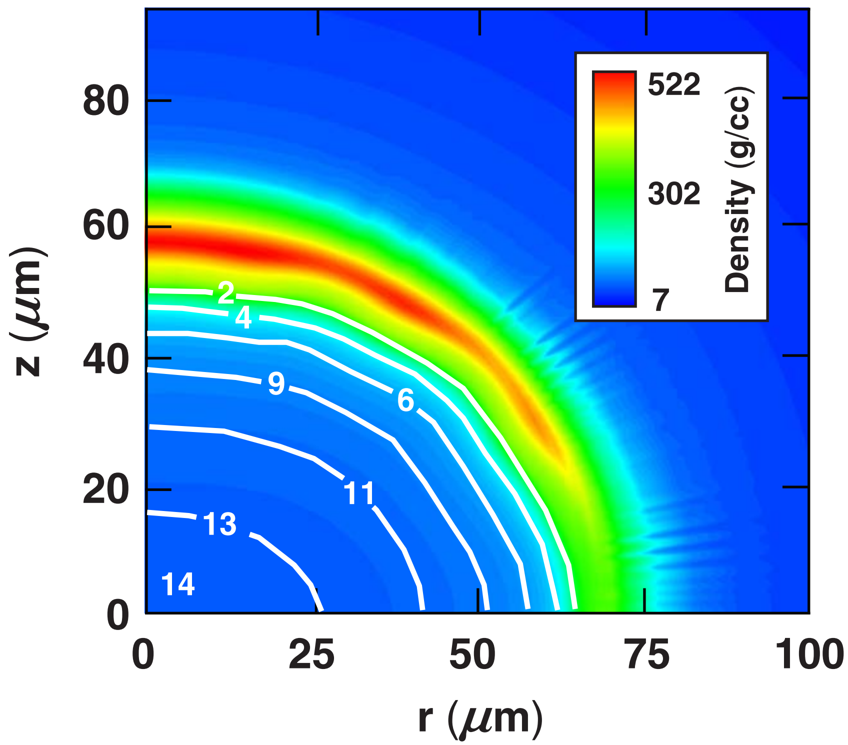
Analysis of a Direct-Drive, 1-MJ, Wetted-Foam Target Design

1.25-μm ice roughness
Density and ion temperature at ignition



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Summary

The stability of a 1-MJ wetted-foam design has been examined with respect to power balance and ice roughness

- This design experiences tolerable gain degradation with a 1.25-μm initial ice roughness.
- Simulations including mistiming and beam-to-beam power imbalance also show modest effects on target gain.
- Preliminary imprint simulations show moderate gain reduction when single-beam nonuniformity modes 10–60 are included.

TC7153

Collaborators

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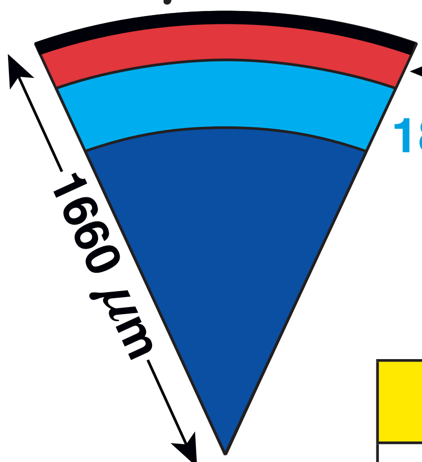
Wetted foams have higher absorption allowing a thicker shell and greater stability



