Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

A General Theory for Chromatic Emittance Growth in a Plasma-Based Accelerator ROBERT ARINIELLO, CHRISTOPHER DOSS, KEENAN HUNT-STONE, VALENTINA LEE, University of Colorado, Boulder, JOHN CARY, University of Colorado, Boulder and Tech-X Corporation, MICHAEL LITOS, University of Colorado, Boulder — Plasma-based accelerators have the potential to drastically shrink the size and cost of conventional electron accelerators. To be useful for applications, however, the accelerator must preserve the emittance of the accelerated beam (the witness beam). The primary mode of emittance growth in a plasma accelerator is chromatic phase spreading, which can occur via multiple mechanisms. These mechanisms must be managed simultaneously to preserve the beam emittance at the levels required by colliders and light sources. Here we present a general theory for the nonlinear blowout regime that describes the chromatic emittance growth within a plasma-based accelerator due to the combination of witness beam-plasma mismatch and transverse offset between the witness beam and the wake driver. We include the effects of the plasma source density ramps, the energy gain of the beam, the loading of the wake, and the initial energy distribution of the beam. From this theory we derive tolerances on the beam offset and mismatch necessary for collider and light source applications.

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Date submitted: 26 Jun 2020 Electronic form version 1.4