AKBP 8: Poster AKBP

Time: Wednesday 9:30–11:00 Location: P4

AKBP 8.1 Wed 9:30 P4

Status of the Automated Activation of GaAs Photocathodes at Photo-CATCH* — •Markus Engart, Joachim Enders, Maximilian Herbert, Robin Petry, Julian Schulze, and Vincent Wende — Institut für Kernphysik, TU Darmstadt, Germany

Photocathodes based on the III-V seminconductor GaAs are used as photo-electron sources to supply spin-polarized electron beams for accelerator applications. In order to achieve a sufficient electron yield, a thin surface layer of cesium combined with an oxidant is applied onto the cathode surface in a process called the cathode activation. It is typically done manually by an experienced operator. This contribution presents the current status in the development and testing of an adaptive algorithm for automated activation at the Photo-CATCH test stand.

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AKBP 8.2 Wed 9:30 P4

Status of the beam dynamics design of the bunch compressor for DALI — •Arthur Delan[1], Ulf Lehnert[1], Atoosa Meseck[2], Najmeh Mirian[1], Raffael Niemczyk[1], and Andreas Wagner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Helmholtz-Zentrum Berlin, Berlin, Germany

Dresden Advanced Light Infrastructure (DALI), a new 50 MeV superconducting linear accelerator at the Helmholtz-Zentrum Dresden-Rossendorf on the national shortlist of research infrastructures, is envisaged as the successor to ELBE, which has served users for over 20 years. Improving on the capabilities of ELBE, DALI contains a superradiant THz source designed to operate between 0.1 and 3 THz, driven by bunch charge increased up to 1 nC. Achieving the required form factor for superradiant emission demands sub-wavelength bunch lengths. The combination of high bunch charge and medium energy causes collective effects such as space charge forces and coherent synchrotron radiation emission to be significant contributions to the beam dynamics. Simulations of the compression and the status of the design for this bunch compressor are presented.

AKBP 8.3 Wed 9:30 P4

Gaussian Process Regression and Bayesian Optimization for a 90 MeV Laser-Plasma Injector for the cSTART Storage Ring — •David Squires, Elias Sailer, Joseph Natal, Alexander Saw, Nathan Ray, and Matthias Fuchs — Karlsruhe Institute of Technology, Kaiserstraße 12 76131 Karlsruhe

Laser-plasma accelerators (LPAs) generate ultrashort high intensity electron bunches from a compact source size. At the Karlsruhe Institute of Technology (KIT), we will use an LPA as one of the injectors for the compact, high-acceptance, non-equilibrium storage ring cSTART.

The LPA injector will be based on an ionization trapping scheme in combination with a tailored plasma density profile to produce an electron beam with small energy spread that maximizes the charge at our target energy, which is at (for LPAs) comparably low energies of 50-90 MeV. Moreover, the LPA injector must produce controlled electron beams with a high shot-to-shot stability and avoid high-energy runaway electrons. These goals can be achieved largely by the detailed design of the plasma density profile and the laser pulse parameters.

In an LPA, small changes across the high-dimensional parameter space can have an outsized influence on overall performance. To handle this challenge, we perform particle-in cell (PIC) simulations and use machine-learning driven approach using Gaussian Process Regression (GPR) and Bayesian Optimization (BO). This procedure allows us to both optimize our gas target design and characterize the effects of the interaction parameters, giving us a functional LPA with a simple tuning mechanism.

AKBP 8.4 Wed 9:30 P4

Programmable Focal Elongation and Shaping of High-Intensity Laser Pulses using Adaptive Optics — •Peter Blum[1], Anna Puchert[1], Emily Archer[1], Sören Jalas[1], Spencer W. Jolly[2], Jens Osterhoff[1,3], Wim P. Leemans[1], Manuel Kirchen[1], Andreas R. Maier[1], and Rob J. Shalloo[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Service OPERA-Photonique, Université libre de Bruxelles (ULB), Brussels, Belgium — [3]now at Lawrence Berkeley National Laboratory

Controlling the intensity distribution of laser pulses in the focal region is becoming increasingly important across many areas of high-intensity laser-matter interactions. Rather than focusing light to a single longitudinal point, like a parabolic mirror, it is often desirable to focus light to a line segment along the optical axis, allowing for the generation of extended regions of high laser intensity. Optics for generating such intensity structures, sometimes referred to as *axioptics*, include the axicon, the axilens, and the more recently proposed axiparabola.

