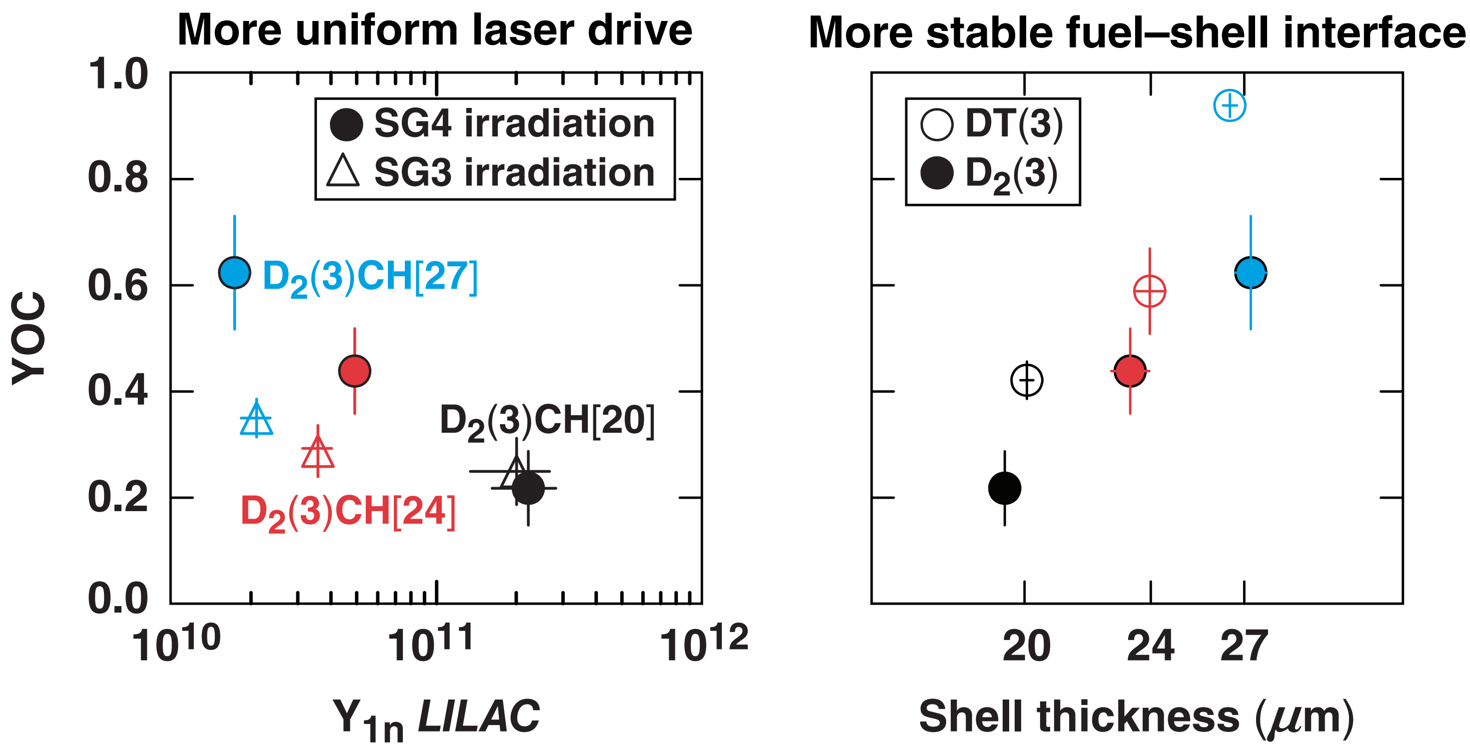
Target Performance of Direct-Drive, D_2- and DT-Filled Plastic Shell Implosions on OMEGA



S. P. Regan *et al.*
University of Rochester
Laboratory for Laser Energetics

47th Annual Meeting of the
American Physical Society
Division of Plasma Physics
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Summary

Improved implosion performance was achieved on OMEGA by reducing hydrodynamic instabilities

- The performance of high-adiabat implosions of D_2- and DT-filled plastic shells with predicted convergence ratios (CR) from 10 to 40 improved with

  1. More uniform drive

     The YOC nearly doubled for some implosions when the laser irradiation nonuniformities in the low and intermediate range were reduced.

  2. More stable fuel–shell interface

     The YOC increased ~1.4× when the Atwood number at the fuel–shell interface was reduced by ~2×.

