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

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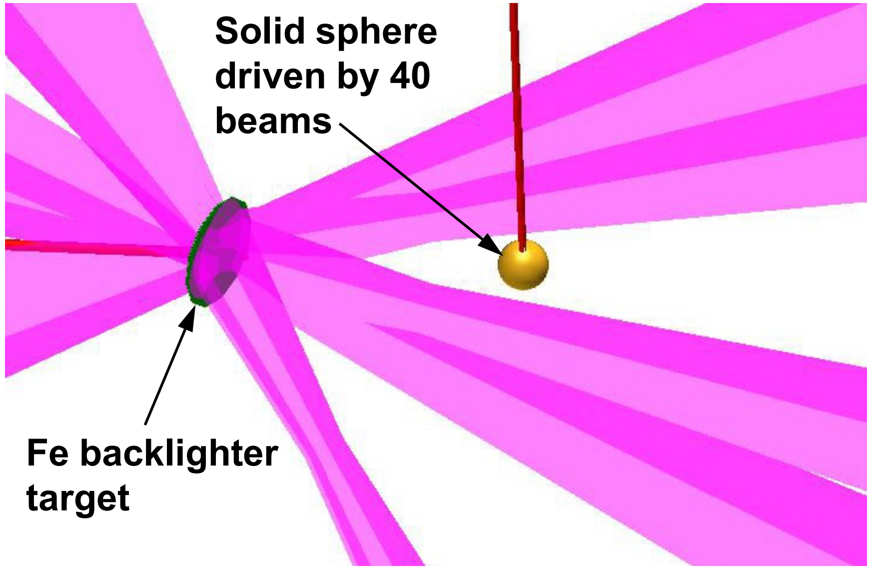
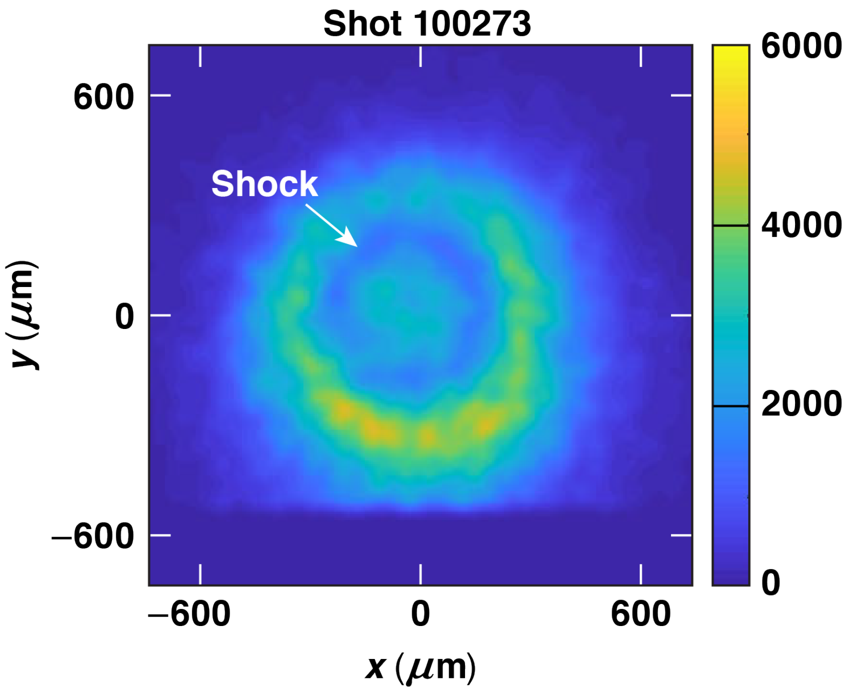
The drive beams on the sphere are not shown for clarity



Time-gated image of imploding shock wave



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University of Rochester

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} 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.*, UO04.00001, this conference;
W. Theobald *et al.*, UO04.00003, this conference.

