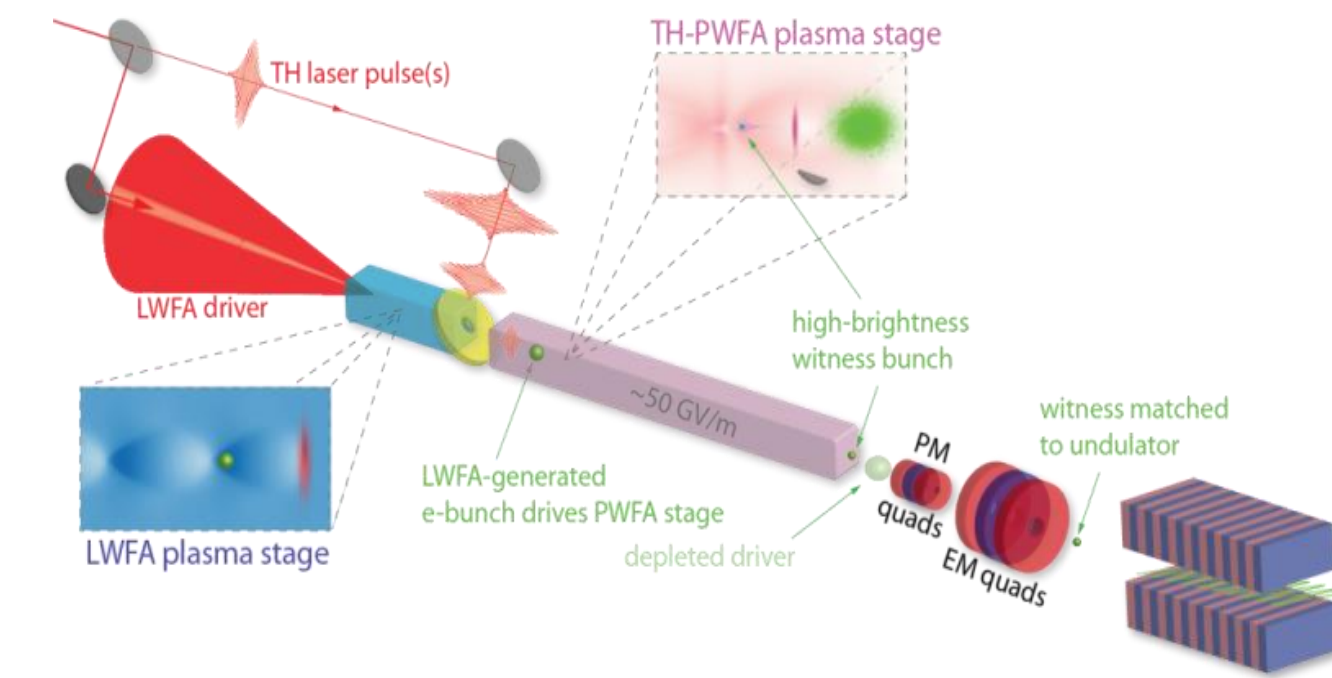Task 14.1. Selective ionization of plasma components