J. P. Knauer FO3.007
P. B. Radha FO3.008

Collaborators

J. A. Delettrez, V. Yu. Glebov, V. N. Goncharov, J. P. Knauer, J. A. Marozas, F. J. Marshall, R. L. McCrory, P. W. McKenty, D. D. Meyerhofer, P. B. Radha, T. C. Sangster, S. Skupsky, V. A. Smalyuk, and C. Stoeckl

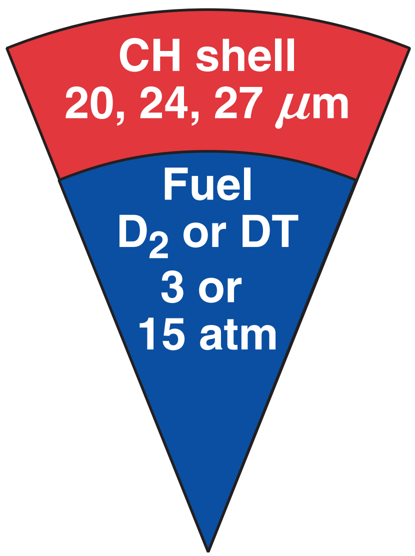
University of Rochester
Laboratory for Laser Energetics

J. R. Rygg, J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin

Plasma Science and Fusion Center
Massachusetts Institute of Technology

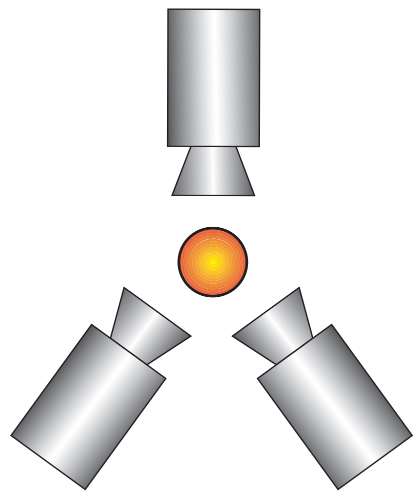
The performance of high-α, D_2- and DT-filled plastic-shell implosions was investigated on OMEGA

$$\alpha \simeq 5 \equiv \frac{\text{pressure in the shell}}{\text{Fermi degenerate pressure}}$$



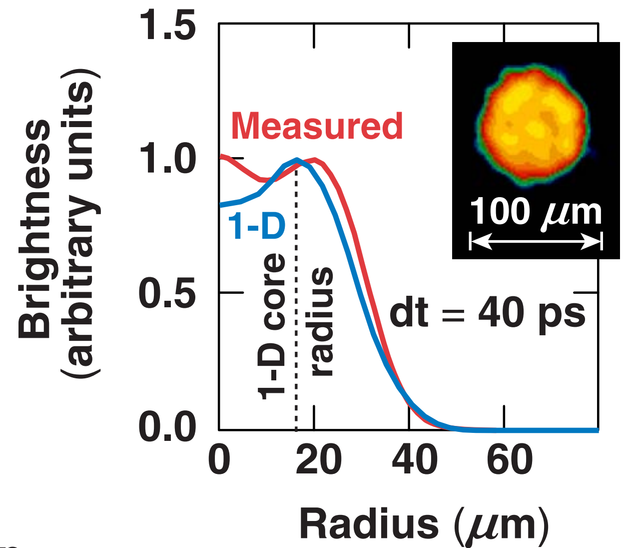
Predicted convergence ratio (CR): 10 to 40

Gated x-ray images[2]



Primary neutron yield

Neutron burn history



- Laser irradiation with 23-kJ, 1-ns laser pulse with 1-THz 2-D SSD and PS[1]

[1]Regan *et al.*, J. Opt. Soc. Am. B 22, 998 (2005).
[2]Regan *et al.*, Phys Plasmas 9, 1357 (2002).

