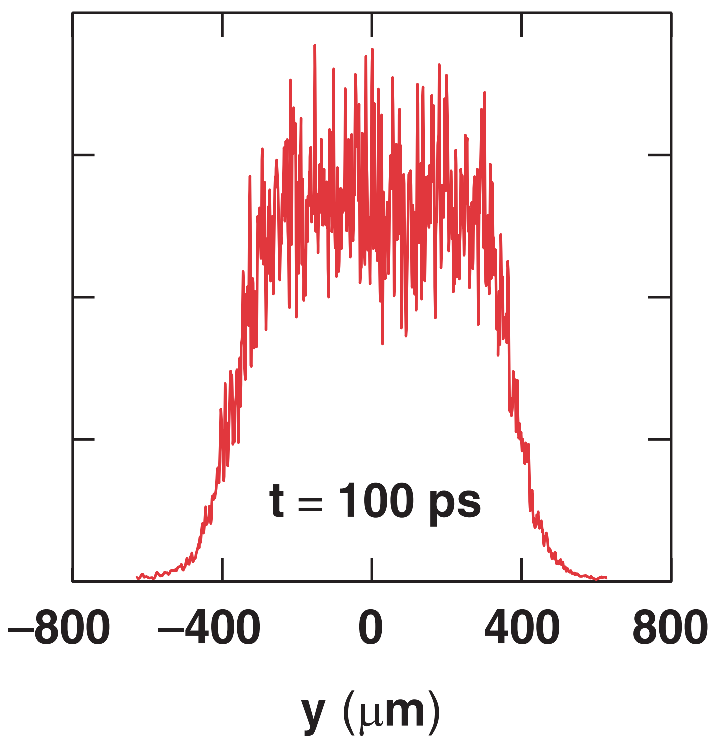
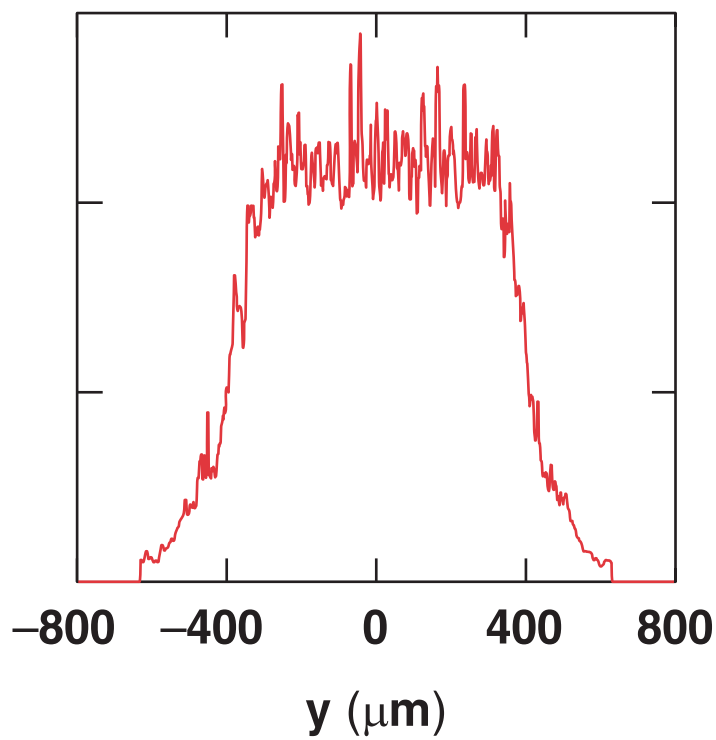
Two-Dimensional Hydrodynamic Simulations of SSD Laser Imprint

Cumulative laser flux



Target momentum



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Two-Dimensional Hydrodynamic Simulations of SSD Laser Imprint

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The two-dimensional hydrodynamics code *SAGE* has been used to model the response of CH-foil targets to realistic equivalent-target-plane (ETP) intensity distributions including smoothing by spectral dispersion (SSD). First the laser propagation code Waasikwa is used to calculate the time-dependent laser ETP distribution, including frequency conversion, for bandwidths up to 1 THz. Up to six such distributions are combined in the target plane. One-dimensional lineouts are then taken in different directions and fed into *SAGE*. The *SAGE* simulations, carried out in planar geometry, provide estimates of imprint in the form of transverse mass modulations including the effects of thermal conduction in the evolving plasma profile. While this work is limited by the inclusion of only one transverse direction, it provides qualitative comparisons between different SSD parameters. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460.

