T 115: Beschleunigerphysik II (PWA I)

Zeit: Montag 11:00–13:00 Raum: WIL-C205

T 115.1 Mo 11:00 WIL-C205

Design und Optimierung der Elektronenstrahlführung für den Laser-Wakefield-Beschleuniger in Jena - Teil 2 — •Bastian Härer, Veronica Afonso Rodriguez, Tilo Baumbach, Axel Bernhard, Peter Peiffer, Robert Rossmanith, Walter Werner und Christina Widmann — KIT, Germany

Laser-Wakefield-Beschleuniger (LWFA) erzeugen kurze Elektronenpakete, haben aber eine große Energiebandbreite und Divergenz. Deshalb gestaltet sich der Transport dieser Elektronenpakete schwierig.

Für eine Diagnostik-Beamline am LWFA in Jena muss der Elektronenstrahl vom Beschleuniger zu einem Undulator geführt werden. Eine dispersive Schikane spaltet die Elektronen nach ihrer Energie auf. Diese Aufspaltung wird an die x-abhängige Magnetfeldamplitude des nicht-planaren Undulators angepasst. Auf diese Weise ist die Erzeugung monochromatischer Undulatorstrahlung möglich. Die Herausforderung beim Design der Strahlführung besteht darin, die für den Undulator notwenigen Strahlparameter für ein großes Energieintervall zu gewährleisten. In linearer Näherung ist die Strahlführung bereits optimiert. Zur Fokussierung werden starke Quadrupolfelder benötigt. Wegen der daraus resultierenden hohen chromatischen Fehler ist der Einsatz von Sextupolen unverzichtbar.

In diesem Vortrag wird das Design der Strahlführung mit Combined-Function-Magneten unter Berücksichtigung der chromatischen Korrektur vorgestellt. Außerdem wird die Stabilität der Strahlführung hinsichtlich der Positionier- und Feldfehler der Magnete diskutiert.

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T 115.2 Mo 11:15 WIL-C205

Laser-Based Discharge Ignition for Capillary Waveguides — •Lars Goldberg[1], Lucas Schaper[2], Tobias Kleinwächter[2], Jan-Patrick Schwinkendorf[2], Matthias Schnepp[1], and Jens Osterhoff[2] — [1]Universität Hamburg — [2]DESY Hamburg

Highly energetic electron beams are required for various applications such as free-electron lasers and particle colliders. Nowadays these beams are almost exclusively produced in conventional radiofrequency-cavities, which are limited to typical acceleration gradients below 50MV/m. Hence long machines on the order of 100m are required to reach the desired energies. Laser-wakefield accelerators in plasma on the other hand are capable of providing acceleration gradients well above 10GV/m, thereby allowing for much more compact devices on scales of centimeters.

Currently, plasma-based devices are rapidly evolving and improving, but still suffer from instabilities in the generated electron-beam properties, largely due to shot-to-shot variations of laser and plasma parameters. In order to minimize possible sources for these fluctuations, a novel, more stable technique for shaping the transverse plasma-density profile in a plasma accelerator based on laser triggering and ignition of capillary discharge waveguides is presented.

T 115.3 Mo 11:30 WIL-C205

Prompt pre-thermal laser ion sheath acceleration with ultra-short laser pulses — •Karl Zeil, Michael Bussmann, Thomas Cowan, Thomas Kluge, Stephan Kraft, Josefine Metzkes, and Ulrich Schramm — Helmholtz-Zentrum Dresden-Rossendorf, Germany

Recent laser-ion acceleration experiments performed at the 150 TW Draco laser in Dresden, Germany, have demonstrated the importance of a precise understanding of the electron dynamics in solids on an ultra-short time scale. For example, with ultra-short laser pulses a description based purely on the evolution of a thermal electron ensemble, as in standard TNSA models, is not sufficient anymore. Rather, non-thermal effects during the ultra-short intra-pulse phase of laser-electron interaction in solids become important for the acceleration of ions when the laser pulse duration is in the order of only a few tens of femtoseconds. While the established maximum ion energy scaling in the TNSA regime goes with the square root of the laser intensity, for such ultra short pulse durations the maximum ion energy is found to scale linear with laser intensity, motivating the interest in such laser systems. Investigating the influence of laser pulse contrast, laser polarization and laser incidence angle on the proton maximum energy and angular distribution, we present recent advances in the description of the laser interaction with solids, focusing on the implications of intra-pulse non-thermal phenomena on the ion acceleration.

T 115.4 Mo 11:45 WIL-C205

Simulating electromagnetic radiation from laser-wakefield acceleration plasmas — •Richard Pausch, Alexander Debus, René Widera, and Michael Bussmann — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Measuring the transient plasma density structures of Laser-wakefield accelerators (LWFA) that are shorter than the drive laser on a μm-fs-scale is experimentally challenging, which complicates comparisons the of these results with numerical models from 3D-PIC simulations. Radiation spectra from LWFA plasmas on the other hand are straightforward to measure, but hard to calculate in realistic detail because it is computationally expensive (both CPU and memory) to calculate the radiation emitted by a complete PIC simulation. However, it would be very useful to know where to look for "good" radiation signatures that show quantitative details on the electron dynamics at electron injection.

Here we present a highly-scalable, classical radiation code based on Liénard-Wiechert potentials, which runs on high-performance computing clusters using GPUs. The memory and disk-space footprint is reduced by directly integrating into the 3D-PIC code PicOnGPU. With this new code, it is possible to calculate logarithmic-scaled spectra from IR to X-ray wavelengths in arbitrary observation directions. In this talk we put the emphasis on the code architecture, the verification of the physics and on some first results.

