Simulations and Experiments on Adiabat Shaping by Relaxation

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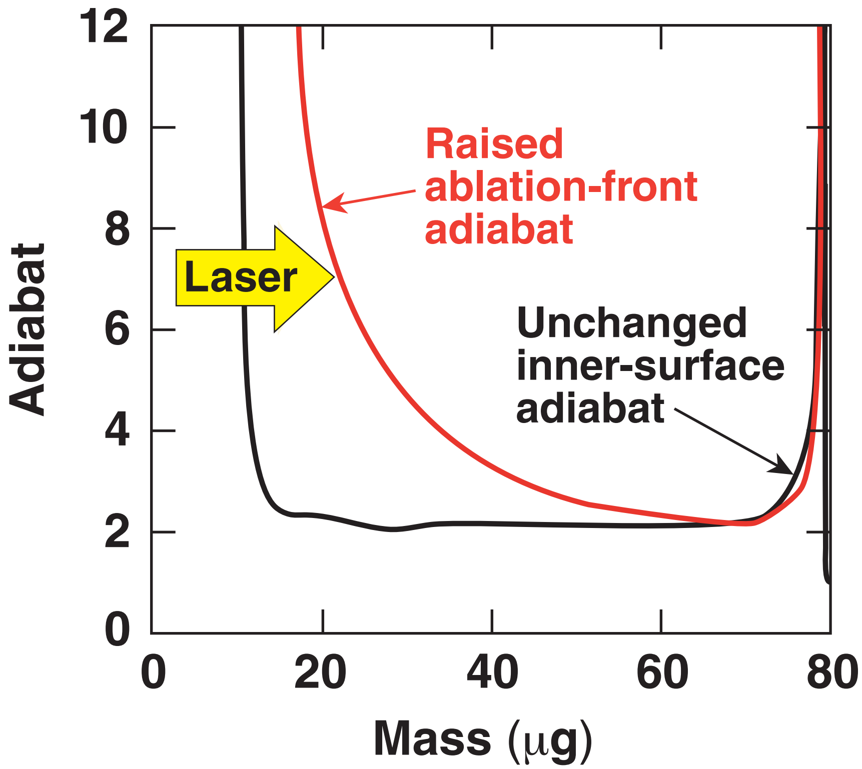

$\alpha \sim P/\rho^{5/3}$

$V_A \sim \alpha_{out}^{3/5}$

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

$E_{ign} \sim \alpha_{in}^{2}$

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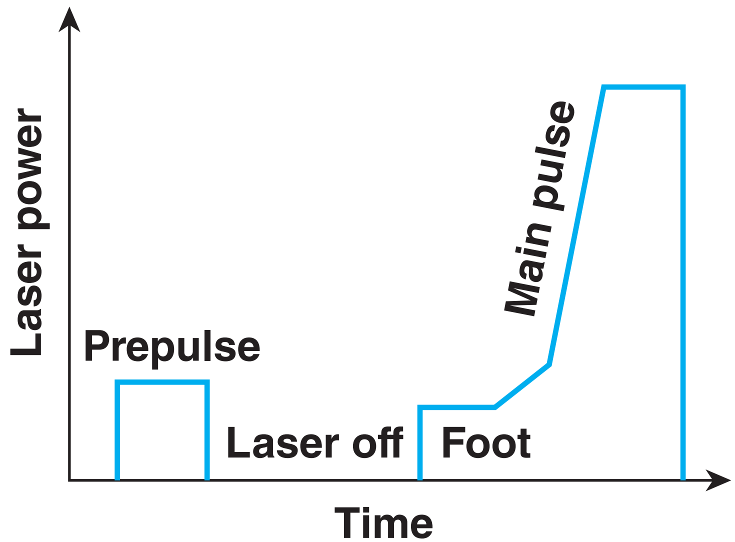
Summary

