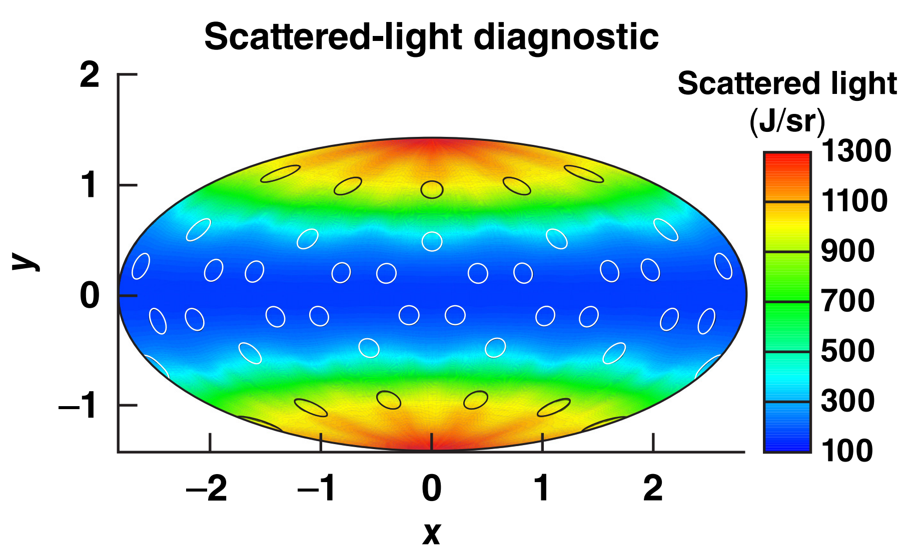
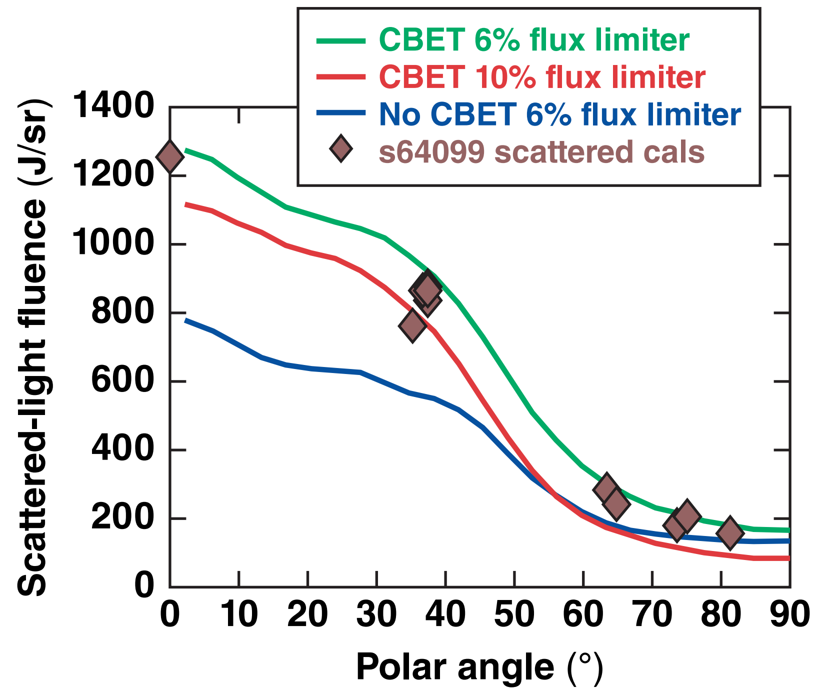
Comparison of the 2-D *DRACO* Cross-Beam Energy Transfer (CBET) Simulations with OMEGA and NIF Experiments





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Summary

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

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- CBET increases scattered light through stimulated Brillouin scattering (SBS) of outgoing rays that removes energy from incoming high-energy rays
- Nonlocal electron thermal transport model has been added to *DRACO*
- The 2-D hydrodynamics code *DRACO* employs feedback control to maintain energy balance with CBET
- CBET improves agreement of hydrocodes with experiment

