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High Current Density Compression of Intense Ion Beam Pulses[1]

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Space-charge-dominated ion beam pulses for warm dense matter and heavy ion fusion applications must undergo simultaneous transverse and longitudinal bunch compression in order to reach high beam intensities. Longitudinal focusing is achieved by imposing an axial velocity tilt on the beam and subsequently neutralizing its space-charge and current in a drift region filled with high-density plasma. A strong solenoid is modeled near the end of the drift region in order to transversely focus the beam to a sub-mm spot size coincident with the longitudinal focal plane. The neutralization provided by the background plasma is critical in determining the total achievable compression of the beam pulse. Simulations predict that the ion beam current density can be compressed over a few m by factors greater than 10^5 with peak n_{beam} in excess of 10^{14} cm^{-3}. The peak n_{beam} sets a lower bound on the n_{plasma} required near the focal plane for optimal beam compression, since simulations show stagnation when $n_{beam} > n_{plasma}$ and the generation of strong collective excitations in the plasma by the beam-plasma interaction. Simulations of simultaneous focusing are presented, as well as beam energy deposition dependence on background plasma and final-focus solenoid parameters.

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