OMEGA Cryogenic Target Design

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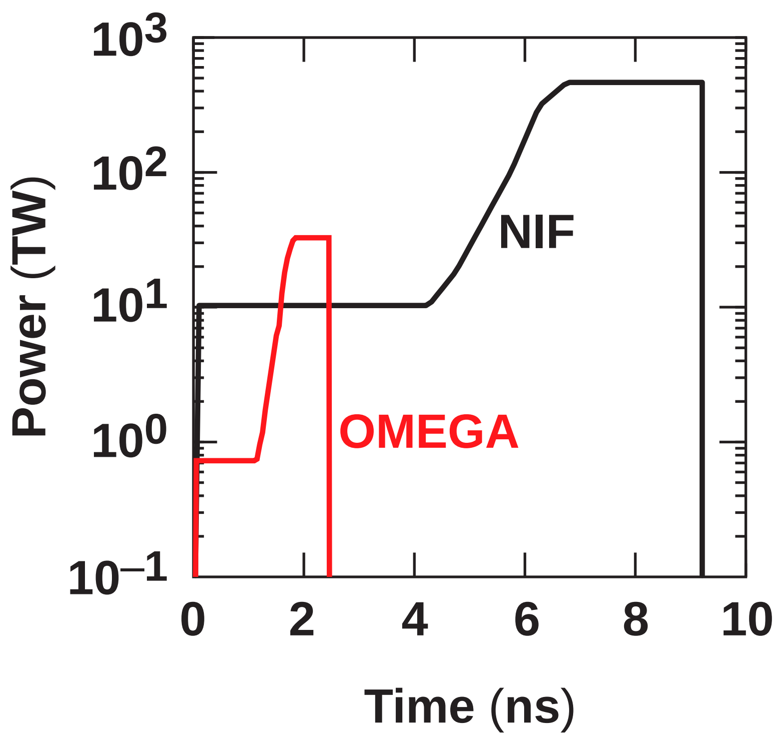
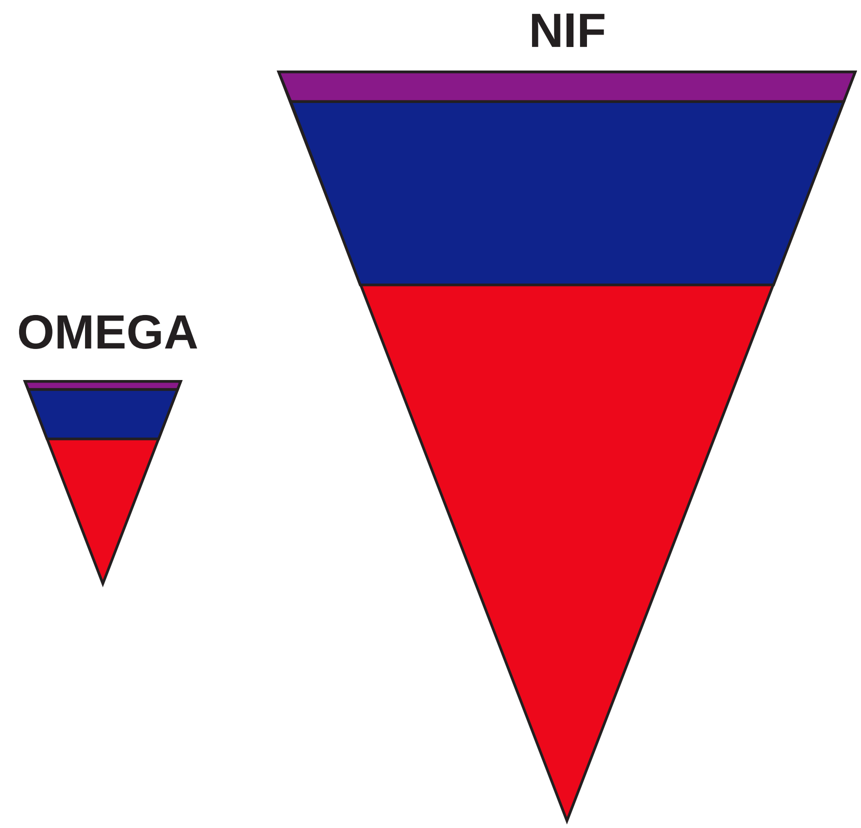
The cryogenic experiments to be performed on OMEGA are an important stepping stone to achieving direct-drive ignition on the NIF. The OMEGA cryogenic target--handling system is scheduled for completion by the end of 1999. This talk will present a brief review of the baseline NIF direct-drive ignition design developed at LLE. This design employs a solid, cryogenic, DT- shell target with a thin polymer ablator surrounding the DT-ice shell.[1] Using energy-scaling arguments, the OMEGA designs will be shown to be hydrodynamically similar to the NIF ignition designs. The important similarities to the NIF design and the expected differences will be outlined. This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC03-92SF19460, the University of Rochester, and the New York State Energy Research and Development Authority.