TC10623

Collaborators

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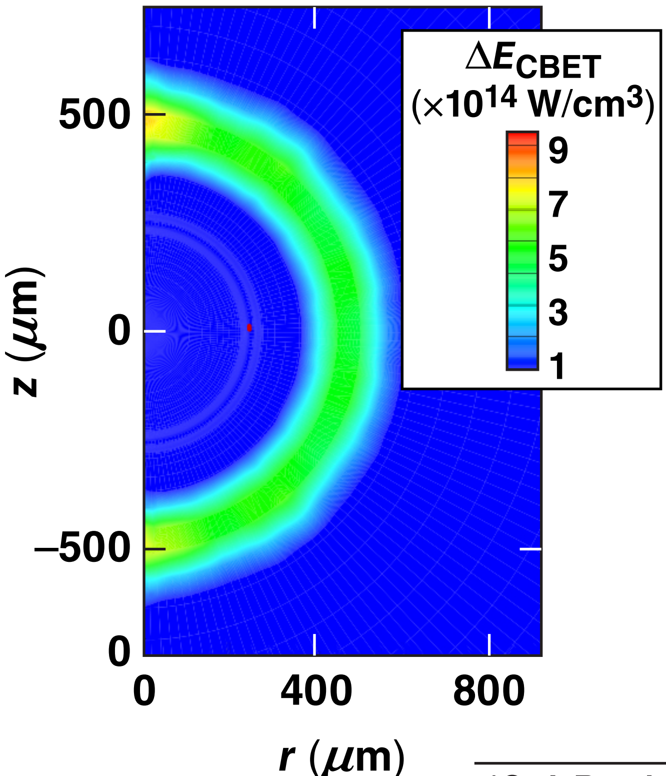
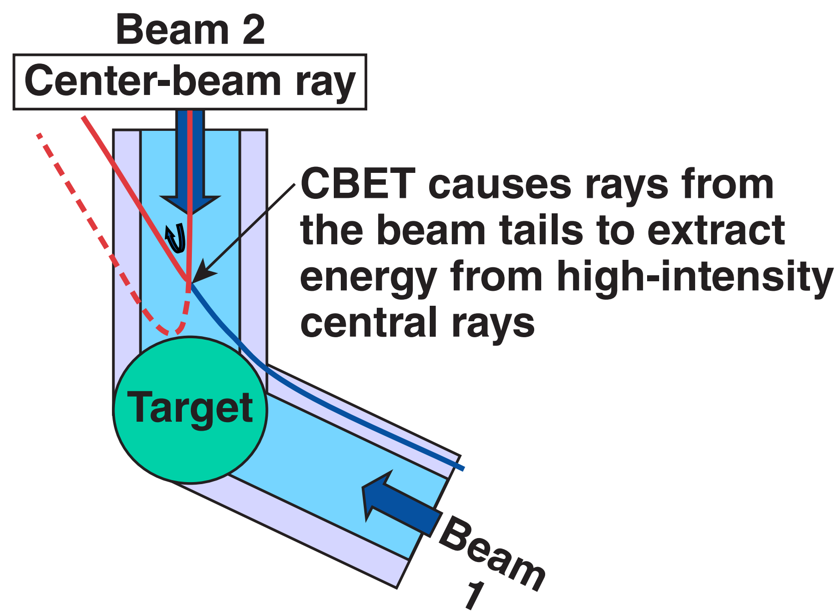
CBET* occurs nearly uniformly over the entire target for OMEGA direct drive

