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Reduction of the electron beam divergence of laser wakefield-accelerators by integrated plasma lenses

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We report on electron beam collimation using a passive plasma lens, integrated directly into a laser wakefield accelerator stage operating in the high-charge regime. The lens is created by reshaping the gas density profile of a super-sonic jet at the beam's exit side through an obstacle mounted above the jet. It reduces the beam's divergence by a factor of two, to below 1 mrad (root-mean-square), while preserving the total charge of 170 pC and maintaining the same energy spread. The resulting
spectral-charge density, charge contained within MeV energy bandwidth propagating at mrad angular direction, of up to 7 pC/(MeV·mrad) played a key role in the recent experimental demonstration of free-electron lasing. The presented simple and robust gas shaping technique holds the potential to generate specific density profiles, essential for the application of adiabatic focusing or staging of accelerators

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