1. C. P. Verdon, Bull. Am. Phys. Soc. **38**, 2010 (1993).

OMEGA Cryogenic Target Designs





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41st Annual Meeting of the
American Physical Society
Division of Plasma Physics
Seattle, WA
15–19 November 1999

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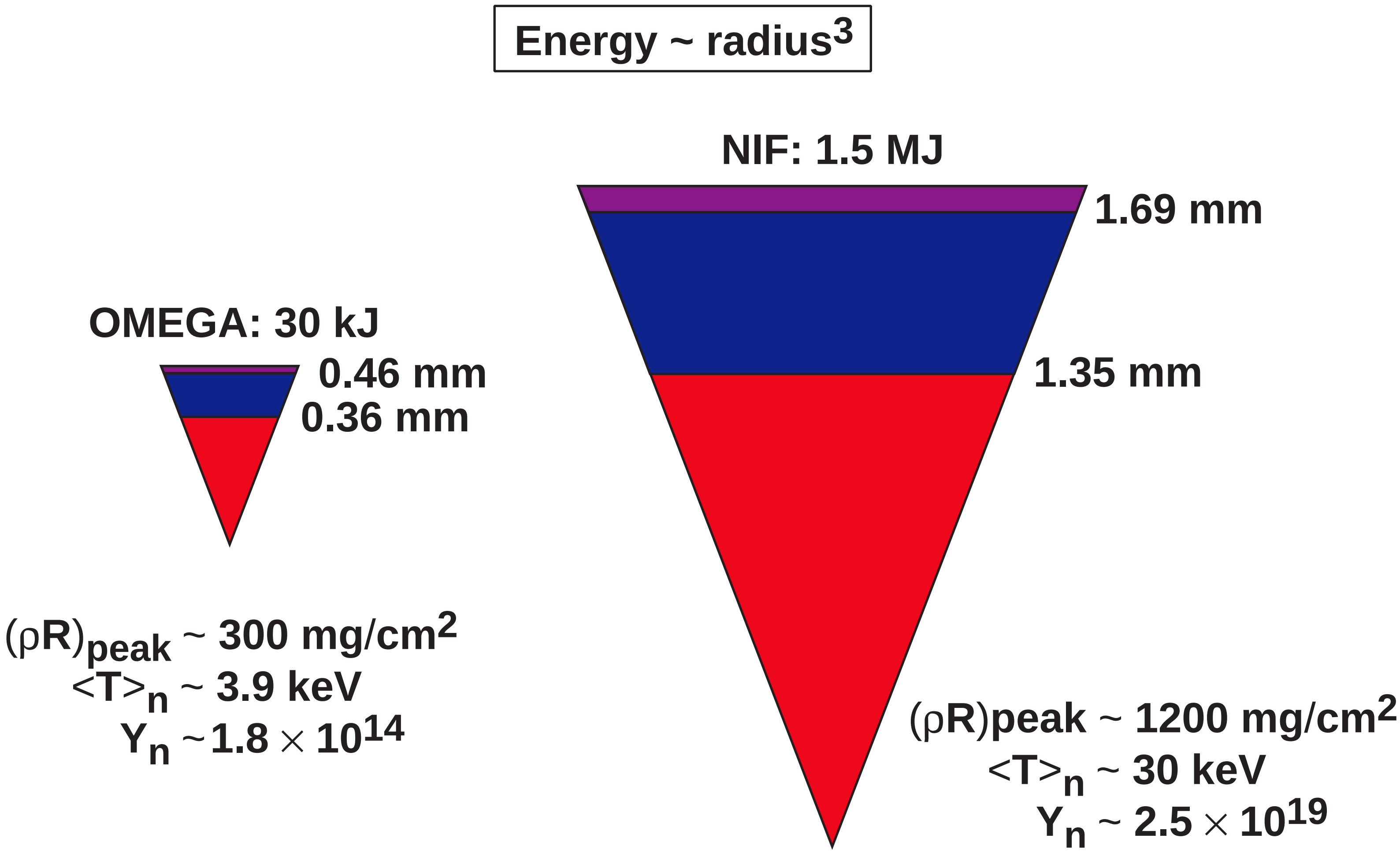
Summary

The OMEGA cryo target campaign is an important stepping stone to direct-drive ignition on the NIF

- The LLE baseline direct-drive NIF target design is a thick DT-ice layer enclosed by a thin CH shell illuminated by a continuous laser pulse.
- The OMEGA cryogenic targets are energy-scaled versions of the direct-drive ignition targets.
- OMEGA and NIF cryogenic designs have similar:
  - 1-D behavior,
  - imprint, and
  - stability properties
- The OMEGA design's smaller hot spot makes OMEGA more sensitive to inner ice nonuniformity than NIF designs.

