Adiabat Shaping by Relaxation in Plastic and Cryogenic Shells for Experiments on the OMEGA Laser

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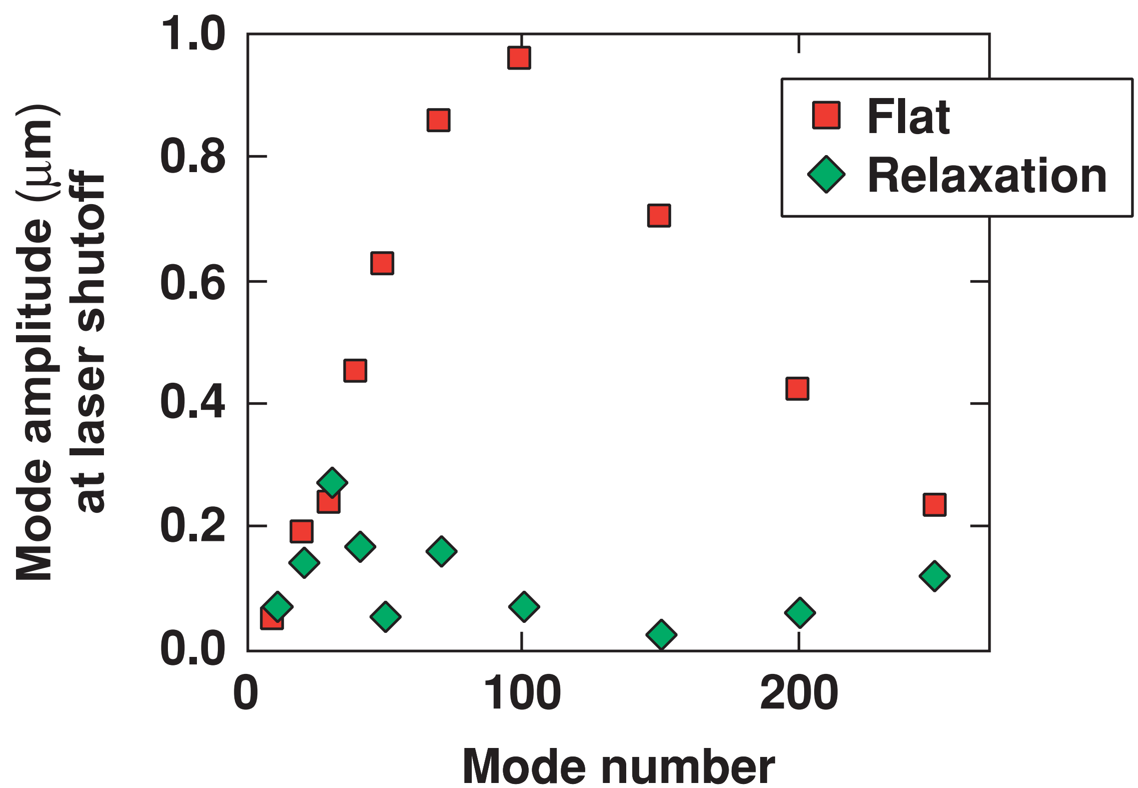

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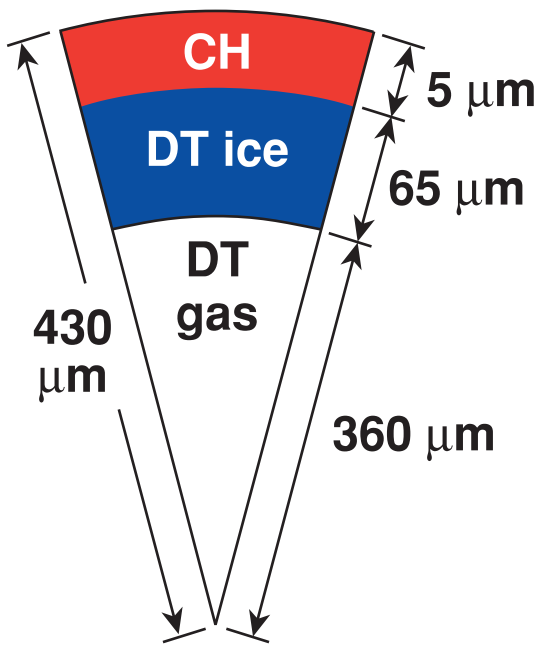
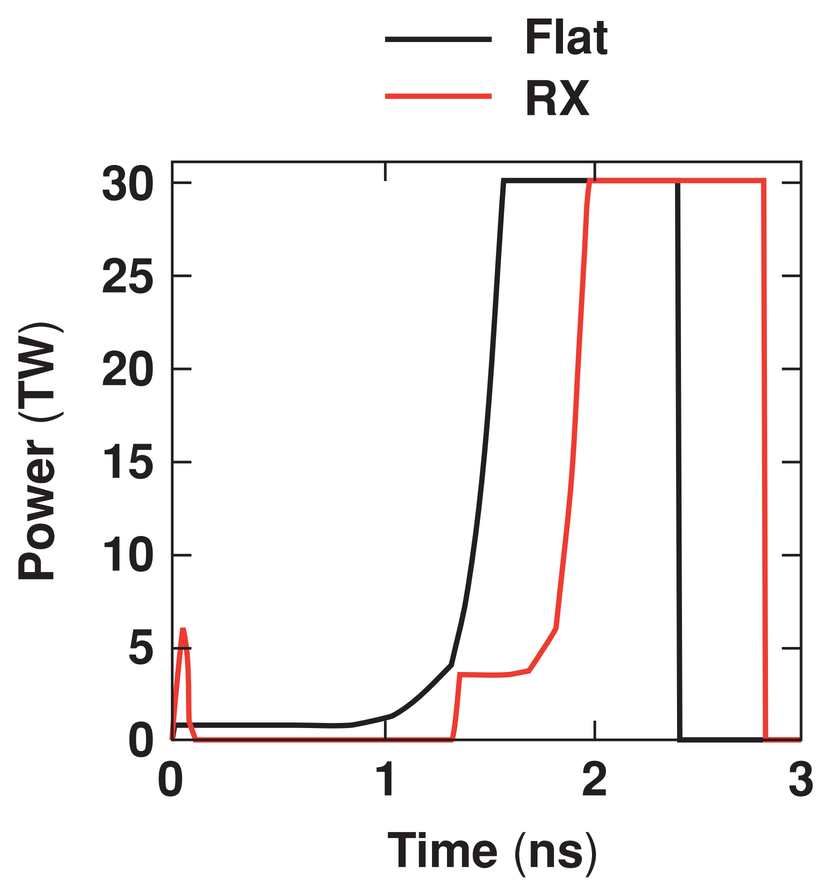
Summary

