Laser-overdense plasma interaction for efficient electron injection and acceleration in a wakefield

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When an ultraintense laser ($\geq 10^{18}$ W/cm^2) irradiates overdense plasmas, it is possible to generate electromagnetic waves at the vacuum-plasma interface, which enable local field confinement for electron acceleration up to relativistic energies. Since these mechanisms involve an overdense plasma, high values of the total electron beam charge can be achieved. Among others, this may be important for applications in the fields of plasma-based accelerators and electron sources. In Ref. [1], it was shown by means of Particle-in-Cell (PIC) simulations [2] how a laser pulse interacting with the wedge of an overdense plasma can produce a diffracted electromagnetic wave with an intense longitudinal electric field that efficiently accelerates plasma electrons. In our work, we expand upon these findings by introducing a second stage of acceleration, in which electrons emitted by the laser-overdense plasma interaction are injected into a wakefield generated by the same laser pulse propagating through an underdense plasma. This approach enables the observation of electron beams with charges comparable to those resulting from laser-overdense plasma interaction (~200 pC) while keeping high quality, translated into high energy (up to ~150 MeV), low energy spread (~10%), and low normalized emittance (~10π μm rad).

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References

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