Results of Two-Dimensional Simulations of Implosions of D_2-Filled-CH Shell Targets on the OMEGA Laser

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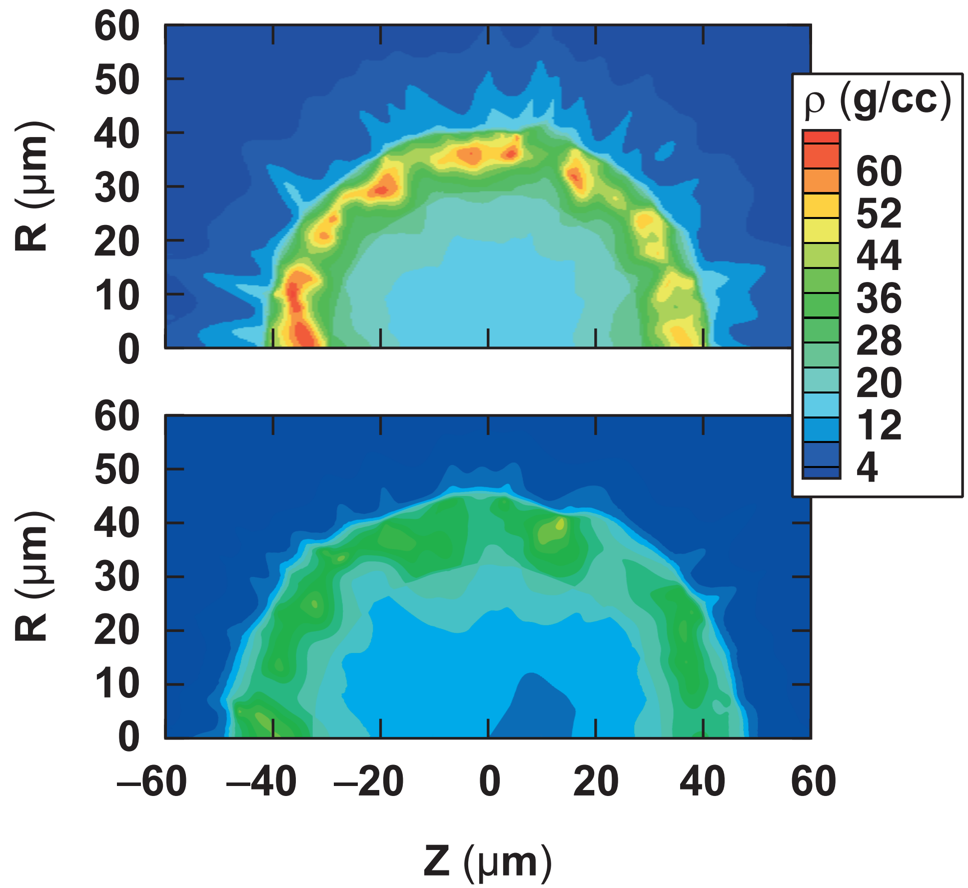
Beam nonuniformity

$\rho\Delta R$ = 132±13 mg/cm^2

Beam nonuniformity and power balance

ρR = 100±9 mg/cm^2



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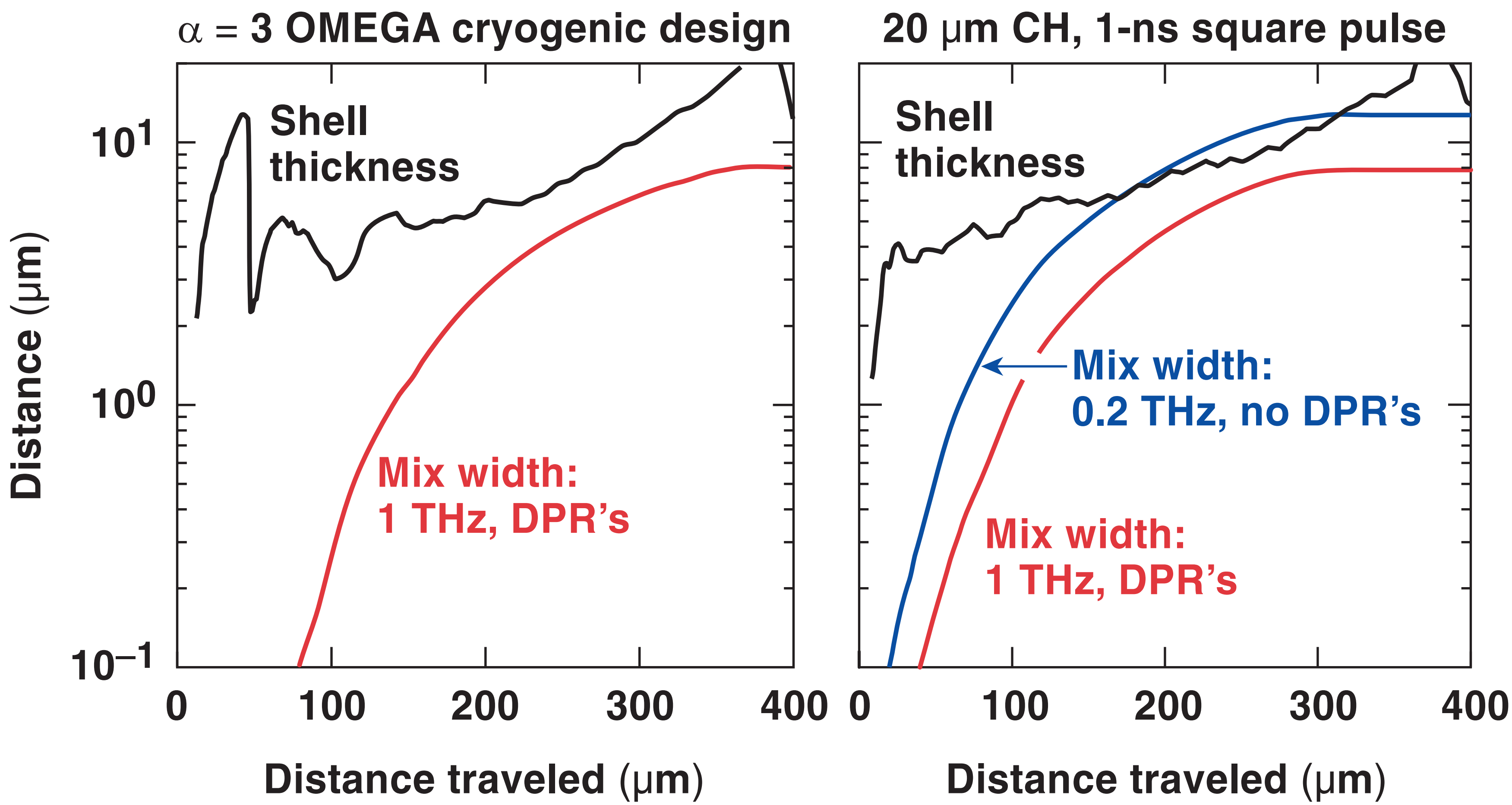
Outline