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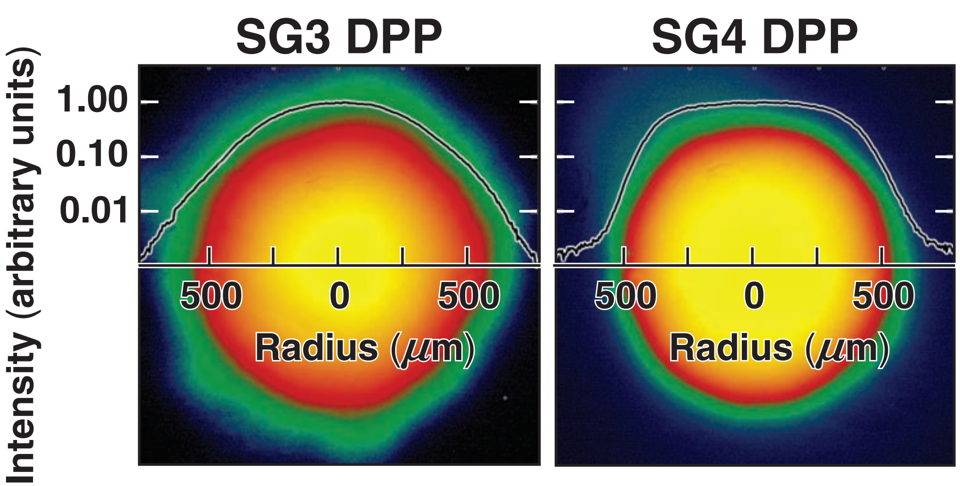
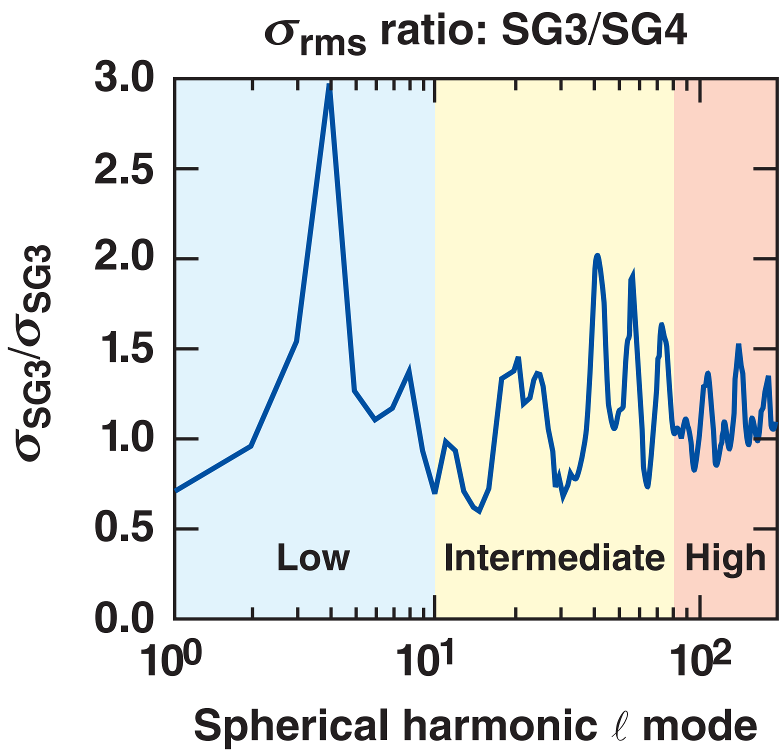
More Uniform Drive

Laser irradiation nonuniformities in the low and intermediate range were reduced with a new distributed phase plate (DPP)

UV far field measurements





Sources of nonuniformities

Single-beam nonuniformity
Beam mispointing (20-μm rms)
Beam energy imbalance (2.6% rms)
Target offset (2 μm)