OMEGA cryogenic targets are energy scaled from the NIF

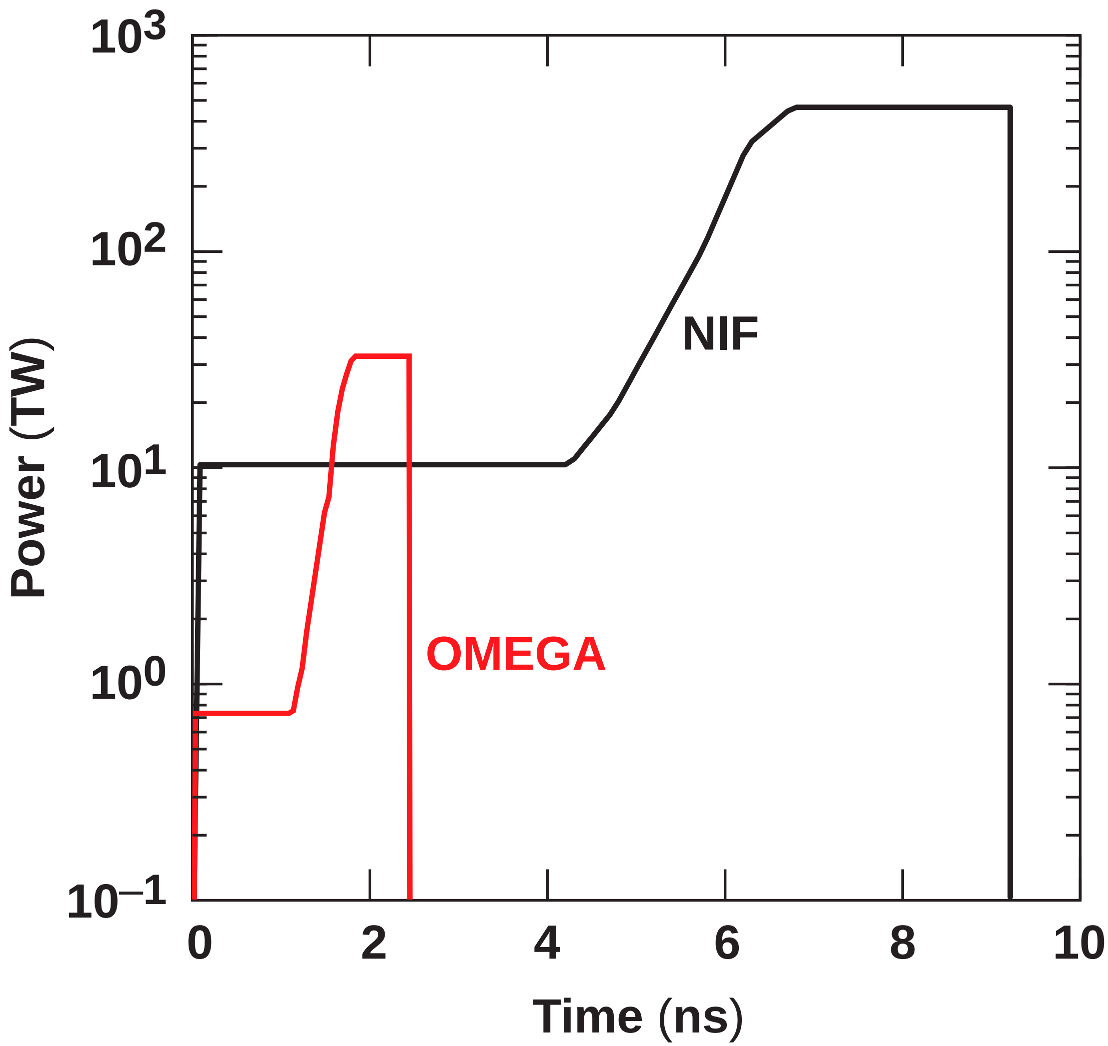


- OMEGA targets are one-third the radius of NIF targets.

