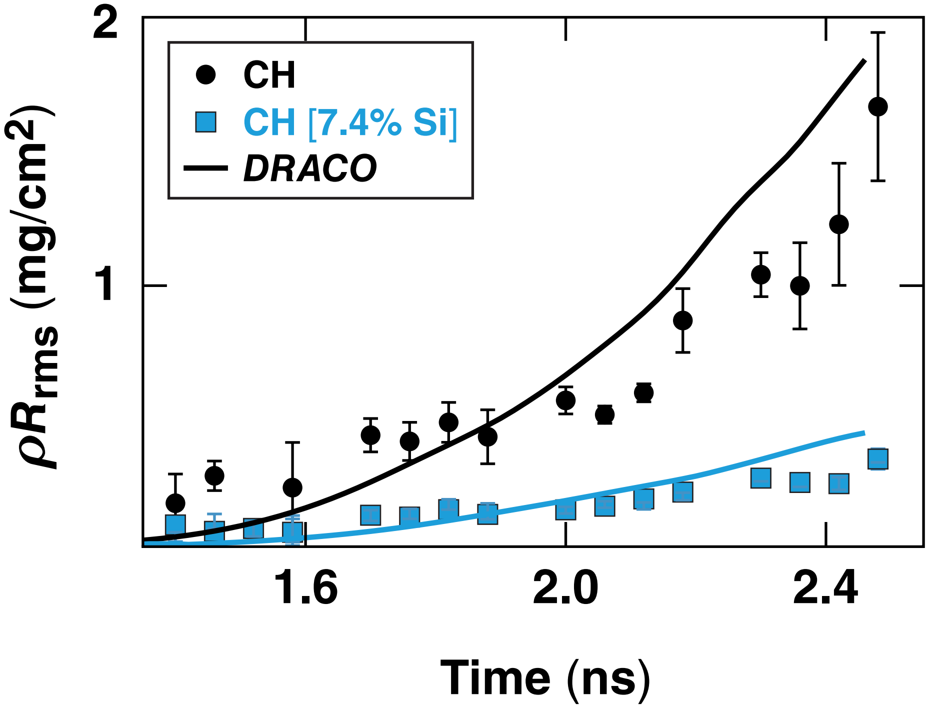
Experimental Reduction of Laser Imprinting and Rayleigh–Taylor Growth in Spherically Compressed, Medium-*Z*–Doped Plastic Targets



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Summary

Target doping reduces laser imprint and Rayleigh–Taylor (RT) growth rate

- Mitigation of laser imprinting and RT instability by doping was studied using spherical implosions
- The stabilizing effect is strong, with a reduction of
  - laser imprint by factor of ~3
  - instability growth rate by a factor of ~1.5
  - final density modulation by a factor of 4 to 5
- Simulations using the 2-D code *DRACO* show good agreement with the measurements

Collaborators

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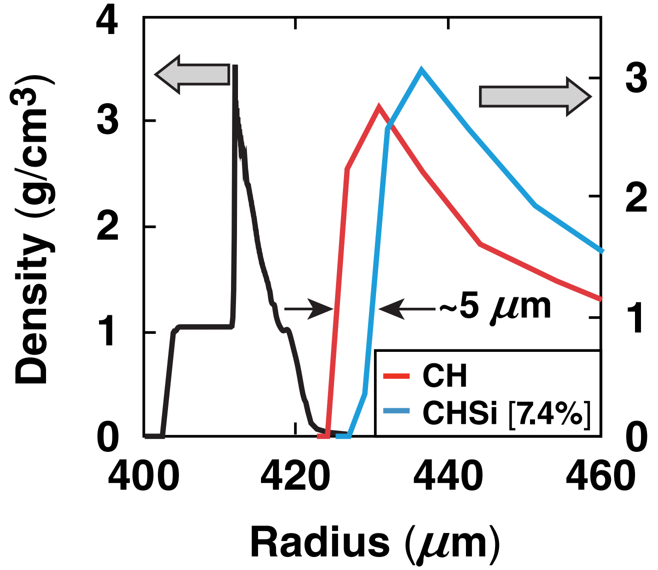
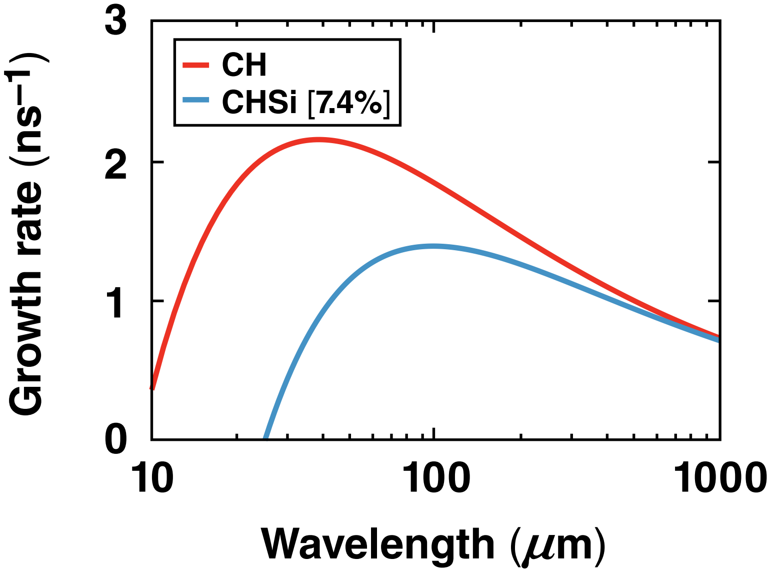
Simulations indicate that medium-*Z* doping can reduce the laser imprint and the growth rate of RT instability*

