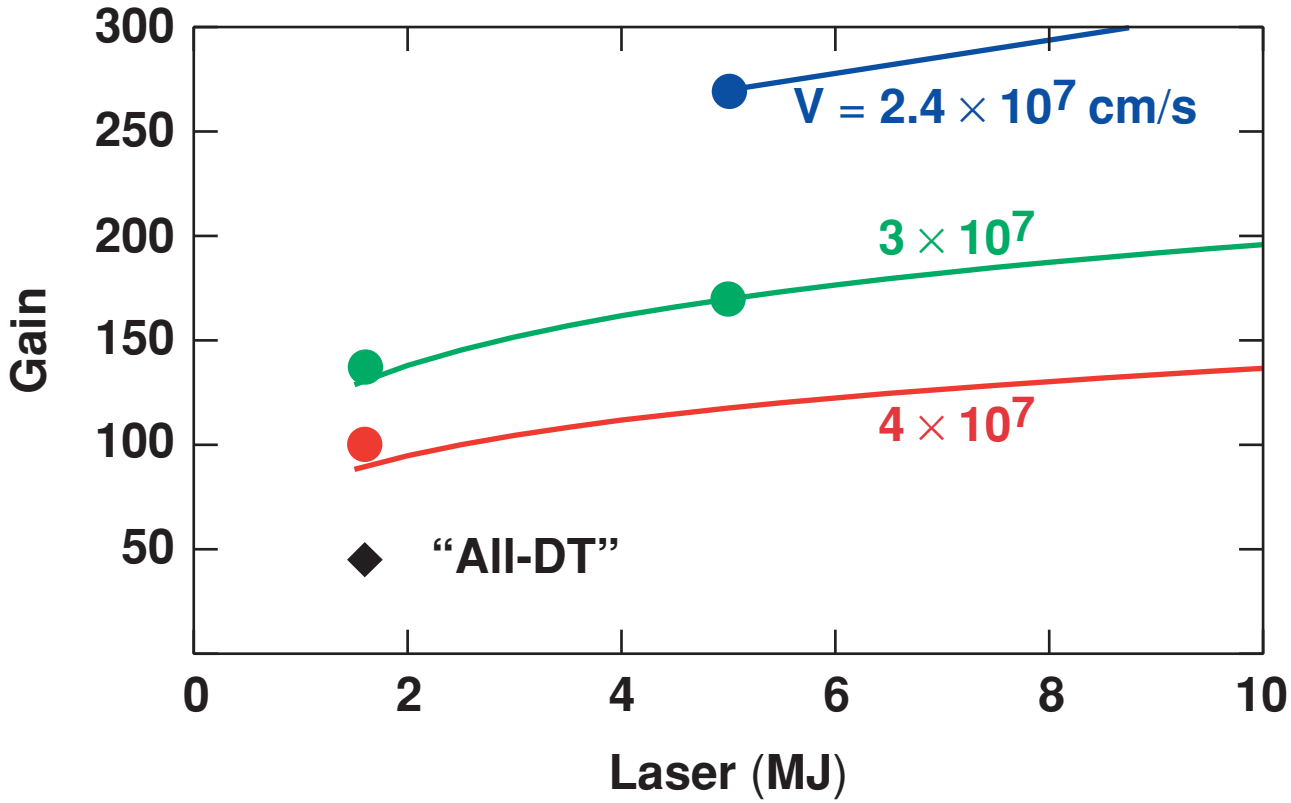
High-Performance Direct-Drive Target Designs for IFE



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UR LLE

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Summary

Direct-drive IFE target designs can have gains approaching 300

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- The designs use
  - wetted foam for enhanced laser absorption and
  - an intensity picket for adiabat shaping and imprint reduction.
- The target design concepts can be tested with experiments on the OMEGA laser

