AKBP 15: PWA and self modulation

Zeit: Donnerstag 16:30–18:30 Raum: S1/05 24

AKBP 15.1 Do 16:30 S1/05 24

Gasentladungszelle für Plasmabeschleunigungsexperimente am Photoinjektor-Teststand Zeuthen — •Gregor Loisch[1], Johannes Engel[1], Matthias Gross[1], Martin Hochberg[2], Gerald Koss[1], Mikhail Krasilnikov[1], Osip Lishilin[1], Anne Oppelt[1], Gaurav Pathak[1], Sebastian Philipp[1], Dieter Richter[3], Martin Sack[2] und Frank Stephan[1] — [1]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen — [2]Karlsruher Institut für Technologie KIT, Kaiserstraße 12, 76131 Karlsruhe — [3]Helmholtz-Zentrum Berlin HZB, Albert-Einstein-Straße 15, 12489 Berlin

Am Photoinjektor-Teststand PITZ in Zeuthen, DESYs Standort bei Berlin, sind Experimente in Vorbereitung, mit Hilfe derer theoretische Modelle der Plasmabeschleunigung experimentell untersucht werden sollen: zum einen die Selbstmodulation eines Teilchenstrahls in einer Plasmawelle, zum anderen die Beschleunigung von Teilchen bei hohem Transformationsverhältnis (Verhältnis von abgegebener Energie des Treibers zu aufgenommener Energie der beschleunigten Teilchen). Zusätzlich zum bereits realisierten Ansatz der Plasmaerzeugung in einem Metalldampfofen, wird hierfür eine Gasentladungszelle geplant, aufgebaut und vermessen. Diese bietet gegenüber den sehr komplexen Metalldampföfen einen vereinfachten Aufbau und einfache Handhabung, hat sich allerdings bisher noch nicht experimentell bewährt. Nach der Konstruktion und Inbetriebnahme sollen erste Diagnostikexperimente zeigen, ob die kapazitive Entladung in Argon bei niedrigem Druck die Anforderungen von 5% longitudinaler Homogenität bei einer Dichte von 10^{15} Elektronen pro Kubikzentimeter erfüllen kann.

AKBP 15.2 Do 16:45 S1/05 24

Electron windows studies for Self-Modulation Experiments at PITZ — •Osip Lishilin[1], Reinhard Brinkmann[2], Johannes Engel[1], Florian Gruener[3,4], Matthias Gross[1], Gerald Koss[1], Gregor Loisch[1], Sebastian Philipp[1], Gaurav Pathak[1], Dieter Richter[5], Carl Schroeder[6], Rico Schuetze[1], and Frank Stephan[1] — [1]DESY, Zeuthen, Germany — [2]DESY, Hamburg, Germany — [3]Universität Hamburg, Hamburg, Germany — [4]CFEL, Hamburg, Germany — [5]HZB, Berlin, Germany — [6]LBNL, Berkeley, USA

The self-modulation instability of long particle beams was proposed as a new mechanism to produce driver beams for proton driven plasma wakefield acceleration (PWFA). The PWFA experiment at the Photo Injector Test facility at DESY, Zeuthen site (PITZ) was launched to experimentally demonstrate and study the self-modulation of long electron beams in plasma. Key aspects for the experiment are the plasma cell of novel design, the flexible photocathode laser system and well-developed diagnostics at PITZ. The plasma cell is a cross-shaped lithium heat pipe oven with inert gas buffer zones at input/output ports. An ArF ionization laser is coupled through side ports for the plasma generation. Thin foils are mounted at the ends of the plasma cell to isolate plasma and buffer gas from the vacuum beamline, while the electron beam has to pass them with minimal distortion. This contribution presents an overview of the experimental setup and preparatory studies for the most suitable parameters of the electron windows as well as proposed improvements for the technical design of the setup.

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Gas Density Measurement for Self-Modulation Experiment at PITZ — •Gaurav Pathak[1], Matthias Gross[2], Osip Lishilin[1], Gregor Loisch[2], Johannes Engel[2], Sebastian Phiipp[2], and Frank Stephan[2] — [1]Universität Hamburg, Luruper Chaussee 149, D-22761, Germany — [2]Deutsches Elektronen-Synchrotron, Platanenallee 6, D-15738, Zeuthen, Germany

Since the time self-modulation (SM) of long charged particle beams has been proposed as an instrument for plasma wakefield acceleration it gained large attention to the physics community all around the world. Instrumental for this scheme is the SM of a long charged particle beam to generate bunchlets for resonant plasma wave excitation and efficient acceleration. The Photo-Injector Test Facility at DESY, Zeuthen site (PITZ) has set up an independent experiment for the proof of principle and detailed characterization of the effect.

In the experiment a plasma oven is placed in the PITZ beamline to study the SM. Plasma generated through single photon ionization relies on the Lithium (Li) gas density. This contribution presents the results of the Li gas density measurement for the PITZ plasma oven. The hook method, direct laser absorption and white light absorption method have been applied for the Li gas density measurement. The results show that with increase of buffer gas and of the Lithium amount independently, the Li gas density increases. The maximum Li gas density that has been achieved so far is which is 2 orders of magnitude less than the desired value.

