HK 38: Beschleunigerphysik VIII

Convenor: Wolfgang Hillert

Zeit: Mittwoch 14:00–16:20 Raum: HG ÜR 8

HK 38.1 Mi 14:00 HG ÜR 8

Design Study for the LHeC — Helmut Burkhardt[1], •Miriam Fitterer[1,2], and Anke-Susanne Müller[2] — [1]CERN, Geneva, Switzerland — [2]KIT, Karlsruhe, Germany

The Large Hadron Electron Collider (LHeC) study aims at lepton-proton collision with center of mass energies in the TeV range and a luminosity of around 10^{33} $cm^{-2}s^{-1}$. In order to achieve this, the existing 7 TeV LHC proton beam has to collide with a 50 to 140 GeV electron beam. Presently two options are considered as electron accelerator: the so called "linac-ring" and "ring-ring" option. Both options provide the possibility to operate in parallel with proton-proton or ion-ion collisions and imply either the construction of a linear accelerator respectively energy recovery linac or the installation of an additional electron storage ring in the existing LHC tunnel. In this paper we give an overview of the LHeC ring-ring option with emphasis on the design and beam dynamics of the electron storage ring.

Gruppenbericht HK 38.2 Mi 14:15 HG ÜR 8

Challenges for an application-ready, high charge laser electron accelerator — •Stefan Karsch, A. Popp, M. Heigolt, J. Wenz, K. Khrennikov, S-W. Chou, Zs. Major, M. Fuchs, R. Weingartner, A. Meier, P. Polzer, T. Weineisen, F. Grüner, and F. Krauss — Fakultät für Physik Ludwig-Maximilians-Universität München & Max-Planck-Institut für Quantenoptik

Laser-wakefield electron acceleration has experienced a breathtaking progress over the past five years since the first experimental demonstration of quasi-monoenergetic electron spectra from such an accelerator. The GeV frontier has been overcome, and sort-of-stable operation has been reported from several groups. In our group, this has recently led to the first demonstration of soft X-ray undulator radiation from a laser-driven source, which raises hopes towards reaching higher photon energies and/or FEL operation. Especially for the latter, the challenges nevertheless are formidable. Current laser driven electron bunches lack at least a factor of 10 in both charge and spectral purity, and are not yet fully characterized in their temporal properties. We will outline our future experimental approach to tackle these issues and develop first application-ready all-optical radiation sources.

HK 38.3 Mi 14:35 HG ÜR 8

Density Measurement inside a Sapphire Capillary for Laser Wakefield Acceleration — •Tobias Weineisen[1,2], Shao-wei Chou[1,2], Matthias Fuchs[1,2], Stefan Karsch[1,2], and Florian Grüner[1,2] — [1]Max Planck Institut für Quantenoptik, München, Deutschland — [2]Fakultät für Physik der LMU, München, Deutschland

Laser wakefield accelerators have shown 1 GeV electron beams from centimeter-length gas capillaries. However, these beams typically have energy spreads on the order of a few percent. In order to improve this, a plasma density gradient can be introduced to control the self-injection process of the electrons into the accelerating wakefield. First experiments have already shown stable electron bunches with longitudinal and transverse momentum spreads more than 10 times lower than previously achieved. The self-injection and acceleration can be combined by embedding a high-density gas jet into a capillary. A new method utilizing density dependence of Raman scattering has been used to characterize the gradient inside the capillary with a 12 mu resolution. This allowed us to measure a density drop of a factor of ten within a few hundred micrometers inside the capillary.