TC5126

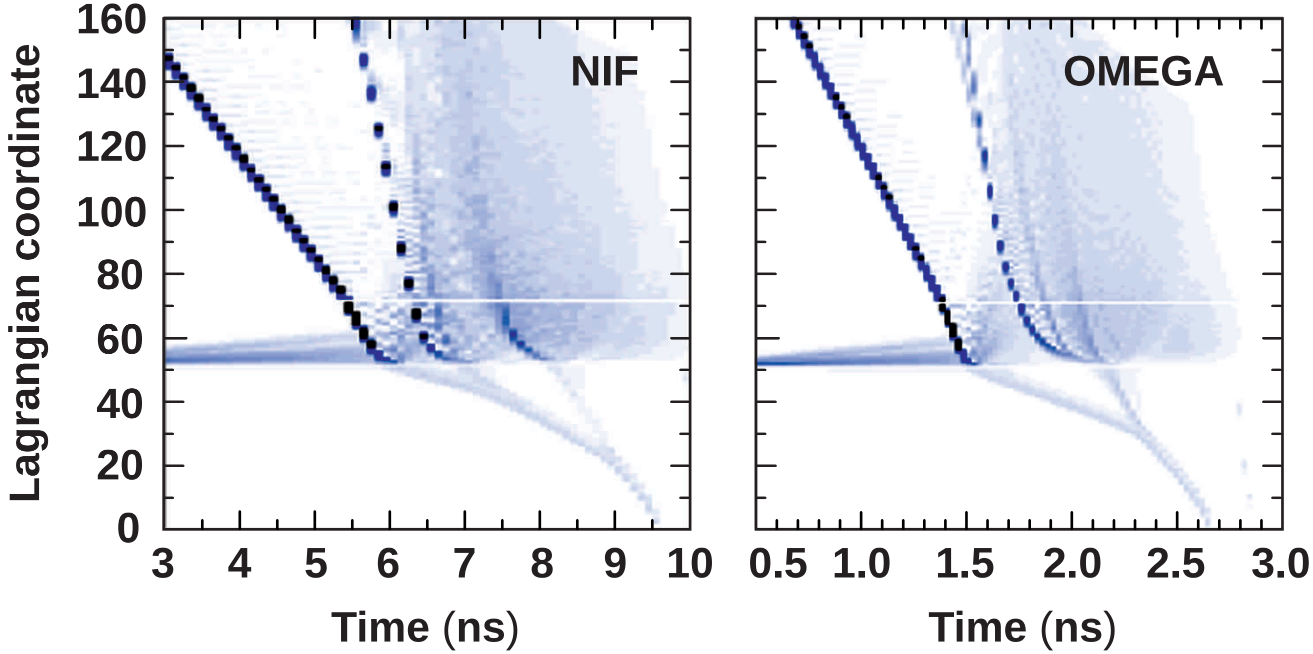
The OMEGA pulse shape is scaled from the NIF design

