Research Group Prof. Hidding

Elevator speeches

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Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

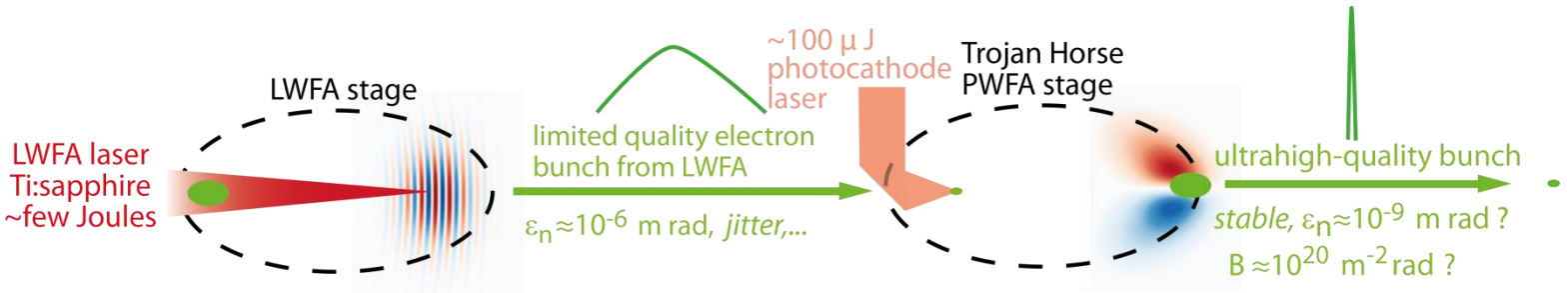
SCAPA University of Strathclyde Glasgow

CFEL SCIENCE

HELMHOLTZ GEMEINSCHAFT

Virtual Institute 503, PWFA@FLASH Brian Foster et al.

Beam quality transformation and stabilzation in a hybrid all-optical plasma accelerator



Use LWFA-generated electron bunches as drivers for PWFA (Hidding, PRL 104, 195002 2010)

- Inherently synchronized electron bunch and photocathode laser (both from the same laser)
- Even large energy spreads from LWFA-generated bunches are not prohibitive
- How sensitive is all-optical Trojan Horse towards variations of LWFA output, i.e.

  driver energy, **energy spread**, **charge**?
- Indeed PWFA stage produces similar output throughout various LWFA parameters!

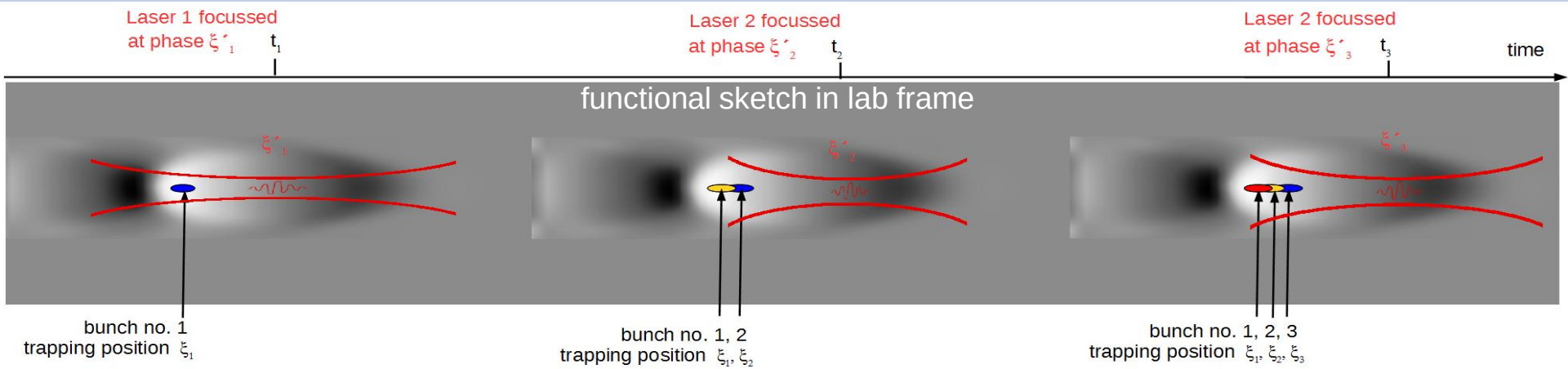
  e.g. if
  driver beam energy deviation: +/- 50 %
  witness beam energy deviation: **down to 3.2 %**

Dramatic stabilization in energy & energy spread & current of witness w/ even huge variation of drive beam parameters!