- Simulation model
- Conditions during acceleration and before stagnation
- Conditions at stagnation
- Results and comparisons
- Conclusions

The purpose of this work is to study the effect of single-beam nonuniformity and power imbalance on target performance

- Generic CH shell of 20-μm thickness and a 450-μm radius, filled with 3 atm D_2.
- 1-ns square pulse with 0.2 THz SSD.
- Initial simulations were carried out with the 2-D hydrodynamic code *ORCHID* to identify trends:
  - 600 transverse zones; full sphere with cosine modes 1–200 with random 0/π phase
  - no material tracking
  - no surface finish

20-μm-thick plastic shells driven by 1-ns square pulses show similar stability to the OMEGA α = 3 cryo design



The mix width is calculated using an instability model with Takabe growth rates and Haan saturation.

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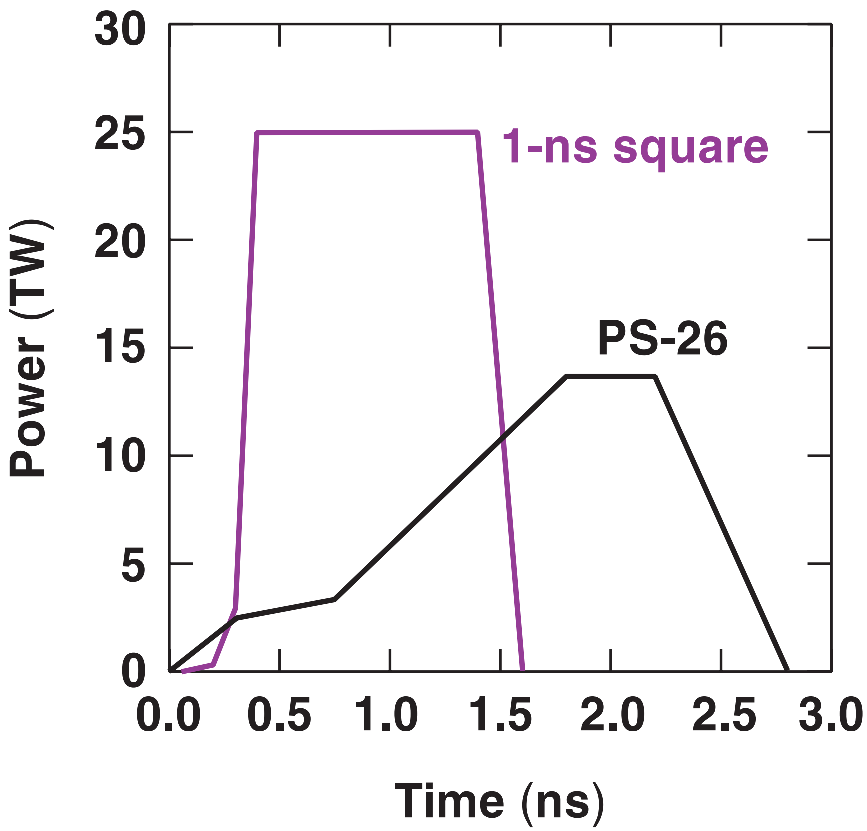
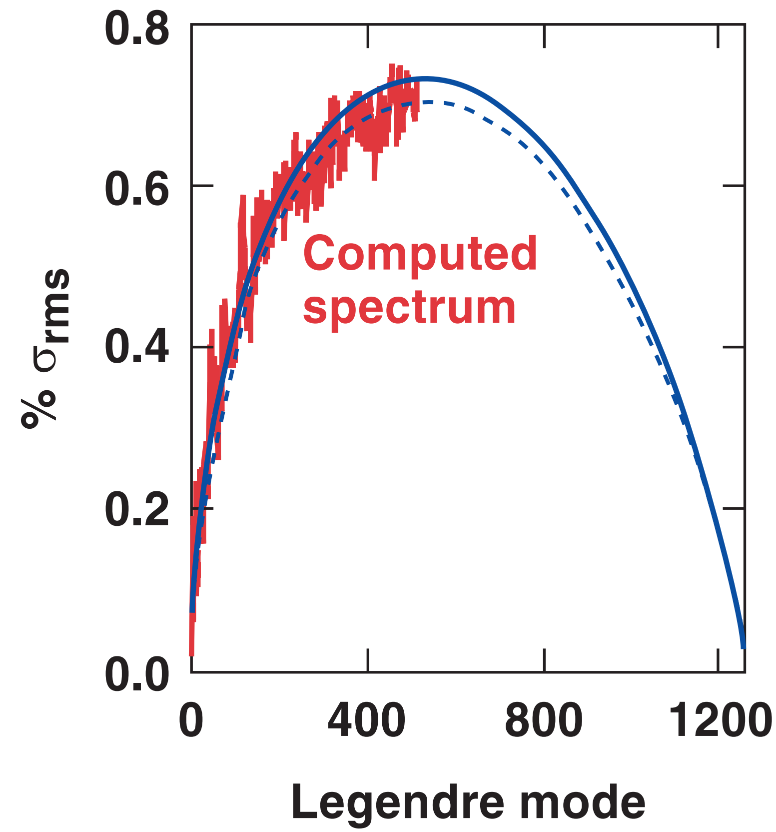
The targets are irradiated with two pulses with DPP spectrum*