Power ~ radius^2; time ~ radius



TC5127

NIF- and OMEGA scaled targets have similar 1-D behavior

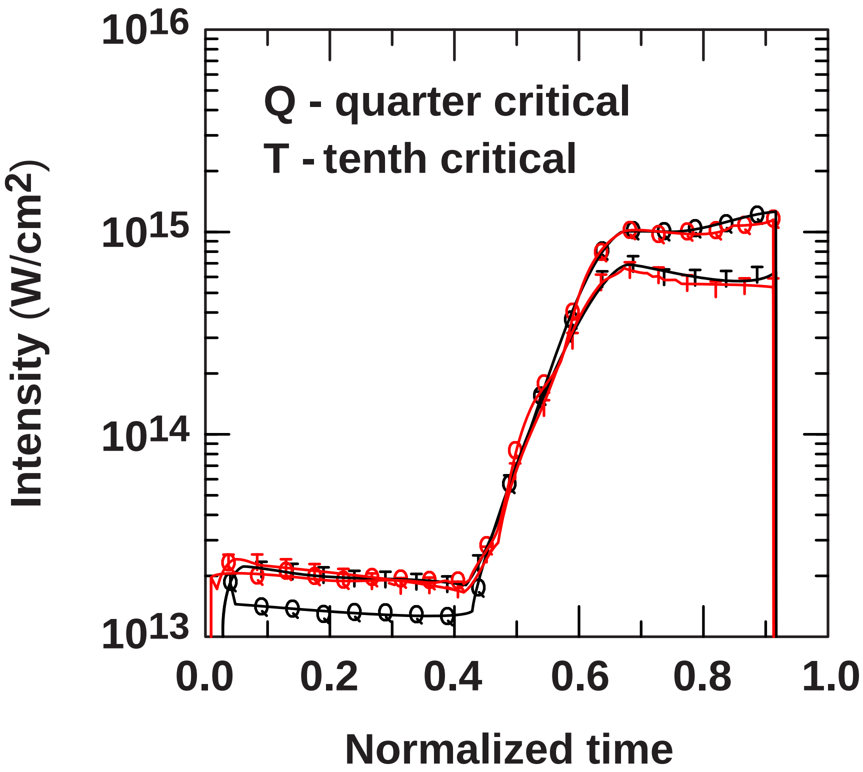


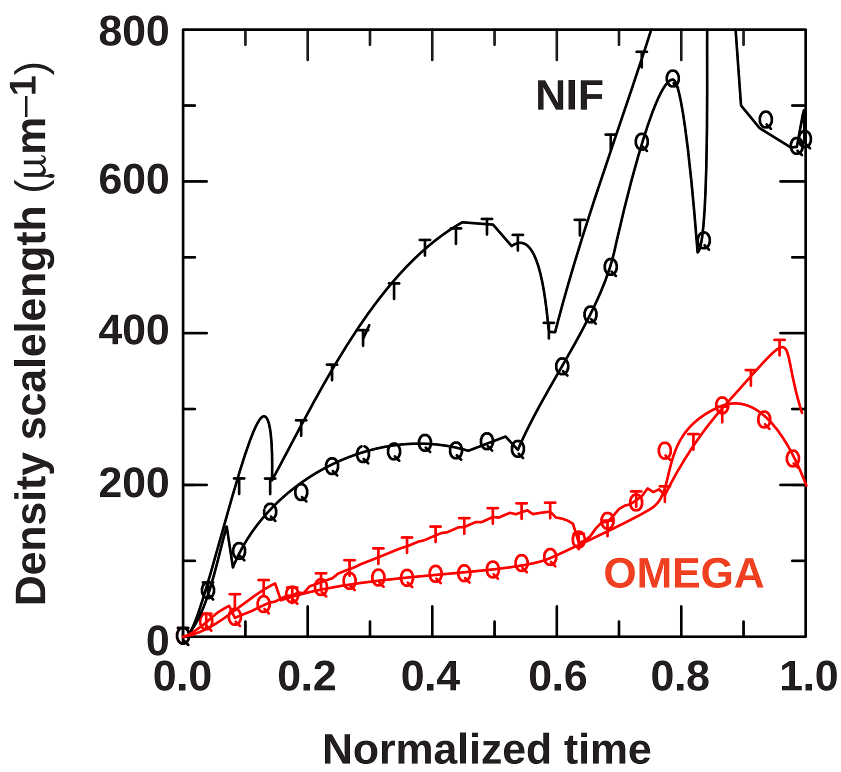
	NIF	OMEGA
Absorption fraction:	60%	40%
Shell velocity (cm/s):	4×10^7	3.7×10^7
Hotspot Convergence ratio:	28	20
$<\rho R>_n$ (mg/cm^2):	250	25
In-flight aspect ratio:	60	50

TC5260

The OMEGA cryodesign will not address all the plasma physics issues associated with the NIF design

- The quarter- and tenth-critical surfaces have similar intensities.
- The scalelengths on OMEGA are shorter than those on the NIF.

