Fast Electrons Transport in Plasma by Strong Laser Interaction

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Fast ignition (FI) \cite{Tabak1994} is an attractive option for inertial confinement fusion (ICF) because it relaxes the requirements on the symmetry of the implosion and the compression energy. How the ignition is realized by the fast electrons or protons \cite{Bake2013} is an important problem. In this talk for the fast electrons transport, a low-density-core target with buried high density layers aiming at efficiently guiding and focusing fast electrons is presented by showing two-dimensional particle-in-cell simulations \cite{Lv2017}. It is found that this target can guide the fast electrons better. Comparing this to that without the buried high density layers, the energy density of fast electrons is increased by a factor of about 1.8 and has a narrower transverse distribution in space. The effect is attributed to the decrease of the longitudinal electric field and the collimation of the self-generated magnetic field.

For the proton transport, we proposed a gold cone-capillary to improve the protons acceleration \cite{Lv2017b}. It is demonstrated that the cone-capillary can efficiently guide and collimate the protons to a longer distance and lead to a better beam quality with a dense density $10n_c$, monoenergetic peak energy $E_k \sim 1.51$ GeV, spatial emittance $\sim 0.0088$ mm mrad with divergence angle $\theta \sim 1.0^\circ$ and diameter $\sim 0.5 \mu$m. The enhancement is mainly attributed to the focusing effect by the transverse electric field generated by the cone as well as the capillary, which can prevent greatly the protons from expanding in the transverse direction. Comparable to without the capillary, the protons energy spectra have a stable monoenergetic peak and divergence angle near to $1.0^\circ$ in longer time. Besides, the efficiency of acceleration depending on the capillary length is explored, and the optimal capillary length is also achieved.

In conclusion, our simulation results show that such these may be useful in many applications, such as FI experiments, laboratory astrophysics, medical applications and so on.

References