SSD is modeled by flipping the phase of each mode from 0 to π every coherence time t = $1/[\Delta\nu \sin(0.5\ k\delta)]$, where $\Delta\nu$ = 0.2 THz and δ = 2 μm.

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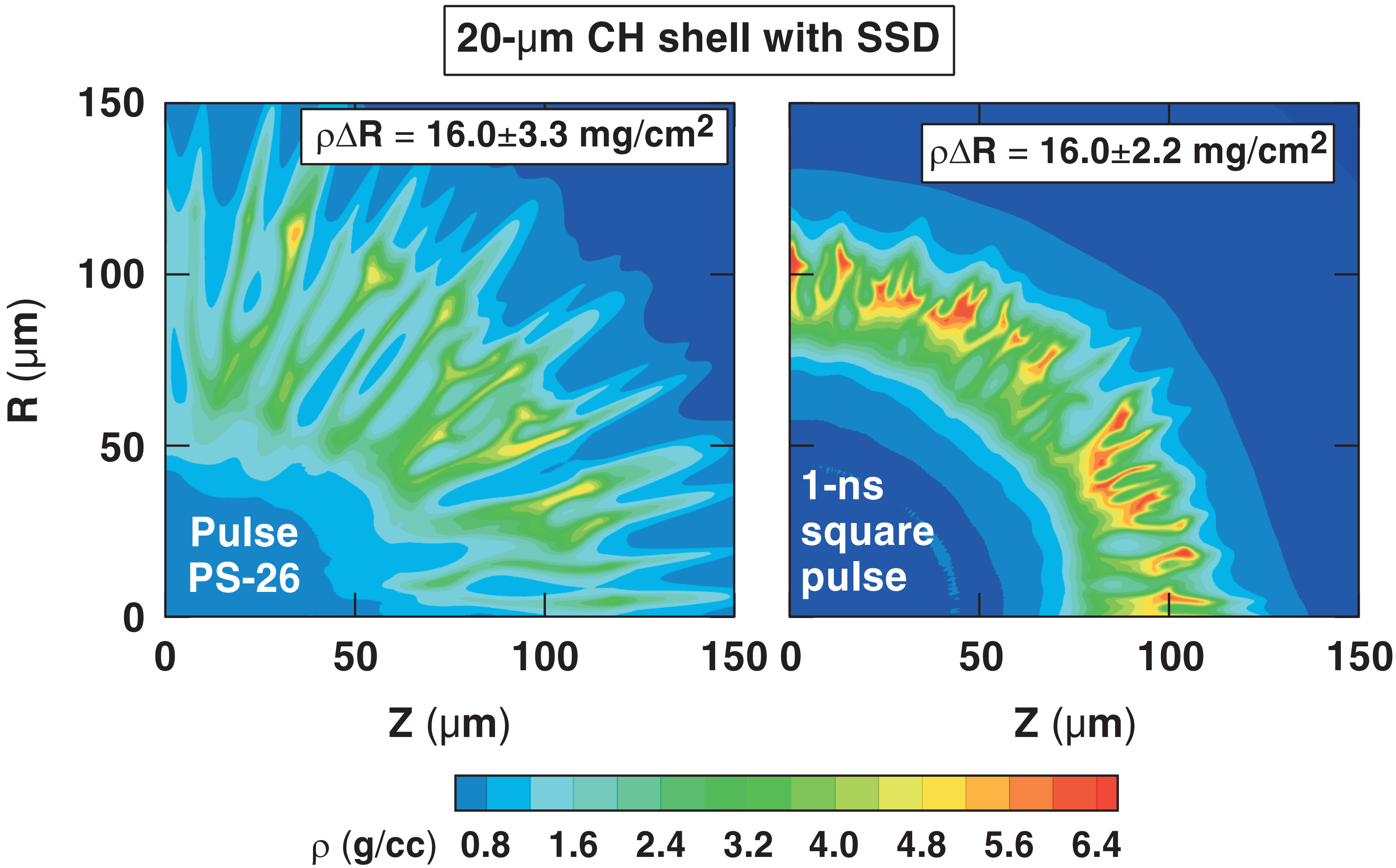
*R. Epstein, J. Appl. Phys. 82, 2123 (1997).