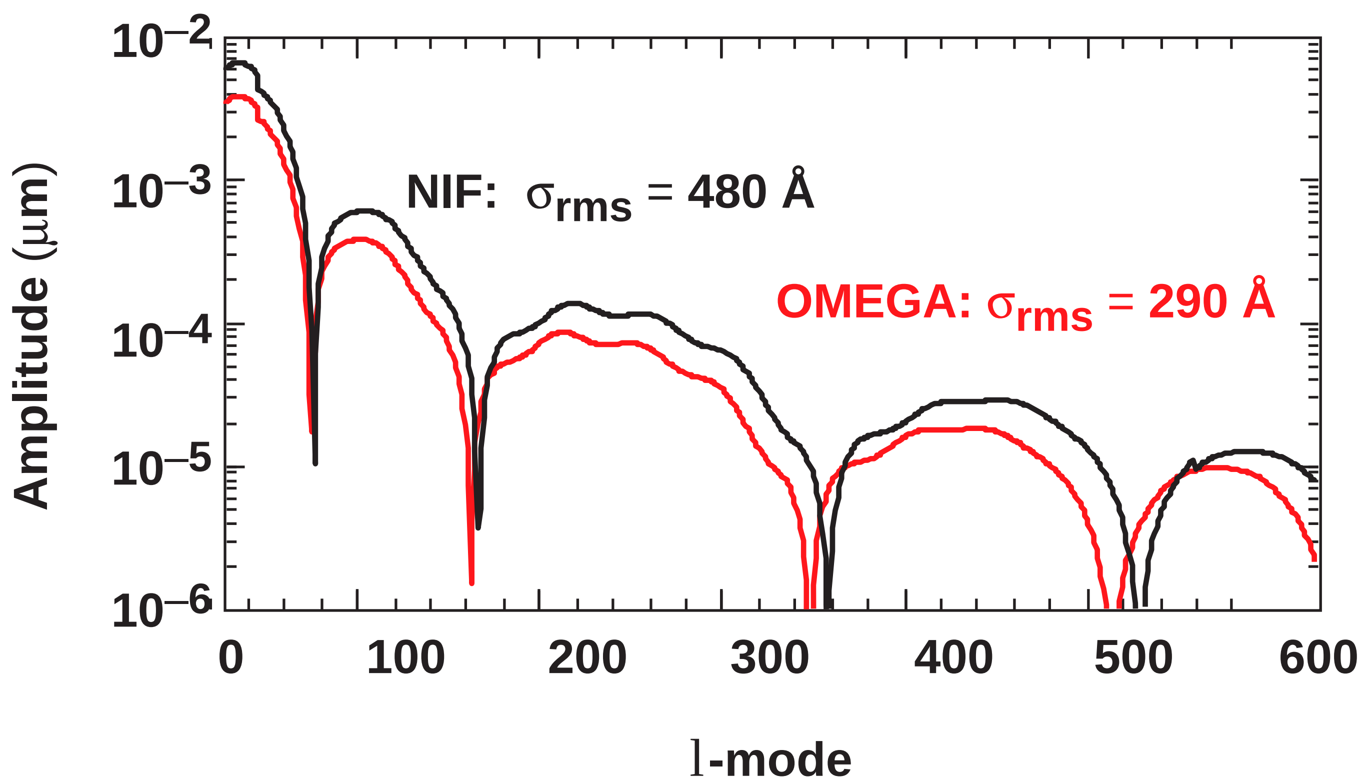




TC5259

The imprint levels on OMEGA are smaller than on the NIF

- The mode spectrum at the start of the acceleration phase for the baseline NIF and OMEGA designs is similar in shape.