- Using a high-*Z* thin layer to improve hydro stability was investigated elsewhere*
- *DRACO* simulations indicate that the imprint is reduced by increasing the standoff distance between the ablation surface and the laser-deposition regions**
- The growth rate is reduced by an increase in ablation velocity caused by radiation preheat

DRACO





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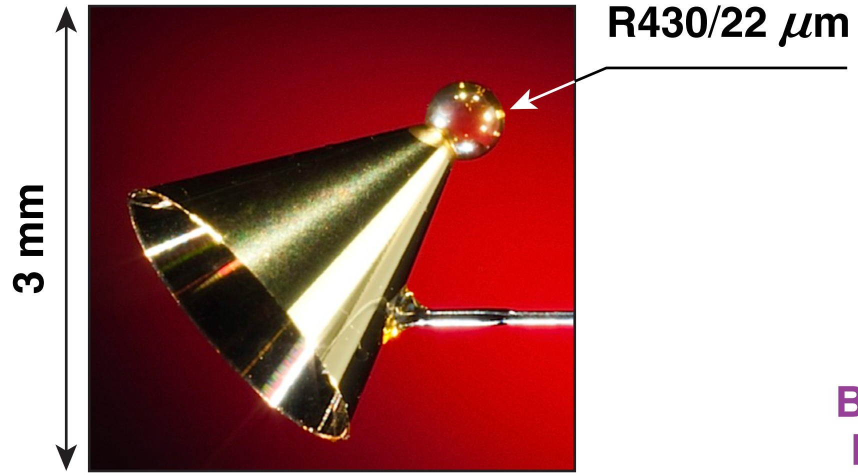
*S. P. Obenschain *et al.*, Phys. Plasmas 9, 2234 (2002).

