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High-efficiency and high-quality laser-plasma accelerator stages for a plasma-based linear collider

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The viability of next generation plasma-based linear colliders relies on the possibility of accelerating high-charge and low-emittance bunches to high energies over short distances with high efficiency, while keeping a small relative energy spread. Laser-plasma accelerators (LPAs) can operate in different regimes, namely, linear (or mildly nonlinear) stages, where laser guiding is achieved by means of an external waveguide such as a plasma channel, or nonlinear stages where the laser is self-guided through the plasma by means of relativistic self-focusing and plasma wave guiding. For the same laser driver energy, channel-guided and self-guided LPA stages are characterized by different accelerating gradients, lengths, optimal bunch parameters, and acceleration efficiencies. In this talk we present a systematic investigation of the properties of channel-guided and self-guided LPAs with fixed laser energy, and we discuss a self-guided LPA stage operating in the nonlinear regime providing high-gradient, high-efficiency, and quality-preserving acceleration of electron beams for collider applications.

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Primary authors: BENEDETTI, Carlo (LBNL); TERZANI, Davide (LBNL); BULANOV, Stepan (LBNL); SCHROEDER, Carl (LBNL); Dr ESAREY, Eric (Lawrence Berkeley National Laboratory)

Presenter: BENEDETTI, Carlo (LBNL)

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