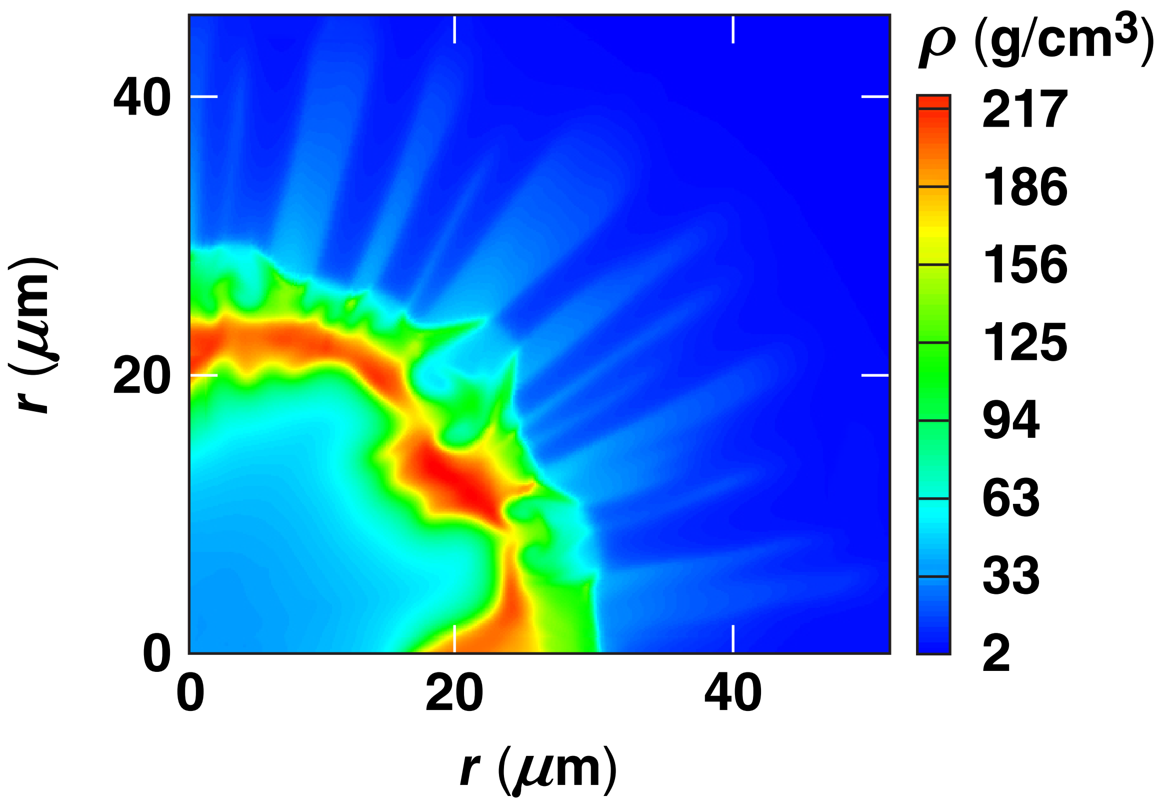
The Effect of Laser Imprint on OMEGA Cryogenic Implosions

***DRACO* simulation of OMEGA α = 3.7**
(shot 77066) at peak neutron production



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Summary

DRACO simulations indicate that an OMEGA cryogenic implosion at an intermediate adiabat ~4 is only marginally affected by laser imprint

- Areal density degrades in OMEGA cryogenic implosions with increasing in-flight aspect ratio (IFAR); it is hypothesized that this is a result of laser imprint and subsequent Rayleigh–Taylor (RT) growth
- *DRACO* simulations include full 3-D ray trace with cross-beam energy transfer (CBET) and nonlocal transport
- Ongoing work is systematically studying designs with varying in-flight stability through changes in imprint (smoothing on/off) and RT growth (varying adiabat and IFAR)

