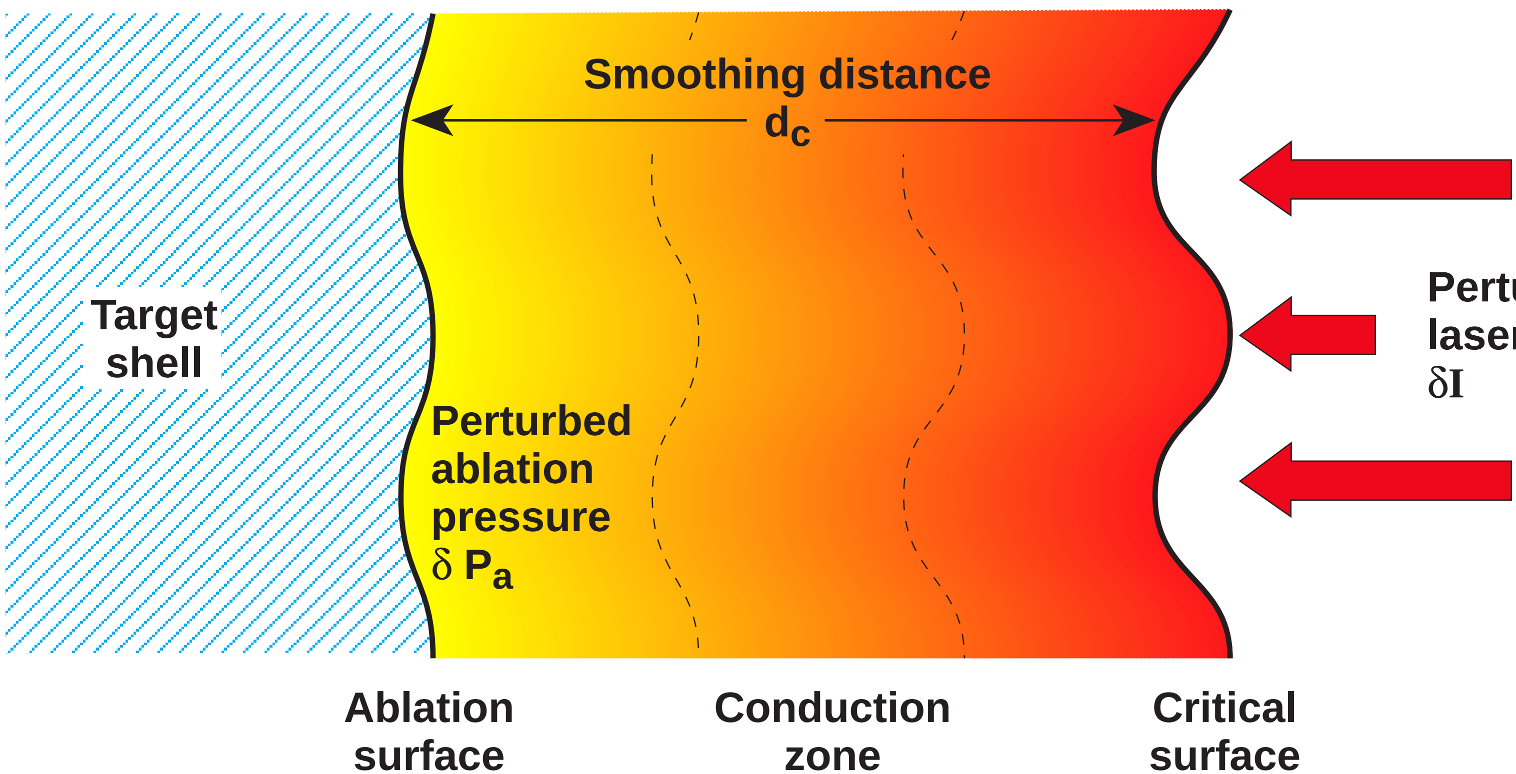
The Effects of Pulse Shaping on Imprint

T. J. B. Collins and S. Skupsky

Laboratory for Laser Energetics, U. of Rochester

The degree of nonuniformity imprinted on the surface of a target depends in part on the time dependence of the laser pulse. Analytic modeling of the conduction zone (the region between the ablation and critical surfaces) in ICF targets has shown that the width of this region, or smoothing distance, is proportional to the laser intensity. In addition, these models show that for a sufficiently thick plasma atmosphere, larger smoothing distances result in decreased imprint of laser perturbations on the target during early times. We have performed one- and two- dimensional simulations of direct-drive NIF targets, comparing the smoothing distances and imprint of