High-gain target designs combine wetted foam with adiabat shaping

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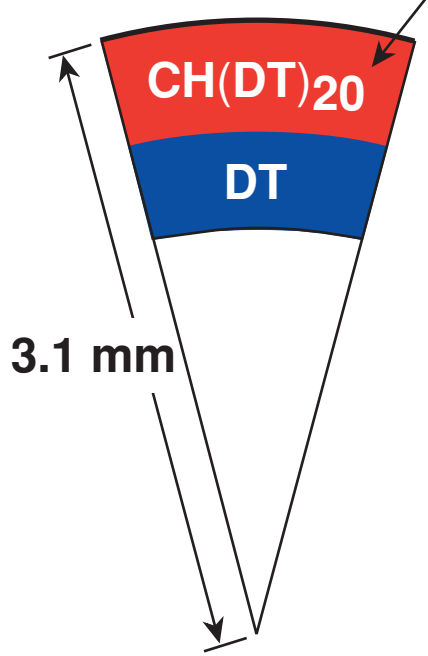
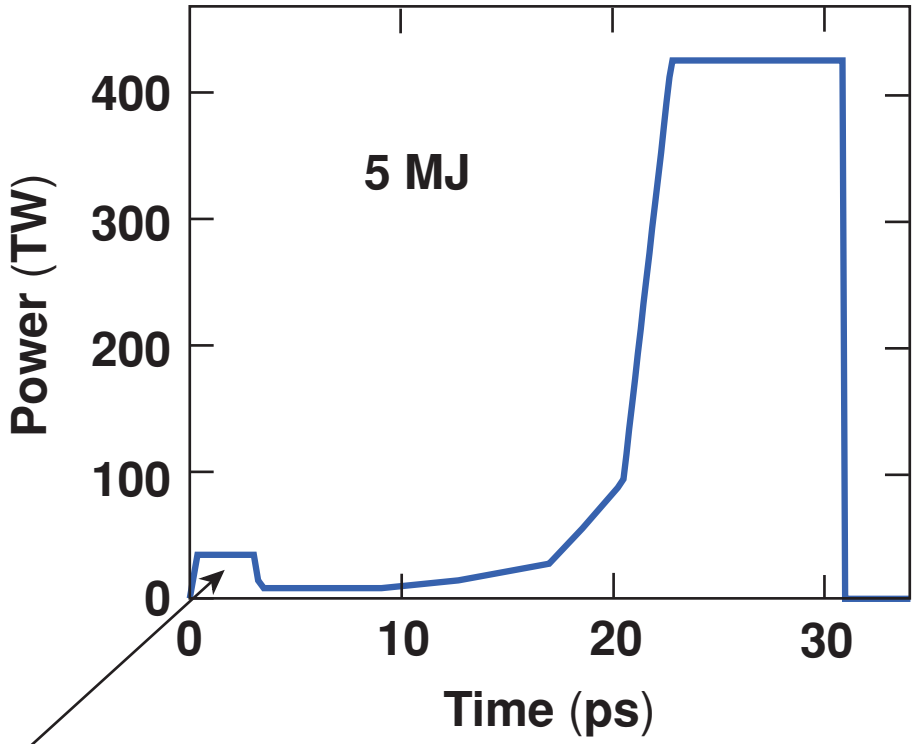
Moderate-*Z* material increases laser absorption without significant radiation preheat.

