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Elimination of Hosing Instability Via Ion Motion in Plasma Wake Field Accelerator

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Hosing instability is the most important instability needs to be controlled when building a future linear collider using plasma based acceleration. The normal method for mitigating the hosing instability requires energy chirps on the beam or longitudinally varying focusing force. However, these methods require additional manipulation on the witness beam, and the beam centroid oscillation exists all the time, which may result in additional emittance growth due to nonlinear process. In this work, we present a natural way to eliminate the hosing instability when accelerating an electron beam in a nonlinear plasma wake field through the plasma ion motion. The ion motion is caused by the large Coulomb force around the tightly focused beam. In fully resolved quasi-static particle-in-cell simulations, the initial centroid offset of the witness beam can be rapidly damped to zero. The emittance growth of the witness beam is acceptable and dependent on its initial seed for the hosing instability.

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