T 121: Beschleunigerphysik VIII (PWA II)

Zeit: Dienstag 14:00–16:15 Raum: WIL-C205

T 121.1 Di 14:00 WIL-C205

Kompakte Combined-Function-Quadrupol-Sextupol-Magnete für die Elektronstrahlführung am JETI-Wakefield-Beschleuniger — •Walter Werner, Veronica Afonso Rodriguez, Tilo Baumbach, Axel Bernhard, Bastian Härer, Peter Peiffer, Robert Rossmanith und Christina Widmann — KIT, Karlsruhe, Deutschland

Laser-Wakefield-Beschleuniger (LWFA) erzeugt kurze Elektronenpakete, mit einer relativ großen Energiebandbreite und Divergenz. Der Transport von Elektronenpaketen mit diesen Eigenschaften erfordert stark fokussierende Magnete mit chromatischer Korrektur. Für die Realisierung einer kompakten Strahlführung am JETI-Wakefield-Beschleuniger in Jena sind Combined-Function (CF) Quadrupol-Sextupol-Magnete vorgesehen.

Die Realisierung der hohen Quadrupol- und Sextupol-Stärken erfordert kleine magnetische Aperturen. Deshalb werden die Magnete im Vakuum aufgebaut, woraus sich besondere Anforderungen an die Kühlung der Spulen ergeben.

In diesem Vortrag werden Ergebnisse der magnetischen Modellierung und Optimierung der CF-Quadrupol-Sextupol-Magnete vorgestellt. Außerdem wird die Kühlung der Spulen im Vakuum diskutiert.

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T 121.2 Di 14:15 WIL-C205

Design und Optimierung einer Elektronenstrahlführung für den Laser-Wakefield-Beschleuniger in Jena - Teil 1 — •Christina Widmann[1], Veronica Afonso Rodriguez[1], Axel Bernhard[1], Bastian Härer[1], Peter Peiffer[1], Robert Rossmanith[1], Walter Werner[1], Tilo Baumbach[1], Maria Nicolai[2], Thorsten Rinck[2], Alexander Sävert[2], Malte C. Kaluza[2,3], Maria Reuter[3] und Oliver Jäckel[3] — [1]Karlsruher Institut für Technologie (KIT) — [2]Friedrich-Schiller-Universität Jena — [3]Helmholtz-Institut Jena

Der Transport von Elektronen aus einem Laser-Wakefield-Beschleuniger (LWFA) gestaltet sich durch die hohe Energiebandbreite und Divergenz schwierig. Die Divergenz im Bereich von wenigen Milliradiant erfordert Quadrupole mit hohen Gradienten. Wegen der relativen Energiebandbreite im Bereich einiger Prozent müssen die starken Quadrupole chromatisch korrigiert werden.

Am LWFA in Jena wird eine Diagnostik-Beamline aufgebaut, in der eine dispersive Schikane den LWFA mit einem nicht-planaren Undulator verbindet. Dabei wird am Eingang des Undulators die Dispersion in x an dessen x-abhängigen Feldgradienten angepasst, um trotz der hohen Energiebandbreite monochromatische Undulatorstrahlung zu erzeugen. Außderdem müssen die Strahlparameter auf den Undulator abgestimmt werden.

In diesem Vortrag wird die Optimierung der Strahlführung in linearer Näherung diskutiert und eine mögliche Realisierung präsentiert.

Gefördert durch das BMBF (Fördernummer 05K10VK2, 05K10SJ2)

T 121.3 Di 14:30 WIL-C205

Trojan Horse Underdense Plasma Photocathode Acceleration — •Oliver Karger[1,2], Thomas Königstein[3], Georg Pretzler[3], James B. Rosenzweig[4], and Bernhard Hidding[1,2,4] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, FLA Arbeitsbereich Beschleunigerphysik, Hamburg — [3]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf — [4]Department of Physics and Astronomy, University of California, Los Angeles

Relativistic electron beams with small emittance and size are needed for advanced applications such as free electron lasers (FEL) and other coherent light sources in the x-ray regime. Present laser plasma acceleration schemes are hardly able to provide electron beams of sufficient quality on a stable level. The concept of underdense plasma photocathode acceleration uses a beam-driven plasma wave in a two component gas mixture consisting a low ionisation threshold medium (LIT) and a high ionisation threshold medium (HIT) and a low-energy laser pulse. Shapeable electron bunches with sub-fs-length and unprecedented normalized emittance down to 10^{-9} m rad can be produced. Based on this method, laboratory-sized-experimental setups may enable performance much better than today's conventional coherent hard x-ray sources. The presentation will discuss the basic concept, shows recent numeroanalytical results and the R&D towards experimental realization.

Reference: PRL 108, 035001 (2012)

T 121.4 Di 14:45 WIL-C205

Optimization of laser accelerated proton beams for possible applications — •Husam Al-Omari for the LIGHT-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt

Optimization of transported proton beams through a pulsed solenoid in the laser proton experiment LIGHT at GSI has been studied numerically. TraceWin, SRIM and ATIMA codes were employed for this study with an initial distribution generated by MATLAB program fitted to Phelix measured data. Two individual tools have been used to produce protons beam as a later beam source: an aperture located at the solenoid focal spot as energy selection tool; and a scattering foil at a suitable position in the beam path that smoothens the simulated radial energy imprint on the beam profile. The simulation results show that the proton energy spectrum is filtered by the aperture and the radial energy correlation is smoothened.

