Hybrid LWFA-PWFA: A stability and beam quality booster for laser-generated electron beams

Moritz Foerster[1]
Supervisor: Stefan Karsch[1,2]
1. Ludwig-Maximilians-Universität, Garching, 2. Max-Planck-Institut für Quantenoptik, Garching
Co-Authors: A. Döpp, F. Haberstroh, K. v. Grafenstein, D. Campbell, Y.-Y. Chang, S. Corde, J. P. Couperus Cabadağ, A. Debus, M. F. Gilljohann, A. F. Habib, T. Heinemann, B. Hidding, A. Irman, F. Irshad, A. Knetsch, O. Kononenko, A. Martinez de la Ossa, A. Nutter, R. Pausch, G. Schilling, A. Schletter, S. Schöbel, U. Schramm, E. Travac, P. Ufer
Joined experiments of the Hybrid collaboration:
Special thanks to:

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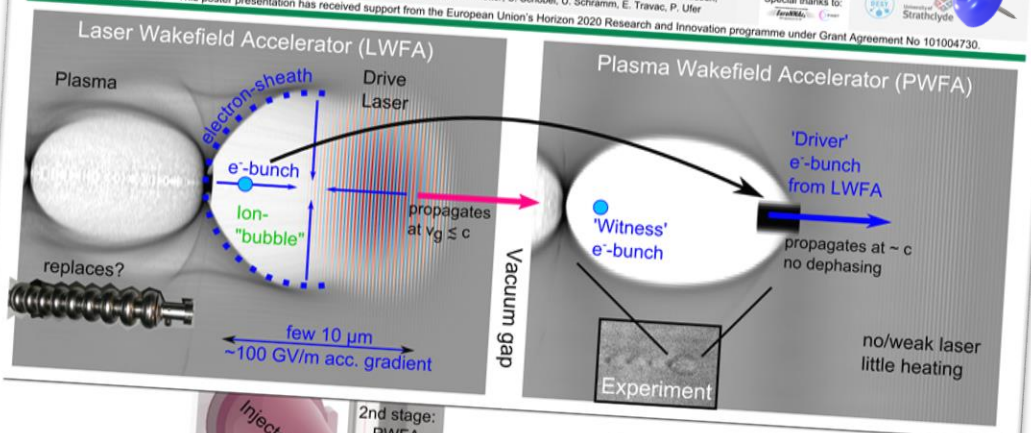
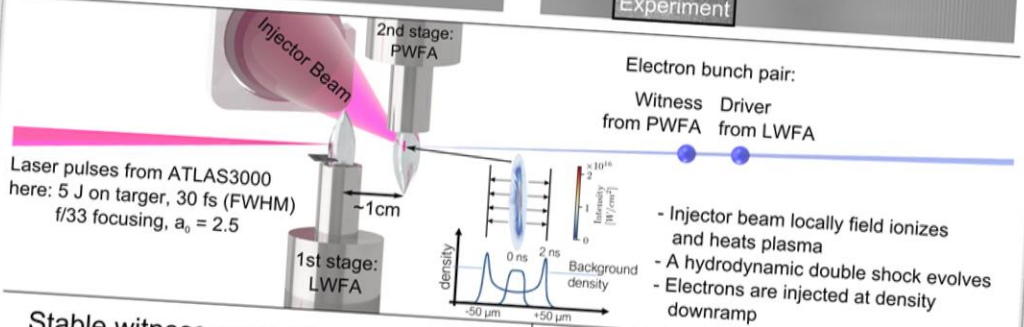
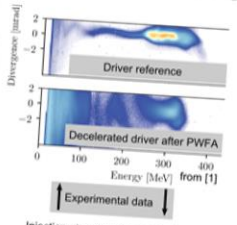




Stable witness generation

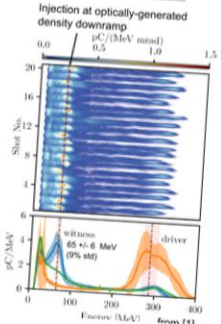


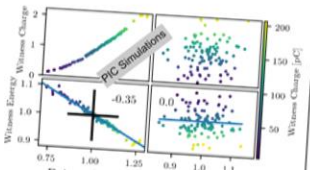
nC-class electron bunches generated in LWFA [2],

serve as wakefield driver [3] in a subsequent PWFA stage.

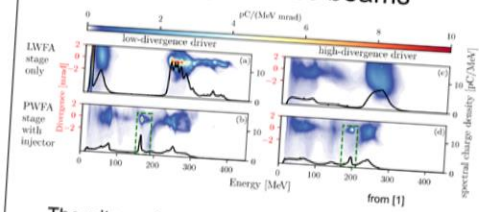
Witness bunches injected in the PWFA stage gain energy from the wakefield [4,5].

