Measurements of Laser Imprinting on the OMEGA Laser System

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We present radiographic measurements of laser imprinting ontargets with pre-imposed, single- mode modulations. These “control modes” allow us to assign an equivalent mass perturbation to the initial imprint levels. Using this technique we compare the imprinting produced by different pulse shapes and measure the effect of uniformity improvements. Sharply rising pulses produce less imprint than slowly rising pulses—a result of the rate at which the coronal plasma is produced. The effect of smoothing by spectral dispersion (SSD) on these pulses can be similarly explained. Two-dimensional simulations of imprint are in good agreement with the experimental observations. 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.

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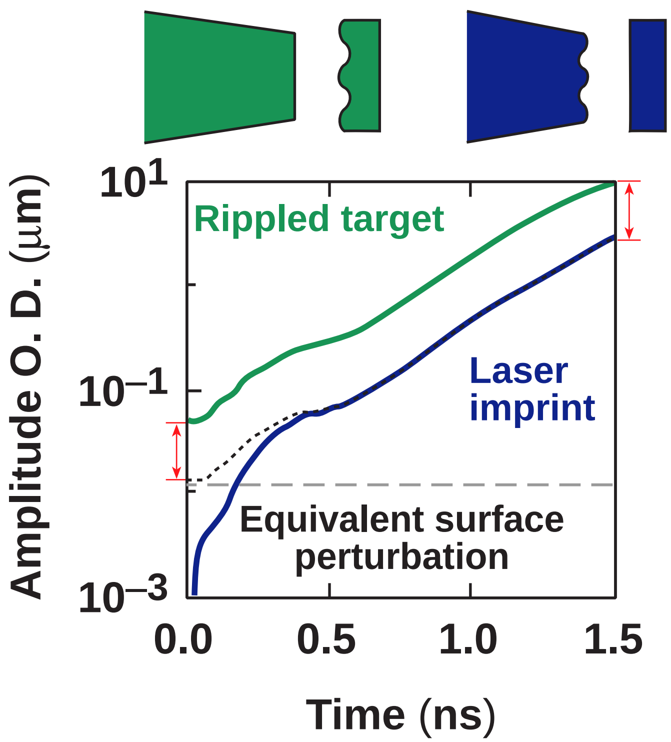
Simulation of method



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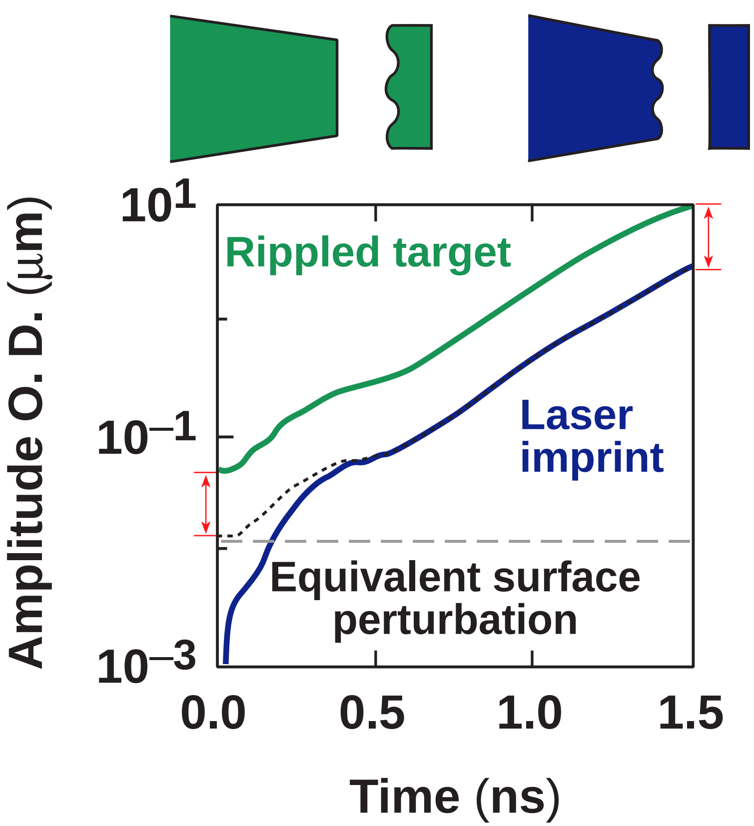
Summary

The effect of beam smoothing and pulse shape on laser imprinting is measured using mass equivalence

