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Minimizing betatron coupling of energy spread and divergence in laser-wakefield accelerated electrons

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Matched beam loading in laser wakefield acceleration (LWFA) flattens the accelerating electric field along the bunch and leads to the minimization of energy spread at high bunch charges. By using the self-truncated ionization injection scheme for controlling the injected charge, we demonstrate that minimal energy spread coincides with a reduction of the normalized beam divergence.
Betatron radiation spectroscopy simultaneously confirms a constant beam radius at the plasma exit. Together, the decrease in divergence can be attributed to the reduction of chromatic betatron decoherence. Thus, beam loading enables the highest longitudinal and transverse phase space densities by optimizing energy spread and normalized divergence.

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