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Collaborators

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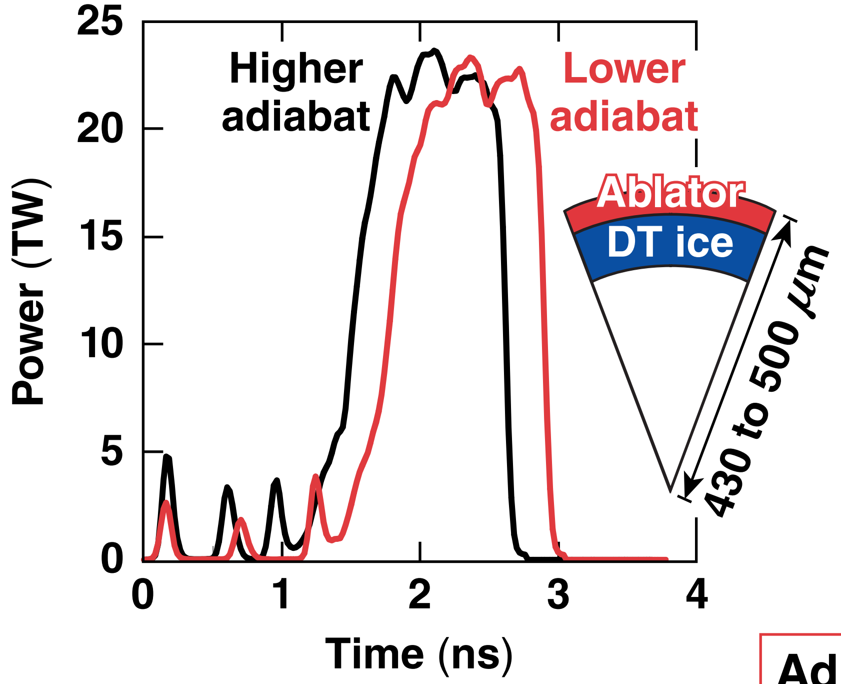
Areal density is compromised with increasing IFAR relative to spherically symmetric simulations in OMEGA cryogenic experiments*

26- to 29-kJ OMEGA cryogenic design

Adiabat and IFAR are controlled by pulse shaping



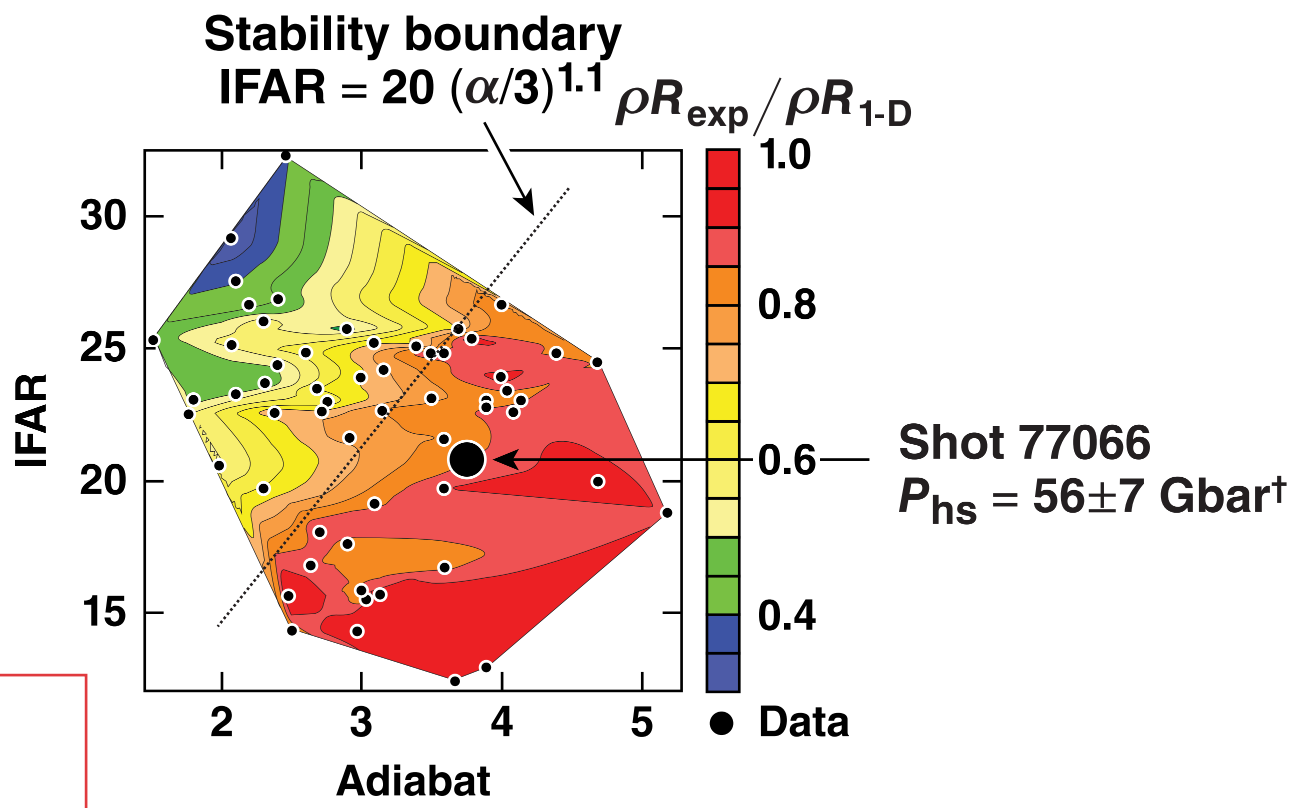
- V_{imp} and IFAR are controlled by varying the ablator (7.5 to 12 μm) and fuel thickness (40 to 66 μm)