2-D simulations have confirmed that adiabat shaping by relaxation suppresses RT growth

- Relaxation (RX) implosion experiments have been designed on OMEGA for both cryogenic and CH-plastic-shell targets.
- Simulations show lower RT growth rates and smaller overall growth with RX as compared to "flat" adiabat designs of similar 1-D performance.
- CH-shell implosions are planned for next month on OMEGA.

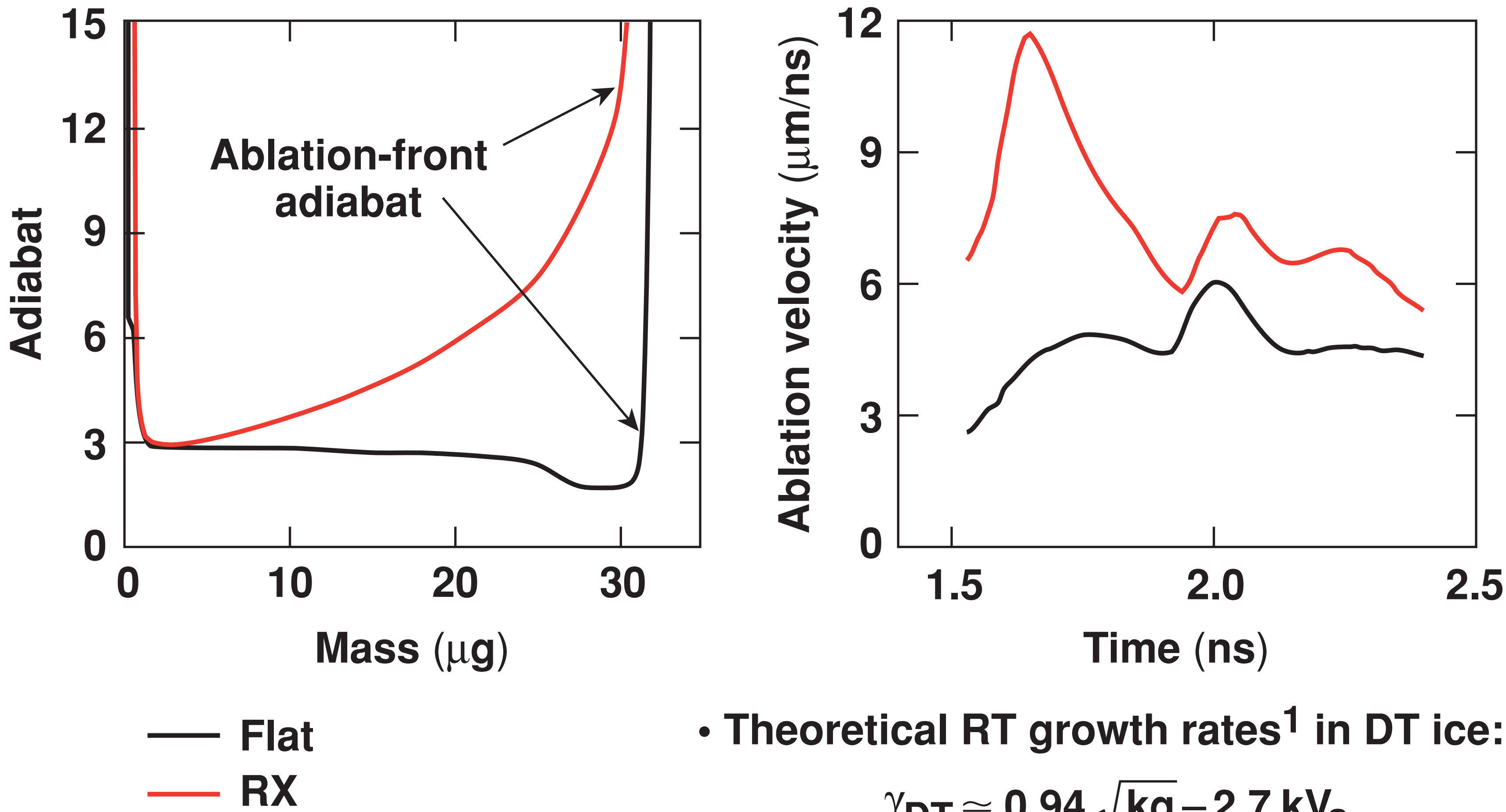
Cryogenic-capsule pulses are designed within limits of the current capabilties of OMEGA