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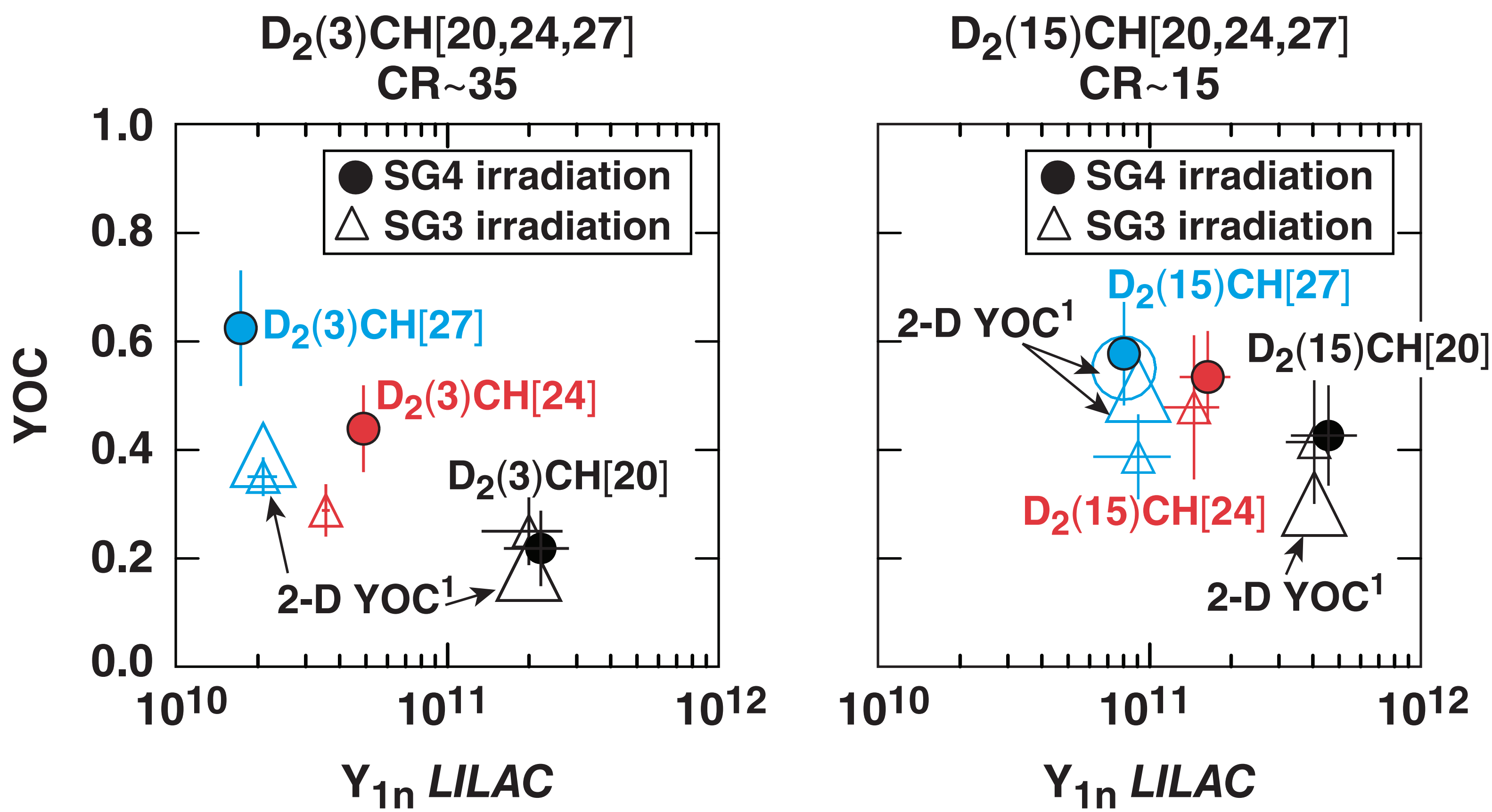
The YOC increased for some implosions with more uniform laser drive



- The thicker shell targets are less susceptible to laser imprint.[1,2]

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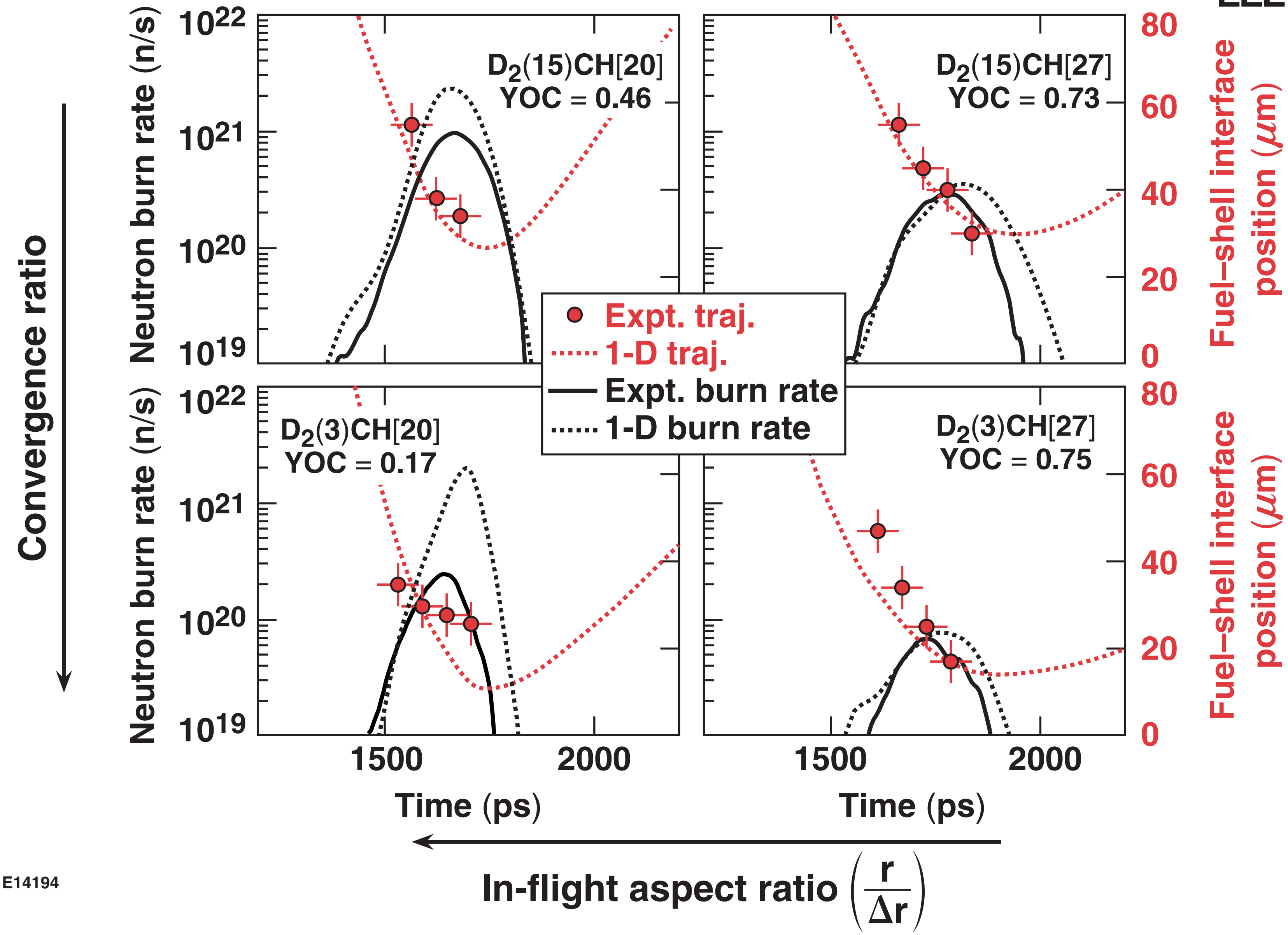
[1]Radha *et al*., Phys. Plasmas 12, 56307 (2005).
[2]Regan *et al*., Phys. Rev. Lett. 92, 185002 (2004).

