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Beam quality optimization in a beam loaded nanocoulomb-class laser wakefield accelerator

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Here we report on beam quality optimization in a stable and robust nanocoulomb-class laser wakefield accelerator. The self-truncated ionization injection scheme enables precise control over the amount of injected charges up to 0.5 nC (FWHM) at a quasi-monoenergetic peak. Stable operation of the accelerator is achieved, enabling us to study key parameters in statistical data-sets. Employing the optimal beam loading condition, the accelerating gradient is flattened and we eliminate additional energy spread contribution from the acceleration process^{1,2}. Simultaneously minimizing beam divergence by limiting betatron coupling, high quality beams with peak currents of over ten kA are reached. Together with the accelerator's tunability and stable operation this paves the road for driving superradiant light sources and enables the first proof-of-principle experiments exploiting the unique beam properties found in these compact accelerators.

1. J.P. Couperus, et.al., "Demonstration of a beam loaded nanocoulomb-class laser wakefield accelerator", *Nature Communication*, 8, 487 (2017)
2. A. Irman et al., "Improved performance of laser wakefield acceleration by tailored self-truncation ionization injection", *Plasma Physics and Controlled Fusion*, 60, 044015 (2018)

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