- 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**





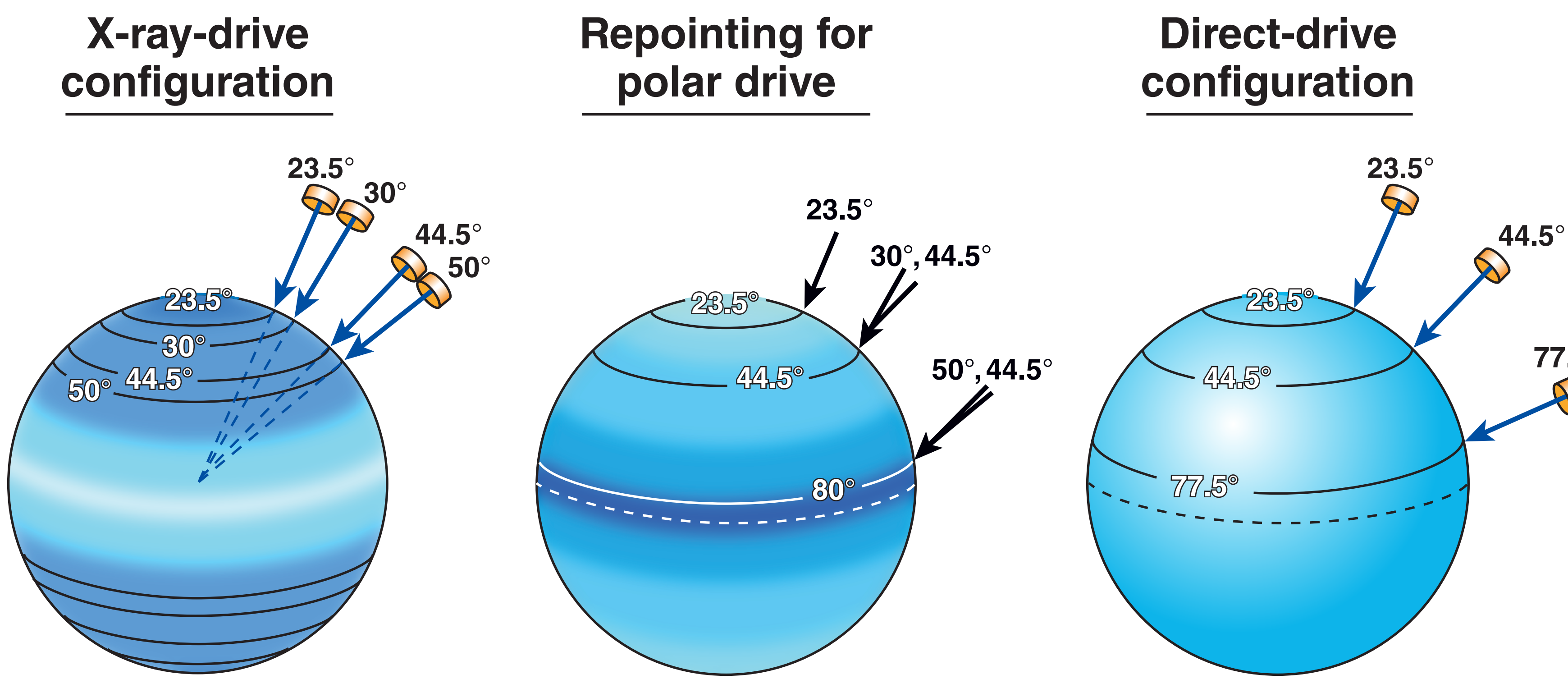
*C. J. Randall, J. R. Albritton, and J. J. Thomson, Phys. Fluids 24, 1474 (1981).
**I. V. Igumenshchev *et al.*, Phys. Plasmas 19, 056314 (2012).

TC10214

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 reaches zero
- The ASR from the previous time step is used to increase convergence by providing an estimate of the current time step's ASR

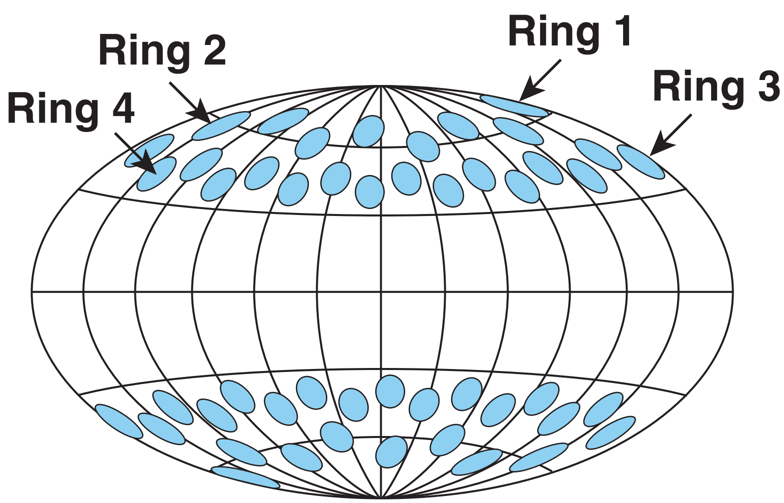
The polar-drive (PD) illumination scheme drives a target using the NIF x-ray-drive ports



