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Control of electron beam properties and x-ray radiation with adjustable density transition injection in LWFAs

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We have studied the dynamics of the accelerated electron beams in laser wakefield accelerators (LWFAs), where the localized injection of the electrons into the accelerating phase of the bubble have been achieved by utilizing density transition injection or the shock-front injection [1, 2]. Physically, such injection schemes demand only a sharp drop in the plasma density near the laser focus point – which is relatively easy to employ in the laboratory experiments. This density transition shape can be systematically controlled by properly adjusting a gas jet-blade assembled system in the laboratory experiments [3, 4]. Here, we have particularly focused on the tilt angle variation of the shock profile. To do this, we have systematically performed multidimensional Particle-in-Cell (PIC) simulations using SMILEI [5]. A linearly polarized laser of peak intensity $2.75 \times 10^{19}\ W/cm^2$ and having wavelength 800 nm has been used throughout our simulations. Underdense plasma density profiles, initially loaded in our simulations, have been shown in Figure 1, for two different tilt angles.

From simulations, it has been found that because of the asymmetry, introduced by the tilted shock configuration, electrons are injected off-axis which eventually attribute to a relatively higher betatron oscillation amplitudes. The variation of the electron beam parameters viz. the beam charge, energy, energy spread and transverse emittance with the tilt angle have been studied in detail. Studies have been further extended to calculate the far-field radiation spectra [6] and their variation with the tilt angle has also been demonstrated.

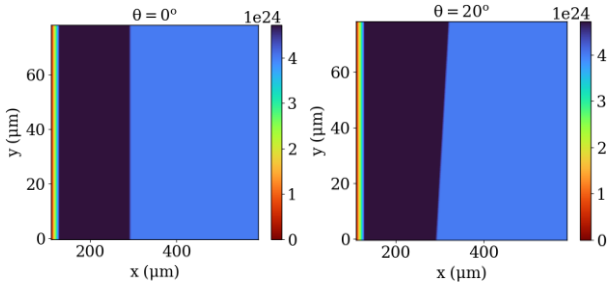

Figure 1: Plasma density profiles for two different tilt angles

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Note: Abstract should be in (full) double-columned one page.