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Hot-Spot Mix in Ignition-Scale Implosions at the National Ignition Facility

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Ignition of an inertial confinement fusion target depends on the formation of a central hot spot with sufficient temperature and areal density. Radiative and conductive losses from the hot spot can be enhanced by hydrodynamic instabilities. The concentric spherical layers of current National Ignition Facility ignition targets consist of a plastic ablator surrounding a thin shell of cryogenic thermonuclear fuel (i.e., hydrogen isotopes), with fuel vapor filling the interior volume.[1] The ablator is doped with Ge to minimize preheat of the ablator closest to the DT ice caused by Au M-band emission from the hohlraum x-ray drive.[2] Richtmyer–Meshkov and Rayleigh–Taylor hydrodynamic instabilities seeded by high-mode ($50 < \lambda < 200$) ablator-surface perturbations can cause Ge-doped ablator to mix into the interior of the shell at the end of the acceleration phase.[3] As the shell decelerates, it compresses the fuel vapor, forming a hot spot. K-shell line emission from the ionized Ge that has penetrated into the hot spot provides an experimental signature of hot-spot mix. The Ge emission from tritium–hydrogen–deuterium (THD) and DT cryogenic targets and gas-filled plastic-shell capsules, which replace the THD layer with a mass-equivalent CH layer, was examined. The amount of hot-spot mix mass, estimated from the Ge K-shell line brightness using a detailed atomic physics code,[4] is typically below the 100-ng allowance for hot-spot mix.[1] Predictions of a simple mix model, based on linear growth of the measured surface-mass modulations, are consistent with the experimental results. The measured dependence of hot-spot mix on the implosion velocity and on the high-mode ablator-surface perturbations will be presented. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC52-08NA28302. In collaboration with the National Ignition Campaign Mix Working Group.

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