Summary

SAGE can model the imprint due to a real 1-THz laser beam in 2-D planar geometry

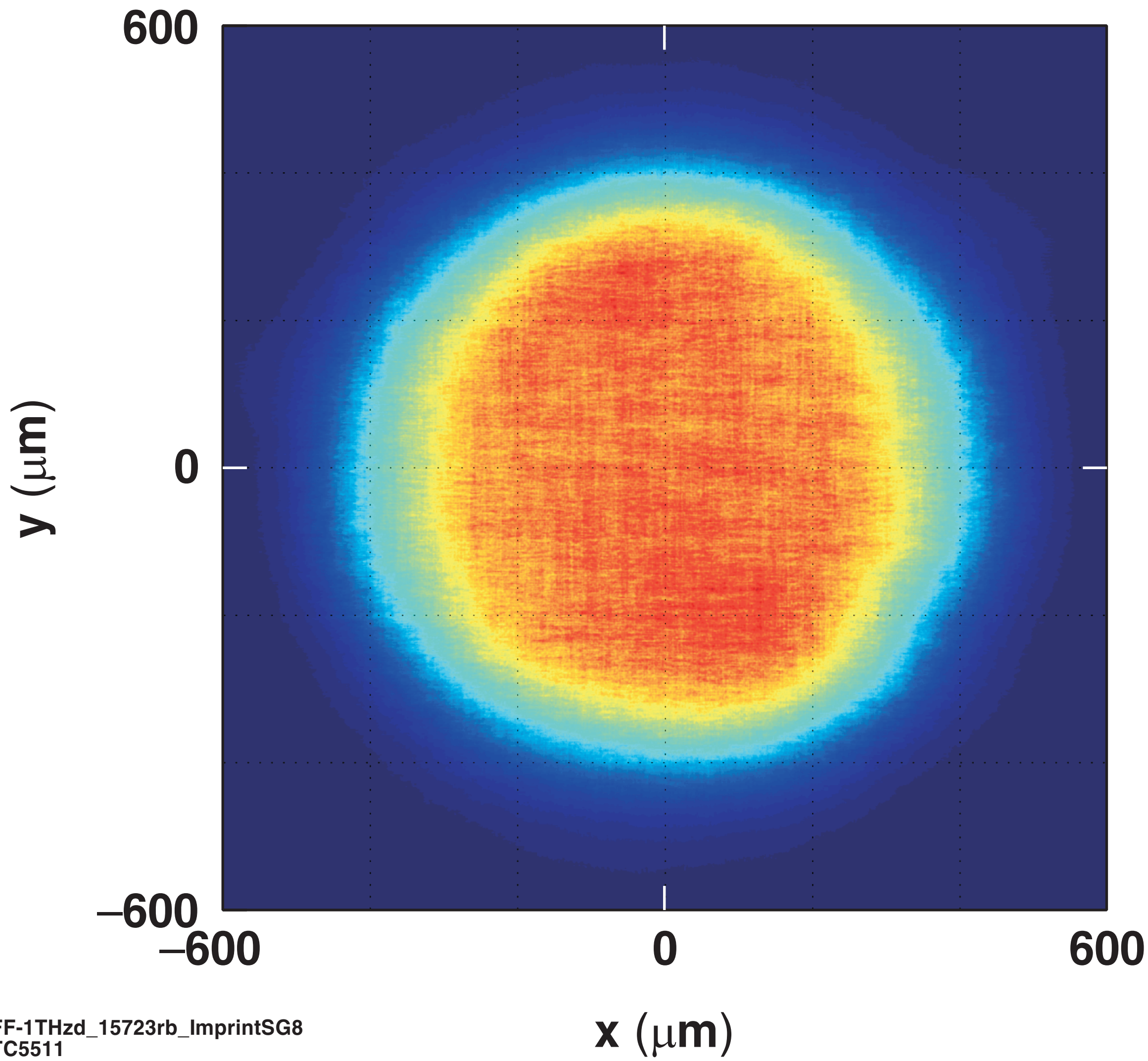
- **Laser deposition uses 1-D lineouts from 2-D far fields calculated by Waasikwa.**
- **Whole-beam effects (L ~ 1 mm) and speckle (L $\gtrsim$ 3 μm) are modeled simultaneously using > 1000 transverse zones.**
- **The evolution of imprinted momentum and mass nonuniformities shows growth in modes with wavelengths 20–50 μm.**

Outline

- Waasikwa far-field calculation for a typical OMEGA beam
  - 1-ns flat
  - “SG8” supergaussian in space
  - 520 J
- *SAGE* calculation
  - density contours
  - heat deposition region
- Evolution of nonuniformities
  - cumulative laser flux
  - momentum
  - mass

SAGE used 1-D far-field lineouts from a Waasikwa calculation for a 1-THz, 2-D SSD beam