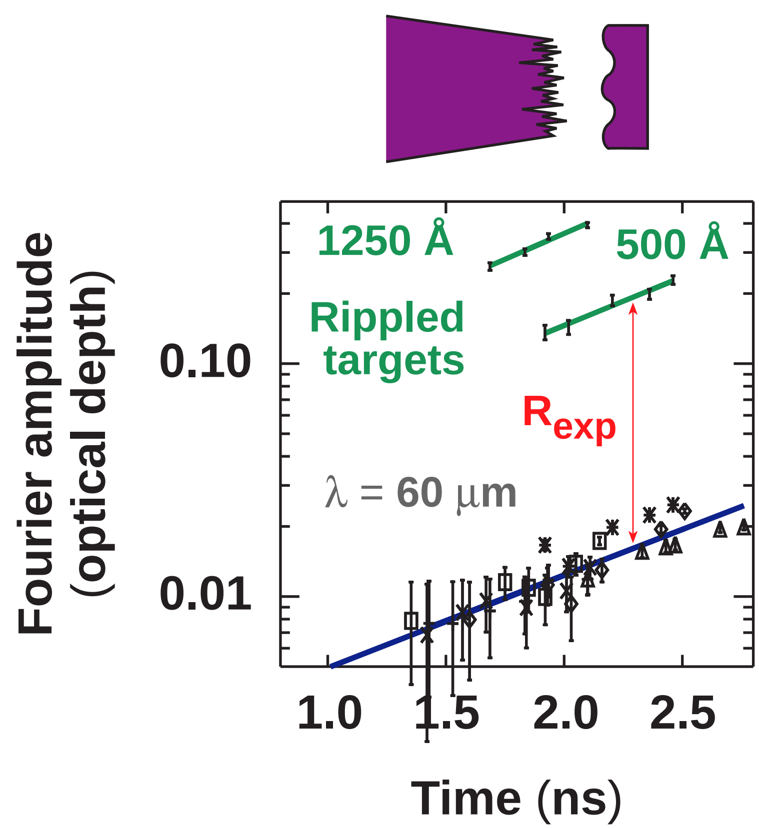
- **Use preimposed modulations to calibrate imprinting at λ = 30 μm and 60 μm.**
- **The method detects changes in imprint due to beam smoothing.**
- **Slowly rising pulses produce greater imprint than steeply rising pulses.**
- **SSD has greater effect on the slowly rising pulses.**
- **The dependence on pulse shape results from the rate that the conduction zone is formed.**
- **These results have verified code performance and SSD smoothing rates.**

Pre-imposed target modulations are used to determine the equivalent surface perturbation of laser imprinting