E14193

High YOC is realized when near 1-D compression is achieved



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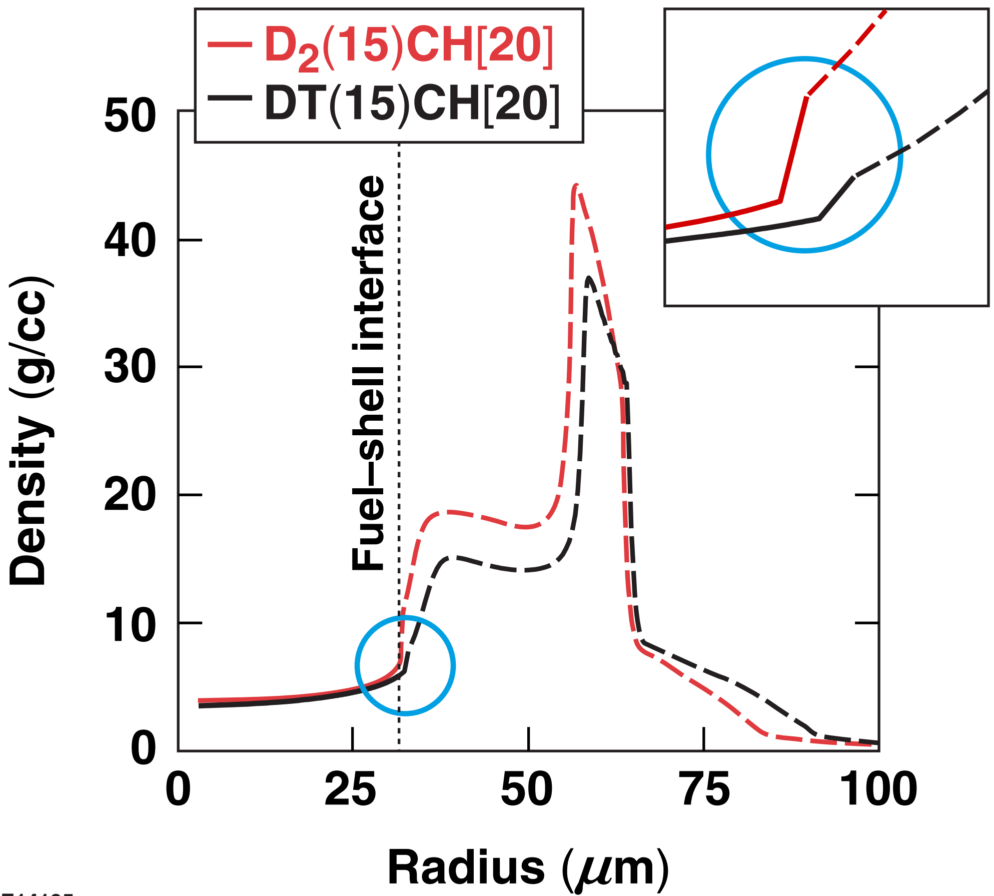
More Stable Fuel–Shell Interface

DT fills have a lower Atwood number across the fuel–shell interface than D_2 fills

- Pressure and temperature are continuous across the fuel–shell interface.

