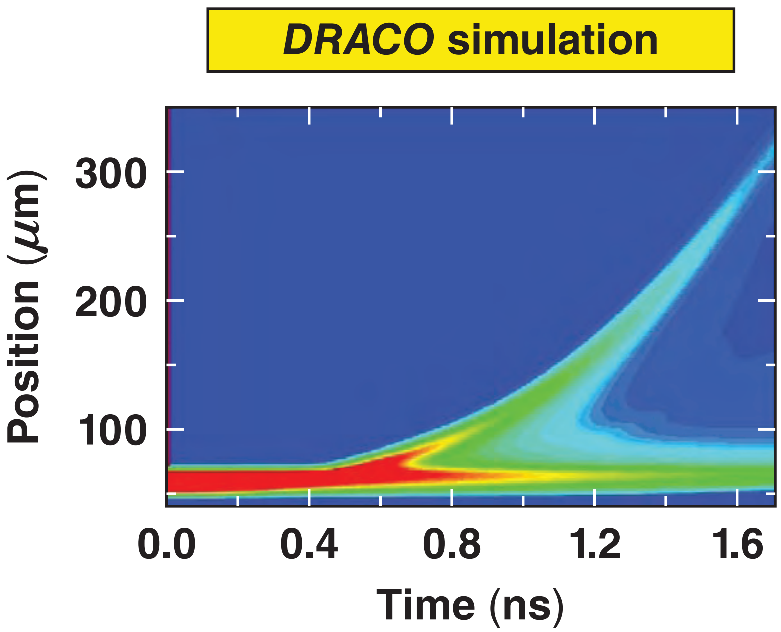
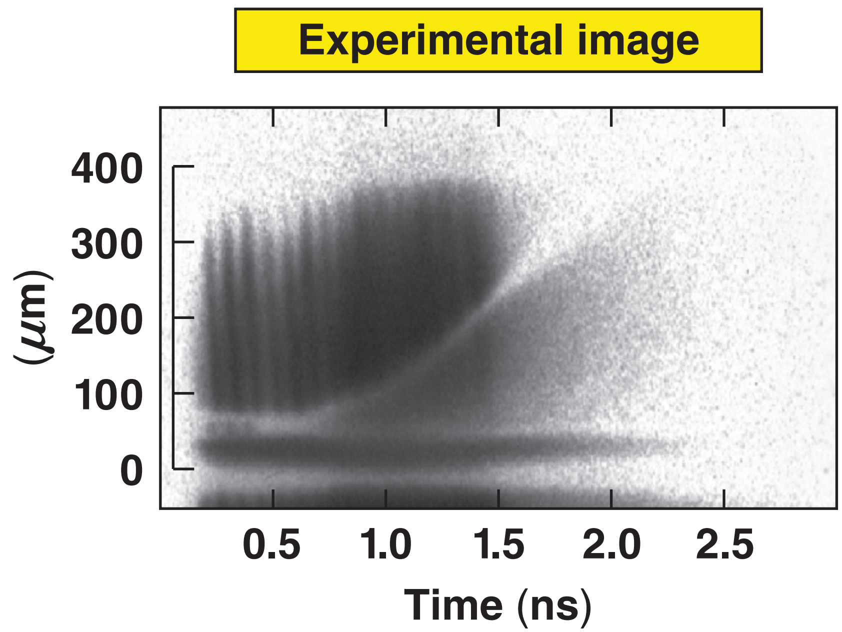
Validation of Thermal-Transport Modeling in Direct-Drive Targets Using Planar-Foil Experiments on OMEGA





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49th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Orlando, FL
12–16 November 2007

Summary

Validation of nonlocal thermal-transport modeling in *DRACO* builds the code predicative capability

- **Direct-drive, planar-foil OMEGA experiments have been studied using the 2-D hydrocode *DRACO*, at intensities and pulse shapes relevant to ignition on the NIF.**

- **Nonlocal thermal transport explains planar-trajectory experiments for different intensities and pulse shapes.**

- **At laser intensities $\leq \sim 6 \times 10^{14}$ W/cm^2, the nonlocal thermal-transport model effectively gives similar results as the constant flux limiter ($f = 0.06$).**

- **For high intensities of $\sim 10^{15}$ W/cm^2 , nonlocal thermal transport is necessary to explain experimental measurements.**