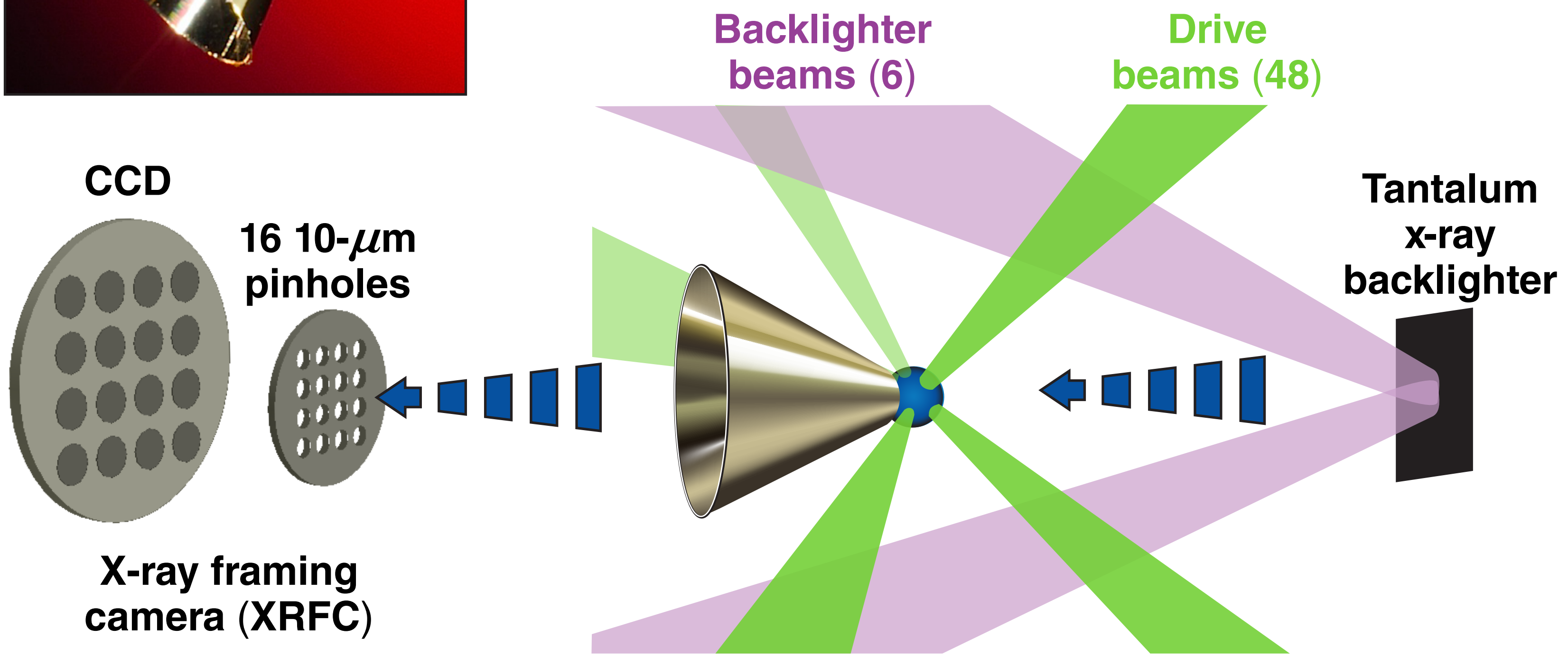
**S. X. Hu *et al.*, Phys. Rev. Lett. 108, 195003 (2012).

Experimental setup

A spherical CH target is compressed by 48 beams and backlit with x rays from a Ta backlighter

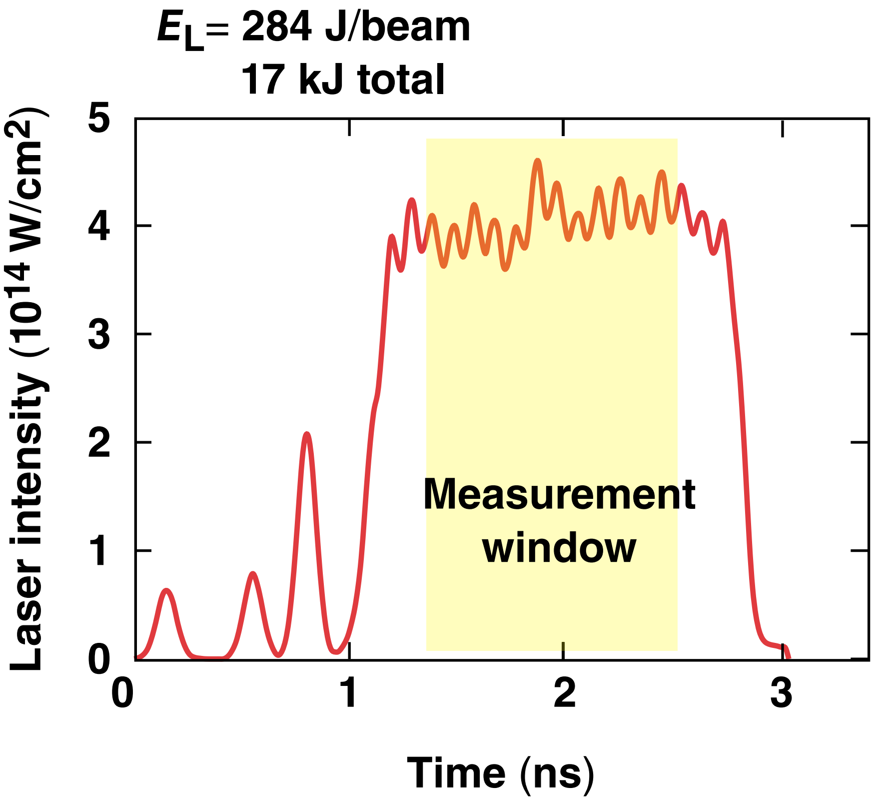


Some of CH shells were doped with Si (4.3% and 7.4%) and Ge (3.9%)

