AKBP 2: PWA / TNSA I

Zeit: Montag 14:00–16:00 Raum: BZ.08.04 (HS 2)

AKBP 2.1 Mo 14:00 BZ.08.04 (HS 2)

Beam Optics for Laser Wake Field Accelerators — •Paul Winkler[1,2], Winfried Decking[3], Bernward Krause[3], Klaus Floettmann[3], and Andreas R. Maier[1,2] — [1]CFEL, Center for Free-Electron Laser Science, 22607 Hamburg — [2]University of Hamburg, Institute of Experimental Physics, 22761 Hamburg — [3]DESY, 22607 Hamburg

Laser wake field accelerators (LWFAs) offer a new technology to produce highly relativistic electron beams on a very compact scale. Nevertheless, beam qualities of today's LWFAs are not sufficient for applications. In particular, due to high energy spread and beam divergence, the emittance is not a conserved quantity.

The University of Hamburg, in close collaboration with DESY, is currently commissioning a dedicated beamline for laser wake field acceleration. The so called LUX experiment aims to achieve particle energies of about 400 MeV with 1 % energy spread and 1 mrad beam divergence. A compact quadrupole doublet is required in order to focus the beam, thereby reduce emittance growth, and then transport the beam through a miniature undulator.

In the talk, the design and construction of an electromagnetic quadrupole doublet is presented. With simple modifications the gradients of existing quadrupoles were increased by 50 % up to 150 T/m.

AKBP 2.2 Mo 14:15 BZ.08.04 (HS 2)

Highly sensitive pulsed spectrometer for laser excited and field extracted electrons — •Stephan Mingels, Vitali Porshyn, Dirk Lützenkirchen-Hecht, and Günter Müller — Physics Department, University of Wuppertal

We have completed an ultra-high vacuum system for investigations of cathodes in a triode configuration under high electric fields E (up to ∼100 MV/m) and pulsed tunable laser illumination (3.5 ns, 10 Hz, $h\nu$=0.5-5.9 eV, >0.3 mJ) [1]. Measurements of the cathode current by a picoammeter and of the electron energy by a spectrometer for DC as well as laser-pulsed beams are enabled. The cathodes can be 3D-positioned with μm precision and cooled or heated in the range of 77-400 K. System commissioning with DC field emission from a W tip yielded a work function ϕ of 4.7 eV and a spectrometer resolution of <10 meV. Precise determination of the emitter temperature from the spectra at low currents (down to 60 nA) demonstrated the high sensitivity of the system. The suitability for laser-pulsed beams was shown with photoemission from a n-GaP(100) wafer. Quantum efficiency $QE(h\nu)$ measurements at low E revealed expected band structure effects and ϕ values of 3.5-4.6 eV depending on the actual oxide layer. In order to develop novel highly brilliant electron sources, the suitability of various materials for photo-induced field emission by indirect ($QE(h\nu, E)$) and direct electron spectroscopy will be performed next.

[1] S. Mingels et al., submitted to Rev. Sci. Instrum.

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AKBP 2.3 Mo 14:30 BZ.08.04 (HS 2)

Generation of intense sub-nanosecond proton bunches with a novel laser-driven beamline concept — •Diana Jahn[1], Simon Busold[2,3], Dennis Schumacher[2], Christian Brabetz[2], Florian Kroll[4], Abel Blazevic[2,3], Vincent Bagnoud[2,3], and Markus Roth[1] — [1]Technische Universität Darmstadt, Darmstadt, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Darmstadt — [3]Helmholtz-Institut Jena, Jena, Deutschland — [4]Helmholtzzentrum Dresden Rossendorf

In the context of the Laser Ion Generation, Handling and Transport (LIGHT) research project at GSI, laser-driven ion acceleration and beam shaping are explored, combining a target normal sheath acceleration (TNSA) proton source with conventional accelerator technology. Therefore, an ion test beamline was built at the Z6 experimental area. In the LIGHT experimental campaign in 2014, protons were accelerated via the TNSA mechanism, an energy of 7.8 MeV was selected and collimated with a pulsed solenoid and injected into a rf cavity. Through phase focusing, temporally compressed proton bunches were generated to a pulse length of <500 ps (FWHM) with up to $5 \cdot 10^8$ particles in a single bunch at a distance of 6 m from the source.

AKBP 2.4 Mo 14:45 BZ.08.04 (HS 2)

Plasma wakefield generated by a modulated electron beam — •Roberto Martorelli — Institut für Theoretische Physik I, Heinrich-Heine-Universität, Düsseldorf

Particle beams have a number of important applications, from medicine to high energy physics. The capabilities of the actual technology is limited and this results in the huge dimensions of the accelerators. One promising alternative to RF accelerators is the plasma wakefield acceleration, due to the high acceleration gradients the plasma can sustain. In a plasma wakefield, a driver - laser or particle beam - is injected in a plasma channel, exciting the Langmuir waves. The electric field associated with the wakefield can be used for the acceleration of a witness bunch.

Our work is focused on the wakefield driven by a modulated electron beam. The main research consists in finding the proper conditions for the train of bunches in order to obtain a higher transformer ratio (TR), defined as the ratio between the maximum accelerating electric field behind the driver and the maximum decelerating electric field inside the driver. Through a semi-analytical approach, combined with particle-in-cell simulations, we look for the proper initial configuration for the train of beams in order to maximize the TR, analysing subsequently the stability of the beams while propagating into the plasma.

