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Plasma Acceleration

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The energy frontier of particle physics is several trillion electron volts, but colliders capable of reaching this regime are costly and time-consuming to build; it is therefore important to explore new methods of accelerating particles to high energies. Plasma-based accelerators are particularly attractive because they are capable of producing accelerating fields that are orders of magnitude larger than those used in conventional colliders. In these accelerators, a drive beam (either laser or particle) produces a plasma wave (wakefield) that accelerates charged particles. The ultimate utility of plasma accelerators will depend on sustaining ultrahigh accelerating fields over a substantial length to achieve a significant energy gain. In this talk I will show recent results on the energy doubling of 42 GeV electrons at the Stanford Linear Accelerator Center (SLAC) in less than one meter using a plasma accelerator. Most of the beam electrons lose energy in exciting the plasma wave, but some electrons in the back of the same beam pulse are accelerated with a field of $\sim$52 GV m^{-1}. This effectively doubles their energy, producing the energy gain of the 3-km-long SLAC accelerator in less than a metre for a small fraction of the electrons in the injected bunch. I will discuss how this new technique may affect future colliders for high energy physics.

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