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Increasing the energy of high-quality electron bunches from a hybrid L-PWFA

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Hybrid laser and electron beam-driven plasma accelerators (L-PWFA) have been a growing focus in recent years, combining the strengths of laser wakefield acceleration (LWFA) and particle beam-driven plasma wakefield acceleration (PWFA). In this approach, an LWFA stage generates a high-current electron bunch, which drives a subsequent PWFA stage where a witness bunch is internally injected and accelerated. This hybrid design leverages the accessibility of LWFA with the stability and beam quality achievable in PWFA.
Our earlier experiments demonstrated witness beams with reduced energy spread and divergence, leading to higher spatial and spectral particle densities—crucial for producing brilliant X-rays and enabling advanced applications. However, energy gain in these witness beams was previously limited, resulting in a transformer ratio below unity.
In this contribution, I will present our latest experimental results, where the witness beam energy equals the average driver energy through optimized plasma density profiles in the PWFA stage. Additionally, ongoing efforts to tailor the drive beam current profile aim to achieve much higher transformer ratios in upcoming campaigns, further enhancing the potential of L-PWFA for future applications.

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