AKBP 4: Plasmas and Lasers

Time: Tuesday 16:30–19:00 Location: CHE/0183

Group Report AKBP 4.1 Tue 16:30 CHE/0183
Large Energy Depletion of a Beam Driver in a Plasma-Wakefield Accelerator — •Felipe Peña[1,2], Carl A. Lindstrøm[1,3], Judita Beinortaite[1,4], Jonas Björklund Svensson[1], Lewis Boulton[1,5,6], Severin Diederichs[1,2], James M. Garland[1], Pau González Caminal[1,2], Gregor Loisch[1,2], Sarah Schröder[1], Maxence Thévenet[1], Stephan Wesch[1], Jonathan Wood[1], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Universität Hamburg, Germany — [3]University of Oslo, Norway — [4]University College London, UK — [5]SUPA, University of Strathclyde, Glasgow, UK — [6]The Cockcroft Institute, Daresbury, UK

Beam-driven plasma-wakefield acceleration has the potential to reduce the size and construction cost of large-scale accelerator facilities, by providing accelerating fields orders of magnitude greater than that of conventional accelerating structures. Affordable running costs require demonstration of high energy-transfer efficiency from the wall-plug to the accelerated bunch. For this, drive bunches must be efficiently produced, strong decelerating fields must be sustained for the drive bunches until their energy is depleted, and the resulting accelerating fields must be strongly beam loaded by the trailing bunches. Here we address the second of these points, showing measurements using a 500 MeV drive bunch where (50±7)% of its total energy is deposited into a 20 cm long plasma. This level of energy-transfer efficiency demonstrates that plasma accelerators hold the potential to become competitive with conventional accelerators.

Group Report AKBP 4.2 Tue 17:00 CHE/0183
SPEED: Worldwide first implementation of the EEHG scheme at a storage ring — •Zohair Usfoor[1], Benedikt Büsing[1], Arne Held[1], Shaukat Khan[1], Carsten Mai[1], Arjun Radha Krishnan[1], Wa'el Salah[1,2], and Vivek Vijayan[1] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany — [2]The Hashemite University, Zarqa, Jordan

At DELTA, a 1.5-GeV synchrotron radiation source at TU Dortmund University, the CHG (coherent harmonic generation) scheme is employed to generate ultrashort radiation pulses. In CHG, the interaction of electron bunches with laser pulses in a first undulator (modulator) causes a periodic electron energy modulation. A chicane then induces a density modulation, giving rise to coherent emission of ultrashort pulses at harmonics of the seed laser in a second undulator (radiator). A reconfiguration of the U250 device that incorporated the two undulators and the chicane went underway in summer 2022 to demonstrate EEHG (echo-enabled harmonic generation, originally proposed for linac-based free-electron lasers) at a storage ring and to enable the generation of higher harmonics. The coils of the U250 were rewired to create two modulators for a twofold laser-electron interaction, two chicanes for the manipulation of the electron density, and a radiator, with only a few undulator periods comprising each section. The produced EEHG pulses are detected by an in-vacuum grating spectrometer. Initial results are presented. To our knowledge, this is the first attempt worldwide to successfully apply EEHG at a storage ring.

Group Report AKBP 4.3 Tue 17:30 CHE/0183
High-temperature superconductor undulators and magnets for the future compact light sources — •Samira Fatehi, Axel Bernhard, and Anke-susanne Müller — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

In this contribution, an overview of the ongoing projects at KIT on the high-temperature superconductor (HTS) undulators and magnets is given, and the research on beam dynamics and magnet design of a laser-plasma accelerator-based, miniature beam transport line using HTS novel periodic magnets is presented in detail. In laser-plasma accelerators (LPA), due to extremely high accelerating gradients, electron bunches are accelerated to high energies in only a few millimeters to centimeters of acceleration length. To efficiently capture and transport the LPA-generated bunches in a compact transport line, beam line designs employing high-strength combined-function magnets based on high-temperature superconductor technology have been studied. Moreover, to overcome coil winding challenges in fabricating miniature HTS magnets, novel periodic magnets have been designed, which can collimate and guide the electron beams in a well-controlled short-length transport line. The designed transport line has a length of 1.4 m matching the beam optics parameters of the LPA-generated electron beams to the transverse-gradient undulator (TGU) requirements.

Group Report AKBP 4.4 Tue 18:00 CHE/0183
Status Of Plasma Diagnostics On The Prototype Plasma Lens For Optical Matching At The ILC e+ Source — •Niclas Hamann[1], Gregor Loisch[2], Manuel Formela[1], Kai Ludwig[2], Jens Osterhoff[2], and Gudrid Moortgat-Pick[1,2] — [1]Uni Hamburg — [2]DESY Hamburg

In recent years, high-gradient, symmetric focusing with active plasma lenses has regained significant interest due to its potential advantages in compactness and beam dynamics compared to conventional focusing elements. A promising application could be optical matching of highly divergent positrons from the undulator-based ILC positron source into the downstream accelerating structures to increase the positron yield. In a collaboration between University Hamburg and DESY Hamburg a downscaled prototype for this application has been developed. Here, we present first plasma diagnostics results, such as discharge current stability, electron density distribution and reproducibility. Additionally, future plans for measuring the magnetic field distribution and a possible fullscale prototype will be discussed.

Group Report AKBP 4.5 Tue 18:30 CHE/0183
Multi-turn ERL mode of the S-DALINAC* — •Manuel Dutine, Michaela Arnold, Jonny Birkhan, Adrian Brauch, Jochim Enders, Marco Fischer, Ruben Grewe, Lars Juergensen, Maximilian Meier, Norbert Pietralla, Felix Schliessmann, Dominic Schneider, Merle Seeger, Alexander Smuskin, and Manuel Steinhorst — Institut für Kernphysik, Technische Universität Darmstadt

The superconducting Darmstadt linear accelerator S-DALINAC is a thrice-recirculating accelerator for electrons supporting a variety of experimental programs in nuclear physics and nuclear photonics. Besides the conventional acceleration scheme, it can also be operated as an energy-recovery linac (ERL) [1] and contributes to research on this exciting topic of technology development. The world-wide first successful operation as a superconducting multi-turn ERL has been demonstrated in August 2021 [2]. A variety of projects address further developments, for instance, dedicated diagnostics to measure the position of two beams in the same beamline, simultaneously, or to resolve its time structure, have been used for first measurements. This contribution gives an overview of their status. [1] M. Arnold et al., First operation of the superconducting Darmstadt linear electron accelerator as an energy recovery linac, Phys. Rev. Accel. Beams 23, 020101 (2020) [2] F. Schliessmann et al., Realization of a multi-turn energy-recovery accelerator, Nat. Phys. (in press). *Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.