Collaborators

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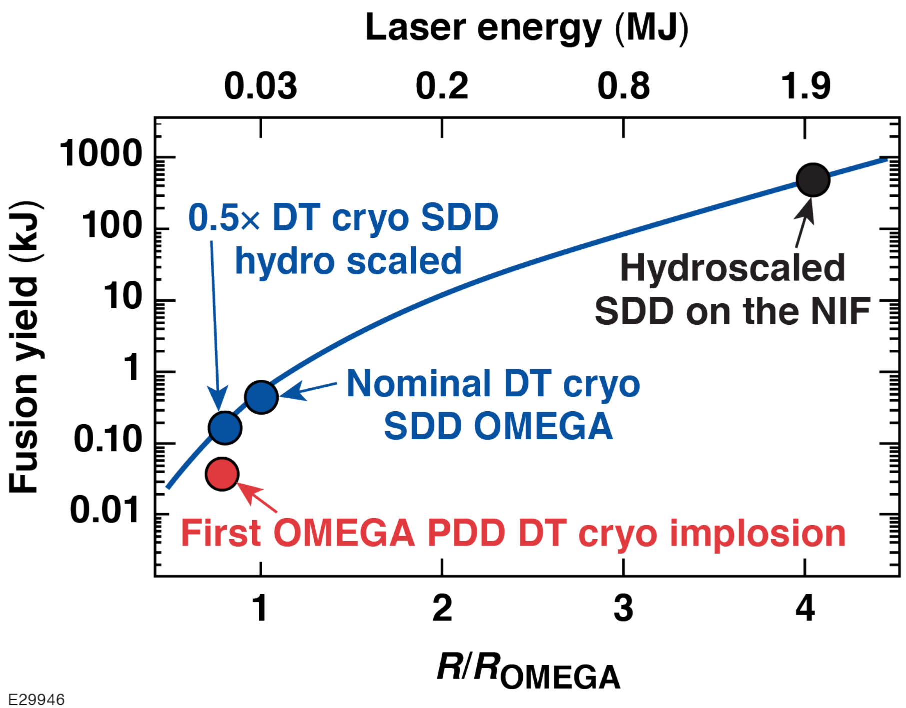
The overarching goal is to test the scaling arguments of PDD implosions from the 20-kJ OMEGA (configured for PDD) to the 2.1-MJ National Ignition Facility*



