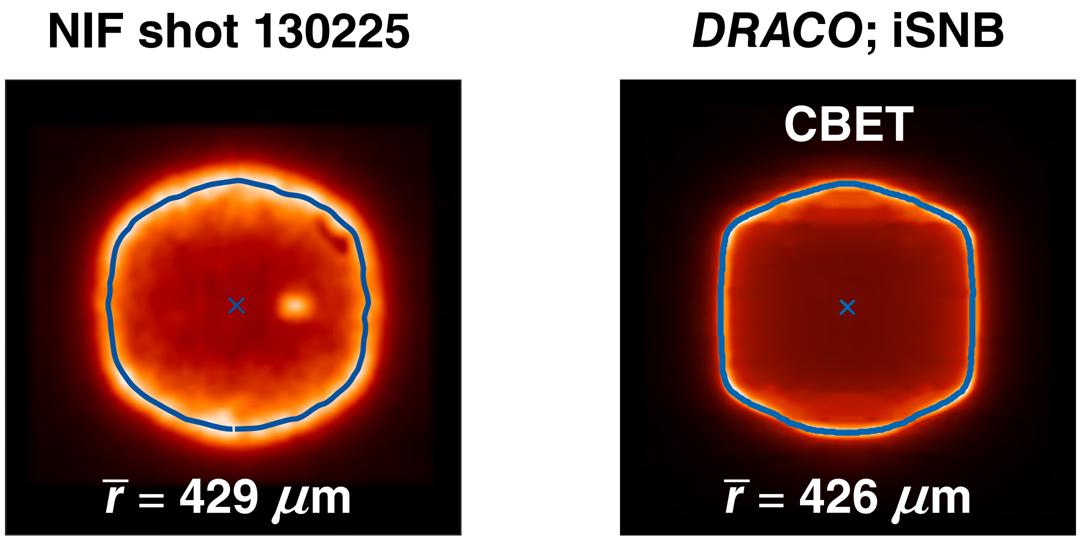
Comparison of 2-D *DRACO* Cross-Beam Energy Transfer (CBET) Simulations with OMEGA and NIF Experiments



J. A. Marozas
University of Rochester
Laboratory for Laser Energetics

55th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
11–15 November 2013

Summary

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

UR LLE

- 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

T. J. B. Collins, J. A. Delettrez, P. B. Radha, P. W. McKenty, I. V. Igumenshchev, D. H. Edgell, D. H. Froula, M. Hohenberger, F. J. Marshall, D. T. Michel, and W. Seka

