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Single-shot measurements of low emittance beams from laser-plasma accelerators comparing two triggered injection methods.¹

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The success of laser plasma accelerator (LPA) based applications, such as a compact x-ray free electron laser (FEL), relies on the ability to produce electron beams with excellent 6D brightness, where brightness is defined as the ratio of charge to the product of the three normalized emittances. As such, parametric studies of the emittance of LPA generated electron beams are essential. Profiting from a stable and tunable LPA setup, combined with a carefully designed single-shot energy-dispersed emittance diagnostic, we present a direct comparison of charge dependent emittance measurements of electron beams generated by two different injection mechanisms: ionization injection and shock-induced density down-ramp injection. Both injection mechanisms have gained in popularity in recent years due to their demonstrated stable LPA performance. For the down-ramp injection configuration, normalized emittances a factor of two lower were recorded: less than 1 micron at spectral charge densities up to 2 pC/MeV. For both injection mechanisms, a contributing correlation of space charge to the emittance was identified. This measurement technique in general, and these results specifically, are critical to the evaluation of LPA injection methods and development of high-quality LPA beam lines worldwide.

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