

Gas-dynamic density downramp injection in a beam-driven plasma wakefield accelerator

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We present the first experimental demonstration of tunable **injection at a gentle density downramp** in a beam-driven plasma wakefield accelerator (PWFA) and acceleration at **gradients up to 120 GV m⁻¹**. This was achieved using a high-peak current driver originating from LWFA

U. Schramm,
A. Irman *et al.*

S. Karsch
et al.

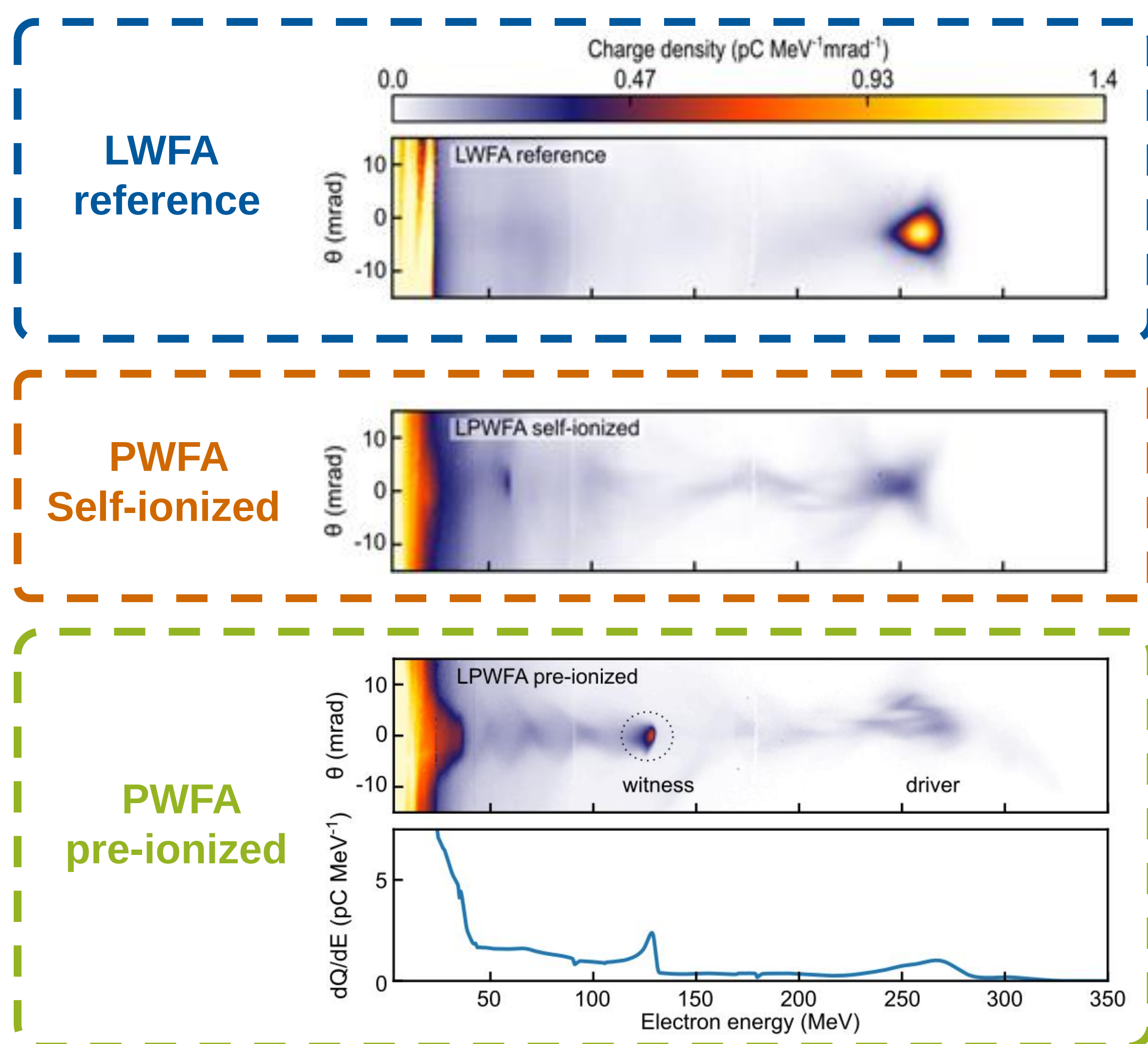
S. Corde
et al.