- Total laser energy: 30 kJ
- 1-D, DT neutron yields ~ 7×10^{14}
- 6-TW, 50-ps Gaussian prepulse (RX)

RX design leads to significantly higher ablation-front adiabats and ablation velocities



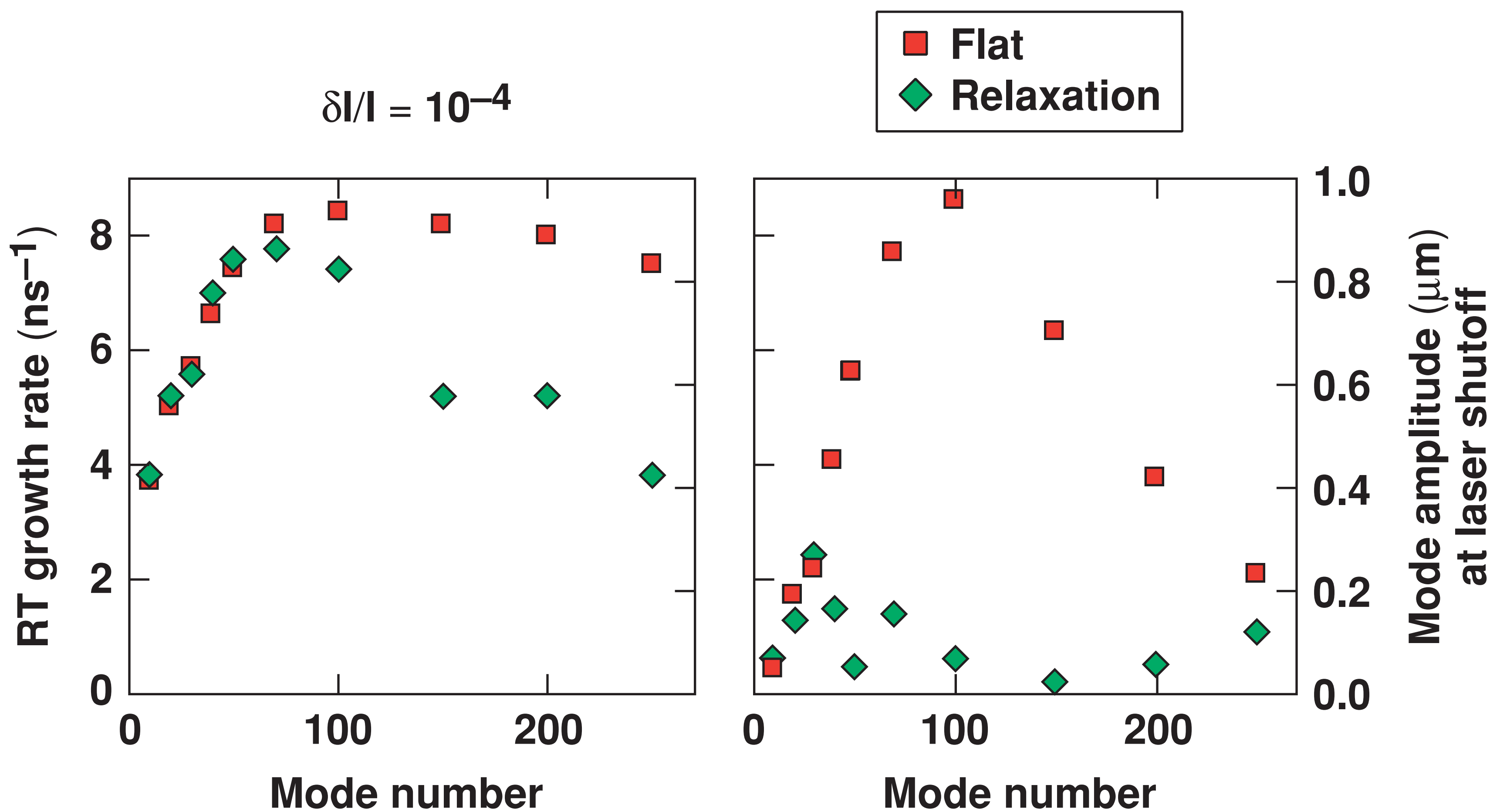
- Theoretical RT growth rates[1] in DT ice:

$$\gamma_{DT} \simeq 0.94\sqrt{kg} - 2.7\,kV_a$$

[1] Betti *et al.* (1998); Takabe *et al.* (1985).

TC6420

Single-mode 2-D simulations of imprint in DT cryo targets show reduced growth rates and lower perturbation mode amplitudes for RX designs



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CH capsule implosions are planned as proof-of-principle for the RX method

- Mitigating the RT instability in CH targets is more difficult than in cryogenic targets due to lower ablation velocities.
- The RX method has demonstrated in simulation a unique ability to significantly shape the adiabat and thereby lower RT growth rates in CH targets.
- Typical flat-adiabat designs exhibit RT cutoff at $\ell \gtrsim 1000$.
- RX designs could see RT cutoffs near $\ell \sim 600$.