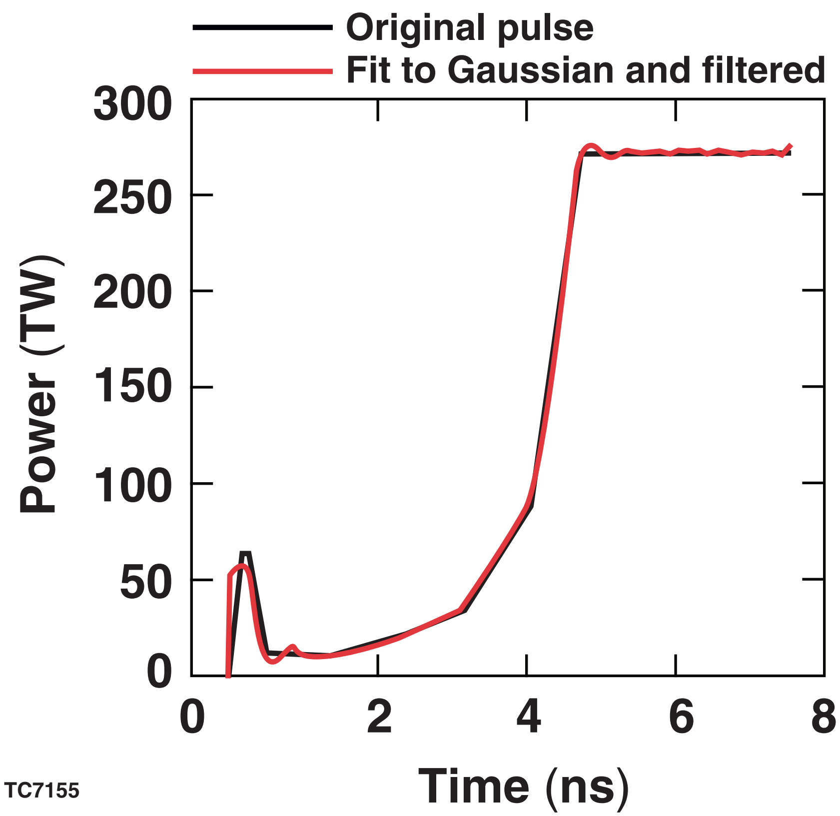
- Foam density is chosen by balancing higher absorption with increased radiative preheat.
- Foam layer thickness is chosen so that foam is entirely ablated.

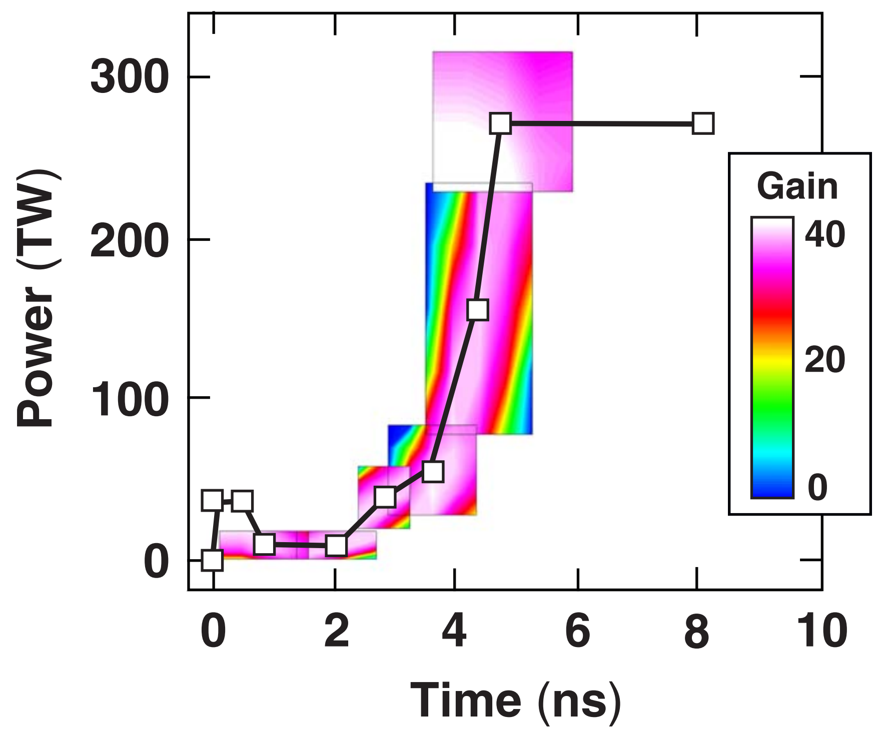
1-MJ designs	All DT	Wetted foam
Gain	29	39
Absorption (%)	57%	91%
ρR (g/cm^2)	1.1	1.0
Margin (%)	46%	44%
Peak IFAR	77	44
A/θ	27%	9%

TC7154

The pulse is within the limits of NIF pulse-shaping capabilities

- Pulses on the NIF are decomposed into a series of Gaussian impulses and filtered with a 1-GHz, low-pass Bessel filter.
- The design is robust in 1-D to control-point variation.

