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Optical Transverse Injection: A New Mechanism of Injection in Laser-Wakefield Acceleration

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Although laser-wakefield accelerators have demonstrated accelerating gradient on the order of 1 TeV/m, they currently still lack the stability and bunch quality that is needed for many applications. Nevertheless, these properties strongly depend on the electron injection into the accelerating cavity, and improved bunch quality can in principle be obtained by choosing a proper method of injection.

After reviewing the main existing mechanisms of injection, a mechanism recently identified through PIC simulations –optical transverse injection –will be described. This mechanism occurs in the colliding-pulse configuration, in which a counter-propagating pulse collides with the driving laser and triggers injection. While in the previously explored regimes of parameters, the mechanism was essentially longitudinal (i.e. effectively 1D), in a well-define range of yet unexplored parameters a transverse mechanism (i.e. fully 3D) appears.

Importantly, this mechanism generates high-quality electron bunches having simultaneously high charge (50-100 pC), low energy spread (2%) and low emittance (0.15 mm.mrad). In addition, the required laser and plasma parameters are available at a number of existing laser facilities, making it an interesting scheme for future applications.

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