CH capsule pulses are designed within the current capabilities of OMEGA

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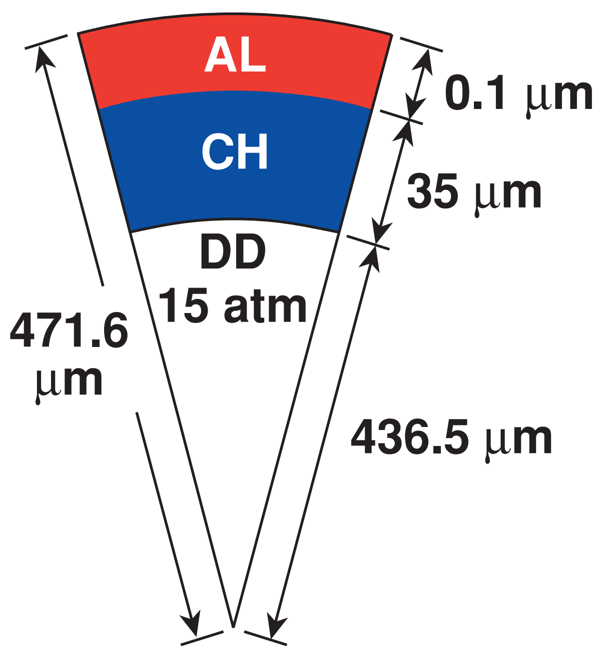

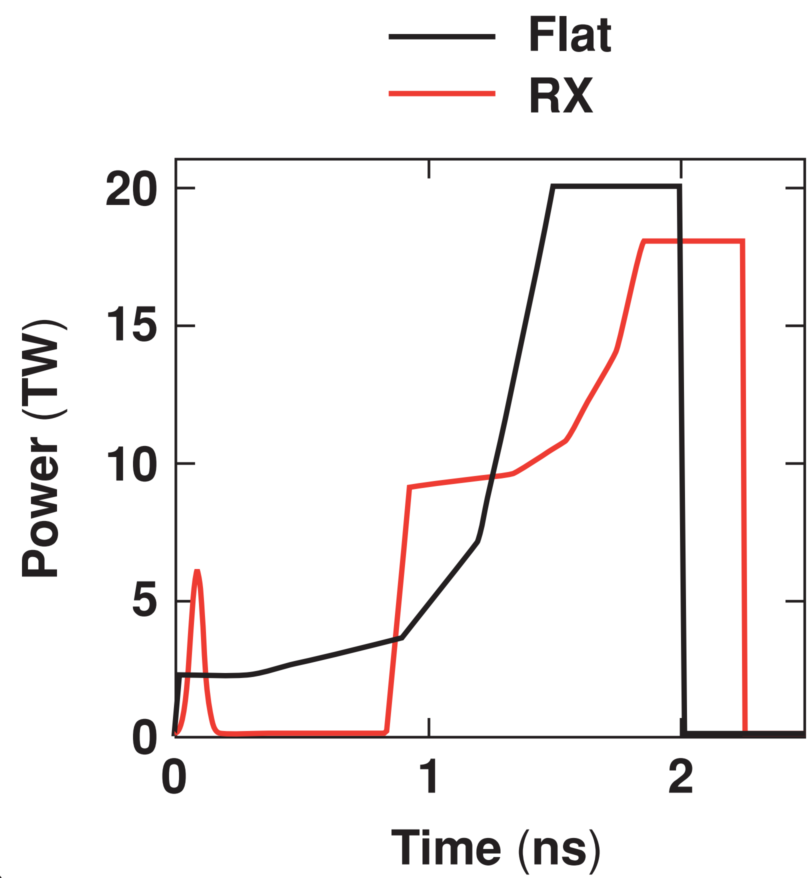

- Total laser energy: 18 kJ
- 1-D, DD neutron yields ~ 5×10^{10}
- 6-TW, 60-ps Gaussian prepulse (RX)
- Contrast ratio of 2 in RX main pulse

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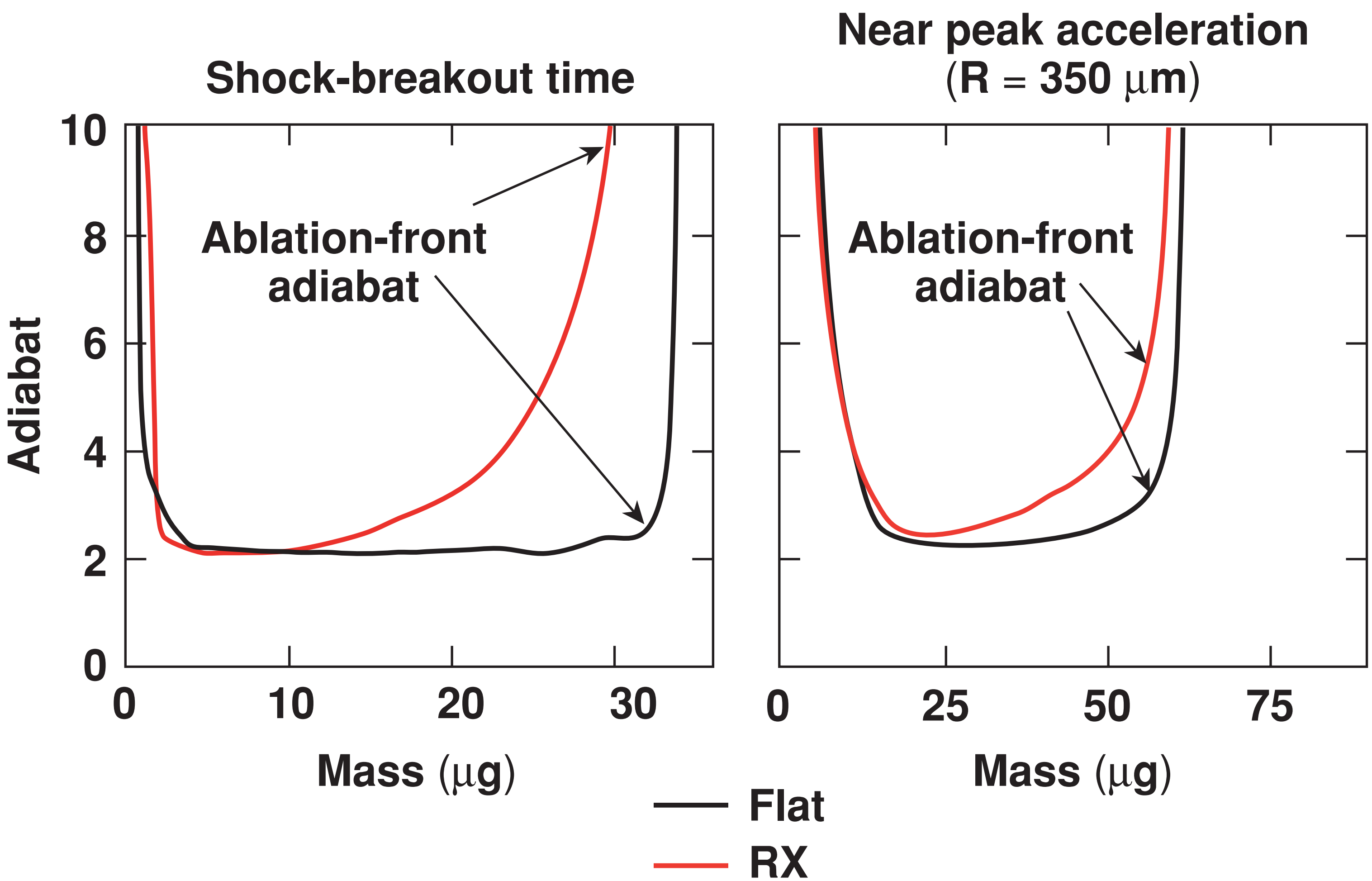
Relaxation adiabat shaping in CH is effective throughout the acceleration phase