Witness energy is insensitive to (relativistic) driver energy. Charge fluctuations of driver are damped.





High quality witness beams



The witness bunch (optimal beam loading case):
- 3.5% FWHM energy spread (Driver: 18%)
- 0.28 mrad rms divergence (Driver: 0.41 mrad)
More charge per energy interval and solid angle

Beams could be interesting for FEL-applications. Further characterisation of (slice) emittance and brightness to be done.

References
[1] Foerster et al. under review (2022) and arXiv:2206.00507
[2] Götzfried et al., Phys. Rev. X. 10, 041015 (2020)
[3] Gilljohann et al., Phys. Rev. X. 9, 011046 (2019)
[4] Kurz et al., Nat. Commun. 12, 2895 (2021)
[5] Couperus Cabadag et al., Phys. Rev. Accel. Beams 24, 031302 (2021)

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iFAST

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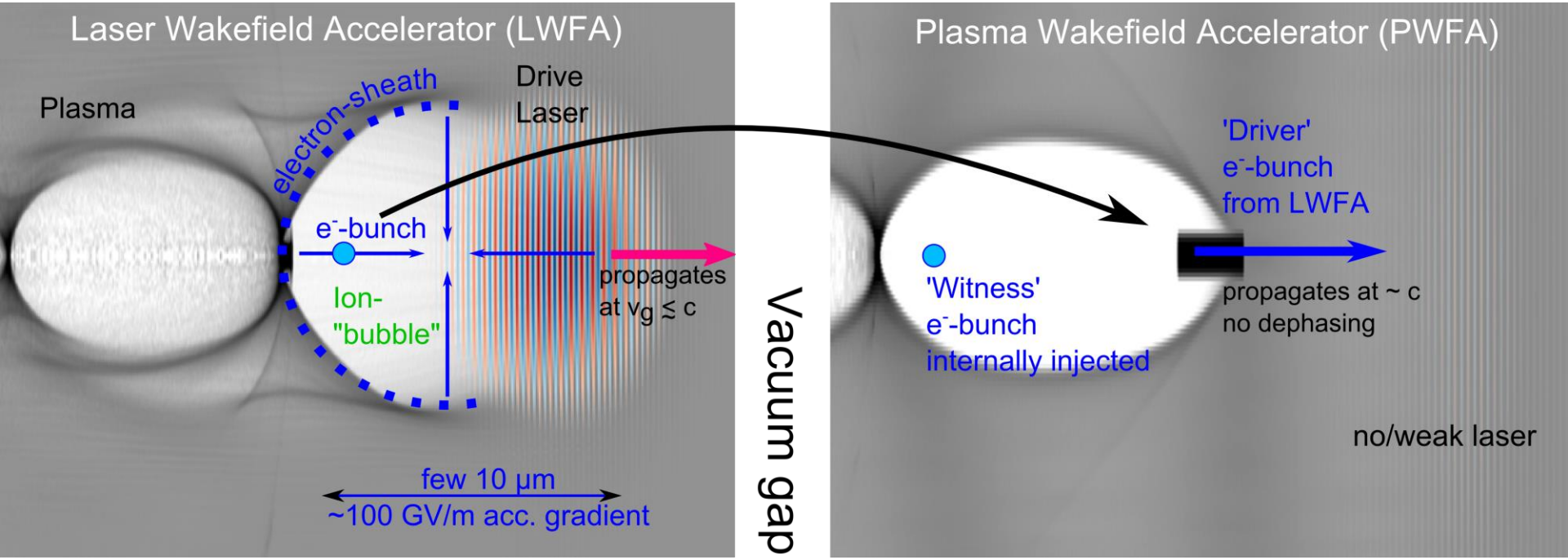
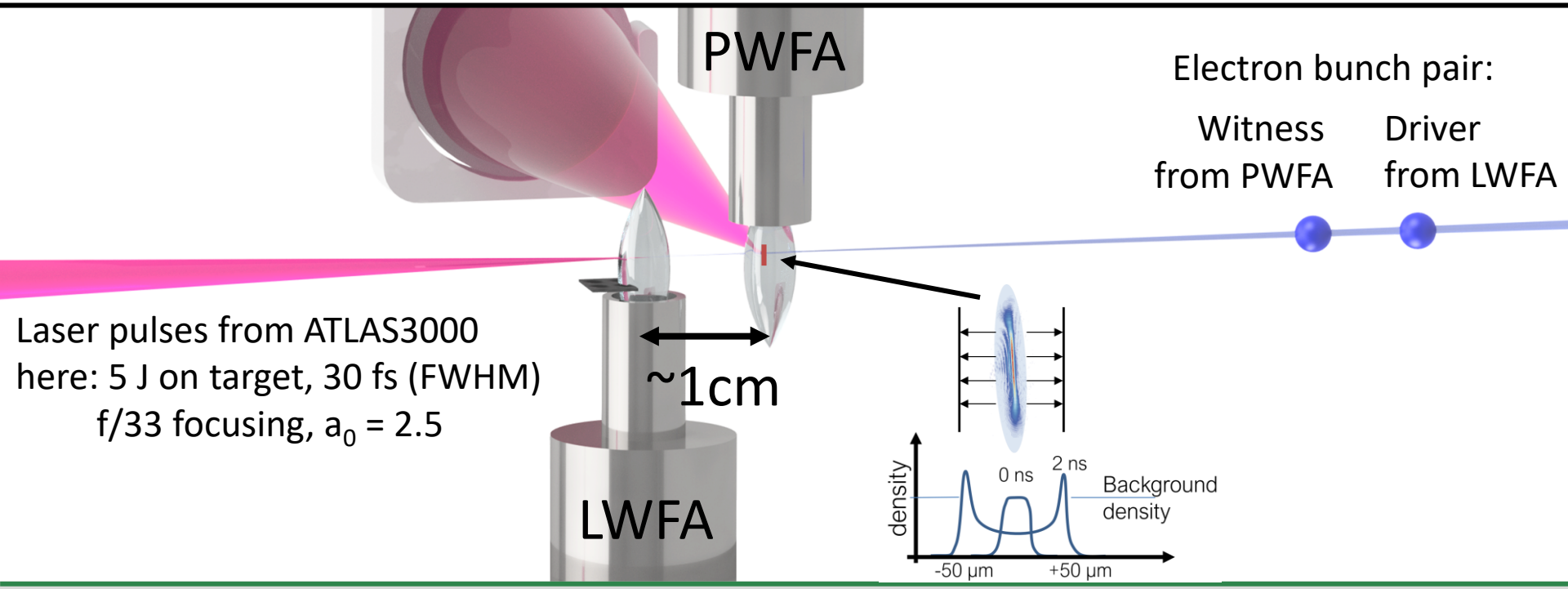
Combine the best of two worlds:



Aims: - improve stability of electron energy
- enhance quality of electron beam

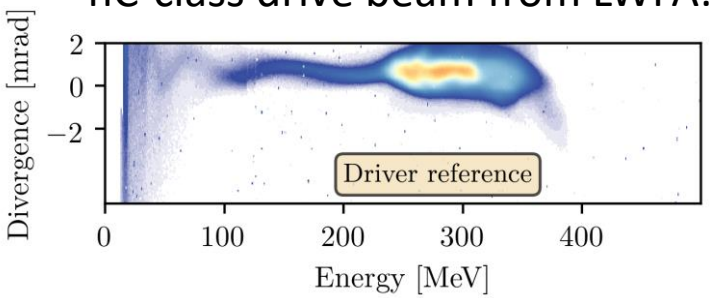
Setup

- Two supersonic gas jets
- A strong laser
- A robust injection scheme (in PWFA)

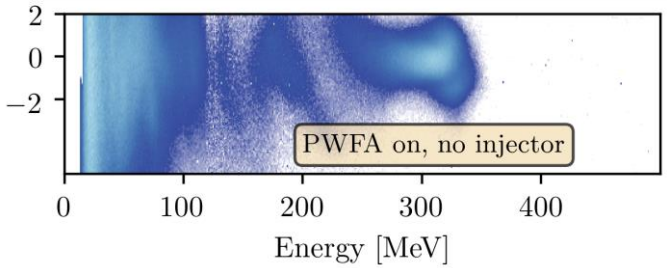


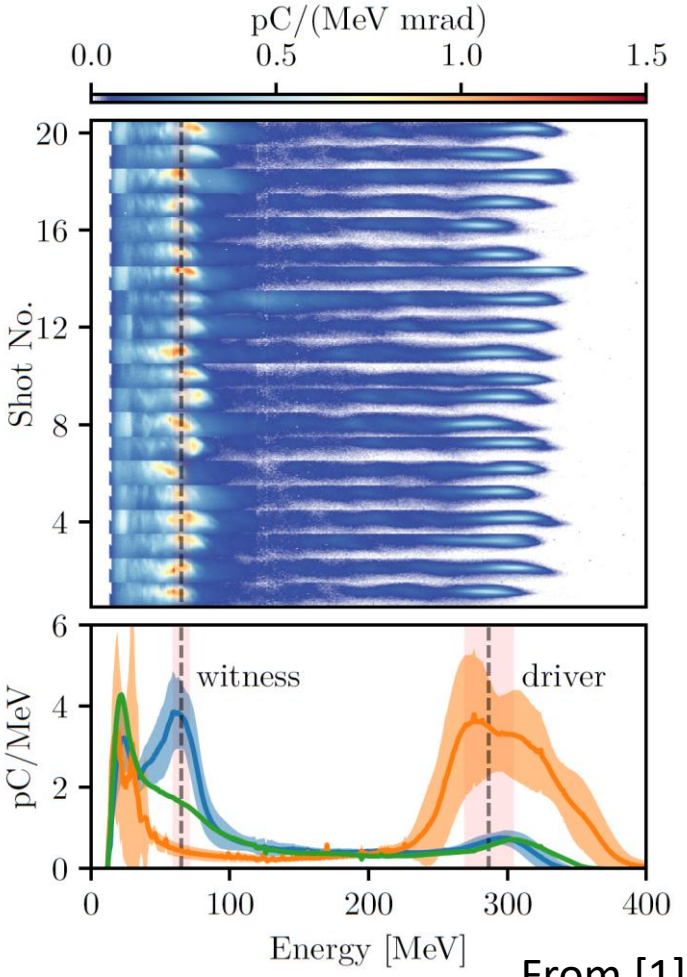