Δx = 1.23 μm, Δt = 0.75 ps



RAINBOW

+

2-D SSD

+

Frequency conversion

+

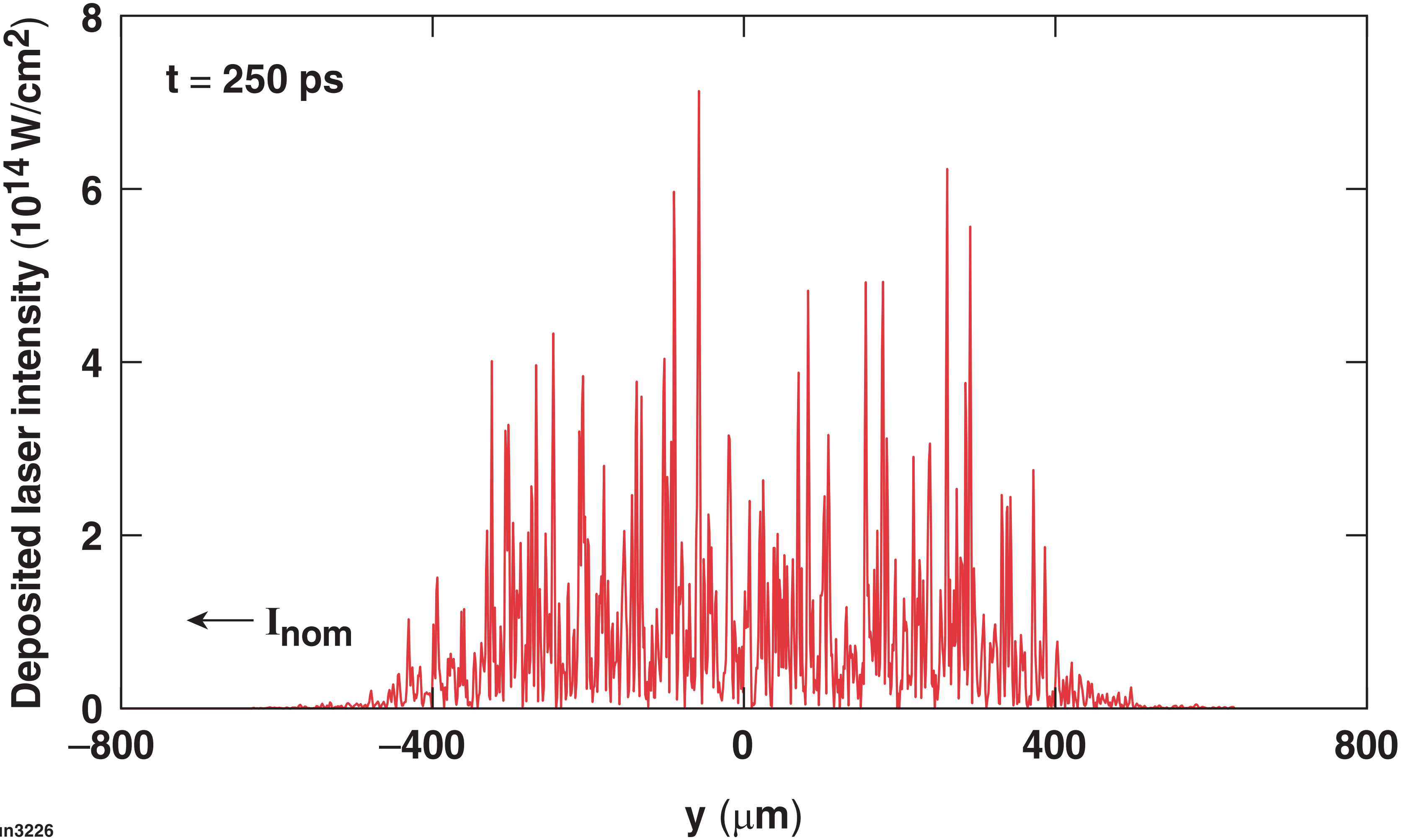
Actual phase plate

+

FFT propagation

FF-1THzd_15723rb_ImprintSG8
TC5511

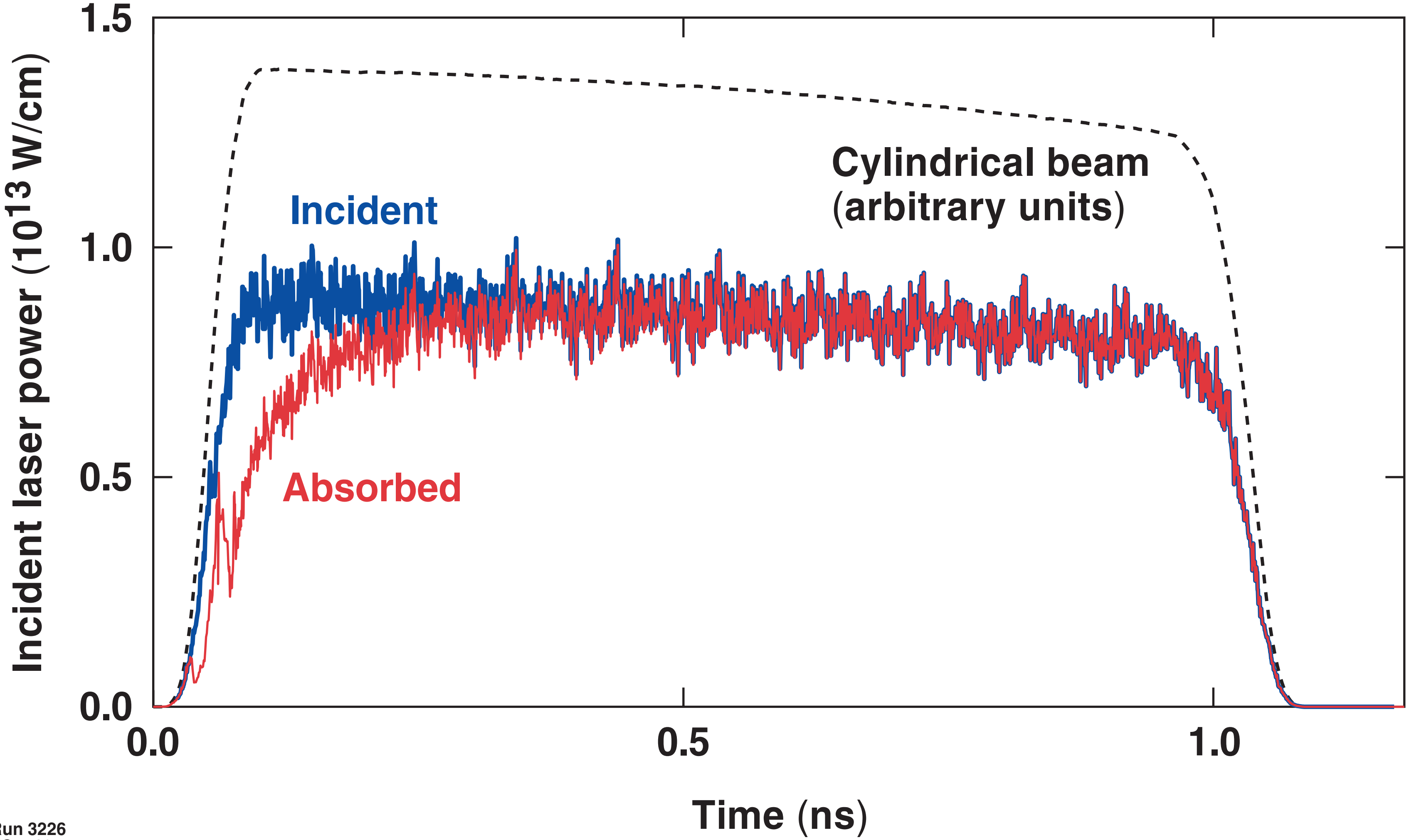
The instaneous laser intensity includes high-spatial-frequency speckle