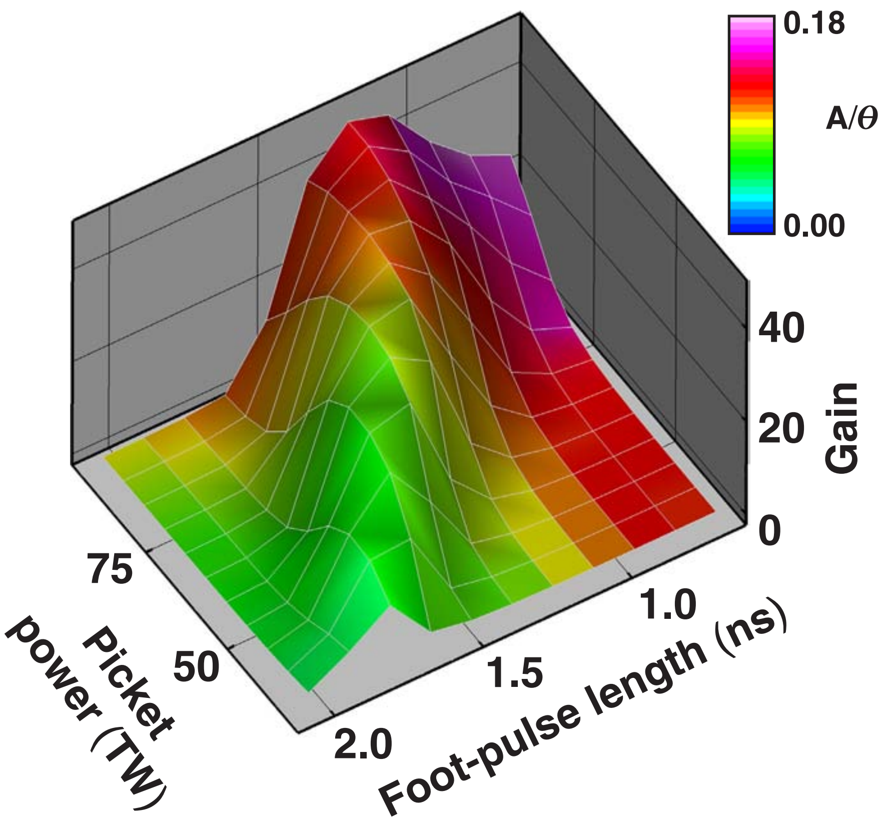


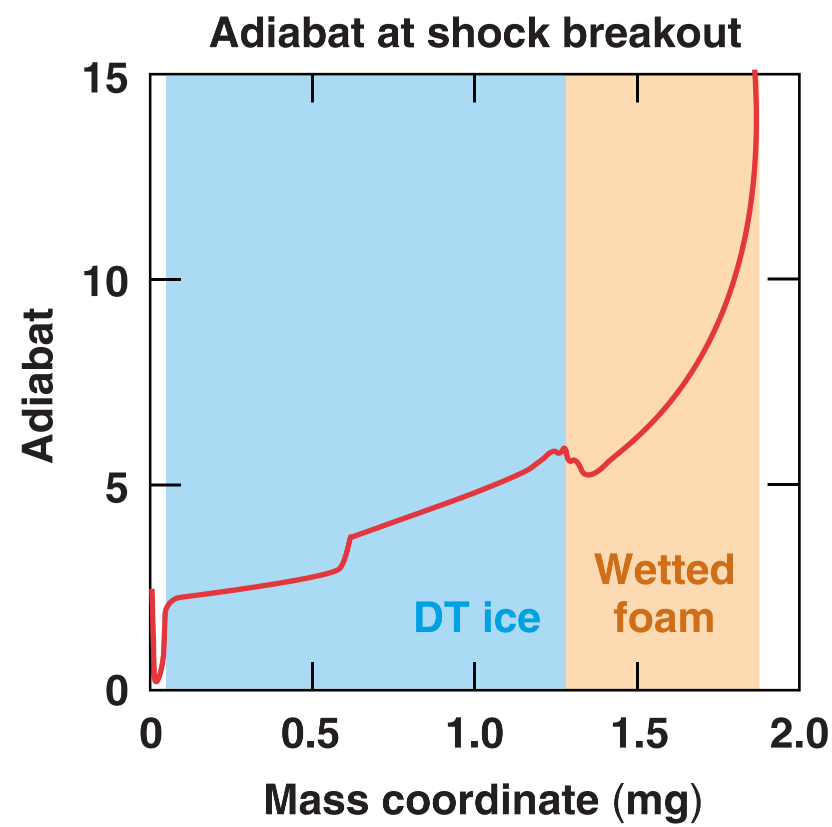


TC7155

The picket is designed to shape the adiabat while maintaining gain and implosion velocity