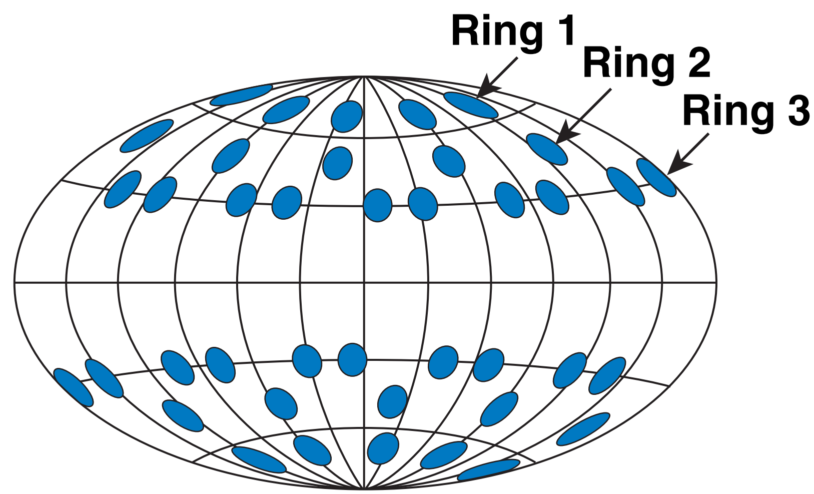
TC7193e

A 40-beam subset of the 60-beam OMEGA laser emulates the NIF x-ray-drive configuration