In laser-plasma accelerators, *axioptics* are essential for forming optically-generated plasma waveguides and for enabling advanced plasma acceleration techniques, including dephasingless wakefield acceleration. Current solutions of tailoring the focal region rely on custom off-axis solutions or diffractive/refractive optics which can be expensive and senstive misalignment and/or aberrations. Here, we present an alternative approach for programmatically generating and shaping extended regions of high intensity, utilising common optical components; an adaptive optic and an off-axis parabolic mirror.

AKBP 8.5 Wed 9:30 P4

Towards spectroscopic characterization of in-target gold fission fragments — •Syed A. Raza[1,2], Maximilian J. Weiser[1], Erin G. Fitzpatrick[1], Laura D. Geulig[1], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians-Universität München, Garching, Germany — [2]University of Bologna, Bologna, Italy

The fission fusion reaction mechanism aims to produce neutron-rich nuclei near the magic neutron number N = 126, which are important for understanding the r-process. A key prerequisite for enabling this mechanism is achieving high bunch densities of accelerated heavy ions, which is why laser-based acceleration is used [1].

In recent experiments at CALA on the acceleration of gold from 300-600 nm foils, using a Thomson parabola spectrometer and CR39 track detectors as diagnostics, we unexpectedly observed a heavy-ion component in the region of $m/q = 2 - 2.5$, where only light ions were expected. This component could be determined to be $A \approx 98$ and attributed to in-target fission fragments [2].

In our experiment in order to unambiguously identify these heavy ions as Au fission fragments, we will use gold target foils ($\approx 300nm - 2\,\mu$m) at CALA and implement a down-stream Mylar catcher foil in front of TPS with a central hole on the target-normal axis to allow accelerated ions to reach the TPS, while the rest will be implanted in the catcher foil and transported out of the vacuum to a well-shielded HPGe detector for characterization of (long-lived) species.

[1] D.Habs et al., Appl. Phys. B 103, 471–484 (2011).
[2] L. D. Geulig, Dissertation LMU, Munich 2025

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MeV-UED: An instrument for experiments on the atomic scale in space and time — Jakob Krämer[1], Verena Kümper[1], Moritz Pfeiffer[1,2], •Christoph Quitmann[1], and Ariane Ufer[1,2] — [1]RI Research Instruments GmbH Friedrich-Ebert-Str. 75 51429 Bergisch Gladbach — [2]III. Physikalisches Institut B, RWTH Aachen, 52056 Aachen

Current research focuses on investigating promising materials that are potential candidates for applications as nano, quantum and energy technologies. For these kind of materials information about static atomic structures and how they change in time is of crucial importance. Such changes happen upon absorption of energy, during chemical reactions, or in phase transitions. In order to observe these changes, it is necessary to measure atomic positions with sub-Å spatial and sub-ps temporal resolution. RF-Photocathodes excited with ultra-short laser pulses allow generation of electron pulses with MeV energies. Such pulses can be used for diffraction experiments where they create Bragg peaks with ca. mrad angles.

We introduce a commercial robust MeV-UED instrument aimed at ultra-fast electron diffraction with 100fs temporal and sub Å spatial resolution based on a 2.5-cell warm RF-gun and a commercial Ti:Sa laser. This instrument is compatible with solid , liquid or gaseous samples (incl. cryogenic option). We present the main design considerations, electron beam dynamics simulations, and the engineering design of the RI-Bornite MeV-UED instrument.

AKBP 8.7 Wed 9:30 P4

Advancing Resolution in LWFA-Driven X-ray Probing of Laser-Nanostructure Interactions — •Maurice Zeuner[1], Moritz Foerster[1], Florian Haberstroh[1], Johannes Zirkelbach[1], Felipe Peña[1,3], Sonja Gerlach[1], Enes Travac[1], Sanchita Sharan[1], Mohamed Ayache[1], Marius S. Schollmeier[2], Gregor Schilling[1], Andreas Döpp[1], Daniel E. Rivas[2], and Stefan Karsch[1] — [1]Ludwig-Maximilians-Universität München, Fakultät für Physik, Am Coulombwall 1, Garching 85748, Germany. — [2]Marvel Fusion, Theresienhöhe 12, 80339 Munich, Germany — [3]Department of Physics, University of Oslo, Olso, Norway

