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Tunable laser plasma acceleration based on ionization injection

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Laser-plasma accelerators generate ultrarelativistic electron beams over only a few centimeters, making them particularly interesting as drivers for compact next-generation light sources. In order to become applicable for these applications, control of electron beam properties, enhanced stability and reproducibility are crucial. Here, we demonstrate dedicated tuning of electron beam parameters based on the ionization injection scheme. Using a 200 TW laser system we generate electron beams from a nitrogen-doped hydrogen plasma. Precisely adjusting laser and plasma parameters, we control beam loading, the electron peak energy, the bunch charge, beam divergence and emittance. Carfully optimizing these parameters allows us to reproducibly operate our plasma accelerator with percent-level electron energy stability between 200-400 MeV, an FWHM energy spread below 20% and a bunch charge between 100 and 300 pC.

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