P 13: Laser Plasmas I

Time: Thursday 11:00–13:00 Location: CHE/0089

Invited Talk P 13.1 Thu 11:00 CHE/0089

Acceleration of spin-polarized ion beams from laser-plasma interaction — •Lars Reichwein[1], Markus Büscher[2,3], and Alexander Pukhov[1] — [1]Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany — [2]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, 52425 Jülich, Germany — [3]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany

Spin-polarized particles are of interest for a variety of applications such as fusion, where the use of spin-polarized reactants may increase the nuclear cross-section, or further investigation of the nucleon structure by means of deep inelastic scattering. In recent years, the acceleration of such polarized particles via laser-plasma interaction has gained traction in research due to the short acceleration distances needed compared to conventional accelerators. While several schemes for efficient proton and ion acceleration are generally known, many of them are not feasible for polarized beams since the target needs to be prepolarized. In our talk, we give an overview of the current experimental and theoretical state-of-the-art for polarized ion beams. Two acceleration mechanisms, Magnetic Vortex Acceleration and Collisionless Shock Acceleration, will be studied by means of particle-in-cell (PIC) simulations. These schemes can be used to obtain highly polarized ion beams even in the regime of near-future laser facilities.

P 13.2 Thu 11:30 CHE/0089

Influence of plasma profile on injection dynamics in a proton-driven wakefield accelerator. — •Pablo Israel Morales Guzmán, Patric Muggli, and John Farmer — Max-Planck-Institut für Physik

Plasma wakefield accelerators (PWFA) have been proposed as a novel technique to accelerate particle bunches to high energies. Due to the high electric fields supported in plasma, this can be done in a shorter distance than in conventional accelerators. PWFA use a relativistic particle bunch to drive wakefields. When the bunch density is much larger than the plasma density, it induces a non-linear plasma response. For negatively charged bunches, there is blow-out of plasma electrons. For positively charged ones, plasma electrons flow towards the axis, creating a high-density filament. This filament sustains defocusing fields for negatively charged bunches.

A proton bunch much longer than the plasma wavelength drives high-amplitude wakefields only after undergoing self-modulation (SM). SM transforms it into a microbunch train that resonantly drives wakefields. An electron bunch can be injected to seed SM or be accelerated.

We present results of a numerical study using particle-in-cell simulations with parameters similar to those of the AWAKE experiment. We show that along the low density ramp leading to the plasma entrance, the proton bunch generates a filament of plasma electrons. These results indicate that the accelerator plasma of future experiments relying on self-modulation, and a drive and accelerated bunch of different charge, cannot have a density ramp.

P 13.3 Thu 11:45 CHE/0089

Relativistic High Harmonic Generation from solid density foils with a PW class short pulse laser. — •Milenko Vescovi[1], Marvin Elias Paul Umlandt[1,2], Stefan Assenbaum[1,2], Thomas Meric[1,2], Florian Kroll[1], Martin Rehwald[1], Radka Stefanikova[1,2], Thomas Püschel[1], Irene Prencipe[1], Stephan Kraft[1], Ulrich Schramm[1,2], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328, Dresden — [2]Technische Universität Dresden, 01062, Dresden

Relativistic High Harmonic Generation (HHG) from the interaction of high intensity lasers with over dense targets has become a topic of great interest in recent years because of its potential to achieve high energy, coherent short pulses of XUV emission. Several studies have shown the mechanism to be highly sensitive to the laser-plasma interaction conditions. Characterization of the high harmonic spectrum could then be used to probe the interaction during the high intensity fraction of the laser pulse, which is usually of most interest because of the extreme matter conditions but challenging to access experimentally. Measurements of the XUV harmonic spectrum have been conducted with the Draco PW laser (peak intensities up to $6\times10^{21} W/cm^2$ in 30fs FWHM). With the aim of using HHG to gain a better understanding about the interaction, different conditions were studied. Harmonics from 14nm to 17nm wavelength were measured from bulk SiO2 targets, metal foils and plastic foils, as well as driving laser energies. In this work, general features of this parameter scan are shown and its potential link to the laser plasma interaction is discussed.