+

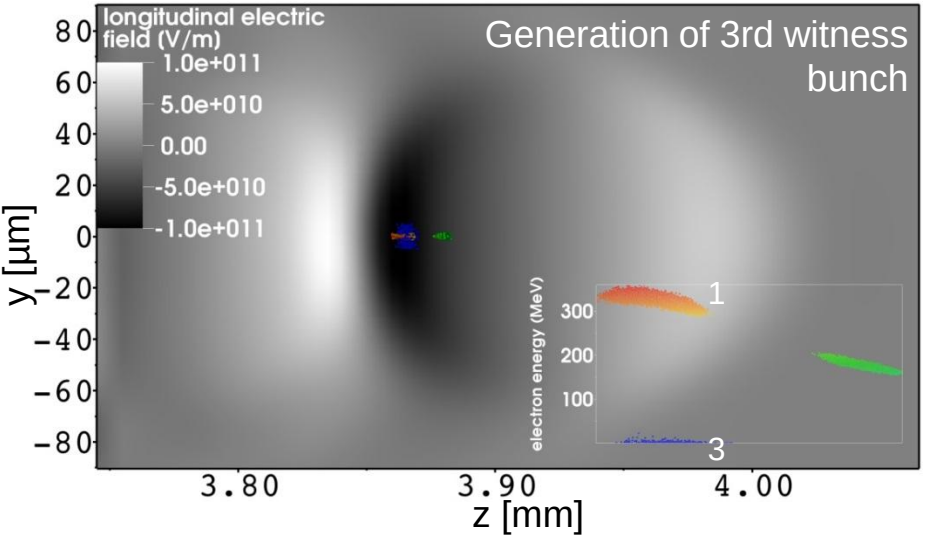
generation of high-quality, ultra-low emittance and high brigtness witness bunches

Multi-bunch production with underdense photocathode*



Simulation with spatial overlapping bunches: independent tunability of each bunch

@ 4 mm acceleration



three injection lasers with different foci:

λ = 0.8 µm

a_0 = 0.14

w_0 = 5 µm

τ_{FWHM} = 25 fs

driver: FACET like electron bunch

σ_z = 20 µm

σ_r = 15 µm

E = 23 GeV

Q = 3 nC

@ 5 mm acceleration

parmeter	bunch 1	bunch 2	bunch 3
energy [MeV]	390	211	48.5
ε [mm mrad]	0.27	0.15	0.23
energy spread	0.03	0.05	0.14
charge [pC]	24.3	8.5	24.3

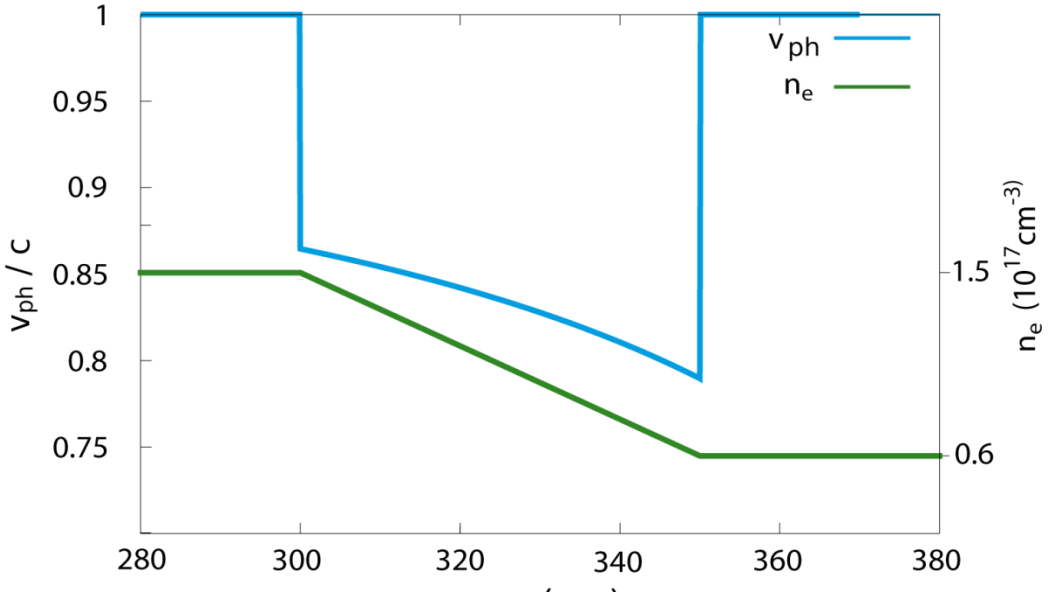
*to be published (http://de.arxiv.org/pdf/1403.1109v1)

LAOLA.

