2-D Simulations of Adiabat-Shaped Implosions for Cryogenic Experiments on OMEGA

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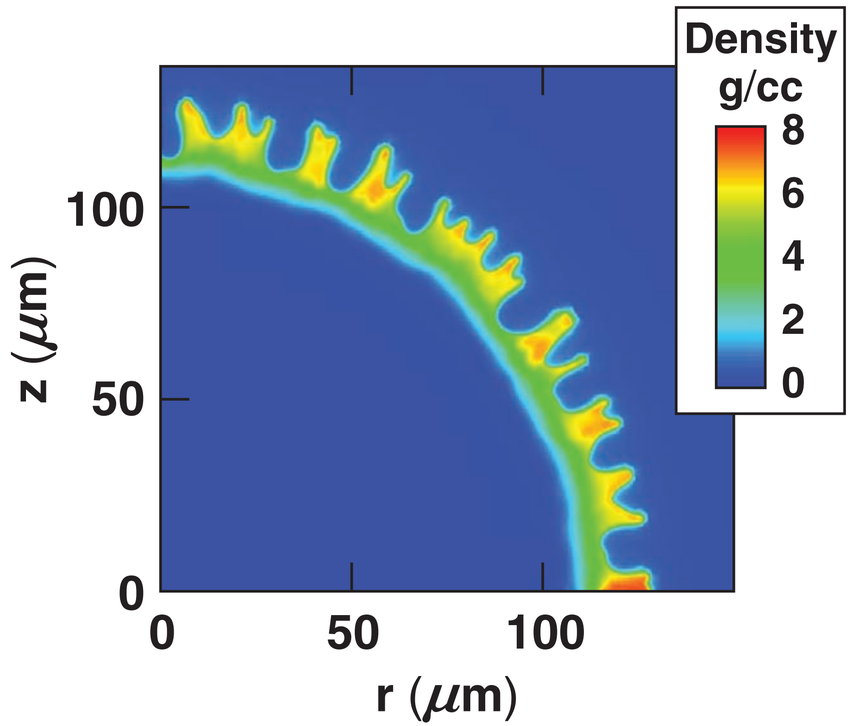

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47th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Denver, CO
24–28 October 2005

Summary

Using laser pickets or prepulses can reduce the Rayleigh–Taylor growth in cryogenic ICF capsules without compromising compressibility

- Decaying shock (DS) and Relaxation (RX) methods use a picket or prepulse to tailor the adiabat in the shell:
  - High adiabat at ablation surface → high stability
  - Low adiabat on inner shell surface → high compression
- Both DS and RX designs are shown to improve shell modulation over conventional flat-adiabat designs with the same 1-D performance.
- The DS target has lowest imprint, the RX has lowest growth rates.

The adiabat in the shell can be tailored to achieve simultaneously high stability and high compressibility

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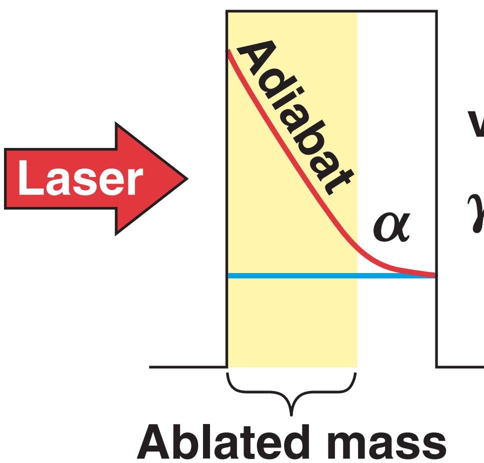
- Stability and compressibility of the capsule depend on the adiabat at <u>different</u> parts of the shell. $\alpha \sim P/\rho^{5/3}$