University of Rochester
Laboratory for Laser Energetics

A. J. Mackinnon, S. LePape, and T. Ma

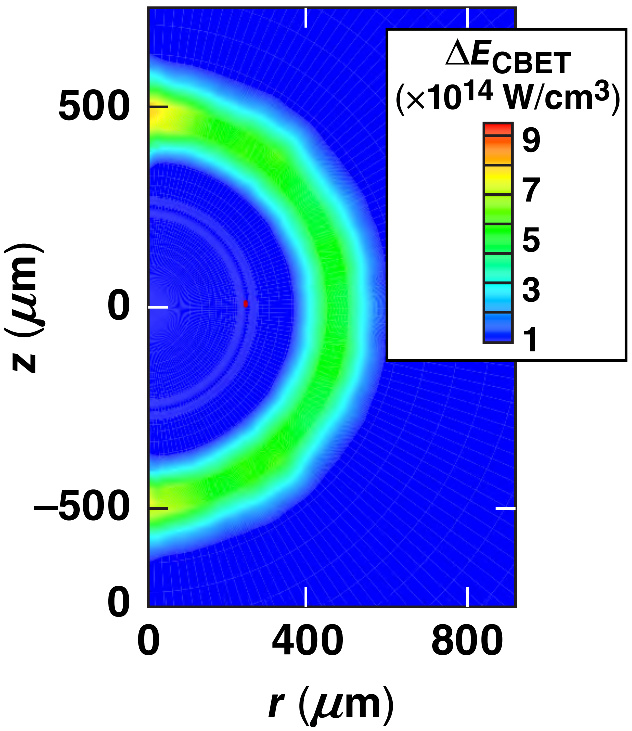
Lawrence Livermore National Laboratory

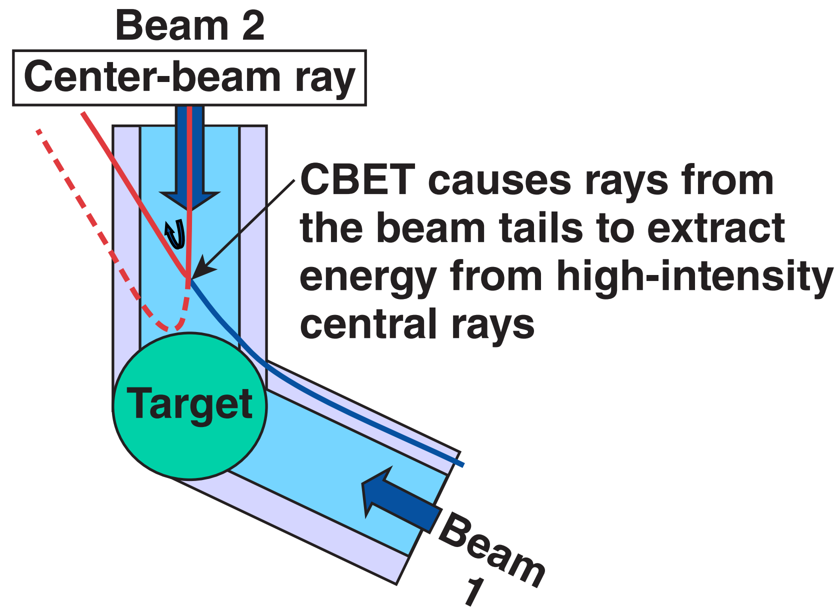
D. Cao, A. Prochaska, J. Chenhall, and G. Moses

University of Wisconsin

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**

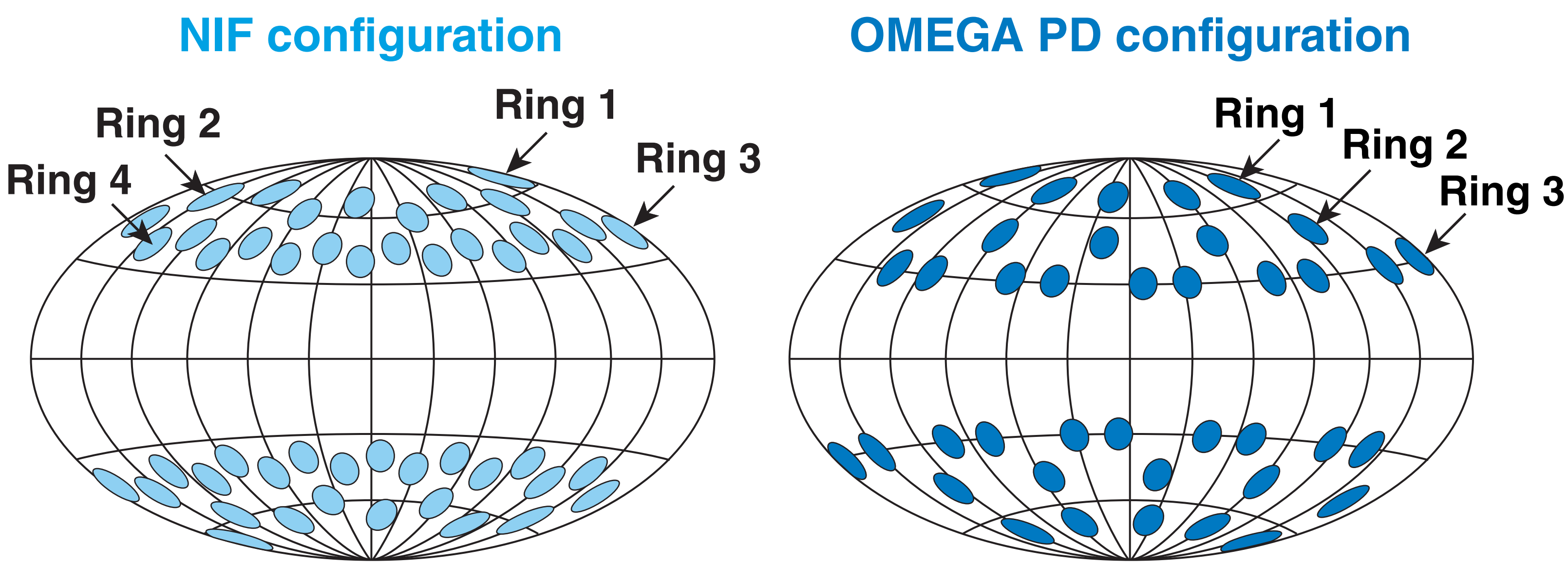
*C. J. Randall, J. R. Albritton, and J. J. Thomson, Phys. Fluids 24, 1474 (1981).
**I. V. Igumenshchev *et al.*, Phys. Plasmas 19, 056314 (2012).

