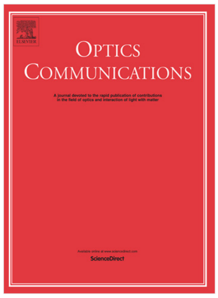
Accepted Manuscript



Effect of temporal asymmetry of the laser pulse on electron acceleration in vacuum

M. Rezaei-Pandari, M. Akhyani, F. Jahangiri, A.R. Niknam, R. Massudi

PII: S0030-4018(18)30681-3
DOI: https://doi.org/10.1016/j.optcom.2018.07.081
Reference: OPTICS 23354

To appear in: *Optics Communications*

Received date : 7 July 2018
Revised date : 28 July 2018
Accepted date : 31 July 2018

Effect of temporal asymmetry of the laser pulse on electron acceleration in vacuum

M. Rezaei-Pandari, M. Akhyani, F. Jahangiri*, A. R. Niknam, R. Massudi
Laser and Plasma Research Institute, Shahid Beheshti University, Tehran, Iran

Abstract

We explore the electron dynamics in a Gaussian laser pulse to assess the contribution of the temporal parameters to the mechanism of vacuum laser acceleration. Our numerical study reveals that a considerable nonzero energy gain can be achieved through a spatio-temporally controlled electron injection. Moreover, three-dimensional optimization of the electron's injection angle suggests that the highest energy gain is obtained by using a sideways injection scheme. We also present the dependence of the electron energy gain on the laser polarization by comprehensively comparing all possible polarization states. It is found that the temporal sensitivity of the electron injection is determined by the polarization of the laser pulse. In addition, it is shown that although the energy gain is maximized in linearly polarized short laser pulses, circularly polarized laser pulses with longer duration would also lead to comparable energy gains but with much less temporal sensitivity for electron injection. To address the technical feasibility of the acceleration procedure under the mentioned optimized conditions, an experimental setup is proposed.

Keywords: laser pulse, vacuum, electron, acceleration
2010 MSC: 00-01, 99-00

1. INTRODUCTION

Charged particle acceleration to high energies using intense laser beam in vacuum has been the subject of extensive research efforts during the last decades [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17]. It has been well established that the electron cannot obtain net energy gain in symmetrical infinite plane-wave laser [2, 3, 4] nor in finite-duration laser pulse [14, 15, 18, 19] in vacuum. During the interaction, the laser pulse phase velocity exceeds the speed of light, c, and phase slippage process prevents the electron to be phase synchronized with the laser field and retain its energy [9, 11, 12, 13, 14, 15, 18, 19, 20].

*Corresponding author
Email address: f_jahangiri@sbu.ac.ir (F. Jahangiri)