- RX shaping is significantly higher than "natural" radiative shaping.



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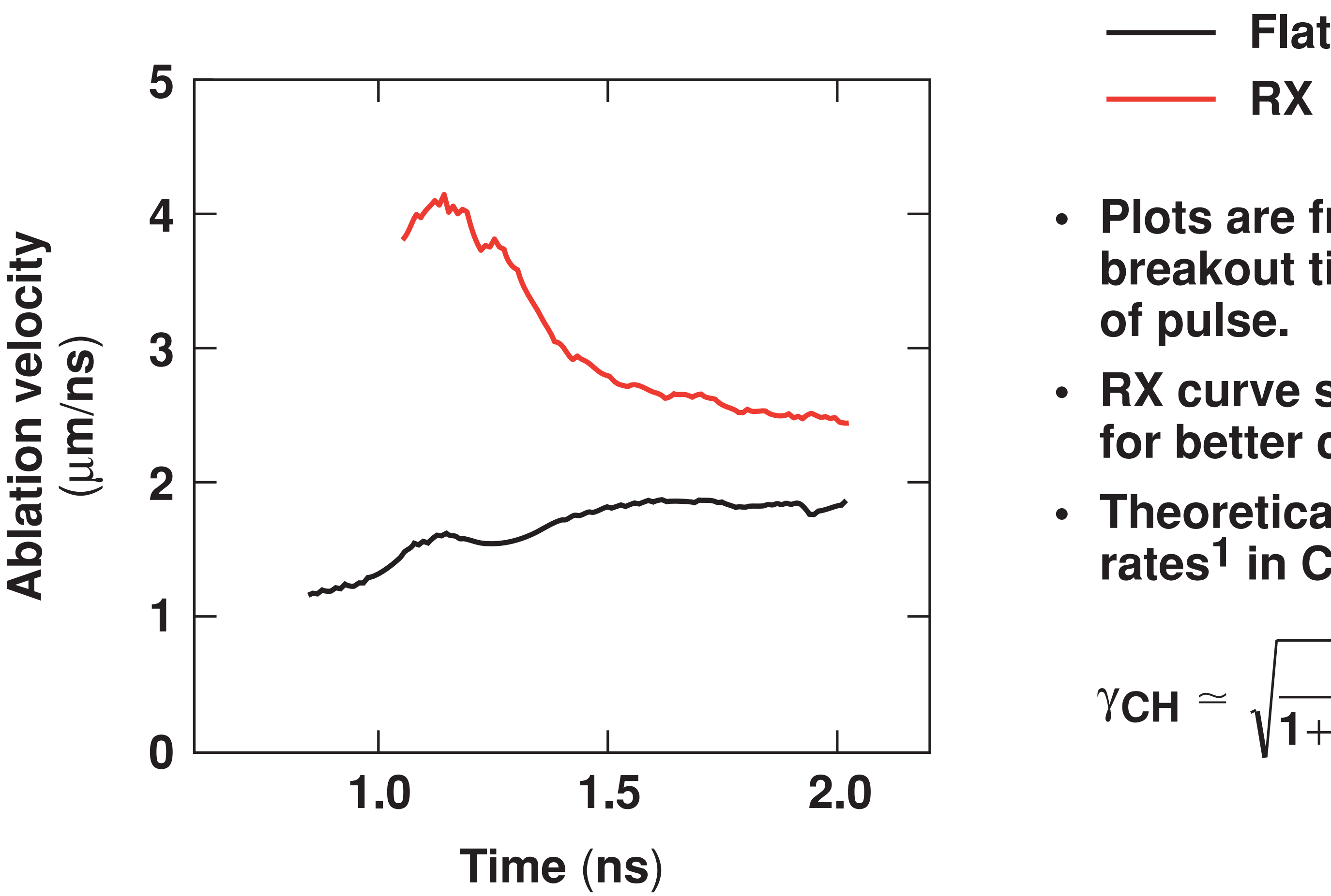
Ablation velocity for the shaped-adiabat design is significantly higher than for flat-adiabat design



- Plots are from shock-breakout time to end of pulse.
- RX curve shifted in time for better comparison.
- Theoretical RT growth rates[1] in CH plastic:

$$\gamma_{CH} \simeq \sqrt{\frac{kg}{1+kL_m}} - 1.7\,kV_a$$

[1] Betti *et al.* (1998).

