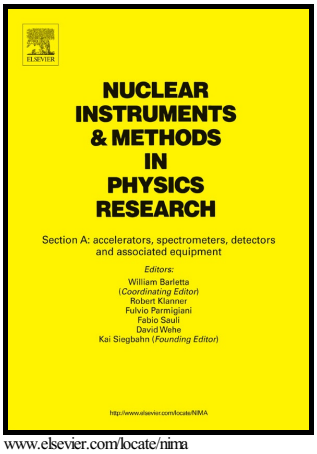
Piecewise-homogeneous model for electron side injection into linear plasma waves

A.A. Golovanov, I.Yu. Kostyukov



www.elsevier.com/locate/nima

PII: S0168-9002(16)30028-6
DOI: http://dx.doi.org/10.1016/j.nima.2016.03.010
Reference: NIMA58677

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date: 13 November 2015
Revised date: 10 January 2016
Accepted date: 3 March 2016

Cite this article as: A.A. Golovanov and I.Yu. Kostyukov, Piecewise-homogeneous model for electron side injection into linear plasma waves, *Nuclea Inst. and Methods in Physics Research, A* http://dx.doi.org/10.1016/j.nima.2016.03.010

Piecewise-homogeneous model for electron side injection into linear plasma waves

A. A. Golovanov[a,*], I. Yu. Kostyukov[a]

[a]*Institute of Applied Physics, Russian Academy of Sciences, 46 Ul'yanov Street, Nizhny Novgorod, 603950, Russia*

Abstract

An analytical piecewise-homogeneous model for electron side injection into linear plasma waves is developed. The dynamics of transverse betatron oscillations are studied. Based on the characteristics of the transversal motion the longitudinal motion of electrons is described. The electron parameters for which the electron trapping and subsequent acceleration are possible are estimated. The analytical results are verified by numerical simulations in the scope of the piecewise-homogeneous model. The results predicted by this model are also compared to the results given by a more realistic inhomogeneous model.

Keywords: electron acceleration, laser-plasma acceleration, linear wakefield, piecewise-homogeneous model, external electron bunch injection
PACS: 52.38.Kd

1. Introduction

Plasma-based methods for electron acceleration have attracted much attention because they can provide the acceleration rate several orders of magnitude higher than conventional methods [1, 2]. Laboratory experiments have demonstrated electron acceleration in plasma up to several GeV energy over the length of several centimeters [3, 4, 5]. These methods are based on the fact that the wakefield excited by a high intensity laser pulse [6] or a particle bunch [7] propagating through plasma has a very high acceleration gradient. In a highly nonlinear regime plasma itself can be a source of relativistic electrons for their further acceleration in the wakefield [8, 9]. However, high energy spread of the accelerated particles limits possible applications of the self-injection regime (e.g. in X-ray free electron lasers). One possible solution is to use external electron bunches (e.g. generated by a compact photo-injector) for their further acceler-

*Corresponding author. Phone: +7 831 416-48-31; address: 46 Ul'yanov Street, 603950, Nizhny Novgorod, Russia

Email addresses: agolovanov256@gmail.com (A. A. Golovanov), kost@appl.sci-nnov.ru (I. Yu. Kostyukov)