WP14 Hybrid Laser-Electron-Beam Driven Acceleration

WP lead: Bernhard Hidding WP deputy: Alberto de la Ossa

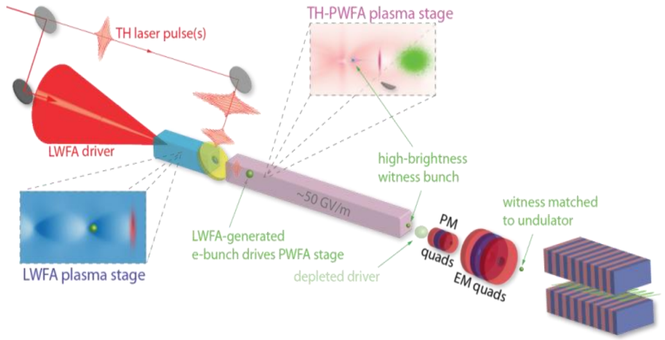
Task 14.1. Selective ionization of plasma components

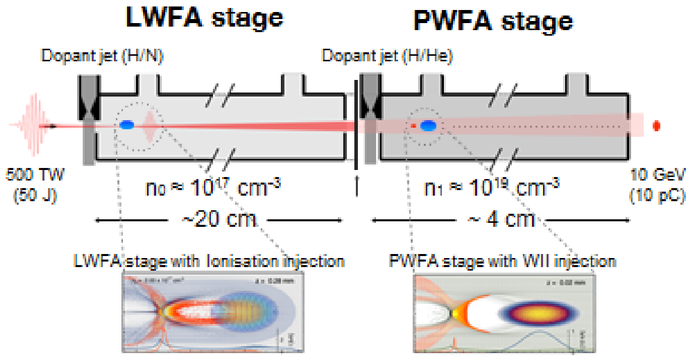
Task 14.2. Trojan Horse underdense photocathode witness bunch generation

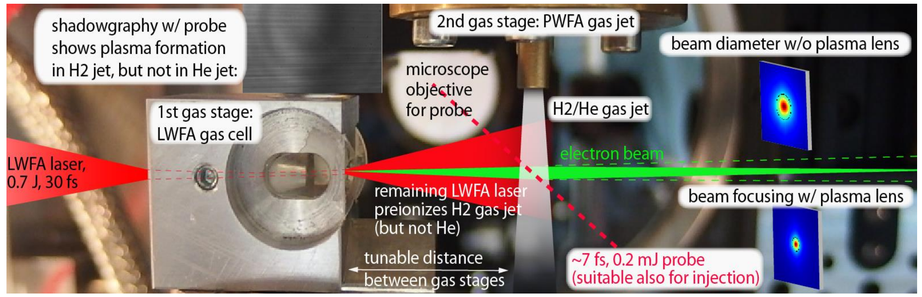
Task 14.3. Wakefield-Induced ionisation injection

Task 14.4. Exploiting LWFA-generated electron bunches as drivers for PWFA

B. Hidding et al., Phys. Rev. Lett. 104, 195002 (2010).
B. Hidding et al., Phys. Rev. Lett. 108, 035001 (2012).
A. Martinez de la Ossa et al., Phys. Rev. Lett. 111, 245003 (2013).
A. Martinez de la Ossa et al., Phys. Plasmas 22, 093107 (2015).







Various approaches and setups..

Picking up steam!

Deliverables:

- D14.1 Design of an optimized plasma ionization module [M18]
- D14.2 Underdense plasma photocathode design report [M40]
- D14.3 Report on wakefield ionization and trapping requirement and technique [M40]
- D14.4 Conceptual design of optimized LWFA-source for PWFA-driver electron bunches [M40]
- D14.5 Integration into EuPRAXIA Desing Report [M46]

Research personnel:

- Prof. Bernhard Hidding (Strathclyde). WP14 leader.
- Dr. Alberto Martinez de la Ossa (Hamburg/DESY). WP14 co-leader.
- Dr. Grace Manahan (Strathclyde).
- Thomas Heinemann (HamburgStrathclyde/DESY). PhD student.
- Paul Scherkl (Strathclyde). PhD student.
- Ángel Ferran Pousa (Hamburg/DESY). PhD student.
- Fahim Habib (Hamburg), Master student. (Strathclyde PhD student Oct 2016)
- Gabriele Tauscher (Hamburg/DESY). PhD student.
- Olena Kononenko (Hamburg/DESY). PhD student.
- …

Papers, documents, talks:

