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Stable injection into a laser plasma accelerator with colliding laser pulses

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Colliding pulse injection of electron beams into a laser plasma accelerator (LPA), thus producing compact, stable, and monoenergetic electron beams, has important applications for narrow bandwidth Thomson gamma ray sources and novel x-ray free-electron lasers. The colliding laser pulses are independently optimized in terms of energy, beam size, and pulse compression. The spatiotemporal overlap of the femtosecond-duration colliding pulses in the underdense plasma is ensured with femtosecond shadowgraphy and top imaging of the plasma. High-quality, stable LPA electron beams from colliding pulse injection were demonstrated over consecutive 100's of shots. The absolute rms energy spread of the injected electron beam could be reduced down to just a few MeV (rms), at peak electron energy of ~150MeV. The peak energy is stably tunable over large respective ranges of the plasma density, gas jet positions, and injector pulse delays. Parameter scan of injection position and plasma density indicate the driver laser pulse depletion and/or diffraction at large plasma density, which causes the decrease of the maximum electron beam energy.

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