Target Design and Debris Modeling with NIF ALE-AMR

Summary

- NIF ALE-AMR is unique in its ability to model hot plasmas and cold fragmenting solids
- NIC targets are analyzed; results help guide NIC target design
- Cold fragmenting solids
- NIF ALE-AMR is unique in its ability to model hot plasmas and cold fragmenting solids

Computational Modeling and Experimental Validation

- Macroscopic verification and validation
- Extension of validation to micro scale
- Simulations show that fragments from Si have a greater safety margin than Al rings
- Keyhole design
- Shock timing campaign simulations
- NIF ALE-AMR simulations

Application to NIF/NIC

- Re-emit capsule experimental design
- Experimental setup
- NIF ALE-AMR simulations
- For re-emit at 10 J/cm², pinholes don’t get launched. Higher energies do.

Protecting NIF Optics and Diagnostics

- NIF targets must be designed to minimize damage to optics and diagnostics from target debris
- Target materials, mass, geometry, and orientation are the critical parameters to understand
- NIF Early Light (NEL) experiments demonstrated effectiveness of tilt-ting diagnos-tic components to redirect debris

Foil samples inside sphere

NIF ALE-AMR

\[ \rho \cdot \frac{\partial v}{\partial t} + \nabla \cdot (\rho \vec{v}) = \nabla \cdot \vec{F}_\text{ext} \]

\[ \epsilon = \frac{1}{2} \rho \vec{v} \cdot \vec{v} \]

Shock timing campaign simulations

Experimental results

Number of fragments

At 26 ns,

\[ \text{Maximum radial velocity} = \text{Average velocity} \times 5 \]

\[ \text{Shrapnel Diameter} \]

\[ \text{Experimental data} \]

NIF ALE-AMR simulations

Windowed and filtered x-rays

NIF ALE-AMR

\[ \text{Material} \]

\[ \text{Material flags:} \]

\[ \text{Lagrangian hydrodynamics} \]

\[ \text{Material model:} \]

\[ \text{Objectives:} \]

\[ \text{phenomenological equation} \]

\[ \text{Challenges:} \]

\[ \text{Strain Rate} \]

\[ \text{Equation of State} \]

\[ \text{Extended validation to micro scale} \]

\[ \text{Experimental results} \]

\[ \text{Number of fragments} \]

\[ \text{Maximum radial velocity} \]

\[ \text{Shrapnel Diameter} \]

\[ \text{Experimental setup} \]

\[ \text{Shock timing campaign simulations} \]

\[ \text{NIF ALE-AMR simulations} \]

\[ \text{For re-emit at 10 J/cm², pinholes don’t get launched. Higher energies do.} \]