AKBP 9: Novel Accelerator Concepts III and Hadron Accelerators

Time: Thursday 13:45–15:45 Location: ZHG004

Group Report AKBP 9.1 Thu 13:45 ZHG004

Establishing a new class of High-Current Acceleratordriven Neutron Sources (HiCANS) with the HBS project — •Andreas Lehrach[1], Thomas Gutberlet[1], Paul Zakalek[1], and Holger Podlech[2] — [1]Forschungszentrum Jülich — [2]Johann Wolfgang Goethe-Universität Frankfurt

Accelerator-driven high brilliance neutron sources are an attractive alternative to the classical neutron sources of fission reactors and spallation sources to provide scientists with neutrons to study and analyze the structure and dynamics of matter. With the advent of high-current proton accelerator systems, a new class of such neutron facilities can be established referred to as High-Current Accelerator-driven Neutron Sources (HiCANS). The basic features of HiCANS are a medium-energy proton accelerator with of tens of MeV and up to 100 mA beam current, a compact neutron production and moderator unit and an optimized neutron transport system to provide a full suite of high performance, fast, epithermal, thermal and cold neutron instruments. The Jülich Centre for Neutron Science (JCNS) has established a project to develop, design and demonstrate such a novel accelerator-driven facility termed High Brilliance neutron Sources (HBS). The aim of the project is to build a versatile neutron source as a user facility with open access and service according to the diverse and changing demands of its communities.

Embedded in an international collaboration with partners from Germany, Europe and Japan, the Jülich HBS project offers the best flexible solutions for scientific and industrial users.

AKBP 9.2 Thu 14:15 ZHG004

Laser cooling of bunched relativistic ion beams at the FAIR SIS100 — •Danyal Winters[1], Michael Bussmann[2,3], Tamina Grunwitz[4], Jens Gumm[4], Volker Hannen[5], Thomas Kühl[1,6], Sebastian Klammes[1], Benedikt Langfeld[4], Ulrich Schramm[2,7], Denise Schwarz[4], Mathias Siebold[2], Peter Spiller[1], Thomas Stöhlker[1,6,8], Ken Ueberholz[5], and Thomas Walther[4,9] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]CASUS Görlitz — [4]TU-Darmstadt — [5]Uni Münster — [6]HI-Jena — [7]TU-Dresden — [8]Uni-Jena — [9]HFHF Campus Darmstadt

The heavy-ion synchrotron SIS100 is (at) the heart of the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. It is designed to accelerate intense beams of heavy highly charged ions up to relativistic velocities and to deliver them to unique physics experiments, such as those planned by the APPA/SPARC collaboration. In order to cool these extreme ion beams, bunched beam laser cooling will be applied using a dedicated facility at the SIS100. We will use a novel 3-beam concept, where laser beams from three complementary laser systems (cw and pulsed) will be overlapped in space, time and energy to interact simultaneously with a very broad ion velocity range in order to maximize the cooling efficiency. We will present this project and give an update of its current status. We will also give an overview of the laser and detector systems that will be used.

AKBP 9.3 Thu 14:30 ZHG004

BEETLE - High average power laser-plasma accelerator using a 1 kW Yb-based laser with nonlinear compression — •Tatiana Nechaeva, Timo Eichner, Sören Jalas, Christian Werle, Lutz Winkelmann, Guido Palmer, Manuel Kirchen, and Andreas Maier — DESY, Hamburg, Germany

Laser-plasma acceleration (LPA) is a promising technology for a future compact accelerator. However, current Ti:Sapphire laser technology typically supports few-hertz repetition rates, with scaling to higher rates being challenging. High energy, kHz-level Yb-based laser systems have longer, sub-picosecond pulses. After nonlinear spectral broadening in a multipass cell, these pulses can be compressed to tens of fs duration, becoming a promising LPA driver alternative. In this poster, we introduce the BEETLE project, recently initiated at DESY, that aims to demonstrate high-energy, high repetition rate electron acceleration. The driver laser pulses, provided by a 5 kHz Yb-based laser system (Trumpf Scientific Lasers), have an energy of 200 mJ and are compressible to 30 fs via spectral broadening. We present an overview, goals and the current status of the project.