Collaborators

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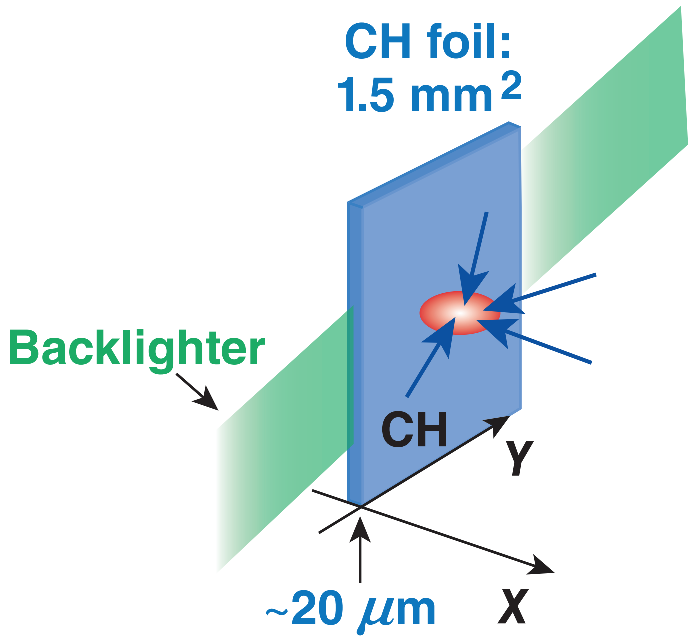
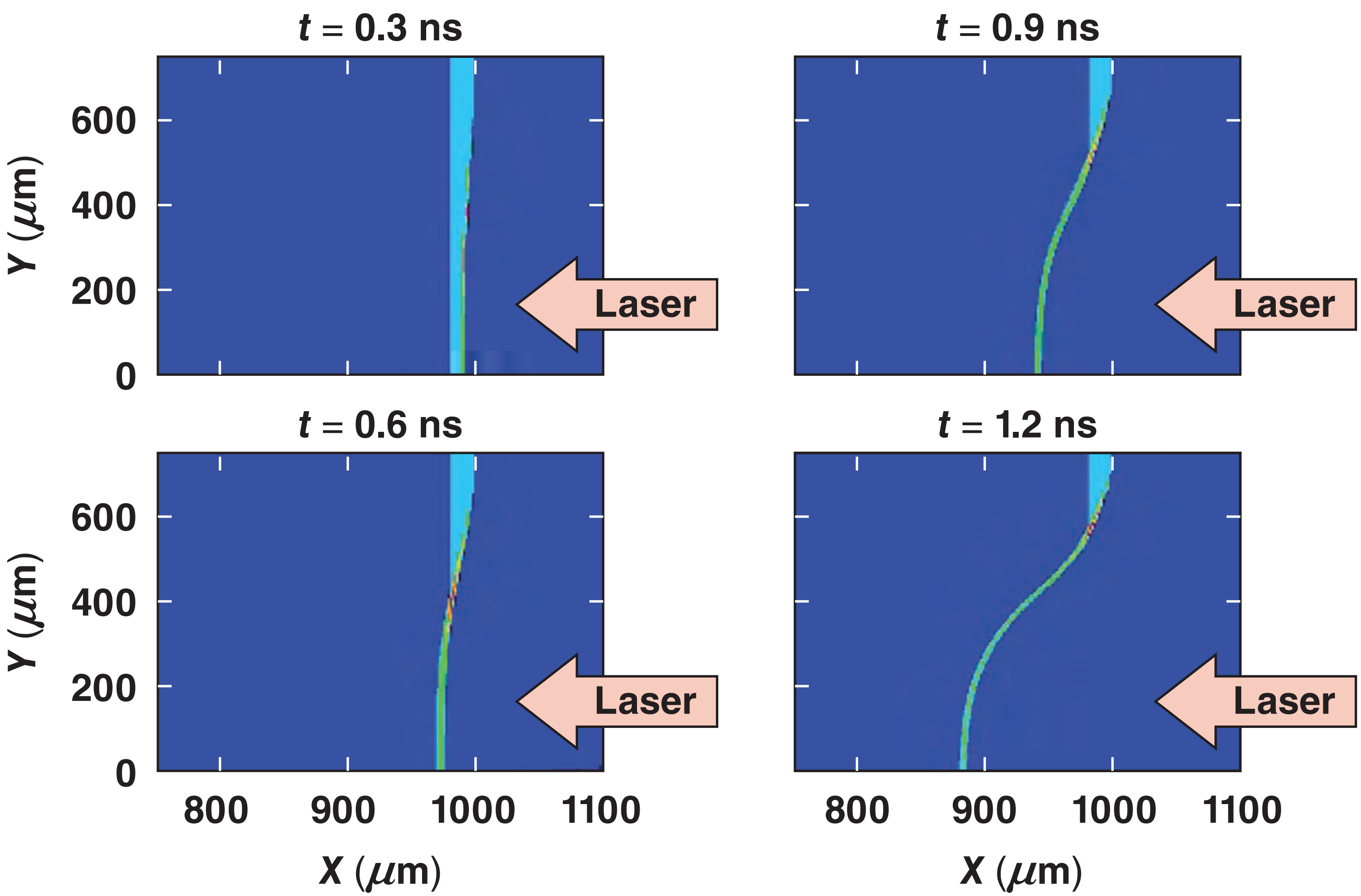
Planar-foil trajectory experiments conducted on OMEGA were simulated in 2-D *DRACO*