- G. G. Manahan et al. (PRAB 19, 011303 (2016)
- A. M. de la Ossa et al., Physics and Applications of HBB. La Habana, March 30th, 2016
- A. M. de la Ossa et al., 5th LAOLA meeting, Wismar, June 22nd, 2016.
- A. Aschikhin et al., Nucl. Instr. Meth. Phys. Res. A806, 175 (2016).
- B. Hidding et al. Physics and Applications of HBB, March 30th, 2016, Cuba
- S. Kuschel et al., PRAB 19, 071301 (2016)
- A.M. de la Ossa et al., Laser Plasma Accelerator Workshop, LPAW 2015. Guadeloupe (France).
- G. Tauscher. master thesis, Hamburg 2016
- A.M. de la Ossa et al., Kick Off Meeting Matter und Technologie 2015. DESY (Hamburg)

Well on track towards deliverables!

Others also find the scheme interesting:

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Accepted Paper

Collective deceleration of laser-driven electron bunches

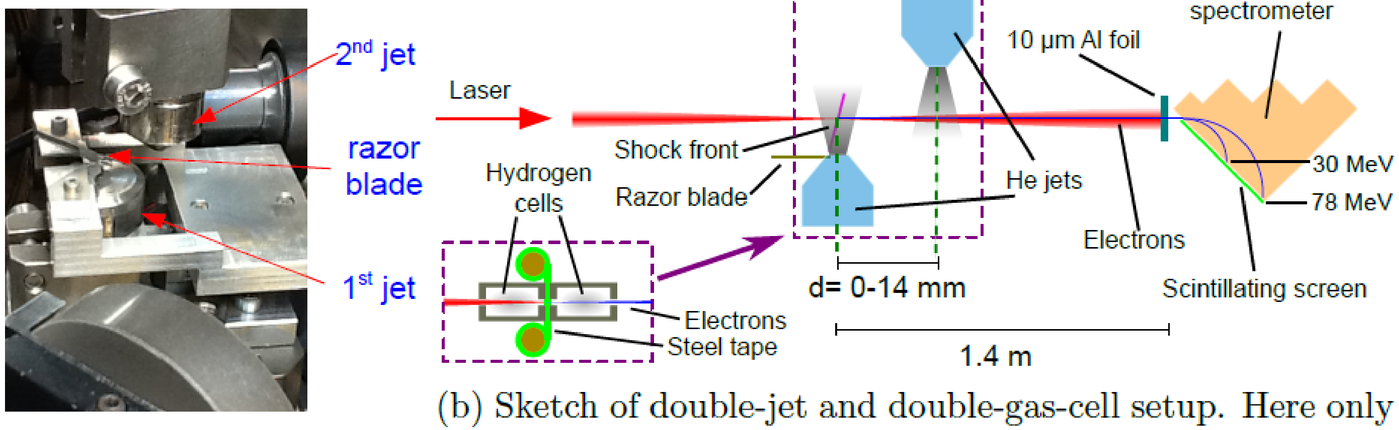
Phys. Rev. Lett.

S. Chou, J. Xu, K. Khrennikov, D. E. Cardenas, J. Wenz, M. Heigoldt, L. Hofmann, L. Veisz, and S. Karsch

Accepted 1 September 2016

ABSTRACT

Few-fs electron bunches from laser wakefield acceleration (LWFA) can efficiently drive plasma wakefields (PWFs), as shown by their propagation through underdense plasma in two experiments. A strong and density-insensitive deceleration of the bunches has been observed in 2-mm of 10^{18} cm^{-3} density plasma with 5.1-GV/m average gradient, which is attributed to a self-driven PWF. This observation implies that the physics of PWFs, usually relying on large-scale RF accelerators as drivers, can be studied by table-top LWFA electron sources.



(a) Photograph of the double-jet and shock-front injection setup.

(b) Sketch of double-jet and double-gas-cell setup. Here only the spectrometer used in the double-jet experiment is shown. The spectrometer of the double-gas-cell experiment is described in [Popp, 2011].

