AKBP 4: New Accelerator Concepts

Time: Monday 16:30–18:00 Location: GÖR 226

AKBP 4.1 Mon 16:30 GÖR 226

Polarized Particle Beams from Laser-Plasma Accelerators — •Anna Hützen[1,2], Johannes Thomas[2], Andreas Lehrach[3,4], T. Peter Rakitzis[5,6], Alexander Pukhov[2], Liangliang Li[7,8], Yitong Wu[7,8], Ralf Engels[4], and Markus Büscher[1,2] — [1]PGI-6, FZJ — [2]HHU Düsseldorf — [3]JARA-FAME — [4]IKP, FZJ — [5]University of Crete, Greece — [6]FORTH, Greece — [7]SIOM, China — [8]CAS, China

The generation of polarized particle beams still relies on conventional particle accelerators which are typically very large in scale and budget. Thus, concepts based on laser-driven wakefield acceleration have strongly been promoted during the last decades. Despite many advances in the understanding of fundamental physical phenomena, one largely unexplored issue is how highly polarized beams can be produced. The realization of laser-plasma based accelerators for polarized beams is now being pursued as a joint effort of groups from Germany (FZJ, RWTH, HHU), Greece, and China within the ATHENA consortium. As a first step, we have theoretically investigated and identified the mechanisms that influence the beam polarization in laser-plasma accelerators. We then carried out a set of Particle-in-cell simulations on the acceleration of electrons and proton beams from gaseous and foil targets showing the generation of intense polarized beams if prepolarized gas targets of high density are employed. Such polarized sources for electrons, protons, deuterons and 3He ions are now being built at FZJ. Proof-of-principle measurements at the (multi-)PW laser facilities PHELIX (GSI) and SULF (Shanghai) are in preparation.

AKBP 4.2 Mon 16:45 GÖR 226

High intensity laser interaction with cryogenic hydrogen jet target — •Constantin Bernert[1,2], Stefan Assenbaum[1,2], Florian-E. Brack[1,2], Lennart Gaus[1,2], Stefan Kraft[1], Florian Kroll[1], Josefine Metzkes-Ng[1], Martin Rehwald[1,2], Marvin Reimold[1,2], Hans-P. Schlenvoigt[1], Karl Zeil[1], Tim Ziegler[1,2], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

High-intensity short-pulse lasers in the Petawatt regime offer the possibility to study new compact accelerator schemes by utilizing high-density targets for the generation of energetic ion beams. The optimization of the acceleration process demands comprehensive exploration of the plasma dynamics involved, for example via optical probing. In particular, experiments using near critcal density cryogenic hydrogen jet targets with um-scale transverse size are well suited to deliver new results which can then be compared to predictive particle-in-cell simulations. We show the results of an experimental campaign at the DRACO PW laser at Helmholtz-Zentrum Dresden Rossendorf where we were able to tune the proton acceleration performance by dedicated shaping of the target density profile.

AKBP 4.3 Mon 17:00 GÖR 226

Resonant small angle x-ray scattering probing ultrashort pulse high-intensity laser-solid interactions — •Lennart Gaus[1], Michael Bussmann[1], Alejandro Laso García[1], Siegfried Glenzer[2], Christian Gutt[3], Bob Nagler[2], Alexander Pelka[1], Melanie Rödel[1], Hans-Peter Schlenvoigt[1], Tom Cowan[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]HZDR — [2]SLAC — [3]Universität Siegen

The development of second-generation short-pulse laser-driven radiation sources requires a mature understanding of the relativistic laser-plasma processes as e.g. plasma oscillations, heating and transport of relativistic electrons as well as the development of plasma instabilities. These dynamic effects occurring on femtosecond and nanometer scales are very difficult to access experimentally. In a first experiment in 2014 at the Matter of Extreme Conditions facility at LCLS we demonstrated that small angle x-ray scattering (SAXS) of femtosecond x-ray free electron laser (XFEL) pulses is able to make these fundamental processes accessible on the relevant time and length scales in direct in-situ pump-probe experiments [Kluge et al., Phys. Rev. X 8, 031068 (2018)]. Here we report on a recent follow-up experiment with significantly higher pump intensity reaching the relativistic intensity domain. We give an overview of the new capabilities in combining a full suite of particle and radiation diagnostics and SAXS scattering. Especially probing at resonant x-ray energies can give new insight into the ultra-fast ionization processes, plasma opacity and equation-of-state in non-equilibrium plasmas.

AKBP 4.4 Mon 17:15 GÖR 226

Temperature effects on the electron injection in laser-plasma accelerators — •Soeren Jalas, Manuel Kirchen, and Andreas R. Maier — Luruper Chaussee 149 22761 Hamburg GERMANY

In laser plasma accelerators a high power laser generates plasma waves that can sustain accelerating fields on the order of GV/m. When the laser intensity is sufficiently high these waves can break which enables electrons from the plasma background to be trapped and accelerated. Here we show that the temperature of the plasma background can influence the plasma wave and thereby changes the threshold for wave-breaking to occur. Further, using the Particle-in-Cell code FBPIC we show that a finite plasma temperature can benefit the accuracy and performance of simulations.

AKBP 4.5 Mon 17:30 GÖR 226

Beamline Design Studies for a Laser-Wakefield Driven FEL — •Lars Hübner[1], Cora Braun[2], Timo Eichner[2], Thomas Hülsenbusch[2], Sören Jalas[2], Laurids Jeppe[2], Manuel Kirchen[2], Philipp Messner[1,3], Matthias Schnepp[2], Maximilian Trunk[2], Christian Werle[1], Paul Winkler[1], and Andreas R. Maier[2] — [1]DESY — [2]Center for Free- Electron Laser Science & Department of Physics, University of Hamburg — [3]Max Planck Institute for the Structure and Dynamics of Matter

Laser-plasma accelerators are promising candidates to drive compact, laboratory-scale free-electron lasers. However, the unique properties of plasma accelerated electron beams present a challenge to the conventional beam transport and lasing concepts. Here, we present the upgrade of the LUX beamline, that is built and operated by the University of Hamburg and DESY, with the goal of demonstrating FEL gain from a laser-plasma accelerator. The beamline design features a chicane to decompress the electron beam and relax the conditions on the initial beam parameters from the plasma target. The presented concept shows a balancing between the decrease in beam current due to the decompression, the effects of coherent synchrotron radiation in the chicane, and the manipulation of the phase-space to optimize the slice properties of the beam.

AKBP 4.6 Mon 17:45 GÖR 226

Characterisation of cryogenic hydrogen jet target for Laser Proton acceleration — •Stefan Assenbaum[1,2], Constantin Bernert[1,2], Florian Brack[1,2], Lennart Gaus[1,2], Stephan Kraft[1], Martin Rehwald[1,2], Hans-Peter Schlenvoigt[1], Karl Zeil[1], Tim Ziegler[1,2], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

With the rise of a new generation of high intensity, high repitition rate laser systems, new interesting fields of application emerge, like e.g. hadron therapy using laser accelerated protons. This trend imposes new demands on targetry systems for laser ion acceleration to offer both high repitition rate capability as well as tight control of all target parameters.

In recent experiments, a renewable, cryogenically cooled, solid hydrogen jet target has been implemented into the Draco PW Laser System at HZDR. This debris-free target system allows for acceleration of single-species ion beams while offering superb acceleration performance through controlled pre-expansion of the jet prior to the high intensity interaction.

In this talk, we present detailed studies on the preplasma expansion process being conducted at the Draco 150 TW system at HZDR via high resolution optical probing. Furthermore, we investigate the geometric properties of the jet and report on further efforts to enhance jet stability.