Run3226
TC5512

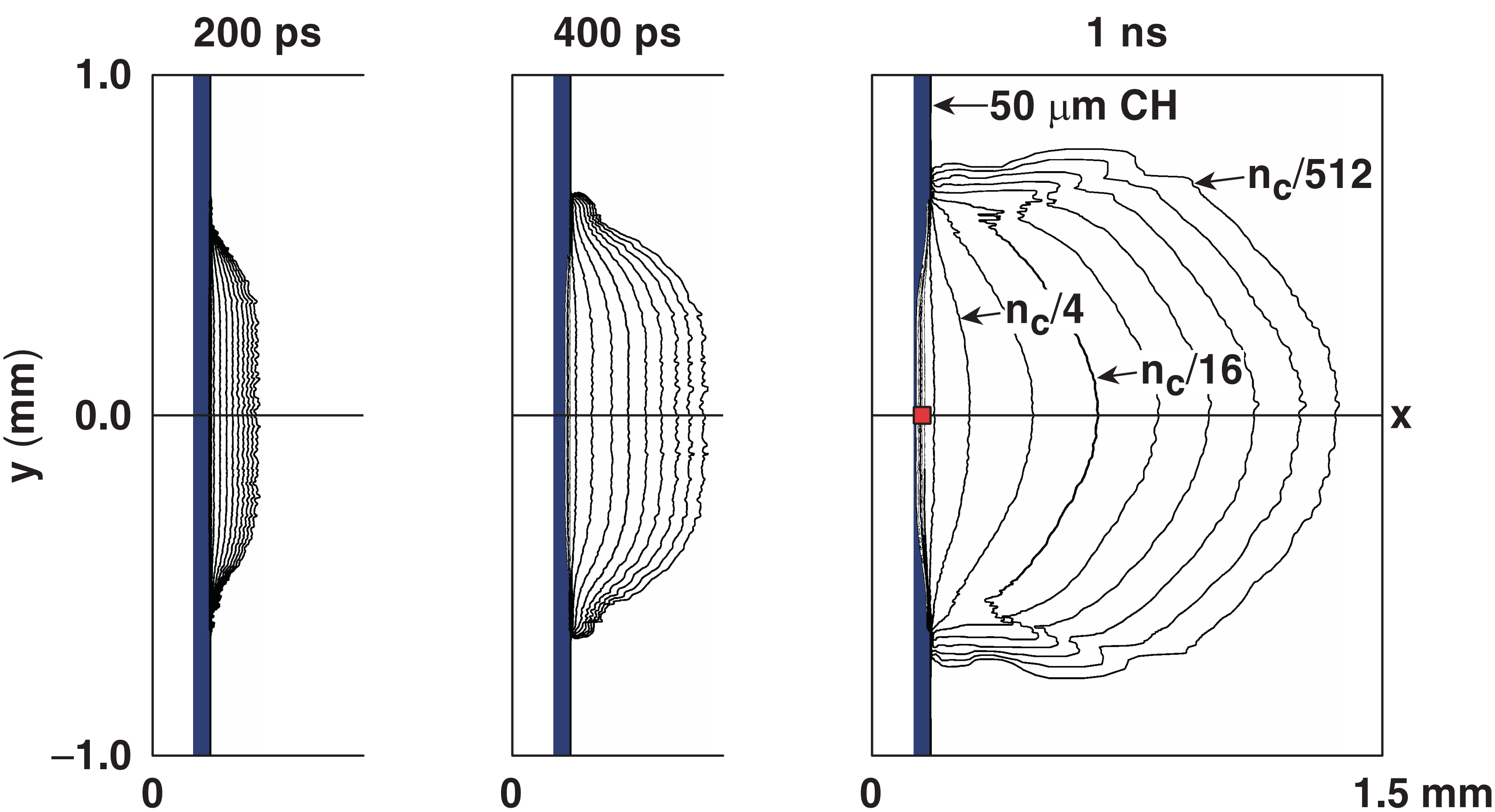
The power incident on the selected 1-D lineout fluctuates rapidly in time due to SSD speckle

UR LLE



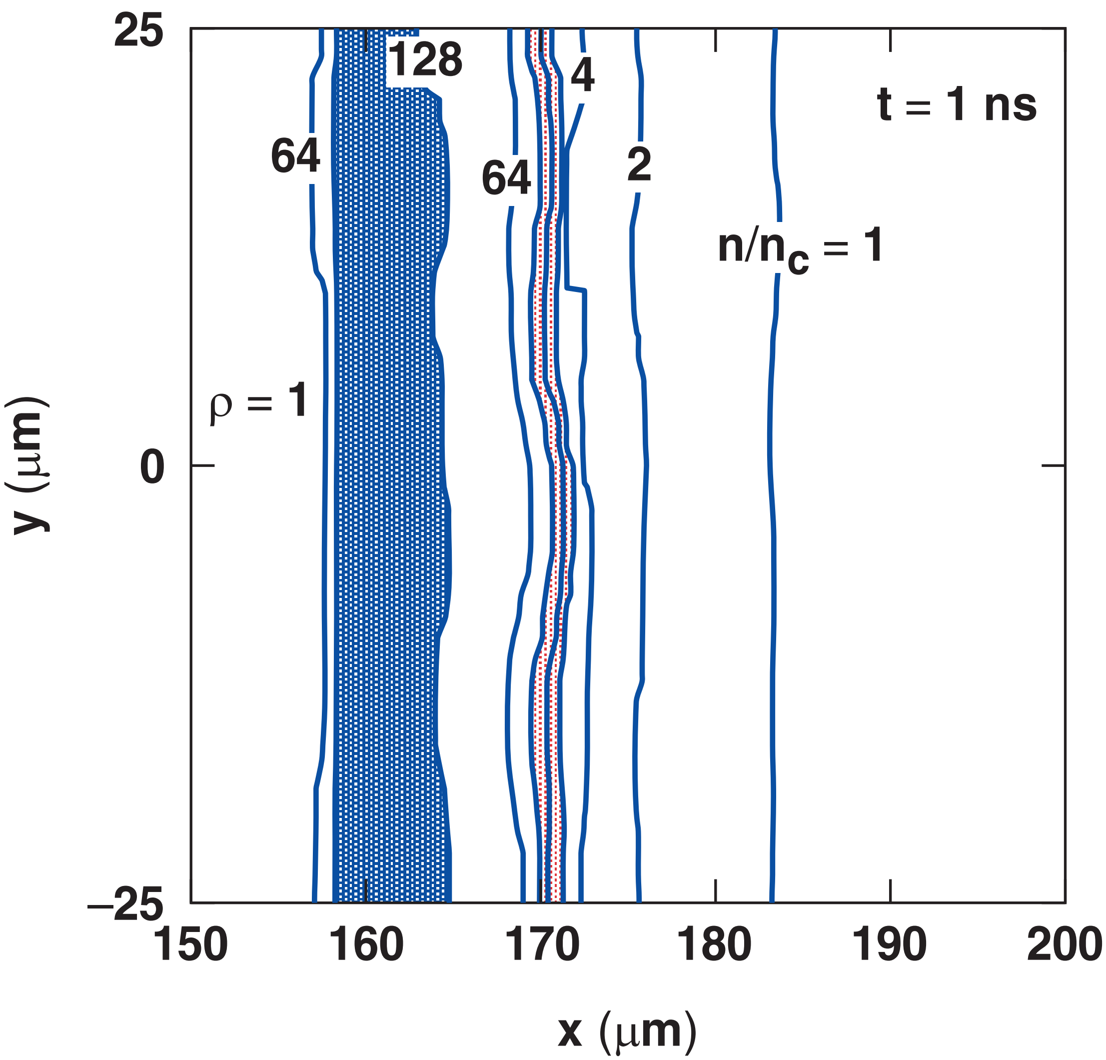
Run 3226
TC5513

The expanding plasma contours provide little indication of density nonuniformities