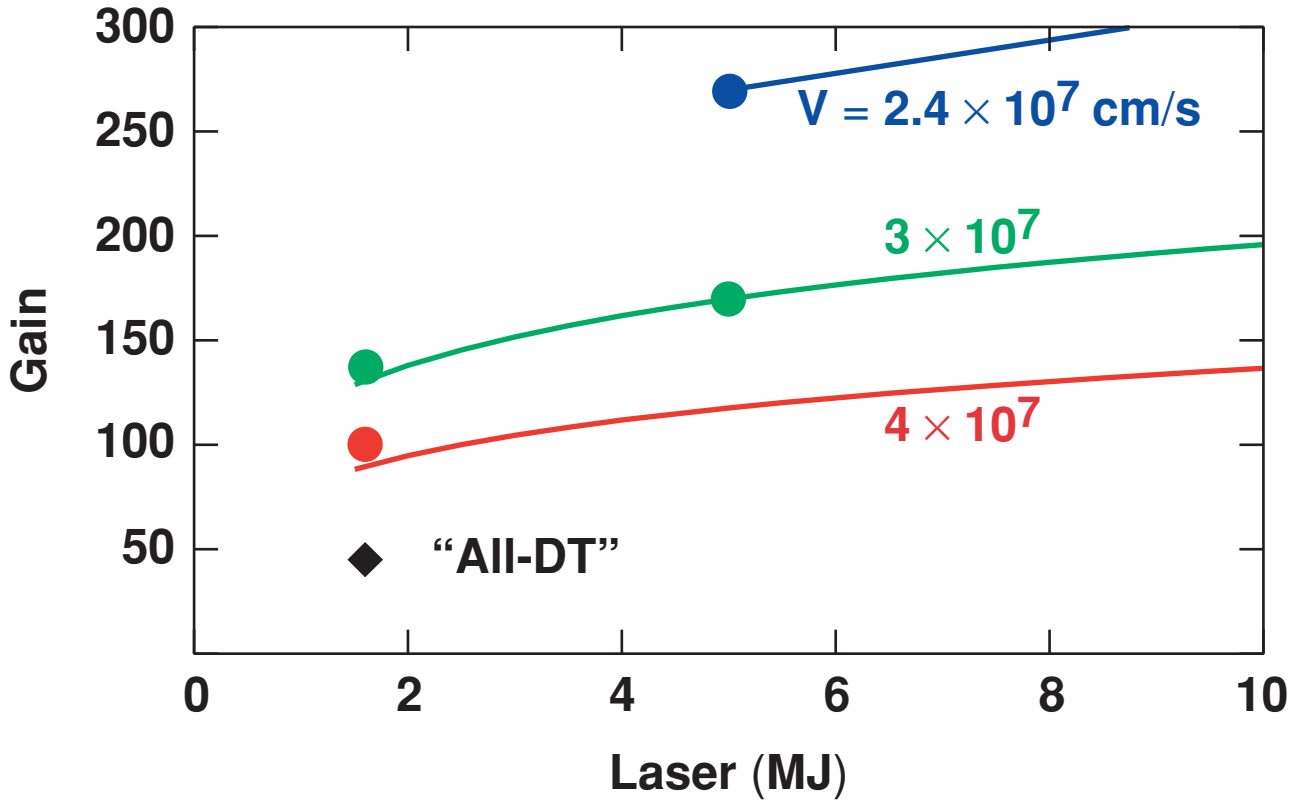




Intensity spike reduces imprint and shapes adiabat.

TC5927a

Target gains of ~300 are possible for direct-drive IFE designs using wetted foam and adiabat shaping



TC5976

NIF

Wetted-foam targets have higher laser absorption than DT, allowing more fuel and higher gain

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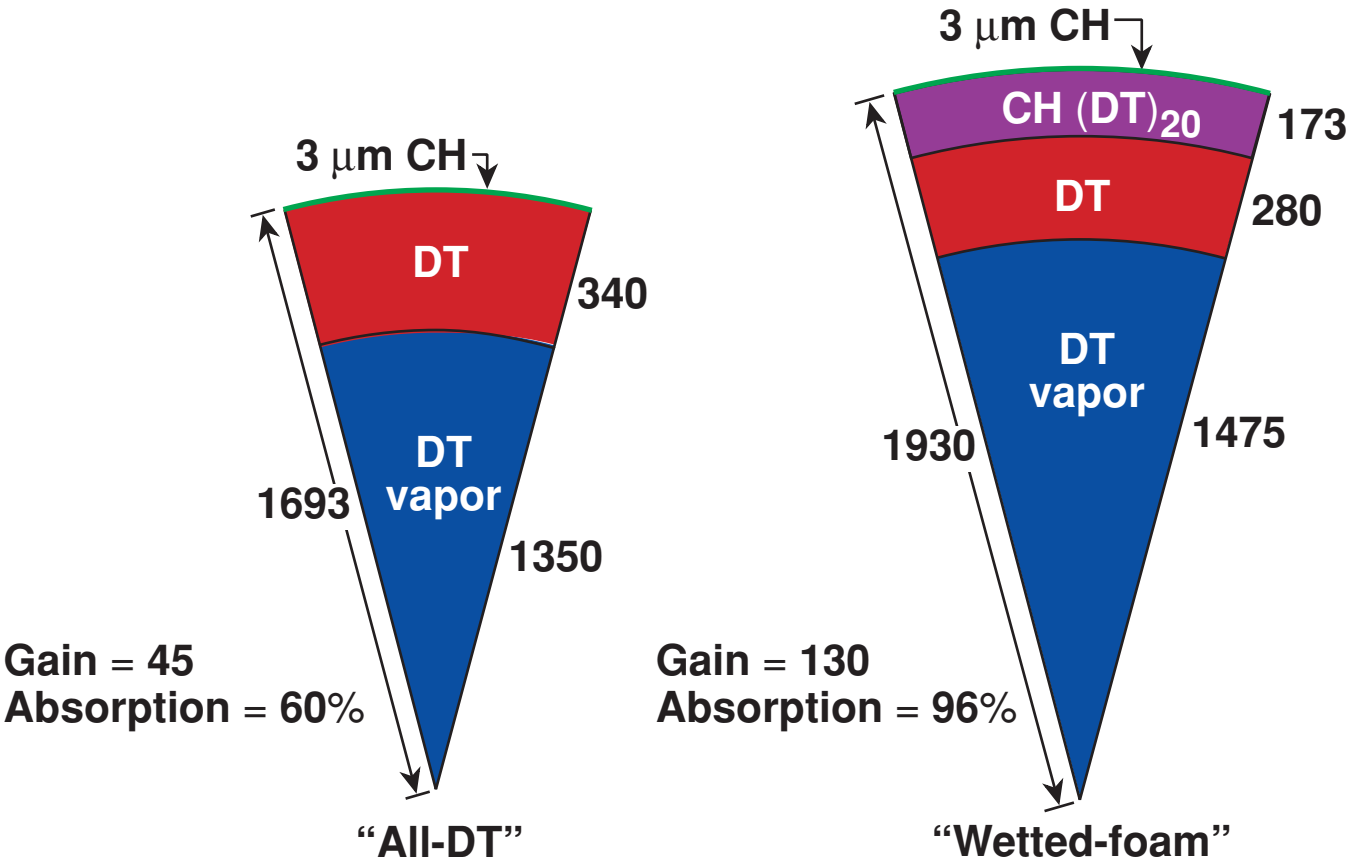
- Foams have been used previously to selectively radiatively preheat the ablator.[1]



