ELECTRON TRANSPORT IN THE BACKGROUND PLASMA WITH STEEP DENSITY GRADIENT

Y.Hayashi[1], A. Das[2] , H. Habara[1], P.K. Kaw[2], K. A. Tanaka[1]
[1]Osaka University, Suita, Osaka, Japan
[2]Institute of Plasma Research, India
hayashi-y@eie.eng.osaka-u.ac.jp

For Fast Ignition, it is important to understand the transport process of fast electrons in dense plasma. As fast electrons enter the plasma, a current channel structure is formed in the plasma. The current channel with a cylindrical shape consists of forward current in the center surrounded by the return current at the side. Strong magnetic field is then associated with the current channel. We investigate how these current structures propagate in the plasma with steep density gradient. This mechanism was previously investigated in the fluid simulation by A. Das et. al.[1] The simulation consists of magnetic dipole structure propagating in plasma with steep density gradient. The magnetic dipole structure is squeezed in the high density plasma region and the energy of the dipole structure is released into the high density plasma region and the energy of the dipole structure is released into the background plasma. The magnetic dipole structure can be regarded as the current channel in a simple approximation.

We performed a PIC simulation for magnetic dipole structure in order to reproduce the effect shown in the fluid simulation because PIC code includes the relativistic and kinetic effects such as electron gyro-motion. We found pinching effect same as the fluid simulation performed by A. Das et. al. We also found collapse of dipole structure, which is not seen in the fluid simulation.

In addition, since the size of filament structure is nearly equivalent to the size of skin depth PIC calculation can easily resolve the physics in this scale. Next we replace the dipole structure as an energetic electron current in order to approximate the actual situations. We observed an evolution of filament-like structure through the current propagation. We also found that the size of filaments becomes finer as electrons propagates into the high density region. Fourier spectrum analysis has shown that the transition of the size of filaments adjusts their sizes to the skin depth of plasma nearby the current. These aspects will be discussed in detail.

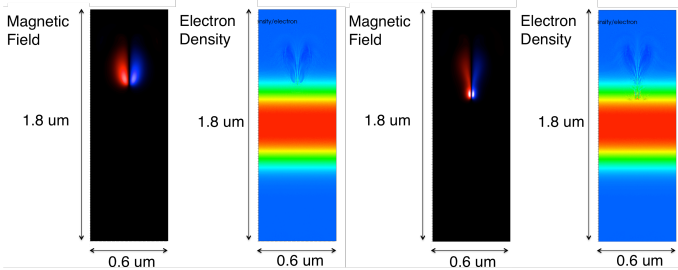

Fig. Propagation of magnetic dipole structure in plasma with density gradient

[1] S. K. Yadav, A. Das, P. Kaw. Propagation of magnetohydrodynamic structures in a two-dimensional inhomogeneous plasma. Phys. Plasmas. 15, 062308, (2008).