Task 14.2. Trojan Horse underdense photocathode witness bunch generation
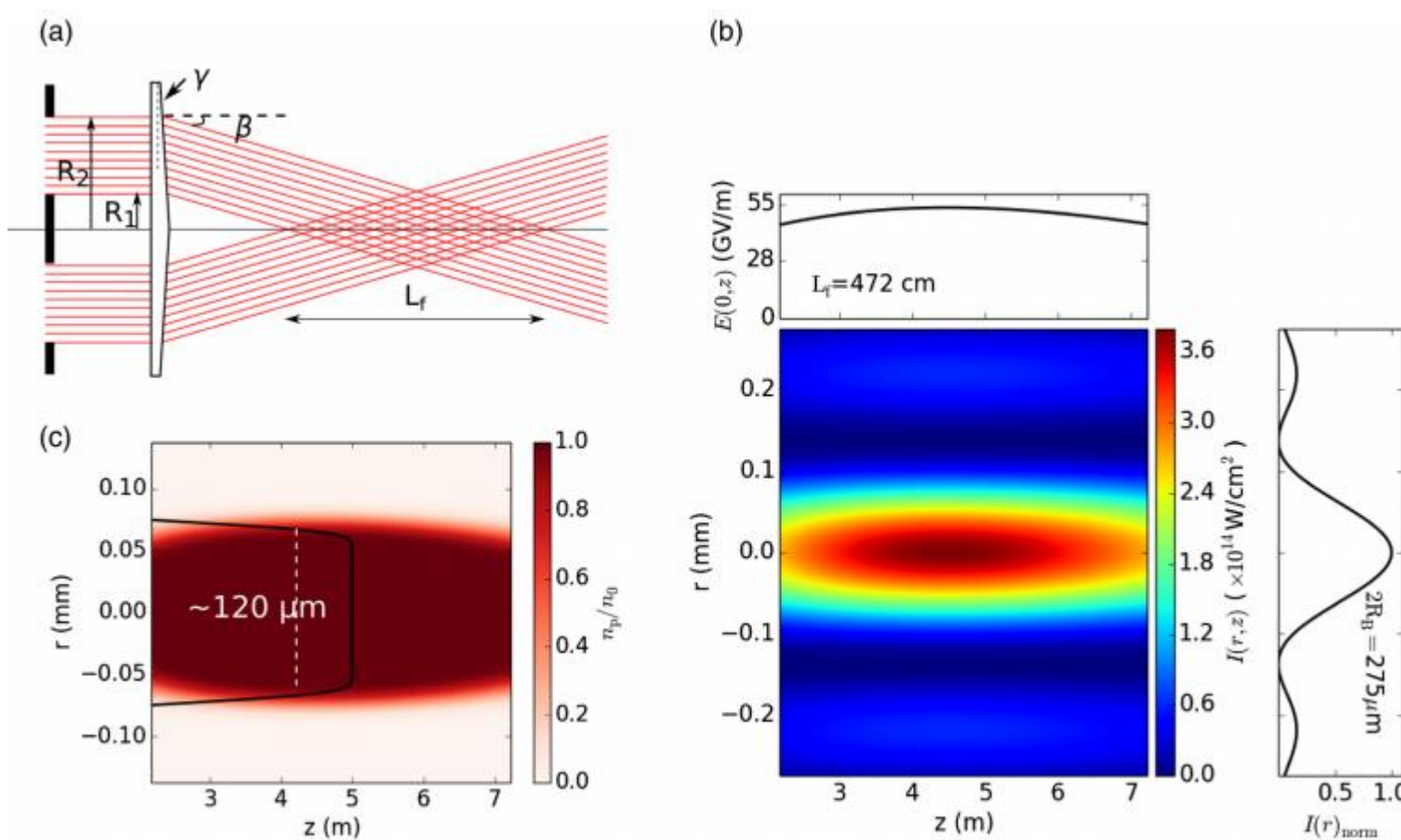
Task 14.3. Wakefield-Induced ionisation injection

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

Fostered exchange of research personnel:
- Dr. Grace Gloria Manahan (Strathclyde) currently at DESY as PIER fellow from may 1st to June 15th (Host: Aßmann) PIER
- Paul Scherkl (previously Uni Hamburg) joined Strathclyde as PhD student
- Fahim Habib (Uni Hamburg) joined Strathclyde in the context of his master thesis from 12/2015 to 6/2016, funded by DAAD

