AKBP 12: New Accelerator Concepts 2

Time: Wednesday 16:00–17:30 Location: AKBP-H14

AKBP 12.1 Wed 16:00 AKBP-H14

Excitation of beam driven plasma waves in a hybrid LPWFA — •Susanne Schöbel[1,2], Richard Pausch[1], Finn-Ole Carstens[1,2], Yen-Yu Chang[1], Sébastien Corde[3], Jurjen Couperus Cabadağ[1], Alexander Debus[1], Hao Ding[4], Andreas Döpp[4], Thomas Heinemann[5,6], Bernhard Hidding[6], Max Gilljohann[3,4], Stefan Karsch[4], Alexander Köhler[1], Olena Kononenko[3], Alastair Nutter[6], Patrick Ufer[1,2], Alberto Martinez de la Ossa[5], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany — [3]LOA, ENSTA ParisTech, CNRS, Ecole Polytechnique, Université Paris-Saclay, France — [4]Ludwig-Maximilians-Universität München, Germany — [5]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [6]University of Strathclyde, Glasgow, UK

Here we present imaging of plasma wakefields driven by both, high intensity laser pulses or high peak current electron beams. In particular, a scheme of high-current electron beams from a LWFA as drivers of a beam-driven plasma wakefield accelerator (PWFA) is being extensively studied, aiming to fulfill the demanding quality requirements for applications such as FELs. Observing plasma wakefields in this regime demonstrates the capability of the LWFA beam to create the plasma as well as drive plasma wakefields. Additionally we observed a correlation between the drive beam charge and the shape of the plasma wave. This enables us to find an optimum parameter set towards the experimental demonstration of the hybrid LPWFA.

AKBP 12.2 Wed 16:15 AKBP-H14

Traveling-wave electron accelerators – Getting PIConGPU simulations ready for exascale — •Alexander Debus[1], Sunita Chandrasekaran[2,3], Klaus Steiniger[1], René Widera[1], Sergei Bastrakov[1], Felix Meyer[1], Richard Pausch[1], Marco Garten[1], Thomas Kluge[1], Jeffrey Kelling[1], Benjamin Hernandez[6], Matthew Leinhauser[2,3], Jeff Young[2,5], Franz Pöschel[1], Axel Hübl[4], David Rogers[6], Guido Juckeland[1], and Michael Bussmann[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]CASUS, Center for Advanced Systems Understanding, Görlitz, Germany — [3]University of Delaware, Newark, Delaware, USA — [4]Lawrence Berkeley National Laboratories, Berkeley, CA, USA — [5]Georgia Institute of Technology, Atlanta, GA, USA — [6]Oak Ridge National Laboratory, Knoxville, TN, USA

Traveling-wave electron acceleration (TWEAC) is an advanced laser-plasma accelerators scheme, which is neither limited by dephasing, nor by pump depletion or diffraction. Such accelerators are scalable to energies beyond 10 GeV without the need for staging and are candidates for future compact electron-positron colliders.

TWEAC simulations to high energies require exascale compute resources. Within the early-access program (CAAR) for the upcoming exascale Frontier cluster at ORNL, we prepare PIConGPU, a 3D3V particle-in-cell code, for large-scale TWEAC simulations, including tuning and refining PIConGPU to run on the latest AMD GPUs. In this talk we present progress in TWEAC simulations and the technical advances in PIConGPU that enable running on Frontier.

AKBP 12.3 Wed 16:30 AKBP-H14

Operational Experience and Characterization of a Superconducting Transverse Gradient Undulator for Compact Laser Wakefield Accelerator-Driven FEL — •Kantaphon Damminsek, Axel Bernhard, Sebastian Richter, Robert Rossmanith, Anke-Susanne Müller, Yimin Tong, and Andreas Grau — Karlsruhe Institute of Technology, Karlsruhe, Germany

A 40-period superconducting transverse gradient undulator (TGU) has been designed and fabricated at Karlsruhe Institute of Technology (KIT). Combining a TGU with a Laser Wakefield Accelerator (LWFA) is a potential key for realizing an extremely compact Free Electron Lasers (FEL) radiation source, as the TGU scheme is a viable option to compensate the challenging properties of the LWFA electron beam in terms of beam divergence and energy spread. The superconducting TGU has been commissioned off-line, step by step reaching its final operational parameters. A specially designed set-up for mapping of the magnetic field in the TGU's extremely narrow gap has been installed, commissioned and employed for the magnetic characterization. In this contribution, we report on the operational experience of the TGU and on the magnetic characterization measurement.