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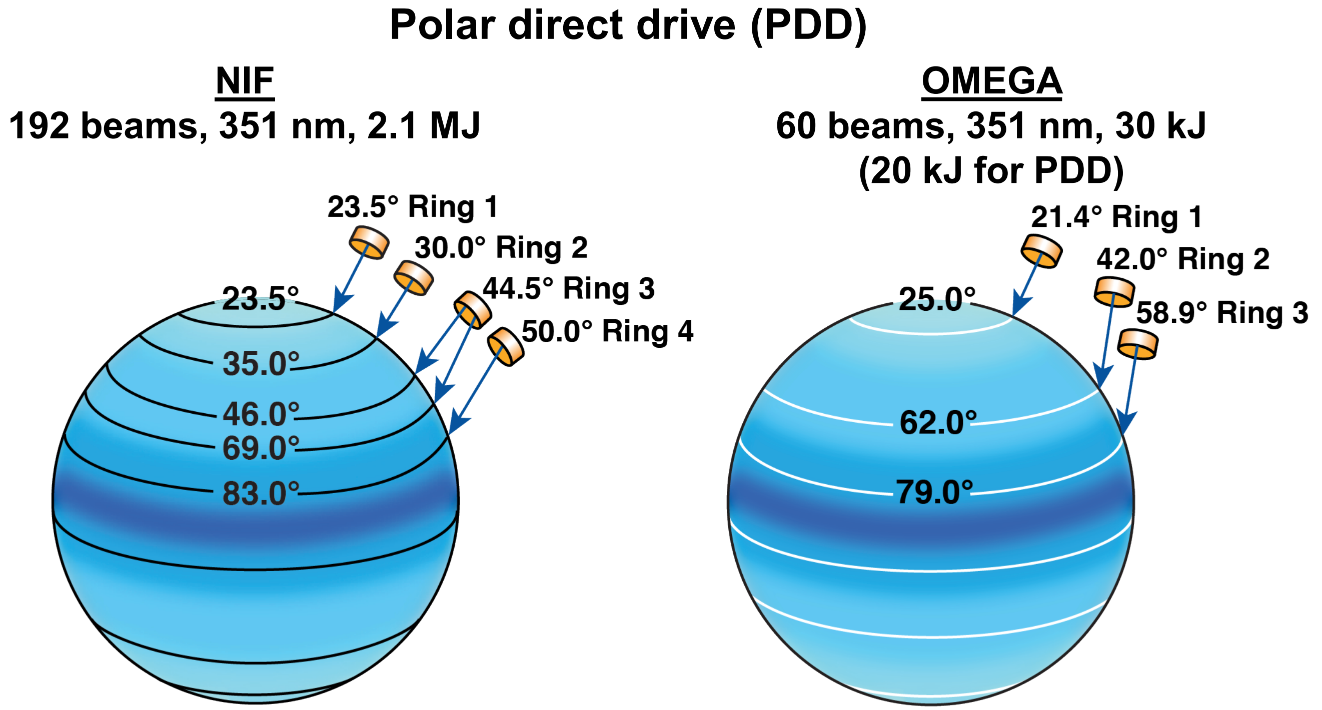