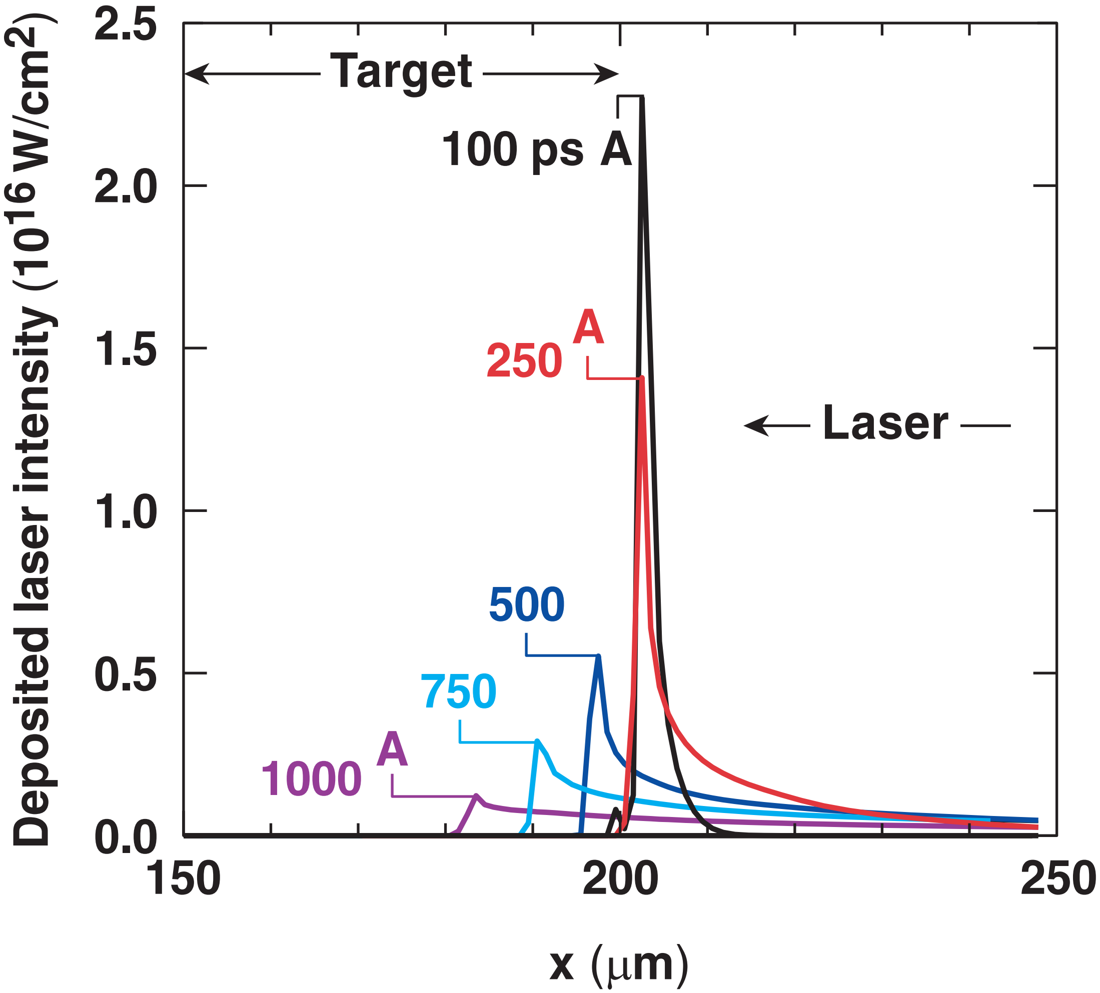
Run3226
TC5514

A blowup within the solid-density region shows evidence of perturbation wavelengths down to ~25 μm