- A thorough understanding of laser-target coupling is critical to properly model the RT growth and to design ignition targets.
- A thin foil of ~20 μm is driven by up to ten OMEGA laser beams at intensities varying from ~2 × 10^{14} to ~10^{15} W/cm^2. Side-on x-ray radiography is used to measure foil trajectory by a streak camera.
- We simulated the two dimensions spanned by the shock propagation (*x*-) axis and the target width using *DRACO*.

The snapshots of density profiles from simulations show the dynamics of the laser-driving planar foils



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The absorption images from our simulation can be directly compared to experimental ones

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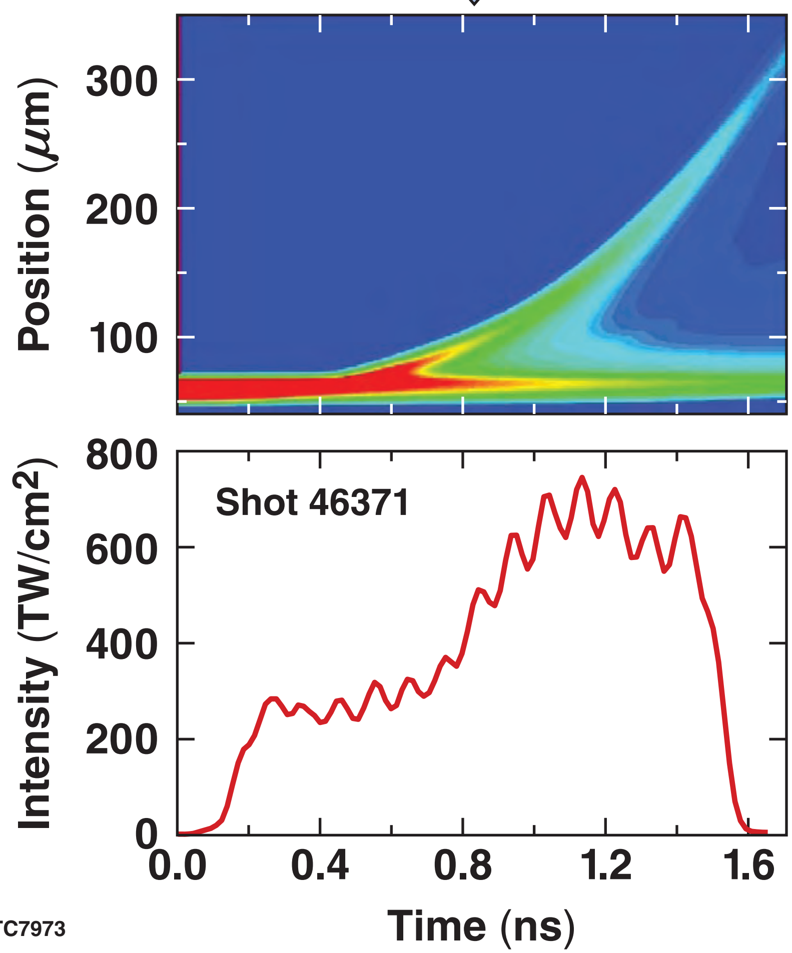
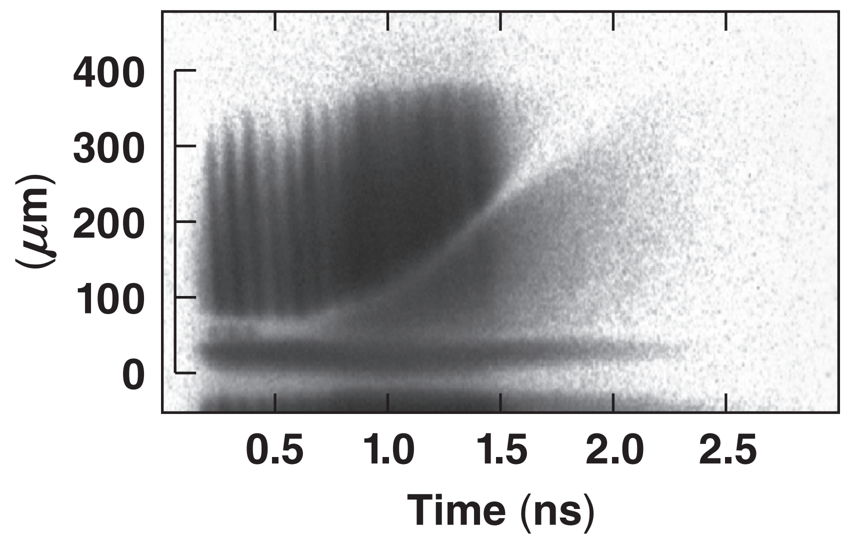
Post-processed image from *DRACO* simulation