B. Hidding
et al.

A. Martinez de
la Ossa *et al.*

LPWFA | proof-of-principle demonstration

T. Kurz, T. Heinemann *et al.*, Nature Comm. **12**, 2895 (2021)

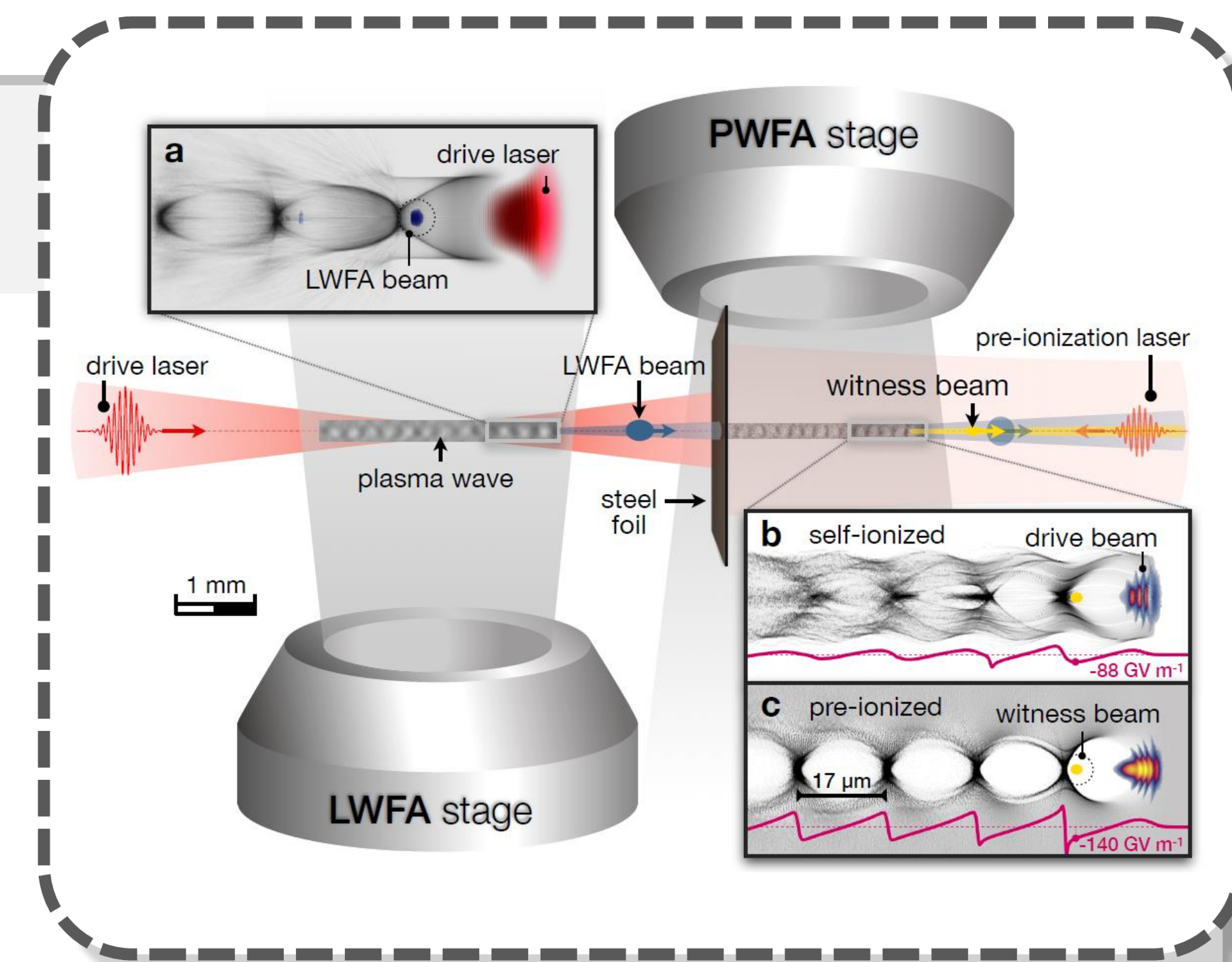


High peak current driver originating from LWFA

Clear driver $\leftrightarrow$ gas/plasma interaction

Stronger driver $\leftrightarrow$ plasma interaction

Clear increase of witness beam energy (~ 70 MeV)