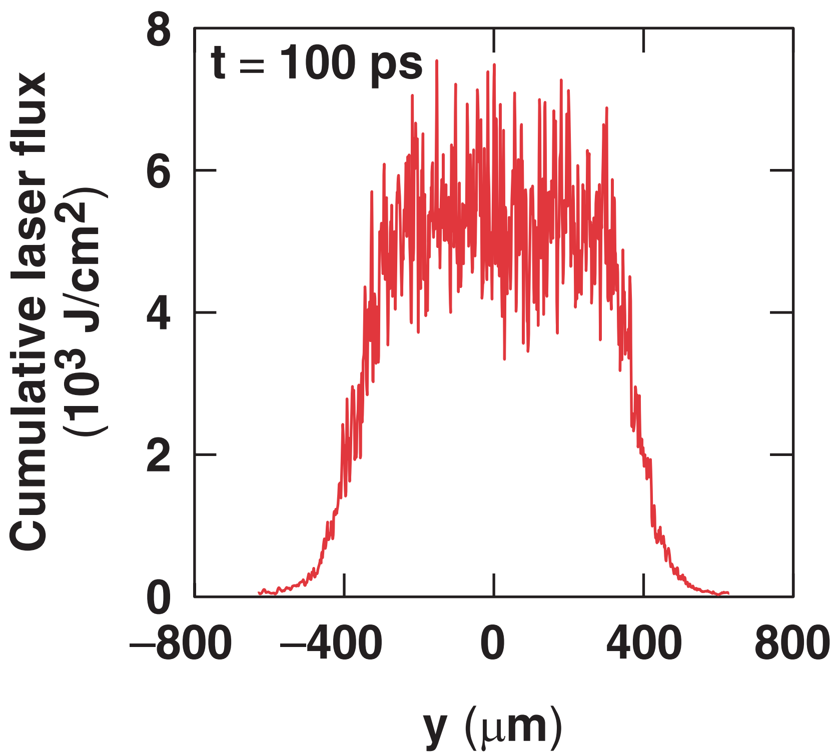
Run 3226
TC5515

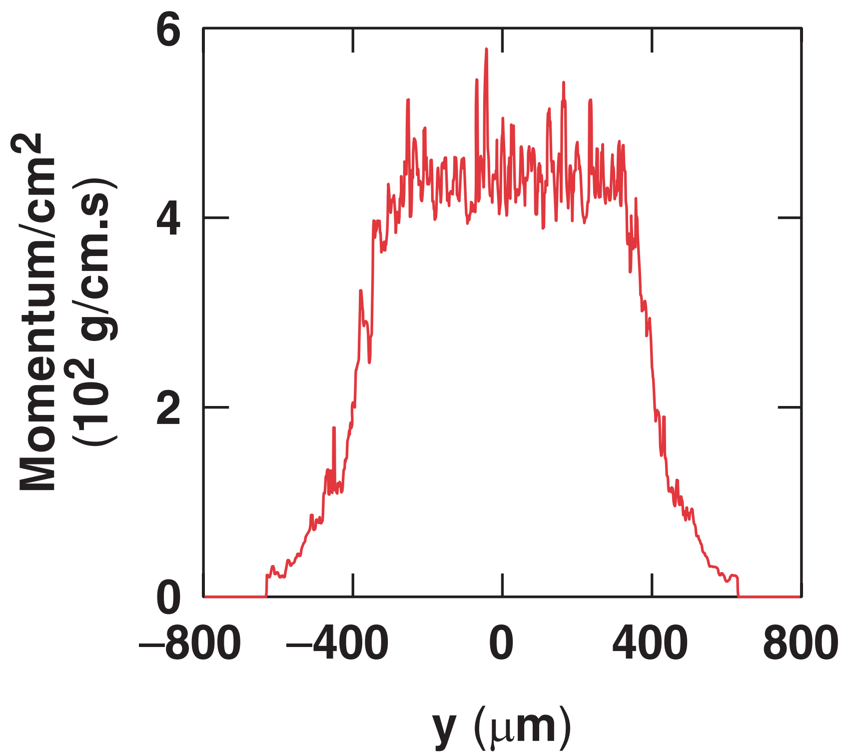
The heat deposition region is narrow at early times and close to the ablation front (A)



Run3226
TC5516

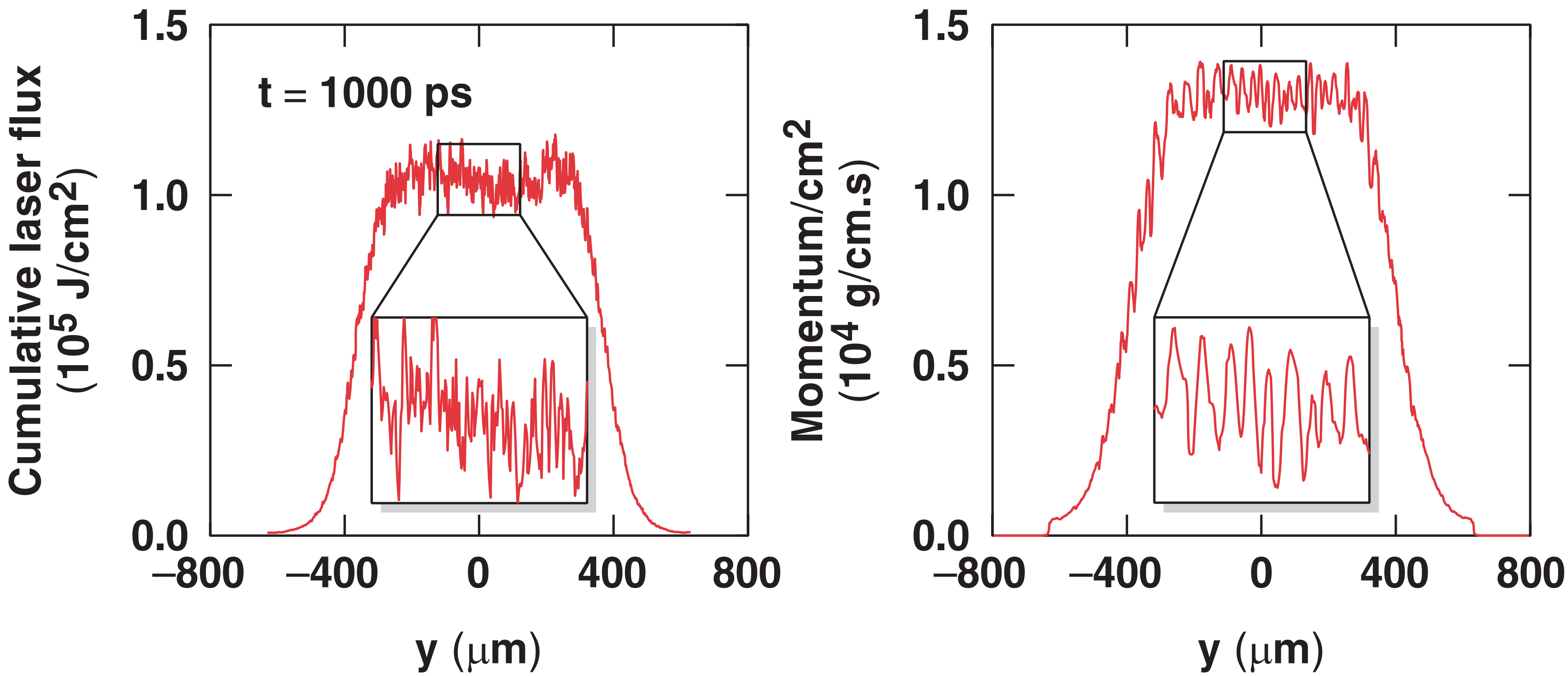
At 100 ps, the target momentum shows less short-wavelength structure than the cumulative laser energy