AKBP 2.5 Mo 15:00 BZ.08.04 (HS 2)

Ion Acceleration at the POLARIS-Laser with ultra high Contrast and ultra thin Foils — •Jan Reislöhner[1], Georg Becker[1], Jens Polz[1], Lennart Bock[1], Andreas Seidel[1], Stephan Kuschel[1,2], Marco Hornung[1,2], Hartmut Liebetrau[1], Alexander Kessler[1,2], Frank Schorcht[2], Marco Hellwing[1], Wenjun Ma[3], Jianhui Bin[3], Jörg Schreiber[3,4], Matthew Zepf[1,2], and Malte Kaluza[1,2] — [1]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität Jena — [2]Helmholtz-Institut Jena — [3]Fakultät für Physik, LMU München — [4]Max-Planck-Institut für Quantenoptik

The petawatt-class laser system POLARIS in Jena has been developed and continuously improved within the last two decades. For Laser induced ion acceleration the contrast of the laser is of crucial importance. The amplified spontaneous emission (ASE) and prepulses of high power lasers, such as POLARIS, create a preplasma on the target nanoseconds before the main pulse arrives. In the case of ultra thin foils with thicknesses of a few nanometers, it is essential that the main pulse ionizes the target. Therefore, the contrast was improved by adding an XPW stage in a double CPA setup. And it was further improved via second harmonic generation of the main laser pulses in a nonlinear crystal. The second harmonic pulses were then focused onto targets with thicknesses in the range of 5 nm to 1000 nm. The aim of this talk is to explain the experiment and to discuss the results.

AKBP 2.6 Mo 15:15 BZ.08.04 (HS 2)

Scaling of ultra-intense laser generated hot electron current and heating — •Thomas Kluge[1], Michael Bussmann[1], Lingen Huang[1], Thomas Cowan[2], and Ulrich Schramm[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Helmholtz-Zentrum Dresden-Rossendorf und TU-Dresden

We study the generation of hot electron currents in solid targets that are generated when an ultra-intense laser beam interacts with the solid. Simulations were performed with highly idealized parameters in order to allow direct comparison to existing and new models that often assume idealized conditions. We compare our results with popular existing scaling laws and show for example that the simple scaling j~gamma*n_c does not apply, especially when the electron energy is derived from the ponderomotive or similar scalings or when the laser intensity is large. We demonstrate the impact of correctly modeling the hot eletron current including its temporal structure on bulk electron heating and finally build a model that is in almost perfect agreement with simulations.

AKBP 2.7 Mo 15:30 BZ.08.04 (HS 2)

Reflective probing of laser-driven plasma for ion acceleration — •Martin Rehwald[1,2], Josefine Metzkes[1,2], Karl Zeil[1], Stephan Kraft[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]Technische Universität Dresden

Plasmas driven by intense, ultra-short laser pulses can support electrical field strengths of up to TV/m, making this concept promising for compact particle accelerators in which ions can gain MeV energies on a micrometer scale. For the acceleration, the laser pulse is focused onto a thin target which quickly ionized and transformed into a plasma in which electrons gain MeV energies in the laser field. These electrons leave the target volume and thereby create quasi-static charge-separation fields along the target surfaces in which the ion acceleration takes place. The acceleration is strongly influenced by the plasma conditions at the target during the main pulse interaction, which are determined by light preceding the intense main pulse or by the rising edge of the main pulse itself.

In this talk, we present a reflective pump probe method which allows to temporally resolve the lateral and longitudinal expansion of the critical plasma density. First experimental results with a pure imaging technique will be shown, in which the front and rear surface plasma were characterized. This technique is currently developed to include interferometry, in that way increasing the sensitivity in longitudinal direction. We will discuss the simulation results and a corresponding experimental setup.

AKBP 2.8 Mo 15:45 BZ.08.04 (HS 2)

Observation of collective deceleration of electrons from laser wakefield acceleration — •Shao-wei Chou[1,2], Jaincai Xu[1], Konstantin Khrennikov[2], Laszlo Veisz[1], and Stefan Karsch[1,2] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermannstr. 1, D-85748 Garching, Germany — [2]Ludwig-Maximilians-Universität, Am Coulombwall 1, D-85748 Garching, Germany

Electrons from Laser Wakefield Acceleration (LWFA) have been shown having an ultra-short, sub-5 fs temporal structure accompanying with a small transverse initial size. These electron bunches can drive a wakefield efficiently in an underdense plasma and lose their energy. We used ATLAS, a Ti:Sapphire based 100 TW laser as a driver for LWFA. A target for electron generation included a 0.3 mm diameter supersonic helium gas jet with shock front injection, and another 1.5 mm gas jet was used as a target for electron deceleration. The measurement has shown that the electron energy as well as the total bunch charge were dumped under certain conditions almost completely (>90%) right after insertion of second jet. This effect was observed even with several mm separations between two jets. The divergence (~8 mrad) and total charge (~30 pC) from the first jet made an ideal bunch for driving plasma wave in second jet. The observed peak deceleration gradient was up to 23.7 GeV/m and 5.1 GeV/m in average. We interpret the observation by collective deceleration. Our measurement has demonstrated the feasibility of an efficient potential driver for particle-driven plasma wakefield acceleration as well as a compact beam dump for the future development the LWFA application.