- **Stability is gauged by the ratio A/θ of the rms bubble amplitude to the shell thickness.**
- **The picket has been designed to provide an ablator adiabat of 10 with an ice adiabat of 2, and with an implosion velocity of 4.3 × 10^7 cm/s.**



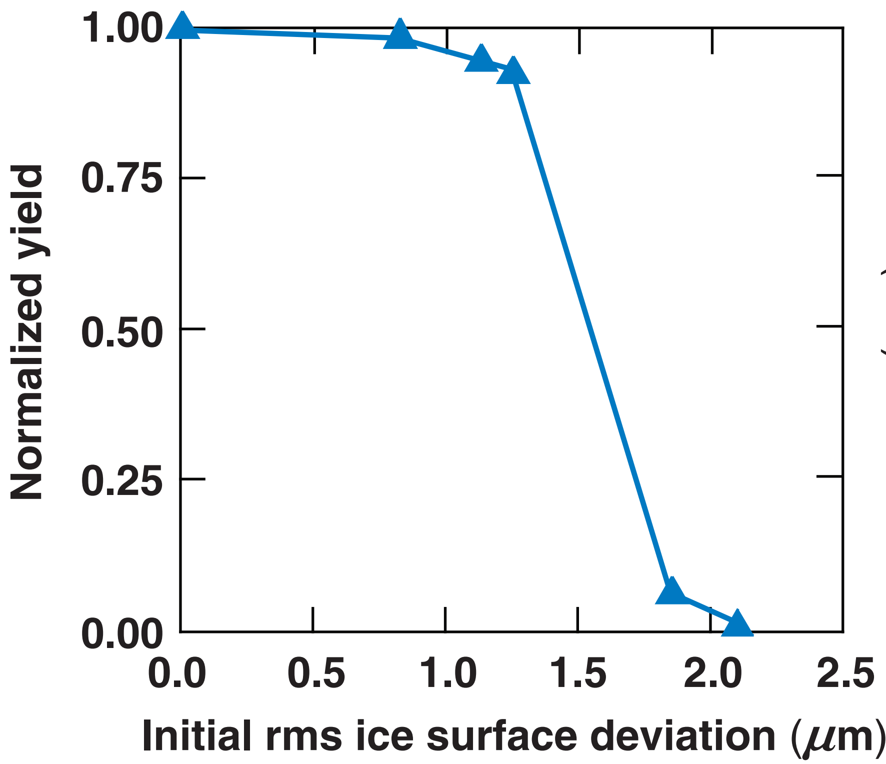


TC7156

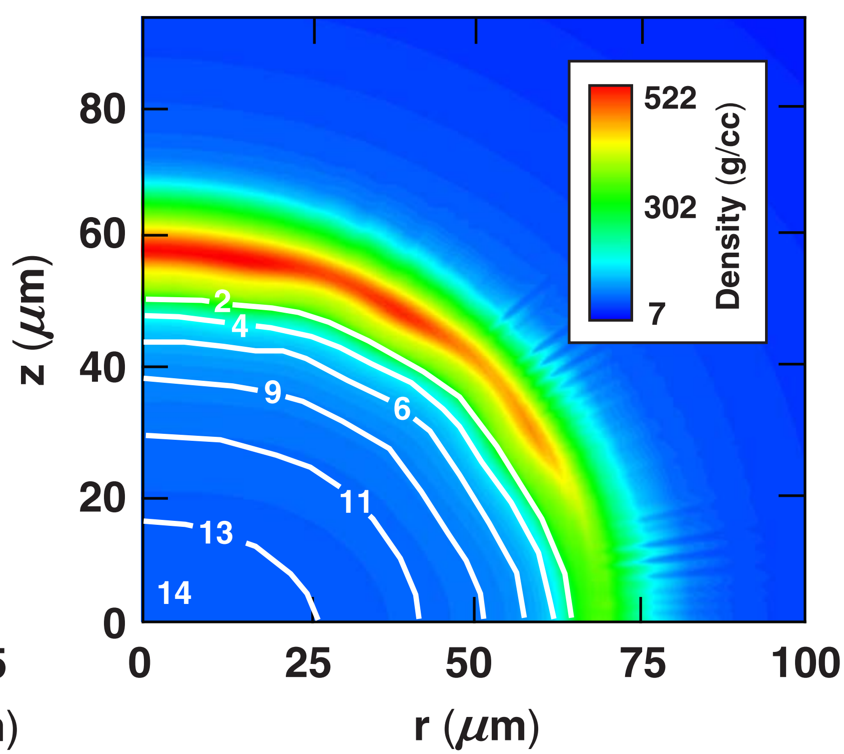
This design tolerates a 1.25-μm initial ice roughness