Simulation of method

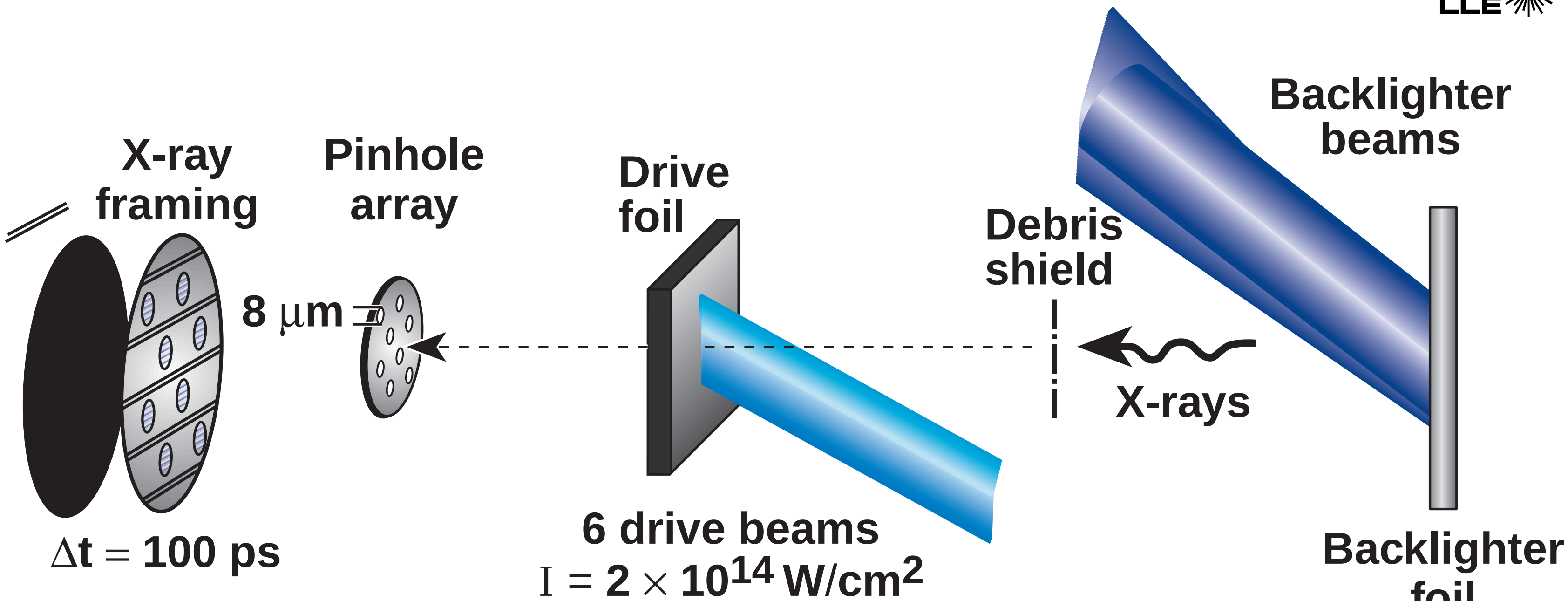


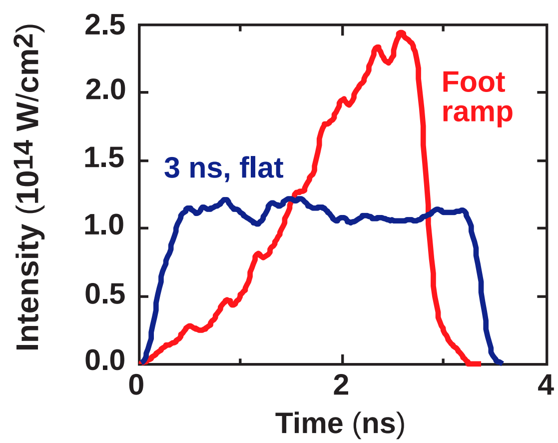
Experiment



E9502

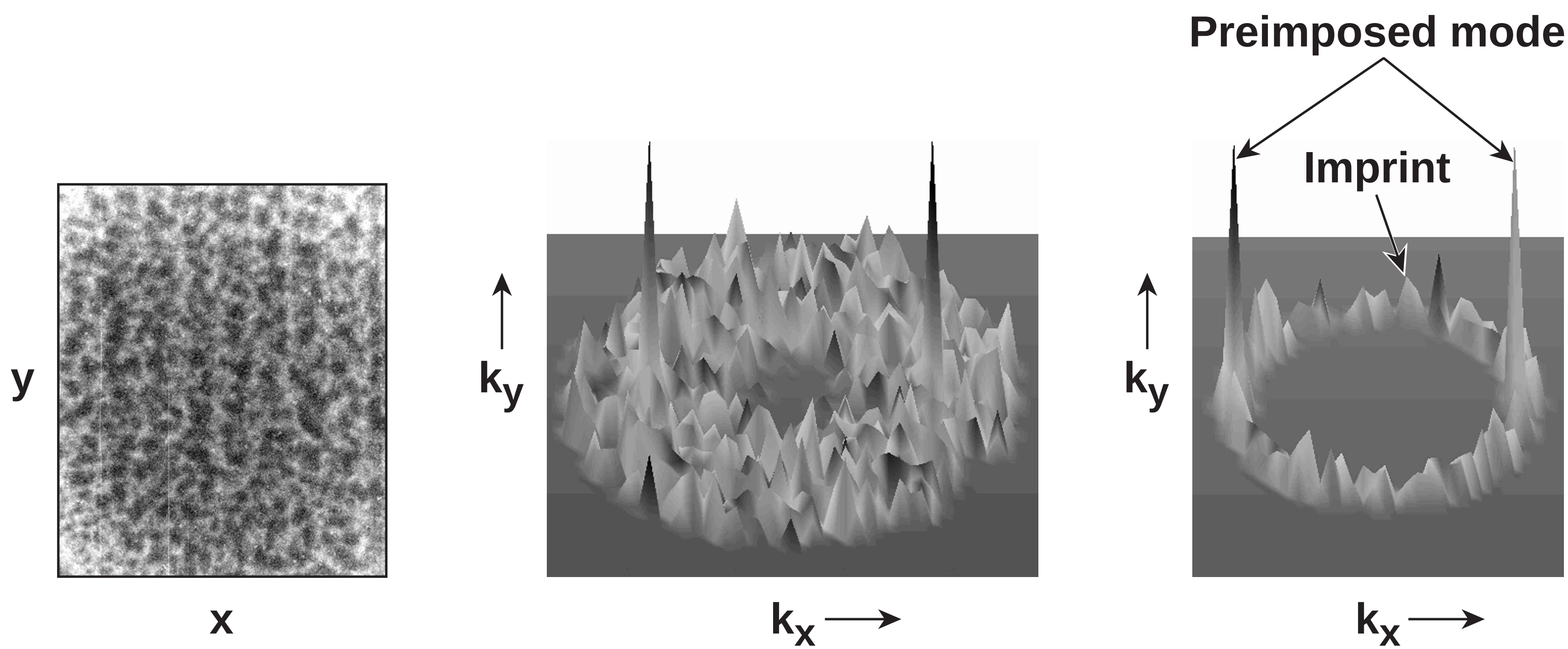
X-ray radiography is used to measure imprinted perturbations produced by two pulse shapes





E10175

Fourier analysis is used to compare the imprinted to preimposed modulations at a single wavelength



