Guiding and Collimation of Electron Current Pulse in a Plasma

Amita Das, Predhiman Kaw and Sharad K. Yadav

Institute for Plasma Research, Bhat , Gandhinagar - 382428, India

Abstract

A host of frontline physics experiments today are associated with generation and/or the utilization of energetic electrons. One is either chasing the possibility and devising new schemes for the generation of electrons with desirable energy range (electron acceleration) or is interesting in utilizing them for a variety of other purposes. For instance for the purpose of localized heating in hot dense plasma targets as in the fast ignition experiments, or as a diagnostic tool for hot dense plasma studies etc. For such diverse applications one often encounters the question of keeping the electron pulse collimated and also its controlled guided propagation along a desired path. A novel mechanism to guide the propagation of electron current pulse in a plasma medium is proposed. It is shown that with an appropriate tailoring of the local plasma density profile one can effectively collimate as well as guide the path of the electron current pulse through plasma medium. The possibility of splitting a single electron current pulse and transporting the individual parts to distinct locations in plasma has also been illustrated (See Fig.1). This mechanism is much simpler to implement compared to other recently proposed schemes which utilize specially structured targets prepared of different materials having varying resistivity transverse to the propagation direction. A recent experiment reported in Nature (2004) by Kodama *et al.* [1] showing the transport of electrons along the direction defined by the orientation of a thin solid carbon wire provides a practical ellucidation of the proposed scheme. The wire after ionization produces a tailored plasma density of the kind required to guide the path of the subsequent part of the electron pulse. This is an illustration of the simplicity of the implementation of the proposed scheme.

Acknowledgement: This work was financially supported by DAE-SRC grant with sanction number: 2005/21/7-BRNS/2454.

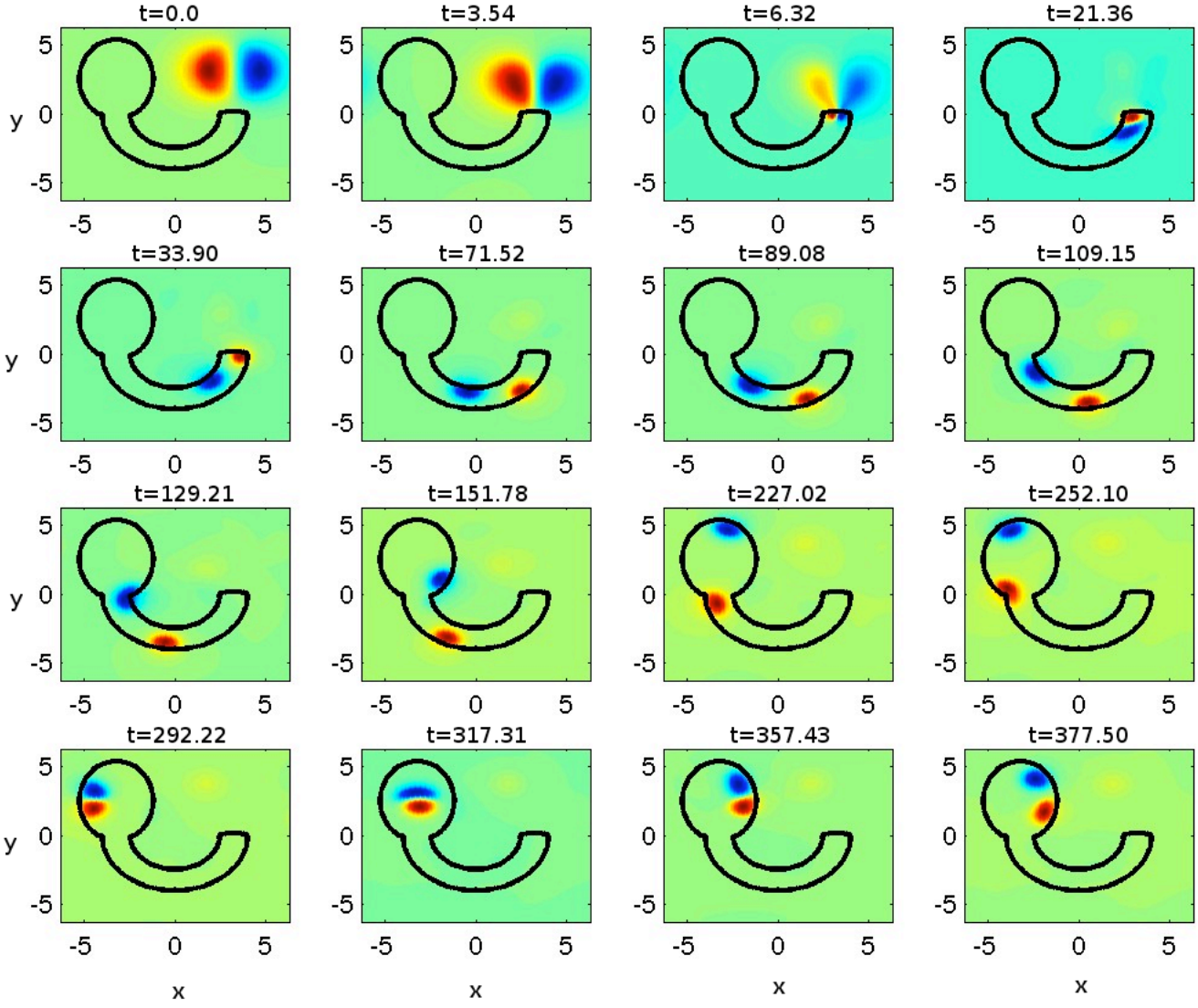

FIG. 1: The bifurcation of an electron current pulse in a specially tailored plasma density profile (indicated by black thick line) is shown.

Reference:

1. R. Kodama, Y. Sentoku, Z. L. Chen, G. R. Kumar, S. P. Hatchett, Y. Toyama, T. E. Cowan, R. R. Freeman, J. Fuchs, Y. Izawa, M. H. Key, Y. Kitagawa, K. Kondo, T. Matsuoka, H. Nakamura, M. Nakasutsumi, P. A. Norreys, T. Norimatsu, R. A. Snavely, R. B. Stephens, M. Tampo, K. A. Tanaka and T. Yabuuchi; Nature bf 432 1005 (2004).