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Ultra-high Charge Electron Acceleration from Solid Target

Liming Chen[1,2,3,4]

1) Institute of Physics in Chinese Academy of Sciences, Beijing, China
2) University of Chinese Academy of Sciences, Beijing, China
3) Songshan Lake Materials Laboratory, Dongguan, Guangdong, China
4) IFSA Collaborative Innovation Center and School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai, China

Collimated electron beams produced by intense laser pulses focused onto solid-density plasmas are studied intensively for many applications. Experiments and simulations have shown that the electron beams are emitted at an angle between laser specular 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, save for a few experiments [1] with low beam charge and large beam divergence angle (> 200). We systematically studied the relationship between the guiding of target surface electrons and fs laser parameters. When a nanosecond prepulse was added without picosecond ASE, the electron beam became concentrated and intense. 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 30 [2]. High-quality monoenergetic target surface accelerated electron beams with 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. 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 using sub-ps high power lasers such as PHELIX in GSI and TITAN in LLNL. Ten MeV monoenergetic and highly collimated (< 20) electron beam with 8nC was observed on PHELIX. The Maximum beam charge of 100 nC are obtained on TITIAN [4]. The Direct Laser Acceleration might be the acceleration mechanism in ps-laser/solid interaction. The good pointing stability and reproducibility of such a ultra-high charge electron beam makes it possible an ideal beam for fast ignition on ICF and drive the warm/hot dense matter.

References

[1] T. E. Cowan et al, NIMA 455, 130 (2000); L. M. Chen et al., Phys. Rev. Lett.100, 045004 (2008); A. G. Mordovanakis, Phys. Rev. Lett.103, 235001 (2009)
[2] J. Y. Mao et al, PRE 85, R025401(2012); W. M. Wang et al, HEDP 9, 578(2013)
[3] J. Y. Mao et al, Appl. Phys. Lett. 106, 131105(2015)
[4] Y. Ma et al, PNAS 115, 6980(2018); J. Y. Mao et al, Opt. Lett. 43, 3909(2018)