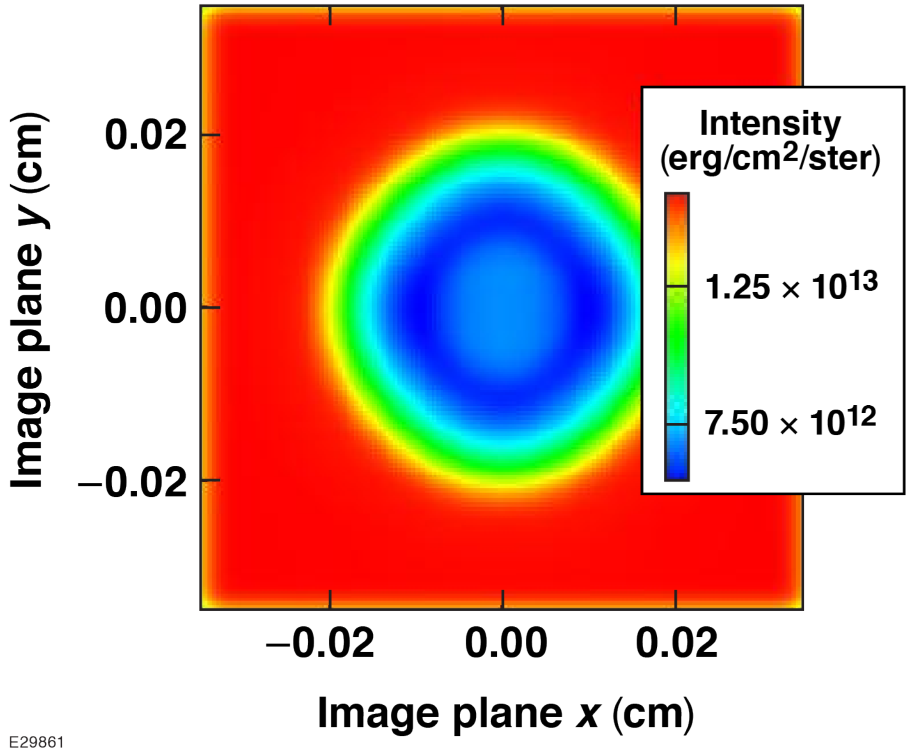
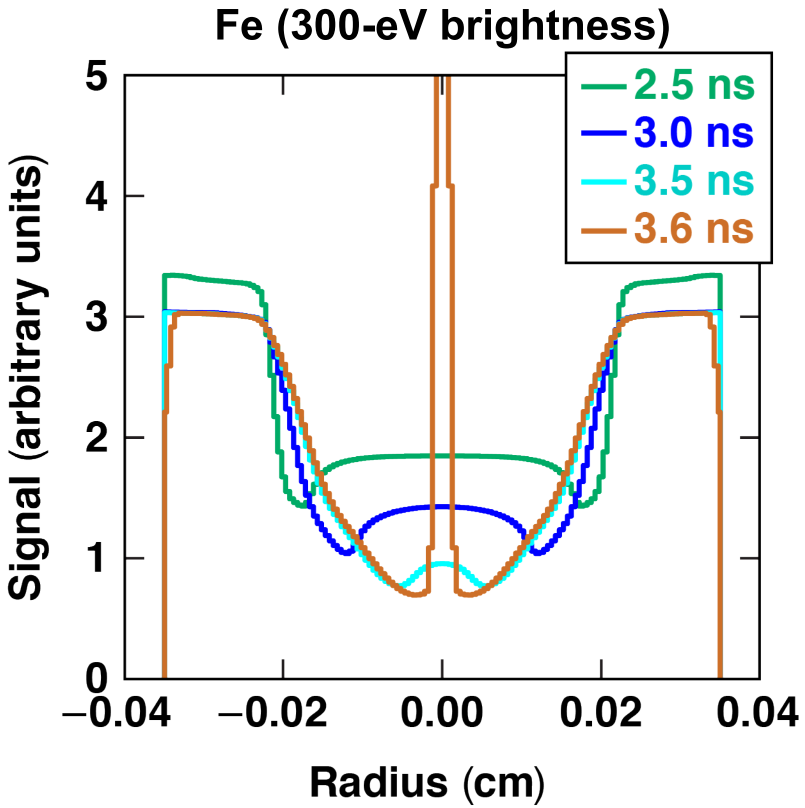