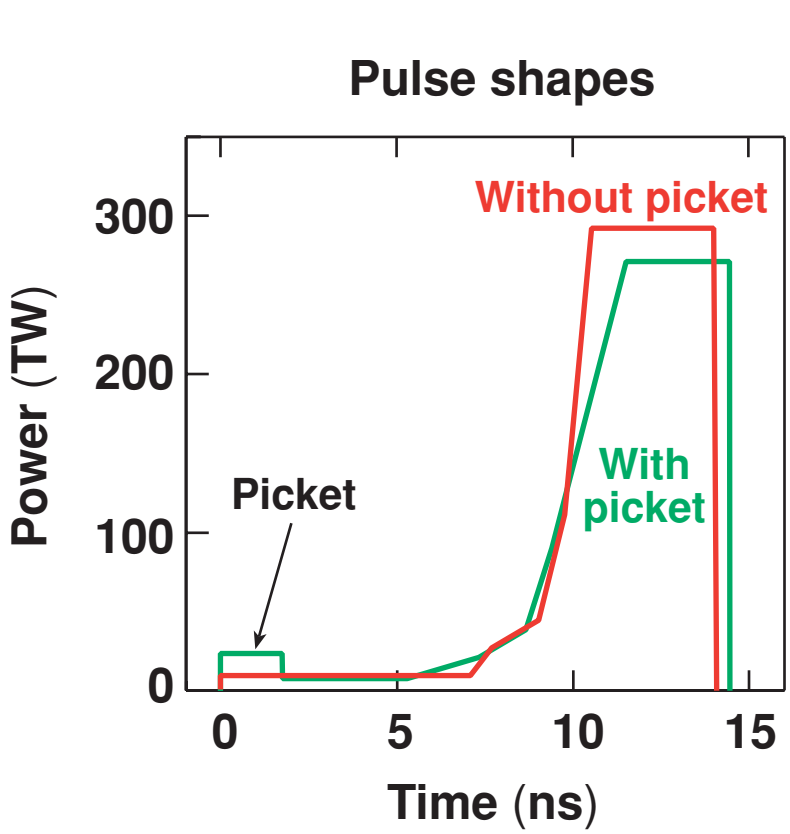
- The foam also protects the fuel from preheat due to radiation from the CH.
- A lower-gain (G = 80), more-stable target with $CH(DT)_4$ foam has also been designed.

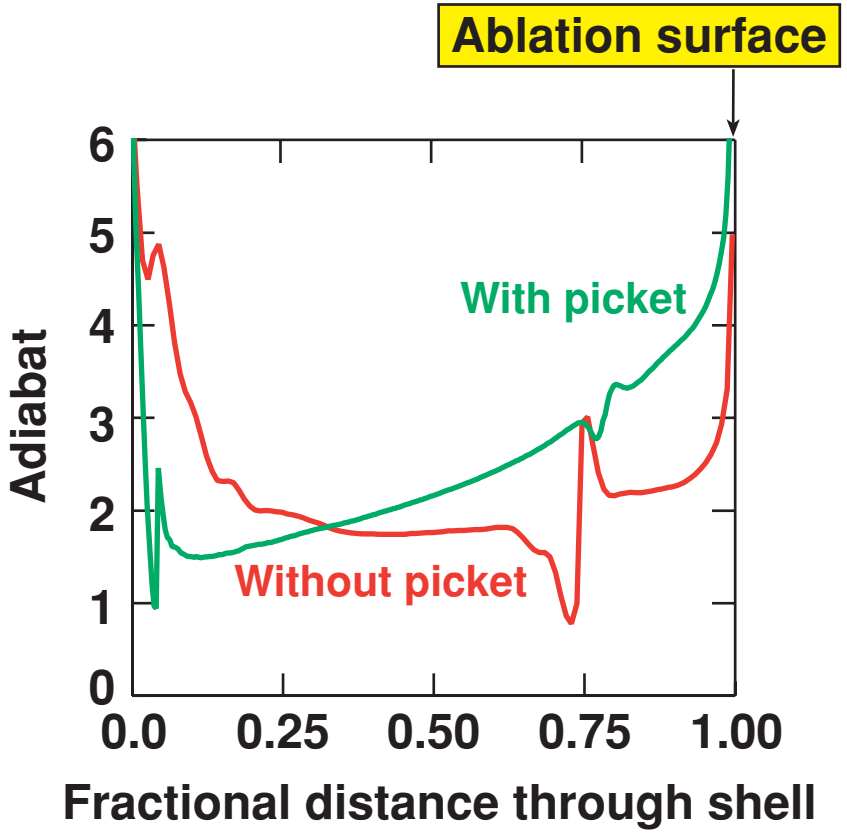
[1] D.G. Colombant *et al.*, Phys. Plasmas 7, 2046 (2000).