UR LLE

- The ice-roughness spectrum is given by $a_\ell = a_0 \ell^{-\beta}$.
- In cryogenic targets fabricated at LLE: $\beta \sim 2$.[1]
- 2-D *DRACO* simulations including modes $\ell = 2\text{–}50$ were performed.



1.25-μm ice roughness
Density and ion temperature at ignition



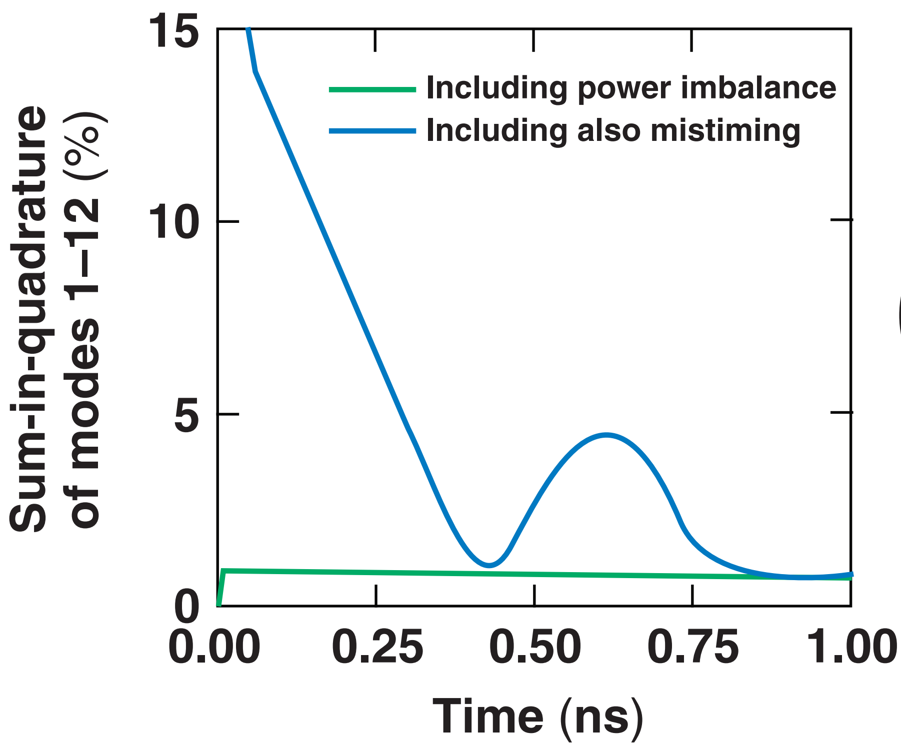
TC7157

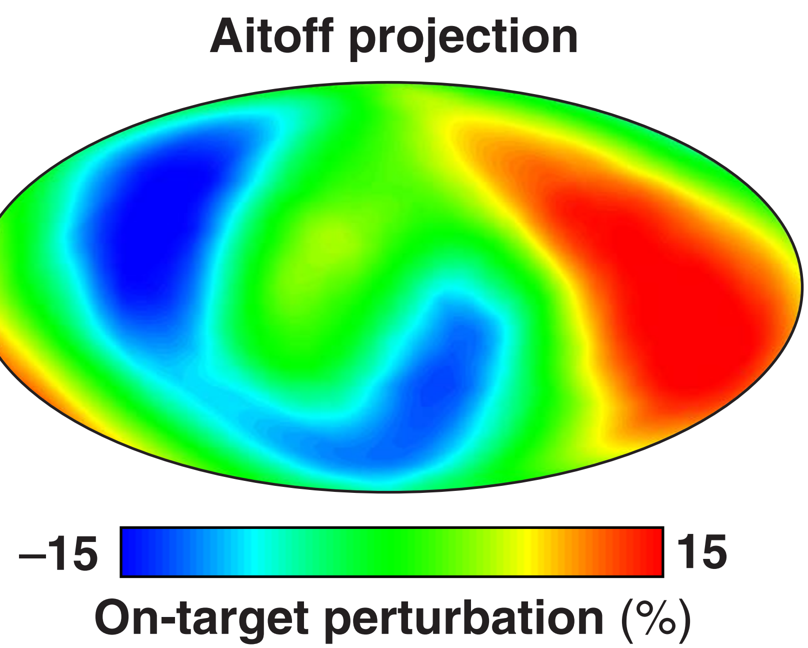
[1]D. Harding and D. Edgell, private communication (2005).