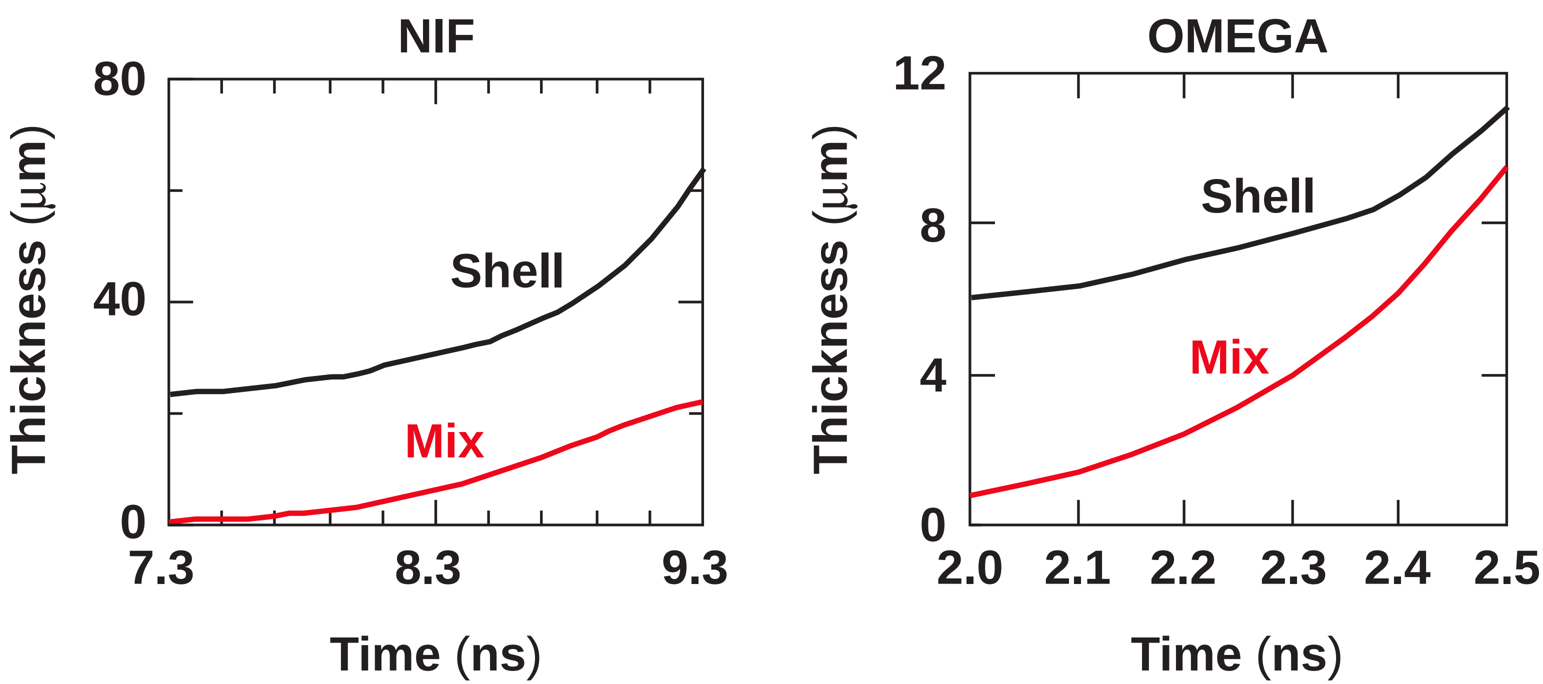


- Cusps are a consequence of dynamic overpressure.*

*See HI1.01: Goncharov

TC5245

Stability analysis of the $\alpha = 3$ LLE design shows that the shell will survive the acceleration phase