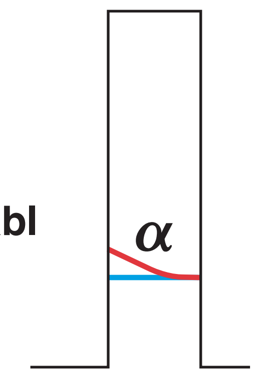
<u>During acceleration</u>
High outer adiabat = high ablation velocity

<u>After acceleration</u>
Low inner adiabat = high compression



$v_{abl} \sim \alpha^{3/5}$,

$\gamma_{RT} = 0.94\sqrt{kg} - 2.7kv_{abl}$



$E_{ign} \sim \alpha_{in}^{1.8}$

Shaped adiabat
Standard flat adiabat

- Such adiabat profiles can be generated by use of pickets or prepulses.

[1]R. Betti *et al.*, Phys. Plasmas <u>5</u>, 1446 (1998).
[2]M. C. Herrmann *et al.*, Nucl. Fusion <u>41</u>, 99 (2001).

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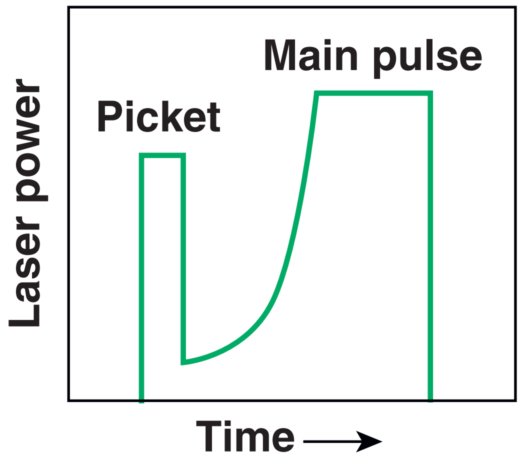
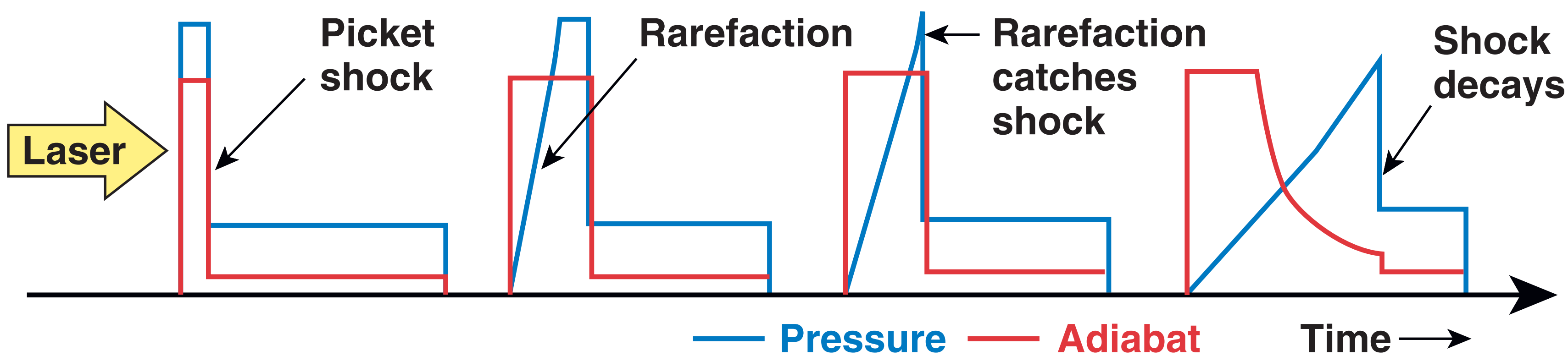
Adiabat shaping by a decaying shock (DS)[1,2] requires only the addition of a laser picket



- High-intensity picket followed by lowered intensity drives the decaying shock.
- An adiabat set by a decaying shock is high at front (outer) surface and low at the back (inner) surface.

