§18. Particle Simulation of High-Intensity Laser Interaction with Cone Targets

Nikolic, Lj. (INRS - ÉMT, Varennes, Québec, Canada),
Škoric, M.M., Ishiguro, S.,
Johnston, W.T., Vidal, F. (INRS - ÉMT, Varennes, Québec, Canada)

The generation of fast particles in a high-intensity laser-solid interaction is a hot research topic with huge potential for a large number of applications. The quality of the particle beams, their energy spectrum, collimation and guiding are some of critical issues in this field and significant research efforts are focused on modeling and understanding the interaction for various laser-target conditions and configurations that range from thin foils, wires and hemispherical shells to sophisticated cone-shaped targets particularly relevant to the fast ignition schemes for IFE [1].

2-dimensional PIC simulations were used to study strong laser-plasma interaction and generation of fast particles. Intense laser light (I = 10^{18} -10^{19} W/cm^2) was focused onto a 12λ focal spot inside overdense (n =10n_{cr}) cone-like shaped plasma targets with a wall thickness of 6.25λ, and a cone angle of 60 . In particular, we put an emphasis on the following target designs: cone (Fig. 1a), cone with an open tip (Fig. 1b), and cone with an attached wire (Fig. 1c).

It is found that in all cases of the laser-cone interaction, the generation of hot electrons is followed by localization of the electron jets that generate quasi-static magnetic filaments in the plasma. The directions of the filaments are close to the inner surface normal directions while the high-energy electron jets exhibit an angular separation. The angular spread of the electrons outside the cone is very pronounced in the open-cone case, however at the same time is the most efficient case from the point of view of generation of the fast electrons. In particular, while for the cone and cone-wire case, high-energy electrons E >10MeV are concentrated around the target (including wire), in the open-cone case two short (few λ) electron beams, shifted by λ/2 are observed far from the target. The electron beams propagate close to the laser beam axis and each beam consists of well-defined thin (< λ) mono-energetic electron sheets separated in space by λ.

Moreover, we further discuss the proton dynamics; in particular, a formation of low-energy proton wings due to the circulation of the hot electrons around the cone walls.

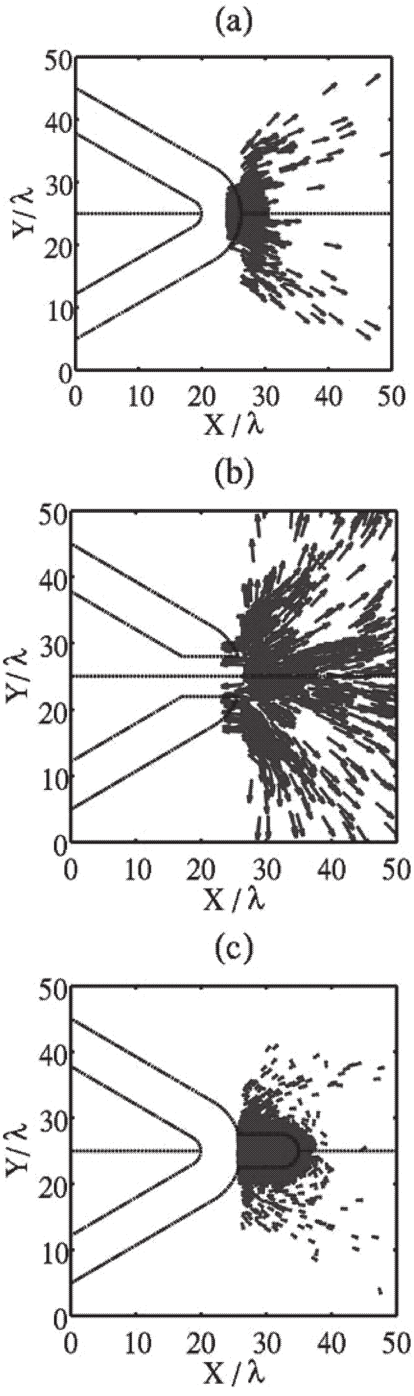

Figure 1: Distribution of fast electrons (E > 3MeV) for x/λ > 26.25 and t/T=88.

Reference

[1] R. Kodama *et al*., Nature **432**, 1005 (2004).