Image

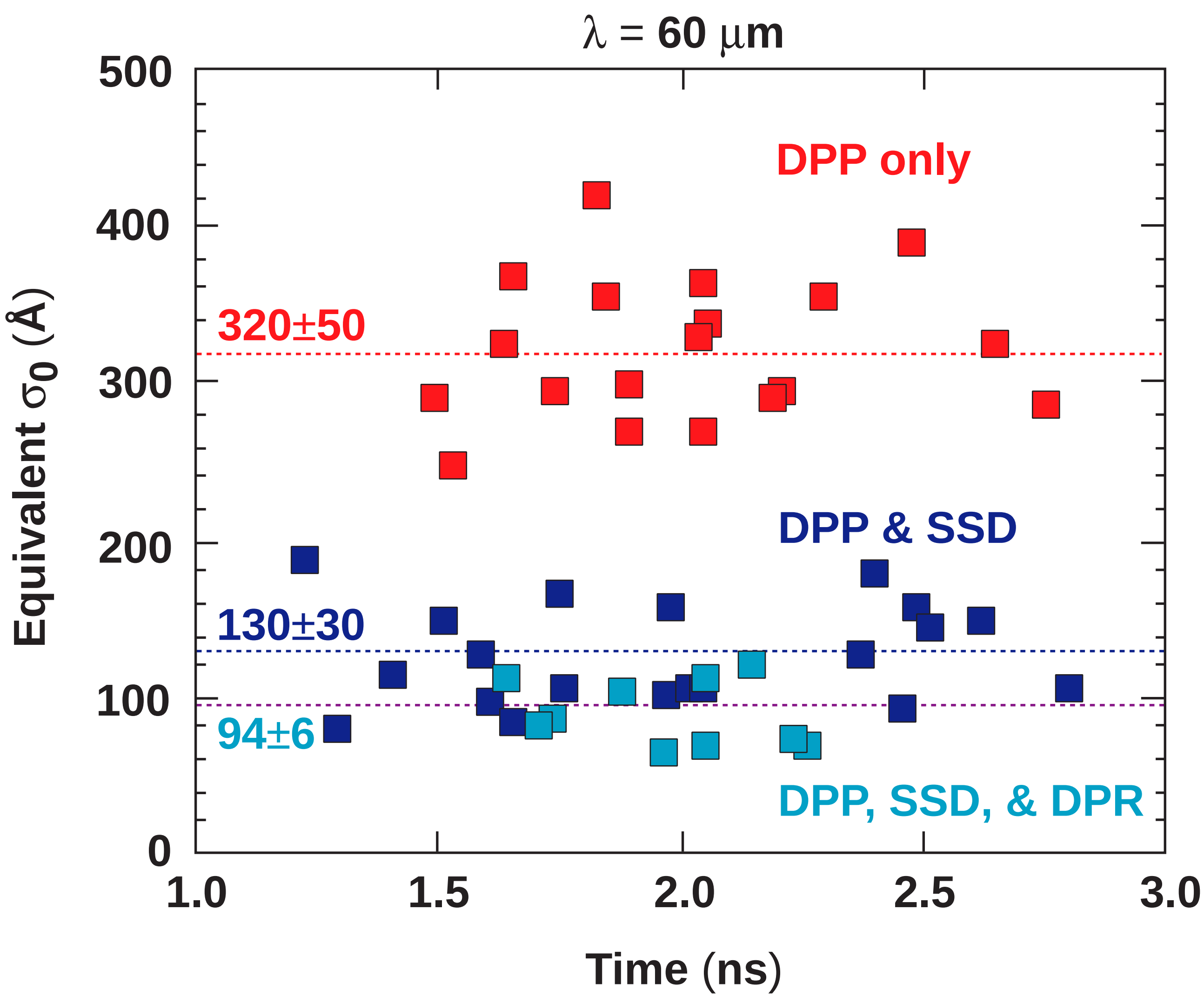
FFT and Wiener filter

FFT (λ = 60 μm)

E9398

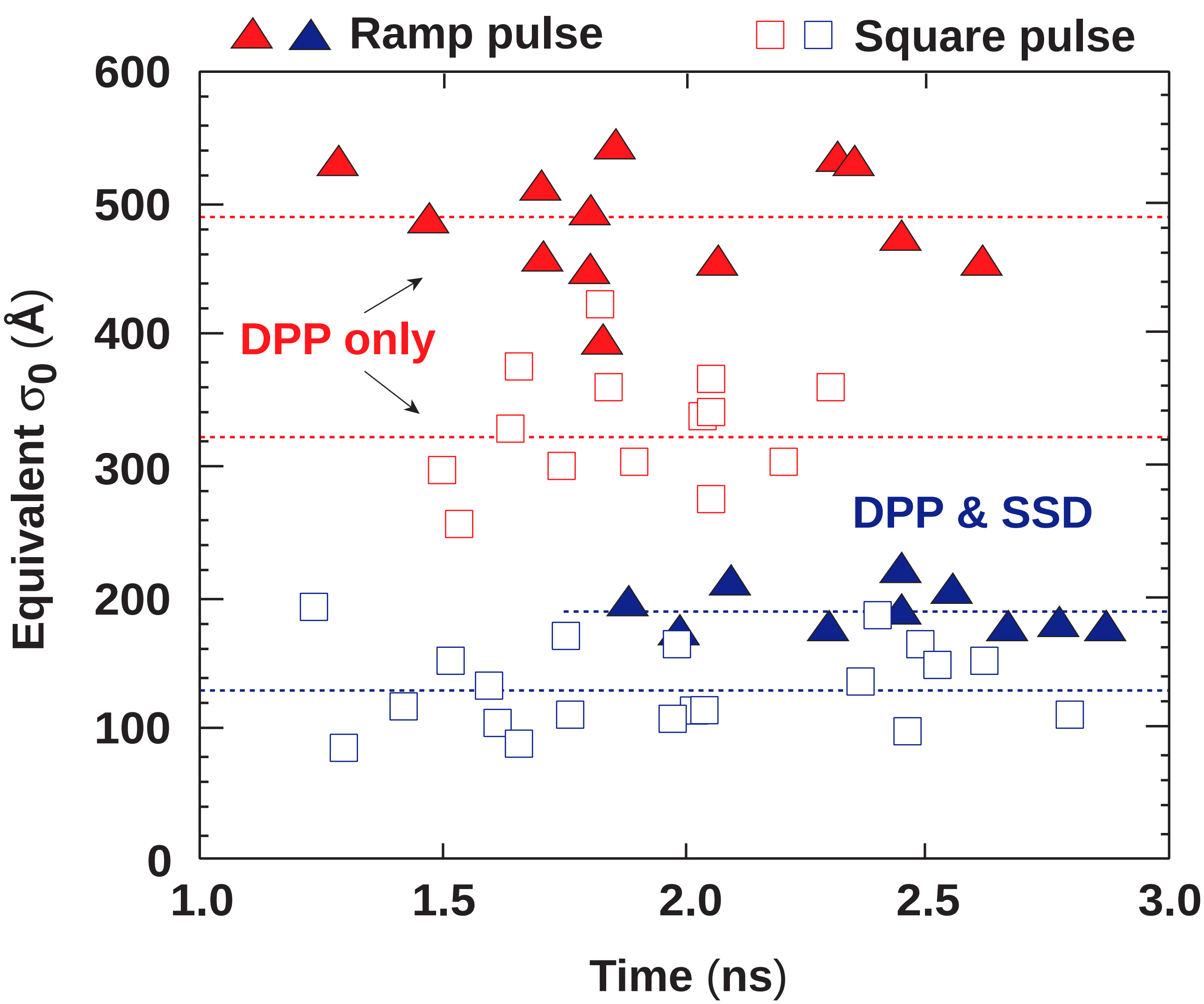
V. Smalyuk *et al.*, Phys. Plas. 6, 4022 (1999).