three basic pulse shapes: the standard continuous pulse consisting of a foot pulse followed by a rise to a flat-top pulse, and the same pulse, preceded by a single prepulse, with and without a thermal relaxation period between it and the foot pulse. We review the effects of these modifications to the standard foot pulse on the smoothing distance and the imprint. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460, the University of Rochester, and the New York State Energy Research and Development Authority.

Proper Pulse Shaping Can Reduce Laser Imprint in OMEGA Cryogenic Targets

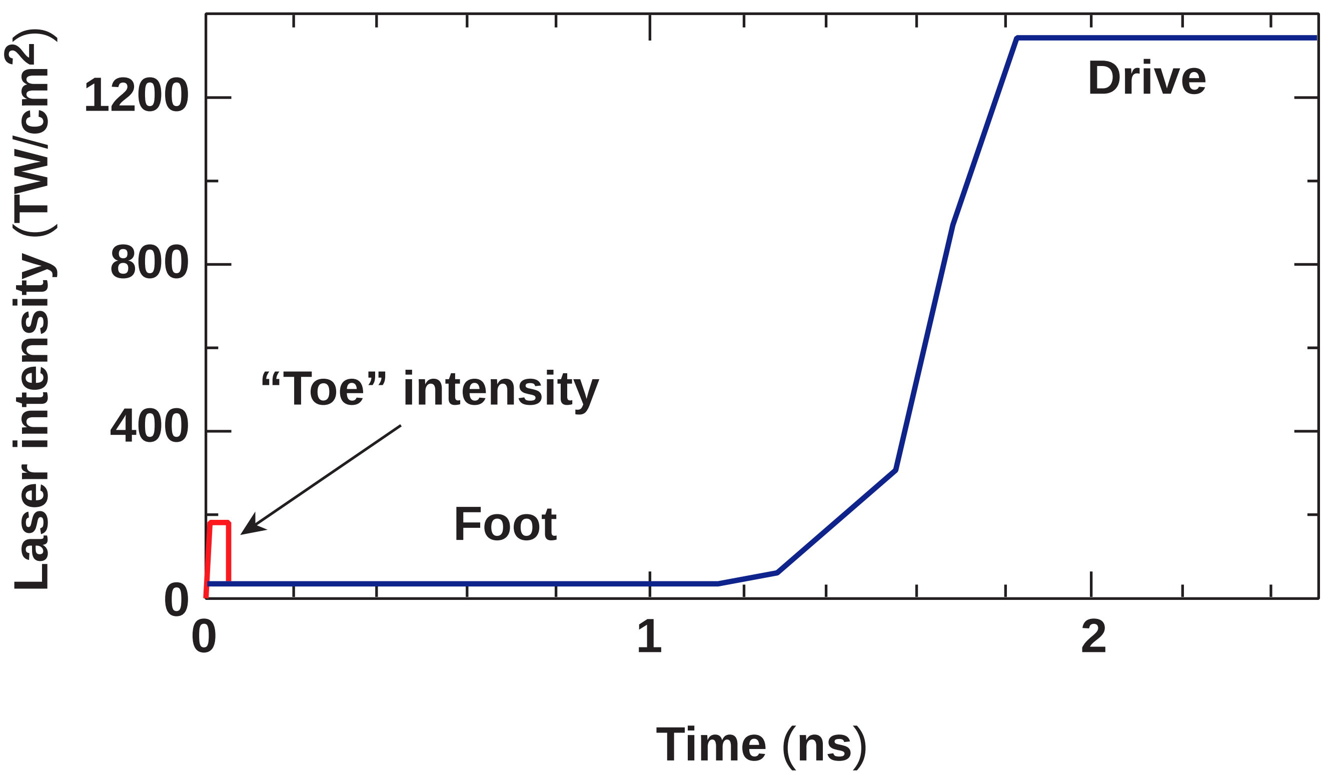


T. J. B. Collins and S. Skupsky
University of Rochester
Laboratory for Laser Energetics

41st Annual Meeting of the
American Physical Society
Division of Plasma Physics
Seattle, WA
15–19 November 1999

