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Electron transport in the nanowire irradiated by high-intensity laser

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Recent developments of laser-nanowire interactions received a lot of attention because they appear showing potentials to increase the coupling efficiency with ultra-intense lasers. Laser-nanowire interactions open up various applications such as attosecond bunch generation, enhanced x-ray generation, brilliance gamma-ray yield, as well as efficient micro fusion. Despite many studies on nanowire interaction, the electron dynamics inside a single nanowire is still obscure. Real-time observation of electron transport inside the nanowire is experimentally almost impossible.

We report the numerical observation of the electron transport inside the nanowire when irradiated by the intense laser pulse. We found that a plasma wakefield is excited by 2 omega electron bunches for both linearly and circularly polarized laser pulse. For linearly polarized laser field, the 2 omega bunches were generated by the J X B heating at the tip and propagate along the nanowire. In addition, electron outside the nanowire cross over the boundary, leading to electron injection and acceleration. For circularly polarized laser field, only the electron crossing contributes to the 2 omega bunches in which the J X B heating is absent. Our study shows for the first time the enhanced absorption of the intense laser propagating along the nanowire in detail by using 2D PIC simulations.

The acceleration of these bunches have generally increased the electron energy absorption by 2 times as compared to a flat target, and may motivate the development of overdense plasma wakefield acceleration and enhancement in Bremsstrahlung generation.