Peak neutron production



$$\text{Atwood number} = \frac{(\rho_{CH} - \rho_f)}{(\rho_{CH} + \rho_f)}$$

$$f = D_2 \text{ or DT}$$

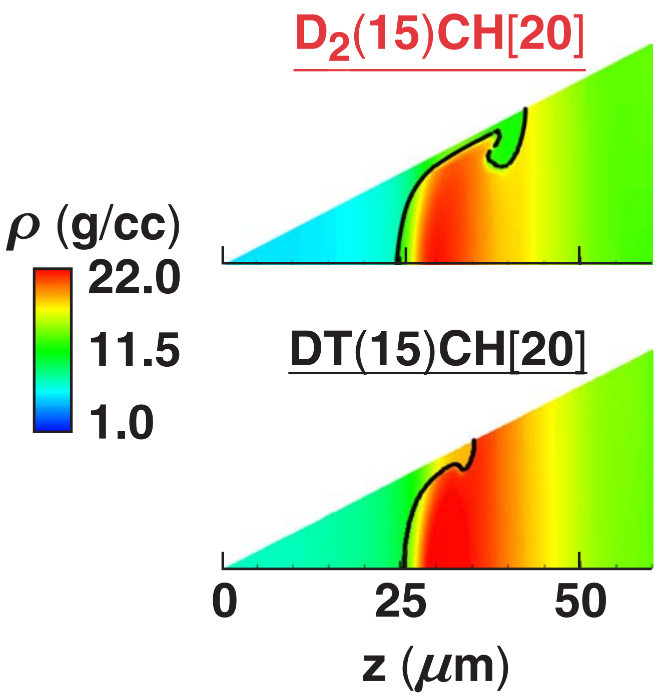
$A_T(D_2) = 0.18, \; A_T(DT) = 0.07$

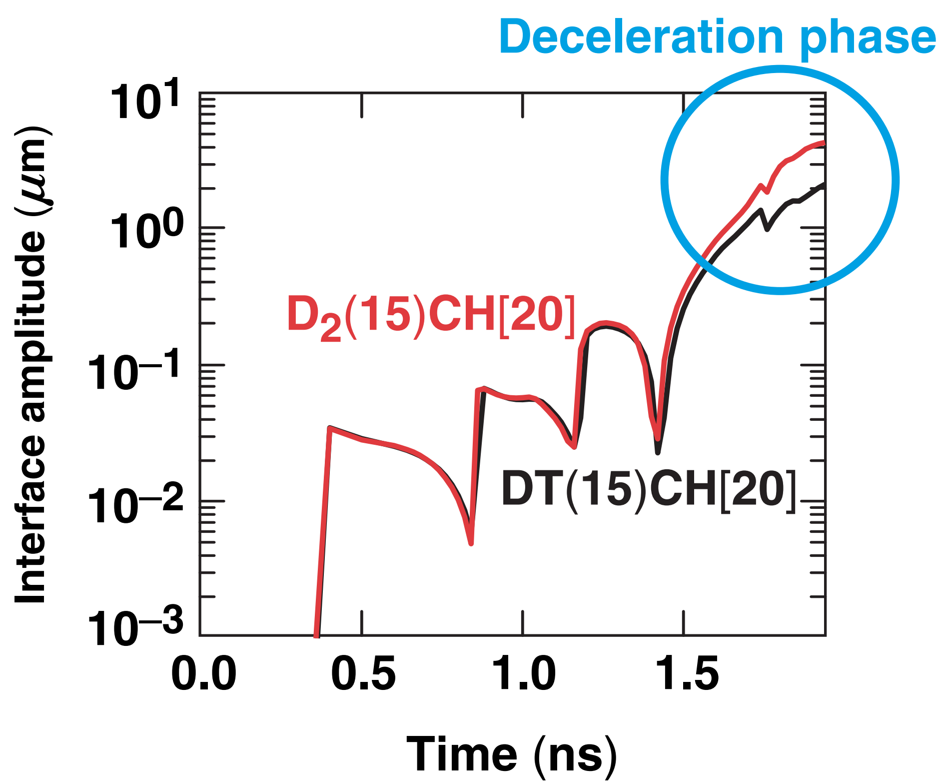
E14195

2-D hydrocode predictions show a less distorted fuel–shell interface for DT fills compared with D_2 fills