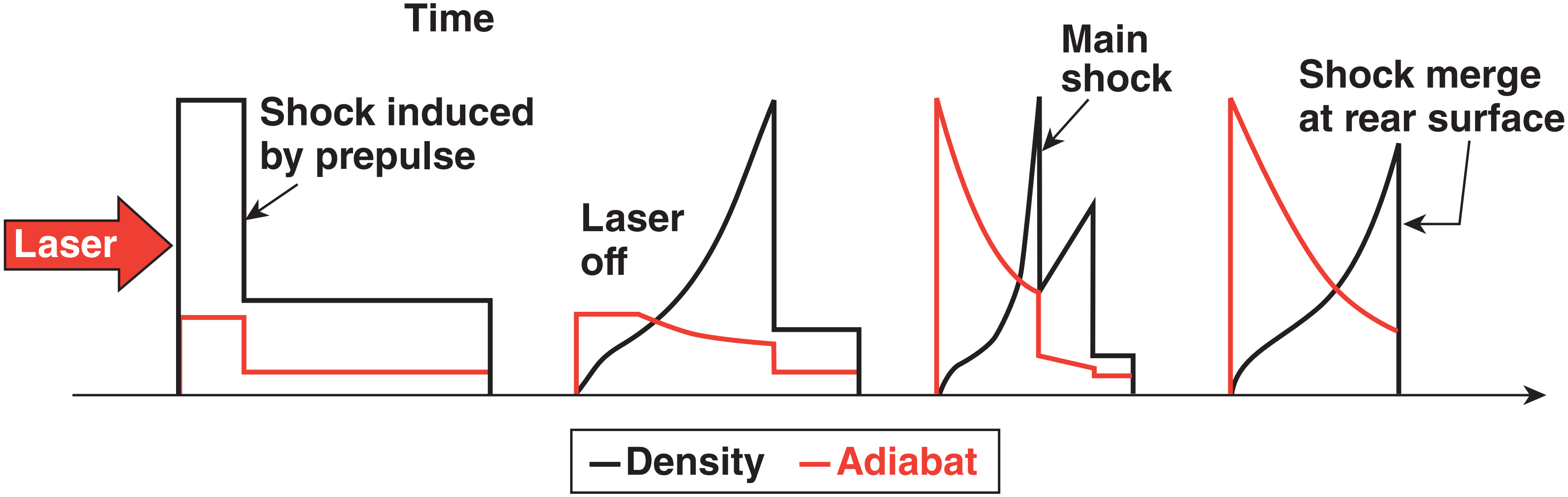
Plastic 35-μm-shell simulations and implosions on OMEGA indicate improved stability for the relaxation design

- Relaxation (RX) design shows less RT growth than flat-adiabat design in simulations.
- Plastic-shell implosions without SSD beam smoothing show higher yield for RX design than for flat-adiabat design, while yields are comparable for implosions with SSD on.
- These experiments indicate increased stability due to adiabat shaping.

In the relaxation design, a prepulse relaxes the outer shell material and the main shock tailors the adiabat



- **Rarefaction after prepulse relaxes density profile**
- **Adiabat tailored by main (foot) shock propagation through the relaxed profile**



TC6727

Thick shells and RX-shaping are required to overcome radiative shaping in plastic capsules

