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All-optical control of nonlinear self-focusing of laser beams in plasma beat wave accelerators[1] S. KALMYKOV, S. AUSTIN YI, G. SHVETS, Institute for Fusion Studies, The University of Texas at Austin — The nonlinear focusing of a bi-color laser beam in tenuous plasmas can be all-optically enhanced or suppressed depending whether the beat wave frequency Ω is below or above the electron Langmuir frequency ω_p. The driven electron density perturbation produces a co-moving index grating, which is focusing if $\Omega < \omega_p$ and de-focusing otherwise. Self-consistent guiding of a mildly over-critical long (many plasma periods) laser beam can be all-optically initiated by mixing with a second, much weaker, beam shifted in frequency by $\Omega > \omega_p$. The guiding effect initially owes to the de-focusing properties of the laser beat wave-driven 3D electron density perturbation. Electromagnetic cascading and resonant self-modulation contribute to the guiding process at propagation distances over one Rayleigh length. Acceleration in the non-resonant plasma beat wave yields quasi-monoenergetic bunched electron beams with the energy over a hundred MeV. In the case of $\Omega < \omega_p$, acceleration efficiency is generally higher because of nonlinear focusing enhanced by the plasma wave excitation. To achieve quasi-monoenergetic acceleration in this regime, electrons should be injected in the plasma wake at a distance from the plasma boundary.

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