Experimental image



SSD modulations provide an accurate temporal fiducial.

For $I \leq 6 \times 10^{14}$ W/cm^2, the nonlocal model results are in good agreement with experiments, equivalent to the flux limiter of *f* = 0.06

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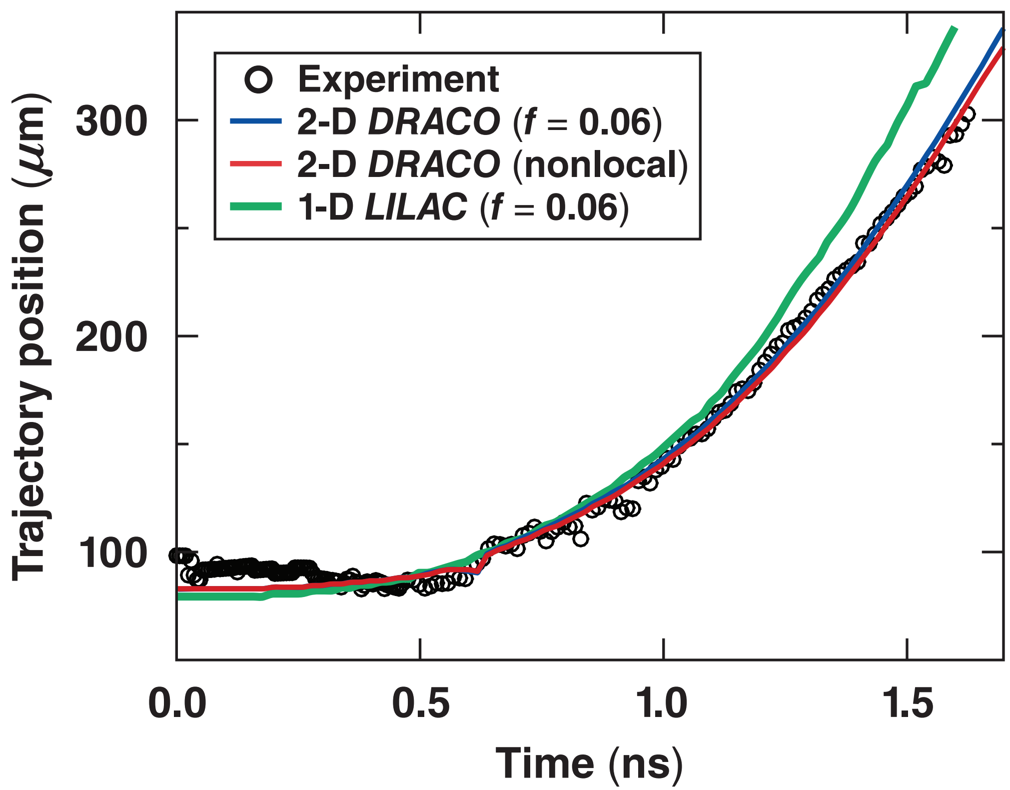
Shot 46371, 1.5-ns shaped pulse (~6×10^{14} W/cm^2)