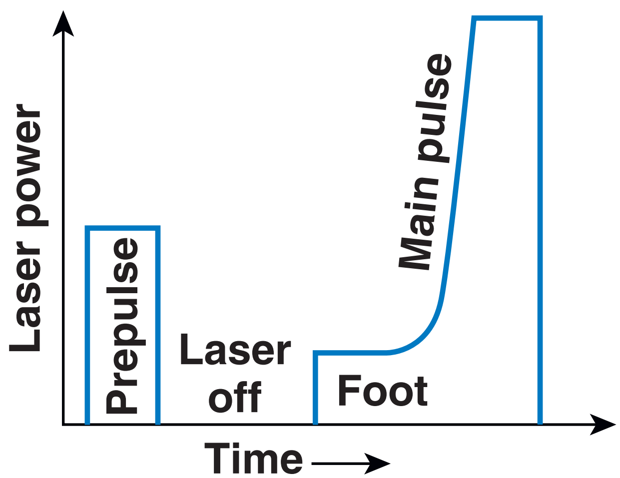
DS shapes postshock pressure

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



[1]Goncharov *et al.*, Phys. Plasmas 10, 1906 (2003).
[2]Anderson *et al.*, Phys. Plasmas 10, 4448 (2003).

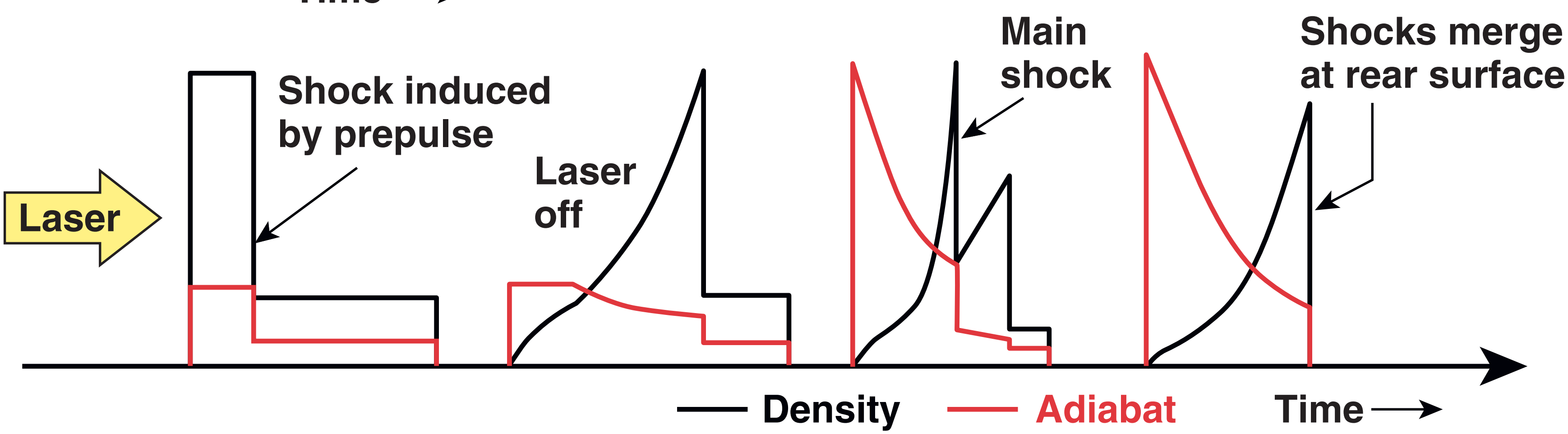
In the relaxation design (RX),[1] a prepulse relaxes the outer shell material and the main shock tailors the adiabat