The equivalent surface perturbation for imprinting clearly shows the effect of beam smoothing



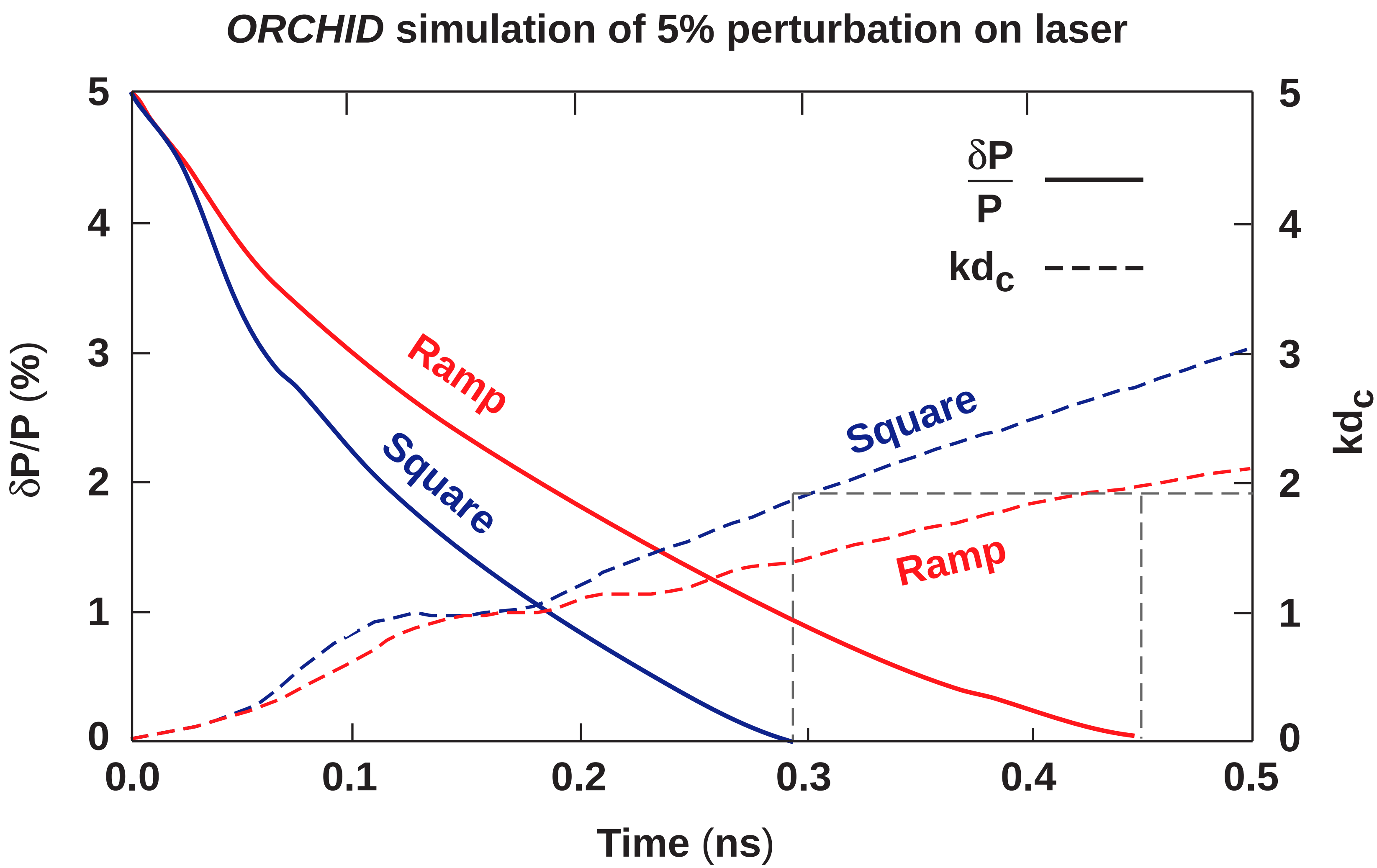
E10031

At λ = 60 μm, the level of imprinting and the effect of SSD depend on pulse shape



