AKBP 11: Diagnostics, Control and Instrumentation III

Time: Thursday 16:30–18:30 Location: AKBPa

AKBP 11.1 Thu 16:30 AKBPa

Experimental investigation of quadrupole-doublet alignment on the focus of laser-accelerated ions — •Luisa Tischendorf, Thomas Rösch, Felix Balling, Marc W. Berndl, Leonard Doyle, Lotta Flaig, Jens Hartmann, Sonja Kundel, and Jörg Schreiber — Ludwig-Maximilians-Universität München, Germany

Employing laser-accelerated ions in radiation related research requires control of ion bunch characteristics such as the energy spectrum and beam size. At the Centre for Advanced Laser Applications (CALA) we have investigated for this purpose a quadrupole doublet consisting of two permanent magnet quadrupoles (PMQs). The broad input energy distribution strongly determines the appearance of the proton focus at 1.8 m remote location, which we observe on a scintillating screen. Misalignments strongly affect the appearance of the downstream focus. We conducted a detailed experiment in which alignment parameters of the focusing system were varied to investigate their effect on the focal shape. We identified a smallest possible spot with dimension 1.2 mm by 0.8 mm. Buch profile calculations based on the matrix formalism provide a comparison to the experimental results and reveal that the source size of the proton emission in the laser-driven plasma is not negligible. This observation could provide an elegant way for determining the particle source emittance in future experiments.

AKBP 11.2 Thu 16:45 AKBPa

Efficient THz generation by tilted-pulse-front pumping in lithium niobate for the split-ring-resonator experiment at FLUTE — •Matthias Nabinger for the FLUTE-Collaboration — LAS, KIT, Karlsruhe

We develop a compact, longitudinal diagnostics for fs-scale electron bunches using a THz electric-field transient in a split-ring resonator (SRR) for streaking at the Ferninfrarot Linac- Und Test- Experiment (FLUTE). For this new streaking technique, intensive THz pulses are required, which will be generated by laser-based optical rectification. We present a setup for generating THz pulses using tilted-pulse-front pumping in lithium niobate at room temperature. Excited by an 800-nm Ti:Sa pump laser with 35-fs bandwidth-limited pulse length, conversion efficiencies up to 0.03% were achieved. Furthermore, the current status of the SRR experiment is shown.

AKBP 11.3 Thu 17:00 AKBPa

New bunch by bunch filling-pattern measuring system at ELSA — Klaus Desch, Dennis Proft, and •Alexandra Wald — Physikalischer Institut, Universität Bonn, Deutschland

The electron accelerator facility ELSA at the University of Bonn can accelerate and store electrons with a final energy from 0.8GeV up to 3.2GeV. To determine the filling pattern in the storage ring a new measuring system is developed. For hadron physics experiments the filling pattern, which is influenced by the injection from the pre-accelerator (the Booster-Synchrotron), should be as homogeneous as possible. The new measurement system should provide a real-time measurement of the filling pattern, so that a continuous optimisation of the injection becomes possible.

To measure the intensity and the position bunch by bunch for all 274 bunches, the signals of the existing BPMs will be digitised by fast 12-bit ADCs synchronous to the 500MHz ELSA radio frequency. The fast pre-processing and intermediate storage of the data is realised with a 500MHz clocked FPGA and transfers the data to a PC for further processing.

The measurement can be verified by a streak camera, which in this case is not suitable for the continuous measurement. The method and first measurements will be presented.

AKBP 11.4 Thu 17:15 AKBPa

Stabilisation der Strahlparameter für das P2 Experiment an MESA — •Ruth Kempf — Institut für Kernphysik, Becher-Weg 45, 55128 Mainz

Am neuen Elektronenbeschleuniger MESA am Institut für Kernphysik in Mainz soll das P2-Experiment den elektroschwachen Mischungswinkel $\sin^2\Theta_W$ mit einer bisher unerreichten Genauigkeit von 0,15 % bestimmen. Dafür wird die Asymmetrie, die durch die Elektron-Proton-Streuung der longitudinal spinpolarisierten Elektronen an unpolarisierten Protonen verursacht wird, gemessen. Wegen der vergleichsweise geringen Strahlenergie von 155 MeV beläuft sich die zu messende paritätsverletzende Asymmetrie auf ca. 30 ppb. Daher ist die systematische Unsicherheit auf 0,1 ppb am Ende der Strahlzeit von 10000 Stunden bei einem Strahlstrom von 150 μA begrenzt. Für eine solch hohe Präzision müssen die Strahlparameter Energie, Strom, Winkel und Position extrem stabil sein und mit einem entsprechend leistungsfähigen Regelungssystem kontrolliert werden. Das erstellte Konzept zur Regelung von Strahlwinkel und -position basiert auf einem digitalen System unter Verwendung von FPGAs und ist damit nicht nur extrem schnell, sondern auch äußerst flexibel an veränderliche Anforderungen anpassbar. Die hohe Genauigkeit der Strahllagemessung wird erreicht durch die Verwendung von Hohlraumresonatoren als Strahllagemonitore. Tests des Regelungssystems, das in diesem Vortrag vorgestellt wird, wurden am Mainzer Mikrotron MAMI durchgeführt und ergaben, dass die Anforderungen des P2-Experiments erfüllt werden und der MESA-Strahl ausreichend stabilisiert werden kann.

