Computational Investigation of Impulse-Fluence Scaling in X-ray Illuminated Materials on the National Ignition Facility*

Griffin Cearley [a], Peter Porazik [b], Laura Berzak Hopkins [b], Steve Moon [b] and Eric Johnsen [a]

(a) University of Michigan (gcearle@umich.edu)
(b) Lawrence Livermore National Laboratory (porazik1@llnl.gov)

A number of systems in high-energy-density physics involve conversion of x-rays into material impulse through absorption processes. In such systems, x-rays of a given energy are deposited within the material up to a depth dictated by the material's opacity. This energy deposition causes an increase in pressure, driving the heated surface layer to blow off and sending a compressive wave into the bulk of the material.

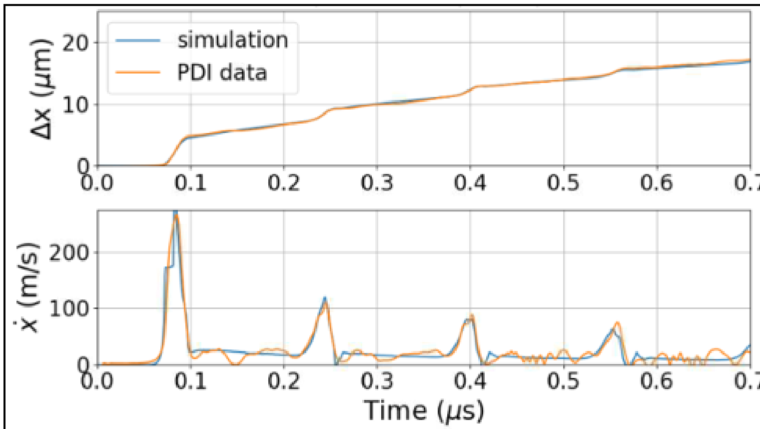

Figure 1 - Simulated tracer particle trajectories vs. PDI data from experiments with Ti-6Al-4V exposed to a Xenon source

The material impulse generated by x-ray energy deposition scales with the overall fluence of the incident x-rays. This scaling is sensitive to the x-ray source spectra and opacity. Modeling the relationship between impulse and x-ray source is challenging; analytical models tend to be overly simplistic, entirely ignoring the sensitivity of this relationship to spectral detail.

For a high-fidelity treatment of this problem requires numerical simulation, we utilize the codes Mercury and Ares to simulate x-ray deposition and the resulting impulse generation, respectively. We validate our numerical method and the constitutive models used therein with data obtained from experiments on the National Ignition Facility. We employ this method to quantify the sensitivity of impulse to the source spectrum and the dependence of impulse-fluence scaling on this sensitivity.

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