Effect of Beam Smoothing and Pulse Shape on the Implosion of DD-Filled CH Shell Targets on OMEGA

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Over the past two years several implosion experiments were carried out on the 60-beam OMEGA laser in which DD-filled CH shells (some with a CHTi layer imbedded) were irradiated with various laser pulse shapes and smoothing conditions. Target CH shell thicknesses varied from 20 μm to 27 μm with DD-fill variations from 3 to 20 atm, sometimes mixed with ^{3}He. Two pulse shapes—a 1-ns square pulse and a 2.5-ns pulse with a 10%, 1-ns foot, with and without SSD—provide several levels of laser imprint. Diagnostics include measured neutron yields, fuel ion temperatures, fuel ρR, and shell ρR. Simulations for these experimental conditions were carried out with the 2-D hydrocode *ORCHID*. The results are compared with the experimental results. The degradation of target performance due to laser nonuniformity is analyzed by comparing the 2-D results with those of 1-D simulations. The effects of pulse shape, target thickness, convergence ratio, and smoothing are presented. 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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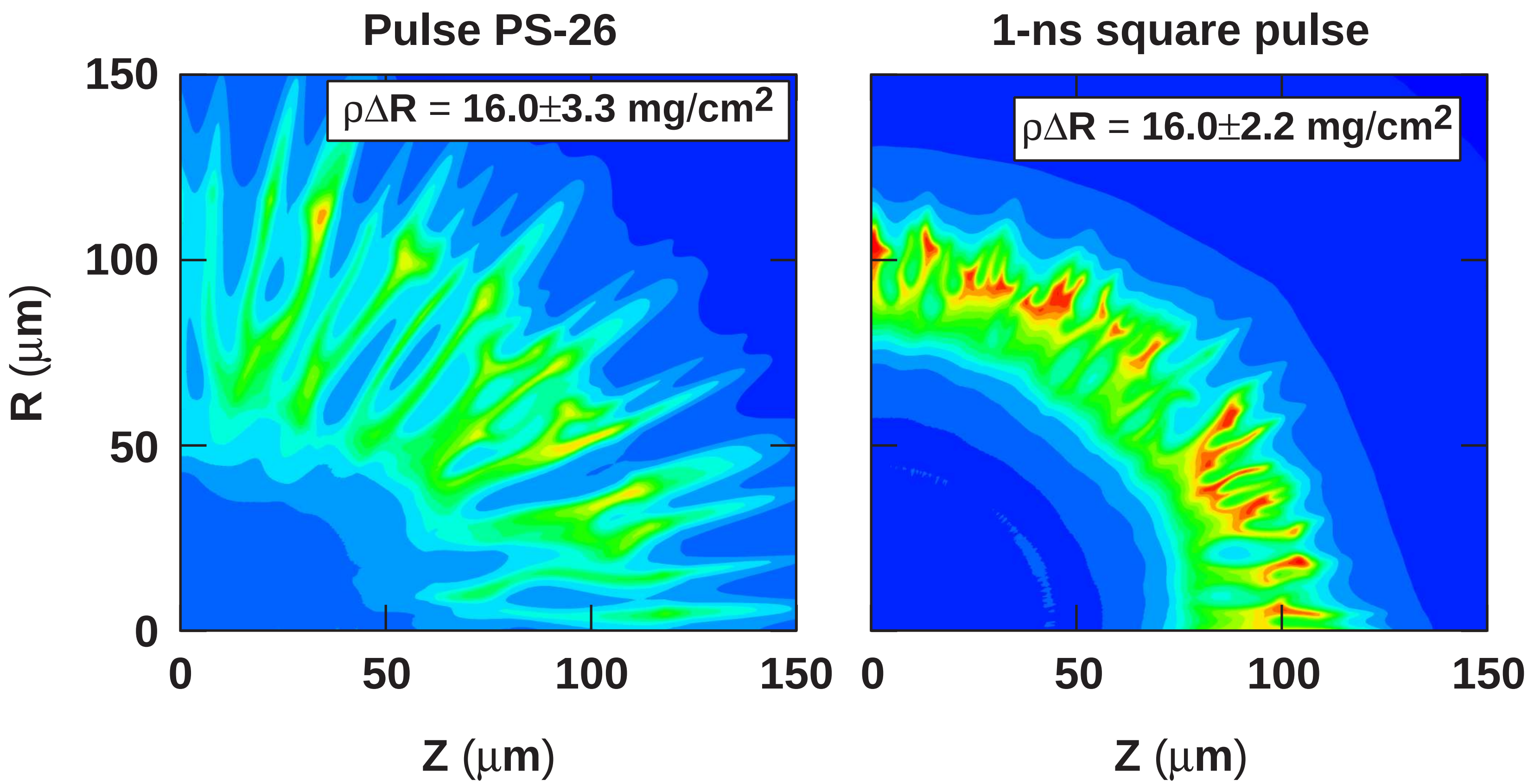