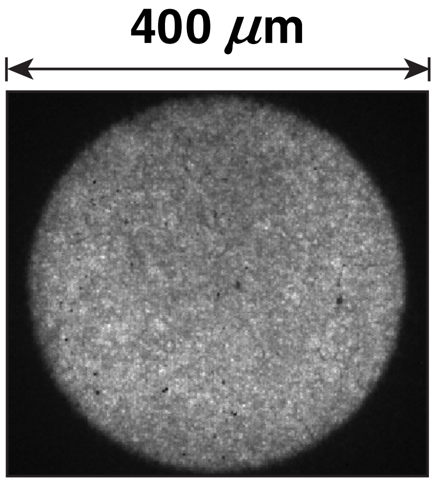


The spherical shells were compressed with a low-adiabat, triple-picket laser pulse

- Beam smoothing by spectral dispersion (SSD) was turned off to provide the initial imprint
- Measurements were made during the time interval from 1.4 to 2.5 ns



The x-ray transmission was measured with a CCD x-ray framing camera to yield an areal density ρR



$$I = I_{BL}\exp(-\overline{\mu}\rho R) \Rightarrow \overline{\mu}\rho R = \ln I / I_{BL}$$

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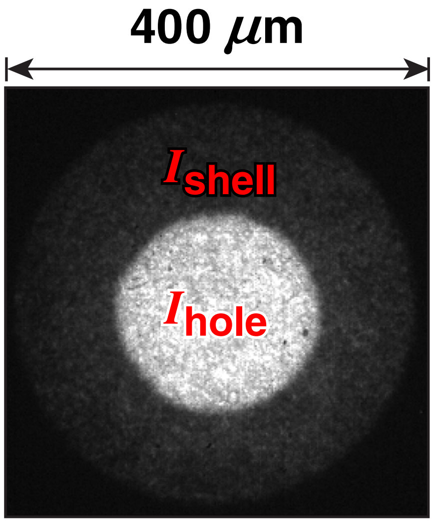
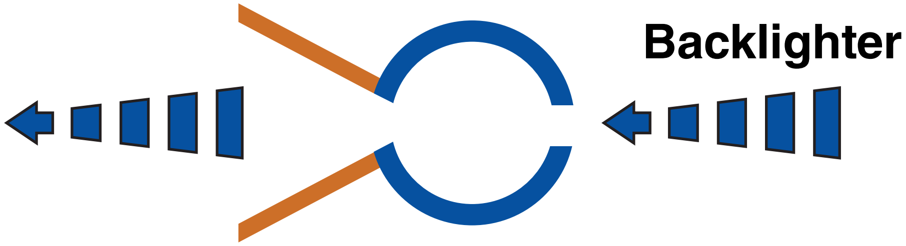
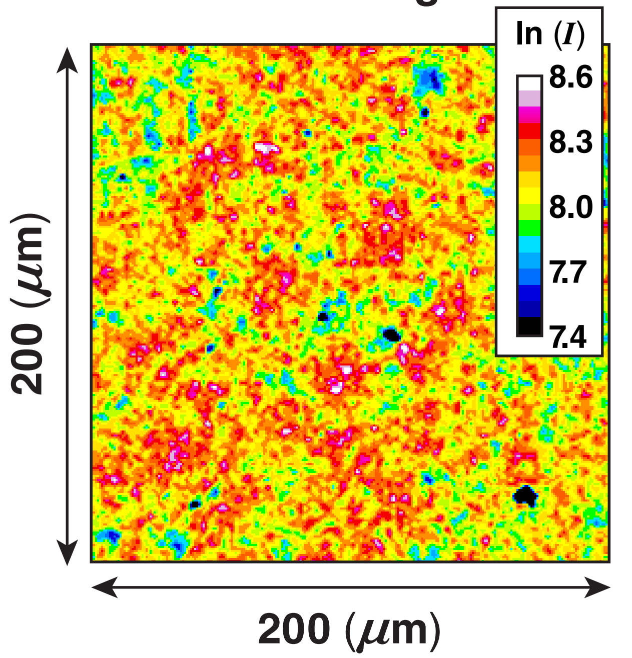
An undriven shell target with a 200-μm hole was used for *in-situ* measurement of the absorption coefficient