The beam-to-beam imbalance perturbation amplitude is ~1% and the mistiming ~10%, early in time

UR LLE

- Beam port locations contribute a perturbation of ~1% in $\ell = 6$.
- Beam-to-beam imbalance is dominated by modes $\ell = 2$–12, with an amplitude of ~1%.
- Beam mistiming contributes ~5–15% in modes $\ell = 1$–3, primarily during the picket.*





TC7158

*R. Epstein, FO3.13.

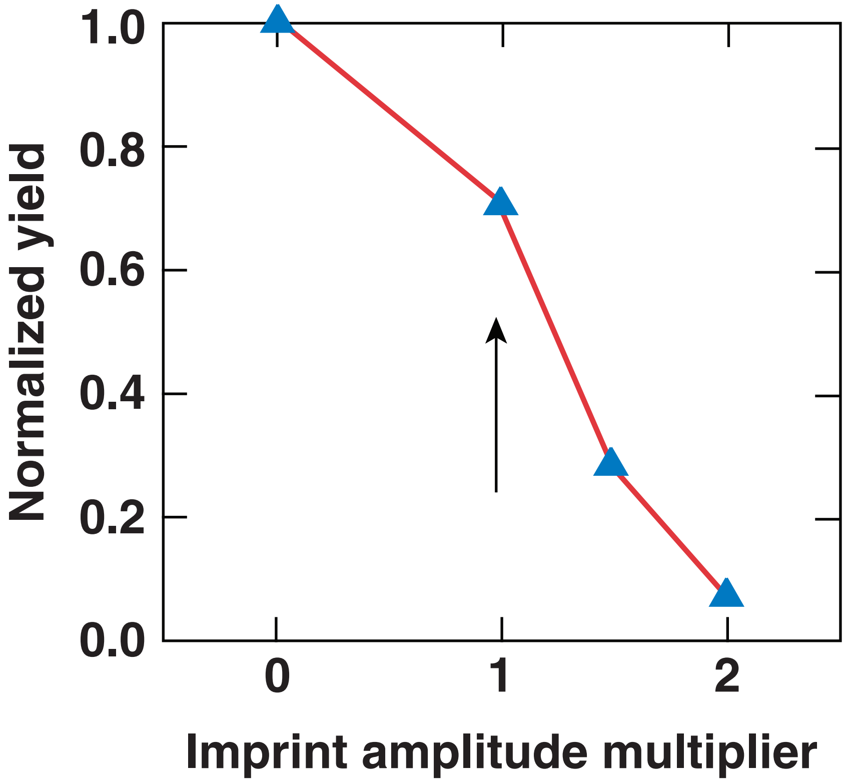
The design is robust to pulse mistiming and beam-to-beam power imbalance

- A number of power-imbalance and mistiming histories[1] with an rms mistiming of 30 ps were simulated in 2-D, including modes $\ell = 2$–12.
- The average gain reduction due to these effects was 12%.

[1] O. S. Jones *et al*., in *NIF Laser System Performance Ratings* (SPIE, Bellingham, WA, 1998), Vol. 3492, pp. 49–54.

1-D and 2-D simulations indicate the design can tolerate single-beam nonuniformity

- A 1-D Rayleigh–Taylor post-processor[1] found a 7% ratio of bubble amplitude to shell thickness.
- Imprint sensitivity is estimated simulating the most dangerous mode, $\ell = 32$, with the amplitude of modes 10–60 added in quadrature.
- Multimode imprint simulations are underway.



TC7160

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

Summary/Conclusions

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