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ORCHID simulations agree qualitatively with experimental observations

- **Most modes saturate early in the acceleration phase.**
  - **Large spikes and nonlinear behavior are observed.**
- **No significant RT growth occurs during deceleration.**
  - **No large-scale fuel–shell mixing.**
  - **Low-order modes (< 50) dominate shell distortion.**
- **Qualitative agreement with experimental results:**
  - **SSD increases the maximum shell $\rho\Delta R$.**
  - **Deviation of shell $\rho\Delta R$ from 1-D is larger for a shaped pulse (PS-26) than for the 1-ns square pulse.**

The purpose of this work is to study the sensitivity of target performance, as measured by the shell $\rho\Delta R$, to single-beam nonuniformity

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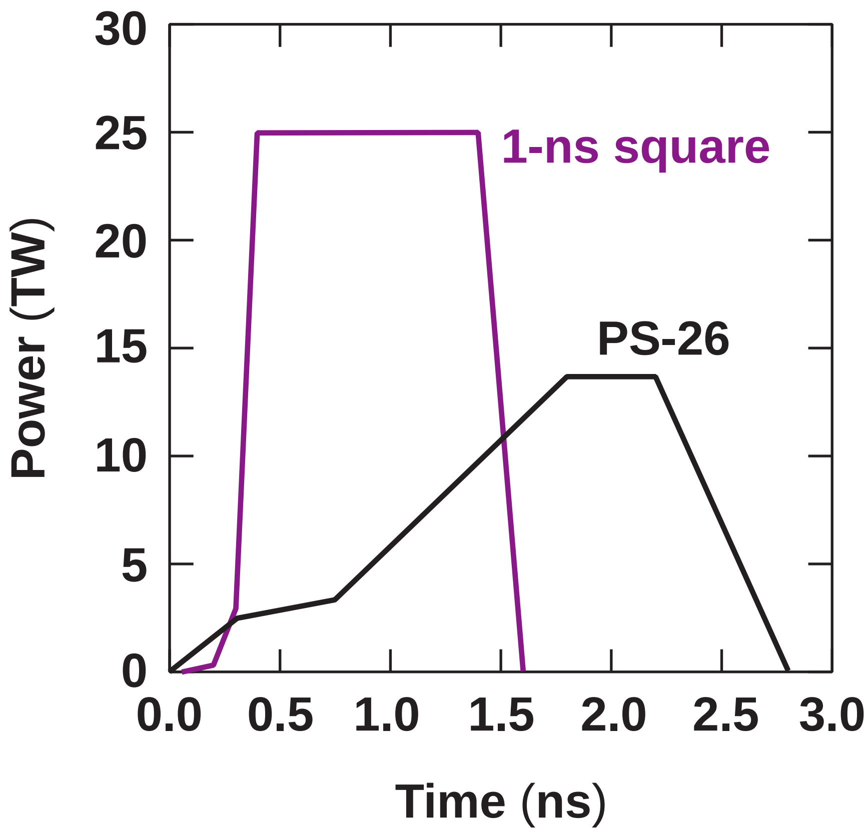
