AKBP 5: New Accelerator Concepts II

Zeit: Dienstag 16:30–18:30 Raum: NW-Bau - HS2

AKBP 5.1 Di 16:30 NW-Bau - HS2

Hybrid plasma wakefield acceleration: Concept & preliminary results — •Thomas Kurz[1,2], Thomas Heinemann[3,4,5,6], Alexander Knetsch[5], Jurjen Couperus[1,2], Alexander Köhler[1,2], Omid Zarini[1,2], Bernhard Hidding[3,4], Ralf Assmann[5], Michael Bussmann[1,2], Ulrich Schramm[1,2], Alberto Martinez de la Ossa[5], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]University of Strathclyde, Glasgow, Scotland — [4]Cockcroft Institute, Warington, United Kingdom — [5]Deutsches Elektronen Synchrotron, Hamburg, Germany — [6]Universität Hamburg, Hamburg, Germany

Plasma wakefield accelerators can be driven by either a powerful laser pulse (LWFA) or a high-current charged particle beam (PWFA). We combine both acceleration methods in a staged setup to efficiently exploit the advantages of each scheme. We present preliminary results of a proof of concept-experiment at the DRACO laser facility at Helmholtz-Zentrum Dresden-Rossendorf (HZDR). The LWFA stage (1st stage) generates ultra relativistic electron beams with peak currents exceeding 20kA via self truncated inonization injection (STII) out of a 3mm super sonic dopant (He+N) gas jet. These beams are sent into the second 3mm dopant (H+He) gas jet, driving plasma wakefields in the non-linear bubble regime. Thereby, injected electrons induced by the field ionization form a second electron beam (witness) that ideally exeeds the driving bunch (driver) quality in terms of energy and brightness.

AKBP 5.2 Di 16:45 NW-Bau - HS2

Investigating the picosecond leading pulse edge influence on ultra-intense laser heating of solids with 3D PIC simulations — •Marco Garten[1,2], Axel Huebl[1,2], René Widera[1], Heiko Burau[1,2], Thomas Kluge[1], Ulrich Schramm[1], and Michael Bussmann[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf — [2]Technische Universität Dresden

Laser-ion acceleration processes depend strongly on the complex plasma dynamics following the generation of relativistic electrons and bulk heating of a solid target by a short-pulse ultra-high intensity laser. A better understanding of the influence of the pre-pulse phase and picosecond leading pulse edge could lead to better control and reproducibility of ion cutoff energies, two crucial requirements for using laser-plasma accelerated ions for medical applications. We present the first results from a 3D PIC simulation campaign, modeling ultra-intense ($a_0 = 20$) laser interaction with up to micrometer thick foils covering the picosecond time span prior to the arrival of the main pulse. In addition to laser absorption efficiency, electron spectrum, divergence and plasma scale lengths we investigate the spatially and energy-resolved spectrum of in-situ calculated Bremsstrahlung and synchrotron radiation originating from keV to MeV electrons. Simulations have been performed at the Piz Daint supercomputer at CSCS, Switzerland, using the fully-relativistic 3D3V open-source particle-in-cell code PIConGPU developed at HZDR.

AKBP 5.3 Di 17:00 NW-Bau - HS2

A Laser- and Particle Driven Plasma Wakefield Accelerator for High-Brightness Beams — •Thomas Heinemann[1,2,3,4], Thomas Kurz[5,6], Alexander Knetsch[2], Olena Kononenko[2], Jurjen Couperus[5,6], Alexander Köhler[5,6], Omid Zarini[5,6], Michael Bussmann[5,6], Bernhard Hidding[3,4], Ralph Assmann[2], Ulrich Schramm[5,6], Alberto Martinez de la Ossa[1,2], and Arie Irman[5] — [1]Universität Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]University of Strathclyde, Glasgow, UK — [4]The Cockcroft Institute, Warrington, UK — [5]Helmhotz-Zentrum Dresden - Rossendorf, Germany — [6]Technische Universität Dresden, Germany

