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Interface slit-induced implosion asymmetry in double-shell targets: Time-resolved high-energy X-ray radiography with 10-μm spatial resolution

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In inertial confinement fusion (ICF) research, the double-shell target emerges as a particularly appealing approach, boasting a series of significant advantages. These include the utilization of noncryogenic deuterium–tritium (DT) fuel, more reliable shock timing control, a reduced ignition temperature threshold, and a relatively lower convergence requirement. During the fabrication process of a double-shell target, the outer shell is typically composed of two hemispherical shells. Inevitably, a joint gap is formed at the junction of these hemispherical shells, and this gap is likely to exert a substantial influence on the implosion performance of the target. To comprehensively investigate the impact of the joint feature, we proposed to conduct radiography of the evolution process using micro-sized high-energy X-rays generated by a picosecond laser. The X-ray backlighter, with a size of approximately 10 microns and a duration of tens of picoseconds, enables the achievement of exceptionally high temporal and spatial resolution. The evolution processes of the slits with three geometric configurations, namely planar, cylindrical, and spherical, were studied respectively. Radiographic images with high signal-to-noise ratio and high spatio-temporal resolution at multiple moments were successfully obtained. Based on the experimental results, the evolution process of the slits and their influence on the implosion symmetry were analyzed. Furthermore, numerical simulation studies were carried out to explain the reasons for the morphology and rupture of the inner shell layer of the double-shell target.

References

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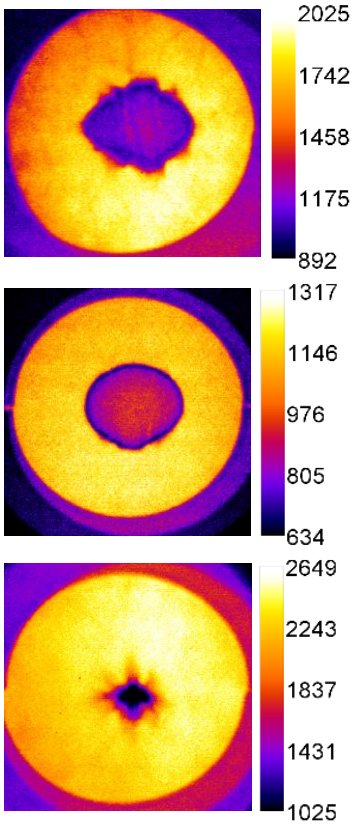

Figure 1. Time-resolved radiographic images of the inner shell of indirectly driven double shell targets.