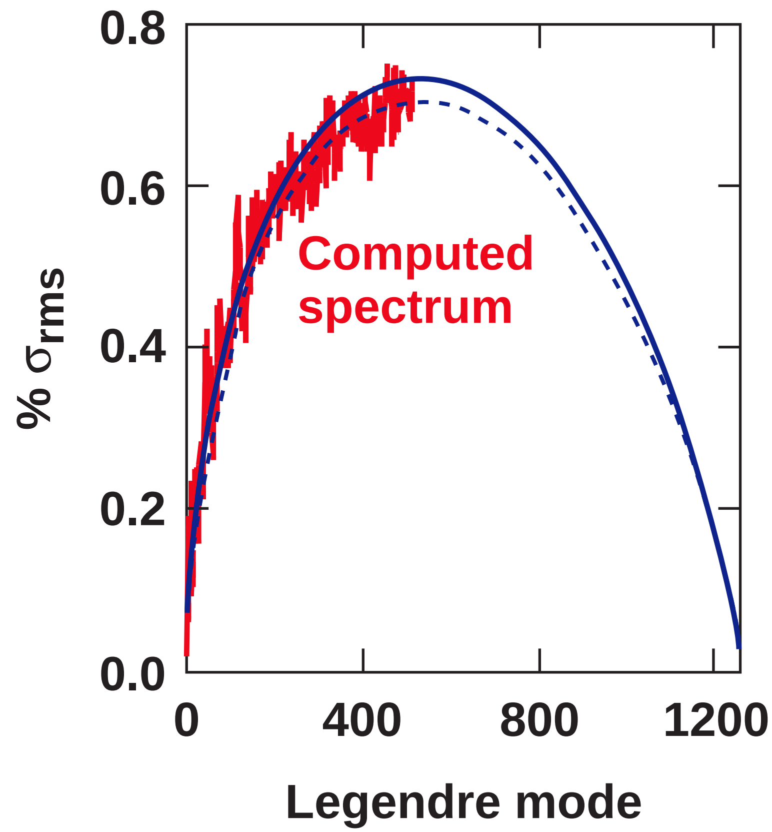
- **Generic CH shells of 20- and 27-μm thickness and a 450-μm radius, filled with 3 atm D_2.**
- **Initial simulations were carried out with the 2-D hydrodynamic code *ORCHID* to identify trends.**
  - **400 transverse zones/quadrants for even cosine modes 2–200 with random 0/π phase**
  - **no material tracking**
  - **no low-order modes from power imbalance and surface finish**

Outline

- Simulation model
- Comparison during acceleration and before stagnation
  - shaped pulse versus 1-ns square
  - SSD versus no SSD
- Conditions at stagnation
- Conclusions

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).

The ablation-surface amplitudes saturate early in the acceleration phase, resulting in significant nonlinear behavior