Stability of the PWFA witness

nC-class drive beam from LWFA:



Deceleration of driver in 2nd stage:



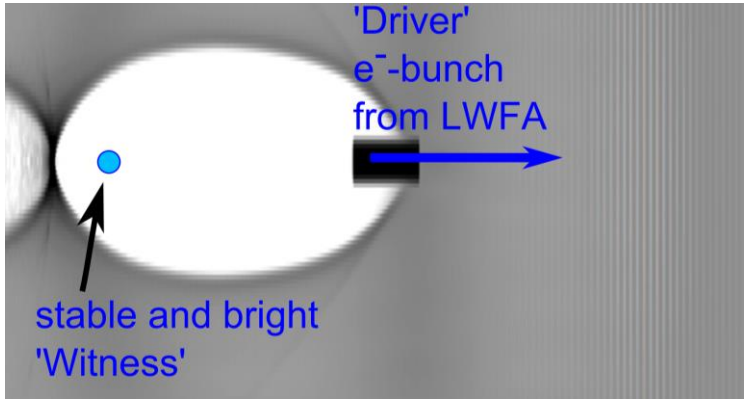


From [1]

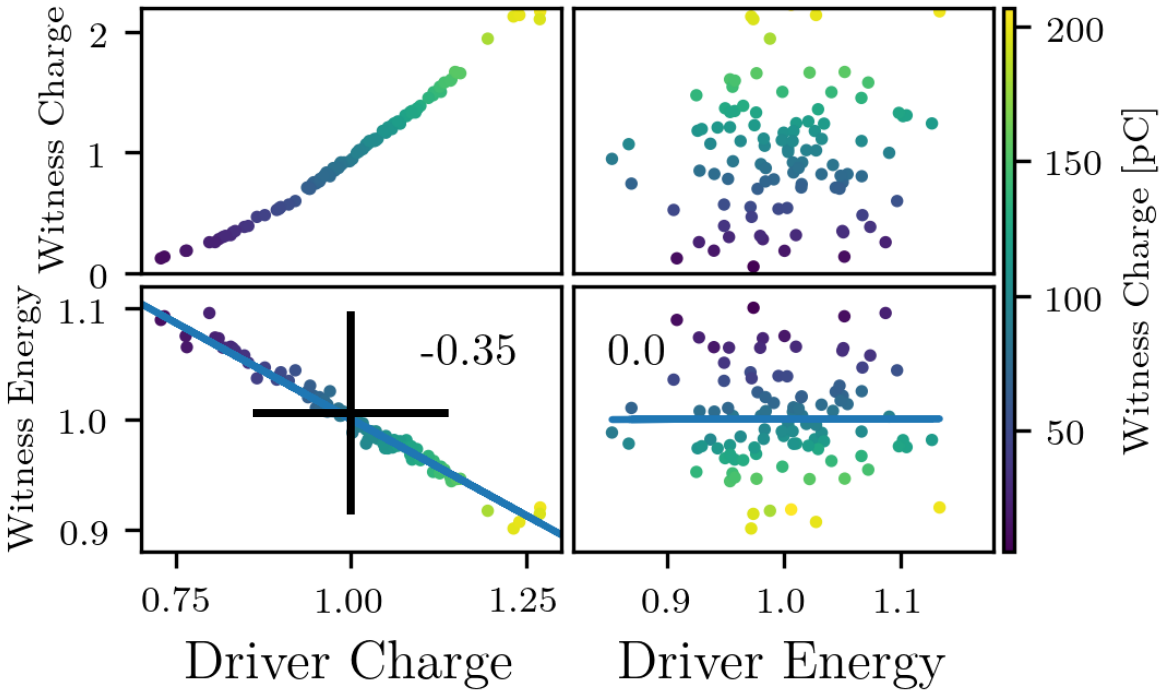
[1] Foerster et al. under review (2022) and arXiv:2206.00507