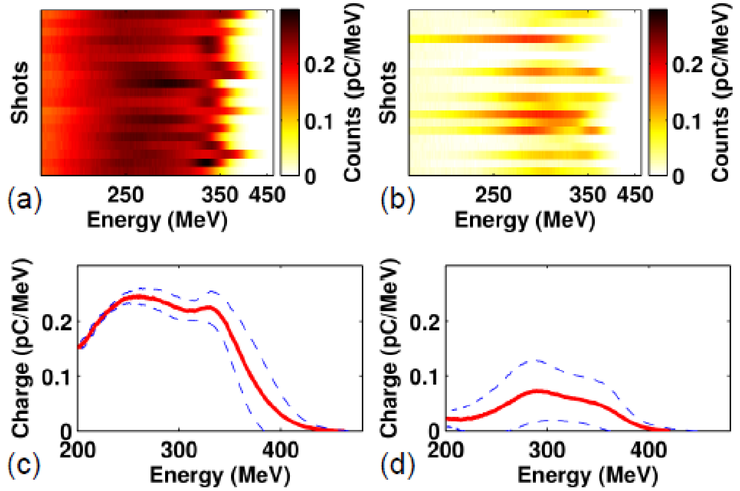


Figure 5.9: Electron spectra from double-cell experiment. Both gas cells had a length of 5 mm with density 6.8×10^{18}cm^{-3} (a) Only the first gas cell was filled with hydrogen, and tape was inserted. The average total charge is 37.80±0.89 pC. (b) The spectra with both gas cells were filled with hydrogen and separated with tape. The average charge is 8.42±1.50 pC. (c) and (d) are the average spectrum of (a) and (b) respectively. The average observed REF=0.23±0.041 and RCF=0.22±0.040.

From: C. Wei, Diss., Munich 2016

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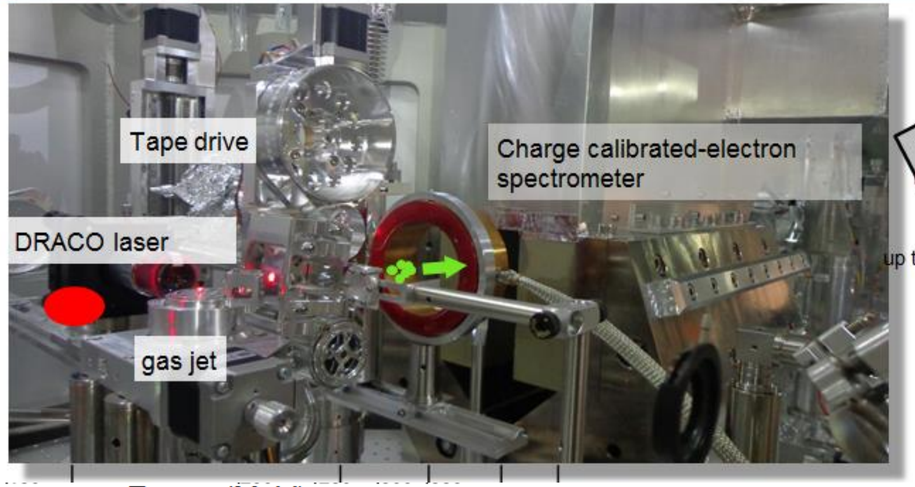
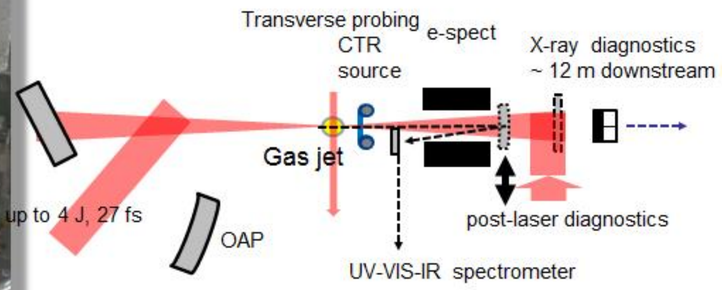
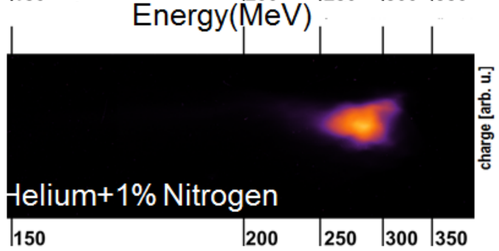
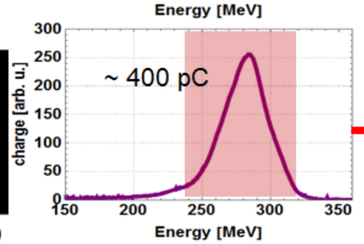
Opportunity for joint experiment at Dresden:

LWFA: self-injection vs ionization injection









Laser: 2.8 J, 28 fs, 20 ⌈m (on target)

Peak energy: ~ 283 MeV
Energy spread: ~ 40 MeV (14%)
More stable: charge, pointing, energy

209 pC, sub 10 fs, **20 kA**

act: Dr. Arie Irman (a.irman@hzdr.de), Prof. Dr. Ulrich Schramm (u.schramm@hzdr.de)

More than enough for hybrid LWFA-> PWFA!

Started discussions with HZDR, hopefully experiment there next year..