E10030

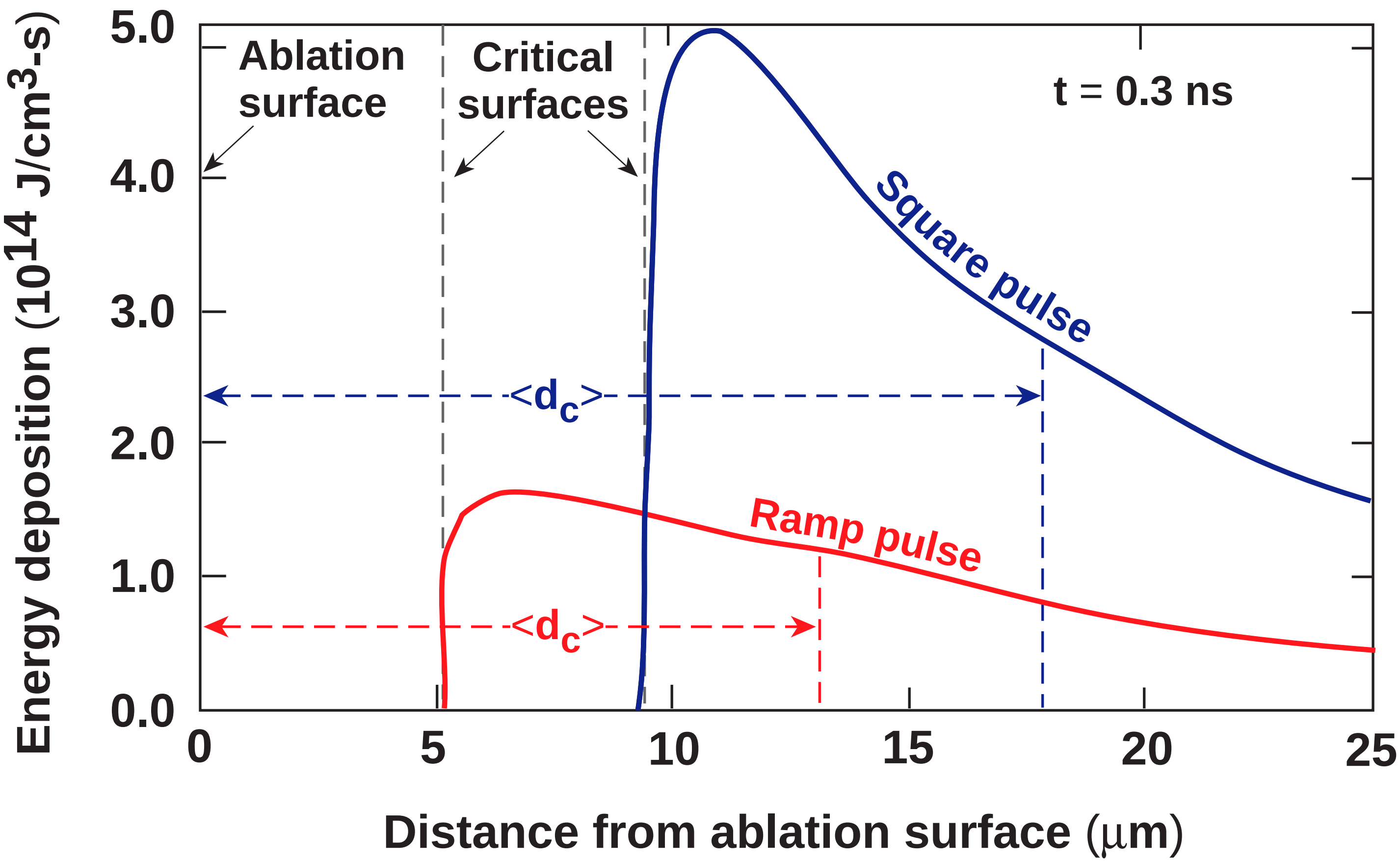
Rapid-rise pulses (square) produce smoothing plasmas faster than slow-rise pulses (ramp)



E9991

The "diffusion length" for thermal smoothing extends into the energy-deposition region