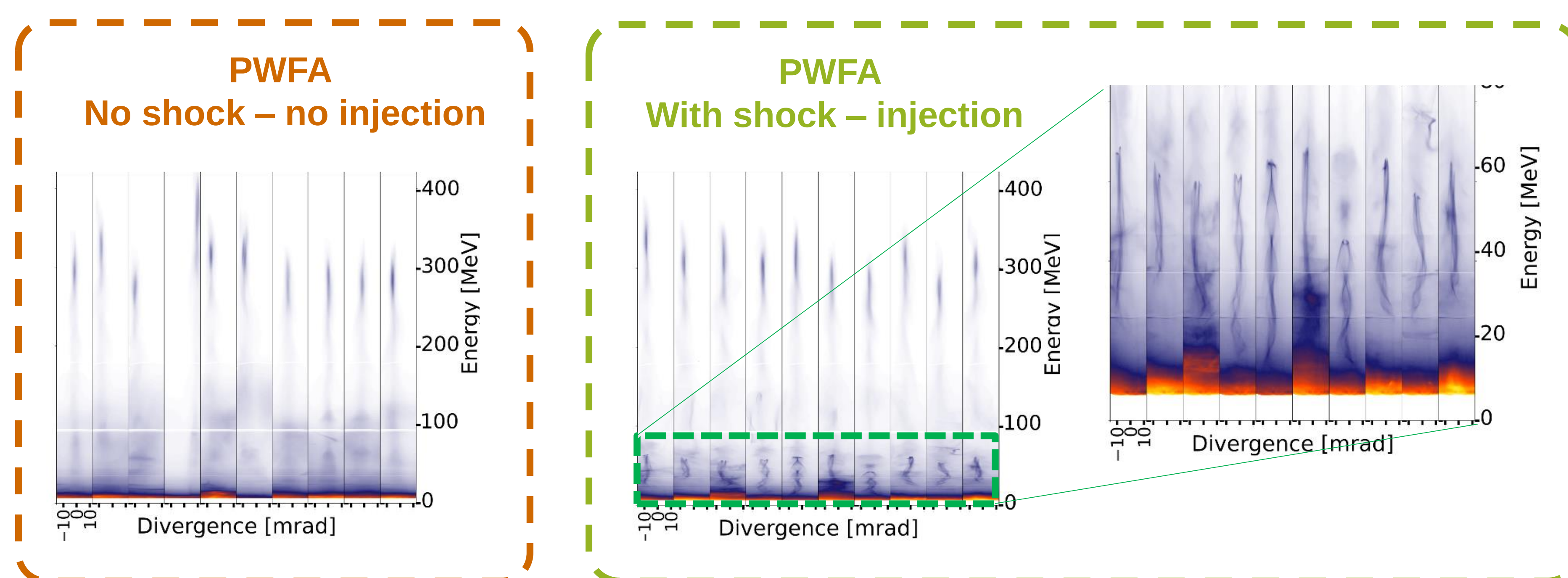
	LWFA reference	PWFA Self-ionization	PWFA pre-ionised
Q_{FWHM} [pC]	104 ± 12	48 ± 3	40 ± 2
ΔE [MeV]	24 ± 4	36 ± 2	51 ± 3
E_{mean} [MeV]	260 ± 9	260 ± 5	235 ± 5
S [pC/%]	11.3 ± 2	3.5 ± 0.3	1.9 ± 0.2

J. P. Couperus *et al.*, Nature Comm. **8**, 487 (2017)
B. Hidding *et al.*, Phys. Rev. Lett. **104**, 195002 (2010)
A. Martinez de la Ossa *et al.*, Phil. Trans. R. Soc. A **377**, 20180175 (2019)