T 115.5 Mo 12:00 WIL-C205

Two Screen Dipole Spectrometer for Laser Wake Field Accelerators — •Paul Winkler, Andreas Maier, and Florian Grüner — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

Today's Laser-plasma-accelerators have high shot to shot energy spread, divergence and pointing fluctuations, but the mean beam energy is one of the most important parameters of any accelerator experiment. It has major impact on many accelerator applications and has to be well known in order to understand further results. An initial deflection angle of the beam from the design axes can yield a big error in energy measurement using a usual (one screen) dipole spectrometer. Two-screen-Dipole-Spectrometers (TSDS) enable to measure the mean beam energy and initial deflection angle separately by using a second screen in order to measure the beam position and direction of momentum behind the dipole.

The talk aims to demonstrate methods to describe particle trajectories through TSDS' of relativistic particles that enter the dipole with initial deflection angles. In particular, optimal screen arrangements, that result a maximum resolution in energy and deflection angle measurement, shall be presented. Furthermore, TSDS' enable separate energy spread and divergence measurement for sufficient resolution in energy and deflection angle measurement.

T 115.6 Mo 12:15 WIL-C205

PIConGPU - A Highly-Scalable Particle-in-Cell Implementation for GPU Clusters — •Michael Bussmann[1], Heiko Burau[1], Alexander Debus[1], Axel Hübl[1], Thomas Kluge[1], Richard Pausch[1], Nils Schmeisser[1], Benjamin Schneider[1,2], Klaus Steiniger[1], Rene Widera[1], Nikolai Wyderka[1], Ulrich Schramm[1], Thomas Cowan[1], Felix Schmitt[3], Sebastian Grottel[2], Stefan Gumhold[2], Guido Juckeland[2,4] und Wolfgang Angel[2,4] — [1]HZDR, Dresden — [2]TU Dresden — [3]NVIDIA, Austin — [4]ZIH, Dresden

PIConGPU can handle large-scale simulations of laser plasma and astrophysical plasma dynamics on GPU clusters with thousands of GPUs. High data throughput allows to conduct large parameter surveys but makes it necessary to rethink data analysis and look for new ways of analyzing large simulation data sets. The speedup seen on GPUs enables scientists to add physical effects to their code that up until recently have been too computationally demanding. We present recent results obtained with PIConGPU, discuss scaling behaviour, the most important building blocks of the code and new physics modules recently added. In addition we give an outlook on data analysis, resiliance and load balancing with PIConGPU.

T 115.7 Mo 12:30 WIL-C205

High-intensity lasers for particle physics — Markus Büscher[1], Mirela Cerchez[3], •Ilhan Engin[1], Paul Gibbon[2], Patrick Greven[1], Astrid Holler[1], Anupam Karmakar[2], Giorgi Kukhalashvili[1], Andreas Lehrach[1], Toma Toncian[3], and Oswald Willi[3] — [1]Institut für Kernphysik (IKP) and Jülich Center for Hadron Physics (JCHP), Forschungszentrum Jülich — [2]Jülich Supercomputing Center (JSC), Forschungszentrum Jülich — [3]Institut für Laser-Plasma Physik (ILPP), Heinrich Heine Universität Düsseldorf

The physics of laser driven particle sources has undergone dramatic developments in recent years. However, it is yet an untouched issue whether laser-induced particle acceleration can be used to realize polarized particle sources. Due to the huge magnetic field gradients during the exposure to laser light (hundreds of Megagauss per micrometer), a coupling to the magnetic moments of the accelerated particles and, thus, an alignment or selection of certain spin states seems feasible.

First polarization measurements of laser-accelerated particles have been carried out at the 300 TW Düsseldorf ARCturus laser facility, where few-MeV protons were produced in thin foil targets. The spin dependence of the differential cross section in a hadronic scattering reaction gives access to the degree of polarization of the laser-accelerated protons. Further target concepts, *e.g.* ^{4}He and polarized ^{3}He gas jets or a H_2 cluster-gas mixture, will be applied in order to optimize the degree of polarization as well as the energies of laser-accelerated particle beams.

T 115.8 Mo 12:45 WIL-C205

Status of a Cylindrical Superconducting Undulator for the Laser Wakefield Accelerator in Jena — •Veronica Afonso Rodriguez[1], Axel Bernhard[1], Andreas Grau[1], Bastian Härer[1], Peter Peiffer[1], Robert Rossmanith[1], Marc Weber[1], Christina Widmann[1], Malte Kaluza[2], Maria Nicolai[2], Thorsten Rinck[2], Alexander Sävert[2], Oliver Jäckel[3], and Maria Reuter[3] — [1]KIT, Karlsruhe, Germany — [2]Friedrich Schiller University Jena, Jena, Germany — [3]Helmholtz Institute Jena, Jena, Germany

Laser-Wakefield accelerators (LWFA) produce electron bunches with several 100 MeV energy within a few millimeters acceleration length, however, with a relatively large energy spread (a few percent). Undulators provide monochromatic radiation with high brilliance. The working principle of undulators requires a small energy spread of the electron beam in the order of 0.1 %. To produce monochromatic undulator radiation with LWF accelerated electrons, a novel iron-free cylindrical superconducting undulator (SCU) is under development at the KIT. This talk will give an overview about the design and the optimisation of the SCU tailored to the particular beam properties of the JETI-LWFA at the University of Jena. In addition a short model test and the construction status of the full scale undulator will be shown. Acknowledgment: this work is funded by the German Federal Ministry for Education and Research under contract no. 05K10VK2 and 05K10SJ2.