Laser-Plasma Accelerators Workshop



Contribution ID: 141

Type: Oral contribution

Efficient proton acceleration in the near critical density regime

Monday, 14 April 2025 11:33 (33 minutes)

Laser plasma-based particle accelerators attract great interest in fields where conventional accelerators reach limits based on size, cost or beam parameters. However, laser accelerators have not yet reached their full potential in producing high-radiation doses at high particle energies. The quest to fully leverage the available laser pulse energies is guided by first principles simulations predicting efficient ion acceleration mechanisms at near critical plasma densities. The most stringent limitation for accessing this regime is the lack of a system that provides a high degree of control of the plasma density conditions at high-repetition rates. In this talk I will outline our approach for overcoming these challenges using a novel cryogenic hydrogen target in combination with petwawatt-class lasers. Controlled pre-expansion of the initially solid target by low intensity pre-pulses allows for tailored density scans from the overdense to the underdense regime transitioning between different acceleration mechanisms. Under ideal conditions, the near-critical density produces proton energies of 80 MeV representing a boost in maximum energy by a factor of more than two compared to the solid jet case. Furthermore, recent investigations provide the basis for transferring the high single-shot performance into a reproducible, robust and, above all, highly repetitive operation mode.

Primary author: REHWALD, Martin (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: BERNERT, Constantin (Helmholtz-Zentrum Dresden-Rossendorf); KROLL, Florian (Helmholtz-Zentrum Dresden-Rossendorf); SCHLENVOIGT, Hans-Peter (Helmholtz-Zentrum Dresden-Rossendorf); METZKES-NG, Josefine (Helmholtz-Zentrum Dresden-Rossendorf); SCHILZ, Joshua D (Helmholtz-Zentrum Dresden-Rossendorf); ZEIL, Karl (Helmholtz-Zentrum Dresden-Rossendorf); HUANG, Lingen (Helmholtz-Zentrum Dresden-Rossendorf); YANG, Long (Helmholtz-Zentrum Dresden-Rossendorf); VESCOVI, Milenko (Helmholtz-Zentrum Dresden-Rossendorf); OR-DYNA, Pawel (Helmholtz-Zentrum Dresden-Rossendorf); KLUGE, Thomas (Helmholtz-Zentrum Dresden-Rossendorf); ZIEGLER, Tim (Helmholtz-Zentrum Dresden-Rossendorf); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf); MEGLER, Tim (Helmholtz-Zentrum Dresden-Rossendorf); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: REHWALD, Martin (Helmholtz-Zentrum Dresden-Rossendorf)

Session Classification: Plenary Session

Track Classification: Ion acceleration