GENERATION OF TARGET SURFACE ELECTRON BUNCH WITH SMALL DIVERGENCE AND ENERGY SPREAD

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Collimated electron beams produced by intense laser pulses focused onto solid-density plasmas are studied intensively, which may be applied to the fast ignition concept for inertial confinement fusion. Experiments and simulations have shown that the electron beams are emitted at an angle between laser specular direction and the target normal direction. In particular, an electron jet emitted along the target surface has been observed using large angles of incidence during laser irradiation of solid targets. However, the target surface electron energy spectrum shows a 100% energy spread in most cases of laser-solid interaction, save for a few experiments [1], however, with low beam charge and large beam divergence angle (> 20^0).

We systematically studied the relationship between the guiding of target surface electrons and laser parameters. When a nanosecond prepulse was added without picosecond ASE, the electron beam became concentrated and intense. Guiding of electron jet emission along the target surface was achieved and the divergence angle decreased after increasing the incidence angle. We obtained a 0.8-MeV peaked electron beam with a charge of 100 pC in a single shot and a divergence angle as small as 3^0 [2].

And then, high-quality monoenergetic target surface acceleration (TSA) electron beams with extremely small normalized emittance (0.03π mm mrad) and large charge per shot have been observed from a 3 TW laser-solid interactions. The 2D PIC simulation reveals that a bubble-like structure as an accelerating cavity appears in the near critical density plasma region and travels along the target surface. A bunch of electrons is pinched transversely and accelerated longitudinally by the wake field in the bubble [3].

Besides these results obtained by using small size fs lasers, we also performed TSA experiment recently using sub-ps high power lasers such as PHELIX in GSI. Several MeV energy level monoenergetic and highly collimated (< 2^0) electron beam with charge several nC is obtained. The acceleration mechanism is still open for discussion. The pointing stability and reproducibility of such a highly collimated TSA beam makes possible an ideal beam for fast ignition on ICF study.

References

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