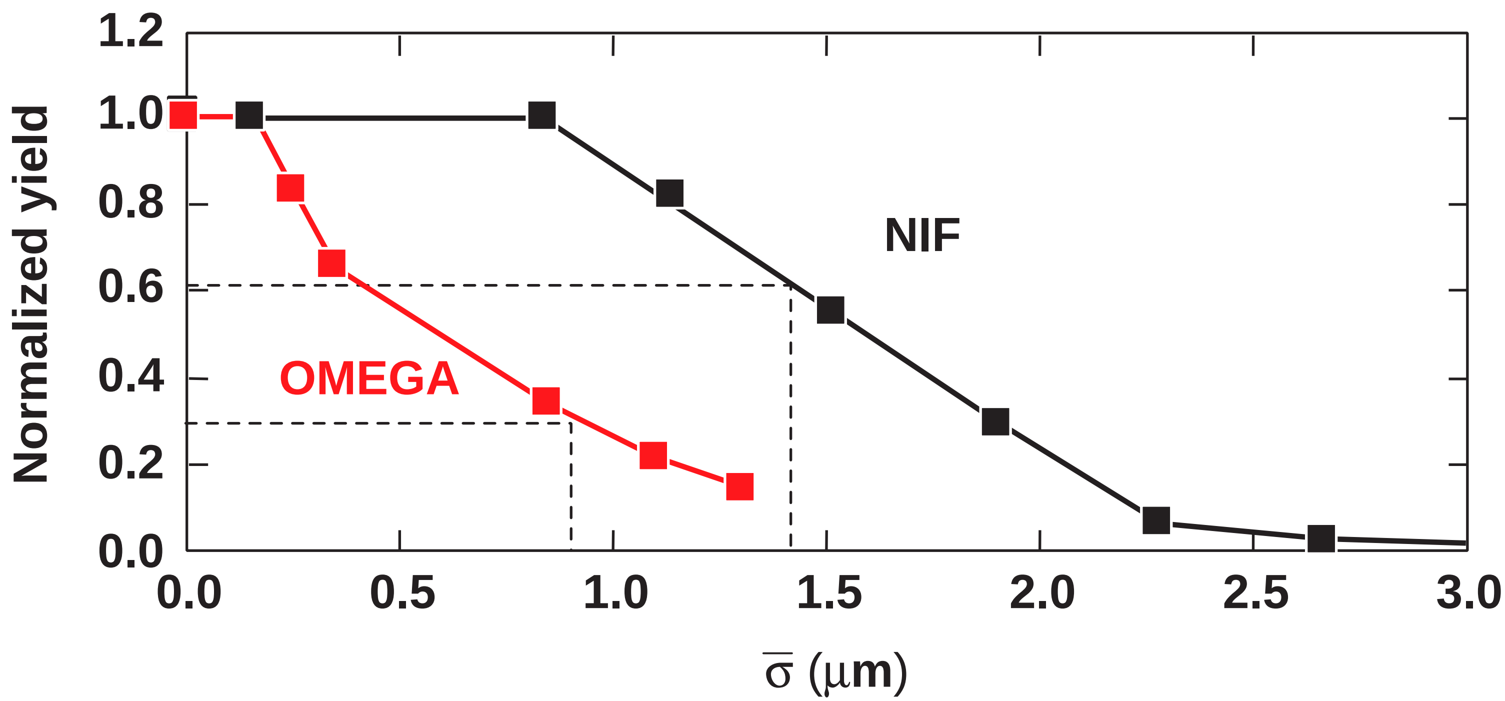


Inner-surface roughness = 2 μm, $\sigma \sim l^{-1.5}$
Outer-surface roughness = 840 Å
Imprint with 2-D SSD at 1-THz

TC5144

OMEGA designs show a greater reduction in performance than NIF designs

- **2-D *ORCHID* calculations haveshown that the NIF gain* and OMEGA yield can be related to $\bar{\sigma}^2 = 0.06\,\sigma^2_{1-9} + \sigma^2_{>10}$**



- **The smaller hot-spot radius in OMEGA designs leads to a greater reduction in yield for a given level of nonuniformity at the onset of deceleration.**

TC5269

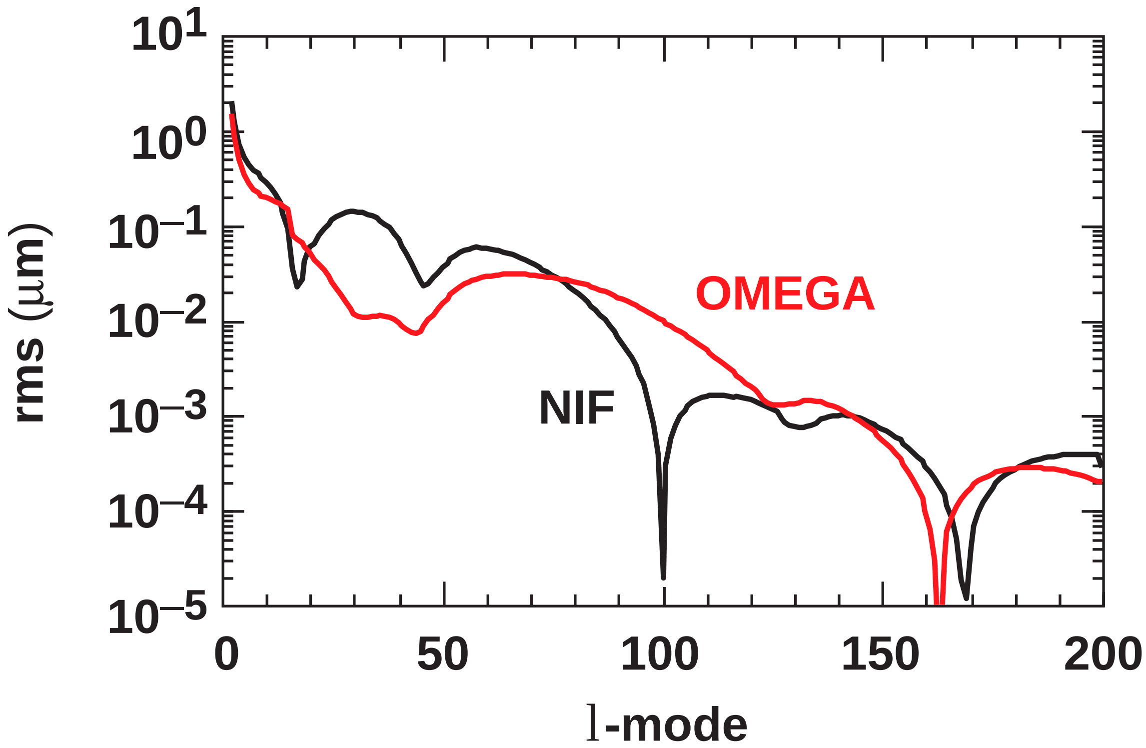
*Goncharov *et al*, Proceedings of IFSA 1999.

At the onset of deceleration, modes below ten dominate the spectrum

- Feed-in of the perturbation from the ablation surface to the rear surface is identical for NIF and OMEGA.
- NIF has more power in the range $10 < l < 100$, where imprint dominates.

$\bar{\sigma}_{NIF} = 1.3\ \mu m$

$\bar{\sigma}_{OMEGA} = 0.9\ \mu m$



Summary/Conclusions

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