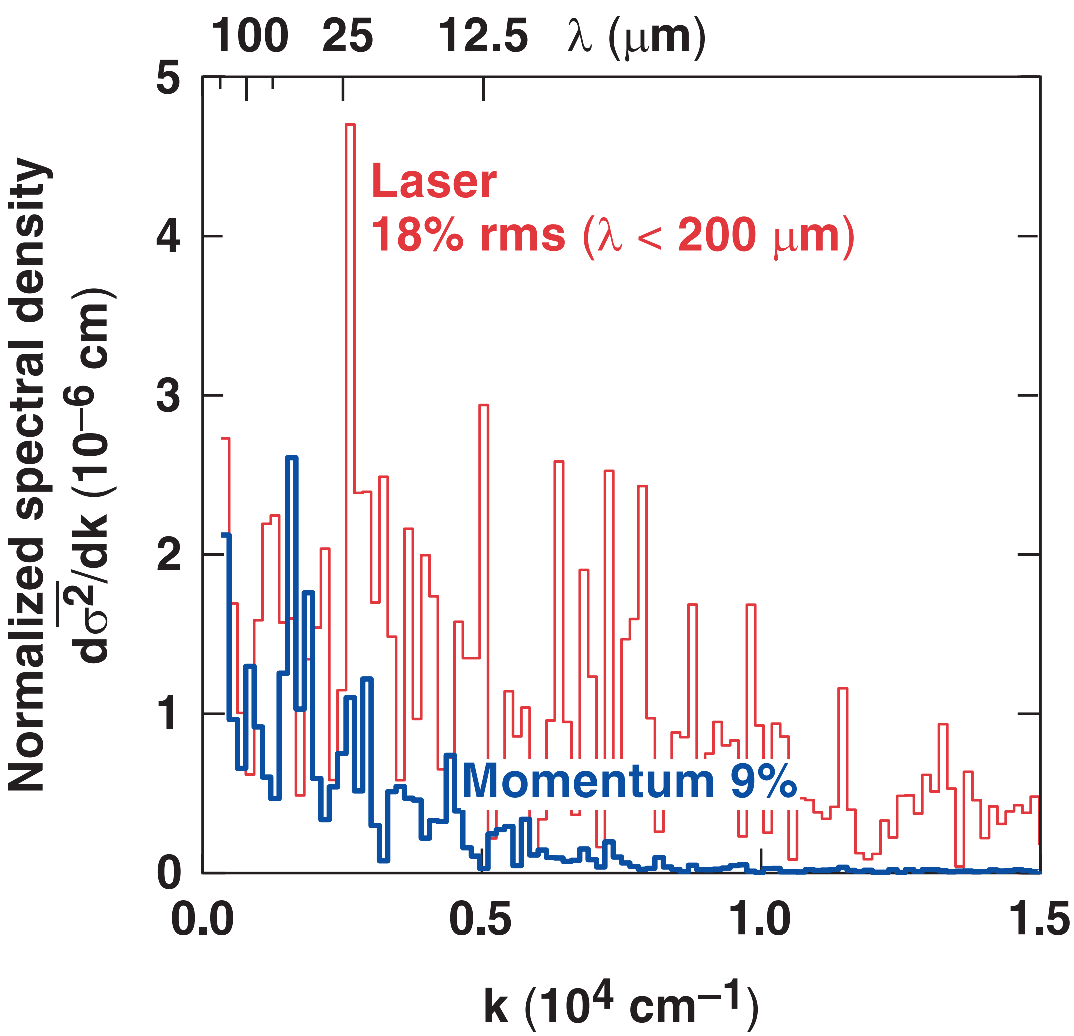
Run 3226
TC5517

At 1 ns, the target momentum shows comparable modulation amplitudes but less short-wavelength structure