TC5787d

A “picket” prepulse provides increased stability

- A high-intensity picket results in a decaying shock.
- This results in an adiabat that decreases throughout the shell, stabilizing the outer surface without preheating the fuel.

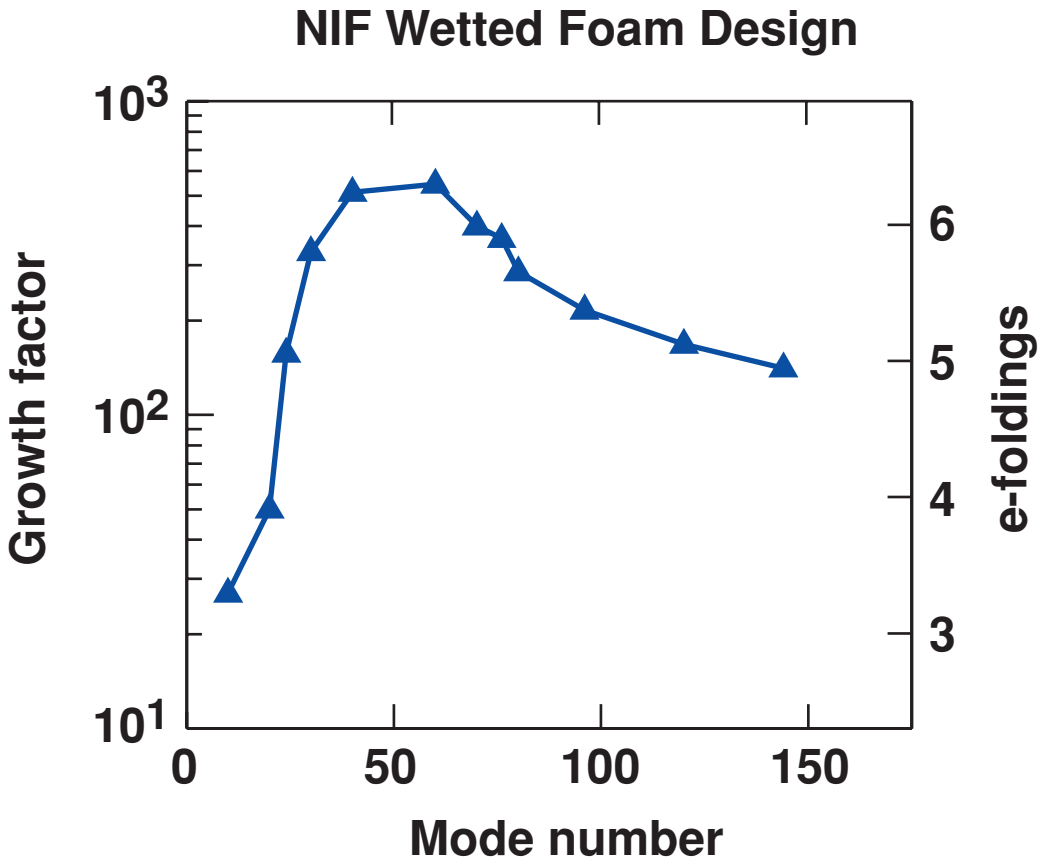




TC6052a

Growth Factors

2-D linear growth-factor calculations show only moderate growth of nonuniformities



TC6053a

OMEGA

Stabilizing effects of adiabat shaping can be tested on the "all-DT," $\alpha = 3$ OMEGA target design