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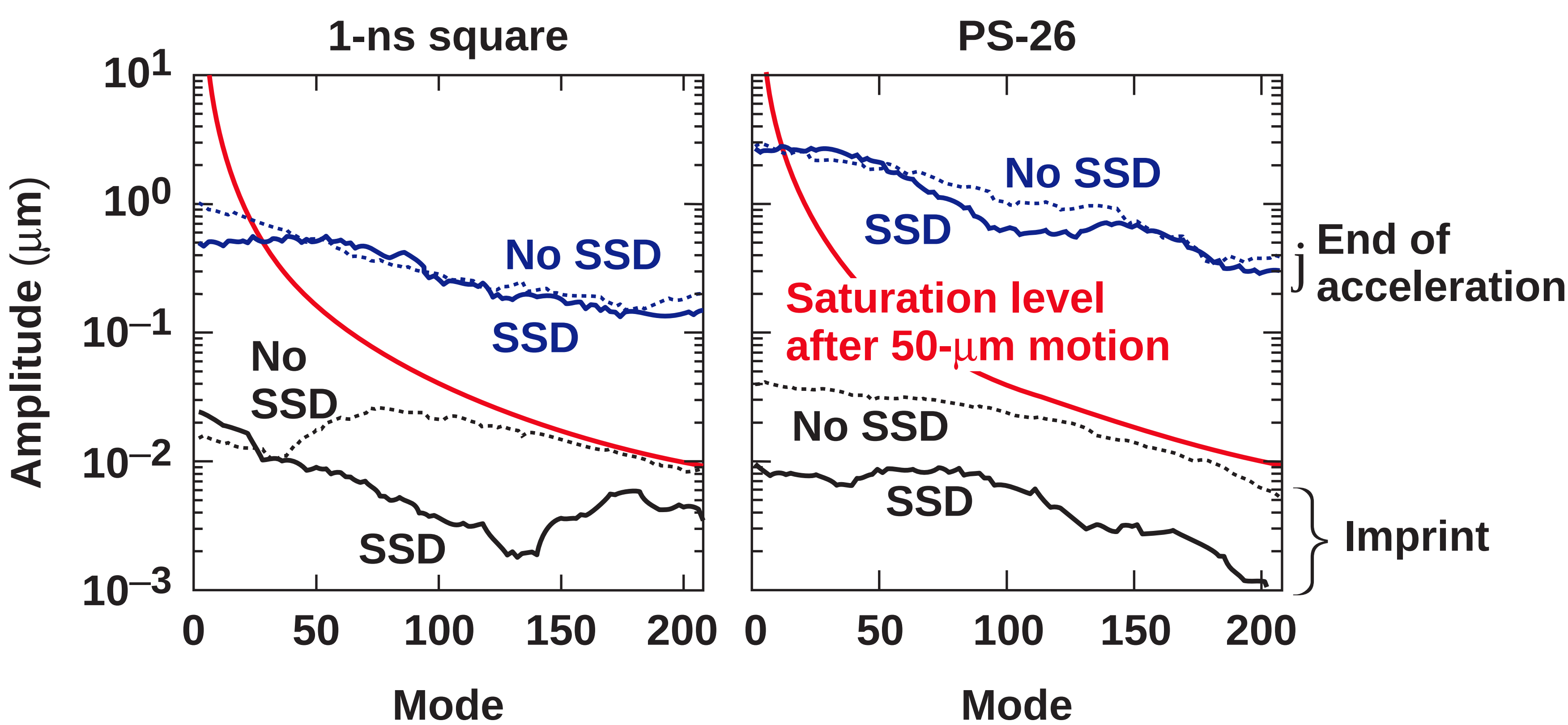