2-D simulation is necessary
2-D: T_e ~ 2.1 keV
1-D: T_e ~ 3.0 keV

At intensity ≤ ~6×10^{14} W/cm^2, the nonlocal model gives similar results as the constant flux limiter of *f* = 0.06.

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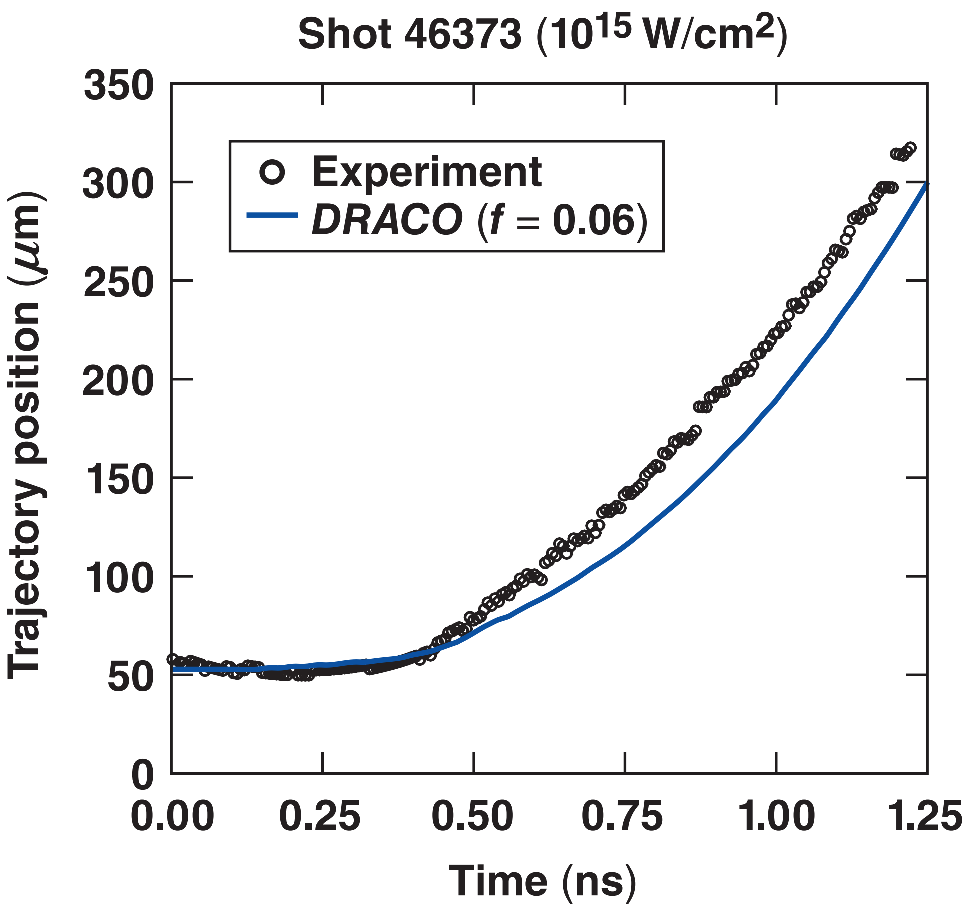
At high intensities of ~10^{15} W/cm^2, we observed deviations between experiments and simulations of f = 0.06



Coronal temperature
T_e ~ 3.0 keV

↓

Heat-carrying electrons have a temperature of 10 to 20 keV

λ_e (10 keV) ≈ 50 μm
≥ L_T ≈ 20 μm

↓

Nonlocal effects become important.*

*A. R. Bell *et al*., Phys. Rev. Lett. 46, 243 (1981).
J. F. Luciani *et al*., Phys. Rev. Lett. 51, 1664 (1983).
A. Sunahara *et al*., Phys. Rev. Lett. 91, 095003 (2003).