Plasma wakefield accelerators can be driven by either a powerful laser pulse (LWFA) or a charged particle beam (PWFA). Here we present a novel plasma accelerator scheme which combines both schemes in a staged setup: The LWFA produces a high current beam electron beam which subsequently drives a PWFA where a new electron beam is produced and accelerated. This hybrid scenario explicitly makes use of several advantages unique to each method. Effectively, this LWFA-to-PWFA (LPWFA) staged setup operates as a beam brightness and energy booster of the initial LWFA output, aiming to match the demanding beam quality requirements of accelerator based light sources in a truly compact setup. We report on theoretical and numerical studies towards an experimental implementation at the DRACO laser facility at Helmholtz-Zentrum Dresden - Rossendorf (HZDR).

AKBP 5.4 Di 17:15 NW-Bau - HS2

Double bunch generation for externally injected plasma wakefield acceleration at FLASHForward — •Sarah Schröder[1,2], Alexander Aschikhin[1], Richard D'Arcy[1], Vladyslav Libov[1,2], Kai Ludwig[1], Alberto Martinez de la Ossa[2], Timon Mehrling[1,2], Bernhard Schmidt[1], Stephan Wesch[1], Johann Zemella[1], and Jens Osterhoff[1] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Universität Hamburg

Owing to the high electromagnetic field gradients (>GV/m) supported by plasma wakefield acceleration (PWFA), plasma-based particle accelerators have the potential to greatly reduce the size of future accelerators. The FLASHForward experiment will be dedicated to studies of beam-driven plasma wakefield acceleration. It is currently under construction and will be housed in an extension beam line to the FLASH free-electron laser (FEL) facility at DESY. One of the core areas of research at FLASHForward is the preservation of bunch parameters for externally injected beams; a process where two electron bunches are injected into plasma, the first bunch driving a plasma wake and the trailing bunch being accelerated by the resulting fields. A metallic mask, placed in a dispersive beam line section, will be used to generate this double bunch structure with variable lengths and separation.

In this contribution particular emphasis is placed on the shaping of the double bunches in order to demonstrate stable and reproducible beam-driven PWFA. Furthermore, simulations of beam dynamics and the acceleration process in the plasma are presented.

AKBP 5.5 Di 17:30 NW-Bau - HS2

Influence of Laser Pulse Shape on Plasma-Accelerated Electron Beams — •Philipp Messner[1,2], Niels Delbos[1], Timo Eichner[1], Sören Jalas[1], Spencer Jolly[3], Manuel Kirchen[1], Vincent Leroux[3], Matthias Schnepp[1], Christian Werle[1], Paul Winkler[4], and Andreas R. Maier[1] — [1]Center for Free-Electron Laser Science, Hamburg, Germany — [2]Max Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany — [3]ELI Beamlines, Dolní Břežany, Czech Republic — [4]Deutsches Elektron-Synchrotron DESY, Hamburg, Germany

Laser-plasma accelerators have proven to be a compact source of ultra-relativistic electron beams, generating GeV beam energies over only a few centimeters. However, the laser-plasma interaction, and thus the phase-space of the generated electron beam, is very sensitive to the initial properties of the driver laser. Here, we present the impact of laser pulse properties, specifically the higher order phases of the laser pulse, on the electron beam properties. By tuning the magnitude of the second (GDD) and third-order (TOD) dispersion of our 200 TW laser pulse, we can optimize the laser parameters for enhanced electron beam quality.