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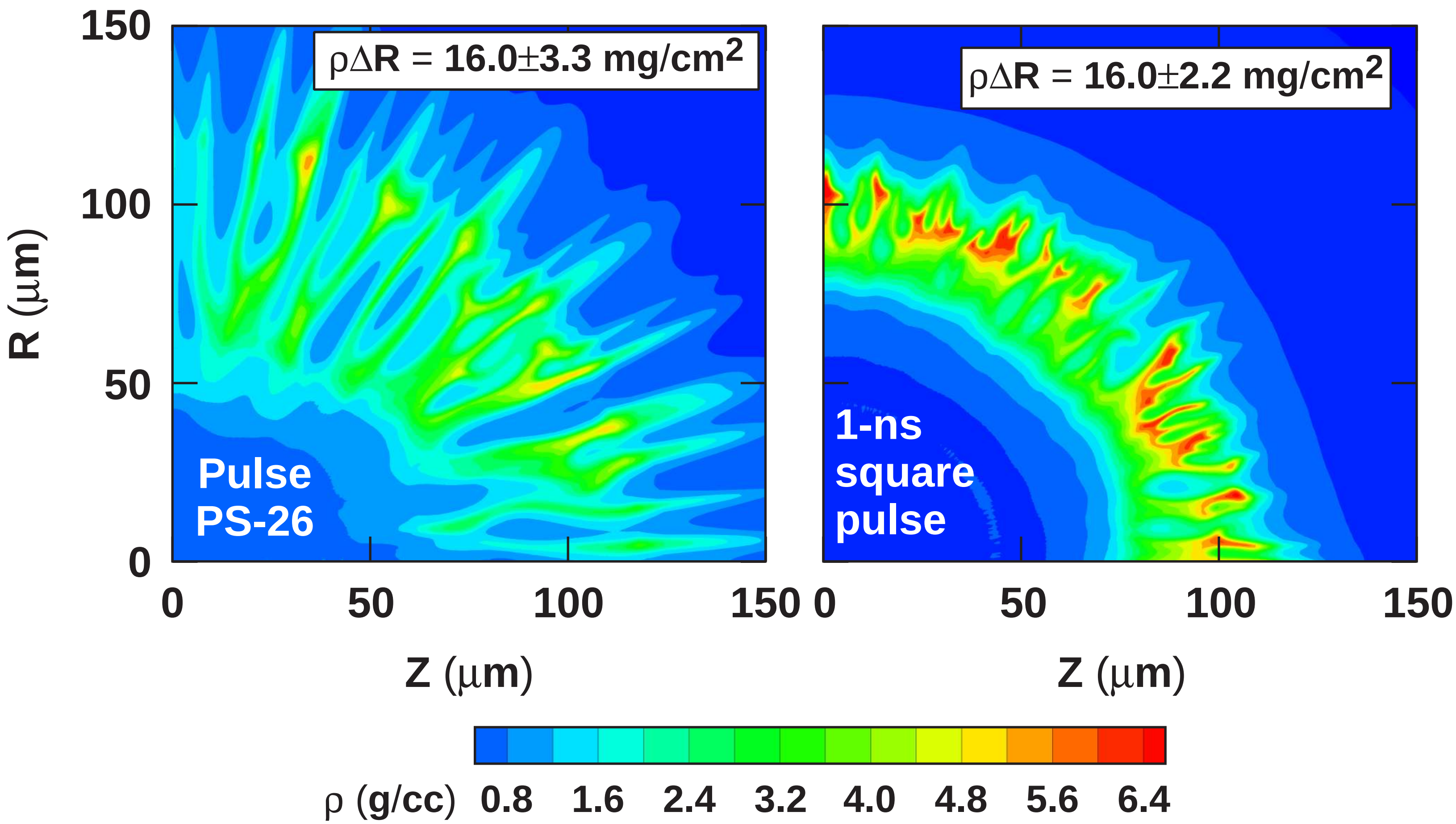
For both pulse shapes, the target is far into the non-linear regime near the end of the acceleration phase