Downramp assisted underdense photocathode PWFA

Target:

- Facilitate trapping for Trojan Horse PWFA
- Open Up PWFA for low current e-beam facilites
- Pave the way for an all-optical PWFA



- Phase velocity

$$v_{\mathrm{ph}} = c\left(1 + \frac{1}{2n_e(z)}\frac{\partial n_e(z)}{\partial z}\xi\right)^{-1}$$

decreased on downramp

- Trapping condition

$$\Phi = \frac{\left(\Psi_{max} - \Psi\right)}{mc^2/e\left(1-\gamma_{ph}^{-1}\right)} > -1$$

depends on phase velocity

Electron driver:

Peak current	3 kA
rms width	7 µm
rms length	6 µm
Charge	150 pC

- strong enough to drive a blowout
  - $\tilde{Q}$ = 2.13
- Too weak to trap electrons
  - Φ = -0.61 > -1

A. Knetsch et al. To be submitted

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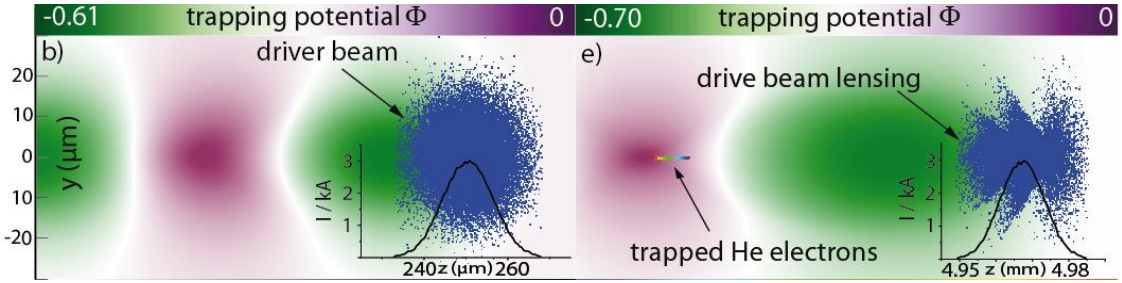
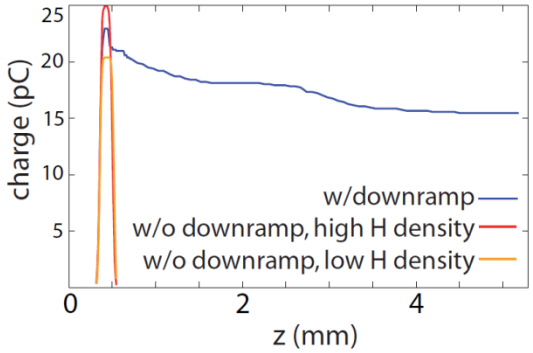
Downramp assisted underdense photocathode PWFA

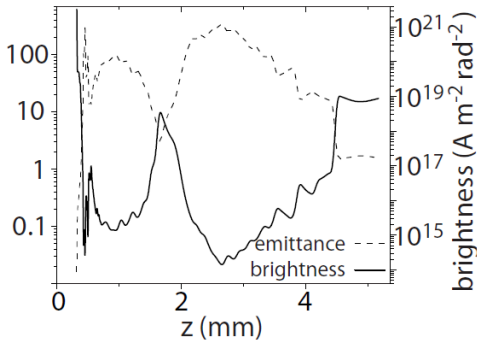


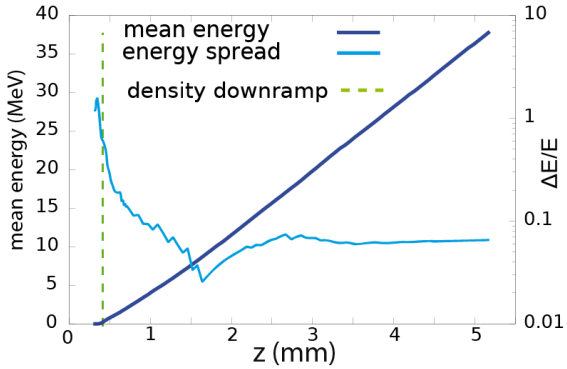
No trapping possible before…

…and after the downramp…



… but on the downramp





Wittness bunch properties

- Low emittance
- High brightness
- Low energy spread
- supressed dark current
- Feasible with weak, low current driver beams

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