TC10214a

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

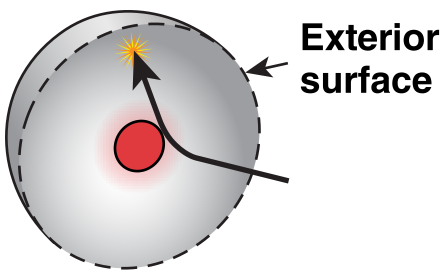


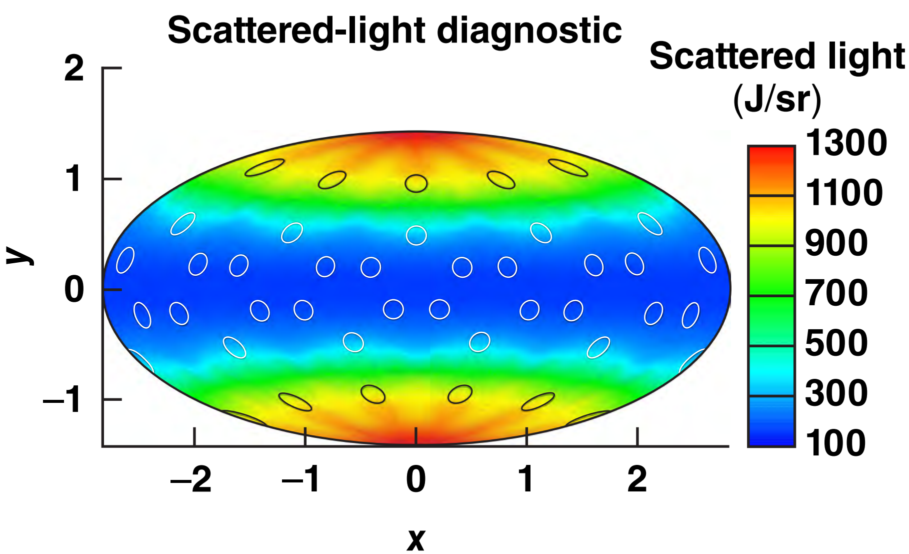
TC7194I

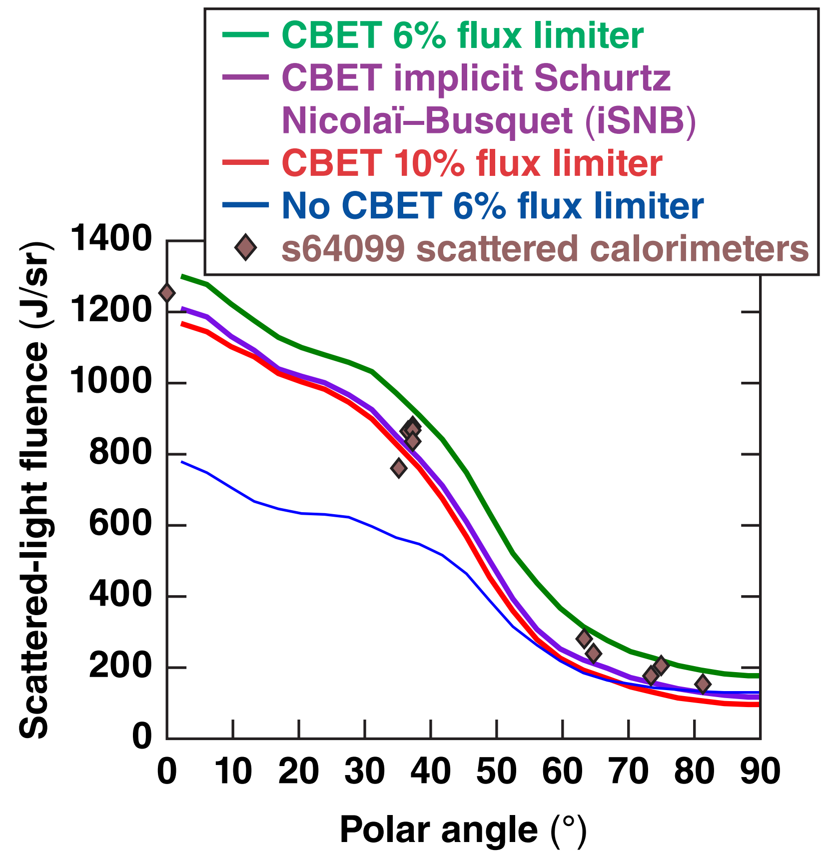
OMEGA PD shot 64099 simulations predict the increased