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

RX shapes density

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



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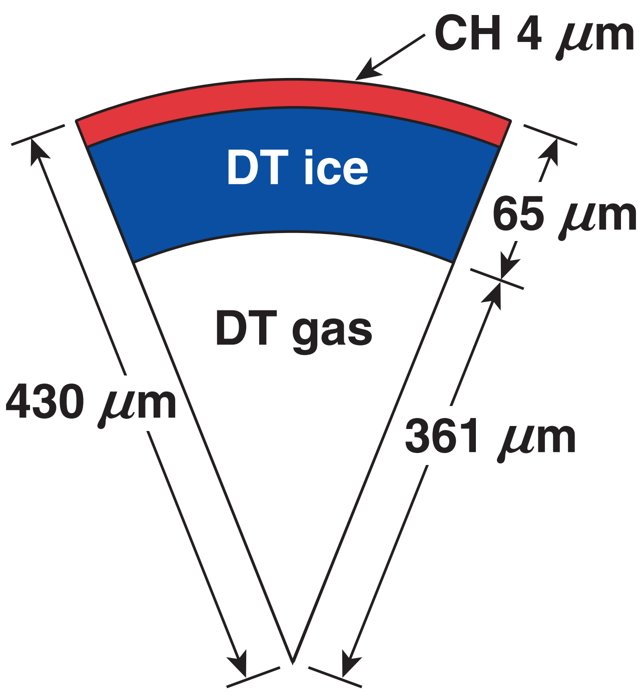
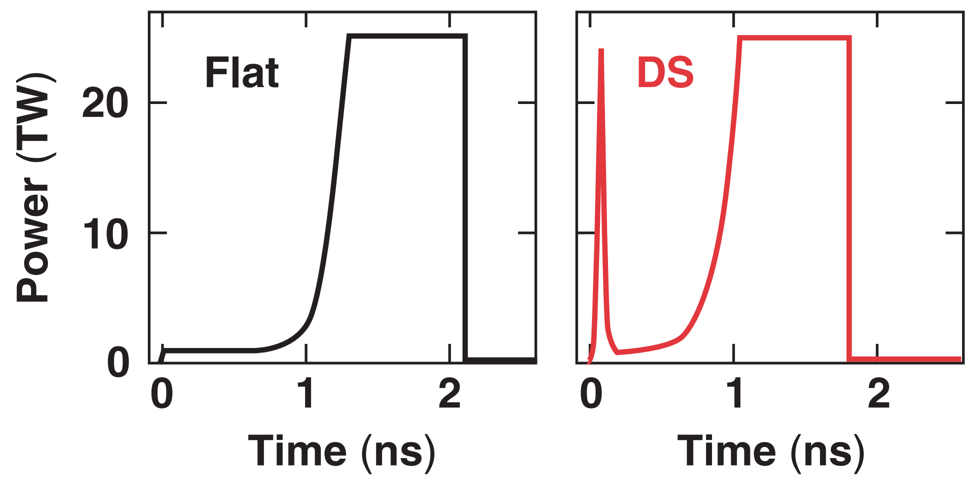
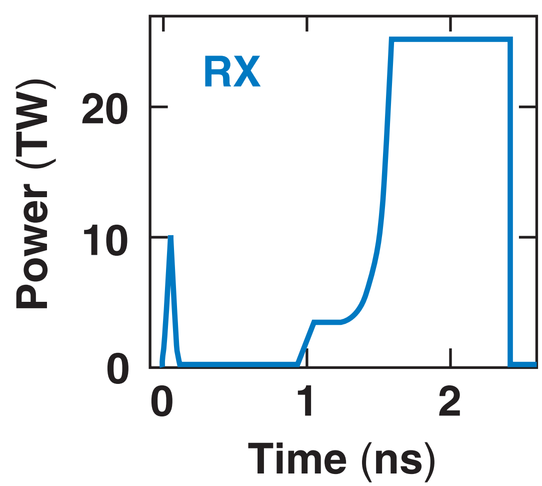
[1]Anderson *et al.*, Phys. Plasmas 11, 5 (2004).