Cross-beam energy transfer (CBET) and electron thermal conduction affect energy coupling in LDD.*

* NNSA 2020 Red Team Review, Laboratory for Laser Energetics, University of Rochester, Rochester, NY (28 May 2020).
NIF: National Ignition Facility SDD: spherical direct drive LDD: laser direct drive SDD: spherical direct drive PDD: ploar direct drive

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

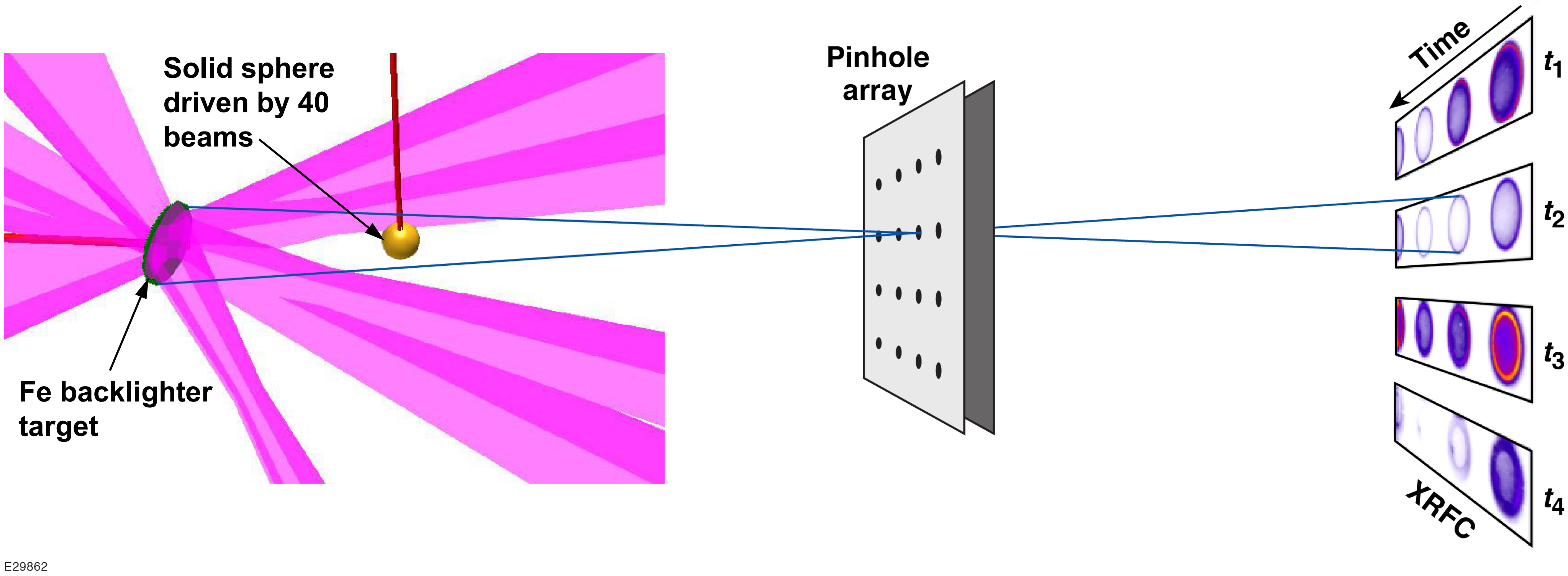




A small $\ell = 4$ perturbation can be seen in the simulated radiograph at 3 ns

The background from the main laser pulse is minimal after 2.5 ns

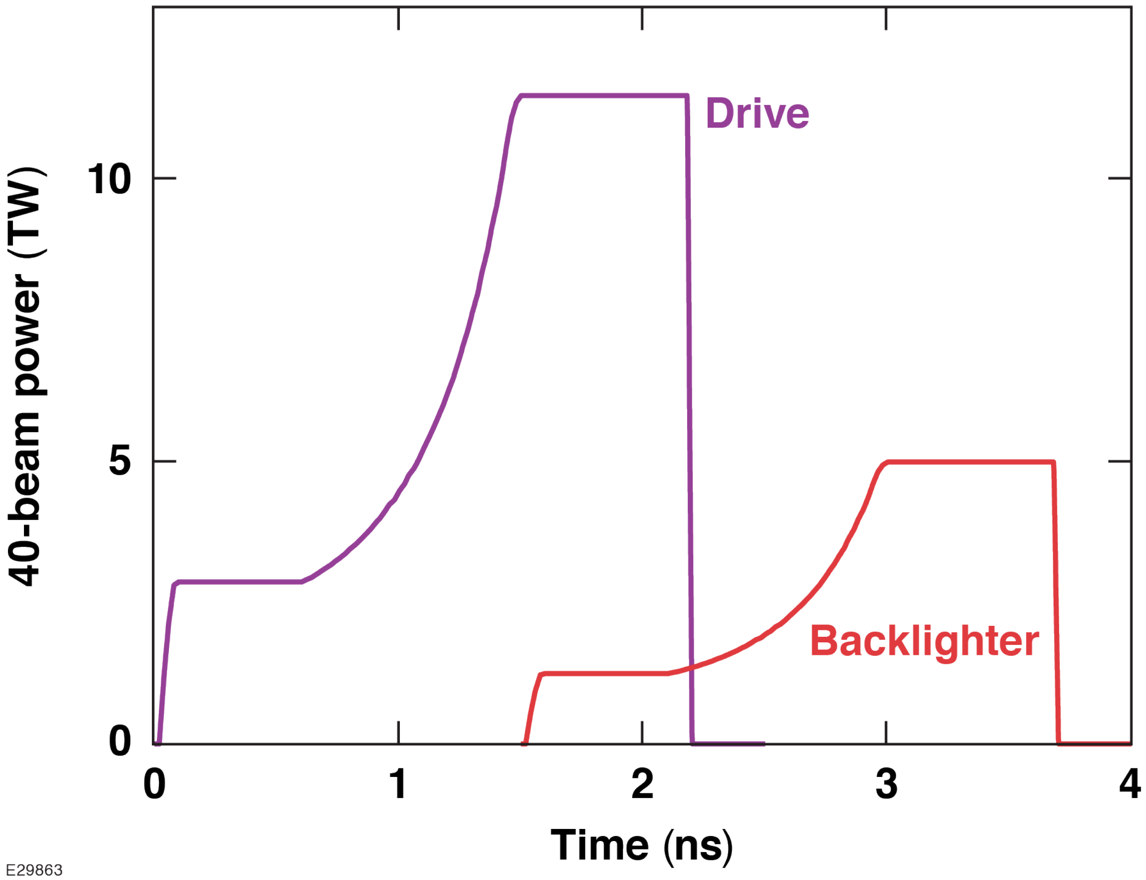
The Fe backlighter foil is illuminated by 11 beams and the solid sphere by 40 beams in a PDD configuration