NIF configuration



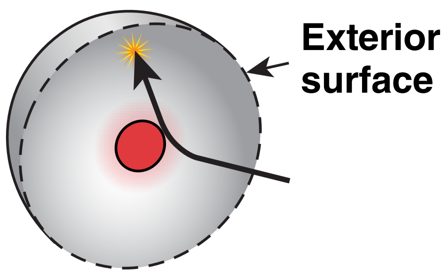
OMEGA PD configuration

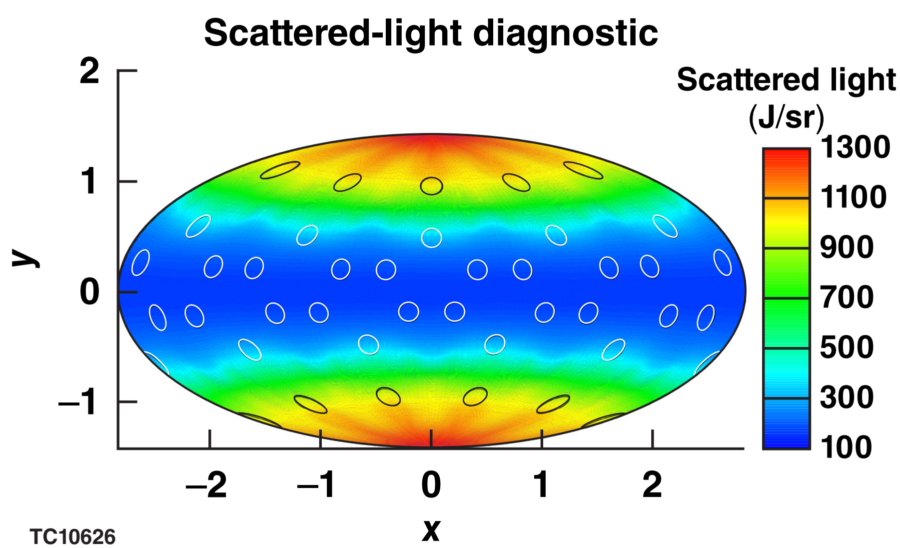


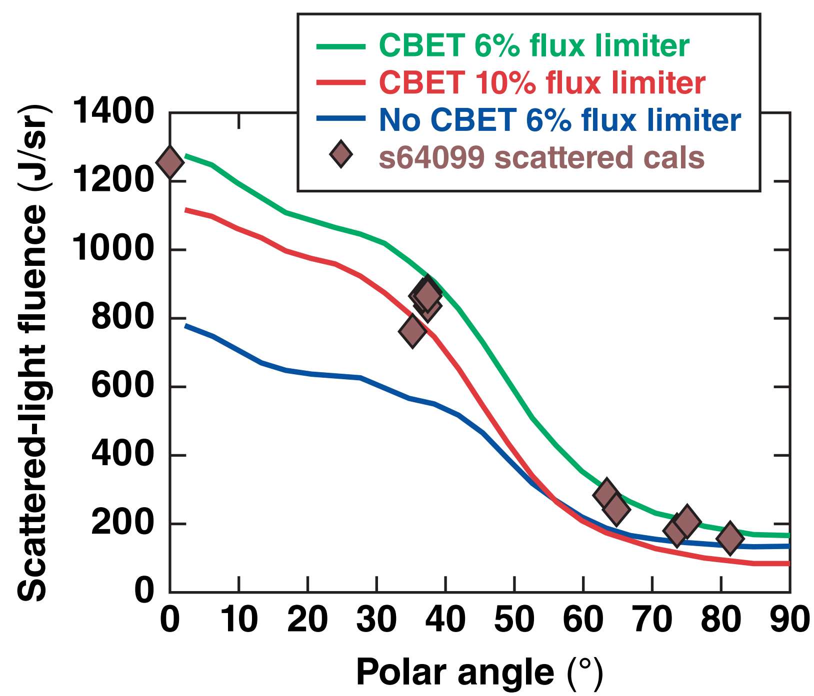
TC7194d

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
- A *DRACO* simulation of shot 64099 reproduces the measured data with CBET; flux limiters of 6% and 10% bracket the data



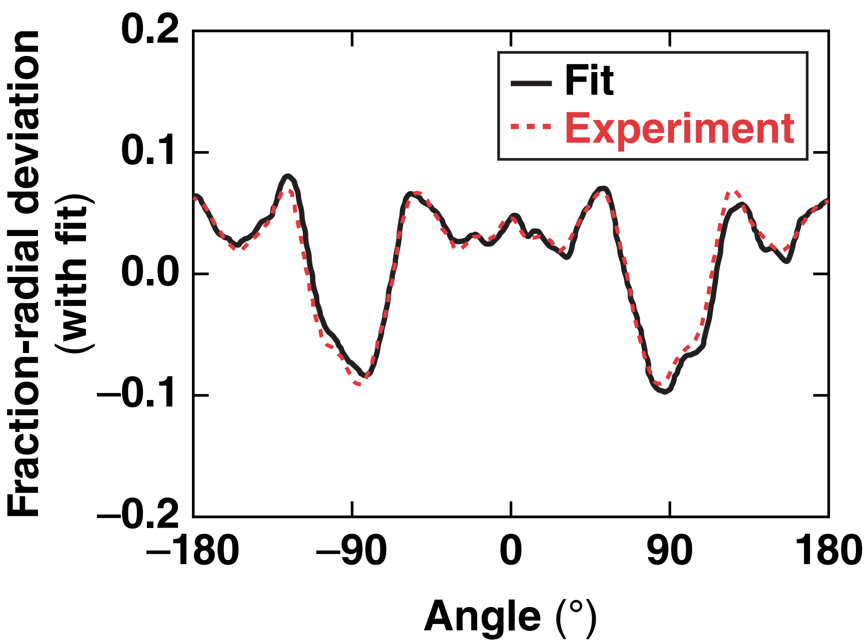


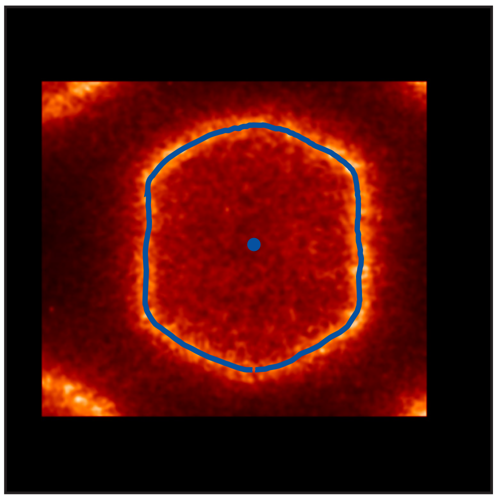


TC10626

The NIF N130129 PD shot was used to commission neutron diagnostics

- N130129 is a 50-kJ, 1540-μm-diam target - Peak $I = 5.4 \times 10^{14}$ w/cm^2
- Beams were refocused and repointed to improve implosion symmetry
- The GXD-3 framing camera shows a distinctive square shape





r_{avg} = 358 μm

The blue curves are the fits to the peak emission. Images are 1500 μm × 1500 μm.

