SIMULATION OF DRIFT-COMPRESSION FOR HEAVY-ION-FUSION *

W. M. Sharp, J. J. Barnard, D. P. Grote, LLNL, Box 808, Livermore, CA 94551

C. M. Celata, S. S. Yu, LBNL, 1 Cyclotron Road, Berkeley, CA, 94720

D. V. Rose, D. R. Welch, Mission Research Corp., Albuquerque, NM 87110

Beams for heavy-ion fusion (HIF) must be compressed lengthwise by a factor of more than ten between an induction accelerator and the final-focus magnets. The compression scenario favored by the US HIF program is to impose a head-to-tail velocity increase or “tilt”, so the beam tail approaches the head in a “drift-compression” section. The beam current and velocity must be accurately tailored before drift-compression in order that the longitudinal space-charge field removes the velocity tilt just as the beam traverses the final-focus lattice. Transverse focusing in the drift-compression lattice must also be carefully designed to ensure that all parts of the beam remain approximately matched as the beam expands to the larger radius needed for final focusing. The principle physics questions posed by this section are how much the total emittance grows, whether a beam halo develops, and how these processes scale with beam and lattice parameters. A second broad area of research is optimizing the initial pulse-shaping schedule to minimize the bandwidth and volt-seconds requirements of the pulsed power.

This paper presents recent theoretical work to model the final longitudinal compression of HIF beams. Pulse-shaping fields are first calculated using a fluid/envelope dynamics model, and these fields are then used in the three-dimensional electrostatic particle-in-cell (PIC) code WARP3d to study beam transport in the pulse-shaping and drift-compression sections. Possible low-energy near-term experiments are investigated, as well as full-scale fusion drivers, and for each accelerator category, we examine how emittance growth and sensitivity to errors scale with the major beam and lattice parameters.

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