1], René Widera[1], Ulrich Schramm[1,2], and Alexander Debus[1] — [1]HZDR — [2]TU Dresden — [3]CASUS

Electrons from laser wakefield accelerators (LWFA) can be ultrashort and quasi-monoenergetic. They have the potential to be an ideal source for advanced light sources or beam drivers for hybrid laser-plasma wakefield accelerators (LPWFA). A wide variety of injection methods have already been developed to produce high-quality LWFA electrons. However, such high-quality electron bunches may degrade upon exiting the LWFA stage.

This poster addresses quality-preserving methods for extracting electron beams from laser wakefield accelerators by adjusting the plasma density of the down ramp. By modeling different gas profiles with the fully relativistic particle-in-cell code PIConGPU, not only the final beam quality but also all relevant physical effects can be studied in detail. This allows not only to find an optimal quality-preserving down ramp but also to study the influence of changes in laser focus position on beam properties during extraction.

AKBP 1.5 Mon 15:00 AKBP-H13

Progress toward high overall energy efficiency in a beam-driven plasma-wakefield accelerator stage — •Felipe Peña[1,2], Judita Beinortaite[1,3], Jonas Björklund Svensson[1], Lewis Boulton[1,4,5], Gregory Boyle[1], Jonathan Christopher Wood[1], Brian Foster[6], James Matthew Garland[1], Pau Gonzalez[1,2], Carl A. Lindstrøm[1], Gregor Loisch[1], Sarah Schröder[1], Stephan Wesch[1], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]University College London, London, United Kingdom — [4]SUPA, Department of Physics, University of Strathclyde, Glasgow, United Kingdom — [5]The Cockcroft Institute, Daresbury, United Kingdom — [6]John Adams Institute, University of Oxford, UK

Beam-driven plasma-wakefield acceleration has the potential to reduce the building cost of accelerator facilities, with large accelerating fields that are orders of magnitude greater than radio-frequency cavities. Sustaining strong decelerating fields for the driver and strong accelerating fields for the trailing bunch across long plasma stages will be key to demonstrating high energy efficiency in this scheme. We present preliminary experimental results towards high overall energy efficiency performed at the FLASHForward plasma-accelerator facility at DESY.

AKBP 1.6 Mon 15:15 AKBP-H13

Experimental results of Trojan horse injection in a hybrid LPWFA — •Patrick Ufer[1,2], Alastair Nutter[3], Yen-Yu Chang[1], Sébastien Corde[4], Jurjen Couperus Cabadağ[1], Alexander Debus[1], Andreas Döpp[5], Thomas Heinemann[3,6], Bernhard Hidding[3], Max Gilljohann[4,5], Stefan Karsch[5], Alexander Köhler[1], Olena Kononenko[4], Richard Pausch[1], Susanne Schöbel[1,2], Alberto Martinez de la Ossa[6], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany — [3]University of Strathclyde, Glasgow, UK — [4]LOA, ENSTA ParisTech, CNRS, Ecole Polytechnique, Université Paris-Saclay, France — [5]Ludwig-Maximilians-Universität München, Germany — [6]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

A hybrid (LPWFA) plasma accelerator combines the two schemes of plasma acceleration, using a laser (LWFA) and an electron beam (PWFA) to drive the plasma wave, with the goal to combine the advantages of both methods. This concept allows studies of PWFA-physics in compact setups as well as generating high-quality electron beams to fulfill the demands of secondary light sources like FELs. We present experimental results from hybrid plasma accelerators using plasma cathode injection also known as Trojan horse injection. A short-pulsed laser is used as the injector in the second stage of the accelerator propagating perpendicular to the electron beam. When timed such, that injector laser and the first cavity of the wakefield overlap, the creation of low-energy-spread witness beams have been observed.