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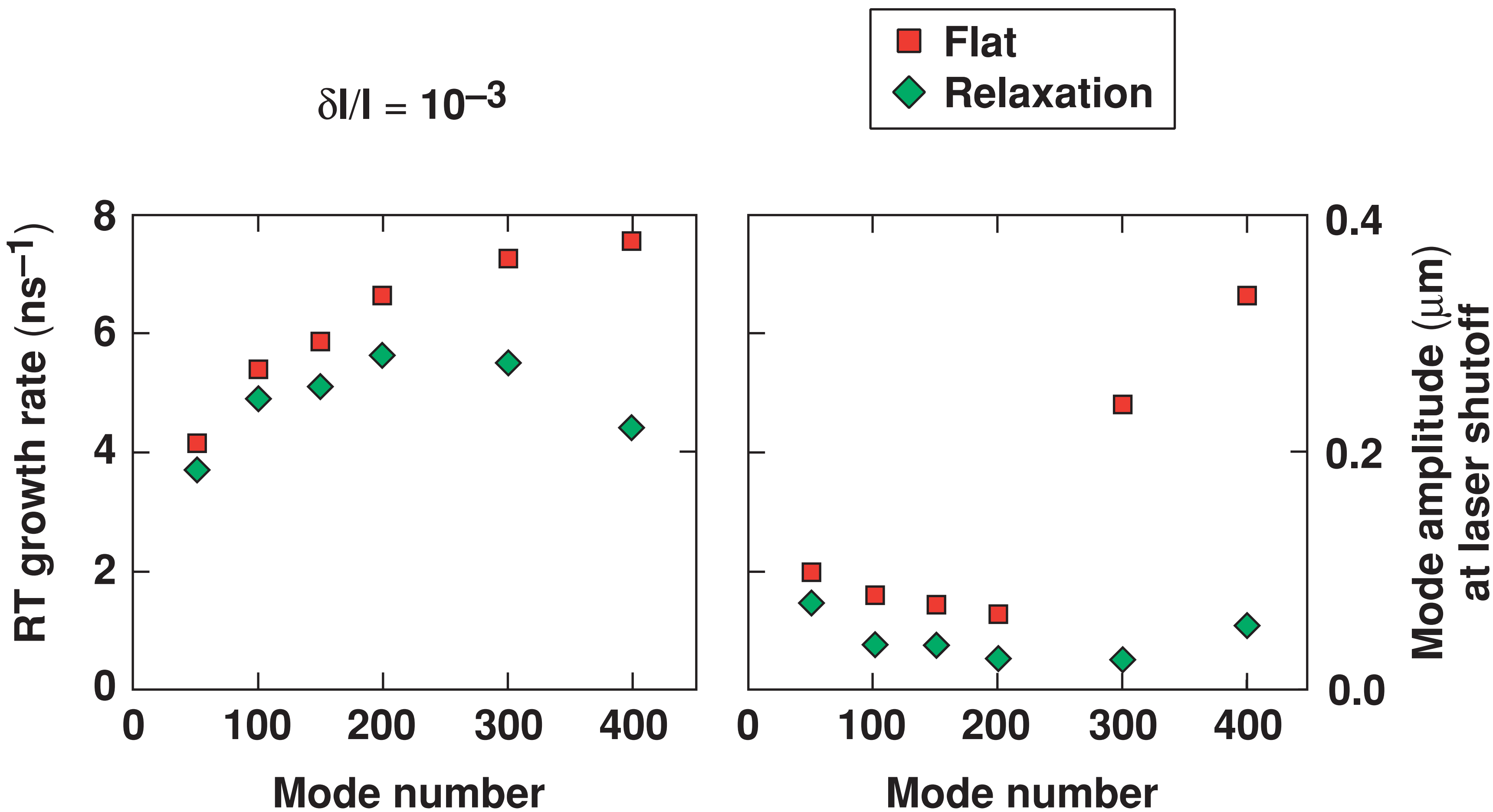
Single-mode 2-D simulations in CH targets show lower Rayleigh–Taylor growth rates for RX designs



