P 3: Laser Plasmas I

Time: Monday 14:00–15:30 Location: P-H12

P 3.1 Mon 14:00 P-H12

Pump-probe XUV platform for ultrafast laser-matter interaction research — •Milenko Vescovi[1], Marvin E.P. Umlandt[1,2], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Interaction of ultrafast relativistic intensity laser pulses with matter has shown to be a promising field for the study of matter at extreme conditions, electromagnetic fields generation/amplification, high energy radiation emission and particle acceleration. For most of the aforementioned applications, advanced proposed schemes require stringent tailoring and monitoring of the target/plasma parameters during the interaction. The short (fs) temporal and small (sub-micron) spatial scales of the evolution of these parameters make direct measurements a challenging task, even more considering that these plasmas are usually overdense for conventional optical diagnostics.

Currently, a pump-probe set up is being developed at HZDR to gain insight into the internal evolution of overdense laser driven plasmas. The XUV beam generated by one of the arms of the Draco laser, through Relativistic Oscillating Mirror High Harmonic Generation, will be used to probe a plasma driven by a second arm of the laser system. The initial set up for these experiments will be shown and probing options of the platform will be discussed.

P 3.2 Mon 14:15 P-H12

Study of x-ray emission from proton acceleration targets at Draco PW laser facility — •Radka Štefaníková[1,2], Niklas Meckel[1,2], Xiayun Pan[1,2], Michal Šmíd[1], Hans-Peter Schlenvoigt[1], Irene Prencipe[1], Michaela Kozlová[1,3], Lennart Gaus[1,2], Marvin E. P. Umlandt[1,2], Milenko Vescovi[1,2], Marvin Reimold[1,2], Tim Ziegler[1,2], Florian Kroll[1], Stephan Kraft[1], Ulrich Schramm[1,2], Karl Zeil[1], Josefine Metzkes-Ng[1], and Katerina Falk[1,2,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Institute of Physics of the ASCR, Prague, Czech Republic

Laser plasma-based ion accelerators are very promising candidates for many applications. In order to ensure the reliability of such accelerators a comprehensive set of diagnostics is required. X-ray emission spectroscopy allows us to directly measure the plasma conditions of the laser-plasma interaction and also provides information about the hot electron population through the cold K-α emission production.

Here, we present preliminary results from two new x-ray spectrometers used to study interaction regimes relevant for laser-driven ion acceleration at ultra-short pulse PW-class laser facility. We acquired the emission spectra from flat Ti targets for a range of target thicknesses and laser energies. Additionally, artificial laser pre-pulses were added to alter the laser absorption efficiency.

P 3.3 Mon 14:30 P-H12

Investigation of laser reflectivity and transmissivity of laser-plasma interaction with thin foil targets — •Marvin E. P. Umlandt[1,2], Tim Ziegler[1,2], Constantin Bernert[1,2], Marco Garten[1,2], Lennart Gaus[1,2], Ilja Göthel[1,2], Thomas Kluge[1], Stephan Kraft[1], Florian Kroll[1], Josefine Metzkes-Ng[1], Irene Prencipe[1], Martin Rehwald[1,2], Marvin Reimold[1,2], Hans-Peter Schlenvoigt[1], Milenko Vescovi[1,2], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Ion acceleration by compact laser-plasma sources promises a variety of applications ranging from medical relevance to fusion experiments. Reaching the required beam quality parameters for those applications demands a very high level of understanding and control over the laser-plasma interaction process. Central components in this context are the absorption of the electromagnetic laser field by the plasma and the quality of the resulting acceleration field structure.

Measuring and analyzing unabsorbed light - as transmitted and/or specularly reflected parts - thus allows insight into properties of the underlying laser-plasma interaction. We experimentally investigate these interactions for high and low-contrast laser pulses with thin solid density foil targets at the Draco PW laser system (HZDR). The results of spectral, spatial, and energy analysis of transmitted and reflected light indicate changes in the plasma interaction and will be presented.

