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Using ionization injection to get high quality electron beam in laser wakefield acceleration

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Ionization injection can be used to get high quality electron beam in laser wakefield acceleration. To get low energy spread, two injection schemes are proposed here. By use of certain initially unmatched laser pulses, the electron injection can be constrained to the very front region of the mixed gas target, typically in a length of a few hundreds micro meters, and energy spread is largely reduced. By using this method, electron beam with FWHM energy spread less than 5% and peak energy around 500MeV is demonstrated by PIC simulations. In a second scheme, we suggest to use two-color beat wave to control the injection length. A beat wave is generated and the highest electric field due to the overlapping of the two peaks of the two laser waves can ionize the internal electrons and trigger the ionization injection. Due to the phase velocity difference of the two color pulses, the ionization distance is very limited which then lowers the injection length. By multi dimensional PIC simulations, we demonstrate electron beam with ultralow energy spread less than 1% percent and central energy of 400MeV can be obtained by using ω and 3ω laser pulses in a gas.

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