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

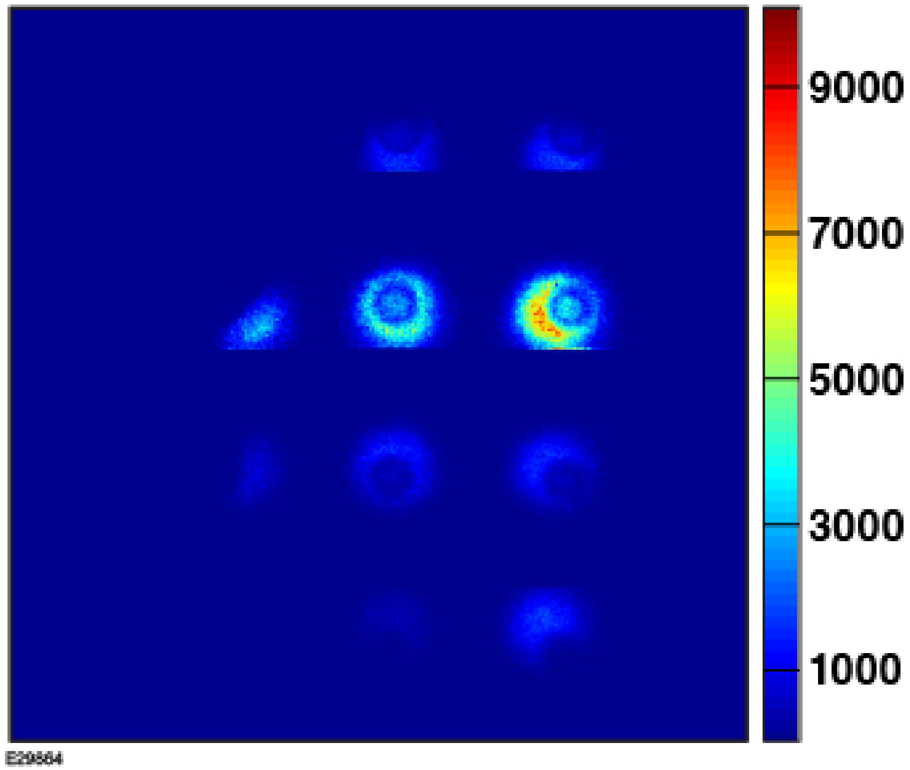
The radiographs are recorded on an x-ray framing camera (XRFC) with a 40-ps gate

