BE 3: New Accelerator Concepts

Time: Tuesday 9:30–12:30 Location: MOL 213

Invited Talk BE 3.1 Tue 9:30 MOL 213
Laser-Plasma Acceleration in Hamburg — •Andreas R. Maier — CFEL, Center for Free-Electron Laser Science

Laser-plasma accelerators promise ultra-compact sources of highly relativistic electron beams, especially suited for driving novel x-ray light sources. The stability and reproducability of laser-plasma generated beams however, is still not comparable to conventional machines. Within the LAOLA Collaboration, the University of Hamburg and DESY work closely together towards stable plasma-driven electron beams. In my talk, I will report on the recently commissioned 200 TW laser ANGUS and new beamlines currently being set up in Hamburg, and will review experimental activities, including external injection, and plasma-driven undulators.

BE 3.2 Tue 10:00 MOL 213
Diagnostik-Beamline mit Transversal-Gradient-Undulator am Laser-Wakefield-Beschleuniger in Jena — •Christina Widmann[1], Veronica Afonso Rodriguez[1], Axel Bernhard[1], Robert Rossmanith[1], Walter Werner[1], Anke-Susanne Müller[1], Maria Nicolai[2], Alexander Sävert[2], Malte Kaluza[2,3] und Maria Reuter[3] — [1]Karlsruher Institut für Technologie (KIT) — [2]Friedrich-Schiller-Universität Jena — [3]Helmholtz-Institut Jena

Zur Erzeugung von monochromatischer Undulatorstrahlung an Laser-Wakefield-Beschleunigern (LWFA) können Transversal-Gradient-Undualtoren (TGU) eingesetzt werden. Am LWFA in Jena wird auf Basis eines supraleitenden, zylindrischen TGU eine Diagnostik-Beamline aufgebaut: In einer dispersiven Schikane aus normalleitenden Strahlführungsmagneten werden die Bunche des LWFA energetisch aufgespalten und auf das Feld des Undulators abgestimmt.

In diesem Vortrag wird der aktuelle Stand des Projekts mit ersten Tests der verschiedenen Komponenten vorgestellt.

Gefördert durch das BMBF unter Fördernummer 05K10VK2 und 05K10SJ2.

BE 3.3 Tue 10:15 MOL 213
Simulation der Strahlung von Elektronen in einem zylindrischen TG-Undulator — •Nils Braun[1], Verónica Afonso Rodríguez[1], Axel Bernhard[1], Peter Peiffer[1], Robert Rossmanith[1], Christina Widmann[1], Tilo Baumbach[1] und Michael Scheer[2] — [1]Karlsruher Institut für Technologie (KIT) — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH

Die Laser-Wakefield-Beschleunigung (LWFA) bietet die Möglichkeit, innerhalb kurzer Strecken eine hohe Beschleunigung der Elektronen zu erreichen bei zugleich sehr kurzer Impulslänge. Gerade für die zukünftige Verwendung in Freie-Elektronen-Lasern (FEL) ist jedoch die große Energiebandbreite des Elektronenstrahls problematisch.

In einem Transversal-Gradient-Undulator kann ein energetisch aufgespaltener Elektronenstrahl monochromatische Strahlung produzieren. Die grundsätzliche Funktionsweise dieses Prinzips wurde nun erstmals durch die Simulation des Spektrums der spontanen Undulatorstrahlung bestätigt.

Projekt teilgefördert durch das BMBF unter Förderkennz. 05K10VK2

BE 3.4 Tue 10:30 MOL 213
Synthetic Diagnostics of Radiation Phenomena in the Particle-in-Cell Code PIConGPU — •Richard Pausch, Michael Bussmann, Heiko Burau, Alexander Debus, Axel Huebl, Arie Irman, Ulrich Schramm, and René Widera — Helmholtz-Zentrum Dresden-Rossendorf

Synthetic diagnostics in particle-in-cell codes provide physical quantities to the scientist that can be directly compared to experiment. We present simulations of laser-wakefield acceleration of electrons and on the dynamics of the relativistic Kelvin-Helmholtz Instability using the code PIConGPU. With PIConGPU it is possible to compute the radiation of every single electron in the simulation caused by acceleration by computing the Lienard-Wiechert Potentials, including both coherent and incoherent radiation. With GPU-accelerated codes Petaflop performance has become possible.

BE 3.5 Tue 10:45 MOL 213
On the plasma lens effect in a hybrid plasma accelerator — •Thomas Heinemann[1], Oliver Karger[1], Constantin Aniculaesei[1], Bernhard Hidding[1,2], and Stephan Kuschel[3] — [1]Universität Hamburg, Germany — [2]University of Strathclyde, United Kingdom — [3]Universität Jena, Germany

An electron bunch propagating into and through a plasma is influenced by various incarnations of the plasma lens effect. Such a plasma lens can operate as a focusing, as well as a deflecting device and is of significant relevance for plasma accelerators. Therefore, experiments at FLAME (Frascati Laser for Acceleration and Multidisciplinary Experiments) and JETI (Jena-Titan-Saphir-Laser) are introduced, measuring the influence of a plasma lens on an electron beam created using the laser wakefield acceleration technique. Those experiments include a hybrid plasma accelerator scheme with two consecutive plasma stages. The first stage generates an electron beam, whereas the second stage operates as a plasma lens.