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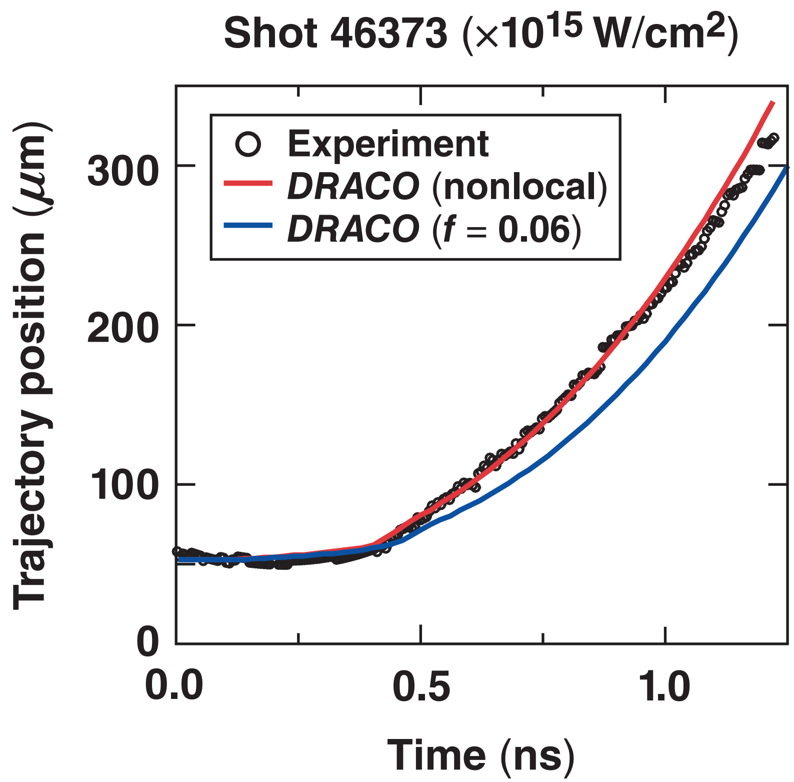
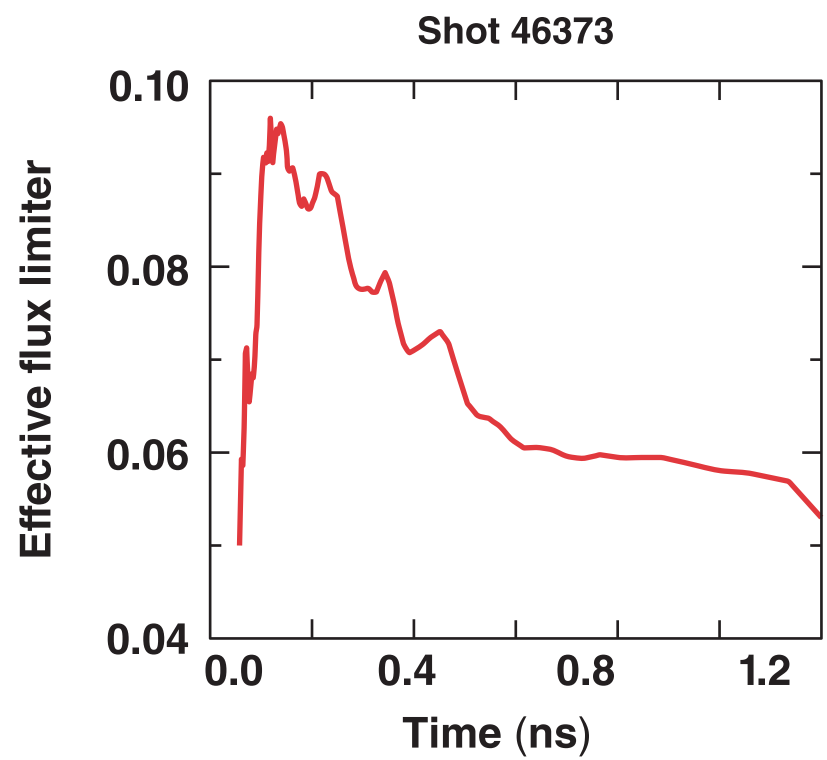
The nonlocal model* resulting in effective time-dependent flux limiters better simulates the laser-target coupling at high intensities





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*V. N. Goncharov *et al.*, Phys Plasmas 13, 012702 (2006).

Summary/Conclusions

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