AKBP 10: Novel Accelerator Concepts IV and Applications

Time: Thursday 16:15–18:15 Location: ZHG004

AKBP 10.1 Thu 16:15 ZHG004

Studies on laser driven fission at CALA — •Maximilian J. Weiser, Erin G. Fitzpatrick, Laura D. Geulig, Jinbao Hong, and Peter G. Thirolf — Ludwig-Maximilians-Universität München, Garching, Germany

The field of laser ion acceleration has attracted great interest in the recent years as an alternative to classical accelerators due to its unique features like a small footprint, short bunch duration and solid state like bunch densities. Especially the latter is crucial for studying the so-called *fission-fusion* nuclear reaction mechanism which could help exploring the r-process nucleosynthesis of heavy elements in the Universe. A necessary preliminary study for realising this mechanism experimentally is to gain a better understanding how fission induced by light particles impinging onto high-Z elements performs [1]. For this reason, we developed a gas-based transportation system which enables us to transport the fission products away from our EMP-contaminated experimental chamber to a shielded HPGe γ-detector. In our first experimental campaign conducted at the Centre of Advanced Laser Applications (CALA) we found that the expected fission products could not be measured due to a to small yield arriving at the detector. Therefore, we are currently focusing onto improving the amount of produced fission fragments and the transport efficiency of the setup. This work has been funded by the BMBF under Grant No. 05P24WM2. We acknowledge the GSI target lab (Dr. Bettina Lommel) for providing the U targets. [1] D. Habs et al., Appl. Phys. B 103, 471-484 (2011)

AKBP 10.2 Thu 16:30 ZHG004

Improved strong-field QED rates for collisions of particle-beams with high-power laser pulses — •Nikita Larin[1,2,3] and Daniel Seipt[1,2,3] — [1]Helmholtz Institute Jena, Jena, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [3]Institute of Optics and Quantum Electronics, Jena, Germany

In collisions of high-energy particle beams with intense laser pulses, dominate effects of strong field QED (SFQED), such as emission of high-energy gamma rays and pair production. Contemporary particle accelerators, combined with high-intensity lasers, make the observation of these effects feasible. And for successful experimental measurements, the reliable numerical simulations are of the great importance.

The key component of these simulations are the probability rates, which contain information about the quantum nonlinear processes that play a significant role in such extreme conditions. These rates can be readily implemented in Monte-Carlo modules amending laser-plasma and laser-beam simulation codes.

In this talk, I will present a new derivation of the so-called "locally monochromatic approximation" of SFQED processes. It is suited to simulate SFQED processes in beam-laser collisions in the transition regime from perturbative to nonperturbative QED, such as the LUXE project [1] aims to measure. Moreover, our new derivation allows us to remedy some technical issues of the previously known rates.

[1] H. Abramowicz et al., Eur. Phys. J. Spec. Top. **230** (2021) 2445-2560.

AKBP 10.3 Thu 16:45 ZHG004

Nonlinear Breit-Wheeler pair production using polarized photons from inverse Compton scattering — •Daniel Seipt[1], Mathias Samuelsson[2], and Tom Blackburn[2] — [1]Helmholtz Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [2]Department of Physics, University of Gothenburg, SE-41296 Gothenburg, Sweden

The production of electron-positron pairs from the collision of photons is one of the most elusive processes in QED. Observing multiphoton electron-positron pair production (the nonlinear Breit-Wheeler process) requires high-energy γ rays to interact with strong electromagnetic fields. In order for these observations to be as precise as possible, the γ rays would ideally be both mono-energetic and highly polarized. In this talk I will present Monte Carlo simulations of an experimental configuration that accomplishes this in two stages. First, a multi-GeV electron beam interacts with a moderately intense laser pulse to produce a bright, highly polarized beam of γ rays by inverse Compton scattering. Second, after removing the primary electrons, these γ rays collide with another, more intense, laser pulse in order to produce pairs. I will show that it is possible to measure the γ-ray polarization dependence of the nonlinear Breit-Wheeler process in near-term experiments, using a 100-TW class laser and currently available electron beams. Furthermore, it would also be possible to observe harmonic structure and the perturbative-to-nonperturbative transition if such a laser were colocated with a future linear collider.

