AKBP 11: Plasma Accelerators, Diagnostics II

Time: Wednesday 16:30–17:30 Location: SCH/A117

AKBP 11.1 Wed 16:30 SCH/A117

Time-Resolved Optical Probing of Water Vapor Effects in Laser-Driven Ion Acceleration — •Kumudini Devendra Pagare, Florian Schweiger, Julia Liese, Alexander Prasselsperger, Sonja Gerlach, Hannah Forsthuber, and Jörg Schreiber — LMU München, Fakultät für Physik-Medizinische Physik, Am Coulombwall 1, 85748 Garching

Applications in laser-driven ion acceleration demand stable and reproducible ion beams with well-controlled properties. The quality of these ion beams depends critically on the dynamics of laser-target interactions, which are determined by both laser and target parameters. Time-resolved optical probing provides insight into these rapid interaction dynamics, revealing the processes responsible for ion acceleration and the mechanisms involved. Here, we examine how water vapor emitted from a recently implemented liquid-leaf target at the Centre for Advanced Laser Applications (CALA) influences the acceleration process. We employ interferometric diagnostics to quantify spatiotemporal vapor density profiles in front of the target surface. This allows us to assess how the expanding vapor interacts with the main laser pulse and affects ion acceleration. These findings elucidate the complex dynamics of laser-target interactions and help optimize the resulting ion beam properties. This work was supported by the DFG under Grant Number 558546291 and CALA.

AKBP 11.2 Wed 16:45 SCH/A117

Active mirror cooling concept for high average power, high peak power Ti:Sapphire laser amplifiers — •Anneli Dick[1,2], Juan B. Gonzalez-Diaz[1], Thomas Hülsenbusch[1], Leonie Jaworski[1], Lutz Winkelmann[1], Andreas R. Maier[1], and Guido Palmer[1] — [1]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany — [2]University of Hamburg, Hamburg, Germany

Advancing laser plasma accelerators from a few-hertz repetition rate to the kHz-regime is essential for unlocking next-generation applications, including free-electron lasers and direct synchrotron injection. Moreover, a high-repetition rate enables direct active stabilization of crucial laser parameters which will support sub-percent energy spread from the plasma accelerator. For efficient electron acceleration, 100 TW-level laser pulses are required, which are commonly generated by chirped pulse Ti:Sapphire amplifier systems. The Kaldera laser system at DESY is being developed to drive such a high-repetition-rate plasma accelerator. It is currently providing J-level energies at 100 Hz repetition rate. However, one major challenge of power scaling this material is the thermal load generated at high repetition rates and pump energies due to its high quantum defect. To control the resulting thermal effects more efficiently, new cooling concepts are required. Theoretical investigations on cryogenically cooled active mirror amplifiers have shown they can be a promising method to achieve this. The presented work evaluates this approach experimentally with respect to further power scaling of the Kaldera laser towards the multi-100 W range.

AKBP 11.3 Wed 17:00 SCH/A117

Patch-MLP-Based Predictive Control: Simulation with an Upstream Pointing Stabilization for PHELIX Laser System — •Jiaying Wang[1], Jonas Benjamin Ohland[3], Yen-Yu Chang[4], Vedhas Pandit[1], Stefan Bock[1], Andrew-Hiroaki Okukura[6], Udo Eisenbarth[3], Arie Irman[1], Michael Bussmann[1], Ulrich Schramm[1,2], and Jeffrey Kelling[1,5] — [1]HZDR, Dresden,Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [4]Amplitude laser group - Dresden operations, Germany — [5]Chemnitz University of Technology, Chemnitz, Germany — [6]Extreme Light Infrastructure - Nuclear Physics, National Institute for Physics and Nuclear Engineering, Ilfov, Romania

High-energy laser facilities such as PHELIX at GSI require excellent beam-pointing stability to ensure reproducibility and reliable operation. Conventional PID control mitigates slow drift but is fundamentally limited by diagnostic latency and mirror inertia. We introduce a predictive control scheme in which beam-pointing errors are forecast using a patch-based multilayer perceptron, and the predicted errors are converted into correction signals via a PID controller. This feed-forward strategy compensates for system delay and is trained directly on diagnostic time-series data. Simulations with an upstream correction mirror at the PHELIX pre-amplifier bridge show reduced residual jitter compared with conventional PID control. Across a 10-hour dataset, the predictive controller remained drift-free and improved pointing metrics by approximately 10%-20%.

AKBP 11.4 Wed 17:15 SCH/A117

2D Measurements of Laser Angular Chirps for the DRACO CPA Laser system — •Mohamed Samir[1,2], Maxwell LaBerge[1], Susanne Schöbel[1], Yen-Yu Chang[1], Patrick Ufer[1,2], Franziska Marie Herrmann[1,2], Stefan Bock[1], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]Technische Universität Dresden

Controlling spatio-temporal properties of ultrashort, high-power laser pulses is essential for laser-matter interactions, particularly Laser Wakefield Acceleration (LWFA). For such broadband pulses, angular dispersion (AD) becomes detrimental due to unavoidable transmissive optics or misalignment in the chirped-pulse amplification (CPA) chain. This dispersion induces wave-front tilt (WFT), degrading the focal spot, lowering the peak intensity on target, and introducing wakefield asymmetries that deflect the accelerated electron beam, thereby reducing the efficiency and stability of the acceleration process.

To quantify this for efficient LWFA and to support next-generation, dephasingless LWFA (DLWFA) concepts, we implemented a compact optical setup and conducted measurements at various positions along the 100-TW DRACO laser chain and inside the target chamber. The laser's AD and WFT were fully characterized in 2D and subsequently corrected at the target-chamber focal plane using the main TW compressor. The setup also enables precise spectral measurements, highly compact (~20 cm), lens configurable, and easily integrated.

These characterizations will support more stable, efficient laser wakefields, while serving as key diagnostics for DLWFA schemes.