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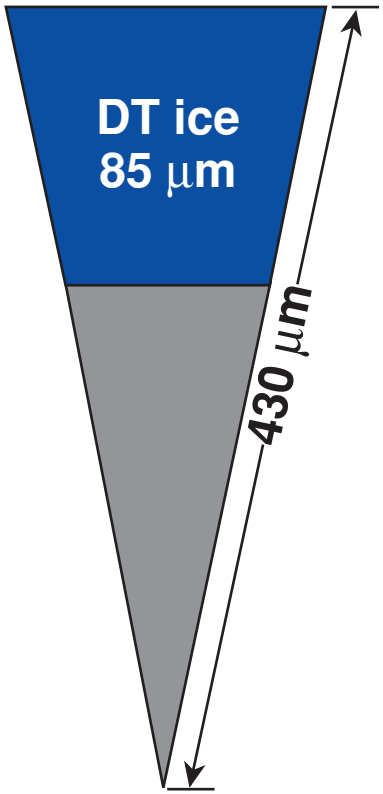
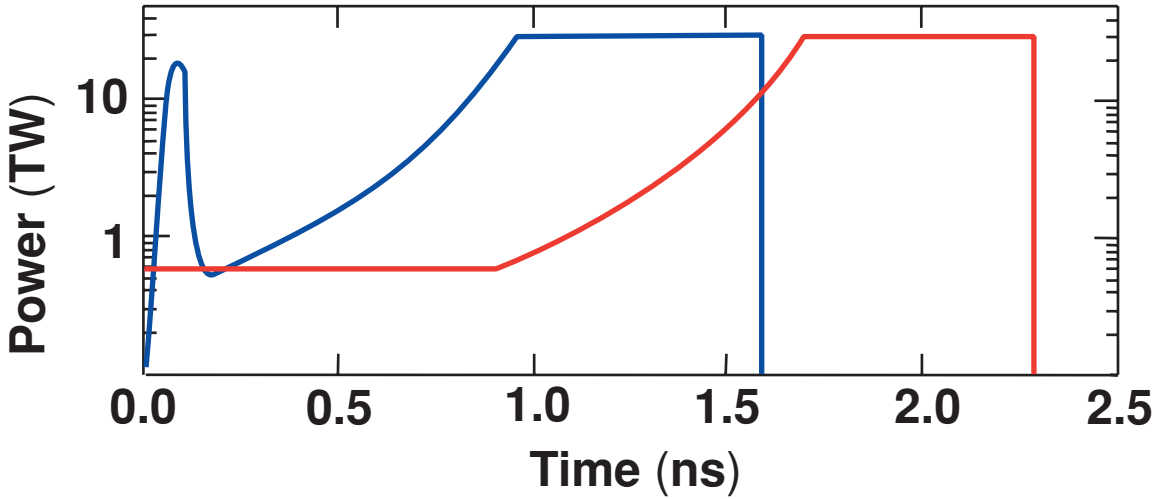
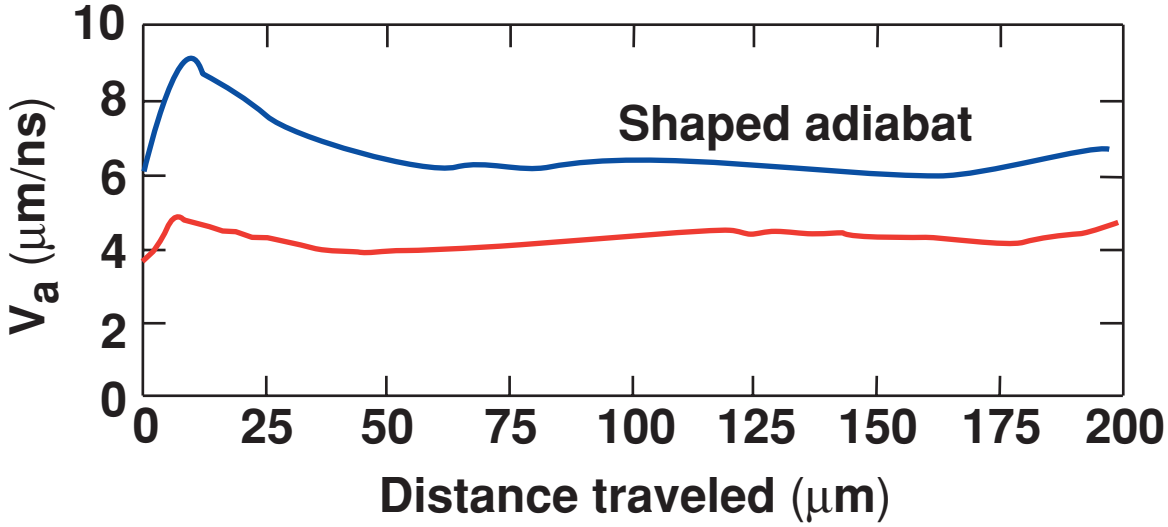
Two pulse shapes were considered