For both pulse shapes, the target is far into the non-linear regime near the end of the acceleration phase



The shaped pulse perturbs the target more than the 1-ns square pulse because it creates a larger imprint (Boehly, C02.01).

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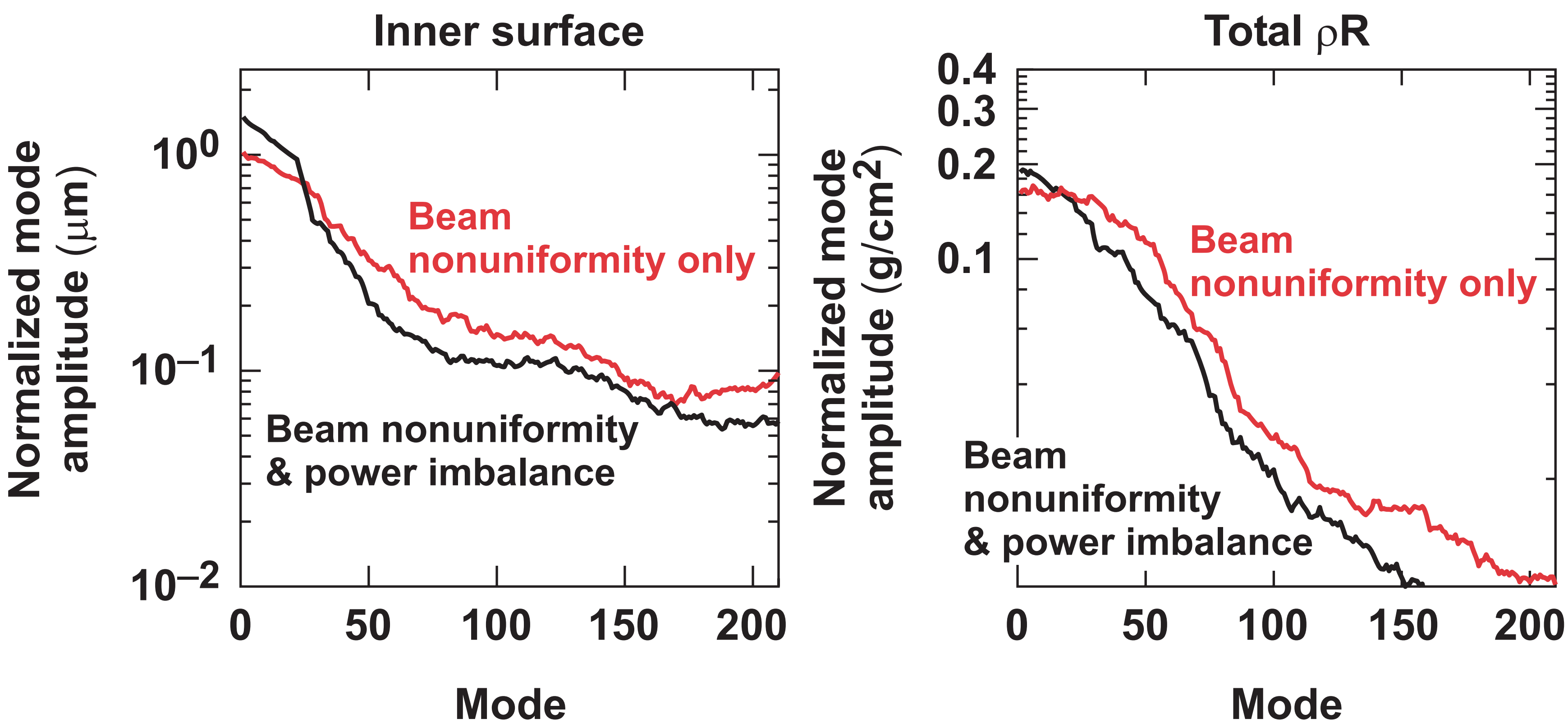
At the end of acceleration, power imbalance introduces larger lower modes, but reduces slightly the high-order modes



1-ns square pulse with 0.2-THz SSD; 20-μm CH shell with 3-atm-D_2 fill

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At stagnation the shell is made up of fairly dense “blobs” with no spikes or mixing

