

Laser-proton acceleration in the near-critical regime using density tailored cryogenic hydrogen jets

Martin Rehwald

Strategic Advisory Board Meeting Research Field Matter, DESY, Hamburg, 03.05.2023

Motivation: Laser-driven plasma accelerators

Developing reliable high energy, high repetition rate laser proton (and ion) accelerators



View onto a laser ion accelerator



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Developing reliable high energy, high repetition rate laser proton (and ion) accelerators

- Plasmas induced by high intensity lasers generate accelerating fields of ~TV/m
- Alternative and compact concept for accelerators with unique properties opening novel opportunities for basic and applied research



View onto a laser ion accelerator



Established acceleration scheme using overdense, opaque targets



Laser pulse mostly reflected / Stationary accelerating field at rear surface





Laser pulse mostly reflected / Stationary accelerating field at rear surface Laser energy efficiently absorbed/ Co-moving accelerating fields in the target bulk











Concept: density tailored self-replenishing cryogenic hydrogen jet target and repetition rate capable PW class lasers



J. Kim et al. RSI (2016), C. Curry et al. JoVe (2020)



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- High repetition rate capability: jet is continuously regenerating
- Single species (pure hydrogen or others) or defined mixtures which under ambient conditions exist in a gas phase





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Experiments demonstrate the enhanced acceleration



Experiments demonstrate the enhanced acceleration

Slide 6



Experiments demonstrate the enhanced acceleration



M. Rehwald et al., under review Slide 6

Conclusion and Outlook

- Efficient laser proton acceleration (up to 80 MeV beam energy) from a repetition-rated cryogenic jet target
 - Even higher beam energies are expected when fully optimized
 - Advanced methods to improve the acceleration stability at high repetition rates are currently investigated







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- Promising path towards the development of application-ready stable high-energy, high-repetition rate laser proton accelerators for current and upcoming (multi-PW) laser system using advanced acceleration schemes
- Unique properties of the target concept of interest for a wider range of research topics and facilities (e.g. study fundamental physics processes, benchmark simulation tools)







Thank you for your attention!

Big Thanks to the HZDR Laser ion acceleration team

S. Assenbaum, C. Bernert, F. B. Brack, M. Bussmann, M. Garten, L. Gaus, I. Göthel, L. Huang, A. Huebl, S.Kraft, F. Kroll, J. Metzkes-Ng, M. Loeser, L. Obst-Huebl, M. Reimold, H.-P. Schlenvoigt, M. Siebold, L. Yang, T. Ziegler, T. Kluge, U. Schramm, T. Cowan, K. Zeil et al.

and

Collaborators

S. Glenzer, C. Curry, M. Gauthier, J. Kim, F. Fiuza, C. Schoenwaelder, S. Göde et al.