Pulse shaping can reduce laser imprint in OMEGA cryogenic targets

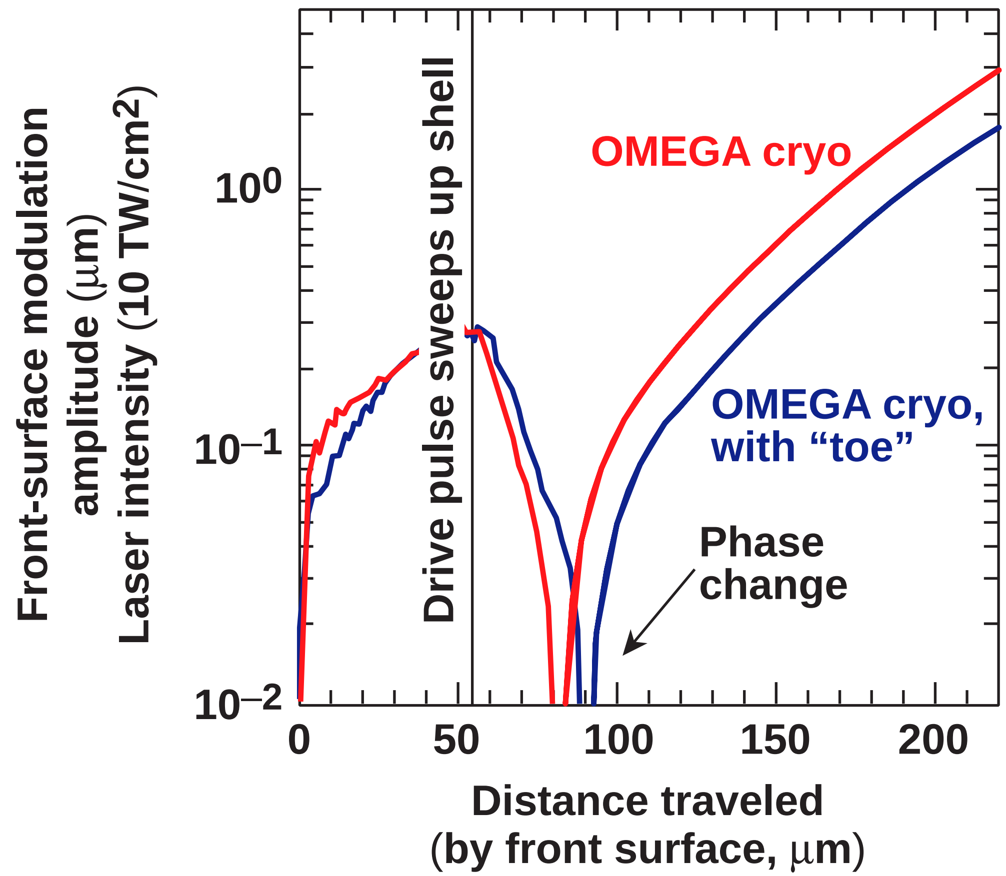
- **Increased intensity (or "toe") at the start of the foot pulse reduces imprint by increasing the thermal-smoothing distance.**
- **1-D *LILAC* simulations show negligible change in the yield due to the "toe" intensity.**