Flat, decaying-shock and relaxation pulses have been designed for high-yield cryogenic experiments

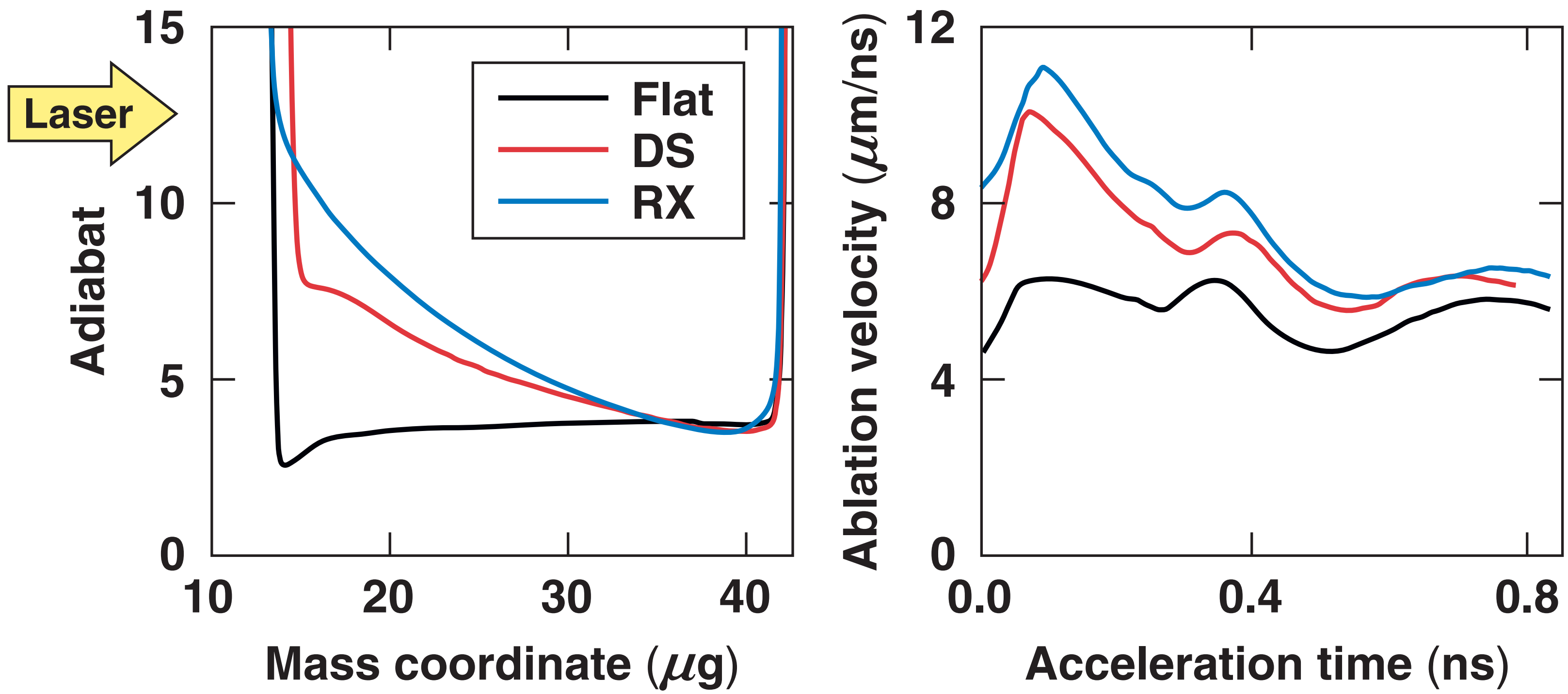






- Laser energy on target: 25 kJ
- 1-D, DT-neutron yields: $4.7 \pm 0.1 \times 10^{14}$

1-D simulations indicate RX adiabat shaping is more effective than DS in increasing the ablation velocity in cryogenic shells