Density contours for a 20-μm shell with SSD

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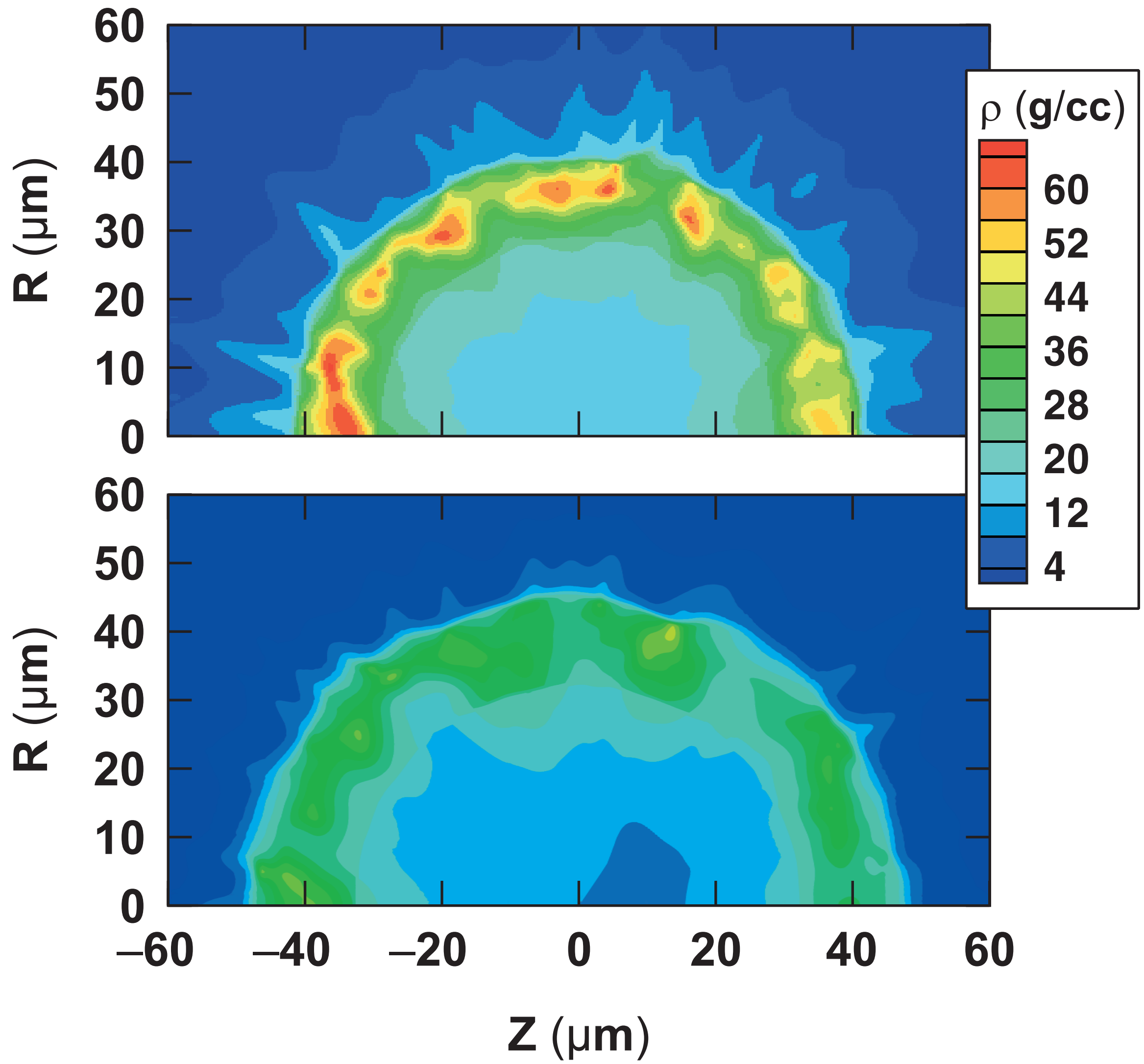

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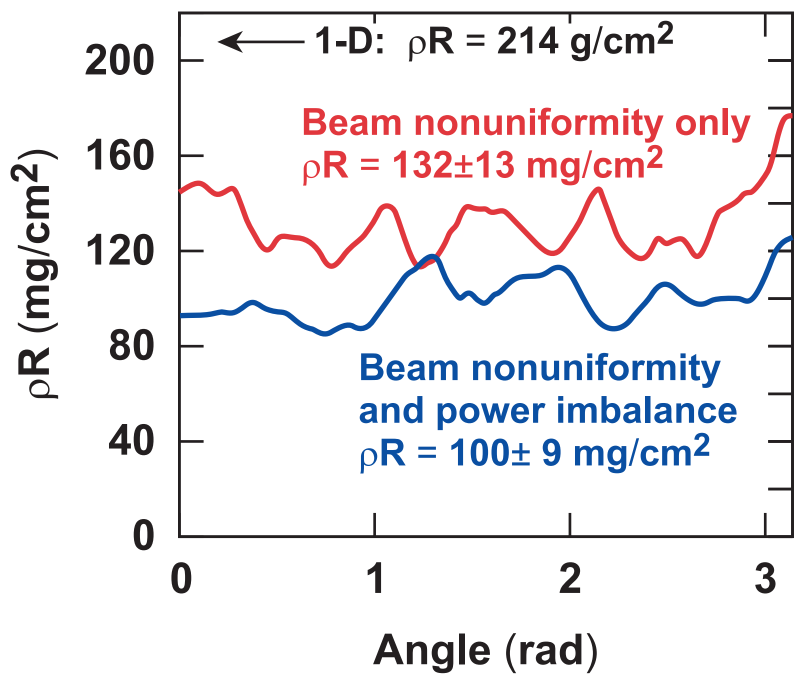
Beam nonuniformity and power imbalance reduce the peak total ρR to values near measured levels

