AKBP 2: New Accelerator Concepts

Zeit: Montag 16:00–18:00 Raum: NW-Bau - HS2

AKBP 2.1 Mo 16:00 NW-Bau - HS2

Generation of sub-nanosecond, intense proton bunches with the laser-driven LIGHT beamline and first imaging studies of a solid target — •Diana Jahn[1], Dennis Schumacher[2], Christian Brabetz[2], Johannes Ding[1], Rene Leonhardt[1], Florian-Emmanuel Brack[4,5], Florian Kroll[4,5], Abel Blazevic[2,3], Tom Cowan[4,5], Ulrich Schramm[4,5], and Markus Roth[1] — [1]TU Darmstadt, Darmstadt, Deutschland — [2]GSI, Darmstadt, Deutschland — [3]HI Jena, Jena, Deutschland — [4]HZDR, Dresden, Deutschland — [5]TU Dresden, Dresden, Deutschland

In the past two decades, the generation of intense ion beams based on laser-driven sources became an extensively investigated and promising field. The LIGHT collaboration combines a laser-driven proton source with conventional accelerator technology. Therefore, a laser-driven multi-MeV ion beamline at GSI Helmholtzzentrum für Schwerionenforschung was installed. Protons with an energy of 8 MeV are selected via chromatic focusing with a high-field solenoid from an exponentially decaying TNSA spectrum. Afterwards, they are injected into an rf cavity and temporally compressed through phase focusing into the subnanosecond regime. At the end of the beamline, a second solenoid was set up as a final focusing system. Newest focusing results and first imaging studies of a solid target will be presented.

AKBP 2.2 Mo 16:15 NW-Bau - HS2

Breaking the dephasing and depletion limits of laser-wakefield acceleration with Traveling-Wave Electron Acceleration — •Alexander Debus[1], Richard Pausch[1,2], Axel Hübl[1,2], Klaus Steiniger[1,2], René Widera[1], Tom Cowan[1,2], Ulrich Schramm[1,2], and Michael Bussmann[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf (HZDR), 5 Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

We show how to simultaneously solve several long standing limitations of laser-wakefield acceleration that have thus far prevented laser-plasma electron accelerators (LWFA) to extend into the energy realm beyond 10 GeV. Most prominently, our novel Traveling-Wave Electron Acceleration (TWEAC) approach eliminates both the dephasing and depletion constraints. The wakefield driver is a region of overlap of two obliquely incident, ultrashort laser pulses with tilted pulse-fronts in the line foci of two cylindrical mirrors, aligned to coincide with the trajectory of subsequently accelerated electrons. TWEAC leads to quasi-static acceleration conditions, which do not suffer from laser self-phase modulation, parasitic self-injection or other plasma instabilities. Particularly, and in contrast to LWFA and PWFA, a single TWEAC-stage can arbitrarily be extended in length to higher electron energies without changing the underlying acceleration mechanism. We introduce the new acceleration scheme, show results from 3D particle-in-cell simulations using PIConGPU, discuss energy scalability for both laser and electrons and elaborate on experimental realization requirements.

AKBP 2.3 Mo 16:30 NW-Bau - HS2

Laser-driven proton acceleration from cryogenic hydrogen jets — •Tim Ziegler[1,2], Martin Rehwald[1,2], Sebastian Göde[3], Stephan Kraft[1], Josefine Metzkes-Ng[1], Lieselotte Obst[1,2], Hans-Peter Schlenvoigt[1], Chandra Curry[4], Maxence Gauthier[4], Christian Rödel[4], Siegfried Glenzer[4], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]European XFEL GmbH, Schenefeld, Germany — [4]SLAC National Accelerator Laboratory, Menlo Park, United States

To advance the development of laser proton accelerators for highly demanding applications like cancer treatment a stable source of energetic particles at high repetition rates is required.

We present recent results from our experimental campaign employing a cryogenic hydrogen jet as a renewable and debris free laser-driven source of pure proton beams generated at the 150 TW ultrashort pulse laser Draco.

Different ion diagnostics reveal mono-species proton acceleration in the laser incidence plane around the wire-like target, reaching cut-off energies of up to 20 MeV and exceeding 10^9 protons per MeV per steradian. In addition, the exact jet-position and the laser-plasma interaction could be monitored on-shot in two axes (perpendicular and parallel to the pump laser) with a temporally synchronized stand-alone probe laser beam. Evaluations of two different target geometries (cylindrical and planar) demonstrate more optimized acceleration conditions using the planar hydrogen jet.

AKBP 2.4 Mo 16:45 NW-Bau - HS2

Probing of laser-plasma experiments at DRACO with a stand-alone probe laser system — •Constantin Andreas Bernert[1,2], Florian-Emanuel Brack[1,2], Stefan Kraft[1], Florian Kroll[1,2], Markus Löser[1], Josefine Metzkes-Ng[1], Lieselotte Obst[1,2], Martin Rehwald[1,2], Hans-Peter Schlenvoigt[1], Mathias Siebold[1], Karl Zeil[1], Tim Ziegler[1,2], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

The exploration of the plasma dynamics and its microscopic parameters is crucial for the optimization of laser-driven ion acceleration. Optical probing is one technique to investigate the temporal plasma evolution. However, strong plasma self-emission at the driver lasers wavelength and its harmonics often masks the laser plasma interaction region and thus complicates the data analysis. Here, we present the implementation of a stand-alone probe laser system, which is temporally synchronized to the Dresden laser acceleration source (DRACO). The probe laser system consisting of a seed laser and one regenerative amplifier is based on Yb:YAG and thus provides a fundamental wavelength of 1030 nm, which is different from the wavelength of the DRACO driver laser (800 nm) and its harmonics. We present the advantages of this probing approach, which was tested during an experimental campaign with wire targets of different materials and diameters in the micrometer range, and give an inside on the current challenges and developments of the probing system.