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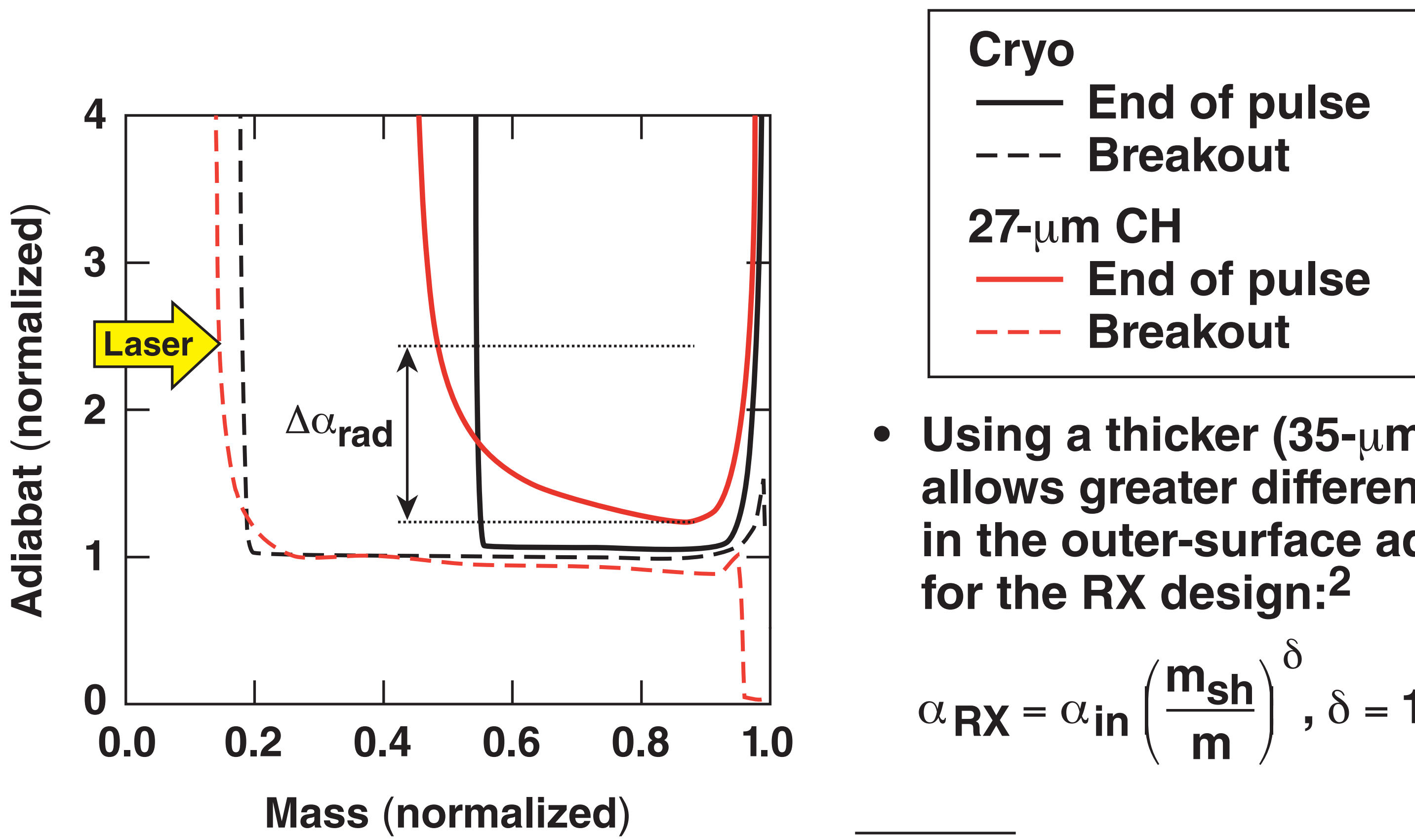
- Radiation from the hot corona is re-absorbed in shell near the ablation front, raising the local value of the adiabat.[1]



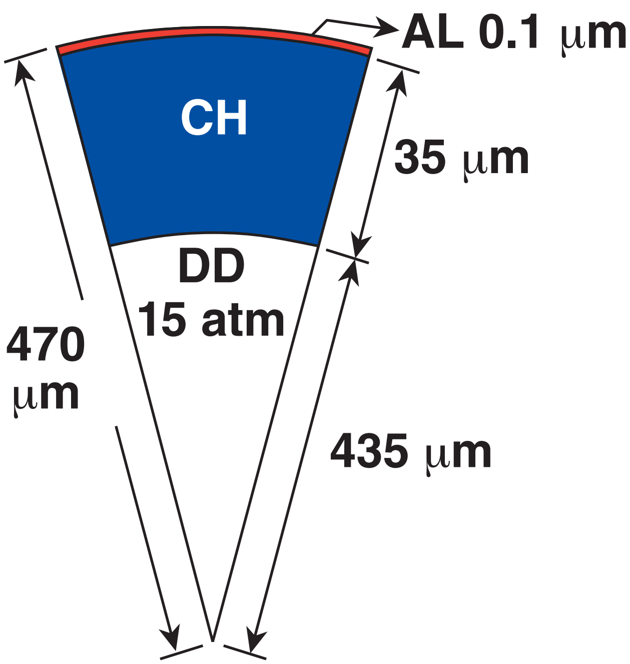
- Using a thicker (35-μm) shell allows greater difference in the outer-surface adiabat for the RX design:[2]