Peak total ρR during stagnation



1-ns square pulse with 0.2-THz SSD;
20-mm CH shell with 3-atm-D_2 fill

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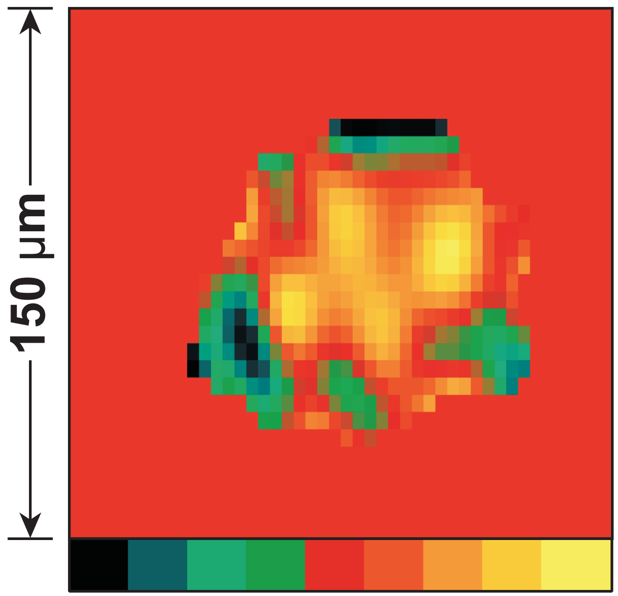
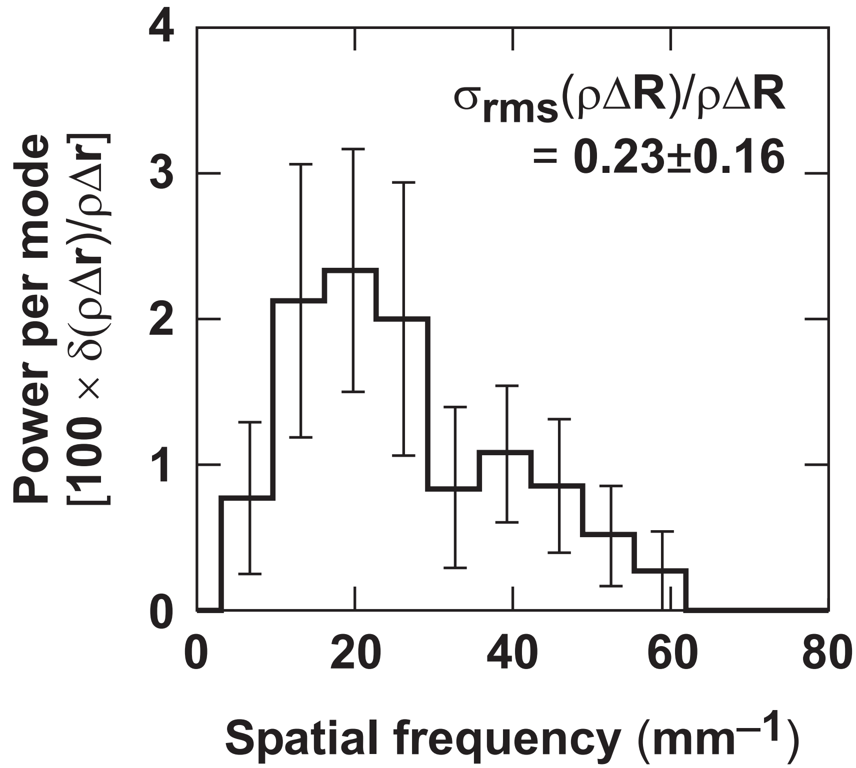
A power spectrum of the relative modulation is obtained from the 2-D image of the cold-shell opacity*





- The image is obtained by subtracting the logarithm of the noise-filtered images below or above the Ti K edge.
- Target includes an inner 2.1-μm Ti-doped CH layer.