A novel inertial fusion concept (by Marvel Fusion) proposes the use of nanostructured targets in the form of arrays of thin rods that are irradiated by high-intensity laser pulses. The resulting interaction potentially enables heating and compression of mixed solid fusion fuels. Experimental validation of this approach is crucial, but the underlying dynamics unfold on femtosecond time scales and nanometer length scales, posing significant diagnostic challenges. In the framework of the VANLIFE collaboration, this work investigates the feasibility of probing nanostructured targets during the laser-target interaction using laser-driven plasma-wakefield accelerators for X-ray generation, delivering ultrashort and high-brightness pulses via Betatron radiation. We want to explore possibilities to use these radiation sources to probe the interaction at such nano targets and gain a better understanding of diagnostic challenges in probing rapidly expanding, high-density laser-plasma interactions.

AKBP 8.8 Wed 9:30 P4

A Roadmap towards Direct Imaging of Plasma Targets during Laser Acceleration using Computation X-Ray Holography — •Ritz Ann Aguilar[1], Long Yang[1], Yangzhe Cui[1], Lingen Huang[1], Martin Rehwald[1], Toma Toncian[1], Karl Zeil[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], Thomas Cowan[1,3], and Jeffrey Kelling[1,4] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]CASUS, Görlitz, Germany — [3]TU Dresden, Germany — [4]TU Chemnitz, Germany

Accurate density diagnostics of laser-driven targets are essential for optimizing high-intensity experiments in laser-plasma acceleration (LPA) and inertial-confinement fusion (ICF). We apply a computational X-ray imaging workflow based on single-shot, in-line coherent holography that records diffraction patterns with strong phase contrast and reconstructs spatial phase, and thus density, from intensity-only data. We use differentiable optical propagators and physics-informed machine-learning-assisted phase retrieval to recover fine-scale structures. As a proof of concept, we present reconstructions of laser-irradiated hydrogen gas jets, resolving features relevant to plasma tailoring and injection control. This is compatible with external light sources and compact plasma-based X-ray sources, supporting feedback-oriented operation on LPA platforms. We also outline an application to ICF: XFEL-based coherent diffraction imaging of shock-compressed solid hydrogen. At the European XFEL's HED-HIBEF instrument, the approach targets resolving fuel-compression dynamics down to sub-micron scales, addressing a central diagnostic need for high-gain implosion studies.

AKBP 8.9 Wed 9:30 P4

Preliminary Studies for a Colliding Beam Møller Polarimeter — •Philipp J. Kompa — JGU Mainz

The Colliding Beam Møller Polarimeter is a proposed setup for measuring the spin polarisation of electron beams with high precision. The proposed setup promises improved systematic uncertainties compared to existing polarimeters which have uncertainties around 0.5%. There are some experimental challenges, one of them being the low cross section of Møller scattering and the therefore low scattering rate even with the high average currents needed for experiments at MESA.

This work discusses the experimental challenges, focusing on background measurements and estimations of how far the background may be suppressed by using coincident measurement of the scattered electrons.

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Development of a precision timing system for beam background characterization using plastic scintillators — •Florian Eisele[1], Fabian Hummer[1], and Luca Scomparin[2] — [1]Institute for Data Processing and Electronics, KIT — [2]SLAC National Accelerator Laboratory

Many facilities employ beam loss monitors that report time-averaged loss rates and do not support precise time-of-arrival measurements. We developed an FPGA-based read-out system that, in combination with plastic scintillator detectors, enables beam loss measurements with sub-nanosecond time resolution over multi-second acquisitions. After calibrating the system with cosmic particles, we commissioned this system at the (50 - 500 MeV) booster synchrotron of the Karlsruhe Research Accelerator (KARA). This measurement campaign demonstrated the potential of this new technique. First, we characterized the beam background with nanosecond-level timing precision. Second, we acquired the accelerator clock and injection triggers, in order to correlate the beam background with beam injection, storage and extraction. We prove that the revolution timing structure of the beam current is present in the beam loss. In addition, we showed versatility of the readout system to sample the signals of a stripline sensor at the KARA main ring. In this contibution, we present the FPGA based data acquisition system, first commissioning results and discuss future applications of this technique.