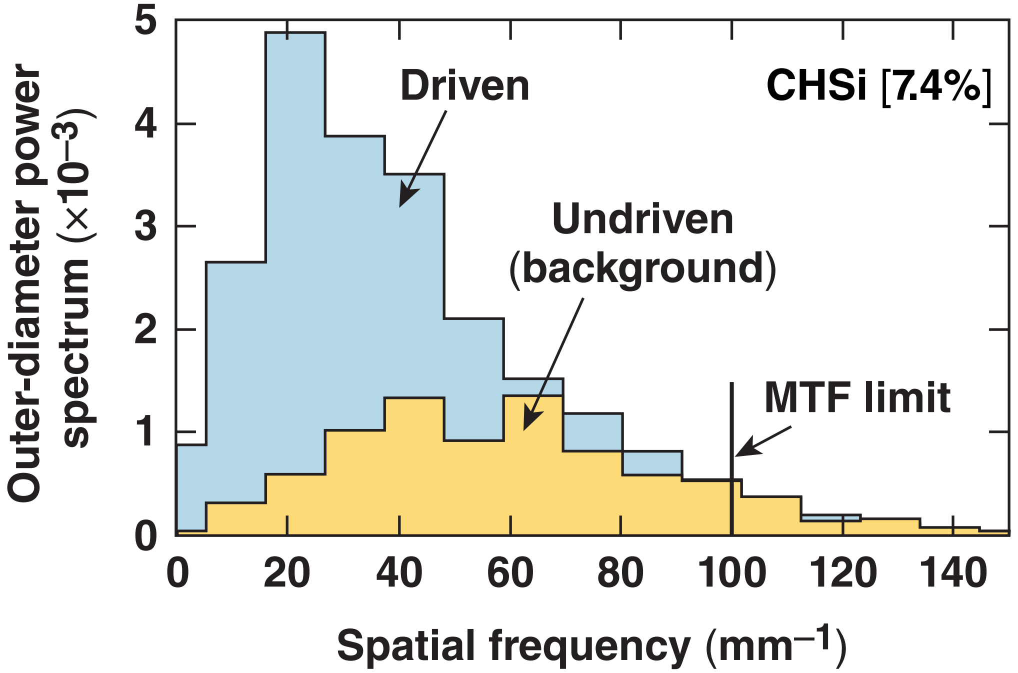




$$\overline{\mu} = \frac{1}{\rho R} \ln \frac{I_{\text{hole}}}{I_{\text{shell}}}$$

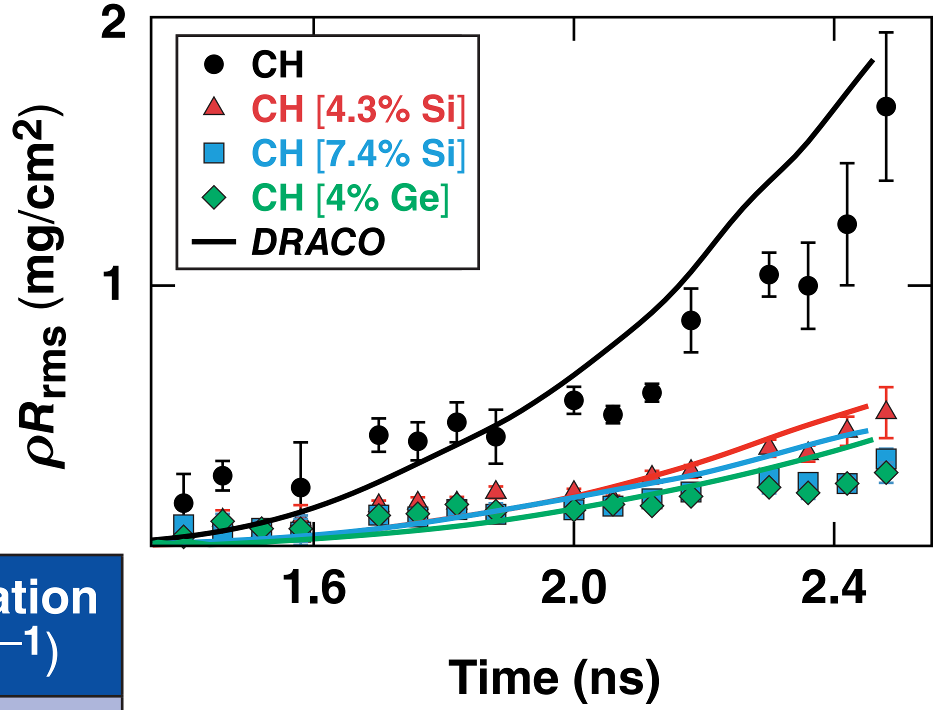
Results from the hole-in-shell targets allow for separation of the background from the actual shell-density modulation


CCD image


Processed signal

Doping reduces the shell areal-density modulation and RT growth rate*

- Impurity doping reduces
  - laser imprint by factor of ~3
  - instability growth rate by a factor of ~1.5
  - final density modulation by a factor of 4 to 5



Target	Experiment γ(ns^{-1})	Simulation γ(ns^{-1})
CH	1.49±0.07	1.51
CHSi [4.3%]	1.24±0.07	1.24
CHSi [7.4%]	1.06±0.06	1.06
CHGe [4%]	0.89±0.07	1.08

Both the initial imprint and growth rate are reduced in agreement with simulations.

