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Simulation study on impact of laser pulses on particle defocusing and acceleration gradients

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Abstract

The demand for accelerators with high electric field gradients is crucial for the development of future electron or proton colliders. To address this, plasma wakefield accelerators have emerged as a potential solution by utilizing short electron or proton bunches to generate substantial plasma wakes. These wakefields exhibit both longitudinal and transverse components, with the former responsible for accelerating the particle bunches and the latter for focusing them. In our research, we conducted an investigation into the effects of twisted and two-color laser pulses on defocusing and the injection of electrons or protons into the counter-propagating ionization front. To analyze, these phenomena, we employed the FBPIC code, which allowed us to accurately simulate laser pulse behavior. Notably, our findings revealed that the utilization of twisted and two-color laser pulses did not result in significant defocusing over longer distances. This implies that these types of laser pulses can maintain the focused nature of electron or proton bunches, enabling effective injection and facilitating their interaction with the ionization front. Therefore, by understanding the role of twisted and two-color laser pulses in defocusing and particle injection, we can advance our knowledge of plasma wakefield accelerators and their potential for achieving high electric field gradients in future colliders.

References

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