P 13.4 Thu 12:00 CHE/0089

Setup and evaluation of a calibration free Thomson parabola spectrometer to study sub-MeV ions from laser plasmas — •Lars Torben Schwabe, Jan Riedlinger, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Since sub-MeV ions from laser pulse plasmas are only scarcely studied, we developed a special Thomson parabola spectrometer with a maximized dynamic range that maps these ions in a charge and energy dependent manner. Predictions for these types of ions tend to be inaccurate because of the amount of processes involved, acting on the particles on different time scales. The plasma is generated by a high-intensity ultrashort laser pulse with peak intensities up to 10^{17} W/cm^2 at pulse durations down to 8 fs focused on a solid. The emitted supra-thermal ions are investigated. These results are compared to simulations in terms of ionization state and energies. In this contribution, the design and construction of such a Thomson spectrometer is discussed, which allows us to detect ions over a wide energy range by utilizing variable fields. Furthermore, we present the multi-step evaluation process which eliminates the need for spectrometer calibration.

P 13.5 Thu 12:15 CHE/0089

Characterization of a laser driven supra-thermal ion source — •Jan Riedlinger, Lars Torben Schwabe, Qëndresa Ibraimi, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Today's laser systems achieve repetition rates up to 100 khz at pulse energies of 1 mJ and sub-10-fs durations. With these parameters, laser plasmas become viable ion sources for applications which require a small source size. We present the results of experiments performed with such a laser, reaching intensities up to 10^{17} W/cm^2 on the target surface. This interaction creates a high temperature plasma emitting bunched ions over a broad spectrum in the keV regime. Here, mostly bulk targets were used due to the nearly free choice of materials and high densities for an increased particle output. The talk gives an in-depth view into the ion emission in terms of its opening cone, ionization states and kinetic energies as well as the purposely designed diagnostics.

P 13.6 Thu 12:30 CHE/0089

Heating in Multi-Layer Targets at ultra-high Intensity Laser Irradiation and the Impact of Density Oscillation — •Franziska Paschke-Bruehl[1], Thomas Kluge[1], Motoaki Nakatsutsumi[2], Lisa Randolph[2], Tom Cowan[1], Ullrich Schramm[1], Lingen Huang[1], Mohammadreza Banjafar[2], and Brian Marré[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]European XFEL, Hamburg, Germany

We present a computational study of isochoric heating in multi-layered targets at ultra-high intensity laser irradiation(10^20W/cm^2). Previous studies have shown enhanced ion heating at interfaces, but at the cost of large temperature gradients. Here, we study multi-layered targets to spread this enhanced interface heating to the entirety of the target and find heating parameters at which the temperature distribution is more homogeneous than at a single interface while still exceeding the mean temperature of a non-layered target. Further, we identify a pressure oscillation that causes the layers to alternate between expanding and being compressed with non beneficial effect on the heating. Based on that, we derive an analytical model estimating the oscillation period to find target conditions that optimize heating and temperature homogeneity. This model can also be used to infer the plasma temperature from the oscillation period which can be measured e.g. by XFEL probing.

P 13.7 Thu 12:45 CHE/0089

K-alpha yield from laser-plasmas on thin layers — •Nico Potzkai and Georg Pretzler — Institut für Laser- und Plasma-

physik, Heinrich-Heine-Universität Düsseldorf

When intense sub 10-fs laser pulses create plasma on solid surfaces, they accelerate electrons into the vacuum as well as into the target. The latter electrons induce characteristic x-rays in the material, most of all characteristic K_α radiation, which constitutes a source of partly coherent x-rays due to the small source and narrow spectral line width. When optimizing the total radiation output of this source, we found that thin layers of aluminum on top of copper emit more K_α photons than expected. In our contribution, we present our experimental results and calculations describing this effect.