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Emittance Reduction by Density Tapering in Laser-Plasma Electron Acceleration

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Laser-plasma accelerators [1] may become a compact, affordable and powerful alternative for delivering relativistic electron beams of relevance for medical treatment and imaging [2] to fundamental researches related to high-energy physics [3]. However, a main obstacle for this approach to fulfill its promise, for some of the applications, is the beam quality with large divergence and emittance [4]. Tapering the plasma density with which the high-power laser interacts is one of the possible ways to affect and mitigate the beam quality degradation upon its extraction from the plasma [5]. The physical phenomena and the ways to implement the density tapering and improve beam extraction are the topics of this work. Theory and simulations support the feasibility of this method to improve the beam's quality, possibly qualifying the laser-plasma concept as the next generation of electron accelerators.

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