Comparison of 2-D DRACO Cross-Beam Energy Transfer (CBET) Simulations with OMEGA and NIF Experiments

NIF shot 130225

\[ r = 429 \, \mu m \]

DRACO; iSNB

\[ r = 426 \, \mu m \]

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Draco provides self-consistent cross-beam energy transfer (CBET) simulations that agree with experiments.

Summary

- CBET increases scattered light through stimulated Brillouin scattering (SBS) of outgoing rays that removes energy from incoming high-energy rays.
- The 2-D hydrodynamics code Draco employs feedback control to maintain energy balance with CBET.
- CBET improves agreement of hydrocodes with experiment.
Collaborators


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CBET* occurs nearly uniformly over the entire target for OMEGA 60-beam direct drive

- OMEGA direct drive offers a high amount of symmetry, which is reflected in the CBET gain power density \((W/cm^3)\)

- The CBET effect can be successfully mitigated by reducing the beam diameter**

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CBET modeling in the 2-D hydrodynamics code DRACO employs an angular spectrum representation (ASR) approach with feedback control

- ASR captures the relevant intensity and direction information from all the beams that propagate through any cell
- Feedback through a PID-controller (proportional-integral-differential) loop provides vital control over CBET energy balance
  - left uncontrolled, CBET equations do not conserve energy; e.g., they lack energy depletion
  - feedback minimizes energy imbalance through a controlled PID loop by temporarily adjusting the ASR until the adjustment approaches zero
- The ASR from the previous time step is used to increase the convergence rate by providing an estimate of the current time step’s ASR
A 40-beam subset of the 60-beam OMEGA laser emulates the NIF x-ray-drive configuration.
OMEGA PD shot 64099 simulations predict the increased scattered light around the poles of the chamber

- OMEGA shot 64099 employed a set of calorimeters around the chamber to measure the theta dependence of scattered light.

- DRACO simulations of shot 64099 reproduce the measured data with CBET; flux limiters of 6% and 10% bracket the data; iSNB* improves the agreement.

*J. A. Delettrez et al., UO4.00007, this conference.
The NIF N130225 PD shot was used to commission neutron diagnostics

- N130225 is a 130-kJ, 1523-μm-diam target: Peak $I = 1.6 \times 10^{15} \text{ W/cm}^2$
- Beams were refocused and repointed to improve implosion symmetry using current optics
- The gated x-ray diagnostic (GXD-3) framing camera shows a distinctive square shape

The blue curve is the the maximum likelihood estimate of the peak emission.
Image is 1500 μm × 1500 μm.
A high-intensity NIF glass exploding-push target shot N130225 demonstrates the need for the CBET model

- N130225 is a 130-kJ, 1523-μm-diam target: Peak $I = 1.6 \times 10^{15} \text{ W/cm}^2$
- Simulations* include the DRACO nonlocal thermal transport model iSNB**

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*Processed with Spect3D; Prism Computational Sciences, Inc. Madison, WI 53711
**J. A. Delettrez et al., UO4.00007, this conference.
**Summary/Conclusions**

*DRACO* provides self-consistent cross-beam energy transfer (CBET) simulations that agree with experiments.

- CBET increases scattered light through stimulated Brillouin scattering (SBS) of outgoing rays that removes energy from incoming high-energy rays.
- The 2-D hydrodynamics code *DRACO* employs feedback control to maintain energy balance with CBET.
- CBET improves agreement of hydrocodes with experiment.
CBET increases the polar drive in N130129 iSNB simulations that is not visible in experimental data

- Shell trajectories are consistent among all three
- A timing difference of ~100 ps exists between simulations
- Including CBET effect reduces the absorption fraction which improves the agreement of bang time but degrades the agreement in shape