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Stable and High-Quality Laser Wakefield Positron Acceleration Scheme

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Laser wakefield acceleration (LWFA) has the advantages of high acceleration gradient and compact scale, which is a promising candidate for the next generation of electron-positron colliders. However, high-quality positron acceleration mechanism based on LWFA is still absent. In this poster, we propose a stable, dephasing-resistant laser wakefield positron acceleration scheme to achieve low-energy-spread, low-emittance and high-charge positron acceleration. A bi-Gaussian laser pulse significantly shorter than the length of the blowout bucket is used, guided by a pre-formed plasma channel. This setup suppresses laser evolution and stabilizes wakefield structure, enabling consistent positron acceleration with low emittance and narrow energy spread. Additionally, the group velocity of the laser lower than the speed of the positron beam will cause the dephasing between the laser and the beam, resulting in changes in the accelerating field experienced by positrons. By optimizing the positron beam's current profile and initial distance from the laser, we can exploit dynamic beam loading, reducing or eliminating the dephasing-induced energy spread over tunable distances. Moreover, a scaling law is derived to show that a nC-level level positron beam can gain over 120 GeV through a <100 m single-stage acceleration using state-of-the-art laser facilities.

Primary authors: Mr JOSHI, Chan (University of California Los Angeles); Mr LI, Fei (Tsinghua University); Ms HUA, Jianfei (Tsinghua University); Mr ZHOU, Shiyu (Institute of High Energy Physics); DING, Siqin; Mr MORI, Warren B. (University of California Los Angeles); Mr LU, Wei (Institute of High Energy Physics)

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