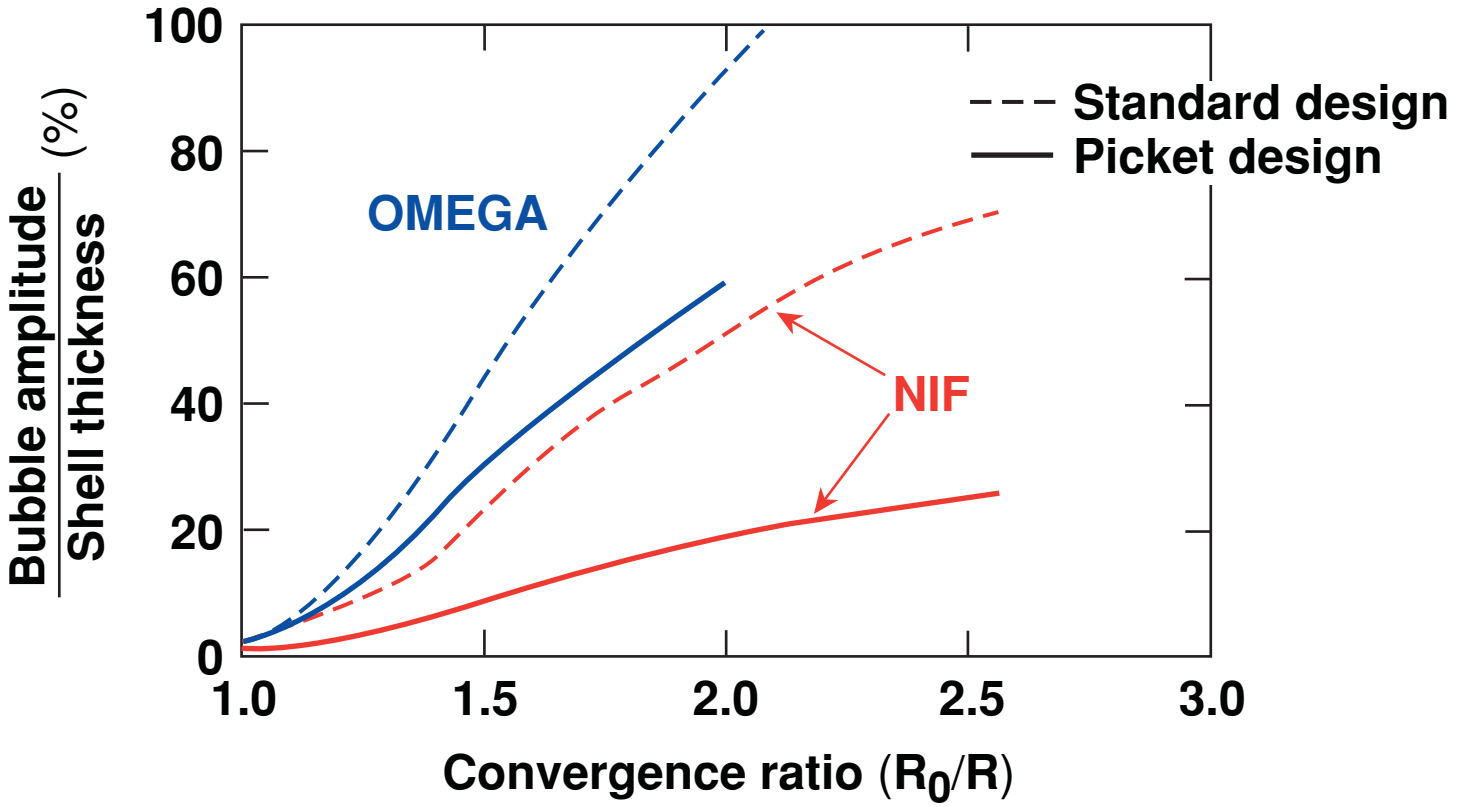




TC5954a

Enhanced stability during acceleration is predicted for the picket design

- 1-THz, 2-D SSD, 80-nm outer surface roughness, 1 μm inner ice roughnes
- The bubble amplitude is calculated using the stability postprocessor.[1]



[1]V. N. Goncharov *et al.*, Phys. Plasmas 7, 5118 (2000).