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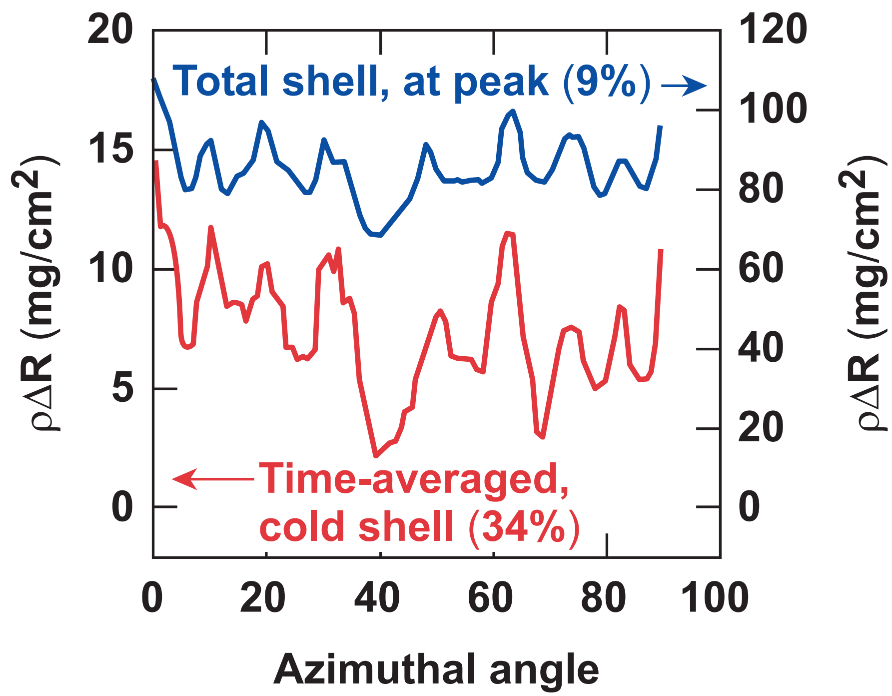
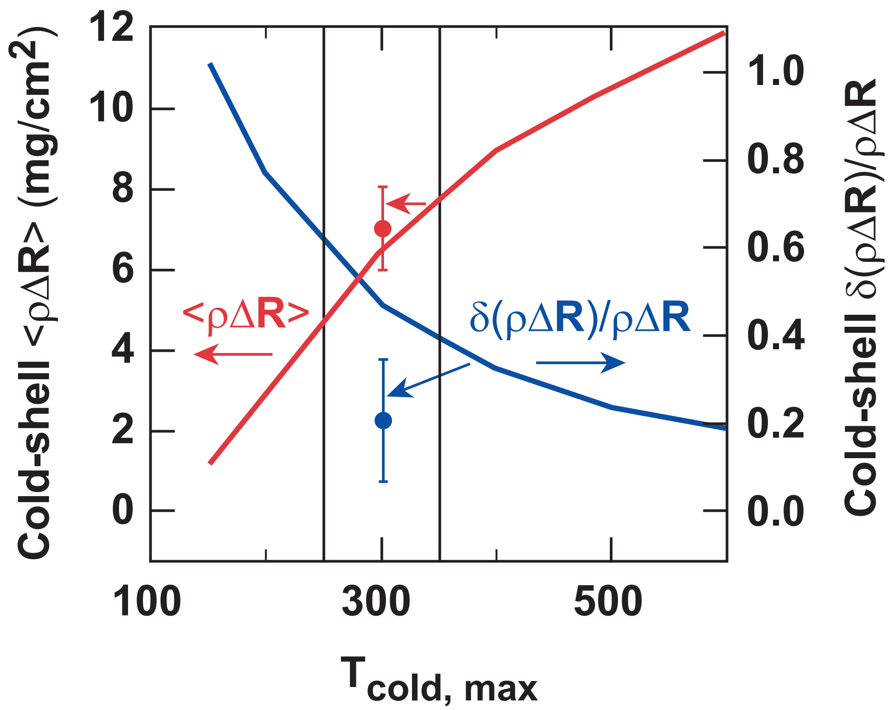
The cold-shell ρΔR obtained from 2-D simulations agrees well with the experimental value





Also, similar total shell ρΔR values have been obtained from the slowing down of DD protons.*

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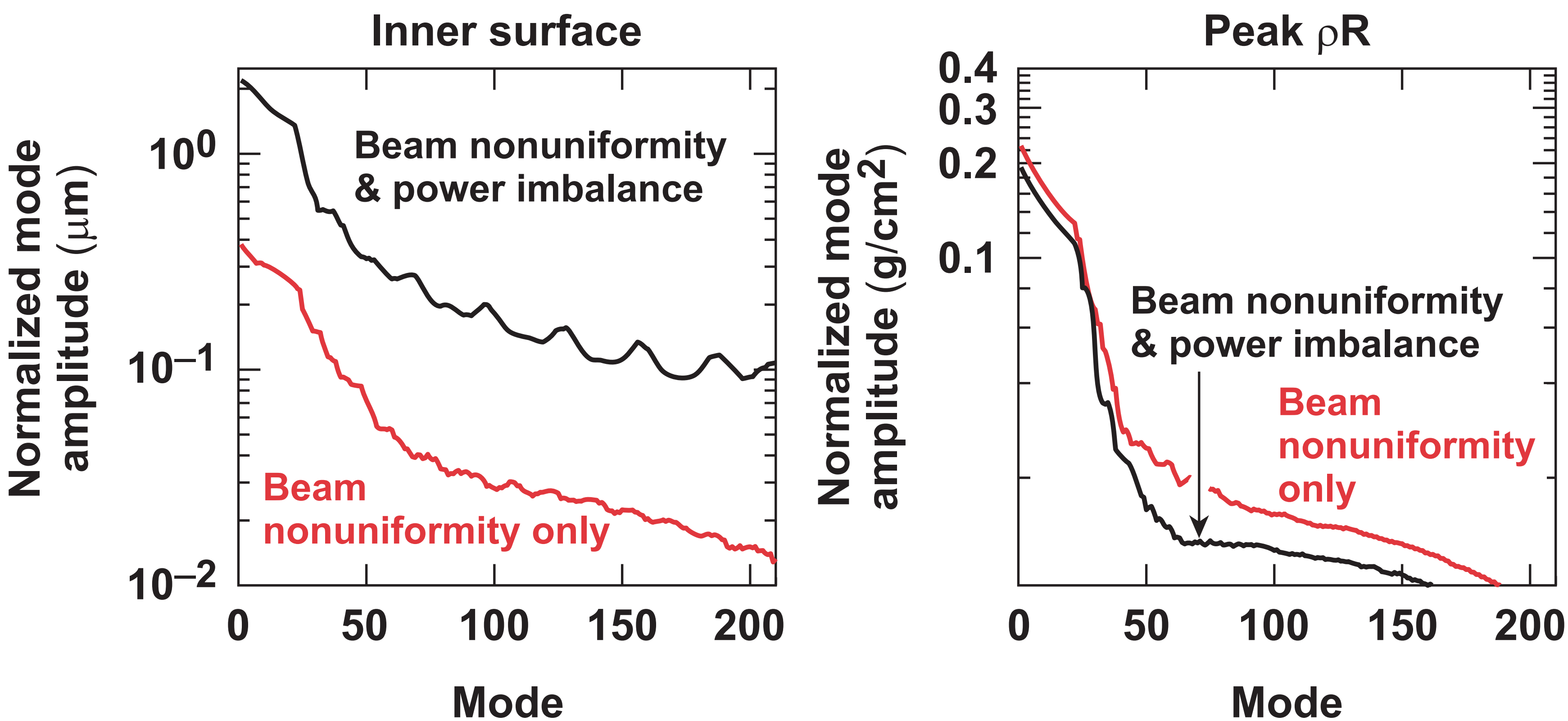
*R. Petrasso (private communication)