P 3.4 Mon 14:45 P-H12

Optimized laser ion acceleration at the relativistic critical density surface — •Thomas Kluge[1], Ilja Göthel[1,2], Constantin Bernert[1,2], Michael Bussmann[3], Marco Garten[1,2], Thomas Miethlinger[1,2], Martin Rehwald[1,2], Karl Zeil[1], Tim Ziegler[1,2], Thomas E. Cowan[1,2], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden — [3]Center for Advanced Systems Understanding (CASUS)

In the effort of achieving high-energetic ion beams from the interaction of ultrashort laser pulses with a plasma, volumetric acceleration mechanisms beyond Target Normal Sheath Acceleration have gained attention. A relativisticly intense laser can turn a near critical density plasma slowly transparent, facilitating a synchronized acceleration of ions at the moving relativistic critical density front. While simulations promise extremely high ion energies in in this regime, the challenge resides in the realization of a synchronized movement of the ultrarelativistic laser pulse (a0 >* 30) driven reflective relativistic electron front and the fastest ions, which imposes a narrow parameter range on the laser and plasma parameters. We present an analytic model for the relevant processes, confirmed by a broad parameter simulation study in 1D- and 3D-geometry. By tayloring the pulse length plasma density profile at the front side, we can optimize the proton acceleration performance and extend the regions in parameter space of efficient ion acceleration at the relativistic relativistic density surface.

P 3.5 Mon 15:00 P-H12

Simulation of optimized TNSA via temporal pulse shaping under realistic laser contrast conditions — •Marco Garten[1,2], Jakob Wetzel[1,2], Tim Ziegler[1,2], Marvin E. P. Umlandt[1,2], Ilja Goethel[1,2], Thomas Pueschel[1], Stefan Bock[1], Karl Zeil[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

Controlling the spatio-temporal coupling of laser energy into plasma electrons is crucial for achieving predictable beam parameters of ions accelerated from ultra-high intensity (UHI) laser-driven solid density plasmas. Especially for highest maximum energies, promising targets are foils of a few ten to hundred nanometers thickness. When working with targets of such small scales, meticulous control and precise metrology of the driving UHI laser pulses are paramount to avoiding premature plasma expansion that would lead to losses in absorption efficiency as well as lower accelerating fields. Recently, significant proton beam quality enhancement was reported from the Draco PW facility at HZDR via spectral phase control of the driving laser pulse. In support of these experiments, we present a particle-in-cell simulation study taking into account realistic temporal intensity contrast features. In particular, we focus on the influence of laser spectral phase term manipulations on the acceleration of ions. We furthermore show how the transient femtosecond plasma dynamics and state of the target are encoded into the spectral content of reflected and transmitted light, giving more insight into the previously obtained experimental results.

P 3.6 Mon 15:15 P-H12

Isochoric Heating in Multilayer Targets upon Ultra High Intensity Laser Irradiation by Density Oscillation — •Franziska Paschke-Bruehl[1,2], Lisa Randolph[3], Mohammadreza Banjafar[2,4], Motoaki Nakatsutsumi[4], Lingen Huang[1], Christian Gutt[3], Ulrich Schramm[1], Thomas E. Cowan[1,2], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Universität Siegen, Siegen, Germany — [4]European XFEL, Schenefeld, Germany

Reaching higher ion and electron temperatures in laser-solid plasma interaction can be done by either increasing laser intensity or changing target design. We will show how a multilayer target behaves under ultra high intensity laser irradiation, based on a PIC simulation study. There we observe density oscillation, a dynamic, that has not been mentioned in plasma physics yet. It describes how neighboring layers repeatedly compress each other, causing the ion and electron density of each layer to oscillate over time. During this process, the particles gain kinetic energy and temerpature, thus heat differently compared to a non layered target. Based on that, we will show how the density oscillation affects the isochoric heating of the target. In addition to that we present a method of confirming these computational results in an experiment by applying a GISAXS (grazing- incidence small-angle scattering) technique.