AKBP 2.5 Mo 17:00 NW-Bau - HS2

Lux - A Plasma-Driven Undulator Beamline — •Andreas R. Maier[1], Niels Delbos[1], Irene Dornmair[1], Timo Eichner[1], Björn Hubert[1], Lars Hübner[1], Sören Jalas[1], Spencer W. Jolly[1,2], Manuel Kirchen[1], Vincent Leroux[1,2], Sebastian Mahncke[1], Philipp Messner[1], Matthias Schnepp[1], Maximilian Trunk[1], Christian Werle[1], Paul A. Walker[3], and Paul Winkler[3,1] — [1]Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Institute of Physics of the ASCR, ELI-Beamlines project, Na Slovance 2, 18221 Prague, Czech Republic — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

The LUX beamline is a novel laser-plasma accelerator. Building on the joint expertise of the University of Hamburg and DESY the beamline was carefully designed to combine state-of-the-art expertise in laser-plasma acceleration with the latest advances in accelerator technology and beam diagnostics. LUX introduces a paradigm change moving from single-shot demonstration experiments towards available, stable and controllable accelerator operation. In this overview talk, we present the various activities covered by our group. We discuss the general design concepts of LUX and present first critical milestones that have recently been achieved, including the 24h operation of the plasma accelerator with several 10.000 consecutive shots, and the generation of spontaneous undulator radiation at a wavelength well below 9 nm.

AKBP 2.6 Mo 17:15 NW-Bau - HS2

A croygentic FEL undulator for a laser-plasma driven light source — Maximilian Trunk[1], •Niels Delbos[1], Johannes Bahrdt[2], and Andreas R. Maier[1] — [1]Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, 22761 Hamburg, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH Hahn-Meitner-Platz 1, 14109 Berlin

Laser-plasma accelerators are promising candidates to drive a next-generation FEL. The LUX accelerator, developed and operated by the LUX research group at the University of Hamburg, recently demonstrated the generation of spontaneous undulator radiation from laser-plasma generated electron beams. A future upgrade of the beamline will include the cryogenic FEL undulator FROSTY to demonstrate first FEL gain from laser-plasma electron beams following the decomression scheme developed in our group. The contribution will cover the design, manufacturing and the current status of the FEL undulator.

AKBP 2.7 Mo 17:30 NW-Bau - HS2

First Undulator Radiation Campaigns at the LUX Beamline — •Christian M. Werle[1], Niels M. Delbos[1], Irene Dornmair[1], Timo Eichner[1], Lars Hübner[1], Sören Jalas[1], Spencer W. Jolly[1,2], Manuel Kirchen[1], Vincent Leroux[1,2], Sebastian Mahncke[1], Philipp Messner[1,4], Matthias Schnepp[1], Maximilian Trunk[1], Paul Andreas Walker[3], Paul Winkler[1,3], and Andreas R. Maier[1] — [1]Center for Free-Electron Laser Science and Department of Physics, University of Hamburg, Hamburg, Germany — [2]ELI Beamlines, Dolní Břežany, Czech Republic — [3]DESY, Hamburg, Germany — [4]Max-Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany

The LUX experiment is a dedicated beamline for the generation of laser-plasma driven undulator radiation. Built within in a close collaboration of the University of Hamburg and DESY we combine novel plasma acceleration techniques with state-of-the-art accelerator technology. After a recent upgrade of the beamline with a compact undulator section, first spontaneous undulator radiation in the few-nm regime was demonstrated in mid 2017. Here, we will report on the first results from the undulator radiation campaigns and report on the beamline performance.

AKBP 2.8 Mo 17:45 NW-Bau - HS2

Wavefront Degradation of a 200 TW Laser from Heat-Induced Deformation of In-Vacuum Compressor Gratings — •Vincent Leroux[1,2], Timo Eichner[1], Sören Jalas[1], Spencer W. Jolly[1,2], Manuel Kirchen[1], Philipp Messner[1,3], Matthias Schnepp[1], Christian Werle[1], Paul Winkler[1,4], and Andreas R. Maier[1] — [1]Center for Free-Electron Laser Science, Hamburg, Germany — [2]ELI Beamlines, Dolní Břežany, Czech Republic — [3]Max-Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany — [4]DESY, Hamburg, Germany

Laser-plasma accelerators are driven by hundreds terawat or up to petawatt laser systems, at a few Hz repetition rates. Furthermore, as the laser technology pushes forward the average power limit, the absorbed heat into the gold-coated in-vacuum compressor gratings increases. This heat leads to deformations of the grating surface which changes the spatial properties of the laser beam during high-power operation. We report the direct measurement of heat-induced wavefront distortion in gold-coated gratings of a 200 TW vacuum compressor using the actual high-energy ultrashort laser to both heat up the gratings and diagnose their deformations. Input energy and laser repetition rate are scanned to cover a wide range of average power, and the degraded wavefront are analyzed to assess the evolution of the laser beam focusability.