Stability of the PWFA witness

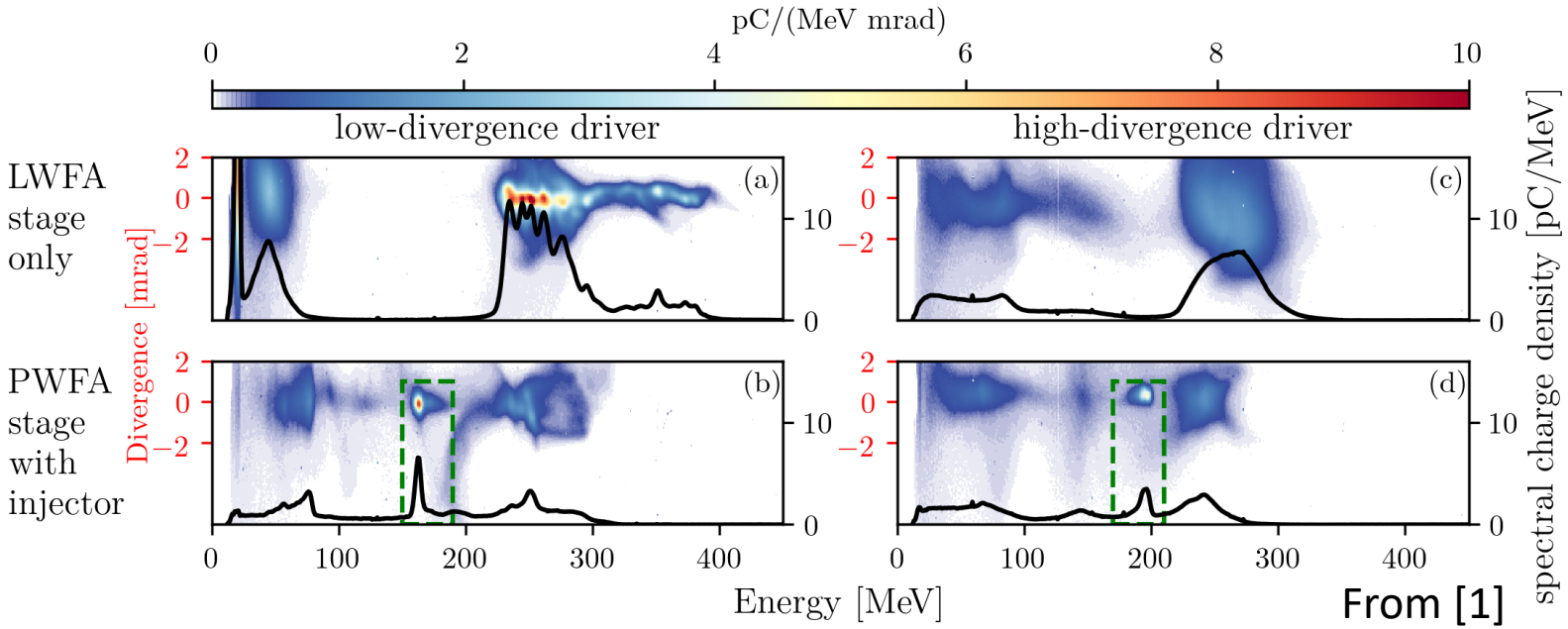
Some PIC simulations:



Beamloading helps stabilizing witness energy



Quality of witness beam from PWFA



Decrease:

FWHM energy spread from 18% (Driver) to 3.5% (Witness)

rms divergence from 0.41 mrad (Driver) to 0.28 mrad (Witness)

Thus, more charge per energy interval and solid angle

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Moritz Foerster
(LMU Munich)

the Hybrid Collaboration

Contact:
moritz.foerster@physik.uni-muenchen.de