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Dephasingless Laser-Wakefield Acceleration

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Laser-wakefield accelerators (LWFA) deliver high quality, mono-energetic electron beams in a compact and reliable way. Yet, achieving multi-GeV electron bunches, without requiring additional laser beams or plasma channels, remains a challenge that may require changing our approach that will facilitate the acceleration of even more energetic electron beams. For that, LWFA must overcome challenges that limit the acceleration achievable in existing systems. The axiparabola, a long-focal-depth reflective optical element, has generated interest in its potential to overcome both the beam diffraction and the electron dephasing limitations of LWFA. This can be accomplished by combining the axiparabola with a manipulation of the spatio-temporal couplings (STCs) of the incoming beam.

In this talk, I will present our recent experimental results and the insights that they provide in the pursuit of dephasingless acceleration. These include the first experimental demonstration of the ability to tune the velocity of peak intensity via an axiparabola and STCs4, the first acceleration of electrons directly with an axiparabola-generated wakefield, and the first direct imaging of such a wakefield. The results are backed up by extensive simulations. These proof-of-concept results explore the novel regime of the axiparabola-generated wakefield and bring us closer to the eventual demonstration of dephasingless LWFA.

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