AKBP 7: PWA / TNSA II

Zeit: Dienstag 13:45–15:45 Raum: G.10.03 (HS 8)

AKBP 7.1 Di 13:45 G.10.03 (HS 8)

Field-reversed bubble in deep plasma channels for high quality electron acceleration — •Alexander Pukhov — Uni Düsseldorf

We study hollow plasma channels with smooth boundaries for laser-driven electron acceleration in the bubble regime. Contrary to the uniform plasma case, the laser forms no optical shock and no etching at the front. This increases the effective bubble phase velocity and energy gain. The longitudinal field has a plateau that allows for monoenergetic acceleration. We observe as low as 10^{-3} r.m.s. relative witness beam energy uncertainty in each cross-section and 0.3% total energy spread. By varying plasma density profile inside a deep channel, the bubble fields can be adjusted to balance the laser depletion and dephasing lengths. Bubble scaling laws for the deep channel are derived. Ultra-short pancake-like laser pulses lead to the highest energies of accelerated electrons per Joule of laser pulse energy.

AKBP 7.2 Di 14:00 G.10.03 (HS 8)

Few-cycle optical probe-pulses: Diagnosing Laser Wakefield Accelerators — •Daniel Ullmann[1], Matthew Schwab[2], Stephan Kuschel[1], Mark Yeung[1,3], Alexander Sävert[2], Matt Zepf[1,3], and Malte C. Kaluza[1,2] — [1]Helmholtz-Institut Jena, Friedrich-Schiller-Universität, 07743 Jena, Germany — [2]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität, 07743 Jena, Germany — [3]Department of Physics and Astronomy, Queens University Belfast, BT7 1NN Belfast, United Kingdom

Several applications of a few-cycle optical probe-pulse (fc-probe pulses) in Laser Wakefield Acceleration (LWFA) experiments on the JETI 40 TW laser system in Jena will be described. These investigations are motivated by the need for high-resolution diagnostics of the wakefield to gain a deeper insight into the physics underlying the acceleration process and to benchmark numerical simulations which have so far been the only source for detailed information.

Various measurements using the fc-probe pulses were performed during a LWFA experimental campaign. Here, a gas-cell filled with a 95:5 Helium:Nitrogen mixture was used as the target material. Interferometric measurements of the electron plasma density were done and compared using both a Mach-Zehnder interferometer and a polychromatic wavefront sensor. Further measurements implementing the relationship between spectral bandwidth and temporal resolution of the fc-probe pulses were performed as an investigation into multi-frame, single-shot shadowgraphic techniques.

AKBP 7.3 Di 14:15 G.10.03 (HS 8)

Synchronous Acceleration in the Optical Regime: Recent Results and Future Directions of Dielectric Laser Acceleration — •Joshua McNeur[1], Jonas Hammer[1], Ang Li[1], Norbert Schönberger[1], Alexander Tafel[1], and Peter Hommelhoff[1,2] — [1]Department of Physics, Friedrich-Alexander-Universität Erlangen Nürnberg, Staudtstr. 1, D-91058 Erlangen, Germany — [2]Max Planck Institute of Quantum Optics, Hans-Kopfermann-Str. 1, D-85748 Garching, Germany

Dielectric laser acceleration scales phase synchronous acceleration – proposed by Widerøe approximately 90 years ago [1] and successfully employed within multitudes of accelerator facilities – to the optical regime. Within the last year, acceleration has been demonstrated in this new regime on multiple fronts (at different electron energies, laser wavelengths and laser pulse energies) [2,3]. The theory [4] and recent demonstration of Dielectric Laser Acceleration of subrelativistic electrons is reviewed. Future directions of the FAU DLA project including proton acceleration, use of a 2 micron Th fiber laser, deflecting and focusing geometries and a laser-triggered electron source, are discussed.

1. Widerøe, R., Arch Electronik Übertragungstechnik 21 4 387
2. Peralta et al., 2013 Nature 503 91
3. Breuer and Hommelhoff, 2013 Phys. Rev. Lett. 111 134803
4. Breuer, McNeur and Hommelhoff, 2014 J. Phys. B: At. Mol. Opt.Phys. 47 234004

AKBP 7.4 Di 14:30 G.10.03 (HS 8)

Pulsed high field magnets – An efficient way of shaping laser accelerated proton beams for application — •Florian Kroll[1,2], Vincent Bagnoud[4,5], Abel Blazevic[4,5], Christian Brabetz[4], Simon Busold[4,5], Oliver Deppert[6], Diana Jahn[6], Leonhard Karsch[3], Stephan Kraft[1], Umar Masood[3], Markus Roth[6], Dennis Schumacher[4], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden - Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany — [3]OncoRay-National Center for Radiation Research in Oncology, TU Dresden, 01307 Dresden, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [5]Helmholtz Institut Jena, 07734 Jena, Germany — [6]Technische Universität Darmstadt, 64289 Darmstadt, Germany

Compact laser-driven proton accelerators are a potential alternative to complex, expensive conventional accelerators, enabeling unique beam properties, like ultra-high pulse dose. Nevertheless, they still require substantial development in reliable beam generation and transport.

We present experimental studies on capture, shape and transport of laser and conventionally accelerated protons via pulsed high-field magnets. These magnets, common research tools in the fields of solid state physics, have been adapted to meet the demands of laser acceleration experiments.Our work distinctively shows that pulsed magnet technology makes laser acceleration more suitable for application and can facilitate compact and efficient accelerators, e.g. for material research as well as medical and biological purposes.