Adiabat
$\alpha = P/P_{Fermi}$

IFAR = shell radius/ shell thickness

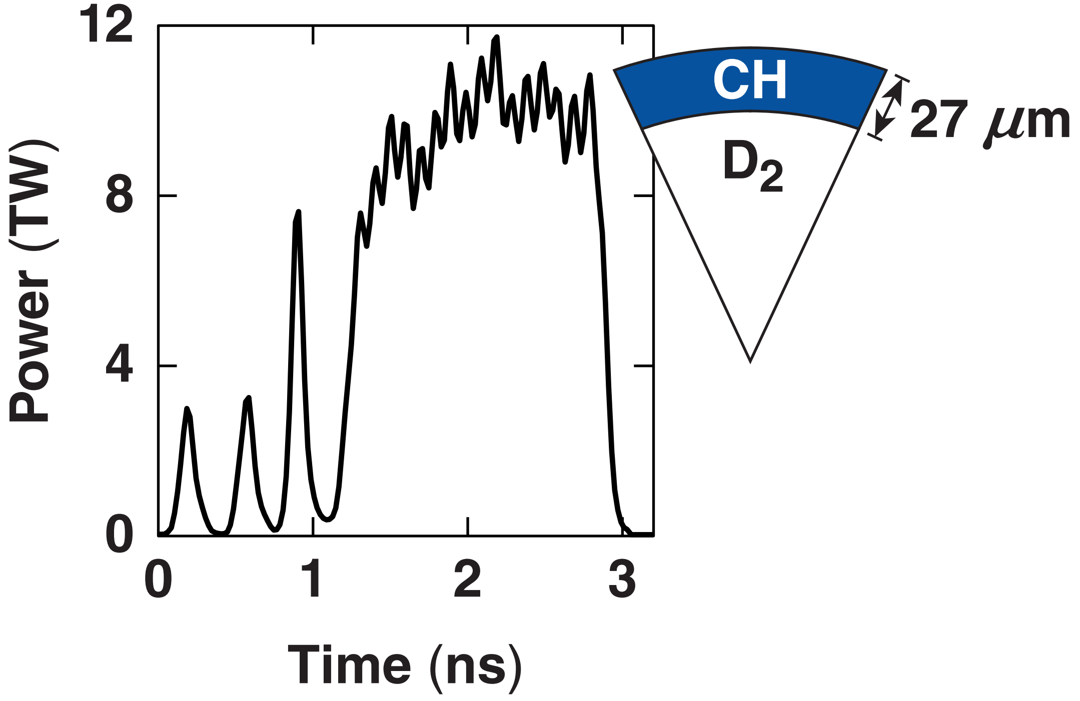
*e-foldings of the most-dangerous mode*** ($\ell \sim 30$)