TC5184

Imprint is reduced in OMEGA cryogenic targets by the "toe" intensity spike

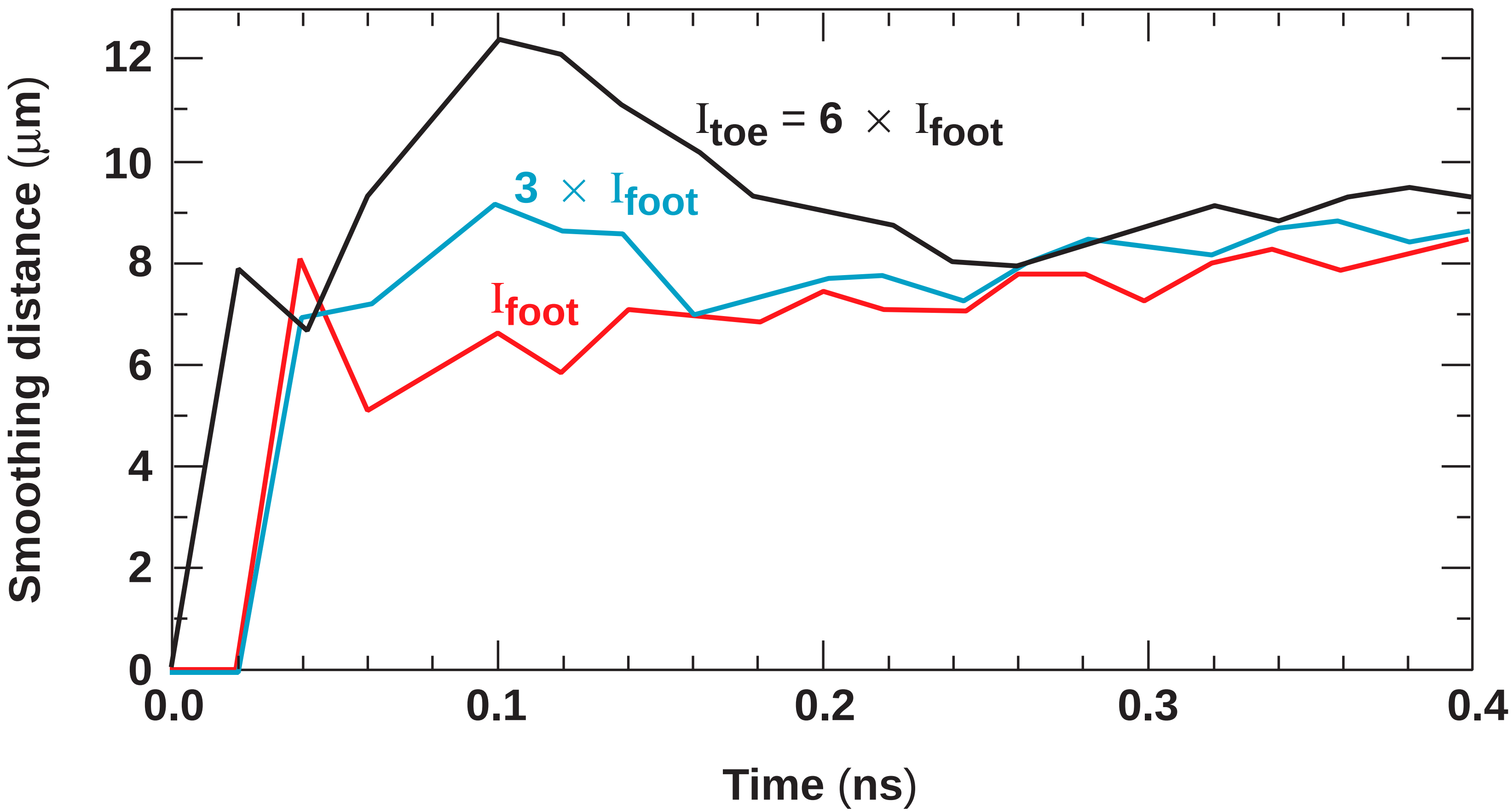
- **Target:**
  - **72 μm, cryo DT**
  - **3 μm CH**
- **Laser:**
  - $\delta I/I$ = **5%**
  - λ = **50 μm** (l **~50**)
- **"Toe" intensity spike:**
  - **180 TW/cm2**
  - **60-ps duration**
- **The toe reduces RT growth.**