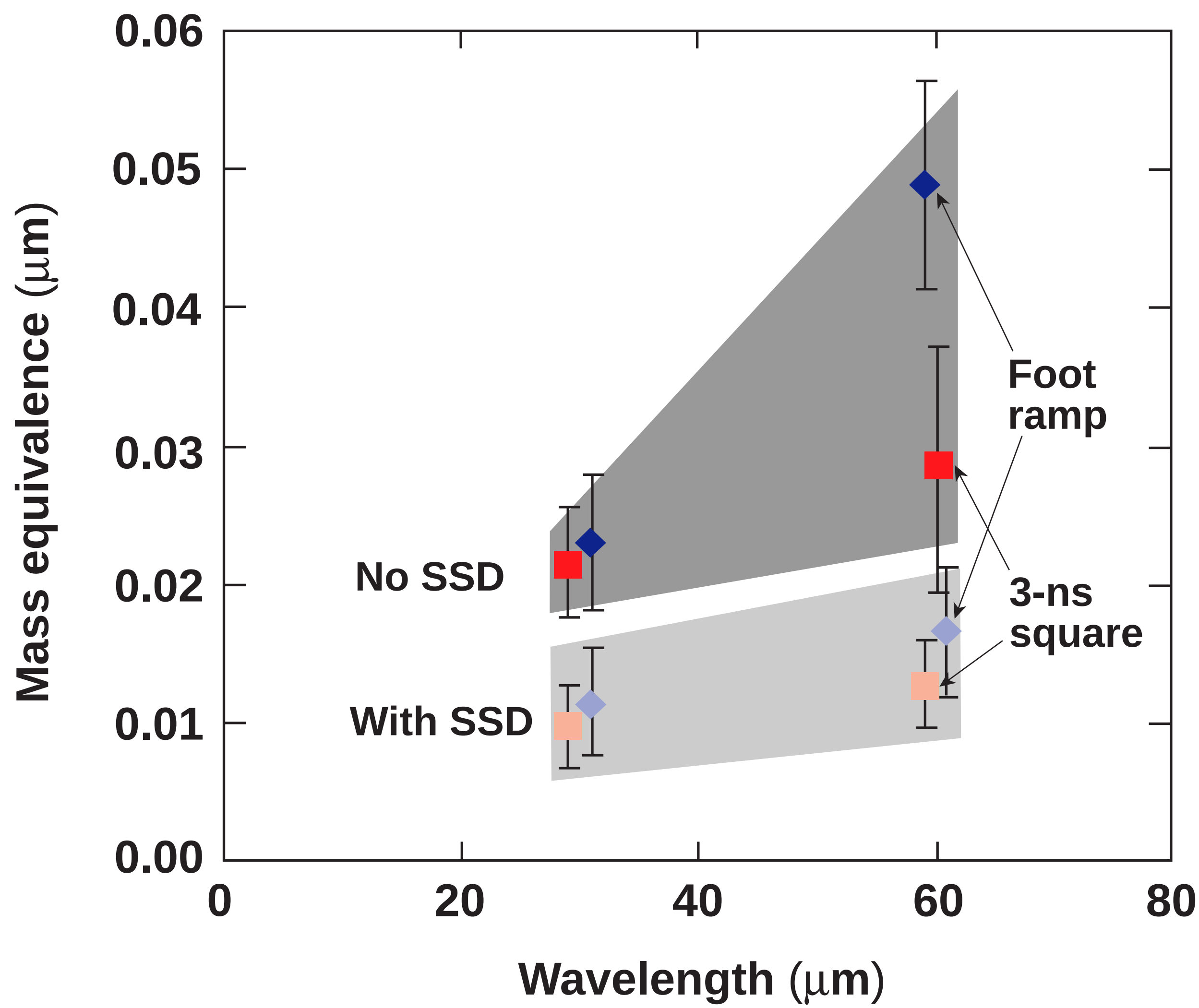
$$< d_c > = \frac{-1}{k} \ln\left[\frac{\int e^{-k(x-x_a)} E(x)\,dx}{\int E(x)\,dx}\right]$$



Azechi *et al.*, Phys. Plas. 4, 4079 (1997).

E9992

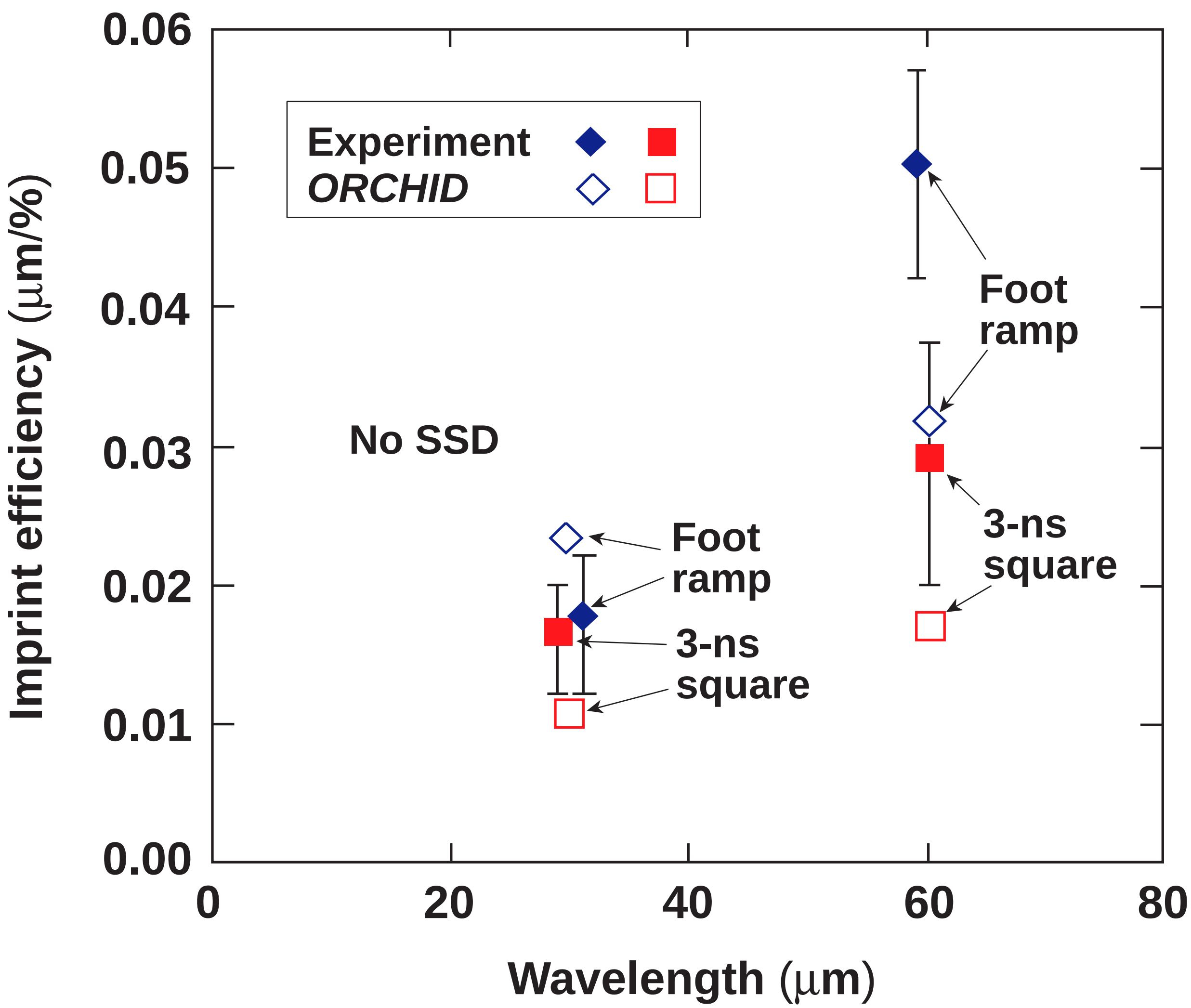
The imprinting mass equivalence is measured at two spatial wavelengths