20-μm CH shell with SSD



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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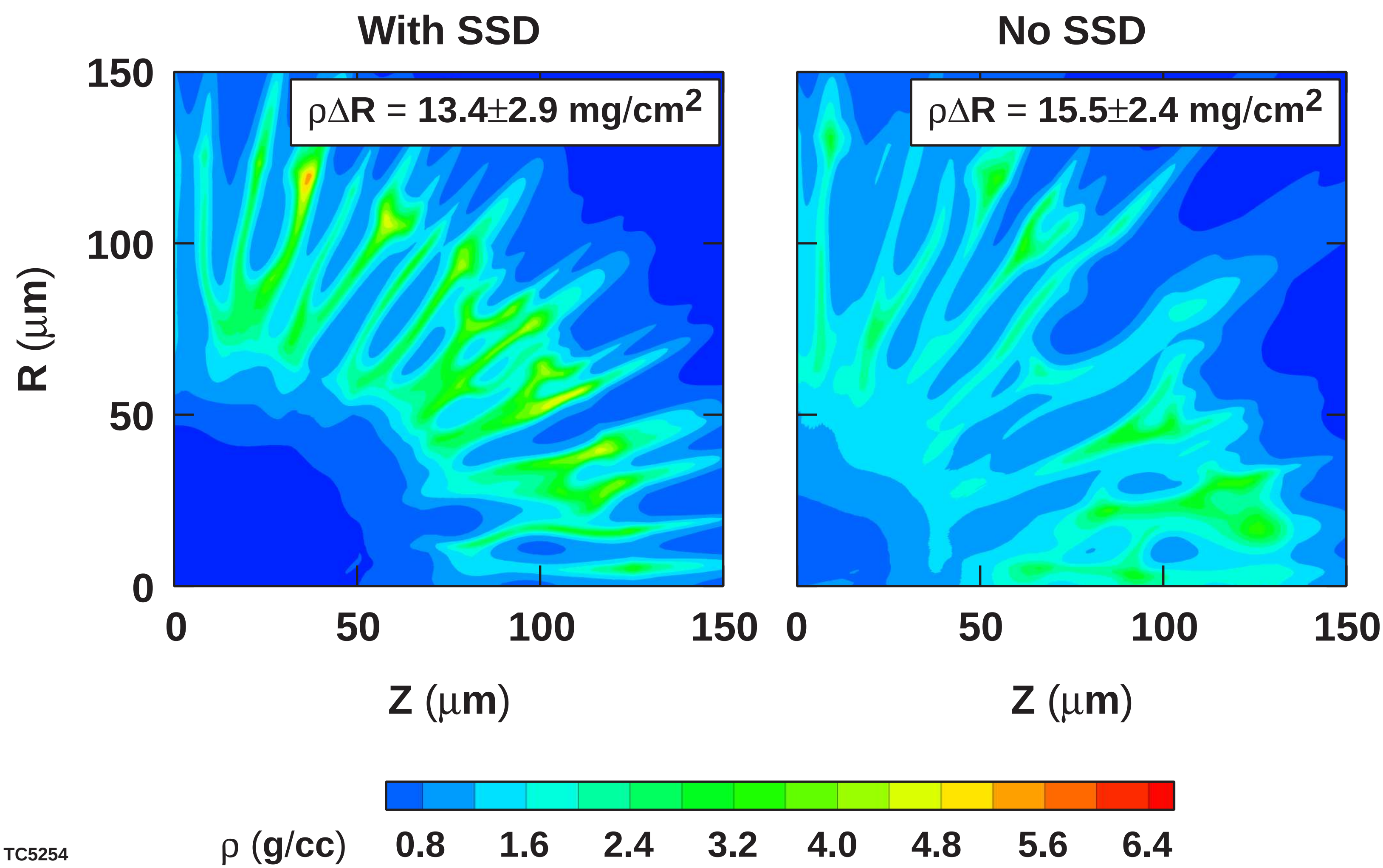
For PS-26, SSD slightly improves the target's massive distortion before stagnation

