20th Advanced Accelerator Concepts Workshop

Contribution ID: **190**

Type: **Contributed Oral**

Ultra-short pulse laser acceleration of protons from cryogenic hydrogen jets tailored to near-critical density

Tuesday, 8 November 2022 15:50 (20 minutes)

Laser plasma-based particle accelerators attract great interest in fields where conventional accelerators reach limits based on size, cost or beam parameters. However, despite the fact that first principles simulations have predicted several advantageous ion acceleration schemes, laser accelerators have not yet reached their full potential in producing simultaneous high-radiation doses at high particle energies. The most stringent limitation is the lack of a suitable high-repetition rate target that also provides a high degree of control of the plasma conditions which is required to access these advanced regimes.
Here, we demonstrate that the interaction of petawatt-class laser pulses with a micrometer-sized cryogenic hydrogen jet plasma overcomes these limitations. Controlled pre-expansion of the initially solid target by low intensity pre-pulses allowed for tailored density scans from the overdense to the underdense regime. Our experiment demonstrates that the near-critical plasma density profile produces proton energies of 80 MeV. This energy presents more than a factor of two increase compared to the solid hydrogen target. Our three-dimensional particle in cell simulations show the transition between different acceleration mechanisms and suggest enhanced proton acceleration at the relativistic transparency front for the optimal case.

Acknowledgments

Primary authors: REHWALD, Martin (HZDR); BERNERT, Constantin (HZDR); BRACK, Florian-Emanuel (HZDR); BUSSMANN, Michael (CASUS, HZDR); Mr COWAN, Thomas E. (HZDR, TU Dresden); CURRY, Chandra B. (SLAC); FIUZA, Frederico (SLAC); GARTEN, Marco (LBNL, HZDR); GAUS, Lennart (HZDR); GAUTHIER, Maxence (SLAC); GÖDE, Sebastian (European XFEL); GÖTHEL, Ilja (HZDR); GLENZER, Siegfried H. (SLAC); HUANG, Lingen G. (HZDR); HUEBL, Axel (LBNL, HZDR); KIM, Jongjin (SLAC); KLUGE, Thomas (HZDR); KRAFT, Stephan (HZDR); KROLL, Florian (HZDR); METZKES-NG, Josefine (HZDR); LOESER, Markus (HZDR); OBST-HUEBL, Lieselotte (LBNL, HZDR); REIMOLD, Marvin (HZDR); SCHLENVOIGT, Hans-Peter (HZDR); SCHOENWAELDER, Christopher (SLAC); SCHRAMM, Ulrich (HZDR, TU Dresden); SIEBOLD, Mathias (HZDR); TREFFERT, Franziska (SLAC); YANG, Long (HZDR); ZIEGLER, Tim (HZDR); ZEIL, Karl (HZDR)

Presenter: REHWALD, Martin (HZDR)

Session Classification: WG6: Laser-Plasma Acceleration of Ions

Track Classification: Working Group Parallel Sessions: WG6 Oral: Laser-Plasma Acceleration of Ions