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Multistage laser wakefield acceleration driven by two laser pulses with different focal lengths

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We are developing high-quality electron source (stable, ultrashort, high charge and narrow energy spread) based on multistage LWFA towards practical applications such as ultrafast electron imaging and x-ray free electron laser. The multistage technique using two laser pulses with different focal lengths enables flexible energy control of the electron beam. In this technique, firstly, tightly focused laser pulse produces injector beam via wavebreaking process of the plasma wave. Then the injector beam injects into the linear wakefield excited by the long focused laser pulse. The energy of the injector beam can be modified in the linear wakefield. The electron beam with narrow energy spread can be obtained by phase rotation and/or the high-energy electron beam can be obtained by further acceleration in the linear wakefield. The energy can be controlled by changing the timing between two laser pulses. We have performed the experiment of the two-pulse-driven multistage LWFA and succeeded to generate quasi-monoenergetic electron beams having the energies from a few MeV to hundreds MeV.

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