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AKBP 12.4 Wed 16:45 AKBP-H14

Studies for a Laser Wakefield Driven Injector at ELSA — •Kilian Kranz, Klaus Desch, Daniel Elsner, and Michael Switka — Elektronen-Stretcher-Anlage, Physikalisches Institut, Universität Bonn

At the University of Bonn the storage ring ELSA extracts electrons with energies up to 3.2 GeV to hadron physics and novel detector testing experiments. We study the feasibility of replacing the current 26 MeV LINAC injector with a laser wakefield accelerator (LWA). For this, contemporary parameters from current LWA setups at other laboratories are assumed and matched to the acceptance of the booster synchrotron. Moreover, a conceptional draft of a potential LWA setup is created. This takes into consideration the influence of building conditions such as available floor space and building vibrations to estimate a setup and laser beam stability of a plasma generating high power laser system and beamline to the plasma cell. The methods and intermediate results of this study will be presented.

AKBP 12.5 Wed 17:00 AKBP-H14

Signal subtraction of consecutive electron bunches from a high-repetition-rate plasma-wakefield accelerator — •Judita Beinortaite[1,2], James Chappell[2], Gregor Loisch[1], Carl A. Lindstrøm[1], Sarah Schröder[1], Stephan Wesch[1], Matthew Wing[1,2], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]DESY, Hamburg, Germany — [2]University College London, London, UK

Plasma-wakefield acceleration (PWFA) is one of the main candidates for future compact-accelerator technologies with applications in high energy physics and photon science. For PWFA, which currently operates at Hz level, to meet the luminosity and brilliance demands of current users, at least thousands of bunches must be delivered per second. As recently explored at FLASHForward, DESY, the fundamental limitation for the highest repetition rate is the long-term motion of ions that follows the dissipation of the driven wakefield (D'Arcy, R. et al. Recovery time of a plasma-wakefield accelerator. Nature (accepted) (2021)). The recovery of the plasma to an undisturbed state after the driving of a wakefield was observed in the images of consecutive electron bunches, separated by tens of nanoseconds, while the imaging screens have scintillation lifetimes of the order milliseconds. As such, an image processing technique capable of resolving individual bunches within that lifetime is needed. This technique - termed the 'subtraction method' - uses many shots of a preceding bunch to accurately identify and remove its signal from the overlapping signal of a subsequent bunch. As a result, high-repetition-rate processes can be studied to advance PWFA for meaningful application to facilities of the future.

AKBP 12.6 Wed 17:15 AKBP-H14

Radiative particle-in-cell simulations of the beam hosing instability – an analysis by components — •Anton Lebedev[1], Richard Pausch[1], Rene Widera[1], Sergei Bastrakov[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], and Alexander Debus[1] — [1]Abteilung Laser-Teilchenbeschleunigung, Helmholtz Zentrum Dresden-Rossendorf, Dresden — [2]Center for Advanced Systems Understanding, Görlitz — [3]Institut für Strahlenphysik, Technische Universität Dresden, Dresden

We present first results and analyses of radiation spectra expected to be produced by ultrarelativistic particle beams propagating through a plasma medium experiencing the hosing instability. We determine these spectra in particle-in-cell simulations by in-situ computation of radiation based on Liénard-Wiechert potentials, emitted by all simulated particles (>10^9) of the beam and plasma for over 160 distinct detectors distributed across half a solid angle.

In the simulation campaign, conducted at the JUWELS Booster cluster at JSC, we considered linear and non-linear regimes of the instability for ultrarelativistic electron beams of varying emittance impacting a homogeneous electron plasma. We further show a preliminary analysis of the data relating observed characteristics of the spectra to the characteristics of the instability.

Our goal is to open up new experimental avenues for better understanding the beam instability evolution by identifying its radiation signatures that can be measured in experiments.