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Towards better electrons for applications: tackling the energy, emittance and luminosity frontier

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We present recent progress at the Center for Advanced Laser Applications (CALA) toward generating high-energy electron beams with minimal divergence and high stability. First, employing the petawatt (PW) laser ATLAS-3000, we aim to produce multi-GeV, precision-injected electron beams for a Breit–Wheeler pair creation experiment. Emphasis is placed on reliable performance in complex collision setups, favoring simpler target geometries such as gas jets and cells to enhance beam stability and energy. Second, we investigate the transformer ratio in a hybrid laser–plasma wakefield acceleration (LWFA)/particle beam-driven wakefield acceleration (PWFA) scheme, demonstrating internally injected, high-quality witness bunches at energies reaching twice that of the 750 MeV driver. These beams exhibit ultralow divergence and a few-percent energy spread, making them promising candidates as compact, table-top free-electron laser (FEL) drivers. Finally, we endeavor to implement a plasma-modulated plasma accelerator concept pioneered at Oxford using the picosecond, fully diode-pumped Yb:YAG CPA laser PFS. Ongoing efforts include integrated laser–target stabilization to ensure reliable electron-beam production, supporting the next generation of secondary radiation sources.

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