T 121.5 Di 15:00 WIL-C205

Experimental results on transport and focusing of laser accelerated protons — •Simon Busold[1], Dennis Schumacher[2], Christian Brabetz[3], Oliver Deppert[1], Martin Joost[4], Florian Kroll[4], Husam Al-Omari[3], Abel Blazevic[2], Bernhard Zielbauer[2], Ingo Hofmann[2], Vincent Bagnoud[2], Tom Cowan[4], and Markus Roth[1] for the LIGHT-Collaboration — [1]TU Darmstadt, IKP, Schlossgartenstr. 9, 64289 Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — [3]JWG Universität Frankfurt, IAP, Max von Laue Str. 1, 60438 Frankfurt — [4]Helmholtzzentrum Dresden-Rossendorf, Bautzner Landstr. 400, 01328 Dresden

Irradiation of thin foils with high-intensity laser pulses became a reliable tool during the last decade for producing high-intensity proton bunches in about a pico-second from a sub-millimeter source. However, the energy distribution is of an exponential shape with a currently achievable cut-off energy <100 MeV (TNSA mechanism) and the beam is highly divergent with an energy-dependent envelope-divergence of up to 60 deg. Thus, for most applications it is necessary to be able to capture and control these protons as well as select a specific energy.

In the frame of the LIGHT collaboration, experimental studies were done at the PHELIX laser at GSI Darmstadt using a pulsed high-field solenoid and alternatively a permanent magnet quadrupole triplet in order to match the beam for injection into a RF cavity. The beam was characterized at several distances after the source and the results are compared to particle tracking simulations.

T 121.6 Di 15:15 WIL-C205

Effects of the proton layer thickness on the TNSA — •Zsolt Lecz[1], Oliver Boine-Frankenheim[1,2], and Vladimir Kornilov[2] for the LIGHT-Collaboration — [1]TEMF, TU Darmstadt — [2]GSI, Darmstadt

This contribution to the LIGHT (Laser Ion Generation, Handling and Transport) project at GSI is devoted to the numerical investigation of the proton acceleration via the TNSA (Target Normal Sheath Acceleration) mechanism. We investigate the acceleration of protons, which are located in a thin hydrogen-rich contamination layer on the rear surface of a thin metal foil interacting with intense and short (several 100 fs) laser pulse. The highly energetic hot electrons, heated by the laser, induce a strong charge separation at the target surface. The spatial profile of the corresponding electric field is studied with a particle-in-cell (PIC) plasma simulation code. Depending on the thickness of the layer the protons can be accelerated in three different ways: quasi-static acceleration for mono-layers, isothermal plasma expansion for thick layers and there is a combined regime for intermediate thicknesses wich is not fully understood. Simulation results exploring this regime will be presented and the effect of the layer thickness on the transverse acceleration (divergence) will be discussed.

T 121.7 Di 15:30 WIL-C205

Considerations for a Higgs facility based on Laser Wakefield Acceleration — •Steffen Hillenbrand[1,2], Anke-Susanne Müller[2], and Ralph Assmann[3] — [1]CERN, Geneva, Switzerland —

[2]KIT, Karlsruhe, Germany — [3]DESY, Hamburg, Germany

Laser Wakefield Accelerators have seen tremendous progress over the last decades. It is hoped that they will allow to significantly reduce the size and cost of a future liner collider. Based on scaling laws, laser-driven plasma accelerators are investigated as drivers for smaller scale facilities capable of producing Z and Higgs bosons.

T 121.8 Di 15:45 WIL-C205

Merging Conventional and Laser Wakefield Accelerators — •Benno Zeitler[1,2], Matthias Schnepp[1,2], Tim Gehrke[1,2], Julia Grebenyuk[1], Timon Mehrling[1], Jens Osterhoff[1], Klaus Flöttmann[3], and Florian Grüner[1,2] — [1]Universität Hamburg — [2]Center for Free-Electron Laser Science — [3]Deutsches Elektronen-Synchrotron

Laser wakefield accelerators deliver high quality electron beams in terms of emittance and bunch length. However there are also parameters which cannot compete with conventional machines, namely spectral width and shot to shot stability.

One reason for that is that there is no direct access to the injection mechanism. Injecting a well-characterized electron beam produced by a conventional accelerator into a plasma wakefield could help to solve that problem, since such a pump-probe type experiment should allow for a direct reconstruction of the field distribution and a better understanding of the injection process.

REGAE at DESY in Hamburg is a suited accelerator for such a type of experiment. We report on the status of the beamline extension at REGAE and the plans towards the external injection project with the goal to directly measure the wakefield and further improve the stability of laser wakefield accelerators.

T 121.9 Di 16:00 WIL-C205

Bunching and phase focusing of laser generated proton beams — •Dennis Schumacher[1], Simon Busold[2], Christian Brabetz[3], Ingo Hofmann[1], Markus Roth[2], Bernhard Zielbauer[4], Oliver Boine-Frankenheim[2], Abel Blazevic[1], and Oliver Deppert[1] for the LIGHT-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]TU Darmstadt — [3]Universität Frankfurt — [4]HI Jena

Laser accelerated proton beams can reach very high intensities and very low emittances. Therefore they are suitable as ion sources for many applications. One is the coupling into common ion accelerator structures to replace pre accelerators that are used so far. The LIGHT (Laser Ion Generation, Handling and Transport) collaboration has been founded to develop ion optics and targets and optimize laser parameter to make this coupling most efficient. In a first step a short pulse beam line for the PHELIX-laser at GSI to the experiment site Z6 has been build in order to laser accelerate protons here. In a second step a pulsed solenoid has been established to collimate the divergent ion beam.

In a third step this collimated beam will be coupled into a bunching unit, which consists of a spiral resonator with three gaps which leads to an overall acceleration voltage of 1 MV. With this cavity it is not only possible to avoid the broadening of the pulse, but also to phase focus it. This talk presents also the progress towards the operation of the spiral resonator as buncher for a laser accelerated ion beam e.g. simulations, tests and performance data and shows the next steps of the beam shaping efforts.