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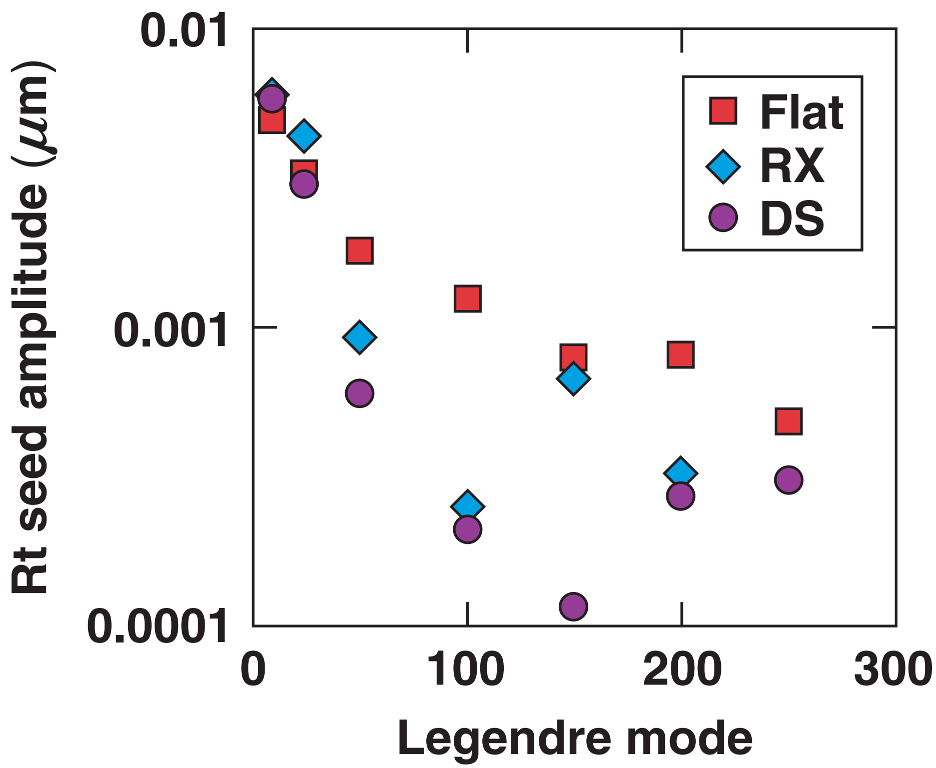
Single-mode *DRACO* simulations show the lowest Rayleigh–Taylor seeds for the DS design



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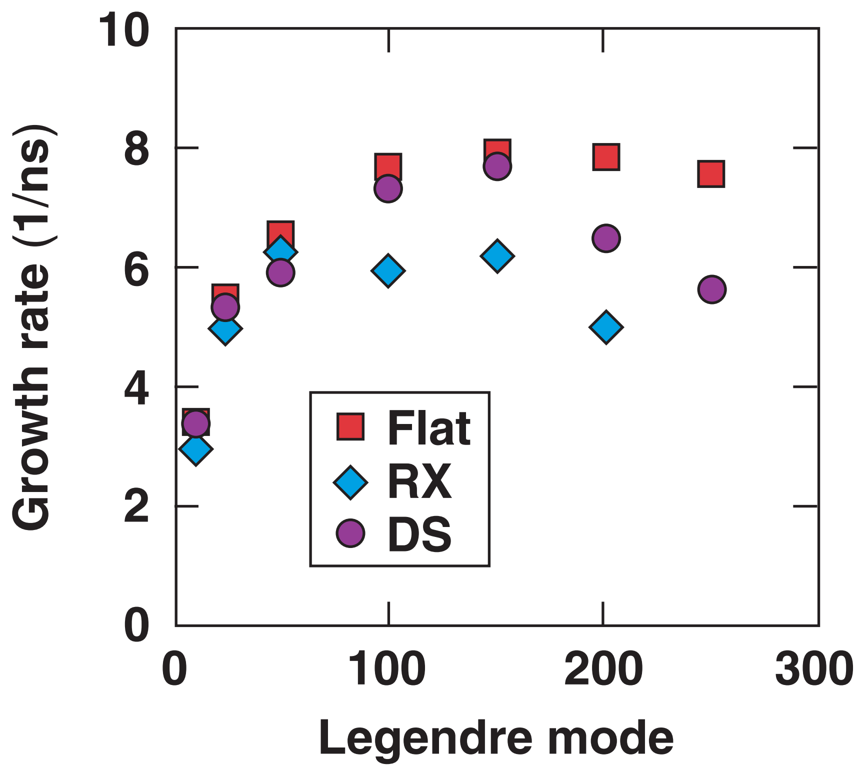
Single-mode *DRACO* simulations in the linear regime show the lowest Rayleigh–Taylor growth rates for the RX design