Task 14.1. Selective ionization of plasma components

e.g. using axicon *G. G. Manahan et al. (PRAB 19, 011303 (2016)*

14.2. Trojan Horse underdense photocathode witness bunch generation

Extensive datamining of successful E210 „Trojan Horse PWFA" multiyear collaboration at SLAC FACET (where preionization was a major bottleneck) in progress
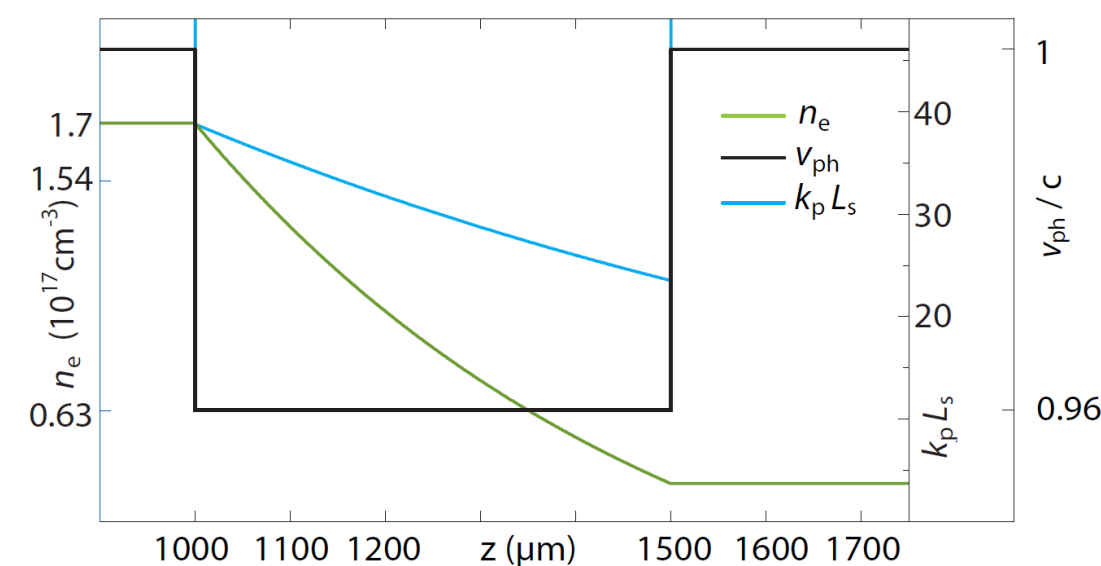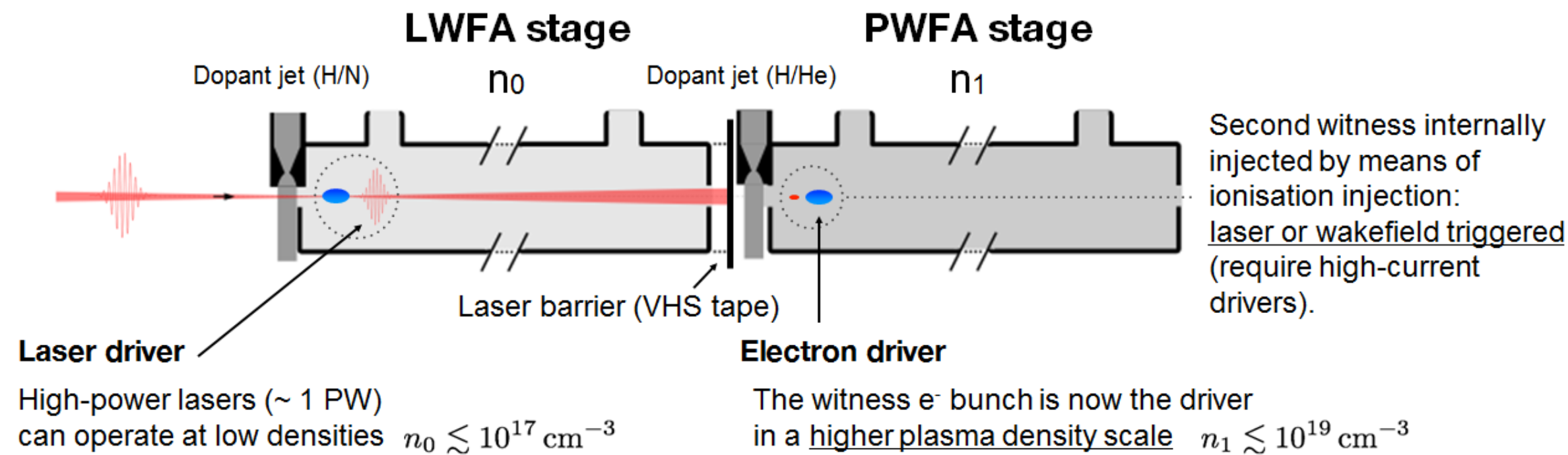
Task 14.3. Wakefield-Induced ionisation injection
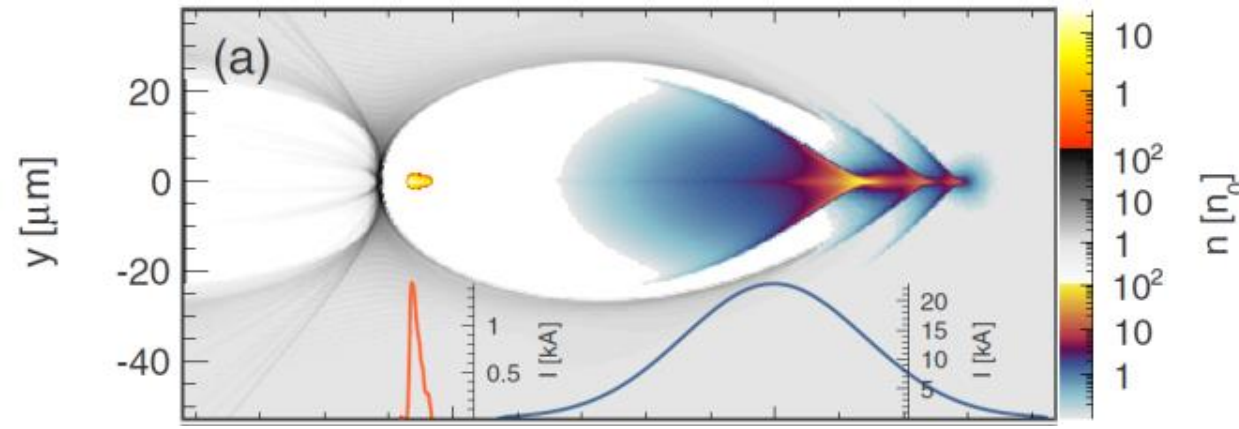
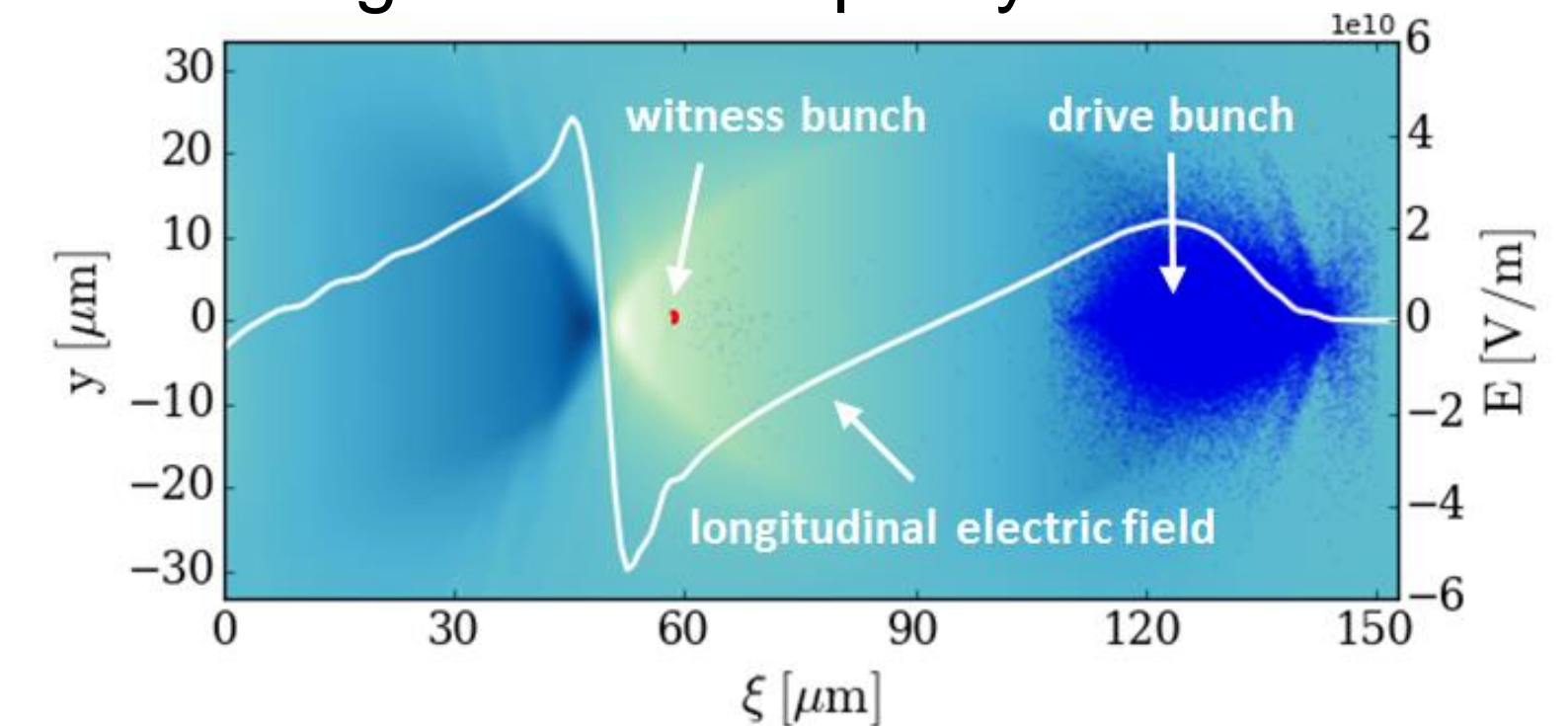Further studies in progress, e.g. in context of FLASHForward (ramping up!)