HK 38.4 Mi 14:50 HG ÜR 8

Active control of laser-wakefield-accelerated electrons using magnetic quadrupole lenses — •Raphael Weingartner[1,2], Matthias Fuchs[1,2], Antonia Popp[1,2], Sebastian Raith[1,2], Stefan Becker[1,2], Shao-wei Chou[1,2], Matthias Heigoldt[1,2], Konstantin Khrennikov[1,2], Johannes Wenz[1,2], Benno Zeitler[1,2], Zsuzsanna Major[1,2], Jens Osterhoff[1,2], Ferenc Krausz[1,2], Stefan Karsch[1,2], and Florian Grüner[1,2] — [1]Ludwig Maximilians Universität, München, Deutschland — [2]Max-Planck Institute für Quantenoptik, Garching, Deutschland

Laser-wakefield acceleration is maturing into a stable source of ultra-relativistic electron beams. We show experimental data of the active control of these novel beams after their generation by using miniature magnetic quadrupole lenses. These devices address the main challenges of high divergence and pointing fluctuations of several mrad whilst still maintaining the intrinsic advantages of ultrashort pulse duration of around 10 fs and expected low emittance. This technology allows the realization of compact synchrotron sources and is of central importance for future applications such as the table-top free-electron laser (TT-FEL). A next step will involve using such lenses for emittance measurements.

HK 38.5 Mi 15:05 HG ÜR 8

Research on laser induced particle acceleration — •Natascha Raab[1], Markus Büscher[1], Oswald Willi[2], Toma Toncian[2], and Andreas Lehrach[1] — [1]Institut für Kernphysik (IKP) and Jülich Center for Hadron Physics (JCHP), Forschungszentrum Jülich — [2]Institut für Laser-Plasma Physik (ILPP), Heinrich Heine Universität Düsseldorf

IKP and ILPP cooperate on research of laser-induced particle acceleration. Measurements are carried out with the high-contrast 100-TW laser system PULSAR of the ILPP.

By focusing the laser beam on thin solid targets or gas jets a plasma is produced at the interaction point and particles from the target are accelerated. Properties like energy- and angular distribution of these particles have been measured. Magnetic systems, like dipole and quadrupole magnets will be employed to adapt their phase space such that they can efficiently be injected into conventional accelerators. In this talk a report on the status of the measurements will be given.

HK 38.6 Mi 15:20 HG ÜR 8

Nuclear based diagnostics in high-power laser applications — •Marc Günther[1], Kerstin Sonnabend[1], Karsten Vogt[2], Vincent Bagnoud[2], Knut Harres[1], Anke Otten[1], and Markus Roth[1] — [1]TU Darmstadt, Institut für Kernphysik, Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

High-power lasers allow focused intensities of $>10^{18}$ W/cm^2. During the laser-solid interaction, an intense relativistic electron current is injected from the plasma into the target. One challenge is to characterize the electron dynamic close to the interaction region. Moreover, next generation high-power laser proton acceleration leads to high proton fluxes, which require novel, nuclear diagnostic techniques. We present an activation-based nuclear pyrometry for the investigation of electrons generated in relativistic laser-solid interactions. We use novel activation targets consisting of several isotopes with different photo-neutron disintegration thresholds. The electrons are decelerated inside the target via bremsstrahlung processes. The high-energy bremsstrahlung induces photo-nuclear reactions. In this energy range no disturbing low energy effects are important. Via the pyrometry the Reconstruction of the absolute yield, spectral and spatial distribution of the electrons is possible. For the characterization of proton beams we present a nuclear activation imaging spectroscopy (NAIS). The diagnostic is based on proton-neutron disintegration reactions of copper stacked in consequtive layers. An autoradiography of copper layers leads to spectrally and spatialy reconstruction of the beam profile.

HK 38.7 Mi 15:35 HG ÜR 8

High-power laser infrastructure at MPQ: ATLAS laser facility — •Konstantin Khrennikov[1], Johannes Wenz[1], Matthias Heigoldt[1], Zsuzsanna Major[1], Antonia Popp[1], Raphael Weingartner[1], Matthias Fuchs[1], Joseph Irlinger[1], Patrick Heissler[1], Daniel Jung[1], Daniel Kiefer[1], Rainer Hoerlein[1], Klaus Witte[1], Dieter Habs[1,2], Ferenc Krausz[1,2] und Stefan Karsch[1] — [1]Max Planck Institut für Quantenoptik, Garching, Germany — [2]Ludwig-Maximilians-Universität, München, Germany