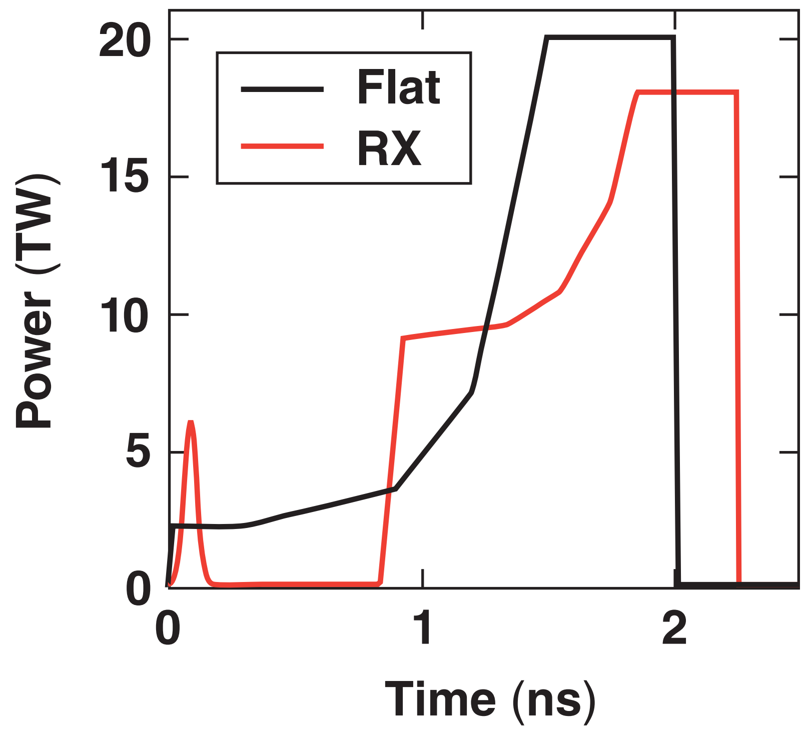
$$\alpha_{RX} = \alpha_{in}\left(\frac{m_{sh}}{m}\right)^{\delta}, \ \delta = 1.6 \text{ to } 1.8$$

[1] Gardner (1991), Phillips (1999), Bodner (2000)
[2] R. Betti, submitted to Phys. Plasmas

