Optimization of Laser Wakefield Accelerators

by Ming Zeng

My history

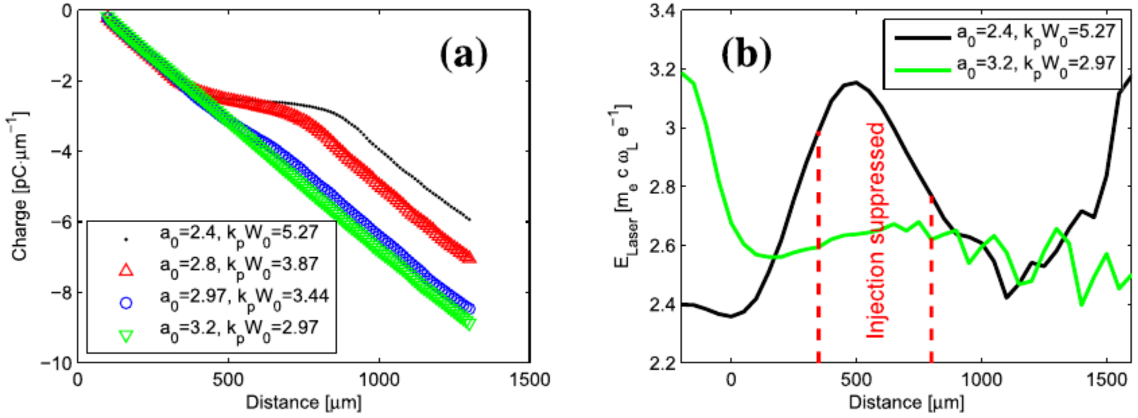
2005 – 2009 B.Sc
2009 – 2015 PhD (plasma physics) at Shanghai Jiao Tong University
12.2015 – 8.2017 Postdoc at ELI-NP, Romania
9.2017 – now FLA, DESY

Research activities

Theoretical and numerical researches for laser and plasma wakefield accelerators
Particle-in-cell simulations
Optimization of ionization injection in laser wakefield accelerators

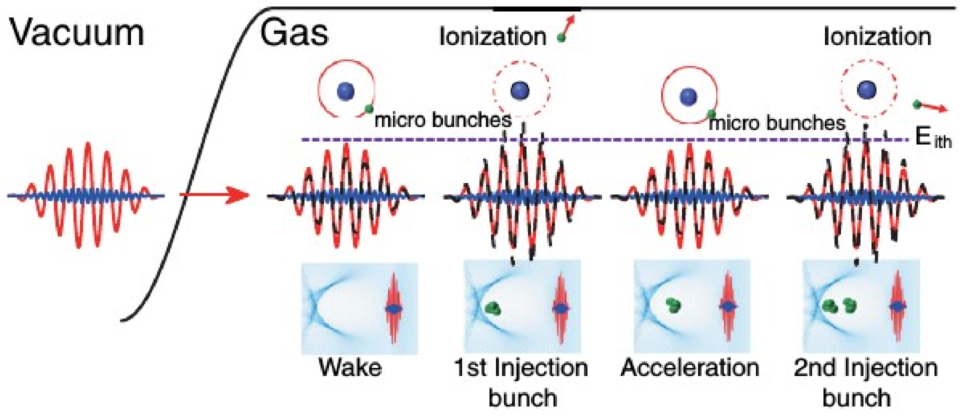
My former works

1. Self-truncation of ionization injections
Self-focusing of laser beam can truncate the continuous ionization injection.
Energy spread of output electron beams reduced from ~20% to ~5%.



Phys. Plasmas 21, 030701 (2014)

2. Multiple injection of low energy spread e-beams by dual-color lasers
If a laser beam and its 3rd harmonic co-propagate in plasma, the peak of E-field evolves periodically, which can produce multiple injections.
Each injection has low energy spread of ~1% or less.



Phys. Rev. Lett. **114**, 084801 (2015)

My Current Work

Number of petawatt laser projects increases rapidly in the world.
Focusing petawatt level lasers to spot sizes suitable for laser wakefield accelerators requires large (>0.5 m) focusing mirrors, which are expensive and hard to replace.
Focal length ∝ laser peak power, which can be 10 ~ 1000 meter.

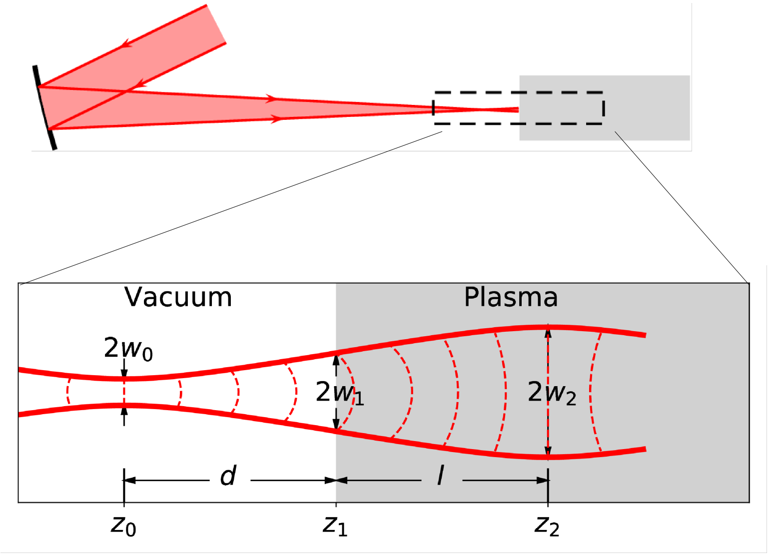
We have introduced a plasma lens for lasers (similar to an eyepiece in a telescope).
The effective focal spot size $w_2 > w_0$.
w_0 is usually fixed, while w_2 is adjustable by changing d.
The focal length is reduced to the ratio of w_2/w_0.

Main findings:

$$\frac{w_2}{w_0} = \sqrt{1 + \frac{d^2}{\zeta^2}}, \qquad \zeta \approx 0.95 z_R - 1.2k - 13,$$

$$l \approx 21.0 \frac{d}{w_0^{2.08}}.$$

(arXiv 1901.07974)



My Favorite Plots