$N_e \sim \sqrt{\text{IFAR}}$

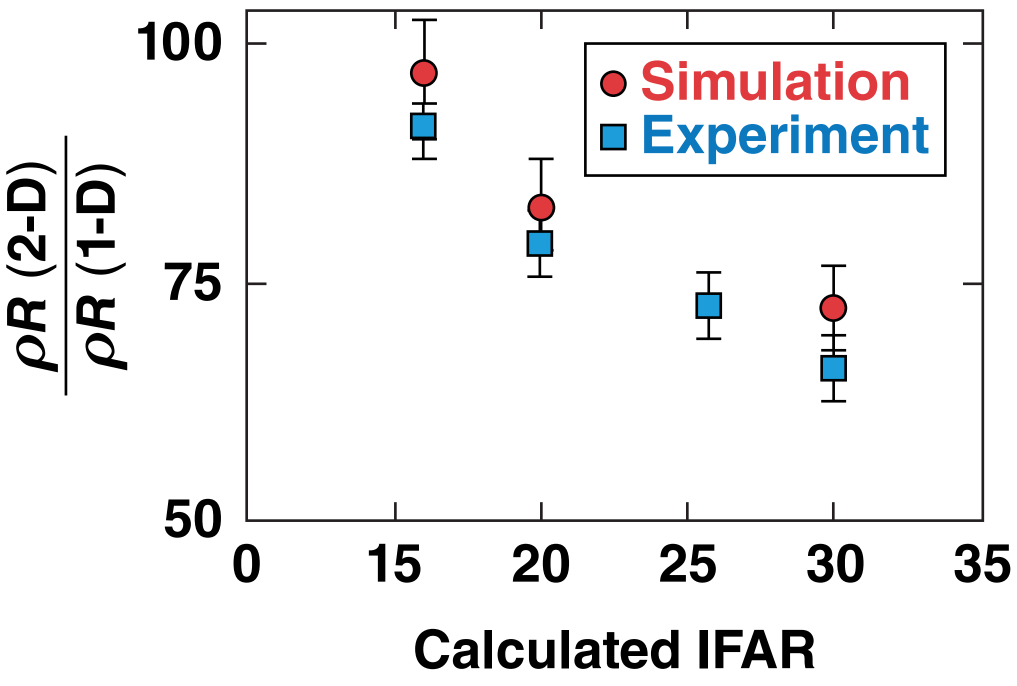


*V. N. Goncharov *et al.*, Phys. Plasmas 21, 056315 (2014).
**C. D. Zhou and R. Betti *et al.*, Phys. Plasmas 14, 072703 (2007).
†S. P. Regan *et al.*, Phys. Rev. Lett. 117, 025001 (2016); 117, 059903(E) (2016).

Imprint has been shown to compromise areal density in room-temperature implosions on OMEGA*



DRACO simulation of room-temperature triple-pickett implosion



- IFAR is changed by changing picket energies
  - other measures of shell stability (shell thickness) have been studied previously in room-temperature implosions**
  - the role of laser imprint on OMEGA cryogenic implosions is being studied with *DRACO*

*P. B. Radha *et al.*, Phys. Plasmas 18, 012705 (2011).
**S. X. Hu *et al.*, Phys. Plasmas 23, 102701 (2016).

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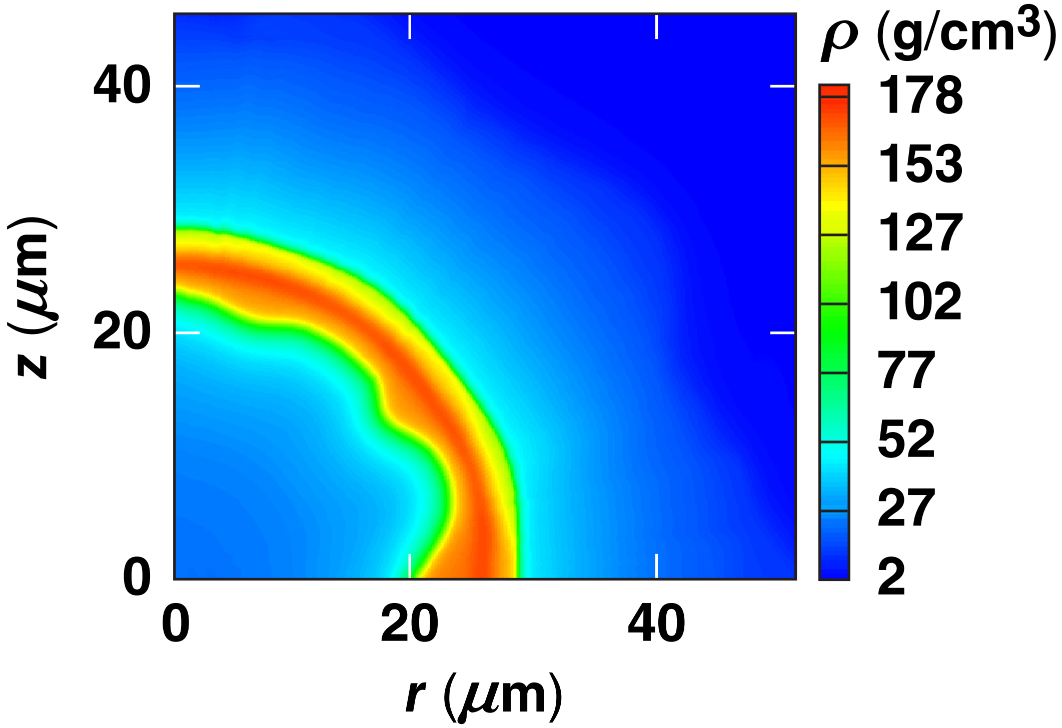
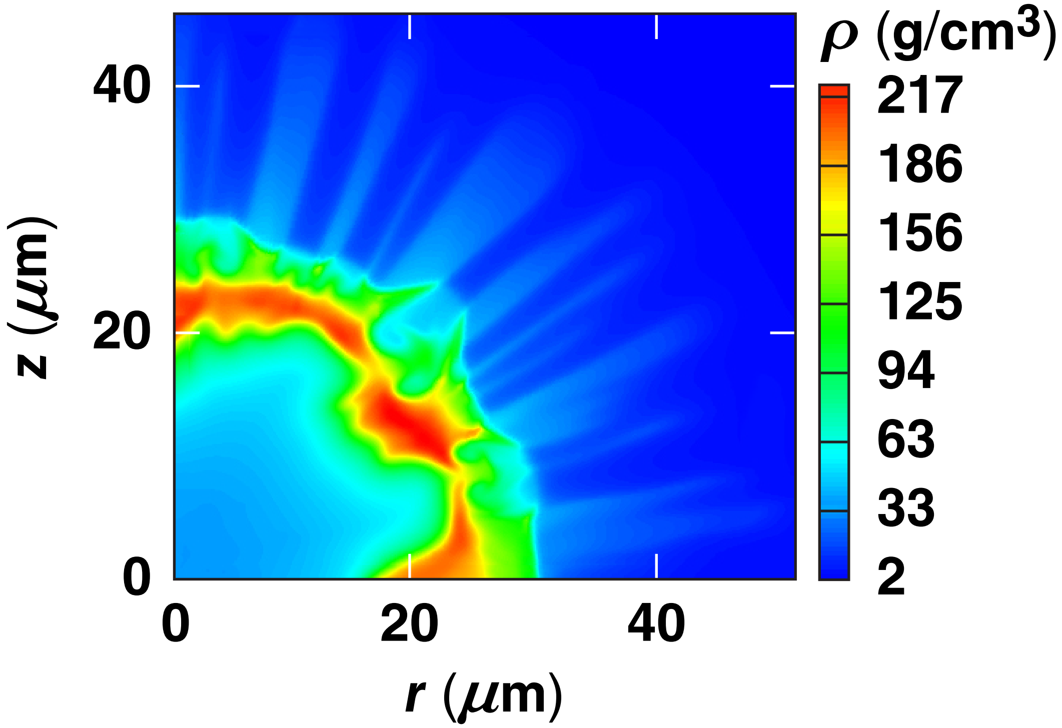
Imprint does not influence the overall compression of an α = 3.7 implosion