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Theoretical and Experimental Studies of Plasma Channel Generation for Beam Driven Plasma Wakefield Accelerators — •Gabriele Tauscher[1], Alexander Aschikhin[1,2], John Dale[2], Jan-Hendrik Erbe[1,2], Lars Goldberg[1,2], Timon Mehrling[1], Lucas Schaper[2], Jan-Patrick Schwinkendorf[1,2], Matthew Streeter[2], Bernhard Schmidt[2], and Jens Osterhoff[2] — [1]University of Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Plasma-based wakefield acceleration is a promising approach in shrinking the size and cost of future particle accelerators and free-electron lasers. In the FLASHForward project a wakefield accelerator will be driven by an electron bunch from the FLASH accelerator while a multi-TW short pulse laser will pre-ionise a hydrogen gas target to form a plasma. Disentangling the processes of ionisation and wakefield driving enables improved control over the plasma density profiles and therefore over the structure of the wakefields crucially effecting the quality of the accelerated beams. To work out the electron density distribution in the target, we compute the ionisation rates of hydrogen molecules in strong laser fields. To be able to benchmark the predicted behaviour experimentally we also take into account the temporal and spatial laser-intensity profile evolution. The here developed understanding of the underlying processes of plasma generation ultimately allows for tailoring of the focusing geometry and laser-power-profile evolution to achieve desired plasma properties. As a proof of concept, we aim to realise plasmas with tailored shapes experimentally early 2016.

AKBP 15.5 Do 17:30 S1/05 24

Emittance conservation through tailored plasma ramps in PWFA scenarios — •Alexander Aschikhin, Alberto Martinez de la Ossa, Timon Mehrling, and Jens Osterhoff — Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg, Germany

The FLASHForward facility will offer unique capabilities or plasma-wakefield acceleration experiments. It uses high-quality beams from the FLASH accelerator to excite plasma wakefields for the exploration and improvement of novel and existing injection mechanisms.

The unique nature of the plasma environment creates several challenges with regard to the conservation of the beam quality, partially due to the strong focusing fields present in the blowout region following a driver beam in the highly nonlinear regime. The beta function of a beam needs to be matched into the wakefield in order to avoid severe growth of the beam emittance - a crucial quality parameter for beam transport, staging and applications.

Since the matched beta function is usually at least an order of magnitude lower than easily accessible for conventional accelerator optics, multiple schemes have been proposed to mitigate severe emittance growth by tailoring the plasma profile to adiabatically reduce the beta function to match the plasma wakefield.

We will focus on an introduction of these techniques, before presenting initial results from numerical and theoretical analyses for the typical FLASH beam parameter space.

AKBP 15.6 Do 17:45 S1/05 24

Single-shot betatron source size measurement from a laser-wakefield accelerator — •Alexander Köhler[1,2], Jurjen Couperus[1,2], Omid Zarini[1,2], Axel Jochmann[1], Arie Irman[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Bautzner Landstr. 400, 01328 Dresden — [2]Technische Universität Dresden, 01062 Dresden

Betatron radiation emitted by accelerated electrons in laser-wakefield accelerators can be used as a diagnostic tool to investigate electron dynamics during the acceleration process. We analyse the spectral characteristics of the emitted betatron pattern utilizing a 2D x-ray imaging spectroscopy technique. Together with simultaneously recorded electron spectra and x-ray images, the betatron source size, thus the electron beam radius, can be deduced at every shot.

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Reaching for highest ion beam intensities through laser ion acceleration and beam compression — •Dennis Schumacher[1], Diana Jahn[2], Johannes Ding[2], Christian Brabetz[1], Abel Blazevic[1], Vincent Bagnoud[1], Florian Kroll[3], Ulrich Schramm[3], Tom Cowan[3], Simon Weih[1], and Markus Roth[2] for the LIGHT-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]TU Darmstadt — [3]Helmholtzzentrum Dresden Rossendorf

Laser ion acceleration provides access to ion sources with unique properties. To use these capabilities the LIGHT collaboration (Laser Ion Generation Handling and Transport) was founded. The aim of this collaboration is the beam transport and manipulation of laser accelerated ions with conventional accelerator structures. Therefor a dedicated beam line has been build up at GSI Helmholtzzentrum für Schwerionenforschung. With this beam line the manipulation of the transversal and also the longitudinal beam parameters has been achieved. It has been shown that laser generated ion beams can be transported over more than 6 meters and pulses shorter than 300 ps can be generated at this distance. This Talk will give an overview over the recent developments and plans of the LIGHT collaboration.

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High-repetition-rate laser-proton acceleration from a condensed hydrogen jet — •Lieselotte Obst[1], Karl Zeil[1], Sebastian Göde[2], Josefine Metzkes[1], Hans-Peter Schlenvoigt[1], Maxence Gauthier[2], Martin Rehwald[1], Christian Rödel[2], Philipp Sommer[1], Michael MacDonald[2], Florian Brack[1], William Schumaker[2], Ulrich Schramm[1], and Siegfried Glenzer[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]SLAC National Accelerator Laboratory, Stanford, USA

Applications of laser-accelerated protons demand a stable source of energetic particles at high repetition rates. We present the results of our experimental campaign in cooperation with MEC/SLAC at the 10Hz Ti:Sa laser Draco of Helmholtz-Zentrum Dresden-Rossendorf (HZDR), employing a pure condensed hydrogen jet as a renewable target. Draco delivers pulses of 30 fs and 5 J at 800 nm, focused to a 3 μm spot by an F/2.5 off-axis parabolic mirror. The jet's nominal electron density is approximately 30 times the critical density and its thickness is 2 μm, 5 μm or 10 μm, depending on the applied aperture on the source. Ion diagnostics reveal mono-species proton acceleration in a solid angle of at least +/-45° with respect to the incoming laser beam, with maximum energies of around 5 MeV. The expanding jet could be monitored on-shot with a temporally synchronized probe beam perpendicular to the pump laser axis. Recorded probe images resemble those of z-pinch experiments with metal wires and indicate an m=0 instability in the plasma.