TC10627

The Schurtz-Nicolaï-Busquet (SNB) non-local model solves for the thermal flux using multi-group diffusion*

- The model is based on the linear steady state transport equations with appropriate diffusion mean-free-paths
- The source at each point is defined as the multi-group Spitzer flux

$$U_g = \frac{1}{24} \int_{E_{g-1}/kT}^{E_g/kT} \beta^4 e^{-\beta} \, d\beta \overline{Q}_{sh}$$

- This is used in conjunction with the group parameter H_g, which is the solution of the differential equation

$$\left(\frac{1}{\lambda_g(\bar{r})} - \nabla \frac{\lambda'_g(\bar{r})}{3} \nabla \right) H_g(\bar{r}) = -\nabla \cdot \overline{U}_g(\bar{r})$$

to solve for the thermal flux

$$\nabla \cdot \overline{Q}_t(\bar{r}) = -\sum_g \frac{H_g(\bar{r})}{\lambda_g(\bar{r})}$$

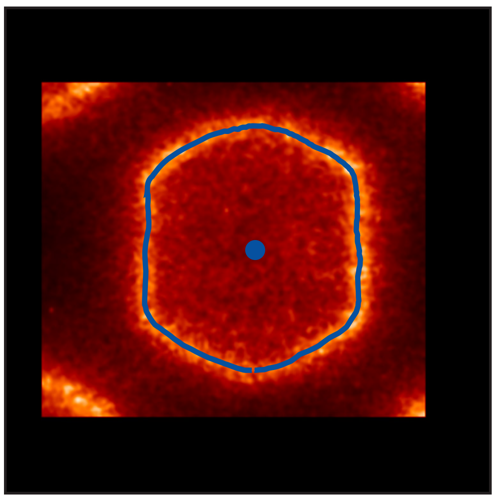
The model does not transport electrons but rather diffuses the Spitzer flux.

TC10667

*G. P. Schurtz, Ph. D. Nicolaï, and M. Busquet, Phys. Plasmas 7, 4238 (2000).

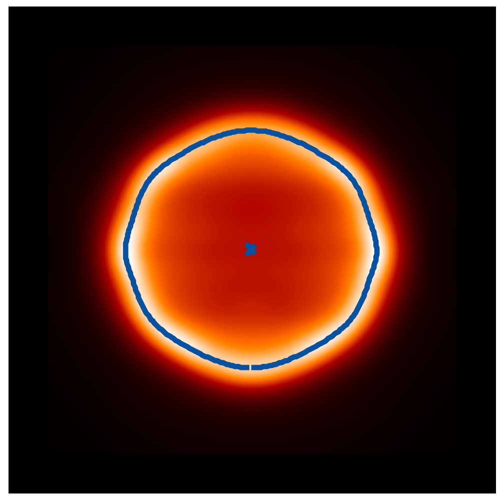
Simulations of NIF N130129 (exploding pusher) show better agreement when the non local model is employed