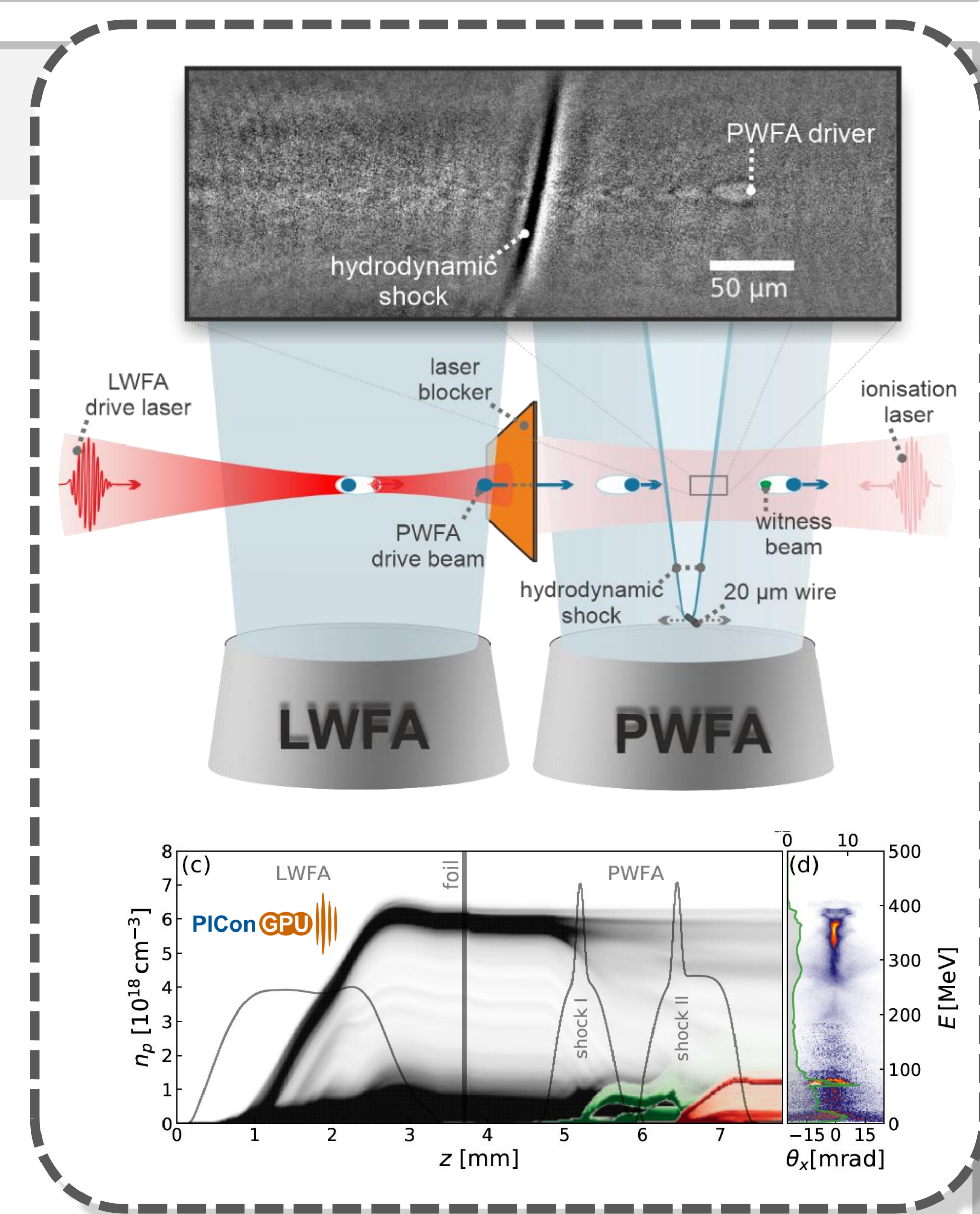
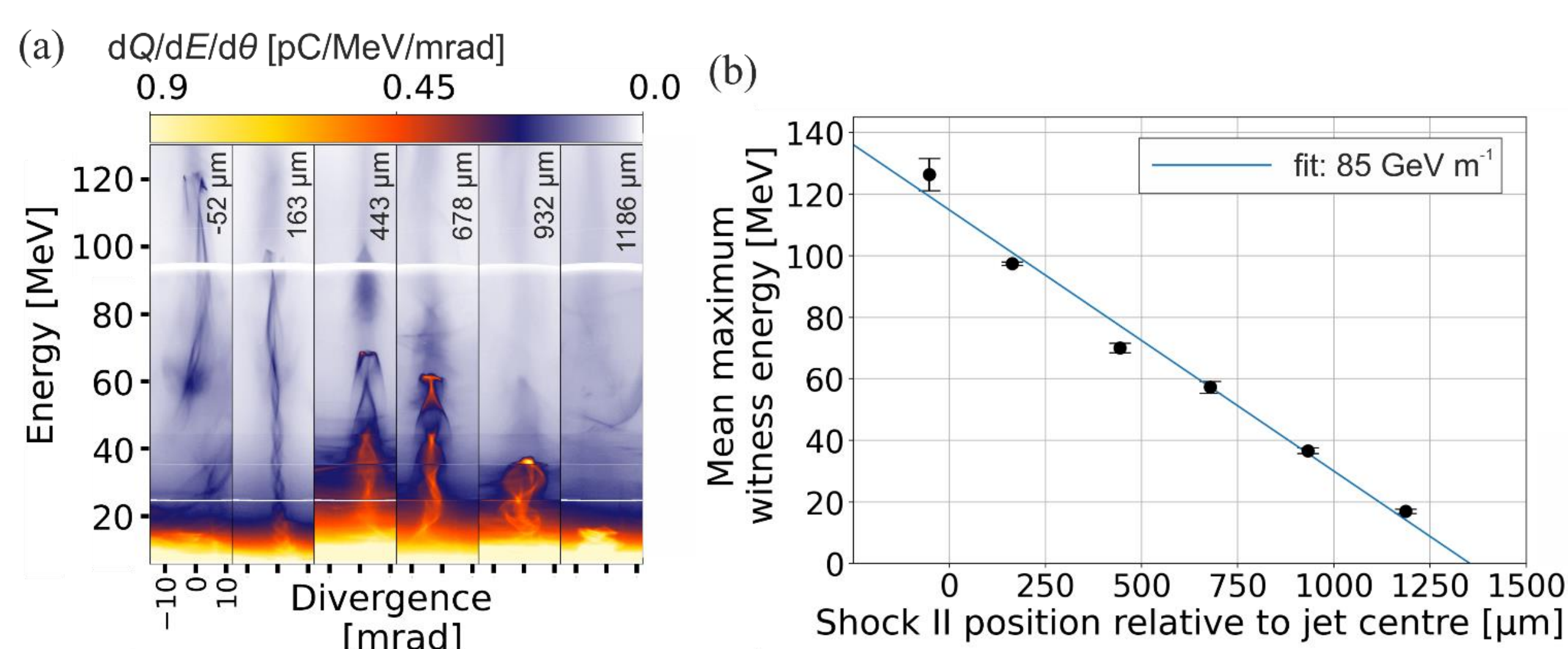
Controlled injection at gentle density downramp ($I_{ramp} > \lambda_p$)

J. P. Couperus Cabadağ *et al.*, in review (2021)

- Laser blocker located **in between** both accelerators.
- Exclude** witness created at LWFA downramp



- Wire introduces adjustable **hydrodynamic shock**
- Injection occurs at a predetermined and **adjustable** position



Outlook

- Proper **fine-tuning of the density step** shape and height promises reduction in energy spread and divergence.
A. Martinez de la Ossa *et al.*, Phys. Rev. Acc. Beams **20**, 091301 (2017)
- Witness bunch creation with **few tens nm emittance** is considered feasible
X. L. Xu *et al.*, Phys. Rev. Acc. Beams **20**, 111303 (2017)
C. Zhang *et al.*, Phys. Rev. Acc. Beam **22**, 111301 (2019)