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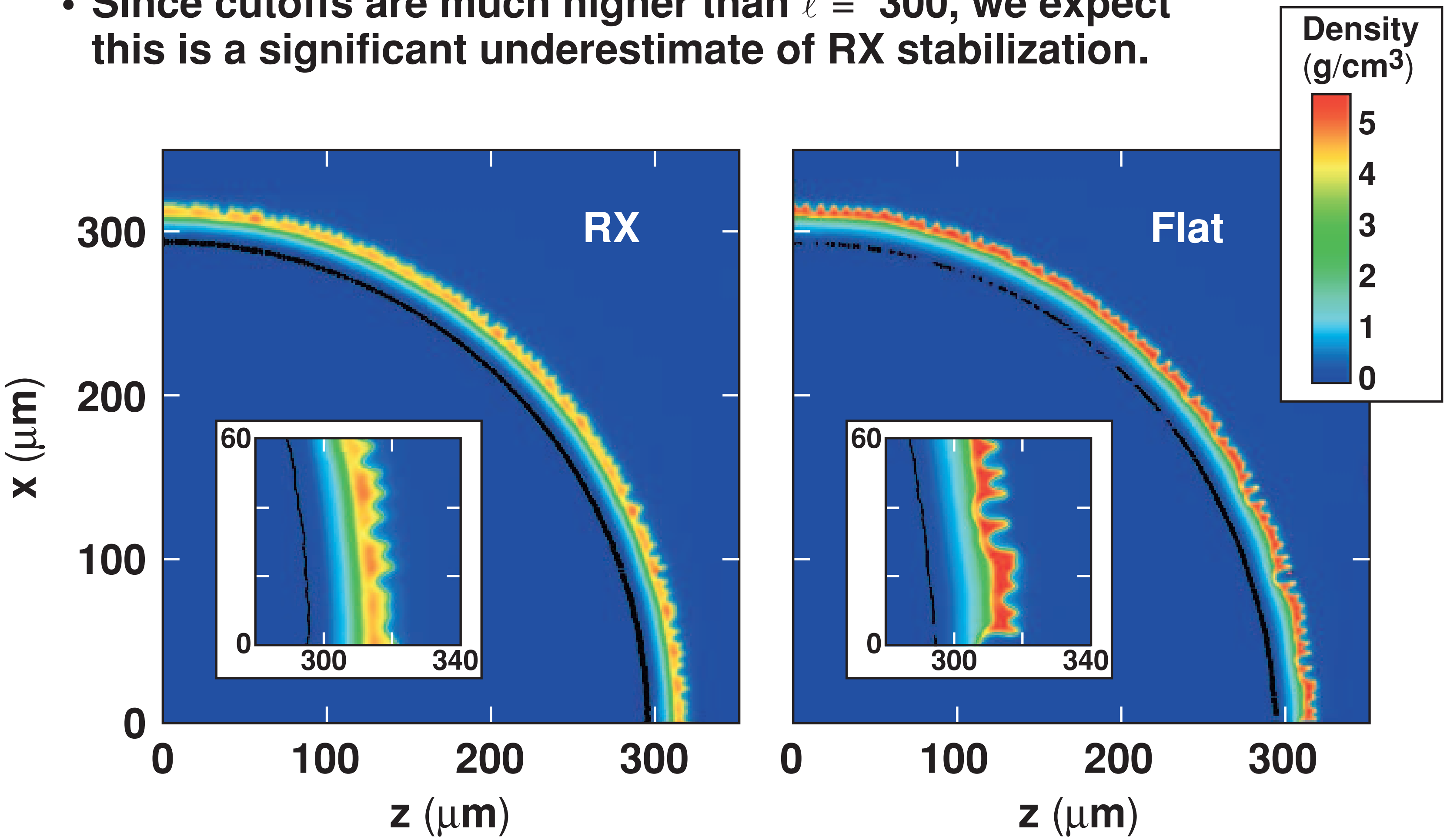
CH multimode simulations of 35-μm shells confirm the RX pulse shape is more stable

- Modes ℓ = 2 to 300 simulated up to 130 ps after laser shutoff.
- Since cutoffs are much higher than ℓ = 300, we expect this is a significant underestimate of RX stabilization.



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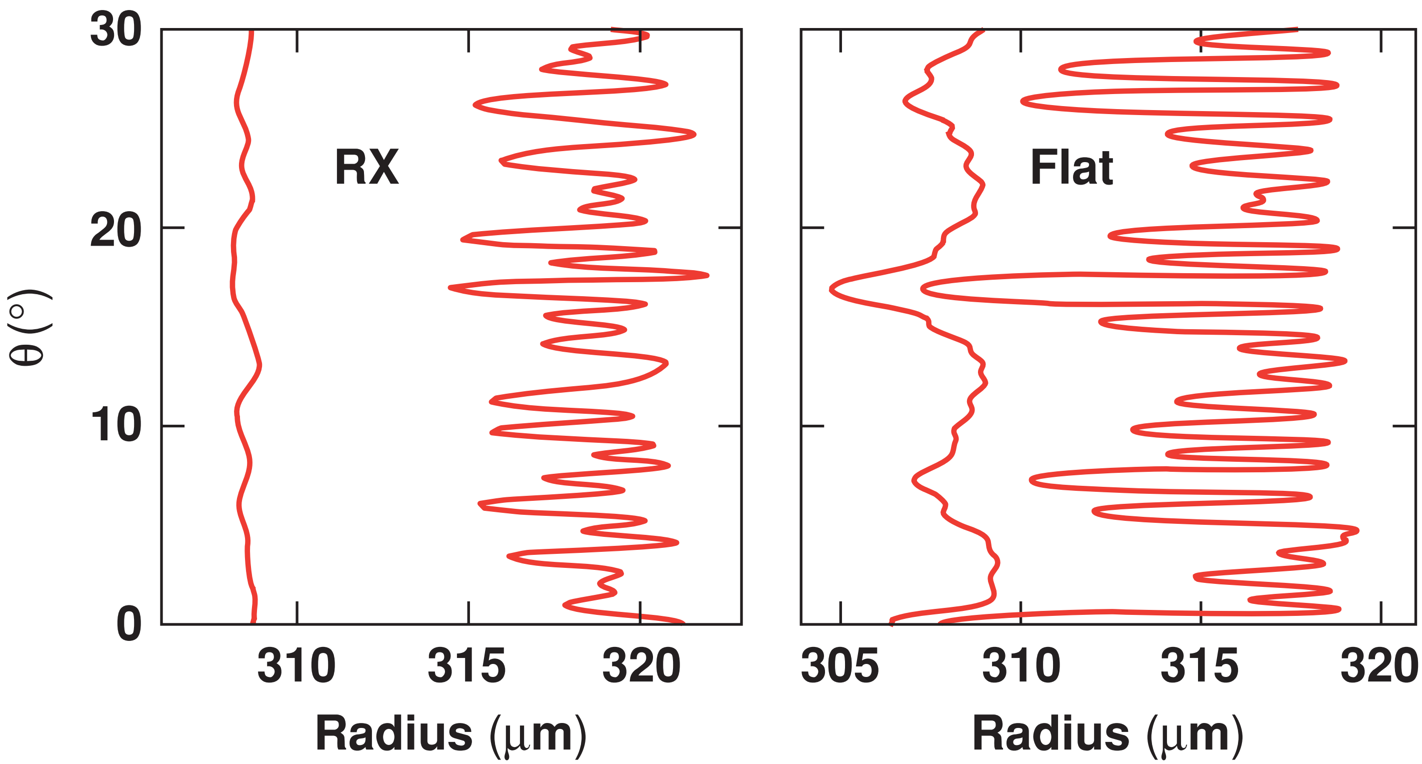
Multimode simulations in CH targets show RX design exhibits better shell integrity