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DRACO multimode simulations show improved capsule stability in DS and RX designs

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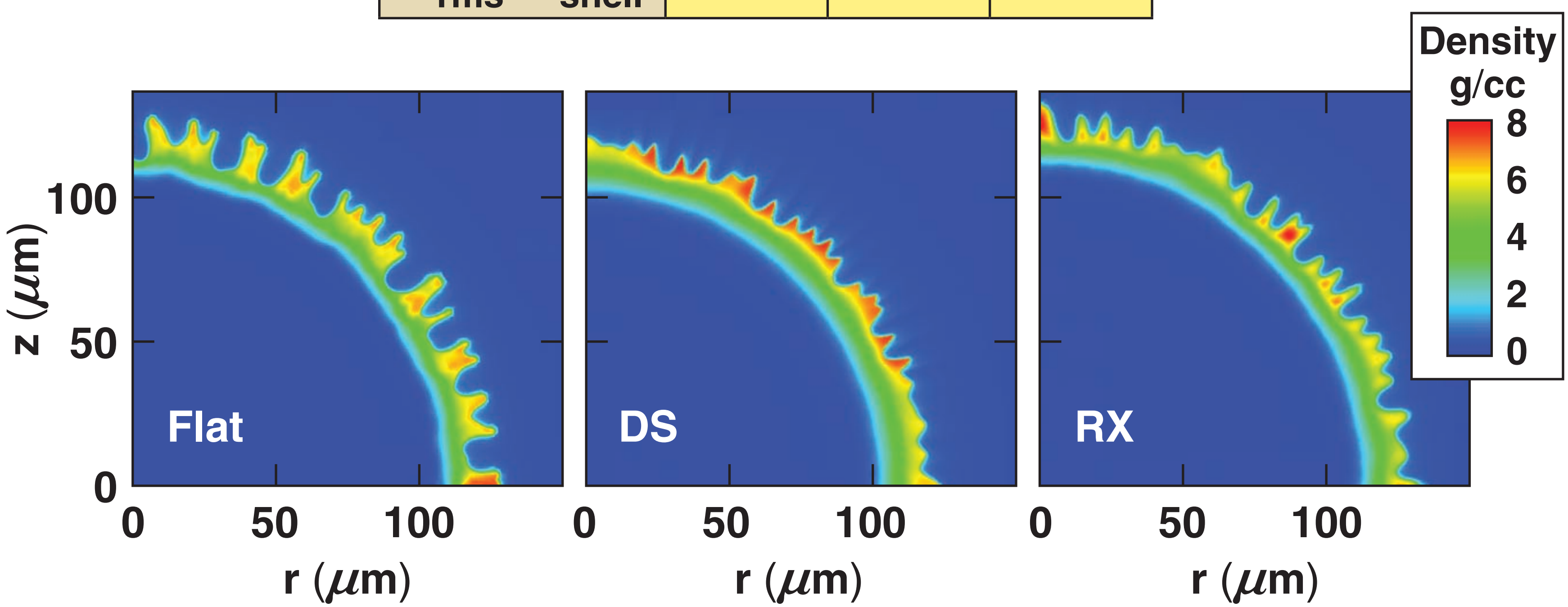
	Flat	DS	RX
$\sigma_{rms}/\Delta r_{shell}$	34%	10%	16%



- Multimode laser imprint modeled for even modes ℓ = 2 to 100
- Simulations ongoing including higher modes ℓ = 2 to 200

- RX cryo experiments planned in late FY06/FY07
- DS cryo experiments ongoing

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Summary/Conclusions

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