TC6537

Flat and relaxation pulses have been designed for 35-μm plastic capsules

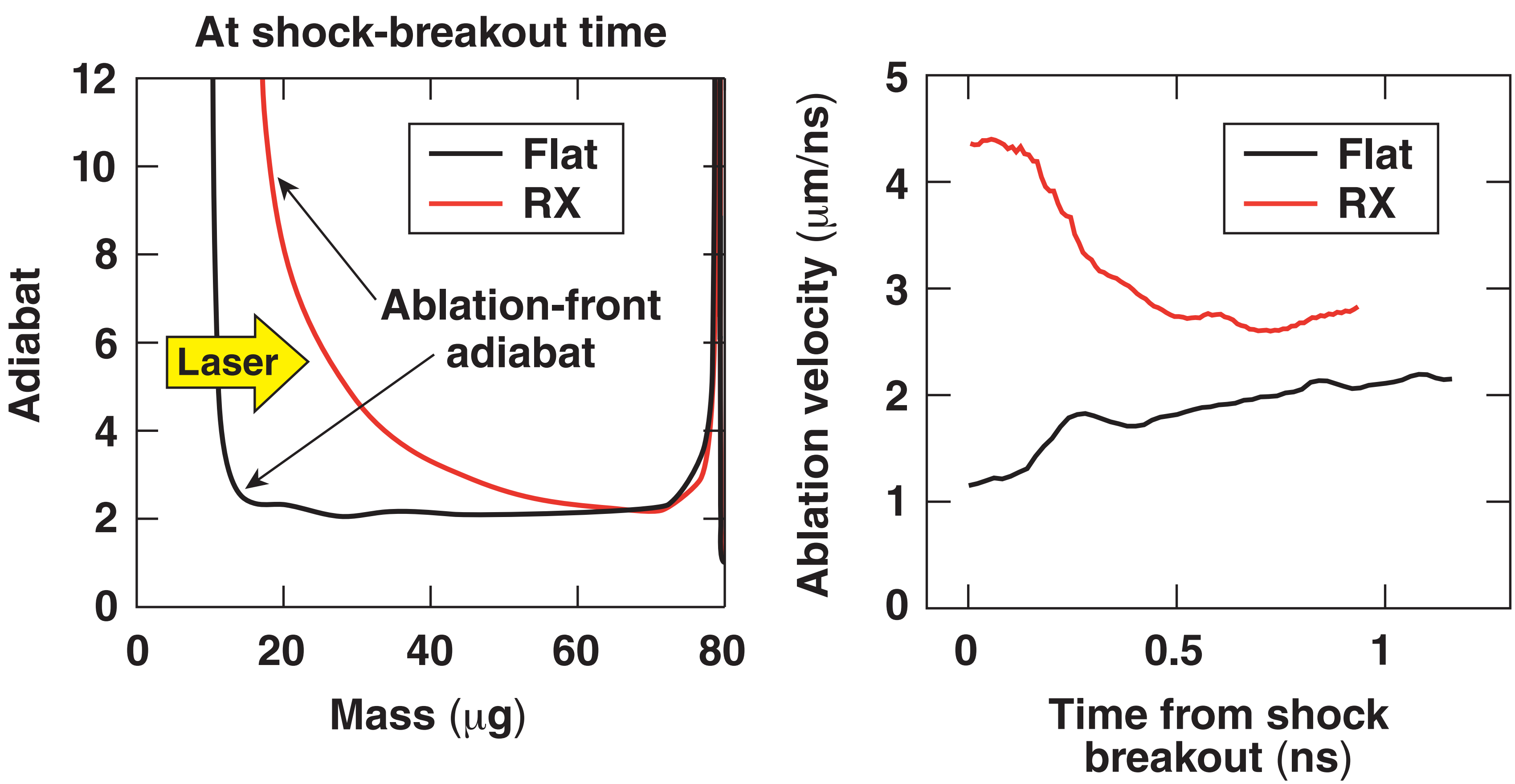




- Total laser energy: 18 kJ
- 1-D, DD neutron yields ~ 5×10^{10}
- 6-TW, 60-ps Gaussian prepulse (RX)
- Contrast ratio of 2 in RX main pulse