In recent years, laser-wakefield acceleration (LWFA) has shown a potential to become a common compact source of ultra-relativistic particles. However the laser parameters should meet tight specifications to make the scheme successful and reliable. In order to reach this goal the ATLAS laser at MPQ has undergone a major upgrade. The pulse length has been reduced to 25fs to fit perfectly to the half plasma-wavelength(by conventional densities in the order of 10^{18} cm^{-3}). Pulse energy has been increased to 2J to extend the acceleration length (and hence output electron energies). Automatic beam alignment system has been introduced to stabilize the laser pointing, which is a key feature for the stability of final laser parameters, which in turn leads to increase in field reproducibility on target. First steps towards temporal contrast improvement have been made to make the laser appropriate also for thin-foil acceleration schemes (where best results are achieved with minimal foil thickness of several nm, which are readily destroyed by even weak prepulses). Future upgrade plans will be presented leading to futher enhancement of particle beam characteristics.

HK 38.8 Mi 15:50 HG ÜR 8

Pulskompression an einem Hochrepetitionslasersystem am DESY Hamburg — •Martina Beer — DESY Hamburg

Das 'Seeding' eines Freie-Elektronen-Lasers (FEL) erfordert ein Lasersystem mit Pulsen im fs-Bereich, Pulsleistungen von ca. 100 GW und Repetitionsraten, die der Bunchrepetition des Linearbeschleunigers entsprechen (z.B. 1MHz bei FLASH). Doch bereits die Entwicklung eines 'seed'-Lasers mit einer Repetitionsrate von 100kHz ist anspruchsvoll, da neben einer kurzen Pulsdauer auch eine Mindestpulsenergie erreicht werden muß. Letztere ist nötig, um statistische Effekte des SASE-Prozesses (Self-Amplified-Spontaneous-Emission) zu überdecken.

Am DESY in Hamburg werden z.Z. verschiedene Konzepte zur Pulsverkürzung an einem Yb:YAG-Laser (800fs, 1030nm, 0.7mJ, 100kHz) getestet. In einem der Verfahren benutzt man eine mit Argon gefüllte Glaskapillare, in welcher der Laserpuls durch nicht-lineare optische Effekte eine spektrale Aufweitung erfährt. Nach dem Austritt aus der Kapillare kann der Puls, der nun eine zeitabhängige Frequenz hat, durch eine geeignete dispersive Strecke verkürzt werden.

Es sollen der aktuelle Stand der Untersuchungen und geplante wissenschaftliche Anwendungen der so verkürzten Pulse vorgestellt werden.

HK 38.9 Mi 16:05 HG ÜR 8

Longitudinal Electron Bunch Profile Measurement with Electro Optic Sampling at the Radiation Source ELBE — •caglar kaya, wolfgang seidel, and christof schneider — Radiation Source ELBE, Bautzner Landstraße 400 01328 Dresden, Germany

At the ELBE Accelerator at the Forschungszentrum Dresden (FZD) we want to perform longitudinal electron bunch profile measurement with Electro Optic Sampling (EOS) technique. We present the preliminary measurement results. The EOS technique is based on the change in the optical characteristics of a birefringent crystal due to the electric field induced by the passage of electrons in the vicinity of the crystal. Therefore we use femtosecond laser (Ti:Sa) pulses to probe the change of birefringence in the electro-optic ZnTe crystal. The resolution in the experiment is limited to about 250 fs by the bandwidth of the detection equipment. One of the important steps in the measurement is to synchronize the Ti:Sa laser pulses emitted with a repetition frequency of 78 MHz with the 13 MHz radio frequency from the superconducting accelerator with low time jitter. The set-up required for determination of the temporal overlap of the femtosecond laser pulse with the real electron bunch was assembled with a OTR sensitive photodiode. The last synchronization step was tuning the time delay of the femtosecond laser relative to the electron bunch by an optical delay unit. By splitting the signal from the ZnTe crystal in a balance detector we achieve information about the longitudinal electron bunch profile.