E9963

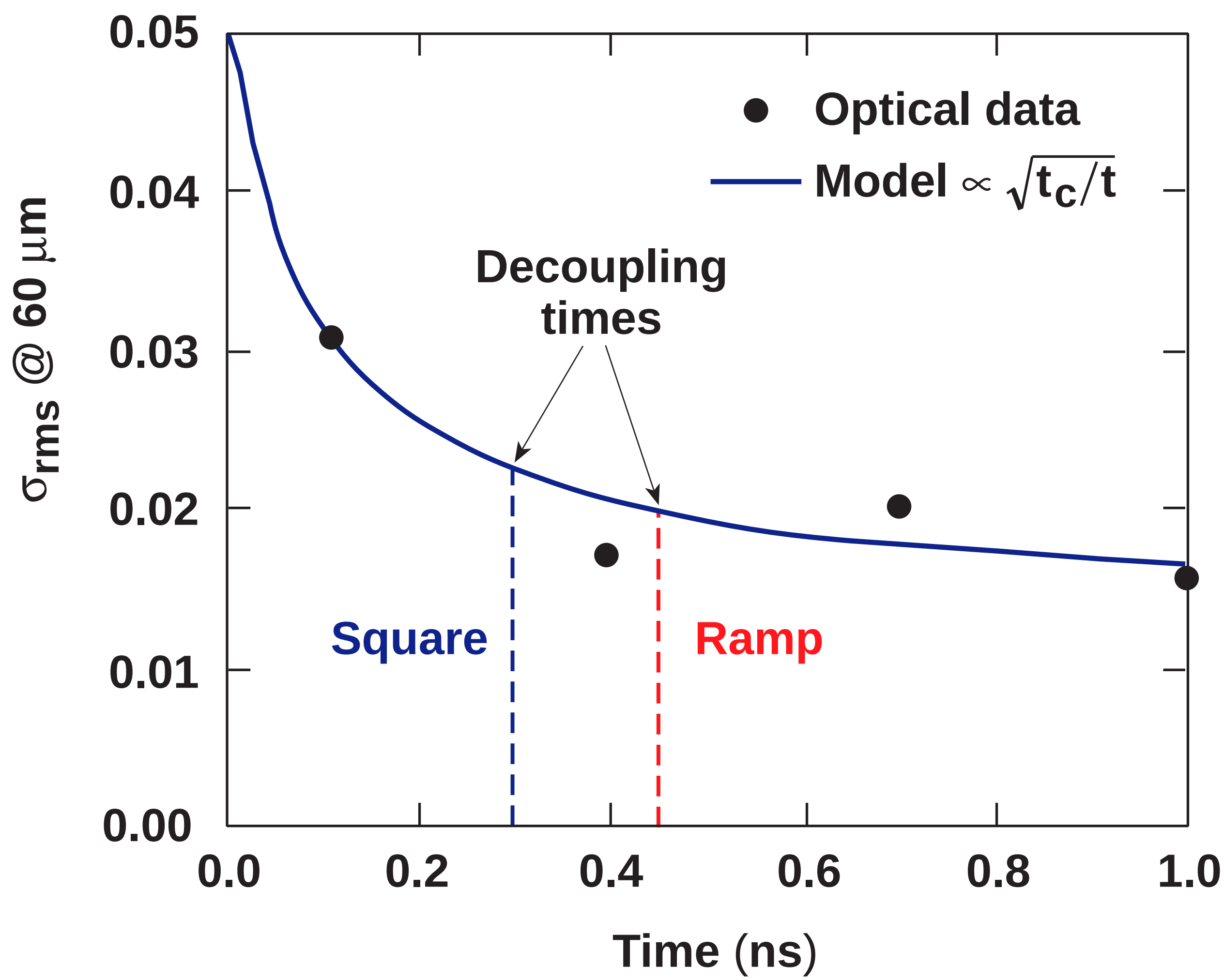
The imprint efficiency without SSD is measured at two wavelengths and compared to *ORCHID* simulations

- The calculated imprint efficiencies are similar to those measured.



E9964

Observed imprint reduction by SSD (2 to 2.5 ∞) is consistent with decoupling times and smoothing rate



E10173

Summary/Conclusions

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