NIF shot 130129



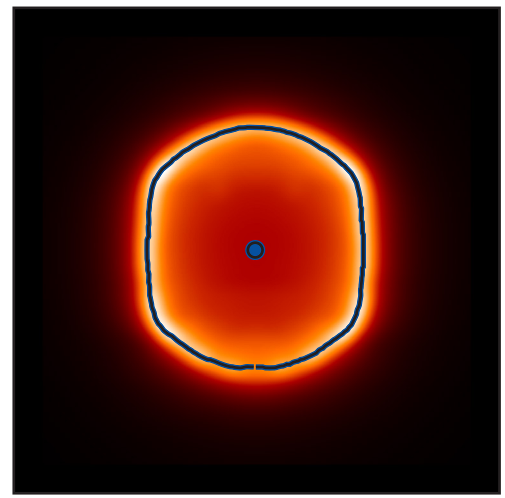
r = 358 μm

DRACO
f = 0.06



r = 374 μm

DRACO
Nonlocal model

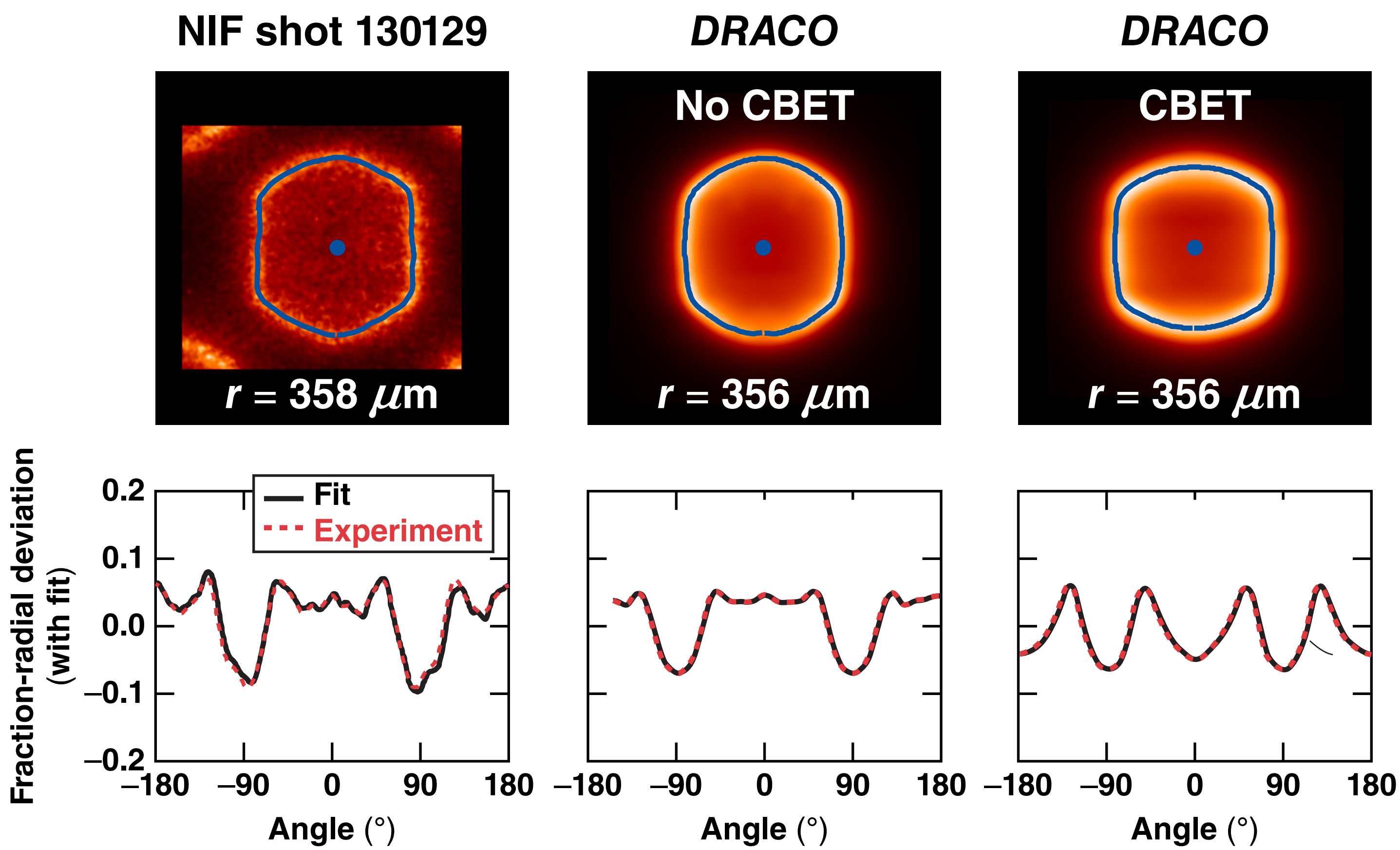


r = 356 μm

DRACO results have been processed with *Spect3D**

*Prism Computational Sciences, Inc., Madison, WI 53711.

