

Abstract Submitted
for the DPP19 Meeting of
The American Physical Society

Emittance Preservation Through Matching the Witness Beam in Plasma Wakefield Acceleration YUJIAN ZHAO, WEIMING AN, University of California, Los Angeles, XINLU XU, SLAC National Accelerator Laboratory, FEI LI, LANCE HIDEBRAND, University of California, Los Angeles, MARK HOGAN, VITALY YAKIMENKO, SLAC National Accelerator Laboratory, CHAN JOSHI, WARREN MORI, University of California, Los Angeles — In plasma wakefield acceleration, the witness beam's emittance needs to be preserved when it propagates through a plasma stage. The plasma includes density ramps at both the entrance and the exit. Using the WKB solution of a single particle's motion, analytical expressions for the evolution of the Courant-Snyder parameters and the beam emittance in an arbitrary adiabatic plasma profile is provided neglecting the acceleration of the beam inside the plasma. It shows that the beam emittance can be preserved under the matching condition even when the beam has an initial energy spread. An expression for the emittance of an unmatched beam with energy spread is also provided. The emittance evolution from 3D QuickPIC simulation results agree well with the theoretical results. In the some of the proposed experiments on FACET II, the matching condition may not be perfectly satisfied. With a given set of beam parameters that are consistent with FACET II capabilities, the witness beam emittance growth can be minimized by choosing an optimal focal plane position.

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Date submitted: 10 Jul 2019

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