AKBP 11.5 Thu 17:30 AKBPa

A transmission ionization chamber for online monitoring of ion-bunch fluence and trajectory of laser-driven ions — •Lotta Flaig[1], Jona Bortfeldt[1,2], Jens Hartmann[1], Thomas Rösch[1], Martin Speicher[1], Johannes Gebhard[1], Leonard Doyle[1], Luisa Tischendorf[1], Marc Berndl[1], Felix Balling[1], Sonja Gerlach[1], and Jörg Schreiber[1] — [1]Ludwig-Maximilians-Universität München, Germany, Department of Medical Physics — [2]European Organization for Nuclear Research (CERN), Meyrin, Switzerland

Since laser-driven ion bunches have unique properties such as large particle numbers and a broad energy spectrum with comparably large shot-to-shot fluctuations, a fundamental requirement is the improvement of online-diagnostics. The Foil Electrode Ionization Chamber with Red Light Emission for Laser-Driven Ions (FIREFLI) is a minimal invasive transmission monitor aiming to detect fluctuations at 1 Hz laser repetition rate. The ionization charge produced by traversing ions can be measured by a gated integrator as a measure for the overall bunch charge. The entrance and exit windows as well as the electrodes of the ionization chamber consist of μm-thin aluminized foils that ensure a minimal material budget for transmitted ions. Simultaneously, locally produced scintillation light from the detector gas can be observed via a camera looking perpendicularly on the beam axis providing additionally a measure for the bunch trajectory inside FIREFLI. First experimental tests with laser-induced ionization as well as at a laser-driven ion beamline show promising results.

AKBP 11.6 Thu 17:45 AKBPa

Non-Destructive Bunch-Resolved 2D Beam Diagnostics at BESSY II — •Marten Koopmans, Ji-Gwang Hwang, Andreas Jankowiak, Markus Ries, Andreas Schälicke, and Gregor Schiwietz — Helmholtz-Zentrum Berlin

Due to the complexity of the filling pattern in the BESSY II electron-storage ring, bunch resolved diagnostics are required for machine commissioning and to ensure the long-term quality and stability of operation. Low-α operation and a possible BESSY VSR upgrade, in addition, demand bunch-length measurements with picosecond resolution. Therefore a dedicated beamline equipped with a fast streak camera was set up and successfully commissioned. Couplings between time- and space-coordinates do also call for bunch-selective and correlated multi-parameter detection methods. Thus, the same beamline and the streak camera have been made capable of direct beam-profile imaging and interferometry of the vertical beam size using the X-ray blocker bar method. Dependent on the polarization choice of visible light one may switch between these diagnostic methods. With an additional transverse dimension in the streak-camera image, bunch-resolved 2D measurements are possible. In the vertical direction the characteristic dip in the center of the image of the π-polarized synchrotron radiation can be observed at the streak camera. We also present a new method to study the properties of the PPRE bunch. Applying a statistical analysis of single-shot images enables one to distinguish between horizontal orbital motion and the broadening of the bunch due to the excitation. The results are compared with data from the BPM system.

AKBP 11.7 Thu 18:00 AKBPa

Laser development for L(P)WFA experiments and driver

laser pulse diagnostics and stability — •Florian Haberstroh — LMU Munich, Germany

The Center for Advances Laser Applications (CALA) combines powerful lasers and experimental areas with a focus on electron and ion acceleration. For such experiments the solid-state laser Atlas-3000 is developed. The lasers backbone, a chain of Ti:Sa based chirped pulse amplifiers (CPA) delivers an energy of up to 90J per pulse at a repetition rate of 1Hz and a central wavelength of 800nm. Compressing these pulses to 28fs (FWHM) yields a peak power of 2PW. Such a system can be used to drive a laser wakefield accelerator (LWFA) to generate electron bunches in the energy regime of GeV and with a charge of multiple nC. The accelerated electron's energy spectrum and charge is determined by the pulse parameters of the driving laser. But how sensitive is the acceleration process to temporal, spatial and spectral pulse properties? With the aim to eliminate pre-pulses and generate cleaner pulses, we evaluate the laser pulse's temporal contrast. It was just as important to ensure a flat wave front for amplification, compression and interaction with the target. Spectral and temporal pulse profiles are recorded during the experiments and are correlated to the accelerated electrons. We show measures to reduce breathing and to stabilize pointing of the focus in the gas target. Recorded HDR images build a 2D intensity map in and near the focus which helps evaluate the focus quality, for instance to optimizing the Strehl ratio.

AKBP 11.8 Thu 18:15 AKBPa

Optimization of laser wakefield accelerators using machine-learning methods — •Faran Irshad, Andreas Döpp, and Stefan Karsch — Ludwig-Maximilians-Universität München, Am Coulombwall 1, 85748 Garching, Germany

With advances in both laser technology and data-acquisition software, the number of parameters that can be tuned to directly influence the behavior of the Laser Wakefield accelerators (LWFA) have increased. One concern with LWFA has been one of stable operation and time spent in optimizing the electron beams. While the former is an engineering challenge, the latter can be improved using techniques from machine learning. Conventionally, optimizing LWFA parameters have been done by human operators on the run. We propose a more systematic approach to optimizing these parameters using sequential optimization on a Gaussian process (GP) model commonly referred to as Bayesian Optimization. Bayesian optimization treats the LWFA as a black-box function and uses GP to model it. The important features of the LWFA such as electron beam energy or peak charge are captured in an objective function defined by the user. This method was applied to FBPIC simulations to optimize plasma parameters such as plasma electron density and laser parameters such as focus position and spectral phase. We show a faster convergence of the laser-plasma interaction to the optimal settings in a computational experiment. In conclusion, the Bayesian optimization can significantly reduce optimization times of a LWFA and help achieve subtle tuning of parameters that otherwise are missed in single-variable scans.