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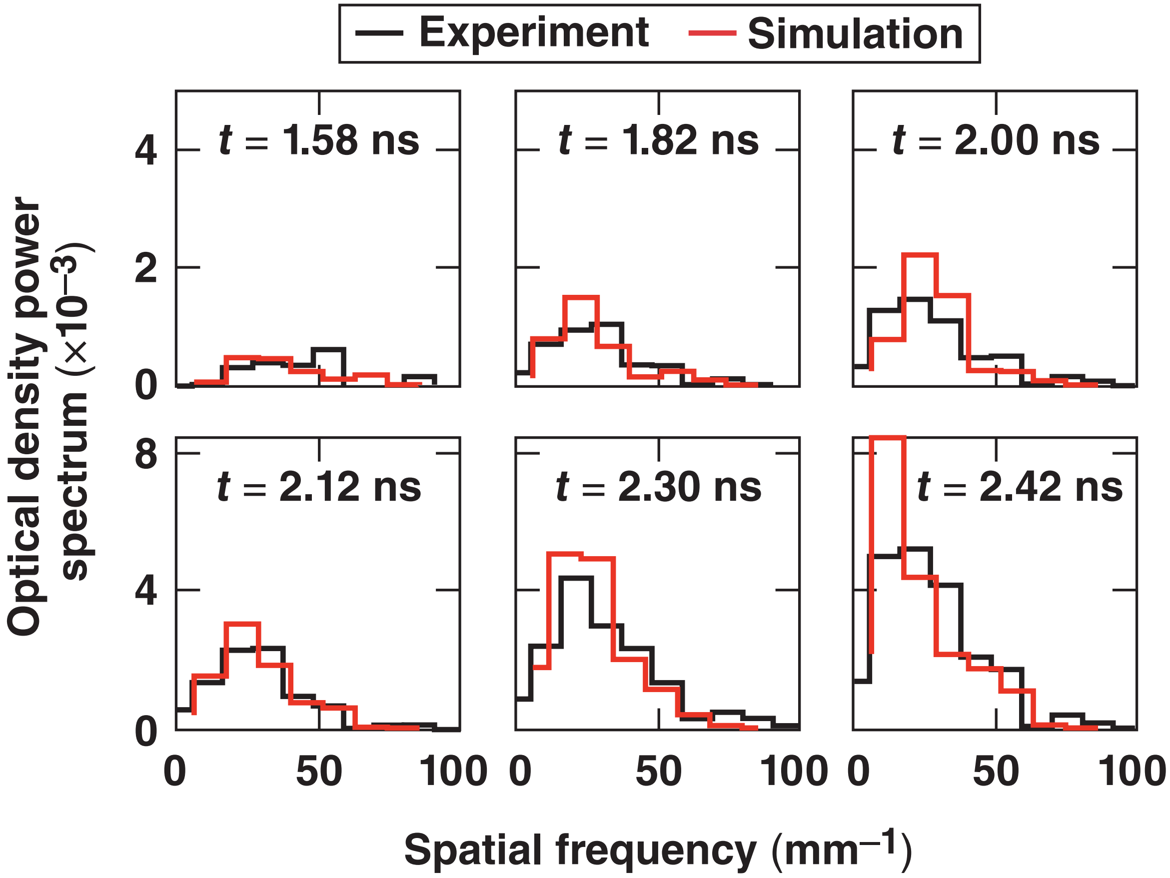
*G. Fiksel *et al*., Phys. Plasmas 19, 062704 (2012).

During compression the spectral power shifts from short to long wavelengths,* similar to what was observed for planar targets**



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*G. Fiksel *et al*., Phys. Plasmas 19, 062704 (2012).

** V. A. Smalyuk *et al*., Phys. Rev. Lett. 81, 5342 (1998); 95, 215001 (2005).

Summary/Conclusions

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