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Modular, Automated Beam Stabilization of the ATLAS-3000 Laser at the Centre for Advanced Laser Applications (CALA) — •Florian Schweiger, Michael Bachhammer, Timo Pohle, Johannes Zirkelbach, Leonhard Doyle, Sonja Gerlach, and Jörg Schreiber — LMU Physik, Munich, Germany

Thermal effects in optical elements as well as subtle changes in the experimental environment (e.g. airflow, humidity, vibrations) are well-known challenges affecting laser alignment. For high-power lasers comprising a multitude of amplification stages, the resulting long-term drifts (occurring over minutes to hours) affect both beam and laser parameters. Monitoring these drifts at the Petawatt-class ATLAS laser at CALA prompted us to develop a modular solution for long-term beam stabilization. This stabilization system consists of separate diagnostic and control modules in between the individual amplification stages of the laser chain. Each module measures the laser near- and far-field and is capable of stabilizing both the position and angle of the beam using motorized mirror mounts. Currently, a total of three stabilization units are installed in the ATLAS frontend, and (supervised) stabilization on the minute timescale has been successfully implemented. Overall, the system improves the stability, precision, and reproducibility of the laser alignment and is therefore advantageous for high-class laser-plasma accelerators. This work was supported by the BMBF within project 01IS24028 and CALA.

AKBP 9.5 Thu 15:00 ZHG004

More realistic laser-plasma simulations by laser profiles measured via Insight — •Fabia Dietrich[1,2], Jessica Tiebel[1,2], Richard Pausch[1], Thomas Püschel[1], Ulrich Schramm[1], and Klaus Steiniger[3] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]TU Dresden — [3]CASUS, Görlitz

Laser-plasma physics is an important field of research with wide-ranging applications such as particle acceleration for medical purposes or inertial confinement fusion. A fundamental challenge in this field is understanding and controlling the complex interaction between high-intensity laser pulses and the plasma, for which Particle-in-Cell (PIC) simulations have become indispensable tools.

A significant limitation in many simulation codes is the assumption of idealized laser conditions, such as perfectly Gaussian beams. This simplification arises from the difficulty in analytically modelling spatio-temporal couplings (STCs) that inevitably influence realistic laser pulses.

To address this discrepancy, we present a method for importing realistic laser field data from INSIGHT measurements into multiple-GPU PIC simulations with PIConGPU. INSIGHT measurements provide complete field information of the laser pulse at the focal position, and therefore allow to create a digital twin of experimental setups. This enables us to investigate in detail the impact of STCs on the performance of laser particle accelerators realized at HZDR. Moreover, this new capability permits the prediction of optimized operation points in upcoming experiments.

AKBP 9.6 Thu 15:15 ZHG004

Full Power Laser Diagnostic — •Luis Gwinner, Michael Bachhammer, Leonard Doyle, and Jörg Schreiber — Faculty of Physics, Ludwig-Maximilians-Universität München, Garching, Germany

In the field of particle acceleration, laser-driven ion acceleration has garnered significant research interest. Recent studies have identified several key parameters in the laser-target interaction that can be optimized to maximize particle acceleration efficiency. However, interpreting results when tuning these parameters is often challenging due to the high shot-to-shot variability inherent in laser systems, such as the PW-class Advanced Titanium Sapphire Laser (ATLAS) at the Centre for Advanced Laser Applications (CALA). If these variations stem from statistical fluctuations, one potential solution is to perform a large number of shots to average out the laser-induced variations. This approach necessitates a high-repetition-rate laser and target system, which is a major focus of current research. Another strategy is to directly monitor the key laser parameters just before the laser interacts with the target, without compromising the full laser power delivered to the target. This poses a significant challenge, as monitoring a laser capable of turning matter into plasma requires sophisticated optical systems. Such minimally invasive systems must split the laser beam, directing a small, predictable portion to diagnostic tools while ensuring that the remaining high-energy beam remains unperturbed and reaches the target. The presentation will include preliminary designs, concepts, and first results for this innovative diagnostic setup.

AKBP 9.7 Thu 15:30 ZHG004

100Hz repetition rate, high energy Ti:Sapphire amplifier for laser plasma acceleration — •Thomas Hülsenbusch, Timo Eichner, Man Jiang, Juan B. Gonzalez-Diaz, Adbullah Yousefi, Jelto Thesinga, Mikhail Pergament, Wim P. Leemans, Guido Palmer, and Andreas R. Maier — Deutsches Elektronen-Synchrotron DESY, Notkestrasse 81, 22607 Hamburg, Germany

To move Laser Plasma Acceleration (LPA) from a few-shot, proof-of-principle experiments to applications, it is necessary to increase the repetition rate of the driving laser to the kHz range. While it has been shown that Ti:Sapphire (Ti:Sa) lasers can deliver the high quality, high intensity pulses required for LPA, the high quantum defect of Ti:Sa poses a major challenge for high repetition rate operation. As a first step towards kHz operation, we here present experimental results on a 100Hz Ti:Sa amplifier that delivers pulses of $>$700 mJ energy, supporting a transform limited pulse duration of $<$30 fs. The thermal lens can be managed with cryogenic cooling of the laser crystal, allowing a high beam quality of $M^2 < 1.7$ at 100Hz to be maintained. This laser will enable high repetition rate LPA experiments in the near future.