AKBP 5.6 Di 17:45 NW-Bau - HS2

Commissioning of a Pump/Probe Beam for LUX — •Timo Eichner[1], Niels M. Delbos[1], Irene Dornmair[1], Björn Hubert[1], Lars Hübner[1], Sören Jalas[1], Spencer W. Jolly[1,2], Manuel Kirchen[1], Vincent Leroux[1,2], Sebastian Mahncke[1], Philipp Messner[1,3], Matthias Schnepp[1], Maximilian Trunk[1], Paul A. Walker[1,4], Christian Werle[1], Paul Winkler[1,4], and Andreas R. Maier[1] — [1]Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, Hamburg, Germany — [2]Institute of Physics of the ASCR, ELI-Beamlines project, Prague, Czech Republic — [3]Max-Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany — [4]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The LUX beamline is a novel laser-plasma accelerator, built in close collaboration of the University of Hamburg and DESY. Here, we report on the commissioning of a dedicated pump/probe beam for advanced diagnostics and first user experiments. Close to the plasma target we split 1% pulse energy off of the main 200 TW Angus driver laser and re-compress the beam using chirped mirrors. Timing stability was demonstrated to be better than few fs using cross-correlation in a BBO crystal. We will present the current status of the setup and discuss first experiments.

AKBP 5.7 Di 18:00 NW-Bau - HS2

Optimizing the efficiency of dielectric laser accelerators via the introduction of a distributed Bragg reflector and novel geometries — •Peyman Yousefi, Joshua McNeur, Martin Kozák, Norbert Schönenberger, and Peter Hommelhoff — Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Staudtstr. 1, 91058 Erlangen

Dielectric laser acceleration (DLA) enables miniaturized particle accelerators in the GeV/m gradient regime with the potential to open new applications from low energy medical irradiation devices to high energy fundamental physics [1]. It is based on the interaction of charged particles with a travelling longitudinal laser-induced near-field excited in the close vicinity of a dielectric nano-structure. Electrons with different energies have been effectively accelerated [2, 3] and studies on phase-controlled staging and focusing have brought this concept closer to its final configuration [4]. To realize longer interaction length over multiple stages, structures that efficiently convert the incoming laser field into the accelerating mode are critical. Here we experimentally present an electron acceleration with a dual pillar silicon grating using a distributed Bragg reflector (DBR). We address the effect of DBR on the acceleration gradient and also report on a new geometry of dual pillars for higher acceleration gradients in sub-relativistic regime.

1.England, R. J.et al. Rev.Mod. Phys. 86, 1337 (2014).
2.Peralta, E. A. et al. Nature 503, 91-94 (2013).
3.Breuer, J., Hommelhoff, P. Phys.Rev. Lett. 111, 134803 (2013).
4.McNeur, J et al., arXiv:1604.07684 [accelerator physics] (2016).

AKBP 5.8 Di 18:15 NW-Bau - HS2

Preparation of animal irradiation experiments with laser-accelerated protons and pulsed high-field magnets — •Florian-Emanuel Brack[1,2], Florian Kroll[1,2], Josefine Metzkes-Ng[1], Lieselotte Obst[1,2], Stephan Kraft[1], Hans-Peter Schlenvoigt[1], Lennart Gaus[1,2], Leonhard Karsch[1], Jörg Pawelke[1], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Germany

Laser-driven ion acceleration has been considered a potential alternative for conventional accelerators like cyclotrons or synchrotrons and thus could provide a more compact and cost-efficient particle therapy solution in the future. Instead of continuous ion beams, laser-driven ions exhibit fs to ps bunch length, carrying up to 10^{13} particles with broad energy spectrum and are highly divergent. Pulsed high-field magnets are a versatile and efficient way of shaping those bunches both spatially and spectrally for application, while preserving the short pulse lengths and high intensities leading to high dose rates when stopped in matter.

We performed experiments with the PW beam of the Dresden laser acceleration source Draco to investigate the feasibility of worldwide first controlled volumetric tumour irradiations with laser-accelerated protons. Therefore, a setup of up to two solenoid magnets was used to efficiently capture and shape the proton beam, matching the radiobiological demands, which was then analysed by means of a Thomson parabola spectrometer, ionization chamber and radiochromic film.