- Contours drawn at time = laser shutoff time + 130 ps.
- Density contours are drawn at 1/*e* points from max. density.



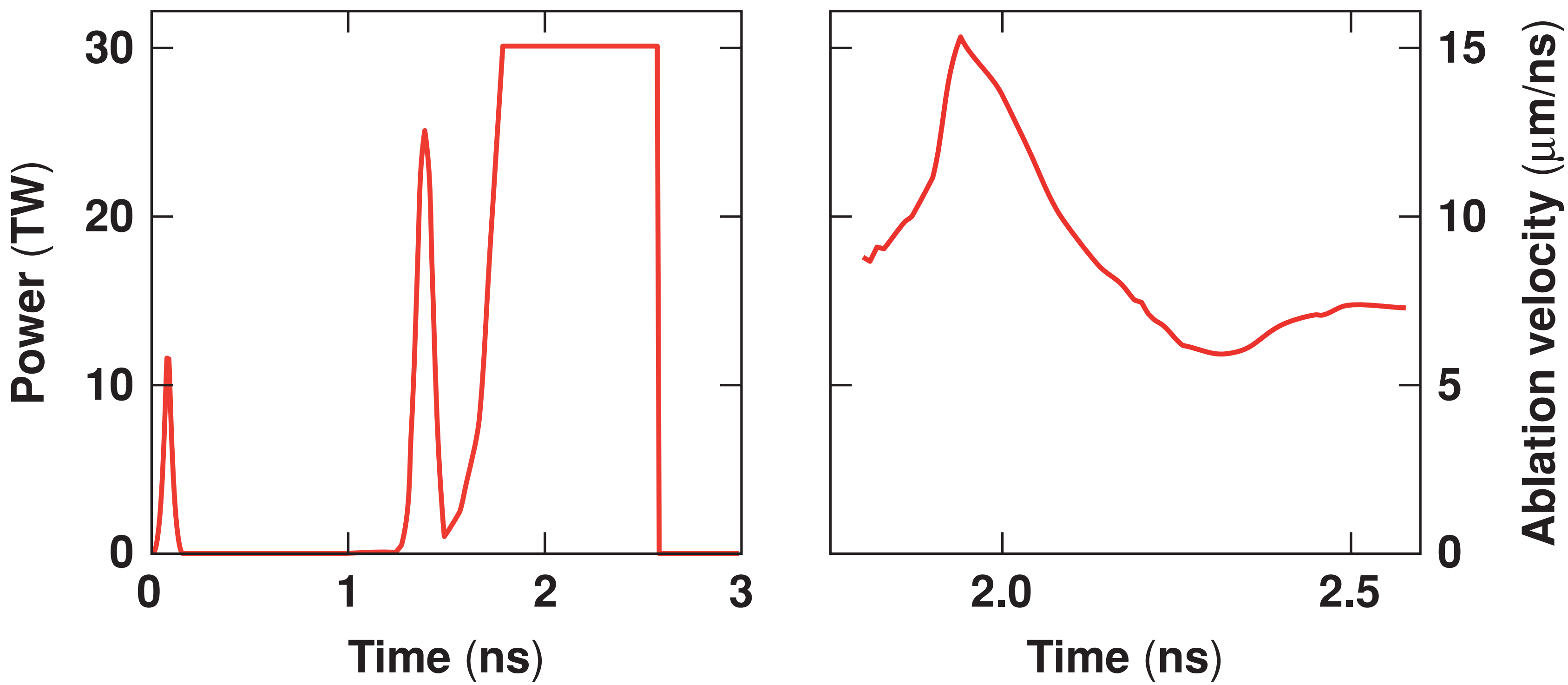
RX: σ_{rms}(outer) = 1.73 μm
σ_{rms}(inner) = 0.23 μm

Flat α = 3: σ_{rms}(outer) = 2.90 μm
σ_{rms}(inner) = 1.22 μm

TC6425

Two-prepulse, all-DT cryogenic design achieves peak ablation velocities of 15 μm/ns

Ablation velocity is comparable to indirect-drive designs!



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Summary/Conclusions

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