- Growth rate at fuel–shell interface $\gamma \sim \sqrt{A_T kg}$

2-D simulation with $\ell = 30$, 0.8% laser perturbation

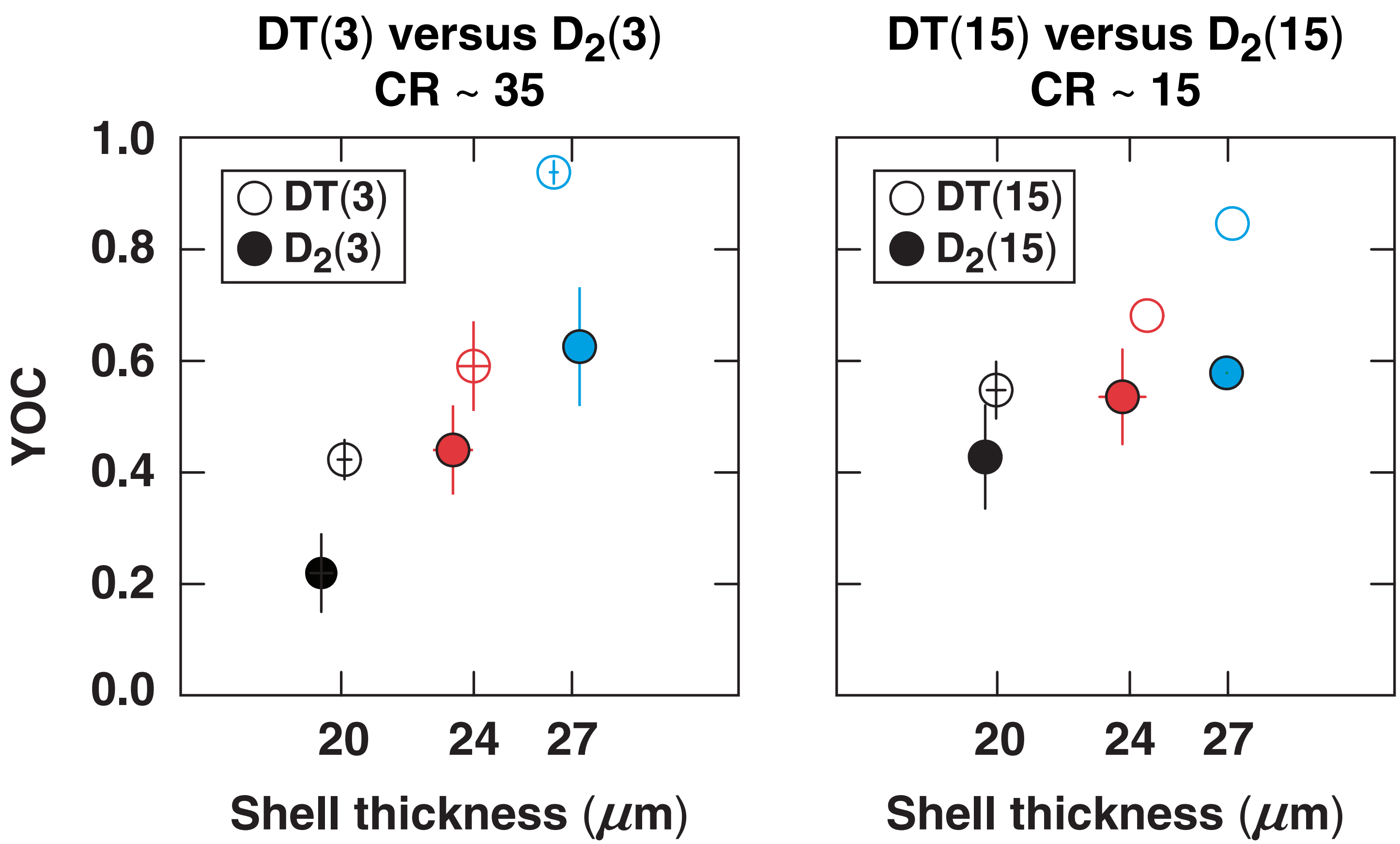




DT-filled implosions should provide higher YOC than D_2 fills.