15 min. break

Invited Talk BE 3.6 Tue 11:15 MOL 213
Laser acceleration of electrons at a dielectric grating structure — •Peter Hommelhoff — Physikdepartment, Friedrich-Alexander-Universität Erlangen-Nürnberg und MPI f. Quantenoptik, Garching

In free space acceleration of charged massive particles with alternating (optical) fields works only over distances as small as the driving wavelength, or is inefficient (higher order effects). However, with proper boundary conditions the acceleration with alternating fields can become efficient, over infinite distances. We will present results on the acceleration of electrons with the optical electric field of 800-nm 100-fs laser pulses at a dielectric grating structure. We employ the third spatial harmonic (grating period of 750nm) to accelerate non-relativistic 30-keV electrons and observe an acceleration gradient of up to 25 MeV/m, already matching the gradient of nowadays large-scale accelerators. With similar laser parameters and relativistic electrons the acceleration becomes more efficient and translates into a gradient of 1 GeV/m. We will present experimental and simulation results as well as an extended outlook on dielectric laser acceleration and manipulation of charged particles, including a discussion of the required ultra-low emittance electron beam properties.

BE 3.7 Tue 11:45 MOL 213
HiPACE simulations of self-modulation of the PITZ electron beam — •Gaurav Pathak[1,2], Matthias Gross[2], Mikhail Krasilinikov[2], Timon Mehrling[2], Jens Osterhoff[1,2], and Frank Stephan[2] — [1]Universität Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron , Germany

In a proposed experiment a plasma oven will be setup in the Photo Injector Test Facility at DESY, Zeuthen Site (PITZ), beam line to study the self-modulation of electron beams when they pass through a laser generated plasma.

For better understanding of the physical process, a set of numerical simulations with the Quasi-Static Particle-in-Cell code, HiPACE, has been carried out. The simulations also help to optimize the beam and plasma parameters that suits best for the experiment. The particular interest is to observe the energy modulation induced into the beam itself by means of the generated wakefields in the plasma. It will reflect the key properties of the accelerating electric fields such as their magnitude and phase velocity, both of significant importance in the design of experiments relying on the underlying physics processes.

BE 3.8 Tue 12:00 MOL 213
Towards high transformer ratios for plasma wakefield acceleration at PITZ — •Galina Asova[1], Anne Oppelt[2], Frank Stephan[2], and Thomas Vinatier[3] — [1]INRNE-BAS, Sofia, Bulgaria — [2]DESY, Zeuthen, Germany — [3]LAL, Orsay, France

In the middle of 2014 the Photo-Injector Test facility at DESY, Zeuthen site, will be extended with a plasma chamber that will be used to study plasma wakefield acceleration, starting with the self-modulation of the electron beam in the plasma. Later on, an electron bunch constituted out of four Gaussian sub-pulses with ramped charge structure will be used to resonantly drive the plasma wave accelerating a trailing probe pulse within the same bunch. The stacked pulse structure with increasing charge gives the possibility to reach high transformer ratios for the energy transfer to the probe pulse.

In order to achieve high-density plasma waves those pulses need to be longitudinally compressed before entering the plasma which imposes stringent requirements towards the longitudinal parameters of the electron bunch. This work concentrates on the possibilities to preserve the ramped charge structure from the photocathode until the bunch compressor while satisfying in the best manner the requirements of the bunch compressor.

BE 3.9 Tue 12:15 MOL 213

Controlled injection of plasma electrons into a beam-driven wakefield using the density down-ramp technique at Facility for Advanced Accelerator Experimental Tests (FACET) — •Olena Kononenko, Christopher Behrens, John Dale, Julia Grebenyuk, Vladyslav Libov, Timon Mehrling, Alberto Martinez de la Ossa, Halil Olgun, Charlotte Palmer, Lucas Schaper, and Jens Osterhoff — DESY, Hamburg, Germany

Plasma wakefields can sustain high field gradients (> 10 GV/m) allowing particle acceleration to ultrarelativistic energies over small distances (few mm). Control over the electron bunch phase-space during the process of injection into the accelerating wakefield is of crucial importance for the production of electron beams in plasma-based schemes. Shaping of the longitudinal plasma-density profile has been proposed as a method of achieving controlled injection. In this report, we describe the study of density down-ramp injection into a beam-driven plasma wakefield which will be explored at the FACET facility.

For the planned experiments at FACET, suitable target density profiles with a low-density plateau region, preceded by a high-density peak are required. The basic target is designed as a capillary tube with inlets along its length. The peak region is achieved by an external gas jet. This gas jet must be operated in pulsed mode to reduce the gas load into the main vacuum of FACET.

Here the goals and preparation for the experiment are presented, including particle-in-cell and hydrodynamic simulations of the tailored target.