Beam brightness and quality transformer:

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

Conceptual design studies onging, e.g.

LWFA stage n_0 **PWFA stage** n_1

Dopant jet (H/N)   Dopant jet (H/He)

Second witness internally injected by means of ionisation injection: <u>laser or wakefield triggered</u> (require high-current drivers).

Laser barrier (VHS tape)

Laser driver

High-power lasers (~ 1 PW) can operate at low densities $n_0 \lesssim 10^{17}\,\mathrm{cm}^{-3}$

Electron driver

The witness e⁻ bunch is now the driver in a <u>higher plasma density scale</u> $n_1 \lesssim 10^{19}\,\mathrm{cm}^{-3}$

Driver beam properties:
- $\sigma_x = \sigma_y = \sigma_z = 7\,\mu\mathrm{m}$ (23 fs)
- $Q = 350$ to 600 pC
- $\bar{\gamma} = 500$ up to 2000
- $\Delta\gamma/\gamma = 10$ up to 50%
- $\varepsilon_n = 2.25 \times 10^{-6}\,\mathrm{m\,rad}$
- $B = 2 \times 10^{17}\,\mathrm{A/(m^2 rad^2)}$

Witness beam properties:
- $\sigma_x = \sigma_y = 0.6\,\mu\mathrm{m}$, $\sigma_z = 0.4\,\mu\mathrm{m}$ (1.3 fs)
- $Q = 7.3$ pC
- $\bar{\gamma} = 610$ (311 MeV) after 9.45 mm of acceleration
- $\Delta\gamma/\gamma = 2.5\%$
- $\varepsilon_{x,y} = 2.4 \times 10^{-8}\,\mathrm{m\,rad}$
- $B = 3.7 \times 10^{19}\,\mathrm{A/(m^2 rad^2)}$

Downramp-assisted TH can reduce drive beam curren threshold to <2.5 kA

Exp. hybrid campaigns including plasma lensing (w/ FSU Jena)