NEUTRON PRODUCTION IN DEUTERIUM GAS-PUFF IMPLOSIONS ON THE REFURBISHED Z ACCELERATOR*

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It has been experimentally demonstrated that deuterium gas-puff implosions at >15 MA are powerful sources of fusion neutrons.[1] Analysis of these experiments[2,3] indicates that a substantial fraction of the obtained DD fusion neutron yields $\sim 3\times10^{13}$, about 50%, might have been of thermonuclear origin. The goal of our study is to estimate the scaling of the thermonuclear neutron yield from deuterium gas-puff implosions with higher load currents available after the refurbishment of Z, both in the short-pulse (~100 ns) and in the long-pulse (~300 ns) implosion regimes. We report extensive 1D and 2D radiation-hydrodynamic simulations of such implosions. The mechanisms of ion heating to the fusion temperatures of 7-10 keV are essentially the same as used in structured gas-puff loads to generate high Ar K-shell yields:[4, 5] shock thermalization of the implosion kinetic energy and subsequent adiabatic heating of the on-axis plasma. We investigate the role of high-atomic-number gas that can be added to the outer shell to improve both energy coupling of the imploded mass to the generator and energy transfer to the inner part of the load, due to radiative losses that make the outer shell thin. We analyze the effect of imposed axial magnetic field ~30-100 kG, which can contribute both to stabilization of the implosion and to Joule heating of the imploded plasma. Our estimates indicate that thermonuclear DD neutron yields approaching 10^{15} are within the reach on refurbished Z.

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