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

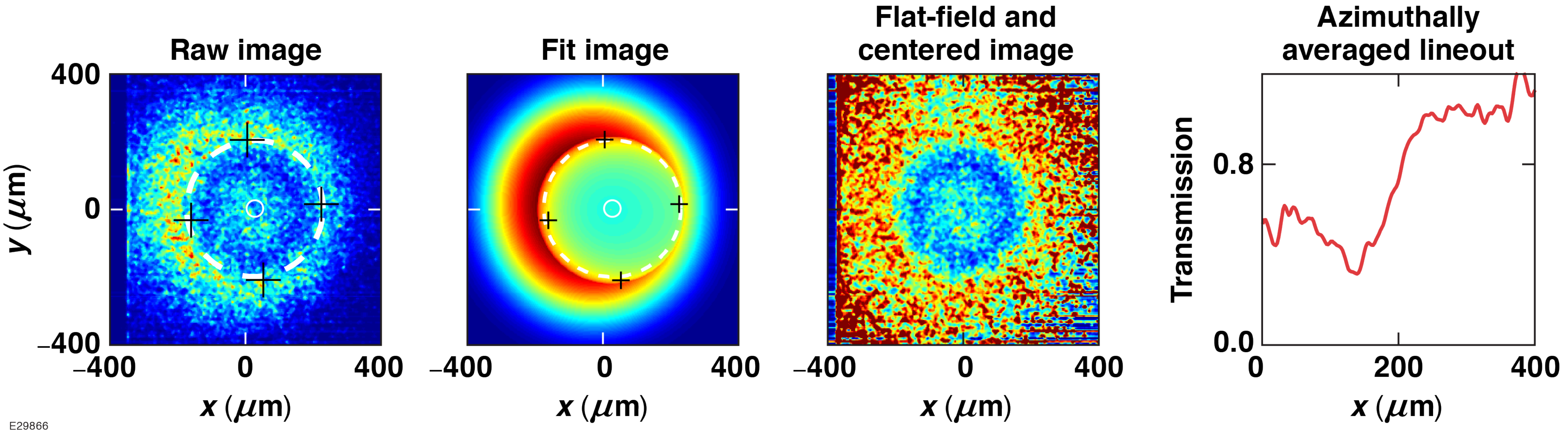
Shot 100273



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

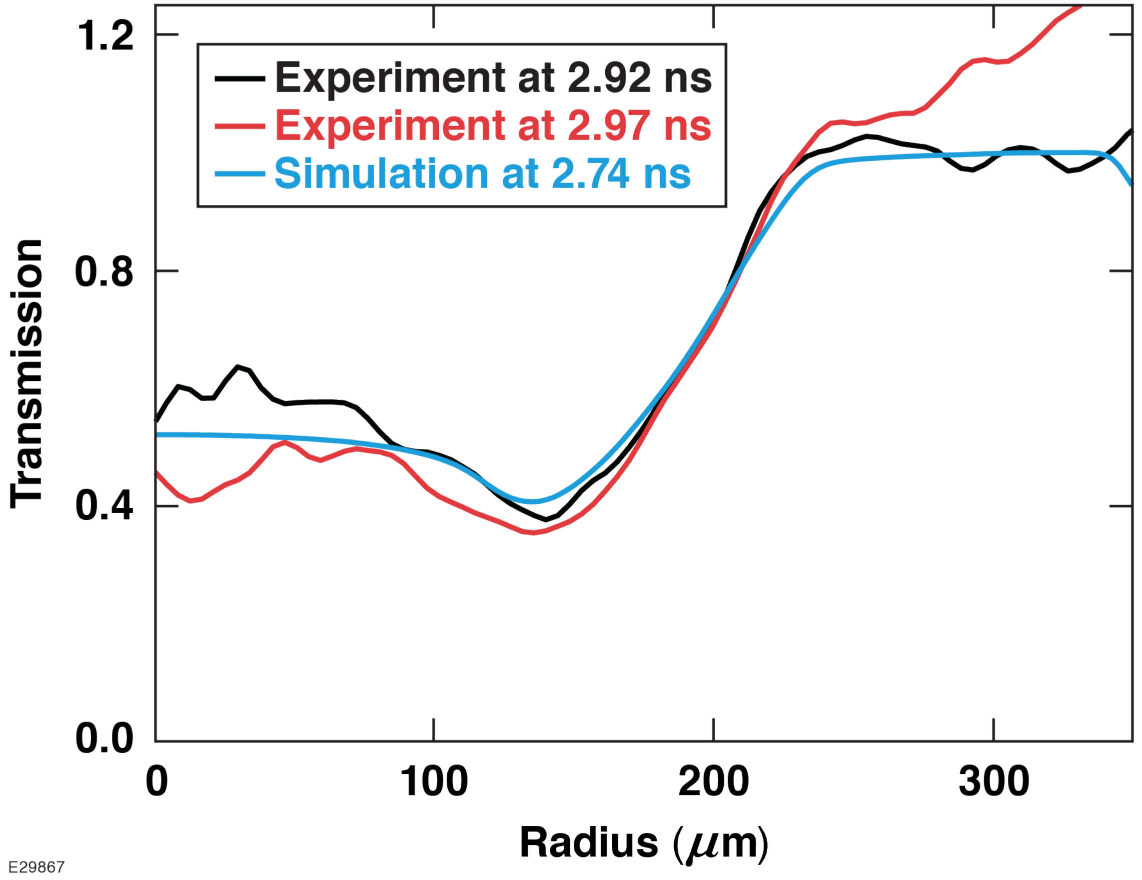
CCD: charge-coupled device

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.

