Control and optimization of electron beam characteristics from laser wakefield acceleration in plasmas

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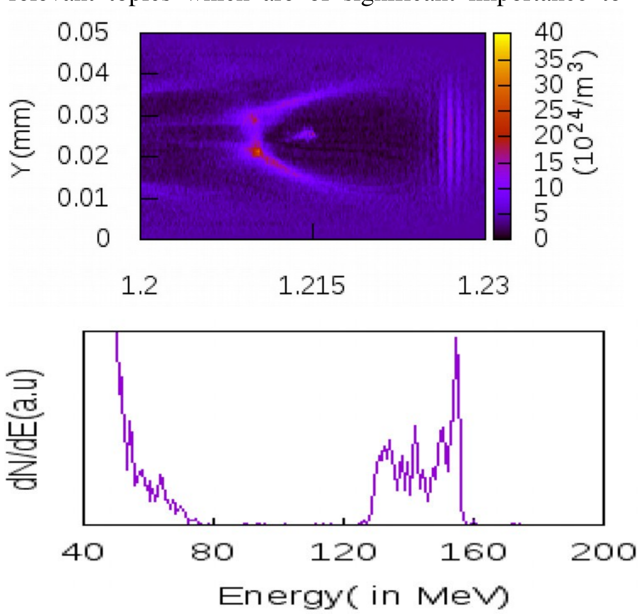
The field of laser-plasma dynamics is very interesting, active and most innovative research branch in physics. The ultrahigh gradients in laser plasma wakefield accelerators (LWFA) on scales of millimeters to centimeters can be extended in a meter scale plasma towards the high-energy frontiers. The unique characteristics of laser-driven particle beams are expected to be find useful in many practical applications, including proton therapy for the treatment of cancers, materials characterization, radiation-driven chemistry, border security through the detection of explosives, narcotics and other dangerous substances, and of course high energy particle physics. In these applications, the electron beam quality generated from LWFA is crucial. We propose to investigate the optimization and control of electron bunch generated from LWFA. The fundamental and experimental research should be continued to optimize the design and construction of compact table-top accelerators, to explore new regime and to validate theories and numerical codes.

With the advent of laser, these studies underwent an explosive growth and wave-plasma interaction emerged as a major rich field of research. Laser plasma accelerators were proposed as a next generation compact accelerator because of the huge electric fields they can sustain [1]. The accelerating electric fields in conventional accelerators are limited to a few tens of MeV/m, owing to material breakdown at the walls. Laser plasma accelerators can produce accelerating fields of hundreds of GeV/m, which accelerate particles to high energies in distances much shorter than in conventional accelerators. Such laser plasma accelerators are capable of producing beams of energetic electrons, protons and γ-rays. If electrons with sufficient energy matching the accelerating electric fields are injected into the wakefield, they can be trapped by the wakefield and accelerated to high energy [2]. In the last fifteen years, several major injection schemes have been proposed and performed by experiments successfully [3]. The major objective of this work is to understand the physics of laser plasma interaction via PIC simulation and theoretical analysis, and to explore new ways to increase energy and coupling from laser energy to the accelerated particles under current experimental conditions. In order to achieve the better beam quality, the injection of the electrons in accelerating phase of the wake wave is the most significant phenomena in LWFA. We provide a better control in electron injection through laser pulse shape optimization in plasmas. Our study reports that the pulse asymmetry is good in terms of mononergetic beam; low emittance and improved injection for pulse duration of 30 fs in laser wakefield acceleration [4]. This work presents researches on laser plasma acceleration and relevant topics which are of significant importance to



and the corresponding electron energy spectrum. The injected bunch becomes monoenergetic in the case of the asymmetric laser pulse because the pulse of the front part of the laser pulse becomes shorter. When the pulse gets compressed and becomes asymmetric, the emittance of the electron bunch reduces. Hence, the pulse asymmetry can be considered as one of the controlling knobs for the emittance of the accelerated bunch.

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