6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Enhancement of laser electron accelerations and betatron gamma-ray radiations with multi-PW laser pulses

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Laser wakefield acceleration (LWFA) [1] is an emerging technology that can provide orders of magnitudes higher acceleration gradient than the conventional electron accelerators. LWFA became a feasible method to realize compact electron accelerators and future linear colliders as high intensity laser technology advanced rapidly. The LWFA is now able to explore new energy regimes of the multi-GeV energy range due to the development of laser systems with peak powers greater than PW [2]. Recently, we were able to produce a 4.5 GeV electron beam, using 2.5 PW laser pulses and a 7-cm helium gas cell target mixed with 1% neon. The sequential ionization of the neon atoms improved the propagation of the intense laser pulse in a plasma medium, as well as inducing the ionization injection [3], according to both experimental and theoretical analysis. In addition, we were able to produce betatron radiation [4] with higher energy and flux by adding a few-mm pure neon gas jet after the acceleration medium. We will discuss recent developments in LWFA and betatron radiation using multi-PW lasers in this presentation. We also present novel LWFA schemes, such as elliptic plasma bubble formation [5] and nanoparticle injection method [6].

References
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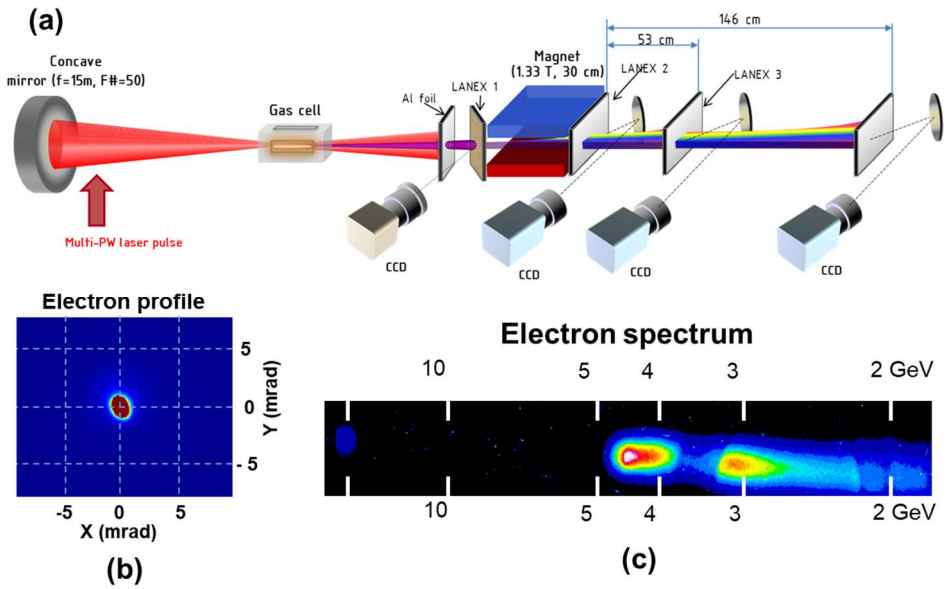

Figure 1. (a) Layout for LWFA experiment with 4 PW laser. (b) profile and (c) energy spectrum of electron beam driven by the 4 PW laser.