AKBP 7.5 Di 14:45 G.10.03 (HS 8)

Gas density measurement for self-modulation experiments at PITZ — •Gaurav Pathak[1] and Matthias Gross[2] — [1]Institut für Experimentalphysik, Universität Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Germany

Self-modulation (SM) of proton beams in a plasma has recently gained interest in the context of the PWFA experiment of the AWAKE collaboration which is in preparation at CERN. Instrumental for experiment is the SM of the proton beam via transverse wakefields in the plasma to generate bunchlets for resonant wave excitation and efficient acceleration. In turn, these generated wakefields dependent on the plasma density. A fundamental understanding of the underlying physics is vital, and hence an independent experiment has been set up at the beam line of the Photo Injector Test Facility at DESY, Zeuthen Site (PITZ), to study the SM of long electron beams in a plasma. This contribution presents experimental progress made for the gas density measurement, which later on, when subjected to an ArF laser radiation will create the required plasma. The Gas density measurement is crucial to optimize the beam and plasma parameters for the experiment. Knowledge of the gas density and hence the plasma density helps to deduce the key properties of the generated wakefields such as their magnitude and phase velocity, which both are of significant importance for the design of self-modulated plasma-based acceleration experiments.

AKBP 7.6 Di 15:00 G.10.03 (HS 8)

Charakterisierung von Ionen aus laserinduziertem Plasma — •Florian-Emanuel Brack[1,2], Josefine Metzkes[1,2], Stefan Kraft[1], Florian Kroll[1,2], Lieselotte Obst[1], Martin Rehwald[1,2], Hans-Peter Schlenvoigt[1], Philipp Sommer[1,2], Karl Zeil[1] und Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstr. 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Durch die Fokussierung eines ultrakurzen und hochintensiven Laserpulses auf ein Festkörpertarget können Pulse von Protonen und anderen positiv geladenen Ionen erzeugt werden. Auf Basis des etablierten TNSA (target-normal sheath acceleration) Prozesses konnten am Helmholtz-Zentrum Dresden-Rossendorf mit dem 150 TW Ultrakurzpulslaser DRACO Protonenpulse mit Energien bis zu 20 MeV erzeugt und charakterisiert werden. Die Charakterisierung dieser Teilchenstrahlung erfordert die Identifizierung der Ionenspezies und die Bestimmung ihrer spektralen Verteilung möglichst nach jedem Puls, wofür standardmäßig Thomsonspektrometer verwendet werden.

In den letzten Jahren wurde das DRACO-Lasersystem bis zu einer Pulsleistung über 500 TW erweitert. Aufbauend auf dem bisherigen Spektrometerdesign wurde in dieser Arbeit ein kompaktes Spektrometer für einen höheren Energiebereich bis über 80 MeV entworfen. Besonders wichtig dabei ist die Identifizierung möglicher das Messergebnis verfälschender Sekundärstrahlungsquellen, die mit Hilfe von Monte-Carlo Simulation analysiert werden müssen.

AKBP 7.7 Di 15:15 G.10.03 (HS 8)

Guiding of pulsed lasers in plasma waveguides created by a slow capillary discharge — Maximilian Messmer[1,2], •Alexander Köhler[1,2], Jurjen Couperus[1], Axel Jochmann[1], Arie Irman[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden - Rossendorf — [2]Technische Universität Dresden

Laser Wakefield Acceleration (LWFA) has emerged as a promising concept for the next generation of high energy electron accelerators. To attain highest possible particle energies in this acceleration scheme, high intensity lasers must be focused over distances much greater than the Rayleigh length. Hence, laser guiding is necessary to counteract the diffraction induced divergence of the beam.

The guiding of pulsed lasers with intensities up to 2×10^{16} W/cm^2 in a plasma waveguides of several centimeter length is shown. A plasma is created within a capillary via the concept of slow capillary discharge. Interferometry shows that the plasma channel has a refractive index profile suitable for laser guiding. Laser guiding capabilities of a pulsed Ti:Sa laser are evaluated. The results show a broad, easy to realize parameter window for pressure and time in which high transmission above 75% are achieved.

AKBP 7.8 Di 15:30 G.10.03 (HS 8)

Concept for Continuous Gas Flow Operation of a LWFA-Target — •Niels Matthias Delbos[1,2], Dariusz Kocon[1,2,3], Philipp Messner[1,2], Paul Pourmoussavi[1,2], Christian Markus Werle[1,2], Benno Zeitler[1,2], and Andreas R. Maier[1,2] — [1]CFEL, Center for Free-Electron Laser Science, 22607 Hamburg — [2]University of Hamburg, Institute of Experimental Physics, 22761 Hamburg — [3]ELI Beamlines, 18221 Praha 8, Czech Republic

Stable operation of the plasma-target for Laser Wakefield Acceleration (LWFA) is a key element for reliable, accessible and reproducible experiments. Most LWFA experiments rely on targets, which are operated with short bursts of gas, as the vacuum system is not capable of handling higher gas loads. After each pulse of gas, the vacuum system needs a considerable amount of time to reduce the pressure to a low enough level for the next laser-shot, which is still the highest limiting constraint in electron shot-to-shot repetition rate of the whole accelerating system. In contrast to a pulsed gas operation, this talk will show a concept to be implemented at the LUX-Beam Line, operated by a collaboration of University of Hamburg and DESY, that allows for continuous flow operation of the target and thus highest electron repetition rates, only limited by the repetition rate of the laser. Furthermore, continuous gas flow operation mitigates possible error sources from pressure fluctuations inside the target and timing jitter between laser pulse and gas pulse. The concept features a differential pumping setup, specially designed for laser applications, as well as a gas supply system and an online pressure measurement inside the target.