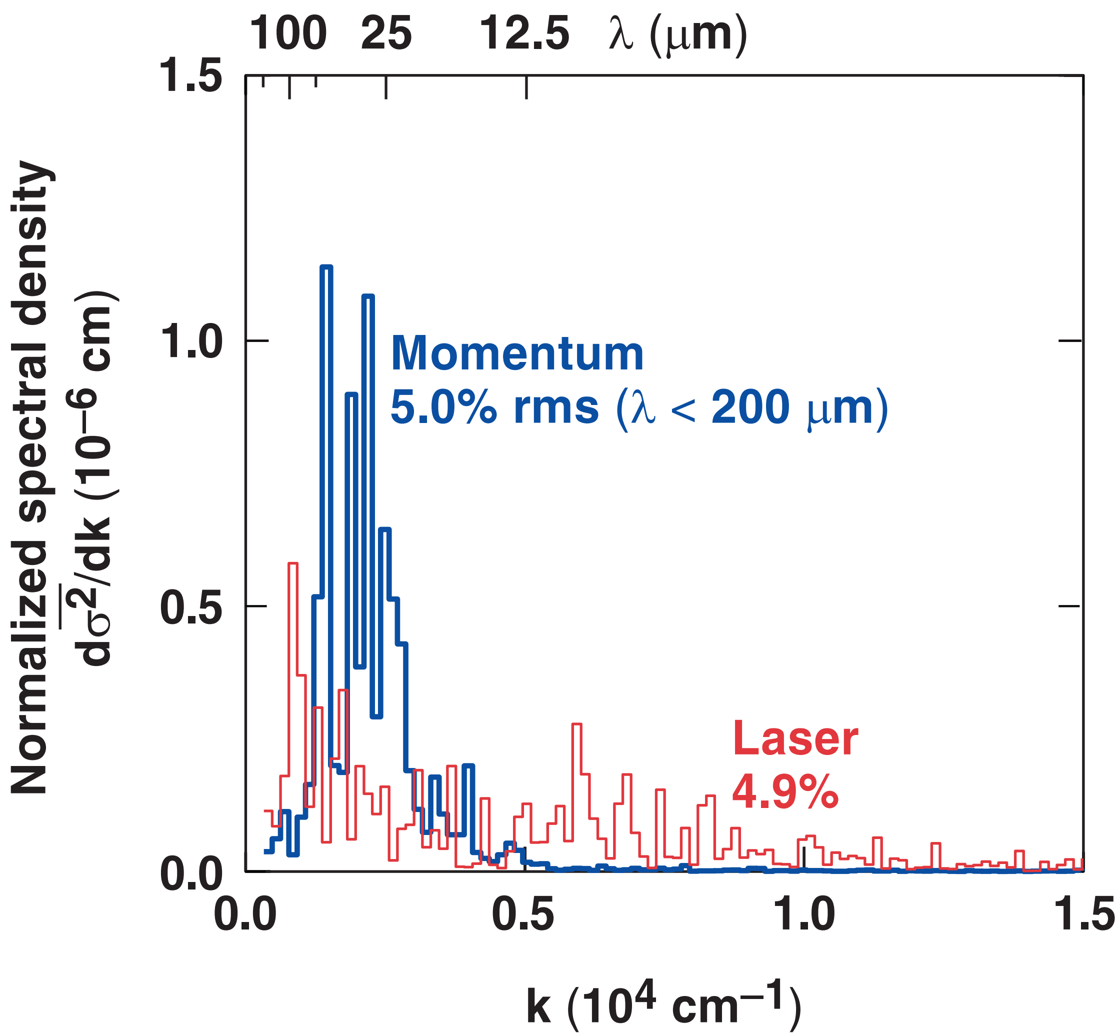
Run 3226
TC5518

At 100 ps the target response shows less σ_{rms}, especially for shorter-wavelength modes



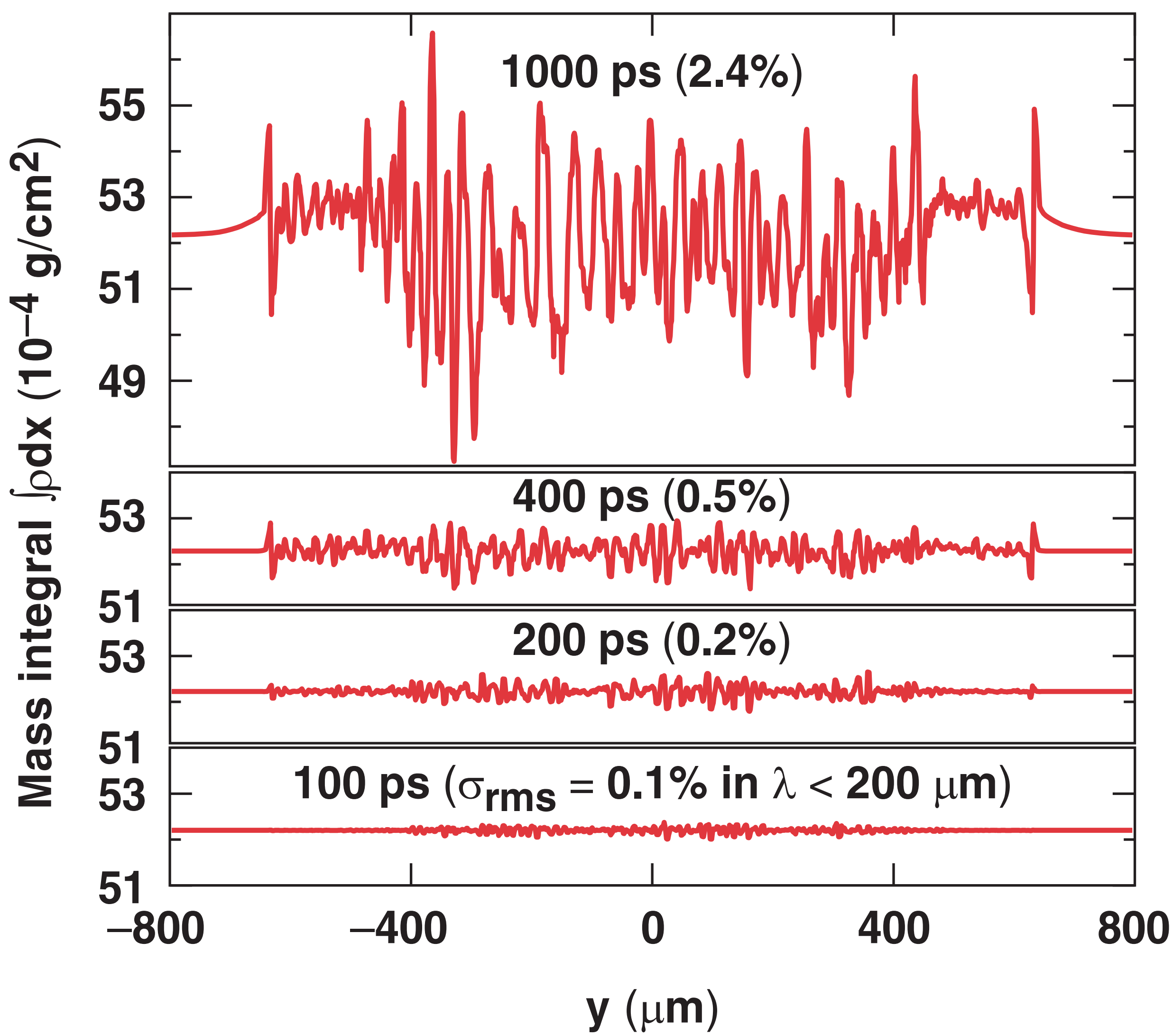
Run 3226
TC5519

At 1 ns, the imprint is dominated by 20- to 50-μm wavelengths



Run 3226
TC5520

The imprinted mass modulations grow in time



Run 3226
TC5521

Summary/Conclusions

SAGE can model the imprint due to a real 1-THz laser beam in 2-D planar geometry

UR LLE

- Laser deposition uses 1-D lineouts from 2-D far fields calculated by Waasikwa.
- Whole-beam effects ($L \sim 1$ mm) and speckle ($L \gtrsim 3\ \mu$m) are modeled simultaneously using > 1000 transverse zones.
- The evolution of imprinted momentum and mass nonuniformities shows growth in modes with wavelengths 20–50 μm.

The model is applicable to a variety of problems.

TC5509a