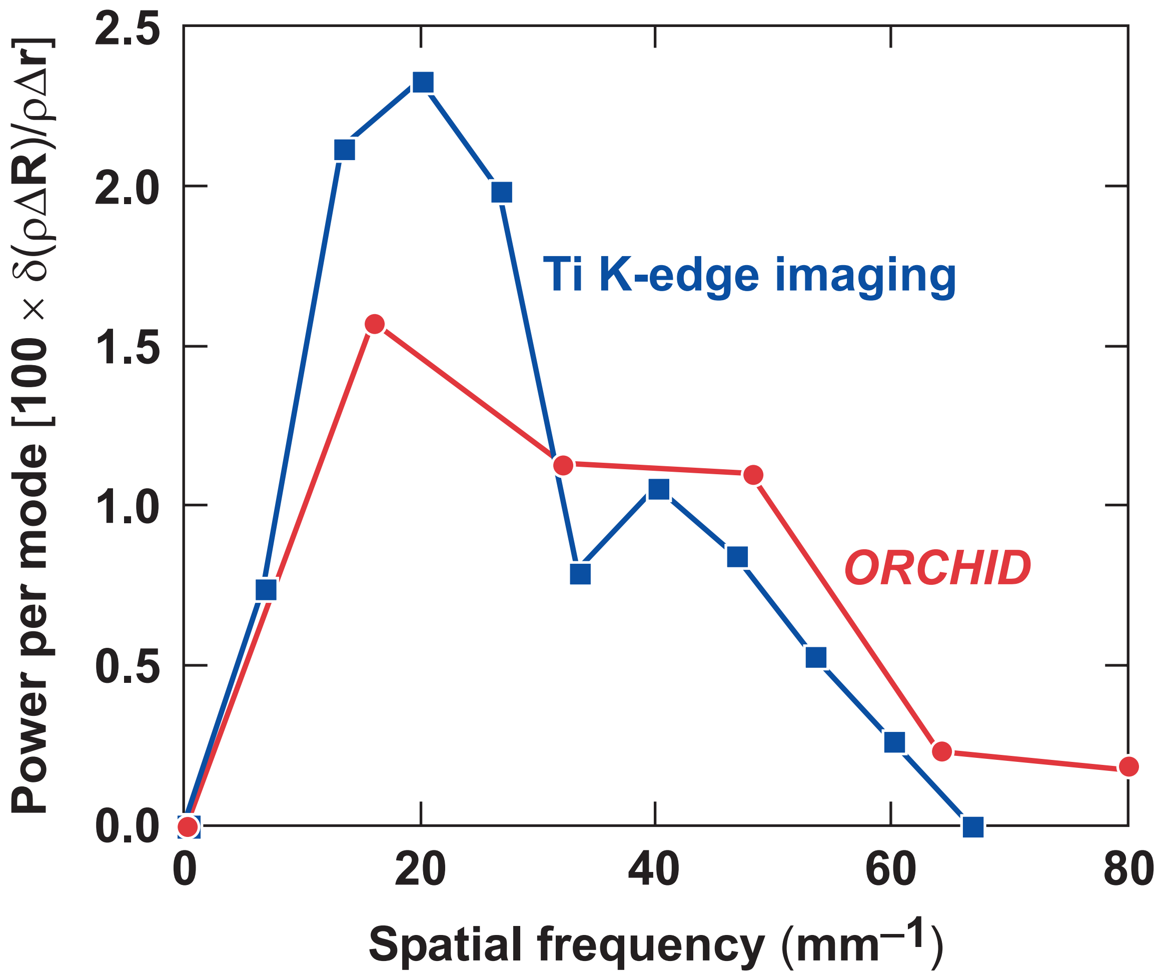
At stagnation, adding the power imbalance to the single-beam nonuniformity affects the inner-surface spectrum but not that of the peak ρR



1-ns square pulse with 0.2-THz SSD;
20-μm CH shell with 3-atm-D_2 fill

TC5398

The spectrum of modulation of cold ρΔR from Ti K-edge imaging compares well with the spectrum from *ORCHID* simulation



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Summary

ORCHID simulations agree qualitatively with experimental observations

- Most modes saturate early in the acceleration phase.
  - Large spikes and nonlinear behavior are observed.
- No significant R–T growth during deceleration
  - Low-order modes (< 50) dominate shell distortion.
  - Addition of power imbalance is not a factor in ρR spectrum at stagnation.
- Qualitative agreement with experimental results
  - Addition of power imbalance leads to ρR's close to measured levels.