Energy-Coupling Experiments Using Solid Spheres in the Polar-Direct-Drive Configuration on OMEGA

The drive beams on the sphere are not shown for clarity.

Solid sphere driven by 40 beams

Fe backlighter target

Time-gated image of imploding shock wave

63rd Annual Meeting of the American Physical Society Division of Plasma Physics Pittsburgh, PA 8–12 November 2021

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Energy-coupling experiments with solid plastic targets on OMEGA show good agreement with current modeling

- Solid spheres offer the advantage of quantifying energy coupling without the challenges from the hydrodynamic instabilities of thin-shell implosions
- The targets were irradiated in the polar-direct-drive (PDD) configuration on OMEGA with ~14 kJ of laser energy at a peak intensity of ~8 × 10^{14} \text{ W/cm}^2
- The energy coupling into the sphere was inferred using the measured shock trajectory
- Two-dimensional DRACO simulations using CBET and nonlocal heat-transport models accurately predict the energy coupling

CBET: cross-beam energy transfer
See also:
R. Bahukutumbi et al., U004.00001, this conference;
W. Theobald et al., U004.00003, this conference.
Collaborators

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The overarching goal is to test the scaling arguments of PDD implosions from the 20-kJ OMEGA (configured for PDD) to the 2.1-MJ National Ignition Facility*

Cross-beam energy transfer (CBET) and electron thermal conduction affect energy coupling in LDD.*

**Motivation**

NIF: National Ignition Facility  
SDD: spherical direct drive  
LDD: laser direct drive  
PDD: polar direct drive

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Preshot simulations showed that an Fe backlighter provides the best contrast for these experiments.

A small $\ell = 4$ perturbation can be seen in the simulated radiograph at 3 ns.

The background from the main laser pulse is minimal after 2.5 ns.
The Fe backlighter foil is illuminated by 11 beams and the solid sphere by 40 beams in a PDD configuration.

The 40 drive beams on the solid sphere are not shown for clarity.

The radiographs are recorded on an x-ray framing camera (XRFC) with a 40-ps gate.
The capsule was driven with 40 beams at a peak power of 12 TW and the backlighter with 11 beams delayed by 1.5 ns
The XRFC records up to 16 backlit images formed by the pinholes at different times on a CCD camera.

Shot 100273

Only six images are usable on this shot due to misalignment of the XRFC and parallax.

CCD: charge-coupled device
The peak attenuation in the azimuthally averaged transmission was used to track the shock trajectory.

The image was fit to a backlighter model to flat field the radiograph and extract the azimuthally averaged lineout of the transmission.
The post processed *DRACO* simulations match the experiments well given the statistical fluctuations in the data.

Azimuthally averaged lineouts are taken from x-ray radiographs calculated with 2-D *DRACO/Spect3D,* which include the instrument response function.

Two-dimensional *DRACO* simulations using CBET and nonlocal heat transport compare well with the trajectory measurements.

The experimental time axis was shifted by ~0.2 ns because no absolute timing calibration of the XRFC time was available.
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