scattered light around the poles of the chamber

- **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**





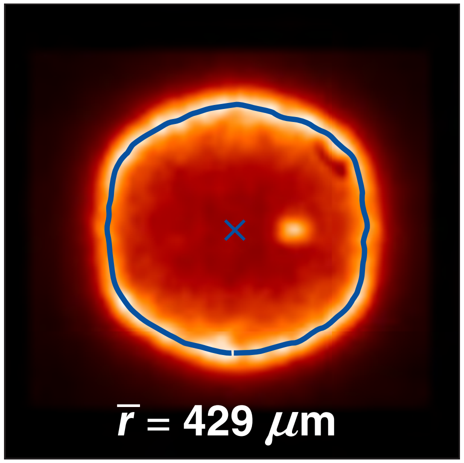


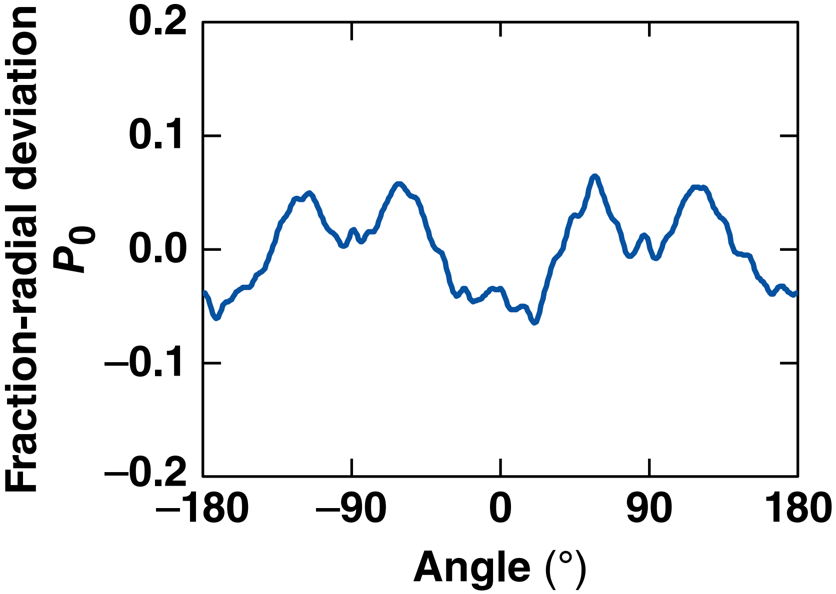
*J. A. Delettrez *et al.*, UO4.00007, this conference.