TC6426b

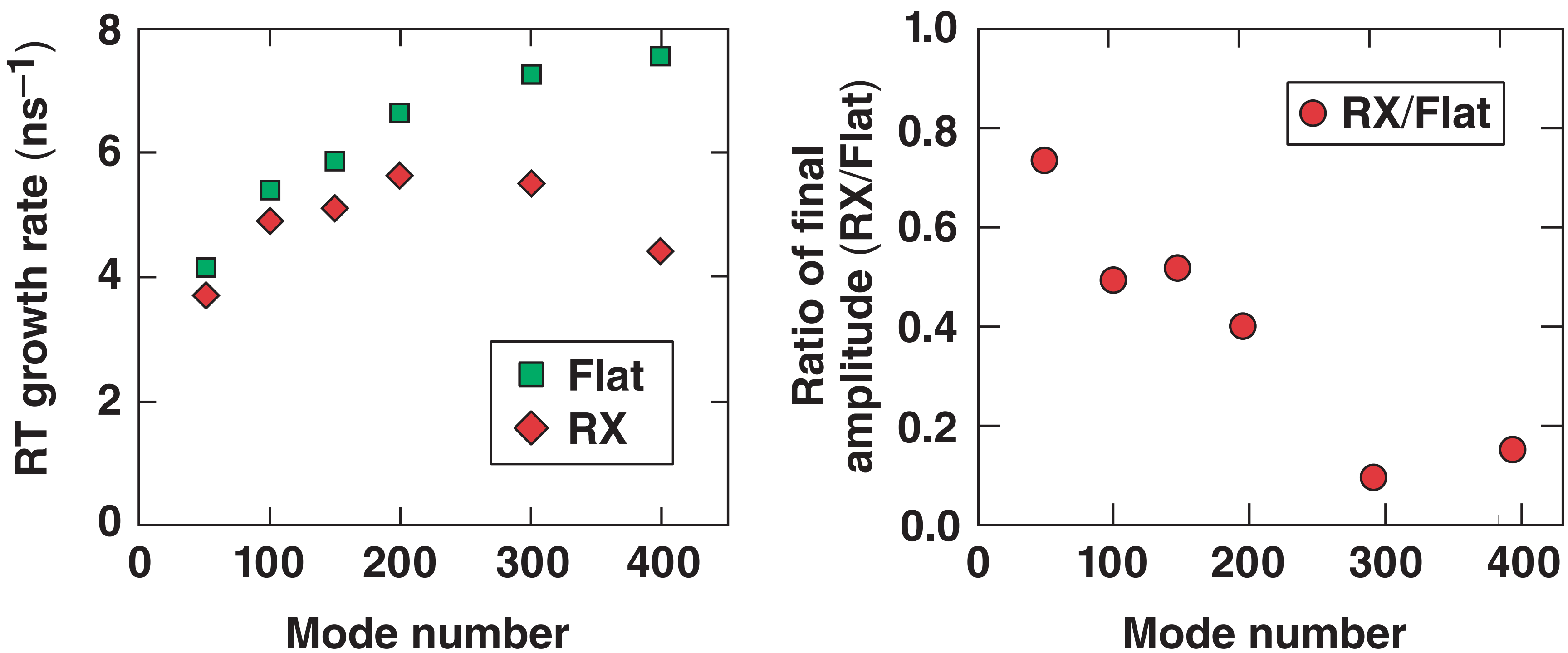
Simulations indicate RX adiabat shaping is effective in increasing the ablation velocity in 35-μm plastic shells



- Ablation velocities in CH are much lower than in cryogenic DT, so RT mitigation should be higher in cryogenic RX designs

TC6428b

Single-mode *DRACO* simulations in the linear regime show lower Rayleigh–Taylor growth rates for RX design



