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Progress Toward a Laser-Ionized, Unconfined Gas PWFA at FACET-II

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We present the progress made toward a plasma wakefield accelerator using a laser-ionized, unconfined gas plasma source for the E301 experiment at FACET-II. One advantage of this plasma source is that the density profile can be semi-arbitrarily defined via controlled focusing of a terawatt class laser pulse, allowing for the creation of entrance and exit ramps that can match the beam into and out of the PWFA, preserving its emittance. Another advantage is the rapid tunability of the plasma density and length, permitting parameter scans for detailed studies of PWFA physics. In addition, this type of plasma source permits the introduction of multiple localized gas species via the placement of gas jets along the length of the primary plasma filament. This is useful for many high-brightness injection schemes. The plasma is also highly accessible to diagnostics due to being unconfined inside a large vacuum chamber. Finally, this type of plasma source is a stepping-stone toward a laser ionized, meter-scale gas jet with supersonic transverse flow. Such a plasma source may be the only means of efficiently dealing with residual heat left in the plasma/gas from the PWFA when operating at high repetition rates.

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