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Radiation energetics of inertial confinement fusion relevant wire-array z pinches[1]

DANIEL SINARS, Sandia National Laboratories

The scaling of the radiation power and energy of z-pinch sources as a function of current and implosion time is of interest for z-pinch-driven, high-yield inertial confinement fusion applications [R.A. Vesey et al., Phys. Plasmas 14, 056302 (2007)]. Short implosion-time 20-mm diameter, 300-wire tungsten arrays maintain high peak x-ray powers on the 20 MA, 100-ns Z pulsed-power facility despite a reduction in peak current from 19 to 13 MA. The implosion kinetic energy is estimated using multiple diagnostics, including the first measurement of the imploding mass density profile of a wire- array z-pinch. The main radiation pulse (i.e., not including the late-time radiation) on tests with a 1-mm on-axis rod to limit the convergence may be explained solely by the kinetic energy flux. However, bare-axis tests require sub-mm convergence of the magnetic field and/or enhanced resistive heating. Sub-mm convergence is never seen in these arrays in the $\sim$450 eV x-ray emission characteristic of the peak of the blackbody emission. Sub-mm widths are seen only in high- energy $>$ 1 keV emission diagnostics. The latter images are characteristic of the high-energy tail in the emission spectrum that accounts for a substantial fraction of the total radiated energy and appears to be associated with small-area, high- temperature sources. The radiography and imaging data discussed here are presently being used to provide strong constraints for simulations beyond just the radiated power and energy. In collaboration with: M.E. Cuneo, S.V. Lebedev (Imperial College), R.W. Lemke, E.M. Waisman, W.A. Stygar, B. Jones, M.C. Jones, J.L. Porter, and D.F. Wenger.

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