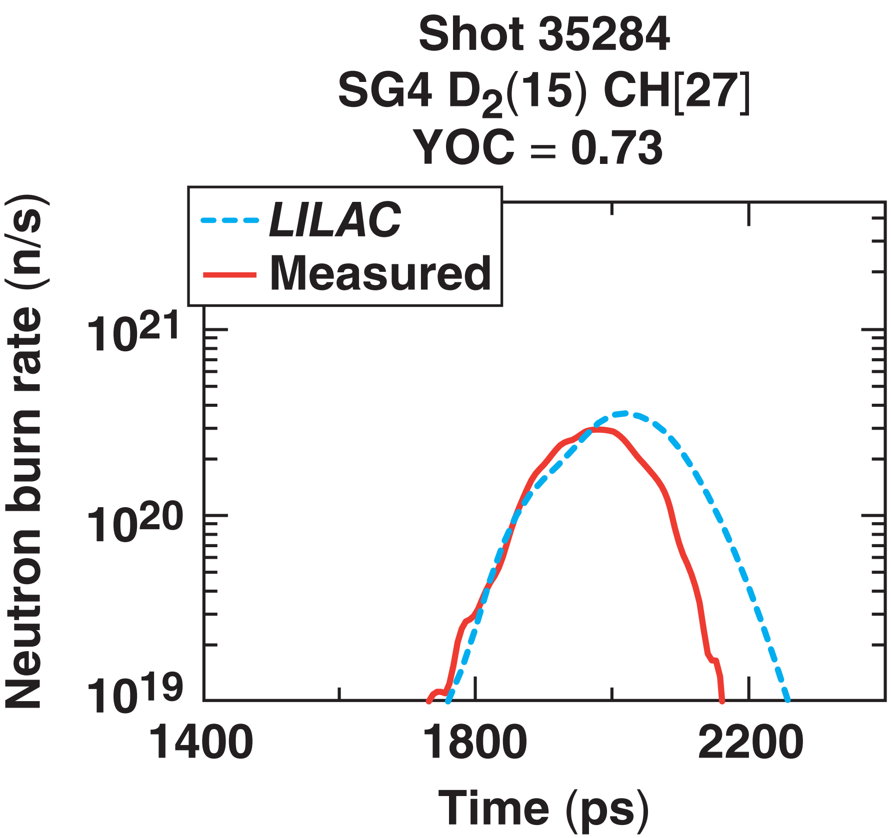
E14196

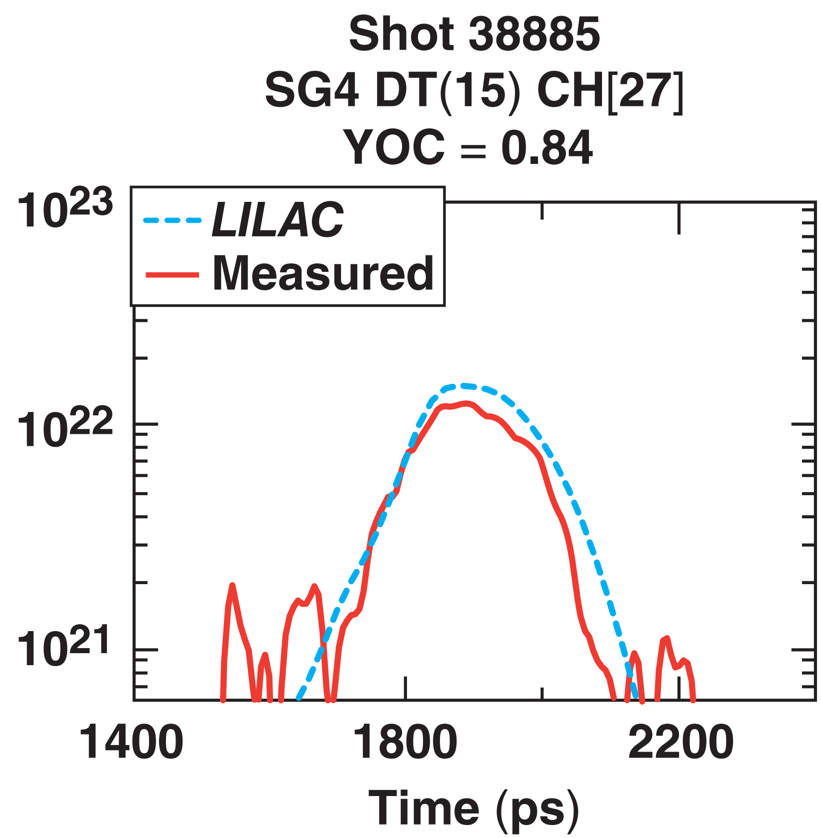
The YOC increased ~1.4× when the Atwood number at the fuel–shell interface was reduced by ~2×



E14197

The neutron burn rate is closer to the 1-D prediction for DT fills





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Summary/Conclusions

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J. P. Knauer FO3.007
P. B. Radha FO3.008

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