AKBP 10.4 Thu 17:00 ZHG004

Real-time search for Dark Photons at the Upgraded LHCb experiment — •Carlos Eduardo Cocha Toapaxi — Heidelberg University, Heidelberg, Germany

Different theoretical model predicts the existence of dark matter mediators which interact minimally with standard model particles. Charm decays are an excellent place to search for dark photons, one kind of light dark matter mediators. The challenge to reconstruct dark photons consists in finding a peak on top of an irreducible non-resonant background of several kHz. Here the search profites enormously from the novel real-time analaysis strategy implement at the LHCb experiment in Run 3. LHCb can read out the entire detector in real time (at 30 MHz) and filter interesting events through a two-stage software trigger using farms of GPUs (first stage) and CPUs (second stage). Sophisticated online selections are employed at both trigger stages to select charm decays, identify the extremely soft electrons that dark photons decay into, and reduce the overwhelming combinatorial background, followed by a dedicated offline selection. In this talk we present the trigger selections and initial sensitivity estimates for dark photons in LHCb Run 3.

AKBP 10.5 Thu 17:15 ZHG004

Simulations of Beam Dynamics and Beam Lifetime for the Prototype EDM Ring — •Saad Siddique for the JEDI and CPEDM Collaborations-Collaboration — GSI Darmstadt Germany

The matter-antimatter asymmetry may be explained through CP-violation by observing a permanent electric dipole moment (EDM) of subatomic particles. An advanced approach to measure the EDM of charged particles is to apply a unique method of "Frozen spin" on a polarized beam in an accelerator. To increase the experimental precision step by step and to study systematic effects, the EDM experiment can be performed within three stages: the magnetic ring COSY (Cooler Synchrotron Juelich), a prototype EDM ring and finally all electric EDM ring. The intermediate ring will be a mock-up of the final ring, which will be used to study a variety of systematic effects and to implement the basic principle of the final ring. The simulations of beam dynamics of prototype EDM ring with different lattices were performed to optimize the beam lifetime and to minimize the systematic effects. After getting beam losses estimations by using analytical formulas for preliminary design of prototype EDM ring , beam-target interaction have been studied in detail which helped to find optimized position of target in storage ring for minimum beam losses. After finding dynamic aperture by using more sophisticated program Bmad, a long term tracking is being performed along with beam-target interactions. Further investigations to reduce systematic effects are also under process.

AKBP 10.6 Thu 17:30 ZHG004

Precision measurement of the beam polarisation for the P2 experiment — •Rakshya Thapa — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

A 5 MeV Mott polarimeter will be implemented at Mainz Energy-recovering Superconducting Accelerator (MESA) to precisely measure the polarisation of the polarised electron beam. The polarimeter is being fabricated and will soon undergo a pilot test at MAMI.

AKBP 10.7 Thu 17:45 ZHG004

Status of the Laser Compton Backscattering Source at the S-DALINAC* — •Lisa Dingeldein, Michaela Arnold, Adrian Brauch, Manuel Dutine, Ruben Grewe, Lars Jürgensen, Maximilian Meier, Norbert Pietralla, Felix Schliessmann, and Dominic Schneider — Institut für Kernpysik, Technische Universität Darmstadt, Darmstadt, Germany

The COmpton Backscattering at a Recirculating Accelerator (COBRA) project utilizes a high-power laser, which is well synchronized to the electron beam of the Superconducting DArmstadt LINear

ACcelerator (S-DALINAC). The backscattering provides high-energy photons for diagnostic and nuclear-photonic applications. A stable and precise laser beam transport to the interaction point in an evacuated beamline is ensured before COBRA will be used during an upcoming operation of the Energy Recovery Linac (ERL). The installation of laser safety precautions, methods for centered alignment of both beams and the detector for the backscattered photons, along with recurring measurements of the laser parameters will be presented.

*Work supported by DFG (GRK 2128, IRTG 2891, Inst163/308-1 FUGG)

AKBP 10.8 Thu 18:00 ZHG004

Advanced bandwidth and energy control of an all-optical hard Compton X-ray source — •Martin Meisel[1], Simon Bohlen[1], Theresa Brümmer[1], Florian Grüner[2], Cristina Mariani[1,2], Theresa Staufer[2], Jonathan Wood[1], Jens Osterhoff[3], and Kristjan Poder[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]Universität Hamburg and Center for Free-Electron Laser Science, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

Compact, tunable X-ray sources with narrow bandwidths are essential for many applications. Laser-plasma accelerator-driven inverse Compton scattering sources show promise but are limited by broad bandwidths and low photon flux. Using an active plasma lens for electron beam tailoring, we demonstrated X-ray tunability from 34 keV to 81 keV without moving parts and reduced electron bunch-induced broadening, achieving a threefold improvement in total bandwidth. Ongoing work to shape the scattering laser aims to further narrow the bandwidth and boost photon production, paving the way for highly precise and efficient compact X-ray sources for future applications.