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Demonstration of divergence reduction of laser driven wakefield accelerated electron beams using a compact plasma lens generator

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We demonstrate the divergence reduction of laser driven wakefield accelerated electron beams using a compact plasma lens in a single stage setup. We modify the gas density profile of a super sonic gas jet and create a shallow second density bump, which serves as a passive plasma lens, using a small ($< 1\text{cm}^3$) metal wedge. The plasma lens decreases the electron beam divergence from averaged 2.1 down to 0.98 mrad (r.m.s.), while at the same time, the changing of the peak energy and the charge of the beam with or without the plasma lens is within the error bar. As a result, the plasma lens preserves the peak current ($\sim$ 10kA) of the electron beam and drastically increases the peak charge density from averaged 1.8 to 4.7 pC/(MeV*mrad). This new technique unlocks the possibility of generating arbitrary gas density in a simple and compact setup, which is essential for achieving adiabatic focusing or staging acceleration.

Primary authors: DEBUS, Alexander (Helmholtz-Zentrum Dresden-Rossendorf); GHAITH, Amin (SOLEIL); IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf); CHANG, Yen-Yu (Helmholtz Zentrum Dresden Rossendorf); Dr COUPERUS CABADAG, Jurjen (Helmholtz Zentrum Dresden Rossendorf); STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf); Mr LABERGE, Max (University of Texas at Austin); UFER, Patrick (Helmholtz-Zentrum Dresden-Rossendorf); PAUSCH, Richard (Helmholtz-Zentrum Dresden - Rossendorf); SCHOEBEL, Susanne (Helmholtz-Zentrum Dresden-Rossendorf); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: CHANG, Yen-Yu (Helmholtz Zentrum Dresden Rossendorf)

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