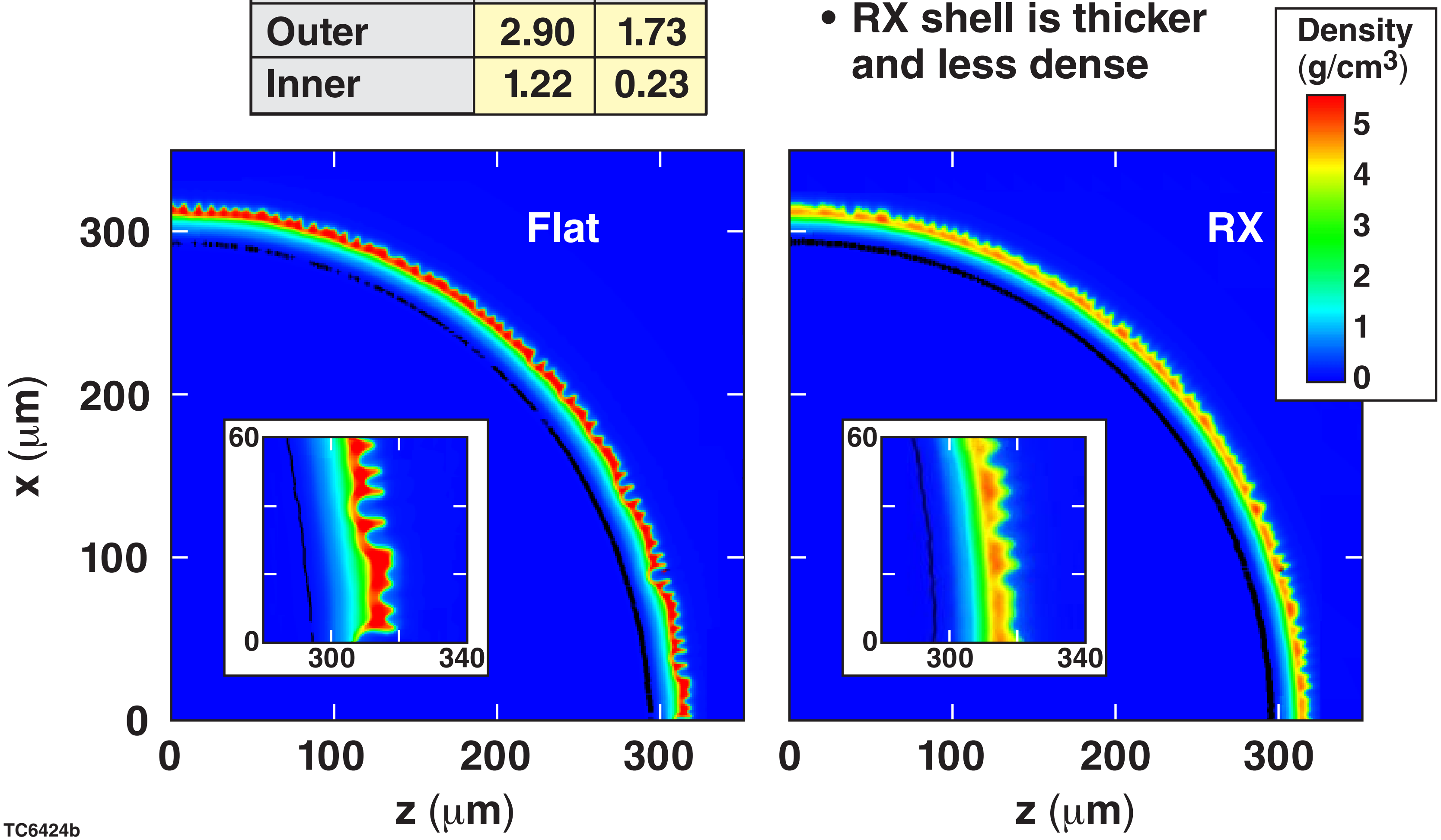
TC6429b

DRACO multimode simulations indicate the RX design is more stable at the end of the acceleration phase

- Multimode laser imprint modeled for even modes ℓ = 2 to 300

σ_{rms} (μm)	Flat	RX
Outer	2.90	1.73
Inner	1.22	0.23

- RX shell is thicker and less dense



TC6424b

Experimental results suggest stabilization of short-wavelength modes due to adiabat shaping

Yield ($\times 10^9$)	Flat	RX
SSD on	5.6±0.2	6.8±0.2
SSD off	2.2±0.1	5.5±0.5

- SSD reduces short-wavelength imprint levels more strongly.
- Neutron yield in SSD-on shots are not strongly affected by short-wavelength asymmetries.*
- With SSD turned off, amplified imprint makes short-wavelengths dominate for flat-adiabat targets, while increased ablation velocity for RX targets compensates for the enhanced imprint, resulting in no degradation in yield.

*P. B. Radha, BI2.004

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TC6726