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Kinetic simulation of neutron production in a deuterium z-pinch[1]

DALE WELCH, DAVID ROSE, Voss Scientific, LLC, WILLIAM STYGAR, Sandia National Laboratories, RAMON LEEPER, Sandia National Laboratories — Fully kinetic particle-in-cell (PIC) modeling of a deuterium gas puff z-pinch can provide insight into the physical mechanisms for D-D fusion neutron production. Experiments with 15-MA current pinches on the Z accelerator have suggested that the dominant neutron-production mechanism is thermonuclear. The non-linear evolution of the Rayleigh Taylor instability as the pinch coalesces on axis, however, induces large electric fields capable of driving a significant number of high energy ions similar to that reported in dense plasma focus machines where measured ion spectra exhibit power-law dependence. In order to gain further insight, we have performed 2D PIC simulations of deuterium z-pinch implosions that permit non-Maxwellian particle distributions, finite mean-free-path effects, self-consistent anomalous resistivity, and charge separation. The calculated neutron yields largely follow the predicted thermonuclear I^4 current scaling [A. L. Velikovich, et. al, Phys. of Plasmas 14, 022701 (2007)], but also exhibit the power law ion distribution and significant non-thermal neutron production. We will discuss both production mechanisms and impact on the scaling of neutron yield at higher current.

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