Seminar

Institute for Plasma Research

Title : Fluid simulation of electron beam driven wakefield in a cold plasma

Speaker : Mr. Ratan Kumar Bera
Institute for Plasma Research, Gandhinagar

Date : 09th August 2017 (Wednesday)

Time : 11.00 AM

Venue : Seminar Hall, IPR

Abstract :

Being an ionized medium, plasma can sustain an electric field ~100 GV/m, almost three orders of magnitude stronger than that obtained from the conventional RF based linear accelerator. This distinct feature of plasma offers a way to design a compact and affordable high performance particle accelerator. In plasma based accelerators, the charge particles are accelerated using the electric field associated with an intense plasma wave (wake) which can be excited either using ultra-intense laser pulse (Laser Wakefield Acceleration (LWFA)) or ultra-relativistic electron beam (Plasma Wakefield Acceleration (PWFA)). Here we mainly focus on the excitation of relativistic electron beam driven wakefield in a cold plasma. Till to date, in this particular field, most of the simulations leading to the modern accelerator designs have been carried out using extensive particle-in-cell (PIC) simulations which are computationally heavy and time consuming. Here, by proposing the fluid depiction of the excitation, we have employed fluid simulation techniques for the excitation of wakefield which are much faster than any sophisticated PIC simulations, both in 1-D and 2-D. A complete characteristic study of the excited wakefield in terms of the accelerating structures, transformer ratio, rigidity of the electron beam, dynamical evolution, effect of ion motion, effect of finite beam dimensions etc. has been studied. Our fluid simulations are also capable of reproducing the “blowout” structure, a novel regime for the recent PWFA experiments. It is observed that the structure of blowout match with the analytical and PIC results, before wave breaking. Further, injecting the test particles in the fluid simulation, we have extensively studied the energy gain by the test particles and their focusing. It is observed that fluid simulations simpler than any elegant PIC simulations are pretty adequate at representing the wake potential structure and also providing a good estimation of energy gained in the process of acceleration.