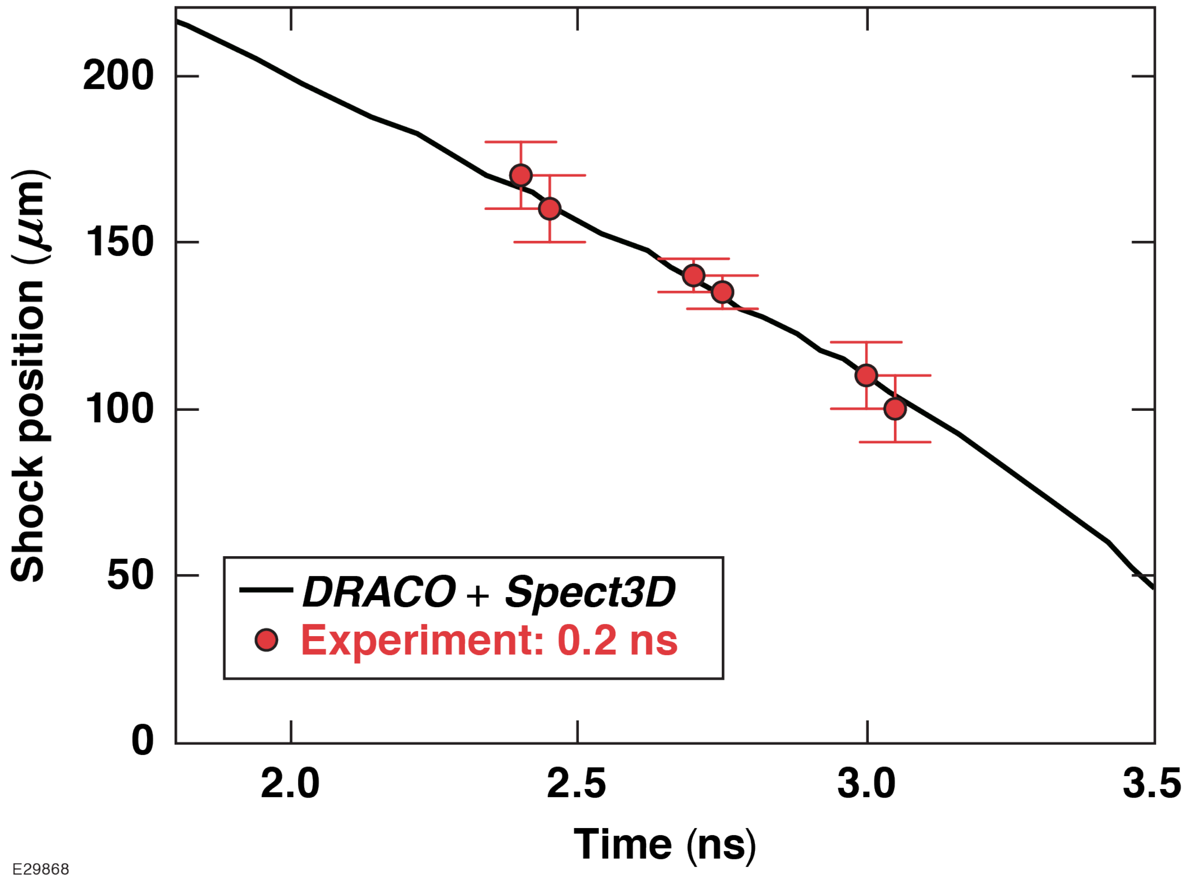
The post processed *DRACO* simulations match the experiments well given the statistical fluctuations in the data



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

* J. J. MacFarlane *et al.*, High Energy Density Phys. 3, 181 (2007).

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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