The NIF N130225 PD shot was used to commission neutron diagnostics

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

NIF shot 130225

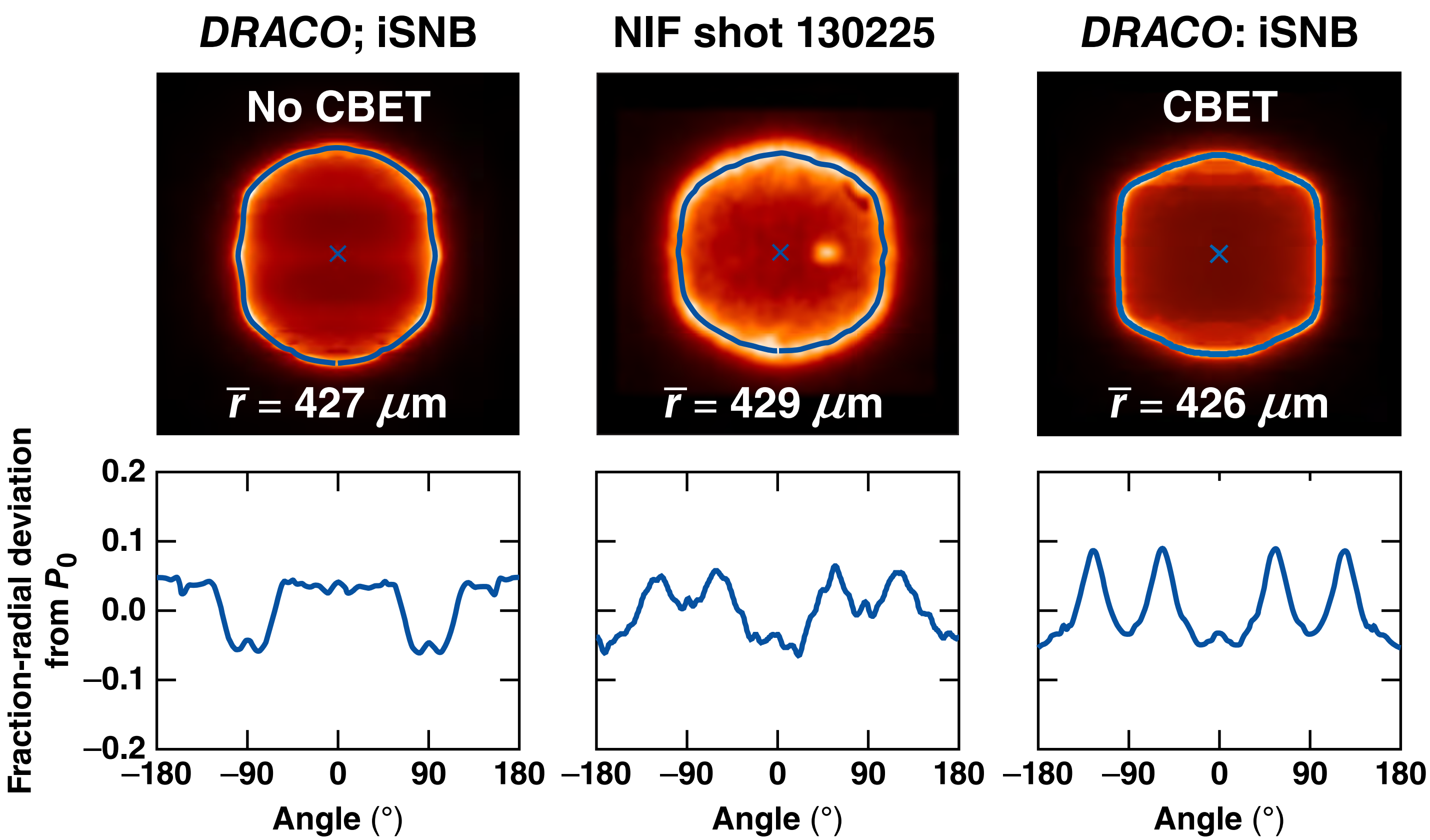




The blue curve is the the maximum likeliehood estimate of the peak emission. Image is 1500 μm × 1500 μm.

