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Experimental Progress of PWFA in a Laser-Ionized Plasma Source FACET-II

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To compete with conventional accelerators, collider and light source applications based on plasma wakefield acceleration need to be able to handle 10s of Joules of energy transfer between the drive beam, plasma, and witness beam at repetition rates exceeding 100 Hz. Scaling up to these parameters is challenging due to the large amount of heat deposited in the plasma source. To begin approaching this regime, we developed a laser ionized plasma source using a pair of diffractive optics to produce a meter-scale Bessel focus with a tailored axial intensity profile. Using this source, we demonstrate multi-Joule energy transfer between the drive beam and the plasma at SLAC's FACET-II facility. Further, we discuss the transverse beam dynamics within the plasma and the alignment tolerance between the drive beam and the laser. Finally, we discuss future opportunities for using the plasma source to produce narrow plasmas for positron acceleration and ion channel lasers.

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