AKBP 6: Plasma Accelerators, Ions II

Time: Tuesday 11:00–12:30 Location: SCH/A117

Topical Talk AKBP 6.1 Tue 11:00 SCH/A117

Efficient high energy and high-repetition-rate proton acceleration from cryogenic hydrogen foil targets — •Stefan Assenbaum[1,2], Martin Rehwald[1], Paweł Ordyna[1,2], Joshua Schilz[1,2], Maximilian Müller[1,2], Thomas Streil[1,2], Julian Garreis[1,2], Thomas Kluge[1], Sebastian Göde[3], Maxence Gauthier[4], Christopher Schönwälder[4], Ulrich Schramm[1,2], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]European XFEL, Schenefeld, Germany — [4]Stanford Linear Accelerator Center, Menlo Park, CA, USA

Laser plasma-based ion accelerators have not yet reached their full potential in producing high radiation doses at high particle energies, mainly due to the lack of a suitable high-repetition-rate targets that also provide adequate control of the plasma conditions. Cryogenic, solid hydrogen jet targets are being developed to fill this gap, as they combine many favourable properties for studying advanced laser ion acceleration regimes, such as low solid density, single ion species composition and ease of probing in experiments, with repetition-rated operation capability by being self-replenishing and debris-free. In a recent experiment, a new foil-like geometry of this cryogenic hydrogen target is used to accelerate proton bunches at 1 Hz repetition rate. Using the Draco PW laser at reduced laser energy, we report stable, continuous acceleration of ion beams over thousands of consecutive shots. Despite the low laser energy of only 1.6 J, we observe maximum proton energies of up to 50 MeV, indicating outstanding acceleration efficiency.

AKBP 6.2 Tue 11:30 SCH/A117

Hybrid study of the prepulse impact on cryogenic hydrogen target — •Arthur Hirsch Passicos[1], Stefan Assenbaum[1,2], Pawel Ordyna[1,2], Constantin Bernert[1], Thomas Kluge[1], and Martin Rehwald[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, 01328 Dresden, Germany — [2]Technical University Dresden, Dresden, Germany

Laser-driven ion accelerators have become more prominent in many fields of applications but are very sensititive to the target density profile in order to to determine the acceleration scheme of the main interaction. At HZDR, we demonstrated the use of cryogenic hydrogen jet targets shaped with controlled prepulse in order to optimise the proton acceleration.

Based on these results, we will present an hydrid study of the target shaping combining hydrodynamic and Particle-in-Cell simulations. By combining the two types of codes, we can correctly simulate and analyse the laser absorption processes, the target expansion as well as the acceleration schemes at play over a large range of pre-pulse intensities and delays.

AKBP 6.3 Tue 11:45 SCH/A117

PIC simulation study of highly efficient, high proton energy laser ion acceleration from cryogenic hydrogen jet targets — •Paweł Ordyna[1,2], Stefan Assenbaum[1,2], Thomas Kluge[1], Karl Zeil[1], and Ulrich Schramm[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Deutschland — [2]Technische Universität Dresden, Dresden, Deutschland

Recent experiments on laser ion acceleration using planar cryogenic hydrogen jet targets have demonstrated high laser to proton coupling efficiency and maximum proton energies that far exceed expected scaling (over 50 MeV at 1.6 J laser energy on target).

We present an accompanying particle-in-cell simulation study that incorporates an approximately 30 ps long laser pedestal and the resulting plasma pre-expansion. Our results reproduce both a highly directional fast proton-beam as well as a return current driven, low-energy, high-charge, nearly isotropic proton emission; both features are observed experimentally. Additionally, we discuss a surprisingly strong influence of small variations in jet orientation on the emission angle of the fast protons.

AKBP 6.4 Tue 12:00 SCH/A117

Investigation of the temporal laser contrast by optical probing of cryogenic hydrogen jet targets — •Thomas Streil — Helmholtz Zentrum Dresden Rossendorf — Technische Universität Dresden

Precise control of experimental parameters in laser-plasma-based ion accelerators is essential for improving acceleration performance. Temporal laser contrast is particularly critical, as it determines pre-plasma formation on the target before the main pulse. Understanding the onset of plasma pre-expansion is therefore vital for realistic simulations and insight into acceleration mechanisms. We investigated this onset by observing laser-induced breakdown, seen as a transition of the target to an opaque state once the electron density exceeds the critical density for the probe wavelength.

Using the DRACO petawatt laser, we scanned intrinsic contrast on a cryogenic hydrogen jet. The method provides a useful correction factor for autocorrelator-based contrast measurements, and additional target characterization and development are presented.

AKBP 6.5 Tue 12:15 SCH/A117

Human-Explainable, Compact, Clustering-based Latents for Fast Proton Energy Spectra Estimation — •Vedhas Pandit[1], Jeyhun Rustamov[1], Martin Rehwald[1], Stefan Assenbaum[1], Vidisha Rana[1], Hans-Peter Schlenvoigt[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], Thomas Kluge[1], and Jeffrey Kelling[1,4] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Center for Advance Systems Understanding (CASUS), Görlitz, Saxony, Germany — [3]Technische Universität Dresden, Faculty of Physics, Dresden, Saxony, Germany — [4]Technische Universität Chemnitz, Institute of Physics, Chemnitz, Saxony, Germany

A bottleneck in gaining a deeper understanding of the complex laser-plasma interaction that generates laser-accelerated protons is the lack of robust and near real-time information extraction from high frequency shot-data, due to human intervention required in the process. Here, we present an approach to employ deep learning methods to reduce the need for human input into the analysis of Thomson Parabola Spectrometer (TPS) measurements of proton energy spectra given relatively limited labelled data. Our approach builds on deep feature extraction using general pre-trained autoencoders, self organizing map-based clustering of global image features and the spectra that are available as labels, to effectively reduce the dimension of input and output modalities. Lower dimensional representations then enable a small model to be trained on limited data to estimate proton spectra and to help with spectrometer re-calibrations.