CBET reduces the equatorial drive in N130129 non-local simulations which is not visible in experimental data

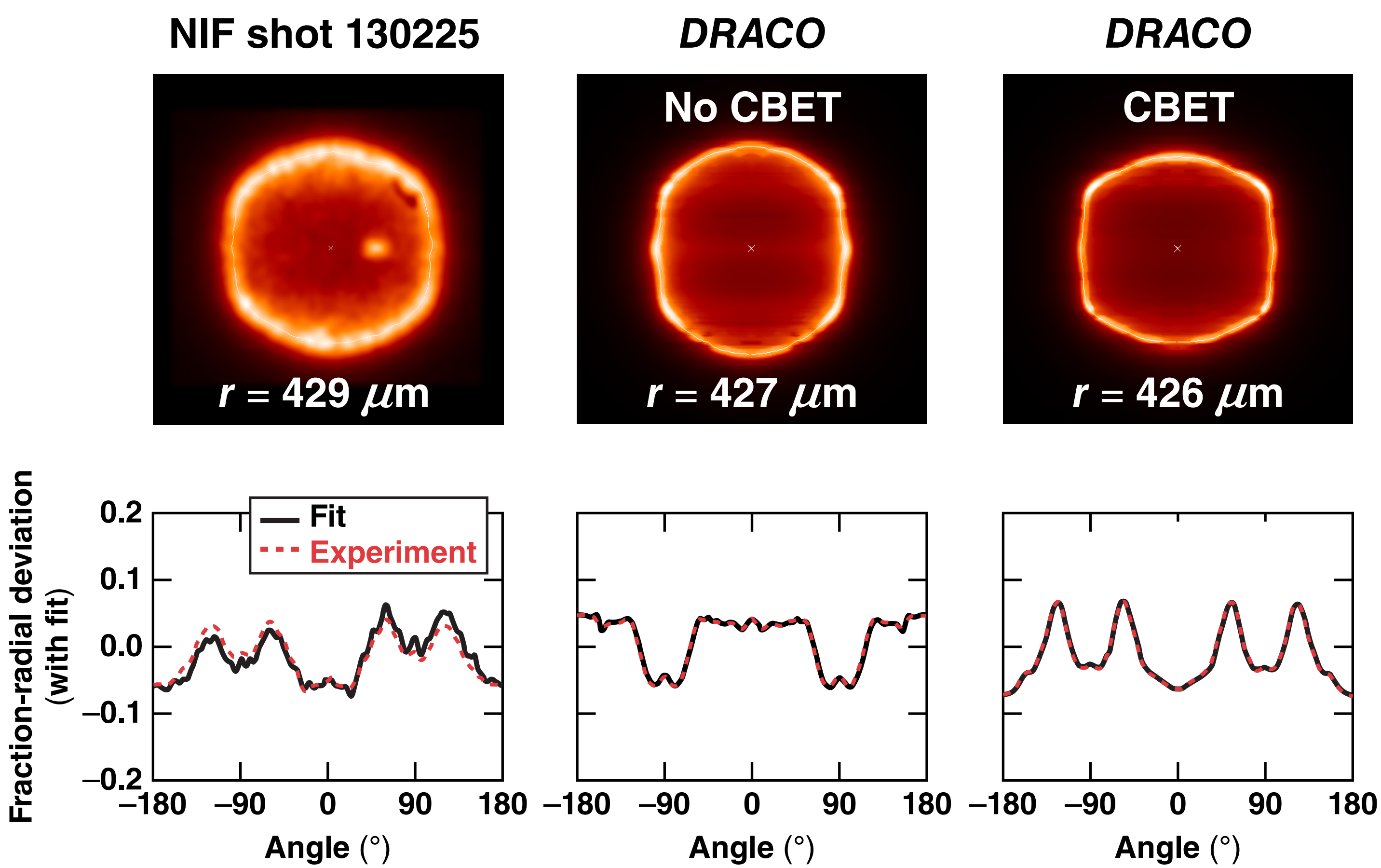


- **Shell trajectories are consistent among all three**
- **A timing difference of ~ 100 ps exists between simulations**

TC10658

Higher-intensity NIF glass exploding-pusher target shot demonstrates the need of the CBET model

- N130225 is a 130-kJ, 1523-μm-diam target - Peak $I = 1.6 \times 10^{15}$



- The simulation without CBET over drives the target equator

TC10629

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