A high-intensity NIF glass exploding-pusher target shot N130225 demonstrates the need for the CBET model

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



- The simulation without CBET underdrives the target poles

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

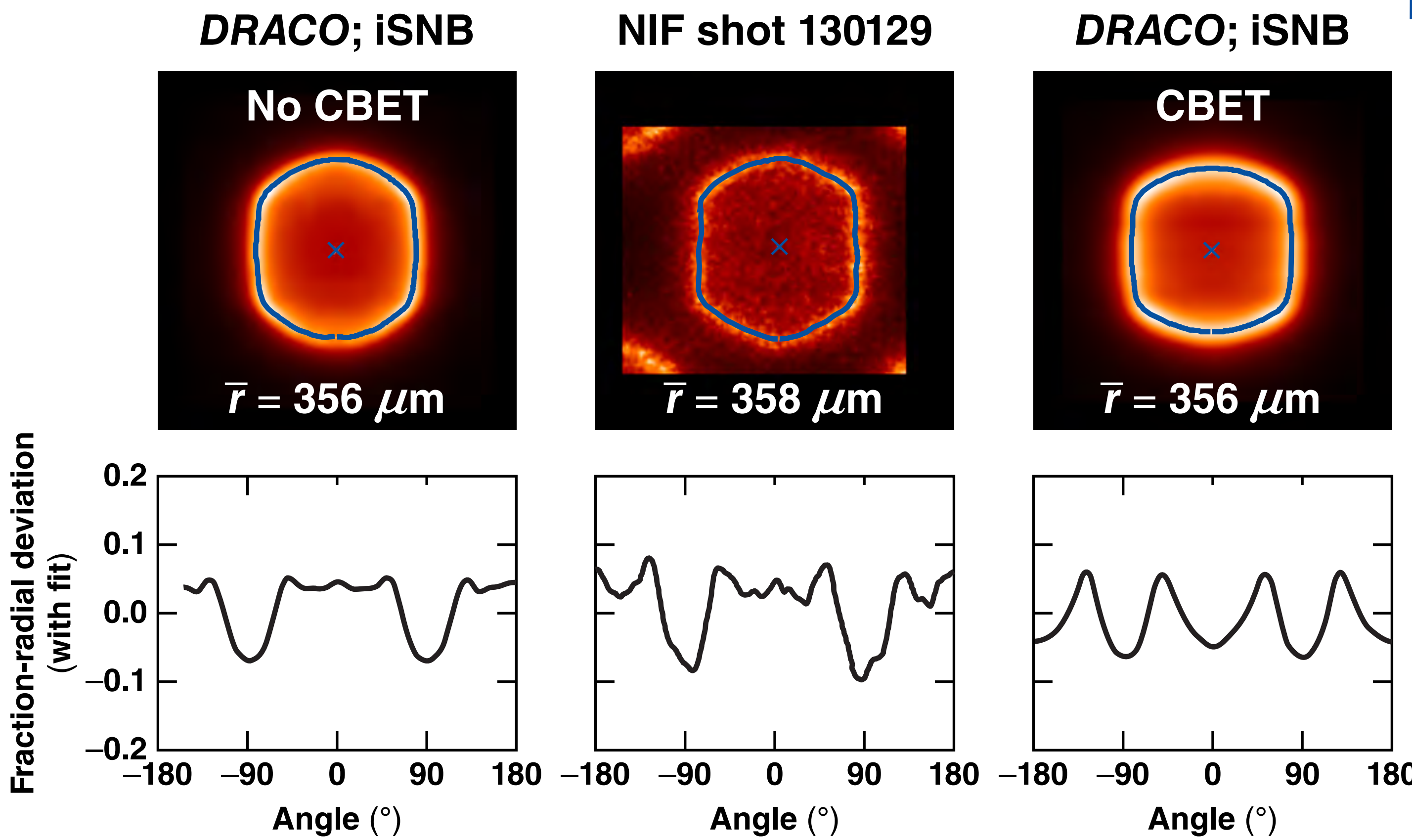
TC10629b

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

TC10658b