Density contours for a 20-μm shell



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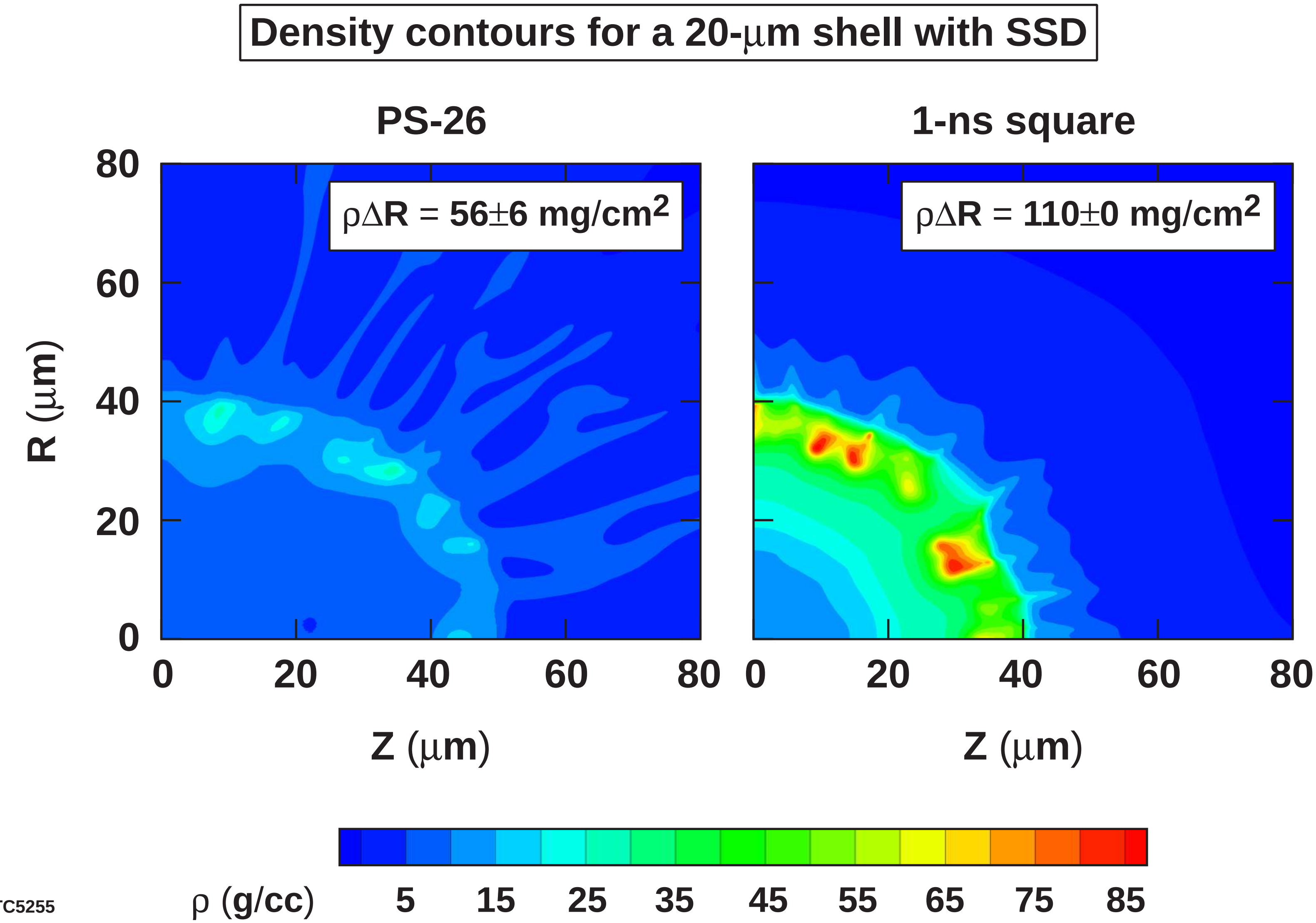
At stagnation the shell is made up of fairly dense "blobs" with no spikes or mixing