- *DRACO* simulation α = 3.7 OMEGA cryogenic implosion (shot 77066) at ~peak neutron production (modes $\ell \leq 150$; CBET* and Schurtz–Nicolaï–Busquet nonlocal transport,** FPEOS,† FPOT‡)



$\rho R^{\dagger\dagger} = 213 \pm^{13\%}_{-5\%}$ mg/cm^2



$\rho R^{\dagger\dagger} = 213 \pm^{30\%}_{-15\%}$ mg/cm^2

*J. A. Marozas and T. J. B. Collins, UO5.00003, presented at the 54th Annual Meeting of the Division of Plasma Physics, Providence, RI, 29 October–2 November 2102.
**D. Cao, G. Moses, and J. Delettrez, Phys. Plasmas 22, 082308 (2015).
†FPEOS: first-principles equation of state; S. X. Hu *et al.*, Phys. Rev. E 92, 043104 (2015).
‡FPOT: first-principles opacity table; S. X. Hu *et al.*, Phys. Rev. E 90, 033111 (2014).
††*IRIS2D*; P. B. Radha *et al.*, KO2 8, presented at the 41st Annual Meeting of the Division of Plasma Physics, Seattle, WA, 15–19 November 1999.

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Observables are only marginally influenced by imprint for this design

	Imprint/"1-D" (%)	Experiment/"1-D" (%)
Yield	80	38±2
$\langle \rho R \rangle_n$**	97	90±8
T_i	94	90±7
R_{hs} (μm)†	100	96±2
P_{hs} (Gbar)	96	62±8

→ Yield comprised by $\ell \leq 10$ seeded by power imbalance*

- The modal approximation of imprint used in *DRACO* will be compared with the speckle model‡
- Simulations spanning the parameter space of IFAR and adiabat will continue to identify trends and the effect of imprint on observables

*I. V. Igumenshchev *et al.*, Phys. Plasmas 24, 056307 (2017).
***IRIS2D*; P. B. Radha *et al.*, KO2 8, presented at the 41st Annual Meeting of the Division of Plasma Physics, Seattle, WA, 15–19 November 1999.
†*Spect3D*; J. J. MacFarlane *et al.*, High Energy Density Phys. 3, 181 (2007).
‡A. Shvydky, JO7.00001, this conference.

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