TC6127

OMEGA

Mode decomposition shows the effect of the picket on the laser imprint amplitudes[1] and RT growth rates

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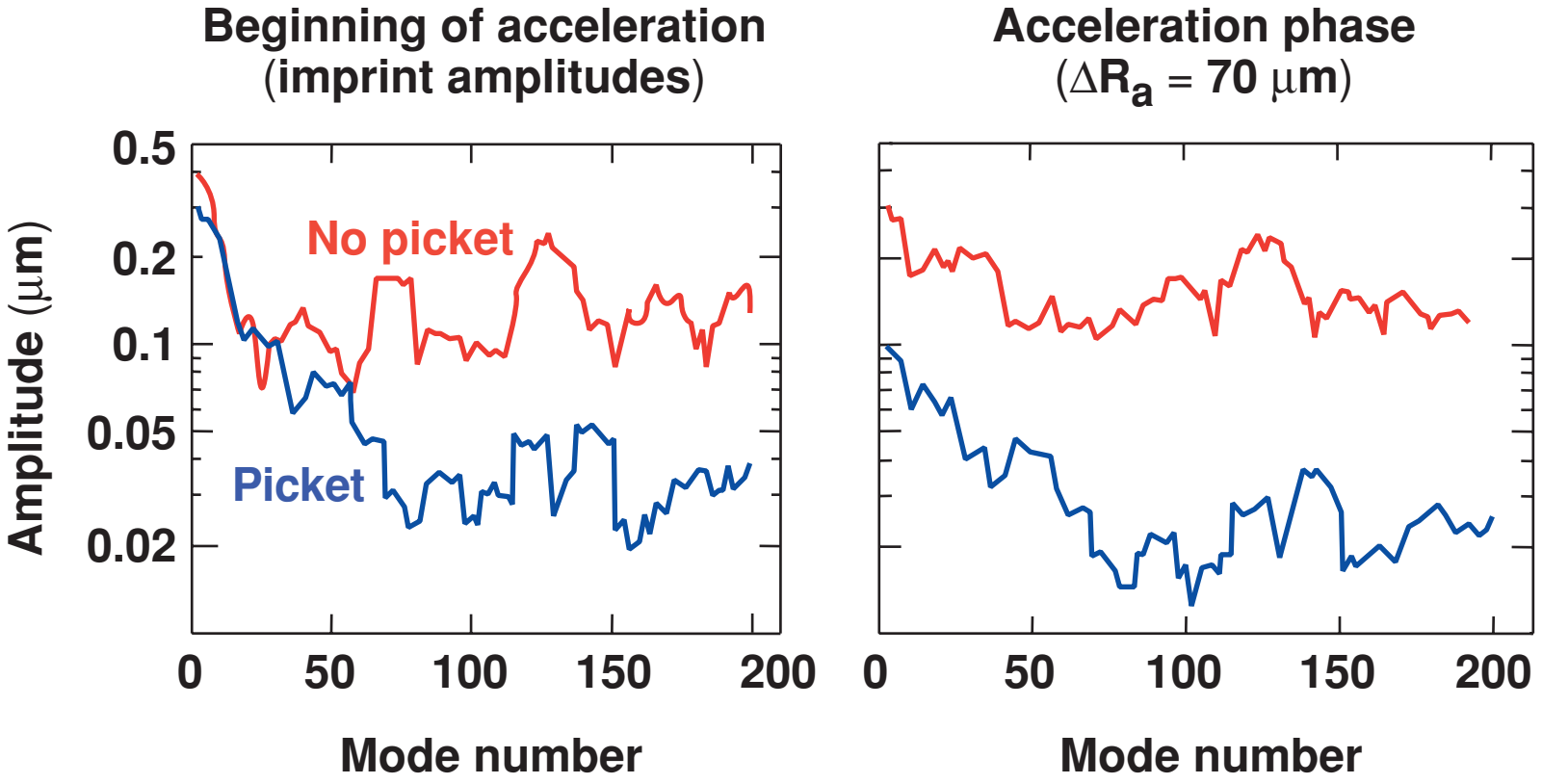

[1]T. J. B. Collins and S. Skupsky, Phys. Plasmas 9, 275 (2002).

TC5958a

Wetted-foam experiments on OMEGA could produce 30× the neutron yield as all-DT experiments due to increased laser absorption

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OMEGA Designs ($\alpha = 3$)

	All DT	Wetted foam
Neutron yield	1.1×10^{14}	3.6×10^{15}
Gain	0.01	0.3
Absorption (%)	40	73
Peak ρR (g/cm^2)	0.25	0.57
Adiabat (α)	3	2.5
Shell velocity (cm/s)	3.7×10^7	4.7×10^7

High gain for IFE requires the shift to low implosion velocities and reduced fuel adiabats

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	1.5 MJ		5 MJ	
Gain	100	137	170	270
V ($\times 10^7$ cm/s)	4	3	3	2.4
ρR (g/cm^2)	2	2	3	3
Adiabat (α)	2	1.5	1.5	1.3
Absorption	92%	87%	88%	90%
Bubble/thickness	0.6	0.2	0.1	0.05

Summary/Conclusions

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