TC5185

Smoothing distance increases with “toe” intensity

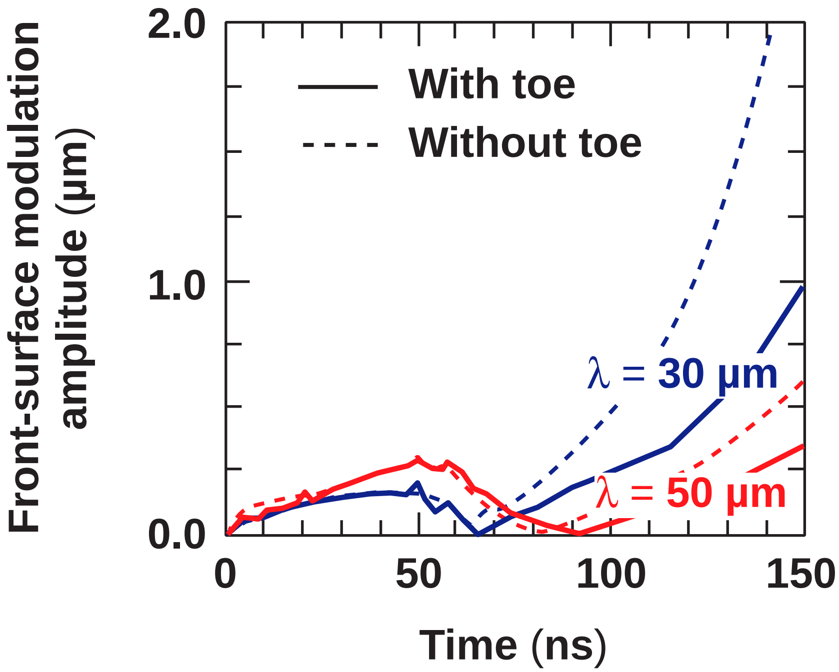
- The smoothing distance d_c is the distance between the ablation and critical surfaces.

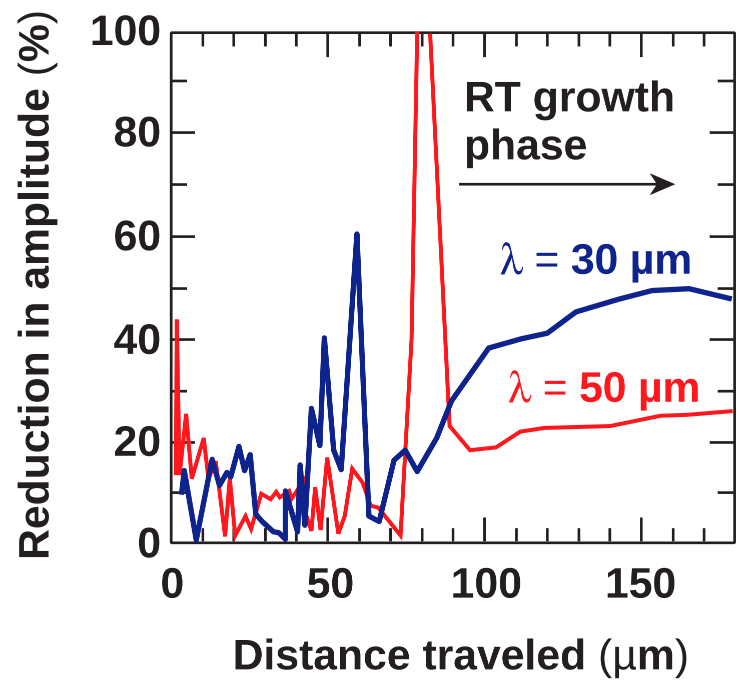


TC5186

Imprint reduction is inversely proportional to illumination perturbation wavelength

- Simple modeling of the condition zone shows that pressure perturbations decay exponentially: $\delta p \sim \exp(-kd_c)$.





TC5187

Conclusion

Imprint is reduced by "toe" intensity spike at the start of the foot pulse in OMEGA cryogenic targets

- Intensity spike at beginning of foot-pulse results in a greater thermal smoothing distance during imprint phase.
- This alteration of the foot pulse does not perturb the shock timing enough to significantly alter the yield.
- The reduction in imprint is greater for shorter wavelengths.