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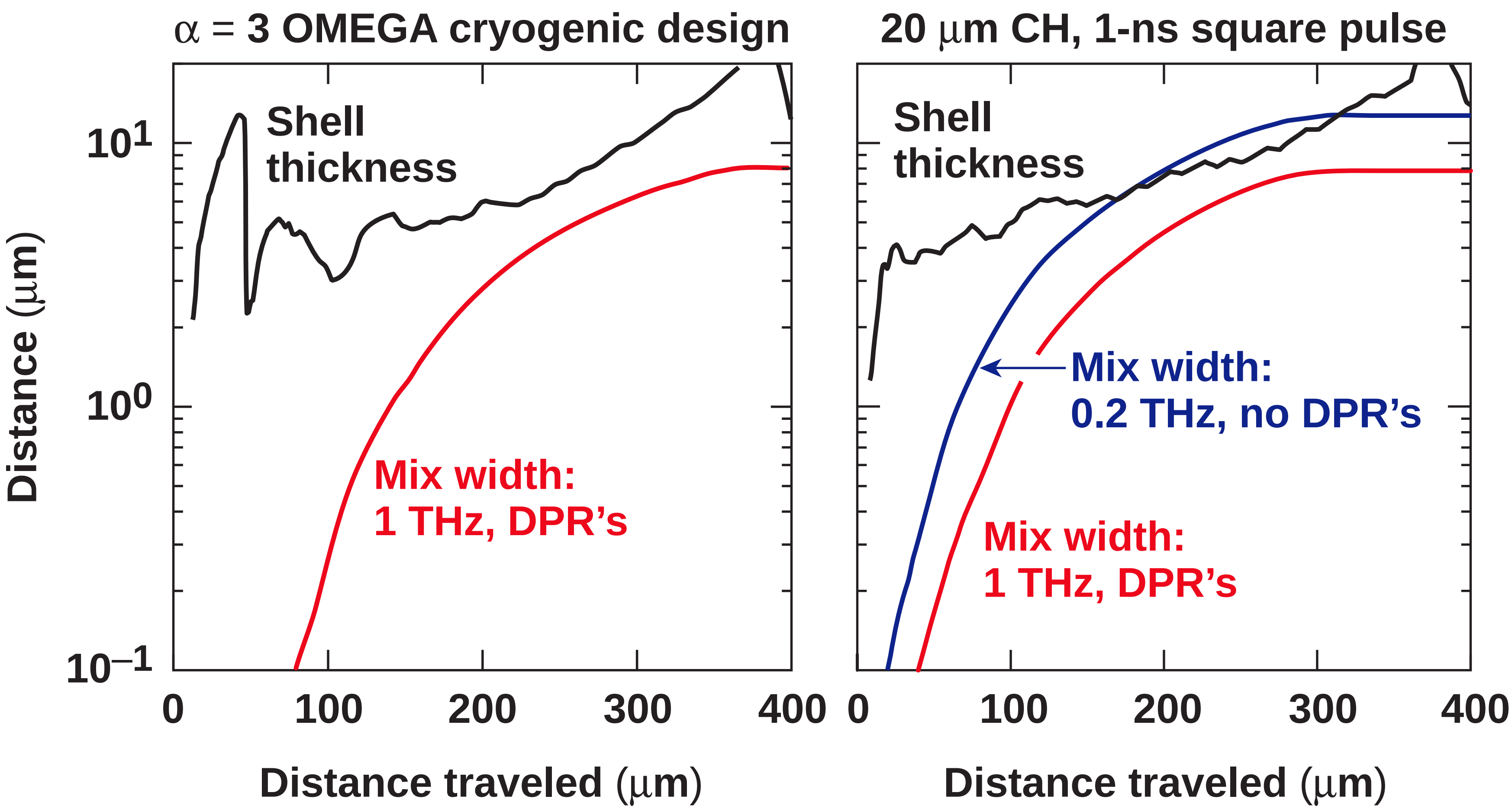
Single-beam laser nonuniformity has a larger effect on implosions driven by PS-26 compared with those driven by the 1-ns square pulse

Comparison of peak shell ρΔR at stagnation normalized to 1-D

		$(\rho\Delta R)_{2\text{-}D}/(\rho\Delta R)_{1\text{-}D}$	
CH thickness	**Pulse**	**No SSD**	**With SSD**
20 μm	**1-ns square**	**0.60**	**0.91**
	PS-26	**0.29**	**0.35**
27 μm	**PS-26**	**0.51**	**0.72**

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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Summary/Conclusions

ORCHID simulations agree qualitatively with experimental observations

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- No significant RT growth occurs during deceleration.
  - No large-scale fuel–shell mixing.
  - Low-order modes (< 50) dominate shell distortion.
- Qualitative agreement with experimental results:
  - SSD increases the maximum shell $\rho\Delta R$.
  - Deviation of shell $\rho\Delta R$ from 1-D is larger for a shaped pulse (PS-26) than for the 1-ns square pulse.
- Experimental results will be discussed in the following papers:
  - This session: Petrasso—3; Glebov—4; Séguin—7
  - Invited paper: Marshall—SI1.01